European
Climate Support
Network

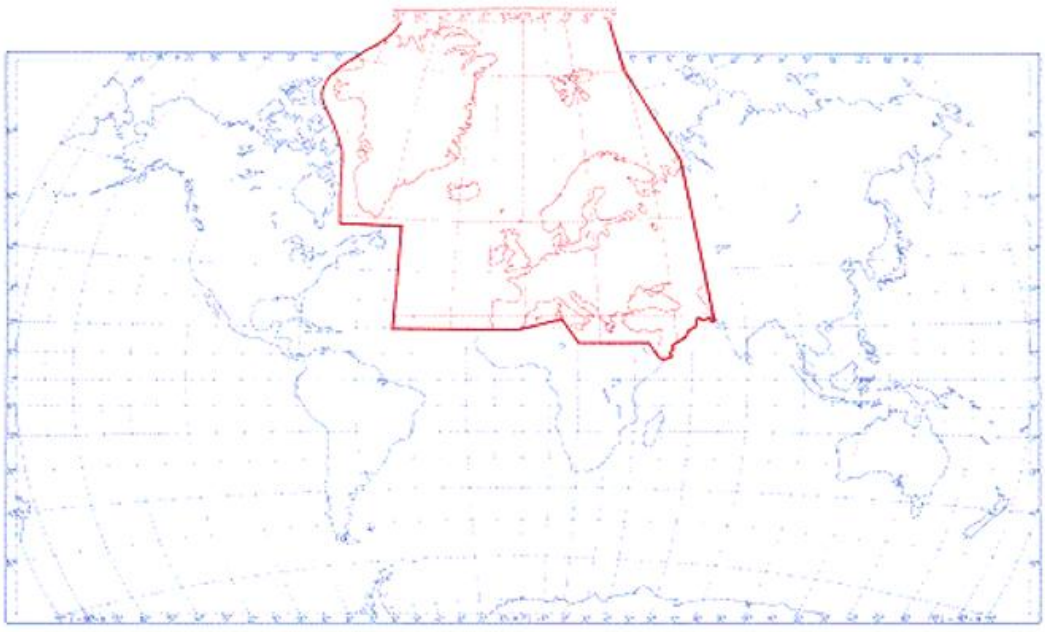
World Meteorological
Organization
World Climate Data
and Monitoring Programme

Deutscher
Wetterdienst

Annual Bulletin on the Climate in WMO Region VI

-Europe and Middle East-

1999



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Annual Bulletin on the Climate in WMO Region VI - Europe and Middle East - 1999

The bulletin is a summary of contributions
of the following national meteorological services
and was co-ordinated by Deutscher Wetterdienst, Germany,

Armenia
Austria
Belarus
Belgium
Bulgaria
Croatia
Cyprus
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Israel
Jordan
Kazakhstan
Latvia
Lithuania
Netherlands
Norway
Portugal
Russian Federation
Slovenia
Spain
Sweden
Switzerland
The Former Yugoslav Republic of Macedonia
Turkey
Ukraine
United Kingdom
Yugoslavia

Furthermore, contributions to the WMO Bulletin article on consequences of abnormal weather in 1999 were referred from the following countries:
Italy, Romania, Slovak Republic

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Foreword

In the year 2000 the Annual Bulletin on the Climate in WMO Region VI appears for the sixth time. Right after the start, dating back to 1995, it became obvious, that here a notable publication had been created, with great interest to a broad spectrum of users, ranging from scientists and National Services to economic and political decision makers.

On the other hand there is a growing number of contributing National Meteorological and Hydrological Services. About 80 % of the WMO member countries of the Region supported the latest editions and provided input. It is worth mentioning in this context that this time nearly all contributions were sent in on electronic media which considerably facilitated the further preparation of the publication and smoothes the way for the development of an Internet version.

With respect to conspicuous climatic events the year 1999 is noteworthy by all means. Catastrophic snow conditions and avalanches in the Alps in winter, severe inundation in Hungary, France and other parts in Central Europe caused heavy damage and losses. This is especially true for two disastrous storms in December, partly known as 'Anatol' and Lothar', one of which affected northern France, the North Sea and Denmark, whereas the other swept eastward over France, Switzerland and southern Germany. Information on these events and lots of other interesting analyses, tables, graphics and comments concerned with climate monitoring are contained in this edition of the Bulletin.

A special feature of the Bulletin is the chapter related to research activities in the region. The topics of the actual edition comprise the Climate of the 20th century in Sweden, the DWD Objective Weather Type Classification (OWTC), the solar eclipse effect on the surface temperature and humidity and the Satellite Application Facility (SAF) on Climate Monitoring.

When in January 2000 the ECSN (European Climate Support Network) - project "Generate Climate Monitoring Products" was launched it was decided to incorporate the Bulletin into this framework as a special sub-project thus broadening the basis for enhancing the fruitful European co-operation in the field of climatology.

I would like to thank all those who have contributed to the success of this remarkable publication. Above all, the participation of Sweden in the editorial review process and the co-ordination, publishing and distribution of the document by Germany were greatly appreciated.



Dr Iván Mersich
President of WMO RA VI

Outstanding Events and Anomalies in 1999

- Warmest year on record in many places with extremely high mean night-time temperatures.
- Wettest year of the century in southern Scandinavia.
- 1998/99 rainfall season driest on record in the Middle East.
- Heavy snowfalls bring deadly avalanches in the Alps in February.
- Sudden snow melt and heavy rains cause severe floods in Central Europe in spring.
- Very dry from December 1998 to August 1999 in Spain.
- Heat and drought cause high economic losses and engender numerous forest fires in European Russia and the Middle East in summer.
- Heavy rains cause several severe floods, esp. in and around Hungary in June/July.
- Warmest September on record in parts of Central Europe and Scandinavia.
- Catastrophic flooding in south-western France in November.
- Again very bad start of the rainy season in the Middle East in late 1999.
- Early winter in central Europe and the East in November.
- Series of fierce storms with high losses in Western and Central Europe at the end of the year.

Annual and seasonal survey:

1999 was another warm year, in many places warmer than 1998, which so far has been the globally warmest year on instrumental record (1860 – 1999).

The series of consecutive warmer years continued at many stations (e.g. in Macedonia with records since 1926, it was the 15th warm year in a row). Annual temperature anomalies (with respect to 1961 - 1990 normal) surpassed + 1 °C in most parts of the Region and up to + 2 °C in the Russian Federation. However, near the Barents Sea, slightly cooler temperatures than usual were recorded. The annual surface temperature anomaly percentiles exceeded 90 %. For many countries, it was the warmest or at least one of the warmest years on record (see figures 1 and 2). In Central England, 1999 became the warmest and equal with 1990 and 1949 in the 341-year record. For The Netherlands, 1999 equalled 1990, the warmest year since the start of regular measurements in 1706. A number of records illustrate, that the high annual means are caused by high night-time temperatures. e.g. the mean minimum Central England temperatures in 1999 were the warmest in the 122-year record (see figure 3). In Amman, a clear rise of the annual mean was due to the high daily minimum temperatures. Most months of the year showed positive night-time temperature anomalies (see figure 4), while maximum temperatures not were increased as much.

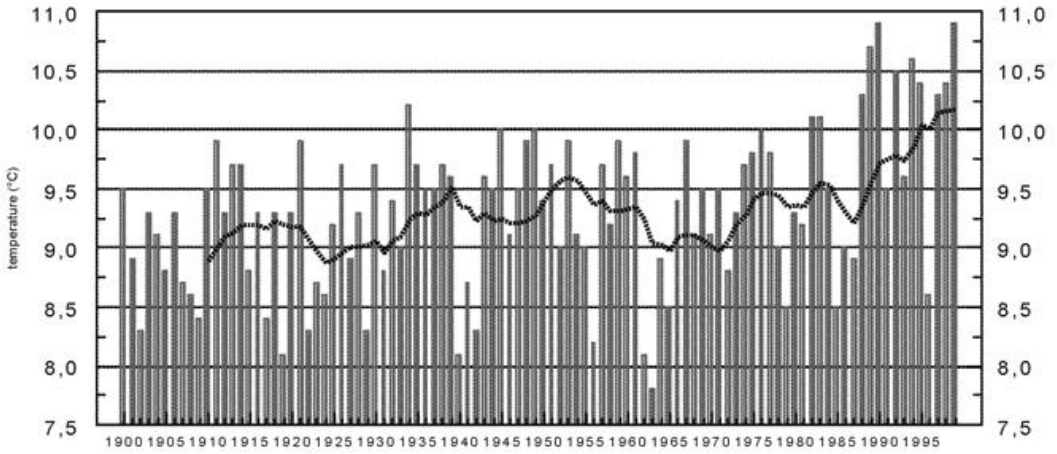


Fig. 1: *Annual mean temperatures and 10-year moving average in De Bilt, Netherlands, between 1900 and 1999*
From: KNMI, The Netherlands

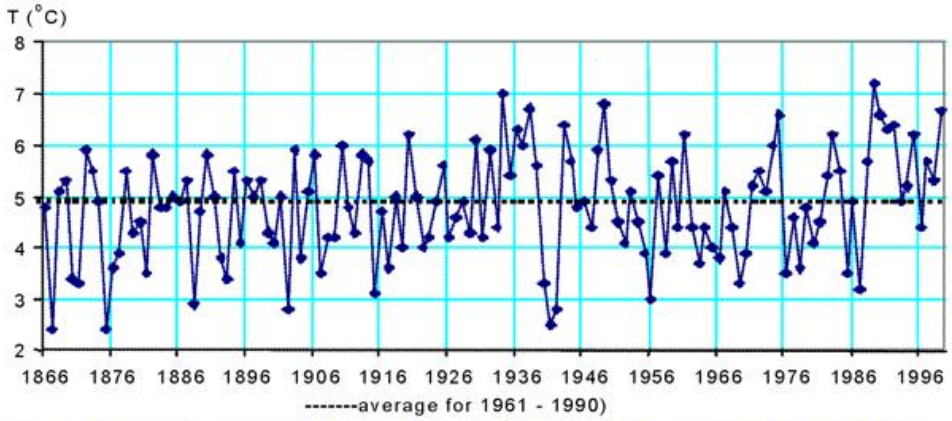


Fig. 2: *Annual mean temperatures in Tartu, Estonia, between 1866 and 1999*
From: Estonian Meteorological and Hydrological Institute

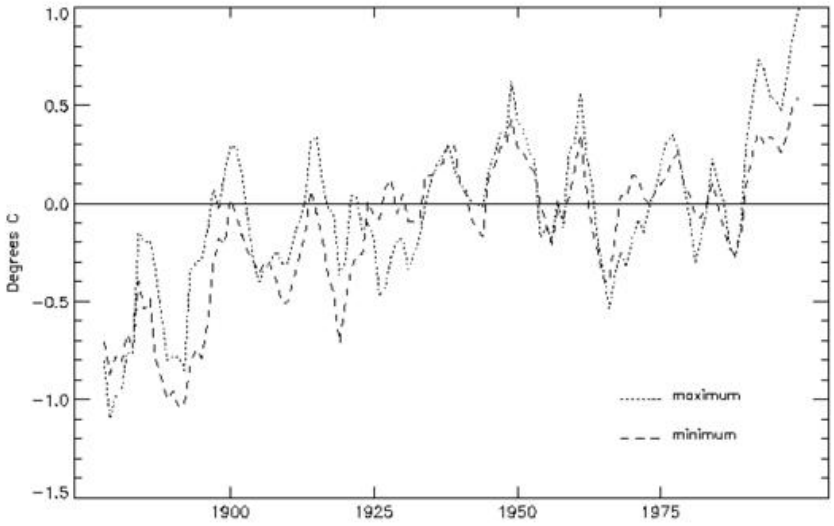


Fig. 3: *Annual Central England maximum and minimum air temperature anomalies (differences from 1961 - 1990) between 1878 and 1999*
From: Hadley Centre for Climate Prediction and Research, United Kingdom

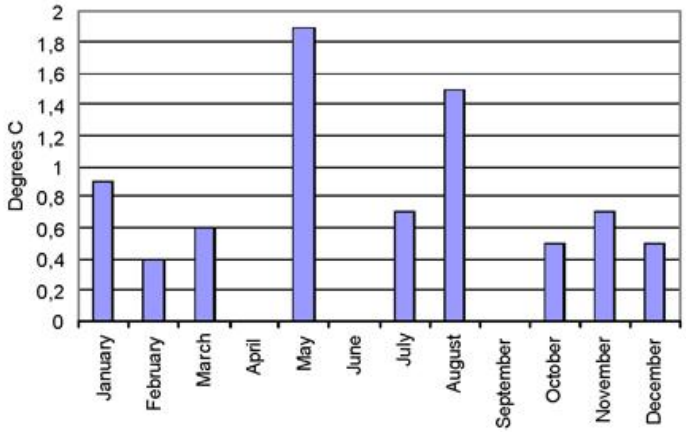


Fig. 4: *Mean monthly minimum temperature anomalies (differences from 1923 - 1997) in Amman, Jordan*
From: Meteorological Department, H. K. of Jordan

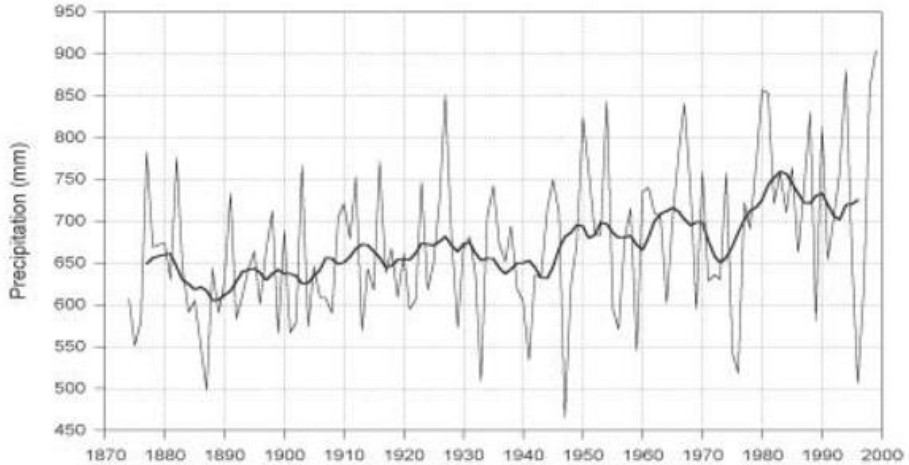


Fig. 5: ***Annual precipitation totals in Denmark between 1874 and 1999***
From: The Danish Meteorological Institute

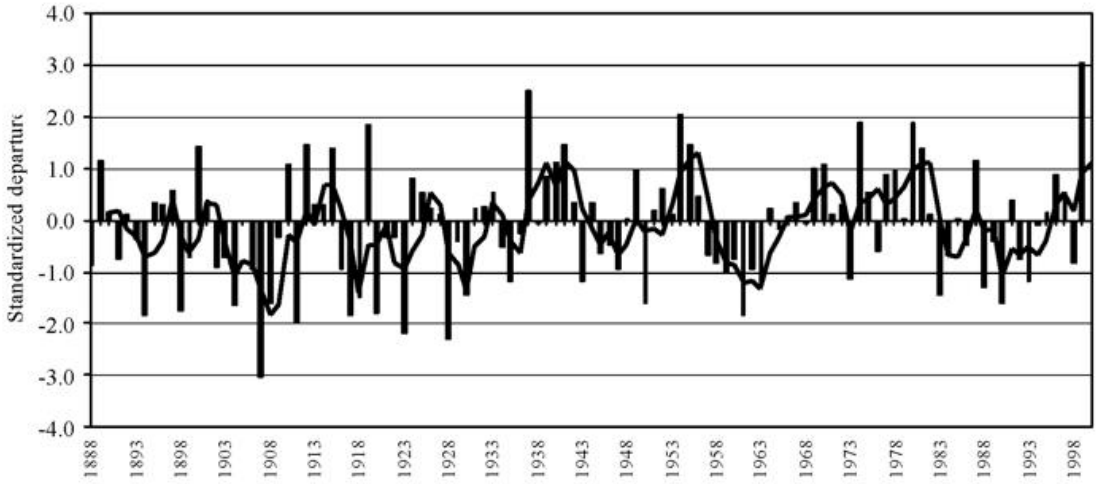


Fig. 6: *Standardised departures of annual precipitation totals from the 1961 - 1990 normal in Belgrade, FR Yugoslavia*
From: Federal Hydrometeorological Institute, Yugoslavia

The distribution of precipitation varied throughout the Region. Western Europe, southern Scandinavia, the Alps and most countries on the Balkans experienced a wet year. For Denmark and parts of the Federal Republic in Yugoslavia, it was the wettest calendar year in the history of registrations since 1874 respectively 1888 (see figures 5 and 6). However in Denmark, it was at the same time the 4th sunniest year since 1920, a rare combination which was also reported from other countries (e.g. The Netherlands). Heavy snowfall, downpours of rain, thunderstorms and hail inflicted massive economic and human distress in large parts of the Region. It was extremely wet in Hungary. There was almost continuous flooding and annual precipitation totals exceeded 200 % of normal.

Dry conditions prevailed in the southern parts of the Region. In Spain, precipitation was rare in the first half of the year with a considerable deficit in the southern half of the mainland. The situation was critical towards the end of August. However, intense rainfalls in autumn, improved the situation. In the Southeast of Spain and on the Balearic Islands, the year ended with less than 50 % of normal rainfall. Cyprus experienced the 5th consecutive year with below normal precipitation. An annual total of 321,6 mm (64 % of normal) had serious effects on the economy and the natural environment (see figure 6.3, page 34). The long-lasting dryness in the Middle East intensified during the year with very low water levels reported from Syria, Israel and Jordan (see figure 1.1, page 27). Crop development in the growing season was seriously affected by an intensive and prolonged drought in Finland, Belarus, Ukraine and in large parts of the Russian Federation.

Fierce storms battered Europe at the end of the year, avalanche catastrophes hit in February and a high number of floods occurred making 1999, a year of severe weather related disasters. In Switzerland, the total amount of damage is estimated at 4 billion CHF, thus considerably higher than the previous record of 1,2 billion CHF for the year 1987 (inflation taken into account). The monthly means of the Atlantic-European zonal index for the latitude belt 35 - 65°N for the 20 - 40°E region, as a measure of the intensity of the circulation, illustrate very well the outstanding zonality in December (see figure 7).

The Venetian lagoon was affected in 1999 by 15 days of water levels of more than 100 cm above mean sea level triggering inundation in vast parts of Venice.

The annul mean of total stratospheric ozone at Hohenpeissenberg, Germany, was slightly decreased (321 DU compared to a 32-year mean of 329 DU), (see figure 8). Individual periods of the year, however, show large variations. Thus, at the end of November/beginning of December, new all-time minimum values were recorded over wide parts of western and central Europe.

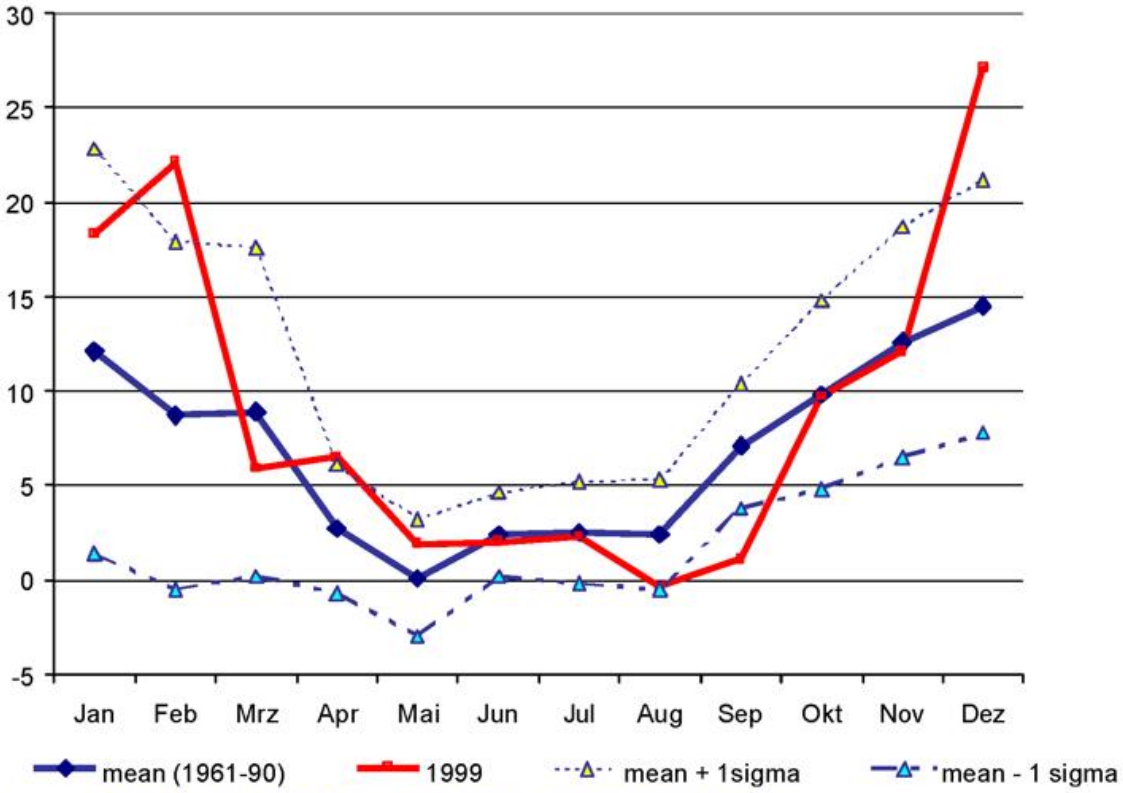


Fig. 7: *Monthly values of the Atlantic –European zonal index:*
1999 values, 1961 - 1990 means and means +/- 1 standard deviation
Latitude belt 35 - 65°N between 20°W - 40°E
From: Deutscher Wetterdienst, Germany

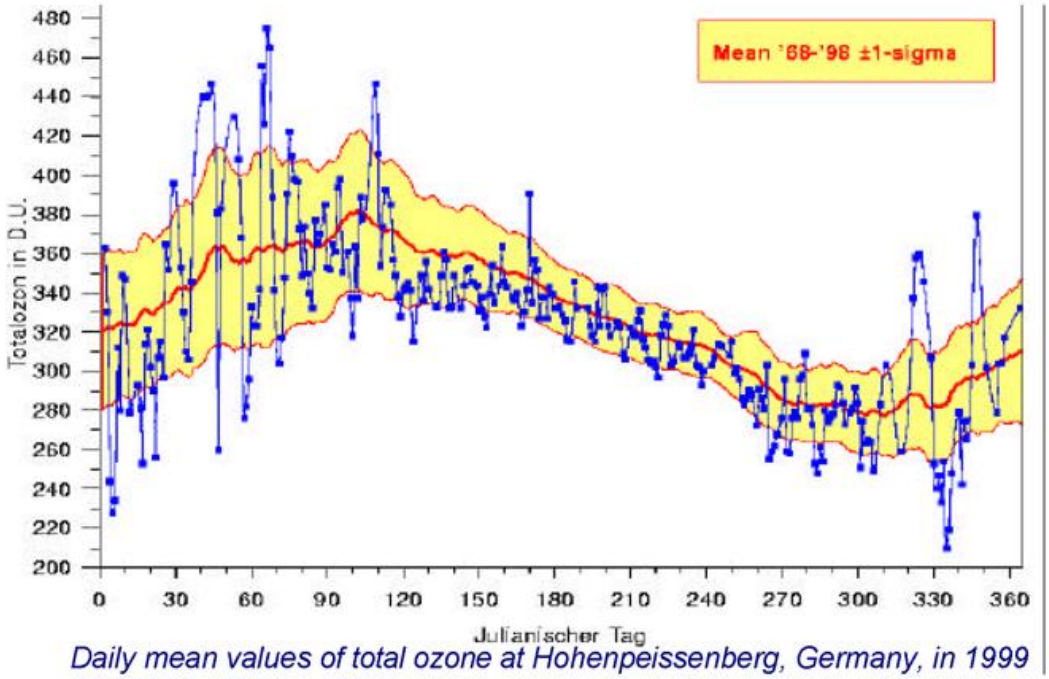


Fig. 8: *Daily mean values of total ozone at Hohenpeissenberg, Germany, in 1999 and 1968 - 1998 means*
From: Deutscher Wetterdienst, Germany

Though the 1998/99 **winter** season was mostly mild all in all (see figures page 14), out-standing wintry periods occurred. A cold wave in late January brought some of the coldest temperatures experienced since the late 1800s in northern Fennoscandia and the western parts of the Russian Federation. In February, colder than normal temperatures in much of Europe were accompanied by extremely heavy snowfalls. In the Alps, more than 60 people were killed in avalanches. Heavy snowfall disrupted communications, power supply and transportation in central Europe.

It was very warm in the Southeast (see figure 9) where temperature anomalies surpassed the 98 % percentile of the 1961 - 1990 normal. Dry conditions prevailed in the South (see figure page 18, above, figures 1.1 and 1.2, page 27). In the whole country of Israel, the 1998/99 rainfall season was, together with 1950/51, the driest recorded in the last 60 years.

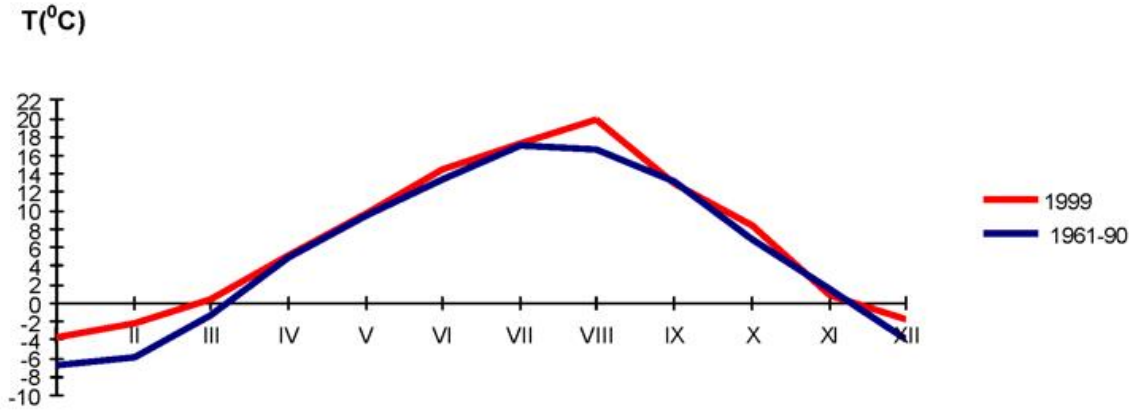


Fig. 9: *Mean monthly temperatures in Armenia*
Administration of Hydrometeorology, Armenia

Spring was wet and very mild in most areas (see figures page 15 and page 18, below). An early warm spring was followed by an extremely frosty period in May. In the East, this caused high losses to crops and plants. Spain experienced a very warm spring and early summer with an outstanding warm May (see figure 10).

Dry weather conditions continued to prevail in the South and East. The mild weather caused sudden ice and snow melt building up ice jams and with heavy rains this led to a number of severe floods. Latvia and Hungary reported high water levels in March and Lake Constance reached its highest level since 1858 in May. For Tyrol, Austria, it was the wettest spring in the last 50 years.

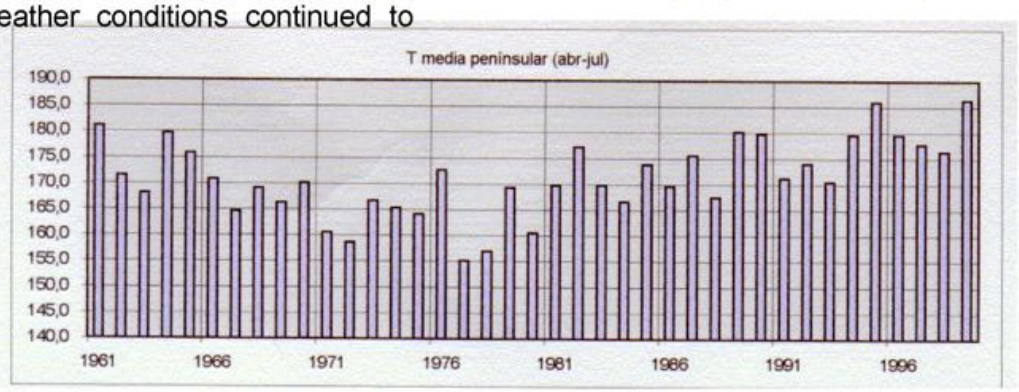


Fig. 10: *Mean temperatures (in 1/10 °C) for the April - July period on the mainland of Spain between 1961 and 1999*
From: Instituto National de Meteorología, Spain

Dry weather that had already prevailed in May in eastern Europe and the Middle East intensified from June to August making the **summer** season of 1999 one of the driest ever in those regions. It was at the same time extremely hot (see figure 7.1, page 35, and figures 9 and 11 - 13). Anomaly percentiles of the temperatures exceeded 98 % in many countries (see figures page 16). In some places in Latvia, it was the warmest summer on record. Heat and drought caused high agricultural losses and engendered numerous forest fires. Israel reported one of the hottest summers, although it was not as hot as in 1998 (see figure 13).

Frequent thunderstorms, gusts and hail caused flooding and much damage in the Region. Heavy rains and severe floods affected Hungary, Romania and the Slovak Republic in June and July (see figure 14, page 13). Large land areas were flooded, buildings collapsed and thousands of people had to be evacuated. In Hrubarnov, south Slovakia, June - July 1999 was warmest on record (since 1881). On Zugspitze, Germany, at nearly 3000 m altitude, the heavy snow falls during winter and spring led to a permanent snow cover at this station all year around for the first time since 1984.

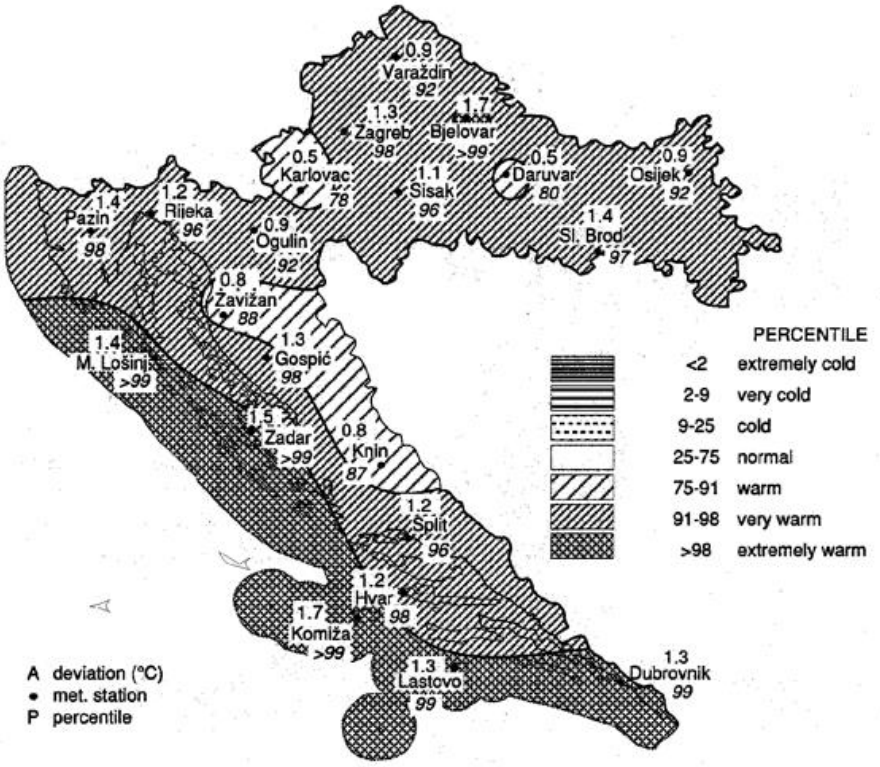


Fig. 12: *Percentiles of temperature anomalies in the summer season in Croatia (reference period 1961 - 1990)*
From: Meteorological and Hydrological Service, Croatia

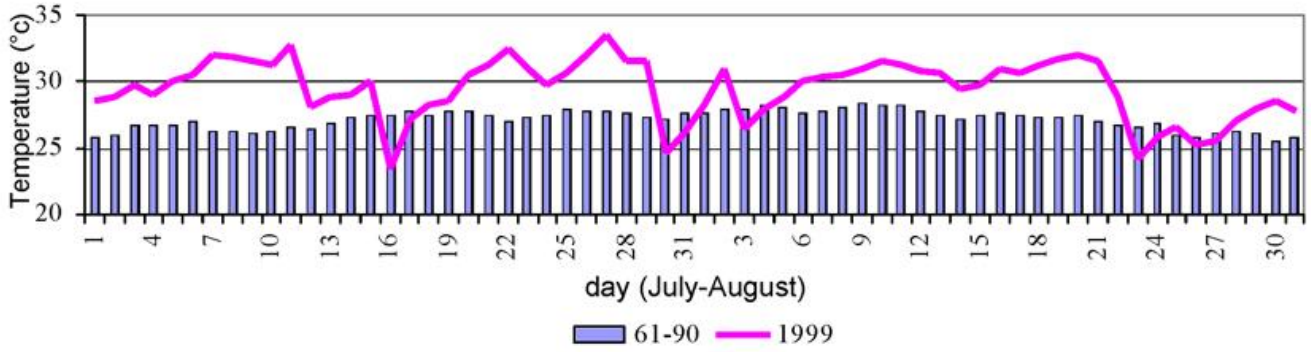


Fig. 12: *Daily maximum temperatures in Varna in July and August*
From: Bulgarian National Institute for Meteorology and Hydrology

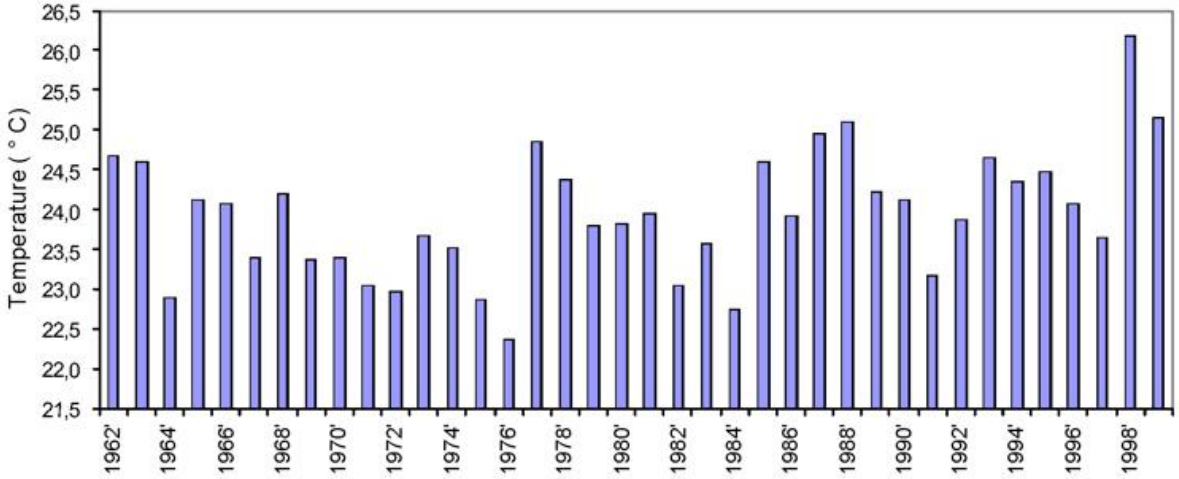


Fig. 13: *Mean daily temperatures in Bet Dagan for the July/August period between 1962 and 1999*
From: Israel Meteorological Service

Autumn was extremely mild from the British Isles to Northern Scandinavia as well as in the Mediterranean region (see figures page 17). For Norway, it was one of the warmest autumns of the century. Record warm temperatures prevailed also in Germany. In some parts of this country, September was the warmest month of the year. An early cold snap extended from Spain to Russia in November. Dry weather predominated in the East and Southeast of the Region. Summer drought in eastern Ukraine turned into autumn drought and still increased until the middle of October. Regionally, there was hardly any precipitation at all for 20 to 45 days, which is extremely rare. Plenty of rains brought relief after the long-lasting drought in most parts of the Iberian Peninsula. There was a number of severe floods, among those, an outstanding flood in southern France in November. The rainfall season in the Middle East started dry (see figure 15). North and Central Israel received only 20 - 40 % of the long-term average and the southern parts of the country less than 10 %. This made it one of the worst starts of the rainy season and similar to the same period of the previous year.

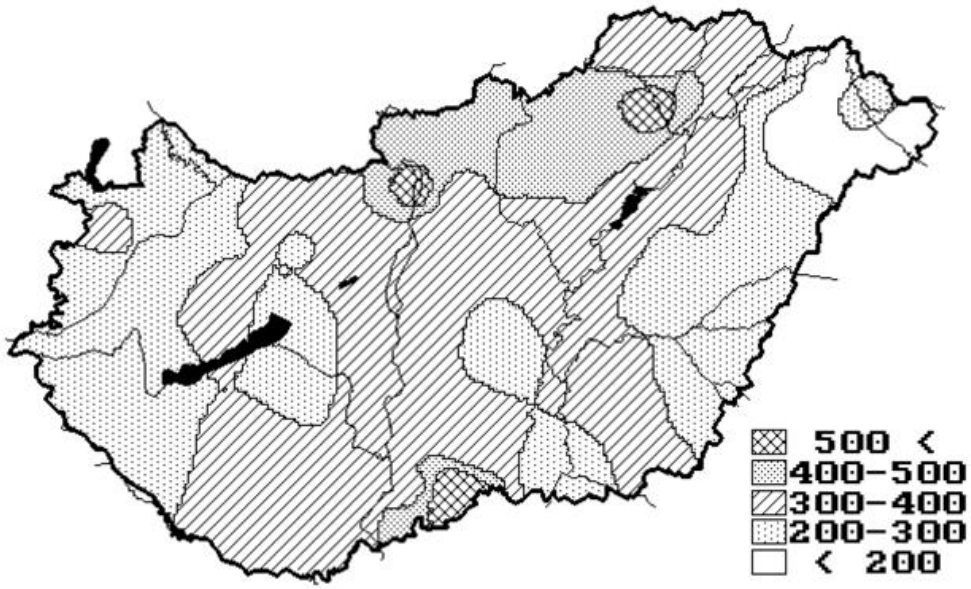


Fig. 14: *Precipitation totals (in mm) of the summer season in Hungary in 1999*
From: Meteorological Service of the Republic of Hungary

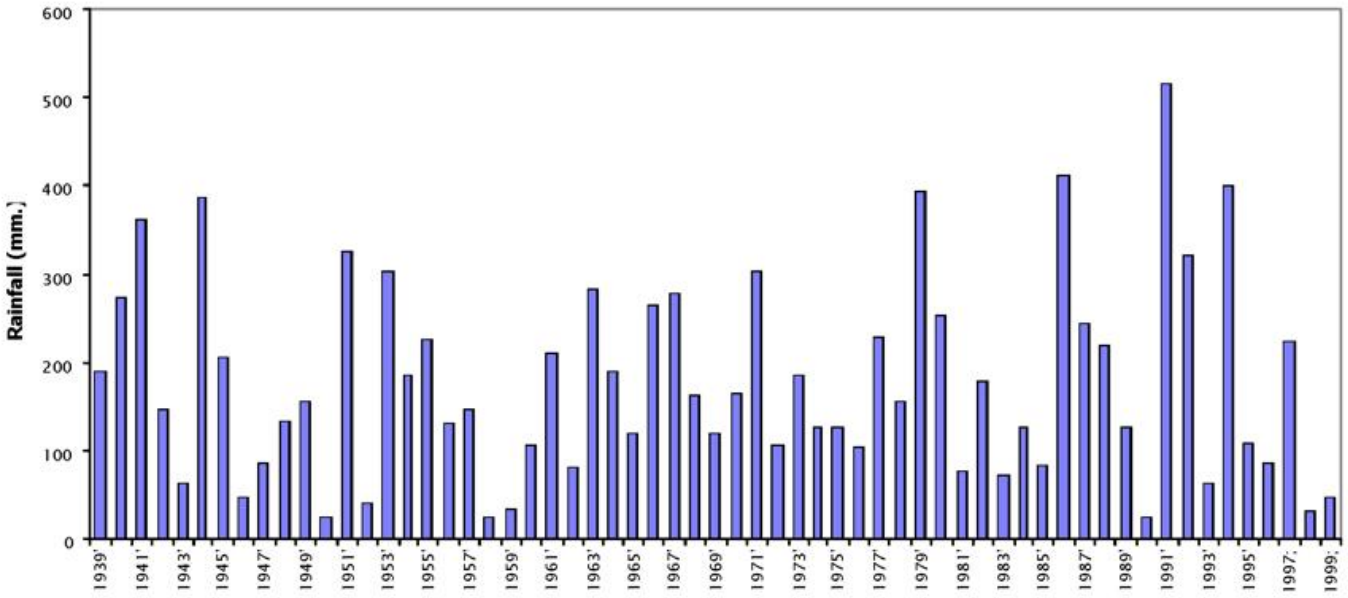
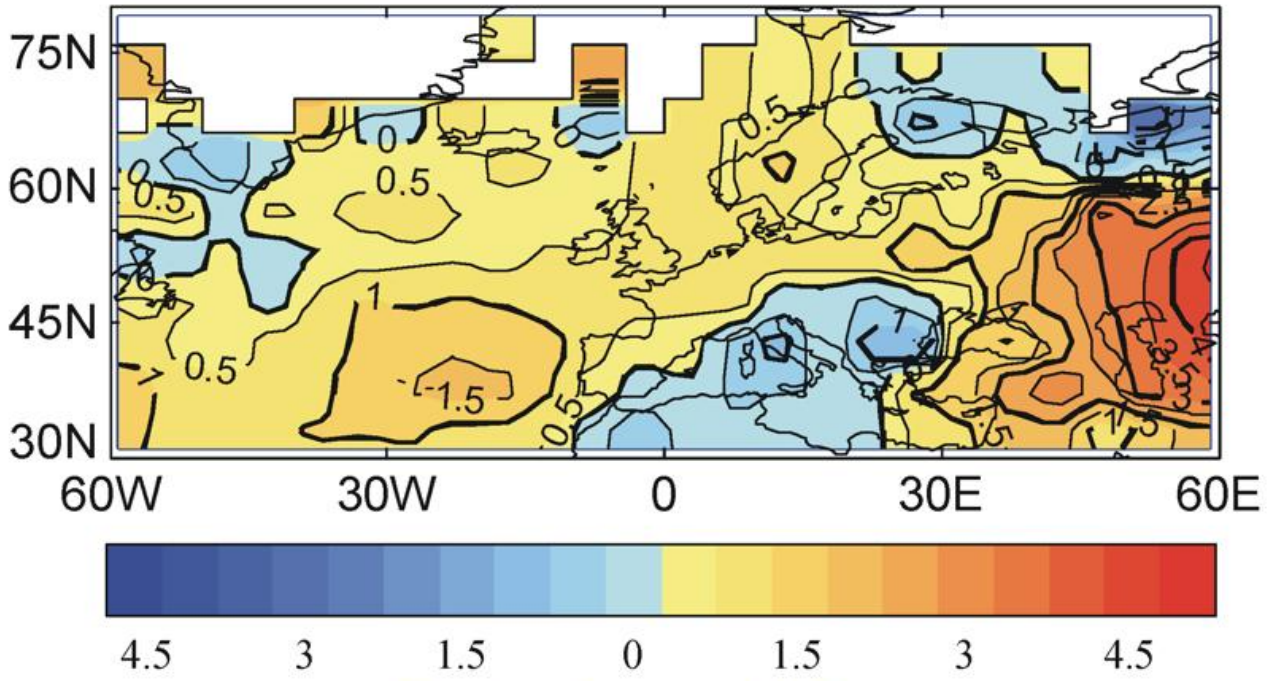


Fig. 15: *September - December rainfall totals in Jerusalem between 1939 and 1999*
From: Israel Meteorological Service

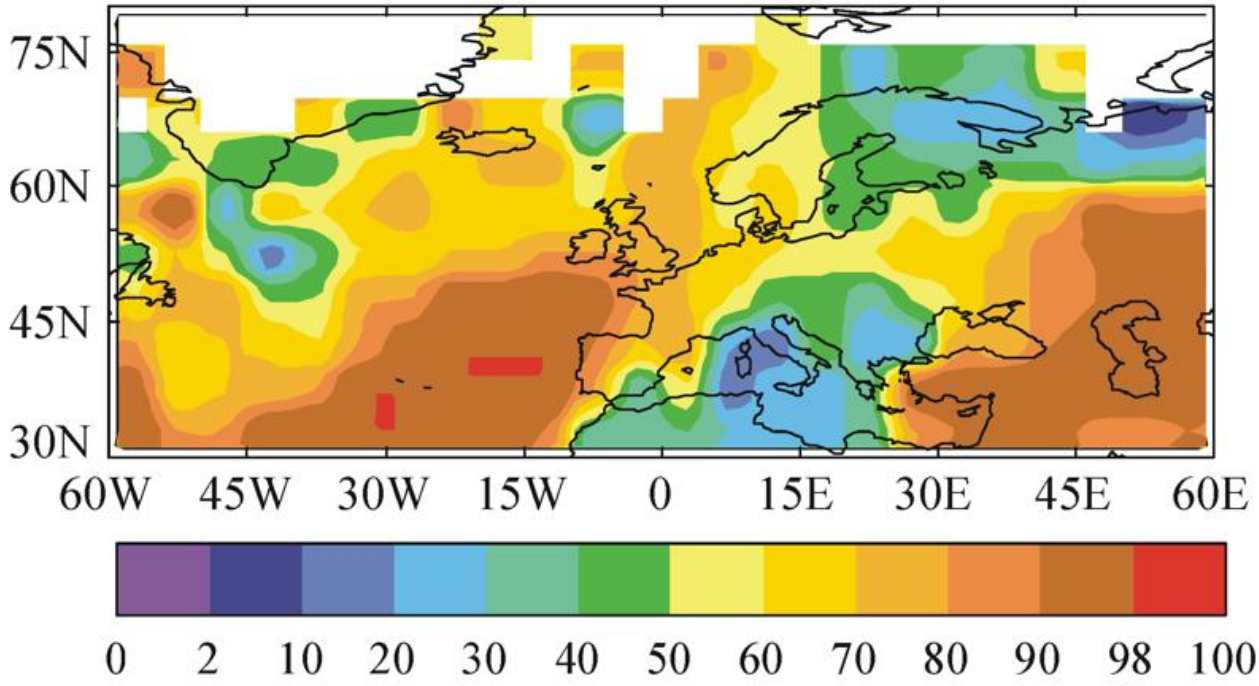
Seasonal Maps

Surface temperature anomalies: December 1998 - February 1999

From: Hadley Centre of Climate Prediction and Research



Departures from normal in °C

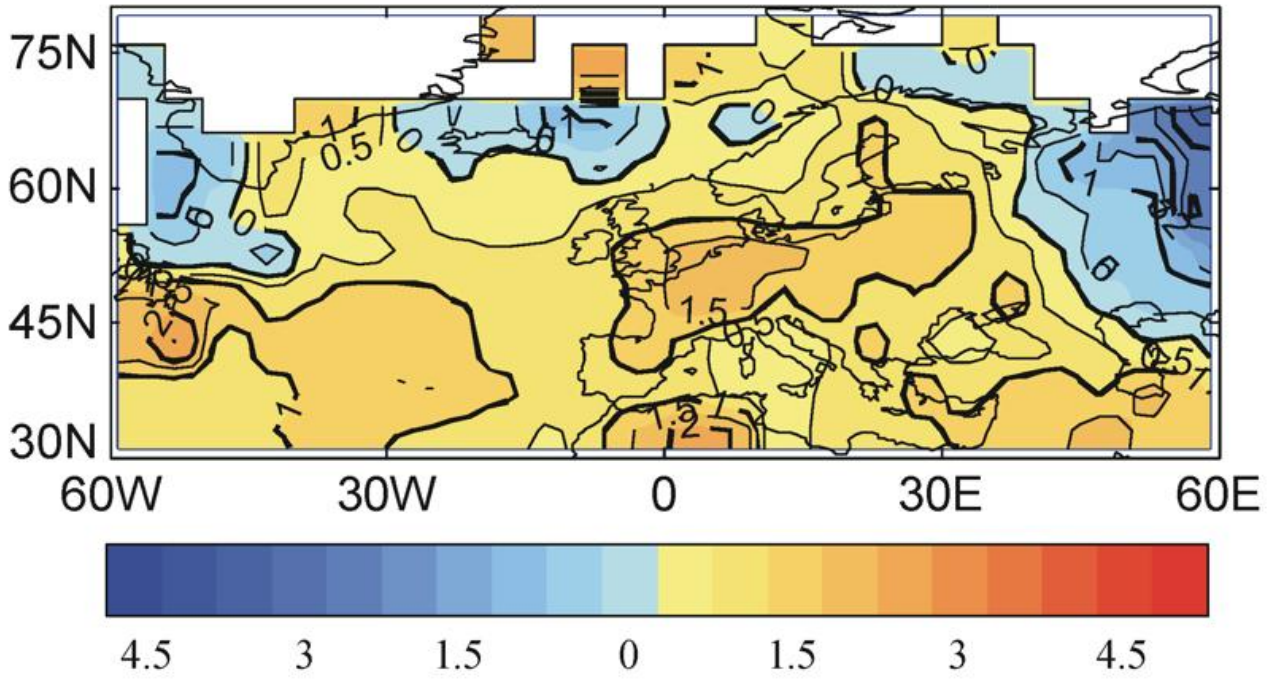


Percentiles (anomalies fitted to gamma distribution)

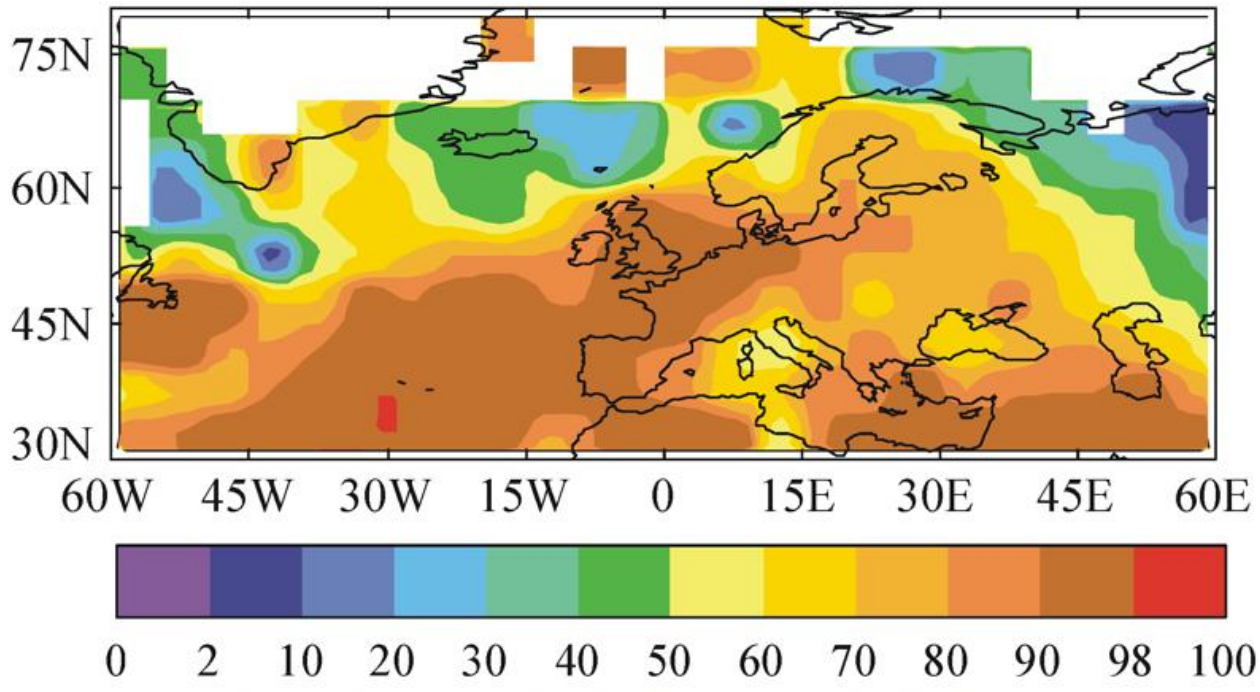
Reference period: 1961 – 1990

Surface temperature anomalies: March 1999 - May 1999

From: Hadley Centre of Climate Prediction and Research



Departures from normal in °C

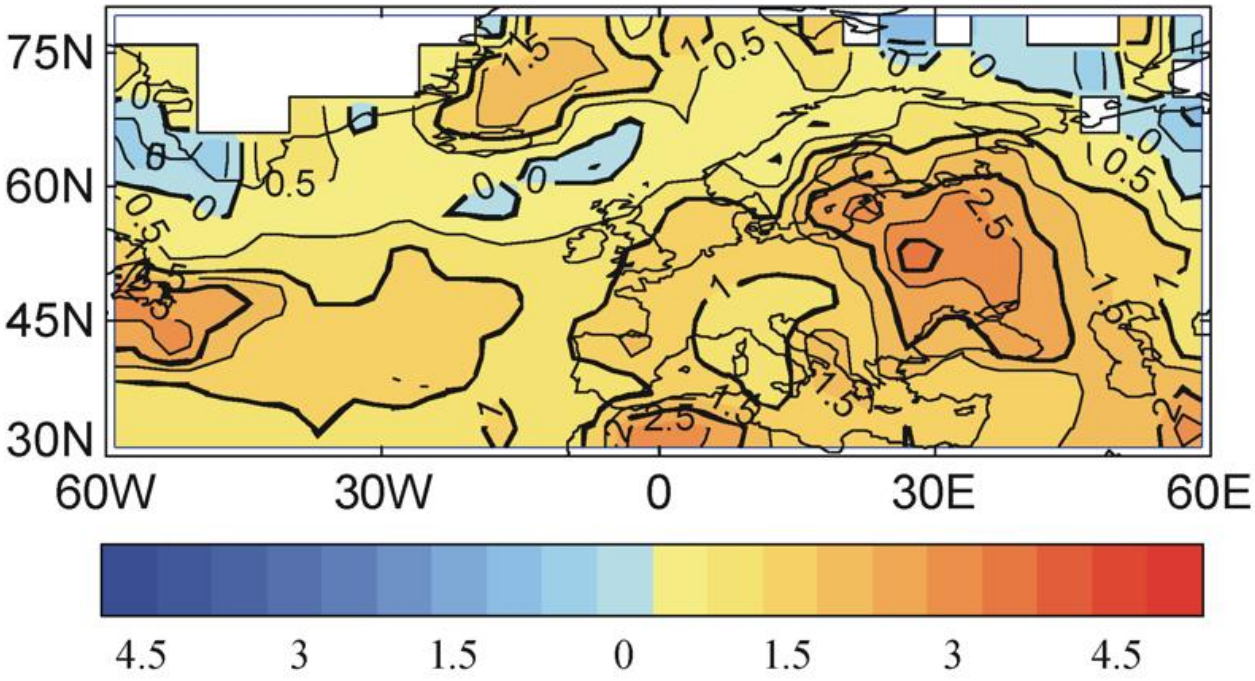


Percentiles (anomalies fitted to gamma distribution)

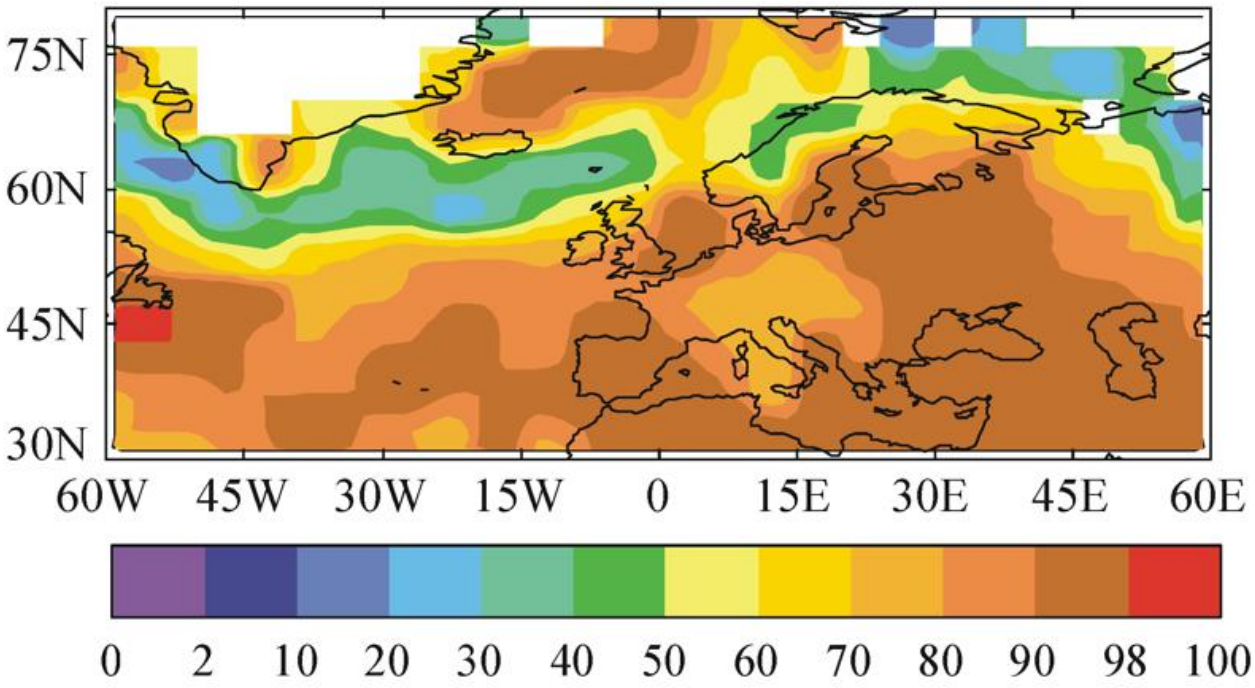
Reference period: 1961 - 1990

Surface temperature anomalies: June 1999 - August 1999

From: Hadley Centre of Climate Prediction and Research



Departures from normal in °C

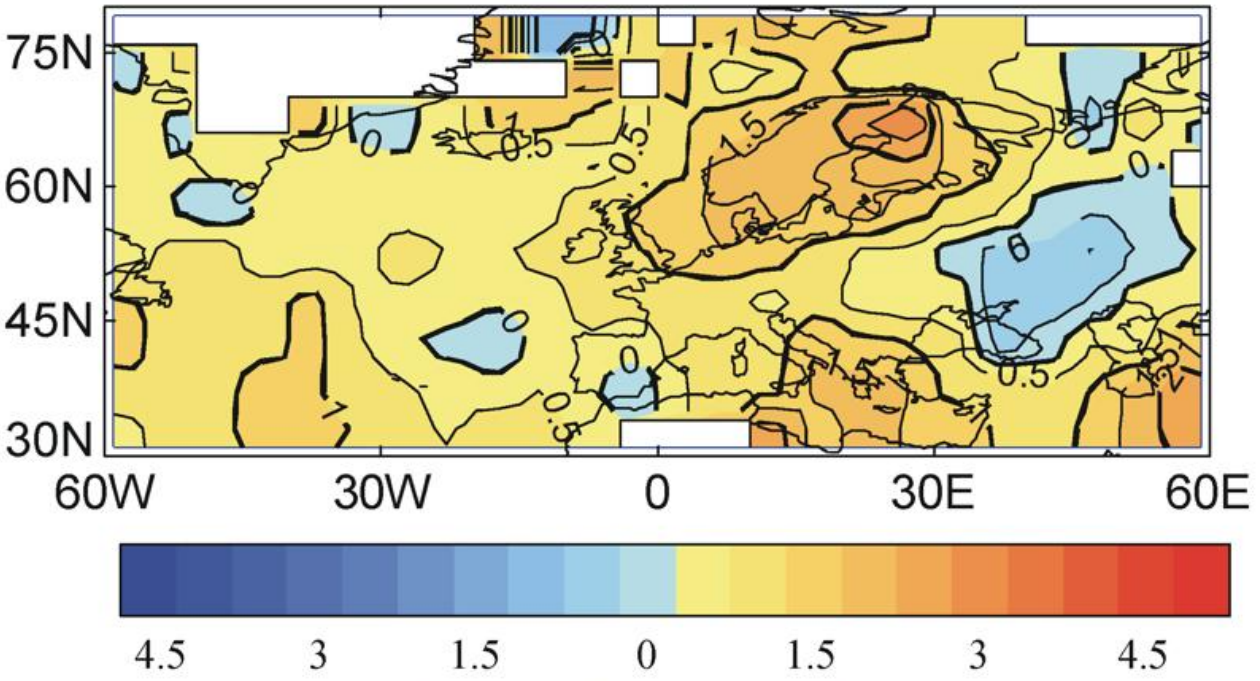


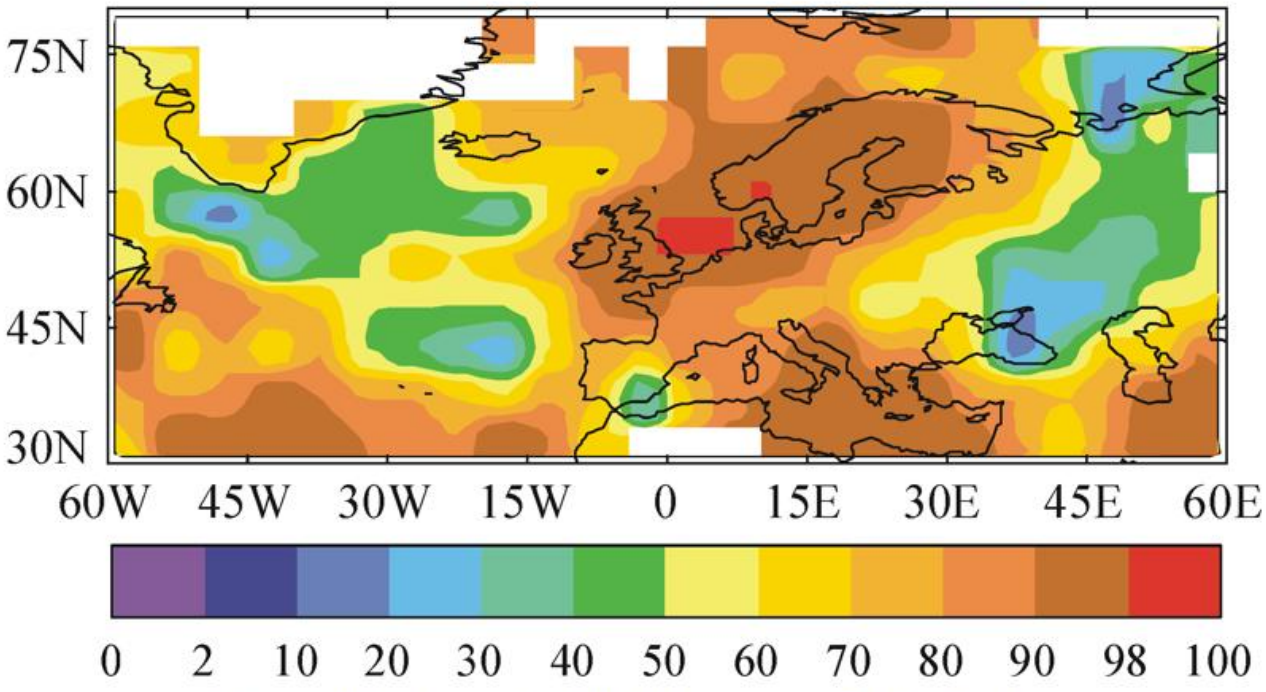
Percentiles (anomalies fitted to gamma distribution)

Reference period: 1961 – 1990

Surface temperature anomalies: September 1999 - November 1999

From: Hadley Centre of Climate Prediction and Research





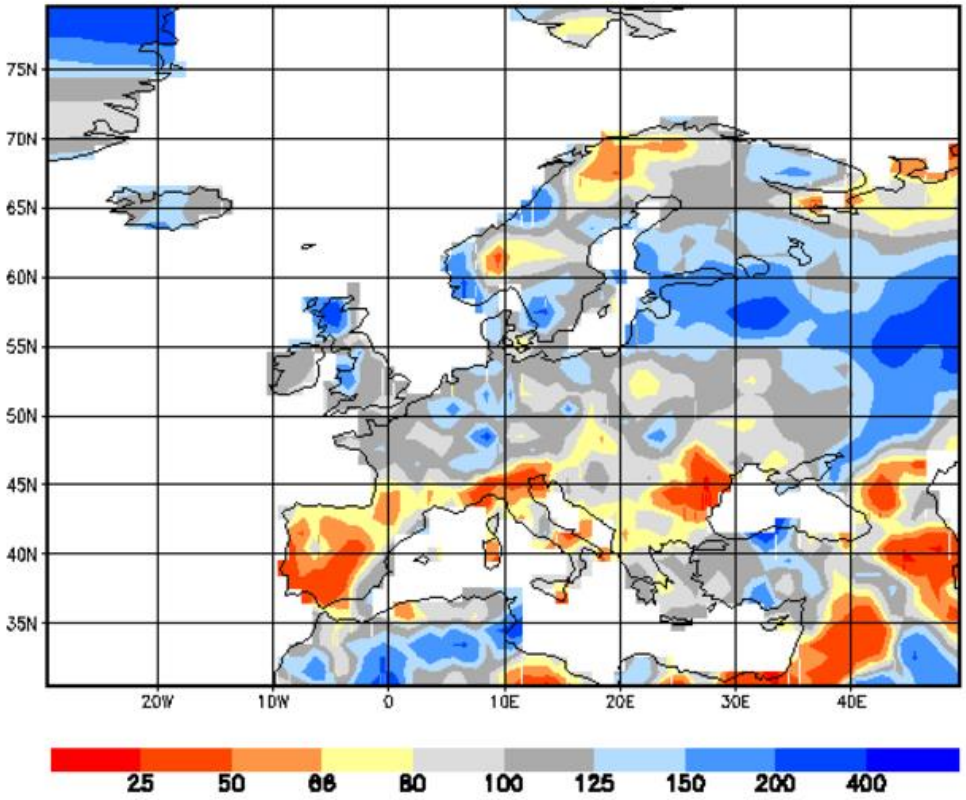
Reference period: 1961-1990

Precipitation in percentage of normal

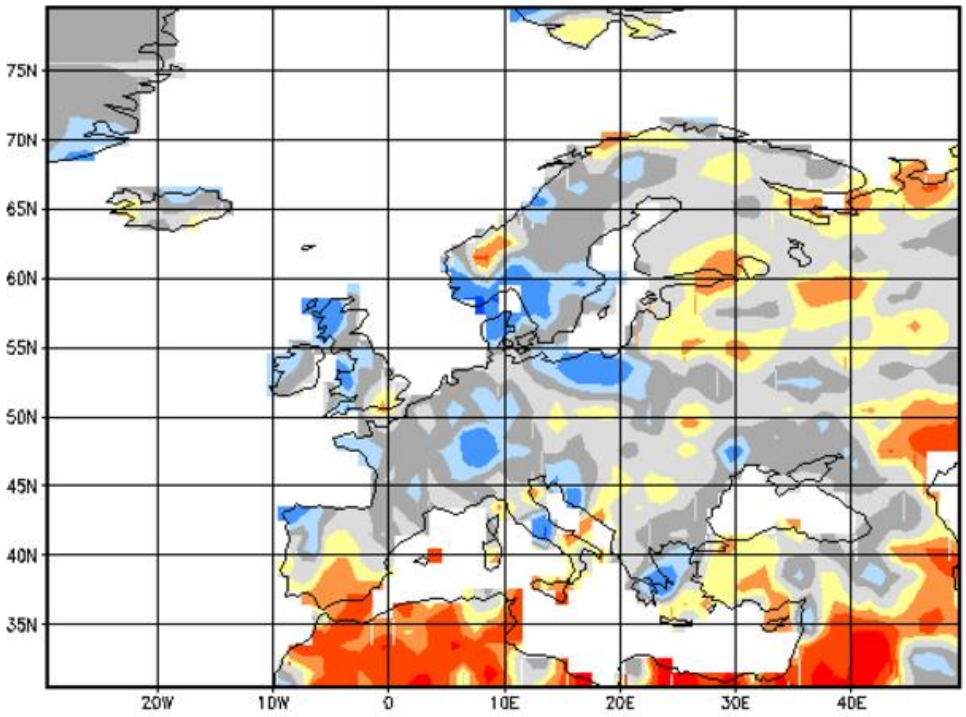
Gauge-Based Analysis 1.0 degree, reference period: 1961-1990

From: Deutscher Wetterdienst / GPCC

December 1998 - February 1999



March 1999 - May 1999

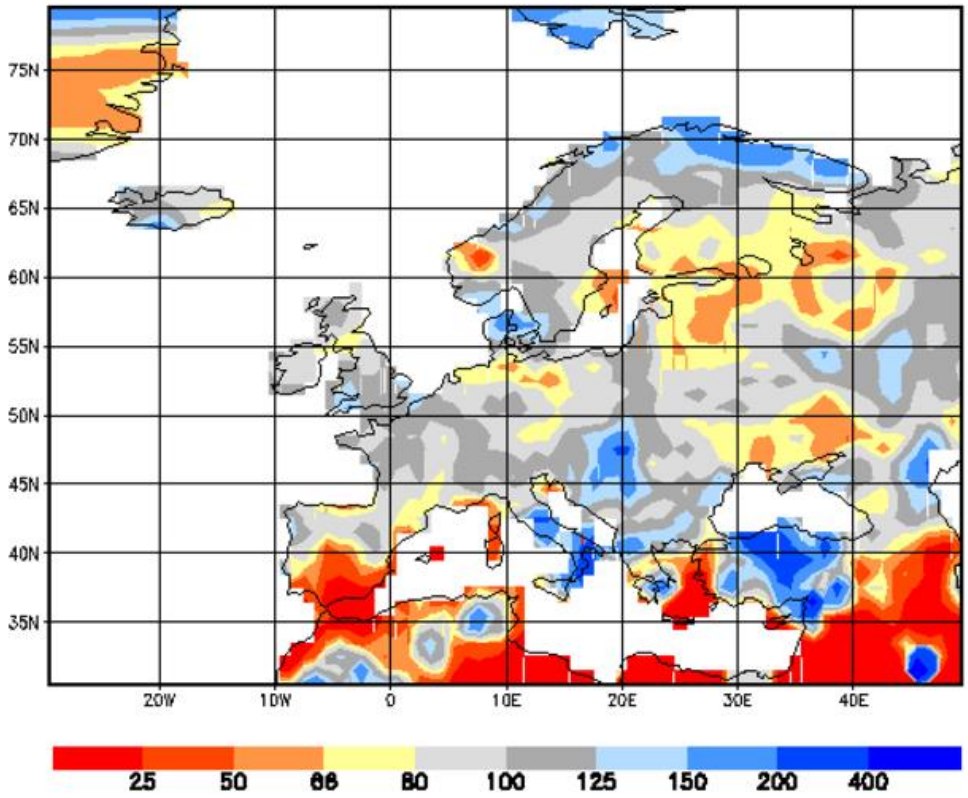


Precipitation in percentage of normal

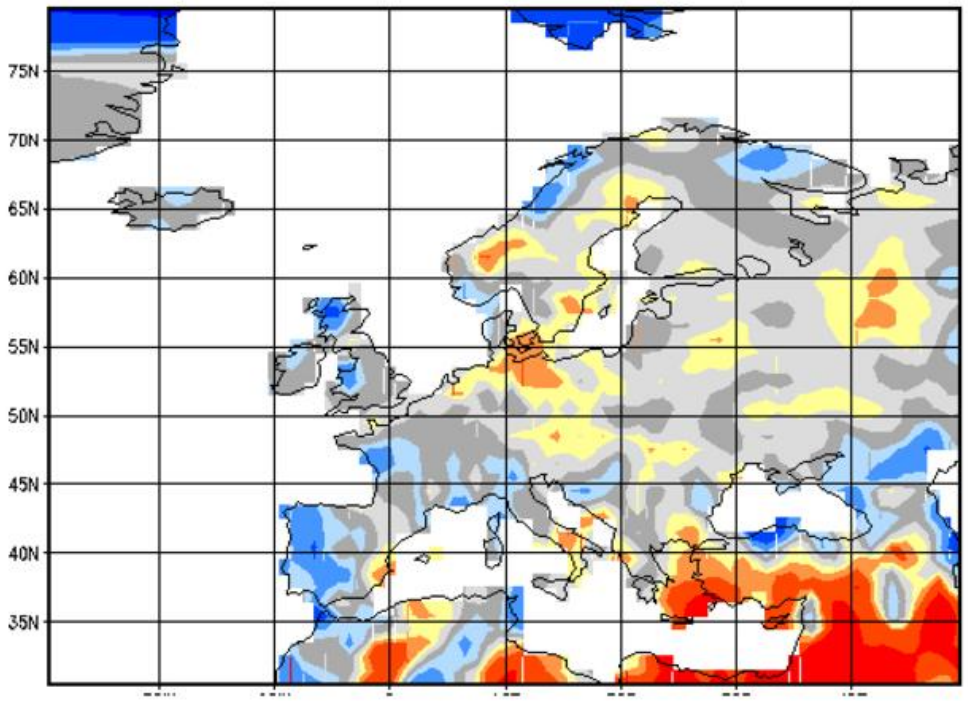
Gauge-Based Analysis 1.0 degree, reference period: 1961-1990

From: Deutscher Wetterdienst / GPCC

June 1999 - August 1999



September 1999 - November 1999



Monthly and Annual Tables

Temperature and precipitation values with departures from their 1961-1990 means

WMO No.	Station	January 1999 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	February 1999 Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	Svalbard	-10.0	5.4	6	-8	-12.8	2.9	2	-17
01025	Tromsø	-3.2	0.8	61	-20	-3.9	-0.2	50	-36
01492	Oslo-Blindern	-2.2	2.1	92	43	-2.4	1.6	36	0
02196	Haparanda	-13.1	-1.0	61	17	-11.3	0.0	46	14
02485	Stockholm	-1.2	1.6	48	9	-1.6	1.4	30	3
02974	Helsinki-Vantaa	-5.9	1.0	49	8	-7.2	-0.4	63	32
03091	Aberdeen	4.2	1.3	50	-30	3.4	0.3	51	-1
03772	London-Heathrow	6.6	2.4	69	17	6.0	1.5	21	-14
03967	Dublin (Casement)	5.5	1.1	87	21	5.8	1.4	35	-16
04030	Reykjavik	0.1	0.6	78	2	-1.3	-1.7	83	12
04320	Danmarkshavn	-24.1	-1.0	27	16	-21.2	3.1	48	37
04360	Angmagssalik	-6.2	1.3	71	-41	-8.1	-0.4	61	-30
06186	København-Landb.	2.2	1.7	48	-3	0.9	0.4	30	-1
06260	De Bilt	5.2	3.0	96	30	3.1	0.6	70	21
06447	Uccle	5.4	2.8	124	57	3.1	-0.4	76	23
06590	Luxembourg	2.9	2.7	54	-17	1.2	-0.2	49	-11
06660	Zürich	2.1	2.2	54	-16	-0.4	-1.3	176	103
06700	Genève	2.6	1.9	58	-22	1.7	-0.3	109	28
07510	Bordeaux	7.5	1.7	69	-31	6.9	-0.2	92	7
07650	Marseille	7.5	0.8	103	57	6.5	-1.4	<1	-54
08222	Madrid	6.0	0.0	14	-32	7.6	0.2	11	-35
08314	Mahon / Menorca	11.1	0.4	53	-8	9.8	-0.9	34	-19
08495	Gibraltar	13.4	0.0	70	-51	13.6	-0.2	32	-68
08515	St.Maria / Acores	15.4	1.0	67	-33	15.5	1.5	3	-83
08535	Lisboa	10.9	-0.5	75	-35	11.6	-0.7	11	-100
10384	Berlin-Tempelhof	3.2	3.4	35	-8	1.6	0.8	63	29
11035	Wien-Hohe Warte	0.7	1.4	17	-21	1.1	-0.2	113	71
11518	Praha-Ruzyne	0.4	2.8	28	5	-1.4	-0.6	20	-3
11903	Sliac	-1.7	2.2	18	-26	-1.8	-0.7	50	5
12160	Elblag	0.0	2.4	39	-8	-1.4	0.8	51	26
12375	Warszawa-Okecie	-0.2	3.1	21	-1	-1.3	0.7	29	8
12843	Budapest-Lorinc	-0.8	0.8	8	-24	0.7	-0.4	42	10
13274	Beograd	1.9	1.5	51	2	2.4	-0.3	63	19
14015	Ljubljana	0.6	1.7	58	-24	0.8	-0.6	117	37
14445	Split	8.2	0.8	72	-11	6.4	-1.8	50	-18
15420	Bucuresti	-0.2	2.2	37	-3	0.7	0.8	20	-16
15614	Sofia	-0.6	1.0	22	-5	-0.4	-0.9	57	24
16090	Verona	2.3	1.1	13	-34	3.2	-0.8	5	-42
16158	Pisa	5.7	-0.4	67	-8	5.6	-1.5	38	-35
16597	Luqa / Malta	12.8	0.6	44	-45	11.3	-1.1	40	-21
16716	Athens (Hellinikon)	10.9	0.7	27	-17	10.8	0.2	14	-29
16754	Heraklion / Kreta	12.6	0.6	79	-11	12.4	0.3	48	-29
17040	Rize	8.2	1.9	129	-88	7.9	1.3	153	-20
17062	Istanbul-Goztepe	7.2	1.6	32	-67	6.8	0.9	123	56
17130	Ankara / Central	3.3	3.2	28	-19	3.2	1.3	86	50
17170	Van	0.3	4.5	8	-27	0.4	3.8	25	-9
17609	Larnaca	13.1	1.6	61	-4	12.6	0.9	40	-17
22113	Murmansk	-15.3	-3.6	18	-15	-12.8	-1.6	16	-6
26038	Tallina	-3.4	2.1	81	36	-4.8	0.9	55	26
26629	Kaunas	-2.1	2.9	41	4	-4.1	0.2	55	28
26730	Vilnius	-2.7	3.4	33	-8	-4.0	0.8	56	18
26850	Minsk	-3.1	3.8	23	-17	-4.6	1.2	59	25
27199	Wjatka (Kirov)	-13.9	0.3	72	34	-9.3	2.5	56	28
27612	Moskva	-4.6	4.7	73	28	-6.3	1.4	53	16
33345	Kiev	-2.2	3.4	48	1	-1.5	2.7	38	-8
33815	Chisinau	1.8	5.1	43	3	0.5	2.2	60	22
34300	Charkov (Kharkiv)	-1.7	5.2	44	-11	-1.5	4.2	49	17
34880	Astrahan'	-1.7	3.7	7	-6	0.2	5.1	11	1
35188	Akmola	-11.6	4.2	15	-2	-9.2	6.7	8	-6
40080	Damascus	7.2	1.0	26	-9	9.0	1.1	86	54
40100	Beyrouth	15.2	1.6	135	-87	15.6	2.1	38	-98
40180	Tel Aviv (Airport)	13.7	1.4	114	-35	14.0	1.1	69	-29
40270	Amman	9.9	0.8	29	-35	10.5	0.5	58	-6
60030	Las Palmas /Gr.Can	18.5	1.0	22	-3	18.4	0.6	3	-24

	March 1999				April 1999				May 1999			
WMO No.	Temp. Mean	(°C) dep.	Prec. sum	(mm) dep.	Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	Temp. Mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	-7.8	6.9	4	-17	-10.6	1.1	9	-3	-2.0	1.7	3	-3
01025	-1.7	0.5	41	-23	1.2	0.5	67	7	5.4	0.5	43	-5
01492	0.3	0.5	121	75	6.7	2.1	47	5	9.6	-1.2	41	-11
02196	-5.1	1.7	33	-2	1.5	2.0	15	-14	5.3	-0.8	29	-2
02485	1.6	1.5	45	19	7.5	2.9	76	46	10.1	-0.6	16	-14
02974	-1.4	1.5	26	-8	5.7	2.8	55	18	8.0	-1.9	11	-24
03091	6.1	1.5	37	-24	8.2	1.8	54	1	10.1	1.1	44	-15
03772	8.7	2.2	26	-21	10.6	1.7	35	-10	14.6	2.1	36	-15
03967	7.3	1.3	48	-1	9.2	1.4	47	0	12.0	1.5	45	-13
04030	-1.0	-1.5	21	-62	2.8	-0.1	26	-32	6.7	0.4	87	43
04320	-21.0	2.3	23	6	-16.6	0.7	3	-7	-5.2	1.4	10	6
04360	-7.3	0.8	13	-75	-2.6	1.4	38	-35	2.0	1.4	50	-7
06186	3.6	1.0	37	-5	8.5	1.9	27	-15	11.1	-0.9	38	-5
06260	7.3	2.3	86	23	9.8	1.8	62	10	14.2	1.9	52	-9
06447	7.9	2.1	72	0	10.1	1.3	71	14	15.0	2.1	40	-31
06590	6.1	1.8	64	-4	9.0	1.2	62	2	14.4	2.3	32	-45
06660	6.1	1.7	56	-17	9.0	1.0	108	14	15.0	2.7	287	183
06700	7.1	2.1	75	-3	9.7	1.0	117	52	16.7	3.8	83	9
07510	10.7	2.3	56	-18	12.4	1.4	96	24	17.9	3.3	89	14
07650	11.4	1.5	53	10	13.6	0.7	56	10	19.3	2.2	26	-16
08222	10.8	0.8	23	-10	13.8	1.6	33	-21	18.0	1.9	48	7
08314	12.8	1.0	15	-34	15.3	1.6	4	-41	19.5	2.5	24	-9
08495	15.2	0.2	77	2	17.6	1.4	33	-27	19.4	0.9	10	-25
08515	15.1	0.5	50	-29	17.0	1.8	12	-43	17.3	0.6	133	103
08535	14.3	0.6	94	25	16.2	1.1	35	-29	17.8	0.4	86	47
10384	5.7	1.5	47	10	10.4	1.8	38	-3	14.9	1.0	27	-29
11035	7.0	1.7	32	-9	11.7	1.5	48	-2	15.9	1.1	91	30
11518	4.8	1.8	20	-8	8.9	1.2	20	-18	13.8	1.1	43	-34
11903	4.5	1.5	26	-17	10.3	1.8	63	16	13.7	0.0	63	0
12160	4.6	2.5	18	-17	9.0	2.2	86	44	11.7	-1.2	88	47
12375	4.6	2.6	23	-5	10.0	2.2	76	44	12.6	-0.8	47	-12
12843	7.3	1.7	22	-7	12.8	1.7	44	6	16.3	0.3	98	43
13274	9.1	1.9	16	-34	13.4	1.0	73	14	17.5	0.3	63	-8
14015	7.8	2.4	82	-16	11.5	1.6	164	55	16.7	2.1	136	14
14445	11.1	0.7	69	-6	14.6	0.7	90	24	20.0	1.4	141	85
15420	6.2	1.4	22	-16	11.9	0.6	106	60	15.6	-1.1	53	-17
15614	5.8	1.2	44	6	10.9	1.0	40	-10	15.3	1.0	81	8
16090	8.8	0.7	69	12	12.8	0.7	75	13	19.0	2.2	56	-24
16158	10.1	0.6	45	-31	12.3	-0.2	67	-12	17.5	1.2	21	-38
16597	13.6	0.2	36	-4	16.6	1.1	1	-22	21.6	2.5	0	-7
16716	13.0	0.4	156	115	17.0	0.9	9	-16	22.0	1.4	<1	-15
16754	14.0	0.6	80	24	17.2	0.9	14	-16	21.9	2.1	2	-14
17040	8.8	0.9	137	-10	12.2	0.6	78	-28	16.0	0.2	191	89
17062	9.1	1.6	53	-9	14.4	2.4	22	-27	17.5	1.0	4	-27
17130	6.6	0.5	55	19	12.1	0.9	14	-34	16.9	1.4	7	-48
17170	2.6	1.5	63	20	8.4	1.1	49	-5	14.9	2.2	42	-7
17609	14.8	1.5	33	-16	17.7	0.3	18	7	22.9	2.0	0	-7
22113	-5.4	1.4	20	0	-0.2	1.7	29	-8	0.5	-3.3	20	-12
26038	0.1	2.3	19	-10	6.4	3.0	65	29	7.8	-1.9	5	-32
26629	2.1	2.3	41	9	9.3	3.3	42	1	10.7	-2.0	32	-24
26730	1.4	2.0	40	1	9.2	3.5	24	-22	10.2	-2.3	14	-48
26850	1.2	2.6	82	40	10.0	4.0	21	21	10.7	-2.2	23	-39
27199	-6.2	-1.1	18	-11	5.6	2.4	29	-7	6.3	-4.8	50	1
27612	-0.8	1.4	37	3	9.7	3.9	27	-13	8.7	-4.2	38	-20
33345	3.2	2.5	43	4	11.6	2.9	20	-29	12.8	-2.3	48	-5
33815	5.2	2.3	30	-5	11.4	1.2	103	61	15.0	-1.1	34	-17
34300	3.1	3.4	25	-2	12.1	3.2	18	-18	12.8	-2.8	43	-4
34880	3.4	2.1	<1	-13	12.0	0.9	20	2	14.8	-3.5	18	-6
35188	-15.4	-7.3	26	12	5.0	0.1	17	-5	15.4	2.3	22	-11
40080	12.1	0.9	4	-20	16.8	1.1	2	-10	22.9	2.5	0	-5
40100	17.1	2.0	66	-54	17.0	-0.8	52	1	22.8	2.4	0	-20
40180	16.5	1.6	27	-35	18.7	0.5	11	-12	23.2	2.1	0	-3
40270	13.2	0.3	15	-29	17.3	-0.5	4	-12	23.5	1.6	0	-3
60030	19.3	1.0	6	-5	20.6	1.8	<1	-6	21.1	1.3	0	-2

WMO No.	Station	June 1999 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	July 1999 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	2.7	0.5	22	12	6.4	0.4	10	-3
01025	Tromsø	10.3	1.0	51	-2	11.0	-0.7	162	90
01492	Oslo-Blindern	14.0	-1.2	143	78	17.4	1.0	66	-18
02196	Haparanda	14.1	1.3	73	32	15.8	0.3	46	-4
02485	Stockholm	17.2	1.6	36	-9	20.2	3.0	18	-54
02974	Helsinki-Vantaa	18.4	3.5	25	-19	19.1	2.5	25	-48
03091	Aberdeen	12.0	-0.1	74	21	14.9	1.1	48	-13
03772	London-Heathrow	15.6	-0.1	98	47	19.6	1.8	9	-37
03967	Dublin (Casement)	12.3	-1.0	65	17	16.2	1.3	24	-30
04030	Reykjavik	9.0	-0.1	47	-4	10.9	0.3	66	15
04320	Danmarkshavn	0.5	-0.2	7	2	4.8	1.1	19	5
04360	Angmagssalik	4.8	0.7	99	47	7.0	0.6	3	-46
06186	København-Landb.	15.1	-1.0	85	31	7.0	1.5	18	-51
06260	De Bilt	15.0	-0.2	89	21	19.1	2.3	37	-38
06447	Uccle	15.6	-0.1	83	4	19.7	2.2	35	-40
06590	Luxembourg	15.3	0.0	105	36	19.4	2.3	49	-18
06660	Zürich	15.1	-0.4	202	75	18.7	1.0	101	-17
06700	Genève	17.1	0.7	98	11	21.0	2.0	87	24
07510	Bordeaux	18.7	0.9	66	10	21.9	1.7	63	16
07650	Marseille	21.6	0.7	4	-24	25.0	1.2	29	15
08222	Madrid	22.1	1.5	24	-3	26.3	1.9	20	7
08314	Mahon / Menorca	21.9	0.9	3	-12	25.1	0.8	0	-5
08495	Gibraltar	22.3	1.2	<1	-10	24.5	0.8	1	0
08515	St.Maria / Acores	19.4	0.7	11	-11	22.6	1.8	16	-9
08535	Lisboa	20.6	0.4	<1	-20	22.5	0.1	7	2
10384	Berlin-Tempelhof	17.2	-0.2	45	-30	21.4	2.6	27	-25
11035	Wien-Hohe Warte	18.2	0.2	62	-12	21.0	1.1	81	19
11518	Praha-Ruzyne	15.1	-0.8	49	-24	18.7	1.2	99	33
11903	Sliac	18.0	1.4	115	29	19.8	1.6	179	120
12160	Elblag	16.9	1.5	76	-18	19.5	2.7	62	-32
12375	Warszawa-Okecie	18.0	1.4	122	50	20.6	2.7	24	-43
12843	Budapest-Lorinc	19.6	0.5	135	72	22.1	1.2	131	79
13274	Beograd	20.3	0.2	142	52	21.9	0.2	262	196
14015	Ljubljana	19.1	1.3	164	9	20.9	1.0	204	82
14445	Split	24.2	1.7	162	110	26.0	0.6	26	-2
15420	Bucuresti	22.2	2.0	52	-25	24.0	2.0	80	16
15614	Sofia	19.1	1.4	86	14	21.5	1.5	57	1
16090	Verona	21.6	0.8	166	78	24.2	0.7	52	-9
16158	Pisa	20.4	0.6	58	14	24.1	1.3	3	-20
16597	Luqa / Malta	25.4	2.4	0	-3	26.3	0.4	0	0
16716	Athens (Hellinikon)	27.6	2.5	<1	-6	29.3	1.5	61	56
16754	Heraklion / Kreta	25.6	2.1	0	-3	26.9	1.2	0	-1
17040	Rize	21.5	1.6	90	-38	24.9	2.7	168	32
17062	Istanbul-Goztepe	21.9	0.8	60	39	25.4	2.2	15	-4
17130	Ankara / Central	20.0	0.4	35	-2	24.4	1.5	45	31
17170	Van	20.0	2.4	7	-14	22.8	0.9	0	-4
17609	Larnaca	25.6	1.3	0.5	-0.5	28.1	1.2	0	0
22113	Murmansk	11.8	2.4	25	-28	13.1	0.3	105	45
26038	Tallina	17.5	3.0	56	3	18.3	2.0	45	-34
26629	Kaunas	19.1	3.1	54	-21	20.0	2.9	31	-37
26730	Vilnius	19.6	3.8	54	-23	20.5	3.6	29	-49
26850	Minsk	21.0	4.9	90	7	21.3	4.0	54	-34
27199	Wjatka (Kirov)	18,6	3.0	14	-50	19.5	1.3	86	0
27612	Moskva	21.4	4.8	10	-66	21.7	3.6	68	-24
33345	Kiev	22.6	4.4	47	-26	22.7	3.4	81	-7
33815	Chisinau	22.4	3.0	40	-35	24.5	3.6	4	-65
34300	Charkov (Kharkiv)	22.8	3.9	25	-33	25.0	4.7	31	-29
34880	Astrahan'	23.8	0.9	10	-12	25.8	0.5	71	48
35188	Akmola	15.1	-3.9	119	84	22.2	0.9	41	-9
40080	Damascus	25.3	0.7	0	-1	27.1	0.5	0	0
40100	Beyrouth	24.9	1.3	0	-1	27.0	1.5	0	0
40180	Tel Aviv (Airport)	25.3	1.3	0	0	27.4	1.7	0	0
40270	Amman	24.1	-0.9	0	0	26.4	0.0	0	0
60030	Las Palmas /Gr.Can	22.6	1.0	0	-0.5	24.5	1.4	0	0

WMO No.	August 1999 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	September 1999 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	October 1999 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	4.9	0.1	16	-9	2.8	2.3	35	12	-6.2	-0.7	13	-2
01025	9.2	-1.7	151	69	9.0	2.2	115	21	4.5	1.6	96	-29
01492	15.9	0.7	30	-60	14.2	3.4	163	73	6.4	0.0	94	10
02196	11.9	-1.4	79	16	9.9	2.0	28	-35	3.7	1.2	48	-16
02485	17.1	0.9	48	-18	16.1	4.9	64	9	8.1	0.6	23	-27
02974	15.4	0.4	66	-14	12.8	2.8	40	-33	6.7	1.3	98	25
03091	13.6	0.0	35	-40	13.8	2.1	84	16	10.0	0.9	68	-10
03772	18.4	1.0	125	74	17.2	2.2	87	36	11.8	0.1	49	-9
03967	14.9	0.3	91	13	14.3	1.3	158	89	10.4	0.1	49	-19
04030	11.3	1.0	65	3	8.5	1.1	72	5	5.6	1.2	115	29
04320	1.1	-1.3	11	-3	-3.5	0.7	15	4	-14.5	-0.9	7	-5
04360	6.0	0.0	124	63	4.3	1.2	42	-26	1.5	2.3	70	-12
06186	17.4	0.4	118	55	16.7	3.1	25	-37	9.7	-0.2	44	-15
06260	17.5	0.8	94	23	17.4	3.4	68	-1	10.6	0.1	43	-29
06447	18.1	0.8	91	28	17.7	3.2	43	-16	10.7	-0.2	47	-23
06590	17.7	1.0	73	2	16.9	3.2	69	2	9.1	-0.2	62	-12
06660	17.9	1.0	135	1	16.7	2.6	129	35	9.5	0.0	52	-20
06700	19.9	1.8	123	42	18.2	3.4	153	71	11.4	1.4	135	61
07510	21.5	1.6	85	32	19.5	1.6	169	95	14.6	0.6	96	12
07650	24.8	1.6	10	-17	22.1	1.8	122	75	16.6	0.5	127	49
08222	25.5	1.6	2	-7	20.1	-0.4	38	8	14.6	-0.2	109	64
08314	26.4	1.9	0	-26	24.3	2.1	41	-14	20.8	2.3	31	-53
08495	24.5	0.3	<1	-5	22.8	0.0	27	12	19.7	0.2	149	85
08515	24.0	1.8	25	-15	22.1	0.7	49	-8	19.4	0.1	38	-46
08535	22.2	-0.6	24	18	20.7	-1.0	129	103	18.1	-0.4	213	133
10384	19.1	0.7	42	-19	18.5	3.9	11	-35	10.1	0.1	17	-19
11035	19.1	-0.1	73	8	17.5	2.1	59	14	10.7	0.6	15	-26
11518	17.1	0.1	21	-49	16.6	3.3	54	14	8.4	0.1	21	-9
11903	17.6	0.3	40	-31	16.5	3.1	17	-41	8.3	0.0	43	-7
12160	17.1	0.4	99	18	16.2	3.5	19	-51	8.4	-0.5	90	37
12375	17.9	0.6	29	-34	15.8	2.6	20	-23	8.3	0.0	41	3
12843	20.3	0.0	51	0	18.9	2.5	15	-25	11.0	0.1	36	2
13274	22.7	1.4	13	-39	19.6	1.9	86	35	12.4	0.0	56	16
14015	20.4	1.3	121	-23	18.0	2.5	74	-56	11.8	1.4	87	-28
14445	26.6	1.4	14	-36	22.9	1.5	56	-4	17.8	0.9	63	-16
15420	21.7	0.5	136	78	17.3	0.4	125	83	10.6	-0.2	82	50
15614	21.7	2.3	12	-40	17.3	1.5	32	-7	11.4	1.0	43	6
16090	23.6	0.9	52	-32	20.6	1.8	102	39	14.2	1.0	98	19
16158	25.0	2.5	26	-31	21.6	2.1	148	59	16.3	1.0	130	10
16597	29.3	3.0	20	13	25.8	1.7	42	2	22.9	2.2	10	-80
16716	29.5	1.9	<1	-4	25.0	0.8	8	-2	21.8	2.5	30	-22
16754	27.6	2.0	0	-1	24.7	1.6	2	-16	22.3	2.6	4	-72
17040	24.9	2.7	215	32	19.3	-0.1	297	76	15.8	0.4	409	137
17062	24.6	1.6	51	25	20.7	1.0	28	-13	16.2	0.9	35	-36
17130	23.8	1.2	31	19	18.8	0.5	21	2	13.9	1.3	43	16
17170	23.8	2.6	2	-5	17.5	0.7	17	3	11.6	1.5	82	34
17609	28.4	1.3	0.5	0.5	26.2	1.1	9	9	23.1	1.8	5	-14
22113	9.8	-1.2	179	114	8.1	1.4	59	7	3.5	2.5	92	50
26038	15.5	0.2	37	-47	13.4	2.6	25	-57	7.4	1.1	136	66
26629	16.8	0.5	86	23	14.4	2.3	29	-30	7.2	0.3	79	28
26730	16.6	0.3	53	-19	13.9	2.3	60	-5	6.8	0.2	56	3
26850	17.7	1.2	48	-24	13.8	2.1	46	-14	6.9	0.6	24	-25
27199	14.4	-1.1	89	24	9.3	0.1	32	-39	6.0	4.3	28	-34
27612	16.4	0.0	89	15	11.8	0.9	48	-16	7.4	2.4	33	-25
33345	19.3	0.7	132	63	15.8	1.9	8	-39	8.2	0.1	52	17
33815	22.2	1.7	27	-18	17.9	1.7	26	-22	10.5	0.4	44	17
34300	19.9	0.4	45	-5	15.3	1.2	12	-29	8.8	1.5	36	1
34880	26.0	2.7	79	60	16.9	-0.4	10	-16	11.9	2.8	62	45
35188	20.4	2.7	9	-31	13.3	1.3	12	-12	7.5	4.7	11	-19
40080	27.6	1.4	0	0	23.9	0.6	0	0	19.4	0.8	0	-12
40100	28.1	1.7	0	-1	27.3	2.1	0	-5	24.4	1.8	77	23
40180	28.4	2.3	0	0	27.0	2.2	0	0	23.8	1.8	<1	-25
40270	27.5	1.1	0	0	24.5	-0.7	0	-0.3	21.2	-0.6	0	-7
60030	25.7	1.8	3	3	24.8	1.0	9	1	23.1	0.6	16	0

WMO No.	Station	November 1999 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	December 1999 Temp. Mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-3.9	6.6	37	24	-10.1	3.2	11	-1
01025	Tromsø	3.2	4.0	140	36	-4.1	-1.1	118	14
01492	Oslo-Blindern	4.1	3.4	27	-48	-2.7	0.1	68	12
02196	Haparanda	0.6	4.7	93	35	-10.3	-0.8	46	14
02485	Stockholm	4.8	2.2	18	-35	-0.9	0.1	117	71
02974	Helsinki-Vantaa	2.5	2.4	37	-35	-2.3	1.8	109	51
03091	Aberdeen	6.9	1.7	53	-22	2.9	-0.8	92	19
03772	London-Heathrow	8.7	1.5	31	-24	5.7	0.6	77	20
03967	Dublin (Casement)	7.7	1.0	59	-11	4.9	-0.4	84	7
04030	Reykjavik	2.0	0.8	72	-1	-1.0	-0.8	59	-19
04320	Danmarkshavn	-14.4	5.5	22	12	-21.9	-0.1	9	-4
04360	Angmagssalik	-3.2	1.5	130	34	-6.6	0.6	27	-76
06186	København-Landb.	5.9	0.4	11	-51	2.6	0.4	67	9
06260	De Bilt	6.7	0.8	60	-21	4.8	1.6	146	66
06447	Uccle	6.2	0.1	33	-43	4.2	0.7	172	96
06590	Luxembourg	3.4	-0.6	41	-38	2.2	1.0	163	85
06660	Zürich	2.1	-2.0	109	24	2.0	1.3	140	63
06700	Genève	4.4	-0.6	62	-30	3.5	1.6	132	45
07510	Bordeaux	7.8	-0.9	58	-32	7.6	1.2	160	65
07650	Marseille	9.2	-1.3	76	19	6.8	-0.5	11	-41
08222	Madrid	7.8	-1.6	33	-31	5.9	-0.5	29	-20
08314	Mahon / Menorca	13.6	-0.8	128	51	11.6	-0.2	44	-36
08495	Gibraltar	15.8	-0.3	43	-98	14.5	0.4	35	-111
08515	St.Maria / Acores	16.5	-0.9	184	82	16.7	1.3	56	-39
08535	Lisboa	13.4	-1.1	41	-73	12.2	0.4	70	-38
10384	Berlin-Tempelhof	4.3	-0.6	26	-23	2.8	1.4	71	-18
11035	Wien-Hohe Warte	3.5	-1.3	52	2	1.6	0.6	64	20
11518	Praha-Ruzyne	2.0	-0.8	26	-6	0.6	1.2	23	-3
11903	Sliac	2.3	-0.7	31	-36	-2.6	-0.9	60	4
12160	Elblag	2.9	-0.4	52	-4	1.1	0.8	52	0
12375	Warszawa-Okecie	3.0	-0.2	31	-11	0.7	1.6	22	-10
12843	Budapest-Lorinc	3.2	-1.6	99	47	0.4	0.0	65	25
13274	Beograd	5.1	-1.9	73	19	2.6	0.3	153	95
14015	Ljubljana	3.1	-1.5	108	-27	0.7	0.7	189	88
14445	Split	11.9	-0.4	81	-29	9.1	0.1	121	16
15420	Bucuresti	4.4	-0.8	12	-37	1.6	1.4	68	25
15614	Sofia	4.9	-0.1	39	-8	2.0	1.5	83	44
16090	Verona	6.8	-0.2	61	-12	2.1	-0.1	29	-23
16158	Pisa	10.0	-0.4	144	20	7.4	0.6	91	6
16597	Luqa / Malta	18.1	1.1	391	311	14.7	0.7	104	-5
16716	Athens (Hellinikon)	15.8	0.3	24	-26	14.0	1.8	45	-26
16754	Heraklion / Kreta	18.3	1.7	6	-53	15.4	1.6	123	49
17040	Rize	10.9	-0.7	278	28	9.1	0.8	53	-189
17062	Istanbul-Goztepe	11.5	-0.1	118	29	10.8	2.7	88	-34
17130	Ankara / Central	6.7	-0.4	31	-2	5.0	2.4	39	-10
17170	Van	4.6	0.6	39	-3	1.0	1.9	5	-29
17609	Larnaca	17.6	1.2	27	-17	14.9	1.7	51	-25
22113	Murmansk	-3.3	1.8	37	-3	-9.4	-0.1	35	-3
26038	Tallina	2.8	1.6	33	-35	-0.8	2.1	109	54
26629	Kaunas	1.2	-0.9	35	-18	-0.5	1.9	57	13
26730	Vilnius	0.3	-0.9	50	-7	-0.9	2.0	50	-5
26850	Minsk	-0.8	-1.6	46	-6	-1.2	2.6	55	2
27199	Wjatka (Kirov)	-9.8	-5.1	48	-4	-6.3	4.0	60	15
27612	Moskva	-4.9	-3.8	40	-18	-1.7	4.4	55	3
33345	Kiev	-0.2	-2.3	47	-4	-0.2	2.1	58	6
33815	Chisinau	2.8	-1.6	44	5	1.4	1.7	59	21
34300	Charkov (Kharkiv)	-2.1	-3.4	33	-11	-0.3	3.1	45	0
34880	Astrahan'	-0.1	-3.4	26	7	1.4	3.3	8	-7
35188	Akmola	-7.9	-2.0	36	14	-10.0	2.6	3	-14
40080	Damascus	11.9	-0.4	0	-27	7.7	0.1	17	-29
40100	Beyrouth	20.3	1.6	47	-57	17.4	2.6	72	-102
40180	Tel Aviv (Airport)	19.6	1.6	28	-40	15.2	1.4	29	-109
40270	Amman	15.8	0.2	<1	-29	11.7	1.0	3	-47
60030	Las Palmas /Gr.Can	21.3	0.6	24	3	18.7	0.4	32	10

Year 1999

WMO No.	Station	Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-3.9	2.5	168	-15
01025	Tromsø	3.4	0.6	1095	122
01492	Oslo-Blindern	6.8	1.0	928	159
02196	Haparanda	1.9	0.8	615	63
02485	Stockholm	8.3	1.7	539	0
02974	Helsinki-Vantaa	6.0	1.5	604	-47
03091	Aberdeen	8.8	0.9	690	-98
03772	London-Heathrow	12.0	1.4	663	64
03967	Dublin (Casement)	10.0	0.8	792	57
04030	Reykjavik	4.5	0.1	791	-9
04320	Danmarkshavn	-11.3	0.9	201	69
04360	Angmagssalik	-0.7	1.0	728	-204
06186	København-Landb.	9.4	0.7	548	-88
06260	De Bilt	10.9	1.5	903	98
06447	Uccle	11.1	1.2	887	69
06590	Luxembourg	9.8	1.2	823	-18
06660	Zürich	9.5	0.8	1549	428
06700	Genève	11.1	1.6	1232	288
07510	Bordeaux	13.9	1.2	1099	176
07650	Marseille	15.4	0.6	617	83
08222	Madrid	14.9	0.6	384	-73
08314	Mahon / Menorca	17.7	1.0	377	-206
08495	Gibraltar	18.6	0.4	478	-297
08515	St.Maria / Acores	18.4	0.9	644	-131
08535	Lisboa	16.7	-0.1	786	33
10384	Berlin-Tempelhof	10.8	1.4	449	-135
11035	Wien-Hohe Warte	10.7	0.7	707	94
11518	Praha-Ruzyne	8.8	0.9	424	-102
11903	Sliac	8.7	0.8	705	16
12160	Elblag	8.8	1.2	732	42
12375	Warszawa-Okecie	9.2	1.4	485	-34
12843	Budapest-Lorinc	11.0	0.6	746	228
13274	Beograd	12.4	0.5	1051	367
14015	Ljubljana	11.0	1.2	1504	111
14445	Split	16.6	0.6	945	115
15420	Bucuresti	11.3	0.8	793	198
15614	Sofia	10.7	1.0	596	33
16090	Verona	13.3	0.7	778	-15
16158	Pisa	14.7	0.6	838	-66
16597	Luqa / Malta	19.9	1.2	688	139
16716	Athens (Hellinikon)	19.7	1.2	376	7
16754	Heraklion / Kreta	19.9	1.4	358	-143
17040	Rize	15.0	1.0	2198	26
17062	Istanbul-Goztepe	15.5	1.4	629	-68
17130	Ankara / Central	12.9	1.2	435	22
17170	Van	10.7	2.0	339	-46
17609	Larnaca	20.4	1.3	245	-84
22113	Murmansk	0.0	0.1	635	157
26038	Tallina	6.7	1.6	666	-1
26629	Kaunas	7.8	1.4	582	-26
26730	Vilnius	7.6	1.6	519	-164
26850	Minsk	7.7	1.9	571	-106
27199	Wjatka (Kirov)	2.9	0.5	582	-43
27612	Moskva	6.6	1.6	571	-117
33345	Kiev	9.3	1.6	622	-27
33815	Chisinau	11.3	1.7	514	-33
34300	Charkov (Kharkiv)	9.5	2.1	395	-124
34880	Astrahan'	11.2	1.2	323	103
35188	Akmola	3.7	1.0	319	1
40080	Damascus	17.6	0.9	135	-59
40100	Beyrouth	21.4	1.7	487	-401
40180	Tel Aviv (Airport)	21.1	1.6	279	-288
40270	Amman	18.6	0.2	109	-166
60030	Las Palmas /Gr.Can	21.6	1.0	116	-23

Monthly Surveys

January 1999:

- **Extremely warm in Central Europe, bitterly cold in the North**
- **Mostly very dry, especially in the Middle East**
- **Destructive winter storm on the Canary Isles**

The year started warm in most parts of the Region with temperature anomalies surpassing +4 °C over Western Russia and Turkey. The mild conditions peaked towards the 6th when several places in Western and Central Europe noted all-time record January temperatures (e.g. London and Paris +16 °C, Jungfraujoch, Switzerland, 3580 m a.s.l., +3,3 °C). For Lithuania, it was the warmest month of the winter. For 13 days, the mean air temperature was positive and anomalies often exceeded +4 - 6 °C, up to +10 - 12 °C in the warmest period. In Estonia, the wet snow seriously wrecked power lines and damaged forests.

The wet and mild weather supported the generation of fog. Airports had to be closed in Central Europe on several occasions. Ljubljana, Slovenia, had 17 days with fog. At least 11 people were killed and 20 were injured in road accidents caused by foggy weather in Syria.

The warm conditions were on contrast to the cold weather in north-western Russia and northern Fennoscandia. On January 27, temperature dropped to –49 °C in Karesuando, Swedish Lappland, establishing a new record in a series from 1879. It is the lowest temperature at an official station in Sweden since February 1966 when Vuoggatjålme in south-western Lapland touched the national record (-53 °C). In Kittilä, northern Finland, a new absolute minimum temperature record of -51,5 °C, was recorded on January 28. On the same day, the second lowest ever recorded temperature in Norway occurred: -51,2 °C in Karasjok. The exceptional cold weather caused substantial problems to traffic, electric power supply and to the heating of houses. Shipping at Arkhangelsk port, Russia, was temporarily disrupted.

A wet belt stretched eastward from the UK over southern Sweden and the Baltic states. Heavy rain affected parts of Cumbria and North Wales, UK, on the 4th and 5th, and Cape Curig received 106 mm of rain in 24 hours. On the 11th and 12th, the Middle Volga region, was affected by heavy snow, with blizzards and gusts of up to 80 km/h. The city of Ulianovsk proclaimed a state of emergency. Heavy snowfall and icy winds caused havoc on the roads in parts of France and northern Spain around the 10th. Rain and flooding brought severe damage near Antalya, Turkey, on the 31st.

Elsewhere, dry conditions prevailed. In Hungary, the driest stations measured monthly sums around 10 mm and the country wide average of 16,3 mm was less than half of the climatological mean. Extremely dry conditions were also reported from Portugal and the Southeast of the Region (see figure 1.1 and 1.2). In Israel, rainfall amounts reached 60 - 80 % of normal in the northern and central parts and less than 50 % in the South. Dryness was even worse in Jordan where monthly precipitation amounted to less than 96 % of normal.

Strong winds occurred. In the town of Selsey in West Sussex, UK, a combination of high tides and gale force winds caused localized flooding in the town when the sea walls were breached. Malin Head, Ireland recorded the highest gust of the year on January 4 (154 km/h). In Galicia, Spain, a strong storm forced the fishing fleet to remain in port for two weeks.

Gusts exceeding 120 km/h haunted the Canary Islands on January 9 and 10. Storm and waves high up to 6 m caused losses above 400 Million US$ to port installations, fish farms and infra-structure.

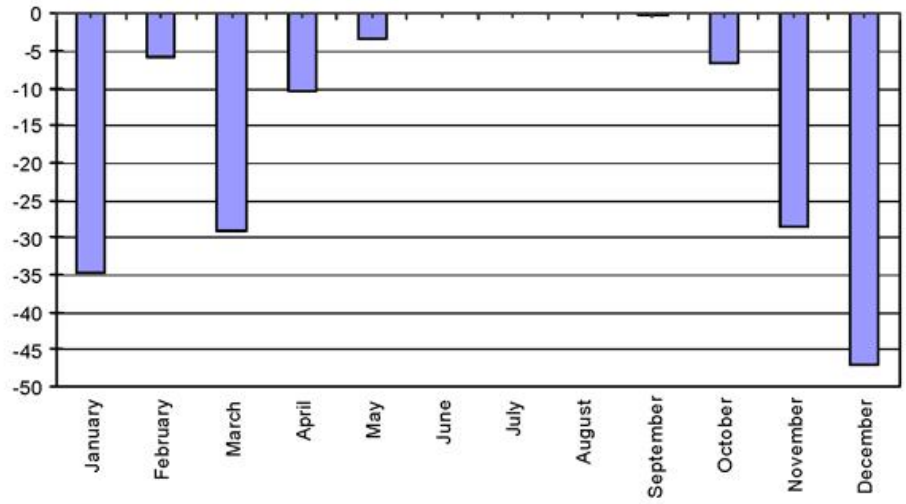


Fig. 1.1: *Monthly rainfall anomalies in mm (reference period: 1923 - 1997) of Amman*
From: Meteorological Department, Jordan

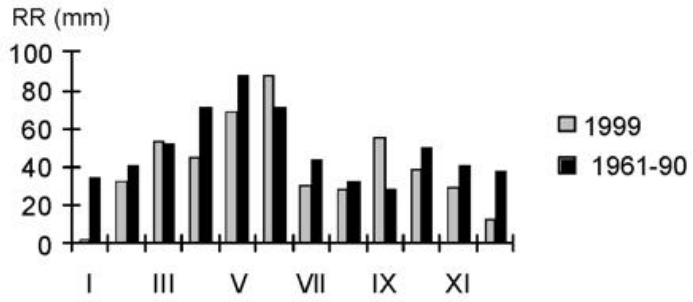


Fig. 1.2: *Monthly rainfall totals and long-term means at Yerevan*
From: Administration of Hydrometeorology, Armenia

February 1999:

- **Abundant snow and deadly avalanches in the Alps**
- **Very dry from the Iberian Peninsula to Greece**
- **Extremely warm in the Southeast**

From January 26 - February 24, enormous amounts of snow fell during several days in the Northern and Inner Alps (see figure 2.1) and snow depths in the mountains exceeded 5 - 7 meters in some regions (Switzerland: Braunwald (1330 m) recorded 723 cm, Säntis (2500 m) 735 cm). In the provinces of Tyrol and Vorarlberg, Austria, the monthly precipitation sums reached 300 - 400 % of normal. Kufstein, Tyrol, received 233 mm which is the highest monthly total in the last 50 years.

The snowfalls caused numerous avalanches, also in regions which had been considered as safe. A deadly avalanche hit Chamonix, France, on February 9. In Galtür, Tyrol, 38 people died on February 23. An avalanche swept away a holiday village near Evolène, Switzerland. All in all, there were at least 60 avalanche victims in the Alps. Many valleys were isolated and some of them during several weeks. More than 100 000 tourists were trapped in their ski resorts.

Around the middle of the month, snow related problems dominated from Spain to The Netherlands and from Germany to Ukraine and the Balkans. In Slovenia, the snow cover in the lowlands was between 30 and 90 cm. In eastern Slovakia, the maximum depth of snow came up to more than 50 cm in the lowlands and 120 – 140 cm in the mountain valleys. These are amongst the highest values since the beginning of snow registrations in 1921. Sicily had its first snow since 1981. Abundant snowfalls and blizzards were also reported from Lithuania and Estonia. The latter reported the greatest amount of snow in the 17 years' record. Two periods with severe blizzards occurred in the Middle Volga region. Wind speeds reached 97 km/h.

In the lowlands north of the Alps, snow, rainfalls and snowmelt caused landslides and flooding. Floods were also reported from north-eastern France and Germany. In the south-western parts of Turkey, heavy rain and strong winds caused considerable damage.

The precipitation was distributed unevenly. Excessive precipitation fell over wide parts of northern Europe, it was extremely dry in Portugal and in Middle East. The northern and central parts of Israel received only 40 - 60 % of average, while rainfall amounts in the southern parts were above normal.

Winds with gusts of 159 km/h were recorded at Kirkwall, UK, on February 4. Strong gusts in Yorkshire caused the closure of the A 1 road where 20 lorries were overturned. At the same time in North and West Scotland around 8 000 homes were left without power as a result of the winds. On February 16/17, a severe winter storm caused wide-spread damage across northern Germany. On the island of Norderney, a tornado destroyed several buildings. Hurricane-like winds devastated towns and villages in northern Bulgaria on February 22/23.

While warm conditions prevailed from Ireland across southern Scandinavia to Western Russia (where anomalies were most extreme with values above +8 °C) subnormal temperatures dominated in the North, over the Alps and in the south-western parts of the Region.

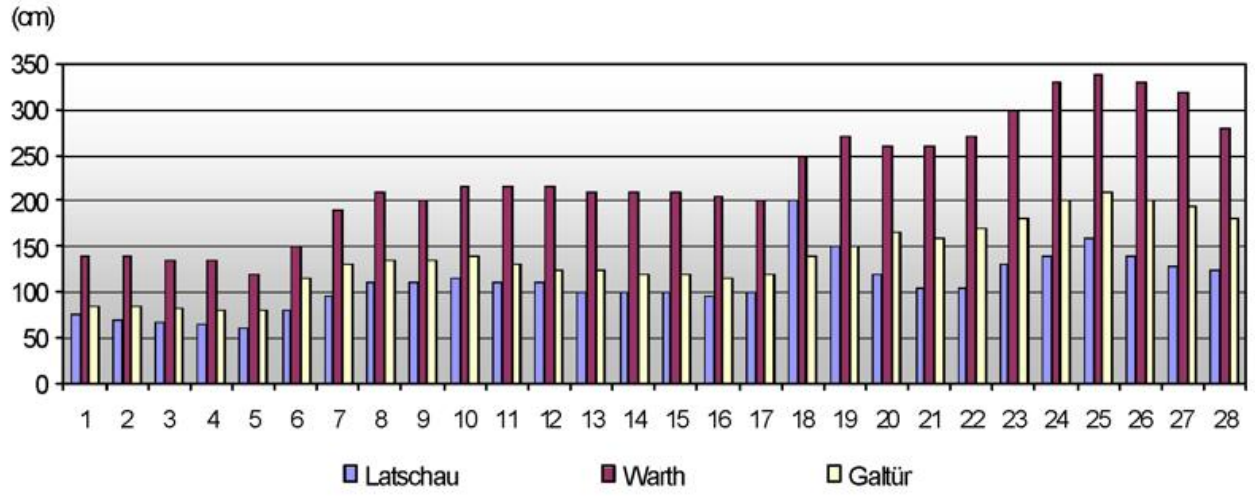


Fig. 2.1: *Daily records of depth of snow (cm) at Lantschau and Warth, Vorarlberg, and Galtür, Tyrol, in February 1999*
From: Central Institute of Meteorology and Geodynamics – ZAMG, Austria

March 1999:

- **Mostly very mild**
- **Heavy flooding over northern Hungary and in the Carpathian mountains**

In Iceland, March became the coldest month of the year and in most parts of the country this was the coldest March in 20 years. Except for the utmost East, unusually warm conditions prevailed in the Region. In the UK, it was the eleventh March out of the past twelve which were warmer than average.

The warm weather caused sudden snowmelt leading to severe flooding regionally. The situation was especially bad in north-eastern Hungary, Slovakia, Ukraine and Romania and Latvia: Many ice barriers developed, water from rainfall and melting snow could not penetrate into the already saturated soils. Therefore by mid-March about 370 000 hectares of land were flooded in Hungary and the resulting damage was among the biggest in this century, only comparable to the losses in the early 1940's or those in 1966. Thousands of homes were endangered or damaged. Rivers Tisza and Bodrog exceeded their highest water-levels, recorded during the past 150 years. In south-eastern Slovakia, the highest water levels since 1921 were registered in the Streda nad Bodrogom profile.

In Portugal, it was extremely rainy. Also northern Spain saw heavy rainfalls: La Coruña (246 mm) and much of the Galician coast, registered record high monthly totals. A new record of daily precipitation (up to 133 mm) was established in Galicia on March 8. In the UK, there were large regional variations in the rainfall amounts. South-east England was particularly dry with only 41 % of the average rainfall, the north-east, however, was very wet with 78 % more than normal. Heavy rain at the start of the month caused river Derwent to flood its banks, and the towns of Malton and Norton had their worst floods since 1931.

Israel and Jordan had another very dry month (see figure 1.1, page 27). South-west Iceland experienced the driest and sunniest March for 20 years. The month started extremely dull in The Netherlands with only 6,5 hours of sunshine in the first ten days of the month.

April 1999:

- **Unusually warm**
- **Regionally heavy snowfalls**

For all parts of Europe, except for Iceland, it was another warm month. The positive temperature anomalies were highest (more than +4 °C) in Belarus, the Baltic states and western Russia.

The rainfall distribution was uneven: Wet conditions prevailed in the UK, France and a belt, stretching from Scandinavia to Romania (more than +200 % of normal in north-eastern France and from southern Sweden to Poland).

Several villages in south-eastern Belgium were without electricity or telephone services after unusually heavy snow on April 15. In Switzerland, on the southern slopes of the Alps and in the central Alps new fallen snow piled up to more than 100 cm on April 16. On the Säntis, there was a record snow depth of 816 cm from April 21 - 23 (records started in 1959). On April 18, 30 - 50 mm of wet snow fell on higher terrain in south-western Sweden where about 12 000 households lost the electricity during the night 18/19. Rainfalls and the warm weather in April after a snowy winter led to severe ice jam and flooding in the Baltic states. River Emajogi in Estonia reached its highest water level in 43 years. On April 28, an ice jam near Arkhangelsk, Russia, caused the river Kholmogory to leave its banks, affecting 136 houses and 9 industrial enterprises.

In Hungary, the wet weather continued and hindered the decreasing of inland water.

An hailstorm caused heavy damage to vineyards in Pyrénées-Orientales on April 21. From April 22 - 25, severe showers with thunderstorms and hail crossed eastern Germany. Locally, hailstones with diameters up to 3 cm fell and hail covered the ground. Orchards and gardens were badly damaged.

There were also high losses by extreme winds: Kocaeli, Turkey, experienced a destructive storm on April 13. The city of St. Petersburg suffered from wind squalls with peaks of 101 km/h on April 18. Trees and advertising boards were broken and blown over, roofs blown off houses and power lines blown down. A tornado occurred in Povoa do Varzim, north-western Portugal, on April 21 leaving a trail of destruction.

May 1999:

- **Extremely cold in the Northeast and warm in the Southwest**
- **Severe flooding in the northern Lower Alps**

The north-eastern parts of the Region experienced extremely cold weather: Low temperatures, reaching 1 - 7 °C below zero, damaged the spring plantings, cherry and apple trees on large territories in European Russia. Such cold weather in May after an early spring had been registered only once before in this century (1918). New fallen snow on May 10 brought down power lines in many areas in Estonia. Lithuania saw as much as 20 nights with frosts, which damaged even cold-sensitive vegetables in greenhouses. After a sharp temperature drop, Armenia received 8 - 12 cm snow in the mountains on May 17 - 21.

While chilly weather prevailed in the Northeast, it was very warm in the South and West of the Region (see figure 6.3, page 34 and figure 9.2, page 39). In Greece, the month started extremely hot with maximum temperatures between 32 and 36 °C (long-term means 23 - 26 °C). In southern Spain, in the past 40 years only May 1964 was warmer. A significant Sharav event occurred in Israel on May 22/23: Temperatures reached 44 - 46 °C in the Jordan Valley and 42 - 43 °C in the coastal areas (the highest temperatures along the coast since May 1988). For England, the warm temperatures ensured that May 1999 was the sixth month in succession to be warmer than normal.

Heavy precipitation coupled with snow melting (see figure 5.1) in European alpine regions of more than 2 000 m altitude triggered heavy flooding in the catchment areas of the Danube River and Lakes Constance and Thune in Germany, Switzerland and Austria. Some regions received from May 20th until 22nd in 3 days precipitation amounts to be expected in a „normal" month of May. Large regions in the Danube catchment area received during May 1999 more than double up to threefold the normal May precipitation (see figure 5.2). Reutte, Tyrol, recorded a daily amount of 213 mm on May 21 and a monthly total of 445 mm. Precipitation totals of May 1999 as well as river levels exceeded record values. Lake Constance reached its highest level since 1858. 13 people died. Damage estimates due to flooding were calculated to more than 750 million US$.

Snowmelt floods caused inundation of hundreds of homes in the Sverdlovsk district, Russia, between May 9 and 15 and on May 29. A tornado with hail stones big as eggs caused damage of property in Jaltusha village, Bulgaria, valued above 250 000 US$ on 15 May. The wind blew off house roofs, rooted out trees and urned over trucks. Hail and rain damaged agricultural areas in parts, of Turkey on May 6 and 26. Edirne, Thrakya experienced heavy rain inundating settlements on May 14.

Towards the end of the month, there was a sequence of very warm days in southern England which triggered off several severe thunderstorms causing local flooding. The 30th of the month brought a series of devastating storms: 20 000 cars were damaged in a severe hailstorm which hit the port of Gent, Belgium.

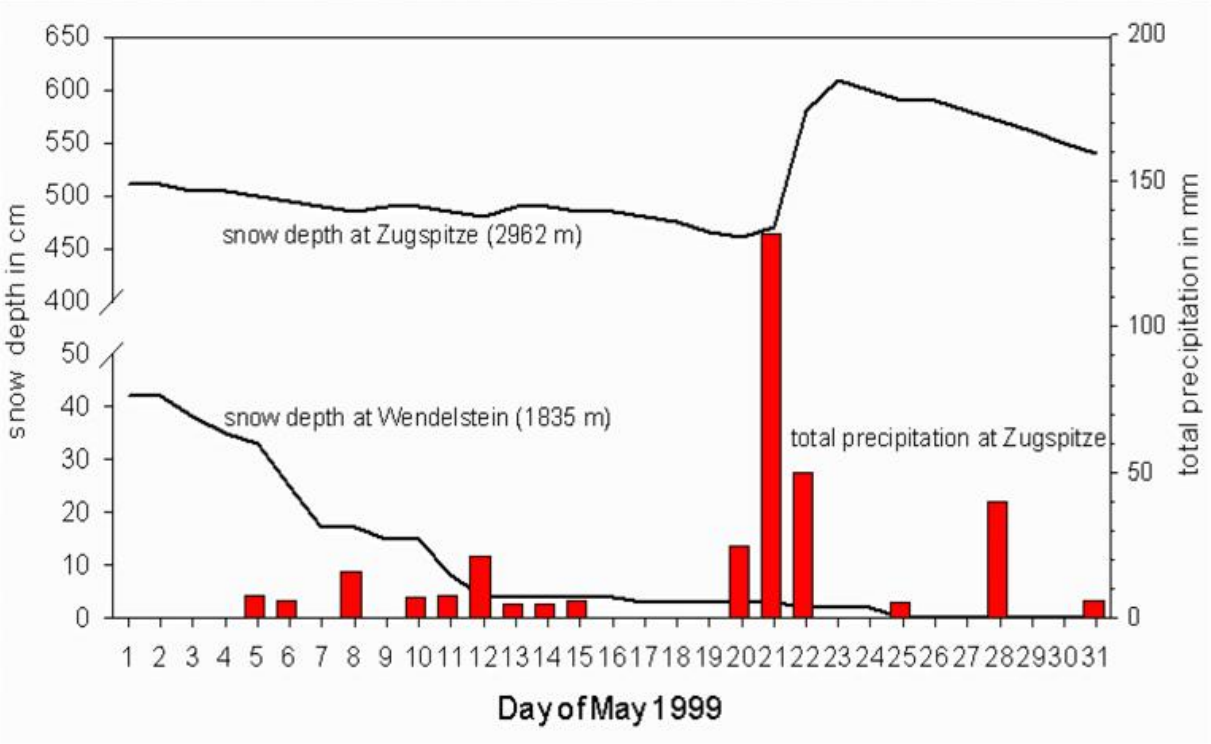


Fig. 5.1: *Variations of daily snow depth measurements at the mountain stations Zugspitze and Wendelstein in comparison to daily precipitation totals at the Zugspitze during May 1999.*
From: Deutscher Wetterdienst, Germany

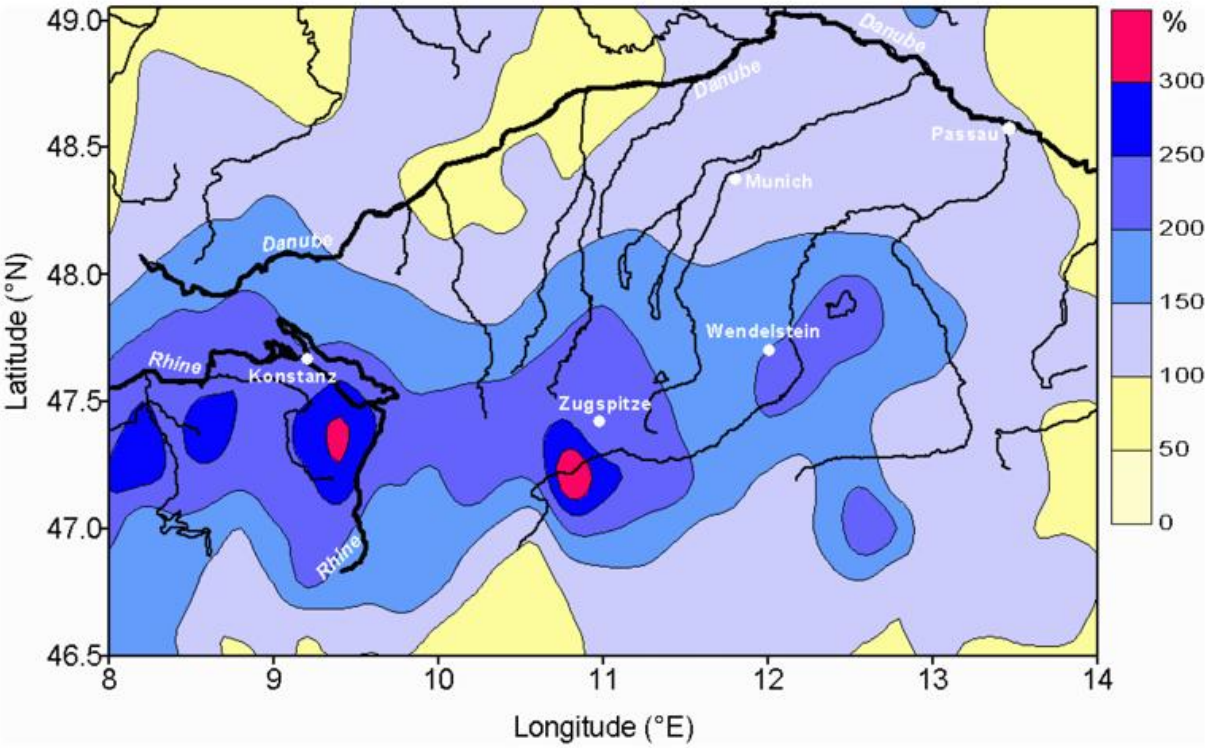


Fig. 5.2: *Rainfall in the catchment area of Danube and Rhine River in May 1999 shown as percent anomaly from the 1961 - 1990 base period.*
From: Deutscher Wetterdienst, Germany

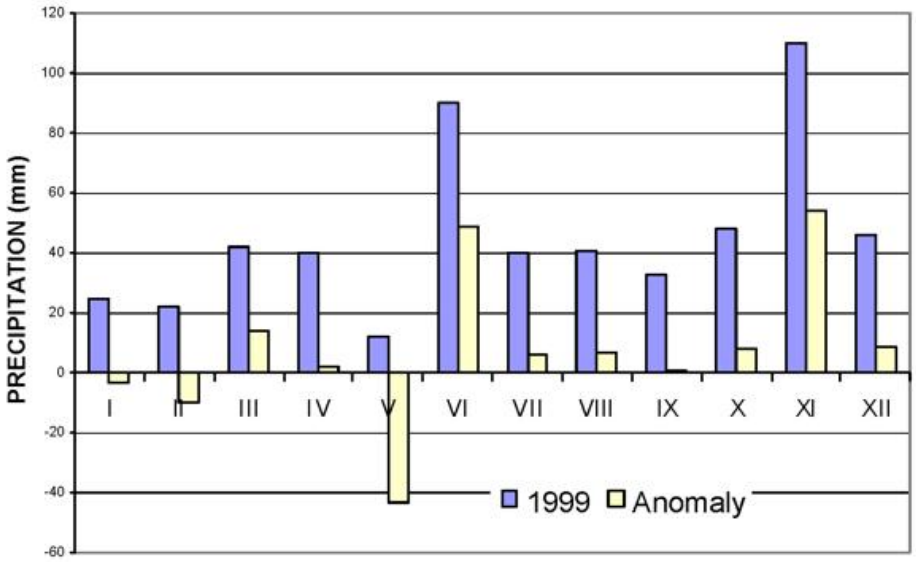


Fig. 5.3: *Monthly precipitation totals and anomalies in Skopje, in 1999*
Reference period: 1961 - 1990
From: Republic Hydrometeorological Institute, Macedonia

An exceptional thunderstorm, in the morning of the 30th of May, stroke Central France. Hail and strong winds were reported with gusts reaching 112 km/h. A cold front crossed with severe thunderstorms, squalls and hailstorms with stones having diameters of 20 - 30 mm in Lithuania.

Most parts of south-eastern Europe and the Middle East were affected by drought (see figure 5.3).

June 1999:

- **Exceptionally warm and dry in the East**
- **Very wet and cool from Scandinavia to the UK**
- **Devastating flooding in Hungary and Romania**
- **Extreme number of heavy thunderstorms**

After the very cold May, a heat wave swept eastern Europe in June (temperature anomalies surpassed + 5 °C, see figure 6.1). In spite of it, isolated frosts (down to - 8 °C) badly damaged 30 % of maize and buckwheat crops in the Perm district.

But also on the Balkans and in the south-western parts of the Region, hot and dry weather prevailed. For the Baltic states, it was one of the warmest Junes of the century. In many parts of Belarus, there was almost no rain from beginning of May - mid-June. As a result, the rainfall deficit increased to critical 50 - 80 % causing considerable agricultural damage. Spain recorded its lowest rainfall in 50 years devastating arable land, sugar beet and livestock farming.

In contrast, it was unusually cold and wet in the north-western parts of the Region. Despite of a temperature rise in the second half of the month, for the UK it was the coolest June since 1991, and the only month in 1999 to have below-average temperatures.

Denmark experienced its second wettest June since records started in 1874 (see figure 6.2). Very large amounts of rain fell also in south-western Sweden. 200 – 350 % of normal precipitation was observed along the west coast of southern Sweden. Varberg established with a monthly sum of 185 mm a new record for June (24 mm more than in 1912).

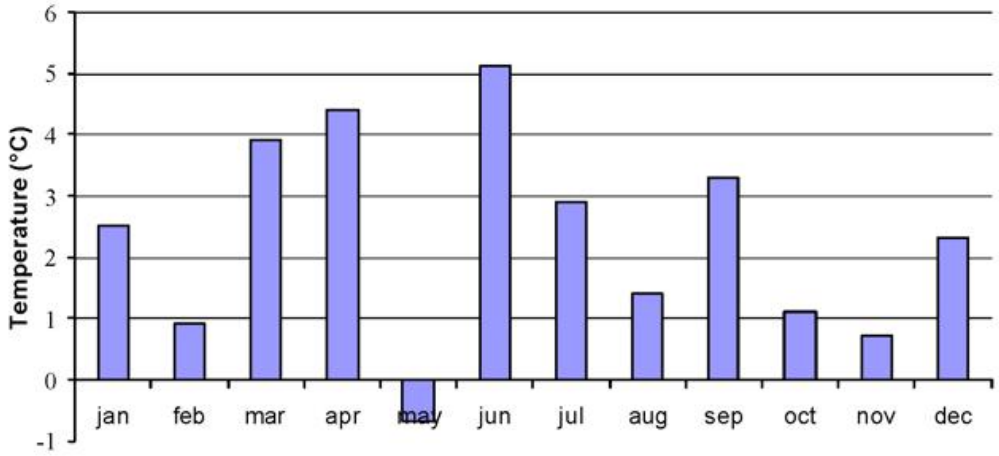


Fig. 6.1: *Monthly temperature anomalies in Riga in 1999, reference period: 1961 - 1990*
From: Latvian Hydrometeorological Agency

In the northern alpine region, the flood situation which had started in May eased slowly and in some areas further rainfall made it extremely long lasting. Lake Constance kept its record level for several weeks and large areas around the lakes of southern Germany remained inundated until July.

Macedonia, after extreme drought in May, received lots of rainfall this month (see figure 5.3). Inundation after heavy rain was reported from Elazig, Sakarya and Kocaeli, Turkey. Hungary and Romania, which had been hit by a severe flood in March, had another devastating flooding. In Hungary, precipitation fell evenly, rains returning every 3 - 4 days. In the northern areas 200 - 400 % of average was recorded. On the pre-saturated soil, on 21 June, 23 mm precipitation fell on the average. Many areas experienced more than 50 mm of rain causing short, but devastating floods. Situation was worst north of Budapest, in the Börzsöny hills, where 100 mm rainfall triggered a never before seen local flood on the small river Kemence. The water demolished houses, bridges and dams in two villages. Other local floods occurred around Budapest and the Balaton region. Losses amounted to about 145 million US$.

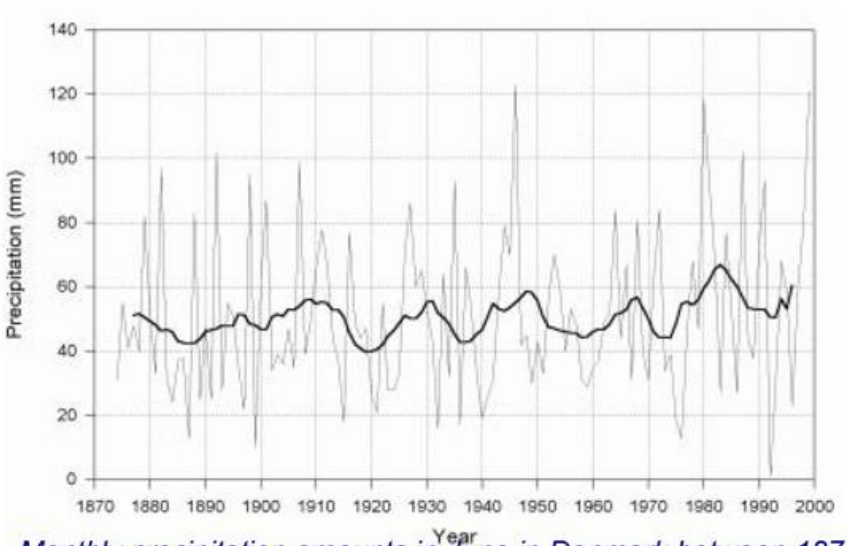


Fig. 6.2: *Monthly precipitation amounts in June in Denmark between 1874 and 1999*
bold curve : 10 year running mean
From: Danish Meteorological Institute

Also in Romania, floods destroyed numerous houses and bridges and inundated vast agricultural fields. In Slovakia, it was the 4th most rainy June in the 20th century, following June 1926, 1958, and 1965. The average precipitation total for the country was 140 mm, which is 163 % of normal.

The Region had a very high number of thunderstorms, hail and showers, especially in the hot countries in the East. In Lithuania, thunderstorms roared on 22 days of the month and there were a number of extreme showers: On June 18, Alytus meteorological station recorded 50 mm of rainfall in 12 hours. In the afternoon of June 20 in some areas of Eastern Lithuania hailstones 20 - 30 mm in diameter were falling. About 16 kilometres north-east of Vilnius, a very strong squall ravaged in the vicinity of the lake Balzio where many people were spending theweekend. A very heavy shower occurred in Trakai, Lithuania, on June 21 resulting in 54 mm of precipitation. A catastrophic shower was recorded by Birzai meteorological station on June 23 with 98 mm of rainfall in 6 h 49 min. More heavy showers occurred on June 29 resulting in 59 mm in 1 h 10 min.

In Latvia, thunders roared 15 - 16 times within the month as against 3 - 7 times normal for June. In Bulgaria, hailstorms occurred on 19 days. A shower with gusty wind and hail caused considerable damage in Plovdiv on June 12. Three persons were killed.

Although temperatures were near the 30 years-normal only 3 days without thunderstorm were recorded over Austria. Violent hail storms raged northern Switzerland on June 2. Flash floods caused by a severe summer storm trapped people in cars and flooded houses and roads in Cyprus (see figure 6.3).

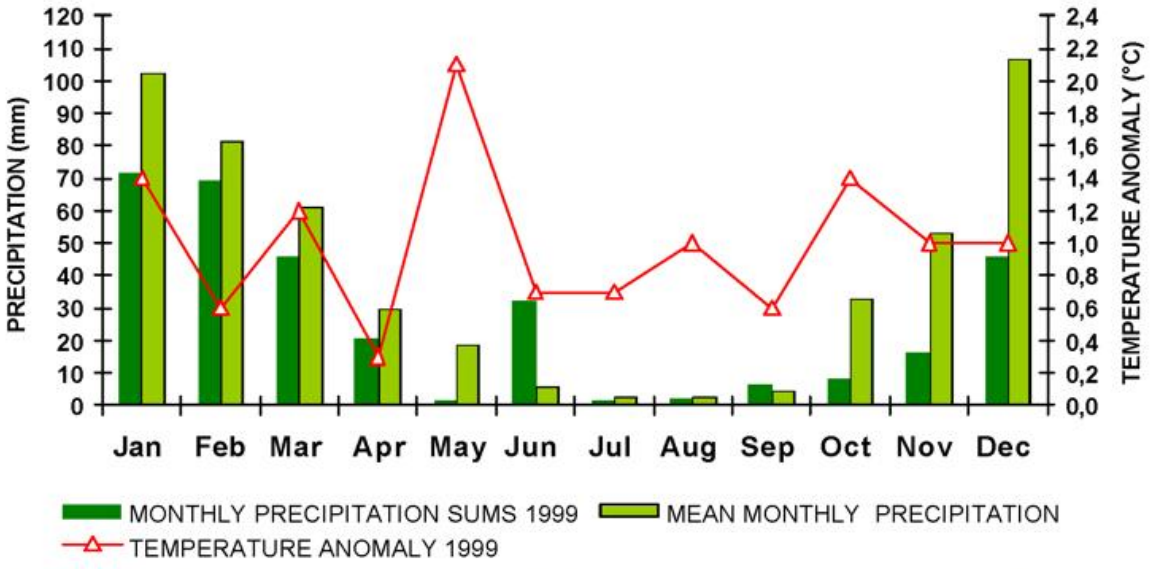


Fig. 6.3: *Monthly area average precipitation and temperature anomalies in Cyprus*
Reference period: 1961 - 1990
From: Meteorological Service of Cyprus

July 1999:

- **Hot and dry from Russia to England**
- **Heavy rains and devastating floods, especially in south-eastern Europe**

The heat over eastern Europe, that had started in June continued in July and for European Russia, it became the biggest heat wave of the century. The record temperatures were equalled last in 1895. Heat and drought sparked off some of the worst forest fires in the recent history. For the whole month, vast areas especially in the Northwest but also around Moscow, suffered from exceptional fire hazard. Also in Ukraine, the hot and dry weather (see figure 7.1), that had started in May, went on, becoming the most severe drought for the last 50 years.

Central and Western Europe experienced an extremely sunny and warm summer month. Across the southern parts of the UK, it was the driest July since 1911 and the sunniest since 1990. The first 10 days of the month were extraordinarily hot in Portugal, and July 8 - 10 set in many places new temperature maximum records (see figure 7.2). In Israel, too, the average daily temperature in July–August 1999 was one of the highest ever recorded, yet not as high as the year before (see figure 13, page 12).

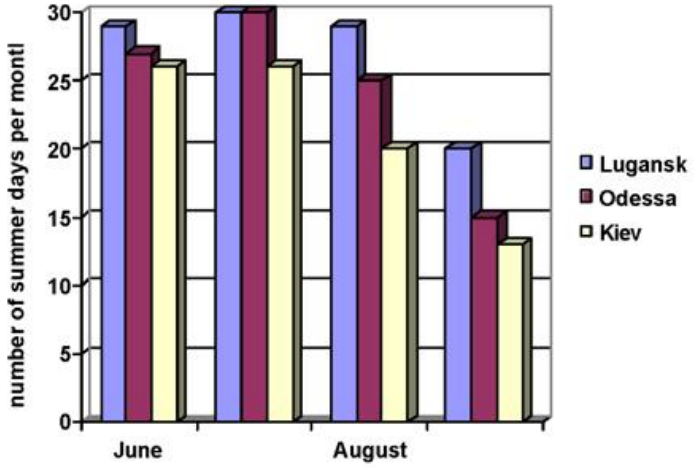


Fig. 7.1: *Number of days with maximum temperatures above 25 °C in Ukraine in 1999*
From: Ukrainian Hydrometeorological Center

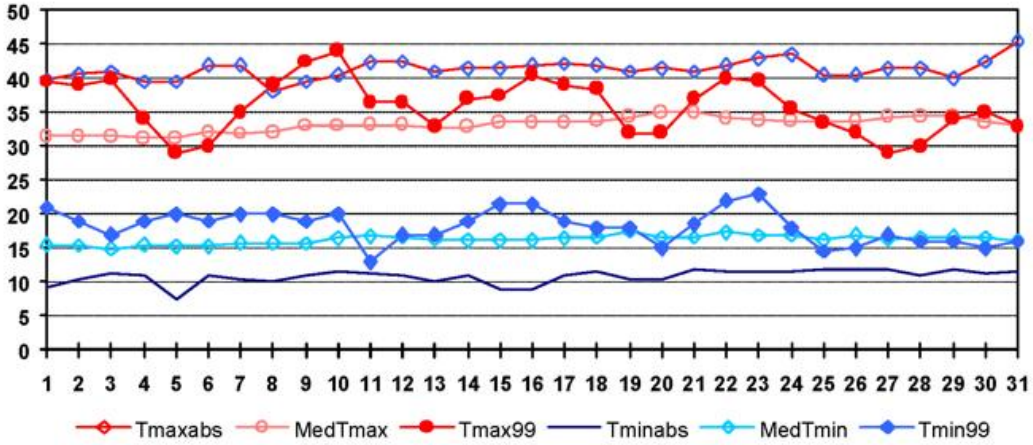


Fig. 7.2: *Daily temperatures in Elvas, Portugal, in July, reference period: 1961 - 1990*
From: Instituto de Meteorologia, Portugal

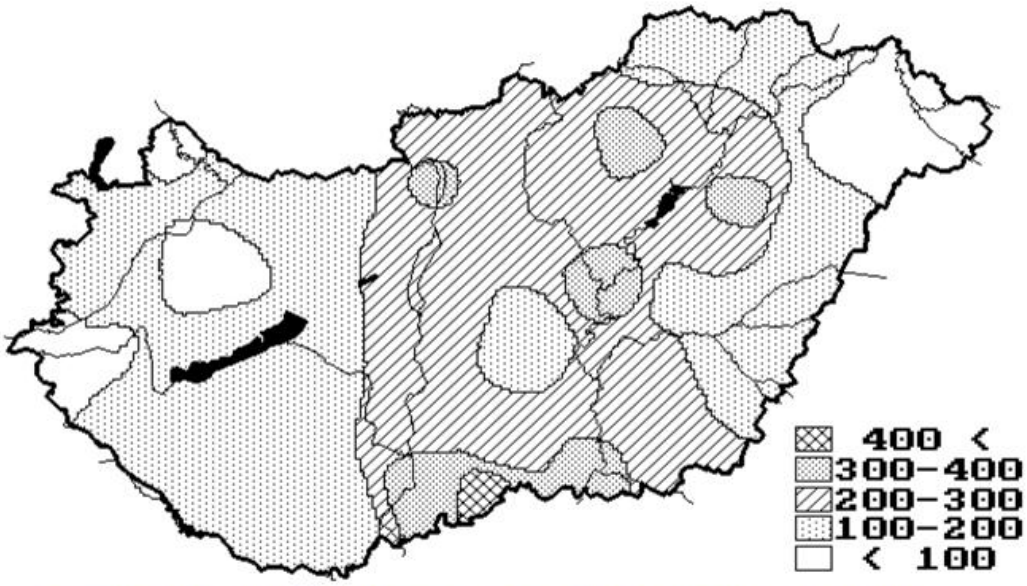


***Fig. 7.3**: Precipitation amounts in percent of normal in Hungary in July 1999*
Reference period: 1961 – 1990
From: Meteorological Service of the Republic of Hungary

July was also a month of heavy rainstorms:

- Floods causing substantial damage followed severe thunderstorms in eastern Belgium and southern Netherlands on July 4/5.
- In the UK, widespread thunderstorms (83 mm of rain at Charing, Kent), mini tornadoes and local flash floods occurred on July 5/6.
- Between July 4 - 8 and 12 - 20, again and again thunderstorms and downpours occurred in the Rhine-Main-area and in parts of south and south-eastern Germany. Intense rainfall (up to 160 mm within 3 hours) and hail (diameters up to 4 cm) caused damage amounting to more than 10 million Euro.
- A cold front, that had crossed Latvia on July 6, fostered showers, hail, thunderstorms and a squall line which raged Sigulda, near Riga.
- Considerable damage by hail occurred in western and north-western Switzerland on July 5.
- Rain and hail caused high, mostly agricultural losses in Turkey in mid-July. 4 people died and 200 houses were flooded in Ki?ikkale.
- Heavy rains caused severe mudflows in the Zaragoza province, Spain.
- On July 18, 21 members of a canoeing group lost their lives when the water level of a small river near Interlaken, Switzerland, rose abruptly after a violent thunderstorm.
- Widespread deluges occurred in south-eastern Europe causing extreme losses, estimated to more than 600 million US$. Vast fields were flooded, industry and infrastructure badly damaged. In Slovakia, the month belongs to the top ten rainy Julys of the century. The heavy rains caused isolated floods. The most extreme situation was in the Krupinica river basin, south-central Slovakia, where the culminating discharge had an estimated return period of about once per 1 000 years. Total losses in Slovakia were estimated to 56 million Euro.
- In Hungary, the monthly precipitation sums exceeded 100 mm at most places, this is for some locations 200 - 400 % of the average (see figure 7.3). Frequent thunderstorms occurred, some of these poured down more than 100 mm of rain in one day. In Heves county, unprecedented losses occurred as a result of floods and high waters, which affected about 40 000 hectares of agricultural lands, one third of the total in the county. In many settlements, water rose to surround houses, many buildings suffered damage or collapsed, several thousands people had to be evacuated. By the end of July, losses due to extreme weather in Hungary were estimated slightly less than 300 million US$.

- Severe damage was caused by rains in Romania on July 11/12: The heaviest losses (33 % of the total annual damage) occurred in the south-western parts of the country. 130 mm of rain in 12 hours made river Fenes to exceed its flooding level by 160 cm. The exceptional amount of 136 mm in 2 hours recorded on July 12 in the mountain area of the Raul Mare river basin caused very water levels flow which triggered flooding and destruction of two blocks of flats. 13 people died and many were injured by mud flows, driven rocks, logs and other wood debris. 217 mm of rain in 48 hours entailed flooding of river Husnita river on July 13.
- In Bulgaria, stormy winds and heavy rain caused disastrous flooding on July 10/11. On July 27, downpours with hail like "apple" (20 cm layer depth) (48 mm in four hours in Montana) led to floods and high damage in the north-west of the country.
- Belgrade, Yugoslavia, recorded a precipitation amount of 262 mm. This is a new record since instrumental measurements started in 1888 (see figure 7.4). The previous maximum precipitation amount was reported in July 1890, amounting to 191mm.

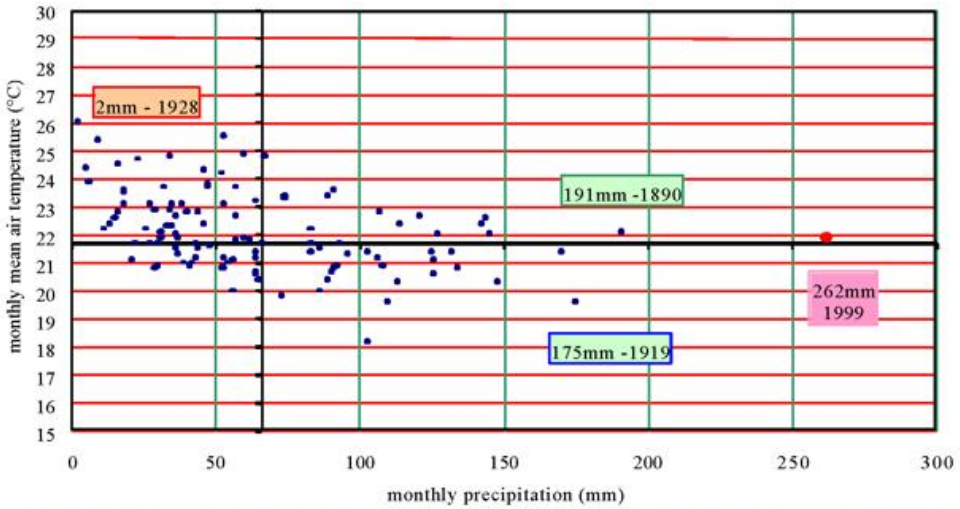


Fig. 7.4: *Monthly mean air temperatures and precipitation totals between 1888 and 1999 in Belgrade in July opposed to the 1961 - 1990 normal (temperature of 21,7°C, precipitation of 66 mm)*
From: Federal Hydrometeorological Institute, Belgrade

August 1999:

- **Relief from the heat wave in the East**
- **Warm and dry in the South**
- **Local heavy thunderstorms, abundant rain in Turkey and Portugal**

August started hot, dry and sunny in most parts, thus the bush fire risk in the Baltic States and European Russia still increased. From August 5 onward, normal temperatures and precipitation conditions brought relief from the long lasting drought. Southern Italy, Greece and Israel were affected by scorching heat waves: Temperatures climbed up to more than 40 °C setting new temperature records at some places (e.g. Catania Signonella 45 °C on August 10). Hot and dry weather affected also Armenia which recorded daily average temperature of 6 - 8 °C above normal. The dry weather in the South engendered a number of bush fires. In Bulgaria, losses due to wild fires reached 5 million US$ (see also figure 11, page 11).

Rainfall conditions varied a great deal across the Region. Precipitation totals of less than 50 % of normal were recorded in

Finland, regionally in Central Europe and in most parts of the Mediterranean. Cardiff and Birmingham, England, however, had their wettest August on record, with 176 and 154 mm of rain respectively. Abundant rain (more than 300 % of normal) fell in Portugal, in parts of Turkey and north of the Caspian Sea. Rainy weather persisted in Hungary. The northern part of the country suffered again receiving as much as 200 - 300 % of the long-term average. In a sub-basin of river Leitha, a tributary of river Danube, in Austria, an extreme flood with a return period of more than 100 years was observed.

Lithuania was hit twice by rain storms: On August 9th, a heavy shower in the city of Kaunas, resulted in 54 mm of rainfall in 1 h 25 min, with hailstones 22 - 30 mm in diameter. On August 16, in the town of Klaipëda 55 mm of rain fell in less than 12 hours and turned streets into streams. The lower parts of the town were inundated. Bulgaria, recorded 15 days with thunderstorms and 12 with hail. Most severe hailstorms (with stormy gusts > 90 km/h) crossed the South and Northeast of the country. Losses were estimated at about one million US$.

In Denmark, an unusual high number of water spouts caused locally considerable damage.

On August 28, a severe storm hit the Azores Islands.

September 1999:

- **Extraordinarily warm in most parts**
- **Very dry in the East**
- **Wet in the West and on the Balkans**

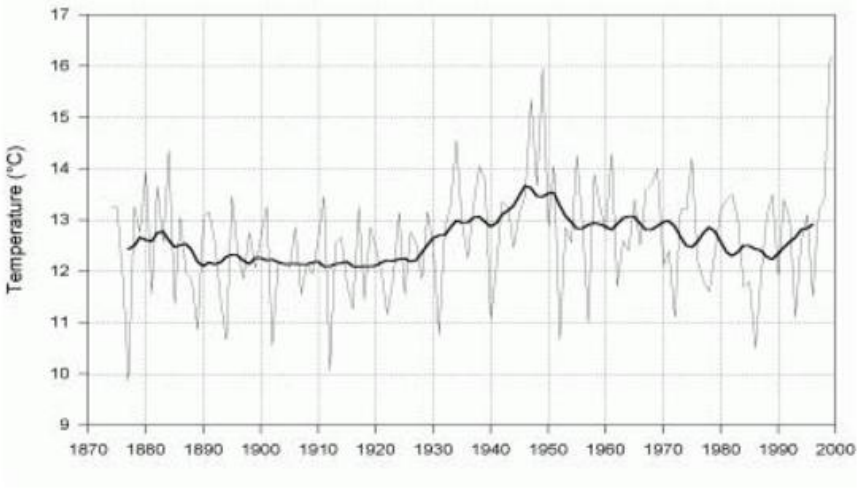


Fig. 9.1: *Mean temperatures in Denmark in September between 1874 and 1999*
Bold line: 10 year running mean
From: Danish Meteorological Institute

September 1999 was extremely warm and mostly very sunny. For Denmark (see figure 9.1), Norway and the Netherlands it was the warmest September since records started in 1874, respectively 1860 and 1706. Over all of Germany, it was the warmest September of the century and at several stations, it was the warmest month of the whole year. For Belgium, the mean temperature and the mean minimum temperatures equalled those of September 1949, which was the warmest since 1833 (see figure 9.2). Gravesend, Kent, reached 30,4 °C on September 11 - the highest September temperature in the UK since 1973. In spite of unsettled weather in the second half of the month, the high temperatures in the earlier part made it the warmest September since 1949, and

continued the trend for warm months during 1999. Also In Austria, it was one of the warmest September of the last 50 years.
Only in the utmost East of the Region and on the Iberian Peninsula, slightly sub-normal monthly mean temperatures were recorded.

In north-eastern Europe, the warm weather went along with extreme dryness. In south-western and southern Finland, an exceptional drought had developed during the summer (see figure 9.3). The deficit was considerable for more than two months from mid-July to the second half of September and caused a very poor harvest in these regions.

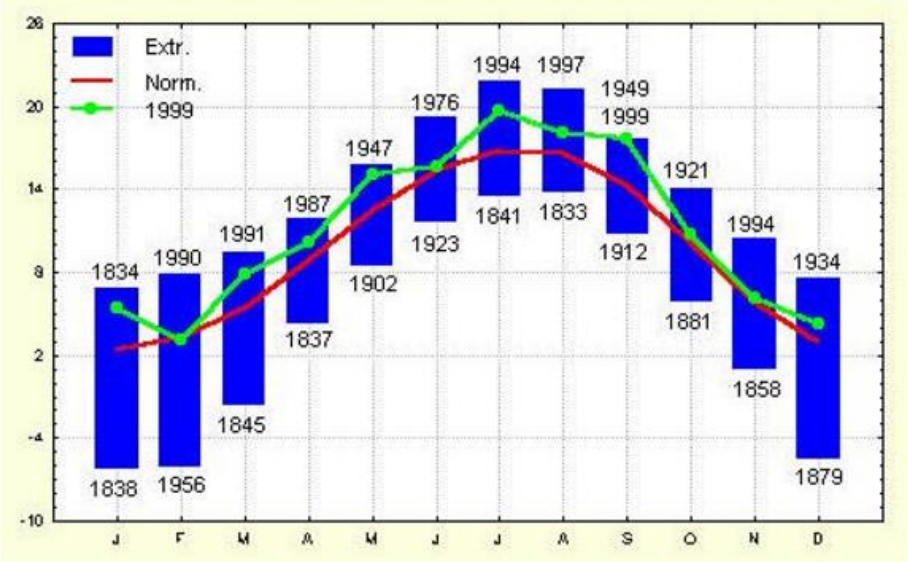


Fig. 9.2: *Mean monthly temperatures at Uccle, Belgium:*
1999 means, 1833 - 1985 normal and absolute extremes since 1833
From: Royal Meteorological Institute of Belgium

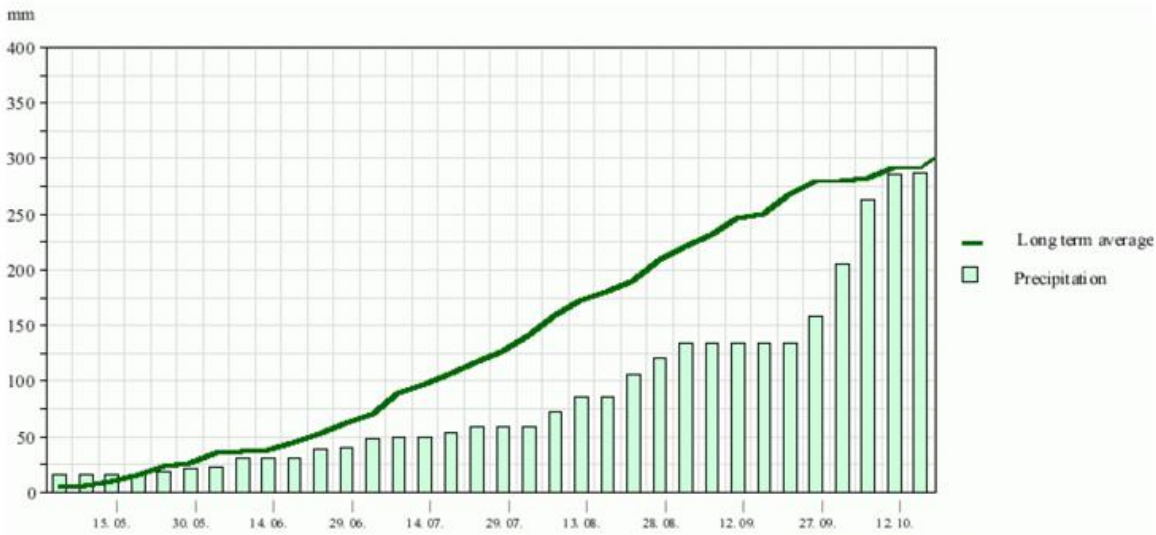


Fig. 9.3: *Accumulative precipitation (mm) of the growing season 1999 at Turku, Finland*
From: Finish Meteorological Institute

In the eastern parts of Ukraine, the summer drought continued and still increased severity in September. This period was one of the warmest and driest of the last 100 years. In many regions, there was hardly any precipitation at all for 20 - 45 days. In Estonia, there was no precipitation during the first 20 days of the month. The rains at the end of the month were the first in almost 3 ½ months.

After a series of extremely wet months, Hungary was more lucky in September when calm, sunny, warm and dry weather prevailed.

The weather was extremely unsettled, especially in the West of the Region and on parts of the Balkans:

- In Ireland, it was the wettest September on record at many stations;
- Heavy rains, local flooding and storms occurred in the second half of the month in central and southern England;
- In Portugal, the rainfall amounts were much above normal all over the country causing great damage due to flooding;
- Valladolid, north-western Spain, received 106,8 mm of rain, the highest monthly total in more than 130 years of measurements. In Segovia, there were up to 17 days with more than 1 mm of rain, this was the highest number of rainy days in September for any year in the last century. Three severe tornadoes occurred in the south-eastern provinces of Alicante, Murcia and Granada;
- The north-eastern parts of Italy were affected by severe rainfall on September 20/21 (up to 230 mm per day with estimated return periods exceeding 50 years);
- Towards the end of the month, a flood situation at some tributaries of the river Inn in Austria appeared with a return period of about 100 years;
- In Slovenia, especially the coastal region suffered from drought. However, precipitation in the central parts were copious. The surrounding of Kocevje and Bela Krajina got about twice their long-term precipitation amount. There were several episodes with intense precipitation, causing local landslides and flooding;
- In north-eastern Bulgaria and along the southern parts of the Black Sea coast, rainfalls from September 2 - 5 caused disastrous floods. The total precipitation for the 4 days period reached 270 mm in Preslav (see figure 9.4) and 289 mm in Staro Oryahovo. Rivers left their banks, dams broke. There were bridges and vehicles carried away, arable fields were flooded with mud, houses, camping and hotels were inundated. Losses surpassed 25 million US$. Thirteen persons died;
- On September 22, torrents in the mountains of the Republic of Dagestan destroyed roads and houses.

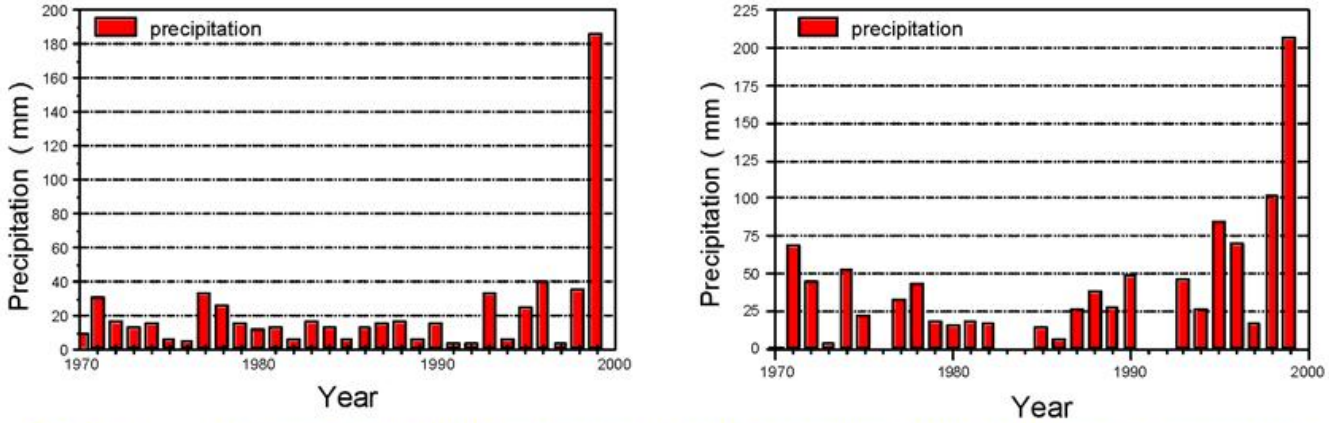


Fig. 9.4: *Maximum daily (left) and monthly (right) precipitation totals at Preslav, northeastern Bulgaria, in September between 1970 – 1999*
From: Bulgarian National Institute for Meteorology and Hydrology

October 1999:

- **Very warm in the South and Northeast of the Region**
- **Early frost in the East**
- **Abundant rains on the Iberian Peninsula**

October temperatures were near normal in most countries. Temperature anomalies of more than + 2 °C were restricted to the Mediterranean and the far Northeast of the Region. Warm weather in southern Europe led to temperatures of 37,4 °C in Palermo and 38,6 °C in Catania, Sicily, towards the end of the month. On contrast, early cold snaps with temperatures as low as –8 °C and snow affected eastern Europe in the second part of the month. In the north of the Astrakhan district, snow and sleet caused havoc on October 22/23: Roads were blocked by snowdrifts, power and telecommunication lines demolished and schools closed.

In the UK and in Central Europe, rainfall was mostly sub-normal and there was an above-average number of sunny days. In England, it was even the sunniest October since 1959, and the second sunniest on record.

Copious rains caused floods and damage in wide parts of Portugal and Spain and the monthly totals reached more than 400 % of normal in the Southeast of Spain.

Moreover, there were a number of regional severe rainfall events:

- The second highest daily precipitation amount in October of the period 1863 – 1999 was recorded in Zagreb-Gric, Croatia, at the beginning of the month (see figures 10.1 and 10.2).
- During the night between October 3 and 4, heavy showers brought 60 - 80 millimetres of precipitation in the western area of The Netherlands, causing a lot of troubles in this rather low lying area of the country.
- On October 6, heavy rain and lightning in the centre of the town of Rujiena. Latvia, were accompanied by falling of 29 – 40 mm large hailstones that covered the ground with a 10 cm deep layer. The hail destroyed greenhouses, damaged crops and cars. This hail event was the fifth during the last 40 years.
- Torrential rains with floods occurred in the mountain watersheds near the Venetian Plain and along the northern Apennines, Italy, between October 23 and 26.
- On October 24, heavy rain and gales hit the British Isles. Many places in North Wales had more than 60 mm of rain in 24 hours while Portland reported a gust of 113 km/h.

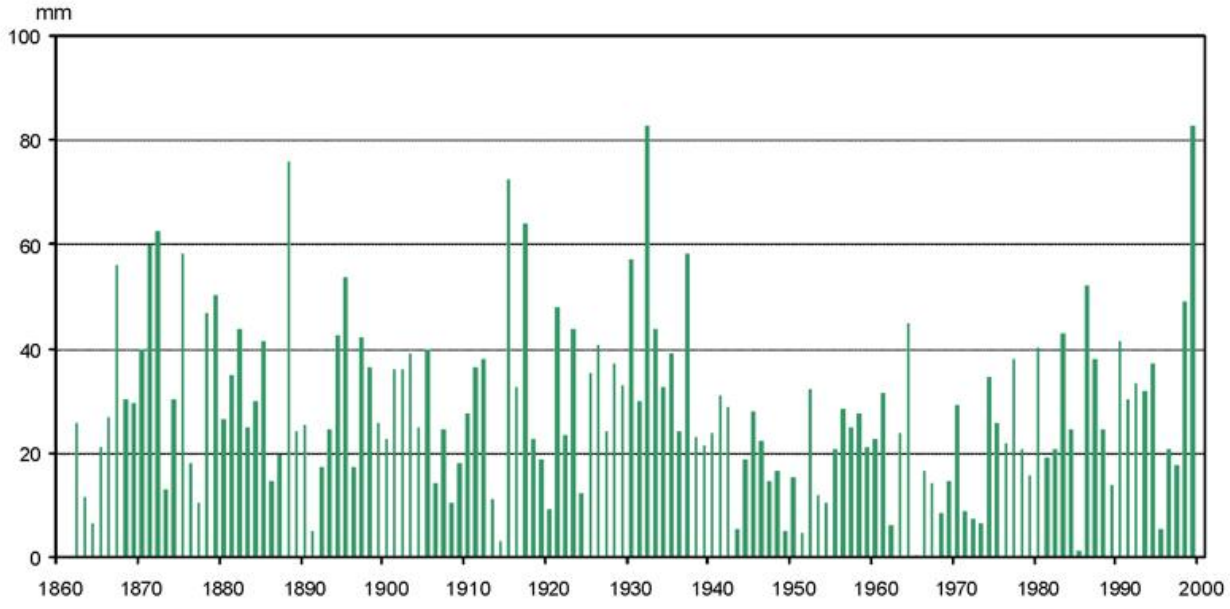


Fig. 10.1: *Maximum daily precipitation totals in October in Zagreb-Gric from 1863 - 1999*
From: Meteorological and Hydrological Service of Croatia

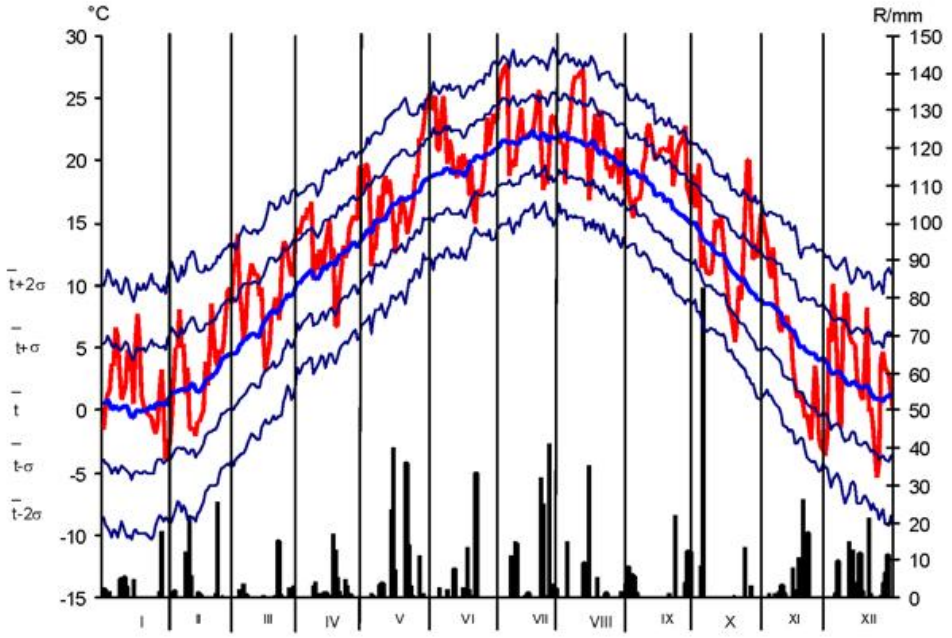


Fig. 10.2: *Mean daily temperatures in Zagreb-Gric in 1999 (thick line), compared to long-term means (central line) and standard deviations (thin lines), reference period:1862 -1995. Daily precipitation sums (columns) in 1999 From: Meteorological and Hydrological Service of Croatia*

November 1999:

- **Very mild in the North**
- **Cold, especially in the East**
- **Mostly dry, but severe floods in southern France, Italy and Greece**

This month, northern Europe was on the warmer side. New monthly maximum temperature records were set in Sweden. In Iceland, two short but extremely warm periods occurred: During the first, there was a new absolute November temperature record for the country as a whole when in the evening of the 10th the temperature rose to 22,7 °C at Dalatangi in the east (prior record 19,7 °C, set in 1971). On the 19th, the temperature in Reykjavík reached 12,6 °C which is the highest temperature ever at that location in November.

For 8 consecutive days (November 17 - 24), temperatures in the coastal area and in the Negev in Israel exceeded 28 °C (5 °C above normal) and even reached 32 - 33 °C.

To the contrary, in a broad belt from Spain across Central Europe to Russia, it was extremely cold. In Russia, monthly temperature undercut the long-term means by more than minus 5 °C and dozens of people died from the early cold snap. For Spain, it was one of the coldest November of the reference period. Only 4 years since 1961 had registered lower November values, and all those were before 1974. For Bulgaria, it was the only month of the year with a negative anomaly of the monthly mean.

The cold and heavy snowfall caused traffic chaos in Central Europe in the second half of the month. In Tyrol and Vorarlberg, Austria, up to 70 cm of snowfall in only 48 hours were recorded on November 22 - 23. On the 24th, Innsbruck reported a new record snow depth for November with 55 cm, the former being only 29 cm in 1977. In eastern Switzerland, too, snow depth records were established (e.g. St. Gallen and Bad Ragaz 62 cm). An unusual high number of days with snow cover occurred in Croatia (see figure 11.1). In Hungary, 20 - 40 cm snow fell and

stormy winds built snowdrifts blocking roads and villages.

It was dry in most parts of the Region. Precipitation totals reached less than 50 % of normal in the Middle East, in southern Scandinavia and in the Southwest of the Iberian Peninsula. In Denmark, November – the statistical wettest month of the year of that country - became the driest month in 1999 (33 mm). In Israel, rainfall amounts were just 15 - 30 % of normal. The dry and warm weather engendered immense forest fires in some areas causing severe damage.

Unsettled weather prevailed in northern Scandinavia and in some parts of South Europe (see also figure 5.3, page 32):

- In Greece, heavy rains and thunder-storms occurred between the 7th and 9th. The heavy storms led to floods and landslides which caused high losses to infrastructure and crops. Four people died.
- From November 12 – 14, an exceptionally rainy episode caused catastrophic floods in Aude, Tarn, Hérault and Pyrénées-Orientales departments, south-western France. Remarkable rainfall amounts were reported, reaching 620,2 mm in 48 hours at Lézignan-Corbières (Aude) (see figure 11.3). The losses were estimated to more than 500 million US$.
- Seven speleologists were captured in a flooded cave for 11 days.
- In Italy, on November 13, an exceptional flooding occurred in the Cagliari district, Sardinina (the Decimomannu weather station recorded 196 mm of rain in 24 hours). A state of emergency had to be declared.
- On November 18/19, rainstorms (100 mm in 10 hours), snow and gale-force winds caused serious problems in Tuscany, Italy. Industrial areas and settlements were inundated, trees uprooted and roads blocked .
- In the lowlands of Slovenia, fog and low cloudiness was very frequent. Thus it was the least sunny month of the year (see figure 11.2).

The month ended stormy in the Baltic area: On November 29, in western part of Estonia storm with gusts over 116 km/h damaged forests and power lines. The same storm felled huge amounts of wood in the provinces Närke and Södermanland in south central Sweden. In St. Petersburg, Russia, wind speeds up to 83 – 94 km/h entailed a severe tidal wave, and badly damaged the municipal infrastructure.

A wild storm caused several casualties and large material damage in the Rize area, Turkey.

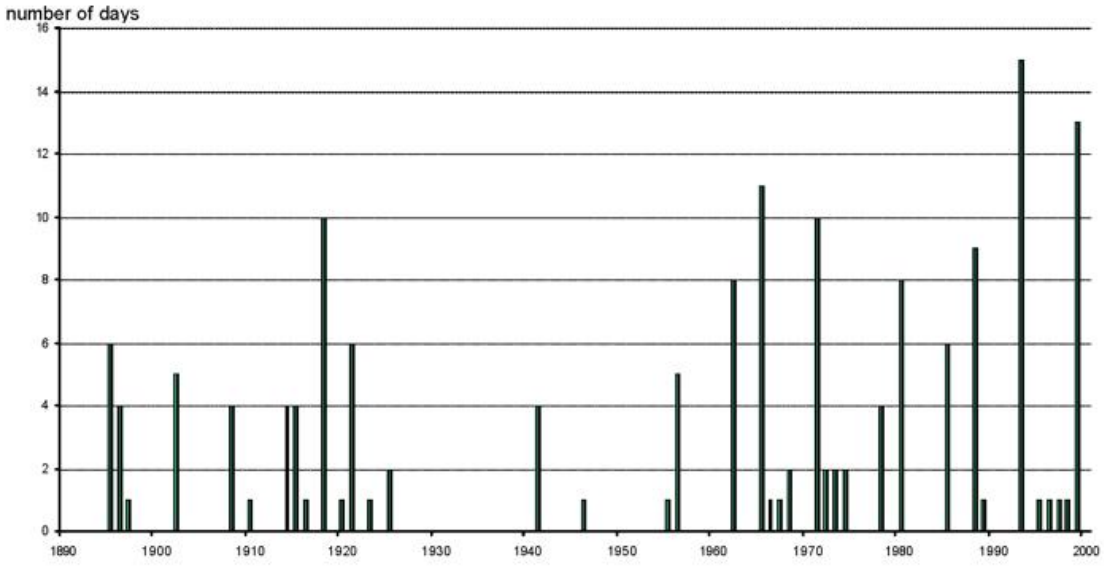


Fig. 11.1: *Maximum number of days with snow cover in November in Zagreb-Gric from 1890 - 1999*
From: Meteorological and Hydrological Service of Croatia

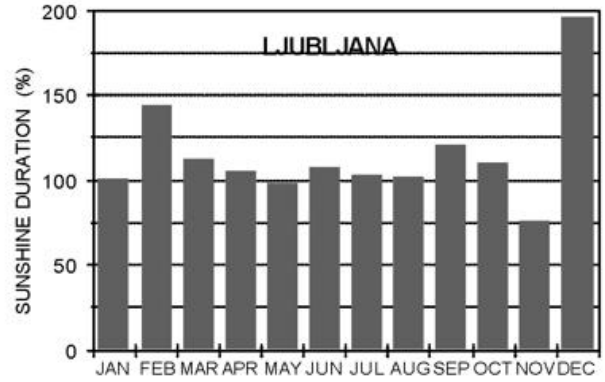


Fig. 11.2: *Monthly sunshine duration in 1999 in percent of normal*
Reference period: 1961 - 1990
From: Hydrometeorological Institute of Slovenia

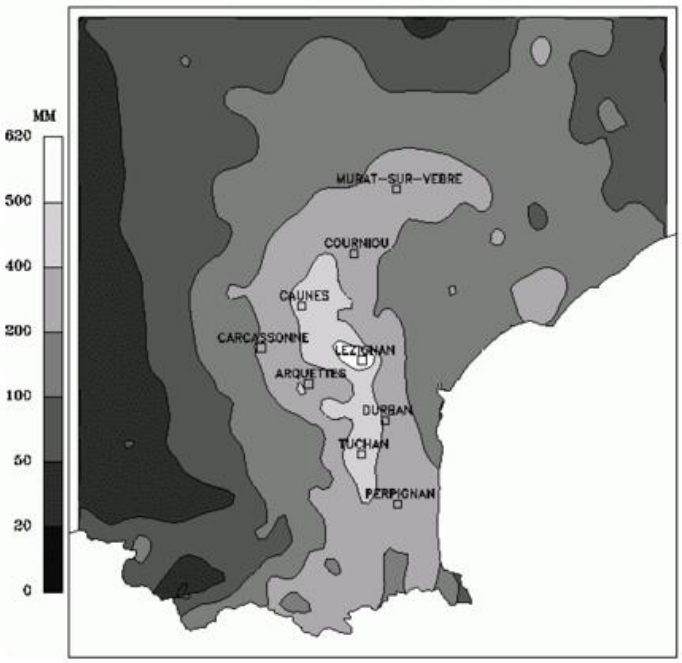


Fig. 11.3*: Precipitation totals in south-western France from 12/11/1999 to 13/11/1999*
From: METEO FRANCE

December 1999:

- **Devastating storms**
- **Wettest December on record in places, but dry in the South-east**
- **Very mild in the East, but cold in the North-west**

It was a very windy and rainy month in most parts of the Region. A series of severe storms brought the highest wind speeds ever recorded in parts of Europe. Two periods of strong winds stand out.

The first major storm, *Anatol,* struck northern Europe on December 3-4 (see figure 12.1, above). New records of maximum wind speed (up to 185 km/h) were set on the islands of Rømø, Denmark, and Sylt, Germany (see figure 12.2). Denmark was hit hardest, but also southern Sweden, Poland and the Baltic states suffered high losses: The winds downed trees, blew off roofs, knocked over trucks and raised hazard tidal waves. Storm-related deaths totaled 20.

Two more fierce storms, *Lothar* (Dec. 25-26, see figure 12.1, below)) and *Martin* (Dec. 27-28), struck wide parts in the West and South of the Region after Christmas, causing even higher losses. In France, these events combined led to wind gusts of more than 200 km/h (see figure 12.3) (Mandelieu-la-Napoule: 205,2 km/h. The corresponding

return period of such an event is estimated to 150 years, or even more.) In the mountains, wind squalls of more than 250 km/h (Wendelstein, Germany: 259 km/h, Jungfraujoch, Switzerland, 249 km/h) were recorded. Freak storms and avalanches claimed over 130 lives in France, Spain, Switzerland and southern Germany. Material losses were estimated at about 11 000 million US$.

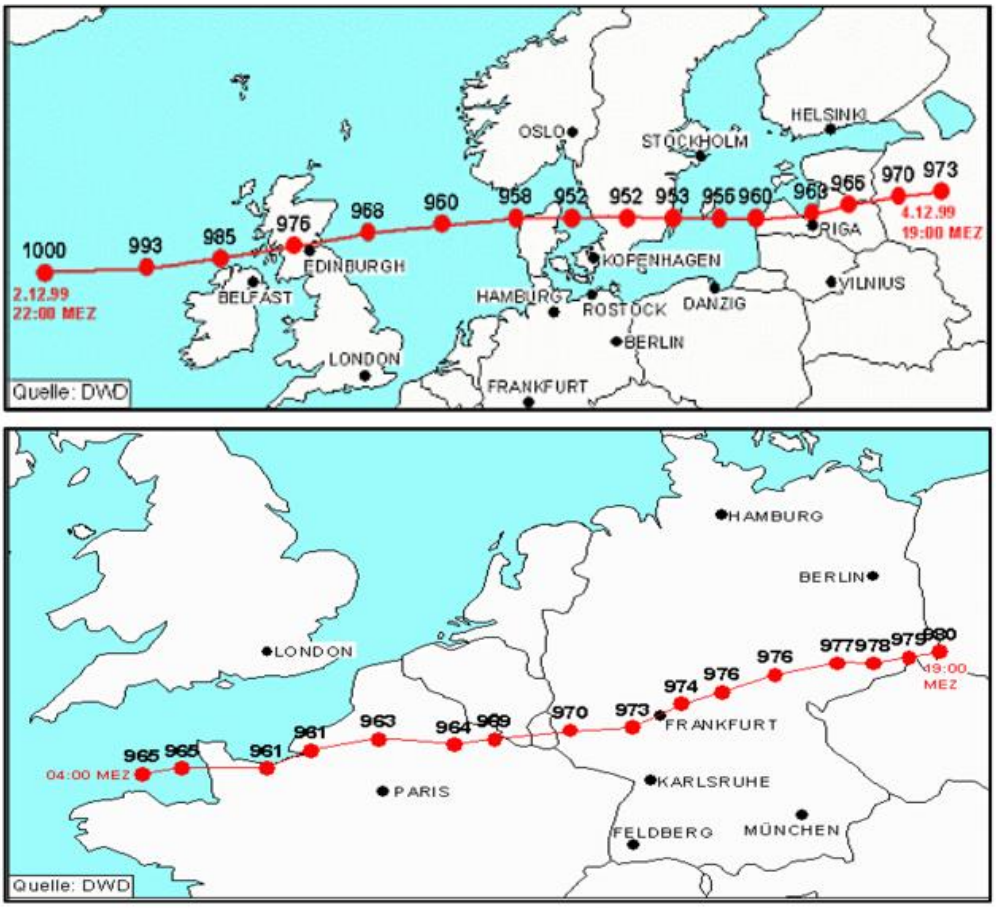


Fig. 12.1: *3-hourly positions and core pressure values in hPa of "Anatol" on Dec. 2/4 (above) 1-hourly positions and core pressure values in hPa of "Lothar" on Dec. 25 (below) From: Deutscher Wetterdienst, Germany*

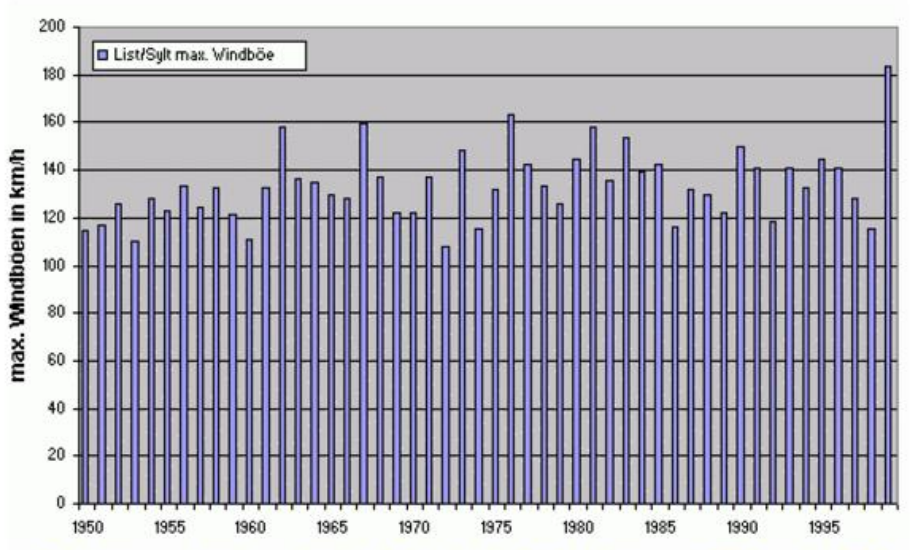


Fig. 12.2: *Maximum wind gusts (km/h) in List, Sylt, between 1950 and 1999 From: Deutscher Wetterdienst, Germany*

The stormy days went along with considerable pressure changes, even at sites far from the pressure centres (see figure 12.4).

The westerly winds brought mild and unsettled weather. And there were frequent rains and thunderstorms. For Belgium (see figure 12.5) and Ireland it was the wettest, for Denmark, the second wettest December on record. From south-western Sweden, several new records and maximum monthly precipitation amounts of around 300 mm were reported. Again, there was plenty of rain in Hungary, increasing the still existing risk of floods in parts of the country.

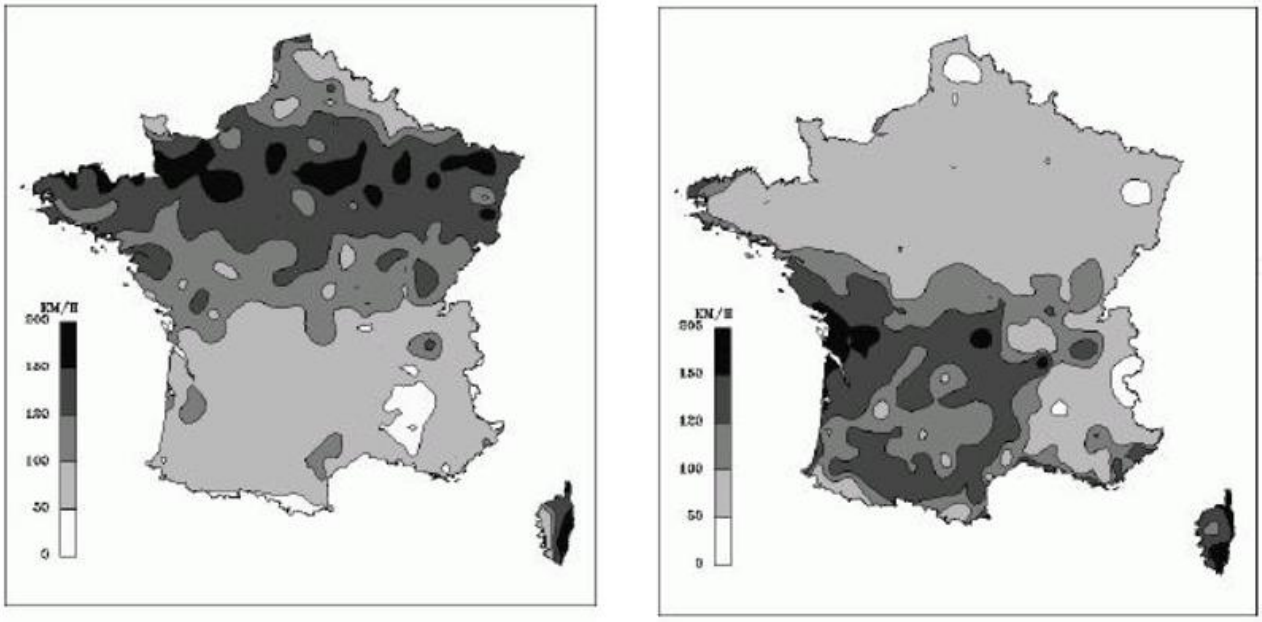


Fig. 12.3: *Maximum gusts in France on December 25 - 26, 1999 (left) and December 27 - 28,1999 (right), using stations with elevation <= 500 m*
From: METEO FRANCE

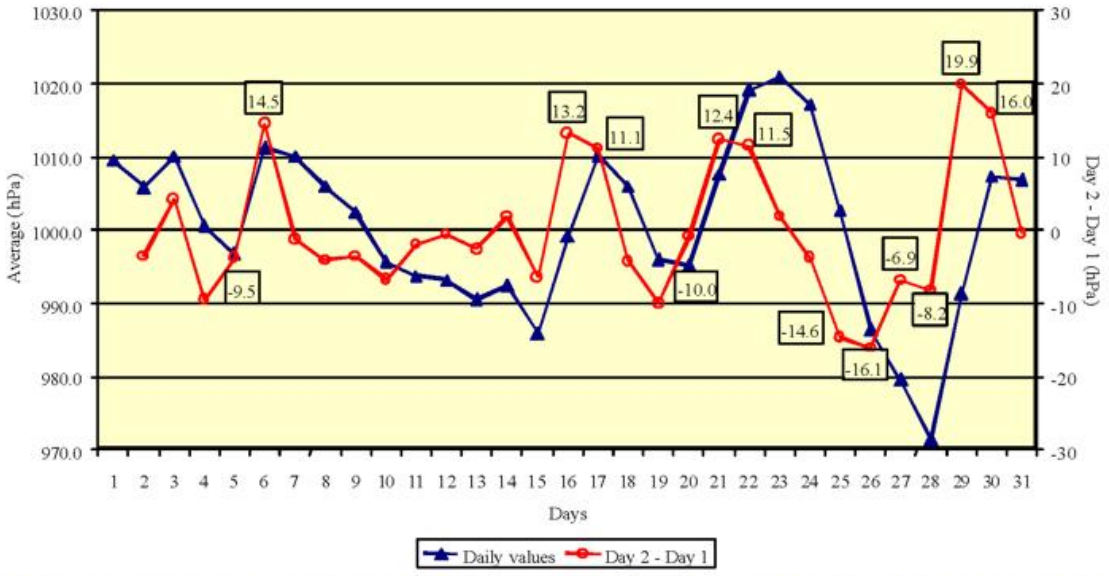


Fig 12.4: *Station pressure and pressure change from day to day in Belgrade in December 1999*
From: Federal Hydrometeorological Institute of Yugoslavia

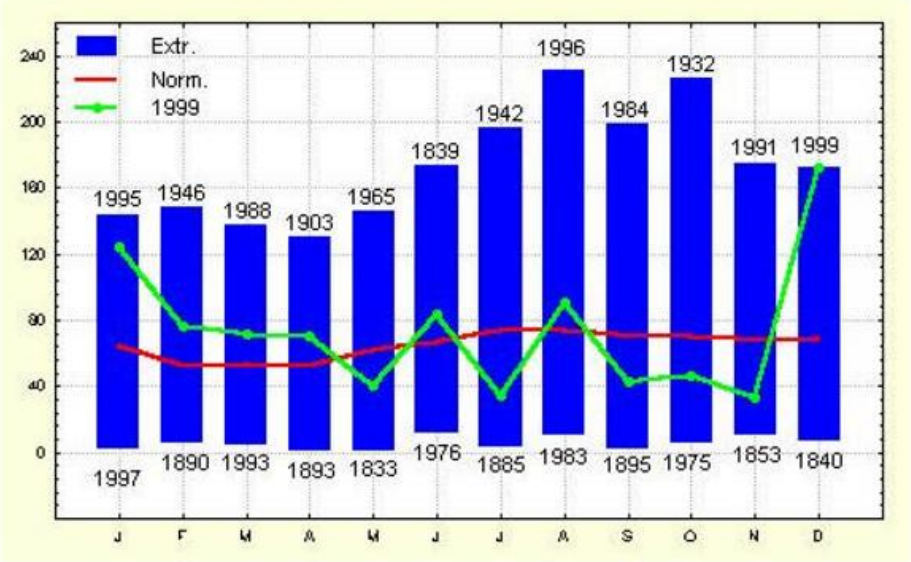


Fig. 12.5: *Mean monthly precipitation totals in mm at Uccle, Belgium: 1999 means, 1833 - 1985 normal and absolute extremes since 1833 From: Royal Meteorological Institute of Belgium*

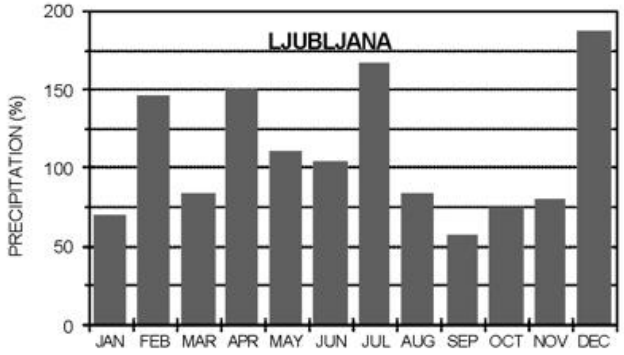


Fig. 12.6: *Monthly precipitation totals in percent of normal (1961 - 1990) in Ljubljana in 1999. From: Hydrometeorological Institute of Slovenia*

On December 14 - 17, a severe rainstorm affected central and southern Italy as well as parts of the former Yugoslavian Republic, triggering regional floods and mudflows with 6 casualties. In the Campania area, east of Naples, 324 mm of rain were recorded within 2 days (return period 80 years).

In Slovenia rainfall was abundant. Some areas in the western mountains received more than twice the monthly average (see figure 12.6). Nevertheless, the bright sunshine duration considerably exceeded the long-term average (see figure 11.2., page 44). This was also true for the UK where the month was mostly wet but, at the same time, one of the sunniest since records started.

However in the Southeast of the Region it was again extremely dry. With only 20 - 40 % of normal precipitation, dry conditions caused severe water shortage in parts of Armenia (see figure 1.2, page 27). Jordan received not even 10 % of normal (see figure 1.1, page 27). In Israel, December rainfall amounts were just 30 – 50 % of the long-term averages. Thus, altogether the accumulated rainfall amounts from the beginning of the rainy season in September till the end of December were much lower than normal – North and central Israel received only 20 - 40 % of normal, and the southern areas less than 10 %. This makes it one of the worst starts of the rainy season, and very similar to the beginning of the 1998/99 rainfall season.

While mild weather prevailed in the East with monthly anomalies surpassing plus 5 °C, it was very cold in the North. Reykjavík, Iceland, recorded 25 days with snow cover, which is highly unusual.

Activities and Results of European Climate Centres

News from the European Climate Support Network

ECA2000

The European Climate Assessment 2000 has as its main goal the description of the climatological variability through observed records of temperature and precipitation. Since the latter are essential in order to fulfil the objective, during the last year the project has continued to put a lot of effort in building its long series dataset. This dataset now comprises over 150 daily and 200 monthly time series form 28 European countries, but the aim is to cover all RA VI territory. Such valuable dataset will form the basis for another ECSN project that will soon be started with the objective of producing a historical daily dataset with no restrictions of use.

Besides making headway in the necessary groundwork of data gathering, the series have also been analysed. A list of climatic variability indicators has been drawn up and applied to the series (these can be found at: http://www.knmi.nl/samenw/eca/index.html). This has allowed the intercomparison of the behaviour of the indicators between nearby stations and so detect possible breaks of homogeneity or anomalies in the spatial coherency that may have escaped the earlier controls at the NMSs. On the other hand the trends in the different indicators have been computed and drawn on maps that give an overall view of the climatic variability for the period analysed. In some regions the lack of complete series casts some doubt on the significance of the trends found, although the precise formulation of those limits is a difficult task that is being tackled now.

Database management

The first workshop of this project took place in Oslo in October 1999. The participants, 27 from 14 countries, gave an overview of the different climate databases in their respective countries. In addition to this different topics were discussed, among them the problems in using commercial database products, the opportunities offered by the relational databases, questions about design and optimisation, storing techniques and retrieval possibilities. Special attention was devoted to the use of web-tools in presenting the information stored in climate databases, which was recognised as having a great potential. A report on this workshop has been issued by DNMI (DNMI Klima 05/2000).

In order to continue this exchange of views and experiences on a regular basis the possibility is being studied of setting up an Internet-based news group. The next workshop is scheduled for next year, and workshops addressing special topics could also be arranged. One of this could deal with quality control issues, a subject that has been already discussed inside the NORDKLIM group and could clearly benefit from a collation and standardisation of methods among the NMSs.

GIS in climatological applications

The Oslo meeting of the Databases project also offered an opportunity for discussing the work plan of this GIS project and exchanging ideas about how to proceed. An enquiry on the use of GIS in the different NMSs has been compiled. The project has produced a report about the different spatial interpolation methods, schematically describing their relative advantages and disadvantages and listing some of their characteristics. It is planned to distribute a package of interpolation methods to be compiled by each receiver.

The relation of this ECSN project with the similar COST719 action, was clarified in a meeting in March this year in Vienna. Both activities should interact constructively, and the broader scope and scientific depth of the COST action will permit the better development of GIS applications in the frame of the ECSN project. Two possibilities are being considered in this respect at the moment, GIS-based information tools and analytic applications.

Climate monitoring products

A kick-off meeting was held in Hamburg (January 2000). A first point in the agenda was to review the activities related to climate monitoring matters that are presently done at the NMSs, as well as the products available from other international institutions like WMO, especially those published by Internet. It was recognised that there is a great variety of weekly, monthly, seasonal and yearly monitoring reports and products available on national levels. However, in order to provide European monitoring products on a monthly and event related basis in a timely manner it is necessary to smooth differences at the border and to standardise formats. The project envisages giving access to such products through a special homepage. The work was divided in five areas according to the type of data, with co-ordinators appointed for each of them: in situ data, satellite data, model output data, special climatological events and RA VI Bulletin.

European Climate Atlas

After a feasibility study showed that the initial objective of making a European Atlas of extremes and climate applications related parameters lacked sufficient agreement on technical questions and was likely to have difficulties in gathering the necessary data, the idea now is to concentrate on producing a climate description for Europe based on monthly values for the 1971 - 2000 "normal" period. Tables with climate statistics and maps will be put in a CD-ROM, extending to Europe the CD-ROM that Meteo-France has commercialised for the 1961 - 1990 normal period. If the proposal of the project co-ordinator is found acceptable to all Members work could begin next year.

Drought project

The activities of this project with few participants (Hungary, Spain and Portugal) have consisted mainly in the comparison of drought indices. At the last ECSN Advisory Committee meeting (Oslo, June 2000) the idea was suggested of including in the ECA2000 some indicator for drought, probably the SPI index. More countries like Austria and Norway have shown their interest in collaborating with this project.

ECSN Climate Dataset (ECD) project

Last year ECSN undertook the creation of a dataset of historical instrumental long series of daily data in order to meet the demand that the scientific community has expressed in this sense (for instance EUROCLIVAR). The EUMETNET Council (June 1999) considered positively a proposal presented by the ECSN Responsible Member INM consisting in building such a dataset with basically no constraint on use and distribution and a network density at a minimum that of the GCOS-GSN. A small working group worked out the details in the summer of 1999. The density of stations envisaged now for this daily dataset is 2 per 100 000 km^2 (plus some mountainous stations and a correction for coast line) and the basic parameters to be included are temperature (both maximum and minimum), precipitation and pressure, starting from as long in the past as possible (recommended at least since 1951). A call for proposals in order to carry out this plan was distributed and only one joint proposal from KNMI-DNMI has been received. If everything goes all right, the project should get its official start with the approval by the EUMETNET Council in November this year.

Results of the ECSN Council Review

Since this is the last year of the present 3-year EUMETNET-ECSN Programme contract, the Council reviewed in April the ECSN activities. Summarising the conclusions, the objectives for ECSN remain valid and the continuation of ECSN was agreed. For the climate Atlas, the drought and climate monitoring projects a decision will be taken as to their further continuation in a year. The Council also gave some general guidelines for the future work of ECSN, for instance to foster the common development of tools and exchange them, to focus the research actions in exploiting the wealth of data stored by the Members and provide a structure allowing to merge European climate data, and to improve the access to the Members' climate data bases.

More information about ECSN at http://www.inm.es/wwc/html/dtemint/ecsn/ecsnhome.html .

The climate of the 20th century in Sweden

By: Swedish Meteorological and Hydrological Institute

In an effort to summarise the climate of the 20th century 10 homogenised series of temperature and 20 series of homogenised precipitation have been used to produce graphs of winter and summer temperature and annual precipitation. It should be emphasised that especially precipitation is loosely or even negatively correlated between some parts of the country so it is a bit artificial to construct nation-wide averages.

The warmest decades of the 20th century were the 1930-ies and the 1990-ies, especially in winter. In both temperature plots there is also a maximum in between around 1970 - 1975. Two very contrasting pairs of summers (very warm and then very chilly) occurred close to the ends of the interval, 1901 - 1902 and 1997 - 1998.

The most obvious trend is the increase of the annual precipitation and it is thought that this, in spite of the efforts to homogenise data, to some extent depends on better instruments and better shelter from winds. But it has also been shown in various studies that the increase is, at least qualitatively, supported by an increase of wet, cyclonic (often westerly or southerly) weather types and/or a decrease of dry, anticyclonic (often easterly) types. The increase from the 1970-ies to the high levels 1980 - 1999 is quite large and undoubtedly real.

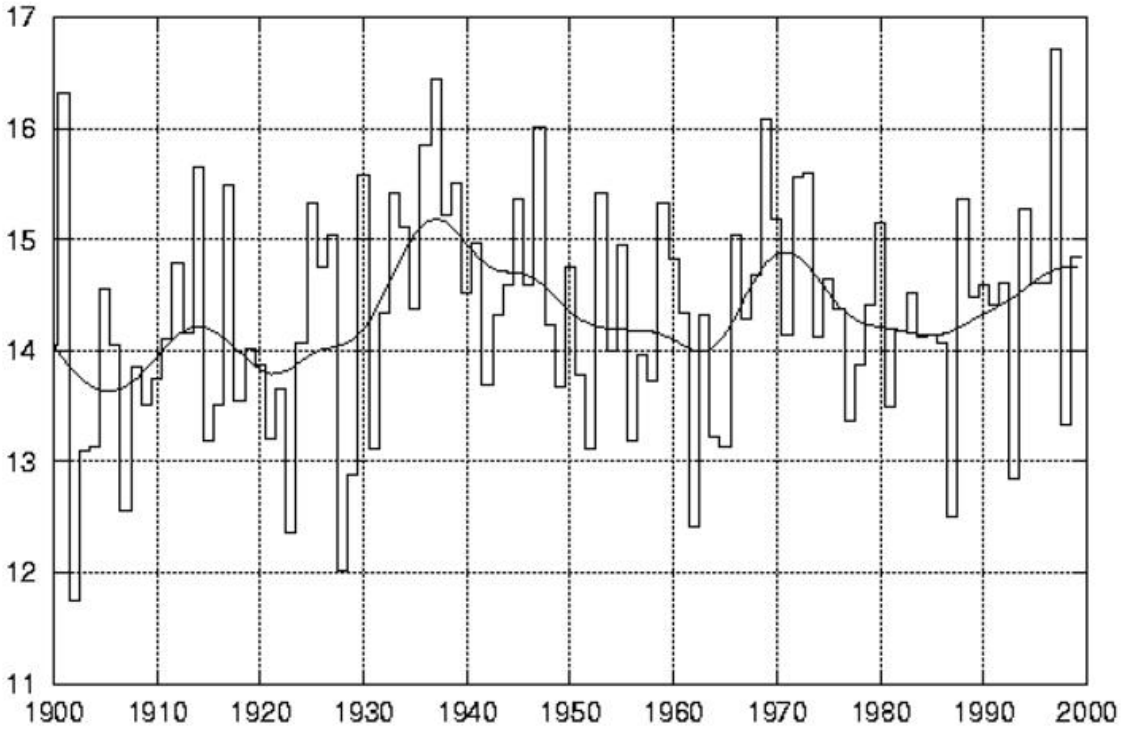


Fig. 1: *Summer (June - August) temperatures in Sweden 1900 - 1999, average from 10 homogenised series. The smooth line represents a low-pass filtered curve of Gaussian type emphasising variations on time scales of ten years and longer.*

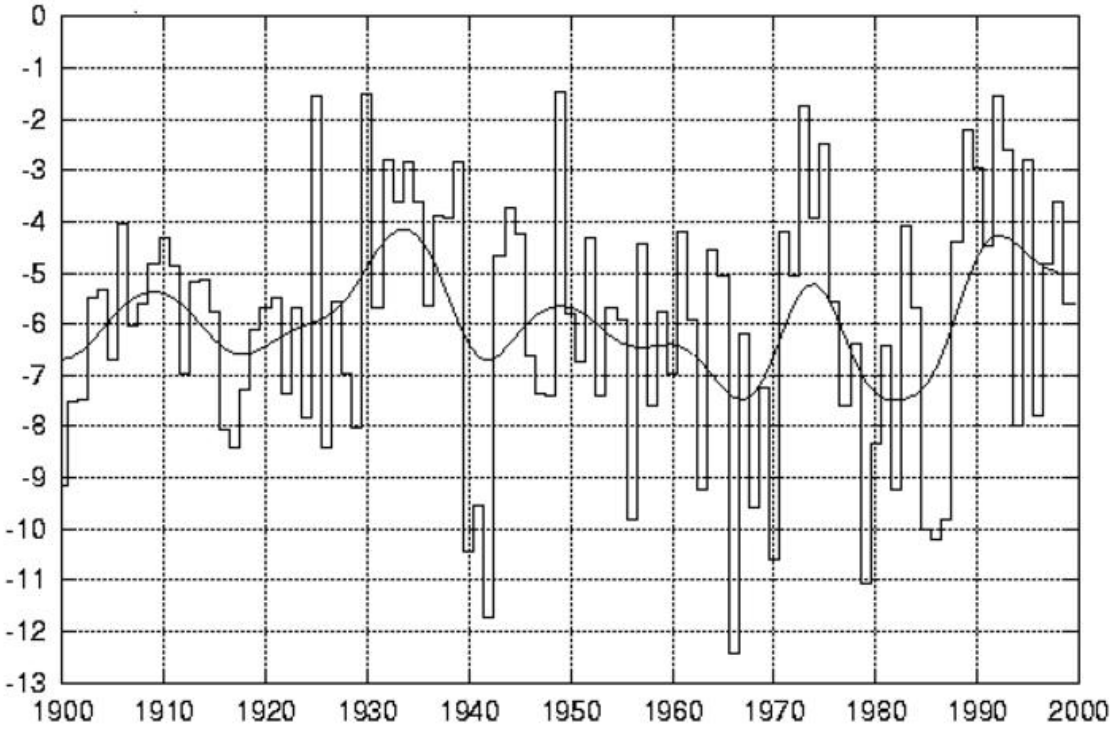


Fig. 2: *Winter (December previous year to February actual year) temperatures in Sweden 1900 - 1999, average from 10 homogenised series. The smooth line represents a low-pass filtered curve of Gaussian type emphasising variations on time scales of ten years and longer.*

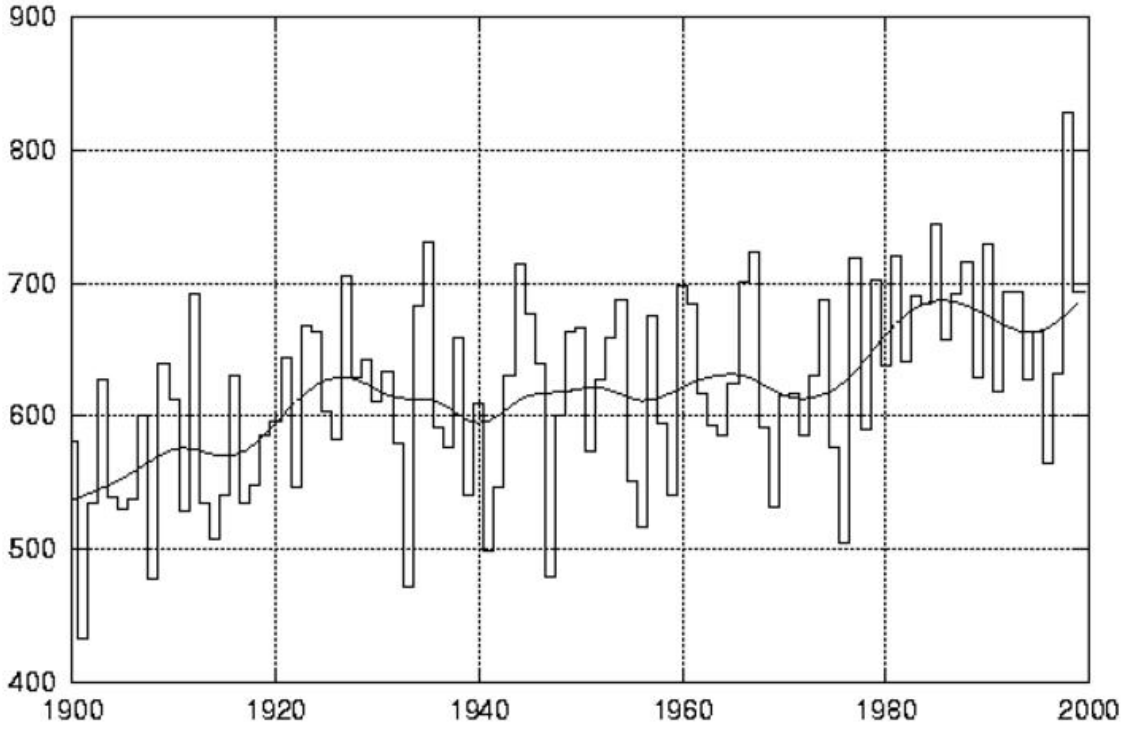


Fig.3: *Annual precipitation in Sweden 1900 - 1999, average of 20 homogenised series. The smooth line represents a low-pass filtered curve of Gaussian type emphasising variations on time scales of ten years and longer.*

The DWD objective weather type classification (OWTC)

By: Dr. Peter Bissolli and Dr. Ernst Dittmann, Deutscher Wetterdienst

The OWTC is based on daily numerical 12 UTC-analyses of the operational weather forecast models of the German Weather Service (Deutscher Wetterdienst = DWD). The focus is on an area covering Germany and adjacent regions. Principally, the OWTC could be applied to other European regions as well.

The classification consists of 40 different weather types, based on the following criteria:

- the advection of air masses (prevailing wind direction in 700 hPa),
  5 classes: NE = Northeast,
  SE = Southeast, SW = Southwest,
  NW = Northwest,
  XX = no prevailing direction;
- the circulation pattern (cyclonality) in 950 hPa and in 500 hPa, 2 classes each (anticyclonic or cyclonic);
- the humidity integrated over the whole troposphere, 2 classes (dry or wet, referring to deviations of the precipitable water from climatic monthly means 1979 - 1996).

In 1999, the most frequent weather type was a north-westerly one with anticyclonic conditions near the surface, but cyclonic conditions in 500 hPa and a mainly dry atmosphere (see figure 1). Such a situation happens quite often in summer and is frequently accompanied by convective precipitation. This year, however, this weather type has occurred in February and December too for several days. During these months the precipitation sums in Germany were considerably higher than normal.

Other weather types which were quite frequent in 1999 are those south-westerly and north-westerly ones with anticyclonic conditions in both height levels and a humid atmosphere. But this is not unusual.

The Christmas storm over Central Europe (December 26, named "Lothar" in Germany) has been taken place during a south-westerly type with cyclonic conditions in both levels and a humid atmosphere. Some other storms have occurred in Germany in December during south-westerly weather types too.

It is remarkable that there is a tendency to an increasing number of wet weather types during the last 20 years (see figure 2). In 1999 this number was in fact the highest since the beginning of the time series 20 years ago.

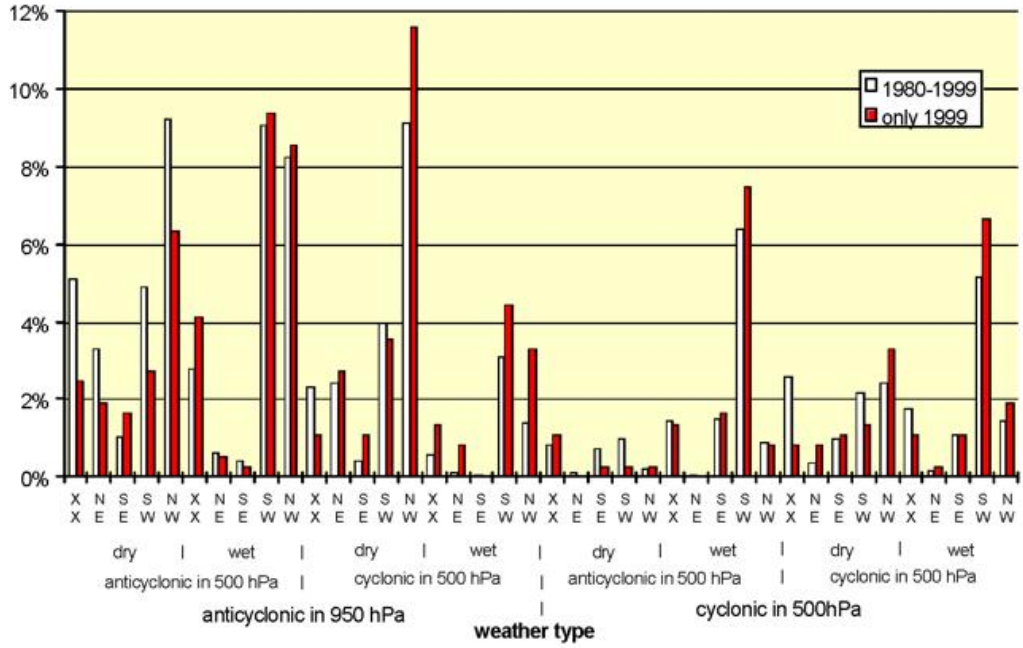


Fig. 1: *Relative frequency distribution of the 40 DWD objective weather types 1999 in comparison to 1980 - 1999.*

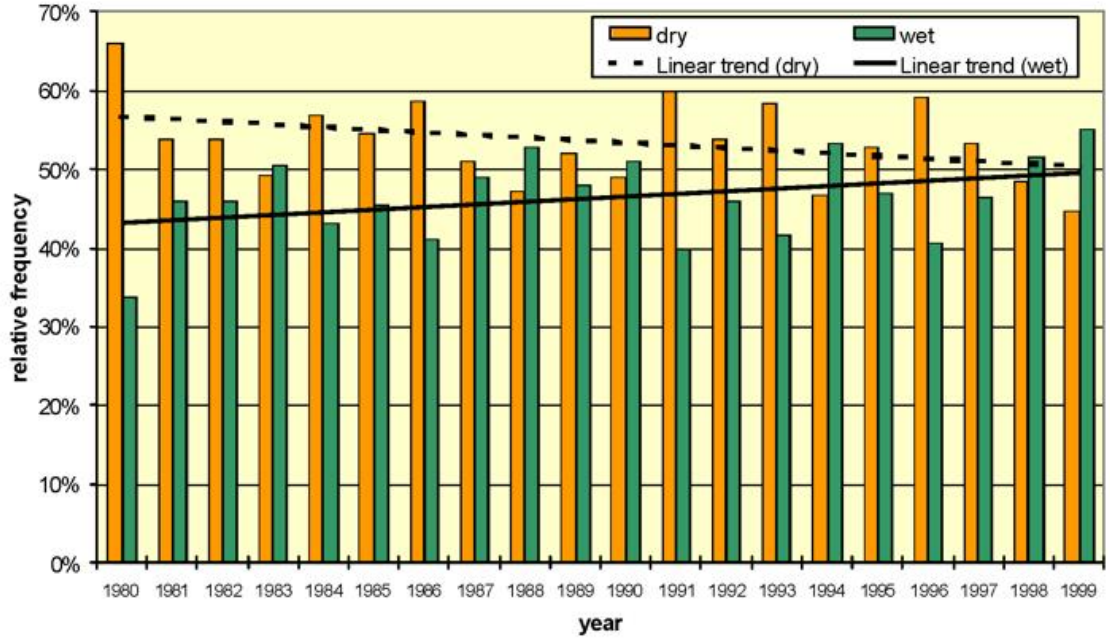


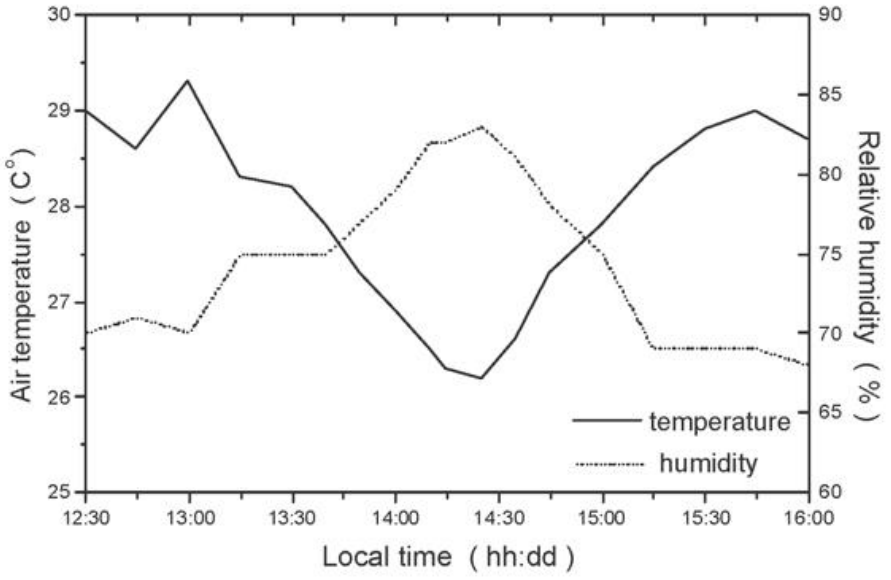
Fig. 2: *Annual relative frequencies of the humidity types of the DWD objective weather type classification 1980 - 1999. Lines are linear trends of these frequencies.*

The Solar Eclipse effects in Bulgaria

By: Bulgarian National Institute for Meteorology and Hydrology

Surface temperature and relative humidity variation during the Solar eclipse on 11.08.1999 recorded by the Bulgarian NIMH team in Shabla (on the North Black Sea cost).

The partial eclipse began at 12h 46min LT and closed at 15h 33min LT. The full eclipse began at 14h 11min LT and lasted 2min and 27sec.



The SAF on Climate Monitoring

A European Initiative to Support the Use of Satellite Data for Climatological Applications

EUMETSAT, the European Organisation for the Exploitation of Meteorological Satellites, developed the idea of decentralised Satellite Application Facilities (SAFs) for the use of satellite data, especially those from EUMETSAT's MSG (METEOSAT Second Generation) and EPS (European Polar System).

Climatological applications are one of the areas, that will make profit from the use of satellite data. Therefore, a SAF on Climate Monitoring was established as an element of the distributed EUMETSAT ground segment. The SAF is hosted by Deutscher Wetterdienst (DWD) and comprises a common project effort, based on the know-how of several partner institutes.

Partners are:

- Finnish Meteorological Institute
- Royal Netherlands Meteorological Institute
- Royal Meteorological Institute of Belgium with Free University of Brussels and Royal Military Academy
- Swedish Meteorological and Hydrological Institute
- Federal Maritime and Hydographic Agency of Germany with German Climate Computing Centre
- Deutscher Wetterdienst with GKSS Research Centre

The project started in 1999 and is designed for 5 years ending with a quasi-operational phase. The outcome of the SAF will be meteorological products, that may be used for climatological applications especially climate monitoring.

Core products are:

- cloud parameters like
  - cloud fractional cover
  - cloud top height
  - cloud type
  - cloud top temperature
- components of the surface radiation budget like
  - surface incoming short wave radiation
  - surface albedo
- components of the radiation budget at the top of the atmosphere like
  - incoming solar radiative flux
  - reflected solar radiative flux
  - emitted thermal radiative flux
- atmospheric humidity parameters...like
  - vertical profiles
  - precipitable water
- and others.

These products will be provided in an area covering Europe and parts of adjacent seas. The horizontal resolution will vary from 15 - 50 km on a time scale between 1 hour up to monthly means, depending on the specific parameter. The products will be distributed to any interested party, be it scientific, administrative, commercial, or else.

DWD itself will be a user of SAF products. A coupled project, financed exclusively by DWD, started simultaneously to generate climate monitoring products using satellite data, together with data from other sources, like the traditional synoptic and climatological networks as well as output from NWP (numerical weather prediction)-models. The outcome of these activities will be maps, diagrams, tables, and interpretations, monitoring climate on a monthly and yearly basis of an area to be defined, starting with central Europe.

More information see:
http://www.dwd.de/research/pos_info.htm

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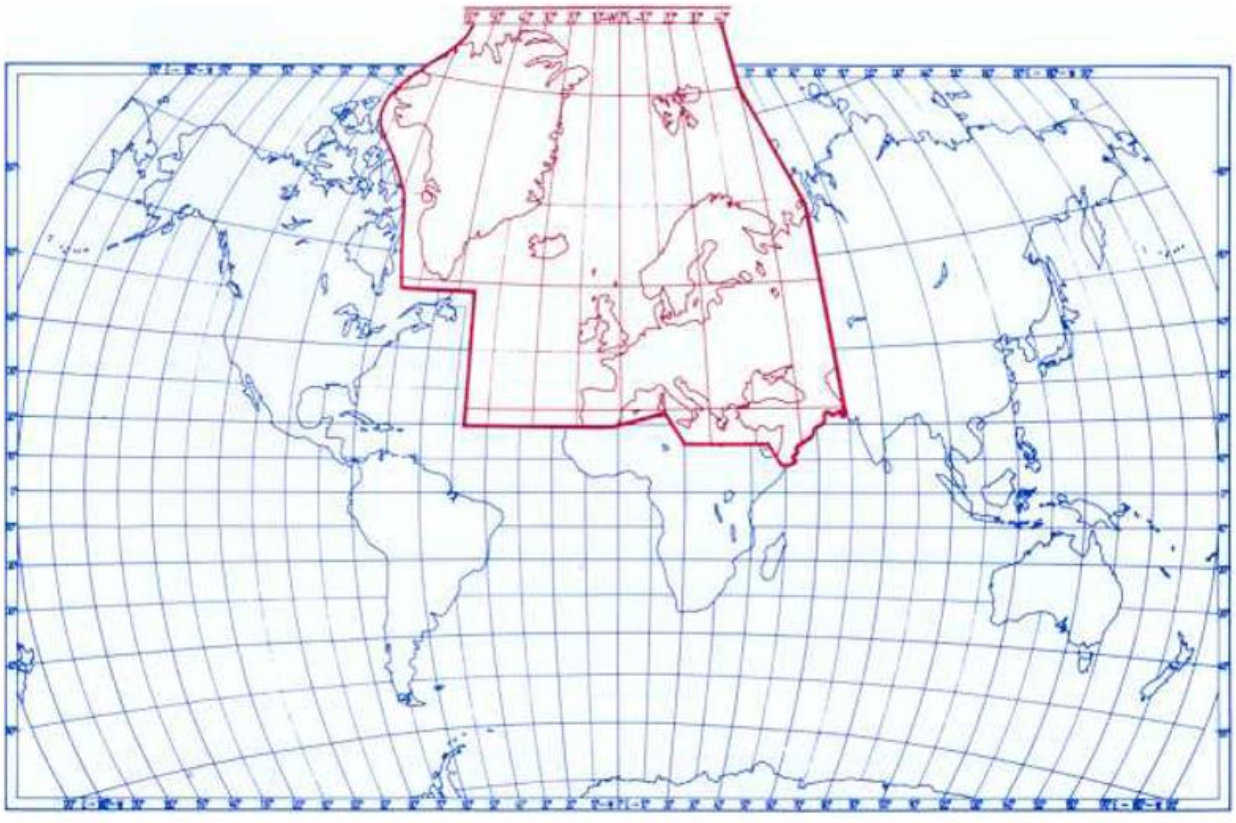
Wetterdienst

Annual Bulletin on the Climate in WMO Region VI

-Europe and Middle East-

2000



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Switzerland
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Yugoslavia

Furthermore, contributions to the WMO Bulletin article on consequences of abnormal weather in 2000 were referred from the following countries:
Bosnia and Herzegowina, Greece, Italy, Russian Federation, Syrian Arab Republic

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Foreword



Dr Iván Mersich
President of WMO RA VI

Outstanding Events and Anomalies in 2000

Temperature

- Warmest year on record in many places
- Warmest spring and autumn on record in parts of Central Europe
- Fierce cold spell in eastern Central Europe in May
- Extraordinary hot and dry summer on the Balkans and in Middle East

Precipitation

- Wettest year on record in south-eastern Norway
- Driest year of the century in south-eastern Hungary
- Drought in eastern Spain aggravates until October
- Abundant snow in northern Fennoscandia in late winter
- Severe flooding in north-eastern Hungary, Romania and Serbia in April
- Extreme drought in parts of south-eastern Europe from mid-April to July
- Extremely wet in Scandinavia in June and July
- Wettest autumn on record in England, Wales and Ireland with repeated floods
- Devastating floods in northern Italy, southern Switzerland and eastern Spain in October

Annual Survey:

Warmer than average **temperatures** prevailed in all seasons and except for Turkey, the annual temperature anomaly was positive all over Europe and in the Middle East. For wide parts of the Region, it was one of the warmest year on record and for parts of Central and North Europe, it was even the warmest of the century (see figures 0.1, 0.2, 0.3 and fig. xc (Croatia, Germany, Poland, Slovakia, UK)). For the Netherlands, it was together with 1999 and 1990, not only the warmest year of the century but also since the start of regular measurements of the temperature in 1706. For Vienna, Austria, and Prague, Czech Republic, the annual temperature means of 11,8 °C and 11,93 °C were the highest since the beginning of measurements in 1775.

Heavy **precipitation** resulting in flooding, loss of life and extensive property damage occurred at several places in the Region. The most notable events were the flooding in north-eastern Hungary, Romania and Serbia in April, in northern Italy and southern Switzerland in October and in the United Kingdom and France from September to December. April was the wettest April, and the autumn the wettest autumn on record in the 235-year monthly England and Wales precipitation series (see fig. 0.10, page xx). South-eastern Norway experienced the wettest year since measurements began in 1895.
On the other hand, major droughts affected the south-eastern part of the Region engendering numerous wildfires and causing water shortages and high agricultural losses. Between mid-April and July, some parts of south-eastern Europe received hardly any precipitation. The Balkans and the Middle East had an extraordinarily hot, dry and sunny summer (see fig. 0.4, fig.xc (Croatia) p. xx,). For parts of south-eastern Hungary, it was the driest year of the century (see fig. xc, p.xx). During the year, the precipitation deficit in the large water-collection basins of Levante and the south-eastern mainland of Spain aggravated the drought from which the area was suffering: The precipitation total in the September 1998 to September 2000 period amounted to 614 mm, only. Such a low 2-year precipitation sum occurs on average once every 118 years. The deficit ended in October 2000 with an intense storm affecting most of the Mediterranean side of Spain (see fig. 0.5).

In Iceland, it was warm and very sunny. In Akureyri, the total number of bright sunshine hours was 1276. This is the highest number of sunshine hours there since the beginning of sunshine duration measurements in 1928 and 230 hours above the 1961-1990 average.

There was in general less **storminess** as in the preceding years. No fierce winter storms affecting larger regions occurred and the number of intense Atlantic winter cyclones was about normal (see fig. 0.6).

Most parts of the Russian Federation recorded normal to slightly reduced values of **total ozone.** For a few days around November 20, there was a deficit of 25 - 25 % over central European Russia and an absolute minimum of total ozone (196 Dobson units) was registered on November 18 over Moscow. At the meteorological observatory Hohenpeißenberg, southern Germany, subnormal ozone values prevailed almost over the year, resulting in the fifth lowest annual mean in the record of the station going back to 1968 (see article page xx).

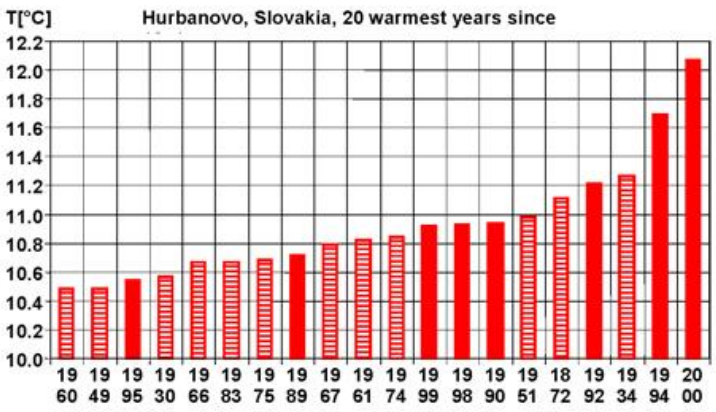


Fig. 0.1: *Mean annual temperatures of the twenty warmest years at the Hurbanovo observatory in the 1871-2000 period (130 years), full columns indicate the years after 1988,*
130-year mean: 9.76 °C,
standard deviation: 0.78 °C
anomaly in 2000: 2.31 °C, this is 3-times the standard deviation.
From: Slovak Hydrometeorological Institute

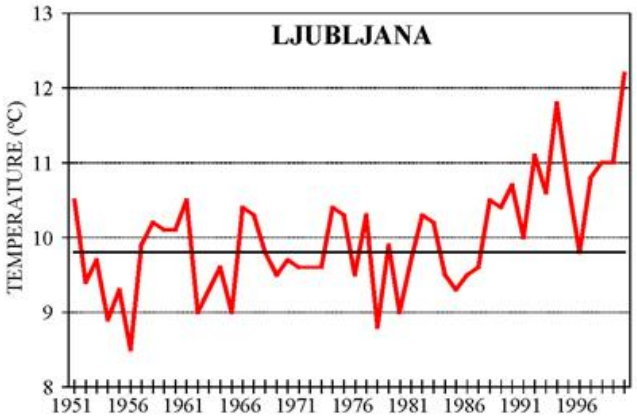


Fig. 0.2: *Mean annual temperature and 1961–1990 normal*
From: Hydrometeorological Institute of Slovenia

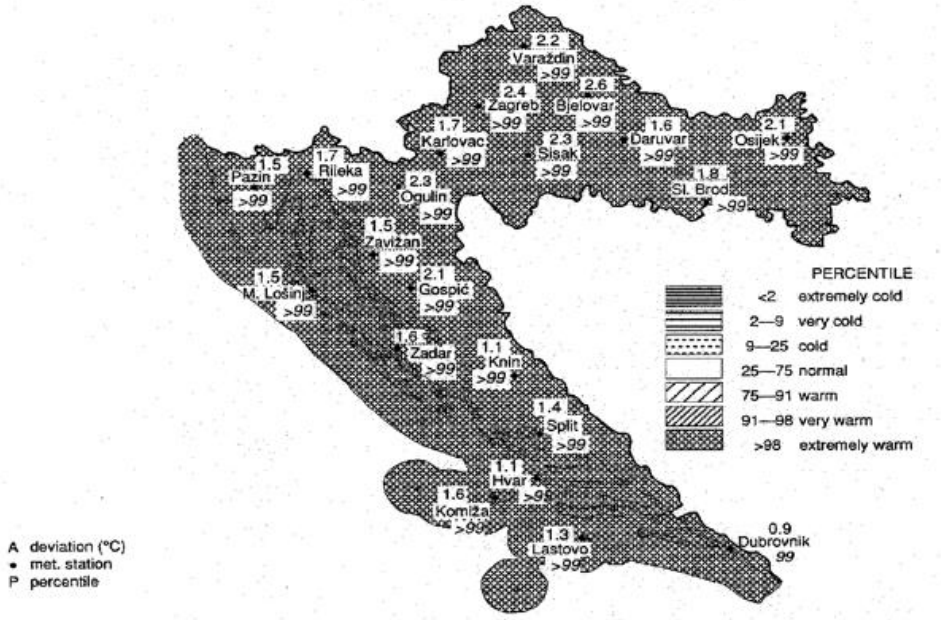


Fig. 0.3: *Percentiles of anomalies of the annual mean temperatures in Croatia, reference period 1961-90*
From: Meteorological and Hydrological Service, Croatia

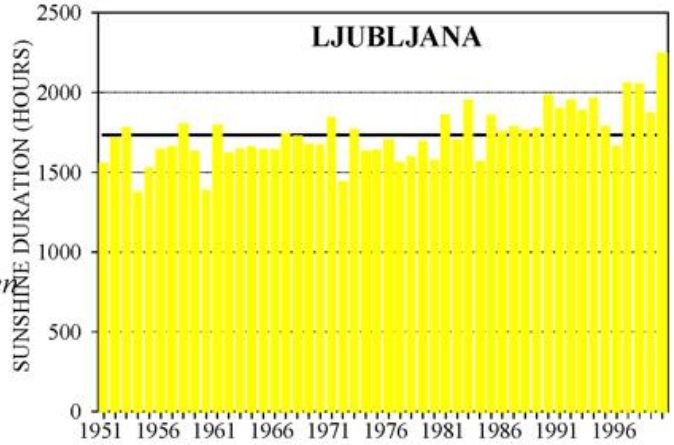


Fig. 0.4: *Annual sunshine duration between 1951 and 2000*
From: Hydrometeorological Institute of Slovenia

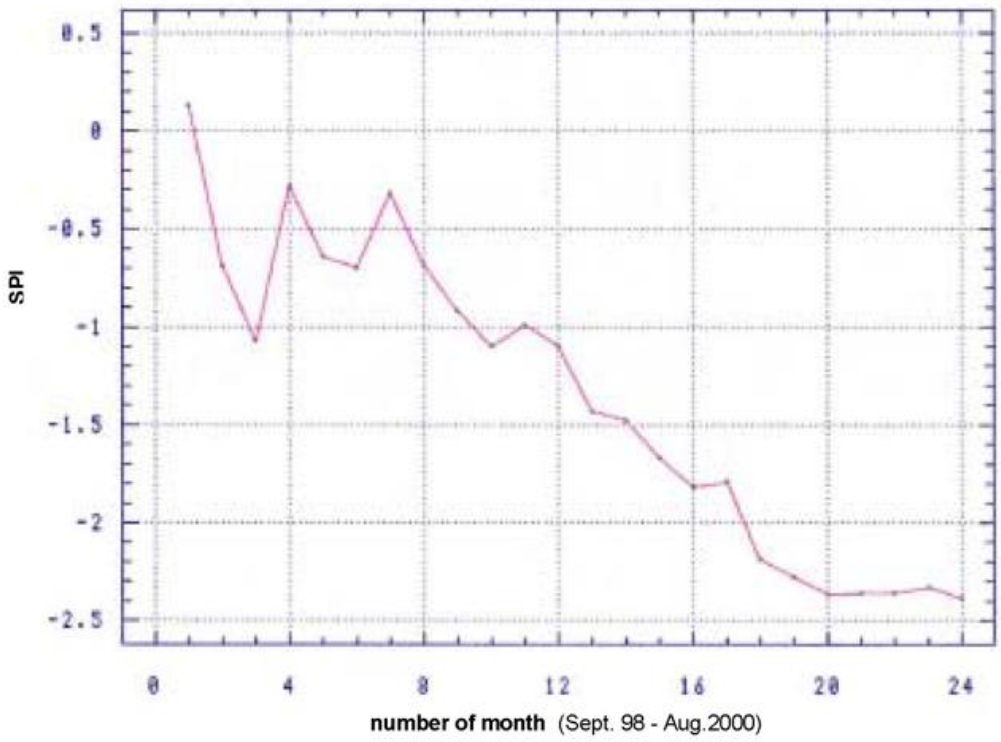


Fig. 0.5: *Standardised precipitation index (SPI) of the Levante basin between September 1998 and Augus 2000t, representing the standard deviation of the accumulated precipitation since September 1998*
From: Instituto Nacional de Meteorologia, Spain

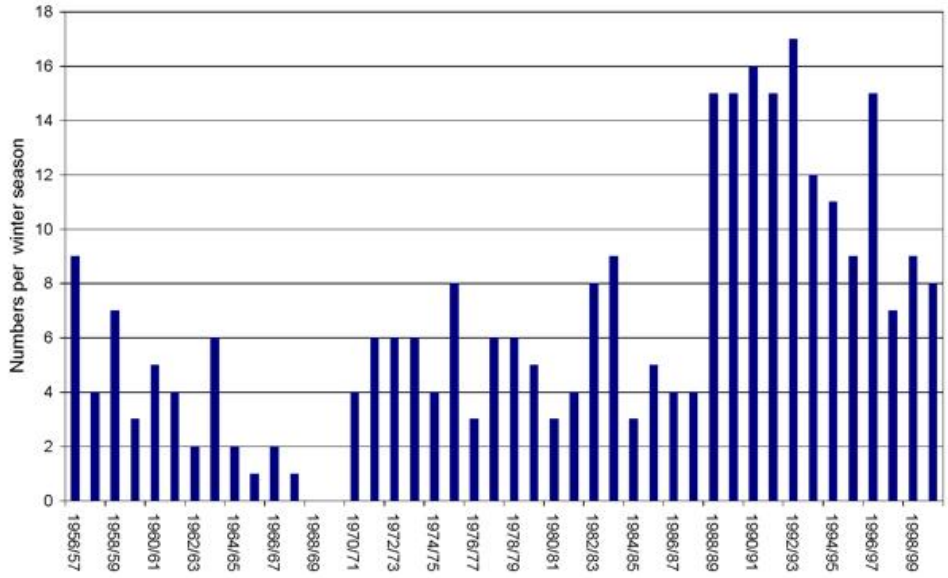


Fig. 0.6: *Numbers of North Atlantic low pressure systems with core pressure ≤ 950 hPa per winter season (November through March)*
From: Deutscher Wetterdienst, Germany

Seasonal Surveys

Winter 1999/2000 was mostly mild. In European Russia, it was one of the warmest of the last decades (see fig. xx, page xx). Temperature anomalies in north-eastern Europe exceeded 2 °C and locally the 98th percentile. Precipitation was distributed unevenly: Surpluses in the northern and south-eastern parts of the Region contrasted with extreme deficits in the Southwest (see fig. xx page xx). For Portugal it was the driest winter of the century. In France, it was the driest winter since 1949 in Provence and along the Mediterranean coast. Dryness affected adversely the agriculture and hydropower production in Italy. Across England and Wales, it was the sunniest winter since 1909. Wet and mild weather brought a lot of snow to northern Fennoscandia.

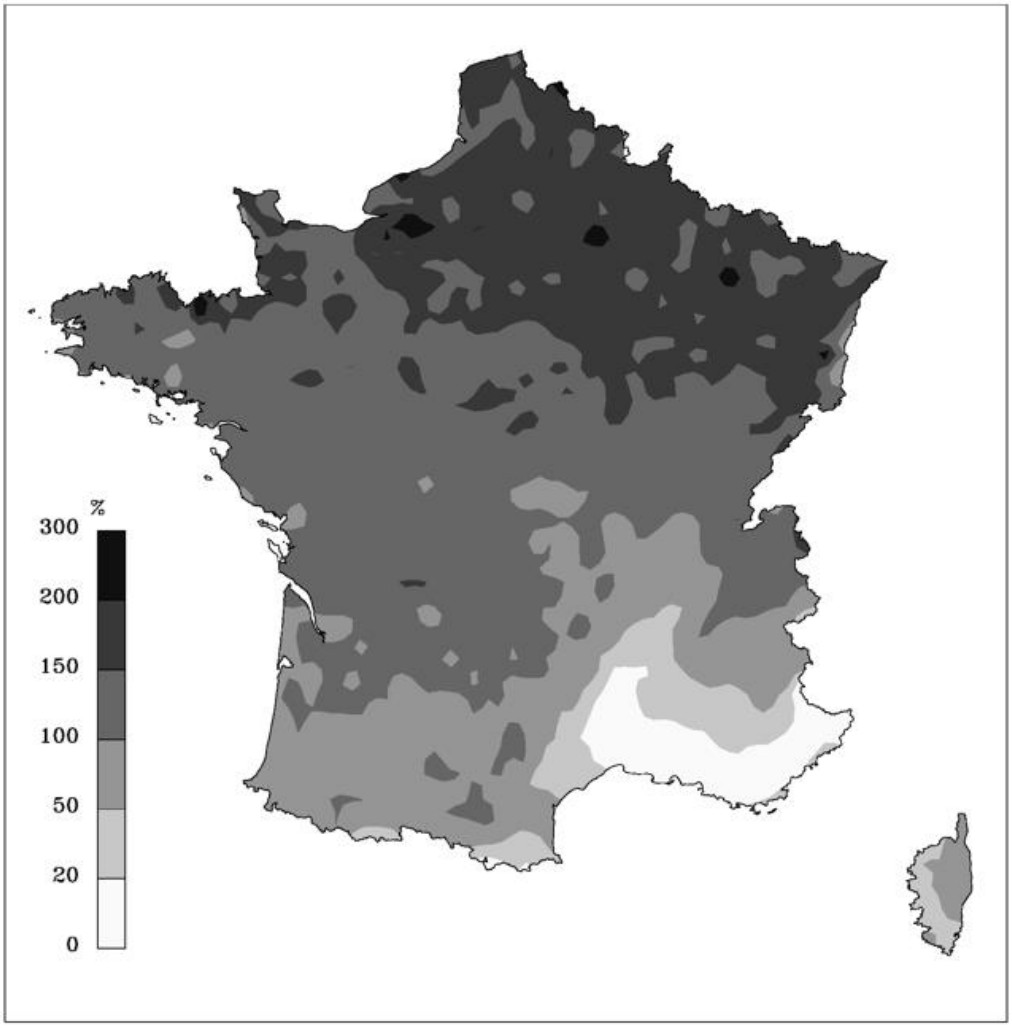


Fig. xx: *Winter precipitation in percentage of 1961-1990 normal in France from December 1999 to February 2000*
From: Meteo France

Spring 2000 was exceptionally warm in northern central Europe, parts of the Mediterranean area and the Middle East (see figures page xx). The spring was early and in general very mild. In Central Europe, the mild winter was followed by a warm spring (see fig. xx). For the whole of Germany, Slowakia and parts of Switzerland, spring 2000 was the warmest spring of the century (see fig. xx). However, in the eastern parts of Europe, a fierce cold spell caused considerable damage to the crops.

In south-eastern Europe, dry weather prevailed from mid-April to July. Some areas received hardly any rain. In contrast, April was the wettest April in the 235-year England and Wales Precipitation series and heavy rains and melting snow caused severe floods in norht-eastern Hungary, Romania and Serbia. In Israel, the 1999/2000 rainfall season ended in general drier than normal, in spite of a very wet January. Snow loads were extremely heavy in northern and eastern Finland, as the water content of the snow was high. However, the snow in Lapland melted away evenly and bare ground appeared in mid May.

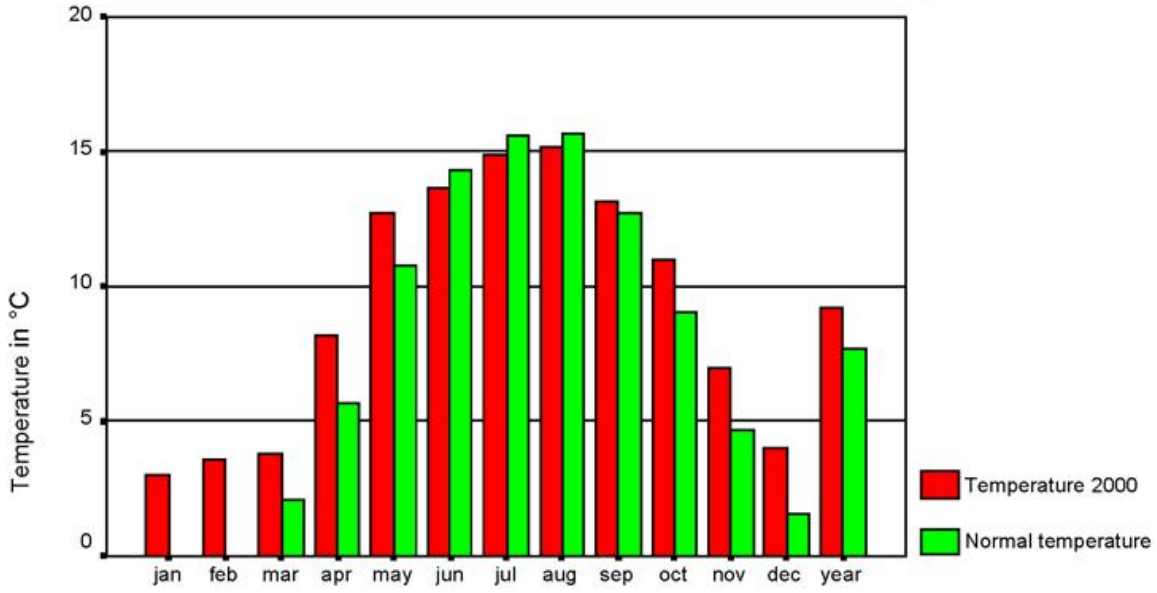


Fig. xx: *Monthly and annual temperature means in 2000 and 1961-1990 normal in Denmark*
From: Danish Meteorological Institute

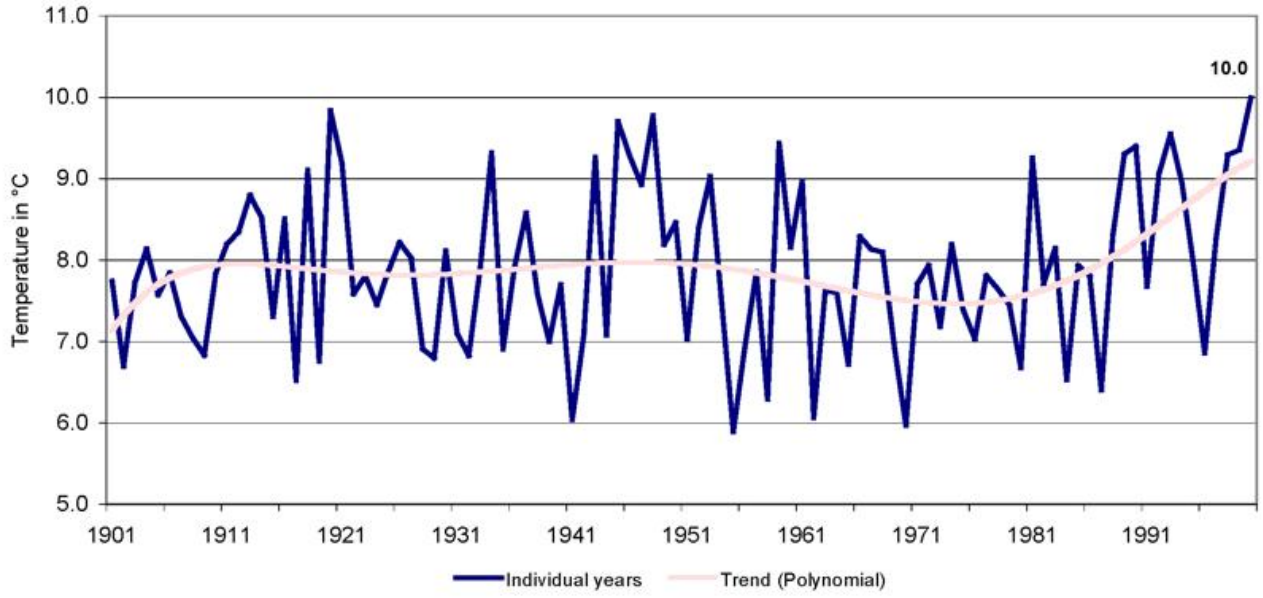


Fig. xx: *Areal mean of the spring temperature for Germany in 2000*
From Deutscher Wetterdienst, Germany

Temperatures in **summer 2000** were below normal in Scandinavia but elsewhere mainly above normal. It was extraordinarily hot and dry in south-eastern Europe and in the Middle East where the temperature anomalies surpassed the 98th percentile (see figures page xx). For Armenia, it was the hottest summer of the century. Major droughts affected much of south-eastern Europe and the Middle East. In Armenia, shortage of precipitation (the rainfall total for the whole summer was only 28 % of normal) caused losses estimated to 110 million US$. In Bulgaria, the warm and dry conditions led to about 1150 wildfires that damaged 127,000 hectares forest and crop areas. Greece suffered from hundreds of fires during the height of the heat wave, particularly on Samos, where fire consumed one-fifth of the island. In Croatia, drought covered about 70% of the country by the end of August. In Hungary, May to August 2000 was drier than in any other year of the century (e.g. Szeged received 64 mm, that is 30 % less than the earlier record). Jordan reported the longest heat on record (since 1923) with temperatures up to 43 °C (see fig. 7.5 page xx).

Although the summer 2000 was not especially dry in the United Kingdom, rainfall total in England and Wales was consistent with the tendency for drier conditions in July and August since the mid-20thcentury.

Autumn 2000 and the early winter were exceptionally warm from Scandinavia to Central Europe (see figures page xx) and the first frost appeared as late as December 17 at many places in the low-lands of Central Europe, which was the latest occurrence on record. For Slovakia, it was the warmest autumn on record. (since 1871).

Except for the south-eastern and south-western parts of the Region , wet conditions prevailed. In wide parts from the UK to northern Italy and in southern Scandinavia it was extremely wet. In much of England, Wales and Ireland, persistent wet weather began around mid-September and lasted beyond the end of the year. In all, the 503 mm of rain recorded was nearly twice the 1961 to 1990 average and there has been no wetter autumn in the 235-year England and Wales Precipitation series (EWP). (see figure xx). As a result there was widespread flooding in many parts of Britain. The worst affected areas were southern England, the headwaters and valley of River Severn in western England and east Wales, and Yorkshire. New precipitation records for autumn were also set in Ireland, which experienced over 60 consecutive days of rain in parts of the West and Southwest.

Two-months rainfall records for October-November were broken across many areas of France, leading to floods (especially in the North in November and in Britanny in December) and to saturated soils nearly everywhere at the end of October.

Torrential rains caused deadly flooding and mudslides in north-eastern Italy and southern Switzerland in October. The 10-day lasting river Po watershed flood was caused by severe rainfall with values never recorded before and recurrence periods exceeding in some sites 1000 years.

Extremely wet weather prevailed in southern Norway and Sweden from October to mid-December resulting in unprecedented high levels in lakes and streams. The biggest lake in Sweden, Vänern, rose to its highest level since regulations commenced in the middle of the 1930-ies.

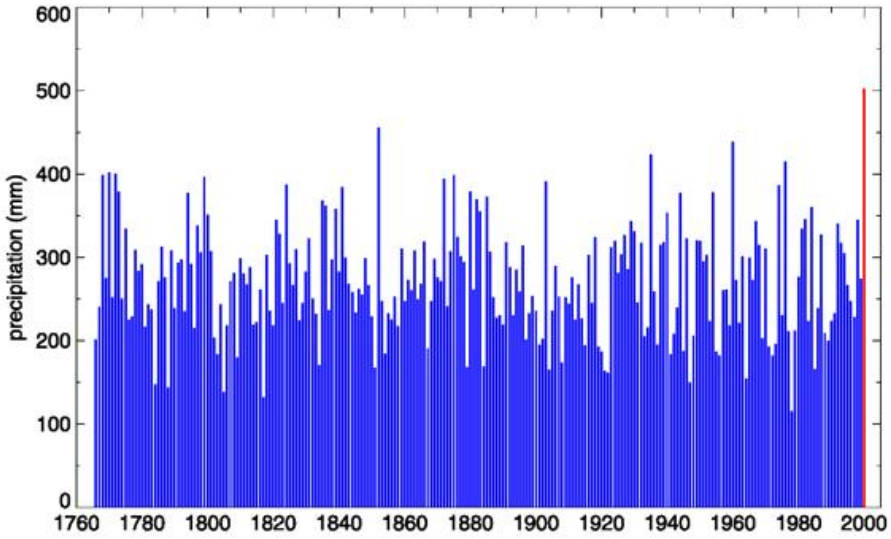


Fig. 0.10: *Yearly totals (mm) of autumn (September to November) precipitation in England and Wales from 1766 to 2000*
From: Hadley Center, Met Office, UK

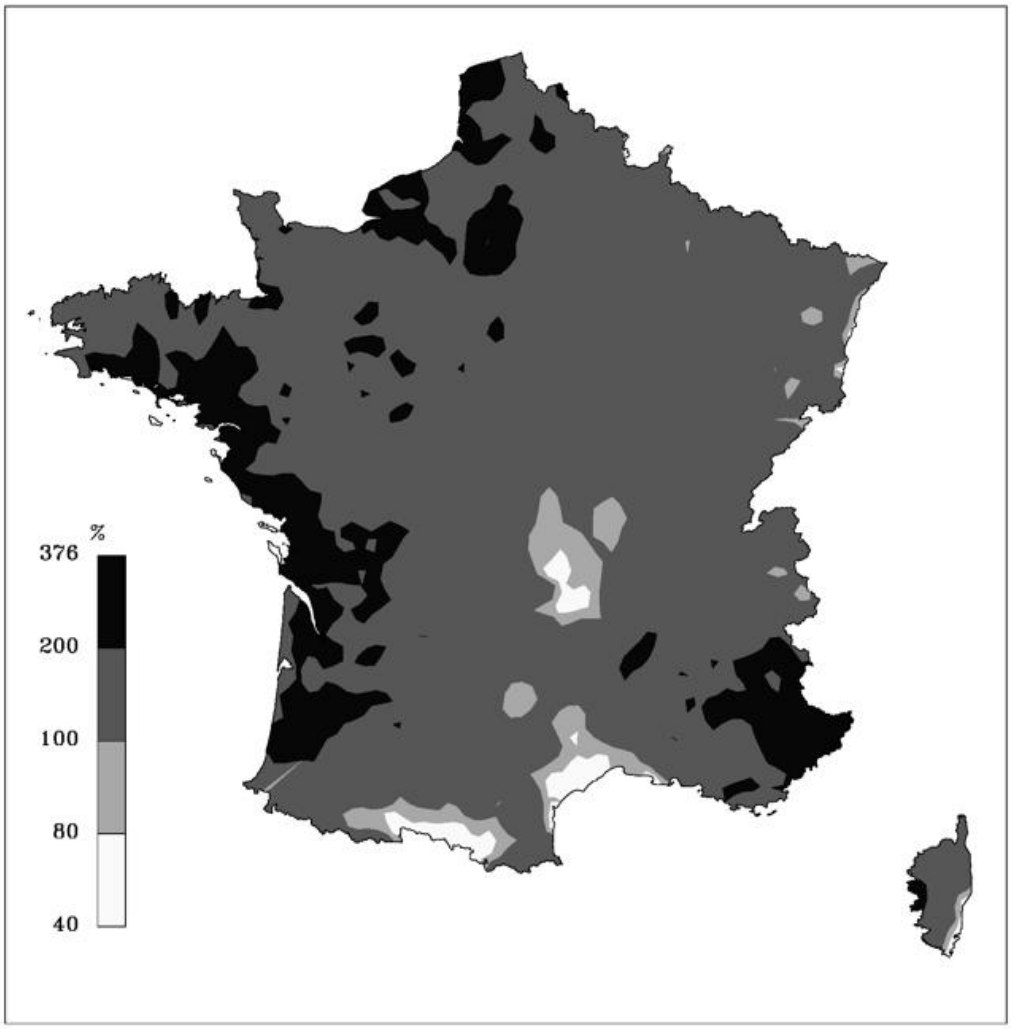
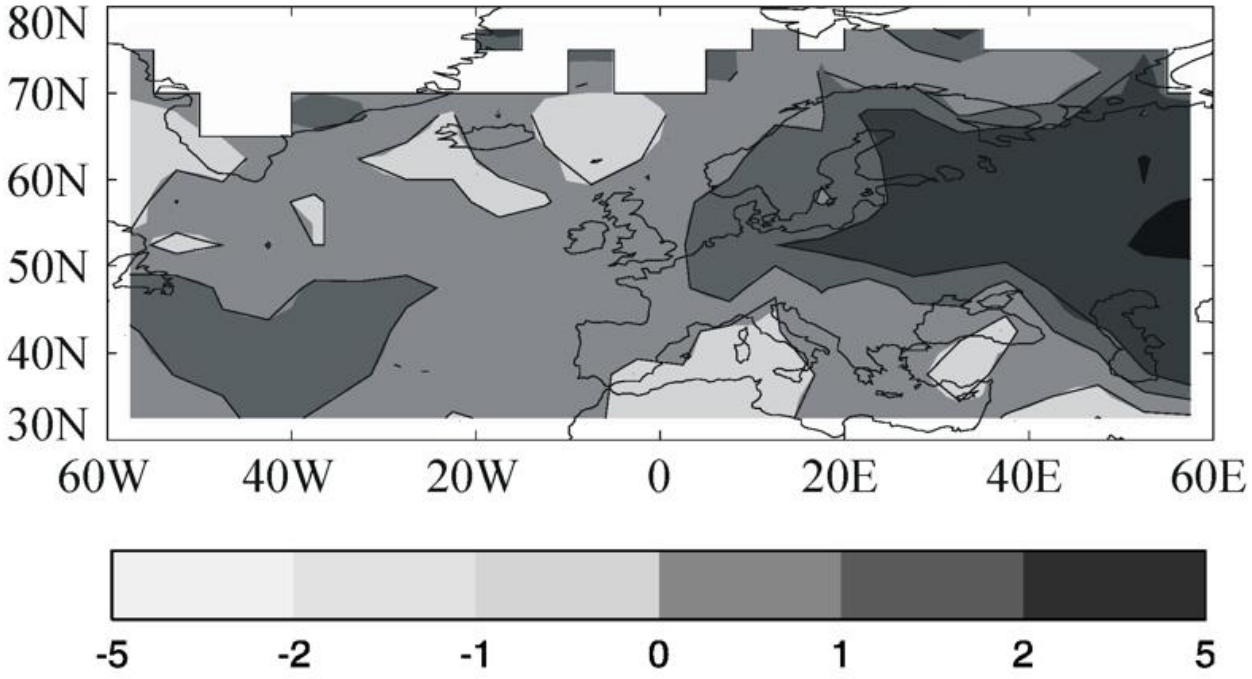


Fig. 0.11: *Precipitation in percentage of 1961-1990 normal in France from October to December 2000*
From: Météo France

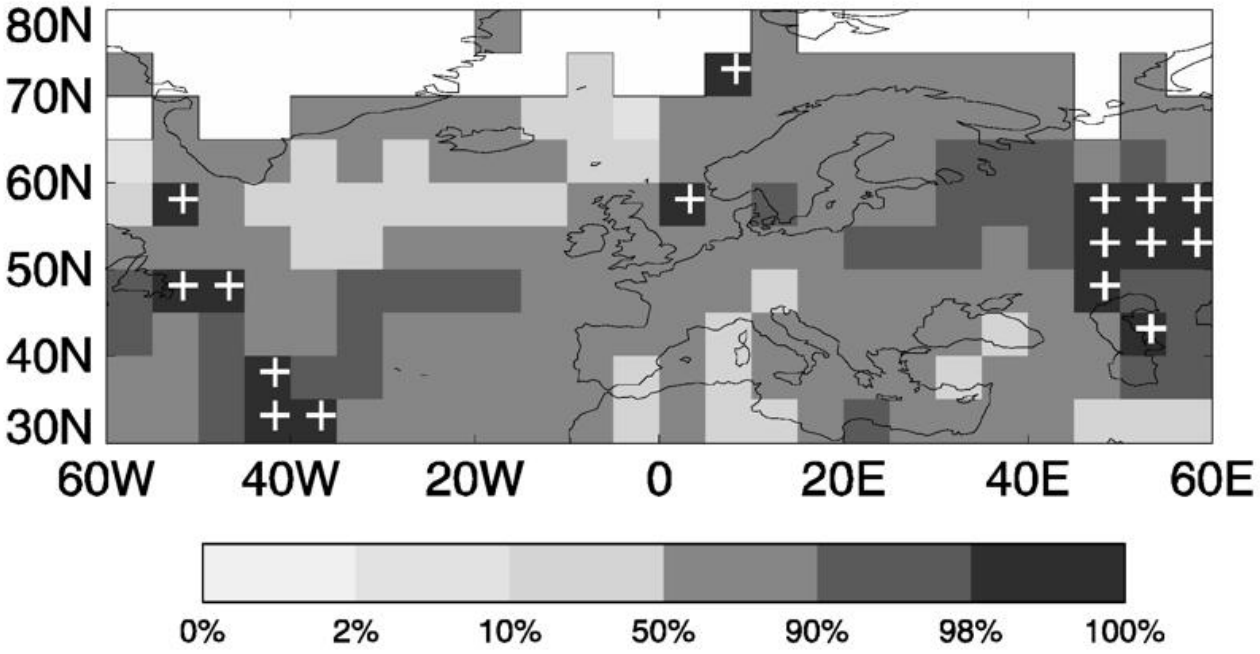
Seasonal Maps

Surface temperature anomalies: December 1999 - February 2000

From: Hadley Centre of Climate Prediction and Research



Departures from normal in °C

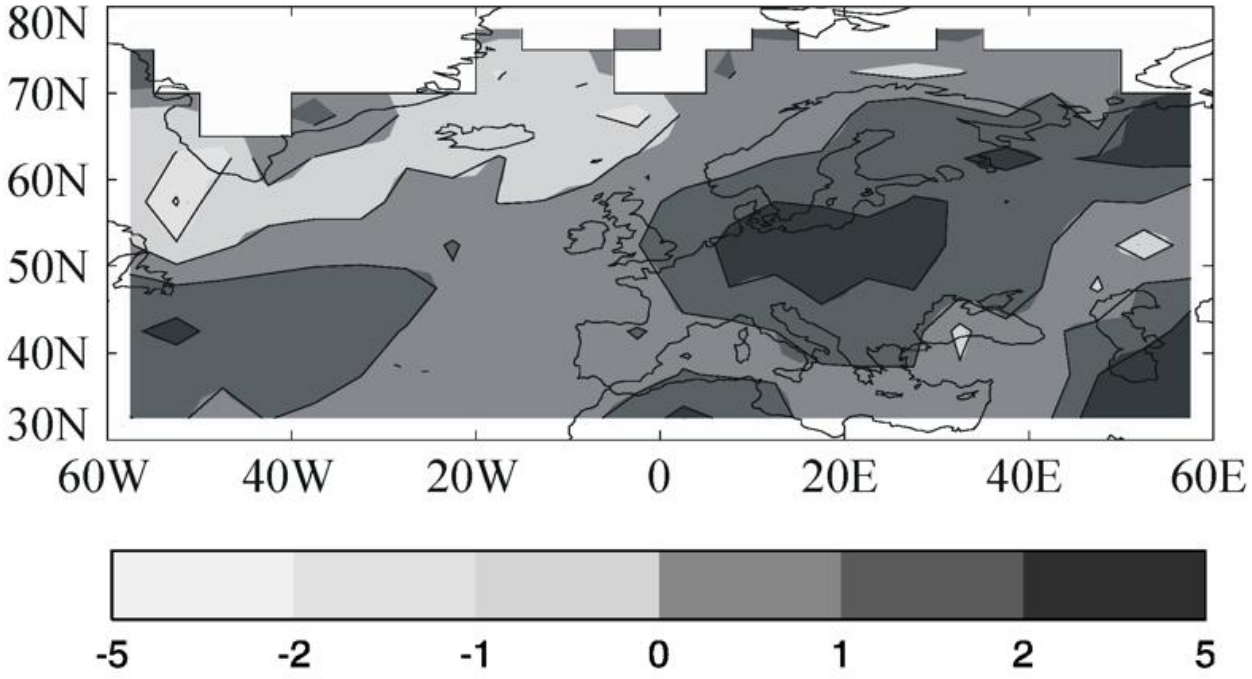


Percentiles (anomalies fitted to gamma distribution)

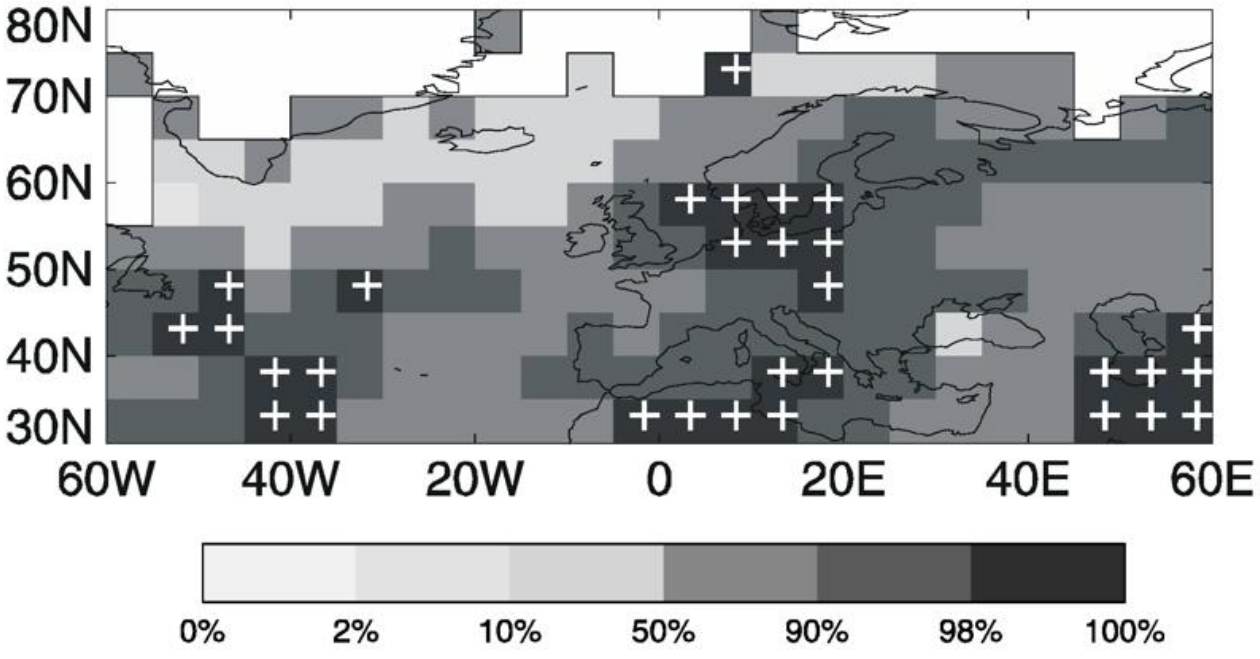
Reference period: 1961 – 1990

Surface temperature anomalies: March 2000 - May 2000

From: Hadley Centre of Climate Prediction and Research



Departures from normal in °C

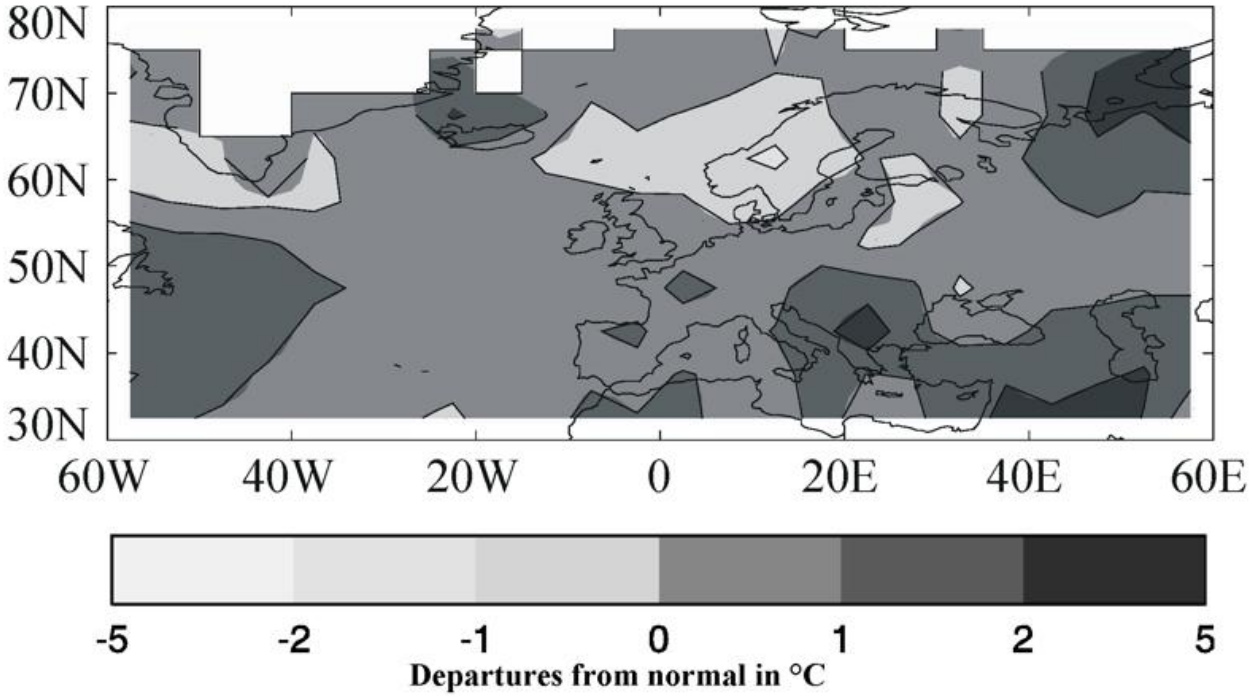


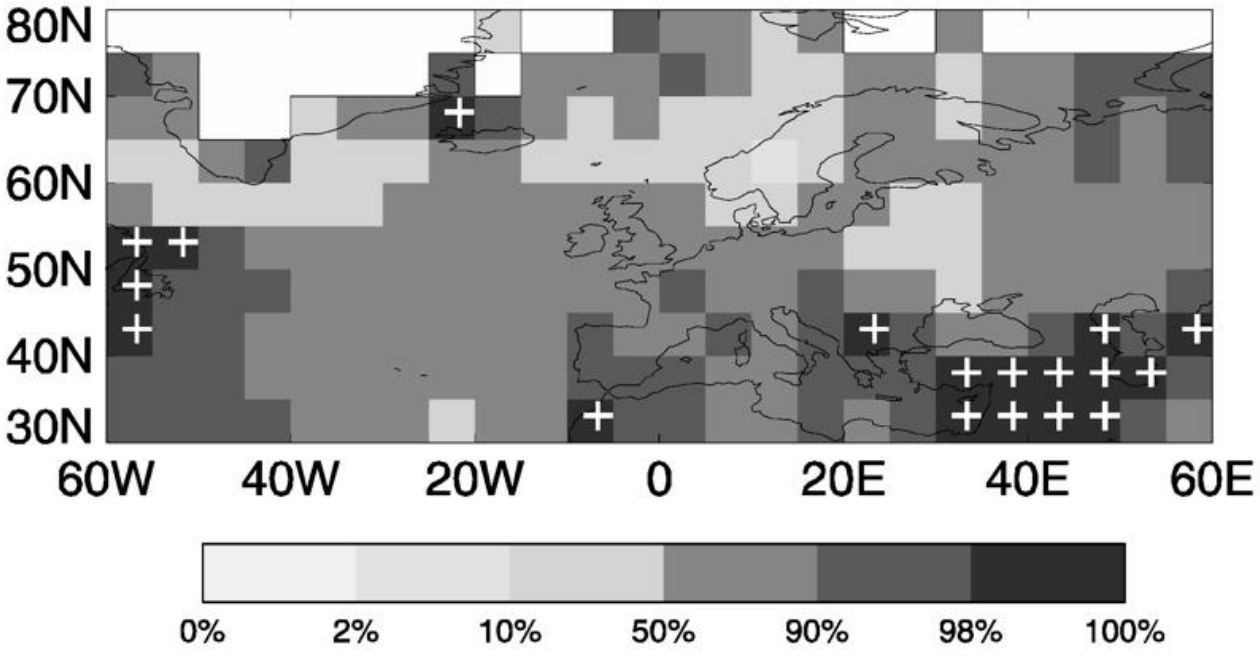
Percentiles (anomalies fitted to gamma distribution)

Reference period: 1961 – 1990

Surface temperature anomalies: June 2000 - August 2000

From: Hadley Centre of Climate Prediction and Research

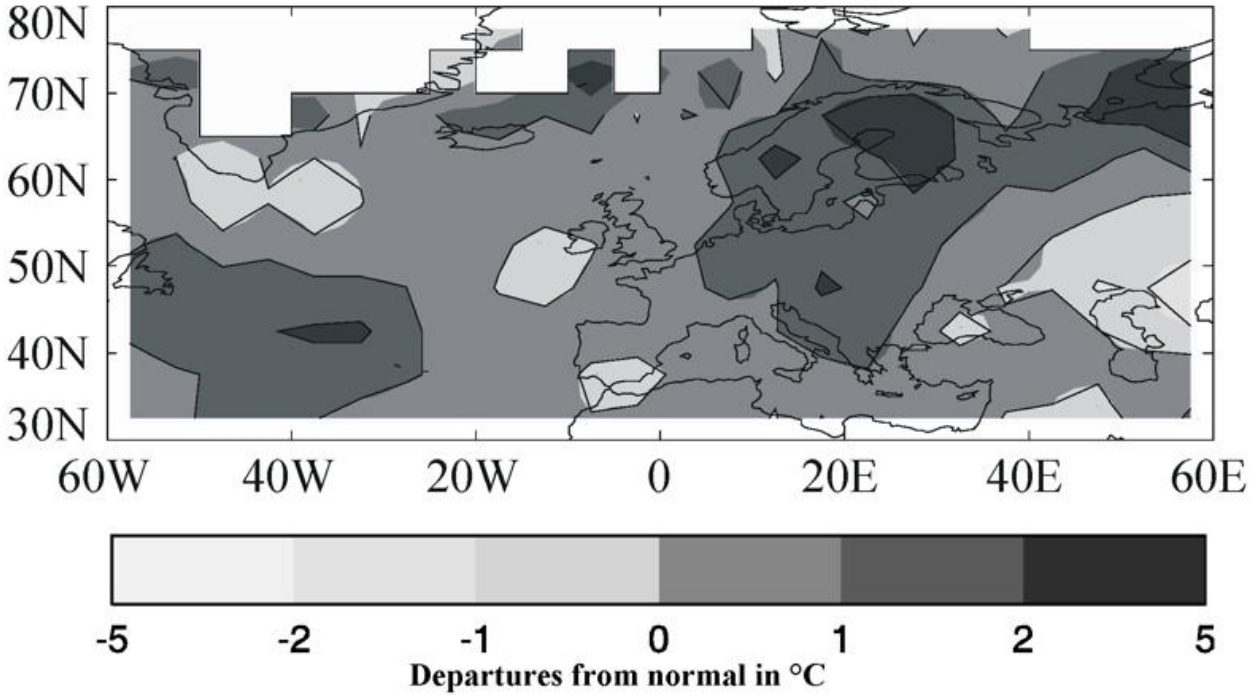


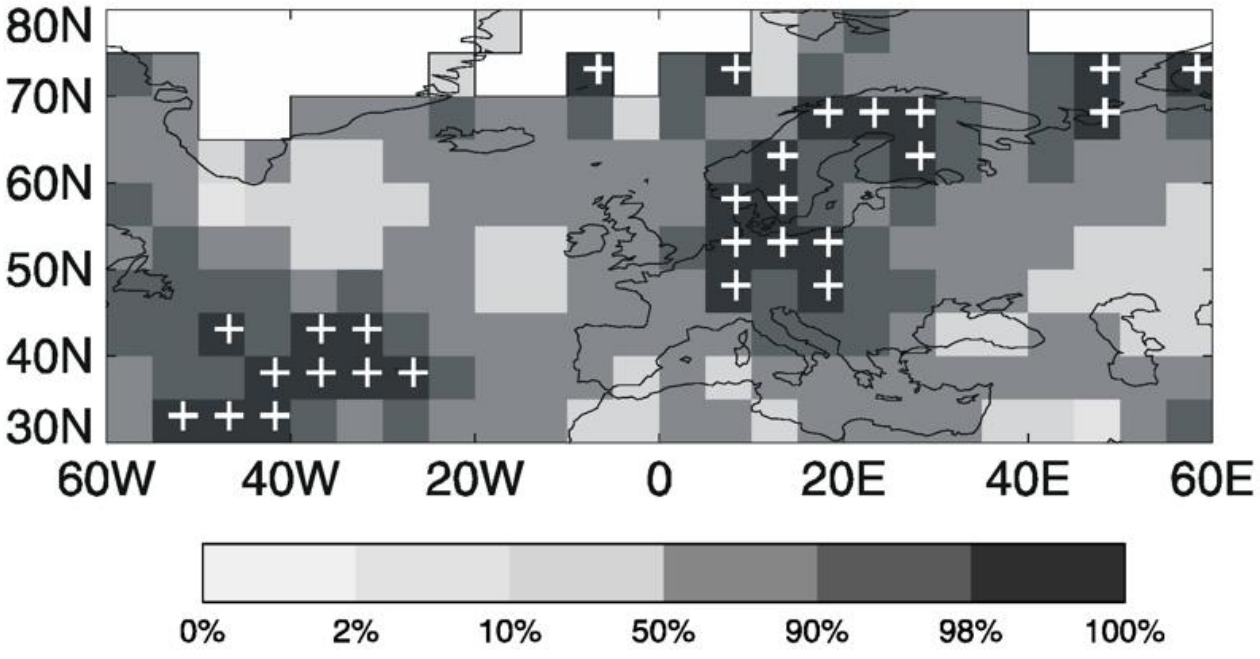


Reference period: 1961-1990

Surface temperature anomalies: September 2000 - November 2000

From: Hadley Centre of Climate Prediction and Research





Percentiles (anomalies fitted to gamma distribution)

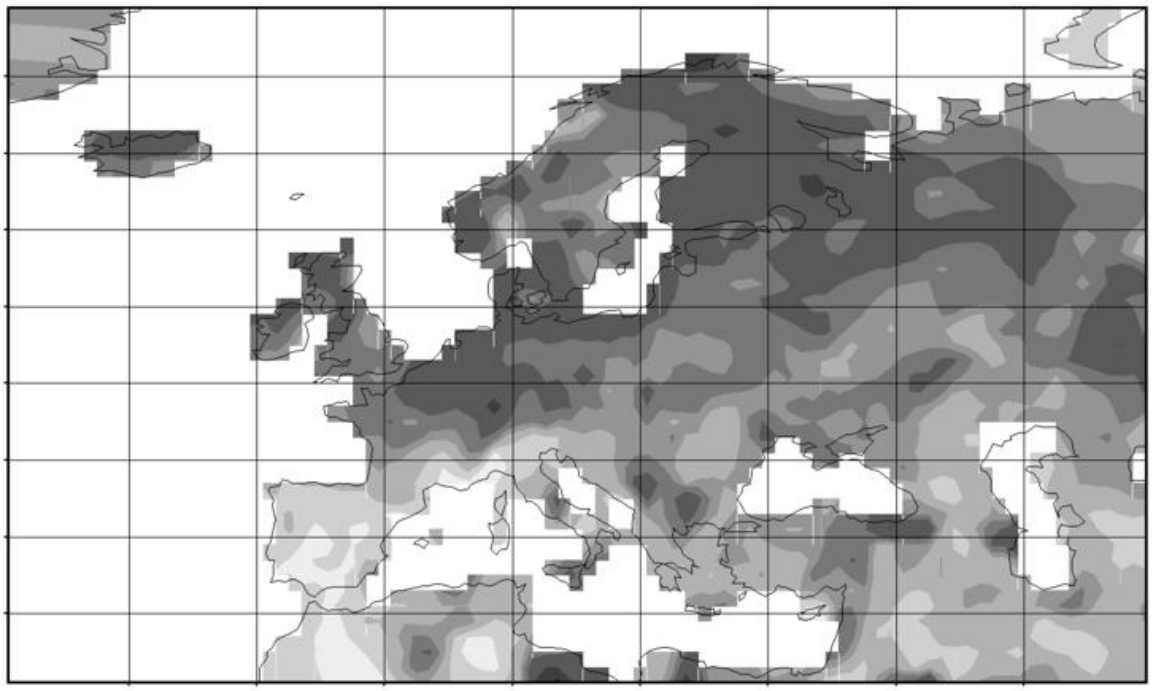
Reference period: 1961 – 1990

Precipitation in percentage of normal

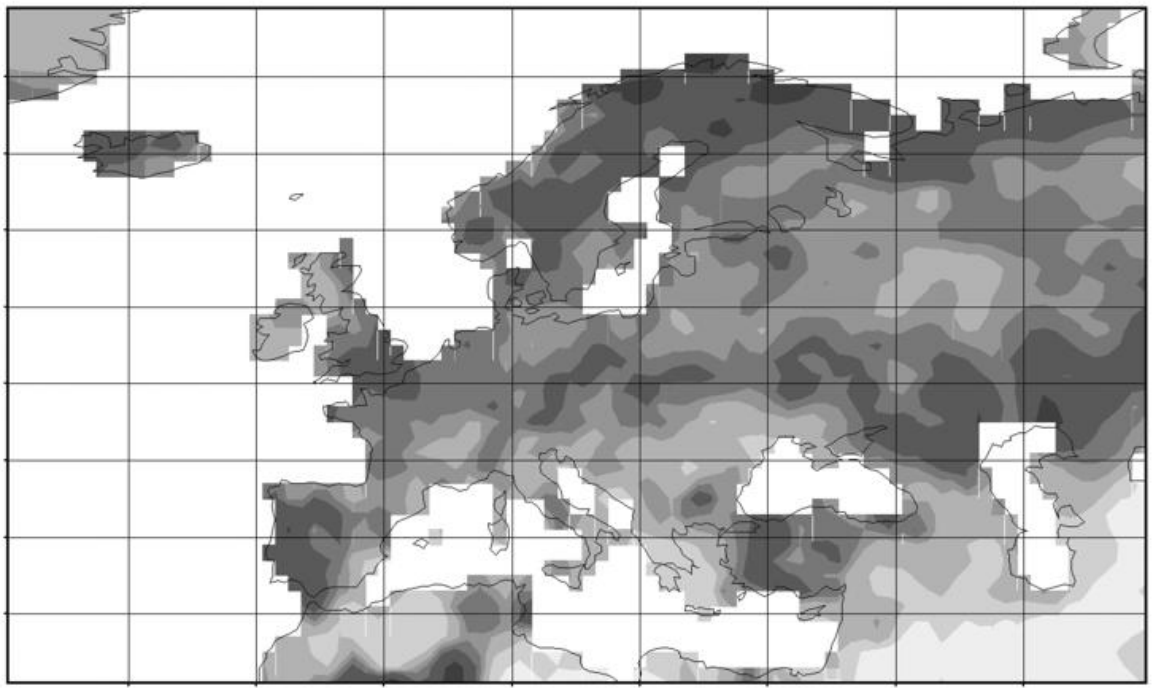
Gauge-Based Analysis 1.0 degree, reference period: 1961-1990

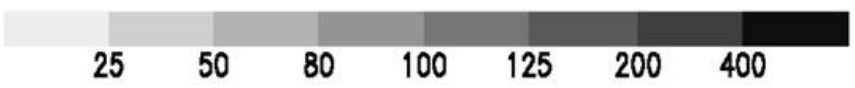
From: Deutscher Wetterdienst / GPCC

December 1999 - February 2000



March 2000 - May 2000



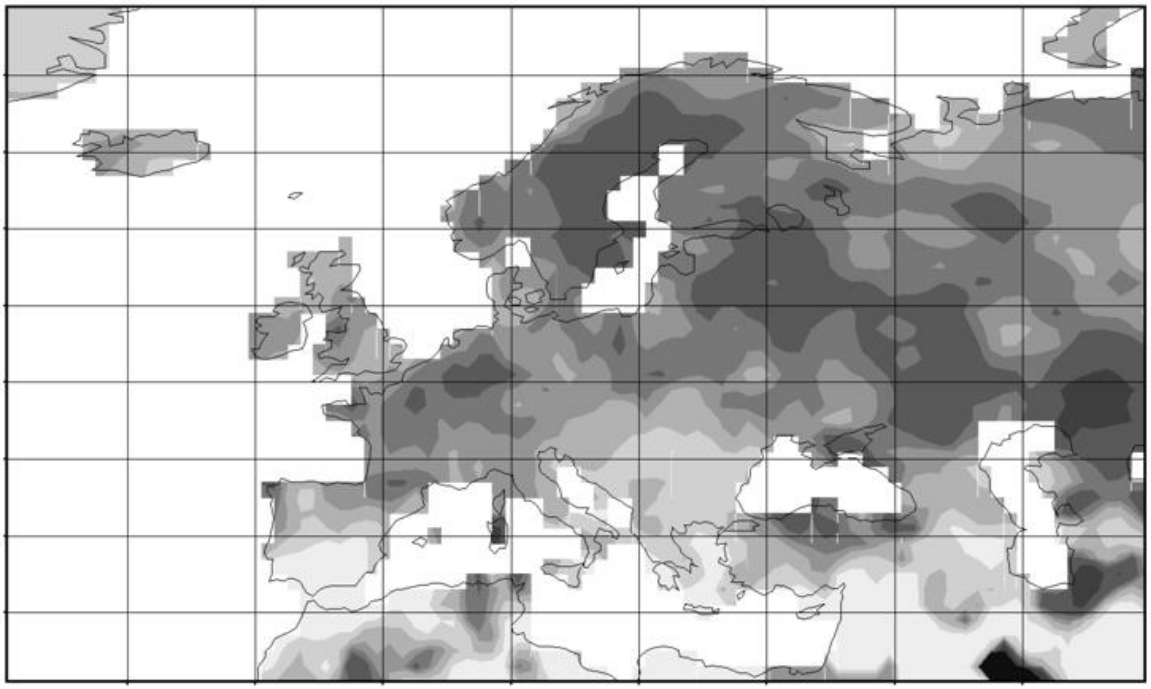


Precipitation in percentage of normal

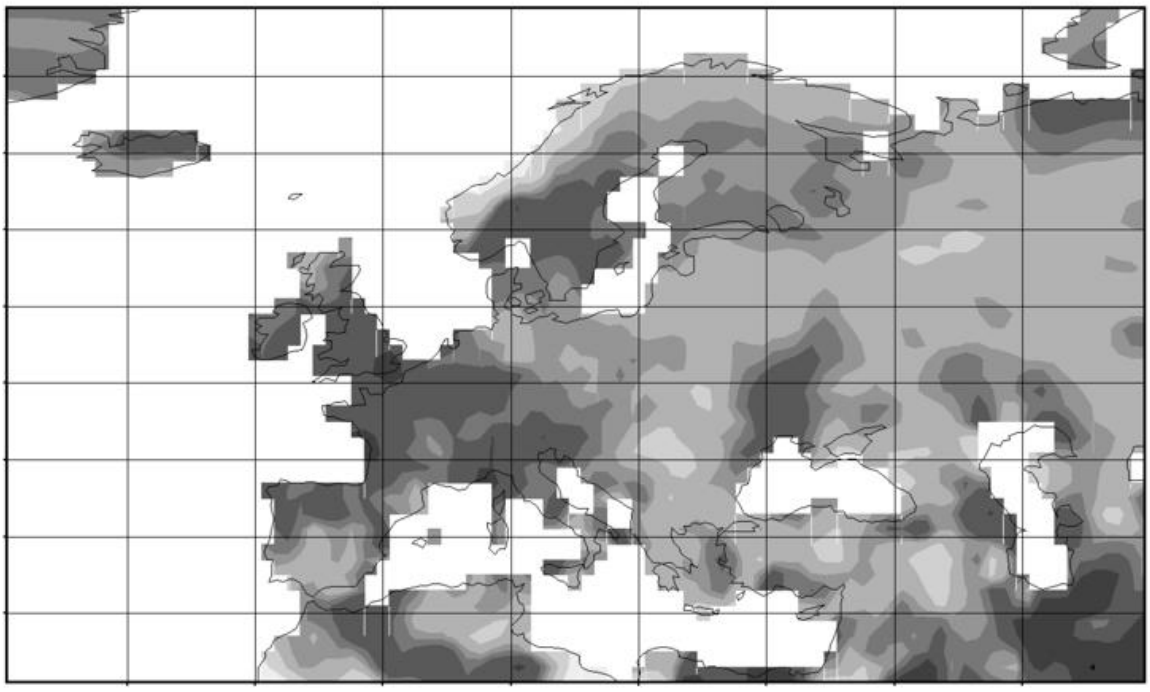
Gauge-Based Analysis 1.0 degree, reference period: 1961-1990

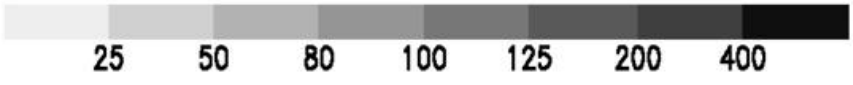
From: Deutscher Wetterdienst/GPCC

June 2000 - August 2000



September 2000 - November 2000





Monthly and Annual Tables

Temperature and precipitation values with departures from their 1961-1990 means

WMO No.	Station	January 2000 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	February 2000 Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	Svalbard	-8.5	6.9	13	-1	-11.1	4.6	6	-13
01025	Tromsø	-1.6	2.4	224	143	-2.8	0.9	120	34
01492	Oslo-Blindern	-0.4	3.9	28	-21	-0.5	3.5	33	-3
02196	Haparanda	-8.2	3.9	68	24	-7.6	3.7	50	18
02485	Stockholm	-0.2	2.6	13	-26	0.5	3.5	10	-17
02974	Helsinki-Vantaa	-2.9	4.0	40	-1	-2.6	4.2	52	21
03091	Aberdeen	4.9	2.0	29	-51	4.8	1.7	20	-32
03772	London-Heathrow	5.8	1.6	17	-35	7.4	2.9	62	27
03967	Dublin (Casement)	4.9	0.5	38	-28	6.1	1.7	52	1
04030	Reykjavik	0.7	1.2	75	-1	-1.0	-1.4	85	14
04320	Danmarkshavn	-20.2	2.9	12	1	-20.0	4.3	29	18
04360	Angmagssalik	-5.2	2.3	113	1	-6.3	1.4	46	-45
06186	København-Landb.	2.7	2.2	30	-21	3.8	3.3	21	-10
06260	De Bilt	4.3	2.1	41	-25	5.9	3.4	102	53
06447	Uccle	4.0	1.4	46	-21	5.9	2.4	82	29
06590	Luxembourg	1.7	1.5	29	-42	3.9	2.5	84	24
06660	Zürich	0.1	0.2	31	-39	4.2	3.3	136	63
06700	Genève	1.3	0.6	19	-61	4.9	2.9	96	15
07510	Bordeaux	5.3	-0.5	17	-83	9.1	2.0	104	19
07650	Marseille	5.9	-0.8	2	-45	9.3	1.4	3	-51
08222	Madrid	4.8	-1.2	25	-21	10.7	3.3	2	-44
08314	Mahon / Menorca	9.9	-0.8	61	0	12.2	1.5	7	-46
08495	Gibraltar	13.0	-0.4	109	-12	15.5	1.7	0	-100
08515	St.Maria / Acores	13.9	-0.5	56	-44	15.1	1.1	34	-52
08535	Lisboa	9.6	-1.8	25	-85	13.9	1.6	25	-86
10384	Berlin-Tempelhof	1.6	1.8	46	3	4.5	3.7	61	27
11035	Wien-Hohe Warte	-0.6	0.1	46	8	5.0	3.7	36	-6
11518	Praha-Ruzyne	-1.2	1.2	21	-2	3.1	3.9	20	-3
11903	Sliac	-4.8	-0.9	31	-13	0.0	1.1	47	2
12160	Elblag	-0.5	1.9	65	18	2.5	4.7	57	32
12375	Warszawa-Okecie	-1.4	1.9	29	7	2.5	4.5	42	21
12843	Budapest-Lorinc	-1.5	0.1	14	-18	3.7	2.6	15	-17
13274	Beograd	-1.0	-1.4	27	-22	5.2	2.5	28	-16
14015	Ljubljana	-1.6	-0.5	4	-78	4.0	2.6	35	-45
14445	Split	5.9	-1.5	33	-50	8.6	0.5	20	-48
14654	Sarajevo	-3.7	-2.8	49	-22	1.2	-0.3	57	-10
15420	Bucuresti	-4.8	-2.4	37	-3	1.8	1.9	35	-1
15614	Sofia	-4.3	-2.7	39	12	1.4	0.9	31	-2
16158	Pisa	5.3	-0.8	64	-11	7.7	0.6	8	-65
16597	Luqa / Malta	11.2	-1.0	120	31	12.1	-0.3	118	57
16716	Athens (Hellinikon)	8.1	-2.1	8	-36	10.6	0.0	11	-32
16754	Heraklion / Kreta	10.7	-1.3	139	49	11.9	-0.2	52	-25
17040	Rize	4.3	-2.0	419	202	5.2	-1.4	215	42
17062	Istanbul-Goztepe	3.5	-2.1	92	-7	6.5	0.6	82	15
17130	Ankara / Central	-3.4	-3.5	47	0	-1.1	-3.0	43	7
17170	Van	-2.5	1.7	23	-12	-2.5	0.9	44	10
17609	Larnaca	10.2	-1.3	55	-10	11.5	-0.2	25	-32
22113	Murmansk	-8.0	3.7	40	7	-8.2	3.0	18	-4
26038	Tallina	-1.6	3.9	71	26	-0.8	4.9	39	10
26629	Kaunas	-2.5	2.5	39	2	1.0	5.3	44	17
26730	Vilnius	-3.3	2.8	43	2	-0.2	4.6	51	13
26850	Minsk	-3.9	3.0	35	-5	-0.6	5.2	47	13
27199	Wjatka (Kirov)	-9.9	4.3	50	12	-7.0	4.8	53	25
27612	Moskva	-6.1	3.2	42	-3	-2.7	5.0	56	19
33345	Kiev	-4.1	1.5	31	-16	0.0	4.2	37	-9
33815	Chisinau	-3.3	0.0	43	3	1.6	3.3	31	-7
34300	Charkov (Kharkiv)	-5.9	1.0	30	-14	-1.8	3.9	24	-8
34880	Astrahan'	-1.2	4.2	2	-11	1.4	6.3	3	-7
35188	Akmola	-14.0	1.8	15	-2	-10.8	5.1	20	6
37789	Yerevan	-1.7	1.5	36	7	-0.5	0.5	6	-32
40080	Damascus	5.3	-0.9	61	26	7.1	-0.8	73	41
40100	Beyrouth	13.3	-0.3	298	76	14.0	0.5	98	-38
40180	Tel Aviv (Airport)	11.9	-0.4	330	181	12.6	-0.3	47	-51
40270	Amman	6.9	-2.2	108	44	8.2	-1.8	17	-47
60030	Las Palmas /Gr.Can	17.3	-0.2	45	20	18.7	0.9	8	-19

	March 2000				April 2000				May 2000			
WMO No.	Temp. Mean	(°C) dep.	Prec. sum	(mm) dep.	Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	Temp. Mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	-14.9	-0.2	18	-3	-12.8	-1.1	8	-4	-4.4	-0.7	5	-1
01025	-2.5	-0.3	175	111	0.0	-0.7	48	-12	5.8	0.9	100	52
01492	1.9	2.1	28	-18	6.3	1.7	75	33	12.5	1.7	95	43
02196	-4.8	2.0	35	0	1.1	1.6	89	60	7.7	1.6	23	-8
02485	2.1	2.0	30	4	6.8	2.2	25	-5	12.4	1.7	30	0
02974	-0.8	2.1	38	4	6.4	3.5	44	7	10.8	0.9	26	-9
03091	6.5	1.9	40	-21	6.1	-0.3	130	77	9.6	0.6	85	26
03772	8.6	2.1	16	-31	9.1	0.2	100	55	13.8	1.3	87	36
03967	7.3	1.3	15	-34	6.9	-0.9	71	24	11.0	0.5	71	13
04030	0.6	0.1	146	63	1.5	-1.4	28	-30	6.5	0.2	48	4
04320	-21.0	2.4	6	-11	-17.5	-0.2	2	-8	-8.0	-1.4	4	0
04360	-7.4	0.8	180	92	-2.1	2.0	65	-8	1.9	1.3	91	34
06186	4.0	1.4	51	9	9.4	2.8	41	-1	13.6	1.6	33	-10
06260	6.8	1.8	79	16	10.0	2.0	39	-13	14.7	2.4	85	24
06447	7.1	1.3	57	-15	10.5	1.7	65	8	15.1	2.2	86	15
06590	5.6	1.3	64	-4	9.6	1.8	49	-11	14.4	2.3	76	-1
06660	6.2	1.8	86	13	10.4	2.4	50	-44	15.2	2.9	137	33
06700	7.1	2.1	44	-34	10.8	2.1	79	14	16.5	3.6	53	-21
07510	9.7	0.9	52	-24	12.1	0.8	154	82	17.2	2.6	99	22
07650	11.3	1.1	71	27	14.2	1.0	96	48	19.5	2.4	26	-16
08222	12.1	2.1	37	4	10.7	-1.5	85	31	18.2	2.1	46	5
08314	13.3	1.5	13	-36	15.5	1.8	41	-4	19.7	2.7	6	-27
08495	16.1	1.1	20	-55	15.9	-0.3	145	85	19.0	0.5	43	8
08515	15.2	0.6	17	-62	15.0	-0.2	77	22	16.6	-0.1	50	20
08535	15.4	1.7	20	-49	13.6	-1.5	163	99	17.8	0.4	33	-6
10384	5.6	1.4	90	53	12.1	3.5	32	-9	16.8	2.9	29	-27
11035	6.3	1.0	81	40	13.5	3.3	12	-38	17.2	2.4	51	-10
11518	4.1	1.1	89	61	10.9	3.2	10	-28	15.2	2.5	55	-22
11903	3.4	0.4	112	69	11.8	3.3	46	-1	15.5	1.8	33	-30
12160	3.2	1.1	63	28	11.7	4.9	21	-21	13.9	1.0	21	-20
12375	3.4	1.4	41	13	12.4	4.6	14	-18	15.3	1.9	38	-21
12843	6.1	0.5	41	12	14.6	3.5	80	42	18.4	2.4	28	-27
13274	8.1	0.9	30	-20	16.2	3.8	42	-17	19.6	2.4	34	-37
14015	7.6	2.2	115	17	13.6	3.7	64	-45	17.0	2.4	93	-29
14445	10.4	0.0	43	-32	16.3	2.4	45	-21	21.7	3.3	14	-42
14654	5.0	-0.1	58	-12	12.7	3.3	51	-23	16.4	2.3	72	-10
15420	5.6	0.8	33	-5	14.0	2.7	51	5	17.8	1.1	38	-32
15614	4.9	0.3	37	-1	12.8	2.9	45	-5	16.4	2.1	13	-60
16158	10.3	0.8	64	-12	13.5	1.0	72	-7	18.2	1.9	14	-45
16597	14.2	0.8	6	-34	17.0	1.5	22	-1	21.1	2.0	5	-2
16716	12.5	-0.1	7	-34	17.6	1.5	12	-13	22.0	1.4	3	-13
16754	13.0	-0.4	22	-34	17.5	1.2	9	-21	20.8	1.0	8	-8
17040	6.6	-1.3	155	8	15.0	3.4	56	-45	16.0	0.2	97	-5
17062	7.7	0.2	105	43	14.3	2.3	88	39	16.7	0.2	33	2
17130	4.5	-1.6	41	5	13.0	1.8	76	28	15.5	0.0	17	-38
17170	0.9	-0.2	24	-19	9.5	2.2	36	-18	14.3	1.6	24	-25
17609	13.1	-0.2	18	-31	18.0	0.6	43	32	21.8	0.9	<1	-6
22113	-4.3	2.5	53	33	-0.3	1.6	72	51	4.7	0.9	43	11
26038	-0.2	2.0	37	8	7.3	3.9	23	-13	10.7	1.0	27	-10
26629	1.9	2.1	60	28	11.5	5.5	24	-19	13.1	0.4	42	-14
26730	1.3	1.9	49	10	11.3	5.6	34	-12	13.1	0.6	55	-7
26850	1.2	2.6	40	-2	10.8	4.8	83	41	13.4	0.5	19	-43
27199	-2.7	2.4	29	0	8.0	4.8	21	-15	8.9	-2.2	72	23
27612	-0.7	1.5	46	12	11.1	5.3	27	-13	10.8	-2.1	37	-21
33345	1.7	1.0	34	-5	12.7	4.0	28	-21	15.4	0.3	73	20
33815	4.2	1.3	29	-6	13.2	3.0	27	-15	17.6	1.5	5	-46
34300	0.8	1.1	66	39	13.6	4.7	22	-14	14.0	-1.6	46	-1
34880	4.2	2.9	5	-9	14.4	3.3	31	13	15.1	-3.2	35	11
35188	-7.2	0.9	11	-3	9.2	4.3	23	1	11.0	-2.1	83	50
37789	4.5	-0.6	7	-34	14.7	3.1	27	-24	16.0	-0.3	46	-14
40080	10.3	-0.9	11	-13	17.4	1.7	3	-9	21.0	0.6	<1	-4
40100	14.9	-0.2	69	-51	19.9	2.1	14	-37	21.5	1.1	0	-20
40180	13.9	-1.0	72	10	19.6	1.4	2	-21	21.8	0.7	0	-3
40270	10.5	-2.4	--	--	18.2	0.4	<1	-13	20.7	-1.2	<1	-3
60030	19.6	1.3	0	-11	19.2	0.4	3	-3	20.3	0.5	0	-2

WMO No.	Station	June 2000 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	July 2000 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	2.1	-0.1	4	-6	6.1	0.1	23	10
01025	Tromsø	8.6	-0.7	63	10	11.7	0.0	10	-62
01492	Oslo-Blindern	13.6	-1.6	75	10	16.2	-0.2	71	-13
02196	Haparanda	13.0	0.2	80	39	16.7	1.2	58	8
02485	Stockholm	14.7	-0.9	77	32	16.2	-1.0	108	36
02974	Helsinki-Vantaa	14.4	-0.5	72	28	16.9	0.3	66	-7
03091	Aberdeen	11.5	-0.6	29	-24	12.9	-0.9	15	-46
03772	London-Heathrow	16.9	1.2	19	-32	16.9	-0.9	53	7
03967	Dublin (Casement)	13.6	0.3	42	-6	15.0	0.1	31	-23
04030	Reykjavik	9.4	0.3	62	11	11.5	0.9	41	-10
04320	Danmarkshavn	0.3	-0.4	2	-3	3.6	-0.1	19	5
04360	Angmagssalik	5.1	1.0	9	-43	6.1	-0.3	35	-14
06186	København-Landb.	14.9	-1.2	45	-9	16.0	-1.2	50	-19
06260	De Bilt	16.0	0.8	60	-8	15.5	-1.3	99	24
06447	Uccle	16.8	1.1	35	-44	15.3	-2.2	134	59
06590	Luxembourg	17.3	2.0	41	-28	14.9	-2.2	197	130
06660	Zürich	18.0	2.5	76	-51	15.9	-1.8	196	78
06700	Genève	19.9	3.5	23	-64	18.5	-0.5	121	58
07510	Bordeaux	19.8	2.0	55	-1	20.0	-0.2	59	12
07650	Marseille	22.7	1.8	13	-15	23.2	-0.6	15	1
08222	Madrid	23.1	2.5	22	-5	23.9	-0.5	18	5
08314	Mahon / Menorca	22.0	1.0	23	8	24.1	-0.2	2	-3
08495	Gibraltar	22.8	1.7	0	-11	23.8	0.1	0	-1
08515	St.Maria / Acores	19.4	0.7	19	-3	20.8	0.0	36	11
08535	Lisboa	21.6	1.4	<1	-20	22.3	-0.1	9	4
10384	Berlin-Tempelhof	19.0	1.6	27	-48	17.1	-1.7	70	18
11035	Wien-Hohe Warte	20.3	2.3	23	-51	18.9	-1.0	66	4
11518	Praha-Ruzyne	17.5	1.6	42	-31	15.6	-1.9	66	0
11903	Sliac	18.4	1.8	45	-41	17.4	-0.8	65	6
12160	Elblag	15.9	0.5	60	-34	15.6	-1.2	77	-17
12375	Warszawa-Okecie	17.8	1.2	14	-58	16.6	-1.3	120	53
12843	Budapest-Lorinc	21.8	2.7	12	-51	20.4	-0.5	67	15
13274	Beograd	22.9	2.8	16	-74	23.5	1.8	29	-37
14015	Ljubljana	20.9	3.1	104	-51	19.9	0.0	158	36
14445	Split	25.0	2.8	7	-44	25.6	0.2	19	-9
14654	Sarajevo	19.6	2.7	23	-68	20.4	1.5	52	-27
15420	Bucuresti	21.6	1.4	35	-42	24.0	2.0	38	-26
15614	Sofia	19.6	1.9	34	-38	22.9	2.9	11	-45
16158	Pisa	22.1	2.3	28	-16	22.2	-0.6	5	-18
16597	Luqa / Malta	24.0	1.0	0	-3	26.9	1.0	0	0
16716	Athens (Hellinikon)	27.1	2.0	12	5	29.4	1.6	0	-5
16754	Heraklion / Kreta	24.1	0.6	0	-3	27.3	1.6	0	-1
17040	Rize	20.2	0.3	150	22	24.2	2.0	37	-99
17062	Istanbul-Goztepe	21.1	0.0	30	9	25.1	1.9	11	-8
17130	Ankara / Central	19.8	0.2	35	-2	26.5	3.6	0	-14
17170	Van	19.4	1.8	3	-18	25.4	3.5	0	-4
17609	Larnaca	26.9	2.6	0	-1	29.1	2.2	0	0
22113	Murmansk	9.6	0.2	101	48	13.8	1.0	54	-6
26038	Tallina	13.7	-0.8	67	14	16.2	-0.1	113	34
26629	Kaunas	15.1	-0.9	64	-11	16.2	-0.9	113	45
26730	Vilnius	15.2	-0.6	59	-18	15.8	-1.1	209	131
26850	Minsk	16.1	0.0	64	-19	16.9	-0.4	79	-9
27199	Wjatka (Kirov)	17.8	2.2	57	-7	21.9	3.7	51	-35
27612	Moskva	16.2	-0.4	116	40	19.3	1.2	167	75
33345	Kiev	17.9	-0.3	65	-8	19.1	-0.2	82	-6
33815	Chisinau	20.5	1.1	8	-67	21.5	0.6	103	34
34300	Charkov (Kharkiv)	17.9	-1.0	13	-45	20.9	0.6	90	30
34880	Astrahan'	22.1	-0.8	12	-10	26.3	1.0	8	-15
35188	Akmola	19.6	0.6	37	2	20.2	-1.1	15	-35
37789	Yerevan	22.0	1.4	0	-29	28.5	3.9	4	-10
40080	Damascus	26.3	1.7	0	-1	30.1	3.5	0	0
40100	Beyrouth	25.2	1.6	0	-1	27.8	2.3	0	0
40180	Tel Aviv (Airport)	25.6	1.6	0	0	28.5	2.8	0	0
40270	Amman	25.0	0.0	0	0	29.6	3.2	0.5	0.5
60030	Las Palmas /Gr.Can	22.2	0.6	0	-0.5	23.8	0.7	0	0

	August 2000				September 2000				October 2000			
WMO	Temp.	(°C)	Prec.	(mm)	Temp.	(°C)	Prec.	(mm)	Temp.	(°C)	Prec.	(mm)
No.	mean	dep.	sum	dep.	mean	dep.	sum	dep.	mean	dep.	sum	dep.
01008	5.2	0.4	16	-9	2.1	1.6	48	25	1.3	6.8	41	26
01025	10.8	-0.1	71	-11	8.1	1.3	108	14	6.5	3.6	47	-78
01492	15.3	0.1	148	58	11.3	0.5	54	-36	9.4	3.0	188	104
02196	13.8	0.5	53	-10	8.7	0.8	47	-16	6.3	3.8	110	46
02485	16.4	0.2	24	-42	12.0	0.8	18	-37	10.7	3.2	89	39
02974	15.4	0.4	52	-28	9.7	-0.3	12	-61	8.8	3.4	94	21
03091	14.2	0.6	82	7	12.4	0.7	102	34	9.2	0.1	120	42
03772	18.6	1.2	32	-19	16.3	1.3	106	55	11.7	0.0	155	97
03967	15.5	0.9	105	27	13.5	0.5	75	6	9.4	-0.9	80	12
04030	10.7	0.4	71	9	8.7	1.3	87	20	4.8	0.4	104	18
04320	1.8	-0.6	3	-11	-4.3	-0.1	12	1	-13.3	0.3	34	22
04360	6.0	0.0	42	-19	4.4	1.3	100	32	0.6	1.4	42	-40
06186	16.2	-0.8	28	-35	13.6	0.0	56	-6	11.7	1.8	49	-10
06260	17.4	0.7	43	-28	15.8	1.8	69	2	11.3	0.8	106	34
06447	18.3	1.0	35	-28	16.1	1.6	70	11	11.3	0.4	98	28
06590	18.4	1.7	62	-9	14.6	0.9	103	36	10.0	0.7	101	27
06660	19.0	2.1	143	9	15.1	1.0	128	34	10.4	0.9	72	0
06700	20.7	2.6	109	28	16.8	2.0	105	23	12.2	2.2	131	57
07510	21.8	1.9	26	-28	18.9	1.0	43	-31	14.1	0.1	159	71
07650	24.8	1.6	6	-23	20.8	0.5	77	30	15.9	-0.2	100	22
08222	24.4	0.5	0	-9	21.0	0.5	13	-17	14.9	0.1	26	-19
08314	25.7	1.2	4	-22	22.8	0.6	76	21	18.8	0.3	58	-26
08495	23.9	-0.3	0	-6	22.7	-0.1	9	-6	18.4	-1.1	86	22
08515	22.0	-0.2	26	-14	21.8	0.4	19	-38	20.2	0.9	49	-35
08535	23.0	0.2	5	-1	21.2	-0.5	19	-7	17.8	-0.7	26	-54
10384	18.8	0.4	82	21	14.5	-0.1	62	16	12.4	2.4	24	-12
11035	21.4	2.2	53	-12	15.2	-0.2	46	1	12.7	2.6	56	15
11518	18.8	1.8	39	-31	13.4	0.1	20	-20	10.6	2.3	54	24
11903	19.9	2.6	20	-51	13.4	0.0	24	-34	11.1	2.8	41	-9
12160	16.9	0.2	79	-2	12.2	-0.5	41	-29	12.0	3.1	13	-40
12375	18.1	0.8	62	-1	12.0	-1.2	53	10	11.6	3.3	5	-33
12843	23.4	3.1	11	-40	16.0	-0.4	25	-15	13.8	2.9	13	-21
13274	25.6	4.3	8	-44	17.9	0.2	71	20	14.6	2.2	17	-23
14015	22.1	3.0	34	-110	16.3	0.8	125	-5	12.9	2.5	175	60
14445	27.9	2.7	6	-44	21.6	0.2	52	-9	18.4	1.5	93	14
14654	21.8	3.3	16	-55	15.3	0.2	67	-3	12.8	2.4	83	6
15420	23.4	2.2	8	-50	15.5	-1.4	81	39	10.1	-0.7	1	-31
15614	22.8	3.4	1	-51	15.9	0.1	72	33	11.1	0.7	6	-31
16158	23.9	1.4	28	-29	20.2	0.7	94	5	16.3	1.0	138	18
16597	27.9	1.6	0	-7	25.1	1.0	23	-17	21.0	0.3	75	-15
16716	29.5	1.9	0	-5	24.6	0.4	5	-5	19.5	0.2	6	-46
16754	26.3	0.7	0	-1	24.0	0.9	0	-18	19.8	0.1	1	-75
17040	23.8	1.6	296	113	20.8	1.4	318	97	16.3	0.9	250	-22
17062	24.1	1.1	47	21	20.7	1.0	44	3	15.3	0.0	76	5
17130	22.8	0.2	24	12	18.9	0.6	5	-14	12.2	-0.4	21	-6
17170	22.9	1.7	0	-7	17.9	1.1	2	-12	11.8	1.7	3	-45
17609	28.6	1.5	0	0	26.2	1.1	2	2	21.9	0.6	24	5
22113	11.6	0.6	51	-14	7.8	1.1	42	-10	5.2	4.2	41	-1
26038	15.3	0.0	52	-32	10.1	-0.7	23	-59	8.9	2.6	62	-8
26629	16.1	-0.2	54	-9	10.6	-1.5	15	-44	9.6	2.7	4	-47
26730	16.0	-0.3	64	-8	10.2	-1.4	11	-54	9.3	2.7	7	-46
26850	17.1	0.6	72	0	10.5	-1.2	31	-29	8.7	2.4	2	-47
27199	14.8	-0.7	100	35	8.9	-0.3	51	-20	3.6	1.9	14	-48
27612	16.8	0.4	83	9	10.0	-0.9	51	-13	7.2	2.2	32	-26
33345	20.6	2.0	20	-49	12.3	-1.6	141	94	9.5	1.4	<1	-34
33815	23.1	2.6	49	4	14.9	-1.3	38	-10	10.7	0.6	6	-21
34300	21.2	1.7	2	-48	13.3	-0.8	66	25	8.2	0.9	9	-26
34880	24.6	1.3	19	0	16.7	-0.6	26	0	8.7	-0.4	3	-14
35188	19.3	1.6	15	-25	11.8	-0.2	32	8	0.1	-2.7	25	-5
37789	26.2	2.3	6	-3	21.7	1.9	2	-7	12.8	0.0	47	15
40080	27.6	1.4	0	0	24.0	0.7	0	0	17.7	-0.9	16	4
40100	28.0	1.6	0	-1	26.7	1.5	66	61	23.7	1.1	67	13
40180	27.9	1.8	0	0	26.4	1.6	7	7	22.5	0.5	111	85
40270	26.0	-0.4	0	0	23.7	-1.5	0	-0.3	18.6	-3.2	9	2
60030	24.7	0.8	0	0	24.7	0.9	0	-8	23.0	0.5	20	4

		November 2000				December 2000			
WMO No.	Station	Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	Temp. Mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-3.7	6.8	12	-1	-9.7	3.6	11	-1
01025	Tromsø	0.8	1.6	9	-95	-2.1	0.9	122	18
01492	Oslo-Blindern	5.8	5.1	279	204	1.2	4.0	99	43
02196	Haparanda	0.9	5.0	92	34	-6.3	3.2	64	22
02485	Stockholm	7.0	4.4	101	48	2.9	3.9	53	7
02974	Helsinki-Vantaa	4.6	4.5	133	61	1.3	5.4	81	23
03091	Aberdeen	5.7	0.5	138	63	4.6	0.9	120	47
03772	London-Heathrow	8.0	0.8	99	44	6.8	1.7	74	17
03967	Dublin (Casement)	6.4	-0.3	146	76	5.7	0.4	141	64
04030	Reykjavik	0.9	-0.3	10	-63	0.1	0.3	45	-33
04320	Danmarkshavn	-20.5	-0.6	5	-5	-24.0	-2.2	2	-11
04360	Angmagssalik	-1.7	3.0	37	-59	-7.2	0.0	20	-83
06186	København-Landb.	7.9	2.4	57	-5	4.3	2.1	42	-16
06260	De Bilt	7.8	1.9	118	37	5.1	1.9	92	12
06447	Uccle	7.9	1.8	87	11	5.7	2.2	59	-17
06590	Luxembourg	6.0	2.0	146	67	4.1	2.9	87	9
06660	Zürich	6.0	1.9	67	-18	3.9	3.2	37	-40
06700	Genève	7.3	2.3	149	57	5.3	3.4	68	-19
07510	Bordeaux	10.1	1.0	322	228	9.8	3.4	119	20
07650	Marseille	11.6	0.9	123	65	10.7	3.4	97	41
08222	Madrid	8.8	-0.6	89	25	7.6	1.2	127	78
08314	Mahon / Menorca	14.8	0.4	74	-3	13.5	1.7	55	-25
08495	Gibraltar	15.4	-0.7	165	24	14.6	0.5	293	147
08515	St.Maria / Acores	18.6	1.2	94	-8	15.6	0.2	104	9
08535	Lisboa	14.2	-0.3	189	75	13.8	2.0	285	177
10384	Berlin-Tempelhof	7.1	2.2	25	-24	3.3	1.9	39	-14
11035	Wien-Hohe Warte	7.6	2.8	33	-17	2.5	1.5	42	-2
11518	Praha-Ruzyne	5.0	2.2	28	-4	0.8	1.4	8	-18
11903	Sliac	6.8	3.8	99	32	0.4	2.1	51	-5
12160	Elblag	6.8	3.5	60	4	2.1	1.8	64	12
12375	Warszawa-Okecie	5.9	2.7	66	24	1.4	2.3	40	8
12843	Budapest-Lorinc	8.4	3.6	51	-1	2.2	1.8	41	1
13274	Beograd	11.9	4.9	21	-33	5.2	2.9	41	-17
14015	Ljubljana	8.4	3.8	312	177	4.9	4.9	145	44
14445	Split	15.2	3.0	162	54	10.9	2.2	95	-5
14654	Sarajevo	10.3	5.0	75	-19	3.2	2.9	94	9
15420	Bucuresti	7.8	2.6	18	-31	2.5	2.3	5	-38
15614	Sofia	8.9	3.9	5	-42	2.0	1.5	10	-29
16158	Pisa	11.9	1.5	374	250	9.7	2.9	101	16
16597	Luqa / Malta	18.9	1.9	15	-65	15.3	1.3	65	-44
16716	Athens (Hellinikon)	17.4	1.9	93	43	12.8	0.6	20	-51
16754	Heraklion / Kreta	17.6	1.0	60	1	14.3	0.5	102	28
17040	Rize	12.5	0.9	68	-182	9.5	1.2	208	-35
17062	Istanbul-Goztepe	13.6	2.0	17	-72	9.6	1.5	51	-71
17130	Ankara / Central	8.7	1.6	7	-26	2.2	-0.4	31	-18
17170	Van	5.6	1.6	14	-28	1.0	1.9	61	27
17609	Larnaca	18.1	1.7	121	77	14.1	0.9	132	56
22113	Murmansk	-1.1	4.0	29	-11	-8.2	1.1	23	-15
26038	Tallina	4.2	3.0	82	14	1.5	4.4	74	19
26629	Kaunas	5.4	3.3	70	17	1.4	3.8	44	0
26730	Vilnius	4.6	3.4	65	8	0.8	3.7	47	-8
26850	Minsk	3.8	3.0	60	8	0.2	4.0	57	4
27199	Wjatka (Kirov)	-5.8	-1.1	30	-22	-12.6	-2.3	40	-5
27612	Moskva	-0.1	1.0	43	-15	-2.6	3.5	82	30
33345	Kiev	4.5	2.4	44	-7	1.3	3.6	24	-28
33815	Chisinau	7.7	3.3	82	43	2.5	2.8	14	-24
34300	Charkov (Kharkiv)	1.2	-0.1	4	-40	0.7	4.1	45	0
34880	Astrahan'	1.4	-1.9	5	-14	0.2	2.1	16	1
35188	Akmola	-10.3	-4.4	14	-8	-10.5	2.1	32	15
37789	Yerevan	6.6	0.0	2	-28	1.0	0.5	36	10
40080	Damascus	11.2	-1.1	6	-21	8.1	0.5	23	-23
40100	Beyrouth	20.1	1.4	31	-73	16.6	1.8	123	-51
40180	Tel Aviv (Airport)	18.6	0.6	9	-59	14.8	1.0	92	-46
40270	Amman	14.3	-1.4	3	-26	10.0	-0.7	51	1
60030	Las Palmas /Gr.Can	21.1	0.4	4	-17	20.1	1.8	7	-15

Year 2000

WMO No.	Station	Temp. (°C) mean	dep.	Prec. (mm) sum	dep.
01008	Svalbard	-4.0	2.4	205	22
01025	Tromsø	3.6	0.8	1097	124
01492	Oslo-Blindern	7.7	2.0	1173	404
02196	Haparanda	3.4	2.3	769	217
02485	Stockholm	8.5	1.9	578	39
02974	Helsinki-Vantaa	6.8	2.3	710	59
03091	Aberdeen	8.5	0.6	910	122
03772	London-Heathrow	11.7	1.1	820	221
03967	Dublin (Casement)	9.6	0.3	867	132
04030	Reykjavik	4.5	0.2	802	2
04320	Danmarkshavn	-11.9	0.4	130	-2
04360	Angmagssalik	-0.5	1.2	780	-152
06186	København-Landb.	9.8	1.2	503	-133
06260	De Bilt	10.9	1.5	933	128
06447	Uccle	11.2	1.2	854	36
06590	Luxembourg	10.0	1.4	1039	198
06660	Zürich	10.4	1.7	1159	38
06700	Genève	11.8	2.2	997	53
07510	Bordeaux	14.0	1.3	1209	286
07650	Marseille	15.8	1.0	629	85
08222	Madrid	15.0	0.7	490	33
08314	Mahon / Menorca	17.7	1.0	420	-163
08495	Gibraltar	18.4	0.2	870	95
08515	St.Maria / Acores	17.8	0.3	581	-194
08535	Lisboa	17.0	0.2	800	47
10384	Berlin-Tempelhof	11.1	1.7	587	3
11035	Wien-Hohe Warte	11.7	1.7	545	-68
11518	Praha-Ruzyne	9.5	1.6	452	-74
11903	Sliac	9.4	1.5	614	-75
12160	Elblag	9.4	1.8	621	-69
12375	Warszawa-Okecie	9.6	1.8	524	5
12843	Budapest-Lorinc	12.3	1.9	398	-120
13274	Beograd	14.1	2.3	364	-320
14015	Ljubljana	12.2	2.4	1364	-29
14445	Split	17.3	1.4	589	-236
14654	Sarajevo	11.2	1.6	697	-235
15420	Bucuresti	11.6	1.0	380	-215
15614	Sofia	11.2	1.5	304	-259
16158	Pisa	15.1	1.1	990	86
16597	Luqa / Malta	19.6	0.9	449	-100
16716	Athens (Hellinikon)	19.3	0.8	177	-192
16754	Heraklion / Kreta	18.9	0.5	393	-108
17040	Rize	14.5	0.6	2269	97
17062	Istanbul-Goztepe	14.9	0.7	676	-21
17130	Ankara / Central	11.6	-0.1	347	-66
17170	Van	10.3	1.6	234	-151
17609	Larnaca	20.0	0.9	421	92
22113	Murmansk	1.9	2.0	567	89
26038	Tallina	7.1	2.0	670	3
26629	Kaunas	8.3	1.8	573	-35
26730	Vilnius	7.8	1.8	694	11
26850	Minsk	7.8	2.0	589	-88
27199	Wjatka (Kirov)	3.8	1.5	568	-57
27612	Moskva	6.6	1.7	782	94
33345	Kiev	9.2	1.5	580	-69
33815	Chisinau	11.2	1.6	435	-112
34300	Charkov (Kharkiv)	8.7	1.2	417	-102
34880	Astrahan'	11.2	1.2	165	-55
35188	Akmola	3.2	0.5	322	4
37789	Yerevan	6.4	0.9	383	-29
40080	Damascus	17.2	0.5	193	-1
40100	Beyrouth	21.0	1.2	766	-122
40180	Tel Aviv (Airport)	20.3	0.9	670	103
40270	Amman	17.6	-0.9	--	--
60030	Las Palmas /Gr.Can	21.2	0.7	87	-52

January 2000:

- **Very wet in the Middle East**
- **Cold in the South, but warm in the North**

Abundant rain poured down in the Southeast. In Israel, in many areas rainfall amounts were more than twice of normal. Near the coast, January 2000 was the second rainiest since the beginning of measurements in the late 1930s, and in some stations even the rainiest (fig. 1.1). Tel Aviv received 150-200 mm on January 4-5 causing severe flooding especially in the southern parts of the city. The same areas were flooded again on January 27-28 when 110-120 mm of rain fell on Tel Aviv within 24 hours. During this extreme event, heavy snow fell over the mountain areas. Snowfall occurred also in areas with an altitude of only 200-300 m above sea level – a rare event in Israel. Jordan received half of the year's rainfall (see fig. 1.2). Turkey recorded the maximum areal average precipitation value of the year 102.8 mm (see fig. 1.3) and snow caused again and again problems across the country. Heavy rains and local floods affected Crete on January 14-15.

Wide parts of south-eastern Europe suffered from cold and wet weather with plenty of snow and local blizzards. In Bulgaria, the snow cover reached a depth of 50 cm almost throughout the country in the beginning of the month. During the third decade, new snowfall and high wind speeds plagued the Northeast of Bulgaria. Abundant precipitation triggered local floods in northern Yugoslavia. In Croatia, drifting snow and a strong Bora with gusts up to 150 km/h afflicted the coastal regions. Some harbours in the middle Adriatic were partly frozen. In Armenia and the adjacent Russian districts, in the period from January 18 to 23 heavy snowfall and blizzards occurred and the avalanche risk was severe. Together with strong winds (up to 28-30 m/s), they caused the river Gavaraget to flood the coastal grounds, 50 houses in the village of Krasnoe were damaged.

The year started extremely cold in the South: New temperature records were set in Spain, e.g. Salamanca registered an average temperature of - 4.6 °C which has been 0.2 °C lower than the previous record of January 1976. It produced the lowest January minimum temperatures in 55 years of registration. On Cyprus, frost caused substantial losses to the agricultural crops. The cold weather mostly went along with dry conditions. Wide parts of Slovenia and Albania got less than 30 % of the 1961-1990 normal precipitation (see fig. 8.2 page xx and 11.4 page xx). In the central parts of Slovenia, the number of sunshine hours were twice as high as usual (see fig. 1.4).

From Iceland across Scandinavia to western Russia, it was unusually warm. While the far North received plenty of snow, long spells of mild weather reduced the snow depth in the southern and western parts of Finland and the Baltic states. The wet snow wrecked power lines and damaged forests.

An unusual high number of thunderstorms appeared in Central Europe: In Slovakia, where only during 10 January months since 1881 there had been one day with thunderstorm, altogether 5 days with thunderstorms were recorded between December 28, 1999 and January 29, 2000.
A severe winterstorm hit northern Germany, Denmark and Sweden on January 29-30. Four people died. Vast amounts of sand were eroded along the coasts.

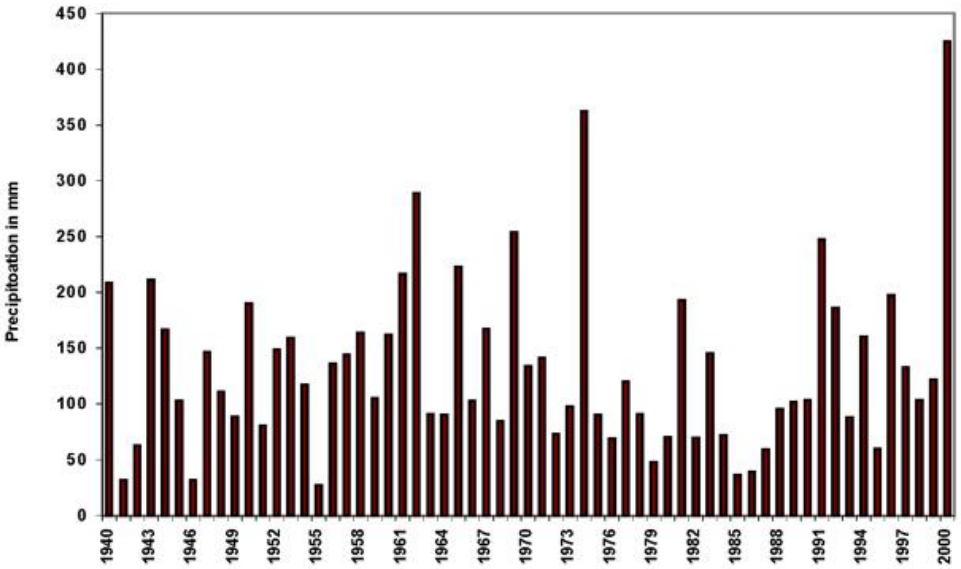


Fig. 1.1: *January rainfall totals in Tel Aviv between 1940 and 2000*
From: Israel Meteorological Service

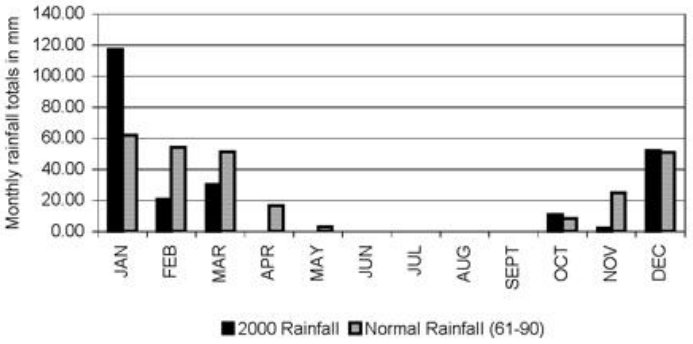


Fig. 1.2: *Monthly rainfall totals in Amman in 2000 and 1961-1990-normals*
From: Meteorological Department, H .K .of Jordan

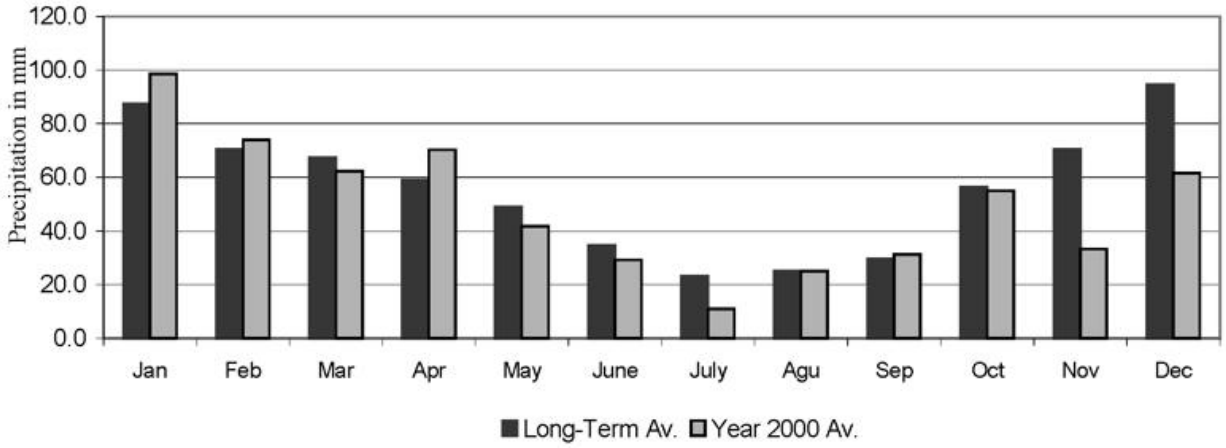


Fig. 1.3: *Monthly areal means of precipitation for Turke in 2000 and long term averages*
From: State Meteorological Service, Turkey

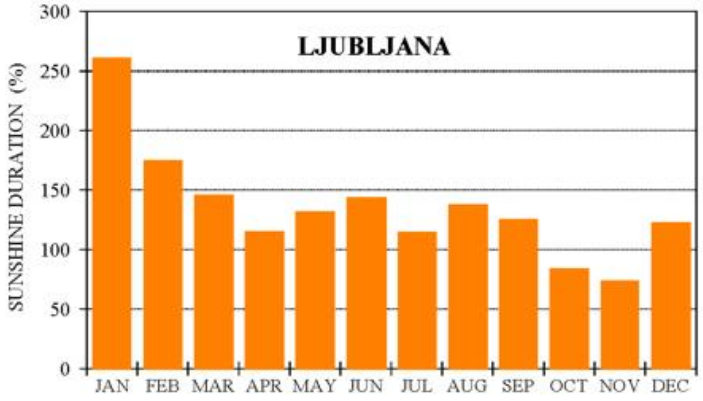


Fig. 1.4: *Monthly sunshine duration totals in % of 1961-1990 normal in Ljubljana*
From: Hydrometeorolgical Institute of Slovenia

February 2000

- **Mostly extraordinarily warm, especially in Eastern Europe**
- **Very dry in the South**

In nearly all parts of Europe, it was a warm month. The mild conditions peaked from Poland to Western Russia with anomalies surpassing +4-5 °C (see fig. 2.1 and 2.2). In Spain, some 30 % of the mainland stations registered new average maximum temperatures. Also new records of the monthly average temperature were recorded for 100-year reference periods, including Madrid, with 16.0 °C, which is 0.6 °C higher than the previous record. An abrupt temperature rise of 20-25 °C in the course of a day and snow, blizzards and gusty wind of up to 13 - 17 m/s occurred in St. Petersburg Oblast and Karelia, north-western Russia, on February 27-28. Ice floes broke away with over 1200 amateur fishermen; rescue operations were carried out, but six people died.

The month was stormy and cold on Iceland with an unusually persistent snow cover in the south and west. Cold conditions prevailed also in the south-eastern parts of the Region (see fig. 11.xx (Cyprus) and 7.5 page xx)).

Whereas wet weather prevailed in the North, dryness predominated in the South. Drought was most extreme on the Iberian Peninsular where large parts received less than 25 % of normal. For the North of Spain as a whole, the average monthly atmospheric pressure levels were the highest registered for 40 years. Bilbao registered a level 1.5 hPa higher than the previous record (1961) and in the north-east, the 1962 record was exceeded by 2.4 hPa (see fig. 2.3). In Israel and Jordan, which had received excessive rainfall in the January, February was cool and dry (see fig. 1.2, page xx) with rainfall amounts of 40 % - 80 % of normal in the northern and central parts. The southern parts received almost no rain at all.

Dry and very sunny weather prevailed also on the Balkans. Primorska and Julian Alps, Slovenia got less than 30 % of the normal precipitation. Wild fires damaged 216 ha in Slovenia. In Ljubljana, more sunshine hours than this year were only recorded in February 1998.

There were plenty of rain and snow on the northern slopes of the Alps. A catastrophic flood caused 3 deads and high damage in northern Poland on February 2-3, where the dam of a water reservoir was broken. Heavy snowfalls, partly with storms caused problems in northern Norway and Sweden. Tromsö region got more than 0.5 m snow depth during a 24-hour period.

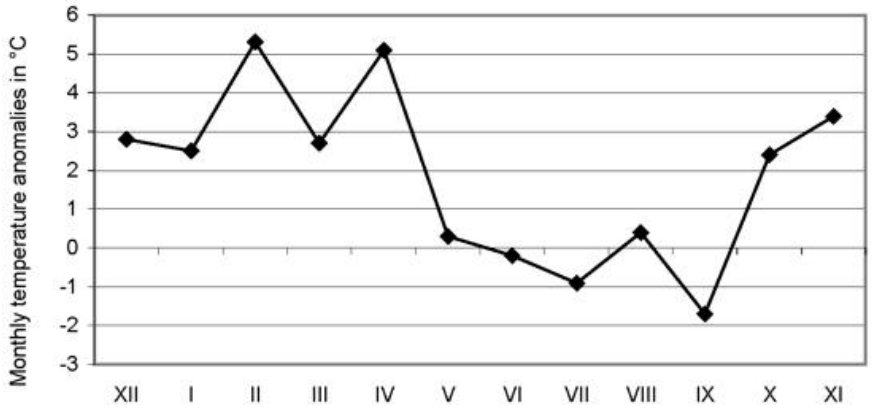


Fig. 2.1: *Monthly temperature anomalies in Belarus in 2000 (reference period: 1881-1990). From: State Committee for Hydrometeorology of the Republic of Belarus*

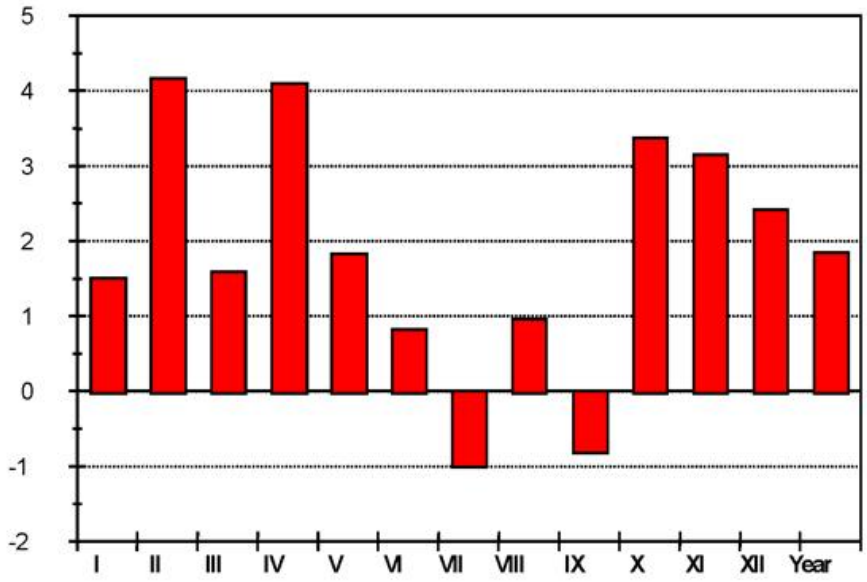


Fig: 2.2: *Monthly temperature anomalies in Poland in 2000 (reference period: 1961-1990. averages of 8 stations.*
From: Institute of Meteorology and Water Management, Kraków, Poland

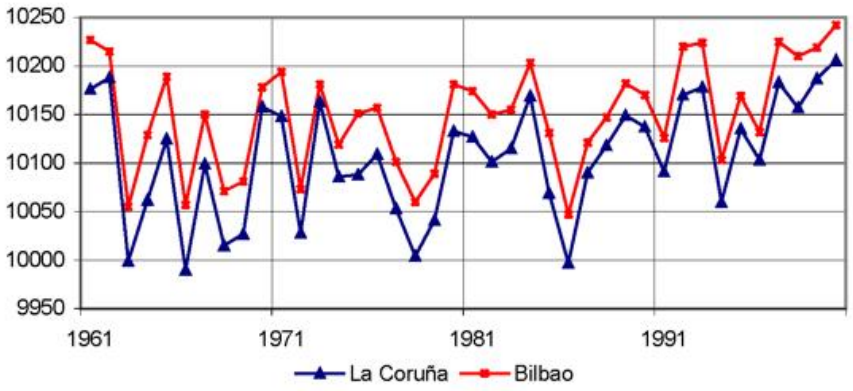


Fig. 2.3: *Mean sea level pressure (in 1/10 hPa) in La Coruña and Bilbao in February from 1961 to 2000.*
From: Instituto Nacional de Meteorologia, Spain

March 2000:

- **Heavy snowfalls in the North**
- **Very wet in wide parts of Central Europe**
- **Cool in the Southeast, elsewhere mostly mild**

Heavy snowfall continued in northern Fennoscandia. In Troms, Norway, roofs broke because of the heavy snow burden. Several settlements in Troms and Finnmark had to be evacuated for longer periods because of avalanche risk. Precipitation records were established at several stations in Troms, one of them with five times the normal precipitation amount of the month. In Sweden, one person was killed on March 6, when an avalanche crushed a house in the north-western mountains. Eastern and northern Finland had between 50 and 100 cm of snow, which was 20 cm above normal. The greatest snow depth of the winter (151 cm) was recorded in Haapovaara in Suomussalmi in early March.
Iceland experienced unusually adverse weather. A fierce storm hit the north-east coast on March 5. The precipitation total in Reykjavik was the highest since 1953. Heavy precipitation and snow melt caused landslides and local flooding in the western part of the country in late March.

Apart from the Southeast of the Region, mild weather prevailed also in March. Record high temperatures (up to 26.4 °C) were reported from southern Switzerland. Cold weather gripped Turkey. On March 7, several hundred people stranded in freezing temperatures on buses and trucks on a snow-blocked road in the north-eastern parts of the country. Fierce frosts caused considerable damage to the vineyards in Edirne region.

Whereas dry conditions prevailed in the western and southern parts of the Region, it was extremely rainy in Central Europe. The areal average rainfall of the Czech Republic amounted to 289 % of the 1961-90 normal and in Poland to 212 % (see fig. 3.1). In Slovakia, new daily precipitation records were set on March 9, some much higher than the monthly normal. The water equivalent of the snow cover reached extreme 53-years' extremes in the second half of the month (401 mm at Oravská Lesná (780 m above m.s.l.) on March 20, 528 mm at Štrbské Pleso (1354 m above m.s.l.) on March 27). Heavy rains and melting snow caused severe flooding in eastern Germany around March 15. A severe flood with a return period of 100 years occurred in the upper Labe river basin in north-eastern Bohemia. Precipitation totals during March 7 to 9 exceeded 100 mm and the additional contribution of melting snow was about 40-50 mm. For Tartu, Estonia, it was the 5th wettest March of the 1870 - 2000 period. The wet and mild weather resulted in a deep snow cover in the high mountains of the Alps. It led to a permanent snow cover for the whole year at Zugspitze, Germany, 2960 m above m.s.l.. A number of avalanches hit the upland regions of the northern Caucasian republics.

Cyprus experienced severe hailstorms on March 22 and 23.

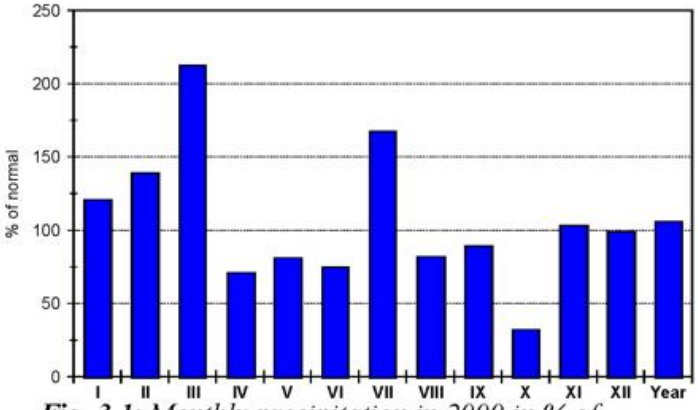


Fig. 3.1: *Monthly precipitation in 2000 in % of normal in Poland in 2000 (reference period: 1961-1990), averages of 8 stations. From: Institute of Meteorology and Water Management, Kraków, Poland*

APRIL 2000:

- **Mostly extremely warm**
- **Abundant rain from Spain across the British Isles to northern Scandinavia**
- **Severe floods in Hungary and Romania**
- **Very dry in south-eastern Europe and on Iceland**

It was another very warm month in the Region. Temperature anomalies surpassed +4 °C, locally +5 °C in the East (see fig. 2.1 and 2.2, page xx). A series of extremely warm days occurred at the end of the month. For Vilnius, Lithuania, it was the hottest ten-day period in April since 1881. Temperatures above 30 °C set a number of new records in Germany. In Tartu, Estonia, it was the warmest April in the 1866 to 2000 period. Norway had the warmest April since 1937. Several stations in southern Norway established new maximum records for April, with the warmest at Høland on April 19 with 26.2 °C. As a consequence of the unusually warm weather, the crop development was more than 14 days ahead of normalin many areas.

Israel experienced a large number of sharav events (hot and dry spells). The highest temperatures were recorded on April 12: 37 °C -38 °C in the coastal areas. The sharav event of April 18-19 ended with severe haze (the visibility throughout the country was less than 2 km) which lasted for three days. Also Cyprus reported extreme hazy conditions on April 19 with a visibility restricted to less than 300 m.
Only in the West of the Region temperatures were subnormal. In Iceland, it was cold, dry and unusually sunny, an unfavourable combination for some types of vegetation at that time of the year. The April records of bright sunshine hours were broken both in Reykjavik and Akureyri.

Dry weather prevailed and initiated in south-eastern Europe a drought that lasted for three months (see fig. 3.1 page xx). Some regions, e.g. western Slovakia, received hardly any rain at all. Whereas a cloud burst on April 25, caused high damage north of Cracow, Poland, most other parts of the country recieved monthly precipitation totals of less than 50 % of normal (e.g. Wroclav 11 mm or 29 % of normal).#

In the western part of the Region it was wet:

- On the Iberian Peninsula, westerly winds brought abundant rain to the river basins on the Atlantic side and to parts of the Ebro Basin. Several new rainfall records for April were set (e.g. Vigo 477 mm, Navacerrada NW of Madrid 375 mm, Spain and Beja and Oporto, Portugal).
- For the UK it was the wettest April in the 235-years' England and Wales precipitation series. The areal average was 143 mm against 139 mm in 1782 (the previous April record).
- In northern Norway, April brought the highest amount of precipitation in 100 years.

Rapidly melting snow in the Carpaths caused the highest water levels ever recorded in a more than 100 km section of river Tisza, Hungary, at the beginning oft the month. The flood also afflicted neighbouring Romania and northern Serbia. All in all 10 people died, 10.000 houses and 2.000 km^2 were flooded. On April 26, heavy precipitation engendered flooding in Bulgaria (daily totals up to 115 mm in Botev).

Southern Switzerland experienced heavy rain balancing the winter deficit (e.g. Locarno-Monti) received more precipitation than the January-April normal.

Frequent storms and hail caused considerable losses in Turkey (see fig. 1.3 page xx). Trees were broken, roofs and power lines destroyed. The maximum gust of the year for France, was recorded on April 4 at Cap-Béar (187 km/h). Storm winds brought sandy grains from the Sahara to Bulgaria on April 4-5.

May 2000:

- **Dry, sunny and warm in most parts**
- **Fierce cold spell in eastern Central Europe**

The dry weather that had started in April continued into May in many parts (see fig. 5.1 and 3.1 page xx). As a consequence, severe drought afflicted western Slovakia (e.g. Maldacky received only 5 mm of rain between April 6 and May 17 (7 % of normal), Kráľová pri Senci only 3 mm from April 6 to May 21, 2000 (5 % of normal)). In Belarus (see fig. 5.2), there was no rain from about April 20 to mid-May and together with very dry air the soil was extremely dry, causing high losses to the agriculture. In Poland, drought was worse in the Northeast: Suwalki received 13 mm of rain which is 22 % of normal. Eastern Austria experienced an unusually dry period from April 16 to May 17 (Vienna 4 mm) causing crop losses of up to 100 %. Also in Hungary, which had suffered from devastating floods in April, weather was hot, dry and sunny in May.

Temperatures were significantly above normal in most parts of the Region (except for the far East). New maximum temperature records were set. Kongsberg, SE Norway, recorded 30.0 °C on May 14, a temperature that had never been exceeded at any station in Norway so early in the year before. Ibiza, Spain, recorded a new absolute maximum for May with 30.4 °C in 50 years of observation. The first half of the month was warmest ever in the low lands of Switzerland. With a mean temperature of 15-18 °C, it was nearly as warm as in July. New records of maximum daily temperature means were reported from Germany. The Netherlands recorded a remarkable sequence of 12 consecutive "summer days", equalling the record set in 1992. It may be noted that this had not even happened in June before, where the present record is 10 such days in a row.

There was a number of severe cloudbursts and thunderstorms.

- Bracknell, southern England, experienced more than 50 mm of rain on May 7 and hail with diameters of 1.5 cm.
- Thunderstorms with heavy rain and hail hit Germany at the beginning of the month.
- Heavy rain and hail caused severe damage in north-western France and Belgium.
- On May 9, a heavy cloudburst hit western Poland.
- On May 27, some cornfields were completely damaged by severe thunderstorms with hail (diameters up to 4 cm) in Lower Silesia, Poland. Afterwards, the strong winds with hail crossed Poland from Cracow to Warsaw.
- Storms with local floods occurred in Croatia at the end of the month.
- Some stations in the Julian Alps, Slovenia, registered monthly totals of more than 250 mm.
- Turkey reported a number of hail events and local floods

In the eastern parts of the Region, the month started with a spell of fierce frost:

- Temperatures dropped to - 4 °C in Suwalki, Poland, on May 3.
- Soil temperatures fell to minus 5 - 10 °C in south-eastern Lithuania and Belarus.

The frost was especially disastrous, as it followed a period of very warm weather in April.

The Arkhangelsk Oblast experienced heavy snow with blizzards and gusty wind of up to 20 m/s on May 12-14. Wide-spread snow cover of 5-28 cm deepness (up to 77 cm in Mezen) destroyed power and telephone lines. On May 2, north-eastern Norway was hit by heavy snowfall and strong winds. Several roads were closed even in southern Norway.

On May 28, unusually strong winds for the season caused considerable damage in the forests and destroyed power lines in Germany. In the western parts of the Netherlands, the gusts reached 35 m/s. Some stations reported a maximum hourly wind speed of 25 m/s. Six people died, buildings were damaged, trees uprooted.

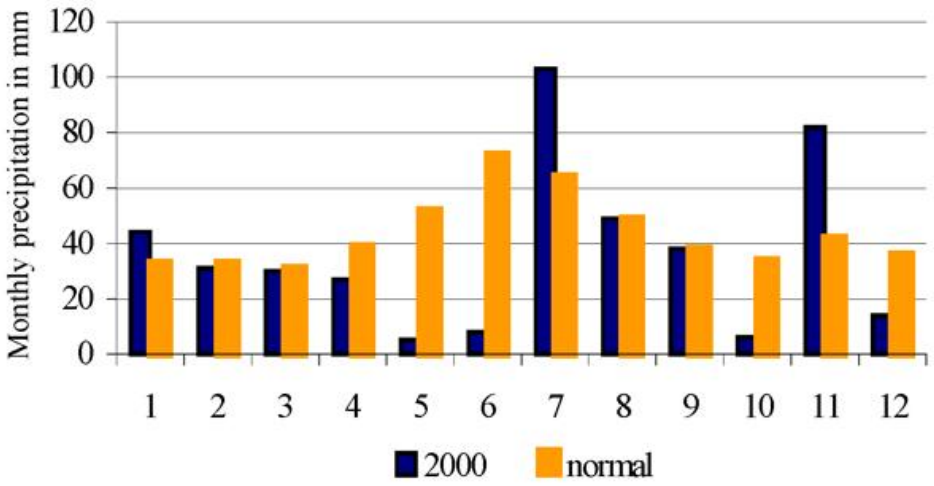


Fig 5.1: *Monthly precipitation totals in mm in 2000 and long-term means in Chisinau*
From: Hydrometeorological Service of the Republic of Moldova

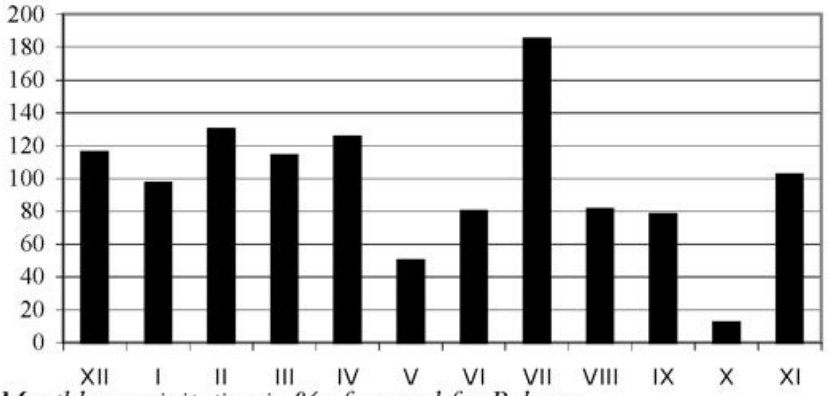


Fig. 5.2: *Monthly precipitation in % of normal for Belarus*
between December 1999 and November 2000,
reference period: 1891-1990.
From: Commitee for Hydrometeorology of the Republic of Belarus

June 2000:

- **Mostly extremely dry, very warm and sunny**
- **Wet and cool from Scandinavia to the Caspian Sea.**

For large parts of Central Europe it was the third dry month in a row (see fig. 6.2, 5.1 page xx) Together with extreme high temperatures the drought situation intensified. Hurbanova, Slovakia, received only 66 mm of rain during the April to June period which corresponds to a 93 mm deficit and mean temperature anomalies exceeded + 3 °C. In Warsaw, Poland, the monthly total precipitation was only 13 mm (18 % of normal). In Slovenia, water deficits varied from 100 mm to more than 200 mm causing the most severe drought since 1964. In northern Germany, the dryness engendered forest fires.

With prevailing high pressure influence, it was prevailingly sunny and warm. There was a new June record of bright sunshine hours in Akureyri, Iceland. For Slovenia it was the warmest June on record. At the mountain observatory Kredarica, there were only 7 days with snow cover, which is the lowest number ever recorded up to now.

An extreme hot spell occurred between June 20 and 23. On Poznan, Poland, temperatures climbed to 36.5 °C, Berlin's 36.1 °C were a new June record as well. 10 % of Spain's mainland stations registered record-high June average temperatures, notably La Coruña with 18.7 °C, exceeding by 0.3 °C the record for 130 years of observation (see fig; 6.1). Yugoslavia reported an exceptional number of "tropical days" (see fig. 6.3)

From Scandinavia across the Baltic States to the Caspian Sea it was wet and cool. In north-western Norway, several stations established new precipitation records. An outstanding cold spell occurred in mid-June, just after a torturing hot spell. Belarus recorded frosts and temperatures down to minus 5°C. Lithuania had morning frosts and Nagykaizsa, south-western Hungary, had a night minimum of 2.6 °C on June 17-18. such cool night's frequency is less than 1 % at this time of the year.

There was a high number of severe thunderstorms, local floods, hail events and storms:

- Heavy showers brought 50-80 mm of rain to the Southeast of the Netherlands on June 3-4.
- On June 5, a bursting thunderstorm and heavy rains caused a severe landslide in Carinthia, Austria. The small village Ingolsthal was badly devastated.
- Heavy thunderstorms , hail and flash floods haunted Switzerland on June 5, 11 and 13.
- Exceptional rains poured down in the Queyras region and Hérault, south-western France, causing severe flooding.
- Heavy rain and floods affected northern Spain.
- A new record-building regional rainfall of 28 mm on June 3, following several wet days led to flooding in north-eastern England.
- Heavy thunderstorms occurred in southern Germany on June 5 and 11. On June 14, hail covered the ground to a depth of 0.5 m in the eastern Allgäu area at the Alpine foothills.
- Poland reported severe thunderstorms some went along which with strong winds. A tornado destroyed several hectares of forest north of Bydgoszczon June 8. On June 15-17, heavy precipiation caused high water level of river Wisłoka.
- On June 16, the Mid-Wolga region experienced squalls of 24 - 31 m/s.
- North-western Tartastan was severely affected by hail with diameters up to 22 mm.
- An unusual deep depression (minimum core pressure < 970 hPa) passed by north-western Scotland in the middle of the month. Gusts up to 35 m/s set new records for June in Lerwick.
- A vast area with heavy thunderstorms caused considerable damage in parts of south-western Sweden on June 21. Several football players and camping youth were severely injured by lightning strokes. Intense thunderstorms caused several fires in late June.
- Several severe storms with hail occurred in Slovenia and Turkey.
- Thunderstorms damaged power-lines and forests in Estonia.

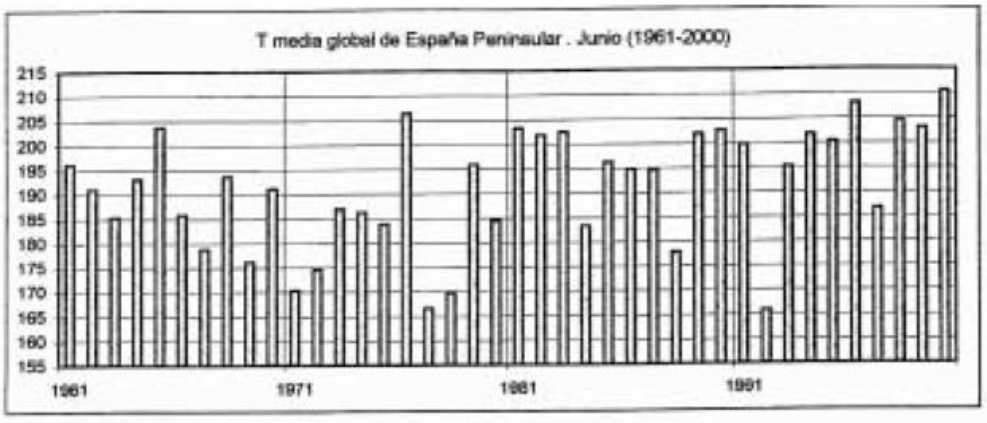


Fig. 6.1: *Mean June temperatures (in 1/10 °C) of the Spanish mainland between 1961 and 2000 From: Instituto Nacional de Meteorologia, Spain*

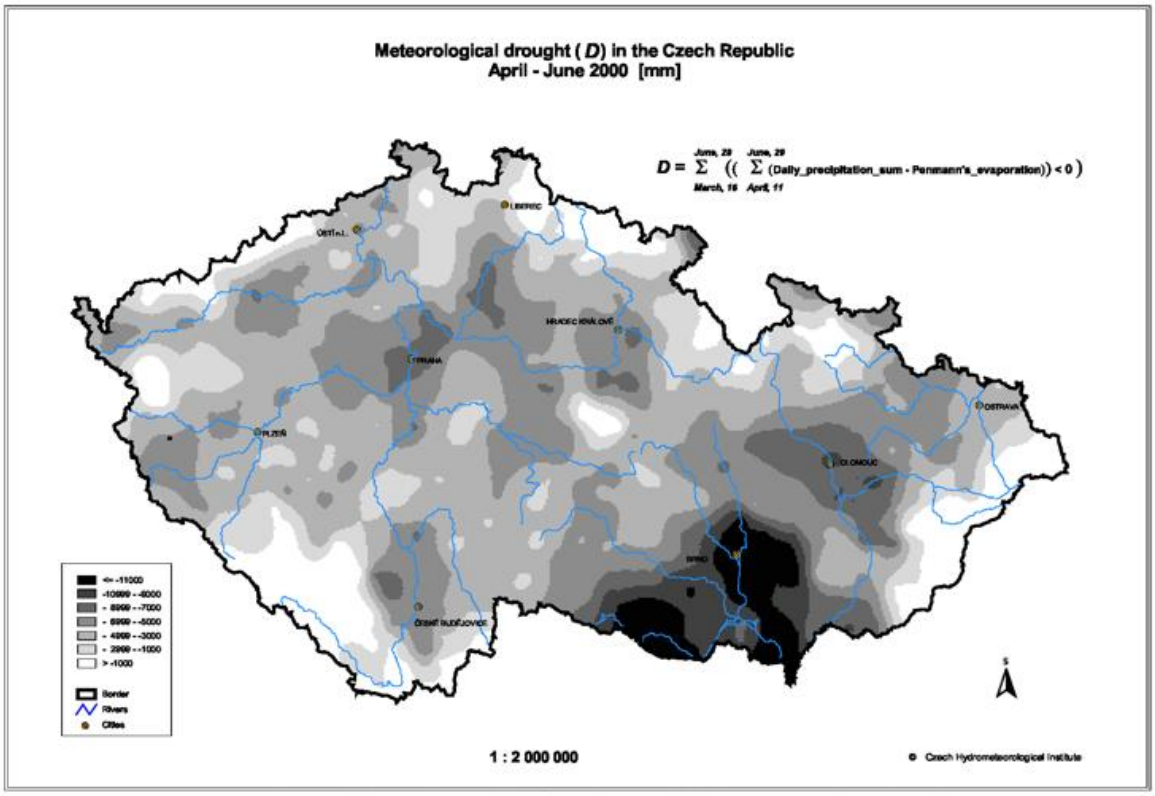


Fig. 6.2: *Meteorological drought in the Czech Republic between April and June 2000*
From: Czech Hydrometeorological Institute

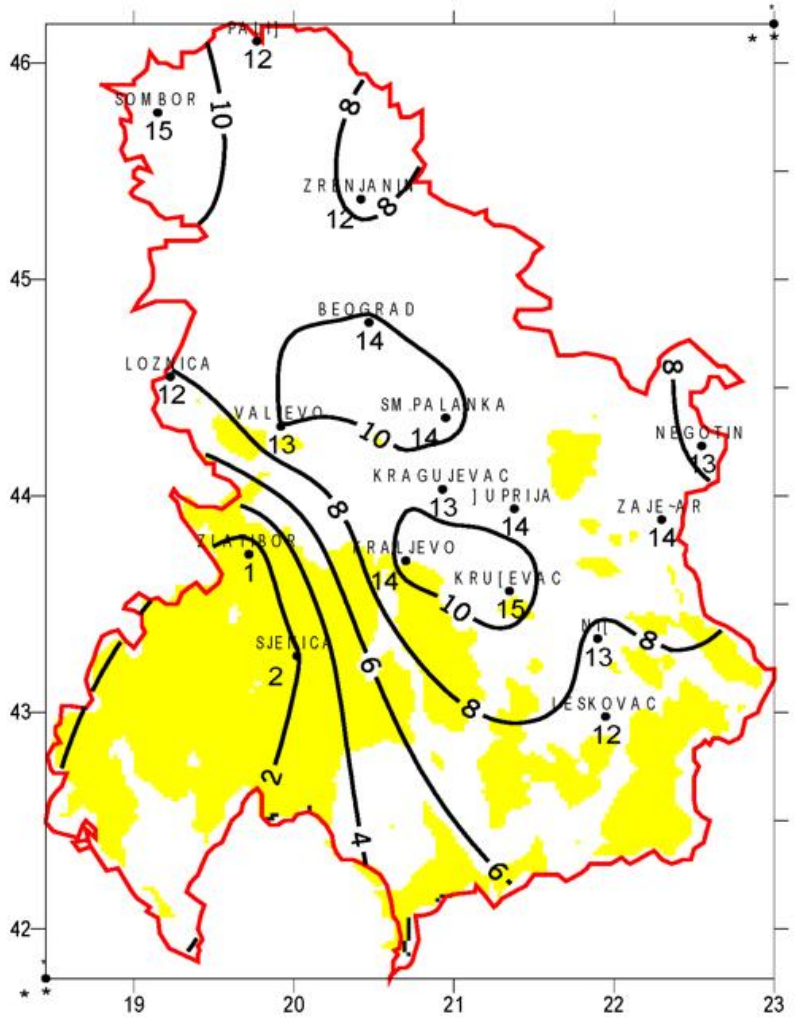


Fig. 6.3:
Number of days with maximum temperatures > 30 °C in Yugoslavia in June 2000
(values below the station names)
and deviations from 1961-1990-normal (isolines).
From: Federal Hydrometeorological Institute of Yugoslavia

July 2000:

- **Abundant rains and flooding in Scandinavia**
- **Cool and rainy from France to Russia**
- **Severe hail storms in the Alps**
- **Hot and dry in the Southeast**

July was even wetter than June in most parts of Scandinavia. During the period July 12-25, more than 200 mm was recorded at several stations in southern Norrland, Sweden. The heaviest rains occurred July 18-19, when many streams and rivers rapidly rose to near record levels and hundreds of roads, bridges and railway embankments were severely damaged. Several houses were washed away, but no people lost their lives. In Norway, July was very dry in the west (Takle 18 mm), but extremely wet in the Southeast. Oksoy fyr received 84.3 mm which is a new July record for that station with measurements since 1875. Finland reported an extreme number of thunderstorms: Except for the last week in July, there was thunder almost every day in many regions and the Häme region had 28 rainy days.

After the outstanding warm early summer, wide parts of the Region from France to Russia experienced an unusual cool and rainy July (see fig. 5.1, 5.2 page xx and 3.1 page xx). Negative anomalies surpassed 2 °C in wide parts of Central Europe. A number of stations in France set new records of precipitation totals, minimum sunshine duration and lowest maximum temperatures (see fig. 7.1 to 7.3). In the Netherlands, only in July 1919, the sun shone less than this year. Heavy showers poured down 30-50 mm within a few hours on July 29. In north-western Lithuania, the monthly precipitation totals amounted up to 240 % of normal. Heavy rainfall and local floods occurred on July 17-18 in Vilnius (75 mm) and on July 27 in Rokiškis, where 53 mm were registered in 12 hours. In Latvia, it was the rainiest month of the year. Precipitation was most extreme between July 24 and 27. Near Jekabpils, a two-days' total of 89 mm was recorded, which is 10 mm more than the monthly normal. Severe thunderstorms with heavy rain and strong wind caused considerable damage in western Germany. Switzerland experienced one of the most severe storms ever on the southern slopes of the Alps on July 4 (gusts up to 38 m/s).

Three extreme hail events occurred in Austria:

- On July 3, heavy damage was caused by hailstones with diameters up to 5 cm along the line Kirchberg in Tirol – Saalfelden, Salzburg – Hartberg, Styria (more then 200 kilometers). Around the area of Saalfelden, 4000 roofs were damaged and many people wounded by hailstones.
- On July 4, the second extreme hail event followed along the line between the towns Salzburg and Enns, Austria: The hailstones with the size of tennis balls wounded a group of 12 girls and caused enormous damage to houses and crops. At the same time, gusts destroyed power lines and trees and blocked roads. There were wind speeds up to 39 m/s. One man was killed.
- On July 7, heavy hail damage was recorded in Styria, near the capital town Graz, with great crop losses of fruits and corn, and finally in Upper Austria there were in Hallstatt heavy damage due to hailstones with diameters up to 5 cm.

A cold front over Latvia in the morning of July 12 caused thunder, precipitation, hail and an abrupt temperature decrease from 28°C to 13°C within one hour. Local whirlwinds reached hurricane-strength. Power lines were destroyed, trees uprooted and hundreds of roofs were blown away or damaged. The risk for forest fires continued to be high in a number of other Russian regions (e.g. in the Arkhangelsk oblast and the Republic of Komi).

An unusual hot spell occurred in north-eastern Norway on July 20: Kirkenes had the highest maximum temperature for the country in 2000 with 30.2 °C. A number of stations in Finnmark had so called "tropical nights", with temperatures not below 20 °C. The minimum temperature on the night of July 20 at the

lighthouse Makkaur fyr (70º 42`N, 30º 04`E) was 22.7 °C.

The Mediterranean region suffered from extreme hot and dry weather. In Greece, temperatures climbed up to more than 40 °C between July 4 -9 and 25-29. At places in the mainland, maximum temperatures of up to 43-45 °C and mean daily temperatures of up to 34 °C were recorded. The hot and dry weather engendered a number of severe wild fires. In Cyprus, the monthly mean temperature was 2.4 °C above normal and severe heat prevailed from July 6 to 14. About 80 % of the Bulgrian stations recorded new maximum temperature records (many surpassing 44 °C) on July 5.

Turkey reported the lowest monthly average precipitation mean of the year with 5.1 mm (see fig. 3.1 page xx). Armenia received only 7-16 % of the normal rainfall. Drought conditions prevailed also on the Balkans. In Slovenia, the dry weather caused high agricultural losses and the discharge of the rivers was on July 8 nearly the lowest one in 30 years. In Yugoslavia, monthly rainfall totals were only 20-50 % of normal.

In Israel, July was much warmer than usual. Temperatures were 3-4 °C above normal, and in many areas it was the hottest July since the beginning of measurements 40-50 years ago (see fig. 7.42), even in comparison with August (normally the hottest month) and only in August 1998 the monthly average temperature was higher. The month was characterised by a long period of hot weather – daily maximum temperatures exceeded 31 °C in the Coastal Plain and in the Foothills for 22 consecutive days and for 13-16 consecutive days in the Mountain Areas. The hot weather reached its peak towards the end of July – temperature in Jerusalem reached 40.8 °C, which is the highest temperature recorded in Jerusalem since 1942.

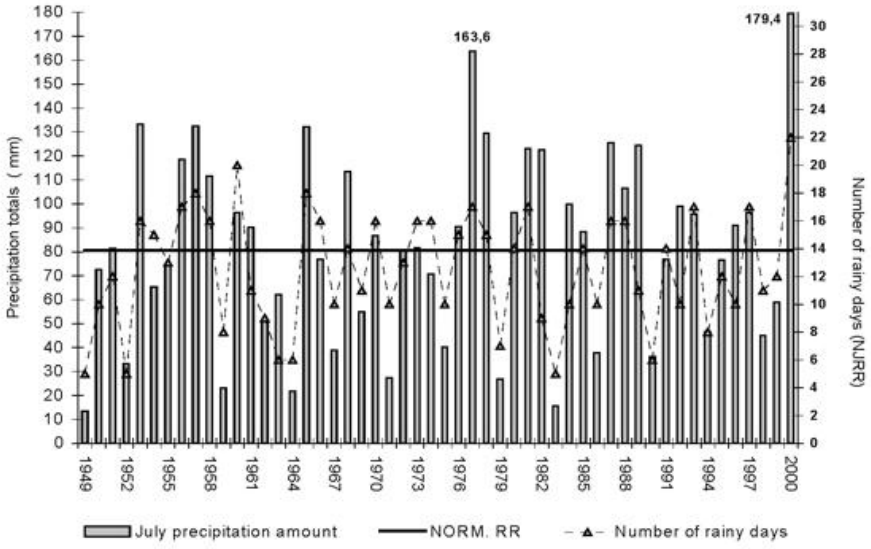


Fig. 7. 1:
Precipitation totals and number of rainy days in Besançon (Doubs) in July between 1949 and 2000 and 1961-1990 normal
From : Météo France

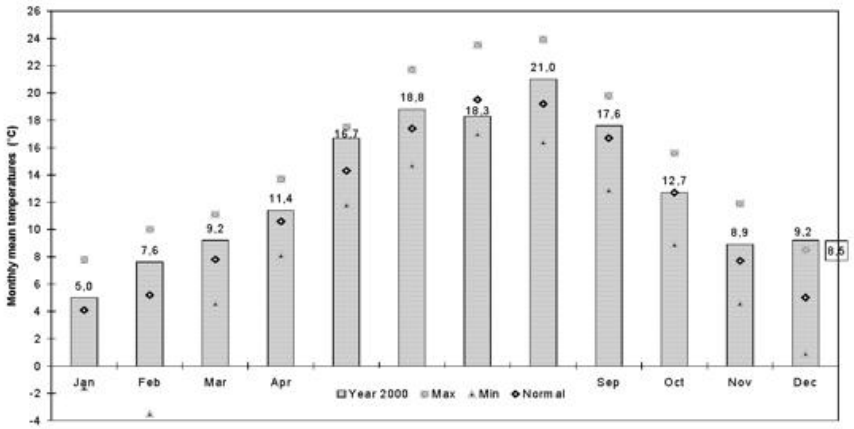


Fig. 7.2:
Monthly temperature means in 2000 compared with 1961-1990 values in Paris-Montsouris
From: Météo France

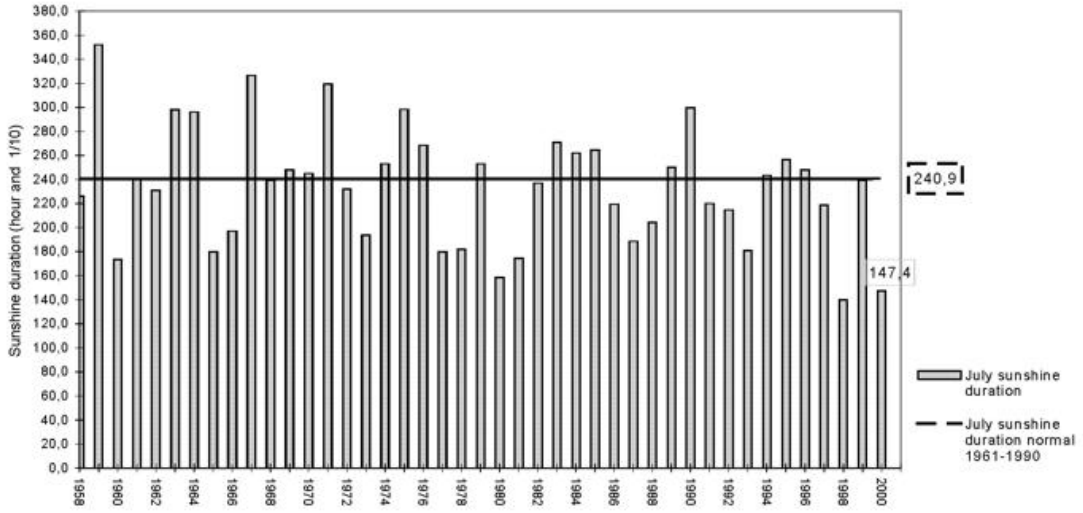


Fig. 7.3: *Sunshine duration in July in Paris- Montsouris between 1958 and 2000 and 1961-1990 July mean*
From : Météo France

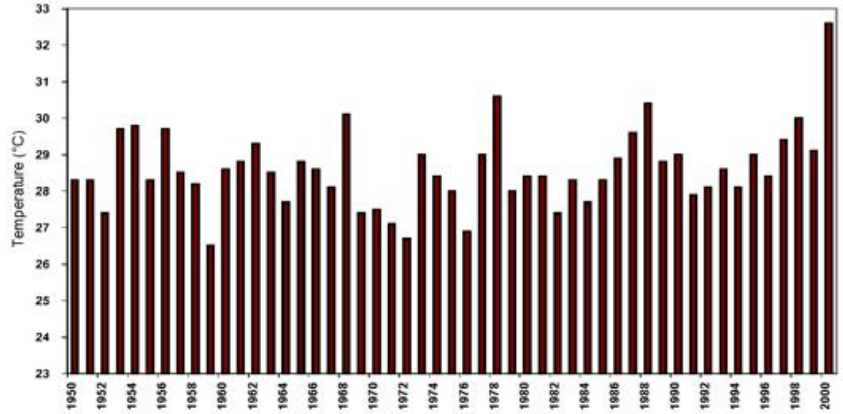


Fig. 7.4: *Mean Daily Maximum Temperature in Jerusalem in July 1950-2000*
From: Israel Meteorological Service

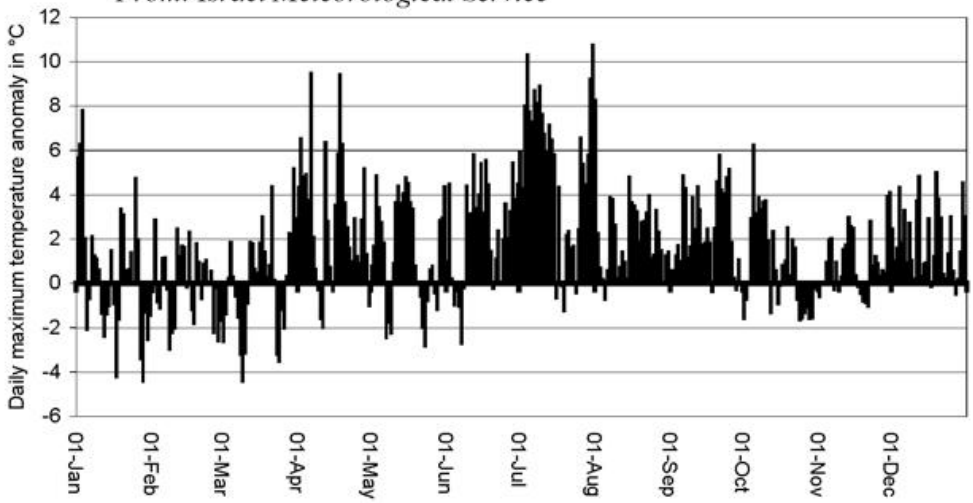


Fig. 7.5: *Anomalies of the daily maximum temperatures in Amman in 2000, reference period 1961-1990.*
From: Meteorological Department, H.K. of Jordan

August 2000:

- **Mostly warm, especially in the Southeast**
- **Very dry in the South**

A severe hot spell scorched the Balkans. Temperatures climbed up to 41.7 °C in Békéscaba on August 21, setting a new record for Hungary. Also Croatia (see fig. 8.1) reported new maximum temperature records (e.g. 41.4 °C in Knin on August 22, surpassing the old record, set in 1950, by 1.0 °C). In Slovenia, with unusually dry and warm weather (see fig. 8.2) the amounts of available soil water for most crops diminished seriously and resulted in severe water stress. Yugoslavia reported precipitation deficits of 10-50 %. The water levels in the rivers were very low, e.g. river Savahad had on August 31 the lowest level of 80 years' observation. The dry conditions in July continued as precipitation totals reached only 20-40 % of normal and it was unusually warm again, in Armenia (see fig. 8.3). Losses due to the drought were estimated to 100 million $. In Cyprus, it was extremely hot between August 14-16 and 21-22. In Israel, August was not as extreme as July, yet it was still warmer than normal.

Nice, stable weather prevailed from Iceland across the UK to Germany. In the Netherlands, it was the sunniest month of the year with 223 h of bright sunshine (normal 192 h). Summer storms were comparatively rare. However, a high number of local thunderstorms and hail events with strong winds occurred in Poland. Heavy rain, hail and gusts ravaged near Moscow, Russian Federation, at the beginning of the month. On August 25, a mountain torrent and rains washed away river banks and roads in the Republic of North Ossetia-Alania. Heavy hailstorms caused severe damage in wide parts of Bulgaria, on August 28.

In the Gulf of Finland, a number of powerful waterspouts occurred in early August. A whirlwind downed hundreds of trees on its 150 m wide track in the Trakai district, Lithuania, on August 19. A tornado north of Lublin, Poland, destroyed about 100 buildings in the village of Ciotcza on August 20. Gusts up to 34 m/s raged in northern Switzerland on August 21.

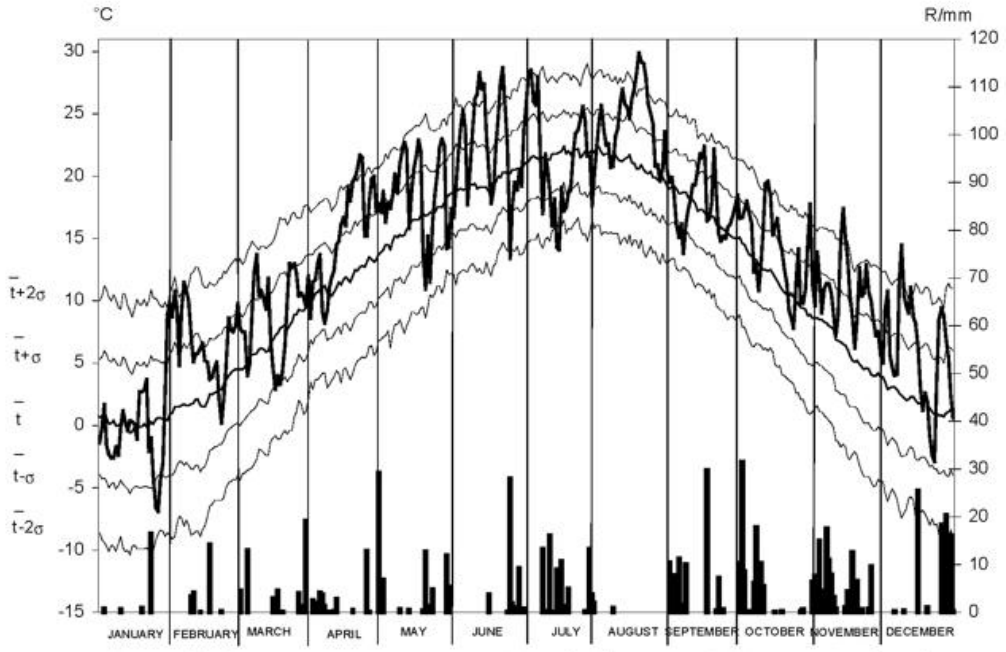


Fig. 8.1: *Mean daily air temperatures in Zagreb-Grič in 2000 compared to long-term means and standard deviations (1862-1995).*
The columns indicate the daily precipitation amounts for 2000.
From: Meteorological and Hydrological Service of Croatia

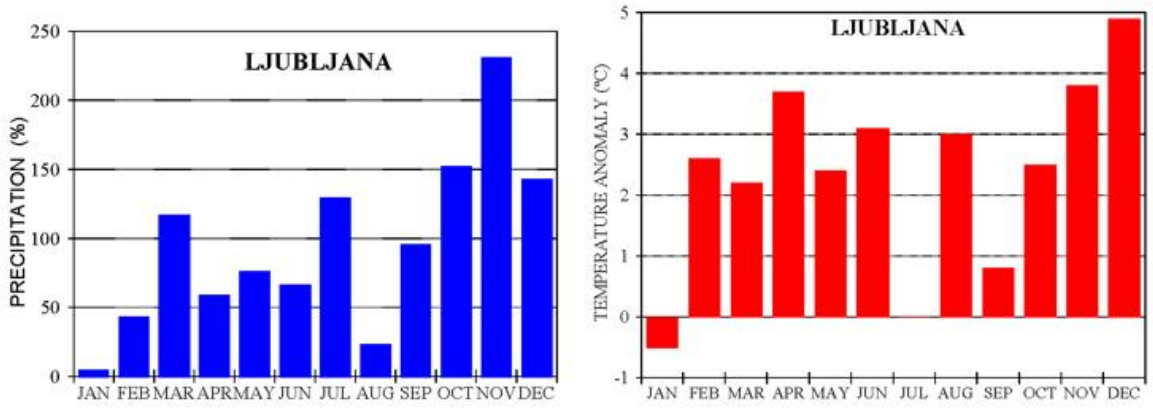


Fig. 8.2: *Monthly precipitation in % of normal and temperature anomalies in Ljubljana in 2000 reference period 1961-1990*
From: Hydrometeorolgical Institute of Slovenia

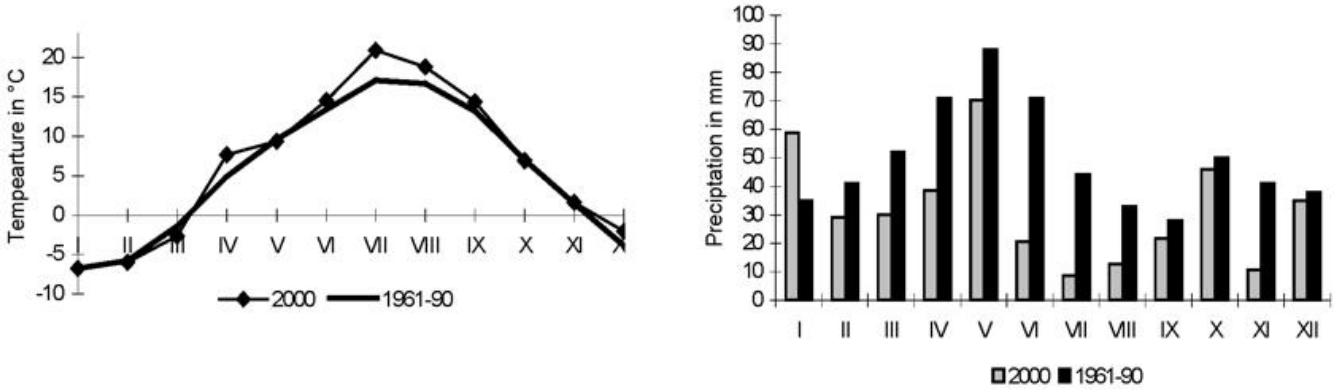


Fig. 8.3: *Monthly temperature means and precipitation totals in 2000 compared with 1961-1990 normal in Armenia*
From:Department of Hydrometeorology of the Republic of Armenia

September 2000:

- **Cold in eastern Europe**
- **Dry in northern and south-eastern Europe**
- **Regionally heavy rainstorms**

September was cool in eastern Europe (see fig. 2.1, 2.2 Page xx). Lithuania reported 19 nights with morning frosts, which from September 16 to 19 occurred everywhere in the country with soil surface temperatures down to minus 5 - 8°C.

Greece experienced unusual dry and warm weather. From September 18 - 23, temperatures climbed up to 34 - 38 °C. 37 °C was also recorded in south-western Bulgaria.Under high pressure influence, it was extremely sunny and dry in Scandinavia and the Baltic States. In Finland sunshine reached record levels and even exceeded the July figures. In Estonia, it was the driest September in 50 years (24 % of normal).

In mid-September persistent wet weather begun in much of England and Wales (see fig. 9.1). It should last beyond the beginning of the next year. Torrential rains poured down in places on the 15th and it was the wettest September in England and Wales

since 1981. On September 7-8, the city of Stavropol, Russian Federation, experienced heavy rain, gave wind gusts of up to 20 m/s and hail of 20-25 mm diameter. On September 13, a severe thunderstorm with hail completely destroyed about 1500 ha of cereals within 20 minutes near Strzelin in Lower Silesia, Poland. By September 18, thunderstorms with hail and heavy rain caused significant damage in wide parts of Bulgaria. On September 19 south-eastern France saw in some places more rain in a few days than the annual normal. Heavy rains were reported from southern Switzerland and northern Italy on September 19-20 and 29-30. On September 22, once again there was flooding caused by rain in the area south of the Danube, Germany. In Yugoslavia, it was the only month of the year with abundant rain. Heavy rains caused flooding in parts of Turkey and Cyprus between September 24 and 28.

The most severe storm, however, occurred in Italy's southern region of Calabria. Torrential rain triggered flooding and mudslides between September 8 and 10 (see fig. 9.2). Several villages were fully or partially isolated, a state of emergency was declared. Worst affected was the town of Soverato, where 13 people died.

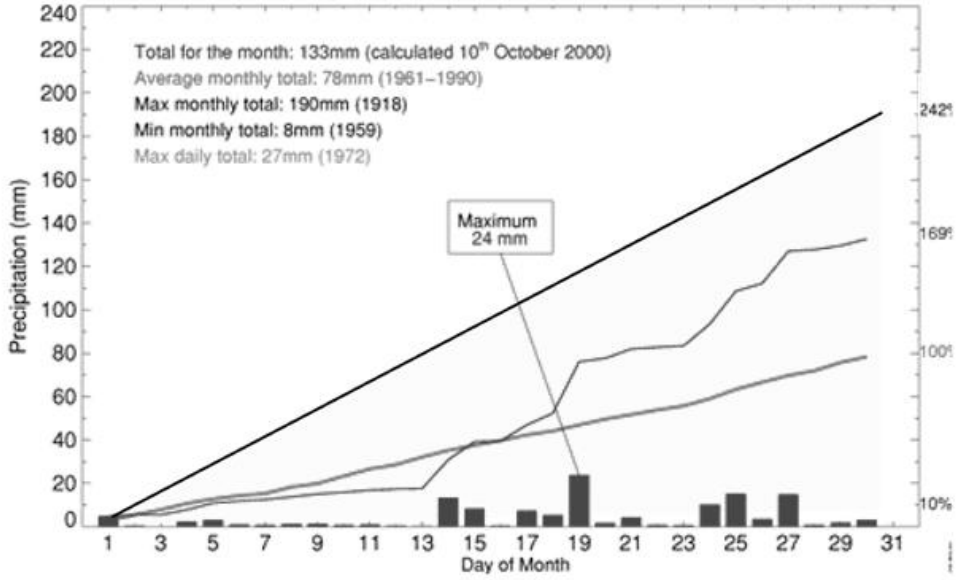


Fig. 9.1: *England and Wales daily precipitation totals in September 2000*
From: UK Met Office

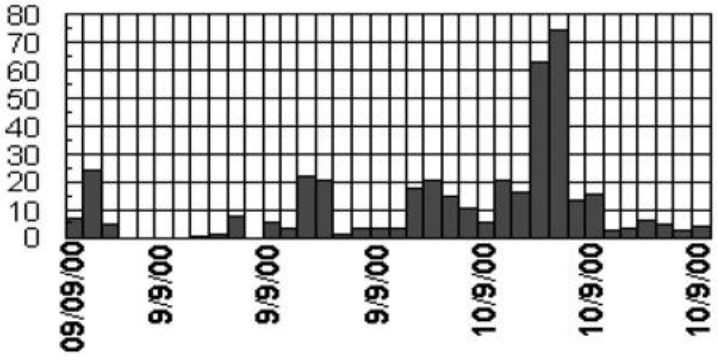


Fig. 9.2: *Hourly rainfall totals (in mm) in Chiaravalle, Calabria, on September 9-10*
From: Servicio Idrografico e Mareografico Nazionale, Italy

October 2000:

- **Very warm in northern and Central Europe**
- **Rainiest October on record in the UK, South Scandinavia and Israel**
- **Devastating floods in north-eastern Italy, southern Switzerland and eastern Spain**
- **Severe first winter storm**

It was exceptionally warm in Northern and Central Europe. For Norway, it was the second warmest October since 1866 (the warmest was in 1961). The station Tafjord in western Norway recorded a maximum temperature of 25.4 °C on October 1; this is the highest official October temperature ever measured in Norway. In parts of Poland, monthly temperature means equalled those of September and anomalies were above 4.8 °C (see fig. 2.2 page xx).

From Poland across the Baltic states to western Russia, precipitation was subnormal (see fig. 5.1 and 5.2 page xx). Poland as a whole received only 32 % of normal (see fig. 3.1 page xx) and in Suwalki, the monthly precipitation total was only 3 mm (6 % of normal). In Lithuania, too, a number of stations received only 1 - 4 mm.

In the UK, the wet weather that had started in September continued (see fig. 10.1 and 12.2 page xx) and in the England and Wales precipitation series (EWP), it was the wettest October since 1903 with 188 mm. Several coastal areas in southern English were inundated at the beginning of the month. On October 9-10, 103 mm of rain poured down in East Sussex and the 122 mm recorded in West Freugh, SW Scotland, have an estimated return period of once in 311 years. Potent wave depressions brought widespread floods and gales to much of England and Wales at the end of the month. The EWP figure of 40 mm on the 29th was the largest daily total in October in the 70-year daily series. Also in southern Scandinavia, the month was unusually wet. Lillehammer, Norway, recorded a monthly total of 227 mm, which is 324 % of normal.

In Israel, the 2000/2001 rainfall season started with very heavy rain. In some areas, it was one of the rainiest Octobers ever recorded (see fig. 10.2). On October 15, 44 mm of rain fell over Sede Boqer in the Negev Desert within less than one hour (almost 50 % of the average annual rainfall). This caused river flooding and 100 travellers had to be rescued by helicopters. The heaviest rains occurred on October 23-25, mostly in the Coastal Area with rainfall amounts above 100 mm. In the southern parts of Tel Aviv 150-160 mm of rain fell in 24 hours and 190-200 mm in 48 hours. Such an event is rare - in Miqwe Yisrael, a station located a few kilometre south of Tel Aviv, with rainfall measurements since 1925. Greater amounts of rain in 24-48 hours were recorded only 3 times for the whole rainy season. The heavy rains caused severe damage. The southern parts of Tel Aviv were flooded for the third time this year (twice in January). Jordan reported cool and wet weather (see fig. 1.2 page xx and 7.5 page xx). Rains and thunderstorms raged all over Greece between October 6 and 10. Heavy rain caused flooding in Cyprus on October 9 and in northern Turkey on October 11 (Giresun) and 22 (Kocaeli).
Very rainy and cloudy weather was reported from western Slovenia. Station Lod pod Mangartom in the Julian Alps (650 m above m.s.l.) received 638 mm of rain (286 %of 1961-1990 normal) and Bilje in the Vipava valley, recorded only 88 sunshine hours, which is 56 % of the 1961-1990 normal.

For all parts of France, it was extremely wet and at the end of the month, the soil was saturated nearly everywhere.

The most outstanding event of the month, however, was a flood that lasted ten days in the Po river shed. From October 11 to 16, southern Switzerland, the north-western sector of Piedmont and the Valle d'Aosta were affected by heavy rain (up to 335 mm/day, and in 6 consecutive rainy days up to 800 mm (see fig. 10.3), with values never recorded before and recurrence periods exceeding 1000 years at some sites). Many Po tributaries were inundated in alpine valleys. Downstream the Dora Baltea and the Po partly flooded the town of Turin. The Maggiore lake reached the highest level since 1868 with 4.66 m and the water level rose 3.87 m in a week. Thanks to

artificial control of inundation of the floodplain losses, similar to those during the 1951 flooding of the Polesine, when about 70 people died, were avoided. However, the death toll amounted to 38, and the material losses were estimated to 8,500 million US $.

October brought intense rain to the Mediterranean side of Spain, from the Pyrenees to Almería, causing river overflow and flooding, especially on the western side of the Sistema Ibérico and in Levante. Between October 21 and 24, new records were established for 24-hour precipitation values in many locations in the mid and lower Ebro basin, some setting 50-years' records. Castellon registered 120 mm of rain on October 24.

Between October 7 and 9, a wind wave in the Taganrog Bay, Russian Federation, stranded 98 vessels on river Don. The month ended stormy and wet: An intense storm hit the southern parts of Britain, northern France, the Netherlands and Germany on October 29-30. 50 mm of rain poured down over already saturated river catchments. Winds exceeding 43 m/s were recorded on exposed southern coasts of England and Wales. North of the storm centre 15 cm of snowcover was reported in Durham, north-east England. Gusts of up to 35 m/s and 80 - 90 mm of rain were recorded on the Frisian Islands in the Netherlands causing local flooding.

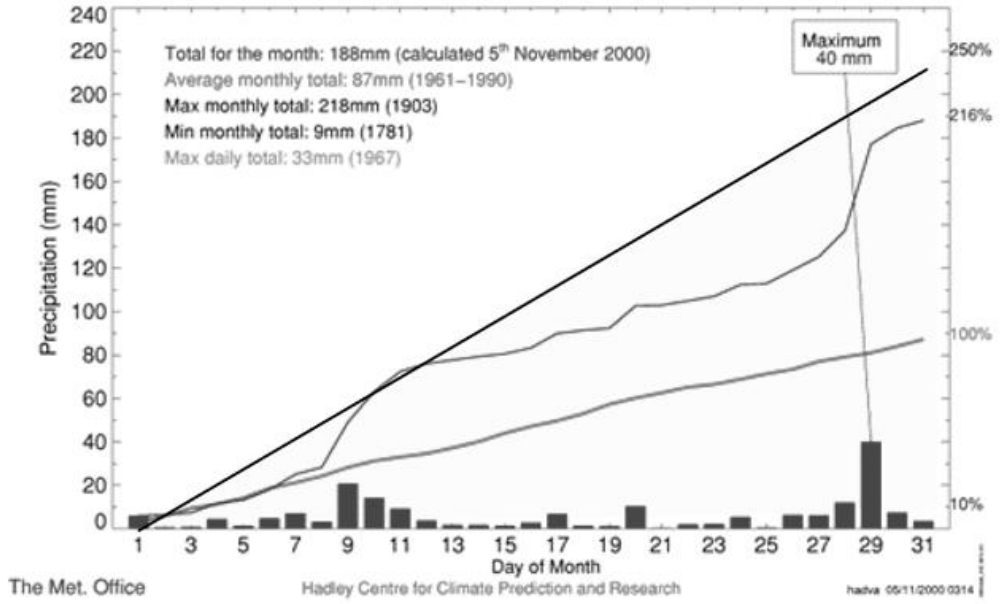


Fig. 10.1: *England and Wales daily precipitation totals in October 2000*
From: UK Met Office

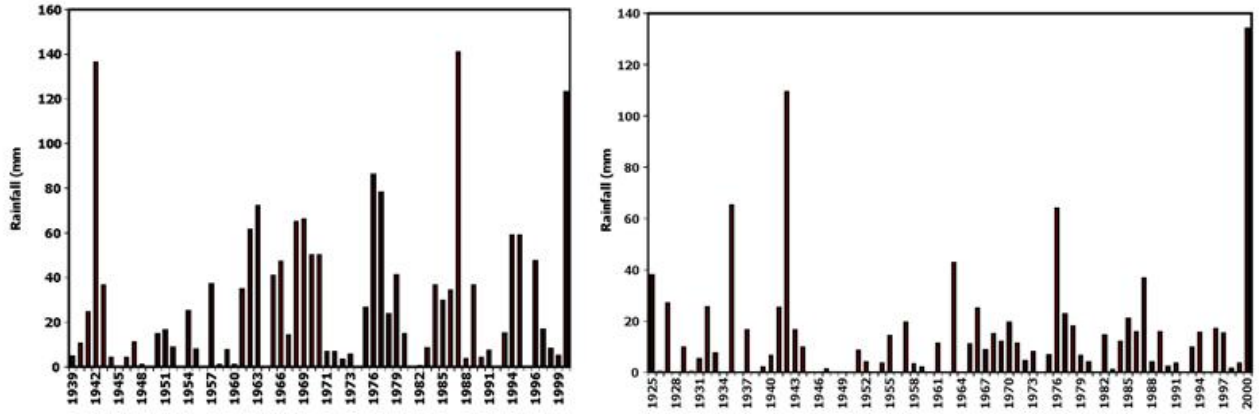


Fig. 10.2: *October rainfall totals from 1939 to 2000 (left) and maximum daily rainfall totals in Miqwe Yisrael in October from 1925 to 2000 (right) From: Israel Meteorological Service*

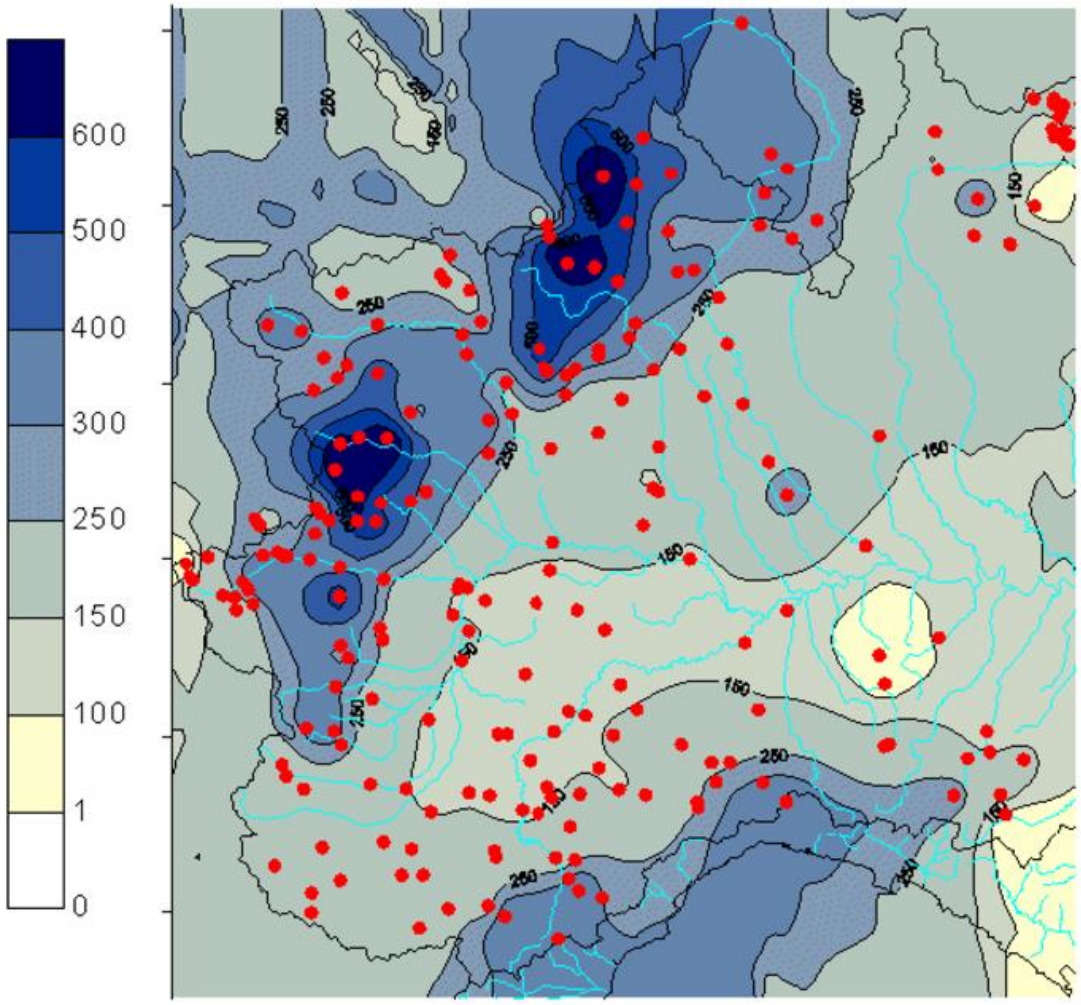


Fig. 10.3: *Precipitation totals(in mm) in the river Po basin from October 11-17, 2000 From: Servicio Idrografico e Mareografico Nazionale, Italy*

November 2000:

- **Another warm month**
- **Abundant rain in South Scandinavia and West Europe**

It was very warm in most parts of the Region. Temperature anomalies above 3 °C were recorded from Scandinavia across the Baltic states, Poland and Belarus to the Balkans (see fig. 2.1 page xx, fig. 8.1 page xx, fig. 11.1). In large parts of Norway and Sweden, it was the warmest November ever, with 6-7° C above normal at many places in south-eastern Norway. The monthly mean temperature in Svinoy (9.1 °C), western Norway, was the highest November temperature since the Norwegian Meteorological Institute was established in 1866. The unusual November weather enabled farmers in certain areas in Western Norway to harvest for a third time during the year, which never had happened before. The bears started their hibernation much later than normal this year! With an average temperature anomaly of 3.2 °C, it was the another extremely warm month for Poland (see fig. 2.2 page xx). The highest deviation from normal was recorded in south-eastern Poland (+ 5.6 °C in Lesko). Central and southern Greece experienced a very warm first fortnight with maximum temperatures of 28-29 °C.

Southern Scandinavia experienced another rainy month causing unprecedented high water levels in lakes and streams, especially in Värmland, Dalsland and Bohuslän, Sweden, near the border to Norway. The largest precipitation amount of 545 mm during the two months October and November was recorded in Östmark, western Värmland. This can be compared with 181 mm, which is the normal value for these two months together. In the city of Arvika large areas close to the bay Glafsfjorden were inundated. The water levels rose to more than three metres above normal. The biggest lake in Sweden, Vänern, rose to its highest level since regulations commenced in the middle of the 1930-ies. Southern and south–eastern Norway had the wettest November ever. One of the stations near Oslo received precipitation every day during 87 days from 24 September to 19 December. Certain areas received more than 5 times the normal amount of precipitation for November. The heavy precipitation amounts caused floods and damage to roads, railway lines etc.

n the British Isles, wet weather that had brought widespread flooding in the preceding weeks continued and more heavy rain fell early in November (see fig. 11.2). On November 2, Leeming in New Yorkshire recorded its wettest November day, a total of 48.4 mm fell. The England and Wales Precipitation (EWP) series showed 32 mm on November 5, setting a new daily record for November. Until November 6, many areas had more than their normal monthly rainfall, particularly in the east and at the end of the month, the EWP had its highest November figure since 1970. In parts of south-eastern Ireland, more than 100 mm of rain poured down within 24 hours on November 5-6. Dublin (Phoenix Park) measured 76.2 mm, its highest daily rainfall for November in over 150 years of record.

In the Netherlands, excessive rainfall caused local flooding in the Westland area.100 mm of precipitation was recorded locally during November 7-11 in the western parts (see fig. 11.3).

There was also abundant rain in wide areas of France: Daily totals exceeded 100 mm in the Southeast on November 6, leading to flooding and landslides. Floods and landslides occurred also in Carinthia and Eastern Tyrol, Austria, where monthly precipitation totals up to 300 - 400 % of normal were recorded (see fig. 11.4). In the Julian Alps, Slovenia, some stations registered more than 1000 mm (station Soča 1493 mm, resp. 494 % of 1961-1990 normal). The most catastrophic landslide, occurred in Log pod Mangartom. Half of the village was destroyed and there were a number of casualties. Water levels of many rivers and of the lakes reached record heights.

Heavy rainfall affected the north-eastern sector of Italy. Large areas were inundated. New maximum records of monthly totals were recorded (Reisa 1482.4 mm, Stolvizza 1352.4 mm). In the Adige River, during November 13-18 two flow peaks

triggered widespread flooding near Trento. Recurrent flash floods affected the Ligurian District between November 5 and 24. Towns and villages along the "Riviera di Ponente" were inundated.

Torrential rains caused flooding in north-western Corfu. Ioannina received 206.0 mm within 12 hours (maximum so far 126.9 mm). A severe storm caused flooding on Corfu and the southern Peleponnissos. Torrential rain and strong winds wreaked havoc on Cyprus on November 27. The monthly rainfall totals surpassed the long-term mean by more than 100 % (see fig. 11.5).

It was extremely rainy in the north-eastern parts of the Iberian Pensinsula. Record monthly totals were registered at almost all stations in Galicia, with monthly values of 590.6 mm in Vigo, 493.4 mm in Pontevedra and more than 300 mm in adjacent areas.

The excessive rainfalls were in contrast to drought conditions in other parts of the Region. In Reykjavik, Iceland, it was the driest November since the beginning of continuous registration in 1920. In Norway, it was very dry in the western, middle and northern parts, with record low amounts of precipitation at many places (Vaernes near Trondheim had the driest November since 1952) which resulted in water restrictions in certain area. Substantial precipitation deficits occurred in the south-eastern parts of the Region (see fig. 1.3 page xx). For Macedonia, it was the 6th dry month in a row (see page 11.6). In most parts of Israel and Jordan, rainfall totals were just 10-40 % of normal (see fig 1.2 page xx).

A fierce winter storm on November 26-27 caused severe damage in Moldavia and Ukraine with widespread power failures.
Sao Miguel Island, Azores, was hit by a severe flash flood. Many streets in Ponta Delgada were flooded and trees uprooted.

Around November 20, deficits of totals of ozone of 25-30 % were recorded over Central European Russia and on November 17, an absolute minimum of total ozone (196 Dobson units) was registered in Moscow (previous minimum 214 Dobson units on December 7, 1996).

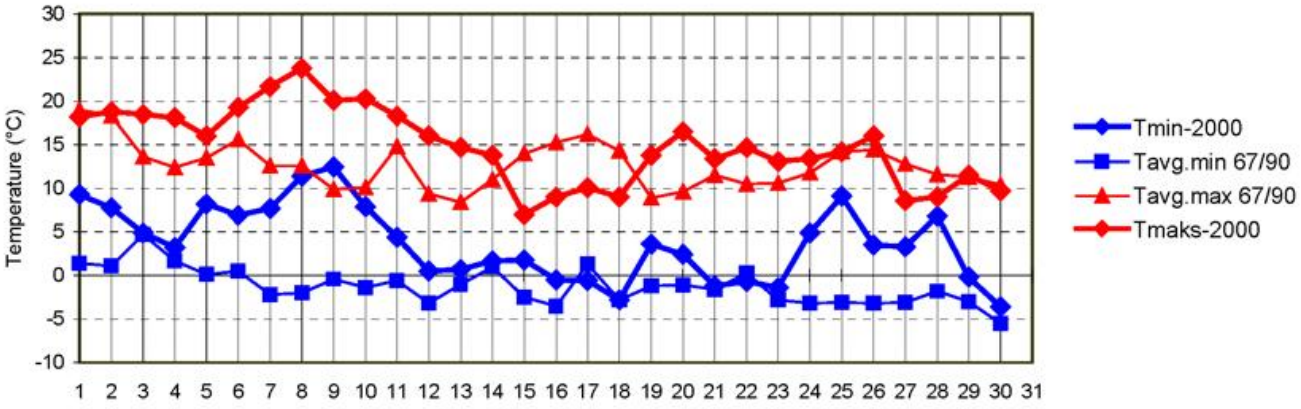


Fig. 11.1: *Daily minimum and maximum temperatures in November 2000 and 1967-1990 means in Skopje Petrovec*
From: Republic Hydrometeorological Institute, Macedonia

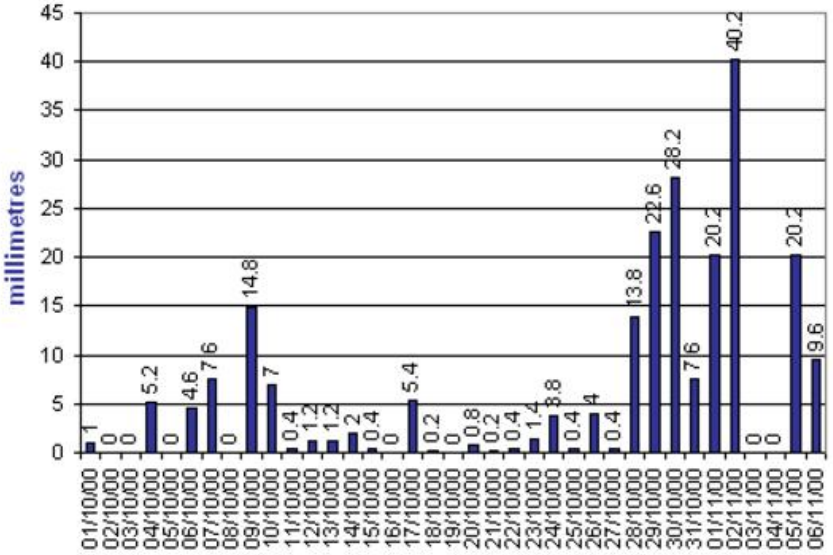


Fig. 11.2: *Daily rainfall totals at Linton-on-Ouse between 2000, October 1 -November 6*
From: UK Metoffice

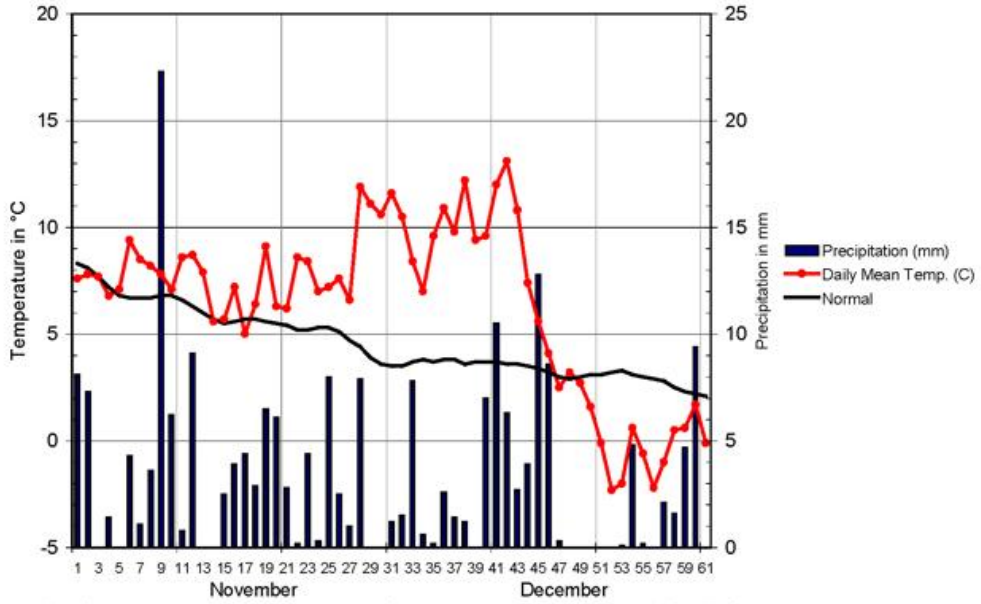


Fig. 11.3: *Daily mean temperatures and precipitation totals in De Bilt in November and December 2000*
From: KNMI, The Netherlands

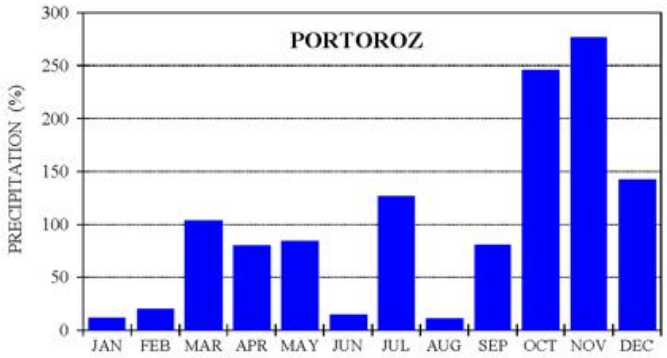


Fig: 11.4: *Monthly precipitation totals in Portoroz in 2000 in % of 1961-1990 normal*
From: Hydrometeorolgical Institute of Slovenia

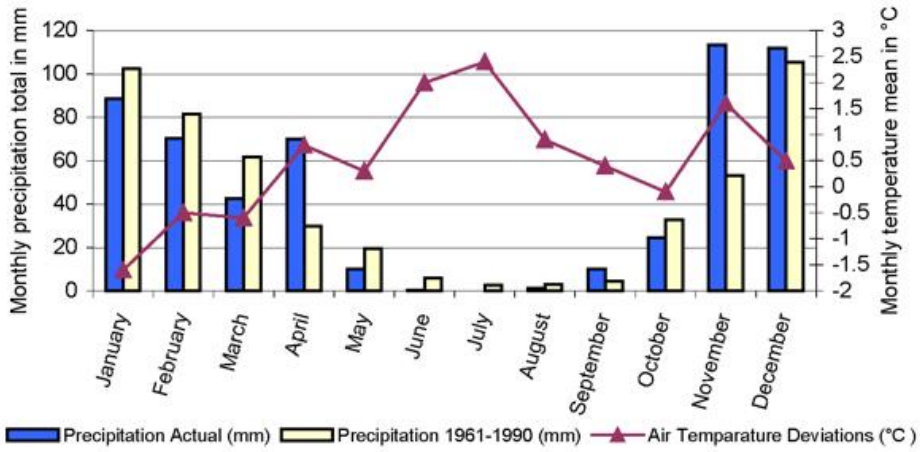


Fig. 11.5: *Monthly areal average precipitation and temperature anomalies in Cyprus*
Reference period: 1961-1990
From: Meteorological Service of Cyprus

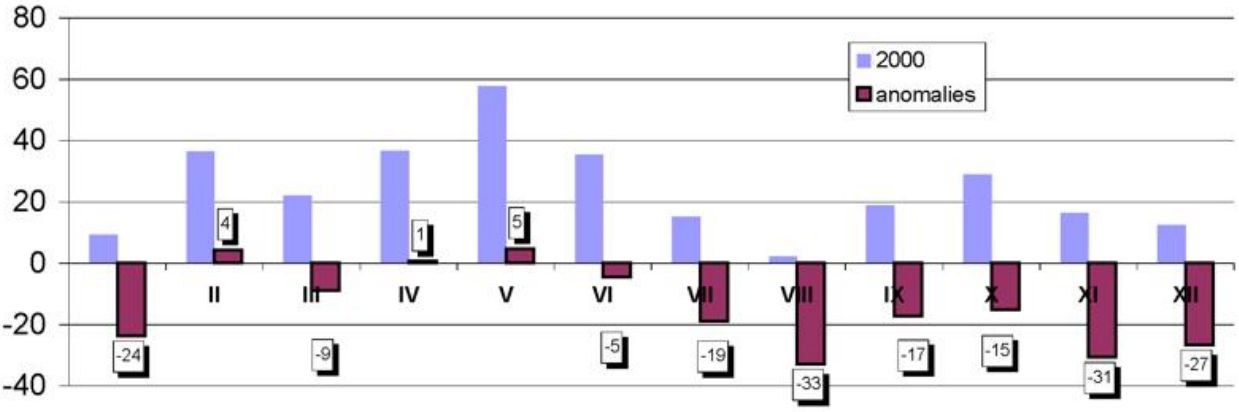


Fig. 11.6: *Monthly precipitation anomalies in Skopje in 2000, reference period 11961-1990.*
From: Republic Hydrometeorological Institute, Macedonia

December 2000:

- **Record warm**
- **Abundant rain in the far South-west and South-east**

A belt of monthly temperature anomalies above 4 °C stretched from southern Scandinavia across Finland to the Baltic states. In France, December was warmer than November. The high monthly values were due to an extremely warm start which grasped nearly all Europe (see fig. 12.1, fig. 8.1 page xx, fig. 11.3 page xx). For many stations, from the Canary Islands across Spain, France and the Netherlands to Germany and from Scandinavia across eastern Europe to the Balkan, it was the warmest first decade on record. The very warm start was slightly balanced by cold conditions later in the month. The Netherlands and the low-lands in Germany recorded the first frost of the winter season only between December 17 and 19. Never before had this event occurred so late in the

year. Only 4 days with snow cover were recorded at Štrbské Pleso, Slovakia, up to December 15 which had been the absolute minimum since the beginning of observation in 1921.

A cold spell with snow and blizzards occurred in wide parts of Europe around Christmas. This led to a breakdown of the electricity supply for some 40,000 households just before New Years Eve in southern Sweden. Snow fell quite widely on December 27-28 in West and Central Europe. North-west England, Wales, Ireland and the northern parts of the Netherlands got a snow cover of over 20 cm.

Dry weather prevailed from the Aegean Sea to the Ukraine (see fig. 1.3 page xx, fig. 5.1 page xx). For Iceland, it was another dry month threatening the water supply in some rural areas. From the Iberian Peninsula across northern France to Scandinavia, it was wet again. Record high monthly precipitation totals were recorded in Portugal. Bragança (with registrations since 1941) totalled 352 mm. Oporto received 481 mm, the second highest value of the century. New records of daily precipitation totals were set in Castelo Branco and in Beja (registrations since 1941 resp. 1899). The number of days with precipitation (≥1 mm) was more than twice the mean of the 1961-1990 reference period. The heavy precipitation caused flooding and landslides, that resulted in some cases in loss of lives and destruction of homes. Strong winds contributed to the uprooting of trees, breakdown of power supply, telephone lines and road obstruction. There were still abundant rains and floods in Brittany, France. Monthly precipitation totals were more than 200 % of normal at some places in Norway. In Finland, there was hardly any sunshine in November and December. In Jyväskylä, there was only one hour of sunshine recorded for both months. Southern Greece reported heavy rain and thunderstorm on December 6-7.

Fogs were frequent this month. Slippery roads due to freezing rain caused many traffic accidents in Germany on Christmas Eve. In wide parts of Lithuania, traffic obstruction after freezing rain on December 28-29 lasted for almost three days.

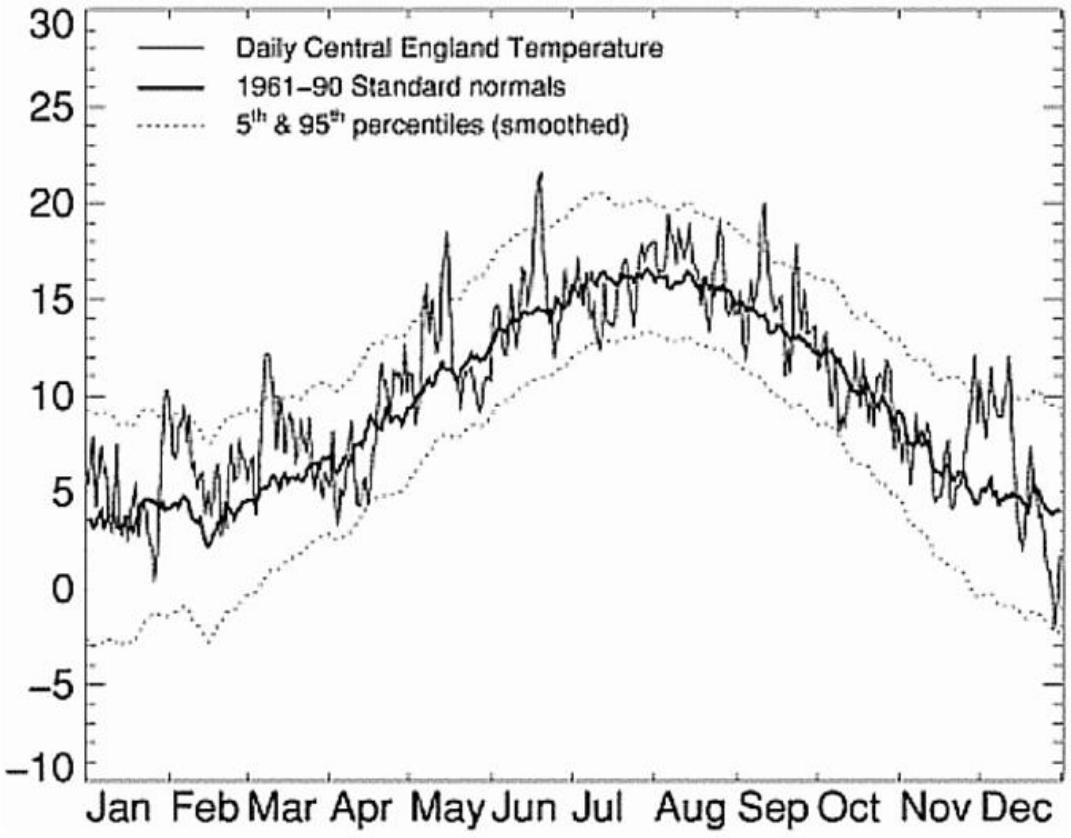


***Fig. 12.1**: Daily Central England temperatures in 2000*
From: UK Met Office

Activities and Results of European Climate Centres

Report on ECSN activities

by: José Antonio Lopez Diaz, INM

The year 2000 was the last of the three-year period during which the INM was the Responsible Member of the EUMETNET ECSN project. This job has been taken over by MeteoSwiss, with Dr Walter Kirchhofer as new Manager. An outline of the activities in the different projects is as follows:

- European Climate Assessment 2000 (KNMI)

  This project is now in its final stage. It has amassed daily precipitation and temperature data from more than 170 stations in Europe and the Middle East. Almost all daily series cover the standard normal period 1961-1990, and about 50 % extend back to 1925 or earlier. A draft version of the publication was presented at the Pisa ECAC 2000 Conference. It begins with sections dealing with the data availability and the homogeneity analyses carried out on them. Temperature trends for mean, maximum and minimum values in each season of the year and through the two periods 1910-1945 and 1946-1999 are visualised and discussed. They are also compared when possible with the corresponding trends in the Jones temperature dataset. The precipitation amounts and a few related indices receive a similar treatment, using for comparison the Hulme dataset.

  This analysis is extended to a number of indicators for temperature and precipitation extremes (11 for temperature and 6 for precipitation), with the NCEP/NCAR data used for comparison. Most of these indices are based on the counts of days exceeding certain thresholds that can be either fixed for the whole region (for instance number of frost days) or site dependent (based on fractiles of the series analysed.

- European Atlas (Meteo France)

- Climate Databases (DNMI)

  After successfully holding its first workshop in 1999 in Oslo, the project this year started focussing on establishing some kind of forum for discussion among participants through the Web. However for technical reasons this has not been possible. The collaboration of DNMI inside the NORDKLIM project has been a source of ideas for the ECSN project in this period, but the person in charge at DNMI got a new job so that at the moment this project has to find a new leader. The second workshop will be held by DWD in November 2001, with a point in the agenda dealing with recommendations for the EUMETNET project UNIDART.

- Generate Climate Monitoring Products (DWD)

  This project's objective is to fill the gap in comprehensive and coherent climate monitoring products, including significant events, at the European scale. Its raw input is mostly already being done at the national level, but to integrate it technical problems related to different practices, choice of variables, smoothing across frontiers, language, etc have to be overcome.

  The project showed some provisional web-pages (still restricted to internal use) developed at DWD in the EAC meeting in Tenerife (December 2000). The structure envisioned contains the following headings: European Climate Monitoring products, National Climate Monitoring

products, RAVI Bulletin issues and Significant Climate Events. The next step starting after the summer will be a pilot phase, using mainly existing products so as to assess the possibilities and needs.

- GIS in climatological applications (ZAMG)

  This new technology is gaining rapidly importance in the field of climatological applications, and with this the need to share expertise is becoming evident. This ECSN project is a first step in this direction. It has produced a questionnaire on the use of GIS in the NMS's and guidelines for the use of interpolation methods. For the future it is important that more NMS's get actively involved and to clarify the relation with the similar COST 719 action that has started this year. At the Tenerife EAC meeting it was agreed that the continuation of this ECSN project will be reconsidered at the end of this year, though it looks likely that its activities will be integrated in the COST action.

- Drought project (OMSZ)

  The participant countries (Hungary, Spain and Portugal) have made some progress towards achieving the initial objectives, namely in the study of long series of drought indices (Hungary, Portugal), the intercomparison of indices (Hungary) or the introduction of a daily operational water balance using the SPI index (Spain). The project will produce a final report in 2001.

- ECSN Climate Dataset (KNMI, DNMI)

  This project's aim to build a daily dataset of temperature, precipitation and a few more parameters with a density of around 2 stations per 100,000 km^2 . Its first phase will comprise the data already collected by the ECA2000 project. In a meeting in April this year between both leading partners the working plan for next year was discussed. According to it, in a year's time the project expects to produce a CD-ROM and provide access through Internet to the data.

The Third European Conference on Applied Climatology - ECAC-2000 16-20 October 2000, Pisa, Italy

by: Walter Kirchhofer, Meteo Swiss

ECAC-2000 was the third European Conference on Applied Climatology and it gave clear evidence that the field of applied climatology is still growing. At the first conference that was held in Norrköping, Sweden, there were 130 papers, at the second conference in Vienna, Austria, there were about 200, and in Pisa there were about 300 contributions on the programme. Over 300 participants, most of them from European countries, attended the conference. With Prof. Giampiero Maracchi as Chairman, the conference was excellently organised by the National Research Council - Institute of Agrometeorology and Environmental Analysis for Agriculture, Florence, Italy.

The high number of about 140 oral papers had to be given in parallel sessions most of the time. Additionally, there were 7 poster sessions, with about 160 presented posters.

ECAC-2000 was structured around seven themes:

- Climate Prediction and Climate Variation for Climate Applications
- Climate, Agriculture and Forestry
- Development and Integration of Climate Data Sets

- Remote Sensing and GIS
- Urban Health and Tourism
- Air Pollution and Renewable Energy Sources
- Extreme Events and Risk Assessment

The proceedings of the conference are available in printed form (short abstracts) and on CD-ROM (extended abstracts) by CNR-IATA, Via Caproni n.8, 50145 Florence, Italy.

The 4th European Conference on Applied Climatology, ECAC-2002, will be held in Brussels, Belgium.

CM-SAF Training Workshop in Dresden

by: Peer Hechler, Deutscher Wetterdienst

Officially started in 1999, a five year's international project is currently being in execution in order to develop methods to exploit data of new EUMETSAT satellite generations MSG (Meteosat Second Generation) and EPS-METOP (European Polar System- Meteorological Operational Satellites) for climatological purposes (for reference see Klimastatusberichte 1997, page 74ff and 1999, page 128f and http://www.dwd.de/research/event.htm).

DWD -kindly sponsored by EUMETSAT and WMO and supported by the project partner institutes- organised a first CM-SAF Training Workshop in Dresden from 20 – 22 November 2000. Nearly 100 scientists –mainly climatologists and satellite experts- from 30 countries convened, amongst them well-known scientists as Prof. Hartmut Grassl, EUMETSAT's Director-General Dr. Tillmann Mohr, WMO Director Dr. Michael J. Coughlan, Prof. Ehrhard Raschke and DWD's President Udo Gärtner.

The aim of the Workshop was threefold:
- make potential users aware of the CM-SAF, its plans and future products
- consolidate the definition of user requirements for the forthcoming Operational Phase
- initiate training activities in the use of CM-SAF products.

The Workshop was accompanied by a public exhibition and a press conference. On the occasion of the latter Dr. Mohr announced that all Member States finally approved EUMETSAT's amended Convention which now widens the Organisation's objectives to include the operational monitoring of the climate and detection of climate change.

CM-SAF plans to derive cloud-, radiation- and water vapour products as well as parameters of the ocean's surface and interior (see background information) were presented and discussed during the Workshop sessions. It can be summarised that DWD together with its partner institutions gained common consent for the strategic direction chosen with the CM-SAF effort.

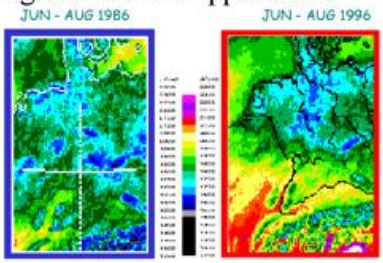
In this context major results and recommendations have been:

- to strengthen the CM-SAF involvement in international projects and activities
- to discuss the feasibility of common data formats and processing algorithms for the whole SAF network
- to explore the definition of homogeneous products covering both MSG and METOP processing areas.

Background: The CM-SAF Products

Cloud and Radiation: Determination of consistent parameters suitable for regional climate applications

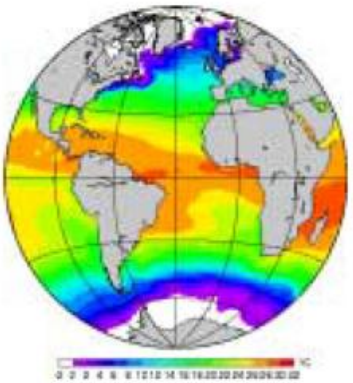
The SAF on Climate Monitoring fills a gap in providing consistent data sets of cloud and radiation budget parameters for an area which covers Europe (including parts of the North Atlantic Ocean). The spatial resolution will be 15 km (except of components of the radiation budget at the top of the atmosphere where a spatial resolution of 50 – 70 km is envisaged). Besides surface- and top of the atmosphere radiation budget components (including albedo), several cloud parameters, such as fractional cloud cover, cloud classification, cloud top temperature and height and others will be derived.



Downward Surface Short-wave Radiation over Germany

Global Ocean State Estimate: Dynamical extrapolation of sea surface observations into the global ocean interior

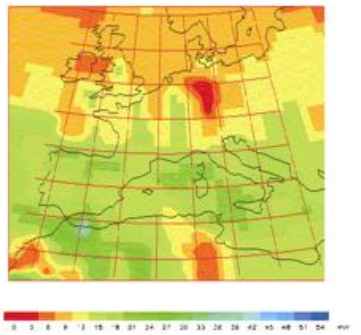
The ocean assumes the central role in the planet's climate system on behalf of its immense capacity to store and redistribute water, heat and radiatively active trace substances. Climate monitoring and predictions therefore require the continued assessment of the state of the interior ocean. By merging data from remote sensing facilities with numerical models of the global ocean circulation the SAF on Climate Monitoring will generate an estimate of the state of the global ocean circulation at monthly time intervals. The estimate includes sea-ice extent, temperatures and salinities of the ocean interior as well as circulation velocities.



Global SST, January 1996

Water Vapour in the Atmosphere: Validation and merging of satellite derived water vapour information

Water vapour in the atmosphere is for several reasons of special interest in climatology: as a greenhouse gas, as a component in the water cycle and because of the latent heat and its role in atmospheric dynamics. The SAF on Climate Monitoring will contribute merged and gridded daily data sets of total precipitable water as well as layer precipitable water (3 layers) based on operational level-2.0 satellite products and validated with in-situ observations as well as ground-based remote sensing data. With an initial spatial resolution of 100 km x 100 km the products cover Europe and parts of the North Atlantic.



Total precipitable water over Europe, 26.12.99

European Ozone Centre at the Meteorological Observatory Hohenpeissenberg

by: Ulf Köhler, Hans Claude, Wolfgang Steinbrecht, Deuscher Wetterdienst

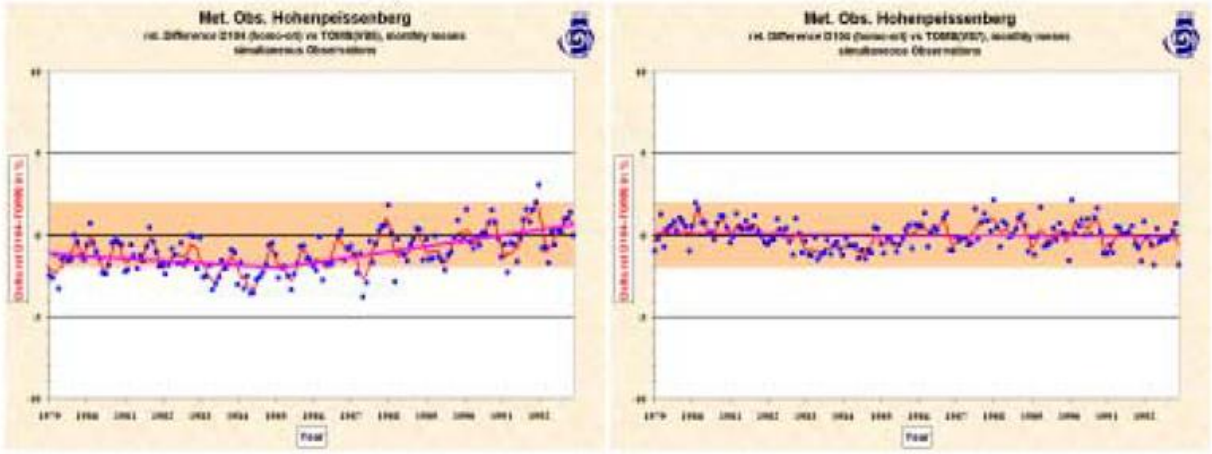
An important part of the global ozone monitoring network GO_3OS within the WMO GAW programme are Dobson spectrometers measuring the total ozone amount. To ensure data quality of these intruments a system of 1 World (NOAA, Boulder, USA) and several Regional Dobson Calibration Centers (RDCC) has been installed. For WMO Regional Association VI (Europe and Middle East) the Meterological Observatory Potsdam had been in charge of this task until the beginning of the 1990s. When the task of European Ozone Centre was assigned to the Meteorological Observatory Hohenpeissenberg (MOHp) in 1994, the function of the RDCC in RA VI (and the Regional Standard Dobson No. 064) were transferred to MOHp as well. After setting up the necessary facilities the RDCC at MOHp (in close co-operation with the Solar and Ozone Observatory in Hradec Králové, Czech Republic) began regular work with two International Dobson calibration campaigns in 2000. In total 7 of the approx. 30 operational European instruments were examined and calibrated during these first campaigns. The main tasks of an RDCC are:

- Service, maintenance and calibration of Dobson spectrometers at least once every 4 years
- Technical and scientific support to Dobson stations incl. training of Dobson operators
- Improvement of technical equipment (Dobson instrument, calibration and repair tools etc.)
- Dissemenination of Standard Operation Procedures (SOP's)
- Providision of software for data processing

The goal is to keep the data quality of Dobson total ozone records on the high level obtained over the last decades. This high quality level is absolutely necessary for:

- Reliable trend analyses
- For validation and verification of satellite data (ground truthing)

***Fig. 1a and b**: Monthly averages of the relative difference (in %) between simultaneous total ozone measurements by MOHp-Dobson No. 104 and by TOMS on NIMBUS 7. Left panel shows the comparison for TOMS Version 6 data, right panel for TOMS Version 7 data.*



The two graphs in Figure 1a and 1b are an example for ground truthing of satellite data with data from a well maintained and calibrated Dobson instrument. The left panel shows a clear indication of a gradual change of the calibration level of one instrument, in this case of the satellite instrument TOMS. After implementation of corrections the TOMS Version 7 data fit much better to Dobson 104.

Only long term ozone records (> 30 years) acquired by reliable instruments like the D104 allow meaningful comparisons of one year's ozone levels with a climatic baseline.

Figure 2, for example, shows, that 2000 was a year with subnormal ozone values almost over the entire year, resulting in the fifth lowest annual mean in the MOHp-record since 1968. From April to June (absolute record minimum) the ozone layer was unusually thin, which led to very high UV-doses compared to years with normal ozone. Although the ozone deficit in February and March 2000 is higher (up to –20 %) the low ozone values later in the year are much more relevant for the amount of UV-radiation penetrating to the earth's surface due to higher sun elevation.

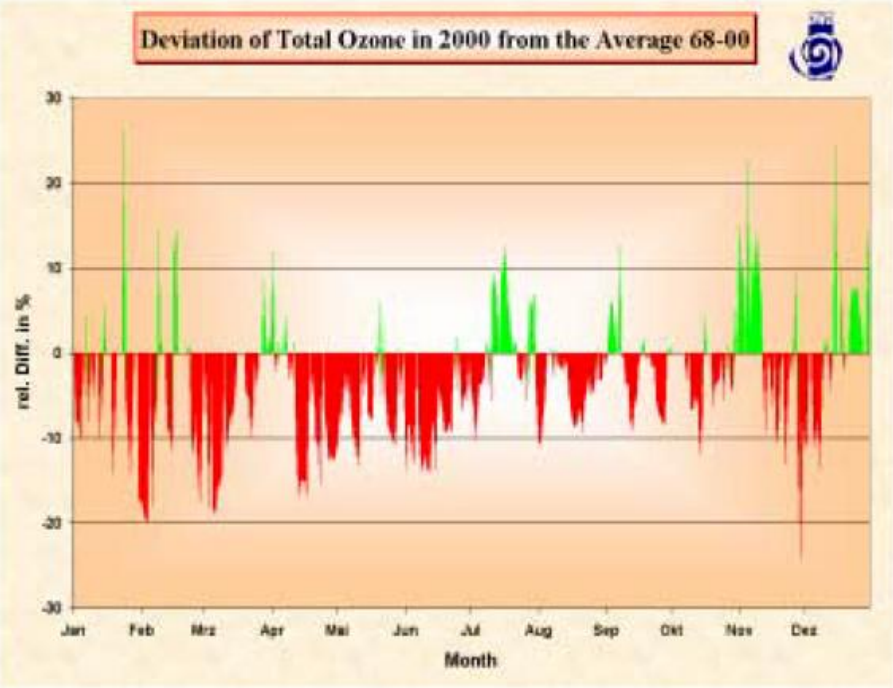


Fig.2: *Relative difference (in %) of the daily total ozone amount over the year 2000 compared to the baseline defined by period 1968 – 2000, for Hohenpeissenberg (Southern Bavaria).*

Figure 3 shows the complete record of June averages of total ozone (solid line) and UV-B radiation at 305 nm (columns) since 1968. It is obvious, that the strongly depleted ozone layer after the eruption of the Philippinian volcano Mt. Pinatubo in the early nineties has not recovered until today, although the volcanic aerosol load has been back to normal values since 1995. At the same time the UV-B-radiation has increased, culminating in a record maximum in 2000. While the strongest negative trends for the entire period 1968–2000 are found for January to April, the last 10 years are characterized by consistently low values in May/June. Recent investigations revealed, that the observed ozone depletion cannot be explained only by chemical reasons (CFC's). Approx. one third of the trend, particularly in spring, is caused by climatic changes (tropospheric warming, stratospheric cooling,

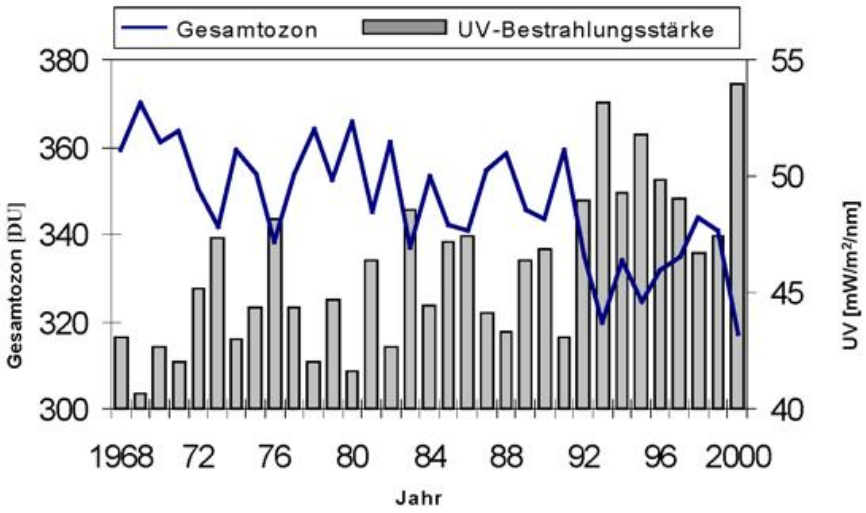


Figure 3: *Trend of total ozone (solid line) and UV-B at 305 nm (columns).*

change of atmospheric circulation) which appear to be related to the increase of greenhouse gases. This might substantially reduce the positive effect on the chemical ozone depletion expected from the stop of CFC-production after the Montreal and following Protocols.

Long-term meteorological changes and UV-Irradiance

by: Sebastian Trepte and Peter Winkler, Deutscher Wetterdienst

The long-term decrease of total ozone observed at Hohenpeissenberg (48°N, 11°E) led to a very low monthly average value in June 2000. At the same time, erythemal UV-irradiance for high solar elevation and clear sky conditions peaked at very high values, which are usually seen over Southern Europe only. Under clear sky conditions (and an otherwise unchanged atmosphere) the long-term ozone decrease clearly plays the key-role for UV-irradiance. However, matters become much more complicated when other factors, like cloud cover or visible irradiance, are considered. In contrast to the increase of UV-irradiance under clear sky conditions, global (total) irradiance shows a significant decrease since 1953 (Fig. 1, left).

This decrease is related to the observed increase in the frequency of high cirrus clouds (Fig.1, right). Since cirrus clouds attenuate visible radiation but also UV-B-irradiance, it is quite possible that the average UV-dose has remained unchanged or even gone down, whereas peak values have increased.

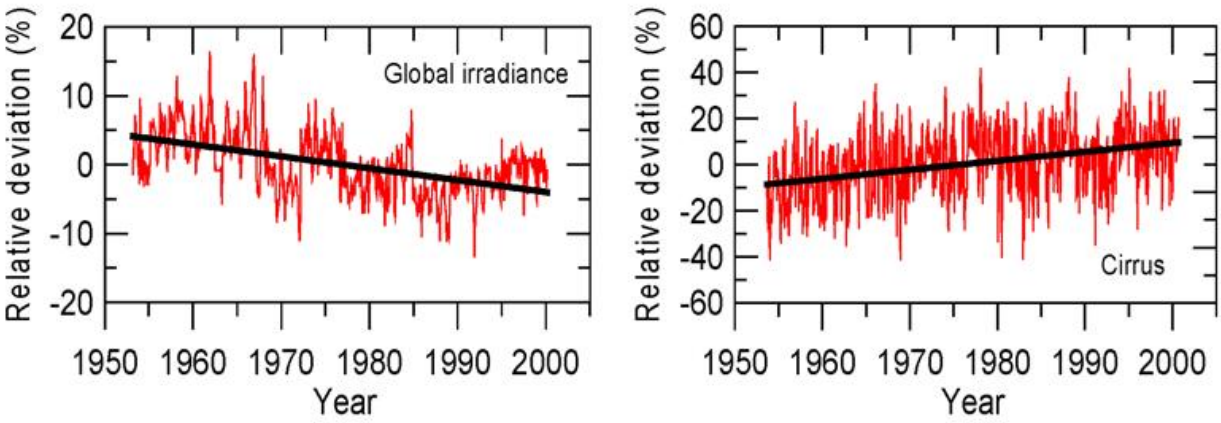


Figure 1: *Left: Monthly deviations of global irradiance from long-term means at Hohenpeissenberg. Data are for sunshine and for solar elevations greater than 10 deg in the period 1953-2000. To eliminate diurnal and annual* variations *the measured global irradiance is normalized with the calculated irradiance of a turbidity-free atmosphere. The fitted trend line shows a long-term decrease of 1.8 % per decade. Right: Monthly deviations of the relative frequency of cirrus clouds, same data sampling as in the left panel. Here the trend line shows an increase of 3.9 % per decade.*

For sunshine situations, cirrus clouds have changed in frequency by 3.9 % per decade. This explains about 20 % of the global irradiance decrease. Cirrus might have also changed in spatial coverage and/or in optical depth. For spatial coverage we found no significant long-term change.

Another aspect is that increased absorption by increasing atmospheric water vapor may have contributed to the reduction of global irradiance as well. Positive long-term trends of the air temperature at Hohenpeissenberg suggest an increasing water vapor content.

Figure 2 shows how increasing cirrus coverage affects UV-irradiance: Compared to clear sky conditions, the erythemal UV-irradiance is attenuated by about 20 % when 7/8 of the sky are covered by cirrus clouds. Note, however, that for short time periods and moderate sky-coverage UV-irradiance can be increased by increased scattering from clouds. In these situations, clouds and total ozone contribute to UV-irradiance peaks.

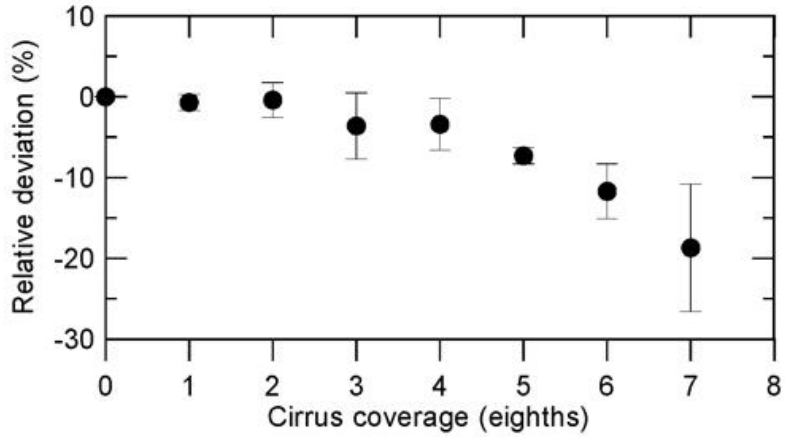


Figure 2: *Averaged attenuation of UV-irradiance (308 nm) for different fractions of sky-coverage by cirrus. Values are given relative to clear sky conditions. Data are for the period 1990-1998. Seven classes of solar elevations between 30° and 45° have been used. Error bars show the standard deviation of these classes.*

Other important meteorological processes relevant for long-term changes in UV irradiance are:

- Global warming leads to an upwards shift of the tropopause and to a cooling of the lower stratosphere. It should also result in an intensification of the water circulation. All these factors would increase the probability of cirrus formation.
-
- A high tropopause is usually coupled with low total ozone. The resulting increase of UV-irradiance may be partially compensated by increased frequency and optical depth of cirrus clouds. However, this compensation would not occur for UV peak values under clear or slightly cloudy sky conditions.

Surface Temperatures of the North Sea in 2000

by: Peter Löwe, Bundesamt für Seeschifffahrt und Hydrographie, Germany

An annual mean sea surface temperature (SST) of 10.4°C made 2000 the 6th warmest year on the record dating to 1971.

Exempting June and July, North Sea SSTs exceeded climatological monthly means at all times and all over the place. Spatio-temporal monthly means assumed ranks between 2 and 6 within the 30-year observational record.
The seasonal warming in June averaged only 1.4K which is 50 % short of the usual heating rate. This caused the jump-like change from anomalously warm conditions in May to a widespread cold anomaly that grew even more intense in July making it the 4th coldest July since 1971. The mean SST of 13.4 °C remained 2.1K behind the 2nd warmest July of 1999.

While usually seasonal cooling sets in around mid-August, August 2000 was special in that a belated extreme increase in SST of 2K occurred which exceeded the average heating rate by 200 %. This again was associated with a rapid return to anomalously warm conditions. The warm anomaly strengthened during fall which underlines the significance of too warm SSTs in fall during the past decade of the 1990s.

Additional information is available at http://www.bsh.de/Oceanography/Climate/Climate.htm

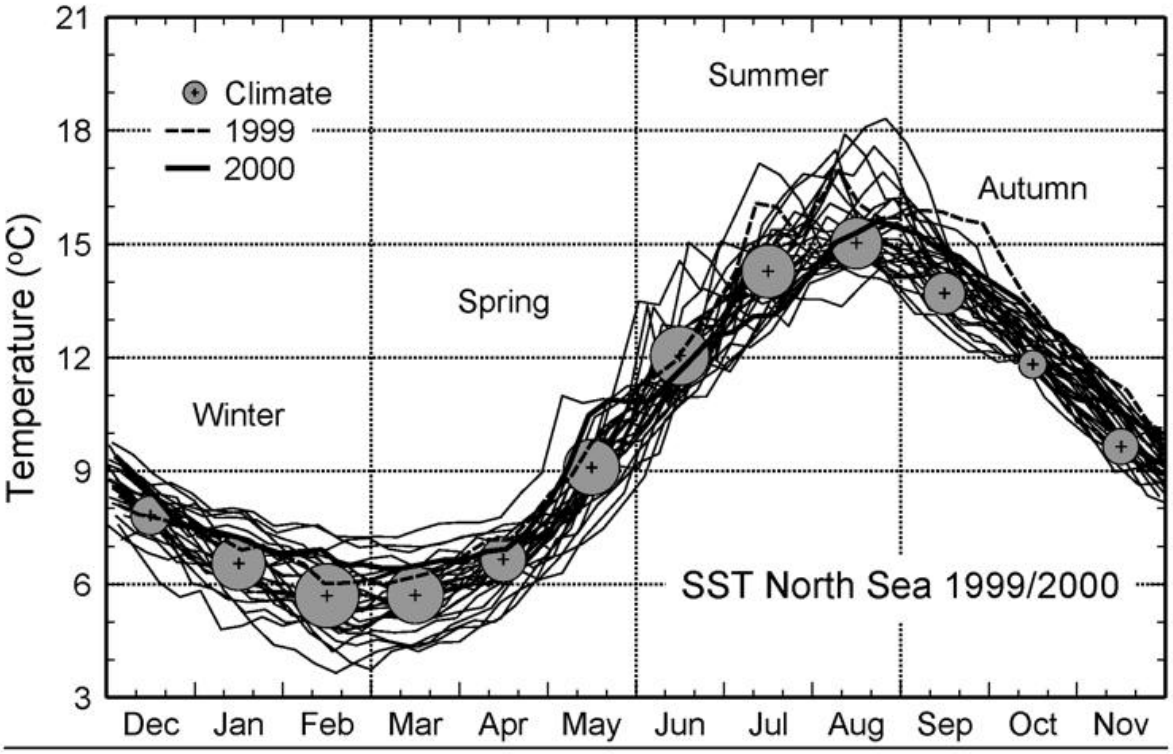


***Figure**: Seasonal cycle of the areal mean SST of the North Sea from December 1999 through November 2000 and ensemble of corresponding cycles since 1971. "Climate Bullets" are for the base period 1971-1993, their size (radius) is equivalent to 1 standard deviation.*

Climate of the Region in the 20th Century

This chapter contains a variety of articles and graphs with long-term perspective concerning the climate of the 20th century mostly out of national scope. Contributions of the national meteorological services of following countries are presented:

Belarus	Latvia
Bulgaria	Moldova
Croatia	Poland
Denmark	Portugal
Germany	Slovakia
Hungary	Sweden
Ireland	United Kingdom

Belarus: Temperature and Precipitation Anomalies

Committee for Hydrometeorology of the Republic of Belarus

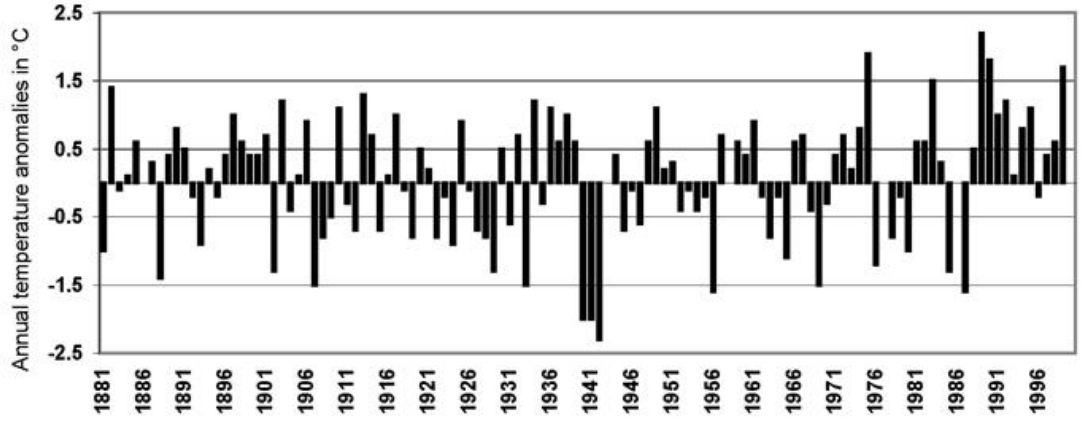


Fig 1: *Anomalies of the annual temperature means of Belarus from 1881 to 2001*

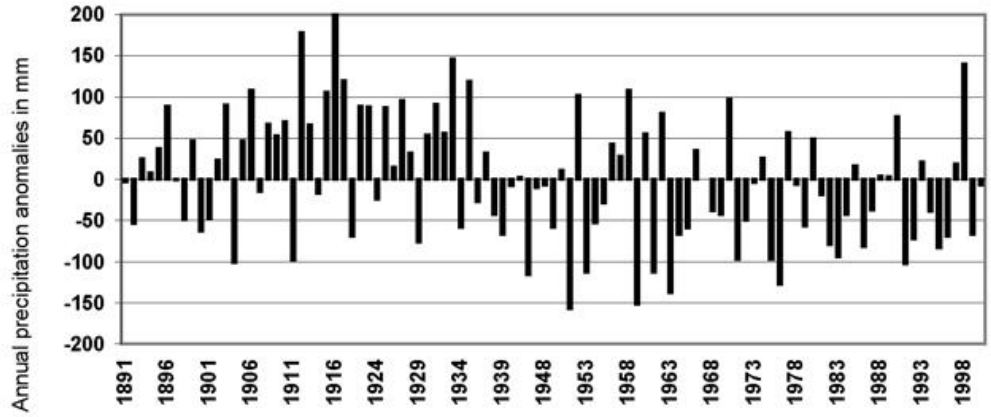


Fig 2: *Anomalies of the annual precipitation totals for Belarus from 1891 to 2001*

Bulgaria: Temperature and Precipitation Anomalies

E. Koleva, National Institute of Meteorology and Hydrology, Bulgaria

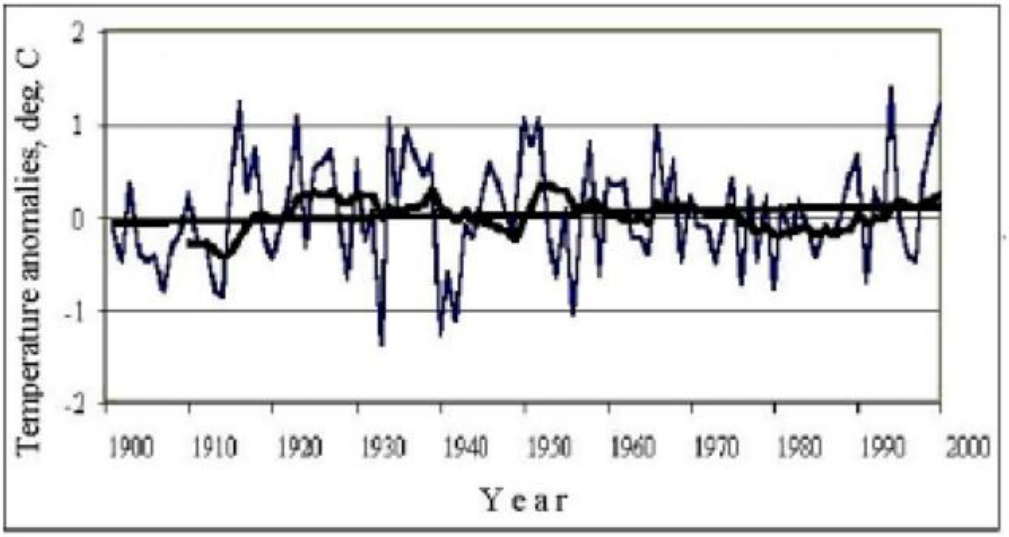


Fig.3: *Anomalies of annual mean temperature from 1901 to 2000 relative to 1961 - 1990, 10-years running smooth line and linear trend for Bulgaria*

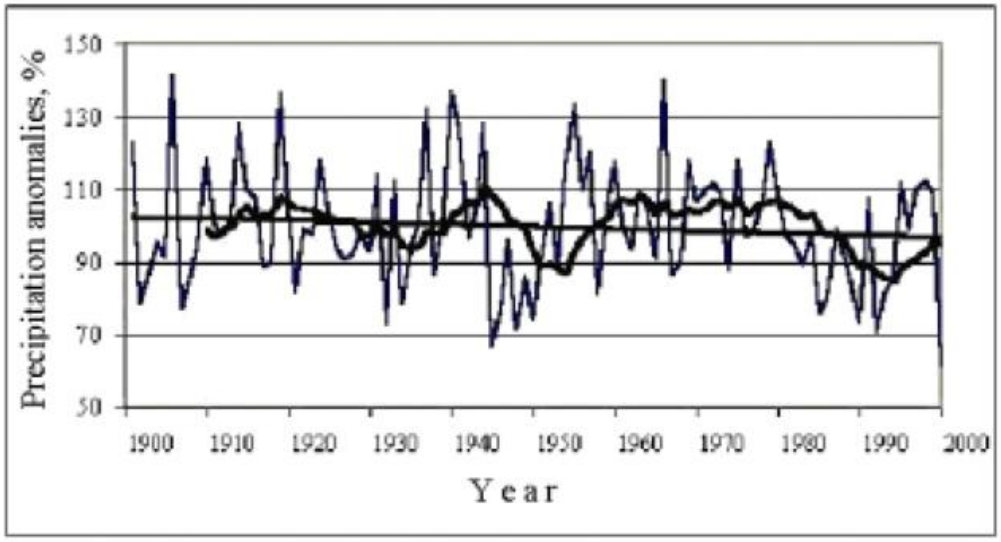


Fig. 4: *Precipitation in percent of 1961 -1990 normal from 1901 to 2000 relative to 1961 - 1990, 10-years running smooth line and linear trend for Bulgaria*

Croatia: Temperature and Precipitation Anomalies

Meteorological and Hydrological Service, Croatia

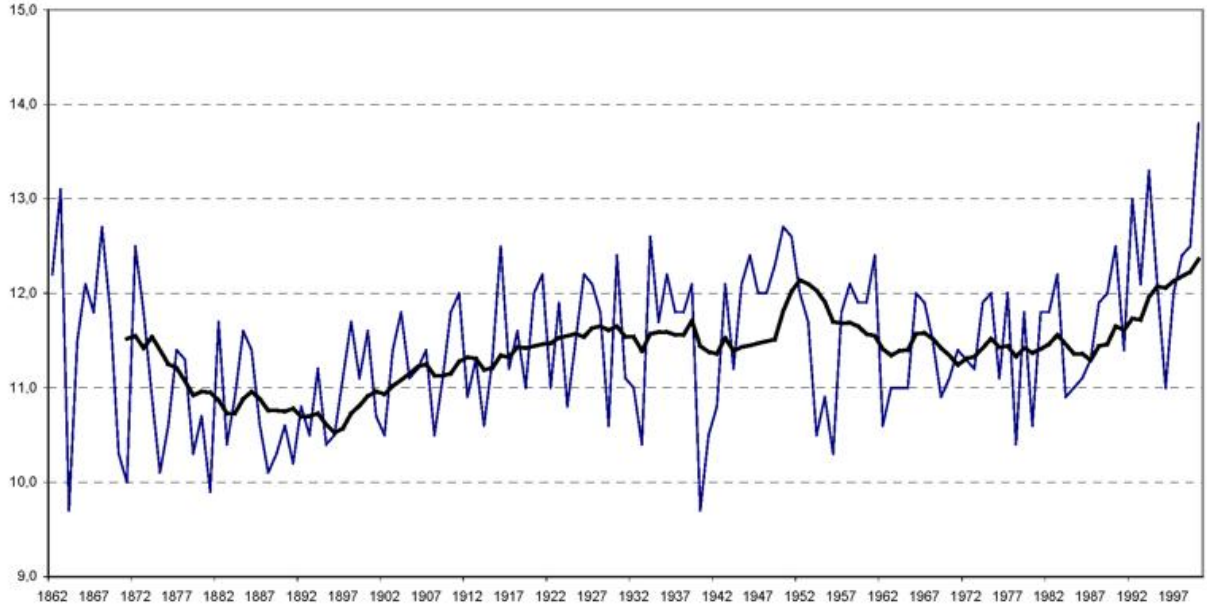


***Fig. 5**: Annual mean temperatures and 10-year moving average in °C in Zagreb Grič, between 1862 and 200*

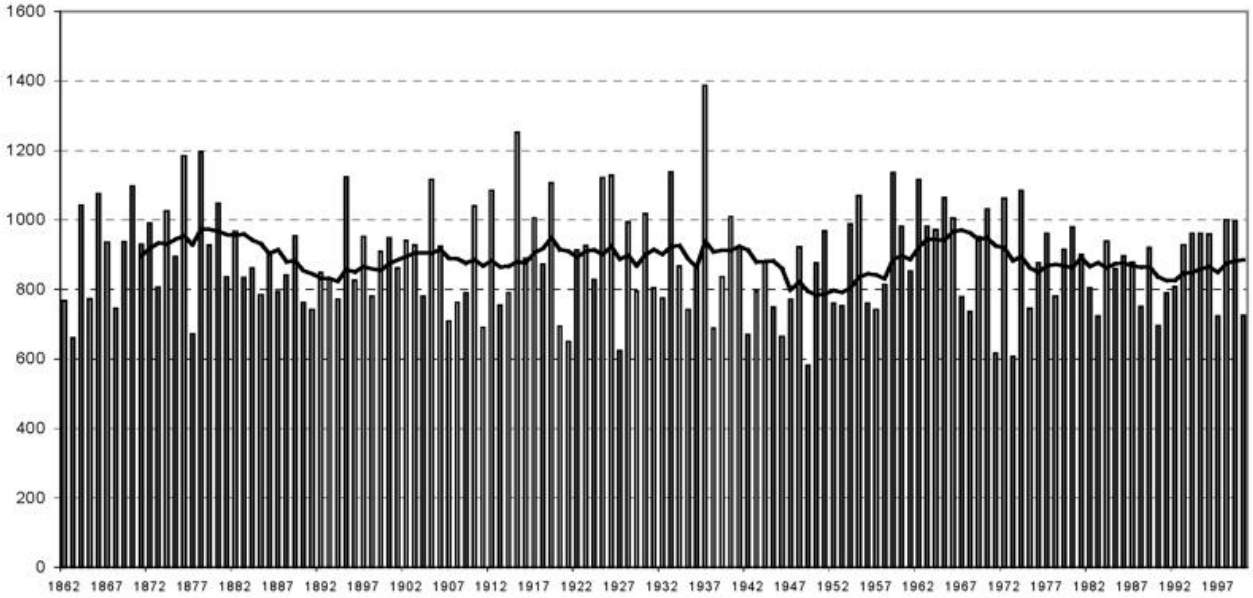


***Fig 6:** Annual precipitation totals and 10-years moving average in mm in Zagreb Grič, Croatia, between 1862 and 2000*

Denmark: Annual Temperature in Denmark, Faroer and Greenland between 1873 and 2000

The Danish Meteorological Institute

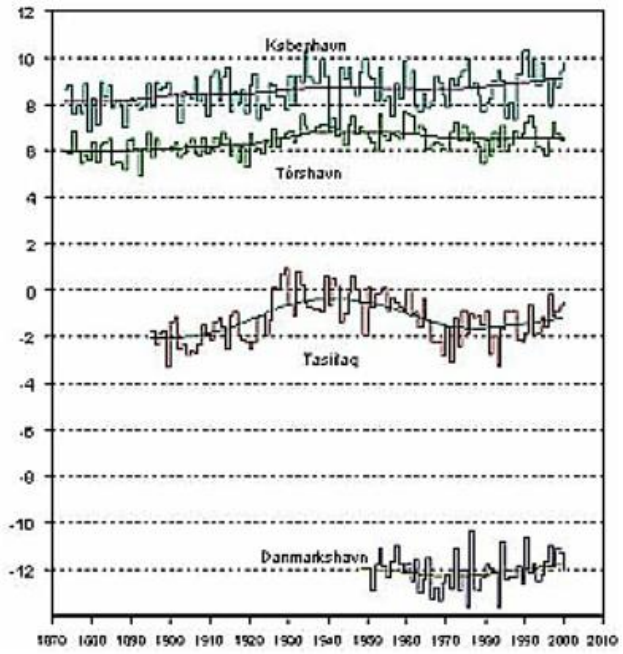


Fig 6: Mean annual temperatures in °C in København, Tórshavn, Tassilaq and Danmarkshavn between 1873 and 2000

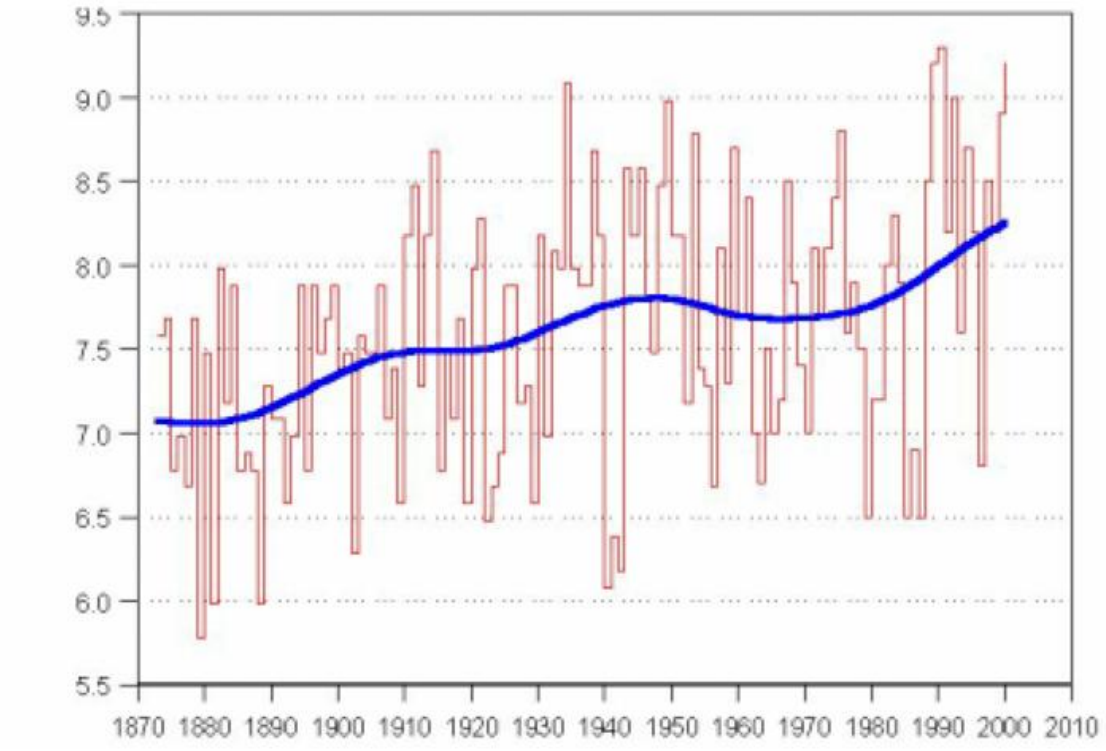


Fig 8: Mean annual temperature in °C in Denmark, between 1873 and 2000

Germany: Annual Mean Temperatures and Precipitation Totals between 1901 and 2000

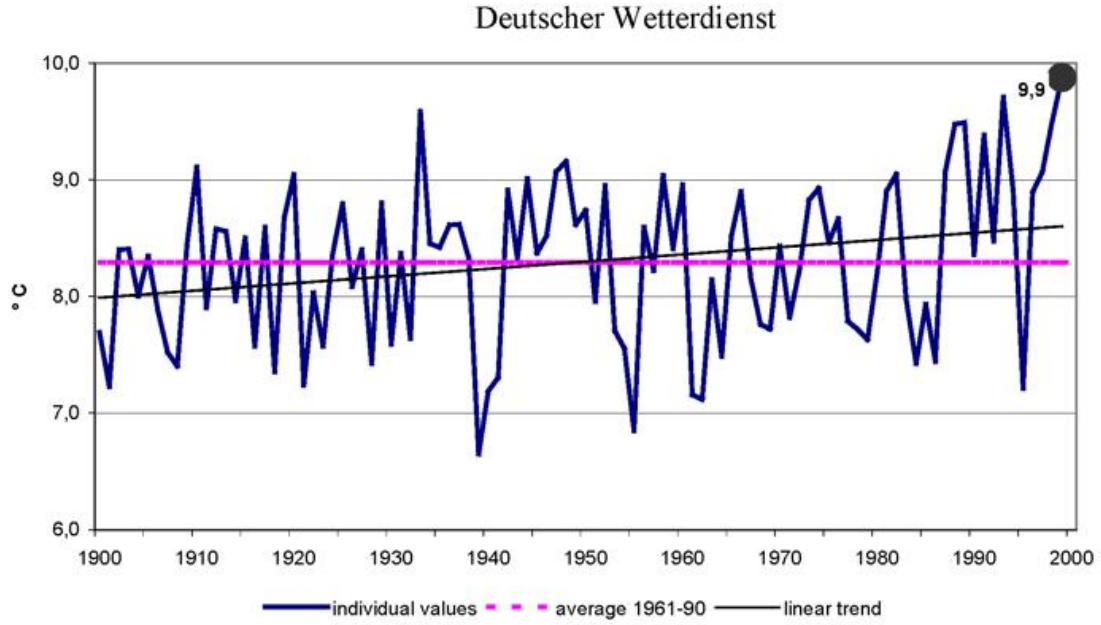


Fig xx: Annual mean temperatures in Germany between 1901 and 2000

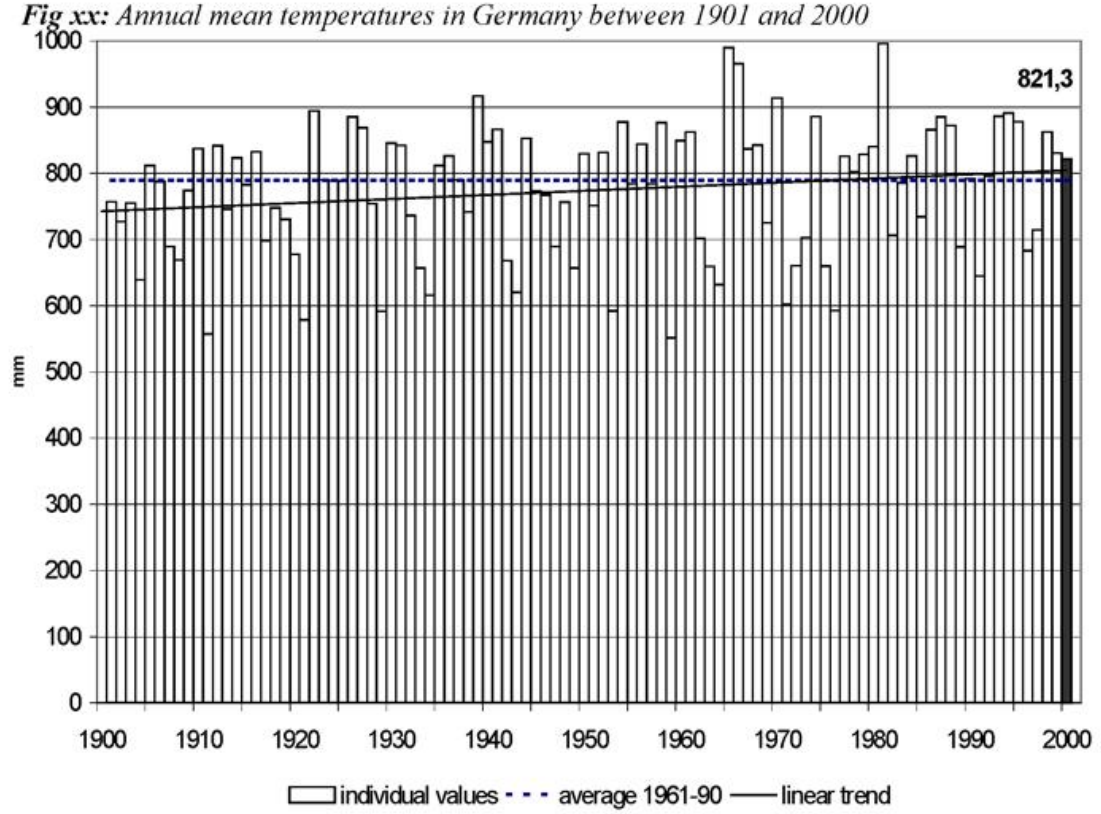


Fig. xx: Annual amount of precipitation in Germany between 1901 and 2000

German Bight storminess between 1879 and 2000

H. Schmidt, Deutscher Wetterdienst

A time series of geostrophic winds has been calculated as a first order approximation from the pressure readings of three stations forming a nearly equilateral triangle with a side length of about 250 km covering the German Bight. Data base were the three climatological pressure readings per day from meteorological annuals. From 1970 on the pressure data were taken from synoptic observations. Basically, the triangle was formed by the stations List/Sylt, Borkum and Hamburg. For several reasons, however, all of these stations had to be replaced temporarily by neighbouring stations.

The data correction was rather difficult, especially for the first decades. Here, error detection could only be performed by plausibility checks. Later on, more neighbouring stations existed, allowing also for cross checks. Most of the errors found were misprints, erroneous pressure readings, or scanning errors. Some errors, especially those of minor magnitude, may still be present in the data.

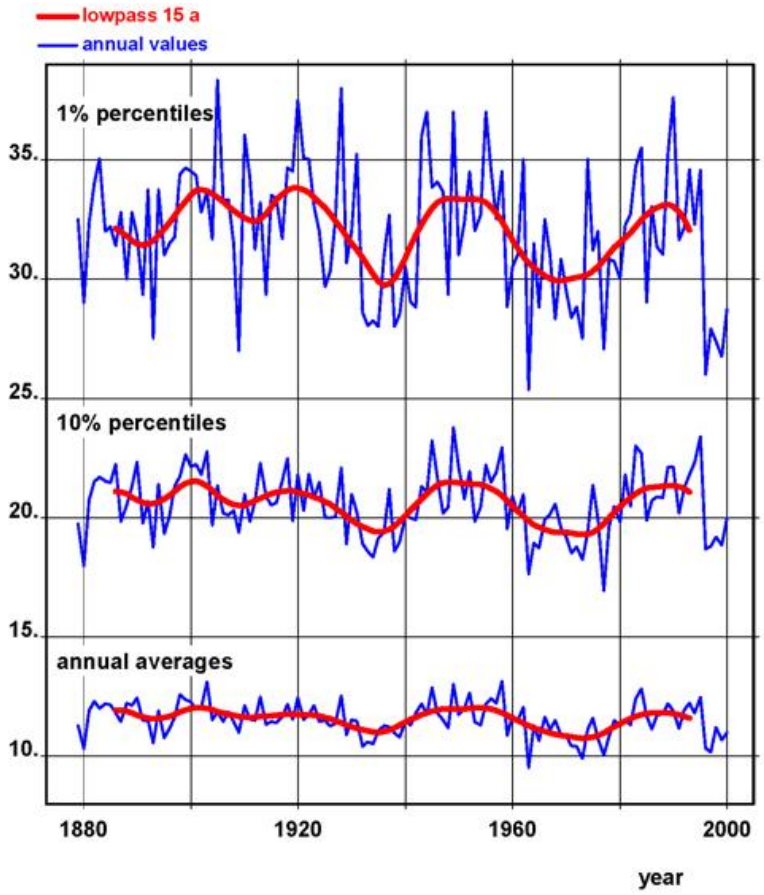


Fig. 9: *Statistical parameters of the annual frequency distributions of geostrophic wind speed. The original annual values are plotted in blue. Smoothed values, calculated with a 15 years low pass filter, are plotted in red. The lower curve are the annual averages. The curves above are those geostrophic wind speeds, which are exceeded by 10 % and 1 % of all of the wind speeds per year, respectively*

The time series of the three distributional parameters are rather similar, only their variance increases with wind speed. There are strong irregular interannual variations. The dominant feature, however, is a low frequency variation with a period of about 35 years, for which no explanation can be given. It also seems to be an irregular variation. The spectral energies of all other periodicities are much lower. All three time series exhibit a slight negative trend, which is -0.4 ms^{-1} per century in the annual averages. Due to the strong

variability of the annual wind values this trend cannot be regarded as statistically significant. Similar results were found by SCHMIDT and VON STORCH (1993) for the German Bight, and by ALEXANDERSSON et al. (1998) for triangles covering the whole northwestern Europe.

The much discussed positive "trend" of the last three decades now appears as part of a low frequency variation. The last five years had very low wind values, which are among the lowest of the century. The smoothed curves already clearly begin to drop since 1990. This was also found by ALEXANDERSSON et al. (2000). But they point out, that "it is, however, dangerous to trust too much in the tails of these smoothed curves, as they will change, when new data points are added".

Literature

Alexandersson H., Schmith T., Iden K., Toumenvirta H. (1998): Long-term variations of the storm climate over NW-Europe. Global Atmos. Ocean Syst. 6, pp 97-120

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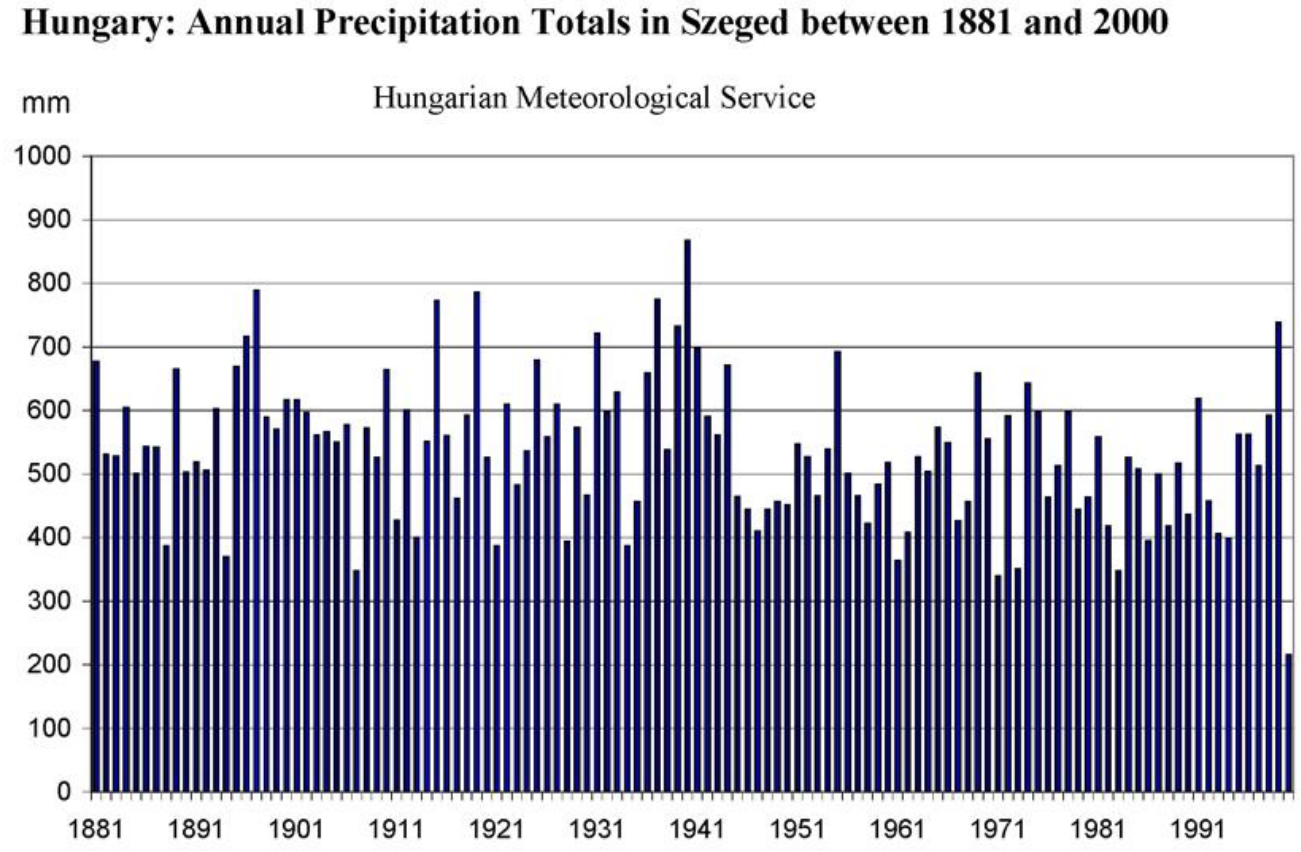


Fig 8: *Annual precipitation totals in Szeged between 1881 and 2000*

Ireland: Weather of the 20th Century in Ireland

Met Eireann, Ireland

Trends from long-term stations show a sharp rise in mean air temperatures during the 1990s, the warmest decade of the century. Four of the warmest ten years of the century were recorded since 1995; these include 1997, which was the warmest year at almost every station. This trend follows the global pattern, as figures from the World Meteorological Organisation show that the 1990s was the warmest decade of the century globally, which itself was the warmest century of the millennium. In Ireland, the warmest month of the century was August 1995, when mean temperatures were around 18 °C, up to four degrees above normal. The highest temperature on record in Ireland, 33.3 °C at Kilkenny Castle in June 1887, was not exceeded during this century, but values of over 32 °C were recorded during June 1976 and in July of 1921, 1934 and 1983. The coldest months of the century were February 1947 and January 1963, when mean monthly air temperatures were below freezing in places and there were also significant snowfalls during both months. The lowest air temperature of the century, -18.8 °C, was recorded at Lullymore, Co. Kildare, on January 2nd 1979, very close to the lowest temperature measured in Ireland, -19.1 °C at Markree Castle, Co. Sligo, in January 1881.

At the long-term stations of Valentia Observatory and Malin Head, the last two decades were the wettest of the century, but elsewhere there was little variation in decadal means of rainfall. The highest monthly total of the century, 790mm, was recorded at one of the mountain gauges in the Cummeragh Mountains of Kerry during October 1996. In contrast, there were a number of months during the century when no measureable rainfall was recorded in places, particularly April 1938, February and September of 1986 and during May 1991. Daily rainfalls of around 200mm were recorded in the east of the country during the 'Hurricane Charley' storm of August 25th 1986, but the highest daily total of the century, 243.5mm, was recorded at Cloone Lake, Co. Kerry, on September 18th, 1993. Over a shorter time span, just over 75mm of rain was recorded in an hour in the Mount Merrion area of Dublin during an intense thunderstorm on June 11th, 1963.

Annual sunshine totals show a downward trend during the century at all stations, but the 1990s were a little sunnier than the 1980s, which was the dullest decade everywhere. The sunniest years of the century were recorded during the first 20 years and also during the 1950s, particularly 1955. July of that year was the sunniest month of the century, when Valentia Observatory measured a total of 308 hours, or almost 10 hours sunshine per day. Winds gusting to around 100 knots have been measured on a few occasions during the century: 98 knots (113 m.p.h.) was recorded in a gust at Malin Head during the 'Hurricane Debbie' storm of September 16th 1961, while a gust of at least this value was recorded at Foynes, Co. Limerick, on January 18th 1945. Mean windspeeds of violent storm force 11 (over 55 knots, or 63 m.p.h.) are extremely rare events at inland stations, but these were recorded in the Dublin area in February 1903 and at both Cork and Shannon Airports during the Christmas Eve storm of 1997.

Monthly extremes recorded at the majority of stations:

Warmest Month: ***August 1995***
Mean temperatures over four degrees above normal in places

Coldest Months: ***February 1947, January 1963***
Mean temperatures below freezing at some inland stations

Wettest Month: ***Variable***

December 1978 in much of east & southeast

Driest Months: ***April 1938, February & September 1986, May 1991***
No measureable rainfall at a number of stations

Sunniest Months: ***July 1955, June 1957, August 1995***
Totals over 250 hours in many places

Dullest Months: ***December 1977, November 1983***
Less than 20 hours sunshine at some stations

Latvia: Temperatures in Riga between

Latvian Hydrometeorological Agency

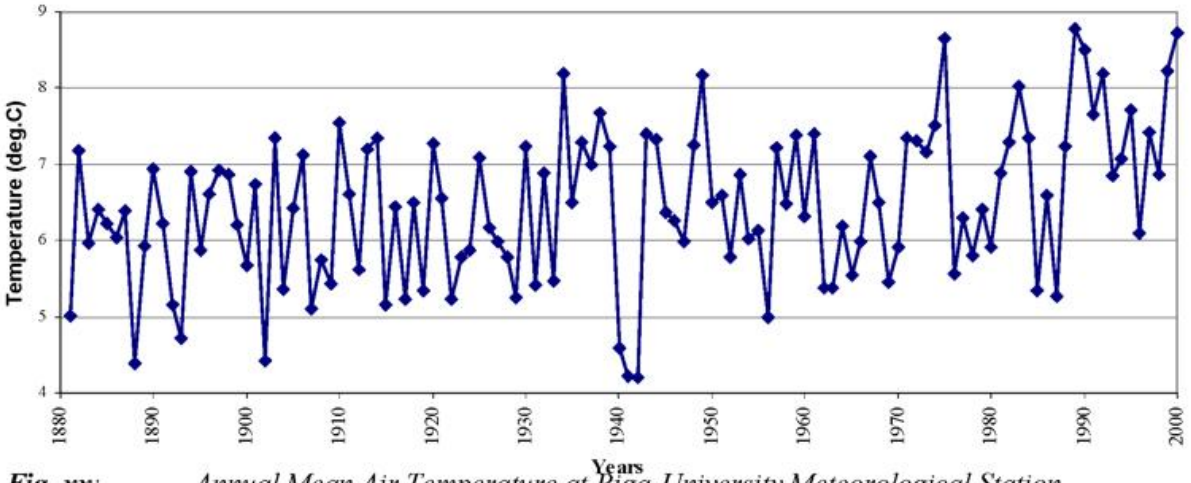


***Fig. xx**: Annual Mean Air Temperature at Riga-University Meteorological Station between 1881 and 2000*

Moldova: Climate Change Tendencies in the Republic of Moldova

Hydrometeorological Service, Republic of Moldova

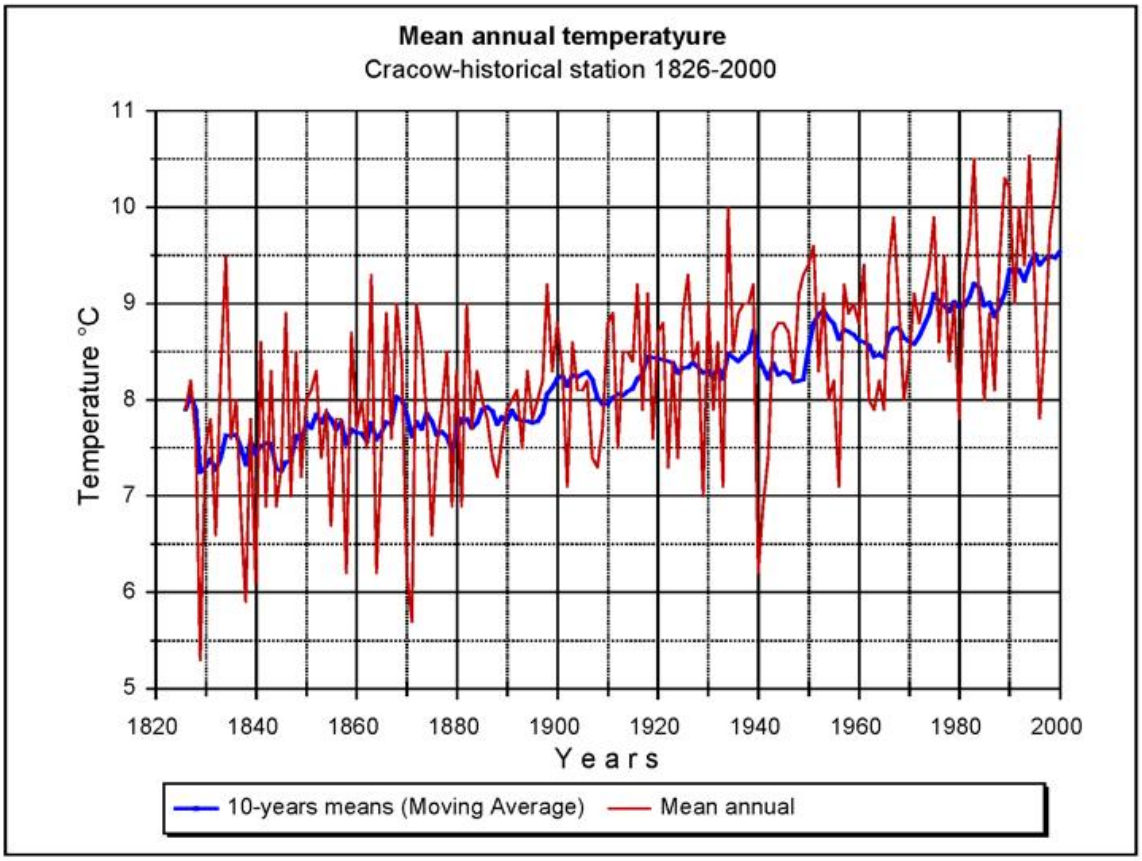
The last ten years, 1991 – 2000, were characterised by a high temperature regime in comparison with many years' period. The yearly average air temperature on the territory during this period was 8.4 – 10.1 °C, exceeding the norm with about 0.5 °C. It is important to be mentioned that especially in these ten years the yearly average air temperature reached twice the highest amounts 9.5 – 11.5 °C, 1994 and 2000, in the observation period of 100 years. The lowest yearly average temperatures were observed in 1996 and 1997 with 7.1-9.3 °C.

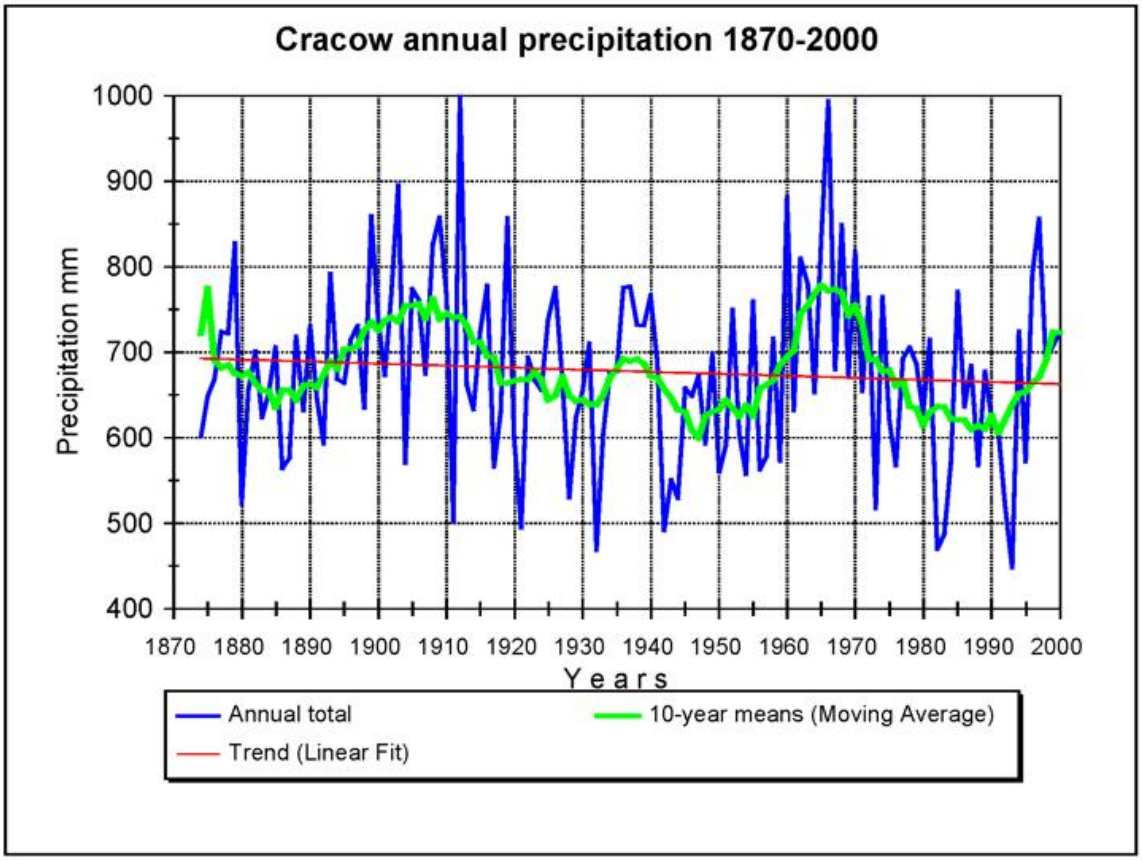
The yearly precipitation quantity average of the territory between 1991 and 2000 was close to the norms of 520 – 620 mm. The precipitation totals of some years oscillated between 400 mm (1994) and 890 mm (1998).

A special characteristic of the last decade was that of a higher temperature regime in **winter**, spring and summer. The average air temperature in winter was -0.9 – -2.3 °C, which is 0.2 – 1.4 °C warmer than usual. Out of 10 seasons, the average temperature exceeded the norm in 9 winters and only the 1995/1996 winter was anomalous cold. Its seasonal average temperature was lower than norm with 3 °C. The warmest winter was in 1993/1994, the average air temperature in Chisinau was 0.9 °C, as for some days in February the temperature reached 17.6 °C. In **spring** the seasonal average air temperature was 8.6 –10.1 °C, exceeding the norms with 0.5 °C. The warmest spring (exceeding the norms with 2 °C) was in 1994 and 2000; the coldest in 1991. The summer in this decade exceeded many years norms' with 0.5 – 0.9 °C and was 19.1 – 21.4 °C. The warmest **summer** was in 1999, the average of the seasonal temperature for the territory oscillated from 20.8 to 23.0 °C. The coldest summer of this decade was in 1993, the temperature was 17.5 – 20.3 °C. The **autumn** temperature regime (8.1 – 10.2 °C) was closer to many years norms. The autumn of 1994 was warmer, the air average temperature was between 9.7 and 11.7 °C. The coldest autumn was 1993 (6.4-8.7 °C).

Poland: Mean annual Temperature and Precipitation

Institute of Meteorology and Water Management, Kraków





Portugal: Climate in the 20th Century

Instituto de Meteorologia, Portugal

1. Introduction

One of the most relevant features of the climate in Portugal during the 20th century was the generalised increase in air temperature. The air temperature increase rate was larger in the growing towns, where there was a larger increase in time of the "urban island effect". When the mean trend related to the urban effect is removed, it is found that the mean air temperature has increased at a rate similar to the global warming rate for similar periods.

When the mean trends of air temperature increase are computed over the whole century, it is found that the maximum air temperature raise was larger than the increase rate in the minimum temperature. This implies an increase in the mean diurnal temperature range *DTR* over the century. Fig. 1 shows, as an example, the time series of the annual averages of minimum, maximum and mean air temperatures in Lisbon Geofisico from 1901 to 2000; the other secular time series show similar behaviour.

However, it is well known that, in recent years, the increase in minimum air temperature has been larger than the increase in maximum air temperature, that is, in the recent years the diurnal temperature range has decreased. This behaviour is generally interpreted as being associated with the increase of the greenhouse effect.

Several questions seem pertinent:

- When did the change in the sign of the trends in *DTR* occur?
- Did the change occur simultaneously in different places and regions?
- Did this change occur just in urban areas or is it a larger scale phenomenon?

2. Analysis of Portuguese Diurnal Temperature Range Time Series

The air temperature series from Lisbon - Geofisico and Coimbra – Geofisico, the best long series of air temperature in Portugal, were analysed to try to find at least preliminary answers to these questions. In Lisbon, the urban island effect is significant and has a considerable effect in the temperature rise; this has been found to be relatively small in Coimbra, a much smaller town.

The time series of *DTR* at Lisbon – Geofisico and Coimbra – Geofisico are represented in Fig. 2; the graph also shows the 5 years moving averages.

It is clearly visible that the series show opposite trends in the beginning and at the end parts. Also there is an acceleration in DTR increase near 1939 and a change of sign in the trends in the vicinity of 1945.

To locate the years of change in the signal of *DTR* two methods where used:

i) Locate the local maxima of moving averages (5 years).

ii) Identify trough Singular Spectral Analysis trends and slow variation principal components and use the time series reconstructed by using only these components to find the local maxima.

With the first method the inversion in the trends is estimated to occur in both series in 1945. With the second one the change is located between 1946 and 1947 for Lisbon and between 1947 and 1948 for Coimbra.

The metadata with the history of the two stations were checked.

For Coimbra there is no registered change in those years. In Lisbon, in 1941, there is a change in the thermometer height from 23.8 m to 1.6 m. This change should have produced a jump in *DTR* of about +0.08 ºC (small compared with the amplitudes of the *DTR* variation of the order of some ºC); however, it can not explain the change from an increasing trend to a decreasing trend in the *DTRs*.

In Fig. 3 the time series of diurnal temperature range in Lisbon – Geofisico and Coimbra – Geofisico are shown, together with the trend lines fitted from 1901 to 1945 and from 1946 to 2000. The trends, of +0.04ºC/year and –0.03ºC/year for Lisbon and of +0.06ºC/year and –0.03ºC/year for Coimbra, are statistically significant (level lower than 0.01).

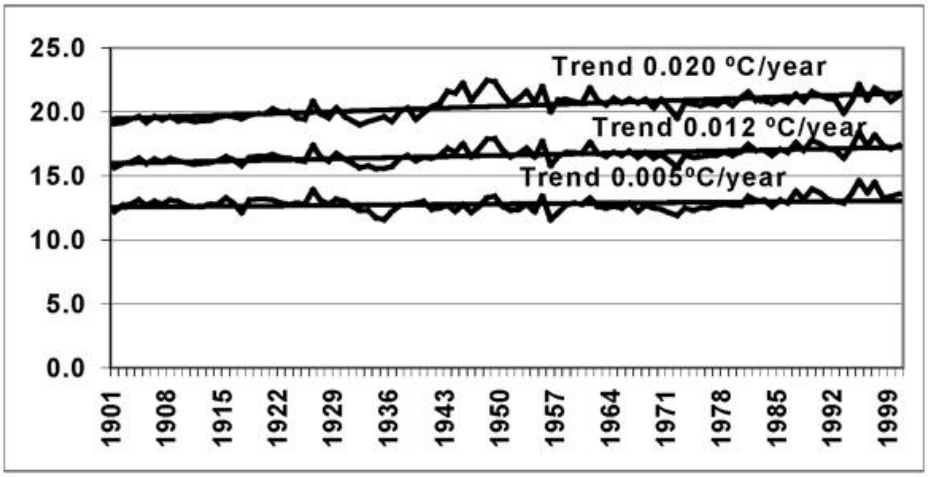


Fig. 1 *- Annual averages of minimum, maximum and mean air temperature at Lisbon and respective trendlines.*

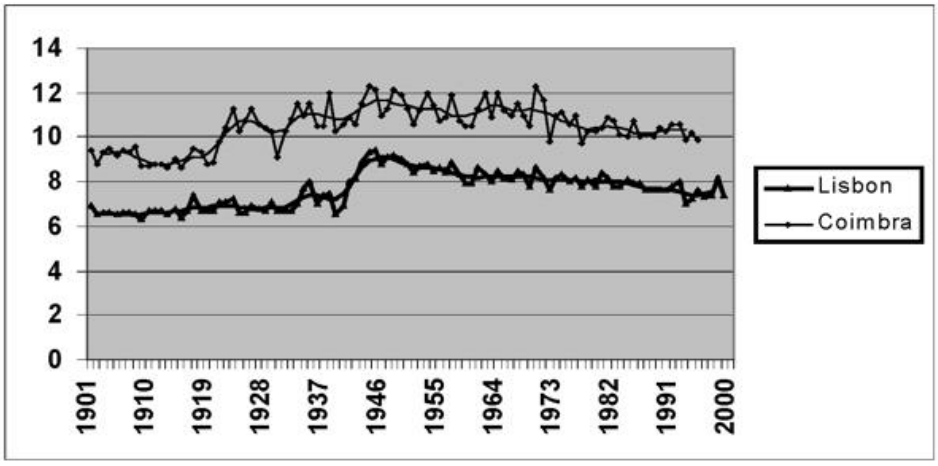


Fig. 2*: Annual averages of Diurnal Temperature Range at Lisbon and Coimbra and 5 years moving averages.*

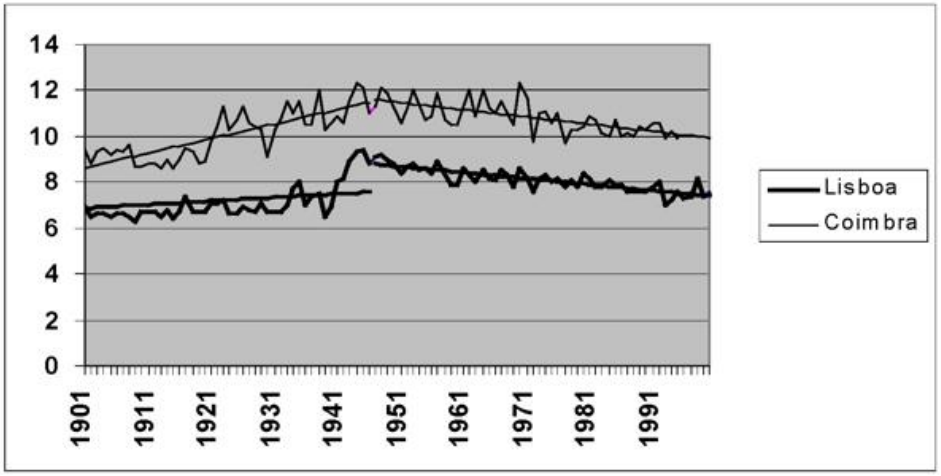


Fig. 3*: Annual averages of Diurnal Temperature Range at Lisbon and Coimbra. Trend from 1901 to 1945 and from 1946 to the end of the series.*

3. Comparison with other European Series of Diurnal Temperature Range

A reversal of trends in *DTR* about the year of 1945, or in the just following years, similar to that observed in Portugal, can be found looking at the graphs of several other European climatological series of *DTR* that are available trough the European Climate Assessment (ECA). Some of those where this behaviour is most obvious are:
Basel Binningen (Switzerland), Stensele (Sweden), Praga Klementinum (Czech Republic) and Uccle (Belgium) – see Fig. 4.

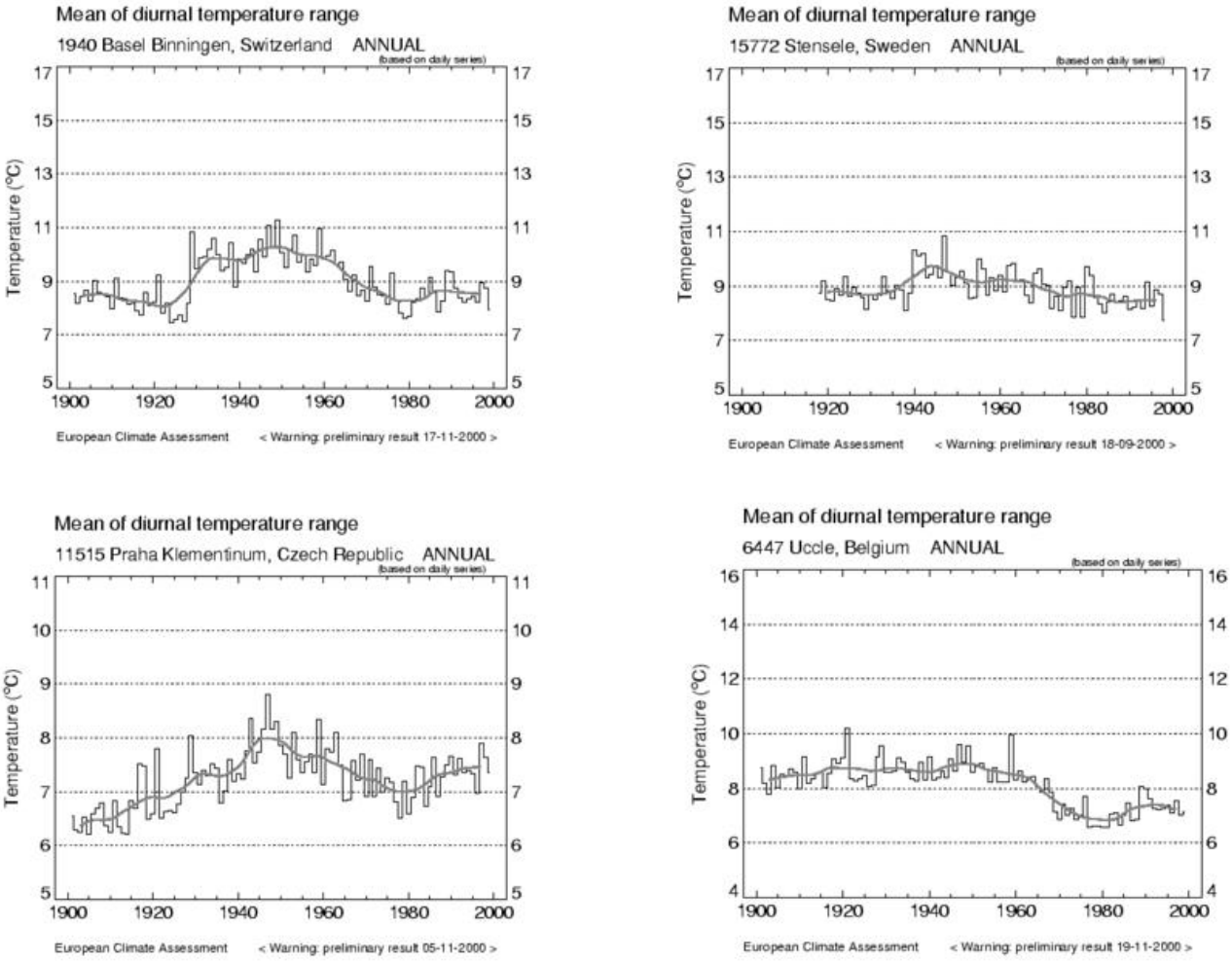


Fig. 4 - Annual averages of Diurnal Temperature Range at Basel Binningen (Switzerland), Stensele (Sweden), Praha Klementinum (Czech republic) and Uccle (Belgium).

SLOVAKIA: The Climate in Slovakia in the 20th Century

Climate Service Division of Slovakia

Significant increase in mean annual temperature by about 1.1 °C was observed in whole Slovakia in the 20th century. This increase can be illustrated also as the deviation of decade mean temperatures from the 1901-2000 average. In January 1991-2000 it was +1.5 °C and in August 1991-2000 it was +1.6 °C, but in December 1991-2000 the decrease by -0.1 °C and in September, October and November 1991-2000 the increase only by 0.4 °C was observed. Figure 1 shows the temporal development of annual temperature means. There can be seen exceptional high values between 1988 and 2000. Only the year 1996 can be considered as slightly below normal, the years 2000 and 1994 were in Slovakia probably the warmest since 1775. Frequent cold summers were observed in Slovakia in the 1901-1920 period and frequent cold winters occurred in the 1928-1947 period. The year 1940 was the coldest in the 20th century, but February 11, 1929 with -41 °C temperature measured at Viglas Pstrusa (central Slovakia) was the day with the lowest minimum temperature in Slovakia. Development and trends of annual precipitation totals show Figure 2. In southern Slovakia decreasing trends up to 15 % was observed in the 20th century. Some stations at the northern border of Slovakia have slightly increasing trends up to 5 %. The areal average annual precipitation totals calculated from 203 precipitation stations have decreasing trends by 5.8 % (Figure 2). The 1986-1993 period had the lowest precipitation totals in Slovakia in the 20th century. The Figure 3 illustrates an occurrence of the highest daily precipitation totals in Slovakia (Hurbanovo observatory). No significant trend in the maximum daily totals can be seen, some increase was observed in the 90ies. The absolute maximum daily total observed in Slovakia in the 20th century was 231.9 mm at Salka (lowland in southern Slovakia) on July 12, 1957. June 29, 1958 can be considered as the most rainy day in the 20th century with daily totals above 100 mm at 36 stations in Slovakia.

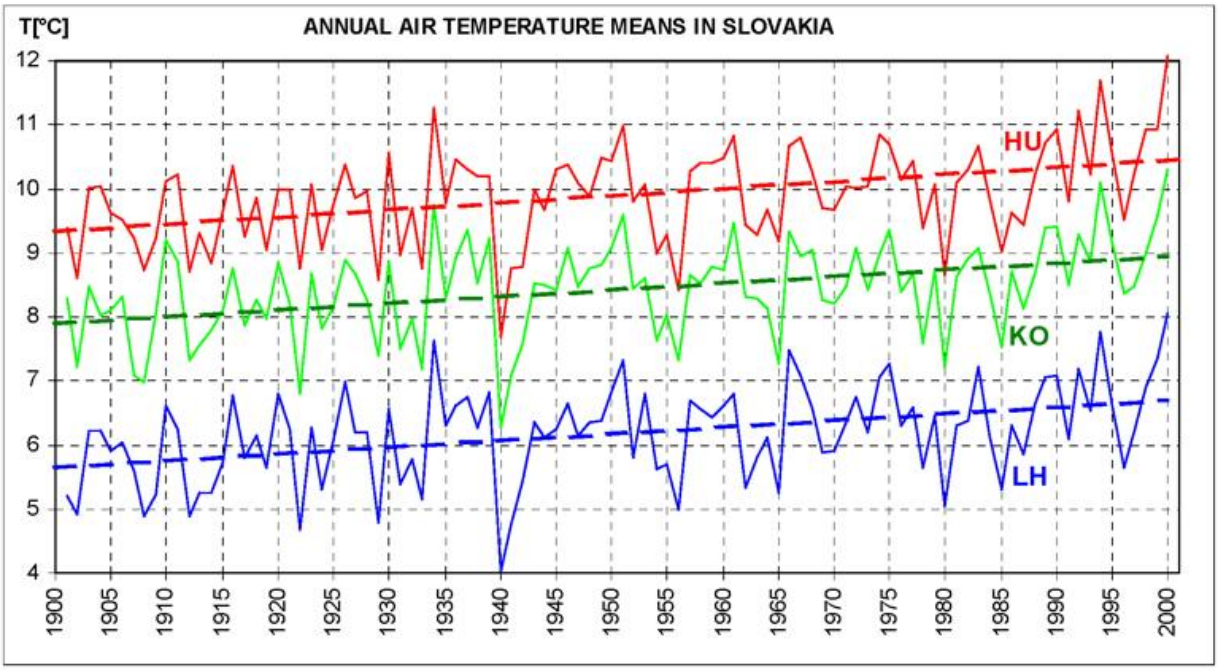


Fig. 1 *Annual air temperature means at the main climatological stations in Slovakia in 1901-2000 and linear trends (HU - Hurbanovo, SW Slovakia, 115 m a.s.l., 47°50'N, 18°12'E, KO - Košice, SE Slovakia, 230 m a.s.l., 48°40'N, 21°13'E, LH - Liptovský Hrádok, N Slovakia, 640 m a.s.l., 49°02'N, 19°44'E)*

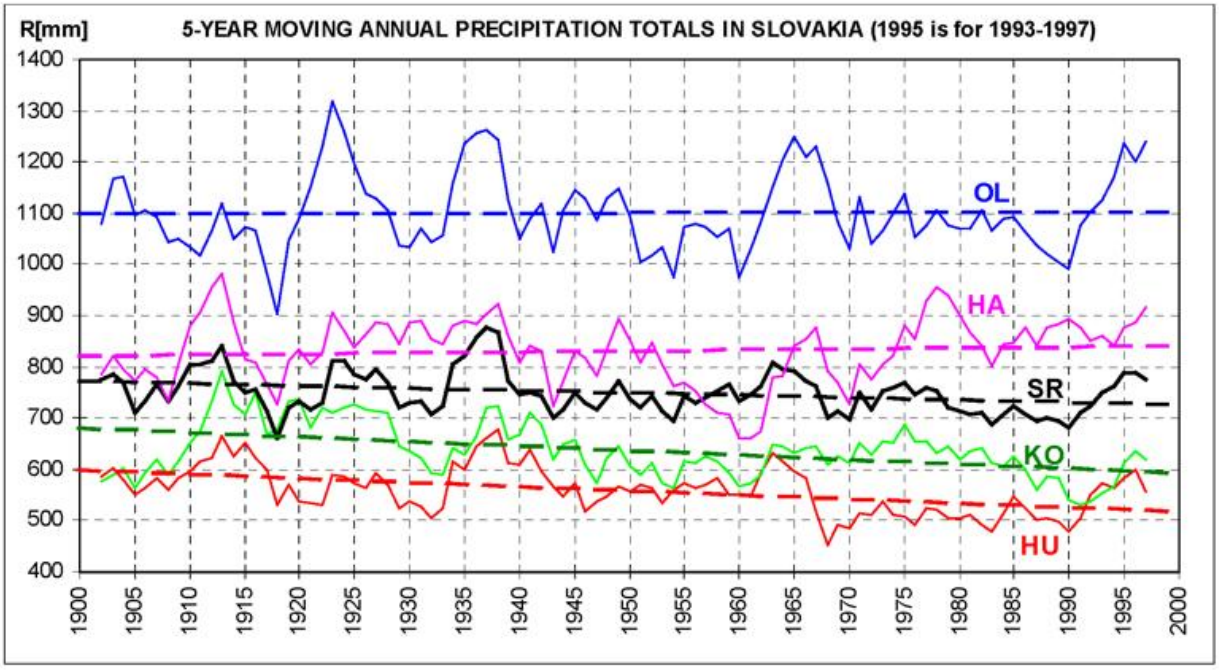


Fig. 2 *Five-year moving annual precipitation totals at the main precipitation stations in Slovakia in 1901-2000 and linear trends (HU - Hurbanovo, SW Slovakia, 115 m a.s.l., 47°50'N, 18°12'E, KO - Košice, SE Slovakia, 230 m a.s.l., 48°40'N, 21°13'E, SR - areal average from 203 stations in Slovakia calculated by double weighted averages method, HA - Habura, NE Slovakia, 372 m a.s.l., 49°19'N, 21°52'E, OL - Oravská Lesná, 780 m a.s.l., 49°22'N, 19°11'E)*

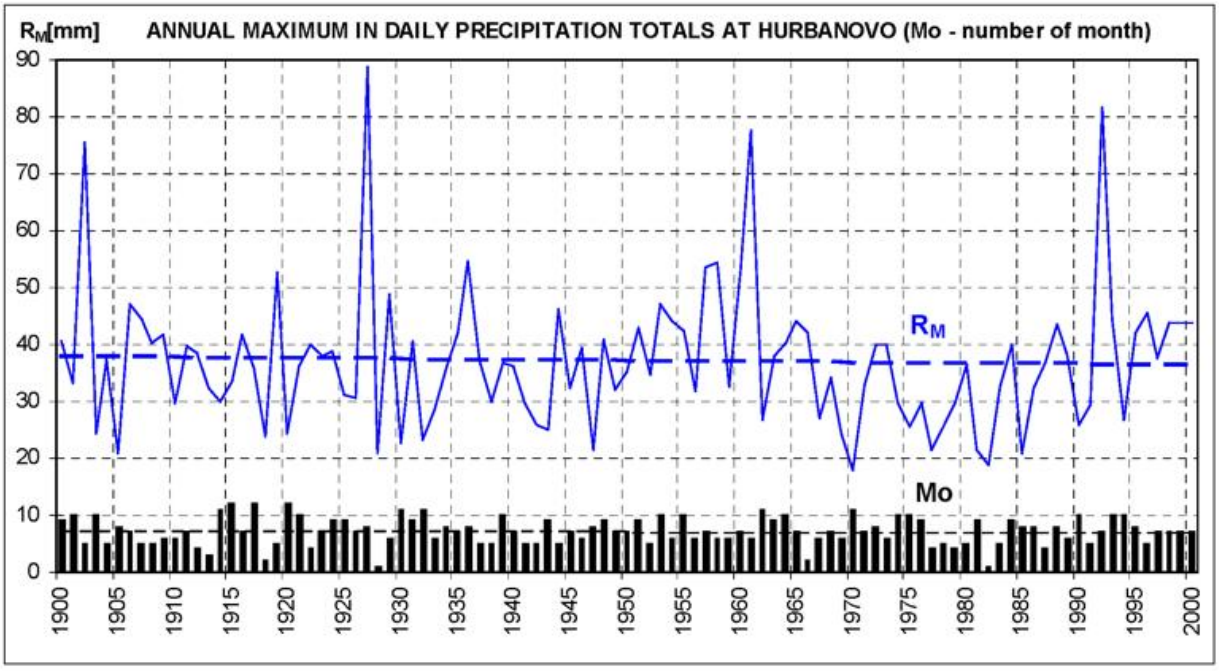


Fig. 3 *Annual maximum in daily precipitation totals at Hurbanovo 1901-2000 (R_M) and linear trend, number of month with maximum daily total (Mo); Hurbanovo, SW Slovakia, 115 m a.s.l., 47°50'N, 18°12'E, Mo = 12 (December), Mo = 7 (July); no significant trends in R_M and Mo values was observed*

Sweden:

see Annual Bulletin on the Climate in WMO Region VI - 1999, pages: 50-51

United Kingdom: Temperature Anomalies in Central England between 1878 and 2000

UK Meteorological Office

A century time-scale perspective on Central England Temperature is given in the following figure. Analyses indicate that about a quarter of the warming in recent decades has arisen because of changes in atmospheric circulation. The series has been designed to avoid urban warming, and the absence of this is confirmed by the equality of warming trends on calm days (when any urban warming would be most evident) and windy days (when any urban warming would be dissipated).

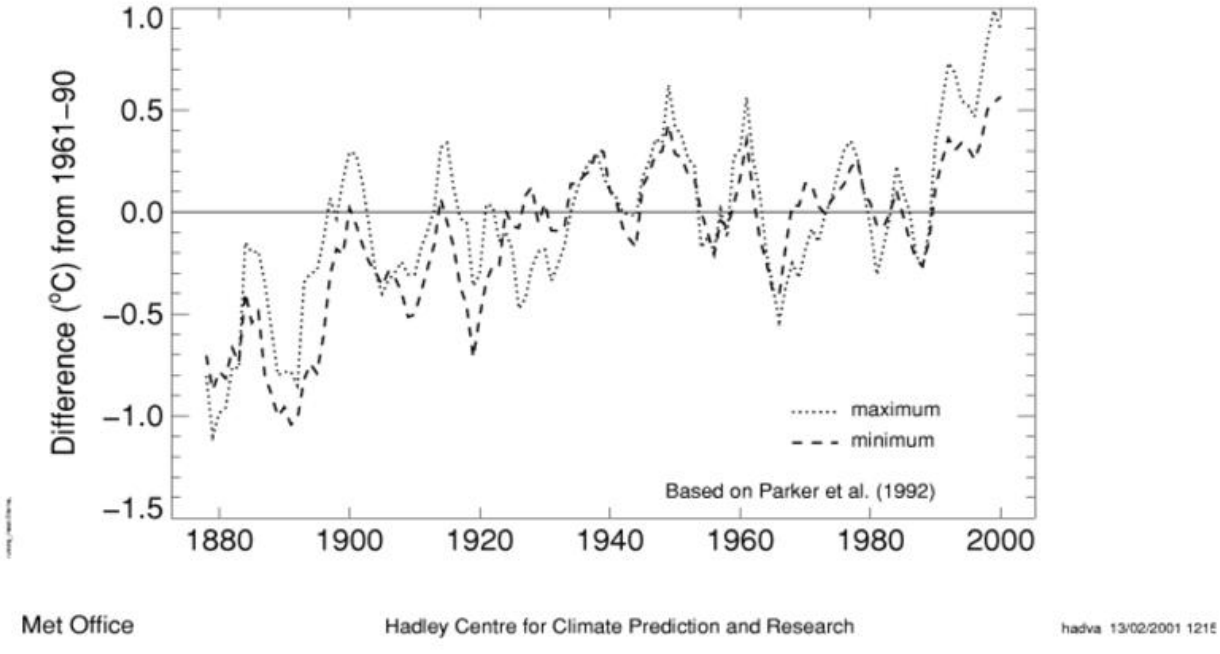


Fig. xx: *Central England maximum and minimum air temperature annual anomalies between 1878 and 2000*

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Climate Support
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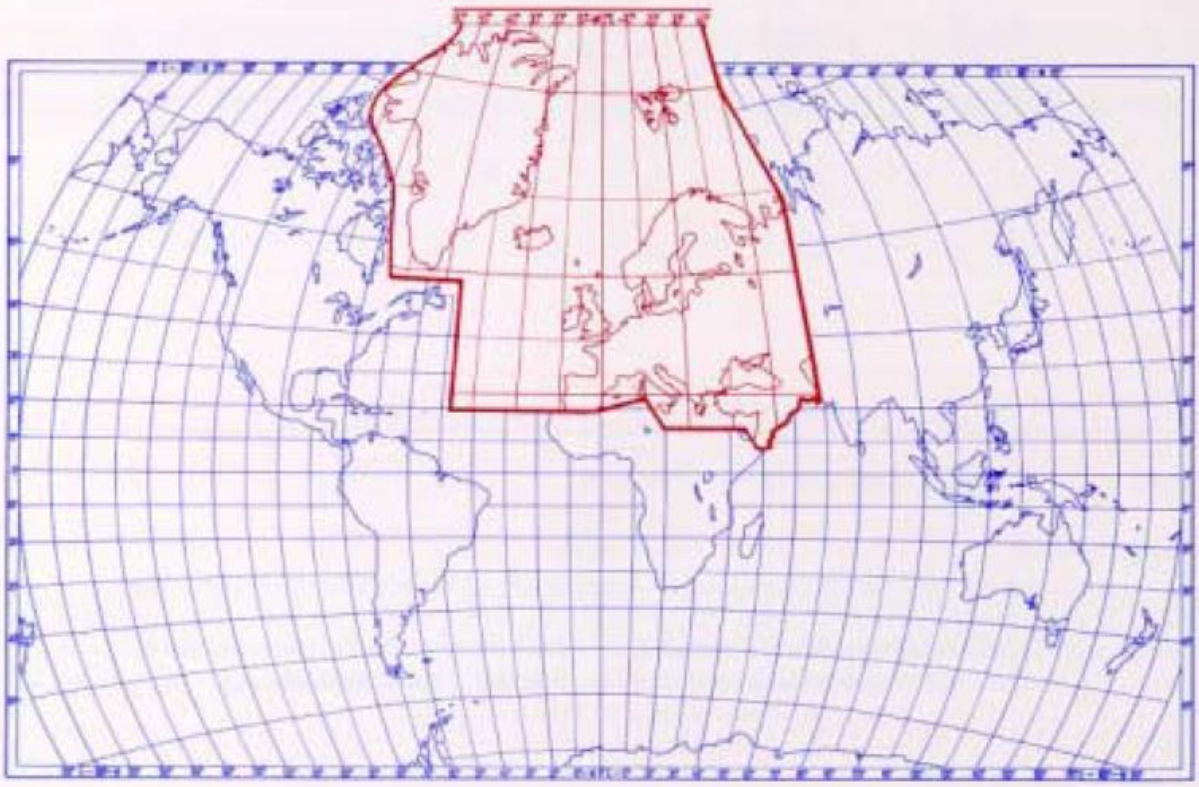
– Europe and Middle East –

2001



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- Europe and Middle East -
2001

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and was co-ordinated by Deutscher Wetterdienst, Germany,

Armenia
Austria
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Belgium
Bosnia and Herzegovina
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Cyprus
Denmark
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Norway
Poland
Portugal
Russian Federation
Slovakia
Slovenia
Spain
Sweden
Switzerland
The Former Yugoslav Republic of Macedonia
Turkey
Ukraine
United Kingdom
Yugoslavia

Furthermore, contributions to the WMO Bulletin article on consequences of abnormal weather in 2001 were referred from the following countries:
Czech Republic, Tajikistan, Uzbekistan

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Foreword

The Annual Bulletin on the Climate in WMO Region VI – Europe and Middle East – for 2001 is now presented as the 8th edition in a sequence since the series started in 1994. All of the 49 national Meteorological and Hydro-Meteorological Services in WMO Region VI have been asked for input to this edition. There were direct responses from 40 member states of the Region. Additionally, WMO Secretariat supported the compilation of the report by providing the contributions to the WMO Bulletin article on consequences of abnormal weather in 2001.

The report from the ECSN manager is also highly appreciated and incorporated to this edition of the Bulletin. The Project 'Generate Climate Monitoring Products' (GCMP) of the ECSN Application Area is closely connected to the objectives of the Bulletin. As for the first time last year, this edition of the Bulletin will be presented again also via Internet.

In 2001, numerous climatic highlights occurred in WMO Region VI on different scales in space and time. Prominent features on the monthly time scale were the record breaking high temperatures in October exceeding those of September in many places, while September had extremely high precipitation rates in large parts of the Region. Devastating floods and long lasting drought affected different and in some cases the same areas at different times.

There were also many reports of extreme short time events on a more local scale. While reports on local whirlwinds and tornadoes have increased compared to earlier years, this may be due in part to enhanced reporting procedures that have been introduced in recent years. A new feature of this edition of the Bulletin is the photographic illustration of some extreme events, that occurred within in the Region.

I would like to thank all those who contributed to this publication. The reader of the Bulletin will find a compilation of selected parts from all national reports with the intention of presenting the characteristic climatic features of the WMO Region VI in 2001.

Last not least I want to thank Germany for the co-ordination, the editorial review, publishing and distribution of the document.



Petras Korkutis
Acting President of WMO RA VI

Outstanding Events and Anomalies in 2001

Temperature

- Overall warmer than normal with highest positive deviations in SE-Europe and the Middle East
- October extremely warm with highest temperatures on record and higher mean values compared to September in many places
- December very cold in nearly all parts of Europe except for the Northwest, with extreme deviations from normal in the Southwest and in eastern Europe
- In contrast to other parts of Europe, absolute records of maximum temperatures were set up on islands in the Norwegian Sea in December
- March extremely warm in the Mediterranean and Middle East
- Extremely mild January in the Volga region

Precipitation

- Overall rainfall slightly above or near normal except some parts of southern Europe and the Middle East
- Intense drought with high temperatures in summer months from central-south to south-eastern Europe, in the Caucasus region and Uzbekistan
- September very wet in Central Europe with extreme rainfall amounts in the Alpine and Balkan regions
- Extreme wintry rainfall in Brittany and the northern part of Portugal, succeeded by abundant flooding at the beginning of the year
- Abundant snowfall in Western Altai leading to frequent avalanches in January and flooding in spring-time

Wind

- Violent storms in November in the mid Baltic area

Annual Survey

Temperature deviations from normal all over the year within the Region were generally positive with maxima above +1°C in south-eastern Europe and the Middle East (e.g. see fig. 0.1), but still below the level of the preceding year.

October temperatures were extremely high in many parts of the region (e.g. fig. 0.2) and exceeded previous all time records at many stations. Monthly mean values lay above September means in many places in Europe (see fig. 0.3).

The Mediterranean and the Middle East were hit by an extraordinary heat wave in March (see fig. 0.4).

On Iceland and Jan Mayen absolute maximum temperature records were broken in December, whereas from the Iberian Peninsula over central to eastern Europe December was very cold with temperatures significantly below normal (see figs. 0.5, 0.6).

Precipitation was generally near to normal or slightly above over the Region (e.g. see fig. 0.7) except for some parts of southern Europe and the Middle East.

September was extremely wet in Central Europe with deviations in some areas up to 300% of the normal precipitation and even more (e.g. see fig 0.8).

In summertime, some parts of southern Europe and the Caucasian region suffered from severe drought, especially at the beginning and the end of the season (see fig. 0.9).

Starting from the second half of November, a growing snow cover affected Latvia and Poland, reaching more than 40 cm in some parts of the area at the end of December (see fig. 0.10).

Sunshine duration was reported to be near normal or slightly above with the exception of central France, where a deficit of sunshine occurred. At the beginning and at the end of the year, the U.K. enjoyed record-breaking sunshine. Ireland gained significantly more sunshine than normal all over the year at nearly all stations (see fig. 0.11).

Extreme **Wind** events occurred all over the Region throughout the year in many localities. In France, the highest gust was recorded on April 8 by 187 km/h at Cap Béar in the eastern Pyrenees near the Mediterranean Sea. A thunderstorm, that developed into a tornado on September 30 hit the county Westmeath in Ireland with impacts illustrated by fig 0.12.

In mid-November, violent storms uprooted millions of trees when crossing Scandinavia to the Baltic States, and caused exceptional sea level rise in the Gulf of Riga.

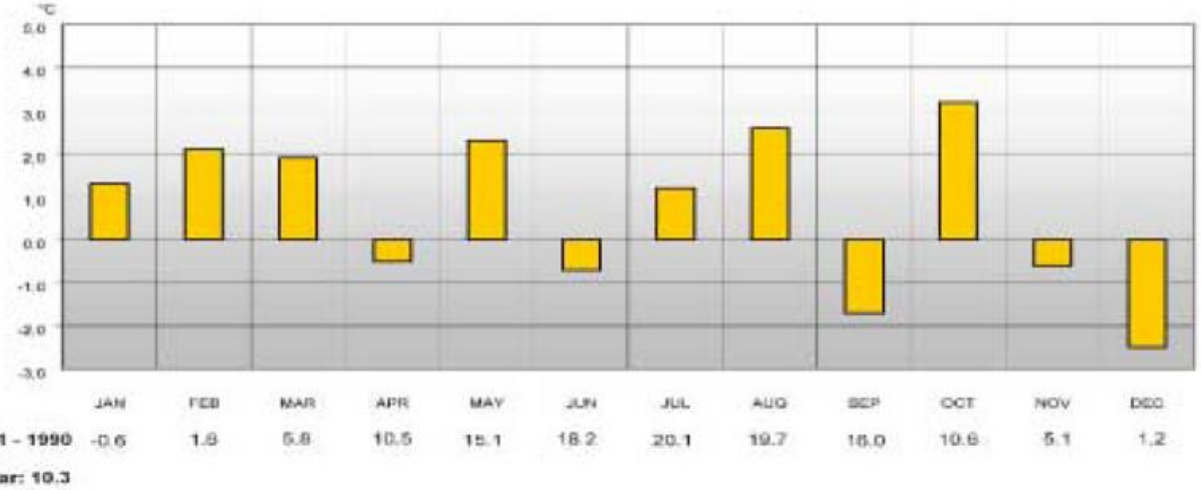


Fig.0.2: *Deviations of monthly mean temperatures from normal, Vienna 2001; long-term average values in °C, reference period 1961-1990*
From: Zentralanstalt für Meteorologie und Geodynamik, Austria

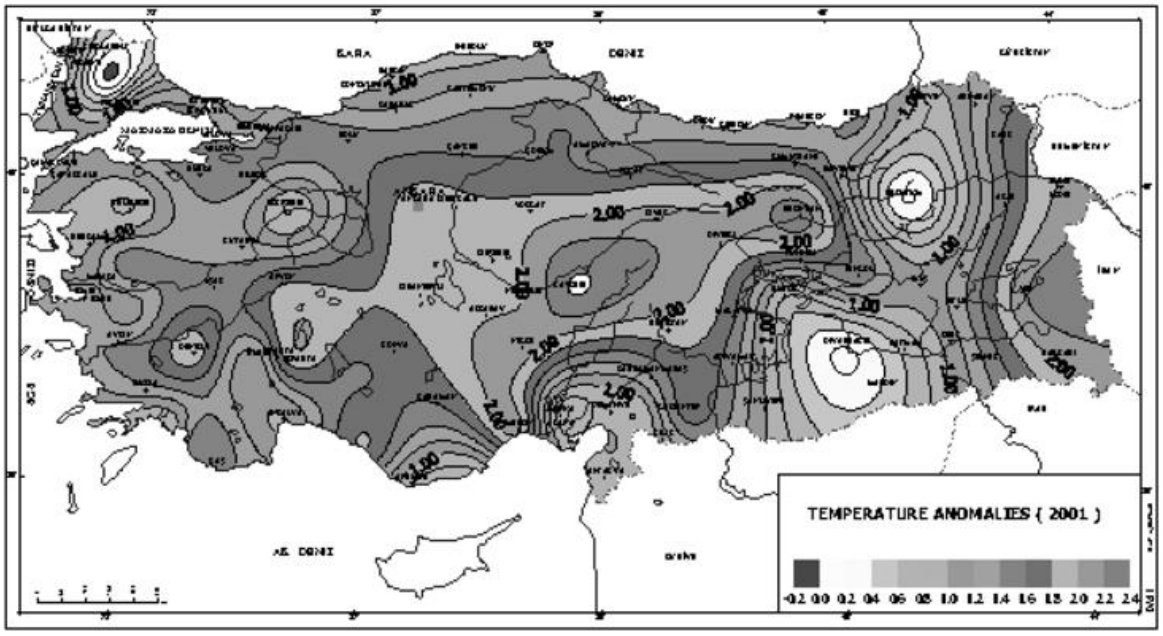


Fig. 0.1: *Temperature anomalies (°C) in Turkey, 2001*
From: Turkish State Meteorological Service

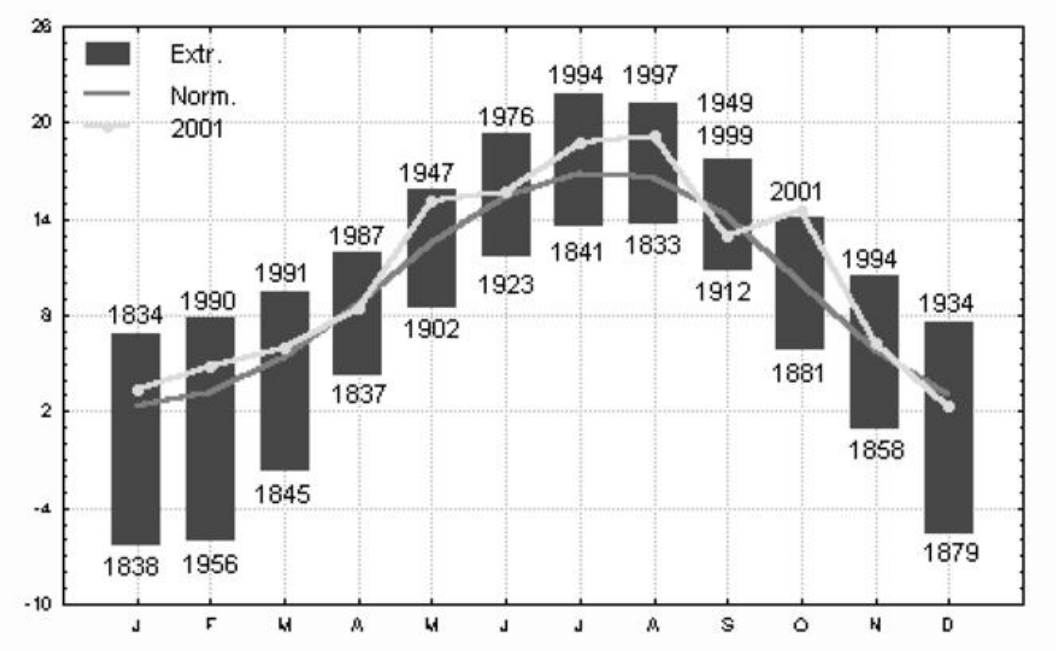


Fig. 0.3: *Monthly mean temperatures in °C for 2001, normal and extreme values since 1833 at Uccle station*
From: Royal Meteorological Institute, Belgium

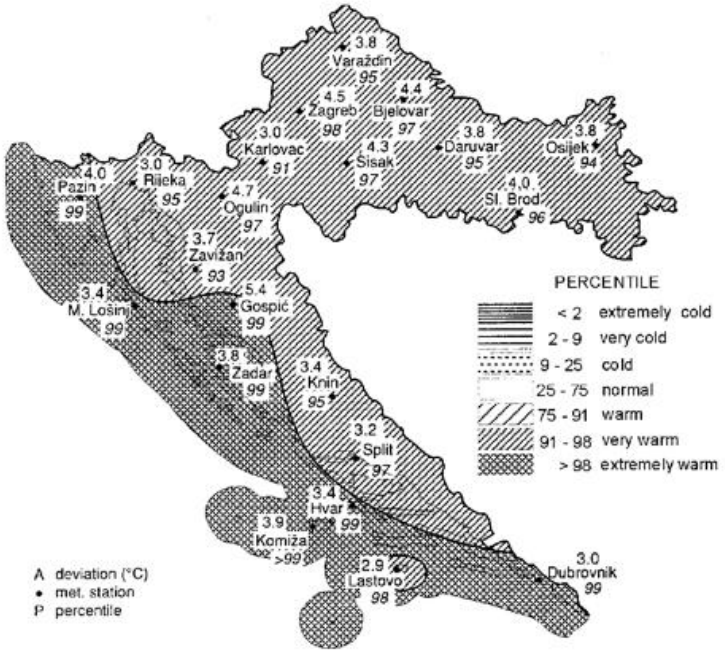


Fig. 0.4: *Percentiles of anomalies of March temperatures in Croatia in 2001, reference period 1961 – 1990*
From: Meteorological and Hydrological Service, Croatia

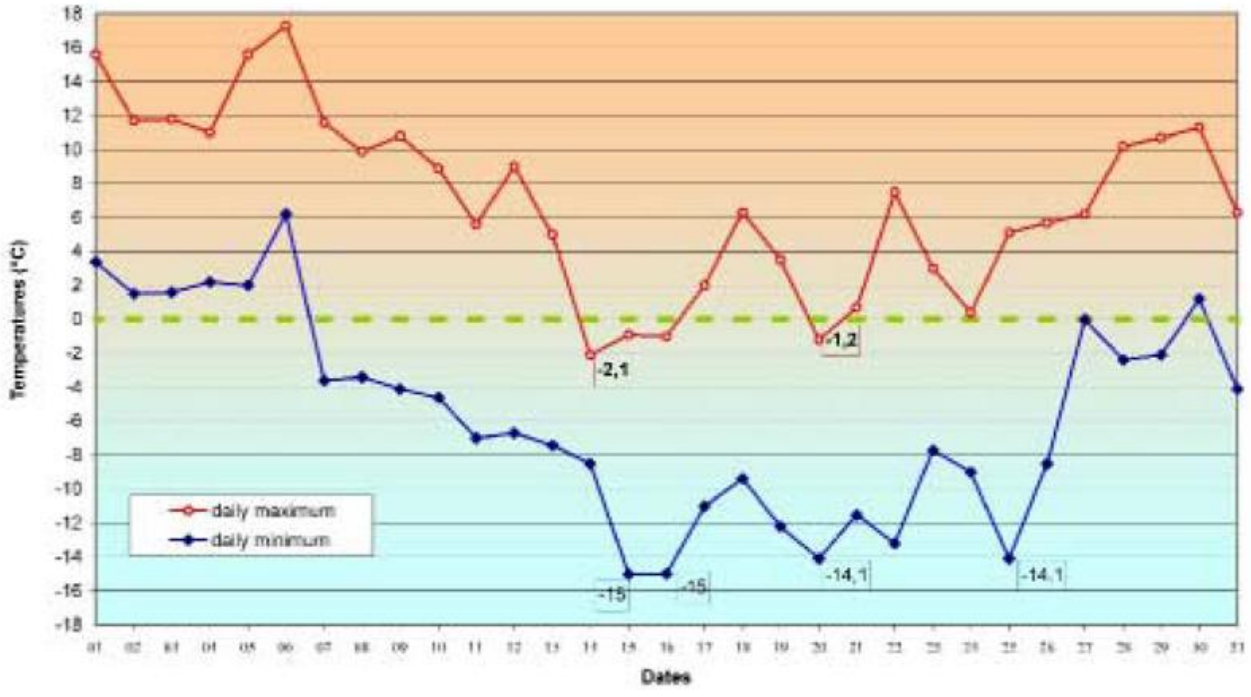


Fig. 0.5: *Daily extreme temperatures in Castellet (Vaucluse), elevation: 288 m, December 2001*
From: Météo France

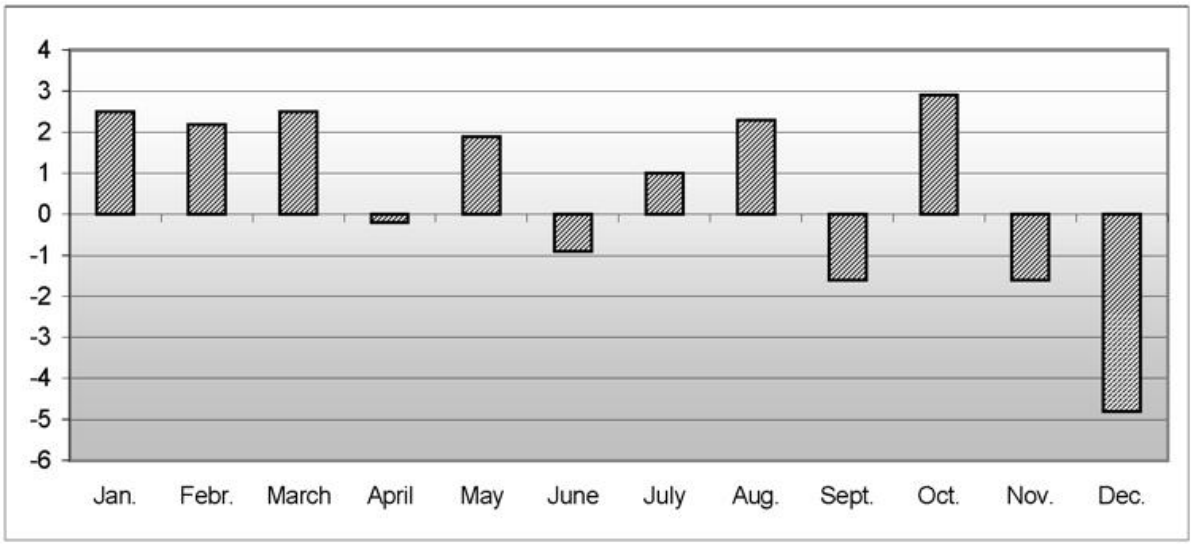


Fig. 0.6: *Variation of the national mean temperature (°C) in Hungary in 2001, related to the average of many years*
From: Hungarian Meteorological Agency

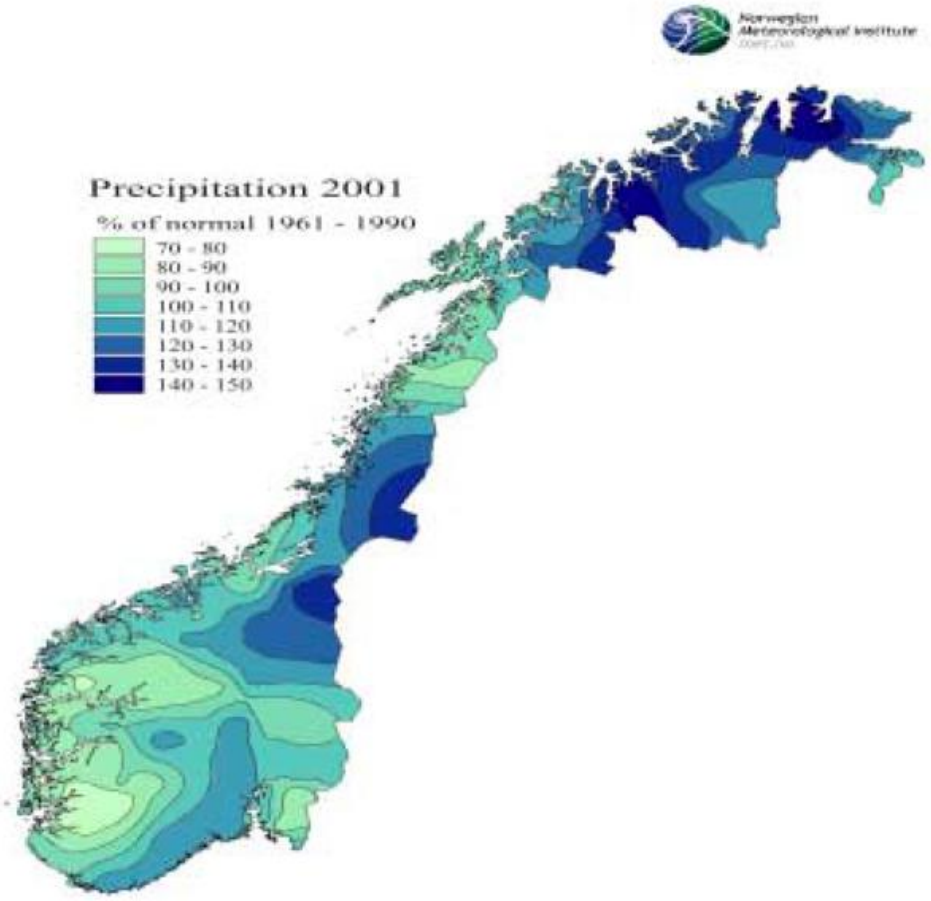


Fig. 0.7: *Spatial distribution of the annual precipitation in % of normal in Norway, 2001*
From: Norwegian Meteorological Institut

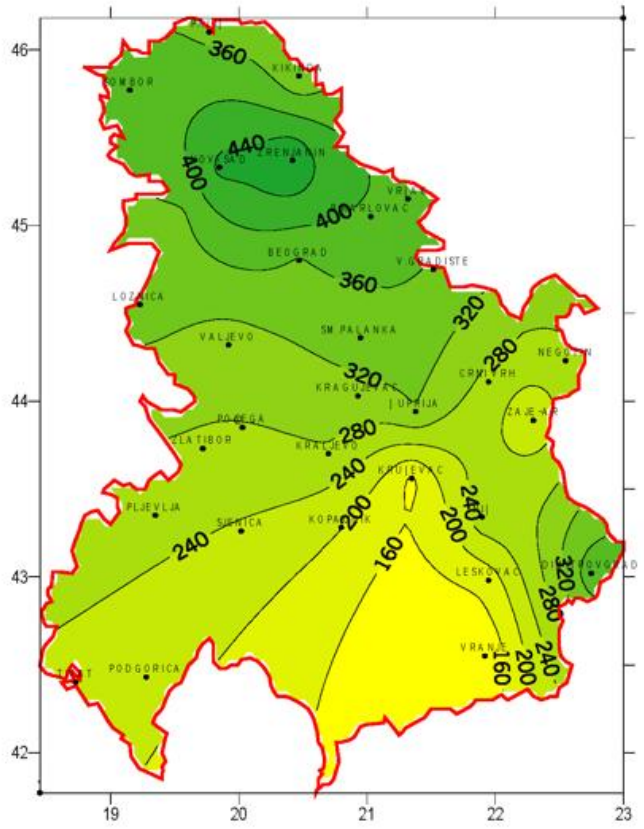


Fig. 0.8:

Precipitation deviations in % from normal in Yugoslavia for September 2001; axes are in geographical coordinates
From: Federal Hydrometeorological Institute of Yugoslavia

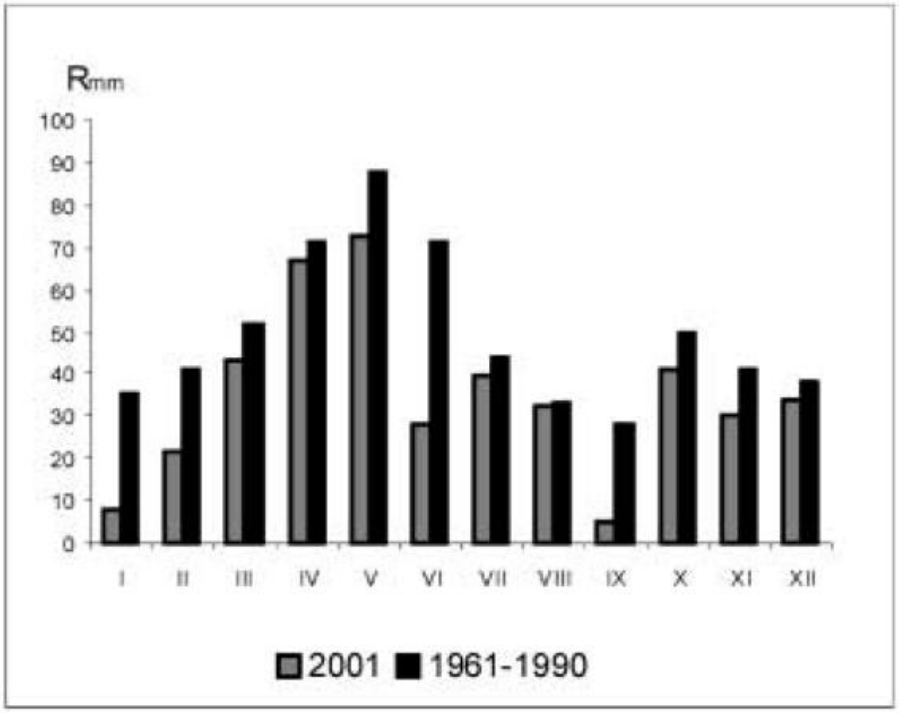


Fig. 0.9: *Monthly percipitation totals in Armenia, 2001*
From: Department of Hydrometeorology of the Republic of Armenia

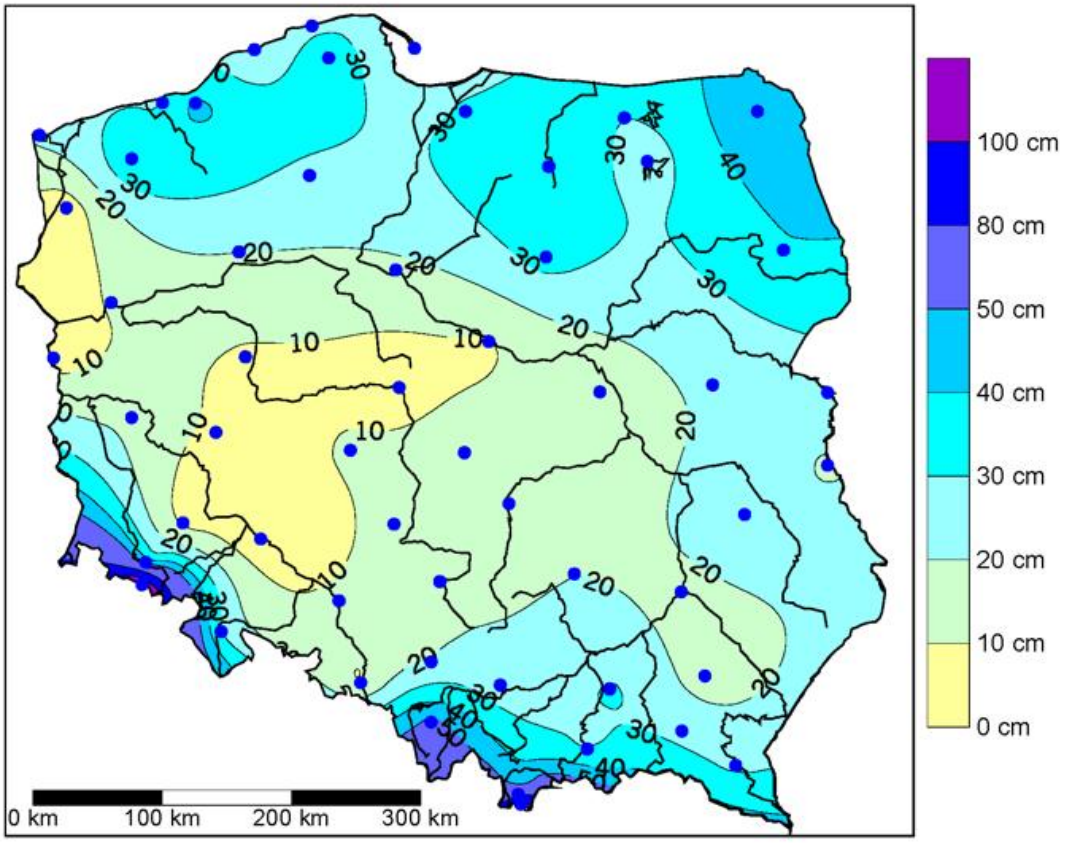


Fig. 0.10: *Depth of snow cover on December 31, in Poland, 2001*
From: Institute of Meteorology and Water Management, Kraków, Poland

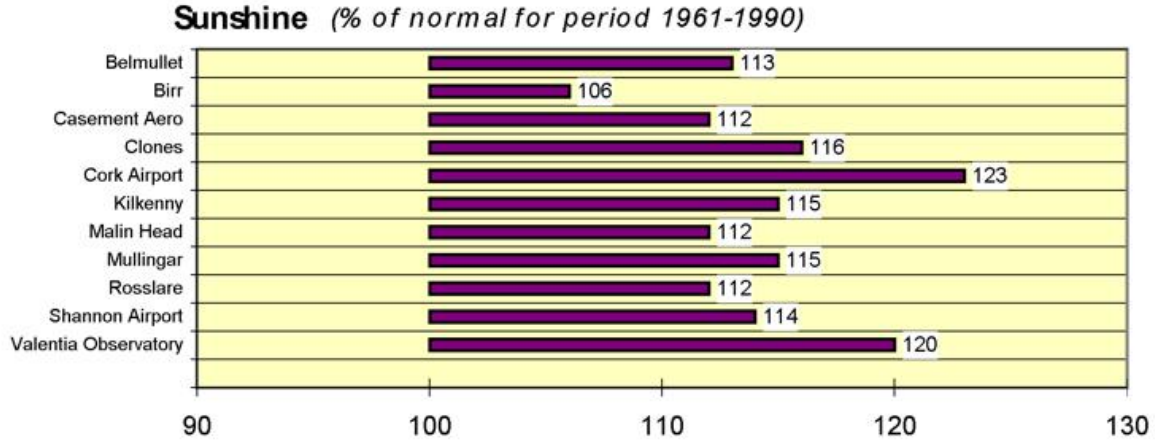


Fig. 0.11: *Sunshine duration in % of normal at stations in Ireland in 2001*
From : Met Eireann, Ireland



Fig. 0.12: *Impact of a tornado on September 30 in the county Westmeath*
From : Met Eireann, Ireland



Fig. 0.13: *Coimbra, January 2001. Photo by: Manuel Correia, reporter from „Jornal de Noticias"*
From: Instituto de Meteorologia, Portugal

Seasonal Survey

Winter 2000/2001 was generally mild except in Ireland with a country-wide slightly negative deviation of 1°C from normal. Positive temperature anomalies occurred elsewhere and increased from the European coastal regions in the West and Southwest into the continental area, where they reached maximum values up to +5°C in eastern Europe. Switzerland had a remarkable relative maximum of positive temperature deviations (see figure page 14 above). The wintry precipitation was distributed in a more complex way over the Region. While some coastal parts of western Europe received enormous amounts of precipitation, other parts like south-central France, the Levante, and areas around the Black Sea had significant deficits (see figure page 18 above). Continuous rainfall over several days around New Year caused large floods on saturated soil in Brittany (France) and in the northern part of Portugal (see fig. 0.13).

Spring 2001 was generally warm with positive temperature anomalies except for northern Scandinavia. Positive deviations from normal occurred up to +3°C, rising from western to eastern Europe and the Middle East (see figure page 15 above). In Tartu, Estonia, the April mean temperature exceeded the normal value by far; the long term linear trend of this parameter shows an increase of +1.9°C since the beginning of observations in 1866 (see fig. 0.14). The spatial distribution of precipitation in springtime has a patchy pattern over the Region. There are areas of up to 200% of the normal precipitation in the north-western part of the Iberian Peninsula, in France, Poland, and north-east of the Black Sea. Significant precipitation deficits occurred in eastern parts of Spain, in several coastal areas of the Mediterranean and the Norwegian Sea, around the central part of the Caspian Sea, and in eastern Europe with centres in Belarus and Moldova (see figure page 18 below). High spring temperatures in western Altai, Kazakhstan, melted large snow reserves and together with abundant rainfall led to extraordinarily high floods in the mountain rivers with destruction of villages, bridges and motorways.

Temperatures in **Summer 2001** were above normal except for the coastal area of middle Norway. The positive deviations from normal increased from the European coastal areas to the centre of the continent up to +2°C and had an even higher maximum around the eastern Black Sea and north of it (see figure page 16 above). The most prominent feature of the precipitation regime in summer was a large deficit of rainfall around the Mediterranean coastline and in the Middle East leading to severe drought in many areas. Central and northern Scandinavia and other, more or less isolated areas in France, eastern Europe, Greece and eastern Turkey had remarkable precipitation amounts exceeding 150% of the normal values (see figure page 19 above).

Autumn 2001 was generally mild with centres of positive temperature deviations from normal in the British Isles, in Scandinavia, and south-eastern Europe (see figure page 17 above). The spatial distribution of precipitation had a more complex structure over the Region (see figure page 19 below). Precipitation amounts up to more than 200% of normal occurred in southern Russia (Volga region) and in some parts of Turkey, especially in the North-East and in the south-western coastal area. Central Europe received precipitation above normal up to 150% as well as the northern Balkans and the Ukraine. The Pyrenees, the Alps, Italy, the southern Balkans, and the eastern Caucasus suffered from precipitation deficits causing severe drought. The special climatic characteristic of autumn 2001 in many European countries was a very wet and cool September followed by a warm October with precipitation significantly below normal. This feature is exemplarily illustrated by fig. 0.15.

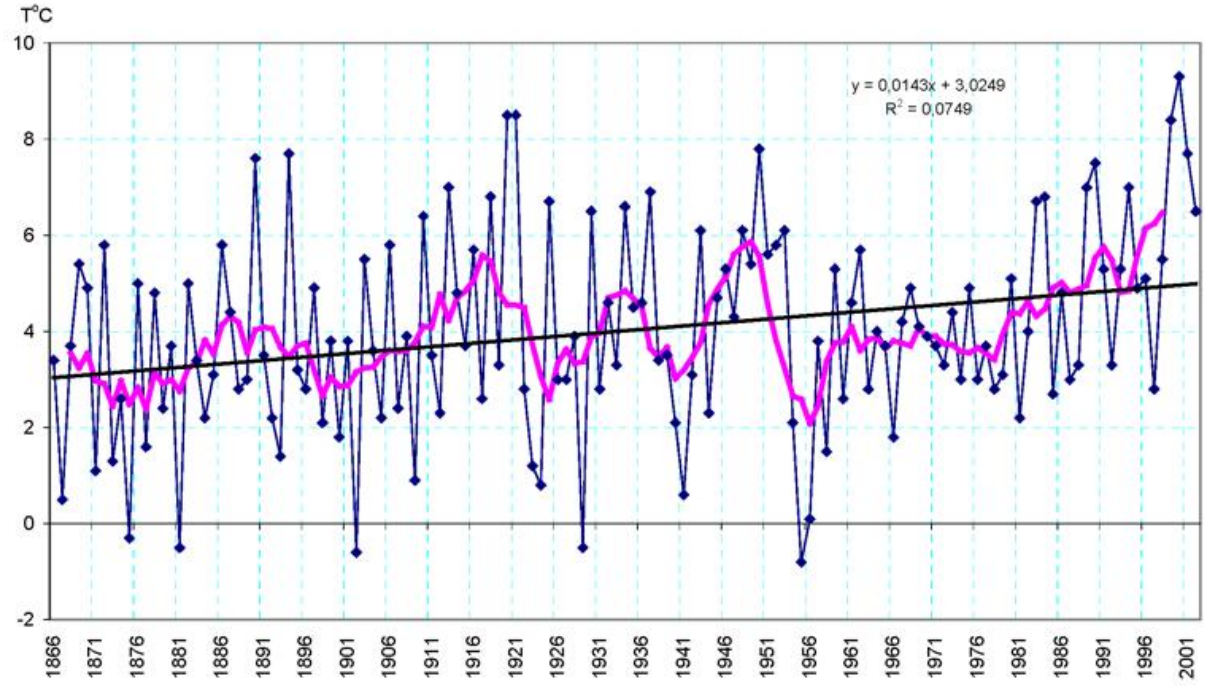


Fig. 0.14 : *April mean air temperatures at station Tartu since 1866*
From : Estonian Meteorological & Hydrological Institute

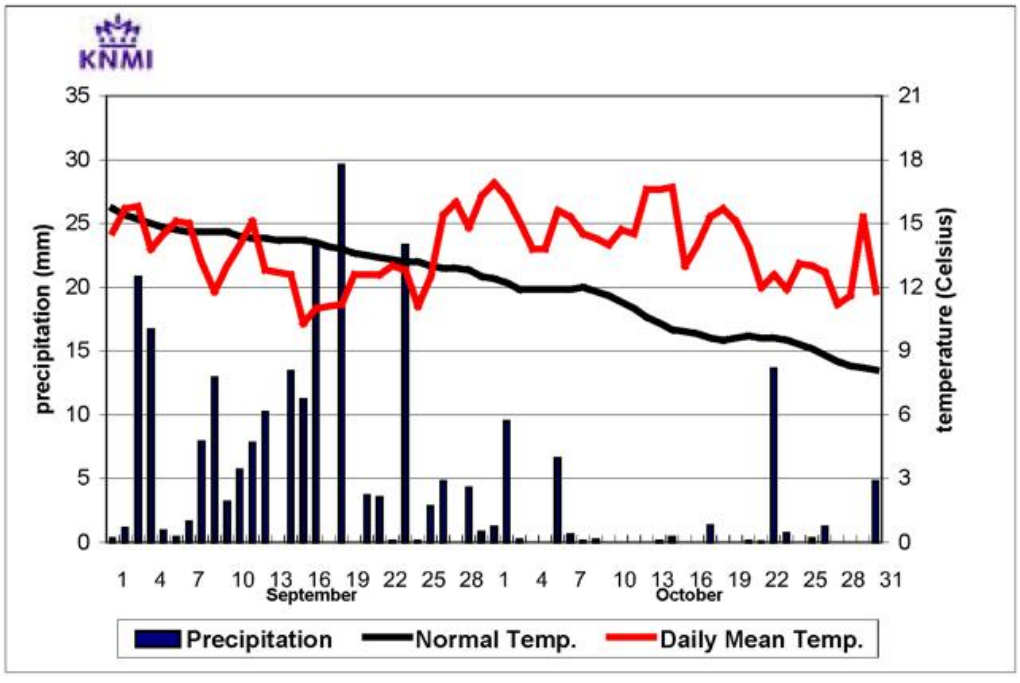
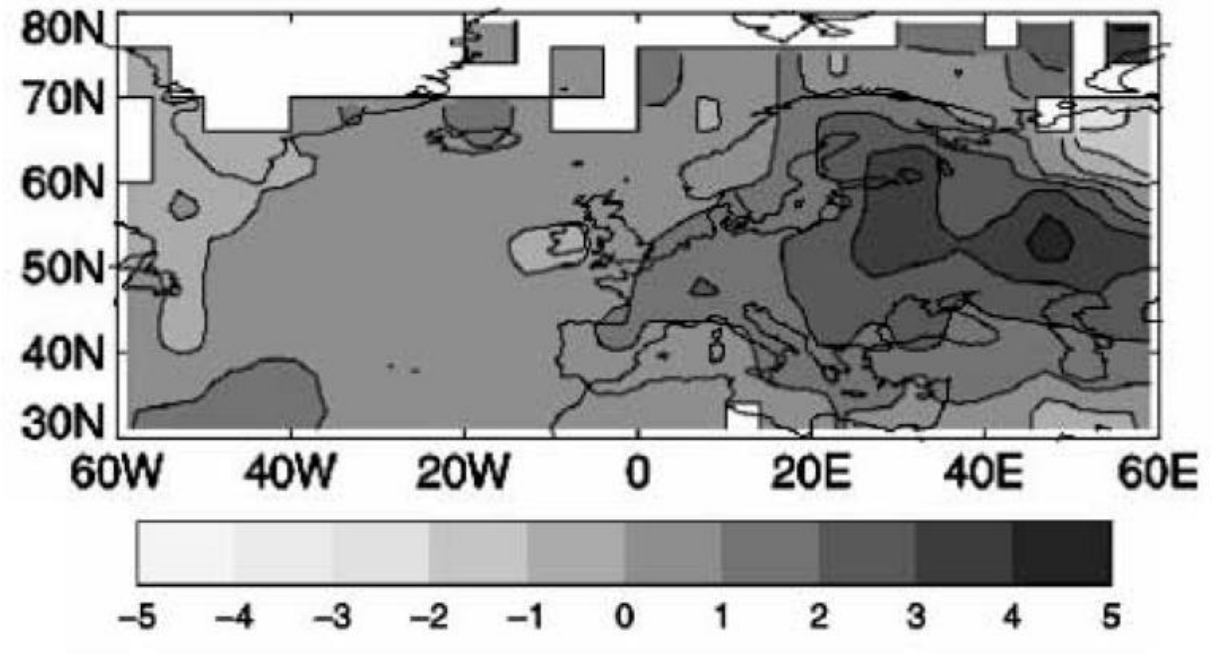


Fig 0.15: *Daily precipitation and daily mean temperature in September and October at the station De Bilt, Netherlands*
From: The Dutch Royal Meteorological Institute

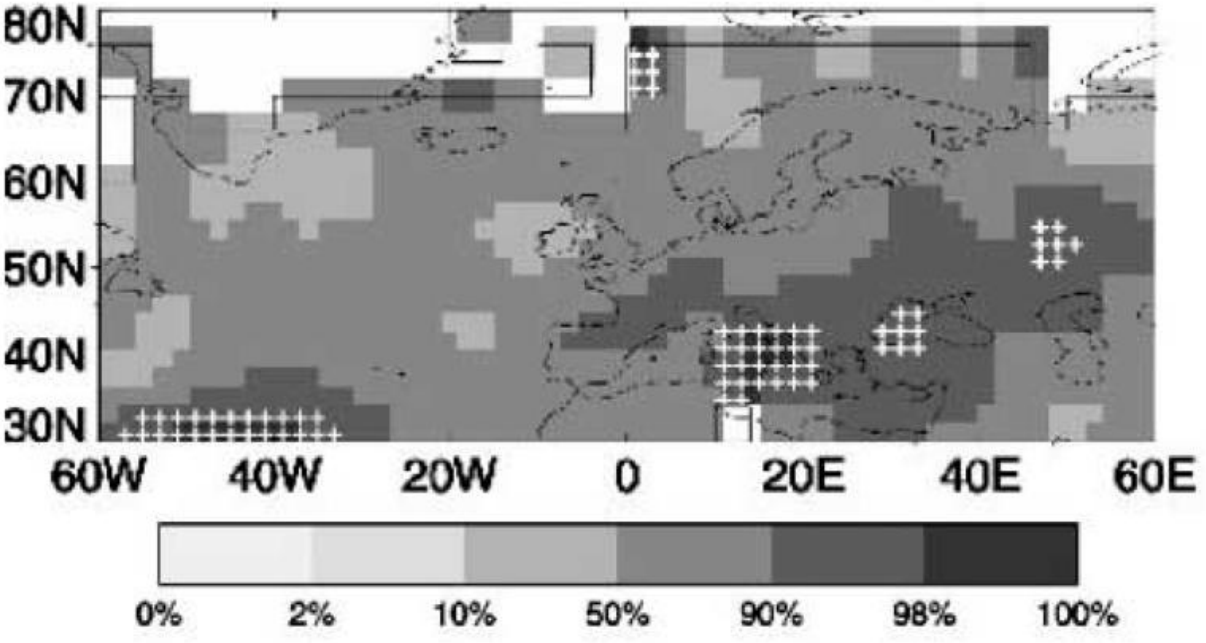
Seasonal Maps

Surface temperature anomalies: December 2000 – February 2001

From: Hadley Centre of Climate Prediction and Research, U.K.



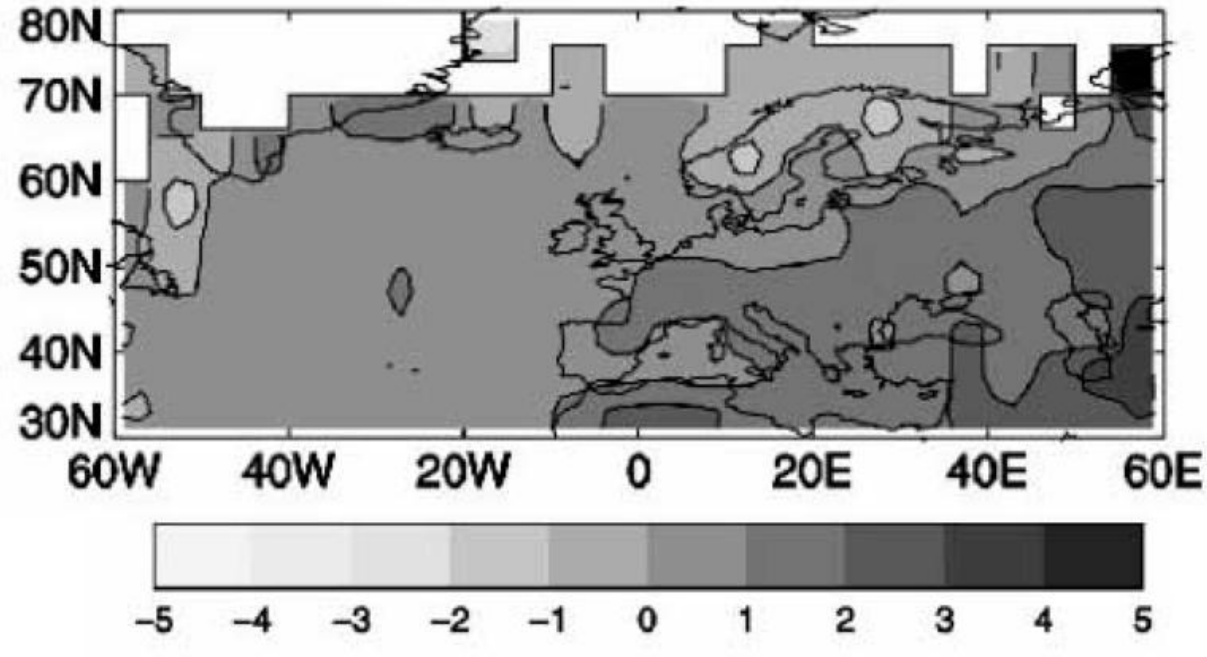
Departures from normal in °C



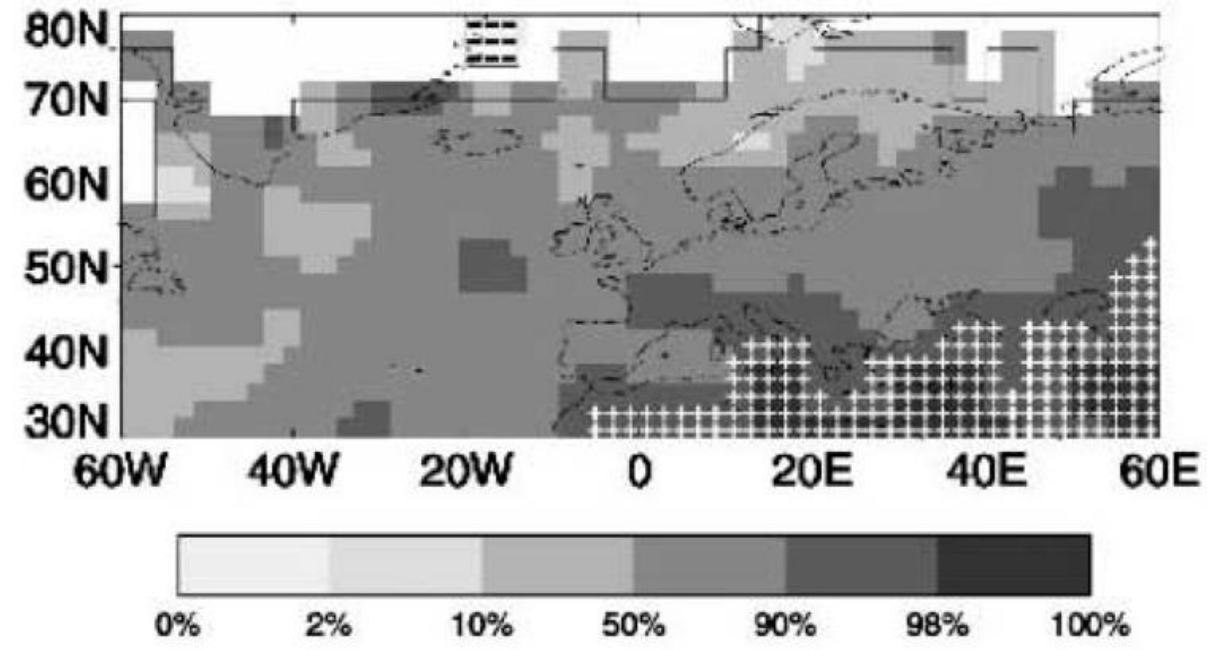
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 – 1990

Surface temperature anomalies: March 2001 – May 2001

From: Hadley Centre of Climate Prediction and Research, U.K.



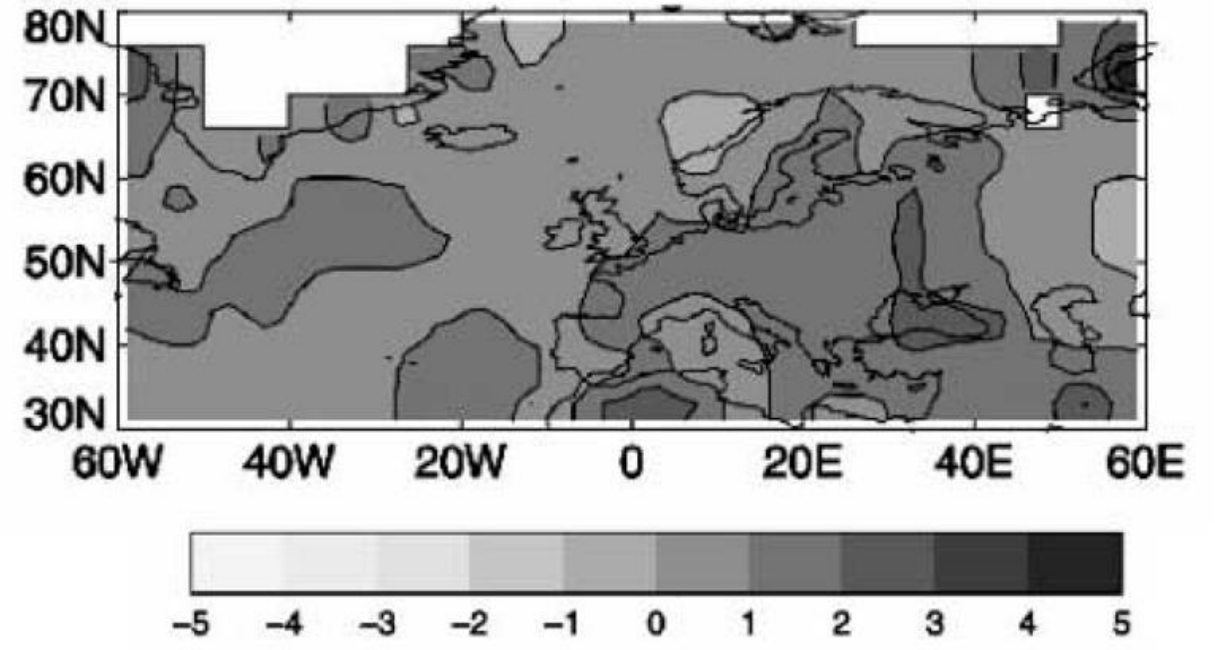
Departures from normal in °C



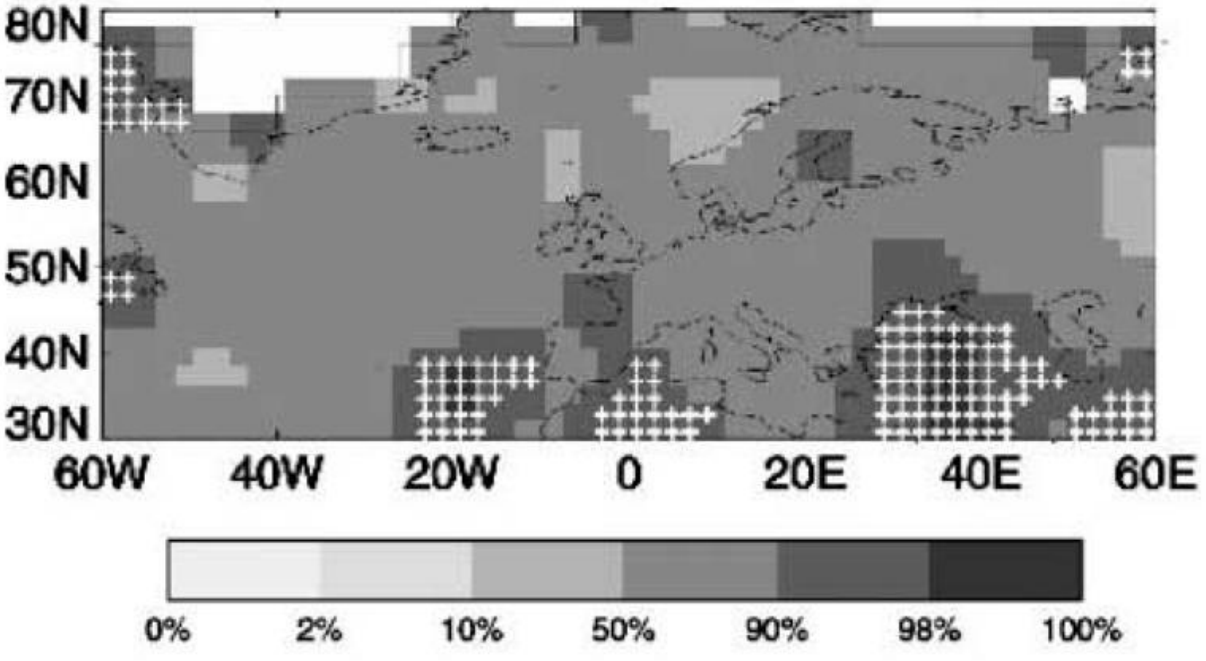
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 – 1990

Surface temperature anomalies: June 2001 – August 2001

From: Hadley Centre of Climate Prediction and Research, U.K.



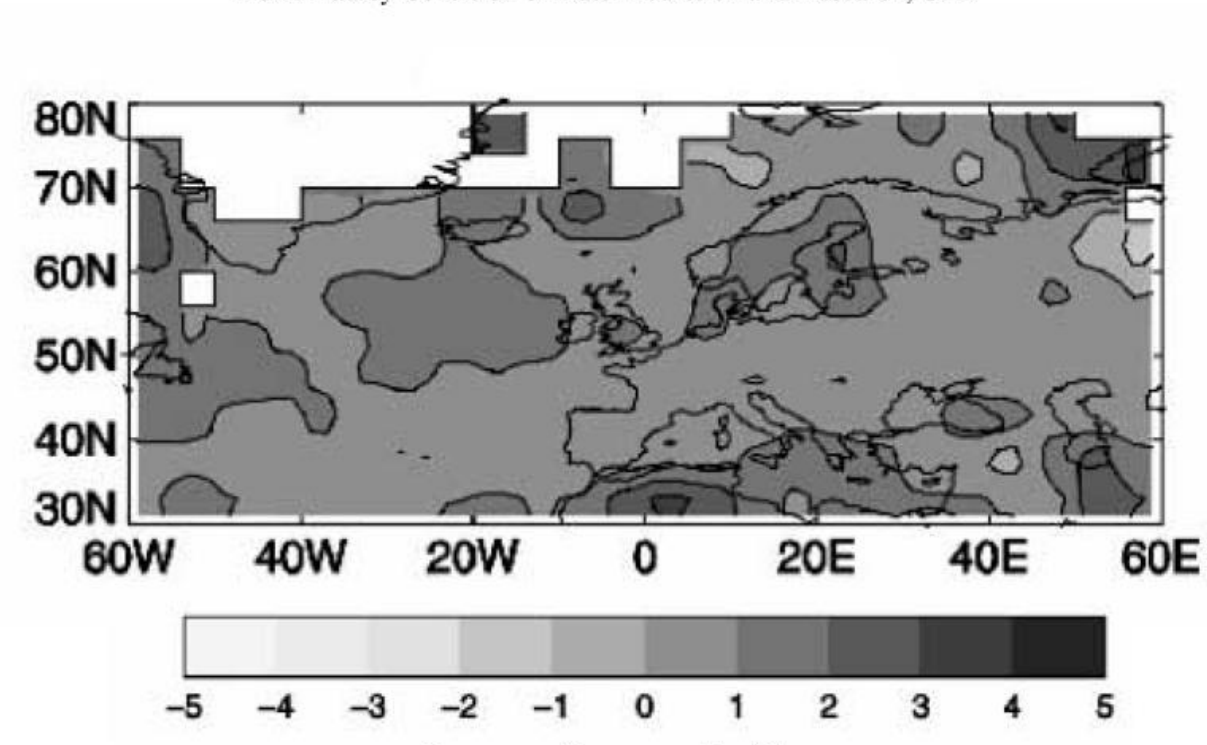
Departures from normal in °C



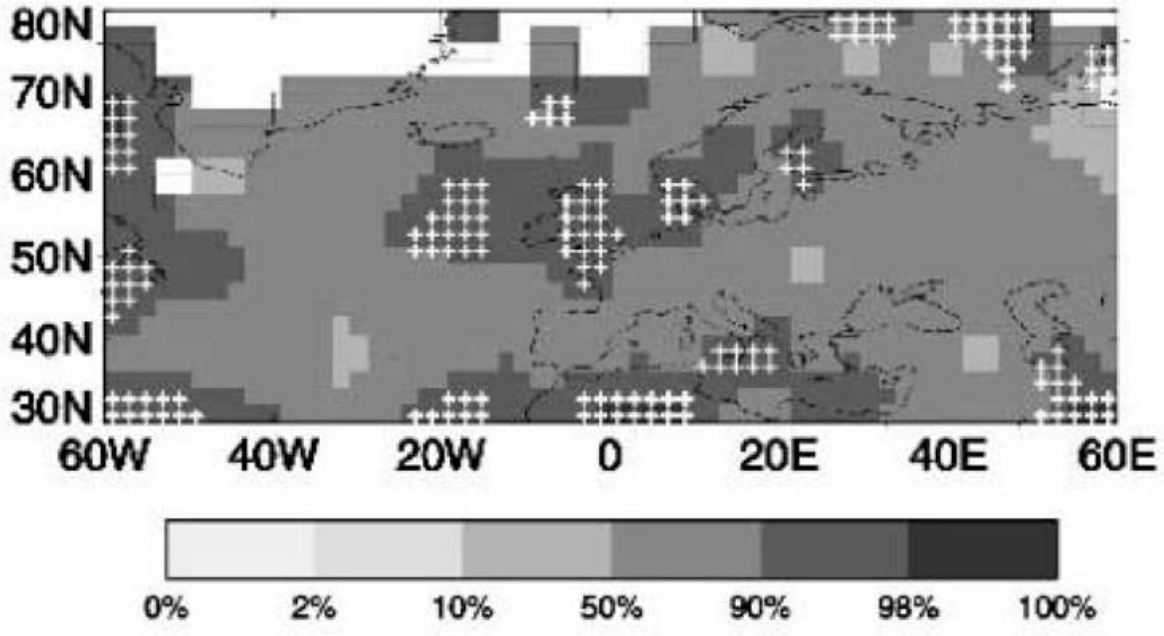
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 – 1990

Surface temperature anomalies: September 2001 – November 2001

From: Hadley Centre of Climate Prediction and Research, U.K.



Departures from normal in °C



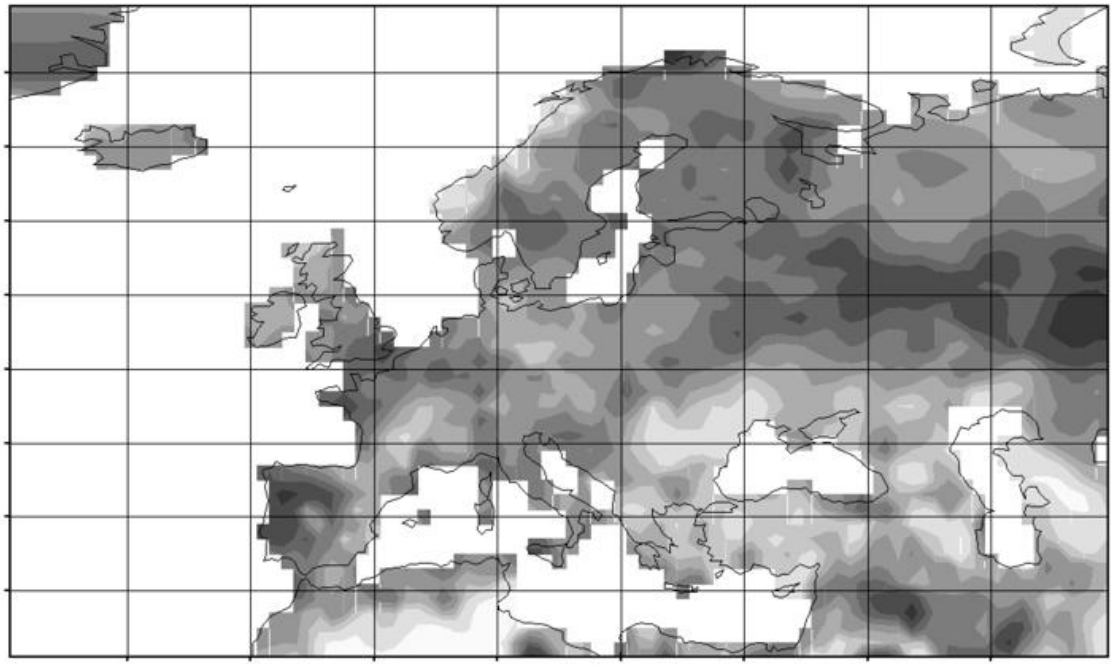
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 – 1990

Precipitation in percent of normal

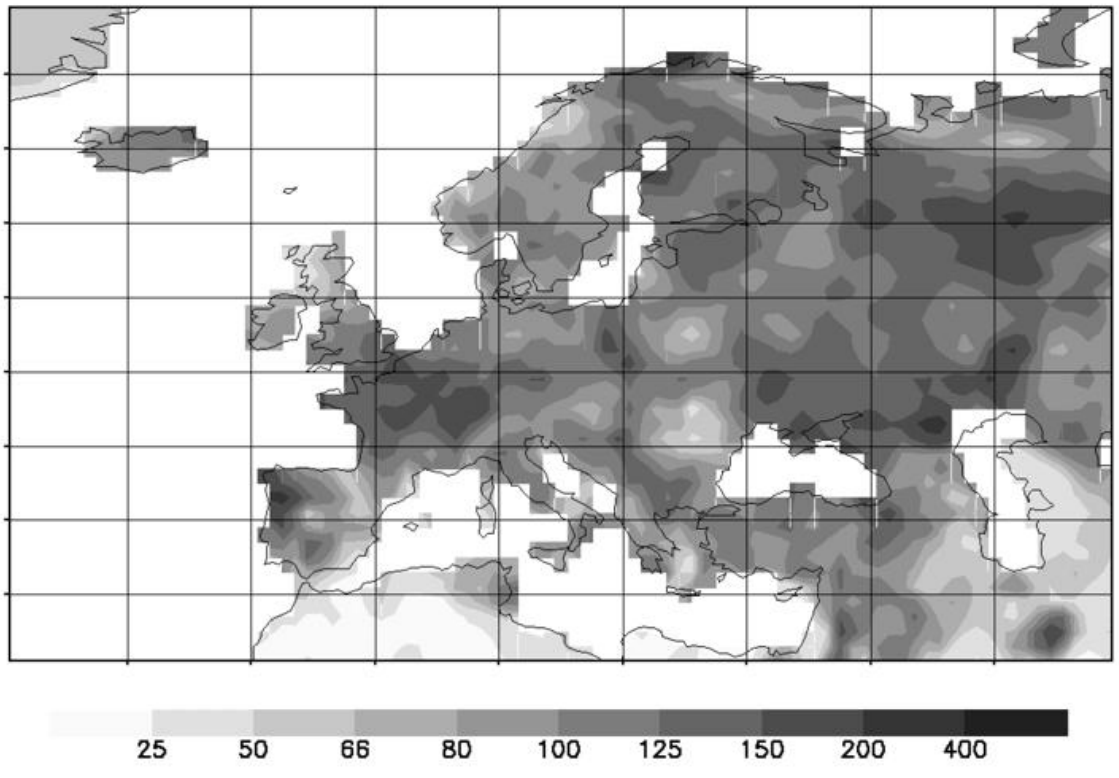
Gauge-Based Analysis 1.0 degree, reference period: 1961 – 1990

From: GPCC / Deutscher Wetterdienst, Germany

December 2000 – February 2001



March 2001 – May 2001

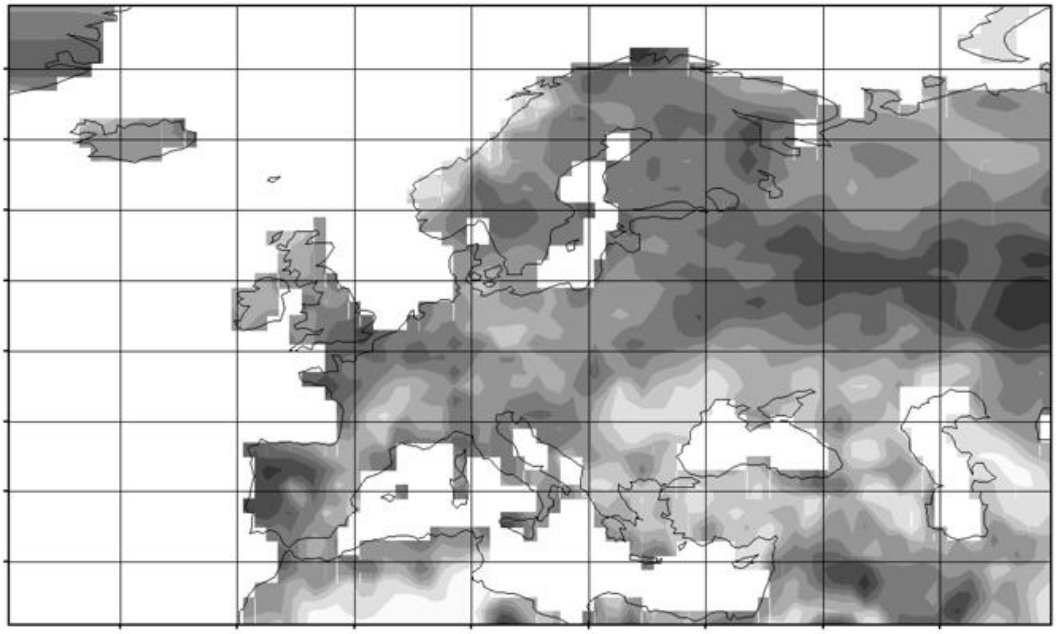


Precipitation in percent of normal

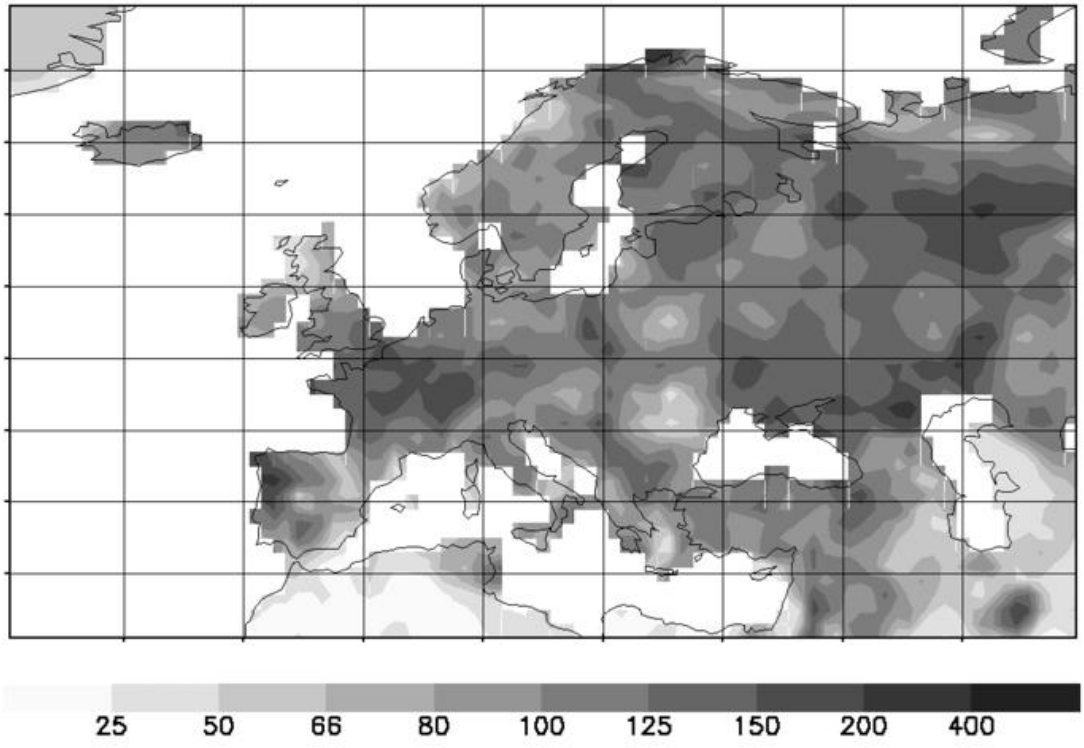
Gauge-Based Analysis 1.0 degree, reference period: 1961 – 1990

From: GPCC / Deutscher Wetterdienst, Germany

June 2001 – August 2001



September 2001 – November 2001



Monthly and Annual Tables

Temperature and precipitation values with departures from 1961-1990 means

WMO No.	Station	January 2001 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	February 2001 Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	Svalbard	-8.3	7.1	21	7	-9.2	6.5	11	-8
01025	Tromsø	-1.1	2.9	127	46	-5.4	-1.7	90	4
01492	Oslo-Blindern	-2.9	1.4	72	23	-5.3	-1.3	26	-10
02196	Haparanda	-5.6	6.5	39	-5	-12.2	-0.9	35	3
02485	Stockholm	0.1	2.9	32	-7	-3.4	-0.4	23	-4
02974	Helsinki-Vantaa	-1.9	5.0	50	9	-7.7	-0.9	49	18
03091	Aberdeen	3.1	0.2	63	-17	2.7	-0.4	83	31
03772	London-Heathrow	4.5	0.3	75	23	6.1	1.6	70	35
03967	Dublin (Casement)	4.0	-0.4	28	-38	4.4	0.0	41	-10
04030	Reykjavik	1.0	1.5	78	2	-0.2	-0.6	81	10
04320	Danmarkshaven	-21.9	1.2	14	3	-21.7	2.6	9	-2
04360	Angmagssalik	-5.6	1.9	80	-32	-7.1	0.6	163	72
06186	København-Landb.	2.1	1.6	28	-23	1.0	0.5	29	-2
06260	De Bilt	2.6	0.4	70	4	4.5	2.0	90	41
06447	Uccle	3.4	0.8	84	17	4.8	1.3	84	31
06590	Luxenbourg	1.9	1.7	118	47	3.3	1.9	73	13
06660	Zürich	1.7	1.8	99	29	3.6	2.7	53	-20
06700	Genève	3.4	2.7	146	66	4.8	2.8	44	-37
07510	Bordeaux	8.0	2.2	134	34	7.6	0.5	58	-28
07650	Marseille	9.5	2.8	55	8	8.5	0.6	35	-19
08222	Madrid	7.2	1.2	74	28	8.5	1.1	32	-14
08314	Mahon / Menorca	12.2	1.5	60	-1	11.1	0.4	103	50
08495	Gibraltar	14.0	0.6	107	-14	14.4	0.6	48	-52
08515	St. Maria / Acores	15.2	0.8	59	-41	14.6	0.6	53	-33
08535	Lisboa	12.6	1.2	193	83	13.1	0.8	76	-35
10384	Berlin-Tempelhof	1.2	1.4	37	-6	2.0	1.2	31	-3
11035	Wien-Hohe Warte	0.5	1.2	19	-19	3.1	1.8	20	-22
11518	Praha-Ruzyne	-1.7	0.7	30	7	0.9	1.7	16	-7
11903	Slica	-1.4	2.5	74	30	-0.7	0.4	27	-17
12160	Elblag	-0.2	2.2	40	-7	-0.7	1.5	41	16
12375	Warszawa-Okecie	-0.5	2.8	18	-4	-0.8	1.2	19	-2
12843	Budapest-Lorinc	0.7	2.3	90	58	3.6	2.5	11	-21
13274	Beograd	4.2	3.8	35	-14	5.4	2.7	27	-17
14015	Ljubljana	3.4	4.5	159	77	4.7	3.3	16	-64
14445	Split	9.7	2.3	208	125	9.3	1.2	25	-43
14654	Sarajevo	3.6	4.5	105	34	2.5	1.0	52	-15
15420	Bucuresti	0.6	3.0	17	-23	1.9	2.0	46	10
15614	Sofia	0.8	2.4	40	13	1.8	1.3	31	-2
16158	Pisa	8.4	2.3	61	-14	8.0	0.9	23	-50
16597	Luqa / Malta	14.3	2.1	71	-18	13.2	0.8	38	-23
16716	Athens (Hellinikon)	11.3	1.1	34	-10	11.7	1.1	33	-10
16754	Heraklion / Kreta	13.6	1.6	114	24	12.5	0.4	137	60
17040	Rize	7.9	1.6	94	-123	8.3	1.7	173	0
17062	Istanbul-Goztepe	8.6	3.0	22	-77	8.0	2.1	74	7
17130	Ankara / Central	3.0	2.9	7	-40	4.1	2.2	43	7
17170	Van	-0.6	3.6	17	-18	0.3	3.7	28	-6
17609	Larnaca	13.0	1.5	55	-10	13.4	1.7	36	-21
22113	Murmansk	-5.2	6.5	22	-11	-13	-1.8	17	-5
26038	Tallina	-0.9	4.6	48	3	-4.6	1.1	59	30
26629	Kaunas	-1.0	4.0	33	-4	-3.0	1.3	32	5
26730	Vilnius	-1.6	4.5	26	-15	-3.9	0.9	29	-9
26850	Minsk	-2.5	4.4	57	17	-4.2	1.6	35	1
27199	Wjatka (Kirov)	-7.9	6.3	57	19	-13	-1.2	50	22
27612	Moskva	-4.3	5.0	38	-7	-7.2	0.5	91	54
33345	Kiev	-1.0	4.6	33	-14	-2.5	1.7	54	8
33815	Chisinau	0.2	3.5	20	-20	0.4	2.1	26	-12
34300	Charkov (Kharkiv)	-0.8	6.1	33	-11	-3.4	2.3	45	13
34880	Astrahan'	-1.4	4.0	3	-10	-1.7	3.2	12	2
35188	Akmola	-14.1	1.7	21	4	-14.8	1.1	17	3
37789	Yerevan	-5.2	1.6	8	-27	-2.6	3.2	22	-19
40080	Damascus	6.5	0.3	4	-31	9.0	1.1	38	6
40100	Beyrouth	15.4	1.8	77	-114	15.0	1.5	209	73
40180	Tel Aviv (Airport)	13.3	1.0	119	-30	13.5	0.6	110	12
40270	Amman	9.1	0.0	35	-26	9.3	-0.7	46	-8
60030	Las Palmas / Gr. Can	19.2	1.7	0	-17	19.0	1.4	0	-22

	March 2001				April 2001				May 2001			
WMO No.	Temp mean	(°C) dep.	Prec sum	(mm) Dep.	Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	-16.6	-1.9	4	-17	12.4	-0.7	5	-7	-2.9	0.8	3	-3
01025	-4.9	-2.7	45	-19	0.4	-0.3	66	6	4.9	0.0	68	20
01492	-1.6	-1.4	6	-40	4.3	-0.3	82	40	11.9	1.1	82	30
02196	-8.3	-1.5	18	-17	0.6	1.1	78	49	6.2	0.1	41	10
02485	-0.4	-0.5	18	-8	5.9	1.3	30	0	11.3	0.6	16	-14
02974	-3.4	-0.5	24	-10	5.7	2.8	54	17	9.9	0.0	18	-17
03091	3.3	-1.3	109	48	6.5	0.1	46	-7	10.7	1.7	21	-38
03772	6.8	0.3	95	48	9.2	0.3	67	22	13.9	1.4	26	-25
03967	5.3	-0.7	49	0	7.3	-0.5	47	0	11.5	1.0	48	-10
04030	0.0	-0.5	24	-59	3.7	0.8	32	-26	6.6	0.3	87	43
04320	-25.9	-2.5	18	1	-20.4	-3.1	1	-9	-7.3	-0.7	1	-3
04360	-7.7	0.5	77	-11	-4.7	-0.6	31	-42	1.8	1.2	42	-15
06186	1.8	-0.8	11	-31	6.4	-0.2	43	1	12.8	0.8	18	-25
06260	4.9	-0.1	74	11	8.3	0.3	87	35	14.1	1.8	29	-32
06447	6.5	1.0	112	58	8.5	-0.3	134	77	15.1	2.2	30	-41
06590	5.7	1.4	138	70	6.9	-0.9	121	61	15.1	3.0	16	-61
06660	6.9	2.5	237	164	7.0	-1.0	130	36	15.5	3.2	116	12
06700	9.0	4.0	282	204	8.5	-0.2	114	49	16.3	3.4	74	0
07510	11.9	3.1	134	58	11.1	-0.2	94	22	16.7	2.1	20	-57
07650	13.3	3.1	36	-8	13.3	0.1	25	-23	18.6	1.5	83	-41
08222	12.2	2.2	72	39	13.7	1.5	21	-33	16.8	0.7	37	-4
08314	15.4	3.6	5	-44	14.4	0.7	18	-27	18.2	1.2	46	13
08495	16.9	1.9	79	4	17.8	1.6	12	-48	18.3	-0.2	18	-17
08515	15.0	0.4	165	86	16.0	0.8	13	-42	17.3	0.6	60	30
08535	14.8	1.1	154	85	15.9	0.8	12	-52	17.9	0.5	30	-9
10384	3.4	-0.8	41	4	8.5	-0.1	34	-7	15.1	1.2	42	-14
11035	7.1	1.8	51	10	9.6	-0.6	31	-19	17.2	2.4	29	-32
11518	3.7	0.7	51	23	7.2	-0.5	57	19	14.2	1.5	40	-37
11903	4.4	1.4	62	20	8.7	0.2	51	4	15.6	1.9	24	-40
12160	1.5	-0.6	54	19	8.0	1.2	64	22	12.3	-0.6	34	-7
12375	2.2	0.2	31	3	8.0	0.2	61	29	14.7	1.3	41	-18
12843	7.4	1.8	66	37	11.0	-0.1	27	-11	18.5	2.5	20	-35
13274	11.8	4.6	66	16	11.9	-0.5	158	99	18.3	1.1	47	-24
14015	8.8	3.4	200	102	10.1	0.2	89	-20	17.2	2.6	134	12
14445	13.7	3.3	111	36	13.8	-0.1	70	4	20.7	2.3	19	-37
14654	9.9	4.8	70	0	8.7	-0.7	130	56	15.5	1.4	75	-7
15420	7.0	2.2	77	39	10.0	-1.3	39	-7	15.7	-1.0	22	-48
15614	9.8	5.2	30	-8	9.5	-0.4	84	34	15.1	0.8	110	37
16158	12.8	3.3	110	34	11.5	-1.0	61	-18	17.9	1.6	40	-19
16597	16.9	3.5	36	-4	16.5	1.0	13	-10	20.6	1.5	31	24
16716	16.0	3.4	6	-35	16.4	0.3	47	22	21.4	0.8	1	-16
16754	17.0	3.6	1	-55	16.6	0.3	68	38	20.4	0.6	8	-8
17040	11.2	3.3	171	24	12.2	0.6	127	26	15.5	-0.3	127	25
17062	12.7	5.2	36	-26	13.6	1.6	53	4	16.8	0.3	31	0
17130	11.5	5.4	33	-3	12.6	1.4	27	-21	14.8	-0.7	110	55
17170	6.3	5.2	46	3	9.6	2.3	33	-21	12.5	-0.2	28	-21
17609	17.0	3.7	2	-47	18.9	1.5	17	6	22.5	1.6	4	-3
22113	-10.1	-3.3	21	1	-1.0	0.9	31	10	3.0	-0.8	14	-18
26038	-2.2	0.0	28	-1	5.9	2.5	95	59	9.6	-0.1	27	-10
26629	-0.2	0.0	51	19	8.1	2.1	32	-11	13.0	0.3	58	2
26730	-0.5	0.1	43	4	8.5	2.8	58	12	12.3	-0.2	60	-2
26850	-0.4	1.0	41	-1	9.4	3.4	61	19	12.8	-0.1	23	-39
27199	-4.0	1.1	62	33	7.9	4.7	9	-27	10.7	-0.4	127	78
27612	-2.1	0.1	48	14	11.0	5.2	29	-11	11.3	-1.6	112	54
33345	2.7	2.0	89	50	11.2	2.5	65	16	14.2	-0.9	33	-20
33815	5.9	3.0	46	11	11.2	1.0	56	14	15.4	-0.7	37	-14
34300	2.1	2.4	63	36	10.7	1.8	48	12	13.8	-1.8	28	-19
34880	5.1	3.8	12	-2	12.7	1.6	47	29	18.0	-0.3	21	-3
35188	-1.9	6.2	5	-9	7.7	2.8	17	-5	18.1	5.0	20	-13
37789	3.8	5.2	43	-9	7.1	2.2	67	-4	8.7	-0.9	73	-15
40080	15.6	4.4	3	-21	18.1	2.4	1	-12	21.4	1.0	7	2
40100	18.7	3.6	34	-86	21.0	3.2	34	-17	22.6	2.2	36	16
40180	18.4	3.5	4	-58	20.3	2.1	5	-18	22.6	1.5	7	4
40270	16.4	3.5	9	-42	17.9	0.1	10	-7	21.0	-0.9	3	0
60030	20.6	2.2	1	-10	20.0	1.3	4	-2	20.8	0.9	0	-2

WMO No.	Station	June 2001 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	July 2001 Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	Svalbard	3.4	1.2	11	1	6.4	0.4	20	7
01025	Tromsø	10.7	1.4	23	-30	10.9	-0.8	99	27
01492	Oslo-Blindern	14.6	-0.6	45	-20	17.7	1.3	81	-3
02196	Haparanda	14.4	1.6	49	8	16.4	0.9	72	22
02485	Stockholm	15.4	-0.2	32	-13	20.0	2.8	65	-7
02974	Helsinki-Vantaa	14.3	-0.6	112	68	20.5	3.9	56	-17
03091	Aberdeen	11.8	-0.3	44	-9	14.6	0.8	35	-26
03772	London-Heathrow	16.1	0.4	39	-12	19.4	1.6	35	-11
03967	Dublin (Casement)	12.9	-0.4	41	-7	15.3	0.4	54	0
04030	Reykjavik	8.8	-0.3	32	-19	10.9	0.3	80	29
04320	Danmarkshaven	1.5	0.8	3	-2	4.1	0.4	17	3
04360	Angmagssalik	4.9	0.8	65	13	6.6	0.2	14	-35
06186	København-Landb.	14.2	-1.9	45	-9	19.0	1.8	40	-29
06260	De Bilt	15.2	0.0	54	-14	18.5	1.7	87	12
06447	Uccle	15.7	0.0	45	-34	18.8	1.3	120	45
06590	Luxenbourg	14.9	-0.4	79	10	18.8	1.7	85	18
06660	Zürich	15.2	-0.3	182	55	18.7	1.0	141	23
06700	Genève	17.2	0.8	127	40	20.1	1.1	108	45
07510	Bordeaux	19.6	1.8	30	-26	20.6	0.4	75	29
07650	Marseille	22.1	1.2	1	-27	24.6	0.8	19	5
08222	Madrid	23.4	2.8	4	-23	24.2	-0.2	3	-10
08314	Mahon / Menorca	22.6	1.6	0	-15	24.9	0.6	12	7
08495	Gibraltar	22.1	1.0	1	-11	23.7	0.0	1	-1
08515	St. Maria / Acores	19.7	1.0	59	37	22.5	1.7	11	-14
08535	Lisboa	21.3	1.1	17	-4	21.4	-1.0	3	-2
10384	Berlin-Tempelhof	15.2	-2.2	66	-9	20.4	1.6	50	-2
11035	Wien-Hohe Warte	17.4	-0.6	47	-27	20.9	1.0	78	16
11518	Praha-Ruzyne	14.3	-1.6	72	-1	18.0	0.5	99	33
11903	Slica	16.4	-0.2	55	-30	20.0	1.8	136	77
12160	Elblag	14.1	-1.3	36	-58	19.8	3.0	158	64
12375	Warszawa-Okecie	15.2	-1.4	36	-36	20.7	2.8	139	72
12843	Budapest-Lorinc	18.4	-0.7	58	-5	22.0	1.1	122	70
13274	Beograd	19.0	-1.1	186	96	23.0	1.3	19	-47
14015	Ljubljana	18.3	0.5	147	-8	21.9	2.0	48	-74
14445	Split	22.6	0.4	46	-5	26.6	1.2	12	-16
14654	Sarajevo	16.6	-0.3	120	29	20.1	1.2	65	-14
15420	Bucuresti	18.6	-1.6	140	63	23.2	1.2	35	-29
15614	Sofia	17.6	-0.1	40	-32	21.9	1.9	15	-41
16158	Pisa	20.7	0.9	2	-42	23.8	1.0	27	4
16597	Luqa / Malta	23.9	0.9	1	-3	27.1	1.2	1	1
16716	Athens (Hellinikon)	26.0	0.9	1	-6	29.9	2.1	12	7
16754	Heraklion / Kreta	24.5	1.0	0	-3	27.7	2.0	0	-1
17040	Rize	20.1	0.2	136	8	25.3	3.1	93	-43
17062	Istanbul-Goztepe	21.8	0.7	5	-16	26.1	2.9	14	-5
17130	Ankara / Central	21.9	2.3	1	-37	26.3	3.4	3	-11
17170	Van	19.6	2.0	5	-16	23.1	1.2	7	3
17609	Larnaca	25.7	1.4	0	-1	27.5	0.6	0	0
22113	Murmansk	11.7	2.3	20	-33	14.5	1.7	51	-9
26038	Tallina	13.6	-0.9	109	56	20.0	3.7	86	7
26629	Kaunas	14.4	-1.6	46	-29	20.9	3.8	144	76
26730	Vilnius	14.4	-1.4	39	-38	20.9	4.0	94	16
26850	Minsk	15.4	-0.7	89	6	22.0	4.7	137	49
27199	Wjatka (Kirov)	16.0	0.4	24	-40	20.1	1.9	17	-69
27612	Moskva	16.3	-0.3	72	-4	23.0	4.9	89	-3
33345	Kiev	16.7	-1.5	152	79	24.6	5.3	6	-82
33815	Chisinau	17.9	-1.5	129	54	24.5	3.6	38	-31
34300	Charkov (Kharkiv)	16.9	-2.0	116	58	25.5	5.2	4	-56
34880	Astrahan'	21.9	-1.0	72	50	26.1	0.8	3	-20
35188	Akmola	18.4	-0.6	59	24	18.1	-3.2	69	19
37789	Yerevan	15.3	1.9	28	-43	17.7	0.6	40	-4
40080	Damascus	26.4	1.8	0	-1	28.3	1.7	1	1
40100	Beyrouth	24.3	0.7	0	-1	27.0	1.5	0	0
40180	Tel Aviv (Airport)	25.2	1.2	0	0	27.1	1.4	0	0
40270	Amman	25.2	0.2	0	0	27.0	0.6	0	0
60030	Las Palmas / Gr. Can	22.7	1.3	1	1	23.9	0.6	1	1

WMO	August 2001				September 2001				October 2001			
	Temp	(°C)	Prec	(mm)	Temp.	(°C)	Prec.	(mm)	Temp.	(°C)	Prec.	(mm)
No.	mean	dep.	sum	Dep.	mean	dep.	sum	dep.	mean	dep.	Sum	dep.
01008	6.5	1.7	16	-9	3.2	2.7	45	22	-5.2	0.3	15	0
01025	11.1	0.2	141	59	8.9	2.1	98	4	3.2	0.3	132	7
01492	15.8	0.6	93	3	11.5	0.7	67	-23	8.9	2.5	149	65
02196	13.9	0.6	39	-24	10.1	2.2	76	13	3.2	0.7	73	9
02485	17.4	1.2	87	21	12.7	1.5	108	53	10.2	2.7	77	27
02974	16.4	1.4	70	-10	12.1	2.1	99	26	8.0	2.6	76	3
03091	14.6	1.0	88	13	11.7	0.0	84	16	12.0	2.9	117	39
03772	18.9	1.5	79	28	14.5	-0.5	60	9	14.6	2.9	108	50
03967	15.2	0.6	103	25	12.9	-0.1	31	-38	12.4	2.1	82	14
04030	11.1	0.8	63	1	9.4	2.0	94	27	6.3	1.9	63	-23
04320	4.0	1.6	27	13	-1.8	2.4	9	-2	-10.9	2.7	17	5
04360	6.8	0.8	21	-40	5.0	1.9	101	33	0.5	1.3	27	-55
06186	17.8	0.8	120	57	12.9	-0.7	99	37	12.1	2.2	31	-28
06260	18.5	1.8	116	45	13.4	-0.6	211	144	14.2	3.7	41	-31
06447	19.2	1.9	43	-20	12.9	-1.6	199	140	14.4	3.5	68	-2
06590	18.9	2.2	47	-24	11.3	-2.4	113	46	12.7	3.4	53	-21
06660	19.2	2.3	112	-22	11.7	-2.4	189	95	13.3	3.8	81	9
06700	20.4	2.3	73	-8	13.1	-1.7	97	15	14.1	4.1	80	6
07510	22.1	2.2	39	-15	16.5	-1.4	51	-23	16.8	2.8	82	-6
07650	25.1	1.9	0	-29	18.7	-1.6	33	-14	19.2	3.1	37	-41
08222	25.5	1.6	2	-7	20.4	-0.1	23	-7	16.2	1.4	67	22
08314	26.1	1.6	13	-13	21.5	-0.7	68	13	21.7	3.2	47	-37
08495	25.1	0.9	1	-6	22.6	-0.2	34	19	20.1	0.6	68	4
08515	23.2	1.0	92	52	22.3	0.9	82	25	19.4	0.1	49	-35
08535	22.4	-0.4	1	-6	21.1	-0.6	61	35	18.7	0.2	151	71
10384	19.9	1.5	40	-21	13.1	-1.5	135	90	13.1	3.1	43	7
11035	21.6	2.4	44	-21	13.6	-1.8	99	54	13.2	3.1	9	-32
11518	18.5	1.5	85	15	11.8	-1.5	66	26	11.9	3.6	20	-10
11903	20.1	2.8	66	-3	12.7	-0.7	154	98	11.4	3.1	13	-37
12160	18.5	1.8	100	19	12.3	-0.4	129	59	11.0	2.1	35	-18
12375	19.3	2.0	38	-25	12.1	-1.1	73	30	10.9	2.6	37	-1
12843	22.9	2.6	31	-20	14.6	-1.8	85	45	13.9	3.0	5	-29
13274	24.0	2.7	57	5	16.2	-1.5	185	134	14.8	2.4	17	-23
14015	22.9	3.8	33	-111	13.8	-1.7	305	175	14.0	3.6	68	-47
14445	27.7	2.5	4	-46	19.0	-2.4	166	105	19.2	2.3	47	-32
14654	20.7	2.2	71	0	13.0	-2.1	231	161	12.6	2.2	37	-51
15420	23.3	2.1	27	-31	17.0	0.1	37	-5	11.8	1.0	6	-26
15614	22.3	2.9	44	-8	16.7	0.9	43	4	13.0	2.6	6	-31
16158	25.3	2.8	1	-56	17.9	-1.6	136	47	17.8	2.5	53	-67
16597	27.7	1.4	14	7	25.1	1.0	14	-26	23.3	2.6	11	-79
16716	30.0	2.4	1	-5	25.6	1.4	2	-8	21.2	1.9	1	-51
16754	27.2	1.6	0	-1	25.3	2.2	0	-18	21.3	1.6	3	-73
17040	25.6	3.4	241	58	22.1	2.7	282	61	16.3	0.9	314	42
17062	25.1	2.1	32	6	21.5	1.8	55	14	16.6	1.3	15	-56
17130	24.7	2.1	19	7	20.8	2.5	13	-6	13.2	0.6	1	-26
17170	24.0	2.8	0	-7	18.9	2.1	2	-12	11.4	1.3	56	8
17609	28.3	1.2	0	0	25.9	0.8	1	1	22.3	1.0	19	0
22113	11.2	0.2	65	0	9.0	2.3	48	-4	0.0	-1.0	61	19
26038	16.3	1.0	61	-23	12.3	1.5	67	-15	8.9	2.6	63	-7
26629	17.9	1.6	55	-8	12.2	0.1	75	16	9.0	2.1	40	-11
26730	17.9	1.6	52	-20	11.9	0.3	83	18	8.3	1.7	43	20
26850	18.2	1.7	75	3	12.1	0.4	48	-12	8.0	1.7	54	5
27199	14.2	-1.3	120	55	11.6	2.4	76	5	1.4	-0.3	81	19
27612	17.0	0.6	57	-17	12.2	1.3	38	-26	4.8	-0.2	70	12
33345	21.0	2.4	16	-53	13.8	-0.1	53	6	9.3	1.2	23	-12
33815	23.5	3.0	5	-40	16.0	-0.2	113	65	11.7	1.6	52	25
34300	21.9	2.4	31	-19	14.5	0.4	44	3	7.2	-0.1	39	4
34880	23.9	0.6	6	-13	17.9	0.6	6	-20	8.8	-0.3	10	-7.0
35188	18.0	0.3	39	-1	10.9	-1.1	15	-9	3.5	0.7	70	40
37789	18.6	1.9	33	0	14.7	1.5	5	-23	7.3	0.3	41	-9
40080	28.0	1.8	0	0	24.6	1.3	0	0	20.4	1.8	0	-12
40100	28.4	2.0	0	-1	27.2	2.0	0	-5	24.8	2.2	42	-12
40180	28.0	1.9	0	0	26.4	1.6	0	0	23.5	1.5	25	-1
40270	26.3	-0.1	0	0	23.5	-1.7	0	0	20.3	-1.5	1	-8
60030	24.8	0.7	1	1	24.5	0.7	2	-6	24.1	1.6	3	-7

WMO No.	Station	November 2001 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	December 2001 Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	Svalbard	-11.1	-0.6	18	5	-9.0	4.3	26	14
01025	Tromsø	0.0	0.8	143	44	-2.1	0.9	88	-16
01492	Oslo-Blindern	2.1	1.4	37	-38	-3.4	-0.6	33	-23
02196	Haparanda	-4.2	-0.1	65	7	-10.4	-0.9	29	-13
02485	Stockholm	3.2	0.6	30	-23	-1.2	-0.2	53	7
02974	Helsinki-Vantaa	-0.1	-0.2	56	-16	-7.1	-3.0	23	-35
03091	Aberdeen	6.7	1.5	48	-27	3.7	0.0	75	2
03772	London-Heathrow	8.1	0.9	34	-21	4.5	-0.6	18	-39
03967	Dublin (Casement)	7.9	1.2	35	-35	4.4	-0.9	22	-55
04030	Reykjavik	1.8	0.6	80	7	2.5	2.7	76	-2
04320	Danmarkshaven	-18.3	1.6	17	7	-16.5	5.3	22	9
04360	Angmagssalik	-4.2	0.5	213	117	-2.0	5.2	211	108
06186	København-Landb.	5.2	-0.3	40	-22	0.7	-1.5	34	-24
06260	De Bilt	7.1	1.2	85	4	2.9	-0.3	94	15
06447	Uccle	6.2	0.1	100	24	2.4	-1.1	70	-6
06590	Luxenbourg	4.3	0.3	77	-2	0.5	-1.3	60	-25
06660	Zürich	2.9	-1.2	99	14	-0.1	-0.8	43	-34
06700	Genève	4.3	-0.7	35	-57	1.6	-0.3	39	-48
07510	Bordeaux	7.6	-1.5	47	-47	3.9	-2.5	43	-56
07650	Marseille	9.3	-1.4	25	-33	4.2	-3.1	1	-55
08222	Madrid	8.1	-1.3	12	-52	2.3	-3.5	18	-31
08314	Mahon / Menorca	13.9	-0.5	251	174	10.3	-1.5	19	-61
08495	Gibraltar	15.4	-0.7	55	-86	14.6	0.5	306	160
08515	St. Maria / Acores	17.0	-0.4	6	96	15.8	0.4	230	135
08535	Lisboa	13.4	-1.1	8	-106	10.2	-1.6	42	-66
10384	Berlin-Tempelhof	4.5	-0.4	48	-1	0.1	-1.3	48	-5
11035	Wien-Hohe Warte	4.1	-0.7	56	6	-1.6	-2.6	54	10
11518	Praha-Ruzyne	2.4	-0.4	30	-2	-2.1	-1.5	32	6
11903	Slica	1.6	-1.4	50	-19	-7.3	-5.6	52	-5
12160	Elblag	3.3	0.0	68	12	-2.6	-2.9	82	30
12375	Warszawa-Okecie	2.4	-0.8	34	-8	-4.2	-3.3	19	-13
12843	Budapest-Lorinc	3.3	-1.5	30	-22	-4.3	-4.7	15	-25
13274	Beograd	4.7	-2.3	63	9	-1.9	-4.2	29	-29
14015	Ljubljana	3.6	-1.0	82	-53	-2.1	-2.1	49	-52
14445	Split	11.3	-0.9	308	200	5.6	-3.1	27	-73
14654	Sarajevo	2.9	-1.9	154	63	-3.1	-2.9	45	-19
15420	Bucuresti	3.3	-1.9	25	-24	-4.0	-4.2	21	-22
15614	Sofia	4.0	-1.0	25	-22	-5.2	-5.7	50	11
16158	Pisa	10.3	-0.1	110	-14	5.6	-1.2	61	-24
16597	Luqa / Malta	18.0	1.0	39	-41	12.8	-1.2	72	-37
16716	Athens (Hellinikon)	14.7	-0.8	159	109	8.8	-3.4	135	64
16754	Heraklion / Kreta	16.6	0.0	91	32	12.2	-1.6	228	154
17040	Rize	11.9	0.3	508	258	8.9	0.6	344	102
17062	Istanbul-Goztepe	8.2	-0.9	150	61	5.0	-3.1	250	128
17130	Ankara / Central	10.9	-0.7	65	32	2.5	-0.1	117	68
17170	Van	6.9	-0.2	83	41	1.2	2.1	51	18
17609	Larnaca	3.9	-0.1	26	-18	13.8	0.6	154	78
22113	Murmansk	17.4	1.0	23	-17	-9.0	0.3	50	12
26038	Tallina	-5.5	-0.4	87	19	-6.4	-3.5	34	-21
26629	Kaunas	1.1	-0.1	74	21	-5.5	-3.1	31	-13
26730	Vilnius	2.3	0.2	64	7	-7.3	-4.4	35	-20
26850	Minsk	1.2	0.0	55	3	-8.4	-4.6	37	-16
27199	Wjatka (Kirov)	1.1	0.3	69	17	-14.1	-3.8	45	0
27612	Moskva	-3.9	0.8	66	8	-10.6	-4.5	52	0
33345	Kiev	-0.5	0.6	70	19	-7.3	-5.0	39	-13
33815	Chisinau	2.3	0.2	78	39	-5.6	-5.3	18	-20
34300	Charkov (Kharkiv)	3.1	-1.3	58	14	-8.5	-5.1	30	-15
34880	Astrahan'	2.1	0.8	32	13	-3.7	-1.8	43	28
35188	Akmola	5.7	2.4	28	6	-12.4	0.2	10	-7
37789	Yerevan	-2.0	3.9	30	-11	-2.9	1.3	34	-4
40080	Damascus	11.7	-0.6	2	-25	8.7	1.1	9	-37
40100	Beyrouth	19.8	1.1	115	11	16.4	1.6	245	71
40180	Tel Aviv (Airport)	18.8	0.8	69	1	14.6	0.8	184	46
40270	Amman	13.8	-1.9	35	10	10.1	-0.6	64	13
60030	Las Palmas / Gr. Can	21.0	0.6	94	73	20.3	2.0	33	12

Year 2001

WMO No.	Station	Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-4.6	1.8	195	12
01025	Tromsø	3.1	0.3	1120	152
01492	Oslo-Blindern	6.1	0.4	773	4
02196	Haparanda	2.0	0.9	614	62
02485	Stockholm	7.6	1.0	571	32
02974	Helsinki-Vantaa	5.6	1.1	687	36
03091	Aberdeen	8.5	0.5	813	25
03772	London-Heathrow	11.4	0.8	706	107
03967	Dublin (Casement)	9.5	0.2	581	-154
04030	Reykjavik	5.2	0.8	790	-10
04320	Danmarkshaven	-11.3	1.0	155	23
04360	Angmagssalik	-0.5	1.2	1045	113
06186	København-Landb.	8.8	0.2	538	-98
06260	De Bilt	10.4	1.0	1038	234
06447	Uccle	10.7	0.8	1089	289
06590	Luxenbourg	9.5	0.9	980	132
06660	Zürich	9.6	1.0	1482	361
06700	Genève	11.1	1.5	1219	275
07510	Bordeaux	13.5	0.8	807	-115
07650	Marseille	15.5	0.8	350	-277
08222	Madrid	14.9	0.6	365	-92
08314	Mahon / Menorca	17.7	1.0	642	59
08495	Gibraltar	18.8	0.6	730	-48
08515	St. Maria / Acores	18.2	0.7	879	296
08535	Lisboa	16.9	0.1	748	-6
10384	Berlin-Tempelhof	9.7	0.3	615	33
11035	Wien-Hohe Warte	10.6	0.6	537	-76
11518	Praha-Ruzyne	8.3	0.4	598	72
11903	Slica	8.5	0.5	764	78
12160	Elblag	8.1	0.5	841	151
12375	Warszawa-Okecie	8.3	0.5	546	27
12843	Budapest-Lorinc	11.0	0.6	560	42
13274	Beograd	12.6	0.8	889	205
14015	Ljubljana	11.4	1.6	1330	-63
14445	Split	16.6	0.8	1043	218
14654	Sarajevo	10.3	0.8	1155	237
15420	Bucuresti	10.7	0.1	492	-103
15614	Sofia	10.6	0.9	518	-45
16158	Pisa	15.0	1.0	685	-219
16597	Luqa / Malta	20.0	1.3	341	-209
16716	Athens (Hellinikon)	19.4	0.9	432	61
16754	Heraklion / Kreta	19.6	1.1	650	149
17040	Rize	15.4	1.5	2610	438
17062	Istanbul-Goztepe	15.3	1.4	737	40
17130	Ankara / Central	13.9	1.8	439	25
17170	Van	11.1	2.2	356	-28
17609	Larnaca	19.4	1.3	314	-15
22113	Murmansk	2.4	0.7	423	-55
26038	Tallina	5.6	1.0	764	97
26629	Kaunas	7.2	0.9	671	63
26730	Vilnius	6.9	0.8	626	-27
26850	Minsk	7.0	1.1	712	35
27199	Wjatka (Kirov)	3.7	0.8	737	112
27612	Moskva	5.6	1.0	762	74
33345	Kiev	8.5	1.1	633	-16
33815	Chisinau	10.3	0.9	618	71
34300	Charkov (Kharkiv)	8.6	0.9	539	20
34880	Astrahan'	10.8	1.0	267	54
35188	Akmola	4.8	1.3	370	52
37789	Yerevan	6.7	1.9	424	-168
40080	Damascus	18.2	1.5	65	-130
40100	Beyrouth	21.7	2.0	792	-96
40180	Tel Aviv (Airport)	21.0	1.5	523	-44
40270	Amman	18.3	-0.3	203	-68
60030	Las Palmas / Gr. Can	21.7	1.3	140	23

Monthly Surveys

January 2001

- **Extremely mild in the East, additionally dry in the Southeast**
- **Catastrophic floods in Brittany and northern Portugal**
- **Sunny and cold in the British Isles**

Temperature anomalies were positive in northern and central Europe by +1...+3°C and increasing significantly eastwards. As an example, the monthly mean temperature anomalies at the station Ljubljana, Slovenia, show, that January was the month with the highest positive deviation from normal by +4.5°C throughout the year (see fig. 1.1). In the Volga region, Russian Federation, the monthly mean temperature exceeded the normal value extraordinarily by +8.6° C.

During the second pentade of the month, a south westerly airflow transported warm and dry air from Africa to south-eastern Europe. As a consequence, record-breaking maximum temperatures were observed in several places: in Greece, on January 6-7 by 18-19°C; at the station Kiskunmajca, Hungary, by 17.6°C on January 7; one day later at Loznica, Yugoslavia, by 21.6°C.

In the Southeast, the relatively high temperatures were combined with deficits of precipitation, especially in Turkey, Cyprus, parts of Israel, and the Caucasus region, where the percentages of normal precipitation ranged from 60% down to 30%.

In contrast to this, some western parts of Europe received unusually high amounts of precipitation. In north-western France, continuous heavy rainfall during the first 5 days of the year (especially 50-90 mm on January 3-4) on already saturated soil caused flooding with catastrophic damage in the southern basins of Brittany.

In the northern part of Portugal rainfall rates near to 300% of normal occurred (see fig. 1.2). In Coimbra, Viana do Castelo and Vila Real, the actual monthly precipitation sums exceeded the previous maxima of cumulated amounts for the 5-month period of September to January, which were 1040 mm, 1511 mm and 1163 mm respectively. Due to these extraordinary precipitation amounts, the dams reached their maximum storage capacities. Their discharges led to floods in north and central areas, causing submerged roads, insulated villages and evacuation of people, landslides and closure of some railways.

Ireland and the U.K. had sunny and cold weather. In England and Wales, it was the sunniest January since 1959; but despite of the sun, January was also the coldest in four years.

In southern Sweden, heavy snowfall on January 2 caused problems to power lines. As a consequence, 80,000 families stayed up to one week without electricity supply. Also in Estonia, wet snow wrecked power lines and caused damage to forests. Although Germany had a small deficit of precipitation and a temperature anomaly of slightly above +1°C, there were a lot of events with heavy snowfall and freezing rain during the month and located all over the country, leading to mass accidents on motorways.

From January 14-16 heavy rains and thunderstorms affected the central and southern parts of Greece, leading to floods in Attiki and the north eastern Peloponnisos with significant destruction. Due to bad weather conditions, a first aid helicopter crashed over the South Agean with the loss of 5 people.

In Kazakhstan, snow depths in the western Altai mountains exceeded normal by 2-3 times, giving cause to frequent avalanches and consequently to the blocking of railways and a 1500 km stretch of the main road.

In Tajikistan, temperatures fell below -50°C in some places, at Bulunkul station down to –56°C.

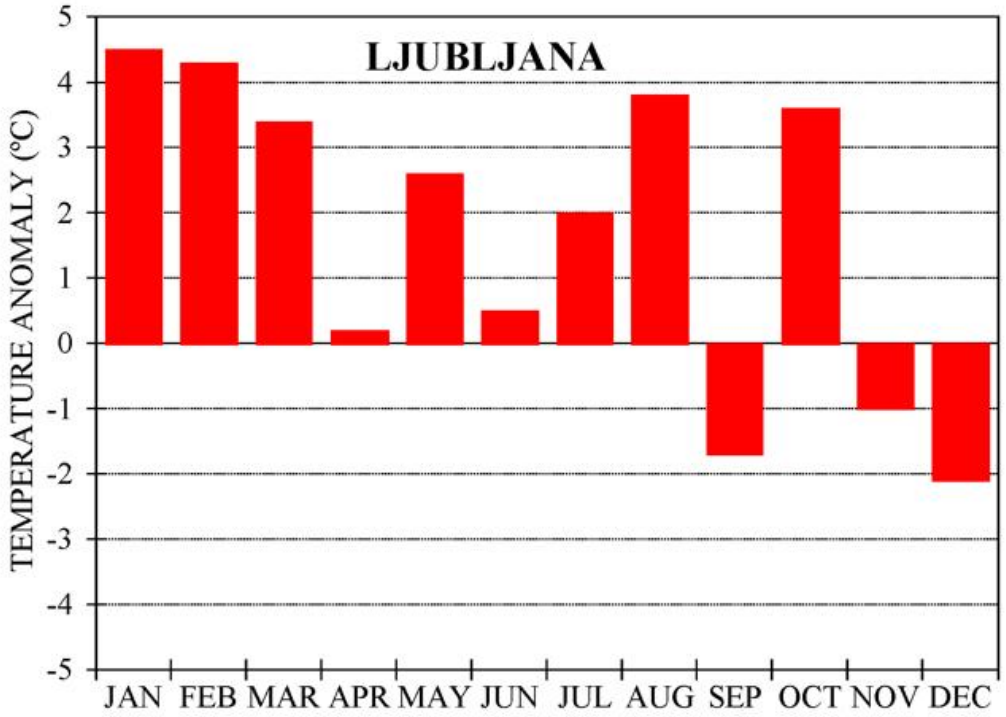


Fig. 1.1: *Monthly temperature deviations from normal 1961 – 1990 at station Ljubljana in 2001*
From: Environmental Agency of the Republic of Slovenia

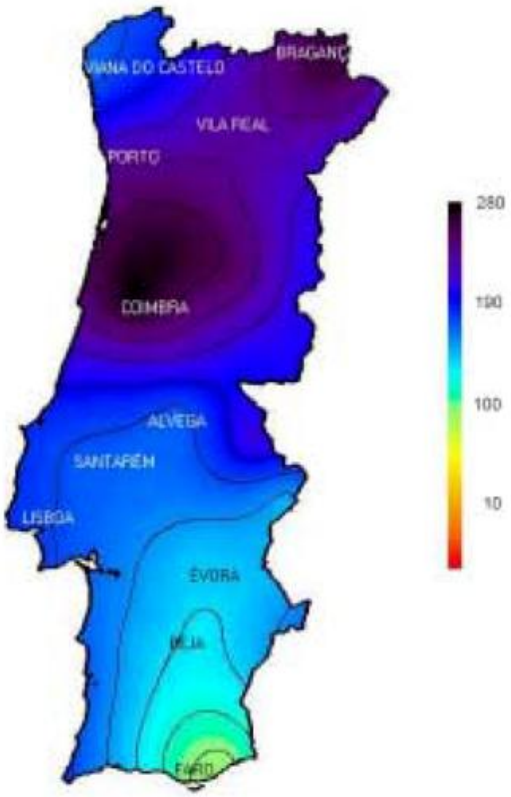


Fig. 1.2:

Precipitation rate for January in % referred to 1961 – 1990 in Portugal
From: Instituto de Meteorologia, Portugal

February 2001

- **Warmer than normal in central, eastern, and south-eastern Europe**
- **Very wet in some parts of western Europe**
- **Very dry on the Balkans and in the Caucasus**

Temperature anomalies in central Europe were above +1°C and up to more than +2°C in the northern Balkan region. In the Caucasus area, positive temperature deviations from normal were up to +4°C.

Precipitation amounts in central Europe were near to normal except for Belgium, where the station Uccle received 158% of the average in 1961-1990.

Heavy snow and widespread floods affected the U.K. in the first week of the month. Snow and ice closed areas of north-eastern England and Scotland, while at the same time parts of southern England were under water. In Kent, more rain fell in one day than normally would fall in a month.

In Portugal some daily maximum records of precipitation were broken (with 71 mm in Porto, 70 mm in Évora and 50 mm in Beja).

On February 21, heavy snowfall, thunderstorms, and icing led to severe calamities on roads in many districts of the Czech Rebublic. On the same day in Austria, gusts up to 100 km/h caused damage of greenhouses, roofs, and trees in the area of Vienna; additionally, traffic was blocked on highways by a lot of accidents.

At station Freiburg, a maximum temperature of +19.5°C was measured on February 6, the highest temperature in Germany for the first decade of the month since more than 100 years.

In France, heavy snowfall in the Southeast led to the closing of roads and motorways. Damage to power lines and trees occurred due to the weight of the snow.

A spell of warm air occurred in Hungary in the second pentade of the month. The country-wide average temperature was +15.5°C on February 9. On the same day, the maximum temperature at the station Baja was +18.6°C.

In the Netherlands, the month was very wet by 168% of the normal rainfall. The first decade of the month was the second wettest on row since 1901 with 70 mm. On February 1, heavy snowfall and icing disrupted public life in the northern half of the country.

At station Svenningdal, Norway, the largest precipitation amount of the country for 24h was observed by 144.5 mm.

In the Russian Federation avalanches blocked transport on the main Transcaucasian routes and broke power lines.

A cold episode early in the month brought a new February record to the province Dalarne, Sweden, with –44°C.

In Switzerland, the weather was very mild in the lowlands during an episode of several days at the beginning of the month; Vaduz/Liechtenstein had an extraordinarily high mean daily temperature of +16.4°C on February 7.

In Turkey, whirlwinds, frosts, and storms caused damage to agricultural areas; telephone and power lines. In Izmir, the seaport was closed on February 26 because of bad weather conditions.

March 2001

- **Extremely warm in the Alps, around the Mediterranean, and in the Middle East**
- **Cold in Scandinavia**
- **Very wet from the South-West over central to eastern Europe**

In Cyprus, it was the warmest and driest March in the last 100 years. The temperature anomaly was +4.4°C combined with a precipitation rate of 14% from normal.

Exceptionally heavy rainfall in France engendered flooding in Franche-Comté, Paris, Lyon, and the whole centre of the country.

In Luxembourg, the highest monthly precipitation amount since 1947 was recorded with 138 mm.

At the end of the month, very cold air came into Germany, producing a snow cover of 25 cm in the North. In Berlin, the coldest March 25 since 1919 was observed by a maximum temperature of –0.1°C.

In Greece, unusually high temperatures were recorded, exceeding normal by +6°C up to +15°C. Daily maximum temperatures varied from 28°C to 35°C within the period March 22-27.

Extreme floods were triggered by intensive precipitation in north-east Hungary from March 3-5. The highest amount of a 3-day accumulation was recorded at the station Tiszabes with 80.2 mm, which has a 20 years' return period.

In Ireland, the highest gust of the year was observed with 122 km/h at station Malin Head on March 6.

Israel experienced the hottest March since the beginning of measurements 40-50 years ago (see fig. 3.1). Several hot and dry spells (called sharav) throughout the month led to temperatures above 30°C. A significant sharav event occurred in the end of the month with temperatures up to 38°C in the Coastal Plain and the northern Negev.

Also in Jordan very warm air invaded the country at the end of the month and caused maximum temperatures exceeding the normal of the daily maximum by +6.3...+13.8°C.

In the first half of the month, frequent fog obstructed aviation in Lithuania. The station at airport Vilnius recorded visibility below 100 m for 15 hours on March 11, delaying all flights. Temperature in Lithuania had an abnormal course during the month. Up to March 20 it was rather mild. In the last decade of the month, temperatures fell to -1.5...-5.5°C below normal and were lower than in the first half of January.

In Belgium (see fig. 5.1) and in the Netherlands, March was rather dull. The station De Bilt received only 55% of the normal sunshine, which is the 4th lowest record since 1901.

At station Sihcajavri in Norway, the lowest monthly mean temperature (except for mountain stations) was measured with -17.0°C, which is –5.7°C below normal.

Heavy snowfall in northern Poland caused much trouble to transport. In the Russian Federation, heavy snowfall on March 16 interrupted transport and damaged power lines in the Moscow area.

In the high mountains of Slovenia, an abundant snow cover had accumulated at the end of the month, combined with country-wide relatively high temperatures and a sunshine deficit. On Kredarica (2514 m), a snow cover of nearly 6 m was observed, the highest ever recorded in March.

South-westerly winds prevailed during the month over the Iberian Peninsula. The result was an extremely warm month in most parts of continental Spain, especially in the East. Historical records for mean monthly values were beaten at many observatories.The greatest anomalies are to be found in the Levante with values around +3ºC. The prevailing winds of Atlantic origin were responsible not only for high temperatures but also for intense precipitation. In almost all Galicia and the Duero Basin new records were registered of monthly precipitation sums. In La Coruña, the monthly total of 262 mm exceeded the previous record over a 124-year long series. In sharp contrast to this, the month was very dry in the Southeast and the Balearic Islands.

In Portugal, daily maximum precipitation amounts were exceeded in some places in the North, e.g. in Porto with 108 mm. Monthly maximum precipitation records were exceeded in places distributed all over the country, e.g. with 629 mm in Viano do Castelo, 327 mm in Bragança, 432 mm in Vila Real, 570 mm in Porto, 177 mm in Alvega and

110 mm in Faro. The fall of a bridge crossing the Douro River, due to the increase of river flow and eventually to the local extraction of sand, caused 59 deaths. The material losses to the whole country were estimated to € 500 million.

In Switzerland, March was extremely mild, wet and dull. Temperature anomalies were up to +4°C. Highest rainfall rates reached 400% of normal and there were up to 26 days with precipitation of at least 1 mm, the maximum number recorded since the beginning of observations in 1864. The snow depth on Bernina pass (2256 m asl) was highest with 641 cm on March 14. It was the most alarming avalanche situation since winter 1950/51. Water levels in rivers and lakes were extremely high, but no major flooding occurred. Sunshine duration was unusually low with 40% to 60% of the average. At the mountain station Säntis, it was the March with the lowest rate of sunshine since records started in 1901.

Hail and heavy rainfall caused large damage to agriculture, roads, and houses on March 8 in the Sanliurfa district, Turkey; 3 people died.

A drought situation affected The Former Yugoslav Republic of Macedonia, caused by decreasing precipitation rates since the beginning of the year (see fig. 3.2) and accompanied by extraordinarily positive temperature anomalies (see fig. 3.3).

During March 3-5, intense rainfall in western Ukraine led to catastrophic floods on the rivers of Zakarpattya in the Carpathian Mountains.

In the U.K., March was rather cold and accompanied by blizzards, high winds and a snow cover of up to 25 cm in Scotland, England and Wales.

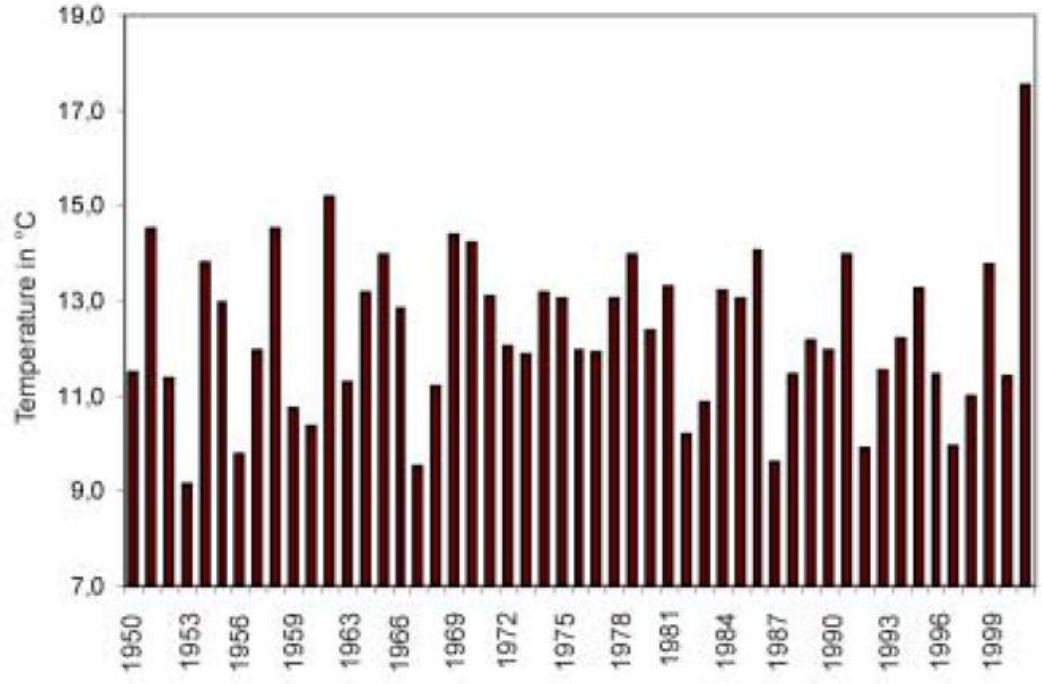


Fig. 3.1: *Mean daily temperature in March, Jerusalem 1950 – 2000*
From: Israel Meteorological Service

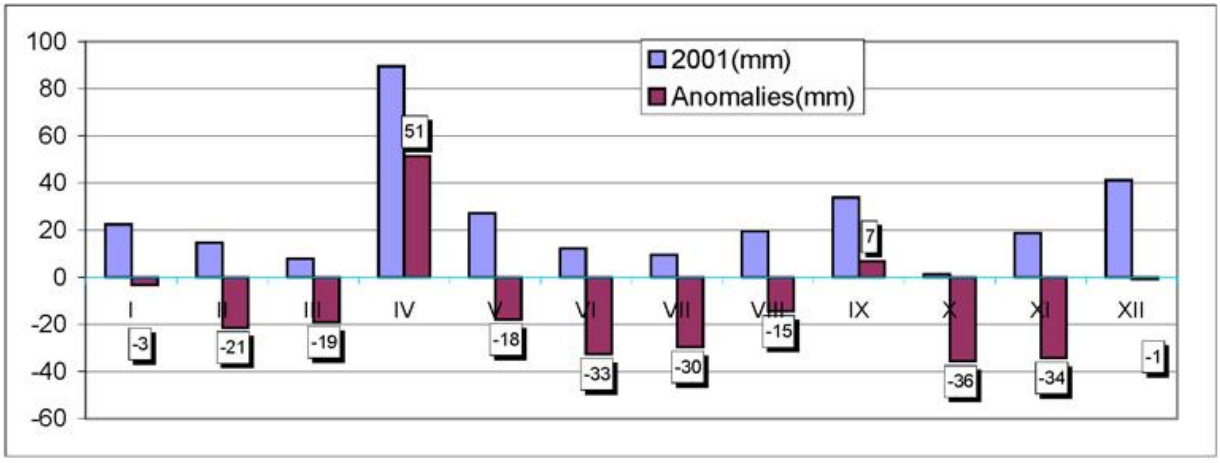


Fig. 3.2: *Monthly precipitation totals and anomalies in SkopjeZajev Rid, in 2001, reference period: 1961 – 1990*
From: Hydrometeorological Institute of Republic Macedonia

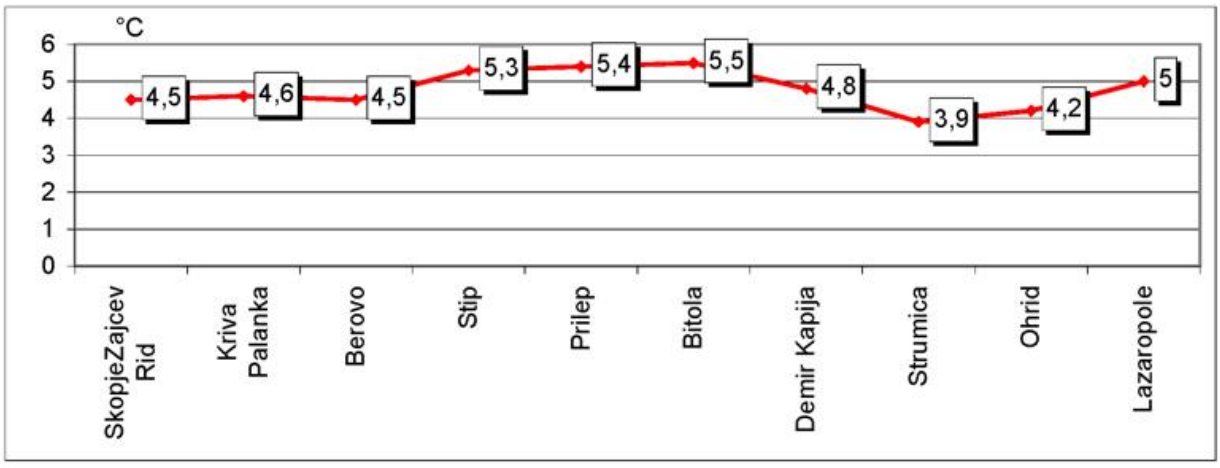


Fig. 3.3: *Monthly temperature anomalies in March 2001, Macedonia, reference period is March 1961 – 1990*
From: Hydrometeorological Institute of Republic Macedonia

April 2001

- **Very wet in a broad strip from the British Isles and northern France over central Europe to the Baltic States, Belarus and parts of the Ukraine as well as on the Balkans**
- **Return of wintry weather in the second decade of the month in central and eastern Europe**
- **Dry on the Iberian Peninsula and in the Caucasus**
- **Very warm in eastern Europe and the Middle East**

At station Uccle, Belgium, a precipitation amount of 134.2 mm was measured, which is 253% of normal and thus as absolute record since observations started in 1833.

A long lasting rainy period in northern France, starting from October 2000 (see fig. 4.1) led to disastrous floods in Brittany and the Somme area. In Lille, the monthly precipitation amount was 112.2 mm and thereby the highest ever recorded in April.

From April 13 to 15, snow and ice lead to chaos on motorways all over Germany. It was the coldest Easter time since more than 20 years. On April 20-21, fresh fallen snow covered S-Germany up to more than 50 cm and increased the avalanche danger in the Alps.

In Hungary, the month started with temperatures around normal. From April 13 on, a very cold period brought enormous damage to flowering fruits and trees.

After a start with warm weather, Latvia was hit by snowstorms from the middle of the month on. After a 24h lasting snowfall, Riga had a fresh snow cover of 20-24 cm accompanied by frost down to –6°C; such an increment of fresh fallen snow has never been observed before in Riga in April. Traffic was paralysed by long lasting snowfalls, -storms and –drifts.

In Lithuania, temperatures in the first decade of the month were above normal up to +5°C. In the second decade, it became cool with temperatures below the average by –1...-2°C. Snowfall led to a snow cover up to 16 cm. During the third decade, mean daily temperatures rose significantly above normal by +3...+5.5°C.

The characteristic climatic feature of the month in Poland was an overall abundant precipitation rate of nearly 150%, compared to normal. Station Kielce received even 400%.

In Portugal, maximum temperatures at the end of the month were +12°C above the normal maximum temperatures. The return period of this event is estimated to more than 500 years.

Cyprus was hit by tornadoes, partly connected with hailstorms, before and at the end of a hazy period in the second half of the month.

In Israel, several sharav events occurred in the second half of the month, leading to sandstorms with severe haze in a warm and dry atmosphere. In the coastal area and northern Negev, maximum temperatures up to 39°C were observed at the end of the month.

A heat wave affected Georgia in the second decade of the month. Daily maximum temperatures up to 40°C were measured.

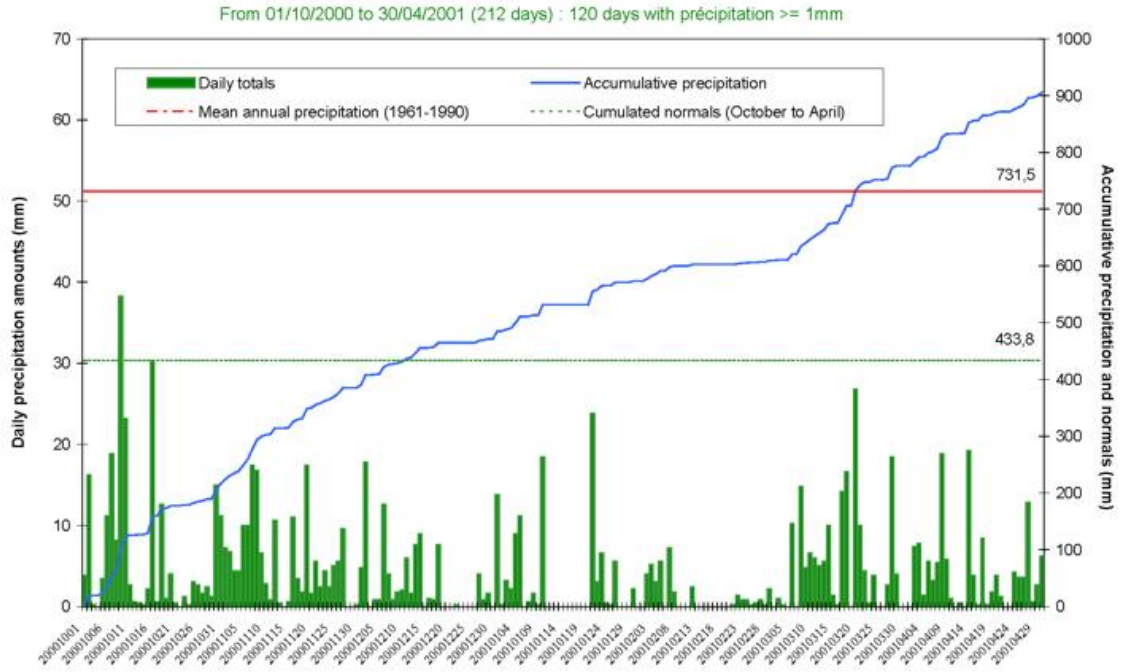


Fig. 4.1: *Daily and accumulated precipitation from October 2000 to April 2001 in Abberville, northern France*
From: Metéo France

May 2001

- **Much warmer than normal except in eastern Europe and the Middle East**
- **Very dry except in France and some parts of the Middle East**

Switzerland experienced the warmest May since 1868. The monthly mean temperature was above normal by +2.5...+4°C.

In the U.K., the month had a very warm start in Southampton (27.3°C).

In the Netherlands, the month was very sunny. Station De Bilt received 277 hours of sunshine, which is 136% of the normal value. This corresponds to the measurements at station Uccle in the neighbour country Belgium, where 130% of the average sunshine duration was observed (see fig. 5.1).

In Lithuania, the month started warm and dry. On May 1, maximum temperatures were up to 27°C. In the second half of the month, daily maxima of temperature fell below 10°C locally, and there were 17 nights with morning frost and minimum temperatures down to −6°C.

New records of the month were set in northern and southern Portugal for daily maximum temperatures by 35.6°C in Viana do Castelo and 37,0°C in Beja.

At the end of the month in Greece, maximum temperatures were up to 37°C and thus +5..+6°C above the long term average maxima of May.

In Slovakia, only 10 mm of precipitation fell during the month. So, it was the third driest May since 1901.

In Italy, especially in the northern and central parts, a long lasting period of very dry weather started in May.

France again suffered from continuous rainfall over several days causing floods in the Paris area and in the Atlantic Pyrenees.

On May 2-3, thunderstorms with hailstones of diameters up to 2 cm affected northern and western Germany. Precipitation amounts up to 110 mm caused floods and the interruption of transportation lines. On May 31, a tornado over Saxony damaged 26 houses and some forest areas, causing the material losses of several million Euro.

On May 8, hailstorms and heavy rains caused local flooding of houses and the destruction of dams in the Czech Republic; 62 mm of rain were measured on that occasion. On the last day of the month, a tornado was observed during the passage of a cold front, damaging houses and woods.

On May 29, a tornado over southern Poland damaged about 140 buildings in Morawczyna.

In the first half of the month, Cyprus was affected by severe hailstorms and heavy rains, leading to floods.

On May 2 in Israel, an unusually heavy rainfall occurred at station Jerusalem. 70 mm of precipitation fell within 4 hours (see fig. 5.2) and caused the flooding of 200 homes. This rainfall intensity was the highest since the beginning of measurements in 1950.

In Turkey, several hail events affected crops in different parts of the country.

On May 28, strong winds with gusts up to 122 km/h broke communication and power lines in Armenia.

In the second half of the month, numerous frosts ruined a lot of agricultural crops in Belarus.

Throughout 24 days of the month, intense frosts in the air and at the soil surface damaged agricultural crops in the Russian Federation. On May 14, torrential rains and hailstones of diameters up to 4 cm caused the damage of about 4500 homes and the death of 34 people in Stavropolsky Kray on the northern slope of the Caucasus mountains.

On May 7-8, landslides and mudflow interrupted traffic on roads and motorways in Kazakhstan.

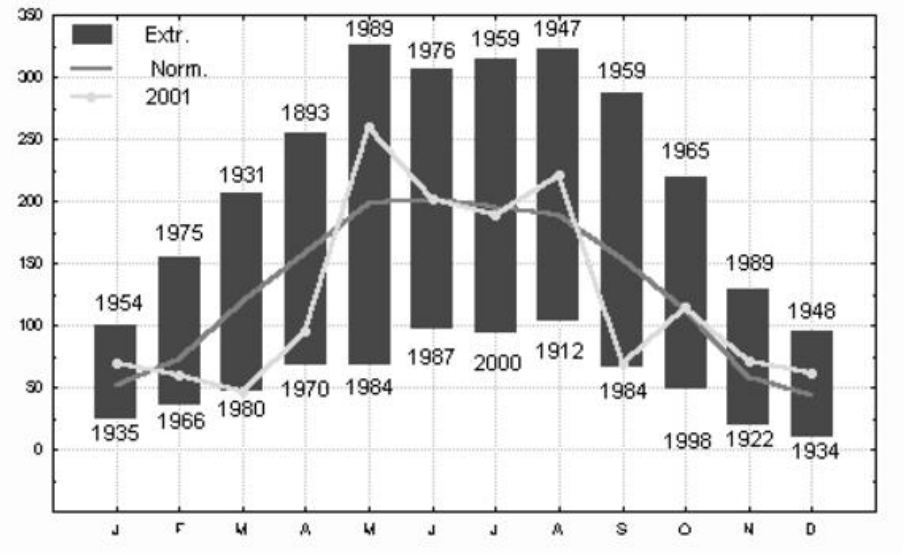


Fig. 5.1: *Monthly Sunshine duration at station Uccle (hours)*
From: Royal Meteorological Institute, Belgium

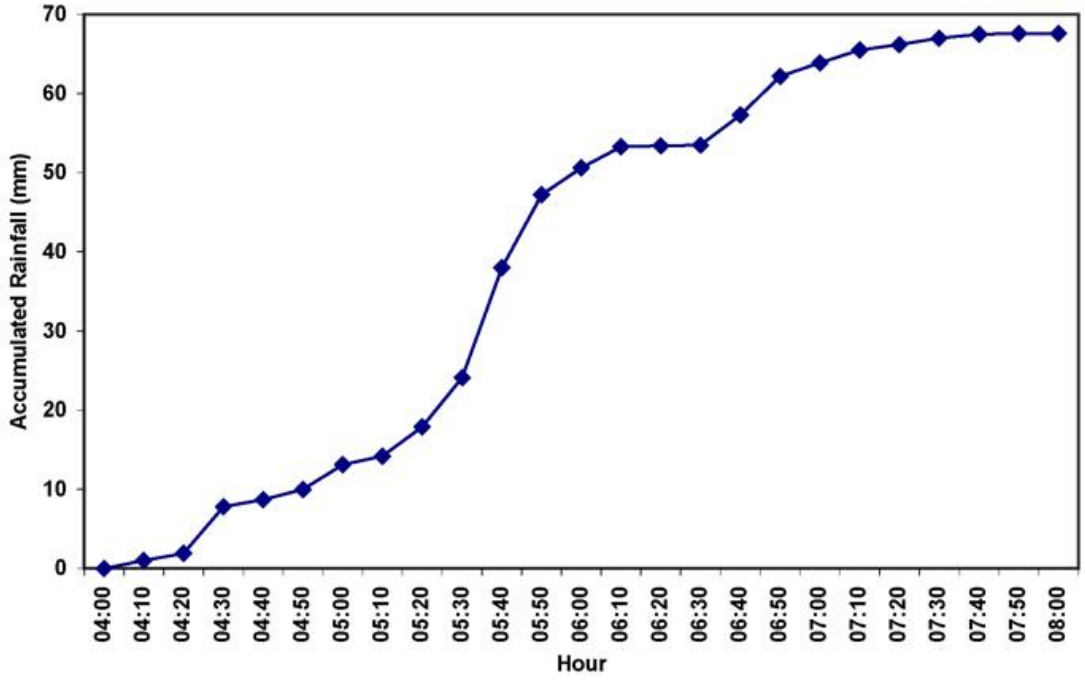


Fig. 5.2: *Accumulated rainfall in Jerusalem on May 2nd, 2001*
From: Israel Meteorological Service

June 2001

- **Cool in Central and East Europe**
- **Wet in some eastern European countries**
- **Very warm and extremely dry in southern Europe and the Middle East**

In Iceland, the month started with snowstorms over the northern lowlands. In the U.K. also, it was chilly during the first days of the month: on June 9, a minimum temperature of –1.8°C was recorded from Redhill station. Later on, it became very warm: the absolute maximum temperature of the year was observed on June 26 in Barbourne with 32.6°C.

The North of France suffered again from heavy rainstorms causing floods. In the north-eastern part of the Netherlands heavy showers accumulating to 60 mm of rainfall on June 15.

Gusts up to Beaufort 8 on Lake Constance (Austria, Switzerland, Germany) capsized several boats during a yacht race on June 15. Two ships were lost and 10 people injured.

On June 8-10, precipitation amounts of up to 230 mm were measured on the southern slopes of the Swiss Alps. This corresponds to a local percentage between 100 and 150 of the normal monthly precipitation.

A heat wave struck the Iberian Peninsula from June 22-24. Maximum temperatures were above 40°C (see fig. 6.1) and temperature anomalies up to +4°C in the central and south-eastern parts of Spain. The mainland of Greece was affected by a heat wave during the period of June 10-13: maximum temperatures reached values up to 39°C. Cyprus recorded a heat wave from June 12-15.

Germany experienced 2 major episodes of heavy rains, strong winds and thunderstorms: the first one from June 15-17 with flooding of houses, uprooting of trees, lightning damage to communication lines and traffic lights in the North. The second one from June 27-30 was even worse and affected areas all over the country; e.g. the airport of Stuttgart received 100 mm rainfall in 2 days leading to

flooding of buildings, streets and subways; in Castrop-Rauxel 42,8 mm precipitation fell within 1 hour including hailstones of a size up to tennis balls, which caused catastrophic damage to public and private property and injured a lot of people.

A violent thunderstorm with cloudbursts in Czerwinsk on June 28, was the most remarkable extreme weather event of the month in Poland. Hungary had a chilly June.

In Estonia, power lines and forests were damaged by thunderstorms and tornadoes. Latvia received abundant rainfall in the third decade of the month. On June 23, new daily precipitation records were set up in the East and the South of the country by rainfall amounts up to 72 mm. Wind induced surges and heavy rain made water levels of rivers rise up to 3 m and led to flooding of some localities for 10 days.

June was the coolest summer month in Lithuania with soil surface temperatures down to –5°C on the first two days and morning frost reaching –1°C in some places until the middle of the month. There were only 6 days without rain. On June 18, station Širvintos recorded 63 mm rainfall in 3 hours. On June 22-23, intense rainfall at stations Nida and Vėžaičiai amounted to more than the monthly normal precipitation. River levels rose enormously and caused the flooding of houses, streets and crop fields.

The month was also very rainy in the Ukraine, especially in the northern parts; up to 235 mm and 4 times the average precipitation were observed. On June 11-12, whirlwinds of destructive force caused catastrophic damage with the loss of human lives in the western and central parts of the country. On June 20-22, intense rainfall in Prykarrpattya caused landslides and the interruption of communication and power lines.

Moldova was affected by heavy rainstorms in the period from June 4-6. Precipitation amounts accumulated locally to 173 mm, which is twice the normal monthly precipitation. On June 5, an absolute record of 147 mm was measured; it exceeds the previously observed daily maximum by 30 mm in a 110 years' series. Agricultural lands were flooded and many buildings destroyed. The material losses are estimated to 1.5 Mill. Euro.

In the Russian Federation, torrential rains poured down on June 21-22 in Krasnodarsky Kray and in Karachevo-Cherkesiya. The rain was mixed with hail up to 30 mm in diameter, accompanied by strong squally winds and caused floods on the mountain rivers of the northern Caucasus with damage to economic facilities, homes, and more than 20,000 ha of agricultural crops.

In Tajikistan, the weather was hazy throughout the month. Maximum temperatures exceeded 40°C in Dushanbe and reached 47°C in the Isanbaya region. At Khumraga station, a maximum wind speed of 122 km/h was observed.

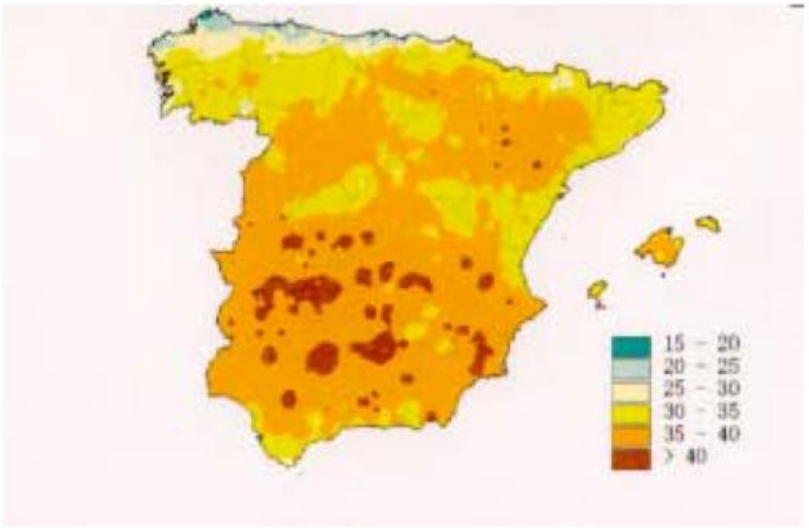


Fig. 6.1: *Maximum Temperatures (°C) in Spain from June 22-24, 2001*
From: Instituto Nacional de Meteorologia Spain

July 2001

- **Very warm in Central Europe and the Middle East, hot in eastern Europe**
- **Rainy in several eastern and some western European countries**
- **Extreme number of thunderstorms in Poland and the Baltic States**
- **Drought in the Mediterranean and in south-eastern Europe**

The month was very warm in southern Norway. The absolute maximum temperature of the year was 31.5°C, measured at Nesbyen station on July 5. The highest monthly mean temperature was observed at the Ferder Lighthouse by 17.8°C, which is +1.3°C above the long term average.

In Denmark, July was the sunniest month of the year; the spatial averaged sunshine duration was 309 hours. In Iceland, unlike in other parts of the Region, the month was rather cool with many afternoon showers.

Thunderstorms and Tornadoes in Estonia damaged houses and 7,000 ha of forests, 2 people were killed. Station Tartu recorded a mean monthly temperature of +4.1°C above normal, which is the third highest value since 1866.

In Latvia, it was the second warmest July since 1914. Subtropical air masses caused the rise of daily maximum temperatures above 30°C for 7 consecutive days. The sun duration was about 100 hours above normal. During the hot weather, the water temperature in rivers rose up to 27°C, exceeding the long term averages by up to +5°C. Thunderstorm events occurred more than twice as normal. On July 1, a thunderstorm accompanied by a spout caused the damage of hundreds of trees, a lot of cars, power lines and obstruction on roads in Riga; one woman was killed. On July 16, another thunderstorm combined with a whirlwind devastated forests in a 20 km long and 5 km wide zone.

In Lithuania, the mean monthly temperature was +4°C above the average. On July 16, the mean daily temperature was 28°C. This value was exceeded only twice in July during the last 50 years. The month was also very wet. There were 24 days with thunderstorms at various places and locally intensive downpour of rain, e.g. station Buivydžiai received 56 mm in 2 hours on July 9, and at Jovana hydrological station 55 mm were measured in 1 hour on July 26.

In Poland, the month was very warm and rainy. The country-wide monthly mean temperature was +2.5°C above normal. On July 9, a downpour of exceptional intensity combined with thunderstorms caused a local splash flood in Gdansk with disastrous consequences to the city. High rainfall rates were observed also in other places, e.g. a daily total of 127.7 mm at Rebiechowo airport. From July 15-17, severe thunderstorms with hail and intense downpours affected many areas all over the country. In Upper Silesia, a thunderstorm with rotor wall was observed on July 16; gusts exceeded 130 km/h and caused large damage to forests near Katowice. During this thunderstorm rapid and frequent pressure variations were measured. In the last decade, more extremely intense rainfall events were observed throughout the country; the most remarkable was on July 25, when station Makow Podhalanski received 190.8 mm within 4 hours.

At many stations in Ireland, the heaviest daily precipitation rates of the year were measured. Johnstown Castle in county Wexford recorded 84,5 mm rain on July 13-14, including a 2-hour fall of 65 mm. July 28 was the hottest day for most stations, e.g. Dublin airport recorded 26.9°C. In the U.K. localised flooding occurred in Nottingham as a consequence of 95 mm rainfall within 15 hours.

Exceptional rainstorms affected France in different areas. Frequent floods occurred in many watersheds, and again in the Somme area. Strong winds associated to a squall line caused 14 casualties to people attending a side-show in Strasbourg, due to tree fall.

In the Netherlands, severe thunderstorms with hail caused extensive damage in South Holland on July 5. On the Frisian island of Terschelling, a downpour of 70 mm rain in 2 hours caused local looding on July 19. Tilburg in the South of the country recorded 69 mm preciptation from heavy showers on July 23.

In southern Germany, heavy rains and storms with gusts up to 130 km/h hit the Black Forest on July 6; a lot of people were injured and 6 died from falling trees. Cars, railways and power lines were broken. Locally, 90 mm

rain fell within 4 hours leading to floods on roads and the interruption of transportation. On July 31, a tornado over Saxony cut thousands of trees, removed roofs from houses and hurt dozens of people.

On July 7, a cold front passage with gusts up to 120 km/h caused heavy damage to forest areas in Austria on a line from Salzburg to Vienna, 12 persons were injured from broken trees. On the lakes of the region, some sailing ships overturned, 1 man was killed.

Slovakia experienced the third rainiest July since 1871. Extreme precipitation totals were recorded from the Tatras region: 582 mm at station Zuberec, 521 mm in Javorina. The highest daily precipitation amount was 142 mm, measured at station Hronec on July 16, including a downpour of 40 mm in 45 minutes within the hour starting at 10 pm. Hundreds of villages were hit by floods, the total amount of material losses is estimated up to 50 Million Euro.

In Belarus, the monthly mean temperature was 22.1°C and thus +5°C above normal (see fig. 7.1). This is the highest value since the beginning of observations 120 years ago.

The Ukraine suffered from an intense drought. In Moldova also, the month was hot and dry. The monthly mean temperatures were up to +4°C above long term averages and the precipitation rate was only 20% of normal.

In the Russian Federation, torrential rain with hail and strong squally winds affected the city of St. Petersburg on July 16-17. On July 24, a thunderstorm with intense rainfall up to 50 mm in 2 hours, hail and strong winds damaged power lines and thousands of trees in Moscow. During a hot weather situation on July 21, photochemical smog formed in Moscow with extremely high values of surface ozone concentration in the afternoon. In the more southern areas like the Volga region and the northern Caucasus, it was not only hot but also very dry with the consequence of a high risk of fire.

In Turkey, the monthly mean temperature surpassed the averages by +3°C. The highest temperature was measured in Cizre by 46.7°C on July 25.

Cyprus experienced a heat wave.

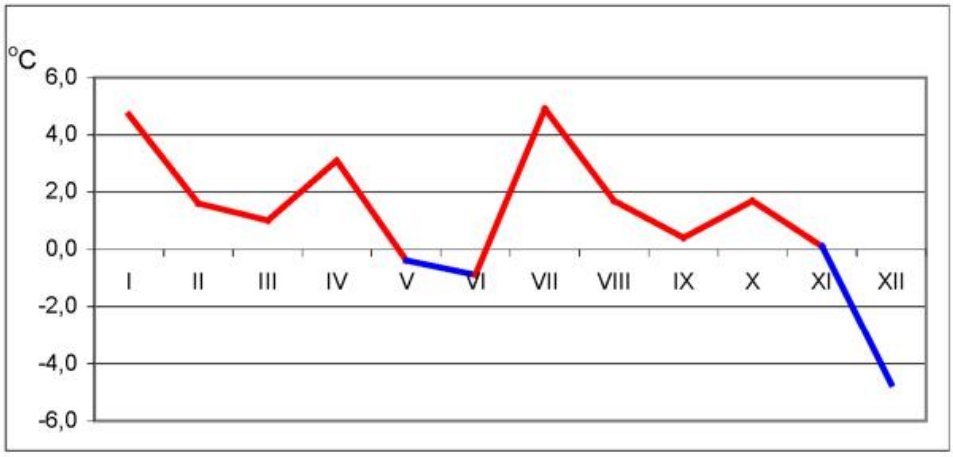


Fig. 7.1: *Deviation of monthly mean temperatures in Belarus from the norm 1961 – 1990*
From: Hydrometeorological Centre of the Republic of Belarus

August 2001

- **Warmer than normal nearly all over the Region, very warm in Central Europe and South East Europe**
- **Wet in the Netherlands, the British Isles, Scandinavia except the Northeast, and Turkey**
- **Dry in the Alpine region, extremely dry around the Mediterranean and north of the Black Sea**

In the Netherlands, the highest temperature of the year was recorded on August 26 in Maastricht with 34.2 °C. The period August 22-26 was marked by a heat wave with temperatures of 25°C or more and three days with maxima ≥30° C. The month was very wet:: Averaged over the country, 108 mm of precipitation was observed compared to 62 mm normally. Hoek van Holland recorded 216 mm. On 5 days at least 50 mm of rain was recorded at one of the Dutch stations. On August 5, 86 mm fell at Honselerdijk in the western part of the country. On August 2, severe gusts caused damage to trees in the province of Limburg. A tornado caused extensive damage to buildings, trees and crops on August 7 near the city of Nijmegen.

In contrast to the nothern neighbouring country, Belgium experienced a very dry August (see table on page 23).

A emarkable rain event in the U.K. was the fall of 56 mm within 12 hours in Northolt.

In Ireland, August was wetter than normal throughout the country. In Iceland, the weather during August was generally mild and fair.

In Austria, a lot of farm houses caught fire by lightning strokes throughout the month. An extreme hail event around Innsbruck caused heavy damage to buildings and agricultural areas on August 2. On August 20, a holiday camp and a reed area of 1 square km at Lake Neusiedl burnt down after lightning strokes. Station Graz airport registered a monthly precipitation of only 28 mm, which is only 24% of the normal and thus the lowest amount since 1951.

From August 3-4, heavy property damage caused by thunderstorms, hailstones and gales was reported from České Budějovice and Holešov, Czech Republic. The maximum wind velocities were up to 126 km/h.

In Bavaria, southern Germany, hurricane like winds with gusts up to 161 km/h devastated forests, homes and power lines on August 3; hailstones injured more than 50 people and accumulated to a layer of several cm on the ground, transportation was blocked on roads and railways. On August 6, a whirlwind near Osnabrück in northern Germany cut a 1 km long break into an inhabited area, causing severe damage to houses, cars and trees. On August 15, maximum temperatures of about 37°C were recorded from western Germany. On August 26, the country-wide mean of daily maximum temperatures was up to 35°C.

In Italy, the month was very dry with temperatures above normal by about two standard deviations.

Heat waves affected several areas of Greece, mostly mainland areas, during the period August 8-9. Maximum daily temperatures exceeded 40 °C.

In Slovenia, the monthly mean temperature all over the country was significantly above normal. Sunshine duration exceeded the long term averages everywhere in the country by at least 10 %, in some parts the normal was exceeded by more than 30 %. Precipitation was rare; in the South and Northeast of the country less than one fifth of the 1961–1990 normal fell with the consequence of a severe drought. On the coast and at station Kočevje, only 5 mm fell, which is 4 % of the norm.

In Poland, August was significantly warmer than the long term average with a precipitation rate near to normal. The highest temperature anomaly was recorded from Cracow by +2.9°C. On August 3, severe thunderstorms with strong winds were observed near Pila. Within the period of August 17-27, several thunderstorms and tornadoes caused a lot of damage to houses, forests and power lines in different parts of the country. On August 22, several fires were caused by lightning strokes in the vicinity of Cracow.

In Hungary, it was the warmest month of the year and the country-wide monthly

mean temperature was +2.3° above normal; in combination with a precipitation rate of only 60% from normal, there were nearly drought conditions.

On August 16, the Swedish capital of Stockholm was seriously hit by an extremely heavy thunderstorm: Three persons were killed and several more injured. On August 27, a powerful rainstorm first hit Uppsala and then even more seriously Sundsvall, two cities in the eastern part of Sweden. Around Sundsvall several roads and also the railway were disrupted due to erosion. Close to Sundsvall 134 mm of rainfall was registered within 24 hours, and a bit further to the north at station Rössjö, a new official Swedish record for daily rainfall in August was set by 160 mm.

An exceptional local rain event occurred in south-western Finland at Merimasku and Rymattyla on August 28: In a convergence zone, precipitation accumulated to 97 mm and 90 mm, respectively. The rain lasted for some six hours and the recurrence period of this event exceeds 100 years.

In Lithuania, the month was moderately warm and moist in the first half, but warmer and drier in the second half. It was raining frequently in the first and the second ten-day period. The heaviest rain occurred around the town of Ukmergė on August 18, amounting to 57 mm in 2 hours. Lowlands were flooded and mechanised harvesting was brought to a standstill, due to over-saturated soil. The third ten-day period was less wet; the monthly amount of precipitation was 69 mm and thus below those of June and July.

The hot weather in Moldova continued in August with an overall precipitation rate of less than 15% of normal. The number of days with a maximum temperature $\geq 30^{0}$C was twice of the normal value. Such an extreme drought event occurred for the first time during the last 50 years in this country.

Drought conditions in the Ukraine lasted throughout the month, especially in the steppe and forest- steppe zones. Dry wind events occurred up to twice the normal number. The heat wave was occasionally interrupted by showers from squall-lines, sometimes including hail.

In southern parts of the Russian Federation, especially the Lower Volga region, the month was very warm and dry. These drought conditions caused the loss of more than half of the crops. Additionally, an extremely high risk of forest fires continued throughout the month in the Volga region and the Northern Caucasus.

The drought in Georgia, which started in June, ended in the third decade of the month. Then, within 4 days the normal monthly precipitation amount was nearly reached or even exceeded at most stations.

In northern and western areas of Turkey, hailstorms damaged houses and agricultural areas, and caused the death of two children in the period from August 21-23.

In Armenia, 80 mm of rain poured down during 6 hours at the station Ashotsk on August 23. This amount of rain equals twice the normal monthly precipitation. The consecutive floods caused considerable material losses.

In Israel, August was very warm with temperatures up to +2.0°C above normal. Nights in the Coastal Plain were especially warm. On August 10-11 the daily minimum temperature in Tel Aviv was 27.5°C.

September 2001:

- **Extremely wet and rather cool in Central Europe and the northern Balkans**
- **Very warm in Greece and Turkey, drought in the Caucasus region**

In the northern Balkan states, the month was extremely wet (e.g. see fig. 9.1). Cloudy and rainy weather was prevailing in Slovenia and the month turned out to be very wet (see fig. 9.2). The Julian Alps were the rainiest region; more than 500 mm fell on some measuring sites. The 1961–1990 normal values were exceeded everywhere, in the south of Slovenia precipitation rates were between 250% and 300% of normal. In the Julian Alps, where abundant rain in autumn is frequent, there fell more than 150 % but less than 200 % of the normal precipitation. The mean air temperature was well below the 1961–1990 average, the largest anomaly was in the high mountains by around -3°C. Sunshine duration was well below normal everywhere in the country, only 55% to 80% of the average sunshine duration of the period 1961–1990 was observed.

Extraordinarily high precipitation rates were recorded from Yugoslavia with maxima in Zrenjanin and Novi Sad (see fig. 0.8).

In the Federation of Bosnia and Herzegovina the overall rainfall rate was more than 300% of normal and especially at station Tuzla the monthly precipitation amounted to 304 mm, which is 475% of the normal value.

Hungary experienced also a very wet September. The country-wide precipitation rate was about 250% of normal (see fig. 9.3). In several places rates up to 400% were observed. The maximum of the 24-hours precipitation total was measured at station Bakonyszücs in 704 m by 132 mm on September 5. The return period of such an extreme event is more than a hundred years.

In Poland, similar to some neighbouring countries, the weather was dominated by a cyclonic circulation pattern. As a consequence, the precipitation rate was country-wide near to double of the long term average. At stations Zielona Gora and Czestochowa the monthly totals of precipitation exceeded even 300% of normal. The monthly mean temperature was moderately below normal by –0.5°C. A severe storm was observed over the Baltic Sea on September 8; lots of trees were uprooted at the seashore near Slupsk and Koszalin.

Lithuania had a rainy, but not too cold month. There were 22–26 days with rain in the western parts of the country while only 14–18 in the eastern regions. Thus, the amount of precipitation was very uneven varying from 47 to 191 mm (70–170 percent of normal). By the end of the month the weather cooled down to morning frosts from 0 to –4°C, at some places to –8°C.

In Sweden, two major precipitation episodes occurred in the first decade of the month. First, the area around Sundsvall was flooded after heavy rains on September 6. Two days later, 108 mm rain was measured within 24 hours in the southern part of the generally dry island of Öland.

Within the last week of the month, tornadoes affected different parts of Ireland. On September 25, a funnel cloud was observed in County Galway accompanied by some localised heavy thundery showers. On September 30, a frontal trough moved eastwards across the country and brought a spell of heavy rain to most areas. Embedded within the front were a number of thunderstorms, at least two of which developed into tornadoes over the midlands. One of these followed a track through County Westmeath for approximately 5 miles. Winds associated with the tornado broke large branches from mature trees along its length (see fig. 0.12), while a 40 m² section of roof from a farm building was lifted over a road and fell almost intact in a field over 100 m away.

September was extremely wet in the Netherlands with a country-wide average of 177 mm rainfall (normal: 75 mm). The month ended in De Bilt as the second wettest on record since 1901 with 211 mm (213 mm was measured in 1953). Hoek van Holland again recorded the highest amount of precipitation: 289 mm, approximately 35% of the normal annual amount. 107 mm fell in 21 hours on September 19. On that day, more than 50 mm fell in a large part of the province Zuid-Holland resulting in flooding in the Westland area.

Precipitation all over Germany was more than twice the normal value, while temperatures were significantly below the long term averages. In northern Germany near Hamburg, heavy rains of more than 30 mm

together with hail caused flooding of streets, subways and houses on September 26. In Austria, a monthly rainfall amount of 159 mm was recorded from station Eisenstadt, which is 350% of the normal precipitation.

In Switzerland, September was wet and cool with very little sunshine in the Alps and north of the Alps. In higher mountain areas the month was 3.5 to 4.5°C colder than normal – the coldest since 1972. From September 9 to 17 occasional snowfalls occurred down to terrain of 1500 m–1200 m asl. On the northern slopes of the Alps and in the neighbouring regions of the Mittelland and the Jura this was the September with the least sunshine since records started in 1901. The rate of sunshine reached 30-60% of the normal monthly total.

Italy experienced an intense cold period throughout the month, characterized by temperatures lower than normal by more than a standard deviation at about 50% of the stations and with precipitation much above normal in the Po valley and over the Alps.

In central and southern parts of Ukraine, intense rains of 90-110 mm during 4-12 hours caused the flooding of a great number of homes on September 26.

In the Russian Federation, 1 man was killed and 37 people injured, when a tornado hit the north-eastern coast of the Black Sea near Sochi at the beginning of the month. Additionally, many houses and power lines were damaged and energy and water supplies were cut off.

In Greece, unusual high temperatures by +5...+10°C above normal were recorded from almost all over the country. The daily maximum temperature varied between 34°C and 37°C. In Turkey also, the overall average temperature was significantly above normal by +1.5°C.

The monthly precipitation amount in Armenia was much below normal (fig. 0.9) and caused, together with positive temperature anomalies, severe drought conditions throughout the country. In Georgia, the weather was also generally hot and dry. Nevertheless, a hailstone event on September 18 caused heavy damage to vineyards in the Gurjaani and Telavi regions on September 18.

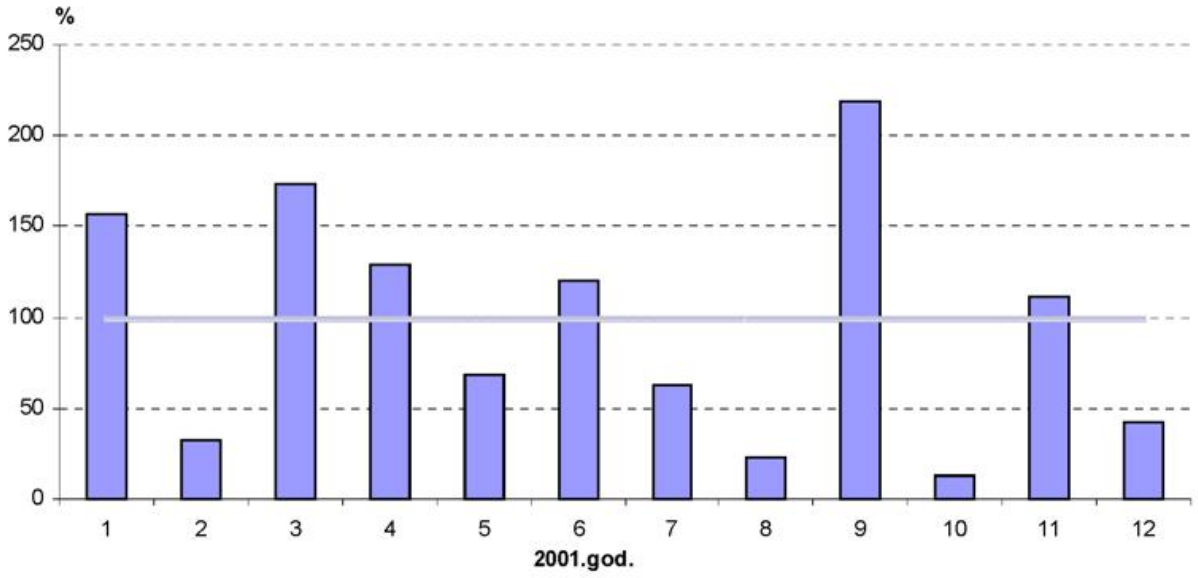


Fig 9.1: *Monthly precipitation totals in % of normal (1961 – 1990) in Zagreb Gric, in 2001*
From: Meteorological and Hydrological Service of Croatia

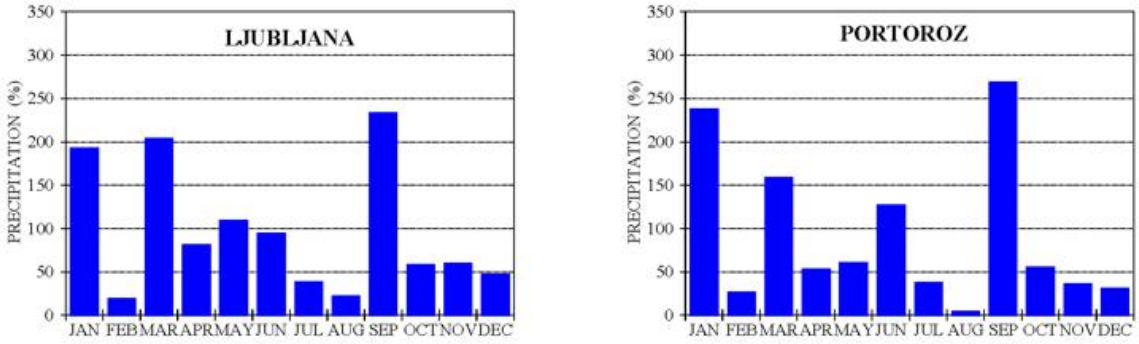


Fig 9.2: *Precipitation rates from normal at 2 stations in Slovenia*
From: Environmental Agency of Slovenia

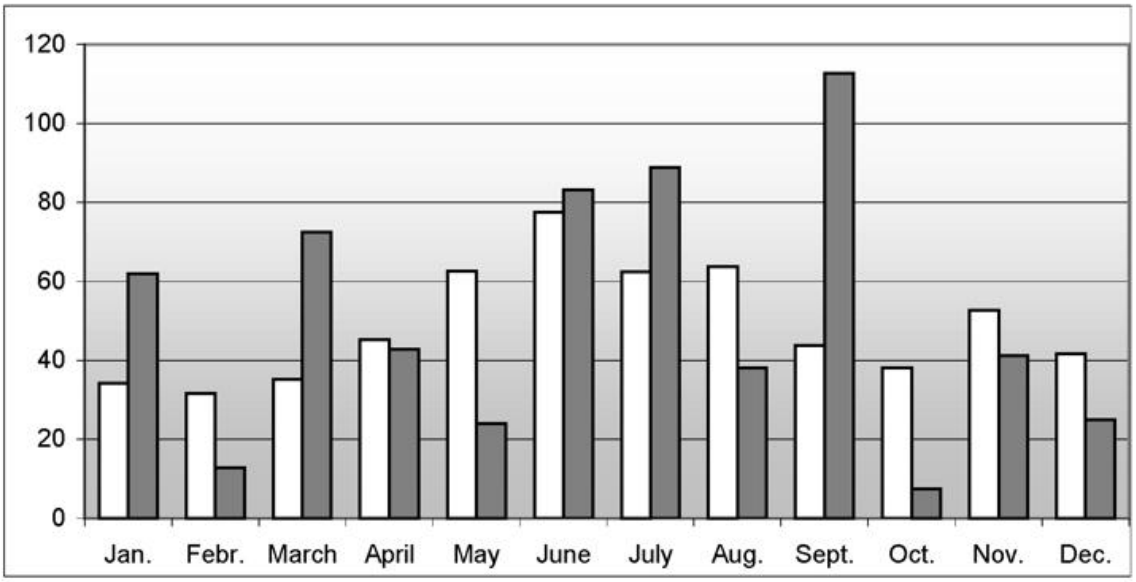


Fig. 9.3: *Monthly precipitation (mm) in 2001 (filled boxes) and between 1961 – 1990 (empty boxes) in Hungary*
From: Hungarian Meteorological Service

October 2001

- **Record breaking warm in Central Europe**
- **Extremely dry in south-eastern Europe**

Nearly all over the Region, the monthly mean air temperatures were above normal (see figs. 0.1, 0.2, 0.3, 0.6, 0.15). In Central Europe, they were extremely high and exceeded September means at many places (see tables on page 23). For example, at the Dutch station De Bilt, this had happened never before since the beginning of observations in 1706. Additionally, the month was very dry in the middle of Europe and extremely dry in the Mediterranean and in a broad strip from Poland southwards over the Balkans to Turkey.

In Norway, the overall monthly mean temperature was +1.7°C above normal. The most southern coastal areas experienced the warmest October since the measurements started in 1874, and they are the northern border of the area with warmest October on

record in Denmark and further south in Europe.

In Denmark, October was record breaking warm and without any frost. With a mean temperature of 12.0°C, the month was 2,9°C above the normal of 1961-1990 and 0,6°C warmer than the earlier record from October 1995 and thus the warmest since the start of observations in 1873.

In the U.K., the rain of the preceding month continued. Cambridge had 90 mm of rain on October 21 causing severe flooding in the adjacent county. But October was also a record-breaking month, being the warmest on record since 1659, with a mean Central England temperature of 13.3°C, which is +2.7°C above the 1961-1990 average. The continuity of high temperatures during the month is shown by fig. 10.1.

October mean temperature was 13.4°C and had never been so warm since the start of regular temperature measurements in the Netherlands in 1706, and for the first time since then, October was warmer than September.

In Belgium at station Uccle, the monthly mean temperature was 14.4°C and thus +0.4°C higher than the preceding record from 1921 and the highest since the beginning of observations in 1833. On October 6, a tornado caused severe damage in areas around Brussels.

In Luxembourg, the monthly mean air temperature was the highest since 1947 with 12.7°C and thus +1.4°C higher than for the preceding September.

In France also, October was an exceptionally warm month with record breaking temperatures. For a large portion of the country, it was the warmest October since 1949, after October 1995, with temperatures as much as 3°C or 4°C above average (see fig. 10.2). On October 29-30, daily temperature maxima up to 30°C were measured at several stations, exceeding records of earlier years since the beginning of observations between 1947 and 1959. Some exceptional rainy and stormy events took place in the Southeast leading to floods in the periods of October 6-9 and 17-20. On these last days, two tornadoes caused much damage close to Montpellier and Perpignan.

The country-wide monthly mean temperature in Germany was 12.5°C and thereby the highest since more than 100 years. On October 2, a daily minimum temperature of 14.9°C was measured at station Potsdam, which is the mildest night since the start of records in 1893. On the same day, a maximum temperature of 29.5°C was observed in Altenstadt and of 27.8°C in Munich, which was the second warmest day of October since 1923 (28.2°C). On October 1, a whirlwind with gusts up to 100 km/h damaged the roofs of 50 houses in a row of 1.5 km in Lower Saxony. On October 31, a stormy depression affected the area north of Berlin with wind speeds up to 115 km/h, uprooting a lot of trees near the coast of the Baltic Sea; 1 man was missed from a capsized sailing boat.

In most places in Switzerland, it was the warmest October since records started in 1864. The month was +2.5°C...+5°C warmer than normal. In the highest regions of the mountains, October was 4°C to 5°C warmer than the preceding September. On October 2, station Chur registered 29.4°C and the mountain station Jungfraujoch +3.9°C in 3580 m above sea level.

In Italy, October was quite dry and warm, particularly on the coastal region in the central and southern part.

The general temperature anomaly in Poland was +3.1°C with a maximum of +3.8°C at station Cracow. The country-wide precipitation rate was 73 % of normal and in S-Poland below 50%.

The relatively warm October weather in Lithuania was predominantly determined by southern edges of Atlantic cyclones, except a steady cold spell of the fifth five-day period caused by a sudden southward move of a northern anticyclone. The monthly mean air temperature was 9.1ºC (+1.9ºC above normal). The monthly amount of precipitation (64 mm) was close to normal at most places, whereas the heaviest rainfalls occurred in the beginning and in the end of the month.

An intense cyclone caused large problems for transportation lines in southern Sweden on October 31, e.g. the bridge over Öresund had to be closed. Additionally, electricity supply was interrupted for about 15,000 families. The highest wind gusts reported were 133 km/h in the Stockholm archipelago.

At Hurbanovo observatory in Slovakia, the mean monthly temperature was + 3.3°C above the average of the normal period 1961-1990, which is the fourth highest record since 1871.

In Slovenia, the mean air temperature in October was well above the 1961–1990 norm, the anomaly was mostly between +2°C and +4°C and statistically significant. In some regions the monthly mean air temperature was even slightly higher than that of September. Sunshine duration exceeded the 1961–1990 average everywhere in the country. There was even more sunshine than in September this year. As mostly sunny weather was prevailing, October turned out to be quite dry. Precipitation was well below normal everywhere in the country.

In Hungary, the country-wide precipitation rate was only 15% (see fig. 9.3) and the overall monthly mean of the temperature +3°C above normal (see fig. 0.6).

In Greece, unusual high seasonal temperatures, significantly +5°C...+8^{0}C above normal, were reported from most parts of the country during the period October 4–24. The daily maximum temperatures varied between 29°C and 33°C.

In Iceland, the weather was generally mild and good. The eastern districts experienced a few days of heavy rain with landslides blocking roads for short periods. On October 18, the temperature in Reykjavik reached 15.6°C, which is the highest ever so late in the year.

In Ireland, mean temperatures for October were well above normal. A localised downpour in county Waterford produced 124 mm of rain in the 2-day period of October 19-20.

The mean monthly air temperature was near to normal in Georgia. The first half of October was warm and dry for the territory of East Georgia. On October 17-19, precipitation amounts of 25 mm-45 mm were very welcome to replenish the soil surface water content. From October 20 to the end of the month, there was not more than 5-10 mm of additional precipitation over most of the territory.

Rainfall amounts in Israel were not homogeneous. They were above normal in the Coastal Plain and below normal in the inner parts of the country.

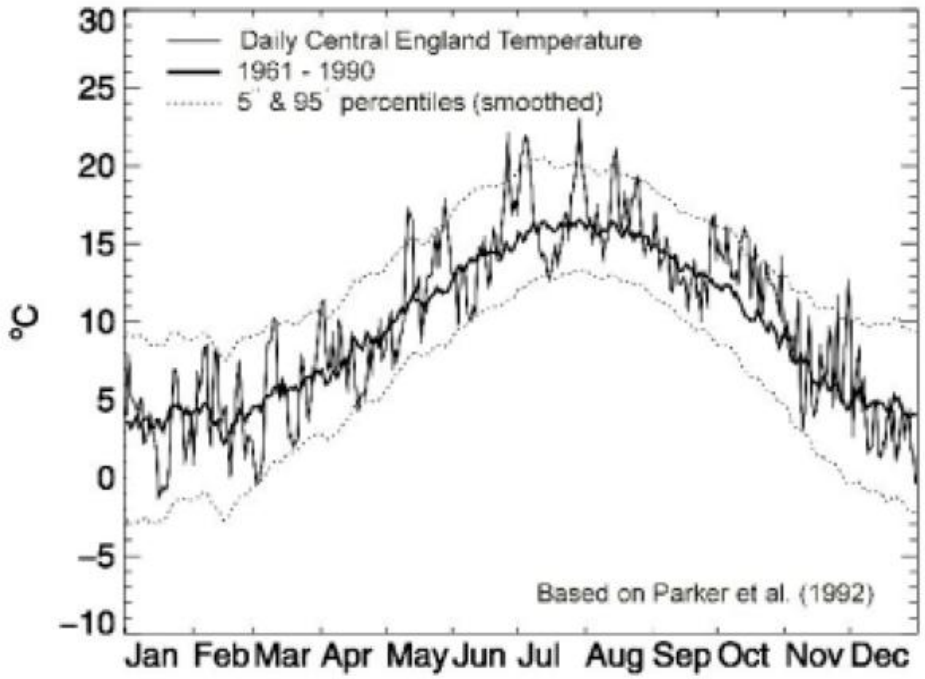


Fig. 10.1: *Central England temperature, daily values 2001*
From: U.K. Met Office, Hadley Centre for Climate Prediction and Research

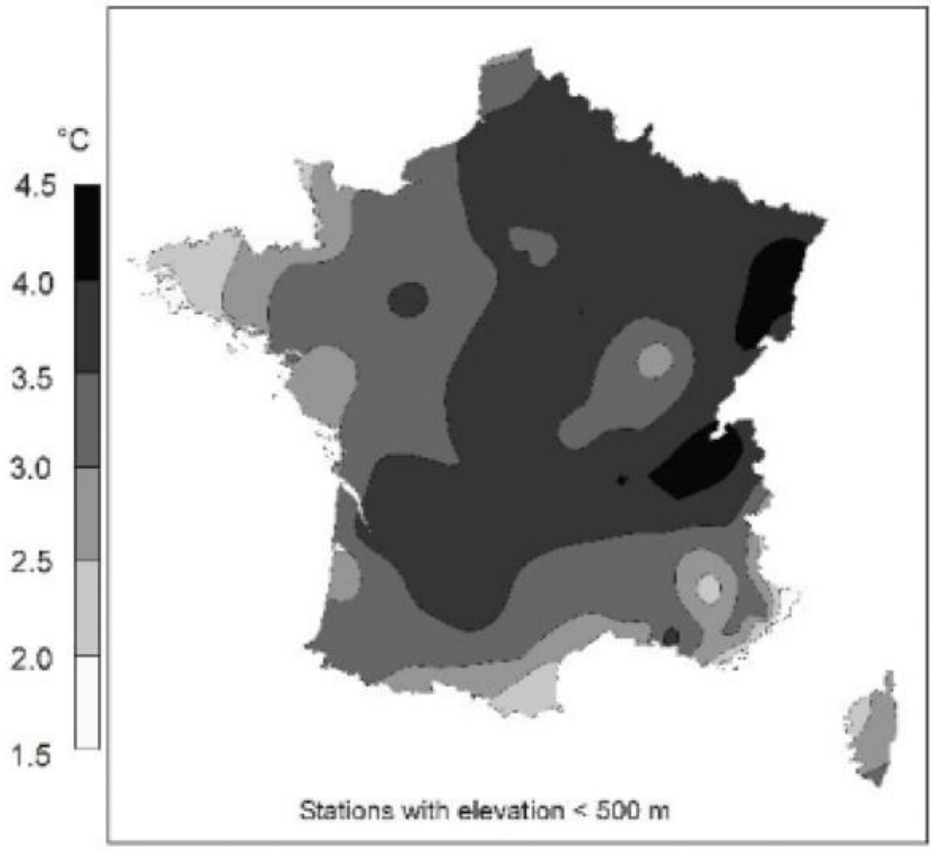


Fig. 10.2: *Mean monthly temperature anomalies, October 2001, Reference periode 1961 – 1990*
From: Météo France

November 2001

- **Violent Storms in many places of the Region**
- **Very wet in Greece and Turkey**

In Iceland, a very dry westerly storm caused some material damage and local disruption of electrical power because of unusually heavy sea-salt deposition on electrical transformers on November 10. The last week of the month brought unusually heavy snowfall to the south-western part of the country.

In Ireland, the highest gust of the year was measured at Malin Head by 122 km/h on November 8 (same record as on March 6).

On November 15, a severe storm affected the middle part of Sweden. Lots of trees were uprooted, constituting a volume of 2 million cubic metres of wood.

Finland was hit by two violent storms at the beginning and in the middle of the month. The first event, in western Finland, started with sleet and freezing rain. Considerable amounts of ice were accumulated on trees and caused, together with upcoming gale force winds, the fall of lots of trees. The second violent storm occurred in south-western Finland on November 15-16 and caused also severe damage to forests. The clearing of this devastation took more than half a year and the economic losses of the forest owners were large in both cases.

Latvia experienced two major storm events. The first one occurred on November 1:

Westerly winds drove enormous water masses from the Baltic Sea into the Gulf of Riga; then, even stronger winds up to 112 km/h from the Northwest caused the rise of the water level in the estuary of the Dauga River up to 1,60 m above normal. The second extreme wind event was a thunderstorm on November 15-16. This time, the water level of the Dauga River exceeded the critical mark of 1,70 m, which is observed only once in ten years. The wind caused damage to the electric power supply of many districts. Latvian ports were non-operational. Traffic on land was made difficult or paralysed because of fallen trees on roads and railways. The roofs of buildings in Riga, some of them of public interest, were damaged or blown away. About 20 people were injured, and one woman was killed. A stable snow cover was formed in the eastern part of the country since November 13 and in central Latvia one week later.

November was the windiest month of the decade in Lithuania. The strongest winds with gusts up to 115 km/h were observed at the Lithuanian seaside on November 1, 11 and 15. These strong winds caused significant damage to the infrastructure in western Lithuania and impeded marine operations. There were 20 days with bad fishing conditions in the Baltic Sea. In the north-eastern region a steady snow cover of 3–9 cm formed since November 13.

On November 1, very strong winds caused lot of damage in N- and NE-Poland. On November 29 the international airport of Warsaw was closed for half a day, due to exceptionally dense fog. A lasting snow cover appeared in Poland at the end of the month.

Although the monthly mean wind speed in Belgium was significantly below normal, the strongest storms of the year were recorded from the Belgian coastline with more than 100 km/h on November 8.

Strong winds crossed Germany under a westerly upper air stream on November 8. Gusts up to 137 km/h were recorded at station Feldberg in the Black Forest. In Frankfurt/Main scaffolding broke down and smashed parking cars. In a place near Osnabrück in Lower Saxony, a whirlwind uprooted trees and damaged cars and the roofs of 40 houses. Starting at the same day, snow fell in many parts of the country in several episodes until November 22. Five people were killed and many more injured by more than a hundred accidents on slippery roads, and numerous trees fell down under the weight of fresh fallen snow.

In the Czech Republic, local damage caused by strong winds was recorded on November 11.

In the middle of the month, snow and ice disrupted traffic on roads in south-eastern France. In Switzerland, a long lasting drought period started in this month.

In Hungary, Croatia, and Bosnia and Herzegovina, the national monthly mean temperature was significantly below normal.

In Slovenia, anomalies exceeded –2°C at several places. On November 9, snow fell over most of the country. The monthly mean sunshine duration exceeded normal everywhere in Slovenia, in most places by 40% up to 60%.

Although dry on a monthly time scale, Spain recorded torrential downpours on the occasion of some extreme local events. E.g., 125.7 mm of rain fell within 24 hours in an episode on the island of La Palma (Canary Islands), leading to several mortal casualties. On November 9, a tornado was observed in the town of Motril near Granada (see fig. 11.1); a nearby camping area suffered from material losses.

Heavy rains and thunderstorms affected central and southern parts of Greece on November 2-5. These extreme conditions led to floods in East Sterea and Attiki with destructive consequences to the infrastructure of the region and the loss of three people. Again, during the period November 28-30, heavy rains and thunderstorms occurred almost all over the country, mainly in the western part and in the East Aegean islands, where the island of Samos was extremely hit by devastating floods.The monthly precipitation amount in several areas of the country (Peloponnisos, East Sterea, Attiki, Cyclades, Crete, Dodecanisa, Islands of East Aegean) was twice to three times greater than normal and thus higher than ever recorded before.



Fig 11.1 : *Funnel cloud of a tornado near Granada on November 9 From: Instituto Nacional de Meteorologia Spain*

In Turkey, the national monthly mean precipitation rate was about 200% (see fig. 11.2). Several extreme rainfall events, some of them combined with storm, caused severe damage to buildings, bridges and agricultural areas, at least 6 people died. Such events were recorded from Rize on November 10, Izmir on November 14, Anamur on November 21 and 24, and Alanya on November 24.

In Cyprus, heavy rains, severe hailstorms with gale force winds and flooding occurred on November 29. Stormy weather was also recorded on November 17.

In Belarus, a positive temperature anomaly continued from the preceding month until November 20. Then, cold weather in the last decade lead to a balanced monthly mean of the country-wide temperature compared to the long term average.

In Israel, rainfall was distributed non homogeneously over the country. Rainfall amounts were above normal in the Coastal Plain and in the Judean Mountains (120%-140% of normal), but in the Galilee and in the Northern Negev they were below normal (60%-80% of normal).

In Jordan, the national monthly rainfall amount was above normal.

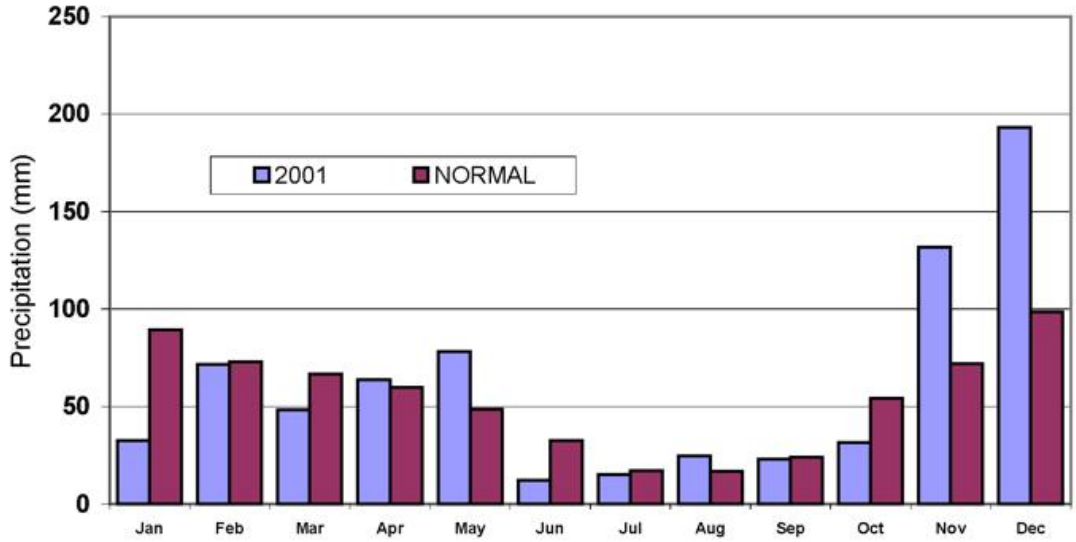


Fig. 11.2 : *Monthly precipitation in Turkey From: Turkish State Meteorological Service*

December 2001

- **Extremely cold in southern and eastern Europe**
- **Record breaking daily maximum temperatures on islands in the Norwegian Sea**
- **Very dry in the Alps, Italy, the northern Balkans and eastern Europe**
- **Wet and cold in the Middle East**

In France, December was very cold, especially in southern parts (see fig. 0.5.), where the temperature average during 14 days (December 14-27) was the coldest since 1949. Snowfall affected large areas of the country. Nevertheless, dry conditions prevailed in the Southeast.

December was very cold in most parts of the Iberian peninsular except for the southernmost areas. Monthly mean temperatures in the centre and the northern half of Spain were down to 4°C below normal. All-time records of low monthly mean temperatures were set in the observatories of Cataluña and Aragon for series, that started more than 60 years ago. Station Zamora in the Duero Basin recorded -10.6ºC, which is the lowest value of its 90-year long series. On December 13, an easterly circulation pattern initiated a very cold phase, that culminated on December 16 and 25.

December was extremely cold in Portugal. Rivers froze and water pipes broke down due to negative temperatures that are unusual in the north-eastern part of Portugal. The record of daily minimum temperature was exceeded in Viana do Castelo, where -5.0 °C was observed. Heavy rains and strong south-easterly winds in the southern mainland areas caused floods and road obstruction. The weather conditions in Terceira Island, Azores, caused damage to the breakwaters, located at the northern and eastern coast of the island. Heavy rains in S. Miguel Island caused floods and road obstructions.

In Greece, heavy rains and thunderstorms occurred during the period December 15–17, affecting the areas of western Greece, Peloponnisos, Aegean, Crete and Dodekanisa. Severe snowfalls occurred almost all over the country, mainly in the northern and central part. The snow depth reached 1.5 to 2 m in many areas. Due to these snowfalls, several aerodromes in the North of the country remained closed for 3 to 4 days. Also many roads in several areas were closed. Floods were recorded on December 16 in the north-western Peloponnisos, which resulted in catastrophic damage to the infrastructure and the loss of two lives. Unusual low daily temperatures and frost were recorded in most areas of the country on December 19-20. Particularly the minimum daily temperatures recorded were the absolute lowest temperatures ever measured since the beginning of observations.

The monthly mean temperature in Poland was significantly below normal by -2.5°C. The anomalies were smaller in the Northwest and larger in the Southeast, where the station Lesko recorded the largest deviation from normal by –4.8°C. A snow cover existed during the whole month. Sometimes, snowdrift caused trouble on roads. Only in W-Poland the snow depth was less than 10 cm (see fig. 0.10). The highest snow cover in the lowlands of Poland increased up to 50 cm at station Suwalki. In the mountains, the snow cover exceeded 50 cm at the end of the month, engendering most dangerous avalanche situations. Four persons died in the Tatra Mountains and one tourist in the Sudety Mountains in avalanches on December 31.

December was the coldest month of the year in Lithuania with a country-wide mean air temperature of –5.6°C, which is 3.2°C below normal. It was one of the ten coldest months of December on record in the past century. In the first half of December snowfall was mostly insignificant, but then became steady and formed a snow cover of 18–41 cm at the end of the month in many places. At station Nida, the snow cover accumulated up to 60 cm. The monthly amount of precipitation was close to normal in most parts of the country, except at the seaside, where it was up to 140% of normal.

In Latvia, the already existing snow cover was replenished during December and increased up to 40-50 cm at the end of the month. Maximum snow depths were recorded from stations near the Baltic Sea. Heavy snowfall and snowdrift made roads impassable at times in many parts of the country. In Estonia, a minimum temperature of –34.6°C was measured on December 25. The month

brought a new record of sunshine duration by 53 hours.

December was the coldest month of the year in Belarus (see fig. 7.1). Generally, the coldest month in Belarus shifted from January to December during the last decades. This is evident from table 12.1.

In Ukraine, the monthly mean temperature was 4°C-5°C below normal, which is extremely low for the whole period of observations.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1881 - 1990	-6,7	-5,9	-1,6	5,8	13	16,2	17,8	16,5	11,9	6,2	0,7	-4,0
1989 - 2001	-3	-2,6	0,8	7,8	12,8	16,5	18,2	17,1	11,7	6,6	0,2	-3,8

Table12.1 : *Monthly mean temperatures in Belarus in °C for two differents reference periods*
From: Hydrometeorological Centre of the Republic of Belarus

At station Brezová pod Bradlom in Slovakia, a maximum snow cover of 39 cm was measured in December. This was the highest value observed in the Slovakian lowlands since 1921.

After the first week of the month, December turned out to become extraordinarily cold in Hungary (see fig. 0.6). The absolute monthly minimum temperature was below -15°C at all stations of the country except for Sopron, while in most parts of western Hungary this value was even below -20°C. The lowest daily minimum temperature was measured in Orosháza by –26.1°C on December 25.

Cold arctic air masses also affected Yugoslavia in December. Consequently, mean monthly temperatures dropped below normal by deviations of –2.3°C...-5.7°C. As an example, fig. 12.1 shows the daily mean temperatures of the month at station Sombor compared to normal. The coldest part of the country was the North with minimum temperatures below –22.0°C. This December was one of the seven coldest in Belgrade since the beginning of observations 113 years ago.

In The Former Yugoslav Republic of Macedonia, the national monthly mean temperature was extremely below normal by -5.8 °C.

The weather station on the island of Jan Mayen, Norway, measured a maximum temperature of 12.3°C on December 14. This is the highest temperature measured at the station in December since the start of observations in 1921 (the old record was 8.0°C from Dec 16, 1997). It was also the highest temperature measured at the station during 2001.

In Iceland, the first decade of the month was very stormy and a fishing boat was lost at sea, only one man was rescued. On the evening of December 13, the temperature at a coastal station in the north (Sauðanesviti) reached 18.4°C, which is a new absolute maximum in December for the whole of Iceland. This temperature is 1°C higher than the absolute maximum of the whole year 2001 in Reykjavík. Until Christmas, the weather continued to be very warm, but a cold snap during the last week of the year prevented a new monthly mean temperature record being set.

The drought in Switzerland south of the Alpine ridge continued throughout the month. These conditions engendered severe danger of forest fires. A remarkable cold spell occurred on December 13. Therefore the lowest December temperatures since 1962 were registered in the highest regions of the mountains, e.g. –30.7°C at the station Jungfraujoch.

Drought conditions prevailed also in Italy throughout the month, including the Alpine region and the Po valley. About 60% of the meteorological stations recorded a precipitation much below normal. The mean monthly temperature was below normal mostly in southern Italy and in the islands.

In Slovenia, the monthly mean air temperature was well below the average of 1961–1990. The anomaly in the Julian Alps was –4°C and in other parts of the country between –3°C and –1°C. The national precipitation amount was far from normal. No station recorded more than 60 % of the normal value. In Zgornjesavska valley, the precipitation rate was less than one fifth of the norm. Although the snow cover was not very deep, it was quite persistent and the number of days with snow cover mostly exceeded the

long term average. In the high mountains, the snow cover was not so deep as usual in December. In correlation with a low precipitation rate, sunshine duration was above normal everywhere in the country (see fig. 12.2). The central part of Slovenia got significantly more sunny weather than the mountain and coastal areas. Ljubljana enjoyed 86 hours of sunny weather, the normal is 37 hours.

In Turkey, the month was rather cold (country-wide monthly mean temperature 1°C below normal) and very wet (country-wide precipitation rate 190% of normal). A lot of extreme weather events occurred throughout the month in different places all over the country. Heavy rains, strong winds, snow storms and severe cold caused flooding and damage of houses and agricultural areas, destruction of transportation devices on land and at the seaside and the loss of lives.

In Cyprus, December was very wet with a monthly precipitation amount above twice normal. Heavy showers and flooding in various periods during the month, especially in the first week, accompanied by gale force winds and severe hailstorms, caused damage to agriculture and properties and also caused a lot of inconvenience to the population. Damage was also caused to boats and fish farm establishments at sea. However, rainfall was very beneficial to the water resources of the island.

December was cool and rainy in Israel. Rainfall amounts in most parts of the country were 120%-160% of normal. The most intense rainfall occurred on December 3-6 with 100 mm-150 mm in northern and central Israel. The coastal plain near the Carmel region received 200 mm-250 mm, and in Zikhron Yaakov there were more than 300 mm. Within two days (December 3-4) Zikhron Yaakov received 285 mm. In the last 90 years, in all parts of Israel, there were only 3 times in which larger amounts of rainfall were recorded for two successive days. A record hourly rainfall was recorded in Zikhron Yaakov with 75 mm in one hour on December 4. As a result of the heavy rains there were floods in the area as well as in other parts of the country. One person died, many homes were evacuated and there was large damage to roads and to agriculture. In the entire month there were 425 mm of rain in Zikhron Yaakov, the rainiest December since the beginning of measurements in 1915 (see fig.12.3).

Snowfall and strong winds restricted transport in Armenia on several days in the second half of the month in Armenia. In Tashir, wind velocities of 84-90 km/h were observed lasting for more than 10 hours on December 18; gusts were up to 122 km/h.

In the territories of Krasnodar and Stavropol, Russian Federation, heavy snowfall formed a snow cover in the period from December 18 to the end of the month. Black ice and hoar-frost affected transportation facilities and power lines. On December 24, melting snow and rain engendered the flooding of several localities.

In Sweden, the month started very mild. But from December 20 on, very cold air dominated the weather for the rest of the year. Heavy snowfall and temperatures close to zero caused serious problems to energy supply and traffic. Especially the south-western part of Sweden was affected; there, up to 15,000 families were without electricity after Christmas. New records of December minimum temperatures were set in Vänersborg (-25°C) and Visby (-22°C) in southern Sweden, stations with more than 100 years of observations.

In Denmark, December was near normal except the last 10 days of the month, which were dominated by frost and at times heavy snowfall.

In Germany, the month was rather cold, especially in the second half. At station Oberstdorf, -30°C was measured at the surface of the snow cover in the night of December 23-24. In the funnel-shaped mountain valley of Funtensee, -45,9°C were recorded in the same night. During the period from December 15-29, snowfall and freezing rain lead to numerous accidents and chaos on roads and motorways all over the country. E.g. on December 21-22, circa 100,000 drivers and passengers spent the night in their cars on a 150 km stretch of a motorway in Bavaria. Aviation and railway traffic was also blocked as a consequence of fresh fallen snow up to 70 cm. In eastern parts of the country, strong winds of about 100 km/h engendered snow drifts forming a snow cover up to 2 m on December 24-25.

In the Netherlands, the lowest temperature of the year was –17.0°C, recorded from station Nieuw Beerta on December 23. On December 28, a gust of 158 km/h was recorded at the coastal station IJmuiden.

In Luxembourg, a new record of sunshine duration for the month of December was set by 91.4 hours.

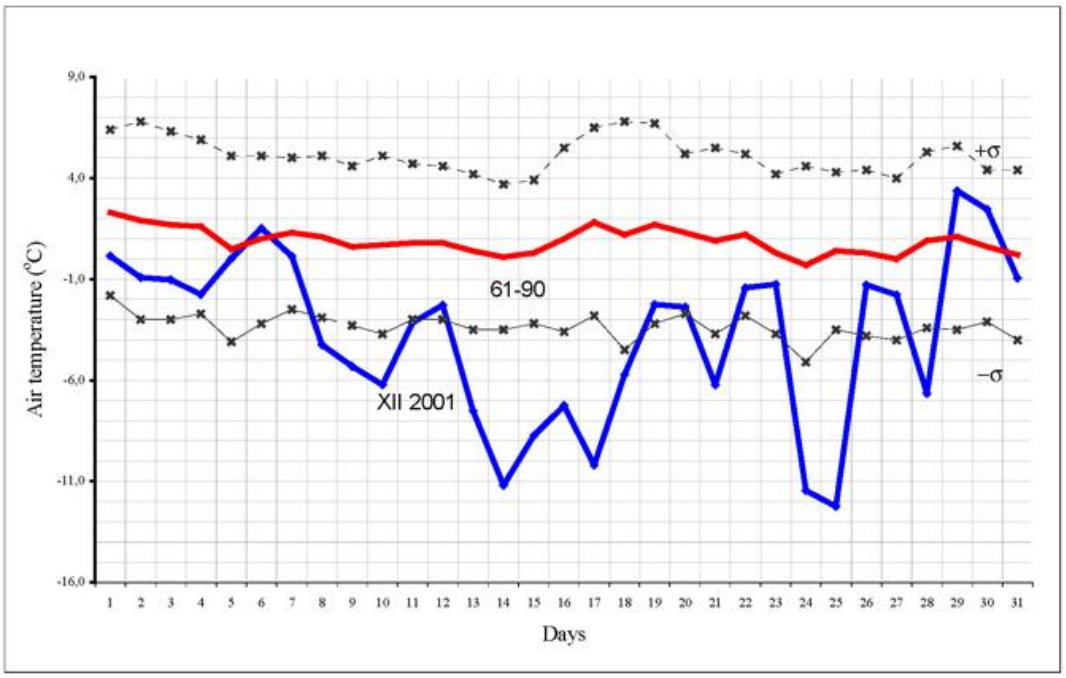


Fig. 12.1 : *Daily mean temperature in Sombor December 2001, compared to normal*
From: Federal Hydrometeorological Institute of Yugoslavia

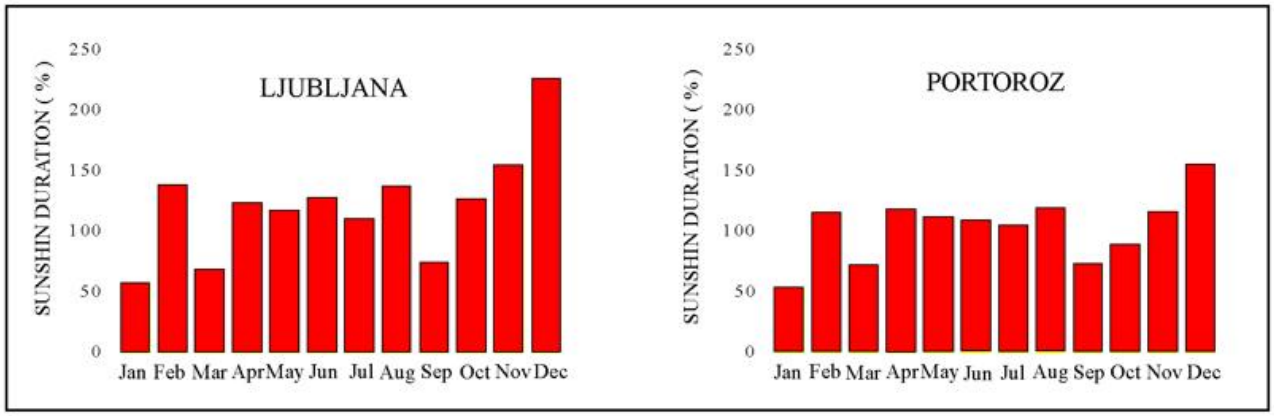


Fig. 12.2. : *Sunshine duration in the year 2001 relative to the average of 1961 – 1990 at two stations in Slovenia*
From: Hydrometeorological Institute of Slowenia

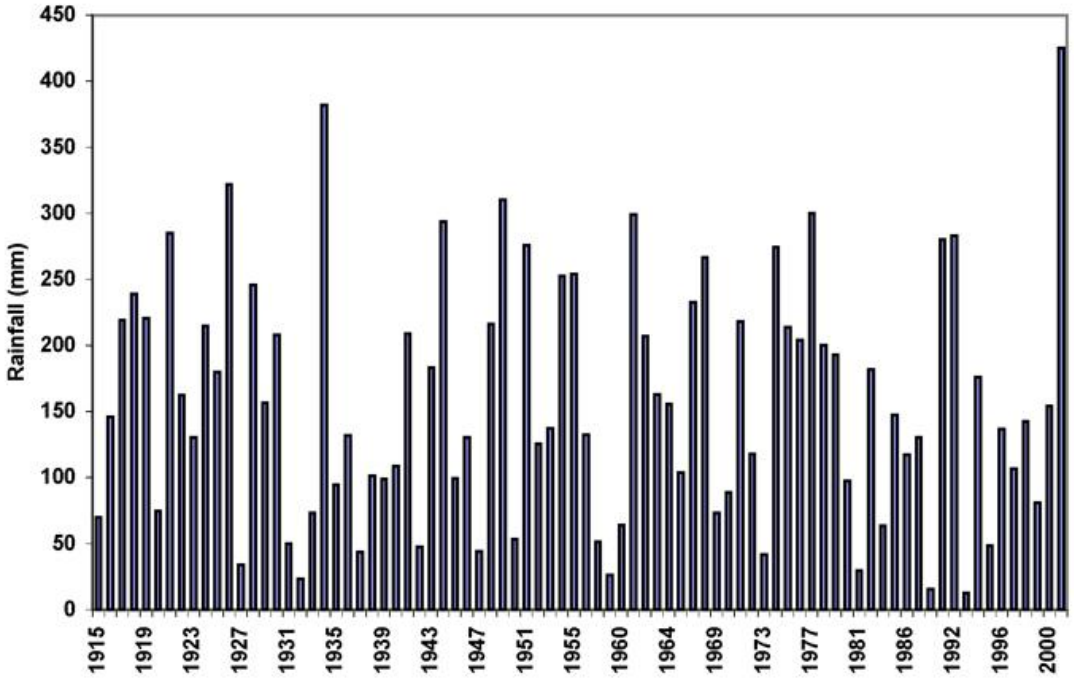


Fig. 12.3 : *Monthly December rainfall amounts in Zikhron Yaakov, 1915 – 2001*
From: Israel Meteorological Service

Activities and Results of European Climate Centres

Report on ECSN activities

by: Walter Kirchhofer, *MeteoSwiss*

- **General remarks**

The EUMETNET Council has designated MeteoSwiss as Responsible Member for the EUMETNET ECSN Programme, starting on 1 January 2001, with Dr. Walter Kirchhofer as Programme Manager.

The ECSN Advisory Committee (EAC) elected Volker Vent-Schmidt as new Chairman of EAC.

The third ECSN-Workshop on Climate Databases has taken place in Langen, Germany, 12-13 November 2001, focussing on climate data exchange and data quality. Since the EUMETNET project UNIDART (Uniform Data Request Interface) is considered to be a suitable project to develop an infrastructure for a border-crossing exchange of climate data, UNIDART was the

main discussion topic. A list of requirements has been prepared for the realisation of the pilot phase and further steps of UNIDART.

At the thirteenth Session of the WMO Commission for Climatology (CCl) in Geneva, 21 to 30 November 2001, a part of the session was devoted to scientific lectures, including a presentation of the main activities of the EUMETNET ECSN Programme.

- **European Climate Assessment (KNMI)**

In the European Climate Assessment (ECA) project the temperature and the precipitation climate was analysed for WMO Region VI, putting particular emphasis on changes in daily extremes. ECA aims at applying uniform analysis methodologies to daily observational series from as many European meteorological stations as possible. About 35 countries participate in the project and the data set contains data from over 200 stations. The project focuses on the twentieth century from 1901 to 2000. The Final Report will be published in spring 2002.

- **Generate Climate Monitoring Products (DWD)**

The status of the project Generate Climate Monitoring Products (GCMP) has been reviewed and a proposal was elaborated concerning the continuation of the project up to the end of the year 2003. It is obvious that European Meteorological Services should provide first hand information about climate variation and derived products for monitoring purposes. With this in mind the project GCMP was started, aiming at developing, generating and distributing standardized climate monitoring products on a monthly as well as on an annual basis. Monthly mean temperatures and anomalies, precipitation and anomalies, satellite cloud cover, and quite a number of other example products are already contained in the clearly structured mechanism on a test version of the GCMP Web pages.

- **Climate Atlas of Europe (Meteo-France)**

The project Climate Atlas of Europe is established for a duration of three years, starting on the 1st of January 2001. The Atlas will contain monthly normal values for precipitation, temperature, wind and sunshine duration and additional statistical information for these parameters and for the occurrence of phenomena such as fog, thunderstorm, hail and snow. The computation period will be 1971-2000. In a first step the Atlas will be made available without maps and implemented as a CD-ROM data base with visualization tools.

- **GIS in Climatological Applications (ZAMG)**

National Meteorological Services are facing many problems in their work which can be solved

more easily with the application of Geographic Information Systems (GIS) tools. Substantial advances in deriving information of various kinds from different sources have been achieved until now. The ECSN activitiy in this field has pushed forward a new action in the framework of COST, namely COST-719: The Use of GIS in Support of Climate Monitoring, Climate Data Quality Control and Climate Information. Therefore the ECSN project Geographic Information Systems in Climatological Application was terminated with a Final Report and followed up by COST-719.

- **ECSN Climate Dataset (KNMI and DNMI)**

The ECSN project Climate Dataset (ECD) is closely related to the project European Climate Assessment. The main objective of the ECD project is the preparation and the distribution of climate data sets on the daily amount of precipitation and daily temperature (minimum, mean, maximum) for the period 1901-2000 via CD-ROM and Internet.

The Bulletin is a summary of contributions provided by the National Meteorological Services.
The author does not warrant, guarantee or make any representations regarding correctness, accuracy,
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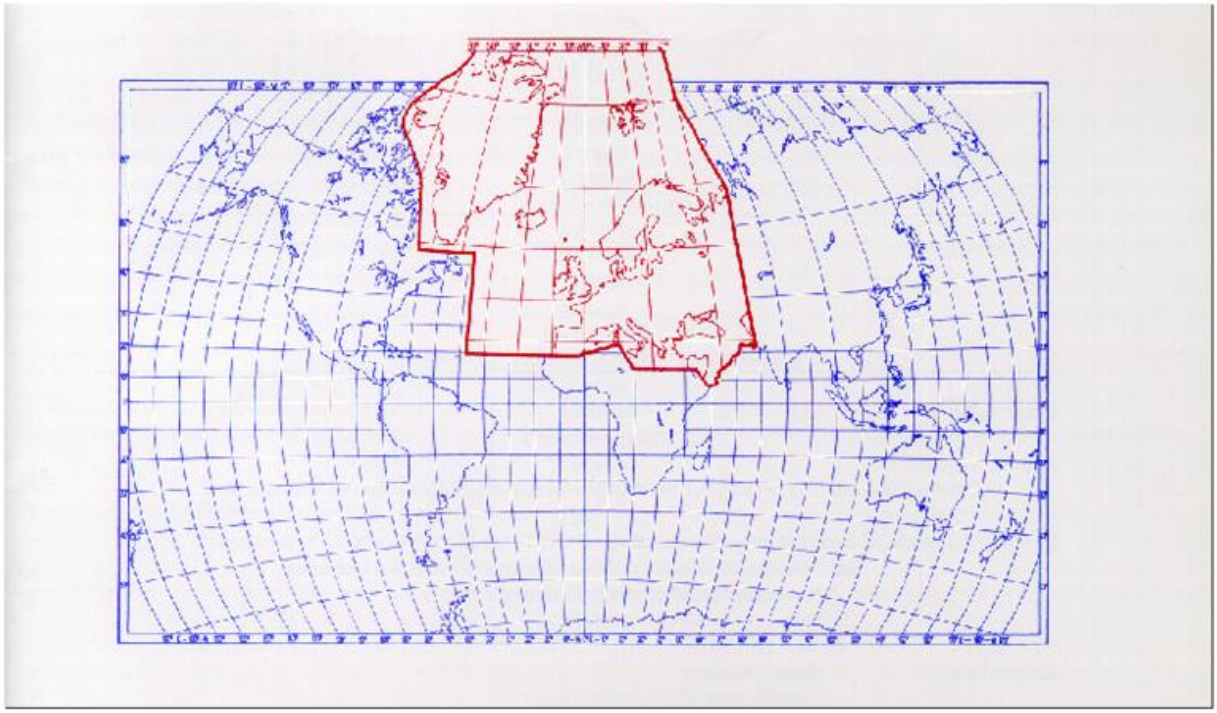
- Europe and Middle East -

2002



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- Europe and Middle East -
2002

The Bulletin is a summary of contributions
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and was co-ordinated by Deutscher Wetterdienst, Germany,

Armenia
Austria
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Slovakia
Slovenia
Spain
Sweden
Switzerland
Turkey
Ukraine
United Kingdom

Furthermore, contributions to the WMO Bulletin article on consequences of abnormal weather in 2002
were referred from the following countries:
Georgia, Kazakhstan, Russian Federation

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Foreword

This 9th edition of the Annual Bulletin on the Climate in WMO Region VI – Europe and Middle East – for 2002 was enabled by national contributions from the Meteorological and Hydro-Meteorological Services in WMO Region VI.

The Call for Input was answered directly by 80% of the 49 member countries. Additionally, WMO Secretariat provided the editor with all national contributions to the WMO Bulletin article on consequences of abnormal weather in 2002 from the WMO Regional Association .VI Thus, even more information could be used for the compilation of this edition, leading to a percentage of 86 of represented member countries. More than 3 quarters of possible national reports were sent in the most preferred way, which is email including attachments or server addresses.

The bulletin elaborates on a very interesting climatological year. A long lasting period of positive temperature anomaly began in the middle of January and dominated the regime of monthly mean temperatures all over Europe. This period ended between August and October, depending on the specific area. Outside this period, relatively cool and sometimes extremely cold weather conditions prevailed in most countries with some exceptions.

Another characteristic and dramatic feature of the year was continuously intense rain fall in central eastern Europe for quite some days in August with disastrous consequences to the infrastructure of wide areas, especially in Austria, Czech Republic and eastern Germany. Hundred thousands of people have been directly involved in this natural catastrophe. A special article on this extreme climatic event is included in this Bulletin.

Other special reports in this edition have been contributed by the ECSN Programme Manager and the Meteorological Observatory Hohenpeißenberg.

On this occasion, I want to thank all, who contributed to this paper by reports and practical support. I am especially thankful to the German Meteorological Service for the co-ordination, the editorial review, publishing and distribution of this Bulletin.



Daniel Keuerleber-Burk
Acting President of WMO Region VI

Outstanding Events and Anomalies in 2002

Temperature

- **A very cold start of the year, followed by a long lasting period of positive anomaly from the middle of January into autemn nearly all over the Region**
- **Extremely mild February in central and eastern Europe**
- **Hottest summer since the beginning of observations in a large area around the Baltic Sea**
- **Extremely cold in eastern Europe at the end of the year**

Precipitation

- **Wet summer in central Europe with record breaking daily rainfall rates in August leading to disastrous flooding in Austria, Czech Republic and eastern Germany**
- **Long lasting drought in the Baltic countries and Belarus in late summer**
- **Extremely wet in the Caucasus at the end of the year**

Wind

- **Strong winds in northern Europe during the last days of January causing lots of life losses and material damage**
- **Stormy weather with lots of damage in many European countries at the end of October**

Annual Survey

Temperature deviations from the long term annual average were mainly positive all over the Region up to about +2.5ºC except for some places in Turkey and parts of northern Russia with slightly negative anomalies. Typical values of the yearly mean temperature compared to normal are presented for example by fig. 0.1.

Scandinavia and great parts of central and eastern Europe had a long lasting period, i.e. from the middle of January until September, of continuously positive monthly temperature anomalies (e.g. see fig 0.2 and tab. 7.1).

Additionally, there were some record breaking observations. At Weather Ship "Mike" (66ºN, 2ºE), operated by Norway, the mean air temperature for the months April to July was the highest ever recorded since the start of the series in 1948; with a time delay of one month, the mean sea surface temperatures were also extremely high. The number of days with snow cover in Iceland was reduced to about two thirds of normal. The mountain range of the High Tatras in Slovakia had the warmest year since 1951; as in other European countries, it was one of the warmest in more than 100 years, illustrated by figs. 0.3-0.5. In the Middle East, the positive temperature anomalies prevailed also, as can be seen from the example of extreme temperatures in fig. 0.8.

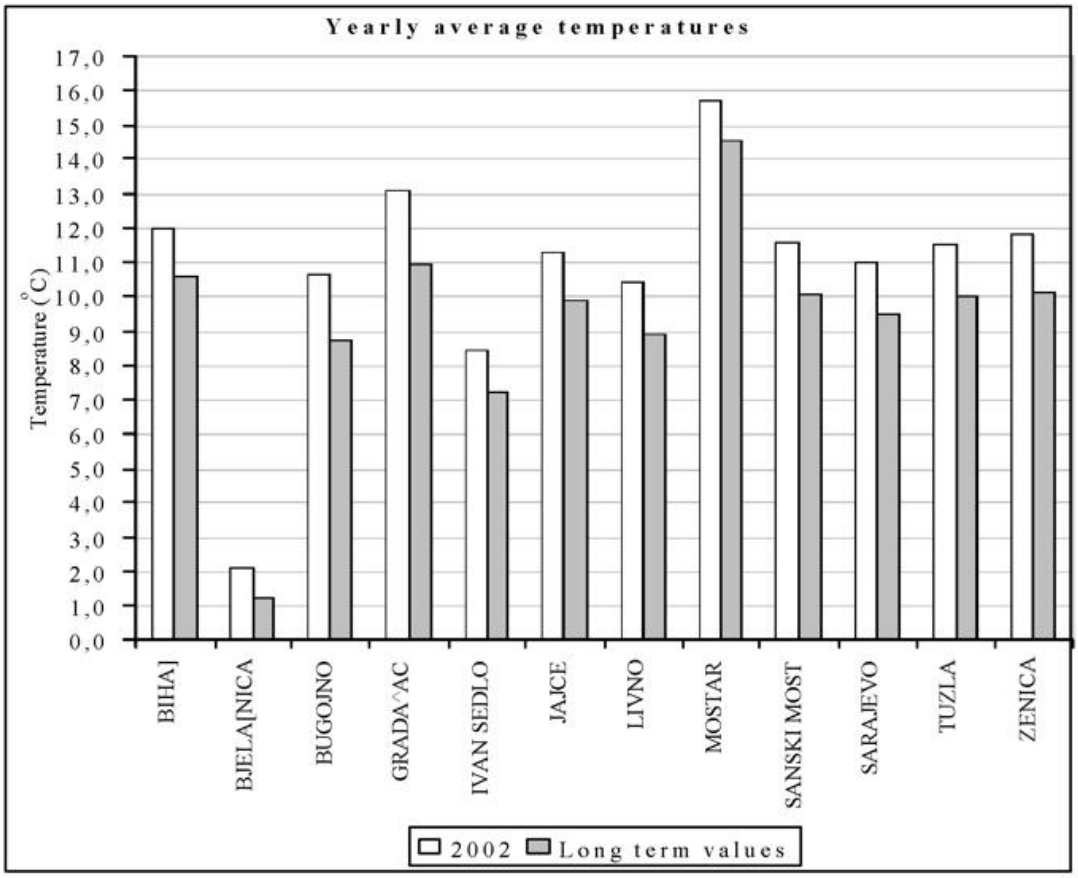


Fig. 0.1: *Yearly average Temperatures in Bosnia-Herzegovina*
From: Federal Meteorological Institute of Bosnia and Herzegovina

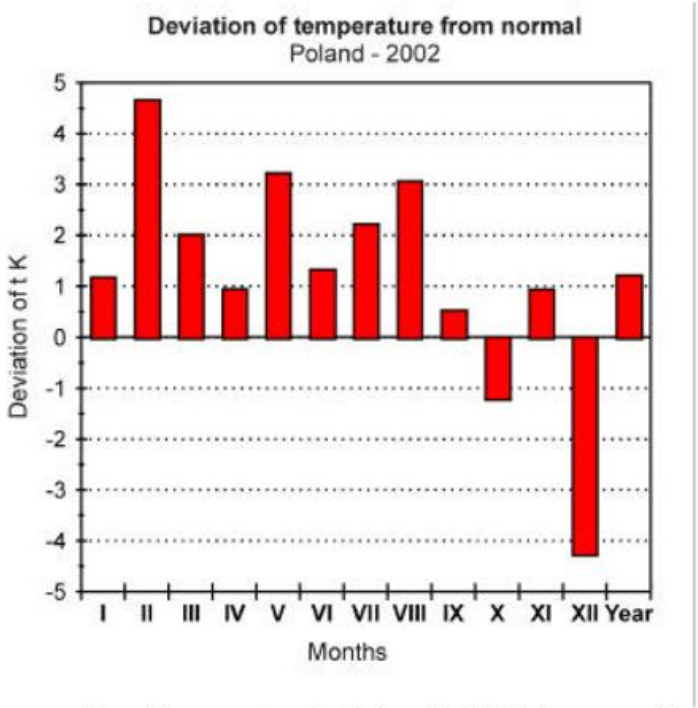


Fig. 0.2: *Mean anomalies of temperature in Poland in 2002 (averages from 8 stations)*
From: Institute of Meteorology and Water Management, Kraków, Poland

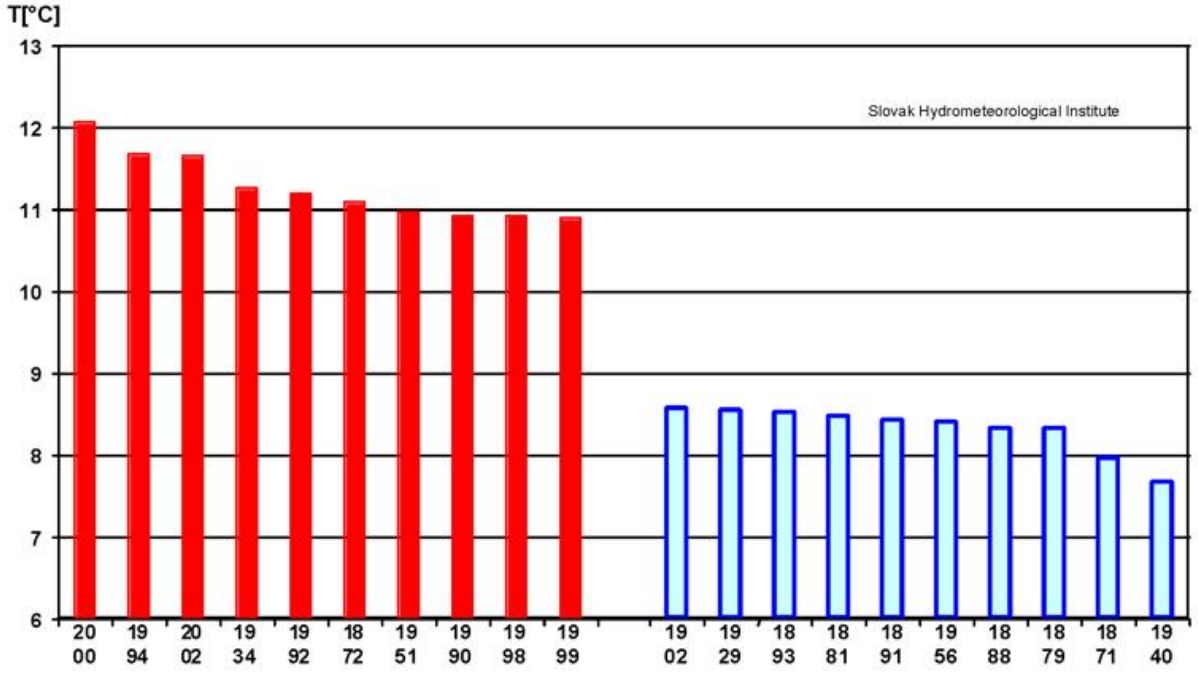


Fig. 0.3: *Ten warmest and ten coldest years at the Hurbanovo Observatory (SW Slovakia, 115m a.s.l.) since 1871*
From: Slovak Hydrometeorological Institute

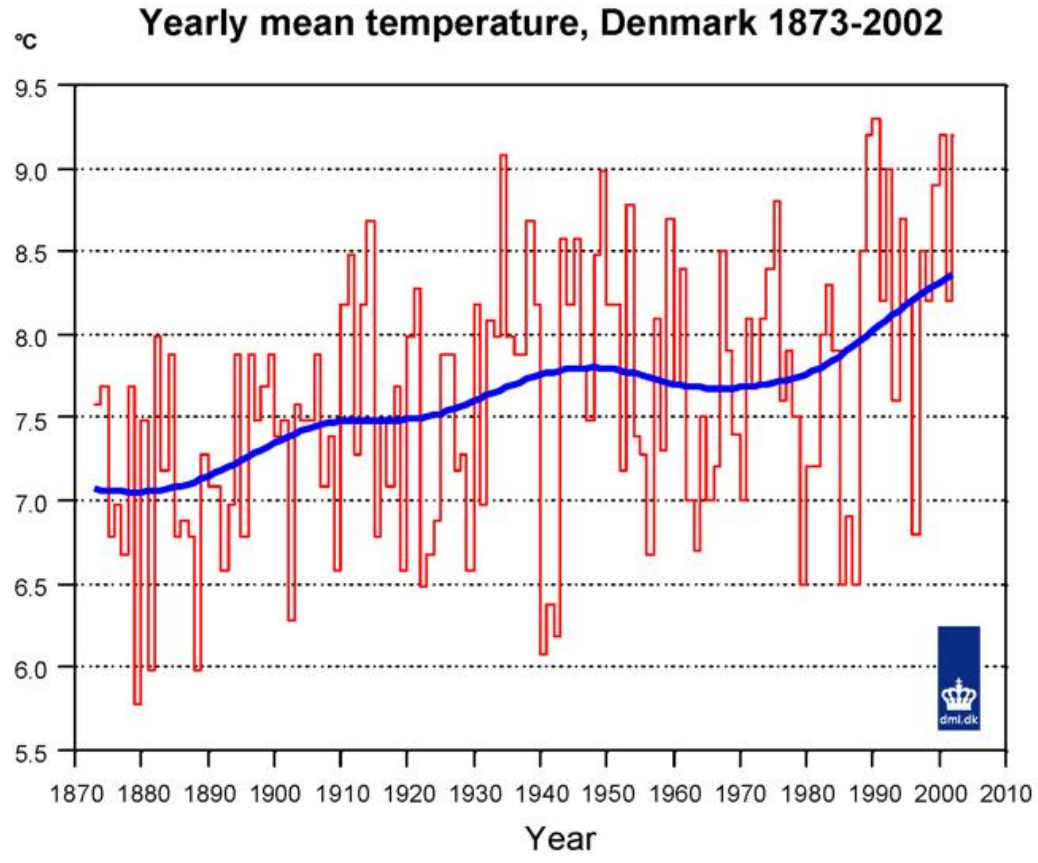
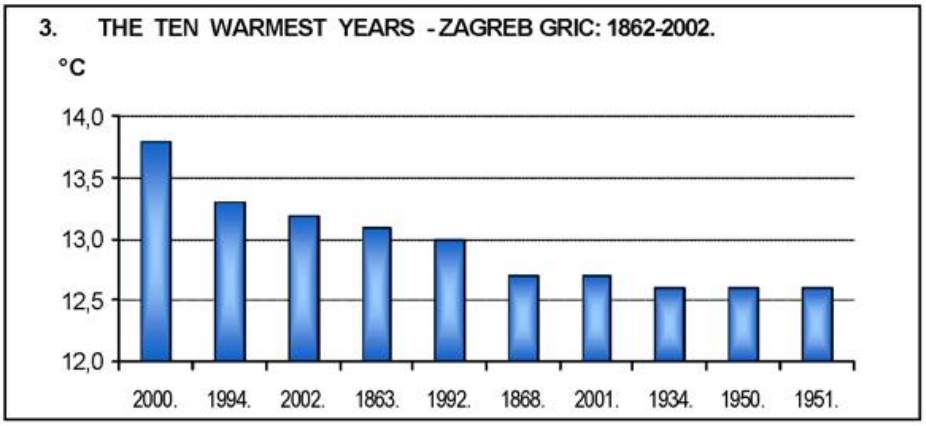


***Fig. 0.4**: Yearly mean temperature in Denmark since 1874, single values and nonlinear trend*
From: Danish Meteorological Institute



THE TEN WARMEST YEARS	
2000.	13,8
1994.	13,3
2002.	13,2
1863.	13,1
1992.	13,0
1868.	12,7
2001.	12,7
1934.	12,6
1950.	12,6
1951.	12,6

***Fig. 0.5:** The ten warmest years in Zagreb since 1862*
From: Meteorological and Hydrological Service, Croatia

Precipitation was above normal in central, north-western and south-eastern Europe except for an area in and around Hungary. Significant deficits to the mean annual accumulated precipitation occurred also near the coastal areas of the Biscay, in the Southeast of Spain, around the middle and northern Baltic Sea as well as in Russia, Turkey and other parts of the Middle East. The surplus precipitation in other parts of the Region as well as the deficits generally did not miss the normal by more than ±50%.

Nevertheless, some records of the yearly precipitation sum were broken; e.g. at station Kvisker, Iceland, the annual total exceeded the previous maximum of 4335 mm (1997) by 7%. This is 36% above normal.

Drought conditions in the Caucasus lasting on from former years, were soothed after the winter months (see figs. 0.6, 4.1, 12.2).

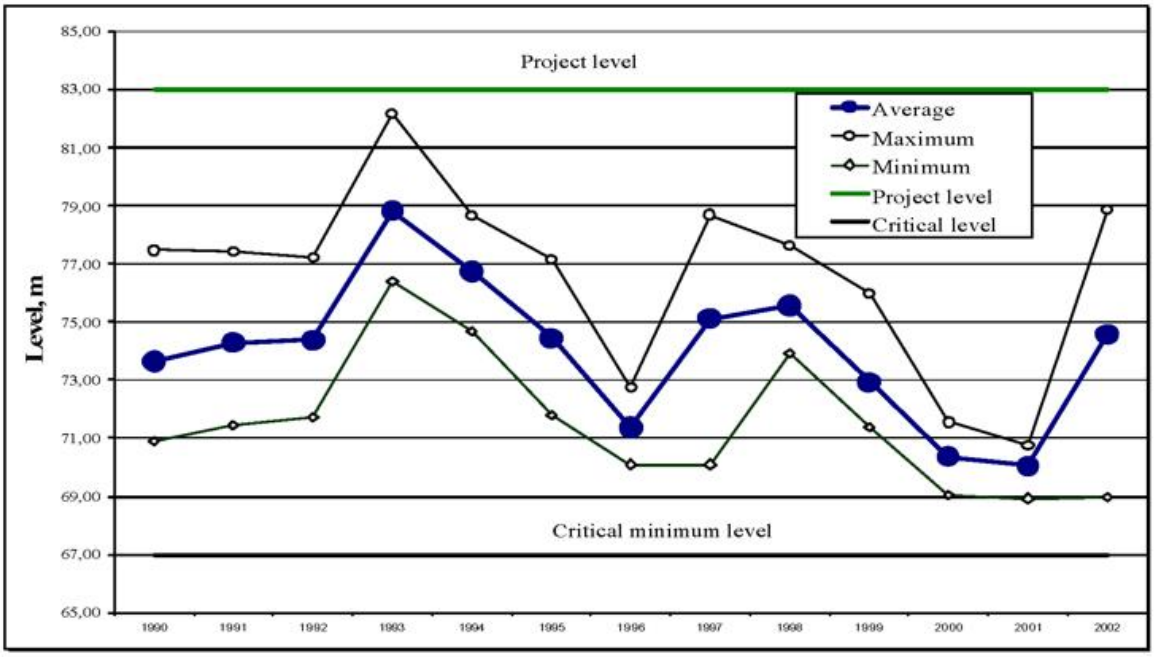


Fig. 0.6: *Annual average, minimal and maximal levels of Mingechevir Water Reservoir, Azerbaijan*
From: Ministry of Ecology and Natural Resources of Azerbaijan

Wind force again caused a lot of damage in the Region, especially at the end of January in northern European countries. But there is also the phenomenon of a considerable decrease of the annual mean wind speed in Belarus during the last five decades (fig. 0.7).

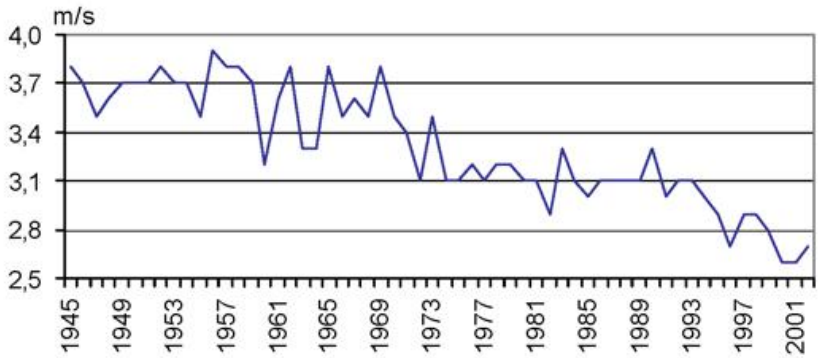


Fig. 0.7: *Mean annual wind speed in Belarus since 1945*
From: Hydrometeorological Centre of Republic Belarus

Seasonal Survey

Winter 2001/2002 was generally mild in terms of mean temperatures above normal except for areas around the Adriatic and the Black Sea. A zone of high positive temperature anomalies is stretching from the British Isles over central Europe to Belarus and central Russia (see figure page 11 above). A remarkable feature was a period of extremely high temperatures starting around the middle of January and lasting for several weeks (see e.g. figs. 1.1 and 1.2). Northern Scandinavia and especially Svalbard had extremely mild winter season. There were many areas with extremely low precipitation. Most of the Iberian peninsula and southern France received less than 50% of the usual precipitation in the reference period. This situation and partly even worse was given in parts of Italy, south-eastern Austria, some Balkan countries, especially Romania, and the Ukraine (see figure page 15 above).

Spring 2002 was generally warmer than normal. The highest positive temperature anomalies up to +3°C were observed in a coherent area of parts of Sweden, Finland, Poland, the Baltic countries and Belarus (see figure page 12 above). It was the warmest spring in a century in Lithuania. The spatial distribution of the seasonal precipitation totals looks rather patchy all over the Region. There are many centres of relatively high and low precipitation rates against normal (see figure page 15 below). The long lasting drought in southern France ended in May. Despite some local relief in March the drought situation in Romania continued and even worsened till the end of the season.

Summer 2002 was warmer than normal nearly all over the Region (see figure page 13 above). In Lithuania, Latvia, Sweden (see fig. 0.9) and in parts of Norway it was the hottest summer since the beginning of observations. Areas of minimum precipitation were the southern Iberian peninsula and central Russia (see figure page 16 above). Other countries like Denmark and Hungary experienced a mixture of intense rainfall with flooding as well as drought periods. Intense and continuous rain over central eastern Europe did not only lift the water balance of the whole season, but firstly caused catastrophic damage to the infrastructure and to people in Czech Republic, Austria and eastern Germany in an extent, that was not known before (see special report on pages 55-62).

Autumn 2002 had negative temperature anomalies in north-eastern Europe with a centre in Finland. Else there were seasonal mean temperatures mostly above normal with relatively high deviations in England, Iceland and the adjacent seas. Maximum temperature anomalies of about +3°C were observed in the Caucasus area (see figure 14 above). It was the third wettest fall across England and Wales as a whole since 1766. Additionally, central Europe as well as Portugal, Greece, the Ukraine and southern Russia received much more precipitation compared to the reference period 1961-1990 (figure page 16 below).

***Note**: Plus signs in figures on pages 11-14 below indicate anomalies exceeding the 98th percentile of a modified 2-parameter gamma distribution fitted to 1961-1990 data (Horton et al. 2001)*

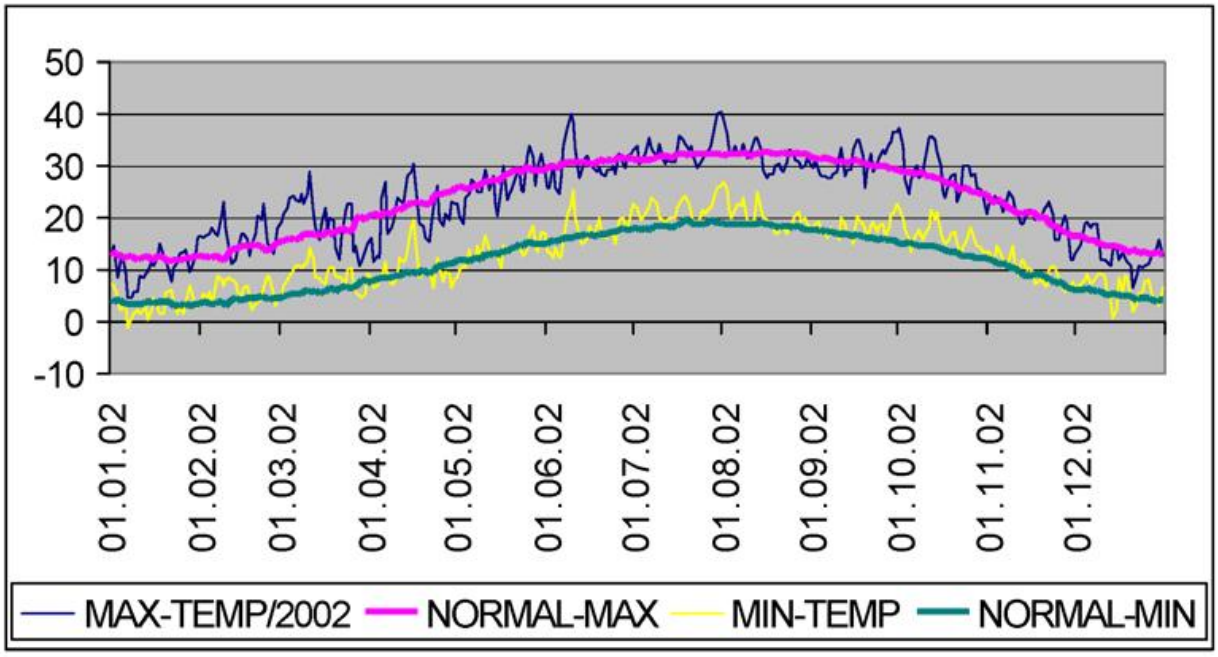


Fig. 0.8: *Daily extreme temperatures in °C at Amman Airport, Jordan, in 2002 and their long term averages*

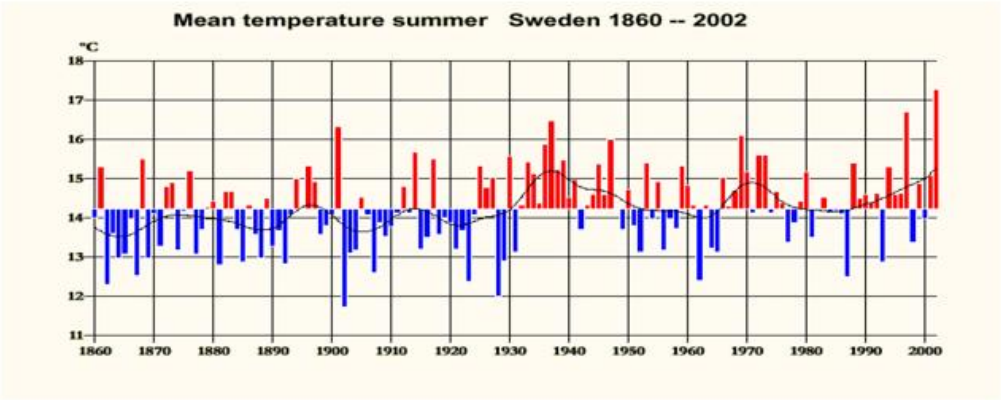
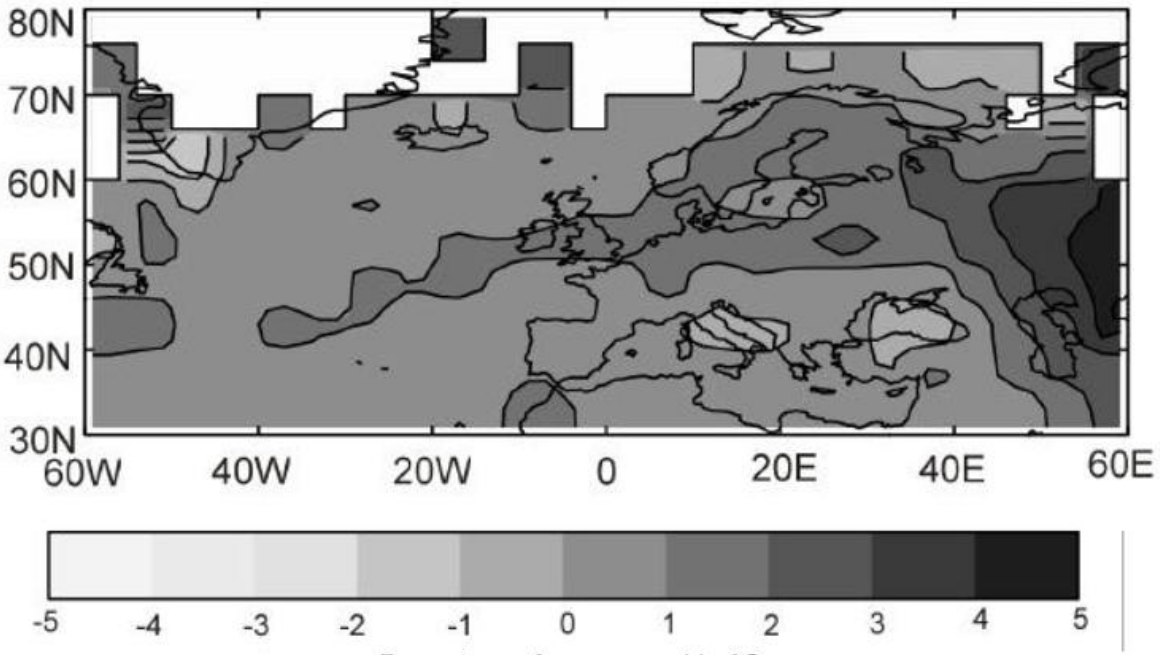


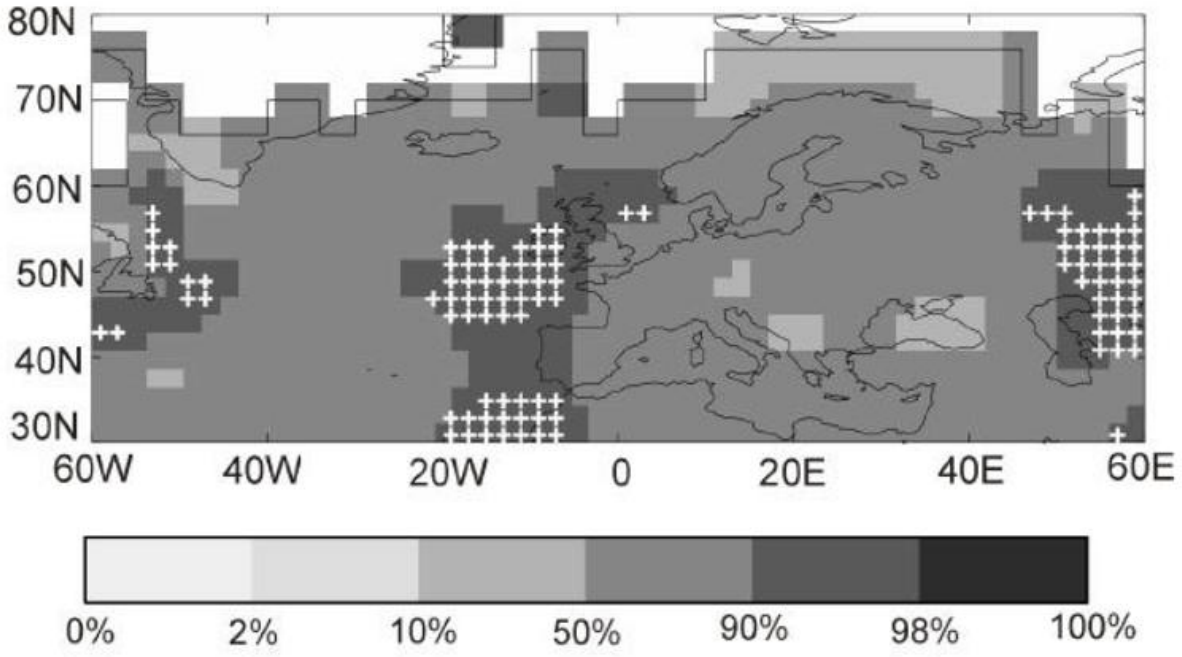
Fig. 0.9: *Summer temperatures in Sweden since 1860 with running and long term average From: Swedish Meteorological and Hydrological Institute*

Seasonal Maps

Surface temperature anomalies: December 2001 - February 2002

From: Hadley Centre of Climate Prediction and Research, U.K.

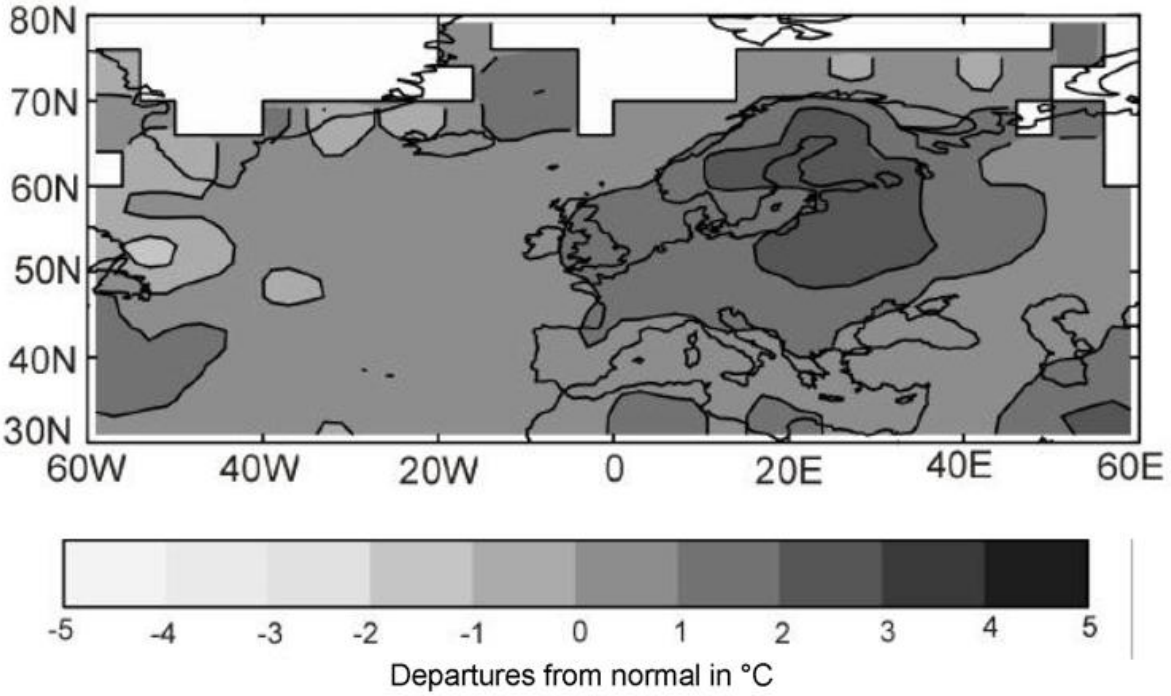


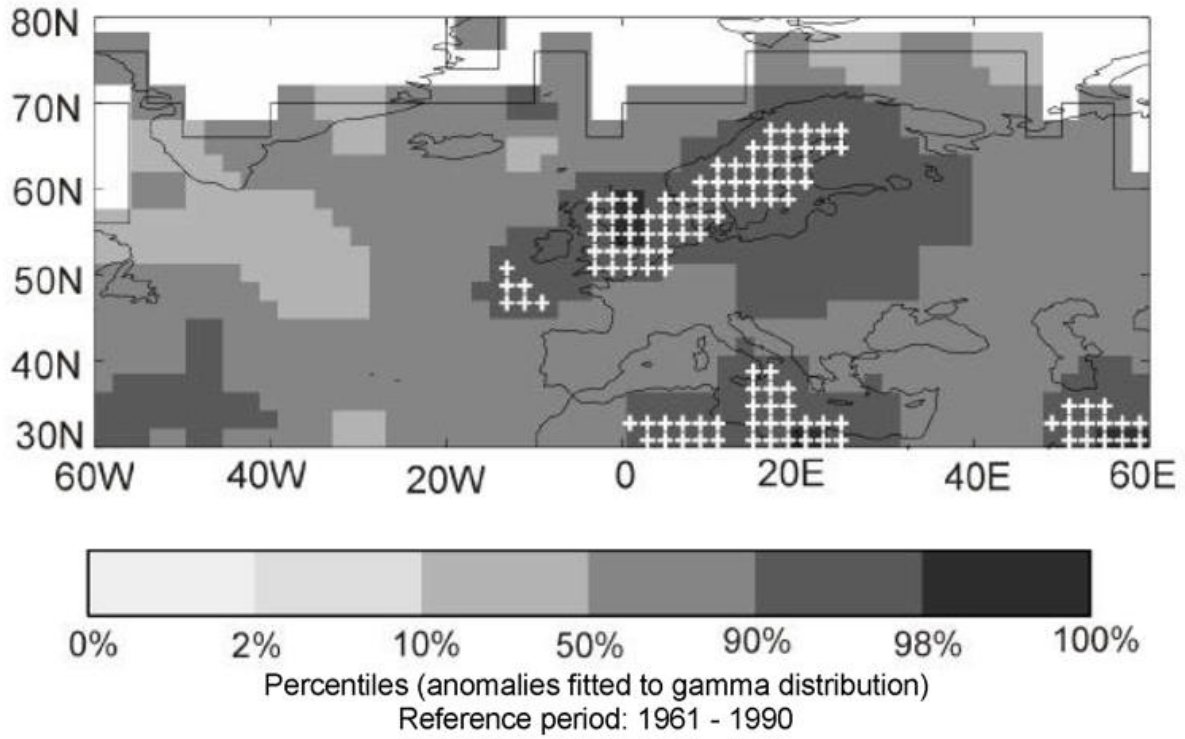


Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 – 1990

Surface temperature anomalies: March 2002 - May 2002

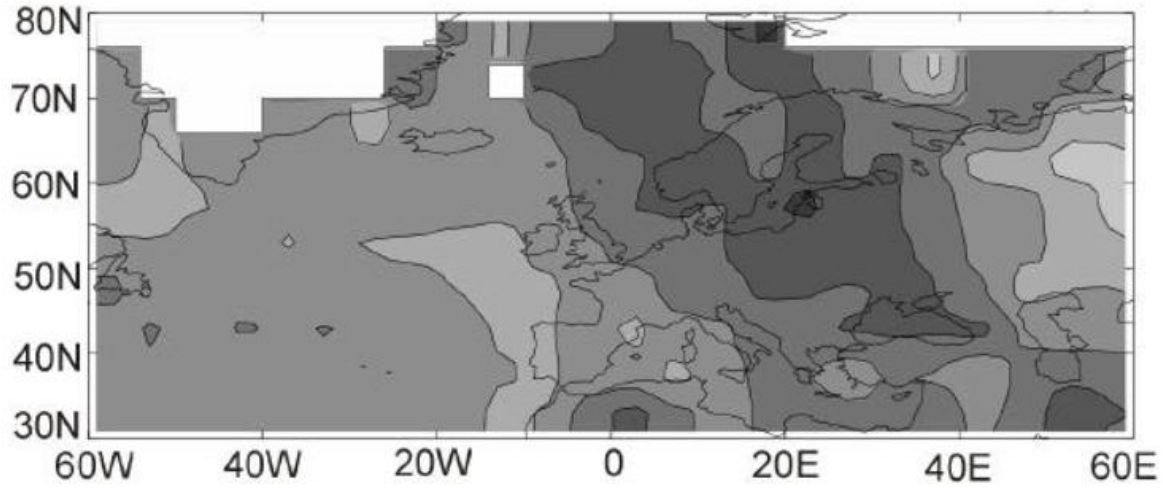
From: Hadley Centre of Climate Prediction and Research, U.K.

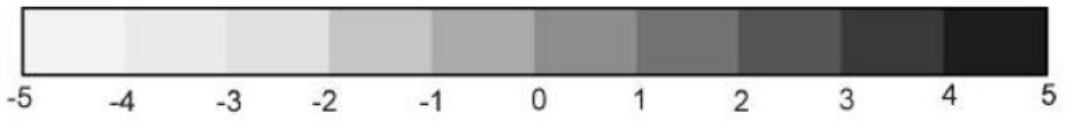




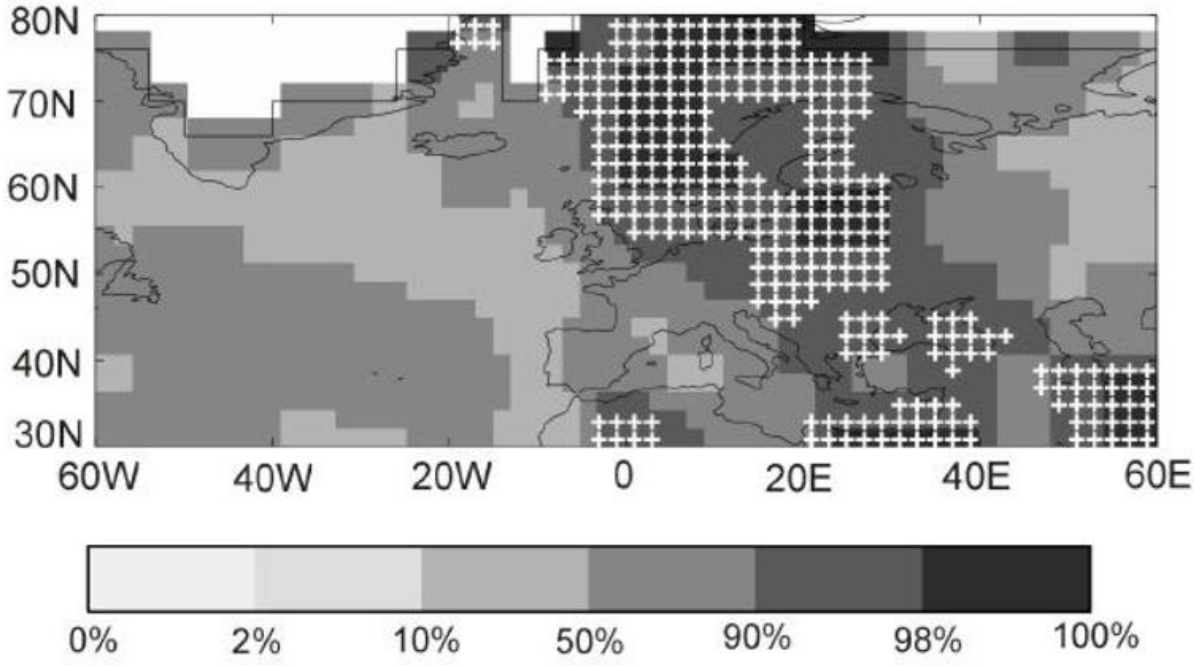
Surface temperature anomalies: June 2002 - August 2002

From: Hadley Centre of Climate Prediction and Research, U.K.





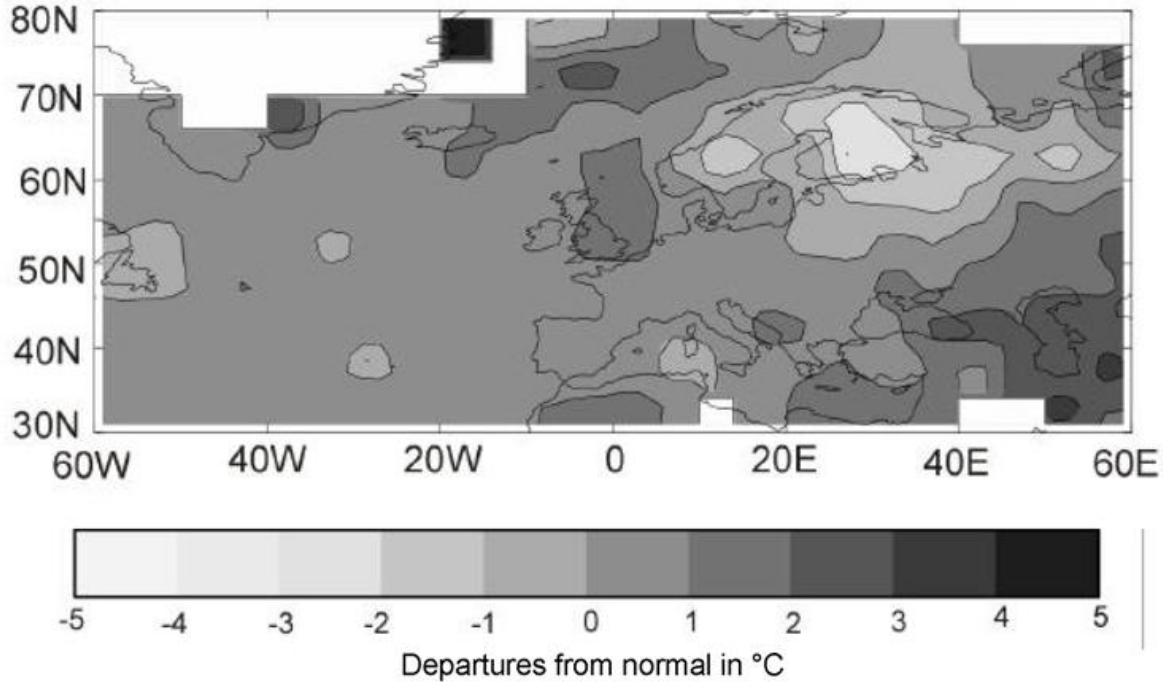
Departures from normal in °C

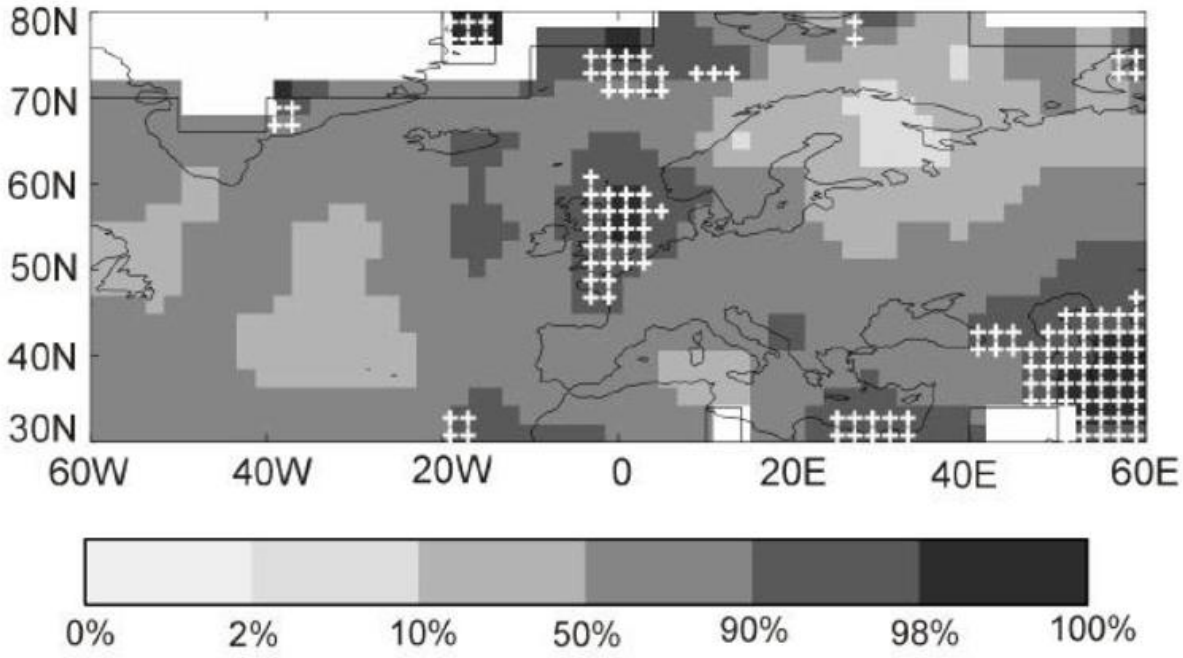


Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 - 1990

Surface temperature anomalies: September 2002 - November 2002

From: Hadley Centre of Climate Prediction and Research, U.K.



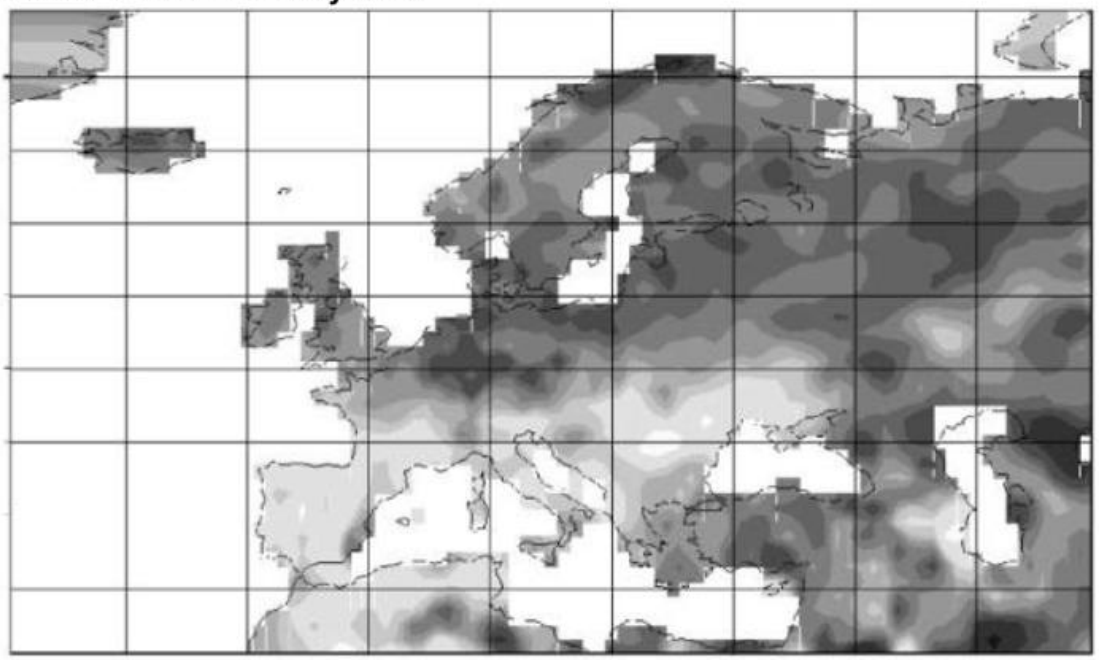


Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 – 1990

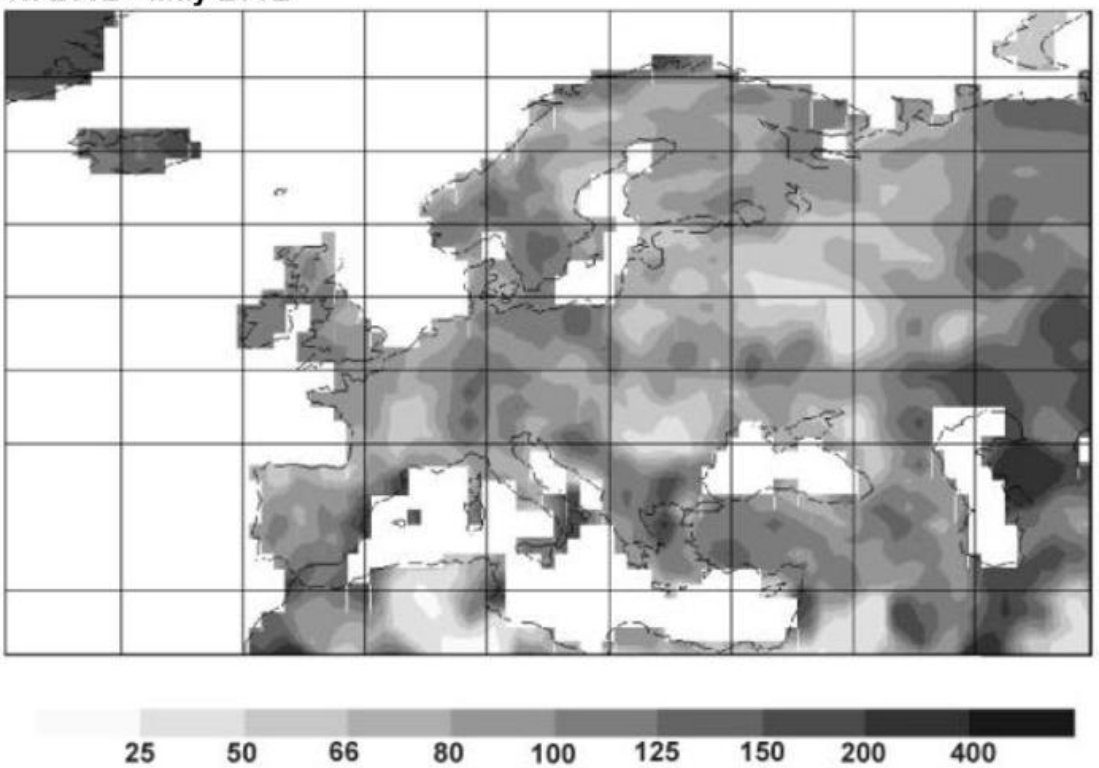
Precipitation in percent of normal
Gauge - Based Analysis 1.0 degree, reference period: 1961 - 1990

From: GPCC / Deutscher Wetterdienst Germany

December 2001 - February 2002



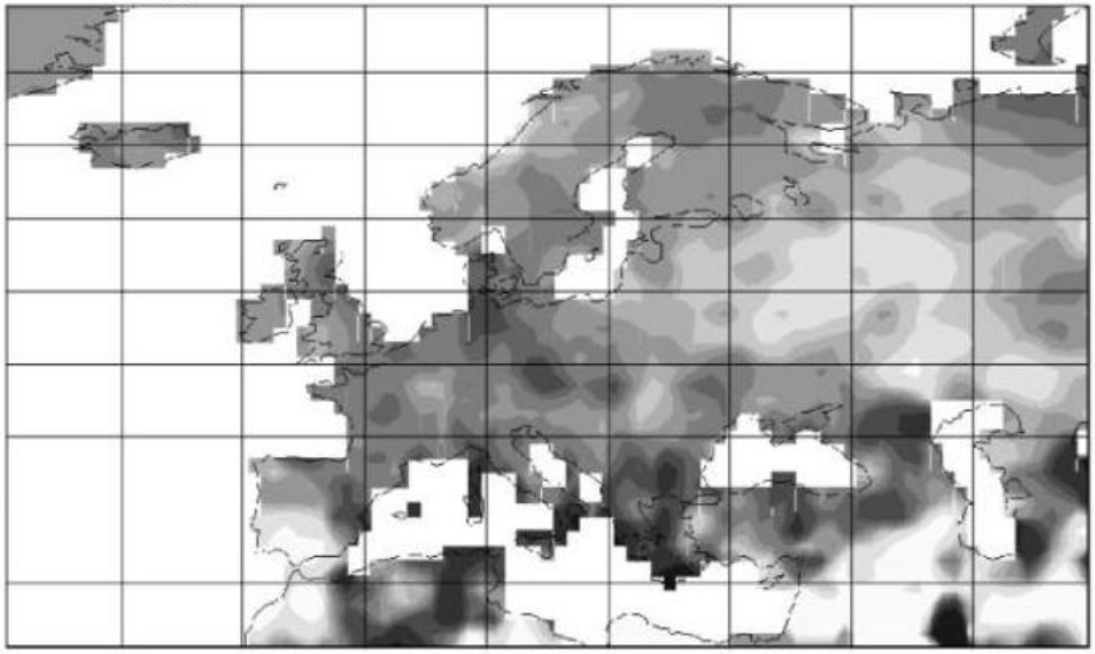
March 2002 - May 2002



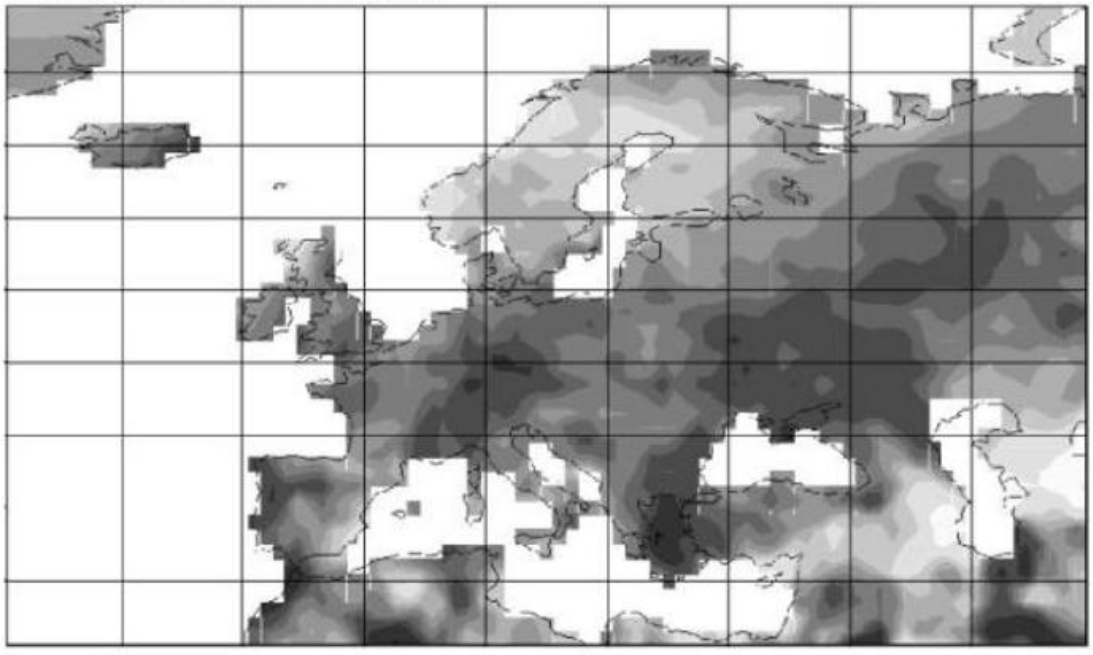
Precipitation in percent of normal
Gauge - Based Analysis 1.0 degree, reference period: 1961 - 1990

From: GPCC / Deutscher Wetterdienst Germany

June 2002 - August 2002



September 2002 - November 2002





Monthly and Annual Tables

Temperature and precipitation values with departures from their 1961-1990 means

WMO No.	Station	January 2002 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	February 2002 Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	Svalbard	-12,7	2,7	21	7	-13,6	2,1	3	-16
01025	Tromsø	-2,6	1,4	165	84	-3,0	0,7	95	9
01492	Oslo-Blindern	-2,8	1,5	75	26	0,6	4,6	58	22
02196	Haparanda	-11,1	1,0	30	-14	-6,1	5,2	68	36
02485	Stockholm	-0,3	2,5	63	24	2,0	5,0	42	15
02974	Helsinki-Vantaa	-3,6	3,3	69	28	-0,9	5,9	52	21
03091	Aberdeen	4,7	1,8	52	-28	4,5	1,4	64	12
03772	London-Heathrow	6,9	2,7	51	-1	8,4	3,9	64	29
03967	Dublin (Casement)	7,2	2,8	62	-4	6,6	2,2	128	77
04030	Reykjavik	1,4	1,9	117	41	-3,3	-3,7	42	-29
04320	Danmarkshaven	-21,9	1,2	17	6	-23,2	1,1	24	13
04360	Angmagssalik	-5,4	2,1	97	-15	-9,0	-1,3	70	-21
06186	København-Landb.	2,4	1,9	57	6	4,2	3,7	73	42
06260	De Bilt	4,4	2,2	78	12	7,1	4,6	139	90
06447	Uccle	4,6	2,0	90	23	7,1	3,6	168	115
06590	Luxembourg	0,4	0,2	49	-22	5,3	3,9	145	85
06660	Zürich	0,8	0,9	25	-45	5,7	4,8	85	12
06700	Genève	1,4	0,7	44	-36	6,3	4,3	79	-2
07510	Bordeaux	7,8	2,0	22	-78	9,3	2,2	54	-31
07650	Marseille	6,4	-0,3	23	-24	9,8	1,9	76	22
08222	Madrid	7,2	1,2	57	11	9,0	1,6	14	-32
08314	Mahon / Menorca	11,0	0,3	32	-29	11,8	1,1	13	-40
08495	Gibraltar	15,0	1,6	24	-97	15,2	1,4	112	12
08515	St. Maria / Acores	14,9	0,5	76	-24	14,7	0,7	94	8
08535	Lisboa	12,5	1,1	76	-34	13,4	1,1	33	-78
10384	Berlin-Tempelhof	2,2	2,4	38	-5	5,5	4,7	90	56
11035	Wien-Hohe Warte	1,5	2,2	13	-25	6,2	4,9	37	-5
11518	Praha-Ruzyne	-0,1	2,3	13	-11	4,1	4,7	45	22
11903	Slica	-4,3	-0,4	18	-26	1,8	2,9	62	18
12160	Elblag	0,2	2,6	50	3	3,7	5,9	45	20
12375	Warszawa-Okecie	-0,7	2,6	38	16	3,6	5,6	72	51
12843	Budapest-Lorinc	0,0	1,6	7	-25	4,9	3,8	12	-20
13274	Beograd	1,2	0,8	15	-34	8,5	5,8	14	-30
14015	Ljubljana	-0,6	0,5	20	-62	5,0	3,6	68	-12
14445	Split	6,8	-0,6	58	-25	10,5	2,4	67	-1
14654	Sarajevo	-1,9	-1,0	41	-30	5,8	4,3	25	-42
15420	Bucuresti	-2,8	-0,4	14	-26	4,4	4,5	17	-19
15614	Sofia	-2,1	-0,5	10	-17	4,9	4,4	17	-16
16158	Pisa	4,5	-1,6	29	-46	9,0	1,9	56	-17
16597	Luqa / Malta	11,5	-0,7	22	-67	13,8	1,4	61	0
16716	Athens (Hellinikon)	8,5	-1,7	33	-11	12,6	2,0	10	-33
16754	Heraklion / Kreta	11,1	-0,9	85	-5	13,5	1,4	14	-63
17040	Rize	5,3	-1,0	172	-45	7,9	1,3	118	-55
17062	Istanbul-Goztepe	4,9	-0,7	56	-43	8,9	3,0	35	-32
17130	Ankara / Central	-3,8	-3,9	30	-17	5,0	3,1	12	-24
17170	Van	-3,3	0,9	31	-4	-0,8	2,6	8	-26
17609	Larnaca	10,4	-1,1	68	3	13,5	1,8	27	-30
22113	Murmansk	-9,6	2,1	32	-1	-9,1	2,1	22	0
26038	Tallina	-1,8	3,7	58	13	0,3	6,0	52	23
26629	Kaunas	-1,5	3,5	62	25	2,0	6,3	66	39
26730	Vilnius	-2,5	3,6	56	15	1,3	6,1	77	39
26850	Minsk	-3,0	3,9	51	11	1,4	7,2	51	17
27199	Wjatka (Kirov)	-9,5	4,7	69	31	-4,2	7,6	75	47
27612	Moskva	-4,8	4,5	48	3	-0,4	7,3	49	12
33345	Kiev	-2,6	3,0	22	-25	3,7	7,9	38	-8
33815	Chisinau	-1,7	1,6	16	-24	4,9	6,6	2	-36
34300	Charkov (Kharkiv)	-4,7	2,2	12	-32	2,0	7,7	27	-5
34880	Astrahan'	-3,1	2,3	10	-3	2,3	7,2	16	6
35188	Akmola	-6,3	9,5	25	8	-5,6	10,3	25	11
37789	Yerevan	-2,7	0,8	22	1	3,5	4,5	11	-13
40080	Damascus	5,4	-0,8	36	1	9,4	1,5	19	-13
40100	Beyrouth	13,5	-0,1	206	-16	16,6	3,1	67	-69
40180	Tel Aviv (Airport)	11,8	-0,5	200	51	14,9	2,0	71	-27
40270	Amman	6,5	-2,6	103	41	10,6	0,6	14	-40
60030	Las Palmas / Gr. Can	18,8	1,3	47	30	19,0	1,4	3	-19

	March 2002				April 2002				May 2002			
WMO No.	Temp mean	(°C) dep.	Prec sum	(mm) Dep.	Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	-18,3	-3,6	4	-17	-6,1	5.6	15	3	-3,3	0.4	4	-2
01025	-1,5	0,7	98	34	4,1	3.4	54	-6	7,7	2.8	41	-7
01492	2,1	2,3	32	-14	6,9	2.3	40	-2	12,9	2.1	99	47
02196	-5,4	1,4	32	-3	2,5	3.0	23	-6	8,4	2.3	30	-1
02485	2,5	2,4	27	1	7,4	2.8	8	-22	12,6	1.9	34	4
02974	0,3	3,2	38	4	5,7	2.8	8	-29	12,0	2.1	26	-9
03091	5,9	1,3	34	-27	7,6	1.2	27	-26	10,5	1.5	54	-5
03772	8,8	2,3	38	-9	10,9	2.0	38	-7	13,4	0.9	66	15
03967	7,4	1,4	28	-21	8,4	0.6	77	30	11,2	0.7	83	25
04030	0,3	-0,2	91	8	3,9	1.0	90	32	7,2	0.9	23	-21
04320	-23,1	0,3	7	-10	-17,9	-0.6	36	26	-5,8	0.8	8	4
04360	-7,2	1,0	101	13	-2,5	1.6	61	-12	1,3	0.7	49	-8
06186	4,6	2,0	27	-15	7,4	0.8	17	-25	13,4	1.4	53	10
06260	7,2	2,2	33	-30	9,3	1.3	49	-3	13,4	1.1	35	-26
06447	7,8	2,3	66	12	9,9	1.1	42	-15	13,6	0.7	57	-14
06590	6,5	2,2	69	1	9,0	1.2	41	-19	12,8	0.7	63	-14
06660	7,2	2,8	58	-15	9,1	1.1	70	-24	13,0	0.9	180	77
06700	7,8	2,8	57	-21	10,5	1.8	23	-42	13,4	0.2	149	83
07510	11,1	2,3	29	-47	12,7	1.4	40	-32	15,1	0.5	93	16
07650	12,7	2,5	46	2	14,8	1.6	32	-16	17,3	0.2	93	51
08222	11,3	1,3	51	18	13,7	1.5	47	-7	15,6	-0.5	46	5
08314	13,6	1,8	68	19	14,9	1.2	63	18	17,6	0.6	54	21
08495	15,2	0,2	94	19	16,8	0.6	67	7	18,7	0.2	23	-12
08515	13,7	-0,9	91	12	15,9	0.7	4	-51	17,7	1.0	22	-8
08535	14,9	1,2	90	21	15,5	0.4	43	-21	16,8	-0.6	17	-22
10384	5,7	1,5	44	7	8,8	0.2	38	-3	15,8	1.9	67	11
11035	7,2	1,9	65	24	10,1	-0.1	57	7	17,5	2.7	47	-14
11518	4,6	1,6	27	-1	8,0	0.3	26	-12	15,1	2.4	59	-18
11903	5,0	2,0	26	-16	8,7	0.2	32	-15	16,6	2.9	63	-1
12160	4,4	2,3	43	8	8,3	1.5	16	-26	17,1	4.2	70	29
12375	4,5	2,5	37	9	9,0	1.2	17	-15	17,4	4.0	44	-15
12843	7,9	2,3	25	-4	11,5	0.4	50	12	19,1	3.1	28	-27
13274	10,3	3,1	15	-35	12,1	-0.3	54	-5	20,1	2.9	21	-50
14015	8,9	3,5	44	-54	10,1	0.2	130	21	17,2	2.6	91	-31
14445	13,0	2,6	12	-63	15,0	1.1	61	-5	20,0	1.6	83	27
14654	8,3	3,2	46	-24	9,4	0.0	114	40	15,6	1.5	80	-2
15420	7,7	2,9	22	-16	9,5	-1.8	26	-20	17,9	1.2	10	-60
15614	7,4	2,8	63	25	8,9	-1.0	40	-10	15,8	1.5	67	-6
16158	11,4	1,9	5	-71	13,0	0.5	64	-15	16,9	0.6	66	7
16597	15,5	2,1	9	-31	16,9	1.4	6	-17	19,5	0.4	9	2
16716	13,4	0,8	47	6	15,8	-0.3	38	13	21,9	1.3	1	-16
16754	14,7	1,3	33	-23	16,9	0.6	18	-12	20,4	0.6	0	-16
17040	9,7	1,8	89	-58	10,5	-1.1	97	-4	16,5	0.7	24	-78
17062	9,4	1,9	61	-1	11,1	-0.9	47	-2	16,9	0.4	20	-11
17130	8,6	2,5	23	-13	10,4	-0.8	101	53	16,7	1.2	39	-16
17170	3,4	2,3	67	24	6,9	-0.4	107	53	12,3	-0.4	55	6
17609	15,2	1,9	39	-10	16,7	-0.7	49	38	20,6	-0.3	4	-3
22113	-6,6	0,2	35	15	1,2	3.1	12	-9	4,5	0.7	25	-7
26038	1,2	3,4	42	13	5,5	2.1	5	-31	12,1	2.4	11	-26
26629	3,3	3,5	40	8	8,2	2.2	28	-15	15,7	3.0	30	-26
26730	2,6	3,2	33	-6	8,0	2.3	31	-15	15,3	2.8	32	-30
26850	3,1	4,5	24	-18	8,4	2.4	43	1	15,1	2.2	59	-3
27199	-1,6	3,5	71	42	3,8	0.6	9	-27	8,0	-3.1	44	-5
27612	2,2	4,4	29	-5	7,2	1.4	14	-26	12,7	-0.2	18	-40
33345	5,5	4,8	17	-22	9,9	1.2	40	-9	16,5	1.4	65	12
33815	7,2	4,3	59	24	10,4	0.2	31	-11	18,0	1.9		
34300	4,9	5,2	26	-1	9,6	0.7	12	-24	15,5	-0.1	48	1
34880	6,9	5,6	9	-5	9,6	-1.5	18	0	15,2	-3.1	34	10
35188	0,9	9,0	29	15	4,2	-0.7	46	24	12,1	-1.0	45	12
37789	7,7	1,9	24	-8	9,7	-3,0	97	60	14,6	-2,9	56	13
40080	13,2	2,0	15	-9	16,5	0.8	6	-6	21,0	0.6	<1	-5
40100	17,5	2,4	102	-18	18,7	0.9	113	62	21,4	1.0	4	-16
40180	17,4	2,5	44	-18	18,7	0.5	32	9	21,3	0.2	8	5
40270	13,9	1,0	42	-9	15,3	-2.5	20	3	19,9	-2.0	NIL	NIL
60030	19,6	1,2	3	-7	20,3	1.6	11	5	20,7	0.8	2	0

WMO No.	Station	June 2002 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	July 2002 Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	Svalbard	3,7	1.5	6	-4	7,1	1,1	7	-6
01025	Tromsø	10,8	1.5	30	-23	13,2	1,5	48	-24
01492	Oslo-Blindern	16,6	1.4	54	-11	17,4	1,0	133	49
02196	Haparanda	15,7	2.9	73	32	17,4	1,9	82	32
02485	Stockholm	17,5	1.9	94	49	19,2	2,0	108	36
02974	Helsinki-Vantaa	16,4	1.5	68	24	19,3	2,7	57	-16
03091	Aberdeen	13,0	0.9	107	54	14,0	0,2	101	40
03772	London-Heathrow	15,8	0.1	74	23	17,9	0,1	67	21
03967	Dublin (Casement)	13,0	-0.3	80	32	14,5	-0,4	74	20
04030	Reykjavik	10,8	1.7	34	-17	10,6	0,0	45	-6
04320	Danmarkshaven	3,5	2.8	6	1	3,5	-0,2	13	-1
04360	Angmagssalik	6,5	2.4	85	33	6,8	0,4	53	4
06186	København-Landb.	16,5	0.4	49	-5	18,3	1,1	74	5
06260	De Bilt	16,5	1.3	85	17	17,6	0,8	97	22
06447	Uccle	17,1	1.4	72	-7	17,8	0,3	97	22
06590	Luxembourg	17,4	2,1	33	-36	17,5	0,4	58	-9
06660	Zürich	19,3	4.1	85	-39	18,2	0,5	110	-8
06700	Genève	20,5	3.8	64	-16	19,9	0,8	118	53
07510	Bordeaux	19,1	1.3	31	-25	19,7	-0,5	29	-18
07650	Marseille	22,8	1.9	71	43	23,8	0,0	17	3
08222	Madrid	23,5	2.9	28	1	24,8	0,4	2	-11
08314	Mahon / Menorca	22,8	1.8	23	8	23,9	-0,4	54	49
08495	Gibraltar	21,3	0.2	13	2	24,0	0,3	0	-1
08515	St. Maria / Acores	19,2	0,5	52	30	21,1	0,3	14	-11
08535	Lisboa	19,7	-0.5	7	-14	21,8	-0,6	<1	-5
10384	Berlin-Tempelhof	18,0	0.6	31	-44	19,6	0,8	56	4
11035	Wien-Hohe Warte	20,5	2.5	69	-5	21,7	1,8	52	-10
11518	Praha-Ruzyne	17,5	1.6	82	9	18,5	1,0	100	34
11903	Slica	18,6	2.0	65	-20	20,8	2,6	167	108
12160	Elblag	16,4	1.0	106	12	19,9	3,1	47	-47
12375	Warszawa-Okecie	17,6	1.0	55	-17	21,1	3,2	23	-44
12843	Budapest-Lorinc	21,3	2.2	51	-12	23,6	2,7	79	27
13274	Beograd	22,9	2.8	80	-10	24,2	2,5	61	-5
14015	Ljubljana	21,1	3.3	176	21	21,3	1,4	127	5
14445	Split	25,1	2.9	24	-27	26,6	1,2	16	-12
14654	Sarajevo	19,4	2.5	51	-40	20,3	1,4	77	-2
15420	Bucuresti	21,8	1.6	109	32	23,8	1,8	92	28
15614	Sofia	20,0	2.3	38	-34	21,9	1,9	82	26
16158	Pisa	22,2	2.4	60	16	23,3	0,5	99	76
16597	Luqa / Malta	24,6	1.6	<1	-3	27,1	1,2	<1	1
16716	Athens (Hellinikon)	27,2	2.1	1	-7	29,5	1,7	7	2
16754	Heraklion / Kreta	24,6	1.1	0	-3	27,9	2,2	5	4
17040	Rize	20,8	0.9	152	24	25,4	3,2	203	67
17062	Istanbul-Goztepe	22,7	1.6	8	-13	26,6	3,4	4	-15
17130	Ankara / Central	20,8	1.2	28	-9	24,8	1,9	35	21
17170	Van	17,9	0.3	20	-1	22,6	0,7	3	-1
17609	Larnaca	25,5	1.2	<1	-1	28,4	1,5	0	0
22113	Murmansk	9,1	-0.3	67	14	14,3	1,5	73	13
26038	Tallina	15,6	1.1	82	29	18,8	2,5	86	7
26629	Kaunas	16,8	0.8	93	18	20,6	3,5	54	-14
26730	Vilnius	16,7	0.9	70	-7	20,8	3,9	34	-44
26850	Minsk	17,1	1.0	63	-20	22,0	4,7	35	-53
27199	Wjatka (Kirov)	15,5	-0.1	73	9	20,8	2,6	47	-39
27612	Moskva	17,4	0.8	42	-34	22,6	4,5	24	-68
33345	Kiev	18,4	0.2	190	117	23,9	4,6	13	-75
33815	Chisinau	20,1	0.7	53	-22	24,2	3,3	134	65
34300	Charkov (Kharkiv)	19,0	0.1	50	-8	24,9	4,6	91	31
34880	Astrahan'	20,4	-2.5	24	2	27,1	1,8	1	-22
35188	Akmola	17,4	-1.6	72	37	19,4	-1,9	22	-28
37789	Yerevan	21,0	-0,9	12	-9	25,2	-0,8	28	18
40080	Damascus	25,2	0.6	0	-1	28,7	2,1	0	0
40100	Beyrouth	25,2	1.6	0	-1	27,9	2,4	0	0
40180	Tel Aviv (Airport)	25,5	1.5	0	0	28,2	2,5	0	0
40270	Amman	23,6	-1.4	0	0	27,1	0,7	NIL	NIL
60030	Las Palmas / Gr. Can	22,2	0.8	3	3	22,8	-0,5	<1	1

	August 2002				September 2002				October 2002			
WMO No.	Temp mean	(°C) dep.	Prec sum	(mm) Dep.	Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	7,5	2,7	27	4	0,1	-0.4	16	-7	-3,0	2,5	26	11
01025	12,5	1,6	121	42	7,4	0.6	130	36	0,6	-2,3	65	-60
01492	20,2	5,0	35	-54	13,1	2.3	97	7	3,4	-3,0	100	16
02196	16,4	3,1	8	-55	7,9	0.0	33	-30	-1,3	-3,8	22	-42
02485	21,3	5,1	3	-63	13,6	2.4	13	-42	4,1	-3,4	45	-5
02974	19,3	4,3	18	-62	11,2	1.2	22	-51	0,6	-4,8	37	-36
03091	15,0	1,4	108	33	12,9	1.2	16	-52	8,2	-0,9	230	152
03772	19,0	1,6	36	-15	15,9	0.9	20	-31	11,8	0,1	62	4
03967	15,3	0,7	65	-13	13,1	0.1	9	-60	9,7	-0,6	179	111
04030	10,2	-0,1	77	15	9,4	2.0	124	57	4,9	0,5	69	-17
04320	3,5	1,1	25	11	-1,0	3.2	2	-9	-6,9	6,7	5	-7
04360	5,8	-0,2	66	5	5,1	2.0	137	69	1,0	1,8	134	52
06186	20,5	3,5	86	23	15,1	1.5	8	-54	7,4	-2,5	105	46
06260	18,6	1,9	112	41	14,6	0.6	32	-35	9,5	-1,0	91	19
06447	18,6	1,3	172	109	14,7	0.2	26	-33	10,5	-0,4	105	35
06590	17,9	1,2	118	46	13,4	0,0	49	-21	9,2	-0,1	142	68
06660	17,7	0,8	150	16	13,0	-1.1	123	29	10,1	0,6	128	56
06700	18,6	0,5	90	12	15,1	0,2	29	-51	11,6	1,6	138	64
07510	19,5	-0,4	79	25	17,7	-0.2	64	-10	15,0	1,0	74	-14
07650	23,1	-0,1	64	35	19,3	-1.0	168	121	16,4	0,3	51	-27
08222	23,7	-0,2	7	-2	19,7	-0.8	28	-2	14,8	0,0	68	23
08314	24,2	-0,3	55	29	22,1	-0.1	52	-3	19,4	0,9	97	13
08495	24,1	-0,1	0	-6	21,1	-1.7	22	7	19,9	0,4	204	140
08515	22,6	0,4	28	-12	21,5	0.1	34	-23	18,9	-0,4	100	16
08535	22,1	-0,7	<1	-6	20,1	-1.6	82	56	19,0	0,5	104	24
10384	21,2	2,8	156	95	15,2	0.6	50	5	8,4	-1,6	107	71
11035	20,4	1,2	210	145	14,5	-1,0	44	-1	9,1	-1,0	92	51
11518	19,1	2,1	121	51	12,7	-0.6	43	3	7,8	-0,5	38	8
11903	19,1	1,8	107	38	13,1	-0.3	60	4	7,4	-0,9	89	39
12160	21,5	4,8	34	-47	13,6	0.9	43	-27	6,9	-2,0	138	85
12375	20,7	3,4	141	78	13,7	0.5	31	-12	7,2	-1,1	64	26
12843	21,5	1,2	96	45	16,0	-0.4	45	5	10,1	-0,8	49	15
13274	22,2	0,9	107	55	17,4	-0.3	52	1	13,2	0,8	88	48
14015	20,1	1,0	187	43	15,0	-0.5	88	-42	11,5	1,1	188	73
14445	24,5	-0,7	170	120	20,2	-1.2	189	128	17,1	0,2	72	-7
14654	18,8	0,3	91	20	13,4	-1.7	197	127	11,2	0,8	122	34
15420	20,8	-0,4	35	-23	15,8	-1.1	58	16	9,9	-0,9	85	53
15614	19,2	-0,2	90	38	14,9	-0.9	106	67	10,7	0,3	78	41
16158	22,5	0,0	158	101	18,8	-0.7	189	100	15,8	0,5	110	-10
16597	26,4	0,1	17	10	24,0	-0.1	21	-19	21,3	0,6	22	-68
16716	27,5	-0,1	22	17	24,0	-0.2	62	52	19,9	0,6	41	-11
16754	27,4	1,8	25	24	24,5	1.4	74	56	20,6	0,9	61	-15
17040	24,3	2,1	125	-58	21,9	2.5	249	28	17,9	2,5	346	74
17062	24,6	1,6	137	111	20,4	0.7	70	29	16,2	0,9	56	-15
17130	22,5	-0,1	7	-5	18,3	0.0	55	36	13,3	0,7	23	-4
17170	22,2	1,0	0	-7	18,1	1.3	6	-8	12,8	2,7	59	11
17609	28,5	1,4	<1	1	26,0	0.9	44	44	23,1	1,8	4	-15
22113	10,1	-0,9	49	-16	5,5	-1.2	54	2	-0,7	-1,7	58	16
26038	18,5	3,2	22	-62	11,7	0.9	35	-47	1,9	-4,4	32	-38
26629	20,4	4,1	14	-49	12,8	0.7	42	-17	4,8	-2,1	167	116
26730	19,9	3,6	32	-40	12,3	0.7	59	-6	4,4	-2,2	150	97
26850	19,7	3,2	44	-28	12,1	0.4	41	-19	4,4	-1,9	142	93
27199	12,4	-3,1	39	-26	9,6	0.4	66	-5	0,9	-0,8	98	36
27612	17,0	0,6	21	-53	12,0	1.1	80	16	2,5	-2,5	131	73
33345	20,1	1,7	101	32	13,9	0.0	76	29	7,0	-1,1	74	39
33815	21,3	0,8	81	36	16,6	0.4	47	-1	9,3	-0,8	29	2
34300	20,3	0,8	20	-30	15,5	1.4	104	63	6,6	-0,7	57	22
34880	22,9	-0,4	14	-5	20,0	2.7	36	10	11,1	2,0	18	1
35188	19,0	1,3	20	-20	14,3	2.3	6	-18	4,6	1,8	17	-13
37789	24,8	-0,4	13	6	22,6	1,9	4	-6	15,5	2,3	42	15
40080	27,2	1,0	0	0	24,6	1.3	0	0	21,3	2,7	4	-8
40100	28,4	2,0	0	-1	27,3	2.1	9	4	24,8	2,2	20	-34
40180	28,2	2,1	0	0	26,9	2.1	0	0	24,1	2,1	19	-7
40270	25,4	-1,0			24,1	-1.1	0	0	22,0	0,2	3	-6
60030	23,6	-0,5	0	0	23,9	0.1	<1	-8	24,9	2,4	2	-8

WMO No.	Station	November 2002 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	December 2002 Temp. mean	(°C) dep.	Prec. Sum	(mm) dep.
01008	Svalbard	-5,6	4,9	46	33	-7,5	5,8	17	5
01025	Tromsø	-3,0	-2,2	50	-54	-3,9	-0,9	79	-25
01492	Oslo-Blindern	-1,2	-1,9	78	3	-5,9	-3,1	28	-28
02196	Haparanda	-8,8	-4,7	17	-41	-12,5	-3,0	24	-18
02485	Stockholm	1,1	-1,5	31	-22	-3,2	-2,2	9	-37
02974	Helsinki-Vantaa	-2,8	-2,9	43	-29	-8,1	-4,0	11	-47
03091	Aberdeen	7,5	2,3	185	110	5,5	1,8	111	38
03772	London-Heathrow	9,8	2,6	151	96	7,2	2,1	119	62
03967	Dublin (Casement)	8,9	2,2	154	84	6,4	1,1	75	-2
04030	Reykjavik	4,7	3,5	85	12	4,5	4,7	119	41
04320	Danmarkshaven	-17,5	2,4	2	-8	-16,3	5,5	38	25
04360	Angmagssalik	1,0	5,7	109	13	-1,2	6,0	128	25
06186	København-Landb.	4,6	-0,9	61	-1	0,2	-2,0	22	-36
06260	De Bilt	7,9	2,0	83	2	2,9	-0,3	89	6
06447	Uccle	8,6	2,5	92	16	4,4	0,9	109	33
06590	Luxembourg	6,9	2,9	114	36	3,1	1,3	88	3
06660	Zürich	6,7	2,6	182	97	3,9	3,3	80	7
06700	Genève	7,8	2,8	295	207	5,6	3,6	81	6
07510	Bordeaux	10,9	1,8	117	23	9,7	3,3	91	-8
07650	Marseille	13,2	2,5	139	81	9,1	1,8	34	-22
08222	Madrid	9,9	0,5	91	27	8,7	2,3	63	14
08314	Mahon / Menorca	16,0	1,6	112	35	13,3	1,5	78	-2
08495	Gibraltar	16,6	0,5	260	119	15,1	1,0	133	-13
08515	St. Maria / Acores	17,4	0,0	36	-66	15,6	0,2	147	52
08535	Lisboa	14,9	0,4	196	82	13,7	1,9	162	54
10384	Berlin-Tempelhof	4,4	-0,5	50	1	-2,0	-3,4	13	-40
11035	Wien-Hohe Warte	7,5	2,7	67	17	-0,4	-1,4	66	22
11518	Praha-Ruzyne	4,3	1,5	81	49	-2,1	-1,5	44	18
11903	Slica	4,8	1,8	50	-19	-3,5	-1,8	66	9
12160	Elblag	3,5	0,2	34	-22	-5,3	-5,6	19	-33
12375	Warszawa-Okecie	4,1	0,9	29	-13	-6,6	-5,7	3	-29
12843	Budapest-Lorinc	7,4	2,6	33	-19	-1,1	-1,5	38	-2
13274	Beograd	10,6	3,6	36	-18	1,3	-1,0	53	-5
14015	Ljubljana	9,3	4,7	119	-16	2,6	2,6	51	-50
14445	Split	14,5	2,3	64	-44	9,8	1,1	99	-1
14654	Sarajevo	9,8	5,0	50	-41	2,4	2,6	71	7
15420	Bucuresti	6,6	1,4	69	20	-5,2	-5,4	70	27
15614	Sofia	6,3	1,3	31	-16	-0,3	-0,8	31	-8
16158	Pisa	14,3	3,9	138	14	9,3	2,5	143	58
16597	Luqa / Malta	18,3	1,3	180	100	14,2	0,4	107	-5
16716	Athens (Hellinikon)	16,0	0,5	119	69	10,9	-1,3	163	92
16754	Heraklion / Kreta	17,0	0,4	93	34	13,4	-0,4	108	34
17040	Rize	13,2	1,6	143	-107	5,9	-2,4	354	111
17062	Istanbul-Goztepe	12,7	1,1	71	-18	6,2	-1,9	58	-64
17130	Ankara / Central	8,0	0,9	19	-14	-0,8	-3,4	16	-33
17170	Van	5,3	1,3	50	8	-2,6	-1,7	73	39
17609	Larnaca	18,8	2,4	14	-30	13,3	0,1	128	52
22113	Murmansk	-8,9	-3,8	44	4	-11,4	-2,1	21	-17
26038	Tallina	-1,0	-2,2	97	29	-6,9	-4,0	15	-40
26629	Kaunas	1,9	-0,2	27	-26	-8,1	-5,7	22	-22
26730	Vilnius	1,4	0,2	22	-35	-8,8	-5,9	19	-36
26850	Minsk	1,1	0,3	27	-25	-9,1	-5,3	14	-39
27199	Wjatka (Kirov)	-4,7	0,0	118	66	-18,8	-8,5	40	-5
27612	Moskva	-1,5	-0,4	41	-17	-12,6	-6,5	37	-15
33345	Kiev	3,9	1,8	50	-1	-8,4	-6,1	11	-41
33815	Chisinau	6,5	2,1	76	37	-6,6	-6,3	5	-33
34300	Charkov (Kharkiv)	2,6	1,3	36	-8	-9,6	-6,2	8	-37
34880	Astrahan'	5,0	1,7	12	-7	-9,7	-7,8	8	-7
35188	Akmola	-2,5	3,4	42	20	-17,8	-5,2	28	11
37789	Yerevan	7,8	1,3	6	-16	-5,7	-5,9	42	19
40080	Damascus	12,5	0,2	29	2	8,2	0,6	30	-16
40100	Beyrouth	20,8	2,1	123	19	15,7	0,9	225	51
40180	Tel Aviv (Airport)	20,5	2,5	30	-38	15,4	1,6	223	85
40270	Amman	14,9	-0,8	16	-9	9,4	-1,3	81	31
60030	Las Palmas / Gr. Can	22,0	1,6	11	-10	20,3	2,0	102	81

Year 2002

WMO No.	Station	Temp. (°C) mean	dep.	Prec. (mm) sum	dep.
01008	Svalbard	-4,3	2,5	192	11
01025	Tromsø	3,5	1,6	976	6
01492	Oslo-Blindern	6,9	2,5	829	61
02196	Haparanda	0,6	0,5	442	-110
02485	Stockholm	6,4	1,1	477	-62
02974	Helsinki-Vantaa	4,2	0,9	449	-202
03091	Aberdeen	7,9	1,1	1089	301
03772	London-Heathrow	10,6	1,5	786	187
03967	Dublin (Casement)	8,9	0,8	1014	279
04030	Reykjavik	4,5	1,0	916	116
04320	Danmarkshaven	-10,6	1,9	183	51
04360	Angmagssalik	-0,3	1,9	1090	158
06186	København-Landb.	7,8	0,6	632	-4
06260	De Bilt	9,2	1,2	923	115
06447	Uccle	9,7	1,2	1096	296
06590	Luxembourg	10,0	2,7	969	118
06660	Zürich	8,9	1,7	1276	163
06700	Genève	10,0	1,9	1167	257
07510	Bordeaux	12,3	1,3	723	-200
07650	Marseille	13,8	1,0	814	269
08222	Madrid	13,2	0,9	502	45
08314	Mahon / Menorca	15,5	0,9	701	118
08495	Gibraltar	16,6	0,4	952	177
08515	St. Maria / Acores	15,9	0,2	698	-77
08535	Lisboa	15,2	0,3	810	115
10384	Berlin-Tempelhof	8,5	0,6	740	157
11035	Wien-Hohe Warte	9,6	1,3	819	206
11518	Praha-Ruzyne	7,5	1,0	679	152
11903	Slica	7,4	0,9	805	119
12160	Elblag	7,4	1,2	645	-45
12375	Warszawa-Okecie	7,6	1,2	554	35
12843	Budapest-Lorinc	10,1	1,3	513	-5
13274	Beograd	11,8	1,7	596	-88
14015	Ljubljana	10,1	1,9	1289	-104
14445	Split	14,9	1,1	915	90
14654	Sarajevo	9,5	1,6	965	47
15420	Bucuresti	9,1	0,3	607	12
15614	Sofia	9,0	0,9	653	90
16158	Pisa	13,2	1,0	1117	213
16597	Luqa / Malta	17,2	0,8	454	-98
16716	Athens (Hellinikon)	16,6	0,5	544	175
16754	Heraklion / Kreta	17,1	0,7	516	15
17040	Rize	12,9	0,8	2072	-101
17062	Istanbul-Goztepe	13,0	0,8	623	-74
17130	Ankara / Central	10,1	0,3	388	-25
17170	Van	7,7	0,8	479	94
17609	Larnaca	17,6	0,8	377	48
22113	Murmansk	-1,0	0,0	492	14
26038	Tallina	4,8	1,0	537	-130
26629	Kaunas	6,4	1,3	645	37
26730	Vilnius	6,0	1,3	615	-68
26850	Minsk	6,1	1,6	594	-83
27199	Wjatka (Kirov)	1,7	0,6	749	124
27612	Moskva	4,8	1,2	534	-154
33345	Kiev	7,6	1,5	697	58
33815	Chisinau	9,1	1,2	533	37
34300	Charkov (Kharkiv)	7,2	1,4	491	-28
34880	Astrahan'	8,7	0,7	200	-20
35188	Akmola	3,4	2,1	377	59
37789	Yerevan	12,0	-0,1	357	80
40080	Damascus	15,5	1,0	139	-55
40100	Beyrouth	19,1	1,5	869	-19
40180	Tel Aviv (Airport)	18,7	1,4	627	60
40270	Amman	15,6	-0,8	NIL	NIL
60030	Las Palmas / Gr. Can	19,5	1,1	184	68

Monthly Surveys

January 2002

- **After a cold start in the very first days of the year, generally warmer than normal in the northern and south-western Region, extremely mild in central Russia**
- **Cold in the south-east with a centre of negative temperature deviations from normal in Turkey**
- **Extremely dry in a zonal belt from the Biscay over the Alps and the Carpathians to the Ukraine as well as in the southern parts of Italy and Spain**
- **Severe storms in northern Europe during the last days of the month**

In Iceland, some meteorological records were broken. The absolute maximum temperature in Reykjavik was +10.6°C and thus the highest temperature ever measured there in January. A relatively warm period during the first three weeks of the month was the reason for the absence of a snow cover in the southern and western lowlands of the island, which is a highly unusual situation. A new national record of 24 hr precipitation was set on January 10, when 293.3 mm were measured at Kvisker. This record exceeds the previous one by 50 mm, measured in 1979 at the same station.

In the U.K., a 31 day period of extremely mild weather started on the 13th of the month, which never before was observed in the Central England Temperature series (fig. 1.1). In the Netherlands, the lowest temperature of the year, -11.9°C, was observed at station Hupsel on January 4. One week later, a period of positive temperature anomaly up to +9°C began and lasted for 5 weeks (fig. 1.2), similar to the situation in the U.K..

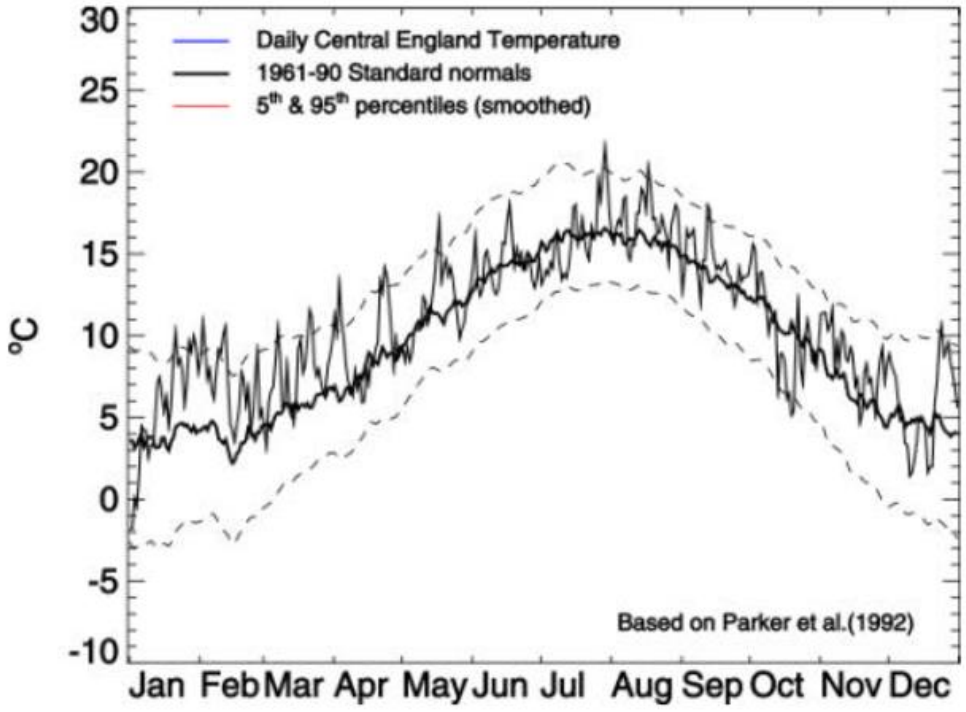


Fig 1.1: *Central England temperature, daily values 2002*
From: U. K. Met Office, Hadley Centre for Climate Prediction and Research

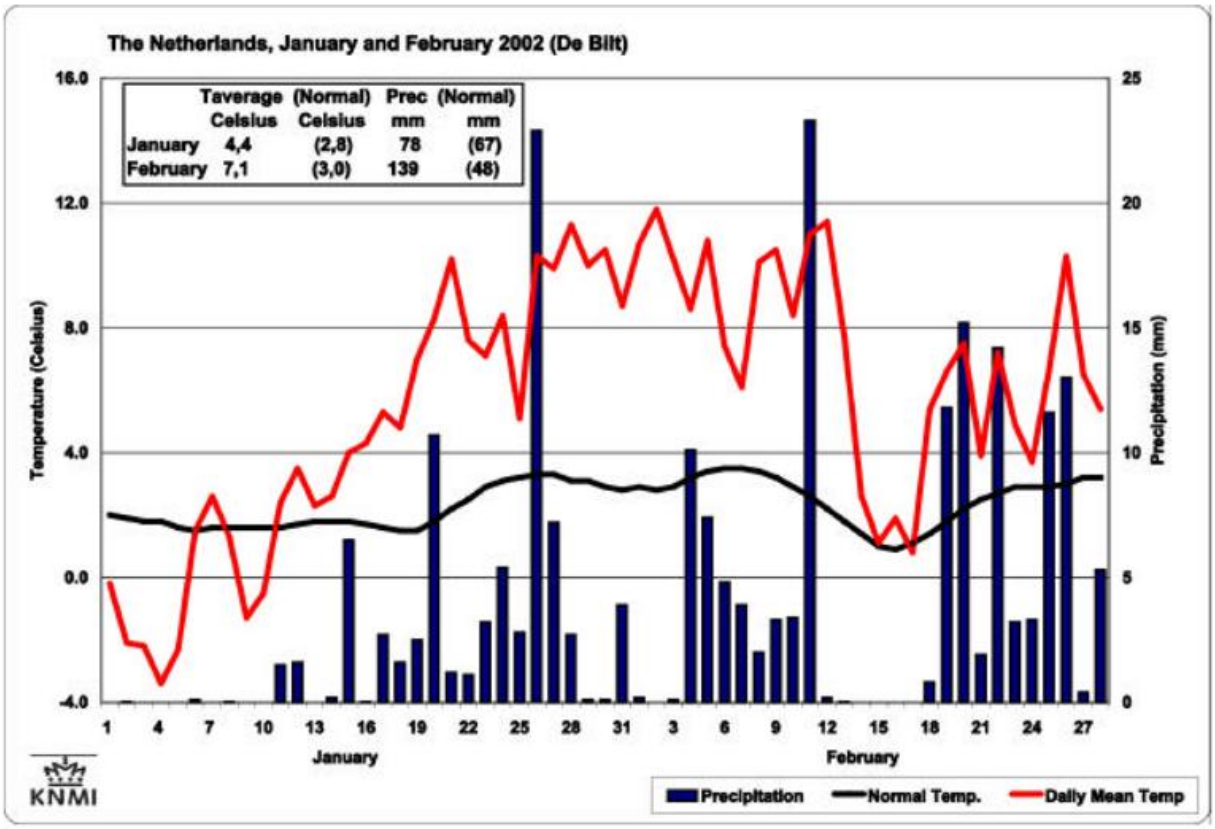


Fig. 1.2: *Daily precipitation and daily mean temperature at Station De Bilt, The Netherlands*
From: The Dutch Royal Meteorological Institute, KNMI

During the last decade of the month, some national records of maximum temperature were broken, especially on January 29 in Austria (+20.5°C, Eisenstadt), Hungary (+20.0°C, Máza), Slovakia (+20.3°C, Bratislava) and on January 30 in Germany (+21.0°C, Altenstadt). Also in La Coruña, Spain, a new record of T_{max} was set in a series of more than 100 years.

Strong winds up to Hurricane force affected N-Europe in a belt from the British Isles over northern Germany and Poland to the Baltic States within the last week of the month.

England and Scotland suffered from heavy damage to traffic and power lines, caused by strong winds, which were up to 190 km/h in the Scottish Highlands. In Husum, Germany, a wind energy converter crashed on January 29, while maximum wind speeds of more than 150 km/h were observed.

The lowest temperatures of the year in Ireland were measured on January 1, namely –8.0°C air temperature at Mullingar and –12.5°C grass minimum temperature at Kilkenny. Strong winds were observed during the last days of the month; Malin Head measured the highest gust of the year, 159 km/h on January 28.

Considerable damage occurred during stormy weather in the centre and the north of Belgium, accompanied by floods in the provinces of Brabant and Luxembourg on January 26-28.

The year started extremely cold in France, whereas the end of January was particularly mild.

Like in many other countries, in Germany very cold weather at the beginning of the year turned into extremely mild conditions at the end of the month. From January 6-7 freezing rain in many parts of the country caused thousands of accidents on roads with 120 people injured and 3 deaths. A period of very strong winds from January 26-29, especially in the northern parts of the country with maximum gusts up to 169 km/h (Brocken), caused floods in coastal areas, disruption of traffic and power lines, and lots of damage to houses and forests.

Stormy weather was also reported from Denmark on January 28-29.

In Norway the month was generally warmer than normal and precipitation was above normal for most of the country. The lowest temperature of the year was -40.6ºC, measured in Kautokeino in Finnmark County on January 24. The station Glomfjord in Nordland County received a precipitation amount of 134.6 mm on January 11, which is the highest diurnal value of all weather stations in Norway for 2002.

A new national record of daily precipitation was set in Sweden, when Katterjåkk got 104 mm. This precipitation came down as rain at a station where the normal temperature for January is -12°C.

Precipitation in Finland was generally well above normal.

In Lithuania the year started with cold frosty weather combined with heavy snowfalls and blizzards. Minimum temperatures in most regions fell down to minus 22 – 27°C. After the first 5 days, frost conditions weakened and the mean daily temperatures became unusually mild, so that the monthly mean temperature resulted to +3.8°C above normal. Precipitation in January was in excess of normal and amounted to 68 mm, which is 162% of normal. In the first five-day and the third ten-day periods, the weather was very windy. The strongest wind was observed in western Lithuania with gusts above 120 km/h on January 29. The wind broke many trees, disrupted power lines, and damaged two ships in the port of Klaipeda.

Very cold weather dominated the first days of the month also in Poland with temperatures below –30°C in the Carpathian Mountains on January 4. In the second half of the month, the wintry conditions turned into very mild weather, which made the snow cover completely disappear. Cracow had a maximum temperature of +13.1°C on January 29 and the countrywide monthly mean temperature rose to +1.2°C. The national precipitation rate was 121% of normal with considerable spatial variation. For example, station Wroclaw received only 70% of normal. The economically most unfavourable weather was observed at the end of the month, according to an exceptionally active westerly circulation. From January 25-31 violent storms and thunderstorms caused a lot of material damage all over the country and the loss of 6 lives.

In Belarus the year started with very mild weather and a monthly mean temperature anomaly of +4°C.

Slovakia had very dry conditions. The precipitation total was 61% of normal; which was the lowest monthly mean of the year.

Also in Slovenia, the month was exceptionally dry. The mean precipitation rate was less than 50% of the long term average. In some places in the north of the country, precipitation rates were even below 10% of normal. Accordingly, the sunshine duration was well above normal. Some areas, like Ljubljana's and Celje's basin, received more than twice the usual sunshine duration. As in many other countries, the month had a cold start and ended with significantly mild weather.

The same conditions were valid for Hungary; where in some places the maximum temperatures exceeded +18.0°C at the end of the month.

In Serbia and Montenegro January air temperatures were within the normal limits, and precipitation was scarce.

The first three days of the year were very cold in Bulgaria with temperatures down to –22.2°C in Sandanski. Due to heavy snowfall and frost more than 200 accidents occurred in the northeast of the country, 3 people froze to death.

In Portugal the monthly average temperatures exceeded their means for the period 1961-90, while the monthly precipitation totals were below normal.

The NW of Spain as well as in the Canary Islands experienced extremely mild weather conditions.

In Turkey two significant weather events occurred at the beginning of the month. Strong winds caused damage to houses, forests and power lines in Kayseri on January 4. Two days later, heavy snowfall cut traffic lines in the area of Yozgat.

January in Armenia was dry and mild.

A tornado affected the west coast of Cyprus on January 4**.** Another unusual event was snowfall in the western coastal area of the island on January 7. Heavy snowfall continued in the Troodos range on January 9 and disrupted traffic lines to many mountain villages.

The weather in Israel was cool and rainy. In some parts of the country rainfall was twice normal. The most significant rainfall event occurred on January 6-9 with 100-180 mm measured in the northern and central parts of the country. This event included snowfall on the mountains, mostly on January 7, when 30 - 35 cm of snow were measured at Har Kenaan.

Snowfall occurred also at areas with an altitude of only 300-400 m above sea level, an unusual event in Israel. Areas at a higher altitude reported more than 1 m of snow.

February 2002

- **Positive temperature anomalies all over the Region except for Iceland and Greenland**
- **Extremely mild in eastern Europe**
- **Extremely wet in central and north-eastern Europe, very dry in southern Europe and the Middle East**

Iceland experienced the coldest February in Reykjavík since 1935 and in Akureyri since 1973. Except for a damaging northerly storm on February 2-3, the weather conditions were favourable during the month.

In Norway the monthly mean temperatures and precipitation totals were well above normal for almost the whole country.

Finland had a wet February, as well as Denmark, where a precipitation rate of more than 200% from normal was recorded.

In Ireland, it was one of the wettest months of the year relative to normal. In addition, a combination of heavy rainfall, strong winds and in particular an exceptionally high tide brought significant coastal flooding on February 1st. Monthly mean temperatures were over two degrees higher than normal in places.

It was a particularly wet month in the U.K. too. North-western England and northern Wales had its highest rainfall, 155 mm, in the 130 year record of the month.

In France, the weather was extraordinarily mild. The long term temperature averages were exceeded all over the country with maximum anomalies of more than +4°C reported from the northern areas. The maximum wind gusts of the year, 144 km/h, were recorded on February 4 at Cap-de-la-Hève and also on February 21 at Cap-Béar.

At station Uccle, Belgium, the monthly mean temperature was significantly above normal. At the same station, the monthly precipitation total was extraordinarily high (see fig. 2.1): 168 mm are equal to 317% of normal and the highest amount since observations started in 1833. Consequently, serious damage was caused by floods in many parts of the country on February 13 and during February 25-28. The mean monthly wind speed was relatively high; 5.3 m/s were measured at Uccle, which is 1/3 above normal.

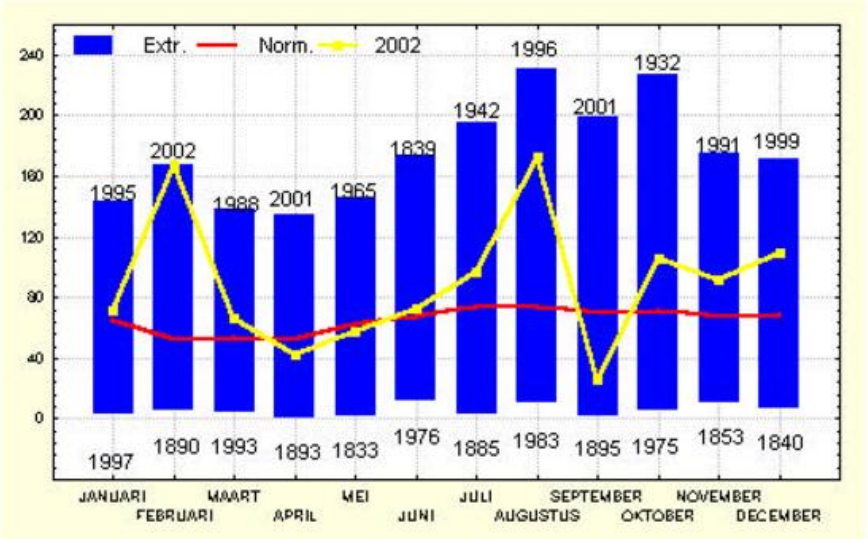


Fig 2.1: *Monthly precipitation totals in mm station Uccle, Belgium. Normal and extreme values since 1833*
From: Royal Meteorological Institute, Belgium

The month was the second warmest February since 1901 in the Netherlands. The countrywide monthly mean temperature was 7.1°C and thus +4.1°C above normal. On February 2 a maximum of 15.5°C was measured, the highest temperature ever recorded so early in the year. The month was also extraordinarily wet. The precipitation total averaged over the country was 147 mm, which is 313% of normal. In De Bilt, the second highest monthly precipitation total was observed since 1901. However, the monthly sum of sunshine duration ended up within the top 10 since 1901. Hourly average wind speeds of 88 km/h and more were reported on February 26.

The weather in Germany was extremely mild and wet. In the series of spatial monthly means it was the second warmest and third wettest February since 1901. Intense precipitation led to high waters in rivers of western Germany with flooding on February 12-14 and 25. Heavy snowfall and freezing rain caused hundreds of accidents on slippery roads all over the country during February 19-24. Motorways around Berlin were blocked by overturned trucks on February 19-20. On February 22 stormy winds up to 115 km/h caused snowdrift on Heligoland. A whirlwind damaged more than 100 houses near Münster on February 23. Winds of hurricane force with gusts up to 180 km/h paralysed public life in Schleswig-Holstein on February 26-27.

The monthly mean temperature of Vienna, Austria, was +5°C above normal and is the second highest value in the time series since 1775.

It was the month with the highest temperature anomaly of the year in Poland. Averaged over 8 stations, the deviation from normal was +4.7°C. The spatial distribution of deviations showed a remarkable positive gradient from the western to the eastern parts of the country. A snow cover in the lowlands, which often existed in former years, was absent throughout the month. On February 2 the maximum temperature in Wroclaw came up to 15.8°C. February was also the wettest month of the year with a countrywide precipitation rate of 220% compared to normal. Locally, precipitation rates up to 400% were observed, e.g. in Plock. On February 12 thunderstorms combined with hail and intense rainfall caused severe damage to houses and power lines of more than 60 villages in NE Poland. On February 27 thunderstorms and winds of hurricane force affected the city of Cracow.

In Lithuania the mean monthly air temperature was +1.8°C, which is +6.4°C above normal. Over the past century, February had been warmer only in 1925, 1989 and 1990. Precipitation was in excess of normal and amounted to 74 mm, which is 247 % of the long term average.

In Belarus, a sequence of daily mean temperatures =0°C continued throughout the month, which normally starts to happen 6 weeks later.

The monthly mean temperature in Slovakia was well above normal and exceeded the long term average up to +5°C in the north-eastern part of the country. Precipitation totals were exceptionally low.

Temperature anomalies in Slovenia were above +1.6°C everywhere and up to +4°C in the eastern parts of the country. The month was unusually cloudy at the coast, in the Karst and some other places, where the sunshine duration merely reached half the normal. Snow depths in the mountains were relatively small. On Kredarica, the snow depth was up to 75 cm, which is lower than any February record of former years.

In Serbia and Montenegro, the extreme positive deviations of the monthly mean temperatures from normal were up to >+6°C similar to those of other east European countries. Even higher deviations from normal were recorded for the mean daily maximum temperatures (see fig. 2.2). At the same time, considerably lower precipitation amounts than normal were registered. In the eastern parts of the country the deficit was over 90%.

The month was extraordinarily mild in Romania. Temperature anomalies were positive all over the country and up +8°C (see fig. 2.3).

In Bulgaria, the month was very mild with mean temperatures of +3...+7°C above normal and dry with precipitation rates from 3...54% of normal. Nevertheless, on February 24-25 stormy winds and wet snow fall caused damage of power lines and interrupted transportation to and in the mountain areas.

The weather in Portugal was rather mild and dry. The monthly precipitation totals were below 50% of normal.

Rather mild and relatively dry weather prevailed also in Cyprus and in Israel, where it was the warmest February since 1977.

Armenia had a temperature anomaly of more than +4°C.

The monthly mean temperature in Azerbaijan, calculated from 15 stations, was 4.6°C above normal, which statistically occurs every 35 years.

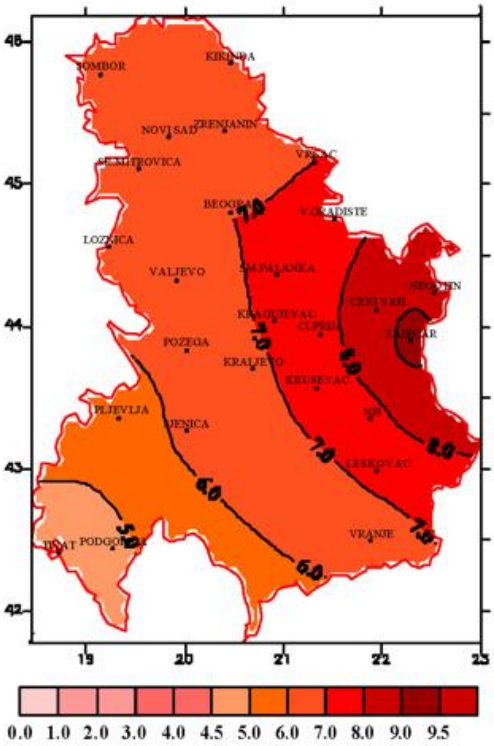


Fig 2.2:

Maximum air temperature anomaly (°C) distribution in February 2002 in FRY (now Serbia & Montenegro)
From: Federal Hydrometeorological Institute of Yugoslavia

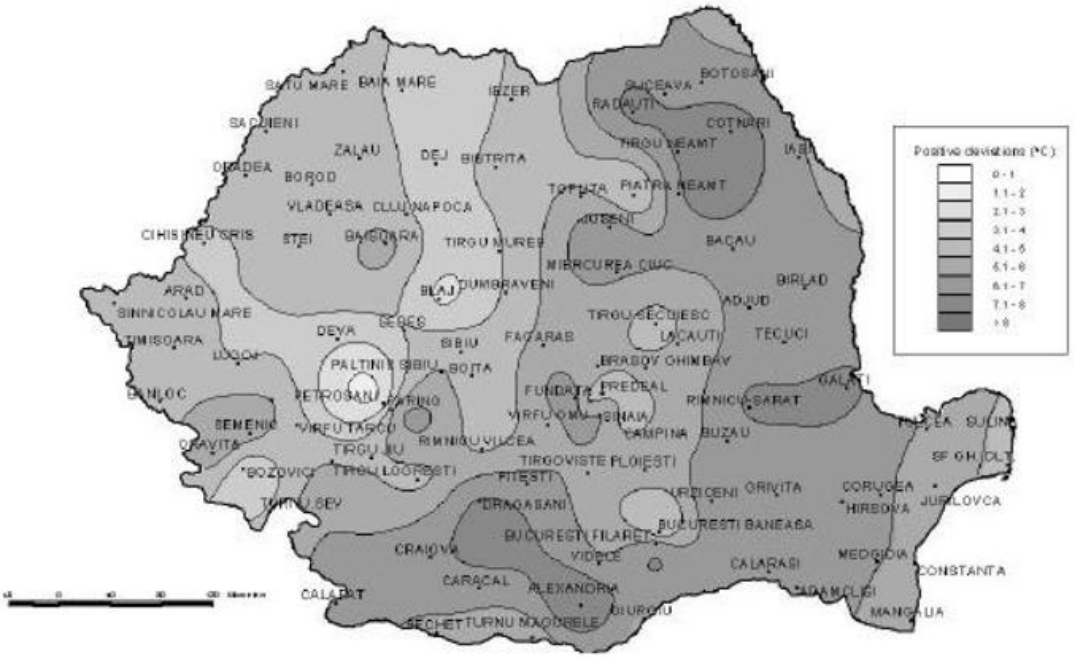


Fig 2.3: *Deviation of mean temperatures against the climatological norm in Febrary 2002, in Romania*
From: National Institute of Meteorology and Hydrology, Romania

March 2002

- **Warmer than normal everywhere except for Iceland, Svalbard and Acores; extremely warm in eastern Europe**
- **Extremely dry in coastal areas of the Greenland Sea, the North Sea, the Biscay, the Tyrrhenian Sea, the Adriatic Sea, in central Ukraine and parts of Russia**

The monthly mean temperature in Sweden was well above normal, especially in the south-eastern parts of the country. The maximum temperature was 21.4°C at station Oskarshamm, which means the 2nd highest national record of the month ever made before.

In the Netherlands March was very sunny and ended in the top 10 since 1901. Hourly average wind speeds of 10 Beaufort (24.5 m/s or higher) were reported on March 9.

In Belgium, the monthly mean temperature was well above normal. A tornado like whirlwind affected the area of Eupen. on March 18.

In Germany the monthly mean temperature was +2°C above normal and the precipitation rate 10% higher than the long term average. However, during the period of March 19-23, intense rainfall together with snow melt in the mountains led to high waters in the rivers of southern Germany together with flooding of cities, e.g. Heidelberg and Passau.

The countrywide temperature anomaly in Poland was +2°C, while the overall precipitation total was near normal. On March 7 intense advection of polar-maritime air lead to strong winds up to 97 km/h in Krakow causing lots of damage.

The month was very dry in Slovakia. The countrywide precipitation totals were only 2 thirds of normal.

The anomaly of the monthly mean air temperature in Slovenia was statistically significant with +3°C above normal. Precipitation totals did not reach the normal rate at any station. Sunshine duration was well above normal everywhere in the country, large basins in the central part of Slovenia got about 60 % more sunny weather than in the long term average.

In Romania monthly temperature anomalies were up to +4°C. At the end of the first decade of the month, the most serious event occurred along the track of gradually intensifying winds up to 145 km/h, when thousands of trees were uprooted and forest fires broke out, especially in the eastern parts of the country.

In Bulgaria, the month was mild and very wet. The deviation of the monthly mean temperature from normal varied between +2°C and +4°C. The monthly precipitation totals were from 250% up to 444% of normal. During the period of March 23-26, strong winds combined with intense rain and snowfall caused the interruption of traffic and power lines, especially in the mountain areas. Landslides were triggered. A bus with passengers was overturned on the road to Varna by wind force on March 25. The ports of Burgas and Balchik were closed for some time.

The monthly mean temperature in the mainland of Portugal was +1.2°C above normal, while precipitation totals reached 130% of the long term average amount.

On March 14 a tornado with gusts up to 149 km/h affected the area of Extremadura, Spain. Intense rain over Santa Cruz de Tenerife, Canary Islands, caused several mortal casualties and heavy material losses; the precipitation total in 24 hours was 232.6 mm with the maximum intensity of 27.1 mm in 10 minutes.

In the area of Konya, Turkey, frost and storm damaged crops and houses as well as telecommunication and power lines on March 22-23.

Monthly temperatures in Cyprus were well above normal. On March 20 a severe hailstorm in the south-eastern part of the island and a thunderstorm in the western part of the central plain on March 28 caused fatal some accidents.

The month started extremely warm and dry in Israel with temperatures of +6...+9°C above normal. The heat-wave reached its peak on March 11 with temperatures of more than 35°C in the coastal plain. In Tel Aviv 36.4°C were reported, and this was the highest temperature in March since the beginning of measurements at this station in 1950. The second part of the month was cool and rainy, but only the northern parts of the country received rainfall amounts larger than normal with a surplus between 20% and 60%. Other

parts of the country received only 50% to 80% of the long term average rainfall.

The mean monthly temperatures in Armenia were up to +4°C above normal.

Relatively low snow depths compared to previous years were recorded from the mountain areas in Azerbaijan. These circumstances caused a dramatic decrease of water resources and endangered the ecosystem of river Kura, which is the main waterway of the country. The monthly mean temperature was countrywide +4.5°C above normal. The statistical recurrence period of such an event is more than 100 years.

April 2002

- **Slightly to moderately warmer than normal except in south-eastern Europe and most parts of the Middle East, extremely mild in Svalbard.**
- **Seriously dry in central France and north-eastern Europe, extremely wet in north-eastern Greenland and around the furthermost eastern Mediterranean compared to normal.**

Iceland had relatively mild weather except for a bad snowstorm in the north and northeast during the last week of April.

In Norway, the month was a lot warmer than normal for the whole country and precipitation below normal for a greater part of the country. On the island of Svalbard the monthly mean temperature exceeded normal by more than +5°C.

Sweden had fairly dry weather conditions. It was still drier in Finland with a precipitation deficit of more than half of the normal rate.

The weather in Belgium was dominated by two different circulation types importing cool and dry continental as well as mild and humid maritime air. These conditions resulted in monthly mean values of the air temperature and precipitation totals near normal. However, sunshine duration at station Uccle was 35 h higher and thereby 22% above the long term average.

In France it was very dry with monthly precipitation rates below 50% of normal in the central part of the country. The monthly mean temperatures were up to +2°C above the long term averages.

Portugal had a precipitation deficit of about 50%, while the monthly mean temperatures stayed slightly above normal.

In Germany, the monthly mean temperature was slightly above the long term average, while the overall precipitation nearly reached normal. Stormy winds with gusts of hurricane force damaged houses, trees and cars in Düsseldorf on April 29.

The mild winter and favourable conditions at the beginning of spring caused a very early start of vegetation in Poland. For example in Cracow the blossoming of bird cherry (prunus padus) was observed very early on April 12; the first blossoms of lilac (syringa vulgaris) appeared on April 28. The monthly mean temperature was slightly above and the precipitation total near to normal.

Weather conditions in Lithuania where rather dry. The mean precipitation amounted to 24 mm only, which is 57 % of normal.

The mean air temperature in Slovenia was very close to the long term average. The anomaly was within the normal variability. The countrywide precipitation total exceeded normal, some places received more than twice the average precipitation amount of the reference period.

On April 7-8, a cold front passed over Serbia and Montenegro and brought an intensive drop of temperatures. At that time morning frost brought great damage, especially to agricultural areas in the north-east of the country. However, the overall temperature anomaly was slightly positive.

In Bulgaria the monthly mean temperature deviation was down to –2°C from normal. There was a 14 day period of hoar-frost, while thunderstorms occurred on 12 days including 7 days with hailstorms.

The monthly mean temperatures in Cyprus were below normal. Precipitation totals exceeded normal significantly. In the south-eastern part of the island, a severe hailstorm damaged potato plantations on April 1. A tor-

Monthly Surveys April / May 2002

nado crossed the western part of the island on April 19.

The month was cooler than normal in Israel with rainfall amounts reaching 150%-250% of normal and a small number of sharav (local term for Sirocco) events.

In Armenia the monthly mean temperature was moderately below normal, while the precipitation total exceeded the long term average by more than 50% (see fig. 4.1).

Frequent rains and hailstones caused severe damage to agriculture and hindered the work in the fields.

The monthly mean temperature in Azerbaijan was slightly below normal and only 1°C higher than in the month before; normally, this difference is +5.5°C. The precipitation total was 65% above the long term average (see fig. 12.2).

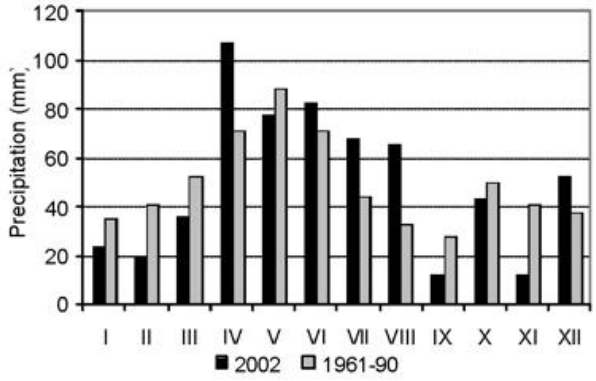


Fig. 4.1:

Monthly precipitation totals in Armenia compared with 1961 - 1990 means

From: Department of Hydrometeorology of the Republic Armenia

May 2002

- **Significantly warmer than normal in Scandinavia and eastern Europe**
- **Very wet in the coastal areas of the north-western Mediterranean, extremely dry in the eastern Balkans and around the Aegean Sea**
- **Lots of damage to local infrastructure in many countries as a consequence of strong winds, intense rainfall and thunderstorms**

In Iceland, the month was sunny and mild in the south and west, but damp and cool in the north-east. In Ireland it was very wet and dull except in the north.

The month was warmer than normal for the whole of Norway and substantially warmer for a greater part of the country. Precipitation amounts were below normal for most of the country. The southern and southeastern part, however, received a lot more precipitation than normal.

The monthly mean temperature at Uccle, Belgium, was +0.7°C above the norm and the precipitation rate 80% of normal. A violent storm in the eastern provinces occurred on May 9.

In France a very hot period happened in the middle of the month, and highest temperatures established new maximum records for the month, e.g. 34.2 °C in Biscarosse on May 16; the previous record was 33.1°C. Three days before, an intense squall line, locally called "Galerne", had crossed the south-west of France from the Basque country over Landes to north of Bordeaux with gusts up to 133 km/h.

The mainland of Portugal had a negative temperature anomaly of -0.7°C. The same deviation from normal was observed for the monthly mean minimum temperature, which was positive for nearly all other months of the year (see fig. 5.1). Very dry weather conditions caused a countrywide mean precipitation rate of about 50% from normal.

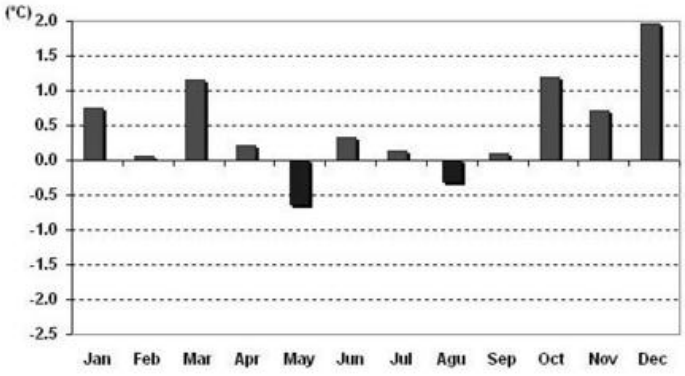


Fig. 5.1:
Mean monthly minimum temperature anomalies, differences from 1961-90

From: Instituto de Meteorologia, Portugal

In Germany the monthly mean temperature was +1.7°C above normal and the precipitation total only slightly above normal. During the course of an extensive thunderstorm along the Elbe river, 6?000 lightnings per hour were registered and numerous houses were set on fire in the night of May 11-12. Another extreme weather event happened during May 18-19 in Bavaria, when widespread thunderstorms caused the interruption of traffic and power lines, burning down of farmhouses, flooding, mudflow and landslides. Similar damage occurred to an area in and around Berlin on May 23-24, again as consequence of thunderstorms.

A severe cold spell occurred in Lithuania on May 19-21 with morning frosts down to – 6 ^{0}C, damaging lots of early vegetables. The precipitation total was merely 32 mm, which is 62 % of normal. In some places, e.g. Vilnius, the month was the beginning of a drought episode with a relative humidity of the air below 30% for 31 consecutive days. Additionally, the monthly sunshine duration was 341 h, which is 82 h above normal.

In Poland the whole month was frost-free. On May 4 the maximum temperature came up to 30.2°C in Krakow. The mean temperature anomaly in Poland was +3.2°C with a spatial variation from +2.0°C to +3.8°C. This large positive anomaly of temperature was caused by a very active southern circulation. The overall precipitation rate was 105% with great spatial differences. Monthly totals in deficit were observed in Lower Silesia with less than half of the normal rate, while in mountain areas precipitation amounts exceeded 250% of normal. During a thunderstorm on May 5, an petrol depot caught fire near Katowice. At the occasion of another thunderstorm near Krakow on May 27, intense precipitation of 133 mm in one hour occurred including hailstones of hen's eggs size. A bridge near Kielce was destroyed by flooding of the river Kamienna after intense rainfall on May 28-29.

The month was very warm in Slovakia. Temperature anomalies were generally above +2°C and exceeded +3°C in some parts of the country.

Slovenia experienced also positive temperature anomalies up to around +3°C, which were statistically significant at most stations. The precipitation was below normal over most of the country combined with a 20% surplus of sunshine duration over the long term average.

In Bulgaria, the temperatures were about and above the norm. In many regions precipitation was below the norms. Hailstorms occurred on 11 days and 17 days with thunderstorms. Heavy rainfall (145 mm in 24 hours) caused floods in the historical capital Veliko Turnovo on May 30.

Although the countrywide mean monthly precipitation total was well below normal, two serious flooding events occurred in Turkey causing lots of damage to agriculture and urban areas: one in Elazig on May 15 and the other one in Istanbul on May 26.

The average temperature was around normal in Cyprus. Severe hailstorms in the area south of Nicosia caused damage to agriculture on May 2. Heavy thundery showers in the afternoon of the 14th caused flooding in the western parts of the town of Nicosia.

In Israel it was the coolest May of the last 10 years. In Azerbaijan the temperatures were slightly below normal (-0.3°C) and the precipitation total ended up in 183% of the long term average.

June 2002

- **Very warm in southern Europe, Greenland and Scandinavia**
- **Very wet in the British Isles, around the north-western Mediterranean and the northern Baltic Sea**
- **Dry in Portugal and south-eastern Europe**
- **Many thunderstorm events, squalls and tornadoes with lots of damage**

Föhn situations produced very high and record-breaking temperatures at several locations in Greenland.

A 'heat wave' in south-western Iceland lasted during the period from June 3-16. The temperature in Reykjavik reached 22.4°C on June 11, exceeding +20°C for the first time in any month at that location since 1995. In Reykjavik, June was the warmest month of the year, wich is highly unusual; last time it happened before was in 1898. It was the warmest June in Reykjavik since 1941. The warm period ended abrubtly on the 17th of June, when an unseasonally fierce northerly storm hit the country, with heavy precipiation in the north and east and snowcover down to sea level in the northeast.

The highest daily sunshine duration of the year in Ireland was measured at Valentia Observatory on June 6. It was the highest daily value since 1989. The monthly mean temperature was slightly below and the overall precipitation rate well above normal.

In Norway the month was much warmer than normal for most of the country. The highest air temperature of the year was 32.5ºC measured at station Høylandet-Drageidet on June 9. The mean air temperature at Weather Ship 'Mike' was 11.4°C, which means a new record since the beginning of observations in 1948; the mean sea surface temperature was 11.8°C and record breaking as well. For a greater part of the country, the precipitation was less than normal, but the western and southern part of Norway received more precipitation than in the long term average.

Due to a rainy latter part of the month, the precipitation totals in Finland were well above normal in most parts of the country. In Denmark several tornado-like waterspouts caused considerable damage.

The month started cool in France and ended record breaking warm. In Luxembourg, the weather was very warm and dry. The monthly mean temperature was more than 2°C above and the precipitation rate less than half of normal.

In Belgium, the monthly mean temperature was well above normal. The absolute extreme temperatures of the month (minimum as well as maximum) at station Uccle had significant positive deviations of more than +3°C against the long term averages. A tornado affected the country on June 4. Two more events of stormy weather with flooding occurred on June 14 in the central and on June 20 in the eastern provinces.

The monthly mean temperature in Germany was +2°C above normal and the countrywide precipitation rate 80% of the long term average. From June 17-19 several places had 'Tropical Nights' with minimum temperatures above 20°C up to 24°C. New local records were set in some cities with maximum temperatures up to 39°C. There were 3 episodes of widespread thunderstorms with disastrous consequences to the local infrastructure: in the south of the country from June 5-7 and June 19-24 and also in the north-west from June. 15-18. Additionally, several whirlwinds affected different areas, e.g. the city of Wittenberg on June 12 (see fig.6.1.).

In Poland, the monthly mean temperature was 1.3°C above normal. In Wroclaw the maximum temperature reached 33.3°C on June 19. The monthly mean precipitation amounted generally to 84% of normal and was even less than 60% in western parts of the country. However, some heavy local rainfall occurred in the second week of the month. The worst event among thunderstorms and heavy downpours was connected to a local tornado on June 13, that destroyed 50 buildings in villages near Czestochowa.



Fig. 6.1: *Consequences of a local tornado in Wittenberg on June 12, 2002*
From: Photo Quelle: http://www.wittenberg.de

Frequent showers ended a drought period in Lithuania and raised the monthly amount of precipitation close to normal and in excess of it at some places. The sunshine duration was 299 h, which is 20 h above normal.

The monthly mean temperature of Vienna, Austria, came up to 20.6°C, which is the highest since 1811, when it was 22.0°C. On June 6-7, intense rainfall of about 200 mm per day caused disastrous floods in Lower Austria. Thunderstorms with heavy rain caused floods in Carinthia on June 17. Heavy thunderstorms with hail were the reason for widespread damage in and around Klagenfurt on June 23-24.

In Hungary a hot spell started in the middle of the month and lasted for about 10 consecutive days. Thus, drought conditions were triggered for most parts of the country. The maximum temperature was higher than 35°C in southern places on 3 days. The annual absolute maximum of 38,4°C was measured in Békéscsaba on June 24.

The temperature anomalies in Slovenia were between +1.9 and +3.6°C and statistically significant everywhere. In the course of a heat wave the highest temperatures of the year were recorded at many stations and the monthly mean temperatures were the highest of the last fifty years in many places. Precipitation was distributed unevenly in time and space, as it is usually the case in summer; the overall monthly average was near to normal.

The month was significantly warmer than normal in Romania with deviations of more than +2°C above the long term averages. The countrywide precipitation rate stayed in deficit.

The monthly mean temperatures in Bulgaria were above normal from +1°C to +3°C. There were thunderstorms on 22 days of the month, including 6 days with severe hailstorms. The diameter of hailstones were up to 5 cm (see figs. 6.2, 6.3), hitting more than 1000 cars in the capital of Sofia. The estimated damage of about 1.5 million € was also caused by flooding of some cities.

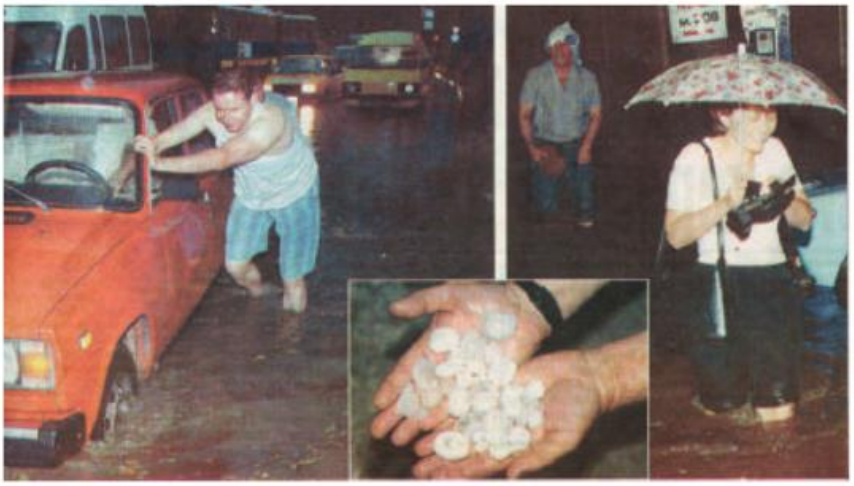


Fig. 6.2:
Lage hail stones from the severe hailstorm over Sofia city, Bulgaria, on June 25
From:
(Photo: I.Donov and V. Borisher, Newpaper "Trud", Bulgaria)



Fig. 6.3:
Large hail stones from the severe hailstorm over Banite village, in Rodpy mountain, Bulgaria, on June 29
From:
(Photo: Press Photo BTA Bulgaria)

Squalls and tornadoes with gusts of more than 100 km/h were observed in western and central parts of the Ukraine on June 24. The agriculture and national economy suffered considerably, there were a number of victims.

In Portugal the temperature was again fairly above the long term average, especially the mean maximum temperature exceeded the normal value by +1.7°C. Precipitation totals continued to stay below normal.

The month was very hot in Spain. New records for monthly mean temperature were set at Madrid and in the Balearic Islands within series of more than 100 years.

Although the monthly mean temperature was just +1.0°C above normal, Cyprus experienced severe heat wave conditions.

In the province of Giresun, Turkey, heavy rainfall triggered flooding of several locations on June 20.

During most days of the month temperatures were lower than normal in Israel. However an extreme sharav event occurred on June 7-9. Temperatures reached 43°C to 45°C in the coastal plain.

In Azerbaijan, the monthly precipitation total, averaged over all stations, was 152% of the normal rate. A thunderstorm with hailstones having a diameter of more than 2 cm. occurred on June 16.

July 2002

- **Temperature anomalies generally increasing from west to east**
- **Very dry on the Iberian peninsula, mixed precipitation pattern else**
- **Lots of extreme weather events in central Europe**

In Iceland and Ireland the month was rather dull, but in other respects close to average.

The monthly mean precipitation rate in England and Wales was 150% of normal. It was the summer month with the highest rainfall amount in that area and the only one with precipitation above normal (see table 7.1).

Month	CET 1961-1990	CET 2002	EWP 1961-1990	EWP 2002
January	3.8	5.5	91	87
February	3.8	7.0	65	115
March	5.7	7.6	74	53
April	7.9	9.3	62	48
May	11.2	11.8	65	81
June	14.2	14.4	65	57
July	16.1	16.0	62	93
August	15.8	17.0	77	76
September	13.6	14.4	78	41
October	10.6	10.1	87	144
November	6.5	8.5	92	176
December	4.7	5.8	96	148
Year	9.5	10.6	914	1118

***Tab. 7.1**: Monthly Mean Central England Temperature and England and Wales Precipitation data for 2002*
From: U.K. MetOffice Hadley Centre of Climate Prediction and Research

In the Netherlands, the highest temperature of the year was 34,9 °C, reported from station Westdorpe, located in the south-western part of the country.

The monthly mean values of temperature and precipitation were slightly above normal in Belgium. However, there were some extreme weather events: a violent thunderstorm in the centre of the country caused local flooding with severe damage at many places on July 20; an even more spectacular event occurred on July 30, when locally more than 100 mm rain fell during the course of widespread thunderstorms in central and north-eastern parts of the country.

In France it was mostly cool. However, a hot spell prevailed at the end of month. There were several severe thunderstorm events with heavy rain and hail on July 15 (evacuation of campers and damage to vineyards in the department Var), on July 17 (land- and mudslides in Savoie), on July 22 (people wounded by hailstones with diameters up to 2 cm in Isère), on July 29 (heavy damage caused by hailstones in Ariège), and on July 30 (railways closed and damage to houses in the north-east).

The monthly mean temperature in Germany was moderately above normal, while the overall precipitation total reached 140% of the long term average. From July 9 until the end of the month, a lot of extreme weather events like thunderstorms with hail, heavy downpours and whirlwinds occurred in many parts of the country; e.g. strong winds up to 152 km/h caused the death of 7 people in and around Berlin on July 10-11.

Vehement and intensive showers released considerable landslides in the area of Salzburg, Austria, on July 9. A lot of buildings in Upper Austria were heavily damaged by landslides and hail on July 13. The showers during the night to July 17 lead to catastrophic situations in Carinthia. Simultaneous showers caused floods in Lower Austria and lead to devastation in the vineyards of the Wachau area as well.

Temperature anomalies in Poland varied from +1.1°C to +3.2°C, while the countrywide precipitation rate was 79% of normal and locally down to 31%, e.g. in Warsaw with a monthly total of 22 mm. However, a lot of extreme weather events occurred in different parts of the country during the month, namely on July 1, 3-4, 7, 10, 14-18 and 21, marked by thunderstorms, downpours, hail, flooding and strong winds up to hurricane force. The worst case was reported from July 4, when a tornado like wind damaged a forest area of about 12 000 ha near Pisz.

Everywhere in Norway, the month was much warmer than in the long term average. Precipitation totals were above normal except for the middle part of the country,.

The month was generally very warm in Sweden with numerous and partly heavy thunderstorms.

Two violent local thunderstorm events occurred in southern and central parts of Finland on July 4 and 5. Accompanying downbursts cut trees and caused considerable economic losses to forest owners.

The month was very warm in Latvia with mean temperatures of about +3°C above normal. Connected to the passage of a cold front, a whirlwind with gusts up to hurricane force affected the capital of Riga as well as southern and central parts of the country on July 4; a lot of trees were downed and uprooted, causing the interruption of traffic and power lines.

In Lithuania the countrywide mean monthly air temperature was +3.2°C above the long term average and the precipitation rate 91% of normal. The highest temperatures were recorded on July 30-31 and reached 30-35°C. On the days of July 4, 19, 20, and 31, squall events with maximum wind speeds of 115 km/h, combined with thunderstorms and local-scale showers, caused a considerable number of injuries to persons and a lot of material damage.

The month was very warm in Slovakia with temperature anomalies from +2.2°C to +3.5°C. The countrywide precipitation total was 139% of normal. Significantly high daily precipitation amounts were reported from July 13, when in the western and central parts of the country more than 50 mm rain fell at 17% of the stations. Landslides were observed locally in the Hron river basin as a consequence of repeated heavy precipitation; stations Jarabá and Pohronská Polhora received monthly precipitation totals of 331 mm and 284 mm respectively.

In Slovenia the monthly mean temperature varied from close to normal on the coast up to more than +2°C above the long term average in the north-eastern parts of the country. Precipitation was distributed unevenly in time and space; the monthly totals were in the range from less then 75% up to more than 150% of normal. The number of days with thunderstorm was above normal all over the country, especially in the second half of the month..

The monthly mean temperature in Hungary was +2.5°C above normal. In the capital and in the south of the country, the maximum temperauture was often higher than 30°C. From the middle of the month a rainy period started and lasted until October (see fig. 7.1). At station Mátraszentlászló, the second highest monthly precipitation total of 328 mm was measured since 1951.

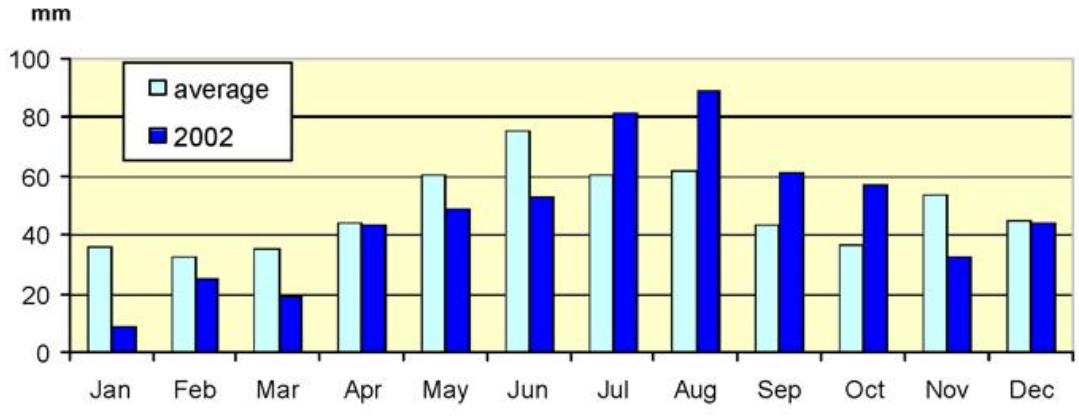


Fig 7.1 *Monthly precipitation sum (mm) in 2002 and between 1961 and 1990 in Hungary*
From: Hungarian Meteorological Service

In Romania, temperature and precipitation anomalies were significantly above normal.

In Bulgaria it was relatively warm with monthly temperature anomalies of +1.2°C to +3.4°C. There was a period of intense rainfall during the last week of the month, that raised the precipitation total to more than twice normal. The number of days with thunderstorm came up to 25. A whirlwind caused damage of about half a million Euro in some villages near Plovdiv on July 17.

The month was unusually wet on the Balearic Islands, Spain. The station Palma de Mallorca received a record breaking monthly total of 57.5 mm rain.

The north-western parts of Italy were affected by heavy showers during July 13-15, when 67 mm rain fell at station Turin and 73 mm in Rome. Four people lost their lives in the floods.

Cyprus had a monthly temperature anomaly of +1.3°C and suffered temporarily from heat wave conditions.

Heavy rainfall followed by flooding caused the death of 27 people in Rize, Turkey, on July 23, and total material losses of about 17 million Euro in the county of Cayeli. Not far away, at Oltu, another extreme rainfall event combined with flooding occurred on July 31 and caused considerable damage of houses and crops.

The month was very hot in Israel. The most extreme temperatures were recorded on the last 2-3 days of the month, e.g. 47.4°C in Eilat on July 31. In Bet Dagan it was the hottest July since 40 years (fig. 7.2).

Azerbaijan had a relatively hot month with an average temperature of +2.1°C above normal. Maximum temperatures were up to 42°C and caused human health problems in some areas.

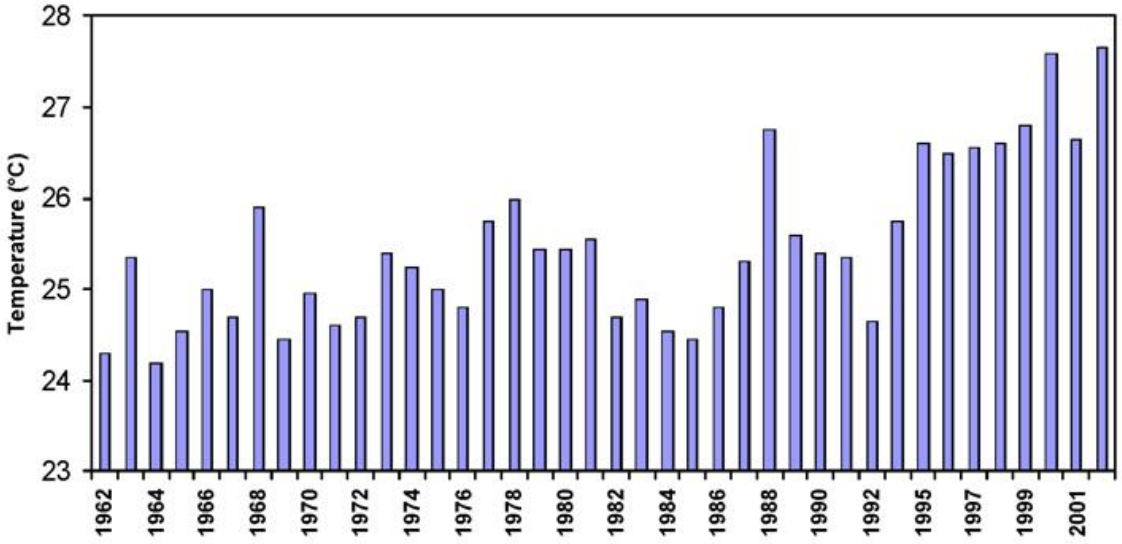


Fig. 7.2 *Mean Daily Temperature in July Bet Dagan (Central Coastal Plain) 1962-2002*
From: Israel Meteorological Service

August 2002

- **Catastrophic flooding in many parts of eastern central Europe because of long lasting intense rainfall**
- **Extremely hot in Scandinavia and the Baltic countries, very cool in northern Russia**
- **Extremely dry around the Baltic Sea and in the southern Iberian Peninsula, unusually wet in south-eastern Europe**

In Iceland, the month was rather dull and damp, but in other respects close to average.

The highest temperature of the year in Ireland was 25.6°C, measured at Clones on August 5. Precipitation totals were well below normal throughout the country.

On August 1, the north-eastern part of England experienced its highest daily rainfall total since records began in 1931 with 61mm, the highest daily regional mean value on record for any month in any England and Wales area. This was a convective rainfall event and some places within the region received much more than this.

The first week of the month in Denmark was dominated by some intense thunderstorms, causing flooding and lightning. The number of lightning strokes was 2-3 times higher than normal. After this episode, a dry period started and lasted on for several weeks with the main focus on the eastern parts of the country.

In Norway, the precipitation total was well below normal except for Troms County in the northern part of the country and some coastal areas. The month was also much warmer than normal for the whole country.

The month was generally very warm in Sweden with numerous and partly heavy thunderstorms. The most exceptional thunderstorm caused flash floods on the island of Orust along the west-coast during the night of August 1-2; private measurements showed that 180-200 mm had fallen on western parts of the island during around 10 hours with horrifying thunder. All roads in the area were disrupted and many houses damaged by water, erosion and lightning

A drought period started on August 3 in Latvia and lasted on over the end of the month. It was the second warmest and the absolute driest August ever recorded. The countrywide precipitation rate was only 4% of normal (fig. 8.1). The heat and drought engendered many forest fires.

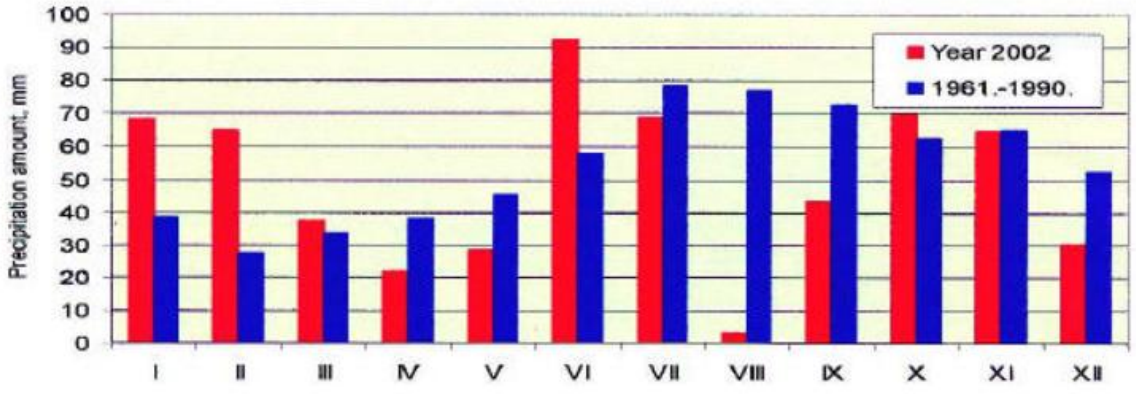


Fig. 8.1: *Monthly precipitation Latvia, actually and for the reference period 1961-1990*
From: Latvian Hydrometeorological Agency

The month was very hot and dry in Lithuania with a mean temperature anomaly of +3.7°C and an overall precipitation total of only 11 mm, which is 14 % of normal. Some stations did not receive any rain during the month. The mean relative humidity was 65% and thus 13 percentage points below normal. The sunshine duration summed up to 351 h; this is 107 h above normal. The soil surface temperature was up to 55°C, and the soil temperature at 20 cm depth reached 22 °C. During the whole month, a disastrous drought affected the country, especially in its eastern parts,. It was the longest and most severe drought since 1992. On August 4, the forest fire index reached its highest level in eastern Lithuania and gradually spread over most parts of the country.

It was the warmest summer month in Poland with a temperature anomaly of +3.1°C, calculated from 8 stations. The mean precipitation total was 119% of the normal rate with a large spatial variability. There was a general increase of precipitation totals from north to south., e.g. 7mm (11% of normal) on Hel, 141mm (240%) in Warsaw, and 275% of normal at station Jelenia Gora in the south-west. A lot of heavy rainfall events were connected to thunderstorms, mainly in central and southern parts of the country. Warsaw experienced catastrophic downpours on August 5. Great damage occurred also at the slopes of the Sudety Mountains, especially in Walbrzych, where the daily precipitation total amounted to 179 mm on August 31.

In the Netherlands, some locations were hit by heavy showers at several times and thus received 3 to 4 times the normal amount of monthly precipitation. In a substantial part of the country, 50 mm or more rain fell on August 24. Station Weesp near Amsterdam recorded 101 mm. At station Eext in the northern part of the country, a new national record of 295 mm for the month was measured; the old one (292 mm) dates back to 1942 at station Voorthuizen.

The monthly mean temperature in Belgium was well above normal, although precipitation rates were generally high and reached 273% of normal at station Uccle. At the same station, the monthly mean wind speed was only 2.3 m/s and thus the lowest monthly mean of the year and 26% less than the long term average of 1878-1986. However, quite a lot of violent storm events were recorded during the month; the most remarkable ones on August 24 and 27 were combined with daily precipitation sums of 100 mm and more in the south-western parts of the country.

The monthly mean temperature in Germany was +2.3°C above normal and the overall precipitation total reached 155% of the long term average. A lot of extreme events occurred during the month. Thunderstorms with intense rainfall and hail caused severe damage in nearly all parts of the country on August 1-2, e.g. the streets of Dresden were covered with a 5 cm layer of hailstones, 65 mm of rain fell in Hamburg within 45 minutes flooding streets and buildings, a whirlwind near Lüneburg removed the roofs of several houses and turned over some cars within a minute. Another period of heavy rains with flooding, especially in northern and southern areas, lasted from August 5 to 8. The most severe event was the period of intense rain on August 10-13 with catastrophic consequences to the south-eastern part of the country. A new record of 312 mm precipitation in one day was set at station Zinnwald. The flooding of the Elbe river and its tributaries caused damage to urban and rural areas at an extent not known there before for natural reasons. 20 people died and the material losses were estimated to thousands of million Euros (see special report on pages 55-62). Again, on August 20, 25 and 27-29 thunderstorms with heavy rains and hail caused a lot of damage to people and infrastructure by flooding, lightning and wind force at many places throughout the country.

Extremely high precipitation hit the Czech Republic in the periods of August 6-8 and 11-13 (figs. 8.2, 8.3). The passage of two distinct depressions and their frontal systems over central Europe caused disastrous floods, one following the other in a very short time. Both depressions hit the country with their rainiest sectors, the area to the WNW from the centre of the depression. Moreover, both of them moved very slowly, which extended the period of continuous rainfall. The precipitation was markedly intensified by the windward effect of the mountains. In the Novohradské hory Mts. and the Cesky Krumlov area 130-250 mm of rain fell within the two days between August 6 and 8, which is 150-200 % of August's normal. The highest precipitation totals for the two days were measured at station Staré Hute, 254.3 mm, and Podhorská Ves , 277.7 mm.

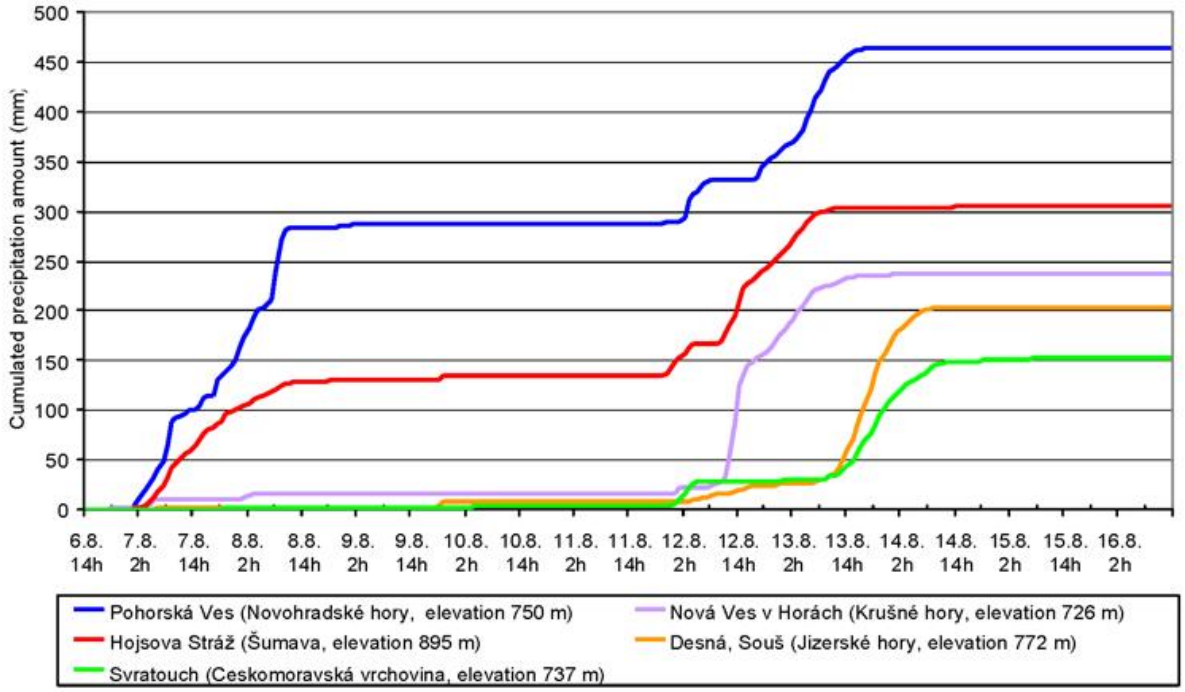


Fig. 8.2: *Cumulative hourly precipitation amounts on selected stations of the Czech Republic*
From: Czech Hydrometeorological Institute

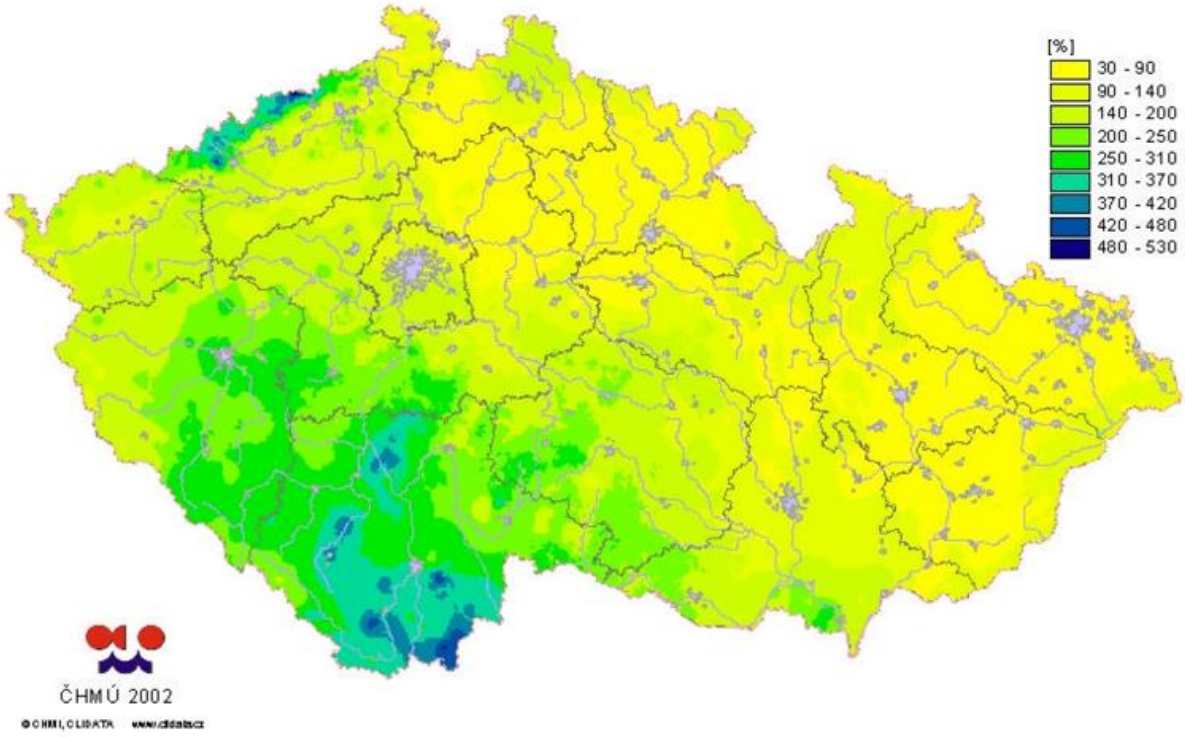


Fig. 8.3: *Anomaly of the precipitation amount on August 6 to 15, 2002 in the Czech Republic (% of August's normal 1961-1990)*
From: Czech Hydrometeorological Institute

On August 12-13 meteorological stations in Krušné hory Mts. and Jizerské hory Mts. recorded daily precipitation amounts of more than 200 mm and two-days' amounts greater than 300 mm. Most was measured at Cínovec, 312 mm in one day, which is the second highest value in history. The 2-days' total on Cínovec, 380 mm, is the highest one ever observed. The whole amounts of water, which fell in the Labe catchment (area of 49?033 km^2) was 6.948 km^3. The first rain period caused the big flood in southern and south-western Bohemia. The second one resulted in terrible floods in the whole Vltava and Ohre catchments. The Vltava river culminated in Prague on August 14 at noon at a level of 782 cm and a discharge of 5?200 m^3/s. This is the highest ever evaluated discharge in the Vltava in Prague in the history of routine observations, which matches a recurrence time of 500 years. On Vltava's left bank near the Charles Bridge the water level was 140 cm above the mark made in 1890 and even 55 cm above the mark of 1784. During the floods 18 people were killed, many houses destroyed, traffic and communication lines damaged as well as bridges, factories and field crops, a lot of animals died. The economical losses were estimated to billions of Euros, the highest damage to this region in written history.

The month was characterized by unusual high precipitation amounts in Austria. More then 300 percent and up to 400 percent of the average monthly total were recorded from many places There were mighty showers during the periods of August 6-7 and August 11-13 leading to disastrous high water-situations. Station Freistadt received a monthly precipitation amount of 405 mm and on August 7 a daily amount of 172 mm. At Linz–Hörsching a new extreme monthly total of 351mm was recorded. Particularly villages and towns along the rivers Inn, Enns and Danube were affected by the floods. The province of Salzburg was declared as disaster area. The total losses were estimated to 1 Billion Euro.

In France, the month was relatively cool; the precipitation regime included heavy rainstorms and came up with an overall total well above normal. Additionally, low sunshine duration was reported.

On the mainland of Portugal, the mean monthly temperature as well as the precipitation total were moderately below normal.

On the mainland of Spain, the monthly precipitation rate varied from about 200% of normal in the north-east to zero in the south-west. The monthly precipitation total at Palma de Mallorca in the Balearic Islands reached record-breaking 119.3 mm.

Northern and central Italy was affected by strong winds and flooding. A peak of 106 km/h was registered at Verona. In the period from August 26 to 29 some violent thunderstorms occurred at Turin with a precipitation total of 138 mm, Brescia (166 mm) and Rome (54 mm). The estimated economic losses were about 200 million Euro, due to damage to agriculture, mostly to viticulture.

In Slovakia, it was the wettest month of the year with a precipitation total of 159% of the normal rate. The combination of long-lasting and heavy precipitation caused numerous flood situations. The sum of material losses was estimated to 41 million Euro.

The heavy rainfalls of August 6-7 over Bavaria and Austria caused extreme flooding of the Danube in Hungary during the following days. The same cyclone carried an extreme rainstorm to the reservoir of the rivers Sajó and Hernád with the consequence of floods in that area.

In Slovenia, the monthly mean temperatures were generally above normal up to about +1.5°C. Precipitation was distributed unevenly in time and space. At the beginning of the month, abundant rainfall in the area of Goriška contributed substantially to the excess of the monthly precipitation total of about 40 % above normal. In Vipava valley the monthly precipitation accumulated to more than 200 % of the normal rate. In the Julian Alps cloudiness was above normal, and consequently the sunshine duration reached only ¾ of the long term average.

The beginning of the month in Serbia and Montenegro was characterised by very intensive rainfall, when in several days the precipitation amount was higher than the long term average total for the whole month in some areas. There was a remarkable increase of the monthly precipitation rate from west to east ranging from a little less than 100% up to more than 300% in south-eastern part of the country. Simultaneously, sunshine duration was below normal everywhere in the country and down to 44% of normal at station Pozega. In Belgrade the monthly sum of sunny hours was the lowest since 1975 (see fig.8.4).

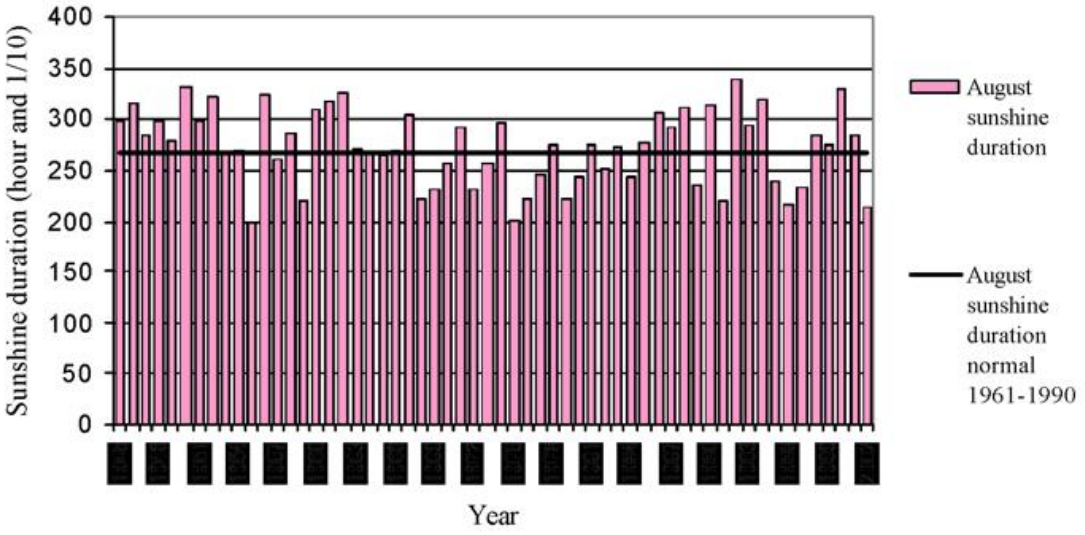


Fig. 8.4: *Sunshine duration in August in Belgrade between 1945 and 2002 and the August mean of 1961-1990.*
From: Federal Hydrometeorological Institute of Yugoslavia

Precipitation totals in Romania were in excess to normal due to torrential rainfalls, frequently accompanied by hail. A whirlwind behind a passing cold front caused severe damage to the town of Facaieni in the south-eastern plain during the night of August 11-12; three people died, houses and crops were destroyed and a lot of trees were uprooted.

In Bulgaria, the month was less warm than normal. The precipitation amounts varied in most areas between 120% and 250% and were up to 355% of the normal rainfall rate in the north-eastern part of the country. There was a great number of thunderstorms, 2 people and a sheep herd were struck by lightning. Rural and urban areas suffered from significant damage to power and traffic lines as well as to houses, especially in and around Sofia on August 7-8 and in Plovdiv on August 12.

Unusually heavy seasonal rains and thunderstorms occurred on August 25-30 in Greece, resulting in floods over the Ionian Mainland, Athens-Attiki and islands of the North Aegean.

In Turkey, heavy rainfall, partly with hail, caused flooding with severe damage to private and public property including buildings, crop fields, transportation facilities and power lines in the provinces of Kocaeli on August 4 and Erzurum on August 27.

The monthly means of temperature and the precipitation total were slightly above normal in the Ukraine. During a period of intense rainfall in Crimea on August 7-9, heavy downpours summed up to more than 100 mm at some places and caused the flooding of houses and railways and the damage of power lines.

In Russia, the Black Sea coastal area was heavily affected by rainfall on August 5-8. Torrential rains totalled 35 mm of precipitation in Novorossisk on August 5 in 30 minutes and 57 mm in Anapa on August 6 in one hour. Thousands of homes were flooded and many of them destroyed. Traffic and power lines were damaged causing the interruption of public transport and energy supply.

In Armenia, rains with thunderstorms and hailstones were frequently observed, causing significant damage to agriculture. Precipitation totals were generally rather high and exceeded 400% of normal in the north-east of the country.

The month was very wet in Azerbaijan with an overall precipitation total of nearly 200% of normal. On August 19 and 27-28 local torrents and floods were observed in rivers of the northwestern part of the Major Caucasus leading to a lot of damage to crops and farms.

Cyprus suffered from some heat waves, although the monthly mean temperature of the island was only moderately above normal.

In Israel, the month was fairly warmer than usual, but not as extreme as the month before.

September 2002

- **Much warmer than normal from the north-western to the south-eastern edge of the Region**
- **Cooler than normal from central to southern Europe and in north-eastern parts of the Region**
- **Extremely wet in the western part of the Iberian Peninsula and in a belt from the western Alps over the Balkans into Turkey**
- **Very dry from the western Mediterranean over western France, the British Isles and southern Scandinavia to the Baltic countries and Belarus**

In Greenland föhn situations gave very high and record-breaking temperatures at several locations.

In Ireland, the month was drier than normal everywhere and very sunny.

Denmark experienced an ongoing drought nearly throughout the whole month, especially in the eastern parts of the country.

The month was warmer than normal for most of Norway. From the Lofoten area and northwards, the monthly mean was below normal. The precipitation was approximately 50% of the normal rate in the southern part of the country, in the mid part near to normal and in the northern part up to 150 % of the long term average.

The period of temperatures warmer than normal lasted on in southern and central Finland, whereas the rest of the country was colder than normal.

The drought period in Latvia, ending in the middle of the month, resulted in minumum water levels in rivers, close to the lowest in1993 over a long term observation period (see fig.9.1).

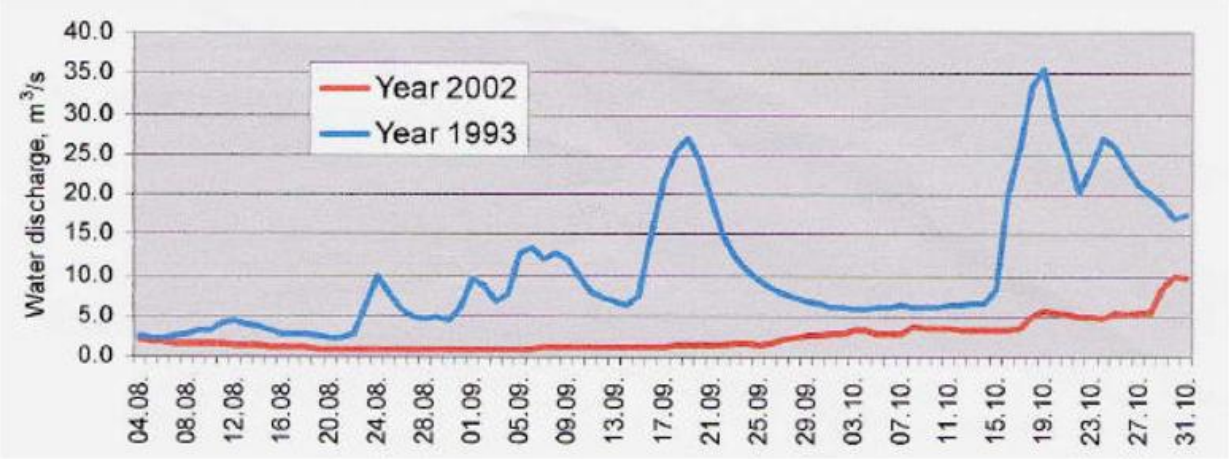


Fig. 9.1: *Water discharge of the Barta river during low flow period of 2002 (lower curve) compared to 1993 of average runoff (upper curve)*
From: Latvian Hydrometeorological Agency

The drought in Lithuania ended with rainfall and inflow of cool air by September 9 – 22. It was the longest and most severe drought since 1992 and lasted for more than 60 days in some areas. The countrywide monthly precipitation total was 41 mm, which is 60 % of the normal rate.

The continual precipitation deficit since March intensified the drought situation in Belarus. Consequences were obstructions to river traffic, damage to agriculture and an increasing risk of forest fires.

The monthly precipitation total in Belgium was below 50% of the long term

average (fig. 2.1), while the temperature was close to normal. The mean wind speed was about 85% and sunshine duration near to 90% of normal.

In Luxembourg the month was very sunny with 62 hours more sunshine than normal.

In Germany the monthly mean temperature as well as the precipitation total were nearly identical to the averages of the reference period 1961-1990. But there was a remarkable meridional trend from relatively warm and dry weather in the north to cool and wet conditions in the south of the country. Thunderstorms with heavy rains of up to 70 mm in less than 1 hour caused flooding of cities in southern Hesse, northern Bavaria and in Saxony on September 9-10. Snowfall occurred in places down to 400 m above sea level on September 24-25 in southern parts of the country leading to many accidents on roads and fallen trees; a closed snow cover appeared in Munich for the first time in this month since1931.

The monthly mean temperature in Poland was moderately above normal by +0.5°C; negative deviations were observed in the southern and positive ones in the northern parts of the country. The first frost of the season occurred in Suwalki with a minimum temperature of –1.7°C on September 24. Precipitation totals were generally 90% of normal with a great local variety, e.g. Szcecin received 140% of the normal rate whereas the total precipitation amount in Suwalki was only 20 mm, which equals 39% of the long term average. Strong mist was observed in central and eastern areas on September 5.

Catastrophic floods occurred in south-eastern France on September 8-9. Exceptional rainfall affected the Languedoc area. In the department Gard daily precipitation amounts exceeded 500 mm during this event. The highest values recorded during this spell were 687 mm in Anduze and 514 mm in Alès (s. fig. 9.2). 23 people died and one was reported missing.

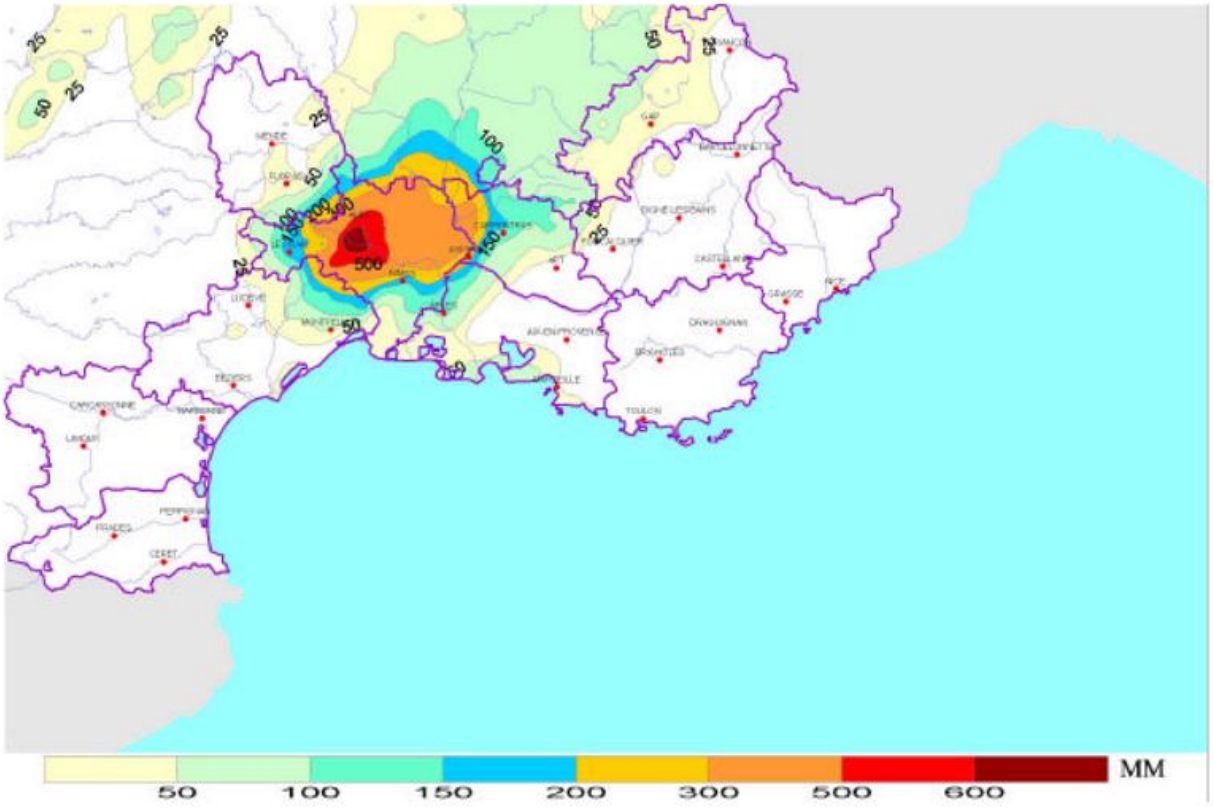


Fig. 9.2: *Precipitation totals from 8th to 9th of September 2002*
From: Météo France

In Portugal the month was cool and rainy. The monthly mean temperature deviation in mainland Portugal was –1.0°C from normal; and the deviation of the monthly

mean maximum temperature even –2.0°C. The monthly precipitation total on the mainland was about 260% (s. fig. 9.3). In southern areas the monthly precipitation amount was 7 times higher than mean value of 1961-90. The large precipitation amounts that occurred during this month caused significant damage in agricultural activities, e.g. tomato production was reduced to about 20% of the previous year's harvest.

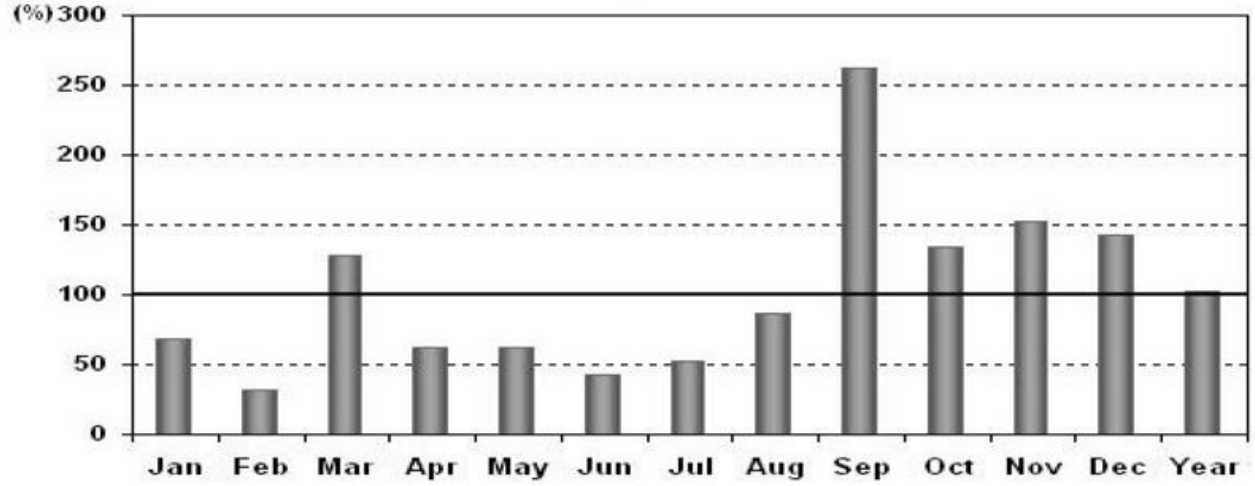


Fig. 9.3: *Monthly precipitations totals in percent of normal (1961-1990) in Mainland Portugal in 2002*

From: Instituto de Meteorologia, Portugal

The monthly mean temperature in Slovakia was slightly below and the precipitation total near to normal.

In Hungary, the monthly mean temperature was 0.4°C below normal and the monthly precipitation total 135% of the long term average. The maximum of the daily precipitation total, 141 mm, was measured in Gagybátor on September 9.

The month started relatively warm in Slovenia, but became cooler after the first ten days with the result of a monthly mean temperature moderately below normal. Precipitation was distributed unevenly in time and space. The normal monthly total was exceeded on the coast and almost everywhere in the southern part of the country, elsewhere precipitation was below normal and down to less than 70% of the long term rate in some places.

In Serbia and Montenegro, the deviation of the mean monthly temperature was negative and the precipitation total was above normal in the whole country

In Bulgaria, the month was cool and extremely wet. The monthly precipitation rate varied from about 200% of normal up to 788% at station Krumovgrad. A severe hailstorm and heavy rainfall on September 25-26 caused great damage to agriculture, communication and power lines as well as to transport facilities.

In Greece, it was the wettest month since 50 years in some areas. The monthly precipitation totals were generally around 200 % and up to more than 500% of normal at some places. E.g. station Lamia received 88,0 mm of rain, which is equivalent to 506% of the normal monthly precipitation sum. Other stations recorded even higher amounts, but with a lesser percentage of normal.

Heavy rainfall and storm affected the area of Trabzon, Turkey, on September 17. Buildings and streets were flooded, roofs torn off, trees broken and road traffic interrupted.

Very heavy rains were observed in the Crimea, Ukraine, on September 16 with precipitation amounts of 31-85 mm in 4-9 hours, and at some places of 120-150 mm in 12 hours. The Crimean economy suffered considerable damage.

Heavy rainfall caused flooding of the tributaries to the Samur river at the northern Caucasian ridge in the Russian Federation on September 19-20; in consequence mudflow damaged roads, bridges and power lines. In North Osetiya, the Kolka Glacier collapsed on September 20 and triggered an avalanche of ice and debris that buried small villages including 6 holiday complexes, killing dozens of people.

Although the monthly precipitation total was only 52% of normal in Azerbaijan, there were torrential downpours of short duration flooding the rivers in the area of Quba/Khachmaz on September 14 and of Balaken/Sheki on September 19.

The month was warmer than normal in Israel. A significant sharav event occurred on September 29-30 with temperatures reaching 37-38°C in the coastal plain and in the northern Negev.

October 2002

- **Very cold in Scandinavia, extremely dry in its central part**
- **Wet in a broad belt from the British Isles over central to eastern Europe**
- **Violent storms in many parts of Europe at the end of month**

The month was very warm in Iceland except for the last week which was unusually cold, as the new absolute temperature minimum testifies. The new national minimum temperature record for the month was reached, when -22.3°C was measured at lake Myvatn in the north-eastern inland on October 28. The previous record was set in 1957 by -21.6°C. It was also one of the two sunniest months of the year relative to normal.

In Ireland, it was one of the wettest months of the year relative to normal and a little cooler than normal over most of the country. The highest daily rainfall on record, 80.0 mm , was measured at Rosslare on October 24. The strongest winds of the year were measured during late October.

The period beginning on October 20 saw the highest 7-day running precipitation total in Northern Ireland, U.K., since records began, 114mm falling over this time.

The month was very cool and rainy in Denmark. Stormy weather on October 27-28 caused the loss of one person.

In Norway, the monthly mean temperature was well below normal for the whole country. At some places the anomaly was down to -4°C. The monthly precipitation was below normal for most of the country but parts of the southernmost region received up to 205% of normal.

An exceptionally early snowstorm hit southern Sweden on October 18-19, and a new record snow depth for this month in southern Sweden was noted close to Ulricehamn with 48 cm. More than 20 000 households were without electric supply, as wet snow broke down birches that still had leaves.

In Finland, the month was very cool and dry with temperature deviations of more than -4°C from normal and precipitation totals below 50% of normal.

A violent storm struck the Netherlands on October 27. The storm was the most severe in 12 years. Highest gusts up to 148 km/h were measured in the south-west of the country. The maximum hourly wind speed reached 101 km/h in the western coastal zone. Public life was disordered and material damage was substantial, 4 people were killed. Another extreme event was a downburst causing extensive damage in the province of Limburg on October 16.

In Belgium, the monthly mean temperature was near to normal and the precipitation total about 50% above the long term average. Stormy weather conditions with thunderstorm and hail prevailed on October 25-27 and caused lots of damage including the death of 4 people in different parts of the country.

During stormy weather in Luxembourg a maximum wind gust of 116 km/h was measured on October 27.

An intense storm hit northern France also on October 27: The wind speed exceeded 100 km/h and highest gusts of 130 km/h and more were recorded on exposed coasts (see for example fig. 10.1) with the consequence of several casualties.

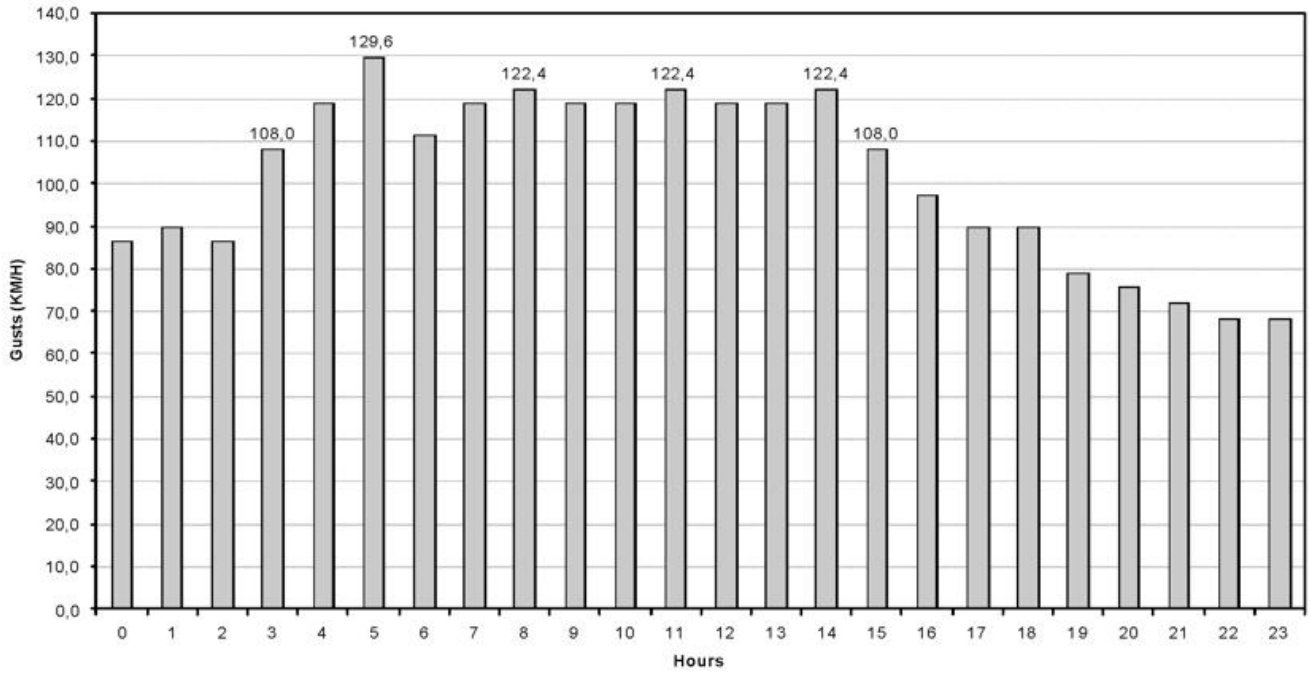


Fig. 10.1: *Hourly maximum wind gusts on 27-10-02 in Cap de la Hague (Manche)*
From: Météo-France

It was the first month of the year with a countrywide negative temperature anomaly in Germany, -0.8°C. A local record for the coldest October 13th since more than 100 years, 4.0°C, was set in Hamburg. The overall precipitation total was 106.4 mm and thus exceeded the normal value by 91%. It was the 10th wettest October since 1901. Three major storm events affected the country on October 22-23, 25-26 and 27-28, especially in the low mountain ranges with winds of hurricane force. During the latter event highest gusts were observed at the mountain stations Fichtelberg (183 km/h) and Brocken (176 km/h) and in Gütersloh (148 km/h). Severe damage occurred to all kinds of transportation facilities, to houses and church towers, wind generators and power lines. Twelve people were killed and 50 injured.

In Belarus, the monthly precipitation total was about 280 % of the average rate of 1961-1990 (fig. 10.2).

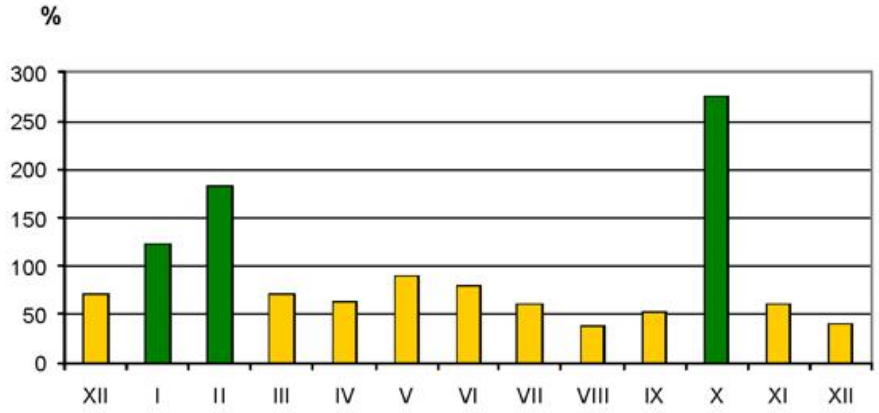


Fig. 10.2: *Monthly precipitation total in % with reference to the period 1961-1999*
From: Ministry of Natural Resources and Environment Protection, Belarus

Strong winds affected Austria north of the main Alpine ridge on October 26-28. In Upper Austria numerous trees were uprooted on October 27 and several streets were blocked. One day later in Tyrol gusts up to 140 km/h caused traffic obstructions, the destruction of power-lines and the damage of houses and cars.

The countrywide monthly mean temperature anomaly in Poland was –1.2°C and the overall precipitation total 208% of normal. It was the wettest month of the year except for February. Station Chojnice received even 300% of the long term average precipitation. Strong winds with gusts up to 101 km/h were observed on October 27-28.

The mean monthly temperature in Lithuania was 4.5°C and thus 2.7°C below normal. The monthly amount of precipitation was abundant with 123 mm, which means 203 % of normal. The rains were very welcome for the national agronomy.

In Latvia the monthly temperature anomaly was nearly down to –4°C and the precipitation total about 110% of normal.

In the mainland of Portugal the monthly mean temperature anomaly was +0.4°C and the precipitation total about 130% of normal. Heavy rain caused floods in Lisbon on October 8. Thunderstorms with heavy rain, strong winds and hail caused the flooding of roads and the damage of houses, forests and power lines in central parts of the country on October 29.

A tornado was registered at Lladux, Spain, on October 21.

In the Ukraine the monthly mean temperature was close to normal, while the precipitation amount summed up to 200% of the long term average.

In Romania, it was moderately cooler than normal and very wet. The countrywide precipitation total was about 200% of the long term average

The month was very rainy in Bulgaria with precipitation rates of generally around 200% of normal and particularly of 400%-500% in the north-east of the country.

Cyprus had only 29% of normally 33 mm precipitation. The monthly mean temperature was +1.2°C above normal. A water-spout turned into a tornado over land in the western part of the island on October 8 and caused injuries of people while damaging touristic installations. Heavy thundery showers in the area of Nicosia on October 14 caused flooding and fire from lightning.

The most significant weather event in Israel occurred on October 15 and it included severe hail, intense thunderstorms, heavy rain and strong winds in the central coastal plain. Very large hailstones caused severe damage to homes, cars and trees. In some places the size of the hailstones was 4-5 cm and even more. On October 30-31 heavy rains, 40-50 mm, fell in the Negev Desert causing floods in the area.

November 2002

- **Very cold and dry in northern Scandinavia**
- **Very mild from Svalbard, Greenland, and Iceland over the British Isles and France to the Alps and the northern Balkans**
- **Very wet over the British Isles, the western Alps and southern parts of Italy and Greece**
- **Intense Alpine foehn event in the middle of the month**

In Iceland it was very mild with monthly mean temperatures of +3°C and more above normal. The snow cover was far below normal in most parts of the country. The eastern parts of the country received exceptional precipitation. A new absolute monthly total record was established, as the accumulation approached 1000 mm at two stations in the east. This case is exceptional, as the stations involved have average annual totals of less than 1500 mm. Although a few roads were blocked by local flooding and debris flows and a house was hit by a landslide, the total damage was relatively small considering the circumstances.

Relative to normal it was one of the wettest months in Ireland with serious flooding in both rural and urban areas. The monthly mean temperatures were over two degrees higher than normal in places.

In Norway the month was colder than normal for the whole country In the northern and southern mountainous terrain the anomaly was about –4.0ºC. In the eastern part of the country the precipitation was above normal but well below else.

Sleet and icing events accumulated heavy loads on trees in some areas of southern and south-eastern Finland. Consequently many of these trees were cut and caused considerable economic losses to forestry.

The month was relatively mild and wet in Belgium. There was one major event of heavy precipitation with flooding in the south-eastern part of the country on November 10-11.

In Luxembourg, the monthly mean temperature was +2.3°C above normal.

The monthly mean temperature in Germany was 5.5°C and thus +1.5°C above normal. The precipitation total amounted to 111 mm, which is 168% of normal and the third wettest November since 1901. Heavy snowfall up to 10 cm caused a lot of accidents on roads in the eastern parts of the country on November 4. Intensive rain on November 11 triggered flooding of the river Rhine and some of its tributaries. Three foehn events with gusts up to 250 km/h at the mountain station Zugspitze caused severe damage to the infrastructure in the foothills of the Alps on November 14-16, 21 and 25.

Temperature anomalies in Poland varied from –0.6°C in Szczecin up to +3.2°C in Lesko with a clear gradient from north to south. In Krakow a maximum temperature of 20.3°C was measured on November 16. The countrywide monthly mean temperature came up to +0.9°C above the long term average. The overall precipitation total was 87% of normal with a spatial variation of values below 60% in the eastern and above 200% in the western parts of the country. Strong foehn winds caused a lot of damage to the forests of the Tatra National Park on November 15. Maximum gusts were up to 108 km/h in Zakopane and 130 km/h at the mountain station Kasprowy Wierch.

The month started very cold in Lithuania and became much warmer in its second half resulting in a monthly temperature anomaly of -0.3°C. Precipitation amounted to 34 mm only, which is 52 % of normal.

Belarus had a temperature anomaly of +0.5°C and a precipitation deficit of 40%.

The month was very mild in France with temperature anomalies between +3°C and +3.5°C. Exceptional rainfall affected the southern and central eastern parts of the country on November 13-17; cumulated precipitation exceeded record values for November. Thunderstorms with intense rain caused floods in eastern areas on November 23-24, people were evacuated in the departments Var, Vaucluse, Drôme and Ardèche. At Cap-Béar close to the Mediterranean sea shore the maximum wind gust of the year, 144 km/h, was recorded on November 7.

During a powerful foehn situation in Austria on November 14-16 new records of absolute maximum temperature for the month were registered, i.e. 21.5°C in Klagenfurt and 22.8°C in Graz. The previous records were 18.6°C and 19.7°C respectively and date back to 1963. This foehn episode was accompanied also by strong winds with gusts of about 150 km/h. Severe damage occurred to the infrastructure and forestry in the area of Salzburg, The material losses were estimated to 95 million Euro.

The first third of the month in Slovenia was slightly colder than normal, but then it became exceptionally mild. The monthly temperature anomalies in the lowland resulted in values between +3°C and +5°C; during the last 52 years the monthly mean air temperature was higher only in 1963. A stormy southerly wind blowing between November 14 and 16 caused severe damage to houses and forests.

The weather in Hungary was mixed between the first snowfall on November 4 and a succeeding late Indian summer with daily maximum temperatures above 15°C everywhere in the country. Local records of the maximum temperature were set at stations Keszthely, 23.9°C, and Fonyód, 24.0°C on November 15. The daily mean temperature in Budapest was above 18°C for 5 consecutive days, which is without precedence in the last 50 years. The countrywide monthly mean temperature came up to be +3.2°C above the average of the reference period 1961-1990 (see fig. 11.1).

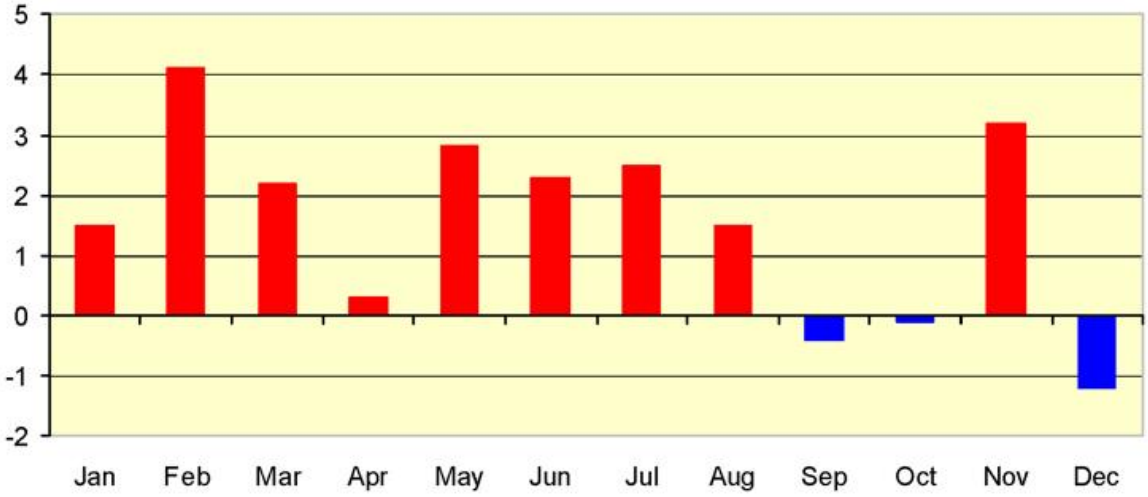


Fig. 11.1: *Monthly temperature anomalies in Hungary in 2002 (reference period 1961-90).*
From: Hungarian Meteorological Service

Extremely high mean monthly temperatures and very low precipitation amounts characterised the weather in Serbia and Montenegro.

In Romania the month was very mild with significant positive temperature anomalies.

Italy was hit by some intense weather events with flooding. During a violent thunderstorm in Tuscany on November 1, a precipitation amount of 104 mm was measured at Grosseto. In the period of November 22-30, intense precipitation occurred in the north-western part of the country. The largest precipitation amount of 300 mm in this episode fell at the Pass of Giovi near Genoa at 475 m above sea level. The damage to agriculture has been estimated to about 350 million Euro. In the same period, fifteen houses were destroyed by landslides following the flood and one person died.

In Cyprus, the month was very warm and extremely dry.

On the occasion of an hailstorm in the area of Antalya, Turkey, greenhouses and plantations of citrus fruits were heavily damaged on November 22.

The month was warm and dry in Israel. In most areas rainfall amounts were only 50% of normal. There were long periods of hot and dry weather with temperatures reaching more than 30°C.

The month was very dry in Armenia with a general precipitation rate of only 30 % of normal.

In Azerbaijan, the month was significantly warmer and drier than usual. The temperature anomaly was +2.8°C and the precipitation totals varied from 25% to 49% of normal.

December 2002

- **Extremely mild in Greenland, Iceland and Svalbard, very mild also in south-western Europe**
- **Very cold in eastern Europe and parts of the Middle East, extremely cold and wet in the Caucasus**
- **Extremely dry from Scandinavia over Poland to the Ukraine and central Russia**

Some foehn situations in Greenland yielded very high and record-breaking temperatures at several locations.

In Iceland it was one of the warmest December months on record in most parts of the country. At a few stations the previous record holder, December 1933, was surpassed. The absolute maximum temperature in Reykjavik in December was 12.0°C, the same as the previous record. The snowcover in the north of th island was the lowest on record for this month.

The monthly average temperature in Norway was below normal for the whole country except for some coastal areas in Finnmark County. In southern parts of the country the anomaly was –3°C to –4°C. The monthly precipitation amount varied from near normal to well below normal. Coastal areas in the southern part and the north-eastern part received nearly 100% while coastal areas in the western part received only 25%. Due to a blocking situation in northern Europe in the end of the year, the station Finsevatn recorded the highest air pressure, 1058.7 hPa, ever measured in this month in Norway. on December 8. Extremely high temperatures were observed in the Svalbard area during December 3-8. All regular weather stations recorded temperatures higher or equal to the previous December records. The maximum temperature of 7.9 °C at Svea Gruber on December 7 is the highest December temperature ever measured in Spitsbergen.

The month in Denmark was mild in the beginning, but then the weather became cool and dry with easterly winds and without any snow.

The unusually cold weather in Sweden culminated with –41°C close to Jokkmokk in Lappland on December 24.

In Finland the month was clearly colder than normal in the whole country.

Many areas in the U.K. experienced flooding at the end of the month following heavy rainfall that started on December 26 and lasted into the next year.

The monthly mean temperature in Belgium was moderately above normal, while the precipitation total clearly exceeded the long term average. Intense precipitation with flooding occurred on the occasion of two major events: in west Flandres on December 5 and in the south-eastern part of the country on December 29-31.

In Germany as a whole the temperature anomaly was slightly negative and the precipitation total nearly reached the normal amount. But there were considerable differences between the very cold and dry northern and the mild and wet southern parts of the country. A cold spell on December 9-11 made some lake surfaces freeze and enabled the harvest of frozen grapes for the making of sweet wine; three people froze to death. Freezing rain and snowfall caused chaos with many accidents on roads and motorways during two other weather events in the north and the east of the country, namely on December 13-18 and 23-26.

In Poland it was a typical cold winter month with a temperature anomaly of –4.1°C. According to a rather low precipitation rate of 51% of normal the snow cover was rather poor. Deep frost of nearly –30°C was observed in the valleys of the Carpathian Mountains on December 26. Icing made a lot of problems on the roads on December 29.

The weather in Lithuania was determined by anticyclones in northern latitudes. This circulation pattern led to very low temperatures, 5.5°C below normal, and scarce precipitation, less than 50% of the normal rate.

The weather conditions in Latvia were very cold with a temperature anomaly of –5°C and dry with a precipitation rate below 60% of normal.

The monthly mean temperature anomaly in Belarus was down to nearly –6°C, while the precipitation total was below 50% of normal.

The month was extraordinarily warm in all parts of France, especially at its end. New records were reported like a daily maximum temperature of 24.7°C in Herrère on December 23 and a daily minimum temperature of 11.9°C in Saint-Yan on December 27. The month was characterised also by a large deficit of sunshine duration: in Dijon with only 3.05 hours between December 1 and 15, it was the lowest sunshine duration for this period since 1947.

The month was unusually warm in the west and south of Austria. The monthly mean temperature in Bregenz reached 4.4°C, which is the highest observed value since 1880, when it was 5.1°C.

The month was very cold in Slovakia with temperature deviations down to –3°C below normal at some stations in the central and eastern part of the country.

In Hungary the monthly temperature anomaly was –1.2°C, while the precipitation total nearly reached the normal amount. The lowest temperature of the year, -28.3°C, was measured in Zabar on December 26.

The monthly mean temperature in Slovenia was clearly above normal with highest anomalies up to +3°C near the coast. Precipitation was abundant at some mountain stations, but scarce at other places like Potorož at the coast with less than 40% of normal.

In Serbia and Montenegro it was a typical winter month with clearly negative temperature anomalies. A snow cover was formed in the second part of the month

The month was very cold in Romania with a temperature anomaly of –2.6°C.

The month started mild and rainy in Bulgaria. After the first week temperatures dropped down to –18°C and snowstorms with gusts up to 86 km/h caused significant damage in the eastern part of the country. Electric power supply was interrupted, hundreds of car accidents occurred on slippery roads, 10 people died.

The monthly average temperature in Portugal was well above normal essentially due to the positive anomaly of about +2.0ºC of the minimum temperature. The precipitation rate was about 140% of normal. Heavy rain and strong winds occurred, mainly in the northern parts of the country on December 25-27. Water levels rose about 7 meters higher than normal in Douro River and 5 meters in Tâmega River. The swell of the river basins caused several floods that submerged roads, dislodged people and led to the interruption of railway traffic. The sea weather conditions forced the closure of several harbours in northern and central coastal zones.

The month was cool and rainy in Israel. Rainfall amounts were 150%-200% of normal and there was a large number of rain days. In the northern and central parts of the country there were 12 succesive days of rain from December 15-26, which is a unique event in Israel.

Unstable weather conditions including thunderstorms with hail prevailed in Cyprus. The monthly precipitation was well above normal, while the monthly mean temperature was near to normal. A tornado caused damage to homes and greenhouses in the western coastal area on December 6. Another tornado in the western part of the central plain again caused damage to farms on December 8. On the same day a very severe hailstorm in the southeastern part of the island caused extensive damage to buildings, cars and farm land. Flooding occurred in the towns of Nicosia, Larnaka and Limassol and land slides in mountain areas.

In Turkey it was very cold, especially at the end of the month. At 75% of 110 stations the long term record of minimum temperature was broken within the last ten days of the month.

The month was extremely cold and dry in the Ukraine. The temperature anomaly was down to about –7.5°C and the precipitation rate was only 40% of normal.

The monthly mean temperatures in Russia were very much below normal, especially the southern areas experienced anomalies down to -8°C. Strong winds with gusts up to 137 km/h in combination with low temperatures caused severe damage to the city of Novorossisk at the Black Sea. One vessel sank and another one stranded because of ice formation. Throughout the month the danger of avanlanches continued in the northern Caucasus area. The situation culminated to the end of the month, when seven people died and several villages were cut off in a series of avalanches.

In Armenia the month was very cold and snowy. The monthly temperature anomalies were generally about -4°C, in Ararat and Sunick valleys down to –8°C. In Yerewan the absolute minimum temperature reached -28^{0}C and -32^{0}C in Ararat town. It was the coldest December since the beginning of observations in 1954. Temperatures dropped down

especially in the second half of the month (e.g. see fig. 12.1). The period with temperatures below -14°C lasted for about 150 hours in Ararat valley and caused significant damage to vineyards and orchards. Material losses are estimated to 30 million Euro. The precipitation totals were about 200% of normal, in Ararat valley even up to 300%. A snow cover was established everywhere with a depth varying from 20 cm up to 50 cm in mountain areas.

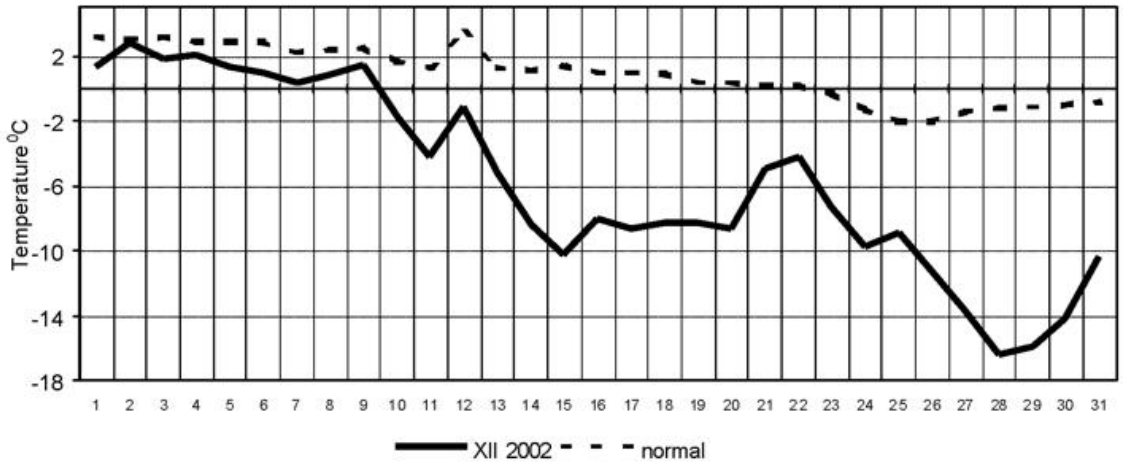


Fig. 12.1: *Daily mean temperature in December 2002 and normal values in Yerevan*
From: Department of Hydrometeorology of the Republic of Armenia

Abnormal cold and wet weather conditions prevailed in Azerbaijan. The monthly mean temperature deviation from normal was -4.3°C, which statistically occurs once in 86 years. Frost periods were accompanied by strong northerly winds and the daily mean temperature dropped down to 9°C below normal on some days. The lowest daily mean temperature in Baku was –2.9°C on December 25. The absolute minimum temperature was measured in Nakchivan on December 28, -30°C. This is 5°C lower than the absolute minimum temperature within the last 100 years. A stable snow cover appeared all over the country. The cold weather conditions caused difficulties in energy supply, 11 people died. The monthly precipitation total as a mean value of all stations was 253% of normal (see fig. 12.1). The precipitation in Baku amounted to 183.9 mm, which is 5.7 times the monthly and 74% of the annual long term average at this station.

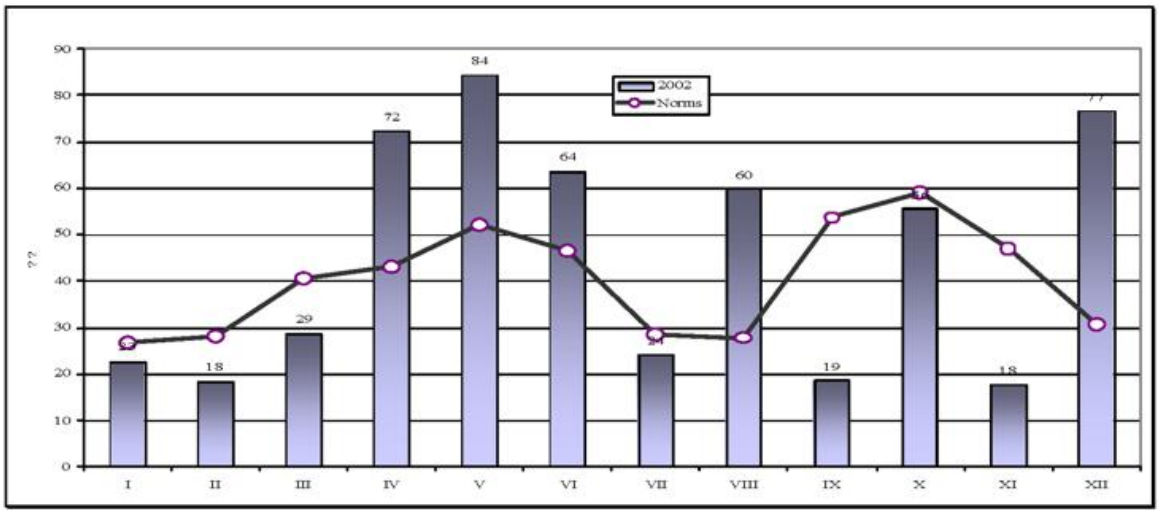


Fig. 12.2: *Monthly average precipitation in 2002 and normal precipitation in Azerbaijan*
From: Minstry of Ecology and Natural Resources, Azerbaijan

Activities and Results of European Climate Centres

The Century Flood of the River Elbe in August 2002:
Meteorological Conditions and Climatological Aspects

By: Bruno Rudolf and Joerg Rapp, Global Precipitation Climatology Centre (GPCC)
German Meteorological Service, Offenbach/Main, Germany

1 The Flood

The meteorological cause of the catastrophic floods along the Danube and - in particular – the Elbe rivers in August 2002 was an extraordinary weather situation with various meteorological factors leading to such extreme precipitation as has never been recorded before in Germany. In parts of the Erzgebirge (mountain range between Germany/Saxony and Czech Republic) more than 300 mm fell in one day, and even in the region north of the low mountains more than 150 mm fell over a widespread area in 24 hours, and in the Berlin area approximately 100 mm were recorded.

The extreme precipitation was followed by a very quick rise in the water levels of the Elbe tributaries, in particular the rivers which drain the Erzgebirge to the north. The water level of the Elbe subsequently reached a maximum mark, which had not been recorded for centuries. The total economic damage resulting from the August flood (the Czech Republic: € 3 billion, Austria: € 3 billion; Germany: € 9.2 billion) represent a new European record for flood damage.

Floods never have merely one single cause, therefore it is important from the point of view of climatological research to examine more closely the individual meteorological factors leading to the flood. Only in comparison with the climatic temporal-spatial precipitation distribution it can be assessed how extraordinary and extreme the meteorological conditions for this event really were.

2 Synoptic description of the weather situation

An essential cause of the catastrophe was the transport of cold maritime air from the Icelandic-Greenland area to the western Mediterranean Sea days before, where on 10 August a well-defined upper-air trough was formed. Dynamic lifting processes led to a rapid fall in air pressure in front of this low over Upper Italy, so that in the night of 11 August over the northern Adriatic Sea a so-called Vb-low was formed. The low included extremely moist and warm Mediterranean air into its circulation, a process that was decisive for the precipitation potential that later existed over Central Europe.

The low subsequently moved on "a Vb-track" north-eastwards (Figure 1), whereby its cloud structure was increasingly transformed into a vortex. At this time high-reaching frontal cloud bands with heavy rainfall, which also included thunderstorm cells, were already lying over the southern side of the Alps and over the Alps themselves. By 12 August the low had moved towards the Czech Republic, strengthening all the time, and later reaching Saxony. On the northern and western side of the low an expanded and strong lifting was connected to a divergent upper current, whereby persisting and abundant large-scale precipitation was initiated. Due to stable high pressure areas over eastern and western Europe the low finally became almost stationary and pivoted itself to a certain extent exactly over the eastern part of Germany. The atmosphere here was supplied again and again with warm and very moist, unstably layered Mediterranean air, which experienced a large-scale lifting, condensation and immediate raining out.

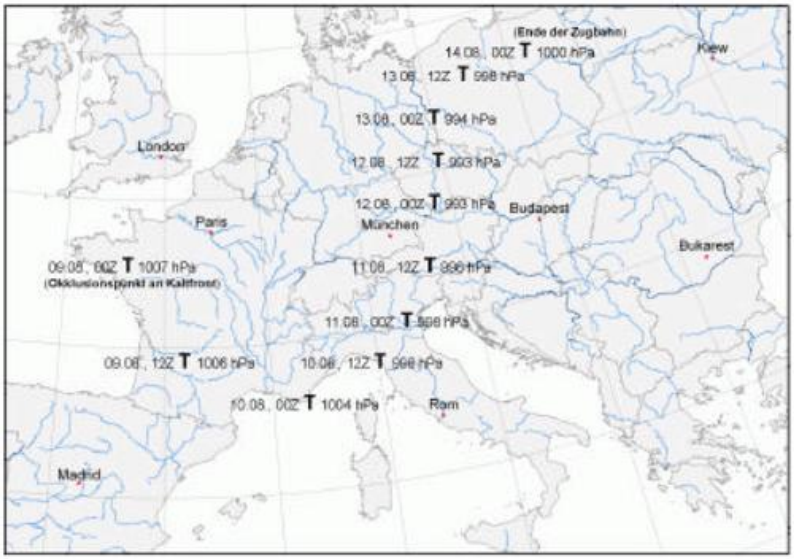


Fig. 1:

Track of the "Vb-low" with indication of the core pressure.

The situation was intensified by the fact that on 12.08.2002, in the region of the Erzgebirge, due to the fall in pressure in the east and the increase in pressure in the west a strong pressure gradient developed, which resulted in a freshening, stormy north-west wind in this mountainous area. As a consequence, the air mass saturated by water vapour was orographically lifted in the Erzgebirge area, which led to extraordinary heavy precipitation.

The impact of at least five meteorological factors upon one another led to the catastrophic flood:
The (1) large-scale, strong and quasi-stationary lifting area was connected with the development of the Vb-low, and is to be classified as an essential synoptic precondition of the heavy precipitation. The large-scale constellation of pressure and airflow over Central Europe changed only very slowly. Warm and very moist air was guided from the Mediterranean and Black Sea via the typical Vb-track, water vapour saturated and with an extended (2) very high liquid water content, a necessary condition for record precipitation, which is naturally fulfilled much better in summer than in winter. (3) Convective precipitation processes in the moist-unstable air mass further east constituted a considerable additional effect locally. Essentially more significant, however, was the (4) additional orographic lifting windward of the Erzgebirge due to a reinforcement of the pressure gradient in the rear of the low. Finally the (5) already deeply water saturated ground and the relatively high water level of many rivers due to the heavy rainfall in the weeks before was responsible for the explosive nature of the Elbe flood, particularly since this river drains - contrary to most of the other rivers - the whole mountain range and not only one side.

On the basis of a synopsis and an interpretation of the observation material available (total precipitation measured at stations, other weather observations, radar and satellite images, lightning echoes etc.), the following estimation of the causal proportions of the various precipitation mechanisms can be made:

- Stratiform (scaled) precipitation — 2 thirds
- Convective precipitation (showers, thunderstorms) — 1 third
- Orographic intensification along the mountains — doubling of the totals

The extremely high diurnal precipitation and the devastating flash floods caused by it, which affected the places in and close to the Erzgebirge, resulted thus above all from the lifting at the northern edge of the mountains. Over all, the precarious flood situation along the Elbe and its larger tributaries with flooding in many places and towns was due to the combination of the five causes described above.

3 Observed precipitation data

The extreme dimension of the flood disaster was thus based also on the soil moisture saturation resulting from the rainy weather before. Figure 2 shows on the left the precipitation totals for the period 6 - 8 August. The rainfall first centred on Upper Austria with amounts of more than 100 mm which led to heavy flooding along the Danube, but it also rained considerably (20 to 30 mm) in the Erzgebirge. Some days later the heavy rainfall expanded northwards to include the Czech Republic, Saxony and Brandenburg. In the period 10 -13 August, 100 mm were exceeded over widespread areas, with many places in the Erzgebirge reaching the 200 mm threshold (Figure 2 on the right).

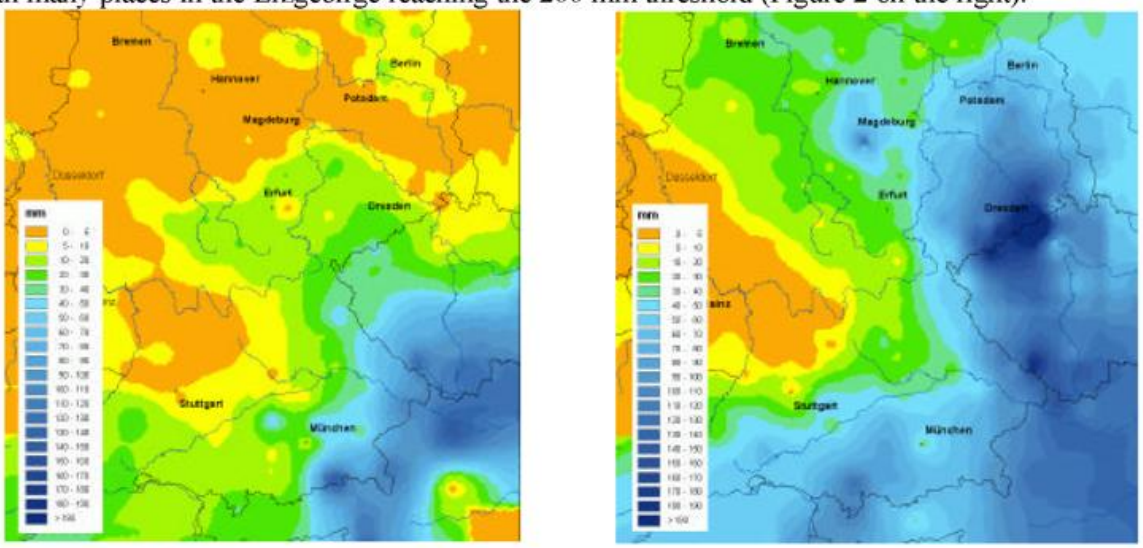


Fig. 2: *Precipitation totals of the periods 6 - 8 August (left) and 10 - 13 August, 2002 (right).*

Zinnwald-Georgenfeld even reported 380 mm of rain. 312 mm fell on one day alone (06 to 06 UTC the following day), or even 353 mm if the reference interval is shifted by three hours (03 to 03 UTC). Radar-based precipitation estimates showed even a maximum of 400 mm/24h. Table 1 shows further impressive individual values of the total precipitation measured. For example, in Dresden, 158 mm fell in 24 hours. The record precipitation also led to unusually high monthly values, which in the areas concerned varied mostly between 150 and 300 mm, which constitutes 200 to 350% of the rain which normally falls in the month of August (reference period 1961-1990).

Tab. 1: *Measured precipitation totals for various periods in August 2002 and August normals.*

Station name	Station height ab. msl (m)	Geogr. latitude (deg:min)	1 day totals 12 August 2002	3d-totals 10.-12. August 2002	August totals 2002	August normals average 1961-90	relation of August 2002 to 1961-90
Berlin-Tempelhof	49	52:28	65.1	69.0	156.3	61	256%
Potsdam	99	52:23	84.1	90.9	183.3	60	306%
Cottbus	69	51:46	49.9	60.0	136.9	69	198%
Doberlug-Kirchhain	97	51:39	93.8	102.2	165.4	64	258%
Oschatz	150	51:18	108.5	119.0	181.7	61	298%
Dresden-Klotzsche	222	51:08	158.0	168.9	233.1	76	307%
Aue	391	50:36	79.9	145.8	230.5	83	278%
Chemnitz	418	50:48	78.0	109.2	196.5	78	252%
Marienberg	639	59:39	166.5	188.3	308.2	89	346%
Zinnwald-Georgenfeld	877	50:44	312.0	379.9	469.6	103	456%
Fichtelberg	1213	50:26	137.8	199.7	299.1	106	282%
Grosser Arber	1446	49:07	88.5	121.1	261.6	131	200%

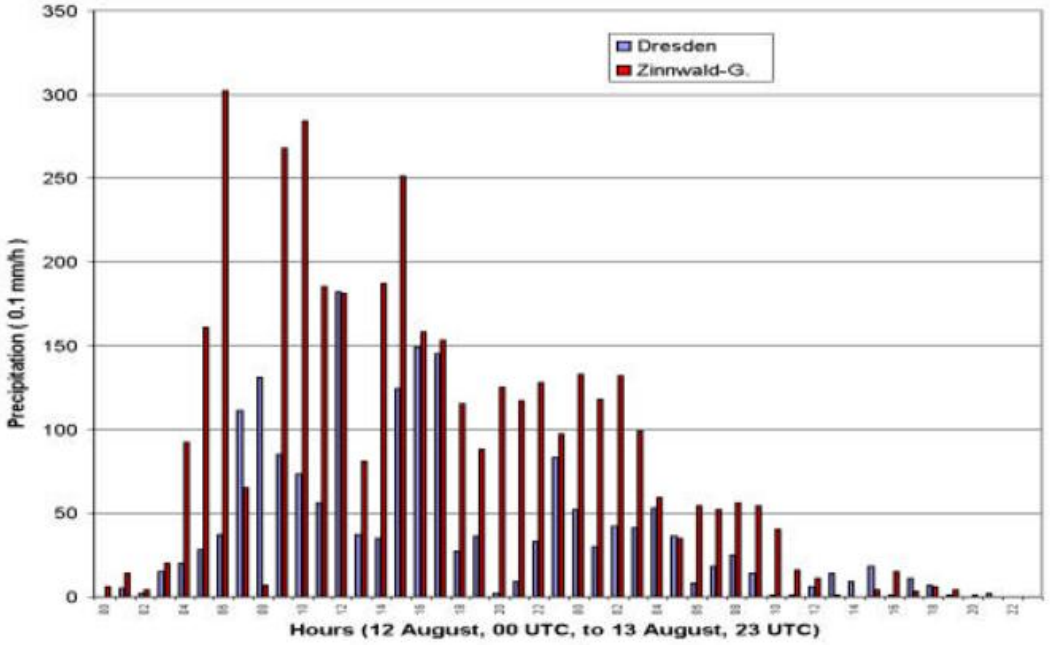


Fig. 3: *Hourly precipitation totals from 12 August, 00 UTC, to 13 August, 24 UTC.*

The exact temporal course of events on 12 and 13 August is shown in Figure 3. The severe rainfall began in the early hours of 12 August and persisted, but with high fluctuations, until the late morning of the following day. On the first day extreme hourly precipitation totals of up to 30 mm were measured in the Erzgebirge (Zinnwald-Georgenfeld), and even in the northerly foreland (Dresden) 15 mm or more fell repeatedly. By 13 August the rain intensity had decreased.

4 Climatological assessment

200 per cent of the normal August precipitation had already fallen in the first half of August 2002 in a belt reaching from Berlin and Brandenburg via Saxony to the Czech Republic. In the Erzgebirge and in the southern Czech Republic even three times the mean monthly precipitation total occurred in this time. With a maximum monthly precipitation total of 470 mm for August 2002 in Zinnwald-Georgenfeld, more than four times the normal August precipitation was measured.

The maximum of both, the regional precipitation total as well as the anomaly, cover the Erzgebirge, located in the Elbe catchment area. The belt of the unusually high monthly precipitation follows to a large extent the course of the Elbe river (Figure 4). The measurements from many stations in the area extending from Austria via Saxony to Berlin/Brandenburg resulted in the highest monthly precipitation totals ever measured in August since records began. Figure 5 shows the time series of the August precipitation for selected stations.

On 12 August 312 mm was recorded at the DWD station Zinnwald-Georgenfeld, the highest daily precipitation total ever measured in Germany. Up to then 260 mm was considered as record daily precipitation total, observed on 6 July 1906 in Zeithain, district of Riesa. The three-day (406 mm) and monthly (470 mm) precipitation totals measured in Zinnwald-Georgenfeld had, however, already been clearly exceeded in Stein, district of Rosenheim, in July 1954 with 458 mm in three days and 777 mm for the month (see Table 2).

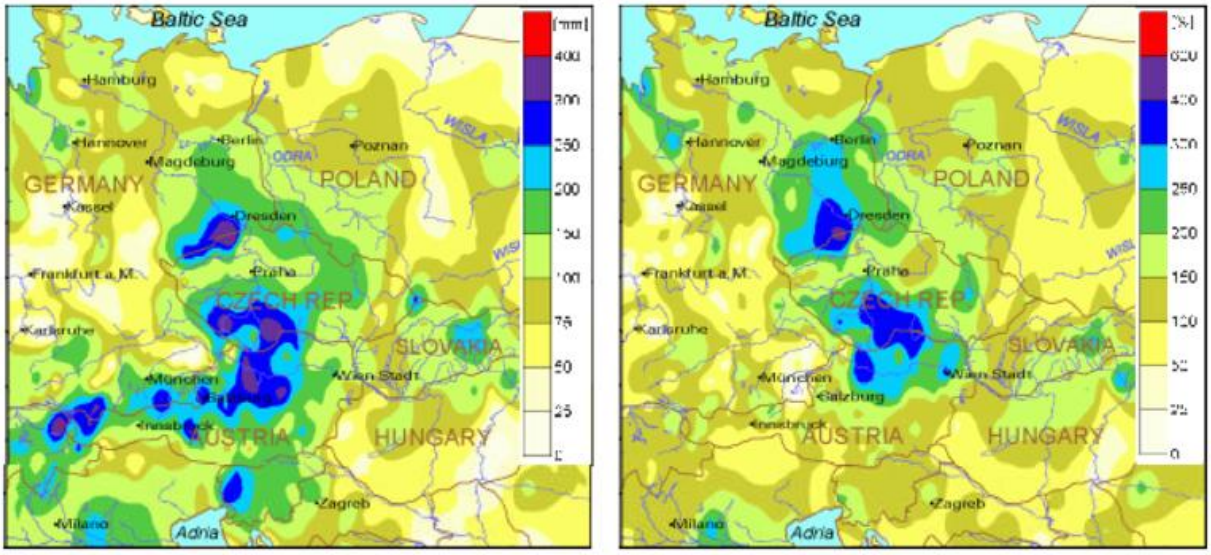


Fig. 4: *Monthly precipitation total in mm/mon for August 2002 (left) and the amount of precipitation in per cent in relation to the period 1961-1990 (right). Data base: Observations of 614 stations (left) and 415 stations (right).*

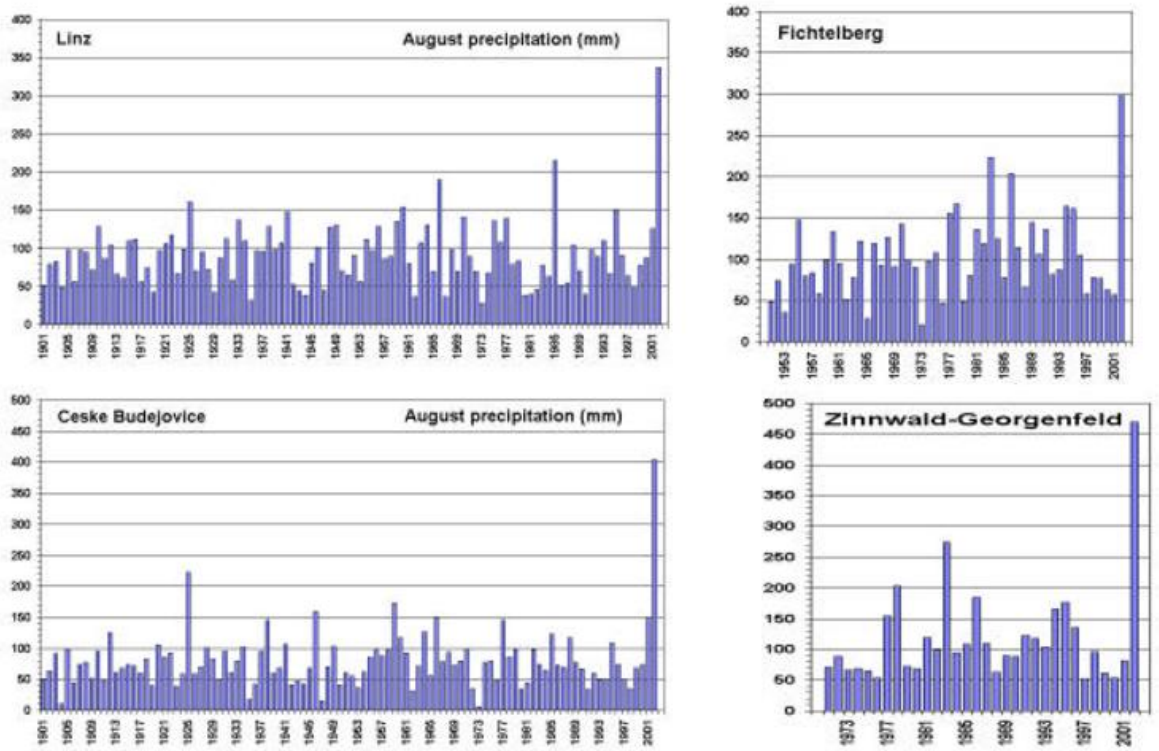


Fig. 5: *Time series of monthly August precipitation totals at the stations Linz (Danube), Ceske Budejovice (Czech Republic), Fichtelberg and Zinnwald-Georgenfeld.*

Tab. 2: *The extreme precipitation totals observed in Germany for various observation time intervals (one observational day = 06 UTC to 06 UTC subsequent day).*

interva	Precipitation depth(mm)	Station name (district / province)	Date
8 min	126	Fuessen (Ostallgaeu)	25 May 1920
1 h	200	Miltzow (Nordvorpommern)	15 September 1968
2 h	239	Daudenzell (Baden-Wuerttemberg)	27 June 1994
1 day	260	Zeithain (Riesa / Sachsen)	6-7 July 1906 (6 – 6 UTC)
1 day	312	Zinnwald-Georgenfeld (Sachsen)	12-13 August 2002 (6 – 6 UTC)
24h	353	Zinnwald-Georgenfeld (Sachsen)	12-13 August 2002 (3 - 3 UTC)
2 days	377	Seehaus bei Ruhpolding (Traunstein)	7-9 July 1954
3 days	406	Zinnwald-Georgenfeld (Sachsen)	11-14 August 2002 (6 – 6 UTC)
3 days	458	Stein (Rosenheim)	7-10 July 1954
7 days	515	Schneizlreuth-Weissbach (Berchtesgaden)	7-14 September 1899
10 days	652	Stein (Rosenheim)	1-11 July 1954
1 month	470	Zinnwald-Georgenfeld (Sachsen)	August 2002
1 month	777	Stein (Rosenheim)	July 1954
12 months	3,661	Purtschellerhaus (Berchtesgaden)	Dec. 1943 - Nov. 1944

But even higher possible precipitation than observed has been calculated for our climate: The study "Maximierte Gebietsniederschlagshöhen in Deutschland" (Maximised Areal Precipitation Totals in Germany), carried out by the DWD (DVWK 1997), provided "a regionally adjusted maximised grid point precipitation total" of 375 mm/24h and 445 mm/72h for the eastern part of Land Brandenburg and 800 mm/24h and 1340 mm/72h for the eastern part of the Bavarian Alps. Corresponding values for the Erzgebirge area were not published. These values were estimated on the basis of the extreme values observed in the region, the regional land form (orography) as well as the most unfavourable values for humidity and wind speed. The authors of the study vote that the results represent "an approximation to the possible physical/climatological maximum" and that the calculated values will not be reached "according to human estimation", however, they also state that these values could apply to the current climate conditions only.

This restriction applies in particular to the recurrence times of heavy precipitation totals, used in applied hydrology, in particular in hydraulic engineering, which are based on observed precipitation data from the 30-year period from 1951 to 1980 (Bartels et al. 1997). The counting of the measured values (classified according to duration and total amount of precipitation) and application of a statistical extreme value distribution resulted in recurrence times for periods of up to 100 years depending on station. According to these statistics the maximum 24- and 72-hour precipitation totals observed in August 2002 at the stations Zinnwald-Georgenfeld, Fichtelberg, Marienberg and Dresden-Klotzsche are expected to occur less than once in 100 years. The DWD plans to update the atlas of recurrence times for the total period 1951 to 2000. A comparison of the results for two subperiods could then supply information on changes in extreme value behaviour, particularly recurrence times, as a result of the climate change during the second half of the 20th century. The first results of another study, independent of this project, with the few available long data series (Grieser and Beck 2003) already show that a change in the extreme value behaviour of daily precipitation totals in Germany can be proved to be significant.

In the previous considerations it had not been stressed that precipitation is not only a basic quantity in relation to time (there is no exact instantaneous recording, but only - although short - time intervals can be observed), but is also in principle an area-related quantity. Even the observation "point", i.e. the funnel of the precipitation gauge is, strictly speaking, an area. According to general technical opinion, the conventional local gauge measurements represent, in case of a suitable installation of the instrument, daily precipitation or of longer time intervals within a radius of approximately 3 km or for an area of 25 km².

In order to quantitatively assess the precipitation, which led to river floodings, it is thus necessary to determine the spatial distribution and area mean of the precipitation from the point data of the measuring networks, whereby radar images and numerical models can provide additional information. In the already above-mentioned DVWK-Study empirically computed maximised area precipitation of different duration (1, 12, 24 and 72 hours) and area sizes (25, 100, 500 and 1000 km²) separated for summer and winter conditions for Germany were mapped. With an area of 1000 km² the northern Erzgebirge falls within the classes 300 mm/24h to 400 mm/24h and/or 450 mm/72h to 550 mm/72h. The precipitation totals observed there in August 2002 show that the results of this study are by no means unrealistic.

Based on the generation mechanisms of precipitation a relationship exists between the maximum precipitation total, its duration and the spatial expansion of the affected area. To put it simply, it can be presupposed that, the longer extreme precipitation persists, the larger the affected area is. In this connection, however, different factors play a large role, firstly the regional orographic and climatic conditions in general and then, in individual cases, the weather situation.

Heavy precipitation, which leads to regional flash floods, is not at all unusual in the Erzgebirge (Marx 1966, 1966a and 1967). In the evening of 8 July 1927, for example, two unusual cloudbursts occurred over the watershed between the Mueglitz and the Gottleuba (Alt and Fickert 1936), which in the shortest time produced precipitation totals of up to 200 mm. These resulted in devastating flash floods of the rivers concerned, which were regionally limited to a small area. The precipitation responsible for the Elbe floods of August 2002 was, however, not only more intensive, it lasted considerably longer and covered - together with the Vb-cyclone moving northwards - a significantly larger area.

With respect to the overlapping of the different meteorological processes and the absolute maximum values of precipitation and river levels, the 2002 Elbe flood can be ranked to be an extraordinary event, which occurred for the first time since the 17th century, the beginning of flood registration at Dresden. Global warming and the observed increase of extreme precipitation days during the last century may indicate a higher risk for such events in future.

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Report on ECSN activities

by: Walter Kirchhofer, MeteoSwiss

- **General remarks**

At the Meeting of the WMO Regional Association VI in Geneva, 3 May 2002, the ECSN activity was presented as one of the successful EUMETNET programme.

The 7th ECSN Advisory Committee (EAC) Meeting took placr at Hohenpeissenberg, Germany, 3-5 June 2002.

After the successful termination of the two projects "European Climate Assessment" (ECA) and "ECSN Climate Dataset" (ECD), a follow-up project was prepared in order to continue the ECSN activities in these fields. The project proposal "European Climate Assessment & Dataset" (ECA & D), promoted by KNMI and the ECSN Advisory Committee, was approved by the EUMETNET Council in its September meeting.

MeteoSwiss has generated a new ECSN web-site. The web-site is placed on the EUMETNET Internet server.

The second workshop of the project "Generate Climate Monitoring Products" (GCMP), hosted by DWD, took place in Hamburg, 25-27 September 2002. This GCMP workshop was an important milestone in the project development.

The Fourth European Conference on Applied Climatology, ECAC-2002, took place in Brussels, 12-15 November 2002, with the focus on "Climate related Risk Analysis and Sustainable Development in the 21st Century". The Royal Meteorological Institute of Belgium organized and hosted this successful ECAC-2002.

At the EUMETNET Council Meeting, 4 December 2002, it was decided that in the future the European Meteorological Society (EMS), in partnership with EUMETNET-ECSN, will organize the European Conference on Applied Climatology (ECAC). The next ECAC will be a combined conference "ECAC-2004 / EMS Annual Meeting 2004" in Nice in September 2004.

UNIDART (Uniform Data Request Interface) is a project to develop an infrastructure for a border-crossing exchange of climate data. ECSN is collaborating very closely with UNIDART and has prepared a list of requirements for the realisation of the pilot phase and further steps of UNIDART.

- **European Climate Assessment (KNMI)**

  In the "European Climate Assessment" (ECA) project the temperature and the precipitation climate was analysed for WMO Region VI, putting particular emphasis on changes in daily extremes. The ECA project focusses on the twentieth century from 1901 to 2000. Respecting the data policies of the participating countries, a selection of the daily series in the ECA dataset is made available to the public on a CD-ROM and through the Internet (http://www.knmi.nl/samenw/eca). With the Final Report "Climate of Europe: Assessment of observed daily temperature and precipitation extremes" the ECA project was terminated.

- **Generate Climate Monitoring Products (DWD)**

  The work on the development of the web-site "Generate Climate Monitoring Products" (GCMP) continued. In order to further improve the Internet platform, external software experts elaborated concept proposals.

  An important milestone in the project development was the GCMP workshop, 25 - 27 September 2002, hosted by DWD in Hamburg.

  Although cooperation within the project has intensified, especially due to the GCMP workshop in September, it is nevertheless indispensable to increase the number of actively participating European NMHSs to achieve sufficient regional coverage, especially concerning the national climate monitoring products.

  Implementation of the workshop results will continue. The GCMP Website will be adapted accordingly. GCMP Web manager and project partners will coordinate the filenaming and directory structure as well as information on the links of the contributions on the respective servers.

- **Climate Atlas of Europe (Meteo-France)**

  The Atlas will contain monthly normals for precipitation, temperature, wind and sunshine duration and additional statistical information for these parameters and for the occurrence of phenomena such as fog, thunderstorm, hail and snow. The computation period will be 1971-2000, and the target spatial density will be about one station per 5000 square kilometres. In a first step the contents of the Atlas project will be made available without maps.

  Metadata from all the participating countries (24) representing about 685 stations have been received, checked, harmonized and put into a single file. Among the non ECSN countries contributions have been made by Albania, Bulgaria, Czech Republic, Slovakia and Slovenia.

  Quality tests applied to the whole dataset have been engaged, revealing the detection of a large number of errors. Considering the large size of the dataset, graphical tools are necessary to assess the quality of some parameters.

- **Drought investigations (Meteo HU, PT)**

  The objectives are the following ones:

  - Evaluation and use of different drought indices;
  - Analysis of long drought index series;
  - Study of thresholds of drought indices;
  - Calculation of the spatial distribution of drought indices on different time scales;
  - Recommendation of drought indices.

  The project could not be cared permanently by a scientist. Nevertheless the project has been completed with a Final Report.

- **ECSN climate Dataset (KNMI and DNMI)**

  The "ECSN Climate Dataset" (ECD) project is closely related to the project "European Climate Assessment" (ECA). The main objective of the ECD project was the preparation and the distribution of climate datasets on daily amount of precipitation and daily temperature (minimum, mean, maximum)for the period 1901-2000 via CD-ROM and Internet. The project was formally finished with the Final Report prepared on Internet. The server is operational in the network environment of KNMI since November 2002.

Ozone Layer over Central Europe in 2002

by: Ulf Köhler, Hans Claude and Wolfgang Steinbrecht, Deutscher Wetterdienst

The total ozone column is affected by numerous processes in the atmosphere such as circulation patterns, radiative variations (e.g. 11-year solar cycle) or special events like major volcanic eruptions. Thus even annual averages are subject to large variations. In 2002 the ozone layer above Germany and also above Europe was a little bit thinner compared to the previous year. The total ozone column as a measure of ozone layer thickness was approx. 319 D.U., which is about 3% below the long term average. This deviation is not an extreme value compared with the post Pinatubo years 1992/93. **Fig. 1** clearly shows a quasi biennial oscillation in the annual means, which is superimposed onto the long term decline mainly attributed to the chemical ozone depletion by the CFCs (Chlorofluorocarbons). This oscillation is in opposite phase to the so-called QBO (**Q**uasi **B**iennial **O**scillation) of the stratospheric winds at 30 hPa in the equatorial region. Westerly winds like in 2002 cause lower ozone values at northern midlatitudes with an amplitude between westerly and easterly phase of the equatorial winds of 10 - 20 D.U..

Statistical analysis further indicates a superimposed 11-year oscillation caused by the solar cycle with minimum solar acitivity around the mid of each of the three decades combined with relative ozone minima. The last years around 2000 are marked by higher ozone (~ 10 D.U.) values compared to the mid nineties due to the recent solar maximum.

Since the very low values after the volcanic eruption of Pinatubo in 1991 there is obviously no recovery of the ozone layer back to the pre-Pinatubo values. Starting from the present low level another severe volcanic eruption of a similar magnitude like Pinatubo (1991) or El Chichon (1982) would probably cause an ozone depletion with annual averages below 300 D.U.. Even without such natural impacts very low values have to be expected, when both solar cycle and QBO are in their negative phase.

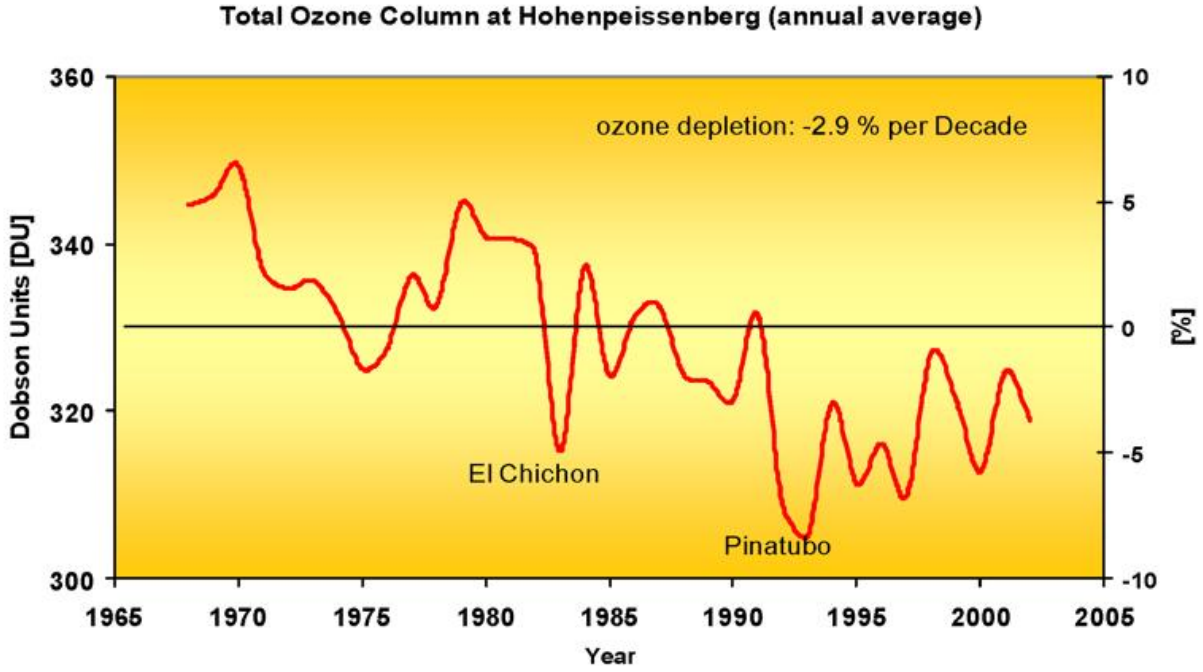

Fig. 1: *Time series of annual means of the total ozone column above Hohenpeissenberg 1967 - 2002. The relative trend of -2.9 % per decade is based on linear regression analysis.*

A detailed look at the annual course of the deviation of daily total ozone in 2002 **(Fig. 2)** draws the attention to the first part of the year. Very low values are seen, especially in February, with maximum deficits down to -30% from the long term mean. This low ozone is closely connected with special weather situations (high pressure, warm troposphere / high tropopause and cold stratosphere). In general February shows not only the largest trend with -5.2% per decade, it is additionally the only month with significantly increasing variability of the daily values. Variance has increased by 8% since 1968, whereas all other months either did not show any increasing variance or even an obvious decrease (April, May, June). The main reason appears to be the more frequent occurence of very deep ozone minima (so-called "mini-holes") with more and more low values. High ozone values do not exhibit such a significant decrease.

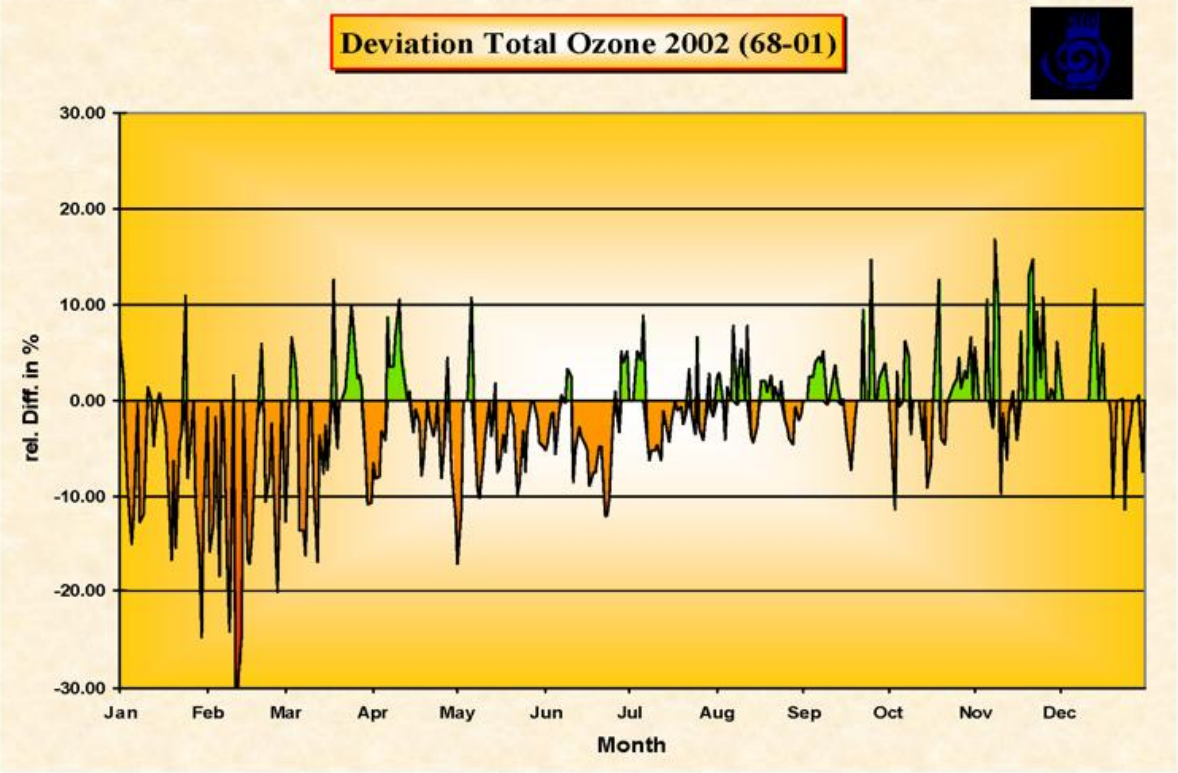

Fig. 2: *Relative deviation (in %) of the daily total ozone amount over the year 2002 compared to the baseline defined by the period 1968 - 2001 for Hohenpeissenberg (Southern Bavaria).*

Analyses of the atmospheric circulation, described by specific oscillation patterns (e.g. Arctic Oscillation AO, North-Atlantic-Oscillation NAO etc.) indicate that climate change is connected to a modified atmospheric circulation. This has substantially contributed to the more frequent low ozone values in late winter. AO and NAO, especially in February, show significant changes resulting in a prominent warming of the free troposphere over Central Europe by 3 K combined with a lift of the tropopause by 450 m and ozone decrease of about 10 D.U. since the end of the sixties.

The Bulletin is a summary of contributions provided by the National Meteorological Services.
The author does not warrant, guarantee or make any representations regarding correctness, accuracy, reliability, or any other aspect regarding characteristics or use of the information presented.

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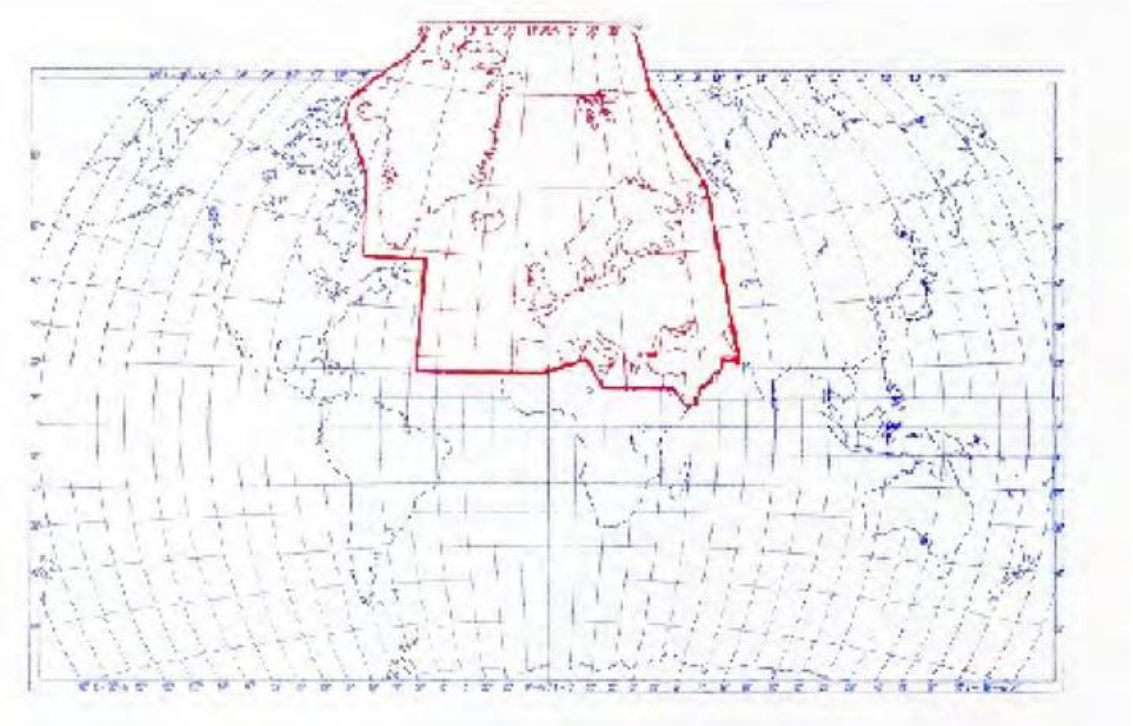
- Europe and Middle East -

2003



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Germany
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Ireland
Israel
Italy
Jordan
Kazakhstan
Latvia
Lithuania
Luxembourg
The former Yugoslav Republic of Macedonia
Moldova
Netherlands
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Sweden
Switzerland
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Turkey
Ukraine
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Foreword

This 10th edition of the Annual Bulletin on the Climate in WMO Region VI – Europe and Middle East – for 2003 was enabled by national contributions from the Meteorological and Hydrometeorological Services in WMO Region VI.
The Call for Input was answered directly by 43 of the 49 member countries, which equals 88%. Additionally, WMO Secretariat provided the editor with all national contributions to the WMO Bulletin article on consequences of abnormal weather in 2003 from the WMO Regional Association VI. More than 90% of the national contributions were sent in the most preferred way, which is email including attachments or server addresses. It is for the first time, that this publication is completely colour printed.

The most prominent climatic characteristic of the reporting year was the extraordinarily hot European summer. New records were set up for all kinds of temperature measures at many stations and for many areas. The statistical recurrence period of such an event in central Europe is at least 500 years.

The socio-economic impact of this long-lasting heat-wave was particularly disastrous to people's health with a dramatic increase of mortality in central European countries. A special article on this extreme climatic event is included in this Bulletin.

An additional climatic feature of the Region was a significant increase in sunshine duration in most countries compared to a long-term average. Surprising was the early seasonal forming of a snow cover in October in several countries.

As in the years before, this edition includes special articles contributed by the ECSN Programme Manager and the Meteorological Observatory Hohenpeißenberg.

On this occasion, I wish to express my gratitude to all, who contributed to this paper by reports and practical support. I am especially thankful to the German Meteorological Service for the co-ordination, the editorial review, publishing and distribution of this Bulletin.



Daniel Keuerleber-Burk
President of WMO Region VI

Outstanding Events and Anomalies in 2003

Temperature

- Extremely hot summer in central Europe with serious socio-economic impact

Precipitation

- Long-lasting drought conditions in many countries
- Early autumnal snow cover in central and eastern Europe

Sunshine

- Record yearly sunshine duration in many countries

Wind

- Many local tornadoes, especially at the end of the summerly heat wave period

Annual Survey

Temperature deviations from the long-term annual average were mainly positive all over the Region except for some areas around the Black Sea. Anomalies above +1°C were registered mainly in central Europe and Scandinavia. Greenland experienced the warmest year since 1941 (fig. 0.1) with deviations from normal up to +2°C and more.

The most prominent climatic feature of the year was the record breaking long-lasting heat wave over Europe with its serious socio-economic impact, especially on human health, agriculture and the risk of forest fires. Fig. 0.2 illustrates the extraordinary jump of the mean temperature in this period against the previous records in line.

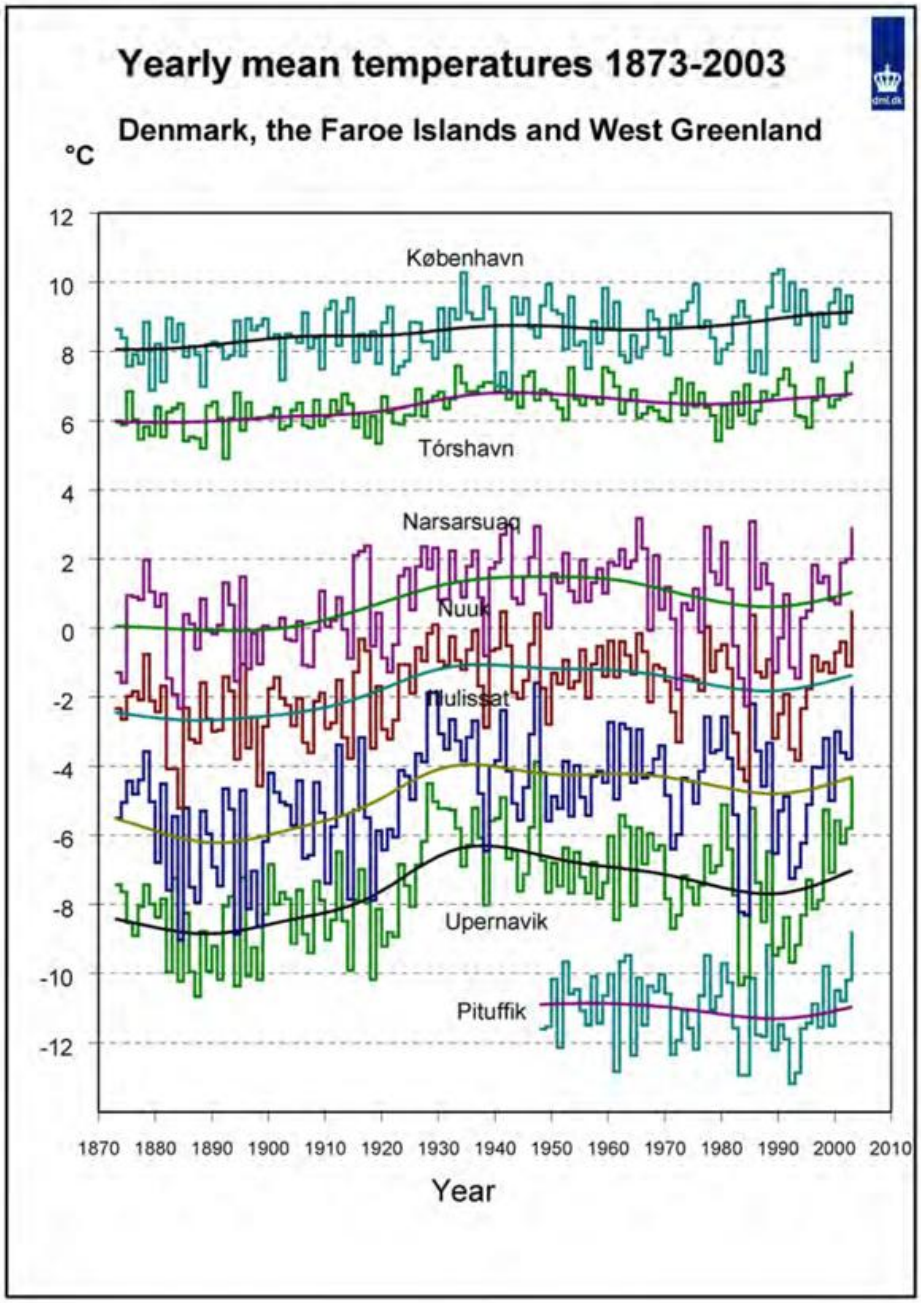


Fig. 0.1: *Yearly mean temperatures at stations in Denmark, Faroe Islands and Greenland*
From: Danish Meteorological Institute, Copenhagen

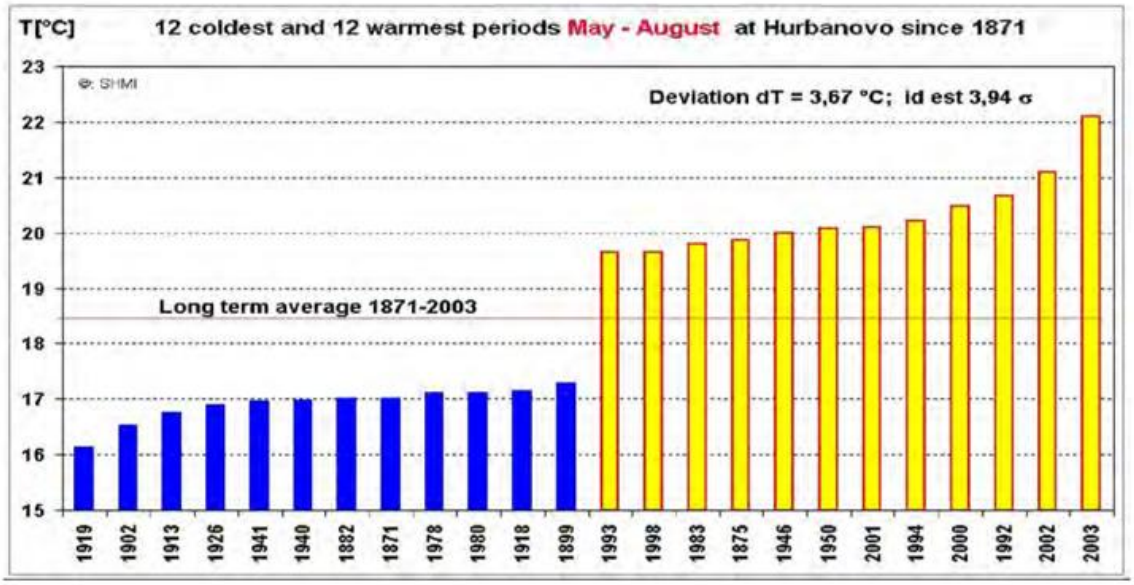


Fig. 0.2: *12 coldest and 12 warmest periods May - August since 1871 at station Hurbanovo, Slovakia From: Slovak Hydrometeorological Institute, Bratislava*

Precipitation was mainly below and up to normal in central parts of the Region and above normal in Iceland and some other parts of Scandinavia and Russia as well as in large areas of the Iberian Peninsula, coastal areas of the Mediterranean and parts of the Middle East. Figs. 0.3 – 0.5 are typical examples for the relatively smooth spatial distribution of annual precipitation rates compared to normal.

Sunshine duration was significantly higher than normal from north-western to central and eastern Europe. Every reporting country registered some record highlights in the observational series. E.g. in the Netherlands, station De Bilt measured a new record since the beginning of observations in 1901; additionally, all months except for May had a surplus of sunny hours (fig. 0.6), a characteristic, which was common also to other places in 2003.

Wind force caused a lot of damage in different countries of the Region, especially during tornado episodes and with the end of the summerly heat wave.

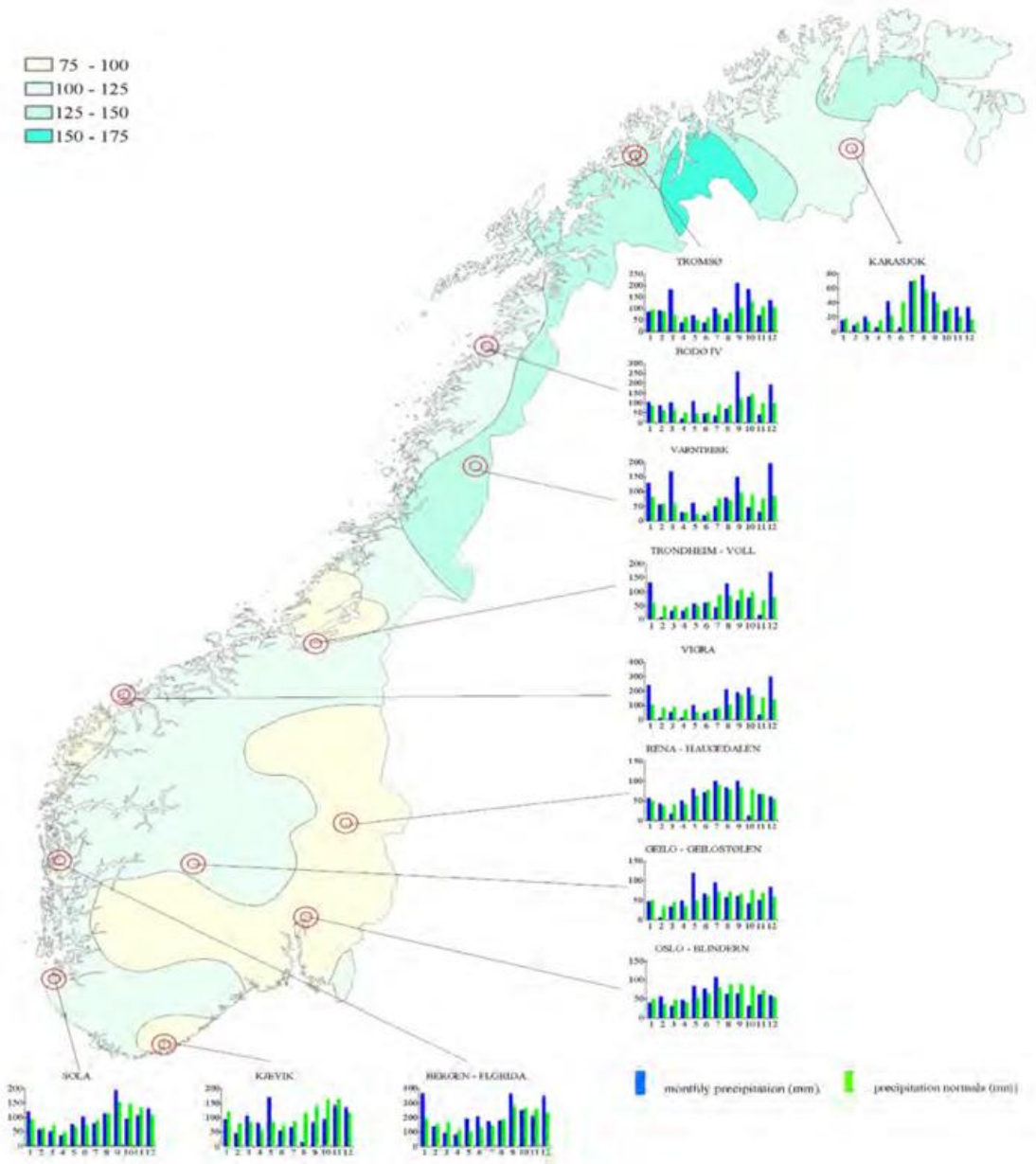


Fig. 0.3: *Precipitation as percentage of normal*
From: Norwegian Meteorological Institute

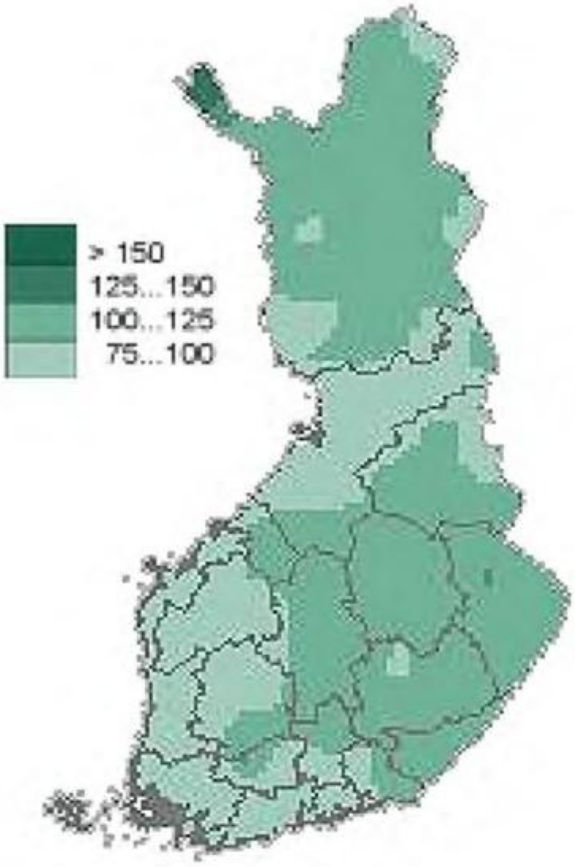


Fig. 0.4

Spatial distribution of the annual precipitation total in % of normal (1971-2000)
From: Finnish Meteorological Institute

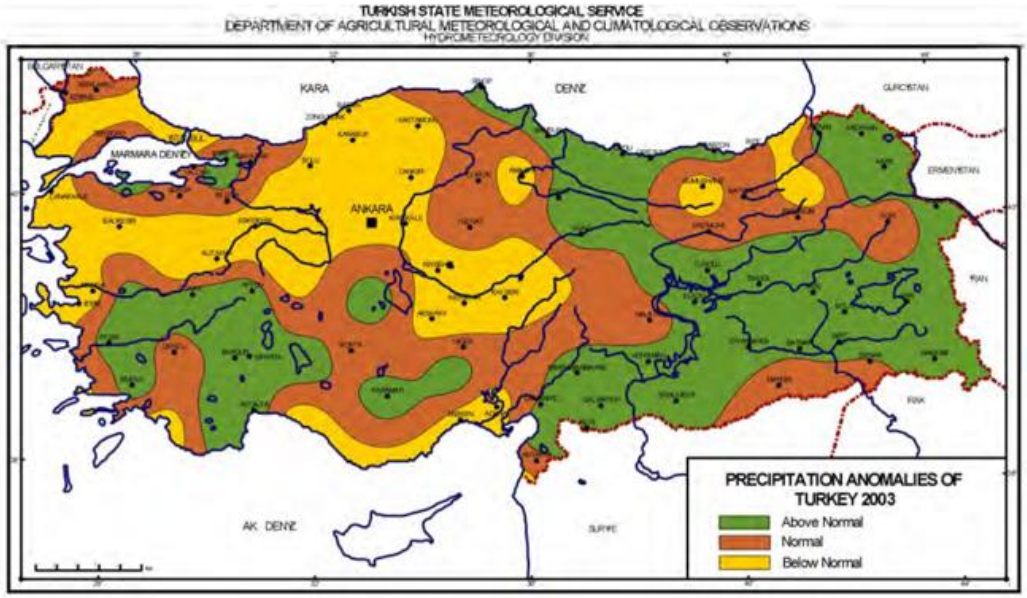


Fig. 0.5: *Spatial distribution of the annual precipitation total compared to normal*
From: Turkish Meteorological Service

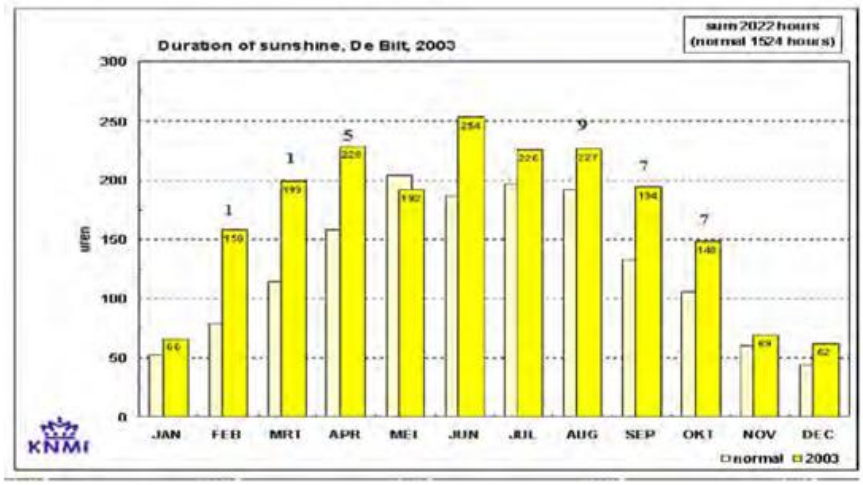


Fig. 0.6: *Monthly sunshine duration 2003 and in the reference period 1971-2000 at station De Bilt, Netherlands, with ranking No in the series since 1901*
From: Royal Netherlands Meteorological Institute

Seasonal Survey

Winter 2002/2003 was milder than normal in western and southern Europe. Eastern Europe and most of the Middle East were clearly colder than the long-term averages, in some areas with statistically significant deviations (see figs. page 12). An example for the wintry conditions in eastern Europe is given by fig. 0.7 with the special aspect, that the coldest period of the season is shifted back from January to December.

Precipitation was rather low in a broad zonal belt from the north of the British Isles over southern Scandinavia and large areas around the Baltic into Russia. The Alpine region suffered also from a deficit in precipitation, whereas the southern parts of Italy and the Balkans as well as Israel were much wetter than normal (see fig. page 16, upper part).

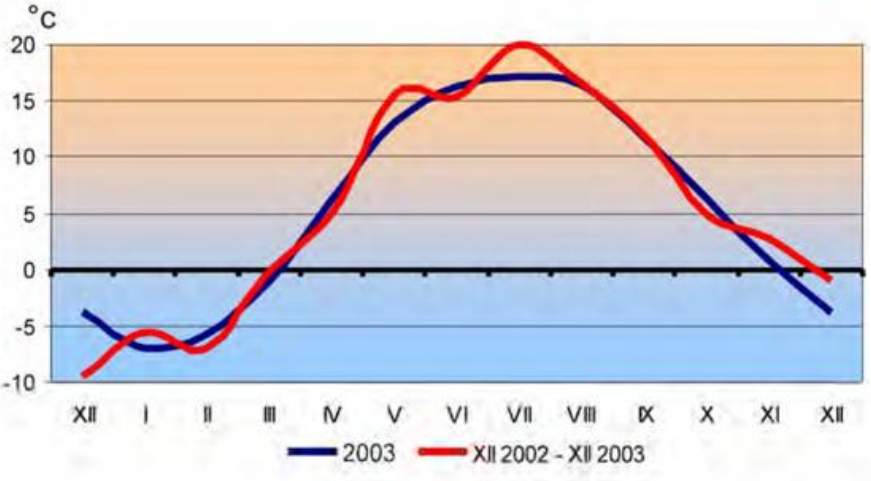


Fig. 0.7: *Monthly mean air temperatures from December 2002 until December 2003 and for the reference period 1961-1990 in Belarus*
From: Hydrometeorological Centre of the Republic of Belarus

Spring 2003 was warmer than normal in most of Europe except for an area around the south-eastern Baltic. In the Middle East the deviations of the monthly mean temperatures from normal were mostly negative, decreasing to the east and with highly significant values at the Caspian Sea (see figs. page13).

In many parts of Europe precipitation was in deficit in a broad and nearly zonal belt from the northern Iberian Peninsula over southern France, the Alps, the northern Balkans and the Ukraine into southern Russia (see fig. page 15, lower part).

Summer 2003 was extremely hot in central Europe and generally warmer than normal nearly all over the Region except for southern Russia. Statistically, it was the hottest summer in the central European countries since more than 500 years (figs. page 14). The long-term series of average summer temperatures from Vienna illustrates this outcome (see fig. 0.8).

The frequent anticyclonic circulation pattern caused also a precipitation deficit over most parts of Europe (see figs. on page 17, upper part). Together with the extraordinary heat wave, these conditions had an immense socio-economic impact, especially on human health, drought conditions for agriculture and the increase of forest fires.

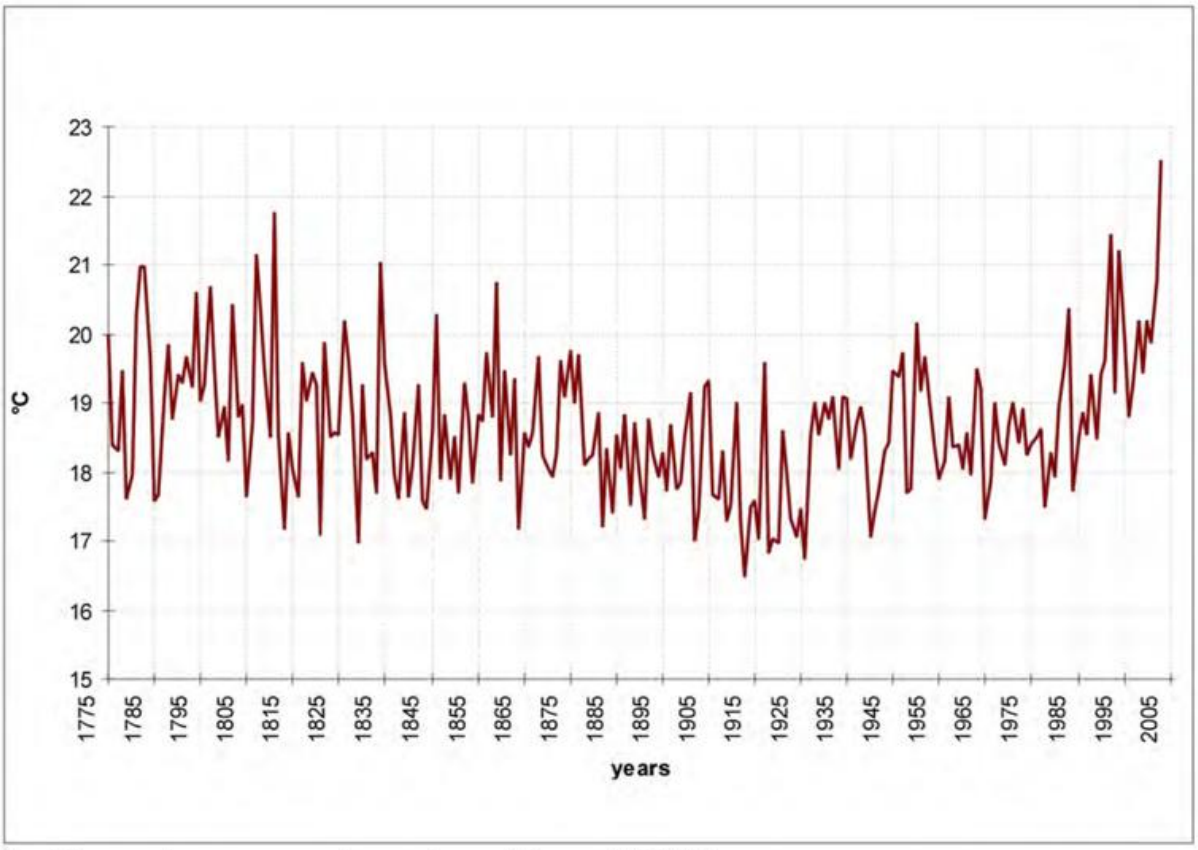


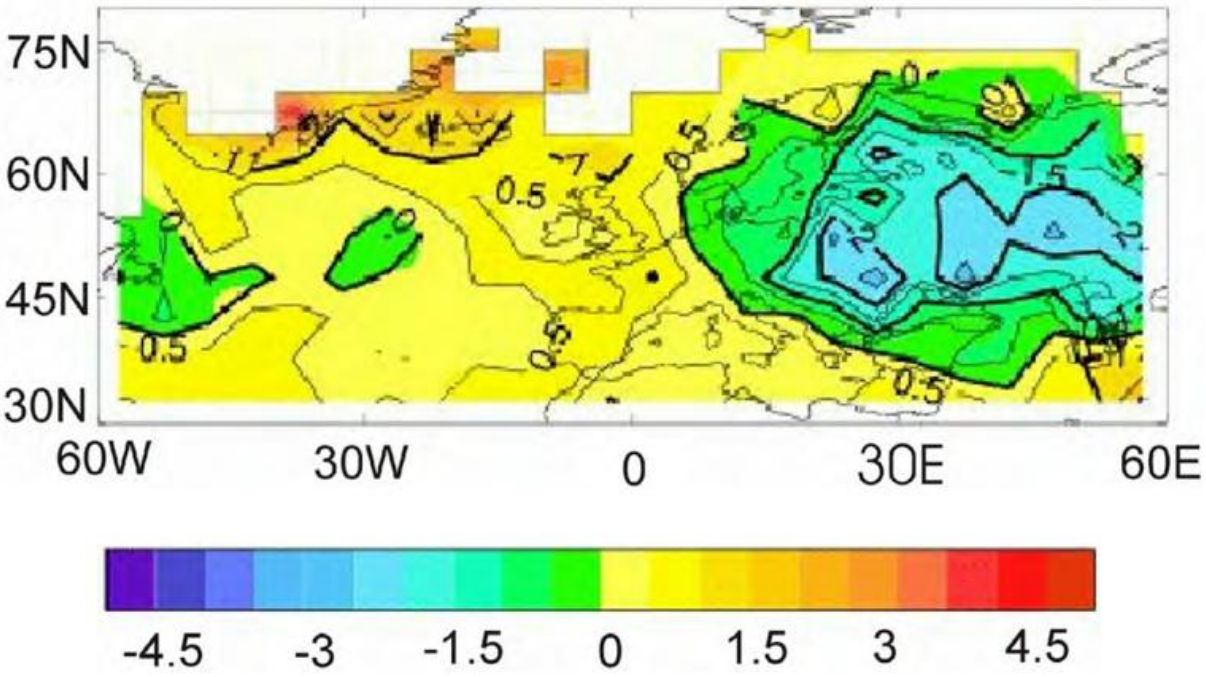
Fig. 0.8: *Average summer temperatures of Vienna 1775-2003*
From: Zentralanstalt für Meteorologie und Geodynamik, Austria

Autumn 2003 was milder than normal all over the Region except for the Alps and the Carpathians. Statistically significant positive deviations were observed mainly in the U.K. (see figs. on page 15). North-western Europe and most of Scandinavia had a precipitation deficit as well as some parts of central and eastern Europe and the coastal areas of the eastern Mediterranean. Centres of precipitation above normal were on the Iberian Peninsula, in southern parts of France and Italy, in Romania, Ukraine, in southern Russia and the north-east of Turkey (see fig. on page 17, lower part).

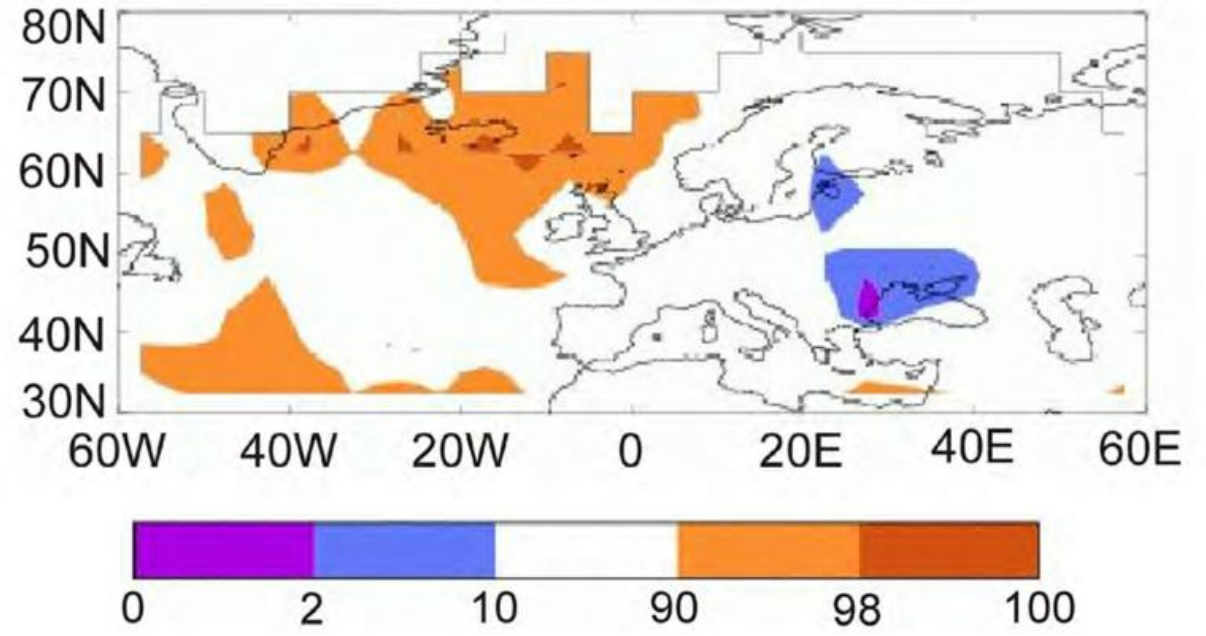
Seasonal Maps

Surface temperature anomalies: December 2002 - February 2003

From: Hadley Centre of Climate Prediction and Research, U.K.



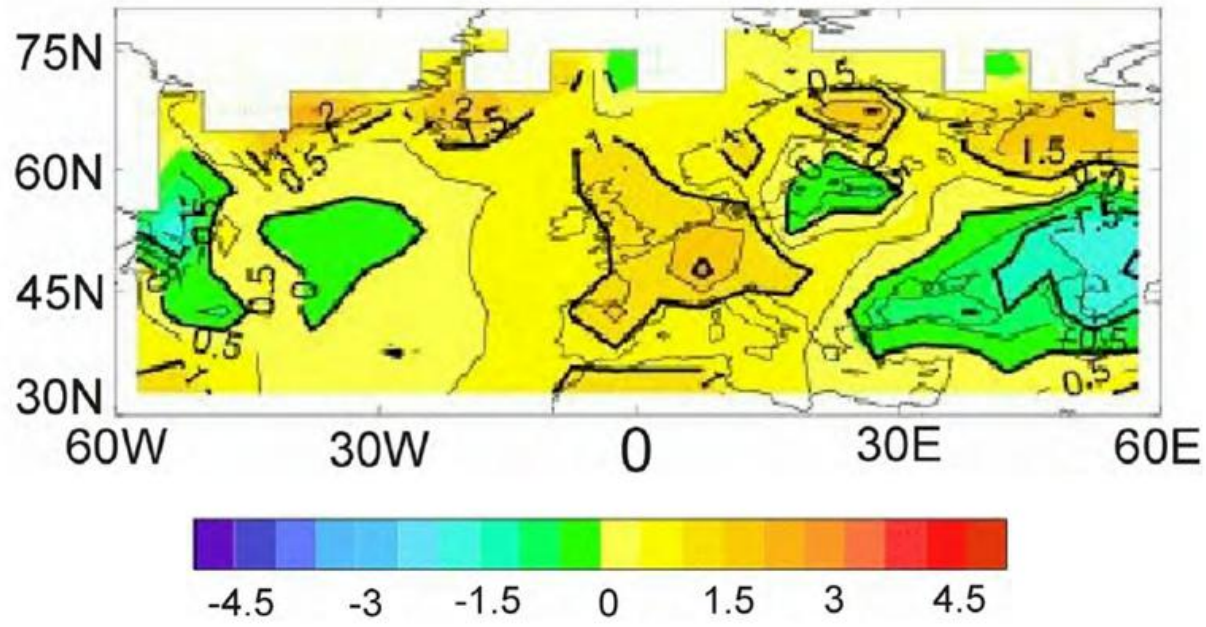
Departures from normal in °C



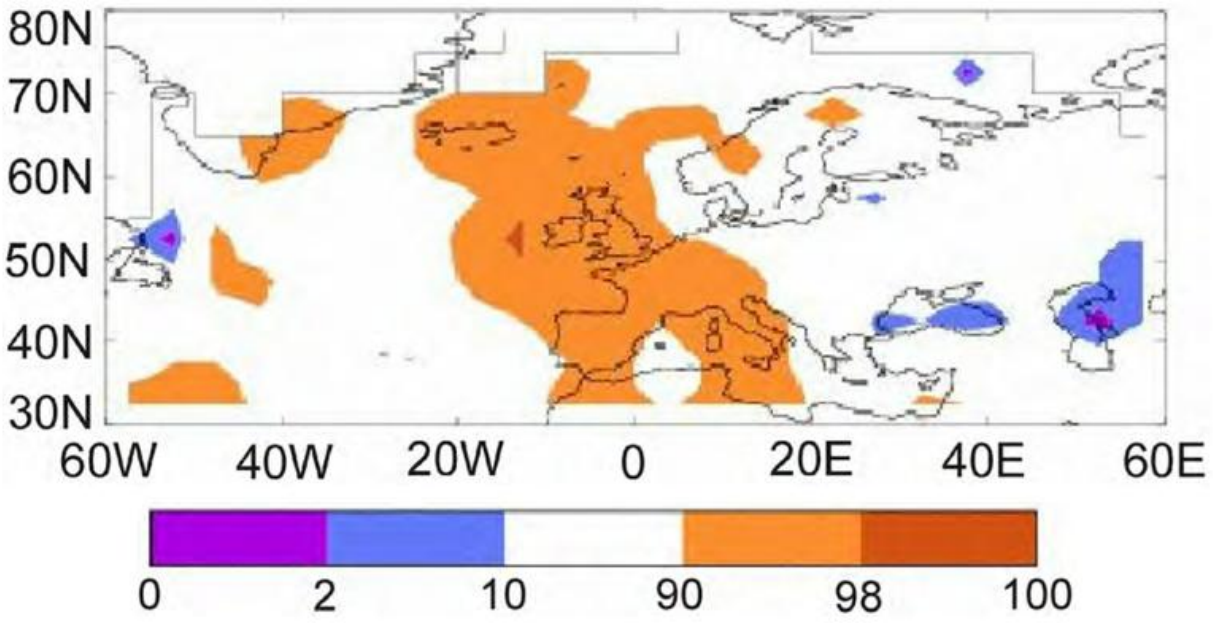
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 - 1990

Surface temperature anomalies: March 2003 - May 2003

From: Hadley Centre of Climate Prediction and Research, U.K.



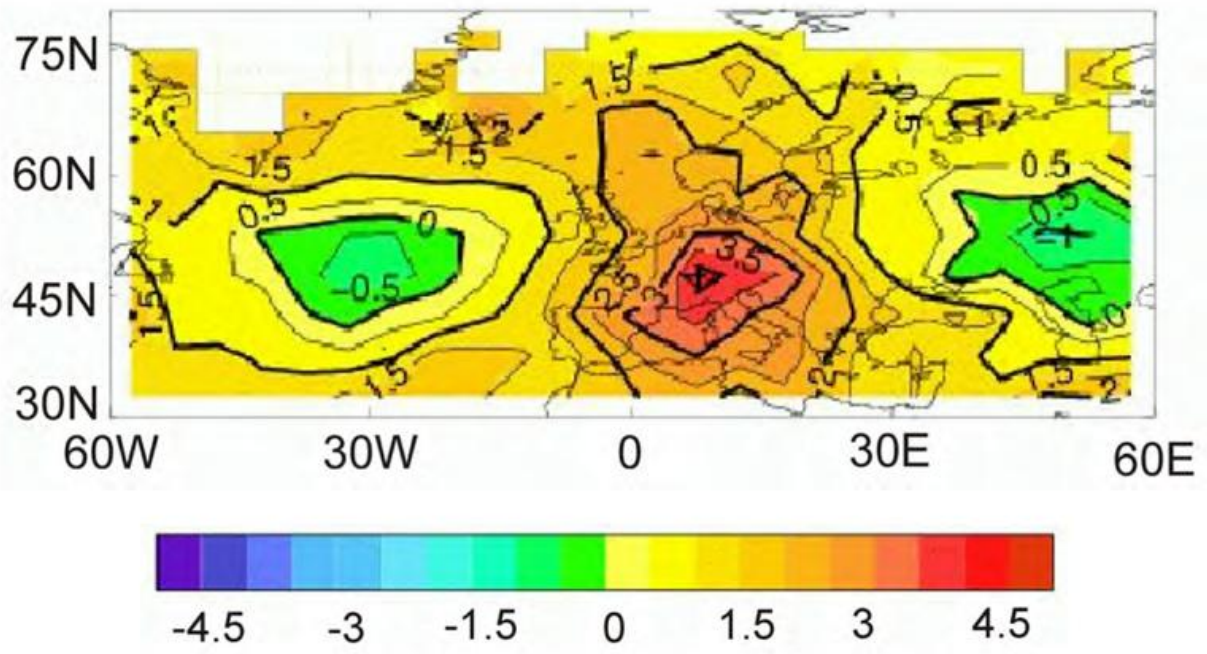
Departures from normal in °C



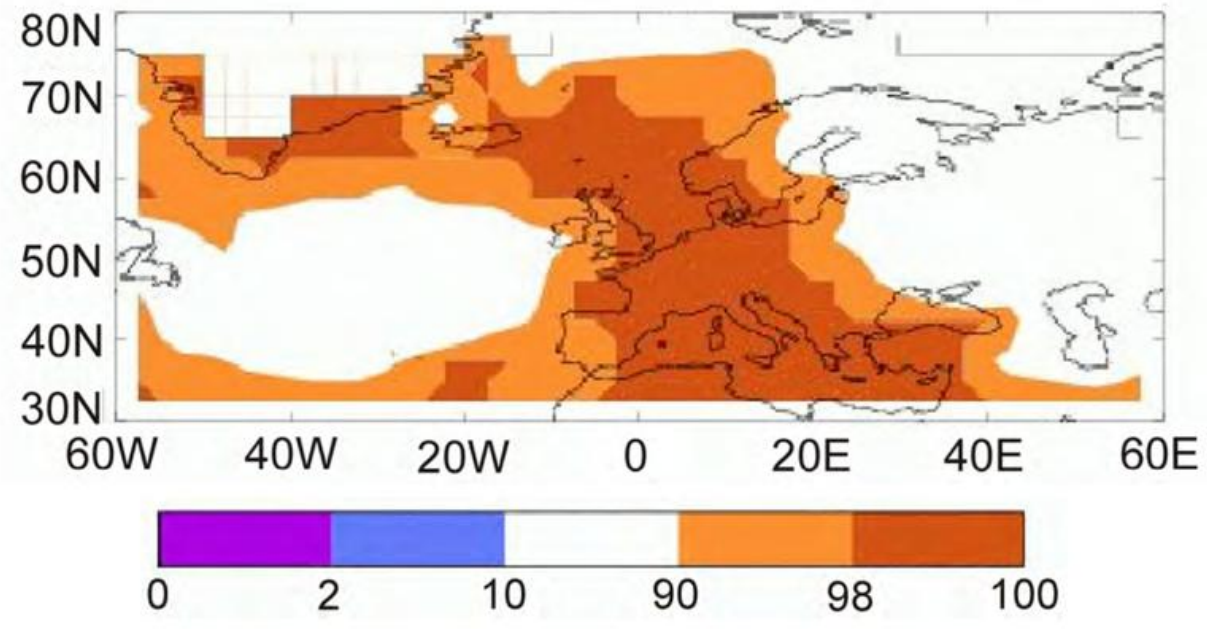
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 - 1990

Surface temperature anomalies: June 2003 - August 2003

From: Hadley Centre of Climate Prediction and Research, U.K.



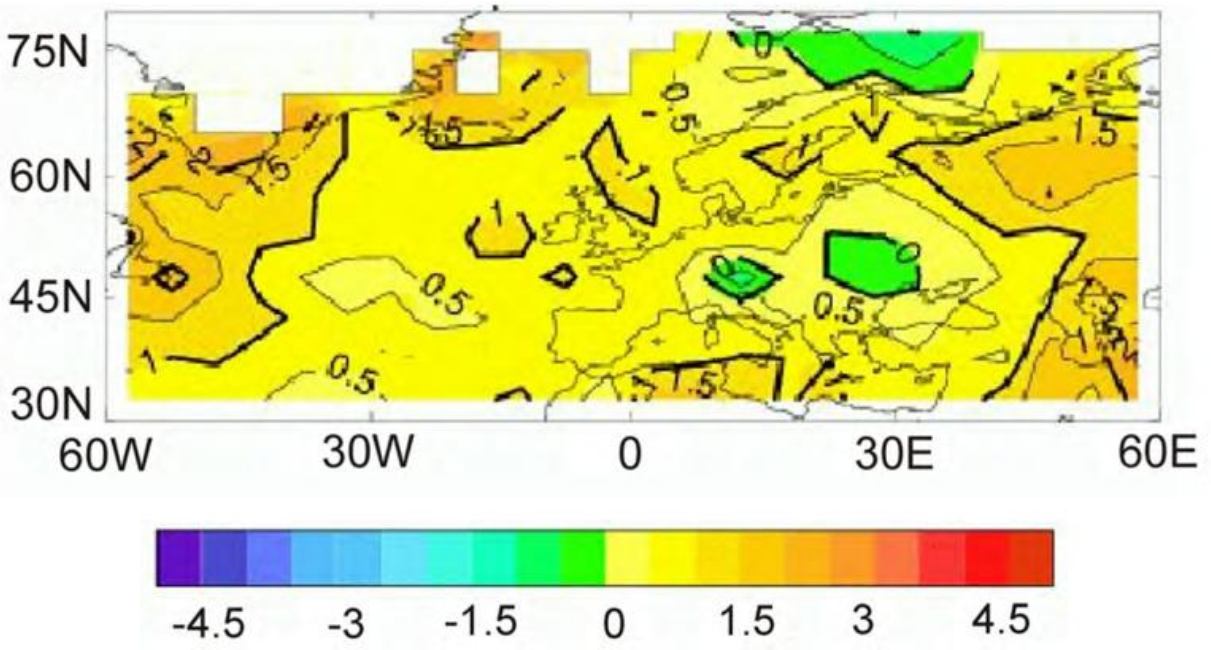
Departures from normal in °C



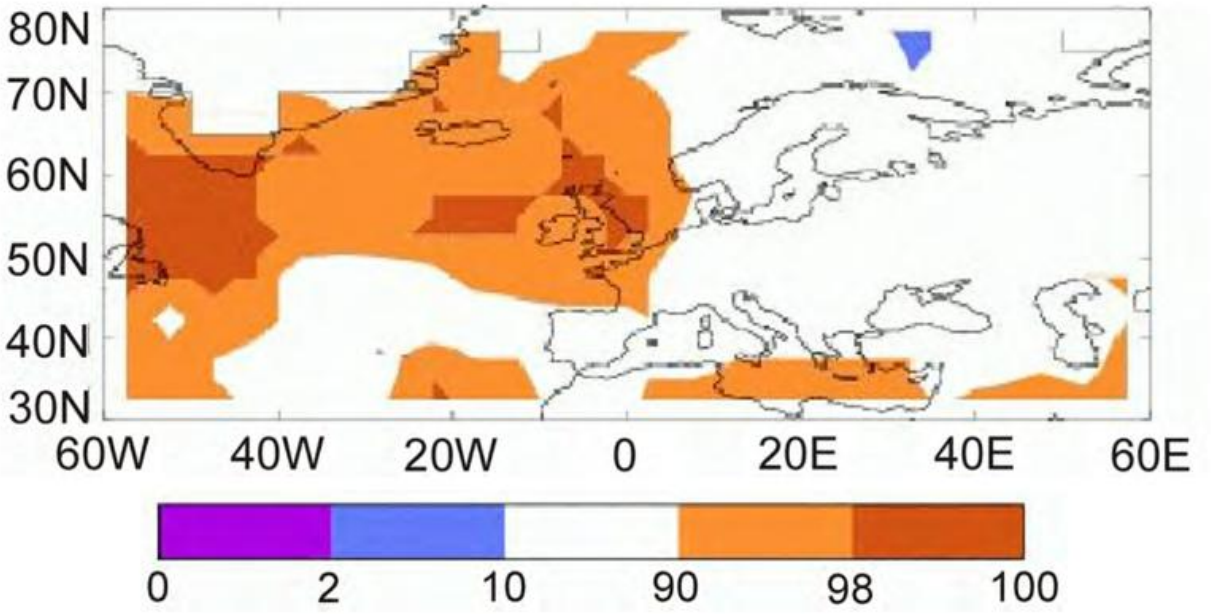
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 - 1990

Surface temperature anomalies: September 2003 - November 2003

From: Hadley Centre of Climate Prediction and Research, U.K.



Departures from normal in °C



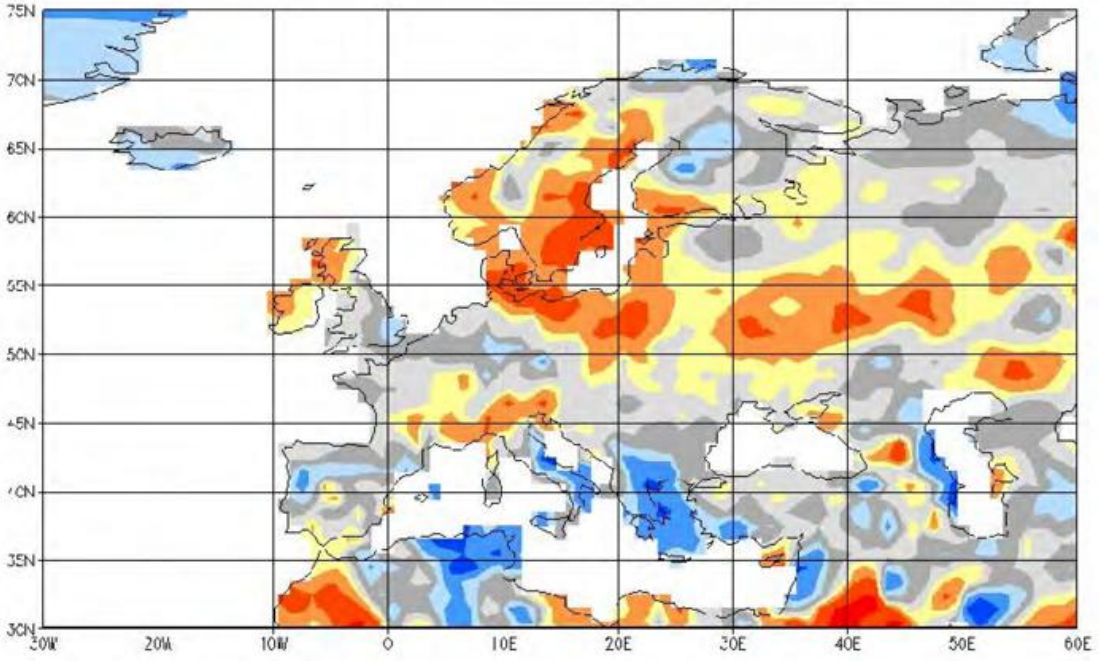
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 - 1990

Precipitation in percent of normal

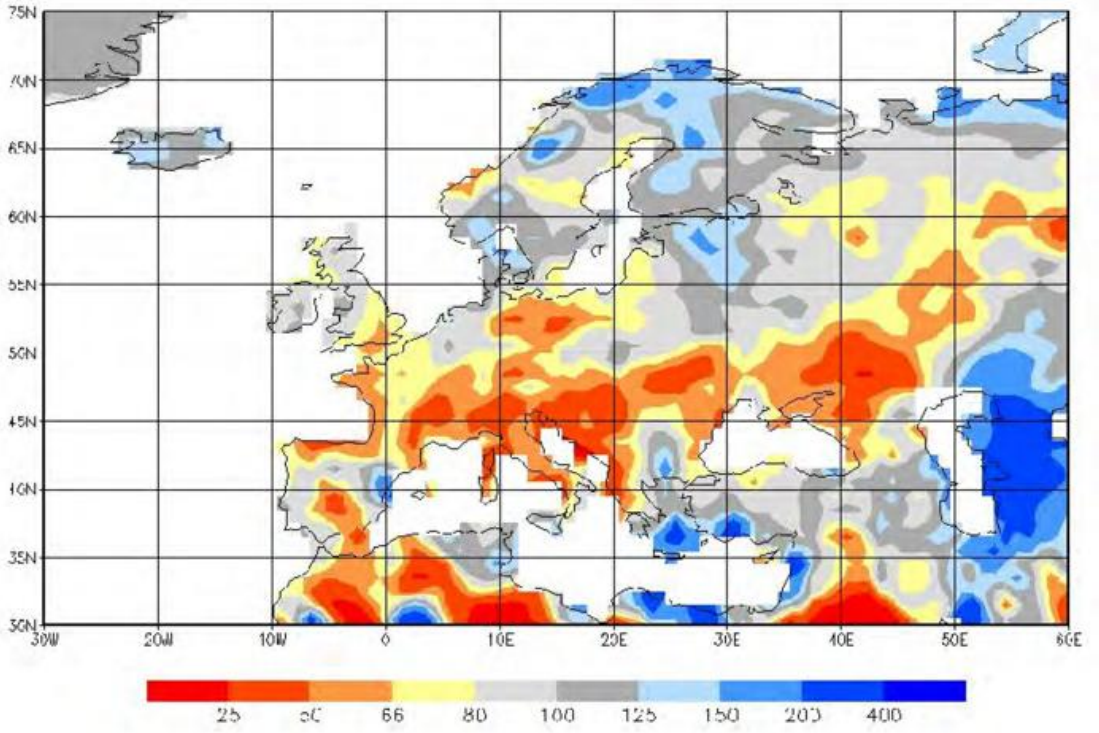
Gauge-Based Analysis 1.0 degree, reference period: 1960 - 1990

From: GPCC / Deutscher Wetterdienst, Germany

December 2002 - February 2003



March 2003 - May 2003

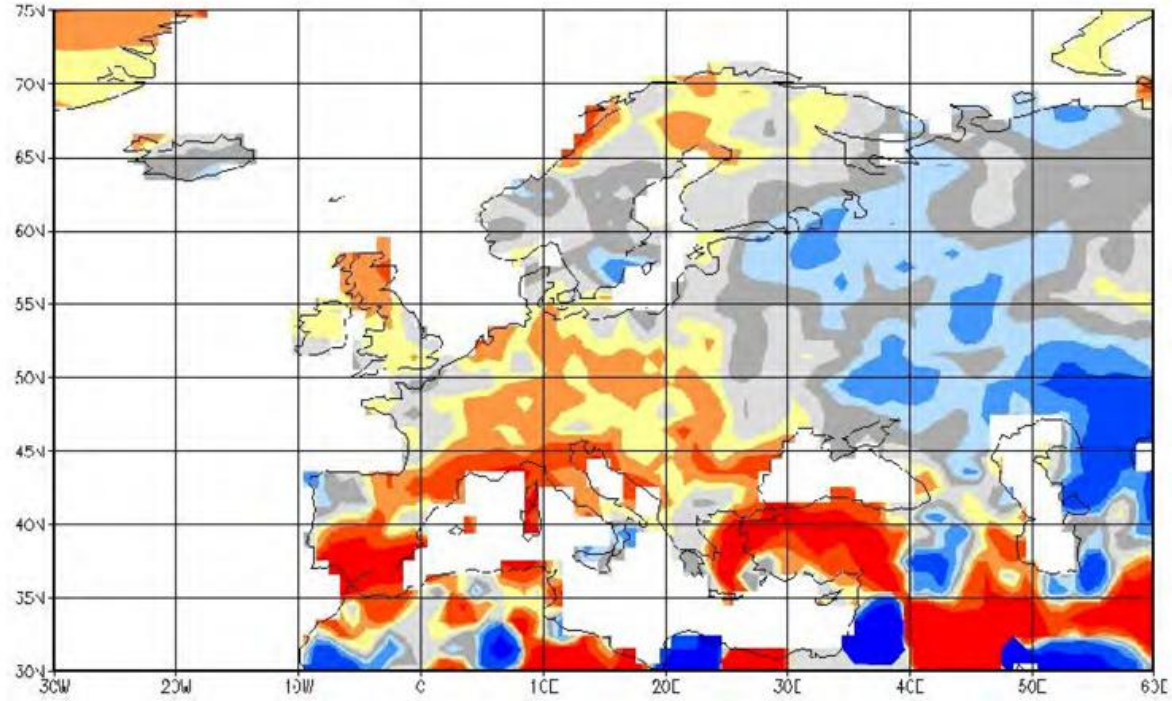


Precipitation in percent of normal

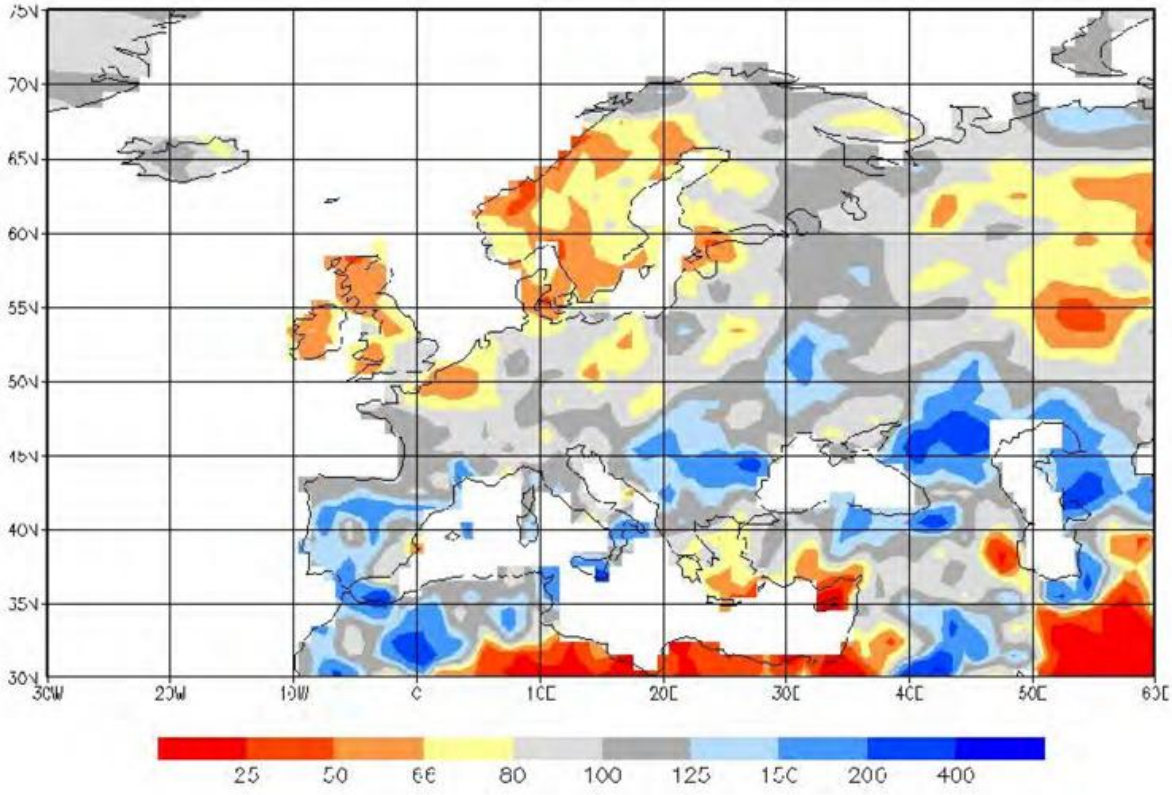
Gauge-Based Analysis 1.0 degree, reference period: 1960 - 1990

From: GPCC / Deutscher Wetterdienst, Germany

June 2003 - August 2003



September 2003 - November 2003



Monthly and Annual Tables

Temperature and precipitation values with departures from their 1961-1990 means

WMO No.	Station	January 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	February 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-18,6	-3,2	4	-10	-12,3	3,4	22	3
01025	Tromsø	-6,7	-2,7	85	4	0,6	4,3	114	28
01492	Oslo-Blindern	-3,8	0,5	40	-9	-2,7	1,3	56	20
02196	Haparanda	-15,9	-3,8	82	38	-6,4	4,9	18	-14
02485	Stockholm	-3,2	-0,4	19	-20	-3,2	-0,2	21	-6
02974	Helsinki-Vantaa	-9,8	-2,9	42	1	-5,7	1,1	7	-24
03091	Aberdeen	4,3	1,4	92	12	3,6	0,5	11	-41
03772	London-Heathrow	5,3	1,1	74	22	5,2	0,7	21	-14
03967	Dublin (Casement)	5,1	0,7	54	-12	5,2	0,8	25	-26
04030	Reykjavik	1,5	2,0	45	-31	2,0	1,6	158	87
04320	Danmarkshaven	-25,7	-2,6	11	0	-21,7	2,6	26	15
04360	Angmagssalik	-4,2	3,3	84	-28	-2,7	5,0	110	19
06186	København-Landb.	0,2	-0,3	36	-15	-1,3	-1,8	3	-28
06260	De Bilt	2,5	0,3	77	11	1,8	-0,7	29	-20
06447	Uccle	2,3	-0,3	102	35	2,8	-0,7	29	-24
06590	Luxenbourg	-0,1	-0,1	102	31	0,2	-0,9	18	-44
06660	Zürich	0,2	0,7	66	-1	-1,8	-2,7	34	-36
06700	Genève	1,6	0,6	80	11	0,4	-2,1	22	-48
07510	Bordeaux	5,1	-0,7	93	-7	5,8	-1,3	57	-29
07650	Marseille	5,4	-1,3	66	19	6,3	-1,6	24	-30
08222	Madrid	6,1	0,1	44	-2	6,8	-0,7	48	4
08314	Mahon / Menorca	10,7	0,0	91	30	9,9	-0,8	156	103
08495	Gibraltar	13,1	-0,3	98	-23	13,3	-0,5	137	37
08515	St. Maria / Acores	15,1	0,7	59	-41	14,0	0,0	60	-26
08535	Lisboa	11,5	0,1	135	25	12,0	-0,3	89	-22
10384	Berlin-Tempelhof	0,0	0,2	63	20	-1,6	-2,4	5	-29
11035	Wien-Hohe Warte	-0,4	0,3	64	26	-1,7	-3,0	1	-41
11518	Praha-Ruzyne	-1,7	0,7	20	-3	-3,5	-2,7	4	-19
11903	Slica	-4,1	-0,2	48	4	-5,9	-4,8	16	-28
12160	Elblag	-2,7	-0,3	42	-5	-3,4	-1,2	26	1
12375	Warszawa-Okecie	-3,0	0,3	31	9	-4,9	-2,9	5	-16
12843	Budapest-Lorinc	-2,1	-0,5	38	6	-3,4	-4,5	28	-4
13274	Beograd	0,4	0,0	63	14	-2,1	-4,8	26	-18
14015	Ljubljana	-1,1	0,0	85	3	-0,9	-2,3	50	-30
14445	Split	8,5	1,1	117	34	4,8	-3,3	23	-45
14654	Sarajevo	-0,4	0,5	110	39	-3,2	-4,7	43	-24
15420	Bucuresti	-2,0	0,4	34	-6	-4,1	-4,0	24	-12
15614	Sofia	0,2	1,8	93	66	-3,8	-4,3	26	-7
16158	Pisa	6,3	0,2	61	-14	4,5	-2,6	11	-62
16597	Luqa / Malta	13,2	1,0	152	63	10,4	-2,0	150	89
16716	Athens (Hellinikon)	12,2	2,0	53	9	6,5	-4,1	69	26
16754	Heraklion / Kreta	14,0	2,0	66	-24	9,8	-2,3	169	92
17040	Rize	8,8	2,5	108	-109	5,7	-0,9	173	0
17062	Istanbul-Goztepe	7,8	2,2	69	-30	2,7	-3,2	151	84
17130	Ankara / Central	5,4	5,3	42	-5	-0,3	-2,2	55	19
17170	Van	-1,4	2,8	26	-9	-1,4	2,0	53	19
17609	Larnaca	14,1	2,6	60	-5	11,0	-0,7	75	18
22113	Murmansk	-15,9	-4,2	32	-1	-4,7	6,5	22	0
26038	Tallina	-7,1	-1,6	47	2	-5,4	0,3	6	-23
26629	Kaunas	-5,0	0,0	33	-4	-5,8	-1,5	18	-9
26730	Vilnius	-5,9	0,2	31	-10	-6,2	-1,4	26	-12
26850	Minsk	-5,7	1,2	31	-9	-6,6	-0,8	28	-6
27199	Wjatka (Kirov)	-12,3	1,9	69	31	-12,7	-0,9	16	-12
27612	Moskva	-7,4	1,9	45	0	-8,7	-1,0	9	-28
33345	Kiev	-4,6	1,0	37	-10	-6,4	-2,2	18	-28
33815	Chisinau	-3,0	0,3	56	16	-5,5	-3,8	23	-15
34300	Charkov (Kharkiv)	-5,0	1,9	40	-4	-8,2	-2,5	11	-21
34880	Astrahan'	-2,3	3,1	12	-1	-5,7	-0,8	5	-5
35188	Akmola	-13,6	2,2	15	-2	-15,1	0,8	7	-7
37789	Yerevan	-2,6	0,6	24	-5	0,4	1,4	40	2
40080	Damascus	8,1	1,9	25	-10	7,1	-0,8	76	44
40100	Beyrouth	16,0	2,4	209	-13	13,2	-0,3	322	186
40180	Tel Aviv (Airport)	14,7	2,4	127	-22	12,7	-0,2	289	191
40270	Amman	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
60030	Las Palmas / Gr. Can	18,0	0,5	44	27	17,6	0,0	16	-6

WMO No.	March 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	April 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	Mai 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	-17,3	-2,6	18	-3	-9,6	2,1	20	8	-2,5	1,2	4	-2
01025	-0,2	2,0	182	118	2,1	1,4	31	-29	6,8	1,9	48	0
01492	1,6	1,8	31	-15	6,0	1,4	48	6	10,2	-0,6	84	32
02196	-1,5	5,3	26	-9	0,0	0,5	19	-10	7,3	1,2	60	29
02485	3,2	3,1	2	-24	4,6	0,0	44	14	11,6	0,9	58	28
02974	-1,4	1,5	10	-24	2,6	-0,3	31	-6	10,0	0,1	61	26
03091	6,4	1,8	17	-44	8,1	1,7	55	2	10,5	1,5	87	28
03772	9,1	2,6	16	-31	11,0	2,1	30	-15	13,5	1,0	39	-12
03967	7,4	1,4	32	-17	9,6	1,8	30	-17	11,2	0,7	100	42
04030	3,5	3,0	117	34	6,2	3,3	74	16	6,3	0,0	40	-4
04320	-23,4	0,0	15	-2	-16,5	0,8	12	2	-6,4	0,2	1	-3
04360	-3,5	4,7	142	54	-0,7	3,4	104	31	1,8	1,2	77	20
06186	3,6	1,0	9	-33	7,1	0,5	19	-23	12,4	0,4	92	49
06260	7,3	2,3	24	-39	9,9	1,9	46	-6	13,2	0,9	92	30,8
06447	8,8	3,3	35	-19	10,7	1,9	47	-10	13,9	1,0	82	11
06590	7,7	3,7	47	-23	9,5	2,0	52	-9	13,7	1,9	96	15
06660	7,6	3,4	31	-38	9,4	1,6	54	-33	14,8	2,7	116	13
06700	8,2	2,9	17	-51	10,9	1,9	59	3	15,9	2,7	31	-35
07510	12,3	3,5	29	-47	14,2	2,9	26	-46	16,0	1,4	40	-37,3
07650	11,1	0,9	4	-40	14,1	0,9	64	16	19,4	2,3	22	-20,3
08222	12,3	2,3	40	7	13,4	1,2	39	-15	18,7	2,6	19	-22
08314	12,7	0,9	20	-29	15,1	1,4	17	-28	18,3	1,3	37	4
08495	15,6	0,6	148	73	16,7	0,5	72	12	19,6	1,1	2	-33
08515	14,0	-0,6	50	-29	14,7	-0,5	137	82	17,4	0,7	2	-28
08535	14,7	1,0	76	7	15,4	0,3	122	58	19,4	2,0	2	-37
10384	4,9	0,7	20	-17	9,2	0,6	18	-23	15,8	1,9	33	-23
11035	6,5	1,2	15	-26	10,0	-0,2	27	-23	17,8	3,0	112	51
11518	4,6	1,6	6	-22	7,9	0,2	23	-15	15,0	2,3	71	-6
11903	3,1	0,1	4	-38	8,1	-0,4	28	-19	16,7	3,0	82	18
12160	2,2	0,1	14	-21	7,0	0,2	60	18	14,0	1,1	41	0
12375	2,0	0,0	11	-17	7,3	-0,5	27	-5	15,7	2,3	45	-14
12843	5,6	0,0	2	-27	10,8	-0,3	20	-18	20,1	4,1	37	-18
13274	7,1	-0,1	11	-39	11,6	-0,8	23	-36	21,5	4,3	40	-31
14015	7,4	2,0	3	-95	10,2	0,3	81	-28	18,3	3,7	66	-56
14445	10,9	0,5	4	-71	14,1	0,2	21	-45	22,7	4,3	8	-48
14654	4,8	-0,3	2	-68	8,8	-0,6	32	-42	17,2	3,1	49	-33
15420	2,2	-2,6	45	7	9,4	-1,9	37	-9	19,5	2,8	14	-56
15614	3,6	-1,0	2	-36	8,5	-1,4	77	27	17,9	3,6	117	44
16158	9,8	0,3	23	-53	12,6	0,1	93	14	18,5	2,2	8	-51
16597	12,7	-0,7	55	14	15,5	0,0	21	-2	20,4	1,3	27	20
16716	10,3	-2,3	29	-12	14,3	-1,8	41	16	22,6	2,0	12	-4
16754	12,0	-1,4	92	36	15,1	-1,2	60	30	20,9	1,1	6	-10
17040	5,0	-2,9	139	-8	9,2	-2,4	86	-15	17,4	1,6	31	-71
17062	4,9	-2,6	32	-30	9,8	-2,2	78	29	18,1	1,6	4	-27
17130	3,2	-2,9	9	-27	10,3	-0,9	70	22	19,0	3,5	18	-37
17170	0,1	-1,0	83	40	8,4	1,1	79	25	14,5	1,8	6	-43
17609	12,6	-0,7	84	35	16,8	-0,6	11	0	24,1	3,2	5	-2
22113	-2,8	4,0	13	-7	-0,3	1,6	16	-5	5,6	1,8	63	31
26038	-0,7	1,5	9	-20	2,1	-1,3	43	7	10,2	0,5	69	32
26629	0,6	0,8	9	-23	5,4	-0,6	32	-11	13,6	0,9	45	-11
26730	0,4	1,0	17	-22	4,8	-0,9	40	-6	13,6	1,1	74	12
26850	-0,5	0,9	29	-13	4,9	-1,1	48	6	15,3	2,4	86	24
27199	-5,2	-0,1	17	-12	4,2	1,0	22	-14	12,6	1,5	45	-4
27612	-2,7	-0,5	21	-13	4,7	-1,1	46	6	15,5	2,6	41	-17
33345	0,1	-0,6	26	-13	7,0	-1,7	24	-25	19,4	4,3	49	-4
33815	1,0	-1,9	12	-23	8,5	-1,7	35	-7	20,6	4,5	4	-47
34300	-2,4	-2,1	28	1	6,2	-2,7	26	-10	18,8	3,2	12	-35
34880	-0,2	-1,5	15	1	8,5	-2,6	20	2	19,1	0,8	17	-7
35188	-9,3	-1,2	17	3	2,4	-2,5	12	-10	16,6	3,5	27	-6
37789	2,5	-2,6	80	39	10,9	-0,7	61	10	17,9	1,6	23	-37
40080	9,8	-1,4	30	6	16,2	0,5	2	-10	23,4	3,0	0	-5
40100	16,0	0,9	206	86	18,9	1,1	56	5	24,5	4,1	1	-19
40180	14,2	-0,7	173	111	19,6	1,4	4	-19	25,3	4,2	0	-3
40270	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
60030	18,7	0,3	4	-6	19,3	0,6	4	-2	21,4	1,5	0,5	-1,5

WMO No.	Station	June 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	July 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	2,8	0,6	3	-7	7,0	1,0	24	11
01025	Tromso	9,4	0,1	31	-22	14,4	2,7	95	23
01492	Oslo-Blindern	16,3	1,1	78	13	18,9	2,5	108	24
02196	Haparanda	12,9	0,1	11	-30	19,5	4,0	36	-14
02485	Stockholm	16,1	0,5	51	7	20,6	3,4	74	2
02974	Helsinki-Vantaa	13,3	-1,6	21	-32	20,5	3,9	25	-48
03091	Aberdeen	14,4	2,3	48	-3	16,2	2,4	13	-48
03772	London-Heathrow	18,3	2,6	57	9	19,5	1,7	29	-17
03967	Dublin (Casement)	14,4	1,1	85	34	16,4	1,5	47	-7
04030	Reykjavik	11,3	2,2	0	-5	12,3	1,7	65	14
04320	Danmarkshaven	2,3	1,6	15	-37	5,6	1,9	4	-10
04360	Angmagssalik	6,2	2,1	43	-11	8,8	2,4	7	-42
06186	Kobenhavn-Landb.	16,6	0,5	35	-33	18,8	1,6	66	-3
06260	De Bilt	17,8	2,6	34	-45	18,8	2,0	30	-45
06447	Uccle	19,3	3,6	48	-34	19,5	2,0	73	-2
06590	Luxenbourg	19,8	4,9	58	-66	19,5	2,6	51	-17
06660	Zürich	22,5	7,3	45	-35	19,8	2,2	111	-6
06700	Genève	24,1	7,4	41	-15	22,5	3,2	41	-17
07510	Bordeaux	22,7	4,9	0	-28	21,9	1,7	88	42
07650	Marseille	26,1	5,2	8	-19	26,3	2,5	1	-13
08222	Madrid	25,5	4,9	1	-15	25,9	1,5	0	-13
08314	Mahon / Menorca	25,4	4,4	0	-11	27,3	3,0	1	-5
08495	Gibraltar	23,1	2,0	7	-15	24,5	0,8	1	-1
08515	St. Maria / Acores	19,9	1,2	5	-16	22,5	1,7	17	-8
08535	Lisboa	21,7	1,5	47	-28	22,3	-0,1	2	-3
10384	Berlin-Tempelhof	20,0	2,6	30	-44	20,6	1,8	58	6
11035	Wien-Hohe Warte	22,5	4,5	25	-48	21,6	1,7	36	-26
11518	Praha-Ruzyne	19,7	3,8	12	-73	18,9	1,4	74	8
11903	Slica	19,8	3,2	55	-39	20,3	2,1	147	88
12160	Elblag	16,7	1,3	43	-29	19,2	2,4	118	24
12375	Warszawa-Okecie	17,9	1,3	15	-48	20,2	2,3	133	66
12843	Budapest-Lorinc	23,6	4,5	33	-57	22,7	1,8	63	11
13274	Beograd	25,0	4,9	63	-92	23,3	1,6	117	51
14015	Ljubljana	23,5	5,7	8	-43	22,6	2,7	120	-2
14445	Split	27,9	5,7	95	4	27,8	2,4	34	6
14654	Sarajevo	20,4	3,5	12	-65	20,7	1,8	65	-14
15420	Bucuresti	22,7	2,5	82	10	22,7	0,7	45	-19
15614	Sofia	21,1	3,4	21	-23	21,4	1,4	16	-40
16158	Pisa	25,8	6,0	16	13	26,7	3,9	23	0
16597	Luqa / Malta	26,1	3,1	1	-7	28,8	2,9	1	1
16716	Athens (Hellinikon)	28,1	3,0	0	-3	29,1	1,3	1	-5
16754	Heraklion / Kreta	25,0	1,5	58	-70	27,6	1,9	0	-1
17040	Rize	20,6	0,7	1	-20	23,3	1,1	204	68
17062	Istanbul-Goztepe	23,1	2,0	0	-37	25,0	1,8	4	-15
17130	Ankara / Central	22,6	3,0	50	29	23,5	0,6	3	-11
17170	Van	18,2	0,6	7	6	23,1	1,2	0	-4
17609	Larnaca	25,7	1,4	9	-44	28,6	1,7	0	0
22113	Murmansk	6,6	-2,8	25	-28	15,5	2,7	65	5
26038	Tallina	12,9	-1,6	57	-18	19,9	3,6	80	1
26629	Kaunas	15,4	-0,6	65	-12	20,1	3,0	118	50
26730	Vilnius	15,2	-0,6	28	-55	19,7	2,8	92	14
26850	Minsk	15,5	-0,6	181	117	19,8	2,5	152	64
27199	Wjatka (Kirov)	12,6	-3,0	80	4	20,3	2,1	29	-57
27612	Moskva	12,8	-3,8	26	-47	20,6	2,5	66	-26
33345	Kiev	18,0	-0,2	21	-54	21,3	2,0	61	-27
33815	Chisinau	21,2	1,8	89	31	21,6	0,7	113	44
34300	Charkov (Kharkiv)	17,3	-1,6	22	0	20,3	0,0	158	98
34880	Astrahan'	20,1	-2,8	44	9	24,6	-0,7	34	11
35188	Akmola	18,3	-0,7	NIL	NIL	18,5	-2,8	60	10
37789	Yerevan	20,3	-0,3	47	18	24,3	-0,3	30	16
40080	Damascus	25,7	1,1	0	-1	27,5	0,9	0	0
40100	Beyrouth	25,0	1,4	0	-1	27,5	2,0	0	0
40180	Tel Aviv (Airport)	25,6	1,6	0	0	27,5	1,8	0	0
40270	Amman	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
60030	Las Palmas / Gr. Can	22,7	1,3	0	0	24,2	0,9	0	0

WMO No.	August 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	September 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	October 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	6,4	1,6	4	-21	0,6	0,1	35	12	-4,3	1,2	9	-6
01025	12,0	1,1	57	-25	6,9	0,1	233	139	2,5	-0,4	197	72
01492	17,2	2,0	63	-27	12,2	1,4	64	-26	3,9	-2,5	32	-52
02196	14,3	1,0	39	-24	8,2	0,3	59	-4	2,1	-0,4	59	-5
02485	17,7	1,5	51	-15	13,6	2,4	20	-35	5,2	-2,3	32	-18
02974	16,1	1,1	68	-12	11,6	1,6	22	-51	3,5	-1,9	73	0
03091	15,8	2,2	17	-58	12,8	1,1	26	-42	8,3	-0,8	51	-27
03772	21,1	3,7	10	-41	16,4	1,4	8	-43	10,6	-1,1	35	-23
03967	16,4	1,8	11	-67	13,9	0,9	38	-31	9,0	-1,3	124	56
04030	12,8	2,5	76	14	8,3	0,9	79	12	5,6	1,2	38	-48
04320	5,3	2,9	3	-11	-1,7	2,5	3	-8	-10,2	3,4	9	-3
04360	8,9	2,9	19	-42	5,8	2,7	26	-42	2,3	3,1	93	11
06186	18,5	1,5	26	-37	14,5	0,9	35	-27	6,7	-3,2	29	-30
06260	19,3	2,6	9	-62	13,9	-0,1	52	-15	7,5	-3,0	84	12
06447	20,4	3,1	44	-19	15,3	0,8	31	-28	7,9	-3,0	64	-6
06590	22,3	5,9	47	-25	15,1	1,7	24	-46	6,9	-2,2	69	-6
06660	22,7	6,0	82	-51	14,6	0,8	46	-46	6,4	-2,9	144	75
06700	24,0	5,6	110	42	15,9	0,8	74	4	8,8	-1,5	175	109
07510	25,2	5,3	36	-18	19,0	1,1	32	-42	12,9	-1,1	155	67
07650	27,9	4,7	3	-26	20,1	-0,2	131	84	15,3	-0,8	57	-21
08222	27,2	3,3	3	-6	21,8	1,3	44	14	14,0	-0,8	149	104
08314	28,9	4,4	19	-7	22,5	0,3	126	71	19,2	0,7	185	101
08495	25,2	1,0	0	-6	23,0	0,2	32	17	19,6	0,1	192	128
08515	23,9	1,7	34	-6	22,6	1,2	127	70	19,0	-0,3	30	-54
08535	24,5	1,7	35	29	22,6	0,9	8	-18	17,6	-0,9	180	100
10384	21,1	2,7	22	-39	15,6	1,0	35	-11	6,6	-3,4	63	27
11035	23,5	4,3	20	-45	15,8	0,4	44	-1	8,0	-2,1	36	-5
11518	20,9	3,9	16	-54	14,4	1,1	25	-15	5,6	-2,7	16	-14
11903	20,2	2,9	21	-48	14,3	0,9	19	-37	6,0	-2,3	68	18
12160	17,6	0,9	39	-42	14,3	1,6	54	-16	5,8	-3,1	131	78
12375	18,7	1,4	54	-9	13,8	0,6	52	9	5,4	-2,9	63	25
12843	24,6	4,3	20	-31	17,3	0,9	16	-24	8,5	-2,4	96	62
13274	25,6	4,3	6	-46	17,8	0,1	58	7	10,8	-1,6	115	75
14015	24,2	5,1	73	-71	15,4	-0,1	133	3	8,8	-1,6	178	63
14445	29,3	4,1	7	-43	21,0	-0,4	65	4	15,7	-1,2	160	81
14654	22,6	4,1	7	-64	14,6	-0,5	79	9	9,4	-1,0	211	123
15420	23,5	2,3	1	-57	15,0	-1,9	137	95	8,8	-2,0	117	85
15614	22,6	3,2	28	-24	15,2	-0,6	37	-2	10,2	-0,2	118	81
16158	27,6	5,1	1	-56	20,5	1,0	42	-47	15,6	0,3	87	-33
16597	28,7	2,4	1	-7	24,5	0,4	260	220	22,1	1,4	37	-53
16716	29,9	2,3	1	-4	24,0	-0,2	4	-6	20,9	1,6	24	-28
16754	27,3	1,7	0	-1	24,2	1,1	0	-18	22,8	3,1	1	-75
17040	23,7	1,5	77	-106	20,0	0,6	404	183	17,4	2,0	448	176
17062	25,5	2,5	1	-26	19,5	-0,2	44	3	16,3	1,0	87	16
17130	24,3	1,7	1	-12	18,0	-0,3	15	-4	14,4	1,8	30	3
17170	22,8	1,6	16	9	17,0	0,2	16	2	12,9	2,8	24	-24
17609	28,6	1,5	1	1	25,7	0,6	12	12	22,3	1,0	9	-10
22113	11,7	0,7	63	-2	7,6	0,9	43	-9	1,6	0,6	97	55
26038	16,3	1,0	55	-29	12,0	1,2	30	-52	4,8	-1,5	59	-11
26629	17,1	0,8	53	-10	12,7	0,6	28	-31	4,7	-2,2	90	39
26730	16,8	0,5	105	33	12,3	0,7	22	-43	4,2	-2,4	69	16
26850	16,6	0,1	52	-20	11,9	0,2	12	-48	4,6	-1,7	77	28
27199	18,2	2,7	123	58	9,9	0,7	47	-24	4,8	3,1	38	-24
27612	16,9	0,5	145	71	11,3	0,4	100	36	5,6	0,6	53	-5
33345	19,2	0,6	87	18	14,1	0,2	32	-15	6,8	-1,3	110	75
33815	22,6	2,1	27	-18	15,6	-0,6	53	5	9,2	-0,9	62	35
34300	19,1	-0,4	138	88	13,6	-0,5	20	-21	7,6	0,3	81	46
34880	25,0	1,7	4	-15	17,0	-0,3	28	2	12,2	3,1	29	12
35188	21,7	4,0	50	10	14,3	2,3	22	-2	5,1	2,3	29	-1
37789	25,4	1,5	11	2	20,4	0,6	14	5	16,5	3,7	54	22
40080	28,1	1,9	0	0	23,9	0,6	0	0	20,6	2,0	0	-12
40100	28,2	1,8	0	-1	26,5	1,3	0	-5	24,3	1,7	16	-38
40180	28,2	2,1	0	0	26,3	1,5	0	0	23,9	1,9	0	-26
40270	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
60030	24,9	0,8	0	0	24,5	0,7	0	-8	22,5	0,0	33	23

WMO No.	Station	November 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	December 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-6,7	3,8	17	4	-19,1	-5,8	8	-4
01025	Tromso	2,4	3,2	74	-30	-2,7	0,3	139	35
01492	Oslo-Blindern	2,9	2,2	62	-13	0,3	3,1	60	4
02196	Haparanda	-1,7	2,4	31	-27	-6,9	2,6	37	-5
02485	Stockholm	4,6	2,0	40	-13	1,6	2,6	49	3
02974	Helsinki-Vantaa	2,8	2,7	46	-26	-1,1	3,0	70	12
03091	Aberdeen	7,3	2,1	72	-3	4,1	0,4	93	20
03772	London-Heathrow	9,8	2,6	114	59	6,1	1,0	52	-5
03967	Dublin (Casement)	8,4	1,7	54	-16	5,5	0,2	64	-13
04030	Reykjavik	2,7	1,5	78	5	0,4	0,6	125	47
04320	Danmarkshaven	-16,1	3,8	16	6	-24,0	-2,2	4	-9
04360	Angmagssalik	-1,6	3,1	73	-23	-6,1	1,1	65	-38
06186	Kobenhavn-Landb.	7,3	1,8	30	-32	4,4	2,2	44	-14
06260	De Bilt	8,0	2,1	40	-41	4,0	0,8	96	17
06447	Uccle	8,3	2,2	65	-11	4,5	1,0	65	-11
06590	Luxenbourg	6,5	2,7	48	-35	2,5	1,5	54	-26
06660	Zürich	5,4	1,5	78	-4	1,2	0,6	40	-33
06700	Genève	6,0	0,8	54	-25	3,0	1,0	28	-47
07510	Bordeaux	10,9	1,8	70	-24	7,7	1,3	68	-31
07650	Marseille	12,1	1,4	68	10	8,5	1,2	95	39
08222	Madrid	10,4	1,0	80	16	6,8	0,4	44	-5
08314	Mahon / Menorca	15,9	1,5	77	0	11,7	-0,1	78	-2
08495	Gibraltar	15,9	-0,2	75	-66	14,1	0,0	150	4
08515	St. Maria / Acores	16,9	-0,5	75	-27	16,4	1,0	190	95
08535	Lisboa	14,7	0,2	131	17	11,5	-0,3	89	-19
10384	Berlin-Tempelhof	6,5	1,6	38	-11	2,8	1,4	50	-3
11035	Wien-Hohe Warte	6,7	1,9	25	-25	1,1	0,1	36	-8
11518	Praha-Ruzyne	4,4	1,6	8	-24	0,0	0,6	18	-8
11903	Slica	4,7	1,7	35	-34	-1,4	0,3	25	-32
12160	Elblag	5,7	2,4	45	-11	2,2	1,9	45	-7
12375	Warszawa-Okecie	4,9	1,7	23	-19	0,9	1,8	43	11
12843	Budapest-Lorinc	7,0	2,2	39	-13	0,9	0,5	5	-35
13274	Beograd	9,2	2,2	23	-31	2,8	0,5	37	-21
14015	Ljubljana	8,2	3,6	131	-4	2,1	2,1	107	6
14445	Split	14,2	2,0	92	-16	9,8	1,1	51	-49
14654	Sarajevo	7,3	2,5	35	-56	0,5	0,7	64	0
15420	Bucuresti	6,4	1,2	69	20	-0,8	-1,0	60	17
15614	Sofia	6,6	1,6	70	23	0,2	-0,3	31	-8
16158	Pisa	12,5	2,1	270	146	8,3	1,5	106	21
16597	Luqa / Malta	18,0	1,0	85	5	13,9	0,1	101	-11
16716	Athens (Hellinikon)	15,6	0,1	65	15	11,1	-1,1	77	6
16754	Heraklion / Kreta	17,3	0,7	53	-6	13,5	-0,3	173	99
17040	Rize	11,7	0,1	197	-53	8,5	0,2	284	42
17062	Istanbul-Goztepe	10,8	-0,8	82	-7	7,8	-0,3	78	-44
17130	Ankara / Central	8,0	0,9	5	-28	1,9	-0,7	62	13
17170	Van	4,5	0,5	60	18	0,2	1,1	15	-19
17609	Larnaca	17,7	1,3	3	-41	14,3	1,1	193	117
22113	Murmansk	-1,0	4,1	17	-23	-7,4	1,9	56	18
26038	Tallina	3,3	2,1	44	-24	0,6	3,5	79	24
26629	Kaunas	3,7	1,6	35	-18	0,6	3,0	55	11
26730	Vilnius	3,0	1,8	30	-27	-0,3	2,6	77	22
26850	Minsk	2,4	1,6	25	-27	-1,2	2,6	48	-5
27199	Wjatka (Kirov)	-2,2	2,5	46	-6	-4,6	5,7	80	35
27612	Moskva	1,1	2,2	52	-6	-2,1	4,0	42	-10
33345	Kiev	3,4	1,3	30	-21	-0,6	1,7	32	-20
33815	Chisinau	5,4	1,0	10	-29	0,4	0,7	39	1
34300	Charkov (Kharkiv)	2,3	1,0	42	-2	-1,4	2,0	39	-6
34880	Astrahan'	3,3	0,0	44	25	-0,6	1,3	10	-5
35188	Akmola	-6,9	-1,0	17	-5	-9,5	3,1	16	-1
37789	Yerevan	6,1	-0,5	64	34	0,3	-0,2	23	-3
40080	Damascus	13,1	0,8	40	13	8,4	0,8	45	-1
40100	Beyrouth	20,3	1,6	62	-42	16,0	1,2	162	-12
40180	Tel Aviv (Airport)	19,7	1,7	28	-40	15,7	1,9	87	-51
40270	Amman	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
60030	Las Palmas / Gr. Can	20,3	-0,1	7	-14	19,0	0,7	10	-11

WMO No.	Station	Year 2003 Temp. mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-6,1	0,3	168	-15
01025	Tromso	4,0	1,2	1286	313
01492	Oslo-Blindern	6,9	1,2	726	-43
02196	Haparanda	2,7	1,5	477	-75
02485	Stockholm	7,7	1,1	461	-77
02974	Helsinki-Vantaa	5,2	0,7	476	-184
03091	Aberdeen	9,3	1,4	582	-204
03772	London-Heathrow	12,2	1,6	485	-111
03967	Dublin (Casement)	10,2	0,9	664	-74
04030	Reykjavik	6,1	1,7	895	141
04320	Danmarkshaven	-11,0	1,2	119	-60
04360	Angmagssalik	1,2	2,9	843	-91
06186	Kobenhavn-Landb.	9,1	0,4	424	-226
06260	De Bilt	10,3	1,0	613	-202
06447	Uccle	11,1	1,2	685	-118
06590	Luxenbourg	10,3	2,0	666	-251
06660	Zürich	10,2	1,8	847	-195
06700	Genève	11,8	1,9	732	-69
07510	Bordeaux	14,5	1,7	694	-201
07650	Marseille	16,1	1,3	543	-1
08222	Madrid	15,7	1,4	511	68
08314	Mahon / Menorca	18,1	1,4	807	228
08495	Gibraltar	18,6	0,4	914	128
08515	St. Maria / Acores	18,0	0,5	786	12
08535	Lisboa	17,3	0,5	916	109
10384	Berlin-Tempelhof	10,1	0,7	435	-148
11035	Wien-Hohe Warte	10,9	1,0	441	-171
11518	Praha-Ruzyne	8,8	1,0	293	-245
11903	Slica	8,5	0,5	548	-147
12160	Elblag	8,2	0,6	658	-10
12375	Warszawa-Okecie	8,2	0,5	502	-8
12843	Budapest-Lorinc	11,3	0,9	397	-148
13274	Beograd	12,7	0,9	582	-167
14015	Ljubljana	11,6	1,8	1035	-254
14445	Split	17,2	1,4	677	-188
14654	Sarajevo	10,2	0,8	709	-195
15420	Bucuresti	10,3	-0,3	665	75
15614	Sofia	10,3	0,6	636	101
16158	Pisa	15,7	1,7	741	-122
16597	Luqa / Malta	19,5	0,9	890	333
16716	Athens (Hellinikon)	18,7	0,2	376	11
16754	Heraklion / Kreta	19,1	0,7	678	52
17040	Rize	14,3	0,3	2152	87
17062	Istanbul-Goztepe	14,3	0,2	630	-83
17130	Ankara / Central	12,5	0,8	360	-38
17170	Van	9,9	1,2	385	20
17609	Larnaca	20,1	1,0	462	80
22113	Murmansk	1,4	1,5	512	34
26038	Tallina	5,7	0,6	578	-111
26629	Kaunas	6,9	0,5	581	-29
26730	Vilnius	6,5	0,5	611	-78
26850	Minsk	6,4	0,6	769	111
27199	Wjatka (Kirov)	3,8	1,4	612	-25
27612	Moskva	5,6	0,7	646	-39
33345	Kiev	8,1	0,4	527	-124
33815	Chisinau	9,8	0,2	523	-7
34300	Charkov (Kharkiv)	7,3	-0,1	617	134
34880	Astrahan'	10,1	0,1	262	29
35188	Akmola	3,5	0,8	272	-11
37789	Yerevan	11,9	0,3	471	103
40080	Damascus	17,7	0,9	218	24
40100	Beyrouth	21,4	1,6	1034	146
40180	Tel Aviv (Airport)	21,1	1,6	708	141
40270	Amman	NIL	NIL	NIL	NIL
60030	Las Palmas / Gr. Can	21,1	0,6	119	2

Monthly Surveys

January 2003

- **Unusually mild around Greenland and from the southern Balkans over Turkey into the Caucasus**
- **Much more colder than normal in northern Scandinavia**
- **Extremely wet in Portugal and The Former Yugoslav Rebublic Of Macedonia**
- **Very sunny in the British Isles and Luxembourg**

In Narsarsuaq, Greenland, the month was record breaking mild. At Nuuk Airport +15.3°C were registered during a foehn situation on January 29.

The month was rather mild and dry in Iceland and high temperatures persisted during the first part of the month, but a harsh cold spell influenced the country during January 18-23.

The month was wet and as a whole warmer than normal in the Faroe Islands, but it was cold in the end with frost and snow.

Norway had a very cold start of the year, especially in the inner part of northern Norway. The station Karasjok in Finnmark experienced the 4th coldest January since the measurements started in 1877. Other stations in Finnmark and Troms registered the month as one of the coldest in the observational series.

In Sweden, very cold weather in the first part of the month gave unusually harsh conditions for the boat traffic, especially in Lake Vänern and in the Gulf of Bothnia. A warmer latter half of the month brought some relief.

The month was rather cold in Finland with anomalies of about -4°C down to -7°C in the northernmost parts of the country. The monthly precipitation rate varied between 75% and 150% of normal in most southern and central parts of the country, whereas it exceeded 150% to the north.

After a cold start of the year in Denmark with temperatures down to -21°C and a snow blizzard, the weather changed and became mild, causing the monthly mean temperature to be approximately normal.

The year started very cold in Latvia. By January 8 all the Gulf of Riga was covered by ice. Within 24 hours the air temperature at the east coast of the Gulf of Riga rose from -32°C to -3°C due to a change of air masses on January 7.

In Ireland the year's lowest temperatures were measured during mid-January in most places. The absolute minimum air temperature of -6.0°C was recorded at station Clones on January 5 and the lowest grass minimum temperature of -12.3°C at station Kilkenny on January 4 and 5. The strongest winds of the year at almost all stations were measured during the second half of the month, but there were no exceptional storms. Station Malin Head recorded the highest gust of the year, 130km/h on January 28.

The highest U.K. temperature for the month was equalled on January 26, with Aboyne/Scotland recording a temperature of 18.3°C. Joint holder of this record is Aber/Wales, which reported a temperature of 18.3°C in both 1958 and 1971. On

January 30 bands of snow affected eastern areas, giving between 5cm and 12cm in most places. There was major disruption and gridlock on some motorways. It was the 2nd sunniest January in the 1961-2003 series for England & Wales with 70.5 hours being recorded (145% of 1961-90 average). The sunniest was 2001 with 74.3 hours.

From the beginning of the year until January 4, heavy rains engendered floods in several parts of Belgium. Thundery weather on January 28 caused damage in some places of eastern Flanders.

The monthly precipitation in Luxembourg amounted to 102.0 mm, which is 141% of normal. In spite of this, the monthly sum of sunshine duration surpassed the long-term average by 25.6 hours or 56%, which is equal to 27% of the theoretically possible insolation.

The monthly mean temperature in Germany was marginally above normal, while the precipitation rate exceeded normal clearly by 35%. Heavy rains triggered flooding in many places all over the country from January 1-4. Gusts up to 200 km/h in the area of the Black Forest and also a small tornado near the city of Ulm caused a lot of damage to people and the infrastructure. A cold spell from January 6-12 caused the blocking of traffic lines on land, at sea and in the air in the eastern part of the country; two people froze to death.

The monthly mean temperature in Poland was lower than the reference of 1971-2000 with a spatial variation from -1.6°C in the north up to -0.1°C in the south. The country wide precipitation total was slightly above normal with rates below 80% of normal in the North and above 160% of normal in the West. A snow cover appeared in the first half of the month and again at the end.

The month had the most contrasting weather of this winter in Lithuania. The first ten days were very cold with daily mean air temperatures of -21°C ... -27°C on January 6-7. The ten-day thermal anomaly reached -8.5°C, which is the lowest record except for the years 1935, 1940 and 1987. The monthly mean air temperature, instead, was -5°C and thus close to normal. The steady snow cover of the first half of the month gradually melted down with the warming weather and reappeared again on the last days of the month. The monthly precipitation amounted to 36mm, which equals 86% of the normal rate.

The month was rather mild in Belarus with monthly mean temperatures about 2°C above normal (see fig. 0.7).

During the first half of the month some very cold days occurred in the eastern part of Austria with temperatures down to -27°C. Later on, milder weather caused the monthly mean temperatures to become normal or slightly above normal. A powerful stream over western and central Europe caused severe damage and floods in some parts of the country on January 2-3; especially in Vorarlberg, Upper and Lower Austria, lots of trees were uprooted and roads and railways were blocked.

In Czech Republic, the year started in its very first hours with a remarkable drop of temperatures. Intensive cold advection from N to NE caused cooling rates of more than 20°C / 24h in many places, followed by warming at a similar scale (see example in fig. 1.1). Such temperature changes occur once per 10-20 years.

The temperature anomaly in Slovenia was within ±1°C. After a few relatively warm days in the beginning, the second third of the month was quite cold. Most of the precipitation fell in the first third of the month, while the second third was quite dry. In the lowlands the snow cover lasted longer than on the average in the reference period. Gusty north-easterly winds, called bora, were quite frequent on Karst, Vipava valley and near the coast.

After a mild start of the year in Hungary, temperatures dropped down considerably. The coldest days were January 12-13 with absolute minima below -30°C in some places.

In Croatia temperature anomalies were slightly positive and the country-wide precipitation rate was well above normal.

While the monthly mean temperature was slightly above normal, precipitation totals exceeded the averages significantly and accumulated to 154% of normal in Bosnia and Herzegovina.

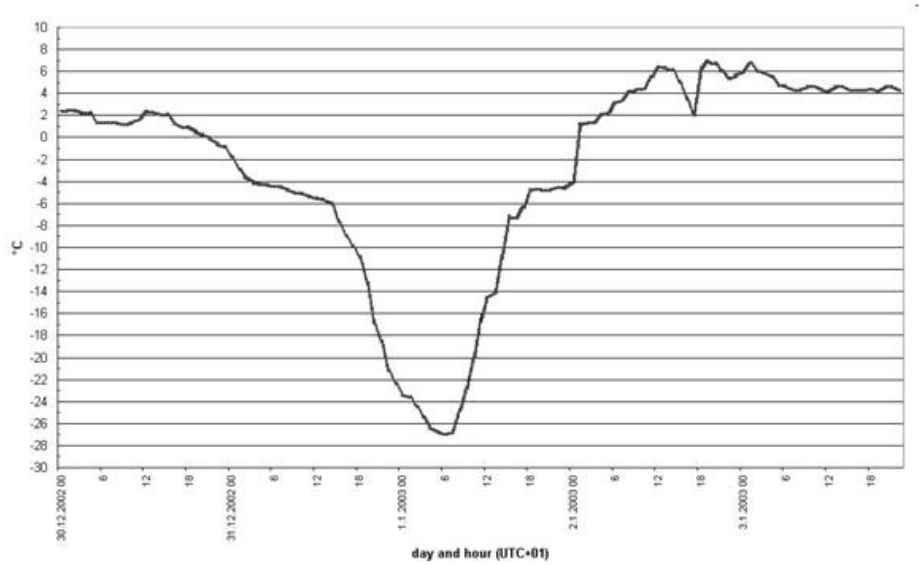


Fig 1.1: *Temperature course at Broumov station (NE Bohemia) around the beginning of the year 2003*
From: Czech Hydrometeorological Institute

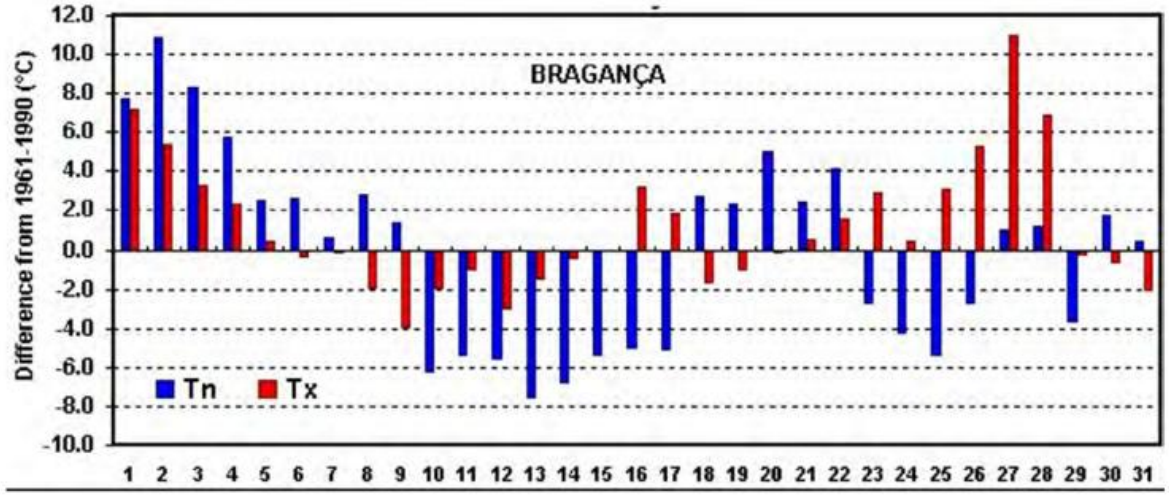


Fig 1.2: *Daily air temperature - anomalies in Bragança (January 2003)*
From: Instituto de Meteorologia, Portugal

The month was extremely rainy in the northern and central parts of Portugal. Precipitation rates were above 150% of normal, e.g. 156% in Vila Real and 210% in Oporto. The floods of the Agueda river in the central region caused great damage and 36 people were dislodged. At station Viseu precipitation amounted to 160mm in 4 days from January 1-4. This is about 95% of the normal monthly total. In spite of monthly mean temperatures close to normal, there were significant variations with time during the month (see fig 1.2).

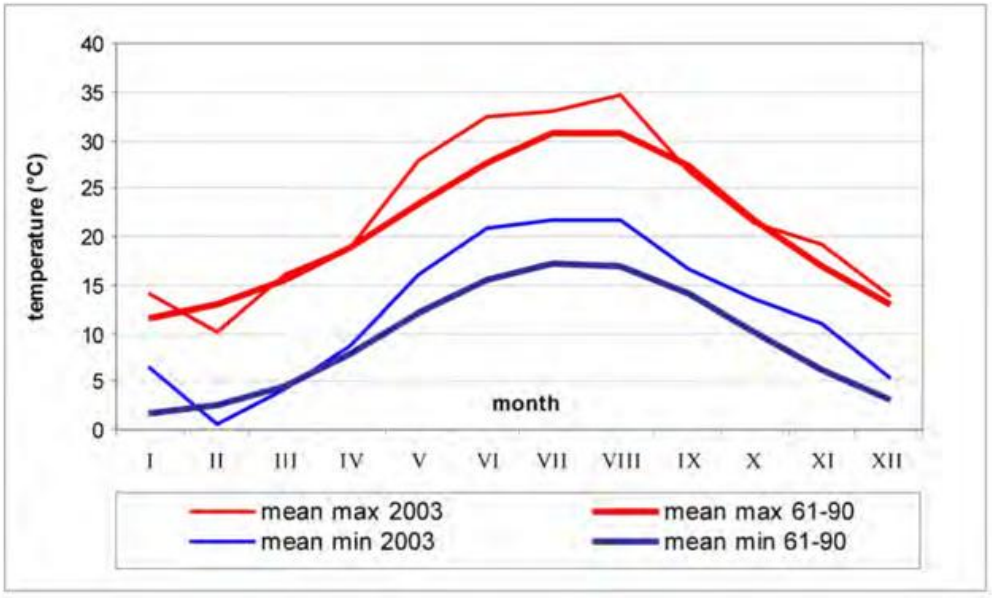


Fig 1.3: *Monthly mean of daily temperature extremes in Tirana*
From: Hydrometeorological Institute of Albania

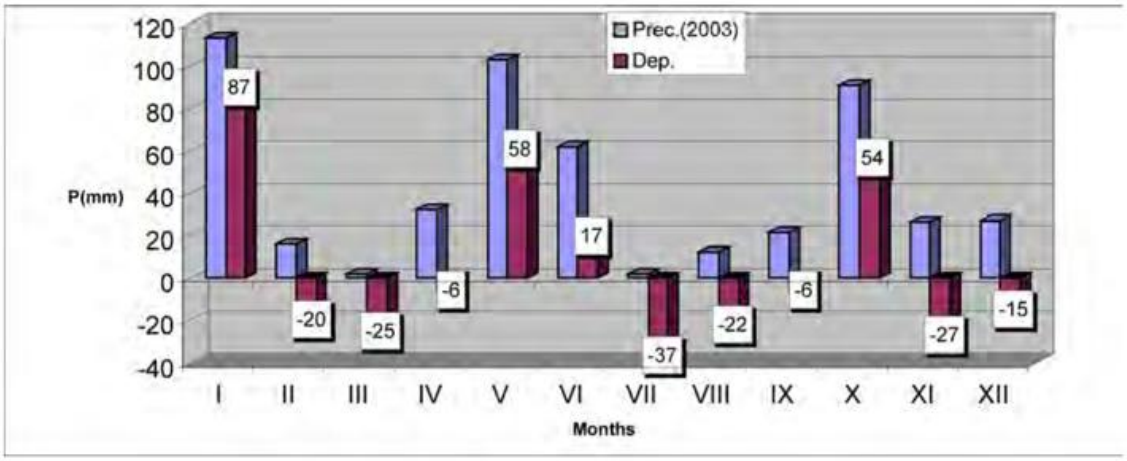


Fig 1.4: *Monthly precipitation totals and departures in SkopjeZajcev Rid, in 2003*
Reference periode: 1961 - 1990
From: Hydrometeorological Service of Republic Macedonia

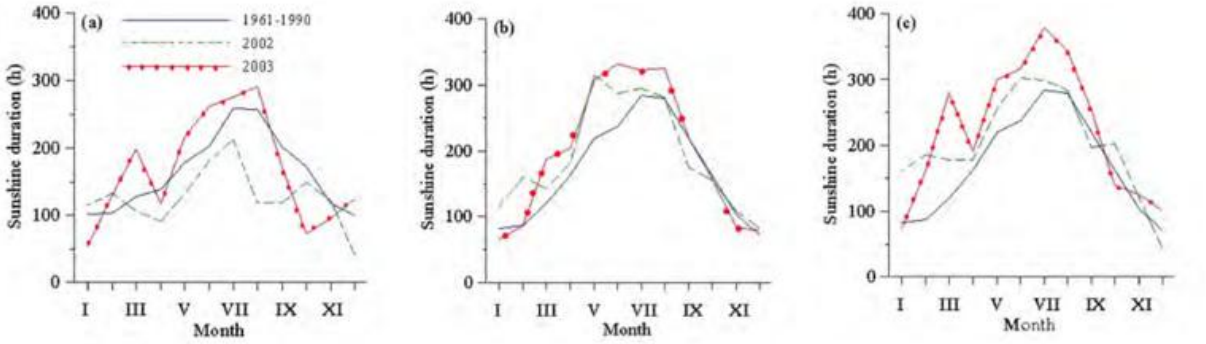


Fig 1.5: *Monthly values of sunshine duration at Cherni vrah (a), Varna (b) and Sandanski (c) in 2003, 2002 and normal (1961 - 1990)*
From: National Institute of Meteorology and Hydrology Bulgaria

The month was very mild in Albania, which is illustrated by the anomalies of the mean daily temperature extremes (fig. 1.3).

In The Former Yugoslav Rebublic Of Macedonia the monthly precipitation rate was about 200% of normal. Fig. 1.4 shows the example of station Skopje. The monthly mean tempera-tures were well above normal with an anomaly of +2.5°C at station Shtip.

The month was warm, cloudy and wet in Bulgaria with mean temperatures up to 2°C above normal and precipitation rates between 115% and 130% of normal. The mean sunshine duration was lower by about 20-30 hours compared to the long-term average (see fig. 1.5). Widespread fog occurred on 18 days of the month. On January 31, heavy rains with a daily total of 31mm caused flooding in the city of Varna.

In Turkey, January was the only month of the year with a positive temperature anomaly. Strong winds forced the closure of the harbour of Bandima at the western coast on January 12. Another storm in the area of Seydisehir/Konya destroyed a minaret and damaged homes and forests on January 26. Stormy weather on January 31 damaged the meteorological station of Giresun at the Black Sea coast. On the same day, the area of Izmir suffered from stormy weather connected with heavy rains and hail. Inside the country, drought affected the agriculture around Nevsehir.

The month was rather mild and dry in Cyprus. But on January 27, severe weather conditions connected with hailstorms and tornadoes affected the western and southern areas of the island. In Limassol, 30 people suffered from injuries, when houses, cars, power lines and telecommunication networks were damaged.

In Israel the month was warmer than average and also dry. In the northern parts of the country rainfall amounts were 70%-90% of normal and only 40%-60% in the central and southern parts. But two areas received large rainfall amounts – the western Galilee (180-220mm: 110%-120% of normal) and Tel Aviv area with 170-180mm (130%-150% of normal). More than half of the monthly total in the latter area were recorded on January 21. Almost 80mm of rain fell within two hours and that caused flooding and damage in the Tel Aviv area (fig. 1.6). Temperatures were high, especially in the first half of the month. In the coastal plain and in the Negev 28-30°C were recorded on January 11-12.

The month was warmer than normal in Jordan with a maximum temperature anomaly of +1.9°C in Amman.

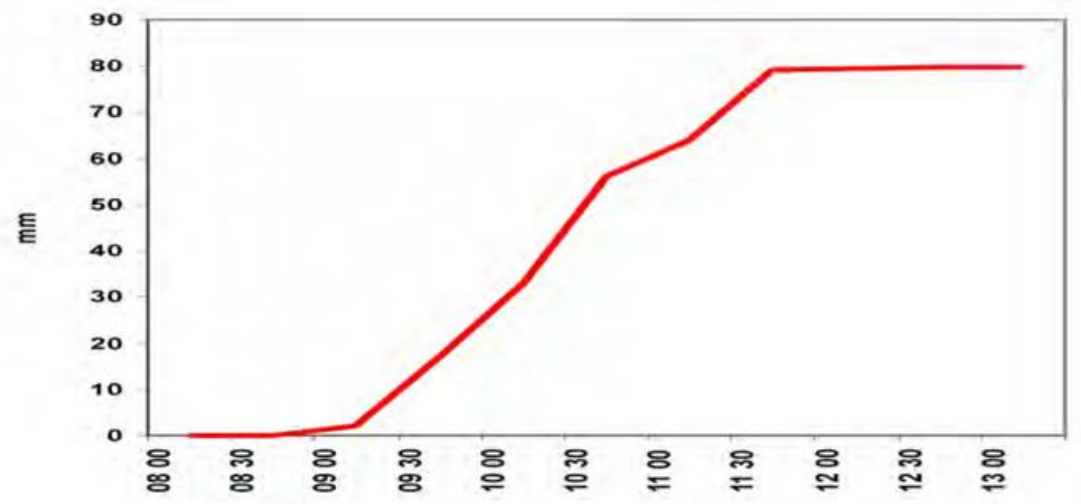


Fig 1.6: *Accumulated Rainfall in Tel Aviv on January 21 2003*
From: Israel Meteorological Service

In the first days of the year rather low temperatures were observed in Armenia, especially in Ararat valley by -19°C ...-21°C, which is 7°C to 9°C below normal. In the third decade of the month the weather turned out to become extremely mild and windy. Maximum temperatures of 17°C to 22°C were measured in some places on January 30-31. Strong winds with gusts up to 108km/h damaged electric-power transmission lines in Martuni on January 30.

February 2003

- **Extremely mild in eastern Greenland and northern Scandinavia**
- **Extremely cold in the Balkans**
- **Extremely dry in the British Isles and in central Europe, wet around western Greenland and at the southern Mediterranean coastal areas**
- **Beginning of a long-lasting drought in many countries**

The month was mild, wet and quite windy in Iceland.

In Northern Ireland, cold conditions prevailed throughout the start of the month. Snowfalls on February 1 and 2 caused widespread disruption across the province, with snow lying up to 6cm deep. It was the 2nd sunniest February in the 1961-2003 series for Scotland with 91.8 hours being recorded (143% of 1961-90 average). The sunniest was 1963 with 92.6 hours.

The month was warmer than normal in the greater part of Norway, especially in the north. In this area the lowest temperature of the year was measured on February 1 at station Karasjok with -42.5°C. At the same station the increase in mean temperature from January to February was 16.2°C. This is the greatest difference between January and February registered here. Several stations in Norway registered new maximum temperatures.

The weather ship Polarfront in the Norwegian Sea measured a monthly mean temperature of 6ºC, which is the highest for the month in the measuring series starting in 1949. The mid and southern part of Norway received very little precipitation and on some stations the monthly sum was the lowest in series starting in 1955 and 1954.

The monthly mean temperature in Finland was above normal nearly all over the country with a clear gradient of anomalies from south to north, starting with +1.1°C in Helsinki and reaching +6.0°C at station Sodankylä. The monthly precipitation was significantly below normal, especially in the south-west with less than 25% of its reference value.

In Denmark the month was considerably colder than normal and extremely dry.

The month was wintry cold and dry in Lithuania. The mean monthly air temperature was -5.6°C, which is an anomaly of -1°C. Prevalence of high pressure formations determined a small amount of monthly precipitation of merely 17mm, which is 57% of normal. Because of a thin snow cover, the ground freeze depth reached 95cm - 105cm in some regions, e.g. in Vilnius exceeding normal by 50cm.

In Latvia the monthly mean temperature was moderately below normal and the precipitation rate was very low (43% of normal). At the end of the month the river ice thickness in the eastern part of the country had reached 50 - 70 cm (150 - 200% above normal). In some places, this winter ice thickness was the greatest since records started in 1945.

In Belgium the month was slightly colder than normal and very dry. The precipitation amounts were about half of the long-term average. Sunshine duration was extremely high. At station Uccle 145h 40min of sunshine were registered during the month, which is almost twice of the long-term average and the 2nd highest record since observations started in 1887 (see fig. 2.1). A tornado hit the area of Hasselt on February 3.

In Luxembourg the month was very dry with a precipitation total of about 30% of normal and cool with a temperature anomaly of -1.2°C.

The month was colder than normal and very dry in the Netherlands. Sunshine duration was extraordinarily high; at station De Bilt 158 hours of sunshine were observed, which is about twice as normal and a new record since observation started in 1901 (see fig. 0.6).

In Germany the month was very dry and colder than normal. The monthly mean temperature was -2.1°C below normal and the precipitation rate about 40% of the long-term average. Sunshine duration was extremely high. Snowfall and ice caused many obstructions on roads in western and southern parts of the country from February 2-7; 9 people died in accidents. Railway and air traffic was also affected. In the Alpine area avalanches endangered public and private life. On February 26 freezing rain caused a lot of accidents on the roads in Rhineland-Palatinate.

The month was extremely cold in Poland. Temperature anomalies were from -2.5°C in the west down to -5°C in the south-east and in coastal areas. The country-wide precipitation rate was only 36% of normal. It was the start of a long-lasting period of insufficient precipitation causing a drought until July, especially affecting the western part of the country. Strong wind with gusts up to 100km/h occurred at the beginning of the month.

In Belarus, temperature anomalies were slightly negative (fig. 0.7), while the precipitation total marginally exceeded normal.

While the monthly mean temperatures were near normal or moderately below in France, a severe drought period started for a long duration of 8 months.

The month was very cold and dry in Switzerland. Temperature anomalies varied mostly between -2°C and -4°C. In the lowlands monthly minima of -10°C to

-19°C were recorded. At station La Brévine -35.7°C was measured on February 1. Very little precipitation fell during the month. North of the Alps a dry period lasted from February 7 - 28. In southern Switzerland only 5%-15% of the normal precipitation quantity fell. Nevertheless, enormous snow depths – up to 80cm – were registered in low regions of eastern Switzerland. Additionally, it was the second to fourth sunniest February in the Alps since 1901.

The monthly mean temperatures in Italy were below normal everywhere. In some southern parts of the country the mean daily minimum temperatures even surpassed three times the standard deviation (see fig. 2.2). The monthly precipitation rates had a very strong gradient from north to south (1% of normal at station Verona and >100% in Sicily).

The month was cold in Austria with temperature anomalies between -1°C and -4°C. It was very dry all over the country, especially in the east, where less than 25% of the normal precipitation rate was registered. In Vienna the monthly precipitation was only 1 mm, the former dryness record for February being 3mm in 1890.

The month was rather cold and extremely dry in Czech Republic. It was also the beginning of a long lasting period of dry conditions until the end of September.

It was the beginning of an excessive dry period in Slovakia lasting until August. Sunshine duration was measured between 130% and 209% of normal.

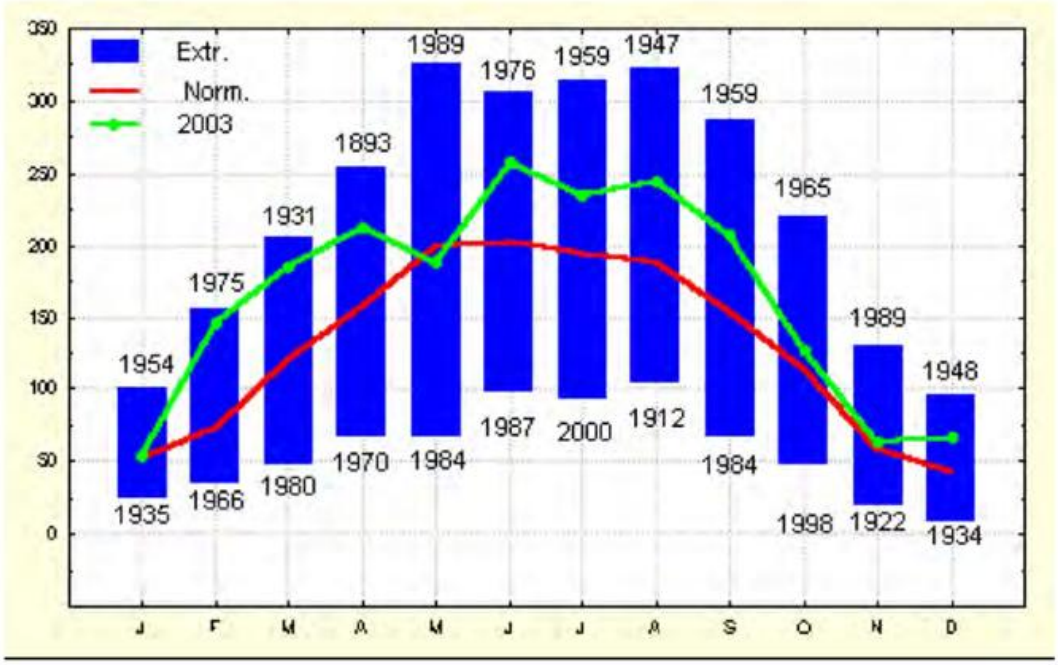


Fig 2.1: *Sunshine duration at station Uccle monthly sums of the year 2003, the reference period 1887 - 1988 and extreme values since 1887 From: Institut Royal Météorologique de Belgique*

Temperature anomalies in Slovenia were significantly below normal down to deviations of -5°C in some places. Most of the precipitation fell during February 4-5. The second third of February was quite dry and the last third completely dry. Sunshine duration everywhere exceeded normal by at least 20%. Near the coast sun was shining 232 hours, which is 93% above normal. A snow cover, although not being very deep, persisted over the whole month.

In Croatia it was very cold and dry. The monthly mean temperature anomaly was below -3°C and the precipitation rate about 50% of normal.

The month was extremely cold in Hungary with a temperature anomaly of -5.2°C (see fig. 2.3). Heavy snowfalls occurred in the whole country except of the most western parts. As a consequence, 45 settlements with 35000 people became isolated due to the snow. With the end of these snowfalls in the first half of the month a long lasting drought period started (see fig. 3.3).

It was extremely cold and rather dry in Romania. The monthly mean temperature was -4.4°C below normal and the precipitation deficit nearly 30% compared to the long-term average. It was the start of a series of relatively dry months until June inclusively.

It was the coldest month of the year in the Ukraine with temperature anomalies from -2°C to -4°C generally and locally even down to -9°C. The absolute minimum of air temperature was recorded as -34°C.

The month was extraordinarily cold and dry in Bosnia and Herzegovina. Temperature anomalies were below -4°C and the precipitation total about half of normal.

The month was very cold in Serbia and Montenegro with a great number of freezing days with ice and snow cover. The daily minimum temperatures in Belgrade were always below normal (fig. 2.4).

It was the coldest month in Albania since the beginning of observations with temperature anomalies down to -5.5°C.

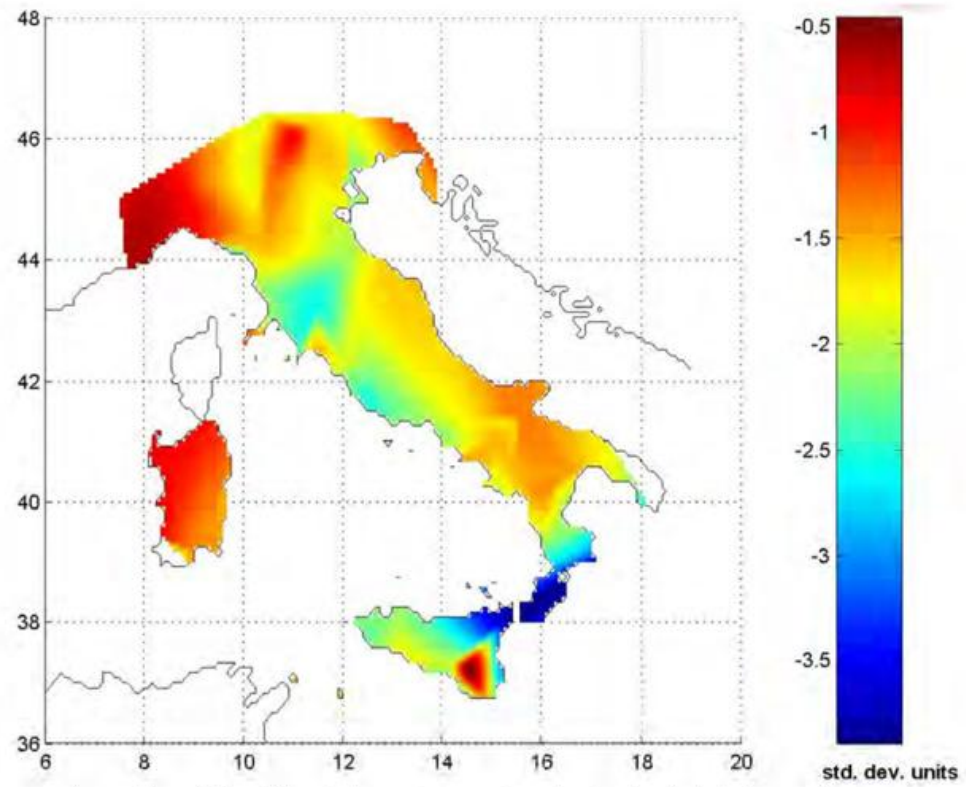


Fig 2.2: *Anomalies of the daily minimum temperature in standard deviation units*
From: Ufficio Generale per la Meteorologia, Italy

The month was extremely cold and very dry in The Former Yugoslav Rebublic Of Macedonia. Temperature anomalies varied from -3.0°C down to -5.2°C (see fig. 2.5). Precipitation rates were about 50% of normal (e.g. see fig. 1.4).

The month was extremely cold and significantly dry in Bulgaria. Temperature anomalies were below -4°C and the

precipitation totals about 20% less than the multi-annual averages. There were 20 ice days (i.e., the daily maximum air temperature is below 0°C) in the northern part of the country and about 4-7 ice days in the south. Snow fall and strong winds on February 1-2 caused snowdrifts amounting up to 1.5m mainly in the eastern regions of the country. Many roads were closed, 44 villages were without electricity and 4 people died. The harbours and airports of Varna and Burgas were closed.

Heavy showers and thunderstorms affected the western part of Greece on February 5 leading to local floods around Epiros with destructive consequences to roads and agriculture and the loss of one life. Heavy showers and thunderstorms again, this time mainly in Cyclades on February 17-18, led to floods with landslides and destruction of roads and plantations. Extreme 24h rainfall amounts were measured in Mykonos (89.8mm) and Paros (121.4mm); both records exceeded by far the mean monthly precipitation sums of 59.8mm and 49.0mm respectively.

In Turkey the monthly mean temperatures were well below normal in most places. The country wide precipitation total exceeded normal by approximately 60%. Strong winds affected the south-western coast on February 2; station Dalaman was damaged by a water spout. Stormy weather in the western

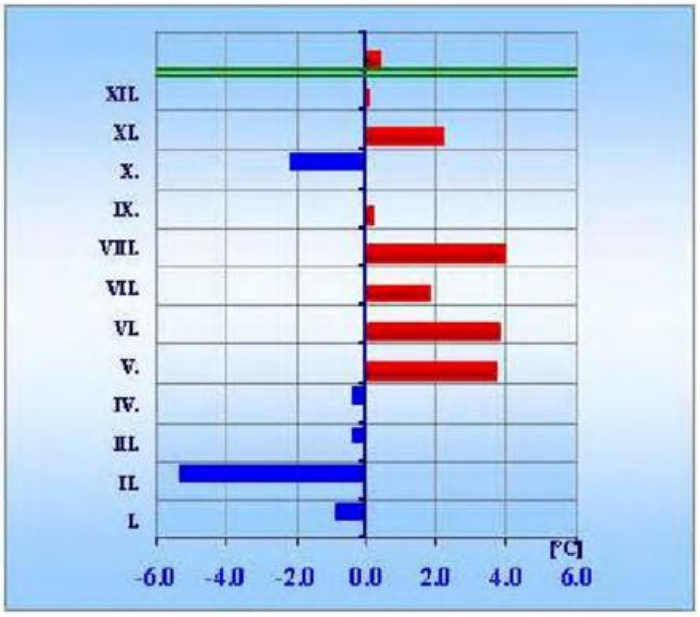


Fig 2.3: *Anomaly of the countrywide monthly mean temperatures 2003 (°C) in Hungary*
From: Hungarian Meteorological Institute

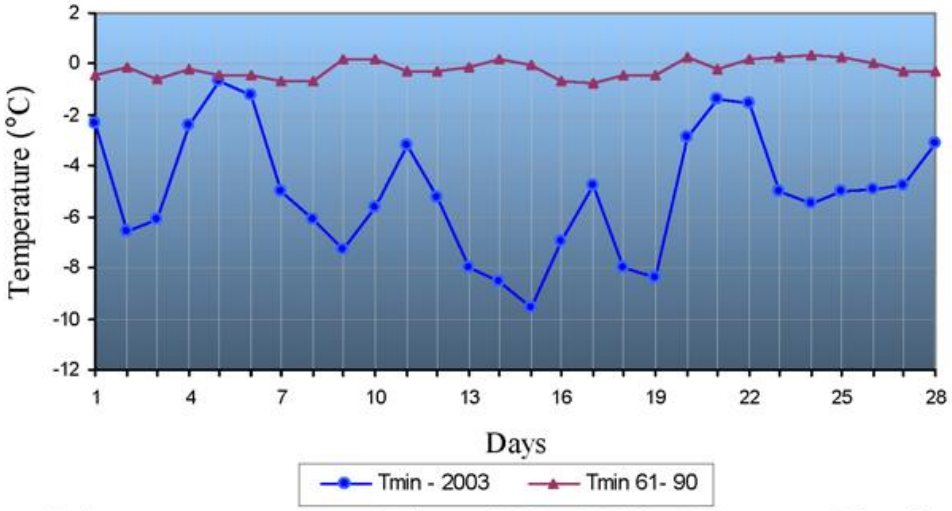


Fig 2.4: *Daily minimum temperature in February 2003 and 1961 - 1990 means in Belgrade*
From: Republic Hydrometeorological Service of Serbia and Montenegro

part of the country caused a lot of damage on February 5; the seaways into the Bosporus and Izmir harbour were stopped. A snow storm on February 18 was the reason for the death of some people in traffic accidents and the subsequent breakdown of public transport in the main roads of Istanbul. An avalanche caused the death of some people and livestock and the collapse of houses in Elazig on February 24.

The month was rather cool and wet in Cyprus. Heavy rains combined with local hailstorms occurred all over the island on February 12. Cars were carried away by floods and one car driver was drowned in the area of Nicosia. Heavy snowfall occurred in the Troodos area on February 24-25 cutting off some villages from the road network. Snowfall occurred also in areas with lower elevation, including Nicosia in the central plain and Pafos on the west coast.

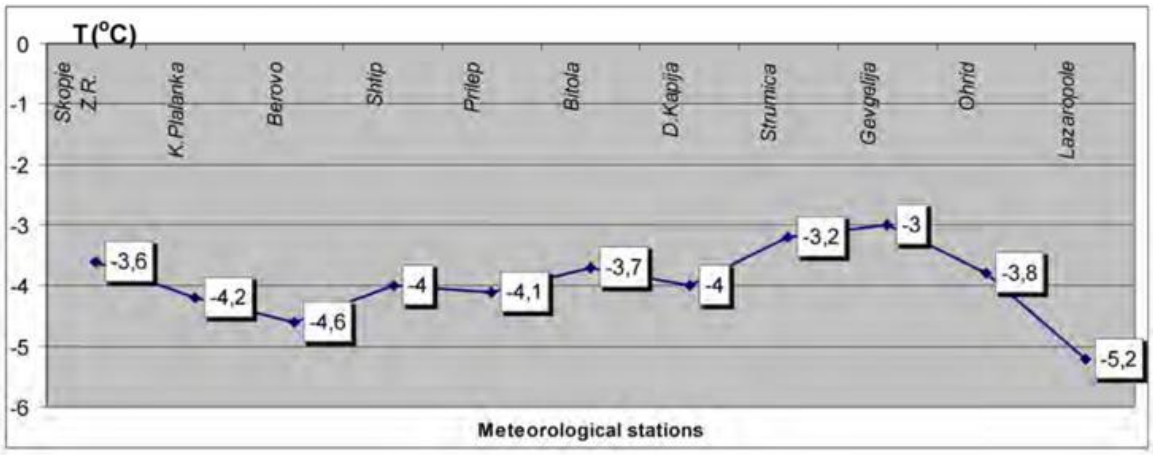


Fig 2.5: *Anomalies of the air temperature in February 2003, Macedonia*
Reference period is February 1961 - 1990
From: Hydrometeorological Service of Republic Macedonia

The month was cool and very rainy in Israel. In the northern and central parts of the country rainfall amounts were 150-300mm and thus 200%-350% of normal. It was one of the two rainiest months since the beginning of measurements at many

stations. These large precipitation amounts resulted in flooding of agricultural areas and in road closures. Most stations in the northern and central parts of the country recorded 22-23 rain days, which is 2-3 times as normal. The most significant rain period was from February 18-28 with 11 successive rain days. This period was very cold with temperatures of 3°C to 5°C below average. On February 24-26 large amounts of snow were recorded in the mountains. The heaviest snowfall occurred in the central mountains causing many road closures. In Jerusalem 25cm of snow were recorded. Snow continued to cover the ground for almost one week.

A snowstorm affected Jordan on February 24-26 (see fig. 2.6). Snow accumulated over most parts of the country with elevations above 600m. Snow depth at station Ras Muneef in the northern region was 90cm, while it was between 5cm and 70cm in the other regions. The snowstorm caused a temporary power outage in Amman and other cities. A lot of damage occurred to agriculture and forestry. It was the 2nd wettest month along the record in most parts of the country with monthly precipitation rates of 200%-350% of normal. Station Salt in the central region recorded the extreme 24h rainfall amount of 145mm on February 25.

The first decade of the month was very warm in Armenia. The precipitation total all over the country exceeded normal by 20%. Only 6 days of the month were without precipitation. Snowfall occurred country wide and continuously from February 19–22. In Yerevan 133% of the monthly normal precipitation amount fell within 62 hours.



Fig 2.6:

Snowstorm near Amman on February 24 - 26
From: Jordanian Meteorological Department

March 2003

- **Much more warmer than usual in western and northern Europe, extremely mild in north Scandinavia**
- **Very cold around the Black Sea**
- **Extremely dry in the British Isles, around the Baltic Sea as well as in central Europe, Italy and most parts of the Balkans**
- **Very wet in Gibraltar, Malta and the islands and coastal areas of the south-eastern Mediterranean**

In Iceland the month was very mild everywhere with heavy precipitation in the southern part of the country.

The monthly mean temperature of 6.8°C at station Kirkja in the Faroe Islands was record breaking high since the observations started in 1873.

In Ireland the month was moderately warmer than usual with a total precipitation well below normal.

The monthly mean temperature all over the U.K. was 2.0°C above normal. The temperature at Altnaharra (Scotland) rose from -9°C to +18°C on March 17, the greatest diurnal rise in temperature for Scotland in March. The country-wide precipitation rate was 59% of normal. The month was very sunny across all parts of the country with many station records broken. The overall long-term average of sunshine duration was exceeded by 57%. Northern Ireland, Scotland and England&Wales also experienced their sunniest March in the 1961-2003 series.

In Norway the month was warmer than normal in the whole country and especially in the inner part of Finnmark. Coastal areas in Troms and Finnmark received 300%-500% of the monthly normal precipitation. The station Nordreisa-Øyeng in Troms recorded 169mm (483% of normal), which is the highest sum for March at this station since measurements started in 1895. The highest daily precipitation amount for the whole year (107.8mm) was measured at station Mandal in the southern part of the country on March 6.

In Sweden the monthly mean temperature was above normal everywhere with a strong gradient from south to north. An anomaly of +5.3°C was registered at station Haparanda. Precipitation was below normal nearly all over the country.

The month was warmer than normal practically in whole Finland with the largest positive deviations of >4°C from the long-term mean in the north-western part of the country. Most parts of southern and central Finland had precipitation less than normal. The monthly precipitation in the south-west was less than 25% of its reference value.

In Estonia the weather conditions were relatively mild and extremely dry.

The weather in Latvia was rather mild and extremely dry. The area of ice coverage of the Baltic Sea was at its maximum of 232,000km² on March 5 (fig.3.1).

In the Netherlands temperature anomalies were about +2°C and the precipitation rates near half of normal. Station De Bilt recorded 199h of sunshine, which is the maximum since observations started in 1901 (see fig. 0.6).

In Belgium the monthly mean temperatures were about +3°C above normal, whereas precipitation had a deficit of about 35%. Sunshine duration at station

Uccle exceeded the very long-term average of 120 h (reference period 1887-1988) by 55% (see fig. 2.1).

In Luxembourg the weather was mild and dry. Temperature anomalies were > 3°C and the precipitation deficit was $^1/_3$ of the normal amount.

The month was rather mild, dry and very sunny in Germany. The overall monthly mean temperature anomaly was +1.8°C and the precipitation rate merely 50% of normal. A local tornado damaged houses and garden sheds near the city of Ulm on March 2-3. Freezing rain caused 410 accidents with cars in Berlin in the morning of March 3.

The monthly mean temperature in Poland was slightly below normal. The weather was variable with the first decade as the coldest period of the month; the warmest was at the end of the month with maximum temperatures >20°C in the south-western part of the country on March 27. Precipitation was rather low. The monthly total was merely 60% of normal and varied between 25% in the north and north-east and 75% in the south.

The weather in Lithuania was changeable. The first ten days as well as March 21-22 were the coldest with little precipitation. The lowest temperature had been falling down to -17°C. In spite of this the mean monthly air temperature was plus 0.5°C with a +1°C anomaly. The monthly amount of precipitation varied from 3mm to 20mm, which means 6% - 55% of normal. The snow cover melted by the middle of the month. The sunshine duration amounted to 150 - 200 hours (45 - 70 h above normal). Ground freeze was deepest in the beginning of the month, gradually thawing by 20 - 40cm from the surface while remaining deep to 80cm at some places.

Drought conditions in France continued all over the month with positive temperature anomalies up to >3°C and precipitation rates below 50% of normal in most parts of the country.

In Switzerland the month was very mild with temperature anomalies between +2.5°C and +3.5°C. It was also very dry. The precipitation rate in the western part of the country was 20%-30% of normal, in the south and south-east 0%-10%. In the lowlands north of the Alps the relative humidity of the air was 60%-65%, thus the lowest monthly average for March since records started in 1901. It was the sunniest March since 1953 with more than 200 hours of sunshine in large areas. In the Alps it was the second sunniest March with respect to the period 1901-2003.

The month was relatively warm and dry in Austria with less than 25 percent of normal precipitation amounts in the southern parts of the country.

In Slovenia the monthly mean air temperature was above normal with anomalies up to +2.5°C. Extremely dry weather persisted during the month. Less than 20% of normal precipitation was observed, half of the territory got less than 5% of normal. Sunshine duration exceeded the long term average for at least 30% everywhere in the country.

In Croatia the month was clearly warmer than normal and extremely dry. The precipitation deficit at station Zagreb was 86% (see fig. 3.2).

In Hungary it was extremely dry, while the monthly mean temperature was slightly below normal (figs. 2.3 and 3.3).

The month was cool and dry in Moldova with temperature anomalies of about -2°C and precipitation rates of 35% from normal.

The month in Portugal was characterised by mean maximum and minimum temperatures well above normal. Significant positive anomalies of the daily minimum air temperature were recorded during almost all the month and for all stations, for example in Oporto and in Faro there were many days with anomalies between +5°C and +6°C. The anomalies of daily maximum air temperature, especially in the northern and central regions were from +8° to +10°C. The monthly precipitation amounts were close to normal almost all over the country.

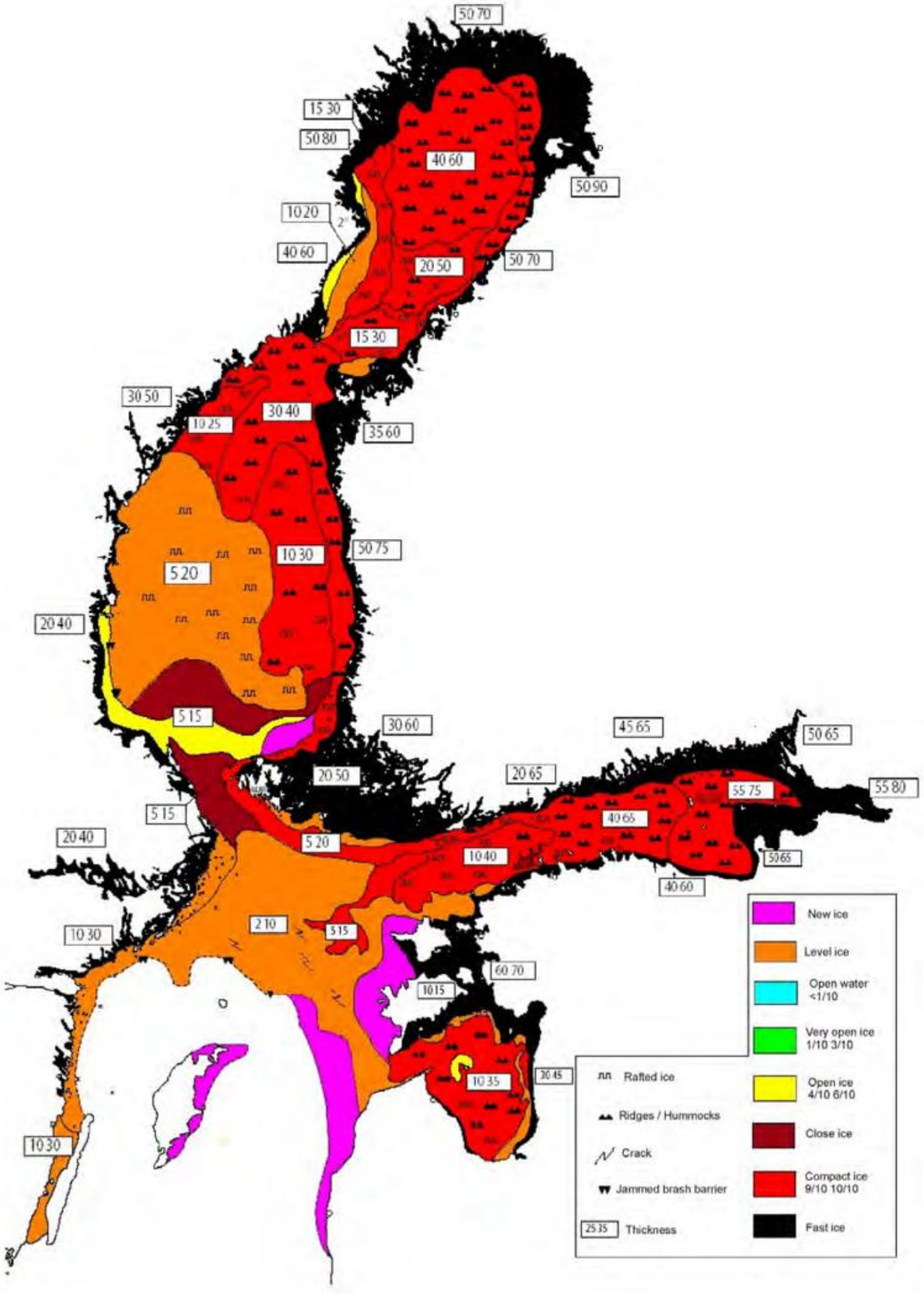


Fig 3.1: *The area of ice coverage of the Baltic Sea at its maximum, year 2003*
From: Latvian Environmental, Geological and Meteorological Agency

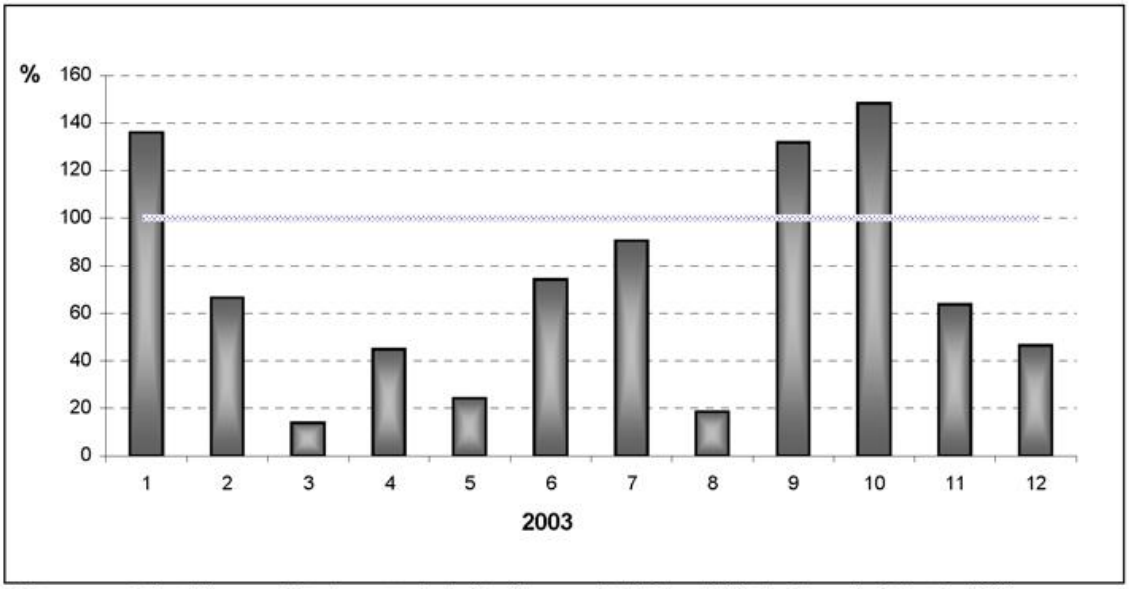


Fig 3.2: *Monthly precipitation totals in % of normal (1961 - 1990) in Zagreb Gric, in 2003*
From: Meteorological and Hydrological Service, Croatia

Temperature anomalies in Spain were generally positive and centered in the north-west with maxima of >2.5°C. Precipitation was unevenly distributed over the peninsula. Except for a zonal belt including Madrid, precipitation amounts were below normal.

Gibraltar received 148mm of precipitation during the month, which is nearly twice normal.

While temperatures were close to normal in Bosnia and Herzegovina, precipitation had an enormous deficit of about 80% of normal.

In Serbia and Montenegro temperature anomalies were mostly negative, but close to normal everywhere. Precipitation amounts were extremely low in the whole country; the deficit varied from about 60% to more than 95% (see fig. 3.4). In mountainous areas a snow cover remained during the whole month.

It was the driest of all months since the beginning of observations in Albania.

In The Former Yugoslav Rebublic Of Macedonia the month was moderately cool and extremely dry with nearly no precipitation.

The month was rather cold and extremely dry in Bulgaria. Temperature anomalies were about -2°C. In the north of the country the precipitation rate was 25% and in the south only 3% of normal (fig. 3.6). There were 40-60 hours more sunshine during the month than usual (fig. 1.5). Fog was observed all over the country on March 1-4 and 10-11.



Fig 3.3:

Monthly precipitation average (%) in 2003 (green boxes) compared to the reference period (red line) in Hungary
From: Hungarian Meteorological Institute

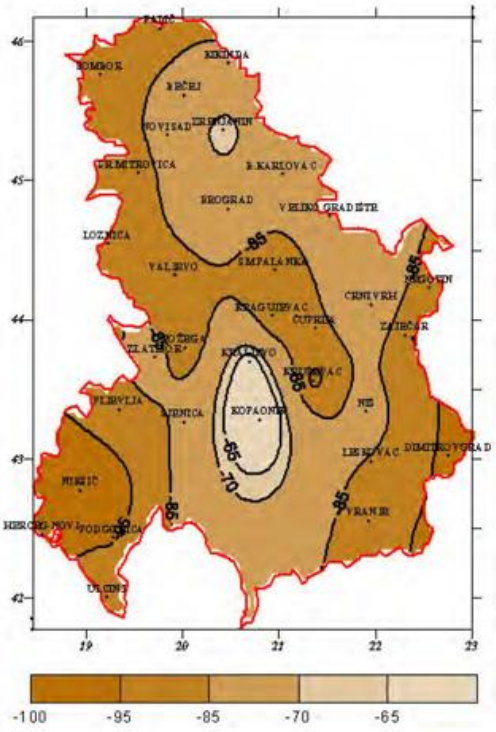


Fig 3.4:

Precipitation amounts deficit (%) distribution in March 2003
From: Republic Hydrometeorological Service of Serbia

In Greece the weather was cooler than normal everywhere and very dry on the mainland. Station Heraklion in Crete had a precipitation rate of 166% compared to normal. Strong north-easterly winds of 75-100km/h prevailed on March 16-17 over the western and southern part of the country and caused the destruction of house shelters and agricultural infrastructure in Peloponnesus and particularly in the city of Kalamata, from where maximum gusts up to 141km/h are recorded. Station Kythira measured a maximum wind force of 133km/h and Athens 93km/h.

In Turkey the monthly mean temperatures were significantly below normal with anomalies down to -3°C. Precipitation amounts were unevenly distributed over the country with dryness in the north-western parts and precipitation rates exceeding normal in the southern and eastern areas. During a storm event 3 minarets were destroyed in Yalvac/Isparta on March 25. On the same and the next day again stormy weather caused a lot of damage in some places at the southern coast.

In Cyprus the month was relatively cool and very wet. The monthly mean air temperature was 1.5°C below normal and the precipitation total exceeded the long-term average by 55%. In the areas west and south of Nicosia hailstorms caused damage to houses and agricultural plantations on March 11; hailstones had a diameter of 1 cm and accumulated to a height of 15cm in some places. Thunderstorms combined with hail and snowfall in the mountains occurred on March 18 in various areas of the island.

The month was cool and very rainy in Israel. Precipitation amounts were 150%-250% of normal. In the north it was the rainiest March in the last 30-40 years (fig.3.6). Most of the rainfall occurred in the period of March 18-26. In the northern and central parts of the country 150-250mm were recorded. March 25 was one of the coldest days in the past 3-4 months, with significant amounts of snow in the northern mountains at an altitude above 1000m. Severe hail and lightening activity occurred on March 24-25 causing some power failures.

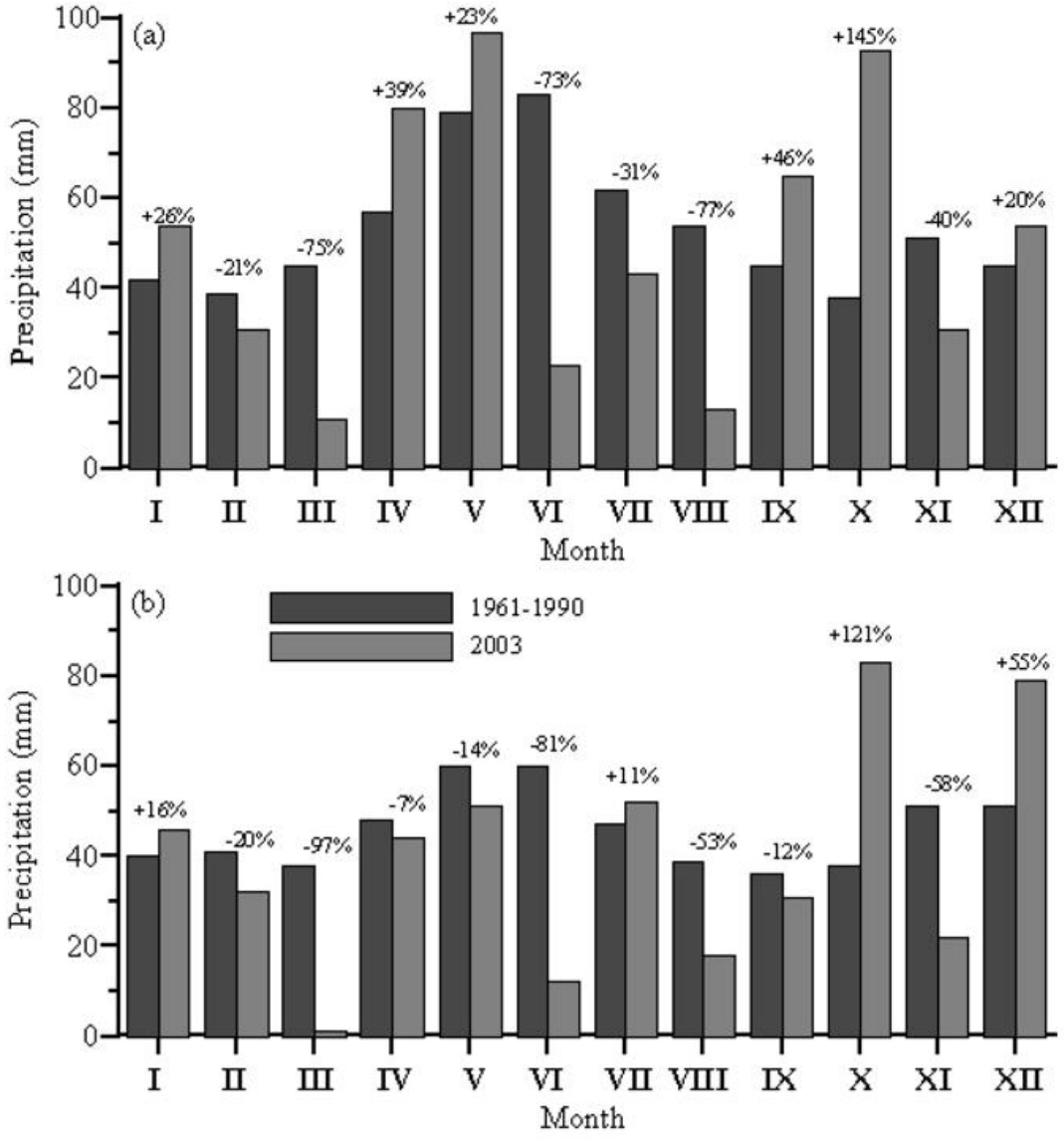


Fig 3.5: *Monthly precipitation in north Bulgaria (a) and south Bulgaria (b) in 2003 and departures (in %) relative to normal (1961 - 1990)*
From: National Institute of Meteorology and Hydrology, Bulgaria

The month was cold and wet in Armenia. Temperature anomalies were between -2°C and -3°C and the amount of precipitation exceeded normal significantly (see fig. 3.7). Most extreme weather conditions like snowfall, blizzards, strong winds and low visibility were observed within March 19-26. Continuous snowfall during 9 hours led to a snow cover of 91cm in Aparan on March 19. A blizzard occurred on March 26 in Jemuk and lasted for more than 20 hours producing a snow cover of 118cm. At the end of the month, advection of cold air masses from the north made temperatures fall down to -18°C ... -25°C in hilly and mountainous regions.

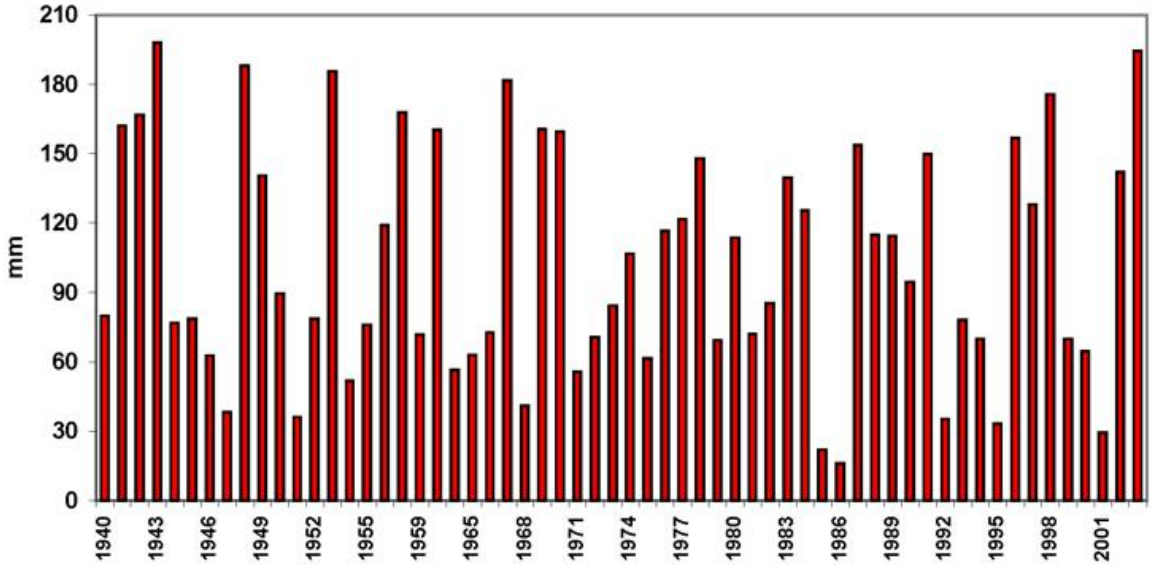


Fig 3.6: *Rainfall amounts in Har Kenaan in March 1940 - 2003*
From: Meteorological Service Israel

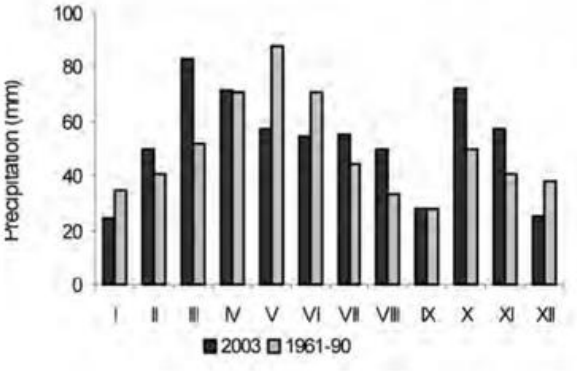


Fig 3.7:

Monthly precipitation totals in 2003 compared with 1961 - 1990
From: Hydrometeorological Instiute, Armenia

April 2003

- **Very dry in most parts of central Europe and in northern Scandinavia**
- **Very mild in south-eastern Greenland, Iceland , Norway, the British Isles and France**
- **Very cold around the Bosporus**

It was the second warmest April on record in Iceland, 1974 being somewhat warmer. It was also dry in most regions except of the south-west. A new absolute temperature record for the month, namely

21.4°C, was reached at Hallormsstaður in the eastern inland on April 19.

Record breaking high temperatures were registered at different places in the Faroe Islands. The monthly mean temperature of 7.7°C at station Kirkja on the island Fugloy equals the record of station Sandur on Sandoy from 1974. The maximum temperature 19°C was measured on April 17 on Fugloy.

Southerly winds brought extremely high temperatures inland to the U.K., with Wolverhampton reaching 27.3°C on April 16. This was the highest April temperature in the UK since 16th April 1949. Records were broken in many places. April 16 brought the highest maximum temperature on record in the 1878-2003 Central England series (fig. 4.1). A heat wave also occurred in Scotland from April 15-18 as the anticyclone over Scandinavia returned westward giving warm southerly winds. It was sunny everywhere, and the temperature reached 26.9°C at Lochcarron on the 17th, a new record April temperature for Scotland (the previous highest being 26.7°C at Dollar in 1870). Over Northern Ireland, April 16-17 were very warm days everywhere with day-time temperatures recording values around 10°C above the average for this time of year. Indeed some areas broke their highest temperature record for April on the 17th. 22.8°C was recorded in the north at Portrush on April 17. Both Scotland and Northern Ireland had their warmest April in the areal series back to 1961.

In Norway the month was warmer than normal in the whole country, especially in the western part. The Easter Days were very warm in the southern part of the country with fair weather. The western part was very dry, receiving only 25-50% of the normal precipitation amount. Svinøy Lighthouse outside mid-Norway received only 8.1mm, which is the lowest sum for April ever measured at this station since observations started in 1955.

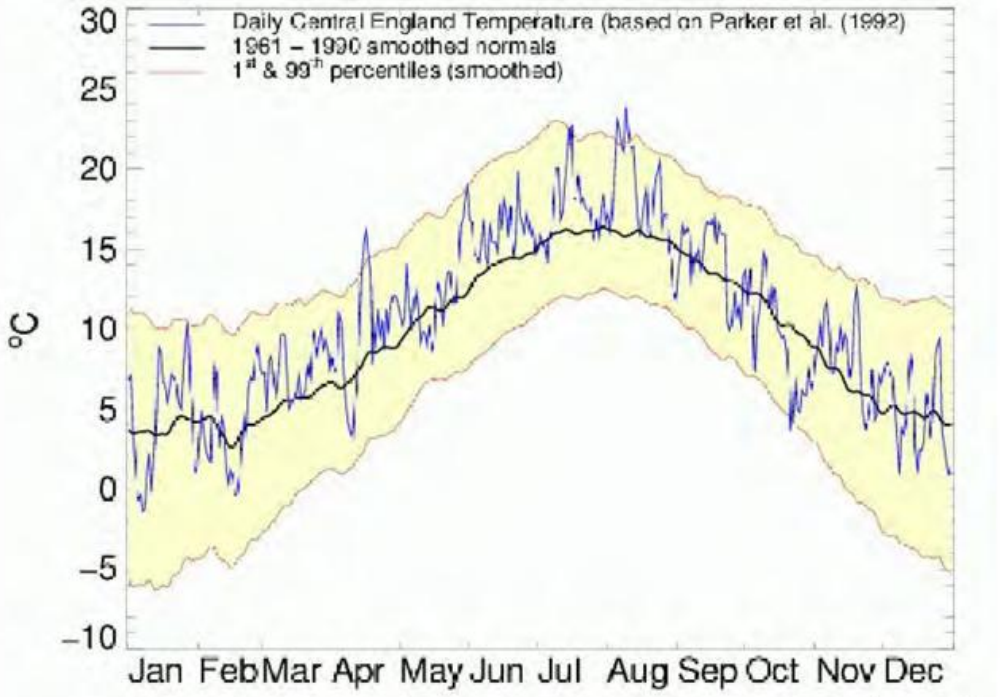


Fig 4.1: *Daily Central England temperature (°C) for 2003, normal 1961-1990 and 1st and 99st percentiles for each day of the year*
From: Met Office, U.K.

In Denmark, the month was warmer and had more sunshine compared to the long-term averages. It was also very dry with about half of the normal precipitation. The phenological phase leafing of the beech

was observed, which is rather new to the country in this month.

The Azores Islands were affected by lows which caused heavy rainfall and winds with very strong gusts. Particularly on April 11-12, strong winds with gusts exceeding 130km/h over all islands and up to 159km/h in S. Jorge, associated with a heavy swell of more than 12m, caused damage estimated at €1.7 million in 1,545 farms (especially in gardening, vine, beet and tobacco) and €187,000 in power supply. Scheduled flights were suspended.

The month was warmer than on the long-term average and extremely rainy in the mainland of Portugal. The precipitation amounts were well above normal in almost all territory, especially in the coastal northern, the central interior and the southern regions and also in the Lisbon area.

Temperature anomalies in Belgium were clearly positive, while the precipitation total had a deficit of more than 10%. Sunshine duration was extremely high; at station Uccle it was 212h and thus exceeded the long-term average by 34%. Heavy rains and strong winds caused flooding over dry ground in the northern part of the country on April 26.

In Germany the country-wide monthly mean temperature was about 1°C above normal, while the total precipitation reached only $^2/_3$ of the long-term average. Freezing rain and snowfall in the early morning of April 7 caused a lot of accidents and obstructions on roads in eastern and southern parts of the country. Heavy rains engendered flooding of streets and houses near the city of Aachen on April 26.

The monthly mean temperature in Poland was close to normal, but the field of anomalies had a clear gradient rising from south-east to north-west. The first two decades were very cold with negative minimum temperatures almost over the whole country. Temperatures gradually rose in the second half of the month with maximum temperatures exceeding 28°C in some parts of the country. Precipitation was still insufficient in a large area with 30% of normal in the west. Snow fell in the first half of the month and snow cover achieved depths of 30cm in the east.

In Lithuania the first ten-day period of the month was the coldest since 1965 with an anomaly of -3.8°C. It caused a snow cover of 10-19cm depth at some places. Frozen ground thawed by mid-April; very active and changeable synoptic processes determined unsteady and chilly weather. The mean monthly air temperature was 4.9°C, which equals an anomaly of -0.5°C. The monthly amount of precipitation was 38mm and thus close to normal in most places and up to 1.5 times normal at the seaside.

In Latvia the monthly anomalies were moderate. The mean temperature was -0.9°C below the reference and the precipitation rate 118% of normal.

In the first half of the month cold air characterised the weather conditions in Switzerland. Temperatures dropped to -8°C in the lowlands. Station Davos recorded -14.7°C; only April 1913 was even colder since the year 1901. A snow cover up to 10cm formed in the lowlands from April 9-11. In large areas significant precipitation deficiencies occurred, particularly on the southern slope of the Alps.

It was extremely cold in Austria during the first days of the month. At the station Innsbruck in Tyrol, a record minimum temperature of -9.6°C was measured on April 8; the previous record was -6.5°C in 1929. At the end of the month strong south-westerly winds brought very warm air to the area. From the city of Salzburg to eastern Austria new all-time maximum values of temperature occurred, reaching 31°C in Salzburg on April 30. Precipitation again was below 75 percent of normal amounts in large parts of the country.

In Slovenia, the first decade of the month was significantly colder than usual. The rest of the month was warmer than on the average in the reference period and the

monthly mean air temperature was very close to normal. The mountain observatory Kredarica recorded the lowest air temperature of the month, -20.3°C, on April 7. Precipitation showed the typical pattern brought by south-westerly upper level winds. Most of the precipitation fell on the mountain ridges of the Julian Alps. Sunshine duration in the high mountains was slightly below normal, the lowland got more sunny weather than usual. The Goriška region got about one third more sunny weather than on the average in the reference period.

While the monthly mean temperatures in Croatia were close to normal, it was very dry with precipitation totals below 50% of normal.

Extremely high temperatures in Hungary at the end of the month did not prevent the monthly mean from staying slightly below normal (see fig.2.3). The country-wide precipitation total was only 40% of normal; therefore, drought conditions continued.

In Romania the monthly temperature anomalies varied from -1°C to -2°C. The country-wide precipitation total reached 85% of normal.

In Bosnia and Herzegovina the mean monthly temperature was slightly below normal, while the precipitation total was merely 45% of normal.

The weather in Serbia and Montenegro was characterised by extreme temperature variations. During the first decade, absolute minimum temperatures were unusually low. By the end of the month extremely high temperatures were registered. At eight stations in Serbia, records of absolute temperature maxima were broken. The highest temperature recorded from Belgrade was 32.2°C, the previous absolute maximum being 30.9°C in 1926. In Montenegro an absolute maximum temperature of 29.6°C was measured at station Berane. The spatial distribution of precipitation amounts was uneven.

In Macedonia the month was rather cool and dry. Temperature anomalies were about -2°C and precipitation rates clearly below normal.

The month was cold in Bulgaria with temperature anomalies about -2°C. The average monthly minimum air temperature was lower than 5°C, which is not typical for this month. The cool weather limited the crop growth and the development of winter crops. In south-western Bulgaria frost damage from 50% to 100% of the flowers of cherry, peaches and apricot trees was registered. Precipitation in the Danube plain was about 40% above normal; daily precipitation amounts of more than 30mm were measured on April 12-13, e.g. 46mm in Lovech, 52mm in Orjahovo and 56mm in Belogradchik. Long lasting and pouring precipitation during the above-mentioned days caused slips of rock masses which closed the road Sofia-Samokov. There were more than 35 road accidents for a day in Sofia because of intensive precipitation. In the low parts of the country a snow cover with a height of 2-6cm was formed, which is not typical for the season.

The weather in Moldova was cool and dry. The deviation of the monthly mean temperature from normal was about -2°C and the precipitation total amounted to 85% of normal.

The temperature anomalies in Greece were negative all over the country. Precipitation rates had a clear gradient from north-west to south-east; while station Kerkyra received 50% of normal precipitation, Heraklion on Crete registered 200%.

In Turkey the month was generally colder than normal. The overall precipitation total exceeded the long-term average by 50%. Frost and hail damaged beets and flowers of trees at different places during the month.

The month was dry and cooler than normal in Israel. Yet very high temperatures were recorded due to a sharav event on April 4-5. Temperatures reached 38-40°C in the coastal plain and 40-41°C in the Negev. In the last 40 years such temperatures were recorded only once (1979) in the beginning of April. Most of

the rainfall occurred in the second part of the month but they amounted only to 60%-80% of normal.

After a very cold start of the month in Armenia mean daily temperatures rose to +3°C ... +7°C above normal on April 5-6, in valley regions even to +11°C above normal. Maximum temperatures in Sunik and Ararat valleys were up to 29°C. On the same days strong winds with gusts up to 104km/h caused a lot of damage to houses, forests and power lines in Martuni.

May 2003

- **Extremely warm in south-eastern Europe**
- **Extremely dry in the western Iberian Peninsula, the southern Alpine area and around the Black Sea**
- **Very wet in southern and north-eastern Scandinavia**

The first 6 days of the month were very cold in Iceland, with some setbacks for the unusually early vegetative growth. After that the temperature was generally above the average. The monthly temperature average in Reykjavík was almost the same as in April and in Akureyri May was colder than April, the first time since 1979.

The month was very wet in Ireland with precipitation rates exceeding normal by more than 50%, while temperature anomalies were moderately above the long-term average.

In the U.K. the monthly mean temperature was 1.0°C above normal, while precipitation exceeded the monthly reference of 1961-1990 by 37%. Sunshine duration was slightly below normal. During the first week of the month, four depressions moved north-east close to the north-west of Scotland. In the west there were strong winds at times, with a gust of 108 km/h at Barra in the early hours of May 8.

The month was warmer than normal in northern Norway and near normal or below in the middle and the south. A greater part of the country received more precipitation than normal. Some places in the south have not measured more precipitation in this month for the last 50-130 years; e.g. Oksøy Lighthouse measured 184.3mm (267% of normal), which is the highest value observed in May at this station starting in 1870.

The overall monthly mean temperature in Sweden was moderately above normal and the total precipitation exceeded normal clearly. A thunderstorm killed two men when a lightning stroke triggered the explosion of a petrol deposit close to Sala on May 21.

The country-wide monthly mean temperature in Finland was moderately above normal. Precipitation was abundant, so that in some western, central, and north-western parts of the country the monthly precipitation was at least 300% with respect to its reference value.

In Belgium the monthly climate parameters of mean temperature, precipitation and sunshine duration were not far away from their long-term averages. In spite of this, thunderstorms and hail caused considerable damage in different places on May 2 and 30.

In Germany the monthly mean temperature was 2°C above normal. A heat wave affected Bavaria and Saxony on May 5; a maximum temperature of 33°C was

recorded from Leipzig. The overall precipitation total reached 95% of normal, but the spatial distribution was uneven (see fig. 5.1). Three major thunderstorm events in southern and south-western Germany combined with hail, lightning, flooding and local tornadoes caused lots of damage and obstruction on May 8-9 , 19 and 30.

In Denmark the monthly mean temperature was near to the long-term average, while precipitation amounts were about 200% of normal.

It was the month with the highest positive temperature anomaly in Poland (together with November, see fig. 5.2). The spatial distribution of temperature was diverse. At the end of the month, maximum temperatures exceeded 30°C in some parts of the country. Rainfall was generally lower than average. It was mostly accompanied by thunderstorms, so its spatial distribution was very diverse: in the western and central parts precipitation was below normal (even less than 20%) and above normal in the north and south (up to 185%). The most intense rainfall was observed late May with daily sums exceeding 50mm.

In Lithuania the weather was changeable with warm periods in the first half of the month and in the middle of the third ten-day period, but colder else. The monthly mean air temperature was 12.9°C with an anomaly of +1.0°C. Precipitation amounted to 34-65 mm and thus was near normal in most parts of the country while reaching 70-104mm in eastern and some southern areas. The monthly sunshine duration amounted to 270-305h at the seaside, which is 10-40h above normal and to 210-250 h in the other parts of the country (20-40h below normal).

Temperature anomalies were moderately positive in Latvia, while the precipitation rates exceeded normal significantly. The Gulf of Riga was not completely clear of ice until May 4, which is 20 days later than normal.

The month was very warm in Belarus (see fig. 0.7). Precipitation was significantly above normal (fig. 5.3).

Drought conditions continued in France except of the northern parts of the country.

In Portugal the month was moderately warmer than usual and extremely dry in almost all parts of the country. In some stations the monthly totals were the lowest values ever registered in this month.

In Spain a long lasting period of extraordinarily high temperatures started in the middle of the month.

In Italy the month was rather warm and also very dry, especially in the northern and central parts of the country.

The month was very warm in Switzerland. Temperature deviations from normal were 2-3°C in the north and 3-4°C in the south. It was the warmest May south of the Alpine crest since 1868. In large areas significant precipitation deficits arose, particularly on the southern slope of the Alps.

The monthly temperature anomalies in Austria varied from 2°C to 4°C, making May 2003 one of the warmest ever since the beginning of observations. In Vienna the month had been warmer only in 1797 (18.1°C) and 1811 (18.4°C) compared to 17.9°C in 2003.

It was extraordinarily warm and relatively dry in Slovakia. Monthly mean air temperatures were up to +4°C above normal and the highest since 1961. The daily maximum temperatures were also very high, but the extreme values of the year 2000 were not overcome. In mountainous regions the mean monthly minimum air temperature was the highest since 1961.

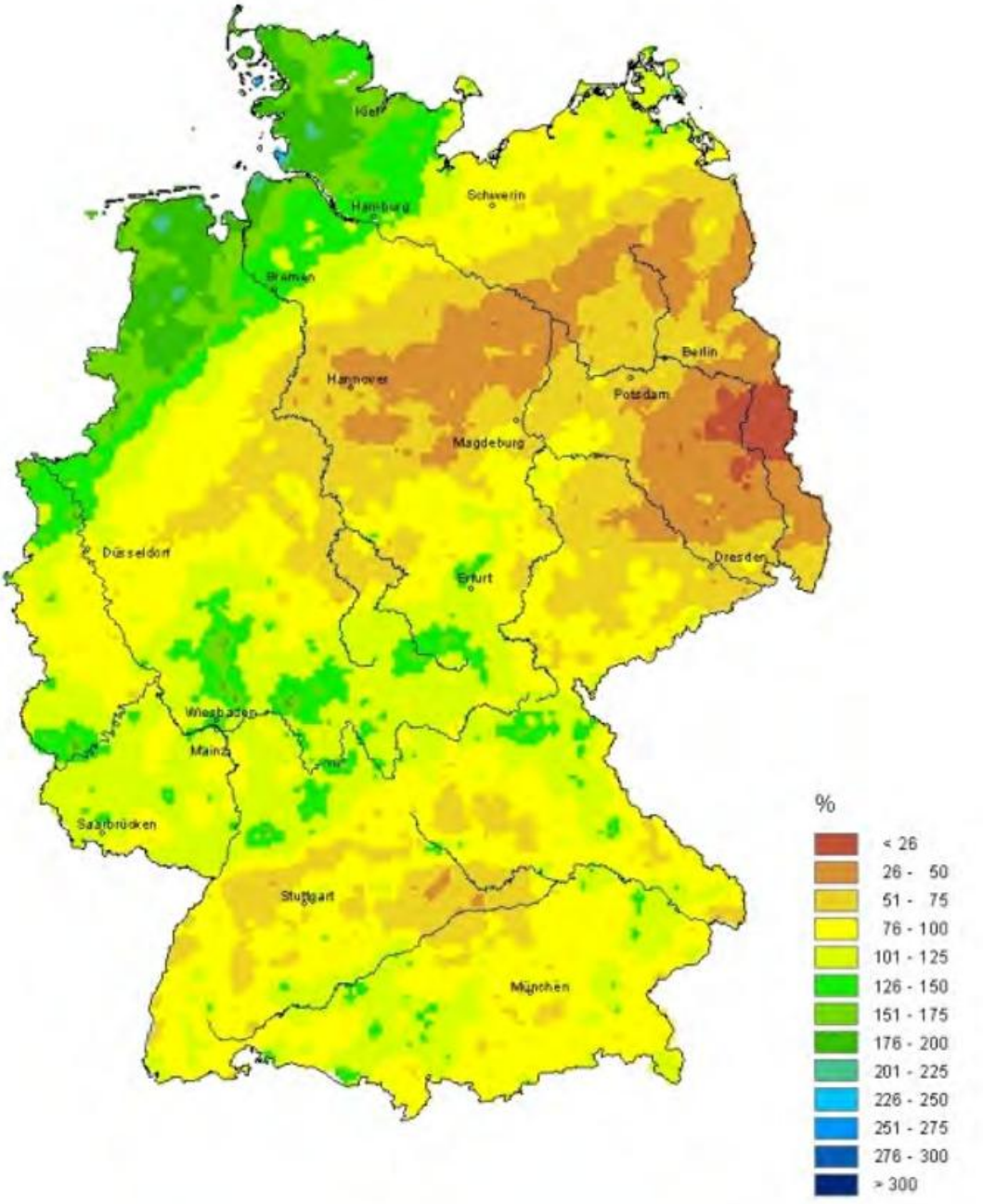


Fig. 5.1: *Precipitation distribution for Germany in % of normal (reference period 1961-1990), May 2003*
From: Deutscher Wetterdienst, Offenbach

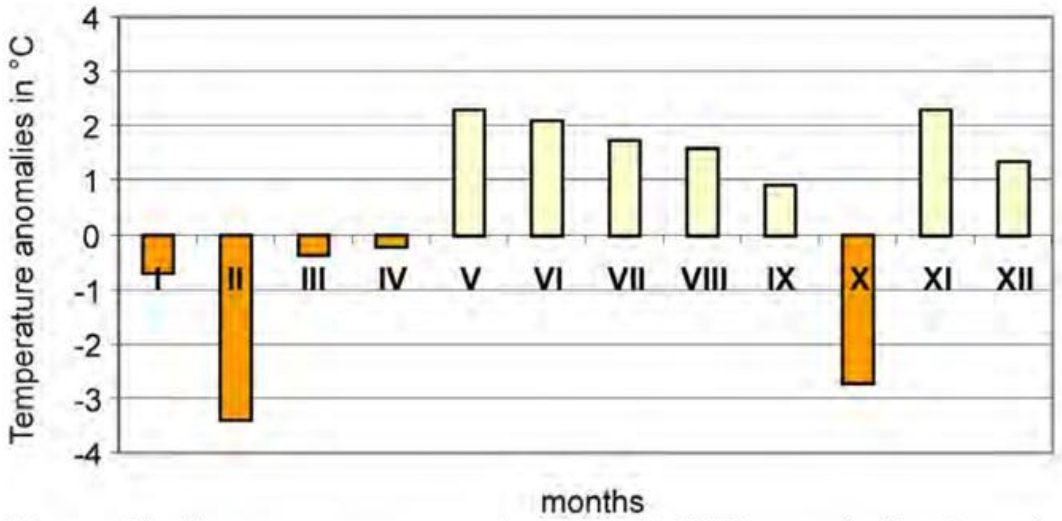


Fig. 5.2: *Monthly mean temperature anomalies in Poland in 2003 (average for 14 stations, reference period 1971-2000)*
From: Institute of Meteorology and Water Management, Poland

The month was extremely warm and very dry in Hungary (see figs. 2.3 and 3.3). The country suffered from a serious drought. The water level of the Danube was very low, only 80cm against 857cm in the same month of the previous year.

In Slovenia, the monthly mean air temperature was well above normal with anomalies up to more than 4°C. It was the warmest May of the last fifty years in Ljubljana and Dolenjska. Lack of precipitation was the other characteristic feature for the whole country. The first third of the month was almost completely dry; the second and last third brought local precipitation with large spatial variability. Sunshine duration exceeded normal everywhere. On the coast 15 % more sunny weather occurred than on the average in the reference period, in the Goriška region even 50% more than usually.

In Croatia the month was extremely hot with temperature anomalies above +4°C. Precipitation was rather low with rates of less than 50% in many places.

In Bosnia and Herzegovina the country-wide temperature anomaly was +3.7°C. The total precipitation reached only 60% of normal.

The month was very hot and dry in Serbia and Montenegro. Temperature anomalies reached +4°C and more. Registered temperatures for almost all stations were the highest in the past 40 years. The number of tropical days was exceptionally high including a ten day series in the first half of the month. Total precipitation amounts were far below the long-term averages in most parts of the country.

The month was very hot in Romania. Temperature anomalies were up to 5°C and more in some areas (see fig. 5.4). It was very dry almost all over the country with precipitation rates of less than 50% of normal in many places.

Moldova experienced an extremely hot and dry month (fig. 5.5). Temperature anomalies exceeded normal from 4.0°C to 5.5°C almost all over the country, which was observed for the first time in the last 100 years. The country-wide precipitation rate was below 20%. These drought conditions caused massive economical damage, especially to agriculture. Additionally, a cold front accompanied by squalls and hail showers affected some areas on May 29; houses and roads were inundated, roofs and power lines destroyed, crops damaged and two people died near Chisinau and in the Ungheni district.

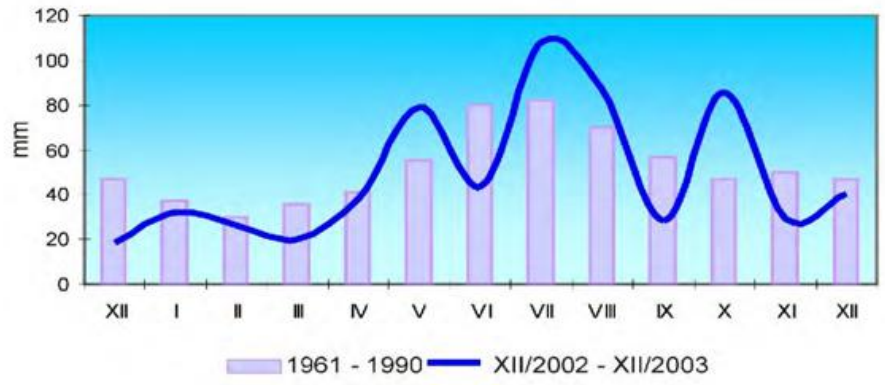


Fig. 5.3: *The monthly precipitation for 2003 and the average long-term precipitation (1961-1990) of Belarus*
From: Hydrometeorological Centre of the Republic of Belarus

In Ukraine the month was very hot and dry. Temperature deviations from normal ranged between +3.5°C and +4.7°C. The drought, that started in most parts of the country one month before, continued.

Albania experienced the start of an unprecedented heat wave lasting until August (see fig. 1.3). In this month of May a maximum anomaly of +7°C was registered in the mountain zones.

The month was very warm in Bulgaria with temperature anomalies ranging from +2.2°C in the south to +3.0°C in the north of the country. In 20-25 days the maximum air temperatures were higher than +25°C. The country-wide precipitation total was near to normal, but in the north precipitation was 23% higher than the long-term average and in the south 14% below. Extreme daily rainfalls above 30mm were registered between May 21 and 31 at different places. In the Rhodope mountains heavy rains activated landslides on May 29. Hailstorms were observed on 11 days of the month.

Temperature anomalies in Greece were clearly above normal everywhere, while precipitation was distributed unequally. Heavy showers and thunderstorms occurred during the period of May 29-30 affecting the southern part of the country, mainly Cyclades and Crete. Station Ierapetra recorded a daily rainfall amount of 113.4mm on May 29, whereas the long-term average is 21.9mm. These storms led to floods with destructive results to roads and agriculture; one person died.

In Turkey the month was clearly warmer than normal. Except for the south-western coastal area precipitation was in deficit. Drought affected agricultural sites especially in the area of Tekirdag in the second half of the month. A hailstorm damaged fruit trees and crops near Bursa on May 24. Heavy rains caused flooding of roads, bridges and crops in coastal areas near Iskenderun on May 31; two people drowned.

The month was very much warmer than usual in Cyprus with a temperature anomaly of +3.1°C. The total precipitation was only $^1/_3$ of normal. Dense fog occurred on May 20 with visibility reduced to 200m. After two days with dust, thunderstorms combined with heavy rains and hail engendered floods in the area of Nicosia causing damage to premises.

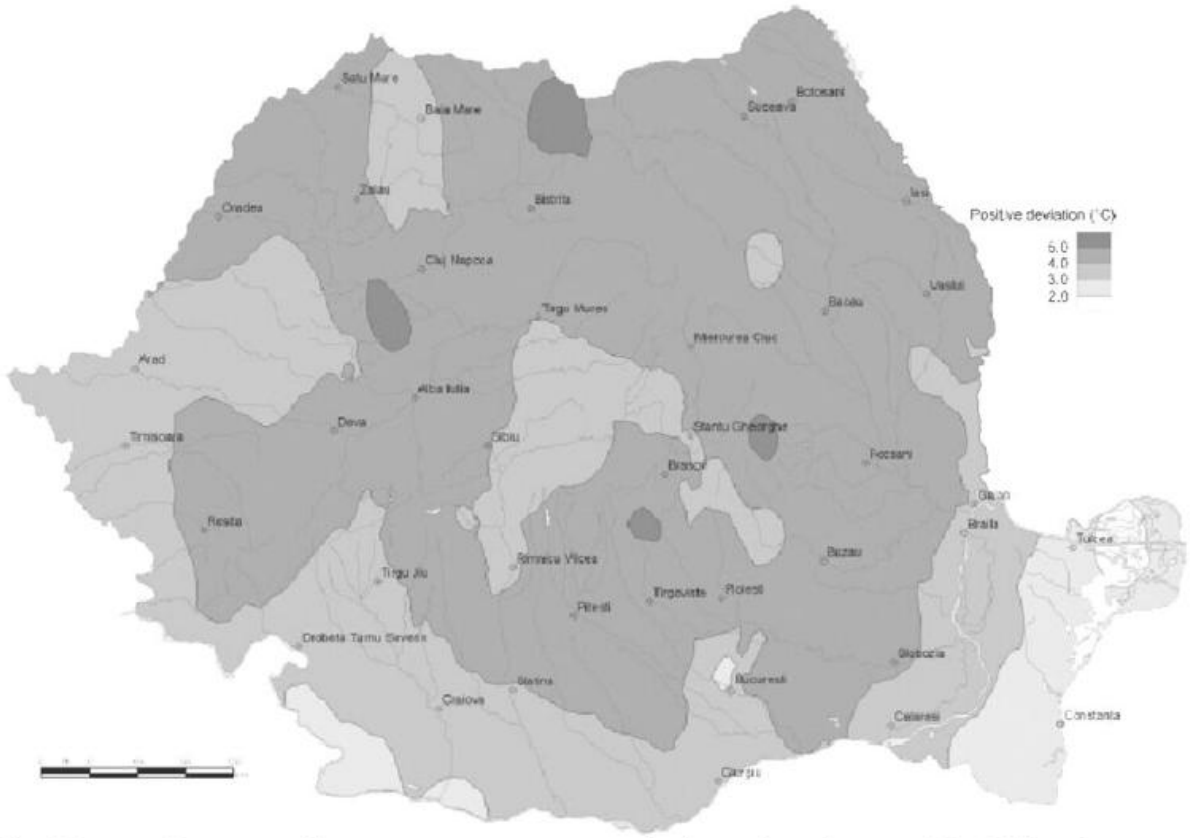


Fig. 5.4: *Deviation of the mean temperature against the climatological norm in May 2003, in Romania*
From: National Institute of Meteorology and Hydrology

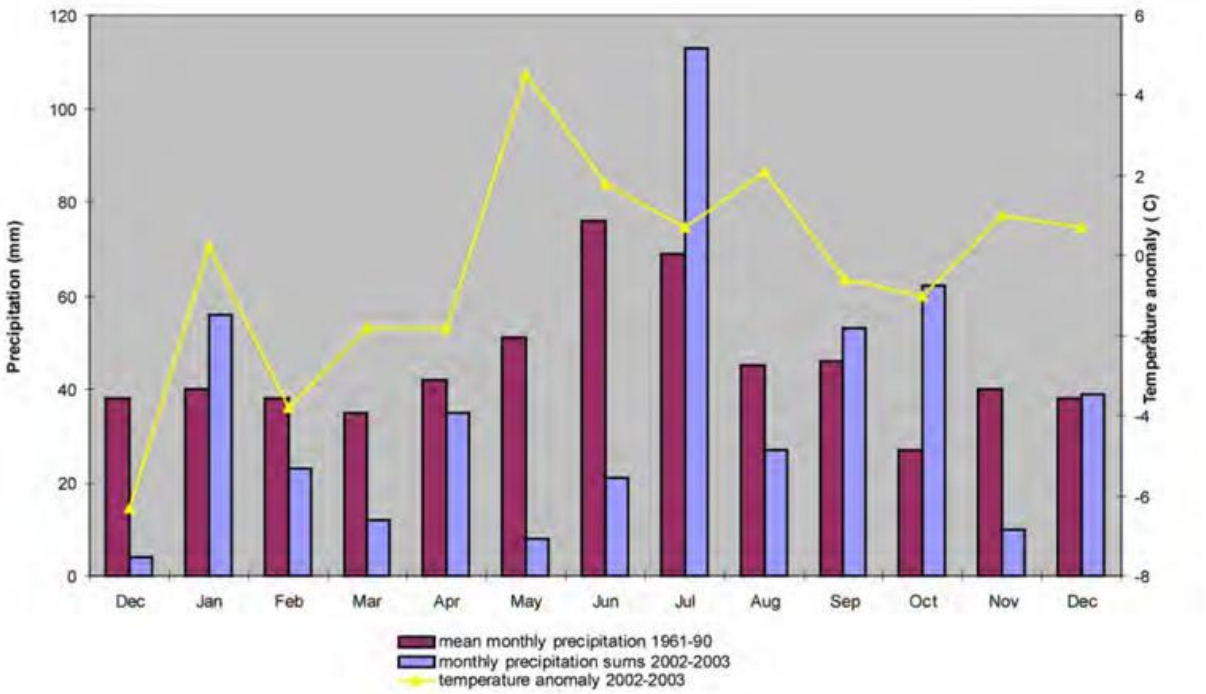


Fig. 5.5: *Monthly area average precipitation and temperature anomalies in Republic of Moldova*
From: State Service Hydrometeo of Republic of Moldova

In Israel it was very hot with monthly mean temperatures of 3°C to 4°C above normal, and at most stations this was the hottest May since the beginning of measurements (see e.g. fig. 5.6). The first part of the month was characterised by

successive hot days. Sharav events with maximum temperatures up to 39°C in the coastal plain and in the Negev occurred on May 4 and 8 - 10. The second part of May was slightly less warmer, but the hottest day of the month was recorded on May 29 with 41°C to 43°C in the coastal plain.

The month was very hot and dry in Jordan. The mean maximum and minimum temperature at the Amman airport had anomalies of +4°C and +2.3°C respectively (see fig. 5.7).

While the monthly mean temperature was near normal in Armenia, the country-wide precipitation total was much below the long-term average (see fig. 3.7). In spite of this, continuous snowfall during 9 hours occurred on May 9 in Goris and produced a precipitation amount of 23mm. A thunderstorm in Ashotsk on May 20 caused the death of one person.

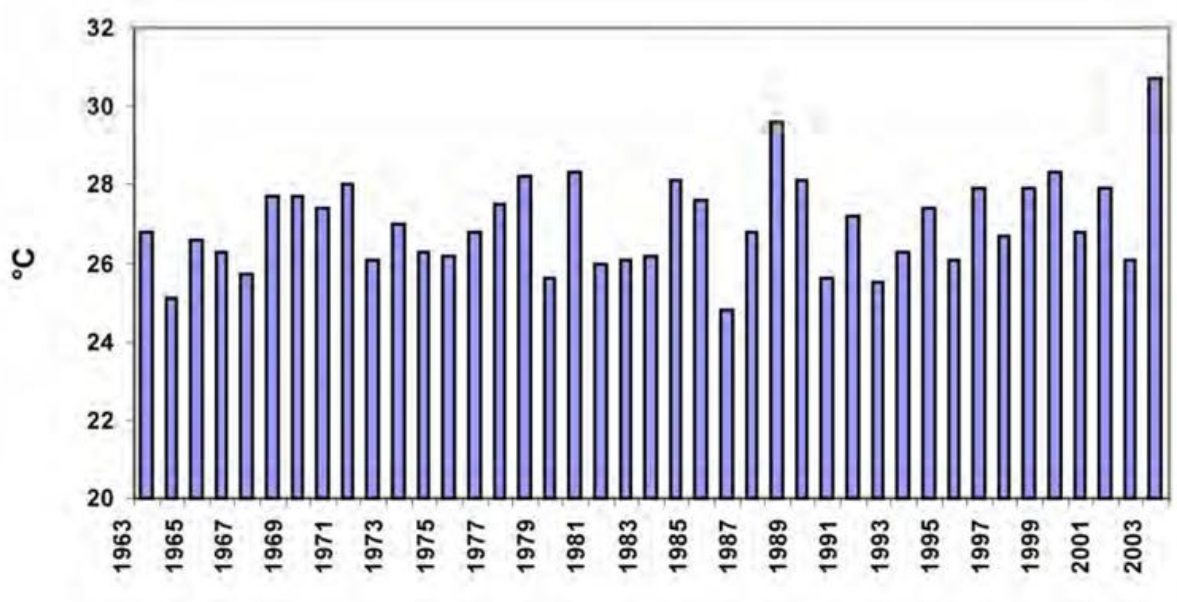


Fig. 5.6: *Mean daily temperature in May; Bet Dagan (Central Coastal Plain) 1963-2003*
From: Israel Meteorological Service

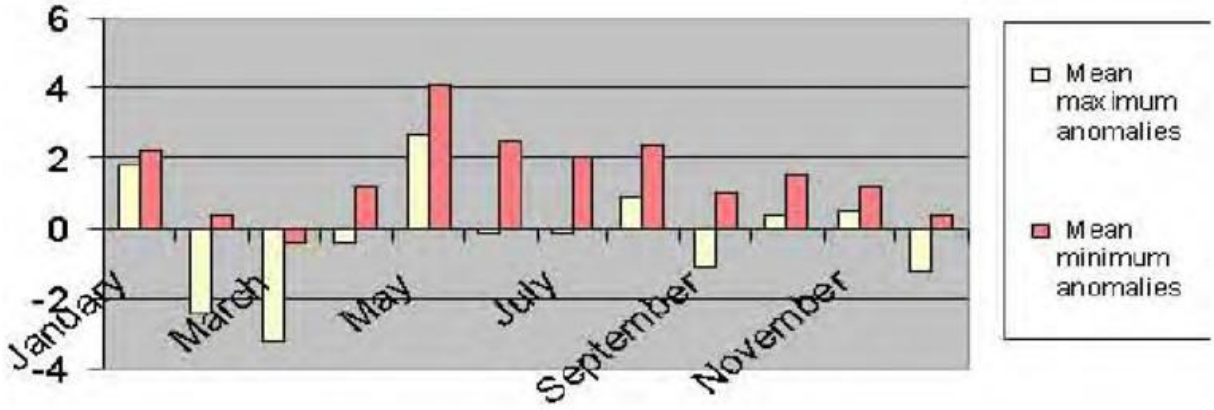


Fig. 5.7: *Mean maximum and minimum anomalies for the year 2003; Amman Airport*
From: Jordanian Meteorological Department

June 2003

- **Extremely hot in central Europe, especially in the Alpine region**
- **Very dry in the southern parts of France and the Iberian Peninsula as well as in eastern Europe and northern Turkey**

The month was relatively warm all over Iceland, but quite wet in the south and east. In Reykjavik it was about as warm as June 1941 which is the warmest on record.

The monthly mean temperature in Ireland was moderately above normal, while the precipitation total clearly exceeded the long term average. A daily fall of 63.7mm at Valentia Observatory on June 9 was its highest daily amount for June since records began in the area in 1892. In spite of this sunshine duration was generally above normal and daily values of more than 15 hours were measured at a few stations during the last week of the month. Station Malin Head measured the year's highest daily sunshine, 16.0 hours, on June 29.

In the U.K. the monthly mean temperature anomaly was +1.9°C and the precipitation total close to normal. The Midlands and south-eastern England had thundery showers on June 1, with station Shepshed recording 39mm in 1 hour. Widespread storms with some flash flooding affected eastern and south-eastern England early on the 2nd, 60mm being reported from St Leonard's on the south coast. During June 17 heavy thunderstorms tracked north-eastwards over much of England. The rain was torrential in places, with flooding and lightning strikes disrupting railway networks in the north-east. 24mm of rain fell in an hour at Coningsby in eastern England.

In Norway the month was warmer than normal in most parts of the country. Precipitation was well below normal in the north and more than normal in the west as well as in some parts of the south-east. Here, stations Rygge (41.6mm) and Sarpsborg (39.3mm) noted new diurnal maxima for the month on June 24.

In Finland the month was cooler than normal, especially in the eastern part of the country, where the deviations came down to -4°C. The monthly precipitation was fairly close to normal in the southern and central areas, but mainly below normal more northwards and in some parts even less than 25% rain fell compared to its reference value.

The month was relatively warm and dry in Belgium with temperature anomalies mostly between +3°C and +4°C and precipitation rates about half of normal. The monthly sunshine duration at station Uccle was 258.2 hours, which is 28% above the long term average of the years 1887-1988 and 40% above normal with reference to 1961-1990. In spite of this some extreme weather events with a varying composition of heavy rains, hail, thunderstorms and strong winds including a local tornado occurred in different parts of the country on June 1-3, 8, 10 and 14.

The month was relatively warm (anomalies about +2.5°C) and dry (precipitation rates near half of normal) in the Netherlands.

In Luxembourg the month was very hot and dry with temperature anomalies up to +5°C and precipitation rates about 60% of normal.

In Germany the month was extremely hot, sunny and dry. The monthly mean temperature exceeded normal by 4°C, thus being the hottest June since 1901. A maximum temperature of 33.7°C was recorded from Munich on June 12, which is the highest value ever measured there on that day since the beginning of observations 130 years ago. The country-wide precipitation total was only 65% of the long term average. In spite of this many extreme weather events with serious

consequences (local tornadoes, heavy rains, thunderstorms, hail, flooding, land slides) occurred in different parts of the country throughout the month.

The monthly mean temperature in Poland was higher than normal by up to 3°C. Only the north-eastern region was close to the long-term average. The western and southern parts of the country were the warmest with maximum temperatures exceeding 33°C. The annual sums of precipitation calculated for 14 Polish stations reached only 45% of the 1971-2000 normal (see fig. 6.1). Very warm and dry weather engendered soil drought and decrease of water levels in rivers and reservoirs.

Weather conditions in Lithuania were variable during the month. The first ten-day period had been warm and dry under anticylonic influence. Then, the circulation gradually changed and northerly winds prevailed leading to the cooling down of the weather and the arrival of rain. The resulting monthly mean temperature was 15.1°C, which means an anomaly of -0.3°C. The mean monthly precipitation amounted to 59mm equaling 87% of normal. The month saw 12 days with thunderstorm and 8 days with a wind speed exceeding 54km/h and gusts up to 80km/h. Sunshine duration amounted to 290 – 340 hours (25 – 60h above normal).

In Belarus the month was moderately cooler than usual and significantly dry (see figs. 0.7 and 5.3).

The month was very hot and mainly dry in France. Temperature anomalies ranged generally from +4°C to +5°C. Except of some places in the north and north-east the monthly precipitation rates were below normal and even down to zero in southern parts of the country.

In Portugal the month was very warm with a mean air temperature of 21.7°C on the mainland, 2.5°C above the 1961-1990 normal. However, in the north-east, the southern coastal zones and the inner southern region, it was extremely warm. In some southern areas the mean maximum air temperature was above 40ºC. The monthly mean of Tx was 28.5ºC with an anomaly of about +3°C, corresponding

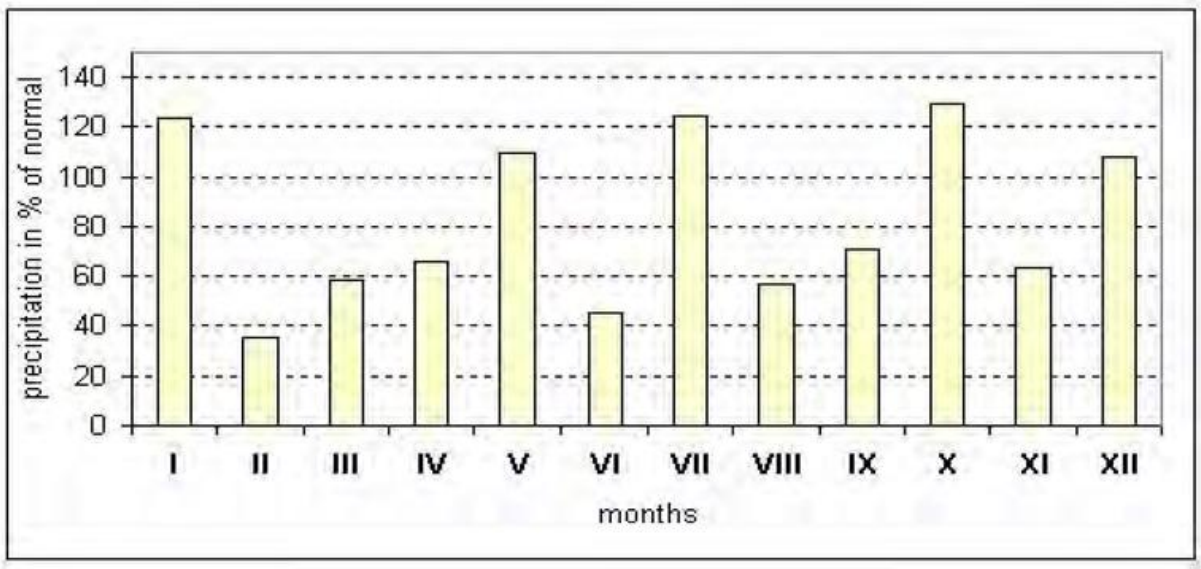


Fig. 6.1: *Monthly precipitation totals in Poland in 2003 in percent of 1971-2000 mean (average for 14 stations)*
From: Institute of Meteorology and Water Management, Poland

to the 3rd highest value since 1931 (higher values: 29.0ºC in 1976 and 28.8°C in 1996). The mean minimum air temperature was 15.0ºC, 1.6ºC above normal, corresponding to the 3rd highest value of the series (higher values: 15.1ºC in 1996 and 1981). Tab. 6.1 shows the number of days with a minimum air temperature of ≥20ºC

(tropical nights), and maximum air temperature equal or above 25ºC (summer days) and 30ºC (tropical days). The month in Portugal was also characterised by values of precipitation near the 1961-1990 normal in the northern region and below in the rest of the country. However, in the northern region precipitation occurred mainly on the last day of the month. For example in Bragança, the monthly total was 38mm (the mean 1961-90 is 39mm) with 31mm on June 30; in Vila Real the monthly total was 40mm (the mean 1961-90 is 53mm) with 34mm on June 30.

In Spain the monthly mean temperature was about 3.5°C above normal, the highest absolute anomaly since more than 40 years (fig. 6.2); new records were set up for more than 70% of all stations since the beginning of observations. The greatest deviations from normal occurred in Catalonia, in the north-east and the Balearic Islands with more than 2ºC above the previous record. At some locations new records were also set for the absolute maximum temperature. A tornado of an estimated intensity F3 on the Fujita scale appeared in the Ebro Valley on June 23 leaving behind a trace, that was 10km long and 400m wide.

In Switzerland, the monthly mean temperatures exceeded normal by 5.5-7.5°C, thus being about 2°C hotter than the hitherto warmest June of 1822. In the lowlands it was the hottest of all months since records started in 1753 with mean temperatures of 21-25°C. Only 20-50% of the normal precipitation quantities fell in many parts of the country. It was the sunniest June at least since 1976, in the south since 1945 and partly the sunniest June in the north since records started in 1901. Sunshine duration was generally between 290 and 330 hours.

In Austria the temperature anomalies ranged from +3.5°C to +6°C. It was the warmest June since the beginning of meteorological measurements in all parts of the country. In Vienna and Krems-münster with series since the eighteenth century, the warmest June before had been in 1811. In 2003 the

Stations	Minimum T >= 20°C		Maximum T >= 25°C		Maximum T >= 30°C	
	June 2003	Mean 61-90	June 2003	Mean 61-90	June 2003	Mean 61-90
Viana do Castelo	4	0.3	14	10.3	6	3.7
Braganca	2	0.1	23	13.5	13	3.5
Vila Real	2	0.3	19	16.3	7	5.3
Oporto / S. Pilar	4	0.3	11	7.0	6	2.4
Penhas Douradas	0	0.2	7	1.7	0	0.1
Castelo Branco	4	3.4	24	20.7	17	10.2
Lisbon / Geofísico	4	1.0	19	12.5	6	3.5
Évora	4	1.1	24	17.2	12	7.6
Beja	4	0.0	30	22.1	19	12
Faro	10	1.2	23	14.7	4	2.5

Tab. 6.1: *Number of days with minimum and maximum temperature equal or above defined limits*
From: Instituto de Meteorologia, Portugal

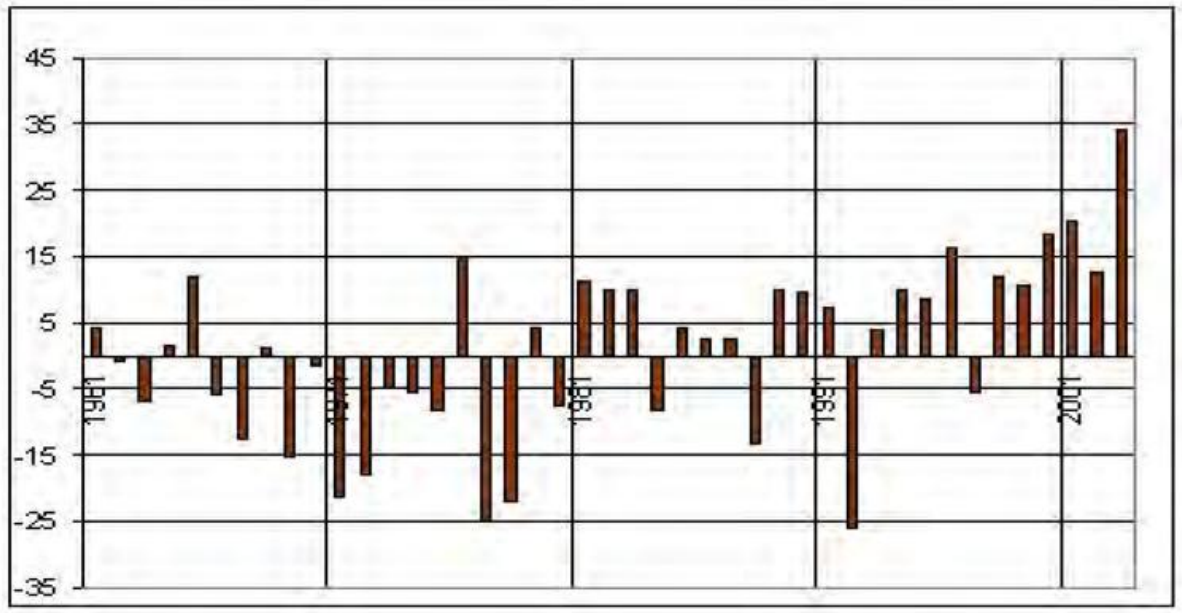


Fig. 6.2: *Deviation of average temperature (in tenths of °C) over the Spanish peninsular territory in June (reference 1971-2000)*
From: Instituto Nacional de Meteorologia, Spain

monthly average in Vienna was +22.4°C (+22.0 in 1811) and +21.2°C in Krems-münster (+20.8 in 1811).

It was the warmest and driest month in Czech Republic since 1961 with the highest positive monthly temperature deviation of +4°C. Drought conditions continued.

The month was very warm in Slovakia with temperature anomalies of about +3°C. It was also very dry with precipitation rates far below normal.

In Slovenia it was the warmest June since the beginning of observations and it was almost as hot as it was in the warmest month in the records which is August 1992. The mean monthly temperatures were 4.5°C to 6°C above the 1961-1990 normal (see fig. 6.3). Everywhere record numbers of days with at least 30°C were registered, in Ljubljana and Novo mesto 16, in Murska Sobota 15, in Portorož 20 and in Bilje 23. At many sites the highest temperatures on record for the month occurred, in Ljubljana 35.6°C, in Murska Sobota 36.0°C and 37.0 C in Vipava valley. Sunshine duration everywhere exceeded normal by at least 100%. On the coast sun was shining 310 hours which is 15% above normal. Kredarica got 229 hours of sunny weather, 39% above normal. Goriška region and Maribor got 40% more sunny weather than on the average in the reference period. Precipitation was clearly below normal everywhere except for Zgornjesavska valley. Only one quarter of normal precipitation fell in the Goriška region, Štajerska and Prekmurje got around one third of normal.

The month was extremely hot and generally very dry in Croatia. The temperature anomalies were ≥+3.8°C everywhere and up to +6.6°C at station Bjelovar (fig. 6.4). Although there were some isolated places, especially in coastal areas, with a monthly precipitation rate above normal, most stations had a considerable deficit in rainfall.

The month was very hot and dry in Hungary. Temperature anomalies ranged from +3°C to +5°C. The daily mean temperature was higher than the long term average of the month every day. More than two thirds of the month the daily temperature maxima were higher than 25°C. The precipitation total was 33% of the normal amount (fig.3.3). The drought had a serious impact on agriculture with 50% lower crops of rape and a minimum yield of

wheat in the last 5 years. Fruits and vegetables needed watering.

In Bosnia and Herzegovina the monthly mean temperature, calculated from 12 stations, was 21.3°C , thus being 4.6°C above normal (reference period 1961-1990). The analogously determined monthly precipitation total was 65mm, which is equal to 68% of the normal amount.

Almost all stations in Serbia and Montenegro registered the highest temperatures in the past 40 years, and for some stations it was the hottest June ever, as long as measurements started (see e.g. fig.6.5). The number of tropical days in row from June 12-21 was exceptionally high. Total precipitation amounts in most of the country were far lower than the long term averages.

In Romania it was rather warm with temperature anomalies about +3°C and very dry with only $^1/_3$ of the monthly normal precipitation.

Drought conditions in Moldova continued (see fig. 5.5).

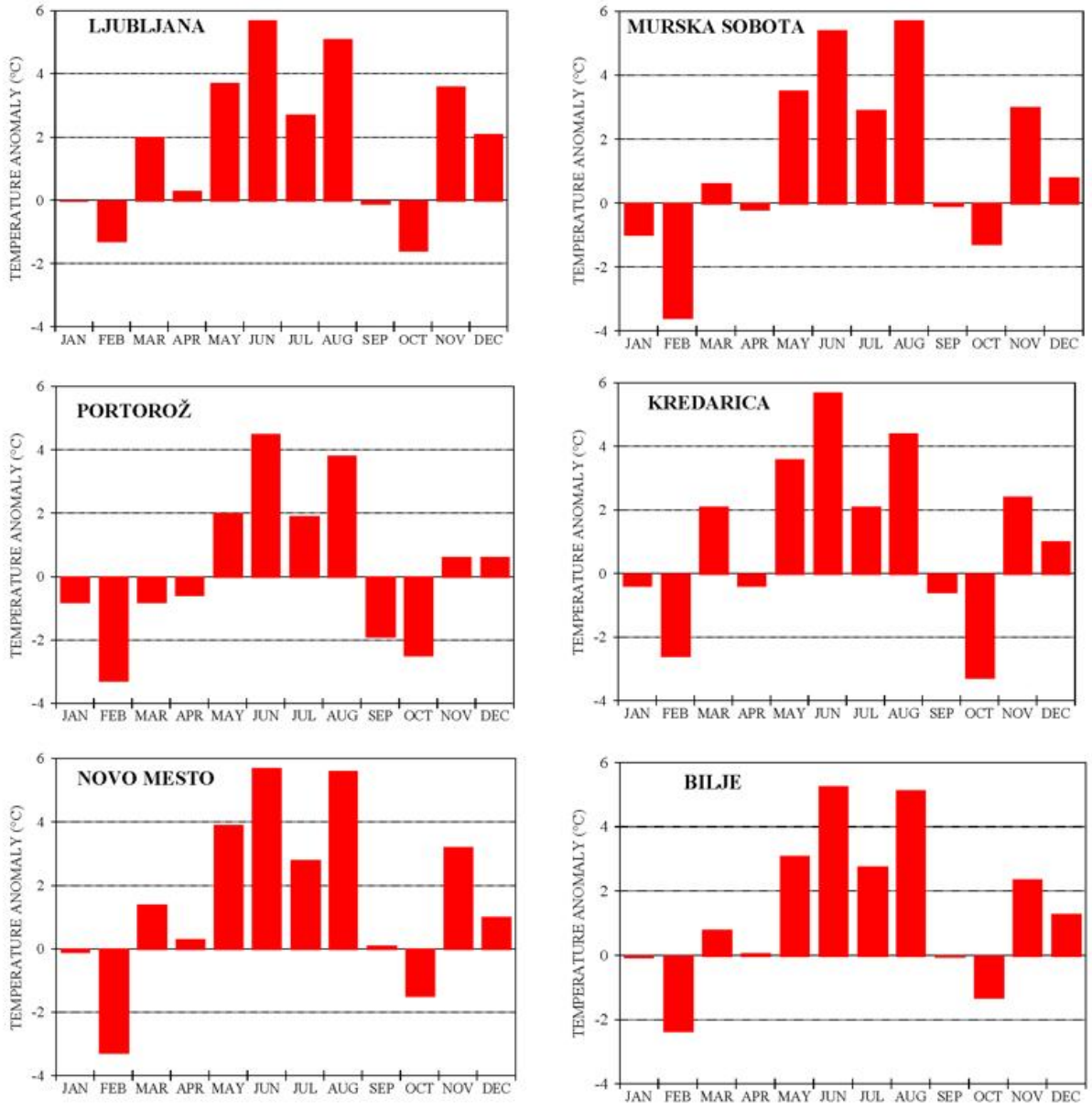


Fig. 6.3: *Mean monthly temperature anomaly in the year 2003*
From: Environmental Agency of the Republic of Slovenia

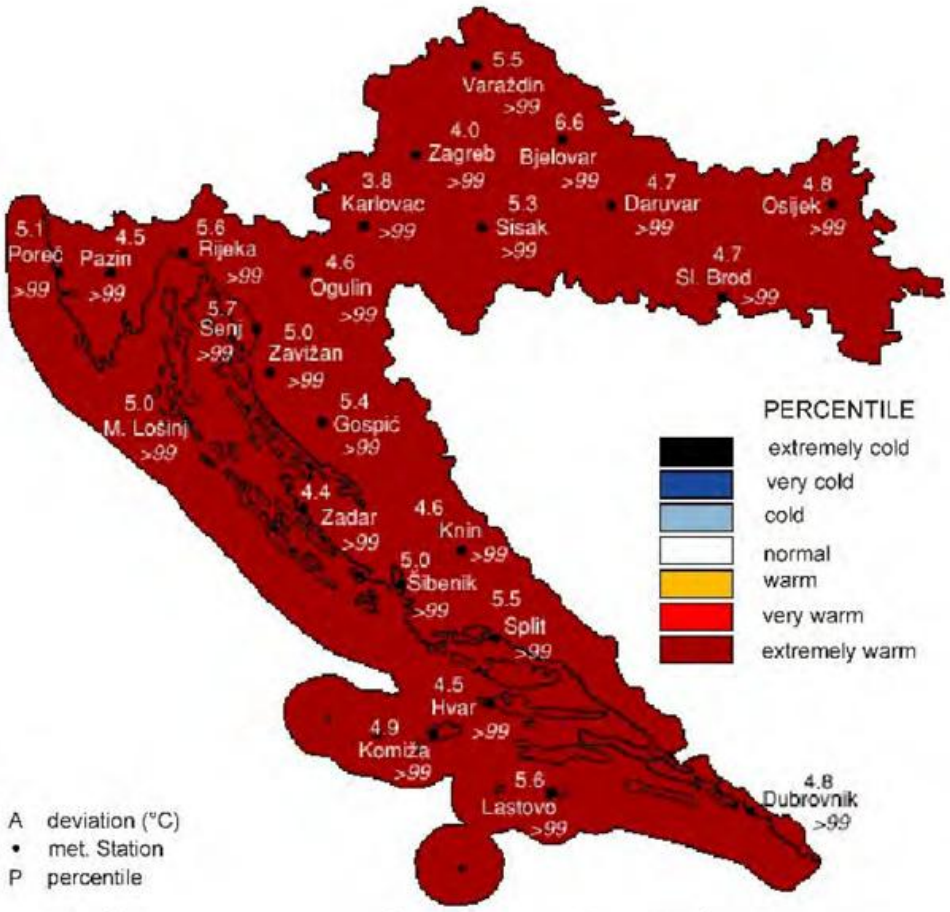


Fig. 6.4: *Monthly air temperature anomalies in Croatia in June 2003,from normals 1961-1990*
From: Meteorological and Hydrological Service Croatia

In Italy the month was rather hot, especially in the northern and central parts of the country with temperatures up to six standard deviations above normal. A mean daily minimum temperature of 20.8°C was registered in Cagliari, the previous record being 17°C from 1999.

The heat wave in Albania continued all over the month. The mean minimum temperatures reached up to 5°C above normal (fig. 1.3) and the anomalies of the monthly mean were even up to 7°C in the lowland zones. The monthly mean temperature was higher than for any June of the reference period 1961-1990. The precipitation total was merely half of normal.

In Macedonia the weather conditions were rather warm and wet with temperature anomalies about +3°C and precipitation rates clearly above normal.

In Bulgaria the monthly average air temperature was about 3°C higher than the long-term averages. It was a very dry month with precipitation rates of only 20-30% of normal. Sunshine duration was 30-50 hours higher than the averages. Intensive and wide-spread hailstorms were observed on June 8 and 16. Thunderstorms were registered in 18 days during the month. A man was killed by a lightning stroke.

In Greece the month was much warmer and in most places drier than normal. Unusual high seasonal maximum temperatures of 7°C - 10°C above the long term averages were reported from many areas of the country in the period June 13-15 (see table 6.2).

In Turkey the month was clearly warmer than normal and mostly dry except of the south-western coastal areas and eastern parts of the country. Heavy rains

on June 17 caused flooding in the area of Yalvac/Isparta. One person died and two were injured from river overflow; 12 houses, livestock and agricultural plantations were damaged.

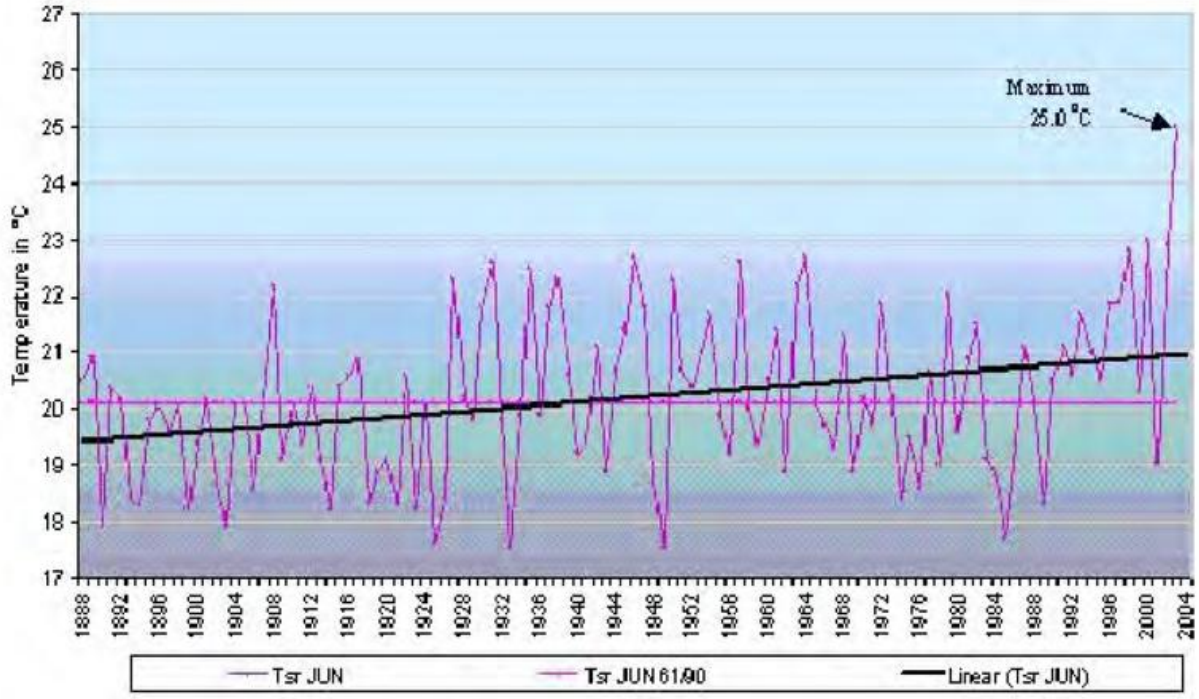


Fig. 6.5: *Mean Daily Temperature in June in Belgrade between 1888 and 2003 and 1961 – 1990 June mean*
From: Republic Hydrometeorological Service of Serbia and Montenegro

Station	Location (lat., long.)	Altitude (m)	Maximum daily temperature (°C)	Date	Mean monthly Maximum daily Temperature (°C)	Reference Period
Kerkyra	39 37, 19 55	2,0	37	13/6/03	28,0	1955-1997
Arta	39 10, 21 00	11,5	37	13/6/03	28,5	1971-1997
Agrinio	38 37, 21 23	24	37	13/6/03	30,4	1856-1997
Pyrgos	38 04, 23 33	30	37	13/6/03	30,6	1958-1997
Kerkyra	39 37, 19 55	2,0	37	14/6/03	28,0	1955-1997
Arta	39 10, 21 00	11,5	37	14/6/03	24,7	1976-1997
Agrinio	38 37, 21 23	24	37	14/6/03	30,4	1956-1997
Agrinio	38 37, 21 23	24	38	15/6/03	30,4	1956-1997
Hellinikon	37 54, 23 45	10	38	15/6/03	28,7	1955-1997

Tab. 6.2: *Maximum daily temperatures (in °C) in June 2003 and mean values*
From: Hellenic National Meteorological Service

In Cyprus the monthly mean temperature exceeded normal by 1.1°C. The overall precipitation amounted to 16.8mm, which is only 3% of the year's precipitation total, but 280% of the month's normal. Heavy rains and thunderstorms occurred on June 2. Fog in the area of Nicosia appeared on June 9. Severe heat wave conditions occurred occasionally during the second fortnight of the month. The airport of Larnaka was closed for four hours because of dense fog in the morning hours of June 30.

The monthly mean temperature in Armenia was 0.5°C below normal. Sudden drops of temperature in mountainous regions led to air and ground frost down to -2°C on June 6-7 and 25-26, which is a rare phenomenon for this month. For the last 100 years frosts were not observed in the third decade of June. Significant damage was done to the agriculture. The monthly precipitation total was only about 2/3 of normal (see fig. 3.8).

Kazakhstan experienced several mudflows in the mountain rivers close to Almaty. Fortunately, they did not reach the city, but they caused great damage to the economy of the country. Road bridges, highways, houses and schools in settlements had been ruined, areas under crops and livestock had been destroyed; some people were killed. The economic damage from one such mudflow is estimated to about 2 million EUR.

July 2003

- **Generally warmer than normal all over the Region except for the south-west and the south-east**
- **Hot in northern Scandinavia**
- **Extremely dry in the western and eastern Mediterranean areas**

There were several magnificent days in Faroe Islands with sunshine and clear skies from morning to evening, among them July 17, when the record breaking maximum temperature of 26.3°C was registered at Vaga Floghavn.

It was a very warm month across all parts of the UK, with the Northern Isles around 3°C higher than their average temperature. Wisley, southwest of London, recorded 33.6°C on July 15 and Maidenhead, west of London, had its hottest July day since 1976. However, Atlantic depressions to the north-west brought an unsettled spell with rain bands depositing copious amounts in places, especially over southwest England, Wales and the Midlands between July 24 and 26. Cardinham in Cornwall received 58 mm in 12 hours ending 0900 GMT on July 25.

The monthly mean temperature in Norway as a whole was 3.1°C higher than the long-term average. It was the warmest July since the measurements started in 1867, the former record being from 1901 of nearly the same order. 38 Norwegian weather stations got new temperature records for this month, most of them situated along the coast from south to north. The greatest positive departures from normal were attained in mid–Norway with 4°C to 5°C. Several coastal stations in the south experienced minimum temperatures above 20°C the night before July 17. At Oslo-Blindern the minimum this night was 20.7°C which is the second warmest measured here since the start in 1937. The

monthly mean for the air temperature (13.1°C) and sea surface temperature (13.4°C) measured at the weather ship "M" in the Norwegian Sea were both the highest for July in the series starting in 1949.

Temperature anomalies in Sweden were generally positive varying from about 1°C in the south up to 4°C in the northern part of the country. Precipitation was also very variable. Heavy rainfalls in the province of Småland caused considerable damage to farms and villages on July 2-6. Monthly totals reached locally 3-4 times the normal amounts with a maximum of 297mm close to Oskarshamn. In Lönneberga many houses were overflowed by water and millions of SEK had to be paid by insurance companies. At station Kalmar a new daily record was set with 73mm during a night-time thunderstorm on July 30. Private measurements recorded up to 115mm south of the city.

In Finland it was very hot compared to the long-term average. Temperature anomalies were about +4°C all over the country. In combination with a relatively high humidity, these weather conditions caused problems to the health of the population. The monthly precipitation rates varied spatially from $^1/_3$ in the south to more than 100% of normal in the northern parts of the country.

The temperature anomalies in the Netherlands were about +2.0°C. Precipitation was rare and reached only about 40% of normal.

In Belgium the monthly temperature anomalies were about +2°C and precipitation close to normal. In the area of the province of Luxembourg a thunderstorm with strong winds and hail caused a lot of damage on July 21. Two more extreme weather events connected with thunderstorms occurred in the province of Brabant on July 1 and 26.

Luxembourg had monthly temperature anomalies of about +2.5°C and a precipitation total of ¾ of normal.

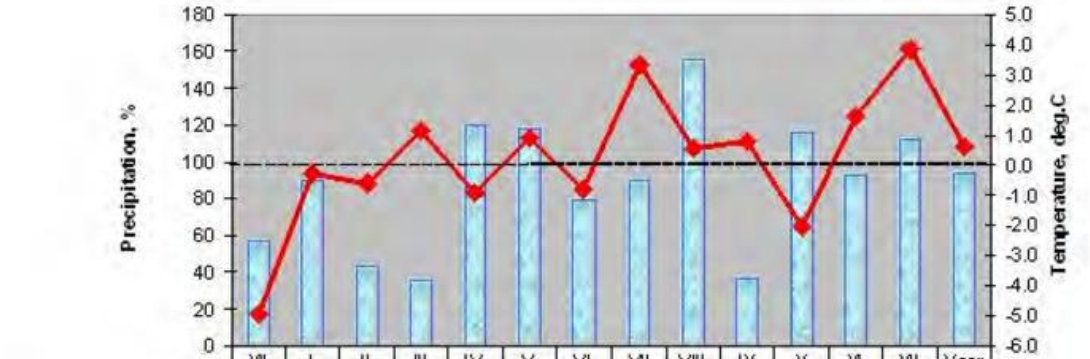
In Germany the country-wide temperature anomaly was +2.3°C and the overall precipitation rate 89% of normal. At station Karlsruhe a maximum temperature of 37.9°C was measured on July 20. There were 3 episodes of thundery weather combined with strong winds and heavy rains causing lots of damage to public and private life: from July 16-17 in western and southern parts of the country, from July 20-24 in the west and the north and on July 27 again in the south, especially in Bavaria.

Positive temperature anomalies continued in Poland throughout the month with values of ≥1°C in the south and >3°C in the north-east. Heat waves occurred in the second half of the month with maximum temperatures up to 36°C. Precipitation was related to thunderstorms in most cases and variable across the country. Torrential rains with daily sums above 50mm were noted as well as hailstorms and strong winds with gusts up to 32m/s. In spite of locally high rainfalls soil drought and decreasing water levels still were observed.

The month was very warm in Lithuania with a mean air temperature of 20.1°C, which is 3.4°C above normal. The country-wide precipitation total was 79mm and thus close to normal but with a very uneven distribution in space and time. The precipitation was mostly of a downpour nature and the monthly amount varied locally from 30mm to 146mm. In the first half of the month most frequent and abundant rainfall occurred in the eastern regions originating from cyclones moving northward. The second half of the month passed under prevailing influence of anticyclones. The third ten-day period of the month was very hot with a mean air temperature of 22.5°C, which is an anomaly of +5.3°C. Station Palanga received 60mm of rain in 2 hours on July 26. The number of days with thunderstorm was counted as 22.

Latvia experienced the second warmest July ever recorded. The monthly mean temperature was 3.3°C above normal (see fig. 7.1) and surpassed only in 2001 by 0.1°C.

The month was very warm in Belarus with temperature anomalies of +2.5°C and more. The country-wide monthly mean reached the limit of 20.0°C, which normally occurs only once in ten years,



	XII 2002	I 2003	II 2003	III 2003	IV 2003	V 2003	VI 2003	VII 2003	VIII 2003	IX 2003	X 2003	XI 2003	XII 2003	Year 2003
Departures in precipitation,%	57	90	43	36	119	118	79	90	156	37	116	93	112	94
Departures in temperature, °C	-5.0	-0.2	-0.6	1.2	-0.9	0.9	-0.8	3.3	0.5	0.8	-2.1	1.6	3.8	0.6

Fig. 7.1: *Monthly temperature anomalies and precipitation rates in Latvia 2003*
From: Latvian Environmental, Geological and Meteorological Agency

but actually it was the third time in a row. The total precipitation was 133% of normal.

The monthly temperature anomalies in France were generally positive and ranged from west to east between about +1°C and +3°C. Precipitation rates had a strong gradient from south-east to north-west and varied within the limits from zero (Ajaccio/Corsica) up to 200% of normal.

The month was rather hot in Switzerland with a temperature surplus of 2-3°C. Precipitation was below normal and drought conditions continued.

The monthly mean temperature in Slovenia exceeded normal significantly (fig. 6.3) in spite of being lower than in the month before. It was the warmest July since more than 50 years in several areas. The number of hot days varied from 11 to 24 at different places. The precipitation totals exceeded normal only in the Julian Alps and the Zgornjesavska valley with more than 200mm. The coastal zone and the Karst were the driest areas where less than 20 mm fell. Unusually high temperature, lack of precipitation in most parts of the country and sunnier weather than on the average enhanced drought.

In Croatia the monthly mean temperature anomaly was +2.3°C and precipitation reached 90% of normal.

In Bosnia and Herzegovina the monthly mean temperature was 2.1°C above normal, while the precipitation total reached only 64% of normal.

At the end of the month extremely heavy downpours fell especially in the northern part of Hungary. A maximum daily rainfall amount of 177mm was registered at station Kompolt on July 29. This was enough rain for the area, but the rest of the country continued to suffer from serious drought conditions.

The monthly mean temperature on the Spanish mainland was clearly above normal, but not as excessive as in the month before. Monthly precipitation amounts varied from 92 mm in the north-west (La Coruna) to zero in the south-east (Almeria, Alicante).

It was very warm in Italy with temperatures anomalies above +2°C and up to +4°C. A daily maximum temperature of 40.4°C was registered in Piacenza on July 11. The spatial distribution of precipitation was variable. Some areas in the south had no or nearly no rain, while station Pisa received the normal rate.

A heat wave episode affected Greece on July 4-5, especially the mainland and the Ionian islands. The maximum daily temperatures were ≥40°C.

In The Former Yugoslav Rebublic Of Macedonia the month was clearly warmer than normal with temperature deviations between +1°C and +2°C. It was also extremely dry.

It was the sunniest month in Bulgaria with average air temperatures above normal. Precipitation was near to normal in the south and 50% of the average in the north. Thunderstorms were observed on 19 days and in combination with hail on 10 days. The most widespread events occurred on July 4–5 and led to damage in 12 counties; in Sofia the thunderstorm was combined with intensive rainfall and hailstones of walnut size and caused significant damage to cars and properties.

Moldova had a monthly temperature anomaly of +0.7°C and a high precipitation total of 112mm, which is equal to 164% related to the long-term average (see fig. 5.5).

In Turkey temperature anomalies were generally positive up to 2°C. Precipitation rates were less than 25% in large central and western parts of the country leading to serious drought conditions.

In Jordan the highest maximum temperatures of the year were measured at the stations Amman and Aqaba on July 6, namely 37°C and 44°C respectively.

The monthly mean temperature in Armenia was 0.4°C below normal. A cold spell occurred in the second half of the month. During a thunderstorm in Jajur on July 18 hailstones with diameters up to 5cm caused considerable damage to the agriculture.

The mean monthly temperature anomalies in Kazakhstan were from -2°C down to -4°C. The monthly precipitation rates varied between 200% and 500% of normal. In Almaty the air temperature at night dropped down to 8.3°C on July 29, which is 3°C below the previous absolute minimum of this day noted in 1938. The decrease in air temperature was accompanied by frequent precipitation, quite often as rain showers. More than 20 rainy days were observed during the month. Frequent and abundant rains caused the overflow of moraine lakes in the Zailiysky Alatau mountain ridge in 3000m asl, and consequently triggered mudflows in the mountain rivers close to Almaty. They were not catastrophic and did not reach the city. As an example, fig. 7.2 shows a ravine of river Left Talgar after the mudflow with a cleft reaching 7m. The mudflow volume amounted to 500 000m^3 and blocked the river-bed of Left Talgar along a distance of 900m; a lake had been formed at an elevation of 2500m asl.



Fig. 7.2:

Ravine of the Left Talgar river after the mudflow 2003
From: Hydrometeorology and Environmental Monitoring Agency, Kazakhstan

August 2003

- **Extremely hot in central Europe**
- **Generally warmer than normal all over the Region except for some places in Russia**
- **Very dry in and around the British Isles, southern Spain, northern Italy, many areas in the Balkans and most of Turkey**
- **Record warm sea surface temperature in the Norwegian Sea**

The south and the eastern coastline of Greenland had relatively high temperatures with anomalies of ≥2°C. A foehn situation at Nuuk Airport made the air temperature rise up to a maximum of 24.1°C on August 26.

The month was unusually warm in Iceland. In the south and the west it was the warmest August since the beginning of observations, in the north-eastern inland only August 1947 was warmer and in the eastern coastal regions it was the third warmest on record. Precipitation was slightly above normal for the whole country.

The month was particularly warm in Ireland relative to normal. Almost every station recorded its highest temperature of the year during early August, when maxima touched 30°C in parts of the west. The highest observed temperature of the year was 30.3°C at station Belderrig on August 8.

The monthly mean temperature in the U.K. was 2.3°C above normal and the total precipitation only 28% of the 1961-1990 average. A heat wave affected the country from August 3 to 12. Faversham, southeast of London, recorded the UK's highest ever temperature with 38.5°C on August 10, passing the previous highest of 37.1°C set

at Cheltenham on 3rd August 1990. Greycrook set up a new Scottish record reporting 32.9°C on August 9, passing the previous high of 32.8°C set at Dumfries on 2nd July 1908. The month was also very dry across England & Wales with about 21 mm recorded; this is the 6th driest August in the 238-year series. The driest was 1995 with about 9mm.

The month was very warm and rather dry in Denmark, introducing many days with high water temperatures along the Danish coastline. Maximum air temperatures were up to 32°C.

In Norway the month was warmer than normal in the whole country, especially along the coast. The highest temperature, 33.1°C, was measured on August 10 at Nesbyen in the SE. The weather ship at station "M" in the Norwegian sea experienced the highest monthly mean both for air temperature (13.2°C) and sea surface temperature (14.1°C). Precipitation showed great differences from region to region. In the central parts of the country the monthly and daily precipitation was of record quantity; some stations received extreme diurnal amounts on August 14-15, leading to local flooding; e.g. station Atndalen-Eriksrud measured 116.5mm on August 15. In the southernmost parts of the country, precipitation was much below normal.

Monthly temperature anomalies were moderately positive everywhere in Sweden. Relatively large amounts of rain fell in the middle part of the country, especially during a thunderstorm sequence from August 13-15. Close to Sundsvall more than 130mm of rain fell within two days interrupting the railway traffic occasionally. Unusually many tornadoes were reported, especially on August 31. The most damaging tornado struck the outskirts of Falkenberg in the province of Halland on August 26.

The month was moderately warmer than normal in most parts of Finland with temperature anomalies at about +1.5°C decreasing slightly from south to north. The monthly precipitation rates varied in most parts of the country between 50% and 150% increasing from west to east.

In the Netherlands the period from the beginning of the month until August 13 was marked by a heat wave. In Arcen in the south-eastern part of the country 12 consecutive tropical days were recorded. On three days, the temperature rose among other stations in Arcen to 37°C or higher; on August 7 even to 37.8°C. These readings are among the highest ever recorded in the Netherlands.

The month was relatively hot in Belgium with temperature anomalies above +3°C. The highest temperature was measured with 38.6°C in Aubange on August 8. Precipitation totals were somewhat below normal and most of the rain fell during the last 4 days of the month. Sunshine duration was significantly above the long-term average, as can be seen from the example in fig. 2.1. Thunderstorms on August 28-29 caused damage in different parts of the country.

In Luxembourg temperature anomalies were up to +6°C and precipitation rates about $^2/_3$ of normal.

The month was extremely hot and very dry in Germany with a country-wide temperature anomaly of +4°C and a precipitation deficit of more than 50% of the normal rate. It was the hottest and sunniest August since observations started more than a century ago. During the night of August 8 to 9 a record high minimum temperature of 26.7°C was measured and repeated on August 12 at station Weinbiet. The absolute temperature maximum of 40.2°C was reached and repeated at station Karlsruhe on August 9 and 13. Agriculture suffered from a continuous drought. A small tornado damaged a farm near Barntrup in Westphalia. A hailstorm with strong winds caused much damage to the area of Rosenheim in Bavaria on August 18. Thunderstorms in combination with heavy rains, strong winds and hail affected different parts of the country on August 28-29, especially in Saarland, Rhineland-Palatinate, at Lake Constance and in Berlin.

The month was very hot and still dry in Czech Republic. The country-wide temperature anomaly was +3.6°C. The warmest day of the year was the August 13, when at station Klementinum in Prague a temperature of 36.8°C was measured, which is the highest temperature there in August since 1775. The temperature maximum on this day was 39.5°C, recorded from the NW part of the country and only 0.7°C less than the absolute national temperature maximum. The highest daily average temperature was measured at station Vlkonice and it was 30°C on the same day.

The month was generally warm and dry in Poland (see figs. 5.2 and 6.1). Temperature anomalies varied from +1°C up to +2.5°C. The warmest parts of the country were the west and the south, the coolest north and NE. The monthly precipitation rates were less than 50% of normal and even below 10% at some sites, but close to normal in the central and north-eastern parts of the country. Thunderstorms with intense rain exceeding 40 mm daily and wind gusts above 20m/s were observed. As a consequence of precipitation shortage and intense evaporation, soil and hydrological drought deepened.

In Lithuania the monthly mean temperature moderately exceeded normal by +0.8°C. The country-wide monthly precipitation total was 94 mm and thus 124% of normal. The first half of the month was dry and warm everywhere, while the second one was rainy and chilly. The highest air temperatures in the first five days reached 27–33°C. Because of the lack of moisture, some Lithuanian regions encountered drought conditions lasting until mid-August. The lack of moisture had originated 885 forest fires burning down 436 ha of forestry and causing lots of material damage. In contrast to this, the second half of the month saw heavy rainfall in many places. Generally, the weather was unfavourable for agriculture: Deficient humidity was posing drought danger for some regions in the first half of the month, and rain was impeding harvest in its second half.

In Latvia the monthly mean temperature was slightly above normal, while the precipitation total exceeded the long-term average significantly (see fig. 7.1). August 21-31 was the rainiest third decade of August since the start of regular precipitation measurements. The amount of precipitation in this decade was between 2 and 3.5 times greater than normal. Continuous rainfall resulted in the loss of almost half of the grain crops. Agricultural losses were evaluated at 80 Million EUR.

In France the record hot summer culminated in this month with temperature anomalies up to +6°C and fatal consequences to people's health. A very long period of anticyclonic situations over western Europe was topped by heated air coming from the south and leading to a stabilisation of the lower atmosphere up to 5000m. The nearly total lack of thunderstorms is a clear illustration of that. The warming up of the lower atmosphere is also visible from the monthly temperature anomaly of more than 4°C at the 850hPa level. Precipitation was mostly far below normal except for some places. Especially during the period of August 1-18 the country suffered from an extraordinary heat wave (see e.g. fig. 8.1). Fig.8.2 provides the daily average temperature time series for Paris, showing the upper decile being surpassed on twelve successive days from August 4 to 15 . The effects were devastating: the National Institute of Public Health reported an official figure of 14,802 additional deaths for the period of August 1-20.

In Switzerland the month was extremely hot everywhere and mostly very dry. It was the warmest month of August since observations started in 1753, surpassing the previous records from 1991/1992 by 1-2°C. Temperature anomalies were from 4°C up to 6°C. In the lowlands, the monthly mean temperatures were 24°C - 30°C and the mean of daily maxima reached 34°C – 37°C. An extraordinary heat wave lasted from

August 4 to 13. The highest temperatures ever measured in Switzerland were recorded from station Grono on August 11: minimum 24.8°C, mean 32.7°C, maximum 41.5°C. Drought conditions continued with serious consequences for the agriculture. In a series beginning 1901, it was the sunniest August together with August of 1962 in the central and eastern parts north of the Alps.

The monthly mean temperatures in Austria were from 3°C to more than 5°C above normal. With 23.6°C in the very long series of Vienna it was the 3rd warmest August after 1807 (24.8°C) and 1992 (24.2°C). August 13 was the hottest day of 2003; the air temperature rose up to 39°C in Zwerndorf in Lower Austria and brought new record values in some towns where measurements reach back only to 1948. Duration of sunshine was more than 300 hours in eastern parts of the country. In Vienna 323 hours of sunshine were registered, which is 76 percent of the possible local sunshine and 16 hours more than the old record from 1992. Because of dry weather conditions, forest fires broke out in different parts of the country between August 21 and 25.

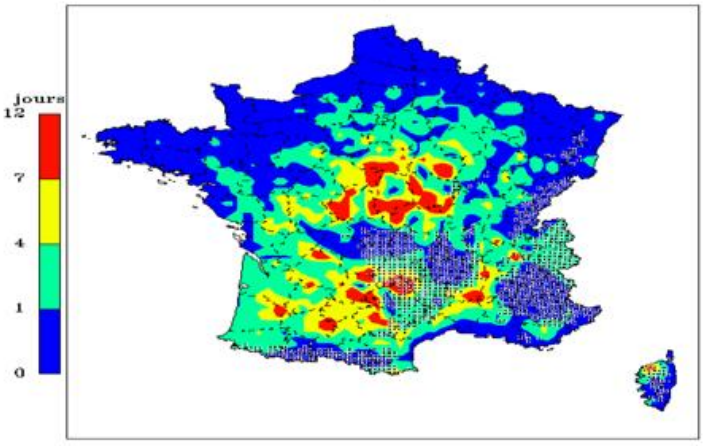


Fig. 8.1:

Number of days with Tx>40°C over the period August 1 to 18, 2003. Red areas indicate a range from 7 to 12 days
From: Météo-France

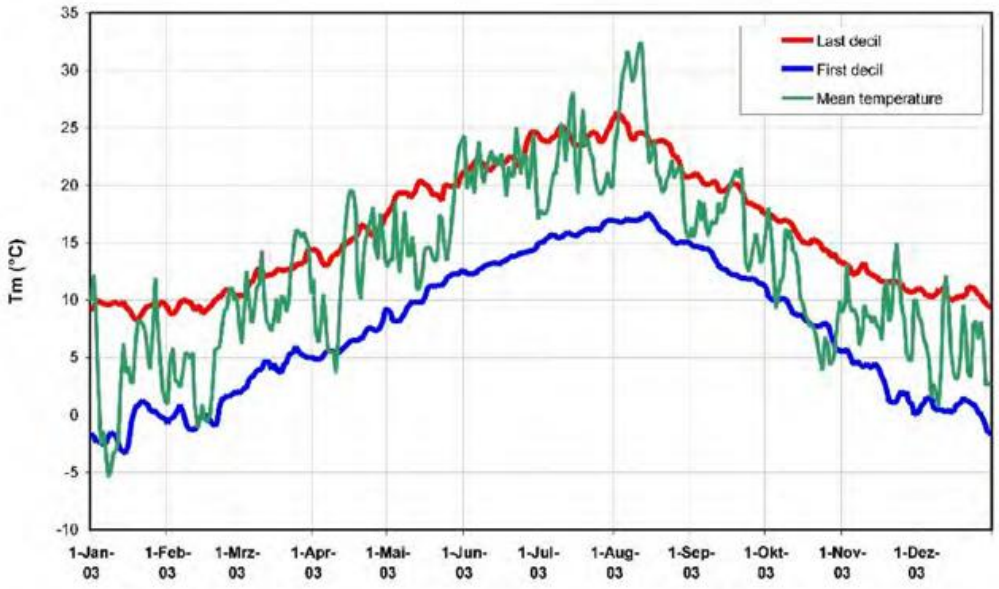


Fig. 8.2: *Daily Paris average temperature time series (geen) compared with the upper (top/red curve) and lower (blue curve) deciles*
From: Météo-France

In Slovakia the month was generally warm and dry with temperature anomalies of about +3°C and precipitation rates below half of normal, thus prolonging the drought conditions.

In Hungary the month was 4ºC warmer than the long term mean (fig. 2.3). Due to a long-lasting anticyclonic situation the precipitation was far below the mean value in the whole country (fig. 3.3). East of the Danube the amount of monthly precipitation was lower than half of the mean value. 250 hectares of agricultural fields were destroyed by fire.

The month was exceptionally warm in Slovenia. The normal monthly mean temperatures were exceeded by at least 4°C everywhere in the country. In many places new records of the highest absolute temperatures in August were set. Hot days with a maximum daily temperature ≥30°C were exceptionally frequent; e.g. 30 in Portorož and 29 in Vipava valley. Unusually high temperature, lack of precipitation in most parts of the country and sunnier weather than on the average enhanced drought almost throughout the country. Locally, some severe thunderstorms with strong wind, gusts and hail caused a lot of damage. During the last weekend of the month, exceptionally abundant precipitation affected Zgornjesavska dolina. On August 31 a strong wind, so-called tramontana, damaged some boats on the coast.

The month was extremely hot and very dry in Croatia. In Zagreb the monthly mean temperature exceeded normal by more than 5°C and the monthly precipitation total was less than half of the long-term average.

In Bosnia and Herzegovina the month was very hot and extremely dry. The country-wide temperature deviation from normal was +4.2°C and the overall total precipitation only 24% of normal.

The month was extremely hot in Serbia and Montenegro. Deviations of the monthly mean temperatures, the maximum and minimum temperatures from the average values ranged from +4°C to +6°C. In the whole country the daily maximum air temperatures were almost continually higher than 30°C and at the end of the month at some stations even higher than 40°C. The number of tropical and summer days as well as the number of tropical nights was much higher than the long-term averages. Climatic conditions were worsening because of the lack of precipitation. At many stations there was no precipitation at all during the month.

In Romania the month was generally warm with temperature anomalies up to >3°C and dry with a country-wide precipitation total less than $^1/_3$ of the normal rate.

It was a hot month in Bulgaria. The number of days with maximum air temperatures higher than 30°C was more than 20, and 35°C were exceeded on 5 days. The monthly temperature anomalies were near +3°C. The month was also very dry, especially in the north of the country. In spite of this, high daily precipitation amounts were measured at some stations (Targovishte - 52mm, Shumen - 45mm). Thunderstorms were observed on 20 days and mainly local hailstorms on 9 days. Some of them caused flooding and considerable damage to several places including Sofia on August 10, 20 and 22. The very hot days (August 13-15, 18-19, 22-25 and 28-31), where in some weather stations absolute records of maximum air temperatures were reported, affected human health and triggered car crashes and fires.

The monthly mean air temperature in Mainland Portugal was 25.1°C, which is 3.2°C above normal, resulting in the warmest month since 1931; the mean maximum air temperature was 32.2°C, with an anomaly of about +3.6°C; the mean minimum air temperature was 18.0°C, +2.9°C above the average of 1961-1990 (fig. 8.3). Both temperatures correspond to the highest values recorded since 1931. The first two weeks of August were extremely hot and an extraordinary heat wave affected the mainland (fig. 8.4). Comparative weather conditions were not ever been

reported before. The highest maximum temperature was 47.3°C, observed at station Amareleja on August 1, while the highest minimum temperature was 30.7°C, recorded at Portalegre on the same day. During the period of this heat wave, mortality of people increased by more than 40%. The number of forest fires in this month was 65.

In Spain temperature anomalies were positive in most of the Peninsula and in the Balearic Islands. In a few places new records for the whole series of observations were set. In the first half of the month a persistent heat wave affected the country. The threshold of 40°C was surpassed in Córdoba on 14 days and in Badajoz on 5 days. Even usually temperate regions such as Galicia had to endure spells of more than 35°C of maximum temperature for several days. A thunderstorm with hailstones of tennis-ball size caused considerable damage to the town of Alcañiz on August 16. A squall

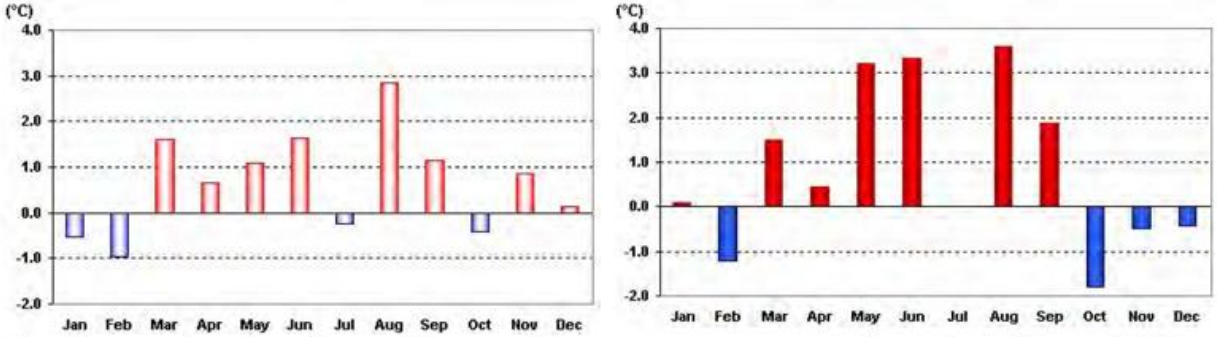


Fig. 8.3: *Anomalies of the monthly means of daily extreme temperatures in the mainland of Portugal, 2003*
From: Instituto de Meteorologia, Portugal

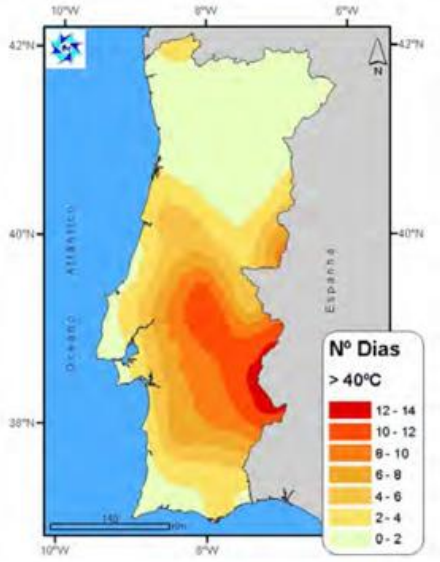


Fig. 8.4:

Number of days with maximum temperature above 40°C in the period from August 1-14
From: Instituto de Meteorologia, Portugal

line produced winds up to 180km/h north-east of Barcelona on August 17.

Temperature anomalies in Italy ranged from about +2°C in the south up to more than +6°C in the north. The monthly precipitation rates varied from below 10% of normal in the north to nearly 50% in most places in the southern parts of the country.

Temperature anomalies in Albania were up to +4°C (see fig 1.3), while the precipitation deficit continued; station Tirana received only 10% of normal (fig. 8.5).

In Greece the month was generally warmer than normal with temperature anomalies up to >3°C at some places. A heat wave affected the country at the end of the month, when daily maximum temperatures were up to 40°C and even more.

In Turkey the month was clearly warmer than normal everywhere and mostly very dry.

The month was hotter than normal in Israel.

In Syria, maximum temperatures of 2-3°C above normal in combination with increased humidity of the air caused health problems to many people.

In Armenia temperature anomalies were moderately positive up to about 1.5°C. The country-wide precipitation total exceeded normal by 50% (fig. 3.7).

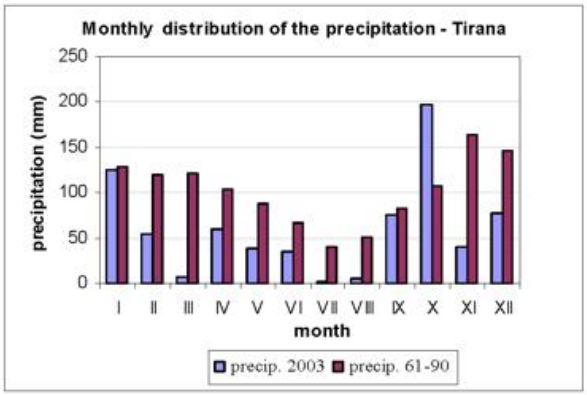


Fig. 8.5:

Monthly distribution of the precipitation at station Tirana
From: Hydrometeorological Institute, Albania

September 2003

- **Moderate monthly temperature anomalies all over the Region, positive in the north-west and negative in large areas to the south-east**

- **Patchy distribution of precipitation rates over the Region with contributions above normal mainly in southern countries**

In Iceland the month started with warm and favourable weather, but a cold spell arrived by the middle of the month. There was an unusually early snowfall in some parts of the north, the snow covering the ground completely in Akureyri on September 18, the earliest autumn snow cover at that location since 1940, when it occurred on September 7.

A thunderstorm near Pollathomas in Ireland on September 19 produced a 3-hour fall of over 80mm rain, resulting in locally devastating floods and landslides. The picture of the Shannon radar illustrates the rainfall intensity in the vicinity of the Pollatomish Mountains (fig.9.1).

The monthly temperature anomaly in the U.K. was +0.9°C and the precipitation rate 54% of normal. In southern England, Boscombe Down had its coldest September night since 1931, with a temperature of -0.1°C on 24th. Redhill, south of London, recorded a low of -2.8°C on the same night. In south-eastern England, temperatures fell by 10°C in less than an hour in many places as a cold front moved southwards on September 22.

The month was 1-2°C warmer than normal in southern Norway while the northern part of the country had mean temperatures near normal. The monthly precipitation in parts of the Troms and Nordland counties was

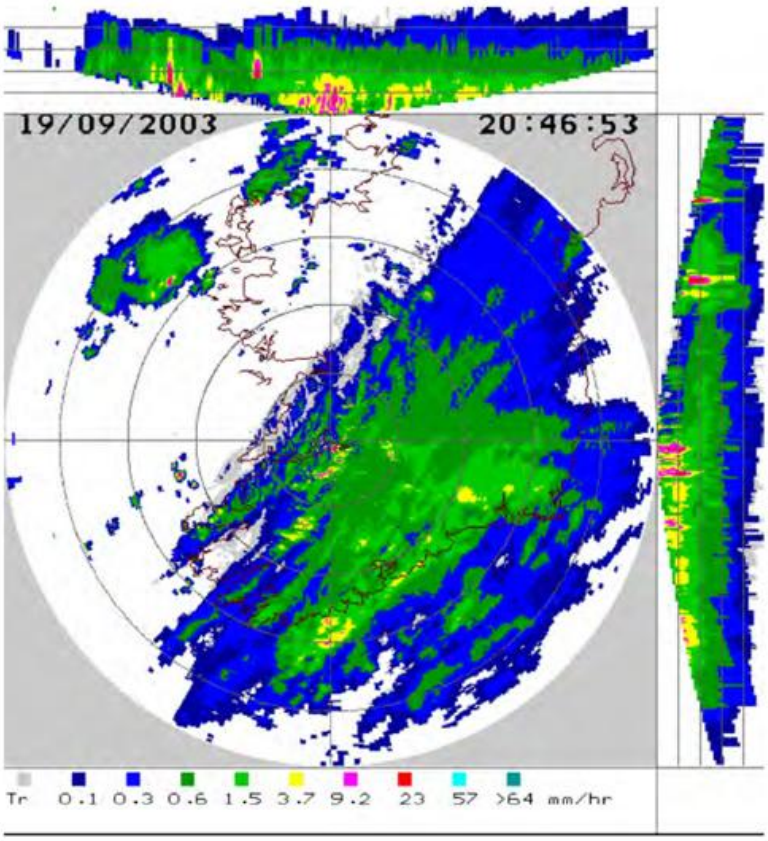


Fig. 9.1:

Shannon radar image illustrating the rainfall intensity in the vicinty of the Pollatomish Mountain on September 19
From: Irish Meteorological Service

record high. 6 stations experienced new records. The recurrence period for such quantities in this area in September is approximately 50-100 years.

The weather in Denmark was relatively mild and dry.

In Sweden the month was generally warmer than normal with temperature anomalies up to ≥+2°C in the central part of the country. The monthly precipitation amounts were less than normal everywhere with rates below 25% of normal in the south increasing northward up to 95%.

The monthly temperature anomalies in Finland were mostly positive and up to +2°C except for the northernmost area. The month was very dry in southern and central parts of the country, especially in the south-west, where it was less than 25% of its reference value. On the contrary the north was quite wet with precipitation above normal.

In Belgium, the monthly mean temperatures were moderately above normal and precipitation near to half of normal. At station Uccle sunshine duration exceeded the long-term average by 54 h or 35%. The monthly mean wind speed was 9 km/h and thus reduced to 75% of the average from the reference period 1878-1986 at the same station.

In Luxembourg the monthly mean temperature was clearly above normal and the precipitation total below half of the long-term average.

In Germany the month was relatively warm, dry and very sunny. The country-wide temperature anomaly was +1°C and the precipitation total 80% of normal. Heavy rains in the area north of Stuttgart caused land slides and obstruction on roads, flooding of city streets and lifting of duct covers on September 9. Strong winds including local tornadoes caused a lot of damage to forests, houses and traffic installations at several places in the north of the country. During heavy thunderstorms near the middle Rhine valley houses, barns and people were hit by lightning strokes on September 22-23.

The long lasting drought in Czech Republic ended at the end of the month.

The month was relatively warm in Poland with a temperature deviation of +1°C from normal (fig. 5.2). There were observed very cold spells as well as hot periods. At the beginning of the month, minimum temperatures fell even below 0°C, but during the second half, maximum temperatures reached 31°C in the south. Precipitation sums were generally lower than normal (fig. 6.1) except for northern and central parts of the country. In the east less than 30% of the long-term average rain fell. Thunderstorms with downpours, above 50 mm daily in mountains, and wind gusts accompanied warm weather in the end of the month. Sunny and in many places rainless weather caused continuing drought.

The monthly mean air temperature in Lithuania was 12.8°C with an anomaly of +0.9°C. The weather had most often been determined by anticyclones and morning frost occurred after 14 nights during the month. The mean monthly precipitation amounted to merely 39mm or half of normal. Sunshine duration was 190 – 240 hours, thus exceeding the normal values by 40 – 70h.

In Belarus temperatures were close to normal (fig.0.7) and precipitation clearly in deficit (fig. 5.3).

Drought conditions in France continued until the end of the month, especially in northern parts of the country. Apart from obvious impact on water resources and agricultural yields, the soil drought had a severe impact on foundations of houses: thousands of houses and buildings spread over two thirds of the country suffered from cracks of the walls or ceilings, many doors and windows could not be shut any more.

In Portugal the monthly average temperature was above and the precipitation amounts were below the 1961-1990 normal in almost all parts of the country.

The monthly mean temperatures in Austria were near normal and precipitation rates varied from less than 25% of normal in eastern Tyrol to more than 125% in parts of Lower Austria.

In Slovenia the monthly mean air temperature was close to the 1961–1990 normal, the anomaly was small and mostly negative. There was more sunny weather than on average in the reference period. More precipitation than normal fell on the coast and over the eastern half of the country. Significantly less rain than on average fell on Karst and Vipava valley.

In The Former Yugoslav Rebublic Of Macedonia the monthly temperature anomalies were about -1.5°C and the precipitation totals near half of normal.

It was a relatively cold, rainy and cloudy month in Bulgaria. The monthly average air temperatures were about 1°C below normal. In the north of the country precipitation rates exceeded normal by about 45% and in the south they were slightly below the long-term average. The Black Sea coast received unusual high amounts of rainfall up to 250% of normal. Daily rainfalls in some locations were also very high, e.g. in Shabla 151mm, Spasovo 85mm and Dobrich 57mm.

A cold spell on September 4 in Greece made the maximum temperatures of the day stay below normal by 4°C to 8°C. Nevertheless, the country-wide monthly mean temperature was near to normal.

In Turkey the monthly mean temperatures were not far from normal with anomalies in the range of ±1°C. The monthly precipitation amounts varied from <10% of normal on the western coast up to 200% in the eastern parts of the country. A frost event damaged vegetables in the area of Nevsehir on September 6. During a storm on the western coast roofs and tiles from houses were displaced, minarets were destroyed and trees were broken in Ayvalik on September 11.

It was the coolest September since 1997 in Israel.

In Armenia the monthly mean temperature and the total amount of precipitation (see fig. 3.7) were close to normal.

October 2003

- **Very cold in central Europe and southern Scandinavia**
- **Very wet in south-eastern Europe, over the Alps and the western Iberian Peninsula**
- **Early seasonal snowfall in several countries**

The monthly mean temperatures in Iceland were moderately above normal. The precipitation was in deficit and amounted to only about half of the reference value.

It was the only month of the year in Ireland with a negative temperature anomaly. The lowest air temperature of the year at station Kilkenny was -4.7°C and recorded in late October during a spell of exceptionally cold weather. Precipitation of more than 60mm fell over the Dublin area between October 21 and 23, accompanied by almost continuous hail and thunderstorms.

In the U.K. the monthly temperature anomaly was -1.3°C and only 57% of the monthly precipitation was observed. Nevertheless, there was 34mm of precipitation at Charterhall in Scotland on October 21, and snow fell above about 200 metres asl. There was 7cm of snow lying at Glenlivet. Southern areas of England had heavy thundery showers on October 22, sleet and snow fell widely, and Dartmoor in the south-west had a covering above 300m. Both Scotland and England&Wales had their sunniest October in the 1961-2003 series.

The month was colder than normal over the greatest part of Norway. In southern parts of the country monthly anomalies were -2°C to -4°C and new absolute minimum temperatures for October were observed at several places. At station Sande-Laukollmyr the minimum temperature was -17.0°C and at station Hovden–Lundane -18.9°C on October 23. These are the lowest temperatures ever measured in October in the two counties, where these stations are located, since measurements started in 1867. The southern part of the country received less precipitation than normal. The monthly precipitation was only 20-30 % of the normal in the eastern counties and in parts of West-Norway.

The month was cold and sunny in Denmark with frost dominating during night time. At station Copenhagen the monthly temperature anomaly was -3.2°C and the precipitation total merely half of normal.

In Sweden a cold spell brought several new minimum temperature records in the southern part of the country. In a more than 100 years' long series new October records were set, e.g. in Örebro (-12.8°C), Göteborg (-8.5°C) and Halmstad (-9.6°C).

In Finland it was colder than normal almost in the whole country due to the very cold latter part of the month. The largest deviations, more than 2°C below normal were found in the south-west and in the north-western tip of the country. The monthly precipitation was close to or above normal in most parts of the country. The only exception was in the south-western coastal areas, where the monthly precipitation varied between 50% and 75% with respect to its reference value.

In Belgium it was very cold with precipitation slightly below normal. At station Uccle the monthly mean temperature had an anomaly of -2.6°C compared to the long-term average of 1833-1985 and of -3.0°C against the reference period 1961-1990. The mean daily minimum temperature was only 4.0°C at that station, thus being even 3.2°C below the long-term average and

the 3rd lowest value in the series since 1833. Stormy weather caused damage to several places in western Flanders on October 7.

The month in Germany was rather cold with an overall temperature anomaly of -3.1°C, with more sunshine than normal and a precipitation total exceeding the reference by 32%. Extreme weather affected western and southern parts of the country on October 7; thunderstorms with hail, intense snowfall, heavy rains and strong winds caused a lot of damage to properties and obstruction on roads. Stormy weather and snow fall again caused traffic obstruction in the island of Usedom and in western and southern parts of the country on October 23-24. The two nights from October 23-25 also brought new records of minimum temperature, e.g. -10.6°C at station Fassberg in the Lüneburg Heath (1.8°C below the old record) and -12.7°C at station Oberstdorf; privately operated stations measured extreme temperatures even below -20°C in the near Alpine area.

In Poland the month was very cold (fig. 5.2). Deviations of the mean monthly temperature from the long-term average achieved -4°C in the western and -2°C in the eastern and northern parts of the country. The minimum temperatures fell often below 0°C, but in some places and days also the maximum temperatures were negative. Precipitation was above normal (fig. 6.1), exceeding 200% in some places. Early in the month there were daily rainfall amounts of ≥40mm. The rich precipitation had a positive impact on soil moisture and water resources. Mountainous areas in the south received a snow cover.

Low pressure formations with frequent precipitation determined the weather in Lithuania. The first ten-day period was relatively warm while the second one was much colder and the third one turned out to become the coldest. There was little sunshine, only half of normal at some places. The monthly mean air temperature was +4.9°C with an anomaly of -2.3°C. It was raining/snowing almost every day. The monthly precipitation amounted to 84mm, 140% of normal. The seaside area encountered 10 windy days with maximum wind speeds reaching 86km/h.

In Latvia the month was rather cold with an anomaly of -2.1°C and a precipitation total slightly above normal (see fig. 7.1). Heavy snowfall led to a snow cover of 39 cm depth in Riga in the morning of October 27 and caused transport problems (fig. 10.1) and many accidents with injured people. It was the deepest snow cover in October for both Riga and the whole country. However this first seasonal snow did not last for long. Due to a sharp rise in temperature it had all melted by October 29.

The month was much cooler than normal in Belarus (fig. 0.7). The country-wide precipitation total exceeded the reference by about 80% (fig. 5.3). The early formation of a temporary snow cover, lasting for 20 days of the month, was the distinctive special feature of year.

In Switzerland it was the coldest October north of the Alps since 1974 with temperature anomalies of -2°C to -3°C. The period from October 23-26 was extremely cold. Snow fell in the north of the country on October 23. For the first time since 1974, a snow cover appeared in the northern and eastern lowlands in October. Zurich had its first ice day for October since records began in 1864 with a maximum temperature of -0.3°C. At some places of the Jura significantly lower minimum temperatures were recorded on October 25 and 26, namely -16.1°C in La Chaux-de-Fonds and -23.2°C in La Brévine, thus being the lowest temperatures measured so far in October since 1901 with -8.8°C and -14.7°C respectively. It was the only month with abundant precipitation north of the Alps; near the Austrian border the precipitation rate reached 250% of normal.

The month was cold and in large parts of Austria very wet. Monthly precipitation amounts reached 200 to 300 percent of normal in the provinces of Vorarlberg and Tyrol. A new record daily amount of 127mm of rain was measured in Bregenz

on October 5. Heavy snowfall formed the earliest snow-cover ever in eastern Austria from October 23 to 24, including the towns of Vienna, Graz and Eisenstadt. In the following clear night at many places in Austria temperatures dropped to new all-time minimum values for October,



Fig. 10.1:

Snow cover in Riga on October 27 2003
From: Latvian Environmental, Geological and Meteorological Agency

e.g. down to -13°C in Mariapfarr in the province of Salzburg.

In Slovakia an unusual early snow cover appeared on October 10 in the south-western part of the country and reached a depth of 6cm to 9cm. It was the earliest seasonal appearance of a snow cover since the beginning of observations in 1921.

In Hungary it was rather cold (fig. 2.3) and wet (fig. 3.3). The month began with summerly warm days but cooled down later. The daily maxima dropped down to values between +1°C and -4°C on October 24. The precipitation was much more than the average and snowfall occurred on October 23-24 which caused a snow cover of 10cm or more in the plains. It was the earliest snow cover in the last 100 years.

The monthly mean temperature in Slovenia was generally below normal with anomalies mostly between -1°C and -2°C. In the north-western part of the country the temperature anomaly was statistically significant; in the Julian Alps the mean temperature was 3.3 C lower than the average of the reference period. Most of the country got more precipitation than on the long-term average. It rained in the first and the last third of the month, while it was dry in between. An unusual phenomenon was the building of a snow cover on October 24-25. A snow cover in October has not been observed in Ljubljana since 1970.

In Croatia the month was rather cool and rainy. At station Zagreb Grič the temperature anomaly was -1.8°C and the monthly precipitation rate 148% of normal.

In Bosnia and Herzegovina the month was relatively cool and very rainy. The monthly mean temperature, calculated from 12 stations, was 1.2°C below normal and the mean precipitation rate at the same stations 201% compared to the reference period 1961-1990.

The month was extremely rainy in Serbia and Montenegro. The precipitation total was two to four times higher than normal.

In Romania the month was cooler than normal and extremely wet. The country-wide temperature anomaly was -1.4°C. The overall precipitation total summed up to 255% of normal and varied throughout the country between 150% and 275%.

In Moldova the month was cool with temperature anomalies below -1°C and very wet with precipitation rates of more than 200% of normal (see fig. 5.5).

In Albania it was the wettest month of the year instead of November according

to the reference period 1961-1990 (see fig. 8.5). The actual monthly precipitation rates varied from 150% up to 300% in several mountain areas in the south-east and north-east of the country.

The monthly mean air temperatures were about normal in south Bulgaria and above the averages in the north. Precipitation was 220-240% of normal. During the passage of a cold front strong winds combined with heavy rainfall and snowfall caused damage to electricity supply and roads in the southern part of the country on October 8-9. Downpours at the northern Black Sea coast caused local flooding and activated landslides. Sunshine duration was 30-50 hours lower than normal (fig. 1.5).

Temperature anomalies in Greece were generally positive and increasing from north to south up to about +3°C. There was also a strong meridional gradient in precipitation rates rising from <50% in the south up to 200% in the NE. Heavy showers and thunderstorms affected the north-western part of the country with floods, landslides and damage to roads and agricultural sites on October 24. On that day extreme rainfall occurred at the stations Aktio and Arta in Epiros, when amounts of 100mm respectively 189mm poured down in 24 hours; the affiliated monthly reference values are 104.1mm and 94.6mm respectively.

In Portugal the month was cooler than normal with temperature anomalies of about -1°C and very wet with precipitation rates up to >200% of normal.

The month was relatively warm in Turkey. Precipitation was unevenly distributed with a surplus in the north and in deficit in the southern part of the country. Stormy weather with heavy rains caused a lot of damage to the north-western coastal areas and to the central northern province of Corum on October 9. Another extreme weather event occurred in the eastern province of Erzurum on October 28, when heavy snow fall led to disruption of water supply, energy and telephone lines.

The monthly mean temperature in Cyprus was 1.3°C above normal and the mean precipitation rate only 42% of the reference value 32.7mm. Heavy rains and thunderstorms, some of them combined with hailstorms and flooding, caused a lot of damage all over the country, especially in the areas of Larnaka, Troodos and Limassol on October 1-2. Strong winds occurred in the area of Pafos causing damage to properties on October 28.

The month was warmer than normal and dry in Israel. Most areas received 5-15mm, which is less than 40% of normal. The only exception was severe rainfall on October 1 in a small area in the north of Hula Valley: 65-75mm of rain fell within 1-2 hours causing local flooding in the area.

In Armenia the month was characterized by unusually warm weather. The monthly mean temperature exceeded normal by 2 - 4°C, although there was a significant cooling down during the last days of the month. Maximum temperatures were ≥30°C and up to 33°C at station Kapan. The monthly precipitation total all over the country was 140% of normal. (see fig. 3.7). At some places 32 - 42mm rain fell on one single day, equaling 100-120% of the monthly normal precipitation.

November 2003

- **Generally milder than normal except for some areas in the south-east of the Region**
- **Much drier than normal in parts of Scandinavia, in large areas of central and eastern Europe, and in western Turkey and Cyprus.**
- **Extremely mild in Norway**

The month was moderately milder and wetter than normal in Iceland. The first days of the month were rather cold with snow in the north, but the second week was unusually warm.

In the U.K. the monthly mean temperature was 1.9°C above normal, whereas the country-wide precipitation total equalled the 1961-1990 average. In Scotland, November 6 and 7 were exceptionally warm and sunny with the temperature rising to 20°C at Aultbea on the 7th. This was just short of the highest temperature recorded in Scotland in November, 20.6°C at Edinburgh in 1946. After a very dry year so far, some locations south-west of London recorded over 75mm of rainfall in a 48 hour period between November 21 and 23. This exceeds the average for the whole month. Northern Ireland had the sunniest November in its 1961-2003 series with 76.6 hours.

In Norway the month was warmer than normal in the whole country and set some new records. The monthly mean temperature at Torsvåg Lighthouse in the north was 5.1ºC, which is 3.5ºC above normal and the highest November temperature since the measurements started here in 1933. Tromsø with measurements since 1920 noted 2.4ºC, which is the same as the record from 1999 with 3.5ºC above normal. In southern parts of the country the monthly mean was 4°C to 5ºC above normal. A special Foehn situation occurred on November 6 with extraordinary air temperatures for the month. At station Tafjord 21.8ºC was measured, which is a new national absolute maximum for November. 34 other stations got new November maxima as well. In central parts of the country, the monthly precipitation amounts were only 10-20% of normal. This is about the second or third driest November month from the measuring series in this area.

The month was very cloudy and consequently relatively mild in Finland, the monthly mean temperature being in most parts of the country ≥2°C above normal. The largest deviations, close to 4°C above normal, occurred in the north-east. The monthly precipitation varied between 50% and 125% of its reference value in most parts of the country.

In Belgium the monthly temperature anomalies were ≥+2°C and the precipitation rates near to normal. A tornado affected the province Hainaut on November 3.

The month in Germany was mild with a temperature anomaly of about +2°C and dry with an overall precipitation rate of nearly 60% of normal. A local tornado carved an aisle of 20-30m width through the town of Kirchhain in Hesse on November 3, displacing roofs from houses and destroying wooden cabins.

The month was relatively warm and dry in Poland. The monthly mean temperatures exceeded normal by 1.5°C in the north-west and 3.5°C in the south-east. In the end of the month maximum temperatures in the south exceeded 17°C. The monthly precipitation sums were generally lower than normal. The southern part of the country got less than 50% of its normal precipitation. In the second half of the month intense rain occurred with daily sums exceeding 20mm.

In Lithuania the weather was medium warm and moist in the first and the third decade of the month and much colder in the second ten-day period. The third decade was the warmest with maximum air temperatures rising up to 7 – 11°C. The mean monthly air temperature was 3.7°C with an anomaly of +1.7°C. The month was rather dull; sunshine duration summed up to merely 10 – 25 hours and only 1 – 3h in the northeast border regions, which is the shortest sunshine duration in this part of the country since 1961. Precipitation was very diverse, from 50% to 150% of normal. The mean monthly precipitation amounted to 46 mm or 71% of normal. There were 12 days totally with fog in most regions and the occurrence of freezing rain and hoarfrost.

In Switzerland the month was especially mild in the mountain areas with positive temperature anomalies of 2.0°C-3.5°C. South of the Alps it was the first month of the year with more precipitation than normal.

Temperature anomalies in Italy were generally positive and higher than 2°C at many places in the north. Precipitation was below normal in the central part of the country, but near to or above normal else and locally even >200% in the north and in Sicily.

The monthly mean air temperature in Slovenia was above normal. The anomaly was statistically significant. In high mountains it was 2.4°C, in low land between 2.0°C and 3.6°C. The highest daily maximum temperature was recorded on November 1; in some places more than 20°C were observed, the warmest was station Črnomelj with 22°C. The monthly precipitation amounts were unevenly distributed with rates above and below normal.

In Croatia the month was very mild with temperature anomalies about +3°C and a precipitation total of nearly $^2/_3$ of normal.

In Bosnia and Herzegovina the monthly mean temperature was 7.5°C and thus 2.1°C above normal. On the average of 12 stations, precipitation amounted to 83mm, which is 73% of the normal rate.

In Serbia and Montenegro the month was significantly warmer than the long-term average. There was a precipitation deficit in the whole country except for the south of Montenegro.

In Romania the month was milder than normal with a country-wide anomaly of +1.4°C and relatively dry with a precipitation rate of 68% against the reference.

The air temperatures in Bulgaria were 1°C higher than normal. The month was relatively dry with precipitation 40-60% of the normal rates. There were significant daily precipitation amounts, 60-85mm on November 29 and 30, which caused flooding of the river Arda in the region of the Rhodope mountains. Sunshine duration was less than normal. Fogs were registered on 22 days – mainly in north Bulgaria. The temperature alteration between warm and cold in combination with wet and foggy weather created appropriate conditions for flue outbreaks in more than 8 cities.

In Portugal the monthly mean air temperatures and the precipitation amounts were above the 1961-90 normal.

The mean monthly temperatures in Greece were clearly above normal, whereas precipitation rates varied from <15% to >150%. Unusually high seasonal maximum temperatures were recorded from all over the country on November 2; the highest temperature measured was 32°C at station Heraklion, being 12°C above the long-term average of the period 1955-1997.

In Turkey the temperature anomalies were near to normal. Except for the east, the month was rather dry, especially in the western central part of the country. The country-wide precipitation total reached about 70% of normal. Nevertheless, heavy rains affected the area of Mugla in the south-west and caused flooding of houses, depots and agricultural plantations on November 6.

Cyprus had a monthly temperature anomaly of +1.1°C and a precipitation

deficit of 57% compared to the reference value 53mm. Heavy rains in combinations with strong winds caused floods and a lot of damage in the area of Limassol on November 9.

The month was warm and dry in Israel. Rainfall amounts were 60%-80% of normal in the northern parts of the country and 40%-60% in the central parts. In the last 8 years November was warm and dry 6 times, and 2 times, 1997 and 2001, temperature and rainfall were close to normal. Only in 1995 November was cool and rainy. There was a warm spell at the beginning of the month; in the coastal plain 31-33°C were recorded and in the mountain areas 28-30°C, an unusual event in November.

December 2003

- **Very mild in the north-eastern Region**
- **Moderate positive temperature anomalies in central Europe**
- **Mainly drier than normal except for the Baltic countries and coastal areas around the North Sea and the Mediterranean**

The month was rather mild and wet in Iceland, but the weather was mainly pleasant. The south-west was hit by a paralyzing snow storm of a short duration on December 29.

In the U.K. the monthly mean temperature as well as the precipitation total had marginal positive deviations from normal. A deep depression formed over the U.K. on December 20 bringing widespread heavy rain. The low moved east to Denmark during next day allowing cold northerly winds with heavy wintry showers in its rear. High ground in the north and north-west including Wales received snow cover as did the north-eastern coastal counties. Early on December 22 more snow fell in eastern counties and some roads became blocked. 80 mm precipitation was recorded in 18 hours at Shap Fell in north-western England on December 26.

The monthly temperature anomalies in southern Norway were from +3°C up to +5°C. In the northern part of the country the monthly mean temperature was a little above or near normal. Precipitation was above normal for the whole country and up to 2-3 times of normal in the north. Continuous heavy rain in the north-west part resulted in sums over 3 days up to 245.3mm on December 17-19. Strong northerly winds of hurricane force affected the western coast and even the capital of Oslo with gusts up to 108km/h on December 4-5. During this extreme weather event platforms on the continental shelf recorded wave heights of about 10 m and even more in the episodes of December 15-16 and 25.

In Denmark the month was mild with occasional frost and snow especially in the days before Christmas. But the weather changed and Christmas eve was mild and grey with very few places still covered by snow. A strong northerly storm damaged the environment in the northern parts of Fyn and Nordsjælland on December 5-6.

In Sweden stormy weather caused prolonged disruption of electricity supply for 100˙000 households in the middle of the country during December 5-6. Another storm event in combination with wet snow caused again long-lasting failure of electric

power for about 80˙000 households in the southern part of the country on December 21-22. Christmas was characterised by rapid changes in temperature and large amounts of rain and later snow in the south-west.

In Finland the month was warmer than normal almost everywhere with the largest temperature deviations, close to 4°C above normal, in the eastern parts of the country. The monthly precipitation rates were above normal with values exceeding 150% of their reference in the south-west, in some eastern areas as well as in the north. An exceptional high number of days with winds of at least strong gale strength was observed in the maritime regions. Within these episodes sleeting and icing events accumulated heavy loads on power lines in some areas of the north-east and caused interruptions in power supply.

In Belgium temperatures and precipitation amounts were near normal. The monthly sunshine duration at station Uccle exceeded the long-term average (1887-1988) of 43 hours by 55% (fig. 2.1).

The month in Germany was generally mild, dry and sunny with a temperature anomaly of +1°C and an overall precipitation deficit of 20% of normal. Nevertheless, there were several extreme weather events in different parts of the country. Strong winds with gusts of more than 150km/h caused lots of damage to the infrastructure and together with heavy snow-fall and ice on roads led to numerous car accidents with a considerable number of deaths and many injured people, especially in the northern lowlands and in western parts of the country, but also in Thuringia and Bavaria, on December 5-6, 11-12, 15-16 and 21-23.

The month in Poland was milder than normal by 1°C in the south-west and 2°C in the north-west of Poland. Maximum temperatures exceeded 12°C in the south and south-west. The second half of the month was colder with minimum temperatures below -10°C in the south and the formation of a snow cover. Precipitation was close to normal but varying across the country from 55% of normal in the south-east to 148% in the north-west.

The weather in Lithuania was influenced by eastward moving cyclones coming from west or south-west and therefore relatively mild. The daytime temperatures were predominantly positive. The monthly mean air temperature was 1.0°C with an anomaly of +3.4°C. There were only three days of the month without precipitation. The precipitation total amounted to 63mm, which is near normal. However, several regions received 94–104 mm of precipitation, which is over 150% of normal. The seaside encountered wind speeds exceeding 54km/h for as many as 20 days in total with gusts up to 94 km/h.

In Latvia the month was extremely mild with a country-wide temperature anomaly of +3.8°C and a precipitation total slightly above normal (see fig. 7.1).

In France temperature anomalies were generally positive up to about +1.5°C. The monthly precipitation rates were unevenly distributed from less than 50% in northern areas up to 200% in the south.

During the month southern Switzerland received abundant precipitation with 200-300% of normal. North of the Alpine ridge much lower amounts were registered; the west and the south-west received only 20-50% of normal.

The monthly mean temperatures in Austria varied from normal to 3°C above normal in the western and south-western parts of the country, while precipitation increased from 50% of normal at lake Constance to 180% in north-eastern Lower Austria. Heavy snowfall, gusts and thunderstorms caused a lot of car accidents leading to obstructions on motorways in Upper and Lower Austria and around Vienna on December 15. On the next day thunderstorms and strong winds damaged forests and power lines and led to the blocking of roads in Carinthia.

In Slovenia the mean air temperatures had anomalies between +0.5°C and +2°C against the 1961-1990 reference. The limit of 2°C was exceeded only in the capital Ljubljana and on the coast. Precipitation was

variably distributed with rates significantly below normal and above at other places. Most of precipitation was concentrated in the last third of December. A snow cover in the lowlands was built up in the second half of the month, its maximum depth remained mostly below 10 cm. There was much more sunny weather than on the average in the reference period, especially in the Ljubljana basin.

The temperature anomalies in Croatia were mostly positive and ≥1°C mainly in the western and <1°C mainly in the eastern and southern part of the country. Precipitation was below 50% of normal in the east and up to normal in the west.

The monthly mean temperature in Bosnia and Herzegovina was 1.0°C and thus slightly (+0.4°C) above normal. The monthly mean precipitation amounted to 57mm, which is 58% of normal.

In Serbia and Montenegro the monthly mean temperatures were close to normal and precipitation amounts less than the long-term average in the whole country. A snow cover formed on December 7 in mountainous areas and remained until the end of the month with a maximum depth of 60cm measured on December 26 on Kopaonik.

In Bulgaria the month was cooler than normal by 1°C in the south and by 0.5°C in the north. Minimum air temperatures were lower than 0°C and -5°C in 20-25 days and 5-10 days, respectively. There were 2-5 ice days during the month. Precipitation exceeded normal by 20% in the northern and by 55% in the southern part of the country. Pouring rain and succeeding snowstorms with precipitation amounts of ≥100mm on December 23-24 caused flooding in Kardjali as well as interruptions of the electricity supply in many villages. The road traffic before Christmas was embarrassed and stopped in some locations. There were many road accidents, 124 cases alone in Sofia. Fog was observed on 23 days, long-lasting in most areas; the Sofia airport was closed several times during fog episodes.

Two extreme weather events were reported from Turkey. Heavy rains engendered flooding of houses and agricultural areas in and around Ceyhan on December 16. Strong winds caused the interruption of power lines and damage to houses and trees in Demirci one day later.

In Cyprus the monthly mean temperature was slightly above normal by 0.4°C, whereas precipitation amounted to 127.3mm or 121% of normal. A tornado occurred in the western area of Limassol causing damage to houses on December 4. Thunderstorms and a tornado occurred in the area of Larnaka in the morning of December 26 causing damage to properties. Floods occurred in the area of Larnaka on December 3, 4 and 15.

Temperatures were close to normal in Israel. Rainfall spread was not homogeneous – rainfall amounts were above normal in the northern parts of the country and in some areas of the coastal plain, and below normal in other parts of the country.

Activities and Results of European Climate Centres

Report on ECSN activities 2003

by: Walter Kirchhofer, MeteoSwiss

- **General remarks**

The EUMETNET Council has decided that in the future the European Meteorological Society (EMS), in partnership with ECSN, will organize the European Conference on Applied Climatology (ECAC). ECSN will remain responsible for the scientific part. The first combined conference ‚EMS4/ECAC5" will take place in Nice, 26-30 September 2004.

The fourth ECSN Climate Database Workshop on Data Management and Data Quality has taken place in Helsinki, Finland, 19-20 May 2003. The workshop continued the series of ECSN Workshops to consolidate the network among climate database experts.

The project Drought Investigations (Meteo HU, PT) was terminated with a Final Report in March 2003. The objectives of this project have been the following ones: evaluation and use of different drought indices, analysis of long drought index series, study of thresholds of drought indices, calculate the spatial distribution of drought indices on different time scales, and recommendation of drought indices.

Within the European Integrated Project ‚ENSEMBLES", the Work Package WP 5.1: ‚Development of high-resolution observational datasets for Europe" was proposed by KNMI in connection with MeteoSwiss and ECSN.

The 8th ECSN Advisory Committee (EAC) Meeting has taken place in Toulouse, France, 24-26 September 2003.

At its 19th Meeting the EUMETNET Council agreed to continue the Optional Programme ECSN for a third phase of three years, starting on1 January 2004. MeteoSwiss was unanimously selected to be the Responsible Member for ECSN with Dr. Walter Kirchhofer as Programme Manager.

- **European Climate Assessment & Dataset (KNMI)**

The paper ‚Homogeneity of 20th Century European Daily Temperature and Precipitation Series" has been published in the International Journal of Climatology.

A document was prepared that describes the technical work of the ECA&D project and its infrastructure (www.knmi.nl/samenw/eca). The document provides an overview of how the ECA&D work is embedded in KNMI, and forms the core of the documentation of the ECA&D system as developed in the project (database, quality control procedures, extremes analyses and website).

The results of the homogeneity analysis of ECA series were presented at the fourth seminar for homogenization and quality control in climatological databases in Budapest in October. The results of the trend analyses of indices of extremes based on the ECA dataset

were discussed at the Norwich meeting of the CCl/CLIVAR working group on Climate Change Detection and Monitoring Indices in November.

The experiences gained over the past years in using indices to analyse changes in extremes were shared with the participants of the CLIPS RA VI workshop in Erfurt (Germany) as part of a training session. As a follow-up, the countries in WMO Region VI that are not yet registered as project member were invited on an individual basis to become participant.

- **Generate Climate Monitoring Products (DWD)**

According to the decisions of the second GCMP workshop in Hamburg, and on request by the project leader, several countries offered to include European and National monitoring products of their Services in the GCMP Web site. Appropriate links to the respective servers have been set up by the GCMP Web master. Efforts were concentrated on the transformation of the GCMP Web site into a quasi operational mechanism. The number of countries contributing to the GCMP web site continued to increase up to eight NMHSs. It should be noted with acknowledgement that in spite of commercial constraints the participants make their contributions timely and freely available to the other NMHSs and to the public via the GCMP web site.

Taking into account the findings of the second GCMP workshop, special emphasis was put on monitoring products of temperature and precipitation. Moreover the layout and navigation were revised and adapted. Thus with the completion of the project a quasi operational Internet platform is at hand, accessible under the URL http://www.gcmp.dwd.de, displaying European and national climate monitoring products on a regular basis.
In order to fully reach the project goals it is important to obtain a good coverage of the European region with national climate monitoring products. Therefore efforts are continued to enhance the number of actively participating European NMHSs.

- **Climate Atlas of Europe (Météo-France)**

The "Climate Atlas of Europe" will contain monthly normals for precipitation, temperature, wind and sunshine duration and additional statistical information for these parameters and for the occurrence of phenomena such as fog, thunderstorm, hail and snow.

After the database, including the metadata, were considered as final, a set of yearly maps has been drawn.

All the information has been provided to the subcontractor in charge of the CD Rom. The priority assigned to the subcontractor was to realize first a web site from which all the information is available to all participants for a final check of both data and language text.

The draft CD-ROM has been presented at the last ECSN Advisory Committee Meeting. It includes all expected functionalities. The database including metadata will be accessible to anyone having the ACCESS software. It is reminded that it contains data from more than 700 stations from 24 countries, with up to 43 parameters.

A CD-ROM comprising the French and the English versions of the software has been made.

Ozone Layer over Central Europe in 2003

by Hans Claude, Ulf Köhler and Wolfgang Steinbrecht, Deutscher Wetterdienst

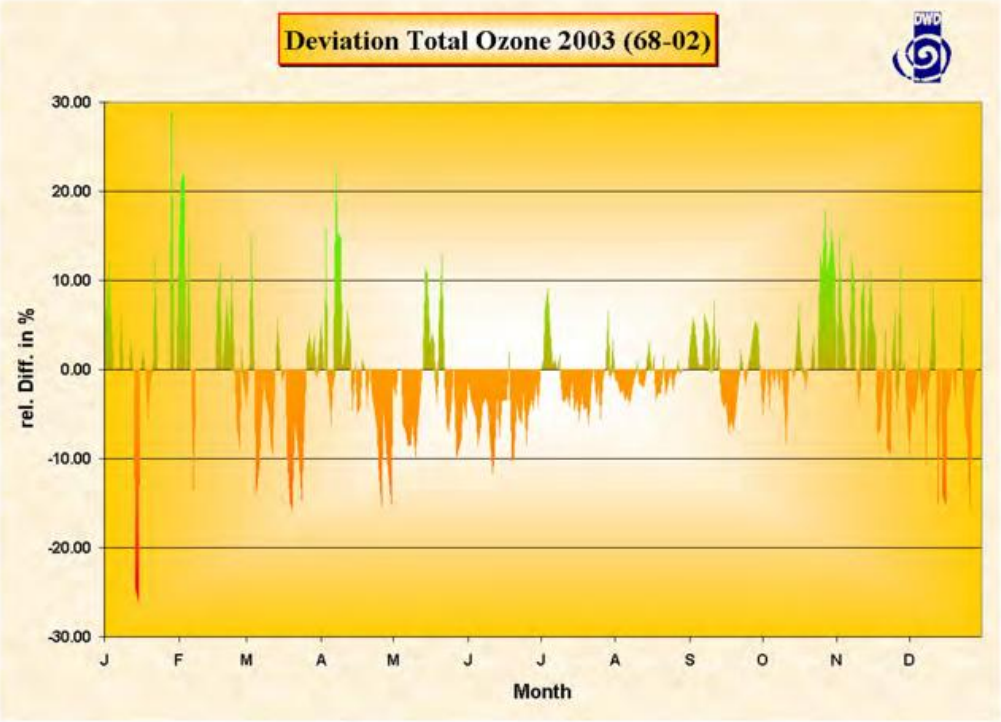


Figure 1: *Relative deviation of total ozone daily means from the climatological long-term mean. Measurements are from the year 2003 at Hohenpeissenberg (47.8°N, 11.0°E).*

The dominant meteorological feature of 2003 was the extremely warm summer in Central Europe, with record temperatures from June to August. At northern mid-latitudes, the lower stratosphere, and thus the total ozone column, is affected by tropospheric circulation patterns. Therefore, this extreme summer with frequent and persistent high pressure systems over Europe should be reflected in low total ozone. Indeed, Figure 1, showing the percentage deviation of total ozone from the long term mean, does indicate a long period of negative deviations from May to August. However, different from the extreme tropospheric temperatures, the total ozone values in the summer of 2003 were not extraordinarily low compared to previous years (e.g. compared to 2000). The frequent and persistent high pressure was only one of many factors affecting total ozone. By itself, it would have resulted in very low total ozone. However, other natural factors like the 11-year solar cycle, the Quasi-Biennial Oscillation (QBO), or variations in the global meridional Brewer-Dobson circulation also influence total ozone at northern mid-latitudes. They have masked the effect of the extremely warm summer of 2003.

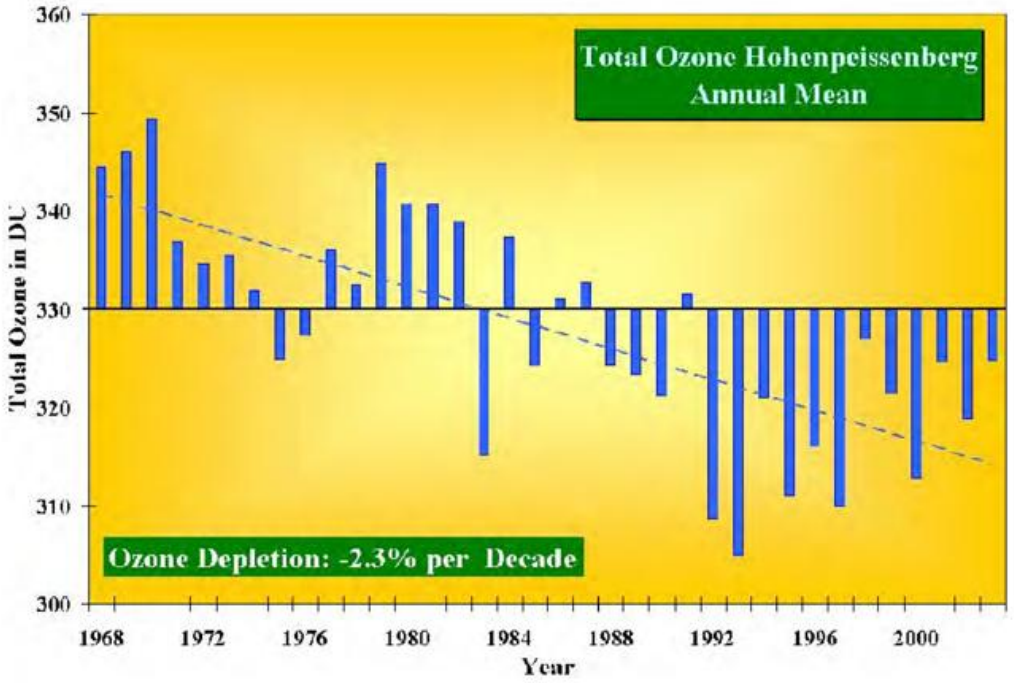


Figure 2: *Annual means of total column ozone above Hohenpeissenberg since 1968.*

The time series of annual means, given in Fig. 2, also does not show extremely low total ozone in 2003. Since the record low values of 1993, two years after the Mt. Pinatubo volcanic eruption, total ozone has been increasing from about 305 Dobson Units (DU) to more than 320 DU. Are these 10 years of rising total ozone level a conclusive indication for a beginning recovery of the ozone layer? The answer is no. While measurements of stratospheric chlorine loading do show a levelling off or even a slight decrease in recent years, the positive influence on total ozone levels is still small, probably less than 5 DU. This is much smaller than recent ozone increases related to other, natural, factors: The gradual disappearance of the Mt. Pinatubo aerosol cloud has increased total ozone by 10 to 30 DU since 1993. Changes in the phase of the Arctic Oscillation also resulted in ozone changes between +5 and +15 DU since the early 1990s. Given these large natural background variations, the small signal of a possible beginning recovery cannot yet be detected in total ozone data.

In order to see positive effects from the Montreal Protocol, which has undoubtedly achieved a beginning decrease of stratospheric chlorine levels, we should look at ozone levels in the upper stratosphere. There, ozone is controlled to a larger degree by photochemical reactions. The number of influences is smaller and better defined than for total column ozone.

First indications of the expected recovery should appear earlier there than in total ozone. Note, however, that the contribution of this region to the total ozone column is very small.

This evolution of upper stratospheric ozone between 35 and 45 km altitude, near Hohenpeissenberg, i.e. over Central Europe, is given in Figure 3. The long-term decline of upper stratospheric ozone by -10% to -15% since 1980 is clearly evident. It is caused by increasing chlorine from man-made sources. Other factors influencing ozone levels in the upper stratosphere are the 11-year solar cycle and the QBO. Their effects on ozone have been estimated and eliminated for Figure 3.

The recent ozone anomalies in Figure 3 show no clear indication of ozone levels above the long-term trend line. There are only inconclusive signs for a levelling off or a slight increase, which would indicate a beginning recovery. The situation is clearer in other parts of the world: Data from near-tropical Hawaii (20°N, 156°W) or from Lauder (45°S, 170°E), at

southern mid-latitudes do show more conclusive evidence for a beginning recovery. Presently it is not understood, why the same is not seen above Central Europe.

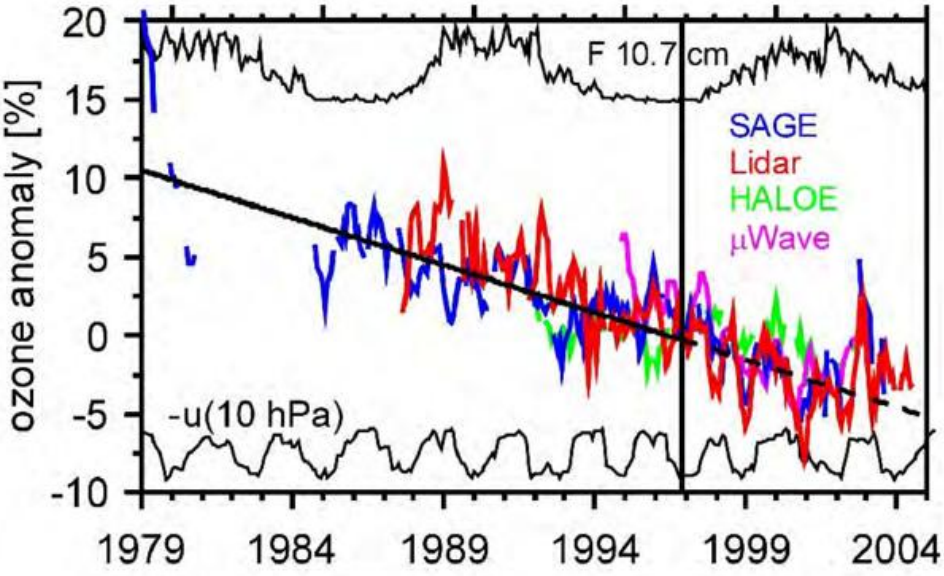


Figure 3: *Anomalies of upper stratospheric ozone between 35 and 45 km altitude, based on measurements by Lidar at Hohenpeissenberg (Germany), microwave radiometer at Berne (Switzerland), and zonal mean data from the SAGE and HALOE satellite instruments. Effects of the 11-year solar cycle (thin black line at top) and the quasi-biennial oscillation (QBO, thin black line at bottom) have been taken out.*

We may conclude that neither total ozone nor upper stratospheric ozone above Hohenpeissenberg and Central Europe show clear and unambiguous signs for a beginning recovery of the ozone layer. Chlorine levels are still near their maximum. Depending on other factors, among them climate change and the future evolution of stratospheric temperatures, periods with very low ozone levels have to be expected for many years.

Hydrometeorological Conditions During the Extremely Dry Year 2003 in the Long-Term and European Context

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In 2003 Europe was affected by extremely high air temperature especially in the summer. According to an analysis of Luterbacher et al. (2004) it has even been the warmest summer in Central Europe since 500 years. The heat is the major cause of the European drought in this year. Figure 1 shows the high seasonal anomaly of air temperature up to 5K in the summer 2003 (June to August), and an area warmer than normal reached from western North Atlantic to the border of Russia and from North Africa to Arctic. A blocking high pressure area covered Europe in the summer and so the spatial distribution shows a typical omega structure.

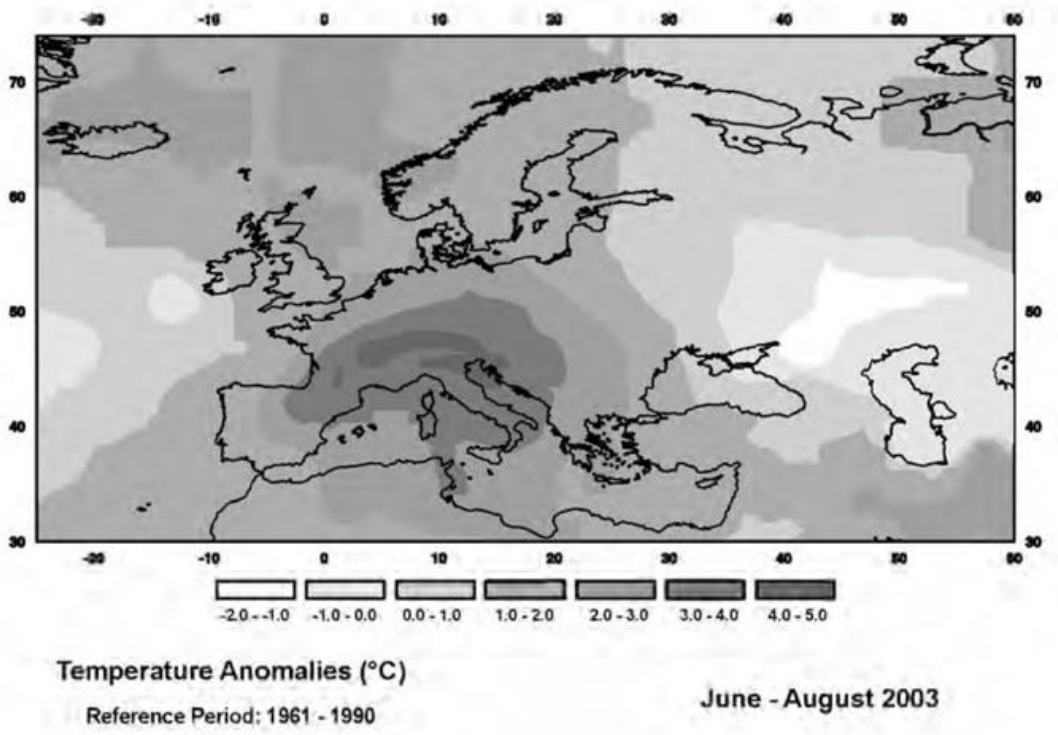

Figure 1: *Seasonal anomaly of air temperature (°C, June - August 2003)*

For complementation the spatial and temporal structures of precipitation anomaly have been evaluated based on gridded monthly precipitation analyses of the GPCC, which are based on meteorological data from SYNOP and CLIMAT reports received via GTS. The following analyses base on the global monthly grid data of the "monitoring product" of the Global Precipitation Climatology Centre (GPCC), available since 1986. This product contains monthly area mean precipitation with a grid area of 1° by 1° longitude and latitude from observed stations, which are calculated upon objective analyses (Rudolf et al.; 1992). So these results represent no selected points of conditions, but area means.

Figure 2 shows that the year 2003 was very dry over Central Europe not only from high temperature but also from low water supply by precipitation.

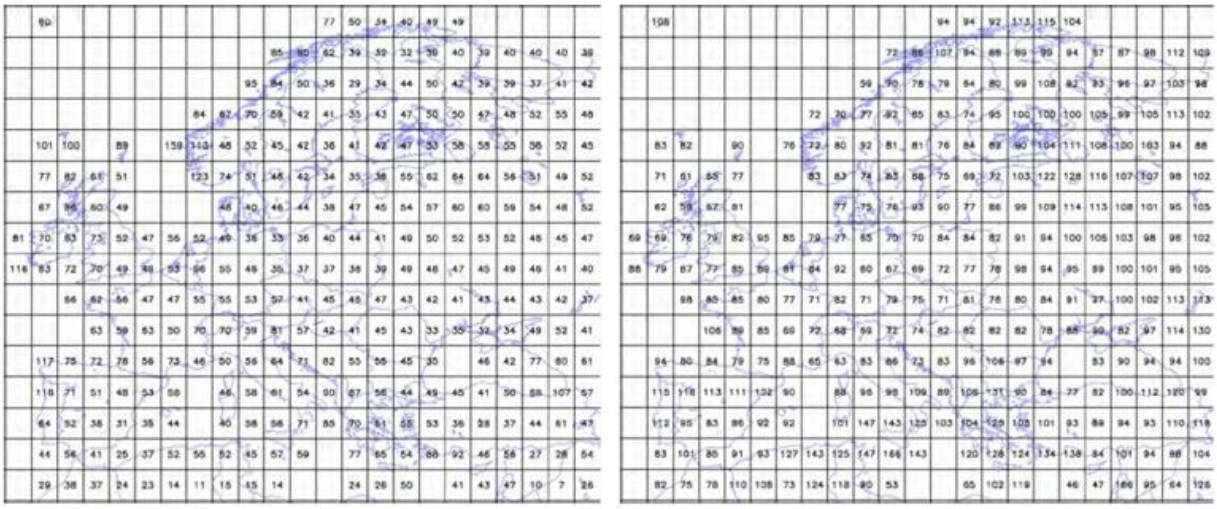

Figure 2: *Annual precipitation totals (mm/month, left) and percentage (%, right) for the period Dec. 2002 - Nov. 2003 (percentage related to normal 1961-1990, based on GPCC's monthly monitoring analyses).*

For seven selected areas of Europe the annual accumulation of monthly precipitation has been derived from the gridded data for each individual year of the period 1986-2003. The seven areas have been selected with respect to the annual precipitation anomaly (Fig. 2) and the spatial data coverage shown in Figure 3. The numbers in Figure 3 indicate the number of stations with data in the grid cell.

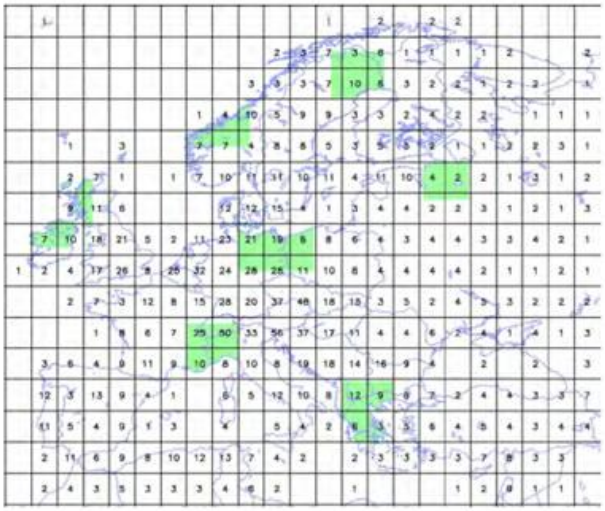

Figure 3: *Regions selected for analysis of time-series shown in Figure 4. Numbers indicate the number of stations for each grid box.*

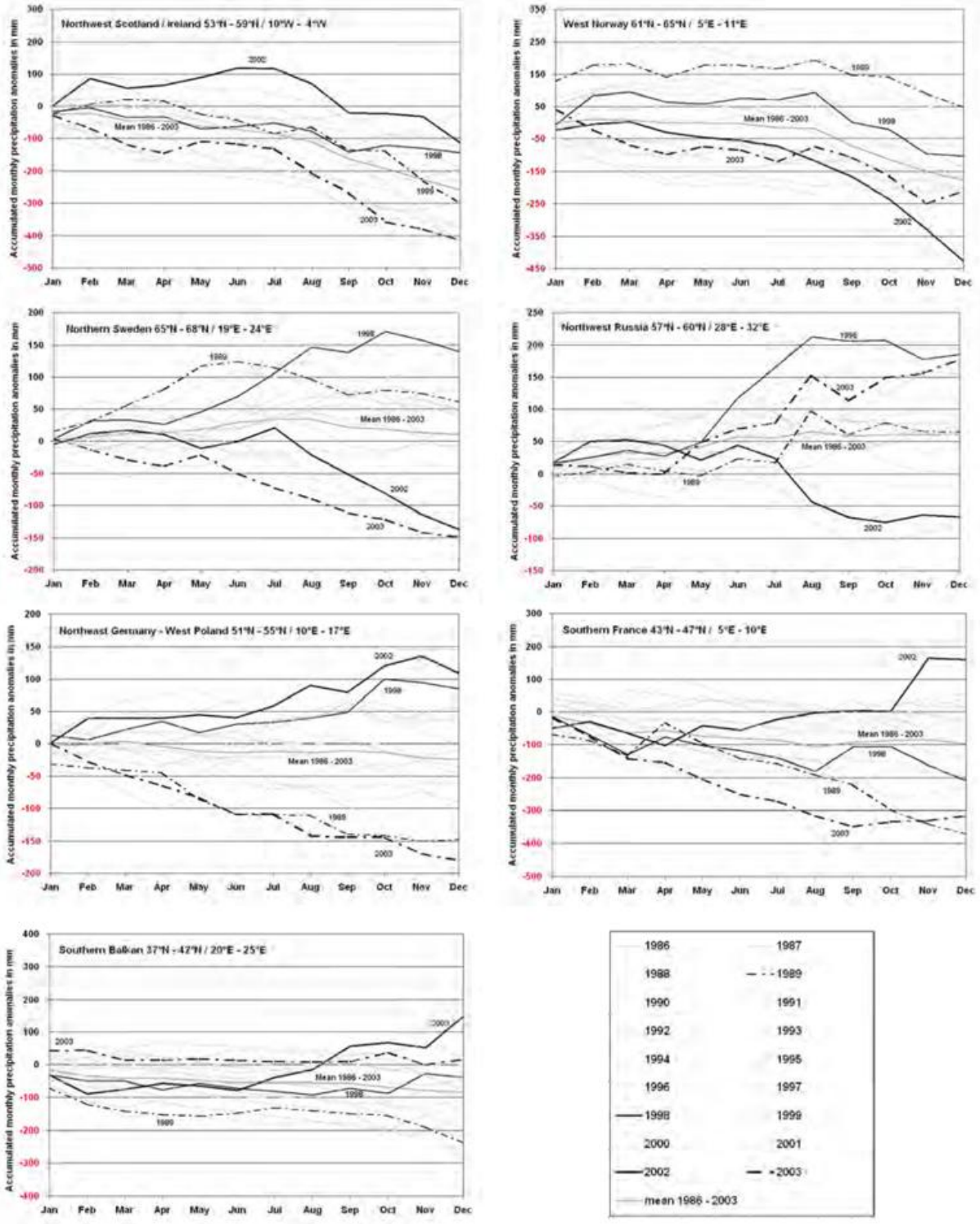

Figure 4: *Annual accumulation of monthly precipitation anomalies (mm) related to the period 1961–1990 for selected regions being marked in Figure 3.*

Comments on the diagrams of Figure 4:

Within the considered period 1986-2003 for the two regions Germany/Poland and Southern France both the recent years 2002 and 2003 are the most extreme years with 2002 being very wet and 2003 very dry. In France only 1989 had less precipitation than 2003. The yearly area mean precipitation for the period 1986-2003 in Germany/Poland is about 20mm, in Southern France nearly 100mm lower than for the period 1961-1990. Especially the precipitation

deficit in spring leads to less soil moisture in the upper layers of the soil. This decreases the evaporation in the summer and so intensifies the heat-wave.

On European scale, however, the behaviour is considerably different, especially for the annual evolution in the single years, caused by the large-scale circulation patterns:

- For Northern Sweden the year 2003 is the driest in the period 1986-2003, too, but 2002 is also dry and in Scotland/Ireland 2003 was nearly as dry as 1996 and 2002 rather humid.

- For the regions in Scotland/Ireland and West Norway near the Atlantic Ocean the precipitation above all in autumn decreases for the last 18 years. For West Norway the yearly area mean precipitation for the period 1986-2003 is more than 170 mm lower than in the normal period 1961-1990, in Scotland/Ireland even nearly 260mm lower than 1961-1990.

- The majority of the 18 years were more wet than normal above Northwest-Russia. The period 1986-2003 has about 60 mm more precipitation than the normal period 1961-1990. The extreme years 2003 and 2002 are contrary to Central Europe, 2003 is very wet, only in 1998 more precipitation has fallen, and 2002 is noticeable drier than normal.

- On the Southern Balkan in 2002 the high December precipitation is significant for the total precipitation in 2002, and 2003 is also rather humid, but 13 of the 18 analysed years were more arid than normal.

Table 1 summarises the annual precipitation results; dry and wet years are highlighted by different shades of grey (dark: wet, bright: dry), years with least and most precipitation in the period 1986-2003 are edged. So the table shows the dry and wet years and the course of the 18 years.

Over all, the period 1986-2003 has been drier than the normal period 1961-1990, apart from Northern Sweden and Northwest Russia. 2003 is drier than normal apart of Northwest Russia and Southern Balkan.

Period / Year	1961-1990	1986-2003	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986
NE - Germany	628	604	449	737	666	581	588	713	567	524	624	687	697	538	508	593	480	619	662	639
S - France	1029	931	714	1189	879	1082	1041	820	802	1066	1006	1042	976	1012	829	834	658	935	996	884
NW - Scotland	1344	1085	930	1230	931	1248	1327	1199	935	925	1040	1121	1050	1156	964	1218	1044	1105	956	1147
W - Norway	1183	1005	972	756	944	956	1016	1079	1090	735	1043	978	954	1111	991	1222	1231	1054	941	1012
N - Sweden	532	541	383	394	578	653	524	672	433	488	579	421	659	612	580	546	593	543	572	516
NW - Russia	601	662	780	534	678	684	532	786	756	520	648	690	641	580	661	763	666	674	718	608
S - Balkan	644	561	661	792	535	373	644	604	516	640	595	604	451	421	562	494	407	549	667	573

Table 1: Annual precipitation for the periods 1961-1990 and 1986-2003 and for the individual years.

Summary and concluding remarks

The character of the yearly atmospheric conditions in Europe first of all is influenced by the constellation of the meteorological conditions. This is shown by the analyses of the GPCC although not discussed here in detail.

During occurrence of extreme wet events within Europe, temporal and spatial differences are more distinct than under dry conditions. The scale differences between spacious droughts and local extreme flash floods can lead to such events at the same time as the extreme hot year 2003 has shown (Rudolf, 2004).

The appraisal of the frequency or the probability of occurrence and especially in dry periods the persistence of rare extreme events require an analysis of homogeneity controlled time series. Considered parameters are the trend of the precipitation depth, the variability of the precipitation, the trend of this variability, and the frequency distribution of precipitation classes. A statistical analysis accomplished at the University of Frankfurt documents a gradual increase of the frequency of extreme dry also as of humid months, and the variability of precipitation increased more strongly than the mean average (Grieser, Staeger, Schönwiese, 2000). The extreme events of the last both years match to these results, although causal connection with this trend is not proved. As single events they also could occur in the climatic range of the 20th century.

Further increase of mean air temperature as forecasted by climate modelling would lead to an increase and intensifying of extreme events in Europe, this means high air temperatures as in the summer 2003 and heavy rain as in the summer 2002 (Schär e tal., 2004).

This small study illustrates the potential of GPCC's gridded precipitation products for regional climate monitoring. This article is based on a poster presented at ECAC 2004 (Nice) and an article published earlier in German language.

Acknowledgement: The chart of the air temperature anomaly was kindly provided by Mrs. M. Seilkopf, Maritime Weather Office Hamburg, for this contribution. Thanks are given to Mr. P. Finger, Mr. J.N. Breidenbach and Mr. P. Stender for the compilation of the precipitation data and assistance at the analysis.

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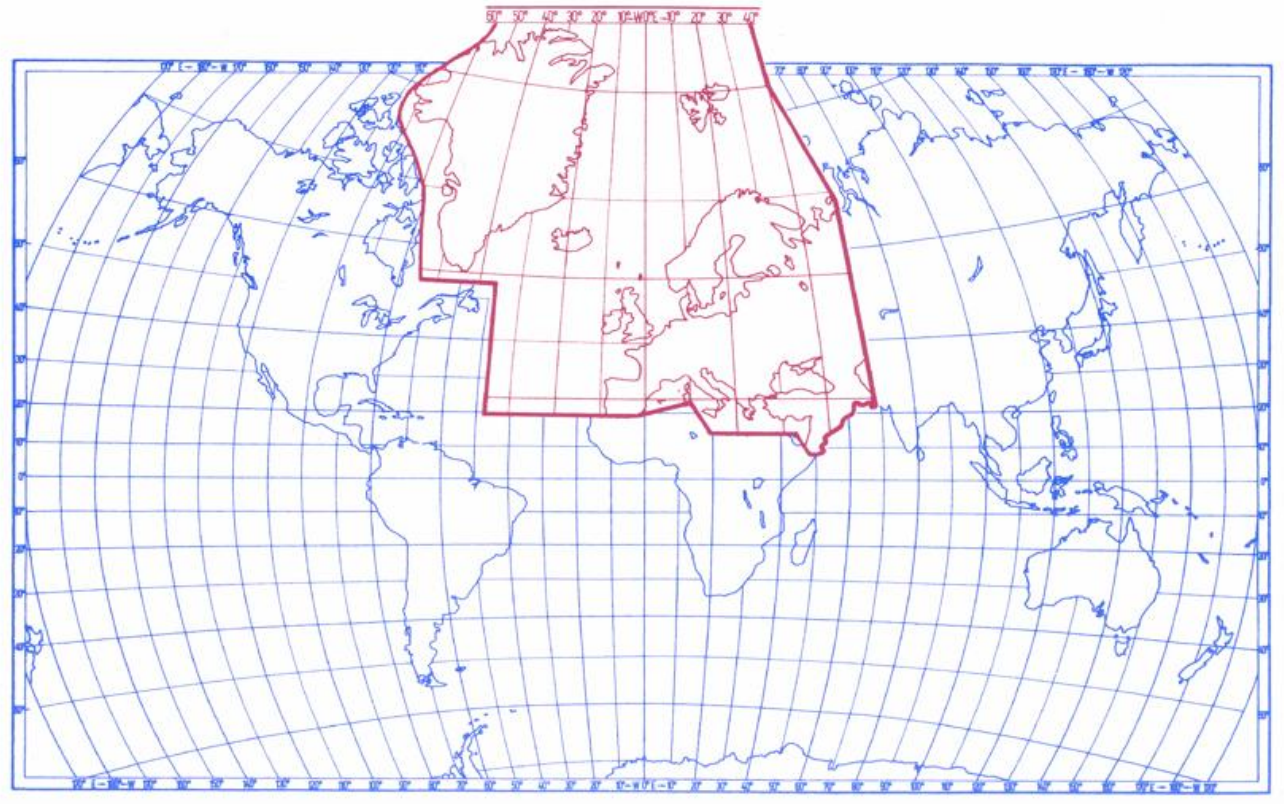
Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2004



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Annual Bulletin on the Climate in WMO Region VI
- Europe and Middle East –
2004

The Bulletin is a summary of contributions
of the following National Meteorological and Hydrological Services
and was co-ordinated by Deutscher Wetterdienst, Germany

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Foreword

This is now the 11th edition of the Annual Bulletin on the Climate in WMO Regional Association VI, providing information on the climate for the year 2004.

The National Meteorological and Hydrological Services of WMO Region VI provided once more valuable contributions to this issue, often illustrated by various maps, diagrams, tables and even photographs. For this reason the editors decided to present all the figures in colour again, like it was already done for the previous year. 40 out of 49 countries responded to the Call for Input which is sent every year in December. This has shown again that a high majority of the Member countries is interested in presenting their national results to the public in co-operation with their partners of the huge WMO RAVI community.

While 2004 was generally not such an outstanding year like 2003 with its unusual warm summer in Central Europe, there were some noteworthy events in 2004 too. It was again a warm year compared to the reference period 1961-1990. Especially in the Arctic regions the anomalies reached about +2°C. In Scandinavia, the months April and December were very mild. But also the precipitation anomalies were remarkable: Whilst Russia had its second wettest year according to the corresponding precipitation time series; it was a very dry year especially in Portugal and southern France. Other disastrous events were some heavy storms in the eastern Mediterranean in January and November, and some strong hailstorms and tornadoes in Central and Eastern Europe in June. Since the observation of tornadoes and other severe weather events have become more and more popular, they have to be included in any regular climate monitoring activity too.

Like in the editions before, this climate monitoring bulletin also reports on recent ECSN activities.

In order to present all this information in a reader-friendly way, the editors have slightly changed the layout of this issue compared to the previous one. The new single-column layout is probably easier to read, and highlighting the names of the countries in the text could help to find the contributions of the various Members more easily.

To all the contributors, I would like to express my warmest gratitude for this large amount of very interesting reports. I am especially thankful to the editors Mr. Peter Bissolli and Mr. Peer Hechler from Deutscher Wetterdienst (Department Climate Monitoring) for again taking over the whole task of coordination, editorial review, publishing and distribution of the Bulletin.



Daniel Keuerleber-Burk

President of WMO Regional Association VI

Outstanding Events and Anomalies in 2004

Temperature

- Very mild in the Arctic regions and in winter in Russia
- Record mild temperatures in Central Europe around February 4
- Very mild April in Norway and Sweden
- Very warm June in Portugal and Spain
- Very mild December in Scandinavia and the Baltic countries

Precipitation

- Very wet in most parts of Russia
- Very dry in Portugal and southern France
- High rainfall amounts with flooding in south-eastern countries in January
- Severe snowfall in the eastern Mediterranean area in February
- Abundant snowfall in the Alps on 23/24 March

Sunshine

- A very sunny September in Central Europe

Wind

- Heavy storms in the eastern Mediterranean in January and November
- Strong hail and tornadoes in Central and eastern Europe in June
- Heavy storm over Central Europe on December 17

Annual Survey

Temperature in 2004 was higher than the 1961-1990 average almost everywhere in the Region. In the Arctic (e.g. Svalbard, Jan Mayen), the annual mean temperature was about 2°C above normal. Northern European countries reported averages about 1°C above normal (e.g. Iceland +1.2 - +1.5°C, Norway +1.4°C, Sweden +1.1°C, Latvia and Lithuania +0.7°C), with higher anomalies in the West than in the East. In most of the other countries, the positive anomalies were between +0.5 and +1.0°C, in parts of south-eastern Europe also less than +0.5°C, in some areas of the East also between +1.0 and +2.0°C. Examples for monthly and annual means and/or anomalies are shown for Estonia (Fig. 0.1), Latvia (Fig. 0.2), Belgium (Fig. 0.3), Slovenia (Fig. 0.4), Romania (Fig. 0.5), Armenia (Fig. 0.6) and daily temperatures for Central England (Fig. 0.7).

The absolute mean temperature 2004 at Jan Mayen was above zero (0.8°C) and the second highest registered there since measurements started in 1921. In Denmark, although the year was warm like in other countries, the summer came very late. It happened the first time in Denmark since 1874 that the first summer day (maximum temperature >25°C) came as late as on 30 July.

Examples for spatial distributions of the annual mean temperature are shown for Norway (Fig. 0.8) and Hungary (Fig. 0.9).

In many countries, 2004 was one of the 10 warmest years since measurements started and the annual mean followed the general warming trend, e.g. in Russia (Fig. 0.10) and Denmark (Fig. 0.11).

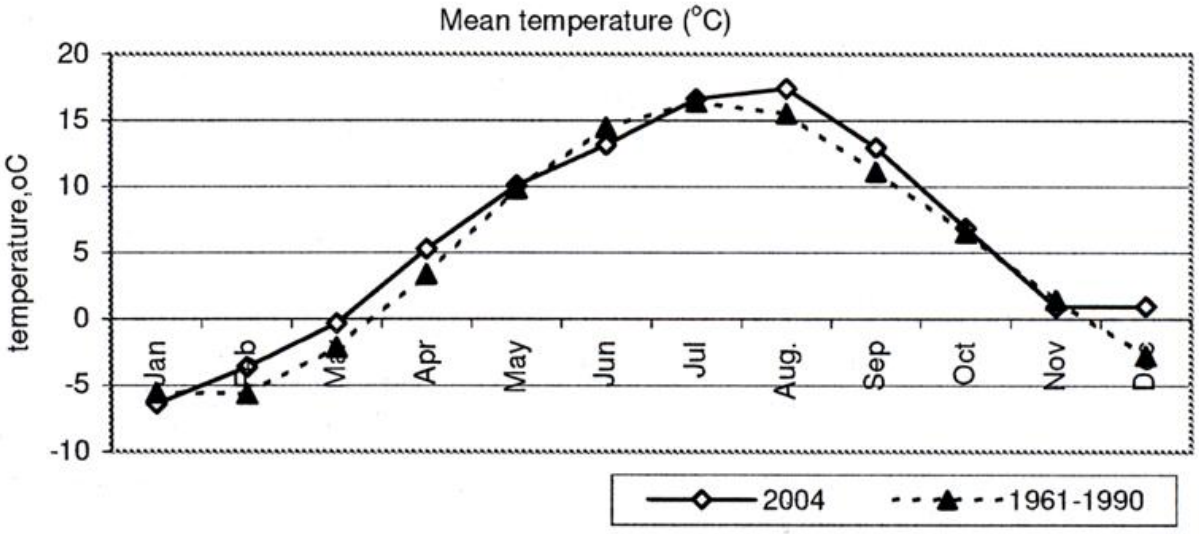


Fig. 0.1: *Monthly mean temperature in Estonia 2004 in comparison to the 1961-1990 normal*
From: Estonian Meteorological & Hydrological Institute

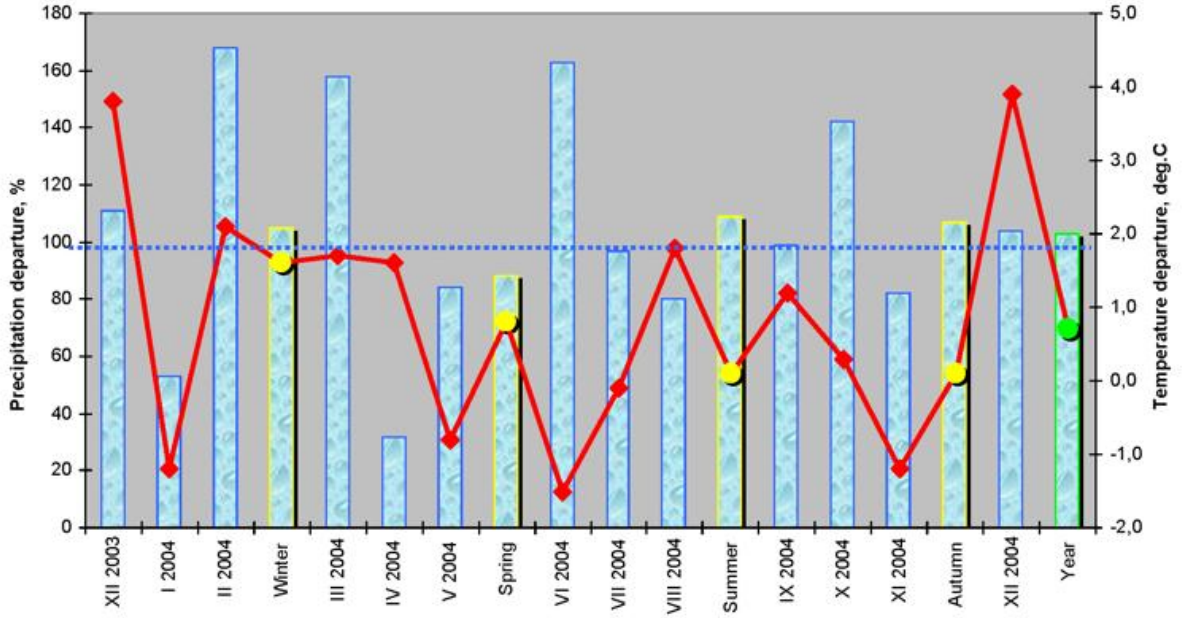


Fig. 0.2: *Mean air temperature deviation (°C) from normal 1961 – 1990 (blue dashed line) and precipitation totals in % of the normal in Latvia*
From: Latvian Environmental, Geological and Meteorological Agency

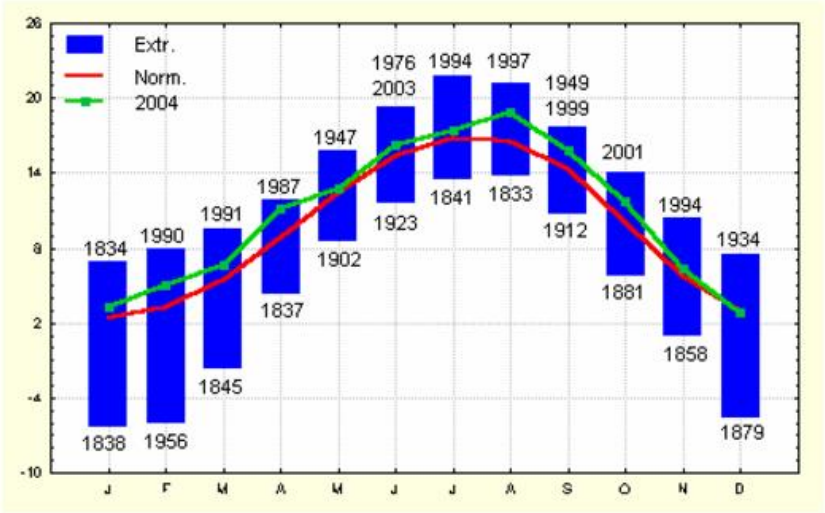


Fig. 0.3: *Monthly mean temperatures (°C) 2004, normal values and absolute extremes since 1833 at Uccle (Belgium)*
From: Institut Royal Météorologique de Belgique

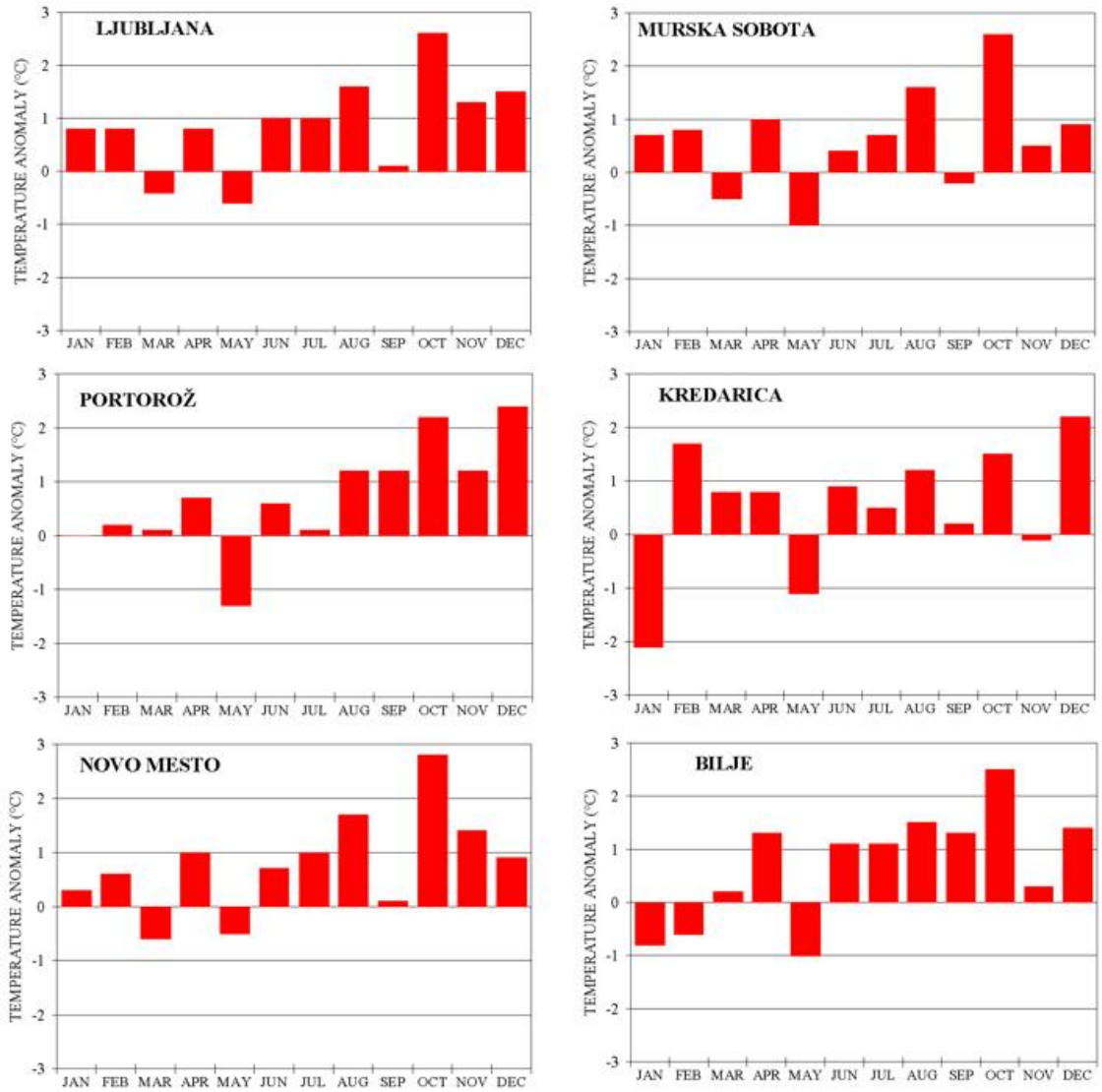


Fig. 0.4: *Monthly mean temperature anomalies 2004 for stations in Slovenia (reference period 1961-1990)*
From: Environmental Agency of the Republic of Slovenia

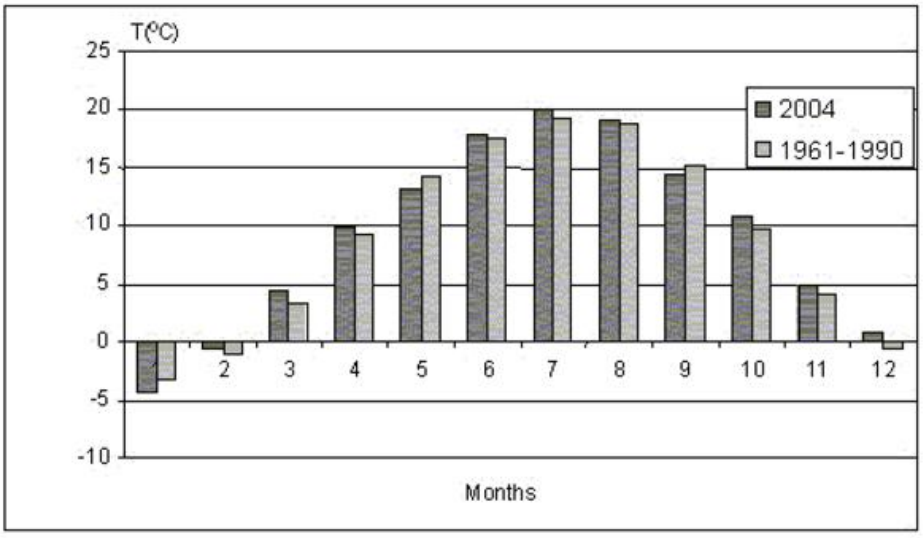


Fig. 0.5: *Monthly mean temperatures 2004 and 1961-1990 in Romania*
From: National Institute of Meteorology & Hydrology Romania

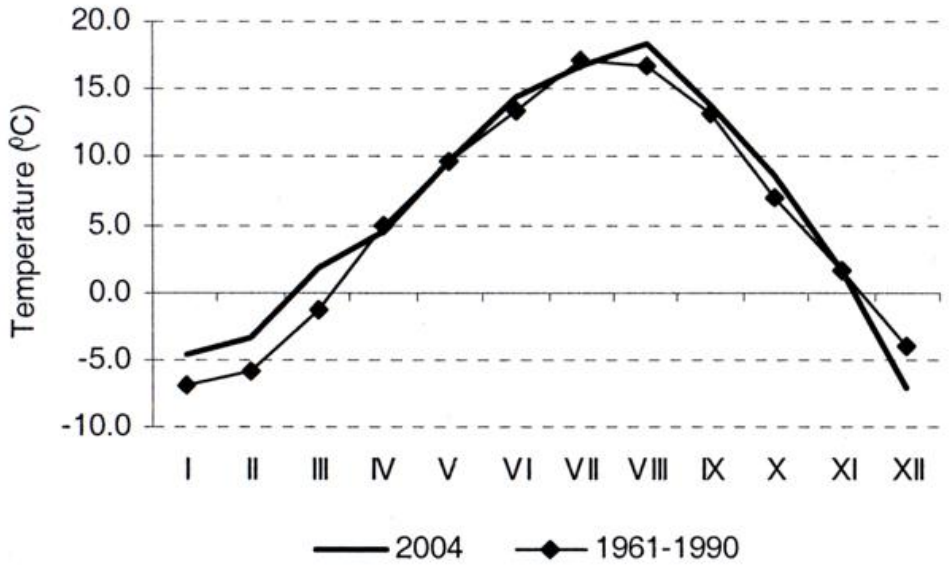


Fig. 0.6: *Monthly mean temperatures 2004 in Armenia compared with 1961-1990 normal values*
From: Department of Hydrometeorology of the Republic of Armenia

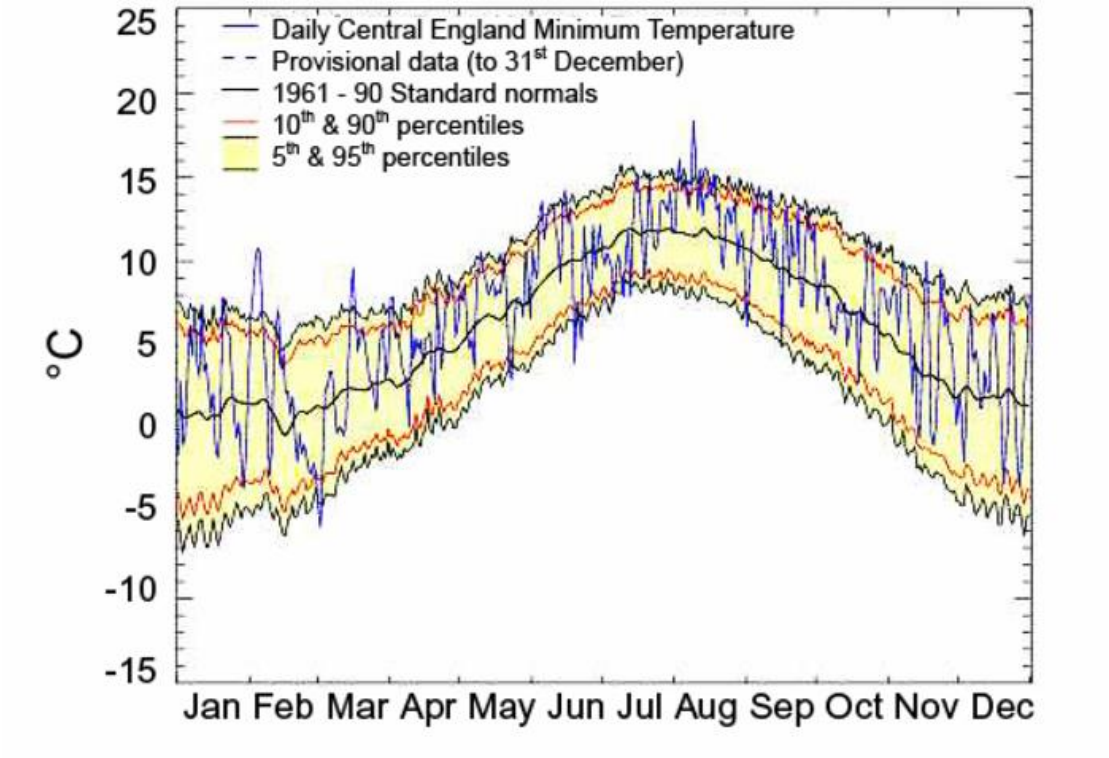


Fig. 0.7: *Daily minimum Central England temperature (°C) for 2004 (blue line): The black heavy solid denotes the normal values for 1961 – 1990, and the shaded areas are the corresponding 5th and 95th percentiles for each day of the year.*
From: Met Office United Kingdom

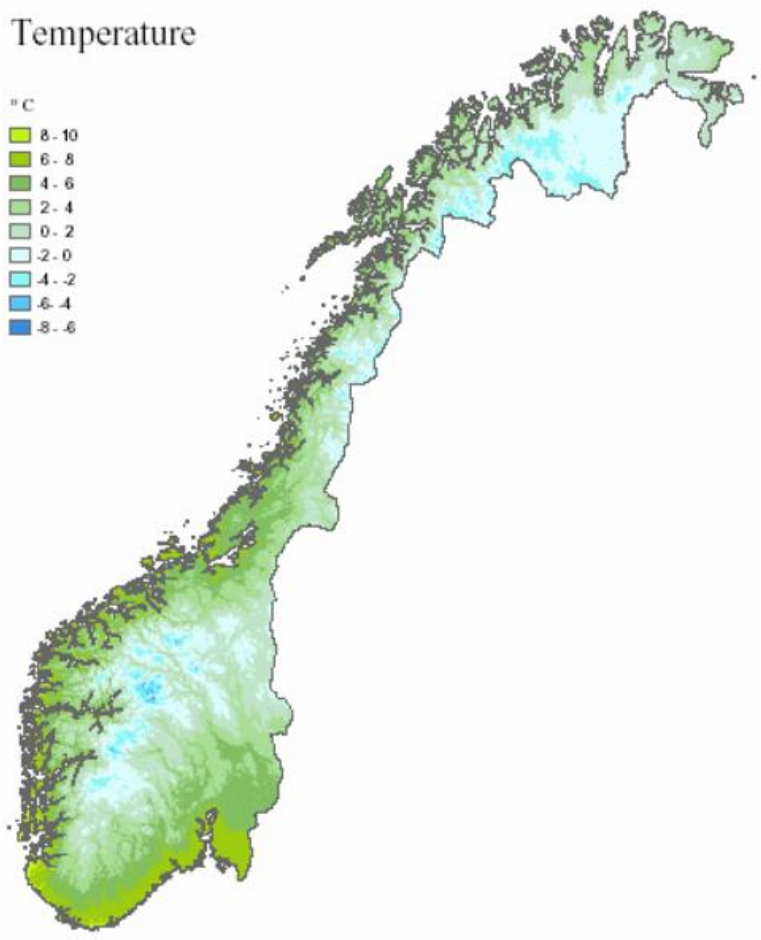


Fig. 0.8: *Annual mean temperature 2004 in Norway*
From: Norwegian Meteorological Institute

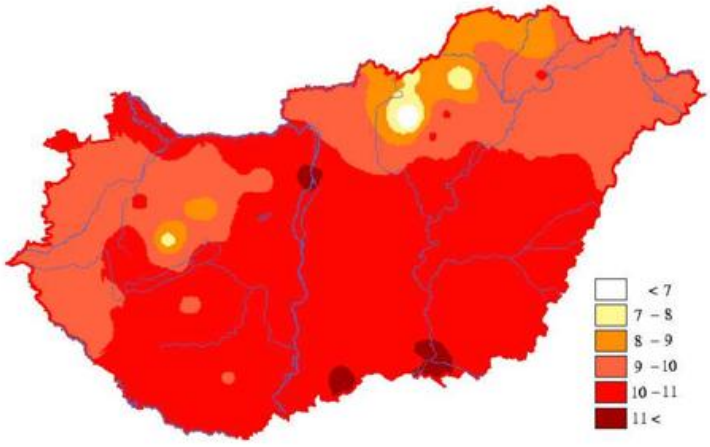


Fig. 0.9: *Annual mean temperature 2004 in Hungary (°C)*
From: Hungarian Meteorological Service

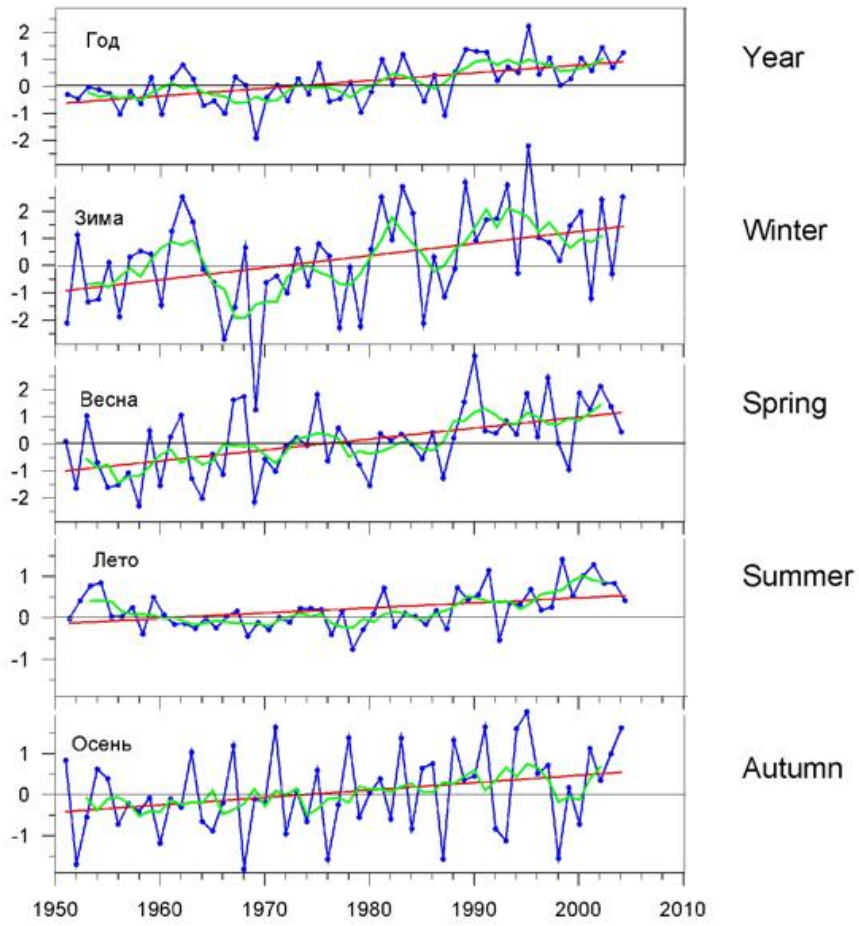


Fig. 0.10: *Average annual and seasonal anomalies of the mean temperatures (°C) for Russia for the years 1951 – 2004. Anomalies are calculated as deviations from the average for the years 1961 – 1990. Green curve: 5 – year moving average. Linear trend is shown by red line*
From: Russian Federal Service for Hydrometeorology & Environmental Monitoring

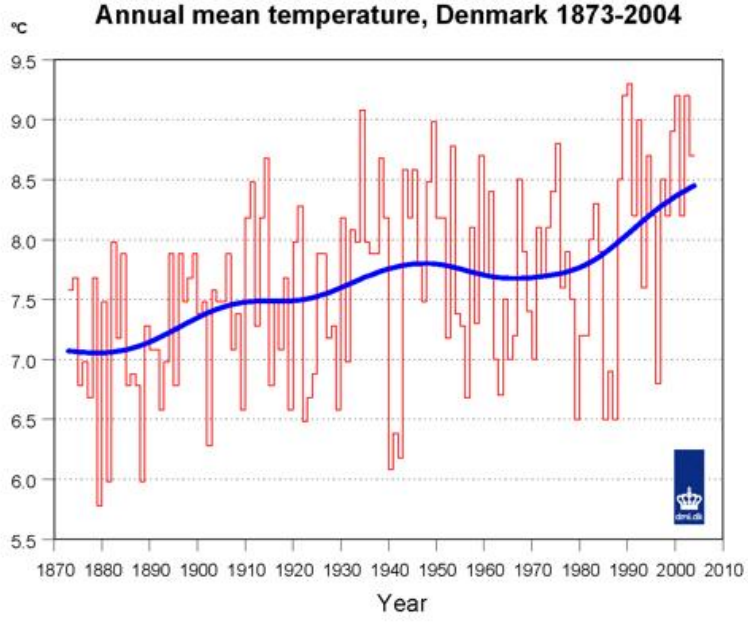


Fig. 0.11: *Annual mean temperatures in Denmark 1873-2004*
From: Danish Meteorological Institute

Precipitation in 2004 was higher than normal in most parts of the northern European countries; typical anomalies were around 10% on country average. In Russia, 2004 was the second wettest year in the precipitation time series. Precipitation in Central Europe was close to normal. In the Southeast of the Region, most countries reported precipitation above normal. In contrast, it was a very dry year in Portugal, being the driest since 1931 and almost everywhere in the country below 60% of the 1961-1990 normal. In southern France it was also very dry (only 356mm or 52% of the normal in Toulon (Var) for the period October 2003 – September 2004), and furthermore, parts of western Switzerland were drier than normal.

Maps of annual precipitation are shown for Norway (Fig. 0.12), Finland (Fig. 0.13), south-eastern France (Fig. 0.14), Hungary (Fig. 0.15) and Portugal (0.16).

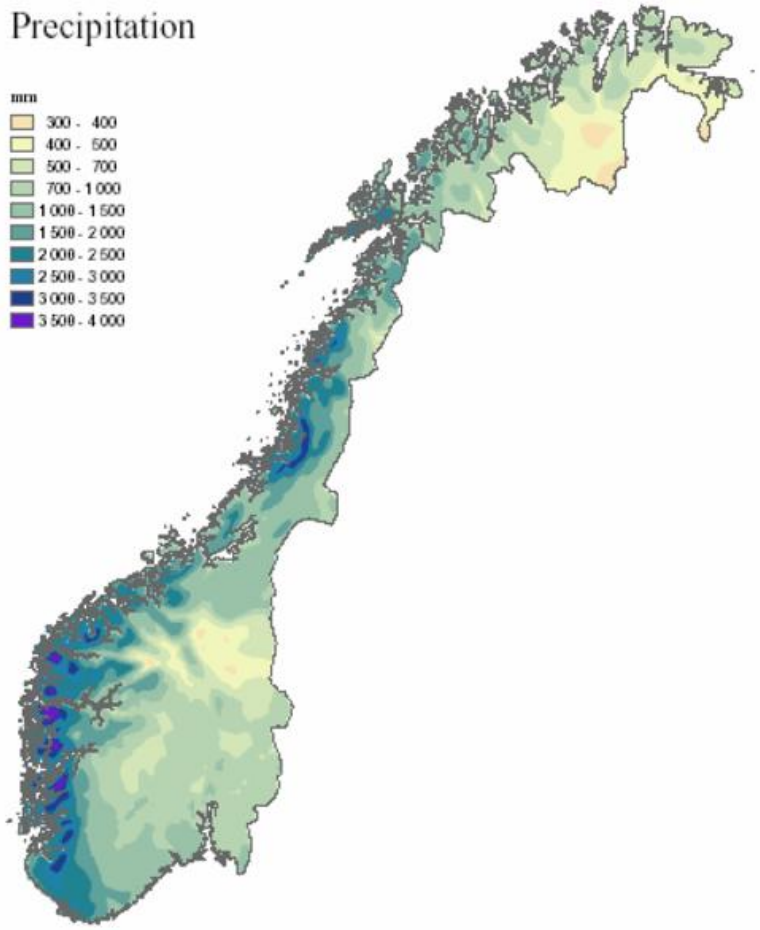


Fig. 0.12: *Annual precipitation amount in Norway 2004*
From: The Norwegian Meteorological Institute

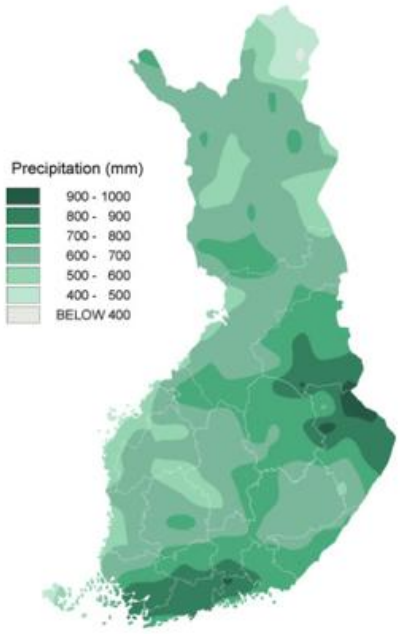


Fig. 0.13: *Annual precipitation amount in Finland 2004*
From: Finnish Meteorological Institute

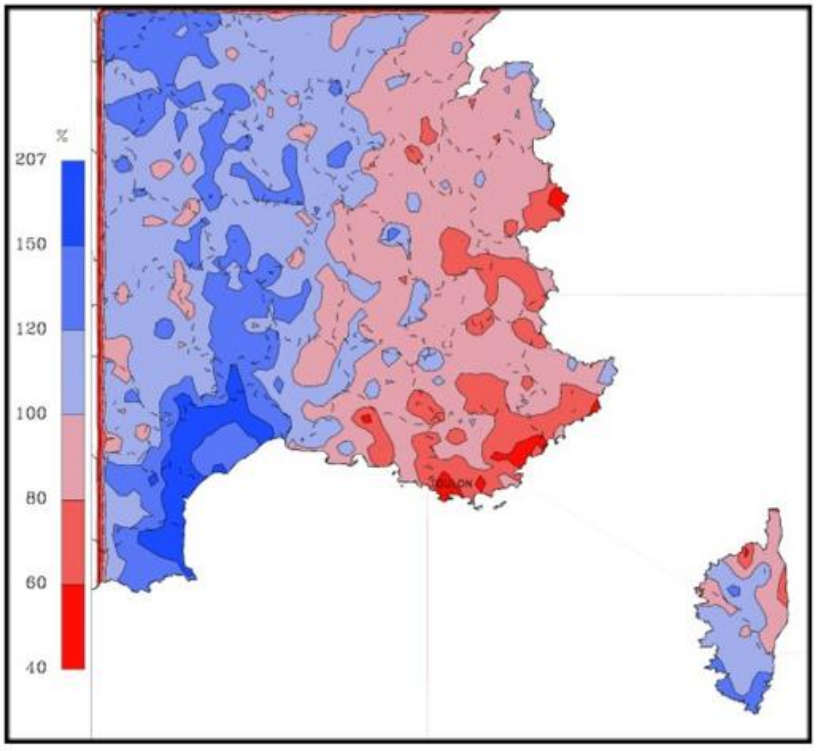


Fig. 0.14: *Precipitation totals (% of normal) for the period October 2003 – September 2004 in south-eastern France*
From: Météo France

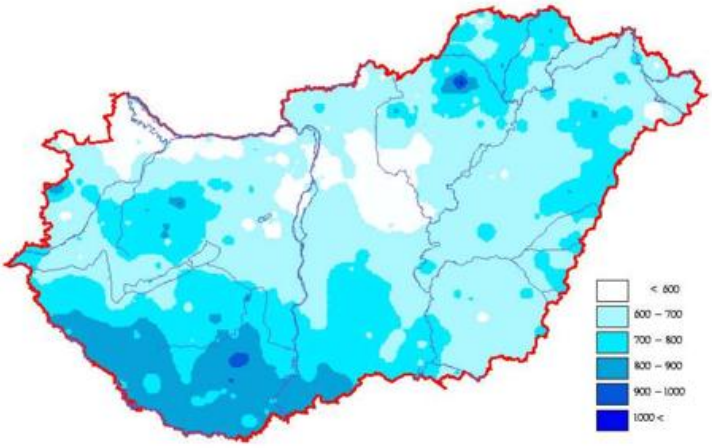


Fig. 0.15: *Precipitation sum (mm) 2004 in Hungary*
From: Hungarian Meteorological Service



Fig. 0.16: *Annual precipitation 2004 in Mainland Portugal in % of normal 1961-1990*
From: Instituto de Meteorologia Portugal

Sunshine duration was higher than normal in some western European countries, e.g. Iceland, the Faroe Islands, Ireland (Fig. 0.17), Netherlands, Luxembourg (Fig. 0.18), Germany, Switzerland. The annual sunshine duration in Belgium (station Uccle) was slightly below normal. Among the more eastern countries, Finland reported a cloudy summer; in Lithuania the mean values were mostly near normal except at the seaside where it was sunnier. In most of the area of Slovenia the sunshine duration was below normal.

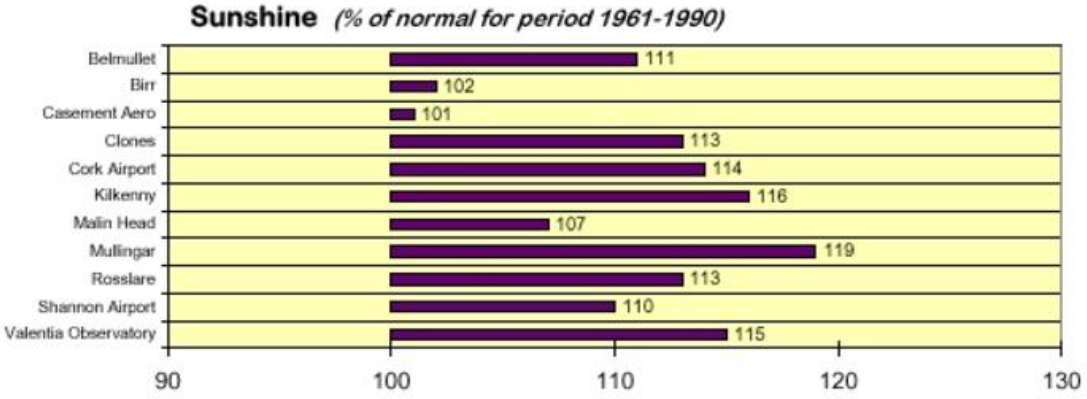


Fig. 0.17: *Anomalies of sunshine duration 2004 for some stations in Ireland*
From: Met Éireann, Ireland

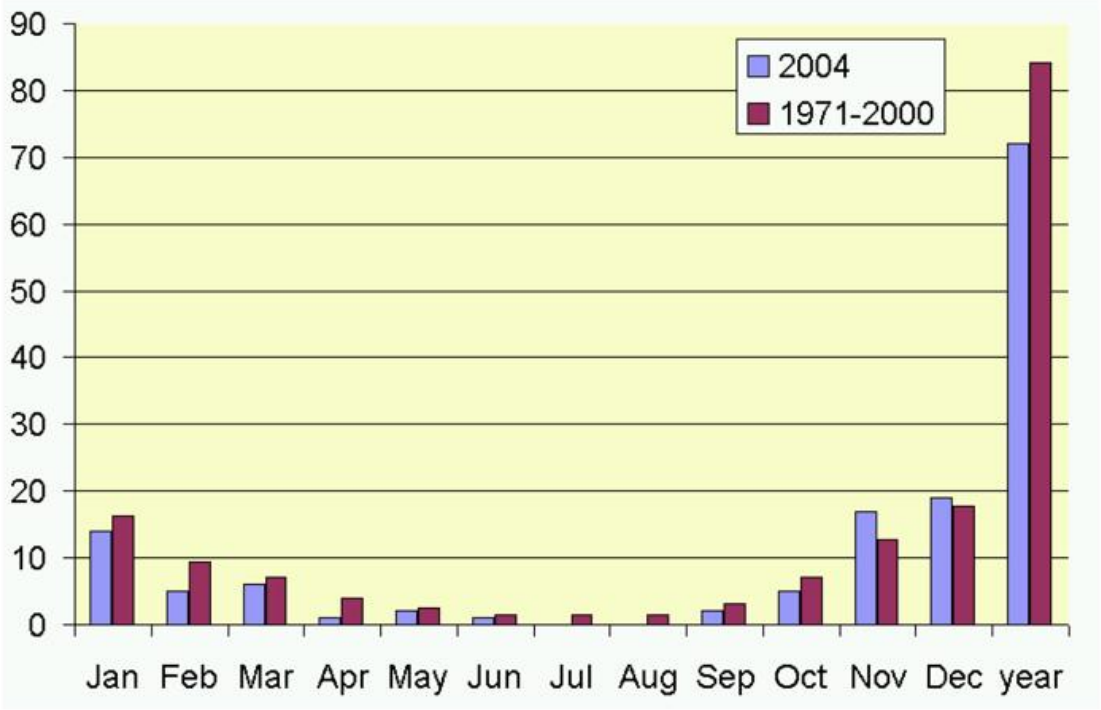


Fig. 0.18: *Monthly and annual number of days **without sunshine** 2004 compared to the 1971-2000 normal for Luxembourg Airport*
Data from: Service Météorologique, Administration de l'Aéroport, Luxembourg

Wind events were reported by some countries, e.g. storms, tornadoes, which are described within the monthly surveys. For the year as a whole, no exceptional storm frequencies were reported. Mean wind speeds of 17 - 20 km/h were reported for Ireland at most stations, 24 - 28 km/h at coastal stations of the North and Northwest.

Seasonal Survey

Winter 2003/04 was milder than the 1961-1990 normal in nearly the whole Region. Only a few areas had slight cold anomalies: parts of the Arctic region and along the northern Norwegian coast, but also in the Southeast around Greece, Turkey and the Black Sea. The highest positive anomalies (> +4°C) occurred over Russia, with lower values towards the West and the South, lowest in southern Central Europe and the Mediterranean, but again higher over parts of western and northern Europe.

Precipitation was higher than normal in most of the Region, especially over eastern areas of Europe, up to more than 150%. Dry areas can be found mainly over the Iberian Peninsula, some of the Mediterranean islands, the Caucasian area, and in the northern half of Europe in Ireland, Greenland, and eastern Sweden.

Spring 2004 also was warmer than normal in nearly the whole Region. Slight cold anomalies were found over parts of the western Mediterranean, the Aegean and the Black Sea. The highest positive temperature anomalies were found around the North Sea and parts of Scandinavia, there were some deviations >+1°C.

Spring was dry in almost the whole Region, especially in northern and Central Europe, Portugal and the eastern Mediterranean. Areas wetter than normal were concentrated on Greenland and Iceland, around the western Mediterranean and the Adriatic Sea, and Russia. Examples are illustrated by the spring precipitation distribution in Croatia (Fig. 0.19), Serbia and Montenegro (Fig. 0.20) and in Bosnia and Herzegovina (Fig. 0.21).

Summer 2004 was again warmer than normal in nearly the whole Region, although it was not such an extreme summer like the year before. Slight cold anomalies were observed over parts of the Atlantic and to the north of the Black Sea. Higher positive temperature deviations were continuing around the North Sea and parts of Scandinavia.

Most of the area had higher than normal precipitation in summer, especially in the eastern United Kingdom, northern Central Europe, parts of Scandinavia and Russia, and around the Black Sea. As an example, the distribution of summer precipitation for the Netherlands is shown in Fig. 0.22. In contrast, the Mediterranean region was mostly very dry, except southern Italy.

Autumn 2004 also had only warm anomalies nearly all over the Region. The highest positive deviations were recorded in central Scandinavia and Russia, but locally also in Central Europe and in the south-eastern countries, reaching >1°C. Lower anomalies and even small areas colder than normal were identified over the Atlantic, especially west of Ireland.

Autumn was mainly dry, in particular there were large dry areas over France and Spain, but also some parts of Scandinavia and around the Aegean Sea were very dry. Wet areas were found over Greenland and Iceland, but also in some other parts of Europe, in particular again in southern Italy and in the eastern areas of the Region.

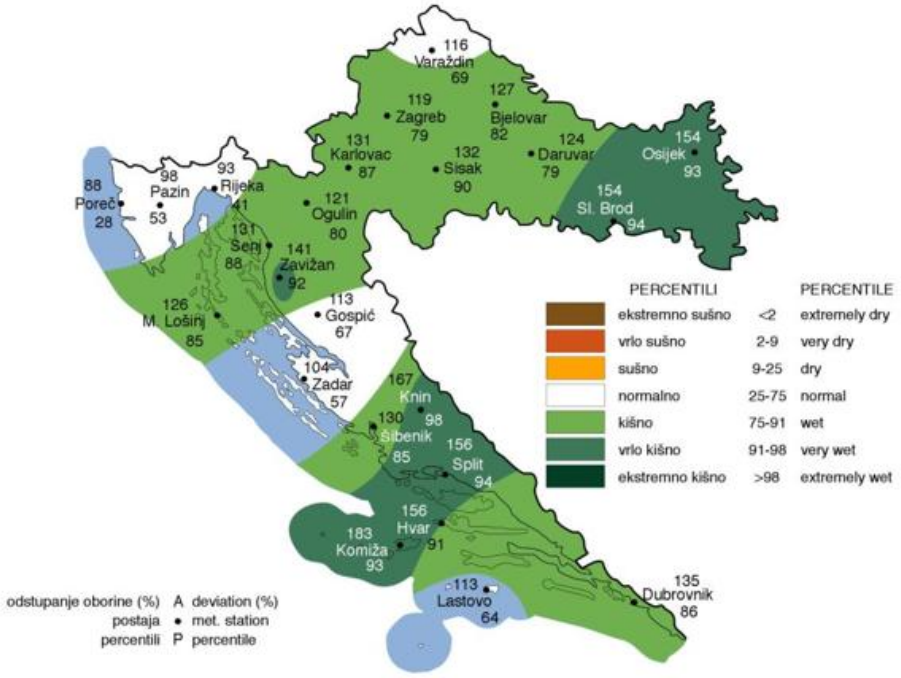


Fig. 0.19: *Seasonal precipitation amount anomalies of Croatia in spring 2004, (March – May) expressed as percentage of normal 1961 – 1990 (upper numbers) and percentiles (lower numbers). Blue colour: water areas.*
From: Meteorological and Hydrological Service of Croatia

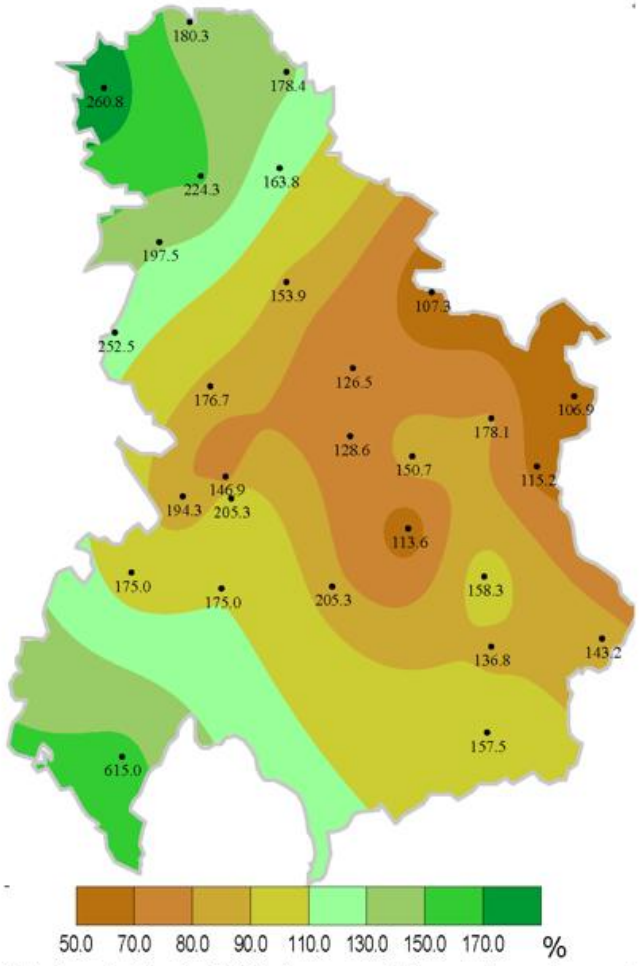


Fig. 0.20: *Spring precipitation totals in 2004 (mean station values in mm) and anomalies in % of normal (isolines) in Serbia and Montenegro*
From: Republic Hydrometeorological Service of Serbia

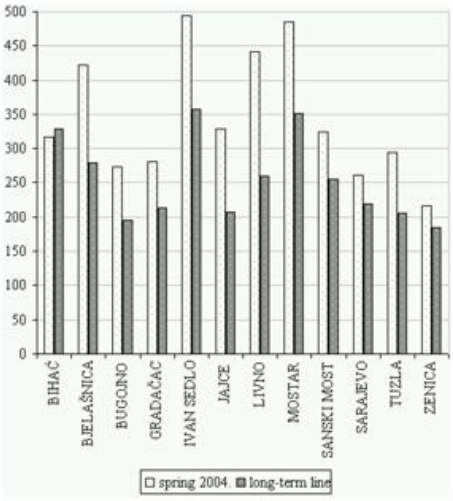


Fig. 0.21: *Precipitation sum in mm for spring 2004 in comparison to the long-term mean 1971-2000 for some stations in Bosnia and Herzegovina*
From: Federal Meteorological Institute Bosnia and Herzegovina

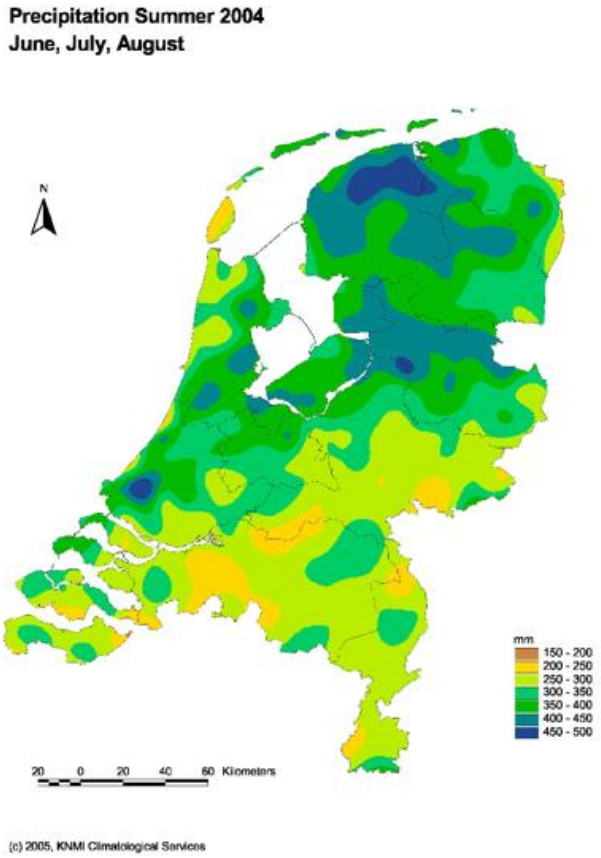
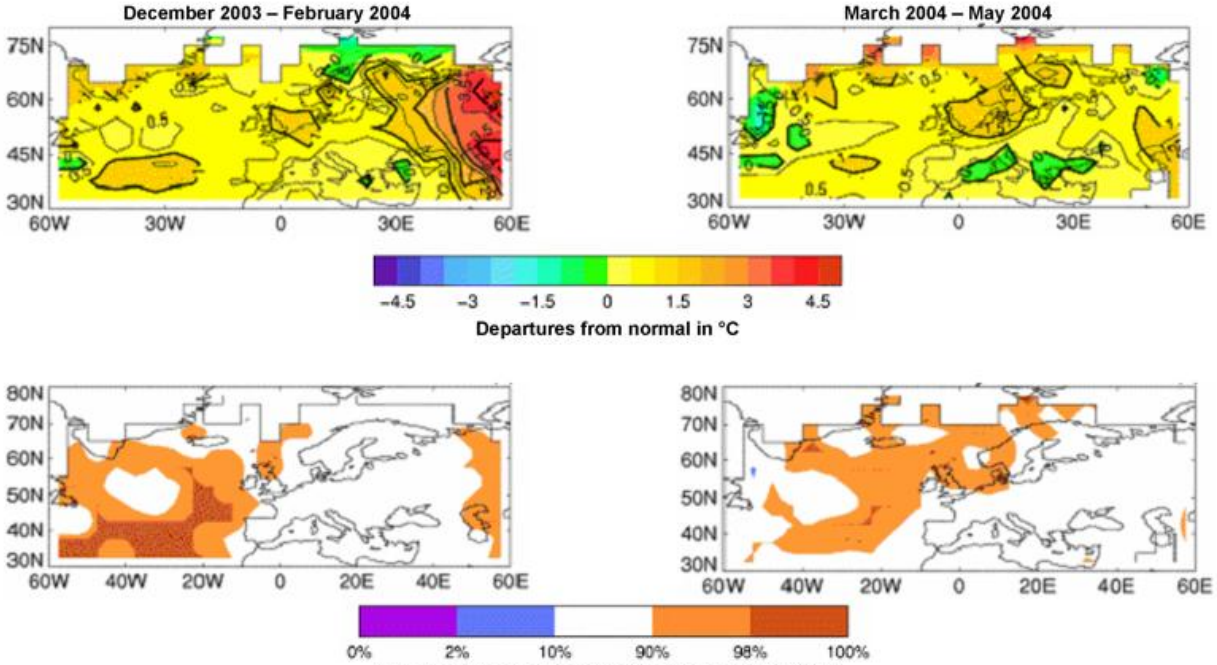


Fig. 0.22: *Precipitation totals in the Netherlands in summer 2004*
From: Royal Netherlands Meteorological Institute

Seasonal Maps

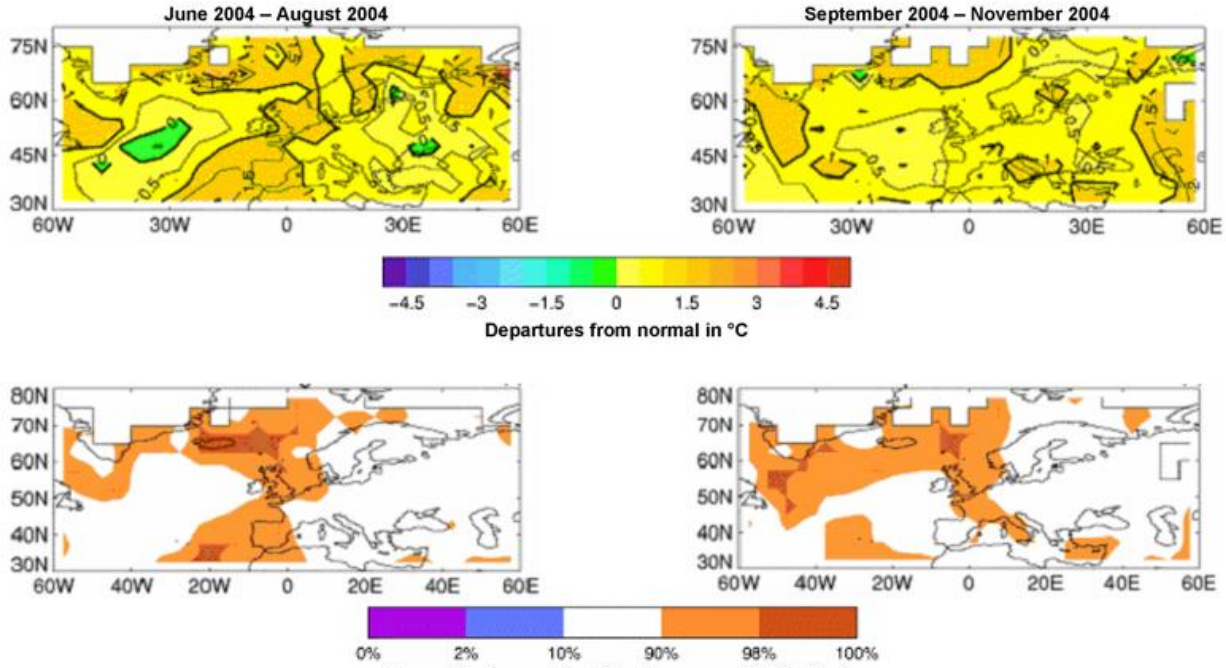
Surface temperature anomalies

From: Hadley Centre of Climate Prediction and Research, U.K.



Surface temperature anomalies

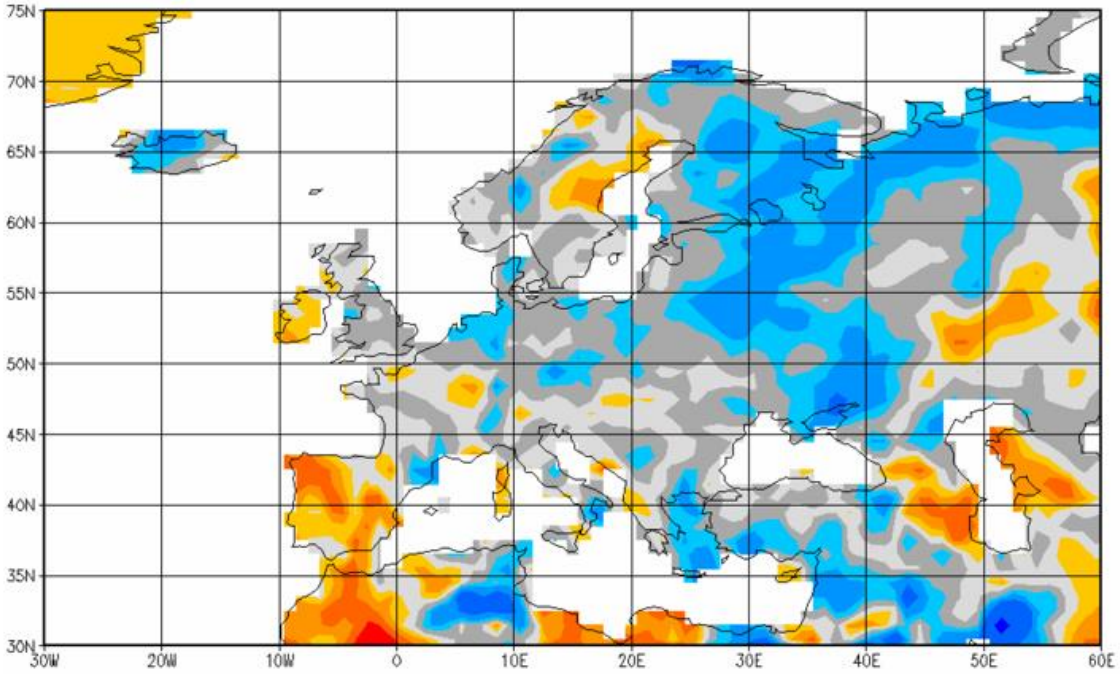
From: Hadley Centre of Climate Prediction and Research, U.K.



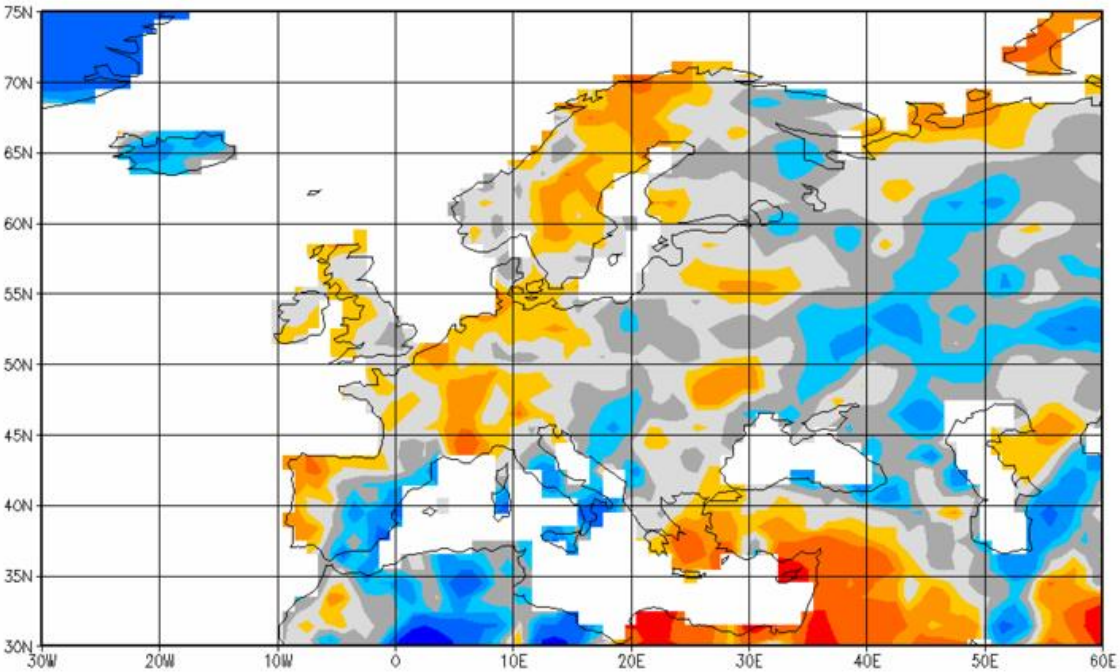
Precipitation in percent of normal

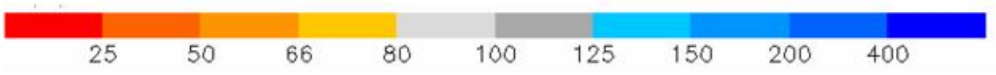
Gauge-Based Analysis 1.0 degree, reference period: 1961 – 1990
From: GPCC / Deutscher Wetterdienst, Germany

December 2003 – February 2004



March 2004 – May 2004

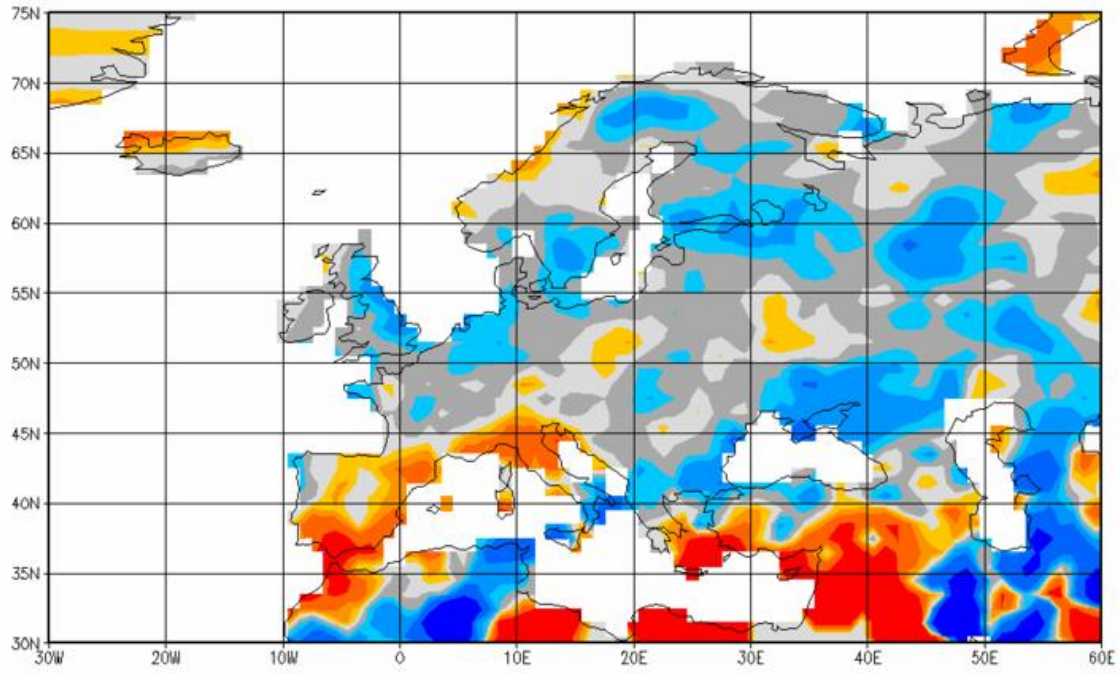




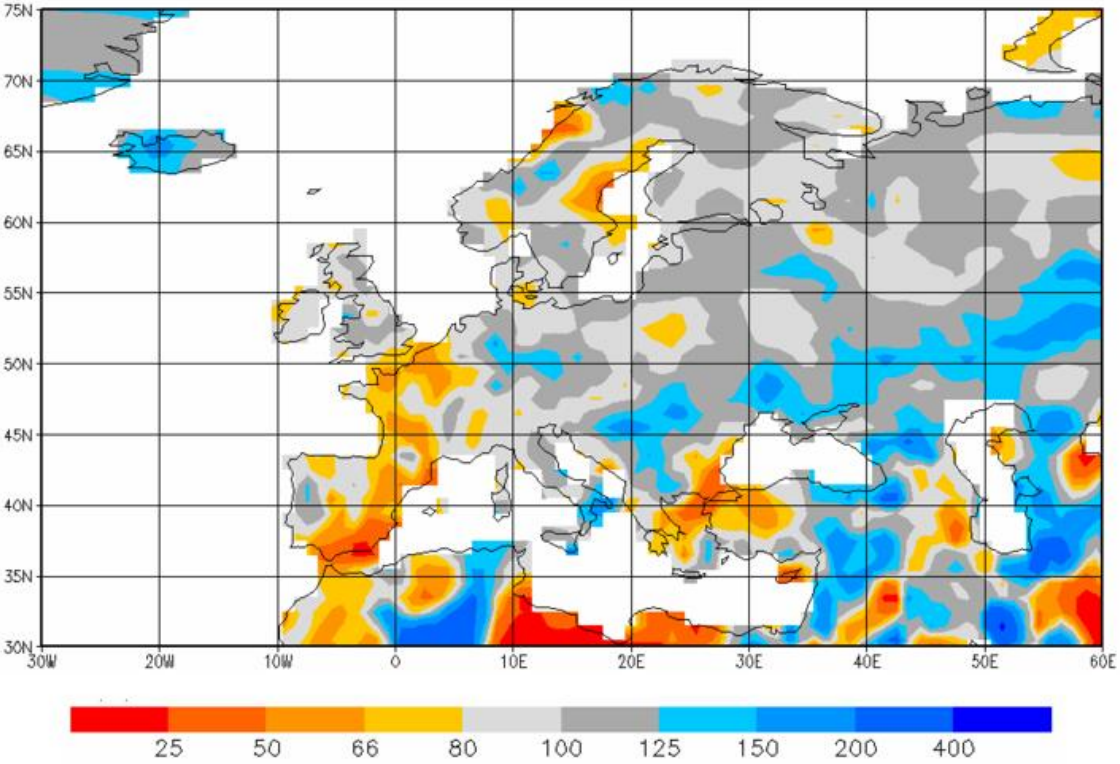
Precipitation in percent of normal

Gauge-Based Analysis 1.0 degree, reference period: 1961 – 1990
From: GPCC / Deutscher Wetterdienst, Germany

June 2004 – August 2004



September 2004 – November 2004



Monthly and Annual Tables

Temperature and precipitation values with departures from their 1961-1990 means
(some stations have shorter reference periods).

WMO No.	Station	January 2004				February 2004			
		Temp mean	(°C) dep.	Prec. sum	(mm) dep.	Temp mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-17,0	-1,7	10	-2	-17,5	-1,2	11	-8
01025	Tromsø	-4,0	-0,2	39	-53	-3,2	0,5	171	85
01492	Oslo-Blindern	-3,8	0,5	109	60	-1,5	2,5	25	-11
02196	Haparanda	-9,7	2,4	56	12	-9,8	1,6	56	24
02485	Stockholm	-2,5	0,3	37	-2	-0,7	2,3	26	-1
02974	Helsinki-Vantaa	-7,1	-0,2	38	-3	-5,0	1,8	41	10
03091	Aberdeen	4,1	1,4	75	-7	4,3	1,4	39	-12
03772	London-Heathrow	6,2	2,0	72	20	6,3	1,8	26	-9
03967	Dublin (Casement)	5,5	1,1	94	28	4,9	0,5	18	-33
04030	Reykjavik	-0,2	0,3	52	-24	1,1	0,7	65	-7
04320	Danmarkshaven	-22,5	0,6	12	1	-24,0	0,3	6	-6
04360	Angmagssalik	-5,9	1,6	43	-75	-5,8	1,9	100	-2
06186	København-Landb.	-0,3	-0,8	39	-12	2,2	1,7	32	1
06260	De Bilt	3,6	1,4	123	54	4,8	2,3	79	30
06447	Uccle	3,2	0,7	154	87	5,0	1,8	49	-5
06590	Luxembourg	0,9	0,9	105	34	3,0	1,9	28	-34
06660	Zürich	0,9	1,5	156	87	2,1	1,4	41	-29
06700	Genève	2,7	2,0	139	66	3,4	1,4	28	-46
07510	Bordeaux	7,3	1,8	136	36	6,8	0,1	20	-66
07650	Marseille	6,6	0,2	16	-31	7,1	-0,5	6	-48
08222	Madrid	7,6	1,5	6	-40	8,1	0,6	64	20
08314	Mahon / Menorca	11,4	0,9	21	-45	11,2	0,5	38	-19
08495	Gibraltar	14,4	1,0	32	-89	13,3	-0,5	111	11
08515	St. Maria / Acores	17,0	2,6	61	-39	15,0	1,0	173	87
08535	Lisboa	12,6	1,2	154	44	12,0	-0,3	40	-71
10384	Berlin-Tempelhof	-1,2	-1,0	69	26	3,0	2,2	52	18
10637	Frankfurt/Main	2,0	1,3	70	26	4,2	2,4	19	-21
11035	Wien-Hohe Warte	-1,4	-0,7	71	33	3,3	2,0	89	47
11518	Praha-Ruzyne	-3,4	-1,4	41	17	1,7	2,3	15	-8
11903	Slica	-6,1	-2,2	62	18	-0,3	0,8	41	-3
12160	Elblag	-5,1	-2,7	53	6	0,2	2,4	74	49
12375	Warszawa-Okecie	-5,1	-1,8	24	2	0,0	2,1	57	36
12843	Budapest-Lorinc	-2,0	-0,4	34	2	2,1	1,0	55	24
13274	Beograd	-0,2	-0,6	93	44	3,6	0,9	29	-15
14015	Ljubljana	-0,3	0,8	115	33	2,2	0,8	109	29
14445	Split	6,3	-1,1	84	1	8,4	0,3	84	16
14654	Sarajevo	-1,2	-0,3	94	23	1,7	0,2	66	-1
15420	Bucuresti	-3,3	-0,9	58	18	0,3	0,4	22	-14
15614	Sofia	-2,3	-0,8	51	20	1,9	1,2	19	-15
16158	Pisa	6,0	-0,1	63	-12	8,6	1,5	103	30
16597	Luqa / Malta	12,2	0,0	49	-40	13,0	0,6	15	-46
16716	Athens (Hellinikon)	8,8	-1,4	145	100	10,3	-0,2	23	-25
16754	Heraklion / Kreta	11,3	-0,7	196	104	12,0	-0,2	65	-12
17040	Rize	7,7	1,4	139	-78	6,7	0,1	244	71
17062	Istanbul-Goztepe	5,3	-0,3	159	60	5,9	0,0	40	-27
17130	Ankara / Central	0,2	0,1	46	-1	2,4	0,5	18	-18
17170	Van	-0,9	3,3	25	-10	-0,6	2,8	40	6
17609	Larnaca	11,9	0,1	214	152	11,9	-0,3	103	51
22113	Murmansk	-8,9	2,4	18	-13	-10,6	0,3	26	4
26038	Tallina	-6,4	-0,9	22	-23	-3,5	2,2	35	6
26629	Kaunas	-7,4	-2,2	48	9	-2,0	2,3	42	11
26730	Vilnius	-7,7	-1,6	58	17	-3,4	1,4	60	22
26850	Minsk	-7,1	-0,2	81	41	-4,5	1,3	82	48
27199	Wjatka (Kirov)	-10,5	3,7	52	14	-10,5	1,5	32	5
27612	Moskva	-6,5	2,8	88	46	-7,0	0,7	51	15
33345	Kiev	-4,3	1,3	55	8	-2,6	1,6	45	-1
33815	Chisinau	-3,8	-0,5	88	48	-0,4	1,3	38	0
34300	Charkov (Kharkiv)	-2,5	4,4	57	13	-3,4	2,3	50	18
34880	Astrahan'	-1,9	3,6	16	1	0,2	5,2	21	11
35188	Akmola	-15,0	0,8	6	-11	-9,6	6,2	27	13
37789	Yerevan	-1,1	2,4	30	9	1,5	2,5	28	4
40080	Damascus	7,4	1,5	59	30	8,1	0,3	15	-9
40180	Tel Aviv (Airport)	13,8	1,5	193	44	14,3	1,4	59	-39
40310	Ma'an	8	0,5	9	2	9,6	0,5	5	-2
60030	Las Palmas / Gr. Can	17,9	0,4	10	-7	18,6	1,0	32	10

WMO No.	March 2004				April 2004				May 2004			
	Temp mean	(°C) dep.	Prec. sum	(mm) dep.	Temp mean	(°C) dep.	Prec. sum	(mm) dep.	Temp mean	(°C) dep.	Prec. sum	(mm) dep.
01008	-7,7	8,1	26	6	-4,3	8,1	18	8	-1,8	2,6	2	-5
01025	-0,1	2,2	53	-16	3,8	3,1	44	-17	6,4	1,3	22	-24
01492	2,0	2,2	36	-11	7,4	2,9	54	13	12,5	1,7	40	-13
02196	-5,2	1,6	34	-1	1,0	1,5	11	-18	7,4	1,3	35	3
02485	1,9	1,8	24	-2	6,8	2,2	13	-17	10,8	0,1	48	18
02974	-1,4	1,5	46	12	4,6	1,7	6	-31	10,3	0,4	37	2
03091	5,6	1,1	43	-15	8,5	2,2	112	59	10,8	1,8	23	-36
03772	7,5	1,0	30	-17	10,6	1,7	69	24	13,9	1,4	45	-6
03967	6,6	0,6	49	0	8,7	0,9	44	-3	11,1	0,6	26	-32
04030	3,9	3,4	122	40	5,2	2,3	107	49	7,3	1,0	70	26
04320	-19,6	3,8	19	3	-10,5	6,8	40	30	-6,6	0,0	4	-1
04360	-2,1	6,1	168	70	-1,3	2,8	36	-41	2,7	2,1	42	-21
06186	4,3	1,7	41	-1	8,8	2,2	28	-14	12,4	0,4	32	-11
06260	5,9	0,9	42	-24	10,4	2,4	33	-20	12,3	0,0	31	-30
06447	6,6	0,9	25	-48	11,1	2,4	37	-20	12,8	0,1	41	-29
06590	4,9	0,9	33	-37	9,7	2,2	57	-4	12,2	0,4	68	-13
06660	2,1	-2,0	67	-3	9,6	1,6	46	-43	11,9	-0,3	172	67
06700	5,5	0,5	59	-15	10,6	1,8	32	-29	13,8	1,0	44	-28
07510	8,5	0,1	38	-38	11,7	0,6	65	-7	15,7	1,3	73	-4
07650	9,8	-0,1	3	-41	13,9	0,9	37	-11	17,0	0,0	19	-23
08222	9,4	-0,6	61	28	12,4	0,2	46	-8	15,1	-0,9	135	94
08314	11,5	-0,1	39	-16	14,2	0,9	25	-26	16,8	0,0	43	6
08495	15,1	0,1	57	-18	15,5	-0,7	88	28	18,0	-0,5	88	53
08515	15,2	0,6	40	-39	15,5	0,3	63	8	17,3	0,6	5	-25
08535	13,1	-0,6	64	-5	15,6	0,5	19	-45	17,9	0,5	14	-25
10384	5,4	1,2	23	-14	10,2	1,6	24	-17	13,1	-0,8	33	-23
10637	5,8	0,6	18	-33	11,6	2,4	19	-33	13,3	-0,4	66	5
11035	4,5	-0,9	92	51	11,5	1,3	22	-29	14,3	-0,4	55	-6
11518	3,5	0,4	33	5	9,3	1,7	17	-21	11,6	-0,9	47	-30
11903	3,3	0,2	36	-6	10,1	1,5	59	12	12,5	-1,1	85	21
12160	3,3	1,2	44	9	8,5	1,7	32	-10	11,3	-1,6	83	42
12375	3,5	1,6	35	9	8,7	1,0	57	24	12,0	-1,5	58	0
12843	5,5	-0,1	63	34	12,0	0,9	53	15	14,9	-1,0	65	10
13274	7,6	0,5	16	-34	13,1	0,7	72	13	16,0	-1,2	63	-8
14015	5,0	-0,4	89	-9	10,7	0,8	171	62	14,0	-0,6	110	-12
14445	10,4	0,0	97	22	14,7	0,8	124	58	17,3	-1,1	88	32
14654	5,3	0,2	51	-19	10,7	1,3	115	41	12,3	-1,8	96	14
15420	5,9	1,1	41	3	10,7	-0,6	20	-26	14,6	-2,1	108	38
15614	5,4	0,6	41	4	11,4	1,0	18	-31	13,4	-1,2	61	-17
16158	9,1	-0,4	80	4	12,3	-0,2	74	-5	15,3	-1,0	81	22
16597	13,8	0,4	22	-19	16,1	0,6	30	7	18,2	-0,9	3	-4
16716	12,8	0,4	6	-38	16,1	0,1	19	-6	20,0	-0,6	7	-7
16754	14,1	0,5	18	-39	16,9	0,3	25	-5	19,8	-0,5	22	7
17040	8,6	0,7	185	38	11,7	0,1	129	28	15,7	-0,1	148	46
17062	8,4	0,9	60	-2	12,2	0,2	22	-27	16,4	-0,1	38	7
17130	7,2	1,1	13	-23	11,5	0,3	38	-10	15,8	0,3	34	-21
17170	3,7	2,6	70	28	6,9	-0,4	27	-27	12,4	-0,3	85	35
17609	14,9	1,4	0,5	-42	17,7	0,8	2	-10	21,1	0,7	0,5	-8,5
22113	-4,2	2,3	16	-3	0,9	2,5	20	0	4,6	1,0	60	29
26038	-0,3	1,9	41	12	5,2	1,8	18	-18	10,1	0,4	26	-11
26629	1,6	2,0	59	24	7,4	1,6	15	-27	11,0	-1,4	38	-17
26730	1,2	1,8	38	-1	7,0	1,3	63	17	10,3	-2,2	45	-17
26850	1,2	2,6	38	-4	6,9	0,9	50	8	10,9	-2,0	37	-25
27199	-1,5	3,5	42	12	0,9	-2,3	28	-8	12,4	1,5	47	-1
27612	1,3	3,5	30	-4	4,6	-1,2	37	-7	11,4	-1,7	58	7
33345	3,9	3,2	21	-18	9,1	0,4	21	-28	13,2	-1,9	53	0
33815	5,4	2,5	31	-4	10,8	0,6	28	-14	14,8	-1,3	75	24
34300	3,8	4,1	43	16	8,6	-0,3	28	-8	13,8	-1,8	102	55
34880	5,7	4,4	15	-1	10,1	-1,0	14	-11	18,3	0,1	8	-14
35188	-7,5	0,6	11	-3	5,0	0,1	30	8	16,9	3,8	13	-20
37789	8,4	2,6	25	-7	10,7	-2,0	72	35	15,8	-1,7	53	10
40080	13,0	2,0	5	-12	16,0	0,5	0,5	-10,5	21,8	1,6	3	-1
40180	17,3	2,4	26	-36	19,2	1,0	1	-22	22,3	1,2	0,5	-2,5
40310	14,3	2,1	0,5	-7	17,2	0,3	0	-4	21,6	0,8	0	-2
60030	18,7	0,3	9	-1	18,7	0,0	8	2	19,7	-0,2	2	0

WMO No.	Station	June 2004 Temp mean	(°C) dep.	Prec. sum	(mm) dep.	July 2004 Temp mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	3,0	1,2	10	-1	7,6	1,8	45	27
01025	Tromsø	8,5	-0,7	53	-2	14,8	3,0	64	-9
01492	Oslo-Blindern	14,2	-1,0	75	10	16,0	-0,4	51	-30
02196	Haparanda	12,2	-0,6	48	7	16,5	1,1	76	27
02485	Stockholm	14,6	-1,0	107	62	17,0	-0,2	55	-17
02974	Helsinki-Vantaa	13,1	-1,8	104	60	16,5	-0,1	201	128
03091	Aberdeen	13,5	1,4	86	33	13,8	0,0	52	-8
03772	London-Heathrow	17,3	1,9	40	-11	18,0	0,2	38	-8
03967	Dublin (Casement)	14,6	1,3	51	3	14,6	-0,3	48	-6
04030	Reykjavik	10,5	1,5	45	-5	11,5	0,9	56	4
04320	Danmarkshaven	1,3	0,6	1	-5	3,7	0,0	31	17
04360	Angmagssalik	4,4	0,3	14	-36	6,8	0,4	118	71
06186	København-Landb.	14,5	-1,6	71	17	16,0	-1,2	104	35
06260	De Bilt	15,5	0,3	69	-1	16,7	-0,1	122	46
06447	Uccle	16,3	0,8	78	0	17,4	0,2	112	37
06590	Luxembourg	15,7	0,8	43	-39	17,2	0,3	69	1
06660	Zürich	16,4	0,9	139	14	17,8	0,2	118	0
06700	Genève	18,8	2,3	61	-23	20,0	0,9	88	23
07510	Bordeaux	20,7	3,0	11	-45	20,4	0,4	54	7
07650	Marseille	22,7	1,9	4	-24	24,3	0,6	1	-13
08222	Madrid	24,5	3,8	5	-21	25,6	1,2	9	-4
08314	Mahon / Menorca	22,3	1,5	18	4	24,6	0,4	2	-2
08495	Gibraltar	21,7	0,6	0	-11	24,3	0,6	1	-1
08515	St. Maria / Acores	20,2	1,4	140	118	21,6	0,8	15	-10
08535	Lisboa	22,9	2,7	0,5	-21	23,4	1,0	0	-5
10384	Berlin-Tempelhof	16,3	-1,1	58	-17	18,1	-0,7	79	27
10637	Frankfurt/Main	17,6	0,5	39	-31	19,0	0,1	88	25
11035	Wien-Hohe Warte	18,0	0,2	125	51	20,1	0,4	47	-16
11518	Praha-Ruzyne	15,6	0,0	107	34	17,6	0,5	48	-18
11903	Slica	16,5	-0,1	118	33	18,4	0,3	75	16
12160	Elblag	14,7	-0,7	67	-27	16,4	-0,4	105	11
12375	Warszawa-Okecie	15,8	-0,9	47	-24	17,9	-0,1	79	10
12843	Budapest-Lorinc	19,1	0,1	69	6	21,6	0,8	54	2
13274	Beograd	20,5	0,5	114	24	23,1	1,4	95	29
14015	Ljubljana	18,8	1,0	172	17	20,9	1,0	126	4
14445	Split	23,1	0,9	55	4	26,9	1,5	1	-27
14654	Sarajevo	18,0	1,0	81	-10	20,1	1,2	140	60
15420	Bucuresti	19,5	-0,7	80	3	21,8	-0,2	88	24
15614	Sofia	18,4	0,4	91	16	20,8	1,0	26	-30
16158	Pisa	20,7	0,9	34	-10	23,0	0,2	16	-7
16597	Luqa / Malta	23,1	0,1	3	0	26,3	0,4	0	0
16716	Athens (Hellinikon)	25,8	0,8	0,5	-6	28,7	0,9	9	3
16754	Heraklion / Kreta	24,4	0,1	0	-3	26,5	0,4	0	-1
17040	Rize	20,1	0,2	177	49	22,7	0,5	116	-20
17062	Istanbul-Goztepe	21,4	0,3	29	8	23,7	0,5	13	-6
17130	Ankara / Central	20,0	0,4	26	-11	23,6	0,7	6	-8
17170	Van	18,5	0,9	3	-18	21,4	-0,5	2	-2
17609	Larnaca	25,2	1,2	0,5	-1	28,0	1,4	2	2
22113	Murmansk	8,7	-0,5	45	-9	17,5	4,9	73	12
26038	Tallina	12,8	-1,7	79	26	16,3	0,0	265	186
26629	Kaunas	14,2	-1,6	63	-6	16,6	-0,3	79	-1
26730	Vilnius	14,1	-1,7	122	45	16,7	-0,2	45	-33
26850	Minsk	15,1	-1,0	74	-9	18,1	0,8	131	43
27199	Wjatka (Kirov)	16,0	0,3	98	33	20,6	2,4	63	-24
27612	Moskva	15,3	-1,3	76	1	19,0	0,8	152	58
33345	Kiev	17,7	-0,4	7	-66	20,5	1,2	113	25
33815	Chisinau	19,3	-0,1	11	-64	21,7	0,8	100	31
34300	Charkov (Kharkiv)	17,3	-1,6	29	-29	19,9	-0,4	75	15
34880	Astrahan'	22,2	-0,6	23	2	23,8	-1,4	27	12
35188	Akmola	19,9	0,9	48	13	20,9	-0,4	42	-8
37789	Yerevan	22,6	0,7	14	-7	24,4	-1,6	11	1
40080	Damascus	25,1	0,7	0	-1	28,0	1,7	0	0
40180	Tel Aviv (Airport)	24,8	0,8	0	0	27,7	2,0	0	0
40310	Ma'an	24,1	0,1	0	0	26,4	0,9	0	0
60030	Las Palmas / Gr. Can	22,9	1,5	0	0	24,9	1,6	1	1

WMO No.	August 2004				September 2004				October 2004			
	Temp mean	(°C) dep.	Prec. sum	(mm) dep.	Temp mean	(°C) dep.	Prec. sum	(mm) dep.	Temp mean	(°C) dep.	Prec. sum	(mm) dep.
01008	5,7	0,9	21	-2	1,3	0,9	8	-12	-3,6	1,9	7	-6
01025	12,1	1,2	43	-36	7,8	0,9	228	128	3,0	-0,2	80	-49
01492	17,8	2,6	81	-8	12,3	1,5	106	16	6,5	0,2	100	16
02196	14,2	1,0	54	-11	9,5	1,5	124	58	2,2	-0,3	36	-28
02485	18,5	2,3	49	-17	13,5	1,6	39	-16	7,8	0,3	44	-6
02974	16,7	1,7	78	-2	12,2	2,2	93	20	5,6	0,2	59	-14
03091	15,1	1,5	94	19	13,0	1,3	24	-44	9,5	0,5	145	68
03772	19,4	2,0	108	57	16,6	1,6	19	-32	12,3	0,6	97	39
03967	16,0	1,4	114	36	13,9	0,9	55	-14	9,2	-1,1	177	109
04030	12,6	2,3	60	-2	9,0	1,6	94	27	4,3	-0,1	66	-20
04320	2,9	0,5	1	-14	-2,3	1,9	31	20	-11,5	2,1	2	-10
04360	8,0	2,0	26	-40	5,2	2,1	97	22	0,5	1,3	43	-43
06186	18,9	1,9	50	-13	14,6	1,0	28	-34	10,2	0,3	79	20
06260	18,8	2,1	127	56	15,2	1,2	62	-5	11,3	0,8	48	-27
06447	18,9	1,9	123	60	15,8	1,4	83	24	11,7	1,3	68	-3
06590	18,1	1,7	128	56	15,0	1,6	40	-30	10,1	1,0	75	0
06660	18,7	2,0	57	-78	15,2	1,3	73	-21	11,4	2,3	127	58
06700	20,1	2,0	206	128	16,8	1,9	24	-56	13,6	3,7	213	140
07510	21,2	1,7	71	17	19,0	1,6	51	-23	15,4	1,9	97	9
07650	24,6	1,7	21	-8	21,2	1,3	48	1	18,1	2,4	113	35
08222	24,1	0,2	39	30	22,3	1,8	4	-26	15,6	0,8	85	40
08314	26,1	1,6	1	-26	23,8	1,6	9	-46	21,3	2,8	81	-3
08495	24,5	0,3	0	-6	22,8	0,0	0,5	-15	19,8	0,3	37	-27
08515	22,3	0,1	20	-20	21,8	0,4	21	-36	19,7	0,4	226	142
08535	23,1	0,3	25	19	21,7	0,0	33	7	18,1	-0,4	116	36
10384	20,2	1,8	67	6	15,0	0,4	26	-20	10,7	0,7	22	-14
10637	20,1	1,8	90	25	16,0	1,2	46	-2	11,3	1,5	51	0
11035	20,6	1,4	25	-33	15,4	-0,1	40	-5	11,2	1,0	39	-2
11518	18,9	2,3	53	-17	13,9	0,7	33	-7	9,5	1,2	22	-9
11903	18,4	1,1	47	-22	13,3	-0,2	29	-27	9,9	1,5	50	0
12160	18,9	2,2	110	29	13,6	0,9	55	-15	9,7	0,8	110	57
12375	19,0	1,7	43	-19	13,6	0,5	17	-26	10,0	1,8	37	0
12843	21,5	1,3	30	-21	16,3	-0,1	14	-26	12,0	1,0	50	17
13274	22,0	0,7	89	38	17,2	-0,5	45	-6	15,1	2,7	33	-7
14015	20,7	1,6	164	20	15,6	0,1	118	-12	13,0	2,6	287	172
14445	25,7	0,5	17	-33	22,2	0,8	11	-50	19,1	2,2	39	-40
14654	19,1	0,6	39	-32	15,1	0,0	36	-34	13,9	3,5	51	-26
15420	20,1	-1,1	75	17	15,8	-1,1	70	28	11,1	0,3	21	-11
15614	20,1	-0,6	48	-1	17,1	1,0	37	-1	12,8	2,1	37	2
16158	24,2	1,7	16	-41	20,7	1,2	79	-10	18,0	2,7	133	13
16597	26,7	0,4	1	-7	23,4	-0,7	80	40	22,2	1,5	20	-70
16716	27,8	0,2	0	-8	24,4	0,1	0,5	-10	21,0	1,7	40	-8
16754	26,8	0,9	0	-1	23,9	0,4	0	-20	21,7	1,8	7	-62
17040	24,0	1,8	255	72	20,0	0,6	166	-55	16,9	1,5	303	31
17062	23,6	0,6	79	53	20,9	1,2	8	-33	17,3	2,0	111	40
17130	22,9	0,3	13	1	19,3	1,0	3	-16	14,2	1,6	11	-16
17170	22,2	1,0	0	-7	18,0	1,2	0	-14	12,0	1,9	48	0
17609	27,6	1,0	1	1	25,5	0,9	0	0	23,6	2,3	0,5	-19
22113	12,7	1,9	105	26	7,8	1,1	74	20	1,5	0,6	57	14
26038	17,3	2,0	58	-26	12,7	1,9	103	21	6,5	0,2	91	21
26629	17,9	1,5	98	20	12,7	0,8	35	-21	8,3	1,2	81	36
26730	18,1	1,8	97	25	12,3	0,7	38	-27	7,9	1,3	65	12
26850	18,6	2,1	106	34	12,5	0,8	80	20	7,6	1,3	73	24
27199	16,4	1,0	77	13	11,0	1,8	56	-16	2,8	1,1	79	16
27612	18,4	2,0	80	3	12,1	1,1	88	23	5,9	0,8	84	25
33345	20,7	2,1	130	61	14,2	0,3	79	32	9,3	1,2	31	-4
33815	21,1	0,6	26	-19	15,9	-0,3	70	22	11,4	1,3	33	6
34300	20,6	1,1	68	18	14,7	0,6	47	6	8,0	0,7	27	-8
34880	25,1	1,8	52	34	18,5	1,1	12	-12	11,2	2,0	29	12
35188	17,9	0,2	65	25	13,6	1,6	24	0	5,5	2,7	31	1
37789	26,7	1,5	1	-7	21,2	0,5	4	-6	14,8	1,6	9	-18
40080	26,1	0,1	0	0	23,8	0,6	0	0	20,4	2,3	2	-8
40180	27,6	1,5	0	0	26,3	1,5	0	0	24,4	5,8	0	-26
40310	25,1	-0,5	0	0	24,4	0,6	0	0	21,6	2,1	4	0
60030	26,3	2,2	4	4	25,0	1,2	2	-7	23,8	1,3	7	-3

WMO No.	Station	November 2004 Temp mean	(°C) dep.	Prec. sum	(mm) dep.	December 2004 Temp mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-11,5	-1,2	11	-2	-6,6	6,7	13	-1
01025	Tromsø	0,1	0,7	173	68	0,2	2,9	142	37
01492	Oslo-Blindern	1,0	0,3	47	-26	0,3	3,4	33	-22
02196	Haparanda	-4,6	-0,4	38	-21	-4,5	5,0	75	33
02485	Stockholm	1,9	-0,7	46	-7	1,6	2,6	39	-7
02974	Helsinki-Vantaa	-0,5	-0,6	63	-9	-0,5	3,6	76	18
03091	Aberdeen	7,0	2,0	52	-23	5,1	1,6	33	-40
03772	London-Heathrow	8,8	1,6	30	-25	6,1	1,0	47	-10
03967	Dublin (Casement)	8,2	1,5	46	-24	6,7	1,4	51	-26
04030	Reykjavik	2,2	1,1	113	40	-0,2	0,0	86	7
04320	Danmarkshaven	-19,6	0,3	7	-5	-19,7	2,1	26	11
04360	Angmagssalik	-3,4	1,3	104	8	-7,5	-0,3	38	-68
06186	København-Landb.	5,6	0,1	45	-17	4,1	1,9	49	-9
06260	De Bilt	6,3	0,4	76	-5	3,2	0,0	46	-37
06447	Uccle	6,4	0,4	78	0	2,9	-0,5	66	-10
06590	Luxembourg	4,4	0,6	44	-39	0,1	-0,9	43	-37
06660	Zürich	4,3	0,3	21	-61	0,7	0,1	54	-21
06700	Genève	5,9	0,9	39	-49	2,9	1,1	58	-24
07510	Bordeaux	8,2	-0,4	11	-83	6,1	0,0	68	-31
07650	Marseille	9,4	-1,0	14	-44	8,0	1,0	32	-24
08222	Madrid	9,1	-0,3	17	-47	7,4	1,0	14	-37
08314	Mahon / Menorca	13,9	-0,5	119	42	12,6	0,8	69	-5
08495	Gibraltar	15,8	-0,3	50	-91	13,7	-0,4	96	-50
08515	St. Maria / Acores	17,6	0,2	45	-57	15,4	0,0	45	-50
08535	Lisboa	13,9	-0,6	36	-78	11,7	-0,1	16	-92
10384	Berlin-Tempelhof	4,9	0,0	58	9	2,5	1,1	27	-26
10637	Frankfurt/Main	5,5	0,8	27	-32	1,4	-0,4	22	-32
11035	Wien-Hohe Warte	6,2	1,5	48	-2	1,3	0,3	15	-28
11518	Praha-Ruzyne	3,9	0,9	44	12	-0,1	0,1	13	-12
11903	Slica	4,3	1,2	54	-15	-0,9	1,0	47	-10
12160	Elblag	3,5	0,2	65	9	2,0	1,7	51	-1
12375	Warszawa-Okecie	3,7	0,5	52	11	1,8	2,7	17	-15
12843	Budapest-Lorinc	6,0	1,2	64	12	0,9	0,5	39	-1
13274	Beograd	7,6	0,6	130	76	3,7	1,4	50	-8
14015	Ljubljana	5,9	1,3	88	-47	1,5	1,5	148	47
14445	Split	12,7	0,5	157	49	10,7	2,0	236	136
14654	Sarajevo	4,2	-1,1	156	62	2,3	2,0	92	7
15420	Bucuresti	5,4	0,2	79	30	1,1	0,9	53	10
15614	Sofia	6,1	1,0	44	-9	1,9	1,3	46	2
16158	Pisa	11,3	0,9	108	-16	8,7	1,9	113	28
16597	Luqa / Malta	16,8	-0,2	149	69	15,0	1,2	92	-20
16716	Athens (Hellinikon)	15,1	-0,3	43	-8	12,3	0,3	76	10
16754	Heraklion / Kreta	17,3	0,7	141	82	13,9	0,1	83	6
17040	Rize	11,9	0,3	387	137	7,5	-0,8	322	79
17062	Istanbul-Goztepe	12,1	0,5	81	-8	8,5	0,4	26	-96
17130	Ankara / Central	7,2	0,1	35	2	2,3	-0,3	9	-40
17170	Van	4,6	0,6	105	63	-3,7	-2,8	41	7
17609	Larnaca	18,0	1,1	41	-2	13,2	-0,2	69	-11
22113	Murmansk	-5,3	-0,3	48	7	-4,6	4,5	20	-17
26038	Tallina	1,5	0,3	69	1	0,8	3,7	63	8
26629	Kaunas	1,4	-0,4	43	-10	1,3	3,6	36	-11
26730	Vilnius	0,7	-0,5	42	-15	0,5	3,4	48	-7
26850	Minsk	0,5	-0,3	38	-14	-0,3	3,5	38	-15
27199	Wjatka (Kirov)	-4,5	0,3	57	4	-8,6	1,9	58	10
27612	Moskva	-1,6	-0,4	63	5	-2,9	3,2	57	1
33345	Kiev	2,9	0,8	44	-7	2,2	4,5	16	-36
33815	Chisinau	5,2	0,8	72	33	2,2	2,5	27	-11
34300	Charkov (Kharkiv)	1,9	0,6	37	-7	-1,1	2,3	36	-9
34880	Astrahan'	4,9	1,7	33	16	-0,3	1,5	32	16
35188	Akmola	-1,4	4,5	28	6	-12,8	-0,2	36	19
37789	Yerevan	7,1	0,6	37	15	3,9	3,7	2	-21
40080	Damascus	12,6	0,8	26	5	5,5	-1,7	10	-16
40180	Tel Aviv (Airport)	19,9	1,9	0	-68	13,9	0,1	74	-64
40310	Ma'an	13,8	0,3	0,5	-4	8,1	-0,9	3	-5
60030	Las Palmas / Gr. Can	21,5	1,1	23	2	18,7	0,4	36	15

WMO No.	Station	Year 2004 Temp mean	(°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-4,4	2,3	182	2
01025	Tromsø	4,1	1,2	1112	112
01492	Oslo-Blindern	7,1	1,4	757	-6
02196	Haparanda	2,4	1,3	643	85
02485	Stockholm	7,6	1,0	527	-12
02974	Helsinki-Vantaa	5,4	0,9	842	191
03091	Aberdeen	9,2	1,4	778	-6
03772	London-Heathrow	11,9	1,4	621	22
03967	Dublin (Casement)	10,0	0,7	773	38
04030	Reykjavik	5,6	1,3	936	135
04320	Danmarkshaven	-10,7	1,6	180	41
04360	Angmagssalik	0,1	1,8	829	-155
06186	København-Landb.	9,3	0,6	598	-38
06260	De Bilt	10,3	1,0	858	37
06447	Uccle	10,7	1,0	914	93
06590	Luxembourg	9,3	1,0	733	-142
06660	Zürich	9,3	0,8	1071	-30
06700	Genève	11,2	1,6	991	87
07510	Bordeaux	13,4	1,0	695	-228
07650	Marseille	15,2	0,7	314	-231
08222	Madrid	15,1	0,8	485	29
08314	Mahon / Menorca	17,5	0,9	465	-136
08495	Gibraltar	18,2	0,0	560	-215
08515	St. Maria / Acores	18,2	0,7	854	79
08535	Lisboa	17,2	0,4	518	-236
10384	Berlin-Tempelhof	9,9	0,5	538	-45
10637	Frankfurt/Main	10.7	1,0	555	-103
11035	Wien-Hohe Warte	10,4	0,5	668	61
11518	Praha-Ruzyne	8,5	0,7	473	-54
11903	Slica	8,3	0,3	703	17
12160	Elblag	8,1	0,5	849	159
12375	Warszawa-Okecie	8,4	0,6	523	8
12843	Budapest-Lorinc	10,8	0,4	590	74
13274	Beograd	12,4	0,6	829	146
14015	Ljubljana	10,7	0,9	1697	304
14445	Split	16,5	0,6	993	168
14654	Sarajevo	10,1	0,6	1017	85
15420	Bucuresti	10,3	-0,3	715	120
15614	Sofia	10,6	0,6	519	-60
16158	Pisa	14,8	0,8	900	-4
16597	Luqa / Malta	18,9	0,3	464	-90
16716	Athens (Hellinikon)	18,6	0,2	369	-2
16754	Heraklion / Kreta	19,0	0,3	557	56
17040	Rize	14,5	0,5	2571	398
17062	Istanbul-Goztepe	14,6	0,5	666	-31
17130	Ankara / Central	12,2	0,5	252	-161
17170	Van	9,5	0,9	446	61
17609	Larnaca	19,9	0,9	434	114
22113	Murmansk	1,7	1,7	562	70
26038	Tallina	6,1	1,0	870	203
26629	Kaunas	6,9	0,6	637	7
26730	Vilnius	6,5	0,5	721	38
26850	Minsk	6,6	0,8	828	151
27199	Wjatka (Kirov)	3,7	1,4	689	58
27612	Moskva	5,8	0,9	864	173
33345	Kiev	8,9	1,2	615	-34
33815	Chisinau	10,3	0,7	599	52
34300	Charkov (Kharkiv)	8,5	1,0	599	80
34880	Astrahan'	11,5	1,5	282	66
35188	Akmola	4,4	1,7	361	43
37789	Yerevan	13,0	0,9	286	9
40080	Damascus	17,3	0,9	121	-23
40180	Tel Aviv (Airport)	21,0	1,8	354	-214
40310	Ma'an	17,9	0,6	22	-21
60030	Las Palmas / Gr. Can	21,4	0,9	134	16

Monthly Surveys

January 2004

- **Cold in most of the East and some areas in the North, mild in western Central Europe, Portugal and Spain**
- **Very wet in most of Central Europe, parts of Portugal and in the East, mainly dry in the Baltic countries and parts of the western Mediterranean, high spatial variability in northern Europe**
- **Some intense snowfall in southern Europe**
- **Severe storms with heavy rain and flooding in the eastern Mediterranean**

In Nuuk, **Greenland**, January was warmer than normal and fairly dry.

On the **Faroe Islands** at Tórshavn, the January temperature was about normal, sometimes with cold spells.

The temperature in **Iceland** in January was close to the 1961-1990 mean, there was substantial snow during a period in the northern part of the country, but elsewhere there was little snow.

There were great deviations from the normal both for temperature and precipitation in **Norway**. The monthly average in the eastern parts of the county of Finnmark was 2-3°C above normal, while in the county of Troms and higher parts in southern Norway the monthly mean was 1-2°C below normal. Sunndalsøra in the county of Møre og Romsdal measured the highest temperature with 11.2°C on January 24 while Karasjok measured -37.4°C as the lowest on January 6. Østlandet and Sørlandet received much more precipitation than normal and in some areas the month was among the wettest within the last 100 years while other areas in the counties Møre og Romsdal, Oppland, Sør-Trøndelag, Nordland and Troms received only 10-20%. At Sørlandet several stations registered new monthly and daily records for precipitation. The highest diurnal precipitation amount (77.0mm) was measured at the station Reine in the county of Nordland on January 23.

January was quite wintry in **Sweden** with some snowstorms, especially on 30-31 when about 20 000 households in south-west Sweden had a failure in the supply of electricity due to wet snow.

The year started a bit cold and wintry in **Denmark** with snow and frost. On January 5-6, considerable amounts of snow fell on the isle of Zealand, especially in the capital Copenhagen. At the end of the month the temperature was rather low with hard frost in the middle of Jutland.

In **Estonia** the month was colder than usual by 1°C and the precipitation achieved only half of the normal.

In **Latvia** this was the 9th driest January over the last 80 years.

January was the coldest month of the year in **Lithuania**. Its mean air temperature was -6.6°C (-1.5°C anomaly). The lowest temperature of the month was -24°C. The last decade was the coldest, when the daily mean temperature was -5°C below normal. Such a cold end of January had previously occurred in 1996. The monthly amount of precipitation was below normal in the western regions while exceeding it 1.2-2 times in the southern and eastern regions with a snow depth up to 30cm.

Kilkenny's (**Ireland**) lowest air and ground temperatures of -7.7°C and -15.6°C, respectively, on January 29 were the lowest such values at the station for around 20 years.

Within the **United Kingdom**, the Central England temperature exceeded the 1961-1990 normal by 1.4°C, the England-Wales precipitation by 32mm (=135% of the normal).

In **Belgium,** January was characterised by alternating maritime and continental flows. On the monthly average, the temperature was slightly above normal. Precipitation was very high, especially during the second decade with 102.4mm, a new record in the period since 1901.

January in **Luxembourg** was slightly warmer than normal (+0.3°C), but it rained very often (25 precipitation days), resulting in an anomaly of +32.8mm (145% of the normal).

Snow and freezing rain led to chaotic traffic on the streets in **Germany** on January 4-6, especially in the north. Two storms occurred with gusts up to 215 km/h in the Alps (Nebelhorn) on January 12-14. Trees broke down; fences and roof tiles flew in the air. 165mm precipitation in 24h fell on the mountain station Schauinsland (Black Forest). At the same time (January 13), a tornado untiled 7 houses north-west of Hamburg. Another traffic chaos due to snow and ice occurred on January 28-30. Some airports were temporarily closed. The monthly mean temperature for Germany was -0.1°C. This was 0.4°C above the value for the reference period 1961-90. However, January 2004 was extremely rich in precipitation (Fig. 1.1) and rather poor in sunshine duration. The average amount of precipitation was 109.4 mm, exceeding the normal by 48.6 mm or 80.0%. So this month became the 3rd wettest January in Germany since 1901. The average sunshine duration was only 34.0h, which is far below normal (anomaly -9.6h or -21.9%).

January was very cold in the entire area of **Poland**: monthly mean values ranged from -2°C in the North to -7°C in the Northeast. Monthly mean departures were between -2°C and -4°C. An extreme minimum temperature of -25.2°C was observed in the South of Poland on January 24. Precipitation in January was close to normal or slightly higher. The lowest values were observed in the North and South (below 70%); in the West precipitation exceeded 160%. A snow cover appeared at the beginning of the month and remained during the entire month, especially in the East. At the coast and over mountains strong winds (>70km/h) occurred together with snow storms.

In **Switzerland**, a westerly storm in the northern Alps with gusts up to 206km/h on the Jungfraujoch was observed on January 12-13. Precipitation of 60-100mm fell in the western part of the Swiss Alps. There were extremely mild temperatures, in some regions rain fell up to the altitude of 2300m. In the lowlands, in spite of continuous rain, 11-15°C were measured.

Up to 300% of normal precipitation fell in north-western parts of upper **Austria**. Very cold nights occurred in western and southern Austria during the last week of January. In St. Michael (province of Salzburg) –27.0°C on January 24 was the lowest temperature at this place since 1985.

An absolute minimum temperature of -21.8°C was measured at Szécsény in **Hungary** on January 23. The countrywide anomaly (compared to 1961-1990) of the monthly mean temperature was -0.5°C. As for precipitation, the monthly average was only slightly higher than normal (105%).

The mean air temperature was close to the 1961-1990 normal in **Slovenia**. The anomaly was mostly between -1 and +1°C; the largest anomaly was at Kredarica, where the temperature was 2.1°C below normal. Most of the precipitation was concentrated on the second third of January. The western part of Slovenia received less precipitation than normal; in Upper Soča valley even less than half of the normal precipitation amount was recorded. Elsewhere the normal was exceeded. The snow cover in the lowlands was up to 40cm; in Upper Sava valley 54cm were registered. At Kredarica on January 19 the snow depth reached 2.5m. There was much more sunny weather than on average, especially in Štajerska and Prekmurje. Only in the Northwest of Slovenia, in Notranjska and Koroška, the weather was less sunny than normal.

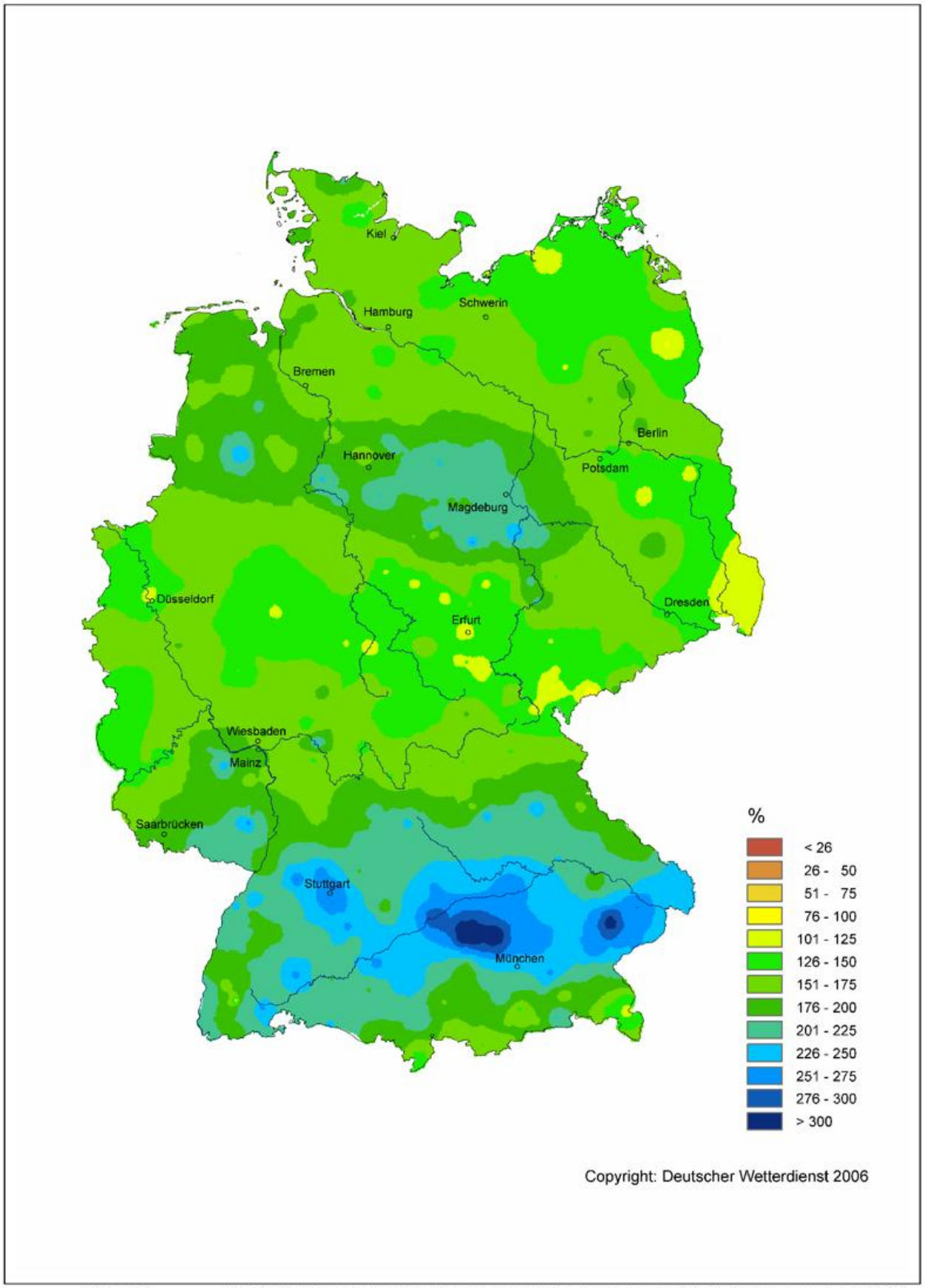


Fig. 1.1: *Precipitation anomalies for Germany in January 2004 (reference period 1961-1990)*
From: Deutscher Wetterdienst (DWD)

The monthly mean air temperature exceeded the 1961-1990 normal in almost the whole territory of **Portugal**. The precipitation amounts were below normal, except in the Lisbon region. In this region the daily maximum precipitation exceeded 101.2mm, the highest amount since 1901.

In **Spain** it was very warm in January, with average values lying generally in the upper quintile of the series. New records of January mean values were recorded at Tortosa (near the Ebro river mouth), at Murcia and at other observatories along the Mediterranean coast.

January was characterised by intense snowfalls in northern and central **Italy**.

In **Croatia**, temperature and precipitation were near normal in most parts of the country, only the South was cold (anomaly around –1°C compared to 1961-1990) and at some locations it was wet (150% of the normal or more).

The month was a little bit colder than normal in **Bosnia and Herzegovina** and wet. Many stations reported a monthly mean around –1°C, which is about 1°C less than normal (1971-2000). Monthly precipitation was around 100mm on station average; this was more than 40% above normal.

In **Romania**, January also was about 1°C colder than normal and the precipitation amount around one third higher than the average 1961-1990.

A high monthly precipitation amount of 394mm was registered in the north-eastern part of **Albania** this month. It also was the maximum of the whole year (usually the maximum is in November, Fig. 1.2) and it was far above the normal (more than 150%).

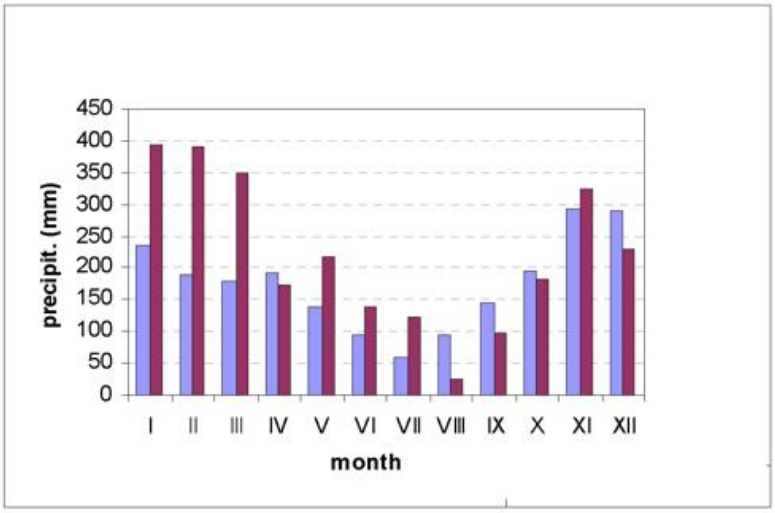


Fig. 1.2: *Annual course of the monthly precipitation sum in Puke in the north-eastern part of Albania (blue: average 1961-1990, red: 2004)*
From: Hydrometeorological Institute Albania

In **Bulgaria**, January 2004 can be identified as a cold month. The temperatures were about 1 - 1.5°C below normal. In terms of precipitation the month was rather normal. Only the north-eastern part of the country encountered precipitation up to 200% of the normal.

Strong storms with gusts >100km/h prevailed on January 22 over the Aegean Sea in **Greece** and resulted in damage of houses and crops. Failures in electric power network occurred in several parts of the eastern Aegean Sea. January 2004 was a very wet month for the country, probably the wettest January in the second part of the 20th century for the eastern and southern part of Greece (Tab. 1.1). An unusual phenomenon occurred in this month: a very deep barometric low with a core pressure of 971hPa (the deepest over the past 30-40 years) crossed the southern island part of the country on January 21-22. The pressure dropped by 28hPa over 24 hours.

Station	Location (latitude °N, longitude °E)	Altitude (m)	Monthly rainfall for January 2004 (in mm)	Long-term average rainfall for January (in mm)	Reference Period
Arta	39 10, 21 00	11.5	193.5	117.9	1976-1997
Mykonos	37 26, 25 25	121.0	243.2	81.8	1989-1997
Sitia	35 12, 26 06	114.5	240.8	90.5	1960-1997
Limnos	39 55, 25 14	3.0	242.4	65.9	1974-1997
Samos	37 42, 26 55	2.3	352.6	133.1	1978-1997
Rodos	36 24, 28 07	34.7	316.1	149.6	1955-1977
Kos	36 48, 27 06	127.1	278.0	94.0	1981-1997
Paros	37 05, 25 09	1.0	199.3	83.0	1975-1995
Argostoli	38 11, 20 29	21.2	178.9	109.7	1977-1997
Skiathos	39 10, 23 30	7.5	221.8	97.6	1986-1997

Tab. 1.1: *Monthly rainfall heights in Greece for January 2004 and long-term mean values From: Hellenic National Meteorological Service*

Houses and roads at Finike and Antalya in **Turkey** were affected by a storm with rain and flooding on January 10-11. Four ships sank in the seaport of Antalya. Another storm with heavy rain was observed there on January 21-23. Greenhouses and orange gardens were damaged, power lines broke off. Other locations, e.g. Istanbul, had snow causing severe problems for traffic roads, but also for sheep and goats.

January was rather warm in **Armenia**; the mean monthly temperature was above normal by 2°C.

The month was the wettest January (281.8mm) in **Cyprus** since 1902. On January 7, heavy snowfall occurred at Troodos, roads to the mountain villages were closed. Snowfall was also registered at Pentadaktylos and snowflakes were observed in southern areas of Lefkosia. On January 10-12 showers, thunderstorms and very strong winds occurred in various areas. The towns Lemesos and Larnaka and also some more south-eastern parts of the island were affected by flooding. On January 22 heavy showers, thunderstorms and very strong winds caused damage in various areas of the country.

January was very rainy in **Israel,** especially in the northern parts of the country, where rainfall amounts were 200-250% of the normal (average of 1961-1990). At many stations in the North this was one of the rainiest winter months since the beginning of measurements. Higher monthly rainfall amounts were measured before only in December 1951 and in January 1969. These large rainfall amounts in the North of Israel caused flooding and road closures. Significant daily amounts were recorded on January 23 with 130-170mm at some stations in the North. Rainfall amounts were larger than normal in the central and southern parts of the country, but not as extreme as in the North. Flooding in Tel Aviv and surrounding areas occurred on January 26 after 30mm of rain fell within 3-4 hours. Temperatures in January were close to normal.

February 2004

- **Generally very mild in most of northern and Central Europe, especially around February 4**
- **Some cold spells with snowfall in the south-eastern Mediterranean region**
- **Very dry in most of western Europe and the Mediterranean, wet in the North and East**

February was rather warm in **Iceland**, but windy, and there was much snow on places in the Northwest, North and East during the first half of the month. A heavy snowstorm passed over the island on February 6 and 7.

On the **Faroe Islands** in Tórshavn, February was warmer than normal, but some cold spells occurred.

The lowest minimum temperature in **Norway** was measured at Sihcajavri with -37.5°C and at Sveagruva (Arctic) with -34.7°C on February 10, the highest temperature at Tafjord with 14.5°C on February 4. With exception of Finnmark, the monthly average for February was above normal, in the inner and higher parts of south-eastern Norway, the anomaly reached between +4 and +5°C. Precipitation was below normal in the south-eastern parts of the country and above in the rest. In parts of the counties Møre og Romsdal, Oppland and Sør Trøndelag the monthly precipitation sum was more than 200% of the normal. The highest diurnal precipitation amount (74.2mm) was measured at the station Ålfoten in the county of Sogn og Fjordane on February 25.

February was considerably mild for the season in **Denmark**.

In **Estonia** the month was wet and warm, 2°C above the normal monthly mean. Snowmelt was observed, precipitation was falling as rain.

New records of maximum temperature were measured in **Latvia** on February 4. In south-east Latvia the air temperature fell from 0 to -27°C on February 18-20 within 40 hours, and then rose again to 0°C in the next 34 hours.

February was wintry in **Lithuania**, but not too cold. The weather was frequently determined by Atlantic cyclones. The mean air temperature was -2.2°C (+2.4°C anomaly). Highest maximum temperature values reached between 4 and 8°C, lowest minima were between -14 and -19°C, in south-eastern regions even between -22 and -25°C. A snow cover vanished in some parts of the country and reappeared 10 - 25cm deep in south-eastern regions. Precipitation in February was abundant and amounted to 240 - 280% of the normal at some places.

February was exceptionally sunny in **Ireland**. Belmullet recorded the highest gust of the year, 135km/h on February 3.

In the **United Kingdom,** on February 4 the highest February daily minimum Central England temperature (CET) and the highest February daily mean CET were recorded at 10.8°C and 12.8°C respectively.

The month of February started with record-high temperatures in the **Netherlands** on February 3 and 4. Eindhoven (southern part of the country) recorded a maximum temperature of 18.0°C on February 4.

In **Belgium,** February was influenced by maritime, sometimes tropical, sometimes polar air. The mild weather at the beginning of the month was compensated by a cold last decade, clearly below normal.

At Gardelegen (about 150km to the west of Berlin), **Germany,** the mildest February night with 14.2°C on February 4-5 exceeded the previous German record of 13.2°C on 16 February 1958 in Freiburg. Snowfall on February 8-11 and again on February 23 caused a lot of traffic accidents in the South and East of the country. For the areal mean of Germany, February 2004 was mild and near average in precipitation and sunshine. But there were large regional differences. While the North was considerably wet, a significant precipitation deficit was observed in the South. The mean temperature for Germany was 2.4°C (+2.0°C above the values for the reference period 1961-90). The average amount of precipitation was 51.3mm, which was 1.9mm or 3.9% higher than the mean of the reference period. The spatial mean of sunshine duration was 66.3 hours; this value was 6.3h or 8.7% below normal.

February was warm in **Poland** – positive mean monthly deviations reached +2.4°C in the West. The highest maximum temperature (+16°C) was observed in the South, the lowest minimum temperature (-20°C) occurred in the Northeast. Precipitation was higher than normal, especially in the Southeast (260%) and locally in the North (240%). A snow cover appeared occasionally with a few centimetres in the West up to 30-40cm in the East and 150 cm on mountains.

Extremely high temperatures in higher mountainous areas of **Switzerland** were observed on February 3-6, with freezing level up to 3600m.

Unusual high temperatures were measured during the first ten days in eastern **Austria**. On February 5, maximum temperatures went up to 22°C in the provinces of Lower Austria and Burgenland, causing new temperature records in some towns, e.g. Wiener Neustadt or Eisenstadt. Up to 310% of the normal precipitation fell in the eastern parts of Austria. A cold front passage on February 8 and 9 caused a lot of storm damage, especially in the counties Vorarlberg and Upper Austria. Along the river Rhine and within the forests east of Bregenz numerous trees were uprooted and roofs were partly damaged. Highest wind speeds, up to 130km/h, were recorded in Upper Austria. In the surroundings of Linz, road traffic was blocked by broken trees.

The mean air temperature in **Slovenia** in February was close to the 1961-1990 normal. The anomaly was mostly between -1 and +1°C; the largest anomaly was observed at Kredarica, where the temperature was 1.7°C above normal. Most of the precipitation fell in the last third of February. Precipitation was most abundant in the Upper Soča valley and in parts of the Julian Alps. The north-eastern part of Slovenia received less precipitation compared to the reference values. Elsewhere the normal was exceeded. The snow depth in the Upper Sava valley was up to 125cm, at Kočevje 68cm. Elsewhere in the lowlands up to 60cm were registered. At Kredarica on February 29, the snow depth was 4m. At the coast and in the Goriška region the average sunshine duration was below normal. The last decade was mostly cloudy everywhere.

February mean monthly temperatures in **Serbia and Montenegro** were near to normal. At the same time, precipitation quantities were higher than average at most places.

Torrential rain occurred at La Palma and Hierro (Canary Island, **Spain**). The highest total in 24h was recorded at La Palma on February 19.

February was characterised by intense snowfalls in northern and central **Italy**. In particular, the snow in late February caused many traffic problems both on railways and highways.

February was relatively warm and dry in **Bulgaria**. In the North and West of the country the temperatures were 1-2°C above normal. In terms of precipitation the northern part of the country reached only 50-70% of the normal and the South only 30-40%. Around February 27 an intense cold front passed the country from the Northwest to the East. It crossed the Danube plane in the North of the country within 3 hours. Thunderstorms were observed with strong winds (up to 70-90km/h). They caused significant damage to buildings and trees in the northern regions of Bulgaria.

The monthly mean air temperature in **Portugal** was equal or above normal in almost the whole territory. The precipitation amounts were below normal, except in the Algarve (southern region).

Severe snowfall occurred in **Greece** during the period February 12-13, affecting mainly the eastern and southern parts of Greece. For the periphery of Attiki (larger area of Athens) it was an unusual extreme phenomenon, particularly the great snow depth, which reached 40cm in the northern suburbs of Athens and 50-100cm in most northern parts of Attiki. Due to these severe snowfalls, the national road Athens - Lamia was closed for several hours causing serious traffic problems in domestic and rural areas. There were also failures in the electric power network and significant damage in agriculture. Unusual low daily minimum temperatures were observed in the middle of the month at some stations (Tab. 2.1). Most of these locations recorded new absolute minimum temperatures.

Station	Location (latitude °N, longitude °E)	Altitude (m)	Minimum daily temperature	Date	Long-term average monthly minimum temperature	Reference period
Arta	39 10, 21 00	11.5	-8.2	14/2/04	4.0	1976-1997
Hellinikon	37 54, 23 45	10.0	-3.8	14/2/04	7.1	1955-1997
N. Filadelfia (Athens)	38 03, 23 40	136.1	-6.0	14/2/04	5.4	1955-1997
Tanagra	38 19, 23 33	139.0	-11.2	14/2/04	3.4	1957-1997
Pyrgos	37 40, 21 26	12.0	-6.0	14/2/04	5.1	1975-1997
Zakynthos	37 45, 20 54	1.5	-2.0	14/2/04	6.2	1982-1997
Tympaki	35 00, 24 46	5.0	-0.5	15/2/04	7.3	1959-1997
Kasteli	35 12, 25 20	332.6	-7.0	15/2/04	5.5	1976-1997
Samos	37 42, 26 55	2.3	-2.8	15/2/04	6.5	1978-1997

Tab. 2.1: *Low minimum daily temperatures (in ^{0}C) in February 2004 and long-term averages*
From: Hellenic National Meteorological Service

A tornado passed Gazipasa and Antalya in **Turkey** on February 12. Greenhouses, farm areas and houses were damaged. Three days later, frost caused damage to citrus fruits, bananas and greenhouses. At Hatay, rain and floods affected farm areas and dwellings on February 21, followed by a storm on the next day, when trees were broken and mosque minarets were destroyed.

February was rather warm in **Armenia**; the mean monthly temperature was 2°C above normal.

Snowfall occurred on February 14 in the area of Troodos as well as in areas of low elevation in **Cyprus**. Slight snowfall was observed in Lefkosia town. On February 22, very strong winds caused damage to greenhouses and to the roofs of houses in the south-eastern parts of the island.

February was rainy in the northern parts of **Israel** and drier than normal in the central and southern parts of the country. Rainfall amounts were 110-130% of the normal in the North and 50-80% in other parts of the country. The most significant rain period occurred on February 13-16 with 100-150mm in the northern parts and heavy snowfall in the mountains, causing many road closures. In Jerusalem, 8-10cm of snow were recorded on February 14, but it melted within 24-36 hours. The last rainfall period was on February 18-21, and no further significant amounts were recorded until the end of the rainy season. The temperatures were slightly above normal with significant changes in the second part of the month. In the mountains, temperatures on February 14-15 were -1 to -2°C. On February 22, low temperatures were recorded once more (-1 to -2°C in the mountains), yet there was a significant warming during the following days. On February 29, 32-33°C were measured in the coastal plain.

March 2004

- **Warmer than normal in most countries except Greenland and some parts of southern Central and south-eastern Europe**
- **Most of the Region dry, but wet in Greenland, Ireland and some parts of the East and the Mediterranean**
- **Storms in Central Europe around March 20**
- **Abundant snowfall in the Alps on March 23-24**

In **Greenland,** March was colder and wetter than normal. The lowest temperature registered in 2004 in Nuuk was recorded on March 8 (-16.5°C). On March 25 a strong storm "hit" the west coast of Greenland, in Nuuk with gusts exceeding 140km/h. It moved through the Davis Strait in a north-easterly direction. The next day frost and rather large amounts of snowfall occurred.

March was very warm in **Iceland**, but windy; there was some local flooding in the first part of the month due to precipitation and snowmelt. It was the 6th warmest March in Reykjavik and the 3rd warmest in Akureyri.

The monthly mean in **Norway** was above normal for the whole country, 4-5°C above normal in the eastern and inner parts of Finnmark. The highest mean temperatures were to be found along the coast of Møre og Romsdal where the coastal station at Svinøy Fyr recorded 5.1°C (1.9°C above normal). The lowest monthly mean was reported from Finnmarksvidda and the mountainous parts of southern Norway. Sihcajavri (Finnmark) had the lowest value with -8.2°C (3.1°C above normal). The highest maximum temperature (16.1°C) was measured at Gvarv (southern Norway) on March 30 while the lowest minimum of the month (-31.0°C) was measured at Røros (Mid Norway) on March 5. The larger part of the country received less precipitation than normal. In some areas the month was among the 4-6 driest March months of the last 50 years. In parts of Troms, Oppland, and Møre og Romsdal the precipitation was 20-30% of the normal. Parts of Nordland and Trøndelag received precipitation above normal (150-175%). Among the synoptical stations, Modalen (western Norway) received most precipitation (229mm, 99% of the normal) while Saltdal (northern Norway) received least (3mm, 20% of the normal). At Lurøy in the county of Nordland 86.6mm were measured on March 18, which was the highest diurnal value of this month.

In **Finland** the 10-minute mean wind speed reached 76km/h in March which is regarded nationally as a level of gale warning in weather forecasts. The highest wind speed values of 104km/h were measured in the beginning of March.

The month was very warm in **Estonia** with mean temperatures up to 2°C above normal.

In **Latvia,** March 2004 was the 7th wettest March over the last 80 years.

The first half of March was dryer and colder than normal in **Lithuania**, while the second half was more humid and warmer. The monthly mean air temperature was 1.2°C (+1.9°C anomaly). In the beginning of the month there was some snowfall, changing to rainfall at the end of it. The monthly amount of precipitation was close to normal at most places, but exceeding the average up to 1.5 times at some localities. In the third decade of March, snowmelt and soil freeze ceased. The month was marked by fogs observed in eastern Lithuania on 4 to 7 days while persisting in western regions for 8 to 12 days in total. Sometimes the visibility went down to 100 metres, affecting air- and seaport operations and impeding road transport.

March was very wet and exceptionally sunny in **Ireland**, especially in the South. The strongest winds of the year at many stations were measured on March 20.

Mild and dry airflows influenced the weather in March in **Belgium** and caused a precipitation deficit. The temperature in Uccle was 1.1°C above normal and the precipitation was less than 50% there.

The monthly mean temperature in **Luxembourg** was slightly higher (+0.2°C) than the 1971-2000 normal. On March 17, a maximum of 20°C was reached, whereas the minimum was -4.6°C on March 1. Only 32.9mm precipitation fell this month, less than 50% of the normal.

March 2004 brought very mild weather to **Germany** (around the middle and at the end of the month), but also still contained wintry episodes (at the beginning and around March 25). The mean temperature for Germany was 4.1°C (+0.6°C above the 1961-90 normal). At two stations in the western part of the country, a new March 17 record temperature of 24.3°C was measured, exceeding the previous record of 23.7°C on 17 March 1961. The average monthly amount of precipitation was 37.6 mm, which was 19.0mm or 33.6% less than normal. The spatial mean of sunshine duration was 129.2 hours, exceeding the normal by 18.6 h or 16.8%. Stormy winds occurred on March 20-21 on the mountains Brocken (165km/h), Fichtelberg (148km/h) and Kahler Asten (130km/h). On March 23-24, record snowfall fell on the highest mountain Zugspitze (150cm in 24 hours).

The monthly mean temperature in March in **Poland** was again higher than normal with the highest values in the Northeast (deviation from normal +1.2°C). Extreme temperatures were -20.6°C and +22.3°C. Precipitation was higher than the 1971-2000 mean reaching 150% of the normal in the South. Only the West was drier with 75% of the normal precipitation.

Abundant snowfalls on the northern edge of the Alps in **Switzerland** were observed on March 23 and 24. A new record for fresh snow (75cm) since measurements started in 1938 was reported from St. Gall.

Austria was very wet with 250 to 300% of the normal precipitation in Vienna and in north-eastern parts of Lower Austria.

March in **Hungary** was a wet month with 158% of the 1961-1990 normal. Monthly temperature and sunshine duration were slightly lower than normal.

In March the mean air temperature in **Slovenia** was close to the 1961–1990 normal and well within the limits of the normal variability. The anomaly ranged mostly between -1 and +1°C. The largest anomaly was recorded from Kočevje, where the temperature was 1.9°C below normal. The first decade of March was colder and the second one was significantly warmer than normal. Maximum air temperatures in the lowlands exceeded 20°C. In the last decade the temperature dropped below normal again. Precipitation in the eastern half of Slovenia exceeded the normal values. About 60% more precipitation than usual fell in the Northeast of Slovenia. In Goriška valley only 38mm fell (37% of the normal). There was no precipitation in the second decade; most of the precipitation was concentrated in the last third of March. The snow depth in the Upper Sava valley was up to 115cm, in Kočevje 57cm, in Ljubljana 41cm. 430cm snow were measured at Kredarica on March 8. No snow cover was observed at the coast, Karst and in the Goriška region. In the western half of Slovenia and Prekmurje the sunshine duration was longer than on the average of the reference period. Especially in the second third of March the sunshine duration was longer than usual, while during the last decade much less sunshine was registered than in the reference period, except in the Goriška region.

The month was characterised as dry to very dry in the whole territory of **Portugal**, except in the northern region and the Algarve, where it was normal. The monthly average mean air temperature and the precipitation amounts were equal or below normal.

March was characterised by intense snowfalls in northern and central **Italy**.

In **Croatia**, the monthly mean temperatures were around normal or slightly below. Precipitation averages were also around normal or locally higher, except the most western region which was very dry. The station Poreč received only 28% of the normal.

Mean temperatures in **Bosnia and Herzegovina** were –0.5°C lower than normal, precipitation was about 120% of the normal on spatial station average.

In **Bulgaria,** March was warm and rather dry. The temperatures were 1 – 2°C above normal. Precipitation was up to 80% of the normal.

Unusual high daily maximum temperatures were measured in **Greece**. Daily maxima above normal were reported over several areas of the country (especially over the mainland) during the end of the second decade of March 2004 (Tab. 3.1).

Station	Location (latitude °N, longitude °E)	Altitude (m)	Maximum temperature on 18 March 2004	Long-term mean monthly maximum temperature	Reference Period
Agrinio	38 37, 21 23	24.0	23	16.9	1956-1997
Arta	39 10, 21 00	11.5	23	16.8	1976-1997
N. Filadelfia (Athens)	38 03, 23 40	136.1	22	15.7	1955-1997
Argos (Pyrgela)	37 36, 22 47	11.2	25	16.7	1980-1997
Lamia			24	15.3	1970-1997
Mikra (Thessaloniki)	40 31, 22 58	4.0	23	14.2	1957-1997
Trikala Imathias	40 36, 22 33	0.8	24	14.5	1980-1997
Trikala Thesalias	39 33, 21 46	108.6	24	15.4	1973-1997

Tab. 3.1: *Maximum daily temperatures (in °C) on 18 March 2004 and mean monthly maximum values*
From: Hellenic National Meteorological Service

Avalanches, floods and severe cold spells were reported on March 5-6 in **Turkey**, e.g. in Erzurum in the eastern part of the country. At the end of the month (March 31) frost returned to Malatya in the central part of Turkey, affecting blossoms of trees.

March was rather warm in **Armenia**; the mean monthly temperature was 2°C above normal. Very high temperatures were measured on March 1-6 and 21-28, when the maxima reached 30-31°C in Syunik valley, 23-28°C in Ararat Valley and Tavush, and 22°C in Yerevan. On March 5-6 stormy wind hit the Northeast of Armenia and the basin of Lake Sevan. The wind speed reached 125-160 km/h. Such strong winds in this region had not been reported during the whole observation period. Roofs of some buildings were blown off; the supply of electricity to some villages was disrupted. The total loss was about 2.5 million €.

The month was the driest March since 1902 in **Cyprus** and the areal average precipitation amounted to 0.8 mm or 1% of the normal. The mean temperature was 2.1°C above the normal value. On March 4-5 suspended dust affected the visibility.

March was warm and very dry in **Israel**. Rainfall amounts were 30-70% of the normal in the central and southern parts of the country. In the North, rainfall amounts reached only 5-20% of the normal, making it one of the driest March months ever recorded – since the beginning of measurements similar or smaller amounts in March were recorded only in 1925 and in 1962. The month was characterised by warm spells especially during its first part. On March 3-4, 34-36°C were measured in the coastal plain and 28-29°C were measured in the mountains. These were the highest temperatures for the first decade of March since 1960.

The lowest minimum temperature in 2004 recorded in **Jordan** was -6.6°C in Shoubak on March 6.

April 2004

- **Extremely warm, especially in northern Europe**
- **Dry in most of Central Europe, Portugal, the north-eastern and eastern parts of the Region, wet in the Northwest and parts of central eastern Europe**

The month was warmer than normal, but wet in **Greenland**.

April was a very favourable month in **Iceland**, amongst the warmest on record. Precipitation in the South was above the average.

The monthly average of the temperature in **Norway** in April was the highest since the Norwegian Meteorological Institute started this time series in 1867. A larger part of the observation stations including Svalbard noted a new record for April. The monthly mean sea surface temperature of the North Sea and the Norwegian Sea was very high too. The weather ship Polarfront, manning station "M" in the Norwegian Sea, noted new April records both for monthly air and sea temperature since 1949. The highest temperature (19.6°C) was measured at Kristiansund airport on April 19 and the lowest (-21.5°C) at Sichajavri on April 1. Precipitation for Norway as a whole was above normal, but there were large regional variations. The highest diurnal precipitation amount (94.4mm) was registered at the station Hovlandsdal in the county of Hordaland on April 14.

In **Sweden** it was especially mild in April when e.g. Östersund in the middle of Sweden set a new mean monthly record with 4.8°C in a series that started 1860.

Monthly precipitation in **Finland** was lower than normal in April 2004. It was the only dry month of that year.

April was warm and sunny in **Estonia**. Sunshine duration set a record in the time series of Tartu with 265 hours. The month was also extremely dry with a mean precipitation of only 10mm. The drought caused several forest fires.

In **Latvia**, April 2004 was the 4th driest April over the last 80 years. Precipitation in parts of the country was about 10 - 20% of the normal, resulting in poor growing conditions after resurgence of vegetation.

April weather was changeable in **Lithuania**: from cool and moist to warm and dry, and vice versa. The monthly mean air temperature of April was 7.1°C (+1.7°C anomaly). April was the sunniest month of the year with a total sunshine duration accumulating to 234 - 294 hours (85 - 110h above normal). Consequently, the monthly precipitation rate was only 57% of the normal, with some stations recording as little as 10%.

As spring was considerably warm in **Denmark**, the beech came into leaf in the last week of April.

April was particularly warm relative to normal in **Ireland**.

Mild airflows during the last two thirds of April caused monthly mean, maximum and minimum temperatures higher than normal in **Belgium**. Sunshine duration, precipitation and mean wind speed were near normal.

April was very warm in the **Netherlands** (10.4°C, normal 8.3°C). Only 5mm of precipitation averaged over the country fell in the period April 11 - 27.

This month was mild, dry and rich of sunshine in **Germany**. The areal mean temperature of the country was 9.3°C (+2.0°C deviation from the 1961-90 normal). For precipitation, the average amount was 40.1mm (-18.2mm or -31.1%). The spatial mean of sunshine duration

was 186.5 hours (+34.2h or +22.5%). A strong thunderstorm on April 22-23 around Cologne caused an interruption of power supply.

April was another warm month in **Poland**. Monthly mean deviations from normal achieved up to +1.6°C in the West. The extreme temperatures ranged from -7.1°C in the Northeast up to +22.4°C in the Southwest. Numerous ground frosts were observed during the entire month. Precipitation varied from less than 50% of the normal in the West up to 260% in central Poland. At the beginning of the month, intensive rainfall, above 30 - 40mm a day, caused high water levels in some rivers.

In April, the mean air temperature in **Slovenia** was slightly above the 1961-1990 normal and well within the limits of the normal variability. The anomaly was mostly less than +1°C; the largest anomaly was less than +1.5°C. In high mountains, at Kredarica, April was 0.8°C warmer than on the average in the reference period. It was mostly the last third of the month which determined the positive temperature anomaly of April. In Črnomelj, Bizeljsko and upper Vipava valley the temperature on April 8 slightly exceeded 25°C. The sunshine duration was lower than on the average in the reference period. Already during the first third of April there was notably less sunny weather than on the average, the second third of April was mostly cloudy, only between 20 and 50% of the usual sunshine duration occurred. In the West and most of the northern part of Slovenia there was less precipitation compared to the normal. In Zgornjesavska valley only 60% of the normal were reached, about 70% of the normal fell in the Goriška region, in Koroška 80% of the normal were reached. In central Slovenia and Bela krajina 50% more precipitation fell than on the average of the reference period. On April 6 and 7 it was snowing even in the lowlands. At Kredarica the snow depth was 465cm on April 7.

In **Croatia**, April was very wet in most parts of the country. Some areas were even extremely wet (Fig. 4.1).

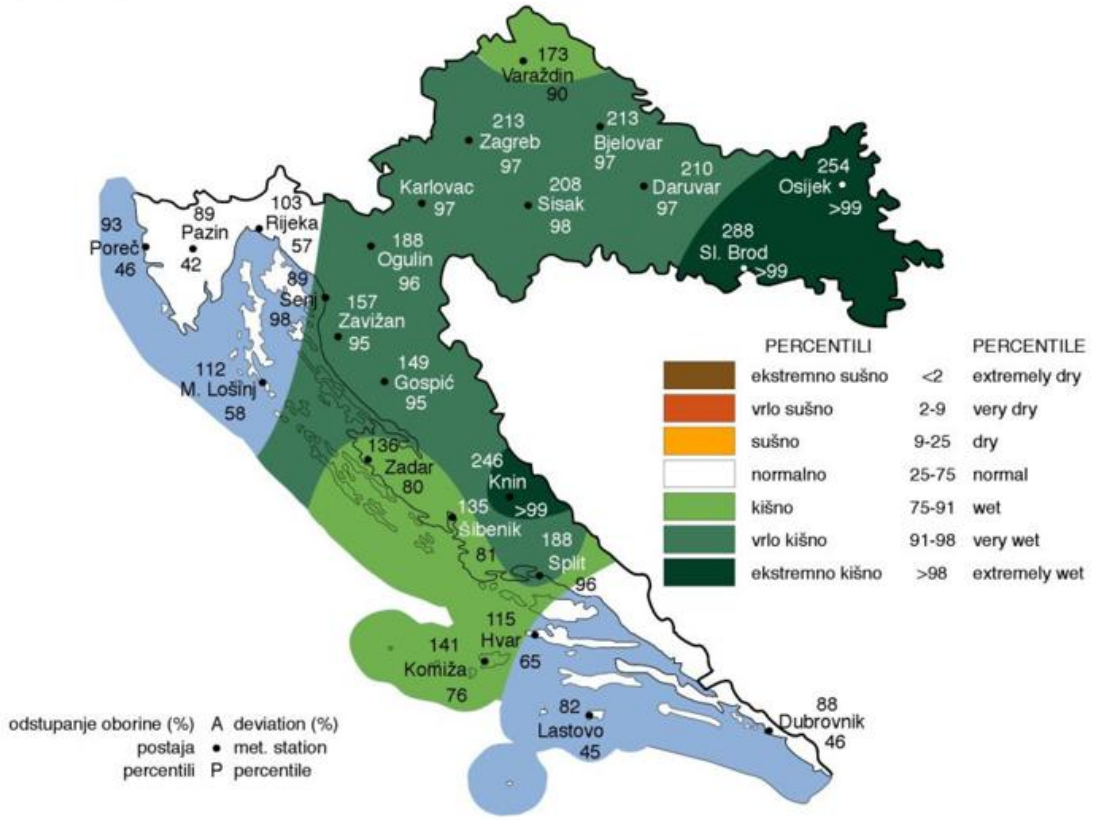


Fig. 4.1: *Monthly precipitation amounts of Croatia in April 2004, expressed as percentage of normal 1961 – 1990 (upper numbers) and percentiles (lower numbers). Blue areas are water areas with precipitation around normal.*
From: Meteorological and Hydrological Service Croatia

In **Bosnia and Herzegovina**, April was warmer than normal with 10.1°C on station average (+1.3°C anomaly with respect to 1971-2000). The precipitation sums were high (158.6mm or 176% of the normal on average), thus, April was the wettest month of the year this time.

The mean temperature of **Romania** was around 10°C on average, slightly higher than the 1961-1990 normal. April was also the beginning of a dry period; the monthly amount was a few mm lower than on long-term average.

April was rather warm and dry in **Bulgaria**. The temperatures were up to 1°C above normal but precipitation was as low as 50% of the normal.

The month was classified as being a dry to extremely dry month in the whole territory of **Portugal**. The monthly mean air temperature was equal or above the 1961-90 normal.

Unusual high daily maximum temperatures were reported over most areas of **Greece** (especially over the mainland) on April 11 (Tab. 4.1).

Station	Location (latitude °N, longitude °E)	Altitude (m)	Maximum daily temperature	Long-term mean monthly maximum temperature	Reference period
Arta	39 10, 21 00	11.5	27	19.7	1976-1997
Adravida	37 55, 21 17	11.1	27	19.2	1959-1997
Pyrgos	37 40, 21 26	12.0	27	19.8	1975-1997
Kastoria	40 27, 21 17	660.0	26	16.6	1980-1997
Naxos	37 06, 25 23	9.0	26	18.6	1955-1997
Spata	37 58, 23 55	67.0	26	18.5	1974-1997
Iraklio	35 20, 25 11	37.0	28	20.0	1955-1997
Mytilini	39 04, 26 36	4.2	28	19.0	1955-1997

Tab. 4.1: *Maximum daily temperatures (in ^{0}C) on 11 April 2004 and long-term mean values*
From: Hellenic National Meteorological Service

Frost and snow occurred in **Turkey** during April 3-5 including Izmir in the western lowlands of the country, damaging vineyards, flowers and trees. On April 21-22 torrential rain and hail was reported from Elazig and Sivas, respectively. However, on monthly average over the whole country, the precipitation amount was with 91% below the 1961-1990 normal.

On April 4-7 an unusual cold wave was observed in **Armenia**, the minimum temperature reached -10°C. A frost duration of 10 -13 hours was reported. As a result of the cold weather and continuous frosts near the surface all fruit trees were damaged in Ararat Valley.

On April 27 suspended dust affected the visibility in **Cyprus**. The month was dry (11.4mm or 38% of the 1961-1990 normal), the temperature mean only slightly above normal (+0.1°C anomaly).

April was dry in **Israel** with temperatures close to normal. There were some Sharav events but temperatures were not extreme.

Heat waves passed over **Jordan** in April 2004 (12, 13, 14 and 26, 27, 28) where the maximum temperature was 5°C above normal.

May 2004

- **Warm in the North and West, especially at the beginning of the month, cold in most of the East and the Mediterranean**
- **Snow in Scandinavia in late May**
- **Mostly wet, but dry in western Europe and in the Baltic countries**
- **Two extreme Sharav events in Israel**

In **Greenland,** May was fairly dry and mostly warmer than normal.

The first half of May was rather cold in **Iceland**, but the second half was warm and favourable.

The mean temperature of the month in **Norway** was above normal in most parts of the country, but the month was characterised by great variations in temperature. In the first week very high temperatures occurred, leading to flooding in rivers in southern Norway. Thereafter very low temperatures prevailed. Record low minimum temperatures for May occurred in the county of Vestfold. Parts of the counties of Oppland, Møre og Romsdal, Sogn og Fjordane and Sør-Trøndelag experienced one of the wettest May months ever with 250 - 400% of the normal for the month. The station Tafjord in Møre og Romsdal registered a new record maximum for May. Orkdal - Øyum measured the highest temperature this month with 26.6°C on May 6 and Sognefjellhytta the lowest with -13.2°C on May 23. Some stations in southern Norway received 20-25cm snow on May 21 and 22 which are quite unusual so late in May. The highest diurnal precipitation amount (123.1mm) was measured at the station Øvstedal in the county of Hordaland on May 19.

In **Sweden,** the latter half of May was chilly and wet.

In early May an exceptionally warm period lasted for about one week in **Finland**. The number of sunshine hours was generally lower than normal.

A relatively warm beginning of the month came to an end on May 13 when it snowed in **Estonia**.

The first decade of May in **Latvia** was the 3rd warmest of all first May decades in the last 80 years. New maximum temperature records for individual days were set this year on May 5 and 8; new minimum individual day records were set on May 13, 14, 17, 18 and 22. The very warm first decade of May gave poor growing conditions after resurgence of vegetation. Further serious problems were experienced with crops due to widespread strong air and ground frosts in the second decade. These weather conditions caused devastation of about 22 300 hectares of grain, rape, grass, potatoes and vegetables.

The beginning of May in **Lithuania** was influenced by southern airflows causing warm weather with a rise of air temperature to maximum values of 22 – 28°C, but later an eastward motion of Atlantic cyclones cooled the air down. As many as 18 nights of the month ended with morning frosts, resulting in a decrease of the minimum air temperature down to between -1 and -4°C and to between -7 and –9°C on the soil surface. The monthly mean air temperature anomaly was -1.3°C. Morning frosts damaged fruit trees and shrubs as well as gardens and crops. The May weather was predominantly overcast with little precipitation. The mean monthly precipitation accumulated to 44mm, these were 85% of the normal with even lower values at some locations.

In **Denmark,** there was occasionally cold weather; on May 22 snow and sleet fell locally.

May was particularly warm and one of the driest months of the year in **Ireland** relative to normal.

In the **Netherlands,** only 4mm precipitation fell from May 8 to 29, the mean temperature was below normal.

In **Belgium**, alternating mild and polar flows led to a temperature average near normal. The monthly precipitation amount in Uccle was 40.8mm (66% of the normal). Also the mean wind speed had an outstanding deficit.

A small negative mean temperature anomaly (-0.2°C) was noted in **Luxembourg**, but no frost was observed this May. The monthly precipitation was 86% of the normal.

The month was slightly cooler than in the reference period 1961-90 in **Germany**, precipitation reached nearly exactly the normal values, and small sunshine deficits resulted. However, there were rather large regional differences especially in precipitation. While the Northwest was very dry, large precipitation surpluses resulted in parts of eastern Germany. Due to a thunderstorm with strong gusts on May 10, houses in the region of Saxony were untiled. The mean temperature for Germany was 11.6°C. This was 0.5°C below the values for the reference period 1961-90. The average amount of precipitation was 72.3mm (1.2mm or 1.8% more than in the reference period). The spatial mean of sunshine duration was 180.0 hours (15.7 h or 8.0% below the normal).

May 2004 was one of the coldest months in **Poland** for the last 38 years and much wetter than the corresponding 1971-2000 normal. The mean monthly departures from normal were -1 to -2°C. The second and third decades were very cold with frequent ground frosts leading to crop damage. Precipitation was very intensive, especially in the first half of May, with downpours exceeding 40mm a day.

Heavy snowfall on May 5-6 on the northern comb of the Alps was observed in **Switzerland**, resulting in a fresh snow depth of 100 - 150cm at higher altitudes and partly causing severe avalanches.

It was a cold month in **Hungary** (-1.4°C anomaly). The monthly precipitation amount reached 84% of the normal.

In **Slovenia,** the mean air temperature in May was slightly below the 1961-1990 normal. Only in Bela Krajina the anomaly was slightly positive. In high mountains, at Kredarica, May was 1.1°C colder than normal. It was during the first third of May that mostly cloudy weather prevailed; the rest of the month was sunnier than on long-term average. Precipitation was abundant in Upper Soča valley; regions with modest precipitation were Prekmurje and Štajerska. At Kredarica on May 8 the snow depth was 435cm.

Most parts of **Croatia** were 1-2°C colder than normal (1961-1990) on monthly average. The precipitation anomaly distribution was very variable this month from 26% of the normal in the North up to 197% in the Southeast (Dubrovnik).

The monthly mean temperature for an average of 12 stations in **Bosnia and Herzegovina** was 13.1°C, which is 0.8°C colder than the long-term mean 1971-2000. The precipitation amount was slightly higher than normal (108% of the normal or 92.5mm).

May was also colder than average in **Serbia and Montenegro,** by 1.3 to 2.4°C (Fig. 5.1). In mountainous areas, frost was recorded, e.g. 9 frost days at Kopaonik (average: 5).

Widespread strong thunderstorms with heavy rain showers and strong wind gusts occurred in **Bulgaria** on May 10. Hailstorms with a reported hail size up to 3cm caused heavy damage on crops (up to 60-70%). On average, May was relatively cold and wet. The temperatures were 1 – 2°C below normal. The north-east region was the wettest with precipitation up to 250% of the normal while the Southwest was rather dry with only 50% of the normal.

May was characterised by a mean maximum temperature up to 2.5°C below normal in **Albania**. The mean minimum temperature in general had a negative deviation in May (-2.3°C); in the north-eastern and eastern part of the country -5.1°C were recorded.

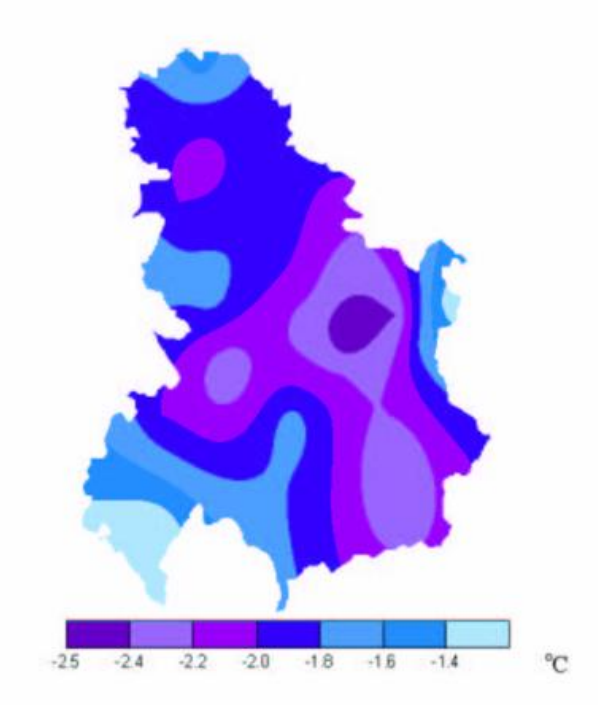


Fig. 5.1:
Deviation of mean temperatures in May 2004 against the normal 1961-1990 in Serbia and Montenegro
From: Republic Hydrometeorological Service of Serbia

The monthly mean temperature of May for Shtip, **Republic of Macedonia** was -2°C below normal representing the sixth lowest value in the time series starting 1926. Similar anomalies were reported in other parts of the territory of the Republic of Macedonia.

In **Portugal,** temperature in May was equal or above normal. The precipitation amounts were below normal in almost every coastal region and equal or above the average in the other regions.

Hail was reported in **Turkey** in the beginning of the month (May 2-3 in Beysehir, Konya, and Karaman) and at the end (May 29 in Kutahya). Rain and floods affecting crops were observed in Merzifon and Amasya. The monthly averages of precipitation and temperature were near normal. On May 20, late frosts with damage on vegetables occurred in Urgup and Nevsehir.

In May the mean monthly temperature was about normal in **Armenia,** in some regions it was above normal by 1°C.

On May 10 - 11 suspended dust affected the visibility in **Cyprus**. Only 3.9mm precipitation fell this month, these were 20% of the 1961-1990 average. The mean temperature was near normal (-0.1°C).

May was slightly cooler than normal in **Israel**, yet two extreme Sharav events occurred. On May 6, 38 - 39°C were recorded in the coastal plain and in the Negev. A Sharav occurred also on May 9 with an interesting phenomenon during the night (May 9 - 10). Towards midnight there was a severe warming with temperatures rising more than 10°C within 30 minutes, reaching 34 - 36°C in the central coastal plain at 00:00 - 03:00 a.m. In the last 40 years there were only two occasions with similar temperatures at night. Temperatures dropped later but rose again during the morning, reaching a maximum of 40 - 42°C in the coastal plain and in the Negev, and 43 - 45°C in the Jordan Valley.

June 2004

- **Warm in Iceland, France, Slovenia and the Iberian peninsula, cold in most of Scandinavia, the Northeast and parts of the East of the Region**
- **Dry in most parts of western Europe, wet in most of the North, the Alps and some countries of the East**
- **Strong hail and tornadoes in Central and eastern Europe**

In **Greenland,** June was mostly warmer than normal.

June was warm and favourable in **Iceland**.

The monthly mean temperature was below normal in most parts of **Norway**. Only the eastern and northern part of Finnmark and Svalbard had temperatures above normal. The maximum temperature of the month (25.5°C) was measured at Lærdal - Moldo on June 2 while Sognefjellhytta in the same county (Sogn og Fjordane) registered the lowest temperature (-4.2°C) on June 16. Some locations in southern Norway and in the county of Nordland received more precipitation than usual. Parts of the county of Møre og Romsdal experienced one of the wettest Junes with 200-250% of the normal. Sundsfjord in the county of Nordland measured 113.5mm as the highest diurnal precipitation amount on June 15.

In **Sweden,** the chilly and wet weather continued in June.

The number of sunshine hours in **Finland** was generally lower than normal.

June in **Estonia** was the wettest since 1998. Two tornadoes were reported in the central part of Estonia.

In **Latvia** it was the 10th wettest June for the last 80 years.

June weather in **Lithuania** was comparatively cool while being predominantly dry in the first half of the month and rainy in the second one. It was the coldest month of the summer, with a mean air temperature of 13.9°C (-1.5°C anomaly). Morning frosts persisted as long as until June 18. In total, morning frosts in June caused damage to agriculture (horticulture) amounting to some 5.5 million €. Due to persistently dry weather, the forests in the north-eastern regions encountered increasing fire danger until June 11, when it started raining almost daily. The total amount of precipitation was very uneven and varied from 44 to 182mm (70 to 180% of the monthly normal).

Cork Airport in **Ireland** measured 16 hours of sunshine on June 15, the highest daily value of the year and the highest value at the station since it opened in 1962.

The highest temperature in 2004 in the **United Kingdom** was 31.5°C at Cambridge on June 8.

The summer started a bit chilly in June in **Denmark** with a few days with clear sky and sunshine, but from June 18 the weather was constantly unstable for 5 weeks and rather chilly for the season.

June was warmer than normal in Uccle, **Belgium**, by 0.8°C. It was the first in a series of wet summer months; the monthly precipitation amount of this station was 78.4 mm, which was about normal.

The temperature anomaly for **Luxembourg** (1971-2000 normal) was 0.6°C. A maximum of 30.1°C was reached on June 9 which also marked the only hot day (maximum >30°C) this month. Only little precipitation fell: 43.1mm or 54% of the normal.

In **France** the monthly mean temperature was approximately 1.5°C above normal, designating June as the month with the largest anomaly of the year.

It was a bit too dry in **Germany** and sunshine duration was slightly less than normal. The mean temperature for Germany was 15.3°C, only 0.1°C below the values for the reference period 1961-90. The average amount of precipitation was 72.6mm which was 12.0mm or 14% below normal. On June 9 and 10 there were strong thunderstorms in northern and western Germany with hail and local daily precipitation of more than 30mm. A storm on June 23-24 with gusts up to 110km/h occurred in the mountains. 3 tornadoes were observed on June 23, all in northern Germany. The spatial mean of sunshine duration was 187.4h. This was 10.8 h or 5.4% less than in the reference period.

The mean temperature in June in **Poland** was lower than the 1971-2000 normal by about 1°C. Only the south-western region was slightly warmer. Ground frosts were still observed in the North. The minimum temperature fell to +1.1°C in north-eastern Poland. It was also a rainy month: 23 days with precipitation occurred on country average (120-130% of the normal). The most intensive rains, above 40mm a day, with storms, were observed in the South.

A tornado of F3 intensity according to the Fujita scale occurred on June 9 in Litovel, in the northern part of the **Czech Republic**. It was connected with a mesoscale convective system that was moving from northern Germany across the north-eastern part of the Czech Republic to Slovakia. This tornado caused extraordinary damage on parts of Litovel town, destroyed tens of houses and rooted up many trees. Many electricity lines were broken off, one man was killed. The cost of this damage was about 3.5 million€.

Large damage was caused by an extremely well developed supercell with strong wind and hail on June 9 in the south-western part of **Slovakia**.

Heavy rain occurred in the catchment-basin of the river Aare in **Switzerland** on the northern slope of the Alps from June 1 to 5; the village of Marbach (canton of Lucerne) received 103.5mm during the period beginning in the morning of June 1 and ending in the morning of June 2. This caused local inundations. At certain locations the highest precipitation quantities since 1901 were measured over 2, 3 and 5 days respectively. Only very few thunderstorms occurred in June in the South of Switzerland (region of Sottoceneri in the Canton of Ticino). It was the driest month of June in this region since records started in 1864.

In **Austria** the month was wet with 150 to 250 percent of the normal precipitation in the South and East. In the morning of June 11 thunderstorms with heavy precipitation caused damage in Upper Austria. Within the district of Braunau the communities Esternberg and St. Veit suffered from flooding. In the towns Linz and Wels a lot of cellars and underpasses were flooded, too. Later, in the evening, precipitation events caused floods in the most eastern regions of Austria. In the county Burgenland several communities of the southern districts Oberwart and Güssing were affected by floods. At the same time hailstones with the size of hens' eggs caused enormous damage to crops in the district Deutschlandsberg, south of Styria. On June 20 another heavy hailstorm occurred in Styria, causing total crop losses on the agricultural areas in the districts Weiz and Fürstenfeld. Simultaneously heavy precipitation resulted in several landslides in Carinthia. Streets were spilled in the valley of the river Lavant; districts of the capital Klagenfurt were flooded. Thunderstorms and heavy precipitation events on June 28 again caused enormous damage in Styria. Hailstones completely destroyed agricultural areas southwest of the capital Graz.

On June 9 a heavy storm rushed through **Hungary** causing one death in Budapest. Several villages suffered from the lack of electricity; trees, traffic sign boards, roofs were torn up by the strong winds (max. wind speed: 116km/h, Budapest). In Miskolc heavy hail contained egg-sized pieces. Averaged over the country, 127% of the normal precipitation fell. The monthly mean temperature was near normal (-0.1°C).

In **Slovenia,** the monthly mean air temperature was slightly above the 1961–1990 normal. In high mountains, at Kredarica, June was 0.9°C warmer than normal. The Primorska region

got about 10% more sunshine than normal, elsewhere the sunshine duration was below normal. At the coast not even one half of the average precipitation fell, but in Koroška, Goriško and Maribor the usual precipitation amount was almost doubled. In the Štajerska region thunderstorms were quite frequent; 12 days with thunderstorm or thunder were registered. At Kredarica the snow depth was 290cm on June 1.

In **Portugal,** the year 2004 was characterised by a very warm June, with air temperature values well above the 1961-90 normal (Fig. 6.1). Values of maximum, minimum and mean air temperatures were the highest since 1931. It was dry to extremely dry in the whole territory.

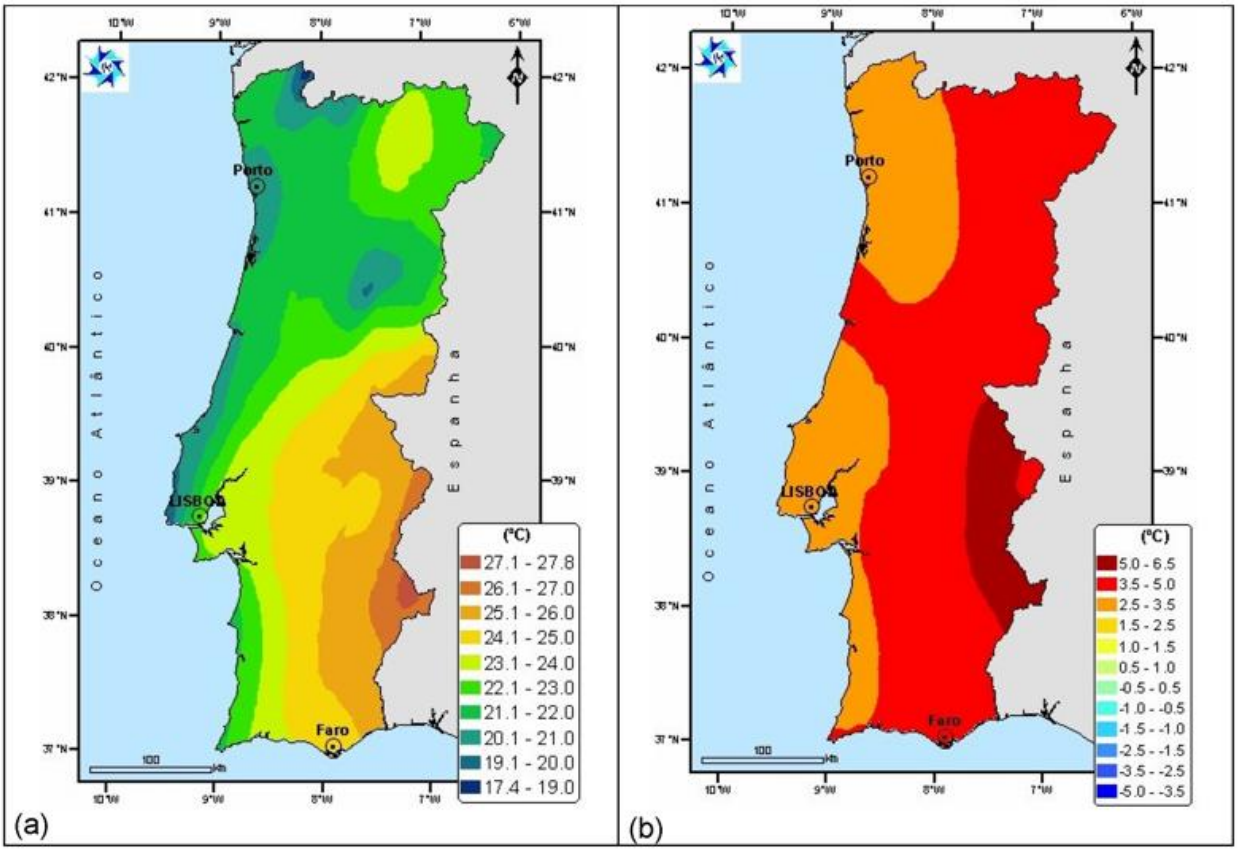


Fig. 6.1: *Spatial variability of mean air temperature in Mainland Portugal in June 2004 (a) and anomalies with respect to the 1961 – 1990 normal (b)*
From: Instituto de Meteorologia Portugal

June was very warm all over continental **Spain** and some of the Canary Islands. However, in most cases it was not so extreme like the June of 2003, especially regarding the persistence of the heat. Nonetheless new records in mean values were set in Galicia, Extremadura and Western Andalucía at around 20% of the observing stations. As an outstanding example at Badajoz the mean value was 1.5°C higher than the previous one for that station. As for mean and minimum mean temperatures the percentage of stations reporting new records was around 15%. The warmest days were concentrated in the period between June 23 and 29, giving new records of absolute maximum temperature for the month at several stations (for example at Madrid – Retiro: 38.4°C on June 29 which is 0.3°C above the previous record).

It was warm in the coastal region of **Croatia** (anomaly between +0.5 and +1.0° compared to 1961-1990), whereas upcountry the mean temperature was near normal.

In **Bosnia and Herzegovina**, the monthly mean temperature was 0.6°C above the 1971-2000 normal. Also the precipitation amount of 96mm on station average was slightly above normal (103%).

Heavy rain caused flash floods during the night of June 5 in **Republic of Macedonia**. Disasters were caused by a south-western outbreak of cold air over the southern and a small north-western part of the country. The floods affected particularly the southern region (Gevgelija, Strumica, Valandovo, Dojran and all the villages). Heavy precipitation was registered from 07.00 until 19.00 h on June 4 and from 01.00 until 07.0 0h on June 5. The daily amount of precipitation in Gevgelija was 201mm on June 5 which corresponds to 350% of the normal 1961/90 for June. The adverse weather caused flooding of all rivers in this region, it damaged more then 20 bridges and dams, railroad tracks and roads, flooded agricultural land and many houses, interrupted the electric power lines, water pipes and phone connections.

On June 21-22, thunderstorm and hailstorm activity was observed in most of **Bulgaria** with heavy rain showers and hail with the size of eggs or even baseballs. The most severe damage was registered in northern Bulgaria. Floods occurred in dense populated urban areas like the cities of Sofia and Varna. On June 29, another severe thunderstorm hit the capital city of Sofia with a heavy rain shower (22mm) and strong wind gusts up to 65km/h. The rain caused floods on the streets in the city centre and in the suburbs as well as in the building of the National Assembly. Trees were uprooted and the public transport system was affected. The thunderstorm caused delays at the Sofia airport. On monthly average, June was normal in terms of temperatures and rather wet. The south-western region was the wettest with up to 280% of the normal.

Unusual heavy rain and thunderstorms occurred on June 5 over the east-central mainland of **Greece**. These thunderstorms resulted in floods in the area of eastern Thessalia, particularly in Volos city, with destructive results on roads, shops and houses, and on agriculture. June 2004 (particularly the first decade) was in general a month with increased thunderstorm activity over the North and central mainland part of Greece. The June 2004 rainfall and the corresponding mean values are shown in Tab. 6.1.

Station	Location (latitude °N, longitude °E)	Altitude (m)	Monthly rainfall for June 2004 (in mm)	Monthly long-term mean rainfall for June (in mm)	Reference period
Serres	41 05, 23 34	34.0	42.9	40.7	1971-1997
Trikala Imathias	40 36, 22 33	0.8	36.0	29.7	1980-1997
Kastoria	40 27, 21 17	660.0	100.5	27.2	1980-1997
Larisa	39 39, 22 26	71.0	29.0	25.6	1955-1997
Kerkyra	39 37, 19 55	2.0	45.0	14.1	1955-1997
Mytilini	39 04, 26 36	4.2	30.0	5.7	1955-1997
Alexandroupoli	40 51, 25 56	2.5	49.5	29.5	1951-1997
Ioannina	39 40, 20 51	483.0	46.4	43.5	1956-1997
Skiathos	39 10, 23 30	7.5	30.0	13.9	1986-1997

Tab. 6.1: *Monthly rainfall heights for June 2004 and long-term mean values*
From: Hellenic National Meteorological Service

Hail damage was reported in **Turkey** on June 5 (Kastamonu), 6 (Merzifon/Amasya), and 16 (Malatya). In addition, strong rain and floods were observed on June 11 (Trabzon), 19 (Kocaeli), and 23 (Goztepe/Istanbul). Late frost occurred at Devrekani/Kastamonu on June 11.

In June the mean monthly temperature in **Armenia** was in general normal; in some regions it was higher than normal by 1°C. One fatality, three injuries due to lightning were reported.

June was cooler than normal in **Israel**, and in the coastal plain it was the coldest June in the last 8 - 10 years.

July 2004

- **Mostly warm, cold in Greenland, Ireland and parts of northern, central and eastern Europe**
- **Dry in most parts of the Mediterranean and Portugal, wet in some parts of central and northern Europe and in the East, occasionally with flooding and hail**

In the **Arctic**, the highest maximum temperature was measured at Bjørnøya with 22.8°C on July 27. This is a new record for July at Bjørnøya. The earlier maximum for July was 22.4°C in 1972.

The highest temperature in 2004 in Nuuk, **Greenland,** was 18.2°C, registered on July 23 during a foehn situation.

In **Iceland**, the July was warm and favourable.

The monthly average of mean temperature was below normal in the southern part of **Norway**, near the normal in the counties of Møre og Romsdal and Trøndelag, and above normal in the county of Nordland and northwards. In the eastern parts of Finnmark the monthly average was 4-5°C above normal. Rustefjelbma and Alta Airport had the highest values both with 17.1°C (4.8°C and 3.7°C above normal). For the larger part of Finnmark and Troms this was the fourth warmest July since 1900. The lowest monthly temperature average was recorded at mountain stations in southern Norway. Sognefjellhytta was coldest with 6°C (0.3°C above normal). The highest maximum temperature (28.8°C) was measured at Nordreisa - Øyeng on July 25 while the lowest minimum temperature (-3.6°C) was registered at Hovden – Lundane on July 8. This was the lowest minimum for July for the county of Aust-Agder. In most parts of the county Troms and some areas in Oppland and Nordland the precipitation was markedly above normal. In the rest of the country the precipitation was below normal. The highest diurnal amount of precipitation (57.8mm) was measured at the station Grunnfarnes in the county of Nordland on July 21.

The chilly and wet weather in **Sweden** continued into July. During the four days July 9-12 about 180mm fell in parts of central Småland with widespread flooding as a result. Hundreds of roads had to be closed for traffic. In some rivers the discharge rose to levels that were estimated to have return periods of some hundreds of years. A canoe tourist drowned in one of the swollen streams. Also the northernmost part of the country and more precisely the Kebnekaise area got very heavy rain on July 20-21 and a landslide disrupted the northernmost road to Norway.

Large areas in southern and central **Finland** experienced very heavy rainfall, particularly in the last week of July. The largest daily precipitation of 122mm was measured in eastern Finland on July 28. Due to the heavy rainfall the water level in many lakes and rivers was high; this caused flooding of some southern Finland rivers and thus economical losses in many buildings and households. The monthly precipitation in July amounted to 200-246mm at some locations and the return period of these high values is longer than 100 years. High precipitation resulted in big problems for agriculture as the harvesting was difficult due to wet fields. The number of sunshine hours in July was generally lower than normal. In Lapland, July was exceptionally warm.

July was outstanding because of torrential rain in Tallinn, capital of **Estonia** (145mm in three days, monthly mean - 79mm). There were also many thunderstorms, and a tornado was reported.

The month was cool and rainy in **Lithuania**. The monthly mean air temperature was 0.2°C below normal. The month had only 6 days without rain. Precipitation was not abundant except isolated heavy rainfall. On July 22, one such downpour in Biržai amounted to 56mm

in 3 hours. The water flooded lowlands and streets; crops were damaged. On July 11, some locations encountered severe hail with 20mm large hailstones smashing about 50 hectares of crops. The monthly amount of precipitation was close to normal at many places, while reaching 50 – 70% of the normal in some western and eastern regions. Thunderstorms, occasionally related with squall lines, were reported on 13 days of the month. The sunshine duration was 25 – 40 hours below normal.

July 2004 was one of the only two months in 2004 which was colder than normal in **Ireland**.

Wittering, Cambridgeshire, **United Kingdom**, recorded 107.4mm of rainfall in 19 hours on July 7-8, with a return period of about 150 years.

In **Denmark**, the chilly and unstable weather continued at first, but at the end of July three weeks of warm, dry and sunny weather began.

In the **Netherlands**, 50mm of precipitation or more were registered on two days in July.

No high temperature deviations from normal were to be found in **Belgium**. The mean temperature at Uccle (17.4°C) was 0.2°C higher than normal. The precipitation amount, however, reached 112.4 mm, which were 151% of the long-term mean.

July was 0.3°C colder than the 1971-2000 normal in **Luxembourg**. The temperature maxima did not exceed 30°C. For precipitation, the monthly sum (68.9mm) was slightly below normal (96%).

The areal precipitation average of **Germany** in July reached 104.0 mm, exceeding the 1961-90 normal considerably (+26.4 mm or +34.0%). This was due to some exceptional thunderstorms: On July 7-8 there was a first thunderstorm with strong precipitation, partly with hail in south-western and central Germany. Around Freiburg/Breisgau and near the lake Bodensee, pigeon egg sized hail grains were observed for 15 minutes. One day later a second thunderstorm with strong rain occurred in the North and East of Germany; 75mm were measured at the station Zinnwald-Georgenfeld, 67mm of this amount fell during one hour. A third violent thunderstorm came on July 18-19, accompanied by a tornado near Duisburg in western Germany. The mean temperature (16.7°C) was near normal, only 0.2°C below. Also the spatial monthly mean of sunshine duration was below normal (196.5h, -12.3h or -5.9%).

July was a further cool month in 2004 in **Poland**. The mean temperature was generally 1°C lower than normal, only in the Southeast it was warmer (0.6°C above normal). The weather in July was very variable throughout the month and within the country. The maximum temperature measured was +33.9°C, the minimum only +7.2°C. Precipitation reached 170%, but the central part of the country was rather dry – only 50% of the normal precipitation occurred in that region. Mixed rain and snow were observed in mid-July in the Tatry Mountains which is a rather rare phenomenon in this month. The southeast region was partially flooded. In July storms with torrential rain and gusts occurred numerous times in various regions of Poland causing damage to buildings and forests.

A significant regional flood occurred after long-lasting abundant precipitation from July 26 to 30 in the eastern part of **Slovakia**. In the most affected areas the 5-day sum of precipitation exceeded 200mm (maximum of the last 54-year period). The water levels of Ondava, Topľa, Hornád and Torysa rivers in the middle parts of their catchments were near to historical records. The costs of damage by floods on property of citizens, municipalities and government were estimated to more than 5 million €.

A severe hail storm north of the Alps in **Switzerland** occurred on July 8. A 40km wide hail zone extended to the whole lowlands from the Lake of Geneva in the Southwest to the Lake of Constance in the Northeast. The sum of insured damage amounted to around 100 million Euro.

Thunderstorms with hail were observed on July 6 in Styria, **Austria**. There were devastations in the district of Radkersburg (along the border to Slovenia). Heavy precipitation events on July 19 and 22 caused destruction in Carinthia, twice within the same area, Metnitztal, in the

district St. Veit an der Glan. Fields, meadows and streets were spilled with rocks, earth masses and water; one bridge and five kilometres of the roadway were destroyed.

In July, the mean air temperature in **Slovenia** was slightly above the 1961–1990 normal. In the high mountains at Kredarica July was 0.5°C warmer than on average in the reference period. The sunshine duration in the Primorska region was about 10% higher than normal; in Prekmurje only 90% of the normal were reached. Precipitation was most abundant in the Julian Alps and Kamniško-Savinjske Alpe, while in Prekmurje, Karst and Vipava valley precipitation was modest. Also some severe thunderstorms with hail occurred in July causing locally significant damage. At Kredarica on July 1 the snow depth was 30cm.

In **Hungary**, an absolute maximum of 37.2°C was registered at Körösszakál on July 9. Between July 26 and 28, 60-110mm precipitation poured into the eastern part of Hungary, which is to be regarded as exceptional. On monthly average, however, the precipitation amount was only slightly above normal (105%), the mean temperature as well (+0.4°C).

Especially the coastal region of **Croatia** was very warm this month (departure from 1961-1990 mean around +1.5°C). Up to the Northeast, the anomalies were smaller, but also mostly positive. Some areas of the country were quite dry. At Split, only 4% of the normal precipitation fell this month.

Many stations in **Bosnia and Herzegovina** had a monthly mean temperature around 20°C which was 0.9°C warmer than the 1971-2000 normal. Also the average precipitation amount (86mm) exceeded the normal by a factor of 109%.

Mean monthly temperatures in **Serbia and Montenegro** were close to normal, but there were some remarkable characteristics this month: high temperatures in the first third of the month, then a sudden drop of temperature on July 10 (maximum and minimum temperature decreased by 10°C within two days), then again high temperatures until July 25, and around the end of the month a breakthrough of considerably colder air and a drop of maximum temperatures by 15°C within two days. Although the maximum temperature often exceeded 30°C, absolute record maxima were not reached. Considerable quantities of precipitation were measured around the end of the month (starting on July 26). Rain fell almost every day. Total monthly precipitation quantities higher than normal were registered in the far north of the country, in western and south-western parts and also in the area of Beograd, Leskovac and Smederevska Palanka. In the area of Negotin and Crni Vrh as well as in the coastal part of Montenegro, precipitation quantities were lower than average.

The highest maximum temperature of the year in **Romania** was 40.0°C, recorded in southern Romania, at Turnu Magurele, on July 10.

On July 11, there were widespread hailstorms in **Bulgaria** with hail as big as eggs. Damage was reported in 8 of 28 administrative regions in the country. The highest precipitation amount registered in an urban area for this stormy day was in Sliven (50mm). On July 24, there was thunderstorm and hailstorm activity mainly in the eastern half of the country with heavy downpours and strong wind gusts. Reported damage concerned, for example, smashed cars by uprooted trees, street floods and inundated houses in the urban areas of Varna and Dobrich. The harbour of Varna was closed and ships were in emergency in the bay of Varna. The monthly mean temperature anomaly of July was between -0.5°C and +0.5°C, the spatial average of precipitation was about normal. However, the precipitation had a very irregular pattern – from 20% to 330% of the normal all around the country.

For July, usually one of the driest months in **Albania**, precipitation values several times higher than the long-term average were registered.

The period July 23 - 27 was extremely hot in **Portugal**, especially in the southern regions with temperatures reaching 40°C. Record values of both maximum and minimum temperatures were exceeded in this period at some stations in the South. The mean air temperature was in general above normal. The Algarve was one of the most affected regions. For example in Faro, on July 25 and 26 the maximum temperature was 44.3°C and 41.7°C, respectively, exceeding the previous maximum of 39.8°C (August 2003). At this

station, the maximum temperature never was higher than 40°C since 1921. In Faro the minimum temperature of 32.0°C on July 26 was the highest minimum temperature ever recorded in Mainland Portugal, it also exceeded the previous maximum of 30.7°C (August 2003, at another station). July was also characterised by precipitation sums below the 1961-1990 normal in the whole country.

The only summer heat wave episode in **Greece** was recorded on July 10-12 over several areas of the country, especially over the mainland. The maximum daily temperature reached 38-41°C. The recorded maximum temperatures and the corresponding mean values are listed in Tab. 7.1.

Station	Location (latitude °N, longitude °E)	Altitude (m)	Daily maximum temperature	Date	Mean monthly maximum temperature	Reference period
N. Filadelfia (Athens)	38 03, 23 40	136.1	39.0	10-07-04	33.5	1955-1997
Elefsina	38 04, 23 33	30	40.0	10-07-04	32.9	1958-1997
Hellinikon	37 54, 23 45	10.0	38.0	10-07-04	31.8	1955-1997
Astros	37 24, 22 43	25.0	40.0	10-07-04	33.3	1974-1997
Kozani	40 17, 21 47	625.0	38.0	10-07-04	29.3	1955-1997
Larisa	39 39, 22 26	71.0	39.0	11-07-04	33.1	1955-1997
Kalamata	37 04, 22 06	7.9	39.0	11-07-04	31.1	1956-1997
N. Filadelfia (Athens)	38 03, 23 40	136.1	40.6	11-07-04	33.5	1955-1997
Elefsina	38 04, 23 33	30	40.8	11-07-04	32.9	1958-1997
Ierapetra	35 00, 25 44	10.0	40.0	11-07-04	31.8	1956-1997
Tympaki	35 00, 24 46	5.0	41.0	11-07-04	31.6	
Lamia	38 51, 22 24	14.3	39.0	11-07-04	32.3	1970-1997
Elefsina	38 04, 23 33	30	39.0	12-07-04	32.9	1958-1997
Argos (Pyrgela)	37 36, 22 47	11.2	38.0	12-07-04	33.4	1980-1997
Ierapetra	35 00, 25 44	10.0	40.0	12-07-04	31.8	1956-1997
Spata	37 58, 23 55	67.0	39.0	12-07-04	31.1	
Lamia	38 51, 22 24	14.3	39.0	12-07-04	32.3	1970-1997
Astros	37 24, 22 43	25.0	38.0	12-07-04	33.3	1974-1997

Tab. 7.1: *Maximum temperatures (in °C) on 10-12 July 2004 compared with mean maxima of reference periods*
From: Hellenic National Meteorological Service

In **Turkey,** hail events occurred on July 16 (Urgup, Nevsehir) and 18 (Ardahan), causing damage to vegetable gardens and crops.

July in **Israel** was warmer than normal, which makes it the tenth July in succession that is warmer than normal. However, July 2004 was not as extreme as July 2000 and July 2002. The hottest period was during the first part of the month with temperatures reaching 39-41°C in the Negev and 43-45°C in the Jordan Valley.

In **Jordan,** the highest maximum temperature recorded at Amman was 39.6°C on July 6 and 44.1°C at Aqaba on July15.

August 2004

- **Warm in nearly the whole Region**
- **Mostly wet, but dry in the Mediterranean**

Bjørnøya in the **Arctic** measured the highest diurnal precipitation of the Norwegian arctic stations with 39.4mm on August 21. This was the highest diurnal precipitation registered at this site in August since measurements started in 1920.

August was warm and favourable in **Iceland**. There was a memorable and unusual heat wave in the second week of August. The heat was especially prominent in the southern and western districts, but also in the interior of the country. Maximum temperature records were broken at many stations, e.g. in Reykjavík, where the temperature reached 24.8°C on August 11, which was the highest-ever registered maximum there. The heat wave lasted for many days and the temperature in Reykjavik rose above 20°C on four consecutive days. This did not happen before since the start of continuous observations in 1870. The highest temperature in the whole country was measured at Egilsstaðir in the eastern inland on August 11, 29.2°C, setting a new record for the country in August which was only slightly lower than the absolute record for Iceland (30.5°C). August 2004 on monthly average was the second warmest on record (only August 2003 had been warmer) and almost 1°C warmer than July 2004, which was highly unusual. Heavy precipitation preceded the heat wave in the south-eastern part of the country, with some local flooding. Elsewhere the month was sunny, generally the sunniest August since 1960. In Akureyri, August 2004 was the sunniest on record.

The highest temperature registered in 2004 in Tórshavn on the **Faroe Islands** was 20°C (August 10). August as a whole was very dry with a surplus of sunshine.

The monthly mean temperature in **Norway** was well above normal for the whole country. In parts of western Norway the mean temperature was 3°C or more above normal. The highest monthly mean was registered around the Oslofjord. Færder Fyr was the warmest station with 18.2°C (2°C above normal). The lowest monthly temperature was registered in the mountains in southern Norway and in the coastal areas of the county of Finnmark. Sognefjellhytta was coldest with 8.7°C (3.3°C above normal), followed by Finsevatn 9.6°C (+2.8°C) and Slettnes Lighthouse 10.5°C (+1.3°C). The highest country-wide maximum (32.4°C) was measured at Vossevangen (western Norway) on August 11. The lowest temperature (-3.2°C) was observed at Hovden – Lundane on August 24. The monthly precipitation for Norway as a whole was 111% of the normal, in some parts of southern Norway even 200-250%. The station Konsmo – Høyland in this area received 348mm which is the second highest monthly amount for August at this station since 1951. In contrast, the county of Nord-Trøndelag registered only 20-70% of the normal. The station Saltdal in the county of Nordland had only 12mm (40% of the normal). Some stations of the county Aust-Agder and Bear Island received the highest diurnal precipitation amount ever measured in August. The highest diurnal precipitation (95.0mm) was recorded at the station Hundseid i Vikedal in the county of Rogaland on August 20.

In **Sweden**, on August 4 exceptional heavy thunderstorms caused flooding and landslides close to Hagfors in the province of Värmland. Some villages were isolated for 2-3 days and a car fell into a new, deep ravine but nobody was seriously hurt. The second largest daily rainfall at an official meteorological station in Sweden with 189mm was measured in Råda close to Hagfors also on August 4. Private measurements registered around 210mm slightly south of Råda. The estimated costs for road authorities were at least 15 million Swedish crowns (1.6 million €) both in Småland and Värmland, and the loss for agriculture was above 100 million crowns (11 million €) in Småland.

The most severe damage in **Finland** was caused by a tornado that hit Kontiolahti in eastern Finland on August 20.

New maximum temperature records in **Latvia** for individual days were set this year on August 3 and 5.

August was warm and rainy in **Lithuania**. It was the warmest month of the summer. Its mean air temperature anomaly was +1.8°C. The highest temperatures of the month reached 27–31°C. Quite often, night-time temperatures remained above 17°C in Nida. The sunshine duration was close to normal except for coastal regions receiving 40 hours above normal. There were many days with rain, but with varying intensity. On August 14, in Biržtonas the rain amounted to 82mm in 9 hours and in Vilnius to 52mm in 10 hours. On August 3, some north-eastern regions were affected by 30 – 40mm large hailstones accompanied by squall winds reaching 110km/h. The hailstones damaged crops and left many trees and gardens leafless. They also shattered greenhouses and some window panes. Wind gusts tore away 20 house roofs and broke many trees. Precipitation amounted to 200% of the normal in some parts of eastern Lithuania while reaching merely 50% at the Lithuanian seaside.

At the majority of stations in **Ireland**, the highest temperatures of the year coincided with the August bank holiday on 1st/2nd, when maxima rose above 25°C in many places and over 27°C at Birr.

The highest temperature in 2004 in the **United Kingdom** was 31.5°C at London Weather Centre on August 7. However, August was the 5th wettest August in the 239-year EWP (England-Wales precipitation) record (1766-2004); the monthly total was 157mm (Fig. 8.1). The heaviest 24-hour total rainfall recorded in the United Kingdom in 2004 was 200.4mm at Otterham, Devon, on August 16, with a return period well in excess of 200 years. Nearly all this rain fell during a 4-hour period and resulted in devastation – though without loss of life – in the coastal village of Boscastle when two rivers burst their banks.

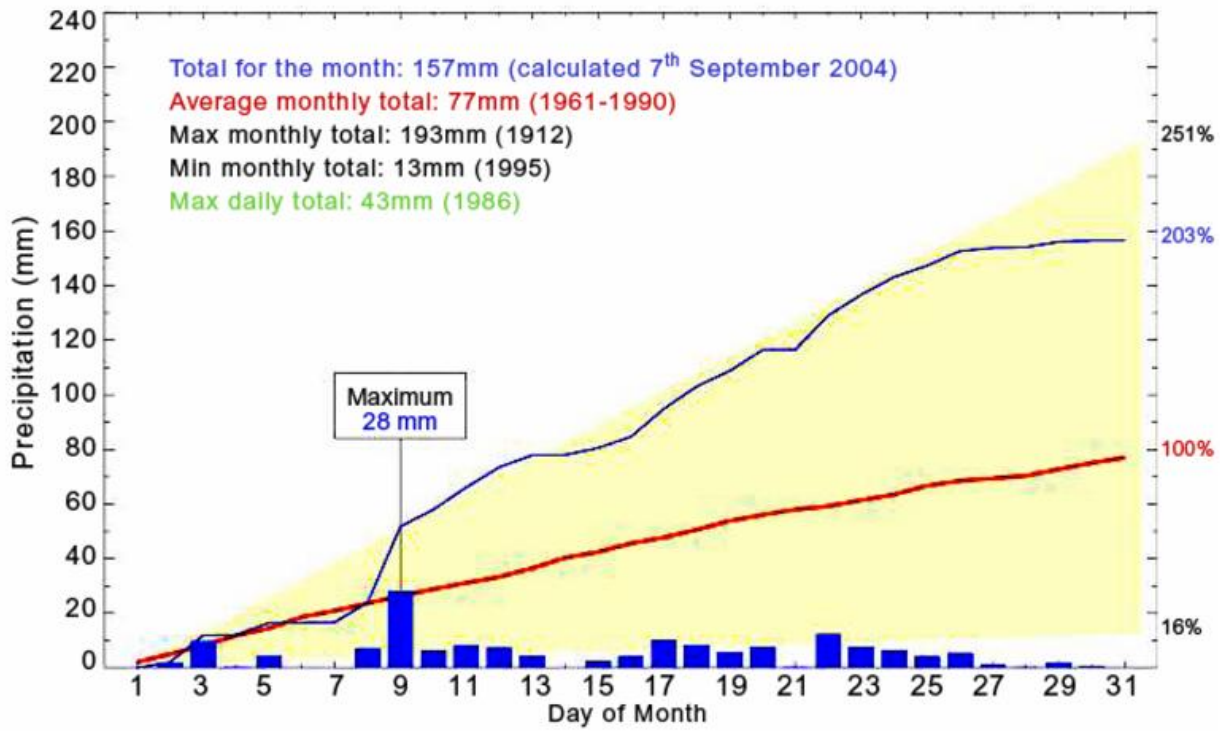


Fig. 8.1: *Daily and cumulative England and Wales rainfall for August 2004. The records of monthly maximum and minimum totals (borders of yellow shaded area) are since 1766 and the daily maximum totals are since 1931*
From: Met Office United Kingdom

August in the **Netherlands** was very warm (18.8°C, normal 17.2°C). The period August 2–11 was marked by a heat wave with temperatures in De Bilt reaching 25.0°C or more and three days with maximum temperatures of 30.0°C or higher. The highest temperature of the year was recorded during this heat wave: 33.6°C on August 9 in Soesterberg (near De Bilt, central part of the country). New record high minima were set on a number of stations during that day with temperatures not lower than 21°C locally. The first decade in August was at many stations one of the warmest for at least 50 years. Station Eelde recorded six "tropical" days (maximum temperatures of at least 30.0°C) on row. The most striking phenomenon was the abundant rainfall in parts of the country during August. At a number of stations more than 200mm fell. In Maasland (south-western part of the country) 325mm were registered. This was a new national record. The old record was 321 mm in Zantvoort (October 1932). On 10 days in August at least 50mm fell at one or more of the Dutch precipitation stations. Extreme amounts fell in particular on August 12 and 13 in the northern part of the country: more than 80mm in approx. 30 hours. Also in Maasland 97mm were recorded in approx. 36 hours and in Purmerend 90mm fell in 36 hours. The return period of these events is once in every 125 years.

In **Belgium**, during the first decade of August the weather was determined by meridional warm air currents, so there was an exceptional high mean of the minimum temperature. At Uccle, the monthly mean minimum (15.4°C) was 2.4°C higher than normal, the mean temperature 2.1°C. Precipitation also had a large amount (159% of the normal at Uccle), relative humidity and mean surface pressure as well. A remarkable number of 23 thunderstorm days was registered, compared to the normal of 11.1 days. This was a new record for the country; the previous one was 17 days in 1939.

In 2004, August was not as hot as in the year before in **Germany**, nevertheless the month was too warm all over the country. The areal mean temperature reached 18.5°C. This value was 2.0° above normal for the reference period 1961-90. Like in the three years before, August was once again the warmest month of the summer. There was quite a lot of rain, but there were significant regional differences. On average, the precipitation amount of August 2004 was 89.2mm, exceeding the normal by 12.0mm or 15.6%. Strong thunderstorms occurred on August 7-8 in the Southwest (49mm rain within 1-2h, hail cover of up to 90 cm), on August 12-13 in the West and South (55mm daily precipitation, in Munich gusts up to 120 km/h), and on August 18-19 in the Southwest and West (34mm daily precipitation, gusts up to 100km/h). Sunshine duration was near to normal (spatial mean 211.3 hours, +14.5h or +7.4%).

August was warmer than normal in **Poland** after a cool three-month period. Mean monthly temperature deviations varied from +1°C to +2°C. The highest measured temperature was +34.8°C (August 19), the lowest +3.8°C in mountain valleys. Precipitation was close to normal except for the eastern and northern regions where 200% of the normal were reached. In mid-August the meteorological conditions changed resulting in a significant decrease of temperature, storms with torrential rain and gusty winds causing damage in northern Poland.

In **Switzerland,** two tornadoes (F2 and F1) at Massonnens (western pre-alpine area) were observed on August 10. It was an extremely wet month in western Switzerland. The highest precipitation amount at Adelboden was reported since records started in 1901. In Geneva this was – after 1927 and 1878 – the third wettest August since measurements began in 1864.

In **Slovenia,** the August mean air temperature was above the 1961–1990 normal values and at some sites it exceeded the limits of the normal variability. In the mountains, at Kredarica, August was 1.2°C warmer than on average in the reference period. The sunshine duration was above normal, in the Julian Alps only by 7%, in Celje by 21%. Precipitation was most abundant in the Julian Alps, while on the coast only 41 mm fell (35% of the normal precipitation in August). There were severe thunderstorms, the strongest ones in Štajerska, some of them with hail and strong gusty winds. At Kredarica on August 27 the snow depth was 7cm.

The maximum daily amount of rainfall in **Hungary** was 128mm (Újszentmargita, August 26), but the monthly mean precipitation amount was near normal (99%). The average temperature was 0.8°C higher than the long-term mean.

In **Croatia**, the month was warm, particularly in the western half of the country where anomalies between 1 and 2°C were recorded. The precipitation amounts were generally low, especially in the West. As an outstanding example, the station Poreč received only 13% of the normal.

August was 0.5°C warmer than normal on average in **Bosnia and Herzegovina**. 91% of the 1971-2000 normal precipitation fell during the month.

In **Serbia and Montenegro**, mean monthly temperatures were in the normal range. Maximum temperatures often did not exceed 30°C, so the number of tropical days was less than average.

On August 28, exceptional precipitation amounts were reported from south-eastern **Romania**. In southern Dobrudja the precipitation summed up to 312mm (at Pantelimon), 281mm (at Agigea), 200mm (at Mamaia), and 195mm (at Constanta).

In **Moldova,** 235mm of precipitation fell during 21 hours at the meteorological station Soroca on August 22 – 23, due to a strong cold front with waves. Such a phenomenon was never recorded before on the territory of the Republic since the meteorological observations were carried out. A record breaking amount of hourly precipitation of 149mm was measured, which was three times as much as the monthly normal. The monthly precipitation sum for this station was 352mm, also this was a record. On August 28 another exceptional precipitation sum was registered: 166mm of precipitation during 9 hours (325% of the normal) at the meteorological station Leovo; again this was a result of a moving cold front with waves and it also was a new record for the South of the Republic. Due to heavy showers that occurred during the third decade of this month, houses, roads and crops were flooded and damaged. In Leovo, two persons died when a dam broke. The total amount of material losses was estimated to about 16 million €.

There were widespread thunderstorms in **Bulgaria** on August 14, 22-23 and 27-28 with heavy rain downpours and strong wind gusts as well as hailstorms. Hailstones as big as walnuts and eggs were seen. Floods were reported from the cities of Veliko Turnovo, Shumen, Dobrich and Varna; daily amounts of precipitation up to 40-50mm were registered. Ball lightnings were observed during thunderstorms on August 3 and 27. 130 villages were without electricity in the administrative region of Dobrich. The monthly average of August was normal in terms of temperature but wet. Precipitation was 100 to 400% of the normal.

Very low values of precipitation (about 30% below the long-term average) were registered over the country of **Albania** this month.

In **Portugal,** August was characterised by significant rainfall. High precipitation amounts were recorded at some stations and, in the northern and central regions, such a rainy August had not occurred since 1999. The maximum mean air temperature was well below the 1961-90 normal (especially on August 9 and 10, with some stations recording anomalies down to -11°C) while the minimum mean air temperature was above normal. The number of days with air temperature equal or above 35°C was significantly below normal, mainly in the northern and central regions. No maximum air temperatures equal or above 40°C were recorded at any of the stations of the territory.

Rain and floods occurred very frequently this month in **Turkey.** A tornado was observed on August 11 at Zonguldak.

In August the temperature in **Armenia** was above normal by +1 to +2°C. The precipitation amounts were low on average. Yerevan reported only 1mm for the whole month.

August was slightly cooler than normal in **Israel.**

September 2004

- **Mostly warm**
- **Mostly dry, except in the North**
- **Very sunny in some countries of Central Europe**

In **Greenland,** September was warmer than normal.

The month was rather warm in **Iceland**, but dull.

September was very wet on the **Faroe Islands,** but also with a surplus of sunshine. A large part of the rain in September was registered on September 13–14, about 50mm.

The monthly temperature was well above normal in **Norway**. For the country as a whole, it was 1.3°C higher than normal, in parts of southern Norway even 2°C. The highest monthly mean temperatures were recorded around the Oslofjord and along the coast until Lindesnes. Færder Fyr was warmest with 14.3°C (1.4°C above normal). The lowest mean temperatures were reported from the mountain areas in southern Norway and Finnmarksvidda. Sognefjellhytta was coldest with 2.7°C (1.5°C above normal). The highest maximum temperature (25.3°C) was measured at Nesbyen-Todokk on September 5 while Rustefjelbma in the county of Finnmark measured the lowest (-8.0°C) on September 19. Precipitation was very plentiful this month in large parts of the county of Trøndelag; the monthly mean was 200-300% of the normal. In some areas of Sør-Trøndelag this was the precipitation record for September for the last 100 years. In contrast, some parts of south-eastern Norway were drier than normal (50-60%). Based on the observations of all the synoptical stations the monthly mean precipitation in Norway was 130% of the normal. The highest value within the country was reported from Kvamskogen in western Norway with 497mm (127% of the normal), the lowest at Saltdal in the county of Nordland (25mm or 78%). Haukeland in western Norway had 99.8mm on September 27 as the highest daily value of the month.

On September 9 – 10 early in the morning, rime was observed on the grass in western Jutland in **Denmark.**

In **Estonia,** the monthly mean temperature of September was 2°C above normal. There were many thunderstorms with hail.

The month was warm in **Lithuania**. Its mean air temperature anomaly was +1°C. The mean daily air temperature decreased below 15°C ten days later than usually. Concerning precipitation, the first and second decade were dry and the third one was rainy. Heavy rain occurred in the south-western regions on September 22 – 24. The three-day precipitation sum amounted to 95 – 147mm, exceeding 4 – 4.5 times the normal of the last decade and 1.5 times the monthly normal. Small rivers flooded about 3 000 hectares of land. The monthly precipitation amount was very inhomogeneous within the country and varied from 29 to 196mm. At the end of the month a second blooming of apple-trees was observed at the seaside, but also 6 days with thunderstorms were recorded there.

September was very sunny in the **Netherlands**. The first decade of this month was the sunniest for at least 50 years at some stations. In De Bilt 99 hours of sunshine were recorded in the first decade. Since 1901, only the first decade in 1959 was sunnier with 109 hours.

Also in **Belgium** it was mostly sunny this month. At Uccle, the sun was shining for 173 hours; these were 113% of the normal. However, a significant deficit of sunshine duration was noted for the third decade: With 14.6 hours this was the lowest registered value since 1951 (the preceding lowest value for the third decade of September was 21.8 hours in 1964). The monthly mean temperature was 1.2°C above normal, the precipitation sum 119% of the normal.

Nearly all over **Germany** the month was warmer and much sunnier than in the reference period 1961-90. The mean temperature for Germany (14.2°C) was 0.9°C above normal. The spatial mean anomaly of sunshine duration (187.3 hours) was +37.9 hours or +25.4% (spatial distribution see Fig. 9.1), and so the month became the 5th in the line of Septembers rich in sunshine in Germany since 1951. On the other hand, the areal mean of precipitation (64.3 mm) was near to normal (+3.2 mm or +5.1%), but there were large regional differences. On September 21, due to a storm, wind gusts of more than 120 km/h were measured on mountains (Brocken, Fichtelberg) in north-east Germany and on the island Helgoland in the North Sea, also with flooding at the North Sea coast.

September was another warm month in **Poland**. Mean temperatures exceeded the average value by 0.5-1.0°C. The difference between the lowest (-0.8°C) and the highest observed temperature within this month (+28°C) was considerable. Precipitation sums in September were generally lower than normal except in the North of Poland. In the South less than 50% of the long-term average rain fell. Rainless weather at many locations caused progressive soil dehydration.

In **Slovenia,** September mean air temperatures were close to the 1961-1990 normal values. The largest anomaly occurred in the Primorska region. With exception of Kočevje, Dolenjska and Bela krajina, the sunshine duration exceeded the 1961-1990 normal. Especially the Gori ška region was very sunny with 20% above normal. Precipitation was most abundant in the Julian Alps, while in Upper Vipava valley and in Goričko less than 60% of the average precipitation fell. At Kredarica the snow depth was 15cm on September 8.

The monthly average temperature in **Portugal** was equal or above normal (1961-90) in almost the whole territory. The precipitation amounts were below normal.

In **Italy**, a flood affected the province of Viterbo, north of Rome. The costs of damage to walls and streets, electrical equipment (due to thunderbolts) and, mostly, to the production of hazelnuts, were estimated to 2 million Euro.

The temperature anomalies in **Croatia** varied between –1°C in the East to +1°C in the West. The variability of the precipitation anomalies was high, from 18% at Split to 284% at Lastovo in the outermost South of the country.

In **Bosnia and Herzegovina**, the monthly mean temperature was exactly normal (1971-2000) on average (14.8°C), but the precipitation amount was less than the long-term mean (67mm or 73%).

Monthly means of temperature and precipitation in **Bulgaria** were around normal except the southern part of the country which received around 150% of the normal precipitation. But September was also a month with some severe weather events. There were violent thunderstorms in the East of the country on September 27. Varna, the major Bulgarian city at the Black Sea coast, encountered a severe hail storm with hailstones as big as eggs. Heavy rain showers and wind gusts were reported to have caused damage in 4 local administrative regions for as much as 2.3 million EUR, in particular in the city of Varna the reported damage was 1.8 million EUR. At this location the wind gusts reached 90km/h causing interruption of the harbour service. There was even a tornado reported in the Rodopi Mountains in the South of the country which caused damage at least to 37 houses.

Heavy rain and floods occurred in **Turkey** at Giresun on September 4 and at Bodrum and Mugla on September 25 with injuries of people and damage on houses and traffic. In contrast, it was very dry on September 9 at Urgup and Nevsehir and on September 30 at Sivrihisar, Eskisehir, Avanos and Nevsehir. Frost with damage on vegetable gardens appeared at Urgup and Nevsehir on September 11.

September was slightly warmer than normal in **Israel**.

Heat waves passed **Jordan** on September 27-29. The maximum temperatures during these days were 5°C above normal.



Fig. 9.1: *Percent of normal 1961-1990 of sunshine duration for Germany in September 2004*
From: Deutscher Wetterdienst (DWD)

October 2004

- **Mostly warm**
- **Dry in the North and around the Mediterranean, wet especially in Ireland, in some parts of Central Europe and in the East**

This month was warmer than normal at Nuuk in **Greenland** and at Tórshavn on the **Faroe Islands**.

In **Iceland**, October broke a run of 30 consecutive months with above-average temperatures in Reykjavík. There were two intense northerly storms with wind gusts above 215km/h in October.

The monthly mean temperature in **Norway** was close to normal for most of the country. At some stations of Finnmark it was 1.5°C above the long-term average. Precipitation was very sparse in parts of the counties of Trøndelag, Oppland and Møre og Romsdal. At some locations that month was among the two to three driest Octobers during the last 50 years. The highest maximum temperature (18.9°C) was measured at the station Hjelvik– Myrbø on October 4 while Kautokeino registered the lowest minimum (-18.5°C) on October 30. The station Laupstad in the county of Nordland measured 123.2mm of precipitation on October 31 as the highest daily value for this month.

October was a further mild autumn month in **Sweden** with no serious storms.

In **Denmark** on October 9, the first frost was registered near Kolding in Jutland. However, the monthly mean temperature was above normal.

The month was warm on average in **Estonia**. 6.9°C was recorded as the mean temperature of the country; this was 0.4°C above the 1961-1990 normal. The maximum temperature was 18.1°C, whereas the minimum was not lower than –4.7°C. The precipitation was slightly higher than the long-term mean (67.2mm or 102% of the normal).

New maximum temperature records in **Latvia** for individual days were set on October 6 and 26. The monthly mean temperature was only slightly above normal, but the month was rainy with around 140% of the 1961-1990 average.

October weather was rather warm and humid in **Lithuania**, though changeable. The mean monthly air temperature was 8.2°C (+1°C anomaly). Especially the first and the third decade were warm. Maximum temperatures reached 18 – 20°C at southern stations on October 25-26. The coldest days were from October 10-15 with a night-time temperature falling to -4 to -7°C. The monthly amount of precipitation was close to normal in the southern part of the country and up to 220% of the normal in the northern borderland. Moist soils hampered agricultural fieldwork. In western Lithuania, water in rivers rose to 170 - 230cm and exceeded its normal level by almost 50cm.

October was very wet in **Ireland**, especially in the South. The heaviest rainfalls of the year occurred during the second half of October, leading to significant flooding in parts of the South and Southeast. Rainfalls of up to 150mm were measured in this area in the 48-hour period of October 27-28 (Fig. 10.1), while at the same time, a combination of exceptionally high tides and gales, caused by a depression with a core pressure of 953hPa in the South of Ireland, brought flooding along the southern coast. The highest daily rainfall amounted to 44.7mm at Rosslare on October 22.

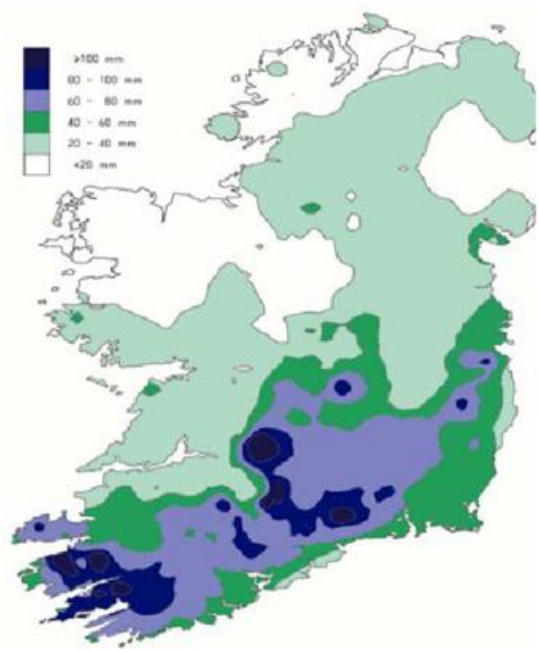


Fig. 10.1: *48-hour sum of rainfall in Ireland during October 27-28*
From: Irish Meteorological Service

For the **United Kingdom**, the Central England temperature was about normal this month, but the England and Wales precipitation was 155m or 178% of the 1961-1990 normal.

The month was warm and precipitation quite normal in **Belgium.** At Uccle, the monthly mean temperature was 11.7°C (anomaly +1.2°C), the precipitation amount 67.6mm (95% of the normal). There were remarkable anomalies of the surface pressure which was lower than normal on monthly average (-4.8 hPa at Uccle), and of the lowest temperature of the month, which was higher than normal (+1.4°C).

In **Luxembourg**, it was also quite warm with a monthly temperature mean of 10.1°C and an anomaly of 1.2°C above the 1971-2000 normal. A maximum temperature of 23.1°C was measured on October 4, a minimum of 2.8°C on October 19, two frost days were observed (the normal is 5.9 days). The precipitation amount was slightly below normal (75.3mm or 92% of the normal).

October 2004 was also rather mild in **Germany**. The areal mean temperature was 10.2°C (1.2°C above the long-term average). With an average precipitation amount of 53.2mm, this month was 2.6mm or 4.6% drier than normal. A spatial monthly mean of 114.2 hours of sunshine duration was reported, this sum was 5.7% or 5.2 hours above normal. However, there were large regional differences, as the Southwest was very wet and relatively poor in sunshine, while it was partly too dry and sunny in the East. On October 5 in western Germany (Minden-Porta Westfalica-Rinteln) heavy rain (up to 22mm), lightning strokes and a tornado were reported. On the same day in southeast Germany, 28.2°C were measured at Munich; this was the highest temperature ever measured there on an October 5 since 1879.

October was warm in **Poland** – deviations of mean monthly temperature from the long-term average reached +2.5°C in the South. Only the second decade was cold, but the mean temperature of the last third of the month exceeded +10°C and the maximum temperature +20°C. Even on October 30 the maximum temperature was +22.8°C in the South. Precipitation was higher than normal exceeding 150% of the normal in the North. Dry conditions were observed in the East with only 50% of the normal precipitation. Mid-October daily rainfall sums were above 50mm in high mountains.

The monthly average temperature was near the mean value in **Portugal**. The month was rainy to extremely rainy in the northern and central regions and dry in the southern regions. Percentages of precipitation totals (with respect to the 1961-90 normal) were between 56% (South) and 300% (Fig. 10.2).

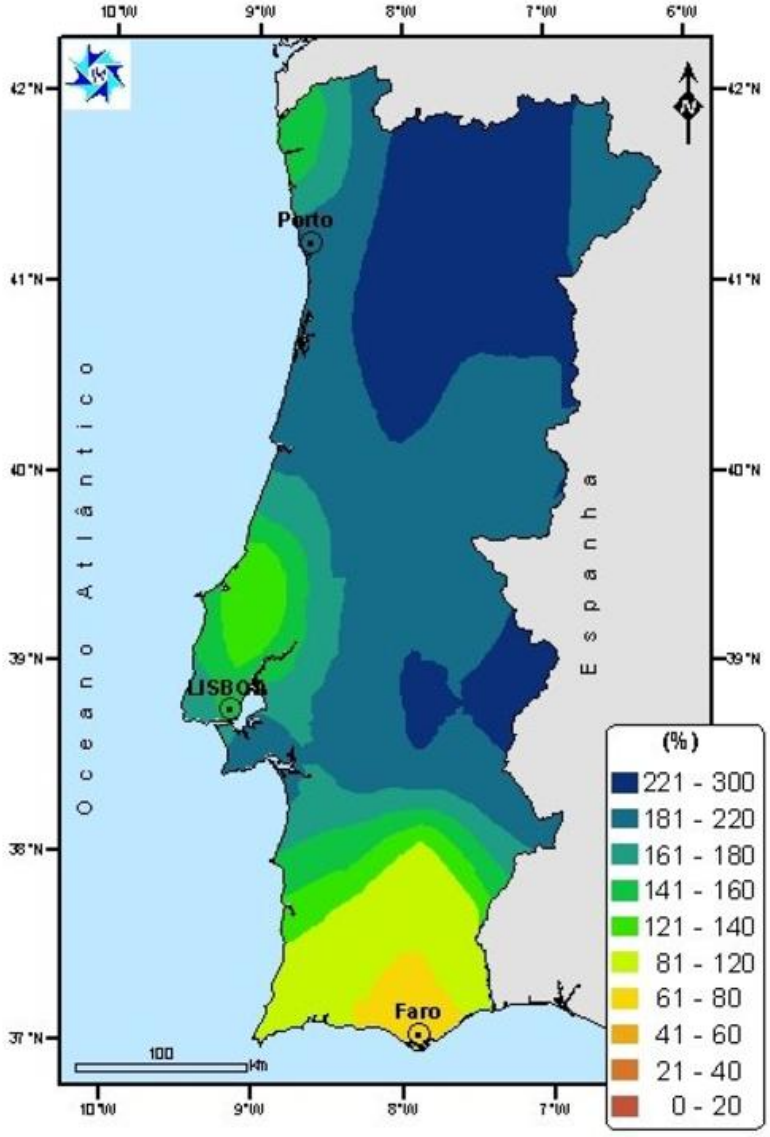


Fig. 10.2: *Percentages of precipitation totals (with respect to the 1961–1990 normal) in October 2004*
From: Instituto de Meteorologia, Portugal

In **Switzerland,** extremely high temperatures in and north of the Alps were measured on October 5, locally attaining 28.4°C. Some values represented the second to fourth highest October values. In the Northwest and the south-eastern neighbouring lowlands, it was partly the wettest October since 1939.

The month was warm in **Austria** with temperatures from 1.5 to 3.5°C above normal, but dry with precipitation around or below normal (50-70% of the normal). A wet period on October 29 – 31 occurred with up to 280% of the normal precipitation in Carinthia. In the South of Carinthia large floods along the rivers Gail, Lesach and Drau affected meadows, fields and cellars. Roads were blocked by landslides. The station Reisach im Drautal recorded a three-day precipitation amount of 167mm, near to the normal monthly precipitation amount.

It was also warm in **Hungary**, 1.3°C above normal on average. On the other hand, it was wet; the precipitation total was 145% of the normal.

In **Romania**, the monthly mean temperature was only slightly higher than normal; precipitation amounts were lower than the long-term mean.

In **Slovenia,** in spite of significant advection of cold air at the beginning of the second third of October, the month as a whole turned out to be warmer than on average. The mean air temperature was at least 1°C above the 1961-1990 normal. At most places the temperature anomaly was statistically significant, at some stations it even reached up to 3°C. Precipitation also exceeded the 1961-1990 normal; it was most abundant in the Julian Alps. Sunshine duration was below the 1961-1990 normal, in Vipava valley and in Notranjska only 40% of the normal sunshine duration was registered. It was snowing in the lowland of Notranjska region during the early morning on October 17. At Kredarica the snow depth reached 85 cm on the same day.

It was very warm over large parts of **Croatia,** partly extremely warm (Fig. 10.3). Precipitation values were very high in the northern part of the country (e.g. in Zagreb 270% of normal), but mostly drier than normal in the South.

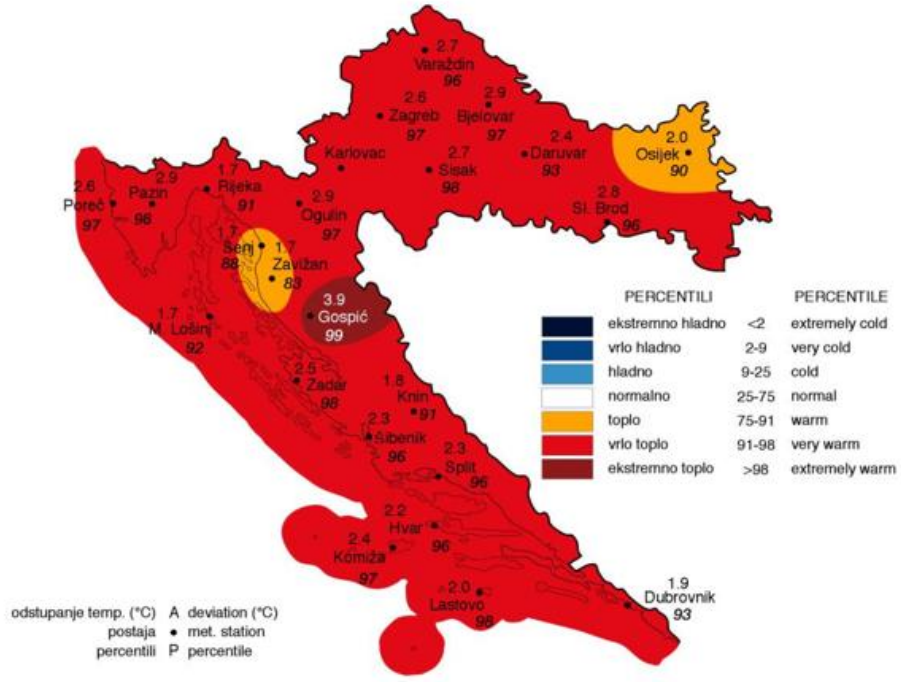


Fig. 10.3: *Monthly air temperature anomalies from normal 1961 – 1990 in °C (upper numbers) and percentiles (lower numbers) in Croatia in October 2004*
From: Meteorological and Hydrological Service Croatia

In **Bosnia and Herzegovina**, it was also very warm. The average monthly mean temperature (13.3°C) was 3.2°C above the 1971-2000 normal. The precipitation amount was notably below normal (82% of the normal 1971-2000).

Again, October was very warm in **Serbia and Montenegro** with mean maximum and minimum daily temperatures of 2 - 3°C above average. Especially the last decade of the month was outstanding warm (Fig. 10.4). Maximum temperatures at all the stations (except those on the mountains) were above 20°C during the first ten days. After October 17 the temperature even exceeded 25°C on some days.

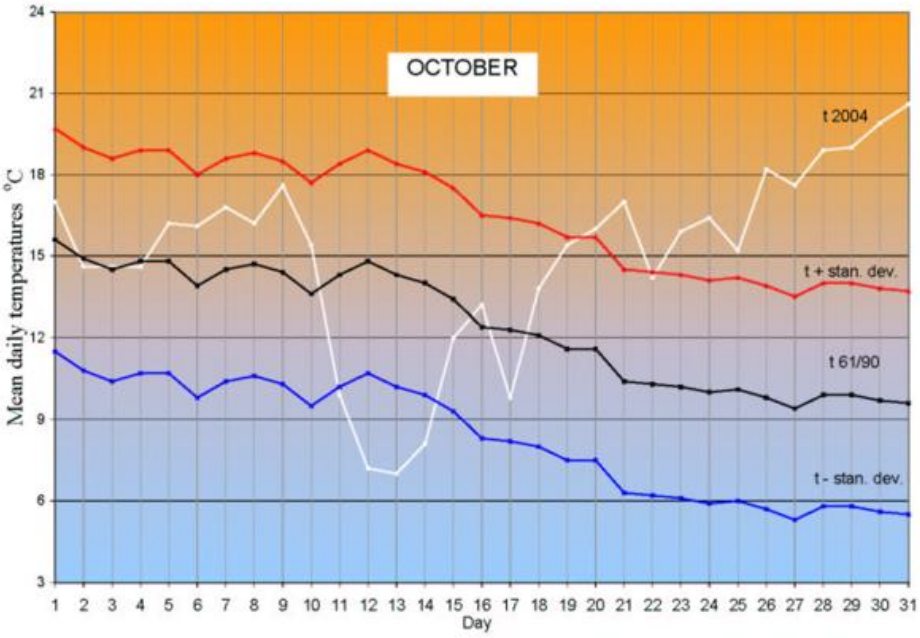


Fig. 10.4: *Mean daily air temperatures in Belgrade in October 2004 compared with 1961 – 1990 normal values and standard deviations*
From: Republic Hydrometeorological Service of Serbia

In **Albania**, the mean maximum temperature of October 2004 was the fourth highest within the available time series. At Elbasan (central part of the country), 2004 had the highest value since 1951 (Fig. 10.5). For the mean minimum temperature mostly a positive deviation was registered (up to 3°C), but a negative one in the north-eastern and eastern parts of the country (-2.9°C).

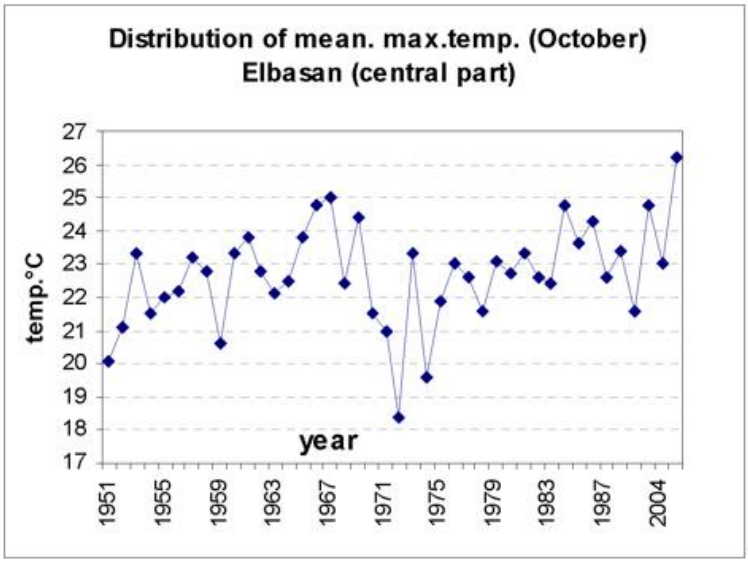


Fig. 10.5: *Mean maximum temperature in October at Elbasan (central part of Albania) 1951-2004.*
From: Hydrometeorological Institute of Albania

October was warm in **Bulgaria** with temperatures from 1.5 – 3.5°C above normal and dry with precipitation amounts around or below normal (50-70%of the normal).

Unusual high daily maximum temperatures between 27 and 33°C in **Greece** were reported for several areas of the country during the period October 17-19. The corresponding monthly long-term averages are 22-25°C (Tab. 10.1).

Station	Location (latitude °N, longitude °E)	Altitude (m)	Highest maximum temperatures during October 17-19	Date	Long-term mean monthly maximum temperature	Reference period
N. Filadelfia (Athens)	38 03, 23 40	136.1	27	17/10/04	23.3	1955-1997
Larisa	39 39, 22 26	71.0	29	17/10/04	22.2	1955-1997
Astros	37 24, 22 43	25.0	30	17/10/04	23.8	1974-1997
Argos (Pyrgela)	37 36, 22 47	11.2	31	17/10/04	24.2	1980-1997
Lamia	38 51, 22 24	14.3	32	17/10/04	22.4	1970-1997
Milos	36 44, 24 26	164.0	29	17/10/04	21.8	1955-1997
Mytilini	39 04, 26 36	4.2	30	17/10/04	21.7	1955-1997
Heraklion	35 20, 25 11	37.0	33	17/10/04	23.4	1955-1997
Tympaki	35 00, 24 46	5.0	32	18/10/04	24.9	1959-1997
Arta	39 10, 21 00	11.5	29	19/10/04	24.0	1976-1997
Pyrgos	37 40, 21 26	12.0	29	19/10/04	24.7	1975-1997
Kasteli	35 12, 25 20	332.6	30	19/10/04	22.1	1976-1997

Tab. 10.1: *Unusual maximum daily temperatures (in ^{0}C) in October 2004 and mean monthly maximum values*
From: Hellenic National Meteorological Service

In **Turkey**, heavy rain and flooding occurred in Istanbul on October 8 injuring people, damaging houses and traffic. A storm was observed on October 12 in Amasra, Bartin, Bandirma and Balikesir; the seaway was closed. A dry period started on October 25 in Seydisehir and Konya, consequently, germination of seeds did not proceed. The month as a whole was also dry, only about half of the normal precipitation fell on average, and it was warmer than normal.

The month was very dry in **Cyprus**. The monthly precipitation amount was only 8.5 mm, which was 26% of the normal value. Furthermore, it was very warm; the mean temperature of the month was 2.3°C above normal. On October 13 heavy showers caused floods in the Lefkosia region. In the same area, a hailstorm occurred on October 29 and on the same day another hailstorm, very strong winds and a tornado caused damage in the south-eastern parts of the island.

In **Armenia**, this month was warm and dry. At the station Yerevan, a monthly temperature mean of 14.9°C (2.1°C warmer than normal) and a precipitation sum of 9mm (28% of the normal) were recorded.

October was warmer than normal in **Israel** with a significant rain event at the end of the month. On October 29 large amounts of rain were recorded within a short time in the southern and eastern parts of the country. In Neve Ur (northern part of the Jordan Valley) 100 mm fell within two and a half hours. This was the largest daily amount ever recorded in that area as well as the strongest rainfall intensity. In Sedom (southern part of the Dead Sea) 74 mm of rain were recorded on October 29, most of it within two and a half to three hours– a record breaking event for this area. Large amounts (40-65 mm) also were recorded at other stations in the Jordan Valley and the Negev. The rains caused severe structural damage which was estimated to more than 50 million IS (10 million Euro)– roads and bridges in the eastern Negev and near the southern Dead Sea were damaged, some were totally ruined. Strong hail in areas near Jerusalem caused damage to cars and to private homes.

November 2004

- **Mostly warmer than normal, colder in the Northeast and Southwest**
- **Dry in western Central Europe and on the Iberian Peninsula, wet in western Norway, eastern Central Europe and in the Southeast**
- **Strong winds in eastern parts of Central Europe around November 18**

In **Iceland**, large temperature anomalies were observed in November. In Reykjavík the minimum temperature went down to -15.1°C, the lowest in November since 1893.

The monthly mean temperature in **Norway** was near normal for the larger part of the country. The highest maximum temperature (15.5°C) was measured at Nelaug in the county of Aust-Agder on November 15 while Kautokeino in the county of Finnmark registered the lowest minimum temperature, -34.3°C on November 21. In the inner parts of Finnmarksvidda the mean temperature was 1.5 - 2.0°C below the long-term average. The monthly sums of precipitation were the highest or second highest for the last 100 years in parts of the counties Oppland, Trøndelag and Møre og Romsdal. The precipitation station Opstveit in the county of Hordaland received 195.0mm on November 15. This was the highest diurnal precipitation value registered in Norway in 2004 and the highest diurnal value registered at Opstveit since the measurements started there in 1968. This was also the fourth highest diurnal precipitation ever measured in Norway.

In **Sweden,** at Visby on the island of Gotland, a record breaking snow depth for November was registered with 23cm of snow, and locally 30-40 cm of snow were measured in southern Sweden. Just 200m east of Gotland a towboat turned over during the snow storm on November 23 and one person drowned. About 15 000 households in south-eastern Sweden had a failure in the supply of electricity due to snow and strong winds on that day.

Frequent storms occurred at the western coast of **Estonia** in November 2004.

In **Latvia,** the air pressure at sea level fell by 43hPa in 38 hours at the Baltic Sea coast on November 23 - 24.

The first half of November was warm in **Lithuania**. During this period, the maximum temperature rose up to 9 – 12°C, but afterwards, starting on November 17, it fell down below zero. The monthly mean air temperature anomaly was -0.6°C. Frequent rainfall appeared during the first half of the month, changing to snowfall in the second half. Most precipitation fell at the seaside, elsewhere it was less, being 86% of the normal. A snow cover formed gradually and reached 4-12cm by the end of the month. The Lithuanian seaside encountered high wind speeds up to 72 – 86km/h for 8 days in total. Fogs were quite frequent, sometimes followed by freezing rain hampering transport operations.

In the **United Kingdom**, November 2004 was the 22nd driest November in EWP (England - Wales precipitation) with 49mm.

Belgium had a persistent flow of maritime air masses, sometimes of polar origin. On average, the month was quite normal. The only remarkable values were an exceptional low mean wind speed and an outstanding anomaly of high surface pressure.

On average over **Germany,** November 2004 did not show any larger deviations from the values of the reference period 1961-90. However, there appeared significant regional differences, especially in precipitation. While it was too wet in large parts of northern and eastern Germany, it remained rather dry in the Southwest. Spatially averaged over the whole country, the precipitation amount was 72.8mm in November 2004, 6.4mm or 9.7% more than in the reference period. On November 9-10, heavy snowfall affected the traffic in central Germany. Up to 30cm fresh snow fell in the mountains. In terms of temperature, the monthly mean for

Germany was 4.2°C, slightly warmer (+0.2°) than normal. The spatial mean of sunshine duration (48.2 hours) was 10.0% or 5.4 hours below normal. Stormy winds were registered on November 17-18 in northern Germany (island Hiddensee in the Baltic Sea 169km/h, mountain station Brocken 158 km/h) and on November 19 over the southern mountains (Zugspitze 169km/h, Feldberg/Black Forest 140km/h).

November was warm and pretty wet in **Poland**. Monthly mean temperature deviations reached 0.5 – 1.0°C. At the beginning of November, maximum temperatures still exceeded 10°C, and even 20°C in the South. The warm weather favoured agricultural activities and winter crops growth. Only the third decade of the month was chilly with minimum temperatures below 0°C. Monthly precipitation sums were generally higher than normal with 200% of the normal at most locations in the South. November was also a very windy month – almost every day wind gusts exceeding 50km/h were observed. The strongest winds (>90 km/h) were measured on November 17-18, resulting in 7 casualties and 10 people injured, much material losses were estimated (damage in energy transmitting lines, buildings, cars). The highest noted wind gust was measured at mount Kasprowy Wierch (137km/h) on November 19.

In **Slovakia**, a strong downslope wind in the High Tatras area reached gusts of 160 - 194km/h on November 19. This event had extensive influence on forest vegetation and caused huge damage (12 500ha of forest were devastated, Fig. 11.1), the volume of windfall wood was estimated to 2.5 million m³. It was the most violent storm in this region for the last 100 years. A previous similar event occurred in the year 1941, with damage not exceeding 20% of the 2004 event.



Fig. 11.1: *Damaged forest vegetation in the High Tatras after the storm on 19 November 2004, photo: Pavel Kapusta*
From: Slovak Hydrometeorological Institute

November was warm and dry in **Austria** with temperatures 0.5 – 2°C above normal and precipitation of 50 - 90% of the normal. A storm situation north of the main ridge of the Alps persisting for five days (Nov. 18 – 23) caused severe damage. Wind speeds up to 119 km/h (recorded at the station Vienna, Hohe Warte, Nov. 18) caused damage to a lot of houses and roofs in Vienna; in the surroundings of Vienna rail and road traffic were blocked by broken trees.

On November 19 a gale (accompanied by 120km/h blasts) caused traffic accidents in **Hungary**, ruined trees and buildings. The month was mild with a temperature anomaly of +0.9°C on average, precipitation amounts were about normal (102%).

In **Romania,** the largest precipitation amounts of 2004 nation-wide fell in November (Fig. 11.2), the monthly sum amounted to 179.3% of the 1961-1990 normal. Torrential rainfalls, generating flooding in the Southwest of the country, caused high damage: 18 people were killed, 14 325 houses were affected, 111 371ha of agricultural land were flooded. The monthly mean temperature was only slightly above normal.

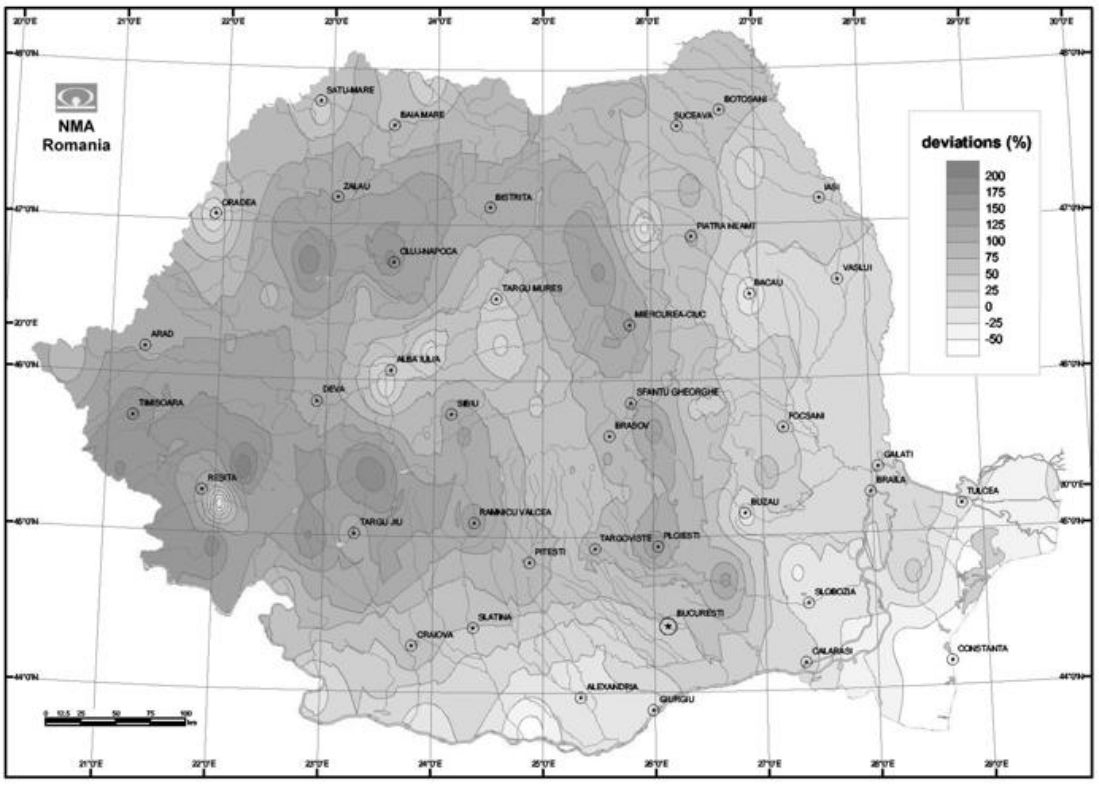


Fig. 11.2: *Deviation of the precipitation amount in November 2004 from the normal 1961–1990 in Romania*
From: National Institute of Meteorology & Hydrology Romania

Air temperature was near the 1961-90 normal in **Portugal,** except in Lisbon and north-eastern regions, where it was below the long-term average. November was extremely dry in the whole territory with precipitation amounts significantly below the mean values. Percentages of precipitation totals (with respect to the 1961-90 normal) were between 11 and 27%.

In November, rainfall was intense in **Spain** on November 8, with more than 150mm at 2 locations.

In **Italy**, the most striking weather phenomena in November concerned Calabria and Sicily regions. Floods in the provinces of Catanzaro, Cosenza and Reggio Calabria occurred together with a sea storm at Crotone and funnel clouds in Catanzaro and south of Sicily;

streets, buildings and agriculture suffered a lot of damage. Related to this event, the weather station of Monte Scuro (Calabria) measured 100.4mm, which is a record value of daily precipitation since 1951. Other stations in the area also registered very heavy precipitation (Fig. 11.3).

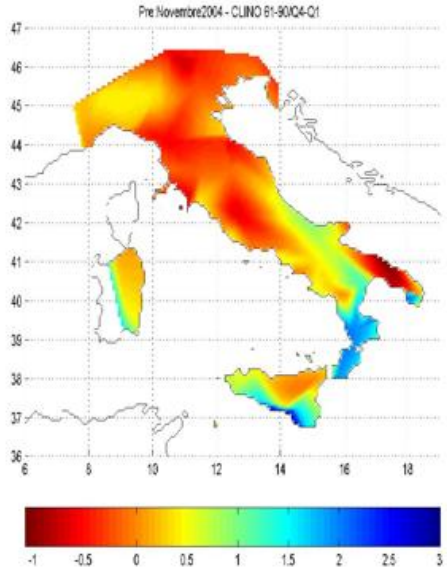


Fig. 11.3: *Precipitation anomaly of November, cumulated values versus 1961–90, divided by the fourth minus the first interquintile range*
From: Ufficio Generale per la Meteorologia, Italy

In **Slovenia,** November began with exceptional warm weather in the Gorška and coastal region. The maximum daily temperature in Bilje was 25.0°C on November 2 and in Portorož 24.4°C was the highest temperature ever recorded in November. The mean air temperature of the month was above normal (1961–1990) almost all over the country. Only on high mountains the mean air temperature was slightly below normal. Precipitation remained below the 1961–1990 average, in the West and at some places in the East of Slovenia not even one half of the usual precipitation fell. The sunshine duration was below normal in the northern part of Slovenia, but in the Notranjska region and Ljubljana's basin, sunny weather appeared more frequently than usual. The most significant weather event was an exceptionally strong wind on November 14, a few days later, on November 19, another episode of a very strong wind occurred, especially in the eastern part of Slovenia and on the high mountains. In both cases the wind caused some damage to buildings, particularly roofs and trees.

On November 2, the highest maximum temperature of the last 56 Novembers (since 1948) was observed in Split Marjan, **Croatia** (Tab. 11.1). But this was also the end of an extremely warm period persisting from the last two weeks of October until the beginning of November. The monthly mean temperatures were generally higher than normal, at Zagreb the anomaly was +1.7°C. For precipitation, it was drier than normal in the North of the country, but wetter in the Northeast and Southeast.

Year	2004	1992	1972	1990	2003	1999	2001	1948	1969	1998
T in °C	25.8	22.0	21.7	21.5	21.4	21.3	20.7	20.6	20.5	20.5

Tab. 11.1: *The ten years with the highest maximum temperatures in November in Split Marjan, period 1948-2004*
From: Meteorological and Hydrological Service Croatia

The monthly mean temperatures were around normal in **Bosnia and Herzegovina**, and also the average monthly precipitation amount exceeded the 1971-2000 normal only slightly (107%).

Large fluctuations of air temperatures during the month were characteristic for November in **Serbia and Montenegro**, especially in mountainous areas. The highest temperature of 27.3°C in the area of Serbia was measured in Sjenica on November 2 (altitude 1038m), exceeding the former absolute maximum of that station since measurements existed. Some more records of absolute maximum temperatures were broken at other mountainous stations: Crni Vrh, Zlatibor, and Kopaonik. In the second half of the month it was cold especially in mountainous areas and in southern Serbia, some stations reported freezing days. The lowest minimum temperature was -18.4°C in Sjenica. Precipitation occurred during the whole month, mostly during the second and third decade. In many parts of the country, precipitation quantities were extremely higher than average (Fig. 11.4). At some stations (Veliko Gradiste, Zrenjanin, Novi Sad, Beograd) new record values of monthly precipitation sums were achieved.

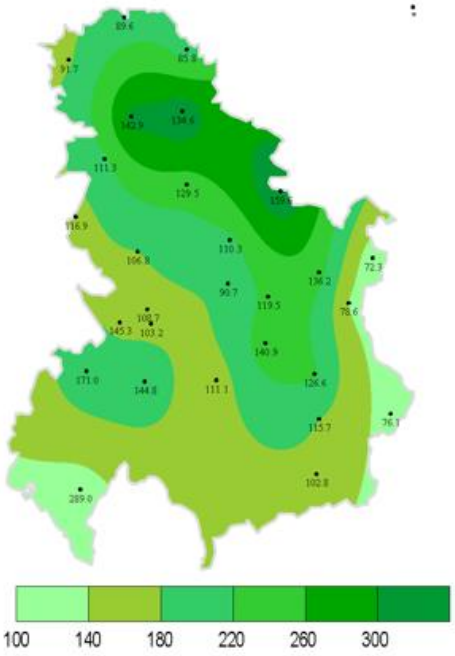


Fig. 11.4: *Precipitation totals in November 2004 in mm (values at stations) and in % of the normal 1961-1990 (isolines) in Serbia & Montenegro*
From: Republic Hydrometeorological Service of Serbia

The second highest monthly precipitation amount of 2004 in **Albania** was registered at Lezhe in the western part of the country with 284mm, which is about one third more than normal.

In **Bulgaria**, 24-hour precipitation amounts of more than 130mm were reported on November 14 (Fig. 11.5). The water level of river Vacha (Zabral Bridge) increased from about 100cm up to more than 350cm during the night of November 14-15. This caused a lot of damage in the villages around.

Heavy thunderstorms affected the island of Crete in **Greece** on November 5 and the periphery of Attiki on November 8. These storms caused floods in the western parts of Crete (Souda) and Attiki, with damage on roads, houses and agriculture. Extreme maximum 24-hour precipitation amounts of 120mm at Souda and 83mm at Attiki were recorded for these days.

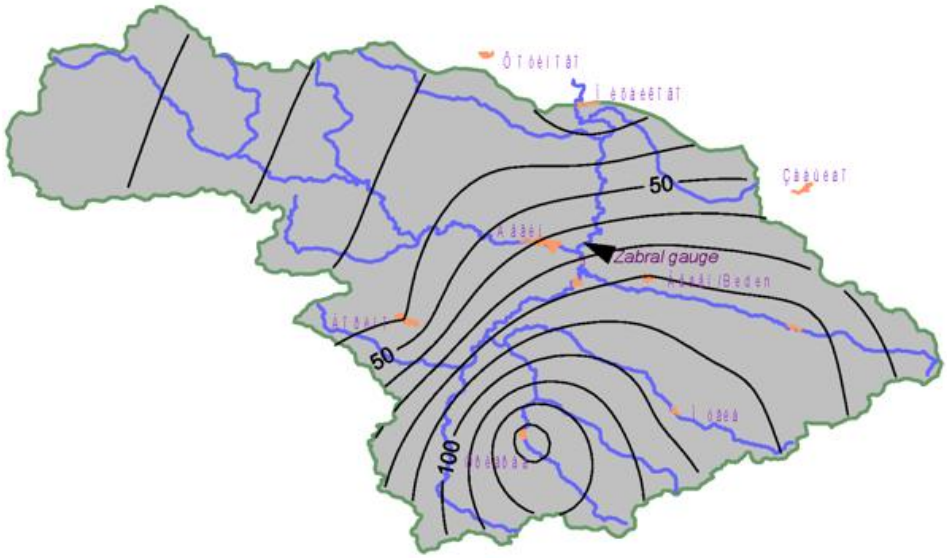


Fig. 11.5: *Distribution of 24-h precipitation totals recorded on November 15 at 08 a.m. local time in a region around river Vacha, Bulgaria*
From: National Institute of Meteorology and Hydrology, Bulgaria

In **Turkey,** a dry period started on November 2 in Urgup and Konya, seeds did not germinate. Frost came to Malatya on November 5 and to Odemis and Izmir on November 23, vegetable gardens were damaged. Heavy rain and flooding affected agricultural areas in Mugla on November 15 and again on November 20. Storms appeared on November 15 in Kocaeli, on November 19 in Kutahya and on November 25 in Cinarcik and Yalova (seaway was closed). Heavy snowfall was recorded in Sivas on November 22 and in Yozgat on November 25, traffic stopped on main roads. The monthly station averaged precipitation sum was high with 116mm or 162% of the normal.

In the Ararat valley and in some mountainous regions of **Armenia** a snowstorm occurred, the wind speed reached 90-100km/h. November was the wettest month of 2004 in the country, the monthly total precipitation was 137% of the normal.

On November 21 very strong winds occurred in various areas of **Cyprus** and a tornado caused damage to greenhouses in the southern part of the island. The first snowfall occurred around Troodos on the same day and later also in other parts of the country, in particular in areas with an elevation above 400 meters. The month as a whole was wet with 73.2mm or 137% of the normal on average. A mean temperature anomaly of +0.6°C was recorded.

November was rainy in **Israel**, with rainfall amounts reaching 150-200% of the normal in most parts of the country. Some parts received 200-300% of the normal. This was the first time that rainfall amounts in November were above normal since 1995. The first part of the month (November 1-15) was warm and dry with an average temperature of 28-30°C in the coastal plain and 23-25°C in the mountains. A rapid fall of temperature started on November 16, and the average temperature for the second part of the month (November 16-30) was 8-10°C less than in the first part of the month. This was the largest difference between the two parts of November for the last 40 years.

In **Jordan** it was very mild on November 4-7 with a maximum temperature 5°C above normal. The highest rainfall amount in 24 hours was 76.4 mm recorded on November 17 in Ras-Muneef.

December 2004

- **Very mild, especially in Scandinavia and in the Baltic countries, colder than normal in some parts of the Southwest ("white Christmas" in northern Spain) and in the Southeast**
- **Mostly very dry, but wet in some parts of the North and the Mediterranean**
- **Heavy storm in Central Europe on December 17**

December was very cold in some parts of **Greenland**, despite a warm start in the first week.

Mean values of December 2004 were close to normal in **Iceland**, but the weather was very unsteady with large temperature fluctuations, leading to difficult traffic conditions in large parts of the country. Only one hour of bright sunshine was measured in Reykjavík (the December average is 12).

December 23 was the day with the lowest temperature of 2004 on the **Faroe Islands** (-4.9°C).

The monthly mean temperature of **Norway** as a whole was 3.6°C above normal. In parts of the county of Finnmark it was 6-8°C above which was the third highest anomaly registered in December during the last 50 years. The highest daily maximum temperature was measured in Tafjord with 15.0°C on December 14, the lowest minimum temperature at Røros Lufthavn with -33.9°C on December 27. As for precipitation, the country average in this month was 135% of the normal. Parts of the county of Hordaland experienced the wettest December for the last 100 years. The station Bergen–Florida received a monthly sum of 568mm which was a new December record for the central parts of the county of Bergen since 1861. Takle in the county Sogn og Fjordane registered 774mm. The highest diurnal value was measured at the station Lavik in the county of Sogn og Fjordane with 161.0mm on December 5. Of the synoptical stations, Takle reported the highest diurnal sum with 114.3mm on this day. In contrast, the eastern part of Norway received less precipitation than normal. For some areas of the counties of Hedmark and Oppland December 2004 was the driest for the last 50 years.

December 2004 was very mild in **Sweden** with no significant weather events.

The end of the year was very mild in **Finland**; the December mean temperature anomaly was about +3°C, in some locations even +6°C compared to the normal. The largest storm in terms of spatial extension and also in terms of damage happened just before Christmas on December 23.

The month was 4°C warmer than normal in **Estonia**. The first ten days were especially warm and were among the warmest for the last half century.

December 2004 was the 7th warmest December in **Latvia**.

In **Lithuania,** December was warm and humid. For the most parts of the month, its mean daily temperature was positive and the monthly thermal anomaly amounted to +3.7°C. Over the past 100 years, a higher mean air temperature was recorded in December 1960 and similar mean values were recorded in the Decembers of 2000 and 2003. Only five days of the month were without precipitation. Mostly precipitation was of mixed nature, including snowfall and sleet. A snow cover was forming and melting alternately. The monthly amount of precipitation was close to normal. There was no soil freeze until the end of the month. December's warm weather was unfavourable for winter crops. Due to a prevailing influence of Atlantic cyclones, the Lithuanian seaside regions encountered strong winds for as many as 10 days, and fogs were very frequent too.

The lowest temperature in 2004 in the **United Kingdom** was -15.2°C at Kinbrace in northern Scotland on December 18-19. December 2004 was dry across England & Wales.

In **Denmark**, December was very mild with occasional frost and snow a couple of times in the last half of the month. On several places in the northern parts of Jutland and Zealand there was a rather deep snow cover on Christmas Eve ("white Christmas").

December was very sunny in the southern part of the **Netherlands**. The month was the 5th sunniest December month in Vlissingen (south-western part of the country) since 1907 and in Maastricht the 7th sunniest since 1906, both with 69 hours of sunshine.

December 2004 in **Belgium** was characterised by an exceptional high mean wind speed. Precipitation, mean temperature and sunshine duration were near normal. The anomalies for Uccle were –0.4°C for the mean temperature, 95% of the normal for precipitation and 121% for the sunshine duration.

The month was cold in **Luxembourg**. A monthly mean temperature of 0.1°C was recorded which corresponds to an anomaly of –1.7°C compared to the 1971-2000 normal. December was the coldest month of the year this time. It also had the lowest maximum (8.2°C on December 24) and the lowest minimum (-8.7°C on December 21) of the year. Nearly on all days of this month (28 out of 31), a frozen soil was reported (the normal is 20.7 days). A monthly precipitation amount of 43.3mm was registered which was only 51% of the normal. The highest wind speed of this month was 84km/h on December 17, when a storm passed over Central Europe.

The most outstanding weather event in **France** of the whole year 2004 also was in fact the storm that occurred on December 17 which swept along the North of the country. Violent gusts occurred from the northern coast of Brittany to the Picardie and as far as the North of Lorraine. In the coastal areas the strongest wind gusts up to 155 km/h were measured at Cap-de-la-Hève (Seine-Maritime). Inland, the strongest winds occurred in Oise, Somme and Aisne with gusts reaching 120 to 140 km/h. This storm caused a lot of damage and the death of six people.

December 2004 was very rich in sunshine and rather dry in **Germany**. The average sunshine duration in Germany in December 2004 amounted to 48.6h, which was 10.1 h or 26.2% above normal. The average precipitation sum in December 2004 was only 45.1mm, this value was considerably lower (25.1mm or 35.8%) than in the reference period 1961-1990. There were some days with freezing rain and/or heavy snowfall on December 16-17 (especially southern and eastern Germany), December 17-18 and December 22-23, causing severe traffic problems on the roads. On December 17-18 a heavy storm passed over south-western Germany. The mean temperature for Germany (1.1°C) was not far from normal (+0.3°C), but there were significant regional differences.

The month was unusually warm in **Poland**. Departures of monthly mean values from the normal in the eastern part of the country reached +2.9°C. The maximum daily temperature of the country exceeded +10°C; the minimum locally fell below -11°C. Precipitation was lower than usual with 72% of the 1971-2000 normal on average. Higher precipitation was noted only in the North (>120%). In the remaining regions, precipitation was scarce, lower than 40% at some sites. The number of days with snow cover ranged from 0 in the West up to 9 in the north-eastern region, but the snow depth was small (<10cm).

The weather was very mild and sunny in **Switzerland** in the Alps during the first half of December with a freezing level at 2500-2800m from December 4 to 13. Consequently, there was an extraordinarily poor snow cover in the Alps until December 16, afterwards the conditions for winter tourism improved only partially.

The monthly average temperature was normal in **Portugal** with respect to the 1961-90 period, except in the Minho region and at some places of the central region. The precipitation amounts were below the 1961-1990 normal in almost the whole territory, and the month was classified as being dry to extremely dry. Percentages of precipitation totals were between 19 and 60% of the normal. At the end of this month, a drought was well established in Mainland Portugal with a moderate to extreme intensity according to the Palmer drought index (Fig. 12.1).

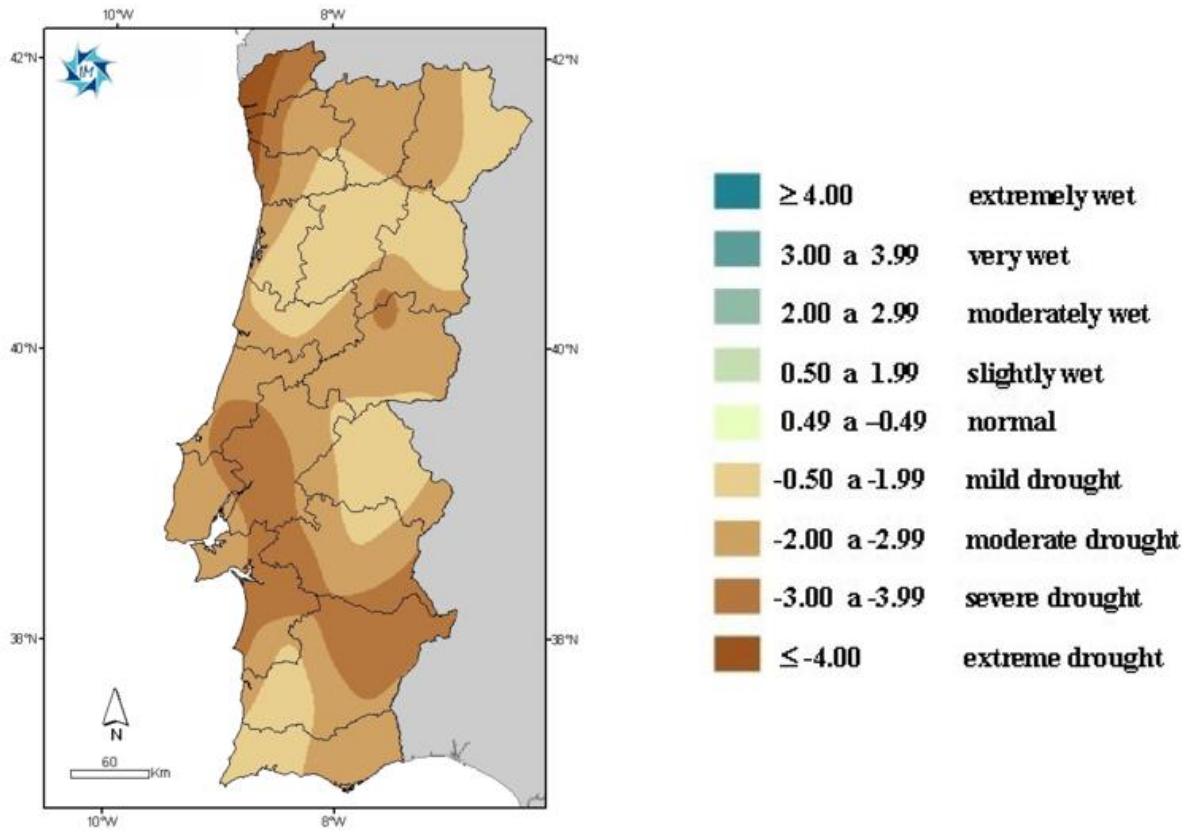


Fig. 12.1: *Palmer drought index (PDSI) in December 2004 in Mainland Portugal*
From: Instituto de Meteorologia Portugal

Abundant snow at Christmas was observed in higher elevations (upper third) of **Spain**. The cities in this region, especially on the Castilian Plateau, were snow-covered on December 26-27, a beautiful spectacle that had not been seen at some places for about 30 years. But not everything was enjoyment; it also caused severe traffic problems on the roads and in the cities.

In **Italy**, some funnel clouds struck again at Sicily, and the minor islands were isolated due to very adverse sea conditions, but the worst was a flood in Sardinia (Fig. 12.2) which caused the death of 3 persons.



Fig. 12.2: *An image of the Sardinia flooding in December 2004*
From: Ufficio Generale per la Meteorologia, Italy

The mean air temperature in December in **Slovenia** was above normal (1961–1990), but only on the high mountains and in the Primorska region the temperature anomaly was significant. There were quite a number of days with a strong temperature inversion and low cloudiness in most parts of the lowland during the first and second third of December. The majority of the precipitation fell during the last third of December, while the second third of the month was almost dry with the exception of the Primorska region. Monthly precipitation was below normal in the Northeast of Slovenia, in the Prekmurje region only about 60% of the usual precipitation fell. In contrast, more than 50% above normal precipitation fell in the coastal region. The sunshine duration was below normal in Bela krajina and Novo mesto, while more than 150% of the sunshine duration normal was registered in the Ljubljana basin and Celje. In most parts of the lowland the first third of December was grey, sunny weather was rare, but the last third of December was unusually sunny everywhere. In Upper Sava valley a snow cover persisted throughout the month, whereas in most of the lowland no snow cover was observed. At Kredarica the maximum snow cover on December 28 reached 125cm.

In **Hungary**, December was 0.6°C warmer than normal, but with 80% of the normal precipitation it was one of the dry months.

The month was warm at the Adriatic coast area of **Croatia**, in some parts even very warm or extremely warm (Fig. 12.3). Some areas of that region were also wet this month. The station Šibenik registered an extremely high monthly amount of 320% of the normal which corresponds to the 99% percentile.

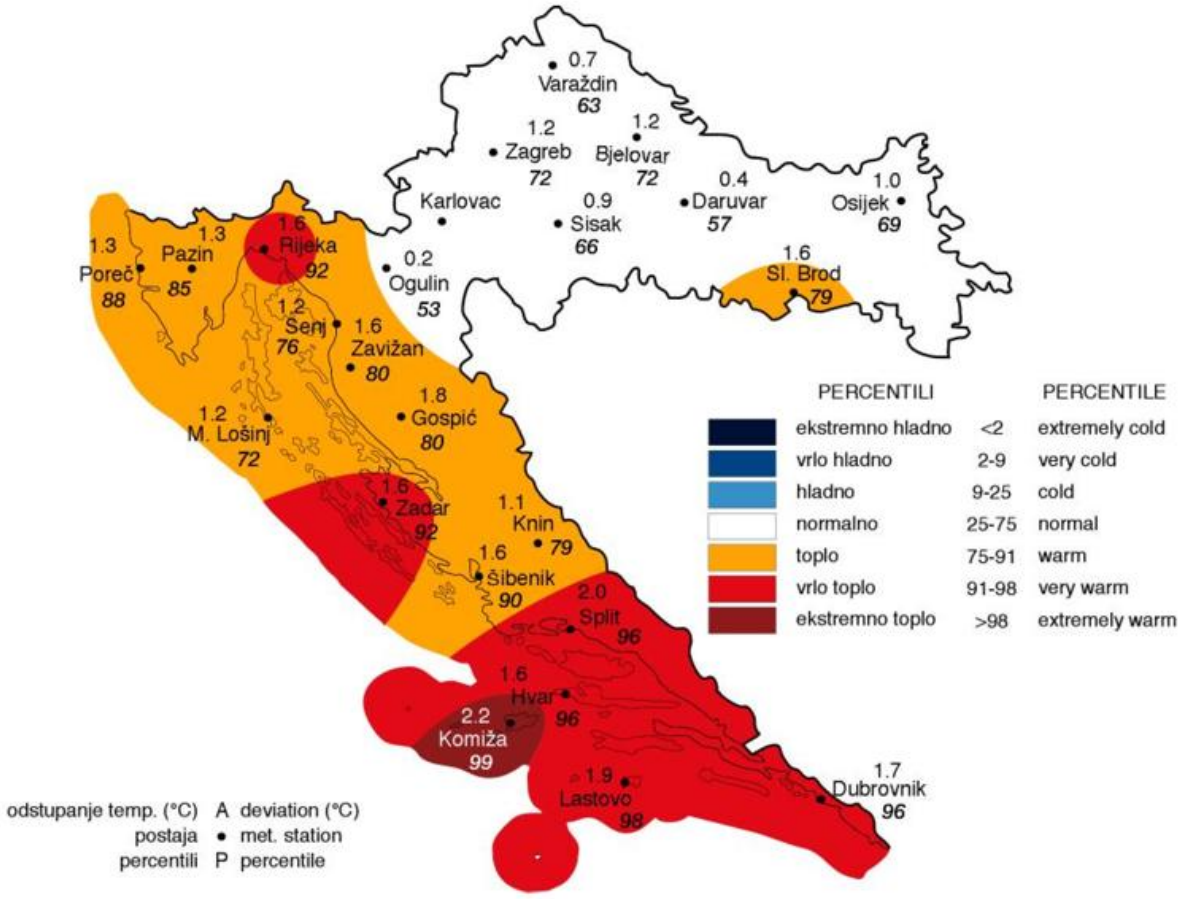


Fig. 12.3: *Monthly air temperature deviations from normal 1961–1990 (upper numbers) and percentiles (lower numbers) in Croatia for December 2004*
From: Meteorological and Hydrological Service Croatia

In **Bosnia and Herzegovina**, December was 1.3°C milder than normal on average. The month was in general wet compared to the 1971-2000 normal (145% of the normal on average). At the station Ivan Sedlo a monthly sum of 288mm (222% of the normal) was recorded, by far the highest value of the whole year at this station. Other stations (Livno, Mostar) also received more than 250mm of precipitation.

December was warmer than average in the whole country of **Serbia and Montenegro**. Especially the minimum temperatures were high. The deviation of mean minimum temperatures from normal ranged from +1.5 to +3.1°C. Precipitation quantities were lower than average in almost the whole country.

The monthly temperature mean was slightly higher than normal in **Romania**. Precipitation amounts were on average 75% of the 1961-1990 normal.

In **Albania**, a positive deviation of mean minimum temperatures from normal was recorded for December (up to 3.0°C). Precipitation amounts were lower than normal.

The mean temperature anomaly of **Republic of Macedonia** was almost +2°C in the whole territory of the country.

December was warm as well in **Bulgaria**. In terms of precipitation the amount was 110% to 230% of the normal in most of the country although it was drier in the far north-western and south-eastern regions with only 60 to 70% of the normal.

An avalanche was observed on December 14 at Artvin, **Turkey**. Heavy rain and flooding occurred on December 18 at Kas and Antalya, affecting agricultural areas, and on December 29 at Edirne. On the latter day, there was also a storm at Seferihisar, Izmir, Uluborlu and Isparata. Greenhouses were damaged, trees were broken. The month as a whole was dry with only 52mm precipitation on average (53% of the normal).

In December, the weather was quite cold and dry in **Armenia**. The monthly mean air temperature was below normal by 3-5°C. Minimum temperatures at Ashotsk reached -30°C, at Yerevan the minima were between –13 and -15 °C. The averaged precipitation amount was only 21% (8mm) of the normal. At Yerevan, not more than 2mm precipitation fell during the whole month.

On December 7 heavy showers occurred in the Pafos area of **Cyprus**. The averaged monthly precipitation amount of 75.9mm, however, was considerably lower than the long-term mean (72% of the normal). For the monthly mean temperature, the anomaly was -0.3°C.

December was colder than normal and dry in **Israel**. The northern parts of the country received only 30-35% of the rainfall average, other parts 50-80%. A significant cold period occurred on December 16-18. In many areas temperatures at night dropped below 0°C. In Yizre'el Valley (northern Israel) the minima were -3 to -4°C, the lowest since 1973.

In **Jordan**, the lowest minimum temperature recorded at Amman in 2004 was -2°C on December 17 (Fig. 12.4).

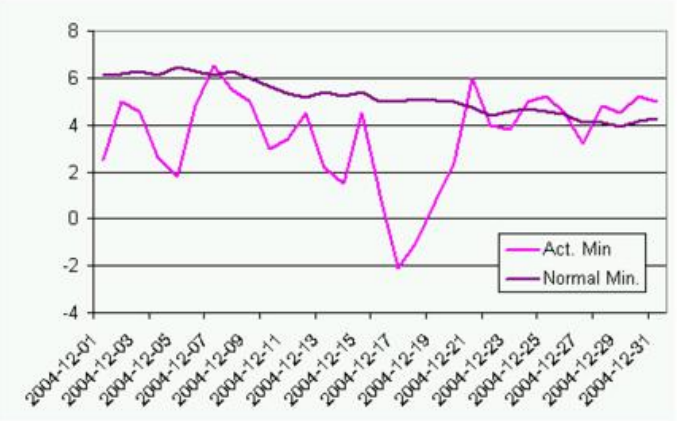


Fig. 12.4:

Daily minimum temperature in °C (Act. Min.) of December 2004 at Amman (Jordan) and corresponding normal values
From: H:K. of Jordan, Meteorological Department, Amman Civil Airport – Marka (diagram simplified).

Activities and Results of European Climate Centres

Report on ECSN activities 2004
by: Walter Kirchhofer, MeteoSwiss

- **General remarks**

The EUMETNET Council decided to continue the ECSN Programme for a third phase of three years, starting on 1 January 2004 with MeteoSwiss as Responsible Member.

The 9th ECSN Advisory Committee (EAC) Meeting took place in Dublin, Ireland, 8 - 10 September 2004. It was an interesting and fruitful meeting, also with regard to new activities, and well organised by Met Éireann.

The EUMETNET Council decided that the European Meteorological Society (EMS), in partnership with ECSN, organises the European Conference on Applied Climatology (ECAC). The first combined Conference "EMS/ECAC" took place in Nice, 26-30 September 2004. The scientific part of ECAC-2004 was managed by the ECAC Advisory Board (EAB) and the Conveners. EAB organised three Planning Meetings, in Berlin, in Toulouse and in Nice. About 250 papers had been submitted and selected by the conveners. Thanks to the efficient work done by the conveners and by the EMS Secretariat, ECAC-2004 was, with respect to climatology and its application, a success.

- **European Climate Assessment & Dataset (KNMI)**

After the successful termination of the two projects „European Climate Assessment" (ECA) and „ECSN Climate Dataset" (ECD), the follow-up project „European Climate Assessment & Dataset" (ECA&D), conducted by KNMI, is well on the way. The new website http://www.eca.knmi.nl was formally launched and presented at the ECAC conference in Nice.

- **Generate Climate Monitoring Products (DWD)**

The project "Generate Climate Monitoring Products" (GCMP) was terminated by a Final Report. European and national climate monitoring products are now available to the Members and to the public via the GCMP Internet platform http://www.gcmp.dwd.de. In order to enhance the number of participating Members, it was decided to keep the GCMP platform in a quasi operational mode. A follow-up project "EuroCLIS" is planned to be launched soon by DWD.

- **Climate Atlas of Europe (Météo-France)**

The project „Climate Atlas of Europe", based on climatological normal values for the period 1971-2000, is completed. A CD-ROM in a French and in an English version of the software has been prepared, containing the dataset from nearly 700 European weather stations, and sent to all the participating countries to make further use of this important climatological information.

- **ENSEMBLES (KNMI, MeteoSwiss)**

Within the European Integrated Project "ENSEMBLES", the project "Development of daily high-resolution gridded observational datasets for Europe" started on 1 September 2004.

- **New project activities**

The projects EuroCLIS and EuroGRID have been initiated. Based on the existing GCMP prototype a new system will be developed to provide climate monitoring products on a routine basis. The idea of a EuroGRID project is to create and to promote a rational and a quality assured climatological production of gridded data in a high resolution, based on information from the European National Meteorological and Hydrological Services (NMHSs).

Ozone Layer over Central Europe in 2004

by Wolfgang Steinbrecht, Ulf Köhler, and Hans Claude, Deutscher Wetterdienst

Above Central Europe, the annual mean ozone column in 2004 was only about 6 DU (Dobson Units) or 2% below its long-term mean. This is exemplified in Fig. 13.1, which gives the annual mean ozone columns observed since 1968 at Hohenpeissenberg in southern Germany. The 2004 ozone column follows the general pattern of stabilised ozone levels since about 1999, after the large decline from 1980 to 1997. In part, this stabilisation reflects the levelling off expected from the evolution of stratospheric chlorine (red curve for ozone changes related to EESC in Fig. 13.1). However, ozone levels in recent years have also benefited from the past 1999 to 2003 solar maximum, whereas in 2004 the solar activity decreased (see blue curve in Fig. 13.1). Another important factor, not included in Fig. 13.1, are changes of the large scale circulation over the Atlantic in the past few years. These are represented e.g. by changes in the Arctic Oscillation or North Atlantic Oscillation indices in recent years, and have contributed several Dobson Units to the improved ozone columns in the past years.

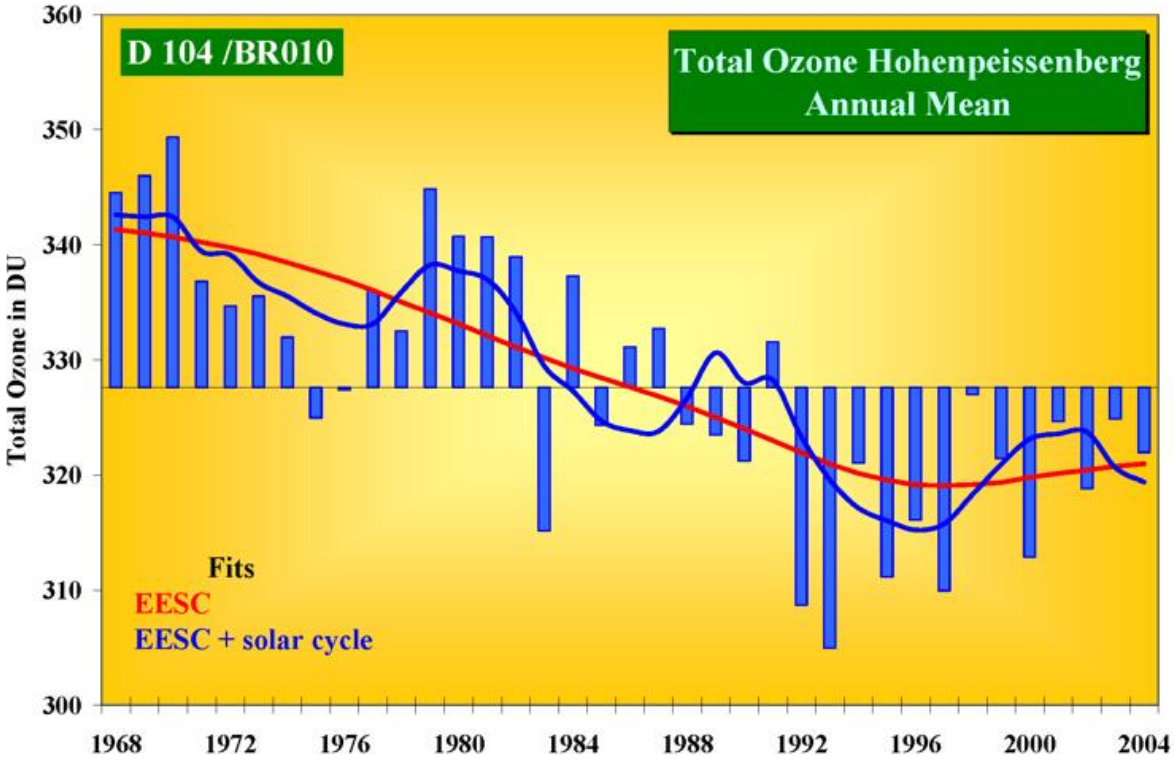


Fig. 13.1: *Annual means of total column ozone above Hohenpeissenberg since 1968. The red line shows the approximate ozone decline due to chlorine (equivalent effective stratospheric chlorine = EESC). The blue line additionally includes the approximate effect caused by the 11-year solar cycle.*

The time series of daily total ozone anomalies for 2004 is given in Fig. 13.2. Anomalies are defined by the relative deviation from the climatological long-term mean for a given day or month. Fig. 13.2 shows the typical sequence of positive and negative anomalies, alternating on a time scale of one or two weeks. Largely, these ozone variations are a consequence of tropospheric weather patterns. In late spring and early summer, substantial additional variation is introduced by air exported from the break-up of the polar winter vortex. Depending on vortex conditions during the preceding winter, this air may be ozone rich, or ozone may be chemically depleted. In 2004, polar ozone depletion in spring was quite small, compared to 2003 when depletion was large. In Fig. 13.2 this is reflected by the absence of large negative excursions in May and June, whereas total ozone levels were quite low in these two months in previous years. Still, the substantial negative anomalies observed in late April 2004 are in part caused by advection of ozone depleted air from the vortex (see also 20 km region in Fig. 13.3). Warm weather in the troposphere played an additional role. In 2004, generally low ozone columns were observed throughout much of summer, from late June to September. Low total ozone usually goes hand in hand with enhanced UV radiation. This can be particularly harmful to human health in spring and early summer, from April to June, when solar irradiation is already high, but the skin of people from Central and especially Northern Europe has not yet adjusted to enhanced UV radiation.

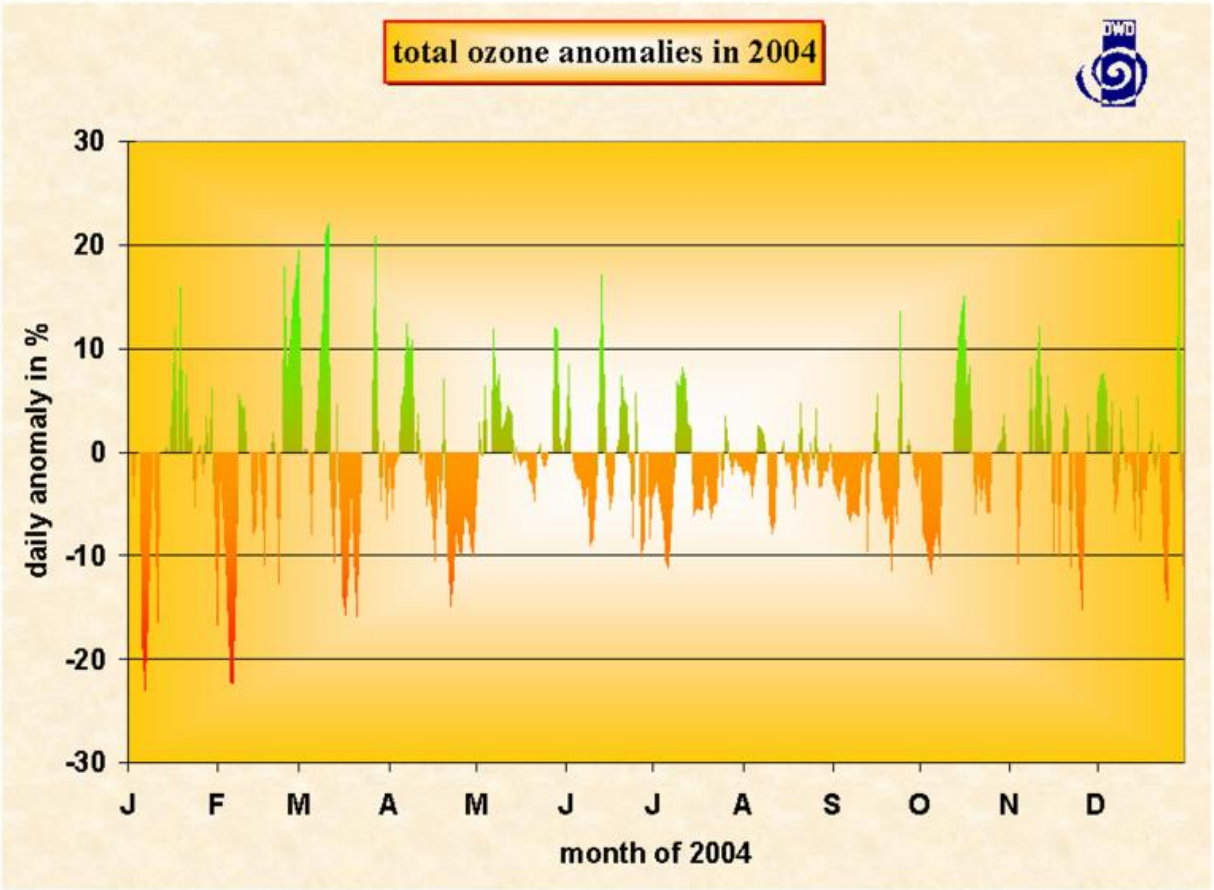


Fig. 13.2: *Relative deviation of total ozone daily means from the climatological long-term mean 1968-2004. Measurements are for the year 2004 at Hohenpeissenberg (47.8°N, 11.0°E).*

The vertical distribution of ozone anomalies in 2004 is given in Fig. 13.3. Above 20 km altitude, ozone was consistently below normal. As in previous years, the largest negative anomalies can be seen in the upper stratosphere, above 30 km. They are a consequence of chemical ozone depletion by man-made chlorine. It is expected that chlorine levels will decline over the next decades, and that ozone levels will begin to improve. Still, the very low levels observed above 30 km in November 2004 are among the lowest of the entire record since 1987.

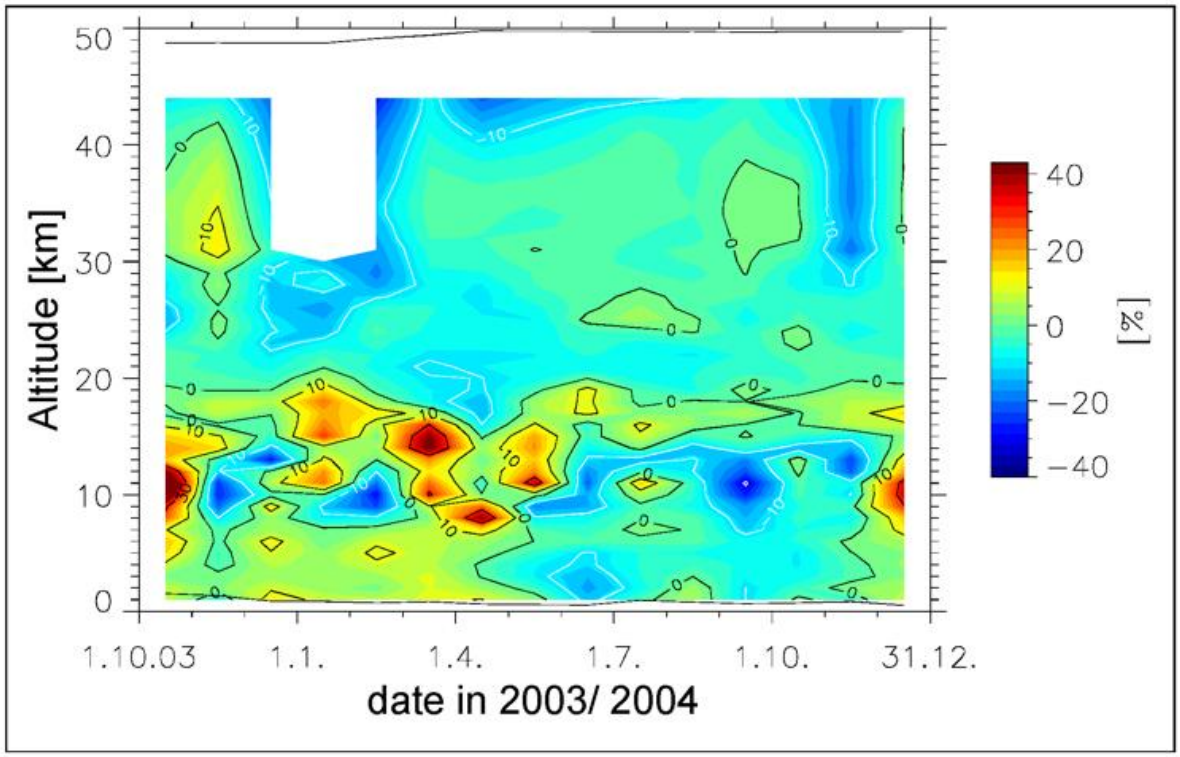


Fig. 13.3: *Relative deviation of ozone monthly means from the climatological long-term mean 1968-2004, as a function of time and altitude. Data are for the year 2003/2004 at Hohenpeissenberg (47.8°N, 11.0°E).*

Below 20 km, ozone is highly variable. The high total columns in March 2004 and the low columns from late June to September 2004 (Fig. 13.2) are associated with corresponding positive and negative anomalies in the 10 to 20 km region of the lower stratosphere (Fig. 13.3). As mentioned, ozone in this region is closely coupled to tropospheric weather and climate. A substantial contribution to the levelling out of the total column in Fig. 13.1 comes from this altitude region. It is not a sign of positive effects from chlorine reduction after the Montreal Protocol, but rather a consequence of complex coupling processes between climate and ozone changes.

To conclude, ozone levels in 2004 were within the range observed in recent years. No spectacular new developments were observed in 2004. As in previous years, neither total ozone nor upper stratospheric ozone above Hohenpeissenberg and Central Europe show clear and unambiguous signs for a beginning recovery of the ozone layer. However, 2004 was another year to show that the strong decline observed in the 1980s and 1990s has not continued in the new millennium.

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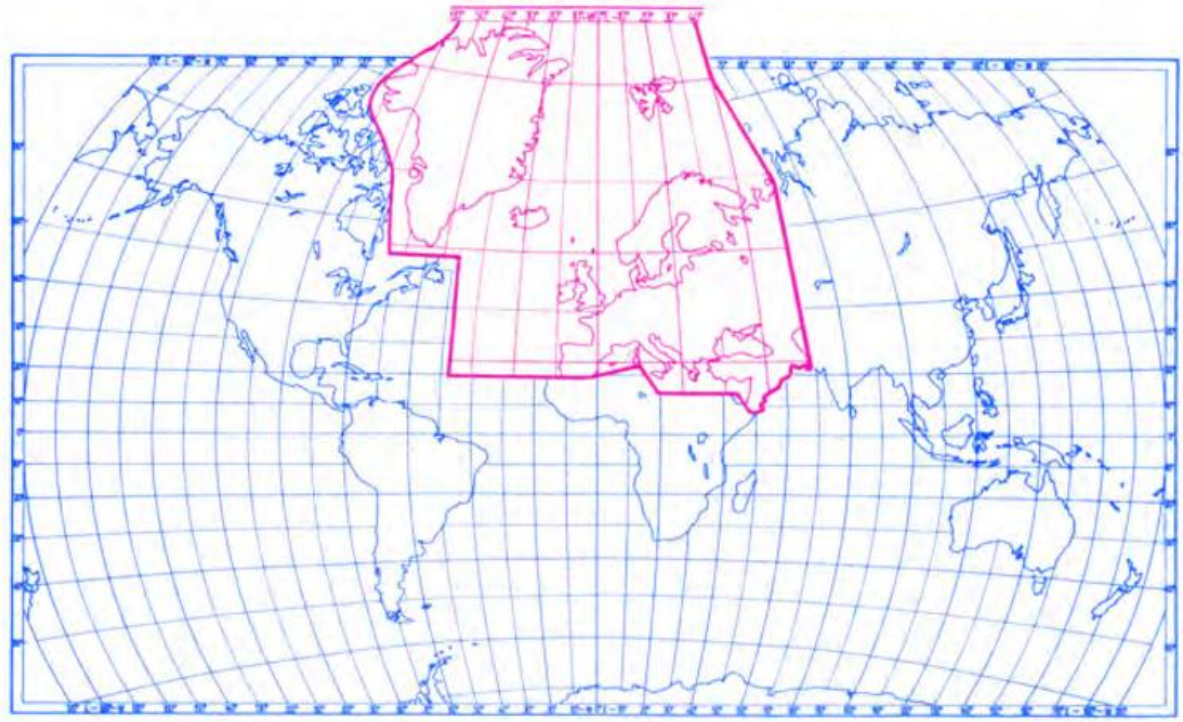

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Foreword

For the 12th time, a new issue of the Annual Bulletin on the Climate in WMO Regional Association VI is ready. It is based on valuable contributions from 37 National Meteorological and Hydrological Services of our Region.

This issue concerns 2005 which was a remarkable year for many reasons. First of all, according to the analyses of the Hadley Centre, it was the warmest year on record, averaged over the northern hemisphere, and also within our Region, it was warmer than normal nearly everywhere. The north was particularly affected. In the Arctic the anomalies of the annual mean temperature reached up to +4°C with even higher anomalies in the winter months. This is considerable and exceeded the positive anomalies of 2004. Another large area which was notable for an enormous warming was the Atlantic Ocean, where sea surface temperatures exceeded the 98th percentile. I think this is quite outstanding. Secondly, two exceptionally long lasting regional climate events affected parts of Europe very seriously: One was the extensive drought in southwestern Europe from the beginning of the year until October, and the other one, in a sharp contrast, the large precipitation amounts in southeastern Europe, especially in Romania and Bulgaria, during the summer. Thirdly, the high number of hurricanes and tropical storms in the Atlantic was another characteristic of that year. Among the 27 named tropical cyclones in the Atlantic, four of them reached our Region when they became extratropical. Out of these four, there was one which passed the south of the Iberian Peninsula and two which affected the west coast of Norway, all of them associated with considerable rainfall amounts. And last, but not least, this year was also a record year of damage reported to the insurance companies, caused by significant weather events. The list of such events this year does not only comprise those already mentioned, but also heavy storms in various parts of the Region, severe flooding in the Alpine region in August, etc.

All these significant anomalies and events were carefully documented by the contributing Members concerned and compiled reliably by the Deutscher Wetterdienst. Three special reports are included in the Bulletin too: on the annual activities of the ECSN, on the ozone trends until 2005 and a review of the August flooding in the Alpine area. The latter was prepared by the Global Precipitation Climatology Centre in Germany. Once more, all the co-ordination, the editorial review, the publishing and the distribution of the Bulletin was in the hands of our editors Dr. Peter Bissolli and Peer Hechler from the Deutscher Wetterdienst, Department Climate Monitoring. After the recent distribution of the previous Bulletin 2004, they went to enormous lengths to prepare this Bulletin 2005 within the same year of publication to reduce the delay between the end of the reporting year and distribution.

I wish to seize the opportunity to gratefully acknowledge the excellent work of the authors and thank them for their effort. I also wish to express my appreciation to the Deutscher Wetterdienst and its President who makes the resources available for this task every year. Last but not least I extend my gratitude to all those from the NMHSs of the WMO Regional Association VI who contributed to the 2005 edition of the Annual Bulletin on the Climate.



Daniel Keuerleber-Burk
President of WMO Regional Association VI

Outstanding Events and Anomalies in 2005

Temperature

- Anomalies of the annual temperature up to +4°C in the Arctic
- Warm North Atlantic in all seasons
- Cold winter in Portugal and Spain
- Warmest summer in Portugal since 1931
- Very warm autumn in northern, central and eastern Europe

Precipitation

- Extensive drought in Spain, Portugal and parts of western and southern France
- Very wet in northern Scandinavia
- Severe flooding May – August between the Adriatic coast and the Black Sea
- Severe flooding in the Alpine region in August

Sunshine

- 15-20% sunnier in many countries of northern and central Europe

Wind

- Heavy storm over northern Europe on January 7-9
- Severe winter storm in central Europe on November 25-27
- Severe storm in western France on December 1-2 (gusts up to 160 km/h)
- 2 storms over eastern Greece and the Aegean Sea with gusts >100 km/h
- 4 Atlantic tropical storms in the Region

Annual Survey

Temperature

The year 2005 was again warmer than normal nearly all over the Region. Especially in the northern countries the anomalies compared to the 1961-1990 mean were mostly higher than +1°C, locally exceeding +2°C, especially in winter. In the central and southern parts of the Region the deviations from normal were mostly less than +1°C; in and around the Mediterranean region some areas were even slightly colder than normal.

Anomalies for countries or large parts of countries (areal or station mean) also imply mainly a decrease from the north to the south and to some extent also from the west to the east (except for the coastal and marine areas): Norway +1.5°C, Sweden +1.6°C, Russia +1.6°C, Denmark +1.1°C, central England temperature +1.0°C, Ireland around +1°C, Netherlands and Luxembourg +0.9°C, France +0.5°C, Germany +0.7°C, Estonia +1.1°C, Latvia +0.6°C, Lithuania +0.9°C, Poland +0.3°C, Hungary –0.2°C, Romania –0.1°C, Cyprus +0.4°C, Portugal +0.6°C (for Luxembourg and Poland the 1971-2000 mean was taken).

In the north, 2005 was among the warmest years ever according to time series available. It was the 6th warmest year for Norway since the measurements began in 1867. The largest deviations from the mean were located in parts of Finnmarksvidda (northern Norway) and the inland parts of eastern Norway (mostly +2.0 to +2.5°C, Fig. 0.1). The annual means of the Arctic stations Svalbard airport (-3.0°C, anomaly +3.6°C) and Hopen (island 100 km southeast of Spitsbergen, -2.4°C, anomaly +4.0°C) were the highest ever registered there. The warmth affected the sea-ice cover considerably. Also in Sweden, 2005 was to be ranked among the warmest years for more than 140 years (since 1860), for Denmark it was the 6th warmest since 1874. Nuuk in Greenland was also rather mild on the yearly average with 0.3°C (5th warmest year on record) which corresponds to an anomaly of +1.7°C, and also the other stations in Greenland were all above normal; at Danmarkshavn in northeastern Greenland it was the warmest year since 1949 (Fig. 0.2). Also in the northern part of Finland unusually high annual mean temperatures of locally 1.5°C were measured which were 2.3°C above the 1971-2000 average. For the Netherlands this was the 5th warmest year since 1901, together with 1989, and the 9th consecutive year with an annual mean temperature of at least 10°C. In Belgium, the anomaly of +1.2°C in Uccle exceeded the 90% percentile.

Over large areas of the North Atlantic ocean, sea surface temperatures exceeded the 98th percentile for the year as a whole and some areas were the warmest for 156 years. Iceland, although located in the north, did not experience extremely high, but still above normal anomalies: +0.7 to +0.9°C in most areas, only +0.3 to +0.6°C in the southeast. For the Faroe Islands the temperature deviations also amounted to only +0.3°C, but even there 2005 could be placed among the 10 warmest years since 1873.

In Austria, Hungary, Slovakia, Bulgaria, Croatia, Serbia and Montenegro the mean temperature was more or less around normal or slightly below. In Belgrade, after seven warm years, the temperature dropped below normal in 2005 (Fig. 0.3). The coastal part of Montenegro was the only area of the country where it was warmer. Slovenia had a mean temperature mostly above normal, but the anomaly was less than 0.5°C, with the exception of Ljubljana where it was higher. Italy reported for 2005 a temperature decrease of about 0.5°C compared to 2004. In Portugal the maximum temperatures were exceptionally high (+1.4°C anomaly on average, 2nd highest since 1931), but the mean minima were slightly below normal for the first time in 18 years. The annual mean temperature in Portugal was above normal all over the country, especially high (>+1°C) in northern and southern inland regions (Fig. 0.4).

Among the eastern parts of the Region, the Ukraine reported an annual mean of 7.1 to 11.7°C, increasing from the north to the south, which was +0.6 to +1.4°C above normal. For Russia, 2005 was the second warmest year since 1936 (Fig. 0.5). The temperature in most parts of the Lebanon was also above normal.

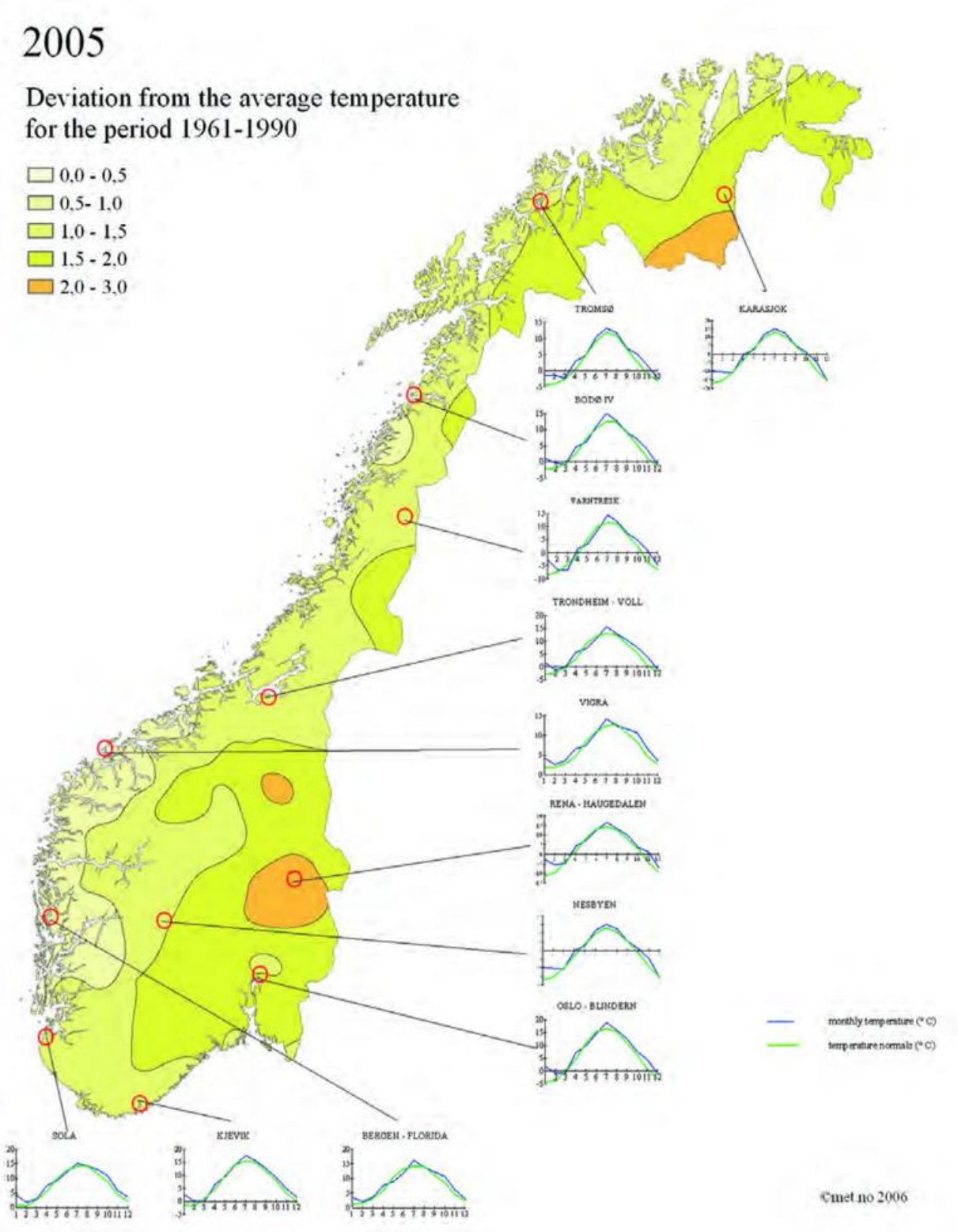


Fig. 0.1: *Temperature deviation 2005 from normal (1961-1990) in Norway*
Source: Norwegian Meteorological Institute

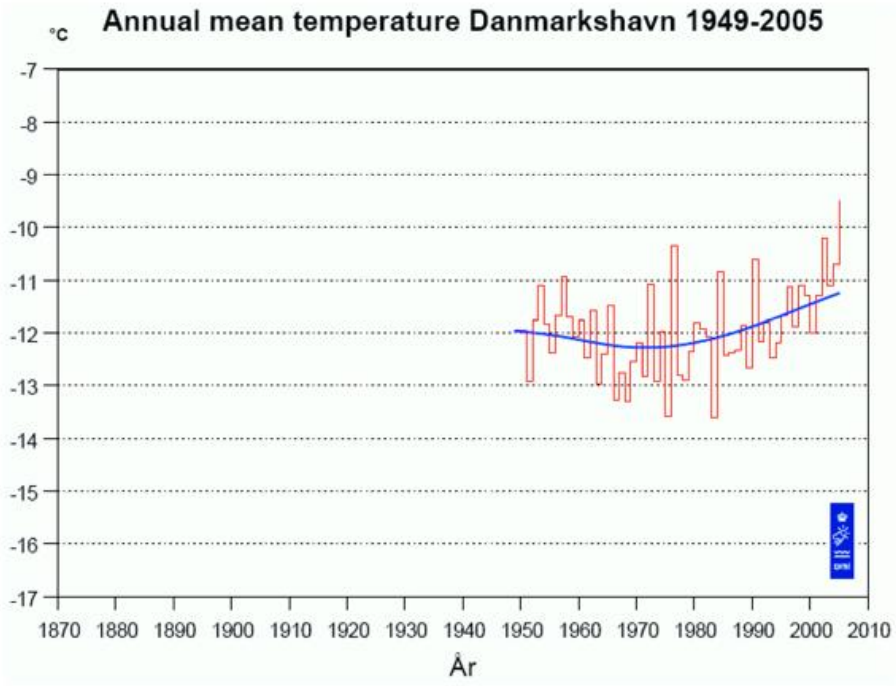


Fig. 0.2: *Annual mean temperature in Danmarkshavn (northeastern Greenland)*
Source: Danish Meteorological Institute

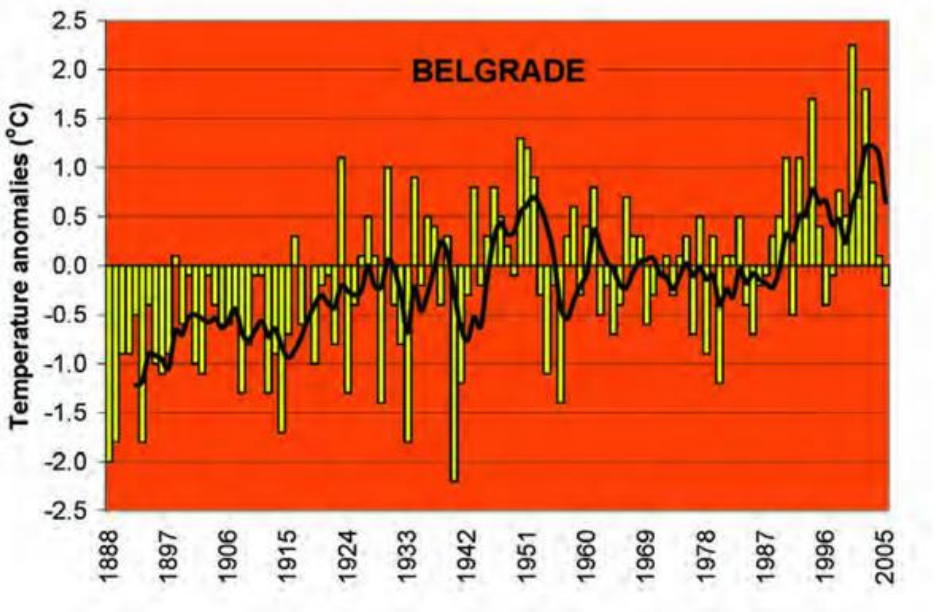


Fig. 0.3: *Annual temperature anomalies from 1961-1990 in Belgrade*
Source: Republic Hydrometeorological Service of Serbia

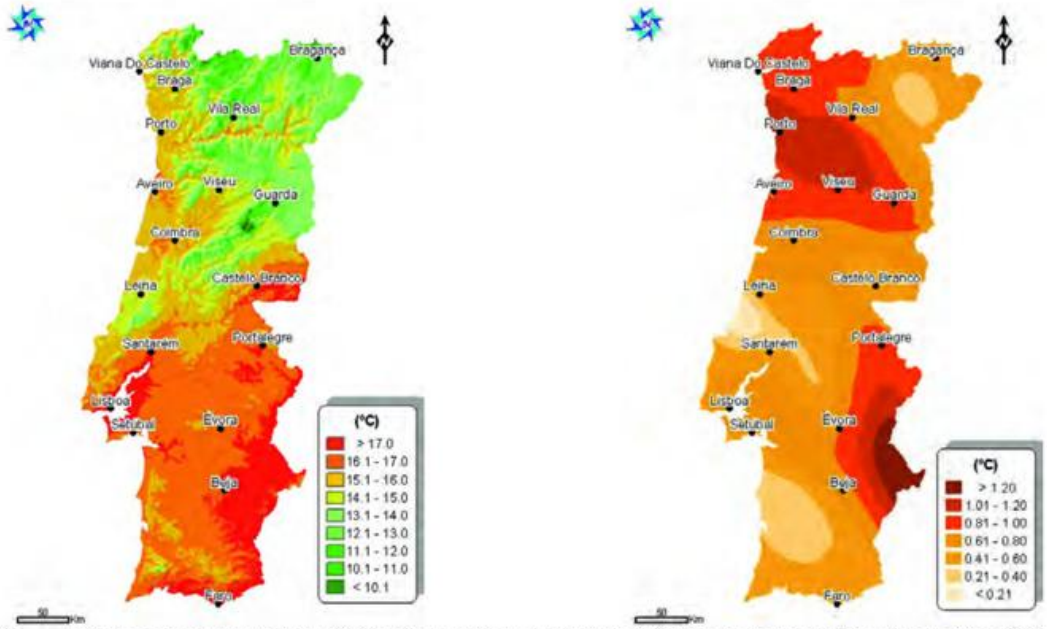


Fig. 0.4: *Mean air temperature 2005 in mainland Portugal (left) and anomalies from the 1961-1990 mean (right)*
Source: Instituto de Meteorologia, Portugal

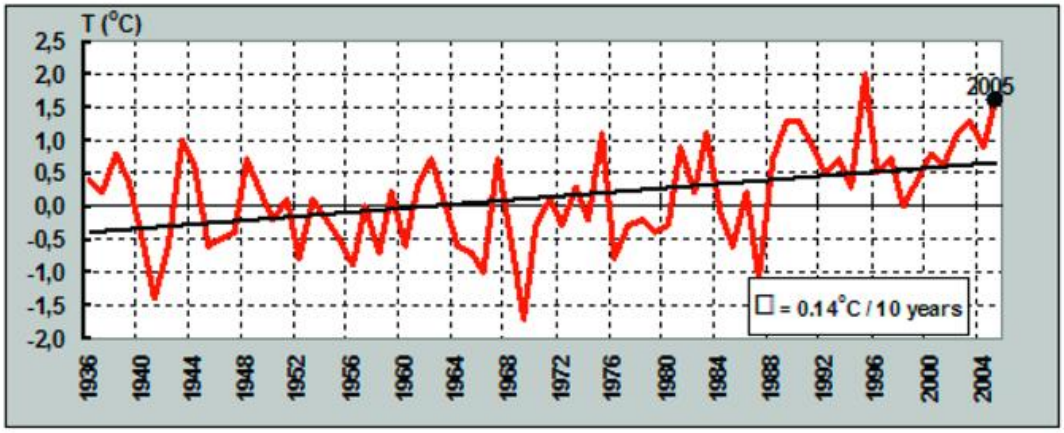


Fig. 0.5: *Anomalies of the mean annual temperature averaged over the territory of Russia 1936-2005 and linear trend*
Source: Roshydromet, Russia

Precipitation

It was a very dry year for Spain, Portugal and for western and southern France, but also for the eastern Mediterranean, in particular Cyprus and southern Turkey. Wetter than normal areas were to be detected in northern Scandinavia including most of Greenland, and partly in the south, especially in parts of Italy due to an extreme event in November and in some countries west of the Black Sea. In the rest of the Region the annual precipitation totals were mainly around normal, in northwestern central Europe mostly slightly lower, in southeastern central Europe somewhat higher.

In Portugal, the annual precipitation total was the lowest value recorded since 1931. In large parts of the country, precipitation amounts were below 60% with respect to the 1961-1990 mean and even below 50% in some northern and central regions of the country (Fig. 0.6). Also for

Spain, new records were set. At Madrid, the hydrological period November 2004 – September 2005 was the driest such period since 1859 (Fig. 0.7). For the whole of the year 2005, the annual total of 252 mm was the second lowest in Madrid after 1954. Numerous stations in the central and western parts of the Iberian Peninsula showed a similar behaviour. Severe forest fires were the consequence. This extremely extended drought persisted from the beginning of the year until October. In western France about 50% of the normal precipitation was registered (Fig. 0.8). Due to some exceptional rainfall events in northern France in July and in southern France in September, the annual amount was not so low in all parts of this country.

At Nuuk in Greenland, the annual accumulated precipitation of 1219 mm reached an extreme value of 162% of the normal. This was the wettest year there since 1958. For Norway, 2005 was the fourth wettest year since 1900. The stations Røst in the county of Nordland (northern central Norway) and Kautokeino in the county of Finnmark (northern Norway) registered new records for the annual precipitation total with 1090 mm and 534 mm, respectively, within a more than 100-year time series. The Bergen-Florida station recorded 3054 mm which was the third highest measured in the central parts of the county of Bergen since 1868. The highest reported value in Norway, however, came from the precipitation station Haukeland – Storevatn (southwestern coastal region) with 4634 mm (131% of the normal). This was not the only location with annual totals above 4500 mm (Fig. 0.9). From the Norwegian arctic stations, Jan Mayen had the highest value with 812 mm (119%).

Sweden was wet in the northern half, while in the southernmost part it was quite dry with anomalies up to 25% below average in some coastal areas. In the southeast of England the total annual precipitation was 572 mm. Thus, 2005 was the 7th driest year in the 133-year record and the driest since 1973.

Moving to the southeast of the Region, some areas with very high precipitation were to be encountered, causing severe floods and landslides. In the Balkan region, the duration of this period of high precipitation lasted from the end of March until August, first with snow, later on with rain. The yearly areal mean precipitation total of Slovakia (880 mm) was the highest since 1974. For the summer half of the year, several stations in eastern Slovakia reached extreme values (828 mm in Kokošovce was the highest total since 1931). In Hungary, the year was 20% wetter than usual. Romania was also very wet with 866.5 mm or 134% of the normal on areal average, causing widespread flooding events. Especially in the west of the country, it was the most severe flooding for 50 years. In Bulgaria, the percentages reached even higher values of 130-170% of the 1961-1990 mean, especially in the warm half of the year they were extremely high (Fig. 0.10). In contrast, some western and southern parts of the Ukraine reported only 75-85% of the normal annual precipitation. The lowest yearly amount measured there was 381mm.

Slovenia was drier than normal in the west, but wetter than normal in the east (Fig. 0.11). Parts of the Dolenjska region (western Slovenia) received about 120% of the normal. In northeastern Croatia the year was extremely wet; the station Osijek received 151% of the 1961-1990 mean. High precipitation amounts also characterised the year 2005 in almost the whole territory of Serbia (Fig. 0.12).

In the eastern Mediterranean, Cyprus reported 383 mm as annual total, which was quite low with 76% of the normal. Rainfall amounts in Israel during the 2004/05 rainy season (September 2004 – May 2005) were below average (70-90%) in the northern parts of the country, but above average (120-160%) in the southern parts.

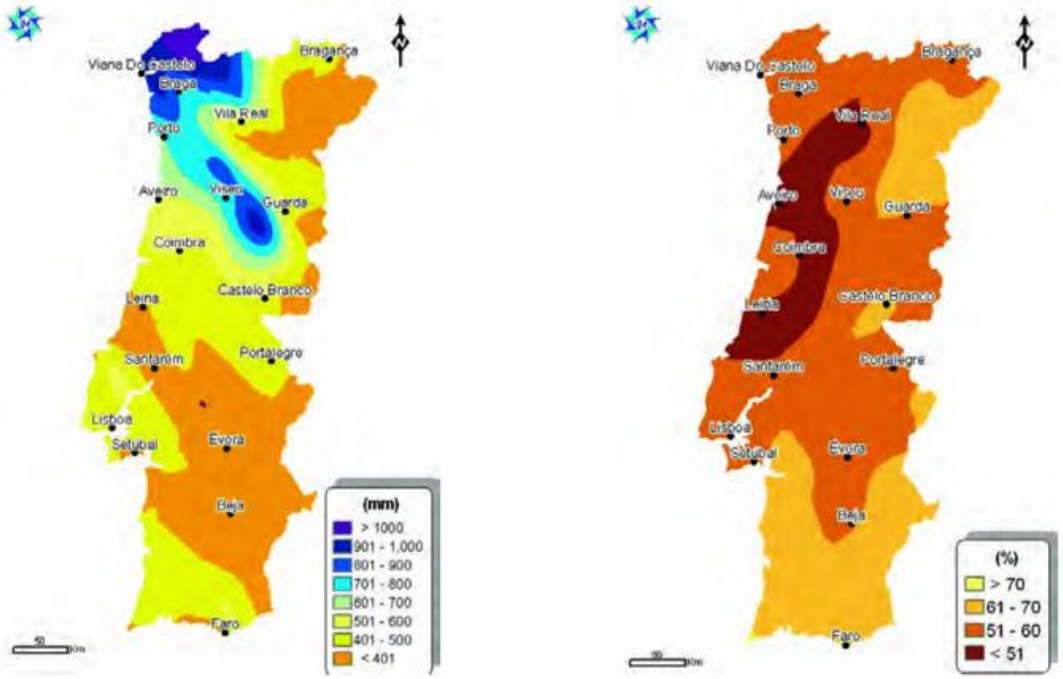


Fig. 0.6: *Total precipitation in mainland Portugal in 2005 (left) and percentages with respect to the 1961-1990 mean (right)*
Source: Instituto de Meteorologia, Portugal

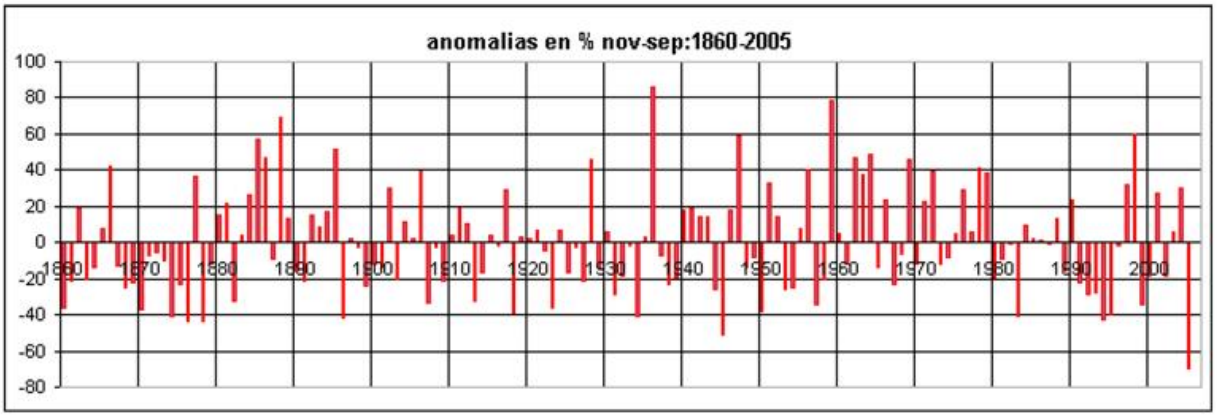


Fig. 0.7: *Precipitation anomalies in % of the long-term mean 1860-2005 at Madrid (Retiro) for the November-September period.*
Source: Instituto Nacional de Meterorologia, Spain

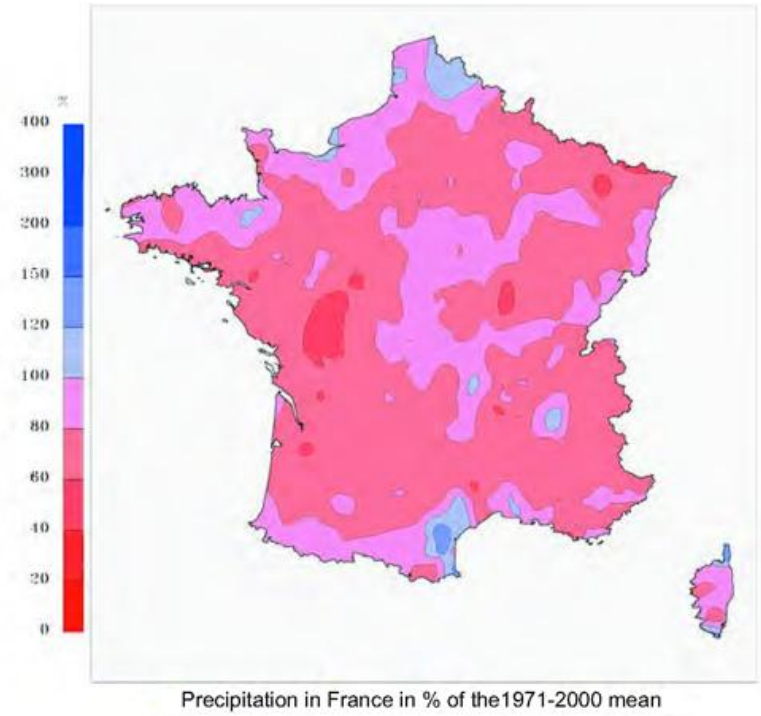


Fig. 0.8: *Annual precipitation 2005 in France in % of the 1971-2000 mean*
Source: Météo France

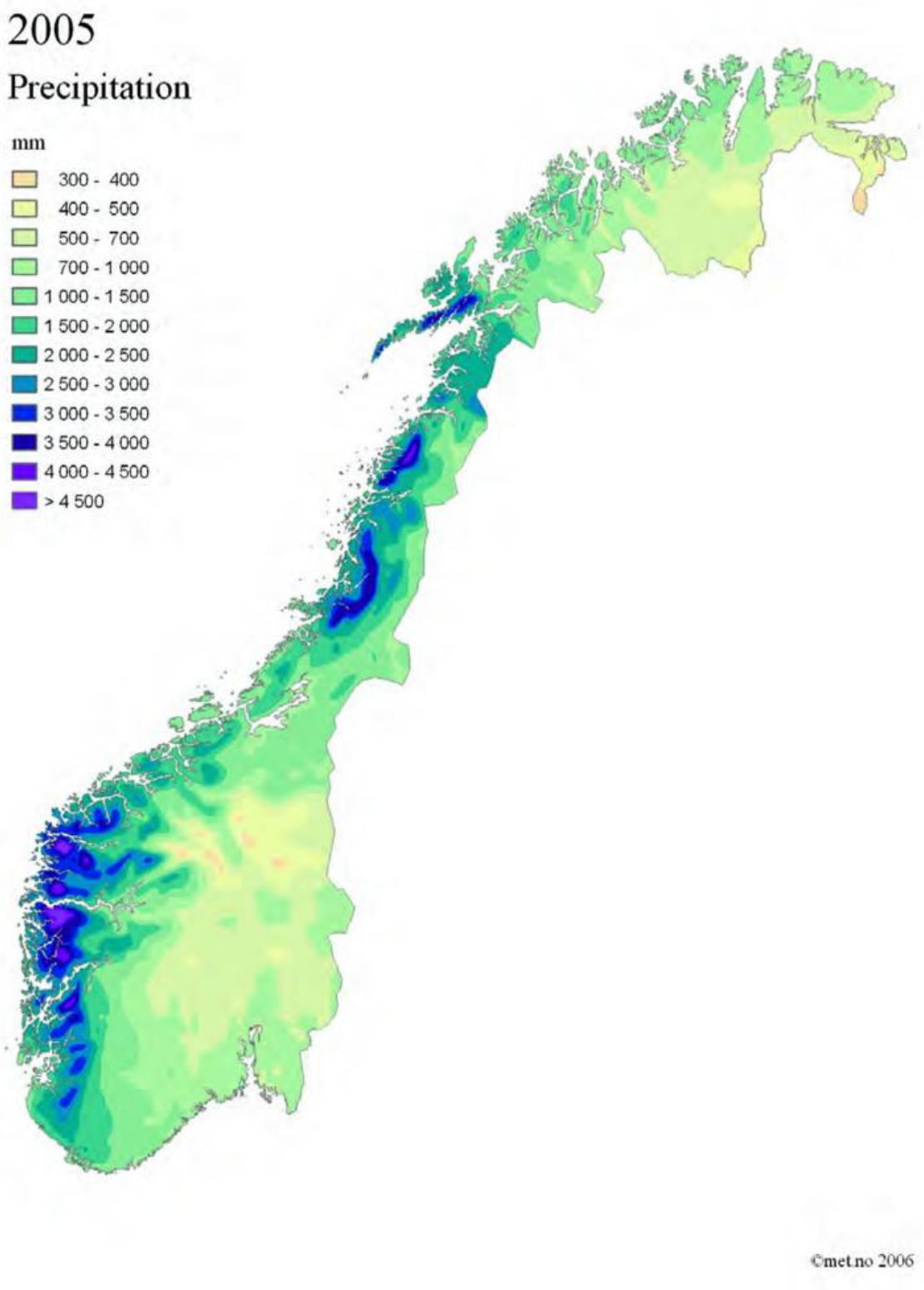


Fig. 0.9: *Annual precipitation in Norway 2005*
Source: Norwegian Meteorological Institute

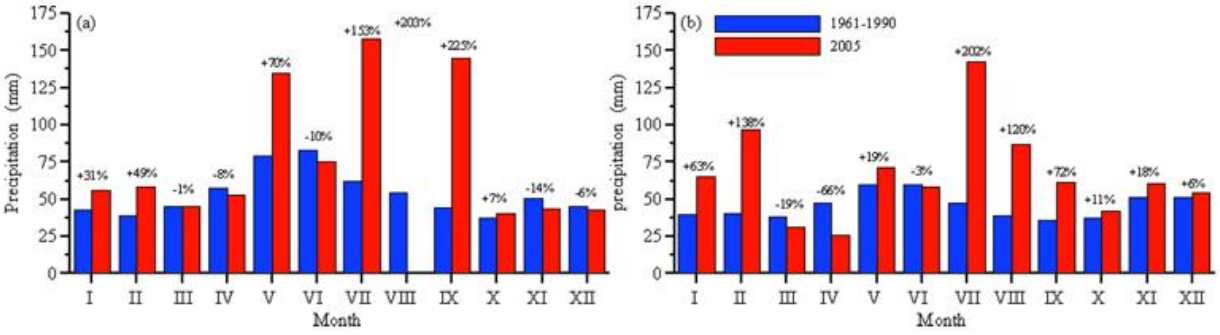


Fig. 0.10: *Monthly precipitation 2005 compared to the 1961-1990 mean in northern Bulgaria (left) and southern Bulgaria (right) with deviations in % of the 1961-1990 mean*
Source: National Institute of Meteorology and Hydrology, Bulgaria



Fig. 0.11:

Precipitation 2005 in Slovenia in % of the 1961-1990 mean
Source: Environmental Agency of the Republic of Slovenia

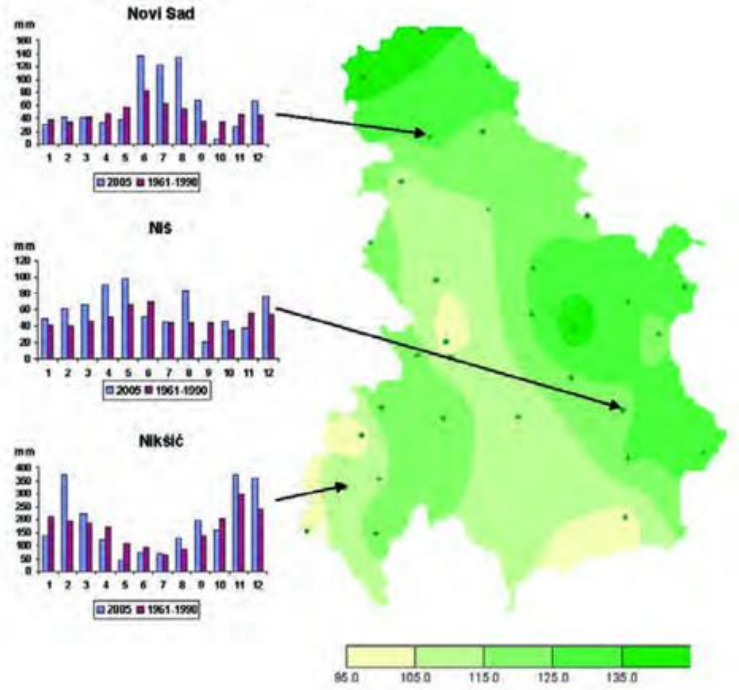


Fig. 0.12: *Annual precipitation totals 2005 as percentage of the 1961-1990 mean in Serbia and Montenegro (map on the right) and monthly totals in mm compared to the mean for 3 stations (bar diagrams on the left)*
Source: Republic Hydrometeorological Service of Serbia

Sunshine duration

2005 was unusually sunny in many countries; the duration was around 115-120% of the normal for northern and central European countries as far as reported. At Reykjavik (Iceland) this was the sunniest year since the record year of 1924, the number of sunshine hours being 1548 or 122% of the 1961-1990 mean. Denmark reported a high value of 1837 hours, corresponding to a similar percentage of 123%. For the Netherlands, 1820 hours of sunshine were registered which was 117% of the normal. Since 1901, only 6 years were sunnier than 2005. Luxembourg received even more sunshine (1905 hours, 116% of the 1971-2000 mean). Only 61 days were without sunshine, the normal value is 84.2 days. In France, the sunshine duration was also higher than normal over the whole country. In Germany, the areal mean was 1742 hours; this was 114% of the 1961-1990 mean. Thus, 2005 became the 5th in line of the sunniest years there since the middle of the 20th century. Austria reported durations in the range of 105-120% of the normal.

An exception was Ireland where the annual sunshine totals were generally close to normal or slightly lower (88-102%, Fig. 0.13). In Slovenia, the sunshine duration also was mostly close to normal, only in the Ljubljana basin and Celje was there significantly more sunny weather than on average of the reference period 1961-1990 (111 and 117%, respectively).

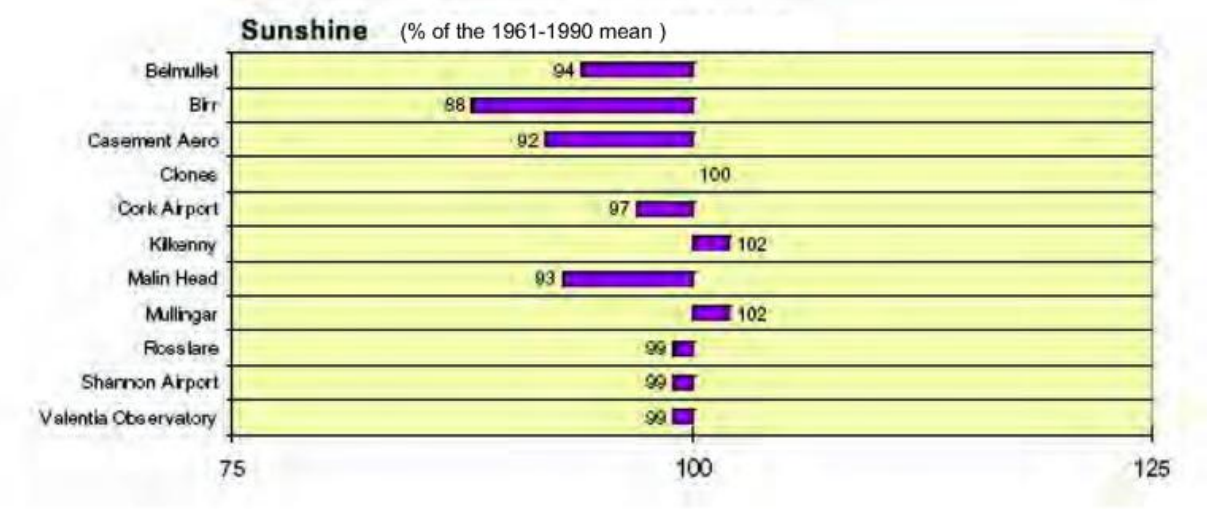


Fig. 0.13: *Sunshine duration 2005 as percentage of the 1961-1990 mean for some stations in the Republic of Ireland.*
Source: Met Éireann, Ireland

Wind

From the beginning of the year until the middle of February, several storms passed over northern Europe and caused severe damage. The highest wind speed in 2005 in Norwegian waters was measured at the Ekofisk field (southern part of the North Sea) on January 8 with 105 km/h. This storm also passed over Sweden, Denmark, Germany and Finland. In Sweden, a mean wind speed of 119 km/h was reached on the same day at the coastal station Hanö in Blekinge; the highest gust was 151 km/h. Germany reported gusts of 156 km/h that day in Kiel in the north of the country. Finland experienced the heaviest storm at the end of October; the highest measured mean wind speed was 97 km/h over the southern coastal waters. The annual number of storm days with a 10-minute mean wind speed >72 km/h, however, was 25 in Finland which was a usual amount. In late summer, a large number of small tornadoes was observed in Finland, more than ever before. Other countries reported several tornadoes too (see monthly survey).

Some severe storms occurred in western and central Europe. Brittany in western France was hit by a severe storm on December 1-2. The gusts reached 120-160 km/h at the coasts of Finistère. On November 25-27, a strong winter storm caused a lot of damage in Germany. In particular, power lines were affected by freezing rain, snow and gusts. Some days later, on December 15-16, another storm passed over Germany with gusts up to 148 km/h on mountains in the east of the country. The maximum mean wind speed in Luxembourg amounted to 87 km/h on February 12.

For the south of the Region, Greece reported storms with gusts around 100 km/h or more on January 16-17 and February 15, both over eastern Greece and the Aegean Sea. In the Lebanon, a wind maximum of 119 km/h was registered in spring, 101 km/h in autumn.

The year 2005 was also notable for being the most active Atlantic hurricane season on record. Some hurricanes even encroached on the Atlantic part of the Region: Maria (September 11), Nate (September 12), Ophelia (September 21) and Vince (October 10).

Seasonal Survey

Temperature

In all seasons, it was mostly warmer than normal within the Region, areas slightly colder than normal appeared only temporarily.

Winter 2004/05 was particularly mild over northern and eastern Europe and the southern part of the North Atlantic (anomalies > +1°C). The greatest positive anomalies (> +3°C) were registered in northern Scandinavia. For Norway, the mean seasonal temperature anomaly was +3.5°C, in parts of eastern Norway the winter was 5.5-6.5°C above normal. Parts of Svalbard experienced the warmest winter ever registered there. In the east, the anomaly for Poland was

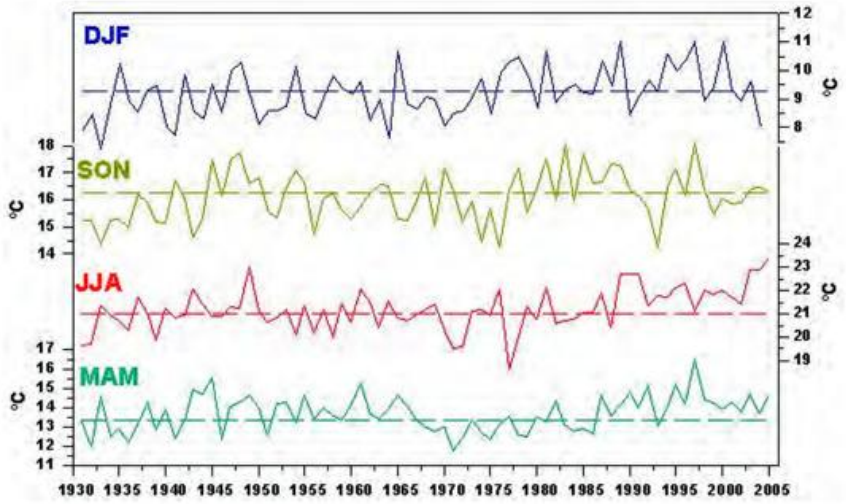


Fig. 0.14: *Mean seasonal temperatures in mainland Portugal 1931-2005*
Source: Instituto de Meteorologia, Portugal

+0.9°C. The temperatures in the remaining parts of the Region were mainly around normal or below. Germany reported a mean anomaly of +0.4°C. In France, the mean seasonal temperature was around normal in the northwest and southeast, but 1 to 2°C below normal in other regions. In Austria, regions with negative anomalies (down to -1°C) could be found in western and central parts of the country. In Portugal, this winter was the 8th coldest since 1931

(anomaly -1.1°C, Fig. 0.14). Such a cold winter had not occurred in Portugal since 1970. A similar case in southwestern Spain: in this region, the winter was the coldest for 34 years with an anomaly of -1.4°C from the long-term mean. This was clearly in contrast to the positive anomalies of the winters before (Fig. 0.15).

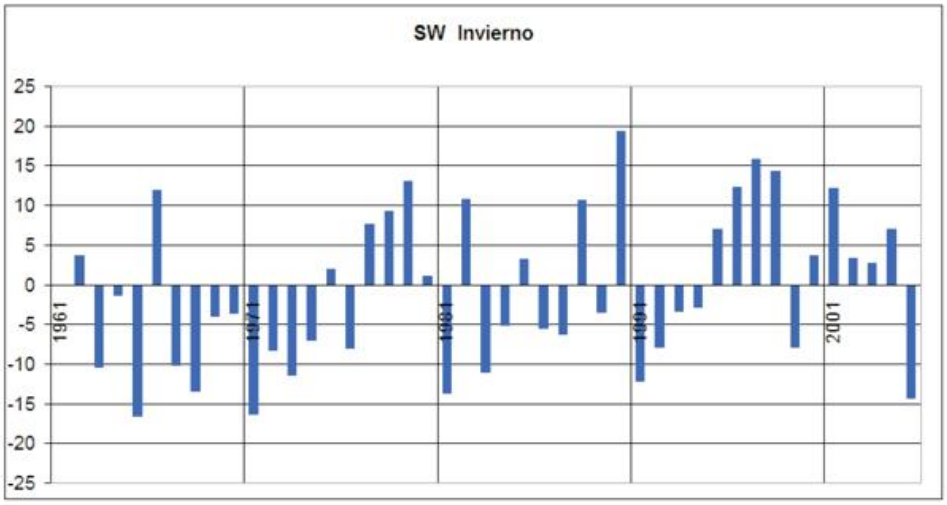


Fig. 0.15: *Mean temperature anomalies in winter in southwestern Spain in 1/10°C from the long-term mean 1961-2005*
Source: Instituto Nacional de Meteorologia, Spain

Spring 2005 was still warm over the North Atlantic and the warm air masses extended from the Atlantic to western central Europe. In France, anomalies of 1 to 2°C above normal were registered in some regions. Germany had an anomaly of +0.8°C. In the other parts of the Region the seasonal temperature was mainly around normal, in the east partly slightly below (e.g. Lithuania -0.6°C, Poland -0.4°C). Anomalies in Norway were not higher than +1.2°C.

Summer 2005 showed a continuation of large positive anomalies over the North Atlantic and significantly in western and southwestern Europe. For Portugal, this was the warmest summer since 1931 (anomaly +2.4°C, Fig. 0.14). In France, the summer temperatures were 1 to 2°C above normal except in the northeast. Scandinavia also had a warm summer, but not outstandingly. The mean anomaly for Norway was +0.5°C. In the more northern parts, the anomalies were higher; at the airport on Svalbard the anomaly was +2.0°C, the highest since 1912. For Russia, this summer was the 4th warmest since measurements began; the mean anomaly amounted to +1.1°C. In the southeast of the Region (eastern Mediterranean and east of it), positive anomalies exceeded the 90% percentile. For example, Israel had a warmer summer than normal; it was warmer than the summer of 2004, but less warm than the summers of 1998-2002. The other parts of the Region had temperatures slightly above normal (e.g. Germany +0.4°C, Poland +0.5°C).

Autumn 2005 had again large positive temperature anomalies especially over northern Scandinavia and Russia. The mean anomaly of Norway was +2.1°C. Russia reported anomalies up to +2.7°C; this was the warmest autumn for Russia since 1900 (Fig. 0.16). In Denmark, it was the second warmest autumn since 1874. The North Atlantic, the North Sea and western Europe remained very warm (anomalies > +1°C). In the Netherlands, this autumn was the warmest for at least three centuries (Fig. 0.17). In Germany, it was the 5th warmest autumn since 1901 (+1.3°C anomaly, spatial distribution Fig. 0.18). Eastern central Europe also registered positive anomalies of this magnitude (e.g. Lithuania +1.4°C, Poland +1.2°C). The southern parts of the Region had temperatures around normal.

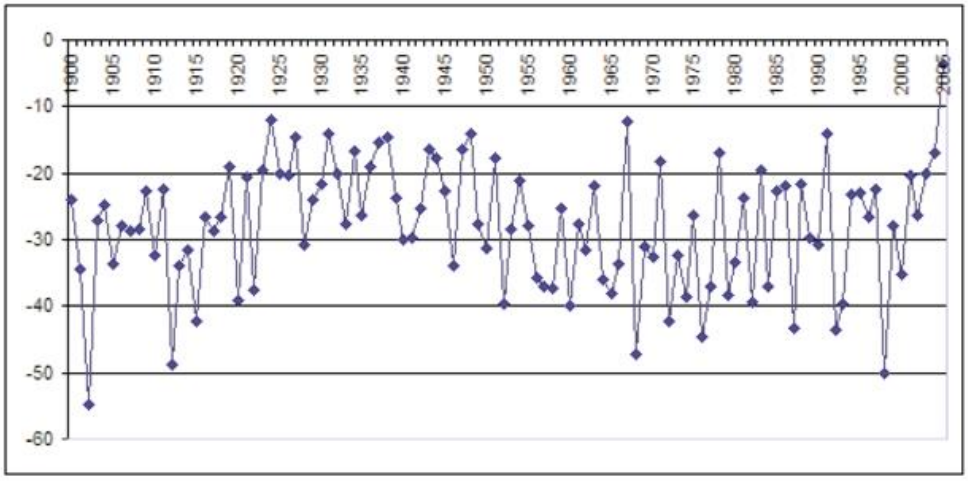


Fig. 0.16: *Mean autumn temperatures of the Russian territory 1900-2005*
Source: Roshydromet, Russia

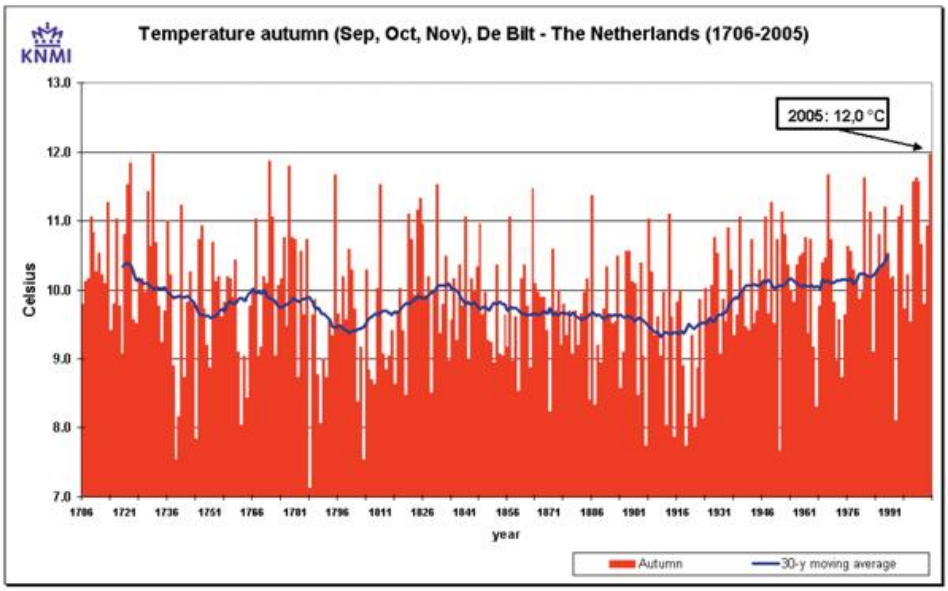


Fig. 0.17: *Mean autumn temperatures in De Bilt (Netherlands) 1706-2005 and 30-year moving averages.*
Source: Koninklijk Nederlands Meteorologisch Instituut (KNMI)

Precipitation

Winter 2004/05 was dry in most parts of western and especially southwestern Europe, but also in Slovenia, in Turkey and east of the Mediterranean. For Portugal, this winter was the driest since 1931 (Fig. 0.19). In Slovenia, less than 50% of the normal fell in the Upper Soča valley and on the Trnovska plateau. Most parts of northern and eastern Europe were wetter than normal. The precipitation for Norway as a whole was 130% of the normal. Parts of western Norway received more than 200%, being the wettest ever registered; e.g. Bergen-Florida measured 208 mm (209% of the normal), the highest amount since 1867/68. Western Russia had a lot of snow. In most of central Europe the precipitation totals were around normal. In Austria, the winter was rather dry in the west and south (50-80% of the normal), but rather wet in the north and east (120-160%). Some areas near the central Mediterranean (e.g. Italy, Greece) were also very wet.

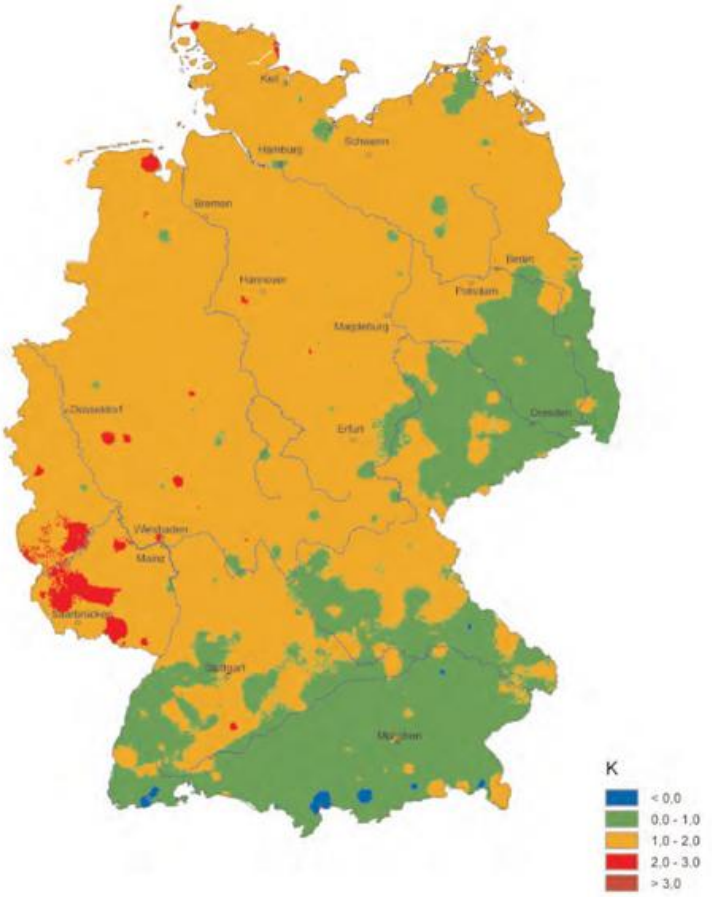


Fig. 0.18: *Mean autumn temperature anomalies 2005 from the 1961-1990 mean in Germany*
Source: Deutscher Wetterdienst

Spring 2005 was dry around the whole of the Mediterranean and most of western Europe. In Portugal, this was the 4th driest spring since 1931 (Fig. 0.19). In the north of the Region, Norway reported a seasonal total of 120% of the normal, in parts of the northern county of Finnmark 200-300%. The station Kautokeino in Finnmark measured 105mm (269% of the normal) which was the highest spring amount since 1895. Larger parts of eastern Norway received less precipitation than normal. Eastern Europe was mostly wetter than on the average. The seasonal mean for Lithuania was 120% of the normal. In central Europe the seasonal totals were mainly around normal. Austria was drier than normal in the south and west, but wetter (up to 180% of the normal) in the rest of the country. Most of the territory of Slovenia received less precipitation than normal.

Summer 2005 showed a continuation of the drought period which was severe especially over southwestern Europe. Forest fires were very frequent in Portugal and Spain. For Portugal, this was the 3rd driest summer since 1931 (Fig. 0.19). In the north of the Region, some northern counties of Norway were wet with a precipitation total of 150-175% of the normal, and also in Finland it rained more than usual. Lithuania reported 126% of the normal. Central and north-eastern Europe had mostly totals around normal, except in the Alpine region where it was wetter due to a severe flooding in August. In parts of western Austria, precipitation amounts reached up to 160% of the normal. In the east of Europe, some very dry areas were to be encountered, e.g. in the Bashkiria region of Russia there was a drought, which was the severest for about 30 years. In southeastern Europe, mainly between the Adriatic coast and the Black Sea, a larger area of wetter than normal precipitation was to be identified. In this area, also some severe

flooding occurred. About one half of the territory of Slovenia received at least 120% of the seasonal normal. In Hungary, this summer was one of the rainiest for about a century, the seasonal precipitation amount was 1.5 - 3 times more than normal (Fig. 0.20).

Autumn 2005 was dry in most of northern, eastern and central Europe. Germany reported an annual mean of 78% of the normal, Poland less than 60%. In large parts of Austria, 50-100% of the normal seasonal precipitation fell, only some regions in the west and south of the country were wet (up to 130% of the normal). In Latvia, this autumn was the 13th driest for the last 80 years (68% of the normal). From Russia, a seasonal total of 88 mm was reported for Moscow;

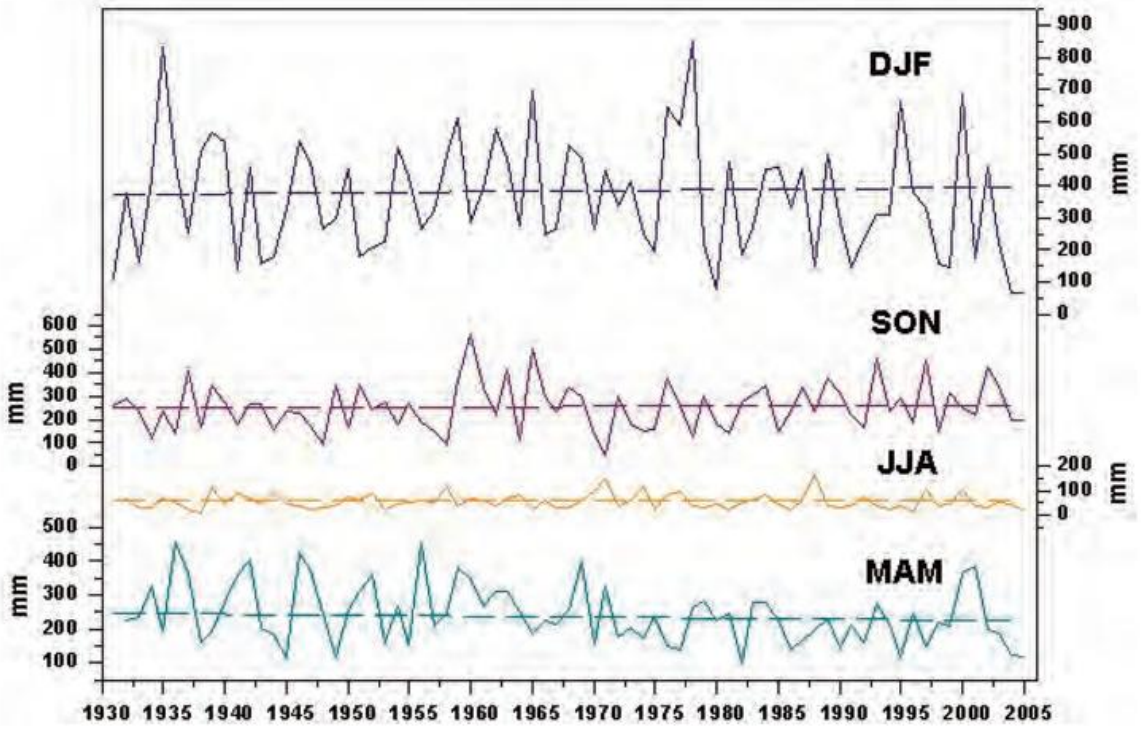


Fig. 0.19: *Seasonal precipitation totals in mainland Portugal 1931-2005*
Source: Instituto de Meteorologia, Portugal

this was the driest autumn since 1975. However, some parts of the northern Norwegian counties received 150-185% of the normal precipitation. In the south of the Region some wet areas were to be found north of the Mediterranean.

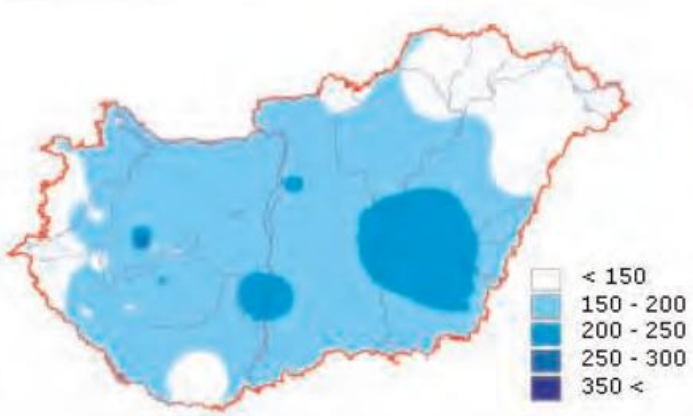


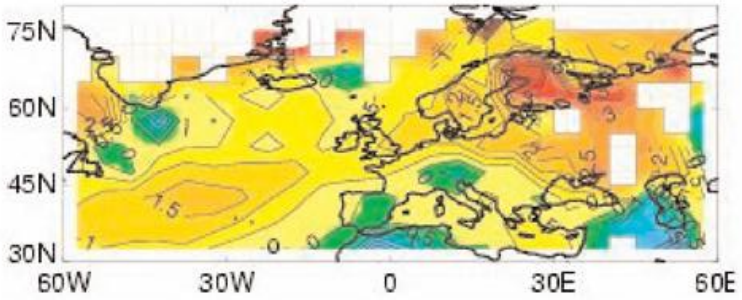
Fig. 0.20: *Summer precipitation 2005 in Hungary in % of the 1961-1990 mean*
Source: Hungarian Meteorological Service

Seasonal Maps

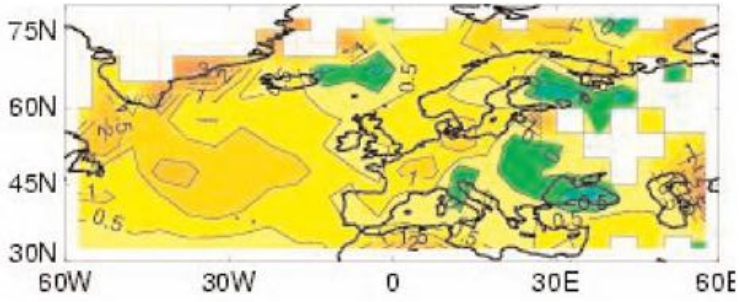
Surface temperature anomalies

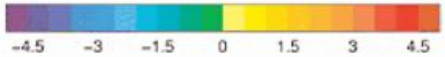
Source: Hadley Centre of Climate Prediction and Research, U.K.

December 2004 - February 2005

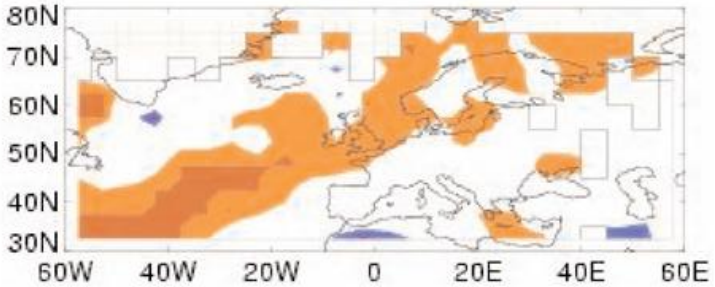


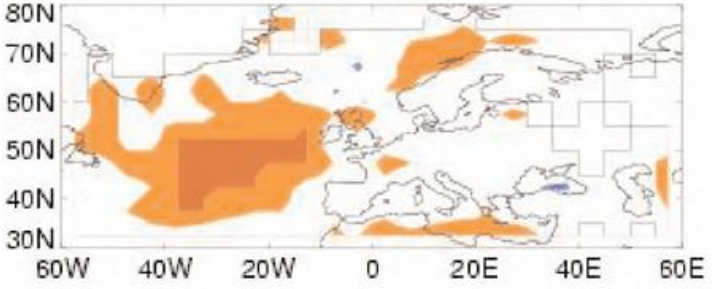
March 2005 - May 2005





Deviations from normal in °C







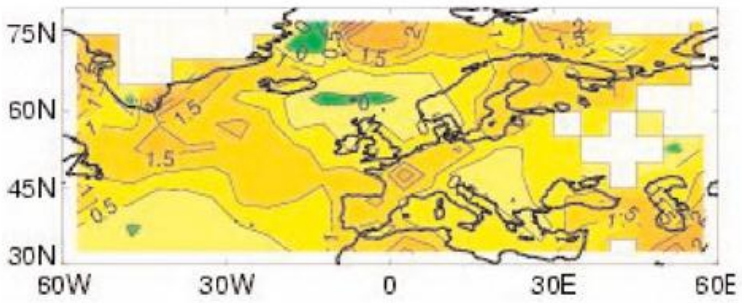
Percentiles (anomalies fitted to gamma distribution)

Reference period: 1961-1990

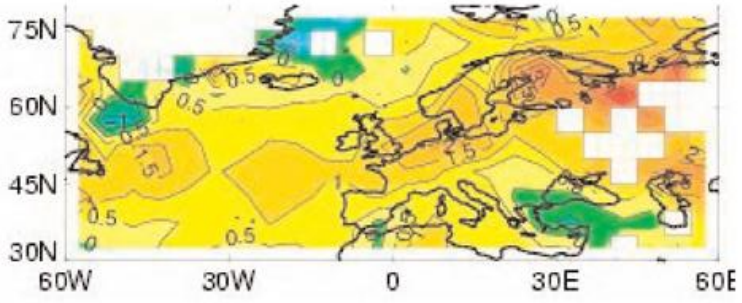
Surface temperature anomalies

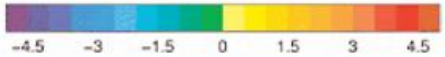
Source: Hadley Centre of Climate Prediction and Research, U.K.

June 2005 - August 2005

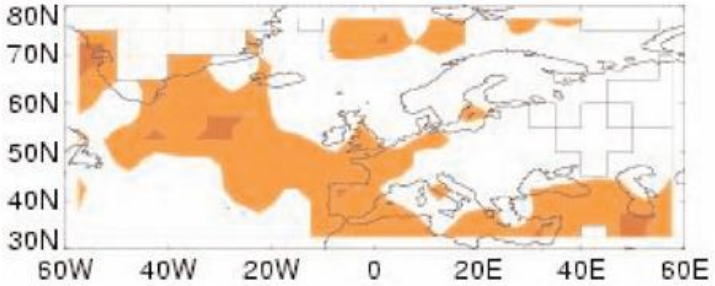


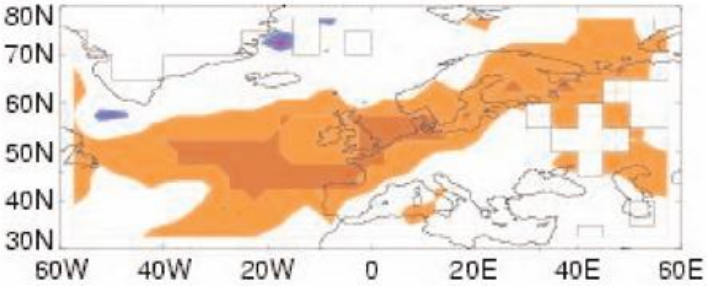
September 2005 - November 2005





Deviations from normal in °C







Percentiles (anomalies fitted to gamma distribution)

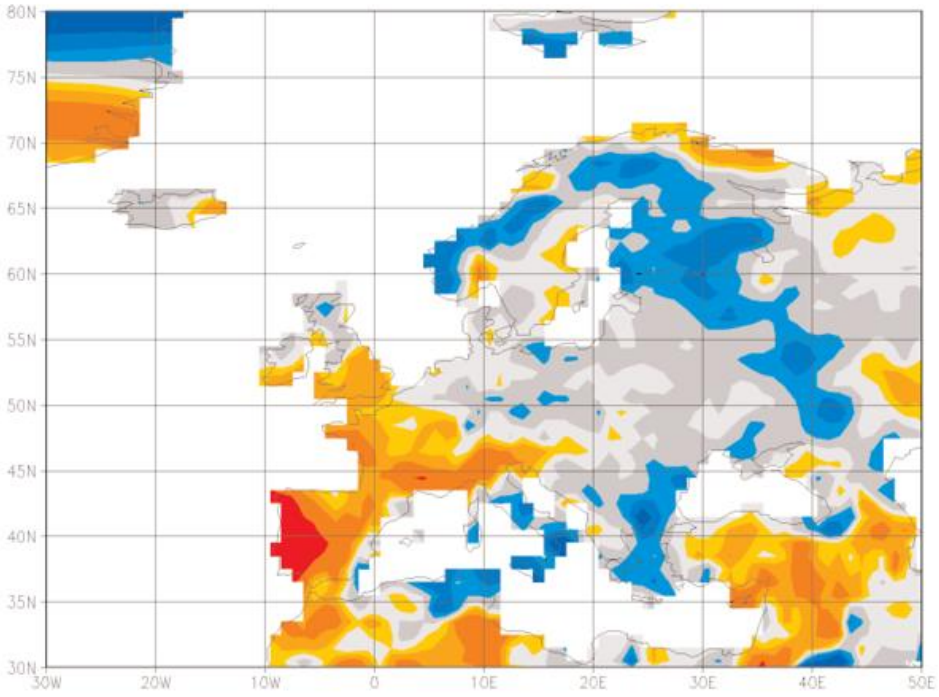
Reference period: 1961-1990

Precipitation in percent of normal

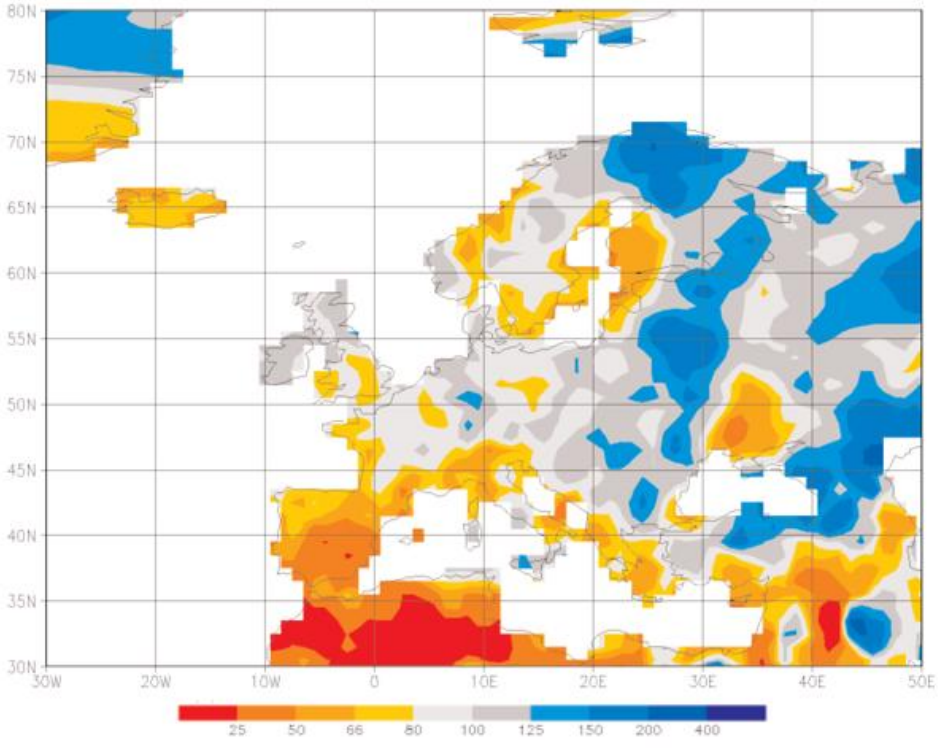
Gauge-based Analysis 1.0 degree, reference period: 1961-1990

Source: GPCC / Deutscher Wetterdienst, Germany

December 2004 - February 2005



March 2005 - May 2005

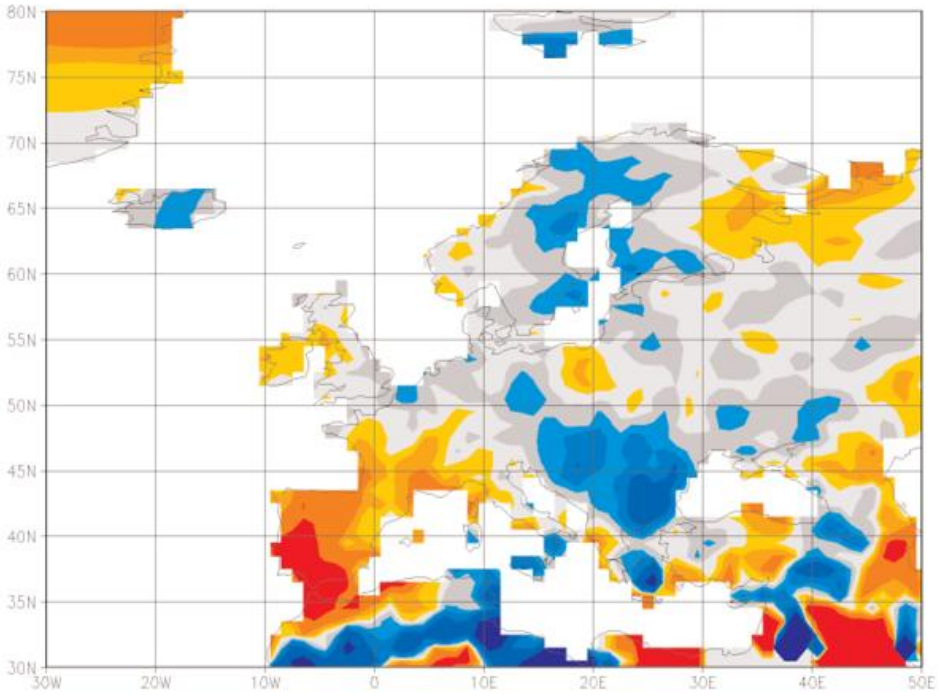


Precipitation in percent of normal

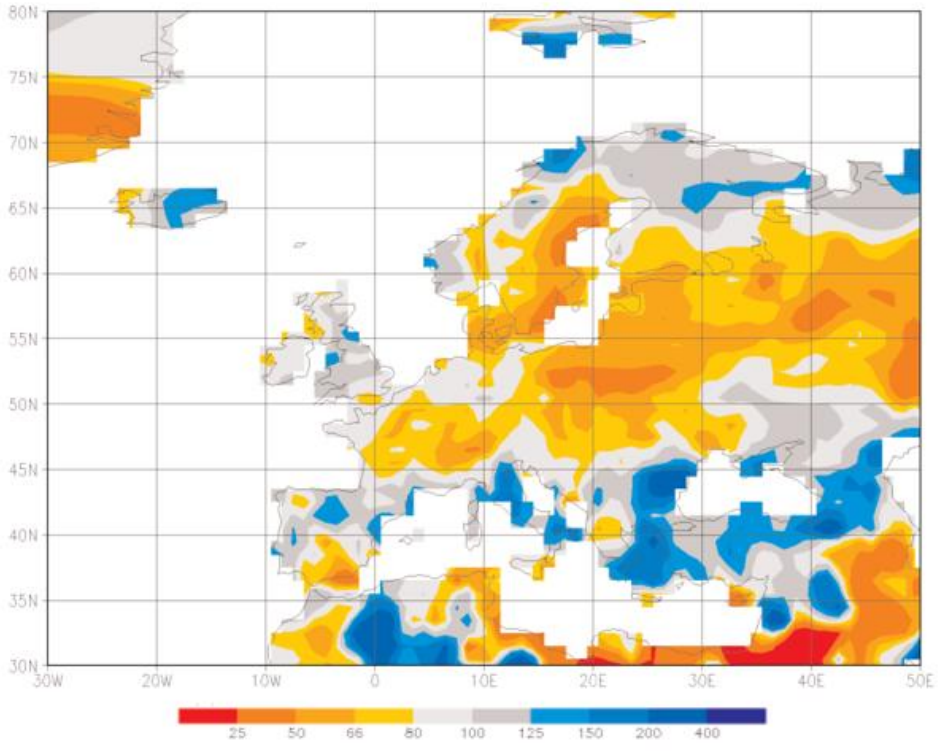
Gauge-based Analysis 1.0 degree, reference period: 1961-1990

Source: GPCC / Deutscher Wetterdienst, Germany

June 2005 - August 2005



September 2005 - November 2005



Monthly and Annual Tables

Temperature and precipitation values with deviations from the 1961-1990 means
(some stations have shorter reference periods)

WMO No.	Station	January 2005 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	February 2005 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard	-7,5	7,9	12	-2	-6,9	8,8	6	-13
01025	Tromsø	-1,1	2,9	100	19	-1,3	2,4	148	62
01492	Oslo-Blindern	1,7	6,0	36	-13	-0,9	3,1	10	-26
02196	Haparanda	-5,4	6,7	81	37	-7,8	3,5	37	5
02485	Stockholm	1,3	4,1	50	11	-1,6	1,4	38	11
02974	Helsinki-Vantaa	-1,2	5,7	105	64	-5,7	1,1	18	-13
03091	Aberdeen	5,6	2,9	43	-38	4,2	1,3	55	4
03772	London-Heathrow	6,9	2,7	22	-30	5,1	0,6	20	-15
03967	Casement Aerodrome	6,8	2,2	75	11	4,8	0,2	48	-1
04030	Reykjavik	-0,2	0,3	66	-10	1,5	1,1	105	33
04320	Danmarkshavn	-16,6	6,5	11	0	-16,3	8,0	14	3
04360	Angmagssalik	-4,5	3,0	200	88	-3,8	3,9	129	38
06186	København-Landb.	3,6	3,1	38	-13	0,7	0,2	24	-7
06260	De Bilt	5,3	3,1	53	-13	2,4	-0,1	73	24
06447	Uccle	4,7	2,1	44	-23	2,4	-1,1	81	28
06590	Luxembourg	1,8	1,8	51	-20	-0,4	-1,5	57	-5
06660	Zürich	0,5	1,1	35	-34	-1,1	-1,8	49	-21
06700	Genève	1,3	0,3	48	-21	0,6	-1,9	35	-35
07510	Bordeaux	6,5	0,7	32	-68	4,5	-2,6	38	-48
07650	Marseille	6,0	-0,7	3	-44	5,1	-2,8	0	-54
08222	Madrid	5,8	-0,3	0	-46	5,3	-2,2	41	-3
08314	Mahon / Menorca	9,8	-0,7	41	-25	8,6	-2,1	64	7
08495	Gibraltar	12,8	-0,6	0	-121	12,5	-1,3	269	169
08515	St. Maria / Acores	15,4	1,0	54	-46	13,8	-0,2	84	-2
08535	Lisboa	10,6	-0,8	0	-110	10,5	-1,8	10	-101
10384	Berlin-Tempelhof	3,1	3,3	54	11	-0,3	-1,1	40	6
11035	Wien-Hohe Warte	1,8	2,5	59	21	-0,9	-2,2	77	35
11518	Praha-Ruzyne	0,8	3,2	25	2	-3,1	-2,3	26	3
11903	Slica	-3,2	0,7	50	6	-5,8	-4,7	58	14
12160	Elblag	1,4	3,8	50	3	-2,1	0,1	17	-8
12375	Warszawa-Okecie	0,9	4,2	34	12	-3,1	-1,1	34	13
12843	Budapest-Lorinc	0,5	2,1	18	-14	-1,9	-3,0	42	10
13274	Beograd	1,7	1,3	52	3	-1,3	-4,0	84	40
14015	Ljubljana	0,1	1,2	3	-79	-0,3	-1,7	44	-36
14445	Split	7,5	0,1	14	-69	5,4	-2,7	84	16
14654	Sarajevo	-0,9	0,0	64	-7	-2,8	-4,3	175	108
15420	Bucuresti	0,6	3,0	61	21	-2,2	-2,1	58	22
15614	Sofia	0,6	2,2	40	13	-1,6	-2,1	52	19
16158	Pisa	5,3	-0,8	32	-43	4,4	-2,7	55	-18
16597	Luqa / Malta	11,1	-1,1	36	-53	10,6	-1,8	83	22
16716	Athens (Hellinikon)	9,9	-0,3	87	42	9,1	-1,4	47	-1
16754	Heraklion / Kreta	12,2	0,2	136	46	11,4	-0,7	71	-6
17040	Rize	8,3	2,0	134	-83	7,1	0,5	139	-34
17062	Istanbul-Goztepe	7,1	1,5	140	41	6,1	0,2	135	68
17130	Ankara / Central	3,5	3,4	19	-28	2,5	0,6	27	-9
17170	Van	-3,3	0,9	34	-1	-3,3	0,1	27	-7
17609	Larnaca	12,7	1,2	143	78	11,6	-0,1	21	-36
22113	Murmansk	-6,9	4,8	20	-13	-7,1	4,1	14	-8
26038	Tallina	-0,6	4,9	81	36	-5,0	0,7	22	-7
26629	Kaunas	-0,3	4,9	48	9	-5,5	-1,2	18	-13
26730	Vilnius	-0,9	5,2	54	13	-5,8	-1,0	27	-11
26850	Minsk	-1,4	5,5	38	-2	-6,2	-0,4	33	-1
27595	Kasan	-7,6	5,5	33	0	-12,1	-0,6	32	4
27612	Moskva	-3,0	6,3	98	53	-8,9	-1,2	43	6
33345	Kiev	-0,6	5,0	50	3	-5,1	-0,9	62	16
33837	Odessa	2,9	4,6	25	-17	-1,8	-0,8	95	54
34300	Charkov (Kharkiv)	-0,7	6,2	47	3	-6,2	-0,5	42	10
34880	Astrahan'	-1,2	4,3	11	-4	-4,3	0,7	10	0
35188	Akmola	-14,3	1,5	9	-8	-19,1	-3,3	4	-10
37789	Yerevan	-4,5	-1,3	37	8	-2,0	-1,0	13	-25
40080	Damascus	6,6	0,7	17	-12	7,7	-0,2	11	-13
40100	Beyrouth	14,7	1,1	198	-24	14,5	1,0	185	49
40180	Tel Aviv (Airport)	14,3	2,0	138	-11	13,6	0,7	116	18
40265	Mafraq	8,2	1,0	24	-10	8,0	-0,7	36	5
60030	Las Palmas / Gr. Can	17,1	-0,4	15	-2	16,3	-1,3	103	81

WMO No.	Station	March 2005 Temp. mean	March 2005 (°C) dev.	March 2005 Prec. total	March 2005 (mm) dev.	April 2005 Temp. mean	April 2005 (°C) dev.	April 2005 Prec. total	April 2005 (mm) dev.
01008	Svalbard	-16,9	-2,2	22	1	-9,1	2,6	5	-7
01025	Tromsø	-2,2	0,0	60	-4	3,2	2,5	53	-7
01492	Oslo-Blindern	-0,8	-0,6	25	-21	7,0	2,4	30	-12
02196	Haparanda	-8,0	-1,2	13	-22	1,4	1,9	60	31
02485	Stockholm	-1,5	-1,6	13	-13	6,9	2,3	11	-19
02974	Helsinki-Vantaa	-6,3	-3,4	7	-27	4,4	1,5	12	-25
03091	Aberdeen	6,1	1,6	51	-7	7,4	1,1	58	5
03772	London-Heathrow	8,2	1,7	44	-3	10,4	1,5	30	-15
03967	Casement Aerodrome	7,9	2,0	15	-35	8,4	1,0	47	-4
04030	Reykjavik	3,7	3,2	37	-45	4,2	1,3	77	19
04320	Danmarkshavn	-20,6	2,8	5	-12	-14,9	2,4	12	2
04360	Angmagssalik	-1,3	6,9	97	9	-1,3	2,8	67	-6
06186	København-Landb.	1,9	-0,7	25	-17	8,3	1,7	7	-35
06260	De Bilt	6,5	1,5	50	-13	10,4	2,4	63	11
06447	Uccle	7,2	1,7	39	-15	10,7	1,9	46	-11
06590	Luxembourg	5,1	1,1	25	-45	9,9	2,4	48	-13
06660	Zürich	5,6	1,5	48	-22	9,3	1,3	140	51
06700	Genève	6,8	1,5	40	-41	10,5	1,5	120	54
07510	Bordeaux	9,4	0,6	38	-38	12,6	1,3	90	18
07650	Marseille	9,4	-0,8	13	-31	13,6	0,4	81	33
08222	Madrid	10,9	0,9	10	-23	14,3	2,1	14	-40
08314	Mahon / Menorca	10,7	-0,9	26	-29	13,9	0,6	23	-28
08495	Gibraltar	14,7	-0,3	97	22	17,3	1,1	3	-57
08515	St. Maria / Acores	15,1	0,5	201	122	16,0	0,8	58	3
08535	Lisboa	14,0	0,3	40	-29	15,9	0,8	25	-39
10384	Berlin-Tempelhof	3,6	-0,6	17	-20	10,4	1,8	12	-29
11035	Wien-Hohe Warte	4,0	-1,3	19	-22	11,2	1,0	29	-21
11518	Praha-Ruzyne	1,8	-1,2	10	-18	9,8	2,1	12	-26
11903	Slica	0,5	-2,5	23	-19	9,9	1,4	90	43
12160	Elblag	0,1	-2,0	49	14	8,3	1,5	15	-27
12375	Warszawa-Okecie	0,0	-2,0	39	11	9,0	1,2	22	-10
12843	Budapest-Lorinc	4,5	-1,1	17	-12	11,8	0,7	103	65
13274	Beograd	5,8	-1,4	34	-16	12,6	0,2	55	-4
14015	Ljubljana	5,7	0,3	46	-52	10,7	0,8	119	10
14445	Split	9,9	-0,5	50	-25	14,3	0,4	82	16
14654	Sarajevo	2,8	-2,3	74	4	9,7	0,3	70	-4
15420	Bucuresti	3,1	-1,7	30	-8	10,5	-0,8	35	-11
15614	Sofia	3,9	-0,7	44	6	10,4	0,5	38	-12
16158	Pisa	8,8	-0,7	50	-26	11,9	-0,6	44	-35
16597	Luqa / Malta	13,4	0,0	8	-33	15,5	0,0	15	-8
16716	Athens (Hellinikon)	12,6	0,2	16	-28	15,7	-0,3	1	-24
16754	Heraklion / Kreta	14,0	0,6	41	-15	16,3	0,0	10	-20
17040	Rize	7,5	-0,4	254	107	12,0	0,4	133	32
17062	Istanbul-Goztepe	7,5	0,0	45	-17	12,4	0,4	18	-31
17130	Ankara / Central	6,2	0,1	68	32	11,6	0,4	79	31
17170	Van	2,5	1,4	59	16	8,9	1,6	56	2
17609	Larnaca	14,6	1,3	16	-33	18,1	0,7	19	8
22113	Murmansk	-7,8	-1,0	23	3	-0,7	1,2	38	17
26038	Tallina	-5,5	-3,3	7	-22	4,6	1,2	3	-33
26629	Kaunas	-3,4	-3,0	49	14	7,5	1,7	37	-5
26730	Vilnius	-3,8	-3,2	52	13	7,3	1,6	29	-17
26850	Minsk	-3,9	-2,5	69	27	7,6	1,6	26	-16
27595	Kasan	-7,9	-2,6	69	43	5,8	1,2	26	-10
27612	Moskva	-6,0	-3,8	40	6	7,1	1,3	49	9
33345	Kiev	-1,6	-2,3	52	13	10,3	1,6	68	19
33837	Odessa	2,4	-0,2	19	-12	9,5	0,5	3	-31
34300	Charkov (Kharkiv)	-2,9	-2,6	25	-2	10,4	1,5	11	-25
34880	Astrahan'	1,1	-0,2	18	2	11,0	-0,1	63	38
35188	Akmola	-3,2	4,9	24	10	5,9	1,0	18	-4
37789	Yerevan	5,3	0,2	59	18	13,5	1,9	78	27
40080	Damascus	12,6	1,6	0	-17	16,8	1,3	6	-5
40100	Beyrouth	16,9	1,8	34	-86	19,3	1,5	17	-34
40180	Tel Aviv (Airport)	15,9	1,0	29	-33	19,5	1,3	3	-20
40265	Mafraq	12,6	1,1	12	-17	17,1	1,3	13	3
60030	Las Palmas / Gr. Can	18,3	-0,1	17	7	19,6	0,9	2	-4

WMO No.	Station	May 2005 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	June 2005 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard	-1,2	2,5	5	-1	4,5	2,3	2	-8
01025	Tromsø	5,0	0,1	57	9	10,2	0,9	102	49
01492	Oslo-Blindern	9,7	-1,1	99	47	14,5	-0,7	41	-24
02196	Haparanda	5,5	-0,6	59	28	13,8	1,0	54	13
02485	Stockholm	11,0	0,3	55	25	15,1	-0,5	66	21
02974	Helsinki-Vantaa	10,3	0,4	61	26	14,2	-0,7	78	34
03091	Aberdeen	9,3	0,3	64	5	13,1	1,0	43	-10
03772	London-Heathrow	13,1	0,6	20	-31	17,9	2,2	33	-18
03967	Casement Aerodrome	10,4	0,3	57	-1	15,1	2,0	25	-25
04030	Reykjavik	5,7	-0,6	14	-30	10,5	1,5	40	-28
04320	Danmarkshavn	-3,6	3,0	22	18	1,9	1,2	10	5
04360	Angmagssalik	1,0	0,4	10	-47	5,8	1,7	41	-11
06186	København-Landb.	12,2	0,2	52	9	15,0	-1,1	53	-1
06260	De Bilt	12,6	0,3	54	-7	16,8	1,6	52	-16
06447	Uccle	13,4	0,5	60	-11	18,3	2,6	54	-25
06590	Luxembourg	12,9	1,1	80	-1	18,0	3,1	38	-44
06660	Zürich	13,7	1,5	119	14	18,3	2,8	112	-13
06700	Genève	15,3	2,1	76	-2	20,5	3,8	52	-39
07510	Bordeaux	16,9	2,3	16	-61	21,7	3,9	32	-24
07650	Marseille	19,0	1,9	49	7	24,0	3,1	34	6
08222	Madrid	19,2	3,2	5	-36	25,1	4,4	6	-20
08314	Mahon / Menorca	18,3	1,5	10	-27	22,7	1,9	1	-13
08495	Gibraltar	20,3	1,8	4	-31	22,0	0,9	0	-11
08515	St. Maria / Acores	16,7	0,0	57	27	19,7	1,0	14	-8
08535	Lisboa	18,6	1,2	19	-20	22,8	2,6	1	-20
10384	Berlin-Tempelhof	14,1	0,2	78	22	17,2	-0,2	30	-45
11035	Wien-Hohe Warte	15,8	1,0	49	-12	19,1	1,1	44	-30
11518	Praha-Ruzyne	13,7	1,0	81	4	16,4	0,5	65	-8
11903	Slica	14,6	0,9	51	-13	17,1	0,5	16	-69
12160	Elblag	12,4	-0,5	68	27	14,9	-0,5	44	-50
12375	Warszawa-Okecie	13,7	0,3	60	1	16,0	-0,6	48	-24
12843	Budapest-Lorinc	17,2	1,2	61	6	19,8	0,7	64	1
13274	Beograd	17,7	0,5	47	-24	20,3	0,2	95	5
14015	Ljubljana	16,3	1,7	97	-25	19,5	1,7	84	-71
14445	Split	20,4	2,0	28	-28	23,8	1,6	17	-34
14654	Sarajevo	14,7	0,6	110	28	16,8	-0,1	79	-12
15420	Bucuresti	16,8	0,1	77	7	18,3	-1,9	82	5
15614	Sofia	15,3	1,0	101	28	17,8	0,1	104	32
16158	Pisa	17,2	0,9	52	-7	22,1	2,3	20	-24
16597	Luqa / Malta	20,1	1,0	1	-6	23,7	0,7	0	-3
16716	Athens (Hellinikon)	21,1	0,5	21	7	25,4	0,4	2	-4
16754	Heraklion / Kreta	20,6	0,8	19	3	23,7	0,2	0	-3
17040	Rize	16,3	0,5	61	-41	19,8	-0,1	219	91
17062	Istanbul-Goztepe	16,4	-0,1	17	-14	20,6	-0,5	26	5
17130	Ankara / Central	16,6	1,1	87	32	19,5	-0,1	37	0
17170	Van	13,3	0,6	36	-13	18,7	1,1	13	-8
17609	Larnaca	21,6	0,7	16	9	25,2	0,9	0	0
22113	Murmansk	4,3	0,5	48	16	11,0	1,6	25	-28
26038	Tallina	10,1	0,4	37	0	13,8	-0,7	61	8
26629	Kaunas	12,1	-0,3	77	22	15,0	-0,8	78	9
26730	Vilnius	12,1	-0,4	136	74	15,0	-0,8	59	-18
26850	Minsk	12,6	-0,3	121	59	15,5	-0,6	82	-1
27595	Kasan	17,0	3,8	23	-14	16,7	-0,6	113	43
27612	Moskva	14,8	1,9	81	23	16,5	-0,1	89	13
33345	Kiev	16,4	1,3	60	7	17,3	-0,9	111	38
33837	Odessa	16,9	1,8	33	-6	19,3	-0,1	51	9
34300	Charkov (Kharkiv)	17,9	2,3	27	-20	17,6	-1,3	104	46
34880	Astrahan'	20,1	1,9	10	-12	22,8	0,0	19	-2
35188	Akmola	15,2	2,1	49	16	20,6	1,6	25	-10
37789	Yerevan	16,9	0,6	64	4	20,8	0,2	35	6
40080	Damascus	20,7	0,5	13	9	24,7	0,1	0	-1
40100	Beyrouth	21,5	0,8	20	5	24,5	0,9	0	-1
40180	Tel Aviv (Airport)	21,4	0,3	0	-3	24,5	0,5	0	0
40265	Mafraq	19,7	-0,1	3	0	22,8	0,1	0	0
60030	Las Palmas / Gr. Can	20,8	0,9	0	-2	22,4	1,0	0	0

WMO No.	Station	July 2005 Temp. mean	July 2005 (°C) dev.	July 2005 Prec. total	July 2005 (mm) dev.	August 2005 Temp. mean	August 2005 (°C) dev.	August 2005 Prec. total	August 2005 (mm) dev.
01008	Svalbard	7,2	1,2	19	6	6,8	2,0	17	-8
01025	Tromsø	12,9	1,2	60	-12	11,6	0,7	122	40
01492	Oslo-Blindern	18,8	2,4	80	-4	15,9	0,7	104	14
02196	Haparanda	17,7	2,2	134	84	15,1	1,8	48	-15
02485	Stockholm	19,4	2,2	121	49	17,0	0,8	65	-1
02974	Helsinki-Vantaa	19,2	2,6	36	-37	16,2	1,2	161	81
03091	Aberdeen	14,6	0,8	45	-15	14,3	0,7	38	-37
03772	London-Heathrow	18,7	0,9	46	0	18,1	0,7	42	-9
03967	Casement Aerodrome	15,9	1,0	79	32	15,4	0,9	31	-28
04030	Reykjavik	11,8	1,2	47	-5	10,5	0,2	72	10
04320	Danmarkshavn	5,3	1,6	9	-5	2,8	0,4	0	-14
04360	Angmagssalik	8,7	2,3	129	80	6,5	0,5	95	34
06186	København-Landb.	18,9	1,7	58	-11	16,6	-0,4	85	22
06260	De Bilt	17,7	0,9	159	84	16,2	-0,5	96	25
06447	Uccle	18,4	0,9	124	49	16,8	-0,5	70	7
06590	Luxembourg	18,3	1,4	141	73	15,9	-0,5	47	-25
06660	Zürich	18,3	0,7	117	0	16,3	-0,4	194	76
06700	Genève	20,9	1,6	66	-2	18,6	0,2	76	-4
07510	Bordeaux	22,1	1,9	20	-27	20,8	0,9	14	-40
07650	Marseille	24,9	1,1	1	-13	23,6	0,4	6	-23
08222	Madrid	26,6	2,2	0	-13	25,7	1,8	0	-9
08314	Mahon / Menorca	24,9	0,7	1	-5	23,7	-0,8	19	15
08495	Gibraltar	24,9	1,2	0	-1	23,4	-0,8	0	-6
08515	St. Maria / Acores	21,3	0,5	13	-12	22,6	0,4	10	-30
08535	Lisboa	22,4	0,0	5	0	24,3	1,5	4	-2
10384	Berlin-Tempelhof	19,4	0,6	142	90	17,2	-1,2	57	-4
11035	Wien-Hohe Warte	20,7	0,8	64	2	18,7	-0,5	105	40
11518	Praha-Ruzyne	18,4	0,9	122	56	16,5	-0,5	57	-13
11903	Slica	19,3	1,1	117	58	17,5	0,2	119	50
12160	Elblag	19,4	2,6	69	-25	16,8	0,1	53	-28
12375	Warszawa-Okecie	20,5	2,6	84	17	17,7	0,4	22	-41
12843	Budapest-Lorinc	21,5	0,6	108	56	19,7	-0,6	170	119
13274	Beograd	22,6	0,9	91	25	20,6	-0,7	166	114
14015	Ljubljana	21,1	1,2	142	20	18,4	-0,7	264	120
14445	Split	26,5	1,1	20	-8	24,0	-1,2	78	28
14654	Sarajevo	19,7	0,8	109	30	17,7	-0,8	141	70
15420	Bucuresti	21,6	-0,4	126	62	20,8	-0,4	146	88
15614	Sofia	20,4	0,4	169	113	19,0	-0,4	191	139
16158	Pisa	24,4	1,6	11	-12	23,6	1,1	20	-37
16597	Luqa / Malta	26,7	0,8	0	0	25,4	-0,9	21	14
16716	Athens (Hellinikon)	28,7	0,9	38	32	28,6	1,0	1	-5
16754	Heraklion / Kreta	27,1	1,4	0	-1	27,0	1,4	0	-1
17040	Rize	24,5	2,3	43	-93	24,7	2,5	210	27
17062	Istanbul-Goztepe	24,3	1,1	40	21	25,2	2,2	23	-3
17130	Ankara / Central	25,0	2,1	12	-2	25,4	2,8	0	-12
17170	Van	24,1	2,2	1	-3	23,2	2,0	4	-3
17609	Larnaca	27,6	0,7	0	0	28,1	1,0	0	0
22113	Murmansk	13,3	0,5	70	10	13,1	2,1	40	-25
26038	Tallina	18,6	2,3	52	-27	16,3	1,0	154	70
26629	Kaunas	19,0	2,1	45	-23	16,7	0,3	136	56
26730	Vilnius	19,1	2,2	69	-9	16,7	0,4	201	129
26850	Minsk	19,6	2,3	48	-40	17,6	1,1	145	73
27595	Kasan	19,1	-0,3	67	-2	18,3	1,1	16	-51
27612	Moskva	19,3	1,2	87	-5	17,6	1,2	29	-45
33345	Kiev	21,4	2,1	29	-59	20,0	1,4	86	17
33837	Odessa	23,1	1,6	36	-13	22,9	1,7	88	54
34300	Charkov (Kharkiv)	20,7	0,4	91	31	21,0	1,5	42	-8
34880	Astrahan'	26,1	0,9	16	-7	24,1	0,8	6	-9
35188	Akmola	21,4	0,1	52	2	18,2	0,5	51	1
37789	Yerevan	26,9	2,3	7	-7	26,3	2,4	1	-8
40080	Damascus	27,8	1,5	0	0	27,2	1,2	0	0
40100	Beyrouth	27,0	1,5	0	0	27,8	1,4	0	-1
40180	Tel Aviv (Airport)	26,8	1,1	0	0	27,6	1,5	0	0
40265	Mafraq	25,2	1,1	0	0	25,8	1,6	0	0
60030	Las Palmas / Gr. Can	23,9	0,6	0	0	24,6	0,5	3	3

WMO No.	Station	September 2005 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	October 2005 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard	-0,2	-0,7	14	-9	-5,3	0,2	9	-6
01025	Tromsø	7,2	0,4	166	72	5,1	2,2	256	131
01492	Oslo-Blindern	12,5	1,7	39	-51	7,5	1,1	100	16
02196	Haparanda	9,3	1,4	64	1	4,7	2,2	15	-49
02485	Stockholm	13,9	2,7	11	-44	8,9	1,4	28	-22
02974	Helsinki-Vantaa	12,4	2,4	25	-48	7,0	1,6	34	-39
03091	Aberdeen	13,3	1,6	32	-36	10,7	0,8	116	39
03772	London-Heathrow	17,1	2,1	47	-4	14,6	2,9	73	15
03967	Casement Aerodrome	14,0	1,4	50	-13	11,7	1,5	84	15
04030	Reykjavik	6,3	-1,1	41	-26	3,0	-1,4	49	-37
04320	Danmarkshavn	-3,5	0,7	4	-7	-14,9	-1,3	7	-5
04360	Angmagssalik	2,5	-0,6	4	-64	-1,8	-1,0	31	-51
06186	København-Landb.	15,3	1,7	10	-52	11,5	1,6	53	-6
06260	De Bilt	15,7	1,7	63	-4	13,3	2,8	56	-16
06447	Uccle	16,6	2,1	74	15	14,1	3,2	47	-23
06590	Luxembourg	15,9	2,5	63	-7	12,5	3,4	47	-28
06660	Zürich	15,6	1,7	53	-41	11,0	1,9	85	16
06700	Genève	16,9	1,8	66	-16	11,7	1,4	66	-12
07510	Bordeaux	18,0	0,1	56	-18	16,4	2,4	55	-33
07650	Marseille	20,2	-0,1	167	120	17,7	1,6	46	-32
08222	Madrid	20,6	0,1	6	-24	15,5	0,7	94	49
08314	Mahon / Menorca	21,8	-0,4	60	5	19,2	0,7	70	-14
08495	Gibraltar	22,3	-0,5	5	-10	19,9	0,4	96	32
08515	St. Maria / Acores	23,1	1,7	0	-57	19,8	0,5	55	-29
08535	Lisboa	21,7	0,0	7	-19	19,0	0,5	145	65
10384	Berlin-Tempelhof	16,3	1,7	54	8	11,8	1,8	38	2
11035	Wien-Hohe Warte	16,4	1,0	44	-1	10,7	0,6	3	-38
11518	Praha-Ruzyne	15,0	1,7	30	-10	9,9	1,6	12	-18
11903	Slica	15,1	1,7	39	-17	8,8	0,5	11	-39
12160	Elblag	16,1	3,4	37	-33	9,8	0,9	26	-27
12375	Warszawa-Okecie	15,9	2,7	33	-10	9,4	1,1	5	-33
12843	Budapest-Lorinc	17,5	1,1	48	8	11,6	0,7	6	-28
13274	Beograd	18,4	0,7	54	3	12,8	0,4	29	-11
14015	Ljubljana	16,4	0,9	294	164	11,8	1,4	54	-61
14445	Split	22,1	0,7	103	42	16,7	-0,2	198	119
14654	Sarajevo	15,1	0,0	102	32	10,9	0,5	28	-60
15420	Bucuresti	16,0	-0,9	270	228	10,6	-0,2	118	86
15614	Sofia	16,0	0,2	92	53	10,2	-0,2	44	7
16158	Pisa	19,9	0,4	56	-33	16,4	1,1	101	-19
16597	Luqa / Malta	24,3	0,2	39	-1	21,3	0,6	94	4
16716	Athens (Hellinikon)	24,4	0,1	42	32	18,4	-0,9	6	-42
16754	Heraklion / Kreta	24,2	1,1	2	-16	19,7	0,0	27	-49
17040	Rize	21,1	1,7	319	98	15,5	0,1	500	228
17062	Istanbul-Goztepe	21,1	1,4	65	24	14,7	-0,6	75	4
17130	Ankara / Central	18,7	0,4	43	24	10,8	-1,8	28	1
17170	Van	17,2	0,4	9	-5	11,2	1,1	35	-13
17609	Larnaca	25,9	0,8	11	11	21,2	-0,1	13	-6
22113	Murmansk	7,9	1,2	59	7	4,2	3,2	66	24
26038	Tallina	13,0	2,2	25	-57	8,2	1,9	47	-23
26629	Kaunas	14,2	2,3	47	-9	8,0	0,9	31	-14
26730	Vilnius	14,0	2,4	30	-35	7,7	1,1	38	-15
26850	Minsk	14,4	2,7	30	-30	7,4	1,1	37	-12
27595	Kasan	13,3	2,1	23	-23	6,6	3,1	17	-30
27612	Moskva	13,1	2,2	12	-52	6,0	1,0	45	-13
33345	Kiev	16,3	2,4	7	-40	9,0	0,9	78	43
33837	Odessa	19,4	2,4	0	-36	11,9	0,7	17	-9
34300	Charkov (Kharkiv)	16,4	2,3	2	-39	8,8	1,5	51	16
34880	Astrahan'	20,6	3,2	0	-24	11,6	2,4	61	44
35188	Akmola	12,8	0,8	11	-13	6,9	4,1	8	-22
37789	Yerevan	20,9	1,1	14	5	14,4	1,6	13	-19
40080	Damascus	23,5	0,3	0	0	17,9	-0,2	5	-7
40100	Beyrouth	27,1	2,2	0	-7	23,6	1,0	110	56
40180	Tel Aviv (Airport)	26,2	1,4	0	0	22,4	0,4	5	-21
40265	Mafraq	22,7	0,0	0	-1	18,5	-0,6	4	-3
60030	Las Palmas / Gr. Can	25,0	1,2	7	-1	23,3	0,8	10	0

WMO No.	Station	November 2005 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	December 2005 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard	-3,8	6,7	13	0	-3,8	9,5	17	5
01025	Tromsø	1,8	2,6	115	11	-2,5	0,5	42	-62
01492	Oslo-Blindern	4,4	3,7	116	41	-1,1	1,7	39	-17
02196	Haparanda	1,0	5,1	88	30	-7,6	1,9	45	3
02485	Stockholm	4,4	1,8	43	-10	0,1	1,1	54	8
02974	Helsinki-Vantaa	3,5	3,4	82	10	-3,7	0,4	36	-22
03091	Aberdeen	5,5	0,5	85	10	5,0	1,5	97	24
03772	London-Heathrow	7,3	0,1	29	-26	5,4	0,3	44	-13
03967	Casement Aerodrome	6,2	-0,3	51	-15	5,7	0,3	62	-12
04030	Reykjavik	1,6	0,5	60	-13	2,3	2,5	136	57
04320	Danmarkshavn	-16,8	3,1	22	12	-16,8	5,0	55	42
04360	Angmagssalik	-1,9	2,8	89	-7	-3,6	3,6	162	59
06186	København-Landb.	6,4	0,9	30	-32	2,7	0,5	44	-14
06260	De Bilt	6,9	1,0	98	17	4,0	0,8	57	-23
06447	Uccle	6,1	0,0	61	-15	3,5	0,0	52	-24
06590	Luxembourg	4,4	0,6	55	-28	1,0	0,0	69	-11
06660	Zürich	3,9	-0,1	22	-60	-0,4	-1,0	69	-6
06700	Genève	4,8	-0,4	37	-57	0,4	-1,6	65	-23
07510	Bordeaux	8,0	-1,1	90	-4	4,0	-2,4	112	13
07650	Marseille	10,1	-0,6	56	-2	4,3	-3,0	23	-33
08222	Madrid	8,6	-0,8	50	-14	6,2	-0,2	25	-26
08314	Mahon / Menorca	14,2	-0,2	81	4	9,9	-1,9	68	-6
08495	Gibraltar	14,9	-1,2	72	-69	14,3	0,2	101	-45
08515	St. Maria / Acores	16,5	-0,9	22	-80	16,2	0,8	52	-43
08535	Lisboa	13,7	-0,8	158	44	12,0	0,2	48	-60
10384	Berlin-Tempelhof	5,0	0,1	20	-29	1,5	0,1	51	-2
11035	Wien-Hohe Warte	4,2	-0,6	25	-25	0,5	-0,5	86	42
11518	Praha-Ruzyne	2,5	-0,3	12	-20	-0,4	0,2	25	-1
11903	Slica	1,6	-1,4	55	-14	-2,2	-0,5	122	65
12160	Elblag	3,6	0,3	54	-2	-0,3	-0,6	82	30
12375	Warszawa-Okecie	3,3	0,1	29	-13	-0,3	0,6	81	49
12843	Budapest-Lorinc	4,2	-0,6	41	-11	1,0	0,6	76	36
13274	Beograd	6,7	-0,3	24	-30	3,3	1,0	79	21
14015	Ljubljana	5,0	0,4	159	24	0,2	0,2	96	-5
14445	Split	11,9	-0,3	186	78	8,3	-0,4	167	67
14654	Sarajevo	4,7	-0,1	67	-24	0,9	1,1	134	70
15420	Bucuresti	4,0	-1,2	47	-2	1,0	0,8	27	-16
15614	Sofia	4,3	-0,7	24	-23	1,7	1,2	66	27
16158	Pisa	10,7	0,3	104	-20	5,3	-1,5	79	-6
16597	Luqa / Malta	17,9	0,9	61	-19	14,1	0,3	147	35
16716	Athens (Hellinikon)	13,8	-1,6	179	128	12,2	0,2	14	-52
16754	Heraklion / Kreta	16,3	-0,3	59	0	14,5	0,7	56	-18
17040	Rize	11,7	0,1	398	148	9,4	1,1	189	-54
17062	Istanbul-Goztepe	10,5	-1,1	141	52	8,8	0,7	109	-13
17130	Ankara / Central	6,1	-1,0	48	15	3,0	0,4	14	-35
17170	Van	4,6	0,6	29	-13	1,9	2,8	34	0
17609	Larnaca	16,5	0,1	49	5	14,7	1,5	10	-66
22113	Murmansk	0,2	5,3	59	19	-7,3	2,0	37	-1
26038	Tallina	4,0	2,8	69	1	-2,2	0,7	38	-17
26629	Kaunas	2,8	1,0	25	-28	-1,6	0,7	46	-1
26730	Vilnius	1,9	0,7	32	-25	-2,3	0,6	56	1
26850	Minsk	0,9	0,1	49	-3	-3,0	0,8	57	4
27595	Kasan	0,5	3,7	16	-30	-5,3	3,8	73	36
27612	Moskva	1,4	2,5	31	-27	-4,1	2,0	79	27
33345	Kiev	2,2	0,1	39	-12	-1,0	1,3	78	26
33837	Odessa	6,1	0,3	43	1	3,0	1,6	52	4
34300	Charkov (Kharkiv)	2,9	1,6	87	43	-1,6	1,8	61	16
34880	Astrahan'	5,1	1,9	9	-8	1,4	3,2	13	-3
35188	Akmola	-2,3	3,6	24	2	-10,5	2,1	15	-2
37789	Yerevan	7,3	0,7	19	-11	0,9	0,4	16	-10
40080	Damascus	11,0	-0,8	79	57	9,3	2,1	15	-11
40100	Beyrouth	18,8	0,1	142	38	16,6	1,8	148	-26
40180	Tel Aviv (Airport)	17,9	-0,1	50	-18	15,7	1,9	132	-6
40265	Mafraq	12,7	-0,8	11	-6	11,1	2,3	21	-7
60030	Las Palmas / Gr. Can	21,0	0,6	30	9	18,6	0,3	27	6

WMO No.	Station	Year 2005 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard	-3,0	3,4	141	-42
01025	Tromsø	4,2	1,4	1281	308
01492	Oslo-Blindern	7,4	1,7	719	-50
02196	Haparanda	3,3	2,2	698	146
02485	Stockholm	7,9	1,3	555	16
02974	Helsinki-Vantaa	5,9	1,4	655	4
03091	Aberdeen	9,1	1,2	727	-56
03772	London-Heathrow	11,9	1,4	450	-149
03967	Casement Aerodrome	10,2	1,0	624	-87
04030	Reykjavik	5,1	0,7	744	-57
04320	Danmarkshavn	-9,5	2,8	171	39
04360	Angmagssalik	0,5	2,2	1054	122
06186	København-Landb.	9,4	0,8	479	-157
06260	De Bilt	10,7	1,3	874	69
06447	Uccle	11,0	1,2	752	-48
06590	Luxembourg	9,6	1,3	721	-154
06660	Zürich	9,3	0,8	1043	-40
06700	Genève	10,7	0,9	747	-198
07510	Bordeaux	13,4	0,7	593	-330
07650	Marseille	14,8	0,0	479	-66
08222	Madrid	15,3	1,0	252	-205
08314	Mahon / Menorca	16,5	-0,1	464	-116
08495	Gibraltar	18,3	0,1	647	-128
08515	St. Maria / Acores	18,0	0,5	620	-155
08535	Lisboa	17,1	0,3	462	-291
10384	Berlin-Tempelhof	9,9	0,5	593	10
11035	Wien-Hohe Warte	10,2	0,2	604	-9
11518	Praha-Ruzyne	8,4	0,6	477	-49
11903	Slica	7,8	-0,2	751	65
12160	Elblag	8,4	0,8	564	-126
12375	Warszawa-Okecie	8,6	0,8	491	-28
12843	Budapest-Lorinc	10,6	0,2	754	236
13274	Beograd	11,8	-0,1	810	126
14015	Ljubljana	10,4	0,6	1402	9
14445	Split	15,9	0,1	1027	202
14654	Sarajevo	9,1	-0,4	1153	235
15420	Bucuresti	10,1	-0,5	1077	482
15614	Sofia	9,8	0,1	965	402
16158	Pisa	14,2	0,1	624	-280
16597	Luqa / Malta	18,7	0,1	505	-48
16716	Athens (Hellinikon)	18,3	-0,1	454	85
16754	Heraklion / Kreta	18,9	0,5	421	-80
17040	Rize	14,8	0,9	2599	426
17062	Istanbul-Goztepe	14,6	0,4	834	137
17130	Ankara / Central	12,4	0,7	462	49
17170	Van	9,9	1,2	337	-48
17609	Larnaca	19,8	0,7	298	-30
22113	Murmansk	2,0	2,1	499	21
26038	Tallina	6,3	1,2	596	-71
26629	Kaunas	7,0	0,7	637	17
26730	Vilnius	6,8	0,7	783	100
26850	Minsk	6,8	1,0	735	58
27595	Kasan	5,4	1,7	508	-34
27612	Moskva	6,2	1,2	683	-5
33345	Kiev	8,7	1,0	720	71
33837	Odessa	11,3	1,2	462	-2
34300	Charkov (Kharkiv)	8,7	1,2	590	71
34880	Astrahan'	11,5	1,6	236	15
35188	Akmola	4,3	1,6	290	-38
37789	Yerevan	12,2	0,8	356	-12
40080	Damascus	17,2	0,7	146	0
40100	Beyrouth	21,0	1,3	854	-31
40180	Tel Aviv (Airport)	20,5	1,0	473	-94
40265	Mafraq	17,0	0,5	124	-36
60030	Las Palmas / Gr. Can	20,9	0,4	214	97

Monthly Surveys

January 2005

- **Very mild and wet in the north and east**
- **Storm with heavy precipitation over Scandinavia, northern central Europe and the Baltic countries on January 7-9**
- **Cold in the south**
- **Very dry in the southwest**
- **Wet in countries west of the Black Sea and in the central Mediterranean**

A strong meridional circulation structure prevailed over the Region this month. A high pressure zone with warm air masses was situated over the North Atlantic. The Azores high moved to a very northward position with its mean centre near the Biscay, indicating subsidence and further warming of the Atlantic there. North of this high pressure centre, mild and humid air masses moved over Ireland and the United Kingdom to Scandinavia and then further to northeastern and eastern Europe. Colder continental air masses from the east seldom reached northern and eastern Europe and then quite weakly. This resulted in a very mild, but wet January in the north and east of Europe.

In **Iceland**, the first part of January brought heavy snowstorms and wind, with avalanche conditions in the northwestern and northern districts. One residential house was demolished and a few other houses were damaged, but as the inhabitants had been evacuated, there were no injuries. During the last week of January, milder weather set in and the snow disappeared quickly.

Ireland had a particularly mild January with a monthly mean temperature anomaly of +2.2°C at the Casement Aerodrome in Dublin. It was also 18% wetter than normal there. The **United Kingdom** mean temperature was 2.3°C above average, making it the warmest January since 1990, and the 7th warmest in the series back to 1914. Rainfall and sunshine levels were both slightly above average, with 113 and 109%, respectively. A lot of precipitation fell in Scotland while the southern parts (England and Wales) were dry with only 60% of the normal precipitation.

The mean temperature was well above normal in the whole country of **Norway**. In parts of the county of Hedmark (southeastern Norway) it was 8 to 10°C above normal. The eastern parts of the country experienced the warmest January for the last 100 years. The monthly total precipitation in Finnmarksvidda, parts of the counties of Trøndelag and the western part of the country was the second highest registered since 1900. January was unusually mild and wet also in **Finland**. The monthly mean temperature was 4 to 6°C above the 1971-2000 mean in the whole country. Thus, precipitation was for the most part rain or sleet. In several places monthly precipitation exceeded 100 mm and it remained wet in January. The highest monthly amount (156 mm) was recorded in the southeast of Finland. Due to the high temperatures, a permanent snow cover did not appear in the southern parts of the country until the end of the month.

Estonia reported a mean temperature anomaly of +4.9°C, making this month outstanding compared to the rest of the year (Fig. 1.1). The mean monthly precipitation in this country was also high with 70 mm (186% of the normal). **Latvia** was mild, too (anomaly +4.7°C), but the precipitation was only slightly higher than normal (118% of the normal). **Lithuania** reported +4.9°C and 136% of the normal precipitation.

In the central parts of **Russia** it was the warmest January since the beginning of the time series in 1900. It was particularly mild in the northeast of the European part of Russia with anomalies of more than +8°C. For Moscow this was the third warmest January since measurements began. However, Moscow also registered the highest snow depth and a monthly precipitation total of 98 mm (233% of the normal). For the **Ukraine**, the temperature anomalies (+4.2 to 5.5°C, depending on the climate region) were also outstanding compared to the rest of the year (Fig. 1.2), the precipitation total was around 120% of the normal.

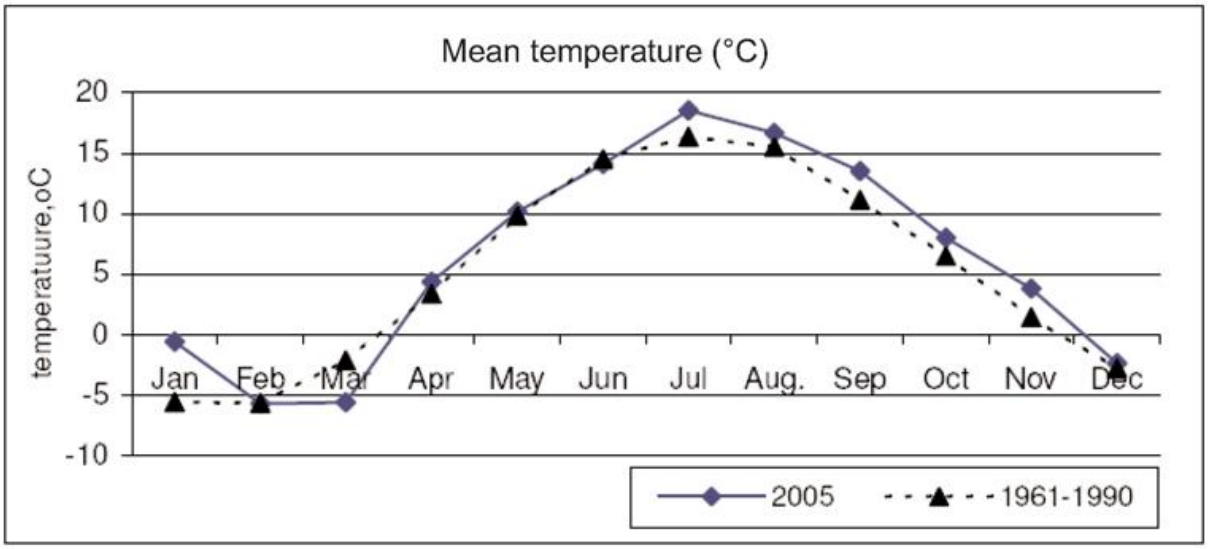


Fig. 1.1: *Monthly mean temperatures 2005 in Estonia compared to the 1961-1990 mean. Source: Estonian Meteorological and Hydrological Institute*

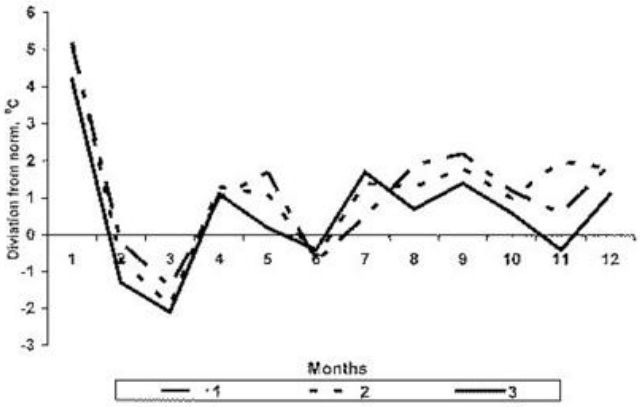


Fig. 1.2: *Ukrainian monthly temperature anomalies from the 1961-1990 mean for all months of 2005 and different climate zones: 1 – above normal humidity zone, 2 – normal humidity zone, 3 – low humidity zone.*
Source: Ukrainian Hydrometeorological Centre

On **January 7-9**, a severe winter **storm** with gusts of hurricane speed moved over Scotland and south Scandinavia to Russia. High rainfall amounts were measured in the northern half of the **United Kingdom**: 143 mm of rain fell in the 24-hour period ending 09 UTC on January 7 at Kinlochewe (Scottish Highlands) and 225 mm fell at Shap (Cumbria, northwest England) in a 72-hour period ending 09 UTC on January 8. This period of prolonged rainfall resulted in severe flooding in Carlisle that was considered to be the worst to affect this town since 1822. The lowest pressure was registered on January 8 around 18 UTC close to the Norwegian-Swedish

border with about 960 hPa reduced to mean sea level. In **Norway** it was the severest storm for more than 10 years. Gusts of up to 105 km/h were reported from the southern part of the Norwegian North Sea (Ekofisk Field station). This high wind speed resulted in significant wave heights of more than 10 m. At the Norwegian station Opstveit in Hordaland (southwest Norway) a diurnal precipitation amount of 146 mm was measured during the storm passage on January 7. **Denmark** was affected by the storm on January 8; it was the severest since December 1999. **Sweden** was hit by the storm on January 8-9 with a maximum gust of 151 km/h measured at the coastal station Hanö in Blekinge (south Sweden, Baltic Sea) and 119 km/h inland in southern Sweden. There it was the worst tree-felling storm since around 1930. Approximately 75 million m³ of trees fell in Sweden. This corresponds to about 250 million mature trees or a normal annual cutting for the whole country. About 85% of the fallen trees were spruces (Picea abies, Fig. 1.3). The total economic loss for Sweden was estimated at around 25 billion crowns (2.7 billion €). For the insurance industry this was the 5th most expensive storm within 50 years. Nine people lost their lives directly during the storm and around 20 during the dangerous clearing up work afterwards. Over 400 000 households were without electric supply, about 10 000 for more than four weeks. The situation was very difficult in the countryside where many elderly people had to be evacuated. The train connection Stockholm-Malmö was interrupted for more than a week. Along large stretches of the west Swedish coast, sea water rose to unprecedented levels, e.g. 164 cm above normal close to Varberg. A high sea water level was also observed in the Gulf of **Finland** on January 8-9. This led to exceptional flooding of sea water into houses on the southern coast of Finland. Huge floods were also reported from Pärnu in **Estonia**. The water level was 275 cm above average. Wind speeds in gusts exceeded 125 km/h. **Latvia** reported strong gusts of hurricane force (up to 144 km/h, Fig. 1.4); in some locations these were new records. As a consequence, electric power lines fell down in many areas of Latvia, causing widespread power interruptions. Trees were destroyed, many houses lost their roofs, and there was damage to agriculture and loss of livestock. The event caused a sea level rise in the southern part of the Gulf of Riga and thus also a rise in the water level in the city of Riga and its port area (up to 213 cm above average on January 9). This level had not been reached since 1969. Several houses and roads were flooded in Riga and in coastal regions. The total cost in storm damage for Latvia was more than 190 million €. In **Lithuania**, widespread gusts of 85-105 km/h were measured, at the coast up to 130 km/h.



Fig. 1.3: *Devastated spruce forest south of Alvesta, Småland, southern Sweden after the storm on 9 January 2005*
Source: Swedish Meteorological and Hydrological Institute

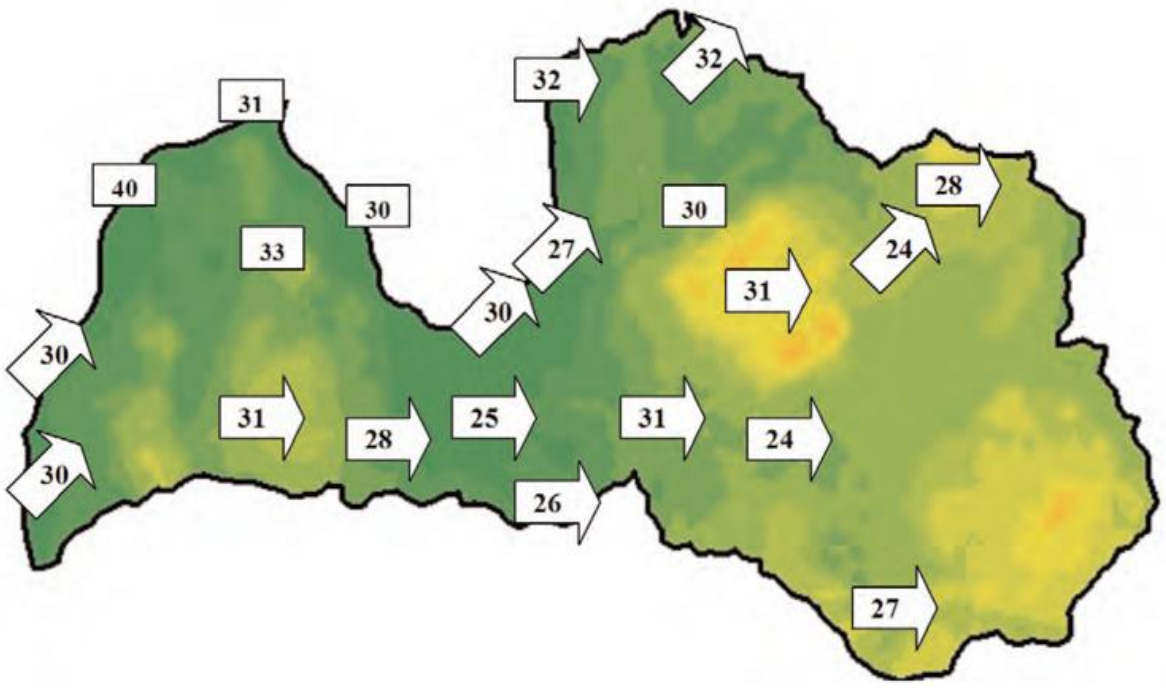


Fig. 1.4: *Maximum wind gusts (in m/sec) and mean wind directions in Latvia on January 8-9. The maximum of 40 m/sec corresponds to 144 km/h.*
Source: Latvian Environmental, Geological and Meteorological Agency

This storm also brought extremely warm air masses to northern Europe. A record-breaking temperature of 12.4°C was measured on January 10 in **Denmark** near the border to Germany. In **Latvia**, new local records of the maximum temperature for 80 years were set during the period January 6-9. **Lithuania** reported a mean diurnal temperature above 5°C during the period January 8-12; the highest daytime temperatures reached 7 to 10°C. Soils were frost-free and the warm weather prompted the germination of snowdrops and tulips, flowering of violets, and in southern forests people were looking for mushrooms. In **Russia**, 5.2°C were measured in Moscow on January 9.

In central Europe, the storm passage was also recorded in **Belgium** on January 8. In northern **Germany**, gusts up to 181 km/h in List (Sylt) and 155 km/h in Kiel were registered on January 8-9. Trees fell on railway lines, houses were untiled, highway bridges had to be closed. The lower lying parts of Hamburg were flooded and local interruptions of power supply occurred.

A second **stormy spell** occurred on the night of **January 11-12** over northwest **Scotland**, with gusts of 171 km/h at Barra and 163 km/h at Stornoway (both Western Isles).

Another **storm** with a low pressure system near Iceland affected in particular Ireland on **January 17-19**. A buoy located west of Ireland measured a wind speed peak value of 70 km/h and a wave height of more than 13 m on January 18 (Fig. 1.5). On January 20-21, this storm passed over **Germany**. Again, disruption to traffic was to be observed, this time not only in the north, but also in the south of the country. In some cities, streets were flooded, trees were uprooted, and some railway lines had to be closed temporarily. Gusts up to 194 km/h were measured on the Wendelstein mountain (elevation ca. 1800 m) in southern Germany. In Freudenstadt (southwestern Germany, Black Forest) 81 mm precipitation fell within 24 hours.

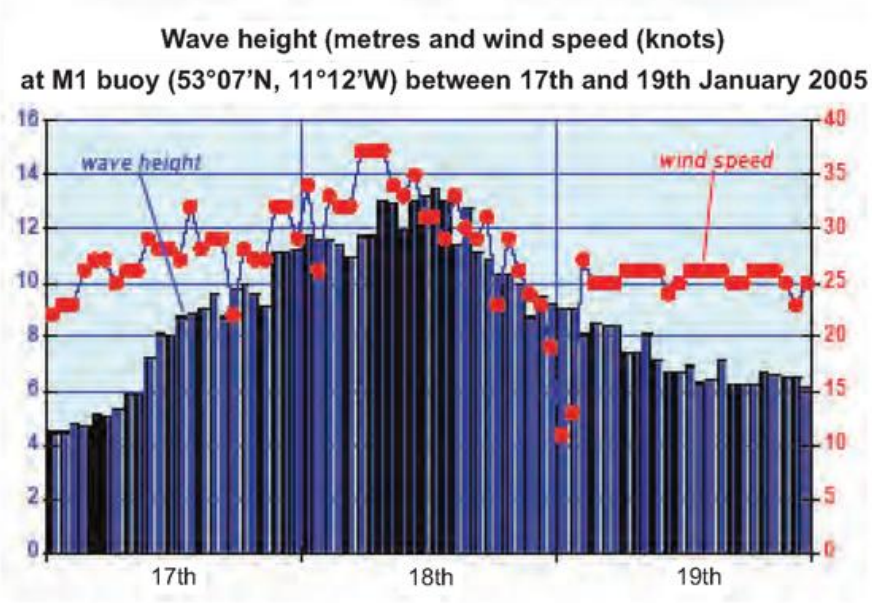


Fig. 1.5: *Wave height in metres and wind speed (knots) at M1 buoy (53°07'N, 11°12'W) on January 17-19.*
Source: Met Éireann, Ireland

Most of central Europe was also very mild on a monthly average. In the **Netherlands**, this was the 7th warmest January since 1901 (anomaly in De Bilt: +3.1°C). On the other hand, this area was also influenced by the Atlantic high pressure system, and thus this January was also the sunniest on record since 1901 at some coastal stations. De Bilt was drier than normal (80% of the normal precipitation). **Belgium** also received much sunshine (145% of the normal sunshine hours and only 66% of the normal precipitation were registered in Uccle), the monthly mean temperature was clearly above normal (+2.1°C in Uccle), only at the end of the month did some polar air masses reach this country. It was a similar situation in **Luxembourg** (152% of the normal sunshine, 72% of the normal precipitation, temperature anomaly +1.8°C). **Germany** had an exceptionally warm first half of the month, and thus the anomaly reached +2.5°C on the areal average. The mean sunshine duration was 132% of the normal. The precipitation total was near normal (109%) on country average, but with large regional differences: in the northern plains and in southwestern Germany, it was very dry (locally less than 60% of the normal), but it was wet (in parts more than 200% of the normal) in the east. **Poland** had similar characteristics: a mean temperature anomaly of +2.8°C (from the 1971-2000 mean), in the northeastern parts even +3.6°C, and in particular the first half of the month was mild. The mean precipitation total reached 142% of the normal, varying from less than 80% in the western and central parts up to more than 200% in the south. There, the highest diurnal precipitation total amounted to 53 mm in the mountains. During the second half of the month, a snow cover of 1 m was measured in this mountainous area. The **Czech Republic** reported a mean monthly temperature anomaly of +2.4°C and 165-170% of the normal precipitation. Maximum temperatures in southern Bohemia reached up to 15°C.

In **France**, the northwest was affected by the warm and humid air over the northern Atlantic, but the south was directly under high pressure influence. Thus, it was warmer than normal in the northwestern areas, but near or below normal in the south. The precipitation totals were higher than normal in the Normandy and in central France, but it was drier than normal in the other regions. Especially the southeastern areas were very dry. In Marseille, only 3 mm of precipitation fell, this was only 6% of the normal.

The Alpine regions had different weather conditions in the north compared to the south. **Switzerland** had sunny weather until the middle of January. In the higher parts of the Swiss Alps it was almost as warm as in spring. Towards the end of the month, the high pressure influence ended with a massive incursion of cold air, associated with heavy snowfall also at lower elevations. The Ticino region south of the Alps remained dry; there it was the driest start to a year for 20 years. In **Austria**, it was mild in the east (up to +2°C); in the western part the temperature was normal. Very dry and sunny conditions prevailed also in the south of the country, in Carinthia and southern Styria with less than 25% of the normal precipitation. In Klagenfurt, capital of Carinthia, 150 hours of sunshine were a new record for this town in January. In contrast, it was very wet in Upper and Lower Austria in the north with up to 200% of the normal monthly precipitation. On January 26, about 70 cm of snow fell within 24 hours (up to the morning of January 27) in the east and southeast of Austria. As a result of severe snowdrifts in the northern Burgenland, railroad tracks were interrupted, side roads were almost impassable. More snowdrifts with depths of up to 1m on January 31 caused the traffic to break down on roads in the direction of Vienna. At the international airport of Vienna, several takeoffs were delayed.

The high pressure influence extended even to the countries east of the Adriatic Sea, except towards the end of the month. **Slovenia** was slightly colder than normal in the west, but at some stations in the east the monthly mean temperature anomaly reached +2°C. The cold spell at the end of the month also touched this area. Precipitation was far below normal, in the central part of Slovenia, the Upper Soča valley (Julian Alps), most of the Gorenjska (northwest Slovenia) and Goričko (northeast Slovenia) regions less than 10% of the normal fell. Nevertheless, a snow cover persisted in the Upper Sava valley (Julian Alps) throughout the month, on January 19 a snow cover was even observed in Ljubljana. At Kredarica (elevation 2515 m) the maximum snow cover was 115 cm on January 1. The sunshine duration was well above normal in the whole country except the Julian Alps. In Ljubljana and Celje it was 3 times sunnier than normal. **Croatia** also was mostly dry; especially in the southern central part north of Split less than 10% of the normal precipitation fell at some stations. It was also colder than normal in the west and warmer in the east, but the anomalies were mostly between -1 and +1°C. In **Serbia and Montenegro** it was first unusually warm with only sporadic rain and snow in the mountains. On January 25, however, cold air with snow extended to the whole country, and ice days were registered every day.

Frontal systems encroached several times on the countries west of the Black Sea and also the central Mediterranean. **Hungary** was quite mild (temperature anomaly of +1.6°C on country average) and sunny (nearly 100 hours of sunshine compared to a normal of about 60 hours), but wet (128% of the normal precipitation). **Romania** also was mild (more than +2°C compared to the normal) and slightly wetter than normal. **Macedonia** reported temperature anomalies of +1.3°C, and around 150% of the normal precipitation. **Bulgaria** was very mild (+1.5 to 3.5°C above normal) and also very wet (150-200% of the normal). Mediterranean cyclones affected this area especially at the end of the month (January 26-31). Up to 100 mm of precipitation (rain and snow) in 24 hours were registered which led to local floods from swollen rivers and overflowed water reservoirs in various parts of the country. Wind speeds up to 100 km/h were measured in southeastern Bulgaria and at the Black Sea coast. In northeastern Bulgaria snow piles up to 2 m accumulated due to snowdrifts.

Southwestern Europe in general was strongly influenced by subsidence within the Atlantic high pressure system. As a result, much of the usual winter precipitation was missing in these areas, giving rise to the start of a long-lasting dry period, but also long sunshine durations and cold nights. **Portugal** recorded the 4th lowest average monthly minimum temperature since 1931, and also the average monthly mean temperature was lower than normal in almost the whole country. The month was also extremely dry, the 4th driest since 1931. Monthly totals were below 20% of the normal, only in some northern regions did the totals exceed 7 mm. In Lisbon and

Évora, there was no precipitation at all during the whole month; this had never happened before in January since 1901. In **Spain**, it was particularly cold in the east and only around 20% of the normal precipitation fell on average over the peninsula. Again, there were some stations without any precipitation at all, e.g. Madrid and Gibraltar. Especially at the end of the month there was a cold spell with snow and temperatures far below zero. In **Italy**, it was colder than normal as well. Northern Italy was also drier than normal (e.g. Pisa 43% precipitation of the normal), but the south was partly wet due to cyclonic influence.

A storm with gusts of more than 100 km/h passed over eastern **Greece** and the Aegean Sea on January 16-17, accompanied by heavy rain and, on the mountains, also snowfall. Thus the monthly precipitation totals were mostly above normal, but the temperatures around normal.

In **Cyprus**, mean monthly precipitation was near normal, mean temperature 0.8°C above. On January 29-30, southerly warm winds with dust affected the island, accompanied by increasing temperatures. A maximum of 22.2°C was measured at Athalassa (near Nicosia); this was the highest value since 1983.

In **Armenia**, the monthly mean temperature was slightly below normal due to cold spells affecting the country on January 8-18 and 26-29 with negative anomalies of 4 to 9°C. The precipitation total was 120-140% of the normal across the main part of the country, but in the eastern regions it was drier with only 60-90%. Strong winds with gusts up to 80 km/h were observed on 3 days of the month.

The temperatures were mostly around 1°C above normal in the **Lebanon**. Precipitation totals were about normal or slightly below. In contrast, it was rainy in most parts of **Israel** with totals reaching 120-150% of the normal. Only in the northeastern parts were they below (85-95% of the normal). Temperatures in Israel were slightly higher than normal.

February 2005

- **Mild in northern Europe and over the North Atlantic**
- **Cold in central and southern Europe and in the east**
- **Very dry in northern, western and in particular southwestern Europe and in some parts east of the Mediterranean**
- **Wet in central and eastern Europe and most of the Mediterranean**

The strong meridional circulation structure with its anomalous high pressure centre over the North Atlantic and a trough over central Europe also persisted in February. On the other hand the Russian high extended westwards to central Europe. Thus, the North Atlantic remained warm, but colder continental air moved to Europe.

It was still mild in northern Europe, but the anomalies were not as high as in January. Due to the Russian high pressure influence, it was also quite dry there.

Greenland was very mild. Danmarkshavn was 8.0°C warmer than normal, Angmagssalik 3.9°C, and also the capital Nuuk was warmer. **Iceland** too was mostly mild with unusual light snow conditions all over the country. Most parts of **Norway** also were warmer than normal. In parts of Hedmark (southeast Norway) and Finnmark (northern Norway) the monthly mean was 5.6°C

above the long-term average, further in the north at Svalbard Lufthavn even 9.3°C, equally high as an earlier record in February 1954. The monthly precipitation total was especially low in eastern **Norway** in the counties of Buskerud and Oppland with only 15-20% of the normal. Sweden reported a mild winter, but sometimes wintry conditions with snow, also in southern Sweden; this implies that some cyclonic systems within the trough over central Europe had impact on the south of northern Europe. In **Finland** an exceptionally dry period started, which lasted until April. Only two or three times in a century was the precipitation amount as low as it had been this year during that period. **Russia** was abnormally mild in the north of the European territory with monthly temperature anomalies of about +10°C. The near-coastal regions around Murmansk and Arkhangelsk reported anomalies between +2 and +5°C. The other areas of the Russian European territory had temperatures close to normal, only east of the Volga river was it was remarkably colder than usual. It was also very dry in the north of the European part of Russia with only 60% of the normal precipitation totals, at some places only 40%, whereas the southern part was clearly wetter (Fig. 2.1).

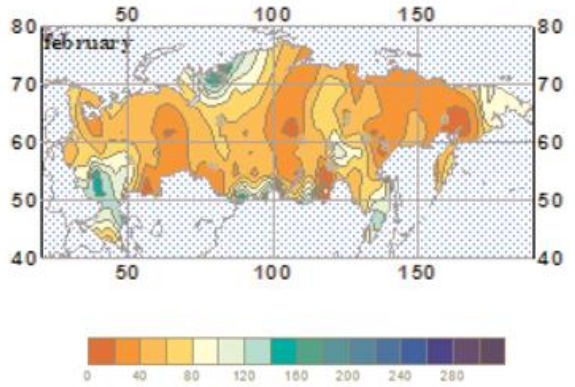


Fig. 2.1:

Precipitation totals in % of the 1961-1990 mean in Russia in February 2005
Source: Roshydromet, Russia

The Baltic countries were mainly under high pressure influence, but also under cold air advection from the east. In **Estonia**, the month was colder than usual by 3°C and precipitation only half of the normal. In **Lithuania**, too, this month was cold and dry. In its eastern regions, the lowest temperature was between -21 and -26°C and the monthly mean temperature was -5.3°C (anomaly 0.9°C). Monthly precipitation amounted to 26 mm (85% of the normal).

The northwest of Europe was influenced by the warm air over the Atlantic and its high pressure system. However, in the Republic of **Ireland** at Casement Aerodrome (southwest of Dublin), temperature and precipitation were nearly normal. In the **United Kingdom**, the monthly mean temperature was 0.7°C above average, sunshine duration slightly above (106% of the normal), and precipitation slightly below (89%). Nevertheless, in the night of February 24-25, an occluded front from the east arrived in England and brought some snow to various parts of the country. A snow depth of 50 cm was reported from Boltshope Park, 30 cm at Westgate, 26 cm at Copley (all County Durham, northeast England) and 23 cm from Carterhouse (Scottish Borders), all on the morning of February 25. On the same day, the lowest temperature of the month was measured at Kinbrace The Hatchery (Highlands) with -11.4°C; Redhill (Surrey, southeast England) recorded -9.5°C overnight on February 27-28 when high pressure influence dominated again.

Western and in particular southwestern Europe still remained under the influence of the Atlantic high pressure system, so this month was also very dry but cold due to outgoing radiation at night, but also due to some cold spells after polar air advection from the north. **France** was cold especially during the second part of the month. By the middle of February, the temperature started to fall, but it was February 22, when the cold spell really intensified, extending over the whole country. Temperatures dropped down to below -20°C in the northeast and below -10°C in the other regions, except in coastal areas. This cold spell was not exceptional, but remarkable for its duration and its late occurrence. The monthly mean temperature was 1 to 4°C below normal from the north to the south. Precipitation was lower than normal mainly in the western

regions, but also in the south. Marseille had no precipitation at all (the normal is 54 mm). In other parts of the country very frequent snowfall was observed during the cold second half of the month. In **Portugal**, mean temperatures were below normal as well and in particular also the average minimum temperatures, which were the second lowest since 1931. One cold spell continued from January, another one occurred by the middle of February. Like January, February was also very dry; the precipitation totals were below 40% in the whole country. At the end of February, more than ¾ of the country was in a drought period of severe to extreme intensity. **Spain** was also colder than normal (anomalies around -2°C) and dry, but not so extreme as in January.

Easthern, central and southern Europe became considerably colder due to cold air advection from the east to the west and occasional polar air advection from the northwest. Within the large-scale trough, which extended further to the south, much cyclonic activity was able to develop over these areas and led to a very wet month there. In **Denmark**, this month was already colder than normal. In the **Netherlands**, the temperature was around normal in De Bilt due to its position near to the North Sea, but the precipitation exceeded the normal by about one half. **Belgium** was influenced by maritime air flows at the beginning of the month, but was affected by polar air at the end of February. Thus, on average this month was around normal. Those areas which are not very close to the coast were mainly under the influence of the polar air, e.g. Uccle was cold with 1.1°C below normal and had a precipitation total of 153% of the normal. **Luxembourg** in contrast reported a slight deficit of precipitation, but an even lower temperature anomaly of -1.5°C. Seven ice days (Tmax <0°C) were recorded at the airport of Luxembourg, soil frost occurred nearly every day. **Germany** was 1.1°C too cold compared to the normal, in southern Germany in parts more than 3°C. On February 28, minimum temperatures below -20°C were measured at several locations, e.g. at Munich airport -23.2°C. The mean precipitation was 121% of the normal (in parts more than 150%); sunshine duration was only 95% of the long-term average. Snowfall occurred frequently. In **Poland** too, February was colder and wetter than usual. Temperature anomalies were between 1 and 3°C below normal, the lowest minimum of -23.3°C occurred in the south. Precipitation was particularly high in the southwest (200%); the highest diurnal total of 47mm was registered in the Sudeten Mountains. Snow depths of 10-30 cm were measured in the lowlands, in mountains they exceeded 2 m. The **Czech Republic** also reported a very cold February with an anomaly of -2.6°C and 165-170% of the normal precipitation. In the **Ukraine**, the temperature anomalies were lower (around -1°C or less), but the precipitation totals were high (140-190% of the normal). The absolute minimum temperature of that month and year (-31°C) was measured in the Carpathian Mountains. In the northern part of the Ukraine, the minima were between -23 and -29°C, in the south between -17 and -23°C. In **Austria**, the temperatures were 1 to 3°C below normal. On the mountain Sonnblick (3109m) a temperature of less than -30°C was measured on February 28, for the first time since 1996. The precipitation amounts varied from 25% in the west and south to 200% in the north and east. Continuing snowfall in the county of Styria caused traffic accidents and interruptions of transport links. In the district of Bad Aussee several localities were not reachable for some days. Avalanches were very frequent, especially on February 5-6.

On **February 12**, a convective **storm** developed from an Atlantic low and passed over central Europe. Damage was reported from all over the country in **Belgium**. In **Germany**, gusts up to 152 km/h were reported from the highest mountain Zugspitze in the Alps and 122 km/h on Rügen in the Baltic Sea. Houses were untiled, severe traffic accidents occurred. In southeastern Germany many river banks were flooded. A cold front passing the Alps resulted in a significant incursion of cold air in **Switzerland** on February 13; this marked the beginning of an unusual long period of cold winter weather there. Up to the end of February, 12-17 days with mostly light snowfall were observed in the areas north of the Alps. In Zürich there were even 19 days

with snowfall. To find a similar number of snowfall days, one has to go back to 1996 and 1986. Due to the low intensity of the snowfall, the snow depth was not extreme. In central **Austria**, heavy snowfalls occurred already on February 11 and 12.

In **Slovenia**, the temperature anomalies varied from -1.2°C at the coast to -4.4°C in the Julian Alps. The coldest period was on February 5-10. The lowest temperature at Kredarica occurred on the last day of February (-25.7°C), at Murska Sobota (northeast Slovenia) -24.1°C were registered. Although these were very low temperatures, they were not the lowest ever measured in February. The monthly precipitation normal was only exceeded in the northeast and southeast of Slovenia, but nowhere were the totals higher than 90 mm. At the coast, in Vipava Valley and in most of Soča Valley less than 20% of the normal precipitation fell. In the Upper Sava Valley the snow cover persisted throughout the month, in Ljubljana it reached 25 cm on February 26, in the mountains at Kredarica 190 cm on February 27. In **Croatia**, this February was among the 10 coldest at most of the stations, with anomalies between -2 and -5°C (Fig. 2.2). Precipitation was mostly higher than normal, especially in the northeast with more than 140% at some stations. **Hungary** also was very cold (mean anomaly -3.6°C) and wet (precipitation 128% of the normal). From **Serbia and Montenegro**, large negative temperature anomalies between -2.4 and -7.9°C were recorded; the number of ice days also was higher than normal at all stations. The lowest temperature of -35.0°C was measured at Karajukića Bunari (western part of the country) on February 7. There was snow during the whole month on the territory of Serbia and in mountainous regions of Montenegro. A new record of snow cover was reached on February 26 in Žabljak with 230 cm. The month was also colder than normal in **Romania** with excessive precipitation and severe winter phenomena. **Macedonia** reported temperature anomalies between -2 and -3°C. **Bulgaria** had an anomaly range between -1.0 and -3.5°C and precipitation totals of 150-250% of the normal. Two Mediterranean cyclonic systems affected Bulgaria, one on February 3-6 and another on February 13-17. Wind speeds up to 144 km/h were measured in both cases. In particular the second system also affected eastern **Greece** and the Aegean Sea; gusts of up to 120 km/h were measured in Attica (around Athens) which was exceptional for this area. Damage was reported from the port of Piraeus (sinking of boats) and electricity interruptions on the Cyclades.

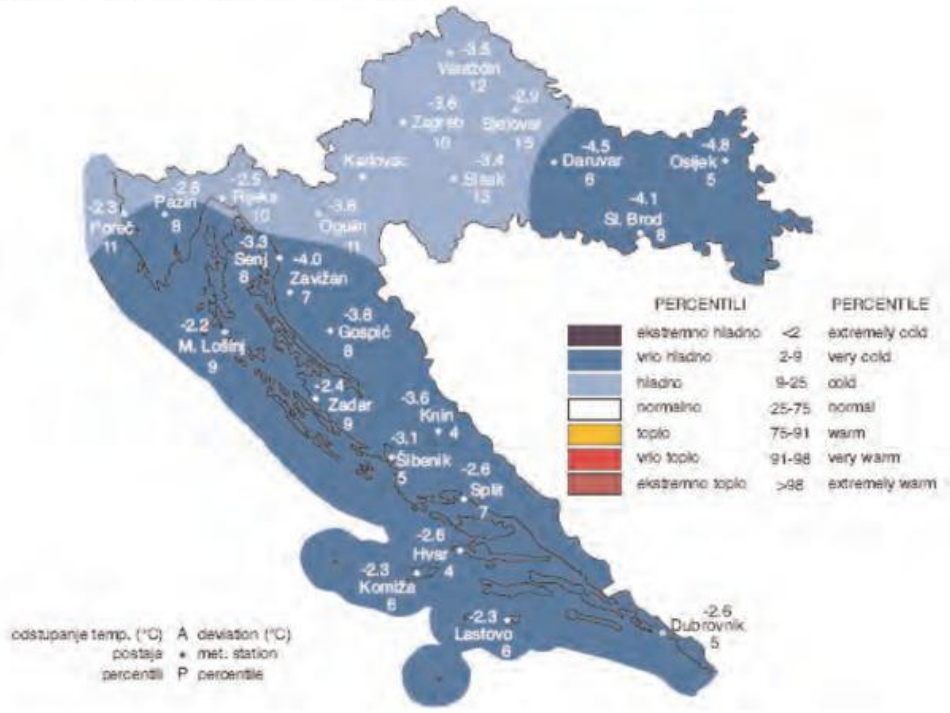


Fig. 2.2: *Monthly mean temperature anomalies in February 2005 from the 1961-1990 mean (upper numbers) and percentiles (lower numbers) in Croatia*
Source: Meteorological and Hydrological Service Croatia

The cold air also reached the Mediterranean. In **Italy**, it was about 2 to 3°C colder than normal in the whole country; it was drier than normal in the north, but wetter in the south due to some cyclonic activity in the Mediterranean. **Greece** had a cold spell on February 8-10; the temperature minima dropped below zero particularly in the northern and central mainland, in higher elevations (e.g. Florina, 689m) down to -17°C (the long-term mean is -1.7°C). **Cyprus** was 0.4°C colder than normal on monthly average, but dry (63% of the normal precipitation). On February 17-19 and again on February 28, suspended dust from north Africa affected the island.

The very southeast of the Region was not or only rarely affected by low pressure systems, so that it was cold but dry in this part. In **Armenia**, the monthly mean temperature was 1 to 2°C below normal, during February 5-15 even 3 to 8°C, in the mountain regions 9 to 12°C. The diurnal minimum temperatures reached down to between -20 and -30°C in mountain regions and between -10 and -19°C in valleys. Two warm spells occurred on February 19-22 and February 27-28 with anomalies between +6 and +11°C. Maxima in the Ararat valley and in eastern regions between 10 and 20°C were measured. It was dry during the whole month (25-70% of the normal precipitation). In some regions gusts up to 133 km/h were registered.

At the eastern Mediterranean coast, the **Lebanon** was mostly warmer and wetter than normal. In **Israel**, February was rainy in the northern and central parts of the country (120-160% of the normal precipitation) and drier than normal in the southern parts (less than 50%). Most of the rain fell in the first half of the month. Snowfall occurred in the mountains in northern Israel. The last rainfall period was on February 19-20, afterwards only minor rainfall affected Israel until the end of the rainy season. The average temperatures were close to normal, but the first half of the month was colder (night temperatures below 0°C in the mountains), the second half was warmer. On February 18-19, 28 to 30°C were recorded in the coastal plain and in the Negev.

March 2005

- **Warm in the west, cold in most of the east**
- **Dry in most of northern, central and southern Europe, wet in most of the east**
- **Cold spell with snow at the beginning of March**

The circulation structure remained mainly meridional, but the Atlantic high pressure zone of the previous winter month became weaker and moved to Europe. Instead, a cyclonic complex developed over the Atlantic. The warm Atlantic air extended to the western half of Europe and was mostly under subsidence, so that it still remained dry in these areas. Atlantic low pressure systems weakened very rapidly over Europe.

It was a very warm month in **Greenland**. Angmagssalik had a temperature anomaly of +6.9°C, Danmarkshavn +2.8°C. **Iceland** was mostly warm with very light snow conditions. There was no snow in Reykjavik for the first March since 1977. Especially the southeast was very dry. Westerly winds prevailed during this warm spell and transported sea ice from the East Greenland current eastward along the northern coast of Iceland. However, the ice cover was generally thin, and coastal shipping was affected for only a few days.

Ireland also was very dry and mostly warm. Near Dublin, at Casement Aerodrome, only 15 mm of precipitation was registered. These were only 31% of the normal, and this month was by far the driest of 2005. The monthly mean temperature anomaly amounted to +2.0°C there. However, there was a cold spell at the beginning of the month, and thus also the lowest air and ground temperatures of the year were recorded. The monthly mean temperature for the **United Kingdom** was 1.7°C above average, which was warmer than March 2004, but not as warm as 2002 and 2003. With sunshine levels at 81%, this was the dullest March for the UK since 1998. The precipitation total was 79%, and this was the 7th consecutive March to experience below average rainfall. Also here the cold spell at the beginning of March was observed with snow drifts up to 30 cm over the Downs (southeast England), causing transport disruption and school closures in Kent and Sussex. Boltshope Park (Durham) reported 40 cm of snow on March 3, the last day of snow lying there in this spell was March 14. In **Denmark**, a snow blizzard, caused by a polar low, passed the islands on March 13-14.

Central Europe was also mainly influenced by the warm and dry air. In the **Netherlands**, De Bilt was 1.5°C warmer than normal; the monthly precipitation total was 79% of the normal. The cold spell at the beginning of March was also experienced in this area. A large part of the north of the country was covered with 20-50 cm of snow on March 2-3. A snow cover of this extension is very rare in the Netherlands. The recurrence time is estimated to be less than once in 50 years. On March 4, the lowest temperature ever measured in the Netherlands in any March was recorded in Marknesse (Ijsselmeer region) with -20.7°C. The polar airflow in the first half of March was also reported from **Belgium**, but again the mean monthly temperature was above normal (+1.7°C in Uccle), precipitation was 72% of the normal. Sunshine duration and mean wind speed were low, too. **Luxembourg** was also dry (only 36% of the normal) and warm (+1.1°C above normal), but a very cold night was registered in the morning of March 1. The station Schimpach (northwest Luxembourg) recorded -18.3°C that morning. **France** as well had a very cold first half of the month, and then a warming took place. Precipitation was below normal except in the centre regions, Limousin, Auvergne and Alsace. Similarly in **Germany**: after a cold first half of the month, it became very mild especially in the southwest. Record temperature minima (lowest values since measurements began) were registered on March 1 in southern Germany, e.g. Augsburg -24.2°C, Stuttgart Airport -18.6°C. In northern Germany, this cold spell was characterised by heavy snowfall, causing chaotic traffic conditions on the roads. Another push of snowfall arrived on March 11-12, when a frontal system passed central Europe from the north to the south. On the monthly average, it was around 1°C warmer than normal in the west, and colder than normal in northern and eastern Germany. Nearly all over the country it was dry; mostly just 50-60% of the normal precipitation were recorded, in the eastern and southwestern areas partly less than 40%.

Extreme temperature minima over freshly fallen snow on March 1-2 were also measured in **Switzerland**, in particular in the plains north of the Alps. Also here, the weather character changed abruptly in the middle of March. A warm air high, situated over Italy, caused a radical rise of temperature. In the Ticino, temperatures up to 28°C were almost summerlike, a new record for that time of year. In **Austria**, March also started extremely cold with frost down to -27°C (Seefeld/Tyrol) on March 1. Some small towns in Styria were not reachable until March 9 due to high amounts of freshly fallen snow. On March 10, a large roof of a supermarket collapsed under the snow load. The prolonged melting of snow afterwards caused flooding situations near the main rivers. On March 18, the river Enns in Upper Austria partly flooded the town of Steyr. In the northwest of Lower Austria, in the region Waldviertel, streets were flooded by melting ice masses of the river Kamp along a distance of 2 km. On monthly average, the temperatures were about normal in western and southwestern parts of the country and 1°C below normal in the remaining parts. Precipitation reached normal amounts only in the northern parts of the Austrian Alps; most parts of Austria only received 25-75% of the normal. **Hungary** too, was cold (-1.8°C), but sunny and dry (74% of the normal precipitation) on average. Temperatures were also was mostly below normal in **Slovenia**, and also here the coldest period

was on the first two days of March (Fig. 3.1), the deepest snow cover was on March 4, at Kredarica in the highland it was 210 cm on March 5. Most of the lowland had more days with snow cover than normal. The warmest day mostly was March 18, at the coast it was March 29. The difference between the lowest and highest temperature this March was great, in Celje it was 45°C. Precipitation was below normal, the lack of precipitation was most evident in the north of the country. Colder than normal temperatures were also reported from **Croatia**, between -0.3°C on the islands in the west and -2.0°C in the east. The precipitation totals were mostly around normal, or, especially in the west, lower, on the islands only 30-65% of the normal.

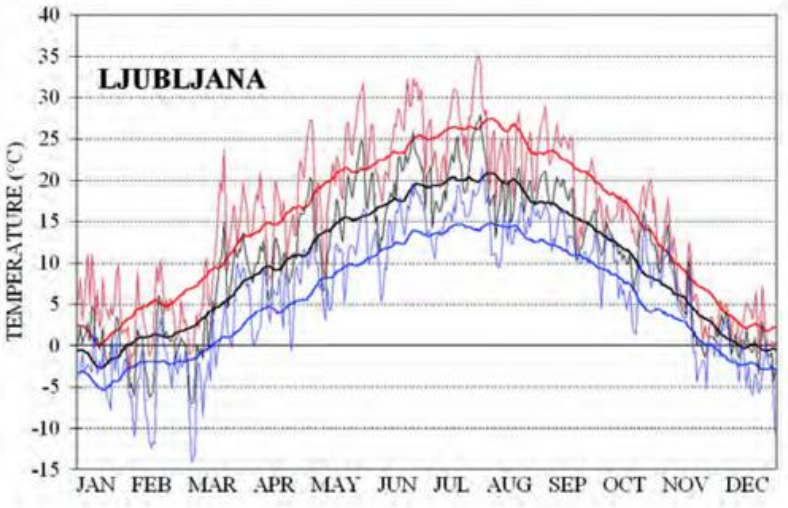


Fig. 3.1: *Daily minimum (blue), mean (black) and maximum (red) air temperature in 2005 (thin lines) and on average of the 1961-1990 mean (thick lines)*
Source: Environmental Agency of the Republic of Slovenia

In **Portugal**, the month of March continued the period of very low precipitation amounts, namely in central and southern regions. At the end of March, 52% of the territory was in drought conditions of severe to extreme intensity (according to the Palmer Drought Severity Index). The monthly mean temperature was above normal, but also here, the minimum temperatures were very low in the first days of the month, records were broken. On March 1, minima below 0°C were observed at 80% of the stations in Portugal, at 30% of the stations the minima were even below -5°C. Only in Faro (Algarve) was the minimum above 5°C (Fig. 3.2). **Spain** also was very dry and on average warmer than normal. Madrid reported a monthly temperature anomaly of +0.9°C and 10 mm of precipitation (30% of the normal). On March 1, after a cloudless night, the minimum was only 1°C. **Italy** was colder and on average mainly drier than normal . As an example, Pisa had a temperature anomaly of -0.7°C and received 66% of the normal precipitation.

Moving to the north, in **Norway**, the temperature varied greatly in the whole of the country. At the beginning of the month, after a temporary cold airflow from the north, Røros Lufthavn registered -39.4°C which was the third lowest temperature measured there. After the high pressure zone and the warm air had moved to Europe, the same station measured 13.2°C at the end of the month which was a new maximum temperature record for March.

Sweden was mostly influenced by colder air from the east. Still wintry conditions with snow in the south were reported. **Finland** also was mainly colder than normal and the exceptionally dry period of February continued. **Estonia** was very cold in particular in early March. In Jogeva (northern central part of the country, also called the Estonian “cold pole”) a colder first decade of March was only recorded in 1942 and 1987. The monthly mean temperature anomaly was -3.5°C, a minimum of -27.8°C was registered which was also the coldest of the whole year. It was also the driest month of the year with 13 mm of precipitation or 43% of the normal. **Latvia**

reported a temperature anomaly of -3.4°C, and 74% of the normal precipitation. In **Lithuania** too, March was cold (monthly mean anomaly -3°C, in its coldest period between -8 and -12°C). Here, the precipitation totals were close to normal in most regions, but some places received up to 65-80 mm (150-200% of the normal). Most of the precipitation fell in the first half of the month; the number of precipitation days of this month was 23.

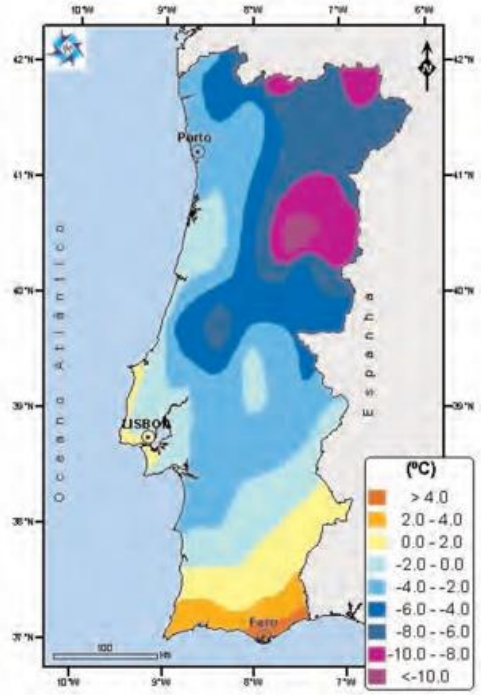


Fig. 3.2:

Minimum air temperatures in Portugal on March 1.
Source: Instituto de Meteorologia, Portugal

In the eastern part of the Region, a low pressure system developed. Thus, this area was mostly wet this month and the cold air did not become much warmer in spring. The monthly mean temperature of the European territory of **Russia** was between 2 and 4°C lower than normal. Such a cold March had not been observed before in the northwestern district since 1981 and in the central district since 1996. The largest anomalies (between -5 and -6°C) were recorded for the Nenetsky autonomous region, the area around Arkhangelsk and the Republic of Komi. Precipitation was mostly above normal, in particular in the Ural, especially in the southern part (300-500% of the normal). There were heavy snowfalls and avalanches particularly on the northern slopes of the Caucasus Mountains. The Trans-Caucasus motorway was opened only during the night. It was colder than normal also in **Poland** (between -1.4 and -3.3°C) with the coldest region in the northeast. The absolute minimum of that month was -20.6°C. Precipitation totals reached 150% of the 1971-2000 mean in the north and east, only the southeast was drier (less than 50%). It was also windy; gusts of 115 km/h in the mountains and 108 km/h at the coast were measured. In the **Czech Republic**, an extraordinary high snow cover was to be observed in the mountains, up to 345 cm on the crests of the Krkonose Mountains in northern Bohemia on March 15. The month was cold furthermore in the **Ukraine** (anomalies between -1.5 and -2°C), but the precipitation totals were very variable (80-140% of the normal). In **Romania**, an alternation of cold and warm periods averaged the monthly mean temperatures close to normal, except for the west of the country, where it was colder than normal. Precipitation totals were mostly above normal except for the northeast and southeast of the country, which had close to normal values. The month was cold in the whole territory of **Serbia and Montenegro**. In the first half of the month the number of ice and frost days was much higher than usual. Some absolute temperature minima records were broken. On March 7, the highest ever measured snow depth of 156 cm was registered in Kolašin (northern Montenegro). Only in 4 years since 1949 was the maximum snow depth more than 1 m. On the same day in

Kotor (coastal town in Montenegro), a snow cover was observed, which had never been experienced before at that location at that time of the year. The cold and wet spell on March 7 even reached **Macedonia** (Fig. 3.3), which was in clear contrast to the second warm and mainly dry half of the month. **Greece** reported an exceptionally large maximum temperature difference between the north and the south of the country on March 1, reaching 33°C between the coldest area in the northwest (-7°C) and the hottest in the southeast (26°C). This extreme situation was a combination of a cold winter onset in the north and warm air advection in the south, in particular on Crete Island, in addition to a Foehn phenomenon. Unusually high daily maximum temperatures (4-8°C above the long-term mean) over several areas of the country, mainly over the mainland, were recorded on March 16-19. In **Bulgaria**, the temperatures were down to 1.5°C below normal. Precipitation was near normal in northern Bulgaria and 50-70% of the normal in the southern parts of the country. There were stormy winds with gusts up to 130 km/h, registered mainly in the north on March 5-7 as well as abundant snowfall in the southern mountains on March 7, causing avalanches which isolated mountain tourist sites. Again stormy winds were registered on March 18-19 in northern and southern Bulgaria, enforcing a state of emergency at the Varna port. Forest fires occureed in the northwestern part of the country.

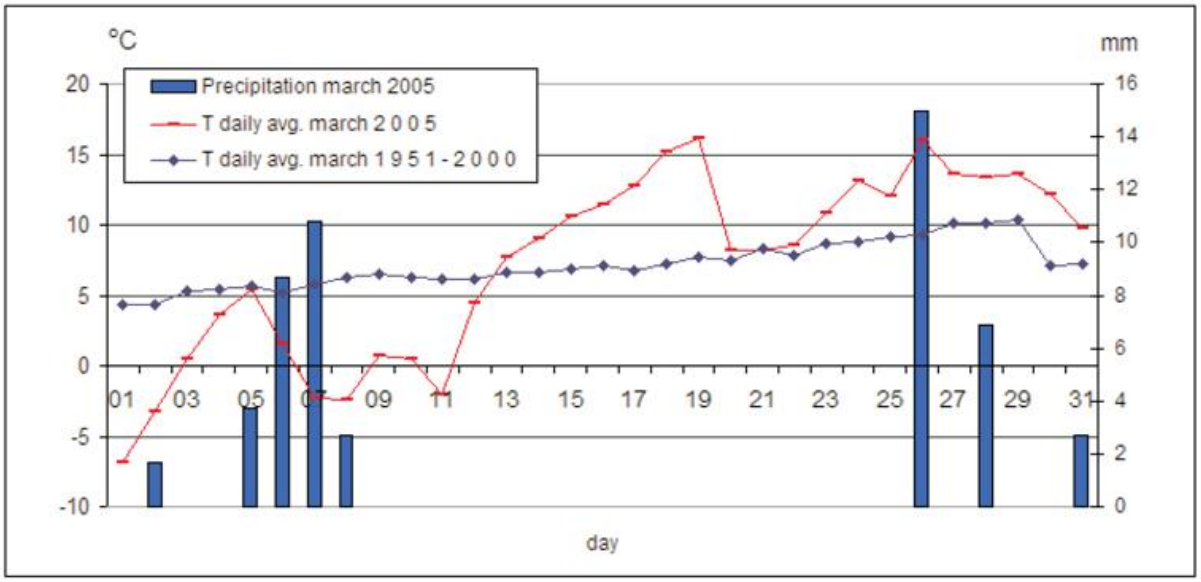


Fig. 3.3: *Daily mean air temperatures and precipitation totals March 2005 in Skopje Zajcev Rid, in comparison to the long-term temperature mean 1951-2000.*
Source: Hydrometeorological Service of Former Yugoslavian Republic of Macedonia

Cyprus in the eastern Mediterranean remained mainly within a warm and dry air mass, the temperature anomaly was +1.5°C, and precipitation was 45% of the normal. The dust which affected the island on the last day of February remained suspended during the first days of March. The **Lebanon**, too, had temperature anomalies mostly around 1 to 2°C above normal and precipitation totals below normal. **Israel** too was warm and dry this month. Rainfall amounts reached 30-50 mm in most parts of the country and were recorded mostly on March 8-11. These amounts were only 20-30% of the normal in the northern parts of the country and 40-60% in central Israel. In the southern parts which normally receive smaller amounts of rain, the monthly totals were 150-200% of the normal. On March 31, 33 to 34°C were measured in the coastal plain and in the Negev. In **Armenia**, March was 0.5 to 1°C warmer than normal, except for the last few days of the month, when the daily minimum temperatures reached values between -15 and -20°C in mountain regions, at the stations Ashocq and Masrik even -26°C, and between -5 and -10°C in the valleys. Precipitation totals were 150-200% of the normal. In some regions, strong winds were measured (gusts to up to 108 km/h).

April 2005

- **Warm in the whole Region except in parts near the Mediterranean**
- **Still very dry in southwestern Europe, Greece and most of northern Europe**
- **Wet in most of western and southern central Europe**
- **Late snow in Switzerland on April 7**

During most parts of the month a ridge extended over southwestern Europe. West of this ridge, warm air and low pressure systems moved from the Atlantic especially to western and southern central Europe. Northern Europe was influenced by a secondary ridge causing warm and dry conditions.

It was particularly warm in **Greenland** with temperature anomalies between +2 and +3°C, but precipitation around normal. **Iceland** was only weakly affected by low pressure systems, so that the month was mainly warm and mostly dry, but windy. Reykjavik was 1.3°C warmer than normal. In **Norway** too, the monthly mean for April was markedly above normal in the whole country. The largest anomaly was found in the inland parts of the county of Troms (northern Norway), where the temperature was up to 3.2°C above normal. Precipitation varied greatly between the different regions of Norway. In parts of the counties Finnmark (north), Hordaland (southwest) and Sogn og Fjordane (southwest) the monthly total was 200-300% of the normal, while parts of the counties Oppland and Hedmark (both in the east) received only 20-40%. **Sweden** had temperature anomalies of around +2°C, it was mainly dry, especially at the east coast. In Stockholm, only 37% of the normal precipitation fell. **Denmark** was also warm and mainly dry. In **Finland**, the dry period starting in February continued into this month. Helsinki had an anomaly of +1.5°C and only about one third of the normal precipitation fell.

Influenced by frequent Atlantic lows, **Ireland** was warm and mainly wet, especially in the west. For the **United Kingdom** as well, April was a warm and wet month (mean temperature anomaly +1.2°C, 135% of the normal precipitation). Newcastle recorded 74 mm in the 48-hour period ending 09 UTC on April 16.

Central Europe was quite warm also. In the **Netherlands**, this April was the 5th warmest since 1901. De Bilt reported a temperature anomaly of +2.4°C. Precipitation was slightly higher than normal. In **Belgium**, too, the Atlantic air flow from the south led to warmer than normal temperatures (+1.9°C at Uccle, precipitation around normal). The mean wind speed was exceptionally low. **Luxembourg** also had a high temperature anomaly (+2.4°C) and was drier than normal. In **France**, the monthly mean temperature was higher than normal by 1 to 2°C, except in the southeast, where the anomalies were lower, but still positive. Very high temperatures were observed at the end of the month. Most regions were quite rainy, but it was dry in Poitou-Charente, Languedoc-Roussillon and in the southeast (Provence, Alpes, Côtes-d'Azur). It was also warm all over **Germany**, on average the normal was exceeded by 1.9°C. Here, the western and southern parts were particularly wet (e.g. Frankfurt 207%, Bonn 249% of the normal precipitation), while the north and east, which were still under high pressure influence in the first half of the month, were dry (less than 50%, locally less than 25% of the normal). Widespread high precipitation with flooding occurred on April 25-26 in southern and western Germany. April was a warm month also for **Poland**. The deviations of the monthly mean temperature from the normal reached up to +2°C in the west and south. The extreme temperatures ranged from -7.1°C in the centre of the country up to 22.0°C in the southeast. Numerous local ground frosts were observed, resulting in plant damage. Precipitation varied a lot from less than 20% in eastern Poland up to 180% in central and southeastern regions.

There were some remarkable precipitation events in **Switzerland** this month. On April 7, a low pressure system caused persistent precipitation south of the Alps and later the same low brought snow to the area north of the Alps, even to lower regions. Berne reported 5 cm of fresh snow in the morning of April 7, Geneva 3 cm. This had never happened so late in the year since 1931, when systematic snow observations started. Even more snow, up to 30 cm, was reported from the Lausanne area. The precipitation was caused by the collision of warm and moist air masses coming from the southwest and cold air masses from the north. On April 16-17, a further low, moving from southern France to northern Italy, again caused notable precipitation in the Jura and the midlands of Switzerland, partly as snow even in the plains. This low moved further on over **Hungary**, causing flash floods and consequently destroyed roads, houses and bridges in Mátrakeresztes (northern Hungary). The daily precipitation amount on April 18 (63 mm) was 150% of the monthly normal in April.

On the monthly average, **Switzerland** and **Austria** were warmer than normal. Temperature anomalies reached up to +1.5°C. Precipitation in Austria varied from 200% of the normal in the northwestern and southern parts to less than 75% in the Vienna region. **Hungary** reported a mean temperature anomaly of 0.5°C and 168% of the normal precipitation. In **Slovenia** too, temperature was slightly above normal in most of the country, only at the coast and on the Trnovska plateau (northeast) was it slightly below. The warmest period was during the last four days of April. Precipitation was mostly above normal, in the Koroška region (northern Slovenia) 175%, in some parts of the Julian Alps, the coast and Kočevje (southeast) slightly below. A maximum snow cover of 240 cm at Kredarica was reached on April 26. In **Croatia** the temperature was mostly less than +1°C above normal, precipitation varied greatly over short distances from 84 up to 190%. **Serbia and Montenegro** reported a very cold first decade of the month with frost and an extremely warm period with summer days (Tmax>=25°C) afterwards. In the northeastern part of Serbia, heavy precipitation and floods were observed, especially in the period April 13-27. At Veliko Gradište, a daily total of 63 mm was registered on April 18. At Kikinda, 444% of the normal precipitation was registered for the period April 11-30. Since there had already been plenty of rain during the past winter, the soil was very moist. Flooding of the river Tamis occurred, and high water levels were registered in the Timok basin as well as on the left tributaries of Velika Morava.

Some frontal systems also reached eastern Europe, especially later in the month. **Estonia** was warm and sunny only in the first half of April. Then it became abruptly cold and there was even snow. The month on the whole was still 1.0°C warmer than normal and precipitation was only 55% of the normal. **Latvia** had a similar temperature surplus (+1.1°C) and precipitation deficit (53% of the normal). Moreover, in **Lithuania** it was predominantly warm (+1.3°C) and dry (63% of the normal precipitation) that month, but in the third decade it cooled down considerably, reaching minima between -2 and -7°C. In **Russia**, this April was the warmest of this century up to 2005. Positive anomalies occurred almost all over the country. However, due to frequent cyclonic activity, it was mostly wet. A lot of snow was to be observed in the Ural and spring floods were very intensive in the east of the Russian European territory. From the **Ukraine**, temperature anomalies around +1°C in all regions were recorded. Precipitation amounts varied between 60 and 120% of the normal, on average there was a precipitation deficit.

For **Romania**, frequent cyclonic activity resulted in a month colder and wetter than normal. Large amounts of precipitation were accompanied by hail, thunderstorms and strong wind gusts. In the southwest of the country, rains were torrential and monthly precipitation excesses of more than 225% were measured (Fig. 4.1). The resulting flooding caused considerable damage. Averaged over the country, the precipitation total was 145% of the normal, which is still high. Numerous hailstorms were also reported from **Bulgaria**, causing damage to agriculture and property. Hailstorms are rather unusual for a spring month such as April there. On the monthly average, it was dry (precipitation only around 50% of the normal), temperatures

were around normal. However, there were frost conditions during the period April 24-26, especially in northern Bulgaria, but on the other hand, maximum temperatures up to 29°C also occurred in this month.

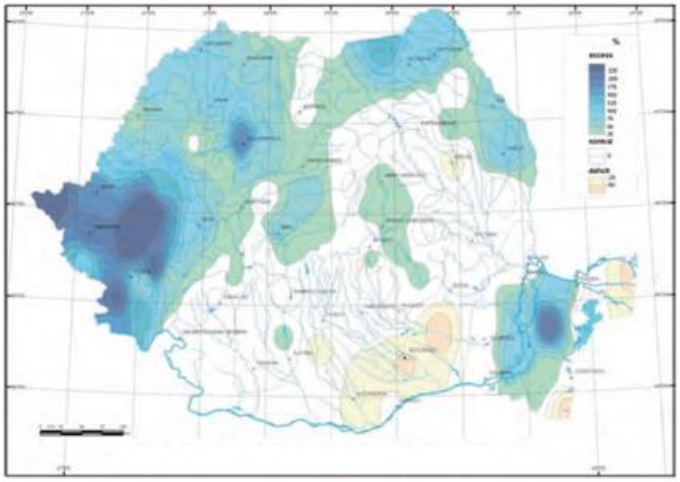


Fig. 4.1: *Deviation of monthly precipitation amounts from normal in April 2005 in Romania (in % of the normal)*
Source: National Meteorological Administration, Romania

In **Portugal**, it continued to be warm and very dry, in particular in the central and southern parts of the country. At the end of April, 63% of the territory was in a drought condition with severe to extreme intensity. It was similar in most of **Spain**; Madrid had a high temperature anomaly of +2.1°C above normal, and only 26% of the normal precipitation fell. Only northern Spain was affected by some more rain from frontal systems. In **Italy**, the temperatures were around normal, but it was very wet locally, e.g. in Sicily. **Greece** reported temporarily high daily maxima of 23-29°C on April 26-28; long-term monthly maximum means for April are only around 20°C. The month was unusually dry in almost the whole country. On Naxos, the precipitation was zero, compared to a long-term average of 17 mm (Fig. 4.2). **Cyprus** was warmer than normal by 0.6°C and only slightly drier than average (91% of the normal). On April 9-10 and April 17, suspended dust affected the island.

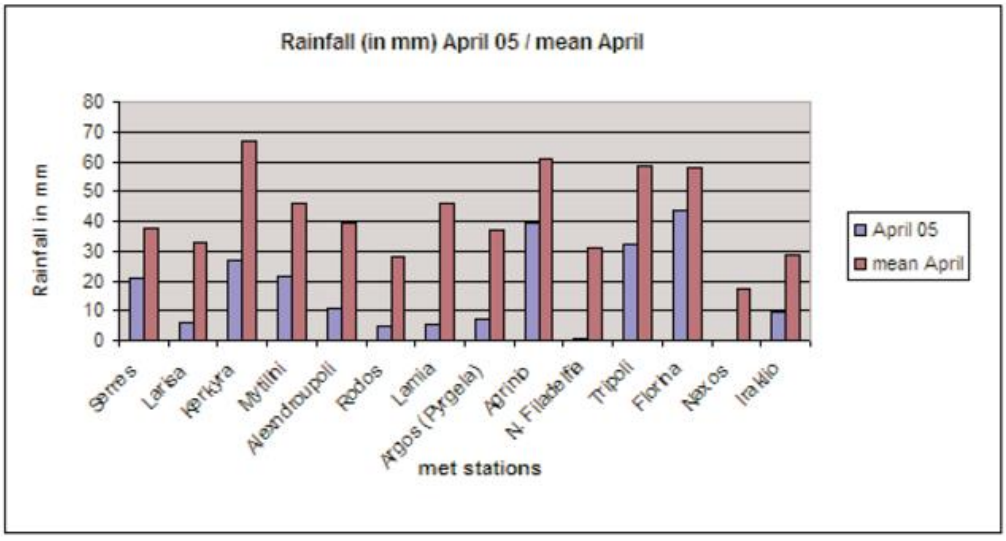


Fig. 4.2: *Monthly rainfall totals in April 2005 at various stations in Greece, compared with the long-term mean (different reference periods)*
Source: Hellenic National Meteorological Service, Greece

Armenia reported a high positive temperature anomaly of 1 to 1.5°C above normal, but there was a cold spell on April 3-9 when the temperature was 2 to 7°C below normal in most of the country, in some regions even 11°C below. The daily minimum temperatures reached between -10 and -15°C in mountain regions and between -2 and -7°C in the Ararat valley. April 23-24 were the hottest days of the month with maxima of 30 to 33°C in the valleys and 22 to 29°C in mountain regions. These values were the highest on record for these days. Precipitation was mostly near normal, only in the eastern regions far below (25-54% of the normal). The **Lebanon** was mostly around 1-2°C warmer than normal, precipitation was around normal. In **Israel**, April was characterised by rapid daily changes of temperature. There were 7-8 Sharav days with hot and dry weather. The most extreme Sharav occurred on April 12 when 37 to 38°C were recorded in the coastal plain and in the Negev. Between the Sharav days, temperatures were much lower (Fig. 4.3). The rainfall amounts were small (10-25 mm) and were recorded mostly on April 1-3.

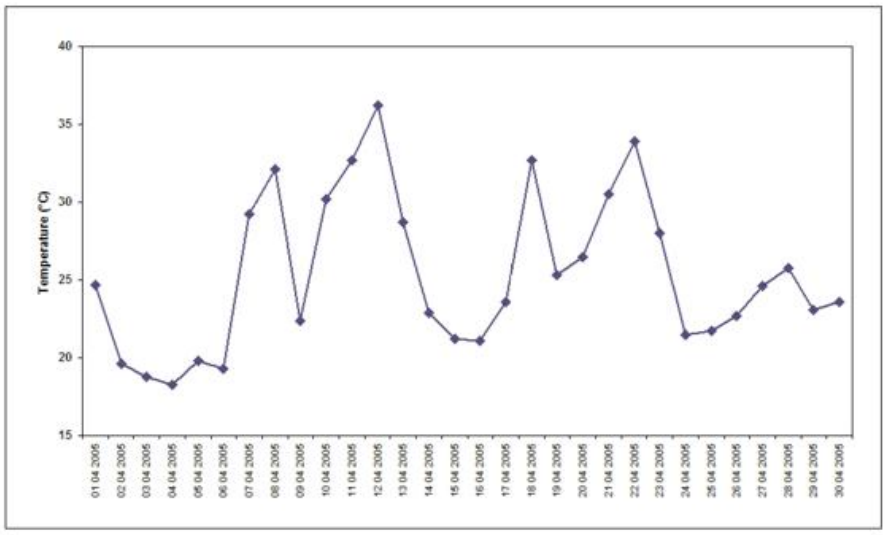


Fig. 4.3: *Maximum diurnal temperature in Bet Dagan (central coastal plain in Israel) in April 2005*
Source: Israel Meteorological Service

May 2005

- **Colder in the north, warm in the south and east**
- **High temperatures at the end of the month in central and parts of southern Europe**
- **Very wet in most of Scandinavia, eastern and northern central Europe**
- **Still dry in southwestern Europe**

During May, the circulation structure over the Region changed from a more meridional to a zonal pattern. Cold air remained mainly in the north and frontal systems moved frequently in the northern half of the Region from west to east.

Greenland was still within the warm air, therefore this month was warmer than normal, but wet in many parts of the country. The capital Nuuk reported a monthly precipitation total of 228 mm or 415% of the normal. During the period May 12-15, 165 mm were measured. In contrast, May was cold in **Iceland** with prevailing night frosts in most of the country, retarding the growth of vegetation. The island was not affected much by northern frontal systems, so that it was dry and sunny in the south of the country. At Vestmannaeyjar on the southern coast it was the driest May since the beginning of precipitation observations in 1881. The **Faroe Islands** were cold.

The monthly mean temperature was below normal also for most of **Norway** except the eastern parts of Finnmark and parts of Troms in the north. Only a few stations registered monthly maxima above 20°C. In parts of the country, the maximum for the month was the lowest for several years. Precipitation in Norway as a whole was 175% of the normal, the second highest since 1900. Many stations measured a new precipitation record for May. For the northern part of the country on average, May 2005 was the wettest registered at all. **Sweden** too, was cold except in the south and mainly wet. **Denmark** was slightly warmer than normal, but also mostly wet. In **Finland**, in the northern and eastern parts, it was raining two or three times more than usual, and, combined with melting snow, this led to all-time high water levels in some of the northern rivers and severe flooding. The western parts of the country were drier than normal, since there was local high pressure influence, and the temperatures were quite normal.

Estonia was rich in precipitation that month (nearly 150% of the normal). Thunderstorms were frequent, sometimes accompanied by tornadoes. The mean temperature was close to normal (anomaly +0.3°C). The precipitation was even more outstanding in **Latvia** (178% of the normal, temperature anomaly -0.3°C). It was the rainiest May in Latvia for 80 years. In the southeastern parts of the country it rained more than 400% of the normal. At the Daugavpils station this month had the highest rainfall amount in its history. On the other hand there was a lack of rain at the Baltic Sea coast. Especially during the first decade of the month, the difference between



Fig. 5.1: *A farm during the floods in south-eastern Latvia in May 2005.*
Source: Latvian Environmental, Geological and Meteorological Agency

the coast and the southeast was extremely high (8% versus 700%). The strong rain in the southeast resulted in a rise of the level of the river Daugava by 2-4 m above normal and flooding of small rivers in the southeastern province of Latgale, submerging parts of farms, fields, meadows and pastures (Fig. 5.1). Small dams were destroyed and some roads were washed away. High humidity after the rain together with flooded fields and a hot period caused extraordinarily large swarms of midges. More than 500 farm animals died as a result of massive

quantities of bites by these cloud-like swarms. In **Lithuania**, temperatures were around normal on monthly average, but especially the first half of May was much cooler than usual. Morning frosts between 0 and -6°C were even registered on May 20 in most regions of the country. In the third decade of the month, warmer air masses from the southwest reached Lithuania, resulting in a mean temperature anomaly of +3.5°C for this period. The highest air temperatures (28-33°C) were close to the absolute maxima for May or even exceeded them. Monthly precipitation was below normal in the west of the country, while reaching 300% of the normal in the southeastern and eastern regions. A hailstorm occurred on May 24, with a hailstone size of 30 mm at the town of Tauragė.

Russia recorded the highest monthly mean temperature (spatially averaged over the whole territory) since 1943 (Fig. 5.2). In the district of the Ural it was even the highest for 105 years. The warm weather was accompanied by frequent rain in almost the whole European territory, except for the region of the Volga River. Precipitation totals up to 300% were achieved at some locations. In the northern Caucasus area, strong precipitation caused flooding on May 9-10.

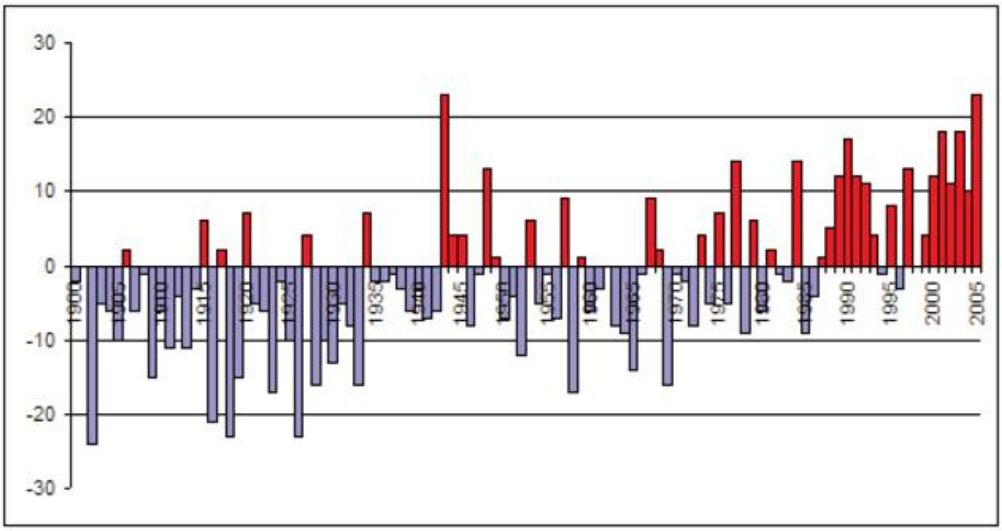


Fig. 5.2: *Anomalies of the monthly mean temperature in May in Russia 1900-2005 (in 0.1°C). Source: Roshydromet, Russia*

Atlantic cyclones moved frequently over **Ireland**, and thus, this month was mainly wet there with temperatures near normal. In the **United Kingdom** too, the mean temperature was close to normal (anomaly +0.3°C), but yet it was the coolest May since 1996. On May 18, Tulloch Bridge (Highlands) recorded -6.3°C, the lowest temperature so late in the season since 1956. On the other hand, central London recorded 31.9°C on May 27, the highest May temperature since 1947. Rainfall was near normal (102%), sunshine duration slightly above.

In northwestern central Europe, it was in general slightly warmer than normal, somewhat more towards the south, and the precipitation totals were more or less close to normal. De Bilt in the **Netherlands** was 0.3°C warmer, precipitation 89% of the normal. Uccle in **Belgium** recorded 0.5°C above normal and 85% of the normal precipitation. In **Luxembourg**, the temperature anomalies were even higher (+1.1°C), precipitation was close to normal (99%).

In **France**, the monthly mean temperature was nearly normal in the north and 1 to 2°C above normal in the south. It was mainly dry, especially in the south except for the Mediterranean coast; and also in some regions of northern France it was wet. Similarly, in **Germany**, a rainy and moderately warm weather character dominated in the north, and drier and warmer conditions in the south. In northern Germany, in parts more than 150% of the normal precipitation was recorded, locally more than 200%. In southern and central Germany, the precipitation totals were mainly below normal and temperature anomalies of more than +1°C,

locally more than +1.5°C were to be found in the south. On country average, 112% of the normal precipitation and 0.6°C above the normal mean temperature were computed. However, over large parts of the month, it was rather cool, but at the end of the month it was hot and at many stations new temperature records for May were registered. This was also characteristic for this month in **Poland**. While ground frosts were recorded until May 20, the maximum temperature exceeded 25°C at the end of the month; the highest value of 33.4°C was noted in the west of the country. It was generally wet in Poland with 200% of the normal precipitation in the central parts of the country. The highest diurnal rainfall amounted to 83 mm and was measured in the Klodzka Valley in the Sudeten Mountains. Several episodes of heavy precipitation were also reported from **Slovakia**. In the **Ukraine** the precipitation totals varied from about 60 to 120% of the normal with a near to normal temperature on average. The southern part of the country had a drought period this month.

Thunderstorms causing damage in central, northern and western **Belgium** occurred on May 2-3 after intensification of a frontal system, partly with hail. This system also passed across **Germany**, and further fronts followed. Damage from thunderstorms was reported from western Germany on May 3, from eastern Germany on May 4-5. In **Hungary**, a low developed at the same time, causing heavy local rain and serious flash floods in Mád in the region of the Zemplén Mountains on May 4. On May 18, again a heavy storm rushed through Hungary. 2500 buildings were destroyed nationwide, several villages suffered from the lack of electricity; trees, traffic sign boards, roofs were torn up by the strong winds.

Another thunderstorm with heavy rain, flooding of streets, and hail was reported on May 21 in Munich, southern **Germany**. **Austria** reported thunderstorms two days later, on May 23 in Upper and Lower Austria, also with heavy rain, hail and local devastations. In the Melk district, several localities were flooded completely. In **Poland**, violent storms occurred with wind gusts of up to 104 km/h.

In **Switzerland**, the beginning of May was dominated by warm weather. On May 3 a disturbance introduced a period with alternating but not very cold weather. There was rain of light or moderate intensity at regular intervals. This type of weather, which is more common for April, lasted until May 23. After that, a large high gave rise to an exceptionally warm and summery end of May as in Germany and Poland. For the first time in 2005, many stations reported temperatures above 30°C. Similarly in **Austria**, outstandingly hot days occurred on May 29-30 with new all-time record temperatures, e.g. in Vienna 33.7°C and Graz 33.1°C. The monthly mean anomaly reached +1.5°C above normal. The precipitation amounts showed a gradient from less than 75% of the normal in the south to more than 125% in the north of Austria. **Slovenia** also had high positive temperature anomalies; only at the coast and in Kočevje was the anomaly less than +1°C. The highest deviation was recorded in the northwest of the country. Here again, the last days of May were significantly warmer than on average and almost dry. Monthly mean precipitation was mostly below normal; only 40-60% of the average precipitation fell in the northwest.

Serbia and Montenegro had a warm beginning to May with maximum temperatures of 30°C and more, then a cold and wet spell, partly with frost until May 24, and the last days of the month were very warm again. For the period April 10 to May 21, the precipitation amounts were more than 200% of the normal, locally more than 300% (Fig. 5.3). All that influenced the water level considerably. In the area of Leskovac many houses were flooded during that period and large material damage was caused. **Croatia** had temperature anomalies mainly between 1 and 2°C, the highest on the southern islands; only in the east of the country were the anomalies below +1°C. In particular, a heat wave occurred on May 27-29. The southern parts also had little precipitation (at some stations less than 30% of the normal); in the northern parts the precipitation was very close to normal. **Hungary** had a mean temperature anomaly of only +0.5°C; precipitation was close to normal (93%). In **Romania** too, temperature and precipitation were not far from normal. On May 7, strong precipitation again caused flooding as in the

previous month. **Bulgaria** was normal to warm as far as temperatures were concerned (anomalies up to +1.5°C) and wet (150-200% of the normal precipitation). It was also a stormy month for Bulgaria with 26 days of thunderstorms and 19 days of hailstorms. Especially on May 29, widespread severe hailstorms occurred in northeastern Bulgaria; a tornado was reported too. Generally in the last decade of the month, abundant rain, swollen rivers and floods were to be observed. Up to 255% of the normal monthly precipitation was registered.

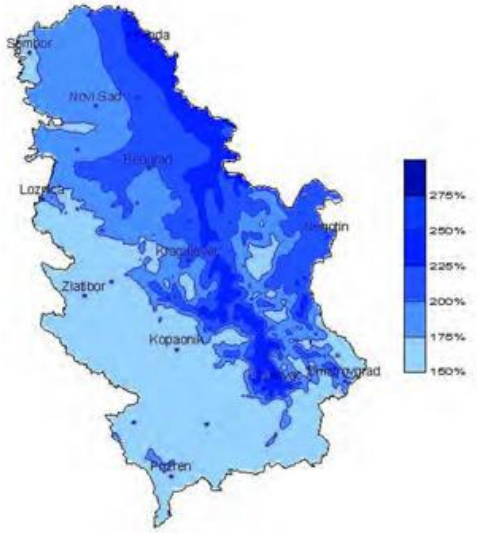


Fig. 5.3:

Precipitation in Serbia and Montenegro for the period April 10 – May 21 in % of the 1961-1990 mean
Source: Republic Hydrometeorological Service of Serbia

Southwestern Europe was still in a southwesterly warm air flow during the first decade of the month. The average monthly temperatures in **Portugal** were above normal (1 to 2°C) in the whole territory. The precipitation amounts were below normal in the northern and central regions, but well above in some parts of the south. In Elvas (Alentejo region), the precipitation which fell during 2 days was above normal for the whole month. Yet, at the end of May, still 68% of the territory was in a drought period with severe to extreme intensity. **Spain** also was warm (1 to 3°C above normal) and mostly dry, especially in the southeast. So was also **Italy**; only the south was partly wet. In **Greece**, unusually high temperature maxima (28 to 32°C) were recorded on May 17-19, well above the long-term means of 22 to 26°C. But it was also a wet month in Greece, particularly the third decade with increased thunderstorm activity in several areas over the mainland (mainly eastern) part of the country, and also the Cyclades and Crete. Hail also was reported locally. In Alexandroupoli (northeastern coast of Greece), 140 mm of precipitation fell that month, which was more than 400% of the long-term 1951-1997 mean. **Cyprus** was slightly warmer (+0.3°C) and wetter (111% of the normal) than on average. In the **Lebanon** the temperatures were around normal, precipitation mostly lower. In **Israel**, May was slightly cooler than normal with only 2 Sharav events occurring during the month. On May 4, extreme rainfall intensities were recorded in the northern parts of the country. In Eilon (northwest Galilee), 16 mm were recorded within 10 minutes and 27 mm within 50 minutes.

The monthly mean temperature was near normal also in **Armenia**. Cold weather was observed on May 3-6, when the mean diurnal temperatures were 5 to 7°C below normal. The last week of May was warm here also; daily maximum temperatures for these days were 28 to 32°C in the Syunik region, 27 to 30°C in the Ararat valley and 20 to 26°C in the mountain regions. Precipitation amounts were 110-120% of the normal. Hailstorms with hailstone diameters of 1-3 cm occurred in some regions from time to time. Strong winds with gusts of up to 104 km/h were registered on 7 days of the month.

June 2005

- **Warm and dry in southern, western and central Europe, partly cold and wet in the north and east**
- **Extreme cold spell around June 9 in the Alps and to the south of them**
- **Heat wave in western and central Europe and heavy thunderstorms**

In June, the mainly zonal circulation continued. Warm air dominated in the south and temporary high pressure influence extended from the Atlantic to central Europe. Low pressure systems passed frequently over northern and eastern Europe, especially over parts of Scandinavia and Russia.

The continental areas of Scandinavia were cooler than normal in the south, but not in the north. Parts of this area were quite wet. **Norway** had a monthly mean temperature below normal in the southern part, while the north of the country was slightly warmer than normal. The largest negative anomaly was found in the mountainous areas of southern Norway, where the monthly mean was 2.0 to 2.5°C below normal. The precipitation sum for the country as a whole was 120% of the normal. For the northern part of Norway this was the 4th wettest June registered with the largest anomaly in the county of Nordland amounting up to 300% of the normal. **Sweden** too was mainly slightly cooler than normal except in the north. The main part of the country was wet, only the southern and western areas including the Swedish west coast were dry. **Denmark** was cooler than normal on the whole, drier than normal in the west, but wetter in the north of Jutland. The other parts of the country had near normal precipitation. **Finland** was cooler and wetter than normal in the south, but warmer and drier in the north.

The Baltic countries were mainly within the colder air, but precipitation was spatially variable, depending on the tracks of the low pressure systems. In **Estonia**, it was slightly colder than normal (-0.4°C), and precipitation was higher (130% of the normal), but there was also much sunshine, and so this month was notable for high UV index values: for a period of 10 days, the index was higher than 7. **Latvia** was 0.6°C colder than normal, precipitation totals were 116% of the normal. **Lithuania**, too, had a monthly temperature anomaly of -0.6°C. Especially the first half of the month was chilly, with sporadic morning frosts; later on, the weather became warmer. Monthly precipitation was very unevenly distributed, since it had a predominantly convective character. In the western and northwestern regions of Lithuania, the monthly total was less than normal, but in some northern and southern parts, 150-200% of the normal amount was registered. Heavy rains were sometimes accompanied by strong winds and hail with hailstone sizes of up to 15-20 mm. On June 9, some southern regions received 54-60 mm of rainfall within 5-10 hours, when an upper air low was situated over the country.

Owing to the frequent advection of cold air in the central and southern areas of the European territory of **Russia**, June was chilly and rainy there. Thunderstorms accompanied by downpours with hail and squally winds occurred nearly everywhere in these parts. In the eastern areas of the European territory, air temperatures of 0 to 2°C and ground temperatures of -4°C were reported during the first two decades of the month. The north of European Russia was drier than normal. On June 26, a heavy storm occurred in the region of Moscow.

Most of the North Atlantic was still warmer than normal. In **Iceland**, it was warm and sunny in the south this month, but gloomier in the north and east, especially in the coastal districts. It was warmer than normal also in **Greenland** and on the **Faroe Islands**. **Ireland** was particularly warm and dry this month. At Casement Aerodrome, the monthly mean temperature was 2.0°C higher than normal, although relatively dull with the monthly precipitation total only 48% of the normal. On June 27, it was exceptionally sunny over most of Munster (south Ireland) and

Leinster (east Ireland) with more than 15 hours of sunshine. It was also quite warm in the **United Kingdom** (+1.5°C above average), although this was not quite as warm as June 2003. Rainfall and sunshine levels were both close to normal, with 101 and 96%, respectively. Central London recorded a temperature of 33.1°C on June 19, which was the highest of 2005. Hawnby (North Yorkshire) recorded 60mm of rain in just one hour on the same day, with considerable flood damage and disruption after the River Rye burst its banks.

Western and central Europe were warm and dry nearly everywhere. In the **Netherlands**, De Bilt was 1.6°C warmer than normal; the precipitation amount was 76% of the normal. Especially the period June 18-24 was marked by a heat wave reaching 25°C or more, on three days there were maxima of 30°C or higher. The station Gilze-Rijen in the south of the country recorded 34.7°C on June 20; this was the highest temperature of the year. This heat wave was also reported from **Belgium**; the duration was from June 18 to June 27. Nearly the whole of June was dry; in some parts of the country this was quite severe for the vegetation. However, here again it was not as outstanding as in 2003. On a monthly average, it was much warmer, sunnier and drier than normal (e.g. Uccle +2.6°C, 68% of the normal precipitation). **Luxembourg** also was warm and dry; the temperature anomaly at the airport was quite high with +3.1°C, the precipitation total was only 46% of the normal, but this was not an exceptional value. The highest temperature of the country in 2005 was 35.1°C, measured on both June 21 and 28. At the airport, 6 hot days (Tmax >= 30°C) were registered, reflecting that a heat wave of several days passed over the country. Furthermore, this heat wave was also reported from **France** for the second half of the month. From June 16 onwards, the temperatures increased rapidly, culminating to values above 35°C in large parts of the southern half of France on June 27-28. These days were among the hottest for June since 1950. The monthly mean temperature was higher than normal by 2 to 4°C from north to south. It was also a very dry month in nearly all parts of the country.

In **Germany**, the first half of the month was rather cool with snow falling at an altitude of 1000m and night frosts even in the southwest, but it was very hot towards the end, so that the average monthly mean temperature was slightly (+0.9°C) above normal. However, there were quite high positive anomalies (up to more than 3°C) in the southwest of the country, while the northeast and the coasts were partly slightly colder than normal. The average precipitation in Germany was 61% of the normal (with large local variations), ranking this month as the 9th driest June since 1901. **Switzerland** had similar characteristics of the monthly course: More or less unsettled and cool weather in the first half of the month and afterwards the subtropical high which drove the temperatures to summery values up to more than 30°C. On the monthly average it was warm and dry. In **Austria** again, in spite of some cold days with night frost down to 1000 m above mean sea level around June 9, monthly means reached up to +2°C above normal in the west and up to +1°C in the east. The country-wide precipitation rate was 50-75% of the long-term means. The **Czech Republic** and most parts of Slovakia were also warmer and drier than normal.

Slovenia had a significant temperature anomaly between +1 and +2°C for most of the territory. Again there was a cold period towards the end of the first third of the month; the second half of June was warm. Precipitation was distributed unevenly; it was mostly below normal, except for Lendava (northeast Slovenia). Most of the territory received more than half of the normal precipitation; in some regions (Vipava valley, Postojna, Kočevska) only one third of the normal precipitation fell. In **Hungary**, the temperature normal was exceeded only slightly (+0.1°C). On June 9, however, the lowest maximum temperature of the century was recorded with 7°C in Pécs. The average precipitation amount was 84% of the normal, so that June was the only dry summer month of the year in Hungary. The cold spell around June 9 was experienced also in **Serbia and Montenegro**. In the period June 5-11 the temperatures were 10 to 14°C lower than normal and were even below the 2nd percentile (Fig. 6.1). Precipitation, too, was extreme in the first decade of the month; it was extremely high especially in the Vojvodina (northern Serbia).

In higher mountainous regions it was snowing. At Žabljak on June 9, a new absolute diurnal snow fall maximum of 13 cm was recorded. After this period, it was warmer than normal and very dry in the whole country until the end of the month. The number of summer days was considerably higher than normal all over Serbia.

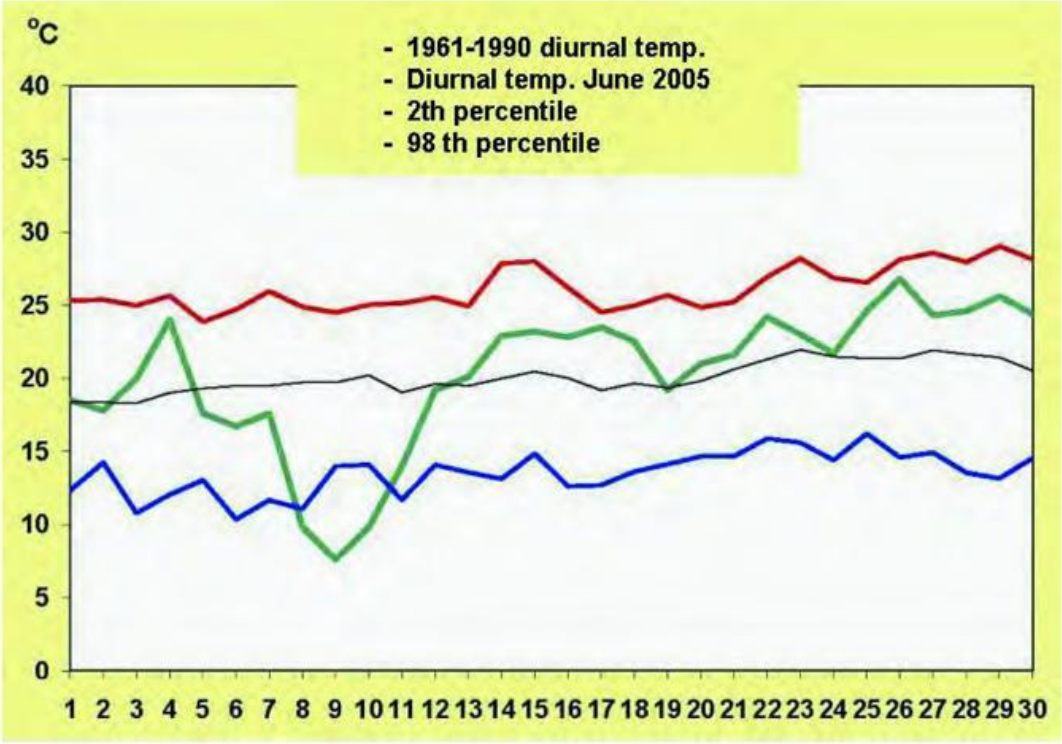


Fig. 6.1: *Diurnal air temperature June 2005 in Belgrade*
Source: Republic Hydrometeorological Service of Serbia

Some severe **thunderstorms** occurred in **central Europe**. The first one was initiated by a cold front passing over central Europe from the west to the east on **June 3-4**. Hail was reported from **Belgium**, especially in northern Flanders. In **Germany**, up to 39 mm of precipitation were measured in the north, streets and cellars were flooded, and also hail was falling. Gusts up to 115 km/h were registered, causing wind damage also in the central and southern parts of Germany. On **June 15**, hail fell in Apače (**Slovenia**) after a squall line passage; on the next day a severe storm developed over Ljubljana and Maribor. Another thunderstorm front passed over Germany on **June 24-25**, locally with large amounts of rain. A lot of damage after vigorous thunderstorms on June 25 with heavy rainfall was reported from **Austria**, especially from the counties of Salzburg and Carinthia. Near the small town of Zell am See (Salzburg), flash floods destroyed the banks of a creek and two bridges. The meteorological station at this location recorded a precipitation amount of 87 mm within two hours. On the same day, several localities within the district St. Veit an der Glan (Carinthia) were devastated partially by heavy rainfalls. A cold front developed with a low pressure system over the Alps and moved southwards to **Slovenia**, where severe thunderstorms damaged some parts of the Štajerska (Lower Styria) region on **June 27**.

Perhaps the most severe storm of the month was on **June 29-30**, towards the end of the heat wave. First, on June 29, a low pressure system brought heavy thunderstorms with local torrential rainfall to **Ireland** (Fig. 6.2). The automatic station at Dublin (Phoenix Park) recorded an hourly precipitation total of 47 mm between 17.35 and 18.35 UTC and a 10-minute fall of 17 mm. On the same day, a frontal system passed through **Belgium**, and the vegetation was

damaged by hail showers with hailstones up to tennis ball size. The hail on some fields looked like a wintry snow cover (Fig. 6.3). In the evening, the storm reached western and southern **Germany** with daily precipitation amounts of up to 71 mm in the Eifel and hail especially near the Alps. Widespread flooding occurred. At the airport of Frankfurt/Main, starts were postponed for 45 minutes. There were also severe thunderstorms even in **Slovenia**; they developed over the Idrija (western Slovenia) and Dolenjska (southeast) region.

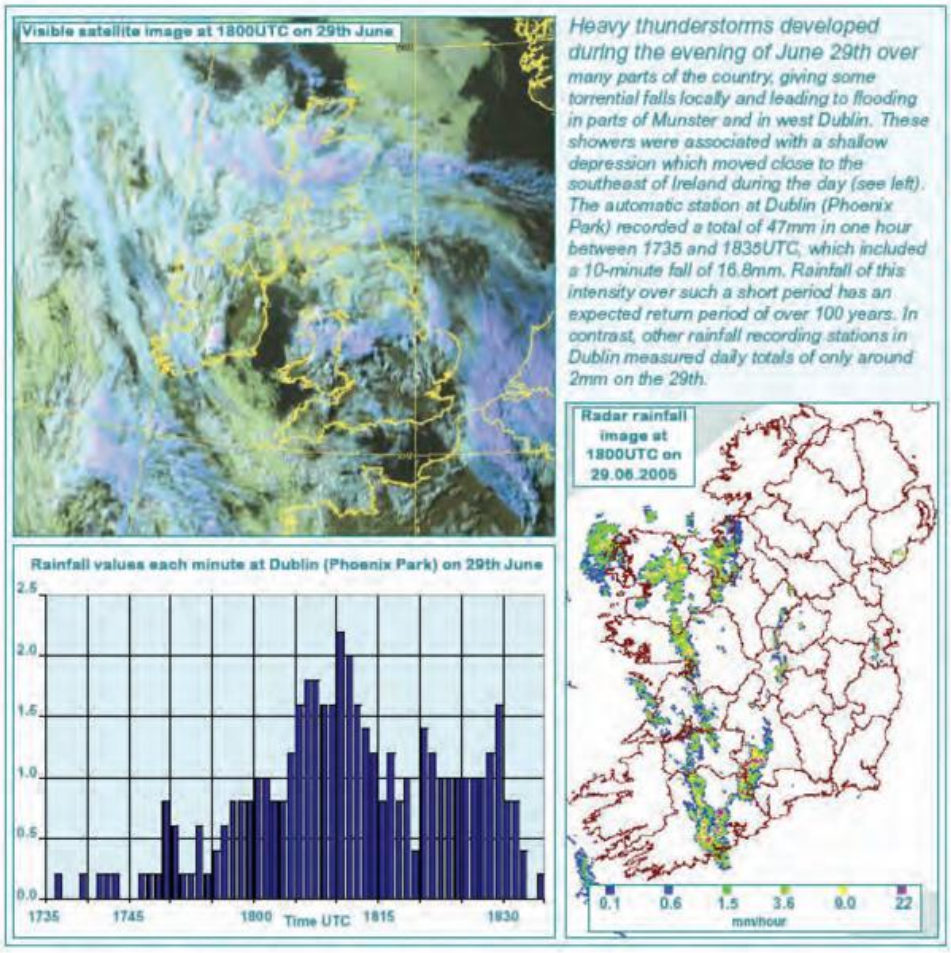


Fig. 6.2: *Radar rainfall image of Ireland on June 29 at 18.00 UTC*
Source: Met Éireann, Ireland



Fig. 6.3:

Hail-covered field in Gavere (south of Ghent), Belgium, on June 29. It gives a wintry impression in midsummer!
Source: Institut Royal Météorologique de Belgique

Eastern central Europe belonged mainly to the cooler parts of the Region in this month. Polar air masses affected these countries, so that the heat wave of western Europe did not move so far. In **Poland**, the monthly mean temperature was lower than normal down to -0.9°C in the northeast, only the southwest was warmer by about +0.7°C and the highest temperature was noted in Poznań in the west with 33.6°C. But as most of the fronts were not so intensive in Poland this month, June was a month with little rain; only 25% of the 1971-2000 mean fell in some areas in the north and east of the country. This was the start of a drought that continued for the rest of the year. However, local downpours caused some high daily precipitation amounts; the monthly maximum was observed in the Carpathian Mountains with 112 mm. The **Ukraine** and **Romania**, too, were slightly cooler than normal, precipitation was around normal. **Bulgaria** was considerably cooler (1 to 2°C below normal), although on some days up to 35°C were reached in the south of the country. Precipitation again was around normal, only partly (in Dobrudja, northeast Bulgaria) did the totals achieve up to 140% of the normal. Sometimes the diurnal precipitation values exceeded 30 mm. There were 21 days of thunderstorm activity and 14 days with hail. Strong winds up to 108 km/h were registered, generally associated with severe thunderstorms. The wettest period was on June 5-11, after the development of a low pressure system, with a flood event near the capital city of Sofia.

The western and central parts of southern Europe were warm and mainly dry. In **Portugal**, the average monthly air temperatures were well above normal in the whole territory by 2 to 3°C; on average this was the 2nd highest value of the mean temperature since 1931. Two outstanding heat waves occurred on May 30 – June 11 and June 16-23. The number of days with Tmax >=35°C was around 2-5 times the average monthly value. June was also another very dry month in Portugal. Lisbon received only 1 mm of precipitation during the whole month. At the end of June, 97% of the territory was in drought conditions with severe to extreme intensity. Similarly, also in **Spain** it was very hot and dry. On the whole, the month was not as extreme as June 2003, although in the southwest of the country the temperatures set records in a 45-year series (Fig. 6.4). Locally, anomalies up to +5.3°C (in Avila) were recorded. The highest temperatures were measured during June 15-23 for most areas of the peninsula and in the last three days of the month in the Mediterranean areas. Italy was mostly 1 to 2°C warmer than normal, in the north even more than +2°C. It was mainly dry, only in southern Italy was it wet.

In **Croatia**, the temperature had an anomaly range from near normal in the east up to +2.3°C in the west and the precipitation was far below normal with a few exceptions, in some central areas of the country even less than 25% of the normal was registered. **Macedonia** was slightly warmer (around +0.3 to +0.4°C) and drier than normal. **Greece** was mainly very dry, but the temperatures were around normal.

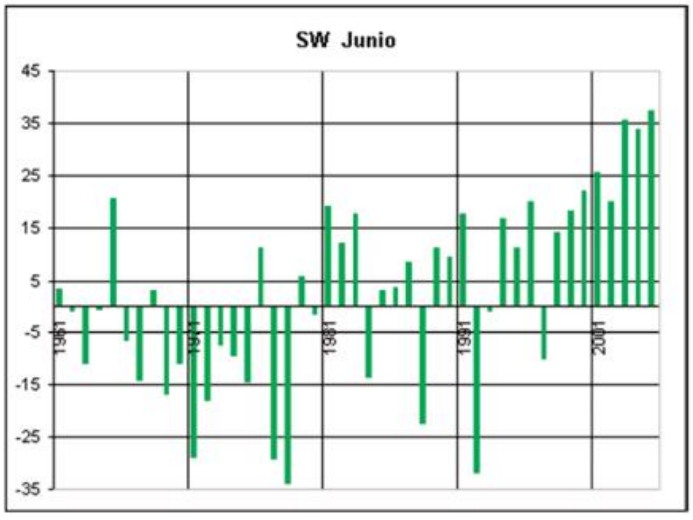


Fig. 6.4:

Average temperature anomalies in June in the southwest of Spain
Source: Instituto Nacional de Meteorologia, Spain

In the eastern parts of the Mediterranean, it was not so warm. **Cyprus** was slightly cooler than normal (-0.3°C) and wet (267% of the normal) which means the duration of the wet period of the year persisted longer into the summer than usual. Especially during the first 5 days of the month it was extremely wet. The **Lebanon** had temperatures and precipitation amounts mostly near normal. **Israel** was slightly cooler than normal.

In **Armenia**, the mean monthly temperature was near normal. Very hot periods appeared during June 10-12 and 16-17 when the daily mean temperature was 4 to 5°C above normal. The maxima reached 34 to 36°C in the Syunik region (southeastern Armenia) and the Ararat valley, 26 to 28°C in the rest of the country. Precipitation was slightly above normal in most parts of the country. Strong winds with gusts up to 108 km/h were registered in some regions. Hailstorms with hailstone sizes of 22-28 mm occurred on 5 days in this month.

July 2005

- **Warm in nearly the whole Region**
- **Very dry in most parts near the Mediterranean**
- **Very wet in some parts of northern, central and southeastern Europe, heavy thunderstorms, frequently with hail**

The zonal circulation of the previous month changed to more meridional, but very variable patterns during July. Cold arctic air masses did not affect Europe considerably, so that it remained warm also in the northern parts. Frontal systems, locally with thunderstorms, heavy rain and hail, passed over various parts of the Region; but the Mediterranean regions were only rarely touched by heavy precipitation.

The first half of July was wet in **Iceland**, but the later part of the month brought warm summer weather to the southern area of the country.

In the whole country of **Norway** the monthly mean for July was above normal. In parts of the counties of Trøndelag and Nordland (central Norway) it was 3°C above average. Stations both in the main country and Svalbard measured a new record for the maximum temperature in July. The precipitation anomalies differed a lot between the west and the east of Norway. For the county Møre og Romsdal (west) the month was the driest for 80 years, while locations in the eastern part and in the county of Nordland registered records of diurnal precipitation. **Sweden**, **Denmark** and **Finland** were warm, but mainly wet this month.

Large parts of eastern Europe were warm and mainly dry. In **Estonia**, the temperature anomalies reached +2.1°C; the precipitation total was 86% of the normal. **Latvia** reported +1.8°C and 95%. **Lithuania** had a mean temperature deviation of +2.1°C from the long-term average and very variable precipitation. The first half of July in Lithuania was warm and dry, while the second half was also warm but rainy. In most regions of Lithuania the diurnal mean temperature frequently exceeded 20°C. The highest diurnal amount of precipitation within this country was 80 mm. **Russia**, too, was characterised by hot and mostly dry weather; only in the southern Volga area were the temperature anomalies negative. The **Ukraine** was also warm and mainly dry, especially in the northwest of the country where the temperature anomalies exceeded +2°C locally; in other parts they were mainly around +1°C or lower, in the easternmost

part even negative. Average mean temperatures were around 20°C. The east of the country was also wetter than normal, while the rest of the country was dry, partly with only around 60% of the normal.

Ireland had the hottest weather of the year during the first half of July, especially on July 10-12, when maxima reached over 25°C in most places; a number of stations measured their highest maxima since 1995 on these days. The monthly mean temperatures were up to about 1°C above normal. But this month also brought some heavy rainfalls in the east and south; over 50 mm were measured near the southern coasts on July 24. At Casement Aerodrome, 78.5 mm was the monthly total which was 167% of the normal. In contrast, northern Ireland and most of the **United Kingdom** were drier than normal (81% on average in the UK, the driest July month since 2000), only the southern and southeastern parts were wetter (England-Wales precipitation was 119% of the normal). The mean temperature of the UK was 0.9°C above normal. Gravesend-Broadness (Kent) recorded a diurnal maximum of 31.7°C on July 14.

Central Europe was warm and wet in most parts. De Bilt in the **Netherlands** and Uccle in **Belgium** both had a monthly mean temperature anomaly of +0.9°C. A heat wave started in the middle of July and continued until August, but it was not so exceptional as in the summer of 2003. The precipitation totals were 212% of the normal in De Bilt and 165% in Uccle, caused by a few thunderstorm periods with heavy rain. In western Belgium, more than 100 mm in 24 hours were registered locally. For **Luxembourg**, this was a very wet month too, although spatially very variable due to the convective character of the precipitation and despite a dry period from July 9 to July 22. The monthly totals reached up to 189 mm locally. In Luxembourg City, July 2005 was the 5th wettest July since 1854. The temperature anomaly also was quite high with +1.4°C at the airport.

France reported mean temperature anomalies mostly around +1°C. The northern parts of the country were partly very wet too, but the south was very dry. Only 1 mm during the whole month fell in Marseille (normal is 14 mm), and also Bordeaux had only 43% of the normal precipitation. **Germany** as well was warm and rich in precipitation this month. Temperature anomalies again were +1°C on average, in northern Germany even more than +1.5°C, in the south partly less than +0.5°C. As elsewhere the monthly averages exceeded 20°C locally, especially in the Upper Rhine Valley. The areal mean precipitation was 136% of the normal; in the northeast of the country more than 300% were reached locally. For some stations it was the wettest July since the beginning of measurements. Flooding occurred in particular on July 10 in southern Germany. In western Germany, in contrast, it was partly drier than normal. July was also hot and mainly wet in **Poland**. The temperature anomalies amounted up to +2.5°C in the centre of the country. For a period of 11 days the temperature exceeded 30°C, on July 28-30 even 35°C. The highest maximum was 36.6°C in the southwest. Monthly precipitation totals reached up to 200% of the normal in the west, while in the northeast only 75% were achieved. The **Czech Republic** and **Slovakia** were mainly warm and wet.

In **Switzerland**, the month started warm, but on July 4 a disturbance accompanied by heavy thunderstorms caused a remarkable temperature drop. In parts of Grisons (southeastern Switzerland), snow fell down to elevations of 1700 m above sea level. Within this highly unstable layered air mass, tornado funnel clouds were observed on July 5 over the Lake of Geneva and in the region of Zürich. After this, the weather remained unsettled, but rather warm. A stable high pressure influence did not persist for long. Towards the end of the month, however, on July 27-28, the temperature reached top values of the year; the country's maximum was reached in Geneva with 36.2°C. Monthly means were also above normal in **Austria** where anomalies amounted to about +1°C. Precipitation totals were high in large parts of Austria (125-225%), in the valleys of Mur and Muerz rivers in Styria even up to 300%. Only in the westernmost part of Austria were the precipitation amounts around normal. Heavy thunderstorms with flooding in

a region from the province of Salzburg to Lower Austria were reported on July 5 and 12. In the early morning of July 12, the flood water in the river Salzach flooded 350 houses of the small town of Mittersill (county Salzburg); the town centre was flooded 150 cm high (Fig. 7.1).



Fig. 7.1:

Town centre of Mittersill (near Salzburg, Austria), flooded on July 12
Source: Central Institute of Meteorology and Geodynamics (ZAMG), Austria

An unusually **heavy hailstorm** occurred over the **Alps** on **July 18**, when a frontal system moved from the north to the south. Near the upper part of Lake Geneva in **Switzerland**, a large area was devastated. Gusts of up to 160 km/h and hail caused enormous damage in local vineyards. In **Austria**, north of the Styrian capital of Graz, hailstones of the size of hens´ eggs smashed roofs, windows and windscreens of cars. In the town Frohnleiten in this area, the streets were covered with hail up to 20 cm high.

On **July 27-30**, very warm but potentially instable air masses caused wide-spread **thunderstorms** over **central Europe**, partly with hail. **Germany** reported thunderstorms with heavy rain, wind gusts and hail on July 27. The hailstones were partly the size of hazelnuts as registered north of Frankfurt/Main. In **Belgium**, more than 45 mm precipitation in less than one hour were measured in Brussels on July 29, and hailstones of 3 cm diameter in the north of the province of Antwerp. The day before, there were also thunderstorms with hail in Belgium and even a tornado at Ath (province of Hainaut, west Wallonia). **Luxembourg** reported up to 64 mm in 24 hours locally and up to 53 mm in one hour on July 29. At the airport of Luxembourg, the highest hourly and daily amounts in any July month since 1947 were achieved. The warm air masses moved from the southwest to central Europe, but even reached northern Europe. Heavy rain was thus reported also from **Sweden** with 135 mm in 3 hours in central Skåne and 80 mm in one hour near Falkenberg at the Swedish west coast. In **Finland** too, frequent heavy showers occurred in late July. Eastern **Lithuania** suffered from a very strong hailstorm on July 30 with gusts up to 90 km/h and hailstone sizes up to 9 cm. **Poland** too reported strong gusts up to 122 km/h.

It was warm and quite wet also in southeastern Europe. In **Hungary**, it was 0.5°C warmer than normal and 156% of the normal precipitation fell on average, the beginning of a rainy late summer period. **Slovenia** reported temperature anomalies between +0.5 and +1.5°C. Here too a heat wave towards the end of July contributed significantly to the monthly means. There were some sudden changes from warm to cold weather and vice versa. The first third of the month was cool, the middle of July was warm. Precipitation was distributed unevenly and was mostly above normal. In some regions, about 200% of the normal precipitation fell. Severe weather

occurred on July 22 in some parts of the regions Gorenjska, Dolenjska and Notranjska (all in western Slovenia), partly with hail, but most of the damage was caused by flash floods. **Croatia** had temperature anomalies around +1°C, in the east also less. Precipitation was especially high in the northeastern and the western coastal parts, locally above 200% of the normal. **Romania** also was around 1°C warmer than normal, and the precipitation amounts were especially high in the southern parts of the country, again partly more than 200% of the normal, on average around 150%. Similar anomalies were to be found in **Serbia and Montenegro**. The first half of July, however, was cold there. July 7 was the coldest day when the diurnal minimum temperature was around 10°C in most places. From July 15 on, the weather became stable and the temperatures higher. Precipitation was distributed mainly over the first and second decade of the month, while it was considerably below average in the third decade. A new record was registered in Sombor (northwest Serbia) on July 2, with a daily precipitation amount of 69 mm and a monthly total of 199 mm. In some areas also storms with strong gusts, heavy precipitation and hail occurred. **Macedonia** was also around 1°C warmer than normal; precipitation was around normal or higher, especially in the east. **Bulgaria** had temperature anomalies up to +1.5°C, and it was very wet: up to 450% of the normal was measured in northeastern Bulgaria. This was by far the highest July amount there since 1950 (Fig. 7.2). In particular the first half of the month was exceptionally wet. The already water-saturated soils facilitated widespread floods. There were 28 days with thunderstorm activity and 19 days with hailstorms this month.

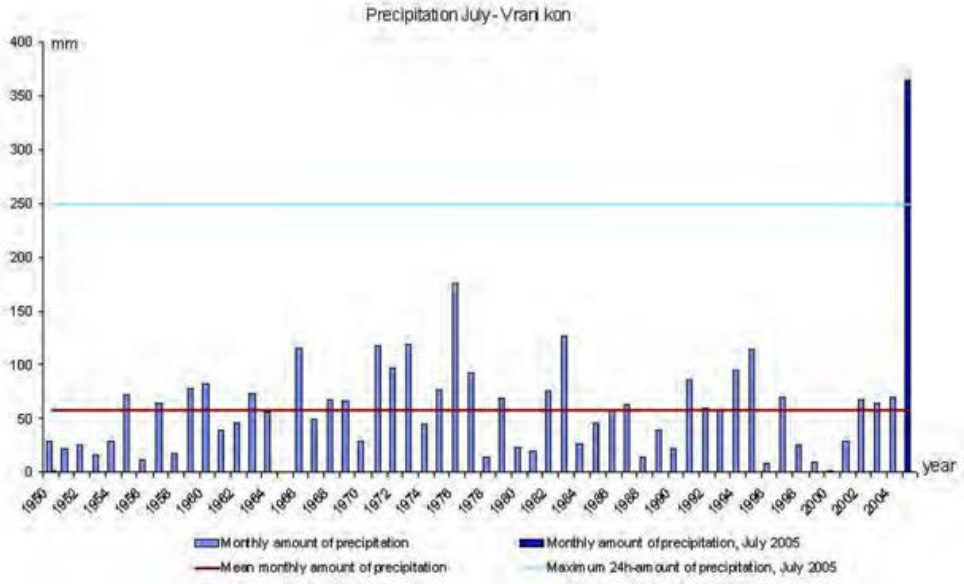


Fig. 7.2: *Precipitation totals July 1950-2005 in Vrani Kon (northeastern Bulgaria)*
Source: National Institute of Meteorology and Hydrology, Bulgaria

Southern Europe was mainly warm and very dry, although locally high precipitation amounts fell. In **Portugal**, July was extremely rainy only in the Minho region, parts of the centre regions and the Algarve, but still dry to extremely dry in the remaining territory. Temperatures were above normal in almost the whole country. The highest value of the maximum temperature was 41.2°C in Beja (southern Portugal) on July 20. **Spain**, too, was warm and very dry. In Madrid, there was zero precipitation this month and it was 2.2°C warmer than normal. **Italy** had temperatures mostly 1 to 2°C above normal and low precipitation, only in southern Apulia and western Sicily were the precipitation amounts high. **Greece** was about 1°C warmer than normal, but precipitation was very variable, locally above 400% of the normal. **Cyprus** reported +0.8°C above normal and only 0.1 mm precipitation (4% of the normal) for the whole month.

Further in the east, the **Lebanon** was warmer than normal, mostly 1 to 2°C, sometimes less. Precipitation was low as usual, frequently zero. **Israel** was also warmer than normal, so that this was the 11th warmest July since 1995, but it was not so extreme as July 2000 and 2002. There was a hot spell on July 3-4 with temperatures reaching 37-39°C in the Negev and 41-43°C in the Jordan Valley. On July 5 there was a temperature drop of 8-10°C within a low-pressure system in the inland areas of Israel and 4-5°C in the coastal plain. Such a sharp change in temperature does not happen very often in the summer months, which are normally characterised by very stable temperatures. Before that, the last time such an extreme change occurred was in July 1995.

In **Armenia**, July was 1.5 to 2°C warmer than normal. Daily maximum temperatures in the Ararat valley reached 38 to 40°C, in mountain regions 28 to 31°C. Extremely hot weather occurred on July 17. Megri (near the Araz River, south Armenia) had a record maximum of 43.3°C. Precipitation was only 50-60% of the normal. However, on July 25, heavy rainfall in Dilijan (northern Armenia) resulted in 50 mm of precipitation during one hour and 25 minutes, and a hailstorm on July 3 in hailstones of 3.5 cm diameter, causing extensive damage.

August 2005

- **Warm and dry in most of the west and the east, cold and wet in most of the central parts of the Region**
- **Some storms with heavy rain in northern Scandinavia and the Baltic countries**
- **Heavy precipitation with flooding in the Alpine region and east of it**

The frontal zone remained mainly over northern Europe; zonal and meridional flows changed with high variability. Several times, strong cold low-pressure systems affected not only northern Europe, but also central and central eastern Europe when the meridionality became stronger. Some of these low-pressure patterns even moved to the central Mediterranean after a cut-off. In contrast, the western and eastern parts of the Region were not so much affected by such low-pressure systems; quite often high-pressure influence resulted in warm and dry weather in these parts.

Scandinavia had mostly near normal conditions, but with some exceptions. In **Iceland**, August was close to average in the south and west, but wet and cold in the north and east, due to the northern cyclone tracks. Akureyri (in the north) recorded the lowest number of sunshine hours in August since 1969. **Norway** reported a precipitation amount of 200% of the normal for parts of the county of Nordland (northern central Norway), while Hardangervidda and the mountainous area northward to Sognefjord (southwest) received only 60-70%. Tromsø in the northern part of Norway registered the second highest diurnal precipitation amount since the start of the series in 1920. Some cyclones caused damage in **Sweden**. In early August, due to prolonged rains there was a dam failure during repairs to a dam in the river Dalälven at Alvesta (southern Sweden), but no one was killed. Late in the evening of August 26, a small but intense cyclone caused storm gusts in northernmost Sweden and around 7000 households lost their electric supply. Heavy showers were also reported from **Finland** in the beginning of August, just during the world championship games in athletics in Helsinki. On August 28, a tornado was

seen during an international golf tournament in Helsinki. It caused damage to the light constructions and also some injuries. **Denmark** was slightly cooler than normal with precipitation around normal or less.

The Baltic countries were mainly warm but wet, since some of the northern cyclones also affected these regions. In **Estonia**, there was a flooding in Pärnu after heavy rain. On August 9, a tornado destroyed roofs near the station at Tartu-Toravere. Another tornado was active near Tallinn. The mean temperature anomaly of Estonia was +1.2°C and the mean precipitation total was quite high with 157% of the normal. From **Latvia** as well, high rainfall was reported, especially in the first half of August. This period had twice the normal rainfall in nearly the whole country, at some locations even 300-400% of the normal. Monthly precipitation was 151% of the normal, the mean temperature anomaly was +0.6°C. The most intensive rain occurred on August 8, due to a frontal system extending from northern Europe to the Black Sea. On this day, about a third of the normal August rainfall was measured within 24 hours. The Liela Jugla River rose by 4.67 m during August 4-12, exceeding the level of this year's spring floods. Fields, meadows and vegetable gardens were flooded just as it was time for harvesting. **Lithuania**, too, had a very rainy period in that time, while the rest of the month was dry and warm. The monthly mean temperature was close to normal. A heavy rain period occurred on August 8-11. In all southern and many western regions of the country the daily precipitation amount reached 65-100 mm, the town of Nida (near the Baltic Sea) received 80 mm within 12 hours. On these 4 rainy days all together a total of 200-230 mm was registered, which corresponds to 250-300% of the normal for the whole of August (Fig. 8.1). This heavy rainfall was accompanied by strong winds of 55-80 km/h. There had never been such prolonged and heavy summer rain in Lithuania before during the entire observation period. The water level in rivers rose by 2.5-4 m; lowland settlements were flooded, forcing evacuation of several villages and farmsteads. Strong winds caused broken trees and disruption of power transmission. The total damage was estimated at 42 million €.

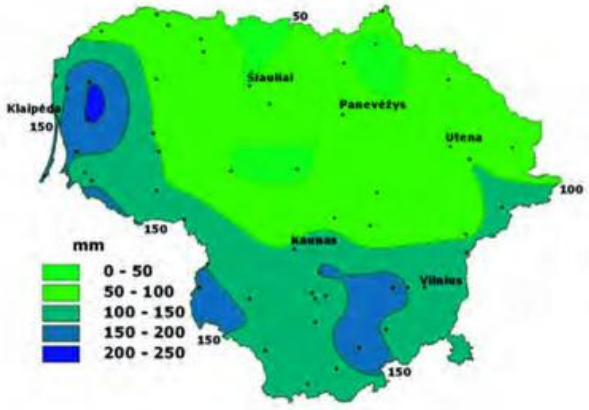


Fig. 8.1:

Precipitation totals during August 8-11 in Lithuania
Source: Lithuanian Hydrometeorological Service

In **Russia**, a stable anticyclone over the centre of the European territory resulted in very dry and hot weather. The temperature was above normal everywhere (mostly around +1°C), in the northwestern and southern federal districts monthly temperature anomalies were partly between +3.0 and +3.5°C. Precipitation totals reached only 25-50% of the normal at some locations.

Western Europe was mainly warm and dry. In **Ireland**, at Casement Aerodrome, only 46% of the normal monthly precipitation fell and the temperature anomaly was +0.9°C. The mean temperature of the **United Kingdom** was 0.6°C above normal, but yet this was the coolest August since 1999, as the previous August months were even warmer. Rainfall was slightly below normal at 94%, in England and Wales 82%. A gust of 126 km/h was recorded at Lerwick (Shetland Islands) on August 29, as a deep depression moved east to the north of Scotland. Central London recorded a temperature of 32.2°C on August 31. In **France**, it was warmer than normal only in the west and south. In most of the country, especially in the northeast, the temperature was below normal, due to some cold spells coming from northern Europe.

Precipitation was below normal except in the north of the country, the Rhône-Alpes and Midi-Pyrénées. In **Portugal**, it was extremely rainy in some regions in the northeast, the centre and some inner parts of the Alentejo (southern Portugal); the remaining territory was very dry. Monthly mean temperatures were above normal in almost the whole territory. The mean maximum temperature was the 2nd highest, the average mean temperature the 3rd highest since 1931. Spain, too, was warmer than normal; anomalies up to +1.8°C were reached in the central and southwestern parts of the country. It was again a very dry month in Spain, mostly less than 50% of the normal precipitation fell; Madrid was again without any rain as in July.

Central Europe was often affected by depressions from the north and thus mainly cool and wet this month. In the **Netherlands**, **Belgium** and **Luxembourg**, temperature anomalies were around 0.5°C; precipitation amounts were variable, but not so outstanding compared to the normal. The first half of August was warm, but not so hot as in 2003. From Belgium, a high number of 23 thunderstorm days was reported this month; it was the maximum of the time series, as the normal value is only 12 days. In central and western Belgium, a thunderstorm with flooding occurred on August 19-20 and tornadoes were seen on August 11 and 12. **Germany** was 0.8°C colder than normal this month, in the western and southern parts locally more than 1°C. It was the first August since 1993 which was colder than normal. With respect to precipitation the month was around average, despite the heavy rains in Bavaria which caused catastrophic flooding in the second half of the month. However, locally more than 150% of the normal precipitation fell, but also less than 50% fell in various parts of the country. **Poland** was very cold in the western part (anomaly -1.1°C); on spatial average it was close to normal, but it was the coolest August since 2002. The precipitation was very diverse within the country; it ranged from 20% in the central parts up to 240% in the mountains in the southeast with local flooding. The highest daily precipitation (147 mm) was also noted in the south. In the **Czech Republic** it was slightly colder (e.g. Prague -0.5°C), precipitation was around normal. **Slovakia** had normal temperatures, but precipitation totals were partly very high. A monthly total of 215 mm was registered at Turany (northern central Slovakia) and Ondavou (eastern Slovakia); this was the second highest total in that territory since 1901. The **Ukraine** was warm with temperature anomalies between +0.5°C in the west and more than 2°C in the east. The absolute maximum for 2005 was measured this month with 39°C in the south. Precipitation totals were mostly above normal, partly more than twice as much, only the eastern part was drier.

The Alpine region was mainly cool and wet. In **Switzerland**, cool and rainy weather prevailed especially in the first part of August. There was snowfall down to the higher passes in the Alps. On occasional clear nights, the temperature dropped to values which were close to the all time minimum for August. At the end of the month a high developed over western Europe and it became warm and sunny. In **Austria**, monthly mean temperatures were normal or up to 1°C below the long-term average. Precipitation reached at least 125-175% of the normal in large parts of the country, in western and northern parts even 230%. From Reutte (Tyrol), a monthly amount of 408 mm was reported; this was the second highest since May 1999.

A period of **heavy precipitation** in the **Alpine region** occurred on **August 20-23**. It was caused by a cut-off low west of the Alps. At its eastern flank, warm and very humid subtropical air crossed the Alps. The first heavy precipitation with thunderstorms occurred in northern Italy. More than 35 mm in 12 hours fell in Verona during the night of August 20-21. The following day, precipitation also affected the Alps, especially **Austria**. Graz in Styria registered 35 mm in 6 hours. A landslide blocked the main rail road connection from Bruck an der Mur to Graz. Three localities around Lake Neusiedl (county of Burgenland) were partly flooded. On August 22, diurnal amounts reached between 180 and more than 200 mm in the province Vorarlberg and in western Tyrol. In the Montafon valley, near the village of Gargellen, the main road was washed away over a distance of several 100 meters (Fig. 8.2). By the evening, all traffic connections to Tyrol had been closed as well as several sections of the Rhine valley highway. The centre of the low had then moved over northern Italy to Croatia. The main lifting processes



Fig. 8.2: *Main road washed away in the village of Gargellen (Montafon Valley, Austria) after the heavy rain on August 22*
Source: Central Institute of Meteorology and Geodynamics (ZAMG), Austria

were now at the northern and western flanks of the low and thus over large parts of the Alps and southern **Germany**. Orographic lifting of the warm moist air at the northern slope of the Alps intensified the precipitation. Near the Alps, more than 100 mm of rain were measured locally on August 21-22 (e.g. Garmisch-Partenkirchen, Oberstdorf). An area of heavy flooding extended from the Alps to the Danube River. Dams were broken, train connections interrupted, roads and houses were flooded, and bridges were damaged. In many towns and districts, disaster alarm was activated. In parts the water levels exceeded those of the flooding on Pentecost 1999. Garmisch-Partenkirchen and some villages in its vicinity were more or less cut off from the outside world. Large parts of the village of Eschenlohe were 1.5 m under water. In **Switzerland**, especially the Bernese Oberland and central Switzerland, were massively affected. In the area from the valley of the Simme to the Canton of Uri, hardly any valley was spared from severe destruction. Landslides, mudflows and brooks swelling to torrential streams submerged villages, farmland, bridges, railway lines and roads. Entire valleys were cut off for several days. Some of the pre-Alpine areas were affected as well, in particular from the Emmental to the Lake of Zug, but also the town of Weesen at the western end of the Walensee. In some places the affected area extended even further north to the midlands. In the city of Berne, the river Aare flooded an urban district and also the river Reuss damaged some houses. Other lakes (Thun, Lucerne, Biel) overflowed their banks. Extensive damage was also reported from northern Grisons and the Engadin. Precipitation amounts reached record values for the 48-hour period August 21-23 (morning) of between 150 and 200 mm or more (Fig. 8.3). On the Säntis mountain (2500 m) a daily amount of 186 mm was measured. The precipitation event did not end until the evening of August 23, when the low moved further to the east and weakened. Another factor for the flooding was the saturation of the soil, since there had been high precipitation also during the weeks before, so that the precipitated water was directly transferred into the surface run-off. Such a weather situation, sometimes referred to as "Vb type" has caused devastating precipitation many times in the past, so it is not unusual. But the high precipitation amounts over such a very large area can be taken to be an extremely rare event with a statistical recurrence time of more than 100 years.

Further to the east, it was also cool and very wet in **Hungary**. The mean temperature anomaly was -0.7°C, the mean precipitation total 259% of the normal, in the southeast of the country even 400-450%. Due to many heavy rains more than 100 buildings were destroyed, 25 000 ha were covered by water; several rivers rose above their banks. The maximum diurnal amount of rainfall of this year was 164 mm at Mezöhék on August 4. **Slovenia**, too, was cool with

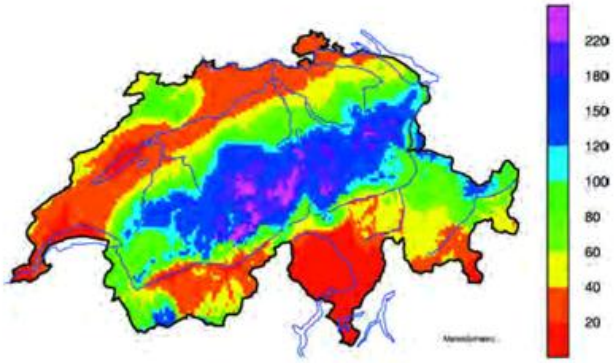


Fig. 8.3:

48-hour accumulated precipitation in mm on August 21-22 (06 UTC until 06 UTC the following day) in Switzerland
From: MeteoSwiss, Switzerland

temperature anomalies between -0.5 and -1.0°C. Precipitation was distributed unevenly and was mostly above normal; only a small part of the Upper Soča Valley had less precipitation than average. In some areas twice the normal amount of precipitation fell. There were also some episodes of severe weather with intense precipitation and hail. **Croatia** also was cool, temperature anomalies were mostly around -1°C, and wet, especially in the northeast with precipitation amounts locally of more than 400% of the normal. **Romania** had temperatures around normal, but also frequent torrential rainfalls; 200 and even 300% of the normal precipitation was reported over large areas. In **Serbia and Montenegro**, monthly mean temperatures were also around normal, but maximum temperatures were higher and minima lower than average. Due to frequent cyclonic activities coming from the central Mediterranean and due to the penetration of humid air from the Atlantic, an extremely high number of precipitation days (mostly 15-20) was recorded. Monthly precipitation amounts were considerably higher than average, locally they were 400% of the average, some new records were set. In Montenegro, a new absolute diurnal precipitation maximum of 47 mm was registered at the Rožaje station (northeastern Montenegro).

Towards the south, **Macedonia** was also cool and wet (e.g. Skopje -0.9°C and 215% of normal precipitation). **Bulgaria** had temperatures around normal and precipitation totals of 150-300% of the normal except in the northwest where it was around normal. Some storms moving through the Balkans brought stormy and wet weather mainly to western and central Bulgaria. The most severe period was on August 4-7 with up to 356 mm of rain in less than 48 hours in a narrow frontal band, causing flooding, e.g. of the Maritza river in the very populous and economically active Upper Thracian Valley. The city Plovdiv (southern central Bulgaria) was partly flooded as well.

The Mediterranean was mainly warmer than normal, wet in the west, but mostly dry in the east. **Italy** was mainly warm, only the northeast was cooler, but this August was considerably cooler than in the previous year. Precipitation was very variable. **Greece** was mainly warm, wet in the north and dry in the south. On August 1-3, the only short summer heat wave episode was recorded in several areas of the country, mainly on the mainland. Maximum temperatures of up to 39°C were measured; average maxima were around 33°C. Unusually heavy rain and thunderstorms occurred on August 5-6 over parts of northern Greece and the Thessaly peripheries. From **Cyprus**, a temperature anomaly of +0.6°C was reported, precipitation was low as usual. The **Lebanon** and **Israel** were mostly 1 to 2°C warmer than normal; only in the interior region in higher altitudes was it cooler. Precipitation was low as usual.

Armenia was warm and wet. The monthly mean was 1.5 to 2°C above normal. Precipitation was 120-160% of the normal in most of the country, only the Syunik region and the Ararat Valley were drier than normal (20-50% of the normal). Heavy rainfall was observed on August 4 in Amasia (north of Udel, northwestern Armenia, 37 mm of precipitation in 2 hours). Large hailstones (20-30 mm in diameter) were found in the Ararat Valley on August 21.

September 2005

- **Mainly warm, except over the northern Atlantic and in southwestern Europe**
- **Most of the Region dry, but wet in most of the Mediterranean and southeastern Europe**
- **Some heavy precipitation in western and southeastern Europe**

In September the frontal zone remained mainly over northern Scandinavia, while most of the other parts of Europe were often under high pressure influence, keeping these areas mostly warm and dry. Troughs and low pressure systems appeared over the Atlantic, but in most cases they weakened rapidly when they came to Europe. Some cut-off lows reached the southern parts of the Region and caused heavy rain locally in particular in the Mediterranean.

Iceland was on the cold side of the frontal zone most of the month and therefore colder than normal. It was the coldest September since 1982. It was very sunny in the south, but there was early snow in the north.

In **Norway**, the monthly mean was above normal for the larger part of the country. Monthly precipitation was very variable. It was the second highest registered in parts of the counties Nordland, Hordaland and Sogn og Fjordane (western and central Norway) while parts of the county of Hedmark (southeastern Norway) noted the driest September for the last 50 years. An extremely high diurnal precipitation amount was registered in the western part of the country on September 14 due to the former tropical storms Maria and Nate; for some stations this was a new record. The highest value was 179.5 mm at Opstveit in Hordaland. **Sweden** also was warm, but dry, especially in the south, and so was also **Denmark**. **Finland** was warm too; the anomalies reached around +2°C in the southern parts. Starting in the middle of the month, an unusually long warm autumn period occurred with temperatures above 15°C during several days. It was drier than normal in the south, while in the north precipitation was around normal.

Large parts of northeastern Europe were especially warm and dry due to prevailing high pressure influence. **Estonia** was 2.4°C warmer than normal, and only 39% of the normal precipitation fell. In **Latvia**, this was the 10th warmest September for 80 years (anomaly +2.1°C) and 55% of the normal rainfall was measured. **Lithuania** reported a temperature anomaly of +2.3°C, although on September 17-18 the night temperature dropped down below zero (between -1 and -8°C). The mean monthly precipitation totals were 42% of the normal; there were only 2-7 days with 1 mm of rainfall or more.

In **Russia**, this September was the warmest of the whole observation period since 1900 (anomaly +2°C, Fig. 9.1). It was also an outstandingly dry September in Moscow (only 12 mm of precipitation in the whole month, corresponding to 18% of the normal), the 3rd driest since 1891. Only 6 days with more than 0.1 mm of precipitation were counted there (normally 16 days). In most parts of the European territory of Russia 25-50% of the normal precipitation was registered. Smog formation in the cities was a consequence of this drought. The **Ukraine** also was warm and very dry. Temperature anomalies were around +1°C in the west and +2°C in the east. The precipitation amounted to 10-45%.

Western Europe was also affected only weakly by cyclonic activity. **Ireland** was around 1°C warmer than normal; precipitation was higher than normal only in the west, but below normal in the east. In the **United Kingdom**, too, September was a well above average month (mean anomaly +1.6°C), and it was the warmest September since 1999. However, there were some very warm and also some very cold days. Northolt (London) recorded 29.7°C on September 4, Kinbrace The Hatchery (Highlands) -3.5°C and Altnaharra (Highlands) -2.6°C, both on September 9. Rainfall was slightly below normal at 92% on average, but some high diurnal

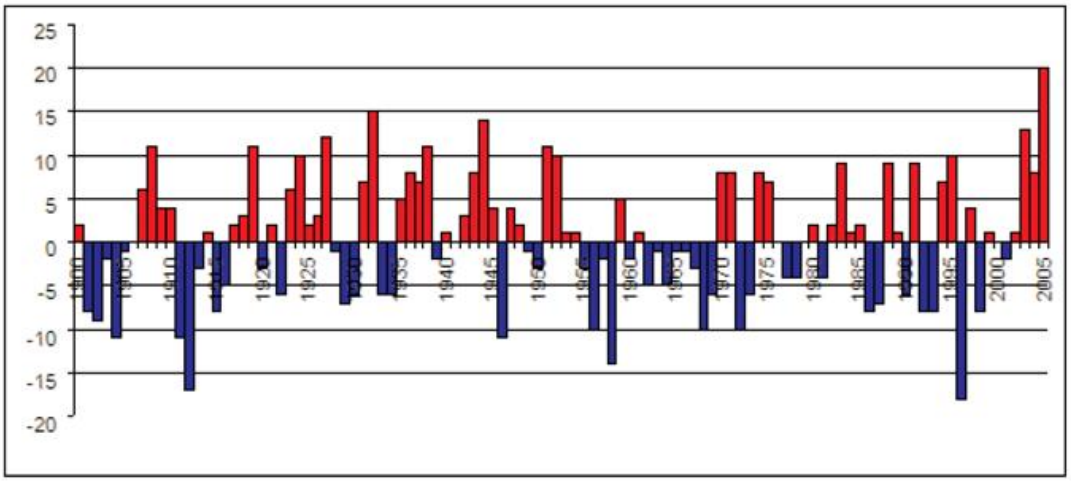


Fig. 9.1: *Anomalies of September monthly mean temperature (in 0.1°C) in Russia 1900-2005*
Source: Roshydromet, Russia

precipitation amounts were registered: 86 mm in Cambridge on September 9, 85 mm in Chieveley (West Berkshire) on September 10. In the **Netherlands**, this month was the 8th warmest September since 1901; the anomaly was +1.7°C in De Bilt. In terms of sunshine, it ranked 8th . The temperature anomaly was even higher in **Belgium** (+2.1°C) and **Luxembourg** (+2.5°C). Precipitation was around normal in the Benelux countries, despite thunderstorms on September 10. At the airport in Luxembourg the highest hourly precipitation amount in September since 1947 was measured that month with 19 mm, 16 mm fell in 30 minutes.

France was warm, especially in the northern half (+2°C). Only the south was partly slightly colder. It was very dry in the western and northern regions, but wet in other areas, in particular in the south. Some heavy rainfalls occurred in the south at the beginning of the month, especially in the Gard and Hérault regions . The first period began in the night of September 5-6 and continued until the morning of September 7. Totals of 200-300 mm were measured in these areas. Another fall of 100-200 mm occurred one day later on September 8 in Gard. Accumulated over the whole period, 500 mm were exceeded locally. These heavy rains caused many floods.

Central Europe was warm, too, and rich in sunshine due to extended high pressure influence. In **Germany**, the mean temperature anomaly was +1.7°C; it was the 10th warmest September since 1901. The mean precipitation was 90% of the normal but with large regional differences. Most of Germany was very dry, locally with less than 40% of the normal, but in the eastern parts of the country local heavy rains caused some totals of more than 150% of the average. In **Poland**, normal temperatures were exceeded by even 3°C in the central and northeastern regions. A maximum of 30.4°C was measured in the west of the country, but also a minimum of -1.3°C in the east. Precipitation sums were generally lower than normal. In the centre of the country only 50% of the normal precipitation was registered, at the eastern borders even less than 25%. This caused progressive soil drying. The **Czech Republic** and **Slovakia** were warm (around +1.7°C) and precipitation was around normal on average.

Switzerland had a similar mean temperature anomaly and was mainly drier than normal. Especially the beginning of the month was warm. In the middle of the month, a cold front, coming from the northwest, reached Switzerland. It was accompanied by heavy rainfall and triggered a remarkable drop in temperature. In the morning of September 17, snow fell down to 1700 m above sea level. This cold front was also remarkable in **Austria**; traces of snow were reported from places down to 1100 m above sea level. Monthly mean temperature anomalies were not higher than +1.5°C. The precipitation amounts ranged from 40% of the normal in the west up to 175% in northwestern and northeastern parts of the country.

The southeastern parts of Europe were mostly warmer than normal, but wet and mostly cloudy due to frequent cut-off lows. **Hungary** reported a mean temperature anomaly of +0.7°C and 122% of the normal precipitation on average. In **Slovenia**, the monthly mean temperature anomaly was between +0.5 and +1°C, in high mountains also slightly negative anomalies were found. Precipitation was distributed unevenly and was mostly above normal, only at the coast, in the Koroška region (northern Slovenia) and in the Upper Soča Valley was there noticeably less precipitation than average. On the other hand, in some areas double the amount of the usual precipitation was registered. On September 2-3, there were severe thunderstorms with heavy precipitation locally, especially in Ljubljana and its surroundings and in the western part of Kamnik (north) and the Savinja Alps. During the period September 17-22, a large low pressure system was established over the central Mediterranean and affected the surrounding countries. Thus, this period was cold and mostly cloudy in Slovenia with frequent precipitation. In **Croatia**, the temperature anomalies were mostly positive, but not higher than +1°C; the highest values were to be found in the very north of the country and at the coast. Precipitation amounts were very variable, ranging from 52 to 175%. Similar temperature anomalies were registered in **Romania**; in this country it was very dry in the north, but very wet in the south (Fig. 9.2). Especially during the last decade of September, the rainfalls were torrential in that region. Exceptional 24-hour amounts of 150-200 mm were recorded at the Black Sea coast and over 100 mm in the south of the country, causing flooding and landslides. The highest monthly amount was 330 mm at the Mangalia station at the Black Sea; this was more than 1000% of the normal. **Serbia and Montenegro** were also warmer than normal in the whole country. In the coastal part of Montenegro, it was extremely warm with 28 summer days and 12 tropic nights. Precipitation was frequent this month, in its second half also heavy, especially during September 18-25. New precipitation maximum records were set at most stations; e.g. at Smederevska Palanka (central Serbia) a daily sum of 93 mm was measured and exceeded the previous record by a factor of more than 2. In **Macedonia**, the temperatures were around normal, but it was also wet on average. **Bulgaria** was colder than normal in contrast to the other countries, with anomalies of -1.5°C in north Bulgaria and -0.3 to -0.4°C in the south. Precipitation totals were high due to some convective events, sometimes with hail, especially during the cyclonic period on September 19-25. The warm sea water at this time of the year facilitated the development of strong convective systems which produced heavy and uninterrupted rain for 48 hours at the northern Bulgarian Black Sea coast. The reported cumulative amount of precipitation e.g. in Shabla was about 900% of the monthly normal.

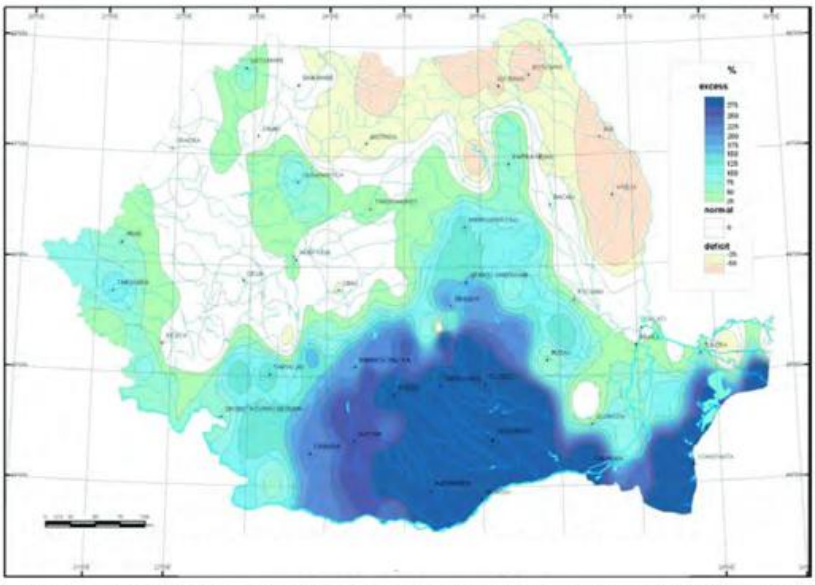


Fig. 9.2: *Deviations of monthly precipitation totals from normal in September 2005 in Romania*
Source: National Meteorological Administration, Romania

The Iberian Peninsula had temperatures around normal and was mainly dry. **Portugal** had high maximum temperatures, but low minima, implying many sunny days and clear nights. Most of the territory was still in extreme drought conditions in continuation of spring and summer. In the northern and central regions of the country the drought situation attenuated for the first time this year due to some rain in the first half of the month. However, on September 30, still 97% of mainland Portugal was affected by severe or extreme drought; this had never happened before for 60 years. In **Spain**, most of the country was slightly colder than normal. Mostly it was dry, but in the east there were some areas wetter than normal. On September 7-8, several tornadoes and waterspouts were seen in the southwest of the province of Barcelona. The airport was hit by a tornado that came from the sea with winds above 150 km/h and a trajectory nearly 50 m wide and 8 km long.

The central and eastern Mediterranean was frequently affected by low pressure systems, so it was mainly wet, but nevertheless quite warm. **Italy** was warmer than normal; in parts the anomalies exceeded +1°C. The main part of Italy was wet, especially in the Apulia region, only in northern Italy and in particular in Sicily was it dry. **Greece** also was warm and unusually wet. Locally the monthly totals exceeded 100 mm (Fig. 9.3). On September 22-23, heavy thunderstorms with hail affected several areas of the Attica periphery with flooding events in these areas. **Cyprus** was slightly warmer than normal (+0.3°C); precipitation was around normal or less. The **Lebanon** was mostly 1 to 2°C warmer than normal, in higher regions partly more than 1°C colder. Precipitation was mainly low as usual, locally slightly higher. Israel was warm and mostly dry as usual, too. On September 16, a Sharav event occurred with temperatures reaching 35 to 36°C in the coastal plain and 38 to 39°C in the Negev. On September 17-18, the temperatures dropped sharply and rainfall was reported from the coastal plain. In Haifa and the Carmel region, 15-20 mm were measured; these were large amounts for this time of year.

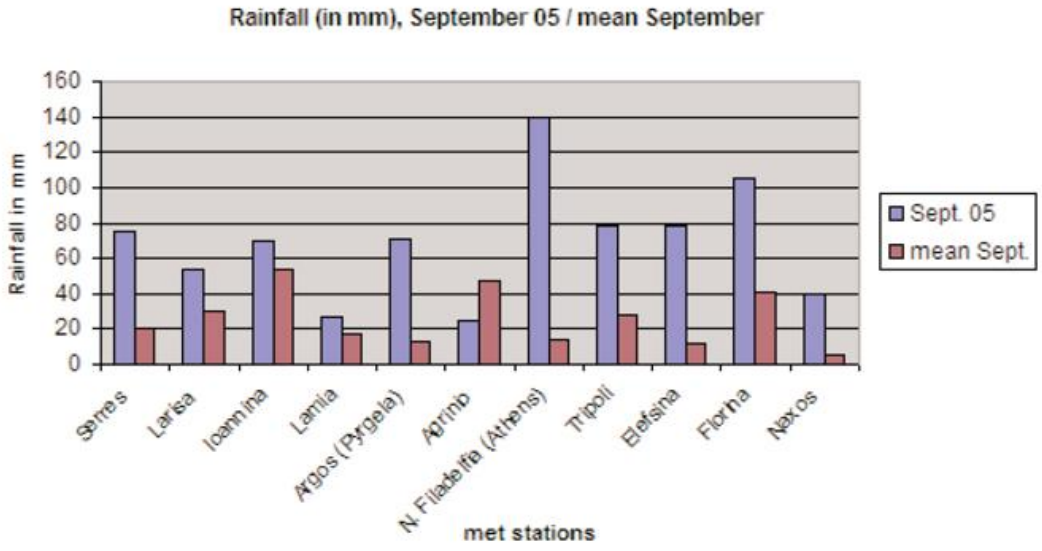


Fig. 9.3: *Precipitation totals at various stations in Greece in September 2005 compared with long-term means (different reference periods)*
Source: Hellenic National Meteorological Service, Greece

In **Armenia**, the monthly mean temperature was near normal, partly above (e.g. Yerevan +1.1°C). High temperatures were measured on September 17-18 (2 to 5°C above normal). The maxima were 32 to 33°C in the valleys and around 26°C in mountain regions. Monthly precipitation totals were 180-200% of the normal in the main part of the country, except Ararat Valley which was drier than normal. Strong winds of about 55-70 km/h with gusts of around 80 km/h were measured on 4 days of the month.

October 2005

- **Warm in nearly the whole Region except parts of the North Atlantic and around the eastern Mediterranean**
- **Most of the Region dry, parts of northern, western and southeastern Europe wet**
- **Hurricane Vince reached southern Spain on October 11**

In October, deep troughs were formed very frequently over the North Atlantic resulting in lower temperatures in that region, and parts of western Europe were influenced by warm, but moist air with frequent precipitation, which put an end to the long-lasting drought of the previous months in these areas. The main part of Europe was quite often under high pressure influence with frequent warm and dry weather, except the very north which was dominated by polar air masses. Southeastern Europe and the eastern Mediterranean were frequently affected by cut-off lows east of the high pressure zone; thus these parts of the Region were colder than normal and rainy.

For **Iceland**, October was the most unfavourable month of the year, being cold and windy. Snow and heavy winds caused considerable problems for traffic in the north during the later part of the month. Unusually heavy precipitation resulted in local flooding of the village of Höfn in the southeast around the middle of the month.

Ireland and the **United Kingdom** were wet, but generally warm, since these parts of Europe were often located on the eastern side of Atlantic troughs in a southerly airflow. In **Ireland**, Casement Aerodrome was 1.5°C warmer than normal; the precipitation total was 122% of the normal due to some heavy rainfalls in the east and south. 100 mm precipitation fell near the southern coasts during the 4-day period on October 17-20 (Fig. 10.1). For the **United Kingdom**, this was another warm month as well (+2.2°C on average, central England +2.5°C). It was the warmest October since 2001 and the 3rd warmest in series back to 1914. Heathrow (London) had 21.0°C on October 27, which was its highest temperature for so late in the year since 1949. It was also wetter than normal with 127% of the long-term average (England-Wales 148%), and some heavy precipitation was noted, too. Carlisle (Cumbria) recorded 109 mm in 24 hours on October 12 at 09 UTC. Furthermore, it was the dullest October since 1982 and the 7th dullest since 1914. At the Eskdalemuir station (southern Scotland) it was the dullest October since 1929 with only 36.5 hours of sunshine.

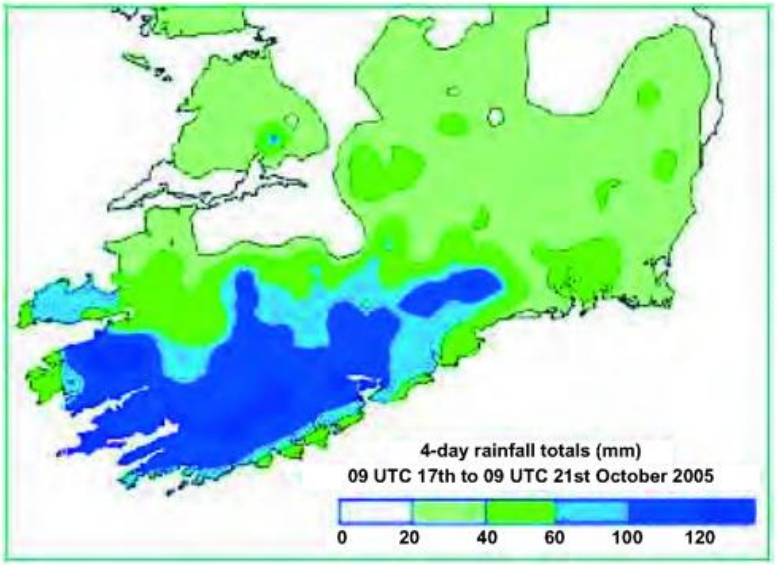


Fig. 10.1:

4-day rainfall totals in mm in southern Ireland on October 17-21 (09 UTC to 09 UTC)
Source: Met Éireann, Ireland

Southwestern Europe was warm and wet as well. In **Portugal**, it was warm until October 9; the warmest days were October 1 and 5 with anomalies above +5°C. The highest anomaly was recorded from Portalegre (Alentejo region, southern Portugal) on October 1 with +8.5°C. The highest maximum of this month was 35.3°C at Alvega (central Portugal). Monthly precipitation totals were mostly above normal, in some regions even above 200% of the normal, putting an end to the long-lasting extreme drought period of the previous months. Extremely high diurnal precipitation amounts above 50 mm were registered on October 28 and 30 at several stations. Similarly, it was warm and mainly wet in **Spain**; only the southeast was very dry. On October 11, tropical storm Vince passed over the south of the Iberian Peninsula, but abated on the same day. Vince brought heavy rain to Andalusia, e.g. 86 mm in 12 hours in Cordoba and also some strong winds, especially near the southwest coast (e.g. a mean wind speed of 55 km/h in Jerez de la Frontera). Some more heavy rain and flooding occurred in the middle of the month in northeastern Spain after the passage of another low pressure system.

In the continental parts of Scandinavia, the monthly temperature mean was above normal almost everywhere. In **Norway**, the maximum temperature at Molde Lufthavn (southern central Norway) was 25.6°C on October 11 which was a new maximum for October within the country. It was also drier than normal in most parts of Scandinavia, but some stations in northern Norway (counties Nordland and Troms) were very wet and had the second highest amounts ever registered in October, partly due to some very high diurnal amounts (e.g. 101 mm in Barkestad in Nordland on October 6, a new record). **Finland** reported two warm spells this month, one continuing from September until the middle of October and the other starting at the end of October. High pressure influence also caused much sunshine in northern Europe this month. In **Denmark**, this October was the sunniest since observations began.

North-eastern Europe also was frequently under high pressure influence and thus mainly warm, sunny and dry. In **Estonia**, it was 1.5°C warmer than normal, precipitation was 87% of the normal on average. **Latvia** recorded +0.6°C and 67% of the normal precipitation. **Lithuania** had a temperature anomaly of +0.8°C and only 52% of the normal precipitation. During the first decade of the month, the highest temperatures in Lithuania reached 18-22°C. The mean diurnal temperature did not fall below 10°C before October 10, at the seaside on October 12-16; this was up to 15 days later than usual. Only the third decade was rainy. **Russia** was extremely warm; in some parts, especially in the eastern European territory, anomalies of more than +5°C were reached. Dry conditions prevailed except in the southern federal district where 200-500% of the normal precipitation was registered in the northern Caucasus and the region of the lower Volga River. In Krasnodar (southwest Russia), 77 mm of precipitation fell in one hour on October 4.

Central Europe as well was very warm, sunny and dry. In the **Netherlands**, De Bilt reported a temperature anomaly of +2.8°C. The month was the 3rd sunniest October since 1901. Precipitation was 78% of the normal. At Uccle in **Belgium**, this was the 2nd warmest October since 1833; the anomaly was +3.2°C. Especially the last decade of the month was particularly remarkable with a mean temperature of 15.2°C; such a value would be typical for late August, but not for October. 67% of the normal precipitation indicated that this month belonged very clearly to the drier ones. In **Luxembourg**, the temperature anomaly was even higher with +3.4°C. At the airport of Luxembourg, the mean maximum temperature was the highest since 1947 with 16.8°C. On October 31, a daily maximum of 20.8°C was measured which was certainly not usual so late in the year. Precipitation was low with 57% of the normal. **France**, too, was outstandingly warm with anomalies above +3°C in most parts of the country, ranking this month the second warmest October since 1950. It was dry in most of the country, only in the Mediterranean areas was it wetter than normal; in the western regions, precipitation was near normal.

In **Germany**, the mean temperature was 2°C above normal on average; in the west of the country, the anomalies were above +3°C as in other countries of western central Europe, but partly only around +1°C in the east. It was the 7th warmest October since 1901. Precipitation was 72% of the normal, locally even less than 50%, and it was the 2nd sunniest October since 1951. On October 22, a tornado was reported in the evening in the Rhön Mountains, leaving a trace of devastation 1 km long and 150 m wide, and another one on October 26 in the Lower Saxony region near Bremervörde. **Poland** reported temperature anomalies of +2°C in the west and +0.5°C in the southeast. Maximum temperatures reached up to 22.9°C. Precipitation was very low; in many regions only 10-20% of the long-term average fell. The drought which had already started already in September, became more severe. On the other hand, a high diurnal precipitation amount of 45 mm was measured at the coast this month. The **Czech Republic** and **Slovakia**, too, were warm and very dry.

In **Hungary**, the monthly mean temperature was only slightly above normal (+0.3°C), but also here the month was very dry (20% of the normal precipitation on average).

Slovenia had temperature anomalies mostly between +0.5 and +1.5°C, in the Julian Alps +1.9°C. Precipitation was distributed unevenly and was mostly below normal. Most of the precipitation was brought by southwesterly airflows; therefore this month was almost dry in the northeast of the country. In Lendava (northeast), there was no precipitation at all, in Murska Sobota only 3 mm. In Lesce (west), Kredarica and Kotlje (north), precipitation amounts exceeded the normal values; most of the precipitation was concentrated during the first third of October. In **Serbia and Montenegro**, the monthly mean temperature was only slightly above normal. On October 15-19, cold air came to this area, causing the first frost in the mountainous parts of Serbia and Montenegro. The precipitation quantity was considerably less than normal in most places, especially in the northern parts of Serbia.

In large parts of the Alpine countries, only the beginning of October was wet, while the rest of the month was dry and warm. Monthly temperature anomalies in **Switzerland** were mainly between +1 and +2°C; monthly precipitation totals were variable, but mostly low, e.g. only 20% of the normal in Ticino. **Austria** had temperature anomalies up to +1.5°C. Precipitation was low in western, northern and eastern Austria (25-75% of the normal), in Lower Austria even less than 25%. Vienna reported only 3 mm for the whole month. During the first 5 days, a deep depression over the northern parts of the Adriatic Sea caused heavy rainfalls over southern Austria, leading to monthly amounts of 125-200% of the normal, and also to significant amounts of rain and snow in Switzerland.

In the central Mediterranean region, temperatures were around normal, but due to some depressions it was mainly wet. **Italy** was mainly slightly warmer than normal, but by far colder than in the October of the previous year. Precipitation was mostly around normal, but locally higher than 200% of the normal. In **Croatia** the temperature anomalies varied from -0.4°C at the coast up to more than +1°C in the north of the country. Precipitation was higher than normal especially at the coast, locally more than 400% of the normal precipitation fell (e.g. in Hvar, Adriatic Sea). In contrast, it was very dry in the northeast, partly with less than 10% of the normal. Further to the south, it was mainly wet in **Macedonia** at around normal temperatures.

In some areas around the Black Sea, frequent cut-off lows caused prevailingly rainy weather. In the **Ukraine**, it was warmer than normal, but the anomalies were only around +1°C or lower. Precipitation totals were higher than normal except in the very west; locally more than 200% of the normal was reached. **Romania** had temperatures around normal; precipitation was low in the northwest (less than 50% of the normal), but higher than normal in the eastern parts, locally more than 200% of the normal amount fell. **Bulgaria** also had temperatures around normal, but locally it was colder by 1°C. First frosts occurred already on October 7-11 in the regions Pernik (west) and Ruse (north). Precipitation was normal or slightly higher; in the region of Dobrudja

(northeast) 140% of the normal was recorded. At some locations, maximum diurnal totals of up to 50-80 mm were registered. In the first half of the month, 6 days with thunderstorms and 4 days with hailstorms were reported.

The eastern part of the Mediterranean region was colder than normal and mostly dry, but locally very wet. **Greece** was especially dry in its southern regions; temperature anomalies down to around -1°C were registered. **Cyprus** was 0.8°C colder than normal; only 47% of the normal precipitation fell. Most of the **Lebanon** also was colder than normal; precipitation was very high at the coast, but mostly around normal inland. **Israel**, too, was colder even though there were two Sharav events during the month with temperatures of more than 35°C. Rainfall amounts were 120-150% of the normal in northern Israel and less than 50% in the central and southern parts of the country.

In **Armenia**, October was slightly warmer than normal. In some regions the daily maximum temperatures (particularly on October 13) were the highest ever recorded there for the whole observation period. Precipitation totals were 100-150% of the normal in the northern and central parts, but the southern regions were drier than normal. Strong winds with gusts of 90-108 km/h were measured on 8 days in that month.

November 2005

- **Mild in the north, colder than normal in the south**
- **Dry in central Europe, wet in some parts of the north and the south**
- **Strong storm over northern Europe on November 14-15**
- **Strong storm over central Europe on November 25-27**

In November, especially in the first half of the month there was frequently a southwesterly flow of warm and moist air to northern Europe, causing milder but often rainy weather in that region, while central Europe remained under drier air masses. In the second half, the whole European continent was often affected by large troughs, so that cold air masses often reached the south, resulting in colder than normal conditions and frequent precipitation in these areas.

In **Iceland**, the weather was very unsettled and gloomy, but it was slightly milder and drier than normal, this was also the case in **Greenland** and the **Faroe Islands**. The monthly mean temperature in **Norway** was markedly above normal in the whole country. In parts of eastern Norway and in Varanger (county of Finnmark), the monthly mean was the second highest since 1900. 30 stations, from Lindesnes lighthouse in the south to Slettnes lighthouse in the north, recorded a new record for the maximum temperature in November. The monthly precipitation total was the third highest ever registered for Norway as a whole. Stations in the western part of Norway had new records for the month. It was also mild in **Sweden**; anomalies were partly above +4°C especially in the north. Precipitation was mainly low there since most low pressure systems coming from the west did not affect Sweden. **Denmark**, too, was warmer (up to +2°C in the north of Jutland) and mainly drier than normal. **Finland** had the highest temperature anomalies of Scandinavia in this month, exceeding +6°C in the central and eastern parts. The

monthly mean temperatures in central Finland were mainly above 0°C and the highest since 1900. The country experienced a mild period until the middle of the month; the maximum temperature reached 10°C during several days.

Extremely **high diurnal precipitation** was recorded on **November 14-15** when a strong low pressure system moved over continental **northern Europe**: At the Opstveit station in the county of Hordaland in western Norway, 223 mm were measured on November 15. This was the second highest diurnal precipitation ever registered in Norway. It was a fairly serious storm also for **Sweden**. 30 000 households, mainly in Värmland, were without electricity for some hours.

It was mild and mainly dry in the Baltic countries. In **Estonia**, it was +2.4°C warmer than normal, precipitation was near normal (96%). **Latvia** had a lesser temperature anomaly of +1.5°C and 83% of the normal precipitation, but was very sunny at times. The first decade of November was the sunniest such period in Latgale (southeastern Latvia) for the last 50 years. **Lithuania**, further to the south, had a temperature anomaly of +1°C and 62% of the normal precipitation. Especially the first half of the month was mild with little precipitation, but the second half was colder and wetter. Rain was then gradually replaced by sleet and snow.

Russia was very mild, especially in the north (e.g. anomaly of +6.7°C at Arkhangelsk). The monthly temperature averaged over the whole Russian territory was the 3rd highest for 30 years. It was also dry in most regions of the European territory of Russia. Heavy precipitation was noted only in the northern parts; there 150-250% of the normal precipitation fell during this month. The **Ukraine** was slightly colder than normal in the west, but warmer in the east (up to +2°C). Precipitation, too, was lower than normal in the west (less than 60%), but higher in the east (locally more than 200%).

Northwestern Europe was in general not far from normal this month. Casement Aerodrome in **Ireland** was 0.3°C colder than normal, precipitation was 77% of the normal. In the **United Kingdom**, this was the month with the least anomaly of the year, but it still managed to be just above average with +0.1°C. Central England was colder than normal by -0.4°C. Anyway, it was the coldest November for the UK since 1998. Rainfall also was close to average at 97% (in England-Wales 94%), but sunshine was exceptionally above at over 140%. This made it the sunniest November for the UK in the series back to 1914. On November 19, Grantown-On-Spey (Highlands) recorded a minimum temperature of -10.5°C. It was a cold night during a high pressure situation. Some days later, on November 25, a cold front had passed over the UK, followed by 10 cm of snow in west Wales. The snow caused significant traffic disruption in Cornwall. The corresponding depression was located in the northern **Netherlands**. 50-90 mm of precipitation fell in a broad band over the middle part of that country in 24 hours. In the eastern part of the Netherlands, precipitation fell as snow and sleet, resulting in an ice/snow layer of about 25 cm in some places. The heavy weight of this layer resulted in the collapse of many roofs. A number of power lines came down, leaving the village of Haaksbergen (Twente region in the eastern Netherlands) without any power for nearly three days. This event contributed quite a lot to the monthly mean precipitation which was 98 mm this month in De Bilt, 121% of the normal. The monthly mean temperature was +1°C higher than normal.

Central Europe was dry with temperatures near normal on average. **Belgium** was affected by maritime as well as continental air masses, so that the monthly mean conditions were near normal there. The first decade of the month was exceptionally mild with a mean temperature of 11.6°C, the highest value since 1901. **Luxembourg** was 0.6°C warmer than normal. The country was located mainly within the dry air mass, so only 66% of the normal precipitation fell.

In **France**, most temperature anomalies were negative (around -1°C). Precipitation was unevenly distributed, in most parts of the country below normal. Long lasting precipitation in the middle of the month caused flooding in southern France. **Germany** had a near normal temperature on average this November (+0.1°C, warmer in the north, colder in the south), here again the first half of the month was very mild, but the second half was already wintry with

frequent snowfall. In particular towards the end of the month (November 25-28) a severe storm resulted in 30-50 cm of freshly fallen snow. Air and road traffic were strongly affected, especially in northwestern Germany; the airport of Düsseldorf had to be closed for 4 hours. Power lines broke down due to extreme icing; about 250 000 people were without electricity. However, most of the month had very dry conditions (65% of the normal precipitation on average, locally less than 30%) and was sunny in most parts of the country. For some stations in the northeast of Germany this was the sunniest November since the beginning of measurements. **Poland** had temperatures around normal; in the north it was warmer than normal up to +1°C. Most of the country received less than 40% of the normal precipitation.

The Alpine countries were mainly colder and drier than normal on average. In **Switzerland**, again, the month started mild and dry, but on November 17 a disturbance reached the Alps, followed by a flow of cold polar air. In the eastern plain, there was snowfall down to the lowlands, bringing the winter's first thin snow cover. The amount of freshly fallen snow was generally small, so that in the whole country November was remarkably poor in precipitation. Since October had already been very dry, the lakes had very low water levels. The Lake of Constance reached almost the lowest level since 1864 when systematic observations began. In **Austria**, the month had negative temperature anomalies down to -1.5°C. In most parts of the country, only 25-75% of the normal precipitation was registered, only in the southern and southeastern parts were the precipitation amounts around normal. Precipitation in southern Austria mainly fell as snow, leading to new record snowfalls in these areas. On November 26-27, 57 cm of snow fell in Villach (Carinthia) in 24 hours. In **Slovenia**, too, an abundant snow cover was recorded during the last days of November, even in the lowlands, which was quite unusual. In the Upper Sava valley, the deepest snow cover since observations began was reached with 103 cm. Most of the monthly precipitation was concentrated in the last decade of the month. The monthly totals were distributed unevenly. At the coast, nearly 150% of the normal was registered, while in other parts precipitation was below normal. The mean temperature in Slovenia was close to normal on average; the first decade was warmer, the last colder and cloudy. At the beginning of the last decade, some very strong Bora episodes were recorded; traffic in the Vipava valley was occasionally hindered due to the strong winds.

The countries in southeastern central Europe were mainly dry too and also mostly colder than normal, e.g. the **Czech Republic** and **Slovakia**. **Hungary** reported a temperature anomaly of -0.7°C and 58% of the normal precipitation on average. In **Romania**, there were negative temperature anomalies around -1°C; precipitation was near normal on country average, drier in the west, wetter in the east. **Bulgaria** had temperature anomalies between -1 and -2°C with the coldest values in the south. Precipitation was around normal in northern Bulgaria, and around 130% of the normal in the south of the country. A snow cover appeared in elevations above 800 m for 8-14 days; the snow depth reached 10-20 cm on average.

The southwest of Europe was colder than normal and had an uneven distribution of precipitation anomalies this month. In **Portugal**, particularly low maximum temperatures were measured on November 13 and 26, below 10°C at several stations, and also low minima resulted on the following morning of these days. The number of frost days (Tmin <= 0°C) was 6-11 in the northern and inner central regions of Portugal (Fig. 11.1) and was 2 to 3 times above normal. Precipitation amounts were above normal in central and southern Portugal, and near normal in the north of the country. **Spain** had temperature anomalies down to -2°C. Precipitation totals were especially low in parts of southern Spain (less than 30% of the normal) and highest in the east of the country (locally more than 200%).

The temperatures in the areas around the Mediterranean were mainly near normal or colder. In **Italy,** precipitation was higher than average in Emilia Romagna, the lower part of Veneto and in the very southern part of the Puglia region. An extreme event occurred in Lazio: The Viterbo station measured 122mm in 24 hours and a monthly total of 319 mm, resulting in flooding. **Croatia** had slightly negative temperature anomalies down to -0.7°C. Precipitation was mostly

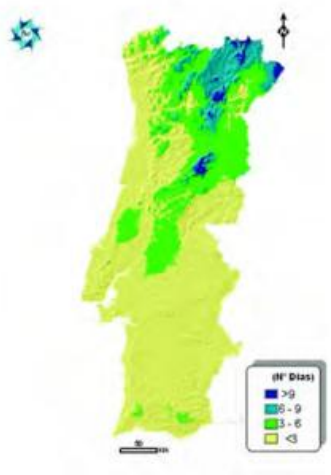


Fig. 11.1:

Number of frost days in Portugal in November 2005
Source: Instituto de Meteorologia, Portugal

around average, but the south was quite wet (150% of the normal or more) while the northeast was dry (50% or less). **Serbia and Montenegro**, too, were colder than usual in the whole country. At most places in Serbia there was a precipitation deficit in that month. In the first half of the month there was almost no precipitation, while in the second half there were more rainy days. At the end of the second and the beginning of the third decade there was snowfall, so that a slight snow cover formed both on mountains and in lower regions but did not last for long. In Montenegro, high intensity precipitation of 209 mm fell on November 16-17 in Niksic. This was the consequence of a large cyclonic activity centre in the western Mediterranean. It was the 2nd highest 24-hour amount of the time series; such an occurrence can be expected only once in 50 years. **Macedonia** reported temperature anomalies around -1°C and it was quite dry. **Greece** also was colder than normal and partly very wet. Athens was 1.6°C colder and 179 mm of precipitation fell that month, which was about 350% of the normal. **Cyprus** was 0.8°C colder than normal with 171% of the normal precipitation amount. On November 19, heavy showers affected the town of Limassol causing floods and damage to properties. The **Lebanon** too, was mostly colder than normal (around 1 to 2°C); precipitation was around normal or slightly higher. In **Israel**, November was slightly colder than normal. The first part of the month was very cold with 3 to 5°C below normal; on the other hand, the last 7-8 days of the month were much warmer than normal. On November 28-29, the temperatures reached 31 to 33°C in the coastal plain and in the Negev. In Jerusalem, 28.3°C were measured on November 28, which was the highest value for the second half of November since 1966. Rainfall was above normal in the northern parts of the country and in the southern coastal plain (110-130% of the normal); in other parts 50-70%. In the last week of November there was no rain at all in the inland areas of Israel.

In **Armenia**, the monthly mean temperatures were slightly above normal. High temperatures were measured on November 1. The maxima reached 20 to 25°C in valleys, which were the highest on record, and 16 to 19°C in mountain regions. But immediately after this warmth the temperature decreased considerably, and on November 6, snow was seen in the mountains. Precipitation totals were mainly lower than normal.

December 2005

- **Warmer than normal in most of the Region, especially in the north, colder in parts of western and southern Europe**
- **Wet in most of the east and the north, dry in most of the west and south**
- **Storm over northern Scandinavia on December 12**

In December, the large-scale circulation was mainly meridional which is not typical for this time of the year. After the passage of a large trough over Europe in the first decade of the month, a high pressure system was established over the Atlantic and northwestern Europe, while the trough remained quasi-stationary in the east of the Region for nearly the rest of the month. Thus, it was wetter than normal in most of the eastern and some of the northern parts of the Region and less rainy than usual towards the west. Mild air from the Atlantic mainly moved to the northern areas, while cold air from the northeast penetrated within the trough far to the southwest, particularly after Christmas. Thus this part of the Region became colder than normal on the monthly average, and all over Europe the last week of the year was more or less wintry.

It was very mild and quite wet in parts in **Greenland**. Temperature anomalies reached up to +6°C. In **Iceland**, the weather in December was again unsettled, but relatively warm with almost no snow in the south. Christmas day in particular was unseasonably mild with temperatures reaching 10 to 13°C in many parts of the country. A storm at Christmas caused some damage in the northwest.

Atlantic warm and humid air masses advanced further to the **Arctic** as well. The monthly mean temperature at Svalbard was around -3.8°C; this was an outstanding anomaly of +9.5°C, implying the 2nd to 5th warmest December (depending on the station) since measurements began. The island station Jan Mayen, located at about 70°N, was 4.4°C warmer than normal. At this station, a new record of diurnal precipitation with 57.5 mm was also registered on December 10 after the passage of a small low pressure system, which was the highest value since 1921. In continental **Norway**, too, the monthly mean temperature was above normal in almost the whole country, in parts of eastern Norway up to +3.5°C. In some counties of central Norway (Møre og Romsdal, Trøndelag and parts of Nordland), the monthly precipitation totals were markedly above normal. It was mostly mild in **Sweden** too. Temperature anomalies reached up to around +4°C in central Sweden. Most parts of the country were also wet except for the Swedish west coast, which was drier than normal. **Finland** was warmer than normal and mainly wet, only the southwest was dry. **Denmark** was warm and dry, only after Christmas did cold weather with a lot of snow begin.

On **December 12**, a **storm** moved over **northern continental Scandinavia**. 118.5 mm of diurnal precipitation were measured this day at Leiråmo in Nordland (Norway). In Sweden, the wind-exposed Stekenjokk station in southwestern Lapland recorded a mean wind velocity of 140 km/h. About 9000 households in southern Lapland were temporarily without electricity.

In the Baltic countries it was mostly mild with precipitation less than average in most parts except the south. December in **Estonia** was warmer than usual (+0.4°C above normal) and was remarkable for lots of snow. However, the monthly precipitation amount was not higher than 78% of the normal on country average. **Latvia** was +0.3°C warmer than normal with 85% of the normal precipitation total. In **Lithuania**, too, the weather was predominantly mild (anomaly +0.7°C), though unsettled. On December 18, a significant freezing period began. Precipitation was 65-80% of the normal in some central and northern regions of the country, but in most parts it exceeded the normal up to 1.5 times. There were only 3 days without precipitation, but the diurnal amounts were mostly below 5 mm.

In **Poland**, monthly mean temperatures were close to normal, only the south of the country was colder (-1.2°C below the 1971-2000 average). The beginning of December was generally mild with maximum temperatures of 9.6°C in the south and 8.3°C at the northwestern coast. The lowest minimum of the month was -16.7°C at the western border of Poland. The month was wet; some monthly precipitation totals reached 200% of the normal. In the second half of the month, strong winds with snowfall occurred (gusts of 100 km/h). The **Czech Republic** was mostly cold and wet. On December 16, a snowstorm affected the country. **Slovakia** had temperatures around normal, but the precipitation amounts were high (locally around 300% of the normal). Averaged over the whole territory of Slovakia, a monthly precipitation total of 122 mm was reached, which was the highest since 1881.

The remaining part of eastern Europe was mainly mild, but wet. In **Russia**, the warm period of the previous autumn months continued in the European territory with anomalies between +1 and +4°C. Precipitation amounts were comparable to normal or above. Especially south of Moscow (e.g. Tula), the monthly totals were 2-2.5 times higher than normal. Only in some regions east of the Volga River, was there little precipitation. The **Ukraine** was mostly 1 to 2°C warmer than normal. Precipitation totals, too, were mostly higher than average, at several stations around 150% of the normal.

Hungary was slightly warmer than normal (+0.3°C), but precipitation was 164% of the normal. In **Slovenia**, the monthly mean temperature was mostly above normal, but not more than +1°C. It was, on the other hand, significantly below normal in the northwest; at the mountain station of Kredarica the anomaly was -3°C. Precipitation was distributed unevenly; in most cases it was above normal (up to more than 160%) and most abundant in the Soča Valley; the least amount was observed in northeastern Slovenia. During the last days of the year, it was snowing all over the country due to a cold low over the central Mediterranean; at some measuring sites this was the deepest snow cover ever registered in December. Most parts of **Croatia** were warmer than normal up to +0.8°C, but in the coastal regions it was colder than normal, mostly between -0.5 and -1.0°C. It was wetter than normal in nearly the whole country, in parts around 200% of the normal precipitation fell, locally even more. **Serbia and Montenegro**, too, were warmer than usual. Monthly mean temperatures ranged from -4.3°C on Kopaonik (mountain in southern central Serbia) to 6.7°C in Podgorica in Montenegro. Precipitation quantities were considerably high, especially in the first decade of the month and in the western parts of Serbia. On Kopaonik a monthly total of 125.1 mm was measured, which was a new record. A snow cover remained on the mountains during the whole month; in other parts of the country it was formed in the second half of the month.

Romania was slightly warmer than normal on country average; precipitation was especially high in the west (locally more than 170% of the normal), but low in the east. **Bulgaria** was mild with temperatures up to +2°C above normal and normal precipitation. Only in the Struma valley were precipitation sums up to 130% of the long-term average. There were, however, some cold days; on 1-3 days the minimum temperatures were below -10°C, but there were also maxima of 15 to 18°C on some days. On December 18, a snow storm affected the country, and on December 27-29, a Mediterranean low pressure system induced strong southerly winds, Foehn in the north and rain at high altitudes in the southern mountains, provoking rapid snow melting, landslides and flooding. Apart from that, a snow cover existed in the mountains during nearly the whole month, in other parts on 5-15 days. The snow depth varied mostly between 25 and 50 cm. In **Macedonia**, positive and negative anomalies were registered for temperature as well as for precipitation.

Northwestern Europe was mostly under Atlantic high pressure influence, and thus mainly mild and dry. In the Republic of **Ireland** at Casement Aerodrome, this December was +0.3°C warmer than normal; the precipitation total reached 84% of the normal. In the **United Kingdom**, too, the mean monthly temperature was +0.3°C above normal, central England was slightly colder with -0.2°C. The month was very dry (69% of the normal precipitation) and sunny (more than 130%

of the normal sunshine duration), one of the sunniest Decembers in the series back to 1914. On December 29, cold air from the northeast came to the UK; -13.2°C were measured at Ravensworth (North Yorkshire) that day. Copley (Durham) recorded a 16 cm snow cover at 09 UTC on the same day.

It was also mainly mild or around normal in temperature and mostly dry in northern central Europe, e.g. in the **Netherlands** (+0.8°C in De Bilt with 71% of the normal precipitation). In **Belgium**, temperatures were around normal, precipitation was normal or below normal (e.g. Uccle 68%), although relative humidity was high on average. **Luxembourg**, too, had around normal temperatures; precipitation was 86% of the normal.

The month was rather mild in northern **Germany** (more than +1°C above normal in the northwest) while in southern Germany it was a little bit colder than normal. On country average the monthly mean temperature was normal. Precipitation was below normal in most parts of the country, 89% of the normal on spatial average, in the west locally less than 50%, in eastern Germany up to around 150%. Snow and freeze frequently affected traffic on roads in many parts of Germany, especially at the end of the year. On December 15-16 a storm caused a lot of damage to roofs, trees and traffic. Some Christmas markets had to be closed. Wind gusts up to 148 km/h were measured on mountains in eastern Germany (Brocken, Fichtelberg).

The Alpine regions were mostly cold and wet on average, but not all the time. After a cold first December day with a high pressure situation, **Switzerland** was influenced by a southerly airflow due to a low coming from the west. There was snow in the southern part of Switzerland; at the same time there was Foehn in the north, which broke down when a frontal system appeared, resulting in rain up to 1300 m above sea level. Some new low pressure systems affected the country on December 6-9; snow fell north of the Alps down to the lowland, while there was sunshine in the south. Then the weather became dry and moderately cold until December 16-17, when northwesterly winds brought a lot of snow to the northern slopes of the Alps; in the plains, snow fell only in the east. A white Christmas was only recorded in areas above 600 m above sea level in most parts. A new incursion of cold air followed on Boxing Day (December 26); temperatures decreased continuously. On December 30, the minima reached between -10 and -15°C in the midlands. In Samaden (Engadin/Grisons), the minimum was -31°C and in La Brévine (Jura near the French border) -35.9°C, the lowest temperature in Switzerland in 2005. On New Year's Eve, the temperature was rising again. In **Austria**, monthly mean temperature anomalies down to -2°C were recorded, especially in the western part of the country. The monthly precipitation totals were mostly 50-125% of the normal, but up to 200% in the east of Austria. Heavy snowfall occurred particularly in the provinces of Salzburg, Upper and Lower Austria.

In parts of western and southern Europe it was very cold and mostly dry. In **France**, the monthly mean temperatures were below normal by -1°C in the north and down to -4°C in the south. Most of France had lower than normal precipitation, except in the regions near the Manche, Limousin and Aquitaine. On December 1-2, Brittany was hit by a severe storm south of an Atlantic low pressure system. Wind gusts reached 120-160 km/h at the coasts of Finistère and 100-120 km/h at the coasts of Armor and Morbihan. There were cuts in power lines due to falling trees. Not much later (December 2-3), the front of the same low caused heavy precipitation in southern France; diurnal totals were e.g. 74 mm in Cannes and 72 mm in Nice. Later on, this front caused high precipitation also in **Italy** and **Albania**.

In **Portugal**, mean and maximum temperatures were around normal, but minimum temperatures were below normal in almost the whole country. The number of frost days ranged from 0 to 20 days (Fig. 12.1) and was 150-300% of the normal in the northern and central regions. A cold spell started in the middle of the month and persisted until Christmas. Precipitation amounts were mostly below normal, except in the Algarve region, where they were

near or above normal. **Spain** had mean temperatures mostly around normal; only in the northeast were anomalies of more than -2°C recorded. In nearly the whole country it was drier than normal, especially in the south and the east less than 50% of the normal precipitation fell.

It was cold but wet in **Italy**. In northern Italy, the lowest December temperatures for 55 years were measured at Vicenza and Brescia with -12.2 and -15.2°C, respectively. Heavy snow fell in the north of the country, causing traffic problems. **Greece** was mainly dry with temperatures around normal. On December 20-23, however, the cold air came far south and very low minimum temperatures (8 to 12°C below the long-term average) were recorded for several consecutive days in some areas of Greece, particularly in the north and in the central mainland. The absolute values were partly lower than -8°C at altitudes above 600 m and even slightly below zero in the lowlands.

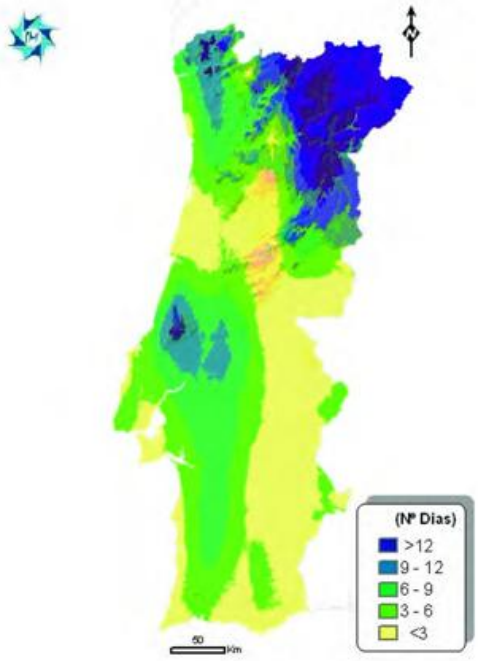


Fig. 12.1:

Number of frost days (Tmin<=0°C) in Portugal in December 2005
Source: Instituto de Meteorologia, Portugal

Apart from this cold spell, it was mild and dry towards the eastern Mediterranean. **Cyprus** reported an outstandingly high temperature anomaly of +2.0°C this month and only 22 mm of the monthly precipitation which was 21% of the normal. This was the lowest amount for the last 10 years and the 7th lowest since the beginning of the previous century. The dry spell started already in November and continued until the end of the first half of December; it was combined with extremely high temperatures up to +5°C above normal for this period. The **Lebanon**, too, was very mild, the temperature anomalies partly exceeded +3°C, especially in high mountains. Precipitation was mostly around 20% lower than normal in the whole country. **Israel** as well was much warmer than normal (between +2.5 and +3.5°C), in the mountains even up to +4°C. In Jerusalem it was the warmest December since 1960 (Fig. 12.2). The first half of December was even 7 to 10°C warmer than normal in the inland areas of Israel. On December 3, 28.3°C was measured in Jerusalem; this was the highest diurnal maximum in December since the beginning of measurements at that station in 1950, and even at other stations in Israel such a high temperature had never been recorded before 1950. It was also very dry in Israel in the first half of the month. From November 22 to December 14 (3 weeks) there was no rain at all. Such a long dry period during the rainy season is not frequent, and it typically occurs only once in 7-10 years; especially during the main winter months (December-February) it is rare. The second half of December was much cooler and rainy. All in all, rainfall amounts this month were above normal in northern and some parts of central Israel (120-140%). In other parts of the country, rainfall amounts were below normal.

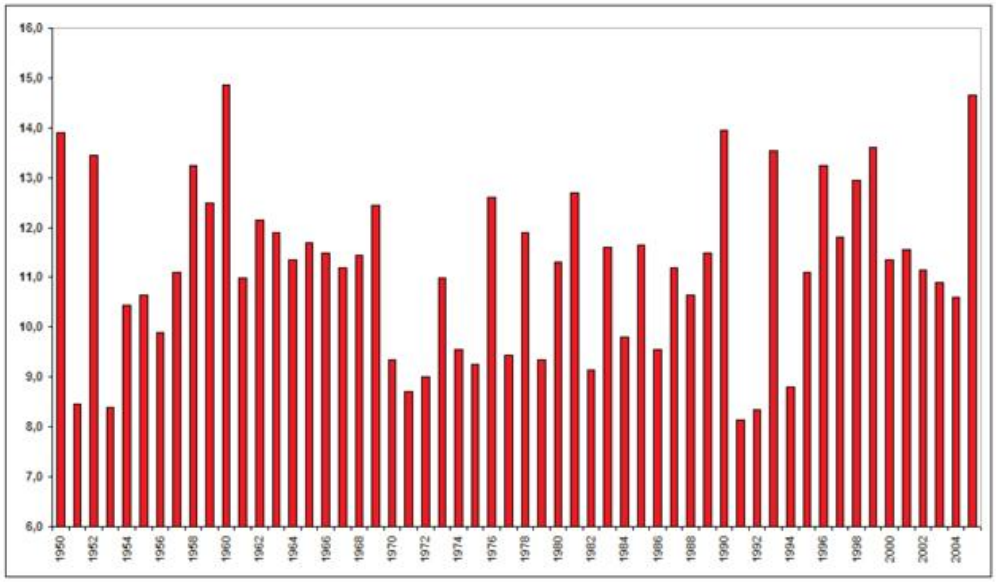


Fig. 12.2: *Mean monthly temperature in Jerusalem in December 1950-2005 (°C)*
Source: Israel Meteorological Service

Further to the east, it was very mild and drier than normal, also in **Armenia**. The monthly mean temperature was in many cases between +3.0 and +3.5°C above normal, in some areas between +8 and +10°C. Especially in the first and second decade of the month the weather was warm. Daily maxima reached 18 to 22°C in the eastern regions, 13 to 15°C in the Ararat valley and 9 to 13°C in mountain regions. Some trees started blooming in the Lori region. The first half of the month was also very foggy in the Ararat valley, visibility being less than 50 m. Because of heavy fog for more than 10 days, all flights were cancelled at Zvartnoc Airport in Yerevan. Only in the third decade of December did the diurnal mean temperature sink below zero in mountain regions, which was one month later than usual.

Ozone trends

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Ozone is a key trace gas in our atmosphere. As the strongest absorber of ultraviolet (UV) radiation, it protects life on the earth's surface from excessive levels of this potentially harmful shortwave radiation. By absorbing and emitting thermal infrared radiation as well, ozone is also an important greenhouse gas. In general, ozone is a heat source, both in the stratosphere and in the troposphere. Ozone is further an important player in atmospheric chemistry. It is a lead substance for urban pollution and photochemical smog, and it is the precursor for the OH radical, the key atmospheric "cleaning agent" in the troposphere.

Since ozone is a fairly abundant trace gas, from 50 parts per billion by volume in the troposphere to 10 parts per million in the stratosphere, and has also strong spectral absorption features, ozone measurements are relatively easy. The beginning of a global ozone observation network based on UV spectrometers was laid down in the 1920s (Dobson and Harrison, 1926). However, the global network of Dobson spectrometers did not start until the 1957/1958 International Geophysical Year. The perception that anthropogenic Chloro-Fluoro-Carbons (CFCs) might destroy our stratospheric ozone layer (Molina and Rowland, 1974; Crutzen 1974) and the discovery of the Antarctic ozone hole (Chubachi, 1984, Farman et al., 1985) have raised widespread scientific interest and public awareness. They have mandated an internationally and globally co-ordinated ground- and space-based monitoring system of the ozone layer. This coordination was very successful and has been in place for over 20 years (WMO, 2003). The resulting WMO Global Ozone Observing System (GO3OS) has been a nucleus for the WMO Global Atmosphere Watch (GAW) programme.

The evolution of near-global annual mean total ozone is shown in Fig. 13.1. Since the 1960s, zonal mean ozone from 60°N to 60°S has declined by about 4%. Note that a much larger decline has occurred near the poles, particularly in spring. Largely, this decline is a consequence of chemical ozone destruction by man-made chlorine and bromine contributions (magenta curve for equivalent effective stratospheric chlorine, EESC, in Fig. 13.1). However, meteorological changes related to climate change have also contributed to the decline (WMO, 2003).

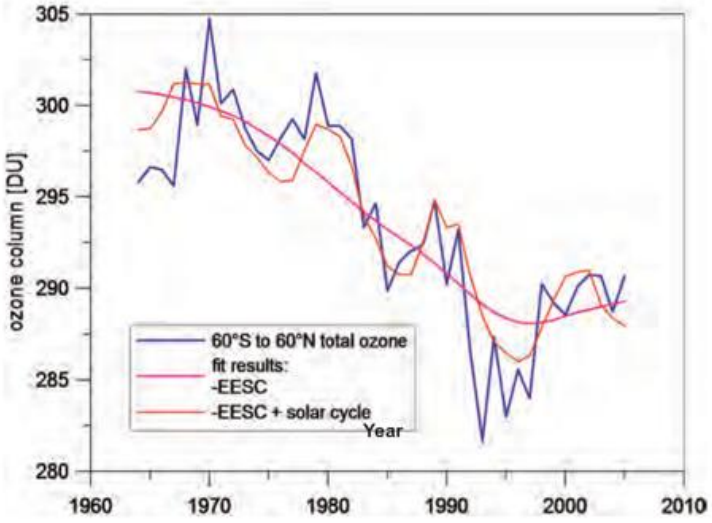

***Fig. 13.1**: Evolution of the near-global annual mean total ozone column. Ozone data (blue line) are obtained by combining ground- and space-based data sets (WMO 2003). The major long-term variations are due to anthropogenic chlorine and bromine, here described by equivalent effective stratospheric chlorine (EESC, magenta line), and the 11-year solar cycle (red-line, combined with EESC).*

Following the international ban on the production of harmful CFCs, chlorine levels in the lower stratosphere peaked around 1996 and are decreasing continuously. In Fig. 13.1 this corresponds to the minimum of the EESC curve (magenta), which is inverted to account for the negative effect on ozone. Since 1996, the trend of lower stratospheric chlorine has changed. However, at this point it is not clear what fraction of the observed ozone levelling since 1998 (blue line in Fig 13.1) is due to chlorine changes, which part is due to recovery from the effects of the 1991 Mt. Pinatubo volcanic eruption, causing the record low values of 1993 and 1995, and what fraction is due to transport changes or due to the 2000 to 2003 maximum of the solar cycle (red line in Fig. 13.1). It will take several years of additional data to resolve these ambiguities.

Most of the atmospheric total ozone column resides in the stratosphere at an altitude of between 12 and 40 km. Above this altitude range, the timescale on which ozone reaches photochemical equilibrium varies tremendously, from years or months near the tropopause to about one day at 40 km. Therefore, ozone in the upper stratosphere is largely controlled by photochemical reactions, whereas ozone variations in the lower stratosphere are largely determined by transport processes. Examples for the evolution of ozone in two selected stratospheric layers and one tropospheric layer are given in Fig. 13.2. At an altitude of 40 km, where ozone is mainly under photochemical control, a fairly straight long-term decline is apparent. It is caused by the destruction of ozone due to increasing chlorine levels over a time. Details are discussed below.

In the lower stratosphere at 20 km, in contrast, transport variations exert a major influence on ozone, although chemical depletion also plays a large role. For the long-term decline of lower stratospheric ozone from 1967 to 1996, e.g. by about 12% at 20 km, it is estimated that about two thirds are due to chlorine (and bromine) increase, and about one third is due to transport changes (WMO, 2003). As for the near global ozone (Fig 13.1), it is not clear which fraction of the levelling observed since 1998 is due to chlorine reduction, and which fraction is due to other factors.

While the two upper levels shown in Fig. 13.2 are representative of ozone at midlatitudes of the northern hemisphere, the evolution of tropospheric ozone in Fig. 13.2 is representative for central Europe only. There, ozone levels increased substantially until the late 1980s. This increase is mainly due to increasing emissions of nitrogen oxides and organic carbon substances. Since the 1990s, European emissions have been reduced. Tropospheric ozone levels in Europe have responded totally with a decrease or have remained more or less constant. However, small variations must be seen in the light of measurement uncertainties of ozone sondes. For some of the finer details, measurement uncertainties of the ozone sondes may play a role. A different behaviour of tropospheric ozone is found in other parts of the world. Over Canada, for example, tropospheric ozone decreased by about 10% during the 1980s, but has increased by about 10% during the 1990s (Oltmans et al., 1998; WMO, 2003). The reasons for this different behaviour in various parts of the world are widely unknown.

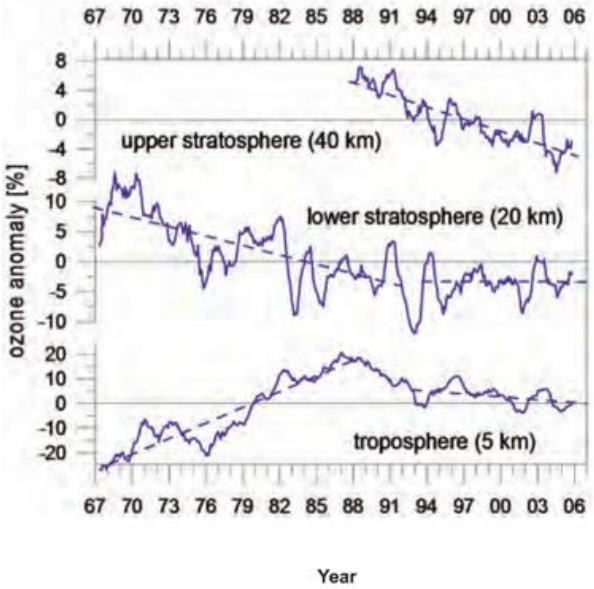

***Fig. 13.2**: Ozone anomalies from 1967 to 2005 at three atmospheric levels above Hohenpeissenberg, measured by ozone-sondes (5 and 20 km) and laser radar (40 km). Anomalies were defined by subtracting the average annual cycle from the monthly mean time series. To reduce short-term fluctuations, the data were smoothed by a 13 -month running mean. Hohenpeissenberg is located in southern Germany at 47.8°N, 11.0°E, 1000 m a.s.l.*

As already mentioned, for total ozone or for ozone levels in the lower stratosphere, a search for beginning positive effects of the recent turnaround in chlorine (or EESC) does not provide conclusive results at this point. There are simply too many competing influence factors. More conclusive evidence for a beginning recovery, however, can be found in the upper stratosphere, where ozone levels are most closely tied to chlorine levels by efficient catalytic destruction cycles. Fig 13.3 shows upper stratospheric ozone residuals for five stations from midlatitudes in the southern hemisphere to the northern hemisphere. These residuals were obtained by averaging all available long-term records from ground- and space-based instruments, and by subtracting the average annual cycle, as well as ozone variations due to the quasibiennial oscillation of equatorial winds and due to the 11-year solar cycle (Steinbrecht et al., 2006). To a large degree the residuals are then determined by chlorine levels. Indeed, for most stations, the residuals follow the inverted chlorine (EESC) line in Fig 13.3. In particular, the levelling of chlorine since about 1996 is mirrored by a levelling of ozone, with values well above the extrapolated ozone trend-line from the 1980s. The steep decline has obviously not continued after 1997. Because most other factors can be eliminated, the levelling gives a very strong indication that ozone is following the chlorine turnaround. The Vienna convention and the Montreal protocol have been effective for the upper stratosphere. There, the ozone layer is showing first signs of a recovery. However, as indicated by the data a the most northerly station (Hohenpeissenberg), other factors, not well understood, do interfere with the recovery signal.

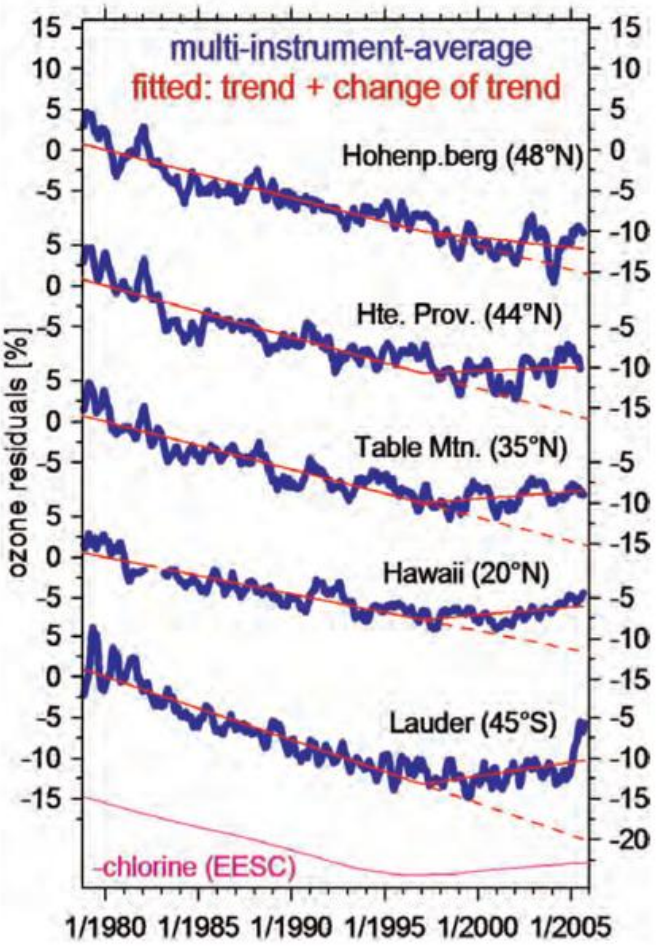

Fig. 13.3: *Upper stratospheric (35 to 45 km) ozone residuals obtained by a mix of ground- and space-based instruments for five stations of the Network for the Detection of Stratospheric Change (NDSC). Ozone residuals were defined by subtracting the average annual cycle, as well as effects from the 11-year solar cycle and the quasibiennial oscillation. Residuals very closely follow the chlorine (EESC) loading. Results from fitting a linear trend and a change of trend term after 1996 are shown as well (red line). After Steinbrecht et al. (2006).*

Chlorine levels are expected to continue declining. They are expected to return to the near natural pre-1980 levels over the next 50 years. This should bring up ozone levels. Nevertheless, further attention to the ozone layer is required. Climate change will affect the ozone layer in the future by both changing temperature and transport patterns. The expected cooling of the stratosphere will slow down ozone destruction cycles in the future, and when chlorine is back to 1980 levels, total ozone and ozone in the upper stratosphere are expected to reach higher levels than in 1980. This will change the vertical distribution of atmospheric heating and may affect the global circulation. As the past has shown, surprises are always possible. One thing is clear, however: an accurate, co-ordinated, and global ozone measurement system, i.e. a Global Atmosphere Watch programme will be required in order to gain knowledge about the true evolution of our ozone layer in the future.

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Activities and Results of European Climate Centres

Report on ECSN activities 2005

Walter Kirchhofer, MeteoSwiss

- General remarks

The European Climate Support Network Programme, ECSN, allows improved co-operation in the field of climate and related activities, in order to expand Members` capabilities to support the European user community through enhanced provision of high quality climate data and products, services and advice. ECSN has initiated a series of projects in order to respond to the most frequent user needs.

The 10th ECSN Advisory Committee (EAC) Meeting took place in Copenhagen, Denmark, 8-10 June 2005. The meeting was well organized by the Danish Meteorological Institute. It was a fruitful meeting, also with regard to new activities.

The combined Conference of the European Meteorological Society (EMS) together with the European Conference on Applied Meteorology (ECAM) took place in Utrecht, The Netherlands, in September 2005. This EMS/ECAM Conference also contained a substantial part of climatological contributions, managed by ECSN.

The 5th ECSN Data Management Workshop took place in De Bilt, The Netherlands, in December 2005. The following main topics were presented and discussed: data rescue, databases, gridding and UNIDART. About 80 participants discussed the actual state of climate data management in Europe. This successful workshop was very well supported and organized by the Dutch Meteorological Institute.

- European Climate Assessment & Dataset (KNMI)

The "European Climate Assessment & Dataset" (ECA&D) project of ECSN aims at increasing the knowledge of past changes in extremes over Europe through the analysis of historical climatological records. The objective of the ECA&D project is to realize a sustainable operational system for data collecting, archiving, quality control, analysis and dissemination. The integration of these activities proved to be essential for the present and the next European Climate Assessment report issued in 2006. Data collecting refers to long-term daily resolution time series from meteorological stations throughout Europe. The scope of the ECA&D project is to analyse mainly the temperature and precipitation climate for Europe in the twentieth century from 1901 onwards, focusing not only on changes in the mean, but also on changes in extremes and climate variability.

- Generate Climate Monitoring Products (DWD)

The "Generate Climate Monitoring Products" (GCMP) project aimed at providing standardized climate monitoring products for the European area, in order to meet the requirements of the Services, scientific institutions and the public. In the course of the project a Web site was created as a platform for easy access to climate monitoring information supplied by the European National Meteorological and Hydrological Services (NMHSs) for the regional and national areas: http://www.gcmp.dwd.de.

- Climate Atlas of Europe (Météo-France)

The "Climate Atlas of Europe" project has been completed for the period 1971-2000, and contains monthly long-term mean values for precipitation, temperature, wind and sunshine duration as well as additional statistical information on these parameters and the occurrence of phenomena such as fog, thunderstorms, hail and snow. A CD-ROM, containing the datasets from nearly 700 European weather stations, is available.

- ENSEMBLES (KNMI, MeteoSwiss)

The "Development of daily high-resolution gridded observational datasets for Europe" project was initiated in 2004 within the European Integrated Project called "ENSEMBLES". The gridded datasets will include several climate variables, as minimum/maximum temperature, precipitation, air pressure and snow cover, and the datasets will go back as far as station data availability allows (45 years or possibly even longer). The resolution of the datasets should be high enough to capture extreme weather events. So far, nearly 700 European stations have been collected in the ENSEMBLES database. Since 4200 stations would be needed for a station density of one station per 2500 km², many more data will have to be collected.

A Web site for the ENSEMBLES gridding project was launched in October 2005: http://www.knmi.nl/samenw/ensembles_rt5/WP51.html.

- Alpine Tmap (ZAMG)

The Austrian Meteorological Institute has taken the initiative to launch a new ECSN project "High Resolution Temperature Climatology in Complex Terrain - demonstrated in the “Greater Alpine Region" test area. The project will provide a high quality data product for a special European region. The "Alpine Tmap" project proposal has been approved by the EUMETNET Council, and the project started on 1st January 2006, with Austria as the leading country. The main deliverable will be a mean monthly temperature field in a 1km resolution, first for the WMO period 1961-1990, and secondly for the "modern period" 1971-2000.

- New project activities

With the purpose of realizing a EUROGRID programme and studying the feasibility of such a concept, a preliminary project for a showcase has been worked out by the Swedish Meteorological Institute in close co-operation with ECSN. The EUROGRID Showcase proposal was discussed at the 26th EUMETNET Council meeting. The importance of the content of the project was supported enthusiastically, but it was stated that the links with other similar activities have to be improved and integrated in a revised proposal.

Meteorological Aspects of the Extreme Flood in August 2005 in Southern Bavaria

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1. The Flood Event

During the second half of August 2005 severe flooding occurred in the northern central Alps. Following heavy precipitation on 21 August, major Swiss cities such as Interlaken, Luzern and the capital Berne were flooded. On the following day a number of rivers in southern Bavaria, including the Lech, Iller, Isar, Inn and also the Danube flooded vast areas. Among other cities Garmisch-Partenkirchen, Kempten and Regensburg were affected by major inundations. In some regions the river gauges even exceeded the level of the century flooding of 1999.

2. The Synoptic Situation

Although the flooding caused disastrous effects regionally, the observed precipitation totals did not exceed former maxima of gauge observations at any station. Instead, the extraordinary flooding resulted from the particular interaction of several meteorological and hydrological processes. A detailed discussion can be found in Rudolf et al. (2006).

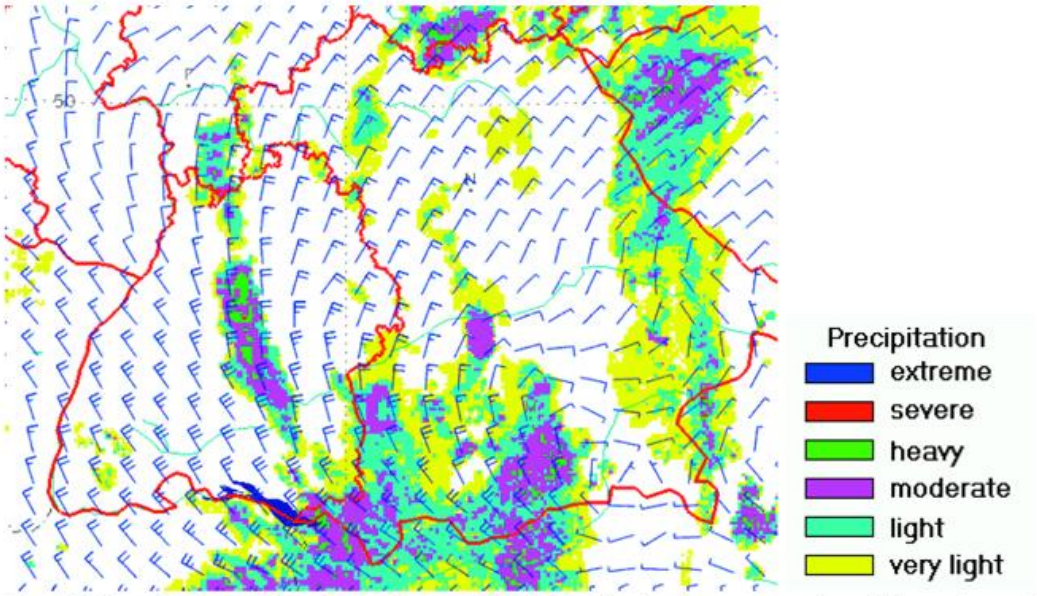

***Fig. 14.1**: Radar estimates of precipitation rate (yellow = very low, blue = low, pink = moderate, green = heavy) and wind field in an altitude of 1500 m from model output (DWD Local model, LM, 850 hPa) for 23 August 2005, 02:00h Middle European Summer Time (MEST).*

Several days before the high precipitation amounts occurred, a cut-off low had separated from the meandering flow over the southwestern part of Europe. Crossing the northern part of the Mediterranean, this low pressure system took up a considerable amount of humidity. Due to cyclonic steering, warm and humid air masses were first transported east- and northward around the Alps, and subsequently shifted westward and finally southward (see Fig. 14.1). Cooling of air masses during the transport resulted in condensation and continuous rainfall. In addition, forced lifting of the advected air masses at the northern slope of the Alps led to a

further amplification of condensation processes and to extreme precipitation events locally. The emergence of the resulting floods was furthermore promoted through soil characteristics. Following a period of high precipitation during July and the beginning of August 2005, soils were already water saturated. Thus all the precipitated water was transferred directly into surface run-off.

3. Forecast and Warning

The weather development that led to the flooding was well observed and forecasted. The local model (LME) of the German Meteorological Service (DWD) predicted precipitation amounts close to the observed ones. As a consequence DWD informed the responsible agencies well in advance and gave the public warning of heavy precipitation. Fig. 14.2 (left panel) shows the precipitation forecast issued on 22 August 2:00h Middle European Summer Time (MEST) for the 24h period starting 22 August 8:00h MEST. The right panel of Fig. 14.2 shows the interpolated observed precipitation from 1377 stations within the same period. The good agreement of both these maps obviously demonstrates that the diurnal precipitation total of this event was well forecasted. The regional Unwetterwarnzentrale (severe weather warning centre) of the DWD located in Munich issued its first warning on 21 August at 8:00h - well in advance of the event.

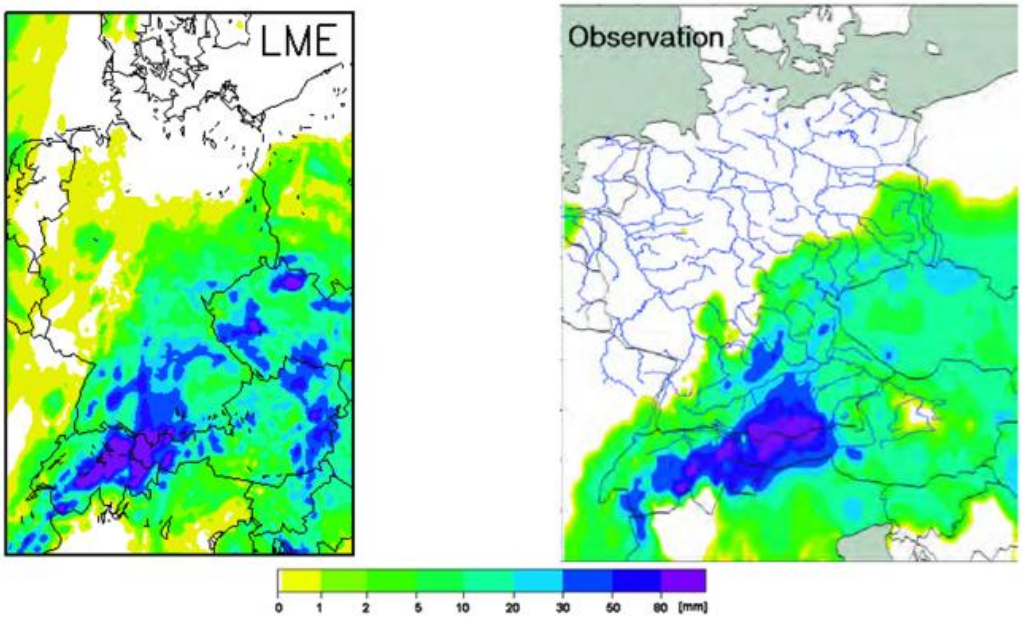

***Fig.14.2**: Precipitation forecast issued 22 August, 2:00h for a 24-hour period starting 6 hours later (left panel) and observed precipitation interpolated from 1377 stations (right panel).*

4. Climatological Evaluation

Fig. 14.3 shows the observed precipitation of 22 August for several stations within Bavaria and Austria. Only a small region in southern Bavaria and the Tyrol faced extraordinary extreme precipitation, which was most pronounced around Reutte and Oberstdorf with values above 100mm/day and an observed maximum precipitation of 189mm/day at Reutte/Tyrol. However, precipitation rates of more than 100mm/day are not unusual within the Alps. Stations situated in the Alpine foothills such as Kempten (with 67.5mm/day) faced less extreme precipitation. Also at very high altitude stations such as Zugspitze (2962m altitude) precipitation was less extreme (45.8mm/day).

For some of the stations shown in Fig. 14.3 long time series of daily precipitation observations exist. Those time series allow an estimation of recurrence periods. At the Kempten station observations are available since 1896. From these nearly 40 000 observed diurnal precipitation totals, 14 exceed the observation of 22 August 2005. This suggests a recurrence period of less than 8 years. The precipitation amount at Mount Zugspitze is usually exceeded twice a year.

However, at Garmisch, Oberstdorf and Oberstaufen the precipitation amount of 22 August 2005 was exceeded only once in their records consisting of more than 25 000 days each. At the station of Garmisch a considerably higher precipitation sum was observed during the precipitation event of 21 May 1999, which led to devastating floods. Assuming stationarity, i.e. the probability of an extreme precipitation event should not depend on time, we estimate a recurrence period in the order of 100 years, given the observed records. Since the most extreme observed precipitation totals reflect small scale convective precipitation events, the estimated recurrence period reflects the probability that the stations under consideration are affected by those events. However, if the meteorological situation had been only slightly different, another but neighbouring region would have been hit. Therefore, the probability that such an event will occur not exactly at the same location but shifted along the northern bounds of the Alps is higher. As a consequence the recurrence period for such an event to occur somewhere in the Alpine region is considerably below 100 years.

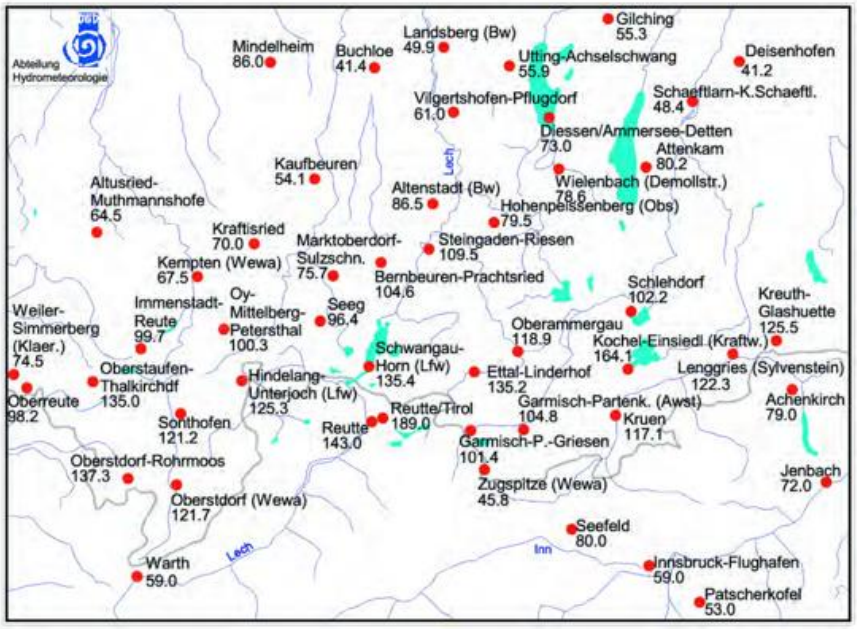

***Fig. 14.3**: Observed precipitation in mm/day on 22 August 2005.*

Against the background of global climate change the question may be asked as to whether or not the probability for an extreme precipitation event such as that under consideration has risen or fallen. In fact there is some conceptual framework arguing that heavy precipitation events should become more intensive in the case of global climate change (Trenberth, 1999).

In order to investigate whether or not the most extreme precipitation events lead to higher precipitation sums within the recent years, Fig. 14.4 shows the records of the highest observed diurnal precipitation total per year for the 3 stations at Oberstdorf, Garmisch and Kempten. These time series do not reveal a systematic increase in the intensity of the highest diurnal precipitation totals per year.

Finally, we focus on the second point that was essential for generating the flood: the saturated soils. These resulted from precipitation during the weeks before the extreme event. If monthly precipitation totals increase, also soil saturation increases on average. This in turn promotes the vulnerability of river catchments to floods triggered by short-lived but extreme precipitation events.

In order to investigate the regional trend in monthly August precipitation for the central northern Alpine and pre-Alpine region, a 50-year gridded dataset with 0.5° spatial resolution of observed monthly precipitation totals created on the basis of homogeneity tested, long and nearly gap-free records is used (Beck et al., 2005). Spatially averaged August precipitation totals for the region bounded by 9°-12° East and 46.5°-48° North are calculated and the respective time series since 1951 is shown in Fig. 14.5. A negative linear trend of about 7% over the period 1951 to 2000 becomes visible, reducing average August precipitation from about 150 mm at the beginning of this period to about 140mm at the end. However, given the high precipitation variability, this negative trend is not significant on a 90% level of significance.

Trömel and Schönwiese (2005) showed that temporal changes in precipitation variability exceed changes in precipitation averages, which may suggest a decoupling of extreme and average precipitation. Grieser and Beck (2003) found significant increases in both, days with extreme precipitation and precipitation totals on days with extreme precipitation. However, they defined a day with extreme precipitation as a day having a recurrence period of 100 days. Thus their statistics based on daily data for the period 1901 – 2000 describe less extreme events. Moreover, they found significant trends in winter only and for the shorter sub period from 1961 to 2000.

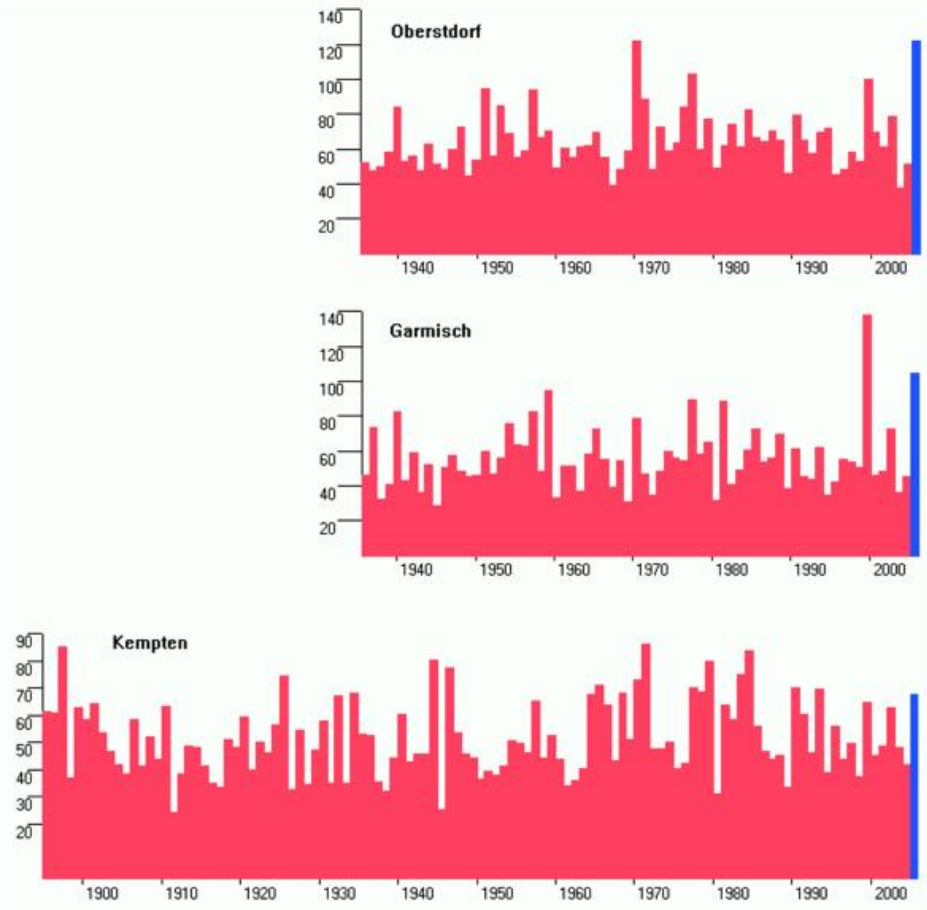

Fig. 14.4: *Time series (red) of highest diurnal precipitation total per year (in mm/day) for the stations at Oberstdorf, Garmisch and Kempten. The blue column is the precipitation total of 22 August 2005.*

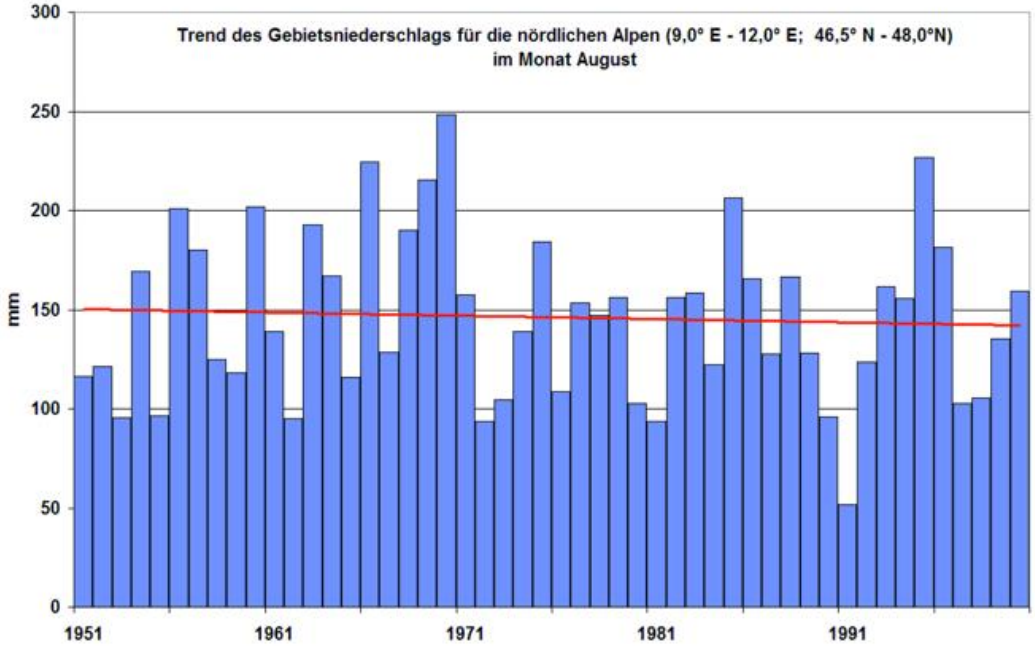

Fig. 14.5: *Time series of monthly mean August precipitation for the region 9°-12°E and 46.5°-48°N (blue columns) and linear trend (red line).*

5. Summary and Conclusion

The flood that occurred in the second half of August 2005 at the northern Alps resulted from extreme rainfall (with a recurrence period of up to 100 years for a small region) on saturated soils. The extreme rainfall itself was caused by a rather rare meteorological situation implying the advection of warm and humid air masses from the Mediterranean that circled eastward around the Alps and cooled down on the northern side, which led to condensation and continuous rainfall. Furthermore, due to forced lifting at the northern slopes of the Alps, precipitation reached outstanding intensities locally.

The potential hydrometeorological effects resulting from this synoptic situation were recognized early by the German Meteorological Service (DWD) and respective warnings were issued well in advance of the event.

As the flooding arose from the combination of unfavourable hydrological preconditions (water saturated soils) on the one hand and a triggering meteorological event (extreme daily precipitation) on the other hand, long-term variations of both factors were investigated in order to place this event in a broader context of global climate change.

Given long records of station observations within the affected region, neither a long-term positive trend of monthly mean August precipitation (which can be used as an indicator for water saturation of soils) nor positive trends in the very extreme diurnal precipitation totals can be detected. Therefore, this individual event cannot be regarded as a consequence of long-term global climate change. However, previous work suggests an increase in more moderate extreme precipitation (recurrence times of 100 days) especially in recent years, but mainly in the winter half-year.

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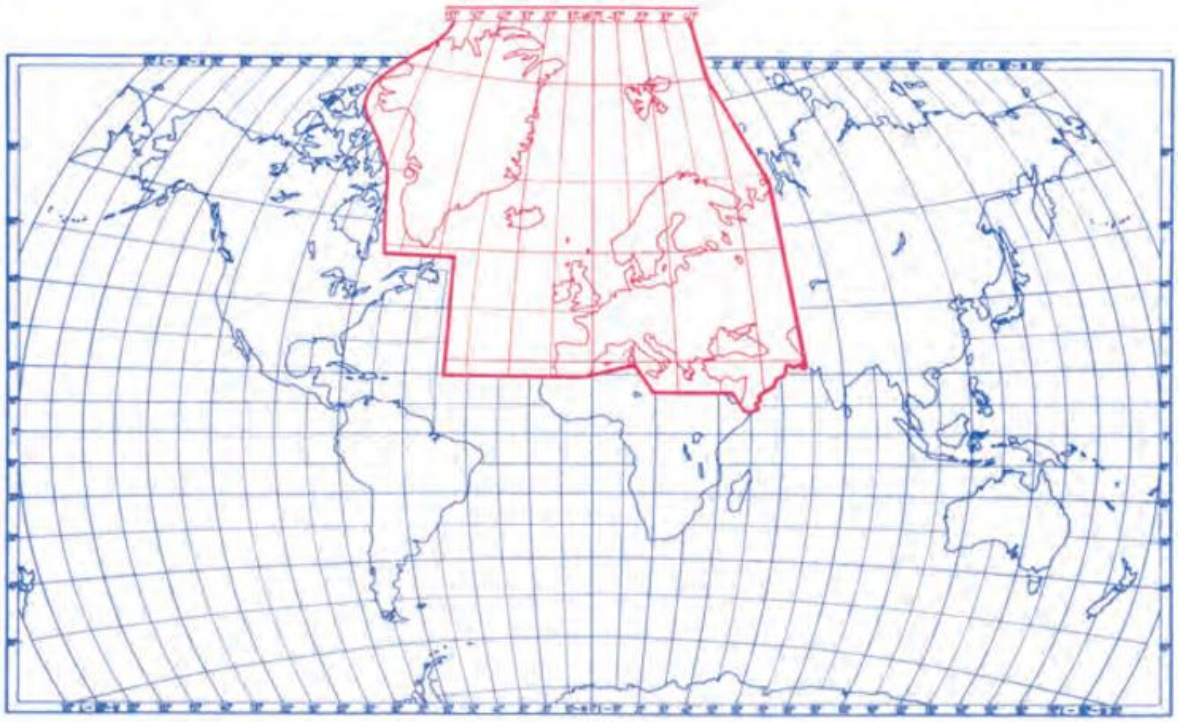
Deutscher Wetterdienst

Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2006



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Annual Bulletin on the Climate in WMO Region VI
- Europe and Middle East -
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The Bulletin is a summary of contributions
from the following National Meteorological and Hydrological Services
and was co-ordinated by the Deutscher Wetterdienst, Germany

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Foreword

The year 2006 was a very exciting year for both climatologists and readers of record books. In various countries and places it was the warmest year or at least one of the warmest, even in very long time series. To give only a few examples: it was the warmest year in the 348-year Central England temperature series and also in De Bilt in the Netherlands, where measurements began in 1706. This already implies that 2006 was an outstanding year, actually having been the warmest for at least 300 years in more than one location.

However, there were some more remarkable features in 2006 concerning our Region. Over large parts of Europe, the year 2006 started very cold with wintry conditions, but this was more than balanced out by most of the following months, especially July and the last four months of the year, which were extremely warm, particularly in central and northern Europe. These months or seasons were, of course, also record-breaking: with one record following the other.

The northernmost parts of our Region were already very mild at the beginning of the year. On Svalbard it was more than 12 °C warmer than normal in January and again in April 2006, and more than 5 °C on the annual average. This was even more than in the years 2004 and 2005, which were already very mild. Nowadays we classify these events as extreme. But, when we look at future climate projections, it could well be possible that in about 100 years such events will no longer be considered as extreme, but normal. The Arctic parts of our Region are expected to be those where climate changes will be largest and fastest, and if we look back on our climate monitoring results, we find strong signs that the recent climate change is already apparent and continuing steadily.

Records of this year did not only concern temperature. Some months, seasons or other longer periods were extremely sunny and dry over large areas; others were extremely wet and dull. Both, extended droughts and flooding can be found during 2006 in various parts of our Region, which caused considerable damage. Luckily, we did not have so many severe storms as in other years.

However, 2006 saw another record which is the most pleasant: the high number of countries participating in this 13th issue of the Annual Bulletin. 44 out of 49 countries sent their contributions in time to our editors Dr. Peter Bissolli and Peer Hechler of DWD (Deutscher Wetterdienst) who once again took over the task of compiling all these very informative contributions into a concise summary comprising the most important anomalies and highlights of this record-breaking year. I would like to express all my warmest thanks to all contributors, reviewers and editors for their excellent work and co-operation concerning this Bulletin issue, also to the authors of the special reports, which are included again as in the previous years. With this issue appearing already in summer 2007, we have further reduced the delay between the reporting year and the distribution of the Bulletin.

I wish you pleasant reading of this interesting documentation.



Daniel Keuerleber-Burk
President of WMO Regional Association VI

Outstanding Events and Anomalies

Temperature

- Very warm year with record anomalies in many places in the Region, particularly in the Arctic area
- Especially July and autumn were record breakingly warm in many countries, especially in Central Europe and parts of northern Europe.
- December extremely mild especially in northeast Europe

Precipitation

- Long dry periods (up to 35 consecutive days without rain), especially in some parts of the east
- Wettest spring in parts of Switzerland for more than 140 years
- Flooding of Danube and Elbe rivers in April
- Driest summer ever recorded in southern and western Finland
- Wettest August in some places in Central Europe

Sunshine

- Extremely sunny July, but extremely dull February and August in Central Europe

Wind

- Severe storms in France on the Atlantic coasts on October 3-4 and on December 8 with gusts up to 150 km/h
- Severe storms over northern Central Europe on October 30 – November 1 and on December 30-31 with gusts up to 156 km/h

Annual Survey

Temperature

2006 was again a warm year nearly all over the Region (Fig. 0.1). The highest anomalies (deviations from the 1961-1990 long-term mean) were recorded on Svalbard, reaching outstanding +5 °C and exceeding even the record values of 2005. This is in line with a recent strongly decreasing trend of Arctic Sea Ice extent which has been reported by, among others, the National Snow and Sea Ice Data Center (USA). In most of northern, western and central Europe, but also in parts of the Middle East, the anomalies were between +1 and +2 °C. In eastern and southeastern parts of the Region and over large areas of the North Atlantic, the anomalies were also mainly positive, but less than +1 °C. Only a few locations in the southeast of the Region (e.g. in Romania, Greece, Turkey, Armenia) recorded slightly negative or zero anomalies.

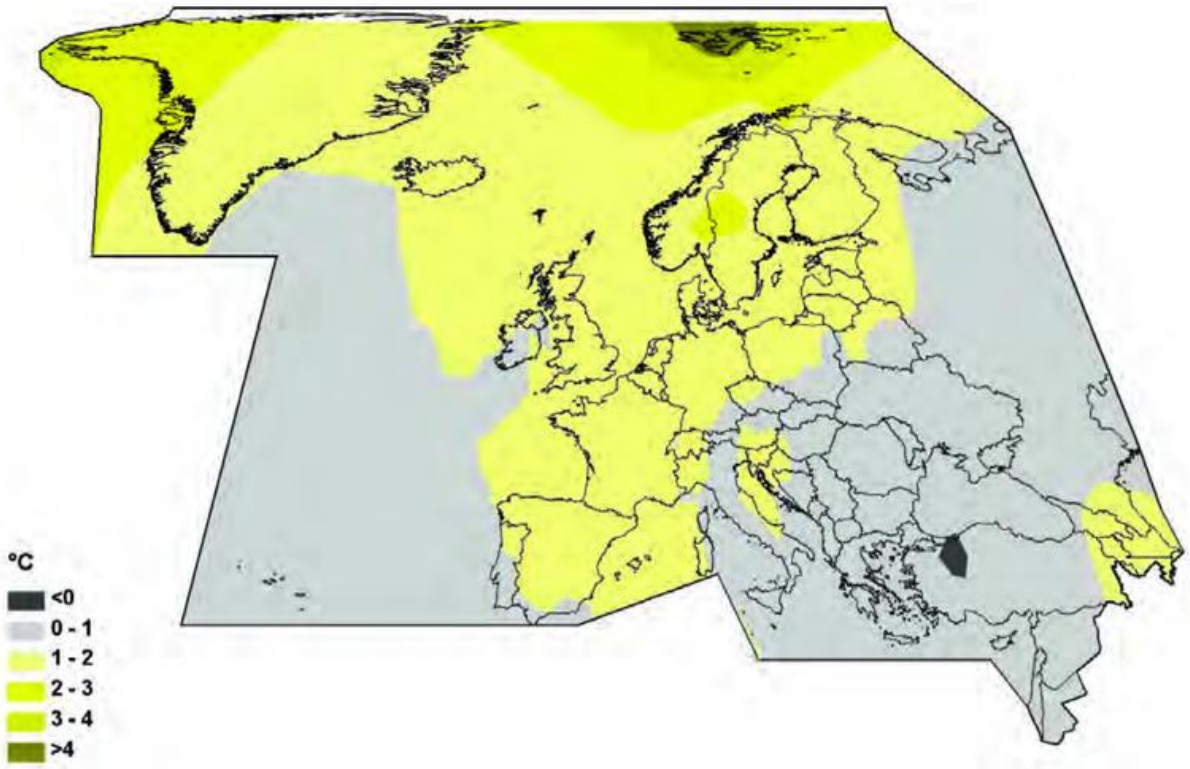


Fig. 0.1: *Mean annual temperature anomalies in 2006 (reference period 1961-1990) in WMO Region VI (interpolation of CLIMAT data).*
Source: Deutscher Wetterdienst

Although 2006 was warm on average, especially Central Europe and its adjacent regions had a very cold start of the year until March. In contrast, July and the last four months of the year were outstandingly warm, in many cases the warmest period ever recorded. In the Czech Republic, for example, the average air temperature of the period September-December 2006 was the highest since 1974. Typical examples of this special annual cycle are Poland (Fig. 0.2), Hungary (Fig. 0.3), Belarus (Fig. 0.4) and the Ukraine (Fig. 0.5). In the Middle East, it was just the other way around: here, it was warm from February onwards during most of the year, whereas the end of the year (November and December) was quite cold.

Many temperature records were beaten this year at many stations in some of the months, seasons or even over the whole year. 2006 was the warmest year within the 348-year Central England temperature time series, and record annual average temperatures were also observed



Fig. 0.2: *Monthly mean temperature anomalies in Poland in 2006 (average of 20 stations, reference period 1971-2000).*
Source: Institute of Meteorology and Water Management, Poland

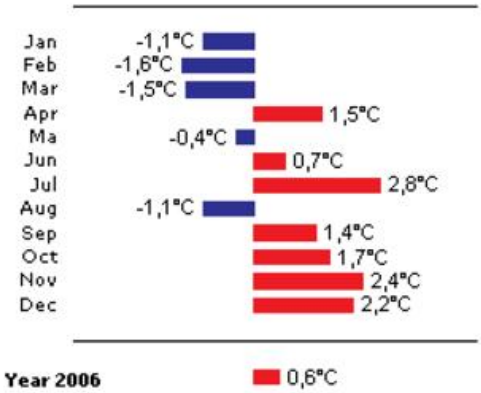


Fig. 0.3: *Monthly mean temperature anomalies in Hungary (country average) in 2006 (reference period 1961-1990).*
Source: Hungarian Meteorological Service

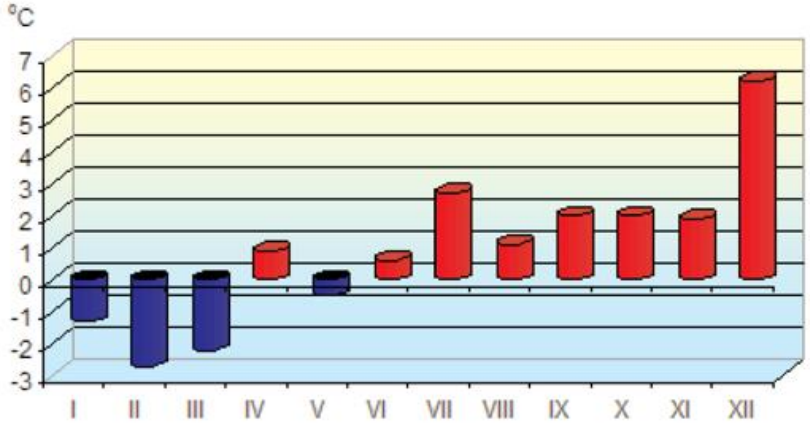


Fig. 0.4: *Monthly mean temperature anomalies in Belarus in 2006 (reference period 1961-1990).*
Source: State Committee for Hydrometeorology of the Republic of Belarus

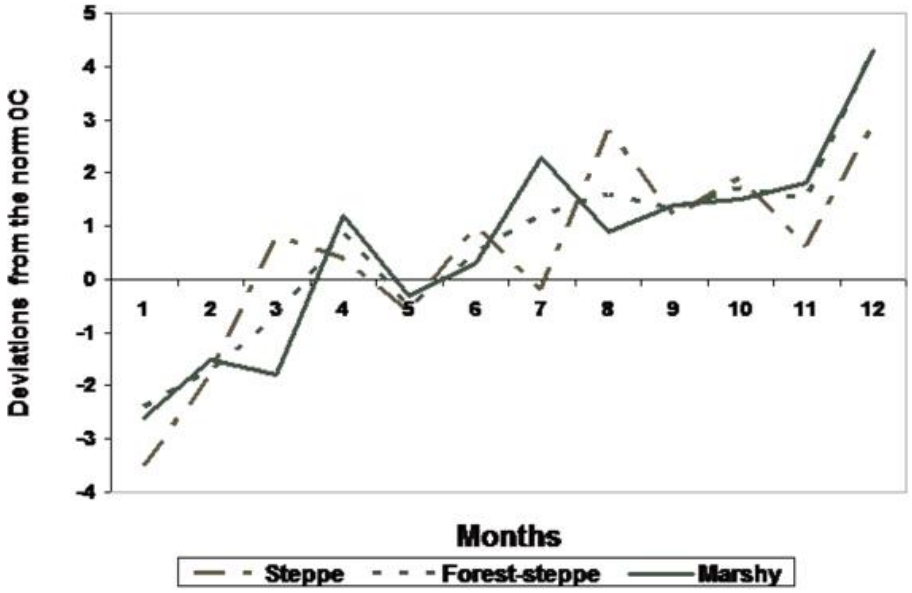


Fig. 0.5: *Monthly mean temperature anomalies for three different regions in the Ukraine in 2006 (reference period 1961-1990).*
Source: Ukrainian Hydrometeorology Centre

for most areas of the United Kingdom and for some stations in Ireland. In particular, the annual average minimum of the Central England temperature was the highest on record (Fig. 0.6), while the maximum temperature was only the 5th warmest.

For Norway as a whole, 2006 was the warmest year (anomaly +1.8 °C) ever recorded, together with 1934 and 1990 (Fig. 0.7); especially for western Norway it was by far the warmest year. Since 2002, the Norwegian annual mean temperature has been considerably above normal

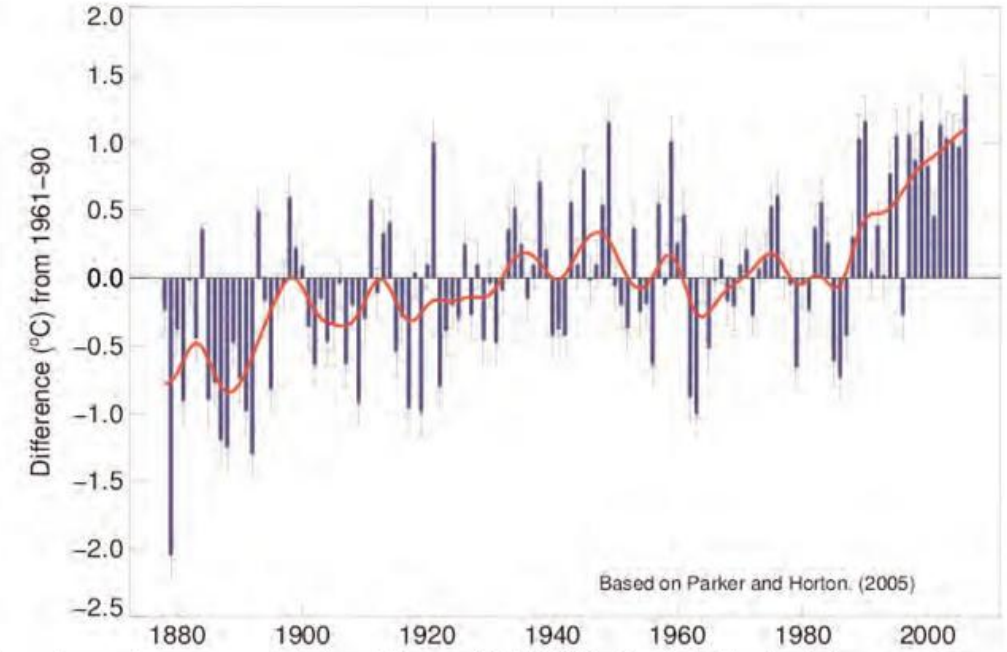


Fig. 0.6: *Annually-averaged daily minimum 1878-2006 Central England temperature anomalies (reference period 1961-1990, blue bars) with 2 standard-error range (grey bars) and smoothed values (21-point binomial filter, red line).*
Source: Met Office, United Kingdom

and has increased steadily. In Sweden, 2006 was the 6th warmest year (since 1860). Nevertheless, the average temperature in Sweden for the whole period from 1991 to 2005 was 0.9 °C warmer than normal, partly more than 1 °C (Fig. 0.8).

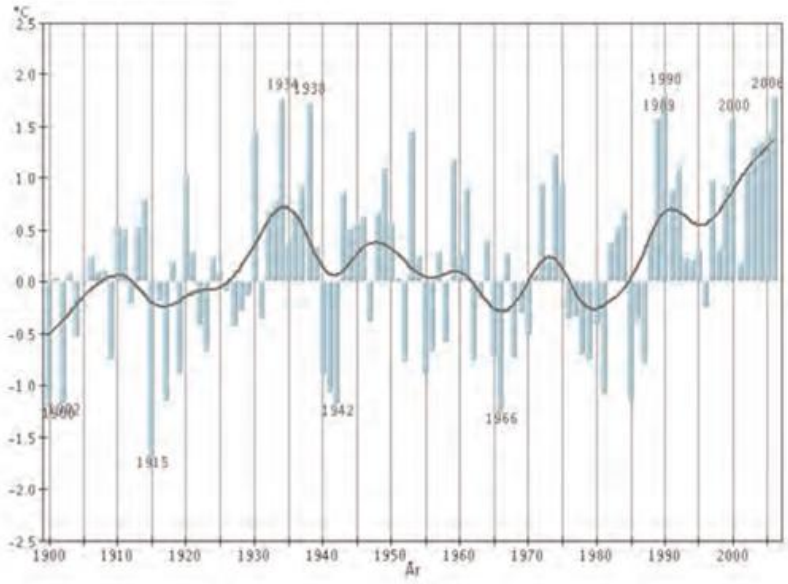


Fig. 0.7: *Annual mean temperature anomalies in Norway (1900-2006, reference period 1961-1990) with smoothed values.*
Source: Norwegian Meteorological Institute

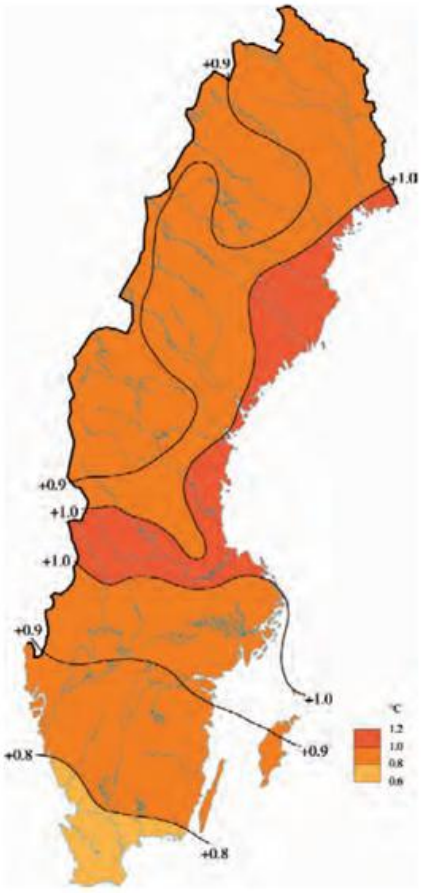


Fig. 0.8: *Difference of the mean annual temperature in Sweden (1991-2005 minus 1961-1990)*
Source: Swedish Meteorological and Hydrological Institute

The annual mean temperature for Denmark on the whole was also a new record: it amounted to 9.4 °C, which was +1.7 °C above normal and 0.1 °C higher than the previous record in 1990 (Fig. 0.9). With 2006, 17 of the last 19 years in Denmark were warmer than normal, thus continuing the sharply rising warming trend of recent decades. In Tórshavn on the Faroe Islands, 2006 was with 7.5 °C the third warmest year since 1873 after 2003 and 1933. Nine of the months in 2006 were warmer than normal on the Faroe Islands, with only the spring months having been colder. On Greenland it was also very warm in 2006, but it was not the warmest year on record: 2003 was warmer in Nuuk, 2002 and 2005 were warmer in Danmarkshavn.

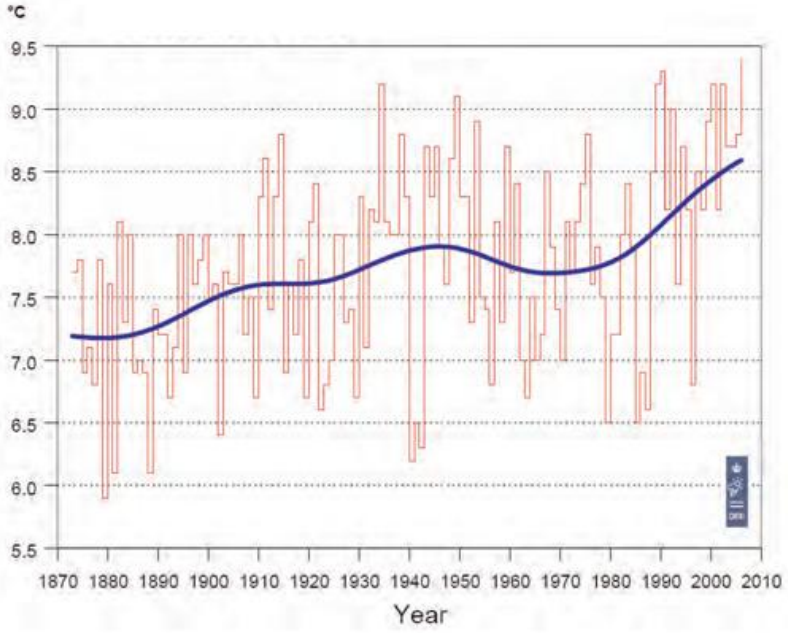


Fig. 0.9: *Annual mean temperatures in Denmark (1873-2006) with Gauss-filtered values (bold line). Source: Danish Meteorological Institute*

In Germany, the areal mean value was 9.5 °C in 2006 (anomaly +1.3 °C); it was the 5th highest since 1901. The number of summer days (Tmax >= 25 °C) was mostly twice or three times as high as compared to the normal, while the number of frost days was around the long-term average. In Switzerland, 2006 was the 5th warmest year, too (since 1864, Fig. 0.10). Luxembourg (airport) reported 44 summer days (normal: 28.5) and 12 hot days (Tmax >= 30 °C, normal: 4).

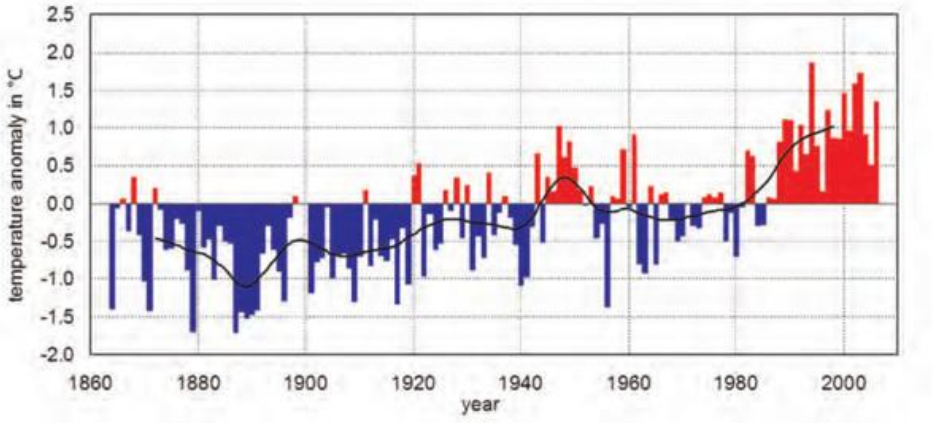


Fig. 0.10: *Annual mean temperatures in Switzerland (1864-2006) and smoothed values. Source: MeteoSwiss*

In Brussels-Uccle, Belgium, the annual mean temperature reached 11.4 °C (normal: 9.8 °C), exceeding the former record of 11.3 °C of 1989. De Bilt in the Netherlands had 11.2 °C on average, thus also recording the warmest year since the start of measurements in 1706 (Fig. 0.11). France recorded 2006 as the 3rd warmest year since 1950 after 2003 and 1994; it was 1.1 °C warmer than the 1971-2000 average. Slovenia observed partly quite high anomalies, too (> +1.5 °C for some minimum and maximum temperatures, Fig. 0.12), so 2006 was the 5th warmest year since 1951, for example, in Ljubljana and at the coast.

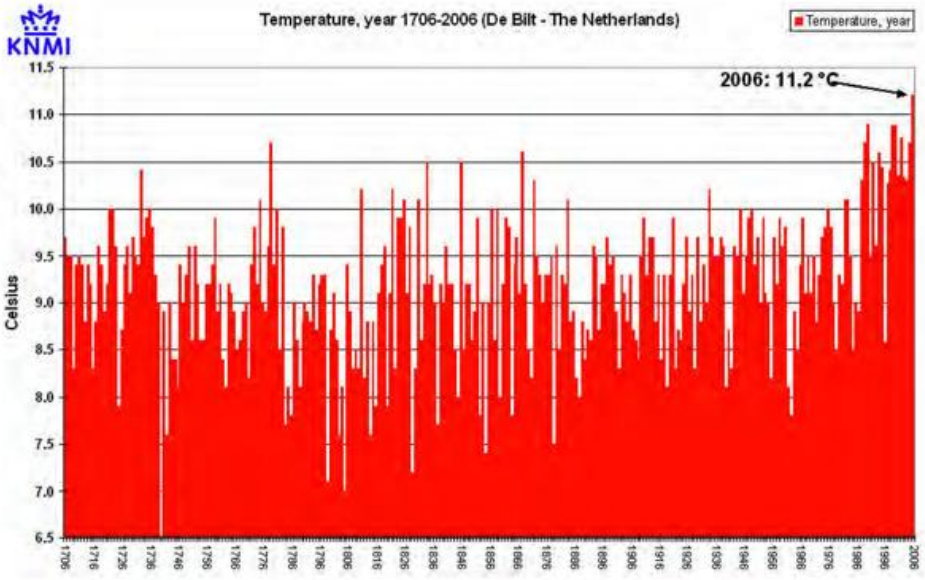


Fig. 0.11: *Annual mean temperatures in De Bilt (Netherlands) 1706-2006.*
Source: Royal Netherlands Meteorological Institute

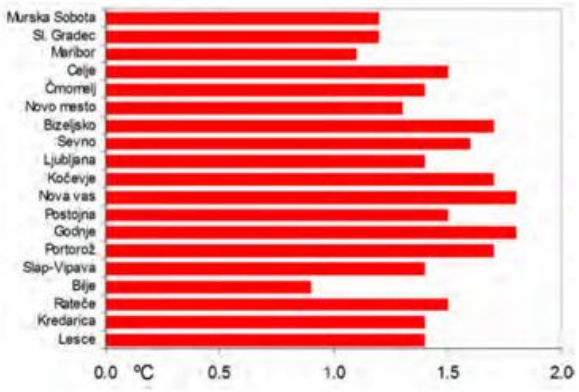


Fig. 0.12: *Maximum air temperature anomalies 2006 (reference period 1961-1990) at some stations in Slovenia.*
Source: Environmental Agency of the Republic of Slovenia

2006 was also one of the warmest years in the south. In Portugal, it was the 5th warmest year since 1931. For Peninsular Spain and the Balearic Islands, it was the warmest year since 1980 (Fig. 0.13), with particularly warm temperatures in the eastern half. The mean trend of this time series is 0.37 °C / 10 years.

In some places in the southeast of the Region, 2006 was also among the 10 warmest years of the time series although the anomalies were only a few tenths degree of a centigrade. In Zagreb Gric (Croatia), 2006 was the 7th warmest year since 1862, in Armenia the 7th warmest since 1929. It was also one of the warmest years in Malta; though still 0.5 °C colder than in 2001 which was the warmest year. The same applies to the sea temperature around Malta.

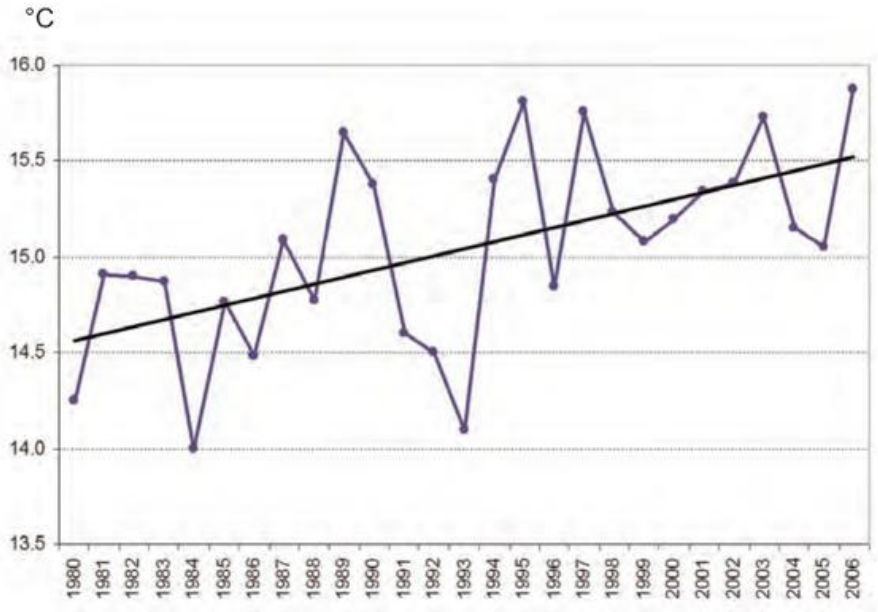


Fig. 0.13: *Areal annual mean temperatures for Peninsular Spain and the Balearic Islands and trend line.*
Source: National Institute of Meteorology, Spain

Daily maximum temperatures above 40 °C were reached in some places in the south at several occasions. Jordan recorded 45 °C as the highest annual value on 4 days in 2006 (May 25, June 6, August 18 and September 29).

Precipitation

Annual precipitation amounts in 2006 were around normal (80-125% of the 1961-1990 normal) in most parts of the Region. Higher-than-normal amounts occurred notably in northern Greenland, Svalbard, and in parts of Iceland, Norway (western Finnmark) and Sweden, whereas in other places it only occurred locally (Fig. 0.14). In Sweden, 2006 was the 6th wettest year on record for the country as a whole. The year was relatively dry on the Norwegian west coast, in the Baltic countries, in and near the western Mediterranean, on the southern slopes of the Pyrenees and the Alps, in Cyprus, in some areas near the Black Sea and the Caspian Sea, in parts of Lebanon (especially in the autumn and winter months), Israel and Jordan. In the high mountains of Lebanon, consequently only 66% of the normal annual snowfall was recorded in 2006.

Estonia recorded in 2006 30-35 consecutive dry days in the vegetation period; only 2002 was drier during the last 50 years. In particular, large parts in the north of the country received less than 70% of the normal annual precipitation. In Latvia, 2006 was the 7th driest of the last 83 years, causing low water levels in rivers. The Gauja River near the city of Sigulda had the lowest water level measured since 1940 during the period July-October (Fig. 0.15). In the south, especially in the Po Valley in Italy, too, a low annual amount of precipitation caused extensive drought conditions in that area with reduced water availability for drinking, agriculture and thermoelectric power stations. On the other hand, flooding events occurred in Romania from March to August. In particular the flooding of the Danube from April to June partly affected many adjacent countries, especially in April.

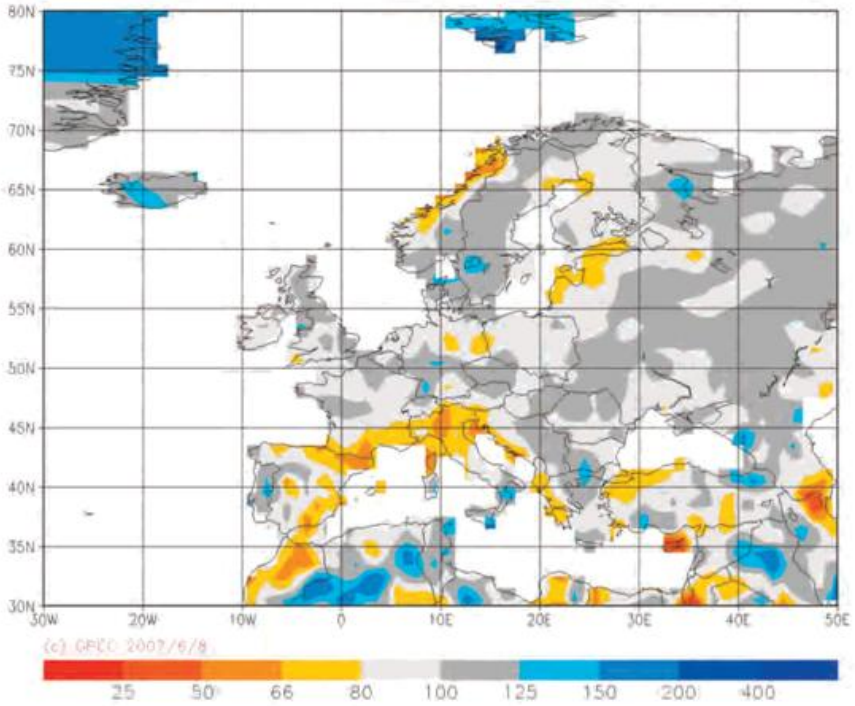


Fig. 0.14: *2006 annual precipitation amounts in WMO Region VI in per cent of the 1961-1990 normal. Source: Global Precipitation Climatology Centre (GPCC), Germany*

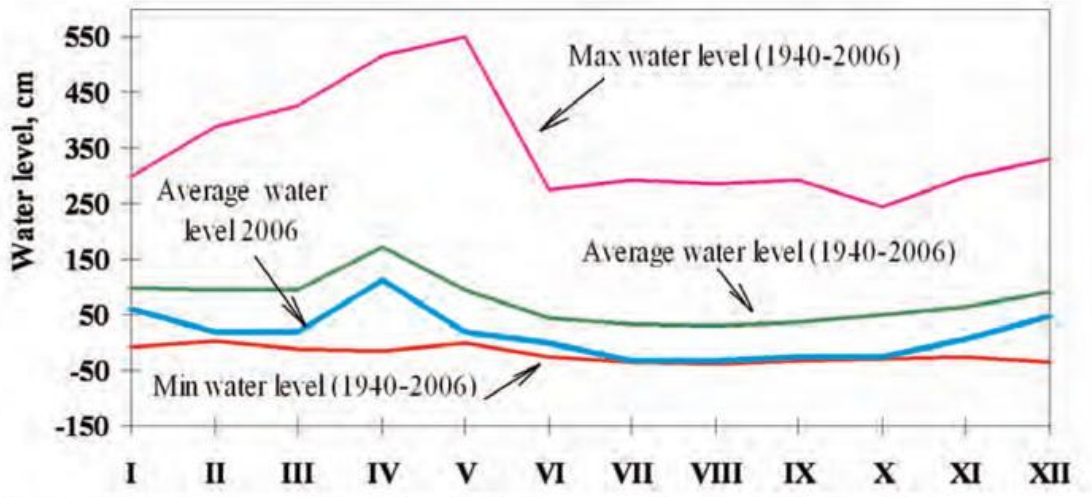


Fig. 0.15: *Water level anomalies in the Gauja River near the city of Sigulda, Latvia. Source: Latvian Environment, Geology and Meteorology Agency*

The monthly distribution of the annual precipitation was quite unusual in some countries. In Ireland, January and February were very dry, especially in the east of the country, whereas widespread heavy rainfalls during the last three months of the year led to flooding in places in midland and western areas. Albania, which has normally the wettest months in winter, received monthly records in March and, in part, higher amounts in the summer months as compared to the winter months (Fig. 0.16). Some parts of Israel had a period of 35 consecutive days without rain from November 16 to December 20 which in the north of the country was by far the longest dry period in the winter season from November to March since 1928/29 (Fig. 0.17).

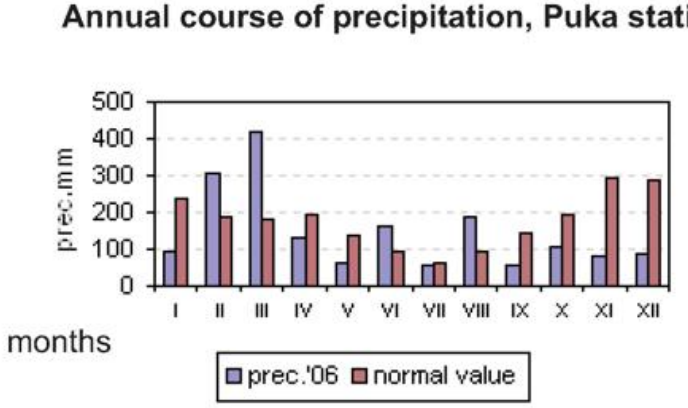


Fig. 0.16: *Annual course of precipitation in 2006 and 1961-1990 average at Puka (northeast Albania). Source: Hydrometeorological Institute Albania*

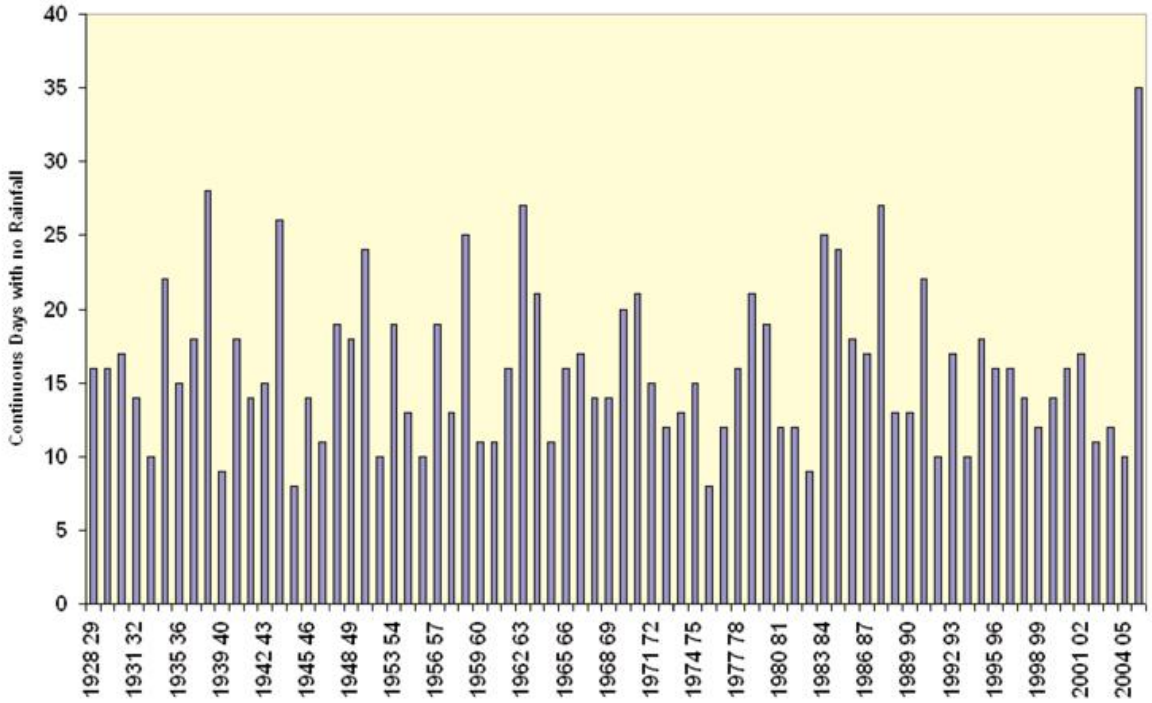


Fig. 0.17: *Longest period without rainfall in Kefar Giladi (northern Galilee in northern Israel) in the winter season November – March 1928/29-2005/06. Source: Israel Meteorological Service*

Sunshine duration

2006 was a sunny year as compared to the normal in many parts of the Region. In some places, it was the sunniest or one of the sunniest within many years.

In the north, 1494 hours of sunshine were recorded in Reykjavik (Iceland), which is 118% of the normal. This excess mainly occurred in spring. In the south of Iceland, it was the sunniest spring since 1924. In contrast, the sunshine total in Akureyri in northern Iceland was slightly below normal.

The sunshine duration was also unusually long in Estonia: since 1955, only the year 2002 was sunnier in Tartu.

In Ireland, annual sunshine totals were around 10% above normal all over the country. April, June and July were particularly sunny months relative to the normal and only March was duller than normal at all stations. Shannon Airport had its sunniest year since 1968, while at Dublin Airport it was the sunniest year since 1959. 1770 hours at Rosslare was the highest annual total within the country. In the United Kingdom, Aberdeen Airport smashed their December sunshine record, with around 90 hours of sunshine being recorded, which is just over double their December average.

In Denmark, 1703 sunshine hours were recorded in 2006 for the country as a whole which is 114% of the normal. July was record breakingly sunny with 321 sunshine hours. In Tórshavn on the Faroe Islands, the sunshine duration in 2006 set a new record with 1064 hours (127% of the normal) throughout the whole year. Germany had an areal mean sunshine total of 1771 hours (116% of the normal) in 2006; it was the 3rd sunniest year since 1951 after 2003 and 1959.

The year 2006 was also very sunny in the Netherlands with a total of 1782 sunshine hours (115% of the normal) particularly in July, whereas February and August were very dull. The coastal station Valkenburg recorded 340 sunshine hours in July; such a monthly total had never been reached there before. Belgium (Uccle) also had a remarkable deficit of sunshine in February (30 hours, normal: 73 hours) and August (94 hours, normal: 188 hours), whereas many sunshine hours (309, normal: 195) were recorded in July. Thus, this was the dullest February and August in Belgium since 1887 and the third sunniest July after 1959 and 1911 (Fig. 0.18). A similar distribution was observed in Luxembourg, although records were not broken. In France, only the southern half and the west of the country received more sunshine than normal.

Austria had an excess in annual sunshine of 15-30% as compared to the normal all over the country, and in Slovenia the normal was also exceeded nearly everywhere, in Celje even by up to 19%. In Hungary, too, most of the year was sunnier than normal, especially the warm months July, September and October.

In the south of the Region, Malta recorded a daily average of 8 hours and 18 minutes of sunshine in 2006, which corresponds to an annual total of 3029.5 hours and was slightly more than the average in the past 78 years.

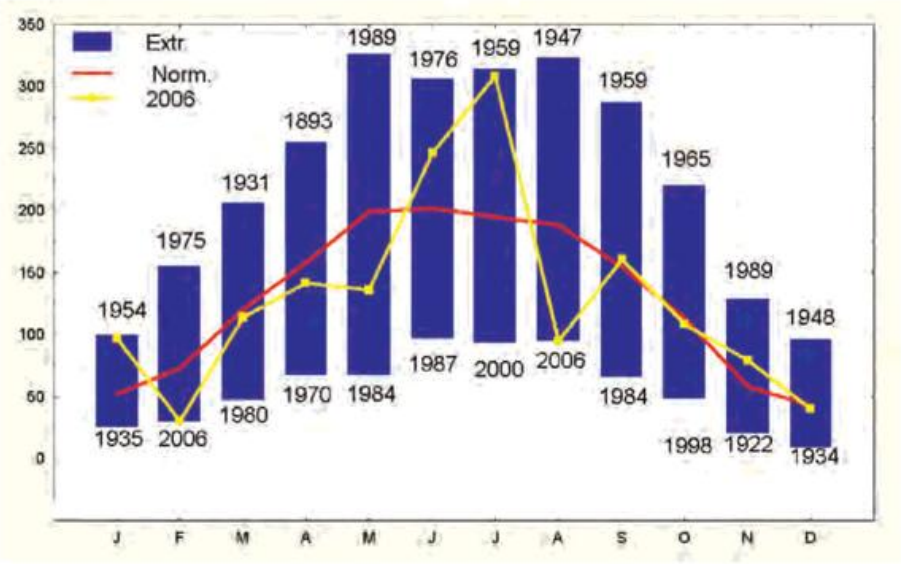


Fig. 0.18: *Annual course of sunshine duration (in hours) in Uccle (Belgium) in 2006 and averages of the normal period 1961-1990, showing the sunniest and dullest years since 1887 (bars). Source: Royal Meteorological Institute Belgium*

Wind

Norway recorded only one strong storm on January 11, causing significant wave heights above 13 metres and damage in the Lofoten area. Within the Norwegian sea area, the highest wind speed on oil platforms in 2006 was measured in the Haltenbank area on January 31 with 110 km/h and also wave heights above 13 metres.

In Germany, strong thunderstorms were recorded on July 5-6. Gusts up to 110 km/h were measured at Lake Constance, and in western parts of the country the wind was strong enough to overthrow trees. In some places, the semi-final soccer match of the World Championship could not be shown at public viewing sites due to thunderstorms and flooding. Apart from this event and a few other thunderstorms and tornadoes in July and August, strong winds in Germany were mainly restricted to the last third of the year. The ex-hurricanes Helene and Isaac caused stormy gusts in October, just like a low pressure system over southern Sweden in the same month. Two severe storms with gusts up to 156 km/h were recorded over the coastal areas of Germany, one on October 30 – November 1 and another at the end of the year on December 30-31. The former one caused the highest flooding at the coast of East Friesland for more than 100 years, but thanks to the fortified dykes no severe damage occurred. However, this storm caused severe high water situations in Denmark in the Øresund, the straits, the sea south of the island Sjaelland and in the Baltic Sea. High waves were also observed in the northern North Sea on October 31.

On October 3-4, a severe storm touched France. It had developed from a low pressure system over the Golf of Gascony. Gusts were particularly high in the region of Aquitaine (150 km/h on the southern Atlantic coast and 130 km/h up-country). The storm then moved to the northeast of France causing severe flooding in the region of Alsace and Lorraine. Another storm in France occurred on December 8 with gusts up to 140 km/h, particularly on the Atlantic coasts and in the northwest. Luxembourg (airport), too, recorded the strongest storm late in the year on December 8, but only with gusts up to 93 km/h.

In Hungary, two heavy storms were recorded in summer, one on July 22, the other on August 20 (the Hungarian National Day), the latter with gusts up to 120 km/h.

The south of the Region was hit by waterspouts that reached the sea surface in the coastal area near Castelldefells in Catalonia (Spain). On May 3, a strong storm caused the rivers in southeast Spain to overflow. Later, on September 21, the remnants of hurricane Gordon interacted with a deep Atlantic low, causing strong winds and severe damage particularly in Galicia (northwest Spain).

The highest wind gust in Malta was 83 km/h on February 1.

In Greece, a winter storm with gusts up to more than 100 km/h passed the northern and central Aegean Sea and then moved westwards the Ionic Islands on January 24. It was accompanied by heavy snowfall which caused damage to the electric power network. This storm also affected the European part of Turkey, causing there a short blackout. Another storm with more than 90 km/h occurred in Greece on February 26 over the Attica region (around Athens). Trees fell down. Five severe storms with damage to plants, mostly trees, were recorded in Turkey in March and April, and three more in November and December. Strong winds also occurred occasionally in various areas of Cyprus, particularly in January, February, March and October. Tornados were recorded on February 7 in the south-eastern coastal area of Cyprus, associated with heavy rainfall, hail, floods and damage to houses and crops, and again on October 31 in the southern coastal area.

In Israel, a tornado hit in western Galilee (north Israel, Fig. 0.19) on April 4. In the Lebanon, south-westerly winds up to about 110 km/h were measured in spring, easterlies up to about 100 km/h in autumn. Syria, too, was affected by strong gusts up to 109 km/h caused by many

low pressure systems during 2006. In Armenia, a hailstorm with heavy rain in the north-east of the country on May 9 resulted in mudflow causing damage to livestock. Strong winds were also observed in November in this country with gusts up to 145 km/h on November 4.

Three tropical storms entered the Region over the Atlantic in 2006: Alberto (June 18), hurricane Gordon (September 20) and hurricane Helene (September 25). Two more hurricanes (Florence in September and Isaac in October) were classified as extratropical depressions before entering the Region.



Fig. 0.19: *Tornado in western Galilee (northern Israel) on 4 April 2006.*
Source: Israel Meteorological Service, Photo taken by N. Mercer, Tuval, Israel

Seasonal Survey

Temperature

The year 2006 was characterised by a change from a cold winter over most of continental Europe to a warm summer and autumn.

Winter 2005/06 was cold over most of the continental areas of the Region, in many places the anomalies were < -1 °C, locally < -2 °C; this was outstanding (percentiles <2%, see seasonal maps), especially in northern Poland and around the Black Sea. Over the Mediterranean the temperature was around normal. On the contrary, nearly the whole Atlantic area, most of Scandinavia, the United Kingdom and Ireland, parts of the Iberian Peninsula as well as the countries in the very southeast of the Region, e.g. Armenia, were warmer than normal.

The highest anomalies were observed in Svalbard, exceeding partly +9 °C. All the Svalbard stations recorded the warmest winter since measurements started. In Iceland, too, this winter was very mild: in Reykjavik and Akureyri, it was the 4th warmest since the inception of continuous measurements. Only 36 days of full snow cover were recorded in Reykjavik (normal 55).

Spring 2006 was cold over parts of northern, eastern central and north-eastern Europe with anomalies mostly not more than 1 °C colder than normal, only occasionally the deviation from normal was < -1 °C. The majority of the rest of the Region was warm that spring, with the highest positive anomalies occurring in Svalbard again, reaching up to more than +6 °C. The abnormally warm Atlantic flow continued.

The mean spring maximum temperature anomalies on the Italian islands Sardinia and Sicily partly exceeded twice their standard deviations (Fig. 0.20).

Summer 2006 was warm nearly everywhere in the Region. The anomalies were mostly above +1 °C, in some places in northern, western and central Europe and in the southeast of the Region also > +2 °C and very exceptional (percentiles >98%). Negative anomalies occurred only at a few locations, e.g. in Greenland.

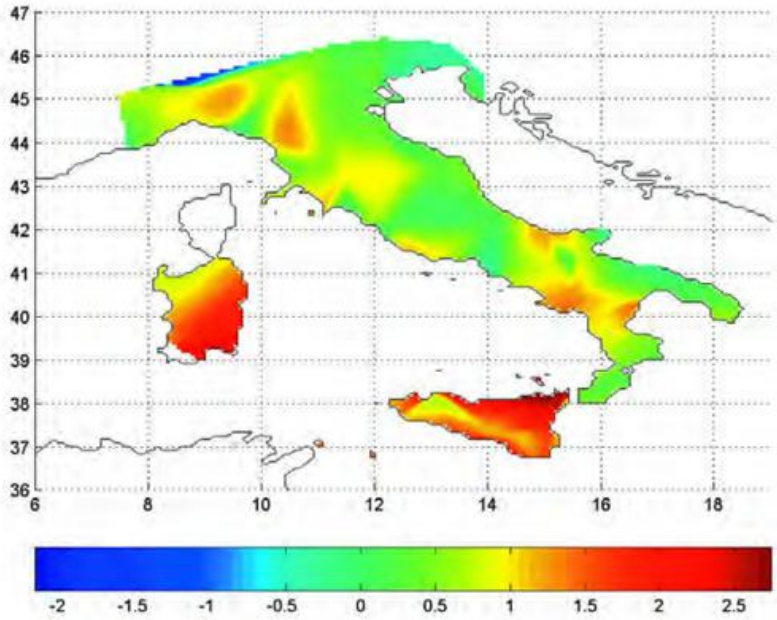


Fig. 0.20: *Seasonal mean of maximum temperature anomalies (reference period 1961-1990) in spring 2006 in Italy, divided by their standard deviations.*
Source: National Centre of Meteorology and Aeronautical Climatology, Italy

The seasonal mean temperature at Svalbard Lufthavn was 6.3 °C; together with 1922 this was the warmest summer since 1912.

Finland counted 59 summer days (Tmax >= 25 °C) and hot days (Tmax >= 30 °C) were recorded in each of the three summer months. Especially the latter phenomenon is quite unusual in Finland and happens only every 10th year on average.

In Sweden, new records for mean summer temperature were observed at some stations in the southernmost part, e.g.in Lund, as compared to more than 140 years of observations. Summer 2006 was the 4th warmest summer in Norway since 1900 and the 5th warmest in Latvia for the past 83 years. With 17.2 °C (anomaly +1.9 °C) it was also the 5th warmest summer in the Central England temperature record. In the Netherlands, it was the 3rd warmest summer since 1901.

In the south, too, this summer was one of the warmest, being for example the 5th warmest in Portugal since 1931. The average minimum temperature reached even its 2nd highest value.

In Armenia, this summer was the hottest for 70 years (anomaly +2.7 °C, Fig. 0.21). Syria was also considerably warmer than normally due to the extending Indian Monsoon effects with heat waves that, from time to time, result in temperatures of 3-5 °C above normal for short periods of time.

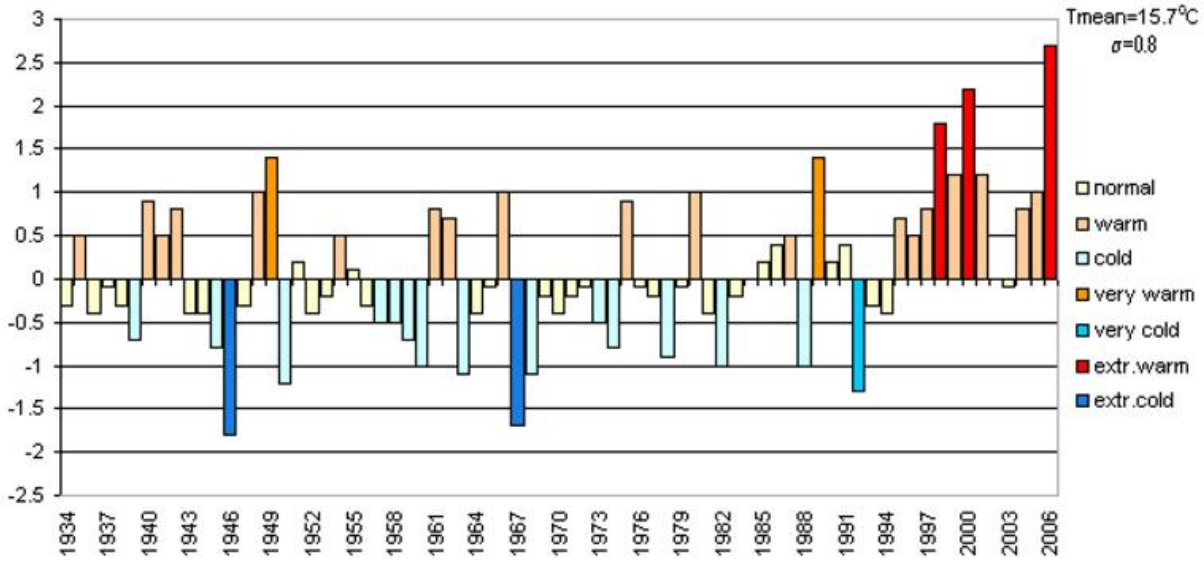


Fig. 0.21: *Summer temperature anomalies (°C, reference period 1961-1990) in Armenia. Source: Armstatehydromet, Armenia*

Autumn 2006 was also warm in allmost all parts of the Region. Mostly, the anomalies were above +1 °C, in large parts of Europe already above +2 °C, and in Central Europe even above +3 °C at many stations. Negative anomalies were restricted to very few places, e.g. in northern Russia and near the eastern Mediterranean.

In several European countries, autumn 2006 was record breaking in temperature. It was the warmest autumn in the Central England temperature record dating back to 1659. The seasonal mean was 12.6 °C (anomaly +2.3 °C). Sea surface temperatures in coastal waters in the United Kingdom were also warmer than in any previous autumn in the records. In some places in Norway, it was the warmest autumn since measurements started in 1867. In Denmark, autumn 2006 was the warmest since 1873 and had an average as high as 12.2 °C (anomaly +3.4 °C). It was also the warmest autumn in the Netherlands (13.6 °C), here for the last three centuries. According to the time series of Brussels-Uccle, Belgium, such a warm autumn statistically does not occur more frequently than once in 500 years. The same applies to other locations in Central Europe (e.g. in Germany). The areal mean in Germany was 12.0 °C (anomaly +3.2 °C), which is by far the highest since 1901 (Fig. 0.22). France recorded by far the warmest autumn since the start of the time series in 1950 (mean anomaly +2.9 °C). Switzerland again set another record: the previous record of autumn 1987 was exceeded by about 1 °C. Austria, too, measured the highest autumn mean temperatures ever, except for the regions of Styria and Carinthia. Bologna (Italy), had its second warmest autumn (anomaly +2.0 °C) since 1948 after autumn 2000. Portugal recorded the 3rd warmest summer after 1997 and 1983; the seasonal mean minimum reached the highest value for 76 years.

Autumn 2006 was also exceptional in eastern parts of the Region: Estonia had the second warmest autumn since 1865 (anomaly +2.8 °C). With a seasonal mean of 9.2 °C, autumn 2006 was the warmest in Latvia for the past 72 years. To find a warmer autumn, one has to go back to 1934 when it was half a degree warmer. Belarus, too, had an exceptional warm autumn

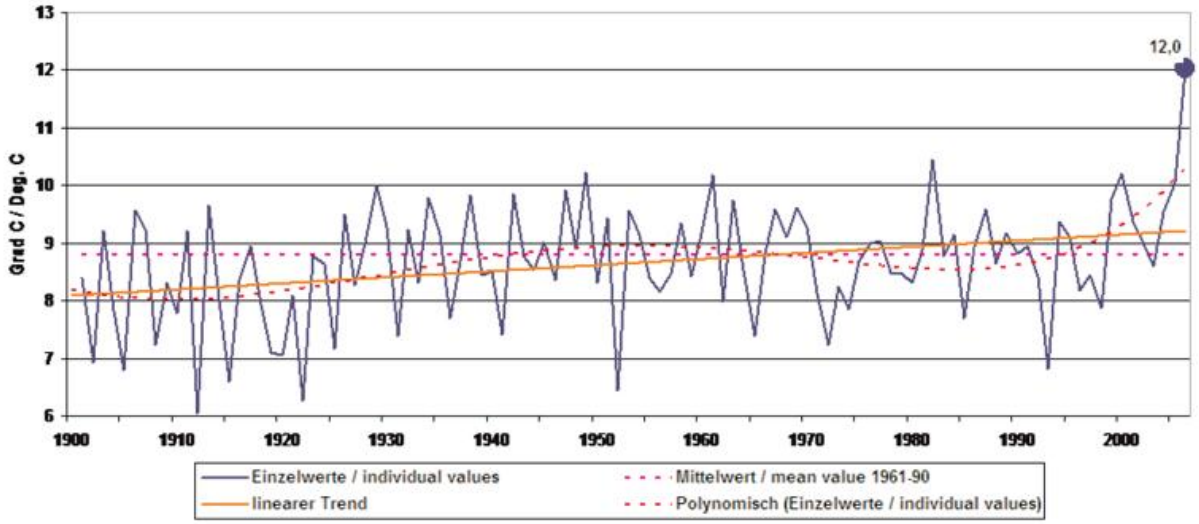


Fig. 0.22: *Autumn temperatures (°C) 1901-2006 in Germany with linear and polynomial trend. Source: Deutscher Wetterdienst*

which statistically occurs only once in 60 years. In most parts of European Russia, in contrast, this autumn was warm, but not like it was in 2005. In Zagreb-Gric (Croatia), autumn 2006 was the second warmest since 1862 after autumn 1926.

Precipitation

Precipitation anomalies in 2006 varied strongly from season to season.

Winter 2005/06 was dry (<80% of the normal) in almost the whole of western Europe, around the Baltic Sea, and in most of Turkey and Cyprus. It was wet in the north, i.e. in Greenland, Svalbard and western Iceland, but also in many places in the eastern half of the Region and the western Mediterranean.

Parts of western Norway received only 50% of the normal precipitation, while other parts of the country (Finnmarksvidda, Trøndelag) had considerably more than the normal, up to 238% (station Kautokeino).

In Ireland, it was particularly dry in the south of the country (Fig. 0.23). It was the driest winter since at least the early 1990s at most Irish stations and the driest since 1964 at both Mullingar and Kilkenny, and also in the United Kingdom.

Spring 2006 was mainly wet in most of the Region, except the west coast of Norway, the Baltic countries (e.g. Lithuania: 60-95% of the normal) and most of the south of the Region where it was partly very dry, e.g. in some parts of Italy.

A larger part of southeastern Norway received 125-150% of the normal, parts of west Norway only 70-80% of the normal precipitation. In lower parts of southern and eastern Norway the snow amount was the highest recorded for many years.

Some stations in Switzerland (e.g. Zurich and Berne), recorded the highest precipitation amounts in spring since 1864. In the western- and northernmost parts of Austria, precipitation totals amounted to up to 200% of the normal.

Summer 2006 was very dry in some larger areas, especially in most parts of northern Europe, the United Kingdom and Ireland, on the coasts of the western Mediterranean, and large parts of the southeast of the Region. Armenia recorded only 60% of the normal precipitation. Some wet areas occurred in eastern Central Europe, near the central and eastern Mediterranean and in parts of the Iberian Peninsula.



Fig. 0.23: *Percentage of normal rainfall (1961-1990) in Ireland in winter 2005/06. Source: Met Eireann, Ireland*

In southern and western parts of Finland, summer 2006 was the driest ever recorded. In Helsinki Kaisaniemi, the whole summer precipitation was only 35 mm which was the lowest summer total since 1845. Hailuoto station on the northwest coast of Finland recorded countrywide the lowest sum with 25 mm for the whole summer. The longest continuous period without any precipitation in Finland was observed in Kauhava in the west of the country. It was also very dry in northeastern Sweden: only 35 mm in Haparanda, near the Finnish border, during the whole summer, which is the lowest amount since 1860. This drought resulted in the largest forest fire since 1933 in Sweden with an area of about 15 km² devastated near Haparanda.

The precipitation totals in most parts of Lithuania fell to 45-95%, in the western borderland even down to 30%.

In the Netherlands, at least one meteorological station recorded 50 mm or more precipition on 13 days, which sets a new record.

Albania recorded an unusually wet summer, especially in mountainous areas.

Autumn 2006 was especially dry in Greenland, on the Norwegian west coast as well in the majority of Central Europe and most areas around the Mediterranean except the northeast. Most of the other parts of the Region were wetter than normal.

In parts of eastern Norway, autumn 2006 was the 4th or 5th wettest since 1867.

Precipitation amounts in Austria were only 40-80% of the normal in southern and eastern parts of the country, partly also in the north.

It was the driest autumn in Dubrovnik (Croatia) since 1961 (Fig. 0.24). Less than 50% of the precipitation was recorded in Albania.

In Portugal, autumn 2006 recorded the 3rd highest precipitation amount of all autumns since 1931. Some places recorded even the highest or second highest precipitation total with up to 300% above the normal (Fig. 0.25). In Spain, too, the autumn precipitation was rather plentiful that year; however, this was welcome after a long drought period that lasted for two years.

On one day Deir Elzour (Syria) recorded a precipitation total of 56 mm.

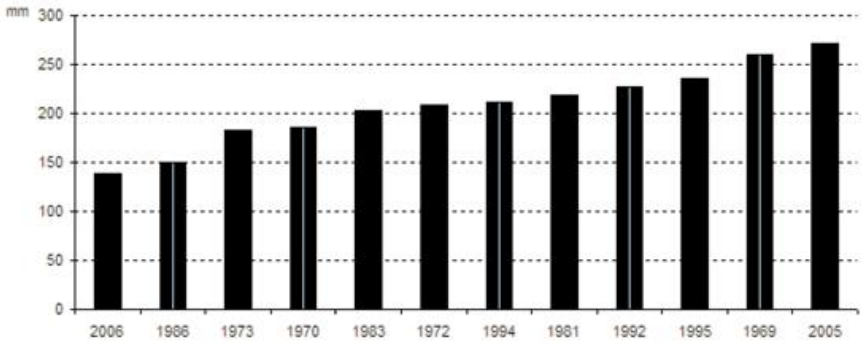


Fig. 0.24: *The driest autumns in Dubrovnik (Croatia), period 1961-2006 and their seasonal totals.*
Source: Meteorological and Hydrological Service, Croatia

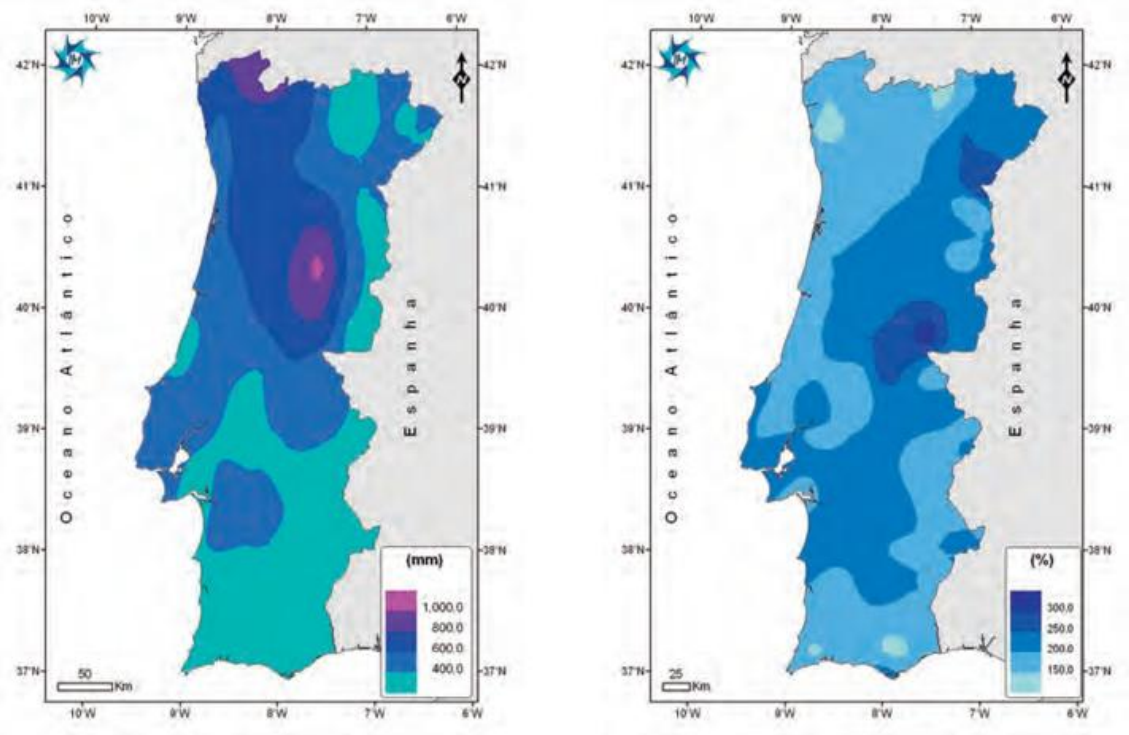


Fig. 0.25: *Precipitation totals (left) and percentage of the 1961-1990 normal (right) in Portugal in autumn 2006.*
Source: Institute of Meteorology, Portugal

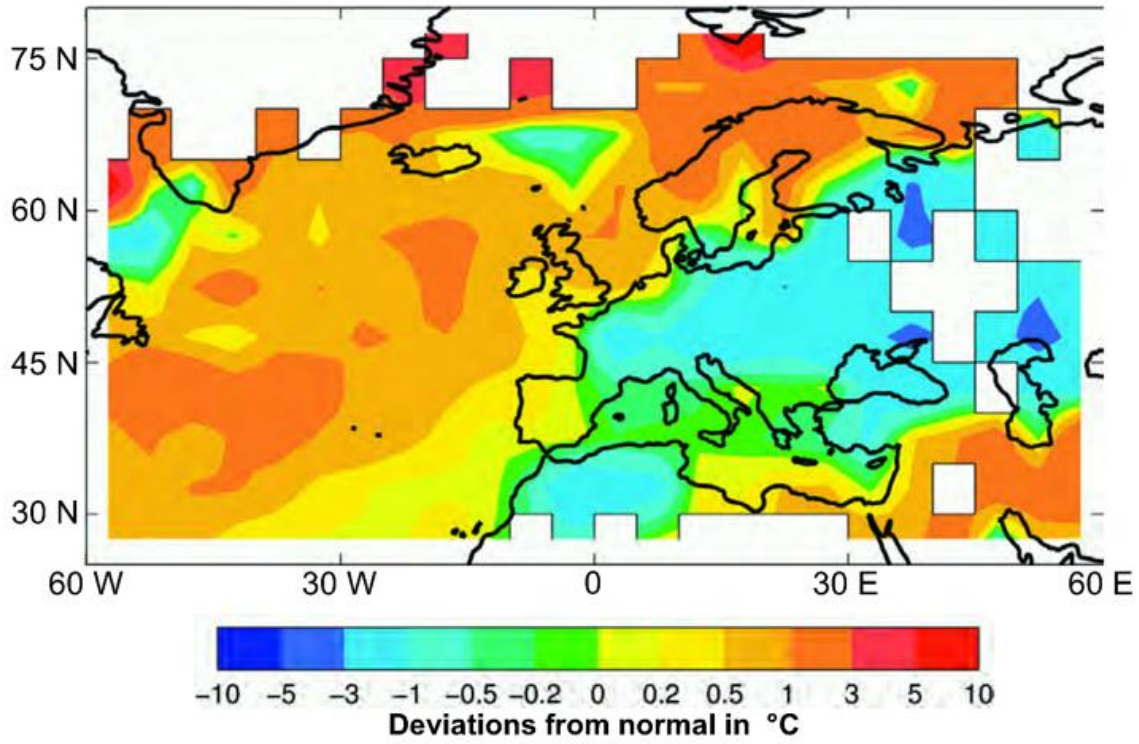
Seasonal Maps

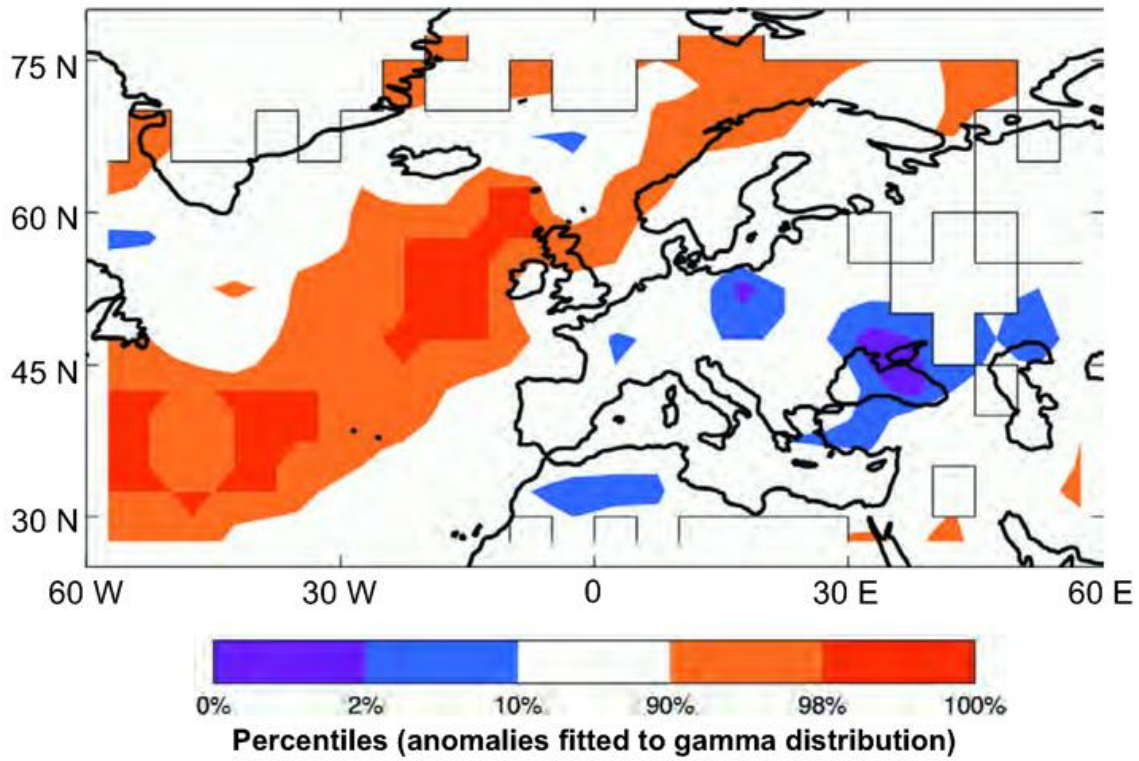
Surface temperature anomalies

Reference period: 1961-1990

Source: Hadley Centre of Climate Prediction and Research, U.K.

December 2005 - February 2006



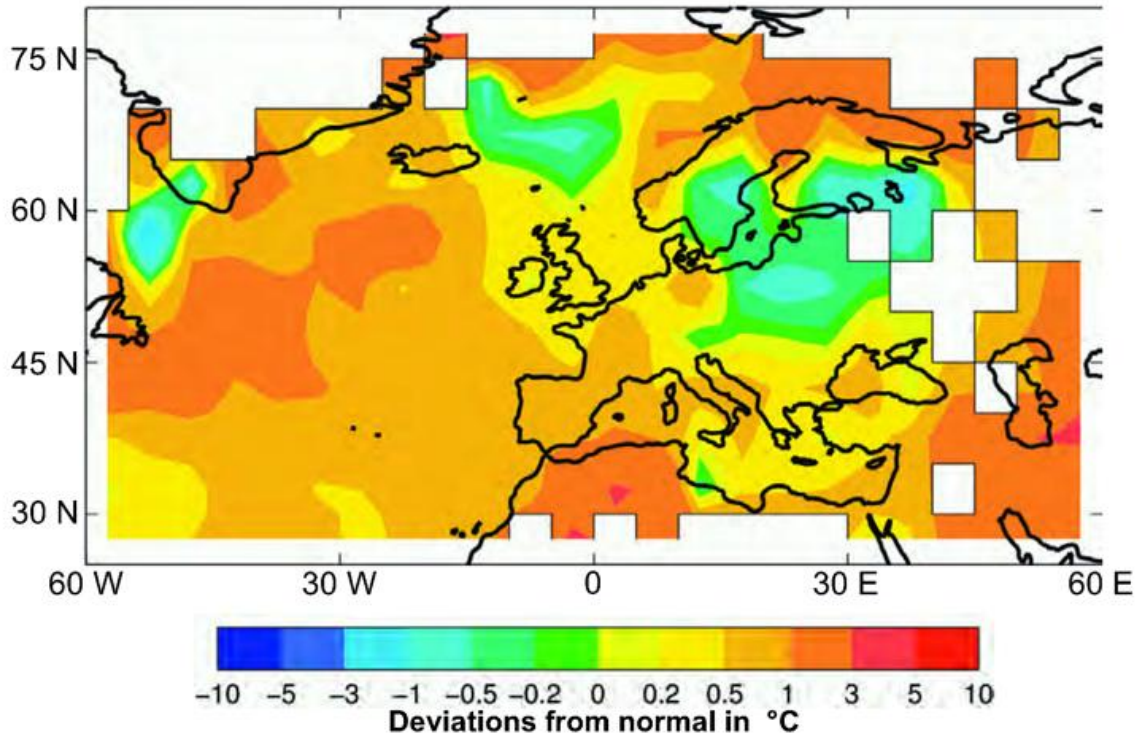


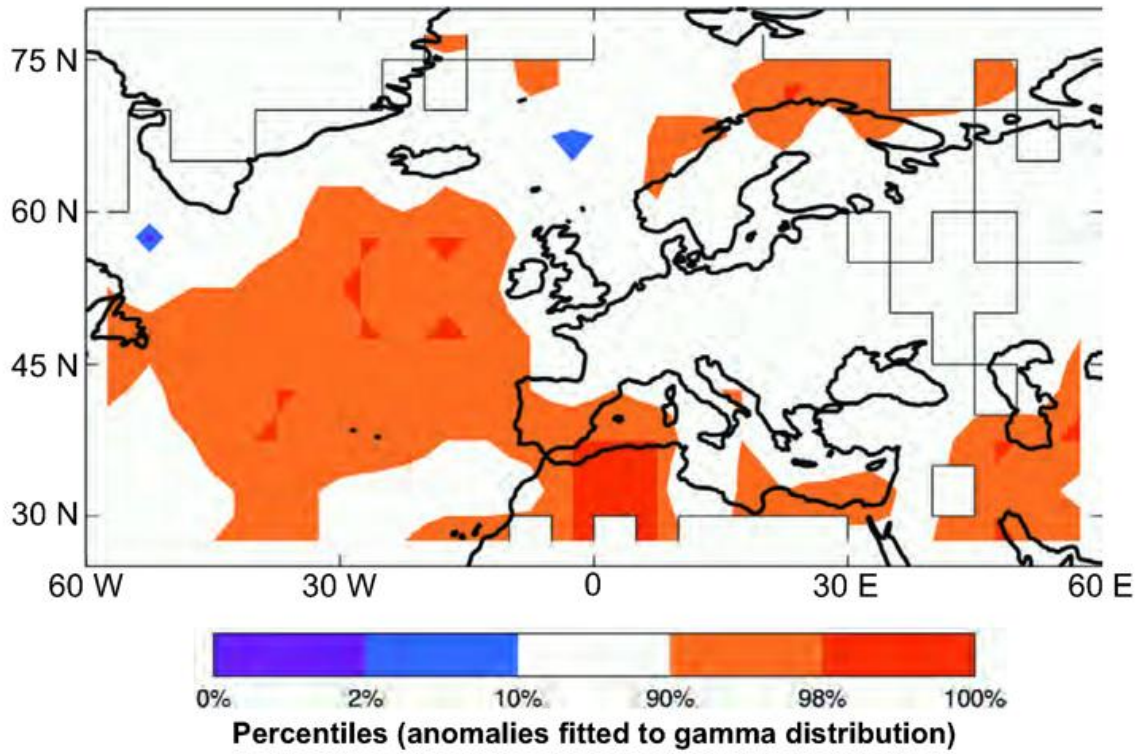
Surface temperature anomalies

Reference period: 1961-1990

Source: Hadley Centre of Climate Prediction and Research, U.K.

March 2006 - May 2006



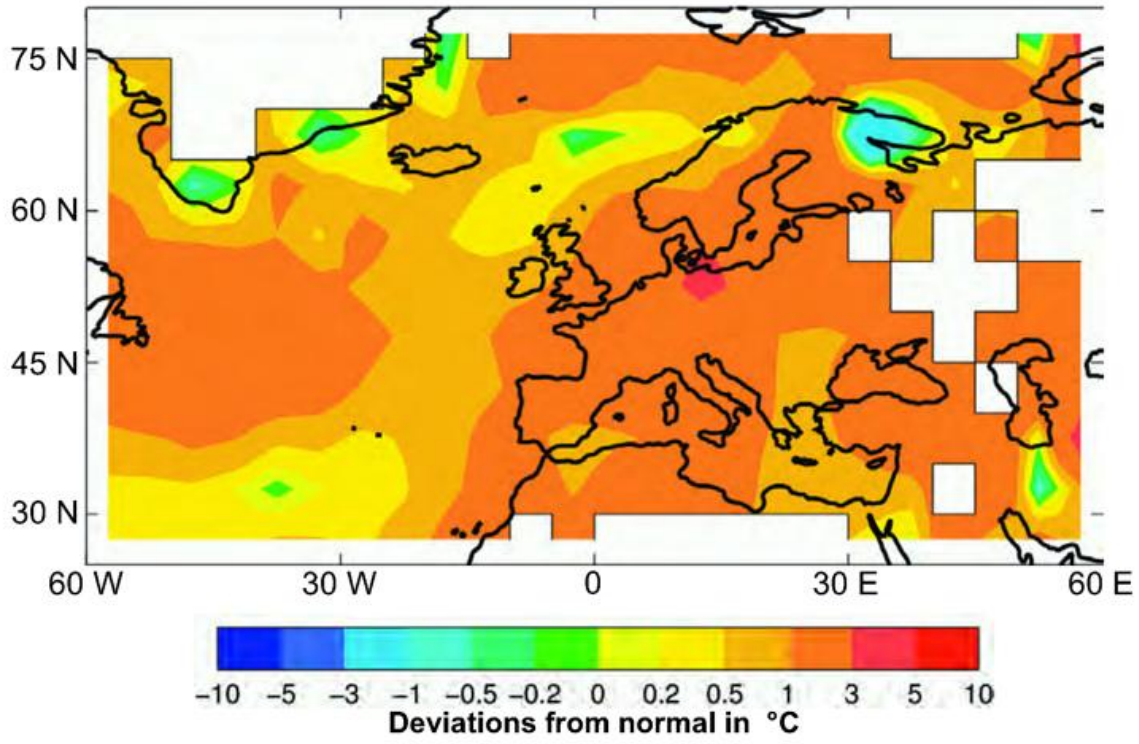


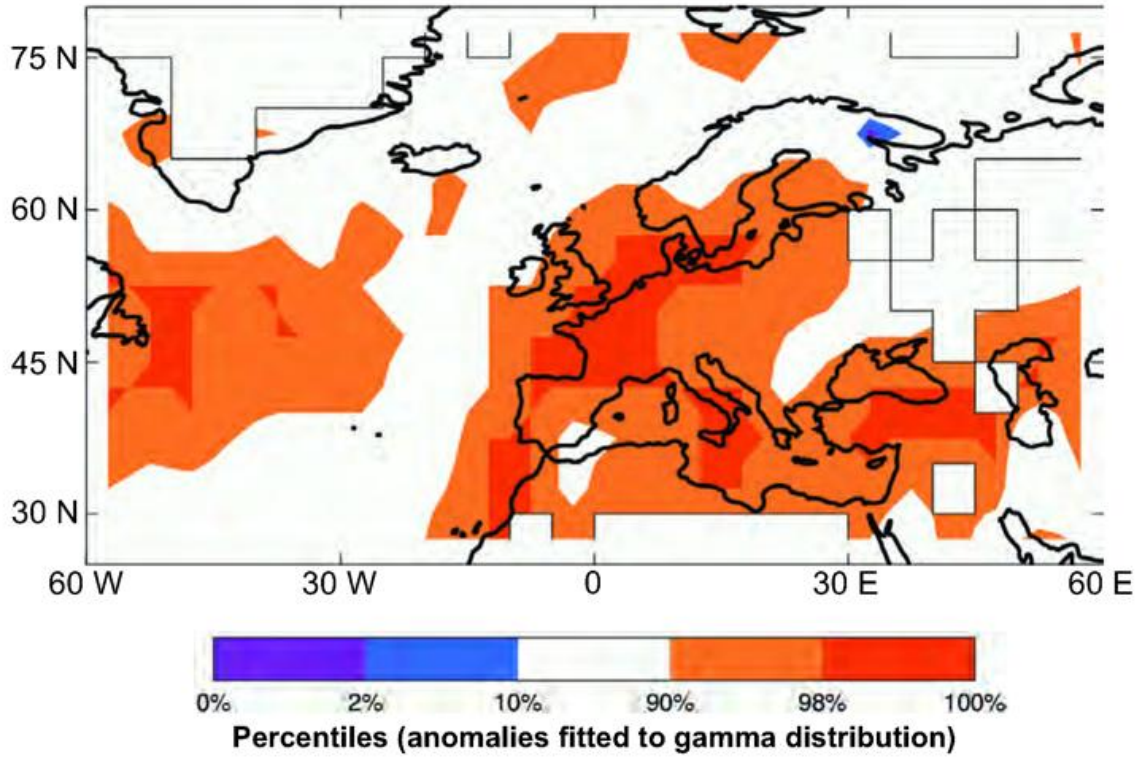
Surface temperature anomalies

Reference period: 1961-1990

Source: Hadley Centre of Climate Prediction and Research, U.K.

June 2006 - August 2006



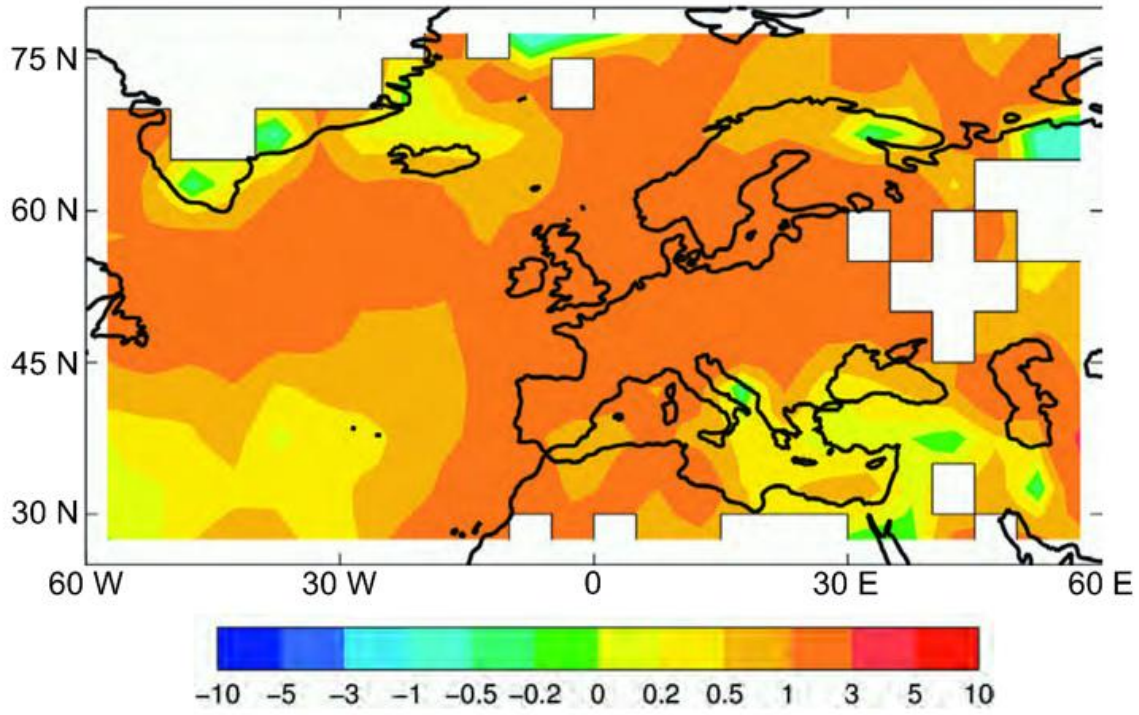


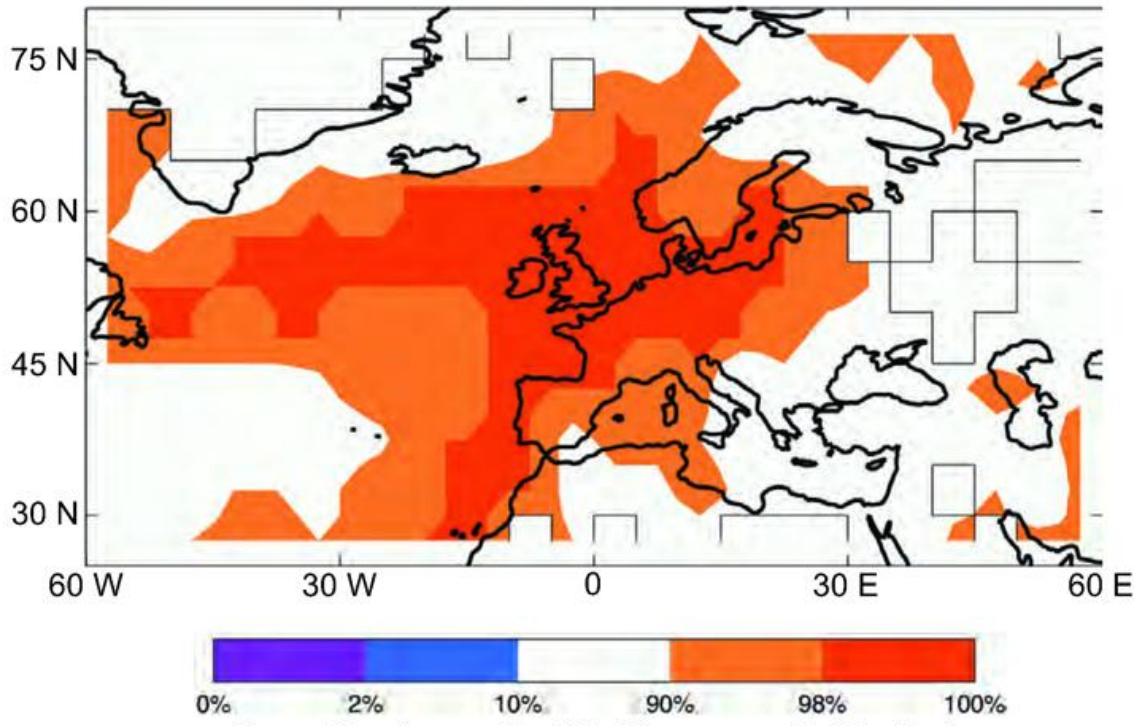
Surface temperature anomalies

Reference period: 1961-1990

Source: Hadley Centre of Climate Prediction and Research, U.K.

September 2006 - November 2006





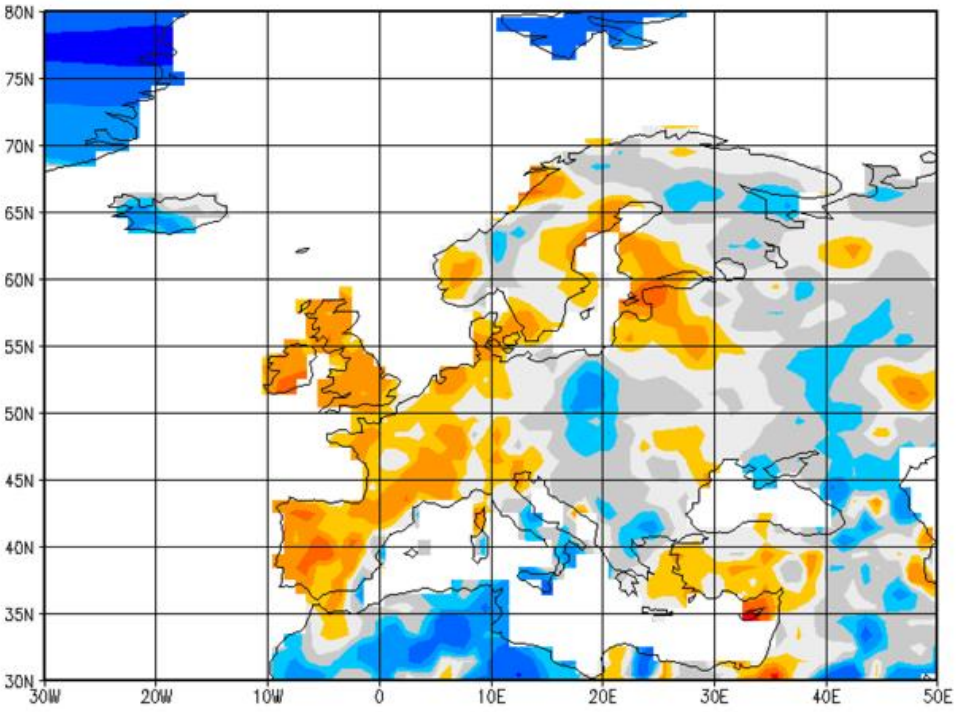
Percentiles (anomalies fitted to gamma distribution)

Precipitation in percent of normal

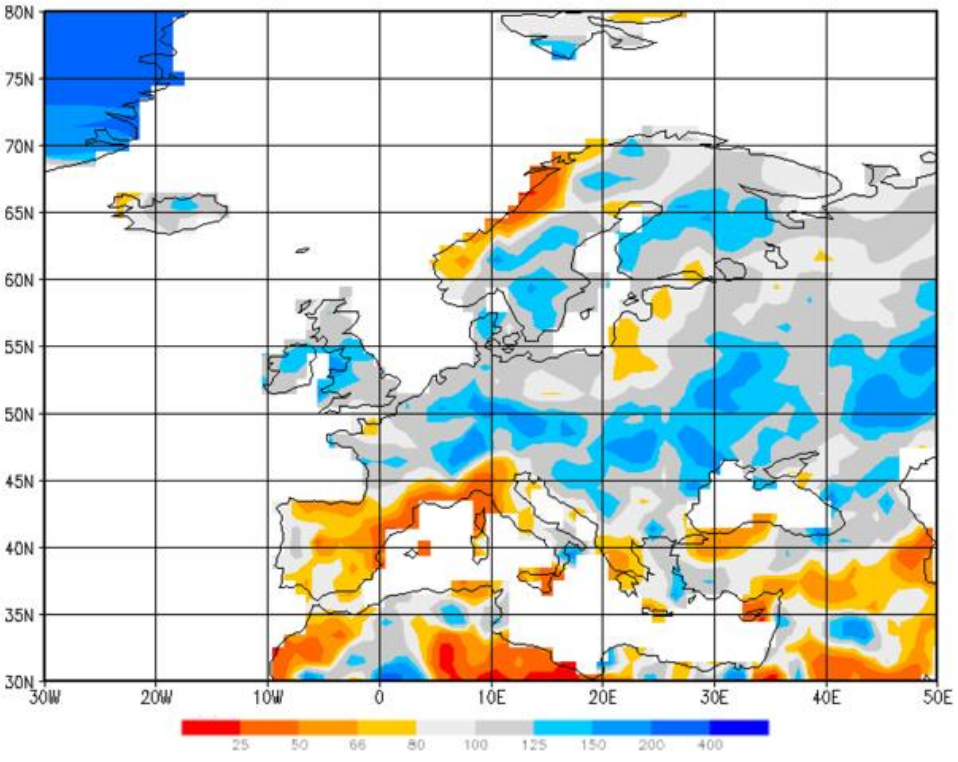
Gauge-based analysis 1.0 degree, reference period: 1961-1990

Source: GPCC / Deutscher Wetterdienst

December 2005 - February 2006



March 2006 - May 2006

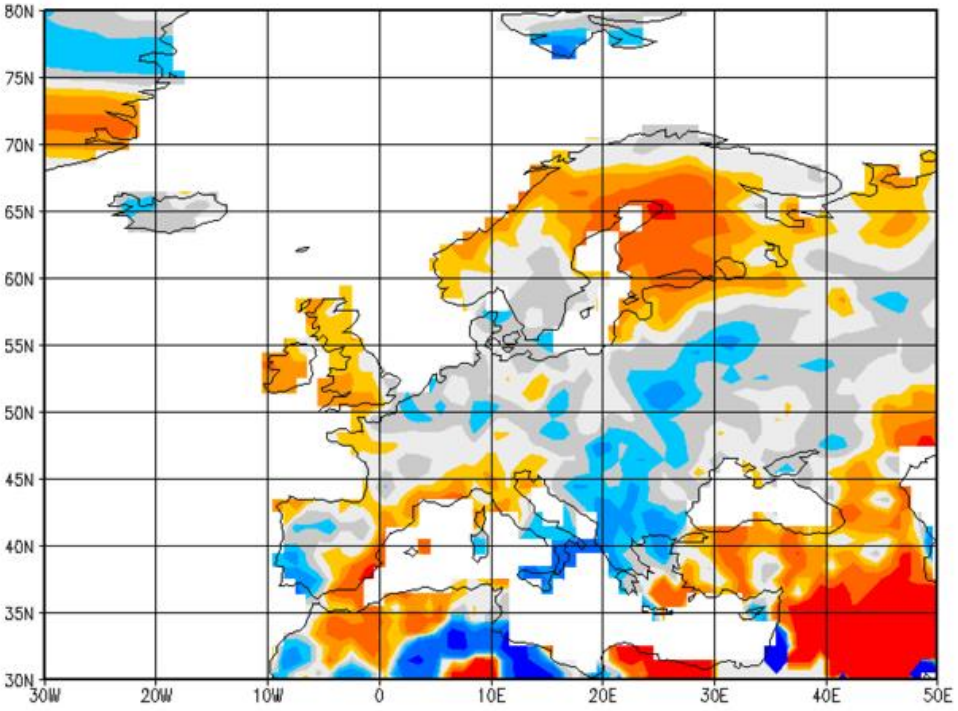


Precipitation in percent of normal

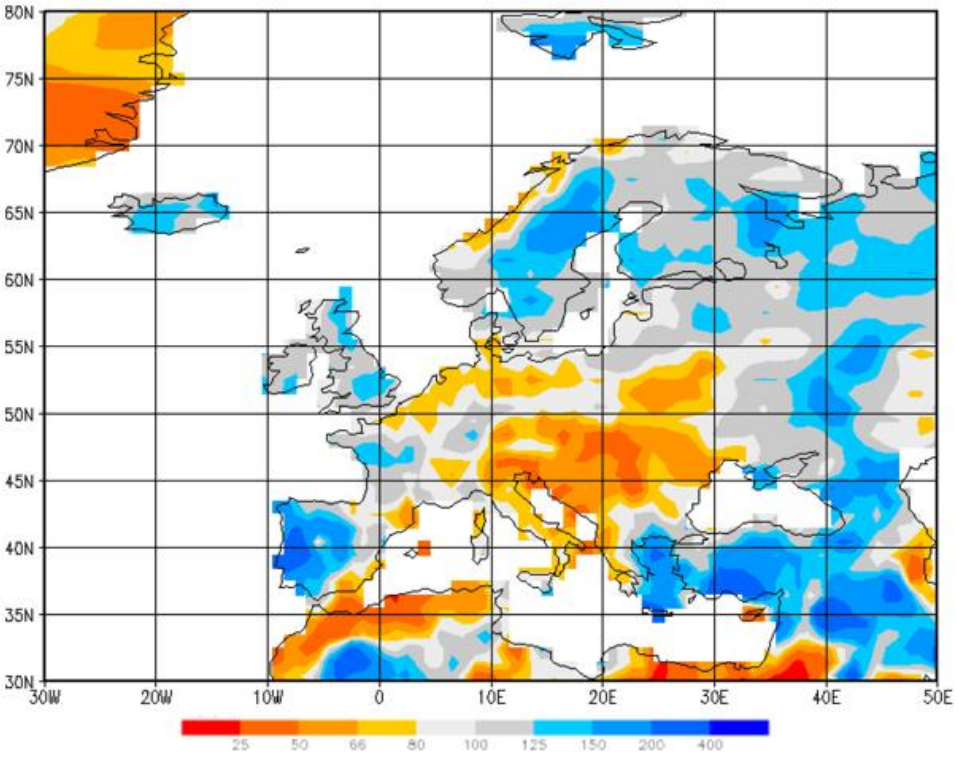
Gauge-based analysis 1.0 degree, reference period: 1961-1990

Source: GPCC / Deutscher Wetterdienst

June 2006 - August 2006



September 2006 - November 2006



Monthly and Annual Tables

Temperature and precipitation values with deviations from the 1961-1990 means
(some stations have shorter reference periods)

WMO No.	Station	January 2006 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	February 2006 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard/Spitsb.	-2,7	+12,7	26	12	-9,8	+5,9	20	1
01025	Tromsoe	0,2	+4,2	95	14	-2,3	+1,4	102	16
01492	Oslo	-2,4	+1,9	40	-9	-3,2	+0,8	64	28
02196	Haparanda	-7,7	+4,4	45	1	-12,0	-0,7	16	-16
02485	Stockholm	-2,3	+0,5	11	-28	-2,6	+0,4	28	1
02974	Helsinki	-4,9	+2,0	18	-23	-9,2	-2,4	17	-14
03091	Aberdeen	4,7	+2,0	21	-60	4,0	+1,1	59	8
03772	London	5,4	+1,2	17	-35	4,7	+0,2	41	6
03967	Dublin Casement Aerodrome	5,6	+1,2	18	-48	4,8	+0,4	45	-6
04030	Reykjavik	2,0	+2,5	153	77	3,3	+2,9	87	15
04320	Danmarkshavn	-15,9	+7,2	93	82	-24,8	-0,5	17	6
04360	Angmagssalik	-7,5	0,0	120	8	-5,2	+2,5	54	-37
06186	Copenhagen	-0,6	-1,1	16	-35	0,6	+0,1	21	-10
06260	De Bilt	1,5	-0,7	15	-51	2,9	+0,4	59	10
06447	Brussels	1,7	-0,9	19	-48	2,3	-1,2	83	30
06590	Luxemburg	-1,0	-1,0	26	-45	0,5	-0,6	49	-13
06660	Zurich	-2,2	-1,7	25	-42	0,0	-0,9	56	-14
06700	Geneva	0,3	-0,7	23	-46	1,4	-1,1	72	2
07510	Bordeaux	5,3	-0,5	49	-51	5,0	-2,1	100	14
07650	Marseilles	6,3	-0,4	56	9	6,5	-1,4	19	-35
08222	Madrid	5,6	-0,5	36	-10	6,7	-0,8	35	-9
08314	Mahon/Minorca	9,7	-0,8	52	-14	9,8	-0,9	63	6
08495	Gibraltar	12,5	-0,9	166	45	12,9	-0,9	75	-25
08515	Santa Maria/Azores	15,1	+0,7	54	-46	14,9	+0,9	146	60
08535	Lisbon	10,2	-1,2	54	-56	11,2	-1,1	76	-35
10384	Berlin-Tempelhof	-3,7	-3,5	21	-22	0,1	-0,7	43	9
11035	Vienna	-3,3	-2,6	48	10	-0,6	-1,9	35	-7
11518	Prague	-5,4	-3,0	9	-14	-1,9	-1,1	18	-5
11903	Slica	-7,5	-3,6	44	0	-3,7	-2,6	37	-7
12160	Elblag	-7,3	-4,9	16	-31	-2,0	+0,2	35	10
12375	Warsaw	-8,3	-5,0	21	-1	-3,2	-1,2	30	9
12843	Budapest	-2,4	-0,8	33	1	-0,7	-1,8	44	12
13274	Belgrade	-0,5	-0,9	44	-5	1,9	-0,8	64	20
14015	Ljubljana	-1,6	-0,5	47	-35	0,5	-0,9	47	-33
14445	Split	6,7	-0,7	58	-25	7,7	-0,4	76	8
14654	Sarajevo	-2,1	-1,2	36	-35	0,5	-1,0	54	-13
15420	Bucharest	-4,0	-1,6	40	0	-1,2	-1,1	46	10
15614	Sofia	-2,7	-1,1	36	9	-0,4	-0,9	38	5
16158	Pisa	4,4	-1,7	87	12	6,9	-0,2	96	23
16597	Luqa	12,4	+0,2	216	127	11,9	-0,5	37	-24
16716	Athens	7,6	-2,6	64	20	10,1	-0,5	28	-15
16754	Heraklion/Crete	10,8	-1,2	82	-8	12,0	-0,1	104	27
17062	Istanbul	4,4	-1,2	104	5	5,8	-0,1	106	39
17130	Ankara	-1,7	-1,8	36	-11	0,4	-1,5	67	31
17170	Van	-3,1	+1,1	90	55	-1,3	+2,1	48	14
17300	Antalya	9,0	-0,9	319	80	11,1	+0,8	85	-106
17609	Larnaka	11,8	+0,3	93	28	12,7	+1,0	17	-40
22113	Murmansk	-7,1	+4,6	28	-5	-10,8	+0,4	12	-10
26038	Tallinn	-3,7	+1,8	10	-35	-7,3	-1,6	36	7
26629	Kaunas	-7,2	-2,2	20	-17	-6,3	-2,0	18	-9
26730	Vilnius	-7,8	-1,7	9	-32	-7,5	-2,7	34	-4
26850	Minsk	-8,4	-1,5	8	-32	-8,4	-2,6	29	-5
27595	Kasan	-16,1	-3,0	24	-9	-13,8	-2,3	41	13
27612	Moscow	-10,8	-1,5	24	-18	-13,3	-5,6	36	-1
33345	Kiev	-7,5	-1,9	17	-30	-6,1	-1,9	33	-13
33815	Kisinev	-6,6	-3,3	39	-1	-3,1	-1,4	22	-16
34300	Kharkiv (Charkow)	-9,8	-2,9	28	-16	-9,0	-3,3	35	3
34880	Astrakhan	-11,2	-5,8	20	7	-4,2	+0,7	7	-3
35188	Akmola	-23,0	-7,2	14	-3	-10,7	+5,2	17	3
37789	Yerevan	-4,1	-0,9	61	32	-1,5	-0,5	46	8
40080	Damascus	6,6	+0,7	16	-13	9,1	+1,2	31	7
40180	Tel Aviv	13,1	+0,8	179	30	14,7	+1,8	52	-46
40199	Eilat	15,2	0,0	2	-3	18,2	+1,3	0	-5
40265	Mafraq	8,2	+1,0	20	-14	10,0	+1,3	25	-6
60030	L.Palmas/Gran Can.	16,6	-0,9	124	107	17,6	0,0	25	3

WMO No.	Station	March 2006 Temp. mean	March 2006 (°C) dev.	March 2006 Prec. total	March 2006 (mm) dev.	April 2006 Temp. mean	April 2006 (°C) dev.	April 2006 Prec. total	April 2006 (mm) dev.
01008	Svalbard/Spitsb.	-13,1	+1,6	4	-17	0,0	+11,7	7	-5
01025	Tromsoe	-4,3	-2,1	84	20	3,0	+2,3	13	-47
01492	Oslo	-3,4	-3,2	48	2	4,8	+0,2	57	15
02196	Haparanda	-10,2	-3,4	8	-27	1,8	+2,3	35	6
02485	Stockholm	-2,9	-3,0	26	0	5,4	+0,8	26	-4
02974	Helsinki	-6,6	-3,7	31	-3	3,8	+0,9	35	-2
03091	Aberdeen	3,2	-1,3	118	60	7,1	+0,8	24	-29
03772	London	6,0	-0,5	45	-2	10,0	+1,1	33	-12
03967	Dublin Casement Aerodrome	5,6	-0,4	53	4	7,9	+0,1	28	-19
04030	Reykjavik	0,9	+0,4	52	-30	2,0	-0,9	71	13
04320	Danmarkshavn	-22,0	+1,4	29	12	-10,1	+7,2	47	37
04360	Angmagssalik	-6,1	+2,1	70	-18	-3,6	+0,5	39	-34
06186	Copenhagen	0,2	-2,4	25	-17	6,6	0,0	36	-6
06260	De Bilt	3,9	-1,1	104	41	9,0	+1,0	40	-12
06447	Brussels	4,5	-1,0	65	11	9,3	+0,5	46	-11
06590	Luxemburg	2,9	-1,1	95	25	8,7	+1,2	51	-10
06660	Zurich	3,1	-1,1	169	100	8,8	+1,0	189	102
06700	Geneva	5,1	-0,2	138	57	10,2	+1,2	117	51
07510	Bordeaux	10,4	+1,6	185	109	12,4	+1,1	27	-45
07650	Marseilles	10,5	+0,3	5	-39	15,0	+1,8	2	-46
08222	Madrid	11,2	+1,2	34	1	14,9	+2,7	46	-8
08314	Mahon/Minorca	12,4	+0,8	29	-26	15,6	+2,3	8	-42
08495	Gibraltar	15,3	+0,3	104	29	17,1	+0,9	54	-6
08515	Santa Maria/Azores	15,8	+1,2	74	-5	15,5	+0,3	60	5
08535	Lisbon	14,1	+0,4	126	57	16,8	+1,7	51	-13
10384	Berlin-Tempelhof	1,7	-2,5	32	-5	9,3	+0,7	46	5
11035	Vienna	3,4	-1,9	79	38	11,6	+1,4	72	22
11518	Prague	1,1	-1,9	35	7	8,8	+1,1	54	16
11903	Slica	0,7	-2,3	33	-9	10,2	+1,7	45	-2
12160	Elblag	-0,9	-3,0	20	-15	7,4	+0,6	75	33
12375	Warsau	-0,6	-2,6	14	-14	9,1	+1,3	35	3
12843	Budapest	4,6	-1,0	28	-1	13,3	+2,2	32	-6
13274	Belgrade	6,5	-0,7	104	54	13,6	+1,2	97	38
14015	Ljubljana	4,4	-1,0	129	31	11,5	+1,6	119	10
14445	Split	9,3	-1,1	57	-18	15,3	+1,4	59	-7
14654	Sarajevo	4,0	-1,1	135	65	10,6	+1,2	77	3
15420	Bucharest	4,6	-0,2	68	30	11,3	0,0	60	14
15614	Sofia	5,0	+0,4	78	40	11,0	+1,1	22	-28
16158	Pisa	8,8	-0,7	22	-54	12,8	+0,3	23	-56
16597	Luqa	13,3	-0,1	26	-15	16,6	+1,1	3	-20
16716	Athens	12,8	+0,2	40	-1	16,9	+0,8	29	4
16754	Heraklion/Crete	13,6	+0,2	22	-34	16,7	+0,4	47	17
17062	Istanbul	8,6	+1,1	93	31	12,8	+0,8	17	-32
17130	Ankara	7,5	+1,4	40	4	13,1	+1,9	29	-19
17170	Van	3,0	+1,9	46	3	9,8	+2,5	40	-14
17300	Antalya	13,3	+0,6	78	-24	17,2	+1,1	87	39
17609	Larnaka	14,1	+0,8	27	-22	17,9	+0,5	24	13
22113	Murmansk	-8,0	-1,2	36	16	1,8	+3,7	13	-8
26038	Tallinn	-4,9	-2,7	46	17	5,0	+1,6	27	-9
26629	Kaunas	-2,7	-2,5	22	-10	6,5	+0,5	29	-14
26730	Vilnius	-3,4	-2,8	30	-9	6,2	+0,5	48	2
26850	Minsk	-3,1	-1,7	43	1	7,0	+1,0	30	-12
27595	Kasan	-5,2	+0,1	71	45	5,5	+0,9	37	1
27612	Moscow	-3,7	-1,5	47	13	6,0	+0,2	44	4
33345	Kiev	0,0	-0,7	62	23	9,7	+1,0	30	-19
33815	Kisinev	2,7	-0,2	89	54	10,9	+0,7	37	-5
34300	Kharkiv (Charkow)	-0,3	0,0	48	21	9,1	+0,2	12	-24
34880	Astrakhan	3,6	+2,3	17	3	11,7	+0,6	28	10
35188	Akmola	-1,6	+6,5	15	1	7,4	+2,5	29	7
37789	Yerevan	8,3	+3,2	14	-27	13,1	+1,5	82	31
40080	Damascus	12,6	+1,6	3	-14	16,6	+1,1	23	12
40180	Tel Aviv	16,1	+1,2	3	-59	19,0	+0,8	92	69
40199	Eilat	21,1	+1,1	0	-4	24,4	+0,2	0	-4
40265	Mafraq	12,6	+1,1	1	-28	16,2	+0,4	22	12
60030	L.Palmas/Gran Can.	17,9	-0,5	4	-6	19,4	+0,7	17	11

WMO No.	Station	May 2006 Temp. mean	May 2006 (°C) dev.	May 2006 Prec. total (mm)	May 2006 dev.	June 2006 Temp. mean	June 2006 (°C) dev.	June 2006 Prec. total (mm)	June 2006 dev.
01008	Svalbard/Spitsb.	0,9	+4,6	4	-2	4,8	+2,6	13	3
01025	Tromsoe	7,0	+2,1	27	-21	9,1	-0,2	71	18
01492	Oslo	12,0	+1,2	80	28	16,0	+0,8	58	-7
02196	Haparanda	7,6	+1,5	41	10	13,0	+0,2	6	-35
02485	Stockholm	11,4	+0,7	42	12	17,0	+1,4	31	-14
02974	Helsinki	10,7	+0,8	42	7	16,3	+1,4	28	-16
03091	Aberdeen	9,1	+0,1	38	-21	13,6	+1,5	28	-25
03772	London	13,9	+1,4	92	41	18,3	+2,6	12	-39
03967	Dublin Casement Aerodrome	11,2	+0,7	75	17	15,1	+1,8	20	-28
04030	Reykjavik	6,4	+0,1	33	-11	9,4	+0,4	58	8
04320	Danmarkshavn	-4,8	+1,8	7	3	-1,5	-2,2	1	-4
04360	Angmagssalik	0,6	0,0	20	-37	4,8	+0,7	45	-7
06186	Copenhagen	12,3	+0,3	51	8	16,9	+0,8	11	-43
06260	De Bilt	14,5	+2,2	90	29	16,7	+1,5	18	-50
06447	Brussels	14,2	+1,3	116	45	17,3	+1,6	26	-53
06590	Luxemburg	13,4	+1,6	143	62	17,7	+2,8	65	-17
06660	Zurich	13,3	+1,2	74	-29	17,7	+2,5	42	-82
06700	Genava	14,5	+1,3	110	32	19,5	+2,8	50	-41
07510	Bordeaux	16,4	+1,8	47	-30	21,3	+3,5	25	-31
07650	Marseilles	19,1	+2,0	8	-34	22,9	+2,0	3	-25
08222	Madrid	19,7	+3,7	16	-25	23,4	+2,7	30	4
08314	Mahon/Minorca	18,3	+1,5	4	-33	22,6	+1,8	6	-8
08495	Gibraltar	19,4	+0,9	1	-34	21,5	+0,4	3	-8
08515	Santa Maria/Azores	17,5	+0,8	79	49	18,7	0,0	38	16
08535	Lisbon	19,6	+2,2	<1	-39	21,1	+0,9	44	23
10384	Berlin-Tempelhof	14,4	+0,5	61	5	18,8	+1,4	13	-62
11035	Vienna	14,9	+0,1	76	15	19,4	+1,4	66	-8
11518	Prague	13,4	+0,7	108	31	17,2	+1,3	63	-10
11903	Slica	13,3	-0,4	103	39	17,7	+1,1	78	-7
12160	Elblag	13,3	+0,4	61	20	16,3	+0,9	60	-34
12375	Warsaw	14,2	+0,8	38	-21	18,2	+1,6	15	-57
12843	Budapest	15,9	-0,1	91	36	20,3	+1,2	169	106
13274	Belgrade	17,2	0,0	41	-30	20,1	0,0	138	48
14015	Ljubljana	15,5	+0,9	177	55	20,5	+2,7	46	-109
14445	Split	19,7	+1,3	52	-4	23,4	+1,2	45	-6
14654	Sarajevo	14,5	+0,4	60	-22	16,9	0,0	78	-13
15420	Bucharest	16,0	-0,7	32	-38	20,2	0,0	30	-47
15614	Sofia	15,3	+1,0	18	-55	18,0	+0,3	144	72
16158	Pisa	17,3	+1,0	48	-11	21,1	+1,3	0	-44
16597	Luqa	20,8	+1,7	2	-5	24,2	+1,2	1	-2
16716	Athens	21,3	+0,7	<1	-16	25,9	+0,8	21	14
16754	Heraklion/Crete	20,3	+0,5	1	-15	24,2	+0,7	0	-3
17062	Istanbul	17,3	+0,8	2	-29	22,0	+0,9	45	24
17130	Ankara	16,6	+1,1	30	-25	21,6	+2,0	32	-5
17170	Van	14,6	+1,9	35	-14	21,5	+3,9	<1	-21
17300	Antalya	21,0	+0,7	12	-16	25,9	+0,9	22	13
17609	Larnaka	21,8	+0,9	2	-5	25,6	+1,3	<1	<1
22113	Murmansk	5,6	+1,8	48	16	11,4	+2,0	50	-3
26038	Tallinn	10,1	+0,4	23	-14	15,9	+1,4	21	-32
26629	Kaunas	12,5	-0,2	75	19	16,5	+0,5	18	-57
26730	Vilnius	12,3	-0,2	46	-16	16,5	+0,7	21	-56
26850	Minsk	12,5	-0,4	75	13	17,0	+0,9	59	-24
27595	Kasan	13,6	+0,4	57	20	20,9	+3,6	30	-40
27612	Moscow	12,4	-0,5	56	-2	18,2	+1,6	55	-21
33345	Kiev	14,4	-0,7	130	77	18,4	+0,2	119	46
33815	Kisinev	15,7	-0,4	97	46	19,8	+0,4	82	7
34300	Kharkiv (Charkow)	15,4	-0,2	46	-1	20,6	+1,7	51	-7
34880	Astrakhan	17,3	-1,0	36	12	26,2	+3,3	6	-16
35188	Akmola	14,0	+0,9	29	-4	21,3	+2,3	52	17
37789	Yerevan	18,2	+1,9	26	-34	25,9	+5,3	3	-26
40080	Damascus	21,7	+1,5	1	-3	25,7	+1,1	0	<1
40180	Tel Aviv	21,6	+0,5	0	-3	25,1	+1,1	0	0
40199	Eilat	28,5	+0,1	0	-1	32,5	+0,8	0	0
40265	Mafraq	20,7	+0,9	0	-3	24,0	+1,3	0	0
60030	L.Palmas/Gran Can.	20,8	+0,9	<1	-2	21,7	+0,3	0	0

WMO No.	Station	July 2006 Temp. mean	July 2006 (°C) dev.	July 2006 Prec. total (mm)	July 2006 dev.	August 2006 Temp. mean	August 2006 (°C) dev.	August 2006 Prec. total (mm)	August 2006 dev.
01008	Svalbard/Spitsb.	7,5	+1,5	20	7	6,6	+1,8	30	5
01025	Tromsoe	10,7	-1,0	77	5	11,4	+0,5	21	-61
01492	Oslo	20,0	+3,6	37	-47	18,1	+2,9	114	24
02196	Haparanda	15,7	+0,2	18	-32	17,1	+3,8	8	-55
02485	Stockholm	20,8	+3,6	32	-40	19,2	+3,0	145	79
02974	Helsinki	19,1	+2,5	4	-69	18,4	+3,4	38	-42
03091	Aberdeen	16,9	+3,1	18	-42	14,7	+1,1	50	-25
03772	London	22,4	+4,6	24	-22	17,8	+0,4	69	18
03967	Dublin Casement Aerodrome	17,7	+2,8	14	-40	15,4	+0,8	66	-12
04030	Reykjavik	11,1	+0,5	43	-9	11,4	+1,1	43	-19
04320	Danmarkshavn	4,2	+0,5	35	21	2,7	+0,3	15	1
04360	Angmagssalik	6,1	-0,3	26	-23	7,4	+1,4	104	43
06186	Copenhagen	21,7	+4,5	26	-43	18,1	+1,1	158	95
06260	De Bilt	22,3	+5,5	15	-60	16,4	-0,3	181	110
06447	Brussels	23,0	+5,5	48	-27	16,3	-1,0	202	139
06590	Luxemburg	23,5	+6,6	12	-56	15,1	-1,3	175	103
06660	Zurich	22,5	+4,9	47	-70	14,7	-2,0	185	52
06700	Geneva	23,7	+4,4	48	-20	16,8	-1,6	137	57
07510	Bordeaux	24,7	+4,5	46	-1	19,4	-0,5	72	18
07650	Marseilles	27,9	+4,1	9	-5	23,3	+0,1	7	-22
08222	Madrid	27,2	+2,8	8	-5	24,1	+0,2	10	1
08314	Mahon/Minorca	26,7	+2,5	<1	-4	24,7	+0,2	2	-24
08495	Gibraltar	24,7	+1,0	2	1	24,3	+0,1	6	0
08515	Santa Maria/Azores	21,6	+0,8	12	-13	22,6	+0,4	92	52
08535	Lisbon	23,9	+1,5	<1	-5	24,3	+1,5	3	-3
10384	Berlin-Tempelhof	24,4	+5,6	56	4	17,7	-0,7	76	15
11035	Vienna	23,9	+4,0	38	-24	17,7	-1,5	212	147
11518	Prague	22,1	+4,6	28	-38	15,8	-1,2	95	25
11903	Slica	21,4	+3,2	31	-28	17,1	-0,2	82	13
12160	Elblag	21,6	+4,8	36	-58	17,5	+0,8	118	37
12375	Warsaw	23,5	+5,6	20	-47	17,9	+0,6	165	102
12843	Budapest	24,4	+3,5	20	-32	19,3	-1,0	155	104
13274	Belgrade	24,6	+2,9	23	-43	21,0	-0,3	121	69
14015	Ljubljana	23,6	+3,7	105	-17	17,7	-1,4	225	81
14445	Split	27,7	+2,3	8	-20	24,1	-1,1	128	78
14654	Sarajevo	19,4	+0,5	116	37	18,0	-0,5	173	102
15420	Bucharest	22,5	+0,5	64	0	21,5	+0,3	70	12
15614	Sofia	20,4	+0,4	88	32	20,6	+1,2	63	11
16158	Pisa	26,2	+3,4	41	18	22,7	+0,2	125	68
16597	Luqa	27,0	+1,1	<1	<1	26,6	+0,3	1	-6
16716	Athens	28,2	+0,4	2	-3	29,2	+1,6	0	-5
16754	Heraklion/Crete	25,5	-0,2	0	-1	27,7	+2,1	0	-1
17062	Istanbul	23,9	+0,7	1	-18	26,1	+3,1	33	7
17130	Ankara	23,2	+0,3	2	-12	27,2	+4,6	<1	-12
17170	Van	22,3	+0,4	22	18	24,1	+2,9	2	-5
17300	Antalya	28,9	+0,8	<1	-5	28,8	+1,1	3	1
17609	Larnaka	27,5	+0,6	2	2	28,0	+0,9	1	1
22113	Murmansk	11,9	-0,9	98	38	11,8	+0,8	33	-32
26038	Tallinn	19,0	+2,7	28	-51	17,7	+2,4	45	-39
26629	Kaunas	20,9	+3,8	71	3	17,8	+1,5	166	103
26730	Vilnius	20,8	+3,9	45	-33	17,6	+1,3	152	80
26850	Minsk	20,4	+3,1	76	-12	17,7	+1,2	255	183
27595	Kasan	18,1	-1,3	63	-6	18,5	+1,3	72	5
27612	Moscow	18,0	-0,1	35	-57	17,5	+1,1	129	55
33345	Kiev	21,0	+1,7	68	-20	19,9	+1,3	52	-17
33815	Kisinev	22,1	+1,2	53	-16	22,1	+1,6	68	23
34300	Kharkiv (Charkow)	20,9	+0,6	27	-33	22,5	+3,0	40	-10
34880	Astrakhan	24,6	-0,7	5	-18	27,1	+3,8	<1	-19
35188	Akmola	18,8	-2,5	39	-11	17,6	-0,1	9	-31
37789	Yerevan	24,9	+0,3	65	51	28,8	+4,9	0	-9
40080	Damascus	26,9	+0,6	0	0	27,8	+1,8	0	0
40180	Tel Aviv	26,8	+1,1	0	0	27,5	+1,4	0	0
40199	Eilat	33,6	+0,7	0	0	34,9	+2,1	0	0
40265	Mafraq	24,4	+0,3	0	0	25,7	+1,5	0	0
60030	L.Palmas/Gran Can.	23,5	+0,2	<1	<1	24,4	+0,3	<1	<1

WMO No.	Station	September 2006 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	October 2006 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard/Spitsb.	1,7	+1,2	12	-11	-5,5	0,0	12	-3
01025	Tromsoe	7,9	+1,1	92	-2	1,6	-1,3	105	-20
01492	Oslo	15,0	+4,2	57	-33	8,5	+2,1	163	79
02196	Haparanda	9,5	+1,6	57	-6	0,5	-2,0	70	6
02485	Stockholm	15,6	+4,4	23	-32	9,8	+2,3	90	40
02974	Helsinki	13,7	+3,7	24	-49	7,5	+2,1	193	120
03091	Aberdeen	14,5	+2,8	52	-16	11,4	+1,5	138	61
03772	London	18,6	+3,6	78	27	14,6	+2,9	64	6
03967	Dublin Casement Aerodrome	15,5	+2,5	74	5	12,0	+1,7	87	19
04030	Reykjavik	10,5	+3,1	64	-3	4,8	+0,4	106	20
04320	Danmarkshavn	-3,2	+1,0	8	-3	-12,8	+0,8	10	-2
04360	Angmagssalik	4,4	+1,3	64	-4	-0,5	+0,3	25	-57
06186	Copenhagen	17,0	+3,4	31	-31	12,8	+2,9	58	-1
06260	De Bilt	17,9	+3,9	9	-58	13,6	+3,1	109	37
06447	Brussels	18,4	+3,9	9	-50	14,2	+3,3	56	-14
06590	Luxemburg	17,5	+4,1	17	-53	12,8	+3,7	92	17
06660	Zurich	16,9	+3,1	110	18	12,7	+3,4	63	-6
06700	Geneva	18,0	+2,9	61	-21	13,6	+3,3	105	27
07510	Bordeaux	20,5	+2,6	98	24	17,2	+3,2	55	-33
07650	Marseilles	21,7	+1,4	94	47	18,8	+2,7	40	-38
08222	Madrid	21,9	+1,4	7	-23	16,8	+2,0	119	74
08314	Mahon/Minorca	23,1	+0,9	60	6	20,8	+2,3	19	-65
08495	Gibraltar	23,1	+0,3	6	-9	20,5	+1,0	134	70
08515	Santa Maria/Azores	22,0	+0,6	76	19	19,7	+0,4	189	105
08535	Lisbon	22,1	+0,4	57	31	19,6	+1,1	247	167
10384	Berlin-Tempelhof	18,5	+3,9	13	-33	12,8	+2,8	26	-10
11035	Vienna	17,5	+2,1	17	-28	12,3	+2,4	11	-30
11518	Prague	16,6	+3,3	10	-30	10,8	+2,5	29	-1
11903	Slica	15,9	+2,5	14	-42	9,7	+1,4	15	-35
12160	Elblag	16,8	+4,1	42	-28	11,0	+2,1	33	-20
12375	Warsaw	16,0	+2,8	31	-12	10,7	+2,4	40	2
12843	Budapest	18,6	+2,2	20	-20	13,4	+2,5	14	-20
13274	Belgrade	19,2	+1,5	24	-27	15,2	+2,8	21	-19
14015	Ljubljana	17,7	+2,2	108	-22	13,4	+3,0	19	-96
14445	Split	22,4	+1,0	117	56	18,8	+1,9	4	-75
14654	Sarajevo	15,7	+0,6	41	-29	12,2	+1,8	81	-7
15420	Bucharest	16,9	0,0	62	20	11,5	+0,7	37	5
15614	Sofia	16,5	+0,7	36	-3	12,0	+1,6	60	23
16158	Pisa	20,3	+0,8	176	87	17,2	+1,9	69	-51
16597	Luqa	24,1	0,0	24	-16	21,8	+1,1	90	0
16716	Athens	23,9	-0,3	27	17	19,3	0,0	98	46
16754	Heraklion/Crete	23,7	+0,6	19	1	19,9	+0,2	169	93
17062	Istanbul	20,3	+0,6	59	18	16,7	+1,4	38	-33
17130	Ankara	18,2	-0,1	78	59	13,6	+1,0	37	10
17170	Van	18,0	+1,2	4	-10	11,6	+1,5	47	-1
17300	Antalya	24,9	+0,4	30	17	19,6	-0,1	495	425
17609	Larnaka	26,3	+1,2	0	0	22,0	+0,7	46	27
22113	Murmansk	6,5	-0,2	69	17	0,1	-0,9	79	37
26038	Tallinn	14,3	+3,5	41	-41	8,7	+2,4	108	38
26629	Kaunas	14,6	+2,5	90	31	9,7	+2,8	48	-3
26730	Vilnius	14,3	+2,7	83	18	9,1	+2,5	56	3
26850	Minsk	13,7	+2,0	51	-9	8,4	+2,1	51	2
27595	Kasan	13,3	+2,1	35	-11	4,8	+1,3	51	4
27612	Moscow	13,3	+2,4	60	-4	7,0	+2,0	53	-5
33345	Kiev	15,5	+1,6	36	-11	9,7	+1,6	39	4
33815	Kisinev	17,1	+0,9	53	5	12,0	+1,9	14	-13
34300	Kharkiv (Charkow)	15,4	+1,3	59	18	9,4	+2,1	34	-1
34880	Astrakhan	18,8	+1,5	12	-14	12,5	+3,4	45	28
35188	Akmola	13,2	+1,2	22	-2	4,3	+1,5	35	5
37789	Yerevan	21,6	-1,8	9	-1	15,2	+2,4	45	13
40080	Damascus	24,6	+1,4	0	0	18,9	+0,8	30	18
40180	Tel Aviv	26,8	+2,0	0	0	23,3	+1,3	115	89
40199	Eilat	31,4	+1,0	0	0	27,3	+0,6	0	-4
40265	Mafraq	24,0	+1,3	0	-1	19,2	+0,1	13	6
60030	L.Palmas/Gran Can.	24,9	+1,1	7	-1	23,1	+0,6	99	89

WMO No.	Station	November 2006 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	December 2006 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard/Spitsb.	-4,1	+6,4	27	14	-6,3	+7,0	26	14
01025	Tromsoe	1,0	+1,8	90	-14	0,9	+3,9	139	35
01492	Oslo	4,1	+3,4	150	75	2,4	+5,2	68	12
02196	Haparanda	-2,9	+1,2	100	42	-2,0	+7,5	86	44
02485	Stockholm	4,9	+2,3	40	-13	4,9	+5,9	34	-12
02974	Helsinki	1,5	+1,4	68	-4	3,0	+7,1	60	2
03091	Aberdeen	7,5	+2,5	69	-6	4,2	+0,7	30	-43
03772	London	9,3	+2,1	98	43	7,5	+2,4	64	7
03967	Dublin Casement Aerodrome	8,0	+1,3	89	19	6,9	+1,6	108	31
04030	Reykjavik	1,2	+0,1	87	14	2,2	+2,4	95	16
04320	Danmarkshavn	-16,9	+3,0	7	-3	-21,5	+0,3	3	-10
04360	Angmagssalik	-5,2	-0,5	36	-60	-2,7	+4,5	145	42
06186	Copenhagen	8,1	+2,6	76	14	7,2	+5,0	56	-2
06260	De Bilt	9,2	+3,3	93	12	6,5	+3,3	75	-5
06447	Brussels	9,1	+3,0	72	-4	5,9	+2,4	93	17
06590	Luxemburg	7,2	+3,4	93	10	3,8	+2,8	70	-10
06660	Zurich	7,0	+3,1	42	-40	2,5	+1,9	55	-18
06700	Geneva	7,7	+2,5	60	-34	3,4	+1,4	59	-29
07510	Bordeaux	11,9	+2,8	68	-26	5,2	-1,2	49	-50
07650	Marseilles	13,9	+3,2	25	-33	8,3	+1,0	47	-9
08222	Madrid	11,9	+2,5	134	70	6,6	+0,2	28	-23
08314	Mahon/Minorca	17,1	+2,7	3	-74	13,1	+1,3	138	64
08495	Gibraltar	17,3	+1,2	97	-44	14,1	0,0	38	-108
08515	Santa Maria/Azores	17,6	+0,2	60	-42	16,2	+0,8	163	68
08535	Lisbon	16,3	+1,8	260	146	11,6	-0,2	80	-28
10384	Berlin-Tempelhof	7,9	+3,0	35	-14	5,7	+4,3	33	-20
11035	Vienna	7,8	+3,2	32	-18	3,5	+2,6	17	-26
11518	Prague	6,1	+3,3	7	-25	3,2	+3,8	15	-11
11903	Slica	5,9	+2,9	31	-38	0,1	+1,8	12	-45
12160	Elblag	6,4	+3,1	114	58	5,1	+4,8	37	-15
12375	Warsaw	5,9	+2,7	43	1	4,0	+4,9	26	-6
12843	Budapest	7,7	+2,9	20	-32	2,4	+2,0	5	-35
13274	Belgrade	8,9	+1,9	24	-30	4,1	+1,8	52	-6
14015	Ljubljana	8,8	+4,2	58	-77	4,6	+4,6	59	-42
14445	Split	12,4	+0,2	48	-60	10,4	+1,7	7	-93
14654	Sarajevo	4,9	+0,1	46	-45	1,1	+1,3	64	0
15420	Bucharest	6,3	+1,1	29	-20	1,2	+1,0	11	-32
15614	Sofia	5,4	+0,4	26	-21	0,4	-0,1	31	-8
16158	Pisa	11,8	+1,4	107	-17	8,8	+2,0	105	20
16597	Luqa	17,7	+0,7	57	-23	16,0	+2,2	81	-31
16716	Athens	13,3	-2,2	24	-26	10,5	-1,7	13	-58
16754	Heraklion/Crete	14,9	-1,7	70	11	13,0	-0,8	15	-59
17062	Istanbul	10,6	-1,0	82	-7	7,9	-0,2	17	-105
17130	Ankara	5,6	-1,5	19	-14	1,2	-1,4	1	-48
17170	Van	3,0	-1,0	49	7	-3,4	-2,5	44	10
17300	Antalya	13,5	-1,3	126	-24	11,3	-0,1	66	-157
17609	Larnaka	16,0	-0,4	16	-28	12,8	-0,4	8	-68
22113	Murmansk	-6,0	-0,9	35	-5	-3,3	+6,0	46	8
26038	Tallinn	3,2	+2,0	33	-35	4,4	+7,3	59	4
26629	Kaunas	4,4	+2,3	48	-5	4,0	+6,4	48	4
26730	Vilnius	3,5	+2,3	44	-13	3,3	+6,2	36	-19
26850	Minsk	2,7	+1,9	35	-17	2,7	+6,5	17	-36
27595	Kasan	-3,0	+0,2	59	13	-2,4	+6,7	46	9
27612	Moscow	0,7	+1,8	51	-7	1,2	+7,3	32	-20
33345	Kiev	3,4	+1,3	25	-26	2,4	+4,7	11	-41
33815	Kisinev	6,4	+2,0	10	-29	3,3	+3,6	1	-37
34300	Kharkiv (Charkow)	2,1	+0,8	60	16	0,9	+4,3	10	-35
34880	Astrakhan	3,0	-0,3	30	11	0,3	+2,2	26	11
35188	Akmola	-3,2	+2,7	53	31	-7,0	+5,6	30	13
37789	Yerevan	6,6	0,0	9	-21	-3,4	-3,9	33	7
40080	Damascus	10,5	-1,3	25	3	4,7	-2,5	2	-24
40180	Tel Aviv	17,5	-0,5	38	-30	13,5	-0,3	125	-13
40199	Eilat	20,3	-1,2	0	-3	15,6	-1,0	<1	-6
40265	Mafraq	11,9	-1,6	1	-16	6,7	-2,1	12	-16
60030	L.Palmas/Gran Can.	21,9	+1,5	9	-12	18,4	+0,1	6	-15

WMO No.	Station	Year 2006 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard/Spitsb.	-1,7	+4,7	201	18
01025	Tromsoe	3,8	+1,0	916	-57
01492	Oslo	7,7	+2,0	936	167
02196	Haparanda	2,5	+1,4	490	-62
02485	Stockholm	8,4	+1,8	528	-11
02974	Helsinki	6,1	+1,6	558	-93
03091	Aberdeen	9,2	+1,3	645	-138
03772	London	12,4	+1,9	637	38
03967	Dublin Casement Aerodrome	10,5	+1,2	677	-58
04030	Reykjavik	5,4	+1,0	892	94
04320	Danmarkshavn	-10,5	+1,8	272	140
04360	Angmagssalik	-0,6	+1,1	748	-184
06186	Copenhagen	10,1	+1,5	565	-71
06260	De Bilt	11,2	+1,8	808	3
06447	Brussels	11,3	+1,4	835	35
06590	Luxemburg	10,2	+1,9	888	13
06660	Zurich	9,8	+1,3	1057	-29
06700	Geneva	11,2	+1,4	980	35
07510	Bordeaux	14,1	+1,4	821	-102
07650	Marseilles	16,2	+1,4	315	-229
08222	Madrid	15,8	+1,5	503	47
08314	Mahon/Minorca	17,8	+1,2	385	-213
08495	Gibraltar	18,6	+0,4	686	-89
08515	Santa Maria/Azores	18,1	+0,6	1043	268
08535	Lisbon	17,6	+0,8	999	246
10384	Berlin-Tempelhof	10,6	+1,2	455	-129
11035	Vienna	10,7	+0,8	703	90
11518	Prague	9,0	+1,1	471	-55
11903	Slica	8,4	+0,5	525	-161
12160	Elblag	8,8	+1,2	647	-43
12375	Warsaw	9,0	+1,2	478	-41
12843	Budapest	11,4	+1,0	631	113
13274	Belgrade	12,7	+0,8	753	69
14015	Ljubljana	11,4	+1,6	1139	-254
14445	Split	16,5	+0,7	659	-166
14654	Sarajevo	9,6	+0,1	961	43
15420	Bucharest	10,6	0,0	549	-46
15614	Sofia	10,1	+0,4	640	77
16158	Pisa	14,9	+0,9	899	-5
16597	Luqa	19,4	+0,8	539	-14
16716	Athens	18,2	-0,3	347	-22
16754	Heraklion/Crete	18,5	0,0	529	28
17062	Istanbul	14,7	+0,6	597	-100
17130	Ankara	12,2	+0,5	372	-41
17170	Van	10,0	+1,3	428	43
17300	Antalya	18,7	+0,3	1323	246
17609	Larnaka	19,7	+0,6	237	-92
22113	Murmansk	1,2	+1,3	547	69
26038	Tallinn	6,9	+1,8	477	-190
26629	Kaunas	7,6	+1,2	653	45
26730	Vilnius	7,1	+1,1	604	-79
26850	Minsk	6,9	+1,1	729	52
27595	Kasan	4,5	+0,8	586	46
27612	Moscow	5,5	+0,6	625	-63
33345	Kiev	8,4	+0,7	622	-27
33815	Kisinev	10,2	+0,6	565	18
34300	Kharkiv (Charkow)	8,1	+0,6	450	-69
34880	Astrakhan	10,8	+0,8	233	13
35188	Akmola	4,3	+1,6	344	26
37789	Yerevan	12,8	+1,3	391	-23
40080	Damascus	17,1	+0,6	131	-16
40180	Tel Aviv	20,4	+0,9	604	37
40199	Eilat	25,3	+0,5	2	-27
40265	Mafraq	17,0	+0,5	94	-65
60030	L.Palmas/Gran Can.	20,8	+0,3	293	176

Monthly Surveys

January

- **Cold in most of Europe, but very mild in the north**
- **Dry in most of the Region, wet in some northern areas, in the western Mediterranean and parts of the southeast**

Ridges over the Atlantic extended to the north, forming large high pressure systems over northern and later also over central Europe. Mild und humid Atlantic air masses moved very often at the west flank of these high pressure systems far to the northernmost parts of the Region. Extremely high temperature anomalies were registered over these areas, particularly in Svalbard; it was up to more than 12 °C warmer than normal there, which was extremely mild (Fig. 1.1), the warmest January ever recorded and even warmer than any previously recorded April. The Arctic Sea ice extent was the lowest since the beginning of satellite measurements in 1979. Within these mild air masses, numerous low pressure systems moved over Iceland, Greenland and Svalbard; and thus, up to more than 400% of the normal monthly precipitation amounts were reached there (Fig. 1.2). Ny-Ålesund in Svalbard measured a new record for diurnal precipitation since 1969 with 34 mm on January 16. Sometimes these low pressure systems also touched parts of northern continental Europe. However, in most parts of Norway, Sweden and Finland it was mild, but dry, since low pressure influence was only weak. Stations in the county of Finnmark (northern Norway) registered a new record for maximum temperature.

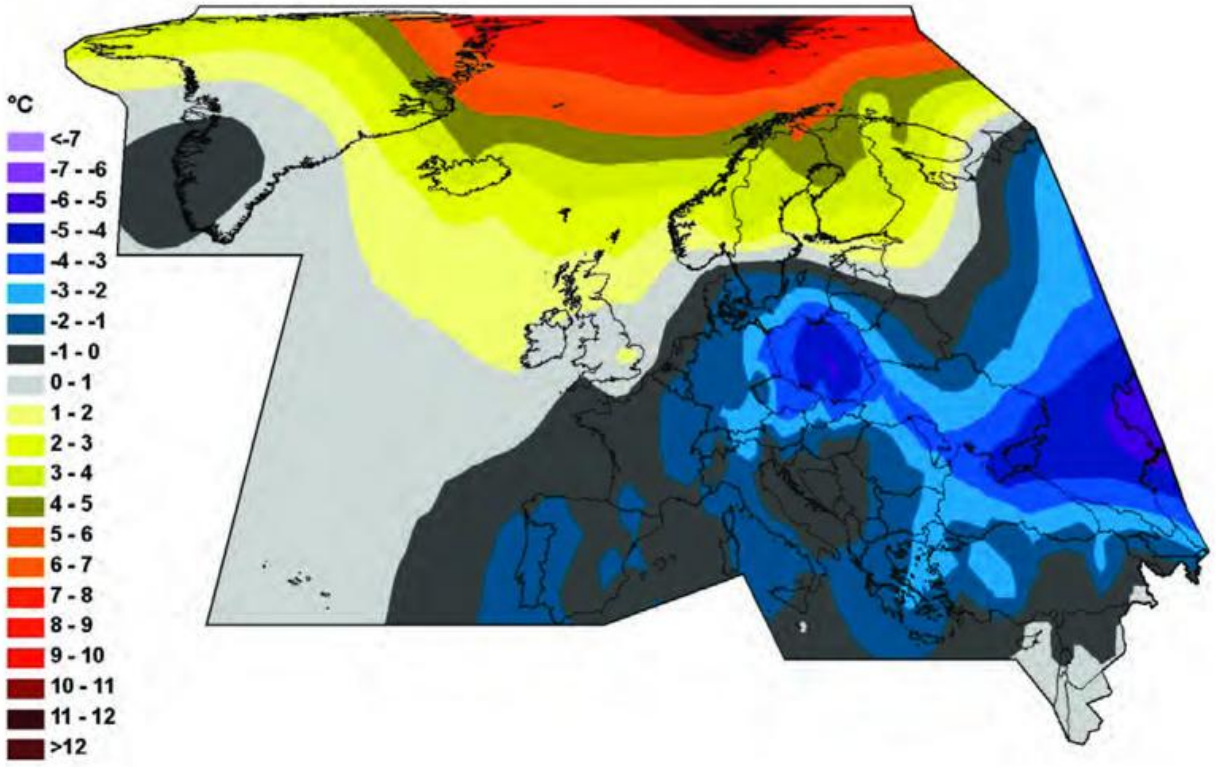


Fig. 1.1: *Monthly mean temperature anomalies in January 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

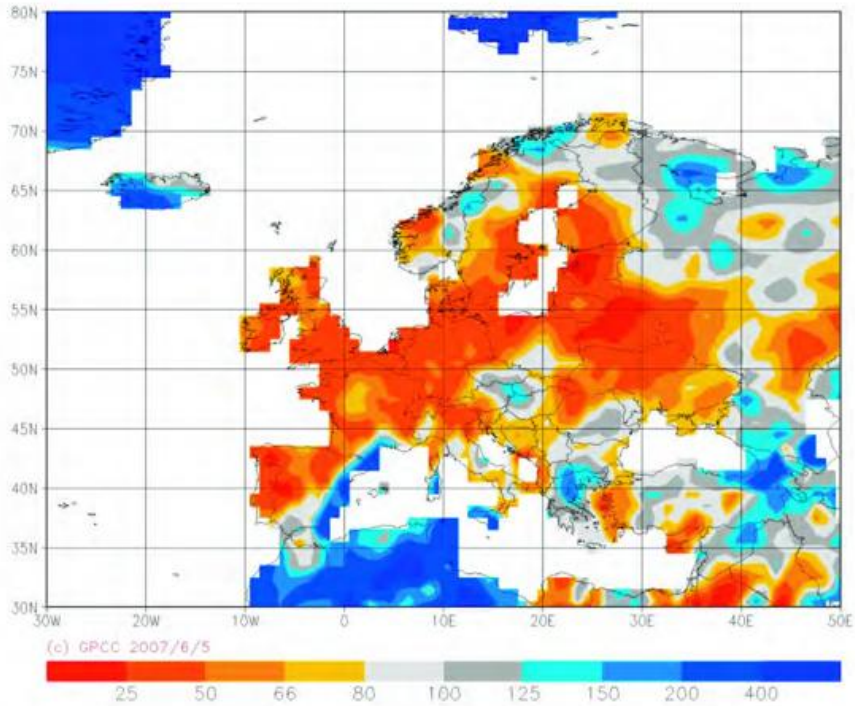


Fig. 1.2: *Monthly precipitation amounts for January 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

Most of the rest of the Region was dominated by continental air masses this month coming from the east and moving at the south flank of the north European high to eastern, central and even western Europe. Locations in the easternmost parts of the Region in west Kazakhstan and Russia experienced the negative monthly temperature anomalies of the Region at below -5 °C, parts of west Kazakhstan even down to nearly -10 °C (Fig. 1.3). In most of eastern central Europe, anomalies were between -5 and -2 °C. The remaining parts of the Region were also colder than normal, except northern Scandinavia, the United Kingdom and Ireland, the Atlantic and a small area in the southeast, but including western and southern Europe. Although the anomalies were smaller there, they were nevertheless outstanding. It was e.g. the coldest January since 1997 in the Netherlands. In Luxembourg (airport), 26 frost days were counted, but none of these was below -10 °C. Portugal recorded minimum temperatures below zero at approximately half of the stations, down to -8 °C and up to 21 frost days, which were 2-3 times as many as normal, particularly in the centre and the south of the country; some of these days were also ice days (maximum temperature <= 0 °C).

Especially the last third of January was very cold; in Russia and the Ukraine the whole second half of the month was cold with night temperatures frequently below -30 °C. The lowest minimum temperature in Poland, however, was down to -32.1 °C in the central part of the country on January 1. Latvia had a warm start to the year, but on January 17 a very cold arctic air mass flowed in, which reduced the air temperature by about 25 °C in one and a half days. The coldest period was during January 19-22 when the daily average air temperature was 15-19 °C below normal and the minimum air temperature reached -32 °C. These were not only the coldest days in 2006, but also the coldest January 19-22 period ever recorded in Latvia. Since the snow had melted before this cold spell came, there was no snow cover which could protect plants and thus they suffered from frost damage during the cold spell. Lithuania, too, recorded low temperatures on January 20-21 down to -31 °C in the east, with only little snow and soil freeze depths down to 95 cm. This cold spell appeared even in Norway, which was otherwise very mild on average. Strong cold winds from the landward side resulted in very strong icing conditions in the northern coastal areas of Norway on January 18-20.

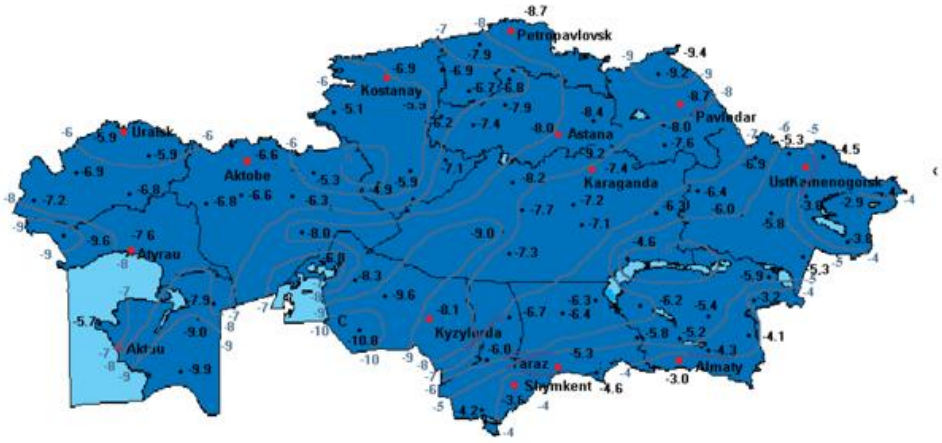


Fig. 1.3: *Monthly mean temperature anomalies in January 2006 (reference period 1961-1990) in Kazakhstan.*
Source: Kazhydromet, Kazakhstan

Central and southeastern Europe experienced this cold period too. In southern and eastern parts of Germany, daily minimum temperatures below -20 °C were measured at several stations on January 22-25. The Rhine-Main-Danube channel was closed during that time. Hungary had its annual temperature minimum of -25.1 °C on January 24. The cold spell was also registered on January 23-28 in the whole of Serbia, with minimum temperatures below -10 °C, in the highland down to -39 °C, which was nearly a new record. Temperature decreased frequently to below -25 °C in Romania during the last decade of the month, with a minimum of -33 °C on January 27. The Black Sea froze at the shore, floating ice formed along the Danube, causing an interruption to river traffic for the first time since 1984. Moldova, too, had a cold spell at that time (January 20-27) with temperatures down to -30 °C; this is recorded only once in 20-25 years on average. Macedonia also experienced an extreme cold spell during January 23-29; the daily mean temperature in Skopje dropped from 4 °C on January 22 to -10 °C two days later (Fig. 1.4). In many eastern and central European countries there were some deaths due to this cold weather.

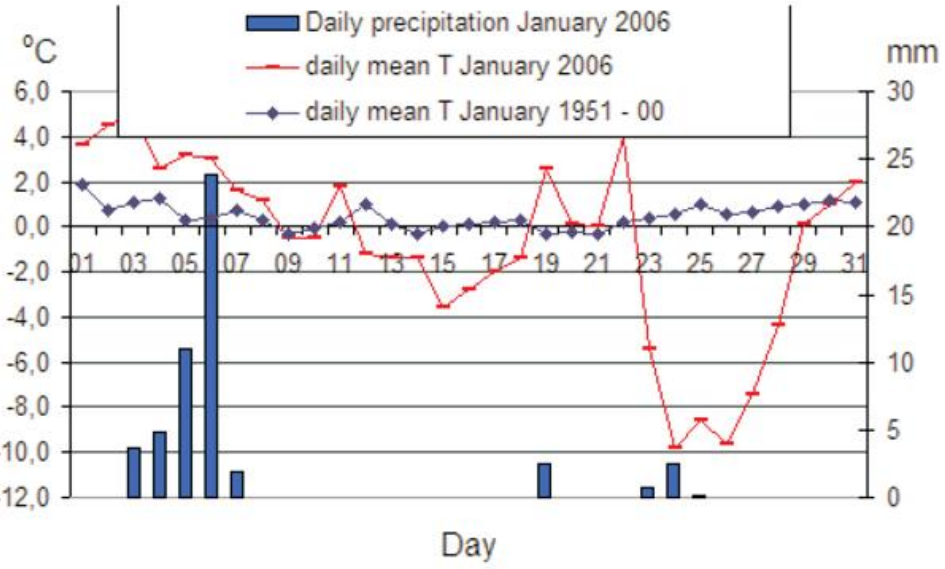


Fig. 1.4: *Daily mean air temperatures and precipitation totals forJanuary 2006 in Skopje Zajchev Rid(Macedonia), in comparison to the long-term temperature mean 1951-2000.*
Source: Hydrometeorological Service of Republic of Macedonia

At the end of the month, Scotland, too, became very cold; temperatures below -12 °C were recorded on January 31.

Beside the low temperatures, extended snowfall was also a remarkable feature this month. The year started already with heavy snowfall in Central Europe. In Poland, a snow cover appeared at the beginning of the month and remained during the whole of January. In southern Germany, the roof of an ice pavilion collapsed on January 2 due to a heavy snow load. Repeated heavy snowfall was also reported from Upper and Lower Austria and the province of Salzburg from January 3-17, leading to numerous accidents, collapses of roofs and damage to forests. Slovenia, too, had quite a persistent snow cover throughout the month which was deepest in the beginning of the month. On January 5, falling temperatures and a snowstorm caused serious road accidents in Bulgaria and blocked the road traffic across the country. This snowstorm was also reported from Romania. In Serbia, snow cover in the mountains remained for the whole of the month.

January 27-30 was a period of heavy rain and snow fall in France, particularly where the southern half of France was concerned. Switzerland recorded its first extraordinary snowfall of th season in the southern part of the Alps at that time. After two days of intense snowfall, the Ticino region had a snow cover of 60-90 cm on January 28. It was the greatest snow depth in the Ticino lowlands since 1986. The snow masses caused considerable interruptions to traffic, many roads were impassable. However, not only the quantity, but also the low density of the snow was exceptional, due to temperatures significantly below zero, especially at the beginning of the event.

Further to the south, some areas in Sicily (Italy), Greece and Turkey were covered by snow. Heavy snowfalls were also reported from Armenia, especially during January 23-26, when all flights were cancelled at Zvartnots airport. On January 29, snowfall occurred even in coastal and lowland regions of Portugal; these are places where such phenomena do not happen often. In Lisbon, for example, the previous occurrence of snowfall was on February 1-2, 1954.

Since the continental air masses were also very dry, the precipitation amounts in most parts of Europe were far below normal; less than 50% of the normal precipitation fell in many places. England, Wales and Northern Ireland had their driest January since 1997. In the east, also Belarus recorded its driest January (for 60 years) with only 22% of the long-term average. Slovenia was especially dry in the second and third decade; there was almost no precipitation during that period. In the south, this January was the 2nd driest in Portugal for 17 years.

Higher than normal precipitation, on the other hand, was registered in the western Mediterranean, partly more than twice the normal, due to a trough moving from central Europe to this area at the beginning of the year. This January, Malta had 22 rainy days, some of them being accompanied by thunder and hail. There were also some heavy local positive precipitation anomalies in Greece and south of the Caucasus, because some of the low pressure systems of the western Mediterranean moved further to the east. In the Ararat Valley (Armenia) twice the amount of the normal monthly precipitation total was recorded. Cyprus received heavy rainfall with hail on January 11 in the eastern parts of the island, causing floods and damage to properties and crops. A large number of 16-20 days with rainfall was reported from northern and central Israel, compared to a normal of 13-15 days. There was a continuous rainfall period of 12 days from January 7-18 in central Israel which occurs only once in 10-12 years.

February

- **Cold in most of Europe, very mild over the North Sea and in the southeast**
- **Dry in most of northeastern and western Europe, other parts of Europe locally wet**

High pressure influence was still dominating most of February in northern and western Europe, and mild and humid air masses were still moving to the northernmost parts of the Region. The temperature anomalies in Svalbard were not as high as in January, but still very high at more than +5 °C; in western Greenland more than +4 °C were registered (Fig. 2.1). Iceland recorded its 4th warmest year in Reykjavik since recordings began in 1870. Bergen-Florida in Norway measured 13.2 °C, which was a new record for February in Bergen since 1867.

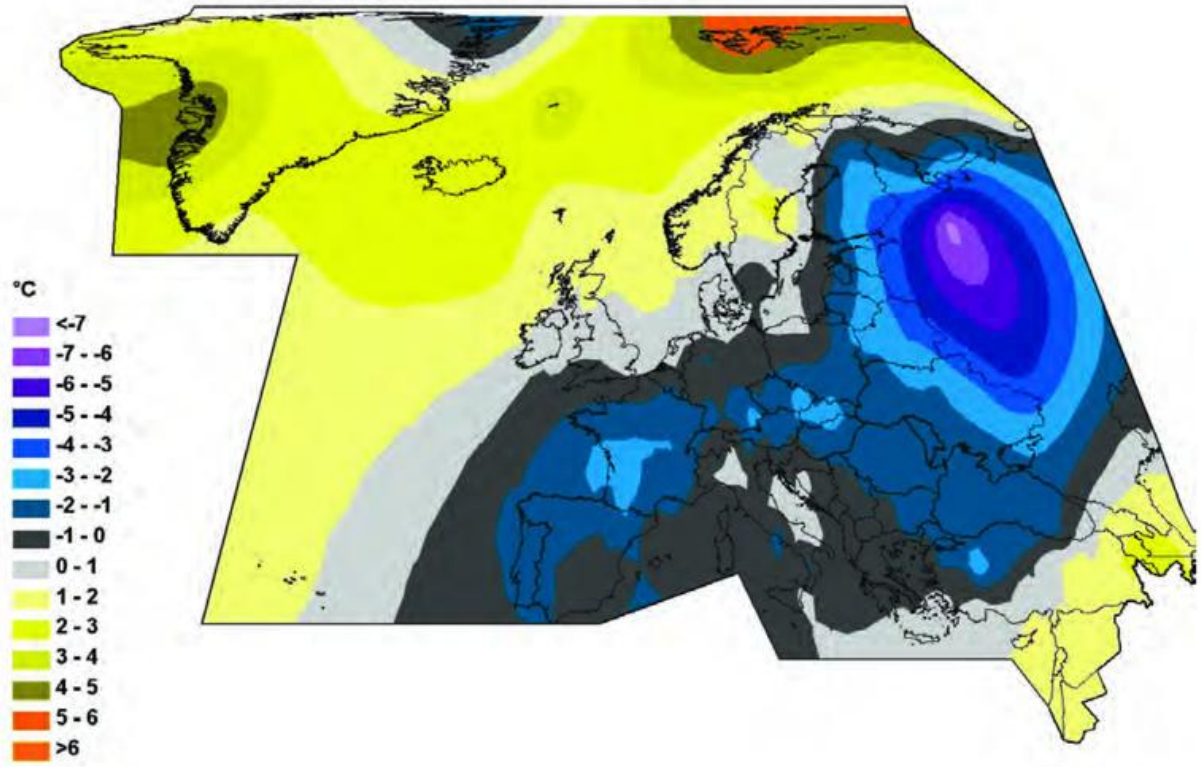


Fig. 2.1: *Monthly mean temperature anomalies in February 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

It was also still wet on Svalbard, Greenland and parts of Iceland (Fig. 2.2). In Norway, a station in the county of Sør-Trøndelag received 361 mm during 4 consecutive days until February 1, resulting in serious flooding in that area.

At the east flanks of north European high pressure systems, cold dry air flowed particularly to eastern Europe, but also further to the west and south. It was very cold in northern European Russia with monthly mean anomalies down to -7 °C and less than 50% of the monthly precipitation; only further to the south, in the western regions of the north Caucasian district, was it very wet. In Estonia, no temperatures above zero were recorded in large parts of the country during the whole month. A minimum temperature of -26.8 °C was measured in Poland on February 6, and also in the Ukraine there were minima far below -20 °C in that month. Towards the west, in Scotland, temperatures below -12 °C were measured on February 1.

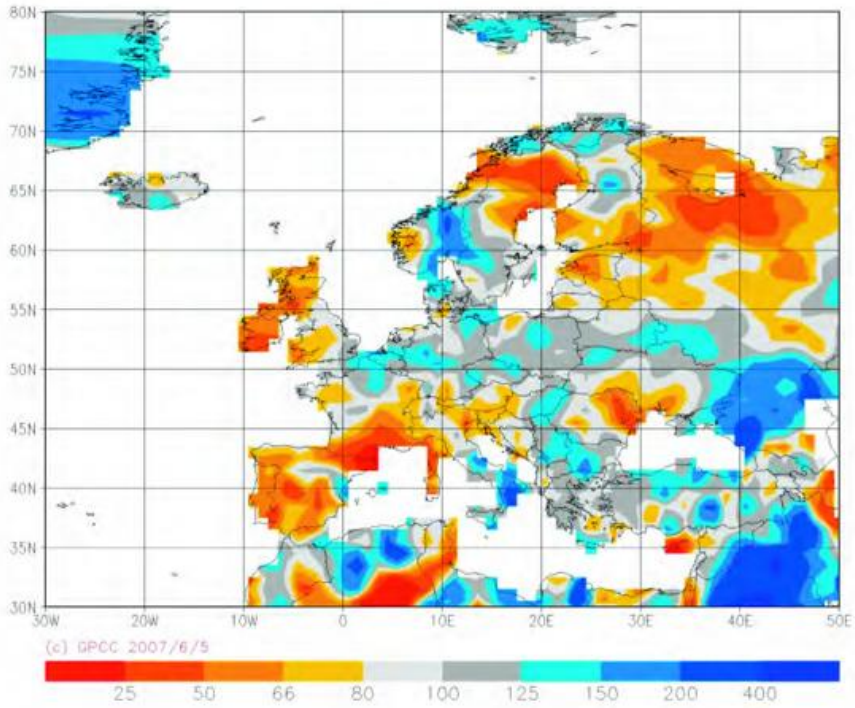


Fig. 2.2: *Monthly precipitation amounts for February 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

The rest of Europe also remained cold on average, but in contrast to January, more low pressure systems could develop and move within some large cold troughs. Thus, it was locally and regionally wetter than normal in parts of central and southeastern Europe. A lot of snow fell even in the lowlands, e.g. in southern Germany snow depths reached up to 150 cm on February 7-11, causing traffic problems and collapsing of buildings and roofs due to high snow loads. Heavy snowfall also occurred in Austria at the northern border of the Alps. In Poland, the snow cover remained during the whole month. Snow storms were reported from Romania on February 16 and 25-28. In Serbia, it snowed during most of the month.

Some parts of the western Mediterranean, too, remained cold and wet, e.g. the Balearic Islands, southern Italy and Crete (south Greece). St. Valentine's night was the coldest night of the year in Malta with a 2 m air temperature of 3.8 °C, and on February 15, the air temperature at grass height level was -1 °C.

In contrast, western Europe was mostly under Atlantic high pressure influence with low precipitation. Especially southern France was very dry. However, France, the Iberian Peninsula and even the southwest of the United Kingdom were mainly within the cold air mass. The number of frost days in the inner northern central regions of Portugal amounted to 21 days as in January 2006, again 2-3 times the normal number.

The areas of the Middle East were mostly no longer affected by the cold spell this month. It was warmer than normal there, in Armenia and Azerbaijan up to more than +2 °C, only the Ararat Valley was 1.5 °C colder than normal. However, 35 cm of accumulated snow were recorded in northern Jordan (Ras-Muneef, elevation 1150 m) on February 8-9. The high mountainous regions of Armenia received a monthly total of 160% of the normal precipitation. On February 3 there was extensive flooding in south Israel (near Eilat) which caused considerable damage.

March

- **Cold in most of Europe, very mild in Greenland, in southwestern Europe and in the southeast**
- **Dry in most of northern Europe and most parts around the Mediterranean**
- **Western, central and eastern Europe mainly wet**

The warm Atlantic air flow to the north relocated to a more westerly position this month. The highest positive anomalies were registered in western Greenland this month; they were very high, at up to more than +8 °C. Eastern Greenland and Svalbard were less than +2 °C warmer than normal, quite a large reduction compared to the previous two months. The mild air masses brought higher than normal precipitation amounts to Greenland, while Iceland and Svalbard remained mainly dry.

Large cold troughs extended frequently from the northeast over Europe, making March the third cold month in 2006 for most of Europe. The highest negative anomalies were found generally over northern Europe, down to below -4 °C (Fig. 3.1). In northern Finland at Enontekiö, almost -40 °C was reached in early March, in northern Norway (county of Finnmark) the lowest minimum of the year, -41.4 °C, was measured at the station Cuovddatmohkki on March 3. For Norway as a whole this was the coldest March since 1962. In the middle of the month, snow depths were around 50 cm in large parts of southern Sweden. Only around March 20 did the snow start to melt rapidly there. Winter weather prevailed during the whole month in south Finland and the temperature rose to 10 °C anywhere. In Estonia, the ground was frozen twice as deeply as normal (95 cm). For Lithuania it was the coldest month of the year, mean daily

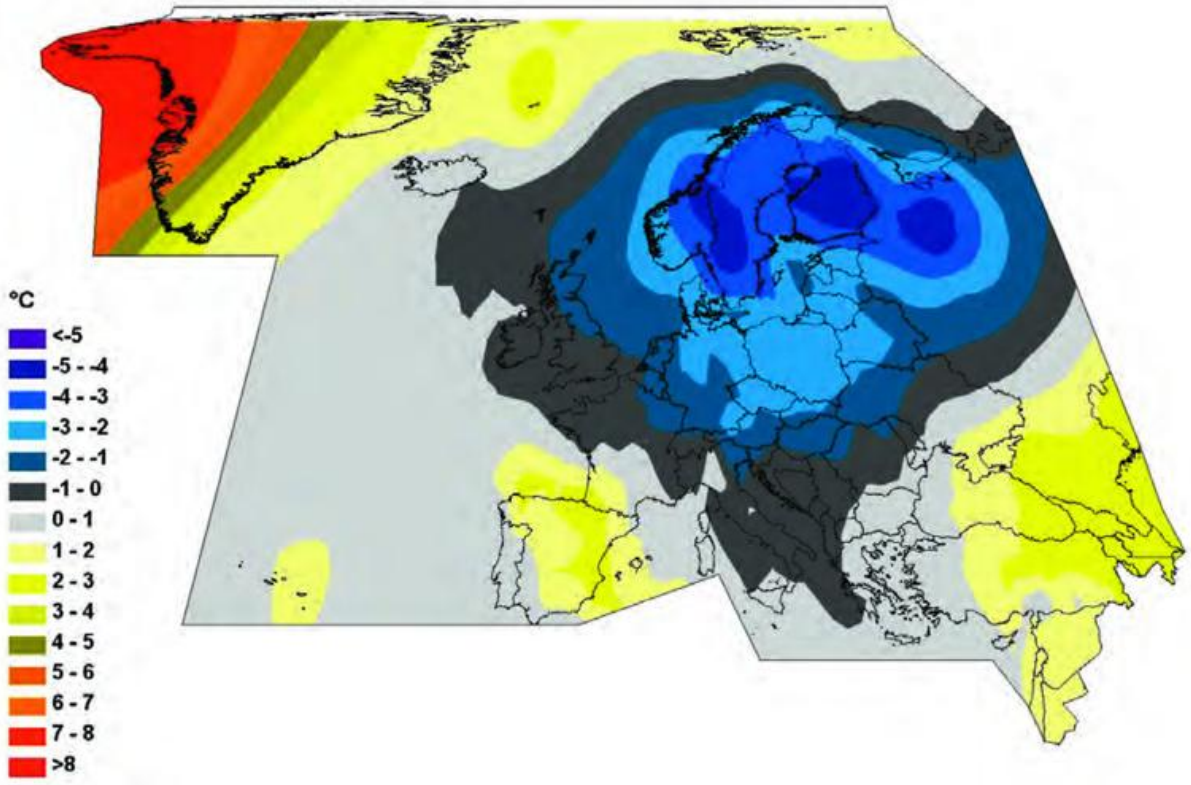


Fig. 3.1: *Monthly mean temperature anomalies in March 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

temperatures rose above 0 °C only at the end of the month on March 27-28; this was almost one week later than normal. Poland recorded a minimum temperature of -20.7 °C in the first decade of March, but a maximum of 19.3 °C at the end of the month and thaw was not registered before March 27. In the Netherlands, the lowest temperature of the year of -11.8 °C was recorded late on March 4. Also in Scotland, March was actually colder than any of the three standard winter months December-February 2005/06; this had not occurred in Scotland since 1975/76. For the second successive year, the lowest air and ground temperatures of the year at almost all stations in Ireland were recorded in early March. In the Alps, wintry weather conditions continued in the first and second decade with frost down to -24 °C in Seefeld/Tyrol. The cold air affected even the south of Europe: in northwest Greece, a temperature drop of more than 12 °C within one day was registered on March 7.

Most of northern Europe was drier than normal (Fig. 3.2) because the low pressure systems took a more southerly route than usual, especially those coming from the Atlantic. Due to the dryness, the largest known grass fire in Iceland started on March 30; about 67 km² were burned.

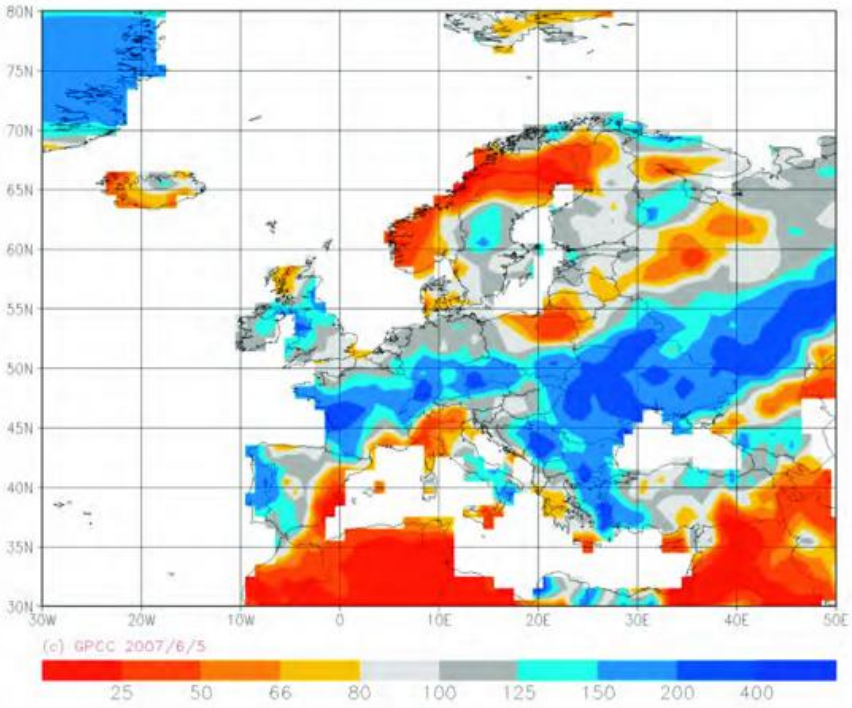


Fig. 3.2: *Monthly precipitation amounts for March 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

Over the eastern North Atlantic, high pressure influence became rare; low pressure systems moved to central, western and eastern Europe at the south flank of the cold air. The monthly precipitation amounts were high over these areas, in same places more than 200% of the normal. At some locations in France it was the highest monthly total for 50 years. Precipitation fell very often as snow. Luxembourg Airport had 10 days of snow this month (on one day a depth of 24 cm) compared to a 1971-2000 average of 5 days. A period of heavy snowfall occurred in western and central Europe in particular on March 3-6. Some places in Scotland saw snow depths rising to 25 cm or more during the first week of March. In northeastern France, record March snow depths since 1950 of 45 cm were registered in Mulhouse and Belfort. Record snow depths were also reported from southern Germany, e.g. 50 cm in Munich on March 5. Many flights at German airports were cancelled or delayed. Another heavy snowfall occurred on March 12 in northern Germany, causing widespread traffic obstructions. A tornado was registered on March 27 in northern Germany (Hamburg) within a temporary warmer air mass, which is rare in that season and such a cold month. Ongoing heavy snowfall already on

March 4-5 led to the most significant quantities of fresh snow measured this year in northern and eastern Switzerland. 54 cm of fresh snow fell in Zurich within one day, 49 cm in Basle and even 60 cm in St. Gall. Heavy snowfalls occurred also in some regions of Austria during the first week of the month, and also Slovenia recorded quite abundant snow especially on March 5; the snow cover did not disappear before the second half of the month, even in Ljubljana. The Slovenian mountain station Kredarica received a maximum snow depth of 440 cm, which was noticeably above normal. In Serbia, snow remained in lower parts until March 20 and on mountains during the whole month. Maximum snow depths in the mountains of Serbia this month were close to the absolute maxima ever recorded.

Around the middle of the month, a storm with heavy rain, snow, flooding and landslides affected especially Romania and Bulgaria, initiated by a Mediterranean cyclone. Widespread thunderstorms were registered in Romania and northern Bulgaria on March 23 and 29, in some places with hail. On March 28, Austria and the Czech Republic were also affected by continuing precipitation, and flooding occurred along the river Thaya. At the end of March, heavy rain and snowmelt caused flooding of the Danube and Elbe rivers with damage particularly in Germany. Also Cyprus in the eastern Mediterranean experienced heavy rainfall and severe thunderstorms on March 27, affecting the area around Nicosia with floods and damage to houses.

The Iberian Peninsula was not affected much by the cold air. Precipitation systems mainly affected Portugal and western Spain, whereas eastern Spain remained very dry (in parts less than 25% of the normal precipitation) and warm (anomalies up to more than +2 °C). For almost the whole country of Portugal this was the first rainy month for a long time; it put an end to the drought conditions in this country which had lasted from the end of 2004 until February 2006.

Most of the areas in the Mediterranean were very dry, except some areas in southern Italy, Albania and western Turkey. In Albania, up to 250% of the normal precipitation were registered. Temperatures were around normal in these parts.

The southeast of the Region was also not touched by the cold air. Temperature anomalies reached up to more than +2 °C over large parts there and precipitation was low, except in the Caucasus region. Extremely high temperatures were reported from Armenia on March 7-9 and March 25, reaching 18-24 °C in southern and central parts of the country.

April

- **Warm in nearly the whole Region, especially in the northernmost parts**
- **Dry, especially in western Europe and near the Black Sea**
- **Wet, especially in parts of northern and central Europe**

In April, a zonal air flow dominated for most of the time, but the frontal zone lay far to the north for that time of year. Warm air often reached especially the northernmost areas of the Region again. As in the winter before, Svalbard experienced extremely high temperature anomalies again, up to more than +12 °C (Fig. 4.1) as in January. 0.0 °C exactly was the monthly mean at Svalbard Airport, (anomaly + 12.2 °C) the highest April temperature since 1911 and even higher than any previously recorded temperature in May. Low pressure systems often moved over Greenland and Iceland; Greenland especially had precipitation amounts of more than 400% of the normal (Fig. 4.2) in parts. Iceland, the Faroe Islands and the Shetland Islands were colder than normal, since they were often located in the colder air mass north of the frontal zone. There was some snow in the north of Iceland during the first half of the month.

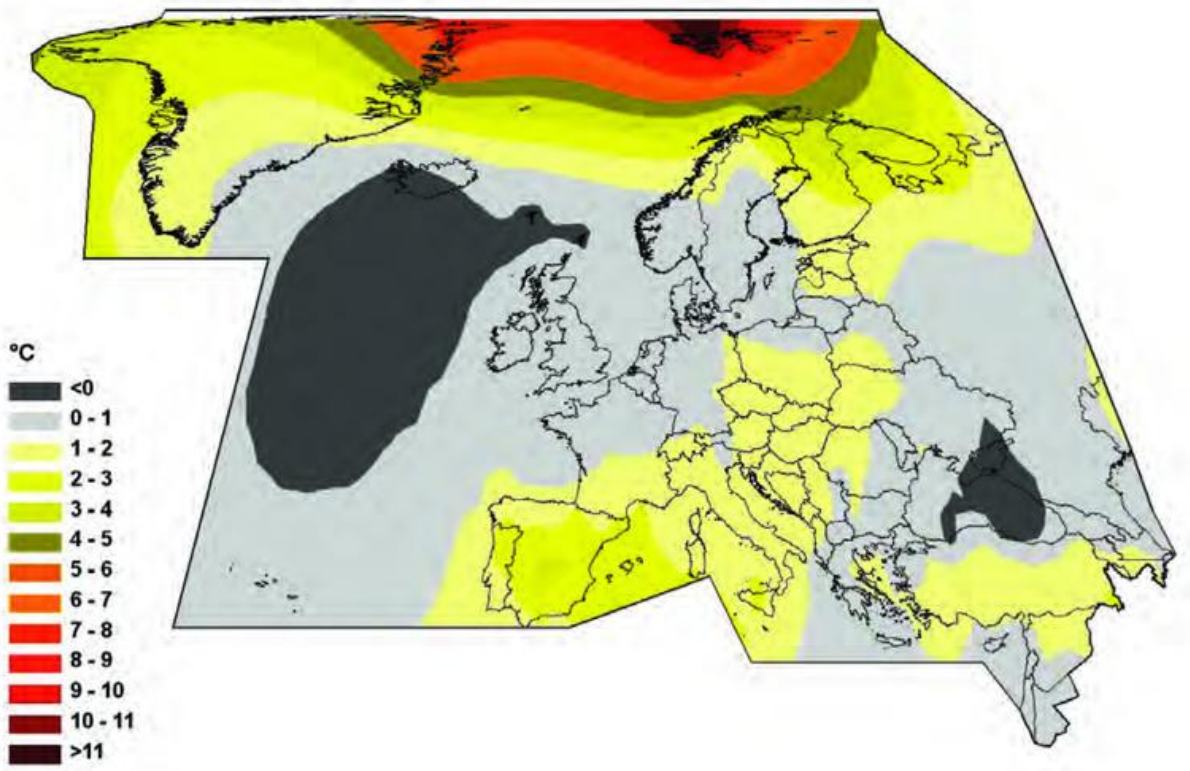


Fig. 4.1: *Monthly mean temperature anomalies in April 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

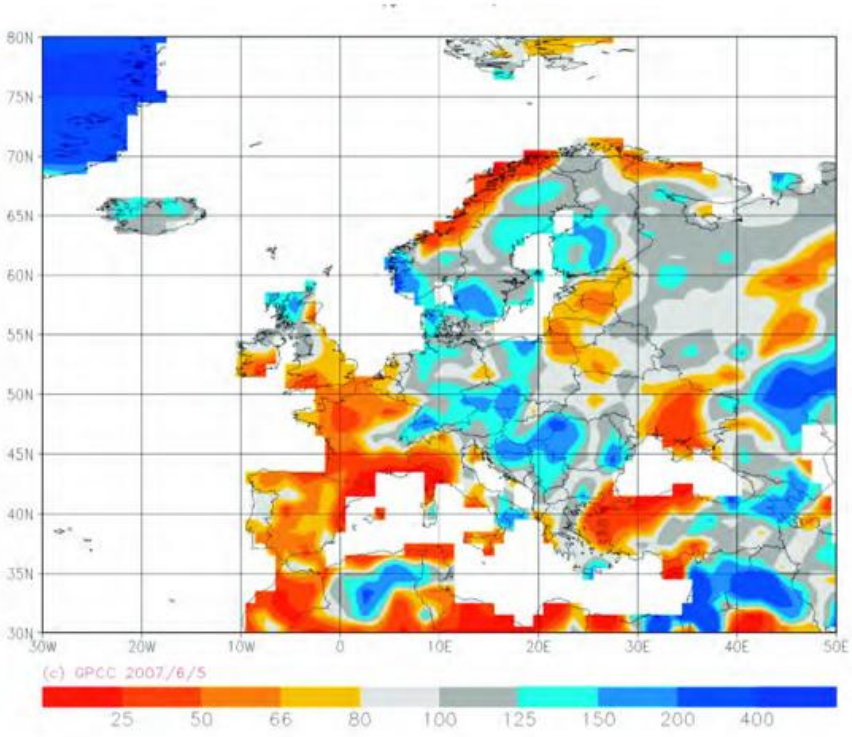


Fig. 4.2: *Monthly precipitation amounts for April 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

The majority of the Region lay within the warmer air mass most of the time and was thus warmer than normal on average, although the anomalies were mostly less than +1 °C, partly between +1 and +2 °C. In northern Norway (parts of east Finnmark), the monthly mean temperature was the second highest since 1867. Especially the second half of the month was warm in some countries, e.g. in Slovenia. Summer days (>= 25 °C) in the second half of the month were recorded in Serbia in most places. To the south, in Crete (Greece), maximum temperatures above 30 °C were measured on April 12 due to foehn. Maxima of 27-31 °C were reached in Armenia (Ararat and Syunik valleys) during a heat wave on April 10-16. During a Sharav event in Israel, the midnight temperature on April 22-23 rose to a peak value of 33-35 °C in the coastal plain, probably the 2nd highest since 1962. On the other hand, a cold spell appeared in Turkey on April 24-26, causing frost damage to trees.

Low pressure systems with precipitation often came from the North Sea to southern Scandinavia and Central Europe, causing higher than normal precipitation amounts in these areas. Sweden recorded the largest spring floods since 1985 along several streams and rivers in its southeastern areas early in April, also resulting from the melt of the large snow amounts which started in March. Heavy precipitation and snow melt led to widespread flooding also along the Danube and Elbe rivers in the first half of the month. The countries affected by this flooding were Germany, Poland, Czech Republic, Austria, Hungary, Serbia, Romania and Bulgaria. Daily precipitation totals on April 3-4 and April 6-7 at stations in Bulgaria close to the River Danube varied between 10 and 30 mm; mean monthly water levels along the River Danube were around 3 m above the long-term mean. Towns in Bulgaria had to be evacuated (Fig. 4.3), some streets were only accessible by boat. Much damage was also reported from Romania, the discharge from the Danube reached nearly historical record levels there on April 15-16. In Serbia, monthly precipitation totals of more than 130 mm were reached locally, exceeding a previous record of the year 1942.

In contrast, most of western and southwestern Europe was mainly dry, since these areas were more often under anticyclonic influence. The northern coasts of the western Mediterranean were particularly dry with amounts of less than 25% of the normal precipitation. The western Mediterranean and especially Spain were considerably warmer than normal with anomalies of locally more than +3 °C.



Fig. 4.3: *The town of Lom (Bulgaria) awaiting evacuation after flooding of the River Danube. Source: National Institute of Meteorology and Hydrology Bulgaria, photo from AP*

In eastern Europe, the cyclonic systems were mostly weaker, therefore high precipitation totals appeared only locally or regionally. Outstanding dry areas (<50% of the normal precipitation) can be found north and south of the Black Sea. On the other hand, the areas east of the Mediterranean experienced high precipitation amounts this month. 260% of the normal monthly precipitation was reported from the Ararat Valley in Armenia.

Extremely heavy precipitation occurred on April 1-2 in Israel. It was the result of an upper air trough over the eastern Mediterranean, accompanied by a surface depression over Syria and Iraq. In the centre of Jerusalem, 128 mm were accumulated on these two days, the largest daily rainfall amount here at least since 1950. At the northern part of the Dead Sea, 65-90 mm were recorded for the same time. Another upper air trough followed on April 4, resulting in thunderstorm activity with hail (hailstones of 4-5 cm in diameter) and a tornado in the western Galilee (see Annual Survey, Wind). A third heavy rainfall period occurred on April 24-25 in the northeast of Israel with 100-130 mm of precipitation in that period, the highest amounts since 1971; more than 50 mm fell within 3 hours, causing flooding in the surrounding area.

May

- **Mostly warm, colder in Iceland and eastern Europe**
- **Wet in most of Europe, dry in the south**

The first half of May 2006 was characterised by two large low pressure systems over the Atlantic and eastern Europe and high pressure over central Europe in between, whereas the airflow was more zonal in the second half of the month. The temperature anomaly distribution of the monthly mean thus reflects especially the patterns of the first half of the month with two colder than normal areas, one over Iceland and the Faroe Islands and the other over most parts of eastern Europe. In Russia, severe frosts were still recorded nearly everywhere, particularly in the Volga-Vyatka region down to -7 °C. The first half of the month was exceptionally cold in Serbia, partly with frost, whereas the second half of the month was considerably warmer, with tropical days in many places. However, the first 10 days of May were warm in Iceland; temperatures in sheltered areas in the southwest of the island reached 20 °C which is highly unusual for this time of the year. Later, around May 20, it became unusually cold for the season with heavy snowfall in the north of Iceland. Most of the other parts of the Region were up to +2 °C warmer than normal on monthly average (Fig. 5.1).

The air masses in the northernmost areas of the Region were still mainly warm, but the temperature anomalies were no longer so high as in April. They exceeded still +4 °C in Svalbard and +3 °C in western Greenland, and the precipitation amounts were also still higher than normal there. The monthly mean temperature in Svalbard and Hopen was the highest ever registered in May.

As in April, it was warmer than normal especially on the Iberian Peninsula and in the western Mediterranean, reaching anomalies of more than +2 °C, in some of parts of Spain more than +3 °C. Some daily maxima were record-breaking, e.g. 39.5 °C in Cordoba was a new record for the month of May. Also for Portugal it was the warmest May (for 41 years). These areas were also very dry due to frequent high pressure influence. This month was the 2nd driest May in Portugal since 1931, after 1990.

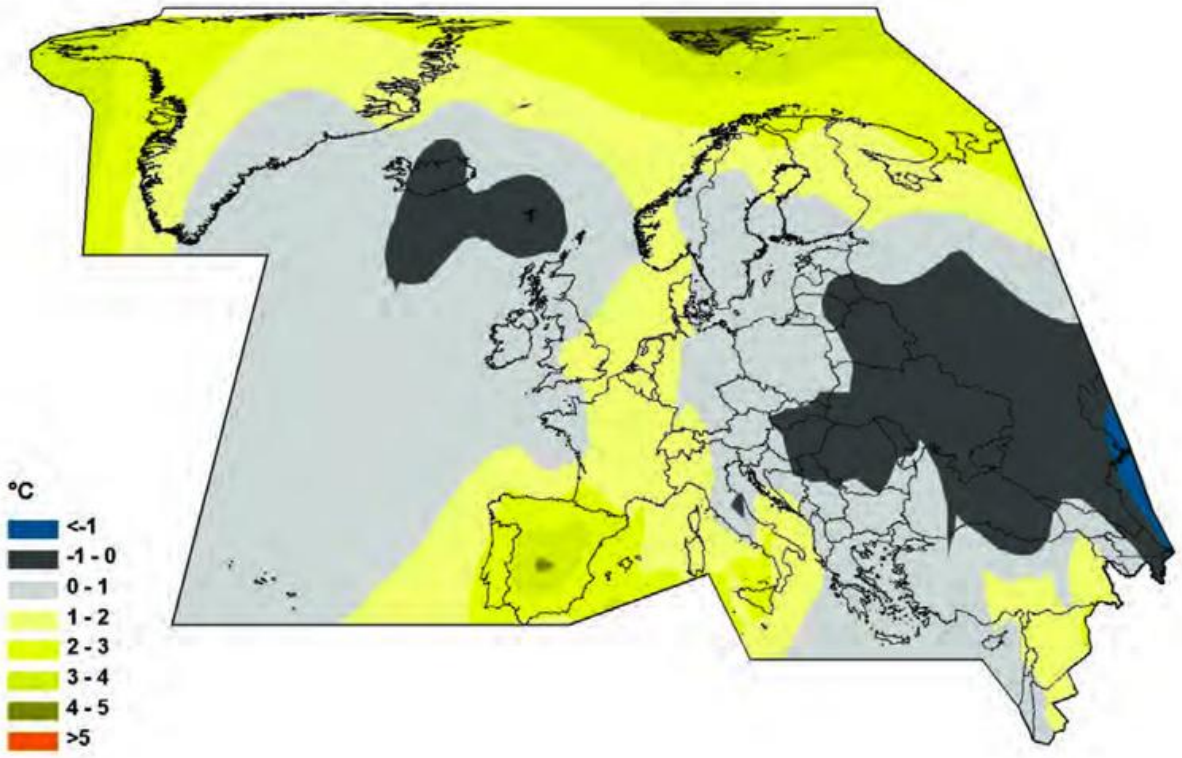


Fig. 5.1: *Monthly mean temperature anomalies in May 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

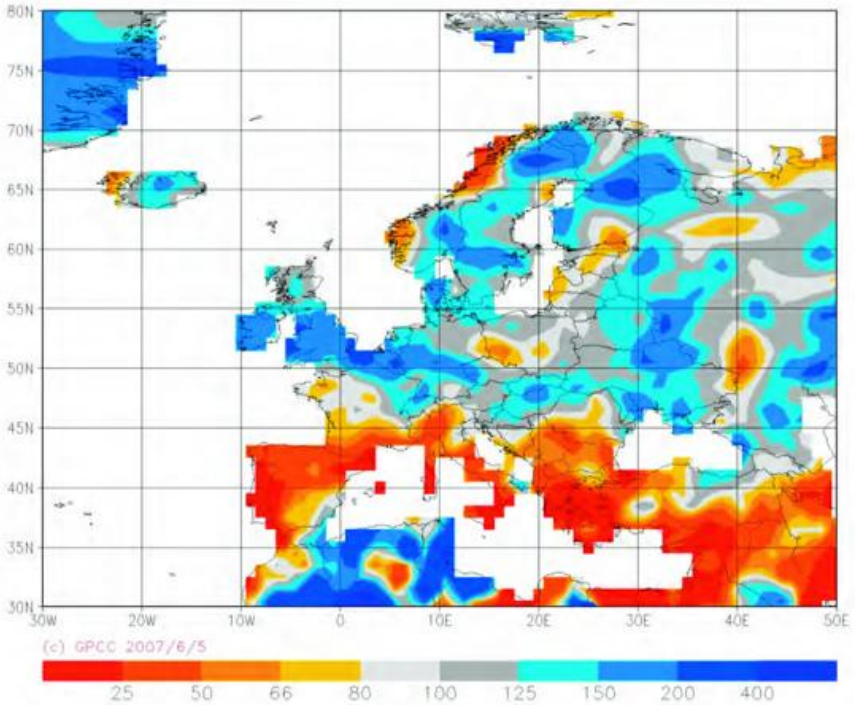


Fig. 5.2: *Monthly precipitation amounts for May 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

Most parts of northern, western, central and eastern Europe were clearly wetter than normal (Fig. 5.2) due to precipitation within the two large low pressure systems mentioned above and also some smaller cyclonic systems passing with the zonal flow over Europe in the second half of the month. A severe thunderstorm on May 20-21 caused damage in France, Belgium and Germany, particularly due to strong gusts. A tornado was also observed in northwest Germany. At the end of the month (May 26-29), heavy rain led to flooding in southeast Germany (north and east Bavaria). On May 31, cold polar air flowed to northern Switzerland and caused snowfall in the Bernese Oberland at altitudes below 600 m. A fresh snow cover at these altitudes in Switzerland is very rare at that time of year, having occurred only 4 times in 50 years. Slovenia, too, experienced a significant drop in temperature during the last days of May.

Further to the east, an aircraft crashed down into the Black Sea due to heavy rain on May 3. Later on, heavy rain, followed by hail causing losses to agriculture, fell in the central region of the Republic of Moldova on May 30; at the station Ungheni, 65 mm of precipitation fell in 45 minutes, normally this is the quantity of the monthly total.

Especially in some countries in eastern Europe, this month started warm and dry, but became cool and wet at the end. May began warm and dry in Estonia. No rain occurred for 18 days there. However, at the end of the month, up to 270% of the normal precipitation for this period was registered on the island of Hiiumaa. Also in Belarus, the first decade of May was the warmest this year, and the third decade the coldest. Poland, too, had a generally bright first part of the month with little precipitation, whereas the second half of the month was colder and wet.

The eastern half of the Mediterranean and the southeast of the Region were very dry too this month and also warmer than normal everywhere. Only during the first decade of May was damage due to hailstorms reported from Turkey. Unusual daily maximum temperatures of up to 38 °C were recorded in Greece on May 23-25. Especially the last pentade of the month was extremely hot in Armenia, with temperatures of 22-27 °C in the mountains and 32-34 °C in the Ararat Valley. In the second half of the month there was no rain in some regions of Armenia, which is very unusual, since April and May are normally the rainiest months of the year in this country.

June

- **Mostly warm, especially in southwestern Europe and in the east**
- **Mostly dry with locally or regionally wet areas, especially in southeastern Europe**

June 2006 was dominated by a meridional circulation pattern over the Region. After a wet and cold start to the month in central Europe, a strong high pressure system over the east Atlantic moved to Europe and then further east, some more ridges followed during this month and led to the beginning of a hot summer weather period in large parts of Europe to coincide with the start of the soccer World Championship on June 9. The frontal zone was quite far to the north, so nearly the whole Region was warmer than normal. Colder than normal areas were only found in east Greenland, northern Norway and a few locations in the Mediterranean. Some low pressure systems within the frontal zone passed Iceland, Svalbard and northern Scandinavia, causing higher than normal precipitation.

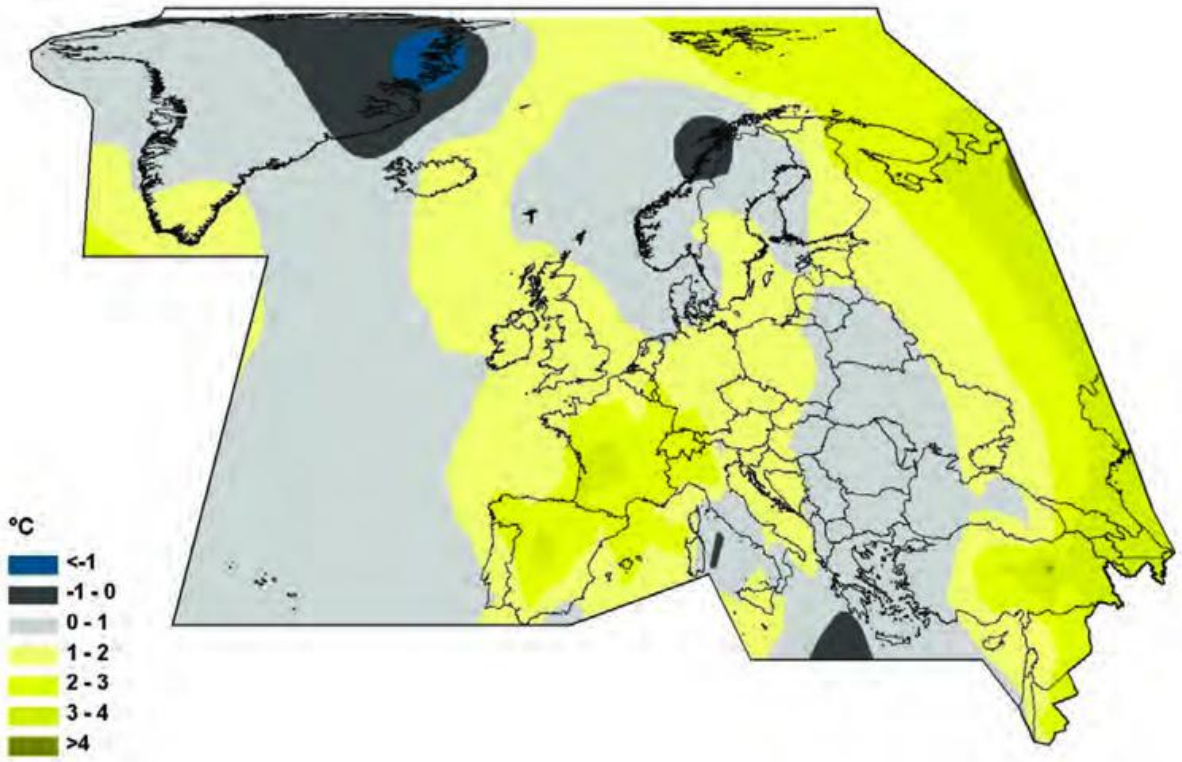


Fig. 6.1: *Monthly mean temperature anomalies in June 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

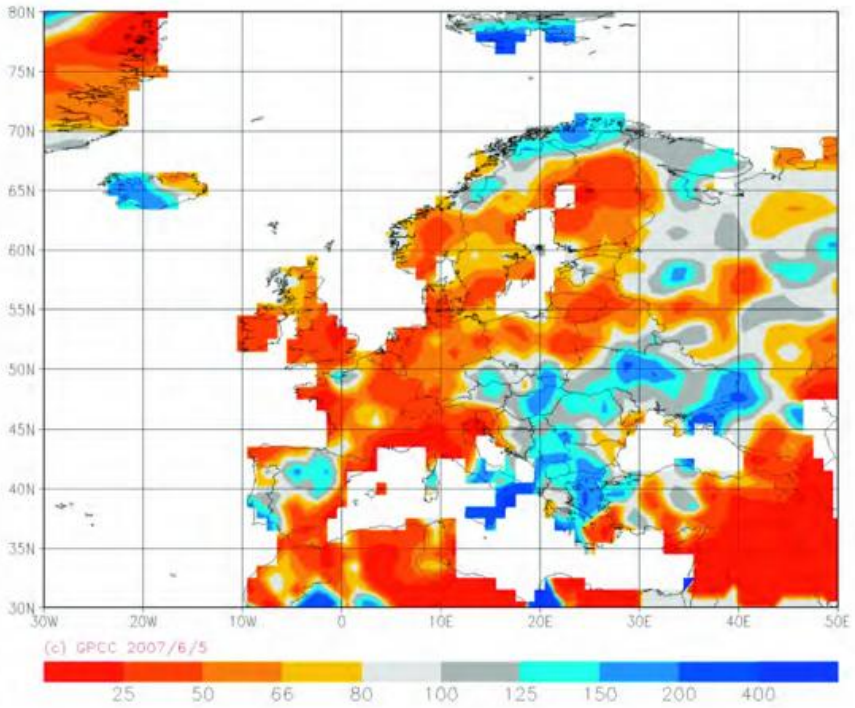


Fig. 6.2: *Monthly precipitation amounts for June 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

Temperature maxima above 30 °C were measured very often this month, even in the northern parts of the Region. Norway recorded the highest maximum temperature of the year at 32.2 °C in the county of Nord-Trøndelag on June 12; central London recorded a daily maximum of 32.4 °C on the same day. High maximum temperatures exceeding 31 °C on June 21-22 were reported from Estonia, and mean daily temperatures were exceeding 20 °C at the same time in Lithuania. Poland had a maximum of 33 °C. European Russia, too, experienced a very warm June; it was the third warmest of its spatially averaged time series and already warm at the beginning of the month. On June 4-6, the temperature rose to 40 °C in the Volgograd and Saratov regions. In the area around Astrahan (near the Caspian Sea) very warm winds were recorded. In North Caucasia, the maximum temperature was above 30 °C for as long as 15-18 days, without any precipitation. By the end of the second decade, soil drought began in the Volgograd region. In Slovenia, the highest ever daily mean and daily maximum temperatures were measured.

Most of the Region was dry too, especially most parts of western, central, northern and northeastern Europe, where the high pressure influence was strongest. Western and southwestern Europe also had large temperature anomalies, partly exceeding +3 °C, notably in France and Spain, locally also in Italy. Another area of similar large anomalies was to be found in the east of the Region (Fig. 6.1).

The dry and sunny period in central Europe was only occasionally interrupted by thunderstorms, e.g. on June 16 when hail stones of the size of tennis balls were registered in Leipzig (eastern Germany); also Austria (Styria) was effected by hail showers that day. Heavy rain with flooding was recorded in Austria on June 28 (county Burgenland in the east) and on June 30 along the valley of the river Thaya in Lower Austria. For this reason, only the west of Austria was dry on monthly average, while the east had a monthly total of more than 200% of the normal precipitation. Severe thunderstorms, locally with hail, occurred particularly on June 29 in Slovenia, but over the whole month it was dry in this country.

Generally, it was mainly wet in large parts of southeastern Europe (Fig. 6.2) and the temperature anomalies were still mostly positive, but smaller there. Heavy rain with flooding near the Danube and Tisza rivers were reported from Hungary on June 7 and another high daily precipitation amount of 107 mm on June 27. Serbia was cold and wet in the first decade as in central Europe, but warm and dry afterwards; the highest maximum temperature in Serbia was 36.2 °C in Cuprija on June 27. In the middle of the month, storms with heavy rain, thunder, hail and landslides lasted for about one week in Romania and Bulgaria. A rain intensity of 30-40 mm/h and hailstones as big as walnuts were reported from Sofia. Also in the Republic of Moldova, heavy rain with hail and strong wind occurred, up to 50 mm of precipitation fell on June 20, which corresponded to 75% of the monthly total.

Daily maximum temperatures of up to 40 °C were reported from Greece on June 19-20 over several areas of the country, mainly over the mainland. The monthly normal maximum is around 30 °C. Malta recorded its highest temperature of the year on June 30 at 38.5 °C, which was far below the record of 43.8 °C in August 1999.

The Middle East was very dry and warm. Parts of Armenia were more than 4 °C warmer than normal, during the first decade even 5-8 °C warmer. A severe drought occurred in this region, only at the end of this month did a cold front cause heavy rainfall, and hailstorms on June 23 and 26, with hailstones of up to 25 mm in diameter, causing losses of crops.

July

- **Very hot, especially in central Europe, cold in Russia**
- **Mostly dry, in the south partly wet**

In July 2006, a more or less stable, mostly meridional circulation pattern was established. Central Europe and surrounding areas were under high pressure influence during nearly the whole month. This situation caused an extremely hot and sunny July, especially in the second half. Temperature anomalies over large parts of central Europe reached more than +5 °C, marking a record heat wave. In some places, this was the warmest July ever registered, e.g. in the central England time series (for 348 years), in De Bilt (Netherlands) for 300 years, in Uccle (Belgium) since 1833, in Luxembourg (airport) since 1947, in France since 1950, in Germany (areal mean) since 1901 and in Vienna since 1775. Also in Switzerland in the lowlands north of the Alps and in most of the Alpine valleys the highest ever July averages were registered, whereas on the southern slope of the Alps the temperatures did not reach the previous highest values recorded in July 1983.

This hot July was exceptional mainly due to the long duration of the heat wave rather than its absolute maxima. At various locations in the Czech Republic, the temperatures frequently exceeded 35 °C, especially in the second half of the month. At most stations in Slovenia both the monthly mean temperature and the number of hot days (maximum temperature >= 30 °C) were among the highest ever observed. In the southern half of France again, maximum temperatures exceeded 35 °C during many days (Fig. 7.1). The duration of the heat wave is also documented by the high number of 27 summer days (>= 25 °C) in Luxembourg (airport); normally only 10 days are to be expected there on average. In the Netherlands, the heat wave during July 15-30 containing 8 tropical days (maximum >= 30 °C) was the longest in a century. Denmark reported the warmest July since 1994, with an average of 19.8 °C, 321 sunshine hours and 15 summer days.

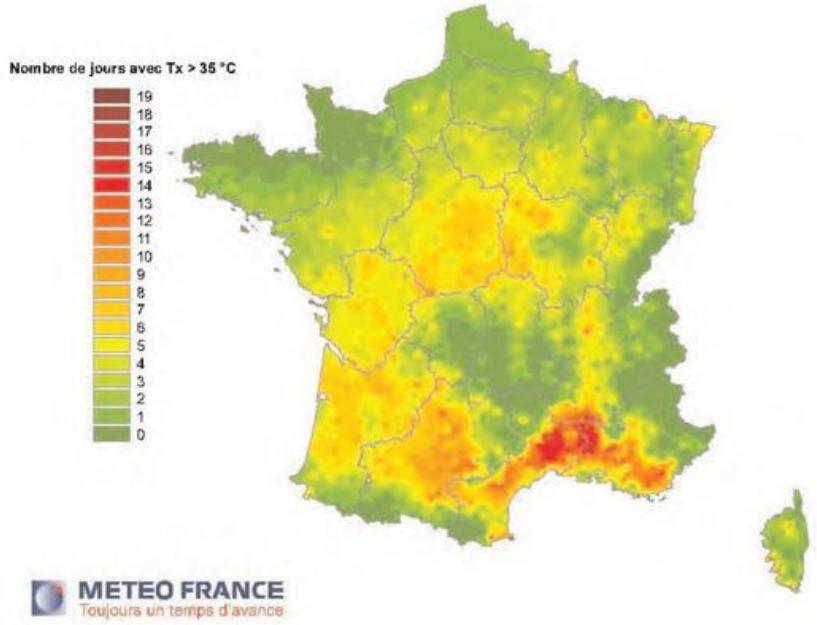


Fig. 7.1: *Number of days with a maximum temperature of > 35 °C in the period 10-28 July 2006 in France.*
Source: Météo France

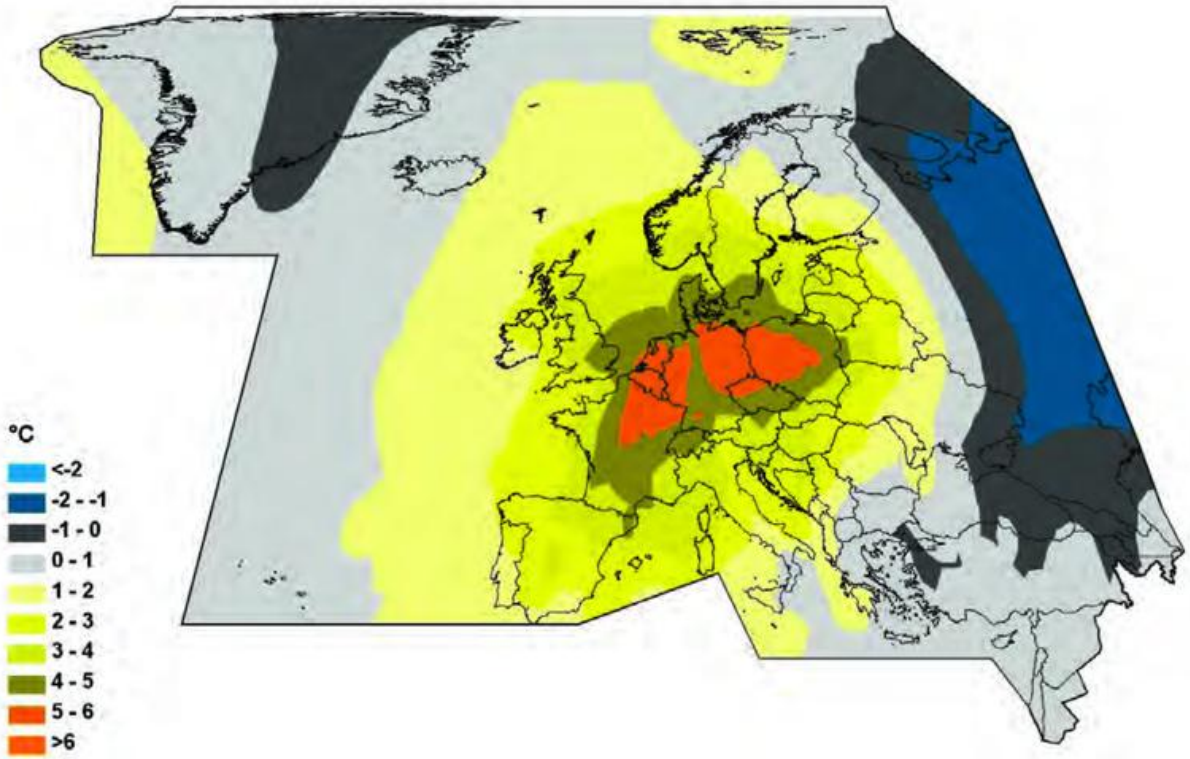


Fig. 7.2: *Monthly mean temperature anomalies in July 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

In the surrounding areas the anomalies were smaller, but still quite high (Fig. 7.2). Sea surface temperatures in the North Sea and Baltic Sea reached record levels too. For the coastal areas in southern Norway it was the warmest July since 1867. A maximum temperature of 35.1 °C was measured in Vöru (southeastern Estonia). In Latvia, 35.3 °C was the highest maximum; it was measured on July 9. July 2006 was the 5th hottest July in Latvia. Poland, too, had a heat wave in the first decade and another in the third decade with maximum temperatures above 36 °C. In western and southwestern parts of Belarus, it was the warmest July since records began, and also in other parts of the country such a hot July occurs only once in 15 years on average.

Some absolute maximum temperatures, nevertheless, were also new records or at least very close. A new UK maximum temperature record for July of 36.5 °C was recorded in Wisley, southwest of London, on July 19, but it was less than the highest known UK value for any month (38.5 °C), which was recorded in August 2003 at Faversham in Kent. The same day, the highest temperature since June 1976 (32.3 °C) was measured at Elphin in Ireland. Luxembourg recorded 35.6 °C as the maximum of the year, and this was also well behind the absolute maximum of 37.9 °C in August 2003. In contrast, the Netherlands set a new national temperature record this July with 37.1 °C in Westdorpe in the southern part of the country, again on July 19. The highest maximum of the year in Hungary was 36.9 °C on July 22, measured in Budapest.

The heat wave even reached the southern parts of the Region. Serbia had an outstanding heat wave on July 20-29; maximum and minimum temperatures exceeded normal values considerably (Fig. 7.3). In Bulgaria the heat wave was during July 25-28 and was the cause of at least 7 field and forest fires. In some coastal and lowland parts of Albania the highest mean maximum temperatures of their time series were registered. It was also the hottest July in Bologna (Italy) since 1999. In Portugal, the duration of the heat wave of 11 days in the Alentejo region was the most significant since 1941 in July. This month was the 3rd warmest in Portugal

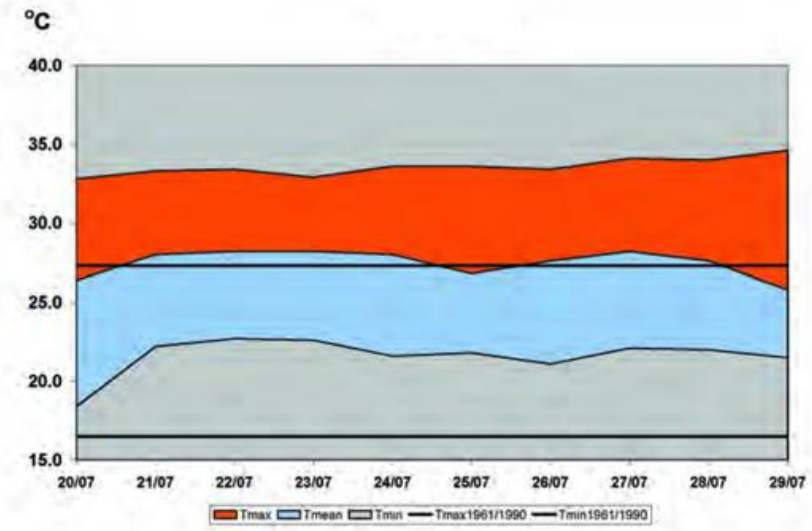


Fig. 7.3: *Maximum, minimum and mean daily air temperature from 20 to 29 July 2006 in Belgrade, Serbia, compared to normal values 1961-1990.*
Source: Republic Hydrometeorological Service of Serbia

since 1931 after 1989 and 1990. It was also the month of July with the longest sequence of tropical nights (minimum temperature >= 20 °C) since 1990 in almost the whole of Portugal, causing high physiological discomfort.

Only in the easternmost part of the Region and partly in Greenland it was colder than normal. Russia and west Kazakhstan had the strongest negative of the Region, but they were not lower than -2 °C. On July 20, the cold spell reached Latvia too; the temperature fell to 2.5 °C and some frost was observed on the grassland. Such a low temperature had not been measured in Latvia at that time of the year for the last 55 years. In Israel the July temperature was close to normal; here it was the first July since 1994, which was not significantly warmer than normal.

Most of Europe was not only warm this month, but also very dry (Fig. 7.4). In Sweden, the dryness, which already started in June, became problematic for the farmers; only late in July did heavy thunderstorms become more frequent. Less than 25% of the normal precipitation fell around the Baltic Sea. Some districts in Estonia received only 3% of the normal precipitation. In Latvia it was the 2nd driest July for 83 years, in some places, e.g. in Riga, it was absolutely the driest ever measured. The hot and dry weather resulted in 1700 registered fires in Latvia, 2.5 times more than in July 2005, and in severe agricultural losses. Drought conditions also resulted in Poland. In the south, it was also dry in northern Italy in the whole Po Valley. On July 22, the Po River reached its minimum daily discharge of 168 m²/s at Pontelagoscuro close to the Po delta; this was the lowest recorded at this location since 1918. Malta was without any rain this month.

In some other parts of the Region, it was very dry too, but sometimes interrupted by heavy precipitation events. Heavy thunderstorms were reported from eastern Finland with large hailstones up to 7 cm in diameter. In the central parts of Europe a few local areas with high precipitation were recorded, mainly due to local thunderstorms. Switzerland was in most areas extraordinarily dry and sunny, but locally exceeded the normal amount of precipitation, due to showers and thunderstorms. On July 24, 30 mm of rain fell within one hour in some parts of Budapest in Hungary, but the monthly total was low. In northern Romania, heavy precipitation caused flooding on July 1-3, and also Bulgaria, the Ukraine and Turkey, partly also Italy were affected by this precipitation event during the first week of the month; especially the Black Sea coast suffered from the flooding of camping sites. The station Malko Turnovo in Bulgaria reported 301 mm of precipitation on July 3, the highest daily amount in that region since 1915.

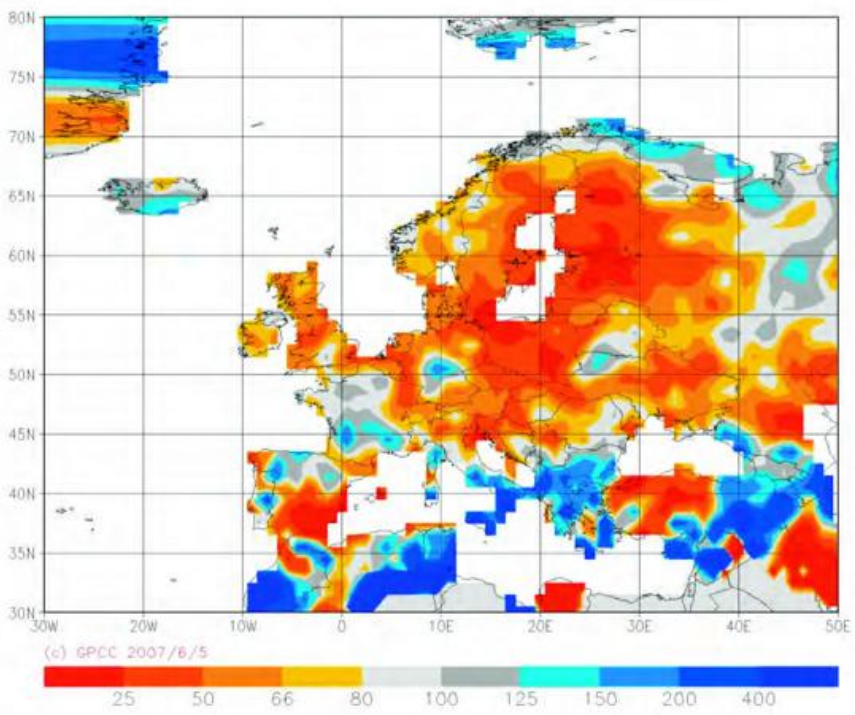


Fig. 7.4: *Monthly precipitation amounts for July 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

In the south of European Russia, dry weather persisted this month, while frequent and torrential precipitation was observed in the northeast.

Larger wet areas with respect to the monthly precipitation total were only to be found in the north (parts of Greenland, Svalbard) and parts of the south (especially southern Italy, Greece, Cyprus and parts of the Middle East). The spatial average precipitation in Cyprus, occurring mainly in the first week of the month, was 15 mm, but this was almost 600% of the normal. In the Ararat Valley in Armenia about 400% of the normal monthly precipitation total was recorded, due to some heavy rainfall events.

August

- **Cool and wet in central Europe**
- **Warm and dry in northern Europe and in the southeast**

In August 2006 the weather situation changed abruptly and put an end to the July heat wave in central Europe right at the very beginning of the month. The high pressure configuration was replaced by a large low pressure pattern coming from the northwest to central Europe and leading to a cool and wet period there. This new circulation pattern remained mainly the same for the whole month, since new lows followed from the northwest. Nearly the whole of central Europe was cooler than normal, in parts more than 2 °C (Fig. 8.1), and all the western, central and also some eastern parts of Europe were very wet, with more than 200% of the normal precipitation over large areas (Fig. 8.2), partly over 400%.

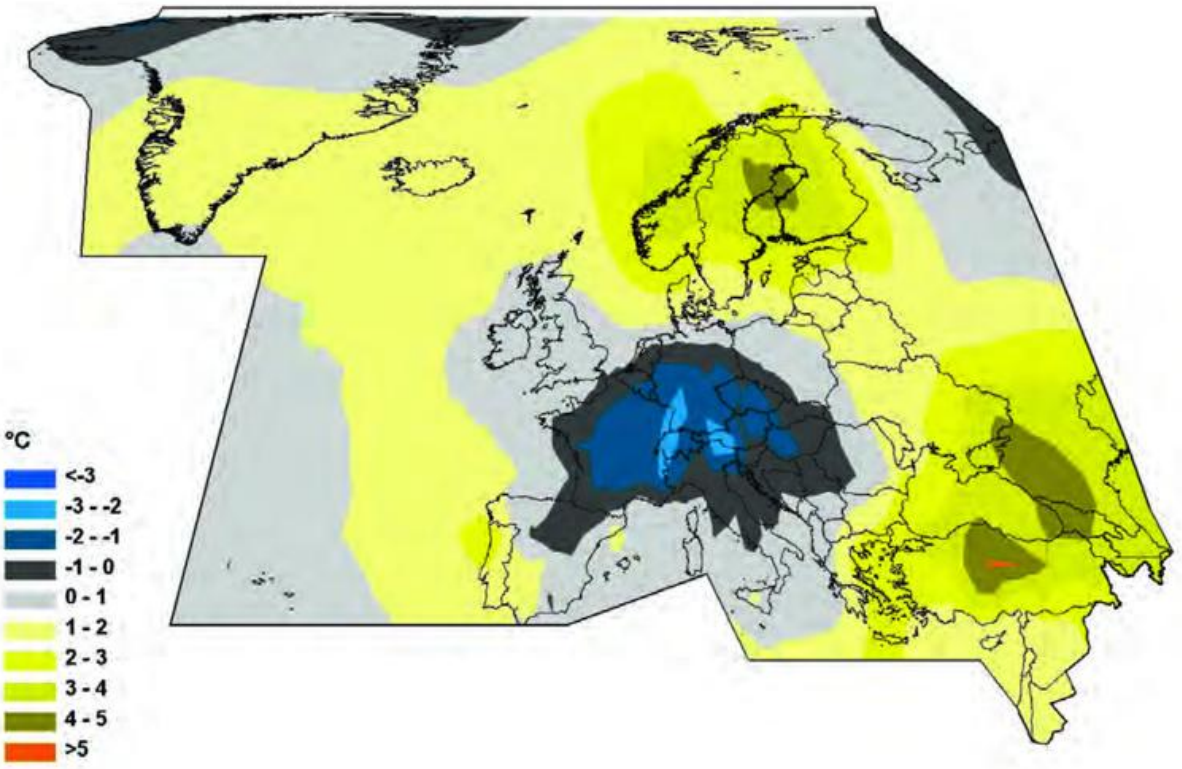


Fig. 8.1: *Monthly mean temperature anomalies in August 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

In some countries this August was one of the wettest ever recorded. In Germany and in the Netherlands, it was the wettest August since 1901, in Denmark the 3rd wettest since 1874. 191 mm fell in Belarus during the whole month; this was 273% of the normal and this amount had never been measured since 1891. At the coast of Slovenia, the highest monthly total ever registered was recorded with 325 mm. In Serbia, monthly precipitation totals achieved new records locally, e.g. in Loznica. In west Albania up to 450% of the monthly precipitation normal was registered this month.

The high rainfall totals of this month were partly due to a high number of rainy days, but also to local heavy rainfall events in various places of the Region. The southern parts of Sweden and Norway were wet, due to many and heavy thunderstorms and showers. Some stations in Sweden measured more than 100 mm in one day. In the southernmost province of Skåne, the drought which had lasted for a long time earlier that summer was replaced by such wet conditions that harvesting had to be delayed. In Lund (southern Sweden) the monthly total of 264 mm was a new record for August. Over 100 mm of rain also fell in the country of Surrey in the UK in around six hours on the afternoon of August 13. Luxembourg Airport reported a high number of 26 rainy days (normally there are 12). Three days of continuous precipitation led to numerous local floods in the counties of Salzburg and Lower Austria up to August 6. Poland recorded downpours exceeding 250 mm a day in some places. Torrential precipitation also fell in many places in Romania, resulting in high monthly totals locally (Fig. 8.3). Extreme rain with daily totals up to 100 mm was reported from northeastern Bulgaria on August 28. Heavy rain occurred also in the northern regions of the Republic of Moldova on August 26, followed by hail of 6 cm in diameter and strong winds. In the Mediterranean, Italy reported intense precipitation with hail and strong gusts of wind occurring in the countryside close to Ferrara in the Po Delta on August 3 (Fig. 8.4), causing damage to buildings and disruption of traffic on the main roads. In terms of temperature, Bologna in Italy recorded its coldest August mean minimum temperature since 1985 and the coldest mean maximum since 1978.

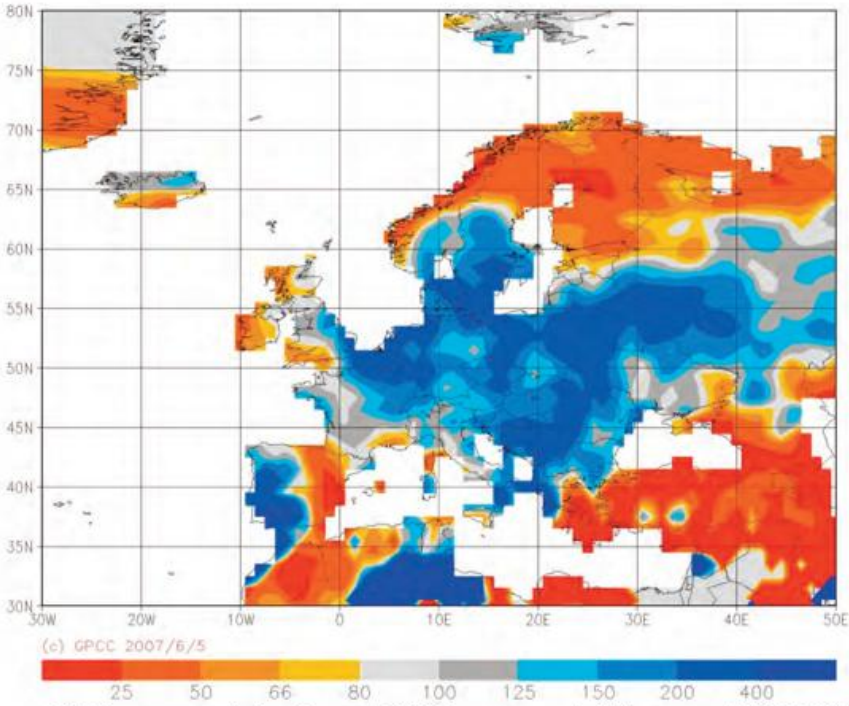


Fig. 8.2: *Monthly precipitation amounts for August 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

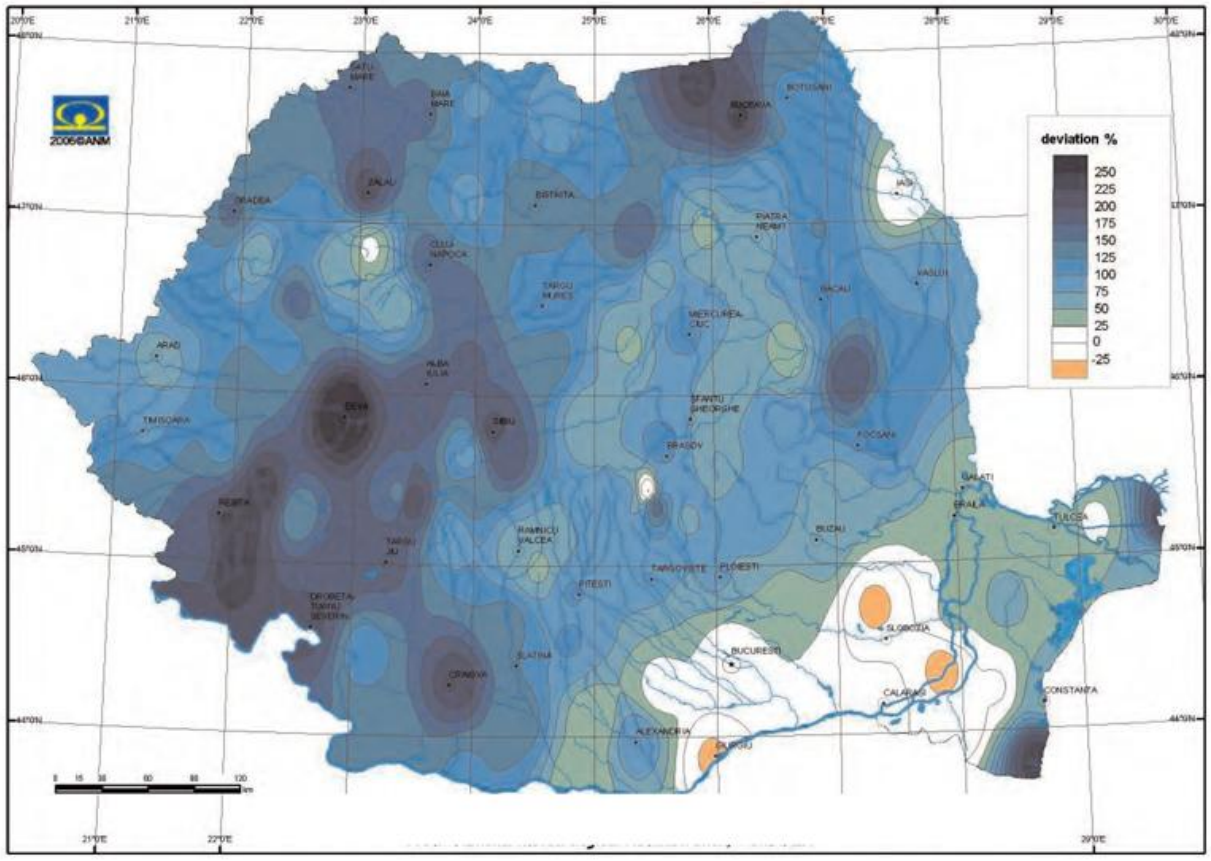


Fig. 8.3: *Deviations of monthly precipitation totals from long-term averages in Romania in August 2006.*
Source: National Meteorological Administration, Romania

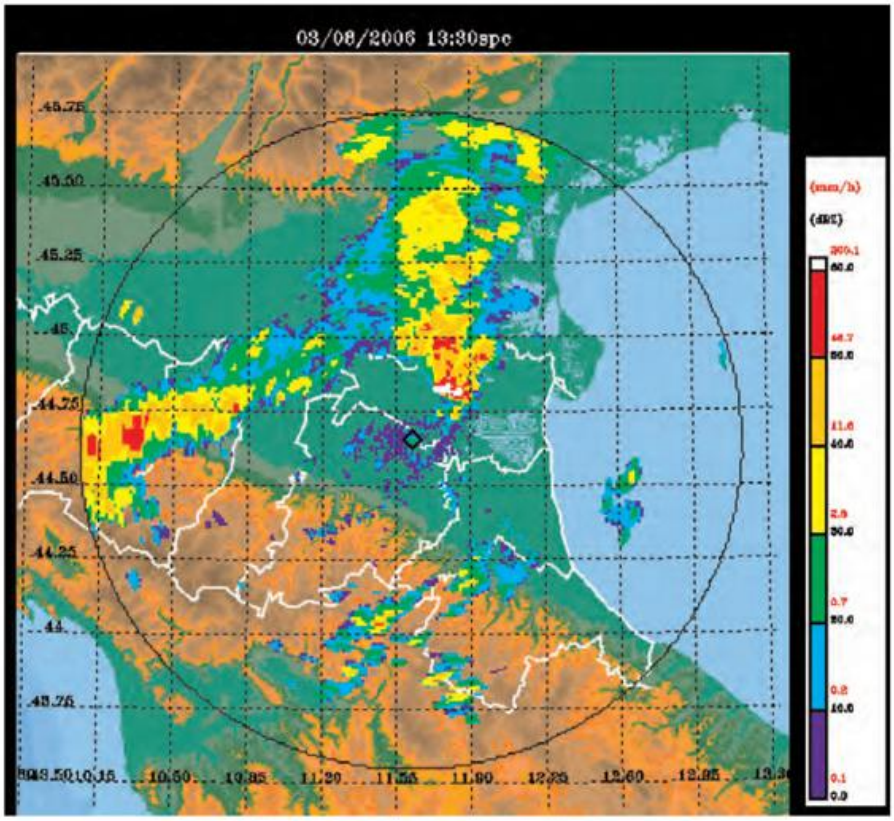


Fig. 8.4: *Radar image of the Po Delta in Italy with interpretation of precipitation intensities, taken at the climax of the heavy precipitation event on August 3.*
Source: Regional Agency of Prevention and Environment, Bologna, Italy

In contrast, northern Europe came under high pressure influence from time to time, so it was warm and dry there. The temperature anomalies exceeded +4 °C in parts; the precipitation was partly less than 25% of the normal. In parts of Norway it was the 2nd warmest August since 1867, for the country as a whole the 5th warmest.

It was also hot and dry in the southeast of the Region with similar anomalies as in the north. Within European Russia, it was especially warm in the south in northern Caucasia and the Lower Volga regions. Locally the anomalies were above +5 °C there. The maximum temperatures were over 30 °C for a longer period of time, in the first half of the month even 37-43 °C, together with long soil droughts, while further in the north, central European Russia (Kaluga region) experienced the rainiest August for 100 years. In the Ukraine, August was the warmest month of the year (in sharp contrast to central Europe), with maximum temperatures of up to 40 °C in the east of the country. A short summer heat wave on August 19-21 was reported from Romania and Greece, mainly on the mainland, with daily maxima around 40 °C. Also in Turkey there was a severe heat wave at that time, causing a forest fire near Izmir. Cyprus reported heat wave conditions during 10 days from August 19-28, when maximum and minimum temperatures were 2-5 °C above normal on average. In Israel, it was the 3rd warmest August in the mountains and the Jordan Valley since 1964. An unusual event occurred on August 20 with 15-20 mm of rain in the Galilee in northern Israel, considering that there is normally no rain at all in Israel in August. In Armenia, the maximum temperatures were about 40-42 °C in Yerevan and the Ararat Valley, the latter was without any rain during the whole month. However, in the northwestern part of Armenia, 80 mm of precipitation was recorded on August 19 (this was 140% of the monthly normal!).

The west part of the Iberian Peninsula was warm and very wet due to heavy thunderstorms, whereas the east was less anomalously warm but very dry. Especially in the first half of August and at the end of the month, long heat waves occurred in Portugal, interrupted by a cooler period on August 15-19. These days were also very rainy.

September

- **Warm nearly everywhere in the Region, especially in northern and central Europe**
- **Dry in parts of northern and most of central Europe and partly in the southeast**
- **Wet, especially in northeastern Europe and around the Mediterranean**

In September 2006, the large-scale circulation pattern changed again considerably. Central and parts of northern Europe frequently came under high pressure influence, whereas low pressure systems were concentrated particularly over the Atlantic, the northeast of Europe and the Mediterranean, in the latter case mostly in the form of cut-off lows. The main result of this configuration was a switch from a cool wet August to a very warm and dry autumn especially over Central Europe. Other parts of the Region remained warm as before, so that higher than normal temperature anomalies were to be found nearly everywhere in the Region (Fig. 9.1). In

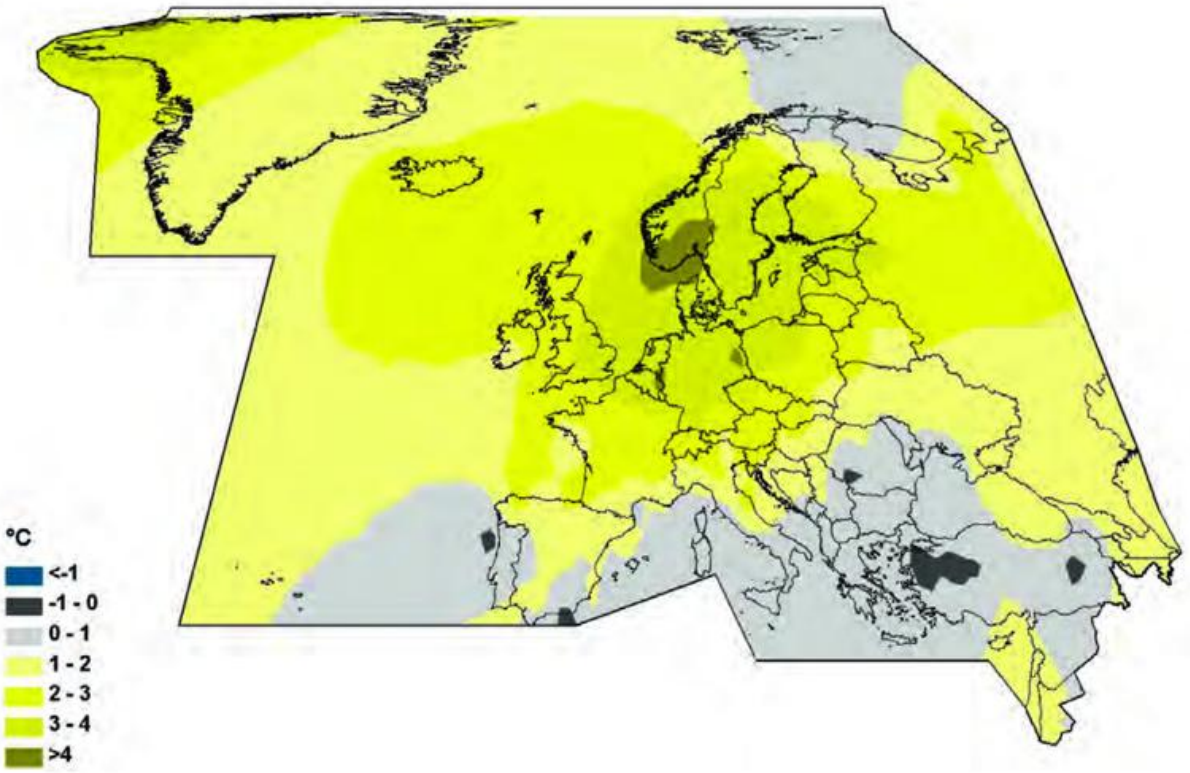


Fig. 9.1: *Monthly mean temperature anomalies in September 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

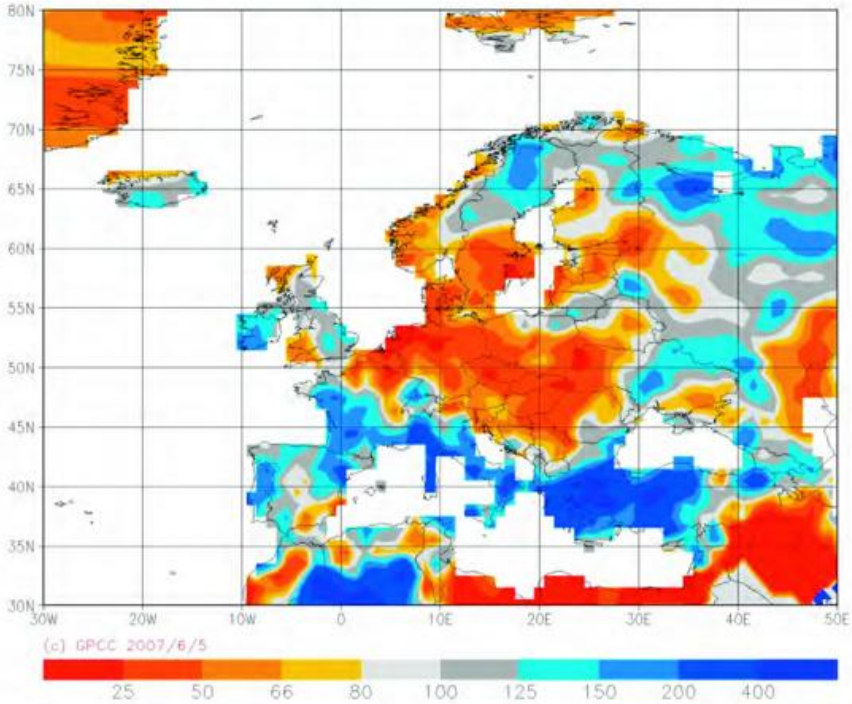


Fig. 9.2: *Monthly precipitation amounts for September 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

most of central and southern north Europe they exceeded +3 °C, in parts +4 °C. These areas were also very dry, partly with less than 25% of the normal precipitation (Fig. 9.2), although a few local thunderstorms with heavy rain occurred.

The Arctic sea ice extent of 5.9 million km² was the second smallest ever measured, only slightly under the previous year 2005.

For parts of southern Norway, the monthly mean temperature was the highest since 1867, and also in southern and central Sweden new records were set. In Denmark, this September shared the temperature record with September 1999 with 16.2 °C as monthly average. On the Faroe Islands, this September was record-breakingly warm at every station of the Danish Meteorological Service. This could be explained by the fact that there was an advection of warm air masses from the south to the Faroe Islands throughout the month. Reykjavik (Iceland) recorded its 4th warmest September since the beginning of measurements in 1870 and the warmest since 1958. In Brussels-Uccle, Belgium, it was the warmest September since the beginning of observations in 1833. Germany, too, reported the warmest September (since 1901), and also in the central England temperature series (348 years) it was the warmest, in other areas of the UK as well. Also for the Netherlands (De Bilt) and Luxembourg Airport it was the warmest September since the beginning of the time series, in France it was the 2nd warmest since 1950. In Tartu, Estonia, it was the 2nd warmest September for 140 years after 1934, in Latvia it was the 3rd warmest. Poland still had maximum temperatures up to 29 °C this month, but also minima down to 3.3 °C. Frosts down to -3 °C were reported from west Kazakhstan on September 18 at night time.

Some parts of northeast Europe and some areas near the Atlantic and around the Mediterranean were also warm, but wetter than normal, particularly in Greece and Turkey, with more than 400% of the normal precipitation in parts (Fig. 9.3). Heavy thunderly rain fell in southern France on September 13-14. On Corsica, locally more than 400 mm of precipitation fell during these two days. High precipitation intensities of more than 100 mm / 24 hours were also recorded in northern Italy on September 14-18. In Portugal, daily precipitation totals exceeded even the normal monthly total in some places from September 21-25.

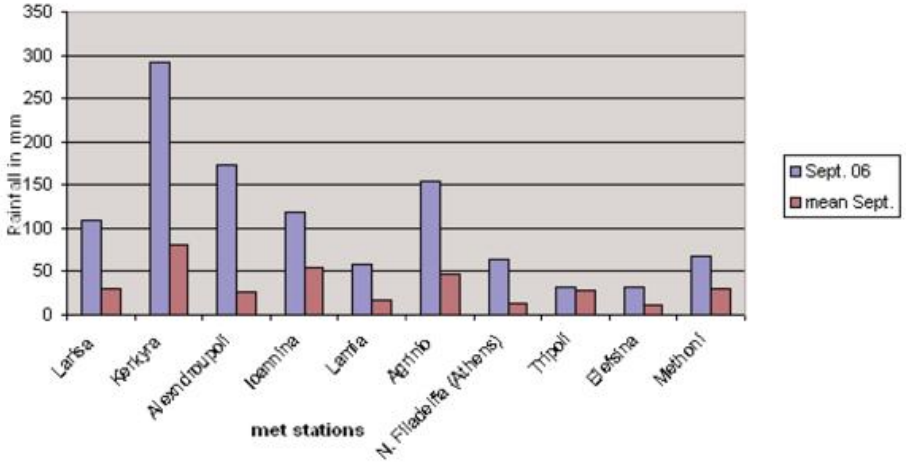


Fig. 9.3: *Monthly precipitation amounts for September 2006 compared to the corresponding long-term mean (various reference periods) at some stations in Greece.*
Source: Hellenic National Meteorological Service, Greece

A few stations in the southern part of the Region (Spain, Romania, Turkey) recorded monthly mean temperatures slightly below normal.

In Portugal, a heat wave which started at the end of August continued until September 10, with anomalies of 10-13 °C of the daily maximum temperature in almost the whole territory, in some locations they were record-breaking. Greece had unusually high maximum temperatures on September 4-7 in some places, partly exceeding 35 °C; the normal maxima are below 30 °C. An extreme Sharav event occurred on September 28-29 in Israel, with temperatures reaching 39-41 °C in the coastal plain and 40-42 °C in the Negev.

October

- **Warm in most of the Region except northern Scandinavia, parts of the Atlantic and the eastern Mediterranean**
- **Wet in most of the Region**
- **Dry in Greenland, western Norway, eastern central Europe, the western Mediterranean, Cyprus and west of the Caspian Sea**

High pressure influence and an airflow of mild maritime air continued mainly over central Europe. Most of the Region remained in a warm air mass. The highest anomalies were again in central Europe with more than +3 °C, as in the previous month and this time also in parts of southern Europe (Fig. 10.1). Another centre of such high anomalies was to be found in southern European Russia.

This October was one of the warmest in central Europe for more than 100 years. In Belgium it was the second warmest after 2001, in the Netherlands, France, Germany and Latvia it was the 2nd warmest, too. The active vegetation period in Lithuania ended 2-3 weeks later than usual, only the end of the month saw the first snow in many regions of that country. Some countries

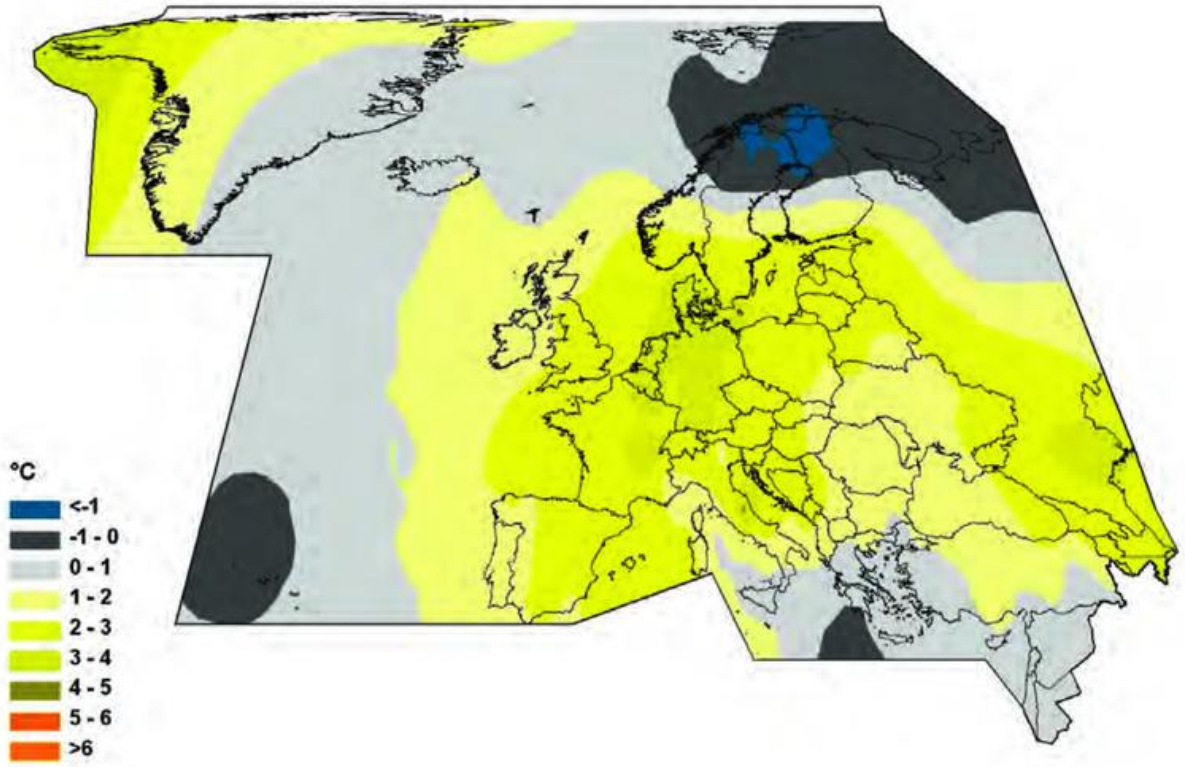


Fig. 10.1: *Monthly mean temperature anomalies in October 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

even recorded this October as the warmest of their time series, e.g. Denmark and Albania. Also the coastal areas of the Norwegian counties of Rogaland and Hordaland experienced the highest registered monthly mean temperatures since 1867. In southern regions of Poland maximum temperatures were still exceeding 25 °C at the beginning of the month. Romania recorded a daily maximum of 34 °C on October 4 in Zimnicea. Serbia had a heat wave from October 21-26 with maximum temperatures >= 25 °C throughout the whole country. Also later in the month, on October 26, some stations in Switzerland registered summery temperatures in the afternoon. 28.8 °C were measured in Vaduz, capital of Liechtenstein; it was the highest October temperature since the beginning of measurements in 1979. In the south, the highest October mean minimum temperature since 1931 was recorded in Portugal; the highest daily value was 19.1 °C at Porto on October 30.

The border line between this warm air mass and the cold Arctic air was still in northern continental Europe. In northern Scandinavia, the temperature anomalies were partly below -1 °C. It was also colder than normal over parts of the Atlantic, notably on some of the western Azores Islands and in small areas of the eastern Mediterranean. On the other hand, it was warm and dry on Greenland.

Due to frequent high pressure influence, it was very dry in eastern central Europe and particularly over the western Mediterranean (Fig. 10.2). Large parts of Italy received less than 25% of the normal precipitation. However, some Atlantic low pressure systems moved over western, central, northern and eastern Europe, resulting in large wetter than normal areas over most parts of Europe. In Sweden and in the western half of the Iberian Peninsula, more than 300% of the normal precipitation fell. Vihti (southern Finland) had a monthly precipitation total of 228 mm which was the highest amount ever recorded in the whole country, but also Helsinki was very wet (Fig. 10.3).

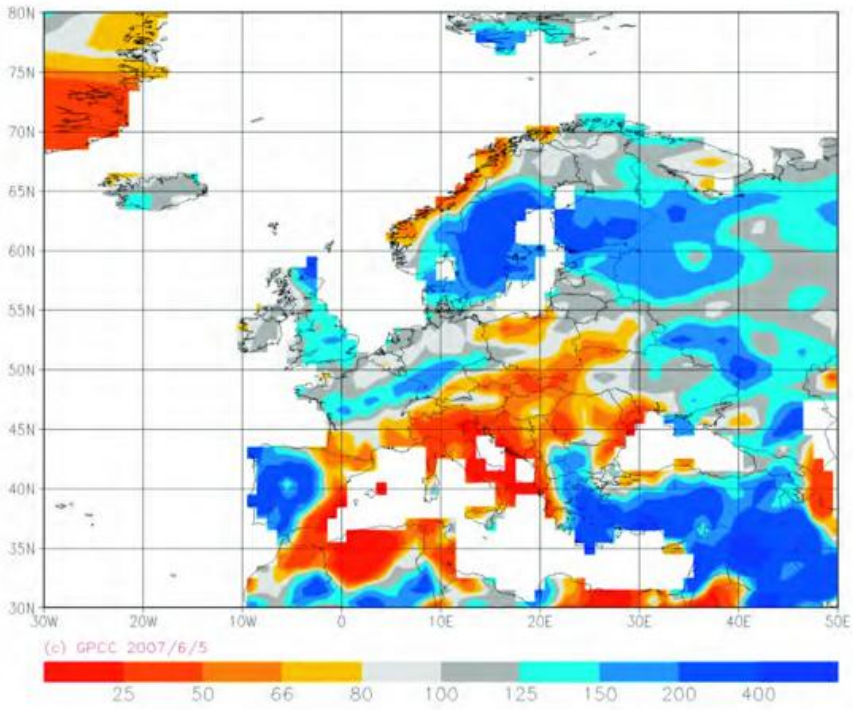


Fig. 10.2: *Monthly precipitation amounts for October 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

In the south, the highest values of the daily maximum precipitation totals ever recorded in any October month were exceeded in some places in Portugal on October 23 and 25, with up to 142 mm in Guarda (central eastern areas; previous record was in 1953). 64 mm fell within 2 hours in Coimbra (central western Portugal) on October 25 at 01-03 UTC, the highest amount since 1973. It was also the 4th rainiest October in Portugal since 1931, especially the period October 19-27 was extremely rainy.

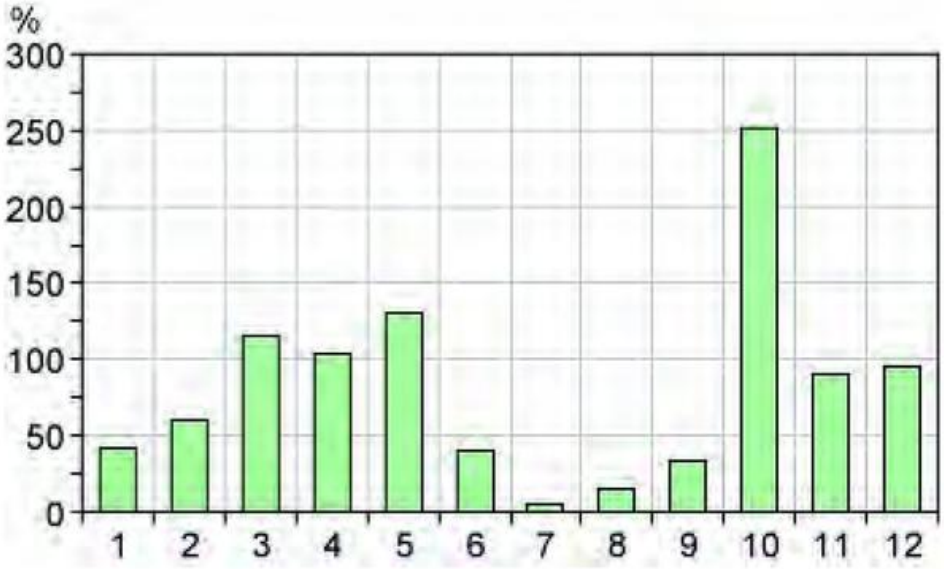


Fig. 10.3: Monthly precipitation amounts for 2006 in per cent of the normal 1971-2000 at the station Helsinki Kaisaniemi, Finland.
Source: Finnish Meteorological Institute

The highest monthly precipitation anomalies (monthly totals up to more than 400% of the normal) within the Region were registered near the eastern Mediterranean this month. Many towns in northern Greece were flooded after heavy rain on October 7-8. More heavy rain events in Greece followed on October 17-18 and October 21, and in Turkey, Syria and the Lebanon at the end of the month. Cyprus received 109 mm of precipitation on spatial average; this was more than 300% of the normal and the second highest October total since 1901. It was mainly due to three heavy rainfall events with hail, causing floods and damage to properties and crops. Israel was very rainy too, with monthly totals of 50-100 mm in northern and central parts, locally even 100-150 mm, compared to a long-term average of 20-40 mm. During the last 60 years, there were only two years in which rainfall totals in October were larger. 32 mm of precipitation fell during a few hours in Masrik in the basin of Lake Sevan in Armenia on October 4.

November

- **Warm in most of the Region, cold in southern Greenland, Iceland, parts of Russia and the southeast**
- **Wet in most of the north, dry in most of the south**

The warm air flow over Europe to the north continued in November. In this month, mild air masses reached even the northernmost parts of the Region. Temperature anomalies in Svalbard exceeded +6 °C (Fig. 11.1). Large areas, especially in northern and central Europe, were more than +3 °C warmer than normal; for some areas all three autumn months had reached this anomaly. Also most of the rest of Europe was considerably warmer than normal.

The coastal areas of the Norwegian county Østfold up to Hordaland had monthly mean temperatures which broke all records since 1867. Denmark reported a record-breaking November monthly mean temperature of 8.1 °C since 1938, despite a wintry start in the first days of the month, with snow and frost during night-time. In Brussels, Belgium, this November was the 4th warmest ever registered, in Germany the 3rd warmest, in the Netherlands and France the 2nd warmest. This November was considerably warmer than normal in Vienna (Austria) for almost the whole month (Fig. 11.2). For Estonia, it was the end of the month which was the warmest for 55 years, and also in Latvia, it was the warmest third decade for 83 years. Only the beginning of November (in particular November 3-6) was cold in these parts; temperatures down to -15 °C were measured in southeastern and northern Lithuania and even below that in Poland, whereas the high value of 19.3 °C was the maximum measured in the second half of the month in west Poland. The first decade of November was also cold in Belarus, the only cold one in this autumn. Serbia, too, was mild, especially in the second half of the month. In the southwest, Portugal recorded its 2nd highest November mean minimum temperature since 1931, after 1983, and its 3rd highest monthly mean temperature.

It was colder than normal in the northwest of the Region, particularly in southern Greenland and Iceland (due to a very cold spell in the middle of the month including a snowstorm), and also in the east and the southeast, here especially the eastern part of European Russia, the complete area of the eastern Mediterranean and the Middle East. Albania reported the coldest November of the time series down to 4.5 °C below normal.

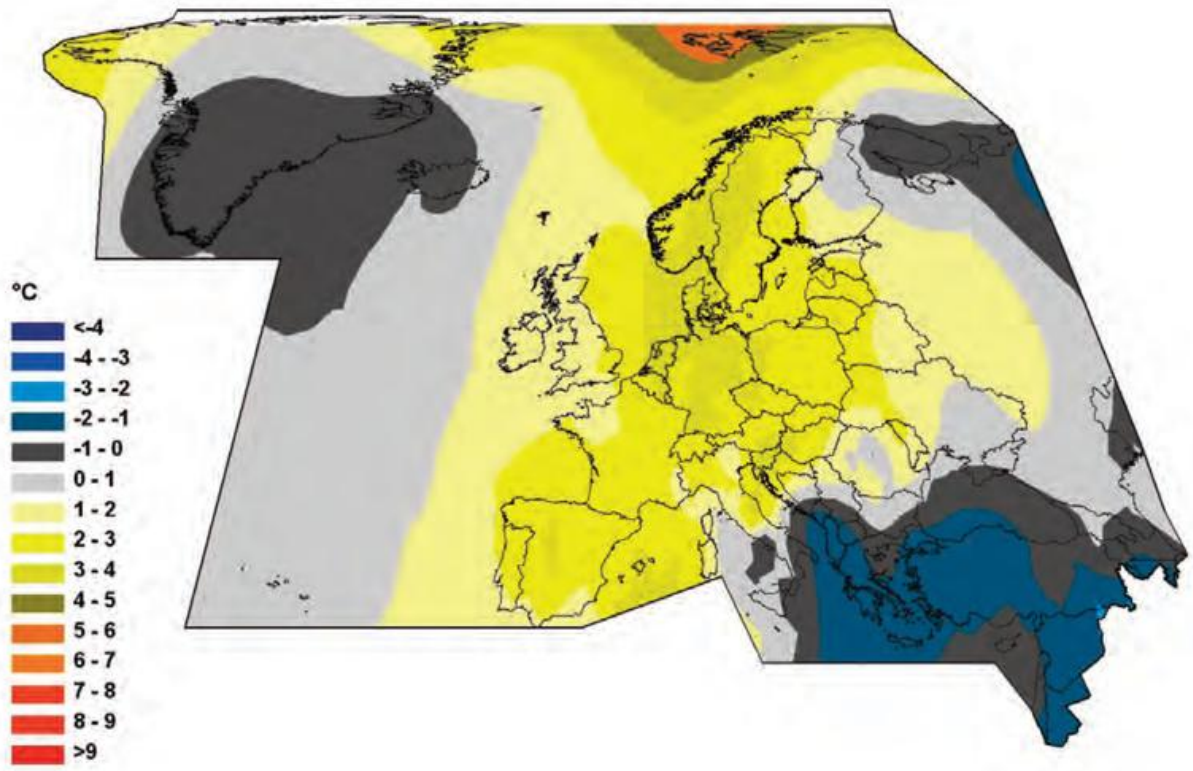


Fig. 11.1: *Monthly mean temperature anomalies in November 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

Due to the warm air flow over Europe, the frontal zone was more relocated to the north than usual and low pressure activity was frequent, particularly in the north. More than 200% of the normal precipitation was registered in Svalbard (Fig. 11.3), and also most of the rest of the northern areas were wetter than normal, except Greenland and the coast of northern continental Scandinavia. For Norway as a whole, the monthly precipitation total was 140% of the normal, the 4th highest since 1900. The whole country of Finland was covered with snow (40-50 cm in the southeast) which was unusual, although the snow had melted away by the end of the month.

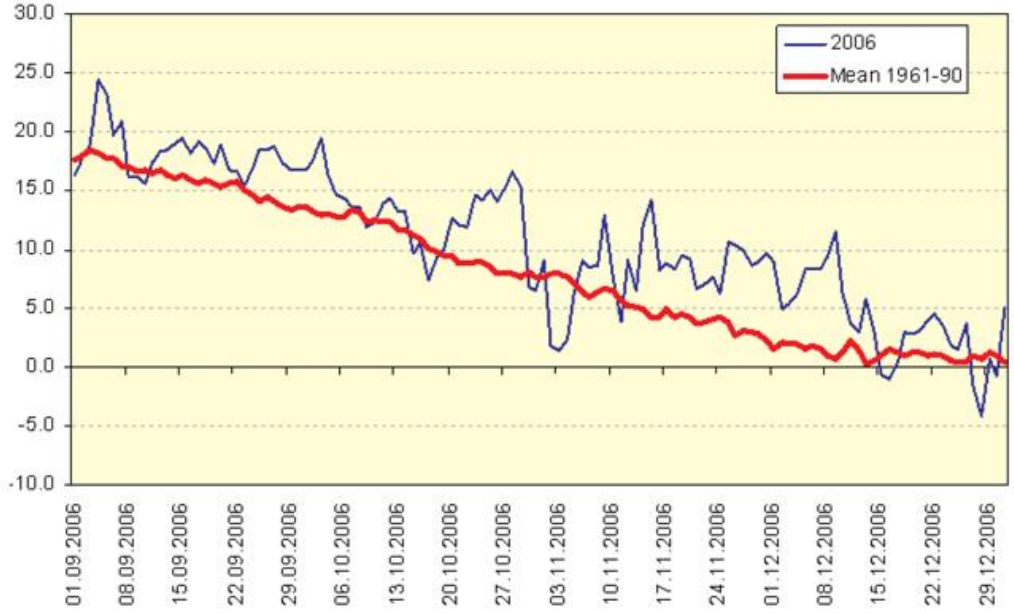


Fig. 11.2: *Daily mean temperature in Vienna (Austria) September – December 2006.*
Source: Central Institute of Meteorology and Geodynamics, Austria

Other wet areas were to be found at the Atlantic and in eastern Europe. Western Scotland experienced its wettest November, with some stations recording well over twice their average rainfall. The station Bishopton, near Glasgow, registered a monthly total of 301 mm.

Most of the southern half of the Region was very dry due to frequent high pressure influence. Precipitation totals in Armenia were 40-60% of the normal. From time to time, local heavy rain and thunderstorms with flooding events occurred in Greece and in Turkey at the beginning of the month. Also Cyprus was relatively wet during the first half of the month, but extremely dry during the second half. Portugal, too, had some heavy precipitation; the total on November 3 in Alvalade (south) was 84 mm and exceeded the highest daily November total recorded before in 1982. Another wet period occurred in Portugal on November 21-29, so that the month as a whole was wetter than normal in contrast to nearly all the other southern countries of the Region. In Faro (Algarve), 44.2 mm were recorded in only one hour on November 29, 09-10 UTC, with 29 mm in just 10 minutes.

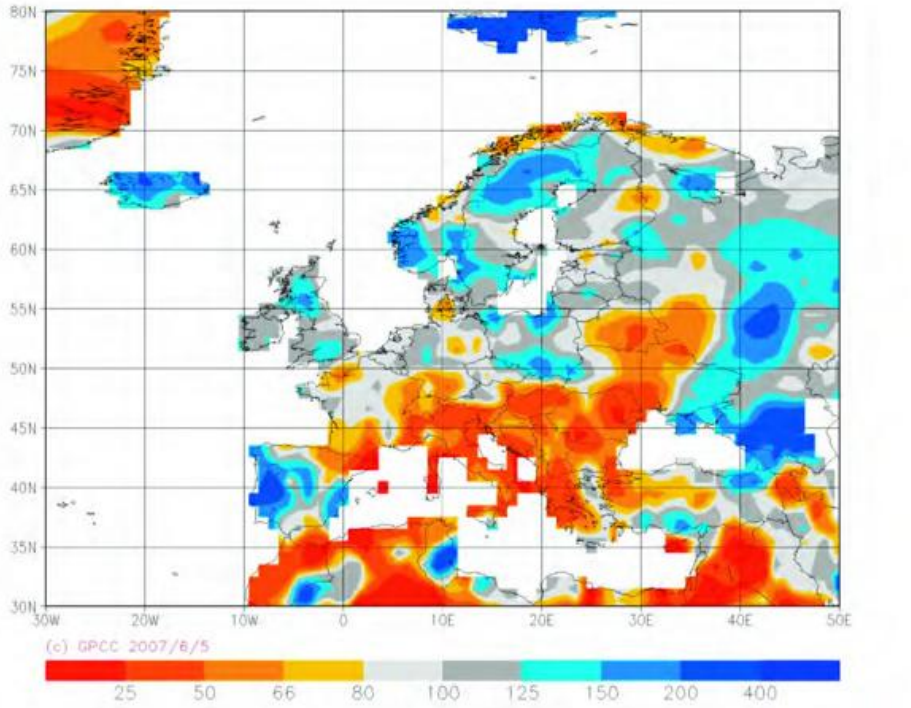


Fig. 11.3: *Monthly precipitation amounts for November 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

December

- **Mostly very mild, especially in the northeast**
- **Very cold in the southeast**
- **Wet in most of the north, dry in most of the south**

In December, the warm air flow over Europe continued but shifted more to the northeast of the Region. Thus, it became extremely mild in northern and northeastern Europe this month. The highest temperature anomalies within the Region were registered in Finland and northern Russia at more than +8 °C (Fig. 12.1). At Helsinki Kaisaniemi, the monthly mean temperature was 4.0 °C, the highest ever measured since 1829. In northern European Russia on spatial average, it was the warmest December since 1930 (Fig. 12.2). Moscow recorded 1.2 °C as monthly mean temperature; this was also a record in the time series, comprising more than 100 years of observations. On December 15, the maximum temperature even reached 9 °C in Moscow. Also in Estonia, such a mild December had not occurred for 140 years (Fig. 12.3), in Latvia for 83 years, at some stations for even a longer time. On December 5 and 6, record temperatures in Latvia were reached with 10-12 °C. Minimum temperatures were as high as 8-10 °C in places in that country; such values are usually measured there in September. Lithuania and Belarus, too, reported their warmest December on record, and also Norway and Sweden, except some of the northernmost parts. Poland recorded maximum temperatures up to 17 °C and no more than 5 days with snow. In Iceland, the first part of December was rather cold, but it became unusually mild after December 17. Heavy rain in the north of Iceland around December 20 resulted in snowmelt, flooding of roads and landslides, causing both loss of property and livestock in various areas.

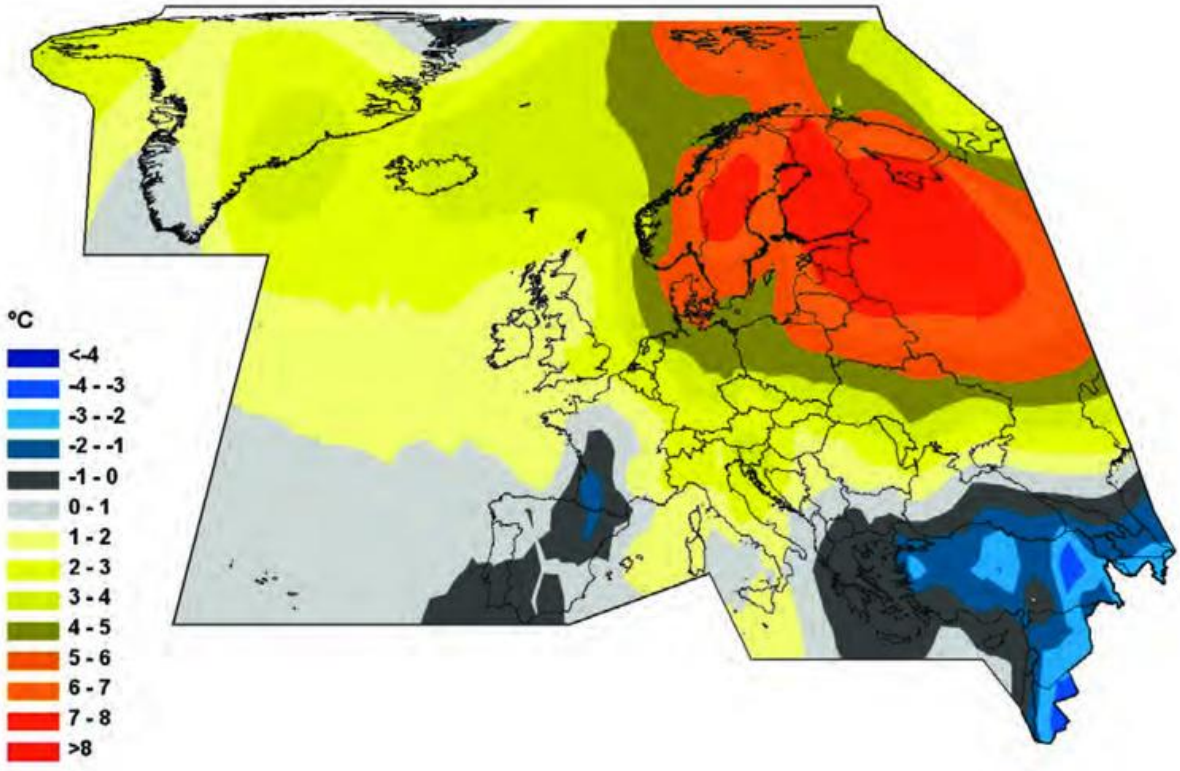


Fig. 12.1: *Monthly mean temperature anomalies in December 2006 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst

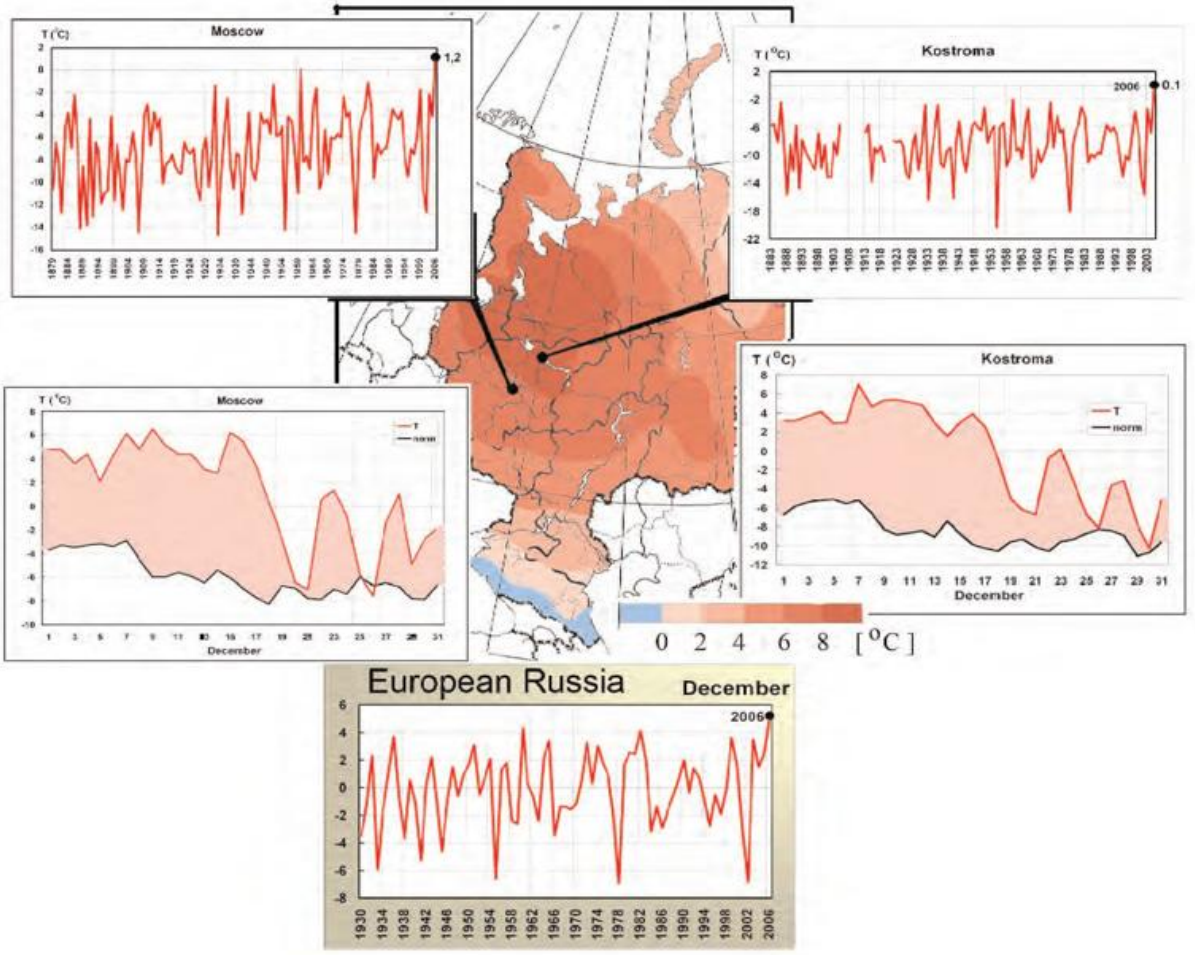


Fig. 12.2: *Monthly mean temperature anomalies in December 2006 (reference period 1961-1990) in European Russia. Insets show monthly temperature time series in December and mean daily air temperature in December 2006 at the meteorological stations of Moscow and Kostroma, and mean monthly air temperature anomalies averaged over the European territory of Russia.*
Source: Roshydromet, Russia

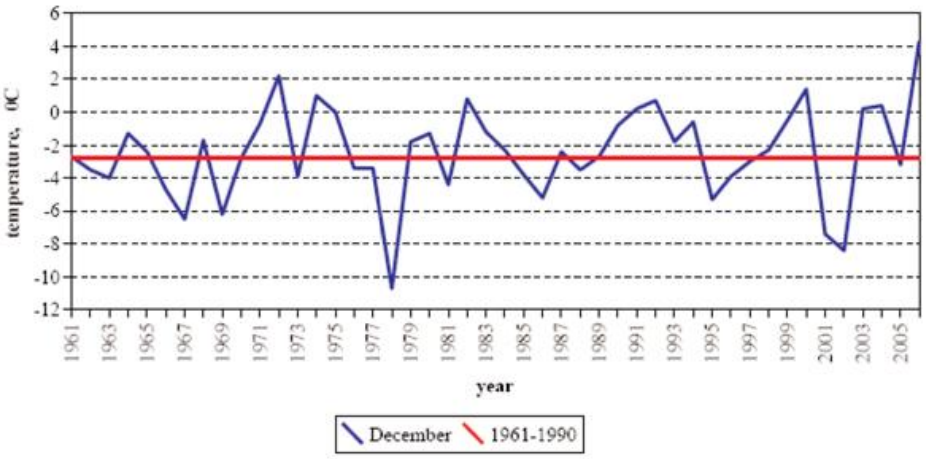


Fig. 12.3: *Monthly mean temperature in Estonia in December.*
Source: Estonian Meteorological and Hydrological Institute

It was also more than 3 °C above normal over most of central and eastern Europe, even in parts of west Kazakhstan, partly also over southern parts. In Denmark, too, this December was record-breakingly warm, nearly 2 °C warmer than the previous record of 1934. For Germany, it was the 3rd warmest December since 1901. Hazel flowering was reported frequently in Germany this month and a pollen warning had to be issued, which was very early in the season. Only at the end of the year (December 27-28) did stronger snowfall and freezing rain appear in Germany, causing many traffic accidents. The airport in Luxembourg had no snow day at all that month, which was very unusual. In the Alps, even at altitudes of 2000 m, could snow rarely be found during the first half of December.

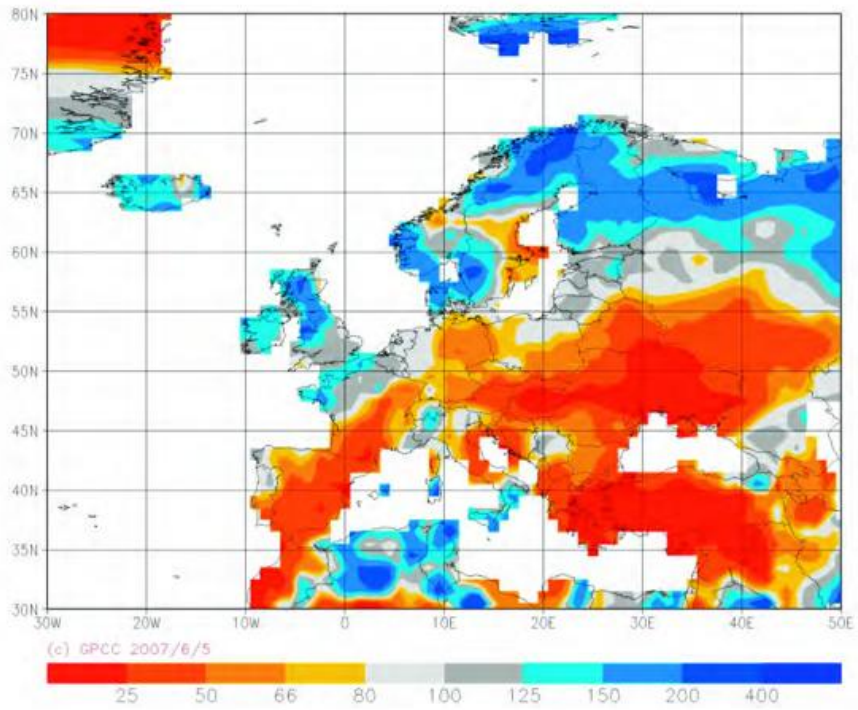


Fig. 12.4: *Monthly precipitation amounts for December 2006 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Germany

The mild air also brought a lot of precipitation to northern Europe, in parts more than twice the normal amount (Fig. 12.4). With 166% of the normal precipitation, Norway experienced its 2nd wettest December since 1900, after 1975. It was also extremely wet in southwestern Sweden, where serious flooding occurred after heavy rains on December 11. The southern half of the Region was mostly very dry due to continuous high pressure influence, except in some places in the western Mediterranean and the Alps. In western Carinthia, Austria, precipitation rose to more than 175% of the normal, caused by a depression over northern Italy around December 9. Israel had a very long dry period until December 20, but large precipitation amounts in the last third, especially on December 26-27 with snowfall in the mountains, including Jerusalem. Snowfall was also recorded in Jordan on these days (28 cm in Shoubak in the south), and the highest daily precipitation total of the year in Jordan was 80.2 mm registered at Salt in the central part of the country on December 26. In contrast, only 7.5 mm of precipitation (7% of the normal) fell in Cyprus during the whole month of December, it was the second lowest amount since 1901.

Widespread fog conditions were observed in Bulgaria during most of the month. During the week of December 11-17, up to 250 flights at the international airport of Sofia were cancelled or diverted.

Some areas in southwest Europe and particularly in the Middle East were colder than normal, mainly due to continental cold air flowing south of high pressure centres from the east to these parts. Especially in eastern Turkey it was partly more than 3 °C colder than normal. Cyprus had at first 3 weeks which were very warm, but towards the end of the month a low pressure system affected the island, and the temperatures dropped below zero on the whole island, causing frost damage to crops. In Israel too, especially the second half of the month was cold. In the northern valleys, the northern Negev and the inland aeras of the coastal plain in Israel there were three periods of ground frost, partly also air frost, which caused damage to potato crops and this happens statistically only once in ten years on average. Jordan recorded its lowest minimum temperature of the year at Shoubak (elevation 1365 m) in the south on December 30 at -12.4 °C. Unusually cold weather was also registered in the Ararat Valley in Armenia (up to more than 5 °C below normal); minimum temperatures fell to -26 °C at an altitude of 800-1000 m there.

Report on ECSN activities

Aryan van Engelen, KNMI

Introduction

The European Climate Support Network is a programme under the auspices of EUMETNET, the Network of (22) European Meteorological Services. In this programme the members co-operate in the field of climate and related activities, in order to expand their capabilities to support the RAVI/European user community through enhanced provision of high quality climate data, products, services, advice and knowledge. Core activity is the initiating and running of a series of projects in order to address the most frequent and urgent user needs of the whole RAVI/European domain. ECSN organises a number of events such as the annual ECSN plenary meetings of its members (EAC), the biennial European Conferences on Applied Climatology (ECAC) in collaboration with the European Meteorological Society (EMS) and the biennial Data Management Workshop.

ECSN is collaborating with the WMO RAVI Working Group on Climate Related Matters (RAVI-WgCRM); especially to address the NMHSs of RAVI that are not (yet) members of ECSN.

MeteoSwiss was responsible member of ECSN.

The 11th ECSN Advisory Committee (EAC) Meeting took place in Exeter, UK, 21-23 June, 2006. The meeting was well organized by the UK Met Office. At the meeting, as a new initiative, a strategic partnership with the RAVI-WgCRM was discussed.

The 6th European Conference on Applied Climatology, together with the Sixth Annual Meeting of the European Meteorological Society, took place in Ljubljana, Slovenia, 4-8 September 2006. This was the most successful ECAC so far, not only because of the large number of participants of about 500, but also because of the high scientific level.

On 28 September 2006, the EUMETNET Council decided to continue the ECSN Programme for a fourth phase, starting on 1 January 2007, for a four year period, with KNMI as Responsible Member.

On 9 December 2006, ECSN launched a joint press release: “Autumn 2006 extraordinarily mild in a large part of Europe”

Projects

S-EUROGRID (SMHI)

The outlines of the Showcase EUROGRID (S-EUROGRID) project were prepared in 2006. The project will start on 1 January 2007 and run for a period of two years. Responsible member is SMHI. Contributing members are Austria, Denmark, Finland, France, Germany, Iceland, Ireland, The Netherlands, Norway, Portugal, Spain, Sweden and Switzerland. Italy and United Kingdom will be participants “in kind”.

S-EUROGRID’s main ambition is to illustrate what the full-scale EUROGRID concept means, which is intended to be a future European shared resource for gridded climate and historical and environmental data.

HRT-GAR (ZAMG)

A new ECSN project, the "High Resolution Temperature Climatology in Complex Terrain – demonstrated in the test area Greater Alpine Region" (HST-GAR), was launched on 1 January, 2006. The project aims at providing high quality data products over mountainous areas in Europe. The principal deliverable will be a monthly temperature field in a 1 km resolution over the 1961-1990 WMO Normal Period and the 1971-2000 Normal Period.

The kick-off meeting was attended by the assembled participants from Austria, Bosnia, Croatia, Czech Republic, Herzegovina, Hungary, Italy, Norway, Slovenia and Switzerland.

Data were collected from 1885 stations, of which 1733 were able to be adopted. A paper "First steps towards a new Temperature Climatology of the Greater Alpine Region (GAR)" has been prepared.

GCMP / EuCLIS (DWD)

The "Generate Climate Monitoring Products" (GCMP) and its successor platform the "European Climate Information System" (EuCLIS) project is aimed at providing standardized climate monitoring products for the European area, in order to meet the requirement of the Services, scientific institutions and the general public. In 2006, 19 NMHSs contributed to this platform (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxemburg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom). A prototype of EuCLIS was presented at the 6th ECAC conference in Ljubljana, where many NMHSs of RAVI expressed their interest to become new contributors. Since then DWD is undertaking activities to turn the prototype into a sustainable operational platform that will probably be launched in 2007.

ECA&D (KNMI)

The European Climate Assessment and Dataset (ECA&D) project of ECSN aims at the creation of a sustainable operational system for data collecting, archiving, quality control, analysis and dissemination. Data collecting refers to long-term daily resolution time series from meteorological stations throughout Europe and bordering areas. Based on this dataset ECA&D will serve as a platform to increase the knowledge of and communication on past changes in (soft) extremes over Europe through the analyses of the historical climatological records. Data were collated with the collaboration of 53 participants (NMHSs predominantly) from 42 countries and datasets, included from EMULATE, STARDEX, GHCND, GSN and MAP. Now the dataset comprises series from some 2200 stations.

ECA&D is widely recognized as a EUMETNET baseline dataset, not only by the European NMHSs but also by a number of strategic bodies such as WMO, EEA and the EU Research Community; the ENSEMBLES and the MILLENNIUM projects.

ENSEMBLES (KNMI, MeteoSwiss)

The focus of the EU-FP6 project "ENSEMBLE-based Predictions of Climate Changes and Impacts" (ENSEMBLES, 2004-2009) is to develop an ensemble prediction system for climate change, based on the principal, state-of-the-art, high resolution, global and regional Earth System models, developed in Europe, validated against quality controlled, high resolution gridded data sets for Europe. Based on the ECA&D dataset MeteoSwiss and KNMI collaborate

in assessing the quality of the dataset (1960-2000) that will be the basis of a daily gridded dataset for the whole of Europe with a 25 km resolution. It is expected that the ENSEMBLES gridded dataset will serve as a baseline dataset for the ECSN project EUROGRID.

Millennium (KNMI)

The EU-FP6 project “Millennium – European climate of the last millennium” (2006-2010) addresses the question as to whether the magnitude and rate of recent climate change will exceed the natural variability of the European climate over the last 1000 years. In 2006 the partners of ECA&D supported this project in collating long instrumental climate time series. This support was also expressed at the 1st MedCLIVAR Workshop in Carmona, focusing on a reconstruction of the Mediterranean climate during the last 1000 years.

At the end of 2006, the ECA&D dataset was officially recognised as deliverable.

The Ozone Layer over Central Europe

Ulf Köhler, Hans Claude and Wolfgang Steinbrecht - Deutscher Wetterdienst

The development of the ozone layer over Central Europe continues the positive trend as observed since the beginning of the nineteen nineties. This trend is documented by the Hohenpeissenberg total column ozone time series (Fig 14.1). This 15-year increase includes the distinct ozone minimum after the eruption of Mt. Pinatubo in 1991, which additionally aggravated the negative trend since the end of the sixties. The mean values of the last years are around 2% below their longterm mean and 5% lower than at the beginning of the measurements.

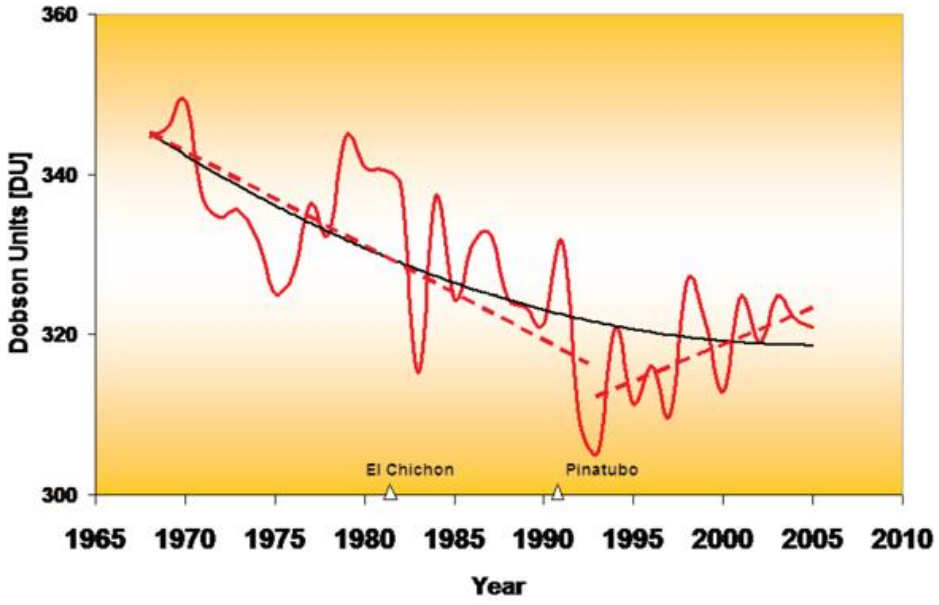


Fig. 14.1: *Annual means of total column ozone above Hohenpeissenberg measured by Dobson and Brewer since 1968 (red curve). The regression lines (dashed red) and the polynomial fit (black) approximate possible trends.*

The causes of trends and fluctuations are the development of the ozone depleting potentials (ODP's) combined with natural influences like solar cycle, and dynamic impacts like e.g. the North Atlantic Oscillation (NAO) and the quasi biennial oscillation of stratospheric winds (QBO) (WMO 2007).

The reduction of effective stratospheric chlorine as a consequence of political protocols (Vienna 1985, Montreal 1987, London 1990, Copenhagen 1992) has begun but its effect on total column ozone has so far been very low.

Figure 14.2 shows the time series of daily total ozone over Central Europe in 2006. It reflects a quite normal year with some outliers in both directions, but most of the daily averages, at least in the first half of the year, are within the bounds of the extreme years 1970 and 2000. However, three significant features are noticeable:

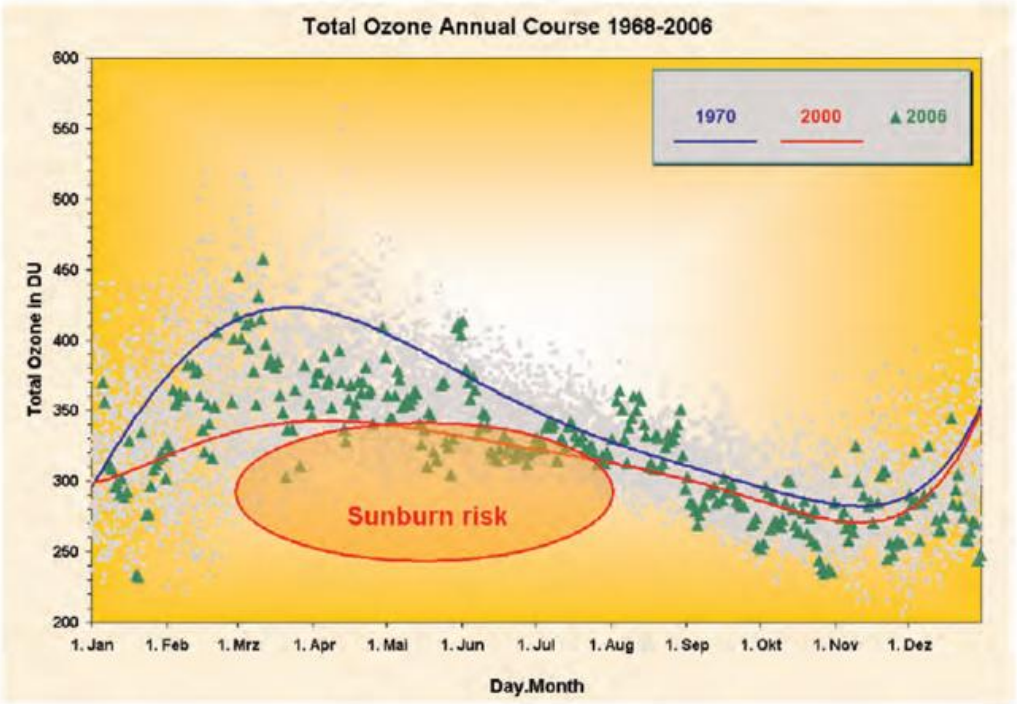


Fig. 14.2: *Daily means of total column ozone above Hohenpeissenberg in 2006 (green triangles) and between 1968 and 2006 (grey dots). The blue line shows the annual course of the maximum year 1970, the red line the minimum year 2000.*

- Two days in January show extraordinarily low thickness of the ozone layer. The deficit on January 19 and 20 was almost –30%. These low values of about 230 DU over Hohenpeissenberg correspond with a so-called mini ozone hole over Western Europe/UK with a minimum below 200 DU. A record minimum of 177 DU was observed in the UK. On the first look this mini hole might only be attributable to a streamer event, which transports ozone poor air from the tropics/subtropics to Western and Central Europe (Fig 14.3). Looking at the development of the ozone distribution above the Northern Hemisphere over a longer period, however, reveals a combination of dynamic effects (streamer) and additional chemical ozone depletion (ozone poor air caused by heterogeneous chemistry coming from northern latitudes). A detailed analysis of ozone sonde profiles and trajectories proved that 2/3 of the ozone reduction come from the UTLS region (streamer effect in the upper troposphere/lower stratosphere) and 1/3 from chemical ozone depletion in the middle and higher stratosphere (Keil et al., 2007). This shows that record ozone minima are possible over Europe at any time.

- High ozone values were observed at the beginning of June and throughout the entire August, whereas ozone was subnormal during the six weeks of the Football World Cup in Germany. This ozone pattern correlates with the weather extremes during the summer 2006. It started with snow fall at Hohenpeissenberg on the 1st and 2nd of June, followed by sunny and hot summer weather due to high pressure systems. August, in contrast, was dominated by low pressure systems with cold weather and much rain over central Europe.

- From September onwards the ozone layer gives evidence of a record fall and winter in weather. As low total ozone values are normally connected with high pressure systems and, subsequently, a warm troposphere, the predominantly subnormal values confirm that the four last months in 2006 were too warm. Fall 2006 was the warmest ever measured in the 225-year long weather records of Hohenpeissenberg. The same applies to the following seasons, i.e. winter 2006/2007 and spring 2007. Since the

amount of total ozone is a combination of different effects at various altitudes, the average total ozone column of these months is indeed low but record minima were not observed.

The coming years will reveal whether the expected recovery of the ozone layer will appear in the data records or not. The global climate change with its various aspects, however, remains a factor of uncertainty, which could compensate the effects of the beginning chemical recovery of the ozone layer. Moreover, the risk of temporary episodes with very low total ozone associated with enhanced UV radiation, harmful to human health, remains.

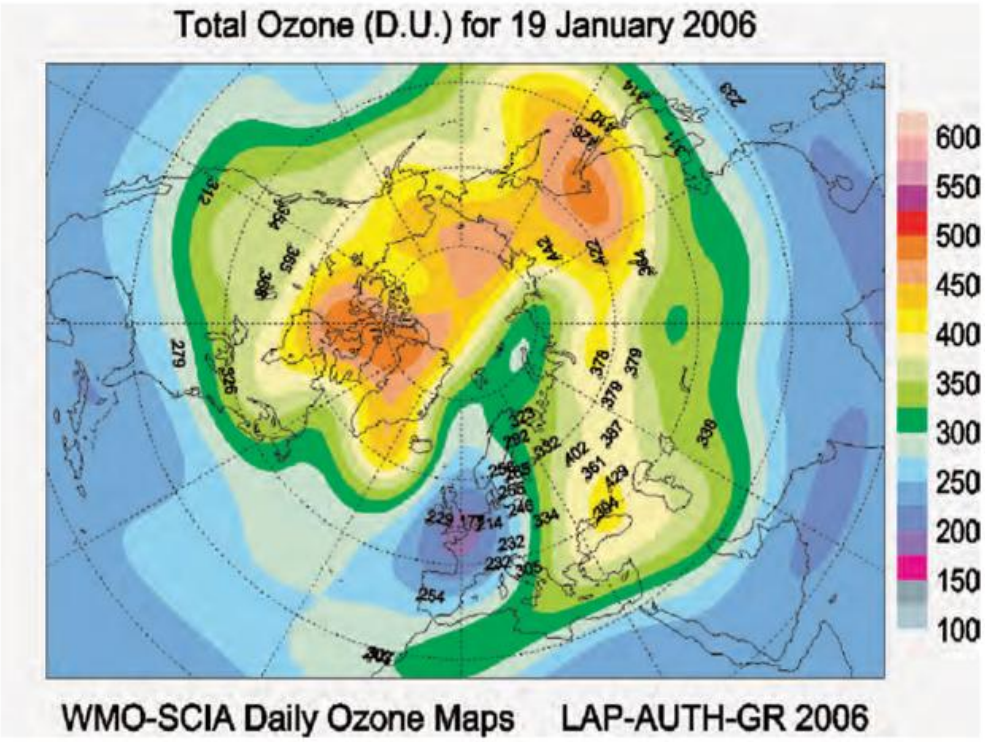


Fig. 14.3: *Distribution of the total ozone column above the Northern Hemisphere on January 19, 2006.*
Source: WMO Total Ozone Mapping Centre, Greece.

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- Europe and Middle East -

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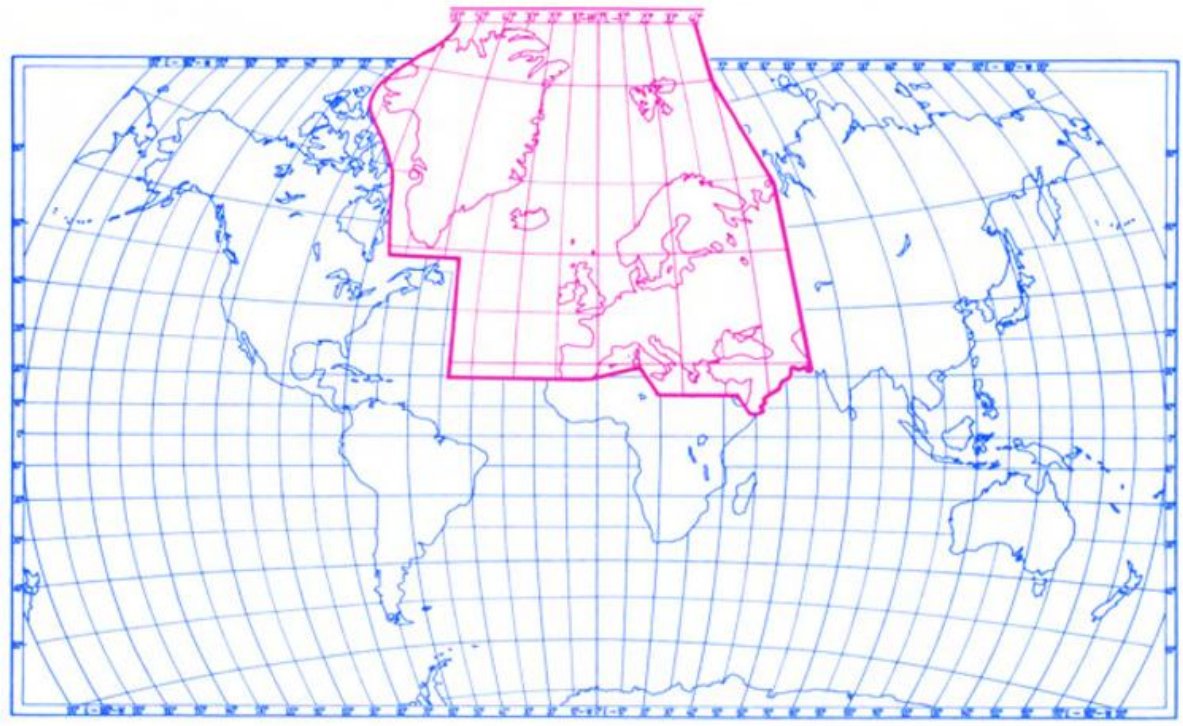

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- Europe and Middle East -
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Foreword

Like the previous years, 2007 again was a very remarkable year for climatologists . In many places of our Region it was the warmest or second warmest year since the beginning of measurements and probably one of the five warmest years since 1850 in Europe.

The most outstanding warmth occurred in January and April. January 2007 was the warmest January in the global average and in many countries of our Region it was the warmest ever recorded. Monthly mean temperature anomalies above +10°C in some of the eastern parts of the Region were the proof of an extraordinarily mild winter month there, with many other parts of Europe also having been considerably warmer than normal. April was extremely warm, sunny and dry especially in western, central and southeastern Europe. In summer 2007, in particular the southeastern countries were concerned by some strong and long lasting heat waves. Numerous forest fires were reported from many countries. December 2007 was very mild in northeastern Europe, making the start to another mild winter season in this area.

Nevertheless, there were some colder-than-normal periods recorded in 2007. One example is the cold February 2007 in northeastern Europe whereas western, central, and sometime later also eastern Europe experienced a colder second half or at least a colder autumn. This is once more a clear demonstration that climate change is a lot more than just a simple global warming. Keeping in mind that cold winter months and cool summers can even occur in a warmer climate, we are aware that a continuous climate monitoring is still very important and not at all a boring job.

Also for precipitation, we had a lot of outstanding anomalies and events in 2007. Although the year as a whole was more or less near normal on average in many areas, many very dry and wet episodes occurred. An extremely dry April in many parts of Europe was followed by a very wet May. Some locations in central Europe were without any precipitation in April, which is far from typical for this month in this climate zone. The summer months were characterised by high precipitation amounts with flooding particularly in northwestern Europe. In many other parts of the Region, frequent violent thunderstorms with heavy rain, hail and tornadoes were recorded, of course with serious consequences for agriculture and daily life. One of the strongest storms ever, named “Kyrill”, hit Germany on Januar 17-19, affecting also large parts of western, central and eastern Europe and the Alps. Furthermore, the areas south of the Alps were concerned due to a north foehn situation resulting in extremely mild temperatures with serious consequences for skiing sites in northern Italy. This example shows that such an event can easily cause important impacts to large parts of our Region, and its monitoring requires contributions from several countries.

The 14th issue of this Annual Bulletin is one result of such a cross-national activity. Our Region consisted of 50 countries in 2007, and I am very happy to notice that we have received contributions from 49 countries this year. This is again a new record and an excellent response to the call for input sent out by the DWD (Deutscher Wetterdienst, the German Meteorological Service) in December 2007. Our editors, Peter Bissolli and Peer Hechler of DWD, succeeded in including the important facts of all thoroughly prepared material and presenting herewith a concise and representative summary. I am convinced that this bulletin helps you inputting your domestic findings in the greater climatological context of the RA VI.

Let me express my warmest thanks to all contributors, reviewers and in particular to the editorial team of DWD for all the work and the kind co-operation.



Daniel Keuerleber-Burk
President of WMO Regional Association VI

Outstanding Events and Anomalies

Temperature

- Warmest or second warmest year, winter and spring on record in many countries
- Extremely warm January and April, particularly in the east and in central Europe respectively
- Severe summer heat waves especially in southeastern Europe
- Cold February in northeastern Europe

Precipitation

- Very dry April in many countries, partly without any precipitation in central Europe
- Severe flooding events particularly in northwestern Europe
- Many severe thunderstorms with heavy rain and hail in many countries

Sunshine

- Sunniest April ever recorded, particularly in central Europe

Wind

- Storm “Kyrill” in January affecting large parts of western, central and eastern Europe

Annual Survey

Temperature

Anomalies

Like the previous years, 2007 was considerably warmer than normal (reference period 1961-1990) in nearly the whole Region. Annual mean anomalies ranged between +1 and +2°C over most of Europe, the North Atlantic and Greenland, over some smaller areas they exceeded +2°C (Fig. 0.1). National examples are given in Fig. 0.2 (Sweden), Fig. 0.3 (Estonia) and Fig. 0.4 (Bosnia and Herzegovina). The highest anomalies were recorded over Svalbard amounting to over +4°C. Smaller anomalies of less than +1°C were observed mostly in western and southern parts of the Region (even in the southeast, e.g. Azerbaijan, Fig. 0.5) and over some areas of the North Atlantic (including e.g. the Faroe Islands and some coastal stations of Greenland). Only very few places were slightly colder than normal, e.g. in Spain and Turkey.

The annual average land surface temperature (derived from the CRUTEM3 data set of the Hadley Centre in the United Kingdom, CRUTEM3 = Climate Research Unit temperature Version 3, land air temperature anomalies on a 5° by 5° gridbox basis) for the year 2007 was +1.2°C above the 1961-1990 normal for the European region 35-75°N, 10°W-30°E and is virtually certain to be one of the five warmest years since 1850.

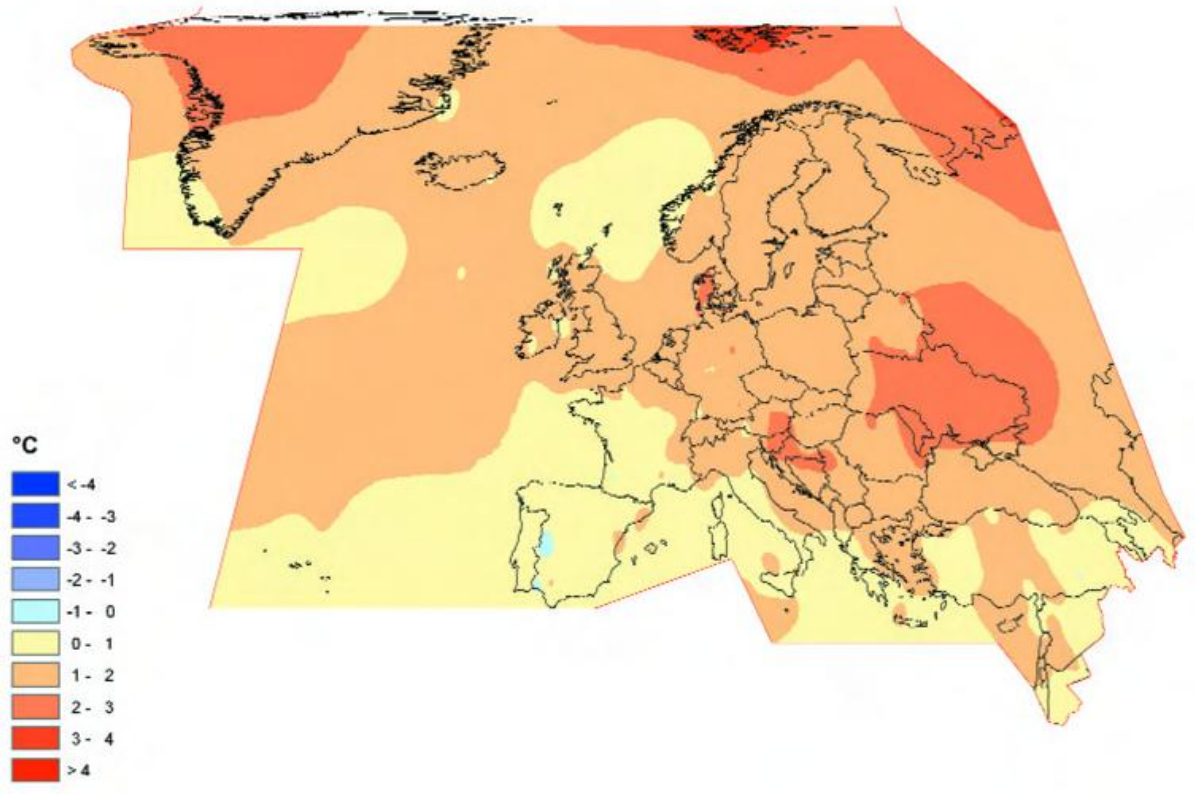


Fig. 0.1: *Mean temperature anomalies in 2007 (reference period 1961-1990) in WMO Region VI. Source: Deutscher Wetterdienst, Germany*

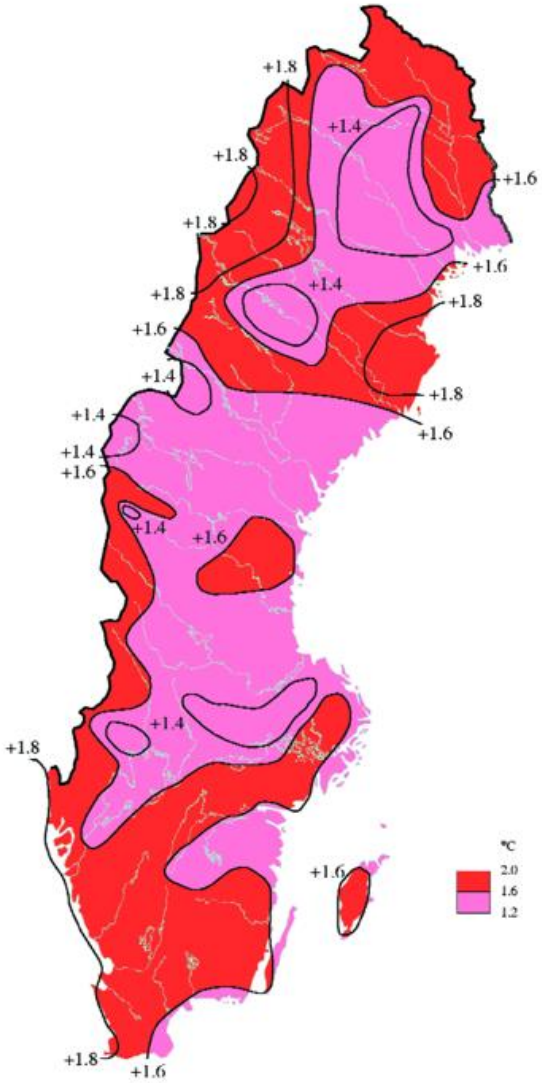


Fig. 0.2: *Mean annual temperature anomalies in 2007 (reference period 1961-1990) in Sweden. Source: Swedish Meteorological and Hydrological Institute (SMHI)*

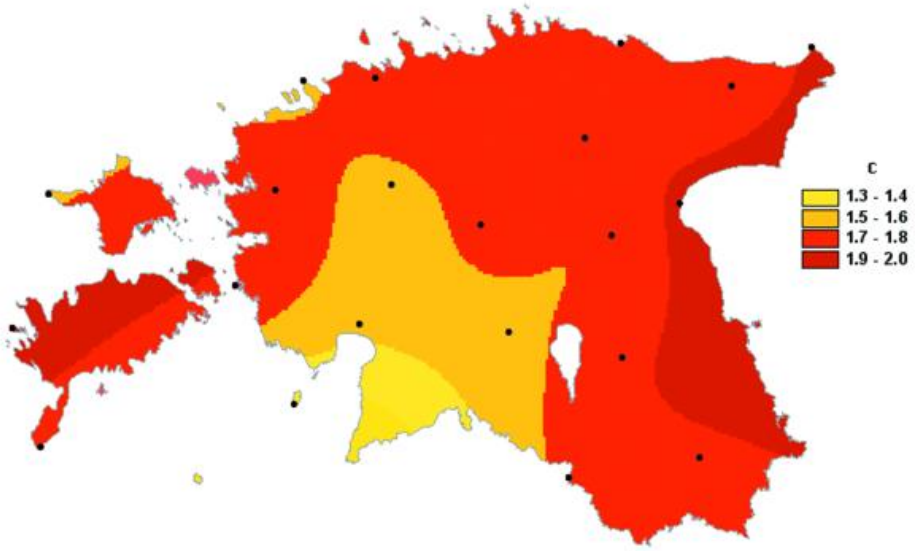


Fig. 0.3: *Mean annual temperature anomalies in 2007 (reference period 1961-1990) in Estonia. Source: Estonian Meteorological and Hydrological Institute*

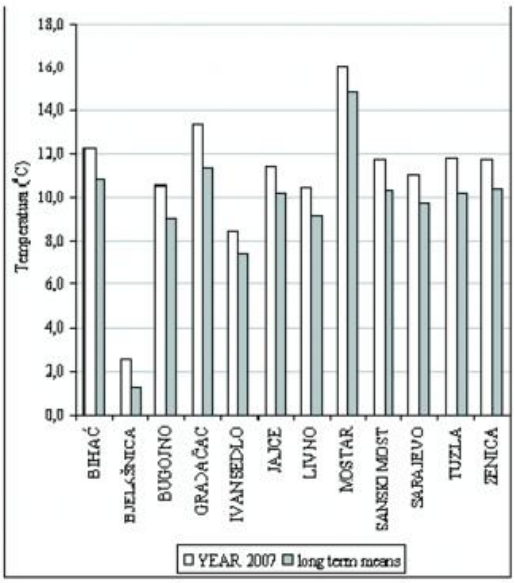


Fig. 0.4: *Mean annual temperature in 2007 compared to long-term means in Bosnia and Herzegovina.*
Source: Federal Meteorological Institute Bosnia and Herzegovina

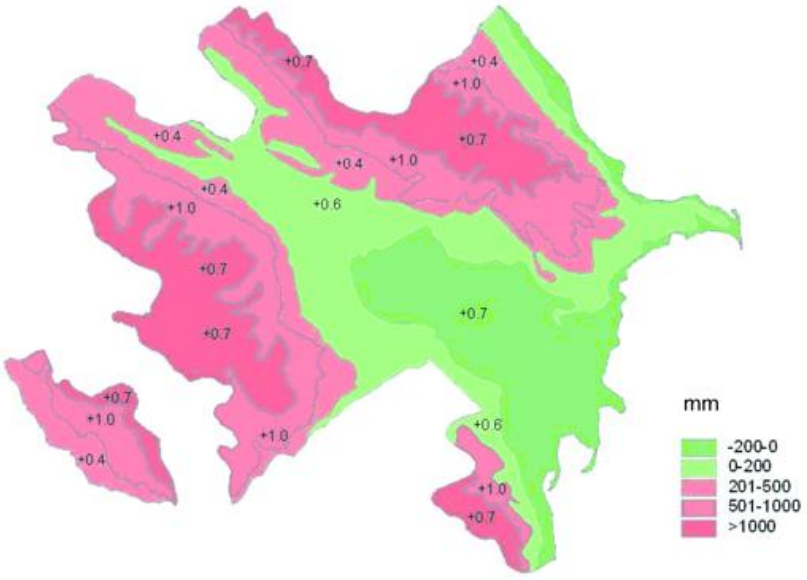


Fig. 0.5: *Mean annual temperature and precipitation anomalies in 2007 (reference period 1961-1990) in Azerbaijan. Temperature anomalies in °C (numbers), precipitation anomalies in mm (colours).*
Source: National Hydrometeorological Department, Ministry of Ecology and Natural Resources of Azerbaijan

Warmest or second warmest year on record in some countries

It was the warmest year on record in the Benelux region (Fig. 0.6 for Luxemburg), eastern Austria, the Czech Republic, Denmark (Fig. 0.7), parts of Ireland and several countries in eastern and southeastern Europe (e.g. at the coast of Slovenia, in Hungary, Bulgaria, Moldova, Ukraine). 2007 was the second warmest year on record in terms of the areal mean in some other countries, at least in some places, e.g. in Germany, the United Kingdom, Russia, Belarus, Slovakia, Croatia, Serbia, but also in Svalbard (average temperature at Svalbard airport was -2.5°C, in some places even slightly above zero). Annual mean temperatures in Norway were above 0°C even in large parts of the north (Fig. 0.8). However, it was not an outstandingly warm year in Spain; it was rather the coldest since 1996.

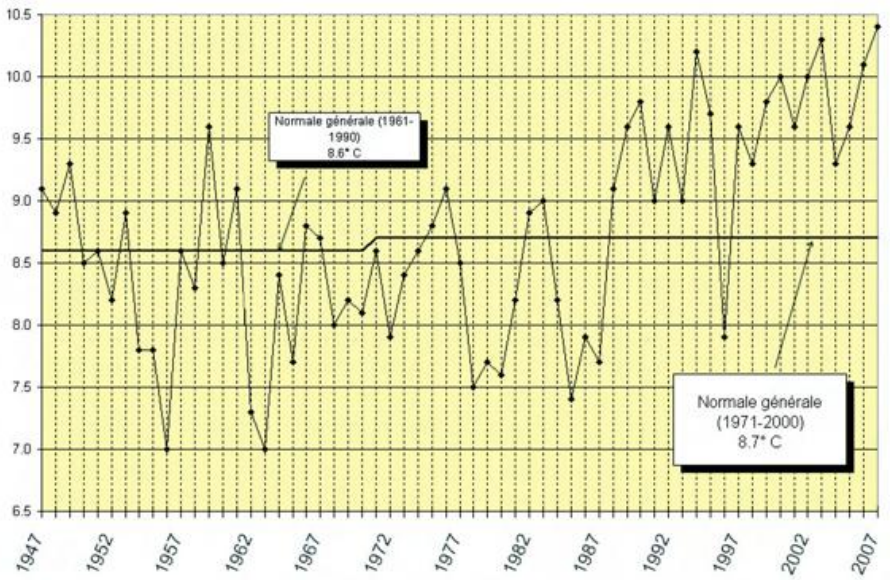


Fig. 0.6: *Mean annual temperature 1947-2007 at Luxembourg airport. Source: Service Météorologique de Luxembourg*

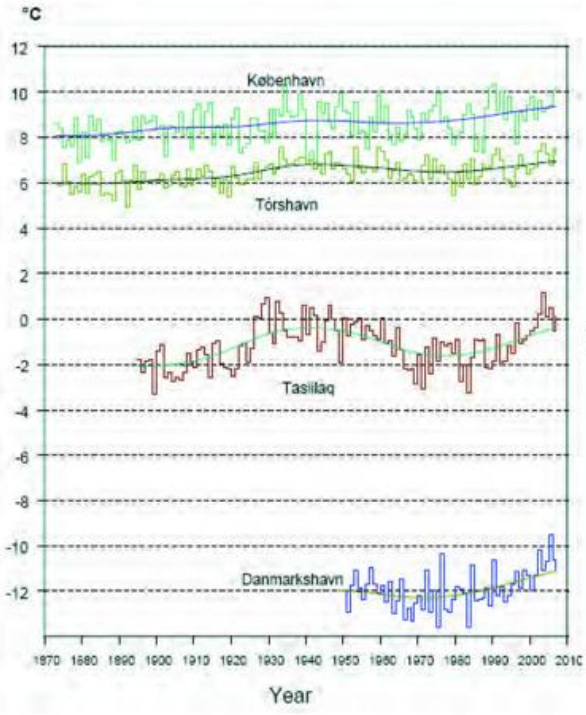


Fig. 0.7: *Mean annual temperature 1873-2007 in Denmark including Greenland. Source: Danish Meteorological Institute*

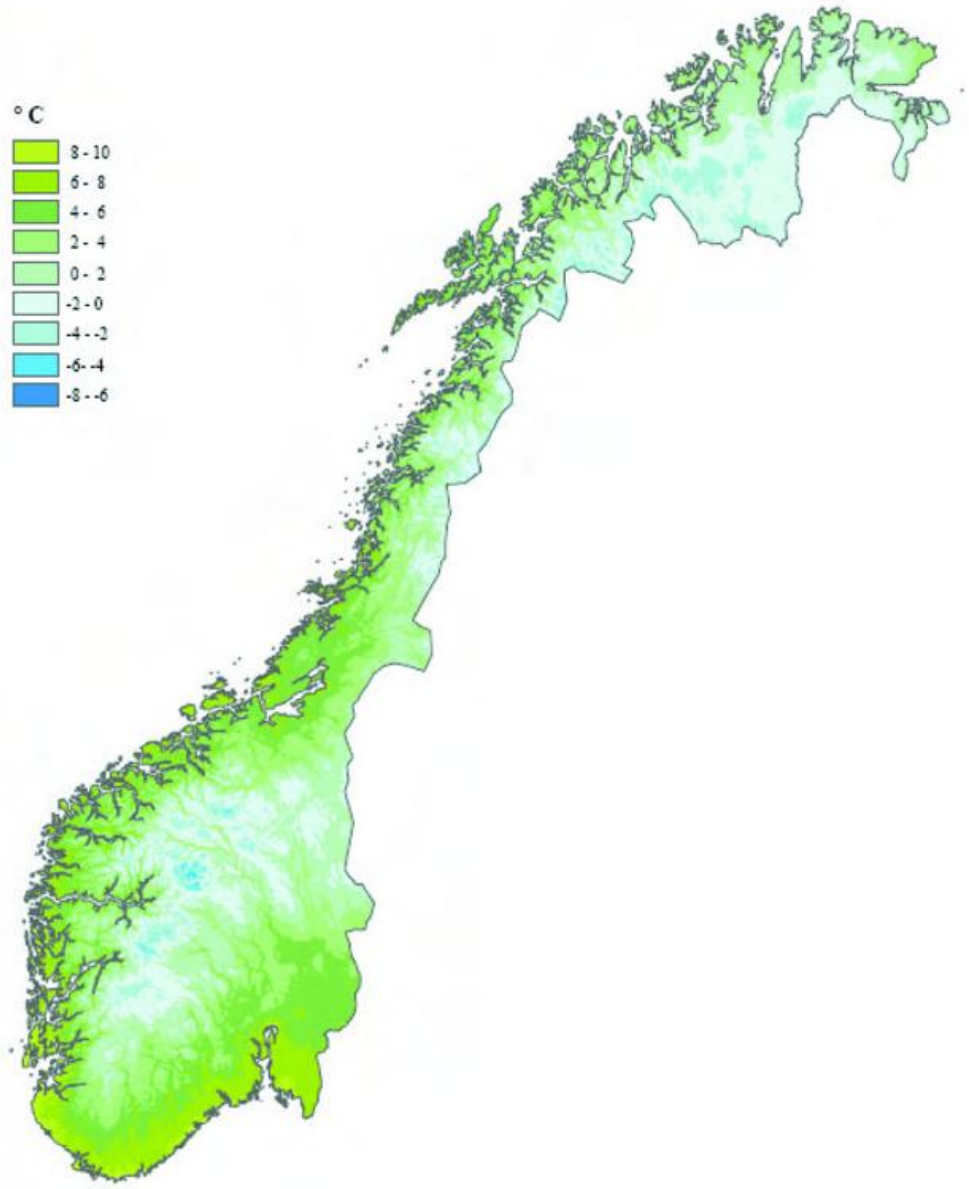


Fig. 0.8: *Annual mean temperature 2007 in Norway.*
Source: Meteorologisk Institutt met.no, Norway

Annual cycle of temperature

The first half of 2007 was exceptionally warm in all western and central European countries (e.g. in Brussels, Belgium, Fig. 0.9). Especially the first third of the year experienced many new temperature records. January and April were the warmest months on record in many countries, and also the winter 2006/07 and spring 2007 seasons. In the second half of the year, a cooling relative to the normal annual cycle extended from western to eastern Europe. In western Europe, this cooling started in July, in most of central, southern and southeastern Europe in September (even in Poland, Fig. 0.10), and in eastern Europe in November. In Belarus and the Ukraine, January and March were exceptionally mild months and also the months May to August were clearly warmer than normal, whereas April was very near to normal as compared to western and central Europe (Fig. 0.11 for the Ukraine). Turkey was particularly warmer than normal in the summer half year from May to October (Fig. 0.12). In contrast, warmer- and colder-than-normal months in Armenia occurred throughout all seasons (Fig. 0.13). On the Iberian Peninsula, warmer-than-average temperatures were recorded in winter, spring and most

of fall; on the other hand summer and the months of November and December were cooler than normal. In Iceland (station Reykjavik), only May was colder than normal. In Ireland only July, and in northeastern Europe only February were very cold months (e.g. in Helsinki, Finland, Fig. 0.14; Latvia, Fig. 0.15).

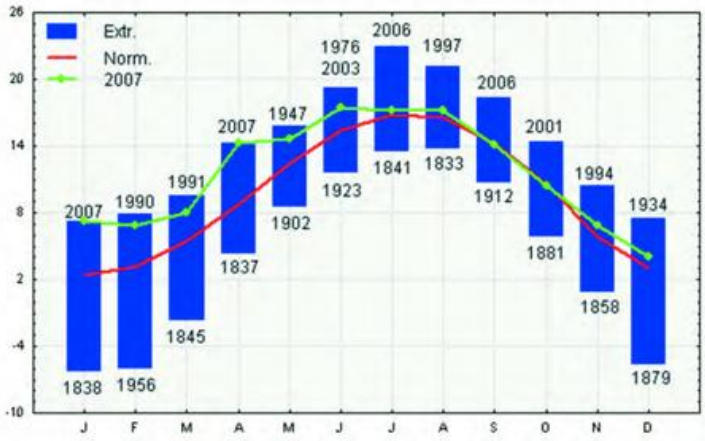


Fig. 0.9: *Monthly mean temperature, normal (1961-1990) and extremes in Uccle (Brussels, Belgium, °C).*
Source: Royal Meteorological Institute, Belgium



Fig. 0.10: *Monthly mean temperature anomalies 2007 (reference period 1961-1990) in Poland.*
Source: Instytut Meteorologii I Gospodarki Wodnej, Poland

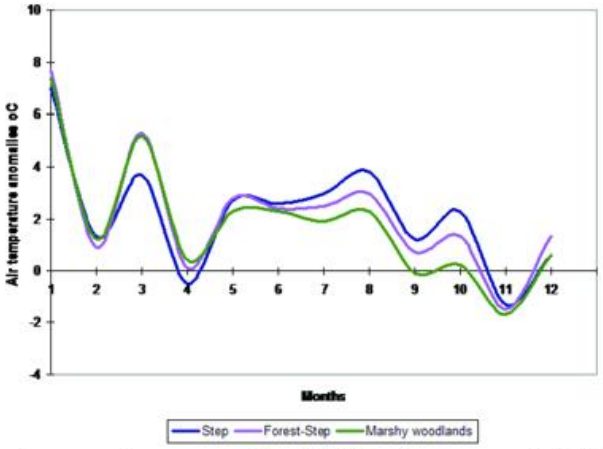


Fig. 0.11: *Monthly mean temperature anomalies 2007 (reference period 1961-1990) for various vegetation zones in the Ukraine.*
Source: Ukrainian Hydrometeorological Center

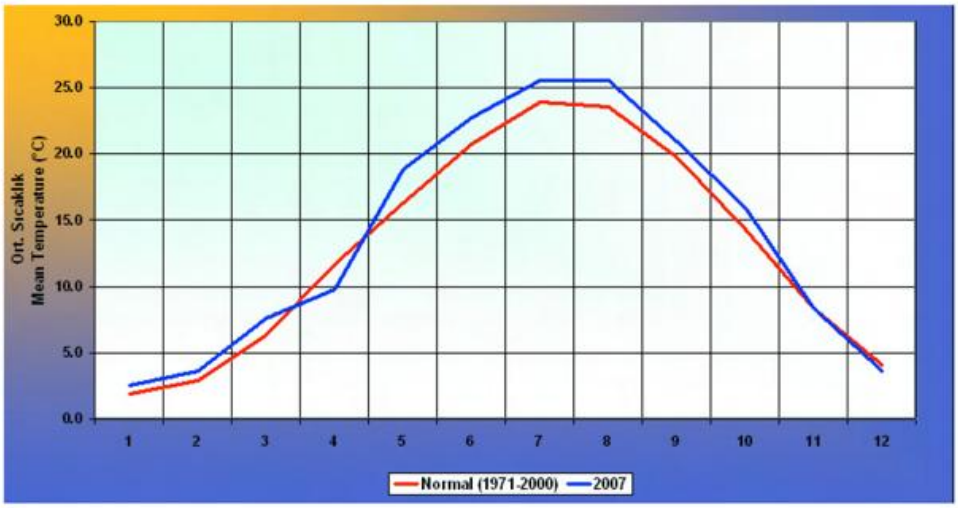


Fig. 0.12: *Monthly mean temperature 2007 compared to the 1971-2000 reference period in Turkey.*
Source: Turkish State Meteorological Service

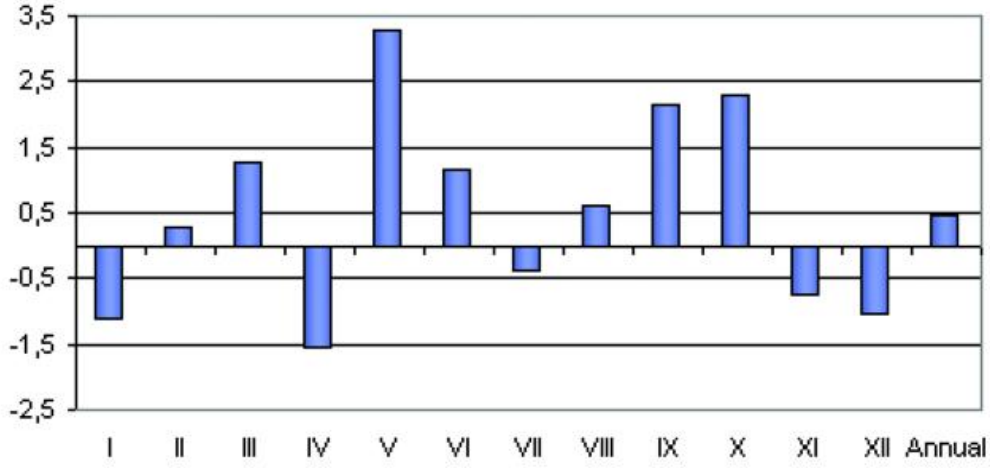


Fig. 0.13: *Monthly and annual mean temperature anomalies (°C; reference period 1961-1990) in Armenia.*
Source: Armstatehydromet, Armenia

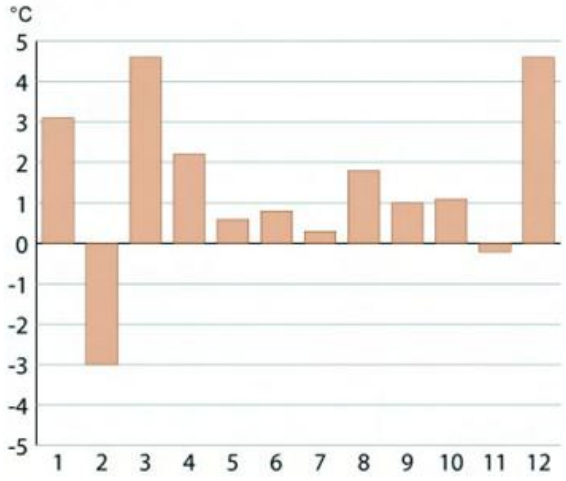
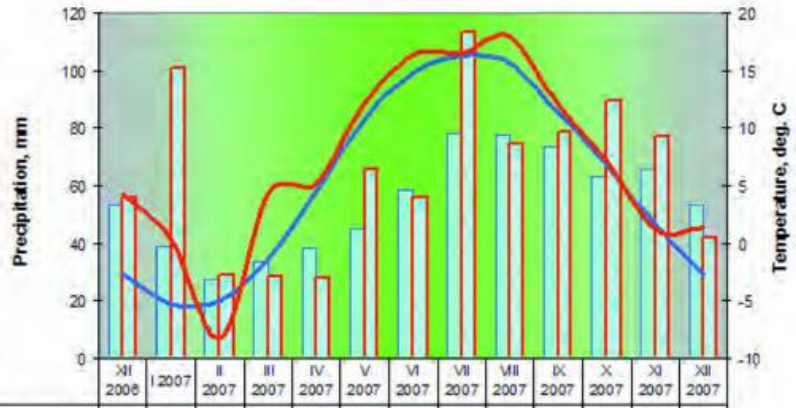


Fig. 0.14: *Monthly mean temperature anomalies (reference period 1971-2000) in Helsinki Kaisaniemi, Finland.*
Source: Finnish Meteorological Institute



	XII 2006	I 2007	II 2007	III 2007	IV 2007	V 2007	VI 2007	VII 2007	VIII 2007	IX 2007	X 2007	XI 2007	XII 2007
Monthly precipitation, 1961-1990	53	39	28	34	38	45	58	78	78	74	63	66	53
Monthly precipitation, 2007	56	101	29	29	28	66	56	114	75	79	90	77	42
Monthly mean air temperature, 1961-1990	-2.7	-5.3	-4.9	-1.3	4.5	10.9	14.8	16.4	15.7	11.4	6.8	1.6	-2.7
Monthly mean air temperature, 2007	4.3	0.3	-8.2	4.4	5.2	12.2	16.4	16.6	18.0	12.0	7.2	1.2	1.4

Fig. 0.15: *Monthly mean temperature and precipitation totals in Latvia. Source: Latvian Environment, Geology and Meteorology Agency*

Frost

The number of frost days (minimum temperature below 0°C) was exceptionally low in western and central Europe. Only 27 frost days were recorded at Brussels (Belgium) for the whole year and 42 frost days at Luxemburg airport, the normal is nearly twice as many. Neither ground nor air frost was seen during the whole summer half year (April-September) at Luxemburg airport.

Heat waves

Unusual heat waves (maximum temperatures 40-47°C, some set new records) occurred in southeastern Europe and the Middle East in June and July, and another weaker one in August. There were 23 to 52 hot days (maximum temperature greater than or equal to 30°C) in Moldova, 3 to 5 times more than the normal. In the Ukraine, 20 to 86 hot days were recorded, and 22 days with a maximum temperature of greater than or equal to 35°C in the south of the country. Even in eastern central Europe the number of hot days was high: 55 hot days were recorded in the Czech Republic on average in 2007; the normal is only 12 days per year.

Sea surface temperature of the North Sea and the North Atlantic

The mean sea surface temperature of the North Sea was the highest since 1971 with 1.7°C above the long-term mean. In winter 2006/07 and the month of December 2007 there was no ice formation recorded there. The high water temperature persisted until June, but decreased to nearly normal in the second half of the year due to colder northerly winds.

In the North Atlantic, the warmth coincided with the continuing warm phase of the Atlantic multidecadal oscillation, which began in the mid 1990s.

Precipitation

Most of the Region recorded annual totals near normal, mostly slightly higher (Fig. 0.16). A few locations all over the Region, however, were quite wet with annual totals exceeding 125% of the 1961-1990 normal. Many places in southern Europe and in the Middle East were drier than normal.

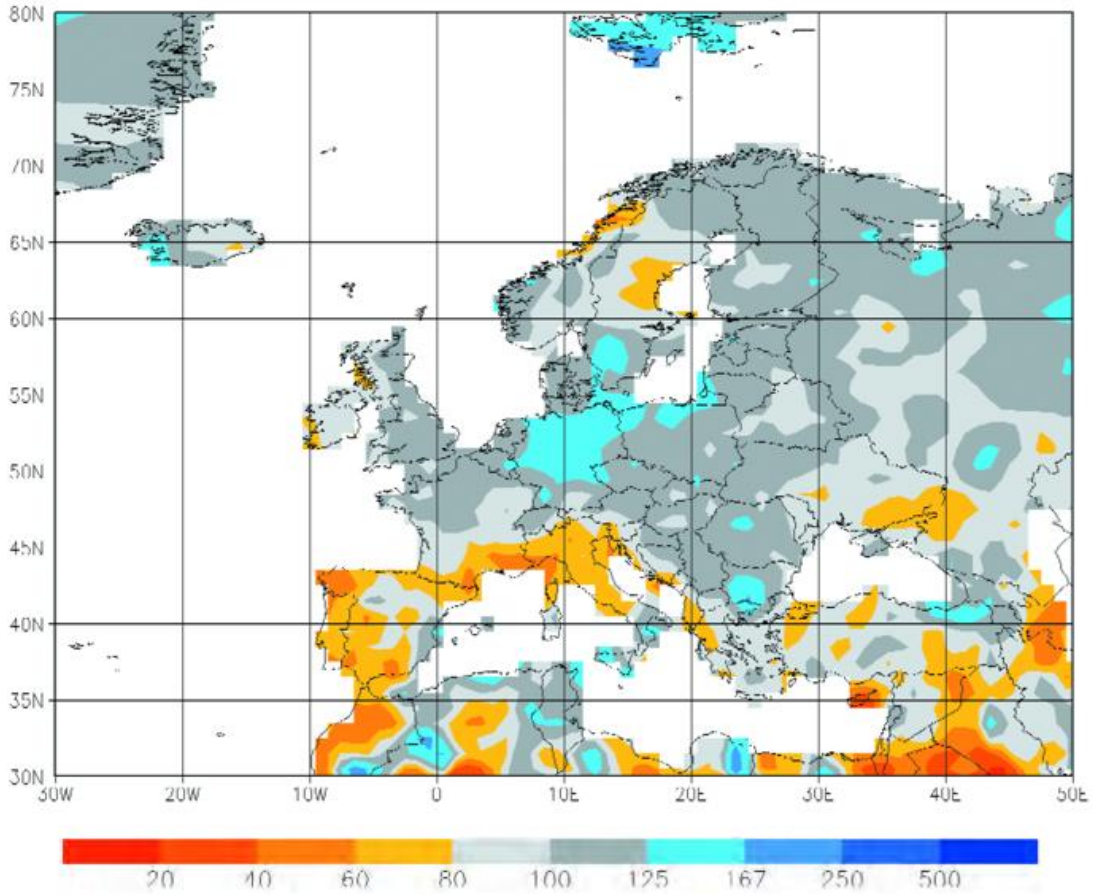


Fig. 0.16: *2007 annual precipitation amounts in WMO Region VI in per cent of the 1961-1990 normal. Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany*

Nordic countries

Precipitation in the Nordic countries was very variable. After a very dry summer in Iceland, the last third of the year was the wettest ever recorded in the southern and western parts of the country. Annual precipitation in Denmark was 155 mm above the normal of 712 mm. Here, in contrast to Iceland, much of the excess was due to an extraordinarily wet summer, the third wettest since 1874. Station records in Denmark show that annual precipitation has increased approximately 100 mm since measurements started in 1870. Annual precipitation for Sweden as a whole was not exceptional; but large regional deviations from the long-term mean occurred. In southern Sweden, several stations reported the rainiest summer since records began, and some records for monthly and annual precipitation were broken; 1725 mm of annual precipitation was a new Swedish record this year (station Baramossa, Halland region, southwest Sweden). In Norway, the wettest seasons were winter and spring. Svalbard on the whole was considerably wetter than the normal annual mean.

Northwestern and central Europe

Although annual precipitation totals were near normal in most of northwestern Europe, England and Wales saw their wettest May to July period ever registered since 1766 with a total precipitation of 415 mm. The result was severe damage due to flooding. It was the severest flooding in southern and central England for 60 years.

In Germany, it was the 4th wettest year since the beginning of the 20th century; nine months of the year were wetter than normal with May being the wettest since 1901. An extremely dry April (nearly no precipitation at all in many parts of central Europe) did not wholly counterbalance the annual excess.

170% of the normal annual total was recorded in northeastern Austria. A new record annual total of 957 mm was measured at Eisenstadt in the Burgenland region in eastern Austria, although there was no precipitation at all in April (Fig. 0.17).

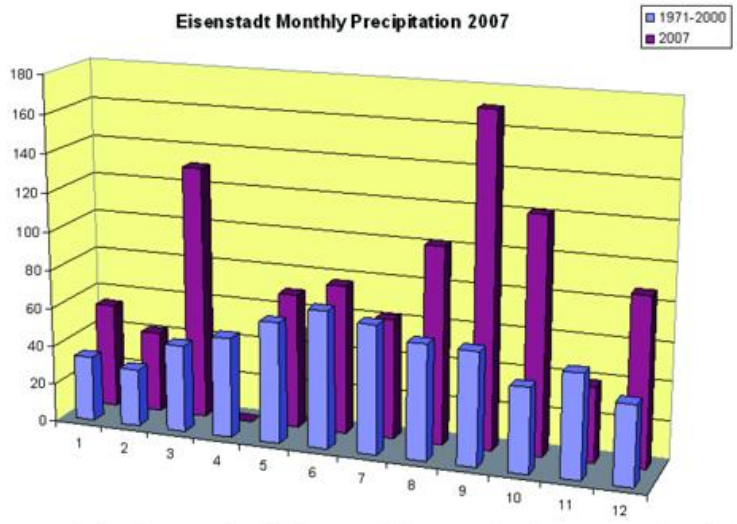


Fig. 0.17: *Monthly precipitation totals 2007 at Eisenstadt (eastern Austria) compared to the 1971-2000 normal.*
Source: Central Institute of Meteorology and Geodynamics, Austria

Southeastern Europe

Parts of Romania, northern Serbia, Bulgaria, and also northeastern Turkey experienced above-average annual precipitation totals of up to about 150% of the normal. Sofia (Bulgaria) received more than double the average amount of rainfall in every month from August to November, and precipitation amounts in Romania were considerably higher than normal in these months, after a drier than normal period from April to July.

Southern Europe and Middle East

In southern Europe and the Middle East, especially large parts on the Iberian Peninsula, southern France, northwest Italy, Israel, Jordan (Fig. 0.18) and Azerbaijan were very dry, receiving locally less than 60% of the normal annual total. Vigo (Galicia, northwestern Spain) recorded only 1038 mm of rainfall (54% of the 1971-2000 average), which was the lowest since measurements began in 1951. For the whole of Portugal it was the second driest year since 1931 (behind 2005, Fig. 0.19). Southeastern Switzerland had 75% of the normal monthly total; it was one the ten driest years in Lugano where regular measurements started in 1864. In the Italian region of Emilia-Romagna (near Bologna), the lowest annual precipitation total since 1925 was recorded with less than two thirds of the normal. Monaco also received very low precipitation totals: only 337 mm were registered at the station in the exotic garden of Monaco for the whole year, this was around half of the long-term mean 1911-1985 at the nearby station of the oceanographic museum. Especially the first third of the year and the summer months were very dry there (Fig. 0.20). Turning to the eastern Mediterranean, Cyprus was also extremely dry with less than 40% of the annual total. Athens (Greece) had no rainfall from the beginning of June until mid October (129 days). From late June through to early September, over 3000 fires were reported in Greece, causing 79 fatalities and destroying more than 2700 km² of forest and farmland. Albania also was very dry especially in the summer half year

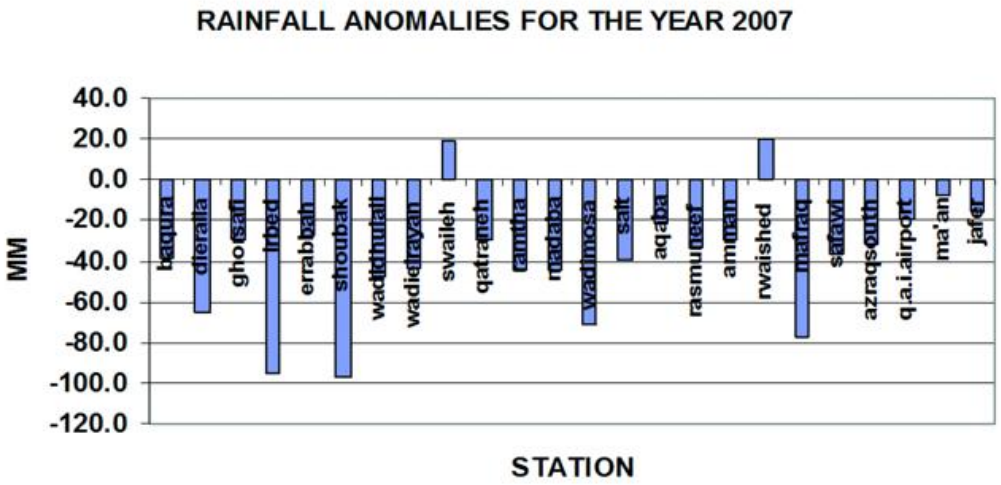


Fig. 0.18: *Annual precipitation anomalies 2007 (reference period 1961-1990) at stations in Jordan. Source: Meteorological Department Amman, Jordan*

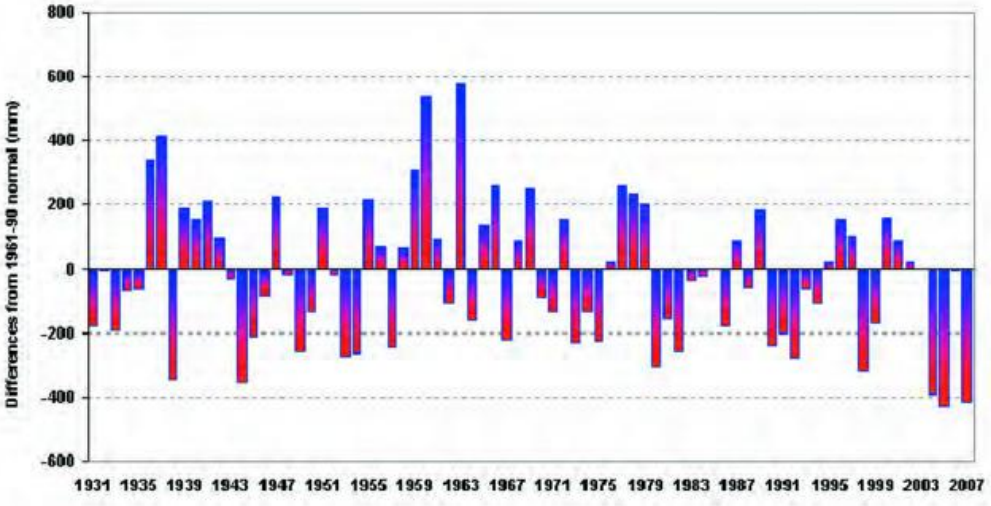


Fig. 0.19: *Mean annual precipitation anomalies in Portugal (1931-2007). Source: Instituto de Meteorologia, Portugal*

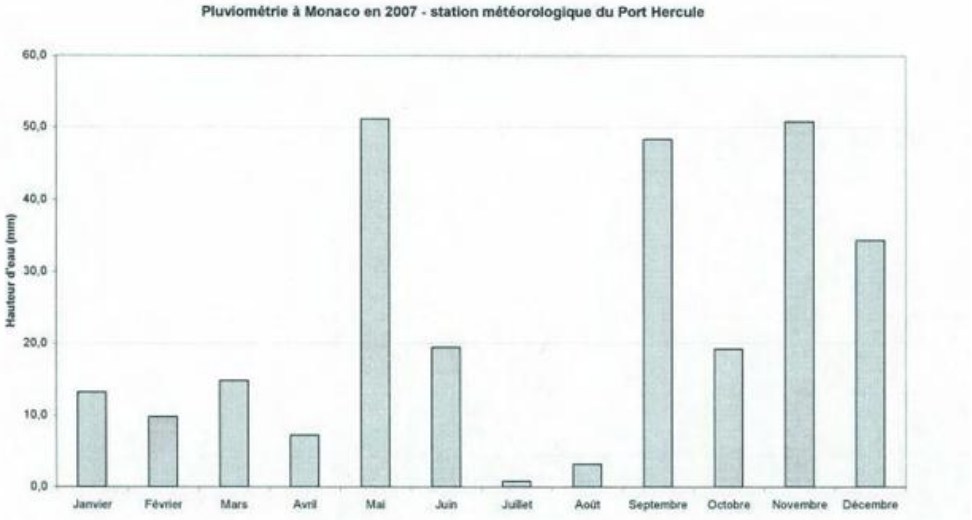


Fig. 0.20: *Monthly precipitation totals 2007 in Monaco (Port Hercule station). Source: Direction de l'Environnement, Monaco*

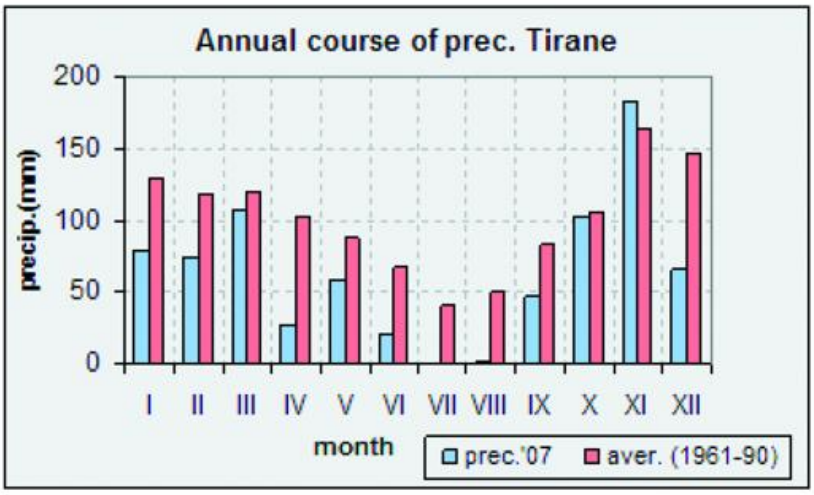


Fig. 0.21: *Monthly precipitation totals 2007 in Tirana (Albania) compared to the 1961-1990 normal. Source: Institute for Energy, Water and Environment, Polytechnic University, Albania*

(Fig. 0.21). Moldova had a dry period from May to July; only 45-140 mm, i.e. 18-56% of the normal total, were registered for these three months together. This was due to four longer episodes without any rainfall, just like in Romania. This led to the severest drought in Romania and Moldova for at least 60 years and caused high crop losses. Another extreme spring-summer drought (middle of May until middle of August) occurred in the southeastern Ukraine. In May it was already too dry for germination of some sowings. In the Middle East, the precipitation affected various seasons throughout the year, e.g. in Beirut (Lebanon, Fig. 0.22).

In the easternmost parts of the Region, the annual average precipitation was near normal, whereas the area was particularly wet in winter and spring. Hard drought conditions were reported from eastern and southern Georgia from the second half of July through to September.

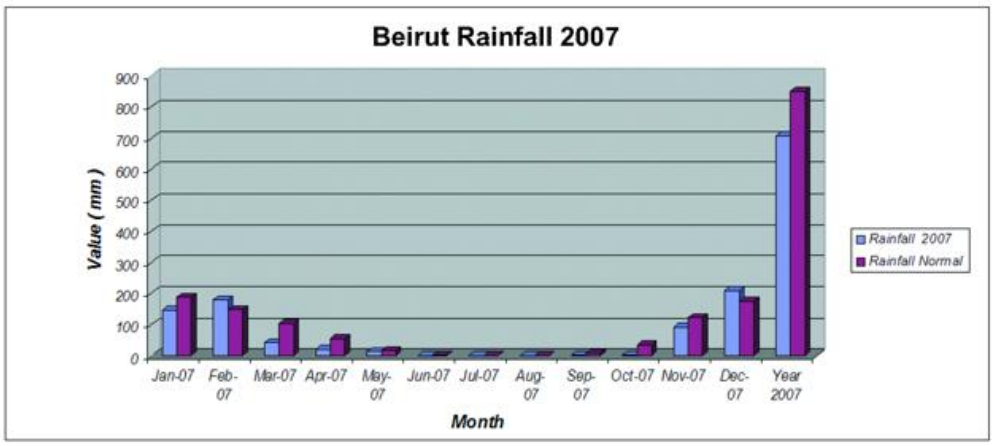


Fig. 0.22: *Monthly precipitation totals 2007 in Beirut (Lebanon) compared to 1961-1990 normal. Source: Ministry of Public Works and Transport, Climatological Service, Republic of Lebanon*

Snow

Snow was generally rare. At Luxemburg airport only 19 snow days were recorded. This is only a little more than half of the normal (36 days).

However, some periodically high snow depths were recorded in 2007. Heavy snowfall events in Switzerland at the end of autumn and beginning of winter 2007/08 brought an early snow cover in the Alps which resulted in significantly higher snow depths as compared with the long-term mean for that season.

In Iceland, except for a two-week period in January the snow cover in 2007 was very light compared to the normal 1961-1990.

Northeastern Europe had a persistent snow cover mainly only in February.

The high mountains of Lebanon received 30% less snowfall than normal. The number of snow days was also less than normal.

Sunshine duration

The majority of the Region was by far sunnier than normal, though, with a few exceptions not beyond 25% (Fig. 0.23). In some months, however, sunshine duration exceeded 150% of the normal in some places. The most outstanding month was April which was very sunny in large parts of western, central and eastern Europe, at many locations it was the sunniest April ever recorded (see also Fig. 4.7 on p. 57). Some locations in Ireland had their sunniest year since 1968.

Only a few larger areas experienced less sunshine than normal: eastern Iceland, northern Scotland, parts of Finland, northern Russia, Belarus, and most of the Middle East. Especially December was very dull in some of these areas, partly with less than 25% of normal sunshine duration.

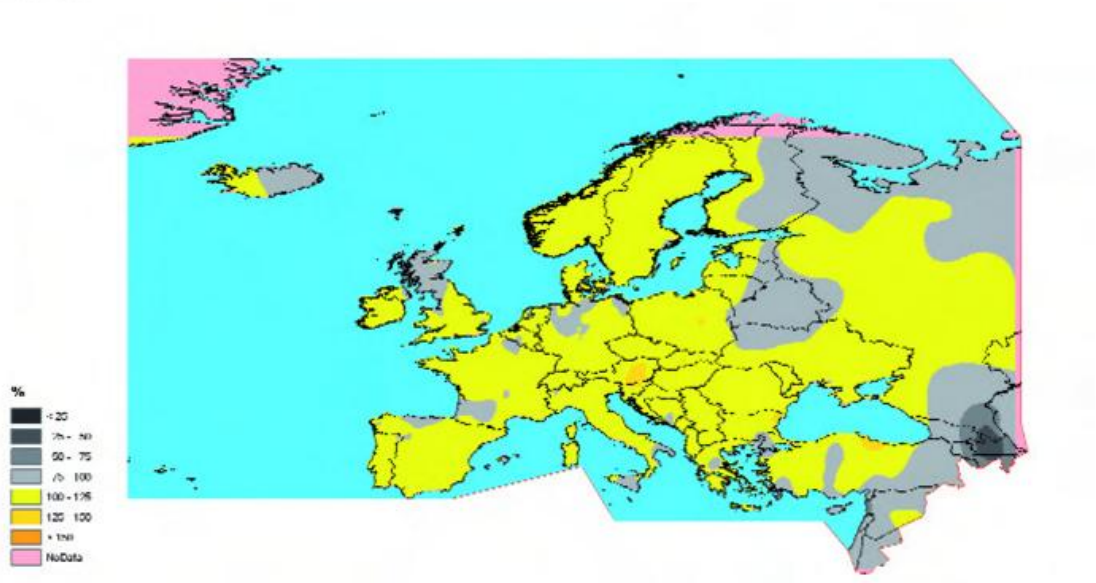


Fig. 0.23: *Mean annual sunshine duration 2007 in per cent of the 1961-1990 normal in WMO Region VI (interpolation of CLIMAT data).*
Source: Deutscher Wetterdienst, Germany

Wind

Many storms moved over northern central Europe, especially in January. The strongest storm, which crossed most parts of central Europe and caused extensive damage was winter storm Kyrill on 17-19 January.

In the east of the Region, wind gusts of over 150 km/h were reported from Armenia (particularly in the basin of Lake Sevan) and Azerbaijan during the period from January to March.

Summer storms affected the western and northern sectors of Iberia, especially in July and August. In late August, the eastern coast of Sweden was hit by a storm with winds as high as 125 km/h. This was the first heavy storm in August in Swedish coastal areas since 1975.

Another storm on 9 November caused high waves in the North Sea of up to 17-18 m and heavy flooding on the islands. December was very stormy in Iceland, causing interruptions in air and land communication on several occasions.

Mean annual wind speeds were exceptionally low in Ireland, with lowest values recorded at Rosslare station.

15 tropical storms developed over the Atlantic. Six of them became hurricanes. This number corresponds to the long-term average. None of these storms affected the Region.

Arctic sea ice

The mean extent of Arctic sea ice amounted to 4.28 million km² in September 2007. This was the smallest extent ever recorded since the start of satellite observations in 1979. At the end of the annual melting period the total Arctic sea ice area was 39% below the long-term mean of 1979-2000 and 23% below the previous record in 2005.

Seasonal Survey

Temperature

In most of Europe the seasonal averages were higher than normal in winter 2006/07, spring 2007 and summer 2007, wheras autumn 2007 was colder than normal over large parts of the continent.

Winter 2006/07 was very mild over most of Europe with significant anomalies exceeding +3°C particularly in central and eastern Europe and +5°C in some parts of the southeast. Around Svalbard, winter temperatures were up to +8°C above normal. In northeastern Europe, February was the only cold winter month, but it did not counterbalance the other two very mild months of the season.

It was the warmest winter on record in England, central and southeast Europe (Slovakia, Hungary, Romania, Croatia, Belgrade in Serbia, Slovenia) and Malta. The recurrence time of such a mild winter was calculated to be more than 50 years for most of central and southeastern Europe, partly even more than 100 years (Fig. 0.24). This was consistent with a strong positive phase of the winter North Atlantic Oscillation (NAO). Furthermore, the North Atlantic and the Mediterranean were warmer than normal, in some parts significantly warmer. A large area with considerable cold anomalies, however, was observed in most of the Middle East.

The mild winter in central Europe led to an early start of the growing season, but also caused some damage to agriculture due to an increased development of mouse population.

Spring 2007 was also significantly warm over most of Europe. Mean anomalies again exceeded +3°C in parts of western, central, southeastern and northeastern Europe, in Spitsbergen even +4°C. In many places there, this was the warmest or second warmest spring ever recorded,

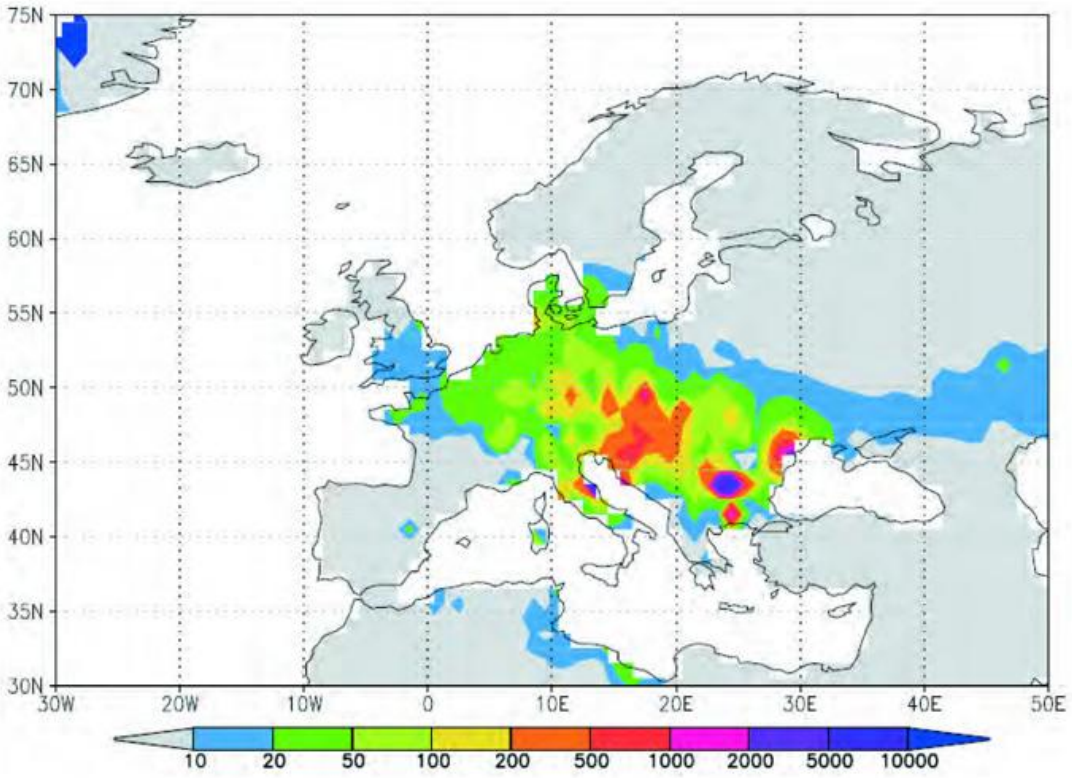


Fig. 0.24: *Recurrence time (in years) of winter 2006/07 temperatures in Europe, based on the HadCRUT3 data set of the Hadley Centre, United Kingdom, corrected for global warming. HadCRUT3 = Hadley Centre and Climate Research Unit temperature Version 3. Provided by KNMI, The Netherlands*

mainly due to the strong anomalies in April. It was the third successive season with a new record in central Europe. The North Atlantic, the Mediterranean and even most of the Middle East were also warmer than normal. Colder-than-normal anomalies occurred only locally.

Summer 2007 again was warmer than normal in nearly the whole Region with smaller but still mostly significant anomalies due to a cool July and August in western Europe.

At Svalbard airport, the summer mean temperature amounted to 6.4°C and was over +2°C higher than normal. This resulted in the warmest summer since the start of measurements in 1912. In Denmark and Sweden, summer started with a very warm and sunny spell in the first half of June, whereas the rest of the summer was dominated by unsettled weather. In contrast, Finland had unusually warm weather only in early August.

The highest anomalies (> +3°C) occurred in southeastern Europe (Bosnia and Herzegovina, Serbia, northeast Romania, Moldova, southern Ukraine) due to some extreme heat waves throughout all summer months. Especially in June and July, two outstanding heat waves occurred there with record daily maximum temperatures of 40-47°C, and also in August temperatures of > 40°C were measured. Several countries in southeastern Europe had their warmest summer since records began. Twice, and in some places even three times as many hot days than usual were recorded in Serbia. Forest fires devastated thousands of hectares of land particularly in Serbia, Croatia, Romania, Bulgaria and Greece. It was the second warmest summer in Romania since 1901, behind 1946, and also in Hungary (behind 2003). The two heat waves also affected the Middle East. Temperatures in Lebanon, Cyprus and most of Syria exceeded the 90th percentile during the summer months. Frequent forest fires occurred.

In contrast, there was no summer heat wave the in Portugal for the first time since 1997, and thus, the anomalies were only slightly positive there. The country recorded the lowest summer mean temperature since 1990.

Again, slight colder-than-normal anomalies occurred only locally, especially over the east Atlantic. Nevertheless, it was the coolest summer in Ireland since 2002, although summer mean temperatures were slightly higher than normal. Only two summer days (Tmax >= 25°C) were recorded in Ireland (10-11 June).

Autumn 2007 set an end to the series of long warmer-than-normal periods in large parts of central, southern, southeastern and also some of eastern Europe – it was the only season in 2007 in this area which was colder than normal, although the difference was slight. Even the eastern provinces of Spain were under the influence of cold air advection. However, only in some parts of eastern and southeastern Europe (e.g. the Baltic countries, Austria, Croatia) the seasonal mean anomalies were below -1°C and thus significant. It was the coldest autumn for nearly 20 years (since 1988) in Hungary.

On the other hand, autumn 2007 was significantly warm over the central North Atlantic with mean anomalies of up to +2°C (or more), and warm over most of northern, western and parts of eastern Europe, and in the Middle East. September and October were more than +2°C warmer than normal in Armenia, which can be put down to two strong heat waves on 4-9 September and 14-17 October.

Precipitation

Wet and dry periods changed frequently depending on the seasons. Whereas northern Europe was wet especially in winter and partly also in spring, western and central Europe had a very wet summer, and eastern and southeastern Europe a wet autumn.

Winter 2006/07 was very wet in the northern half of Europe and very dry in the southern half of the Region. It was the wettest ever recorded winter in Denmark and the second wettest in Latvia. Locally, seasonal totals exceeded 300% of the normal in Norway and 200% in some other parts, e.g. Poland. Less than 40% of the seasonal precipitation fell in parts of southern Spain, Greece and the Middle East.

Due to the mild and mostly dry winter in the Alps, snow was quite rare there (Fig. 0.25). Further southeast, there was not a single day with snow cover in some places in Serbia (Vojvodina); as opposed to a normal of 30 days. In Scandinavia, due to higher-than-normal winter temperatures, only the northern parts and the highlands had a persistent snow cover during the whole winter season and more snow than normal. In many parts of the southern half of northeastern Europe a persistent snow cover occurred only in February. Lower parts of southern Norway reported much less snow than normal.

Spring 2007 continued to be wet in most of Scandinavia and northern Russia, locally with over 200% of the normal seasonal precipitation; only central Sweden remained quite dry. Most of western and central Europe received a near-normal seasonal precipitation total: a very dry April was compensated by a very wet May. Most of eastern Europe, however, was very dry and also some areas south of the Alps and in the Middle East.

In the Netherlands, little or no precipitation fell during the period from 22 March to 6 May, making it the driest period in at least 100 years. In Uccle (Belgium), no rainfall occurred from 31 March to 7 May, which is there the longest ever recorded period without rainfall in spring.

In northeast Spain the seasonal totals were quite high due to heavy rain events from the end of March until the beginning of April. These heavy rainfalls, combined with snow melt caused flooding and severe damage to agriculture.

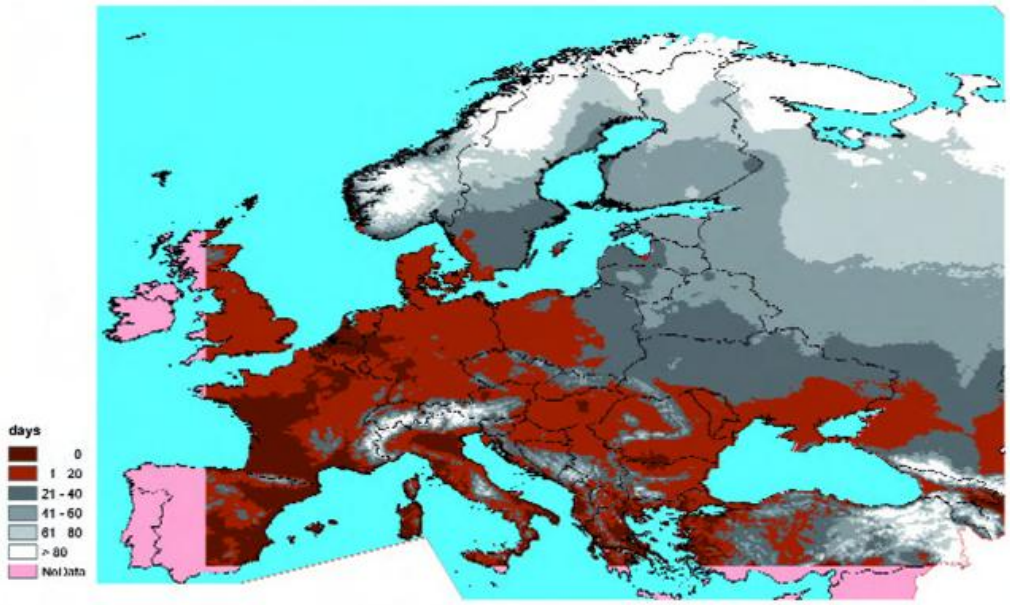


Fig. 0.25: *Number of snow days in Europe in winter 2006/07. NoData areas: no station observations available beyond the western and southern border lines for the whole winter. Source: Deutscher Wetterdienst, Germany*

Summer 2007 was very wet in most of western and central Europe with up to 200-300% of the seasonal precipitation in Ireland, parts of the United Kingdom and northern France. This was mostly due to thunderstorms and heavy rainfall, causing severe flooding. In Ireland, Kilkenny and Dublin Casement Aerodrome had their wettest summer since rainfall records began in the 1950s, while England and Wales had their wettest summer for over 90 years. 33 successive rain days (with at least 0.2 mm daily rainfall) were recorded in Dublin between 11 June and 29 July. Portugal saw its rainiest summer of the 21st century.

In northern Europe, there were wet as well as dry areas to be found. In Iceland, an extended period of warm and dry weather in June and July caused local water shortages, and the southeastern region of the country had its driest summer since 1873. This unusual dry spell was followed by an exceptional wet period beginning in the second half of August. Large regional precipitation occurred in Finland during the summer season, with some of the southeastern part of the country receiving precipitation amounts of 383 mm, which is 50% more than usual. Sweden was very dry in the north, but wet in the south. Several stations in southernmost Sweden recorded the rainiest summer ever. Parts of eastern Norway received 175-200% of the seasonal normal. Summer 2007 was the third rainiest summer in Denmark: only the first two weeks in June were dry, the rest of the summer was very wet with local floodings. It was also very wet around the southern Baltic Sea. Another zone of high precipitation can be found in northern Russia.

The Alpine region experienced unusually heavy thunderstorms with hailstones up to tennis ball size. Zurich (Switzerland) had its 4th wettest summer since measurements began in 1864. In some other parts of Switzerland this summer was the wettest ever recorded.

In contrast, it was drier than normal in southeastern Europe, around the Mediterranean and the Black Sea. Several sectors of eastern Iberia received less than 40% of the seasonal average. The southern Adriatic region was affected by severe drought in July and August with precipitation totals less than 60% of the normal. Only 15 mm of precipitation fell in Dubrovnik

(Croatia) during the whole summer season, making it the driest summer there since 1961. In the Middle East, parts of Syria, Lebanon and Cyprus received less than 50% of the normal rainfall. The Ukraine experienced the severest drought in summer for 100 years.

Autumn 2007 was very dry in western Europe, as opposed to the preceding summer. It was the driest autumn for more than 30 years in many places in Ireland and the driest autumn of the 21st century in Portugal. Southern Scandinavia and northern Russia were dry, too.

Central, southeastern and parts of eastern Europe, parts of the Mediterranean and southern Italy, however, had a large excess of precipitation. Autumn precipitation totals exceeded 200% of the normal e.g. in eastern Austria and parts of Serbia. Autumn floods were reported from many places in Romania.

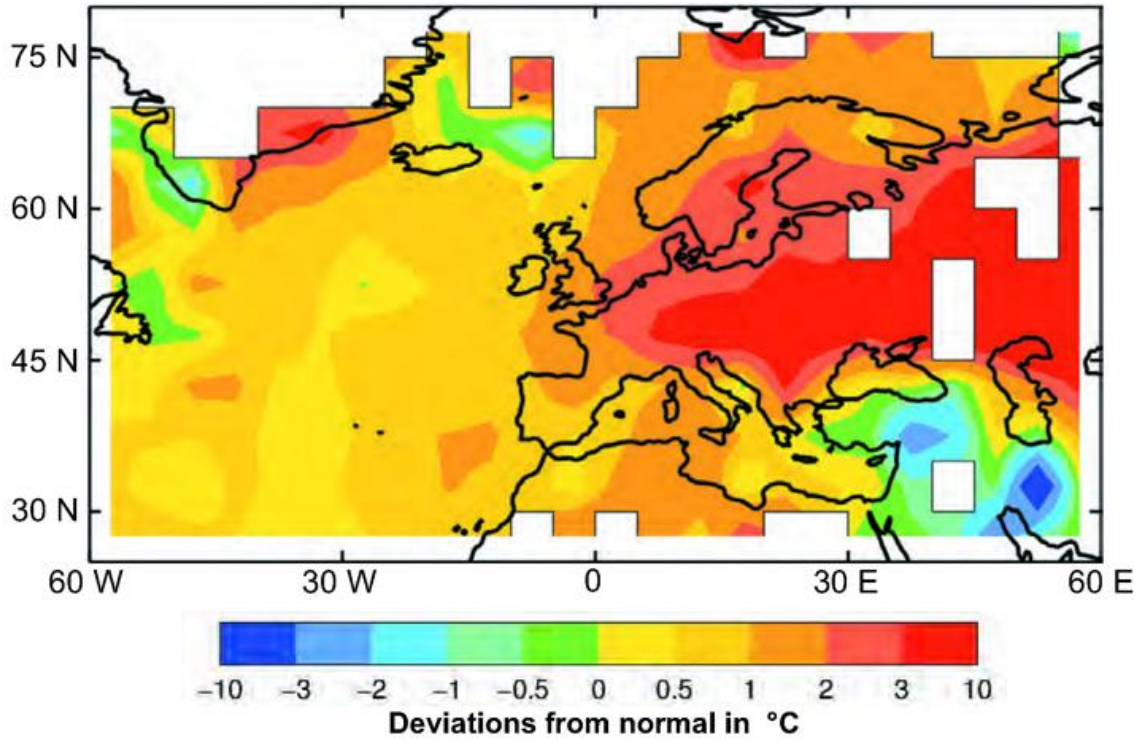
Seasonal Maps

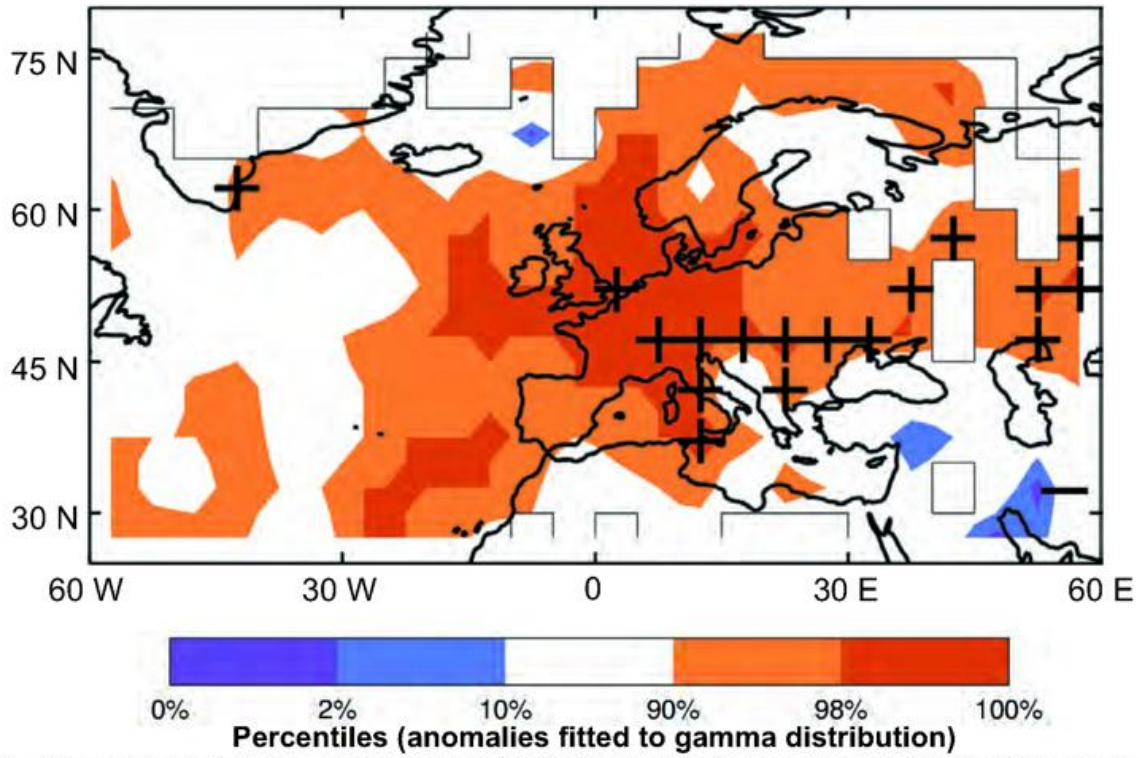
Surface temperature anomalies

Reference period: 1961-1990

Source: The Met Office Hadley Centre, U.K.

December 2006 - February 2007





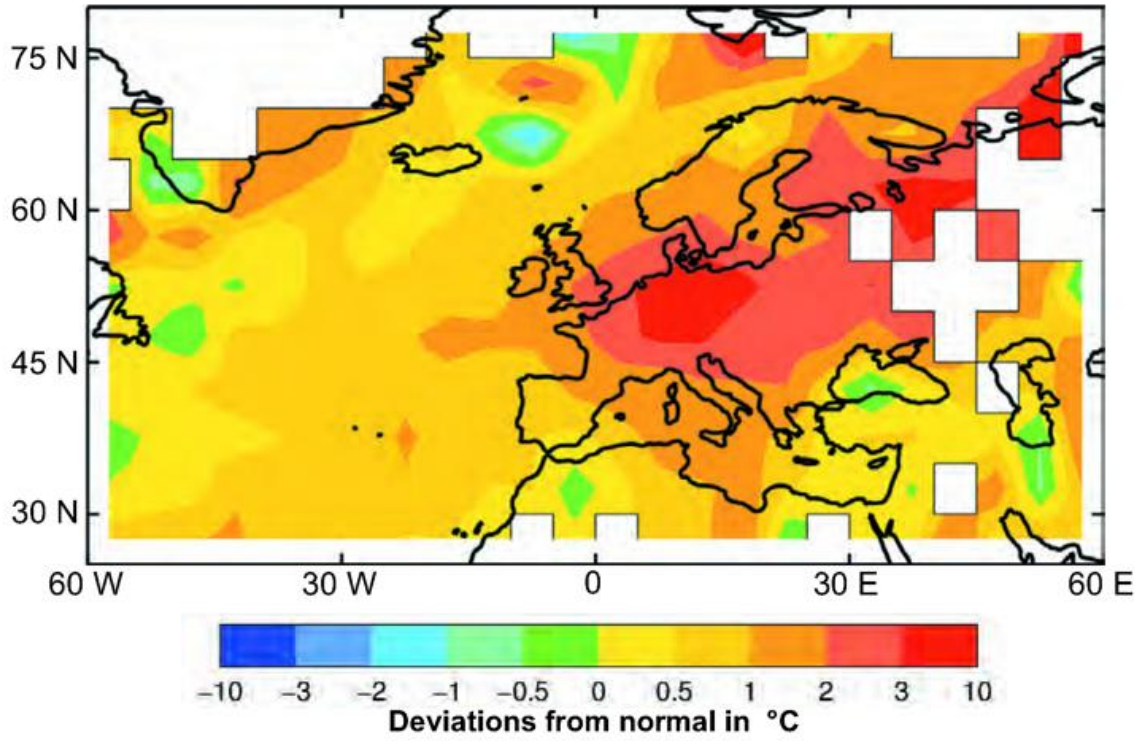
+/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the 158 year record

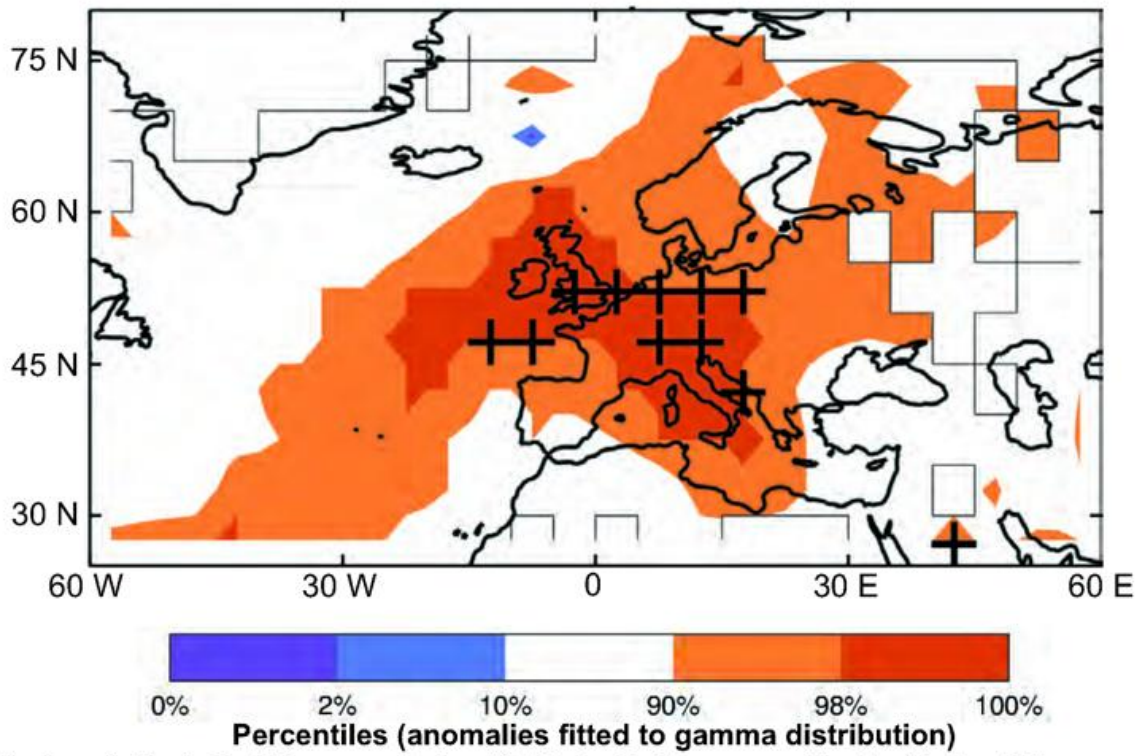
Surface temperature anomalies

Reference period: 1961-1990

Source: The Met Office Hadley Centre, U.K.

March 2007 - May 2007





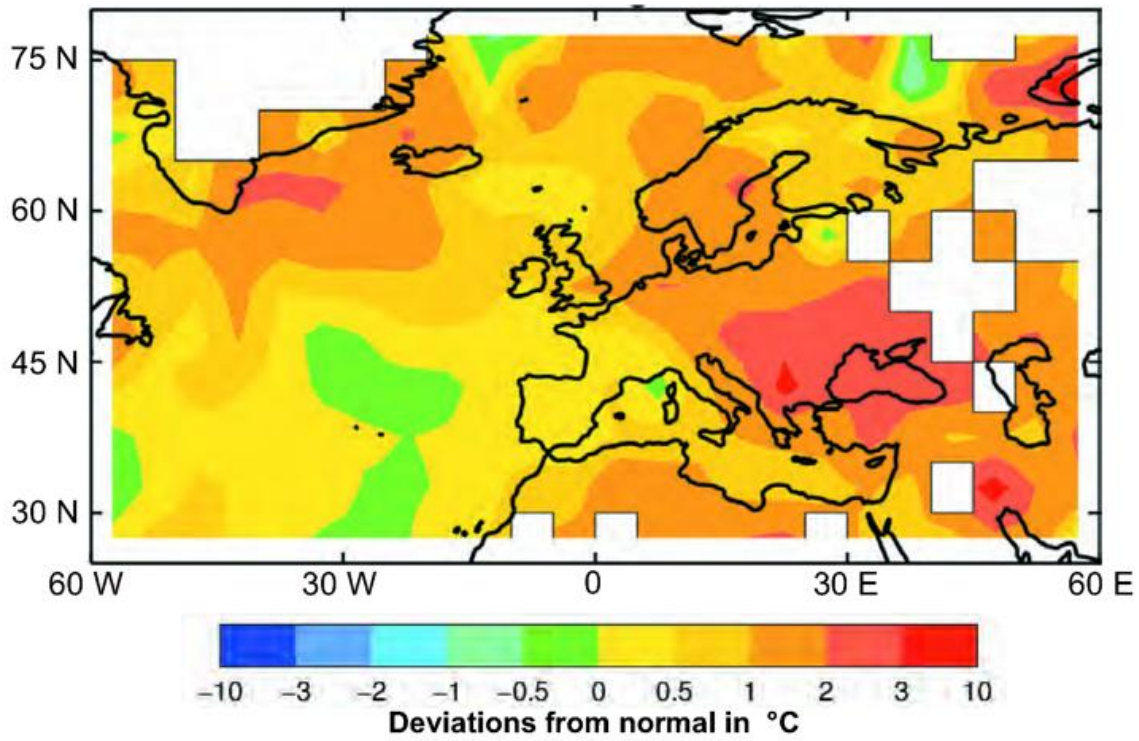
+/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the 158 year record

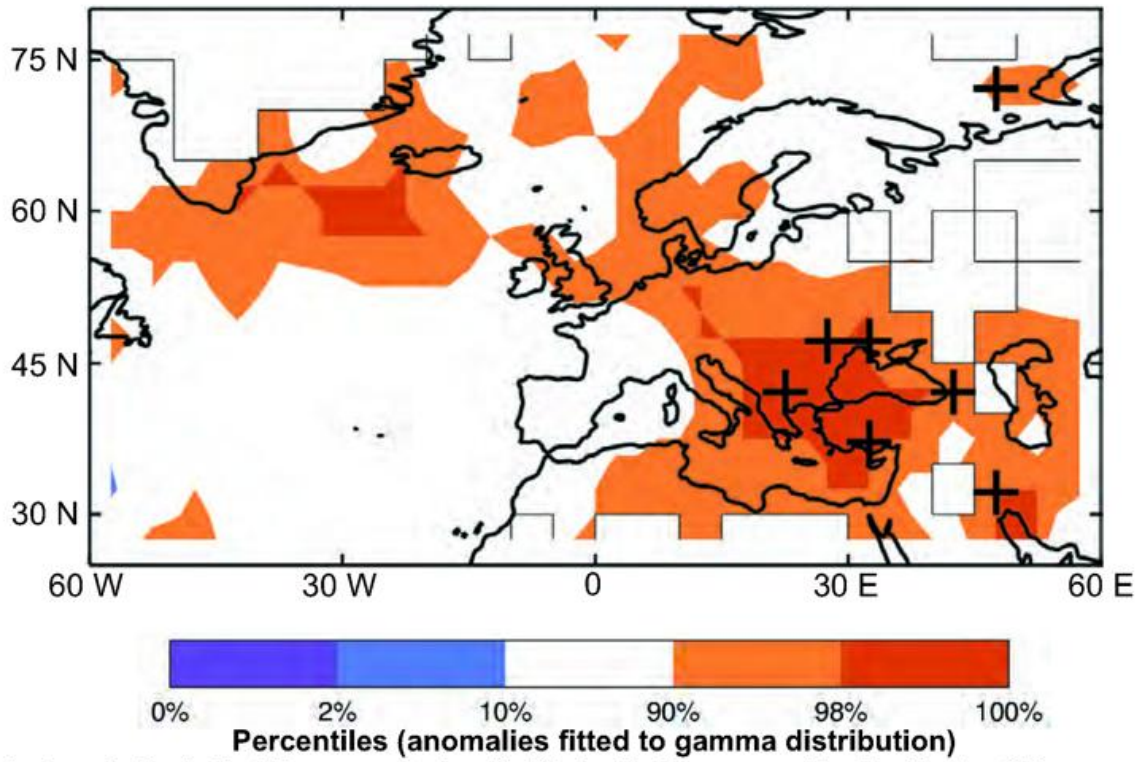
Surface temperature anomalies

Reference period: 1961-1990

Source: The Met Office Hadley Centre, U.K.

June 2007 - August 2007





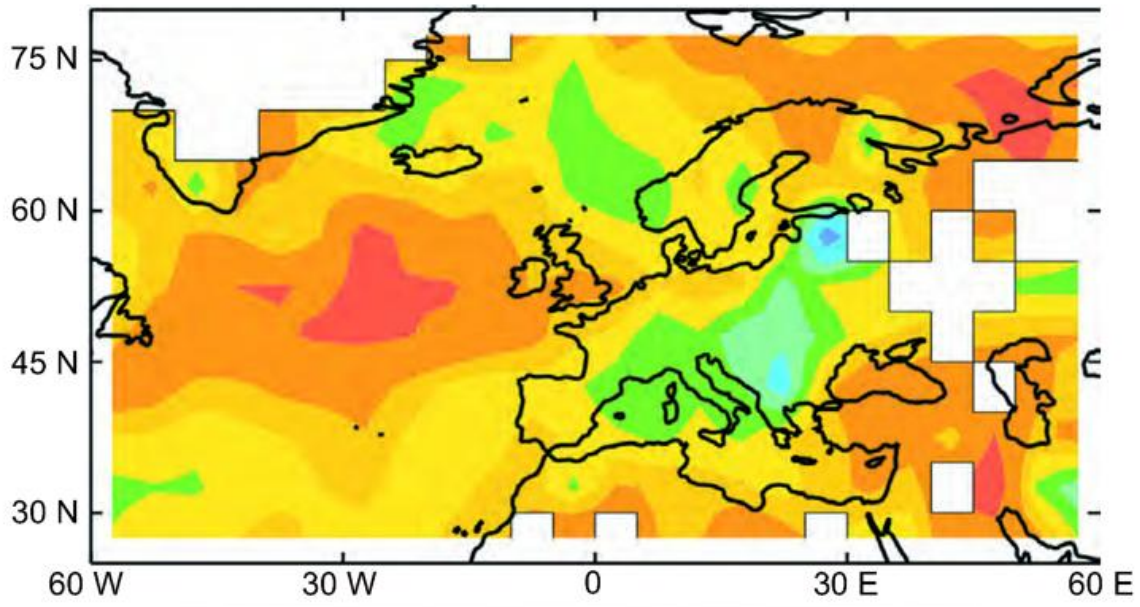
+/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the 158 year record

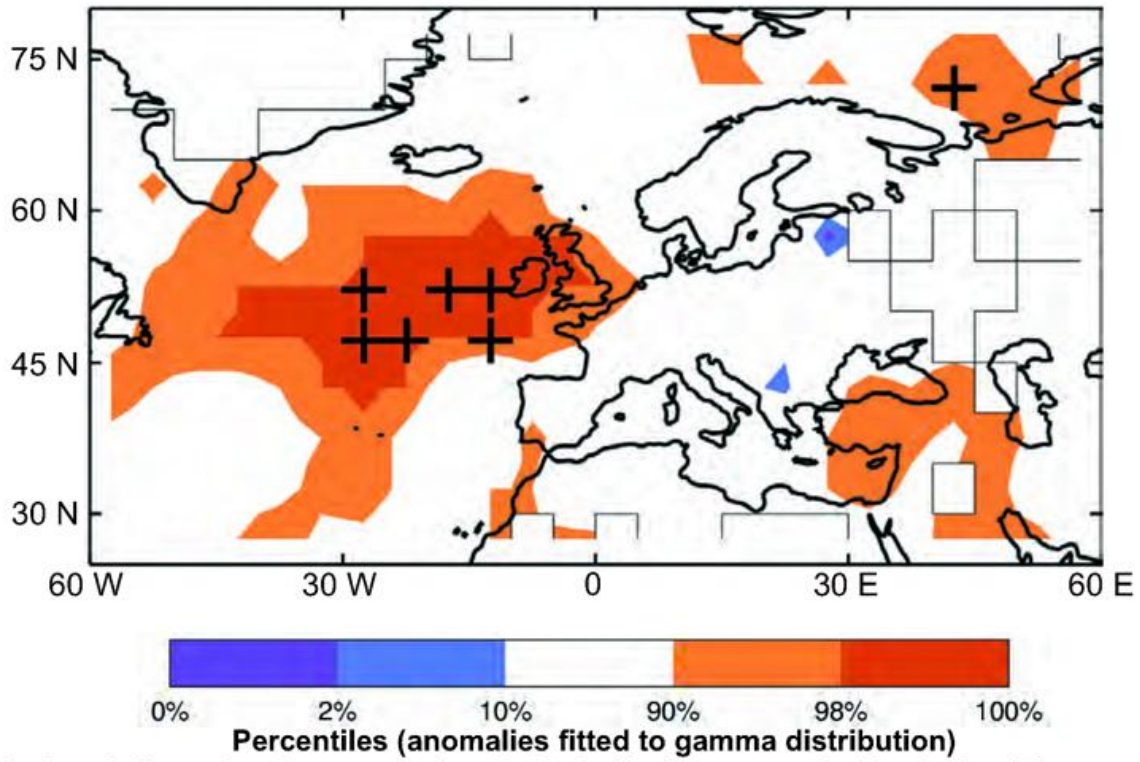
Surface temperature anomalies

Reference period: 1961-1990

Source: The Met Office Hadley Centre, U.K.

September 2007 - November 2007





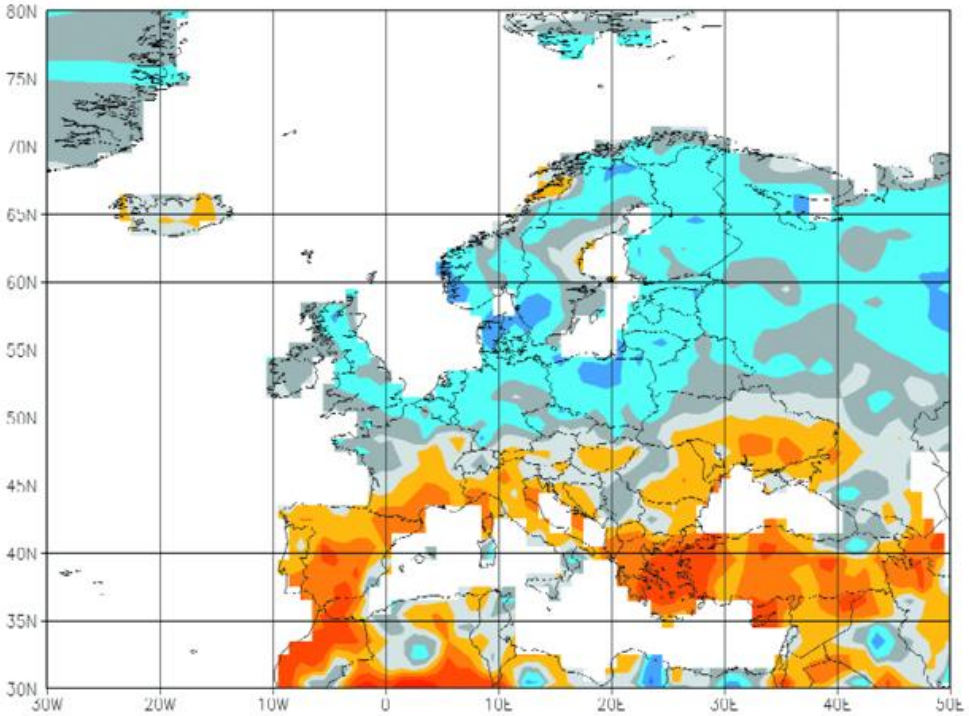
+/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the 158 year record

Precipitation in per cent of normal

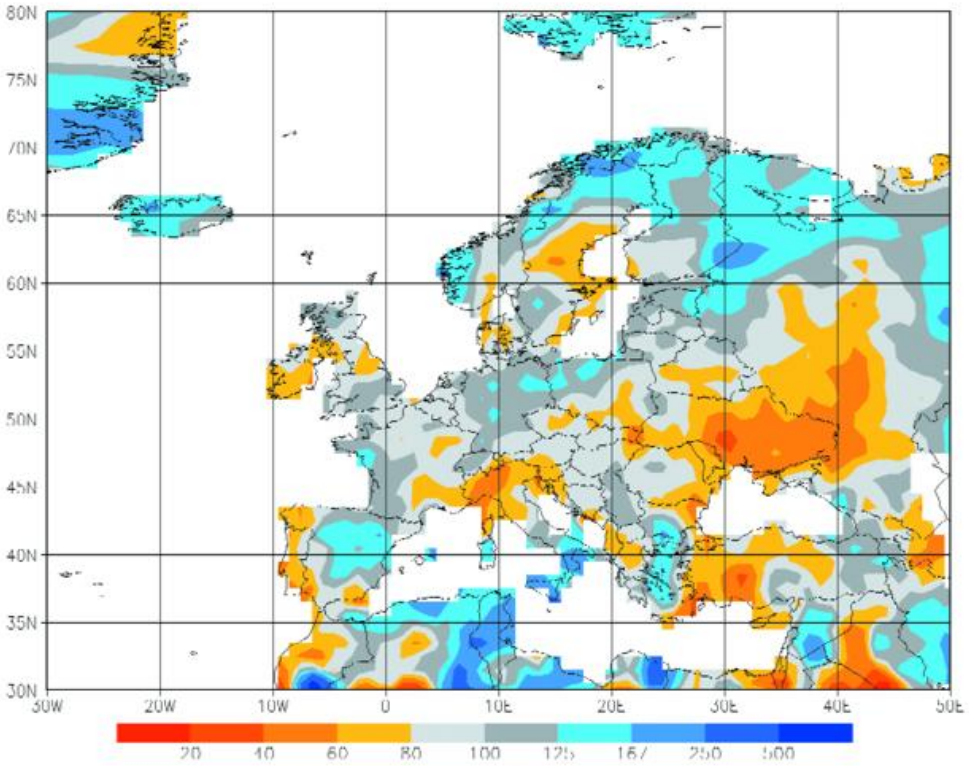
Gauge-based analysis 1.0 degree, reference period: 1961-1990

Source: GPCC / Deutscher Wetterdienst, Germany

December 2006 - February 2007



March 2007 - May 2007

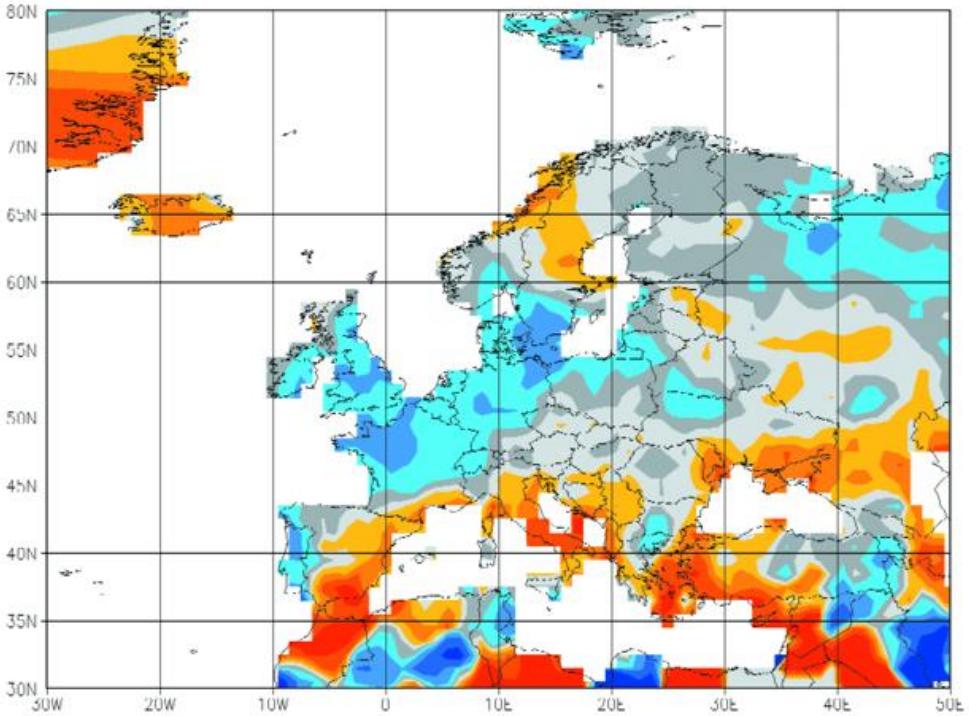


Precipitation in per cent of normal

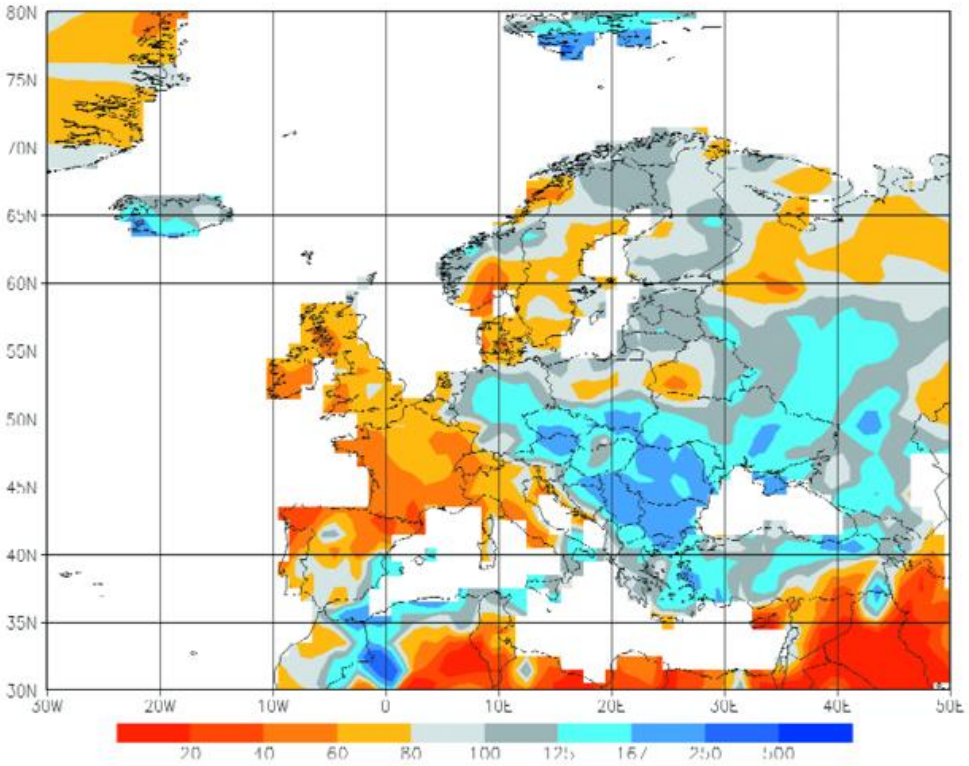
Gauge-based analysis 1.0 degree, reference period: 1961-1990

Source: GPCC / Deutscher Wetterdienst, Germany

June 2007 - August 2007



September 2007 - November 2007



Monthly and Annual Tables

Temperature and precipitation values with deviations from the 1961-1990 means
(some stations have shorter reference periods)

WMO No.	Station	January 2007 Temp. mean	(°C) dev.	Prec. (mm) total	dev.	February 2007 Temp. mean	(°C) dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	-9,0	6,4	11	-3	-9,0	6,7	7	-12
01025	Tromsoe	-3,0	1,0	117	36	-6,7	-3,0	70	-16
01492	Oslo	-0,9	3,4	71	22	-3,2	0,8	40	4
02196	Haparanda	-9,5	2,6	83	39	-14,8	-3,5	29	-3
02485	Stockholm	0,4	3,2	74	35	-2,8	0,2	26	-1
02974	Helsinki	-2,5	4,4	100	59	-9,6	-2,8	15	-16
03091	Aberdeen	5,6	2,9	49	-32	5,0	2,1	114	63
03772	London	7,9	3,7	56	4	7,1	2,6	92	57
03967	Dublin Casement Aerodrome	6,8	2,4	73	7	6,1	1,7	58	7
04030	Reykjavik	-0,6	-0,1	59	-17	0,7	0,3	44	-28
04320	Danmarkshavn	-22,4	0,7	18	7	-22,8	1,5	24	13
04360	Angmagssalik	-6,5	1,0	65	-47	-4,3	3,4	22	-69
06186	Copenhagen	5,1	4,6	85	34	2,3	1,8	32	1
06260	De Bilt	7,1	4,9	104	38	6,0	3,5	68	19
06447	Brussels	7,2	4,6	82	15	6,8	3,3	95	42
06590	Luxemburg	4,9	4,9	84	13	5,0	3,9	120	58
06660	Zurich	4,5	5,0	56	-11	4,8	3,9	70	0
06700	Geneva	4,3	3,3	76	7	5,6	3,1	103	33
07510	Bordeaux	8,1	2,3	82	-18	9,7	2,6	139	53
07650	Marseilles	8,6	1,9	14	-33	9,6	1,7	29	-25
08222	Madrid	6,5	0,4	12	-34	9,3	1,8	32	-12
08314	Mahon/Minorca	11,8	1,3	13	-53	12,1	1,4	50	-7
08495	Gibraltar	13,0	-0,4	137	16	15,2	1,4	101	1
08515	Santa Maria/Azores	15,7	1,3	99	-1	15,3	1,3	134	48
08535	Lisbon	11,2	-0,2	43	-67	13,2	0,9	116	5
10384	Berlin-Tempelhof	5,5	5,7	111	68	3,6	2,8	56	22
11035	Vienna	5,9	6,9	54	16	5,2	4,2	72	30
11518	Prague	4,0	6,4	34	11	3,7	4,5	24	1
11903	Slica	2,0	5,9	127	83	2,6	3,7	51	7
12160	Elblag	3,5	5,9	87	40	-1,3	0,9	34	9
12375	Warsaw	3,7	7,0	79	57	-1,1	0,9	30	9
12843	Budapest	5,2	6,8	24	-8	5,7	4,6	39	7
13274	Belgrade	7,5	7,1	49	0	7,1	4,4	56	12
14015	Ljubljana	4,9	6,0	89	7	5,9	4,5	126	46
14445	Split	10,4	3,0	60	-23	10,9	2,8	115	47
14654	Sarajevo	4,4	5,3	83	12	5,5	4,0	48	-19
15420	Bucharest	3,6	6,0	33	-7	2,7	2,8	18	-18
15614	Sofia	4,4	6,0	46	19	3,8	3,3	26	-7
16158	Pisa	9,1	3,0	63	-12	9,2	2,1	49	-24
16597	Luqa	14,5	2,3	9	-80	13,8	1,4	18	-43
16716	Athens	11,6	1,4	<1	-44	10,7	0,1	41	-2
16754	Heraklion/Crete	12,9	0,9	46	-44	12,0	-0,1	106	29
17040	Rize	7,3	1,0	185	-32	6,5	-0,1	156	-17
17062	Istanbul	8,7	3,1	37	-62	8,0	2,1	11	-56
17130	Ankara	1,4	1,3	39	-8	2,7	0,8	16	-20
17170	Van	-4,6	-0,4	18	-17	-0,9	2,5	11	-23
17609	Larnaka	11,5	0,0	30	-35	12,8	1,1	160	103
22113	Murmansk	-8,7	3,0	56	23	-16,8	-5,6	12	-10
26038	Tallinn	-0,9	4,6	99	54	-8,0	-2,3	17	-12
26629	Kaunas	1,3	6,3	90	53	-6,2	-1,9	31	4
26730	Vilnius	0,6	6,7	103	62	-7,3	-2,5	43	5
26850	Minsk	0,4	7,3	68	28	-7,9	-2,1	49	15
27595	Kasan	-3,2	9,9	61	28	-14,2	-2,7	53	25
27612	Moscow	-1,6	7,7	70	25	-11,0	-3,3	47	10
33345	Kiev	2,1	7,7	48	1	-4,1	0,1	61	15
33815	Chisinau	3,9	7,2	44	4	0,5	2,2	62	24
34300	Kharkiv (Charkow)	0,6	7,5	64	20	-4,7	1,0	32	0
34880	Astrakhan	2,5	7,9	7	-6	-2,1	2,8	5	-5
35188	Akmola	-8,5	7,3	13	-4	-10,9	5,0	36	22
37789	Yerevan	-8,4	-4,9	43	22	-0,8	0,2	4	-20
40030	Hama	6,2	-0,4	47	-26	9,7	1,4	42	-12
40180	Tel Aviv	12,6	0,3	111	-38	14,2	1,3	61	-37
40199	Eilat	15,6	0,4	6	1	17,7	0,8	3	-2
40265	Mafraq	7,1	-0,1	14	-20	9,7	1,0	29	-2
60030	L.Palmas/Gran Can.	17,7	0,2	82	65	18,0	0,4	<1	-22

WMO No.	Station	March 2007 Temp. mean	March 2007 (°C) dev.	March 2007 Prec. total	March 2007 (mm) dev.	April 2007 Temp. mean	April 2007 (°C) dev.	April 2007 Prec. total	April 2007 (mm) dev.
01008	Svalbard Airport	-6,7	8,0	18	-3	-9,4	2,3	4	-8
01025	Tromsoe	0,8	3,0	55	-9	1,3	0,6	138	78
01492	Oslo	4,2	4,4	29	-17	7,6	3,0	49	7
02196	Haparanda	-2,5	4,3	65	30	1,5	2,0	31	2
02485	Stockholm	4,7	4,6	19	-7	8,2	3,6	16	-14
02974	Helsinki	2,9	5,8	30	-4	5,3	2,4	47	10
03091	Aberdeen	6,7	2,2	34	-24	10,0	3,7	27	-26
03772	London	8,6	2,1	44	-3	13,3	4,4	4	-41
03967	Dublin Casement Aerodrome	6,6	0,6	46	-3	10,6	2,8	5	-42
04030	Reykjavik	2,2	1,7	129	47	5,2	2,3	65	7
04320	Danmarkshavn	-21,2	2,2	17	0	-15,0	2,3	5	-5
04360	Angmagssalik	-5,7	2,5	70	-18	-1,7	2,4	139	66
06186	Copenhagen	7,0	4,4	22	-20	9,9	3,3	13	-29
06260	De Bilt	8,0	3,0	85	22	13,1	5,1	0	-52
06447	Brussels	8,0	2,5	62	8	14,3	5,5	0	-57
06590	Luxemburg	6,4	2,4	83	13	14,6	7,1	7	-54
06660	Zurich	5,7	1,5	107	38	13,9	6,1	6	-81
06700	Geneva	6,7	1,4	79	-2	14,3	5,3	23	-43
07510	Bordeaux	9,7	0,9	93	17	15,6	4,3	35	-37
07650	Marseilles	11,2	1,0	7	-37	16,6	3,4	30	-18
08222	Madrid	10,1	0,1	18	-15	13,2	1,0	88	34
08314	Mahon/Minorca	11,7	0,1	82	27	15,5	2,2	129	79
08495	Gibraltar	15,4	0,4	23	-52	16,0	-0,2	83	23
08515	Santa Maria/Azores	15,0	0,4	20	-59	16,3	1,1	133	78
08535	Lisbon	14,4	0,7	17	-52	15,9	0,8	45	-19
10384	Berlin-Tempelhof	7,7	3,5	61	24	12,1	3,5	2	-39
11035	Vienna	7,6	2,6	90	49	13,2	3,3	1	-50
11518	Prague	5,9	2,9	17	-11	11,2	3,5	3	-35
11903	Slica	6,2	3,2	70	28	10,6	2,1	<1	-47
12160	Elblag	7,0	4,9	31	-4	8,1	1,3	24	-18
12375	Warsaw	7,2	5,2	27	-1	9,7	1,9	16	-16
12843	Budapest	8,1	2,5	35	6	14,0	2,9	3	-35
13274	Belgrade	10,1	2,9	100	50	14,7	2,3	4	-55
14015	Ljubljana	8,5	3,1	112	14	14,6	4,7	6	-103
14445	Split	12,4	2,0	164	89	17,3	3,4	22	-44
14654	Sarajevo	7,3	2,2	79	9	11,7	2,3	19	-55
15420	Bucharest	7,0	2,2	36	-2	11,5	0,2	7	-39
15614	Sofia	6,8	2,2	31	-7	11,5	1,6	12	-38
16158	Pisa	10,3	0,8	62	-14	14,8	2,3	2	-77
16597	Luqa	14,3	0,9	68	27	16,7	1,2	5	-18
16716	Athens	13,1	0,5	49	8	16,6	0,5	5	-20
16754	Heraklion/Crete	14,1	0,7	11	-45	15,9	-0,4	8	-22
17040	Rize	8,9	1,0	154	7	10,0	-1,6	120	19
17062	Istanbul	9,7	2,2	47	-15	11,7	-0,3	16	-33
17130	Ankara	7,3	1,2	38	2	9,2	-2,0	24	-24
17170	Van	3,0	1,9	35	-8	5,9	-1,4	87	33
17609	Larnaka	14,2	0,9	23	-26	16,8	-0,6	21	10
22113	Murmansk	-0,6	6,2	22	2	0,4	2,3	33	12
26038	Tallinn	3,0	5,2	31	2	5,2	1,8	36	0
26629	Kaunas	5,2	5,4	31	-1	7,1	1,1	22	-21
26730	Vilnius	5,1	5,7	33	-6	6,4	0,7	20	-26
26850	Minsk	5,2	6,6	29	-13	6,5	0,5	21	-21
27595	Kasan	-1,2	4,1	30	4	6,1	1,5	39	3
27612	Moscow	4,4	6,6	39	5	5,8	0,0	24	-16
33345	Kiev	6,3	5,6	15	-24	9,0	0,3	9	-40
33815	Chisinau	7,1	4,2	34	-1	10,6	0,4	37	-5
34300	Kharkiv (Charkow)	4,7	5,0	24	-3	8,4	-0,5	14	-22
34880	Astrakhan	3,4	2,1	2	-12	10,1	-1,0	68	50
35188	Akmola	-9,0	-0,9	20	6	7,2	2,3	25	3
37789	Yerevan	8,1	2,3	65	33	9,0	-3,7	101	64
40030	Hama	13,1	1,5	18	-31	15,0	-0,9	36	4
40180	Tel Aviv	15,7	0,8	62	0	18,8	0,6	0	-23
40199	Eilat	19,7	-0,3	<1	-4	23,1	-1,1	7	3
40265	Mafraq	11,2	-0,3	12	-17	15,8	0,0	<1	-10
60030	L.Palmas/Gran Can.	18,1	-0,3	7	-3	18,9	0,2	<1	-6

WMO No.	Station	May 2007 Temp. mean	May 2007 (°C) dev.	May 2007 Prec. total	May 2007 (mm) dev.	June 2007 Temp. mean	June 2007 (°C) dev.	June 2007 Prec. total	June 2007 (mm) dev.
01008	Svalbard Airport	-1,4	2,3	13	7	5,1	2,9	16	6
01025	Tromsoe	5,9	1,0	64	16	9,7	0,4	46	-7
01492	Oslo	10,9	0,1	87	35	17,0	1,8	133	68
02196	Haparanda	6,7	0,6	57	26	13,5	0,7	44	3
02485	Stockholm	11,4	0,7	17	-13	16,6	1,0	67	22
02974	Helsinki	11,0	1,1	43	8	15,8	0,9	45	1
03091	Aberdeen	9,6	0,6	116	57	11,8	-0,3	109	56
03772	London	13,7	1,2	80	29	16,9	1,2	64	13
03967	Dublin Casement Aerodrome	11,2	0,7	39	-19	13,8	0,5	131	83
04030	Reykjavik	6,0	-0,3	28	-16	10,7	1,7	25	-25
04320	Danmarkshavn	-8,1	-1,5	0	-4	0,8	0,1	0	-5
04360	Angmagssalik	1,3	0,7	11	-46	6,3	2,2	31	-21
06186	Copenhagen	13,2	1,2	72	29	17,4	1,3	114	60
06260	De Bilt	14,1	1,8	138	77	17,5	2,3	90	22
06447	Brussels	14,6	1,7	104	33	17,5	1,8	99	20
06590	Luxemburg	14,6	2,8	120	39	17,2	2,3	133	51
06660	Zurich	14,6	2,5	121	18	17,2	2,0	121	-3
06700	Geneva	15,3	2,1	121	43	18,6	1,9	171	80
07510	Bordeaux	16,1	1,5	142	65	18,9	1,1	57	1
07650	Marseilles	19,2	2,1	85	43	22,5	1,6	30	2
08222	Madrid	16,4	0,4	91	50	20,2	-0,5	32	6
08314	Mahon/Minorca	18,6	1,8	10	-27	21,8	1,0	3	-11
08495	Gibraltar	19,4	0,9	43	8	20,2	-0,9	2	-9
08515	Santa Maria/Azores	17,8	1,1	6	-24	19,1	0,4	28	6
08535	Lisbon	17,5	0,1	45	6	19,6	-0,6	33	12
10384	Berlin-Tempelhof	15,9	2,0	147	91	19,1	1,7	108	33
11035	Vienna	16,8	2,2	89	28	21,1	3,2	66	-8
11518	Prague	15,0	2,3	60	-17	18,4	2,5	77	4
11903	Slica	15,4	1,7	135	71	19,0	2,4	35	-50
12160	Elblag	14,4	1,5	81	40	17,9	2,5	141	47
12375	Warsaw	15,7	2,3	44	-15	18,9	2,3	134	62
12843	Budapest	17,5	1,5	82	27	22,6	3,5	46	-17
13274	Belgrade	19,4	2,2	79	8	23,5	3,4	108	18
14015	Ljubljana	17,2	2,6	113	-9	20,9	3,1	80	-75
14445	Split	20,9	2,5	64	8	26,1	3,9	18	-33
14654	Sarajevo	15,6	1,5	109	27	19,8	2,9	58	-33
15420	Bucharest	18,6	1,9	44	-26	23,3	3,1	24	-53
15614	Sofia	16,6	2,3	146	73	20,7	3,0	119	47
16158	Pisa	18,0	1,7	156	97	21,2	1,4	9	-35
16597	Luqa	20,5	1,4	<1	-7	24,8	1,8	76	73
16716	Athens	21,5	0,9	62	46	27,1	2,0	7	0
16754	Heraklion/Crete	20,7	0,9	25	9	25,9	2,4	<1	-3
17040	Rize	18,5	2,7	43	-59	22,9	3,0	80	-48
17062	Istanbul	19,3	2,8	29	-2	24,5	3,4	24	3
17130	Ankara	20,5	5,0	18	-37	22,6	3,0	32	-5
17170	Van	15,7	3,0	27	-22	19,9	2,3	9	-12
17609	Larnaka	22,3	1,4	43	36	26,3	2,0	<1	<1
22113	Murmansk	4,2	0,4	54	22	8,5	-0,9	34	-19
26038	Tallinn	11,0	1,3	54	17	15,1	0,6	45	-8
26629	Kaunas	13,6	0,9	97	41	17,8	1,8	71	-4
26730	Vilnius	13,8	1,3	71	9	17,7	1,9	59	-18
26850	Minsk	14,6	1,7	72	10	18,7	2,6	49	-34
27595	Kasan	15,8	2,6	40	3	16,4	-0,9	45	-25
27612	Moscow	15,9	3,0	34	-24	17,4	0,8	21	-55
33345	Kiev	18,4	3,3	49	-4	20,4	2,2	85	12
33815	Chisinau	18,9	2,8	19	-32	23,2	3,8	27	-48
34300	Kharkiv (Charkow)	18,2	2,6	41	-6	20,7	1,8	94	36
34880	Astrakhan	19,0	0,7	36	12	23,6	0,7	9	-13
35188	Akmola	15,0	1,9	51	18	18,0	-1,0	19	-16
37789	Yerevan	18,5	1,0	39	-4	21,9	0,0	30	9
40030	Hama	23,3	2,2	106	96	26,8	1,0	0	-4
40180	Tel Aviv	23,4	2,3	4	1	25,4	1,4	0	0
40199	Eilat	30,0	1,6	1	0	32,6	0,9	0	0
40265	Mafraq	22,5	2,7	0	-3	24,2	1,5	0	0
60030	L.Palmas/Gran Can.	20,6	0,7	1	-1	21,8	0,4	0	0

WMO No.	Station	July 2007 Temp. mean	July 2007 (°C) dev.	July 2007 Prec. total (mm)	July 2007 dev.	August 2007 Temp. mean	August 2007 (°C) dev.	August 2007 Prec. total (mm)	August 2007 dev.
01008	Svalbard Airport	7,8	1,8	7	-6	6,4	1,6	9	-16
01025	Tromsoe	13,8	2,1	84	12	11,2	0,3	124	42
01492	Oslo	16,1	-0,3	185	101	16,5	1,3	61	-29
02196	Haparanda	15,7	0,2	103	53	14,4	1,1	57	-6
02485	Stockholm	17,0	-0,2	51	-21	17,8	1,6	17	-49
02974	Helsinki	17,4	0,8	61	-12	17,4	2,4	64	-16
03091	Aberdeen	14,1	0,3	116	56	13,9	0,3	85	10
03772	London	17,3	-0,5	115	69	17,2	-0,2	41	-10
03967	Dublin Casement Aerodrome	14,6	-0,3	152	98	14,9	0,3	108	30
04030	Reykjavik	12,8	2,2	33	-19	11,0	0,7	96	34
04320	Danmarkshavn	3,6	-0,1	4	-10	3,7	1,3	20	6
04360	Angmagssalik	7,0	0,6	20	-29	7,6	1,6	37	-24
06186	Copenhagen	16,7	-0,5	162	93	17,9	0,9	56	-7
06260	De Bilt	17,0	0,2	161	86	17,1	0,4	42	-29
06447	Brussels	17,2	-0,3	97	22	17,2	-0,1	57	-6
06590	Luxemburg	16,8	-0,1	98	30	16,9	0,5	118	46
06660	Zurich	17,6	0,0	171	54	17,0	0,3	260	127
06700	Geneva	18,9	-0,4	143	75	18,7	0,3	159	79
07510	Bordeaux	19,5	-0,7	54	7	19,9	0,0	84	30
07650	Marseilles	24,2	0,4	2	-12	23,2	0,0	5	-24
08222	Madrid	24,7	0,3	0	-13	23,7	-0,2	15	6
08314	Mahon/Minorca	23,9	-0,3	1	-3	24,4	-0,1	21	-5
08495	Gibraltar	24,3	0,6	<1	<1	24,2	0,0	<1	-6
08515	Santa Maria/Azores	21,4	0,6	11	-14	21,9	-0,3	10	-30
08535	Lisbon	22,2	-0,2	3	-2	22,1	-0,7	5	-1
10384	Berlin-Tempelhof	18,8	0,0	92	40	18,7	0,3	88	27
11035	Vienna	22,0	2,3	55	-8	20,5	1,6	60	2
11518	Prague	18,7	1,2	72	6	18,3	1,3	84	14
11903	Slica	20,1	1,9	29	-30	19,7	2,4	73	4
12160	Elblag	17,5	0,7	107	13	18,7	2,0	116	35
12375	Warsaw	18,8	0,9	73	6	19,0	1,7	60	-3
12843	Budapest	23,9	3,0	38	-14	22,7	2,4	133	82
13274	Belgrade	25,7	4,0	18	-48	24,2	2,9	72	20
14015	Ljubljana	22,0	2,1	148	26	20,4	1,3	80	-64
14445	Split	27,8	2,4	31	3	26,6	1,4	28	-22
14654	Sarajevo	21,7	2,8	67	-12	21,4	2,9	25	-46
15420	Bucharest	26,2	4,2	22	-42	23,3	2,1	87	29
15614	Sofia	23,7	3,7	7	-49	21,2	1,8	140	88
16158	Pisa	22,9	0,1	0	-23	22,5	0,0	44	-13
16597	Luqa	26,6	0,7	0	0	27,3	1,0	<1	-7
16716	Athens	30,7	2,9	0	-5	29,6	2,0	0	-5
16754	Heraklion/Crete	27,4	1,7	0	-1	27,2	1,6	0	-1
17040	Rize	24,2	2,0	217	81	25,0	2,8	404	221
17062	Istanbul	25,8	2,6	16	-3	26,1	3,1	19	-7
17130	Ankara	26,8	3,9	4	-10	26,4	3,8	10	-2
17170	Van	22,7	0,8	29	25	21,8	0,6	7	0
17609	Larnaka	28,8	1,9	<1	<1	28,5	1,4	<1	<1
22113	Murmansk	11,5	-1,3	121	61	13,3	2,3	61	-4
26038	Tallinn	16,9	0,6	72	-7	17,8	2,5	126	42
26629	Kaunas	17,1	0,0	149	81	18,5	2,2	79	16
26730	Vilnius	17,0	0,1	210	132	18,8	2,5	26	-46
26850	Minsk	17,6	0,3	121	33	19,9	3,4	15	-57
27595	Kasan	19,8	0,4	196	127	21,6	4,4	33	-34
27612	Moscow	18,9	0,8	81	-11	20,2	3,8	87	13
33345	Kiev	21,3	2,0	110	22	21,5	2,9	96	27
33815	Chisinau	25,8	4,9	4	-65	23,9	3,4	34	-11
34300	Kharkiv (Charkow)	22,1	1,8	36	-24	23,4	3,9	39	-11
34880	Astrakhan	26,0	0,7	8	-15	27,4	4,1	<1	-19
35188	Akmola	21,2	-0,1	58	8	19,1	1,4	11	-29
37789	Yerevan	24,5	-1,5	31	21	24,9	-0,3	22	15
40030	Hama	30,1	1,9	0	0	28,9	1,0	0	0
40180	Tel Aviv	27,5	1,8	0	0	27,8	1,7	0	0
40199	Eilat	33,0	0,1	0	0	34,1	1,3	0	0
40265	Mafraq	26,0	1,9	0	0	25,7	1,5	0	0
60030	L.Palmas/Gran Can.	23,8	0,5	0	0	23,4	-0,7	0	0

WMO No.	Station	September 2007 Temp. mean	(°C) dev.	Prec. (mm) total	dev.	October 2007 Temp. mean	(°C) dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	2,1	1,6	11	-12	-2,5	3,0	32	17
01025	Tromsoe	6,7	-0,1	87	-7	6,3	3,4	101	-24
01492	Oslo	11,0	0,2	65	-25	6,9	0,5	17	-67
02196	Haparanda	7,7	-0,2	85	22	5,2	2,7	68	4
02485	Stockholm	12,2	1,0	74	19	7,7	0,2	39	-11
02974	Helsinki	11,0	1,0	104	31	6,4	1,0	74	1
03091	Aberdeen	12,2	0,5	68	0	10,3	0,4	23	-54
03772	London	15,7	0,7	17	-34	12,0	0,3	38	-20
03967	Dublin Casement Aerodrome	13,0	0,0	41	-28	11,5	1,2	17	-51
04030	Reykjavik	7,9	0,5	163	96	5,8	1,4	175	89
04320	Danmarkshavn	-3,6	0,6	2	-9	-12,3	1,3	6	-6
04360	Angmagssalik	4,0	0,9	89	21	0,3	1,1	74	-8
06186	Copenhagen	13,7	0,1	60	-2	9,3	-0,6	46	-13
06260	De Bilt	13,8	-0,2	97	30	10,1	-0,4	32	-40
06447	Brussels	14,1	-0,4	58	-1	10,4	-0,5	65	-5
06590	Luxemburg	13,0	-0,4	53	-17	9,5	0,4	35	-40
06660	Zurich	13,0	-0,8	75	-17	9,3	0,0	21	-48
06700	Geneva	14,7	-0,4	88	6	10,8	0,5	17	-61
07510	Bordeaux	17,1	-0,8	37	-37	13,4	-0,6	48	-40
07650	Marseilles	19,9	-0,4	<1	-47	15,4	-0,7	33	-45
08222	Madrid	21,1	0,6	5	-25	14,9	0,1	54	9
08314	Mahon/Minorca	21,7	-0,5	46	-8	18,4	-0,1	98	14
08495	Gibraltar	22,6	-0,2	90	75	20,8	1,3	37	-27
08515	Santa Maria/Azores	21,1	-0,3	22	-35	20,2	0,9	58	-26
08535	Lisbon	21,5	-0,2	37	11	19,3	0,8	18	-62
10384	Berlin-Tempelhof	13,8	-0,8	79	33	8,8	-1,2	5	-31
11035	Vienna	13,6	-1,5	195	150	9,1	-0,8	69	28
11518	Prague	12,5	-0,8	61	21	8,1	-0,2	17	-13
11903	Slica	11,9	-1,5	50	-6	7,9	-0,4	26	-24
12160	Elblag	13,5	0,8	57	-13	8,3	-0,6	91	38
12375	Warsaw	13,3	0,1	58	15	8,3	0,0	26	-12
12843	Budapest	14,5	-1,9	42	2	11,1	0,2	43	9
13274	Belgrade	16,3	-1,4	84	33	11,7	-0,7	104	64
14015	Ljubljana	14,4	-1,1	220	90	10,3	-0,1	138	23
14445	Split	19,8	-1,6	37	-24	16,3	-0,6	65	-14
14654	Sarajevo	13,2	-1,9	146	76	8,8	-1,6	139	51
15420	Bucharest	16,0	-0,9	24	-18	11,2	0,4	63	31
15614	Sofia	14,5	-1,3	78	39	10,6	0,2	98	61
16158	Pisa	18,9	-0,6	81	-8	15,1	-0,2	61	-59
16597	Luqa	25,0	0,9	30	-10	21,4	0,7	93	3
16716	Athens	24,3	0,1	<1	-10	20,1	0,8	72	20
16754	Heraklion/Crete	24,0	0,9	2	-16	20,4	0,7	57	-19
17040	Rize	22,2	2,8	201	-20	18,5	3,1	269	-3
17062	Istanbul	21,3	1,6	16	-25	17,3	2,0	64	-7
17130	Ankara	20,8	2,5	0	-19	15,4	2,8	14	-13
17170	Van	17,8	1,0	0	-14	12,2	2,1	38	-10
17609	Larnaka	26,1	1,0	0	0	23,2	1,9	4	-15
22113	Murmansk	7,4	0,7	95	43	5,1	4,1	69	27
26038	Tallinn	11,8	1,0	80	-2	7,2	0,9	78	8
26629	Kaunas	12,8	0,7	42	-17	7,6	0,7	57	6
26730	Vilnius	12,7	1,1	29	-36	7,3	0,7	67	14
26850	Minsk	12,9	1,2	15	-45	6,9	0,6	53	4
27595	Kasan	12,3	1,1	84	38	6,6	3,1	29	-18
27612	Moscow	11,8	0,9	57	-7	7,0	2,0	109	51
33345	Kiev	14,8	0,9	30	-17	9,4	1,3	23	-12
33815	Chisinau	16,7	0,5	25	-23	11,3	1,2	71	44
34300	Kharkiv (Charkow)	15,1	1,0	61	20	9,4	2,1	62	27
34880	Astrakhan	19,1	1,8	18	-8	12,0	2,9	2	-15
35188	Akmola	14,1	2,1	7	-17	5,8	3,0	29	-1
37789	Yerevan	23,3	2,6	0	-10	16,1	2,9	37	10
40030	Hama	26,8	1,5	0	-2	22,4	3,1	10	-11
40180	Tel Aviv	26,2	1,4	0	0	24,4	2,4	0	-26
40199	Eilat	31,0	0,6	0	0	28,1	1,4	0	-4
40265	Mafraq	23,9	1,2	0	-1	21,1	2,0	2	-5
60030	L.Palmas/Gran Can.	22,8	-1,0	0	-8	22,5	0,0	3	-7

WMO No.	Station	November 2007 Temp. mean	(°C) dev.	Prec. (mm) total	dev.	December 2007 Temp. mean	(°C) dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	-5,3	5,2	20	7	-8,6	4,7	24	12
01025	Tromsoe	0,4	1,2	79	-25	1,5	4,5	177	73
01492	Oslo	1,5	0,8	88	13	-1,4	1,4	48	-8
02196	Haparanda	-2,8	1,3	87	29	-1,0	8,5	46	4
02485	Stockholm	2,4	-0,2	49	-4	1,7	2,7	45	-1
02974	Helsinki	0,0	-0,1	84	12	1,5	5,6	93	35
03091	Aberdeen	6,9	1,9	118	43	4,0	0,5	54	-19
03772	London	8,1	0,9	85	30	6,1	1,0	45	-12
03967	Dublin Casement Aerodrome	8,2	1,5	75	5	6,3	1,0	68	-9
04030	Reykjavik	3,1	2,0	113	40	1,3	1,5	197	118
04320	Danmarkshavn	-16,2	3,7	15	5	-20,1	1,7	9	-4
04360	Angmagssalik	-2,1	2,6	150	54	-4,5	2,7	145	42
06186	Copenhagen	5,5	0,0	26	-36	4,1	1,9	37	-21
06260	De Bilt	6,9	1,0	58	-23	3,8	0,6	77	-3
06447	Brussels	6,8	0,7	72	-4	4,1	0,6	89	13
06590	Luxemburg	4,4	0,6	71	-12	1,7	0,7	111	31
06660	Zurich	2,9	-1,0	42	-40	0,6	0,0	103	30
06700	Geneva	4,2	-1,0	69	-25	2,3	0,3	88	0
07510	Bordeaux	7,7	-1,4	35	-59	5,9	-0,5	75	-24
07650	Marseilles	9,5	-1,2	61	3	6,8	-0,5	12	-44
08222	Madrid	9,1	-0,3	44	-20	6,3	-0,1	15	-36
08314	Mahon/Minorca	13,5	-0,9	150	73	11,5	-0,3	22	-52
08495	Gibraltar	17,0	0,9	67	-74	15,0	0,9	177	31
08515	Santa Maria/Azores	18,6	1,2	176	74	17,0	1,6	75	-20
08535	Lisbon	15,0	0,5	104	-10	11,7	-0,1	59	-49
10384	Berlin-Tempelhof	4,1	-0,8	56	7	2,4	1,0	30	-23
11035	Vienna	3,8	-0,8	55	5	0,7	-0,2	60	17
11518	Prague	2,0	-0,8	35	3	0,1	0,7	15	-11
11903	Slica	1,9	-1,1	33	-36	-3,2	-1,5	39	-18
12160	Elblag	1,9	-1,4	92	36	1,6	1,3	26	-26
12375	Warsaw	1,8	-1,4	31	-11	0,2	1,1	13	-19
12843	Budapest	4,1	-0,7	50	-2	-0,6	-1,0	32	-8
13274	Belgrade	5,3	-1,7	132	78	1,1	-1,2	34	-24
14015	Ljubljana	5,1	0,5	33	-102	0,1	0,1	51	-50
14445	Split	10,7	-1,5	83	-25	7,9	-0,8	64	-36
14654	Sarajevo	2,4	-2,4	172	81	-1,4	-1,2	51	-13
15420	Bucharest	3,1	-2,1	74	25	-0,9	-1,1	87	44
15614	Sofia	2,8	-2,2	98	51	-0,6	-1,1	29	-10
16158	Pisa	9,9	-0,5	47	-77	5,7	-1,1	81	-4
16597	Luqa	17,6	0,6	115	35	14,3	0,5	206	94
16716	Athens	14,7	-0,8	31	-19	10,3	-1,9	38	-33
16754	Heraklion/Crete	16,9	0,3	30	-29	12,6	-1,2	149	75
17040	Rize	11,6	0,0	419	169	7,8	-0,5	245	2
17062	Istanbul	12,0	0,4	89	0	7,3	-0,8	68	-54
17130	Ankara	6,9	-0,2	67	34	2,0	-0,6	44	-5
17170	Van	4,2	0,2	75	33	-2,0	-1,1	44	10
17609	Larnaka	18,2	1,8	16	-28	13,6	0,4	39	-37
22113	Murmansk	-3,4	1,7	42	2	-1,6	7,7	39	1
26038	Tallinn	1,1	-0,1	48	-20	2,3	5,2	40	-15
26629	Kaunas	0,9	-1,2	46	-7	0,8	3,2	25	-19
26730	Vilnius	0,0	-1,2	43	-14	-0,4	2,5	30	-25
26850	Minsk	-0,3	-1,1	63	11	-1,1	2,7	19	-34
27595	Kasan	-4,5	-1,3	44	-2	-11,0	-1,9	23	-14
27612	Moscow	-2,0	-0,9	65	7	-2,0	4,1	14	-38
33345	Kiev	0,6	-1,5	86	35	-0,9	1,4	22	-30
33815	Chisinau	3,0	-1,4	60	21	-0,4	-0,1	62	24
34300	Kharkiv (Charkow)	0,1	-1,2	50	6	-2,1	1,3	21	-24
34880	Astrakhan	1,4	-1,9	24	5	-2,8	-0,9	26	11
35188	Akmola	-4,4	1,5	18	-4	-12,9	-0,3	17	0
37789	Yerevan	6,4	-0,1	59	37	-0,3	-0,5	11	-12
40030	Hama	14,3	1,6	43	3	7,7	-0,2	64	-3
40180	Tel Aviv	19,4	1,4	127	59	14,7	0,9	64	-74
40199	Eilat	21,8	0,3	0	-3	16,5	-0,1	0	-6
40265	Mafraq	14,2	0,7	14	-3	8,8	0,0	10	-18
60030	L.Palmas/Gran Can.	20,8	0,4	16	-5	18,7	0,4	26	5

WMO No.	Station	Year 2007 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-2,5	3,9	172	-11
01025	Tromsoe	4,0	1,2	1142	169
01492	Oslo	7,2	1,5	873	104
02196	Haparanda	2,8	1,7	755	203
02485	Stockholm	8,1	1,5	494	-45
02974	Helsinki	6,4	1,9	760	109
03091	Aberdeen	9,2	1,3	913	130
03772	London	12,0	1,5	681	82
03967	Dublin Casement Aerodrome	10,3	1,0	813	78
04030	Reykjavik	5,5	1,1	1127	329
04320	Danmarkshavn	-11,1	1,2	120	-12
04360	Angmagssalik	0,1	1,8	853	-79
06186	Copenhagen	10,2	1,6	725	89
06260	De Bilt	11,2	1,8	952	147
06447	Brussels	11,5	1,6	880	80
06590	Luxemburg	10,4	2,1	1033	158
06660	Zurich	10,1	1,6	1153	67
06700	Geneva	11,2	1,4	1137	192
07510	Bordeaux	13,5	0,8	881	-42
07650	Marseilles	15,6	0,8	309	-235
08222	Madrid	14,6	0,3	406	-50
08314	Mahon/Minorca	17,1	0,5	625	27
08495	Gibraltar	18,6	0,4	761	-14
08515	Santa Maria/Azores	18,3	0,8	772	-3
08535	Lisbon	17,0	0,2	525	-228
10384	Berlin-Tempelhof	10,9	1,5	835	251
11035	Vienna	11,6	1,9	866	259
11518	Prague	9,8	1,9	499	-27
11903	Slica	9,5	1,6	669	-17
12160	Elblag	9,3	1,7	887	197
12375	Warsaw	9,6	1,8	591	72
12843	Budapest	12,4	2,0	567	49
13274	Belgrade	13,9	2,0	840	156
14015	Ljubljana	12,0	2,2	1196	-197
14445	Split	17,3	1,5	751	-74
14654	Sarajevo	10,9	1,4	996	78
15420	Bucharest	12,1	1,5	519	-76
15614	Sofia	11,3	1,6	830	267
16158	Pisa	14,8	0,8	655	-249
16597	Luqa	19,7	1,1	621	68
16716	Athens	19,2	0,7	306	-63
16754	Heraklion/Crete	19,2	0,7	435	-66
17040	Rize	15,3	1,4	2493	321
17062	Istanbul	16,0	1,9	436	-261
17130	Ankara	13,5	1,8	306	-107
17170	Van	9,6	0,9	350	-35
17609	Larnaka	20,2	1,1	338	9
22113	Murmansk	1,6	1,7	638	160
26038	Tallinn	6,9	1,8	726	59
26629	Kaunas	8,0	1,6	740	132
26730	Vilnius	7,6	1,6	734	51
26850	Minsk	7,8	2,0	574	-103
27595	Kasan	4,5	0,8	677	137
27612	Moscow	7,1	2,2	648	-40
33345	Kiev	9,9	2,2	634	-15
33815	Chisinau	12,0	2,4	479	-68
34300	Kharkiv (Charkow)	9,7	2,2	538	19
34880	Astrakhan	11,6	1,6	206	-14
35188	Akmola	4,6	1,9	304	-14
37789	Yerevan	11,9	-0,2	442	165
40030	Hama	18,7	1,1	366	14
40180	Tel Aviv	20,8	1,4	429	-138
40199	Eilat	25,3	0,5	18	-15
40265	Mafraq	17,5	1,0	82	-78
60030	L.Palmas/Gran Can.	20,6	0,1	136	19

Monthly Surveys

January

- **Mildest January on record in many European countries**
- **Eastern Europe extremely mild**
- **Wet in the north and east, dry in the south and west**
- **Heavy storms in the northern half of Europe**

Atmospheric circulation characteristics

Many Atlantic low pressure systems passed over the Region, most notably over northern, central and eastern Europe, within a strong westerly, very mild airflow, with some of them developing into heavy storms. In contrast, the southern and southwestern parts of the Region were under high pressure influence during most of the month. Only occasionally some low pressure systems moved further south over the eastern Mediterranean. Towards the end of the month, a strong high pressure system formed over the East Atlantic and colder air masses from the north reached Europe, causing frequent snowfall.

Temperature

The year 2007 started with a very mild January over of almost all Europe (Fig. 1.1). Especially the first 20 days of the month were very mild. The highest monthly anomalies were recorded in the east and reached over +10°C in parts of Russia and Kazakhstan (Fig. 1.2). The monthly mean temperature in Uralsk (western Kazakhstan), for example, was -11.7°C, compared to a normal of -22.4°C.

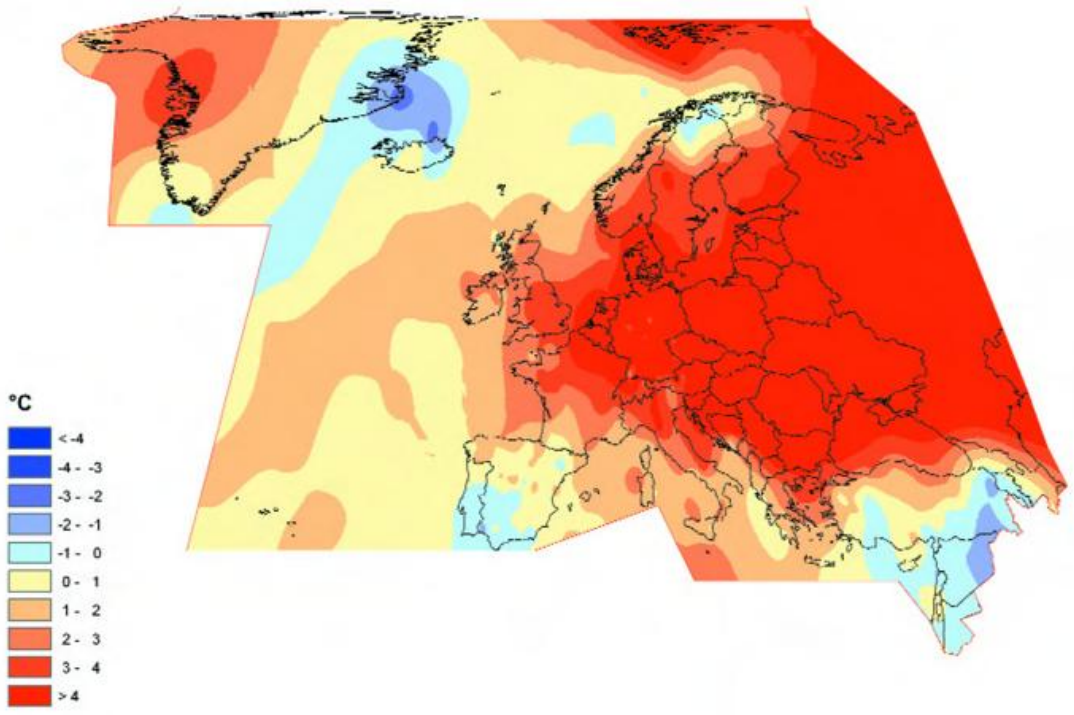


Fig. 1.1: *Monthly mean temperature anomalies in January 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

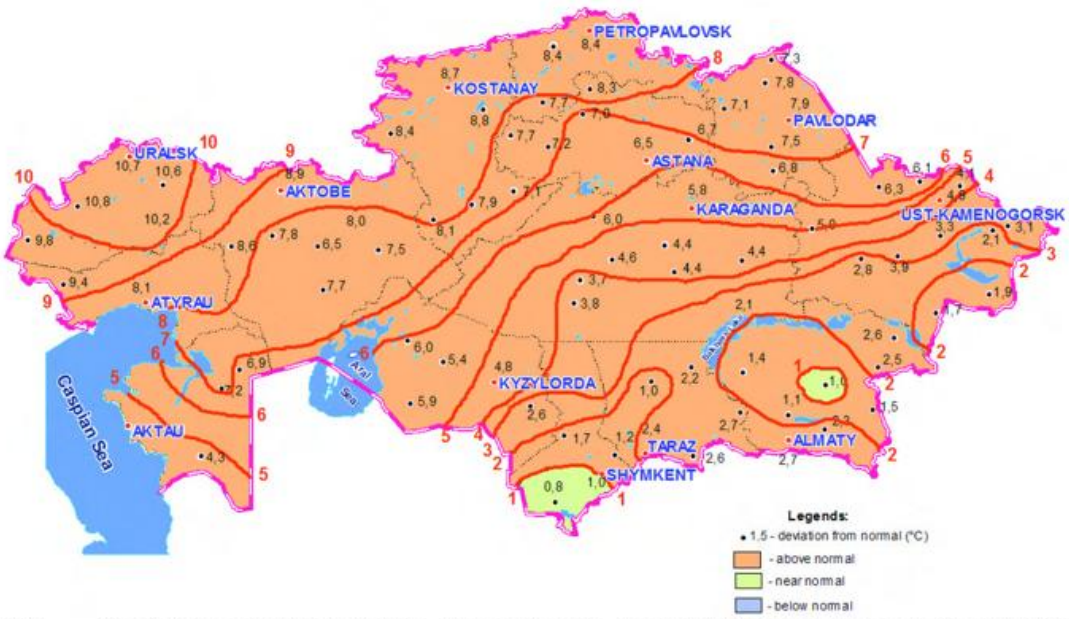


Fig. 1.2: *Monthly mean temperature anomalies in January 2007 (reference period 1961-1990) in Kazakhstan.*
Source: Kazhydromet, Kazakhstan

In central Europe, the month was around +5°C warmer than normal, in some parts of Italy partly around +4°C. Further to the east, the anomalies were, on average, +6-8°C e.g. in Lithuania, Poland, Belarus, eastern Austria and Slovenia, Hungary, north-eastern Croatia, northern Serbia, Romania (Fig. 1.3), Bulgaria, Ukraine and European Russia (Fig. 1.4). The period 7-24 January was the warmest period in Romania when daily deviations topped +10°C. Macedonia, experienced a similar period, but later in the month (19-26 January). The station Zavizan in the Velebit mountains in western Croatia (1594 m altitude) saw a monthly January mean above 0°C for the first time since 1954 (Fig. 1.5). Even the water surfaces were remarkably warm. Particularly the North Sea and the Baltic Sea were 3-4°C warmer than normal near the coasts of central Europe.

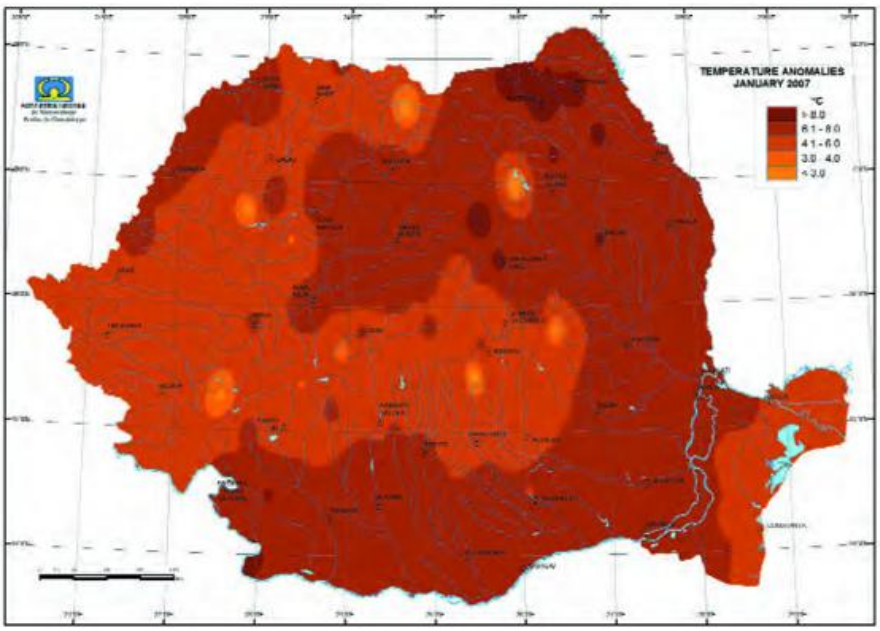


Fig. 1.3: *Monthly mean temperature anomalies in January 2007 (reference period 1961-1990) in Romania.*
Source: National Meteorological Administration Romania

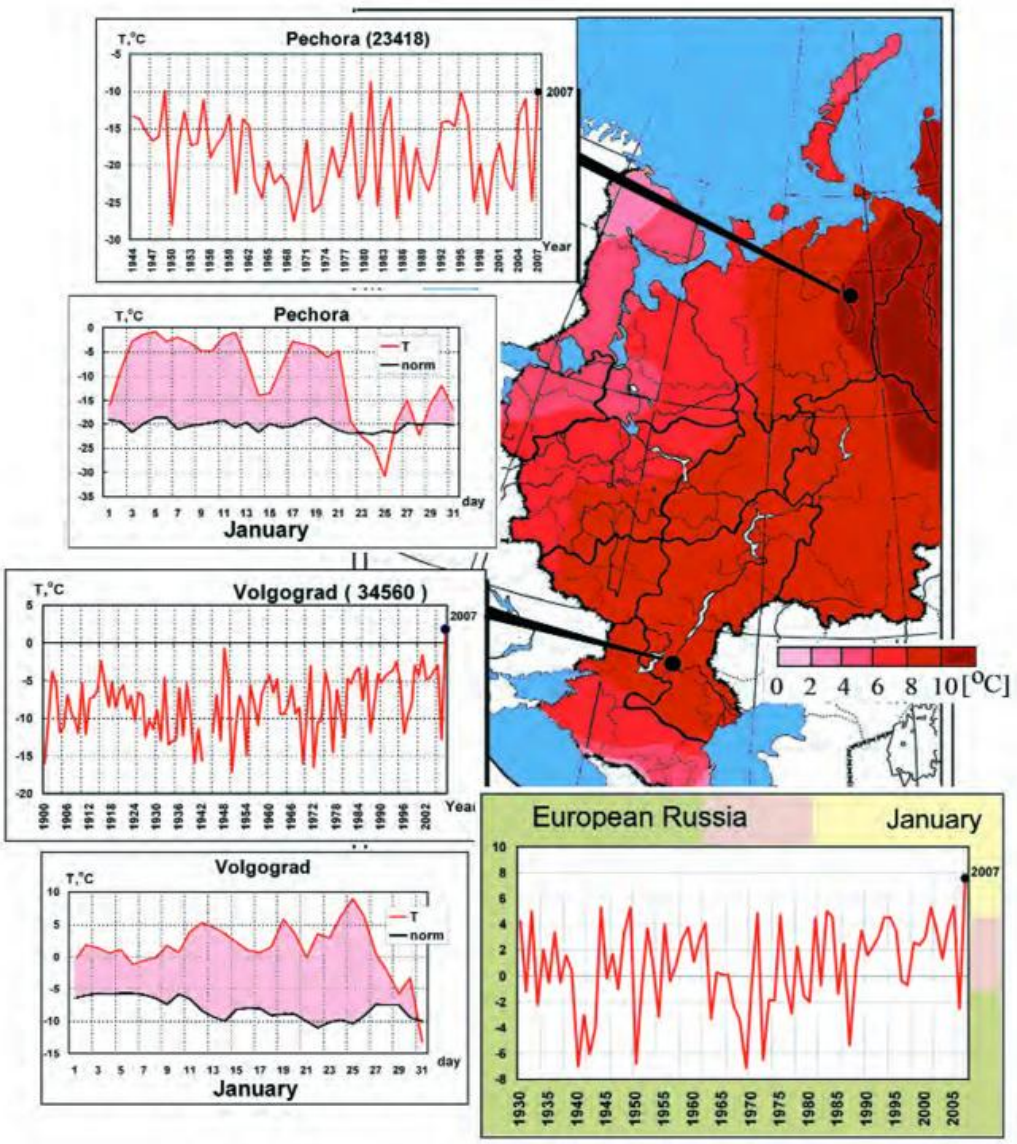


Fig. 1.4: *Time series of January monthly mean temperature and daily anomalies of January 2007 from the 1961-1990 normal in European Russia.*
Source: Roshydromet, Russia

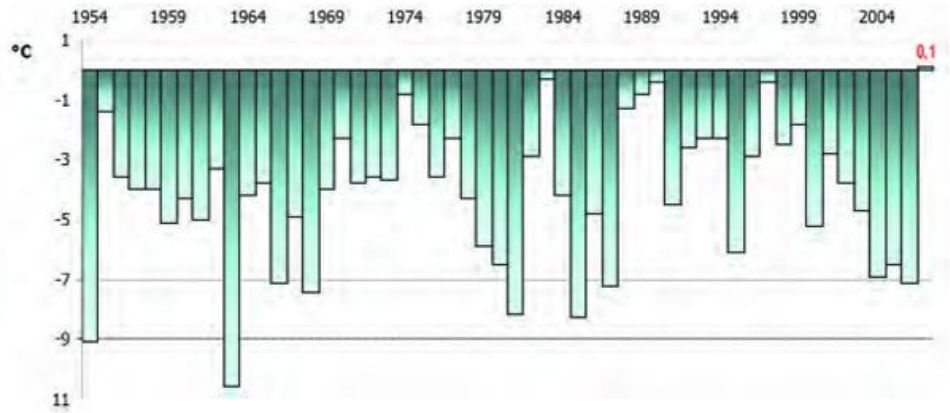


Fig. 1.5: *Monthly mean air temperature for January in Zavizan, western Croatia (altitude 1594 m) 1954-2007.*
Source: Meteorological and Hydrological Service of Croatia

Many European countries had their mildest January on record on national average (on global average it was also the mildest ever recorded!) or at least at some stations, as e.g. in the Benelux region, France, Germany, Switzerland, Austria, Italy, Hungary, Serbia, Romania, Belarus, European Russia, Malta. The United Kingdom experienced the mildest January since 1916 (mean temperature 6.7°C, anomaly +3.4°C). Jan Mayen in the Arctic and some coastal stations in southern Norway registered new records for maximum temperature in January. No air frost occurred at most coastal stations of Ireland. The coastal station Hallands Väderö in Sweden reported the first frost of the season not until 22 January, which is the latest date ever reported by a Swedish station. German lowlands partly did not see any ice days (days with maximum temperature below 0°C). Moscow in European Russia reported with -1.6°C a new record of monthly mean January temperature in at least 130 years. Poland had a monthly maximum temperature of 15.8°C. Italian farmers were in alarm because of the early flowering of many species of fruit trees. Daily maximum temperatures above 20°C were recorded at several stations in Italy and also in Malta. People went swimming in the sea in southern Italy. A series of 22 consecutive days with maximum temperature anomalies over +5°C were registered in Serbia (Fig. 1.6).

Only the last week of January was characterised by a sudden drop of temperature in northeastern Europe and later also in parts of central Europe. On 23 January, the maximum and minimum temperatures in Estonia decreased by 10°C within two days. It was only towards the end of January that ice began to form in all sea areas around Scandinavia. In Germany, minimum temperatures dropped to less than -15°C on 26 January locally even in the lowlands.

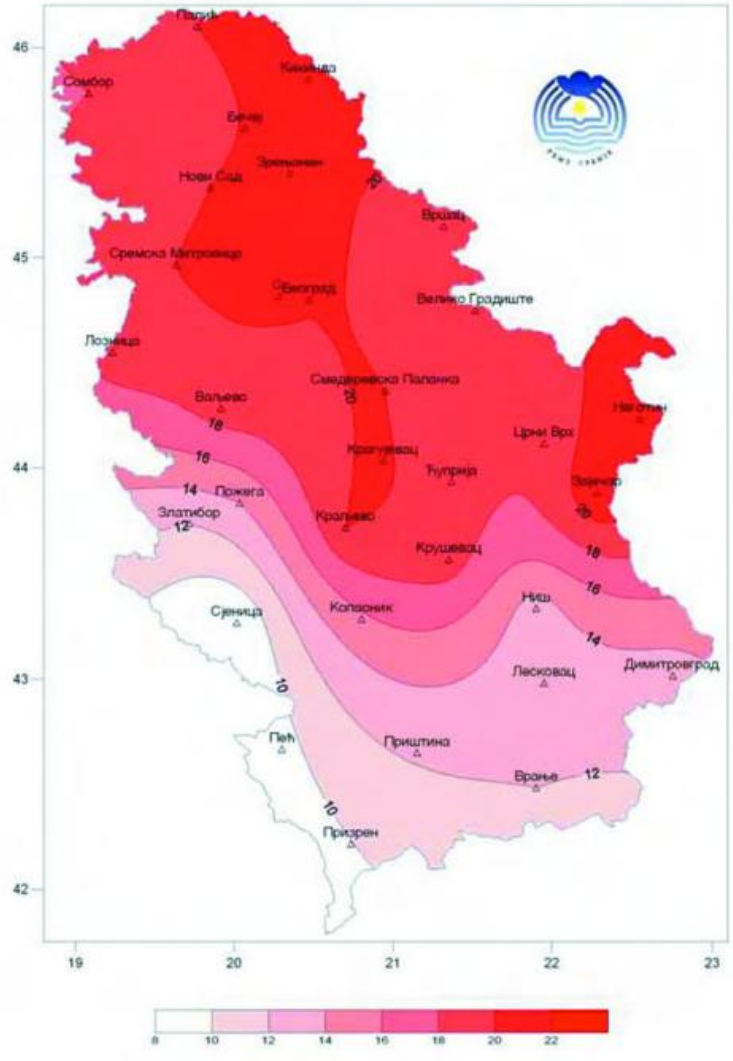


Fig. 1.6: *Highest number of consecutive days with monthly mean temperature anomalies above +5°C (reference period 1961-1990) in January 2007 in Serbia. Source: Republic Hydrometeorological Service of Serbia*

Some slightly negative monthly anomalies were recorded in parts of eastern Greenland, Iceland and its surroundings in the North Atlantic, northern continental Scandinavia, the southwestern Iberian Peninsula and the Middle East. Extremely cold conditions were reported from the Ararat Valley in Armenia where persistent below-normal temperatures were recorded throughout the whole month and the mean monthly temperature was 6-7°C below the 1961-1990 normal. Minimum temperatures reached -24 to -26°C in some parts of the valley, thus breaking the daily minimum records. In contrast, maximum temperatures up to +22°C were measured in the lowlands of Azerbaijan and Georgia, and also in the Lebanon.

Precipitation

Northern, central and eastern Europe were generally very wet, with the precipitation in many places amounting to 200-300% of the normal monthly totals, locally even more e.g. in Estonia, Poland, whereas western and particularly southern parts of the Region were very dry (Fig. 1.7). The areas of high precipitation partly report some heavy rainfall events due to several winter storms moving from the North Sea to eastern Europe. These heavy rainfalls also caused local flooding in the areas concerned.

At some locations, January 2007 was record breaking wet, e.g. in West Scotland (since 1993), at some stations in Norway and Denmark, and in Belarus. All Baltic countries received on average a monthly precipitation total of at least 100 mm. Latvia had its highest monthly average January total in the last 84 years. With such conditions in January, flash floods occurred, which is unusual for winter time. Latvian river levels rose by 1 to 3.6 m. The Daugava, Latvia's largest river by basin area, had the largest January runoff ever recorded.

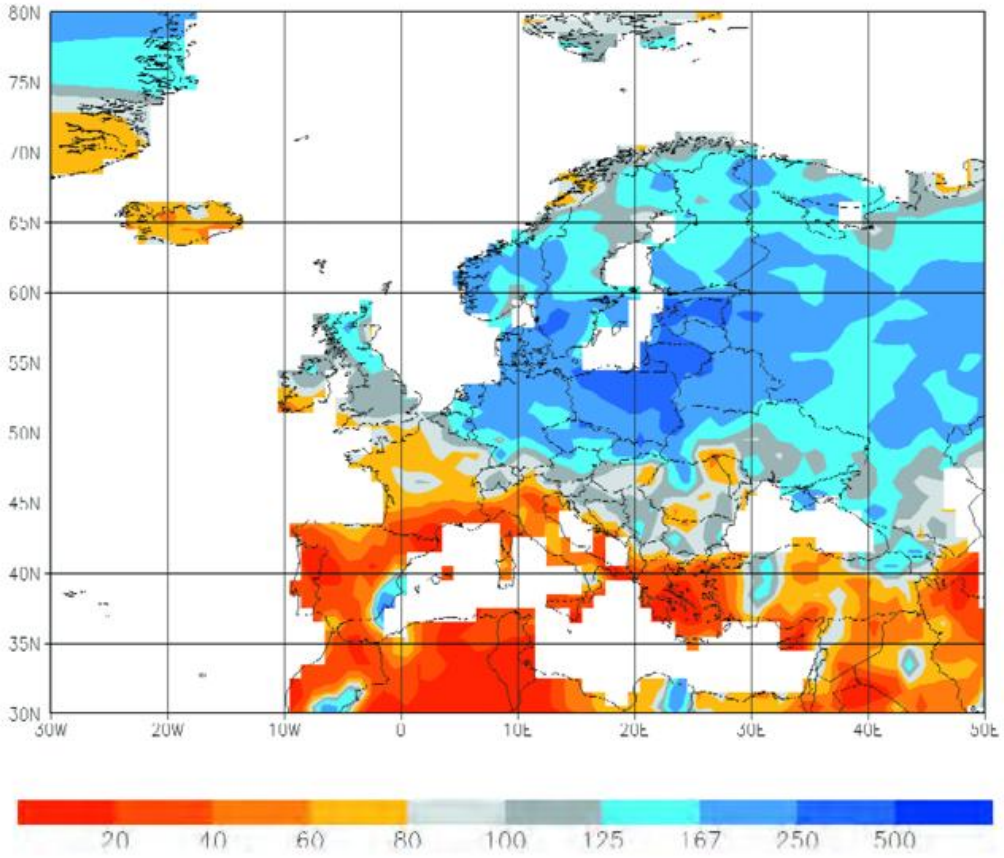


Fig. 1.7: *Monthly precipitation amounts for January 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

In contrast, the south and the west of the Region were generally dry. Some stations in Greece registered drought conditions with less than 10% of the normal precipitation. Malta saw its second driest January (behind 1983) in the past 84 years. With only five rain days and a mere total of 8.6 mm (long-term average is 95.5 mm), rainfall in Malta was in sharp contrast with last year's when January was the second wettest ever recorded.

In the Middle East, monthly rainfall totals were below normal in Israel and the Lebanon. However, several heavy local floodings were reported from the Lebanon after up to 73 mm rainfall within 12 hours.

Snow

Due to high precipitation, higher mountain areas in southern Norway and parts of northern Norway had considerably more snow than normal. As a result of the mild weather conditions, however, southern and central parts of Finland had no snow cover until mid-January. In German lowlands, a snow cover appeared only shortly if ever. In Austria, large amounts of fresh fallen snow were reported only from east Tyrol and upper Carinthia. Elsewhere in the country precipitation mostly fell as rain, or snow melted instantaneously. In most parts of southeastern countries, e.g. Slovenia and Serbia, particularly in the valleys, the number of days with snow cover was also considerably less than the normal average.

Significant weather events

January 01-06:	Heavy snowfall and avalanches in the high mountains in France (Alps), Switzerland, Liechtenstein, Austria, northern Italy
January 03:	Sea storm along the coasts of Italy with strong north-westerly winds up to 100 km/h and heavy rainfall over southern parts of the country. Later, storms and heavy rain were also reported from Turkey and the Ukraine.
January 09-10:	New January maximum temperature records for most of Latvia and Lithuania (9-13°C)
January 10:	Severe storm with heavy rain and flash floods in Russia (St. Petersburg)
January 11:	Daily maximum January temperature record in Moscow (8.6°C) in at least 130 years
January 11-12:	Storm in western, central and eastern Europe with gusts up to more than 180 km/h and torrential rain
January 14-16:	Storm in northern Europe (Norway, Sweden, Latvia, Lithuania, Belarus) with gusts up to 170 km/h
January 15:	Due to lack of snow over the Alps, water level of rivers in northern Italy reached historical low levels.
January 17-19:	Storm with gusts over 200 km/h in the mountains and over 140 km/h in the lowlands, heavy rain and widespread damage in western, central and eastern Europe and in the Alps (storm "Kyrill"). In Germany this was the strongest storm since Christmas 1999 (storm "Lothar"). Globally it ranks on place 13 of most expensive natural catastrophes since 1989 (MunichRe 2007). A daily precipitation total of 90 mm was measured on the Brocken (Harz, Germany) on 18 January.
January 19-21:	Record high maximum temperatures over 20°C in Austria, Switzerland and northern Italy resulted from a north foehn situation in the aftermath

of storm Kyrill on January 17-19. This had strong impact on skiing sites in northern Italy (Fig. 1.8). In eastern Austria, night temperatures up to 17-20°C during some hours

January 20: About 5,000 people had to be evacuated in northeast Israel due to a snowstorm.

January 20: Salt (central Jordan) recorded 68.2 mm of precipitation in 24 hours.

January 22-24: Rapidly increasing snow cover of 10-30 cm and more within some hours in France, southern and southeastern Germany and Switzerland after a short, but intense snow storm, combined with cold airflow from the north

January 24-30: Severe storms in Bulgaria and Turkey with heavy rain, thunder and hail. The ports of Burgas and Varna in Bulgaria were closed. Local disruption of electricity supply. On 28 January, widespread gusts up to about 90 km/h in Greece. Storm and heavy precipitation also in west Georgia

January 25: Daily maximum temperature of 22°C at Baku, capital of Azerbaijan

January 28: Snowfall in coastal and low latitude regions of Portugal for the second consecutive year. Such kind of phenomena is very rare in these places.



Fig. 1.8: *Ski slopes at Corno alle Scale (Italy, central part of the Apennines). Left: on a "normal" winter, right: on 19 January 2007 Source: ARPA-SIM, Emilia-Romagna, Italy*

February

- **Mostly mild, but very cold in northeastern Europe**
- **Mainly wet in western, central and eastern Europe, other areas partly very dry**

Atmospheric circulation characteristics

At the beginning of the month, an extended high pressure system persisted over northwestern and western Europe, leading cold air at its east flank to most of the continent, but only for a few days. Later, the cyclonic systems passed over western, central and eastern Europe, very frequently in a mainly mild airflow, whereas northern Europe and the Arctic region were often under high pressure influence. Some cold troughs moved over northeastern Europe, with forming a large cold high pressure system there, especially in the second half of the month. In the Mediterranean, low pressure systems were mostly quite weak und occurred only occasionally. Particularly the western Mediterranean was often under high pressure influence within a warm air mass, especially at the end of the month.

Temperature

February 2007 was again a very mild winter month in most of Europe (except the northeast), over the Atlantic, in the Arctic region and most parts of the Middle East (Fig. 2.1), despite a cold spell during the first decade in many parts of the Region. The highest monthly mean anomalies were recorded in western Greenland and Spitsbergen with over +6°C. Large areas of central Europe and parts of west Kazakhstan had anomalies of over +3°C, in some areas in southeastern Europe (e.g. northeast Croatia, western Romania) amounting to even around +5°C.

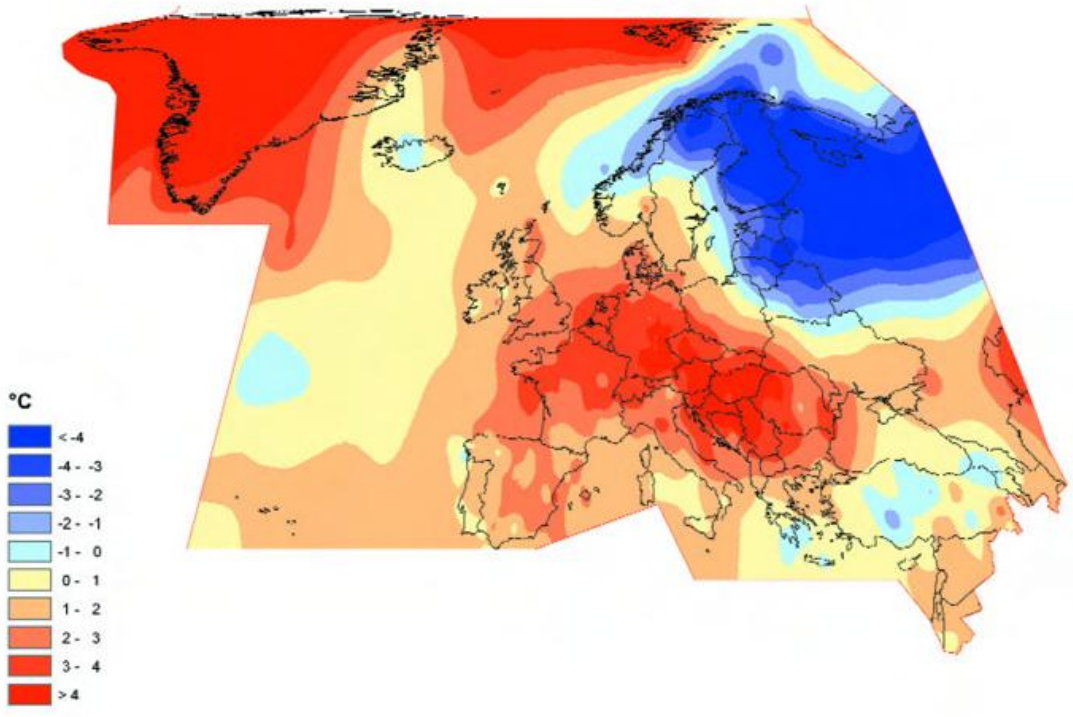


Fig. 2.1: *Monthly mean temperature anomalies in February 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

Slovenia reported the warmest February ever at the coast and the second warmest in some other places inland. The frequency of frost in central Europe was low, with only 4 air frost days and no ice days having been counted at the airport in Luxemburg (the normal 1971-2000 is 18 frost days and 4 ice days). In the south, it was warm especially at the end of the month: temperatures of 20-25°C were measured in southern Italy and eastern Sardinia, and also near the eastern Mediterranean in Turkey and the Lebanon (normal maximum temperatures in February at the coast of the Lebanon are around 17°C). February in Malta had the highest average daytime temperature (16.8°C) in the past 9 years. The month was also particularly warm throughout Iberia, making it the 4th warmest February in Spain.

Armenia had slightly above-normal monthly mean temperatures, but two cold spells on 1-4 February and 26-29 February with minimum temperatures down to -30°C in the northwest of the country.

On the other hand, north-eastern Europe was very cold on the monthly average with monthly mean anomalies down to -8°C in northern European Russia and below -5°C in northern Norway and Sweden, parts of Finland and the Baltic countries. Following two very mild months, this was the first typical winter month in this season in that area. Especially the first part of February was cold. European Russia had a cold spell on 5-11 February with mean (!) daily temperatures below -30°C in the north of Karelia. The Finnish station Salla registered a minimum temperature of -39.9°C in early February. Northern Norway (especially the Finnmark region) recorded monthly mean anomalies below -5°C, with the lowest minimum temperature of -39.0°C having occurred on 13 February. The Baltic countries had monthly mean anomalies ranging from -1°C in the west to around -4°C in the east. Throughout the month there were two cold spells with minimum temperatures below -30°C in Latvia and northeastern Lithuania. Even in the Ukraine, minimum temperatures down to -26°C were reached. Monthly mean maximum temperatures were also low in northeastern Europe: in Estonia the average temperature was recorded at 4.3°C compared to a normal of 12.4°C.

Precipitation

With totals of more than twice the normal in many places, and even 300% of the normal over some smaller areas in the northern and southern parts (Fig. 2.2), western, central and eastern Europe were very wet. Southeastern and central southern England had the wettest February since 1990. In large areas of northeastern Europe, where it was cold, a persistent snow cover finally occurred after the mild winter months, whereas especially in central and southeastern Europe snow was rare or restricted to the mountains.

Other areas were quite dry, especially in various parts of northern Europe, the western Alps, southern Spain, Malta (less than a third of the long-term average), the Aegean, and around the Black Sea. In central parts of Armenia, only 25-40% of the normal precipitation were recorded. Other countries in the Middle East partly received heavy precipitation throughout the month, especially the areas near the eastern Mediterranean. Lebanon was very wet in its coastal and interior parts, but precipitation was below normal in the high mountains.

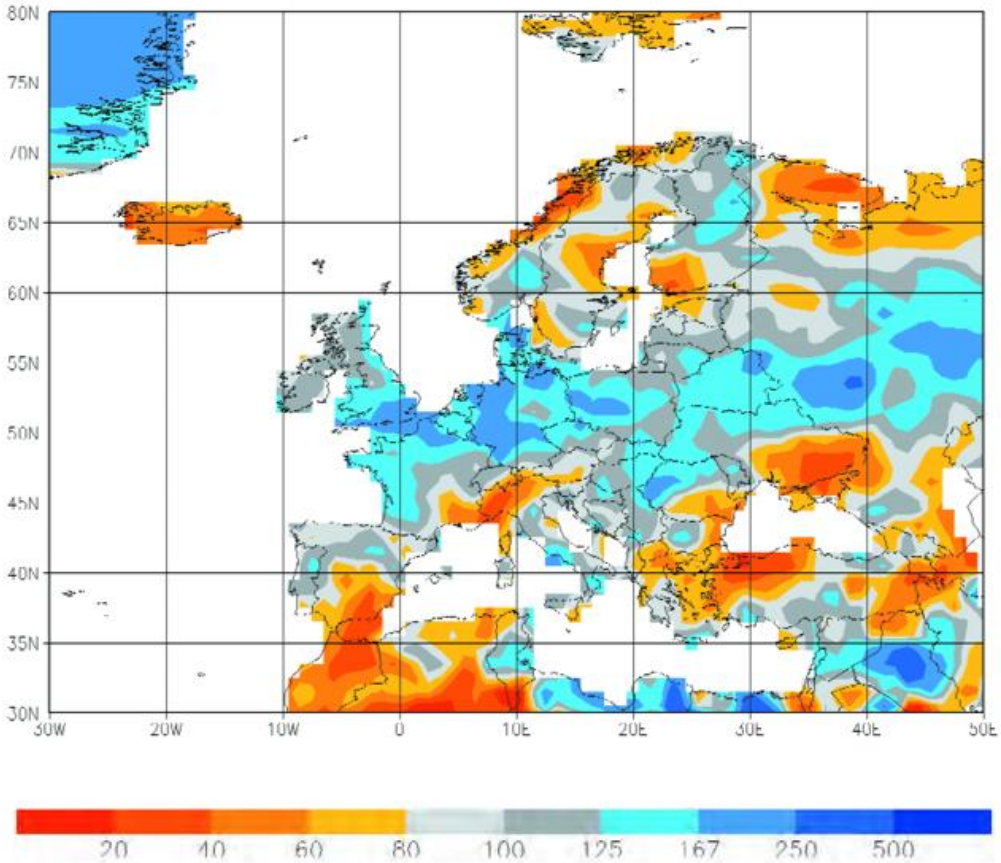


Fig. 2.2: *Monthly precipitation amounts for February 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Significant weather events

February 01-02:	Thunderstorm with heavy rain, flash floods, landslides in Switzerland
February 01:	Wind speeds up to 108 km/h in northern Bulgaria in a foehn situation
February 01-02:	Heavy snow and avalanches in Georgia
February 02-07:	Snowstorm in Turkey: up to 2 m snowfall, roads blocked, more than 1,000 villages cut off
February 03:	Storm in Greece with gusts up to 110 km/h
February 08-11:	Snowfall and freezing rain in Germany, numerous traffic disruptions
February 11:	Small tornado in eastern France (Lorraine, Vosges), roofs damaged, power supply cut off
February 13:	Heavy storm with gusts up to 115 km/h in Monaco in the early morning
February 21-24:	Snowstorm in northern Europe (southern Norway, southern Sweden, Denmark). Roof of supermarket, sport halls damaged, highway blocked. Freezing rain in northeastern Germany caused severe traffic problems.
February 22-25:	Severe storms caused by a cold front in east Romania (with snow), southeast Bulgaria, Georgia, Azerbaijan, western Kazakhstan, with gusts over 145 km/h, houses damaged
February 24:	Storm with strong gusts in Switzerland

March

- **Warm nearly everywhere, especially in the Arctic and eastern Europe**
- **Very irregular precipitation distribution**

Atmospheric circulation characteristics

A mild westerly airflow with frequent low pressure systems passing from the Atlantic to western and central Europe continued into the beginning of March 2007. In eastern Europe, a blocking high prevented further eastward propagation of these frontal systems. Instead, eastern Europe was influenced by a southerly flow of warm air at the west flank of this blocking high. At the beginning of the second decade of the month, the main frontal zone shifted northwards to northern Europe, and a large high pressure zone extended over western and central Europe. In the second half of the month, the large-scale circulation changed again considerably, this time from a zonal to a strong meridional pattern. A large trough extended from the north over central Europe to the south. At the end of the month, a large cut-off low formed over central Europe and the western Mediterranean, while a high pressure system set up over northern Europe, resulting in an easterly flow over central Europe.

The Arctic region remained frequently under low pressure influence.

The southern parts of the Region, especially the southwest, were most of the time under the influence of high pressure systems, except a few temporary cut-off lows affecting the western Mediterranean.

Temperature

March 2007 was warmer than normal nearly everywhere in the Region except for a few places over the North Atlantic, on the Iberian Peninsula, in France, eastern Turkey, northern Syria and Jordan (Fig. 3.1). The highest anomalies were recorded in the Arctic region and Russia, reaching more than +7°C, which is in sharp contrast to the preceding month of February in the latter area. In Finland, the Baltic countries, Belarus and the northern Ukraine, the monthly mean anomalies exceeded +5°C on areal average. Especially the last decade of the month was very warm, leading to a start of the vegetation period 20-25 days earlier than normal in these countries. Tartu in Estonia set a new monthly mean March temperature record of 4.5°C (normal: -2.1°C). In some countries March 2007 was the warmest ever recorded, e.g. in many parts of Norway (including Svalbard), Finland, Latvia, Belarus and European Russia. There were also new records for March maximum temperature in many places in this area, e.g. in Helsinki 17.5°C on 27 March.

In central Europe the anomalies ranged between +1°C and +4°C, with, however, a cold spell affecting particularly the areas around the Alps starting on 19 March (see significant weather events below).

The southern parts of the Region were only slightly warmer than normal, due to variable weather conditions throughout the month. In Georgia, Armenia and Azerbaijan, especially the first decade of the month was warm; the maximum temperature reached up to 21°C in the south of Armenia and 24°C in Georgia. However, very low temperatures were reported afterwards, with minima between -18 and -19°C in the high mountains of Armenia above 2000 m altitude on 20-21 March. Georgia had minimum temperatures below zero even in the lowlands and on the coast; this was also the minimum at the annual scale.

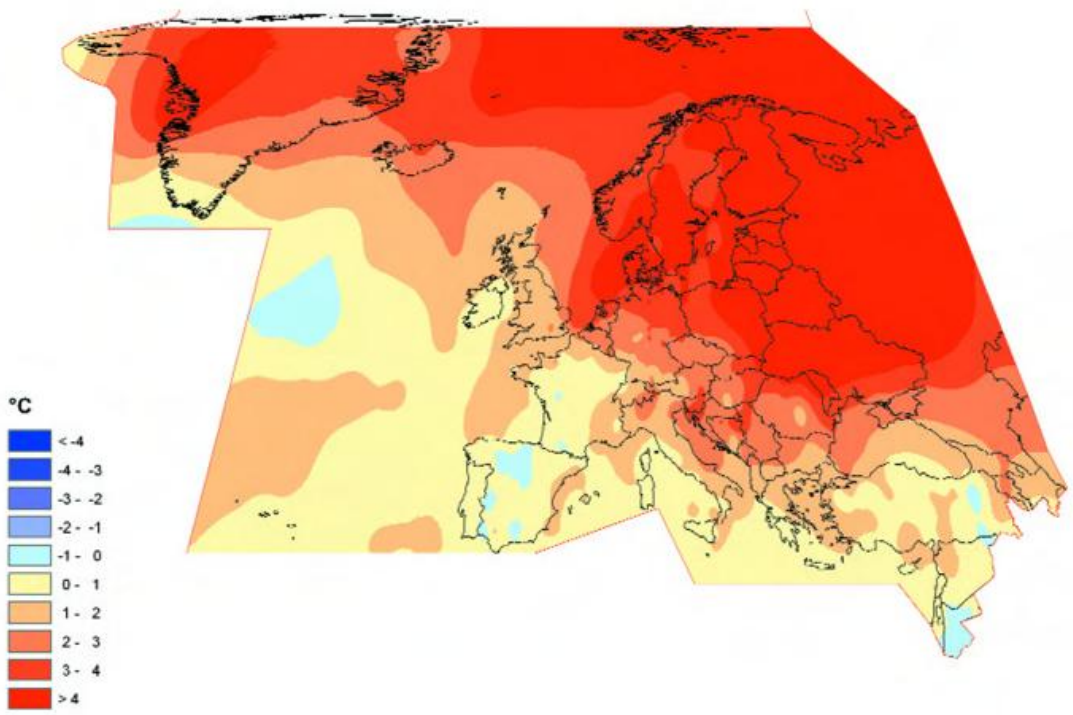


Fig. 3.1: *Monthly mean temperature anomalies in March 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

Precipitation

As the circulation pattern changed several times over the month, wet and dry areas were distributed very irregularly throughout the Region (Fig. 3.2). It was considerably wetter than normal particularly in the Arctic region, the southern west coast of Norway, parts of northeastern Europe, large parts of eastern central Europe, some parts of Slovenia, Croatia and Serbia, near the Black Sea and over/near the western Mediterranean, partly with more than twice the normal precipitation. In some places in Italy (particularly in Sicily, e.g. Palermo), monthly totals of more than 200 mm were registered, and some historical records broken. Žabljak in northeastern Montenegro recorded its second highest monthly precipitation total (171 mm) and its highest ever measured daily total (83 mm) in March since 1958 (Fig. 3.3).

In the east of the Region, up to 17 rainy days were counted in west Georgia. Central parts of Armenia received almost twice the monthly normal precipitation.

Large dry areas were to be found over central Scandinavia, eastern Europe and west Kazakhstan (due to prevailing anticyclones in the second half of the month), the western Iberian Peninsula, southern France / northwestern Italy and the eastern Mediterranean.

Significant weather events

March 04-06: Severe storm, tornado, heavy rain and flooding in the southern and eastern United Kingdom, houses and roads damaged/flooded, train derailed

March 06-07: Severe storm and landslides in Turkey. Settlements damaged, trees broken

March 07-08: Severe storms in Spain, gusts up to 110 km/h, heavy rain, forest fires, roofs damaged

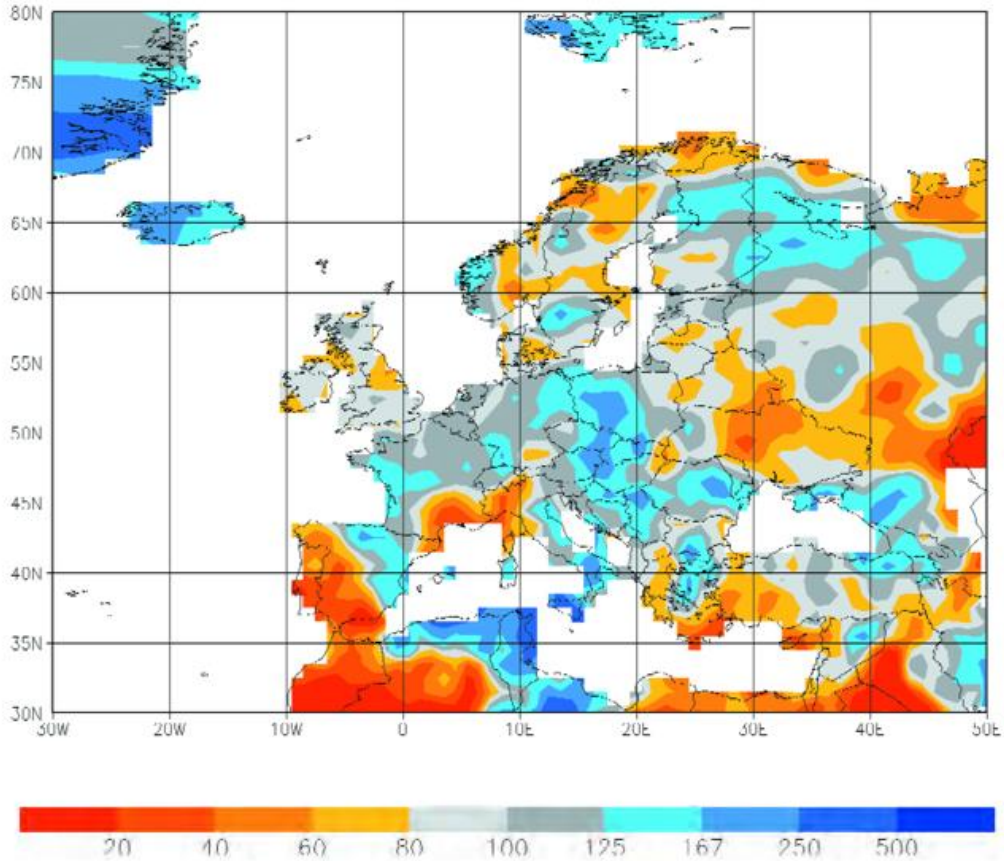


Fig. 3.2: *Monthly precipitation amounts for March 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

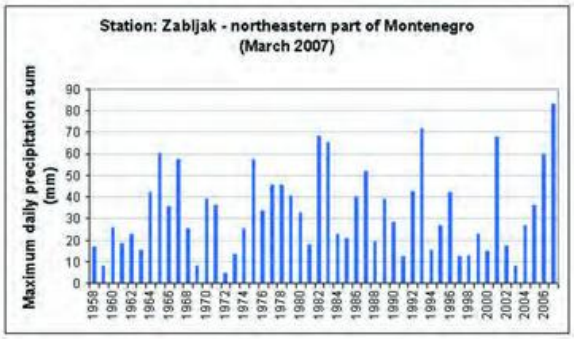


Fig. 3.3: *Maximum daily precipitation totals at the meteorological Station Žabljak (northeastern Montenegro) in March*
Source: Hydrometeorological Institute of Montenegro

March 12: Flash flood in Lithuania, Neman River burst its banks due to ice-drift, roads flooded, 130 people isolated

March 12: Low temperatures in south-central parts in Italy, snowfall in the mountains

March 13: A tornado and a severe hailstorm in Cyprus

March 15: Large amounts of rainfall in Israel with snowfall in the mountains

March 17: Floods in Latvia, ice jam, Daugava River burst its banks, houses flooded

March 18-19: Storm in northwestern Germany, snowfall, frost, high waves, camping grounds flooded, fish market in Hamburg flooded

March 19-21: Severe storm in England, hail and snow, high waves

March 19-24: Heavy snowfall in the Alpine region (Germany, Switzerland, Austria) due to the formation of a strong low over northern Italy. 50 cm of snow fell within a few hours in southern Austria, almost 30 cm in various towns of northern Switzerland; some areas of the northern Alps received 1 m. These days brought more snow to large parts of Austria than the whole preceding winter. Damage to trees and power lines. Strong snowfall also in northern and eastern parts of Germany. Even in the lowlands of Slovenia snow was falling. In Slovakia, highest ever measured snow depth of 402 cm on 24 March (and on 5 March as well)

March 20-25: Heavy rain, floods, strong gusts over >140 km/h in Romania, Bulgaria, Greece and Turkey. Houses, bridges, roads damaged. In Bulgaria, locally more than 80mm/24h of precipitation. In a ski resort in south Bulgaria, tourists were cut off due to fresh deep snow. In Turkey, roofs were damaged, a minaret of a mosque collapsed

March 23: In Armenia, heavy snowfall. Snow cover reached 80-90 cm in the high mountains at 2000-2500 m altitude

March 23: Sharav event (hot and dry weather spell) in Israel. Temperatures reached 27-28°C in the late evening at 21 UTC. It was the 3rd highest temperature at 21 UTC in Bet Dagan (coastal plain) since 1962 (Fig. 3.4).

March 25-31: Heavy rain and floods in Spain, Ebro River overflowed, losses to agriculture

March 26: Heavy hailstorm in Cyprus

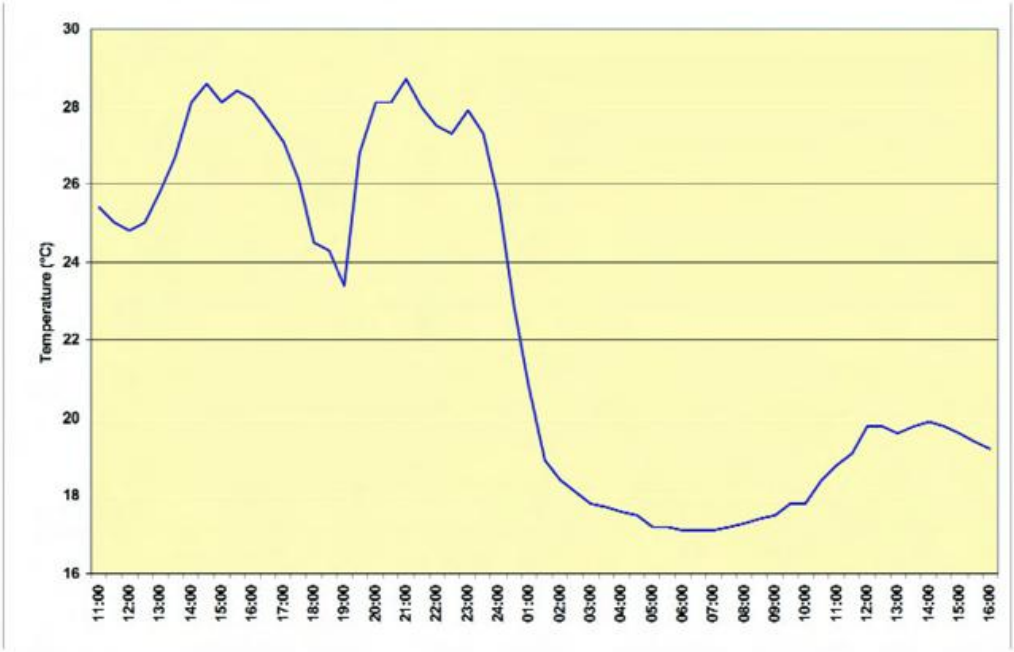


Fig. 3.4: *Temperature at Bet Dagan (central coastal plain in Israel) during and after a Sharav event on 23-24 March 2007*
Source: Israel Meteorological Service

April

- **Warmest, driest and sunniest April ever recorded in many countries in western and central Europe**
- **Cold in the Middle East**

Atmospheric circulation characteristics

The main frontal zone was located very far in the north, almost in the Arctic region at the beginning of the month. Some strong low pressure systems affected Iceland, Svalbard, the western and northern coasts of Scandinavia and occasionally also Russia. South of this frontal zone, a high pressure zone extended over northern Europe, while a low pressure zone resided in the south.

During the first decade of the month, the frontal zone moved southwards to central Scandinavia and the centre of the anticyclone to northwestern and later to central Europe where it remained almost stationary. The high pressure influence extended to eastern Europe and even to the southeast as far as the eastern Mediterranean.

The North Atlantic was mainly under low pressure conditions, though with a warm airflow from the south.

At the end of the month, an omega pattern set up with high pressure over northern, western and central Europe and with low pressure over the North Atlantic and the east. Cold air advanced to the Middle East.

Temperature

April 2007 again was considerably warmer than normal in most of the Region, this time especially in western and central Europe with anomalies of + 4-6°C in many places (Fig. 4.1), locally even more. These anomalies were comparable to those of June 2003 e.g. for Zurich, Switzerland (Fig. 4.2); they were in the upper tail of the frequency distribution and thus are expected to occur very rarely.

Many locations in western and central Europe, but also up to the south in northeastern Spain, Italy and Slovenia, had by far their warmest and sunniest April ever recorded (e.g. France, Fig. 4.3). With a monthly mean of 11.2°C it was even the warmest in the long 349-year Central England Temperature time series. In De Bilt (Netherlands), the monthly average amounted to 13.1°C, the highest value since 1706.

Especially the second decade was exceptionally warm in central Europe. On April 13 or 14, the first summer day (daily maximum at least 25°C) was recorded in many places (e.g. Netherlands, Luxemburg, Czech Republic). In the Netherlands this had not happened so early in the year since 1901. With 29.8°C, 15 April was the warmest April day in De Bilt in 100 years. Maximum temperature of 28.7°C in Uccle (Belgium) was the highest since the start of the time series in 1833. Luxemburg airport reported 7 summer days, but no frost days (normally, April is without any summer days but has 4-5 frost days at this station). Germany had 14 summer days on average.

Even Iceland recorded the highest temperature ever measured in April: 23.0°C at the station Ásbyrgi in the northeast of the country. Several stations in Norway and Sweden (e.g. Stockholm, Malmö) registered their warmest April, too. The high temperatures led to a very early development of the vegetation.

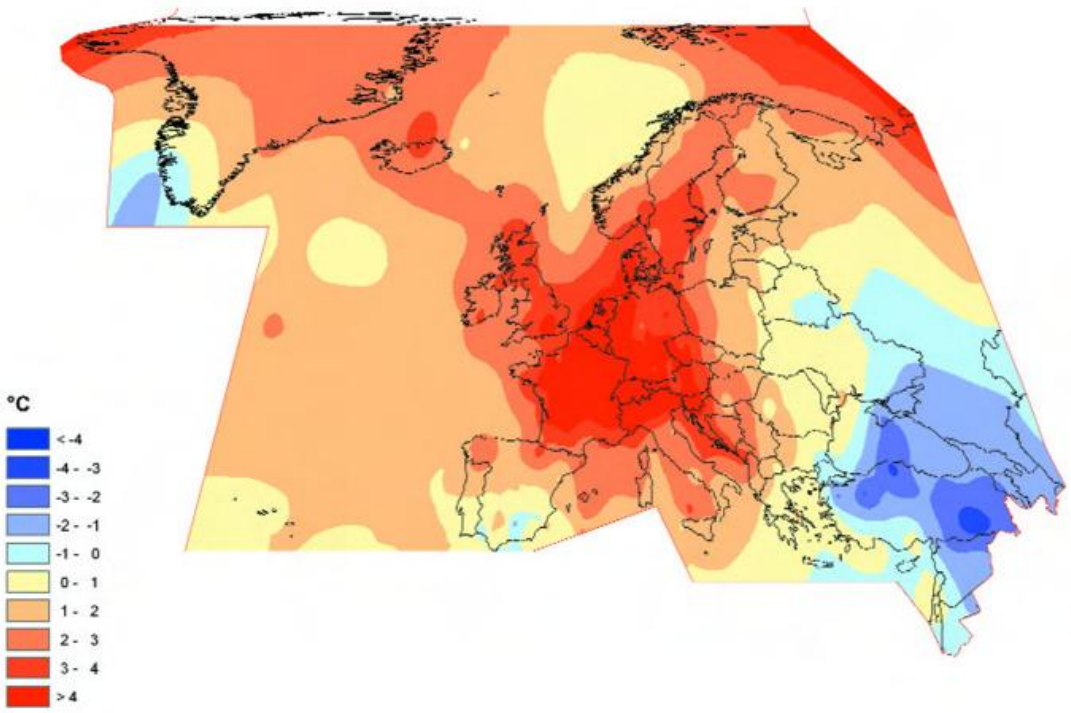


Fig. 4.1: *Monthly mean temperature anomalies in April 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

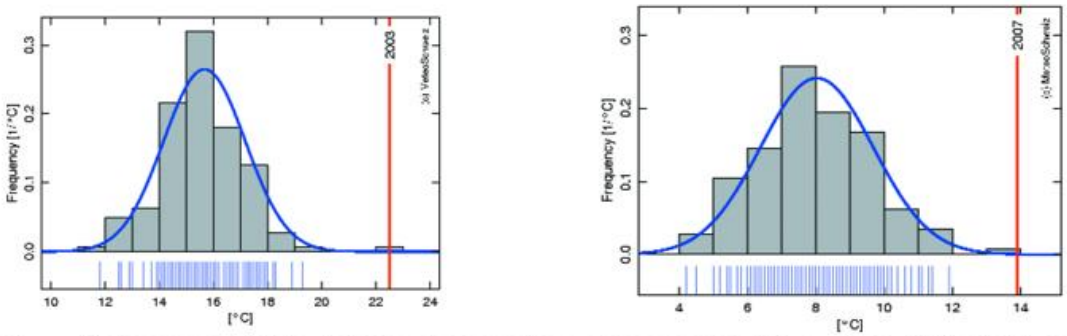


Fig. 4.2: *Comparison of the 2-meter temperature of record breaking June 2003 (left) and the extraordinary hot April 2007 (right), with the corresponding normal frequency distribution of April/June 1961-1990 in Zurich, Switzerland.*
Source: MeteoSwiss, Switzerland

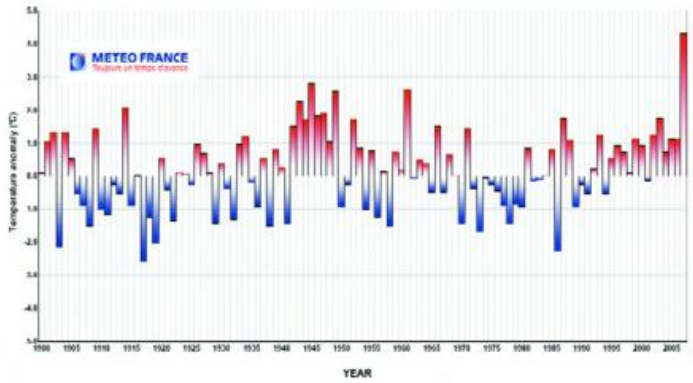


Fig. 4.3: *Monthly mean temperature anomalies in April 1900-2007 (reference period 1971-2000) in France.*
Source: Météo France, France

New records were also set for monthly mean April maximum temperatures. 20.5°C was the highest mean maximum in Belgium since 1901. 20-25°C were recorded in Lithuania at the end of the month. Also in Italy, monthly mean maximum temperatures of more than 20°C were reached in some places, e.g. in Verona, Trieste, Pisa and Rome, all breaking records since 1961. For Spain, a new national record for April maximum temperature was set at the station Oviedo in the north of the country (28.3°C).

On the other hand, it became considerably colder than normal in some eastern and south-eastern parts of the Region with anomalies down to -3°C in northern and eastern Turkey, Georgia and Azerbaijan. Frosts were reported from Armenia and Georgia during the first half of the month causing damage to plants, especially blooming trees. In Israel, however, April 2007 was characterised by a large number of Sharav events, the warmest on 7 April with temperatures reaching 35-37°C in the coastal plain and in the Negev.

In southern Greenland and a few places in southern Spain, the monthly mean temperature stayed slightly below the normal.

Precipitation

It was an unusually dry April in most of Europe. Especially large parts of central Europe and adjacent areas, even in southeastern Europe, received less than 20% of the normal precipitation (Fig. 4.4). Less than 3 mm fell during the whole month in many places, e.g. in southeast England, Luxemburg city, western Slovakia (Fig. 4.5), Hungary, Bosnia and Herzegovina, some locations in Greece, or even no precipitation at all (e.g. most of the Benelux region, some locations in northeast France, Germany, Switzerland, eastern Austria, Poland, Czech Republic and Serbia). These drought conditions were the reason for widespread significant soil moisture

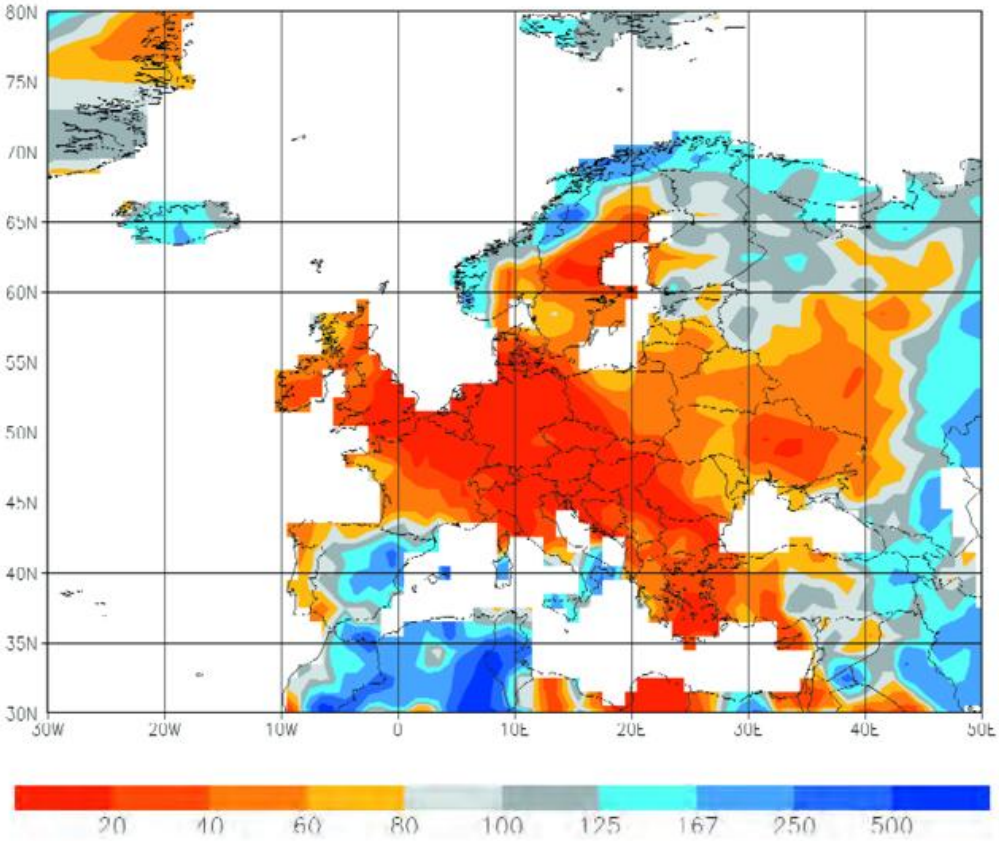


Fig. 4.4: *Monthly precipitation amounts for April 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

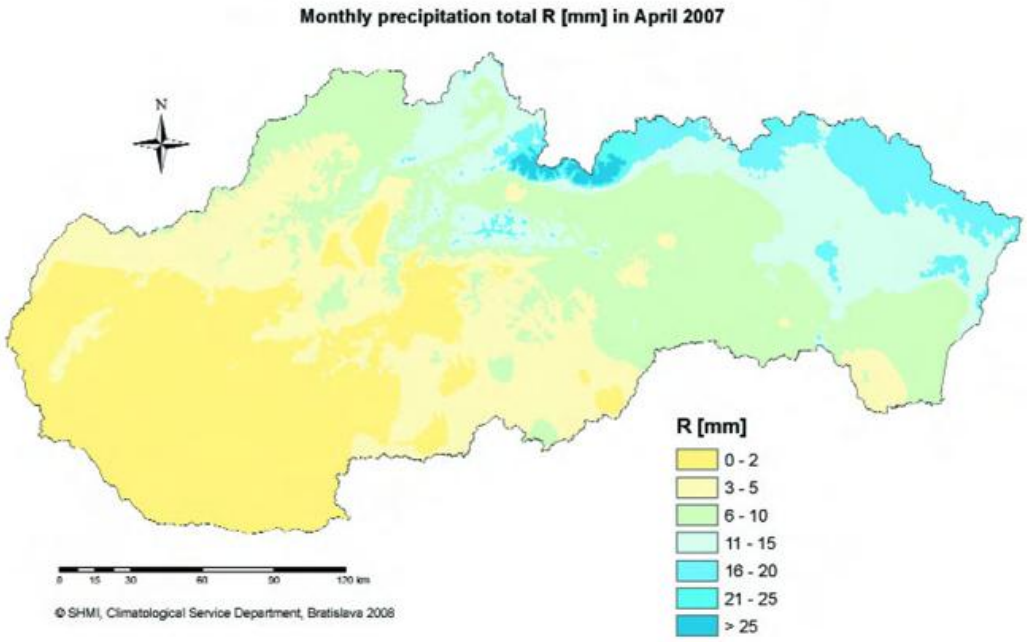


Fig. 4.5: *Monthly precipitation totals in April 2007 in Slovakia. Source: Slovak Hydrometeorological Institute*

deficits endangering winter and spring crops, and causing the outbreak of fires. In Ireland, only 2-6 wet days (daily precipitation total of at least 1 mm) were recorded, at Luxemburg airport even only 1 day with a local thunderstorm (normal is 11 days) occurred. Many other countries reported similar conditions.

Many stations in western, central and parts of southeastern Europe experienced their driest month on record. Germany had a monthly spatial average total of 4 mm (7% of the normal), making April 2007 the by far driest month in Germany since 1901 and in Hungary as well (Fig. 4.6). In Brussels (Uccle), such an April without rainfall had never occurred before (since 1833). 10 mm (15% of the 1961-1990 normal) of rainfall were recorded within the England-Wales precipitation series starting in 1766, making it the lowest April total since 1938.



Fig. 4.6: *Rank of years referring to the lowest monthly April precipitation totals in Hungary, period 1901-2007. April 2007 was by far the driest. Source: Hungarian Meteorological Service*

In most of northern and eastern Europe, April 2007 was not as dry as in western and central Europe, but even there the precipitation totals were only around 50% of the normal, or less, in many places.

Even Malta in the Mediterranean was very dry although, in contrast to central Europe, it was a very cloudy month there (Fig. 4.7, average sunshine duration 6 hours per day).

Wet areas were only recorded at the northern and western coasts in Scandinavia, in the easternmost parts of the Region and over/near the western Mediterranean, partly with more than twice the normal monthly precipitation total. Some stations in northern Norway received even 400% of their monthly total, thus even setting new monthly precipitation records in some cases. In west Georgia, only the first half of the month was rainy whereas the second half was dry.

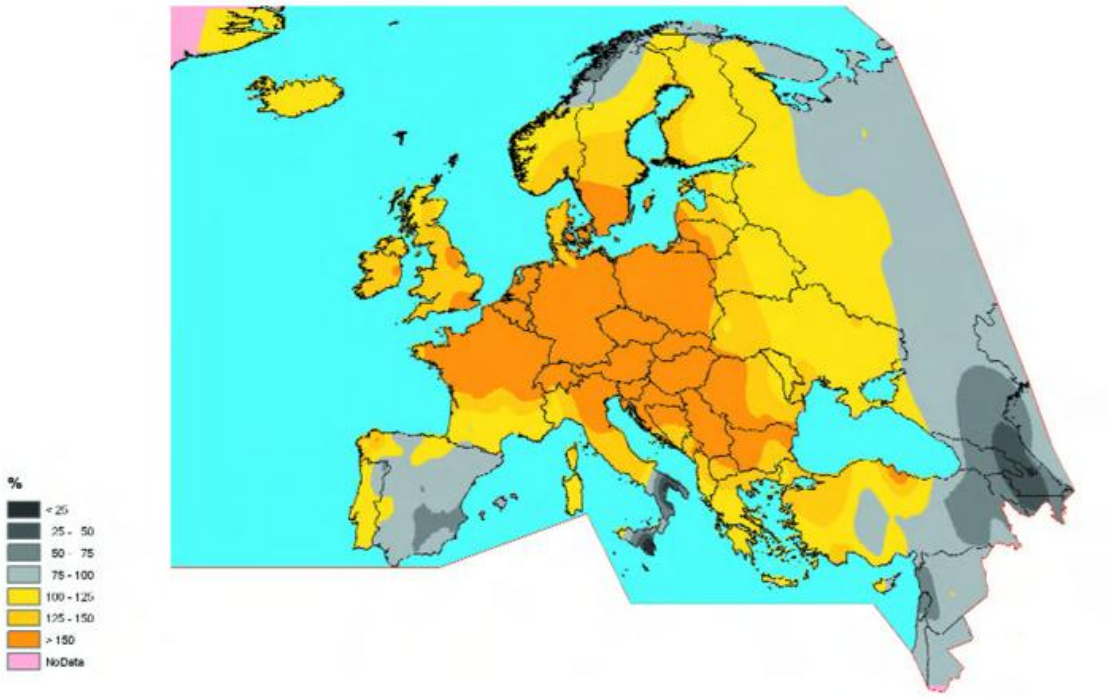


Fig. 4.7: *Mean monthly sunshine in April 2007 duration in per cent of the 1961-1990 normal in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

Significant weather events

April 03-08: Heavy rain and flooding in northeast Spain

April 10-11: Gusts up to 103 km/h and high waves up to 13 m in the maritime Arctic (weather ship Polarfront)

April 13: Heavy rain in the central parts of the Negev desert in Israel and in Jordan. Highest rainfall amount in a 4-hour period since 1953 (38 mm) in Israel

April 15-25: Frequent frost events in various parts of Turkey. Flowers and fruits of trees damaged

April 16: Heavy rain (180 mm within a few hours) in Mallorca. Several houses, roads and parking lots flooded

April 23-25: Record high daily minimum temperatures at many stations in the United Kingdom, e.g. London (St. James Park) 14.5°C on 24/25 April

April 23: Water level of the Po River (northern Italy) reached its lowest record, causing problems for agriculture. Water level lowering of Lake Garda about 50 cm below normal

April 24-25: Heavy rainfall in Armenia (Yerevan and Ararat Valley), intensity up to 30mm/6h, flash flood of River Ksani in Georgia

April 28-29: Frost and snow in some places in Georgia

April 29-30: Heavy rain with hail particularly in central and eastern France. Roads, cars flooded, 300 evacuations

April 29-30: Heavy rain in Turkey and Syria

May

- **Warm in most of Europe and in the Middle East**
- **Very wet in northern, central and most of western Europe, dry in the east**

Atmospheric circulation characteristics

May 2007 began with a meridional circulation pattern over Europe with a large high pressure system over northern, western and central Europe, and low pressure west and east of it. However, the high pressure zone weakened rapidly and was replaced by a mainly westerly zonal airflow propagating from the Atlantic eastward. Thus, cyclonic activity with precipitation became frequent in western, central and northern Europe, while a blocking high persisted over European Russia. Towards the end of the month, some larger troughs moved from the Atlantic to Europe, sometimes extending to the Mediterranean.

In the south, the Iberian Peninsula and the western Mediterranean were temporarily under the influence of the Azores High, whereas the eastern half of the Mediterranean was mostly affected by some cyclonic activity.

Temperature

Mai 2007 was again quite a warm month in nearly the whole Region. The monthly mean anomalies were generally not as high as in April, but still reached +1-3°C in large areas of western, central, southern and eastern Europe and in the Middle East (Fig. 5.1), locally even more than +3°C.

Whereas the first decade of the month was quite cold in eastern Europe (frequent ground frosts in Poland and European Russia led to crop damage), it became especially hot at the end of the month in this area. In Russia, Belarus and the Baltic countries, heat waves at the end of the month led to daily maximum May temperatures above 30°C; historical records were nearly reached or exceeded. 3-8 days with such high temperatures were recorded in Belarus; this was very unusual for May in this country. Near the Black Sea in the lowlands of Georgia a

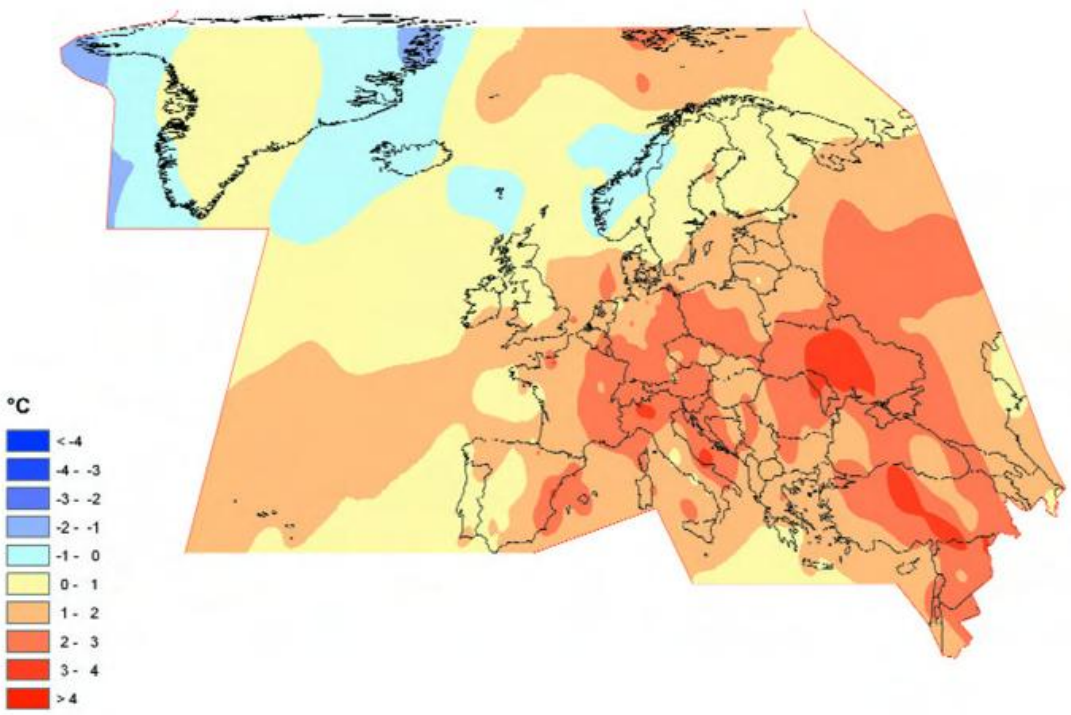


Fig. 5.1: *Monthly mean temperature anomalies in May 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

maximum of 34°C, in the southern parts of European Russia locally even up to 42°C were reached. Armenia, too, had record high maximum temperatures at the end of the month (23-27°C in the mountain regions, 33-35°C in the valleys). In the plains of Azerbaijan 34-39°C were reached, the highest May values in 100 years.

At the same time, a strong temperature decrease occurred over western and central Europe, although these areas had relatively high temperatures the weeks before. In southern Ireland, maxima above 25°C were reached on 17 May; the Czech Republic had its first tropical day in the year on 14 May.

May 2007 was also extremely hot in the entire Mediterranean coastal region, with several stations breaking monthly mean and maximum temperature records in Spain (e.g. Murcia, Alicante). Daily maxima of 30°C were also exceeded in several places in Italy (e.g. Verona 34.8°C, a new record), even on lower mountains (e.g. Monte Argentario, 632 m altitude).

Most of northern Europe was only slightly warmer than normal. Some places in the northwest (parts of Greenland, Iceland, some northern parts of the North Atlantic, west coast of Norway) were even colder than normal (anomalies down to -2°C).

Precipitation

It was very wet in large parts of northern, northeastern, western, central and southeastern Europe, and also in most parts around the Mediterranean, again with locally more than twice the normal total, in northern Scandinavia even three times (Fig. 5.2). May 2007 was the wettest on record in many places: Germany received 131 mm on spatial average (184% of the normal, making it the wettest May since 1901), De Bilt in the Netherlands 138 mm. This was really in sharp contrast to the preceding extremely dry April and filled up the soil water reservoirs in

central Europe which were dried out before. Many plants were thus saved from drought damage. But some of the high precipitation was due to various thunderstorms and hail events, particularly in the second half of the month, causing flooding events.

In contrast, most of the east of the Region was dry. Monthly precipitation totals in widespread parts of southern Ukraine, Georgia and Azerbaijan were below 40% of the normal, partly (e.g. in Romania around the Danube Delta) even below 25%. In the west, parts of Greenland, Iceland and Ireland as well as parts of the Iberian Peninsula experienced a notable precipitation deficit, too. Malta, too, was very dry – only 0.4 mm of precipitation (4% of the long-term average) fell at the international airport throughout the month.

Some countries in southern and southeastern Europe, i.e. most of central and southern Spain, Serbia and Bulgaria, were very wet particularly in the second half of the month due to frequent thunderstorms with heavy rain, partly with hail, which also caused damage to agricultural crops.

Some smaller areas with high precipitation were also to be found near the eastern Mediterranean, e.g. in Greece, Cyprus and Israel, due to an above-normal thunderstorm activity with heavy flood-causing rain events. Cyprus received 68 mm of precipitation on country average, which is nearly 350% of the normal for May. Monthly totals in Israel amounted to 20-50 mm in the inner parts of the country; this is a multiple of the long-term average of less than 5-10 mm for May. Israel and also Lebanon saw more than twice the normal number of rainfall days in many parts of the countries.

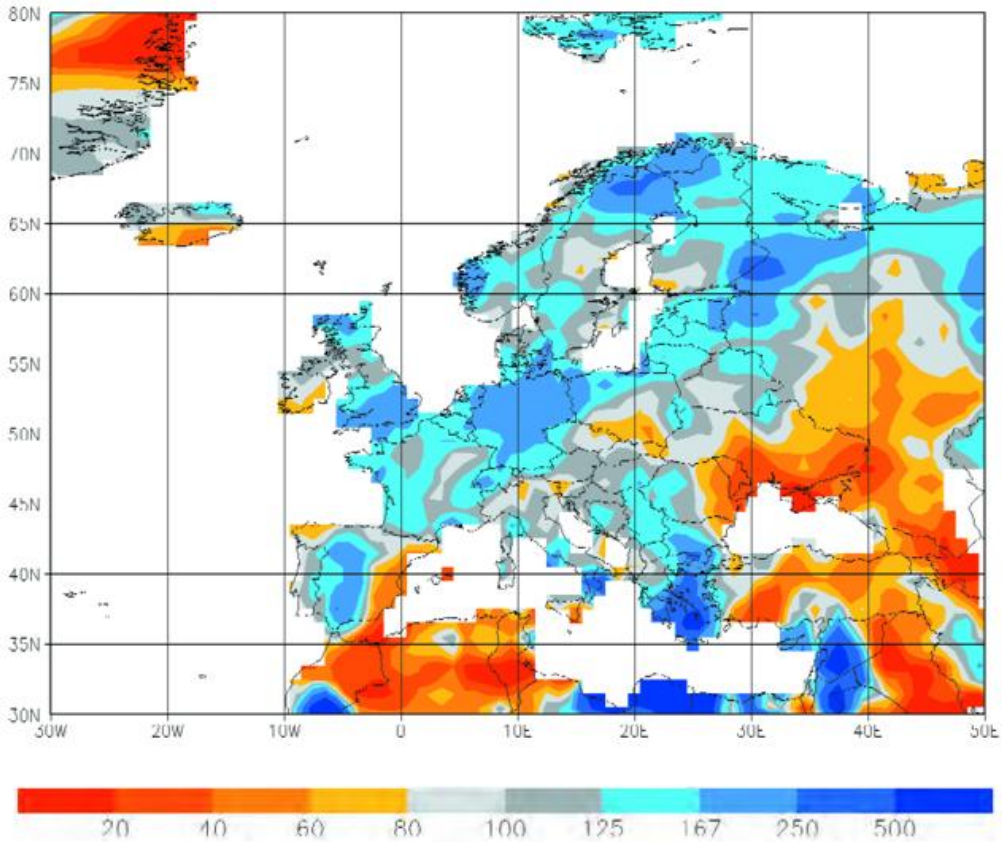


Fig. 5.2: *Monthly precipitation amounts for May 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Flooding due to snow melting

Although precipitation totals were low in Armenia, rapid increase of temperature caused very intensive melting of snow in the mountains. The result were numerous floodings across the country with high damage to agriculture, livestock and roads.

Significant weather events

May 02:	Strong cold front with frost below -6°C in some places in northern and north-eastern Hungary
May 03:	Heavy rain and flooding in western Azerbaijan (Gazakh region). Agstafa and Kyur River burst their banks, villages flooded
May 04:	Heavy rain, flash flood, landslide in southwestern France (Bayonne). Nivelle River burst its banks, houses flooded/damaged, 5 injured and 3 deaths
May 09:	Tornado in North Ireland (United Kingdom), houses and cars damaged, 1 injured
May 10-12:	Heavy rain and flooding in eastern Georgia. Rivers Mataniskhevi, Kobaskhevi burst their banks, 200 houses, farmland flooded, livestock killed
May 11:	Storm with gusts up to 120 km/h in many parts of Germany. Trees fell down, disruption of roads and electricity
May 11:	Severe storm and heavy rain in western and central Belarus. More than 200 houses and agricultural structures damaged, 290 settlements without electricity, 5 injured, 1 death
May 11:	Severe storm in southeastern Cyprus (Larnaca, Nicosia), tornado, heavy rain, hail. Roads flooded, trees and power lines downed, air traffic affected
May 12:	Heavy rain in Israel (Judean desert, northeast of the Dead Sea) caused flooding of the Kumeran River
May 13:	2 relatively long lasting tornadoes in northern and western Germany with tracks of 5 and 12 km. Roads blocked, trees downed
May 13:	Flash floods and heavy rain in Israel around the Dead Sea, 4 deaths
May 16:	25 mm of precipitation in 1 hour in central Jerusalem (Israel) in the early afternoon. Many streets were flooded.
May 17-22:	Thunderstorm and heavy rain in north Bulgaria with hail balls of egg size and tornadoes. 161 mm of precipitation accumulated over 4 days, Vladayska River near Sofia overflowed. In Greece (South Aegean), locally more than 55 mm of rain within 24 hours were reported on 19 May. Heavy hailstorm also in Cyprus on 17 May, in Turkey a few days later, causing damage to crops and fruit trees
May 21:	Severe thunderstorms, flash floods, landslides in central and western Switzerland (Berne, Lausanne). 50 houses damaged, cellars flooded, roads blocked
May 22-27:	Heavy thunderstorms caused by a cold front over Germany. Strong gusts, hail and heavy precipitation especially in western Germany (e.g. 17 mm within 30 minutes in Bonn, at other locations even more), flooding of buildings and roads, trees fell down
May 23-26:	Heavy rain in central and southern Spain. Streets were flooded in Madrid, widespread flooding of fields and vineyards, disruption of railroads, 400 evacuations
May 26-28:	Frequent thunderstorms, hail, flooding, landslides in Greece, east Turkey, Georgia, Azerbaijan

May 27: Rainfall total of 74.8 mm in 24 hours at St. Catherine's Point (Isle of Wight, UK)

May 28: 2nd lowest May maximum day-time temperature of 7.9°C at Heathrow (London, England) since 1949

May 28: Heavy snowfall/rain and storm in Corsica (France) after strong temperature decrease. Wind speeds up to 120 km/h, huge waves (3 meters)

May 28-29: Strong temperature dropdown in southwestern Germany by up to 20°C caused fresh snow cover of several cm in mountain regions even below 1000 m altitude. In lower altitudes, abundant rainfall (partly more than 70mm/24h) especially in eastern and southeastern Germany caused overflow of smaller rivers.

May 28: Highest temperature in May in Moscow since 1891: 32.9°C

June

- **Mostly warm, except northern Russia and a few other places**
- **Heat wave in southeastern Europe**
- **Very wet in western and central Europe, dry in most parts of the north and east**

Atmospheric circulation characteristics

Northern Europe was mainly under high pressure influence. The Arctic frontal zone with cold troughs mainly affected Svalbard and northern Russia.

Low pressure influence (sometimes with quite strong cyclonic systems) continued over the North Atlantic, western and central Europe, but warm air masses still remained. A blocking high persisted over eastern Europe and temporarily in the Middle East at the beginning of the month, but became weaker later in the month.

The Azores High also weakened compared to the previous month, and some low pressure systems reached the central Mediterranean.

In the last decade of the month, warm air from the Mediterranean moved to southeastern Europe, causing a further temperature increase and resulting in a heat wave with extremely high temperatures there.

Temperature

June 2007, too, was mostly warmer than normal (Fig. 6.1). Anomalies above +3°C were recorded especially in southeastern Europe, locally up to +5°C, e.g. in Greece. This was mainly caused by an extreme heat wave in the last decade of the month with daily maxima of 40-47°C, partly record-breaking and lasting several days, especially in the Balkan countries, Italy, Greece, Cyprus and Turkey, but also Israel and Jordan. In Israel, the temperatures were not record-breaking, but the long duration (one week) was unusual for June.

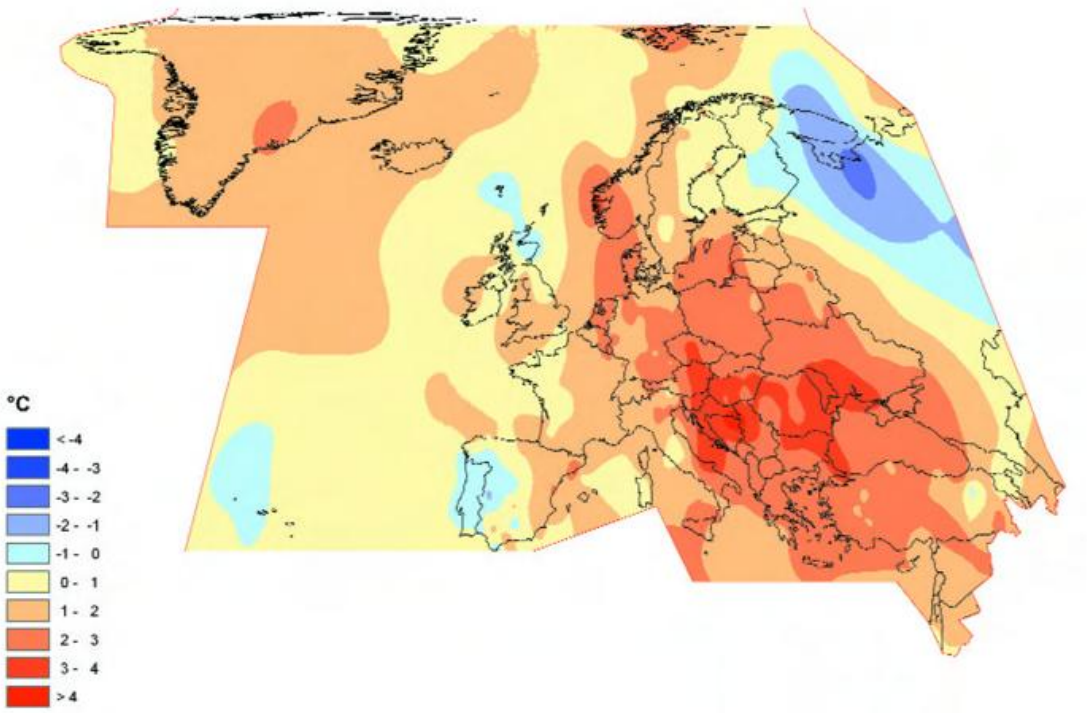


Fig. 6.1: *Monthly mean temperature anomalies in June 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

Western Europe saw some temperature records, e.g. Belmullet in Ireland had a monthly mean temperature of 14.6°C, the highest mean June temperature on record since 1956. At several stations in eastern provinces of Spain, monthly records were broken.

In Sweden, there was a long heat wave during the first half of June, followed by cooler temperatures afterwards.

It was colder than normal in northern European Russia (anomalies down to below -2°C), parts of eastern Finland, and towards the west of the Region in Scotland, on the western Iberian Peninsula, and parts of the Azores Islands.

Precipitation

Notably most of western and central Europe was wet, with monthly totals partly more than 200% of the normal (Fig. 6.2). At Kilkenny (Ireland), it was the wettest June on record since 1957; the highest monthly total in Ireland was measured in Dublin at 171.5 mm. Also in eastern and northeastern England, June 2007 was the wettest on record in some areas: in the region of Yorkshire, the monthly total was over 300% of the normal, some stations reported even more than 500% (Fig. 6.3). Generally it was the wettest June in the United Kingdom since 1873 and also the wettest ever recorded June in Denmark. 11 thunderstorm days were recorded at Luxemburg airport, more than twice the normal. In Switzerland, especially the first 10 days of the month were characterised by many thunderstorms over the entire country, causing considerable damage. In the south, Messina in Sicily (Italy) registered 79 mm as the monthly total, breaking the previous record of 1977 by nearly 5 mm. It was the wettest June in 85 years at Malta Airport, mainly due to a heavy rainfall episode at the beginning of the month.

In most of northern and eastern Europe and partly in southern Europe and the Middle East, precipitation amounts were low or around normal. Large parts of western and central Norway received less than 25% of the normal, just like most parts of southeastern Europe, especially

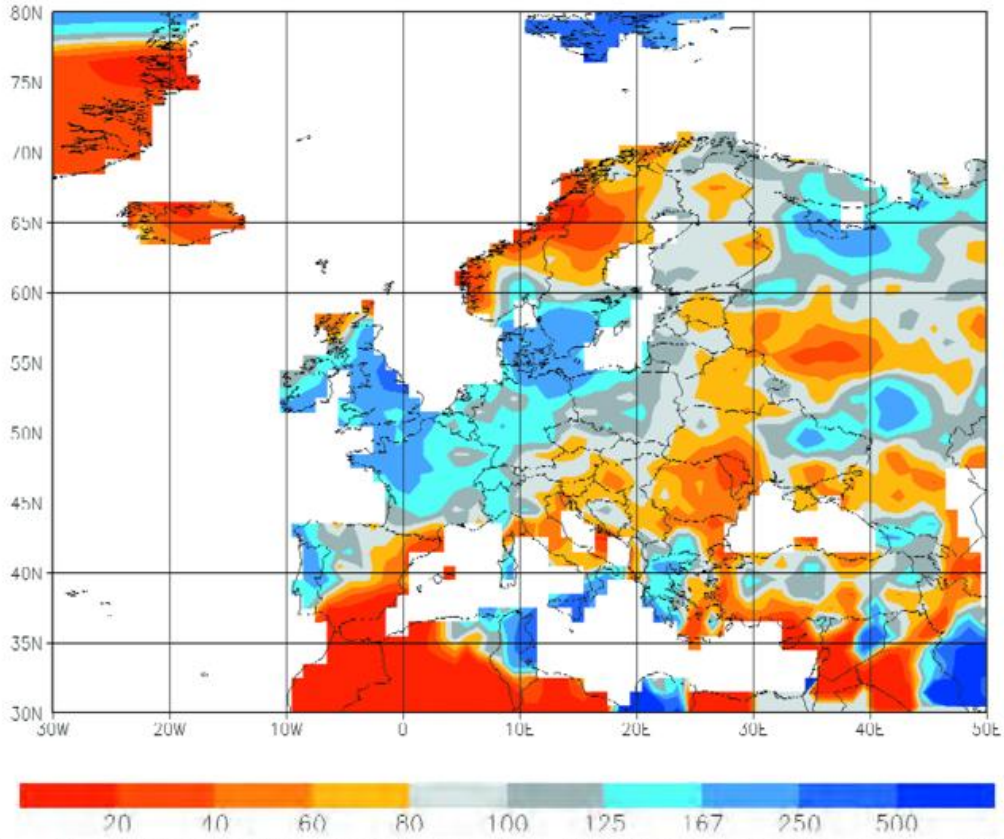


Fig. 6.2: *Monthly precipitation amounts for June 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

northeastern Romania and Moldavia. Some areas near the eastern Mediterranean were very dry, although storms with heavy rain, thundering and hail occurred frequently. The Baltic countries and European Russia experienced a very dry beginning of June, whereas the second half of the month was rainy with many thunderstorms and hail. West Georgia reported drought conditions for this month, but there were also several severe storms with flooding in some parts of the country.

Significant weather events

June 01-04: Severe storms with gusts up to 100 km/h in the Volga area of Russia. More than 270 buildings damaged, trees and power lines downed, 3 deaths, many injured

June 03: Flooding in Quba (Azerbaijan), causing losses of cattle, bridges destroyed, damage to agriculture. Flash flood at rivers in Georgia.

June 06-07: Heavy precipitation in Bulgaria: 279 mm (600% of the monthly normal) in the Pazardjik region. In Turkey, too, heavy rain and flooding

June 07: Hailstorm with hailstones of 25 mm diameter in central Armenia

June 08: 100 mm of rain within 1-2 hours in the evening in central Switzerland (Langeten catchment), locally probably a lot more. Langeten River took a new path passing a village, causing serious devastation

June 09-16: Heavy thunderstorms partly with hail (pigeon egg size) in western and southwestern Germany. Trees uprooted, rain up to 100 mm, streets flooded

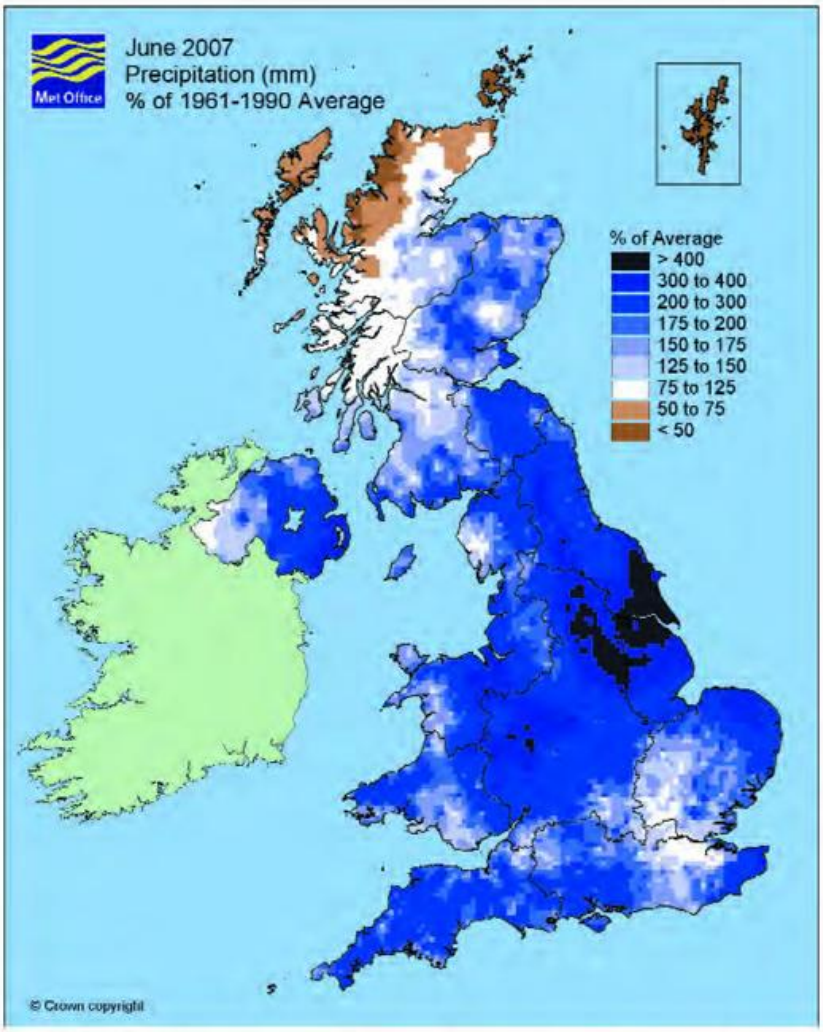


Fig. 6.3: *Monthly precipitation totals for June 2007 in per cent of the normal 1961-1990 in the United Kingdom*
Source: Met Office, United Kingdom

June 10-11: Severe thunderstorm with hail and heavy rain in southwest France (Gers). Houses flooded, vineyards damaged

June 10: Extreme Sharav event in Israel with temperatures reaching 40-42°C in the coastal plain, in the northern valleys and in the Negev

June 12-14: Heavy rainfall with flooding in northern Ireland, northern England and the midlands of the United Kingdom. Flash floods, rivers burst their banks, schools closed

June 14-16: Severe thunderstorms in southern and northeastern Germany, strong gusts, hail, heavy rain (50 mm / 24 h), flash floods, mudslides. Buildings damaged, trees and power lines downed, roads flooded

June 15: Severe storm over Venice (Italy), strong wind, heavy rain, hail. Power outage, bridge closed, concert cancelled

June 16-17: Severe storm in the Carpathian region, Ukraine. Heavy rain, hail, flash floods, mudslides, TV tower and bridges damaged, houses flooded, losses in agriculture

June 19-23: Heavy thunderstorms in Germany, Switzerland and Austria with supercell and hail. Gusts up to 135 km/h. During the evening of 20 June, 21 mm within 10 minutes in Chur (Switzerland), highest value at this location since 1981. Flooding in the city of Zurich on 21 June. Agricultural losses (vine, fruits, crops) in Austria over areas of several thousand hectares. Devastations by water and mud masses in the Alps. Gusts up to 120 km/h in Vienna. Several open air stages of the "Danube Island Festival" were destroyed.

June 23: Tornado in Frankfurt/Main (Germany), thunderstorm, heavy rain. Roads flooded, trees downed

June 23-29: Heat wave in southeastern Europe and the Middle East: 42-45°C in southern Italy with several fires, 39.5°C in Malta on 25 June, 41°C in Serbia, 45°C in Romania on 26 June, heavy storm one day later; 42°C in Bulgaria in many places, 46.4°C in Greece, 42-46°C in the Jordan Valley in Israel, 44°C in Deir Alla (Jordan)

July

- **Mostly warm with heat waves especially in the southeast**
- **Cool in western and parts of northern Europe**
- **Wet in most of the north, dry in the south**

Atmospheric circulation characteristics

Strong low pressure influence continued across northern and central Europe throughout July 2007. The main frontal zone first had a zonal pattern and extended from the North Atlantic to central Europe and later also to eastern Europe. In the middle of the month, the circulation pattern became more meridional. A trough formed over the North Atlantic, affecting western Europe with cold and wet air, whereas warm Mediterranean air masses flowed to southeastern Europe, causing two more heat waves in this area. This situation remained stationary for many days. Only at the end of the month, the large-scale circulation became zonal again.

The very northern Scandinavian areas remained under high pressure influence most of the month.

Southern Europe was affected by a strengthening and extending Azores High.

Temperature

Most of the Region was still warmer than normal (Fig. 7.1). In the Baltic countries, especially the first ten days were warm, with another heat spell in the middle of the month in Lithuania. Southeastern Europe and the Middle East were particularly warm, just as the preceding month, with monthly anomalies above +4°C, which was the result of two more extreme summer heat waves in the second half of the month.

Daily maxima of 40-47°C were measured in many places (in some cases new records were set), e.g. in Slovakia, Hungary, southern Italy, Croatia, Montenegro, Serbia, Romania, Moldova, the southern Ukraine, Bulgaria (Fig. 7.2), Macedonia, Greece, Cyprus, Turkey, Jordan and Israel. Even in eastern Germany, Austria and Malta, values above 38°C were recorded. It was the warmest July since 1901 in Romania. There were 8 consecutive days in July 2007 with a maximum temperature over or equal 40°C in Podgorica (Montenegro), and also in Romania the

number of maxima over or equal 40°C set a new record. The July average maximum temperature for Italy was 34.7°C, which makes it the warmest July in at least 30 years. Israel and Lebanon were also affected by the heat wave.

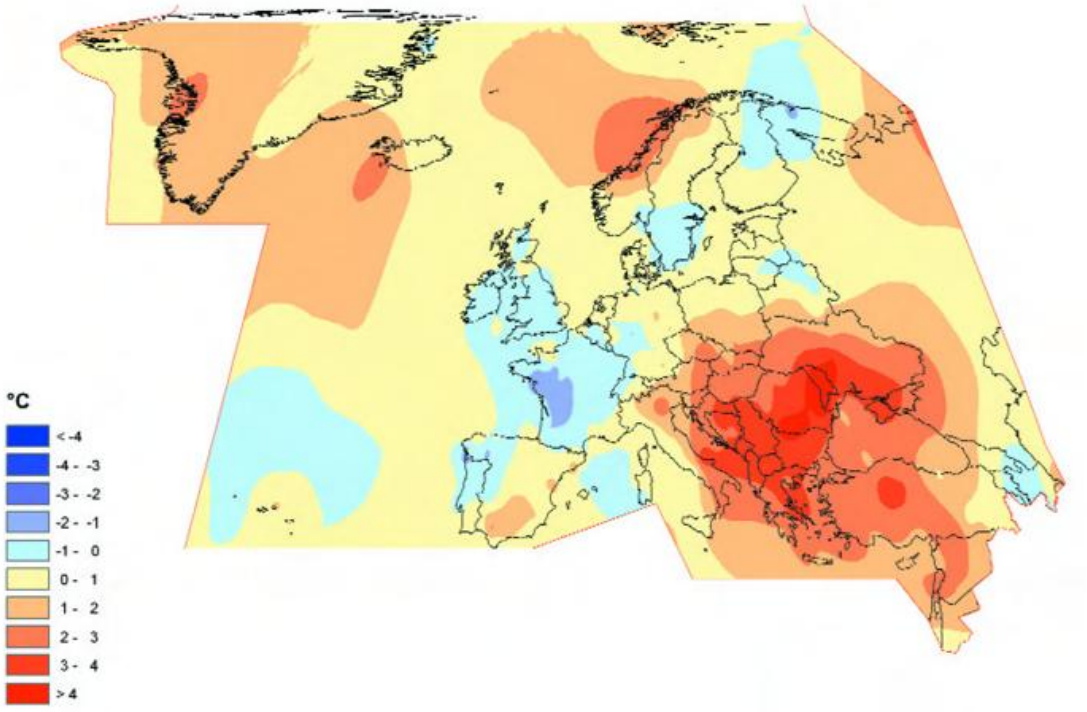


Fig. 7.1: *Monthly mean temperature anomalies in July 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

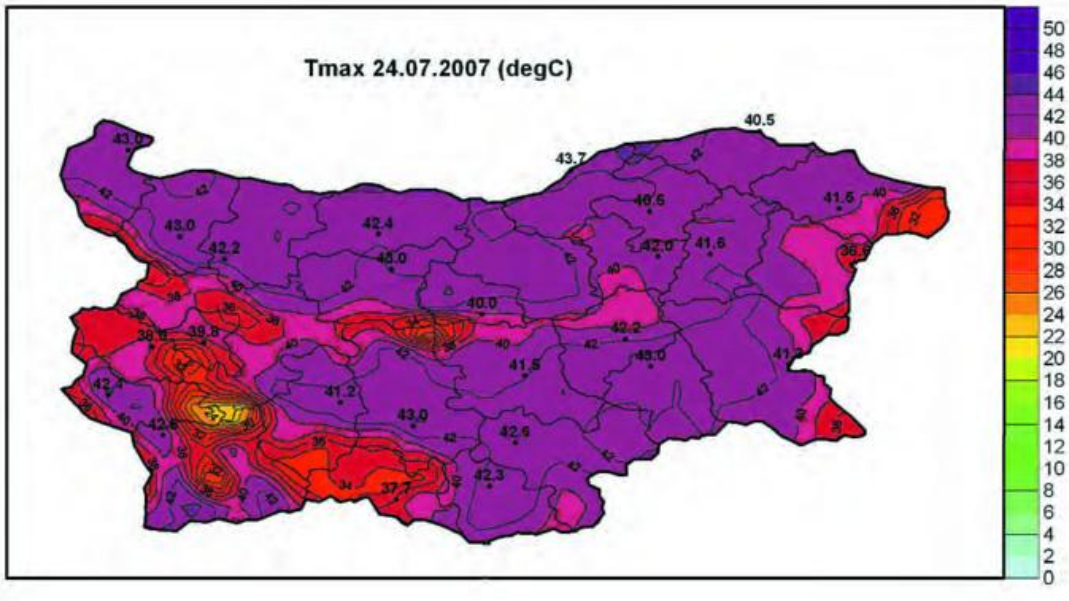


Fig. 7.2: *Maximum temperatures for the hottest day in July in Bulgaria*
Source: National Institute of Meteorology and Hydrology, Bulgaria

On the other hand, large areas of western and some parts of northern Europe as well as parts of the North Atlantic and the western Mediterranean were cooler than normal, for the first time in 2007. Notably in western France, the anomalies were below -1°C. Armenia was also slightly cooler than normal (-0.4°C).

Precipitation

It was wet in western, central, eastern and parts of northern Europe, except Greenland, Iceland, northern Norway and central Sweden (Fig. 7.3). Ireland, southern parts of the United Kingdom, northern parts of France and even parts of southern Norway saw more than 300% of the normal precipitation. Rainfall was even more extreme in western England and Wales. In many places, this was the wettest July in many years and the number of wet days was unusually high there (up to 25 days with monthly totals of at least 1 mm in Ireland, the normal being 9 to 14 days). For the Netherlands, this was the wettest July since 1942 (155 mm, 200% of the normal). Sweden registered a new record for the highest monthly July precipitation total at 334 mm. The Baltic countries and Belarus also had a very wet July, locally even record-breaking, with more than 200% of the normal rainfall in Lithuania. This was partly due to a heavy rainfall event at the beginning of the month when some places in Lithuania received 96-202 mm of precipitation within 5 to 8 days (Fig. 7.4).

Southern Europe was very dry. There was nearly no precipitation over parts of the Mediterranean region and near the west coast of the Black Sea. Bulgaria received only 12% of the normal precipitation, southern Serbia even only 5%. Wildfires were reported from Macedonia and Greece. The severest drought in 60 years was recorded in Moldova, as July

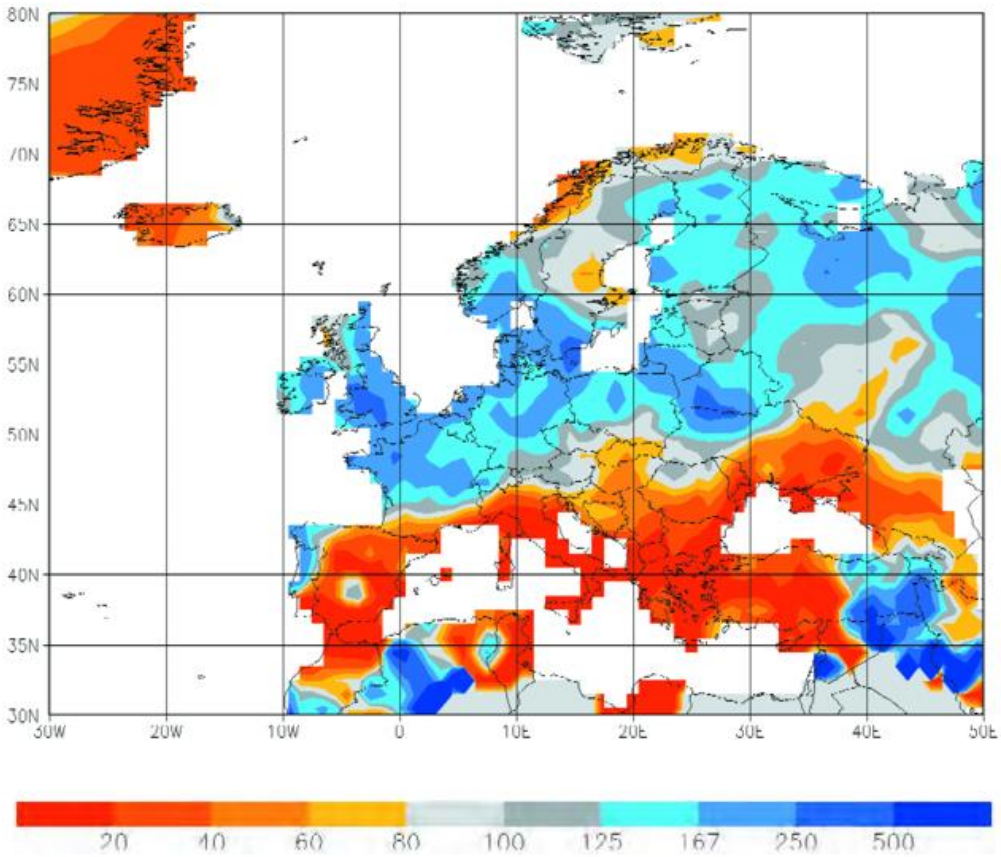


Fig. 7.3: *Monthly precipitation amounts for July 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

2007 was the third successive very dry month there, causing severe losses of agricultural crops (Fig. 7.5). Drought conditions and forest fires were also reported from northern parts of Montenegro where droughts normally are very rare in contrast to the southern parts of the country. In the Middle East, some high positive anomalies were to be found, but since the summer precipitation amounts are generally low there, the absolute totals were not very high. July in Armenia is one of the driest months normally, but July 2007 was unusually rainy with 150-300% of the normal due to some heavy showers.

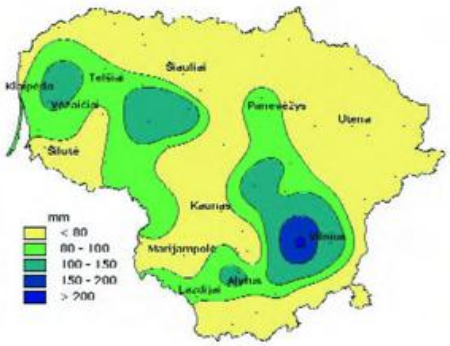


Fig. 7.4: *Precipitation totals after an extreme rainfall event over 5-8 days in the beginning of July 2007 in Lithuania*
Source: Lithuanian Hydrometeorological Service



Fig. 7.5: *Drought in Moldova in July 2007*
Source: State Hydrometeorological Service, Republic of Moldova

Significant weather events

July 01: Heavy rainfall with flooding of Pedieos River in Cyprus

July 03-04: Flash flood in northern Ireland. River burst its bank, houses, bridges, roads flooded, evacuations

July 04: Flash floods in Switzerland, landslides. Rivers burst their banks, buildings flooded

July 07: Heavy rain (85-86 mm / 12 h) during the night in Lithuania. The quadrennial Lithuanian Song and Dance Festival had to be disrupted.

July 11: Severe storm in Romania, heavy rain, hail, flash floods, landslide. More than 100 houses damaged, trees and power lines downed, crops destroyed

July 12: Hail in Horki (Belarus), average hailstone diameter 43 mm, some hailstones had 50-60 mm (Fig. 7.6). Such a hail event occurs there only once in 50 years on average.

July 15-22: Heat wave in many European countries with maxima around 40°C and more particularly in southeastern Europe. In Lithuania, maximum temperatures of 30-34°C on 17 July

July 18: Widespread strong thunderstorms with heavy rain showers and strong gusts near Tartu (Estonia). Hail caused heavy damage to crops.

July 19-20: Hailstorm in the Bernese Oberland (Switzerland). Golf or even tennis ball-sized hailstones

July 19: Tornado and hailstorm in the western and central Czech Republic. Houses damaged, trees and power lines downed

July 20-29: Up to 147 mm of rain in central England with extensive flooding on 20 July. On the following days, heavy rain in southern parts of the United Kingdom, causing the severest flooding in 60 years

July 21-22: Heavy thunderstorms with hail and heavy rain in southeastern Germany. Thunderstorm also in Switzerland (around Berne), flooding and landslides

July 21: Heavy precipitation in Georgia with daily amounts up to 101 mm

July 22: Tornado in southern Poland. 100 buildings damaged, power outages

July 22-29: Heat wave in southeastern Europe and parts of the Middle East: new temperature records in Serbia 44.9°C, in Romania 44.3°C and Bulgaria 44.8°C, maximum in Athens (Greece) 45.6°C, in the Jordan Valley (Israel) 43-45°C, in Jordan 42-47°C



Fig. 7.6: *Hailstones after a hail storm in Horki (Belarus) on 12 July 2007*
Source: Republican Hydrometeorological Centre, Belarus

August

- **Very warm in the east, but western Europe mostly cool**
- **Western, central and parts of southeastern Europe mainly wet**
- **Eastern Mediterranean and some of the easternmost parts of the Region very dry**

Atmospheric circulation characteristics

In August 2007 low pressure influence continued in western and central Europe. Shortly after the beginning of the month, some more large troughs affected western and, increasingly, central Europe with cold and humid air, whereas a high pressure system formed over southern Scandinavia, the Baltic countries and Belarus, and later over European Russia. High pressure influence was also dominating over Greenland and the Mediterranean area, in the second half of the month also over the North Atlantic. At the end of the month, a large low pressure system developed over Scandinavia.

Temperature

Most of the Region was warmer than normal with the highest anomalies in the east (Fig. 8.1, up to +5°C in the eastern Ukraine, southern European Russia and western Kazakhstan). It was the second warmest August in European Russia since 1972, in Belarus in 60 years (behind 1992). In Finland, the highest recorded temperature during the summer was measured unusually late in the middle of August at 30.7°C. In Lithuania, 32-33°C were reached.

Like in the preceding two summer months, record-breaking daily maxima of more than 40°C were also recorded in August in the southeast and south, especially in southern Italy, Bosnia and Herzegovina, Bulgaria, Greece, but also in the easternmost parts of the Region (southern Ukraine, European Russia, Azerbaijan). There were twice as many tropical days than normal in Serbia.

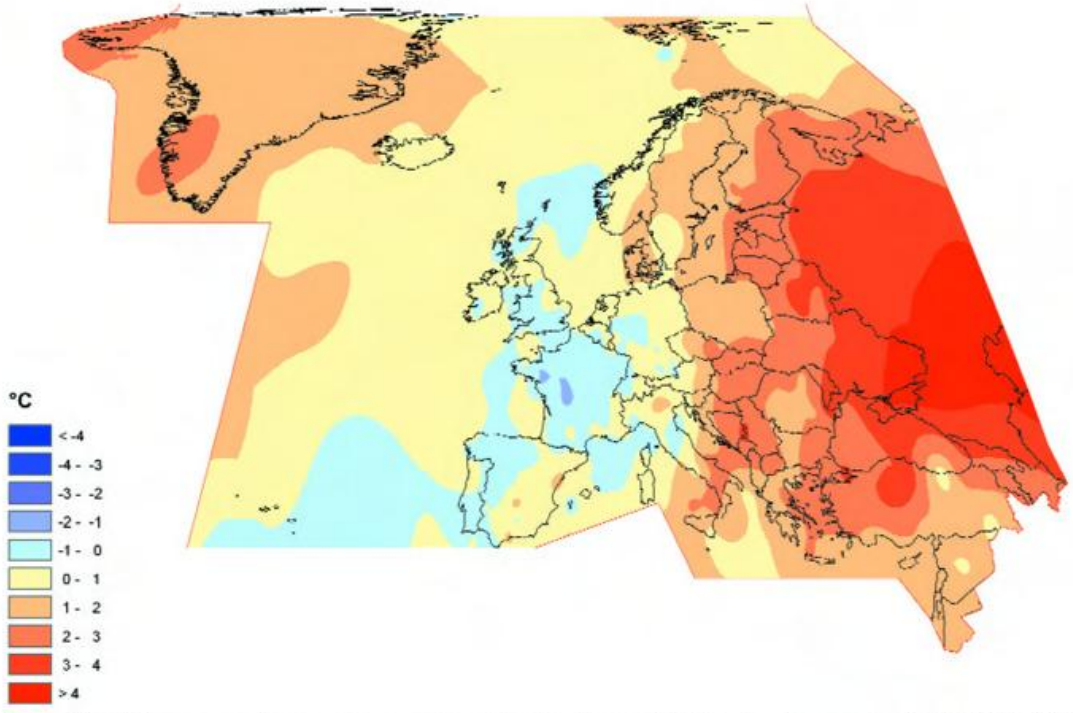


Fig. 8.1: *Monthly mean temperature anomalies in August 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

In contrast, most of western Europe was slightly cooler than normal; locally the anomalies were below -1°C in France and Spain. England had its coldest August since 1993.

In the Arctic region, Greenland and western Svalbard had monthly mean anomalies below +1°C this August. Due to glacier calving in Svalbard, a cruise ship was hit by a wave of ice and water.

Precipitation

Large parts of western, central and southeastern Europe were wet, also eastern Turkey and a few locations in the north of the Region, partly with more than 200% of the monthly total (Fig. 8.2). Zurich (Switzerland) recorded a monthly total of 260 mm, making it the second wettest August on record since 1864. In the first half of August, the highest daily rainfalls in Switzerland in more than 100 years were measured, especially in some regions in the midlands. During the last days of the month, exceptional thunderstorms hit several parts of Switzerland (the Lake District, Freibergen and Bernes Jura). Precipitation amounts within 72 hours locally reached or even exceeded the normal monthly totals, resulting in local land slides and floods. Other parts of Europe (Germany, northeast France, Austria, northern Italy, Romania and Bulgaria) were also affected by heavy rain with local flooding. Hailstones of tennis ball-size caused enormous damage to houses and fields in Austria several times. Southeastern Portugal received the highest August precipitation totals since 1976. Some stations in Romania had their highest ever registered August precipitation totals, up to nearly 300% of the normal.

Most of northern, eastern and southern Europe was dry. Near the central and eastern Mediterranean, and partly in the east of the Region (central European Russia, west Kazakhstan, Azerbaijan) less than 20% of the normal precipitation fell over a large area. In Italy (e.g. in central and southeastern Sicily) there was no precipitation to all.

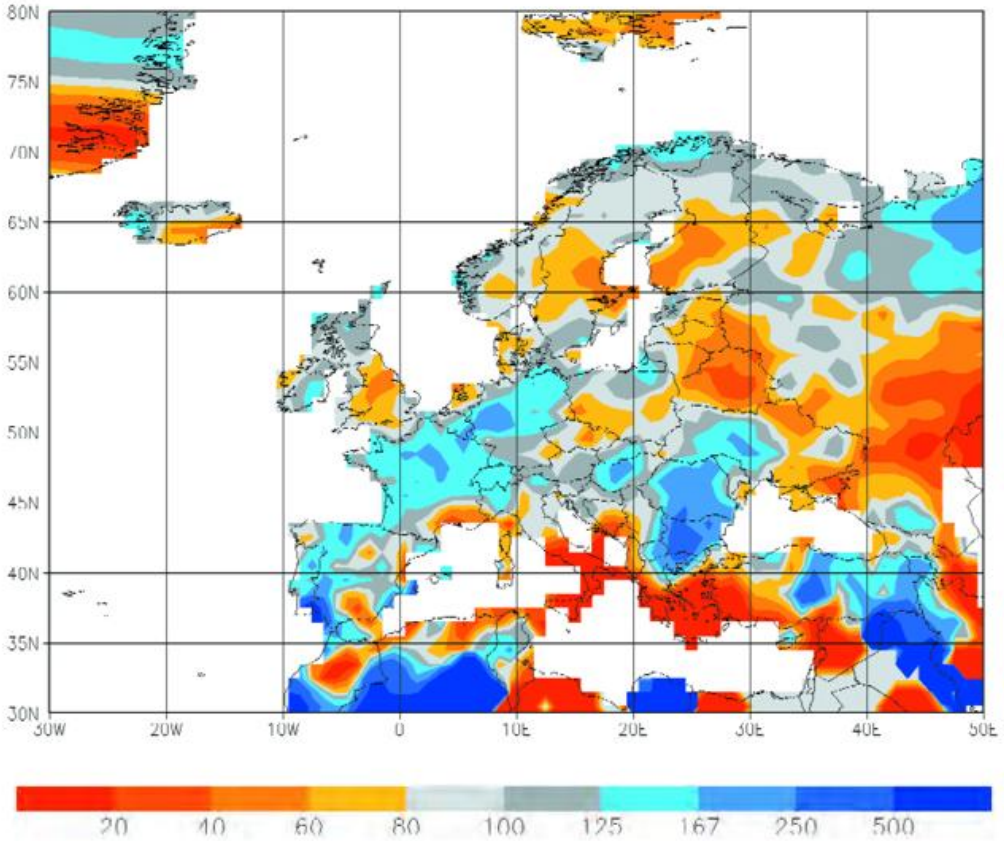


Fig. 8.2: *Monthly precipitation amounts for August 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Significant weather events

August 02-03:	Flooding in Austria (regions Tyrol and Salzburg), thunderstorms and hailstones of tennis ball-size. Flooding also in southern Germany
August 06-12:	Thunderstorms and heavy rain in Germany, Austria and Switzerland (daily totals over 100 mm) due to a low pressure system over northern Italy
August 05-07:	Heavy rain and thunderstorm in northeast Bulgaria: 291 mm in less than 24 hours. Flooding due to a broken water reservoir barrier in the region of Razgrad. Torrential rain up to 80 mm/h in Romania. Thunderstorms and heavy rain with flooding also in Greece (> 50 mm / 24 hours)
August 11-16:	Severe storms with flash floods in northern Germany. Torrential rain up to 176 mm / 24 h. Villages, towns inundated, roads closed, evacuations. Flash floods also in northern Ireland.
August 17:	Devastating storm in parts of Savinja Valley (Slovenia). Thunderstorm with heavy rain also in northern Italy (Piedmont)
August 19-20:	Hailstorms in Austria. Torrential rain, flash floods
August 21-22:	Heavy rain in western and northern Germany up to 91 mm in 24 hours, 50 mm within 3 hours. Towns and roads flooded. Severe storm (gusts up to 120 km/h) and heavy rain also in northeastern Poland
August 23:	New record of rainfall intensity of 70 mm / 6 hours in Kapan (southern Armenia)
August 23-25:	Heat wave: maximum temperatures of 40-45°C e.g. in Montenegro, Bulgaria and Greece. Forest fires resulting from the heat and additional strong winds in eastern and southern Greece.
August 28:	Storm at the Swedish east coast at 90 km/h, the first storm in August in Swedish coastal waters since 1975
August 30:	Snow depth of 2 cm in Kiruna, northernmost city of Sweden. First measurable snow depth in August at any Swedish station since 1994

September

- **Colder than normal in many parts of Europe**
- **Warm over the North Atlantic and in the Middle East**
- **Western Europe, eastern Mediterranean and Middle East very dry**
- **Central and eastern Europe mostly wet**

Atmospheric circulation characteristics

A high pressure area over the North Atlantic extended to western Europe and persisted there during a longer time. Central Europe was still under cyclonic influence. Cold air masses flowed at the east flank of the Atlantic high pressure system to western and central Europe and even further to southern parts. A large cut-off low developed over central Europe and moved to the southeast. Over eastern Europe, a warm air flow from the south was dominating, but mostly with cyclonic circulation. The eastern Mediterranean and the Middle East saw anticyclonic conditions most of the month.

In the middle of the month, central Europe became also increasingly anticyclonic and the main frontal zone moved northwards. A large quite stable low pressure system resided over northern Europe and led cold air especially to western parts of Scandinavia.

The circulation changed again at the end of the month. Another deep trough extended from the north to western and central Europe, whereas a high pressure area formed over eastern Europe.

Temperature

The area of colder-than-normal temperatures in western Europe extended further to the east. September was a cold month for many parts of continental Europe except the East (Fig. 9.1); the anomalies were below -1°C in many places, locally below -2°C (e.g. northwestern Austria).

It was still warmer than normal over most of the North Atlantic, large parts of northern and eastern Europe, parts of the Mediterranean and particularly the Middle East. High anomalies between +4 and +5°C and daily maximum temperatures up to 37°C were reached in Azerbaijan, up to 34°C in Georgia.

Precipitation

Most of western Europe was very dry, also some areas in northeastern Europe, particularly in Belarus and northern European Russia, in many places with less than half the normal precipitation total (Fig. 9.2). The eastern Mediterranean and the Middle East mostly had extremely low precipitation totals (less than 20% of the normal). Most of Armenia received only 1.7 mm precipitation on country average, which was 2-3% of the normal, and in some parts of the country there was even no precipitation at all. These extremely dry (and hot) conditions resulted in extensive drought in Armenia; several forest fires were reported. Cyprus, too, had no precipitation, and Moldova had also a severe drought.

In contrast, central and parts of southeastern and eastern Europe were very wet (partly 200-300% of the monthly total), just like a couple of other local areas in northern Europe, parts of Italy and on the southern Iberian Peninsula (due to thunderstorms with heavy rain). 300-500% of the normal monthly total fell in large parts of eastern Austria, record-breaking in many places. In some places along the Danube River, heavy rain caused the severest flooding in 20 years. September was the wettest month of 2007 in the Czech Republic, where normally June is the wettest month of the year.

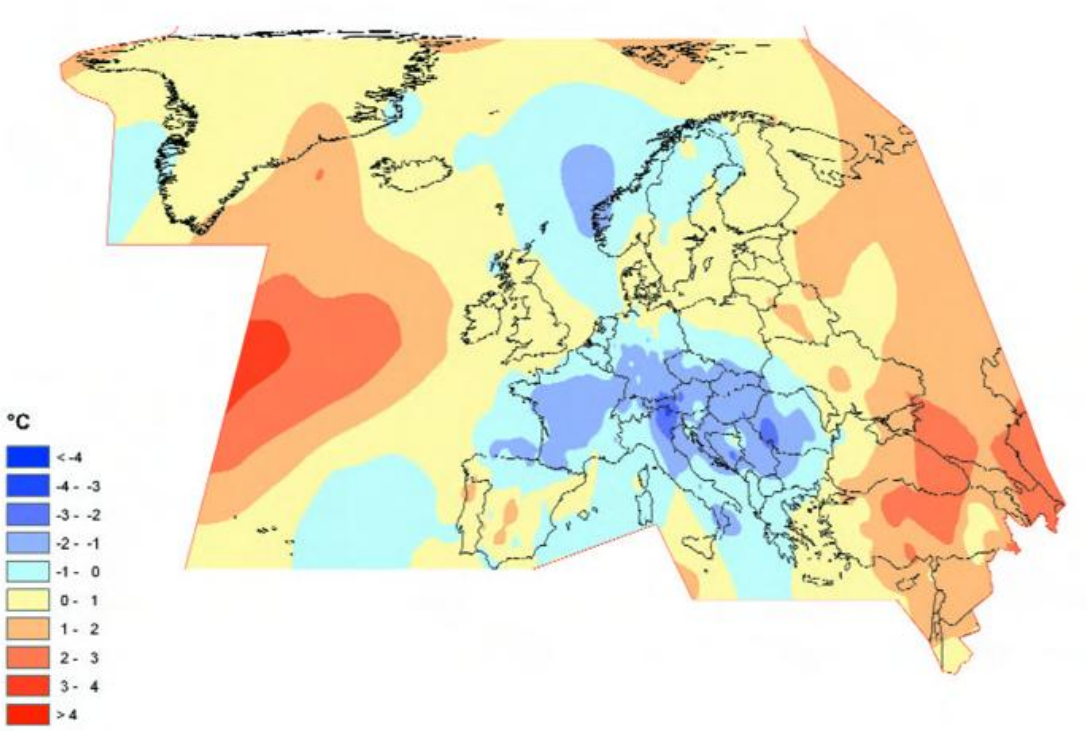


Fig. 9.1: *Monthly mean temperature anomalies in September 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

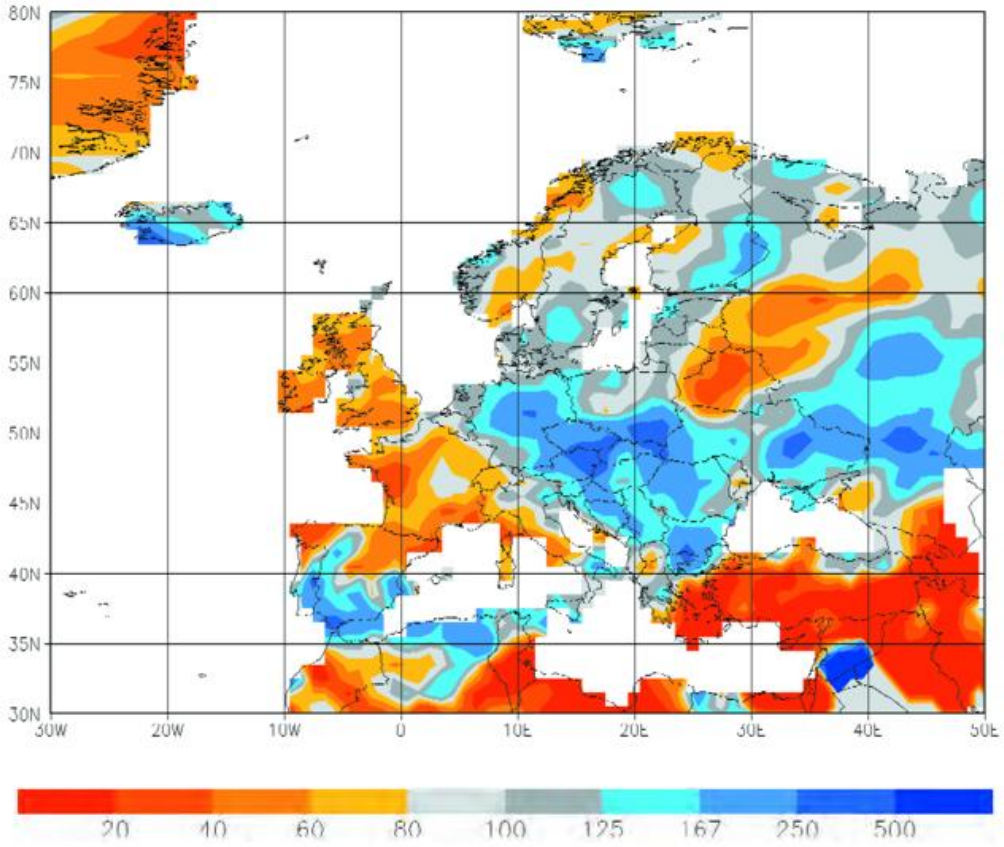


Fig. 9.2: *Monthly precipitation amounts for September 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Significant weather events

September 01-02:	Thunderstorms with hail (egg size), heavy rain, tornado and wind gusts >140 km/h in southern and central Bulgaria. Heavy rain also in north-eastern Greece
September 04-07:	Severe storm with flash floods in eastern and southern Romania. Gusts up to 100 km/h, more than 1300 houses flooded, 225 km of roads/bridges damaged/destroyed, train service disrupted, 1400 evacuations. Heavy rain and flooding also in Poland, Czech Republic, Austria
September 04-09:	Heat wave in Armenia: new September records with maximum temperatures at 32-40°C.
September 05-08:	Heavy rains in Austria along the main ridge of the Alps caused flooding. Rainfall rates up to 245 mm in 72 hours, snow down to 1000 m altitude. Heavy rain and floods also in the Czech Republic and southern Poland (Carpathians). In Italy, foehn storm with losses to agriculture
September 13:	Severe storm in southern Spain with hail and heavy rain
September 17:	Tornado north of Stuttgart (southern Germany). Damage: € 100 000
September 18-19:	Abundant rain within a cold front over Slovenia causing flooding and land slides, particularly in Železniki (Fig. 9.3)
September 21-23:	Thunderstorms with severe hail and rainfall in Andalucía (southern Spain) leading to floods and crop damage
September 23:	Heavy rain in Turkey, flooding of several towns.
September 24:	Thunderstorms, series of small tornadoes in southern and central England. Houses, vehicles damaged, trees downed
September 27-30:	Heavy rain with regional flooding in western and northern Germany
September 27:	160 mm of daily precipitation over the Venetian Lagoon (Italy) with flooding. Many crops destroyed



Fig. 9.3: *Flooding a day after exceptionally heavy precipitation in Železniki, Slovenia. Source: Environmental Agency of the Republic of Slovenia*

October

- **Cold in many parts of Europe**
- **Warm in the north, the east and over the North Atlantic**
- **Very dry in most of the Region, very wet in parts of eastern and southeastern Europe**

Atmospheric circulation characteristics

The main frontal zone extended from the North Atlantic to the northeast across Iceland and Svalbard, with mild air and cyclonic systems moving into these areas.

High pressure influence was dominating over large parts of Europe, even in southern Scandinavia. Most of that area, however, was in a cold air mass. Only the eastern parts of the Region were often within a warm southerly air flow. A strong stable cyclonic system developed over the Baltic countries, persisted there during some days and moved northwards.

In the middle of the month, Arctic air masses moved southwards to southeastern Europe and cold fronts passed over these areas, bringing frequent showers with them. Towards the end of the month, a strong cut-off low formed over the central Mediterranean.

Temperature

Like the preceding month, October was also colder than normal in many parts of Europe, partly with deviations from the long-term mean of less than -1°C (Fig. 10.1). Only the first weeks were mild, e.g. in Switzerland, with maximum temperatures up to 22°C, whereas in the second half of the month the temperatures went down.

However, it was remarkably warmer than normal in northern and, again, in eastern Europe as well as in the Middle East, over the North Atlantic and in northwestern Europe. Monthly mean anomalies exceeded +6°C in northeastern European Russia. The active vegetation period in Lithuania ended ten days later than normal.

Precipitation

In most of the Region, October 2007 was a dry month, especially in western, central and northern Europe as well as the Middle East (Fig. 10.2), partly with monthly totals less than 50% of the normal. It was the driest October of this 21st century in Portugal. In many areas of Israel, there was no rainfall at all or less than 5 mm in the whole month (normal monthly total is 25-40 mm).

In contrast, parts of eastern and southeastern Europe were very wet with totals above 350% of the normal in Romania. Southeastern Spain saw thunderstorms around Alicante and Valencia, with partly 100 mm of precipitation during one hour. There was also abundant precipitation over Corse in the Mediterranean. In the east of the Region, the coastal zone of Georgia received 140% of the normal precipitation, whereas the other parts of the country were dry or around normal.

Snow

Within a cold air flow at the beginning of the last third of the month, the snow line dropped to quite low altitudes in Slovenia.

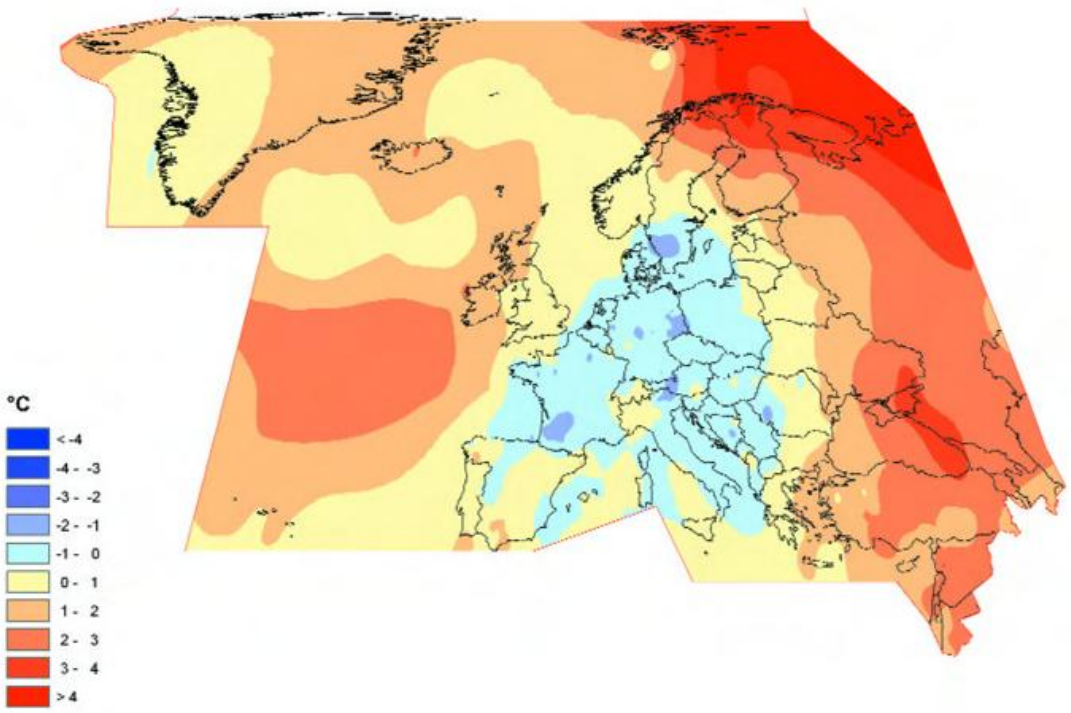


Fig. 10.1: *Monthly mean temperature anomalies in October 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

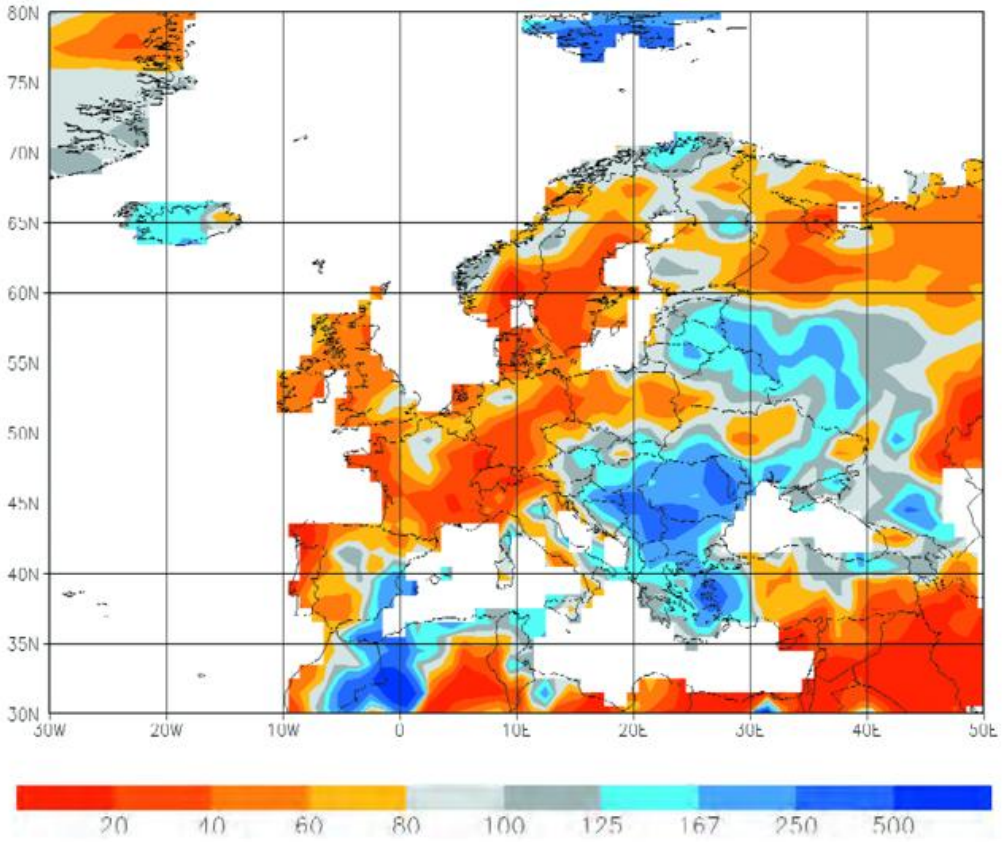


Fig. 10.2: *Monthly precipitation amounts for October 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Significant weather events

October 04:	Violent storm over Mallorca Island in the evening moving from SSW to NNE, with central axis over Palma – Inca – Puerto de Alcudia. Probably several tornadoes on a path of 15-20 km length
October 06:	Severe thunderstorm in southern Italy. Heavy rain, flash floods, roads, tunnels flooded
October 11-12:	Torrential rainfall around Valencia (eastern Spain). Two-day precipitation totals exceeded 400 mm in the mountainous regions of the Alicante province (Fig. 10.3), more than 50% of the annual normal. In Valencia, 170 mm was registered on 11 October alone, making this the second wettest day since records began. 87 mm fell within one hour at Alcalalí in the Marina Alta region of Alicante.
October 14:	Heavy snowfall in Moscow, Russia. More than 40 000 people without electricity
October 14-17:	Heat wave in Armenia, the second one this autumn. Maximum temperatures up to 32°C in the valleys. This heat wave was followed by a rapid decrease of temperature of 10-12°C. In the Ararat Valley, minimum temperature fell down to 0-2°C.
October 17-18:	Severe thunderstorm and flash flood in eastern Spain (Costa Blanca, Mallorca). Vehicles swept away, power failure, evacuations
October 20:	Snowfall in some areas of the lowlands in Switzerland
October 20:	Tornado near Nicosia (Cyprus), causing damage to properties
October 20-23:	Heavy precipitation in southern Romania and Bulgaria: up to 129 mm in 24 hours

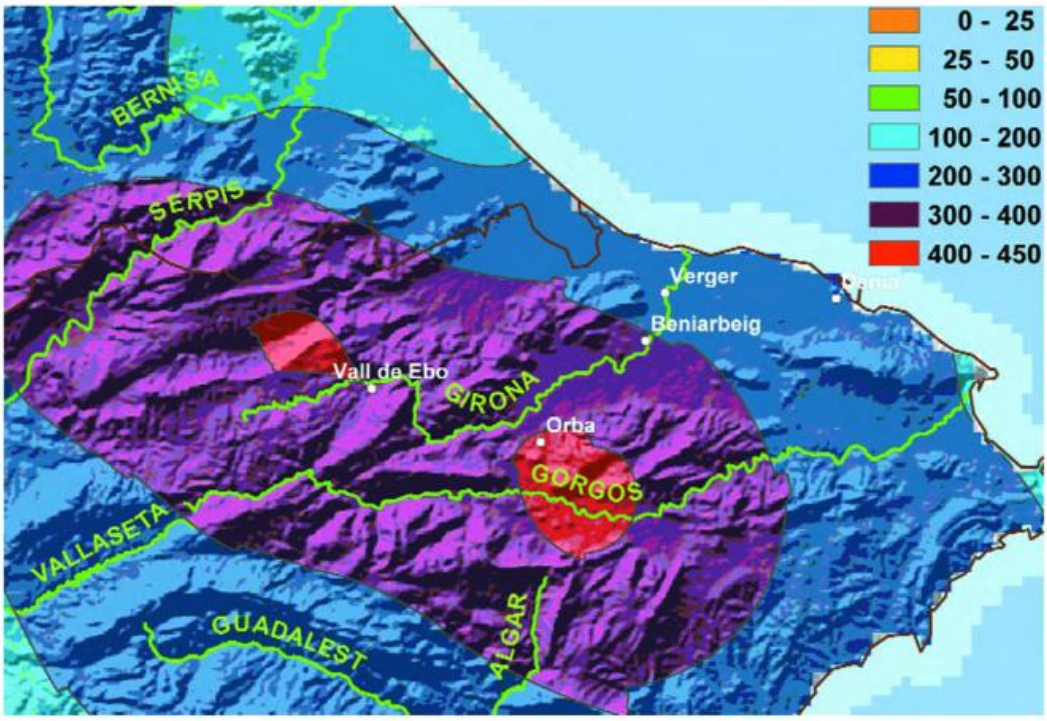


Fig. 10.3: *2-day rainfall totals in mm on 11-12 October 2007 in the Marina Alta region, Alicante, eastern Spain*
Source: National Meteorological Institute Spain

November

- **Cold in most of Europe**
- **Mild in the Arctic and over the North Atlantic**
- **Dry in western Europe, wet in central and eastern Europe**

Atmospheric circulation characteristics

The eastern North Atlantic and western Europe were again under unusually strong high pressure influence most of the month. A cold air mass was still lying over most of Europe, now extending further to the east. Cyclonic activity was concentrated to the eastern parts of the Region with cold fronts passing frequently over the Black Sea. Temporarily, it became also cyclonic over central Europe and the central and eastern Mediterranean.

Mild air masses passed over the North Atlantic from the south to the Arctic region, reaching as far as Greenland and Spitsbergen.

Temperature

The third autumn month of 2007, too, was cold in many parts of Europe, this time, however, also in the eastern parts (Fig. 11.1). In some places, the anomalies were below -2°C, locally even below -3°C, e.g. in Romania. In northeastern Europe, the weather cooled down markedly in the middle of the month when minimum temperatures fell to values between -6 and -13°C in Lithuania. There was frost during the whole month in Serbia. Only the Arctic region, most of the North Atlantic, northwestern and northern Europe as well as parts of the eastern Mediterranean and the neighbouring countries remained considerably warmer than normal. In Svalbard, the anomalies exceeded +4°C, over the North Atlantic partly +3°C.

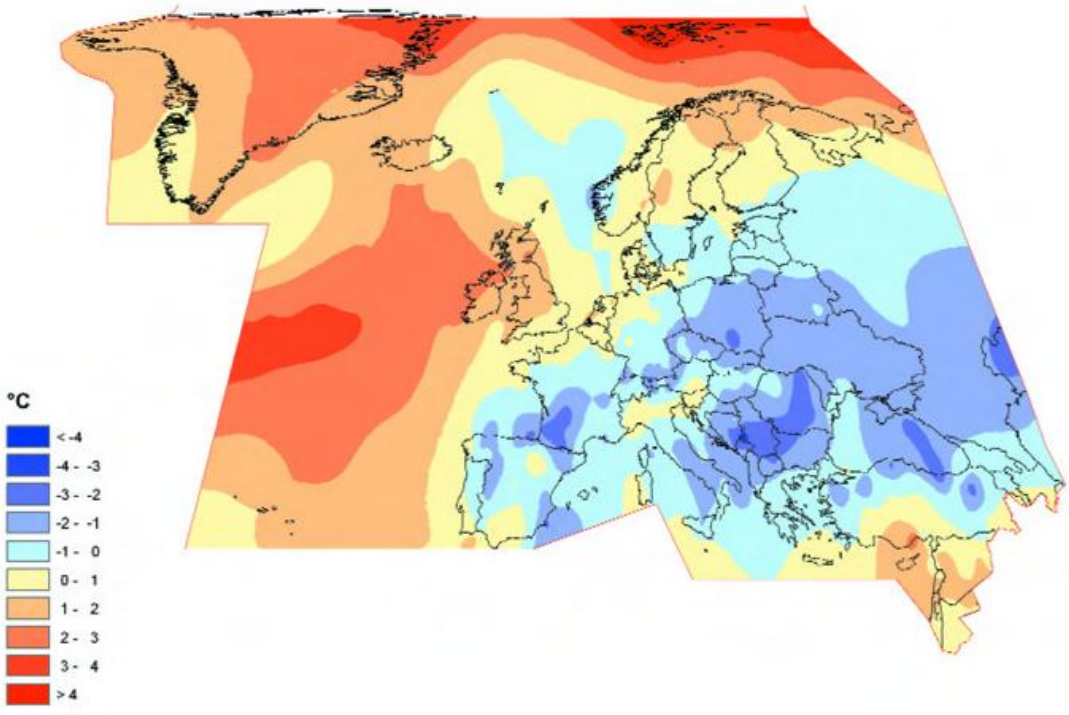


Fig. 11.1: *Monthly mean temperature anomalies in November 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

Precipitation

November again was dry in western Europe especially (Fig. 11.2). Southwestern France (Pyrenees) and eastern Spain received less than 20% of the normal monthly total. Other parts of the Region, particularly northern Italy, Slovenia and the respective Adriatic coasts were very dry, just like southern Scandinavia and parts of European Russia.

Central and parts of eastern and southeastern Europe, some areas of northern Europe and a large area around the Black Sea were wet, partly with more than twice the monthly total (e.g. Bulgaria). Flooding of houses occurred in Serbia, Montenegro, and at the end of the month also in Greece. East of the Black Sea, in the coastal zone of Adjara (Georgia) the monthly total was 534 mm due to some daily totals up to 100 mm. Local high rainfall amounts up to 79 mm in 13 hours were registered in Lebanon.

Heavy snowfall was recorded in Austria and Switzerland as early as in the first half of the month, causing snow depths of more than 1 m even in the lowlands. It was the heaviest snowfall in Switzerland since 1955. In Davos, 62 cm of snow fell in 24 hours, setting a new record. Some regions in the Alps received snow depths up to 150 cm; winter resorts could never open so early in the season. A snow cover of 100 cm and more occurred also in the highlands in Romania during the second decade of the month, and Serbia had more snow days than normal at that time of the year.

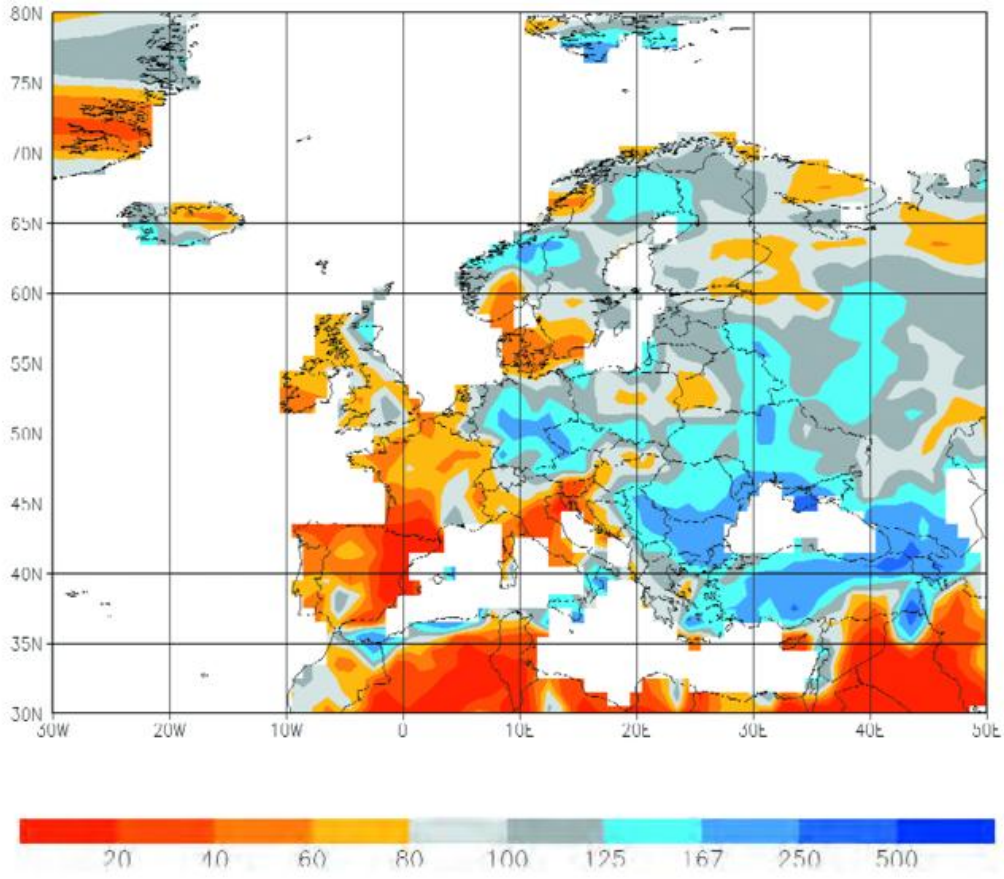


Fig. 11.2: *Monthly precipitation amounts for November 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Significant weather events

November 05-06:	Sharav event in Israel: 33-35°C in the coastal plain and the northern Negev. In the last 45 years, there were only 2-3 days on which temperatures in November were similar or higher.
November 08-09:	Storm over the North Sea with heavy flooding on the islands and waves up to 17-18 m. One of the highest storm surges on the East Anglian coast (United Kingdom) since 1953. In Germany, beaches flooded, parts of Hamburg City flooded, gusts up to 140 km/h on the islands
November 09-10:	Heavy snowfall particularly in southeastern Germany up to 70 cm
November 10:	Storm with gusts up to 120 km/h in Greece (north, east, south) and Turkey. Damage to infrastructure and agriculture
November 11:	Storm with gusts of hurricane force in the Rostov region of southern European Russia, the Ukraine and over the Black Sea. Waves up to 6 m. Ships sank, oil tanker broke into two, nearly 5 million litres of oil spilled, gas pipeline damaged, ports closed, roads blocked
November 15:	Intensive snowfall (40 cm within 4 hours) in eastern Austria in the late afternoon. Highway southwest of Vienna blocked
November 16:	Hailstorm in northwest Malta, gusts up to 90 km/h, heavy rain, crops destroyed
November 16-19:	Heavy rain and gusts over 140 km/h in Bulgaria. Heavy rain in Greece and Turkey with flooding. Hundreds of buildings damaged, traffic paralysed, power outages, water supply affected, thousands of evacuations
November 17:	70 cm snow depth in the region of Javorina (Slovakia). Earliest occurrence of such snow depths in this place since, at least, 1951
November 18:	New record for the lowest all-time daily minimum temperature in Mirandela (Portugal): -10.9°C
November 18:	Severe hailstorm in Cyprus, in some villages damage to properties and crops
November 19:	Storm with gusts up to 122 km/h in Novorossiisk (southwestern European Russia, at the Black Sea)
November 19-21:	200 mm of precipitation in 3 days at one station in the Carmel region (northwest Israel). Highest 3-day total since the beginning of measurements in 1953
November 20:	Severe storm in southern Spain (Andalucía). Gusts up to 90 km/h, heavy rain, landslides. Roofs of buildings damaged, trees downed
November 26-28:	Heavy rain and snowfall in southwestern Serbia and Montenegro. Rivers burst their banks, part of dam broken. 145 houses damaged/flooded, bridges damaged/destroyed, roads blocked

December

- **Very mild in the north, colder than normal in the south**
- **In northern Europe mainly wet, rest of the Region mainly dry**

Atmospheric circulation characteristics

At the beginning of the month there was a more or less zonal air flow from the Atlantic to Europe with frequent cyclonic activity. However, during the second decade of the month, a high pressure area developed over most of Europe with cold air persisting over the southern half of the continent. At the northwest flank of the large anticyclone, mild Atlantic air moved to northern and northeastern Europe. Towards the end of the year, anticyclonic conditions became weaker there.

The Mediterranean was mainly under low pressure influence during most of the month.

Temperature

The winter season 2007/08 started with a very mild December in northern Europe (Fig. 12.1). Monthly mean anomalies exceeded +4°C over a large area in the northeast and reached up to +9°C in eastern Lapland and between +6 and +8°C in northern European Russia. Temperatures in Finland were well above zero during nearly the whole month; values as high as 7.4°C were reached even in the most northern corner of Lapland. In the northernmost part of Sweden, December 2007 was the warmest December in more than 70 years. In parts of northern Norway, it was the warmest December on record.

In contrast, it was still colder than normal in most of the southern half of Europe (like the preceding month), and also over the northern parts of the North Atlantic. Monthly mean anomalies were mostly below -1°C, in southeastern Europe partly below -2°C, in Romania and west Kazakhstan locally even as low as around -4°C or less. The number of ice days was two or three times higher than usual in Serbia. An unusually long period of 10 ice days (Tmax <= 0°C) also occurred in the northwest mainland of Greece. In Armenia, a minimum temperature of -32°C was reported from the north of the country. Daily minimum temperatures in the lowlands of Israel were around 0°C at the end of the year, in Jordan even below.

In central Europe as well as in Italy and parts of southeastern Europe, December 2007 had a mild start, but was followed by a quite cold second half of the month. Some new daily minimum temperature records at -5°C or less were recorded in Italy.

Precipitation

December 2007 was a dry month in most of the Region (Fig. 12.2). The Iberian Peninsula, northern Italy, eastern Europe and parts of the Middle East were the driest areas, frequently with less than 40% of the monthly total. Parts of Portugal and Spain received less than 20% of the normal precipitation, as well as in the Middle East, the lowlands of Armenia and the Ararat Valley. Rainfall totals in Israel were also low (70% of the normal), but distributed to quite a large number of 14-16 rainfall days. Local heavy rainfall up to 75 mm in 11 hours was reported from Lebanon.

It was wet especially in the Arctic region and most of Scandinavia. Only the southern and central parts of the west coast of Norway were considerably drier than normal.

Towards the end of the year, prolonged freezing rain lasting up to 6-7 days occurred in some places in Lithuania. Icing caused considerable damage to electric cable networks.

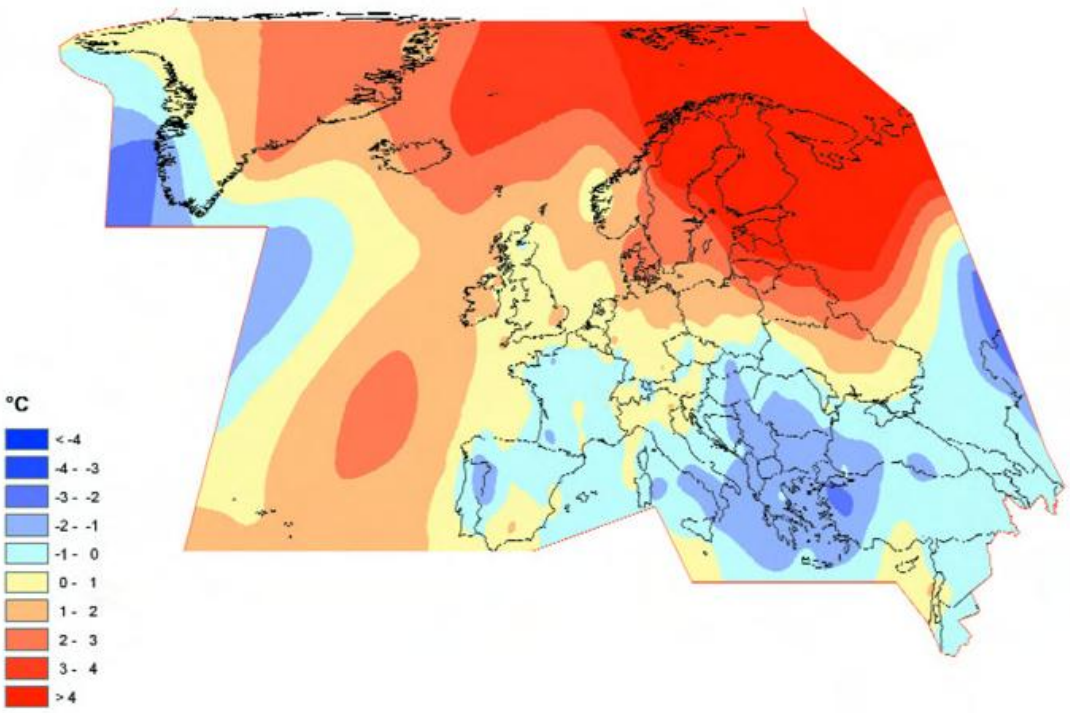


Fig. 12.1: *Monthly mean temperature anomalies in December 2007 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

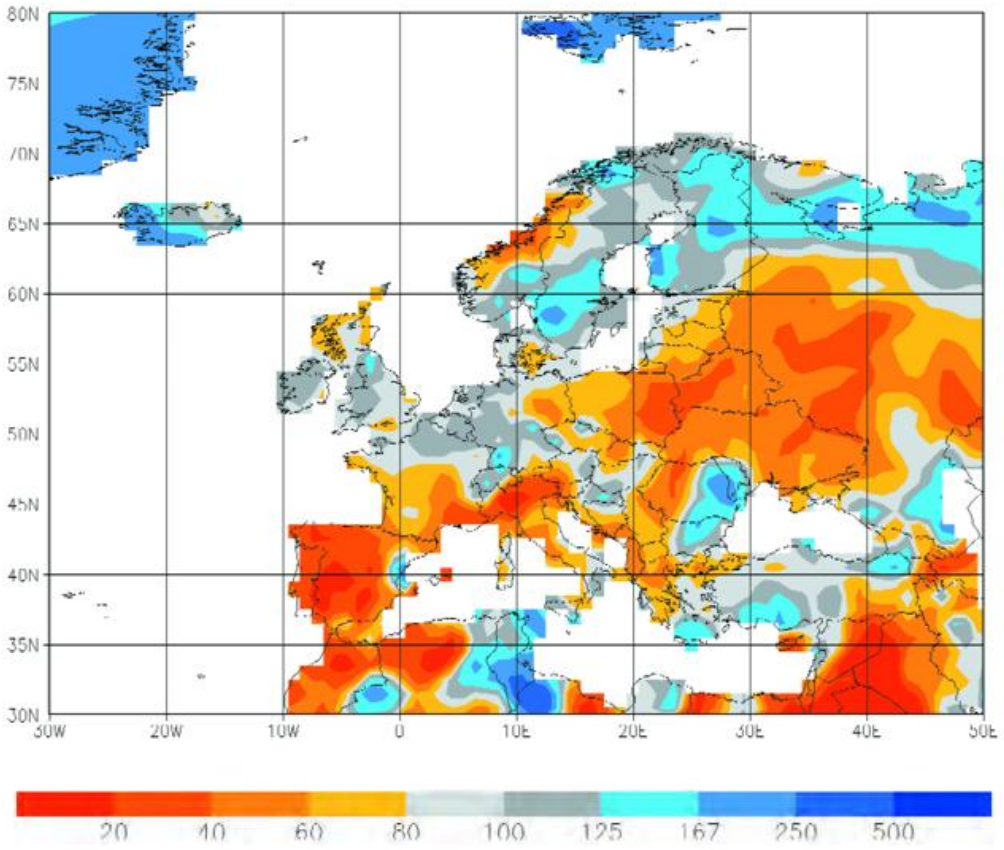


Fig. 12.2: *Monthly precipitation amounts for December 2007 in per cent of the normal 1961-1990 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Rainfall totals across the United Kingdom were generally close to average, with some stations in northwest England, though, having recorded over 150% of their normal rainfall.

In central and southeastern Europe, Dezember 2007 had very different periods in terms of precipitation. In Brussels (Belgium), the first decade was the wettest since 1901 with 82 mm, the second decade the driest with 0.9 mm. In Bulgaria, too, a wet first half of the month was followed by a dry second half.

West of the Black Sea, it was very wet with monthly totals up to twice the normal in northeastern Romania. Malta also received about 200% of the normal, which makes a monthly total of over 200 mm.

Snow

During the second decade, snowfall occurred over the south-central Adriatic regions in Italy, even at sea level. Several harbours at the south-central Adriatic Sea were affected by snowfall, which is quite rare (Fig. 12.3).

An intensive snowfall period on 9-12 December occurred in Switzerland resulting in snow depths far above the long-term mean for this time of the year. Ski areas experienced a perfect start into the season 2007/08.

In the lowlands of Germany, only some smaller areas had a snow cover for a few days, mostly in the last decade of the month. In Poland, the number of days with snow cover ranged from 0 in the west up to 20 in the southern region. The snow cover, though, was thin (<10 cm). Romania had a snow cover in most regions, with up to more than 150 cm in high mountains above 2000 m altitude. It was snowing every day in Serbia in the second half of the month.

In contrast, especially northeastern Europe saw less snow than usual. At the end of the year, no snow was left on the ground in southern Finland. A white Christmas was only to be celebrated in the north and the easternmost parts of the country. In some other northeastern areas, e.g. in Lithuania, there was no chance for a persistent snow cover throughout nearly the whole month.



Fig. 12.3: *Snow blowing over Bari Harbour (Italy) in December 2007*
Source: National Weather Service CNMCA, Italy

Significant weather events

December 02-03:	Storm in Germany and Switzerland with gusts up to 160 km/h in the mountains. Trees fell down, disruption of power lines. Heavy rain up to 51 mm in 24 hours, flooding of streets, Christmas markets closed
December 04-06:	Heavy rainfall with transport disruptions in Bulgaria and flooding in Turkey and Cyprus
December 07-09:	Slow-moving depression (966 hPa central pressure) brought stormy conditions and an exceptionally high wave of over 17 m to the west coast of Ireland (Fig. 12.4). Highest wave ever measured by the Irish buoy network. Storms also over Belgium and Germany
December 15-25:	Unusually long period of ice days in Florina in the northwest mainland of Greece, altitude 689 m
December 17-18:	Heavy snowfall over south-central Italy. Traffic blocked. More than 1 m of snow at Fonni (Sardinia, Italy, altitude 1029 m)
December 18:	11°C in Nikkaluokta in northernmost Sweden, the highest ever recorded December temperature in this part of the country
December 21:	137 mm of daily precipitation at Sundsfjord, Norway
December 25:	Daily minimum of -9.2°C in Shoubak (Jordan)
December 28:	Heavy rain and landslide in southern European Russia (Dagestan)
December 29-30:	Thunderstorms and heavy rain (100 mm / 24 h) in northwest Malta. Roads flooded, telephone lines cut off

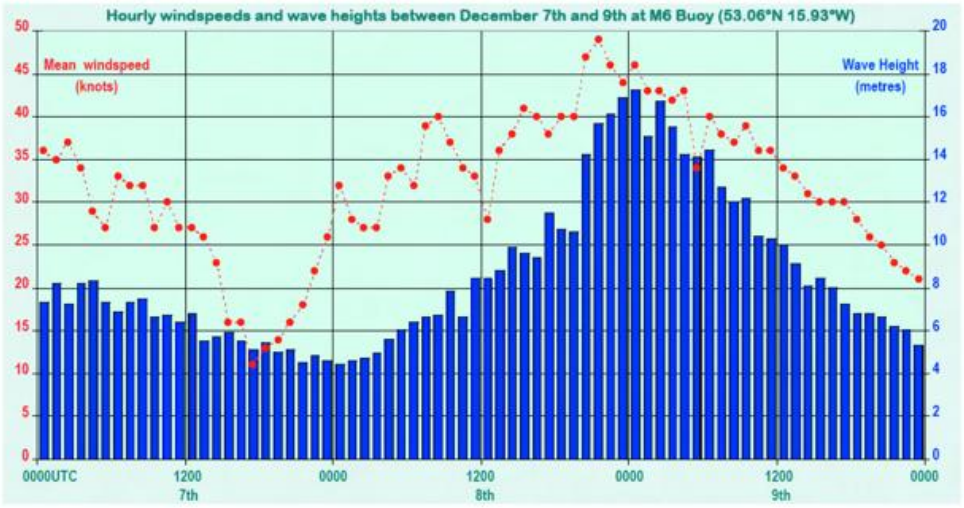


Fig. 12.4: *Hourly wind speeds and wave heights on 07-09 December at M6 Buoy (53.06°N, 15.93°W). Highest wave of 17 m near the west coast of Ireland in the night of 08-09 December 2007 Source: Met Eireann, Ireland*

ECSN Activities Report 2007

Responsible member: KNMI; Programme Manager: Aryan van Engelen

The objective of the optional programme ECSN – the European Climate Support Network – is to strengthen the (now 24) members' capabilities and resources in their climate practices (Fig. 13.1) predominantly by jointly carrying out projects and initiatives that have a European coverage and focus on tangible deliverables addressing the user community.



Fig. 13.1: *Per 31 December 2007, all 24 EUMETNET members participate in the Optional Programme ECSN.*
Source: ECSN

In 2007, ECSN intensified its active collaboration and involvement outside the strict ECSN community, which was materialized by participation in the EU projects ENSEMBLES and MILLENNIUM, by appointing a rapporteur on ECSN in the WMO Working Group on Climate related Matters of RA VI (Europe) and by inviting non ECSN members to attend major ECSN conferences: the Data Management Workshop and the biennial European Conferences on Applied Meteorology and Climatology (ECAM resp. ECAC, in collaboration with EMS, the European Meteorological Society). The enhanced activity of ECSN is expressed by the nomination of the results of two major ECSN projects (EuCLIS and ECA&D) as platforms of WMO Regional Climate Centres.

For showcase **EUROGRID** (**S-EUROGRID**, SMHI, Christer Persson) the main ambition is to illustrate the importance of the full-scale EUROGRID, which is intended to be a future European central resource for gridded climate, meteorological, hydrological and environmental products and data, in line with overarching European and Global initiatives such as Inspire and GEOSS.

In 2007, S-EUROGRID focussed on demonstrating how existing shared gridded datasets from European NMHSs can be used for high standard products and services (Fig. 13.2). Nine gridded datasets have been incorporated: amongst them are two European datasets, ERAMESAN (SMHI) and ENSEMBLES (MeteoSwiss and KNMI). A web designed S-EUROGRID demo system has been realised (www.e-grid.eu).

Outlook: the reputation of S-EUROGRID is obvious from an increasing number of NMHSs expressing their ambition to become partners. Also, it is recognised that a high resolution grid, based on the high quality observational networks of the European NMHSs, should be their core business in the light of the increasing need for derived products that support the society's adaptation to the changing European climate.

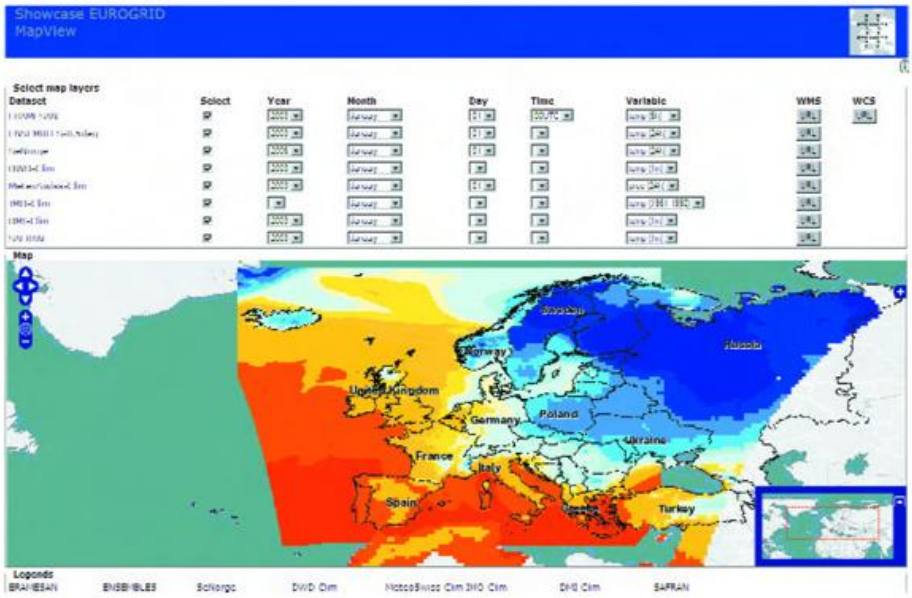


Fig. 13.2: *S-EUROGRID screenshot: demo Map View of data sets. Source: www.e-grid.eu*

HRT-GAR (ZAMG, Ingeborg Auer) aims at the preparation of a High Resolution Temperature Climatology for the Greater Alpine Region with a high temporal and spatial resolution. It envisages to supplement the coarse resolution of temperature information provided by the ECSN Climate Atlas of Europe and to provide an optimal basis for further applications. In 2007, the modelling of temperature data from approximately 1700 stations was performed.

Outlook: together with the final report the results will be accessible on an open website and be submitted to a peer reviewed journal.

The **European Climate Information System** (**EuCLIS**, DWD, Peter Bissolli) is the successor of the Generate Climate Monitoring Products (**GCMP**), an ECSN project which was completed in 2004. GCMP is a Web Platform allowing access to national and European climate monitoring products in the form of thematic maps, descriptive texts, significant weather events and the RAVI Bulletin, provided by 21 participating NMHSs (Fig. 13.3). GCMP will be maintained until the development of EuCLIS has been completed. Based on modern Web-technology, EuCLIS provides a significant extension of the GCMP functionalities, e.g. handling of a higher number of contributing institutions, restricted and public user access, descriptions according to the WMO metadata standard etc.

Outlook: EuCLIS is nominated (like ECA&D) as a candidate platform for a future WMO-RAVI Regional Climate Centre. Links will be made with monitoring products arising from the ECSN projects EUROGRID and ECA&D.

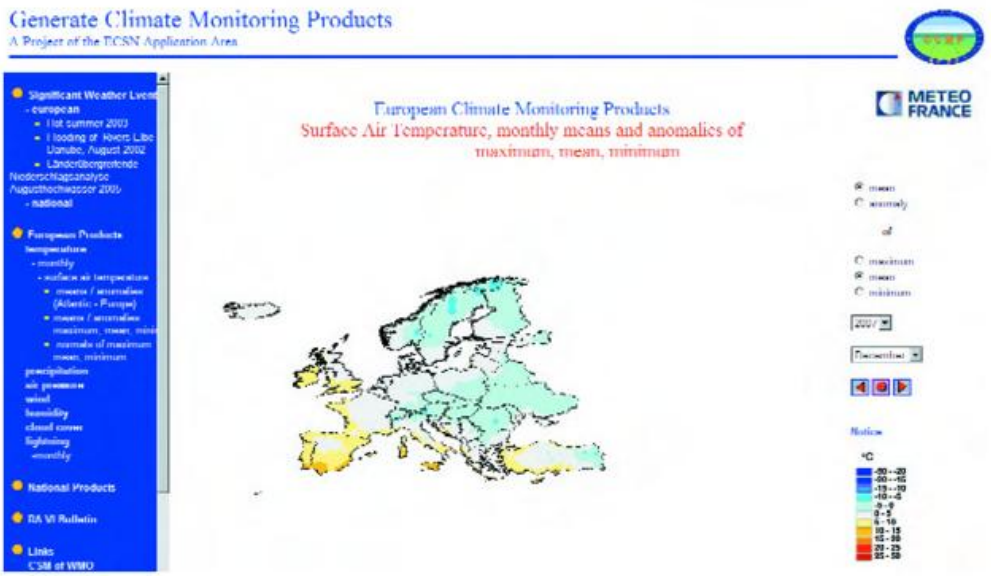


Fig. 13.3: *GCMP screenshot: mean temperature December 2007 for Europe. Source: www.gcmp.dwd.de*

The **European Climate Assessment and Data set** (**ECA&D**, KNMI, Aryan van Engelen) project was initiated in 1998 by ECSN (http://eca.knmi.nl). Today, in its fourth phase, the aims are unchanged: to create and maintain a European data set of daily high quality observational series and, on the basis of derived indices, to produce assessments of European climate. ECA&D co-operates with 53 partners (European NMHSs predominantly) and offers some 6600 climate time series (temperature, precipitation, air pressure, snow depth, relative humidity, cloud cover and sunshine duration), including a set of 40 standardized indices, observed in a network of more than 2000 stations (Fig. 13.4). In April 2007, the EUMETNET council agreed to the proposal to continue ECA&D as a EUMETNET project for a period of 4 years.

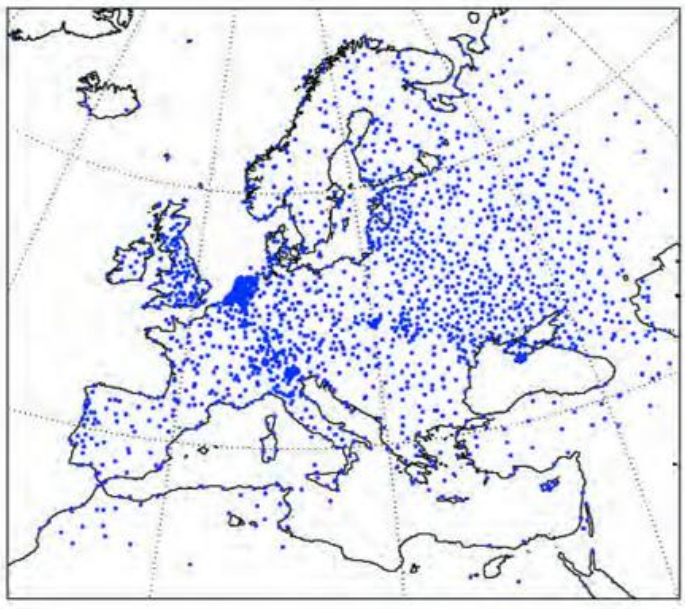


Fig. 13.4: *Station density ECA&D per December 2007. Source: ECSN*

Outlook: ECA&D is aiming to fulfil, like GCMP/EuCLIS, a role as a platform of an RCC. For this purpose the soft- and hardware is put through a major overhaul (completion planned for spring 2008), necessary for the aimed transition from project environment to operations.

In the EU-FP6 **ENSEMBLES** project Wp5.1, MeteoSwiss (Christoph Appenzeller) and KNMI (Albert Klein Tank) collaborate since 2004 with the objective of producing daily gridded datasets (1960-2000) for surface climate variables (max/min/mean temperature, precipitation, surface air pressure and snow cover) covering Europe, for the greater part with a resolution (~50 km) high enough to identify extreme weather events and with attached information on data uncertainty. The work has been completed in November 2007 and the gridded data set has been made publicly available through the ECA&D website.

The aim of the EU-FP6 project **MILLENNIUM** (KNMI, Aryan van Engelen) is to determine with quantifiable precision whether the magnitude and rate of the 20th Century climate change exceeds the natural variability of European climate over the last millennium. ECA&D forms the baseline platform for the Millennium instrumental data. Especially for the Millennium community (www.millenniumproject.net) datasets of monthly aggregated data of all ECA&D indices and all stations have been constructed, accessible via web pages with a dedicated design.

The **6th ECSN Data Management Workshop** (20-22 November 2007, Vienna, ZAMG, Ingeborg Auer) was a real success. About 80 participants from 23 countries were updated on the actual state of climate data management in Europe by 43 oral and 8 poster presentations in 5 sessions: “Data Recovery, rescue and very long series“, „New Tools for Data Quality Control”, “Homogenisation” “Gridding” and “Data Services and Products”.

The Ozone Layer over Central Europe in 2007

Wolfgang Steinbrecht, Hans Claude, and Ulf Köhler - Deutscher Wetterdienst

In 2007, the recent overall tendency towards higher ozone values has continued. As shown in Fig 14.1, annual mean total ozone columns were very similar in the last 5 years, and about 2% below the long-term average at Hohenpeissenberg. This is 2% higher than the decadal mean during the 1990s. However, total ozone is still substantially lower than in the 1970s and 1980s. By no means has ozone fully recovered from the large chemical losses in the previous millennium. Nevertheless, ozone levels in 2007 are consistent with the general levelling seen in recent years. This is expected, since major influence factors (chlorine loading, aerosol loading, solar flux) have not undergone any major changes in 2007. If the very low total ozone columns of 1992 and 1993, after the Pinatubo volcanic eruption, are disregarded, measurements at Hohenpeissenberg (and other European stations) indicate a turn-around of ozone some time after 1995. This is consistent with stratospheric chlorine loading, which has also turned around between 1997 and 2000. Chlorine is expected to keep decreasing slowly in the future.

The largest contribution to the total column comes from ozone in the lower stratosphere, between 15 and 30 km altitude. Ozone variations in this altitude region are shown in the middle panel of Fig. 14.1. They are the main force for total ozone variations. The lowest annual means at 20 km occurred after volcanic eruptions in 1983, 1985, 1992 and 1993. In the last 10 years, ozone near 20 km height has also increased. In 2007, annual mean ozone above the long-term average was registered for the first time since 1994. Given the usual ups and downs, ozone in the lower stratosphere shows signs of recovery. However, a good part of this (e.g. the high values in 1998, 2004, and 2007) is not due to the slow and smooth decline of chlorine, it is rather due to the specific meteorological conditions in these years.

In the free troposphere (5 km), ozone develops quite differently. From the late 1960s to the late 1980s, tropospheric ozone at Hohenpeissenberg (and other stations) has increased tremendously. After 1987, this increase has not continued, instead ozone decreased sharply until about 1991. Since then, tropospheric ozone values above Hohenpeissenberg have gone down

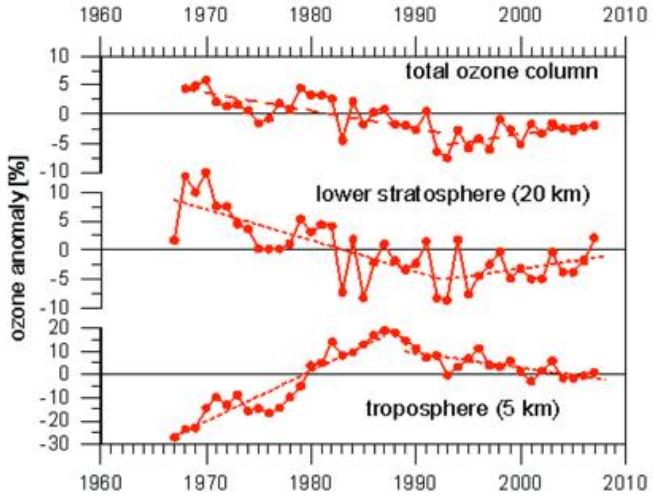


Fig. 14.1: *Annual mean anomalies of total ozone column (top panel), ozone partial pressure in the lower stratosphere (middle), and ozone partial pressure in the free troposphere (bottom), all at Hohenpeissenberg. Trend-lines are given for the main periods with ozone decrease and increase.*
Source: Deutscher Wetterdienst, Germany

slightly. A similar behaviour has been observed at the ozone sounding stations in Uccle (Belgium) and, to a lesser degree, in Payerne (Switzerland). It must be noted, however, that ozone measurements near the ground at many stations, including Hohenpeissenberg (988m) and Zugspitze mountain (2965m), show a more or less continuous ozone increase since the late 1980s and not the steady decline registered by sonde data in the free troposphere (DWD Ozone Bulletin No. 116, http://www.dwd.de/ozonbulletin). The cause for this major discrepancy is currently not understood.

Although stratospheric ozone shows signs of improvement, the ozone layer is still thinner than in the late 1970s before substantial ozone destruction by man-made chlorine set in. The reduced thickness of the ozone layer, combined with its substantial natural variation from day to day (sometimes exceeding 30%), means that very low ozone columns are possible at any time. Especially on clear days this can result in substantially enhanced solar UV-radiation, and pose substantial sun-burn risk. Fig. 14.2 demonstrates this risk by giving the weekly maxima of the UV Index at Hohenpeissenberg in 2006 and 2007. Results are based on the regular spectral UV measurements at Hohenpeissenberg, which started in 1990 (DWD Ozone Bulletin No. 117, http://www.dwd.de/ozonbulletin). Due to high position of the sun in the sky, the highest UV values occur in summer and at noon. UV is also enhanced when total ozone is low and when the sky is clear. Clouds usually result in a substantial UV reduction, but sometimes they can reflect light and increase UV irradiation. Despite the general levelling of total ozone, very high UV Index values were measured at several occasions in recent years, e.g. in March and June 2006, or in May, June and July 2007. UV Indices higher than 7 imply a significant risk of sun-burn (unless precautions are taken) and can occur at Hohenpeissenberg from the end of April until August. To help reduce this risk, the Deutscher Wetterdienst, within in the ESA PROMOTE project, provides a global forecast of the expected UV Index values, available at http://www.uv-index.de.

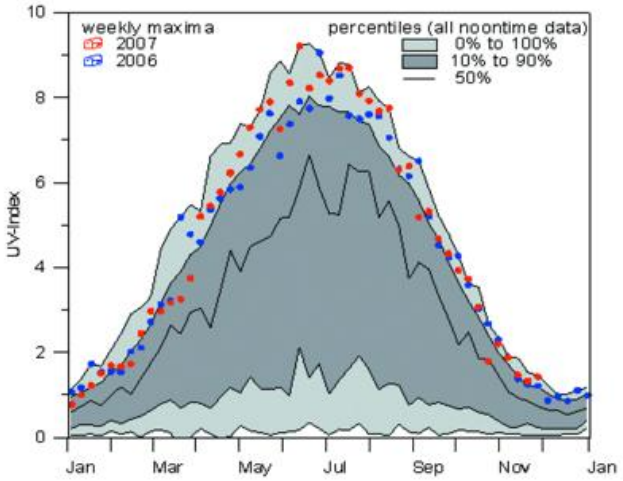


Fig. 14.2: *Annual course of weekly maxima of the UV Index in the years 2006 (blue) and 2007 (red) from UV B measurements at Hohenpeissenberg. The background shading gives the probability of exceeding a certain UV index, calculated on the basis of all measurements at local noon ± 1 hour (not just weekly maxima) at Hohenpeissenberg since 1993. At the beginning of May, for example, 100% of (all) UV Indices measured near local noon are less than 7.4, 90% are less than 6.5, 50% less than 3.9 and 10% less than 1.1.*
Source: Deutscher Wetterdienst, Germany

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European Climate Support Network

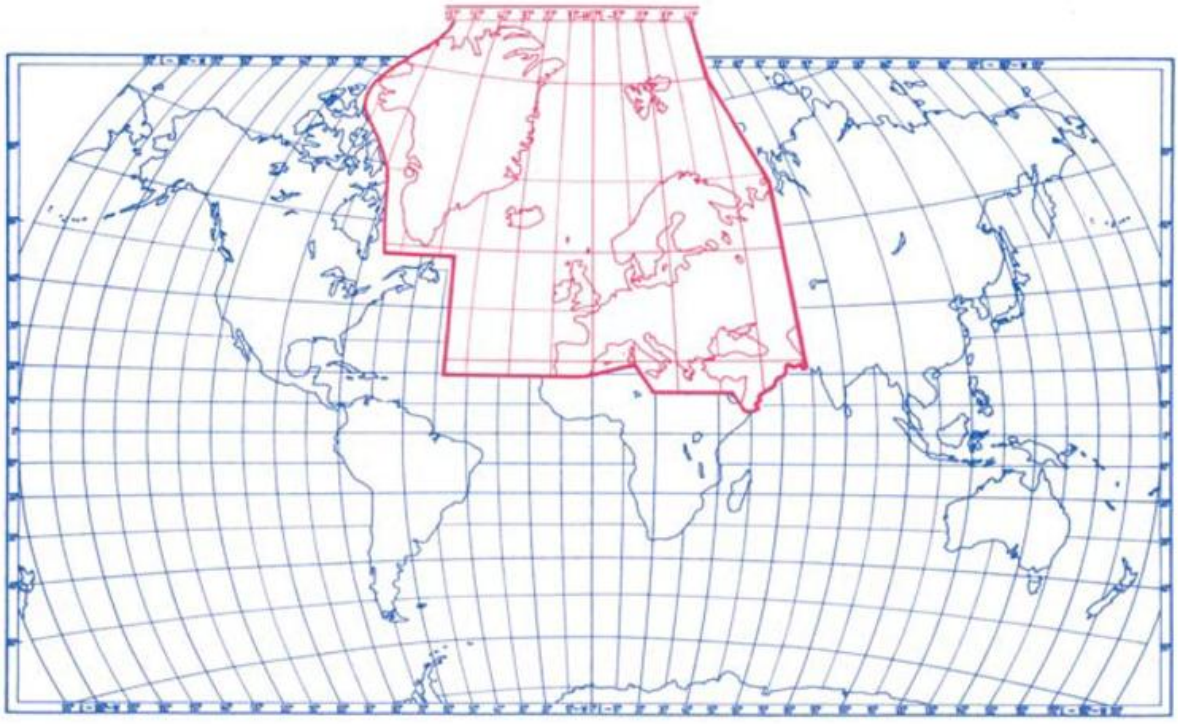
World Meteorological Organization
World Climate Data and Monitoring Programme

Deutscher Wetterdienst
Department Climate Monitoring

Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2008



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Annual Bulletin on the Climate in WMO Region VI
- Europe and Middle East -
2008

The Bulletin is a summary of contributions
from the following National Meteorological and Hydrological Services
and was co-ordinated by the Deutscher Wetterdienst, Germany

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Foreword

"Better climate information for a better future" – this is the theme of the WMO's World Climate Conference 3 in August/September 2009.

Nowadays, a large amount of climate information is available, provided by National Meteorological and Hydrological Services and climate research centres: climate data from various data sources, climate analyses, assessments and predictions as well as impact studies. We all know their main message: climate change is still ongoing, even faster than in the past, and consequently, mitigation and adaptation to future climate continue to be important topics over the next years. Climate variability, however, shows a wide variety, both spatially and temporally. Policymakers, on their part, need to know details of climate change and its consequences to take the right measures at the right time and at the right place.

This Annual Bulletin on the Climate – it is the 15th issue now – is one of the main contributions to the provision of climate information especially devoted to our Region VI as it combines valuable national information into one summarising, but nevertheless comprehensive report. Its significance also becomes particularly apparent with regard to the future Regional Climate Centre on Climate Monitoring whose pilot phase started in June 2009. The Annual Bulletin gives an overview of climate variability in 2008 in our Region and also contains many noteworthy details about climate events in the various countries. To show what has happened and what can happen in a world where the climate is changing is indispensably needed to assess what the future will bring and whether this will be more frequent than today.

The year 2008 has taught us another lesson about how contrasting climate variability can be in our Region which doubtlessly shows a very heterogeneous climate. The winter of 2007/08 was very mild particularly in northeast Europe but unusually cold in the Middle East. Some places in northern and northwestern Europe experienced their wettest year on record whereas Spain suffered from a long-lasting winter-spring drought. These contrasts are the result of the interaction of various circulation mechanisms which influence our regional climate and which are also embedded in the general global climate change manifesting itself in our Region. 2008 was once more one of the warmest years in at least more than 150 years on European average.

This presentation of the whole climate information would not have been possible without the numerous national contributions from our Members, the National Meteorological and Hydrological Services. Once again, nearly all Members of the Region (48 out of 50 countries) have sent very interesting articles and figures to our editors at the German Meteorological Service (Deutscher Wetterdienst, DWD). I would like to express my sincere thanks to all contributors and also to the editorial team of DWD, namely to Peter Bissolli, Peer Hechler, Volker Zins and all internal reviewers, for compiling and writing the texts and doing all the editorial and technical work. Congratulations to the colleagues from DWD for their voluntary dedication to all 15 issues of this publication in all these years.



Daniel Keuerleber-Burk
President of WMO Regional Association VI

Outstanding Events and Anomalies in 2008

Temperature

- Mild winter 2007/08 particularly in northeast Europe
- Cold January in the Middle East
- Several heat waves in southeastern Europe in summer

Precipitation

- Wettest year on record in some places in northern Europe
- Long winter-spring drought in Spain

Sunshine

- Sunny February and May in many parts of Europe

Annual Survey

1. Atmospheric circulation

Europe commenced the year under a strong zonal (positive) North Atlantic Circulation (NAO) pattern, which continued until March, when a blocking pattern developed over Russia resulting in a strong meridional pattern during April. May saw high pressure dominate northern and central Europe, followed by cyclonic conditions with frequent thunderstorms across central Europe during the summer. A negative phase of the Arctic Oscillation (AO) brought cold Arctic air into northeastern and at times also central and southern Europe from April to September. Conversely, south-westerly flow during the summer across southeastern Europe resulted in several heat waves. In October, a blocking pattern established over Russia and remained there for most of the rest of the year, producing mild conditions over eastern Europe and colder air masses over western Europe. In November, a deep trough extended from Scandinavia to Iberia. The year ended with very cold air flowing from the high latitudes to southeastern Europe and the Middle East on the eastern flank of a central European high pressure system.

In contrast to the North Atlantic-European pattern, Greenland, especially its western part, was affected by cold air masses at the beginning of the year. Starting in February/March, however, it was then included in the general Arctic warmth, particularly at the end of the year.

The Southern Oscillation Index (SOI), which is a measure of the strength of the El Niño Southern Oscillation phenomenon (ENSO) and is described by the pressure difference between Tahiti (tropical Pacific) and Darwin (Australia), was positive throughout the whole year except a slight negative value in May. Highest values occurred from January to March and again from September to December, while ENSO was weak in late spring and summer. High positive SOI values indicate La Niña conditions. It can be assumed that the La Niña conditions from January to March were related to the parallel positive NAO/AO phase due to the general strengthening of the NAO during La Niña winters. Also, the northward shift of the frontal zone during winter 2007/08 is congruent with La Niña conditions. In November, the La Niña cooling of the East Pacific could have inversely affected the NAO due to a smaller thermal difference on the thermal planetary frontal zone and thus causing weaker west winds also over the North Atlantic. Normally, the ENSO impact on Europe is highest in spring, but as the SOI decreased considerably in spring 2008, there was probably only little impact on spring climate in 2008.

The zonal index over central Europe (20°W-40°E, data from DWD) was very high in January-March and again in October-November, with values being considerably higher than normal. April, May and September had negative and below normal values. This reflects the positive NAO/AO mode in January-March and the sudden switch to a strong meridional pattern in April. The high October-November zonality over Europe is in accordance with the AO, but not with the NAO, which suggests that the shift of the Icelandic Low to the central Arctic region nevertheless caused a zonal circulation over Europe.

In central Europe, cyclonic weather types dominated throughout the year; anticyclonic types were in majority only in May and October. The total number of days with cyclonic types was considerably higher than normal especially in spring and summer, but also, though to a lesser extent, in other seasons. However, the high number of cyclonic types did not have any major effect on the annual precipitation totals in central Europe.

2. Temperature

Overview

Warmer-than-average[1] conditions extended across most of Europe in 2008. The mean land surface temperature for the European region (35°N-75°N, 10°W-30°E), as derived from the CRUTEM3 dataset (Climate Research Unit Temperature Version 3, land air temperature anomalies on a 5°x5° grid box basis, http://www.cru.uea.ac.uk/cru/data/temperature/), was 1.16±0.17°C above the 1961-90 mean. This made 2008, along with 2006, the 4th warmest year in Europe since 1850. With the northern latitudes not taken into account (35-65°N, 10°W-30°E), it was even the second warmest since 1901. Anomalies ranged from around zero in southwest Europe up to more than +2°C in the northeast of the Region (Fig. 0.1). The high anomalies in the northeast were mainly due to exceptionally high temperatures during the winter of 2007/08 (Fig. 0.2 Finland). January and February were very mild not only in these areas, but also in most of Europe except the southeast. 2008 did not set so many new weather records as the previous two years, but this year has once more confirmed the general warming trend on the global as well as the regional level.

Only a few places in southwestern Europe and in some parts of Turkey reported a cooler-than-average annual temperature in 2008. In many countries across central and southeastern Europe, September was the only colder-than-normal month, whereas all the other months were warmer than normal (Fig. 0.3 Poland).

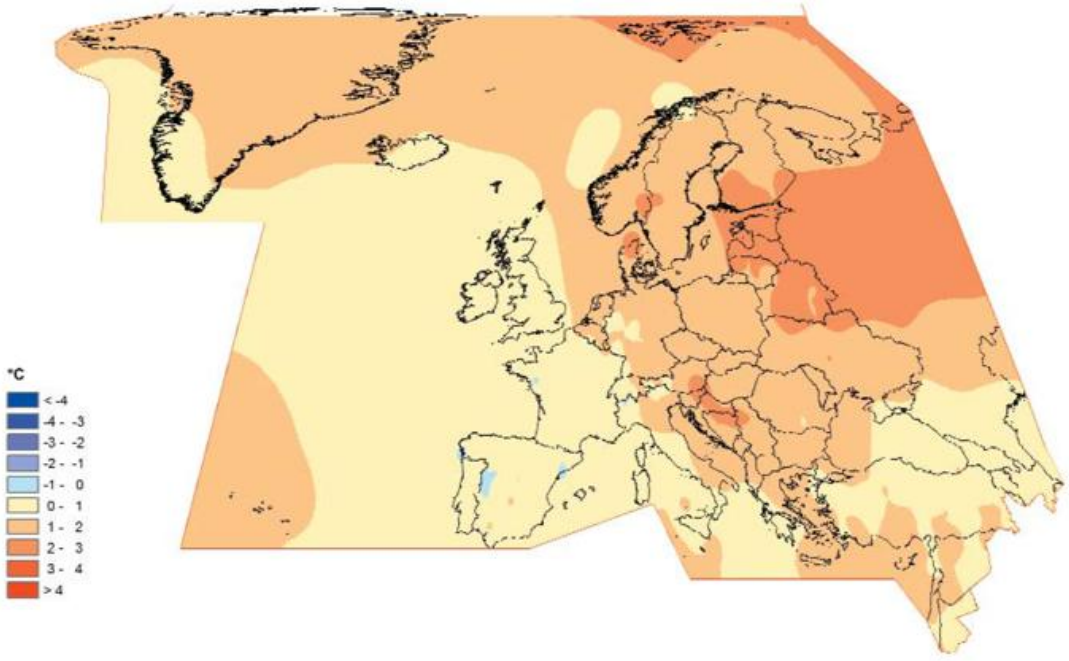


Fig. 0.1: *Mean annual temperature anomalies in 2008 (reference period 1961-1990) in WMO Region VI (interpolation of CLIMAT data).*
Source: Deutscher Wetterdienst, Germany

[1] The standard reference period used in this publication for European averages is 1961-1990 for temperature, and 1951-2000 for precipitation, unless otherwise expressly specified.

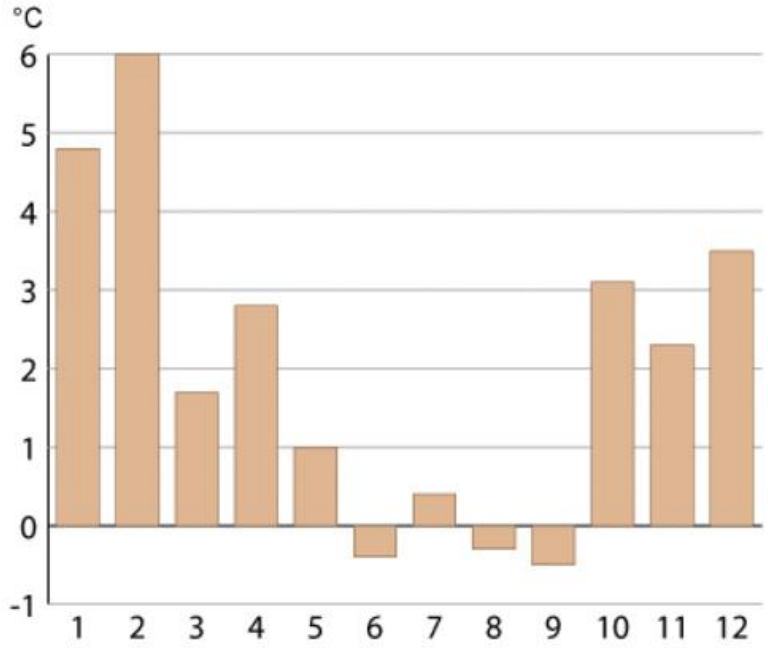


Fig. 0.2: *Mean monthly temperature anomalies 2008 (reference period 1971-2000) in Helsinki, Finland.*
Source: Finnish Meteorological Institute

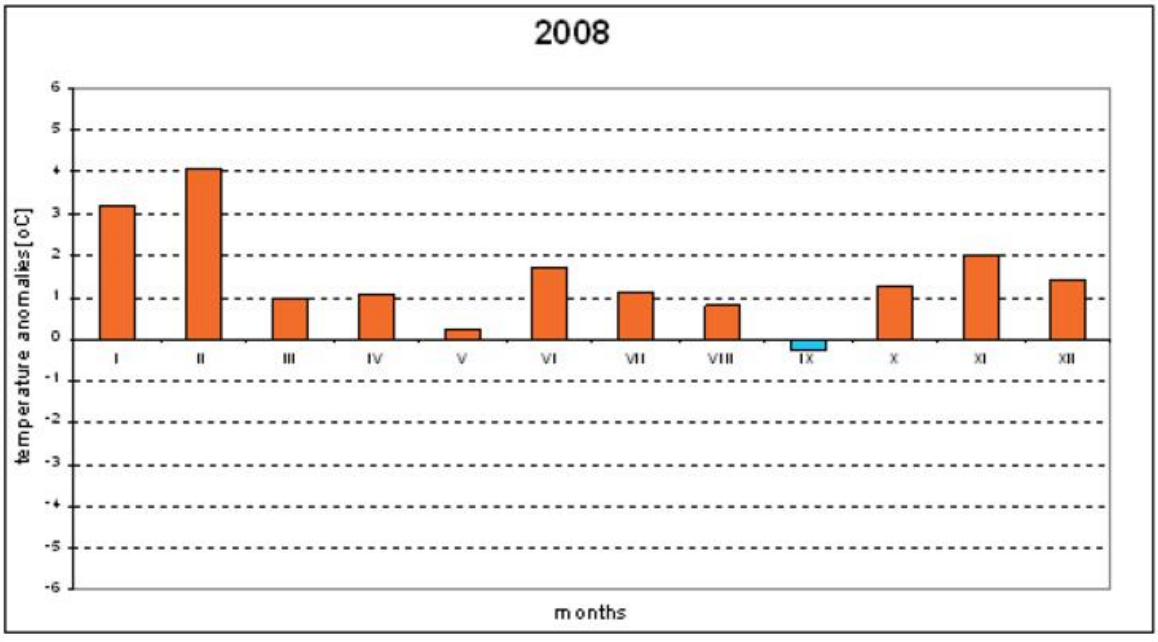


Fig. 0.3: *Mean monthly temperature anomalies 2008 (reference period 1971-2000) in Poland (averaged over 20 stations).*
Source: Institute of Meteorology and Water Management, Meteorology Centre, Poland

Northern Europe and Arctic region

Widespread anomalous warmth was present over the European Arctic in 2008. The island of Hopen, in the Svalbard archipelago, experienced a temperature anomaly of +2.7°C (annual mean temperature -3.7°C). The island of Jan Mayen (northeast of Iceland) had an annual average temperature of 0.7°C, 2.1°C above normal. Greenland and the Faroe Islands also were warmer than usual (Nuuk in Greenland +0.3°C, Tórshavn, Faroe Islands +0.6°C).

2008 was the 13th consecutive warmer-than-average year in Iceland. The Icelandic capital Réykjavik reported an annual temperature anomaly of +1.0°C, with similar records coming from many other Icelandic stations. Temperatures during May to September were unusually high in parts of the country (Fig. 0.4) and the period from May to July has never been so warm in Réykjavik since 1941. October was the only colder-than-normal month in the country as a whole.

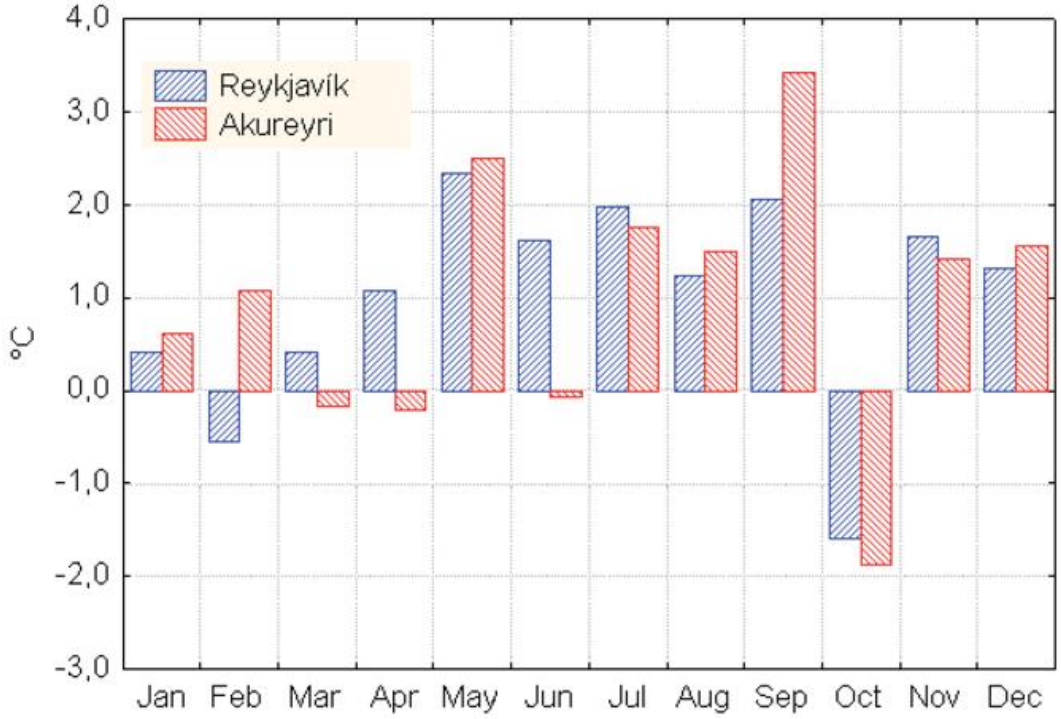


Fig. 0.4: *Mean monthly temperature anomalies 2008 (reference period 1961-1990) in Réykjavik and Akureyri, Iceland.*
Source: Icelandic Meteorological Office

In Norway, Sweden, Finland and Denmark, annual mean temperatures were well above normal (Norway: +1.4°C, locally above +2°C (Fig. 0.5); Sweden: +1°C to +2.5°C). It was the second warmest year in Denmark (along with 2006 and behind 2007), with an annual mean temperature of 9.4°C, which is +1.7°C above normal. Thus, the last three years were the warmest ever recorded in Denmark since 1873 (Fig. 0.6). There were no new temperature records in Denmark for 2008, but it was consistently warm throughout the year. 2008 was the warmest year at some southeastern stations in Sweden (Fig. 0.7). Stockholm and Uppsala both noted their warmest year (in Stockholm together with the year 2000) since the start of their long time series in the middle of the 18th century (mean annual temperature 8.5°C in Stockholm, 7.8°C in Uppsala).

Southwestern and most of southern Finland experienced the warmest year since 1961 . Annual anomalies in Finland reached up to around +2.5°C above normal in the south of the country.

It was the warmest year since 1961 in Lithuania, where the annual mean air temperature rose to 8.2°C. Latvia reported its second warmest year over the last 85 years (7.6°C country mean). With an annual countrywide mean of 7.4°C, 2008 was the warmest year in Estonia since 1989, when the same value was reached. In the long-term time series of Tartu, the year 2008 shows the highest annual mean since 1866 at 7.2°C. Anomalies in all Baltic countries were around +2°C.

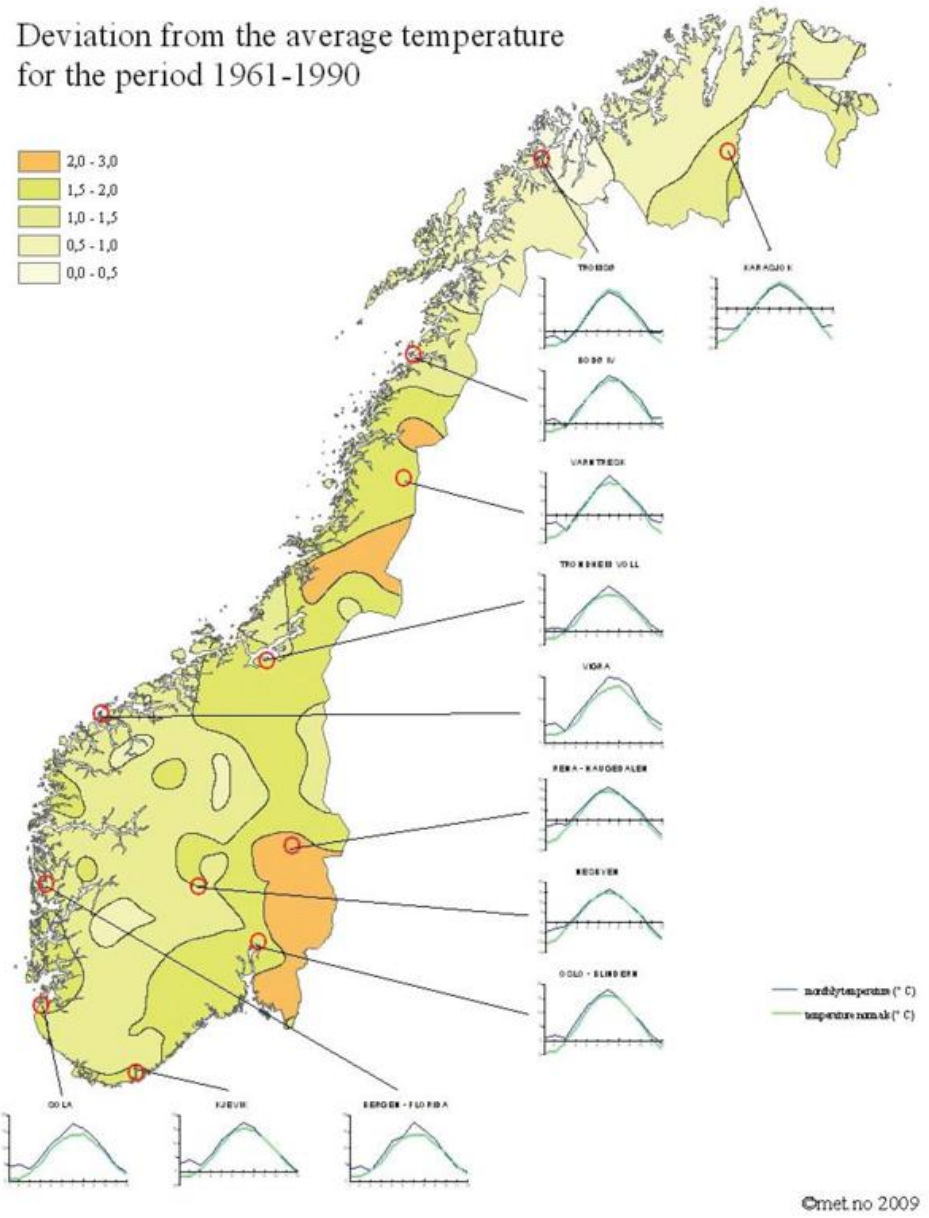


Fig. 0.5: *Mean annual temperature anomalies 2008 (reference period 1961-1990) in Norway.*
Source: Norwegian Meteorological Institute

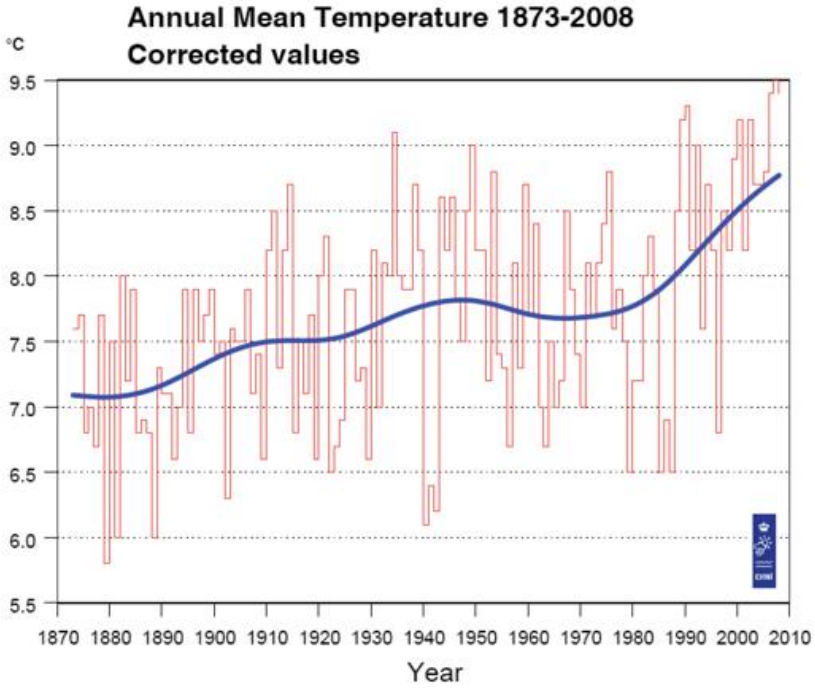


Fig. 0.6: *Mean annual temperature 1870-2008 in Denmark. Source: Danish Meteorological Institute*

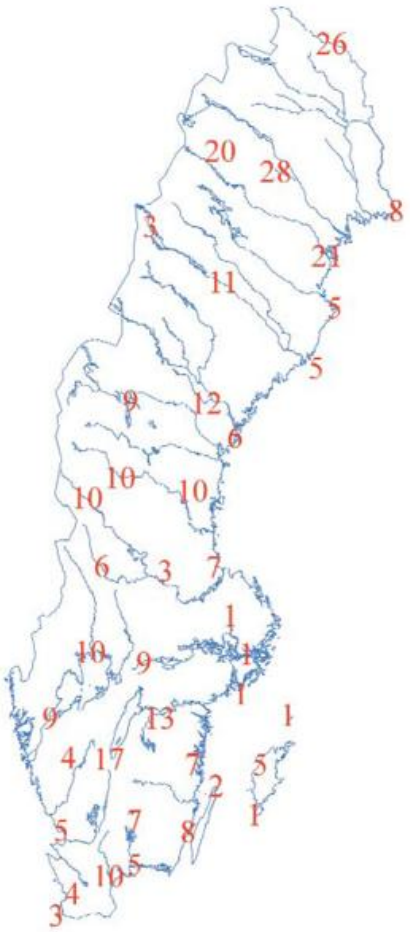


Fig. 0.7: *Ranking of mean annual temperature 2008 in comparison with years 1901-2007 at stations in Sweden (1 = warmest, 108 = coldest year). Source: Swedish Meteorological and Hydrological Institute*

North Atlantic

The North Atlantic was around +1°C warmer than normal, in the North and near the Azores somewhat more, near western Europe less, but still above zero. It is assumed that warmer-than-normal sea surface temperatures have also contributed to positive anomalies over land.

Central and western Europe and the Alpine region

Central Europe was warmer than normal, but not so warm as 2007. Anomalies ranged from near zero in southwestern and western Germany up to +2°C in Poland. At various stations in Slovakia, 2008 was the warmest year since records began in 1871, but as there were no extreme heat waves in summer, the absolute maximum did not exceed 35°C in that country. Belgium did not have any ice days (maximum temperatures below 0°C) in 2008, which was quite a very exceptional situation.

Over western Europe, annual temperature anomalies were generally lower than in central regions. Despite temperatures mostly of 0.4-0.7°C above normal, 2008 was one of the coldest years in the last decade in France, the UK and Ireland. The Netherlands recorded an anomaly of +0.8°C (annual mean temperature 10.6°C) with particularly warm months in January and May. Similarly, Belgium had outstanding warm months in January, February and May while the other months were closer to the long-term average (Fig. 0.8).

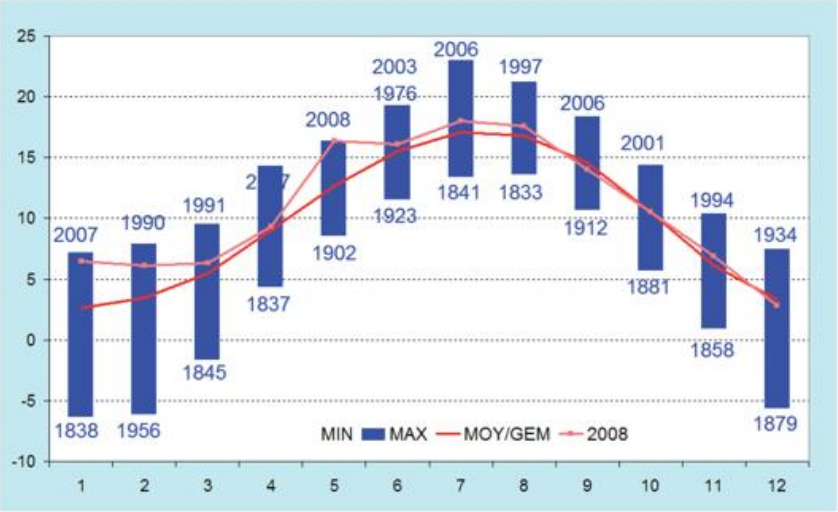


Fig. 0.8: *Monthly averaged mean temperature (°C) in Uccle, Belgium in 2008 (pink) and on long-term average 1901-2000 (red). Blue bars indicate maximum and minimum mean temperatures and the corresponding years.*
Source: Royal Meteorological Institute, Belgium

The weather conditions in Switzerland during the first half of the year were determined by frequent foehn events and generally high temperatures, followed by a second half with more alternating warm and cold spells. Anomalies in Switzerland were about +1°C, making 2008 as another warm year, though clearly colder than the recent 5 warmest years on record (Fig. 0.9). Anomalies in Austria were in the range from +0.6 to +1.5°C. Due to frequent southerly foehn events, valleys in the northern Alpine region experienced temperature anomalies above +1.3°C.

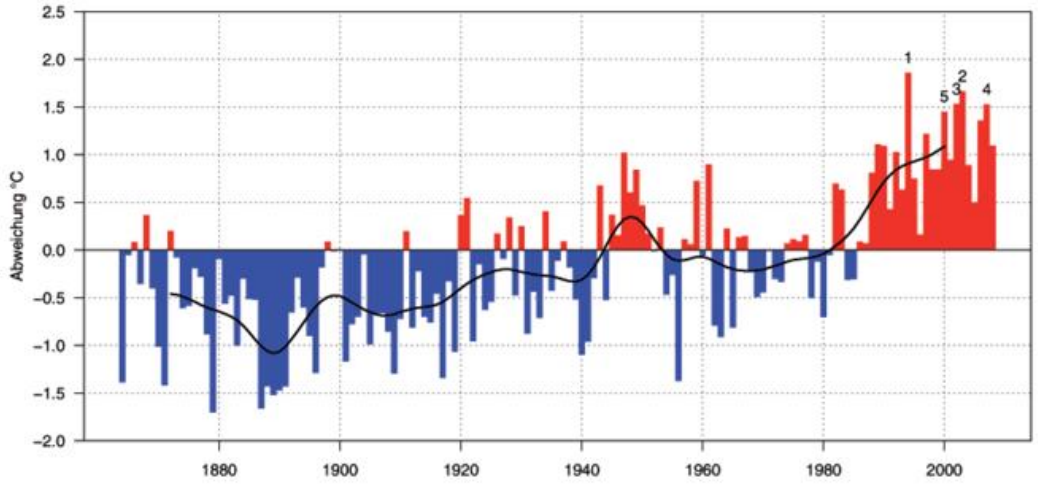


Fig. 0.9: *Mean annual temperature anomalies 1864-2008 (°C; reference period 1961-1990) in Switzerland (averaged over 12 stations). Red (blue) bars indicate positive (negative) anomalies. Black curve: 20-year Gaussian low pass filtered data.*
Source: MeteoSwiss, Switzerland

Iberia

While western Iberia registered negative anomalies throughout the year (except at the beginning of the year), the eastern and southern parts were characterised by consistent positive anomalies (except autumn). Although annual temperatures in Spain were slightly above average, it was the coldest year since 1996 (Fig. 0.10). The country mean of mainland Portugal was 0.2°C lower than the 1971-2000 average. Here, it was the coldest year since 1993, and for the first time since then the annual mean maximum temperature was below normal. Especially the second half of the year was colder than normal in Portugal.

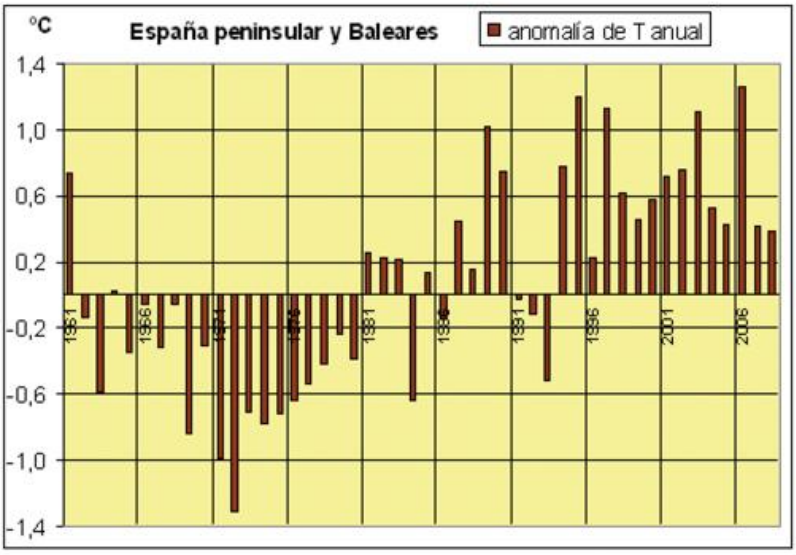


Fig. 0.10: *Mean annual temperature anomalies 1961-2008 (reference period 1971-2000) in Peninsular Spain and Balearic Islands.*
Source: National Meteorological Institute Spain

Mediterranean, eastern and southeastern Europe

The year 2008 was 1° to 2°C warmer than normal across most of eastern and southeastern Europe (Fig. 0.11 showing Bosnia and Herzegovina as an example). In Belarus, most of northern European Russia and parts of the southeastern Ukraine, anomalies exceeded +2°C, while anomalies in southern Greece, Sicily and parts of the Italian Peninsula were below +1°C. In Hungary, it was the third warmest year on record since 1901; all months except September were warmer than normal and two short, but severe heat waves occurred in August and September. On more than 40 days, maximum temperature was 30°C or more in southern Hungary (Fig. 0.12). In Belarus, 2008 was the warmest year on record, along with 1989 (Fig. 0.13). All months were warmer than normal except May; February was especially mild. Behind 1995 and together with 2007, 2008 was the second warmest year in European Russia in a 100-year record. In the Ukraine, especially February and March were considerably warmer than normal, but also summer and late autumn (Fig. 0.14).

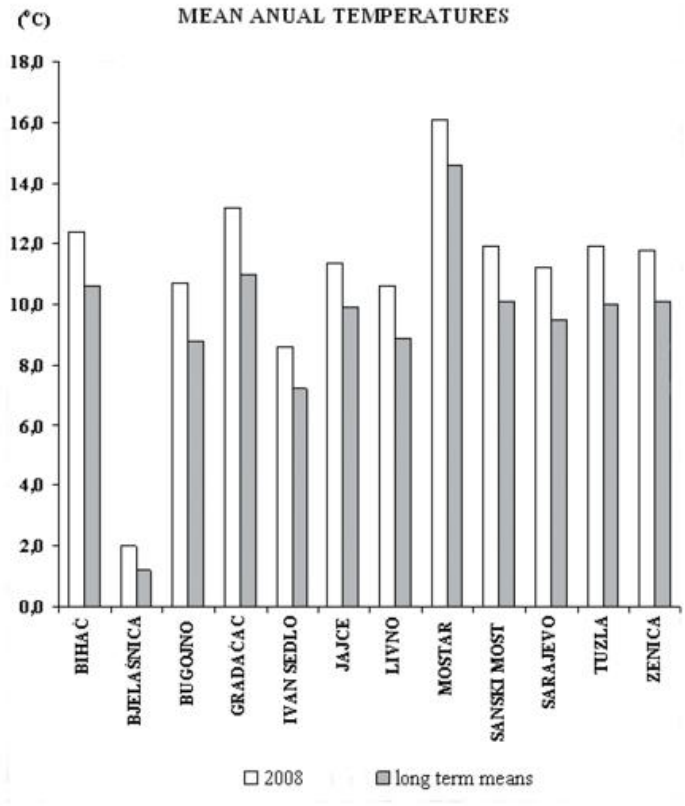


Fig. 0.11: *Mean annual temperatures in 2008 and for the reference period 1961-1990 at stations in Bosnia and Herzegovina.*
Source: Federal Hydrometeorological Institute, Bosnia and Herzegovina

On the Balkan Peninsula, the highest deviation from normal was observed in Bosnia and Herzegovina and in northern parts of Croatia. Across most of Croatia, temperatures exceeded the 98th percentile of the 1961-90 distribution. With 13.4°C, 2008 was the third warmest year in Zagreb, ranking behind 2000 and 2007 (beginning of records in 1862). New absolute maximum records were reached in Serbia in February, May and September at several locations throughout the country. Serbia also recorded heat waves from 26 May to 3 June and from 20 to 27 June while in August, the number of tropical days (>=30ºC) was twice the long-term average. Bulgaria experienced its 3rd warmest year on record since 1901, behind 2007 and 1994. Albania had annual mean maximum temperatures up to +2.6°C above normal and minima up to +3.4°C above normal, especially in the coastal zone.

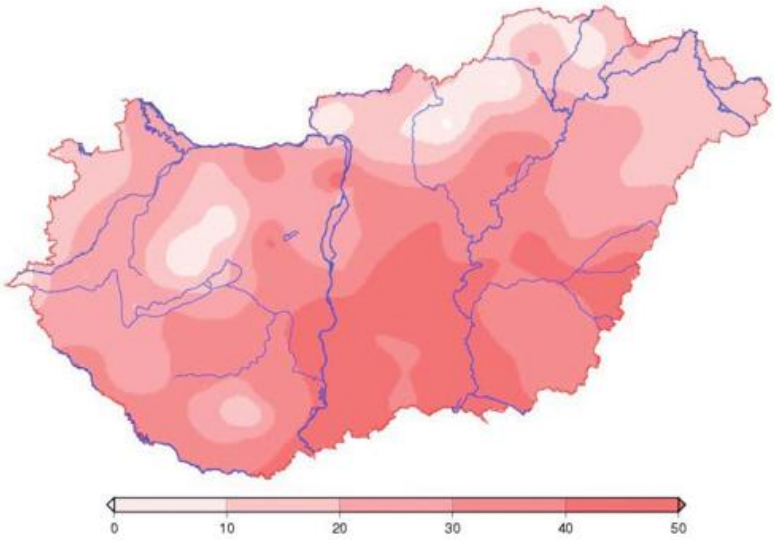


***Fig. 0.12**: Spatial distribution of the number of hot days (maximum daily temperature >=30°C) in 2008 in Hungary.*
Source: Hungarian Meteorological Service

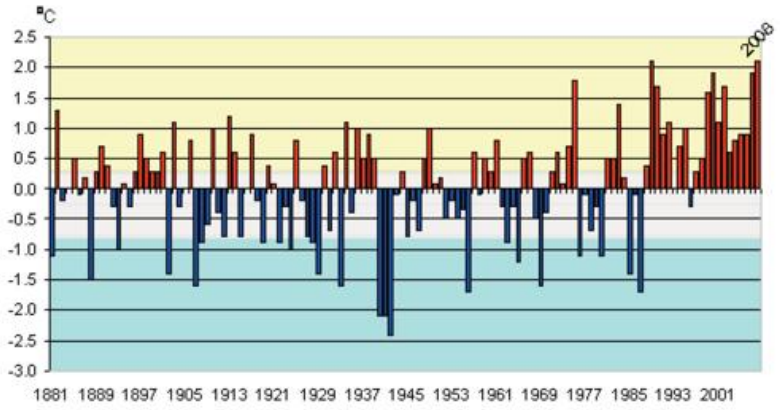


***Fig. 0.13:** Mean annual temperature anomalies 1881-2008 (reference period 1961-1990) in Belarus.*
Source: Republican Hydrometeorological Centre, Belarus

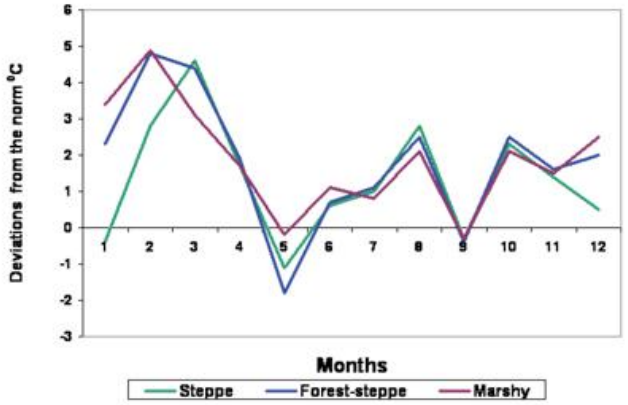


***Fig. 0.14:** Mean monthly temperature anomalies in 2008 (reference period 1961-1990) in various climate regions in the Ukraine.*
Source: Ukrainian Hydrometeorological Centre

Middle East and South Caucasus region

Annual temperatures across the Middle East were generally 0° to 1°C above normal, although anomalies in Cyprus, southern Turkey and parts of Syria, Lebanon, Israel and the mountain regions of Azerbaijan (above 1000m altitude) exceeded +1°C. Positive anomalies in the Caucasus countries (e.g. in Azerbaijan), but also in Turkey were mainly due to warm months in March and April (Fig. 0.15). Although 2008 was generally a warm year in Turkey, it was slightly colder than the preceding 3 years (2005-2007). In particular the annual mean minimum temperatures were higher than normal in Turkey while the maxima were lower. Jordan had frost for a couple of days on several occasions in February-April in hilly regions in southern and eastern parts of the country. Severe frost damage mainly affected fruits (zucchini, bananas), but also vegetables and crops.

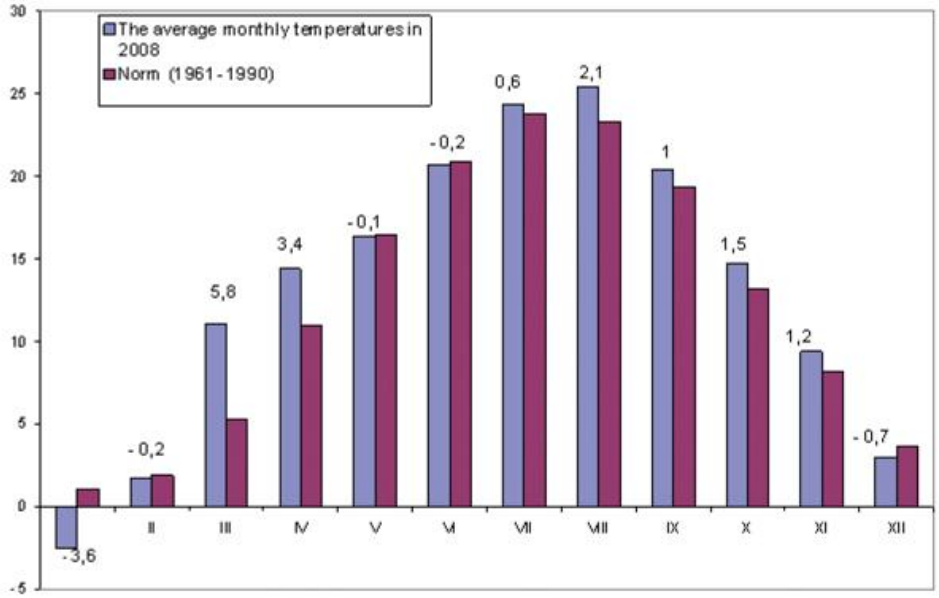


Fig. 0.15: *Mean monthly temperatures in 2008 and for the reference period 1961-1990 in Azerbaijan.*
Source: National Hydrometeorological Department of Azerbaijan

3. Precipitation

Overview

In 2008, rainfall in Europe was unevenly distributed both, spatially and temporally (Fig. 0.16), and the year was characterized by several major storm events with extremely intense and heavy precipitation. Annual precipitation was mostly above the long-term average (1951-2000) in northern and western parts of Europe and below average in southern Europe. Less than 80% of normal precipitation was observed in Bulgaria, Greece and the Middle East, in parts of the eastern Mediterranean even less than 60%. Some areas, particularly in northern Europe and the Arctic, received more than 125% of normal precipitation.

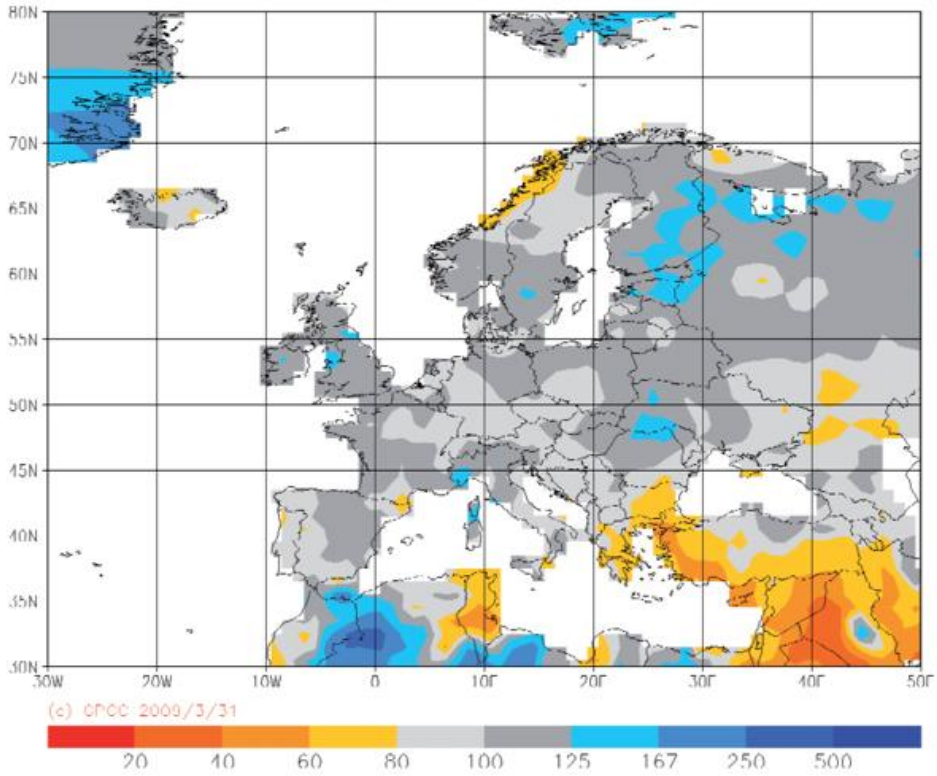


Fig. 0.16: *2008 annual precipitation amounts in WMO Region VI in per cent of the 1951-2000 normal.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst , Germany

Northern Europe

Precipitation in 2008 was mostly above the long-term average in the Nordic countries. Highest anomalies occurred in southeastern and southwestern Finland, where precipitation was 150%-200% of the 1961-1990 normal. Kemiö recorded 1064 mm of precipitation, the second highest total recorded in Finland in the last hundred years.

In Sweden, precipitation totals locally reached 175% of normal, which was partly due to the wet winter. The Swedish station Mollsjönäs (near Gothenburg) reported an annual total of 1866 mm and thus set a new Swedish record for highest annual precipitation beating the previous one of 2007. Denmark received 109% of normal precipitation with a very dry May partly compensating for wet conditions in January, March, August and October. Denmark's annual rainfall has risen by about 100 mm since 1870. Annual precipitation was close to normal in Norway, although some southern parts received 50% more than normal.

Parts of the European Arctic experienced well-above-average precipitation. Ny-Ålesund on Svalbard reported 128% of average precipitation. On Iceland, precipitation was close to normal in the north and east but in the southwest of the island, 2008 was a wet year (Reykjavik 117%), though not as wet as 2007. The year 2008 began with heavy precipitation in Iceland, whereas the first part of the summer was very dry. Tórshavn on the Faroe Islands received 115% of the 1961-90 normal annual precipitation, Nuuk in western Greenland 139%.

In the Baltic countries, Tartu in Estonia saw its second wettest year since 1866 with 873 mm of precipitation (144% of the 608 mm normal). Latvia had an annual precipitation total of 744 mm (113% of normal) with August and October having been particularly wet. Lithuania noted near-

normal annual precipitation: a wet start of the year (especially in January to March) was compensated by some drier-than-normal months during the summer half year (May-September, Fig. 0.17).

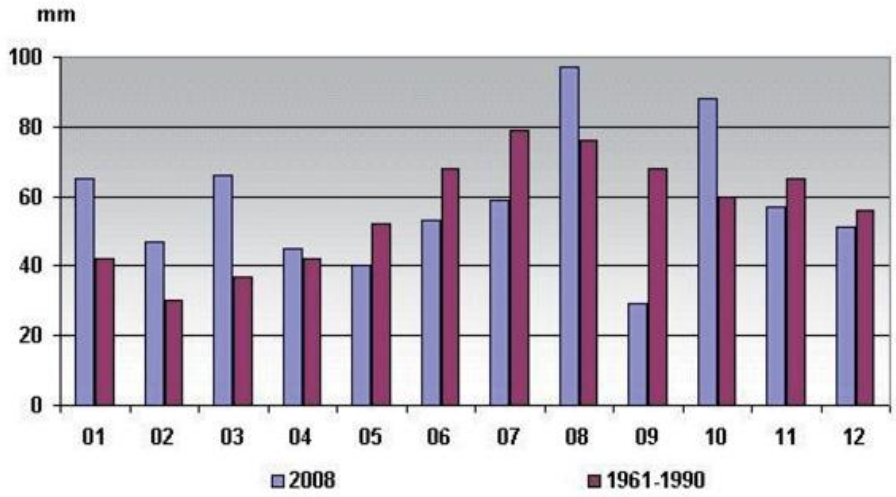


Fig. 0.17: *Precipitation totals in 2008 and the 1961-1990 average in Lithuania. Source: Lithuanian Hydrometeorological Service*

Western and central Europe

With 118% of the 1961-1990 mean annual rainfall the United Kingdom experienced its third wettest year in a national rainfall series that begins in 1914. The annual totals partly exceeded 135%, particularly in northeast England and southeast Scotland (Fig. 0.18). Rainfall totals in Ireland were also well above average, especially due to high summer rainfall, but also to a 10-20% higher-than-normal number of wetdays (days with 1 mm or more rainfall). It was the wettest year on record in places of Ireland (Fig. 0.19): e.g. Shannon Airport recorded its highest annual precipitation total (1268 mm) since observations began in 1945. In most of France, precipitation was only slightly higher than normal with only some areas in the southeast reporting annual totals up to 150% of the 1971-2000 normal which were close to records in some places.

In central Europe, precipitation was close to or slightly below average, with the exception of eastern Austria (> 110%), the southern alpine region (120%-140% due to some heavy rain and snowfalls resulting from depressions over northern Italy), and Slovakia (115%). Between May and September, a large number of strong thunderstorms with heavy rain, tornadoes and hailstorms were observed in central Europe, causing some casualities and significant damage. Long dry periods as in 2007 did not occur in 2008 in central Europe.

Iberia

The Iberian Peninsula generally experienced below-average rainfall in 2008, with the largest anomalies of more than 20% below the long-term mean over Portugal. There have now been 4 very dry years in the recent past in Portugal (2004, 2005, 2007, 2008; Fig. 0.20). In the north-eastern regions of Spain, annual precipitation was slightly above average. The 2008 accumulated precipitation over the Iberian Peninsula was slightly less (around 5%) than the 1961-1990 average, but averaged only over Peninsular Spain and the Balearic Islands, it was

rainier than usual. The annual total of 630 mm at La Rioja exceeded by 8% the previous year's record in a series of almost 60 years. Spain also broke new records for daily precipitation during spring and autumn, with the highest being 155 mm in Cádiz.

The year was generally characterized by periods of drought interspersed with local heavy rainfalls. Drought conditions prevailed in Spain from the beginning of the year until mid-April, making it the worst drought in this country for over half a century. From the beginning of the year until mid-March in Spain, only 2.8 mm of precipitation fell on spatial average which is around 40% of the winter half year precipitation from October 2007 to March 2008. The following seasons show a very different pattern, with most of Iberia recording above-average spring rainfall on the one hand and below- (above)-normal values over western (eastern) Iberia in summer and autumn on the other hand. The southernmost coast of Iberia was (as compared with the normal) much drier than the rest of Iberia in spring and much wetter in autumn.

From April to June and September to November, heavy rainfalls were recorded frequently in Spain. Each month, at least one Spanish station set a new daily precipitation record. Despite locally heavy rainfalls, however, it was generally very dry in Portugal between October and December. The Azores Islands were also dry at that time of the year.

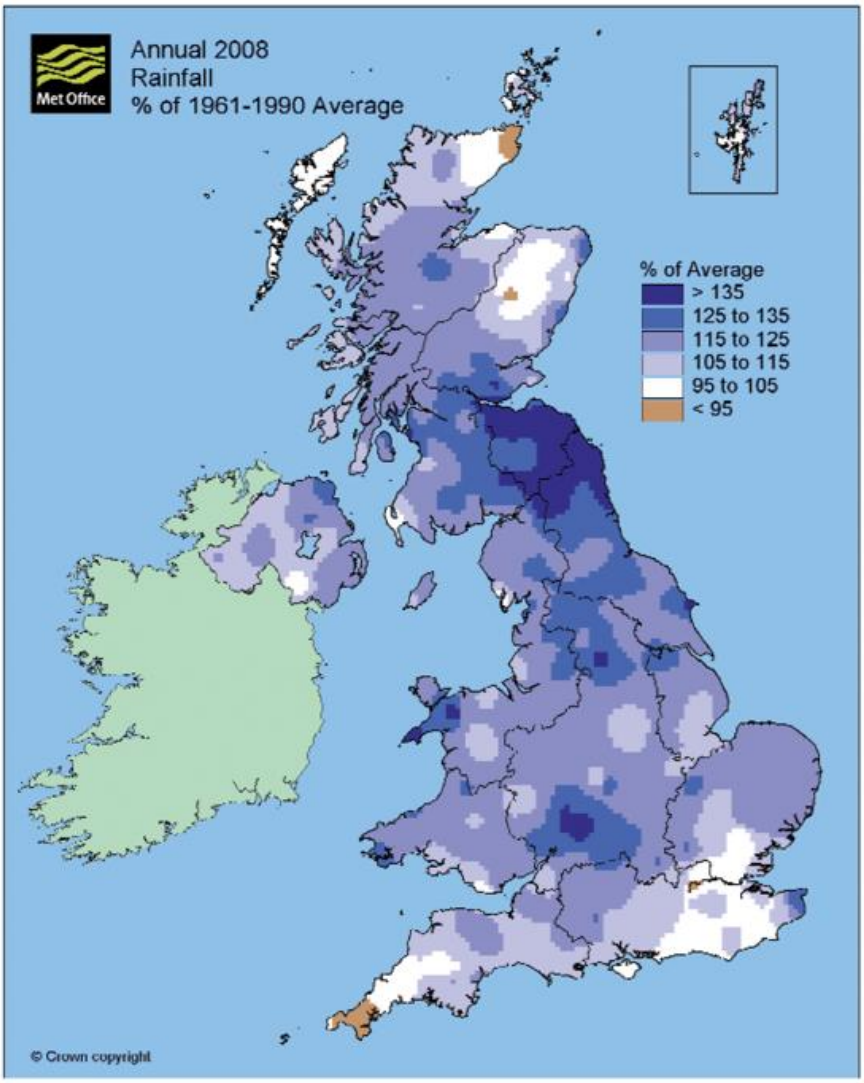


Fig. 0.18: *2008 annual precipitation amounts in the United Kingdom in per cent of the 1961-1990 normal.*
Source: UK Met Office, United Kingdom

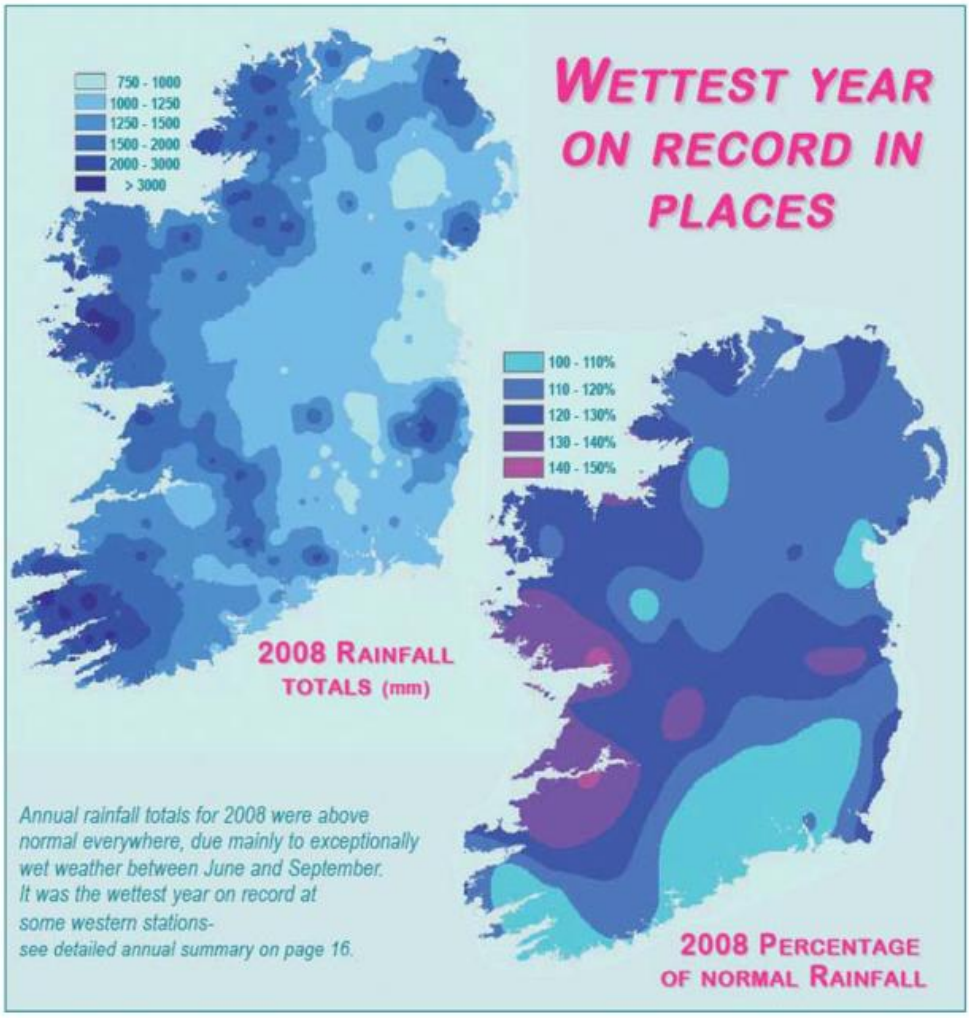


Fig. 0.19: *2008 annual precipitation amounts in Ireland, in mm and in per cent of the 1961-1990 normal.*
Source: Met Eireann, Ireland

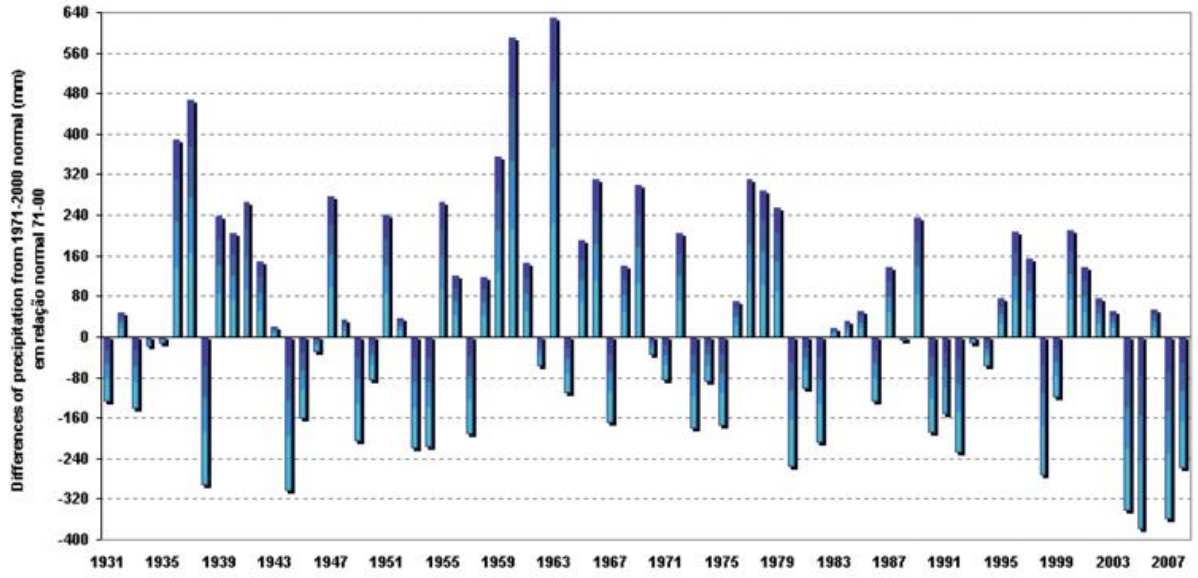


Fig. 0.20: *Annual area-averaged precipitation anomalies 1931-2008 in Mainland Portugal (reference period 1971-2000).*
Source: Instituto de Meteorologia, Portugal

Mediterranean, eastern and southeastern Europe

In 2008, rainfall deficits were observed in some areas of the Italian and Balkan Peninsulas and in the eastern Ukraine while precipitation was above average in parts of central European Russia, Slovenia and Romania. Belarus and Hungary had near-normal annual precipitation. However, the precipitation anomalies were distributed very irregularly over the year: e.g. Hungary had a very dry February which was followed, though, by a very wet March; in the Ukraine, February and August were very dry, April, July and September, on the contrary, very wet.

Corsica in the western Mediterranean was wet in 2008 reaching the highest annual rainfall totals for over 40 years. Northern Italy experienced two very intense rain periods in May and June. Croatia had a deficit in annual rainfall, especially in northern parts and southern coastal areas. Precipitation in Dubrovnik was below the 10th percentile (1961-90 base period). It was also dry in most parts of Serbia, where the annual total as well as the number of rain and snow days was low. Macedonia, too, was dry most of the year, but September and December were very wet months. The annual total rainfall in Athens in Greece was 87% of the 1961-90 average.

Middle East and South Caucasus region

Drier-than-average conditions affected most of the Middle East region in 2008. Precipitation anomalies ranged between 40% and 60% of normal in Cyprus and in parts of Jordan and Syria. Averaged over the whole country of Cyprus, the hydrological year October 2007 to September 2008 was the second driest since 1902 with an annual precipitation of 272 mm (Fig. 0.21). The country now suffers its 3rd consecutive year of drought and, as a result thereof, severe water shortages.

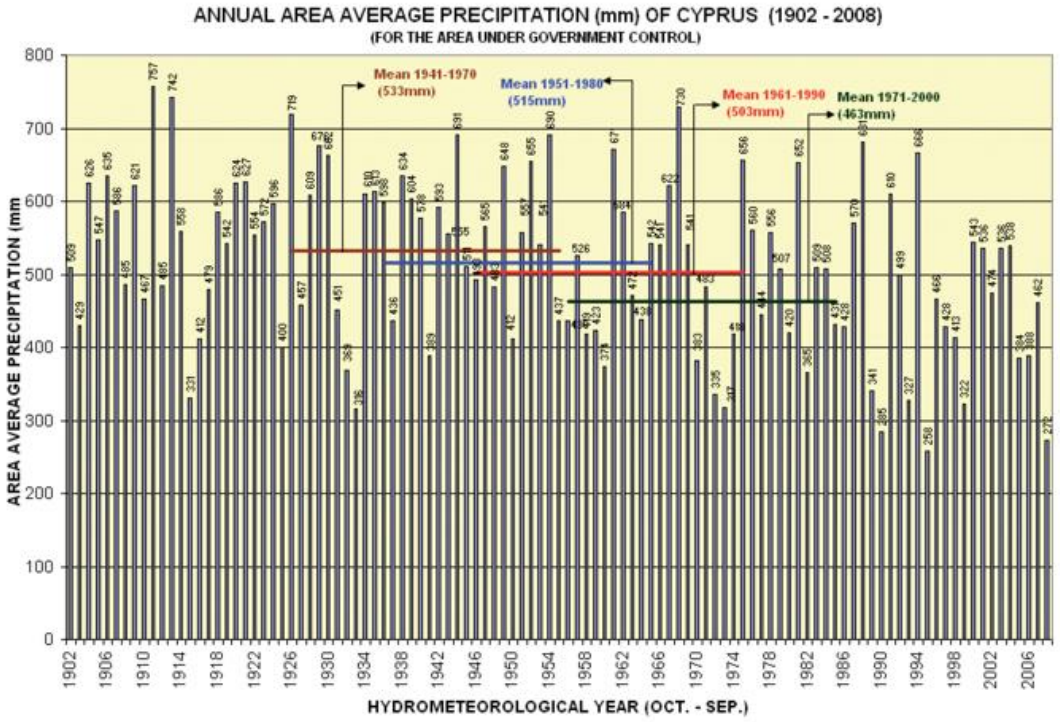


Fig. 0.21: *Annual area-averaged precipitation totals 1901/02-2007/08 (hydrological years October-September) in Cyprus, compared to various climatological means. Source: Meteorological Service, Cyprus*

Annual rainfall was 60-80% of average in Lebanon, Israel and parts of Turkey. Heavy rain in the Lebanon was reported particularly in January, February and October. Less rain than normal occurred in the other months of the winter half year. Precipitation deficits in Jordan amounted to more than 100 mm in several places (Fig. 0.22). In Turkey, the deficits were mainly due to low winter and spring precipitation. Only September was a wet month (Fig. 0.23). In other areas of Turkey and in the Caucasus region, annual precipitation generally was close to the long-term mean, although shortage of precipitation throughout the year was recorded in Armenia which also reported, however, frequent hailstorms and heavy rains from May to September. In Azerbaijan, February to March were dry whereas the summer half year (May-October) was quite wet except August.

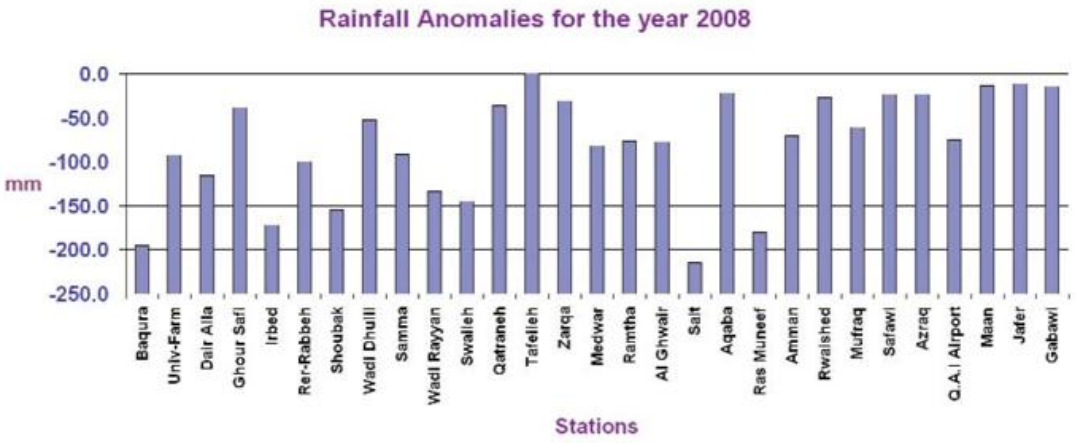


Fig. 0.22: *2008 annual precipitation anomalies at stations in Jordan (reference period 1961-1990).*
Source: Jordan Meteorological Department

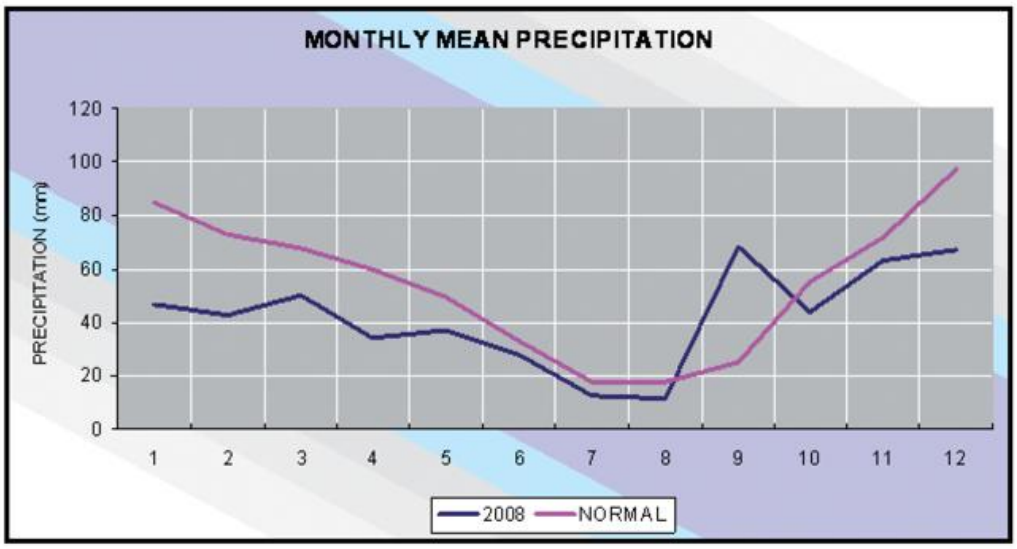


Fig. 0.23: *Monthly mean precipitation totals averaged over Turkey in 2008 in comparison with the 1961-2000 normal.*
Source: Turkish State Meteorological Service

4. Snow

In Iceland, snowfall in 2008 was slightly more frequent than in the previous eight years, but it barely reached the average totals of the preceding decades. There were 64 days with snow cover in Réykjavik, which is 9 days more than the 1961-90 average. On the other hand, the snow season from autumn 2007 to spring 2008 had its lowest number of snow days averaged over northern Europe in more than 25 years (Fig. 0.24).

Lithuania experienced its first snowfall of the 2008/09 season as late as in the second half of November and a short period of heavy snowfall (>30 mm / 12 h) at the seaside at the end of that month, though fortunately followed soon by fast snowmelt. In European Russia, a lower-than-usual snow cover was recorded in western and southwestern parts, whereas snow persisted longer than usual in the other areas.

After a winter season 2007/08 with generally very little snow, central Europe had snow in March. Basel and Geneva registered their first snowfall of the year at the end of March, the latest arrival of snow since measurements began in 1931. Many areas over central Europe experienced a white Easter. In the following snow season, during the last weeks of autumn, the Alpine region received an early snow cover even at lower altitudes. Due to continuous southern flows, considerable snow amounts were also recorded at the alpine south side. At the end of November and in December, the snow cover was unusually deep in the western part of the Julian Alps.

In the last week of October and in November, snow affected large areas of Iberia. From 28 November to 3 December, a cold spell brought snow to areas above 600m in Portugal.

The annual number of days with snow cover was generally low this year on the Balkan Peninsula. In most parts of Serbia, for example, there were around 20 snow days less, locally even around 30 days less (Fig. 0.25). The Lebanon in the Middle East had 30% less snow than normal (only 380 cm on average on high mountains) and 35% less snow days.

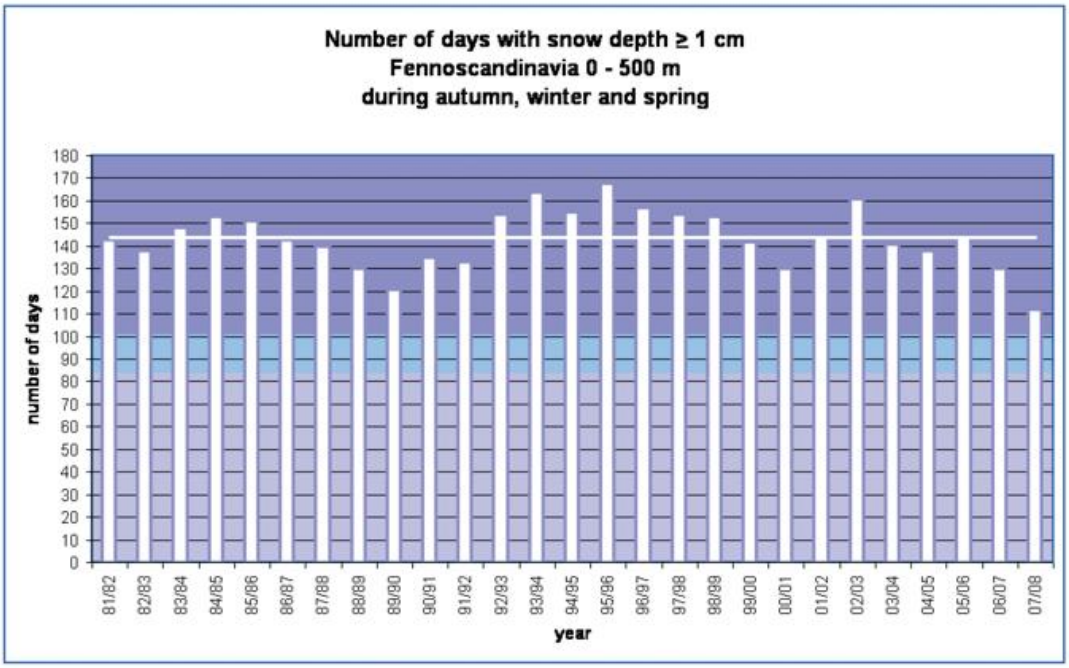


Fig. 0.24: *Number of snow days in Fennoscandinavia during September 2007 – May 2008 (grid point average over Norway, Sweden, Finland, Denmark, and the Baltic countries, based on interpolation of SYNOP data, only elevations 0-500 m considered). Source: Deutscher Wetterdienst, Germany*

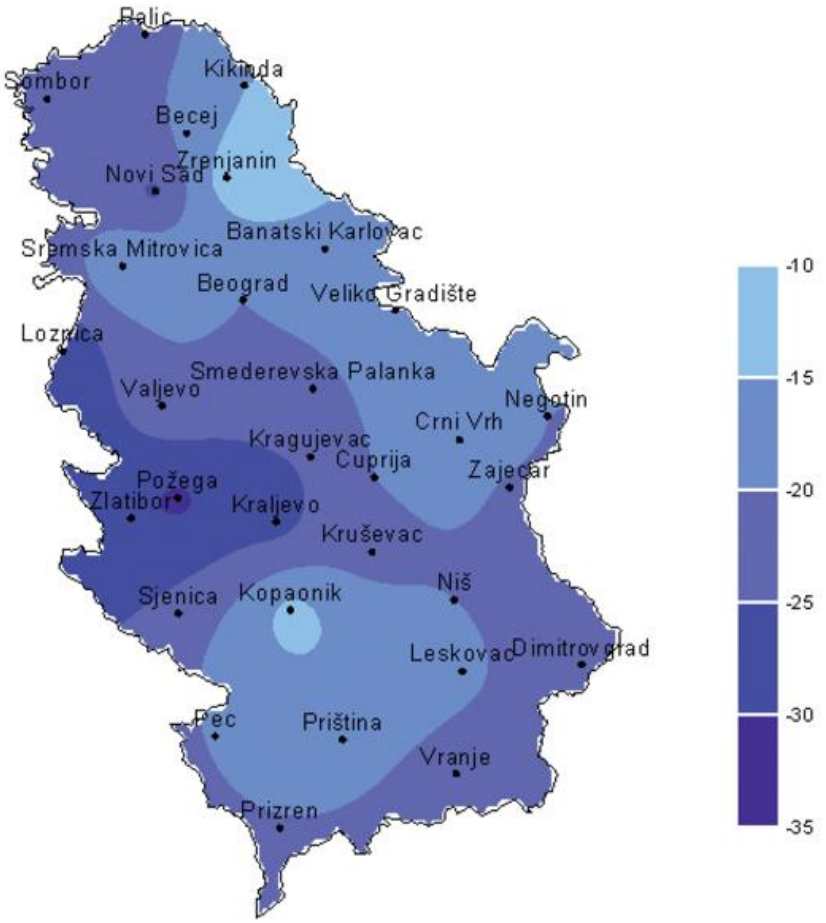


Fig. 0.25: *Deviation of number of days with snow cover in 2008 in Serbia from the reference period 1961-1990.*
Source: Republic Hydrometeorological Service of Serbia

5. Sunshine duration

Most places in northern, central and southeastern Europe were sunnier than normal in 2008, whereas most of eastern and parts of western Europe, but also the Middle East received less sunshine than normal (Fig. 0.26).

In the north, Tórshavn on the Faroe Islands registered an annual total of 1003 hours of sunshine (normal 840 hours). Réykjavik in Iceland also experienced a very sunny year with more than 1400 hours of bright sunshine, 195 hours more than on average, whereas the rest of Iceland was quite dull. Denmark had a surplus of 22% of sunshine duration as compared with the climate normal. This corresponds to almost one additional sunshine hour per day.

In central Europe, it was a very sunny year in the Netherlands (1794 hours, almost 250 hours more than normal) and in Poland. In Germany, however, the year was only 7% sunnier than normal. Sunshine duration in France was also near to normal.

On a seasonal level, winter 2007/08 was the sunniest winter in France since 1950, particularly in the northern two thirds of the country, the sunniest winter in Germany since 1951 (Fig. 0.27) and the 2nd sunniest winter in the United Kingdom since 1929. Large parts of western and central Europe, including the United Kingdom, France, Germany, the Netherlands, Switzerland and Austria, also had an exceptionally sunny February with some areas recording over twice

their monthly average sunshine duration. In Slovenia, it was also one of the sunniest February months ever recorded in some places. On the other hand, February, and also the whole winter of 2007/08, had less sunny days than average in southern and central Finland, making it a very dark season for the country.

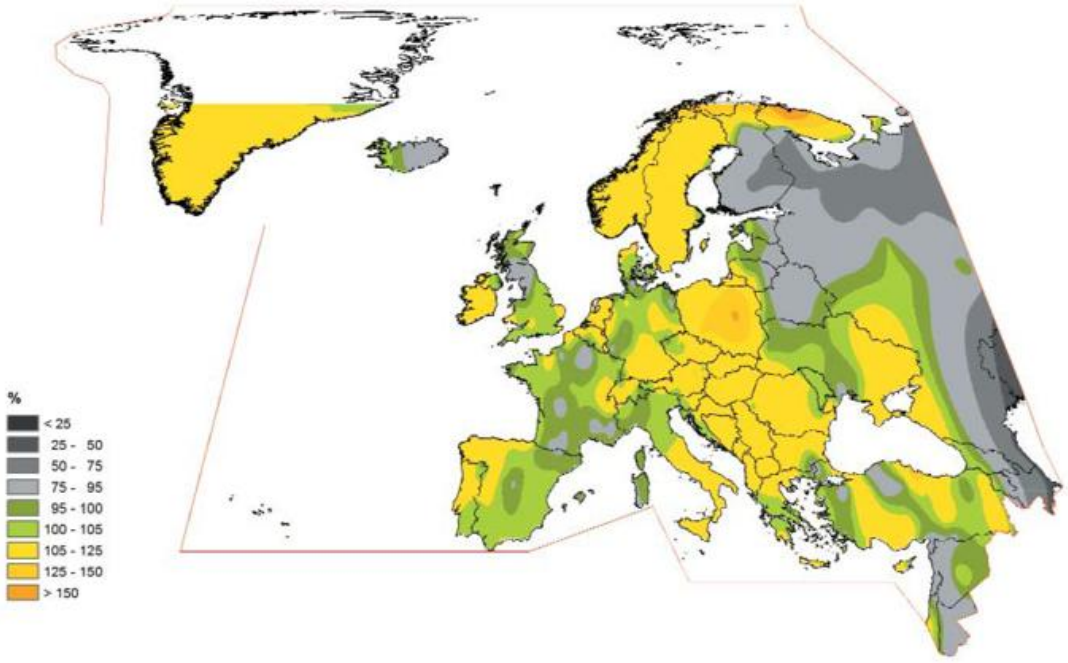


Fig. 0.26: *Mean annual sunshine duration in 2008 in per cent of the 1961-1990 normal in WMO Region VI (interpolation of CLIMAT data).*
Source: Deutscher Wetterdienst, Germany

May was exceptionally sunny in many parts of central and southeastern Europe, but also in southern Scandinavia. It was the sunniest spring (663 hours) and May (347 hours) ever recorded in Denmark. In the Netherlands, the first decade of May was the sunniest on record for that time of year in over a century. Germany, too, had a very sunny May (the third sunniest since 1901) with up to around 400 hours of sunshine (12.5 hours a day on average) at the Baltic coast.

Summer was not very sunny in Finland: less than half of the usual sunshine durations were measured in many places in eastern and northern parts of the country due to a wet season. Lithuania, however, had a very sunny June, recording 360-370 hours of sunshine in some places, which is 95 hours more than normal. Eastern Europe in general experienced a very sunny summer with up to around 200 hours more sunshine than normal.

In many places in Ireland, August was the dullest on record with only around 60% of normal. In other parts of western and northern Europe and in the Middle East, August was rather gloomy whereas it was a very sunny month in southeastern Europe.

September was a dull month in most of Europe, but exceptionally sunny in Hungary where the sunshine duration amounted to more than 300 hours (normal around 250).

December was sunny in western and central Europe, with partly more than 150% of normal. Some places in the northwest of Germany had up to 80 hours of sunshine.

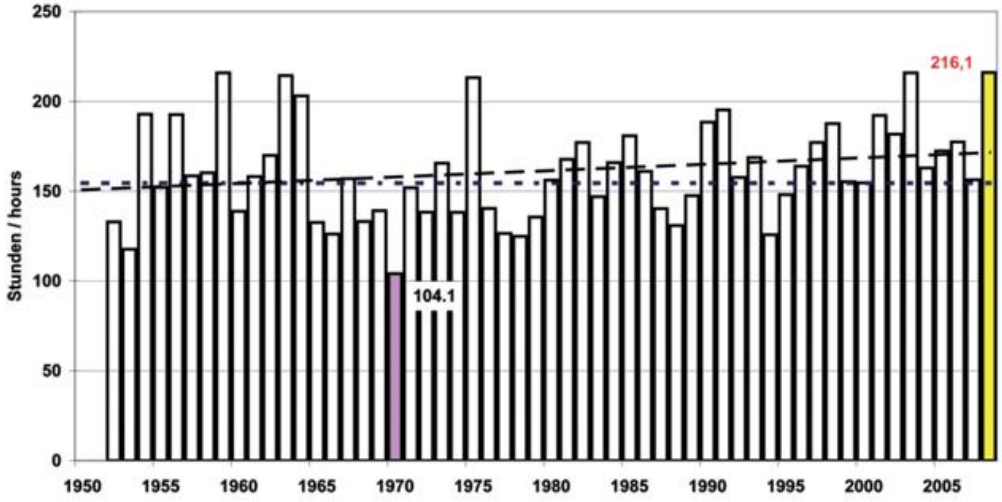


Fig. 0.27: *Mean sunshine duration averaged over Germany in winter 1951/52 – 2007/08. Source: Deutscher Wetterdienst, Germany*

6. Wind

The highest wind speed measured in 2008 at Norwegian maritime stations was 107 km/h (on the 26th of October on the Heidrun field outside the county of Trøndelag).

In 2008, Norway's capital Oslo also was affected by several heavy storms.

There were no severe storms in Denmark in 2008, but it was quite windy for several days between the end of January (25th) and the 1st of March, on midsummer night and on the 21st of December.

Mean annual wind speeds in Ireland amounted to 13-22 km/h. They were above normal everywhere in the country and thus the highest annual values for 6 to 9 years.

Central Europe was affected by some severe winter storms between January and March, and a large number of strong thunderstorms occasionally accompanied by tornadoes between May and September. October was quite stormy over the northern coastal areas, locally with up to hurricane force. However, parts of central Europe had an abnormally low wind speed on annual average, e.g. Belgium, although it was a little bit higher than during the past years in this country.

Thunderstorm activity was very high in Bulgaria.

The annual mean surface wind speed in the Lebanon was 30% lower than normal in the lowlands of the country, but around normal in mountainous regions.

7. Sea ice

The maximum sea ice extent of 2008 in the Baltic Sea was reached on the 24th March, covering as little as 49.000 km². This is less than 12% of the whole Baltic Sea area. In a typical winter, the sea ice covers an area of about 218.000 km² (52% of the total sea area). This was due to the warmer-than-normal sea water in late autumn 2007, relatively high air temperatures in December 2007 and the absence of cold spells in the winter of 2007/08, preventing longer lasting formation of sea ice.

On 14th of September 2008, the extent of the Arctic sea-ice-covered area was recorded to be 4.52 million km², which is the second smallest in 30 years behind 2007. This confirms once again the present negative trend of Arctic sea ice cover in summer. The Greenland Sea (east of Greenland) had even less sea ice than 2007.

Seasonal Survey

Temperature

All seasons were mostly warmer than normal, though not everywhere in the Region. The mild winter especially in northeastern Europe was outstanding. It was colder than normal in the Middle East in winter, in northeastern Europe in summer and in western Europe in autumn.

Winter 2007/08 was mild in most of Europe and extremely mild during all three winter months especially in northeastern Europe. In the southeast of the Region, however, it was in general colder than normal.

Mean temperature anomalies in the far north exceeded the 98th percentile. They ranged between +3° and +4°C in southern Scandinavia and exceeded +4°C in northern and eastern Norway and Sweden as well as in most parts of Finland and the Baltic States. Finland recorded temperatures 4° to 6.5°C above the 1971-2000 average, i.e. temperatures that were around 1°C higher than the previous record set in 1925. The number of winter days (daily mean temperature below 0°C) was 20-30 in southern and 45-55 in central Finland, which is significantly less than the normal for these parts of the country (typically the mean temperature during winter is below 0°C in all of Finland). Even Lapland had about 10 winter days less than usual. Svalbard reported monthly temperature anomalies of +7 to +8°C in January and February.

There was hardly any ice cover in the Baltic Sea and no permanent snow cover in most of southern Finland. Average winter temperatures in Latvia and Lithuania were 5°C above the long-term mean and even +6°C in Estonia (station Tartu). Seasonal anomalies exceeded +2°C in northern parts of the Ukraine and +3°C in Belarus and in northern Russia.

In many parts of Norway, Sweden, Finland and the Baltic States, winter 2007/2008 was the warmest in recorded history. The same is confirmed by various other long time series, e.g. the Helsinki and Stockholm series (since 1829 and 1756, respectively). In Stockholm and Uppsala, this winter was at least +0.5°C warmer than any other winter on record. In Norway, it was the third warmest winter on record for the country as a whole. Denmark had only 18 frost days on an areal average as compared with a normal of 53 days. Sea ice measurements in the Baltic Sea indicated that this winter had the lowest sea ice extent since 1720, and thus was probably the mildest winter over the Baltic Sea in at least nearly 300 years. It was also the warmest winter on record in Tartu (Estonia) since 1865 and the second warmest winter in Latvia (slightly behind the winter 1924/25). In Belarus, this winter was also exceptionally warm.

The very mild winter in the northeast was mainly due to a dominant southwesterly flow, in conjunction with anomalously high sea surface temperatures in the North Atlantic. This pattern was consistent with an ongoing positive phase of the winter North Atlantic Oscillation (standardised NAO-Index = +1.37 for December 2007 – March 2008). Very probably, global warming also has its effect on the increasing temperatures like, for example, the winter temperatures in Finland which have risen by over +1°C in more than a century. Since 1990, more than two out of three winters have been warmer than the 1971-2000 average in this country. In northeastern Europe, especially minimum temperatures were high in 2008 due to reduced radiative cooling whereas maximum temperatures were closer to the normal.

Western and central Europe were mostly 1-3°C warmer than normal. In Germany, winter 2007/2008 was the sixth warmest on record. This was partly due to the high sunshine duration as this winter was the sunniest winter in Germany in more than 50 years. The winter in the United Kingdom (and other countries) was cooler than in 2006/07 despite the relatively high temperature anomaly of +1.6°C. France as a whole was about +1°C warmer than normal.

Winter 2007/08 was also much warmer than average in Iberia (around +1°C), with Seville experiencing its warmest winter since 1951. Temperatures across Italy and the Balkan Peninsula were closer to the long-term mean, especially towards the south. Winter in Serbia, for example, was characterised by a succession of extremely warm and extremely cold periods. The total number of freezing days for the whole winter was nevertheless well above normal in many parts of Serbia, which was mainly due to a cold spell in the second half of December 2007.

In contrast to other parts of the Region, the winter was characterized by unusually cold conditions across the eastern half of the Mediterranean, the Middle East, most of the Black Sea, the Caucasus countries, southern European Russia and west Kazakhstan, locally with anomalies even below -2°C. Especially January was very cold in these areas, but the other two winter months were also colder than normal. Particularly eastern Turkey was significantly colder. Armenia had the third coldest winter in the last 50 years. Even parts of southeastern Europe experienced several cold spells with daily minima below -10°C in the lowlands, e.g. in Bosnia and Herzegovina.

The southwestern coast of Greenland and the adjacent ocean areas were colder than normal during the whole winter (seasonal anomalies mostly between -1 and -2°C).

Spring 2008 was warmer than normal nearly everywhere in Europe and the Middle East and significantly warmer in the southeast of the Region, over the eastern North Atlantic and in central Europe between northern Italy and Denmark. Anomalies ranged between +1 and +2°C over most of the land areas. Around the Caspian Sea, temperatures were higher than ever recorded. In Belarus, such a warm spring statistically occurs only once in 7 years. Locally, seasonal anomalies exceeded +3°C in the east of the Region due to warm March and April months (in spite of a cool May). On the contrary, a warm May (especially a heat wave in the last days of May) mainly contributed to a warmer-than-average spring season in western and central Europe, whereas a wintry spell came over large parts of Europe at the end of March and the beginning of April.

Over most of the sea areas and in parts of northern, western and southern Europe, anomalies were less than +1°C but still positive. Spring was relatively warm (+0.44ºC) over Iberia. In Portugal, it was the 15th consecutive spring with temperature anomalies above the 1971-2000 average.

Spring temperatures in Montenegro were in the upper decile of the 1961-90 distribution in coastal areas and northeastern parts, and in Croatia. Israel had two long Sharav events in early spring with record breaking temperatures.

Only a few areas in the far north were slightly colder than normal.

Summer 2008 again was warmer than normal almost everywhere in the Region. Anomalies were highest in east Greenland and in the southeast, locally exceeding +2°C or even +3°C (e.g. in Bosnia and Herzegovina). Some places in Greenland were record-breaking warm (e.g. Upernavik in northwest Greenland, Danmarkshavn in northeast Greenland). Over most of the other areas in the Region, anomalies ranged between 0 and +2°C.

Summer was especially warm in parts of the northern Balkan Peninsula during all three summer months, with several strong heat waves. Mean temperature anomalies in Croatia, Serbia, Bosnia and Herzegovina as well as in Montenegro exceeded the 98th or 99th percentile in most parts. The highest summer temperatures in Serbia were close to 40°C (Valjevo 39.1°C on 15 August) and the number of hot days (maxima of 30°C or higher) was above average in the whole country, in August even twice the normal. Summer temperatures were also well above average in Greece due to several heat waves during all three summer months, with highest deviations in August. Temperatures exceeding 40°C affected Cyprus in the second half of July and during the last week of August.

On the other hand, it was a colder-than-normal summer in northeastern Europe, particularly in eastern Lapland, almost the whole of Finland (except the most southwestern part) and northwestern European Russia, partly with anomalies < -1°C. In eastern and northern Finland, there were hardly any temperatures above 25°C, and even in the southwest of the country, this threshold was exceeded on 5-11 days only, which is just half of the usual.

Over western Europe, summer 2008 was one of the coldest since the turn of the century. On a national average, Ireland experienced fewer than 10 days with maximum temperatures exceeding 20°C. However, seasonal mean temperatures were still above average throughout most of central and western Europe, with anomalies generally around +1°C, which was chiefly due to warmer than normal nights. Only some smaller parts in western Europe (e.g. western France, Spain) were slightly cooler than normal. No heat waves were recorded in Portugal this summer. Daytime temperatures in the United Kingdom were in general below normal, which gave the impression that the summer was unusually cool.

Autumn 2008 was warmer than normal in the Arctic region, most of the North Atlantic, northern, central and eastern Europe and the Middle East. Anomalies exceeded +2°C over parts of the Arctic and European Russia, in some areas exceeding the 90th percentile. In Russia, it was the warmest autumn in the Moscow region in more than 100 years. The warm autumn in eastern Europe is mostly due to the temperatures recorded in November. In eastern central Europe, the seasonal anomaly amounted to around +1°C.

It was a cold autumn in most of western Europe, particularly in Ireland, Portugal, Spain, France, Belgium and the western parts of Germany, in Switzerland, Austria and Italy, mainly due to a cold September. Locally, seasonal anomalies were below -1°C. It was the coldest autumn at many stations in Ireland in ten years and in the United Kingdom in 15 years. Having been largely dominated by an extremely cold November, particularly in the later days of the month, the minimum temperatures in Portugal were the third coolest since 1931. Spain experienced its coldest autumn since 1993. Parts of southeastern Europe were slightly colder than normal (e.g. Bosnia and Herzegovina in all three autumn months) despite a long warm spell from 28 October to 8 November (e.g. in the major part of Serbia).

Below normal temperatures in the Adriatic were due to below normal sea surface temperatures in that region.

Precipitation

The distribution of wet and dry seasons was very heterogeneous. Northern Europe, for example, was wet in winter and summer, the middle latitudes were wet in spring, and the Mediterranean region was particularly dry in winter.

Winter 2007/08 proved to be much wetter than normal across the Nordic countries. Norway experienced over 145% of the 1951-2000 normal, parts of the country over 200%. Denmark and the United Kingdom both received 125% of the 1961-1990 normal on country average. In many parts of Finland, annual total precipitation was well above the 1971-2000 normal (the annual total was 150-200% of the normal). Lithuania recorded more than 150% of the normal monthly total (1961-90) in both, January and February. Latvia, too, was clearly wetter than normal in both months and periodic melting of snow together with rain produced several winter floods.

On the contrary, it was a very dry season in the southern half of Europe, particularly in Iberia, the Mediterranean region and north of the Black Sea. The seasonal precipitation total was less than 80% over most of these areas and in many places even less than 60%. At some locations in Montenegro and Croatia, seasonal rainfall was only 40% of the average. Long dry spells in Cyprus during the winter caused a decrease in crop production. Portugal suffered its most severe winter drought since 1917. These conditions were related to positive mean sea level pressure anomalies over western Europe and northern Africa, which along with 500 hPa

geopotential height anomalies, suggested that the northern European blocking pattern was shifted slightly southwards, a feature that limits the natural progression of Atlantic low pressure systems bound for southern Europe. Even most of the Alpine region was dry, seasonal precipitation was below 40% of the normal in southern Austria.

Snow was quite rare (20 snow days or less) in the lowlands of western, central and southern Europe. Due to mild weather, the southern parts of northern Europe, especially around the Baltic Sea, rarely received snow and if so, only little amounts (Fig. 0.28). No ice was recorded in the Latvian sector of the Baltic Sea or in the Gulf of Riga this winter. Only 20-30 snow days were recorded in southern and southwestern Finland, which is well below the normal (more than 70 days). In Germany, there was almost no snow cover during the winter months. No snowfall at all was measured during all three winter months at most locations in the central and western lowland parts of Switzerland. Austria also received little snow, as little as 10-30% of the winter average and the Pyrenees had a deficit in snow, too. However, the northern parts of Scandinavia, most of European Russia and the high mountains had their usual snow during the whole winter. In Cyprus, snow fell in areas above 100m at several occasions in January and February.

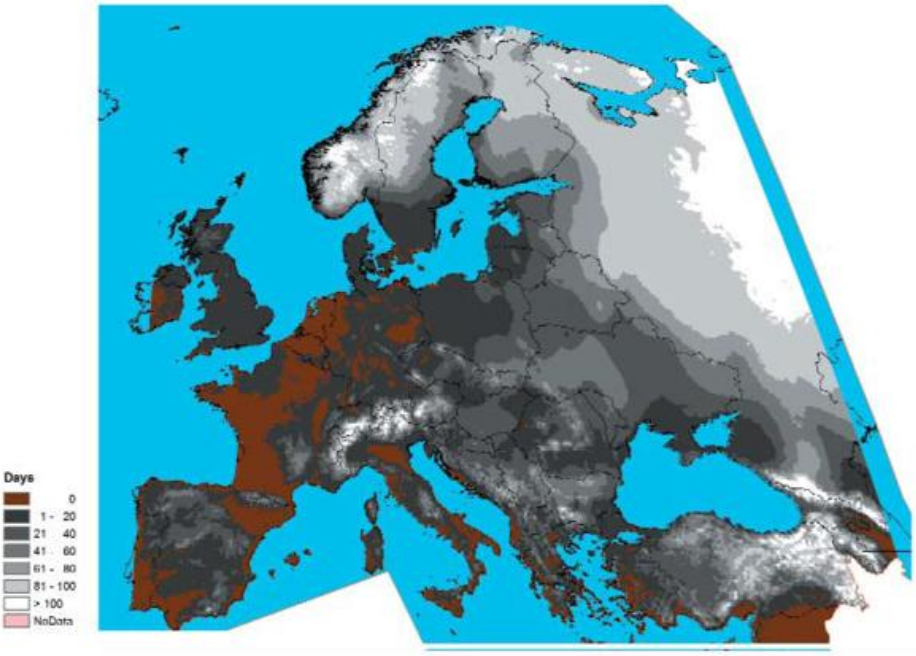


Fig. 0.28: *Number of snow days (number of days with at least 1 cm of snow cover on the ground) in Europe in winter 2007/08.*
Source: Deutscher Wetterdienst, Germany

Spring 2008 was wet over large parts of western Europe, especially southern England, France, Spain and Portugal, and over most of eastern Europe with seasonal totals of more than 150% of the normal in many places. Parts of eastern Norway received up to 200% of the spring normal. The northern part of the Netherlands was an exception: local totals of only 30 mm were reported during the months of April and May.

It was particularly dry in Svalbard (partly less than 30 mm or less than 40% of the seasonal total) and unusually dry in western Iceland.

Spring precipitation was near normal in central Europe where a very dry May compensated wet March and April months. Some of the precipitation in March and April fell as snow due to a late wintry spell.

In the south, it was near normal or wetter than normal in the western half of the Mediterranean, but dry in the eastern half and especially in the Middle East with very little precipitation (around 60% of the seasonal total or less) during the whole season. Iberia experienced a very dry March (except northeastern Spain). A very wet period, however, started there in April. Spring rainfall exceeded 125% of the normal over most parts of Iberia, with several new monthly precipitation records. The records set in March, though, were largely confined to the Basque country stations of Bilbao (215 mm) and San Sebastián (238 mm). In the following months, however, several new all-time records of accumulated monthly precipitation were observed over a wider area of southern (April) and coastal (May) Mediterranean provinces, including stations with more than 100 years of data (e.g. Tortosa). In general, it was the wettest spring in Spain since 1971 (which remains the wettest on record).

Summer 2008 was wetter than normal over the higher mid-latitudes, especially in Ireland, the United Kingdom (parts of northern Ireland and eastern Scotland had around twice their seasonal normal), southern Sweden and northeastern Europe (parts of the Baltic countries, Finland and northern Russia). Summer precipitation reached more than 200% of the 1961-90 normal in eastern Ireland. Eastern and southern parts of the country, including Dublin Airport, experienced their wettest summer in 50 years. Summer 2007 had already been wet, nearly as wet as summer 2008 in eastern Ireland. In the England and Wales precipitation series, the summers of 2007 and 2008 together were the wettest consecutive summers since 1879/1880. In the UK-wide time series started in 1914, this is also true for the United Kingdom as a whole where, however, summer 2007 had been wetter than summer 2008.

Central and western Europe (except Ireland and the United Kingdom) mostly had a summer of near normal precipitation, but high spatial and temporal variations. The Netherlands, however, reported 111 mm of rainfall in July (70 mm average) and 110 mm in August (62 mm average). In general, the summer season was characterised by often and quickly changing weather situations in the mid-latitudes due to frequent disturbances in a southwesterly air flow, partly with quite intense thunderstorms. Agricultural soil irrigation was not necessary in Slovakia this summer.

Parts of eastern Austria measured their wettest summer on record. Anomalies reached 120-160% of the 1961-90 normal. A new seasonal record was set at Eisenstadt (Burgenland, eastern Austria) with 479 mm of precipitation, which is almost 250% of the normal. Unusually heavy thunderstorms with hail occurred in Austria in all three summer months, causing flooding and large agricultural losses. In Hungary, too, summer 2008 was abundant in showers, especially in June and July.

In the Arctic region, there was in general very little precipitation, less than 80% of the seasonal total in many places, in northern coastal areas of Norway partly only 30-50%.

Summer was dry also in the southern parts of Europe, particularly over western Iberia and the Mediterranean except Sicily, and in the southeastern parts of the Region in southern Serbia, Bulgaria, Greece and Turkey. Southern Portugal received less than 10 mm of precipitation, which is less than 20% of the normal average. On the contrary, parts of eastern Iberia were characterized by above average summer precipitation totals, and this despite the fact that Iberia is typically extremely dry in summer.

An extended period of flooding occurred in Moldova from the end of July until the middle of August as a consequence of heavy precipitation at the end of July (see July section for more details).

Autumn 2008 had near normal precipitation in most of the Region. There were some places with considerably higher than normal precipitation (150% of the normal or more) in the north (e.g. southern Iceland, Svalbard, southern Finland, northern Russia, northeast and midlands of England) and locally over and near the Mediterranean and around the Black Sea.

Northern England recorded the wettest autumn since 2000. Some intense rainfalls occurred in western and southern Europe, especially in France, Spain and Italy. Seasonal totals in Corsica were up to twice as high as the 1971-2000 normal. 350 mm of precipitation fell over northern Italy near Bologna between 28 October and 1 November. Between 31 October and 2 November, France was locally affected by flooding after up to around 500 mm of precipitation had fallen in the regions west of the Rhône River in the southeast of the country.

It was dry in some other parts of the Region, in Lapland, in central Sweden, Russia, some parts of the Middle East and particularly in Portugal and western Spain (less than 60% of the normal). However, Portugal locally also experienced some very heavy rainfalls. An extremely wet period also occurred over Gibraltar.

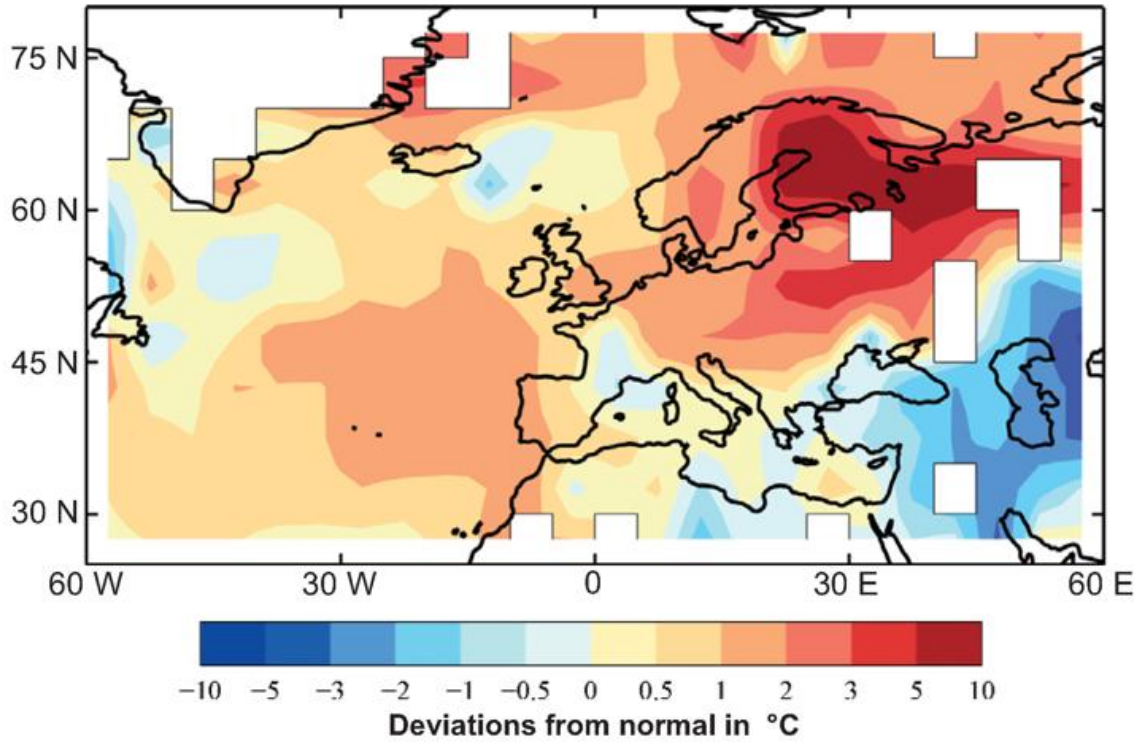
Seasonal Maps

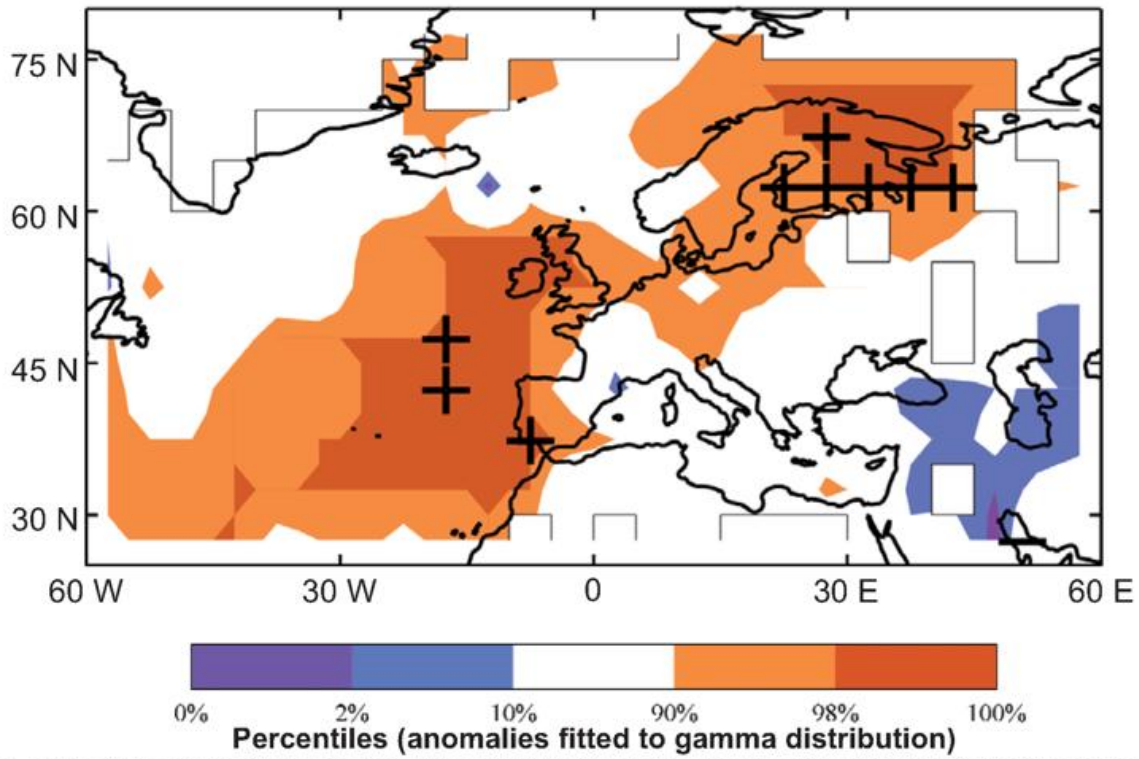
Surface temperature anomalies

Reference period: 1961-1990

Source: The Met Office Hadley Centre, U.K.

December 2007 - February 2008





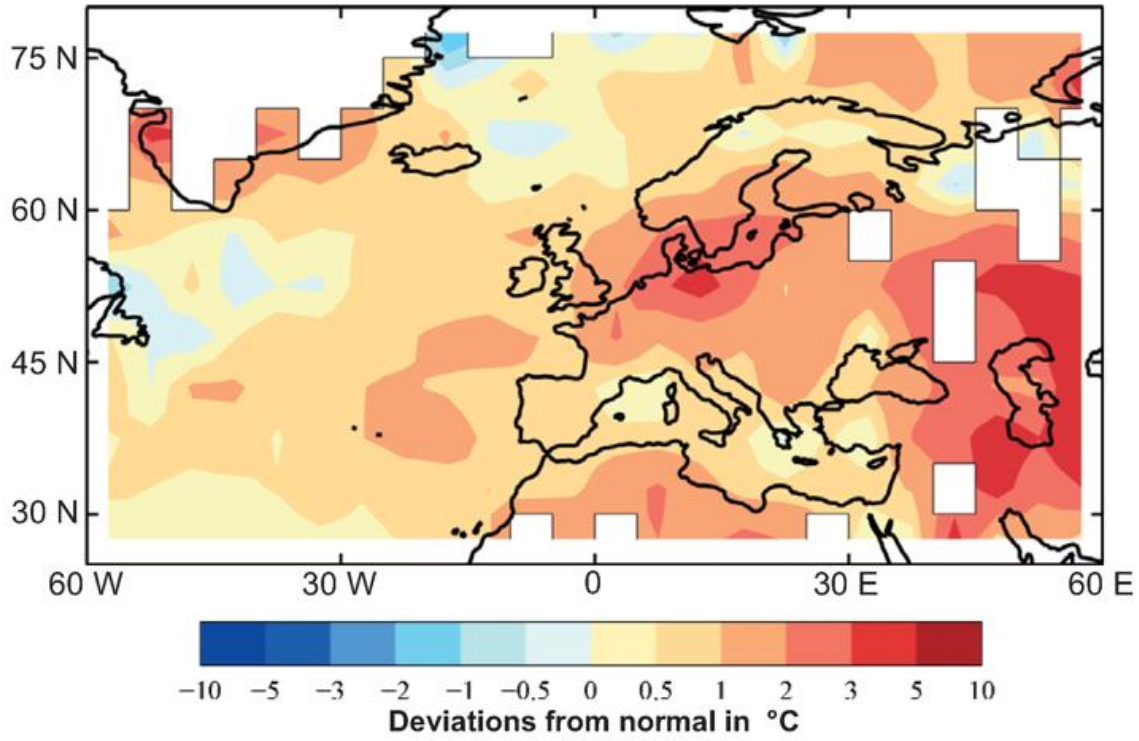
+/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the 159-year record

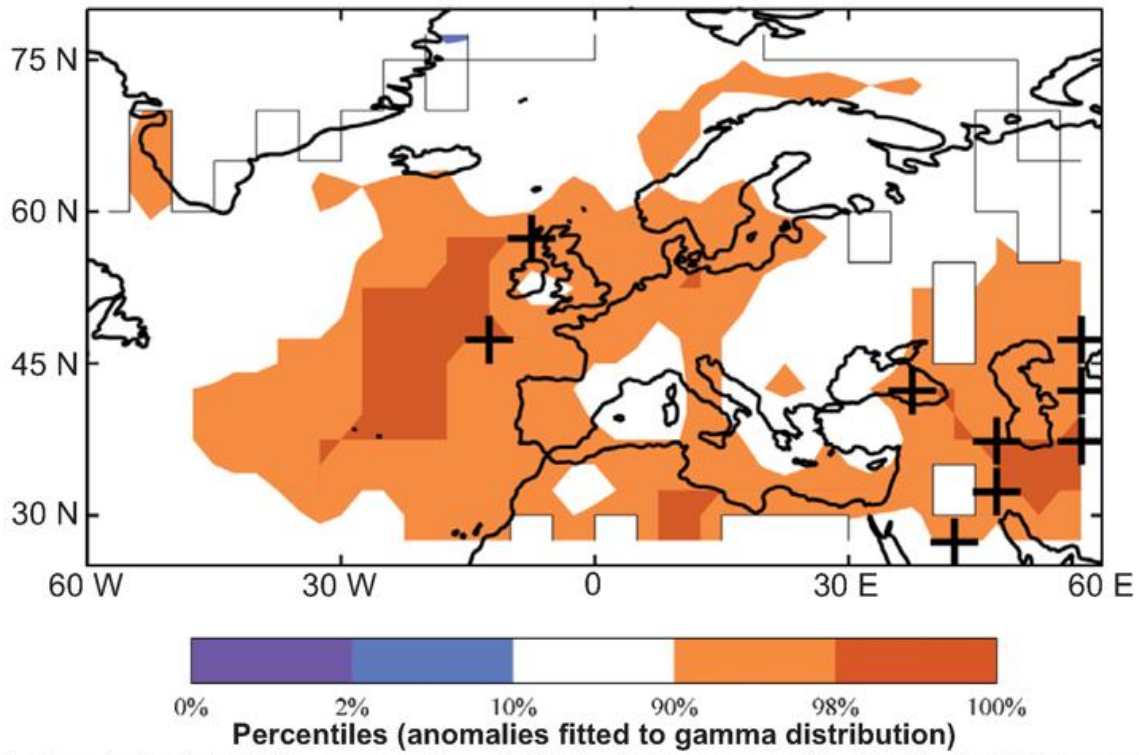
Surface temperature anomalies

Reference period: 1961-1990

Source: The Met Office Hadley Centre, U.K.

March 2008 - May 2008





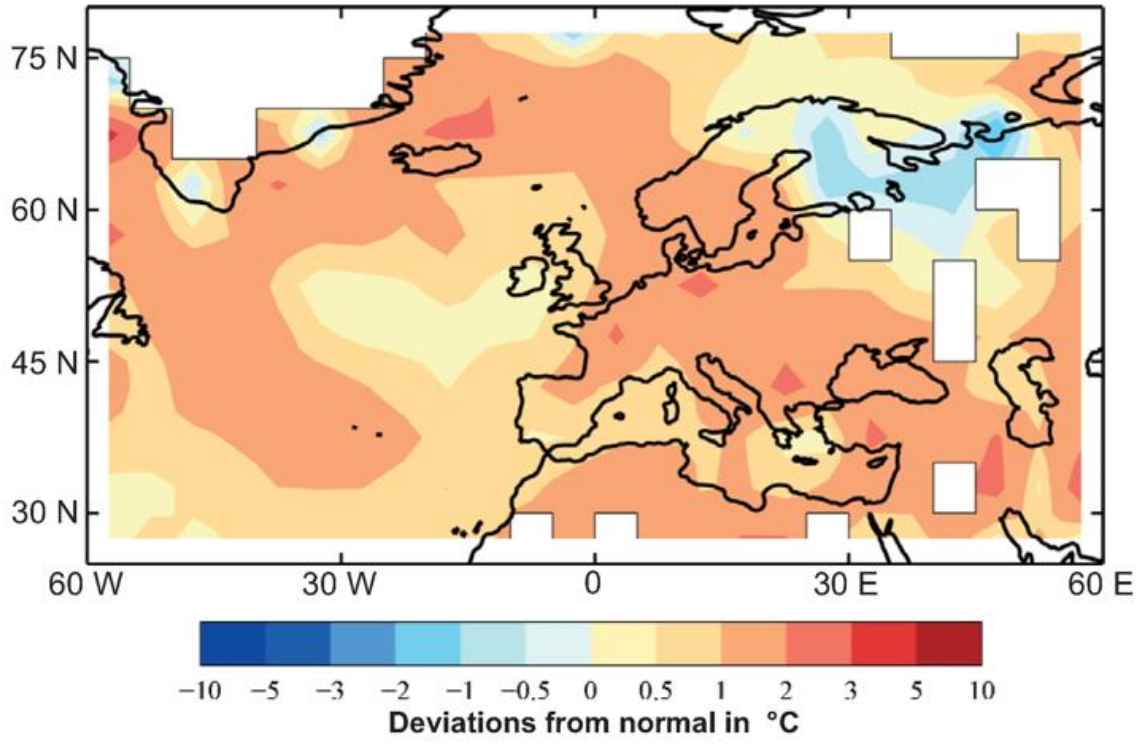
+/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the 159-year record

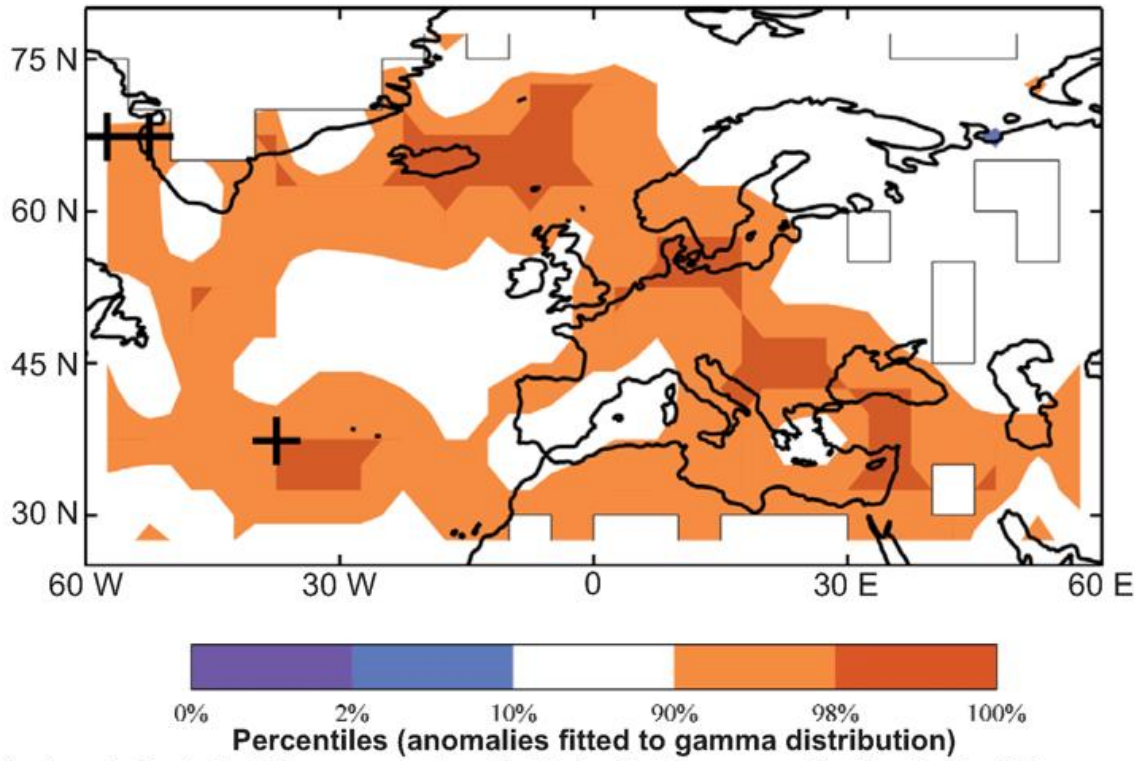
Surface temperature anomalies

Reference period: 1961-1990

Source: The Met Office Hadley Centre, U.K.

June 2008 - August 2008





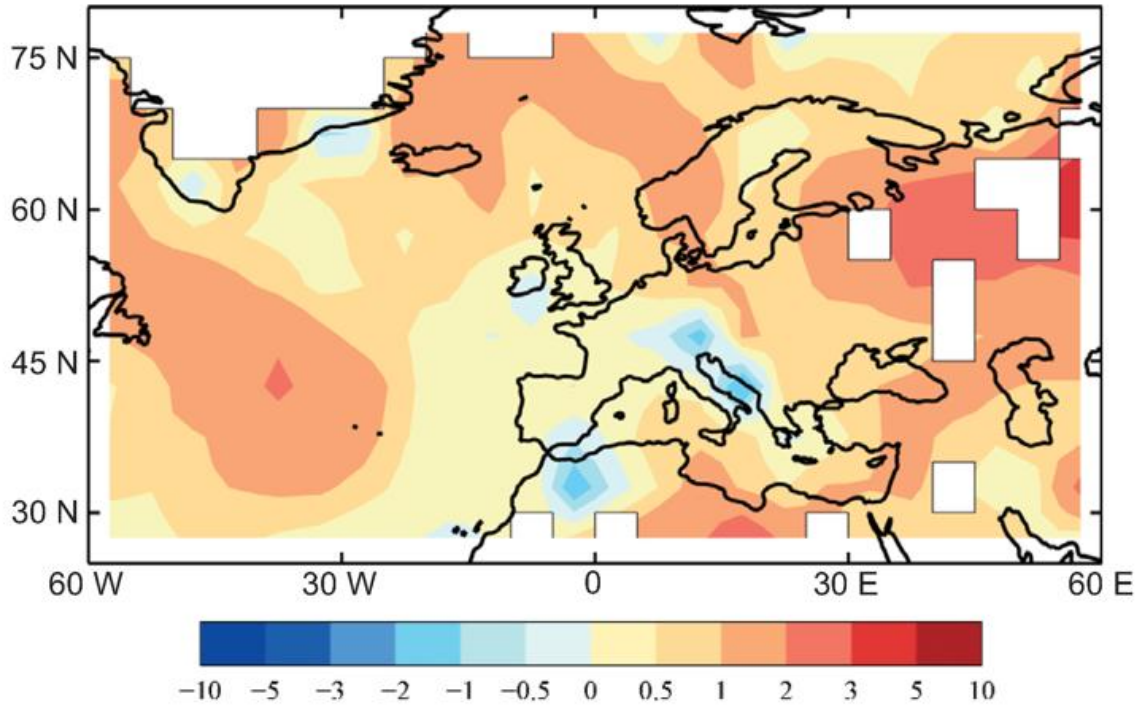
+/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the 159-year record

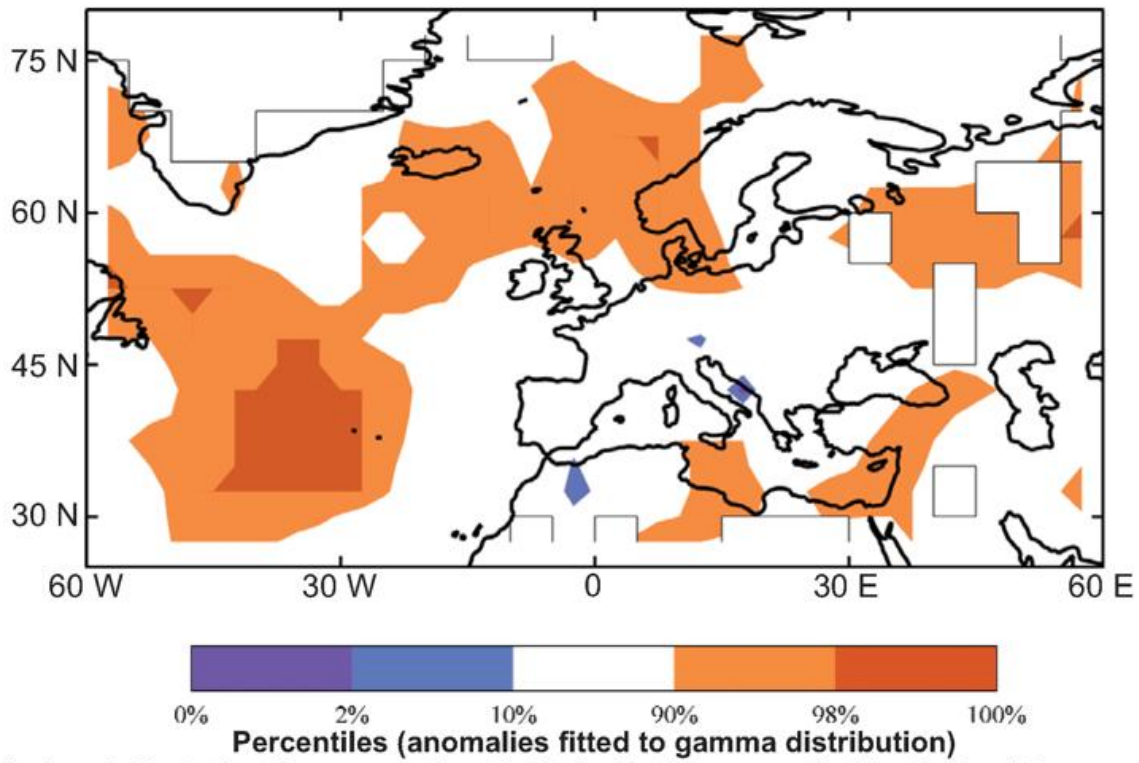
Surface temperature anomalies

Reference period: 1961-1990

Source: The Met Office Hadley Centre, U.K.

September 2008 - November 2008





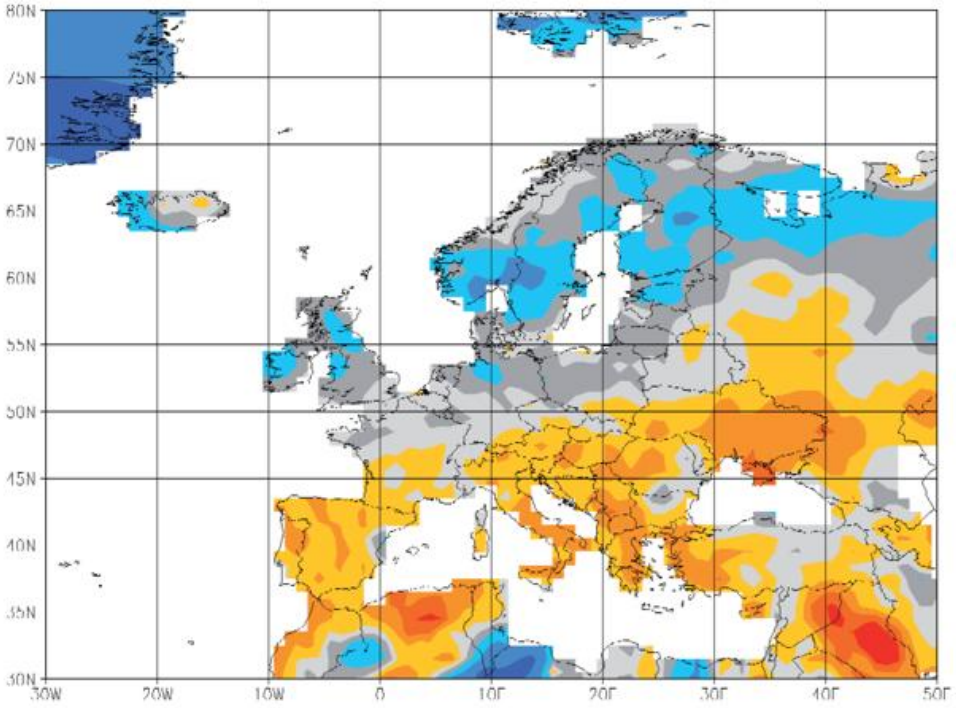
+/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the 159-year record

Precipitation in per cent of normal

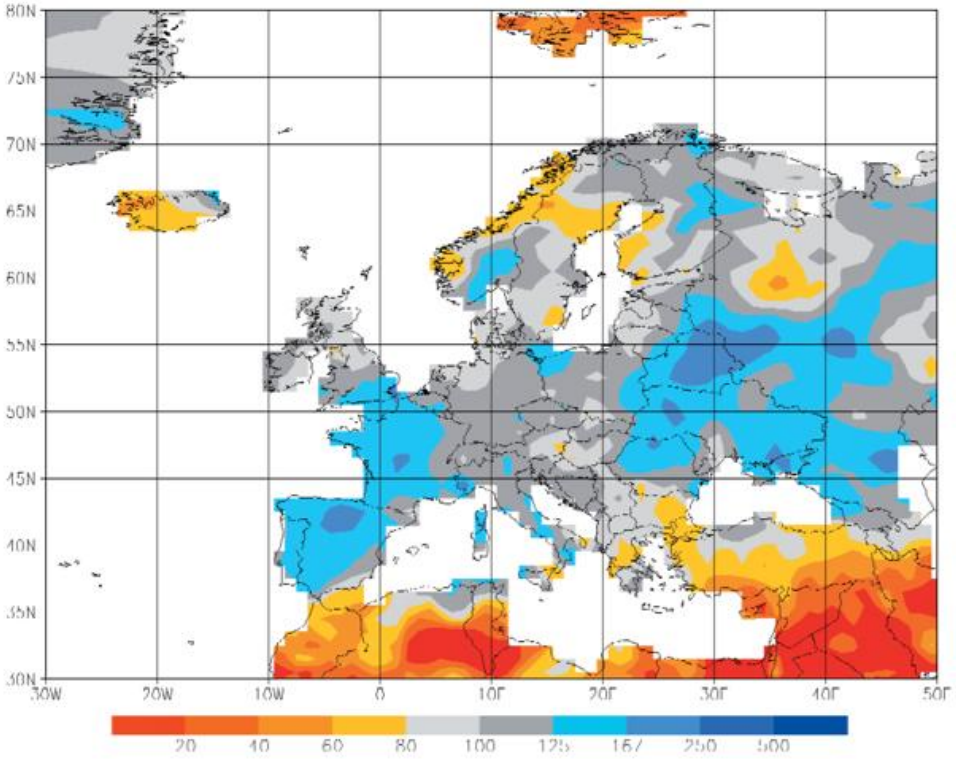
Gauge-based analysis 1.0 degree, reference period: 1951-2000

Source: GPCC / Deutscher Wetterdienst, Germany

December 2007 - February 2008



March 2008 - May 2008

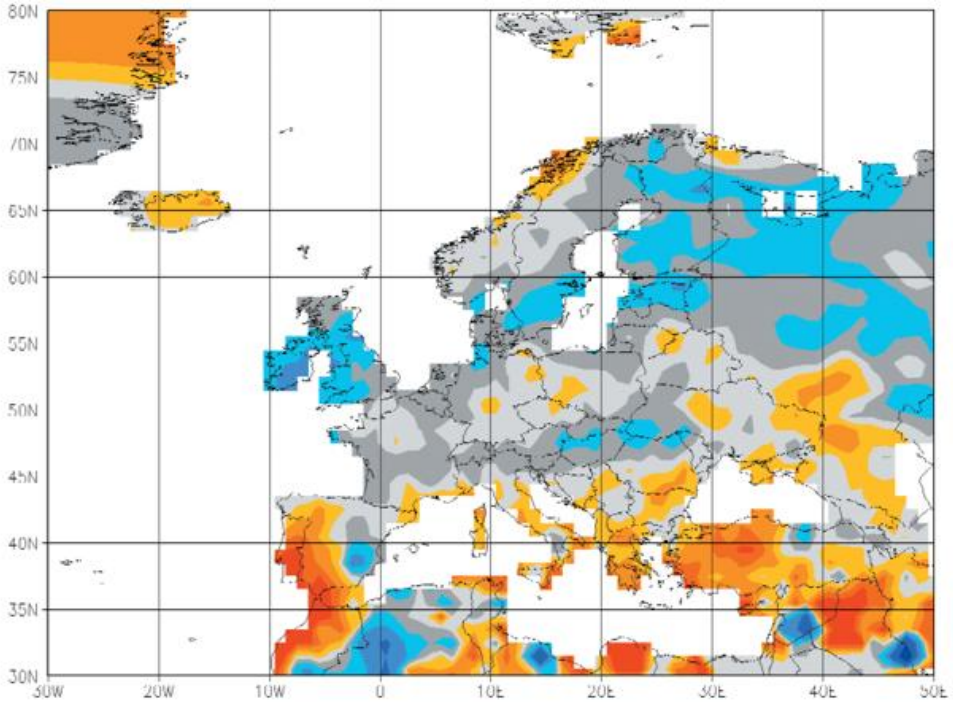


Precipitation in per cent of normal

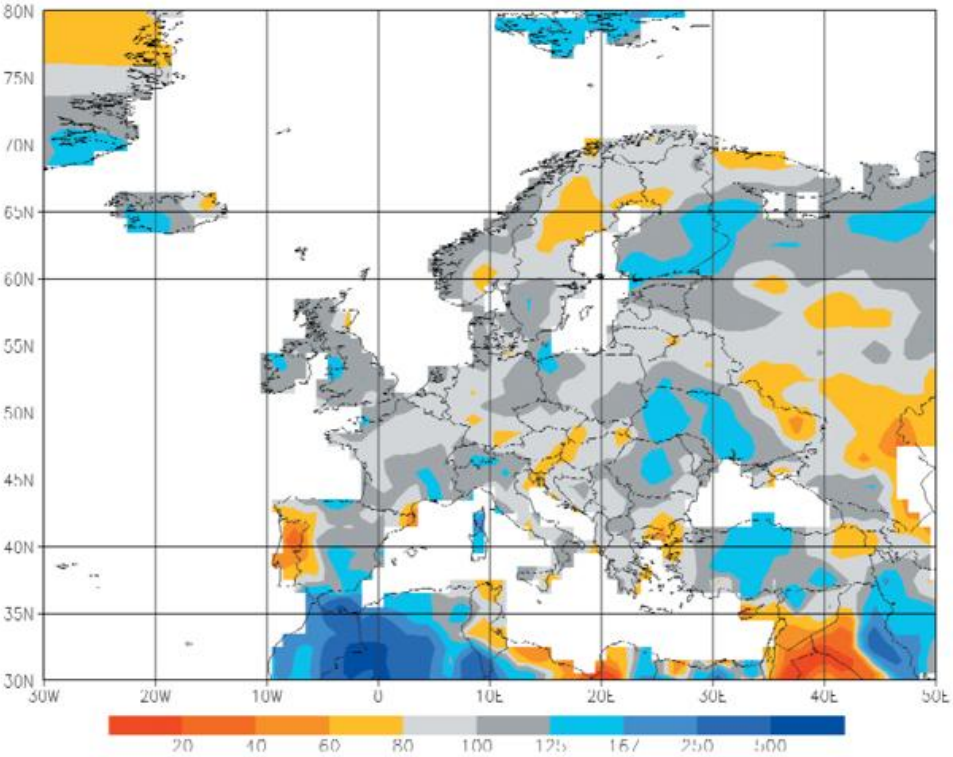
Gauge-based analysis 1.0 degree, reference period: 1951-2000

Source: GPCC / Deutscher Wetterdienst, Germany

June 2008 - August 2008



September 2008 - November 2008



Monthly and Annual Tables

Temperature and precipitation values with deviations from the 1961-1990 means
(some stations have shorter reference periods)

WMO No.	Station	January 2008 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	February 2008 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-7.5	7.9	28	14	-8.9	6.8	11	-8
01025	Tromsø	-1.6	2.4	70	-11	-1.4	2.3	81	-5
01492	Oslo	0.9	5.2	107	58	1.9	5.9	77	41
02196	Haparanda	-5.5	6.6	92	48	-5.7	5.6	45	13
02485	Stockholm	2.2	5.0	69	30	2.9	5.9	23	-4
02974	Helsinki	-0.4	6.5	85	44	0.2	7.0	60	29
03091	Aberdeen	4.3	1.6	116	35	5.8	2.9	20	-31
03772	London	7.8	3.6	69	17	6.7	2.2	15	-20
03967	Dublin Casement Aerodrome	6.5	2.1	111	45	5.9	1.5	19	-32
04030	Réykjavik	-0.2	0.3	78	2	-0.2	-0.6	135	63
04320	Danmarkshavn	-24.6	-1.5	24	13	-16.0	8.3	52	41
04360	Angmagssalik	-7.3	0.2	NIL	NIL	-9.5	-1.8	NIL	NIL
06186	Copenhagen	4.3	3.8	38	-13	5.2	4.7	12	-19
06260	De Bilt	6.5	4.3	96	30	5.1	2.6	39	-10
06447	Brussels	6.5	3.9	71	4	6.1	2.6	35	-18
06590	Luxembourg	3.6	3.6	78	7	4.4	3.3	98	36
06660	Zurich	3.1	3.6	62	-5	3.9	3.0	37	-33
06700	Geneva	3.8	2.8	75	6	3.9	1.4	30	-40
07510	Bordeaux	7.8	2.0	108	8	9.7	2.6	31	-55
07650	Marseilles	9.1	2.4	46	-1	9.3	1.4	38	-16
08222	Madrid	8.0	1.9	25	-21	9.3	1.8	32	-12
08314	Mahón/Minorca	11.9	1.4	33	-33	11.6	0.9	11	-46
08495	Gibraltar	14.6	1.2	70	-51	15.4	1.6	153	53
08515	Santa Maria/Azores	16.3	1.9	47	-53	15.3	1.3	76	-10
08535	Lisbon	13.3	1.9	104	-6	13.8	1.5	170	59
10384	Berlin-Tempelhof	4.0	4.2	103	60	5.1	4.3	16	-18
11035	Vienna	3.4	4.4	41	3	4.4	3.4	10	-32
11518	Prague	2.0	4.4	22	-1	3.5	4.3	13	-10
11903	Sliač	-0.6	3.3	42	-2	0.8	1.9	21	-23
12160	Elblag	1.5	3.9	44	-3	3.6	5.8	36	11
12375	Warsaw	1.1	4.4	68	46	3.1	5.1	28	7
12843	Budapest	1.2	2.8	29	-3	4.5	3.4	1	-31
13274	Belgrade	3.0	2.6	45	-4	6.1	3.4	8	-36
14015	Ljubljana	2.5	3.6	51	-31	4.6	3.2	42	-38
14445	Split	9.4	2.0	54	-29	9.2	1.1	38	-30
14654	Sarajevo	1.7	2.6	28	-43	3.5	2.0	14	-53
15420	Bucharest	-3.1	-0.7	39	-1	2.1	2.2	8	-28
15614	Sofia	-1.6	0.0	27	0	2.7	2.2	1	-32
16206	Grosseto	9.4	2.4	51	-13	8.4	0.4	31	-26
16597	Luqa	14.5	2.3	39	-50	13.3	0.9	62	1
16716	Athens	9.3	-0.9	16	-28	9.3	-1.3	12	-31
16754	Heraklion/Crete	11.7	-0.3	29	-61	11.2	-0.9	72	-5
17040	Rize	3.7	-2.6	277	60	4.6	-2.0	154	-19
17062	Istanbul	4.9	-0.7	43	-56	6.4	0.5	51	-16
17130	Ankara	-4.0	-4.1	20	-27	0.1	-1.8	7	-29
17170	Van	-5.6	-1.4	13	-22	-3.6	-0.2	31	-3
17609	Larnaca	10.6	-0.9	29	-36	12.0	0.3	8	-49
22113	Murmansk	-5.5	6.2	29	-4	-6.6	4.6	24	2
26038	Tallinn	-0.5	5.0	80	35	1.3	7.0	55	26
26629	Kaunas	-0.5	4.5	67	30	2.1	6.4	39	12
26730	Vilnius	-1.6	4.5	61	20	1.0	5.8	50	12
26850	Minsk	-2.6	4.3	43	3	0.5	6.3	36	2
27612	Moscow	-5.8	3.5	33	-12	-1.5	6.2	59	22
33345	Kiev	-3.0	2.6	33	-14	0.6	4.8	14	-32
33815	Kishinev	-1.5	1.8	26	-14	2.3	4.0	6	-32
34300	Kharkiv	-6.4	0.5	23	-21	-1.5	4.2	10	-22
34880	Astrakhan	-9.0	-3.6	6	-7	-4.2	0.7	8	-2
35188	Astana	-21.5	-5.7	5	-12	-13.6	2.3	12	-2
37789	Yerevan	-9.0	-5.5	24	3	-2.1	-1.1	13	-11
40080	Damascus	2.6	-3.3	29	0	7.2	-0.7	7	-17
40199	Eilat	13.3	-1.9	1	-4	16.3	-0.6	<1	-5
40265	Mafraq	4.6	-2.6	57	23	8.3	-0.4	22	-9
60030	L.Palmas/Gran Can.	18.3	0.8	1	-16	18.5	0.9	18	-4

WMO No.	Station	March 2008 Temp. mean	March 2008 (°C) dev.	March 2008 Prec. total	March 2008 (mm) dev.	April 2008 Temp. mean	April 2008 (°C) dev.	April 2008 Prec. total	April 2008 (mm) dev.
01008	Svalbard Airport	-14.7	0.0	5	-16	-10.5	1.2	8	-4
01025	Tromsø	-3.2	-1.0	26	-38	0.0	-0.7	75	15
01492	Oslo	0.9	1.1	76	30	6.7	2.1	67	25
02196	Haparanda	-5.7	1.1	47	12	0.7	1.2	48	19
02485	Stockholm	1.7	1.6	41	15	7.4	2.8	28	-2
02974	Helsinki	-0.6	2.3	46	12	6.3	3.4	42	5
03091	Aberdeen	4.6	0.1	58	0	6.5	0.2	86	33
03772	London	7.3	0.8	70	23	9.4	0.5	63	18
03967	Dublin Casement Aerodrome	5.9	-0.1	99	50	7.7	-0.1	33	-14
04030	Réykjavik	0.8	0.3	51	-31	3.9	1.0	22	-36
04320	Danmarkshavn	-24.5	-1.1	22	5	-20.0	-2.7	5	-5
04360	Angmagssalik	-5.5	2.7	61	-27	-1.2	2.9	17	-56
06186	Copenhagen	4.2	1.6	45	3	8.4	1.8	33	-9
06260	De Bilt	5.9	0.9	92	29	8.9	0.9	34	-18
06447	Brussels	6.3	0.8	141	87	9.3	0.5	45	-12
06590	Luxembourg	4.5	0.5	123	53	7.7	0.2	72	11
06660	Zurich	4.7	0.5	93	24	7.9	0.1	184	97
06700	Geneva	6.0	0.7	79	-2	9.2	0.2	144	78
07510	Bordeaux	9.4	0.6	102	26	11.7	0.4	77	5
07650	Marseilles	10.7	0.5	17	-27	14.1	0.9	60	12
08222	Madrid	10.9	0.9	6	-27	14.0	1.8	66	12
08314	Mahón/Minorca	11.8	0.2	108	53	14.7	1.4	14	-36
08495	Gibraltar	15.7	0.7	67	-8	16.7	0.5	94	34
08515	Santa Maria/Azores	15.6	1.0	64	-15	15.6	0.4	122	67
08535	Lisbon	13.9	0.2	45	-24	16.6	1.5	151	87
10384	Berlin-Tempelhof	4.9	0.7	60	23	8.9	0.3	70	29
11035	Vienna	6.4	1.4	57	16	10.9	1.0	61	10
11518	Prague	3.8	0.8	25	-3	8.1	0.4	56	18
11903	Sliač	3.7	0.7	77	35	9.7	1.2	40	-7
12160	Elblag	3.6	1.5	62	27	8.4	1.6	37	-5
12375	Warsaw	3.8	1.8	39	11	9.4	1.6	28	-4
12843	Budapest	6.8	1.2	67	38	12.1	1.0	38	0
13274	Belgrade	9.2	2.0	80	30	13.8	1.4	35	-24
14015	Ljubljana	6.2	0.8	163	65	10.7	0.8	121	12
14445	Split	11.5	1.1	81	6	14.7	0.8	81	15
14654	Sarajevo	6.0	0.9	138	68	10.3	0.9	61	-13
15420	Bucharest	7.8	3.0	9	-29	12.4	1.1	81	35
15614	Sofia	7.6	3.0	31	-7	12.5	2.6	79	29
16206	Grosseto	10.2	0.0	60	-12	13.5	0.8	38	-31
16597	Luqa	14.9	1.5	53	12	17.4	1.9	4	-19
16716	Athens	14.5	1.9	49	8	16.9	0.8	69	44
16754	Heraklion/Crete	16.0	2.6	6	-50	18.3	2.0	42	12
17040	Rize	11.6	3.7	76	-71	14.6	3.0	37	-65
17062	Istanbul	11.9	4.4	78	16	15.4	3.4	21	-28
17130	Ankara	10.1	4.1	55	19	13.9	2.7	33	-15
17170	Van	5.8	4.9	31	-12	10.5	3.2	25	-29
17609	Larnaca	16.8	3.5	3	-46	19.1	1.7	5	-6
22113	Murmansk	-6.8	0.0	30	10	-2.0	-0.1	19	-2
26038	Tallinn	0.7	2.9	61	32	6.4	3.0	28	-8
26629	Kaunas	2.5	2.7	61	29	8.8	2.8	32	-11
26730	Vilnius	1.8	2.4	63	24	8.9	3.2	63	17
26850	Minsk	1.7	3.1	75	33	9.1	3.1	71	29
27612	Moscow	1.8	4.0	56	22	9.4	3.6	51	11
33345	Kiev	4.6	3.9	36	-3	10.7	2.0	123	74
33815	Kishinev	7.2	4.3	36	1	11.0	0.8	48	6
34300	Kharkiv	5.3	5.6	47	20	11.2	2.3	98	62
34880	Astrakhan	7.1	5.8	6	-8	13.2	2.1	19	1
35188	Astana	0.2	8.3	48	34	6.6	1.7	21	-1
37789	Yerevan	11.0	5.2	14	-18	16.1	3.4	8	-29
40080	Damascus	15.5	4.5	<1	-17	19.0	3.5	0	-11
40199	Eilat	23.3	3.3	0	-4	26.2	2.0	0	-4
40265	Mafraq	15.7	4.2	<1	-29	18.5	2.7	0	-10
60030	L.Palmas/Gran Can.	18.9	0.5	<1	-10	21.3	2.6	0	-6

WMO No.	Station	May 2008 Temp. mean	May 2008 (°C) dev.	May 2008 Prec. total (mm)	May 2008 dev.	June 2008 Temp. mean	June 2008 (°C) dev.	June 2008 Prec. total (mm)	June 2008 dev.
01008	Svalbard Airport	-1.9	1.8	5	-1	3.4	1.2	6	-4
01025	Tromsø	4.4	-0.5	84	36	8.5	-0.8	47	-6
01492	Oslo	12.3	1.5	21	-31	15.8	0.6	51	-14
02196	Haparanda	6.6	0.5	36	5	12.3	-0.5	72	31
02485	Stockholm	12.0	1.3	17	-13	16.5	0.9	55	10
02974	Helsinki	11.1	1.2	13	-22	14.5	-0.4	124	80
03091	Aberdeen	10.4	1.4	14	-45	12.5	0.4	89	36
03772	London	15.1	2.6	64	13	16.4	0.7	46	-5
03967	Dublin Casement Aerodrome	12.8	2.3	37	-21	13.3	0.0	70	22
04030	Réykjavik	8.6	2.3	31	-13	10.6	1.6	13	-37
04320	Danmarkshavn	-7.4	-0.8	1	-3	4.0	3.3	4	-1
04360	Angmagssalik	1.5	0.9	109	52	5.2	1.1	12	-40
06186	Copenhagen	13.5	1.5	53	10	16.2	0.1	17	-37
06260	De Bilt	15.7	3.4	33	-28	16.5	1.3	40	-28
06447	Brussels	16.4	3.5	54	-17	16.1	0.4	70	-9
06590	Luxembourg	16.1	4.3	34	-47	17.0	2.1	91	9
06660	Zurich	15.4	3.3	67	-36	17.3	2.1	91	-33
06700	Geneva	15.8	2.6	80	2	18.5	1.8	60	-31
07510	Bordeaux	16.7	2.1	151	74	18.7	0.9	79	23
07650	Marseilles	18.6	1.5	86	44	22.3	1.4	22	-6
08222	Madrid	15.4	-0.6	86	45	21.2	0.5	37	11
08314	Mahón/Minorca	17.8	1.0	99	62	21.1	0.3	43	29
08495	Gibraltar	17.7	-0.8	28	-7	21.4	0.3	0	-11
08515	Santa Maria/Azores	17.7	1.0	68	38	20.7	2.0	30	8
08535	Lisbon	16.7	-0.7	78	39	21.7	1.5	<1	-21
10384	Berlin-Tempelhof	15.6	1.7	6	-50	19.2	1.8	30	-45
11035	Vienna	16.2	1.6	57	-4	20.4	2.5	115	41
11518	Prague	13.8	1.1	54	-23	17.5	1.6	66	-7
11903	Sliač	14.8	1.1	35	-29	18.9	2.3	130	45
12160	Elblag	12.7	-0.2	27	-14	16.7	1.3	70	-24
12375	Warsaw	13.8	0.4	35	-24	18.9	2.3	22	-50
12843	Budapest	17.4	1.4	42	-13	21.2	2.1	101	38
13274	Belgrade	19.0	1.8	61	-10	22.8	2.7	43	-47
14015	Ljubljana	16.8	2.2	94	-28	20.3	2.5	155	0
14445	Split	20.6	2.2	36	-20	24.5	2.3	96	45
14654	Sarajevo	15.4	1.3	57	-25	19.0	2.1	83	-8
15420	Bucharest	16.1	-0.6	37	-33	21.5	1.3	42	-35
15614	Sofia	15.7	1.4	28	-45	19.8	2.1	72	0
16206	Grosseto	17.9	1.0	116	72	21.4	0.8	81	53
16597	Luqa	20.2	1.1	3	-4	23.9	0.9	1	-2
16716	Athens	21.4	0.8	4	-12	27.6	2.5	6	-1
16754	Heraklion/Crete	20.6	0.8	8	-8	24.8	1.3	0	-3
17040	Rize	15.6	-0.2	170	69	20.3	0.4	114	-11
17062	Istanbul	18.2	1.7	11	-20	23.6	2.5	3	-18
17130	Ankara	15.5	-0.1	45	-10	22.1	2.5	10	-27
17170	Van	12.3	-0.5	40	-10	19.5	1.9	2	-19
17609	Larnaca	21.6	0.7	28	21	26.7	2.4	<1	<1
22113	Murmansk	3.0	-0.8	34	2	9.0	-0.4	30	-23
26038	Tallinn	10.2	0.5	14	-23	14.3	-0.2	63	10
26629	Kaunas	12.3	-0.4	36	-20	16.0	0.0	83	8
26730	Vilnius	11.4	-1.1	104	42	15.8	0.0	70	-7
26850	Minsk	11.3	-1.6	104	42	16.4	0.3	40	-43
27612	Moscow	11.3	-1.6	68	10	15.6	-1.0	76	0
33345	Kiev	14.3	-0.8	38	-15	18.8	0.6	100	27
33815	Kishinev	15.5	-0.6	43	-8	20.9	1.5	63	-12
34300	Kharkiv	13.7	-1.9	37	-10	18.8	-0.1	42	-16
34880	Astrakhan	17.4	-0.9	30	6	22.5	-0.4	27	5
35188	Astana	15.7	2.6	53	20	20.1	1.1	15	-20
37789	Yerevan	15.8	-1.7	58	15	21.3	-0.6	41	20
40080	Damascus	20.7	0.5	0	-4	26.9	2.5	0	0
40199	Eilat	28.5	0.1	<1	<1	33.4	1.7	0	0
40265	Mafraq	19.6	-0.2	0	-3	24.6	1.9	0	0
60030	L.Palmas/Gran Can.	20.9	1.0	2	0	22.2	0.8	0	0

WMO No.	Station	July 2008 Temp. mean	July 2008 (°C) dev.	July 2008 Prec. total (mm)	July 2008 dev.	August 2008 Temp. mean	August 2008 (°C) dev.	August 2008 Prec. total (mm)	August 2008 dev.
01008	Svalbard Airport	6.2	0.2	24	11	5.0	0.2	21	-4
01025	Tromsø	10.9	-0.8	48	-24	9.9	-1.0	35	-47
01492	Oslo	18.3	1.9	149	65	15.2	0.0	180	90
02196	Haparanda	15.2	-0.3	79	29	12.2	-1.1	96	33
02485	Stockholm	18.8	1.6	37	-35	16.0	-0.2	154	88
02974	Helsinki	17.3	0.7	24	-49	14.8	-0.2	82	2
03091	Aberdeen	14.9	1.1	57	-3	14.6	1.0	100	25
03772	London	18.2	0.4	77	31	17.9	0.5	64	13
03967	Dublin Casement Aerodrome	15.4	0.5	102	48	15.5	0.9	172	94
04030	Réykjavik	12.5	1.9	51	-1	11.5	1.2	82	20
04320	Danmarkshavn	5.4	1.7	NIL	NIL	4.4	2.0	10	-4
04360	Angmagssalik	NIL	NIL	NIL	NIL	7.1	1.1	30	-31
06186	Copenhagen	18.8	1.6	30	-39	17.8	0.8	144	81
06260	De Bilt	18.1	1.3	127	52	17.4	0.7	114	43
06447	Brussels	18.0	0.5	102	27	17.6	0.3	89	26
06590	Luxembourg	18.1	1.2	85	17	17.2	0.8	64	-8
06660	Zurich	18.4	0.8	137	20	17.7	1.0	174	41
06700	Geneva	20.0	0.7	113	45	19.3	0.9	91	11
07510	Bordeaux	20.3	0.1	20	-27	19.9	0.0	83	29
07650	Marseilles	24.4	0.6	4	-10	24.3	1.1	1	-28
08222	Madrid	25.0	0.6	<1	-13	25.7	1.8	<1	-9
08314	Mahón/Minorca	24.2	0.0	<1	-4	24.9	0.4	1	-25
08495	Gibraltar	25.1	1.4	1	0	25.6	1.4	0	-6
08515	Santa Maria/Azores	21.9	1.1	19	-6	23.2	1.0	9	-31
08535	Lisbon	22.2	-0.2	<1	-5	21.8	-1.0	<1	-6
10384	Berlin-Tempelhof	20.1	1.3	27	-25	19.1	0.7	52	-9
11035	Vienna	20.4	0.7	96	33	20.1	1.2	43	-15
11518	Prague	18.3	0.8	74	8	18.2	1.2	68	-2
11903	Sliač	19.3	1.1	114	55	19.3	2.0	24	-45
12160	Elblag	18.0	1.2	91	-3	17.7	1.0	156	75
12375	Warsaw	19.4	1.5	88	21	18.7	1.4	87	24
12843	Budapest	21.5	0.6	125	73	21.8	1.5	38	-13
13274	Belgrade	23.5	1.8	53	-13	24.0	2.7	46	-6
14015	Ljubljana	21.4	1.5	188	66	20.7	1.6	176	32
14445	Split	27.0	1.6	20	-8	27.0	1.8	20	-30
14654	Sarajevo	20.1	1.2	101	22	20.6	2.1	41	-30
15420	Bucharest	22.4	0.4	50	-14	24.1	2.9	9	-49
15614	Sofia	21.2	1.2	68	12	23.0	3.6	10	-42
16206	Grosseto	24.4	0.8	5	-15	24.8	1.3	30	-7
16597	Luqa	26.7	0.8	<1	<1	26.9	0.6	0	-7
16716	Athens	29.6	1.8	<1	-5	30.0	2.4	2	-3
16754	Heraklion/Crete	27.2	1.5	0	-1	26.9	1.3	0	-1
17040	Rize	23.7	1.5	205	71	25.0	2.8	120	-66
17062	Istanbul	24.9	1.7	38	19	26.2	3.2	<1	-26
17130	Ankara	25.0	2.1	0	-14	26.7	4.1	<1	-12
17170	Van	22.7	0.8	11	7	23.9	2.7	7	3
17609	Larnaca	28.2	1.3	2	2	28.8	1.7	1	1
22113	Murmansk	11.9	-0.9	65	5	9.0	-2.0	57	-8
26038	Tallinn	16.7	0.4	61	-18	15.4	0.1	126	42
26629	Kaunas	18.1	1.0	43	-25	17.9	1.6	99	36
26730	Vilnius	17.8	0.9	57	-21	17.6	1.3	55	-17
26850	Minsk	18.1	0.8	90	2	18.3	1.8	63	-9
27612	Moscow	19.1	1.0	181	89	17.5	1.1	115	41
33345	Kiev	20.8	1.5	84	-4	21.6	3.0	27	-42
33815	Kishinev	22.2	1.3	51	-18	23.7	3.2	31	-14
34300	Kharkiv	21.8	1.5	47	-13	22.3	2.8	30	-20
34880	Astrakhan	26.2	0.9	24	1	25.1	1.8	7	-12
35188	Astana	23.2	1.9	69	19	19.9	2.2	47	7
37789	Yerevan	25.9	-0.1	2	-8	26.5	1.3	13	6
40080	Damascus	28.0	1.7	0	0	28.4	2.4	0	0
40199	Eilat	34.4	1.5	0	0	34.7	1.9	0	0
40265	Mafraq	25.4	1.3	0	0	26.3	2.1	0	0
60030	L.Palmas/Gran Can.	23.6	0.3	0	0	24.1	0.0	0	0

WMO No.	Station	September 2008 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	October 2008 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	3.3	2.8	36	13	-5.7	-0.2	22	7
01025	Tromsø	7.0	0.2	98	4	3.9	1.0	40	-85
01492	Oslo	10.8	0.0	52	-38	6.8	0.4	124	40
02196	Haparanda	7.2	-0.7	23	-40	3.4	0.9	79	15
02485	Stockholm	11.4	0.2	27	-28	8.4	0.9	64	14
02974	Helsinki	9.8	-0.2	48	-25	8.3	2.9	166	93
03091	Aberdeen	12.5	0.8	42	-26	8.5	-1.4	62	-15
03772	London	14.8	-0.2	43	-8	11.1	-0.6	45	-13
03967	Dublin Casement Aerodrome	12.4	-0.6	124	55	8.8	-1.5	112	44
04030	Réykjavik	9.4	2.0	174	107	2.8	-1.6	78	-8
04320	Danmarkshavn	-1.5	2.7	23	12	-12.6	1.0	NIL	NIL
04360	Angmagssalik	4.8	1.7	155	87	-0.3	0.5	45	-37
06186	Copenhagen	14.0	0.4	24	-38	10.2	0.3	57	-2
06260	De Bilt	13.6	-0.4	100	33	10.1	-0.4	92	20
06447	Brussels	14.0	-0.5	71	12	10.5	-0.4	72	2
06590	Luxembourg	12.4	-1.0	116	46	9.1	0.0	73	-2
06660	Zurich	12.3	-1.5	117	25	10.0	0.7	148	79
06700	Geneva	14.1	-1.0	215	133	11.2	0.9	87	9
07510	Bordeaux	16.5	-1.4	66	-8	13.0	-1.0	90	2
07650	Marseilles	19.8	-0.5	36	-11	16.0	-0.1	85	7
08222	Madrid	19.8	-0.7	58	28	14.6	-0.2	99	54
08314	Mahón/Minorca	21.8	-0.4	95	41	19.1	0.6	103	19
08495	Gibraltar	22.3	-0.5	127	112	19.5	0.0	130	66
08515	Santa Maria/Azores	21.9	0.5	13	-44	20.8	1.5	13	-71
08535	Lisbon	20.7	-1.0	36	10	17.9	-0.6	62	-18
10384	Berlin-Tempelhof	13.9	-0.7	88	42	10.0	0.0	68	32
11035	Vienna	14.5	-0.6	62	17	10.6	0.7	24	-17
11518	Prague	12.8	-0.5	18	-22	8.6	0.3	46	16
11903	Sliač	13.7	0.3	36	-20	9.9	1.6	64	14
12160	Elblag	12.5	-0.2	19	-51	9.1	0.2	80	27
12375	Warsaw	12.8	-0.4	61	18	10.1	1.8	15	-23
12843	Budapest	15.6	-0.8	55	15	12.3	1.4	23	-11
13274	Belgrade	17.1	-0.6	68	17	14.8	2.4	18	-22
14015	Ljubljana	15.1	-0.4	34	-96	12.0	1.6	97	-18
14445	Split	20.8	-0.6	31	-30	18.1	1.2	19	-60
14654	Sarajevo	13.9	-1.2	85	15	12.0	1.6	60	-28
15420	Bucharest	16.0	-0.9	52	10	11.4	0.6	26	-6
15614	Sofia	15.6	-0.2	71	32	11.8	1.4	41	4
16206	Grosseto	19.5	-0.9	72	7	17.3	1.2	53	-34
16597	Luqa	24.6	0.5	88	48	21.1	0.4	61	-29
16716	Athens	24.2	0.0	37	27	19.8	0.5	5	-47
16754	Heraklion/Crete	24.1	1.0	22	4	20.6	0.9	<1	-76
17040	Rize	21.6	2.2	349	126	17.0	1.6	219	-54
17062	Istanbul	21.2	1.5	101	60	17.2	1.9	112	41
17130	Ankara	19.9	1.6	62	43	13.4	0.8	19	-8
17170	Van	18.3	1.5	45	35	11.0	0.9	58	10
17609	Larnaca	26.0	0.9	9	9	22.2	0.9	17	-2
22113	Murmansk	6.2	-0.5	27	-25	2.6	1.6	47	5
26038	Tallinn	10.5	-0.3	58	-24	8.9	2.6	86	16
26629	Kaunas	12.2	0.1	27	-32	8.7	1.8	70	19
26730	Vilnius	11.9	0.3	31	-34	8.4	1.8	60	7
26850	Minsk	11.8	0.1	51	-9	8.5	2.2	65	16
27612	Moscow	10.9	0.0	70	6	8.9	3.9	63	5
33345	Kiev	13.5	-0.4	151	104	10.7	2.6	18	-17
33815	Kishinev	15.5	-0.7	75	27	12.4	2.3	16	-11
34300	Kharkiv	14.1	0.0	38	-3	10.4	3.1	24	-11
34880	Astrakhan	16.9	-0.4	12	-14	11.5	2.4	7	-10
35188	Astana	10.5	-1.5	31	7	6.1	3.3	21	-9
37789	Yerevan	21.9	1.2	53	43	15.0	1.8	11	-16
40080	Damascus	25.4	2.2	0	0	19.8	1.7	10	-2
40199	Eilat	32.3	1.9	0	0	26.7	0.0	2	-2
40265	Mafraq	24.3	1.6	<1	<1	19.3	0.2	4	-3
60030	L.Palmas/Gran Can.	23.2	-0.6	17	9	21.9	-0.6	18	8

WMO No.	Station	November 2008 Temp. mean	(°C) dev.	Prec. (mm) total	dev.	December 2008 Temp. mean	(°C) dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	-8.6	1.9	7	-6	-8.0	5.3	28	16
01025	Tromsø	-0.2	0.6	80	-24	0.0	3.0	71	-33
01492	Oslo	2.1	1.4	71	-4	-1.2	1.6	31	-25
02196	Haparanda	-3.3	0.8	58	0	-1.9	7.6	43	1
02485	Stockholm	3.3	0.7	63	10	1.5	2.5	50	4
02974	Helsinki	2.5	2.4	105	33	0.4	4.5	54	-4
03091	Aberdeen	5.7	0.7	59	-16	4.1	0.6	107	34
03772	London	8.2	1.0	59	4	4.6	-0.5	41	-16
03967	Dublin Casement Aerodrome	6.7	0.0	54	-16	4.2	-1.1	53	-24
04030	Réykjavik	2.8	1.7	93	20	1.1	1.3	124	45
04320	Danmarkshavn	-18.1	1.8	5	-5	-19.0	2.8	37	24
04360	Angmagssalik	-2.8	1.9	71	-25	-4.1	3.1	143	40
06186	Copenhagen	6.5	1.0	39	-23	3.3	1.1	44	-14
06260	De Bilt	6.9	1.0	91	10	2.4	-0.8	24	-56
06447	Brussels	6.9	0.8	68	-8	2.8	-0.7	43	-33
06590	Luxembourg	5.0	1.2	48	-35	0.9	-0.1	52	-28
06660	Zurich	4.3	0.4	32	-50	0.5	-0.1	72	-1
06700	Geneva	6.3	1.3	44	-48	1.6	-0.2	118	31
07510	Bordeaux	9.0	-0.1	131	37	5.6	-0.8	74	-25
07650	Marseilles	10.3	-0.4	138	80	7.1	-0.2	109	53
08222	Madrid	7.9	-1.5	8	-56	6.3	-0.1	45	-6
08314	Mahón/Minorca	13.5	-0.9	156	79	10.5	-1.3	81	7
08495	Gibraltar	14.5	-1.6	183	42	12.8	-1.3	176	30
08515	Santa Maria/Azores	17.7	0.3	52	-50	16.0	0.6	65	-30
08535	Lisbon	13.1	-1.4	48	-66	11.4	-0.4	127	19
10384	Berlin-Tempelhof	6.0	1.1	34	-15	2.0	0.6	35	-18
11035	Vienna	7.2	2.6	60	10	2.6	1.7	39	-4
11518	Prague	4.5	1.7	23	-9	1.0	1.6	29	3
11903	Sliač	5.0	2.0	40	-29	1.4	3.1	90	33
12160	Elblag	4.7	1.4	45	-11	1.0	0.7	24	-28
12375	Warsaw	5.2	2.0	29	-13	1.3	2.2	37	5
12843	Budapest	6.9	2.1	34	-18	3.0	2.6	63	23
13274	Belgrade	9.2	2.2	51	-3	4.6	2.3	79	21
14015	Ljubljana	6.4	1.8	128	-7	2.0	2.0	225	124
14445	Split	13.4	1.2	160	52	9.8	1.1	134	34
14654	Sarajevo	7.2	2.4	91	0	3.3	3.5	76	12
15420	Bucharest	5.5	0.3	26	-23	1.9	1.7	21	-22
15614	Sofia	6.2	1.2	22	-25	2.5	2.0	36	-3
16206	Grosseto	12.2	1.0	180	86	8.0	0.1	176	111
16597	Luqa	17.9	0.9	86	6	14.6	0.8	103	-9
16716	Athens	16.4	0.9	26	-24	12.2	0.0	63	-8
16754	Heraklion/Crete	17.7	1.1	19	-40	14.5	0.7	87	13
17040	Rize	13.4	1.8	173	-77	8.1	-0.2	280	42
17062	Istanbul	13.5	1.9	51	-38	9.3	1.2	95	-27
17130	Ankara	8.8	1.7	44	11	2.0	-0.5	29	-20
17170	Van	4.9	0.9	21	-23	-1.8	-0.7	37	3
17609	Larnaca	19.0	2.6	34	-10	14.1	0.9	39	-37
22113	Murmansk	-4.0	1.1	23	-17	-2.7	6.6	21	-17
26038	Tallinn	3.1	1.9	88	20	0.4	3.3	38	-17
26629	Kaunas	3.3	1.2	30	-23	0.3	2.7	49	5
26730	Vilnius	2.3	1.1	34	-23	-0.2	2.7	43	-12
26850	Minsk	1.9	1.1	30	-22	-0.9	2.9	24	-29
27612	Moscow	2.3	3.4	47	-11	-1.8	4.3	52	0
33345	Kiev	3.5	1.4	41	-10	-0.7	1.6	77	25
33815	Kishinev	5.1	0.7	16	-23	1.2	1.5	54	16
34300	Kharkiv	3.2	1.9	28	-16	-2.7	0.7	17	-28
34880	Astrakhan	5.2	1.9	2	-17	-3.0	-1.1	19	4
35188	Astana	-0.9	5.0	20	-2	-11.4	1.2	21	4
37789	Yerevan	8.2	1.7	9	-13	0.4	0.2	32	9
40080	Damascus	13.1	1.3	7	-15	7.2	0.0	16	-10
40199	Eilat	22.6	1.1	0	-3	18.3	1.7	0	-6
40265	Mafraq	14.5	1.0	3	-14	9.6	0.8	11	-17
60030	L.Palmas/Gran Can.	19.1	-1.3	6	-15	17.4	-0.9	38	17

WMO No.	Station	Year 2008 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-4.0	2.4	201	18
01025	Tromsø	3.2	0.4	755	-218
01492	Oslo	7.5	1.8	1006	237
02196	Haparanda	3.0	1.8	718	166
02485	Stockholm	8.5	1.9	628	89
02974	Helsinki	7.0	2.5	849	198
03091	Aberdeen	8.7	0.8	810	27
03772	London	11.5	0.9	656	57
03967	Dublin Casement Aerodrome	9.6	0.3	986	251
04030	Réykjavik	5.3	1.0	932	131
04320	Danmarkshavn	-10.8	1.5	NIL	NIL
04360	Angmagssalik	NIL	NIL	NIL	NIL
06186	Copenhagen	10.2	1.6	536	-100
06260	De Bilt	10.6	1.2	882	77
06447	Brussels	10.9	1.0	861	61
06590	Luxembourg	9.7	1.3	934	59
06660	Zurich	9.6	1.2	1214	128
06700	Geneva	10.8	1.0	1136	194
07510	Bordeaux	13.2	0.5	1012	89
07650	Marseilles	15.5	0.7	642	97
08222	Madrid	14.8	0.5	462	6
08314	Mahón/Minorca	16.9	0.3	744	146
08495	Gibraltar	18.4	0.2	1029	254
08515	Santa Maria/Azores	18.6	1.1	578	-197
08535	Lisbon	16.9	0.1	821	68
10384	Berlin-Tempelhof	10.7	1.3	589	6
11035	Vienna	11.4	1.7	665	58
11518	Prague	9.3	1.5	494	-32
11903	Sliač	9.7	1.7	713	27
12160	Elblag	9.1	1.5	691	1
12375	Warsaw	9.8	2.0	537	18
12843	Budapest	12.0	1.6	616	98
13274	Belgrade	13.9	2.1	587	-97
14015	Ljubljana	11.6	1.8	1474	81
14445	Split	17.2	1.3	770	-55
14654	Sarajevo	11.1	1.6	835	-83
15420	Bucharest	11.5	0.9	400	-195
15614	Sofia	11.4	1.7	486	-77
16206	Grosseto	15.6	0.7	893	191
16597	Luqa	19.7	1.1	500	-53
16716	Athens	19.3	0.8	289	-80
16754	Heraklion/Crete	19.5	1.0	285	-216
17040	Rize	14.9	1.0	2174	5
17062	Istanbul	16.1	1.9	604	-93
17130	Ankara	12.8	1.1	324	-89
17170	Van	9.8	1.2	321	-60
17609	Larnaca	20.4	1.3	175	-153
22113	Murmansk	1.2	1.3	406	-72
26038	Tallinn	7.3	2.2	758	91
26629	Kaunas	8.5	2.0	636	28
26730	Vilnius	7.9	1.9	691	8
26850	Minsk	7.8	2.0	692	15
27612	Moscow	7.3	2.4	871	183
33345	Kiev	9.6	1.9	742	93
33815	Kishinev	11.3	1.7	465	-82
34300	Kharkiv	9.2	1.7	441	-78
34880	Astrakhan	10.7	0.8	167	-53
35188	Astana	4.6	1.9	363	45
37789	Yerevan	12.6	0.5	278	1
40080	Damascus	17.8	1.4	69	-76
40199	Eilat	25.8	1.1	3	-28
40265	Mafraq	17.6	1.1	97	-62
60030	L.Palmas/Gran Can.	20.8	0.3	100	-17

Monthly Surveys

January

- **Very mild in most of Europe, cold in Greenland and the Middle East**
- **Wet in the north, dry in the south**

Atmospheric circulation characteristics

Due to both, an unusually strong Icelandic low and Azores high, mild Atlantic air masses passed Europe within a southwesterly flow and were accelerated even up to the northernmost sea areas. A colder Arctic air mass remained stagnant over Greenland.

A number of Atlantic low pressure systems passed across northern and northern central Europe, causing high amounts of precipitation. A few heavy storms occurred too.

Most of the time, the southern half of the Region was under high pressure influence, except a few local low pressure systems. Especially the Middle East was affected by an unusually strong Siberian high and cold continental arctic air masses, some of which extended far southwards.

Temperature

January 2008 was very mild over nearly the whole of Europe. Temperature anomalies exceeded +4°C in the northern, eastern and central parts of the continent (Fig. 1.1), +6°C in Sweden, Finland and northern Russia and amounted to nearly +8°C in Svalbard and up to almost +10°C at the northeastern-most coast of the Region.

Daily temperatures showed large variations in northeastern Europe. The first third of the month was cold (e.g. minima down to -18°C in Lithuania) whereas it was very mild at the end.

Mean temperatures were more than +3°C above normal in parts of the United Kingdom (in the Midlands and East Anglia). A local maximum temperature of 15.2°C was recorded on 20 January at a station in Herefordshire (Preston Wynne).

Central Europe was also very mild. With a mean temperature of 6.5°C (+3.7°C anomaly), January 2008 was the second mildest January (behind 2007) in the Netherlands since the start of regular temperature measurements at the station De Bilt in 1706. Monthly averages in France were up to +4°C warmer than normal in the northeast (same as in Germany). In the middle of the month, maximum temperatures of more than 10°C were recorded on several days for large parts of central Europe, with record values of up to 15°C near the Rhine River. Sea surface temperatures in the German North Sea reached 5-6°C, in the German Baltic Sea 4-5°C. Poland was up to +3°C warmer than normal in the west of the country.

The northern Alpine region profited from high temperatures due to several south foehn events. Southern upper and lower Austria recorded highest monthly mean anomalies of up to +4.5°C. Only the first 5 days of the month were very cold, then it was mild for the rest of the month.

January was also a particularly warm month throughout Iberia. In Portugal, the anomaly amounted to +1.5°C making January 2008 the second warmest January since 1931. Averaged over continental Spain, January mean temperatures were 1.7°C above the 1971-2000 average. Southern Spain reached temperatures of about 22-23°C around 20 January. Italy had monthly anomalies which mainly ranged between +1.5 and +2.5°C, in some northwestern parts even up to +4.5°C due to a warm spell in the last week of the month.

January was also unusually mild in eastern and some parts of southeastern Europe. Anomalies exceeded +4°C in northern Slovenia and the northern and central parts of Croatia. An exceptionally low number of freezing days was recorded in the mountainous areas of Serbia. It was cold in Macedonia at the beginning of the year, but the second half of January became mild with maximum temperatures exceeding 10°C and minima frequently above the freezing point. Russia recorded its mildest January in Moscow in 130 years.

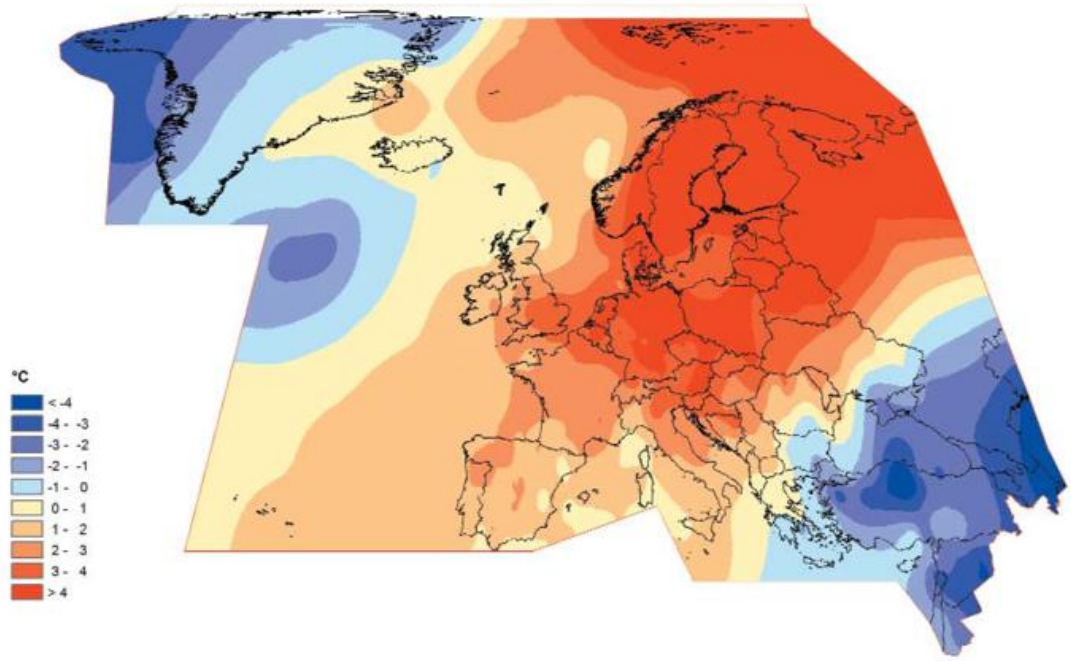


Fig. 1.1: *Monthly mean temperature anomalies in January 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

There were only two large areas where the temperatures were colder than normal: Greenland with the central Atlantic and the Middle East. Especially western Greenland and the nearby Atlantic areas were very cold. On early morning of 29 January, the station Eismitte in Greenland (3207 m altitude) recorded -54°C.

The whole Middle East and some southeastern parts of Europe also experienced a cold start of the year with monthly mean anomalies locally going down to -4°C and even down to -8° or -10°C in parts of Turkey, Armenia and Azerbaijan. Minimum temperatures below -24°C were measured in the interior parts of Bulgaria. Greece also recorded unusually low minimum temperatures in many places during a cold spell from 03-05 January. Turkey had frost at the end of the month in Izmir, causing damage to vegetables. Some places in Turkey experienced their coldest January nights in nearly 50 years; night temperatures dropped down to -34°C in eastern Turkey. Monthly mean temperatures across Cyprus were around 1°C below normal, with widespread ground frost during the first half of the month causing damage to crops. Severe frost was also reported from southern Israel and Jordan; temperatures dropped below 0°C even in the coastal plain. The frost period lasted 4-6 days; it was the longest since at least 1964 and caused extensive damage to agriculture, especially vegetable crops in many places in Israel. In most parts of the country, it was the coldest winter month since 1992. In Syria's capital Damascus (station 611 m above sea level) night-time temperatures fell below -10°C in mid-January, and Jordan recorded its lowest 2008 minimum temperature at -10°C on 10 January. Further east, parts of Georgia also experienced one of their coldest nights in 10 years, again with temperatures dropping to -10°C in the capital Tbilisi and to -25°C in mountainous areas.

An unprecedented prolonged cold spell was reported on 08-24 January all over Armenia with extremely low temperatures due to the invasion of an arctic cold air mass from the northeast. With -33.6°C on 13 January, the town Tashir in the north of Armenia set a new monthly minimum record. The surface of Lake Sevan was completely covered with ice (Fig. 1.2) by 14 January which is the earliest date of freezing of the lake water ever reported. The extremely low temperatures also caused freezing of fruit trees in the Ararat Valley. In Azerbaijan, Baku registered its lowest temperature in 100 years on January 7-8. January was also very cold in west Kazakhstan (monthly mean temperatures between -8 and -11°C, anomalies between -3 and -5°C) and southern European Russia. Daily minimum temperatures between -25 and -28°C were measured in the south Russian region between the Caucasus Mountains and Volgograd.



Fig. 1.2: *The entire surface of Lake Sevan (Armenia) became completely covered with ice by 14 January 2008.*
Source: Armstatehydromet, Armenia

Precipitation

January 2008 was wetter than normal in almost all parts of northern and northern central Europe, with locally more than twice the normal amounts (Fig. 1.3). The southwestern Norwegian coastal areas received monthly totals above 300 mm, the western parts of the United Kingdom and Ireland totals of more than 200 mm. In parts of northern England and southern Scotland, monthly precipitation exceeded the normal average by 150%. It was the wettest January in eastern Scotland and the second wettest in Northern Ireland since 1914. Poland was also exceptionally wet with monthly totals of over 300% in eastern and central parts of the country. The northern Norwegian coast, on the contrary, received by far less precipitation than normal.

On various occasions, there was also freezing rain in central Europe, causing hundreds of traffic accidents e.g. in Germany.

Most of the southern half of Europe was quite dry. Less than 60% of the normal precipitation was registered in many parts of this area. Southeastern Austria recorded less than 25% of normal January precipitation. Some parts of northern Croatia, including Zagreb, received less

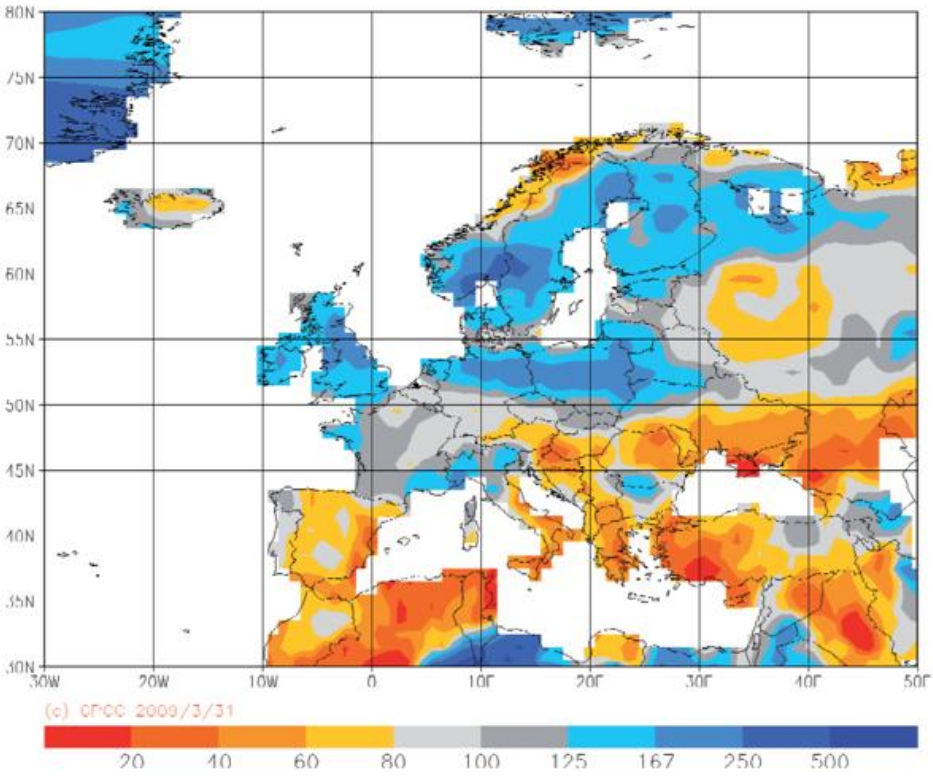


Fig. 1.3: *Monthly precipitation amounts for January 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

than 20% of normal. Locally, the monthly total was less than 10 mm in some southern countries, e.g. at the southeastern coast of Spain, Greece, western Kazakhstan and the plains of eastern Georgia.

A few areas in the south, e.g. in the western Alps and southeastern France, however, recorded high precipitation due to a Genoa low on 11-12 January. In these parts, monthly precipitation totals exceeded 100 mm, mostly caused by the said event. Parts of northern Italy also received high rainfall amounts, e.g. Pisa 152 mm (203% of the 1961-1990 normal). Jordan reported a local monthly total of 141.9 mm in Rass Munef.

Snow

Generally, snow was rare over most of Europe due to the prevailing mild weather. In the north, Iceland did not have much snow although communication was often disrupted due to snowstorms and slippery roads. Parts of northern Russia, the Baltic countries, central and southern Sweden, which normally are completely snow-covered in January, were without snow in the middle of the month. Western Europe had hardly any snow in the lowlands during the whole January, and almost everywhere in Germany, there was no snowfall at all in January. Very small amounts of snow fell in the alpine parts of Austria but there was no snow in the eastern lowlands of the country.

On the other hand, some remarkable snow events occurred in the southern and eastern parts of the Region. So, southern France, parts of Italy, and southeast Europe recorded heavy snowfall at the beginning of the month. The alpine south side had several snowfall events due to south foehn events. Poland also had snow, being snow-covered at the beginning of January

with more snowfall events throughout the month. In Serbia, the mountainous areas were snow-covered during the whole month, other areas only during the first half of the month. Due to a snowstorm on 2-3 January, eastern and southeastern Romania was very soon covered by snow up to a depth of 143 cm in the mountains. Another snowstorm affected the mountains in Romania at the end of the month (26-28 January).

The southeast of the Region, which was very cold in January, saw some unusual snowfalls. Heavy snowfall was recorded on 29-30 January in Greece, Turkey and in Cyprus, even at lower altitudes above 100 m. Armenia also received snow well above normal, particularly in the mountain regions. The snow cover on the Aragats Mountain had reached 181 cm by the end of the month. In Georgia, snow fell at the beginning and once more at the end of the month, with a snow depth of up to 50-100 cm in the east Georgian mountain areas and 2.5-4 m in the high mountain regions of the country. Snowfalls even occurred during the last decade of the month in Israel, Syria and Jordan. A snow depth of 65 cm was measured in Jordan and up to 20 cm in Jerusalem. Altogether, snow is very rare in this part of the Region at this time of the year.

Significant weather events

January 02-03:	Southeastern Europe (especially Romania, eastern Bulgaria, southern European Russia) was hit by an intense storm with heavy snowfall. Black Sea harbours and main airports of Romania closed. Strong gusts (Bora) in Novorrossisk, European Russia (Black Sea coast) of over 120 km/h.
January 03-05:	An exceptionally strong and sustaining foehn storm swept over the Alps from the south. Wind gusts exceeded 130 km/h, the temperature rose up to 12°C in typical foehn valleys in Switzerland. The alpine south side experienced snowfalls down to low altitudes.
January 05-07:	Freezing rain caused widespread traffic accidents in Germany.
January 08:	Traffic in Georgia was severely disrupted after the temperature fell to its lowest level in 15 years. Temperature dropped to -10°C in Tbilisi and to -28°C in mountainous areas. Roads were left impassable in some areas due to snowfall.
January 09:	On the morning, a storm developed over Scotland with a central pressure below 965 hPa. Gusts of hurricane force were recorded in southern Scotland and northern Ireland. Malin Head in Ireland recorded the highest gust (168 km/h) of all stations in the country since December 1998.
January 11-12:	Storm due to a Genoa low affected Corsica Island with gusts around 110 km/h and high precipitation amounts in the western Alps and southeastern France.
January 12-13:	Strong snowfalls in the Alps in Switzerland, avalanches in northern Italy.
January 14:	Strong winds up to 100 km/h at the northwestern Atlantic coast of Iberia, causing a shipwreck with five victims. During the following days, the storm extended to the northern half of Spain.
January 16:	Storm in northern France, trees fell down, shopping centre evacuated.

January 18-22: Heavy rain in northern Germany caused flooding of rivers. Up to 200 mm in 5 days fell on the Harz Mountains. Hail up to 1 cm diameter was found in northeastern Germany.

January 19: Storm in Norway and Sweden up to 117 km/h over sea and 88 km/h at the Swedish west coast. Power disruptions, trees fell down and blocked roads.

January 22-24: Sea storm with strong winds over southern Italy and Sicily up to around 115 km/h. Highway and trains were blocked for several hours in Calabria.

January 22: Fruits and vegetables destroyed in the Jordan Valley due to frost.

January 24-29: 2 storms over the Aegean Sea with snow and gusts up to 117 km/h. Heavy storm also in Turkey on 28-29 January.

January 25-28: Storm in central Europe (with gusts of up to 115 km/h in northern Germany, up to 165 km/h in Austria) following a cold front passage caused power blackout and massive forestry losses. Strong winds >70 km/h also in Poland on 26-27 January.

January 27-29: Heavy rain in the Lebanon and Jordan. 57.4 mm in 10 hours fell in Beirut on 27 January. 49.6 mm in 24 hours were recorded in Rass Munef, Jordan, on 29 January.

January 30-31: During a storm, Jerusalem was covered by snow with a recorded depth of 20 cm. Likewise, Jordan's capital Amman received 30 cm of snow, while Lebanon, Syria and even Cyprus were affected by severe cold conditions. Armenia had a severe snowstorm on 31 January with a precipitation intensity of 31 mm / 12 hours, particularly severe on the Poushkin pass in the north of the country and across the western shore of the Lake Sevan.

January 31: Storm in Denmark and northern Germany, trees uprooted, roofs untiled. Storm with high waves over sea also in the United Kingdom.

February

- **Again very mild in most of Europe, cold in southern Greenland and the southeast**
- **Wet in the north, dry in the south**

Atmospheric circulation characteristics

The main circulation patterns were very similar to January: a mild Atlantic air flow and an ongoing passage of a large number of Atlantic low pressure systems over most of the northern half of the Region and dominating high pressure influence in the southern half. However, in contrast to January, even the northeast of Greenland was affected by the mild air mass.

Again, like in January, temporarily cold air masses advanced far to the south in the eastern parts of the Region, even down to the eastern Mediterranean. Over the northwest Atlantic, cold Arctic air masses moved from Canada southwards and affected the south of Greenland.

Temperature

February 2008 was warmer than normal in nearly the whole Region. Anomalies exceeded +4°C in northern, eastern central and eastern Europe (Fig. 2.1) and +7°C in parts of Finland, Estonia, northwest Russia and the Arctic area. Coastal waters near northern Germany were around +1°C warmer than normal and without ice.

February 2008 was the warmest February in southwestern Finland since 1990 and the second warmest on record on country average in Norway. Especially the last third of the month was extremely mild there. On 24 February, 9.2°C were recorded in Jomala on the Åland Islands. With 16.5°C, a new local record for the highest maximum in February was set in Belarus.

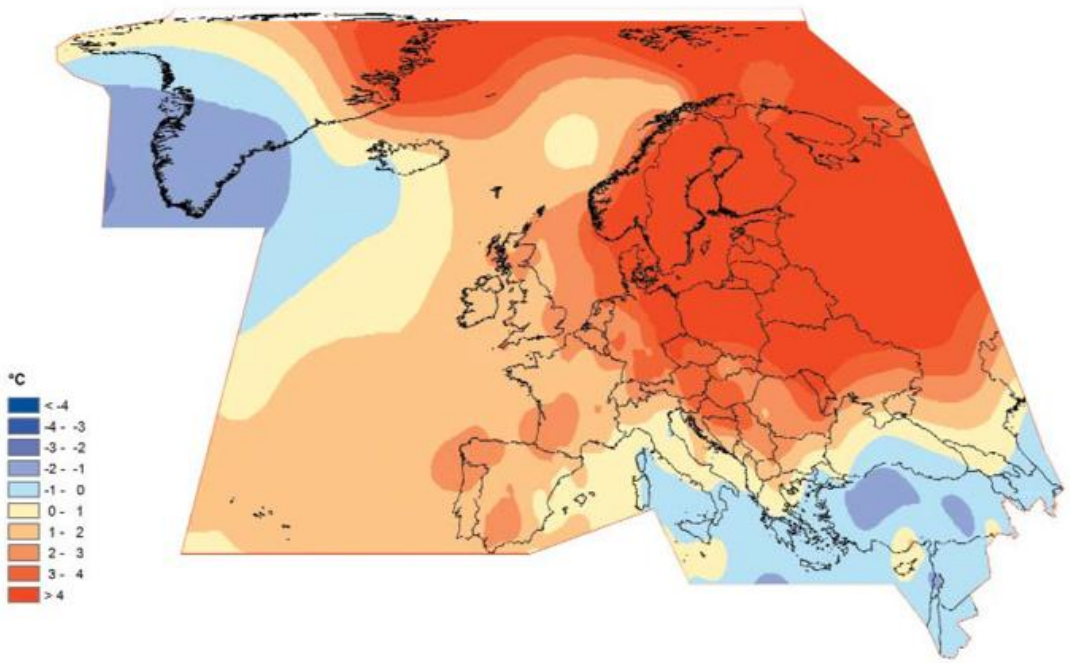


Fig. 2.1: *Monthly mean temperature anomalies in February 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

Southern parts of western and central Europe also experienced a mild period towards the end of the month. Again on 24 February, local daily record maxima of over 20°C due to foehn were measured on a sunny day in southern Germany (Munich, Stuttgart), Austria (Salzburg, Innsbruck) and eastern Switzerland (and a few days earlier also in southwestern France). Averaged over the whole month, monthly mean temperature anomalies ranged from around +1 to +3°C in western Europe and from +2 to +5°C in central Europe.

February was also extremely mild in the southern Spanish cities of Seville, Cordoba and Cadiz as well as at the north-western (Galicia) stations of Santiago and La Coruña, which measured new monthly records with regard to their time series longer than 60 years.

With up to around +3°C, southeastern Europe was warmer than normal only in its northern parts. New records of absolute February maximum temperatures were set on 25-27 February at 22 stations across Romania and in the northeast mountainous region of Montenegro (up to 24°C above 600 m altitude). Serbia and Bulgaria were also unusually warm around that date. Earlier that month, already on 5 February, some stations in Serbia had, with maximum

temperatures exceeding 25°C, reported new records for this time of year. The absolute maximum temperatures recorded in many places in Slovenia were also among the highest ever recorded February maxima.

Like in January, in February only two areas were colder than normal: over and around southern Greenland and the southeast of the Region, but now extending further over the Mediterranean. Italy, Greece and Turkey had frost during several days even in the lowlands, especially in the middle of the month. Monthly mean anomalies in the Middle East mostly dropped down to -1°C, in Turkey locally even below -6°C.

Precipitation

The precipitation anomalies were also similar to the values reported in January: February 2008 was mostly wetter than normal in the north of the Region, but unusually dry for this time of the year in the southern half, except a few local wet areas (Fig. 2.2).

In the Nordic countries, parts of western Norway received more than 300% of the precipitation normal. Bergen at the west coast of Norway had a precipitation total of 329 mm, which is more than twice the normal. Some areas in Estonia received a monthly total of 290% of the 1961-90 normal precipitation. Various places in European Russia also saw more than twice the normal.

Rainfall was also well above normal across northwestern Scotland, with some stations recording over 200% of their normal rainfall (1961-90). However, precipitation was lower than normal in most of the other parts of the United Kingdom and France, particularly in southwestern France. In the England-Wales precipitation time series, only 38 mm or 58% of the 1961-90 normal was recorded for the whole month.

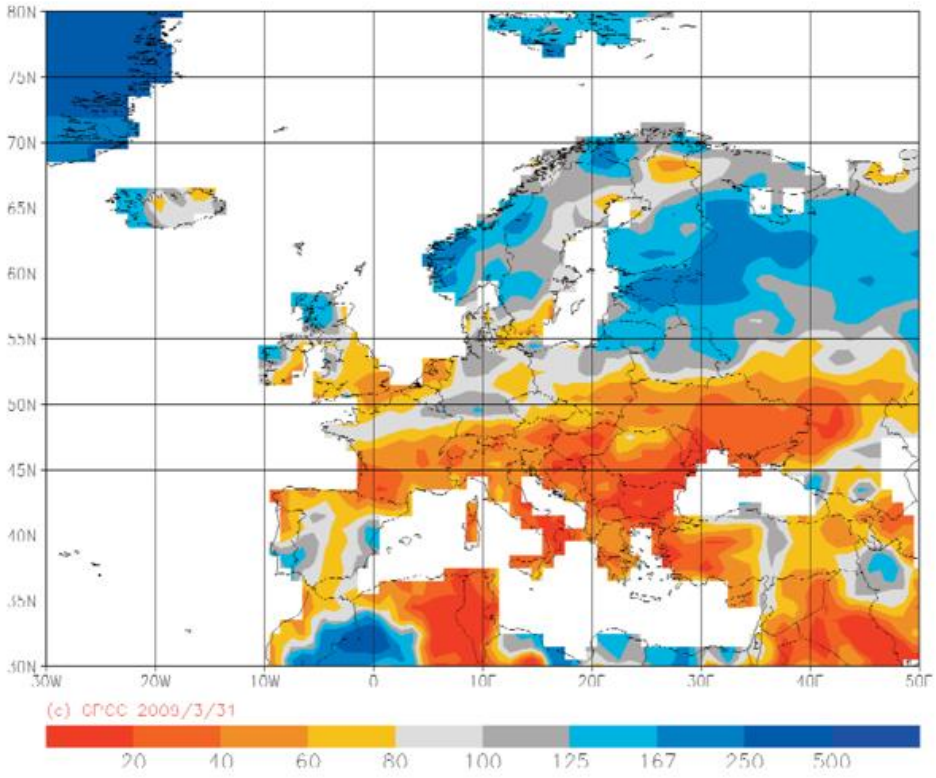


Fig. 2.2: *Monthly precipitation amounts for February 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

February was especially dry in Hungary (only 19% of the 1971-2000 normal), eastern Austria and southeastern Germany (both locally < 25% of the 1961-90 mean), parts of Switzerland and southern France as well as southwestern Poland (around 50% or less).

In February, most of Iberia was particularly affected by severe drought conditions. The month was also exceptionally dry in most of Romania and parts of Moldova, the Ukraine, Bulgaria, Greece, Serbia, Croatia and Hungary, where in many places less than 10 mm of precipitation fell, which is less than 20% of the normal. Sofia (Bulgaria) and Budapest (Hungary) both recorded a monthly total of only 1 mm. Monthly precipitation in Athens was about 25% of the normal. Further to the east of the Region it was 20-50% in Armenia and 20% in western Georgia. Damascus in Syria only received 7 mm of precipitation which is less than 30% of the normal.

Snow

The southeastern parts of the Region were still widely affected by snow. Frequent snow was reported from Greece and Turkey around the middle of the month, also at the southern coast of Turkey. Many villages were cut off. Also in Cyprus, snow fell in areas above 100 m. Snow was even recorded in Lebanon, Israel and Jordan. In Georgia, the snow depth amounted to 60 cm in the mountain areas and 2-2.5 m on high mountains, locally even more than 4 m. The lowlands of western Georgia also reported a snow cover of 30 cm. The northern Balkan Peninsula had less snow. In Serbia, only the mountains were persistently covered by snow throughout the whole month whereas other areas temporarily had snow around the middle of the month. Romania had a continuous, but in the lowlands light snow cover the whole month.

In the north, Iceland had more snow than normal. In contrast, the snow cover was thin in western and southern Finland at the end of the month with a completely bare ground in some southern and southwestern parts of the country. In some places in northern Finland, however, the snow cover was even thicker than usual.

In western and central Europe snow was rare in the lowlands and the lower mountains. Like in January, Germany again was widely without snow. A continuous snow cover was observed in southern Poland, whereas the rest of the country saw snow covers only temporarily.

Significant weather events

February 01:	Snowstorm forced Oslo's airport to be closed for several hours.
February 02:	Thunderstorm in western Estonia.
February 08-09:	Storm over Iceland with damage caused by both, wind and local snowmelt.
February 10:	Hail in Antalya, Turkey; settlements damaged.
February 11:	Persisting fog caused around 100 flight cancellations at the airport of Frankfurt, Germany.
February 11:	Tornado in Cyprus, west of Nicosia, caused damage to agriculture.
February 13-14:	Strong wind at about 110 km/h around Murmansk, northern European Russia.
February 17-18:	Heavy precipitation with flooding in Lisbon (Portugal). 18 February was Lisbon's rainiest day on record since 1877 with a daily total at 118 mm.
February 17-19:	Storm and heavy snowfall in southeastern Europe and the Middle East. Ports of Varna and Burgas (Bulgaria) closed because of storm and high

sea. Temperatures dropped rapidly and roads were blocked due to strong icing. More than 25 villages in Greece and some more thousands in Turkey were cut off by heavy snowfall, and Athens was covered by several centimetres of snow. The Acropolis had to be closed for visitors. On 18 February, the storm reached Israel, bringing snow, hail, rain and strong winds. Five centimetres of snow were reported in Jerusalem. Thunderstorms with hail affected southern Lebanon.

February 22: Storm of hurricane force hit Gothenburg (Sweden), causing numerous power blackouts. The severe storm also reached Denmark, northern Germany, the coast of Lithuania and northwest Poland with local wind speeds of more than 100 km/h.

February 22-26: Persistent dense mists and fogbanks over eastern Po Valley, Italy.

February 23: Thunderstorm in Belarus, a rare event at that time of the year which occurs in that country in winter only every 20-50 years.

February 24-25: Storm over Azerbaijan, gusts up to 100 km/h.

February 25: Flooding of the David River (Israel) due to local large rainfall amounts.

March

- **Mostly warm, especially in the east, cold over the polar Atlantic areas**
- **Mostly wet, a few dry areas in the north and the south**
- **White Easter in central Europe**

Atmospheric circulation characteristics

A strong zonal circulation with frequent cyclonic activity continued to persist over the Atlantic and Europe. The circulation extended over nearly the whole continent except the Arctic, even down to the Mediterranean, and moved north-eastwards over its eastern parts. Thus, particularly the Middle East and southern parts of eastern Europe were dominated by a southwesterly flow of warm air.

Temperature

March 2008 was also mostly warmer than normal in the Region, but the spatial distribution of anomalies was quite different from the preceding winter months. The highest monthly anomalies, exceeding +4°C, were to be found over the southeast of the Region (Fig. 3.1) where the winter had been cold. In the eastern Ukraine, southern European Russia, Kazakhstan, Armenia, Azerbaijan and Jordan, March was more than +5°C warmer than normal. The month was up to +8°C warmer than normal in west Kazakhstan at the eastern border of the Region (anomalies were even higher in other parts of the country not being part of the Region, Fig. 3.2). The central North Atlantic and also most of Greenland (except the northeast) were more than +2°C warmer than normal.

The Arctic Region and the high latitude Atlantic areas east of Greenland had monthly mean anomalies below normal, dropping down to -2°C in northeast Greenland and locally in Lapland and northern European Russia. Minimum temperatures below -40°C were recorded in Greenland (e.g. Danmarkshavn on 6 March) and Lapland (station Nikkaluokta in northern Sweden on 23 March). The Summit Camp of Greenland (elevation 3000m) saw a lowest daily minimum temperature of -59°C at least.

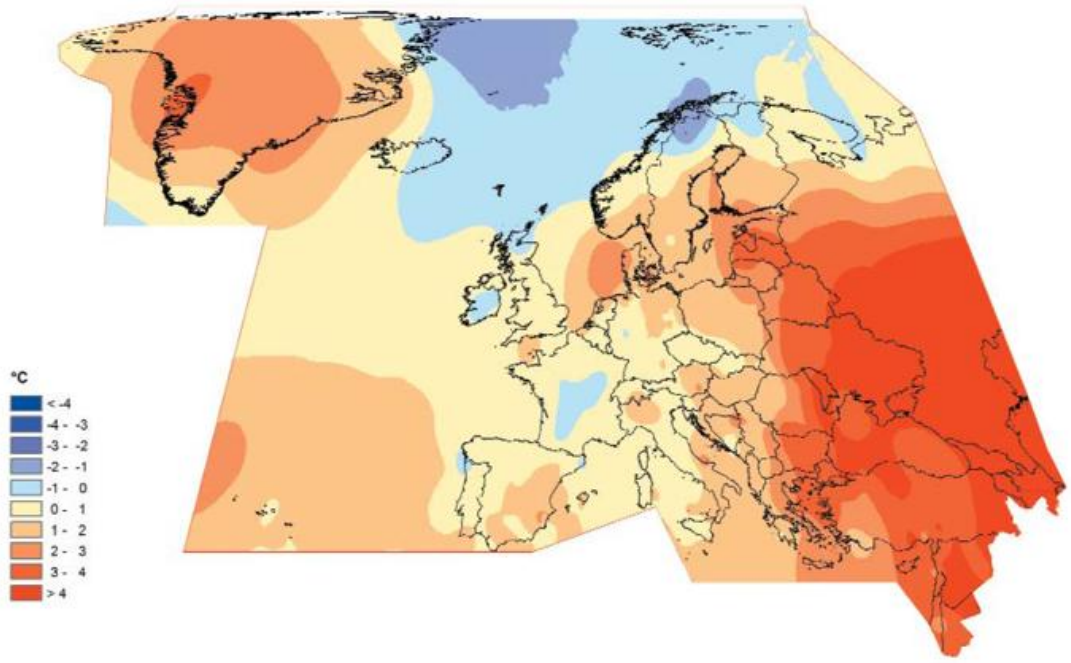


Fig. 3.1: *Monthly mean temperature anomalies in March 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany



Fig. 3.2: *Monthly mean temperature anomalies in March 2008 (reference period 1961-1990) in Kazakhstan.*
Source: Kazhydromet, Kazakhstan

In central Europe, the anomalies were still mostly positive, but by far lower than in February (below or around +1°C). Only locally were they negative. Thus, March was colder than February, e.g. in some places in eastern and southern Germany. Anomalies were higher for the North Sea and the Baltic Sea compared to the land areas in central and western Europe due to the warming during the preceding mild winter. With the daily minimum of -20.6°C, the lowest temperature in Austria in 2008 (except high mountains) was measured in Seefeld (Tyrol, Austria) on 6 March.

A very cold episode occurred around Easter (23-24 March) in central and western Europe. In many places in Germany it was the coldest Easter holiday since the beginning of measurements. Minimum temperatures went below -5°C, locally even below -7°C (e.g. Frankfurt/Main) on Easter Monday; the maximum temperature on Easter Sunday was only around or below 0°C at various sites in the German and Swiss lowlands. The cold air mass extended from northern Europe southwards. In central Sweden, minimum temperatures of -26°C were measured on 21 March. With -9.6°C, Denmark experienced its lowest temperature of the year on 23 March. The sea ice extent over the Baltic Sea (where hardly any sea ice had formed due to the mild winter) peaked as late as 24 March following the arrival of cold Arctic air and the consequential freezing of the Bay of Bothnia. Still, the maximum sea ice extent in that winter was the smallest in almost 300 years.

Even in the south, northern Italy experienced three frost days in the lowlands of Emiglia-Romagna during the last decade of the month, causing a substantial loss of fruit. In Slovenia, it was also colder than normal in the third decade of the month after the two preceding decades of the month had been warmer than normal.

At the same time, a tropical air mass and foehn effects caused night (!) temperatures of 30°C on the Black Sea coast of Turkey. The same temperature was reached during daytime in southern Russia north of the Caucasus Mountains. The heat wave even hit Armenia with daily maxima of 30-32°C in the southernmost part of the country. The vegetation period in Armenia started 15-20 days earlier than usual; apricot and peach blossomed already in the third decade of March. In Baku, Azerbaijan, a maximum temperature of 31°C on 26 March set a new record for the place.

In the area of the eastern Mediterranean, Tel Aviv (Israel) recorded 38°C on 24 March during a Sharav event. In some parts of the Negev, temperatures even rose as high as 39-40°C. At most stations in Israel, these were the highest March temperatures ever recorded since the beginning of measurements (Fig. 3.3) and the event was also record-breaking in terms of duration (5 days from 21 to 25 March) since 1964 at least. Jordan reported two heat waves, one from 5 to 10 March, the second from 17 to 26 March with a maximum temperature of 39.4°C in Deir Alla on 23 March. In Cyprus, temperatures reached 33°C at the end of the month, in Greece they rose up to 30.8°C.

Other parts in the south of the Region also experienced high temperatures. On 2 March, very high maximum temperatures (25-28°C) were recorded in northern Italy (e.g. Milan, Verona, Bologna, Ferrara) caused by a strong foehn situation, thus setting new records for March. Later, on 15 March, maxima up to 25°C were measured in some places of central and southern France (e.g. Vichy 23°C). At the end of the month (29 March) the temperature climbed up to 28°C in southern Spain (e.g. Seville).

Precipitation

March 2008 was wetter than normal nearly all over Europe (Fig. 3.4). At various places in Europe, precipitation totals reached about twice the normal, e.g. in the Baltic countries, northeastern Poland, European Russia (mid-Volga region), Germany, parts of upper Austria, Slovenia, Croatia, Montenegro (Fig. 3.5) and Albania. New records of monthly precipitation

were measured at the two stations Nikšić (413 mm) and Kolašin (427 mm), and also of the number of precipitation days (23 and 24 days, respectively). At other places, the precipitation totals even amounted to around 300% and up to 350% of the normal in Estonia and near the eastern border of the Region in west Kazakhstan, respectively. Some locations in Albania recorded the second wettest March ever. Some places in Bosnia and Herzegovina received nearly 200 mm even in the lowlands. Georgia in the Caucasus region recorded 130-140 mm (110-130% of normal). In the northeast, Latvia saw its wettest March in 85 years although Latvia's central and western rivers were spared from extreme spring floods. In northwestern Europe, England and Scotland experienced its wettest March since 1981 and 1994, respectively. Uccle in Belgium recorded its wettest March since 1833.

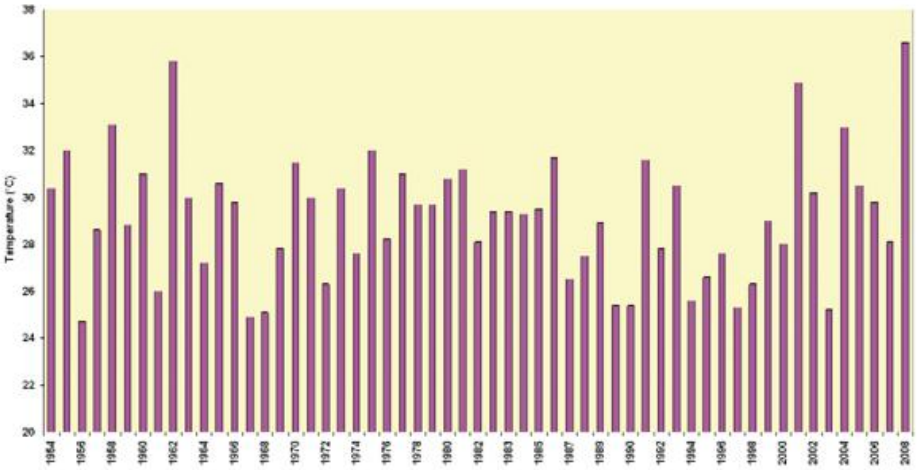


Fig. 3.3: *Absolute maximum temperature in March at Kefar Blum (Hula Valley, Israel) 1954-2008.*
Source: Israel Meteorological Service

In contrast, a few areas in the northernmost and southernmost parts of the Region which lay outside of the frontal zone received very little precipitation. Svalbard in the north and parts of Spain, southern Romania, Greece and the southern Middle East recorded monthly totals below 10 mm, which is far less than normal. Larnaca on Cyprus received a monthly total of only 3 mm (less than 10% of the normal) with the result that all months of that year's winter rain time (October 2007 until March 2008) were much too dry, which caused a severe drought in Cyprus. In central and southern Israel, there was virtually no rain and these places had seen only 3 more years in the last 70 years, in which they had received no rain in March. Damascus in Syria also received no measurable precipitation throughout the month. Armenia registered only 45% of the normal March precipitation on spatial average while the values in Azerbaijan were less than 40%.

Most of Italy was wet compared to the rest of the Mediterranean countries due to a persistent low pressure system residing there during the first decade and bringing frequent rainfall.

Snow

Snow in March 2008 did not only cover higher latitudes and high mountains, but also occurred especially in large parts of central and eastern Europe. An Arctic trough extending to northern and central Europe caused snow showers and a temporary snow cover in the lowlands of Germany and Switzerland on 4-5 March and around Easter (23-24 March). So, quite large amounts of snow arrived in central Europe late in the season after a winter with very little snow. Brocken mountain station (Germany) recorded a snow cover of 1 metre, a depth which had not

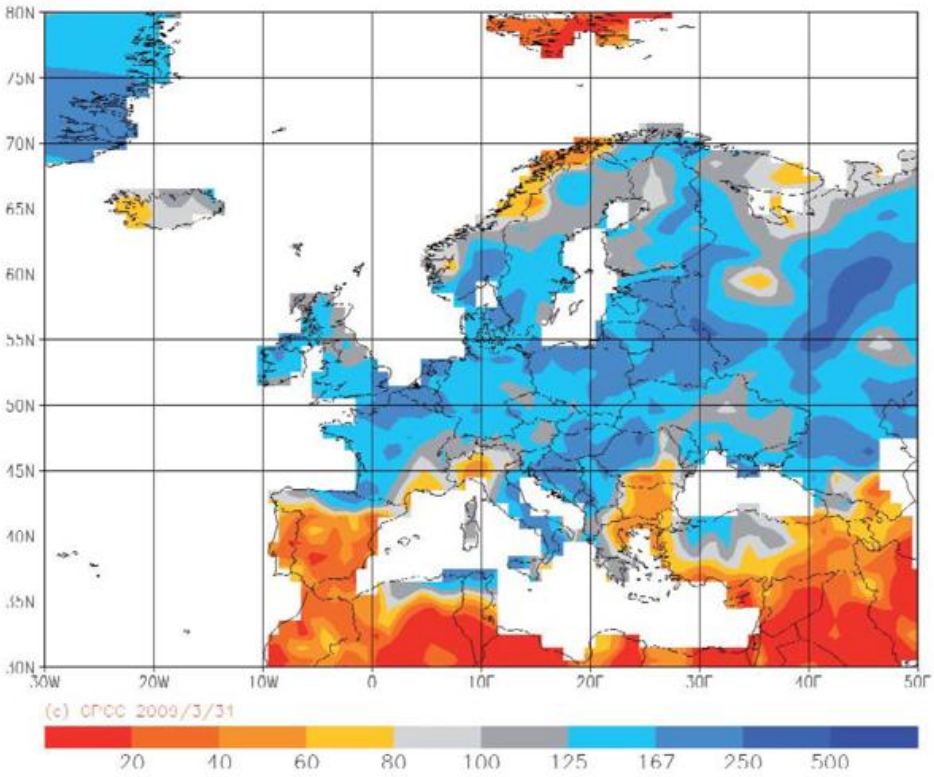


Fig. 3.4: *Monthly precipitation amounts for March 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

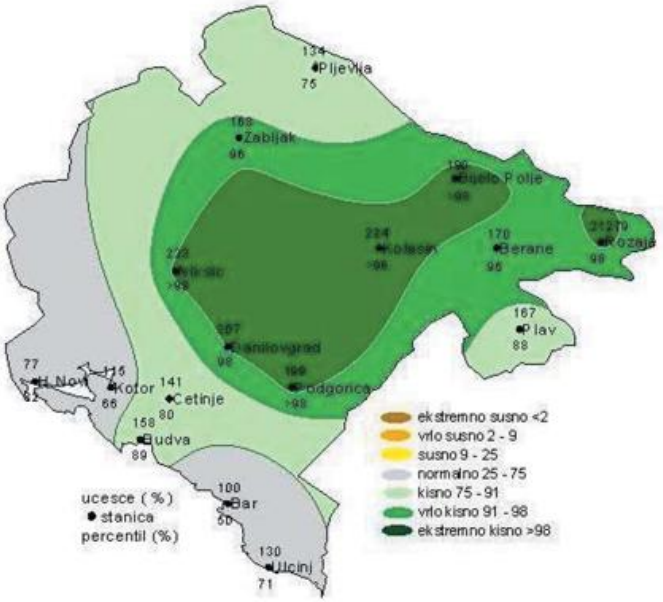


Fig. 3.5: *Monthly precipitation amounts for March 2008 in per cent of the normal 1961-1990 in Montenegro (upper numbers) and in percentiles (lower numbers).*
Source: Hydrometeorological Institute of Montenegro

been seen there during the whole winter. 15 cm were recorded in the northernmost parts of Germany (Schleswig station) while the Zugspitze, Germany's highest mountain (almost 3000 m altitude), reported 340 cm. In Austria, March brought more snow than any of the preceding winter months. Even in Italy, snow fell in many places above 400 m altitude, and various places in Slovenia also experienced snowy Easter holidays.

Snow even fell in the more maritime areas of the western half of Europe, e.g. with around 5 cm in the southern Netherlands, which then received the largest amount of this snow season. Snow also fell in Luxembourg, and some eastern areas of England received a snow cover of 5-10 cm on the morning of Easter Sunday (23 March). Iceland, too, was slightly snowier than usual this month.

Only a few days later than in central Europe, a snow event arrived in northeastern Europe. Intensive snowfall was recorded on 26 March along the west flank of a low pressure system in Belarus, Estonia and southern Finland causing a fresh snow cover of about 30 cm in some places.

Snow also covered parts of Romania during the last decade of the month. In Serbia, snow fell only on the mountains and temporarily in western and southeastern lower areas of the country. Eastern Georgia received snow at the end of the 2nd decade, with snow depths of up to 80 cm in lower mountain areas and 5 m on high mountains.

Significant weather events

March 01-02: A heavy storm (“Emma”) moved from the Norwegian Sea over central Europe to the east. Gusts of hurricane force were recorded even in the lowlands (e.g. up to 140 km/h at Salzburg, Austria) and up to over 220 km/h in mountainous areas. The storm was accompanied by heavy thundery precipitation and hail with local flooding. Infrastructure and electricity disruptions, forest damage and at least 14 fatalities were reported. Strong wind and hail was also reported from Romania.

March 04-07: Storm with heavy rainfall, snowfall and strong winds initially affected northern Italy, later the whole country. Gusts of up to 120 km/h occurred in Trieste on 06 March, Venetian harbour had to close, boat connections to the islands were interrupted.

March 09-13: A severe storm with flooding hit the UK, Belgium, France and Germany. A mean sea level pressure of 950.1 hPa was recorded in southwest Ireland (Shannon Airport) on 10 March at 6 UTC, the lowest March value on record in Ireland. 2-day rainfalls of up to 50 mm were measured in the south of the country. In certain places of France, strong winds lasted more than 12 hours. Gusts exceeded 130 km/h at the coasts of northwestern France, locally even reaching a speed of 155 km/h and causing flooding due to storm surges. Inland areas of northern France saw gusts often amount to 80-100 km/h. At sea, a buoy off the southwest coast of Ireland recorded a wave of 13.4 m on 10 March at 11 UTC, the highest wave on record there for March. The Black Forest in Germany received almost 100 mm of precipitation in 5 days. Another storm hit parts of the United Kingdom on 12 March.

March 14: Strong winds affected Cyprus, causing damage to property in Nicosia and uprooting trees in the southern coastal area.

March 18: A rather small, but quite active cyclone brought abundant snowfall to Lithuania with a snow cover of up to 10 cm that persisted over a week in

northern regions.

March 20: Hail at the Costa del Sol in southern Spain, flooding of roads. It was one of the rare precipitation events during a several-months-long drought period in Spain.

March 20-26: Coldest Easter on record in Germany with frequent snow; at the coasts of northern Germany also strong wind and flooding. Italy also had bad Easter weather: wind and rain with heavy sea storms over central-southern Tyrrhenian regions and damage and flooding in Rome.

March 24-25: Strong southern winds in Romania and Bulgaria with foehn effect at the northern slopes of the mountains. Gusts of up to 144 km/h on the Danube River. Heavy storm also in Turkey.

April

- **Mostly warm, some local cold areas in Scandinavia and western Europe**
- **Mostly wet, Arctic and most of the Mediterranean very dry**

Atmospheric circulation characteristics

The western Arctic areas still profited from warm air, high pressure influence and mild sea surface temperatures, whereas Lapland was in a cold northeasterly air flow at several times.

Western and central Europe occasionally lay in a northwesterly cold air flow. During the first half of the month, frequent passages of low pressure systems occurred. In the second half of the month, high pressure influence extended from the north to central Europe.

Eastern Europe and the Middle East were affected by a southwesterly flow of tropical air. Due to a blocking high over Russia, the easternmost parts of the Region were spared from the large rainfall area west of it. High pressure also dominated in the western Mediterranean.

Temperature

April was again mainly a quite warm month throughout the Region. The highest monthly anomalies (> +3°C) occurred in the Middle East, western Greenland, southeastern Norway and parts of eastern Europe, including the Baltic countries (Fig. 4.1). In some places in Syria, the anomalies were more than +4°C.

By the end of the month, mean daily temperatures reached 10°C in Lithuania and the active vegetation period started 1-2 weeks earlier than normal. Maxima of more than 20°C were recorded in Russia near Volga River on 4 April and in Moscow one week later. Very warm weather was also recorded in the second half of April in central European Russia, exceeding normal values by 4-5°C.

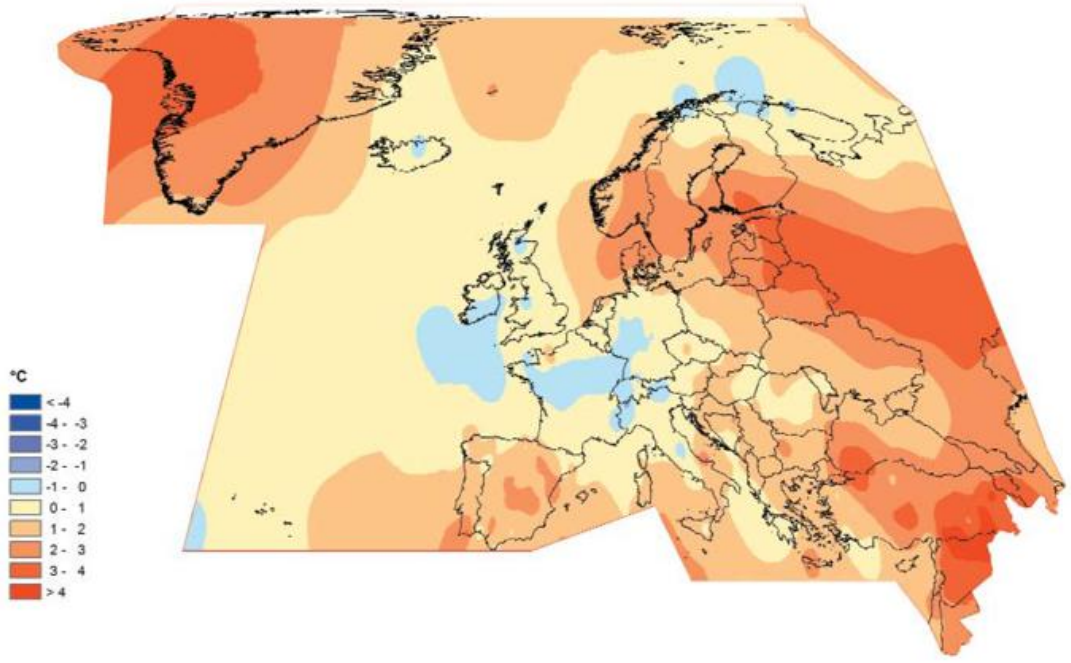


Fig. 4.1: *Monthly mean temperature anomalies in April 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

Monthly mean anomalies in April were around +1°C in most of Austria, Hungary and Poland, up to +2°C in northeast Poland, mostly less than +1°C in Slovenia and only 0.3°C in Germany where the first two cold decades of the month were compensated by a warm decade at the end of the month. The North Atlantic temperatures were mostly around normal, in some areas in the north and the south about +1°C warmer.

Spain and Portugal were very warm at the beginning of the month (daily maxima up to 31°C on 3 April in Cordoba, southern Spain), with a monthly average of around +2°C above normal.

In April, several heat waves occurred in southeastern Europe and the Middle East. On 13-15 April, advection of Sahara air caused the maximum temperature to rise up to 30-36°C in Greece, Cyprus, Turkey and Israel. One week later (22 April), the station Heraklion on Crete (Greece) recorded 37.4°C which is the highest temperature ever measured in April in this place. In Israel, the month was characterized by a large number of Sharav events. Tel Aviv had 41°C on 23 April. With temperatures of 42-45°C, the Jordan Valley recorded its highest April temperatures over the last 40-50 years. Exceptionally high temperatures were also measured on 24-29 April in Armenia due to the invasion of hot and dry air from the deserts of the Arabian Peninsula; a maximum at 35.6°C was reached in Meghri in the south of the country. Never before had such a high temperature been recorded in Armenia in April. Azerbaijan also reported high temperatures on 24 April.

Only a few areas in Lapland and western Europe were slightly colder than normal. Temperatures in Lapland remained below 0°C in the first half of the month with minima below -20°C. The northern part of the Baltic Sea was frozen. In western Europe, frequent rain showers and cloudiness as well as occasional cold air flows especially in the first two thirds of the month were the main reasons for low monthly mean temperatures. England, Wales and the United Kingdom as a whole had their coldest April since 2001, although temperatures were close to normal. Sometimes, temperatures showed a large day-to-day variability. In England, 18°C were

measured in London on 4 April whereas the next day saw a strong cold snap from the northwest causing the temperature in southern England to drop down to near-zero values during the night of 5-6 April.

Precipitation

Most parts of the Region were clearly wetter than normal, especially most of western, central and parts of eastern Europe (above all the Ukraine), but also most parts of Iberia, Bulgaria, Greece and parts of Scandinavia (Fig. 4.2). More than twice the monthly normal was reached in some places, even in the southern half of Europe, e.g. Switzerland (Geneva, 144 mm), parts of Austria, Portugal (e.g. Lisbon, 151 mm), Greece (Athens, 69 mm) and the Ukraine (Kiev, 123 mm).

In the United Kingdom, rainfall totals were well above normal in parts of eastern Scotland and northeastern England. Central Europe was especially wet in the first half of the month. Although the second half of the month was drier in central Europe this did not compensate the high rainfalls at the beginning of the month. In Estonia, only the last third of the month was very dry: for 9 days there had been no rain at all. This led to drought conditions and forest fires. It was the same in Georgia in the Caucasus region: the first half of April was rainy, the second half dry.

The higher latitudes including most of eastern Greenland, Svalbard, Iceland and the northwest coast of Norway were considerably drier than normal. Parts of Greenland received less than 25% of their normal monthly precipitation. Stykkishólmur in Iceland experienced its driest April since 1951. It was also dry in Ireland, on the North Sea coast of central Europe, in southern Sweden and large parts of European Russia, in the Middle East and most of the Balkan Peninsula and the Mediterranean.

Eastern Spain continued to suffer from the ongoing winter-spring drought although it was already wet over in the other parts of Iberia. In the whole month, the Balearic Islands received a precipitation total of only 2-4 mm, i.e. about 10% of the normal. Malta Airport recorded a monthly total of only 3.6 mm and thus one of the driest Aprils over the past 84 years with monthly totals of only about one third of normal. Various places in Turkey received less than 40% of their monthly normal, Cyprus a monthly total of only 2.3 mm which is 8% of the 1961-1990 normal. Israel had no rainfall at all in April as opposed to the small amounts it receives normally. Out of the last 70 years, there had been only 2 or 3 years that were completely rainless in northern Israel. Large parts of Syria and Jordan were also rainless.

In Armenia, the monthly total precipitation was only 30-50% of normal, locally even less, thus causing problems for irrigation. Azerbaijan also received only around half the normal precipitation on country average, which made April 2008 the third successive dry month in this country.

Snow

Due to high precipitation, the snow depth on the peaks of the northern Alps increased in April up to 7 metres. In the first half of the month, snow came even down to the lowlands in northwestern and central Europe. On 6 April, a marked cold snap caused snowfall in southern England and one day later also in central Europe. As late as on 17 April, southern Germany measured a snow cover of a few cm.

Significant events

April 03: Thunderstorm with hail and tornado in Zakynthos (island in Ionian Sea, Greece, Fig. 4.3)

April 06-07: An area of sleet and snow moved across much of the Midlands of the United Kingdom and southeastern England with 5-10 cm reported fairly widely, causing Heathrow airport to close for a time.

April 17-19: Funnel cloud over Rome causing damage to trees, antennas etc. on 17-18 April. A tornado was seen in Romania on 19 April.

April 22-27: Heavy thunderstorm in lower Austria and southeastern Europe. Tornado in northeastern Bulgaria, hailstorm with hail stones as big as eggs. 220 houses and electricity network damaged, trees uprooted. Port and airport in Varna (Bulgaria) temporarily closed due to strong foehn winds.

April 28: Hail up to 50-70 mm in diameter near Krasnodar, southern European Russia.

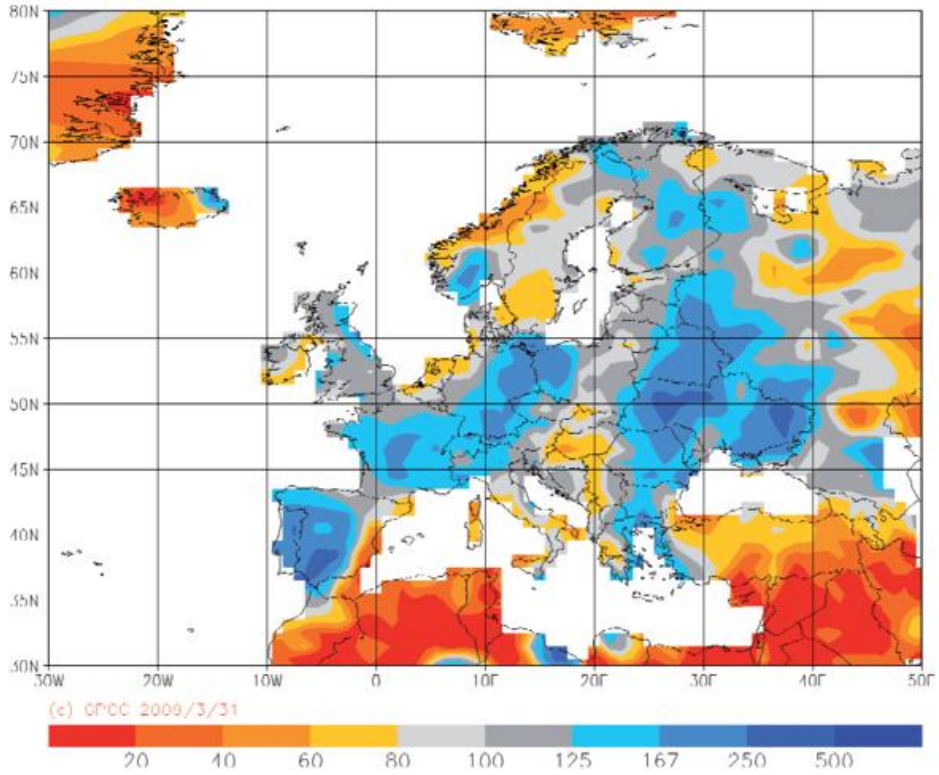


Fig. 4.2: *Monthly precipitation amounts for April 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany



Fig. 4.3: *Tornado over Zakynthos, island in the Ionian Sea, Greece on 03 April 2008. Source: Hellenic National Meteorological Service, Greece*

May

- **Warm in the west, cold in the east**
- **Heat wave in central, southern and southeastern Europe at the end of the month**
- **Most of the Region dry, southwestern and eastern Europe wet**

Atmospheric circulation characteristics

High pressure influence was dominating over northern and central Europe and over the eastern Mediterranean and the Middle East.

The Azores high was weaker than usual this month and shifted to the south. At its north flank, Atlantic low pressure systems with moist air and frequent precipitation moved slowly over western Europe, Iberia and the western Mediterranean. Another centre of frequent cyclonic activity occurred over eastern Europe except the north.

At the end of the month, especially the central Mediterranean and central Europe were within a strong flow of very warm air, leading to a short, but intense heat wave over large areas of the continent.

Temperature

It was a warm May especially over western, central and southeastern Europe, the North Atlantic and most of the Arctic (Fig. 5.1). Anomalies over Europe were highest in western Ireland, northern France, Belgium, the Netherlands and western Germany, but also in Bulgaria in the southeast with more than +3° and in northwest France and Luxemburg with locally more than +4°C. The western German Baltic Sea also was around +3°C warmer than normal, whereas the German North Sea recorded +1.7°C more than normal and thus the second warmest May since 1971.

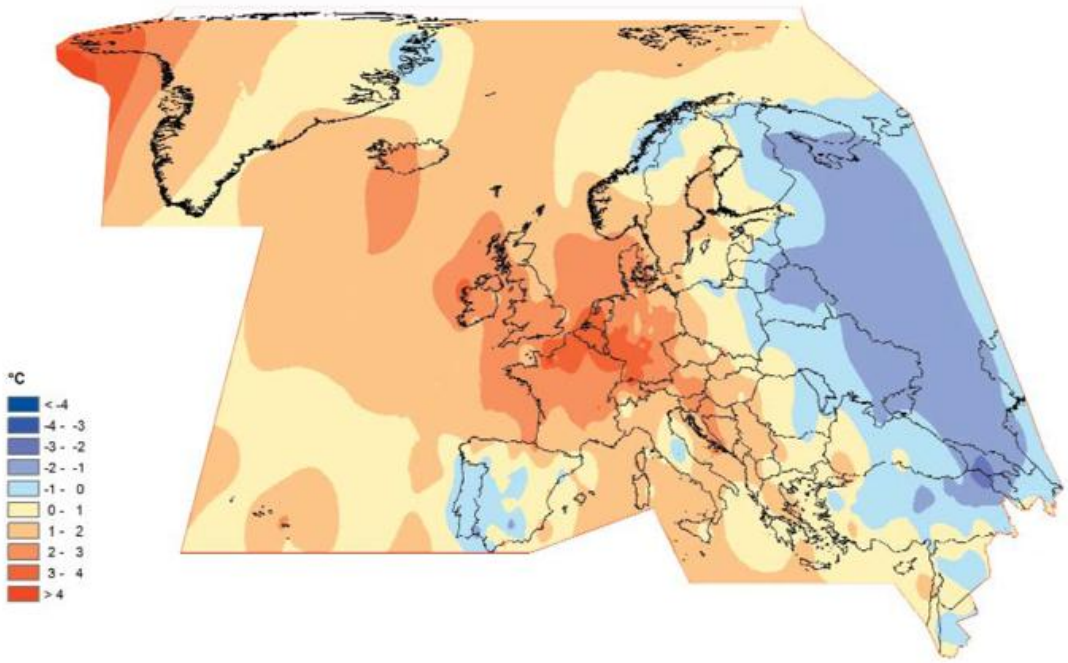


Fig. 5.1: *Monthly mean temperature anomalies in May 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

It was the warmest May on record in the United Kingdom, at most stations in Ireland and in many places of the Low Countries, e.g. in Uccle (Belgium). The high anomalies were caused to a considerable part by high maximum temperatures due to long sunshine durations over large parts of Europe. London-Heathrow recorded a maximum temperature of 25.0°C on 08 May. A temperature of more than 27°C was measured in the Champagne in northern France. The North Atlantic also continued to be warmer than normal, mostly more than +1°C. May also was exceptionally warm across the Netherlands – it was the warmest May in De Bilt in more than a century. It also was the third warmest May on record in Germany. Eastern and southern Germany had monthly maxima of more than 30°C at many stations and night frost in Germany occurred only at very few locations in the north and in the Alps. Most of Austria and Slovenia were 1-2°C warmer than normal.

At the end of May, warm Saharan air caused particularly high temperatures in southern, southeastern and parts of central Europe. Palermo, Sicily experienced 38.9°C, and 37-38°C were measured in Greece. Maximum temperatures in western Turkey reached 32-37°C. Chirpan, Bulgaria, recorded 36.2°C. Temperatures surpassed 35°C on 28 May in places in Serbia. The absolute maximum temperature for this May exceeded 33°C for the first time and thus was the warmest on record in many places of Croatia in the long time series of Zagreb Grič starting in 1881 (Fig. 5.2). New temperature records up to 34°C also were recorded in Montenegro. At some places at the coast of Slovenia as well, absolute maxima were the highest

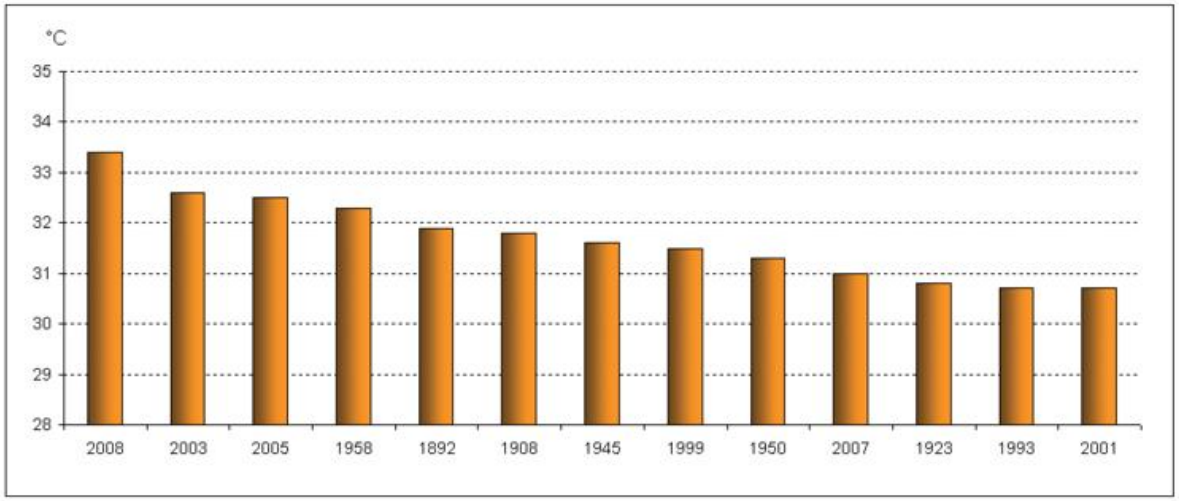


Fig. 5.2: *Years with highest absolute maximum air temperature for May in Zagreb Grič, Croatia (time series 1881-2008).*
Source: Meteorological and Hydrological Service, Croatia

ever measured in May. In Ljubljana, it was the third highest maximum. Austria also had a short heat wave in the last days of May, which brought new record May temperatures in many places, e.g. 34.9°C on 28 May in Graz. With 30°C on 27-29 May some stations in Switzerland set a new monthly temperature record due to foehn. Poland reported a monthly maximum of 29.1°C.

In the north, it was exceptionally warmer than normal in western Greenland (up to +3°C). On Iceland, it was the warmest May in Reykjavik since 1960 and the second warmest behind May 1935 in the whole time series of Stykkishólmur starting in 1845. Sweden reported new records of May maximum temperatures, again due to the heat wave in late May (and early June). In the northeast, monthly mean temperatures were around normal, but the weather was very variable with rapid changes between cold and warm spells.

Eastern Europe, parts of the Middle East as well as southwestern Iberia were 1-2°C colder than normal. Particularly the first decade of the month was colder than normal in Armenia by more than 3°C, and severe frost was to be found in Turkey that time.

Precipitation

May was a significantly dry month namely in most of the Nordic region, especially Denmark, southern Finland and the Baltic States (Fig. 5.3). Denmark had only 13 mm of monthly precipitation averaged over the country (normal 48 mm). Some areas in Estonia received only 9% of the normal May precipitation, which was the reason for many forest fires. Places in Lithuania received around 5 mm or less than 15% of the normal precipitation. The month also was exceptionally dry in Ireland, most of the UK except the south and most of central Europe including the Alpine region. It was the driest May in Germany since 1919: only around 25% of the monthly normal fell on country average, at some eastern German stations even less than 10 mm during the whole month. In Maribor, Slovenia, it was the second driest May since observations started with monthly precipitation totals of up to 37% of the 1961-1990 normal.

On the contrary, large parts of western and southwestern Europe (southern United Kingdom, western and southern France, Iberia, even northern Italy) were very wet, partly with twice the normal monthly total, over eastern Spain and the western Mediterranean even up to 3-6 times the normal: 237 mm fell in Ajaccio, Corsica, as compared to a normal of 40 mm. May was the wettest in Spain since at least 1971 due to both high rainfall amounts and a high number of rainy

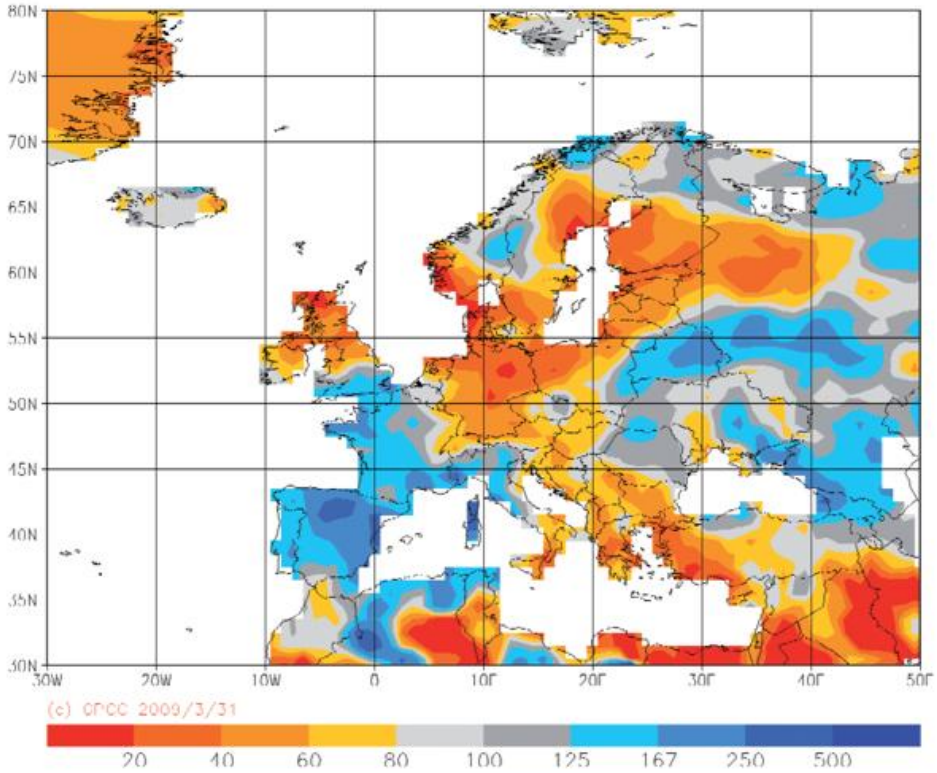


Fig. 5.3: *Monthly precipitation amounts for May 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

days, the latter especially in the northwest and southeast of the country. Particularly high amounts of more than 200 mm of the monthly precipitation were measured in northeast Spain, causing flooding in this area at the end of the month, and in the western Alps.

Another large area of higher-than-normal precipitation was to be found in eastern Europe. Particularly high amounts of more than 300 mm (more than 150% of the normal) fell along the southern slope of the western Caucasus Mountains. Azerbaijan also had a wet May due to partly intensive rainfalls after three preceding, very dry months. West of the Black Sea, torrential rainfall with frequent hail fell in Romania during the last decade of the month.

In contrast, large parts of southeastern Europe, the eastern Mediterranean and the Middle East were very dry. Even in southern Italy, a couple of places in Sicily recorded as little as a few mm on only 1 or 2 days during the whole month. Stations in Macedonia received a monthly total of less than 10 mm (10% of the normal precipitation). In Greece, stations in Athens recorded totals of 2-4 mm of precipitation for the whole month, which fell on just one day. The same was recorded for Antalya at the Turkish south coast (normal is 28 mm). Turkey as a whole experienced a dry period at the beginning of the month, causing a delay of seed germination. Syria, Lebanon, Israel and Jordan had hardly any precipitation, even in those places which normally are not rainless. Beirut, Lebanon recorded just 1 mm this month, compared to a 20 mm normal.

Snow

Snow cover continued to persist in Lapland (20-50 cm depth) at the beginning of the month, whereas the snow in southern and central Finland had completely melted by then.

A snow depth of 13 cm accumulated in Archangelsk, northern Russia, until 18 May. At the end of the month, a depth of 35 cm was still measured on the Canin Peninsula in northern Russia.

Significant weather events

May 08: Heavy rainfall and thunderstorms accompanied by heavy hail affected Cyprus (the area of Nicosia and Larnaca), bringing floods to the area.

May 09-10: Heavy rain over Mallorca and northern Spain, up to more than 40 mm in 12 hours on 10 May in the afternoon, 76 mm in 6 hours in Barcelona. (Winter and early spring months before were very dry in Spain!)

May 19-20: Very intense rain between Bologna and Modena, northern Italy. Local maxima of 60 mm in 1 hour, 83 mm in three hours, 140 mm over two days. Highest total rainfall in over 70 years with a return period for such rain intensity of more than 200 years. Heavy rain also over Corsica and Sicily.

May 20: Large hail up to 30-35 mm in diameter in Dagestan, eastern Caucasus, European Russia.

May 21-22: Strong thunderstorms in Romania and Bulgaria, partly with hail, hailstones as big as eggs, intense rain causing local flooding on Danube River (Fig. 5.4), land slides, electricity breakdowns.

May 24-27: 121.4 mm of precipitation fell in 4 days at a station in southeast England.

May 27-28: Severe foehn storm in Switzerland. Highest gust ever measured in May since 1981 at Gütsch above Andermatt (2287m altitude) at 180 km/h on 27 May. Large amounts of Saharan dust were transported to Switzerland.

May 27: Tornado at the Tarragona coast (near Barcelona, Spain).

May 29-30: Flooding in Piedmont region in northern Italy (Piedmont, Lombardy, Veneto), landslides. Heavy rain also in Corsica, 133 mm in 24 hours in Ajaccio at the west coast of the island, the heaviest rainfall for nearly 60 years.

May 29-31: Heavy thunderstorms with local flooding and tennis-ball sized hail (8 cm) in western Germany. Daily precipitation of 64.4 mm fell at station Asselborn, northern Luxembourg on 29 May. Heavy rain also in eastern France.

May 31: Heavy rain in northern Spain (89 mm in 24 hours in Bilbao) and western France (85 mm in 24 hours in Le Mans).



Fig. 5.4: *Flash flood on 21-22 May 2008 in Nikopol town on the Danube River, Bulgaria. Photo by A. Tonev.*
Source: National Institute of Meteorology and Hydrology, Bulgaria

June

- **Mostly warm, cold in the east**
- **Heat waves in southeastern Europe**
- **Mostly dry, but some heavy thunderstorms, wet in parts of northern and southern Europe**

Atmospheric circulation characteristics

At the beginning of June, an omega pattern developed during the first decade, with warm air particularly over central and southeastern Europe and also western Scandinavia, whereas especially Russia, but temporarily also parts of western Europe including Iberia were within colder air.

At the end of the first decade, the Azores high extended to the north and also to the east over the middle latitudes of Europe, whereas a strong low pressure system persisted particularly over northern Europe.

In the second decade, the circulation changed to a more zonal pattern over the middle latitudes with not too strong frontal systems. However, low pressure and cold air in higher atmospheric levels extended temporarily from the north far to the south, even to southern Europe and the central and western Mediterranean, leading to frequent thunderstorms over these areas.

Strong high pressure influence persisted over Greenland and its surroundings, including Iceland and Svalbard. High pressure influence was also dominating over the eastern Mediterranean and the Middle East.

Temperature

June was another warm month in most of the Region including the whole North Atlantic (Fig. 6.1). The centre of the highest anomalies in Europe (> +3°C) was over southeastern Europe, another one in Greenland.

Angmagssalik at the southeast coast of Greenland saw a maximum temperature of 18°C on 14 June and still 15°C in the following night due to foehn. In southeastern Europe, Serbia had two quite long extreme heat waves, one from the beginning of June until 3 June, the other one from 21-27 June with a maximum of 38°C on the 25th. The latter heat wave reached even Romania, Bulgaria and western Turkey with maxima of 39°C, around 37°C and 40-41°C, respectively. The water temperature of the Black Sea reached 25°C. There were two short heat waves (18-19 June and 25-26 June) over the mainland of Greece with maximum temperatures of 38-40°C. Cyprus also recorded temperatures around 40°C. In Israel, it was one of the warmest June months in the last 40-50 years with mean monthly anomalies of 1.5-2.0°C above normal. This was due to some extreme Sharav events with temperatures reaching up to 40-41°C in the northern valleys and the Negev.

Southern Iberia was another centre of high positive mean temperature anomalies. Prevailing high temperatures culminated to values above 40°C particularly in southern Spain. In the Mediterranean, the monthly mean sea surface temperature near Malta was 22.1°C, slightly more than +1°C above the June average since 1978. Italy also was hit by a heat wave in the second half of the month with temperatures up to 38°C at several stations. Vienna in Austria reached 35°C on 22 June.

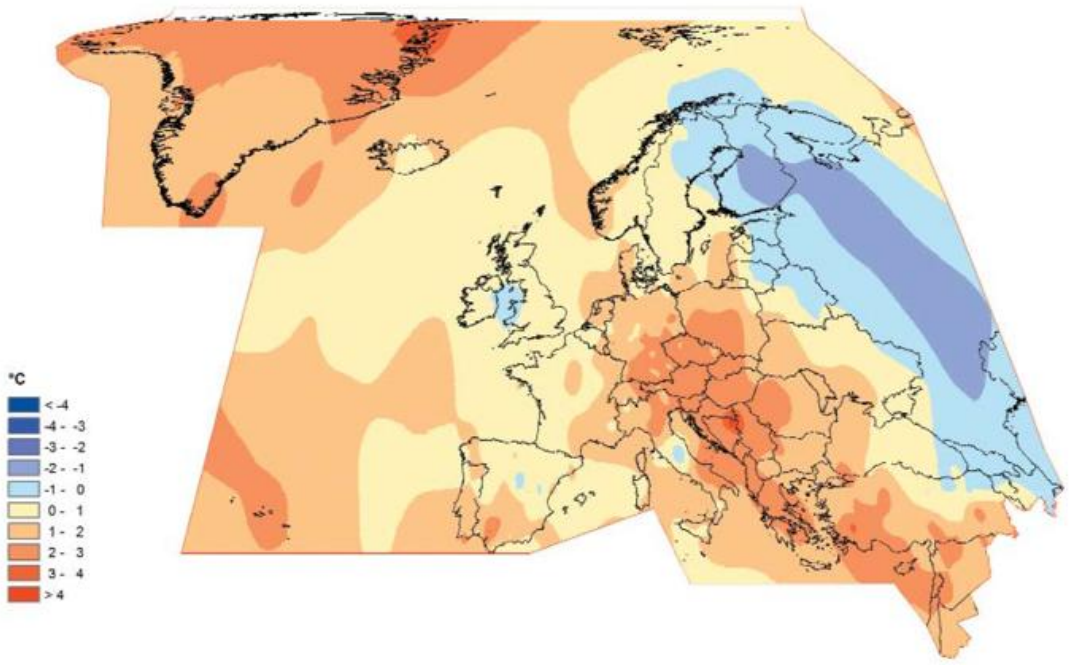


Fig. 6.1: *Monthly mean temperature anomalies in June 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

In western Europe, monthly anomalies amounted to +1°C in France. In the United Kingdom, June temperatures were generally close to or just above normal, but it was the coolest June since 2001. Temperatures were well above normal in southwestern and western Iceland.

Central Europe had anomalies around +2°C. Germany was 1.6°C warmer than normal on country average, with only one cool period around the middle of the month, Austria saw monthly mean temperatures around +2°C, partly up to +3°C above normal. The monthly mean temperature anomalies in Poland reached up to 2.5°C, with the warmest parts in western and central parts where maximum temperatures exceeded 32°C. Hungary was +1.9°C warmer than normal (1971-2000 reference), Romania +1.8°C.

It was still colder than normal in eastern and northeastern Europe. Anomalies below -1°C were recorded in Russia and southeastern Finland as well as in mountainous regions of Georgia. Minimum temperatures in some regions of Georgia dropped below 10°C even in the lowlands on 8 June. The first ten days in Estonia were also colder than normal, whereas southern parts of Norway and Sweden experienced high temperature maxima above 30°C at the same time. In European Russia, ground and air frosts were recorded everywhere in that decade except the south; in the northwestern part of the country, soil surface temperatures dropped to -6°C.

Precipitation

It was mainly dry in most of the Region, especially in the Arctic, in the middle latitudes, over the eastern Mediterranean and southwestern Iberia (Fig. 6.2). June was exceptionally dry in western and southwestern Iceland, e.g. in Iceland's capital Réykjavik (30% of normal), and drought affected some farming areas. Western Greenland was also exceptionally dry; only 3 mm fell in Nuuk at the west coast during the whole month as compared with the normal of 54 mm.

Some places in central and eastern Europe received less than 40% of the normal precipitation due to the fact that rainfall was especially rare during the first decade of the month. However, several local thunderstorms with heavy rain occurred in central Europe throughout the whole month.

A monthly total of 1.4 mm only was recorded in Malta. Although this location is generally dry in summer, the June total was less than half the normal of 3.2 mm. No measurable precipitation fell in Lisbon, Portugal, and only 3 mm (14% of the 1961-90 normal) in Istanbul, Turkey. Places in southern Spain and Gibraltar and in the Mediterranean on Sicily in Italy, on Crete in Greece and at the south coast of Turkey (e.g. Antalya) also had zero precipitation. Persisting drought on Cyprus caused numerous forest fires.

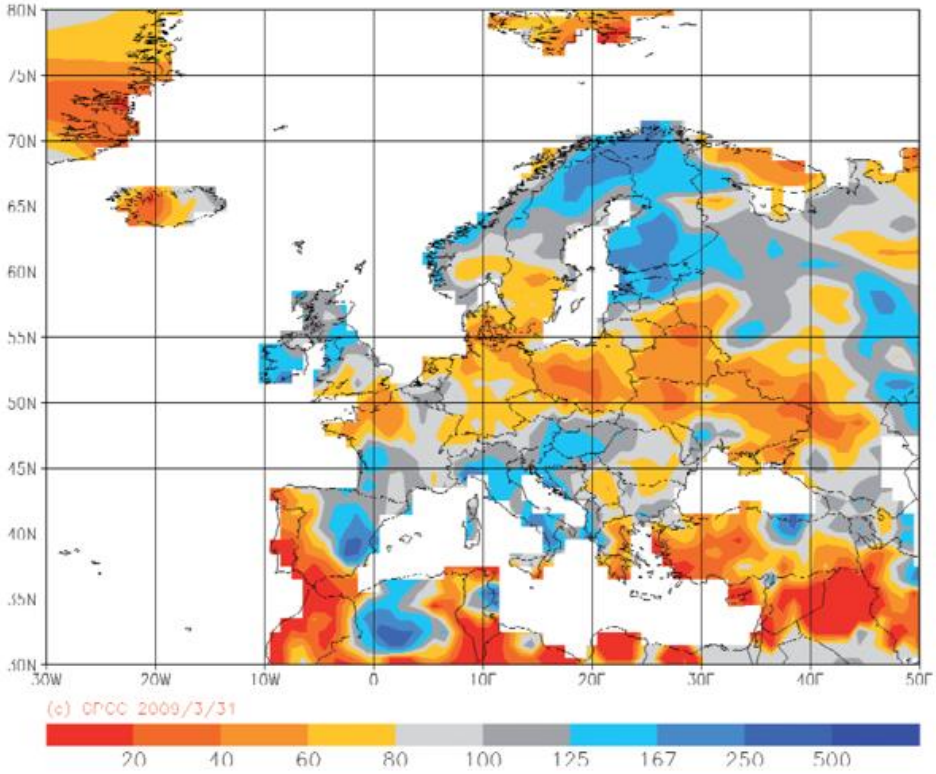


Fig. 6.2: *Monthly precipitation amounts for June 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Nevertheless, some places within the Region were very wet, especially Finland and northern Scandinavia, parts of Ireland and the United Kingdom, eastern Spain and southwestern France, parts of eastern Austria, Hungary, Italy and the western Mediterranean, the northern Balkan peninsula and parts of European Russia, partly with more than 200% of the normal monthly total. This was very often due to heavy thunderstorms. In northeastern Europe, the rainy period started on June 12 and continued until the end of the month. Latvia saw some extremely heavy rains, partly accompanied by hail with hailstones of several cm in diameter. During showers in southern European Russia (e.g. northern Caucasia), a precipitation total of 75-96 mm fell in 1-3 hours and hailstones of 25-40 mm in diameter were detected.

Hungary recorded 27 days with showers, i.e. nearly the whole month. Up to 300% of the 1961-1990 normal precipitation fell in Austria (south of Vienna) and in Albania. The highest monthly total in Albania was registered in Koplik with 157.1 mm which is the second highest June record ever. Such values are rather typical for a winter month in Albania, but not in summer which is normally much drier.

Armenia reported heavy rainfalls and thunderstorms in the second half of the month.

Significant weather events

June 02-03: At first, severe thunderstorms and heavy rain in southwestern and western Germany, later also in eastern Germany, partly with more than 50 mm in 1-3 hours.

June 06: Large hail up to 35-40 mm in diameter in Dagestan, eastern Caucasus, European Russia.

June 12-16: Heavy showers in various regions of the Ukraine and northern Caucasus, European Russia; 50-96 mm of precipitation within 3 hours or less.

June 14: Very intense rain close to Ferrara, Italy, along the Adriatic coast. Intensity locally 80 mm/h and totals for the whole event greater than 180 mm. Maximum total in more than 70 years, return period more than 200 years. Causing mildew in vineyards and fungi diseases in wheat.

June 17-19: 98.4 mm of rain due to an intense low pressure wave in North Wales (United Kingdom) within a 48-hour period ending 21 UTC on 19 June.

June 22-26: Thundery showers on 22 June with strong gusts and hailstones of approximately 5 cm diameter caused much damage in the eastern Netherlands. A large hailstorm was reported in Kaunas, Lithuania, with hailstones up to 28 mm in diameter. A heavy thunderstorm on 25 June occurred in central Germany with hail in the city of Mainz and on vineyards around. In Austria, heavy thunder and hailstorms with high precipitation also caused serious damage in the county Carinthia in the southeast; the cities of Spittal and St. Veit an der Glan partly flooded, agricultural losses (vine, fruits, crops). The TV transmission of the semi-final match of the European Soccer Championship in Austria was interrupted due to a heavy thunderstorm front passing over Vienna that time. Intense storm activity and precipitation also over the whole Czech Republic with gusts over 108 km/h and in Slovakia (daily precipitation of 70 mm in Kosice, east Slovakia, due to an isolated cumulonimbus cluster). In Hungary, 114 mm of precipitation fell within a few hours on 26 June.

June 28: A daily precipitation of 87.6 mm fell in eastern Latvia, more than the whole monthly normal precipitation. On average, such heavy precipitation occurs once every 4 years.

July

- **Mostly warm, cold in northeast and southwest Europe**
- **Middle latitudes, northeastern and eastern Europe mostly wet, western Scandinavia and Mediterranean mostly dry**

Atmospheric circulation characteristics

At the beginning of the month, a large low pressure system extended over northwestern, western and central Europe. In the second decade of the month, the low pressure centre moved to the North Sea, and central and eastern Europe were within a southwesterly air flow with warm air masses, causing heat waves particularly in southeastern Europe.

A high pressure system established over western Scandinavia and later extended to Iceland and Greenland, whereas frequent cold Arctic low pressure systems moved over northeastern Europe. Temporarily, in the second half of the month, a new cyclone with Arctic air masses developed over Scandinavia, and later moved to central and southeastern Europe under intensification.

Towards the end of the month, a new omega pattern built up with high pressure over northern and central Europe and low pressure over the Atlantic and eastern Europe.

Iberia and the Mediterranean remained mainly under high pressure influence.

Temperature

July was also warm in most of the Region. Anomalies exceeded +1°C in many parts of the area, especially in the northwest (e.g. Greenland, Iceland, Scotland, western Nordic countries) and in the southeast, locally even +2°C (Fig. 7.1).

Réykjavik in Iceland reported a new all-time record of daily maximum temperature since 1870 reaching 25.7°C on 30 July and an automatic station near Réykjavik even 29.7°C. It was the warmest July in Stykkishólmur since 1933. Another local record for July was set in southeastern Norway (county of Hedmark): 33.8°C on 26 July. Denmark also experienced a heat wave at the end of the month. Again, most of the North Atlantic was warmer than normal, too.

Central Europe was quite hot at the beginning of the month. Maxima up to 36°C were measured in southwestern Germany. Further maxima above 35°C were rare in Germany. With 33°C, the German North Sea island Norderney saw the highest temperature in the first decade of July since 1947. After the first hot days in July, however, the weather character changed to cooler and more variable conditions. And still, especially eastern parts of central Europe had another warm period at the end of the month. Berlin in Germany recorded a period of 8 days with a daily maximum of 30°C or more as compared to normally only 2.5 days.

Spain, Greece and Cyprus were hit by several heat waves with maximum temperatures locally exceeding 40°C. On the Adriatic coast in Italy, maxima of 35-40°C were recorded at the beginning of the month, whereas in Malta, the temperatures did not go beyond 35°C. In Bulgaria, 35°C were exceeded in many places on 18-22 July, causing wild fires. In the southeast of the Region, maximum temperatures reached up to 41°C in Azerbaijan and up to 44.5°C in Jordan.

Some areas of northeastern, western and southwestern Europe were slightly colder than normal. In parts of Finland, there were monthly mean anomalies below -1°C, mainly due to the first week of July which was the coldest since 1993, and minimum temperatures were falling as low as -2.7°C in the west of the country. Iberia was still warm in the south and east, but colder than normal in the northwest.

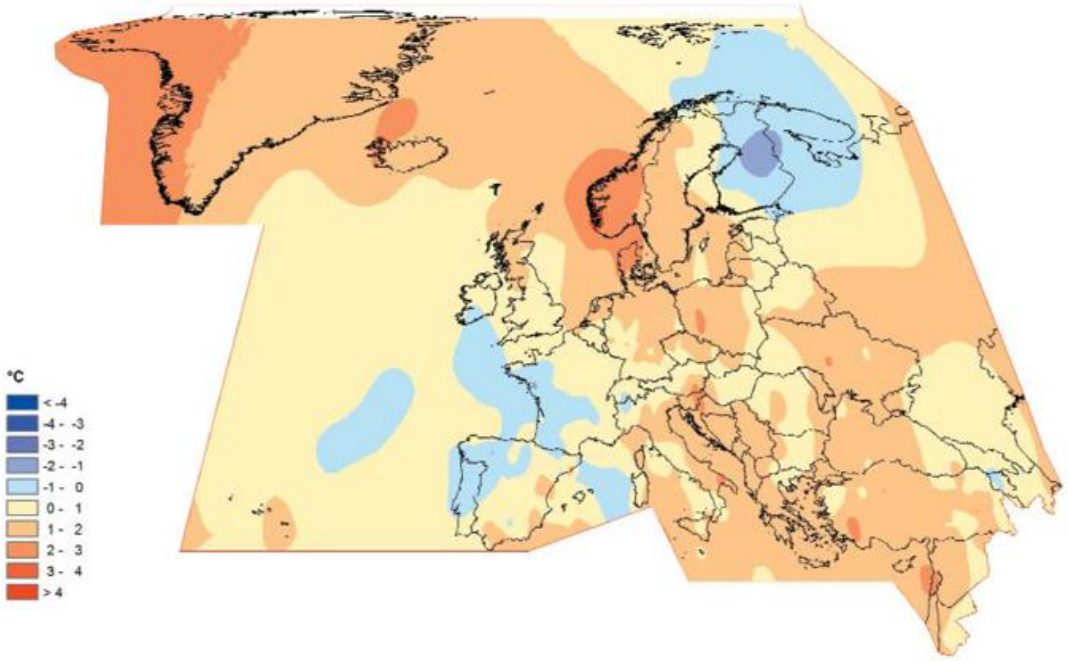


Fig. 7.1: *Monthly mean temperature anomalies in July 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

Precipitation

The middle latitudes, the Alps, eastern and northeastern Europe were mostly wet (Fig. 7.2). In many places more than 150-200% of the normal monthly total was recorded, in parts of eastern Austria and European Russia even more than 250%, in Slovakia more than 300%. 430 mm was the monthly total recorded by a Slovak station at the north side of the High Tatras, the second highest on record since 1951 behind July 2001. In Lugano, Switzerland, it was the second wettest July since 1864 (359 mm) due to consecutive heavy thunderstorms, and also Germany had some severe thunderstorm events although July precipitation totals exceeded the normal only by 10% on country average. In parts of the United Kingdom, rainfall was also well above normal. The England-Wales precipitation time series recorded 104 mm for July 2008, which is168% of the 1961-90 normal.

In eastern Europe, precipitation was characterised by a high spatial variability, ranging from a monthly precipitation of 30 mm in the western part of Estonia to 130 mm in the southern part of the country. Like in June, again heavy thunderstorms with large hail of 20-30 mm in diameter occurred locally in the north Caucasian region in southern European Russia. Azerbaijan south of the Caucasus Mountains also experienced heavy weather with hail. With over 180 mm of precipitation, it was the second wettest July in Moscow in more than 100 years. In Chertkovo (near the Russian border to the Ukraine), it was the wettest July at least since 1961 (Fig. 7.3).

Large parts of Scandinavia received very little precipitation, especially in central Norway and Sweden. Monthly totals were lower than 50 mm (less than 60%) over large areas and locally even below 30%.

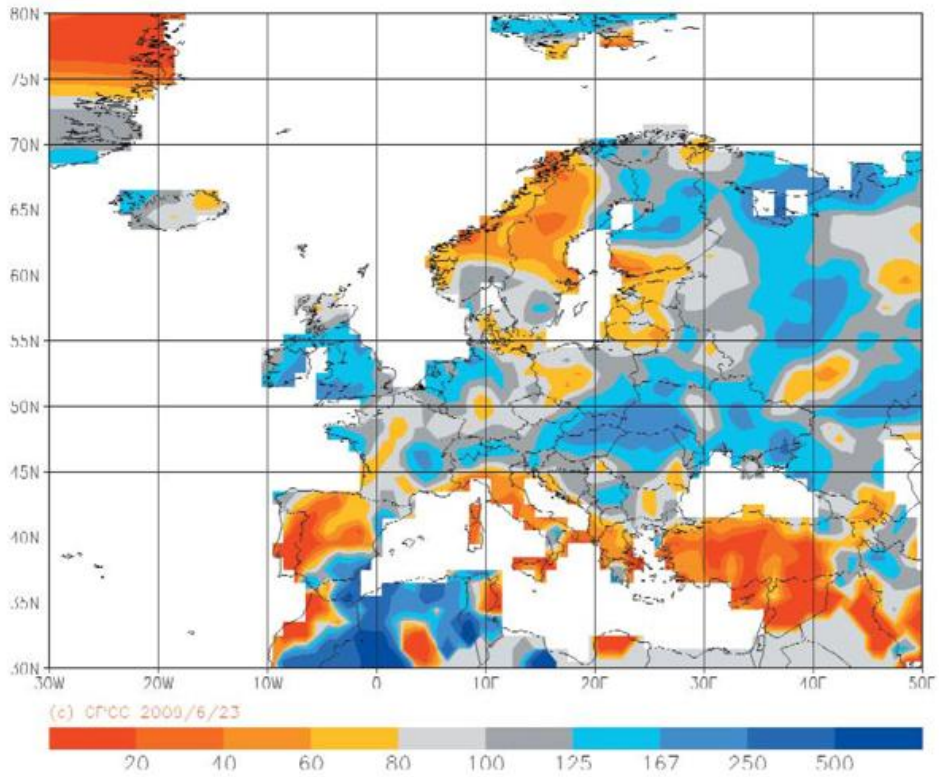


Fig. 7.2: *Monthly precipitation amounts for July 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

It was also very dry over most of the Mediterranean region and Iberia, except some smaller areas (due to local showers) especially in eastern Spain and the western Mediterranean. Monthly precipitation totals were less than 20% of the normal. Several locations (e.g. Lisbon in Portugal, Pisa in Italy, Athens in Greece) did not receive any measurable rainfall that month.

Snow

A stationary cold front in the middle of the month caused up to 1 m of fresh snow in the Alps in Switzerland. Snowfall was seen down to 1700 m. Montenegro recorded a snow cover in the highlands above 2000 m.

Significant weather events

July 02: 67 mm of precipitation in the afternoon in central-western Sicily (Italy). Heavy thunderstorms occurred also in central France (daily precipitation of more than 70 mm).

July 04: Eisenstadt, the capital of county Burgenland in Austria, was covered by hailstones up to 15 cm within a few minutes.

July 05: Oslo was affected by an intense thunderstorm, causing heavy rainfall and flooding. Gusts up to more than 95 km/h were reported.

July 06: Heavy shower with 72 mm of precipitation in one hour and ten minutes near Krasnodar, southern European Russia.

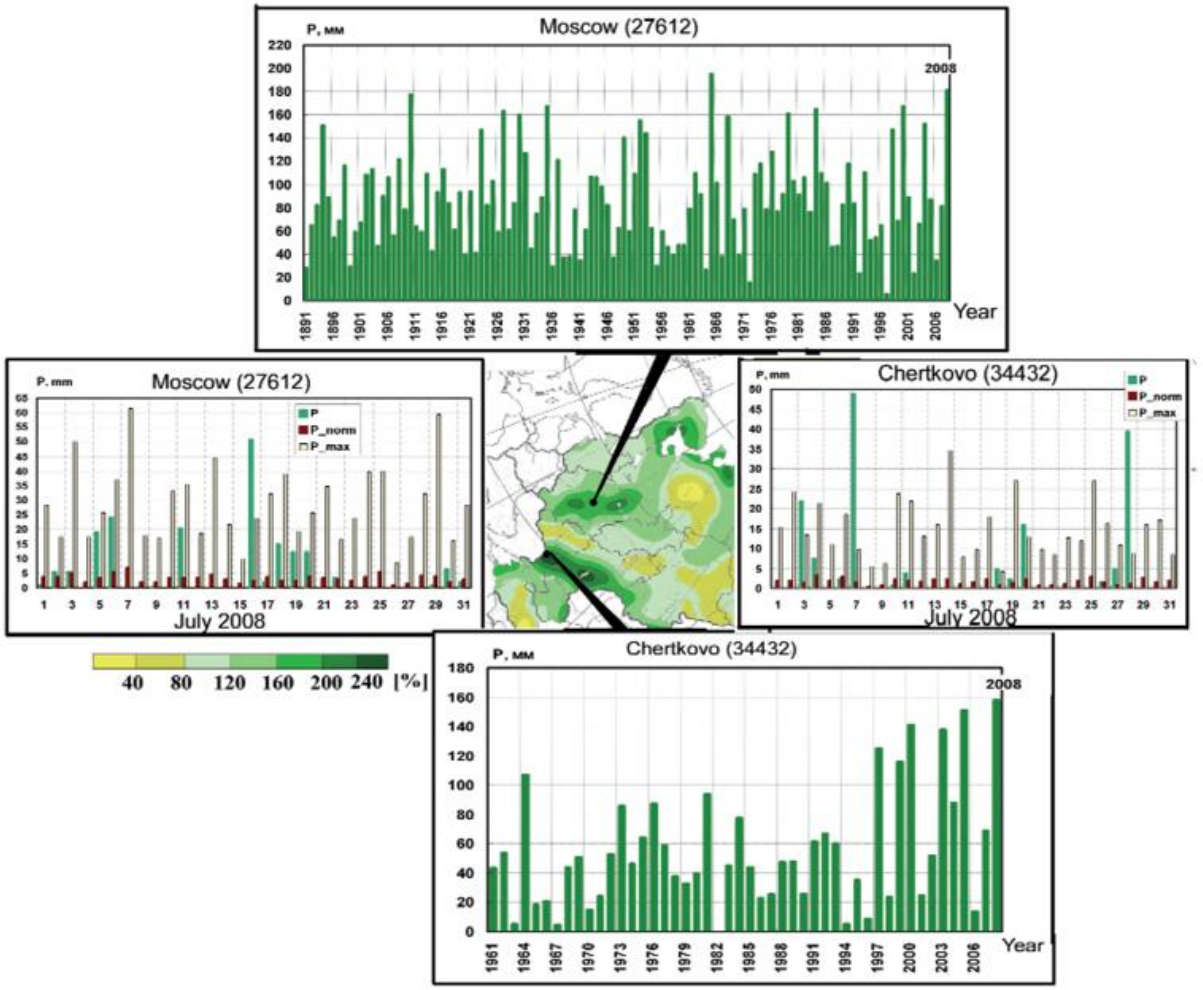


Fig. 7.3: *Precipitation totals in July 2008 in per cent of the normal 1961-1990 in European Russia. Insets show time series of monthly and daily precipitation at two meteorological stations (Moscow and Chertkovo, Russia).*
Source: Roshydromet, Russia

July 06: Heavy thunderstorms in northern Italy. Hail up to tennis ball size in the South Tyrol region and near Lake Garda.

July 08: 131.9 mm of daily precipitation fell near Kristiansand (south coast of Norway).

July 08: Thunderstorm caused damage in southwestern Bulgaria, tornado, hail stones as big as nuts.

July 08-09: Flooding in the Dashkesan region in Azerbaijan.

July 12-14: Heavy hailstorm along intense cold front affected upper Austria, Slovenia and northeastern Italy, particularly Venice. Crop losses in upper Austria over an area of 6,000 hectares; local heavy rain caused flooding of houses, the ground was covered by rocks, rubble and mud masses up to 3 m high, 750 inhabitants had to be evacuated for several weeks. Parts of forests in Slovenia were severely damaged (Fig. 7.4). Heavy rain and flooding also occurred in southern Switzerland (Ticino, 117 mm in 12 hours in Lugano).

July 15: Heavy rain in Võru (Estonia): 70 mm in 3.5 hours followed by hail causing damage to agriculture.

July 20: Heavy rain caused landslides in Austria (Upper Styria). Hail, strong gusts and flooding in other parts of Austria and southeastern Germany.

July 21: Ex-hurricane Bertha moved into the Region over the North Atlantic and Iceland, but weakened quickly.

July 21: Thunderstorm with tornado in northwestern Germany (west of Münster). Roofs untiled, but no fatalities.

July 21: Strong hailstorm in northern Italy with heavy rainfall.

July 21-29: Torrential rainfall due to a slow moving cyclone affected parts of the Ukraine (Carpathians), Moldova and Romania. Precipitation totals of up to 100 mm were measured in Romania (Moldavia region), in some places more than 200 mm (Fig. 7.5) and more than 350 mm in the Ukraine. At least 50,000 houses were affected by flooding and several ten thousand hectares of farmland were destroyed. 34 fatalities were reported. Dniester and Prut Rivers in Moldova saw a water level increase of 3-9 m until the middle of August (Fig. 7.6). In eastern Slovakia, heavy rains with flooding occurred on 20-25 July (Fig. 7.7). With 199 mm, a new 2-day precipitation record since at least 1951 was set on 22-23 July. Heavy rain and stormy gusts also occurred in eastern Austria.

July 22-28: Due to strong heat and drought over several weeks over the eastern Mediterranean, extensive forest fires occurred over Rhodes Island in Greece.

July 26: Heavy rainfall and strong hail in western Germany along a convergence line; up to 200 mm of precipitation within 5 hours in Dortmund, causing widespread flooding of the city of up to more than 1 m.

July 28-31: Slow moving depressions centred near the southwest of Ireland brought bands of heavy rain across Ireland and England. 28.8 mm of rain fell in one hour from 28 July 23 UTC to 29 July 00 UTC in central England. On 31 July, widespread rainfalls with 20-40 mm in 24 hours, locally even up to 90 mm, were measured in Ireland, most of which fell between 18 UTC and midnight. Such a 24-hour precipitation total has a return period of about 250 years and the 6-hour precipitation total was one of the highest values ever recorded in Ireland. River Arra (Ireland) overflowed its banks, many buildings flooded to a depth of over one metre.



Fig. 7.4: *Damage of wood in Slovenia after thunderstorm on 13-14 July 2008. Source: Environmental Agency of the Republic of Slovenia*

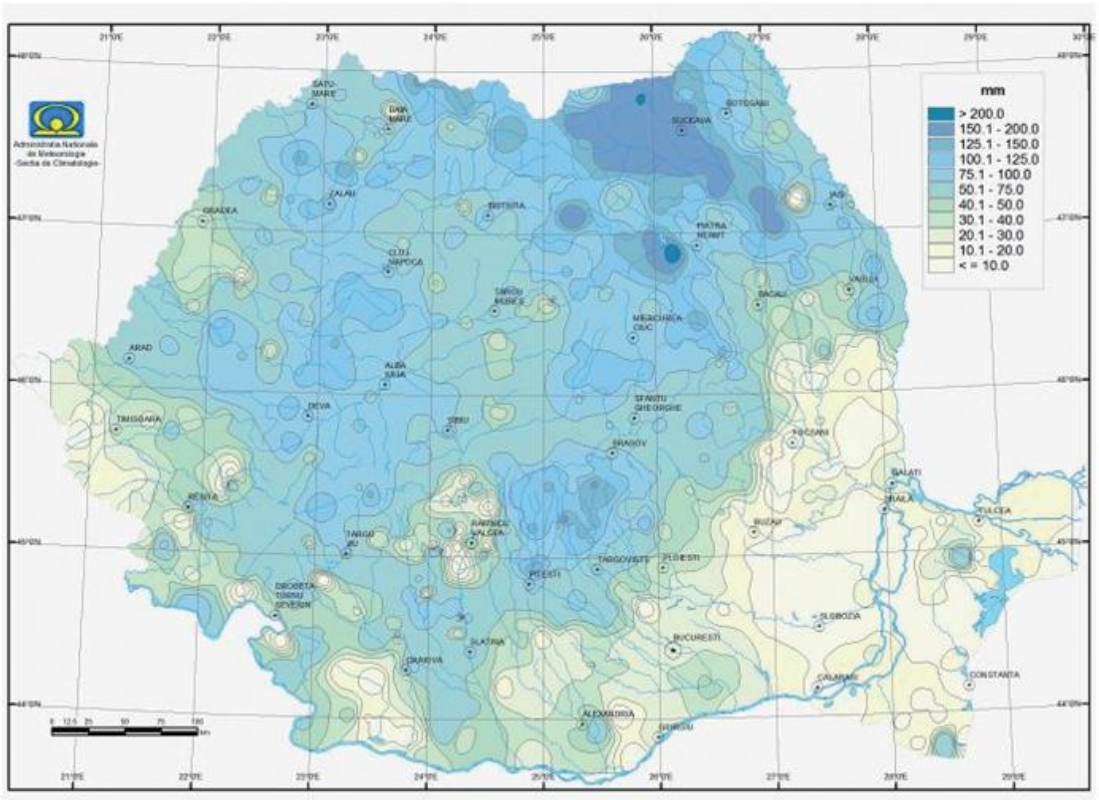


Fig. 7.5: *Precipitation totals for the period 22-31 July 2008 in Romania.*
Source: National Meteorological Administration, Romania



Fig. 7.6 *Flooding in the city of Tiraspol (at Dniester River, southeast Moldova) in July/August 2008 after heavy rainfall on 22-27 July 2008.*
Source: State Hydrometeorological Service, Republic of Moldova

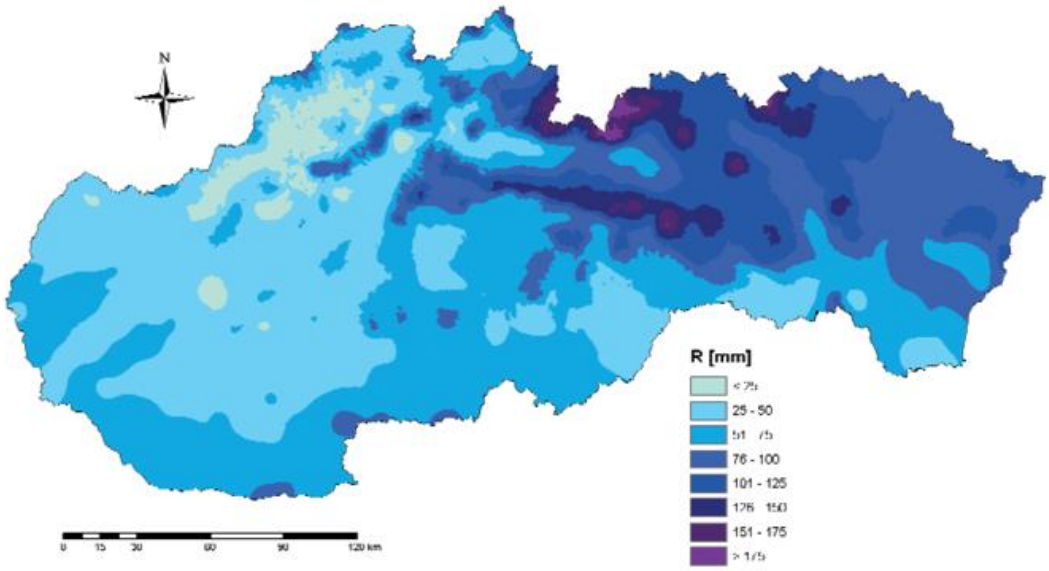


Fig. 7.7: *6-day precipitation totals on 20-25 July 2008 in Slovakia. Source: Slovak Hydrometeorological Institute*

August

- **Mostly warm, cold in northeast and southwest Europe**
- **Wet in most of the north, dry in the south**

Atmospheric circulation characteristics

A strong low pressure system persisted over the central North Atlantic at the beginning of the month. The frontal zone with cyclonic activity extended soon over most of northern and central northern Europe. Only the Arctic region remained mostly under high pressure influence. However, several strong Arctic cyclones over the Barents Sea led cold air to northeastern Europe.

The Mediterranean and also eastern Europe around the Black Sea were mostly under high pressure influence. By the middle of the month, a trough extended temporarily far southwards to the western Mediterranean, causing once again a strong southwesterly flow with warm air over southeastern and eastern Europe and heat waves in these parts.

Temperature

The distribution of temperature anomalies was almost the same as in July. It was warmer than normal in most of the Region, except northeastern Europe and some places in western and southwestern Europe (Fig. 8.1). Most of the North Atlantic continued to be warmer than normal, except some areas west of Europe. The monthly mean sea surface temperature in the Mediterranean near Malta was 27.3°C, which is +1.5°C warmer than normal.

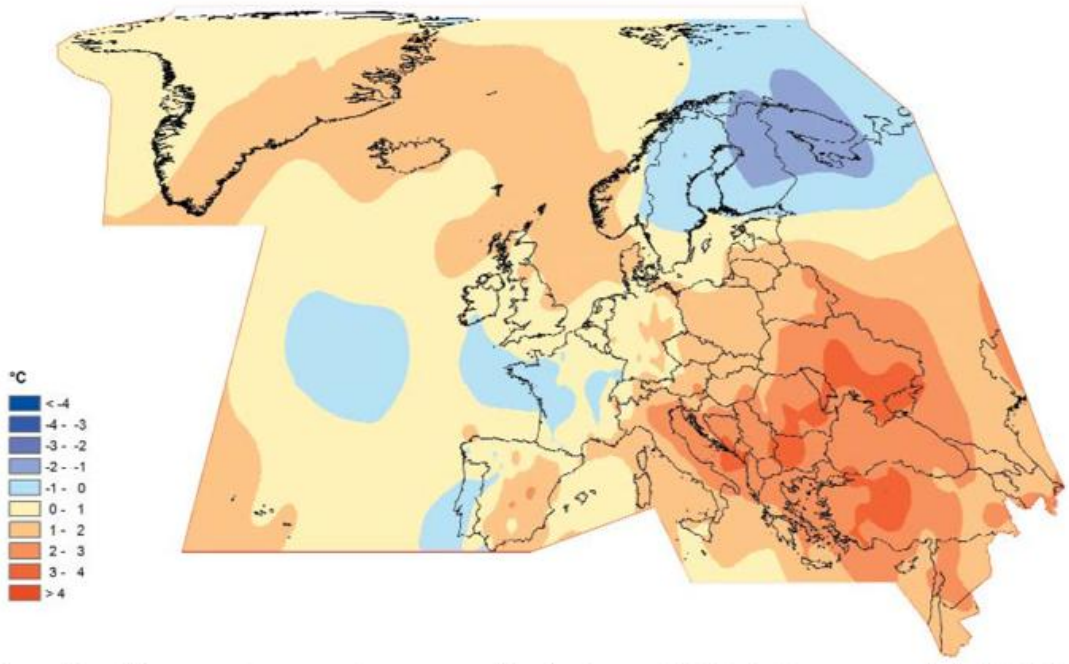


Fig. 8.1: *Monthly mean temperature anomalies in August 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

The highest anomalies were observed in the southeastern parts of the Region, exceeding +3°C in many places and +4°C locally in Turkey. Monthly mean maximum temperatures reached even more than +5°C as compared with the normal, e.g. in many parts of Albania, where various new August records were set.

Maxima in southeastern Europe exceeded 40°C in some places, reaching e.g. 41.1°C in Mostar (Bosnia and Herzegovina). Some places in Greece and Cyprus reached 40°C during the several heat waves. August was also particularly hot in Hungary, Serbia, the Ukraine, Romania and Bulgaria, with daily maxima above 35°C particularly on 12-17 August and partly also on 20-24 August leading to extended wild fires especially in southeastern Bulgaria. Macedonia also saw a warm month and monthly mean temperatures exceeded 25°C in several places (Fig. 8.2). Southern European Russia also experienced very hot weather especially in the second half of the month when maximum temperatures rose to 35-40°C and caused extreme fire risk. Azerbaijan reached similar temperatures (38-41°C).

Locally, temperatures were also quite high at night. Belgrade in Serbia, for example, recorded 10 tropical nights as compared with the August normal of 2.8 nights. The Ukraine saw local daily minimum temperatures above 25°C. With 21.8°C, the monthly mean minimum temperature in Tirana, Albania, set a new local record.

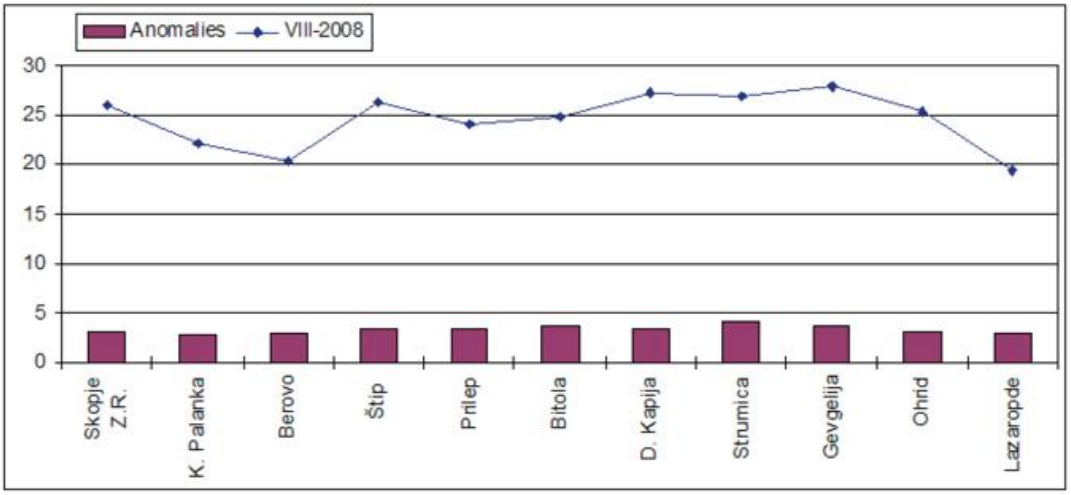


Fig. 8.2: *Monthly mean air temperature and anomalies (reference period 1961-1990) in August 2008 at stations in Macedonia.*
Source: Hydrometeorological Service of Republic of Macedonia

In the central Mediterranean, 40.2°C were measured on Sardinia on 6 August. Spain was also warmer than usual on monthly average: maximum temperatures reached 37-40°C in the south of the country at the beginning of the month, with similar values recorded at several later occasions. Portugal had a monthly mean around normal, but maxima climbed up to 38°C on 4 August.

Monthly mean temperatures in central Europe were less above average than in the southeast. Monthly mean anomalies mainly ranged between +0.5 in parts of Germany and +2°C in Slovenia. Poland's highest monthly maximum temperature of 33.7°C was measured on 1 August already and was the highest of the whole year. Germany recorded highest monthly maxima of up to 35°C in the northeast of the country on the first day of the month shortly before the heat wave ended.

Heat waves extended even to the northern parts of eastern Europe. Lithuania had a warm spell in the middle of the month when the maximum temperature locally climbed up to 29-32°C. The warm spell also affected Belarus bringing it a high mean temperature of 20.7°C in the second decade of the month (16 August was the warmest day). Most of Belarus has seen such a warm decade for the first time on record.

In the United Kingdom, only the monthly mean minimum temperatures were well above normal (+1 to +2°C), while the mean maxima were close to normal on average.

In August 2008, only the far northeast of Europe was remarkably colder than normal. Anomalies below -1°C were again recorded in Finland and northern Russia as in the preceding summer months. Northern Sweden and Finland saw slight frost at the beginning of this August.

Precipitation

August 2008 was very wet in most of northern and northern central Europe (Fig. 8.3). Monthly precipitation totals were higher than 100 mm (150% of the normal, locally more than 200%) in many places of Ireland und the United Kingdom, western France, the northern coastal areas of

Germany and Poland, southern Scandinavia, the Baltic countries and northern Russia. In Ireland, it was the wettest August since records began in 1837 and in Northern Ireland since at least 1914. By mid-month, several heavy rainfall events had destructed crops and severely affected harvesting over southern and eastern Ireland. Widespread flooding also occurred in Northern Ireland and parts of eastern Scotland. In the Netherlands, a monthly precipitation of 267 mm fell on Ameland island. In Denmark, it was the wettest August in 40 years. Some parts of Estonia received more than 300% of the 1961-90 normal (Fig. 8.4), making it the wettest August since 1950.

Some high monthly precipitation totals were recorded even in southern central Europe. Austria received monthly totals of up to 175% of the normal due to several hailstorms which caused enormous damage to houses and fields in several parts of the country. Severe thunderstorms with hail and heavy precipitation were also frequent in Slovenia, causing widespread damage to crops, buildings and cars.

The higher northern latitudes (parts of Greenland, Iceland, Svalbard, Lapland) were dry with some locations with less than 60% and locally even less than 30% of the normal precipitation.

The southern half of the Region was also mostly very dry. Especially during the second decade, there was no measurable precipitation in most places in Serbia. In many parts across and around the Mediterranean and the Black Sea, just a few mm or less than 20% of the normal precipitation fell throughout the whole month. Athens in Greece received a monthly total of 2 mm. Some parts of the Mediterranean, e.g. Malta, recorded no rain at all in this month as compared to a small normal average of at least 5.3 mm. Madrid, Lisbon and Istanbul were also without any measurable precipitation. Even in some mountain regions in Georgia, as little as 30-40% of the normal (30-40 mm) were registered. Only a few locations in the southeast of the Region received high amounts of shower precipitation. After a first rainy decade of the month, Azerbaijan was without any rain at all during the second and third decades.

Significant weather events

August 03: In the evening, a tornado was observed in northern France within a rainy front. Its path was longer than 15 km and had a width of 100-200 m, damaging, or completely destroying around one thousand houses (Fig. 8.5). The intensity level was estimated F3 or F4 on the Fujita scale. On the same day, another tornado devastated numerous farms in the northeastern Netherlands.

August 03-12: Many thunderstorms in Germany with heavy rain, strong gusts causing damage to buildings (due to a thunderstorm downburst or possibly a small tornado) on 04 August in the hills (Odenwald); roads flooded in northern Germany. In eastern Austria (Burgenland), flooding of vineyards on the same day. Several tornadoes in various parts of Germany.

August 04: Summer storm in southernmost Sweden, wind gust of hurricane force at 3 coastal stations. Most intense summer storm since 1985. Heavy rain, e.g. 58 mm in 24 hours in Gothenburg. Storm with hurricane force also over the southern Baltic Sea.

August 06-09: Highest-ever hourly rainfall (38 mm per hour) at Shannon Airport (Ireland) during a thunderstorm on 06 August (return period of over 100 years); almost 30 mm were recorded within a 30-minute spell. Another severe rainfall event with flooding followed on 09 August: 76.2 mm at Dublin Airport was the second highest daily total ever recorded in the station's 67-year history.

August 07: Heavy thunderstorms in northern Germany with heavy rains and strong winds. A tornado was observed, too.

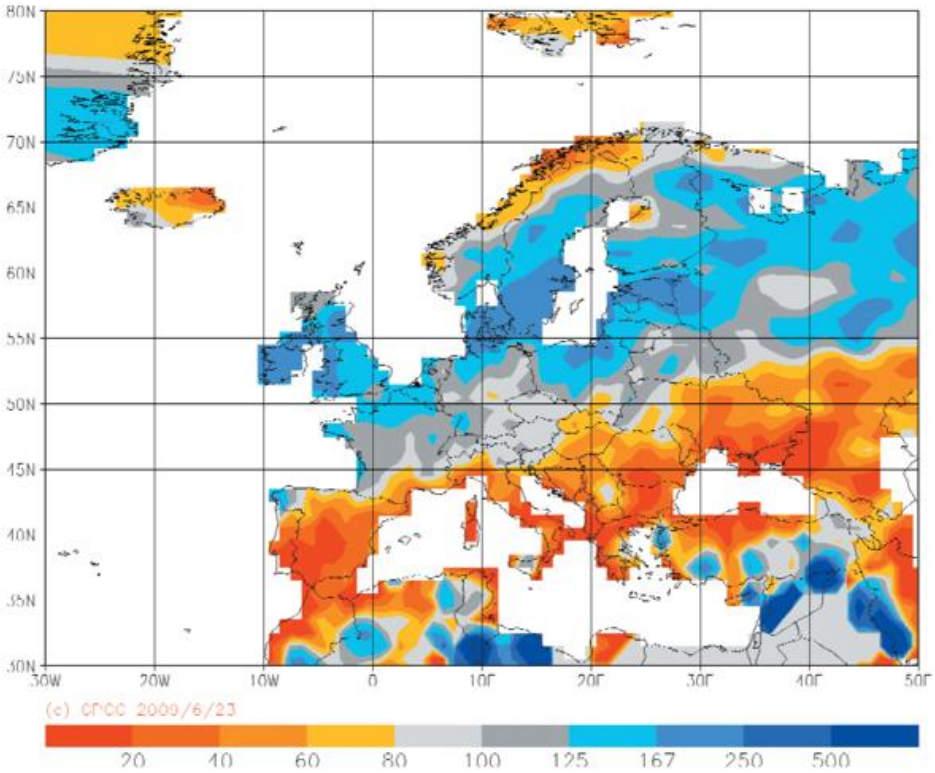


Fig. 8.3: *Monthly precipitation amounts for August 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

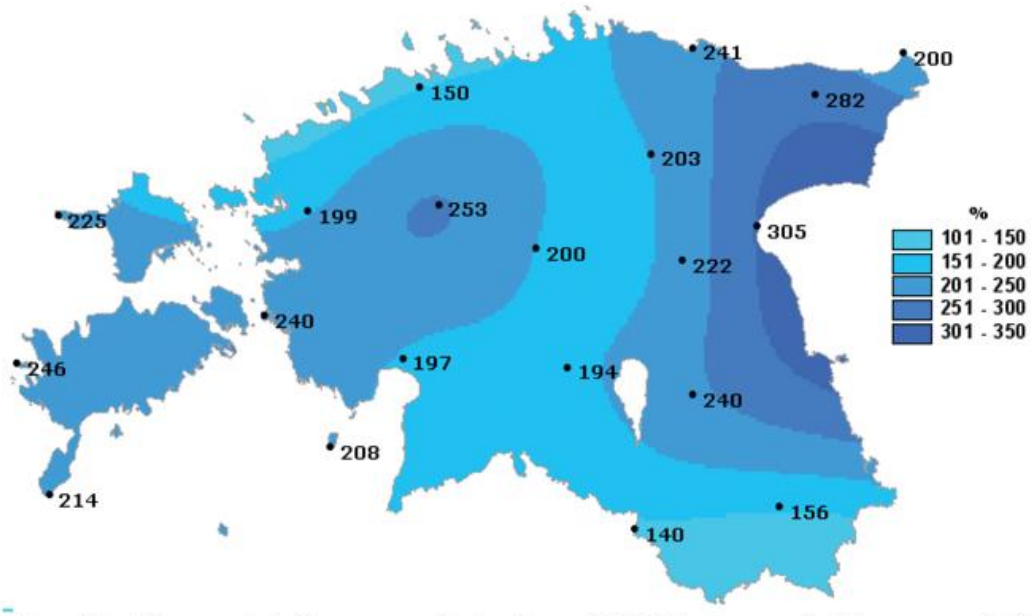


Fig. 8.4: *Monthly precipitation amounts for August 2008 in per cent of the normal 1961-2000 in Estonia.*
Source: Estonian Meteorological and Hydrological Institute

August 09: Strong thunderstorms in mountainous regions in Bulgaria with egg-sized hail stones. Heavy thunderstorms also in Slovakia and the western Ukraine.

August 12: Heavy thunderstorms in western and central Germany. 2 tornadoes damaged several houses and forests.

August 15: Hailstorms in eastern Austria (Burgenland again), damage over an area of 3,000 hectares. High daily precipitation of more than 100 mm fell at mountain stations in southern Austria. Heavy storms also in northern Italy, Slovakia and Poland.

August 16: Fair Isle (United Kingdom) recorded a daily precipitation total of 101.2 mm, thus setting a new record with an estimated return period of over 200 years.

August 16: Tornado affected Cyprus over the area south of Nicosia, causing damage to properties.

August 16: Rainfall in northeastern Israel – a most unusual event during the dry summer months.

August 26: Torrential rain in Jõhvi (Estonia) with a daily total of 116 mm.

August 31: Heavy rain and thunderstorm in east Thessalia and the Sporades (Greece). Flooding in the greater area of the city of Volos; daily rainfall total of 80.8 mm.



Fig. 8.5: *Track of a tornado on 03 August 2008 over Hautmont, northern France. One house was completely destroyed after the tornado had passed.*
Source: Météo France

September

- **Cold nearly all over Europe, warm in the Arctic and the Middle East**
- **Dry in most of Scandinavia, wet in the southeast**

Atmospheric circulation characteristics

In the first decade of the month, low pressure systems over the Atlantic transferred humid and only moderately warm air to northwestern and western Europe, whereas southeastern Europe and the Middle East were still in a warm air flow. Subsequently, a strong high pressure system with very dry air established over Scandinavia, leading cold air from the northeast to central Europe. In the second half of the month, a large low pressure complex moved cooler air masses also to southeastern parts of the continent.

In general, the Arctic region and Iceland experienced a very mild and humid air flow, particularly triggered by the ex-hurricane Ike which moved up north towards the south coast of Greenland in the middle of the month.

Temperature

September 2008 was colder than normal nearly all over Europe and the eastern central North Atlantic (Fig. 9.1). Most countries in western and central Europe were about 1°C cooler than average. In some places in France, Germany and Switzerland, the anomalies were below -2°C, in southeastern Europe between -0.5 and -1°C, in European Russia -0.4°C on average (due to alternation between intensive heat and cold waves).

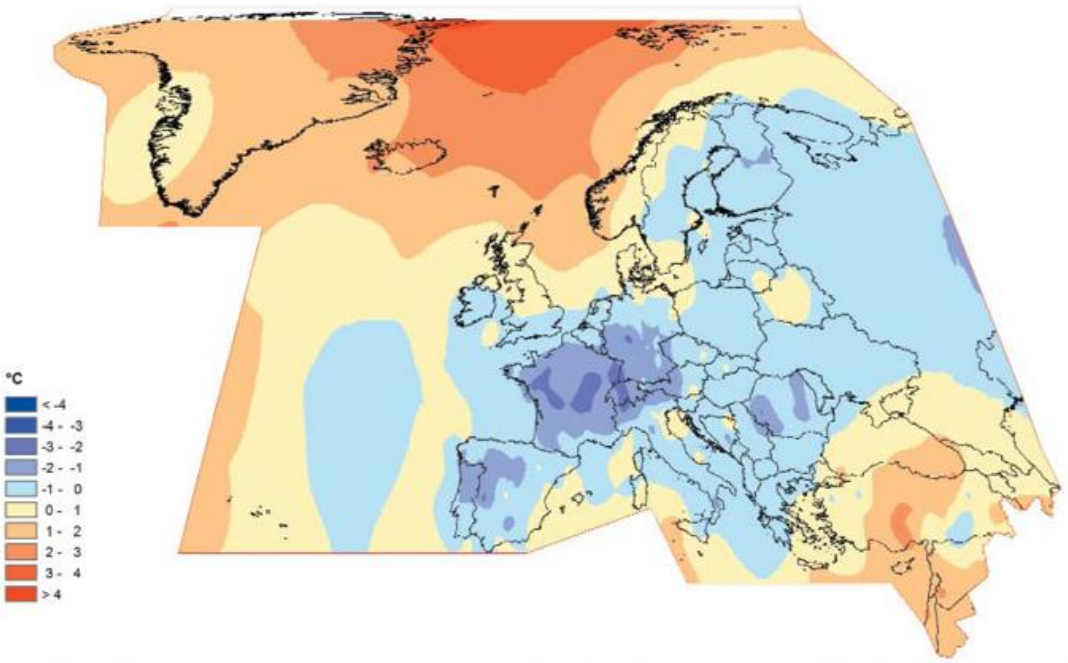


Fig. 9.1: *Monthly mean temperature anomalies in September 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

In Germany, Switzerland, Austria, Poland, the Czech Republic, Hungary, Croatia, Serbia and Romania, September was the only month of 2008 in which temperatures below the country average were recorded. In the middle of the month, widespread night frost occurred in central

Europe. New low maximum temperature records were set in Hungary with maximum values at around 5°C and thus the lowest maximum ever recorded since the beginning of measurements in this country. In Lithuania, mean daily temperature fell below 10°C by the middle of the month, bringing active vegetation to an end about 10 days earlier than normal. Across the United Kingdom, September mean temperatures were generally close to normal, while Wales and Northern Ireland had their coolest September since 1994.

In some countries, the cooling arrived some time later in the month. Hungary, Serbia, Montenegro, Romania and Bulgaria as well as the Mediterranean region (e.g. Greece, Malta) experienced a heat wave at the beginning of September with widespread maximum monthly temperatures of up to 35-40°C, whereas cooler conditions prevailed there in the second half of the month. Montenegro experienced its hottest 7-day period ever recorded; the average maximum temperature in that period was 34.3°C compared to the climatological mean of 28.6°C. Central and eastern Europe (e.g. southeastern Germany, Austria, Poland, Belarus, Ukraine) also recorded high maxima at the beginning of September, although the temperatures were somewhat lower than in southeastern Europe (30-35°C).

Averaged over the whole month, the Middle East was also characterized by warmer-than-normal conditions, but again this was mainly due to heat waves at the beginning of the month. Anomalies higher than +2°C were recorded in various places in the Middle East. Jordan experienced a heat wave on 1-7 September, with the highest maximum temperature measured at 43.4°C in Rwaished on 5 September. In Georgia, only the beginning of the month was warm with maximum temperatures up to 34°C in the coastal zone. The second half, however, was notably colder with first autumn frost in mountain regions. Armenia recorded 35-38°C in the lowlands.

It was also warmer than normal in the Arctic and the northern North Atlantic with monthly mean anomalies up to +4°C in northeast Greenland. Réykjavik in Iceland was +2°C warmer than the normal monthly average, other parts of Iceland more than +3°C (e.g. Akureyri). Temperatures above 20°C were recorded in Iceland on 17 September. Norway as a whole was +0.6°C above the normal monthly average, mainly due to high maxima during high pressure influence. Temperatures in Lapland reached up to 14°C.

Precipitation

Much of northern Europe was very dry. Less than 25 mm (or 40% of the normal) fell over large areas in Sweden and other parts of the north (Fig. 9.2). Latvia and Lithuania also saw less than half its normal September precipitation (1961-90). Various parts of western and central Europe including parts of the Alpine region, northern Iberia, central Italy and the Adriatic coasts were also dry despite various local heavy thunderstorms. In Ljubljana, Slovenia, it was the second driest September ever, together with September 1966.

Wet areas, on the contrary, were to be seen in the Arctic and in Iceland. It was a very wet month for Réykjavik (>250% of the normal), and Stykkishólmur on the west coast of Iceland recorded its wettest September since 1856. More than 200% of monthly precipitation was also reported from eastern Greenland. The midlands and the northeast of England, too, experienced a wet month, with some stations recording around 300% of their normal monthly rainfall (1961-90).

In other parts of the western half of Europe, there were also a few areas of high precipitation. Luxembourg Airport reported 162% of average September precipitation (1971-2000) and set new records for hourly and daily rainfall totals. Geneva had a monthly total of 215 mm, which is more than 250% of the normal. Italy received high monthly totals in its northern regions, particularly near the central Alps (up to 200-300 mm) and in the south (Puglia region). Most of the Mediterranean (except Corsica and Sardinia) was also wetter than normal. A monthly total

of 88 mm fell at Luqa Airport in Malta, far above normal. Most of this rain fell at the end of the month when 41.8 mm, alone, were measured on the last day of the month during a thunderstorm.

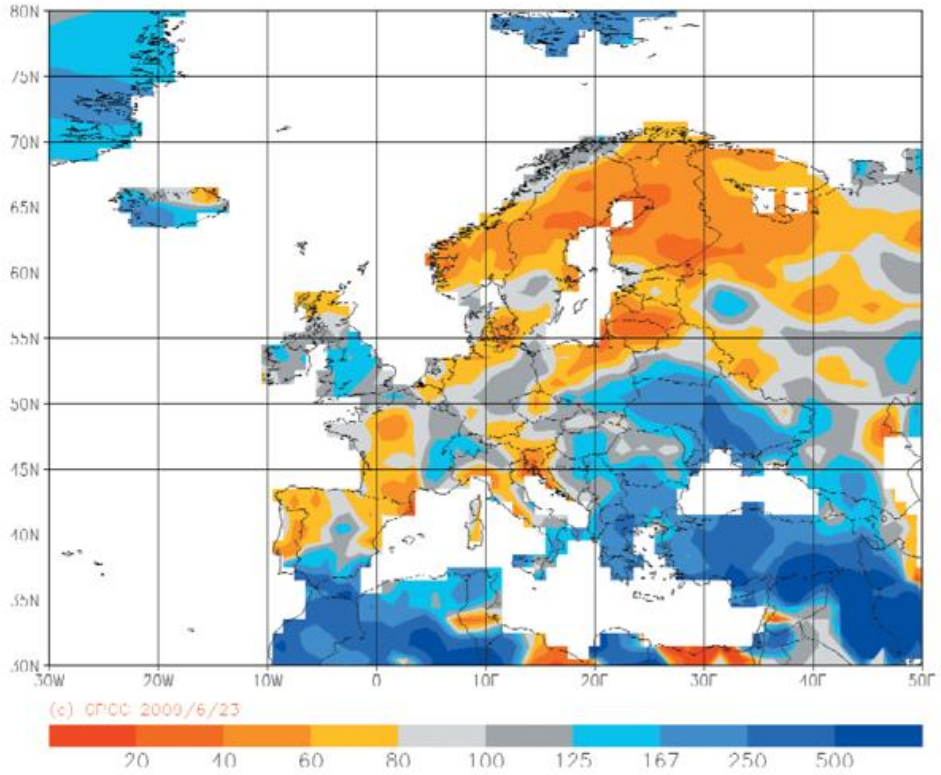


Fig. 9.2: *Monthly precipitation amounts for September 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Faro on the southern Atlantic coast of Iberia set a new record with 80.4 mm in 24 hours from 28 to 29 September and recorded a monthly total of 147.3 mm, its highest September total since the beginning of the measurements in 1965. At the end of September, the heaviest rainfall in 30 years occurred in eastern Spain and caused local flooding. Valencia recorded an hourly rainfall total of 144 mm and a 24-hour rainfall total of 390 mm. New monthly records were also set for southern Spain (e.g. Cadiz).

Many southeastern areas of the Region also received much precipitation, mainly due to some heavy rain events in the second half of the month especially around the Black Sea and the central and eastern Mediterranean. Along the southern and eastern coasts of the Black Sea, monthly totals amounted to more than 150 mm. It was exceptionally wet (around 200%, locally even 300% of the normal) in the Ukraine, Bulgaria, eastern Croatia, Macedonia and parts of Greece. Athens and southeast Albania received 350% of the September normal, marking a new September record since 1961 with monthly totals of close to 200 mm. Cyprus received a monthly precipitation of 22.4 mm, 5 times its normal. Turkey also experienced an exceptionally wet month with frequent heavy rain and flooding and monthly totals of 2 to 5 times the normal. In Israel, 5-10 mm of rain were measured at the end of the month. Some areas (mountains and the southern coastal plain) recorded even 15-30 mm and thus the highest monthly totals ever measured in September. Rainfall in Israel in September is not unusual, but in general the amounts remain below 1 mm. With heavy showers in several locations, it was also unusually

rainy in Armenia throughout the whole month. Armenia's capital Yerevan received more than 500% of its normal precipitation. Azerbaijan also had a wet month with some intense thunderstorms, and Georgia reported several flooding events.

Snow

Due to the widespread cooling in September 2008, snow fell on mountains above 1800 m in the northern Alps (e.g. on Wendelstein in Germany) in the middle of the month.

In the second half of the month, precipitation fell as snow in Romania in the mountains above 1500 m.

Significant weather events

September 05-06:	Flooding of buildings and transport disruption in the United Kingdom (Wales and England). Local 48-hour rainfall totals of more than 150 mm, estimated return period of over 200 years.
September 08:	Heavy rain in the morning in Riga, Latvia. Streets were flooded for several hours (Fig. 9.3). Heavy rain also in Estonia.
September 11-12:	Heavy rain and flooding in western Germany in the evening of 11 September. On the following day, thunderstorms with heavy rain also in other parts of Germany.
September 13:	Daily precipitation of 263 mm at the airport of Torino Caselle, Italy, caused by an intense low pressure area over the gulf of Genoa. About 50 flights cancelled, temperatures fallen by about 10°C particularly in the northwestern parts of the country, flooding, hailstorms, strong gusts, violent electrical discharges.
September 13:	8 hours of heavy rain near Krasnodar, southern European Russia, amounting to a total of 132 mm in that time.
September 15:	Torrential rainfalls up to a daily total of 100 mm in northern Dobrudja, Romania, during a thunderstorm. Heavy rain and temperature decrease up to 15°C in Montenegro; 125 mm of daily precipitation in the north-west part of the coastal area.
September 17:	Daily precipitation of around 200 mm in various places in southwestern Iceland.
September 23:	Heavy rain in eastern Spain (south of Valencia), up to 340 mm in 24 hours, heaviest precipitation in 30 years.
September 26:	Heavy, but short (less than 30 minutes) storm in Istanbul, Turkey; minaret crashed down on a restaurant. Gusts up to 104 km/h.



Fig. 9.3: *Flooded streets in Riga, Latvia after heavy rain on 8 September 2008. Source: Latvian Hydrometeorological Agency*

October

- **Cold in western Europe, warm in the east**
- **Wet in most of northern and western Europe, mostly dry in the east and south**
- **Early snow in northwestern and central Europe**

Atmospheric circulation characteristics

A large low pressure complex extended over northern and northern central Europe. Cold air masses moved over Iceland, northwestern and western Europe, reaching as far as Iberia. On the other hand, eastern Europe, particularly Russia, remained in a southwesterly warm air flow, partly anticyclonic. This situation occurred at the beginning of the month and once more at the end of October.

In the second decade of the month, a large high pressure area established over central Europe while northwestern and northern Europe were lying within the main frontal zone. The high pressure zone extended also to the central Mediterranean, whereas two low pressure systems affected the western and the eastern Mediterranean for several days.

Temperature

In the western parts of Europe, the cold conditions continued into October. Anomalies below -1°C were registered in many places (Fig. 10.1).

On Iceland, October was the only colder-than-average month in 2008. During the last week of October (28-29 October), some stations in the United Kingdom set new October records for low maximum temperatures since 1960. Northern Ireland had its coldest October since 1993. Even Spain and southern France were colder than normal despite a summery period with

temperature maxima above 25°C in the middle of the month. Malta in the Mediterranean also saw a colder-than-normal October with 0.4°C below the monthly normal. Especially the mean maximum temperature was lower than normal.

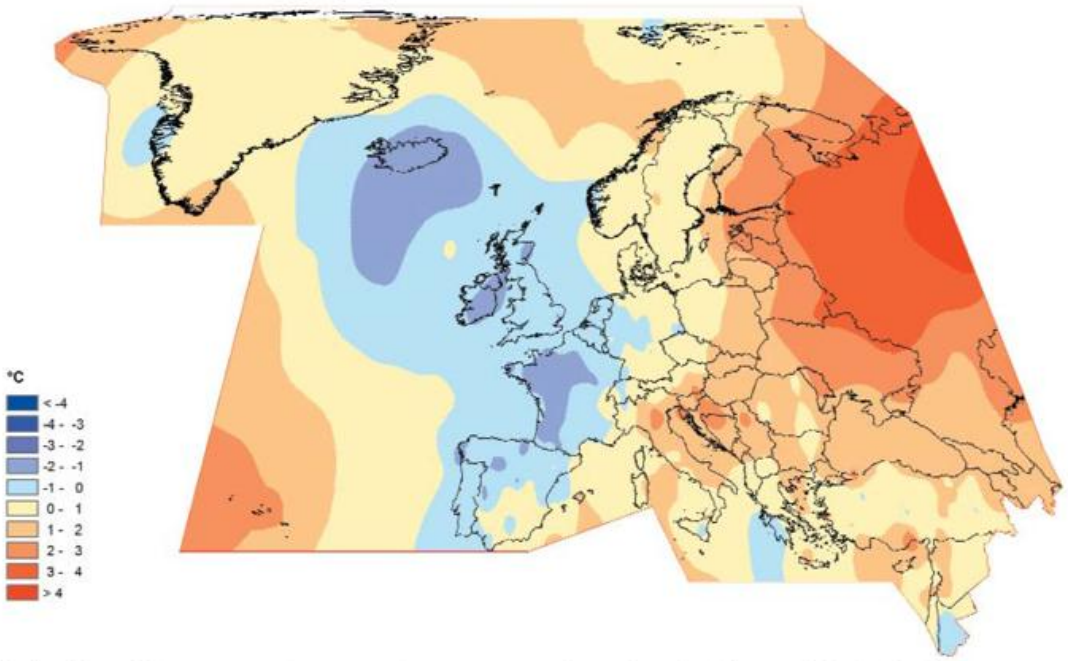


Fig. 10.1: *Monthly mean temperature anomalies in October 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

The North Atlantic was colder than normal over areas around Iceland and western Europe, but warmer elsewhere. Over the Azores Islands and the central North Atlantic, the anomalies were above +2°C.

In central Europe, Germany recorded at many places daily maxima above 20°C, at some places in the southeast even above 25°C, but a monthly average near normal (+0.1°C anomaly). In Switzerland, daily maximum temperatures rose to 20°C in the plains on both, the north and south sides of the Alps, and up to 15°C at an altitude of 1500 m.

The remaining areas of the Region were, in general, warmer than normal, most of the eastern half of Europe by more than +1°C. It was particularly warm in the easternmost parts of the Region with anomalies above +4°C over eastern European Russia. Lithuania was warm especially at the end of the month with maximum temperatures of 15-18°C. Poland even measured temperatures up to 21°C (Lodz) and Croatia up to 27°C. Frost was very rare in Serbia. Bulgaria saw temperature maxima up to 29°C at the beginning of the month, but afterwards experienced an abrupt temperature decrease.

Precipitation

It was mostly wet in the western and northern parts of Europe (Fig. 10.2). Some areas near the west coasts of Ireland, Scotland and England received monthly totals of more than 200 mm which in some places was more than 200% of the 1961-90 normal.

Scotland experienced its wettest October since 1954. Northernmost areas of Germany received more than 100 mm of precipitation during the first 5 days of the month which partly was more than the normal monthly total. With 181 mm, the German North Sea island Helgoland set a new monthly record for October causing the monthly total for the whole of Germany to rise to more than 130%.

Exceptionally high rainfalls also occurred at various places in Spain, along the Norwegian west coast and in a large area extending from southern Finland to northern Russia and the Baltic countries. More than 200% of the normal precipitation fell in Madrid and in Helsinki. The country average in Estonia was 154% of the 1961-90 normal precipitation. Western Greenland was also wet: Egedesminde at the Disko Bay received a monthly total of 79 mm, which is more than 300% of the normal.

Austria saw two episodes of heavy rain on 3 and 29 October in the southeast of the country, whereas northern and eastern Austria were rather dry with precipitation totals less than 75% of normal.

Coastal zones in Georgia received more than 100 mm (i.e. 140% of normal precipitation).

It was dry over most of eastern Europe and eastern parts around the Mediterranean, partly with monthly totals of less than 40% of the normal. In some places in Greece, only a few mm of precipitation fell during the whole month. In other places, there was no precipitation at all, which is very unusual for the place and month. However, October in Israel was rainy, with extreme rainfalls most of which occurred almost every day between 22 and 29 October. Haifa received 80 mm in just one hour, the highest 1-hour total ever measured in Israel.

Portugal, particularly the Azores Islands, was dry, the latter with locally less than 15% of the normal monthly precipitation.

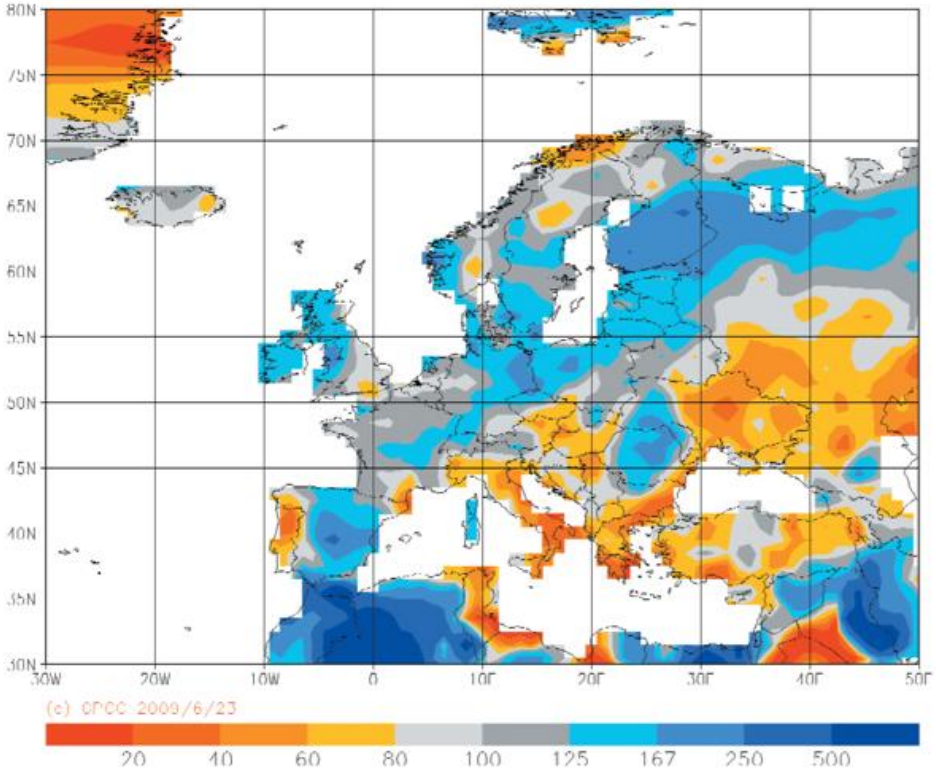


Fig. 10.2: *Monthly precipitation amounts for October 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Snow

Many mountainous regions received an early autumnal snow cover in the first days of the month. In the northern Alps, snow fell down to an altitude of 1000 m in parts of Switzerland and Austria. Some northern slopes received up to 15 cm of fresh snow. In the United Kingdom, Scotland also saw the first snow of the new season.

During a cold spell at the end of October, snow was observed in many places. London received October snow for the first time since 1934. New fresh snow records for October were set at many places in Switzerland on 30 October, particularly on the plains north of the Alps and in the Alps. October snow events normally are extremely rare in the lowlands of Switzerland. 20 cm of fresh snow in Zurich beat the October record of 1931 (14 cm). Snow even fell in the lowlands of eastern and southern Germany and in the Black Forest (up to 30 cm), where the heavy and wet consistence of the snow caused widespread damage to forests.

There was also more snow than usual at this time of the year on Iceland.

Significant weather events

October 01:	94.2 mm of precipitation fell in Höglekardalen, central Sweden, highest official daily total in 2008.
October 01-04:	In the northern Alps, a cold snap brought winter conditions to altitudes above 1000 m in parts of Switzerland and Austria. Several high roads and passes were closed to traffic.
October 02-03:	Flooding in Lenkoran and Quba, Azerbaijan.
October 05:	Heavy thunderstorms in many places across Bulgaria with daily precipitation totals of around 80 mm. Widespread damage to houses, trees uprooted, electricity and phone lines cut. Storm also in Turkey.
October 09-10:	Heavy precipitation and flooding at the eastern coast of Spain. Tornado in southeast Spain on 10 October.
October 12:	Large hailstones caused damage to fruit trees and potatoes in Cyprus. Floods caused damage to property in Nicosia.
October 19:	Intense precipitation above 50 mm in 24 hours in various places of the United Kingdom, particularly Scotland and north Wales. Locally, gusts with hurricane force in the Scottish highlands during the night 19-20 October.
October 22-23:	Supercell affected southern Sardinia, Italy. 276.4 mm of precipitation in 6 hours on southern Sardinia, Italy, most of which fell in the morning hours. Some areas of Cagliari were left without electricity for several hours. Corsica also received more than 200 mm of precipitation.
October 22-23:	Intensive rainfall in Cyprus accompanied by hail, strong winds and thunderstorms causing floods in the cities of Larnaca and Limassol.
October 30:	Torrential hailstorm in the southwest of the United Kingdom (east Devon) with an estimated rainfall/hail total of 160 mm in 3 hours in the morning, causing major flooding.

November

- **Mostly warm, cold in Iberia**
- **Mostly dry, wet in Scandinavia and the western Mediterranean**
- **Wintry spell with much snow in many parts of Europe**

Atmospheric circulation characteristics

A cold trough extended from Scandinavia to the southwest until Iberia. A cut-off low developed over Iberia early in the month, moving then to western Europe. As a result, Iberia was affected by a very cold air flow from the north. Iberia was also quite frequently influenced by high pressure with cold nights. The Azores high was strong and shifted to the north, whereas the mean position of the Icelandic low shifted towards northern Europe.

The central Mediterranean experienced much cyclonic activity with frequent rain and thunderstorms.

The rest of Europe mostly lay in a southerly or southwesterly air flow with warm air reaching even Russia or often was under high pressure influence. In the second half of the month, most of Europe was temporarily affected by a large cold trough, western and southwestern Europe once again at the end of the month.

Some cold Arctic troughs with cyclonic activity passed over Scandinavia, whereas the Arctic region was mainly in a mild air flow.

Temperature

In general, November 2008 was mild in most of the Region, particularly in the Arctic and in eastern Europe. The highest anomalies were more than +4°C in northeast Greenland and European Russia (Fig. 11.1) and up to about +6°C at the eastern border of the Region. Some stations in European Russia recorded their highest mean November temperature ever. All the other countries in the eastern half of Europe were mostly 1-2°C warmer than normal. A vast warm air mass from the south reached Lithuania, rising maximum temperatures to 8-15°C by 11 November. The daily temperature records were exceeded in many places.

Particularly the beginning of the month was very mild especially in central and southeastern Europe. November maximum temperature records were broken at numerous stations in Germany, with temperatures exceeding 22°C in the southeast of the country due to foehn. Parts of eastern central Europe (e.g. southern Poland, eastern Austria, parts of the Balkan Peninsula) locally also saw temperatures above 20°C during the first days of the month. In Slovenia, the absolute maximum temperature in Ljubljana and at the coast was the second highest since observations began. New temperature records also were measured in Montenegro in the coastal area and the northeast mountainous region. Unusually high temperatures of around 29°C were measured in Serbia on 1 November, 30°C in southern Greece on 2 November and up to 32°C at the southern coast of Turkey.

Averaged over the month, it was colder than normal in southwest Europe, particularly in Iberia. Monthly mean anomalies below -2°C were recorded in some places of Spain and Portugal. The North Atlantic had temperatures mainly around normal. Only west of the Azores Islands the temperatures were around +2°C higher.

November ended with a cold spell across western and central Europe. On 30 November, Northern Ireland recorded its lowest November maximum temperature on an areal average since records began in 1960. In Iberia and in Italy, minimum temperatures were below 0°C in many places.

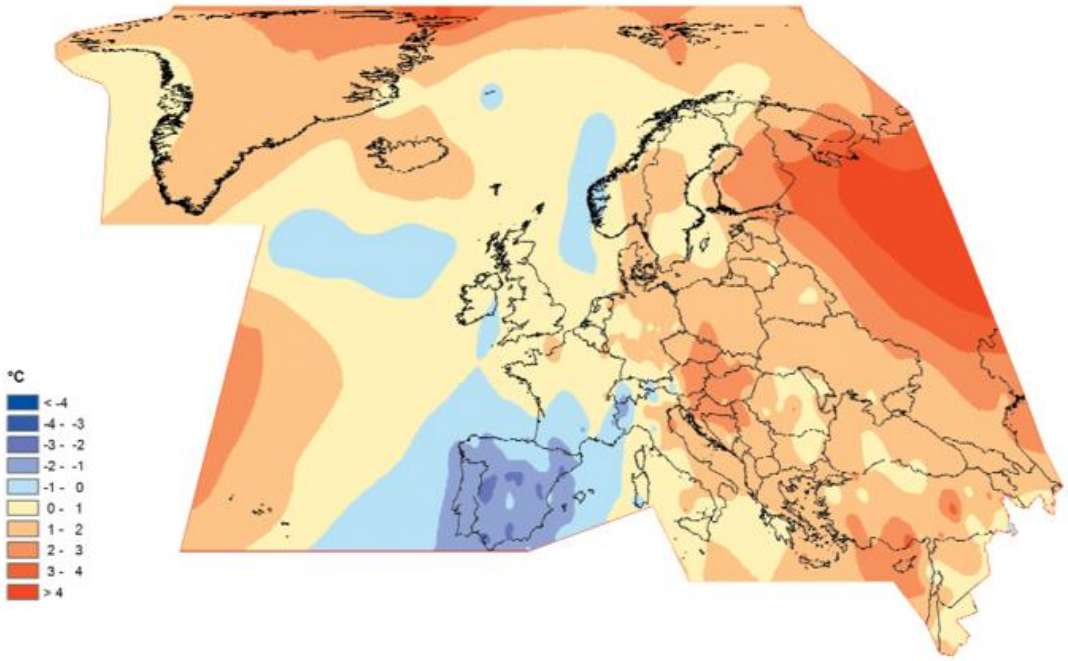


Fig. 11.1: *Monthly mean temperature anomalies in November 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

Precipitation

Most of the Region was drier than normal, particularly in the mid-latitudes, in Iberia, around the Black Sea and in the Middle East (Fig. 11.2). Southern Poland and some places in southeastern Europe and the Middle East received less than 50% of its normal precipitation, some locations in southwestern Germany even less than 30%. Parts of central Spain as well as central and southern Israel received only 20% of the normal. In the central coastal plain of Israel and the Judean Mountains, it was one of the 5-6th driest November months in the last 60-65 years. Cyprus received 40% of its normal precipitation, Damascus in Syria around 30% (7 mm). 20-30% of the monthly normal was recorded in Armenia, even less in Georgia. These dry conditions were unfavourable for winter wheat so that additional irrigation was required.

Only some areas in northern Europe (especially Scandinavia and northern Russia) as well as Italy and the areas around and across the western Mediterranean (including the southern Adriatic coast of Croatia) were very wet, partly reaching more than three times the monthly average. Already in the first decade of the month, rainfall totals up to 200 mm were measured at the southern slope of the Alps and in northwestern Italy. Southeastern France experienced a very intense rainy episode and flooding at the beginning of the month. In Belgium, it was not the intensity, but the number of 26 precipitation days which was exceptionally high. Around 150% of the monthly 1961-1990 normal was recorded in parts of central and eastern England. Monthly precipitation totals in southern Norway and in Estonia reached more than 200% of the 1961-90 normal.

Snow

On 15 November, a cyclone brought heavy snowfall (66 mm in 12 hours) and snowstorms to Lithuania, and here especially to the Baltic seaside. In some places, the snow cover rapidly reached a depth of 45 cm. On 23 November, the Baltic countries were again affected by a snowstorm with the snow depth reaching 56 cm in the central part of Estonia.

A wintry spell spreading from the north to the south arrived in Germany and Switzerland on 21 November. Snowfall was recorded especially in the hills and the Alps with fresh snow depths of around 35-40 cm and up to more than 10 cm in the lowlands. On 24 November, nearly the whole of Germany was snow covered. It was the strongest winter outbreak in a November month since 1999. A period with rich snowfall began on 28 November in southern Austria where a snow cover of up to 2 m built within three days.

The snow also reached the alpine south side. The Ticino (southern Switzerland) was covered by enormous snow amounts, e.g. 12 cm in Locarno Monti (367 m above sea level) on 29 November. On this occasion, the second highest fresh snow amount in November in this place since 1931 was measured. The upper part of the Engadin received more than 1 m of fresh snow, which is very rare and even record-setting for some stations at this time of the season. Towards the end of the month, it also snowed over most of the continental parts of Slovenia, bringing a snow cover of 17 cm to Ljubljana on 29 November. Most of Serbia also received the first snow for this season in the third decade of the month. The number of snow days, however, was near normal in most places in Serbia. In mountainous regions of Bulgaria, the ground also remained covered with snow. It even snowed on mountain sites in Iberia.

In general, there was less snow than usual this month in European Russia due to anomalous warmth and little precipitation.

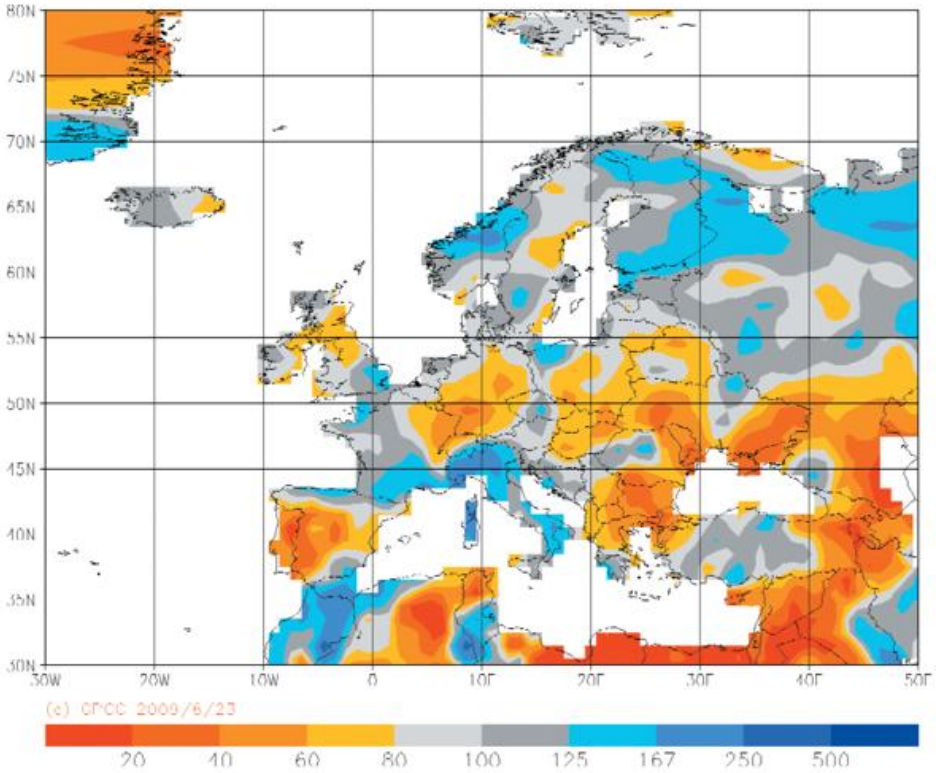


Fig. 11.2: *Monthly precipitation amounts for November 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Significant weather events

November 02: Heavy precipitation in northeastern Spain (especially Costa Brava) and southern France with flooding. In Valencia, Spain, a total rainfall of 390 mm was recorded in 24 hours, 144 mm fell in less than 1 hour.

November 04: Supercell downburst over the area of Rome, Italy. Strong gusts causing numerous fallen trees and broken branches, flooding. Heavy precipitation particularly over eastern Corsica, southeast France and parts of the southern Alps.

November 10: Strong winds and heavy rains over parts of Malta. A waterspout was detected southwest of Malta (Fig. 11.3).

November 11: Heavy storm in Estonia with gusts up to 110 km/h, damage to houses and forests.

November 11-13: Heavy rain and thunderstorms caused flooding at southeastern coastal areas and later in Nicosia.

November 20: 59.7 mm of precipitation in 2 hours in Beirut, Lebanon.

November 21: Strong cold front passage with stormy winds (up to hurricane force over high mountains) and snow showers caused damage to houses and trees and traffic disruption in several regions of Germany.

November 22-23: Storm with gusts above 100 km/h over Italy, Ionian and Aegean Sea due to thunderstorms along a cold front. Turkey was also affected with damage to settlements. Seaway traffic stopped in Aydin, western Turkey.

November 23-24: Storm over the White Sea, wind speed up to 130 km/h due to a very intense low pressure system. A pressure level of 951.5 hPa was measured in Estonia on 23 November at 18 UTC.



Fig. 11.3: *Waterspout southwest of Malta observed from the airport in Luqa on 10 November 2008 at 11:38 local time.*
Source: Malta Meteorological Office

December

- **Warm in the north and in eastern Europe, cold in western Europe and the south-east**
- **Cold spell at the end of the year in many parts of Europe**
- **Dry in northwestern Europe and the southeast, wet over the central Mediterranean**

Atmospheric circulation characteristics

A cold trough extended over the western half of Europe and regenerated several times. In the middle of the month, a ridge formed over northwestern and western Europe and remained quite stable throughout the rest of the year, extending also to central Europe.

At the west flank of a high pressure system over Russia, mild air masses from Africa moved over southeastern Europe to the northeastern part of the continent until Christmas. The Arctic region remained under a mild and humid air flow from the Atlantic.

Strong cyclonic activity continued to persist over the western and central Mediterranean while dry air masses dominated in the eastern parts.

At the end of the year, very cold air flowed from the northern latitudes to southeastern Europe and the Middle East at the east flank of a central European high pressure system. Within an easterly air flow, cold continental air also reached central and western Europe.

Temperature

The year 2008 ended with very mild conditions in the Arctic region, northern, eastern and southeastern Europe, and over the eastern Mediterranean and most of the North Atlantic (Fig. 12.1). Anomalies exceeded +4°C in many places of the Arctic and northeastern Europe, coming close to +8°C in the far northeast of the Region.

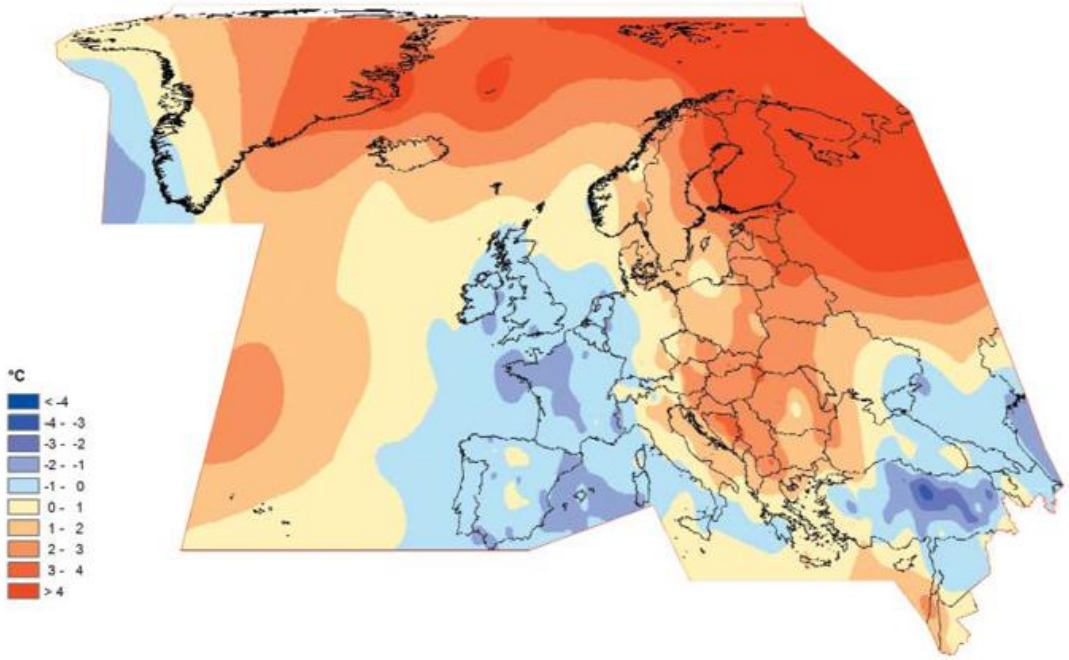


Fig. 12.1: *Monthly mean temperature anomalies in December 2008 (reference period 1961-1990) in WMO Region VI.*
Source: Deutscher Wetterdienst, Germany

With 10.1°C, a station in the county of Finnmark (northern Norway) measured a new daily maximum temperature record. Down in the south of the Region, various stations on the coast of the Black Sea saw maxima of more than 25°C, even on the Krim Peninsula. Some minimum temperatures were also unusually high, e.g. 9°C in Moscow.

Central Europe had monthly mean anomalies only slightly above normal (Germany +0.3°C, western Austria +0.5°C), in eastern central Europe the anomalies were around +2°C. Unusually high daily maxima up to 13°C were recorded in Poland at the beginning of the month.

The whole of western Europe including the western Mediterranean and some parts of the Middle East had a slightly colder-than-normal December. Some places within these areas had anomalies below -1°C; in parts of western France, in Turkey and west Kazakhstan they were below -2°C and locally even below -4°C. It was the coldest December since 1996 in Northern Ireland. The United Kingdom and Ireland had air frost throughout half the month, which is 2 to 5 days more than usual.

Very low temperature values were recorded in late December especially in Ireland, but also in other countries. The end of the year saw frozen ground in many places in Lithuania, locally reaching a depth of 15-20 cm. After a mild period around Christmas (the typical Christmas thaw singularity came almost in time), Germany experienced a temperature drop with daily minimum temperatures down to around 10°C in many places by the end of the year. Sea ice formed in the bays of the southwestern Baltic Sea. South of the Alps, Italy and southern Switzerland also experienced a sudden temperature decrease on 26 December. Malta had some warm days in the first half of the month with maxima around 20°C, whereas temperatures dropped to near-normal values in the second half. Serbia, too, was under the influence of colder air at the end of the year, reaching maximum daily temperatures below normal. Even Cyprus saw widespread frost on 31 December in the western coastal areas, causing damage to agricultural plantations.

Precipitation

Northwestern and northern central Europe experienced a drier-than-normal December (Fig. 12.2). Especially the areas along the western coasts of Norway and Sweden, Denmark, northwestern Germany and France, the Low Countries, the United Kingdom (except eastern Scotland) and Ireland were very dry. Southern Iberia was also very dry, resulting in a drought situation in this part of the Region. Parts of southern Norway received only 25-40% of the 1961-90 normal monthly precipitation. Parts of northwest Germany locally received even less than 15% (e.g. 9 mm in Bremen), making December 2008 at some locations the driest December since the beginning of measurements. Some areas in eastern Europe, especially southern European Russia, and the Middle East were also dry. Parts of the Turkish Mediterranean coast had less than 40% of the monthly normal (more than 100 mm less than normal), the southern parts of Israel less than 50% and the mid-Volga region in Russia only 5-30%.

On the contrary, it was wet south of the Alps over the whole of Italy and the western and central Mediterranean (except Malta), in Hungary, over most of the Balkan Peninsula and in the Arctic region. December precipitation was also well above average in southeastern France (locally up to 300% of the normal) and over southern Austria (up to 400% of normal; Fig. 12.3). This was largely due to persistent low pressure in the Gulf of Genoa. Monthly totals for the western Mediterranean area locally exceeded 200 mm which, in many cases, was more than twice the normal and caused local flooding. Various places in northern Slovenia received more than 300% of the normal precipitation. In Albania, December was by far the wettest month of the year (usually November) with the highest monthly total measured at Vlora in the western coastal zone (451.2 mm, i.e. around 350% of the normal). This was also the highest monthly total in the whole time series 1951-2008 of this station (Fig. 12.4).

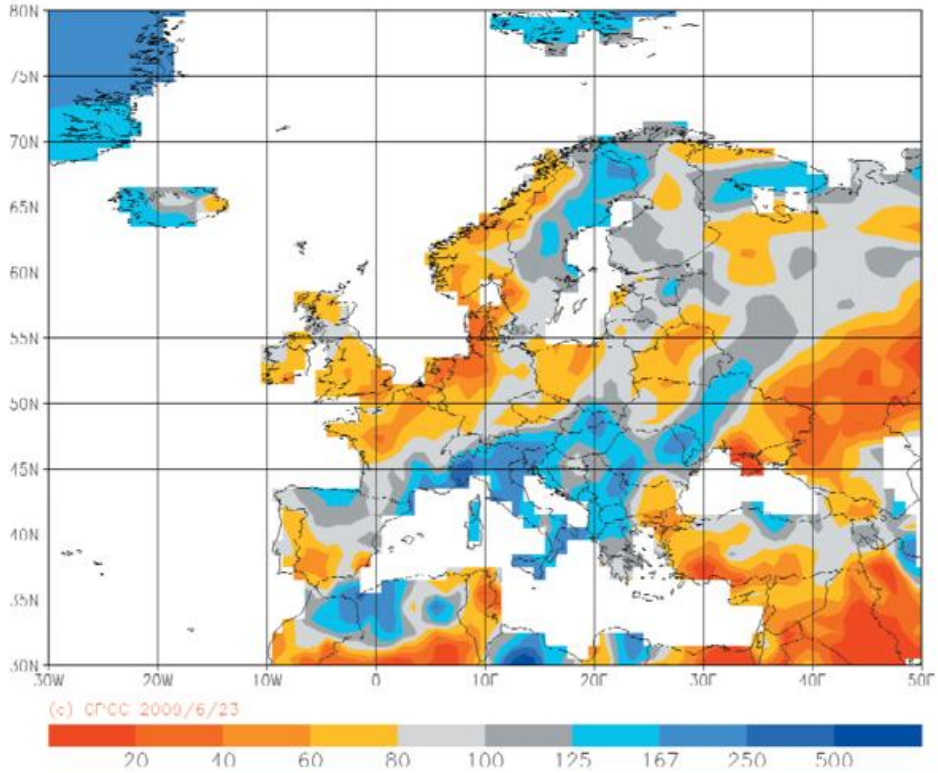


Fig. 12.2: *Monthly precipitation amounts for December 2008 in per cent of the normal 1951-2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Snow

Snow fell in most areas of the Region except the major part of the lower coastal areas and some of the southern parts. Mean snow depths above 20 cm were partly observed in Scandinavia and the Alpine region. Snow depths of more than 1 m occurred only on high mountains.

There was a persistent snow cover on Iceland during the first three weeks, which, however, has disappeared by Christmas.

Most parts of Lithuania saw dangerous black ice up to 3 mm thick due to freezing rain in the second half of December.

In central Europe, it snowed very frequently, but only above 1000 m Christmas was white. On 3 December, snowfall in the lowlands, especially in northern and western Germany, caused numerous road traffic problems. 15 cm of fresh snow was recorded in the hills (Eifel, Westerwald). A station in northern England recorded a snow cover of 21 cm on 4 December.

Another intense snowfall period occurred in the middle of the month, affecting particularly the Alpine region, various regions in France and northern Spain. On 18 December, a December record snow depth of 38 cm since at least 1931 was measured in Switzerland's capital Bern. In Austria, a new December record snow depth of 125 cm was reported from eastern Tyrol's capital Lienz on 12 December. Southern Alpine regions experienced heavy snowfalls until the middle of the month. The snow load heavily affected forests, power lines and rooftops. Thousands of households were repeatedly cut off from electrical power. Most of the snow in the alpine lowlands melted away before Christmas whereas the mountain regions of the Alps

remained covered by above-average snow depths over the Christmas holidays. Great amounts of snow were also observed in Slovenia where the mountain station Kredarica measured a snow depth of 3 m.

In the eastern parts of Europe, there was less snow than usual. Poland did not have any snow at all in the northwest whereas the southern parts of the country had 17 days with snow cover. In Serbia, the mountains were snow-covered throughout the month, the lower parts of the country, however, only during the last decade. Romania had snow cover in the mountain area and in Moldavia and occasionally also in the remainder of the country. Snow affected traffic in Turkey at the end of the year (24-29 December).

In Armenia, a snow cover formed with a delay of 15-20 days in mountain and submountain regions, threatening the winter wheat to freeze. Georgia received snow only in the third decade of the month, with a snow cover up to 50 cm in some places.

At the end of the year, it also snowed in northeastern Spain.

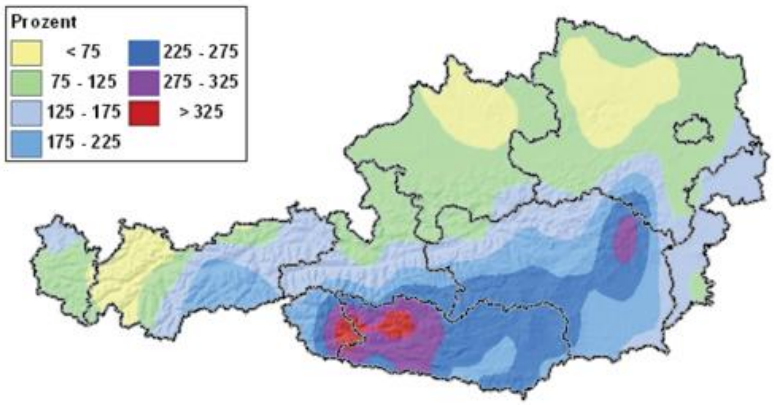


Fig. 12.3: *Monthly precipitation amounts for December 2008 in per cent of the normal 1961-1990 in Austria.*
Source: Central Institute of Meteorology and Geodynamics, Austria

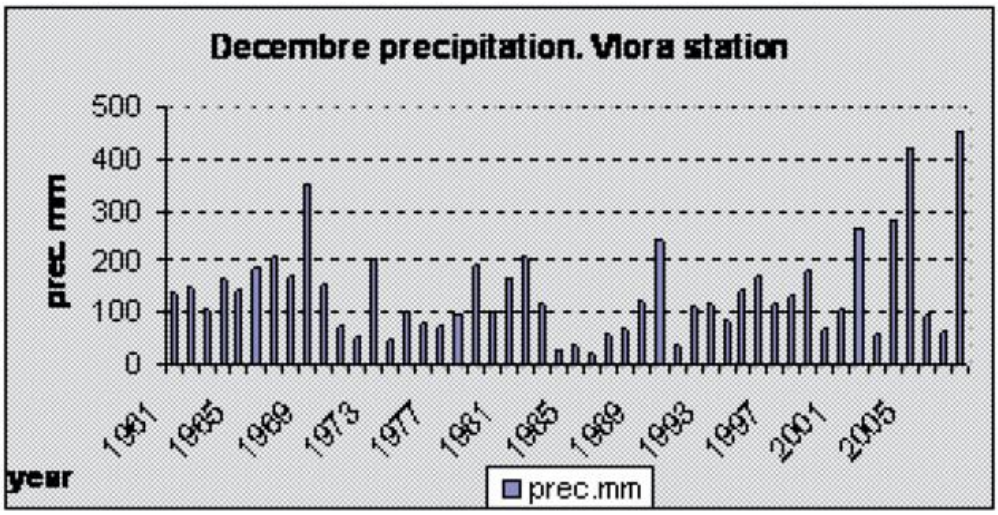


Fig. 12.4: *Time series of monthly precipitation totals for December (1961-2008) at the station Vlora (coastal west area of Albania).*
Source: Institute for Energy, Water and Environment, Polytechnical University Tirana, Albania

Significant weather events

December 01:	Heavy flooding in Venice; nearly the whole city was flooded to a depth of more than 150 cm, highest flooding level since 1986.
December 03-04:	Strong gusts in southern Greece (Corfu) and southeastern Italy up to around 110 km/h. Heavy rain in Venice (flooding), southern Italy (Brindisi) and Montenegro. Highest wind gust ever recorded in Montenegro on 04 December (236 km/h).
December 10-12:	A storm system brought heavy rainfall and strong winds to Italy causing flooding in several places. Rainfall around Rome was particularly high (more than 70 mm in 24 hours on 11 December), Tiber River and its tributaries almost rose to the critical levels (Fig. 12.5). Cumulative rainfall totals over three days partly exceeded the monthly average. 337 mm of precipitation in 24 hours were recorded in Palermo, Sicily. The same storm also affected Greece (Ionian and Aegean Sea) on 12 December.
December 14:	Foehn storm in Switzerland; gusts of more than 250 km/h on high mountains in 2300 m.
December 14:	Hail shower in northern Mallorca. Hail layer of several cm in mountainous areas and hailstones of 1 cm in diameter.
December 21:	Gusts up to hurricane force in the north-westernmost part of Jutland, Denmark.
December 22:	Heavy rain and thunderstorms affected the main cities in Cyprus, causing floods after the first three weeks of the month had been exceptionally dry.
December 24:	133 mm of precipitation in 20 hours in the mountain region of the Lebanon.
December 27:	2-hour hailstorm in Valletta, Malta, in the morning.
December 27:	Storm with heavy rain and snow on the eastern Spanish coast. Sea waves up to 8 m high at Costa Brava.



Fig. 12.5: *Water level of Tiber River near Coliseum in Rome, Italy on 12 December 2008. Source: National Weather Service CNMCA, Italy*

ECSN Activities Report 2008

Support and co-operation in best climate practices

Responsible Member: KNMI; Programme Manager: Aryan van Engelen

The objective of ECSN, the European Climate Support Network, is to support its 24 members in their climate practices in order to better serve the European user community with climate products and services for the benefit of environment, safety, economy and health.

This objective is reached by a portfolio of activities: carrying out projects such as ECA&D, S-EUROGRID, EuCLIS and HRT-GAR focusing on a better understanding of Europe's past, present and future climate and the provision of data and info products, participation in major EU projects like ENSEMBLES, MILLENNIUM and EURO4M, co-operation with other partners such as the EEA (European Environmental Agency) and the WMO (World Meteorological Organization) and organizing the biennial European Conferences on Applied Climatology and Data Management Workshops.



Fig. 13.1: *24 European NMHS's participate in the EUMETNET Programme ECSN Source: ECSN*

ECA&D, KNMI, http://eca.knmi.nl

The European Climate Assessment and Data set aims to create and maintain a European data set of daily high-quality observations and to produce assessments of Europe's climate on the basis of derived indices. ECA&D co-operates with 53 partners and offers a baseline data set of more than 10,000 time series of temperature, precipitation, air pressure, snow depth, relative humidity, cloud cover and sunshine duration observed at some 2800 European and North African stations. A set of 40 standardized indices is presented in graphs and maps. ECA&D will serve as the core platform for a WMO-RAVI (Europe) Regional Climate Centre on Climate Data, to be established in 2009.

S-EUROGRID, SMHI, http://www.e-grid.eu

Showcase EUROGRID demonstrates the potential of the EUROGRID concept as the future European central resource for gridded climate, meteorological, hydrological and environmental products. 11 national and two European transnational gridded data sets are incorporated: ERAMESAN (SMHI) and ECA&D/ENSEMBLES (KNMI). The project has been completed in 2008. The proposal for its successor, the full scale EUMETGRID which is to be submitted in 2009 sets a focus on gridded data sets derived from the high-quality observational network of the European NMHSs. Apart from providing operational long-term climate monitoring, it will generate detailed near-real time monitoring and warning products on extreme events, food and safety, and energy production and consumption.

EuCLIS / ECSM / GCMP, DWD, http://www.dwd.de/ecsm

The European Climate Information System will be the successor platform of GCMP (Generate Climate Monitoring Products) and as such give access to European national and regional climate monitoring products like maps, graphs, assessments as well as monthly and annual reports. Presently, an interim platform called ECSM (European Climate System Monitoring) has been established before the operational start of EuCLIS. Climate products provided by activities like ECA&D and the upcoming EUMETGRID will be incorporated. EuCLIS will serve as the core platform for a WMO-RAVI (Europe) Regional Climate Centre on Climate Monitoring to be established in 2009.

HRT-GAR, ZAMG,
http://www.zamg.ac.at/forschung/klimatologie/klimamodellierung/ecsn_hrt-gar/

Based on the Alpine high density network, a High Resolution Temperature climatology for the Greater Alpine Region was developed for a 30-year period with a temporal resolution of 1 month and a spatial resolution of 1*1 km. With the collection of monthly temperature series from more than 1700 stations, the calculation of multiple linear regressions and regionalisation, further significant improvements could be reached by adjustments for meso-scale effects in cold air pools, coastal and lakeshore belts, urban areas and slopes. The project has been completed in 2008.

ECAC

The 7th European Conference on Applied Climatology, organised by ECSN together with the 8th Annual Meeting of the European Meteorological Society (EMS), took place in Amsterdam in fall 2008. The theme was “tools for understanding of and adaptation to current and future climate”.

The conference served as a platform for experts and scientists of the EMI (European Meteorological Infrastructure) and the research community to meet private and public stakeholders. The session programme was organised by some 90 convenors and attended by 625 registered visitors.

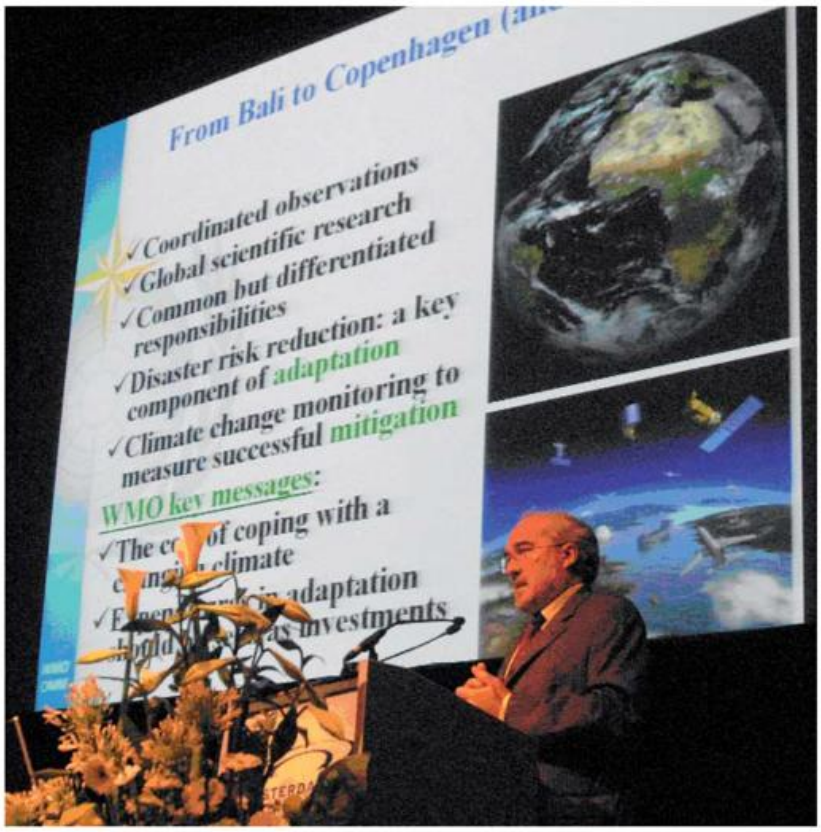


Fig. 13.2: *The Secretary-General WMO, Michel Jarraud, spoke on the opening of the EMS/ECAC conference 2008.*
Source: ECSN

The Ozone Layer over Central Europe in 2008

Wolfgang Steinbrecht, Hans Claude, and Ulf Köhler - Deutscher Wetterdienst

After a decade of almost continuous total ozone increases, 2008 shows an ozone decrease compared to the previous years. Amounting to 316 DU (Dobson Units), the 2008 annual mean of total ozone was significantly below the mean values of previous years by about 2% (compare Fig. 14.1). Other European stations show similar results. Throughout the entire 41-year time series at Hohenpeissenberg, only 6 years show lower values, three of which followed major volcanic eruptions (El Chichón 1983, Pinatubo 1992/1993).

Nevertheless, the annual mean of total ozone in 2008 was within the usual range of fluctuations around the „normal" long-term behaviour (green line in Fig. 14.1). This slow long-term variation is determined mainly by anthropogenic chlorine (from chlorofluorocarbons or CFCs), by the already mentioned major volcanic eruptions and by the 11-year solar cycle. Recovery from the Pinatubo eruption, together with the 2002 solar maximum, has resulted in a distinct ozone increase from 1993 to 2003. Lower total ozone values were to be expected due to the solar minimum from about 2005. It was, however, not before 2008, that the westerly phase of the quasi-biennial oscillation (QBO) and the positive phase of the Arctic Oscillation / North-Atlantic Oscillation combined, thus causing the annual mean of total ozone to fall 6 DU below the level of previous years.

Years with enhanced total ozone alternate with years with reduced values throughout the entire time series. Low-ozone years, for example, were the years 1997 or 2000 when air-masses from very stable winter vortices had substantially influenced chemical ozone depletion in the Arctic spring and had finally reached lower latitudes in central Europe in early summer. This resulted in very low total ozone values in the early summer, like the record-low total ozone mean in June 2000 at Hohenpeissenberg. The low total ozone value of 2008 (or 2000) shows that low values are possible anytime, even nowadays, given the right meteorological conditions. At this point, ozone recovery due to the beginning decline of chlorine is small and amounts to only 2 or 3 DU (red line in Fig. 14.1).

Fig. 14.2 takes a look at the expected future evolution of total ozone at northern mid-latitudes. It is based on state-of-the-art 3-dimensional chemistry climate model simulations, carried out for the 2006 WMO ozone assessment. In comparison with the Hohenpeissenberg measurements (red line), the combined models give a good representation of the long-term evolution and range of total ozone observations. The model average (blue line) follows the observed long-term evolution quite well. Random variations in the model runs and the spread between the models (light blue area) correspond well with the annual mean variations observed at Hohenpeissenberg. This lends great credibility to the model predictions. According to the models, low values as observed in 2008 are quite possible over the next decade. The model predictions do not include any major volcanic eruptions in the future. As chlorine concentration will remain high over the next decade(s), a major volcanic eruption would lead to substantial ozone depletion and very low total ozone values comparable to those recorded in 1983 or 1993.

A return to the high ozone values of before 1975, when CFC levels were low and ozone destruction by anthropogenic chlorine was negligible (grey bar in Fig. 14.2), is not predicted until after 2035. Even then, anthropogenic chlorine will not have disappeared completely. However, cooling of the stratosphere caused by future increases of CO2 is also expected to slow the normal chemical destruction cycles of odd oxygen (and ozone). Therefore, the models predict enhanced total ozone after 2050. This has been termed „super-recovery" of the ozone column causing even higher values than those observed in the 1960s and early 1970s. Still, the ozone profile in this changed climate after 2050 should be different from the undisturbed profile of the 1960s. The models predict higher ozone in the upper stratosphere, but less ozone in the lower stratosphere. Climate change is intrinsically linked with the future evolution of the ozone layer.

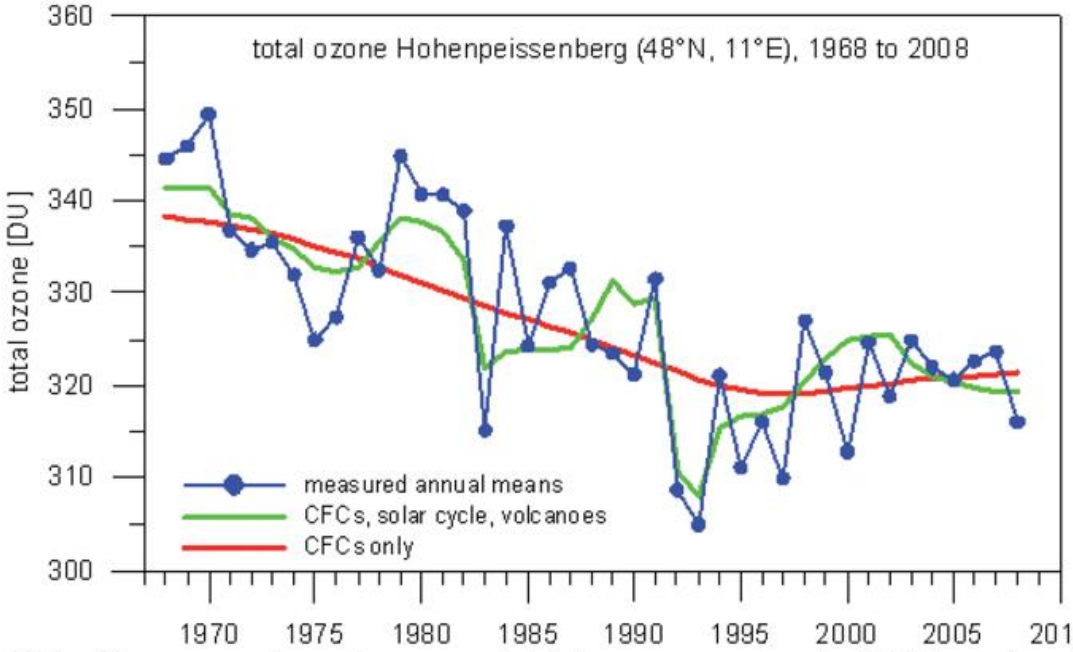


Fig. 14.1: *Blue curve: Annual means of total ozone measured at Hohenpeissenberg. Red curve: Long-term variation attributed to anthropogenic chlorine (from CFCs). Green line: Long-term evolution attributed to chlorine, volcanoes, and 11-year solar cycle. Red and green curves are estimated by multiple linear regression.*

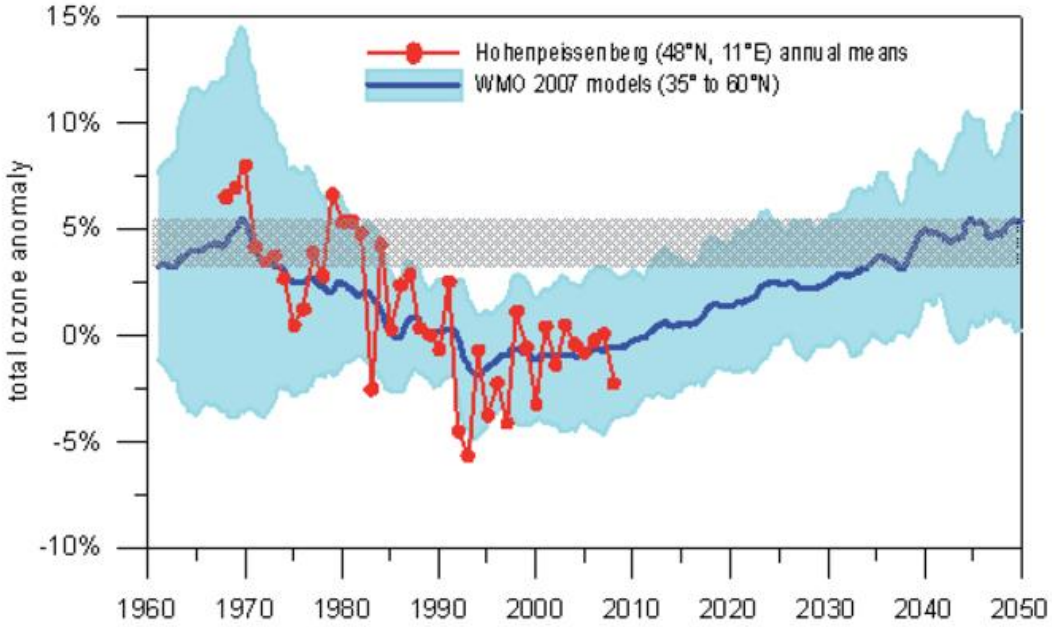


Fig. 14.2: *Blue: Evolution of Northern hemispheric total ozone from 1960 to 2050, according to calculations from chemistry climate models for the 2006 WMO Ozone Assessment. The blue line gives the model average, the shaded area the range of model predictions.*
Red line: Measured annual means at Hohenpeissenberg. All anomalies are relative to the 1980 to 2000 average. Grey bar: Range of undisturbed ozone values before 1975.

The Bulletin is a summary of contributions provided by the National Meteorological and Hydrological Services. The authors do not warrant, guarantee or take any responsibility regarding correctness, accuracy, reliability, or any other aspect concerning the characteristics or use of the information presented.

The Network of European Meteorological Services
European Climate Support Network

World Meteorological Organization
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Deutscher Wetterdienst
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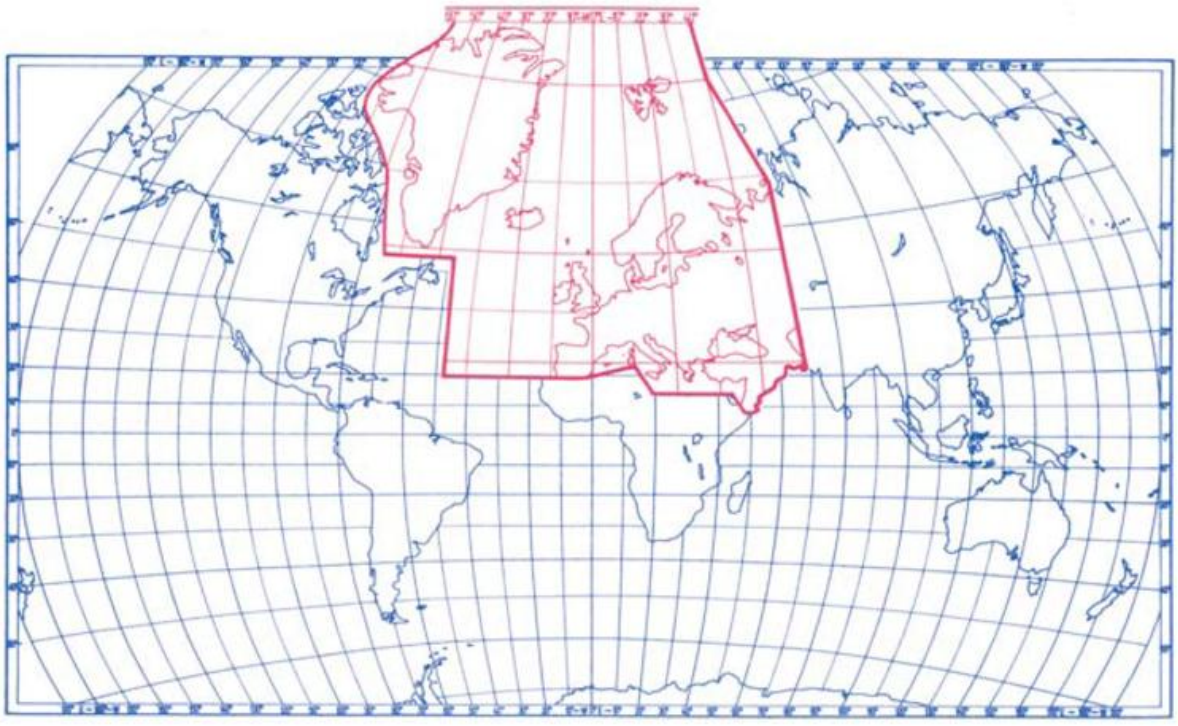
Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2009



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Foreword

The year 2009 completed the warmest decade on record since the beginning of widespread instrumental measurements around 1850 - in Europe and around the world. Against this backdrop and in the light of global warming, 2009 was just another warm year.

However, 2009 was characterised by some particularities which do not occur every year. It was no surprise that most of the warming took place in the Arctic during winter months – this is what had happened in previous years too. But what was outstanding in that year was the month of April: extremely warm and dry in large parts of Central Europe, in some places even topping April 2007, which had also been very warm over a large area. Interestingly, there were also some very cold months in 2009, especially October (in northern Europe) and even more December. The Arctic Oscillation, which is an important circulation pattern for the northern hemisphere in general and seems to be one of the key factors in the European climate, shows an extremely low value for December 2009, by far the lowest in any December since at least 1950 according to NOAA data.

In terms of precipitation, 2009 was a normal year only when looking at the annual average. April was not only warm but also extremely dry. On the other hand, some heavy precipitation events occurred, though confined to very limited areas and of high impact. Among these were the exceptionally heavy rainfall events in Istanbul in September, in the north-west of England in November and in southern Spain in December.

These few examples show that climate in Europe is far from being boring although it is generally less extreme than in other parts of the world. Climate monitoring, and especially climate monitoring in Europe, remains an important task to be accomplished to find out whether climate trends continue and which factors of climate variability and its extremes can modulate, mask or even change current trends. Climate monitoring is one link in a chain of climate activities from gathering of data, its evaluation and interpretation as well as the identification of interrelations through to climate modelling, long-range weather and climate predictions. It is for sure that climate predictions will be more convincing if today's climate variability already reveals indications for the future.

A very important action for climate assessment within our RA VI Region is the development of a Regional Climate Centre network. The approval of the RCC implementation plan in 2009 by RA VI was an important step in this direction. The RA VI Region consists of quite a large number of Member countries with a very diverse climate. In general, the RCC activities have a cross-border view (climate does not stop at national borders), but at the same time they also take account of the specific features characterising the climate in Europe and the Middle East.

The Annual Bulletin on the Climate in RA VI – now on its 16th issue presenting the overview assessment for 2009 – is one part of RCC climate monitoring activities in our Region. Its preparation would not have been so fruitful without the valuable contributions from nearly all Member countries and almost impossible without a reliable co-ordinator. The Deutscher Wetterdienst (DWD) has once again volunteered to take over this task. My sincere thanks go to the editorial team of DWD, especially to Peter Bissolli for compiling and writing the texts, Volker Zins for his technical support and, of course, to all the national contributors and internal reviewers. I wish everyone a pleasant reading.



Ivan Cacic
President of WMO Regional Association VI

Outstanding Events and Anomalies in 2009

Temperature

- Extremely warm April in central Europe
- Widespread cooling in December over northern Europe

Precipitation

- Unusual snowfall in February in the United Kingdom
- Extremely dry April in eastern and eastern central Europe
- Heavy rain with flooding in June in eastern central Europe
- Heaviest rain in Istanbul for 80 years on 9 September
- Exceptionally heavy rainfall and flooding in Cumbria, north-west England on 19-20 November
- Extremely heavy rainfall in southern Spain in late December

Storm

- Heavy storm (Klaus) in south-western France and northern Spain on 23-24 January

Annual Survey

1. Atmospheric circulation

The year 2009 was characterised by strong fluctuations in the atmospheric circulation patterns in the Region throughout the year, notably a transition from a La Niña to an El Niño phase, high fluctuations of the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO) with extremely low values for both indices at the end of the year, but also by several high pressure phases over Europe.

1.1. El Niño / La Niña

Moderate La Niña conditions in winter 2008/09 came to an end in March, as documented by the Southern Oscillation Index (Fig. 0.1). A typical feature of La Niña conditions is a dislocation of the frontal zone to northern latitudes and a stronger Azores high. This was to be seen on the seasonal scale for winter 2008/09. The consequence was a flow of mild and humid air to the Arctic whereas much of western and central Europe was cold and dry.

An El Niño event started in June 2009 with first signatures in the tropical Pacific. In October 2009, the Southern Oscillation switched to a moderate El Niño phase. Here, the typical pattern is a southerly frontal zone due to a stronger subtropical jet and a weaker Azores high. This pattern occurred especially in October and December 2009 with northern Europe being cold and mainly dry whereas the Mediterranean was mainly wet.

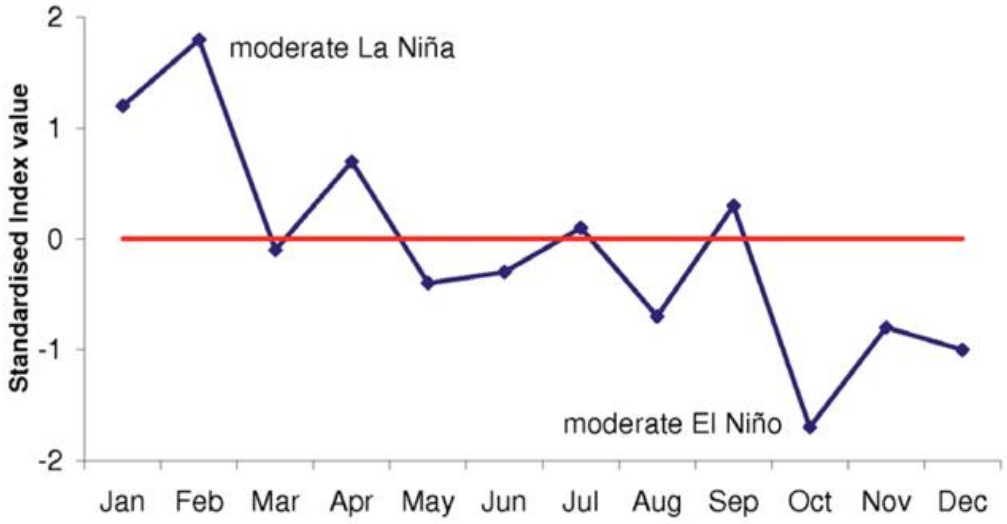

Fig. 0.1: *Standardised Southern Oscillation Index for 2009, as expressed by the difference of standardised sea level pressure anomalies in Tahiti and Darwin (Australia)*
Source: NOAA, www.cpc.ncep.noaa.gov/data/indices/soi

1.2. Arctic Oscillation (AO) and North Atlantic Oscillation (NAO)

On the monthly scale, AO and NAO were characterized by strong fluctuations during the year (Fig. 0.2). Positive AO and NAO phases, implying a stronger zonal flow component over the northern hemisphere (AO) and particularly over the North Atlantic (NAO), occurred in January, late spring (April/May), late summer / early autumn (August/September) and in November. In all these months, northern Europe was mainly warmer than normal because cold Arctic air was confined to the northern polar region.

In contrast, negative AO and NAO phases (weaker-than-normal zonal or a meridional flow) took place in February, early summer (June/July), October and December. The end of the year was characterized by an extremely negative phase of the Arctic Oscillation (AO) with high pressure dominating the higher latitudes of the Northern Hemisphere and affecting the weather in Europe. The AO Index in December 2009 was -3.4, the lowest value observed for any December in 60 years.

The NAO, too, was extraordinary in December and in June. During all these negative AO/NAO phases, parts or even the whole of northern Europe and some parts of the middle and southern latitudes were colder than normal.

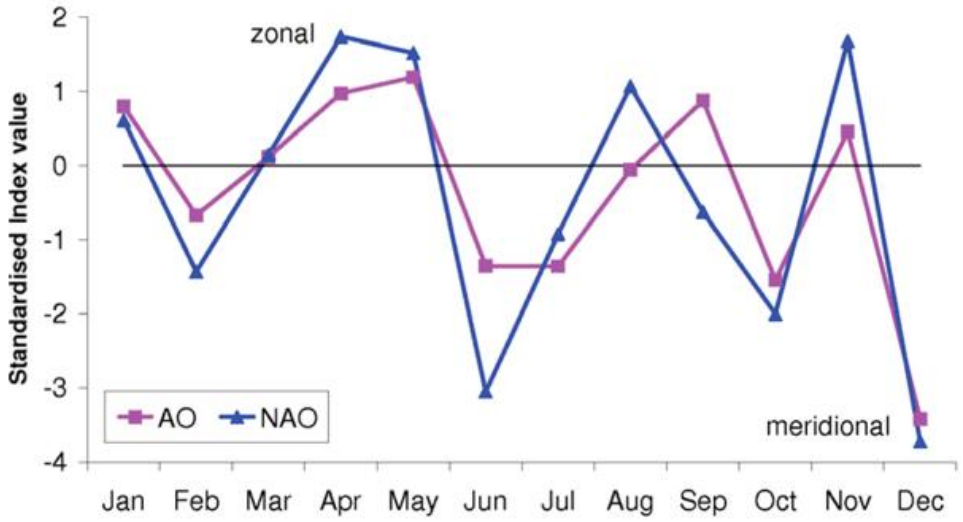

Fig. 0.2: *Standardised Arctic Oscillation (AO) Index and North Atlantic Oscillation (NAO) Index for 2009, as expressed by the difference of standardised sea level pressure anomalies between southern and northern latitudes over the whole northern hemisphere (AO) and the North Atlantic (NAO)*
Source: NOAA (AO), www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/ao.shtml and Climate Research Unit, University of East Anglia, United Kingdom (NAO), www.cru.uea.ac.uk/cru/data/nao/

1.3. Zonality over the North Atlantic and Europe

The zonal index over the North Atlantic and Europe for 2009 also reflects the monthly AO and NAO variations (Fig. 0.3). Whereas during positive AO/NAO phases the slightly enhanced zonality follows more or less the mean annual cycle, it shows large deviations during negative AO/NAO phases with a much higher meridional component than usual. In February 2009, the circulation was already as meridional as in April and May. June was by far the month with the highest meridionality instead of May as usual. October and December, normally months with high zonality, were more meridional than the spring months. The consequence was that the air mass exchange between north and south was enhanced during these months, and some exceptionally colder-than-normal periods occurred in larger parts of Europe, although the year on the whole was warm.

Especially January had a strong zonal circulation over the Atlantic, which was blocked, however, by high pressure over Europe. The situation was similar in April, although the Atlantic zonal circulation was weaker and the high pressure influence was very strong.

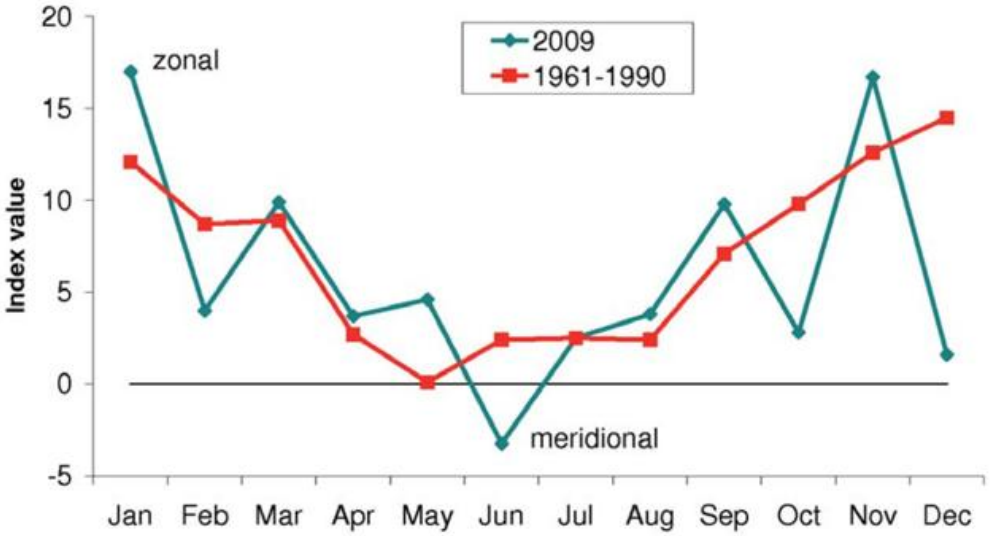

Fig. 0.3: *Zonal Index over the North Atlantic and Europe (20°W-40°E) for 2009, as expressed by the difference of zonally averaged sea level pressure between southern and northern latitudes Source: Deutscher Wetterdienst, www.dwd.de/GWL*

1.4. Sub-regional Overview

1.4.1. Central and eastern North Atlantic

Due to the high variability of the NAO, the circulation over the North Atlantic showed some quite unusual patterns in 2009 causing higher-than-normal air and sea temperature fluctuations. The very strong and early development of a meridional structure in February made especially the central Atlantic very mild. In summer, in contrast, the highly meridional situation caused a particularly strong meridional exchange of air masses resulting in a colder-than-normal central North Atlantic whereas the northern parts of the ocean were warm. In October, the whole central and eastern North Atlantic area experienced a warming due to the extreme meridional situation although in December, an easterly flow dominated, leading very cold air masses from the European continent as far as Atlantic regions.

1.4.2. Arctic regions in Europe

During most of the year, like in preceding years, the European Arctic experienced a mild southerly airflow, which was particularly effective in the winter months. Occasionally, very cold air masses affected eastern Greenland. April was an exceptional month with a strong Arctic oscillation that kept the cold air within the Arctic region while warm air remained in lower latitudes.

1.4.3. Northern Europe (Baltic countries, northern European Russia, Scandinavia)

Northern Europe experienced some outbreaks of cold Arctic air during the months of negative AO phases, notably in February, June, July, October and December. Partly only some limited areas were affected, but in October and December, the whole of northern Europe was concerned. During the other months, mild airflows or high pressure situations dominated.

1.4.4. Western and central Europe (Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxembourg, the Netherlands, Poland, Slovakia, Switzerland, United Kingdom)

These parts of Europe, too, experienced large temperature and precipitation fluctuations due to the large circulation variability. The strong zonal flow in January was blocked by high pressure, resulting in a cold and mainly dry month, except for the westernmost areas. In February and March, it was mainly the Azores high that caused the weather to be mostly dry in western Europe, sparing central Europe, however. Extended high pressure influence dominated in April, making it an extremely warm and dry month. In May, only the southern parts profited from the persisting high pressure influence. Very high pressure with warm and dry weather continued to dominate the weather in August and September.

The negative AO phases in June, October and December affected large parts of central Europe, bringing cold Arctic air particularly into the northern regions. In December, an easterly continental flow affected the whole northern parts of western and central Europe.

In June/July and October/November, many low pressure systems passed western and central Europe, causing some heavy precipitation events.

1.4.5. Iberia

After a more or less normal winter 2008/09 with several low pressure situations, high pressure influence dominated in spring, summer and autumn, with only occasional rainy spells and thus resulting in mostly warm and dry months. In December, however, a southerly frontal zone built up due to El Niño conditions, causing a very rainy end of the year.

1.4.6. Mediterranean (including Italy, Monaco and Malta)

A lot of low pressure activity occurred in various parts of the Mediterranean, especially over the central parts. However, several months of the summer half year (May, July and August) were characterised by dominating high pressure influence, causing summer heat waves and shortage of rain. On the other hand, particularly in February and October, both of which were colder and with negative AO, cold air from the north moved towards the Mediterranean.

1.4.7. Balkan Peninsula (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Slovenia)

The Balkan Peninsula generally was not much affected by AO/NAO fluctuations, but by several Mediterranean low pressure systems throughout the year. An extensive high pressure phase took place in April/May and another one in September.

1.4.8. Eastern Europe (Belarus, western Kazakhstan, Moldova, Romania, European Russia, Ukraine) and South Caucasus region (Armenia, Azerbaijan, Georgia)

The Russian high was stronger than normal in winter 2008/09, and eastern Europe remained in a warm airflow at its flank most of the time from January to March. In April, however, when the large high was establishing over most of Europe, the eastern areas came under a northerly flow east of that high. During the summer, high pressure influence dominated again, although another cold airflow prevailed in August. Seasonal cooling in autumn was lower than normal due to frequent westerly airflows.

The negative AO phases did not have much impact on eastern Europe, except for the extreme situation in December when cold air from Siberia came into most parts of that area.

1.4.9. Middle East (Cyprus, Israel, Jordan, Lebanon, Syria, Turkey)

High pressure influence dominated most of the year until summer. It ended in September when strong low pressure activity set an end to the dry period and marked the start of the rainy period. The AO/NAO fluctuations had no noticeable effect on that area.

1.5. Stratospheric warming

The monthly mean temperature of February 2009 at 30 hPa over the North Pole has been the highest February mean since 1942. The polar vortex broke down as early as in January, and in the first days of February a warm high pressure area formed instead. This stratospheric warming was related to an increase of ozone.

2. Temperature

2.1. Overview

Widespread anomalous warmth averagely affected continental Europe in 2009. The annual average land surface air temperature anomaly from the CRUTEM3 dataset (http://www.cru.uea.ac.uk/cru/data/temperature/) referring to 1961-1990[1] was +1.05±0.07°C for the European region (35-75°N, 10°W-30°E). This ranks 2009 between the third and tenth warmest year since 1850, with the nominal ranking placing it seventh. Noteworthy is that 2000-2009 was the warmest decade on record for Europe, with an anomaly of 1.00±0.12°C and significantly warmer than previous decades (1990s: +0.58±0.11; 1980s: +0.06±0.10). In many countries, all years of the decade 2000-2009 were, on average, warmer than normal, although 2009 was not the warmest year in that period. Some months in 2009 were even much colder than normal over large areas.

Annual mean anomalies > +2°C in 2009 were mainly confined to the Arctic regions, notably Svalbard and some other islands, and some parts of the northern coasts of Greenland (Fig. 0.4). Over large parts of Europe, the Middle East and the northern North Atlantic, however, anomalies exceeded +1°C. Some other parts of the continent, the central North Atlantic and most of the Mediterranean recorded anomalies below +1°C, though above zero. Negative annual mean anomalies were found only locally in very few places, e.g. over the central North Atlantic and eastern Turkey.

During the year, however, there were some periods that were colder than normal on the monthly and seasonal scales, notably in the western parts of Europe in January/February, in northern Europe in June, October and December, in the Arctic and eastern Europe in April and over the North Atlantic in summer. In contrast, some very warm periods occurred in the Arctic and eastern Europe from January to March, over central Europe in April, in parts of southern Europe in May and late summer, in nearly the whole of Europe in November, and in the Middle East in October and December.

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[1] The standard reference period used in this publication for European averages is 1961-1990 for temperature, and 1951-2000 for precipitation, unless otherwise expressly specified.

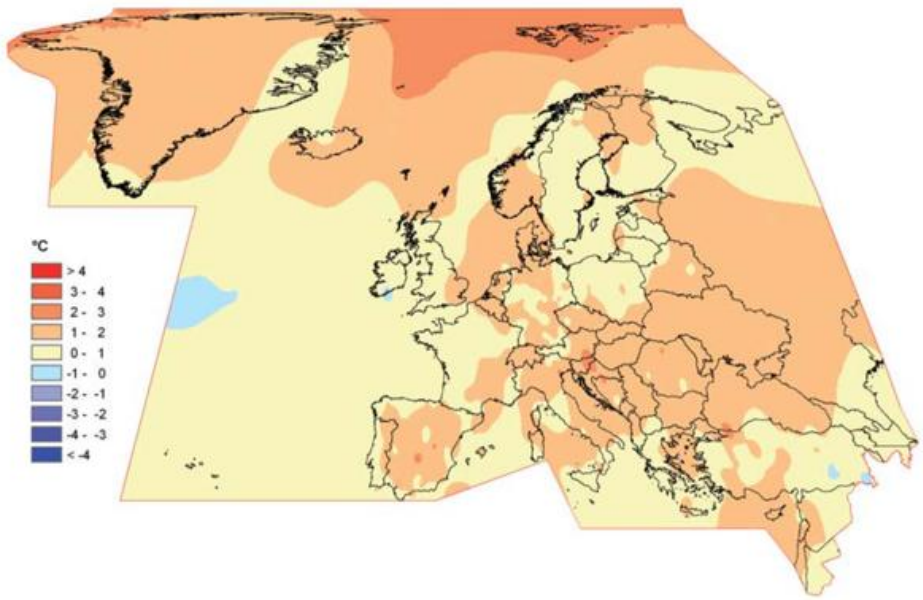

Fig. 0.4: *Mean annual temperature anomalies in 2009 (reference period 1961-1990) in WMO Region VI (interpolation of CLIMAT data)*
Source: Deutscher Wetterdienst, Germany

2.2. Northern Europe and Arctic region

Mean annual temperatures in the Nordic Countries were above normal, with annual temperature anomalies mostly ranging from +0.5 to +1.5°C, except in the Arctic where they were even higher. The highest positive anomalies were recorded in Svalbard (arctic Norway), where mean temperatures of 2-3°C above the 1961-90 average were recorded.

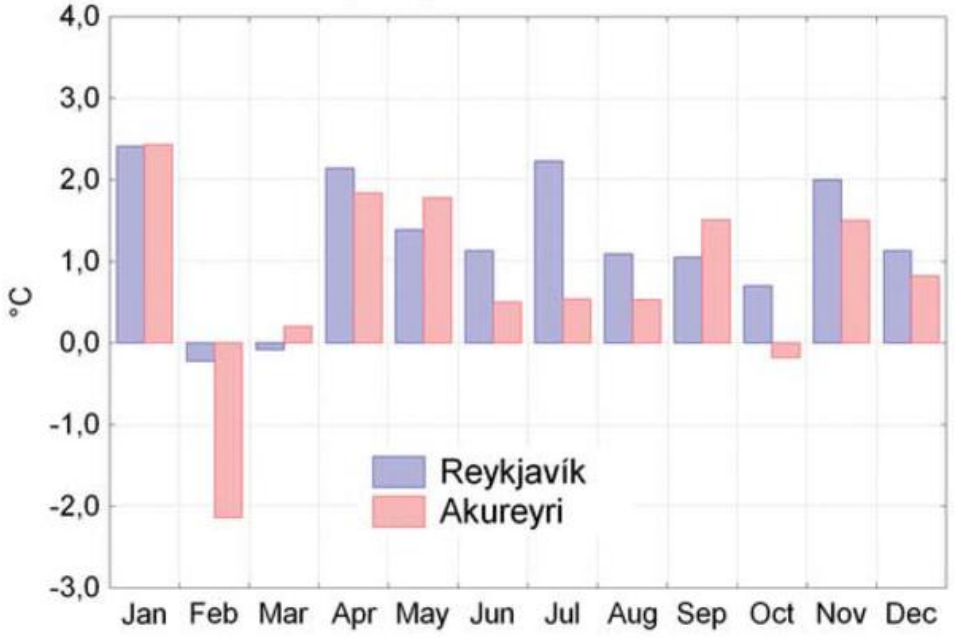

Fig. 0.5: *Mean monthly temperature anomalies in Reykjavik (south-west Iceland) and Akureyri (north Iceland) in 2009, reference period 1961-1990*
Source: Icelandic Meteorological Office, http://en.vedur.is/weather/articles/nr/1802

In the Arctic, monthly anomalies were particularly high in the cold months January, November and December 2009, but also in May (> +4°C). Monthly anomalies at Svalbard airport rose to +8.4°C in November and +10.9°C in December. Most of the other months were also warmer than normal there. A clear exception was April, which was colder in the whole European Arctic except western Greenland. Whereas many locations in Greenland were warmer than normal in most of the months, the temperatures in the summit area in the middle of the ice sheet were mostly below normal. In Iceland, only February was considerably colder than normal in the northern parts (Fig. 0.5). In the Faroe Islands' capital city Tórshavn, all months in 2009 were warmer than normal and 2009 as a whole was the second warmest year on record with an annual mean of 7.6°C (+1.1°C anomaly), together with 1933 and behind 2003 (Fig. 0.6).

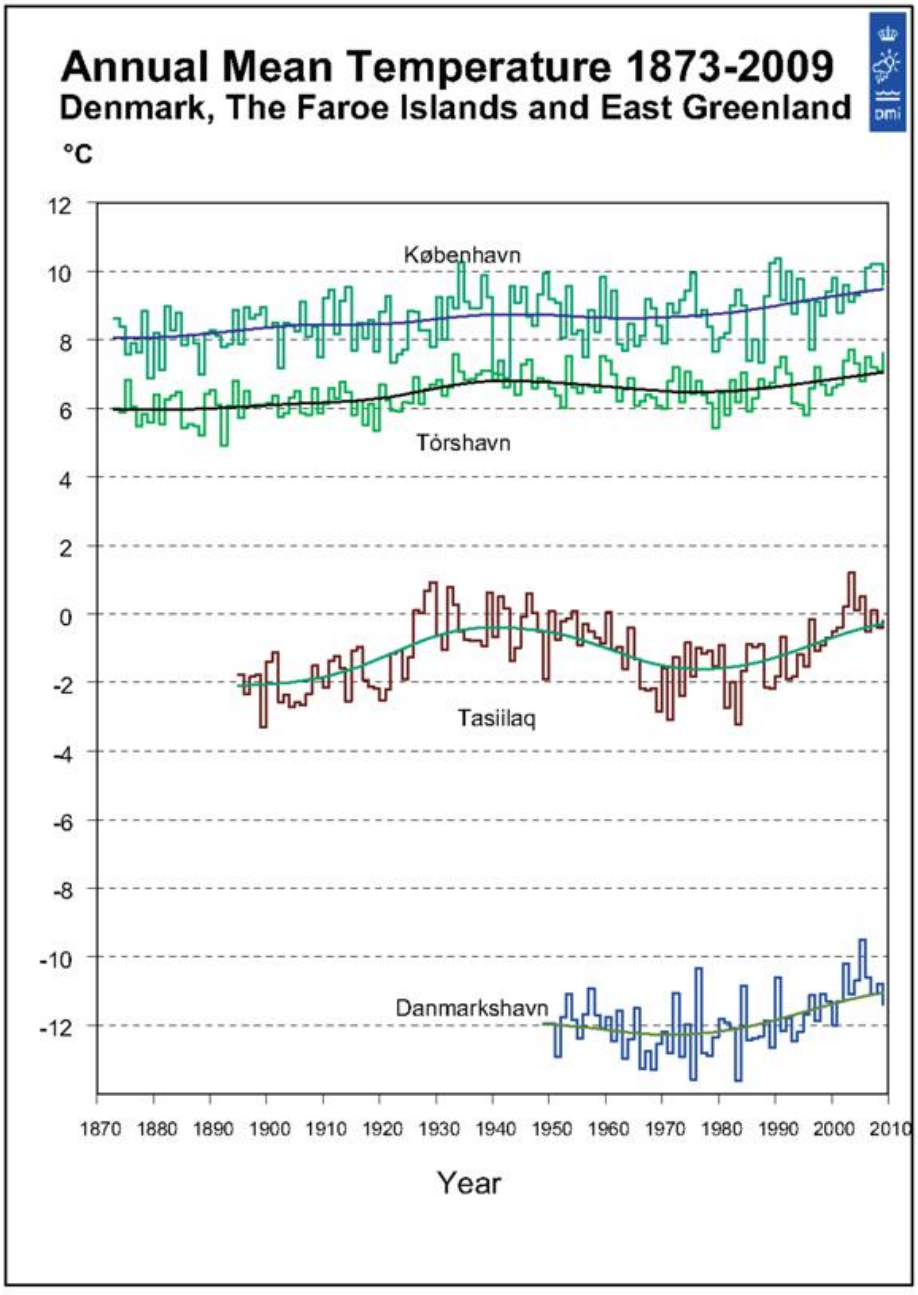

Fig. 0.6: *Mean annual temperature and smoothed values 1873-2009 for some locations in Denmark, the Faroe Islands and east Greenland*
Source: Danish Meteorological Institute

Northern continental Europe experienced a high variability of warmer- and colder-than-normal months. February was locally very cold, especially in Sweden. June, October and December were colder than normal in nearly the whole of Scandinavia and the Baltic countries. All the other months were, on average, warmer than normal across much of the Nordic and Baltic region; it was particularly warm in Scandinavia in August and in the southern parts of northern Europe, e.g. in Lithuania (Fig. 0.7), in April.

Annual means in Norway in 2009 were lower than in most of the previous years in the past decade; although the year was generally warmer than on average. Local means of up to 8.8°C were measured in the south of the country (Fig. 0.8) in 2009.

Throughout the Baltic countries, annual temperature anomalies were also around +1°C except Latvia and Lithuania where 2009 was colder than the previous three years 2006-2008 and 2008, respectively.

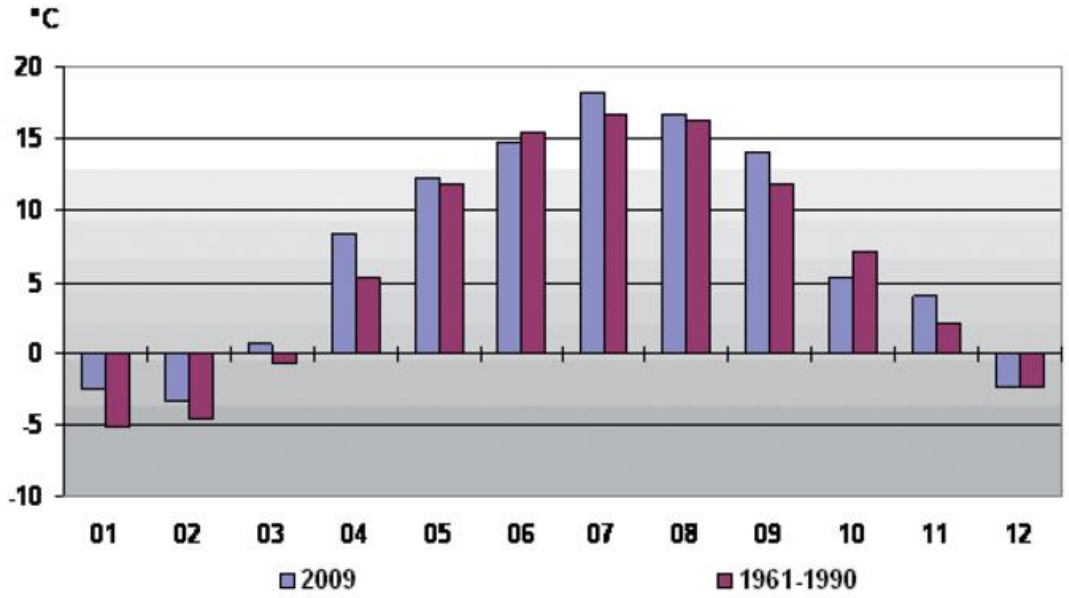

Fig. 0.7: *Mean monthly temperature in Lithuania in 2009, compared to the 1961-1990 normal*
Source: Lithuanian Hydrometeorological Service

2.3. North Atlantic

The central North Atlantic had near normal temperatures on annual average whereas over the northern North Atlantic, it was more than +1°C warmer than normal. It also was slightly warmer than normal on the Azores Islands.

The central North Atlantic was warm at the beginning of the year and in spring, but seasonal warming in summer was lower than usual. It was also colder than normal in November and December. Northern parts of the North Atlantic were mostly warmer than or near normal throughout the year.

2.4. Central and Western Europe and the Alpine region

Annual means in central Europe (including the Low Countries) and in the Alpine region were mostly around +1°C higher than normal. Anomalies in western Europe and in Poland were mostly below +1°C, but still above normal. Only some places (e.g. in south Ireland) were locally near to normal, mainly due to very cold weather at the end of the year. The Irish station at Cork Airport has seen its coldest year since 1996.

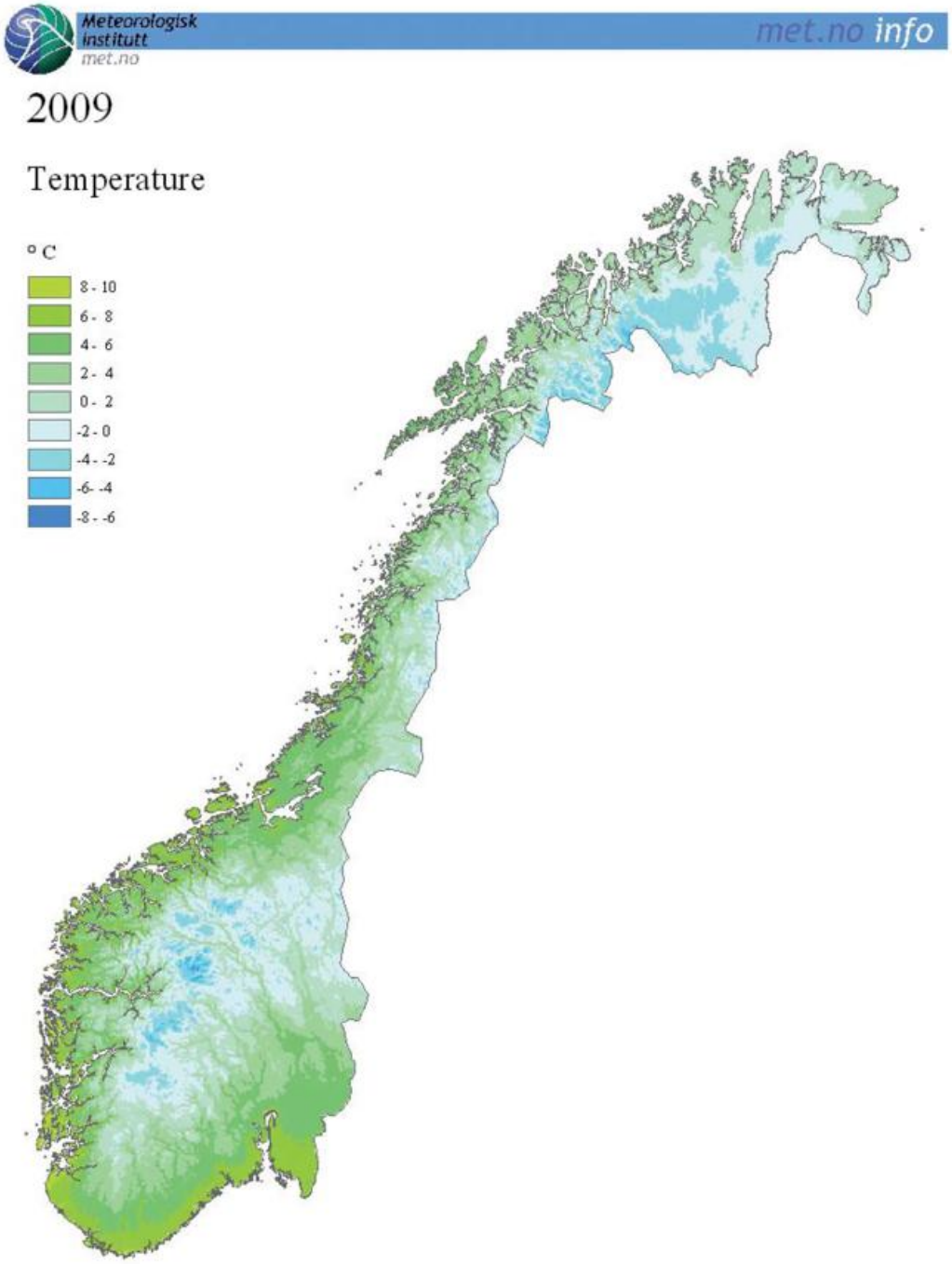

Fig. 0.8: *Mean annual temperature 2009 in Norway*
Source: Meteorologisk Institutt met.no, Norway

In Luxembourg, where the annual mean anomaly was slightly higher than in other adjacent countries (+1.6°C), the 2009 temperature corresponded roughly to the average of the last decade 2000-2009 (Fig. 0.9). Belgium, Luxemburg and Germany all recorded an abnormally high number of 36-37 summer days (maximum temperature >= 25°C) in places or on areal mean which was around one third more than normal. On the other hand, the number of hot days (maximum >= 30°C) was not considerably above normal because the summer had many cloudy days, and longer heat waves were missing. Days with air frost were less than normal e.g. in Luxembourg and Germany due to the mild months of April and November.

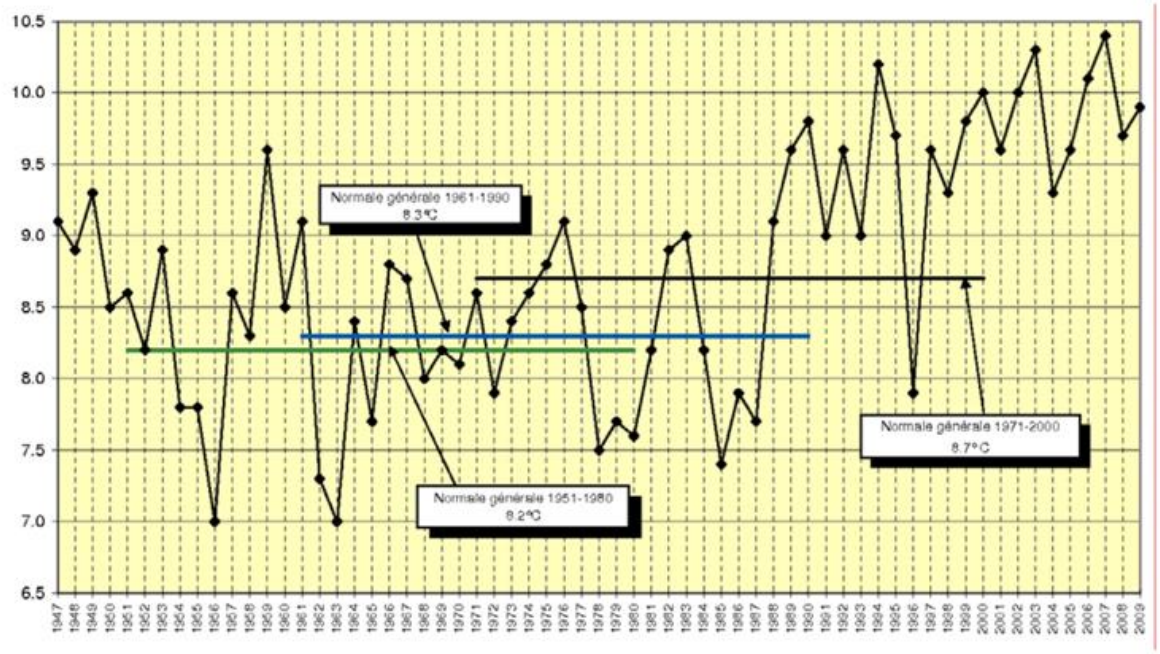

Fig. 0.9: *Mean annual temperature 1947-2009 in Luxembourg Airport, compared to various normal temperatures*
Source: Service Météorologique de Luxembourg, Administration de la navigation aérienne

Most of the months were warmer than normal in western and central Europe, especially April/May, July to September and November. On the other hand, January was generally a cold month; June and October were colder than usual particularly in north-eastern central Europe, e.g. in Poland (Fig. 0.10a), while December was colder than normal in the whole northern part of western and central Europe.

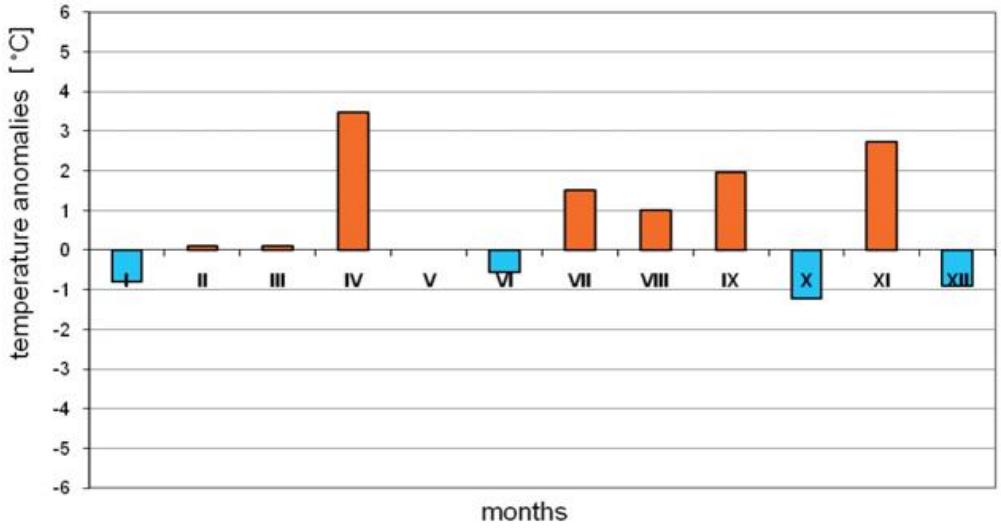

Fig. 0.10a: *Mean monthly temperature anomalies 2009 in Poland (reference period 1971-2000)*
Source: Institute of Meteorology and Water Management (IMGW), Poland

2.5. Iberia

Temperatures registered in 2009 over the Iberian Peninsula were significantly above the long-term average. The annual mean anomaly in most of Iberia ranged between +1 and +2°C and was higher in the east than in the west. In large parts of the western areas, especially near the coasts, anomalies were below +1°C, but still positive, particularly due to higher maximum temperatures. Portugal recorded seven heat waves[2] (periods of succeeding high temperatures) from spring to autumn.

It has been the 3rd warmest year in most areas of Spain since 1961 (behind 2006 and 1995, with an anomaly of +1.2°C referenced to 1971-2000, Fig. 0.10b), and also summer and autumn were the 3rd warmest on record. The largest annual anomalies were observed in the central and southern regions as well as on the north-western Iberian Peninsula. The lowest deviations were found in Asturias (northern Spain) and on the Balearic Islands (around +0.5°C). Temperature deviations in Portugal were highest in the north (+0.9°C, 1971-2000 base), but in general lower than in Spain (+0.5°C averaged over the whole mainland of Portugal, 1971-2000 base).

The year 2009 began with a negative temperature anomaly during winter (especially in January), continued with a warmer-than-average spring, a particularly warm summer and a moderately warm fall. In spite of some colder episodes in some areas of Iberia throughout the year, half of the months were much warmer than normal. The warmest months of 2009 in Spain (relative to normal) were May, June, October and November, when mean temperatures were around +2°C above average. Overall in Portugal, the warmest months (relative to normal) were March, May and October.



Fig. 0.10b: *Mean annual temperature anomalies 1961-2009 in Spain (°C, reference period 1971-2000) Source: AEMET, Spain*

2.6. Mediterranean, Italian and Balkan peninsulas

Much of Italy and south-eastern Europe were 1-2°C warmer than average during 2009, even exceeding +2°C in eastern Slovenia and +2.5°C in north-eastern Italy and western Slovenia. On the Slovenian coast, 2009 was the 2nd warmest year on record, together with 1994, 2000 and

[2] *There is no universal definition of a heat wave. The WMO recommended defining a heat wave as a period of at least 6 succeeding days with a daily maximum temperature exceeding the normal by at least +5°C*

2002. Throughout Croatia, very high annual temperatures prevailed, particularly in spring and summer, exceeding the 98th percentile of the 1961-90 distribution over most regions. In Zagreb, it has been the equal (together with 2008) 3rd warmest year since 1862, behind 2000 and 2007 (Fig. 0.11). Further to the west, it was the 3rd warmest year since 1969 in Monaco, behind 2006 and 2007 with an annual means of 17.2°C.

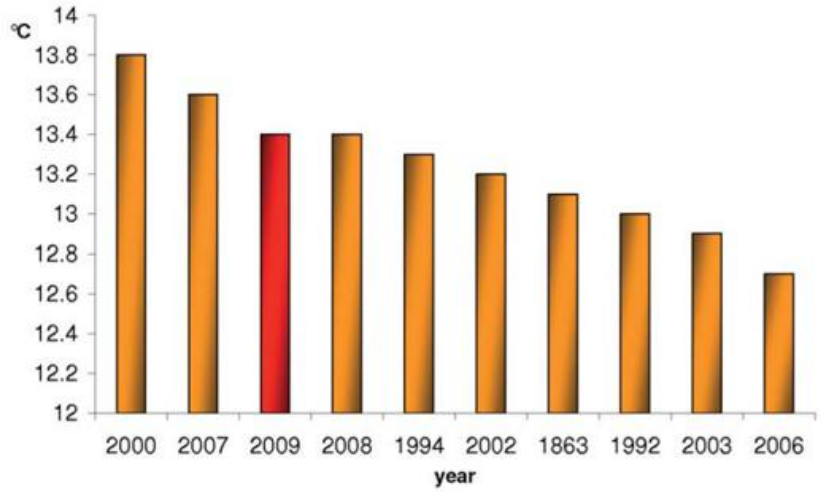

Fig. 0.11: *The ten warmest years (annual mean temperatures) in Zagreb Gric, Croatia, of the observation period 1862-2009*
Source: Meteorological and Hydrological Service of Croatia

Some periods of the year were considerably warmer than normal, notably April/May (except Bulgaria in April), August/September and November/December. In Ljubljana (Slovenia), all months in 2009 were warmer than normal, except January. In Malta, all warm months (May-September) as well as the winter months January and December 2009 had mean temperatures above normal. February, on the contrary, was a very cold month in the central Mediterranean.

2.7. Eastern Europe

Annual temperature anomalies over Eastern Europe ranged between +1°C and +2°C, with only northern parts of European Russia recording an anomaly below +1°C. Parts of Romania exceeded +2°C. Moldova experienced its second warmest year in history, beaten only by 2007 (Fig. 0.12a).

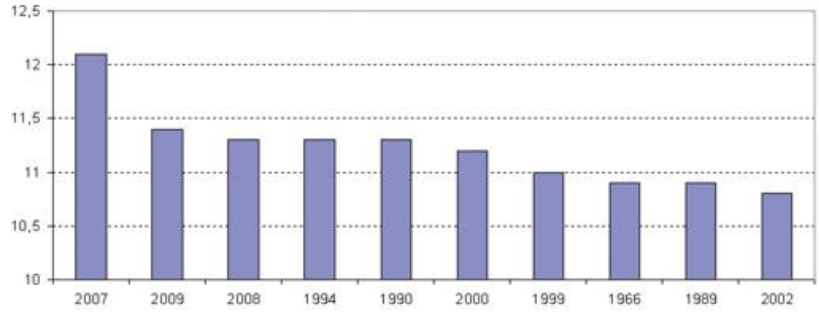

Fig. 0.12a: *The ten warmest years (annual mean temperatures in °C) in Chisinau, Moldova, of the observation period 1886-2009*
Source: State Hydrometeorological Service of the Republic of Moldova

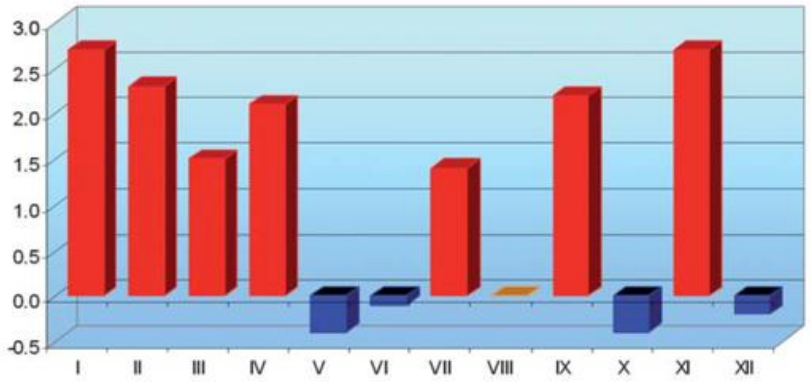

Fig. 0.12b: *Mean monthly temperature anomalies 2009 in Belarus (°C, reference period 1961-1990). Source: Republican Hydrometeorological Centre, Belarus*

Most of the months throughout the year were much warmer than normal, however, with some outstanding colder-than-normal periods in April or May, in July (only in northern European Russia), August (only in the east), October (only in the north-west) and December (Fig. 0.12b for Belarus). The westernmost parts of eastern Europe (e.g. Romania, Moldova) were also warmer than on average, except for March in Romania and December in Moldova.

2.8. Middle East and South Caucasus region

Warmer-than-average conditions prevailed in the entire region throughout the whole year. The largest anomalies were experienced in the eastern Mediterranean region in Cyprus, Israel, Lebanon and the western parts of Syria and Kazakhstan, with values generally ranging between +1° and +2°C. Other parts were less warmer (0-1°C) than normal on annual average (e.g. Turkey, Armenia, Azerbaijan), parts of eastern Turkey locally even slightly colder.

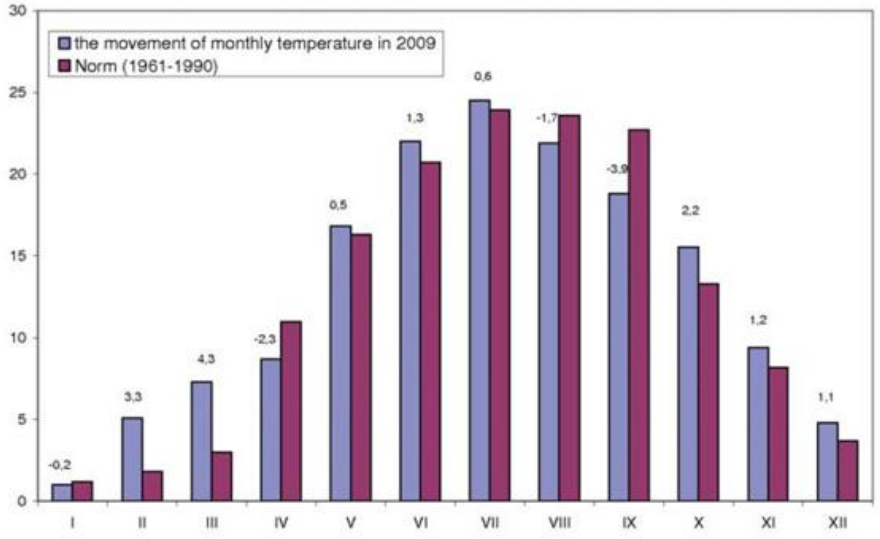

Fig. 0.13: *Monthly mean temperature (°C) in Azerbaijan in 2009 (blue bars) compared with the 1961-1990 normal (red bars). Numbers above the blue bars are monthly anomalies (°C) in 2009 from the normal*
Source: National Hydrometeorological Department Azerbaijan

Some of the months were much warmer than normal, particularly February, June, October and December. Western Turkey and Cyprus also saw a mild January, and March was very warm particularly in Azerbaijan (Fig. 0.13). November was generally warm in the South Caucasus region, Cyprus and most of Turkey whereas April and August/September were cold especially in the South Caucasus region. Jordan had significant heat waves even in May and October as opposed to frosts in mountainous regions in January-March and November-December; March and November were colder than normal in parts of the country. The station Ma'an in Jordan (around 1000 m above sea level) recorded 42 days of frosts in 2009.

3. Precipitation

3.1. Overview

Total precipitation for the year 2009 (Fig. 0.14) was above average over most of eastern and south-eastern Europe, Ireland, northern and southern parts of the UK, Iceland and in parts of Fennoscandia. Locally, it was particularly wet in several regions in Austria, where new annual precipitation records were set in several places in Belarus and adjacent parts of Russia and in the eastern half of the Mediterranean region including southern Italy.

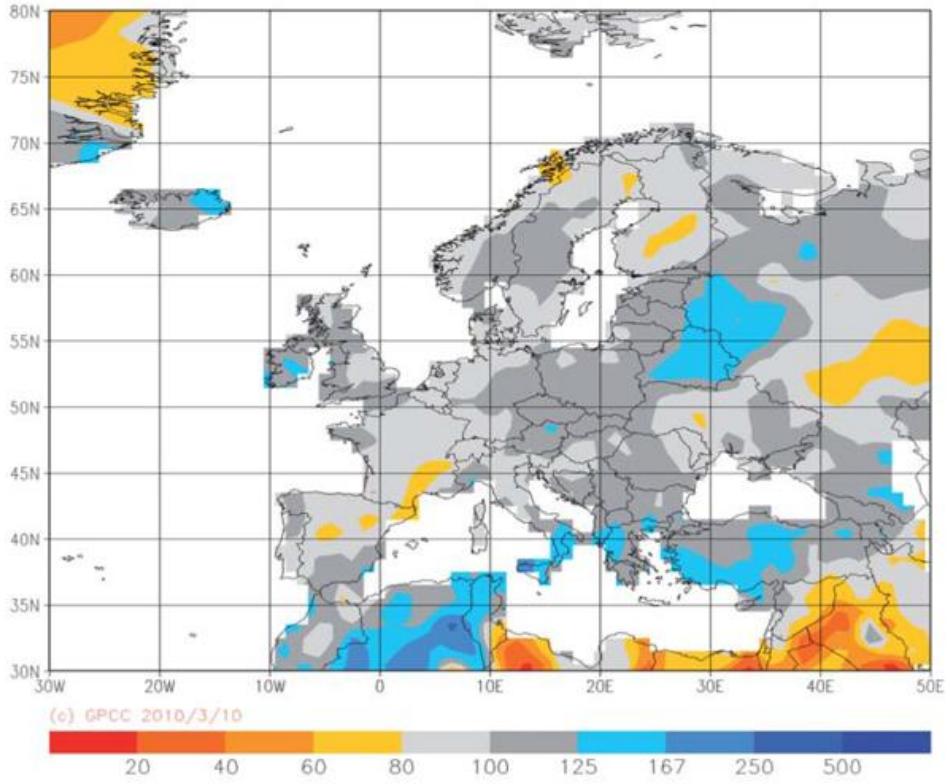

Fig. 0.14: *2009 annual precipitation amounts in WMO Region VI in per cent of the 1951-2000 normal*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Drier-than-average conditions occurred over large parts of Scandinavia, the Low Countries (Netherlands, Belgium and Luxembourg), the western parts of Germany, wide parts of France and Iberia, and the central parts of England, where totals were 80-100% of normal precipitation. Some smaller parts of Greenland, Scandinavia, Russia, southern Iberian region, southern France, and the Middle East received annual rainfall totals below 80% of the long-term average.

Throughout the year, there were some exceptional periods of high or low precipitation in the Region. High precipitation fell notably over the central Mediterranean in January, in central and south-eastern Europe in March, June and October, in the United Kingdom, Ireland and southern Scandinavia in July and November, and in southern and eastern Europe in December.

In contrast, April was outstandingly dry in large parts of northern, central and eastern Europe while August/September was a very dry period particularly in the middle latitudes and parts of the subtropics.

3.2. Northern Europe and the Arctic

The Arctic region was mainly dry in 2009, as were most of Iceland and the Faroe Islands. Especially some areas in Greenland received less than 80% of its annual normal. Reykjavik, which is located in south-western Iceland, had slightly below normal precipitation and below normal precipitation days (205 compared to 221 normally), recording its driest year since 1995. Only the south-eastern parts of Greenland and eastern Iceland were exceptionally wet, with more than 125% of the normal. Generally, the Arctic region was very dry in June-September, but wet in November/December.

The year was also dry in most parts of continental Scandinavia. Some parts of northern Scandinavia and Finland had less than 80% of its annual normal. Nevertheless, there were some wet areas particularly in south-eastern Norway, central Sweden and northern Denmark, which can be explained by heavy rain in July. In some places in central Sweden, 2009 has been among the 3 wettest years since 1901 while ranking among the driest years in both northern and southern Sweden (Fig. 0.15).

Most of Scandinavia saw some very dry months, notably January, March, April, June, October and December. July and November were wet in southern Scandinavia, September at the Norwegian coast. Helsinki in southern Finland was quite wet from May to July, but very dry in the months before and afterwards (Fig. 0.16).

The Baltic countries and most of northern European Russia had above normal precipitation, in some areas in Estonia and northern European Russia more than 125% of the normal. In Latvia, 2009 was the third consecutively wetter-than-normal year after a very dry year 2006.

April and May were also extremely dry in the Baltic countries while June, October and December, on the contrary, were wet. Precipitation was often very intense in summer and early autumn.

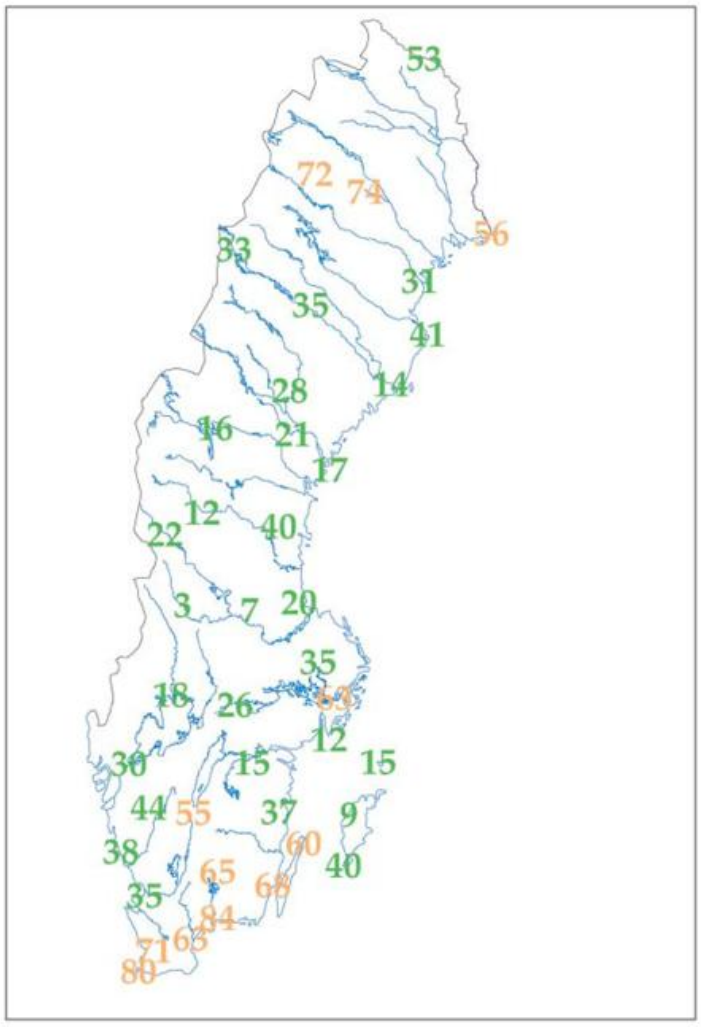

Fig. 0.15: *Ranking of precipitation 2009 in comparison with the years 1901-2008. 1= wettest, 109 = driest year*
Source: Swedish Meteorological and Hydrological Institute (SMHI)

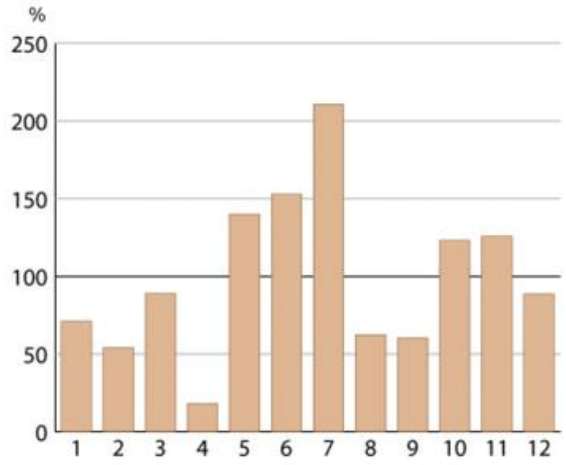

Fig. 0.16: *2009 monthly precipitation amounts in Helsinki Kaisaniemi (Finland) in per cent of the 1971-2000 normal*
Source: Finnish Meteorological Institute

3.3. Western and central Europe

Large parts of France, Belgium and the Netherlands, the western half of Germany, and Switzerland were slightly drier than normal on average. Some areas of southern France received less than 80% of their normal annual precipitation. Ireland, large parts of the United Kingdom, Luxembourg and nearly the whole of eastern central Europe had above normal precipitation.

In some areas in Ireland, the mean annual precipitation totals were exceeded by 25%. Valentia Observatory in Ireland has reported its highest annual rainfall total since records began in 1866. The high totals in Ireland were mostly due to heavy rainfall events in summer and November and to a 10-20% higher-than-normal number of rain days.

Eastern Austria, too, reported several very wet areas. Graz received in 2009 an annual precipitation total of 1205 mm, i.e. 143% of the 1971-2000 mean, making it the second highest annual total in the 173-year continuous station record.

Over the year, western Europe generally was especially dry in February/March and September/October whereas most parts of it were wet in July and November. Particularly Ireland and the United Kingdom received a lot of rain.

Central Europe saw a very dry January and an exceptionally dry April particularly in its eastern areas. August and September were also very dry, causing unusually low water levels in many rivers followed by restrictions to shipping transport. France and Switzerland had a prolonged dry period from August to October. Wet periods in central Europe occurred in February/March, during some periods in May-July and in October-December. Frequent heavy thunderstorms in late spring and summer caused much damage and local flooding in central Europe. In Austria, particularly April as well as October and November were dry, whereas most of the other months were wet, particularly February/March and June. In Hungary, the cold months (January-March, October-December) were wet while the summer half year (April-September) was much drier than normal, except June (Fig. 0.17).

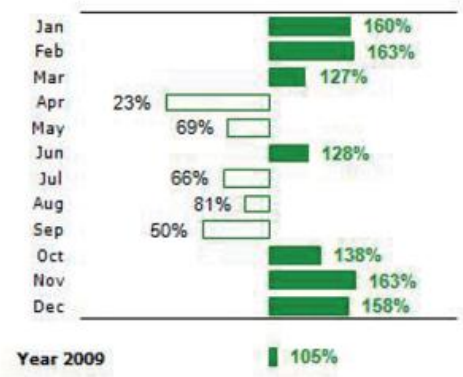

Fig. 0.17: *2009 monthly precipitation amounts in Hungary (country average) in per cent of the 1971-2000 mean*
Source: Hungarian Meteorological Service

3.4. Iberia

On average, Iberia experienced near-normal or slightly drier-than-normal conditions during 2009, with only few regions receiving less than 80% of the climatological average. The north-west of the Iberian Peninsula and southern Spain had above normal precipitation, the other parts below normal.

Dry episodes are relatively common in Iberia and, regarding the duration and intensity of dry periods, 2009 can in this context be classified as a moderately dry year, particularly when compared with exceptional dry years such as 2005. Nevertheless, all seasons recorded lower-

than-average precipitation for the aggregate area of Iberia in spring, summer and autumn (particularly from May to July) whereas December 2009 was an exceptionally wet month. Portugal reported drought conditions for almost the whole country between March and October (Fig. 0.18). Most of the Azores Islands were drier than the normal annual average, although October and December were wetter than normal.

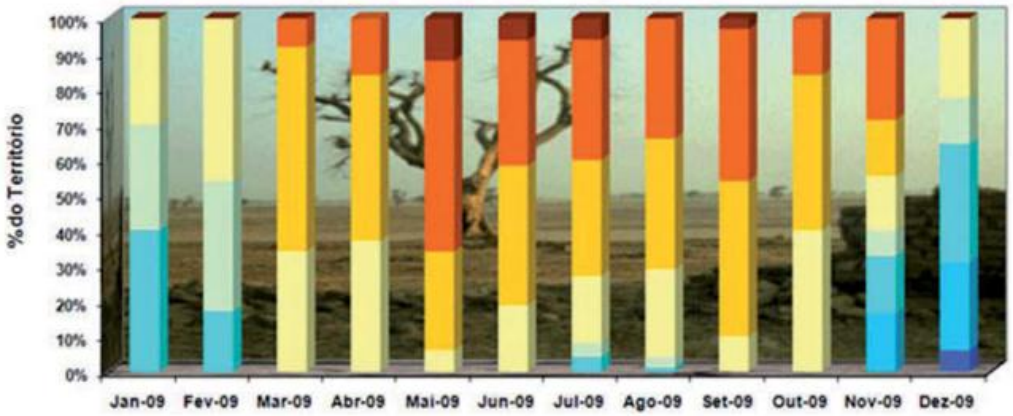

Fig. 0.18: *Monthly distribution of drought classes (Palmer Drought Severity Index) in % of the territory in Portugal for 2009. Classes range from very wet (dark blue in December 2009 on the bottom of the bar) – moderately wet – slightly wet – normal (light blue) – mild drought (light yellow) – moderate drought (white) – severe drought (orange) to extreme drought (dark red in the hot months on top of the bars)*
Source: Instituto de Meteorologia, Portugal

3.5. Italian and Balkan peninsulas, Mediterranean region

Most of the Balkan Peninsula and parts of Italy received above-normal precipitation in 2009. Southern Italy and parts of Greece recorded more than 125% of their normal annual total. In Bosnia and Herzegovina, some stations had an annual total of more than 1800 mm (Fig. 0.19a), on high mountains (station Bjelašnica) as well as near the Mediterranean (station Mostar), which was more than 20% of the normal. Some northern parts of Italy and of the Balkan Peninsula (e.g. in parts of Slovenia) had less precipitation than normal, whereas Monaco had quite a rainy year (880.5 mm, 114% of the 1969-1998 average).

Northern Italy and Slovenia were much wetter from January to March/April, relative to the normal reference period. The following months were mainly dry, although there were several severe thunderstorm episodes with hail particularly in summer. December again was characterised by very much precipitation.

Near the central Mediterranean and on the Balkan Peninsula, some periods with high precipitation occurred particularly in January, March, June, October and December. In contrast, it was very dry in Italy in May, July/August, November, and over most of the Balkan Peninsula notably in April/May and September. Monaco saw an extremely dry summer, but very wet months of April, November and December (Fig. 0.19b).

The south of the Balkan Peninsula, however, saw some special features, with a mainly wet spring in Macedonia and a particularly wet June in Skopje (Fig. 0.19c) and several heavy rain events with severe flooding in Greece from September to December.

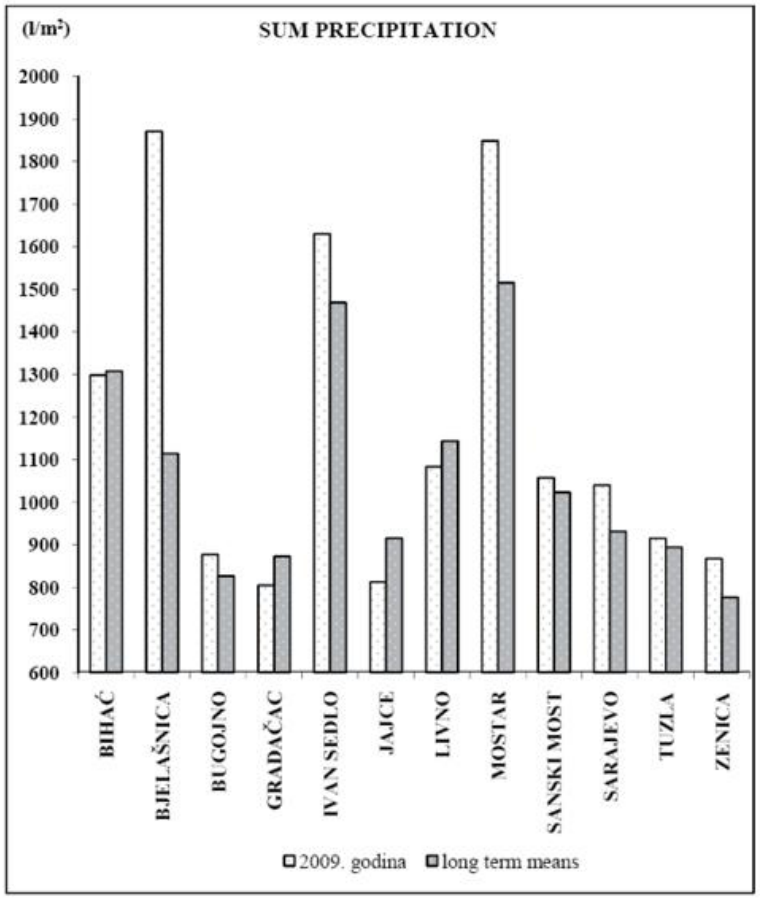

Fig. 0.19a: *2009 annual precipitation totals compared to the normal (long-term means) for stations in Bosnia and Herzegovina*
Source: Federal Hydrometeorological Institute, Bosnia and Herzegovina

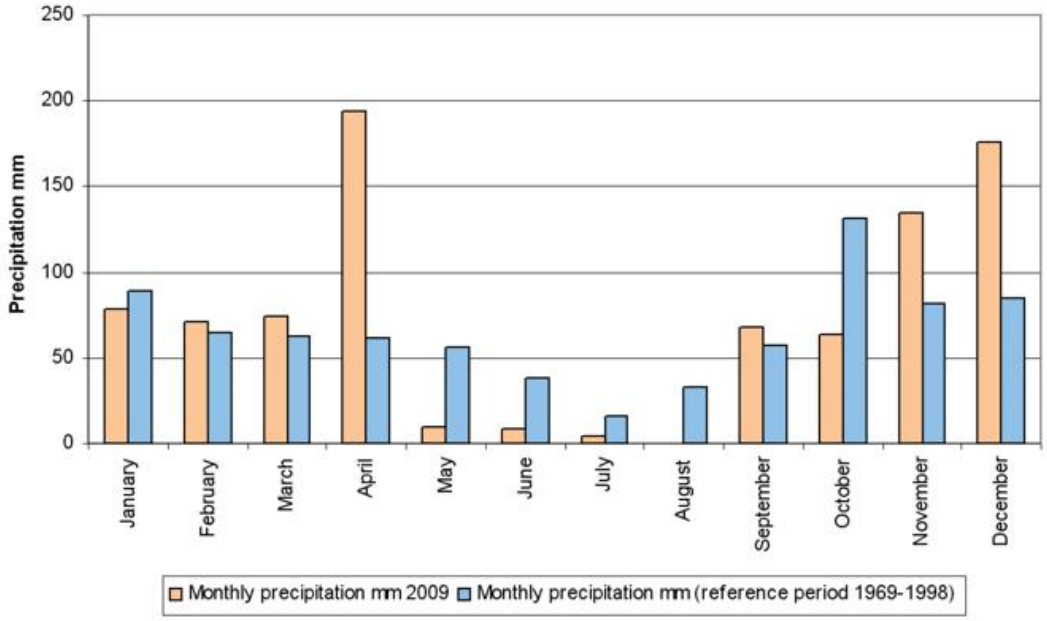

Fig. 0.19b: *2009 monthly precipitation totals compared to the long-term means 1969-1998 for Monaco*
Source: Direction de l'Environnement, Principauté de Monaco

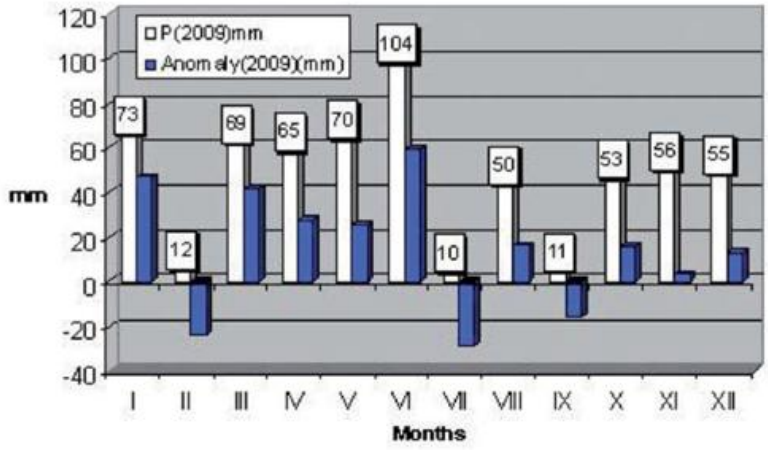

Fig. 0.19c: *2009 monthly precipitation totals and anomalies in Skopje Zajcev Rid (Macedonia), reference period 1983-1990*
Source: Hydrometeorological Service, Former Yugoslav Republic of Macedonia

Malta had extremely high precipitation in January and February. Then, after a usually dry summer, the year continued with a wet September and lower-than-normal precipitation for the rest of the year.

3.6. Eastern Europe

Precipitation totals in 2009 were generally close to average for most of eastern Europe with only a few areas well above or below. It was particularly wet over Belarus and western Russia (>125% of the annual normal). Only a few places in Moldova, the Ukraine and central European Russia reported a significant rainfall deficit between 60 and 80% of average, in a few cases even below. This set a new local record of lowest annual precipitation in Moldova with unfavourable effects on agriculture.

The whole of eastern Europe saw an extremely dry April, with eastern European Russia being also very dry in January/February, June/July and during the whole autumn. Belarus, the Ukraine, Moldova and parts of Romania had three very dry months (April, August and September; Fig. 0.20), causing drought conditions; the eastern Ukraine was also very dry in June. Eastern Europe was mainly very wet in March, October and December, triggering several flooding episodes e.g. in Romania.

In western Kazakhstan, the first half of the year featured a contrasting temporal pattern of rainfall. Winter was particularly dry, with areas receiving less than 40% of average precipitation, while spring rainfall was significantly above average, locally exceeding 160% of the normal.

3.7. Middle East and South Caucasus region

The western parts of the South Caucasus countries, Turkey (except south-eastern Anatolia), Cyprus and northern Jordan had above-normal precipitation in 2009. This brought an end to the 3-year drought period in Cyprus. Some places in Turkey recorded more than 150% of their annual average. Thus, 2009 has been the wettest year in Turkey since at least 1941, with 170 mm (27%) above the 1971-2000 average (Fig. 0.21).

Annual precipitation in western Syria and the Lebanon ranged between normal and slightly below normal.

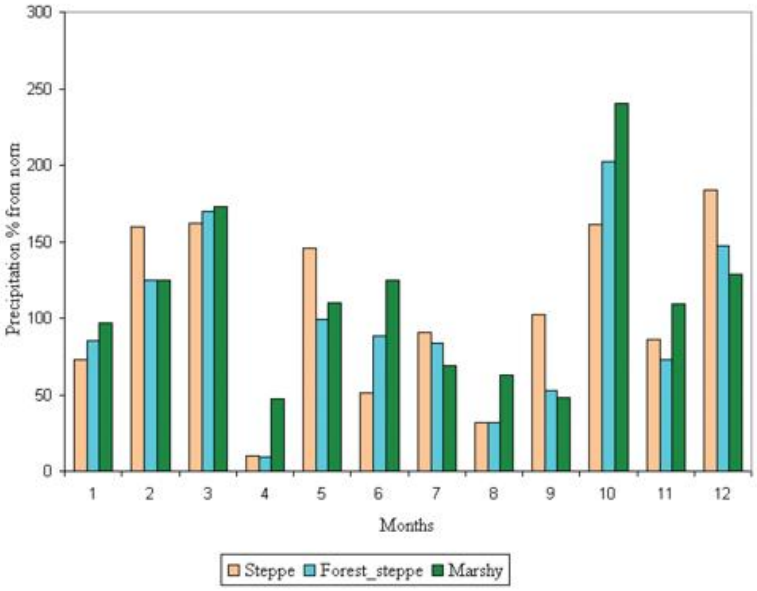

Fig. 0.20: *2009 monthly precipitation totals in per cent of the 1961-1990 normal for three vegetation zones in the Ukraine (steppe, forest-steppe, marshy)*
Source: Ukrainian Hydrometeorological Centre

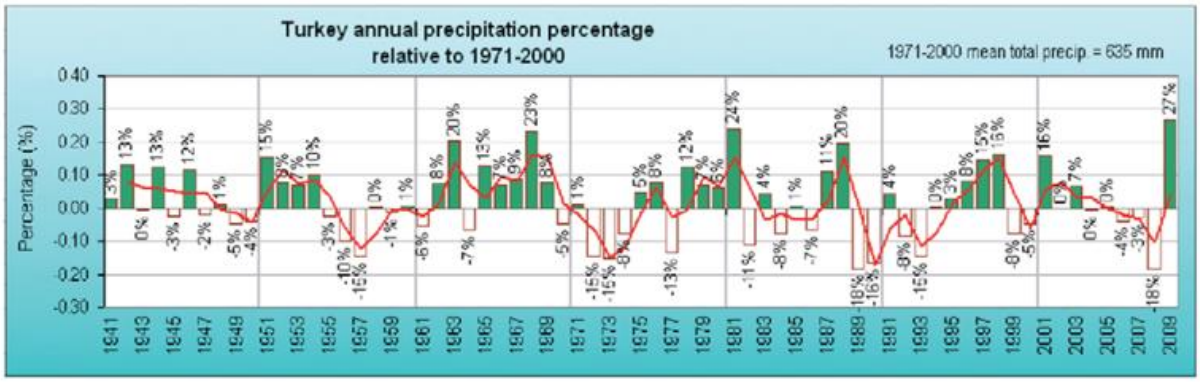

Fig. 0.21: *2009 annual mean precipitation in Turkey 1941-2009 in per cent of the 1971-2000 mean*
Source: Turkish State Meteorological Service

The southern Middle East was mainly dry, partly with less than 80% of the normal and, in the eastern parts of Jordan, even less than 40%. The spatial variability of precipitation anomalies, however, was quite high in Jordan, varying between up to more than 150 mm above or below the normal (Fig. 0.22). For the sixth year in succession, Israel's 2008/09 rainfall season delivered below-average rainfalls which resulted in water shortages and deteriorating quality of ground water reservoirs.

Armenia, which normally has a dry summer, experienced frequent showers in summer 2009; rainfalls were reported almost every day from July to September while October to December were drier than normal. Azerbaijan had very intense precipitation in August and September, spring and October, however, were dry. Turkey was very wet in February and partly in March, July, September, November and December, but dry in August. Cyprus was drier than normal in April, June, July and November and wetter than normal in the other 8 months, due to several heavy rains and hail storms except in summer. Most of the south-eastern Middle East (large

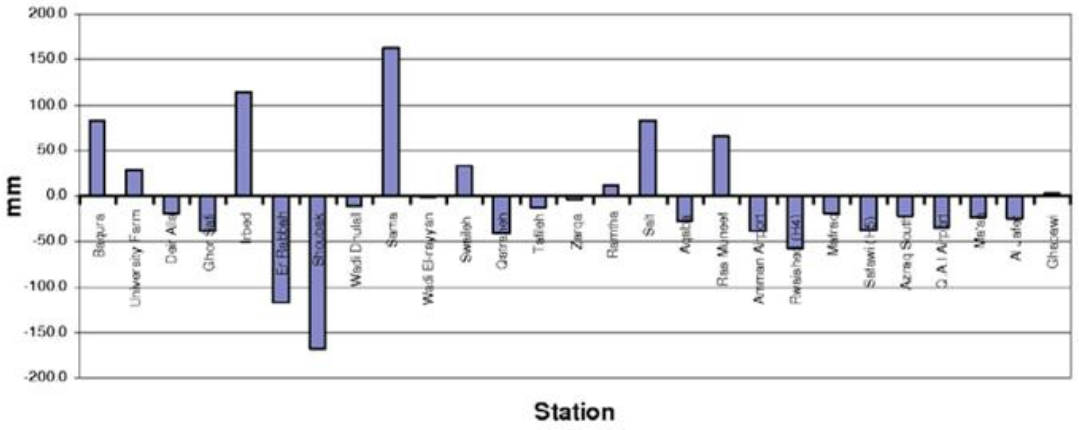

Fig. 0.22: *2009 annual precipitation anomalies at various stations in Jordan*
Source: Meteorological Department of the Hashemite Kingdom of Jordan

parts of Syria, Lebanon, Israel, Jordan) was particularly dry in January and April as opposed to more precipitation than normal including some severe rainfall in September and October, which meant an early start of the 2009/10 rainfall season.

4. Snow

In Iceland, the number of days throughout the year on which the ground was covered by snow was much lower than the 1961-90 normal (e.g. 40 days in Reykjavik compared to a normal of 65 days). The largest measured snow depth was 166 cm at the station Mýri in the northern inland on 18 January.

In Sweden, exceptionally high snow depths were recorded in February. Östersund recorded an average snow depth of 81 cm during February, which has been the highest monthly mean depth at this station since March 1988.

In the north-eastern areas of European Russia, the snow cover of the 2008/09 season persisted 20-38 days less than the long-term average in European Russia. Over most of the country, the maximum snow depth recorded in the season was below the 1961-90 normal; in some places, however, it was more than 40 cm above normal (Fig. 0.23).

5. Sunshine duration

The year 2009 was a sunny year for most of northern, western, central and southern Europe (Fig. 0.24). Most places within this area received 105-125% of normal annual sunshine, some stations 100-105% and only a few locations, mostly in higher elevations had below normal sunshine. Tórshavn on the Faroe Islands saw a new record of annual sunshine duration at 1139 hours (135% of the 1961-90 normal). The Malin Head station in Ireland has had its sunniest year since 1960. In the Netherlands, some places had more than 2000 sunshine hours that year, thus placing 2009 among the three sunniest years at these locations at least since 1908.

In contrast, nearly the whole of eastern Europe and the Middle East were dull compared to the normal, mostly with only 75-95% of the annual normal, in the easternmost parts of the Region even below 75%.

Northern, western and central Europe received more sunshine than normal already in January. It was the second sunniest January on record in Germany (behind 2006) and the Netherlands (behind 1940), respectively. In contrast, February was very dull in most of the Region except

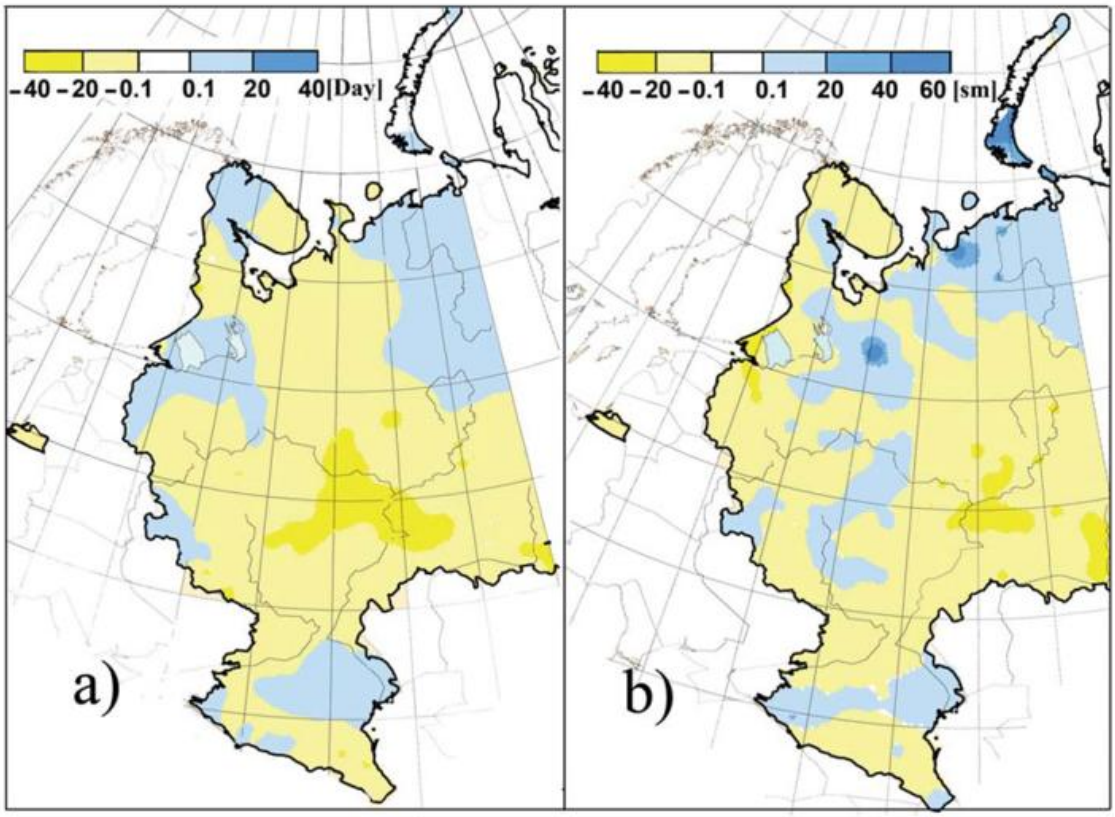

Fig. 0.23: *Snow cover anomalies in European Russia for the season 2008/09 (reference period 1961-1990) of a) the number of days with snow cover, b) the maximum snow depth in cm*
Source: Roshydromet, Russian Federation

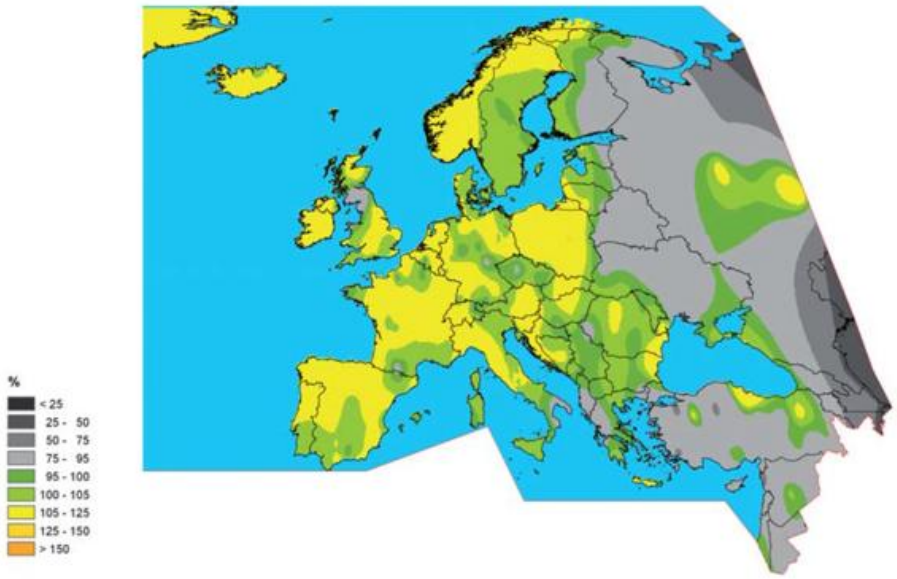

Fig. 0.24: *Annual sunshine duration in 2009 in per cent of the 1961-1990 normal in WMO Region VI (interpolation of CLIMAT data)*
Source: Deutscher Wetterdienst, Germany

south-western and northern Europe. In Germany, it has been the dullest February since 1970, in England and Wales the dullest since 1993, in Belgium (Brussels-Uccle) the second dullest since 1887 (behind 2006, Fig. 0.25). In March, especially the whole of western Europe was sunny and places in northern England received more than 170% of the monthly normal.

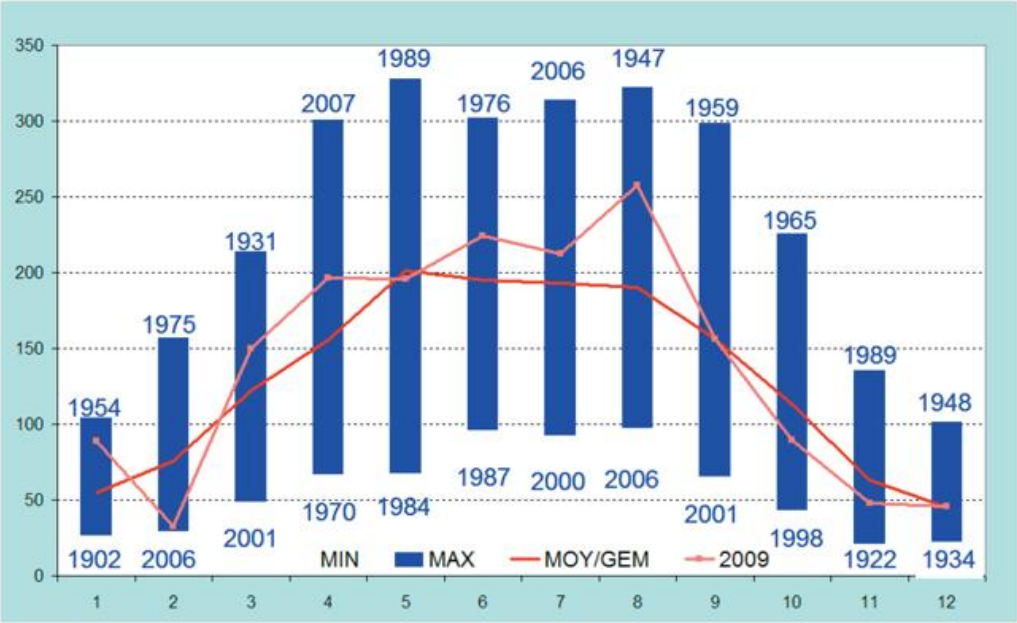

Fig. 0.25: *Monthly sunshine duration in 2009 in hours (pink line) in Brussels-Uccle, Belgium, compared to the 1901-2000 average (red line) and absolute monthly maxima and minima (bars, with years of maximum/minimum indicated)*
Source: Royal Meteorological Institute of Belgium

April, with its very extensive high pressure situation, was sunny over large areas, particularly in eastern central Europe with more than 150% of the normal, partly even 200%, e.g. in places in north-eastern Germany. It was the sunniest April on record in Denmark (272 hours of sunshine as compared with a normal of 162 hours) and locally in Sweden, and the second sunniest April in Germany, Austria and in some places of Slovenia since at least 1951.

During the summer half year, notably the months May, August and September were mostly sunnier than normal, June and July only partly. June sunshine in the United Kingdom was 120% of the normal, in the north partly 150%. In some places in Ireland, it has been the sunniest June for over 50 years. New records of August sunshine duration were measured e.g. in Berlin, Germany (295 hours, normal 197), and it was the second sunniest August in Germany as a whole since 1951 (behind August 2003) and the third sunniest August in Ljubljana/Slovenia. Malta in the Mediterranean was sunnier than normal during the whole warm season (May-August).

October was sunny in northern and south-western Europe and south of the Alps, but mainly dull in most of the other parts of the Region. November was extremely dull (partly <25% of the monthly normal sunshine duration) in most of northern and eastern Europe and dull in western Europe, but sunny in most of the Mediterranean region. December was dull nearly everywhere in the Region except the north-west and a few other places in the Region. Remarkably, it has been the second sunniest December on record in the United Kingdom since 1929.

6. Wind

The Nordic Region was hit by some significant storms that locally caused damage and even casualties. Three of them (occurring in June, July and November) were particularly severe. The highest mean wind speed measured in 2009 on some maritime stations in Norway was 96 km/h on 4 November.

Although a few storms had a high intensity, however, the number of heavy storms in northern Europe was quite low that year. In Iceland, easterly winds have been more prevalent than in any year since 1985, and the north to south pressure gradient was stronger than average, sign of a higher mean wind speed than usual, but the number of damaging windstorms remained considerably below average. A record-breaking 13-month storm-free period over Swedish coastal waters ended on 25 December when local stormy winds up to 90 km/h (mean wind speed) swept the Swedish east coast. Denmark did not report any severe storms. Finland likewise had less storm activity than usual; the number of stormy days (wind speed >75 km/h) was only 11, compared to the long-term average of 23. Latvia recorded both below normal mean and maximum annual wind speeds.

Mean wind speeds were higher than normal in north-western Europe, but lower on the continent. Annual mean wind speeds in Ireland were between 13 and 22 km/h, locally exceeding the normal and maximum annual values for up to 15 years. Not far away, in Belgium, the mean annual wind speed was lower than normal with 12.2 km/h (normal: 13.3 km/h); such an anomaly is expected only once in 10 years. The same was observed in Luxembourg (annual mean: 12.4 km/h, normal 14.0 km/h).

In January and February, a few severe winter storms mostly affected the western parts of Europe. The heaviest one was storm Klaus which hit south-western France and northern Spain in late January with gusts up to 193 km/h in the Pyrenees. Another storm in January with gusts up to 174 km/h affected Ireland.

Between May and July, some heavy thunderstorms swept across western and central Europe, locally with tornadoes. Unusually frequent thunderstorms were also recorded in Armenia in June and July with gusts up to 110 km/h. In Georgia, 12 strong wind gust events were recorded during the whole year, which has been the by far highest number since 1995 (Fig. 0.26). Azerbaijan also experienced strong gusts up to 108 km/h especially in April.

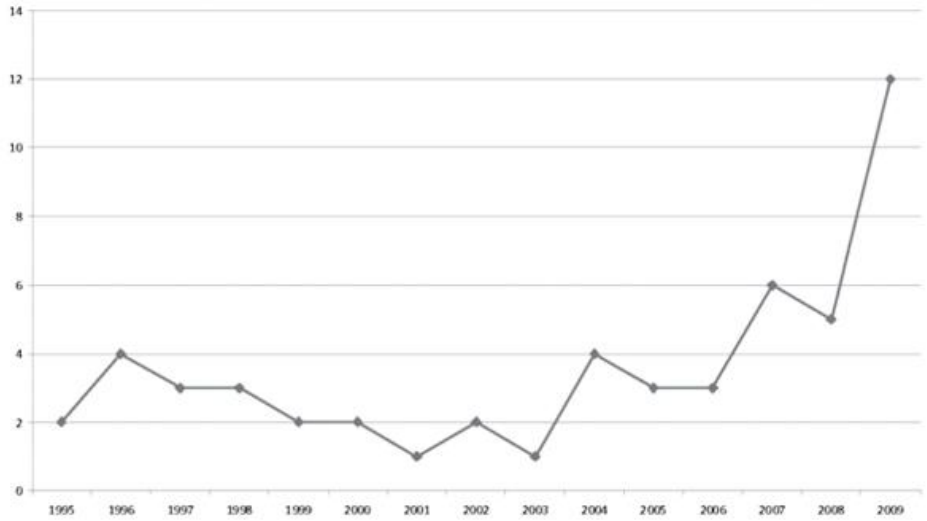

Fig. 0.26: *Number of strong wind gust events (causing significant damage) per year in Georgia 1995-2009*
Source: The State Department of Hydrometeorology of Georgia

In September and October, several severe thunderstorms hit mainly southern Europe.

Ex-tropical storm Danny crossed the North Sea in early October causing gusts near hurricane force. Another tropical storm (Grace) formed near the Azores islands in October, approaching England in a north-easterly direction; but it did not cause any serious damage.

An unusually high number of storm events occurred in Turkey in 2009. Cyprus likewise reported several severe storms and tornadoes throughout the year.

7. Sea ice

As documented by satellite data, the extent of the whole Arctic area covered by sea-ice in September 2009 has been the third lowest since 1979 (behind 2007 and 2008) with 5.1 million km² or 76% of the long-term mean of 1979-2000. This once more small sea ice extent was also due to the ongoing anomalous warmth of the European Arctic region in 2009. The cold April in the European Arctic, however, delayed the spring melting compared to the previous years 2007 and 2008. The annual maximum extent in March 2009 was about the same as in 2008; in April 2009, it was slightly higher than in April 2008.

Seasonal Survey

Temperature

All seasons were warmer than normal in most of the Region, though more or less with some colder-than-normal areas.

Winter 2008/09 showed mild temperatures over the Arctic and eastern Europe, with peak anomalies > +4°C in Svalbard, north-west Russia and Finland (see section "Seasonal Maps" Fig. S39) . It was also warmer than normal over most of the North Atlantic, central Scandinavia, eastern central and south-eastern Europe and the Middle East, but with smaller anomalies (< +2°C, only locally higher). In northern and central Europe, however, that winter was not as mild as previous winters. Anomalies in Denmark, for example, were +1°C, which is much less than in 2006/07 and 2007/08, when anomalies exceeded +4°C. Nevertheless, the warming of the central North Atlantic exceeded the 98% percentile. In Bulgaria and Montenegro, some locations recorded their warmest winter ever. Serbia reported a smaller number of freezing days than normal, especially in mountainous areas.

Western Europe, parts of central and south-western Europe including the western Mediterranean and parts of Italy were colder than normal. Anomalies were lowest in France and in high alpine regions (< -1°C) and only slightly below zero in other areas, but mostly not below the 10% percentile. The winter of 2008/2009[1] has been the coldest in the UK since 1996/1997, with a seasonal mean of 3.2°C. France had its 3rd coldest winter in 20 years and it was also one of the coldest winters within that period in Switzerland. It has actually been the coldest winter for 22 years on the Jungfraujoch in Switzerland. Severe cold waves during January and February brought temperatures of -25°C (and below) to Germany and Poland, and below -10°C to Belgium. Several cold spells in January and February also affected Iberia.

The warming of the central North Atlantic and the northern latitudes was mainly due to a stronger-than-normal south-westerly flow of mild air over the central North Atlantic which continued to move to the north. The NAO index was slightly negative due to negative values in December 2008 and, in particular, in February 2009, as the sign of a more meridional circulation during most of the winter with less mild westerlies flowing to western Europe followed by lower-than-normal temperatures there. A stronger-than-normal Siberian high led to a more intense blocking and a stronger-than-normal southerly flow of subtropical air to the Middle East and into eastern Europe.

Spring 2009 was very warm in most of Europe, although somewhat less in the east. Anomalies exceeded +2°C or the 90% percentile particularly in the central parts of central Europe, the Alps, northern Italy, the north-western Balkan Peninsula and in some places in northern and southern Europe and over the North Atlantic (Fig. S40).

In western Norway, it was the warmest spring ever registered. There were only 8 frost days in Denmark that spring, as compared with usually 22 days. The Netherlands, Belgium (Brussels-Uccle) and Switzerland reported their 2nd warmest spring in more than a hundred years (behind 2007, Fig. 0.27), Germany its 3rd warmest since 1901 behind 2007 and 2000. Some places in Slovenia had their 2nd or 3rd warmest springs ever recorded.

Especially April was outstandingly warm in central and northern Europe whereas May was warm in southern Europe and in the Alpine region. Two heat waves occurred in Portugal (March and May).

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[1] *data from Climate Research Unit, University of Anglia, United Kingdom: http://www.cru.uea.ac.uk/~timo/datapages/naoi.htm*

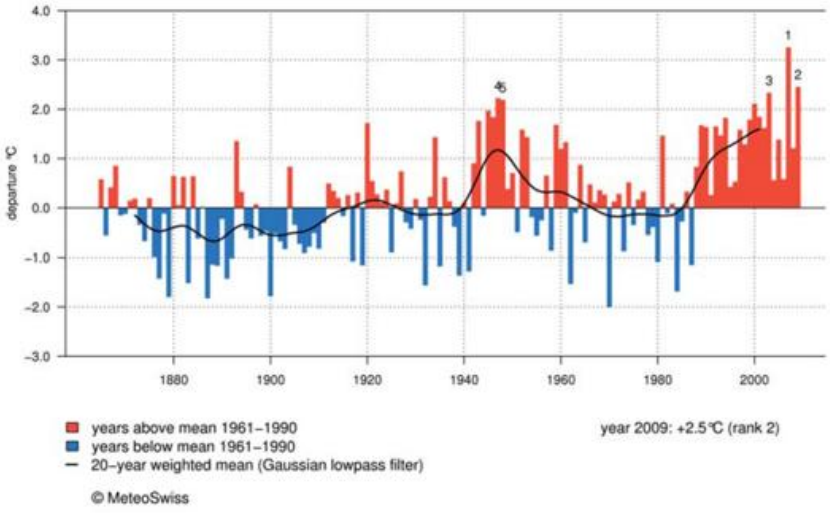

Fig. 0.27: *Time series of seasonal temperature anomalies in spring at 12 representative Swiss stations for the years 1864-2009, reference period 1961-1990*
Source: MeteoSwiss, Switzerland

It was slightly or insignificantly colder than normal in the Caucasus region, in Turkey and partly along the coasts of Greenland.

The warming over Europe was mainly due to a large ridge dominating over the area during most of the season, whereas the Caucasus region lay mostly on the east flank of that high and in the flow of colder air from the north.

Summer 2009 was also warmer than normal over almost the whole of Europe and the Middle East, with partly smaller anomalies, however, than during the spring (Fig. S41).

In most of the northern half of Europe, anomalies were only slightly above zero (< +1°C), in some places they were even below zero. Large parts of the northern North Atlantic and western Greenland as well as land areas near the North Sea, especially western Norway and Denmark, were significantly warmer than normal, with a deviation of more than +1°C and even more than +2°C on the western coasts of Greenland. Northern Europe had some outstandingly warm spells; with some stations in Norway reporting new daily maximum temperature records.

Most of northern and central Europe started with a cold June, but became much warmer in the following summer months. Finland was mainly cold in June and July, but warm in August. The Baltic countries also started with a cold June, and warmed up only gradually and later than usual. Latvia had near-normal summer temperatures, although the highest maxima were well below the long-term average. In central Europe, the summer was characterised by a large variability of warm and cool periods, but here, too, a cool June was followed by a warmer July and a particularly warm August.

In the easternmost parts of the Region (eastern European Russia, eastern Ukraine, west Kazakhstan, Caucasus region), it was quite the contrary: after a very warm June, it became cool during the remaining summer from the north to the south. Monthly mean temperature anomalies reached +3°C in the Ukraine during June and July, with a highest daily maximum temperature of 40°C. Mean summer temperature anomalies exceeded +1°C in Romania and Moldova, while anomalies in European Russia (+0.5°C) and Belarus were closer to normal; only July was considerably warmer than normal in Belarus. Eastern Turkey and Armenia saw a rather cool summer (anomalies < -1°C). In Armenia, it was the first cool summer since 1995.

The southern half of Europe and the Middle East mainly had higher positive anomalies than the north. The anomalies were greater than +1°C, in some places even +2°C, exceeding the 98% percentile. The number of tropical nights was above normal in the Mediterranean region. On the other hand, the central North Atlantic was more than -1°C colder.

A significant heat wave affected the whole of western Europe during July; another one in France from 15–20 August resulted in temperatures above 36°C in the north and 40°C in the south of the country. Italy also saw a heat wave in July, with temperatures locally reaching 45°C. Iberia, too, experienced several heat waves during the summer. The summer of 2009 has brought record mean temperatures relative to the last 50 years to many stations in Catalonia as well as to other parts of northern and central Iberia. Spain as a whole has had the third warmest summer since 1970 (behind 2003 and 2005). Portugal saw three heat waves during that summer.

In south-eastern Europe, Slovenia had a higher-than-normal number of hot days, but no extremely high temperature maxima. Serbia, too, had a very hot summer; daily maxima above 30°C were measured much more often than normal, except in the mountains. In Mostar (Bosnia and Herzegovina), it was the warmest summer on record. In Cyprus, several heat waves were recorded in all summer months, most of them in July.

The warm summer in most of the Region was due to the high pressure influence which prevailed particularly over the southern half of the continent, while the north profited from a still warm North Atlantic and a quite weak Icelandic low during the season. The Azores high was weaker than normal and shifted to the south, with the result that the central North Atlantic was more affected by cold air masses from the north than usual. In the east of the Region, cold arctic air penetrated from the north into the south.

Autumn 2009 was another very warm season throughout nearly the whole Region, particularly in central and eastern Europe (Fig. S42). Seasonal anomalies were highest in the Arctic, with up to +4°C above the normal. In many other parts of the Region, anomalies were still greater than +1°C, partly exceeding the 90% percentile, in places particularly in eastern Europe more than +2°C.

Several countries reported their 2nd (France, Belgium) or 3rd warmest autumn (Netherlands, Switzerland, Spain) in at least 40 years, partly even in more than 100 years. However, autumn 2006 was even warmer in all these countries.

September and November were extremely mild months in most of Europe, especially throughout eastern Europe, with temperatures generally above the 90th percentile of the 1961-1990 distribution. October was very cold notably in northern Europe, but this did not compensate the warm September and November months. In Iberia, October was very warm and contributed much to the warm autumn there. Portugal saw heat waves in September and October.

Conditions colder than the autumn average were restricted to some small places in southern Norway, over the central North Atlantic, in the Mediterranean and eastern Turkey.

This autumn warming mainly resulted from a strong south-westerly flow of warm air to most parts of Europe which predominated throughout the whole season.

Precipitation

Precipitation patterns show a high spatial variability changing from season to season. Dry conditions predominated in winter and spring, wet conditions in summer and autumn, but with many regional exceptions.

Winter 2008/09 was drier than normal over most of western, central and northern Europe due to the predominating high pressure influence (Fig. S43a). It was also drier than normal over large parts of eastern European Russia and the Middle East which were much influenced by the Siberian high. Seasonal totals were below 80% in many places. Winter in Denmark was particularly characterized by well-below-average precipitation, recording only 66% of its average 1961-1990 total for the season.

The southern slopes of the Alps, the central Mediterranean and south-eastern Europe received considerably-above-average precipitation and increased winter storm activity. It was particularly wet in the southern Alps, Italy and over parts of the Balkan Peninsula due to a persistent cyclone over the central Mediterranean, locally with seasonal totals of more than 125% of the normal (in the Alps more than 200%) especially in January due to high precipitation amounts.

The snow period in the winter of 2008/09 was longer in most of the Region and especially in many parts of the middle and southern latitudes (Fig. 0.28). In western Europe, snow was rare in the lowlands due to little precipitation. However, some heavy snowfall occurred in western and central Europe particularly in February. Parts of the northern Alpine region saw peak snow depths of over four meters. Altogether, the amount of fresh snow in Austria came back to normal conditions after the previous two winters with little snow. Snowfall also occurred frequently south of the Alps and even in low-altitude coastal regions of Portugal - which is highly unusual for these areas. In some of the lowlands of Slovenia and in Serbia, the number of days with snow cover was smaller than normal. Armenia received below-normal snow depths, i.e. 80% of the 1961-1990 average.

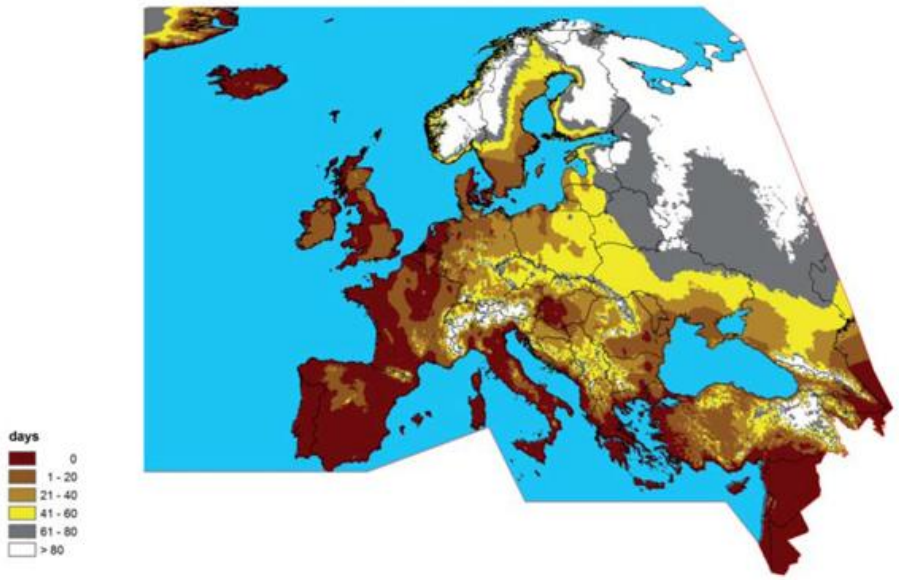

Fig. 0.28: *Number of snow days (number of days with at least 1 cm of snow cover on the ground) in Europe in winter 2008/9*
Source: Deutscher Wetterdienst, Germany

Spring 2009 was dry in most of the Region due to predominating high pressure influence (Fig. S43b). Various larger areas received less than 80% of the seasonal total. Places in eastern Scandinavia and in the Baltic countries, in particular, saw a precipitation total of less than

25 mm or less than 60% of the seasonal normal. It has been the driest spring since 1997 in England and Wales.

In most of central Europe, spring precipitation was near normal. The reason for this is that a dry April (particularly in eastern parts) was compensated by the mostly wet months of March and May. In the Alps, spring 2009 started wintry with much snowfall in March and record-breaking amounts of precipitation in eastern Austria. May brought intense convective precipitation to parts of central Europe and to Slovenia.

In eastern Europe, spring was particularly dry in Moldova, where some areas received only 50 to 75% of the average seasonal rainfall. Parts of Romania and the Ukraine were also very dry.

In the south, especially Iberia (except the south-east), the Balkan Peninsula and the Middle East all had a very dry spring with less than 50 mm or 80% of the seasonal total; some places even received much less. It was the driest spring since 1931 in Portugal, with well below normal precipitation in all three spring months.

Some smaller areas throughout the Region (in the north particularly the southern coasts of Greenland and Iceland and the north-western and northern coasts of Ireland, the United Kingdom and northern Norway) were wet, with more than 125% of the seasonal normal. These areas were affected by a stronger-than-normal Icelandic low. In the south, especially Italy, but also parts of Turkey and southern European Russia, was concerned with local excessive rain due to much convective activity particularly in March. Monaco had a very wet April, but a very dry May.

Summer 2009 was wetter than normal in large parts of the northern half of Europe except the Arctic, partly with more than 125% of the seasonal totals due to frequent low pressure influence (Fig. S44a). On the contrary, large areas in the south and east were very dry.

Summer was dry in the Arctic and in western Iceland. In western Greenland, especially July and August were very dry. In Iceland, it was especially the first part of the summer (June and July) which was very dry in the southern and western part of the island. The summer has been the driest for the capital, Reykjavik, since 1889. The northern Norwegian coasts were more or less dry in all summer months.

In southern Scandinavia, especially the southern parts of Norway and Sweden were very wet, mainly due to much rain in July.

North-eastern Europe received most of its rain in early summer already, often with sporadic heavy showers and sometimes with hail. Summer was unusually wet in Belarus (second wettest since 1936), mainly due to well-above-average precipitation during June and July.

The year 2009 brought the third consecutive wet summer to Ireland and the United Kingdom, behind 2007 and 2008, that had mostly been even wetter. Despite this, some total rainfall records were by far broken in Ireland, e.g. at Valentia Observatory with a seasonal total of 620 mm (Fig. 0.29). Ireland reported rainfall on almost every day during July and August. On 6 June and 16 -17 July, the United Kingdom experienced daily totals of more than 90 mm.

Western and central Europe, and even the northern parts of south-eastern Europe were affected by some severe thunderstorms, accompanied by heavy rain and hail and causing local flooding. Luxembourg Airport recorded 23 days with thunderstorms, which is well above the 1971-2000 mean of 14 days. Nevertheless, the seasonal precipitation total was low in most of these areas.

In Austria and northern Slovenia, summer was wet due to some heavy precipitation events; especially in the east; it has been the rainiest summer in Austria since 1966.

The eastern Ukraine and parts of southern European Russia were very dry; these areas had less than 50 mm or 40-80% of the normal.

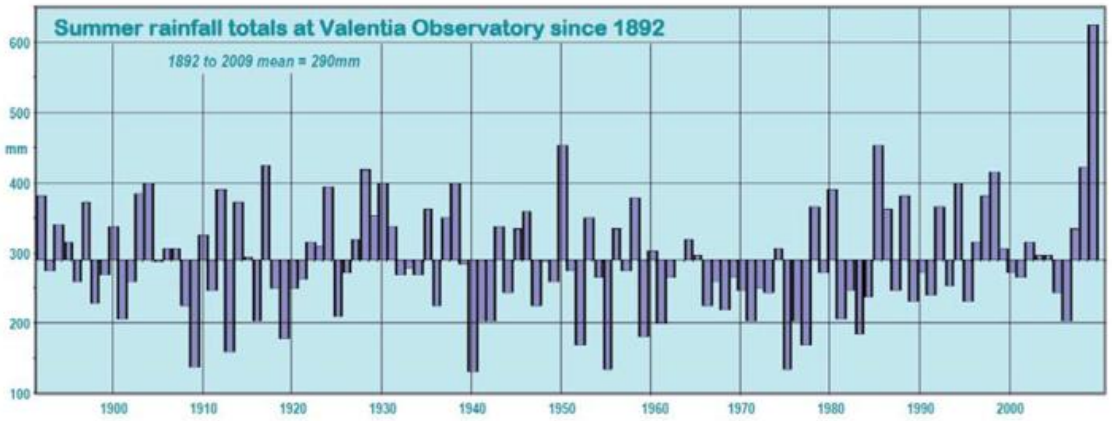

Fig. 0.29: *Summer rainfall totals at Valentia Observatory (Ireland) 1892-2009. The bars indicate anomalies compared to the long-term mean 1892-2009*
Source: Irish Meteorological Service

In the south, few regions were affected by higher-than-normal precipitation, particularly areas in southern Italy, the southern Balkan Peninsula, parts of eastern Turkey and in Armenia. The seasonal summer total in Armenia exceeded the 1961-1990 normal by 50%; the south-west of the country recorded even more than twice the normal precipitation (Fig. 0.30).

Most of the Mediterranean region and Iberia, however, were drier than normal due to frequent high pressure influence. Southern Iberia and eastern parts of the Mediterranean received less than 10 mm during the whole season which was partly less than 60% of the normal. Monaco had a summer total of 12 mm, only 14% of the 1969-1998 average.

The new DWD drought index for summer 2009 (Fig. 0.31) shows extremely dry conditions in the Middle East and locally severely dry conditions for southern Iberia, some places in the eastern Mediterranean and in the eastern Ukraine. Compared to the 1961-1990 reference, drought conditions were more severe than normal in the eastern Ukraine, whereas in the other affected areas this effect was not unusual.

Autumn 2009 showed very diverse precipitation anomalies throughout the Region (Fig. S44b).

Most of northern Europe had around-normal precipitation. However, northern middle latitudes were wet, with more than 125% of the seasonal total in many places due to frequent low pressure systems crossing these areas. In western and central Europe, there were also some heavy rain events with flooding.

In Germany, Switzerland, Austria and the Czech Republic, early snow fell in October, but melted again during the warm November even in higher elevations.

Eastern Europe was mainly wetter than normal, though with some very dry areas in the Ukraine and in central and eastern European Russia. Large parts of central European Russia had less than 25 mm or below 60% of the seasonal precipitation.

Abundant rainfall occurred in southern Italy and Sardinia in September and October, whereas drier-than-average conditions were to be found in Tuscany and north-eastern Italy, but also on the western Balkan Peninsula. Monaco had a near-normal seasonal total, but the seasonal maximum precipitation (normally in October) was shifted to the end of the year. Autumn was very wet in the southern and eastern parts of the Balkan Peninsula, near the eastern Mediterranean and in the northern Middle East. Israel, too, had very heavy rainfall during September and October, marking an early start of the 2009/10 rainy season.

South-western Europe (still affected by the Azores high), including the western Mediterranean, large parts of France and areas around the Alps was very dry. Especially Iberia experienced

another very dry season after having seen a dry spring and summer, partly with less than 60% of the seasonal total or less than 50 mm. Averaged across Iberia, autumn seasonal mean deficits were similar to spring and summer, although some regions, such as the southern Mediterranean coast, were much wetter than normal.

In general, autumn showed extreme temporal and spatial variation. While most of eastern and south-eastern Europe saw a very wet October, north-western Europe had exceptional precipitation in November.

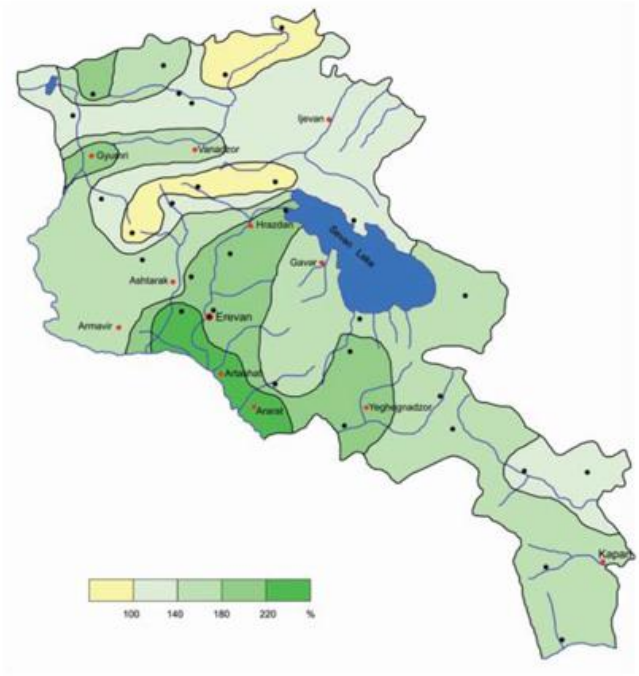

Fig. 0.30: *Seasonal precipitation in per cent of the 1960-1990 average for summer 2009 in Armenia*
Source: Armenian State Hydrometeorological and Monitoring Service

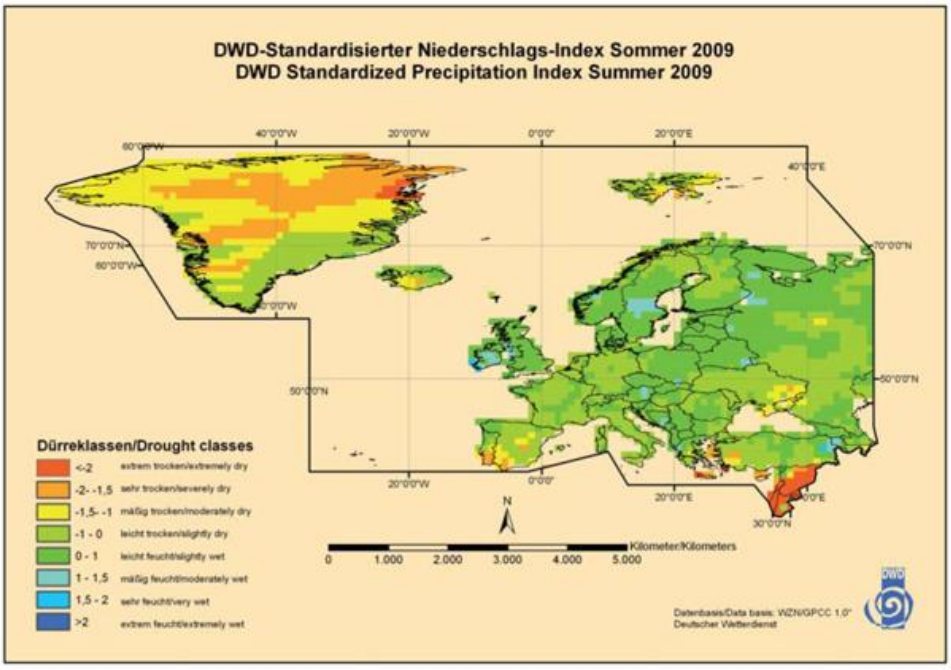

Fig. 0.31: *Standardized precipitation index (DWD version) for summer 2009*
Source: Deutscher Wetterdienst, Germany

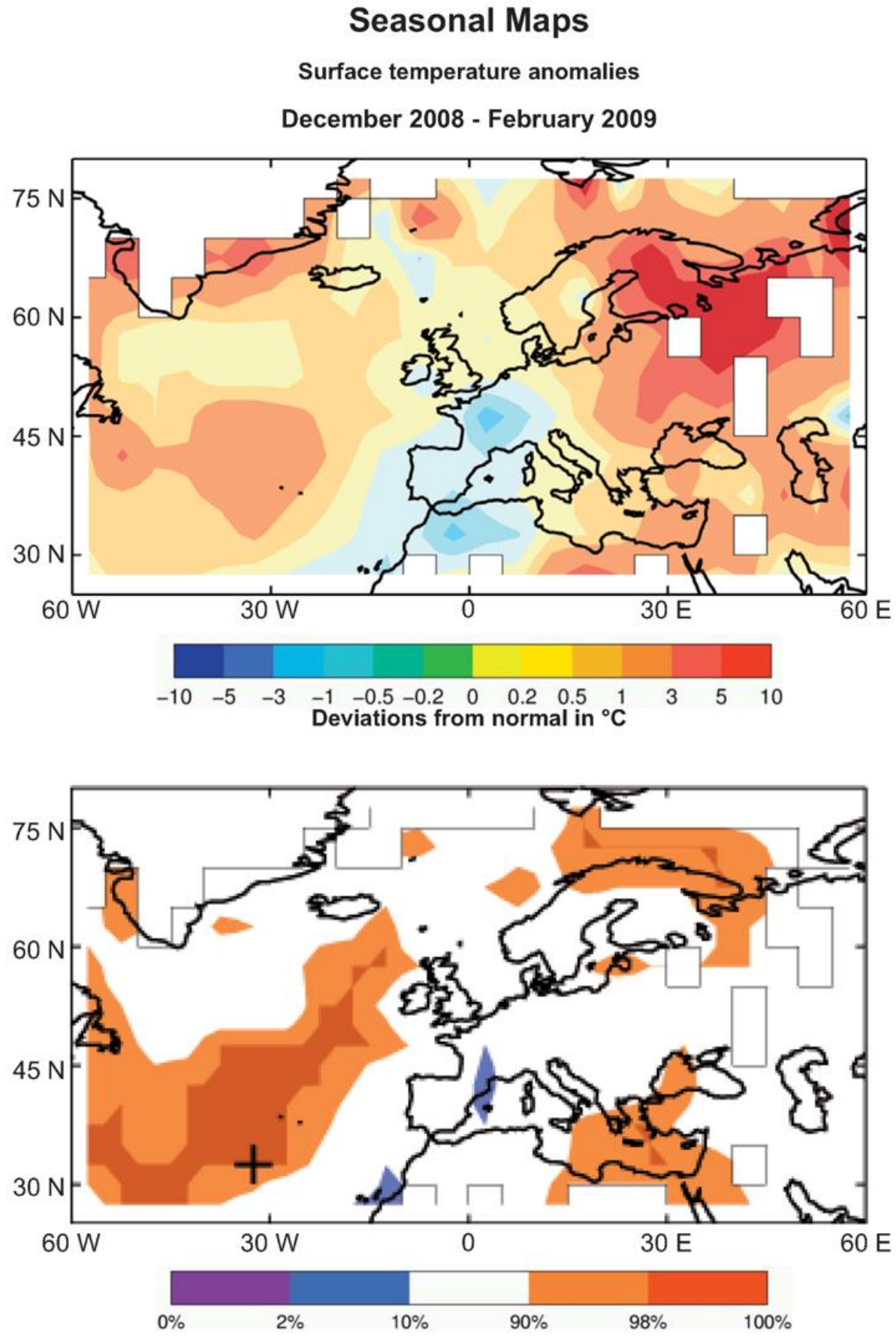

Fig. S39: *Surface temperature anomalies (reference period 1961-1990, upper map) and percentiles (anomalies fitted to gamma distribution, lower map) for winter 2008/09. The +/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the period 1850-2009*
Source: The Met Office Hadley Centre, United Kingdom

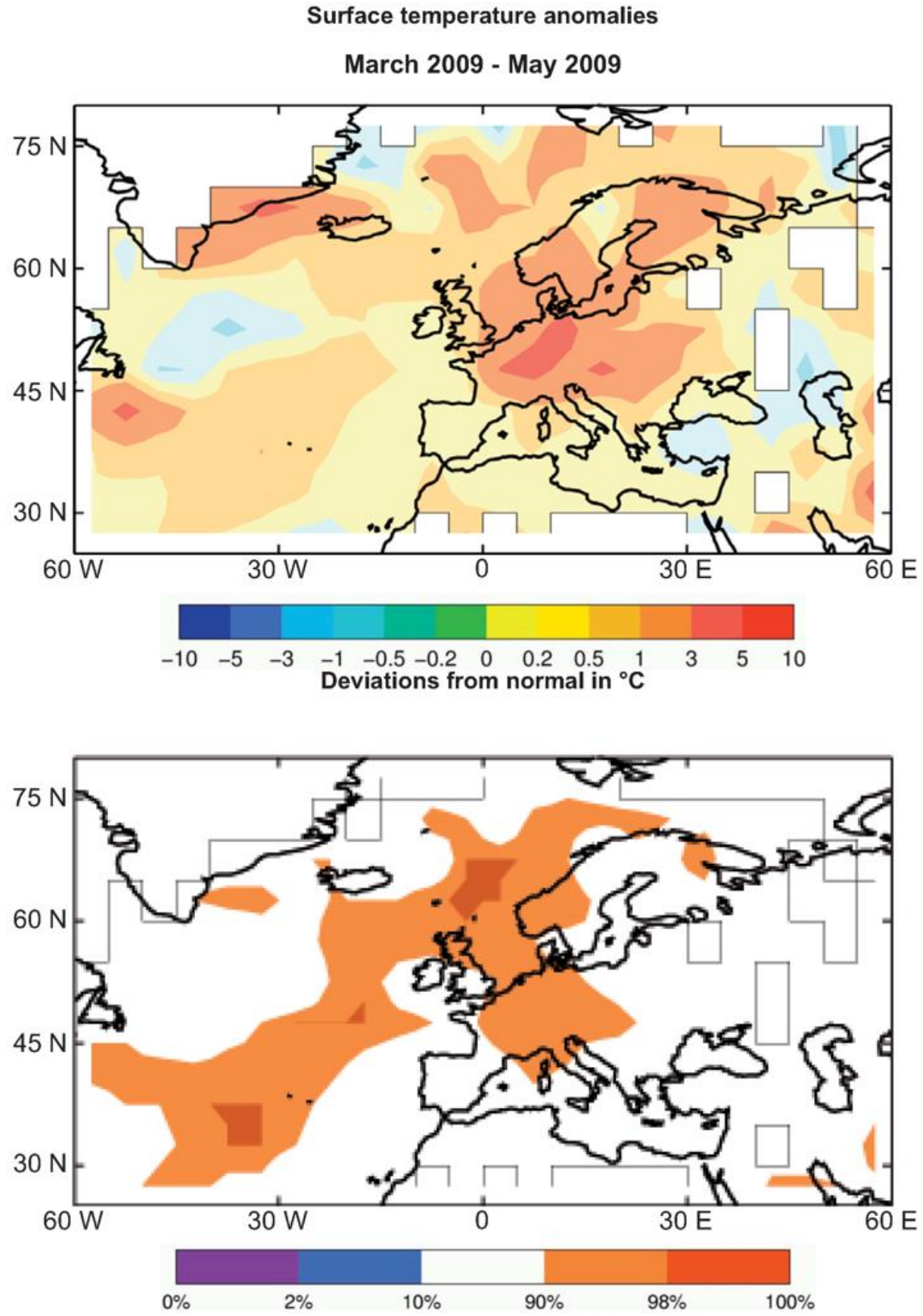

Fig. S40: *Surface temperature anomalies (reference period 1961-1990, upper map) and percentiles (anomalies fitted to gamma distribution, lower map) for spring 2009. The +/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the period 1850-2009*
Source: The Met Office Hadley Centre, United Kingdom

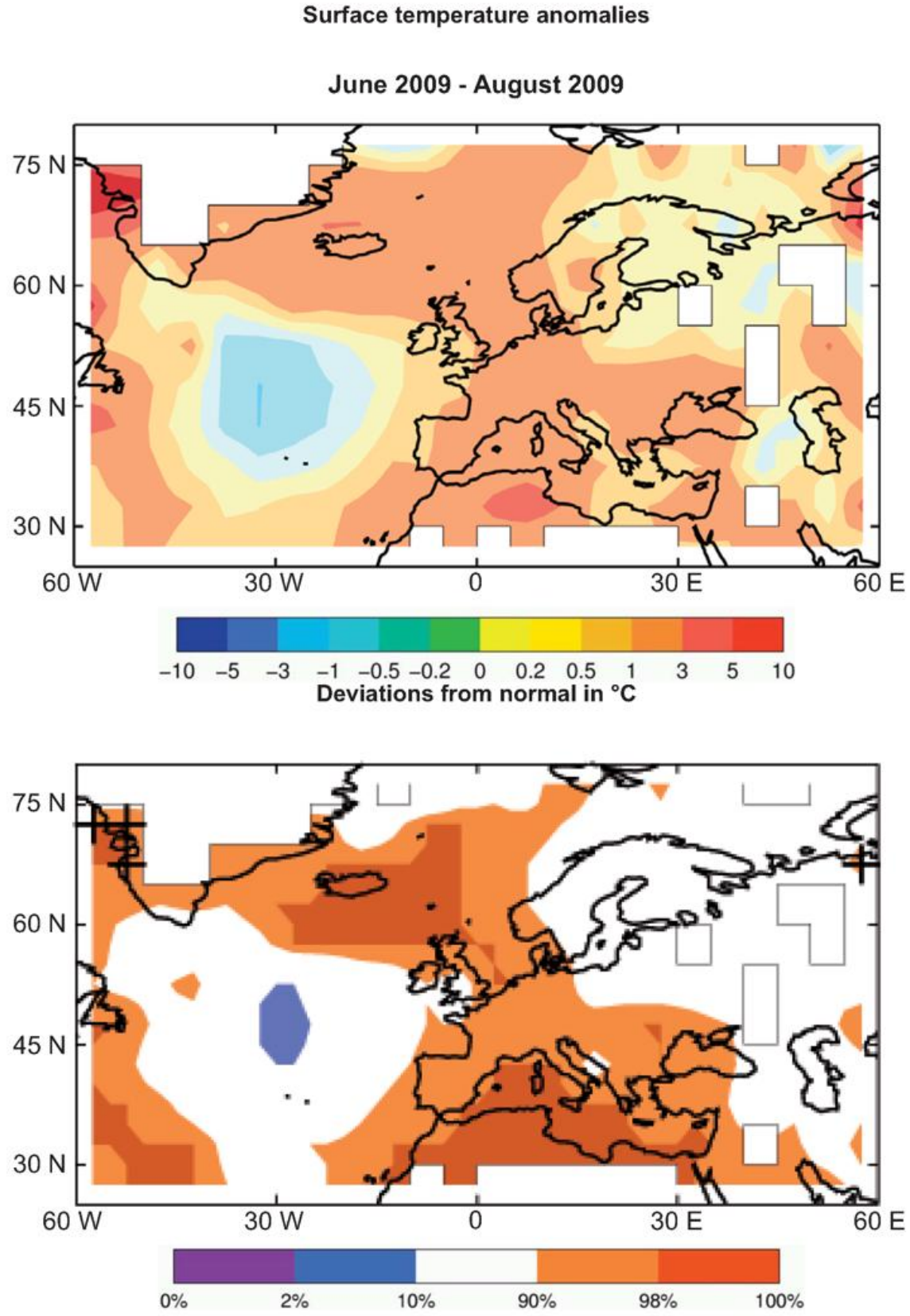

Fig. S41: *Surface temperature anomalies (reference period 1961-1990, upper map) and percentiles (anomalies fitted to gamma distribution, lower map) for summer 2009. The +/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the period 1850-2009*
Source: The Met Office Hadley Centre, United Kingdom

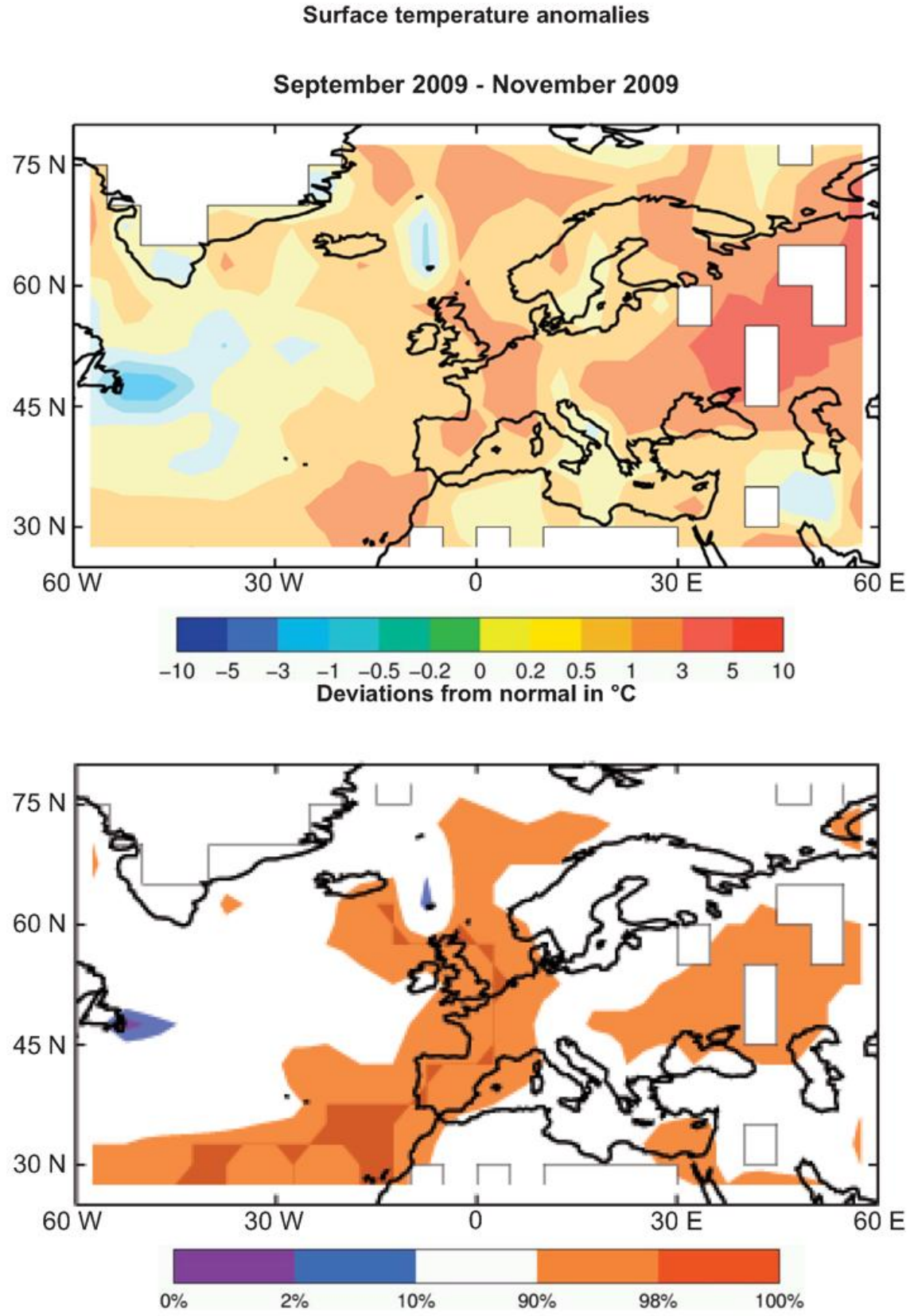

Fig. S42: *Surface temperature anomalies (reference period 1961-1990, upper map) and percentiles (anomalies fitted to gamma distribution, lower map) for autumn 2009. The +/- signs indicate that the anomaly in a 5°x5° pixel is the warmest/coldest in the period 1850-2009*
Source: The Met Office Hadley Centre, United Kingdom

Precipitation in percent of normal

December 2008 - February 2009

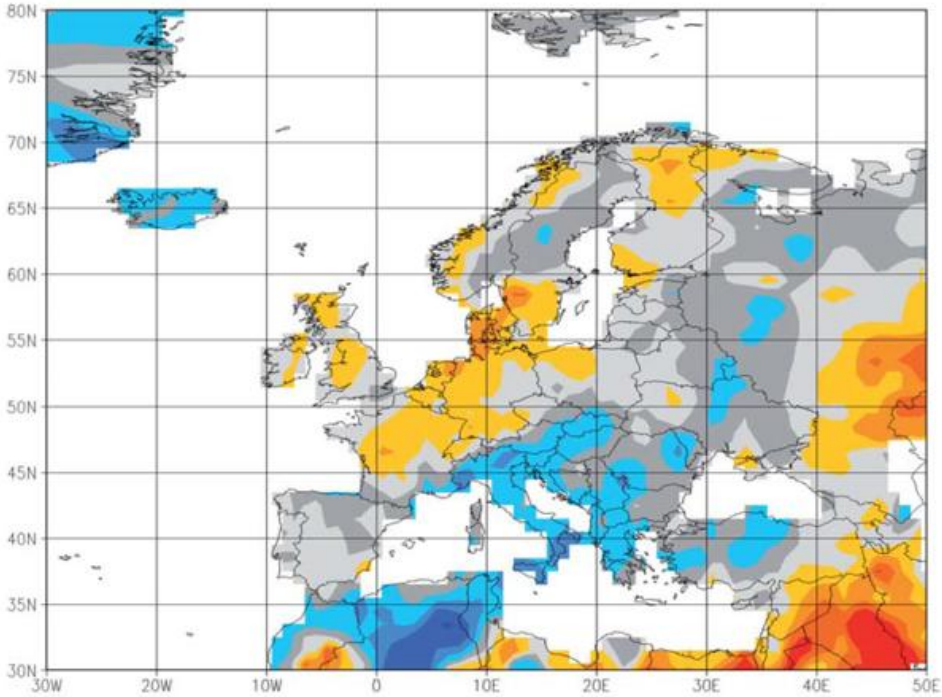

Fig. S43a: *Precipitation in per cent of normal (reference period 1951-2000) for winter 2008/09. Gauge-based analysis 1.0 degree*
Source: GPCC / Deutscher Wetterdienst, Germany

March 2009 - May 2009

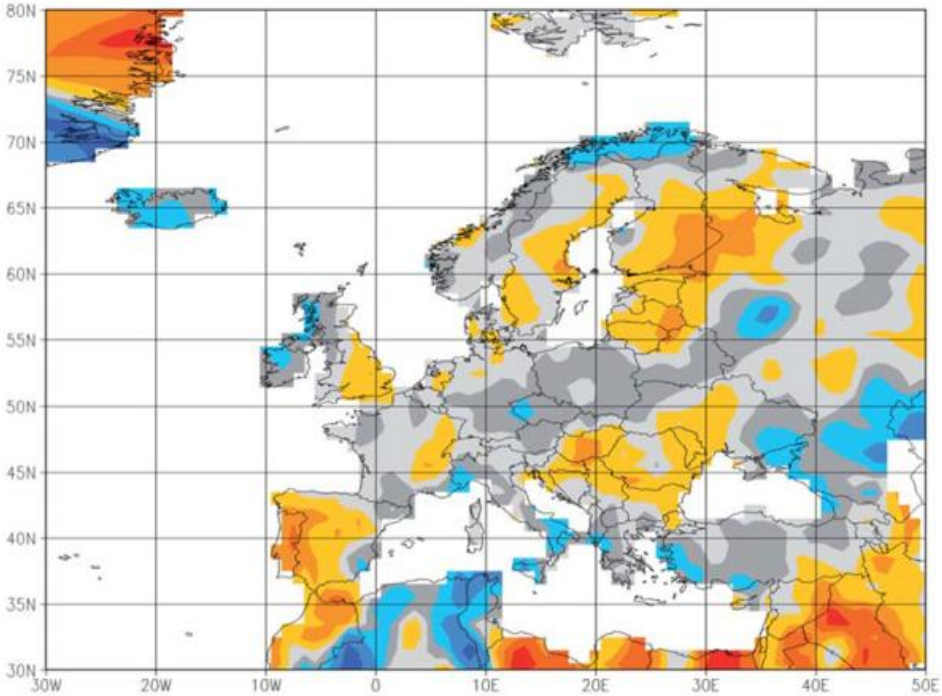

Fig. S43b: *Precipitation in per cent of normal (reference period 1951-2000) for spring 2009. Gauge-based analysis 1.0 degree*
Source: GPCC / Deutscher Wetterdienst, Germany



Precipitation in percent of normal

June 2009 - August 2009

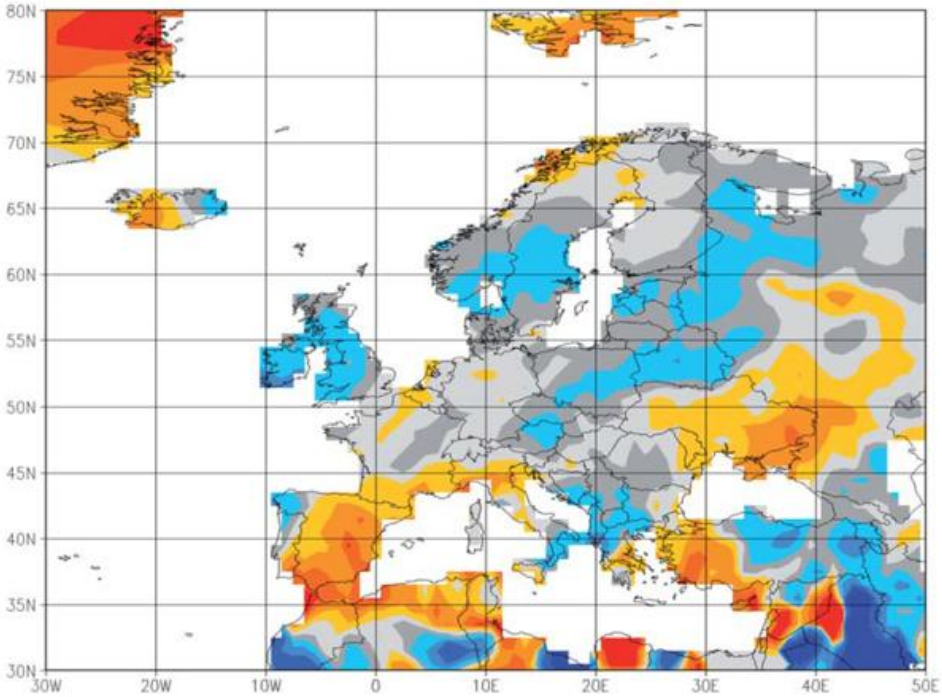

Fig. S44a: *Precipitation in per cent of normal (reference period 1951-2000) for summer 2009. Gauge-based analysis 1.0 degree*
Source: GPCC / Deutscher Wetterdienst, Germany

September 2009 - November 2009

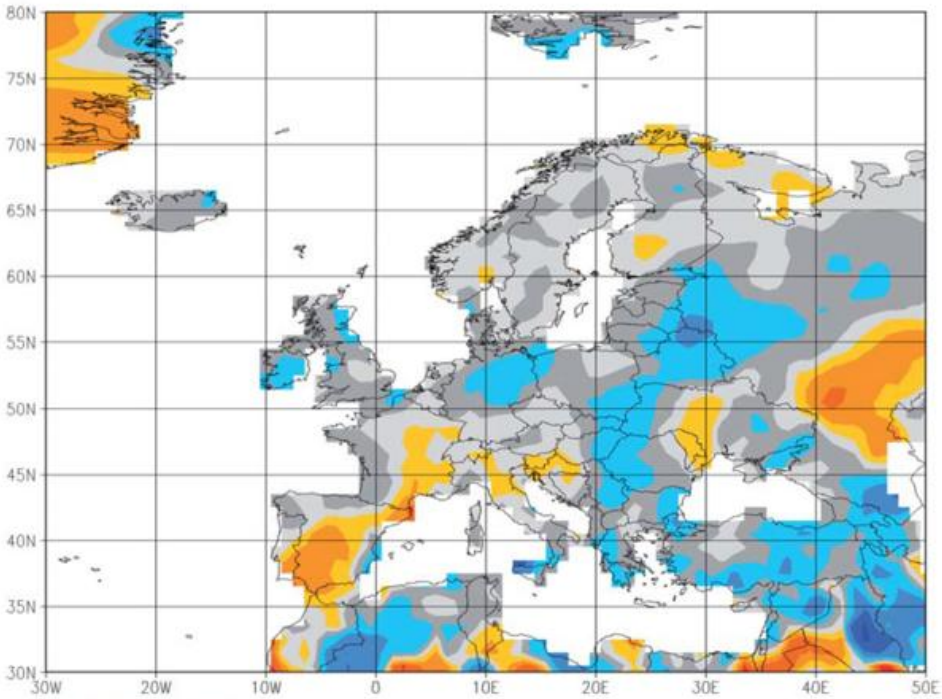

Fig. S44b: *Precipitation in per cent of normal (reference period 1951-2000) for autumn 2009. Gauge-based analysis 1.0 degree*
Source: GPCC / Deutscher Wetterdienst, Germany



Monthly and Annual Tables

Temperature and precipitation values with deviations from the 1961-1990 normal
(some stations have shorter reference periods)

WMO No.	Station	January 2009 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	February 2009 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-12.7	2.7	6	-8	-11.3	4.4	9	-10
01025	Tromsø	-2.5	1.5	92	11	-4.1	-0.4	88	2
01492	Oslo	-2.2	2.1	58	9	-5.1	-1.1	70	34
02485	Stockholm	-1.2	1.6	21	-18	-1.8	1.2	24	-3
02836	Sodankylä	-11.4	3.7	10	-21	-12.3	1.3	23	-2
02974	Helsinki	-4.1	2.8	30	-11	-5.0	1.8	15	-16
03091	Aberdeen	3.6	0.9	49	-32	4.1	1.2	75	24
03772	London	3.8	-0.4	72	20	5.1	0.6	70	35
03967	Dublin Casement Aerodrome	4.3	-0.1	60	-6	4.8	0.4	58	7
04030	Reykjavik	1.8	2.3	108	32	0.1	-0.3	53	-19
04320	Danmarkshavn	-20.0	3.1	nil	nil	-25.7	-1.4	nil	nil
04360	Angmagssalik	-4.4	3.1	73	-39	-7.9	-0.2	75	-16
06186	Copenhagen	1.3	0.8	14	-37	0.9	0.4	26	-5
06260	De Bilt	0.8	-1.4	54	-12	3.3	0.8	55	6
06447	Brussels	0.7	-1.9	63	-4	3.6	0.1	57	4
06590	Luxembourg	-1.6	-1.6	74	3	1.4	0.3	49	-13
06660	Zurich	-1.9	-1.4	42	-25	0.4	-0.5	60	-10
06700	Geneva	-0.2	-1.0	69	-11	1.8	-0.5	54	-27
07510	Bordeaux	4.7	-1.1	129	29	6.8	-0.3	33	-53
07650	Marseilles	5.1	-1.6	79	32	7.6	-0.3	37	-17
08222	Madrid	5.2	-0.9	30	-16	7.9	0.4	42	-2
08314	Mahón/Minorca	9.9	-0.6	66	0	9.8	-0.9	55	-2
08495	Gibraltar	12.4	-1.0	77	-44	12.2	-1.6	123	23
08515	Santa Maria/Azores	16.2	1.8	24	-76	14.6	0.6	57	-29
08535	Lisbon	10.7	-0.7	247	137	12.3	0.0	84	-27
10384	Berlin-Tempelhof	-1.8	-1.6	18	-25	0.9	0.1	47	13
11035	Vienna	-1.5	-0.5	35	-3	1.2	0.2	72	30
11518	Prague	-3.6	-1.2	12	-11	-0.4	0.4	16	-7
11903	Sliač	-4.7	-0.8	39	-5	-0.7	0.4	45	1
12160	Elblag	-1.9	0.5	42	-5	-0.7	1.5	30	5
12375	Warsaw	-2.7	0.6	19	-3	-0.6	1.4	33	12
12843	Budapest	-1.3	0.3	35	3	1.2	0.1	36	4
13274	Belgrade	-0.3	-0.7	55	6	2.8	0.1	85	41
14015	Ljubljana	-1.5	-0.4	89	7	2.3	0.9	103	23
14445	Split	8.5	1.1	170	87	7.3	-0.8	63	-5
14654	Sarajevo	-0.8	0.1	102	31	1.0	-0.5	54	-13
15420	Bucharest	-0.5	1.9	56	16	2.0	2.1	28	-8
15614	Sofia	-0.9	0.7	57	30	0.6	0.1	30	-3
16206	Grosseto	7.4	0.4	43	-21	7.0	-1.0	60	3
16597	Luqa	13.2	1.0	248	159	11.3	-1.1	118	57
16716	Athens	11.8	1.6	81	37	10.2	-0.4	27	-16
16754	Heraklion/Crete	13.5	1.5	54	-36	12.1	0.0	98	21
17040	Rize	7.1	0.8	158	-65	9.2	2.6	229	58
17062	Istanbul	7.7	2.1	103	4	7.4	1.5	146	79
17130	Ankara	2.4	2.4	62	21	4.4	2.7	70	34
17170	Van	-3.9	0.5	43	9	0.1	3.9	49	16
17609	Larnaca	13.2	1.7	141	76	13.0	1.3	53	-4
22113	Murmansk	-8.5	3.2	41	8	-11.2	0.0	14	-8
26038	Tallinn	-2.0	3.5	40	-5	-4.3	1.4	14	-15
26629	Kaunas	-3.4	1.6	72	35	-3.4	0.9	42	15
26730	Vilnius	-3.8	2.3	45	4	-3.6	1.2	29	-9
26850	Minsk	-4.1	2.8	48	8	-4.1	1.7	49	15
27612	Moscow	-5.6	3.7	42	-3	-5.4	2.3	51	14
33345	Kiev	-3.3	2.3	34	-13	-1.6	2.6	45	-1
33815	Kishinev	-1.0	2.3	25	-15	1.5	3.2	27	-11
34300	Kharkiv	-4.8	2.1	36	-8	-1.6	4.1	69	37
34880	Astrakhan	-6.1	-0.7	16	3	-1.5	3.4	34	24
35188	Astana	-13.5	2.3	23	6	-16.0	-0.1	9	-5
37789	Yerevan	-4.4	-0.9	17	-4	4.0	5.0	27	3
40080	Damascus	5.6	-0.3	6	-23	8.8	0.9	54	30
40199	Eilat	16.2	1.0	0	-5	18.3	1.4	0	-5
40265	Mafraq	7.6	0.4	6	-28	9.6	0.9	52	21
60030	Las Palmas/Grand Canary	17.0	-0.5	10	-7	16.9	-0.7	11	-11

WMO No.	Station	March 2009 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	April 2009 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-11.5	3.2	21	0	-15.9	-4.2	7	-5
01025	Tromsø	-1.7	0.5	67	3	0.8	0.1	69	9
01492	Oslo	1.2	1.4	57	11	7.7	3.1	55	13
02485	Stockholm	1.0	0.9	37	11	8.5	3.9	5	-25
02836	Sodankylä	-7.0	1.5	10	-15	-1.6	0.5	9	-15
02974	Helsinki	-1.8	1.1	22	-12	4.5	1.6	9	-28
03091	Aberdeen	6.5	2.0	41	-17	8.3	2.0	26	-27
03772	London	8.4	1.9	30	-17	11.7	2.8	28	-17
03967	Dublin Casement Aerodrome	6.7	0.7	24	-25	8.8	1.0	74	27
04030	Reykjavik	0.4	-0.1	60	-22	5.0	2.1	100	42
04320	Danmarkshavn	-24.4	-1.0	nil	nil	-20.1	-2.8	nil	nil
04360	Angmagssalik	-6.4	1.8	132	44	-2.0	2.1	13	58
06186	Copenhagen	4.2	1.6	29	-13	10.5	3.9	11	-31
06260	De Bilt	6.3	1.3	48	-15	12.2	4.2	20	-32
06447	Brussels	6.7	1.2	68	14	12.5	3.7	47	-10
06590	Luxembourg	5.1	1.1	65	-5	12.3	4.8	47	-14
06660	Zurich	4.2	0.0	119	50	12.0	4.2	20	-67
06700	Geneva	6.3	1.2	50	-29	12.4	3.6	36	-29
07510	Bordeaux	9.9	1.1	31	-45	11.9	0.6	116	44
07650	Marseilles	10.8	0.6	36	-8	14.5	1.3	98	50
08222	Madrid	12.4	2.4	10	-23	12.6	0.4	18	-36
08314	Mahón/Minorca	11.4	-0.2	33	-22	14.0	0.7	99	49
08495	Gibraltar	15.4	0.4	35	-40	15.9	-0.3	37	-23
08515	Santa Maria/Azores	14.8	0.2	16	-63	16.4	1.2	10	-45
08535	Lisbon	16.1	2.4	10	-59	14.5	-0.6	45	-19
10384	Berlin-Tempelhof	5.5	1.3	44	7	13.5	4.9	4	-37
11035	Vienna	5.7	0.7	145	104	14.3	4.4	5	-46
11518	Prague	4.2	1.2	36	8	12.6	4.9	22	-16
11903	Sliač	3.4	0.4	68	26	12.9	4.4	9	-38
12160	Elblag	2.4	0.3	79	44	10.6	3.8	2	-40
12375	Warsaw	2.7	0.7	44	16	11.3	3.5	6	-26
12843	Budapest	6.0	0.4	33	4	15.5	4.4	3	-35
13274	Belgrade	7.9	0.7	65	15	15.8	3.4	6	-53
14015	Ljubljana	7.1	1.7	158	60	13.2	3.3	113	4
14445	Split	10.6	0.2	56	-19	16.0	2.1	76	10
14654	Sarajevo	4.8	-0.3	84	14	12.1	2.7	61	-13
15420	Bucharest	5.5	0.7	35	-3	11.4	0.1	11	-35
15614	Sofia	4.9	0.3	33	-5	11.2	1.3	49	-1
16206	Grosseto	10.6	0.4	81	9	14.2	1.5	38	-31
16597	Luqa	13.4	0.0	40	-1	15.3	-0.2	40	17
16716	Athens	12.6	0.0	46	5	16.3	0.2	28	3
16754	Heraklion/Crete	13.4	0.0	24	-32	16.8	0.5	37	7
17040	Rize	8.8	0.9	190	44	10.6	-1.0	83	-19
17062	Istanbul	9.0	1.5	112	50	12.2	0.2	27	-22
17130	Ankara	5.4	-0.6	56	20	11.1	-0.1	71	23
17170	Van	1.9	1.0	75	33	6.5	-0.8	47	-7
17609	Larnaca	13.8	0.5	39	-10	17.9	0.5	8	-3
22113	Murmansk	-6.0	0.8	16	-4	-1.1	0.8	37	16
26038	Tallinn	-0.7	1.5	42	13	5.4	2.0	5	-31
26629	Kaunas	0.9	1.1	47	15	8.9	2.9	9	-34
26730	Vilnius	1.1	1.7	39	0	8.7	3.0	6	-40
26850	Minsk	0.2	1.6	45	3	8.5	2.5	2	-40
27612	Moscow	-0.6	1.6	36	2	5.1	-0.7	25	-15
33345	Kiev	2.3	1.6	55	16	11.1	2.4	2	-47
33815	Kishinev	3.9	1.0	63	28	12.2	2.0	3	-39
34300	Kharkiv	1.5	1.8	84	57	9.2	0.3	6	-30
34880	Astrakhan	3.6	2.3	45	31	8.8	-2.3	6	-12
35188	Astana	-4.5	3.6	21	7	5.9	1.0	11	-11
37789	Yerevan	6.4	0.6	43	11	10.0	-2.7	91	54
40080	Damascus	11.3	0.3	16	-1	16.8	1.3	4	-7
40199	Eilat	19.4	-0.6	0	-4	25.1	0.9	0	-4
40265	Mafraq	11.0	-0.5	19	-10	16.4	0.6	<1	-10
60030	Las Palmas/Grand Canary	18.5	0.1	15	5	18.8	0.1	<1	-6

WMO No.	Station	May 2009 Temp. mean	May 2009 (°C) dev.	May 2009 Prec. total	May 2009 (mm) dev.	June 2009 Temp. mean	June 2009 (°C) dev.	June 2009 Prec. total	June 2009 (mm) dev.
01008	Svalbard Airport	-1.0	2.7	5	-1	3.0	0.8	9	-1
01025	Tromsø	7.1	2.2	111	63	8.3	-1.0	62	9
01492	Oslo	12.0	1.2	75	23	15.8	0.6	32	-33
02485	Stockholm	12.0	1.3	27	-3	14.0	-1.6	79	34
02836	Sodankylä	7.9	2.9	66	31	11.2	-0.4	31	-25
02974	Helsinki	11.6	1.7	30	-5	14.2	-0.7	77	33
03091	Aberdeen	10.0	1.0	74	15	12.3	0.2	72	19
03772	London	14.2	1.7	30	-21	17.3	1.6	34	-17
03967	Dublin Casement Aerodrome	11.2	0.7	53	-5	14.2	0.9	73	25
04030	Reykjavik	7.7	1.4	66	22	10.1	1.1	29	-21
04320	Danmarkshavn	-3.2	3.4	nil	nil	-0.1	-0.8	nil	nil
04360	Angmagssalik	2.4	1.8	80	23	4.1	0.0	10	-42
06186	Copenhagen	12.7	0.7	56	13	15.1	-1.0	93	39
06260	De Bilt	13.9	1.6	65	4	15.6	0.4	53	-15
06447	Brussels	14.4	1.5	43	-28	16.5	0.8	65	-14
06590	Luxembourg	14.3	2.5	59	-22	16.0	1.1	89	7
06660	Zurich	15.4	3.3	88	-15	16.5	1.3	186	62
06700	Geneva	17.0	4.0	29	-48	18.3	1.8	92	3
07510	Bordeaux	16.8	2.2	78	1	20.2	2.4	75	19
07650	Marseilles	20.3	3.2	18	-24	22.9	2.0	44	16
08222	Madrid	19.3	3.3	32	-9	23.7	3.0	11	-15
08314	Mahón/Minorca	19.0	2.2	30	-7	23.2	2.4	2	-12
08495	Gibraltar	19.4	0.9	5	-30	22.0	0.9	7	-4
08515	Santa Maria/Azores	17.1	0.4	18	-12	18.8	0.1	53	31
08535	Lisbon	18.5	1.1	29	-10	21.8	1.6	59	38
10384	Berlin-Tempelhof	14.6	0.7	88	32	16.0	-1.4	96	21
11035	Vienna	16.3	1.7	85	24	18.2	0.3	142	68
11518	Prague	13.8	1.1	84	7	15.1	-0.8	90	17
11903	Sliač	15.3	1.6	78	14	16.7	0.1	112	27
12160	Elblag	12.5	-0.4	82	41	14.8	-0.6	88	-6
12375	Warsaw	13.6	0.2	79	20	16.2	-0.4	149	77
12843	Budapest	17.6	1.6	19	-36	19.0	-0.1	103	40
13274	Belgrade	19.7	2.5	35	-36	20.7	0.6	151	61
14015	Ljubljana	18.1	3.5	59	-63	18.9	1.1	170	15
14445	Split	21.8	3.4	34	-22	22.6	0.4	173	122
14654	Sarajevo	16.2	2.1	64	-18	17.6	0.7	154	63
15420	Bucharest	17.1	0.4	56	-14	20.8	0.6	87	10
15614	Sofia	16.3	2.0	67	-6	19.2	1.5	49	-23
16206	Grosseto	19.2	2.3	18	-26	21.6	1.0	82	54
16597	Luqa	20.6	1.5	2	-5	23.7	0.7	1	-2
16716	Athens	21.9	1.3	<1	-16	26.6	1.5	0	-7
16754	Heraklion/Crete	20.4	0.6	36	20	25.1	1.6	0	-3
17040	Rize	16.3	0.5	139	38	22.4	2.5	73	-52
17062	Istanbul	18.7	2.2	7	-24	23.6	2.5	7	-14
17130	Ankara	15.9	0.3	25	-30	22.0	2.4	28	-9
17170	Van	13.2	0.4	32	-18	17.6	0.0	27	6
17609	Larnaca	21.8	0.9	3	-4	27.1	2.8	<1	<1
22113	Murmansk	4.9	1.1	37	5	8.2	-1.2	57	4
26038	Tallinn	10.8	1.1	19	-18	13.5	-1.0	89	36
26629	Kaunas	12.7	0.0	42	-14	14.8	-1.2	107	32
26730	Vilnius	12.5	0.0	48	-14	15.0	-0.8	129	52
26850	Minsk	12.6	-0.3	69	7	15.8	-0.3	187	104
27612	Moscow	13.6	0.7	59	1	17.3	0.7	46	-30
33345	Kiev	15.1	0.0	35	-18	20.4	2.2	63	-10
33815	Kishinev	16.6	0.5	33	-18	21.7	2.3	39	-36
34300	Kharkiv	14.8	-0.8	35	-12	21.9	3.0	44	-14
34880	Astrakhan	17.0	-1.3	58	34	24.9	2.0	<1	-22
35188	Astana	14.1	1.0	51	18	18.8	-0.2	17	-18
37789	Yerevan	17.1	-0.4	29	-14	21.6	-0.3	26	5
40080	Damascus	21.1	0.9	7	3	26.8	2.4	0	0
40199	Eilat	28.5	0.1	<1	<1	33.3	1.6	0	0
40265	Mafraq	20.3	0.5	<1	-3	24.7	2.0	0	0
60030	Las Palmas/Grand Canary	19.9	0.0	0	-2	22.2	0.8	0	0

WMO No.	Station	July 2009 Temp. mean	July 2009 (°C) dev.	July 2009 Prec. total	July 2009 (mm) dev.	August 2009 Temp. mean	August 2009 (°C) dev.	August 2009 Prec. total	August 2009 (mm) dev.
01008	Svalbard Airport	7.7	1.7	4	-9	6.3	1.5	15	-10
01025	Tromsø	12.3	0.6	29	-43	12.7	1.8	56	-26
01492	Oslo	17.3	0.9	164	80	16.1	0.9	156	66
02485	Stockholm	17.8	0.6	87	15	17.5	1.3	47	-19
02836	Sodankylä	13.7	0.4	78	13	13.8	2.6	94	31
02974	Helsinki	17.2	0.6	102	29	16.3	1.3	60	-20
03091	Aberdeen	15.1	1.3	105	45	15.2	1.6	57	-18
03772	London	18.4	0.6	71	25	19.0	1.6	40	-11
03967	Dublin Casement Aerodrome	15.0	0.1	111	57	15.4	0.8	68	-10
04030	Reykjavik	12.8	2.2	12	-40	11.3	1.0	52	-10
04320	Danmarkshavn	5.0	1.3	nil	nil	1.9	-0.5	nil	nil
04360	Angmagssalik	8.1	1.7	70	21	7.6	1,6	19	-42
06186	Copenhagen	19.0	1.8	56	-13	18.7	1.7	39	-24
06260	De Bilt	18.1	1.3	107	32	18.5	1.8	47	-24
06447	Brussels	18.7	1.2	73	-2	19.4	2.1	35	-28
06590	Luxembourg	18.4	1.5	75	7	19.5	3.1	49	-23
06660	Zurich	18.6	1.0	154	37	19.9	3.2	69	-64
06700	Geneva	20.5	1.4	84	17	21.2	3.0	67	-12
07510	Bordeaux	21.1	0.9	47	0	21.9	2.0	24	-30
07650	Marseilles	25.4	1.6	<1	-14	25.7	2.5	65	36
08222	Madrid	26.3	1.9	2	-11	27.5	3.6	<1	-9
08314	Mahón/Minorca	25.5	1.3	4	0	26.0	1.5	<1	-26
08495	Gibraltar	25.1	1.4	0	-1	25.2	1.0	1	-5
08515	Santa Maria/Azores	21.3	0.5	18	-7	22.9	0.7	8	-32
08535	Lisbon	21.9	-0.5	0	-5	23.5	0.7	1	-5
10384	Berlin-Tempelhof	20.1	1.3	70	18	20.8	2.4	28	-33
11035	Vienna	21.4	1.7	149	86	21.0	2.1	85	27
11518	Prague	18.5	1.0	65	-1	19.4	2.4	23	-47
11903	Sliač	21.0	2.8	53	-6	20.4	3.1	39	-30
12160	Elblag	18.5	1.7	126	32	18.3	1.6	25	-56
12375	Warsaw	20.0	2.1	88	21	18.5	1.2	60	-3
12843	Budapest	23.0	2.1	33	-19	22.7	2.4	31	-20
13274	Belgrade	24.0	2.3	80	14	24.1	2.8	44	-8
14015	Ljubljana	21.7	1.8	168	46	22.4	3.3	77	-67
14445	Split	26.9	1.5	42	14	27.6	2.4	34	-16
14654	Sarajevo	20.6	1.7	93	14	20.4	1.9	53	-18
15420	Bucharest	23.2	1.2	112	48	22.2	1.0	52	-6
15614	Sofia	21.5	1.5	80	24	20.7	1.3	124	72
16206	Grosseto	24.4	0.8	<1	-20	25.8	2.3	<1	-37
16597	Luqa	27.0	1.1	<1	<1	27.3	1.0	<1	-7
16716	Athens	29.6	1.8	1	-4	28.7	1.1	18	13
16754	Heraklion/Crete	27.1	1.4	0	-1	26.2	0.6	0	-1
17040	Rize	24.4	2.2	299	165	22.6	0.4	95	-91
17062	Istanbul	25.8	2.6	3	-16	24.6	1.6	14	-12
17130	Ankara	23.6	0.7	14	0	23.3	0.7	<1	-12
17170	Van	21.2	-0.7	21	17	20.1	-1.1	3	-1
17609	Larnaca	28.9	2.0	<1	<1	29.0	1.9	0	0
22113	Murmansk	11.0	-1.8	57	-3	11.8	0.8	29	-36
26038	Tallinn	16.9	0.6	121	42	16.1	0.8	67	-17
26629	Kaunas	18.4	1.3	83	15	16.9	0.6	88	25
26730	Vilnius	18.0	1.1	107	29	16.4	0.1	68	-4
26850	Minsk	18.6	1.3	162	74	16.5	0.0	40	-32
27612	Moscow	18.8	0.7	91	-1	15.6	-0.8	86	12
33345	Kiev	21.7	2.4	38	-50	19.2	0.6	16	-53
33815	Kishinev	24.0	3.1	68	-1	22.3	1.8	33	-12
34300	Kharkiv	22.9	2.6	59	-1	19.1	-0.4	8	-42
34880	Astrakhan	26.3	1.0	9	-14	21.9	-1.4	50	31
35188	Astana	18.9	-2.4	87	37	18.6	0.9	22	-18
37789	Yerevan	24.4	-1.6	62	52	22.6	-2.6	13	6
40080	Damascus	28.0	1.7	0	0	27.2	1.2	0	0
40199	Eilat	34.5	1.6	0	0	34.0	1.2	0	0
40265	Mafraq	25.5	1.4	0	0	25.2	1.0	0	0
60030	Las Palmas/Grand Canary	25.1	1.8	0	0	24.9	0.8	0	0

WMO No.	Station	September 2009 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	October 2009 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	1.7	1.2	8	-15	-3.6	1.9	25	10
01025	Tromsø	8.4	1.6	202	108	2.3	-0.6	95	-30
01492	Oslo	12.9	2.1	23	-67	4.4	-2.0	55	-29
02485	Stockholm	14.1	2.9	32	-23	5.7	-1.8	67	17
02836	Sodankylä	8.6	2.7	69	14	-2.7	-2.4	34	-17
02974	Helsinki	12.9	2.9	37	-36	3.3	-2.1	106	33
03091	Aberdeen	13.1	1.4	103	35	10.1	0.2	184	107
03772	London	16.2	1.2	36	-15	12.9	1.2	39	-19
03967	Dublin Casement Aerodrome	12.8	-0.2	29	-40	11.2	0.9	89	21
04030	Reykjavik	8.4	1.0	78	11	5.1	0.7	78	-8
04320	Danmarkshavn	-3.5	0.7	nil	nil	-12.2	1.4	nil	nil
04360	Angmagssalik	3.4	0.3	45	-23	-1.2	-0.4	79	-3
06186	Copenhagen	15.4	1.8	30	-32	8.3	-1.6	62	3
06260	De Bilt	15.0	1.0	34	-33	10.7	0.2	90	18
06447	Brussels	15.8	1.3	29	-30	11.3	0.4	105	35
06590	Luxembourg	15.4	2.0	56	-14	9.3	0.2	61	-14
06660	Zurich	15.4	1.6	69	-23	9.6	0.3	56	-13
06700	Geneva	16.6	1.7	62	-19	10.6	0.5	38	-39
07510	Bordeaux	18.7	0.8	49	-25	15.0	1.0	34	-54
07650	Marseilles	21.2	0.9	214	167	16.1	0.0	84	6
08222	Madrid	21.4	0.9	12	-18	17.3	2.5	37	-8
08314	Mahón/Minorca	22.8	0.6	193	139	18.9	0.4	49	-35
08495	Gibraltar	21.7	-1.1	58	43	21.0	1.5	48	-16
08515	Santa Maria/Azores	22.3	0.9	31	-26	20.7	1.4	92	8
08535	Lisbon	21.7	0.0	9	-17	20.5	2.0	107	27
10384	Berlin-Tempelhof	16.4	1.8	30	-16	8.5	-1.5	84	48
11035	Vienna	17.2	2.1	20	-25	9.8	-0.1	43	2
11518	Prague	15.8	2.5	16	-24	8.1	-0.2	34	4
11903	Sliač	16.3	2.9	33	-23	8.7	0.4	102	52
12160	Elblag	14.7	2.0	26	-44	6.6	-2.3	109	56
12375	Warsaw	15.5	2.3	13	-30	6.9	-1.4	67	29
12843	Budapest	19.2	2.8	20	-20	11.1	0.2	46	12
13274	Belgrade	20.6	2.9	4	-47	13.2	0.8	99	59
14015	Ljubljana	17.4	1.9	64	-66	11.0	0.6	93	-22
14445	Split	23.2	1.8	26	-35	16.3	-0.6	95	16
14654	Sarajevo	16.6	1.5	20	-50	9.3	-1.1	172	84
15420	Bucharest	17.5	0.6	44	2	11.2	0.4	68	36
15614	Sofia	16.3	0.5	60	21	11.1	0.7	48	11
16206	Grosseto	22.2	1.8	18	-47	16.0	-0.1	52	-35
16597	Luqa	24.6	0.5	77	37	20.2	-0.5	61	-29
16716	Athens	23.3	-0.9	48	38	19.8	0.5	54	2
16754	Heraklion/Crete	23.5	0.4	53	35	21.2	1.5	116	40
17040	Rize	20.4	1.0	396	173	18.3	2.9	147	-126
17062	Istanbul	21.0	1.3	90	49	18.4	3.1	87	16
17130	Ankara	18.3	0.0	10	-9	16.8	4.2	14	-13
17170	Van	15.5	-1.3	46	36	10.6	0.5	16	-32
17609	Larnaca	25.6	0.5	13	13	23.7	2.4	14	-5
22113	Murmansk	8.8	2.1	78	26	0.4	-0.6	16	-26
26038	Tallinn	13.8	3.0	52	-30	5.0	-1.3	139	69
26629	Kaunas	13.8	1.7	28	-31	5.4	-1.5	101	50
26730	Vilnius	13.6	2.0	59	-6	4.8	-1.8	108	55
26850	Minsk	14.1	2.4	56	-4	5.5	-0.8	103	54
27612	Moscow	13.8	2.9	43	-21	5.8	0.8	136	78
33345	Kiev	17.3	3.4	16	-31	9.1	1.0	27	-8
33815	Kishinev	18.7	2.5	22	-26	11.5	1.4	30	3
34300	Kharkiv	17.0	2.9	23	-18	9.6	2.3	47	12
34880	Astrakhan	18.7	1.4	18	-8	12.9	3.8	1	-16
35188	Astana	12.4	0.4	27	3	5.3	2.5	15	-15
37789	Yerevan	18.5	-2.2	72	62	16.1	2.9	13	-14
40080	Damascus	23.8	0.6	2	1	21.1	3.0	19	7
40199	Eilat	30.9	0.5	0	0	28.7	2.0	0	-4
40265	Mafraq	23.0	0.3	0	-1	22.0	2.9	14	7
60030	Las Palmas/Grand Canary	23.7	-0.1	6	-2	24.2	1.7	<1	-10

WMO No.	Station	November 2009 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	December 2009 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-1.9	8.6	16	3	-5.5	7.8	28	16
01025	Tromsø	0.6	1.4	9	-95	-4.4	-1.4	43	-61
01492	Oslo	3.9	3.2	126	51	-3.8	-1.0	67	11
02485	Stockholm	5.6	3.0	52	-1	-1.4	-0.4	45	-1
02836	Sodankylä	-2.2	5.2	55	16	-12.1	1.0	22	-9
02974	Helsinki	2.5	2.4	88	16	-5.3	-1.2	57	-1
03091	Aberdeen	6.8	1.8	147	72	2.0	-1.5	81	8
03772	London	10.0	2.8	148	93	4.4	-0.7	85	28
03967	Dublin Casement Aerodrome	7.4	0.7	184	114	3.4	-1.9	103	26
04030	Reykjavik	3.1	2.0	35	-38	0.9	1.1	43	-36
04320	Danmarkshavn	-19.0	0.9	nil	nil	-16.3	5.5	nil	nil
04360	Angmagssalik	-3.1	1.6	26	-70	-2.9	4.3	42	-61
06186	Copenhagen	7.7	2.2	80	18	1.8	-0.4	32	-26
06260	De Bilt	9.5	3.6	120	39	2.2	-1.0	84	4
06447	Brussels	9.7	3.6	98	22	2.9	-0.6	81	5
06590	Luxembourg	7.5	3.7	155	72	1.2	0.2	113	33
06660	Zurich	7.2	3.3	124	42	1.1	0.5	111	38
06700	Geneva	7.8	2.8	150	58	2.3	0.5	155	68
07510	Bordeaux	11.6	2.5	204	110	7.0	0.6	92	-7
07650	Marseilles	12.9	2.2	42	-16	7.9	0.6	99	43
08222	Madrid	11.4	2.0	13	-51	6.1	-0.3	129	78
08314	Mahón/Minorca	15.8	1.4	39	-38	12.2	0.4	77	3
08495	Gibraltar	16.4	0.3	19	-122	15.3	1.2	508	362
08515	Santa Maria/Azores	17.1	-0.3	50	-52	15.1	-0.3	252	157
08535	Lisbon	15.8	1.3	138	24	12.3	0.5	289	181
10384	Berlin-Tempelhof	8.2	3.3	69	20	0.6	-0.8	58	5
11035	Vienna	6.8	2.2	77	27	1.4	0.5	52	9
11518	Prague	6.2	3.4	32	0	-0.8	-0.2	50	24
11903	Sliač	5.1	2.1	76	7	-0.9	0.8	135	78
12160	Elblag	5.8	2.5	38	-18	-1.1	-1.4	37	-15
12375	Warsaw	5.7	2.5	51	9	-1.0	-0.1	45	13
12843	Budapest	6.8	2.0	90	38	1.4	1.0	71	31
13274	Belgrade	9.8	2.8	60	6	4.6	2.3	121	63
14015	Ljubljana	7.5	2.9	127	-8	2.0	2.0	185	84
14445	Split	13.0	0.8	117	9	9.4	0.7	108	8
14654	Sarajevo	7.9	3.1	64	-27	3.1	3.3	145	81
15420	Bucharest	6.7	1.5	23	-26	0.7	0.5	59	16
15614	Sofia	7.4	2.4	11	-36	2.8	2.3	57	18
16206	Grosseto	12.5	1.3	90	-4	8.7	0.8	82	17
16597	Luqa	16.9	-0.1	36	-44	15.6	1.8	56	-56
16716	Athens	15.2	-0.3	22	-28	14.1	1.9	87	16
16754	Heraklion/Crete	17.0	0.4	71	12	15.8	2.0	50	-24
17040	Rize	12.2	0.6	315	65	10.8	2.5	156	-82
17062	Istanbul	12.6	1.0	189	100	10.7	2.6	100	-22
17130	Ankara	7.3	0.2	43	10	5.4	2.9	68	19
17170	Van	4.5	0.5	90	46	1.9	3.0	35	1
17609	Larnaca	17.9	1.5	26	-18	15.3	2.1	146	70
22113	Murmansk	-1.8	3.3	16	-24	-8.8	0.5	62	24
26038	Tallinn	2.8	1.6	81	13	-3.9	-1.0	52	-3
26629	Kaunas	3.9	1.8	75	22	-2.5	-0.1	47	3
26730	Vilnius	3.3	2.1	77	20	-3.0	-0.1	70	15
26850	Minsk	3.5	2.7	59	7	-4.2	-0.4	79	26
27612	Moscow	2.2	3.3	70	12	-6.5	-0.4	56	4
33345	Kiev	4.7	2.6	31	-20	-3.2	-0.9	88	36
33815	Kishinev	6.5	2.1	9	-30	-1.0	-0.7	95	57
34300	Kharkiv	4.5	3.2	47	3	-3.7	-0.3	92	47
34880	Astrakhan	3.7	0.4	18	-1	-0.9	1.0	15	0
35188	Astana	-4.0	1.9	39	17	-14.0	-1.4	25	8
37789	Yerevan	8.1	1.6	16	-6	4.2	4.0	22	-1
40080	Damascus	11.7	-0.1	31	9	9.8	2.6	11	-15
40199	Eilat	21.6	0.1	<1	-3	18.6	2.0	<1	-6
40265	Mafraq	12.9	-0.6	21	4	10.9	2.1	25	-3
60030	Las Palmas/Grand Canary	22.3	1.9	6	-15	21.2	2.9	18	-3

WMO No.	Station	Year 2009 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-3.7	2.7	153	-30
01025	Tromsø	3.3	0.5	923	-50
01492	Oslo	6.7	1.0	938	169
02485	Stockholm	7.6	1.0	523	-16
02836	Sodankylä	0.5	1.5	501	100
02974	Helsinki	5.5	1.0	633	-18
03091	Aberdeen	8.9	1.0	1014	231
03772	London	11.8	1.3	683	84
03967	Dublin Casement Aerodrome	9.6	0.3	926	191
04030	Reykjavik	5.6	1.2	714	-84
04320	Danmarkshavn	-11.5	0.8	nil	nil
04360	Angmagssalik	-0.2	1.5	782	-150
06186	Copenhagen	9.6	1.0	528	-108
06260	De Bilt	10.5	1.1	777	-28
06447	Brussels	11.0	1.1	764	-36
06590	Luxembourg	9.9	1.6	892	17
06660	Zurich	9.9	1.4	1098	12
06700	Geneva	11.2	1.6	886	-68
07510	Bordeaux	13.8	1.1	912	-11
07650	Marseilles	15.9	1.1	817	273
08222	Madrid	15.9	1.6	337	-119
08314	Mahón/Minorca	17.4	0.8	648	50
08495	Gibraltar	18.5	0.3	918	143
08515	Santa Maria/Azores	18.1	0.6	629	-146
08535	Lisbon	17.5	0.7	1018	265
10384	Berlin-Tempelhof	10.3	0.9	636	52
11035	Vienna	11.0	1.3	910	303
11518	Prague	9.1	1.2	480	-46
11903	Sliač	9.5	1.6	789	103
12160	Elblag	8.4	0.8	684	-6
12375	Warsaw	8.8	1.0	654	135
12843	Budapest	11.9	1.5	520	2
13274	Belgrade	13.6	1.7	805	121
14015	Ljubljana	11.7	1.9	1406	13
14445	Split	16.9	1.1	994	169
14654	Sarajevo	10.7	1.2	1066	148
15420	Bucharest	11.5	0.9	631	36
15614	Sofia	10.9	1.2	665	102
16206	Grosseto	15.8	1.0	565	-137
16597	Luqa	19.1	0.5	680	127
16716	Athens	19.2	0.7	413	44
16754	Heraklion/Crete	19.3	0.8	539	38
17040	Rize	15.3	1.4	2280	108
17062	Istanbul	16.0	1.9	885	188
17130	Ankara	13.0	1.3	462	55
17170	Van	9.1	0.5	484	106
17609	Larnaca	20.6	1.5	444	115
22113	Murmansk	0.6	0.7	460	-18
26038	Tallinn	6.1	1.0	721	54
26629	Kaunas	7.2	0.8	741	133
26730	Vilnius	6.9	0.9	785	102
26850	Minsk	6.9	1.1	899	222
27612	Moscow	6.2	1.3	741	53
33345	Kiev	9.4	1.7	450	-199
33815	Kishinev	11.4	1.8	447	-100
34300	Kharkiv	9.2	1.7	550	31
34880	Astrakhan	10.8	0.8	271	51
35188	Astana	3.5	0.8	347	29
37789	Yerevan	12.4	0.3	431	154
40080	Damascus	17.7	1.2	150	4
40199	Eilat	25.8	1.0	2	-30
40265	Mafraq	17.4	0.9	138	-21
60030	Las Palmas/Grand Canary	21.2	0.7	67	-50

Monthly Surveys

January

- **Milder than usual in northern and eastern Europe, cold in western and central Europe**
- **Extreme cold spell in the first ten days affecting large parts of Europe**
- **Dry in northern Scandinavia, central Europe and the Middle East, very wet over the central Mediterranean**

Atmospheric circulation characteristics

A strong westerly airflow prevailed over the North Atlantic whereas most of the European continent was frequently affected by high pressure. Both the Icelandic low and the Azores high were stronger than normal. For this reason, the Atlantic airflow was often blocked by the high pressure over Europe, and mild air flowed into the Arctic regions, northern and eastern Europe. Only in the first ten days, a large trough with polar air affected northern and north-eastern Europe. At its rear, very cold arctic air came into central Europe, and a cut-off low brought heavy snowfalls even to the Mediterranean.

In general, the central parts of Europe were mostly affected by cold and dry continental air, whereas some of the Atlantic low pressure systems (some of them were quite severe) at least touched the western parts of Europe. In some cases, these systems with snowfalls even crossed the whole of western and central Europe and extended far to the south, especially during the first and the last ten days of the month.

South-eastern Europe, in contrast, was often under a warm and moist airflow from subtropical latitudes south of the high pressure zone with much low pressure activity over the Mediterranean. At the same time, the Middle East was often under high pressure influence. At the beginning of the month, however, cold air reached even Turkey.

Temperature

The year 2009 began with a very mild January in the Arctic, Scandinavia and eastern Europe, with monthly mean anomalies partly exceeding +4°C (Fig. 1.1), e.g. +4.8°C in Egedesminde in Greenland, +4.4°C in St. Petersburg in Russia and up to +5.3°C in eastern Estonia (Fig. 1.2). Maximum temperatures in southern Greenland partly exceeded 10°C.

In north-western Europe, January temperatures were around normal over most of the United Kingdom as a whole, but it has been the coldest January for England and Wales since 1997.

Western, south-western and central Europe as well as northern parts of south-eastern Europe all saw a cold January. Anomalies below -2°C, locally even -3°C, were recorded notably in large parts of northern France, Belgium, Luxembourg, in the southern half of Germany and parts of Austria. It was the coldest month in France for 20 years and the coldest January in the Netherlands in more than 10 years. The number of ice days in central Europe was higher than normal. Especially in Germany, after two very mild winters, January 2009 has been the first winter month since February 2006 which was colder than normal. Water areas near the North German coasts had cooled to 1-3°C at the end of the month, and ice formed temporarily. In south-western Europe, Spain recorded minimum temperatures below zero in many places, e.g. in Madrid (600 m altitude).

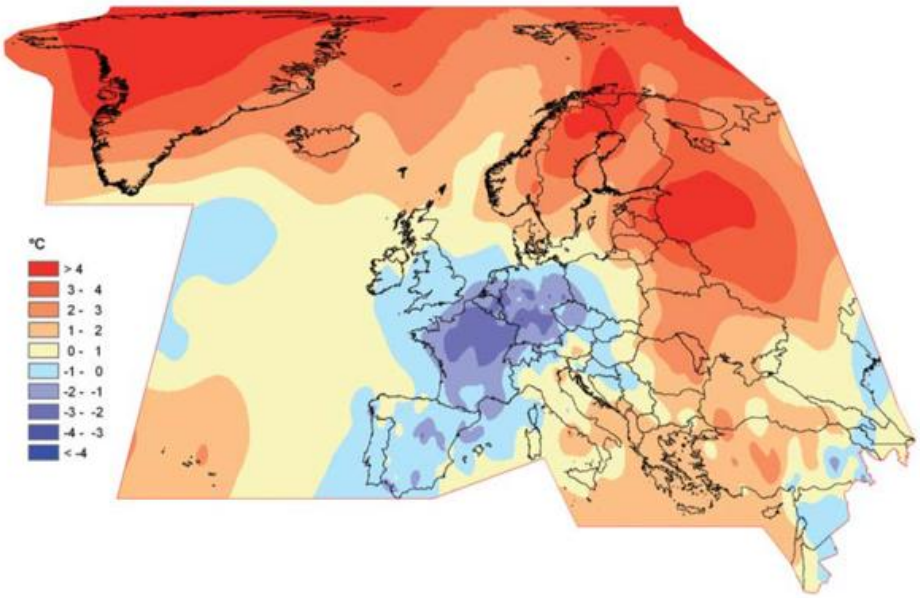

Fig. 1.1: *Monthly mean temperature anomalies in January 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

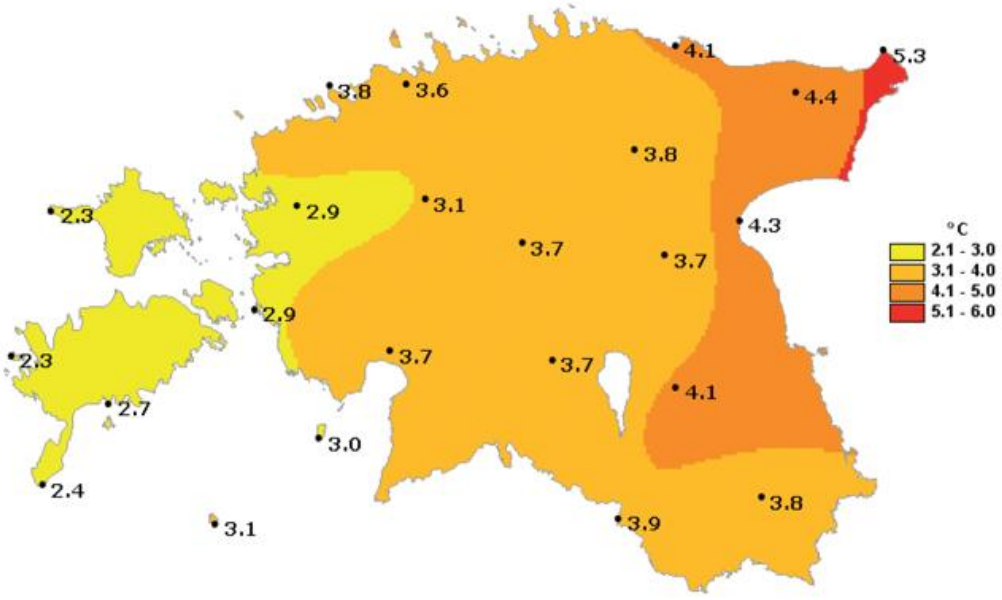

Fig. 1.2: *Monthly mean temperature anomalies in January 2009 (reference period 1961-1990) in Estonia*
Source: Estonian Meteorological and Hydrological Institute

A severe cold spell hit most of Europe in the first half of the month. The lowest monthly and annual minimum recorded at Norwegian arctic stations was -38.6°C. Northern and eastern Europe, too, saw quite low minima (e.g. central Sweden, Finland, European Russia and eastern Ukraine below -30°C, Lithuania below -25°C). Northern European Russia, however, became very mild later in the month and some new records of daily maxima were set in the north-western areas of the country.

Large parts of western and central Europe reported several-day-long periods with daily minima between -10 and -15°C. Absolute minima of the month dropped even to -20°C and below in many places from the Netherlands to Hungary. Extremely low, at several stations record-breaking temperatures below -28°C were measured in Germany and Poland on 7 January. Some rivers in northern Germany froze over including parts of the river Elbe.

In Austria, the cold spell started a few days later on 10 January. The Danube storage reservoirs and ports froze to a depth up to 30 cm, causing economical losses. The cold weather caused an inversion situation; smog alert was issued e.g. in Budapest on 10 January. In many places in southern and south-eastern Europe, daily minimum temperatures also dropped to low values, e.g. -17°C in Bulgaria, -10°C and below in mountainous regions in Spain (lowest value -13.4°C on 12 January) and -8.6°C in Portugal.

Some areas in the Middle East, including the western part of eastern Turkey, parts of the South Caucasus countries and western Kazakhstan were also colder than normal. In Turkey, minimum temperatures dropped to around -20°C at altitudes around 1000 m on 2 January after a far-reaching advance of cold air to the south locally causing new minimum January records below -25°. Azerbaijan also recorded minima around -20°C. In Jordan, the minimum temperature fell to -9.8°C on 4 January.

January 2009, however, also saw some warmer-than-normal areas in the southern parts of the Region (some of which were more than +1°C, in places even more than +2°C warmer than normal, namely the eastern Mediterranean region and the Azores Islands).

Precipitation

It was very dry in northern Scandinavia, central Europe, southern European Russia and the Middle East (Fig. 1.3). Over large areas, the monthly totals were below 60% of the normal, in Israel and Jordan even below 20%. It was one of the driest Januarys in the 70-year measurement history in Israel (Fig. 1.4).

Wetter-than-normal areas were found in southern Greenland and Iceland and in most of western, eastern, south-eastern and southern Europe. Ireland reported its highest January rainfall since 1974, with a total of 291 mm (including a 12-day period with more than 10 mm). South-eastern Austria received more than 300% of its monthly normal, the highest amount since 1979. In some places in Slovenia, it was the 2nd or 3rd wettest January on record. More than twice the normal precipitation also fell particularly in southern Italy and other parts of the central Mediterranean, on the Adriatic coast of the Balkan Peninsula, in parts of north-eastern Slovenia, on the southern Balkan Peninsula in Bulgaria, the Former Yugoslaw Republic of Macedonia, Greece, in Cyprus as well as in south-western Europe, e.g. Portugal. Italian stations reported several record-breaking precipitation totals of up to 362 mm or 4 times the normal. Luqa Airport on Malta has received its highest monthly January rainfall total in 85 years (247 mm).

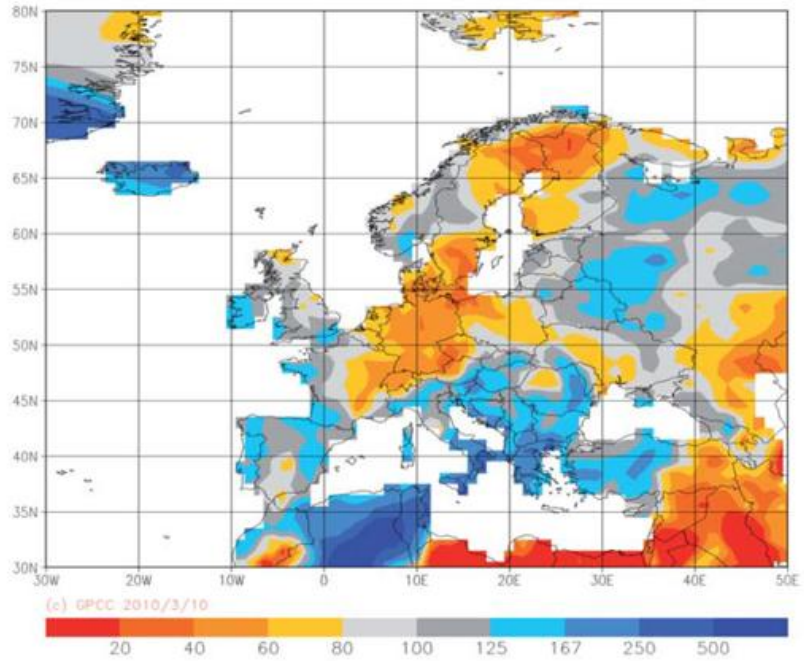

Fig. 1.3: *Monthly precipitation amounts for January 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

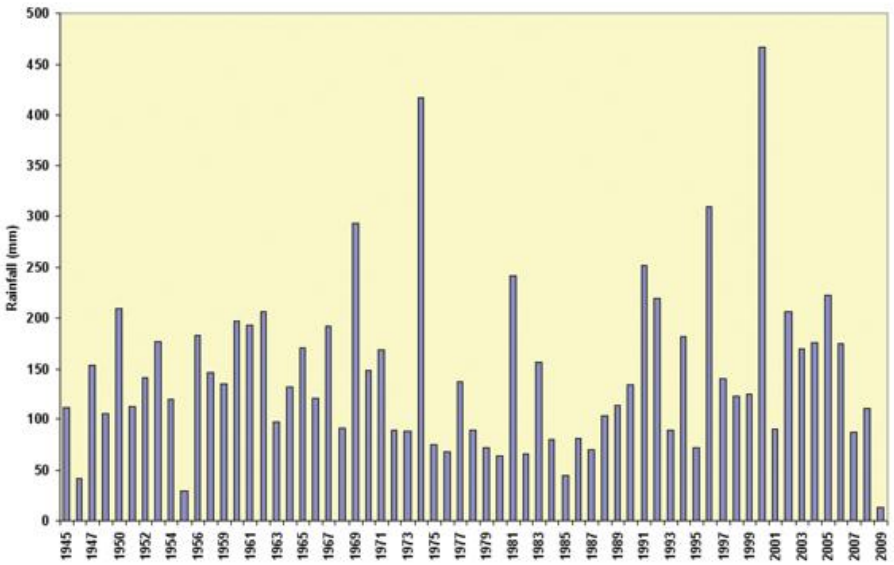

Fig. 1.4: *Monthly rainfall for January 1945-2009 in Tel Aviv, Israel*
Source: Israel Meteorological Service

Snow

In the north, much snow (up to 166 cm) was recorded in Iceland in the middle of the month after some heavy snow showers. In Kaunas (Lithuania), a heavy snow shower of 29.8 mm in 12 hours increased the snow cover by 44 cm.

At the beginning of the month, snow blankets formed after a winter storm over large parts of Europe, especially in the United Kingdom, France and Germany, in places reaching a snow depth of more than 30 cm. Due to the following cold spell, the snow cover persisted in central Europe at least until the middle of the month. Many flights had to be cancelled due to heavy snow. The Eiffel Tower in Paris had to be closed due to slippery icy conditions. Snowfall even reached southern parts of Europe; Marseilles in southern France has had its heaviest snowfall in 20 years; the Rhône river delta received 20-40 cm of snow on 6-7 January. Even Madrid in Spain was affected by up to 10 cm of snow, causing disruption of traffic on road and rail. New records in the number of snow days in Spain in January were reached, e.g. in León (14 days, highest since 1938, about 800 m elevation) and Ávila (11 days, highest for about 20 years, 1100 m). In Portugal, snowfall occurred on 29 January even in coastal and low latitude regions where this kind of weather phenomenon is very rare.

In the Alps, large amounts of snow were found especially in the south-eastern parts of Austria. Later in the month, on 27 January, a period with abundant snowfall started there. The snow load caused much damage on trees and power lines. Preitenegg in Austria at the south-eastern slope of the Alps reported 83 cm of fresh snow. A snow cover of 380 cm was measured on Kredarica Mountain in Slovenia; it was the third greatest snow depth in January on record there. In Hungary, snow in the second half of the month caused serious damage to power lines in parts of the country.

The outbreak of cold air from northern Europe also brought abundant snowfall over northern Italy from 3 - 10 January. On 7 January, Milan reported a snow depth of 26 cm (Fig. 1.5) which led to a temporary closing of airports. Other locations in the Po Valley recorded even more than 35 cm.



Fig. 1.5: *Milan under snow in January 2009*
Source: CNMCA (Centro Nazionale de Meteorologia e Climatologia Aeronautica, National Centre of Meteorology and Aeronautical Climatology), Italy

A snow cover persisted in mountainous areas of Serbia during the whole month, in lower parts of the country during the first half of the month. The maximum snow depth recorded in Serbia was 46 cm. A snow cover of up to 20 cm depth accumulated over most of Romania.

Later in the month, temperature increase caused rapid snow melting in southern parts of Europe, e.g. in northern Italy and Romania, snow melt followed by flooding.

Intensive avalanches were recorded in the first ten days of January in the northern Caucasian mountains. Among the South Caucasus countries, the area of Georgia was snowy during the first twenty days of the month. Azerbaijan reported snow depths of up to 35 cm. In the northern regions of Armenia and the very south of the country, no snow cover occurred that month.

Significant weather events

January 06-07: Extreme cold spell (minimum temperatures down to -28°C) and heavy snow over large parts of the Region. A Mediterranean storm dropped 20-40 cm of snow across south-eastern France for the first time since 1987. Three fatalities due to freezing. Ice on rivers.

January 12: 117.5 mm of precipitation in Norway (Rogaland) were measured within a large low pressure complex.

January 13-14: Severe icing in central and western Bulgaria due to rain falling on snow. Freezing rain also in Hungary; several cm thick glaze formed on the roads and disabled traffic.

January 17: A severe storm with strong gusts up to 174 km/h (local 50-year record in Ireland) and heavy rain crossed over much of the United Kingdom and Ireland. Electricity broke down in around 100,000 homes across Ireland. The Faroe and Hebrides Islands also recorded gusts of hurricane force. The central minimum mean sea level pressure of the depression located north of Ireland was 946 hPa. Iceland saw heavy snow showers.

January 19-25: Heavy precipitation in northern Italy. 3-day totals exceeded 200 mm over large areas. A series of cyclones generated in the Genoa Bay moved towards the Adriatic Sea and then continued to south-eastern Europe. Heavy precipitation in Montenegro up to 155 mm (new local record), locally higher-than-normal monthly totals and snow melt caused river flooding. Even Turkey was affected by these storms; water spouts were seen near Antalya. Floods were recorded in the Larnaca area in Cyprus on 23-24 January; suspended dust appeared at the same time.

January 23-24: Storm Klaus hit south-western France and northern Spain with torrential rains, very high waves in the eastern Atlantic and the Mediterranean, and gusts up to 193 km/h in the Pyrenees (Fig. 1.6). The storm's force was equivalent to a category 3 hurricane. At least 20 fatalities. About one million homes were left without power supply. Roads, airports and railways were forced to close. It has been the worst storm in that area since December 1999. In the aftermath of the storm, heavy avalanches were released in the French Alps. Storm Klaus had been preceded by storm “Joris”, which affected especially Switzerland with gusts of up to 155 km/h.

January 29-30: Southern Ireland saw heavy rain (around 100 mm within 2 days) with severe flooding due to an Atlantic storm coming from the south. The centre of the town Clonmel was flooded when the river Suir burst its banks.

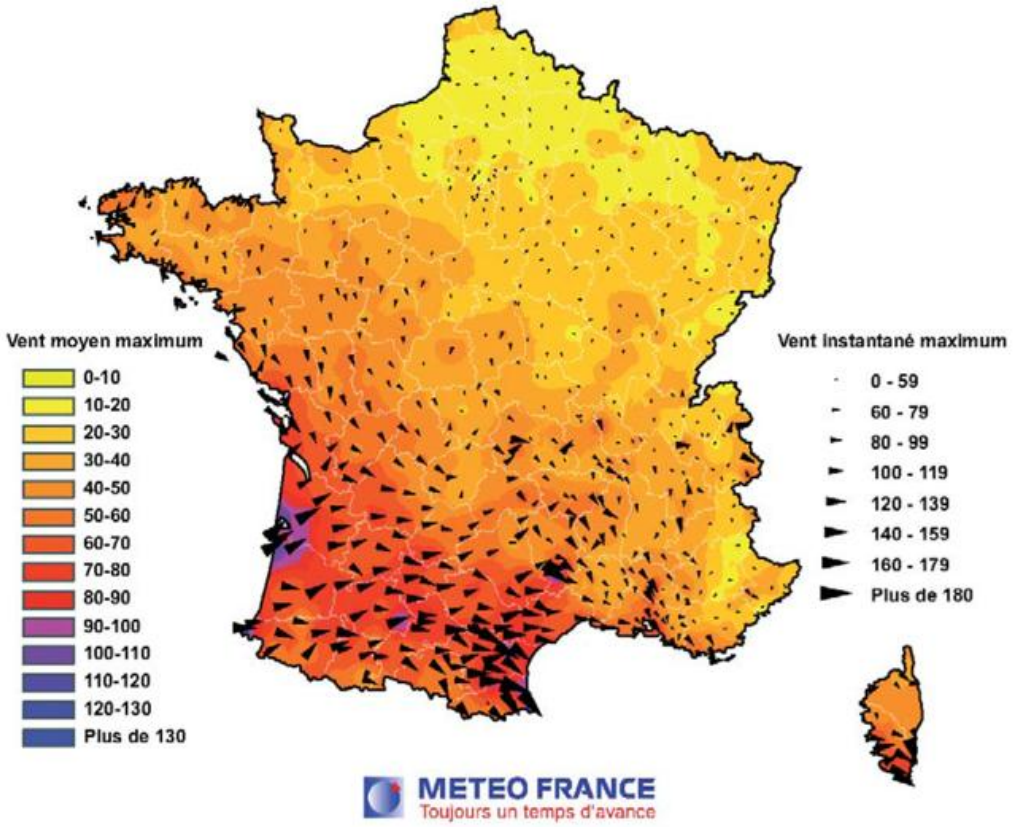

Fig. 1.6: *Maximum 10-minute-mean wind speeds (coloured shaded areas) and maximum wind gusts (arrows, both in km/h) in France on 24 January 2009 during passage of storm Klaus. Source: Météo France*

February

- **Milder in eastern Europe, Svalbard and over the central North Atlantic, cold over the Mediterranean and locally in northern Europe**
- **Western Europe dry, central and eastern Europe mainly wetter than normal**

Atmospheric circulation characteristics

At the beginning of the month, an intensive cut-off low crossed Europe from east to west and caused heavy snowfall over north-western Europe. Thereafter, a large trough extended over the eastern Atlantic and western Europe, and cold air masses moved southwards as far as Iberia, crossing from there the Mediterranean. In addition, a violent storm from the Atlantic (Quinten) affected western Europe early in the month and passed central Europe after weakening.

In the middle of the month, another broad trough centred over central Europe and the Mediterranean followed, remaining very stable for many days. Western and south-western Europe were under a high pressure area which frequently caused dry, but cold nights in these areas. Even the western parts of northern Europe occasionally came under high pressure influence and experienced much nocturnal cooling.

Due to dislocation and weakening of the Icelandic low, the mean airflow over the eastern North Atlantic took a more south-westerly direction. The flow of mild and moist air into the Arctic region continued and only east Greenland mainly remained under cold and dry polar air.

Central and parts of northern Europe were often affected by low pressure systems moving from north-west to south-east; occasionally, some cold air and snowfalls reached western and even south-eastern Europe.

The influence of the Siberian high retreated eastwards and the east of the Region came under an increasingly warm and moist airflow from the south. At the end of the month, however, a trough over eastern Europe extended far into the eastern Mediterranean, causing frequent precipitation in the Middle East.

Temperature

February was very mild in Svalbard and the whole of eastern Europe and the Middle East, with monthly mean anomalies exceeding +2°C over large areas (even +4°C in Svalbard and in some of the easternmost parts of the Region (Fig. 2.1). Yerevan in Armenia was even +5°C warmer than normal. The central North Atlantic was also warm.

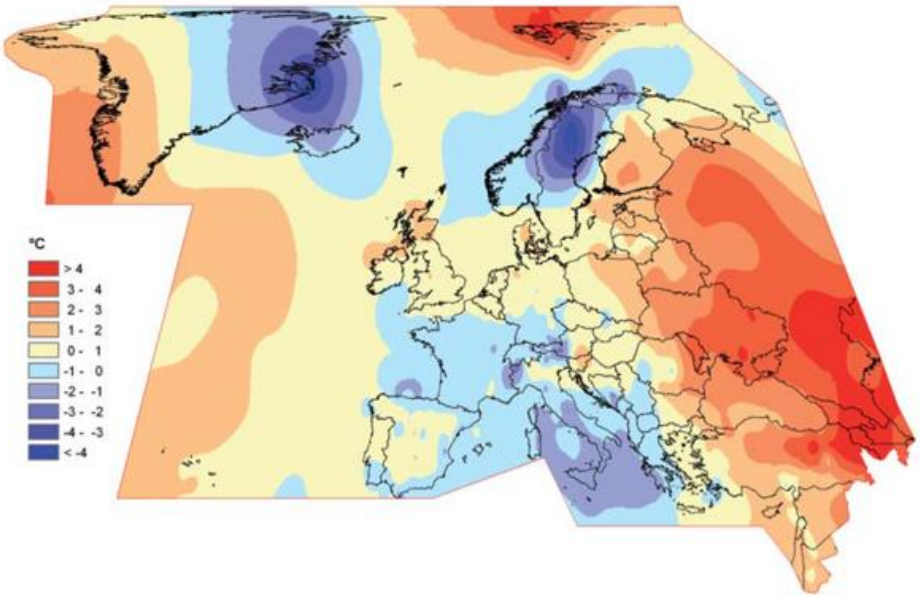

Fig. 2.1: *Monthly mean temperature anomalies in February 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

There were some very cold areas in eastern Greenland and Sweden, with local monthly averages of more than -4°C colder than normal. It was the coldest February in 15 years in northern Sweden. Norway was -2 to -4°C colder than normal. Lapland (northern Fennoscandia) saw minimum temperatures of around -35°C, locally below -38°C. Iceland was -2°C colder than

normal in the north, especially during the first part of the month, and a minimum of -29°C was recorded in the northern inland. The north-eastern coasts of European Russia were slightly colder than normal, also due to severe frosts especially in the first ten days.

The United Kingdom had a cold first half of the month, but this was compensated by milder conditions in the second half.

It was also colder than normal in France (although not as cold as in January), the Alpine region (except the east), south-western parts of the Balkan Peninsula and almost the whole Mediterranean (except the eastern parts but particularly the central Mediterranean, where the temperatures were -1°C below normal). Especially the second half of the month was colder in the central Mediterranean region.

Central Europe was slightly warmer than normal in the north and east, but colder or near normal in its southern parts. Temporary sea ice was still seen near the North German coasts. Southern Germany had a sharp cold spell on February 18-19, resulting in daily minimum temperatures around -20°C. Poland reported a minimum temperature of -20°C in the northeast of the country. A station in the Jura Mountains in Switzerland recorded -33.1°C. During the last days of the month, however, maximum temperatures in western Europe and the western parts of central Europe exceeded 15°C due to the mild airflow coming in from the west.

Some very warm days occurred in the Middle East and the Caucasus region. On 9 February, temperatures above 30°C were recorded in parts of Israel, while on 13-16 February maximum temperatures reached 18-20°C in southern Armenia. Similar temperatures were reached in Azerbaijan.

Precipitation

In northern Europe, it was wet in south-eastern Norway and large parts of Sweden (up to around 200% of the normal), but very dry in the other areas (Fig. 2.2). Iceland was very dry during the first part of the month whereas the country's south was hit by heavy precipitation by the middle of the month.

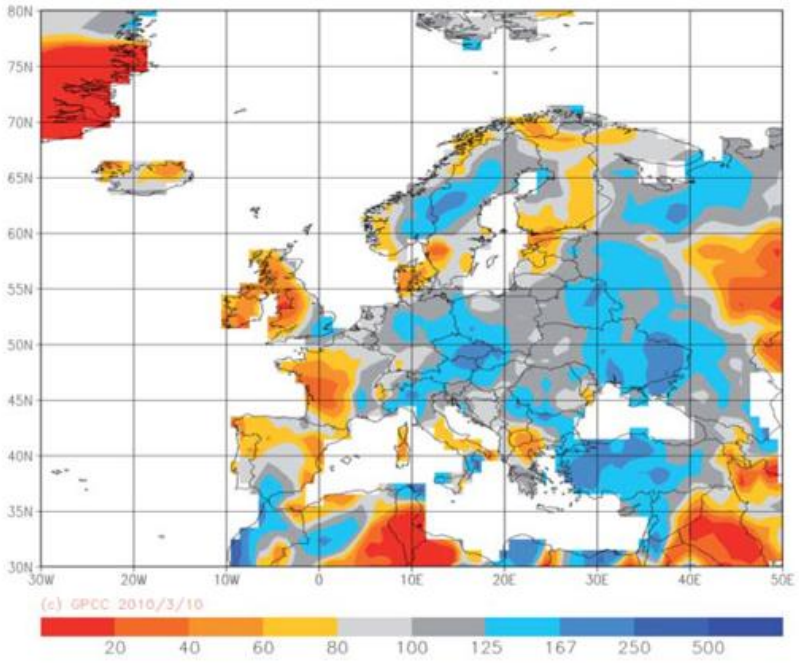

Fig. 2.2: *Monthly precipitation amounts for February 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Nearly the whole of western Europe was unusually dry, with less than 40% of the monthly normal precipitation in places. In the United Kingdom, only south-eastern England was very wet (70 mm or 200% of the 1961-90 normal in London), in contrast to the western parts of the country which reported their driest February since 1993.

The month was wet over most of central and eastern Europe, including most parts of the alpine region and locally with more than twice the normal monthly precipitation total. Precipitation was particularly high in south-eastern Austria (around 300% of the normal).

However, some of the easternmost parts of the Region (eastern European Russia, west Kazakhstan and Armenia) were very dry. Some valleys in southern Armenia received only 10-20 mm of precipitation, which is 20-25% of the 1961-1990 normal.

Most of the western and central Mediterranean region was drier than normal, except northern and southern Italy, Malta and southern Spain. 118 mm of rain fell at Malta International Airport - which is more than twice the normal; half of that amount resulted from one heavy rain event. Livorno in the Tuscany region of Italy had a daily total of 110 mm on 6 February.

Turkey and the Middle East were very wet, with locally twice the normal amount of precipitation. February 2009 was the 3rd rainiest February in 70 years in some areas in Israel. Salt in Jordan had a monthly total of 280 mm; this was also the highest local monthly total recorded in Jordan during the whole year.

Snow

Heavy snow at the beginning of the month disrupted air, road and rail travel in the United Kingdom, Belgium, north-western France, Spain and Italy. The United Kingdom has experienced its most widespread snowfalls since 1991, resulting in peak snow depths of up to more than 40 cm even in the lowlands. London received its heaviest snowfalls in 18 years, with up to 28 cm on 2 February.

During the course of the month, further snowfalls occurred in various parts of Europe, especially in Russia (35 cm in Moscow on 28 February), Poland and the Baltic countries, and in the south-east, e.g. Serbia, Montenegro, Romania and Bulgaria. It even snowed in the coastal area of Montenegro, which is the third time within the last 60 years.

Snowfall in the Alps was particularly frequent and high. Germany's highest mountain Zugspitze (approx. 3000 m a.s.l.) had reached a snow depth of 4 m towards the end of the month. The snow lasted until the end of February, even at low elevations in the Alpine region, which was unusual especially for the areas south of the Alps. Road and rail traffic was severely affected in various parts of Austria due to snow and avalanches. On Mount Kredarica in Slovenia, the maximum snow depth reached 487 cm, which has been Slovenia's 2nd highest record in February since observations started. In Ljubljana, the snow cover reached 23 cm on 4 February; there were 10 days with snow cover.

Mountains in Serbia were covered in snow during the whole month, while the lower parts of the country were covered only partly. The maximum snow depth in Serbia was 130 cm (on Kopaonik on 20 February).

Unusual snowfall occurred in Sicily (Italy) on 12-15 February even in lower elevations and particularly in the northern parts of the island, e.g. Palermo.

Intensive snowfall and avalanche conditions persisted in the northern Caucasian mountains. In the South Caucasus countries, a stable snow cover persisted in the high mountains of Georgia with a maximum depth of 135 cm. Azerbaijan had up to 33 cm of snow. There was no snow cover in central and southern Armenia due to the anomalous warmth during that month.

In Jordan, snowfalls occurred in mountainous regions in the southern, western and northern parts of the country, resulting in a temporary snow cover of up to 12 cm.

Significant weather events

February 08-10: Hail storms in s everal parts of Bulgaria and Turkey along with the passage of a cold front. This was an unusual event for that season. The same low pressure system also caused heavy rain and flooding in south-eastern Austria.

February 09-10: A depression named Quinten formed over the Atlantic Ocean and moved along the coasts of the English Channel, causing gusts of up to 148 km/h, which hit northern and western France, disrupting electricity and transport routes. The two main airports of Paris had to be closed for the first time in 34 years. The southern United Kingdom was also affected by heavy rain, sleet and snow, as were Switzerland and Germany where high wind gusts occurred. The large spatial extent and the long duration of the wind gusts especially affected air traffic. Even the Mediterranean area (e.g. Corsica) was affected by high wind gusts.

February 18-20: A violent storm disturbed road traffic due to heavy snowfall in Serbia and Montenegro. The Alps also received abundant snowfall due to that storm. Austria's Sonnblick Mountain received 66 cm of fresh snow. In Bulgaria, rain changed to abundant snow, disrupting electricity in many villages.

February 21-22: Snowstorm in north-western Armenia with gusts up to 80 km/h

February 24: Exceptionally heavy rainfall in Malta led to the cancellation of the National Carnival grand finale. 66 mm of precipitation were measured at Luqa Airport within 2 days (23-25 February).

February 26-28: Severe rainfall was recorded in northern Israel. Rainfalls of 100-180 mm in 48 hours caused flooding and extensive damage to agriculture. This event also affected Turkey (storm and hail) and Cyprus (flooding in a number of places). Salt in Jordan received 100 mm of precipitation in 24 hours.

March

- **Mostly warm, colder in Greenland and in some places in southern Europe and the Middle East**
- **Dry in northern and western Europe, wet in central, eastern and southern Europe**

Atmospheric circulation characteristics

The strong frontal zone over the North Atlantic persisted into March and moved northwards. Strong low pressure influence as well as mild and moist air affected particularly the northern parts of the North Atlantic, the North Sea and, on some occasions, central, eastern and south-eastern Europe. Mild air masses frequently penetrated Scandinavia. Particularly north-eastern Scandinavia also was under high pressure influence from the east. Greenland continued to be under cold and dry polar air.

Western and most of south-western Europe were mainly under strong high pressure influence, with warmer-than-normal and dry air masses.

The eastern parts of the Region were continuously affected by warm and moist subtropical air masses from the south while especially the eastern Mediterranean experienced much low pressure activity.

Temperature

In the north, only most of Greenland and western Iceland were colder than normal.

Most of the Region, however, was up to +2°C warmer than normal (Fig. 3.1). Svalbard in northern Norway even had monthly mean anomalies of +3°C. Southern Sweden was especially warm in early March, but wintry temperatures struck back later in the month.

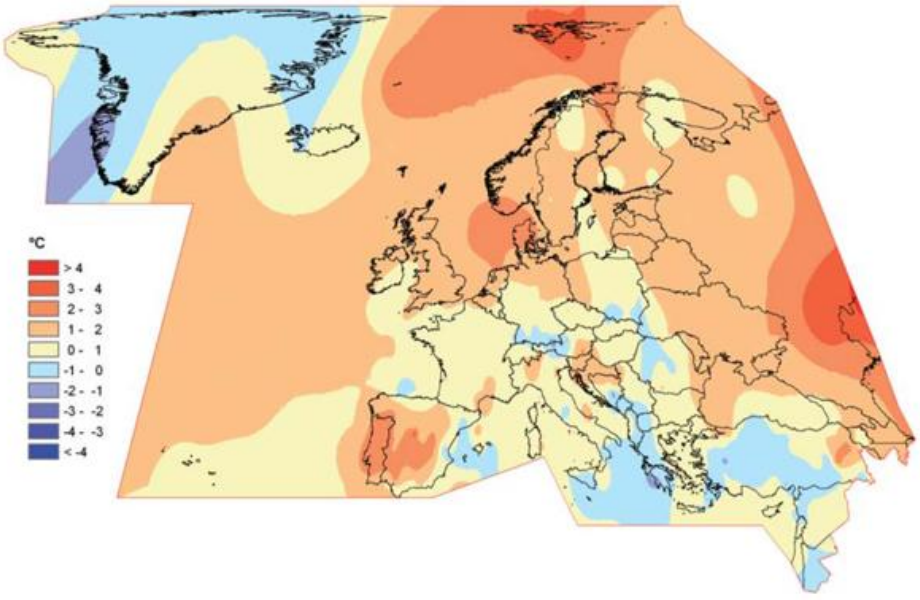

Fig. 3.1: *Monthly mean temperature anomalies in March 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

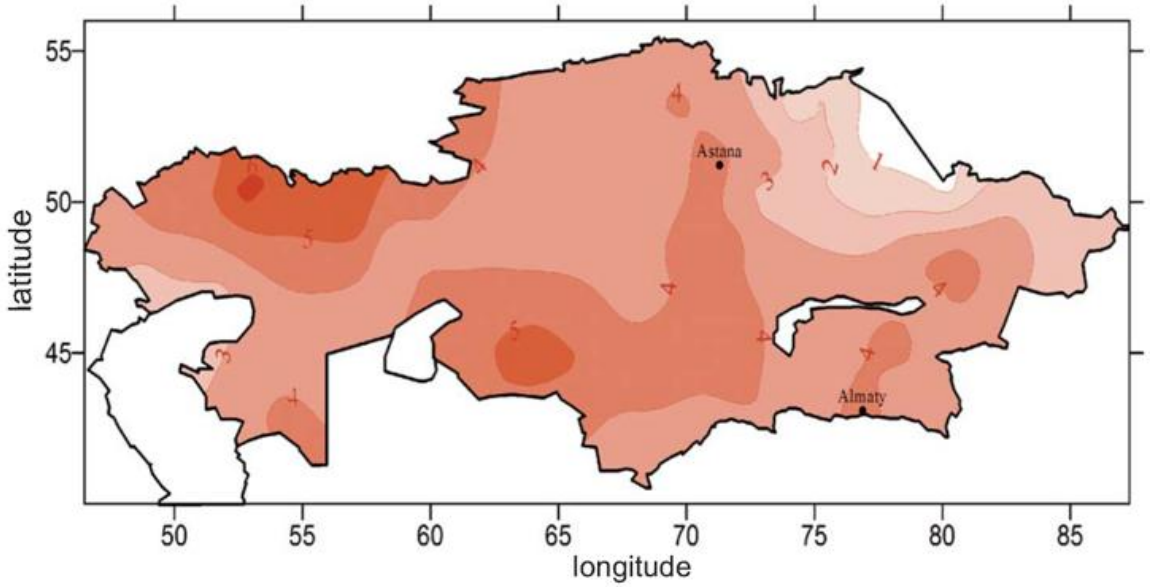

Fig. 3.2: *Monthly mean temperature anomalies (contours, °C) in March 2009 (reference period 1961-1990) in Kazakhstan*
Source: Kazhydromet, Kazakhstan

The eastern parts of the Region, too, were very warm in March. Monthly mean anomalies were highest over western Kazakhstan (+4°C, Fig. 3.2). Daily maxima were quite high during the month, 23-25°C in southern valleys of Armenia and locally more than 28°C in Turkey (new local record for March). In early March, new record-breaking maxima of daily air temperature were also recorded in southern European Russia (Krasnodar territory). In Belarus, daily temperatures above 0°C were measured already very early in the month, around 10-20 days earlier than usual.

Most of the North Atlantic was +1-2°C warmer than normal.

Some places in Iberia were over +2°C warmer than normal (e.g. Madrid and Lisbon). Maximum temperatures in southern Spain reached nearly 30°C.

Most of western, central and south-eastern Europe was only slightly warmer than normal (< +1°C). The warming took place especially in the lowlands, but not in the mountains. The number of freezing days in March in Serbia was lower than normal in the lowlands, but higher than normal in the mountains. Hoarfrost was reported in most parts of Romania during the last ten days of the month.

Several places in the southern half of Europe were slightly colder than normal, especially in the Alps, north-eastern France and southern Germany, parts of the Balkan Peninsula, the central Mediterranean as well as the Baleares, Malta, Turkey, Cyprus, and the Middle East.

Precipitation

March was very dry in most of northern and western Europe including Portugal and western Spain, but wet in many central, eastern and southern parts of the continent (Fig. 3.3).

A wet area in the region was to be found in the Baltic countries. Here, Estonia recorded 150% of the monthly normal precipitation, including some freezing rain.

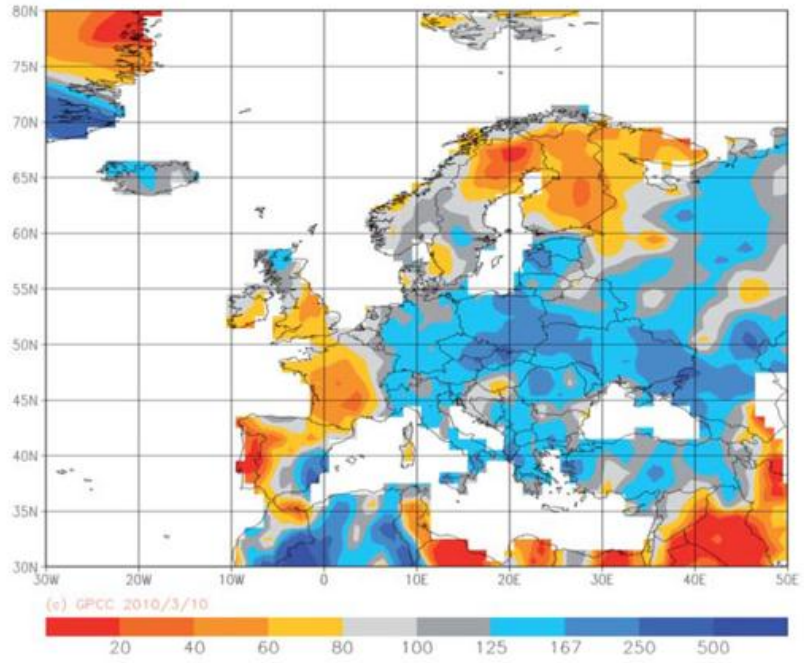

Fig. 3.3: *Monthly precipitation amounts for March 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

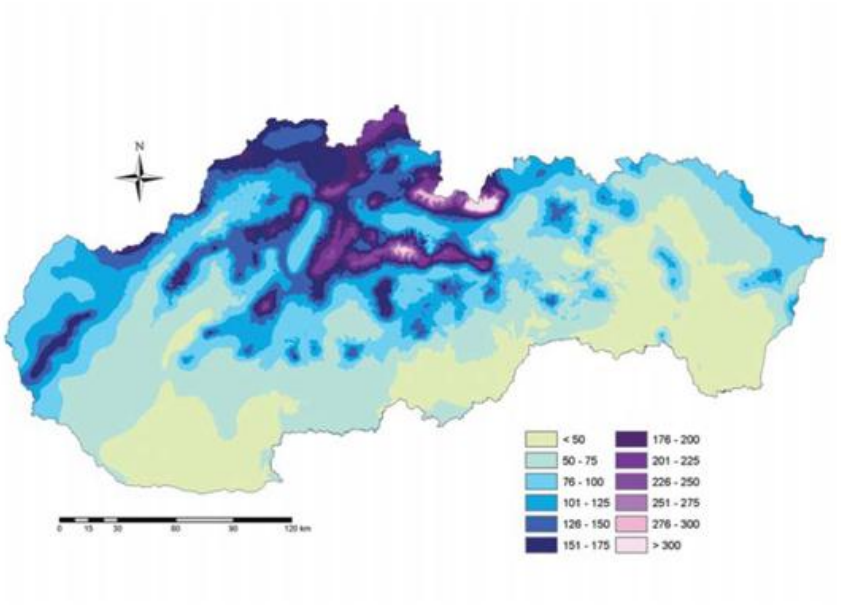

Fig. 3.4: *Monthly precipitation amounts for March 2009 in mm in Slovakia*
Source: Slovak Hydrometeorological Institute, Slovakia

March was exceptionally wet in eastern central and large parts of eastern, south-eastern and southern Europe (except parts of the north-western Balkan Peninsula), Cyprus and Turkey. Over large areas, the double amount of normal March rainfall was exceeded; locally it was more than 300%. In the more southern areas, precipitation was accompanied by thunder and local hail.

The eastern parts of Austria received even up to 400% of the normal, making March 2009 the second rainiest March on record since the start of measurements in 1820. Intense rainfalls caused regional flooding, e.g. in Slovakia and Slovenia; monthly totals exceeded 200 mm in several places, especially in the mountains (Fig. 3.4).

Portugal was extremely dry; most of the country received less than 20% of the normal monthly precipitation.

Snow

March 2009 was characterised by widespread snowfalls in many parts of Europe.

In the north, snow seriously affected traffic conditions in Iceland, especially in northern parts late in the month, and there was a persistent danger of avalanches.

A temporary snow cover of about 8 cm formed on the south coast of England, severely affecting roads and rails.

In the Baltic countries, up to 46 cm of snow were recorded in Latvia. Northern Lithuania saw heavy snowfall at the beginning of March, with the resulting snow cover persisting throughout the whole month. Eastern Germany and Poland had a snow cover of up to around 20 cm in the lowlands.

Abundant snow fell on mountains in Germany and in the Alps. On the Wendelstein mountain (over 1800 m a.s.l.) a snow depth maximum of 350 cm was reached, which has been the highest March snow depth since 1952. The snow cover on the Zugspitze in the Alps (approx. 3000 m a.s.l.) has exceeded 500 cm for the first time since 2002. Lower altitudes at the alpine north side also received several snowfalls. The southern slope of the Alps had unusually high snow depths, partly more than 3 m in high valleys.

Kredarica mountain in Slovenia reported a maximum snow depth of 560 cm, which has been the third deepest snow cover in March since observations began. Mountains in Serbia were snow covered during the whole month, with the maximum depth of 142 cm recorded on Kopaonik on 23 March. Other parts of Serbia temporarily saw some snow in the first and third ten days of the month. In Romania, it snowed in the mountain area during the first days of the month.

Northern Caucasian mountains continued to receive snowfall followed by avalanches throughout the month. In the South Caucasus region, a snow cover persisted in high mountains in Georgia during the whole month. In Azerbaijan, however, snow melting due to higher-than-normal temperatures caused several rivers to flood.

March even saw snowfalls in Jordan in the Middle East, with the snow cover reaching up to 6 cm on hills.

Heavy snow showers were also seen in Spain and Portugal.

Significant weather events

March 01: A series of avalanches affected some districts in southern Austria (Styria). Up to 900 people were cut off from the surroundings for 2 days.

March 04-06: A heavy thunderstorm developed over the western and central Mediterranean with gusts up to hurricane force, tornadoes, heavy rain, snowfall in the southern Alps and high seas due to a cut-off cyclone and caused damage to crops and roads in Sicily. Gusts up to 85 km/h at Luqa in Malta on 4 March; damaged a protective shelter being installed over the prehistoric Mnajdra Temples. Saharan

dust was observed over most parts of Greece and the western coast of Turkey, and there was a storm in Turkey.

March 25-28: A Tornado caused damage in Nea Manolada, Peloponnese, south-west Greece on 25 March (Fig. 3.5). Normally, tornadoes in Greece are rare. Strong winds were reported from Bulgaria: the port of Varna was temporarily closed. Storm with hail occurred in Turkey and Cyprus. Another tornado affected the area of Larnaca in Cyprus on 26 March.



Fig. 3.5: *Damage after tornado passage in Manolada, north-west Peloponnese, Greece on 25 March 2009*
Source: Hellenic National Meteorological Service, Greece

March 29-30: A very strong warm upper air south-west current caused wind gusts above 100 km/h in the higher mountainous region of northern Montenegro, resulting in damage to infrastructure.

April

- **Much warmer in Central Europe, colder in the Arctic and eastern Europe**
- **Extremely dry particularly in the eastern half of Europe**

Atmospheric circulation characteristics

The frontal zone over the North Atlantic persisted and was still stronger than normal; it moved further south and mainly affected the western parts of Europe, with some troughs extending far into the south.

The Arctic region was under dry and colder-than-normal polar air.

Most of the other parts of Europe (except the easternmost and westernmost parts) were dominated by a strong high pressure zone with a very dry air mass, stretching from the Middle East very far into the north and causing a strong and extended warming.

Low pressure activity was dominating over the western and central Mediterranean due to a dominating trough which extended from the eastern North Atlantic south-eastwards.

Eastern Europe and the Caucasian region came under the east flank of the high pressure area over central Europe and were influenced by cold and dry air masses from the north.

Temperature

April was warmer than normal in most of Europe including the Mediterranean and the North Atlantic (Fig. 4.1). But the Arctic, European Russia, west Kazakhstan and the eastern Ukraine, the Caucasian region, Turkey, Bulgaria, Malta and places in Iberia were colder than normal.

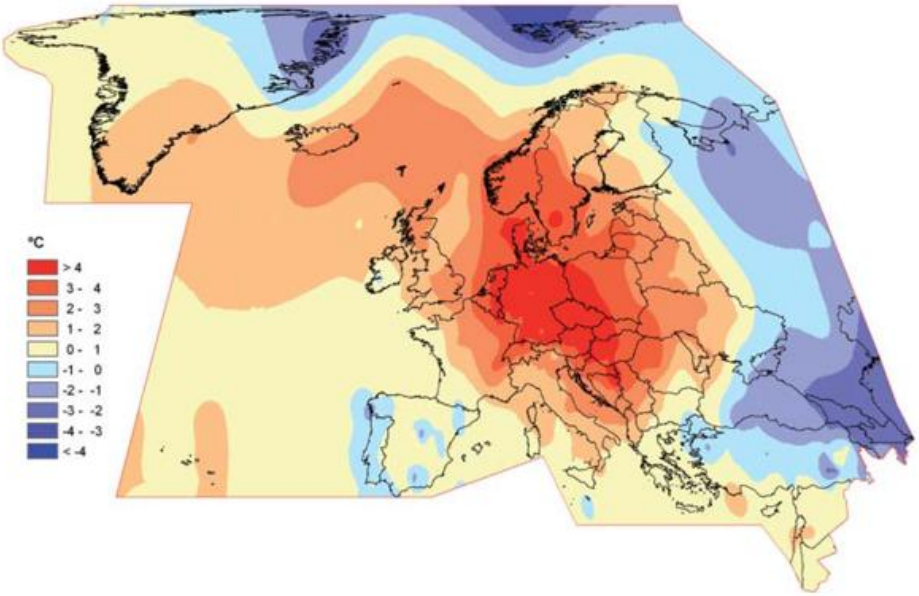

Fig. 4.1: *Monthly mean temperature anomalies in April 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

Monthly mean anomalies were below -2°C in eastern Greenland, and below -4°C in places on Svalbard. April was the only month of the year with below-average temperatures on Svalbard. On 22 April, Longyearbyen recorded its coldest mean temperature in April (-19.5°C) since 1993. At Svalbard Airport, a daily minimum of -28.6°C was measured on 6 April.

It was much warmer than normal on the European continent. April was exceptionally warm in northern Europe. In Norway, it was the 3rd mildest April since 1900 (more than +5°C warmer than normal), with several stations in the south setting new monthly mean temperature records. At 9.4°C (which is +3.7°C above normal), Denmark noted a new mean temperature record for the country. In Sweden, April average temperatures were generally +1 to +4°C higher than normal. For the first time ever since records began in 1860, some areas had monthly mean temperatures above 10°C. The April mean temperature in Gothenburg was 10.4°C, thus beating

by far any former nationwide records. The Baltic countries were also considerably warmer than normal (around +2°C, in Lithuania even +3°C). Maximum temperatures in Lithuania reached 17-21°C already on 5 April, and new records were set in some places.

England and Scotland saw their third warmest April on record since 1914, with anomalies around +2°C.

Central Europe was also extremely warm, with monthly anomalies of up to more than +5°C in places in Germany (Fig. 4.2), Austria and the Czech Republic. In most of central Europe, the mean temperatures for April ranged between 10 and 15°C, compared to normal values of 5 to 10°C. De Bilt in the Netherlands had its second warmest April on record (1706-2009), with a monthly average of 12.2°C and only April 2007 being warmer. In April, several new national records were set in Hungary (mean anomaly of +4.2°C, 1971-2000 reference) and Germany

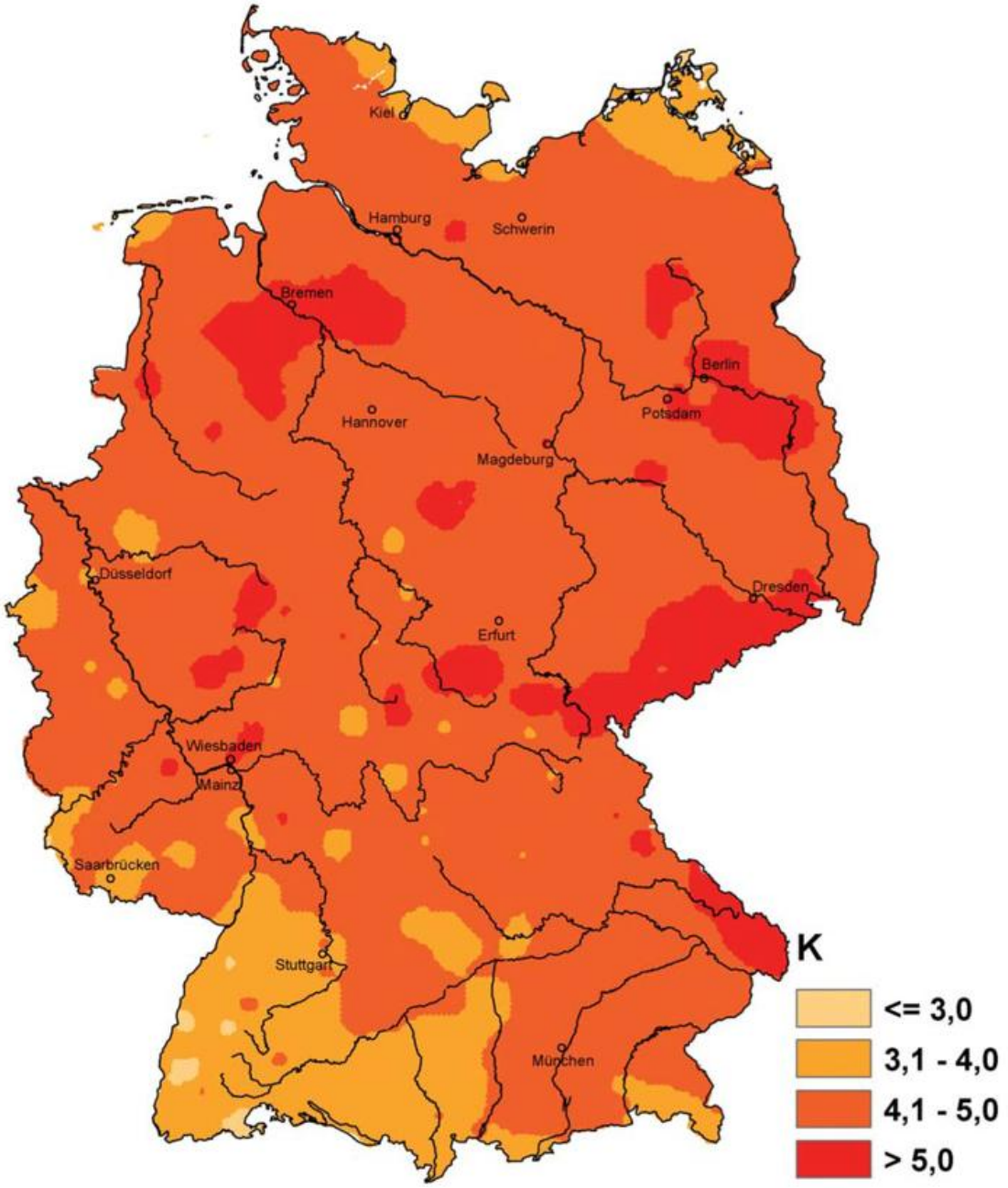

Fig. 4.2: *Monthly mean temperature anomalies in April 2009 (reference period 1961-1990) in Germany*
Source: Deutscher Wetterdienst, Germany

(+4.5°C, 1961-1990, see Fig. 4.2). Daily maxima in Germany went up to 27°C on several occasions. The monthly mean daily maximum in Berlin reached 20.1°C, which is +7°C more than normal. Temperatures in flat water areas near the German coasts rose to 10-14°C. In some parts of eastern Austria, it was the warmest April in more than 200 years.

It was also particularly warm in Slovenia, Serbia and Croatia (anomalies up to more than +4°C); even the number of freezing days in the mountains was much lower than normal. The highest temperature in Serbia in April was 26.2°C. During a warm spell on 17-19 April, maxima in Greece locally exceeded 25°C (in Athens, e.g., the normal is around 20°C).

In contrast to many other states in Europe, the eastern countries of the Region experienced a cold and frosty April. A 10- to 20-day frost period occurred in particular in eastern parts of the Ukraine, producing air temperature minima between -5 and -12°C which caused damage to crops and fruit buds. The Caucasus region was much colder than normal, with anomalies below -2°C. Armenia experienced a cold spell on 10-14 April with the result that blossoming fruit trees were damaged. Southern European Russia was also affected by extended damage to agriculture due to frost from -6 to -8°C.

Precipitation

April was very dry in most of the Region and extremely dry in most of the eastern half of Europe and in the Middle East (Fig. 4.3). Only a few parts of the Region received more than the monthly normal, locally twice as much, among which were southern Greenland, Iceland, northern Norway, Ireland, southern and western France, the southern slopes of the Alps in Switzerland, parts of Slovenia, most of Italy, Monaco and several locations in Turkey and southern Armenia.

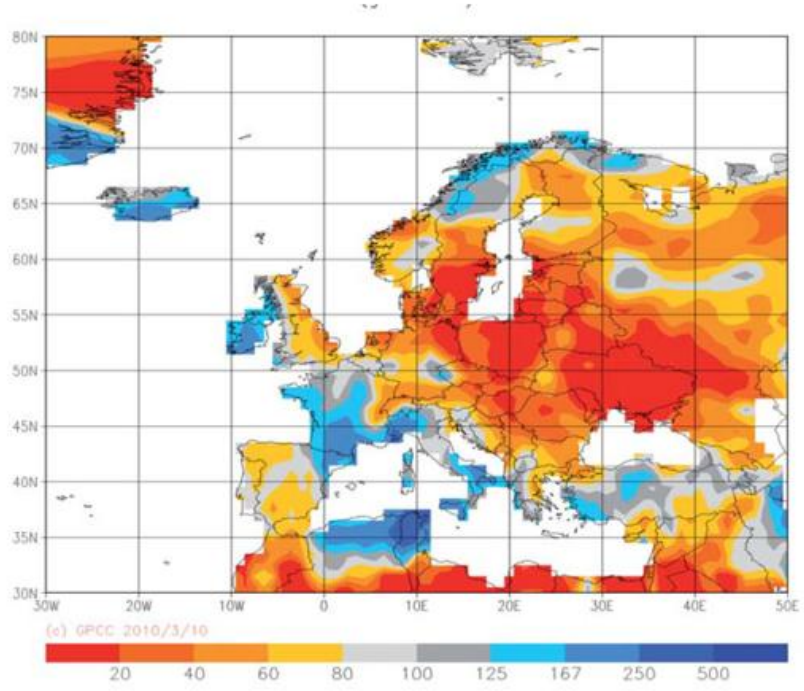

Fig. 4.3: *Monthly precipitation amounts for April 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

It was an especially wet month for Iceland. A station in south-east Iceland received 523.7 mm during the month, thus setting a new local April record.

Most of northern Europe, however, was very dry, in particular the southern areas of that region. Parts of southern Norway registered the driest April in more than 30 years. April was also particularly dry in south-eastern Sweden (in places the driest since 1974), where only less than 5% of the 1961-1990 average amount of rain was recorded. Locally, no measurable precipitation at all was reported; in some parts of Sweden the last month without any measurable precipitation had been August 2002. Denmark, too, was very dry, as was most of the United Kingdom, in particular its eastern parts.

The region around the southern Baltic Sea and large areas south-east of it received less than 20% of the normal monthly precipitation total, partly even less than 10%. In Latvia, it was the second driest April ever recorded, with only 7 mm on average. Similar values were recorded in Lithuania (8 mm and only 3 days of rainfall during the whole month).

Soils were very dry due to the missing rain. In eastern Germany, the uppermost 20 cm of the soil were very dry. However, there were still large soil water resources in lower layers of ground due to the wet March.

Some north-eastern parts of Austria recorded no more than 1 mm of precipitation during the whole month, some places in Slovakia even less. Hungary recorded 23% of its average April rainfall (1971-2000 reference), while Poland, north-eastern Croatia, Montenegro, the Ukraine and Russia experienced rainfall in the 10th percentile of their precipitation distribution (Fig. 4.4). The major part of the Ukraine, including Odessa was rainless during the whole month. Kiev received no more than 2 mm. In Moldova, 11.5 mm (26% of normal) of rainfall was recorded, making April the second driest in 60 years behind April 1974 (9 mm).

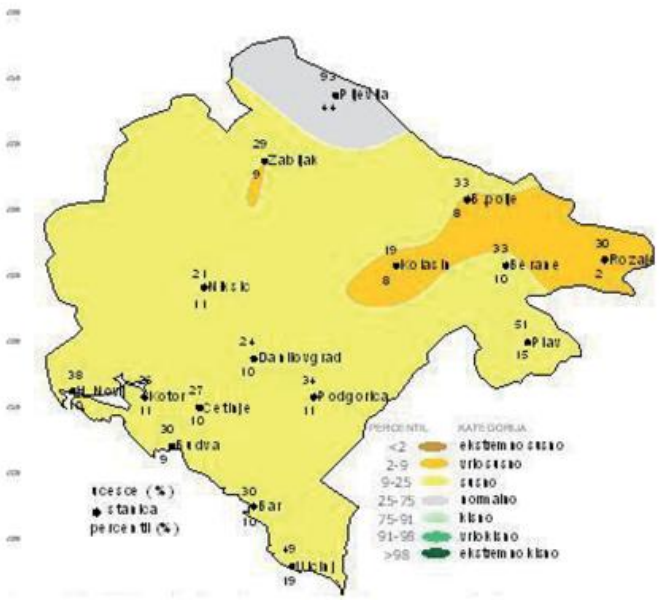

Fig. 4.4: *Monthly precipitation amounts for April 2009 in per cent (upper numbers) and in percentiles (lower numbers) of the normal 1961-1990 in Montenegro*
Source: Hydrological and Meteorological Service of Montenegro

In the south-west, Iberia was dry except the north-eastern areas. Large parts of the peninsula received less than 80% of the normal monthly precipitation.

Dryness in many parts of Europe was one reason for the increased number of forest fires.

The western Mediterranean, however, saw a wet month. Lots of rain fell in southern France, Monaco and over large areas of northern and southern Italy. Some regions in northern Italy registered the second wettest April of past 75 years or even more, resulting in flooding of the Po River banks. In Monaco, it was the second wettest April since at least 1969 with a monthly total of 193.7 mm, only slightly behind April 1989 (194.7 mm).

Snow

Due to the strong and extended warming, the area covered by snow decreased considerably compared to the preceding months, even in Scandinavia and the Alps, although much snow was still left.

A snow cover of more than 50 cm continued to persist in Lapland until the beginning of the month. Tromsø in northern Norway had even more than 100 cm.

The Alps still had snowfall down to elevations of about 1100 m. Southern Germany temporarily recorded more than 100 cm of snow at elevations around 1500 m. On 5 April, three skiers were buried beneath 4 m of snow in an avalanche in the high alpine region of eastern Tyrol in Austria. A snow cover also persisted in the mountains of Slovenia.

In Serbia, the Kopaonik Mountain reported 9 days with snow cover and a maximum depth of 66 cm on 1 April. Romania had snow on high mountains.

Large parts of European Russia were also still covered with snow (14 cm in Moscow on 3 April), although snow had already started to melt before.

In the South Caucasus region, a snow cover was still found in western Georgia on the mountains (snow depth of up to 160 cm) and in Azerbaijan (up to 16 cm). Heavy snowfall was reported in north-eastern Armenia on 23 April.

Significant weather events

April 02-03: Flooding on Kurmukchay River in Azerbaijan after heavy rainfall resulting from a cold front passage.

April 14-15: Sharav event (hot and dry spell due to hot winds from the Arabian Desert) in Israel with temperatures up to 35-37°C, gusts up to 93 km/h, sandstorms, severe haze. Suspended dust in Cyprus, causing reduced visibility.

April 17-18: Low Quirin crossed central Europe and caused heavy rain, in particular in central and southern Germany. Locally, there was more rain during these 2 days than is normally recorded for the whole month. At the same time, many other parts of central Europe were very dry. Heavy rain was also recorded in Switzerland, even south of the main chain in the Ticino. In central European Russia, wind gusts up to 70-90 km/h were measured.

April 21-23: Winds up to hurricane force and local heavy rain in Bulgaria, hail in Turkey.

April 30: Severe flooding of the Po River banks after days of intense precipitation.

May

- **Mostly warmer than normal, especially in the Arctic and in southern Europe**
- **Mostly wet in the north, dry in the south**

Atmospheric circulation characteristics

The Atlantic frontal zone moved northwards again. Atlantic low pressure systems mainly crossed the northern half of Europe and much warm air flowed to these parts and to the Arctic. A high pressure system formed over Scandinavia, but persisted only temporarily.

Most of the southern half of the Region was dominated by high pressure influence, causing again a strong warming in these areas. Within the warm air, however, thunderstorms occurred occasionally, sometimes growing to severe events.

The eastern parts of the Region were on the flank of the high pressure zone so that colder air masses occasionally advanced to these areas.

Temperature

May was another warmer-than-normal month in most of Europe and in the Arctic (Fig. 5.1), especially at the end of the month. Only some areas in eastern Poland, eastern Europe, the Middle East and over the North Atlantic were slightly colder than normal.

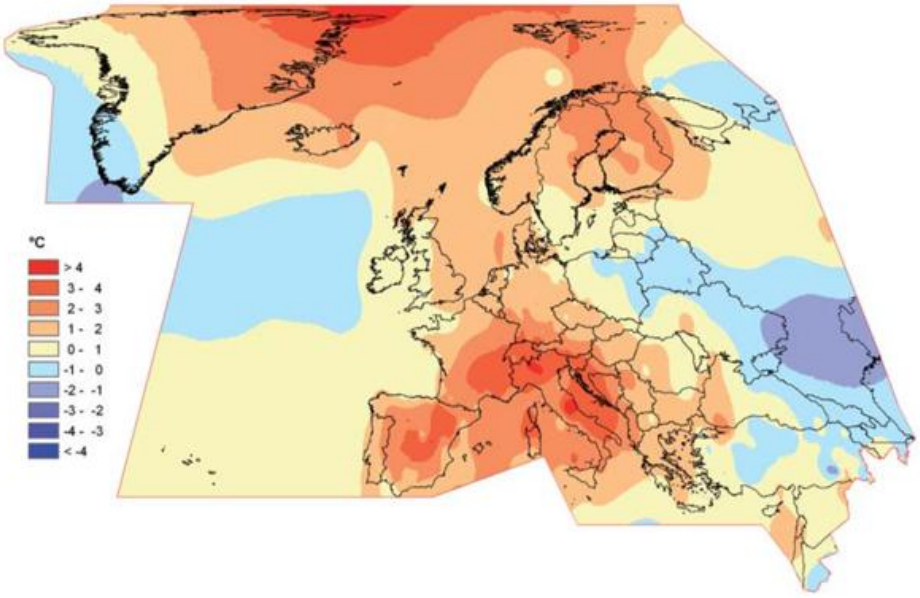

Fig. 5.1: *Monthly mean temperature anomalies in May 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

The Arctic region warmed considerably compared to the preceding cold April. Anomalies reached up to more than +4°C in north-east Greenland. On Jan Mayen, this May was the warmest ever registered.

Large areas of the Nordic countries were more than +1°C warmer than normal, northern parts even more than +2°C. In central Scandinavia, a maximum temperature of 25°C were exceeded at the end of the month.

Many parts of western and central Europe were also more than +1°C warmer than normal. It was particularly warm in southern and south-eastern Europe. Places in Iberia, southern France, the Alpine region, Slovenia, western Croatia and Italy were more than +3°C warmer (in some places in Italy even more than +4°C). In Monaco, it was the warmest May since 1992 with a monthly average of 19.5°C (+2.6°C compared to the 1969-1998 reference).

Several countries in central Europe, the alpine region and in southern and south-eastern Europe widely reported maximum temperatures above 30°C, especially at the end of the month. At several locations, records were broken, which also led to high monthly mean temperatures. The new absolute May record in Luxembourg was at 30.4°C. It was the 2nd warmest May since 1864 in Switzerland and the 3rd warmest May in the last two centuries in Italy, mainly due to a heat wave on 22-27 May. The peak temperatures in Switzerland and Italy were 35.1°C in Sion and 36.8°C at a station in Rome, respectively. Due to heat stress, this heat wave in Italy affected agriculture during wheat grain filling and led to a reduction of wheat yield by 20-30%. Malta was also affected by this heat wave.

Mountain stations, too, reported increased temperatures. The maximum air temperature recorded at the Slovenian mountain station of Kredarica reached 14.4°C, which is the highest temperature ever measured there. Some places in Slovenia saw their warmest or second warmest May ever recorded.

Minimum temperatures also were quite high, especially in the south. 10 stations in Portugal reported tropical nights, partly setting new local records.

Jordan had a maximum temperature of 45°C in the Jordan Valley already on 18 May, which is nearly +9°C more than the typical maximum value for this time of year.

In eastern Europe, May continued the cold spell from April. The northern parts of eastern Europe, however, had near normal monthly mean temperatures due to high maxima at the end of the month. This was also the case in other parts of Europe. Lithuania reached 25°C at the end of May, as did Scandinavia which, however, also saw morning frosts during the active vegetation period in more than one third of the country. It was colder than normal in southern parts of eastern Europe and in parts of the Middle East. Southern European Russia and western Kazakhstan saw monthly mean anomalies below -1°C. Many areas in European Russia still experienced frost even in the last ten days of the month.

Precipitation

Most of the northern half of Europe was wetter than normal, although a few very dry areas were also to be found, for example, in the Baltic countries and north of it (Fig. 5.2). May was the second wettest on record in northern Norway, resulting in a nation-wide mean rainfall value that was 165%, locally even more than 200%, of its 1961-90 average. Several places in Russia and western Kazakhstan also received more than twice the normal.

Frequent, locally heavy thunderstorms occurred especially in northern central Europe, occasionally also in southern Germany, Austria and Slovenia. Partly, they were accompanied by hail. Thunderstorm activity was very high even in the eastern Carpathians in Romania and in Bulgaria. Frequent hailstorms were also recorded during the second half of the month in north-western Armenia. Very high precipitation amounts (twice the normal) due to local thunderstorms were to be found locally along the southern Turkish coast. Cyprus received 29 mm of precipitation, which is about 150% of the normal.

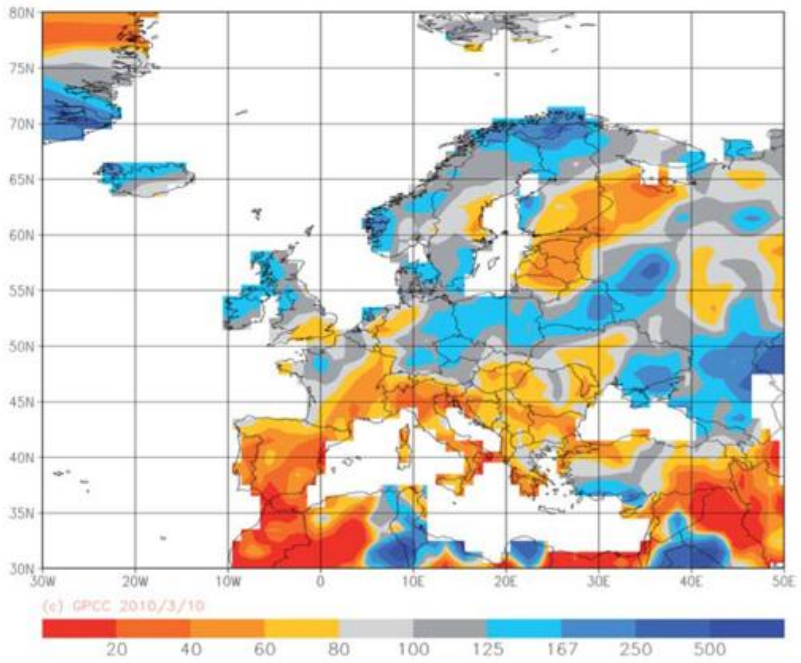

Fig. 5.2: *Monthly precipitation amounts for May 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Apart from these thunderstorms, the southern half of the Region was mainly very dry in May. Many places received less than 60% of the normal monthly precipitation. It was especially dry (40% of normal, locally less than 25%) in large parts of Iberia, with some stations in north-eastern Spain recording new historical minima (as low as 1.1 mm) in up to 130 years. Many places in western Croatia had less than 10% of its normal precipitation. Athens in Greece reported no measurable precipitation at all. In Armenia, May normally is one of the wettest months of the year; in 2009, however, there was a shortage of precipitation during the wet season.

Snow

The high temperatures in the alpine regions, together with a high sunshine duration, caused rapid snowmelt. At altitudes between 1500 and 2500 m, the snow depth partly decreased down to 250 cm. Kredarica in Slovenia still had 520 cm of snow. In Montenegro, it still snowed at the end of the month, covering northern mountains with a few centimetres of snow. In Romania, snow cover continued to exist on mountains above 1400 m.

Significant weather events

May 04-05: Sharav event in Israel with temperatures up to 39-41°C in the Jordan Valley and gusts up to 100 km/h in mountain areas. Storm with hail in Turkey.

May 09: Hail in the mountains of Cyprus, causing damage to fruit trees.

May 11: Heavy rain in southern European Russia (Krasnodar region): 107 mm of precipitation in 6 hours.

May 12: Heavy thunderstorm in south-western Germany and near the northern slopes of the Alps, with a hail cover up to 15 cm in the Black Forest.

May 18-22: Flooding in Lower Austria due to heavy rain during cold front passage, road traffic disrupted, gas pipelines washed out. Hailstorms in various parts of Austria, with up to hen's egg-sized stones, crop losses, agricultural damage in the value of around 6 billion Euros; ice cover of 20 cm near Graz. Severe thunderstorms in Slovenia, with locally up to more than 50 mm of rain in 10 minutes and strong gusts up to 113 km/h at the airport of Pécs in Hungary.

May 20: Tornado in Nicosia (Cyprus) at noon, with uprooted trees and damaged house roofs.

May 25-26: After temperatures of 32-33°C in parts of France, Switzerland and western Germany, a cold front passage caused severe thunderstorms with hailstones of up to 7 cm and heavy rain about 50 mm in 24 hours, gusts > 100 km/h. 65 mm of daily precipitation were measured near Lake Constance. The city of Konstanz in south Germany was covered with at least 10 cm of hail. The Netherlands, Denmark, Austria, Slovenia and Italy were affected by heavy thunderstorms. Road and rail transport was disrupted by fallen trees and branches.

May 24-29: Frequent hailstorms in north-western Armenia with hailstones of 20-25 mm diameter.

May 28-30: High wind speeds on mountains in Sweden. Mean wind speed up to 122 km/h, gusts up to 176 km/h (both are new records for May).

May 29-30: Southern European Russia (Astrakhan region) was affected by a quite intense low pressure system and received 75-141 mm of precipitation in 4-5 hours. More than 3000 ha of green crops were flooded.

May 30: Heavy thunderstorm spoiled the yearly rose festival in Kazanluk, Bulgaria (Fig. 5.3), with 34 mm of rain, wind gusts of 90 km/h and hailstones as big as walnuts.



Fig. 5.3: *Emergency in Kazanluk (Bulgaria) on 30 May 2009 after heavy rain and a strong hailstorm Source: BGNES, provided by the National Institute of Meteorology and Hydrology, Bulgaria*

June

- **Warmer in southern Europe and the Middle East, cooler in northern and parts of central Europe**
- **Higher than normal precipitation mainly in Italy, the central Mediterranean, the Balkan Peninsula, eastern central Europe and northern central Russia, dry in the western and eastern Mediterranean and southern Russia**

Atmospheric circulation characteristics

During the first ten days of the month, a large low pressure complex affected most of Europe. Arctic air advanced southwards, causing a noticeable cold spell particularly in northern and central Europe.

In the second ten days, low pressure systems embedded in a mainly zonal flow crossed Europe, in particular central Europe.

During the last third of the month, a strong meridional circulation pattern formed. While western and south-western Europe, the western Mediterranean and the eastern North Atlantic were mostly in a warm and dry airflow from the south, cold polar air, rainfall and thunderstorms affected most of north-eastern and central Europe. A high pressure system over Scandinavia caused a warm and sunny spell there at the end of the month.

Due to frequent cut-off lows, high thunderstorm activity occurred over the central Mediterranean.

The Russian high was stronger than normal and a southerly airflow carried warm and dry air to the eastern Mediterranean and eastern Europe.

Temperature

Most of northern and central Europe, especially around the Baltic Sea, was colder than normal. The anomalies were locally below -1°C, as they were in eastern Greenland and parts of the central North Atlantic (Fig. 6.1). In Sweden, especially the first ten days of June were the coldest for this time of the year in locally more than 50 years. Right at the beginning of the month, Stockholm experienced a sharp temperature drop from 26°C on 31 May to 10°C on 2 June as a result of a Baltic sea storm. It was the first colder-than-normal month in Denmark since October 2007. Maximum temperatures on 6 June remained below 10°C in Germany even in the lowlands; in some parts this was the lowest temperature on record for this time of the year. Lithuania recorded an unusually cold night on 17-18 June, with morning frosts down to -2°C on the ground in the western and northern parts of the country. However, the end of June was warm in parts of northern and central Europe, with maxima of up to 26°C in Iceland, 29°C in Lapland and central Finland, over 30°C in some valleys of Norway, Sweden and the southern parts of Germany.

Based on monthly average, June was warmer than normal in western, southern and eastern Europe. The highest monthly mean anomalies were to be found in the southern parts, particularly in Spain, southern France, northern Italy, the eastern Ukraine, southern European Russia, western Kazakhstan, Cyprus and Israel (+2°C or more, in some places in Spain, the eastern Ukraine and west Kazakhstan even more than +3°C).

Portugal reported two heat waves, one at the beginning of the month, the other from 10-22 June, with daily maxima of up to more than 40°C.

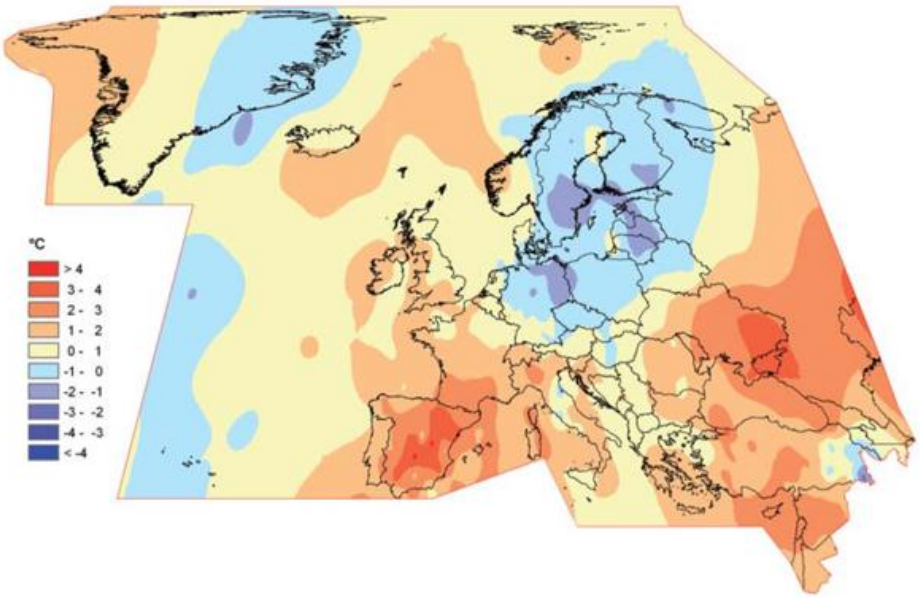

Fig. 6.1: *Monthly mean temperature anomalies in June 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

Serbia, southern Romania and Bulgaria, Greece, western Turkey, Georgia, Azerbaijan and European Russia saw daily maxima (partly record-breaking) of up to 35° to 40°C. Especially in southern European Russia, the hot weather was accompanied by soil drought and hot winds.

June 2008 and 2009 were the two warmest Junes in the last 40-50 years in Israel, due to several Sharav (hot winds from the Arabian Desert) events. One extreme Sharav event at the end of the month caused temperatures of up to 44-46°C in the Jordan Valley and 38-40°C in the coastal plain. Sharav events normally occur in the inner parts of the country, but are very unusual in summer in the coastal plain (during the last 40-50 years there have occurred only three such events, in 1979, 1995 and 2009).

Precipitation

Most of the Region saw a wetter than normal June (Fig. 6.2). Particularly high precipitation totals of more than twice the monthly normal were recorded over large areas in eastern central and eastern Europe, but also over the central Mediterranean and in Portugal. Monthly precipitation records were broken locally.

In the north, the most affected countries were eastern Denmark (Sjælland Island, due to a 2-day heavy rain event), Poland, Belarus, the Baltic countries and parts of northern Russia. In Belarus, Minsk reported a new record of monthly precipitation in June (187 mm). In the Alps, places in north-eastern Austria even received more than 300% of the normal; some were the wettest on record since the 19th century. Much precipitation also occurred further to the south, i.e. in some places in Slovenia, in southern Italy and the south-western Balkan Peninsula. Precipitation totals over the Adriatic Sea partly reached four times the normal or more. With a monthly total of 162 mm, which is more than 10 times the normal, it also was a very wet June in Messina on Sicily. Locally, heavy rainfall was also reported from Armenia, with daily totals of more than 60 mm (which was about double the monthly normal).

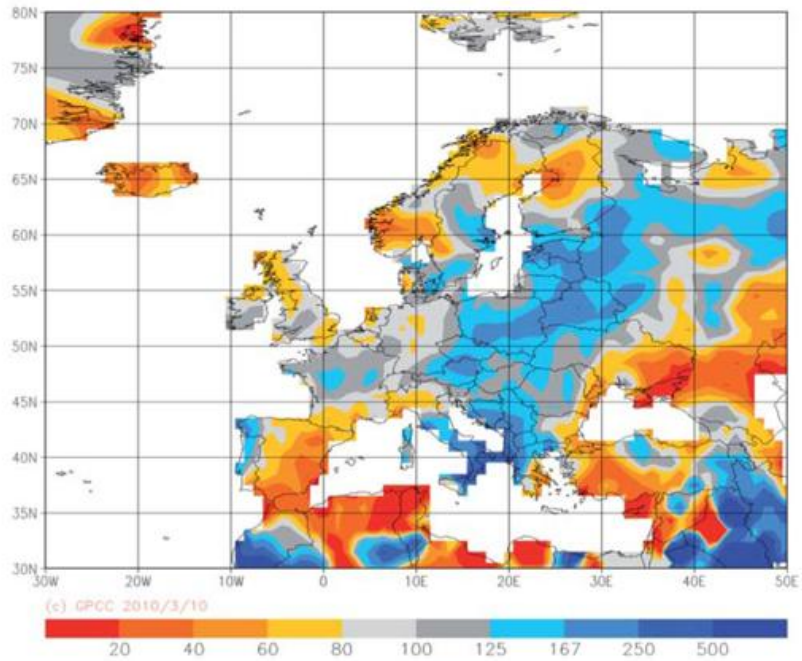

Fig. 6.2: *Monthly precipitation amounts for June 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

There were, however, also some large very dry areas, especially in northern Europe and in eastern Iberia, southern France, Monaco (8 mm), northern Italy, southern Greece, western Turkey, Cyprus, the Middle East, the eastern Ukraine, west Kazakhstan and southern European Russia. Many places there received less than 60% of the normal precipitation, some even much less. Locations in west Kazakhstan did not have any rain at all in that month. Both Greek stations Athens and Heraklion (Crete) were also without any rain at all. Luqa Airport in Malta recorded 1.4 mm (the normal is 3.2 mm).

June showed a remarkable dipole pattern over Iberia. While the eastern half of the Peninsula, particularly the Mediterranean coast, was dry, it was extraordinarily wet in Galicia and much of Portugal. Monthly totals exceeded 150% of the normal along the Atlantic coast. In Lisbon, they even reached 59 mm or nearly 300%, because June in general is a relatively dry month and hence moderate precipitation can result in a large percentage anomaly.

Snow

Heavy snow showers were recorded from the Kola Peninsula in northern European Russia on 8 June.

A depth of 70 cm fresh snow was measured on Germany's highest mountain, the Zugspitze (approx. 3000 m a.s.l.), in the Alps on 23 June due to depression Qinton (see below).

Kredarica in Slovenia had a maximum snow depth of 210 cm at the beginning of the month.

Significant weather events

June 02: Heavy thunderstorm in Romania. Damage to roofs, trees and power lines, especially in Bucharest. Hailstorms (hailstones of fist size) and tornadoes in Bulgaria

June 04: Large hail (50-70 mm) in southern European Russia (Krasnodar region)

June 06-07: A hailstorm with a small tornado crossed the county of Suffolk in the United Kingdom. 93 mm of rain in Exeter within 13 hours on 06 July. Tornadoes were also seen in western and northern Germany. Many houses in a quarter of Cologne were damaged.

June 06: Severe thunderstorms with record-breaking precipitation, partly with hail in Switzerland. Locarno registered more than 100 mm within 3 hours. A tornado hit several towns in north-eastern Italy.

June 10: Heavy downpours in the Sheffield area of the United Kingdom blocked roads and a railway line; 48 mm of rain fell in 24 hours.

June 11-12: Sjælland in the eastern part of Denmark received more than twice its monthly normal rain within these two days. One station on Sjaelland recorded 160 mm during that event.

June 11: Heavy rain in Taktaharkány, Hungary with a daily total of 97 mm. Tornado near Adács, Hungary.

June 13: Hailstorm with walnut-sized hail affected villages in the mountains of Cyprus, causing damage to fruit trees, vineyards and other agricultural products.

June 14-15: Severe hailstorm in Armenia with hailstones up to 30 mm in diameter. Crop damaged, trees and roofs broken, people injured.

June 16: Severe thunderstorm with heavy rain in north-eastern Slovenia and Hungary, partly with hail, caused significant damage on fields.

June 18-19: Gusts up to 108 km/h in west Kazakhstan during cold front passage. Heavy rains in the eastern parts of the north Caucasian region in European Russia; flooding of Sunzha River. In Azerbaijan local heavy precipitation (85 mm within 6 hours in Guba), a few villages were flooded, damage to agriculture, bridges, animals. Heavy rain and flooding in Turkey.

June 19-25: A strong disturbance moving from the Atlantic into the Mediterranean (depression Qinton) affected most of Italy and the Adriatic coasts with heavy rainfall and strong winds including some tornadoes. Daily precipitation on 21 June set new records in the 58-year time series at four locations in Italy. Austria had extreme precipitation, too, and reported up to 207 mm within 3 hours on 23 June. An event such as this is estimated to occur once in 50 years. Southern Germany registered a local total of 155 mm of precipitation. Widespread flooding of rivers occurred in southern Germany and Austria. Around 1000 ha of fields and grassland were under water. Later, the cold front of Qinton also affected Turkey with storm and hail.

June 25-28: Heavy rain caused river levels to rise and flooding in the eastern Czech Republic on June 25. This flooding was the worst in central Europe since 2002. In Austria, the Danube river rose after some of the heaviest rainfalls in 50 years. Three days later, heavy rain flooded the southern parts of the Czech Republic, with mudslides damaging houses and roads. Heavy rain and flooding occurred also in south-east Poland.

June 28: A supercell thunderstorm hit the southern part of central Finland, an event, which is quite rare for that area. Storm downbursts (estimated > 118 km/h) caused extensive forest damage. Furthermore, extremely large hailstones with diameters up to 8 cm damaged buildings and cars.

July

- **Mostly warmer, cooler than normal only in north-east Europe and the central North Atlantic**
- **Wet in western, central and northern Europe, mostly dry in the south and in the Arctic**

Atmospheric circulation characteristics

Strong low pressure zones persisted for a longer time than normal most of the month particularly over north-western and northern Europe, causing frequent rainfall and thunderstorms over these areas. Western and central Europe and the areas around the Black Sea were under occasional low pressure influence.

Most of the other parts of the Region were mainly under high-pressure influence and a warmer air mass, but high pressure systems did not persist for very long and were frequently interrupted by cyclonic disturbances. Arctic cold air affected north-eastern Europe only here and there.

During the last ten days of the month, warm air advected from northern Africa towards the western and central Mediterranean, leading to high temperatures there.

Temperature

July continued the series of warm months in most of the Region. In most of Europe, the Arctic and over the Mediterranean, monthly mean anomalies were higher than +1°C, in large parts from eastern central Europe to the Ukraine over +2°C, locally even up to +3°C (Fig. 7.1). North-eastern Europe, parts of Turkey and Armenia and the central North Atlantic were colder than normal, with anomalies partly below -1°C. Some places in western Europe were also colder (though only slightly).

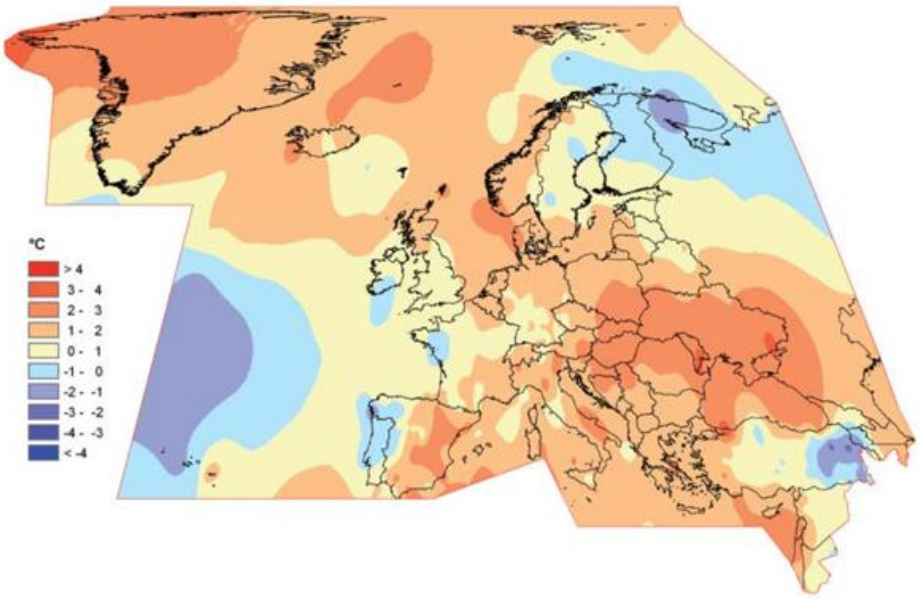

Fig. 7.1: *Monthly mean temperature anomalies in July 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

The Arctic and northern Europe saw quite high maximum temperatures. Svalbard Airport reached a maximum of 14.8°C on 28 July. Norway recorded local monthly mean anomalies of up to +3°C, while some stations in southern Norway set new maximum temperature records. Norway's highest maximum of that month and year was 34.2°C; the same value was reached in Belarus. Lithuania recorded 29-32°C in mid-July on the coast, which in some areas was also record-breaking for this time of the year.

Although Greenland and Iceland were much warmer based on the monthly average, a severe cold spell hit Iceland during the last days of July. Night frosts in the southern lowlands caused large damage to the potato crop, in some places reducing the harvest by up to 80%.

Very cold air masses also affected northern European Russia, Finland and Estonia. On 6 July, some locations in Estonia recorded their lowest minimum 2 m temperature (4-5°C) for that day of year and frost on the ground during the night.

The United Kingdom continued to experience its strongest heat wave in three years. The heat wave also affected Belgium, France and Germany, whereas the periods before and after were much cooler. In Germany, the highest maximum temperature for 2009 was recorded at 37.0°C on 23 July, which was slightly below the record of 37.4°C in 1984. Similar or slightly lower values (34-37°C) were also reached in Poland, the Czech Republic, Austria (where new records were set) and Hungary.

Temperatures of around 40°C favoured numerous forest fires, mainly in Spain and Greece, but also in other parts of the Mediterranean region (Corsica, Sardinia, Sicily). A heat wave in the second half of the month brought temperatures of 40-45°C to various places in Spain and Italy. The peak value registered at official Italian stations was 45.0°C in Decimomannu, Sardinia, setting a new local record for this location. Malta (Fig. 7.2) and large parts of south-eastern Europe, e.g. Montenegro, Romania and Bulgaria, as well as the south-eastern Ukraine, the north and south of the Caucasus in European Russia (Volgograd and Astrakhan regions) and Azerbaijan also reached 40°C or more. Serbia had daily maxima above 30°C during nearly the whole second half of the month (the highest value was 38.4°C). Jordan had its highest annual maximum on 1 July with 45.5°C in the Jordan Valley.

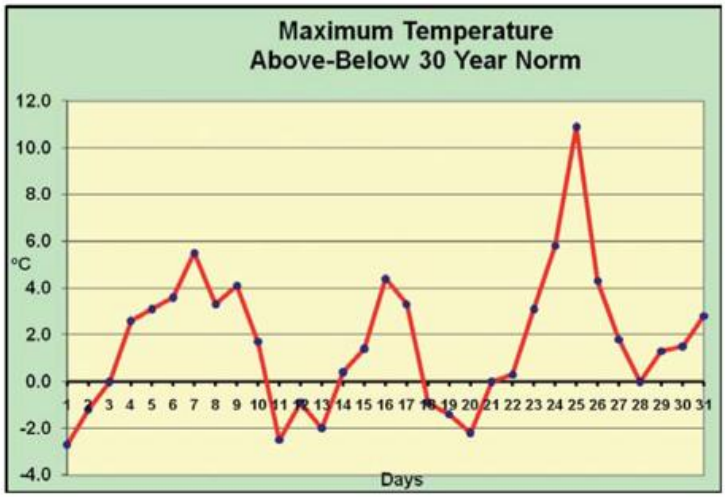

Fig. 7.2: *Daily maximum temperature anomalies in July 2009 (reference period 1961-1990) at Malta International Airport. The peak value (41.6°C) recorded on 25 July during a heat wave exceeded the monthly normal by more than +10°C and was the highest temperature since 1998*
Source: Meteorological Office of the Malta International Airport in Luqa, Malta

Precipitation

July was wetter than normal in western, central and northern Europe (except for the Arctic) and around the Black Sea and Turkey (Fig. 7.3). Large parts of southern and eastern Europe and some of the Middle East were drier.

The Arctic was exceptionally dry. In western Greenland, the station of Nuuk recorded its second driest July since 1890, with a total of only 1.4 mm. In Iceland, it was the driest July in Reykjavik since 1889.

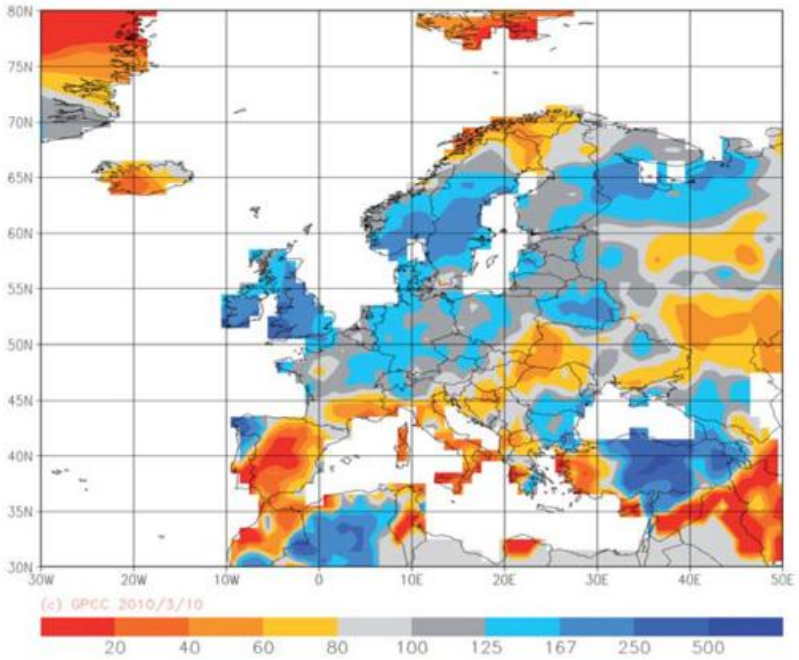

Fig. 7.3: *Monthly precipitation amounts for July 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

In many places in Norway and Sweden, July was among the wettest since records began in 1900. Some areas in Sweden recorded up to 350% of their average July totals, setting new monthly July records at several stations as the result of some days with very heavy rainfall. The Baltic countries also saw some heavy rain events.

England and Wales as well as some places in Ireland had their wettest July on record. Monthly totals exceeded 300% of the normal in parts of the United Kingdom and south-eastern Ireland.

Central Europe including the alpine region saw much rain due to frequent thunderstorms, partly with much hail and locally twice the normal precipitation. In southern Switzerland, the city of Lugano reported its highest July precipitation (397 mm) since records began in 1864, mainly due to two large thunderstorms during the middle of the month.

It was also very wet in north-western Iberia, several places in Serbia, southern Romania, Bulgaria, eastern Turkey, Georgia and Armenia due to frequent and intense thunderstorms. Some regions in western Georgia registered 400% of the normal. Some locations in the Ararat valley in Armenia received 500-600% of the monthly normal precipitation. Azerbaijan was not so wet, but unstable weather with rainfall and hail, partly with flooding, prevailed during the last ten days of the month.

Most of Iberia and the Mediterranean region saw a very dry July. Less than 20% of the monthly normal total fell in central Spain and southern Portugal and in several areas in southern France and other parts in the Mediterranean region. Some places, e.g. Lisbon in Portugal and Pisa in Italy, did not have any precipitation at all in that month. In Monaco, it was the 4th consecutive dry July.

Snow

In the northern highlands of Iceland, snow appeared in the last days of July during a severe cold spell.

In the middle of July, a cold spell with snowfall occurred in the Alps down to elevations below 2000 m a.s.l. The Zugspitze, Germany's highest mountain (approx. 3000 m a.s.l.), recorded 45 cm of fresh snow within 24 hours.

Significant weather events

July 02: Dublin was affected by flooding after torrential rainfall due to heavy thunderstorms. Parts of the city received 40-50 mm within 9 hours; 26.5 mm fell within one hour at Dublin airport in the early morning, the largest clock-hour rainfall ever recorded at the station. During the afternoon and evening of the same day, even heavier falls affected various parts of Ireland.

July 02-04: Hail as large as 43 mm in diameter was recorded in Petrozavodsk (Karelia, north-western European Russia) on 2 July, although hail rarely occurs in these latitudes (almost 62°N). On 4 July, heavy prolonged rain in the east of the Kaliningrad region; 144 mm of precipitation fell in 12 hours.

July 03-07: Hailstorm, a tornado and local flooding mainly in southern and western Germany, local flooding also in Austria. Several cm of hail in the streets of Essen in western Germany.

July 04-05: Severe storms, partly with hail over large areas of northern and central Armenia with hailstones of 20-25 mm.



Fig. 7.4: *Cumulonimbus above Belgrade (Serbia) on 8 July 2009*
Source: Republic Hydrometeorological Service of Serbia

July 08: Nearly 90 mm of precipitation in 24 hours fell at a station in Sweden (Munktorp) in a large low pressure complex over northern Europe.

July 08: Heavy storm in Serbia in the afternoon over a large area due to extended and high-reaching convective cells (Fig. 7.4).

July 11: Hailstorm with walnut-sized hailstones and heavy local rain up to 80 mm within 24 hours in Bulgaria.

July 15: Hailstorm in southern Austria (Styria); tennis ball-sized hailstones smashed several roofs.

July 16-17: An area of unusually low pressure brought prolonged and heavy rainfall across the United Kingdom. Torrential downpours of more than 94 mm in 24 hours in Cornwall. Flooding particularly in north-east England.

July 17-18: Intense convective events with strong gusts, heavy rain, hail, and snow on the mountains in northern regions of Italy. Roads were closed and railways interrupted. Heavy rain and flooding also in many places in Austria, heavy thunderstorms with hail in large parts of France. An intense cold front passed Hungary; several people were killed, trees fell on power lines, causing serious property damage.

July 21-24: Very intense thunderstorm in Armenia with precipitation up to 70 mm in 4 hours (local record). Heavy rain and flooding also in Turkey.

July 22-23: A thunderstorm with heavy rain, hail and gusts up to hurricane force due to extreme lability following high surface temperatures affected Poland, the Czech Republic, Austria, Switzerland and parts of eastern and south-eastern Germany, causing trees to fall and local flooding (Fig. 7.5). Much damage on houses, vineyards, crops. Electricity was disrupted in 50,000 households in Austria.



Fig. 7.5: *Flooding in the town Steyr in upper Austria on 23 July 2010 after heavy thunderstorms*
Source: Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Austria

July 30-31: An intense low-pressure system over southern Norway produced very strong winds in Denmark, southern Sweden and southern Norway. Wind speeds of up to more than 100 km/h were locally measured along the Danish and the Swedish west coast; on the southern Norwegian coast it even reached hurricane force. A ship sank off the Swedish west coast, causing the death of six people; a bulker grounded in southern Norway, causing an oil spill across a wide area. Normally, storms are rather rare events in this region during summer.

August

- **Mostly warmer, but colder in eastern Europe and over the central North Atlantic**
- **Mostly very dry, some very wet places in north-western Europe and in the east**

Atmospheric circulation characteristics

The frontal zone over the North Atlantic became stronger than in the months before. Again, low pressure systems crossed north-western and northern Europe. In Scandinavia, temporary high pressure periods caused high summer temperatures only in the first half of the month.

Most of the western, central and southern parts of the Region were mainly under the influence of high pressure. There was only rare convective activity over the Mediterranean. The warm air mass frequently spread over the whole of Europe and the Arctic.

Eastern Europe often lay on the east flank of the high pressure zone, and cold air masses from the north moved across these areas as far as the Caucasus.

Temperature

The third summer month, too, was warmer than normal in most of Europe and the Arctic (Fig. 8.1) and much more settled than July. Monthly mean anomalies were highest in the Alpine region and south of it, locally even exceeding +4°C, which was particularly due to warm nights. Large parts of central, south-eastern and southern Europe were more than +2°C warmer than normal.

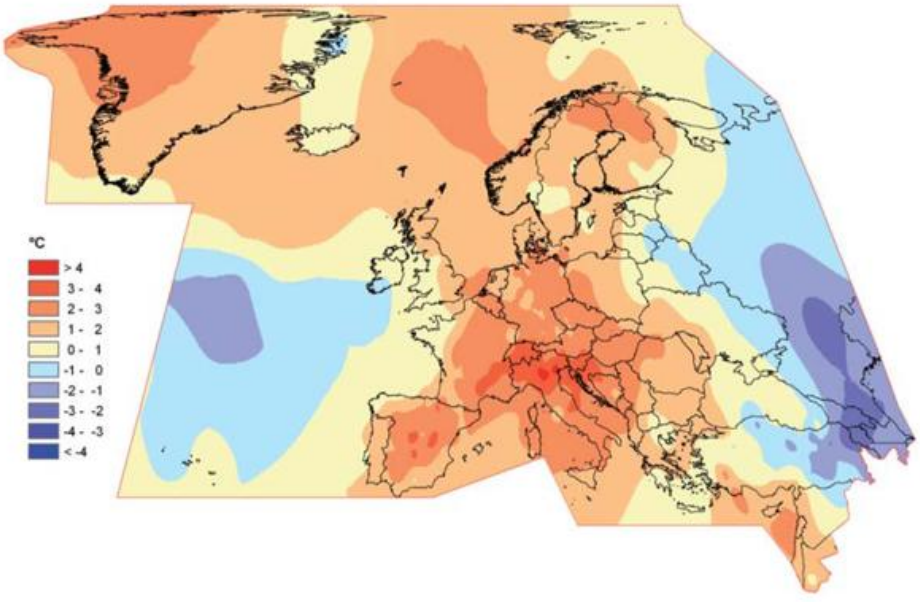

Fig. 8.1: *Monthly mean temperature anomalies in August 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

At the beginning of the month, temperature maxima above 25°C were reached in northern Scandinavia, however followed by frosts after a cooling in the middle of the month.

During a short heat wave in western and central Europe around 20 August, maximum temperatures rose to 37.8°C in north-western parts of Germany, but did not reach the German record values of summer 2003. A maximum temperature of 37°C was also reached or exceeded in the Netherlands, Luxembourg and in many places in south-eastern Europe. Locally, temperatures reached or exceeded 40°C in southern France, Italy, Spain and Romania, while Malta reported a maximum of 35°C and Monaco 34.5°C (the highest since at least 1990).

The long persistence of high temperatures was unusual even for Spain, where temperatures usually tend to decrease at this time of the year. It was the warmest August in Madrid since 1970. Maxima in Italy were not as high in August as in July, although the perceived temperature was very high due to high humidity and the resulting unfavourable thermal stress conditions causing physical discomfort. During the nights, temperatures remained above 20°C (tropical nights) even in southern Switzerland. It was the third warmest August in Switzerland since 1864. In Monaco, it was the warmest August since 1969 with a monthly mean of 26°C.

Eastern Europe, the Caucasus region and the central North Atlantic were colder than normal. In southern European Russia and in parts of the south Caucasus region, mean anomalies were below -2°C. Southern European Russia has not seen such a cold August for more than 30 years and new daily minimum records were measured in many places.

Precipitation

It was a very dry August in most of the Region (Fig. 8.2). Many places particularly in the south and around the Black Sea received less than 20% of their normal monthly precipitation. Some heavy thunderstorms, however, occurred in many parts of the Region.

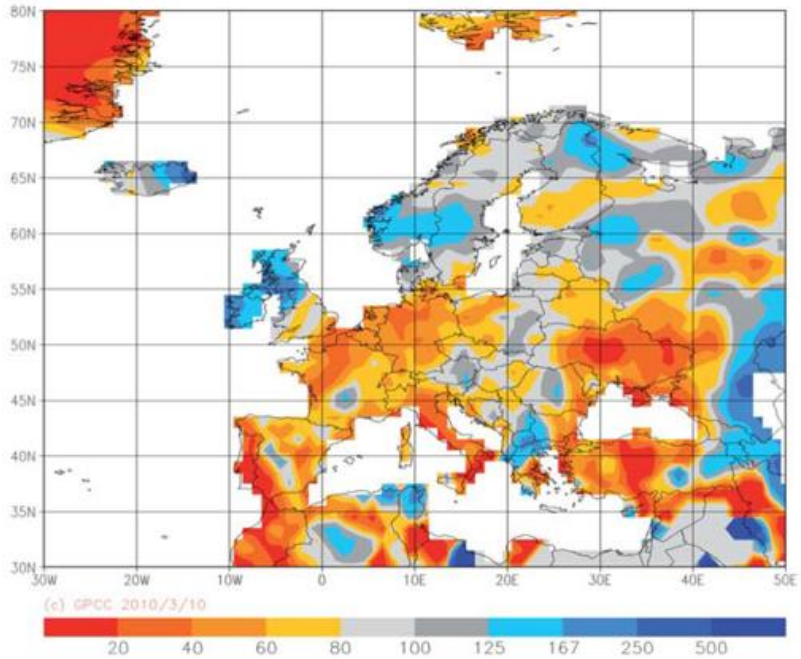

Fig. 8.2: *Monthly precipitation amounts for August 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

In Iberia, Madrid and Lisbon, as well as Pisa in Italy did not see more than 1 mm of precipitation throughout the whole month. Monaco registered only 0.1 mm the whole month (long-term average: 33 mm); it was the driest August since at least 1969. Severe drought conditions also

affected eastern Syria during August. Thousands of Syrian farming families were forced to migrate to cities after two years of drought and failed crops.

There were only a few areas which were wetter than normal, mainly in north-western Europe (eastern Iceland, Ireland, northern United Kingdom), in Fennoscandia, the eastern alpine region, on the southern Balkan Peninsula and in the east (particularly around the Caspian Sea, where more than 200% of the normal were reported).

Western Scotland had its wettest August since records began in 1910, with about twice the normal August rainfall. Northern parts of southern Norway received over 200% of the normal, partly with new local monthly and daily records. Armenia received nearly 200% of the long-term average precipitation due to frequent heavy precipitation with hail. Similar precipitation anomalies were recorded in Azerbaijan, while parts of eastern Georgia even received 500% of the normal.

Snow

Very intense snow melting was observed on the glaciers in the Alps and on the Sonnblick mountain in Austria.

Significant weather events

August 03-05: Heavy precipitation in Austria: locally 100 mm or more within 24 hours. Severe thunderstorms with hail in Slovenia.

August 05-07: Torrential rain caused floods and damage in Bulgaria (district of Sofia and in the east).

August 08: Heavy shower in the upper Volga region (Mordovia, European Russia); 80 mm of precipitation fell in 48 minutes.

August 22: Severe hailstorms and heavy precipitation in Austria and Slovenia. Floods and mudflows south of Innsbruck and in southern Austria.

August 22-23: Strong north-eastern winds up to 82 km/h over eastern Greece, contributing to the extension of forest fires in north-eastern Attica.

August 24-26: Thunderstorms with locally heavy rainfall in France: 136 mm (Puy-de-Dome), 152 mm (Loire).

August 29: Heavy rainfall in southern Lithuania with 57 mm of precipitation in 8 hours.

August 29: Intense convective storm with hourly precipitation totals over 60 mm at several stations around Bologna, Italy.

September

- **Warmer nearly in the whole of Europe, particularly in the eastern parts, colder in the Middle East**
- **Mostly dry, wet in northern Fennoscandia, the Mediterranean region and the Middle East**

Atmospheric circulation characteristics

A frontal zone extended from the North Atlantic to northern Europe. The Arctic was mainly influenced by low pressure, middle latitudes mostly by high pressure.

The Mediterranean region was located at the south flank of this large high pressure zone. Frequent and strong low pressure activity occurred there, causing heavy rain in various parts of that area.

Temperature

September was another warmer-than-normal month in nearly the whole of Europe and in the Arctic. Highest monthly mean anomalies were to be found in European Russia (more than +3°C over large areas) and places in the Ukraine (Fig. 9.1). In the whole of northern, central and eastern Europe and the central Mediterranean region it was more than +1°C warmer than normal (except for the southern parts, e.g. Malta: +0.5°C), while in eastern Europe and many places of eastern central and south-eastern Europe the temperatures were more than +2°C higher than normal. Based on the monthly average, western and south-western Europe were only slightly warmer (< +1°C).

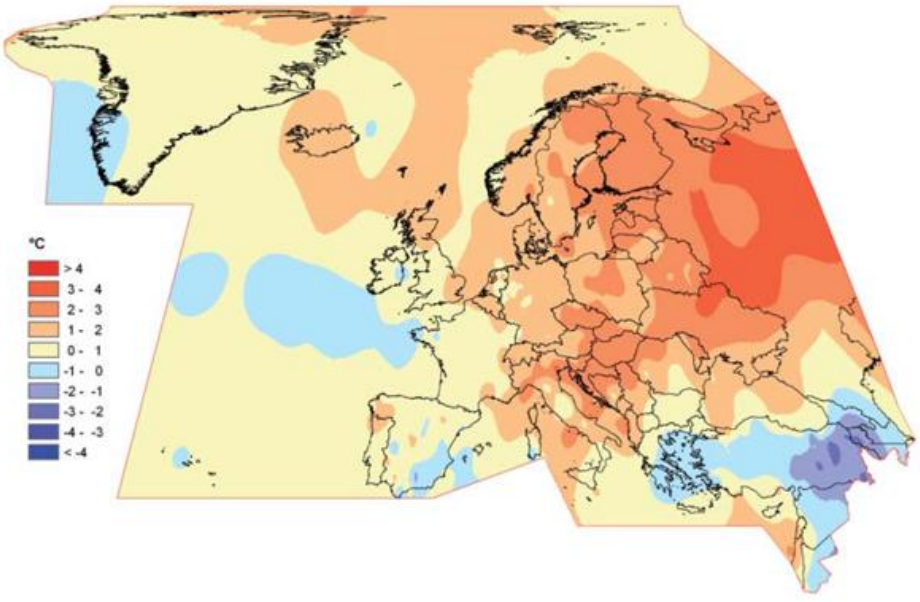

Fig. 9.1: *Monthly mean temperature anomalies in September 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

At the end of the month, cold arctic air reached the Nordic and Baltic countries, bringing the first morning frosts of the coming cold season to Lithuania.

The beginning of the month was particularly hot in Germany and Austria, with maximum temperatures above 30°C and marking 1 September as the hottest September day on record in central Germany. Serbia had a daily maximum of 36.8°C on 4 September. Northern and central Serbia had twice as many summer days (daily maxima >=25°C) as normal. The nights were also warm, and tropical nights were recorded in Romania.

Portugal experienced two heat waves of 6-7 days each and peak temperatures above 35°C, one early in the month, the other at the end, largely affecting the central region of Portugal. Near the western Mediterranean, Monaco saw its highest September maximum temperature (33°C) since 1990.

The Middle East including the Caucasus region and some places in southern Europe, over the Mediterranean and the North Atlantic were colder than normal. Anomalies below -2°C were recorded particularly in eastern Turkey and at some locations in Armenia. However, temperature maxima in Turkey locally exceeded up to 37°C.

Precipitation

September was very dry in most of Europe, especially in the middle latitudes and in the southern parts of northern Europe, but also in mainland Portugal, western Spain and south-eastern Europe, with less than 20% of the normal monthly precipitation in various places (Fig. 9.2). Drought conditions affected various parts of the continent, even central Europe (e.g. the Czech Republic) at the end of the month. However, some areas in the north and in the south were much wetter than normal.

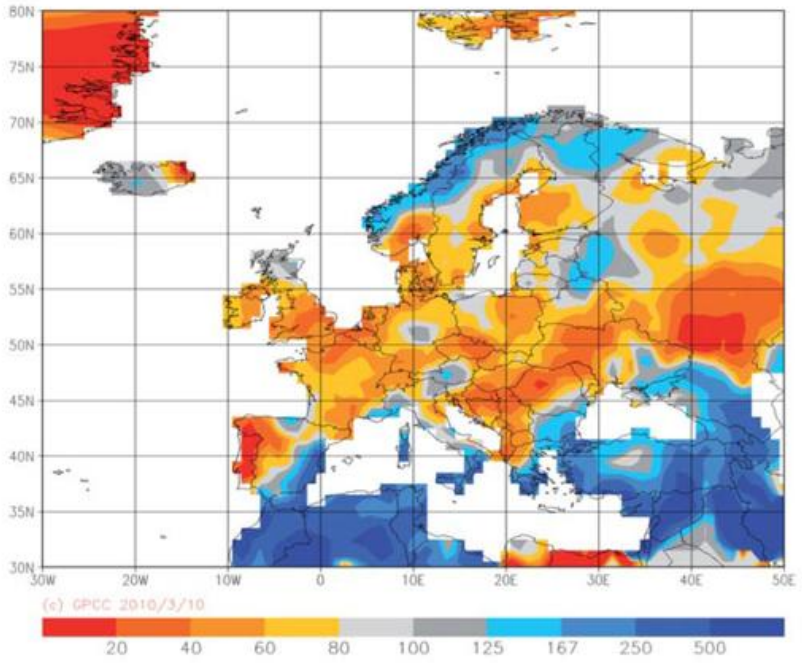

Fig. 9.2: *Monthly precipitation amounts for September 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

It was very wet particularly along the Norwegian west coast and in northern Fennoscandia; locally, it was the wettest September in at least 100 years.

In the first half of the month, some thunderstorms with hail were recorded in central Europe.

Another wet area was to be found in the southern parts of Austria (up to more than 200% of the normal precipitation) and in northern Slovenia. Most of the precipitation here fell during the first half of the month.

In the south, it also was between twice as high and even four times higher over large parts of the Mediterranean, around the Black Sea and in the Middle East, where the high September rainfall brought an end to the preceding drought period. Heavy rain with flooding was especially seen in south-eastern France, south-east Spain, southern Italy, eastern Romania, Greece, Cyprus and Turkey.

Marseilles in southern France received 214 mm of precipitation, which was 455% of the 1961-1990 normal; similar records for Palma de Mallorca in the Mediterranean (222 mm, 444%) and even more in Alicante in Spain (309 mm, 754%). Although convective episodes are well typical for this time of the year in Spain, monthly totals broke previous records in some locations. Lajes on the Azores Islands (North Atlantic) received 126 mm (229%).

September also brought exceptional rainfall totals to the eastern parts of the Mediterranean region, the Caucasus region and the Middle East. Athens in Greece received 48 mm or 480% of the 1961-1990 average. Monthly rainfall in Cyprus was eight times higher than normal. Antalya in Turkey recorded 79 mm, Yerevan in Armenia 72 mm, both more than seven times the 1961-1990 normal. Places in Azerbaijan had similar amounts and much flooding, especially in the second half of the month. On the Black Sea coast in Georgia, very high monthly totals of up to 665 mm were measured. The northern Caucasus region (southern European Russia) was also very rainy. Israel, too, saw significant rainfall (30-80 mm in northern and north-eastern parts) which is unusual for this time of year and marked new records for that area.

Snow

Short snowfalls occurred in the mountain areas in Slovenia and Romania. Apart from that, only smaller areas in Scandinavia and the Alps had snow as usual.

Significant weather events

September 03-04:	Storm with gust near hurricane force (ex-tropical storm Danny) and heavy rain over the North Sea. Daily precipitation totals exceeded 120 mm in north-east Scotland. Parts of Aberdeen city centre were flooded with disruptions to road traffic and rail services.
September 04-05:	A low pressure system with heavy precipitation caused damage in north-western Slovenia. An intense cold front passed Hungary; an extended storm system developed in the frontal zone, causing serious damage to property and power lines.
September 07-09:	Flash floods seriously affected north-western Turkey, especially the city of Istanbul after the heaviest rain in 80 years. 80 mm of rain in 48 hours were measured at the airport in Istanbul; 67 mm fell within one hour on 9 September in Duzce. The return period for such rainfall events has been found to be once in 500 years. This event occurred during a season which is normally very dry since the rainy season starts only at the end of September. More than 100 fatalities, hundreds of buildings were destroyed.
September 09:	A new national September record of mean wind speed on mountain stations in Sweden was measured at 148 km/h.
September 12:	Heavy rain in Lower Austria in the morning caused flooding of homes.

September 12: Torrential rain on the island of Evvoia in Greece caused flooding of buildings, roads and a bridge to collapse. More heavy rain and flooding in north-western Turkey.

September 12: Extreme Sharav event in Israel with temperatures up to 38-41°C.

September 15-17: A violent storm crossed southern Italy, with the city of Palermo (Sicily) flooded due to heavy rain. Naples and Rome were also affected.

September 16-18: Heavy rain in southern Spain with thunderstorms and hail caused a mudslide in the city of Ibros with much damage. Locally, 300 mm of precipitation fell within 48 hours. Heavy rain (more than 160 mm) also fell in south-western France in the area of Bayonne (Pyrénées Atlantiques).

September 17: Heavy rain in south-east Latvia due to showers in connection with a cold front passage (locally 105 mm in 9 hours, more than 150% of the monthly normal).

September 18-19: Accompanied by heavy precipitation and hailstorms, tornadoes and large-sized hail affected several areas in Cyprus, causing injuries and significant damage. Israel, too, saw heavy precipitation.

September 20-21: Heavy rain in Dagestan (north Caucasus, European Russia), locally 100 mm or more precipitation in about 3 hours, causing mudflows, river flooding and significant economic damage.

September 20-24: Heavy rain in north-eastern Turkey caused flooding and mudslides.

September 26-29: Intense precipitation was recorded in many locations on the southern Mediterranean coast in Spain (in the region Alicante – Valencia) and on the Balearic Islands. Total rainfall of locally more than 300 mm was recorded within these 4 days. The normal annual precipitation is 450 mm.

September 28-30: Heavy rainfall (or snowfall in the mountains) throughout Armenia. Storm affected agriculture during the harvest season, causing significant damage to the crop.

October

- **Cold in Fennoscandia and Central Europe, milder in the Arctic, the Middle East, in Iberia and over the North Atlantic**
- **Wetter in central, eastern and south-eastern Europe, dry in northern and western Europe as well as in the Caucasian region**

Atmospheric circulation characteristics

Large areas of low pressure dominated over much of the North Atlantic, the Arctic and northern Europe. Especially in the middle of the month, cold polar air spread over northern, occasionally also central Europe, the Alpine region and the central Mediterranean, while milder air masses moved to the Arctic.

Western Europe including the western Mediterranean and the Caucasian region in the east were mostly and frequently influenced by high pressure. The Azores high, however, was rather weak.

South-eastern Europe and the central and eastern Mediterranean region often lay at the south flank of a high pressure zone, and intense low pressure activity continued there.

Temperature

In October, the temperature pattern changed considerably compared to the previous month. Large parts of Europe experienced colder-than-normal conditions, especially Fennoscandia, north-western European Russia, the Baltic countries and central Europe, with monthly mean anomalies partly around or below -2°C (Fig. 10.1), in Fennoscandia locally even below -3°C. It

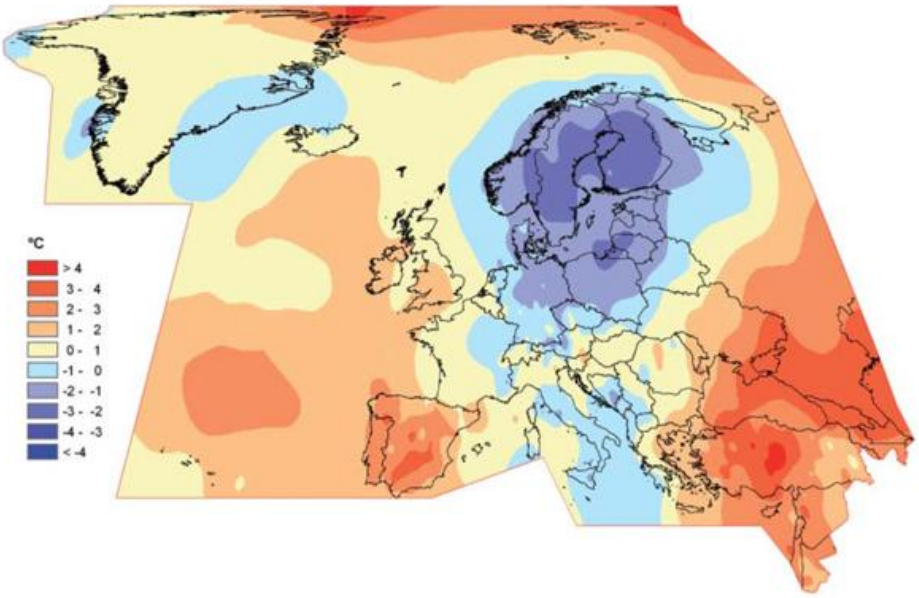

Fig. 10.1: *Monthly mean temperature anomalies in October 2009 (reference period 1961-1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

was the first time in more than 3 years that a month was colder than normal in all parts of Sweden. October had brought a quite early wintry spell from northern to central Europe. In the south, the central Mediterranean region was colder than normal.

The Arctic, the Middle East including the eastern Mediterranean and the Caucasian region, large parts of eastern Europe, particularly the eastern Ukraine, west Kazakhstan and southern European Russia, Iberia, most of western Europe and the North Atlantic were warmer than normal. Mean anomalies exceeded +4°C in the Arctic and in places in southern European Russia and central Turkey.

The last 10 days of October were very mild in the United Kingdom, with the result that the month on the whole was warmer than normal (+1.0 to +1.5°C).

Places in the Alpine region experienced a near normal October mean temperature. This was, however, an average of a very warm start of the month and of a wintry spell later.

The beginning of the month was still very warm in central and south-eastern Europe. Places in Austria saw their highest October daily maximum temperature in many years, e.g. 28.6°C in Vienna on 7 October was the highest in 50 years. In south-western Germany, a maximum of

30.9°C marked a new national October record for that day of the year. Northern and western parts of Serbia recorded a tropical day (maximum >=30°C) on 8 October, which is rare in that area for that time of the year. Even northern Italy recorded a temperature of up to 27°C.

After a very warm first decade, however, very cold air masses from the north crossed central Europe and reached the Alpine region on 12 October, bringing wintry conditions to large parts of central Europe, the Alps and even the central Mediterranean until 20 October. Temperatures showed a sharp decrease, e.g. the maximum temperature dropped by 20°C within one week in the Czech Republic. At -17.9°C, the Zugspitze (Germany's highest mountain, approx. 3000 m a.s.l.) set a new October minimum temperature record. Several lowland stations in Germany also experienced new records of lowest maximum and minimum temperatures for mid-October.

Iberia and southern France experienced some quite hot periods, with maxima above 30°C, and most of Portugal and Spain were more than +2°C warmer than normal based on the monthly average. Portugal had a 9-day heat wave on 10-18 October, with maximum temperatures of 30°C or more in the south of the country.

Israel had a 5-day heat wave on 15-20 October, with maximum temperatures continuously above 35°C in many places. This was the first heat wave of such duration in October since at least 1964. Jordan, too, was affected by this heat wave; the highest maximum there was 41°C on 18 October, +8°C above the normal maximum for this time of the year.

Precipitation

Northern and western Europe, Switzerland, Monaco, northern Italy and Slovenia, most of Iberia (except the north-west), southern European Russia, large areas of Turkey and the Caucasian region were very dry, with less than 80% of the normal monthly total over large areas. Some places received even much less precipitation (Fig. 10.2). Norway, on the whole, received 60% of its monthly normal.

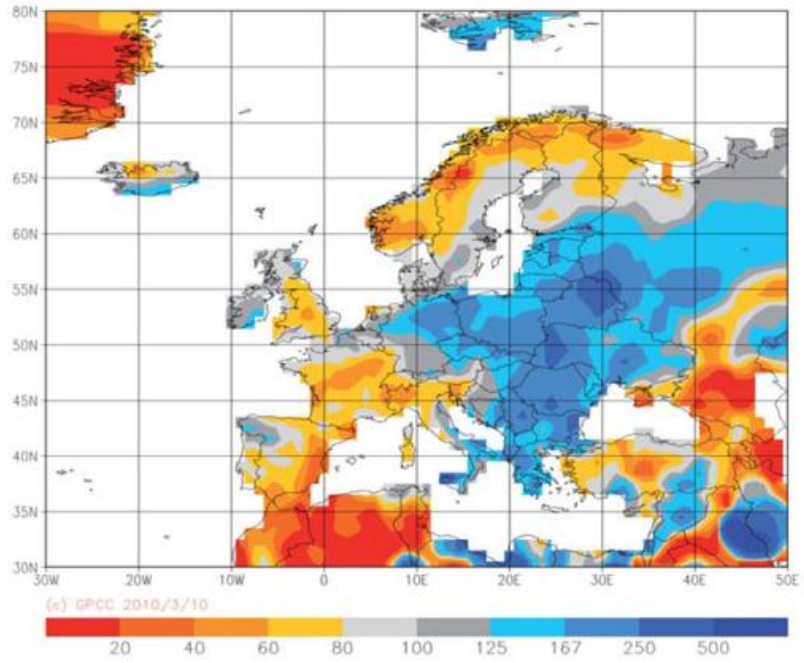

Fig. 10.2: *Monthly precipitation amounts for October 2009 in per cent of the normal 1951-2000 in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

October was a wet month in central, eastern and south-eastern Europe (including parts of the central Mediterranean) and in places of the Middle East. 200% of the normal monthly totals were exceeded in various places, e.g. in Estonia, Belarus, European Russia, west Kazakhstan, the Ukraine, Romania, Bulgaria, Serbia, Hungary, Slovakia, Poland and Germany. In northern Germany, unusually heavy thunderstorms occurred due to a sharp temperature contrast between the north and the south. More than 300% of the precipitation normal was received in places and local records were broken, e.g. on mountains in Serbia (Kopaonik mountain had a monthly total of 193.7 mm).

It also was rainy over the North Atlantic. In Horta on one of the Azores Islands, monthly mean precipitation was around twice the normal.

Thunderstorms with heavy rain occurred over large parts of the Mediterranean; daily totals above 200 mm or 200% of the normal were particularly recorded over Sicily, but also in Greece.

Rainfall totals in northern and central Israel were 50-150 mm, compared to a long-term average of 20-40 mm. Most of the rainfall occurred at the end of the month. It was one of the rainiest October months in the last 60-70 years, although not record-breaking.

Snow

Early snow affected large areas of northern and central Europe including the Alps in the middle of the month following a cold front passage on 12-13 October.

On 14-26 October, a snow cover formed in eastern Germany even at altitudes below 1000 m; locally, it was the highest snow cover in October since at least 1971. Other countries in eastern central Europe also saw heavy and exceptionally early snowfall in the middle of the month. The Czech Republic reported a snow depth of 103 cm on 18 October for the mountain station Lysa Hora (altitude 1324 m). Poland also had heavy snowfall.

The Alps, too, received a lot of snow during that period. In Germany, the Zugspitze mountain (approx. 3000 m a.s.l.) recorded a snow depth of 160 cm while the Wendelstein mountain (approx. 1800 m a.s.l.) had accumulated 82 cm of snow until 19 October. A snow depth of 45 cm was recorded at a station near Salzburg in Austria at 2000 m a.s.l.; Switzerland reported similar values. The Austrian Sonnblick mountain (3106 m a.s.l.) had 75 cm of snow, although only two weeks before it had been completely free of snow. High mountains of the Italian Alps had a snow cover of 100-120 cm and Kredarica in Slovenia reached a maximum depth of 40 cm on 24 October. Even Serbia had up to 32 cm of snow in the second decade in mountainous areas, locally also in lower altitudes (3 cm).

Significant weather events

October 01:	Ball lightning in Mustjala, Saaremaa Island in Estonia.
October 01-02:	A storm dropped 70 mm of rain within six hours in Messina, Sicily. Civil protection measurement stations recorded up to 300 mm of precipitation in the mountains, causing severe mudslides, collapsing of buildings and cut-off roads. Thunderstorms in Malta with a daily total of 42 mm at Luqa Airport.
October 03:	Storm moving from the United Kingdom to southern Scandinavia. Gusts up to hurricane force over the North Sea.
October 03-07:	Heavy rain up to 200 mm on coastal areas of south Galicia (north-west Spain).
October 05-07:	Tropical storm Grace formed near the Azores developing to an

extratropical cyclone; it came near to England, but weakened before reaching it. Intense rainfalls of 20-40 mm in 24 hours occurred in England on 6-7 October.

October 07-08: Heavy thunderstorms with more than 50 mm of rain in 12 hours in northern Germany, especially in the night from 7 to 8 October, when the temperature contrast between hot subtropical air in the south and cold polar air in the north became very strong. The intensity of thunderstorms was unusually high for October. Heavy rain occurred also in Belgium.

October 07-08: Heavy rain in Azerbaijan due to a distinct low pressure system. Floods damaged bridges, roads, houses; 2 houses were destroyed completely.

October 10: Heavy precipitation and strong winds in eastern and south-eastern Iceland, with local daily totals of more than 180 mm within a strong Icelandic low.

October 12-26: Early heavy snowfall in large areas of northern and central Europe including the Alps.

October 13: An extended low pressure area affected the central Mediterranean and its surroundings. Heavy storm in Italy (especially in Rome and on the Adriatic coast). A small tornado hit Rome, causing falling trees and traffic chaos. Wind gusts up to 150 km/h were reported from Lower Austria. Heavy precipitation, especially in western and northern Romania. Storm and heavy rain in Turkey.

October 20-22: Heavy rain in southern France in the Rhone delta and the Provence region. Locally up to 157.5 mm within 8 hours. Heavy rain in Portugal (60 mm in 24 hours) during a front passage.

October 25: A storm with heavy rain caused flooding of homes and farms across Greece. The national road between Athens and the Peloponnese was blocked due to mudslides.

October 25-26: Gusts up to 108 km/h during 10 hours under strong low pressure influence in west Kazakhstan.

October 27-31: Heavy rainfall in Israel. Daily totals of more than 120 mm were recorded in the Sharon Plain (north of Tel Aviv) on 30 October, making it one of the three rainiest days since the beginning of measurements in that area. Heavy rain and flooding also in Turkey and Cyprus.

November

- **Very mild in Europe and the Arctic**
- **Mostly wet, dry along the north European coasts and over the western and central Mediterranean**

Atmospheric circulation characteristics

The Icelandic low became much stronger than normal whereas the Azores high retreated southwards. Intense low pressure activity and a mild flow of marine air from the south-west mainly affected north-western and northern Europe, and occasionally other parts of the Region.

Iberia, the western Mediterranean and the easternmost parts of the Region were dominated by high pressure most of the month. Only in the first decade two intense low pressure systems crossed the Mediterranean region.

Eastern central Europe, too, experienced a change after the first ten days. At the beginning of the month, it was under east European high pressure influence with cold air masses near the ground. Later in the month, the area came under the influence of a mild south-westerly airflow.

Temperature

November was a very mild month in Europe and in the Arctic. Monthly mean anomalies exceeded +4°C not only over large parts of the Arctic Sea, but also in places in northern and central Europe (Fig. 11.1); in northern Scandinavia the anomaly went up to +5°C, in northern Svalbard even to +9°C, which was a new record. Most of the European continent was +2 to +4°C warmer than normal.

The United Kingdom had a mean anomaly of +1.8°C and there were notably few days with air frost. Many places in western and northern central Europe were without frost. Monthly mean temperatures for November across the United Kingdom, Netherlands, Belgium, France, and Germany were among the three warmest in the last century. Daily maxima in France ranged up to 25°C, and minima to 12–15°C. In southern Germany, Switzerland and Austria, maximum temperatures of around 20°C were reached in the middle of the month, as a result of foehn winds; however these were not record-breaking temperatures.

The Baltic countries had anomalies between +1.5 and +2°C; the final third of the month was particularly mild there. Latvia reported the highest November temperatures since 1926, which were around 11°C in some areas on 21 November.

Most of the southern Caucasus region was +1 to +2°C warmer than normal; maximum temperatures of up to 23°C were measured in Azerbaijan and in south-eastern Europe (e.g. in Serbia). The station Antalya in southern Turkey even reached 32.5°C.

Some stations with long histories in southern and eastern Spain reported record-breaking monthly mean temperatures, for example at Valencia, with observations dating back 141 years. Daily maxima exceeded 25°C on several occasions. In Monaco, it was the mildest November since 1994 (15.1°C, +1.4°C above the 1969-1998 average).

The central North Atlantic and a few places over the eastern Mediterranean and in the Middle East were slightly colder than normal.

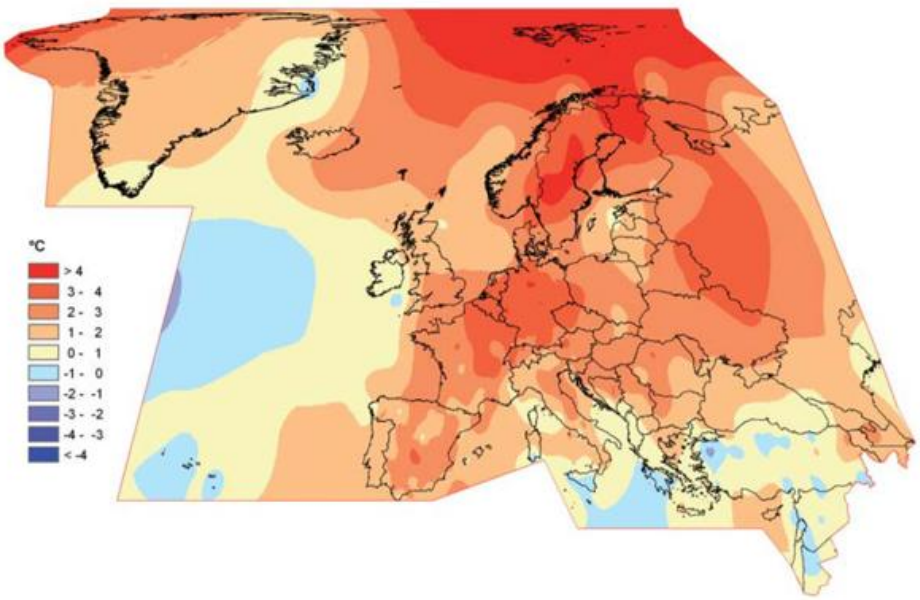

Fig. 11.1: *Monthly mean temperature anomalies in November 2009 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

Precipitation

November was wet over large areas of Europe, in Turkey, northern Israel and in most parts of the southern Caucasus countries (Fig. 11.2). It was much drier than normal along north European coasts, in most of the Czech Republic, Austria and Slovenia, over most of the Mediterranean and Iberia (except the north and west), west of the Black Sea and in central and eastern European Russia and western Kazakhstan.

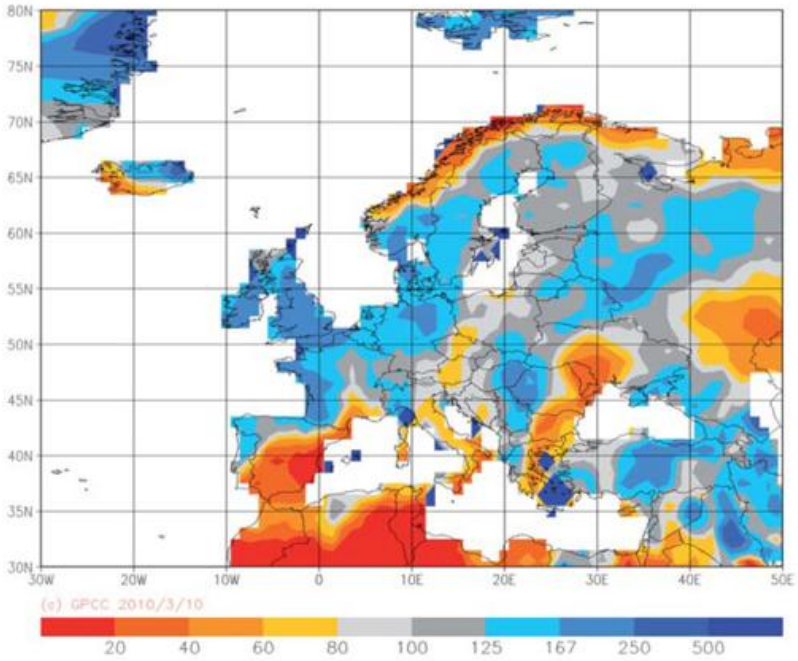

Fig. 11.2: *Monthly precipitation amounts for November 2009 as percentages of the normal in 1951–2000 in Europe and adjacent areas.*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Some areas of northern Norway saw less than 20% of the normal precipitation. Other parts of Scandinavia, in contrast, were much wetter than normal. In southern Scandinavia and Denmark, the 90th percentile of the 1961–90 distribution was exceeded. It was the second wettest November ever registered in parts of southern Norway. A new November record of 27 precipitation days was registered for Denmark.

There was more than 200% of the normal monthly precipitation in Ireland and some parts of the United Kingdom. It was the wettest November on record in the United Kingdom since 1914 and in parts of Ireland, with an average of 217 mm of rain across the UK. For Scotland alone, average monthly rainfall totals rose to record-breaking 256 mm. Much of that rain was due to a heavy rain event on 18–20 November. Ireland had no days without rain every day somewhere and 24–29 rain days (i.e. 0.2 mm or more of rainfall) at most stations, compared to a November normal of 16–22 rain days.

High precipitation was recorded also over various parts of the Balkan Peninsula (except the eastern parts), with locally more than 200% of the normal, e.g. on the southern coast of Montenegro.

Parts of the northern Caucasus region in southern European Russia received up to more than 5 times the monthly normal in places. In Azerbaijan, monthly precipitation was between twice and four times the normal. Several stations in Turkey received around twice the normal monthly precipitation with flooding in the north. Exceptional rainfalls were recorded in Greece during the first half of the month, causing flooding in many parts of the Greek mainland and islands.

In contrast, it was extremely dry in parts of eastern Spain, especially in Barcelona with only 3 mm in the whole month (4% of the normal). However, heavy rains fell in northern and western Iberia during the first ten days of November, with up to 300 mm in some locations such as San Sebastián.

Snow

November started with a temporary snow cover in north-eastern Germany and Denmark. Brief snowstorms occurred sporadically in Lithuania.

The mild conditions during November were sufficient to melt all the snow that had fallen in October up to high altitudes in the Alps. However, heavy snowfalls occurred during the course of November, even at low altitudes on the northern side. Up to 90 cm within 24 hours fell on the southern slope of the Alps in Switzerland. It also snowed on the mountains in Serbia and Romania, and in eastern Slovenia even in the lowlands.

Heavy snowfalls caused avalanching in the northern Caucasus mountain areas. First snowfalls also occurred on high mountains in Georgia and Azerbaijan in the final third of the month.

Significant weather events

November 01–02: Rivers in the United Kingdom (Scotland and Wales) burst their banks after heavy rain (daily totals of up to more than 50 mm) and caused flooding in towns. In Scotland, the river Deveron hit its highest level since records began in 1959.

November 06–11: There was abundant rainfall in western Romania and eastern Serbia; with local levels of up to 80–90 mm of daily precipitation in the mountains. Later, heavy rain and flooding occurred in Turkey.

November 18–20: Record rainfall and widespread flooding affected north-western England, Scotland and Ireland after the passage of frontal systems enforced by a

strong wind shear and orographic lifting. A new 24-hour record of 316 mm of rainfall was noted in the UK in the county of Cumbria (north-western England). Parts of the high ground received more than 400 mm in 72 hours. The flooding problems became worse due to water-saturated soil following wet weather earlier in the month. Many rivers in the Lake District exceeded their previous maximum flows by a wide margin, and exceptionally high flows were also reported across north Wales and southern Scotland. Several road bridges collapsed or were damaged, and some 1,500 properties were flooded (Fig. 11.3). Several places in Ireland were also exceptionally wet, receiving more precipitation during these three days than during a whole November ever, e.g. more than 50 mm on Valentia Island and at Cork Airport and over 100 mm in other places in the west and south-west of the country.



Fig. 11.3: *Aerial view of the River Derwent and the remains of Northside Bridge in Workington, Cumbria (England) in November 2009. Photo provided courtesy of the UK Environment Agency*
Source: Met Office Hadley Centre, United Kingdom

November 18–20: The same low pressure system hit Denmark with wind gusts of up to hurricane force (132 km/h) on 18 November. The strong winds considerably raised the sea level along the west coast, uprooted trees and caused minor damage to buildings. There were also strong winds in northern Germany. In Norway, a precipitation station recorded a daily total of 143 mm on 20 November.

November 21–22: Landslides and flooding occurred in northern Turkey during and after a cold front passage with heavy precipitation.

November 23–24: The passage of a cold front brought gusts of up to hurricane force to lower mountain areas in Central Europe and heavy storms and rain to the lowlands.

December

- **Cold over the northern half of Europe, much milder in the Arctic, the Mediterranean and in the south-east**
- **Mostly wet, but dry along the north-west coasts of Ireland, the United Kingdom and Norway**

Atmospheric circulation characteristics

At the beginning of the month, a large cold trough extended from northern Europe to the central Mediterranean, whereas eastern Europe was under a mild southerly airflow. This situation changed very soon to a zonal circulation with low pressure systems and a generally mild airflow moving from the Atlantic to western, central and northern Europe.

In the middle of the month, however, a strong blocking high moved from eastern to northern Europe, and later to Greenland. Cold air from the north-east spread over the whole of Europe, particularly its northern half. A large low pressure complex developed over the Mediterranean and extended almost to the whole of Europe. During the same period, mild air from the North Atlantic moved to the Arctic region.

At the end of the month, many Atlantic low pressure systems again crossed the European continent. Warm subtropical air masses and a persistent high pressure system over Africa led to mild weather especially over the central and eastern Mediterranean and south-eastern Europe.

Temperature

It was very mild in the Arctic (monthly anomalies more than +4°C above normal (Fig. 12.1), with some places in Greenland and Svalbard at least +7°C warmer than average, and parts of Svalbard even +8 to +9°C) and in Iceland. Daily maxima at the west coast of Greenland and in Iceland were around 10–12°C on several days, and in the north-east of Iceland locally over 14°C because of the foehn. However, the last week of December was cold in Iceland. In Greenland, the beginning of the month was particularly cold. The peak station Eismitte (ice centre) in Greenland (3200 m a.s.l.) recorded -13.1°C in the middle of the month, which was very mild compared to -55.3°C at the beginning of December.

December was a cold month in the northern half of Europe and in the Alps. Monthly mean anomalies below -1°C were recorded over large parts particularly in northern Europe. In eastern European Russia and some areas of the highlands in southern Norway, they were even below -4°C. Ice days were unusually frequent in Scandinavia and in the Alps. Ireland experienced its coldest December in 28 years, the United Kingdom since 1995.

December temperatures in many parts of Europe differed largely between the start and the end of the month. The beginning of the month was unusually warm in the northern and eastern parts of Europe, e.g. in Belarus with temperatures ranging between +5°C and +10°C above average. On 2 December, several locations in Lithuania, Belarus and European Russia set new records for this day, including Minsk (Belarus) (where temperatures reached 9.3°C) and Moscow (9.0°C), while in Moldova, the night of 2 December was the warmest for that day of the year in the last 65 years. The warmest day in Moscow in December 2009, however, was the 6 December, with 9.4°C. Remarkably, this value had been measured in the early morning and was a local record for December.

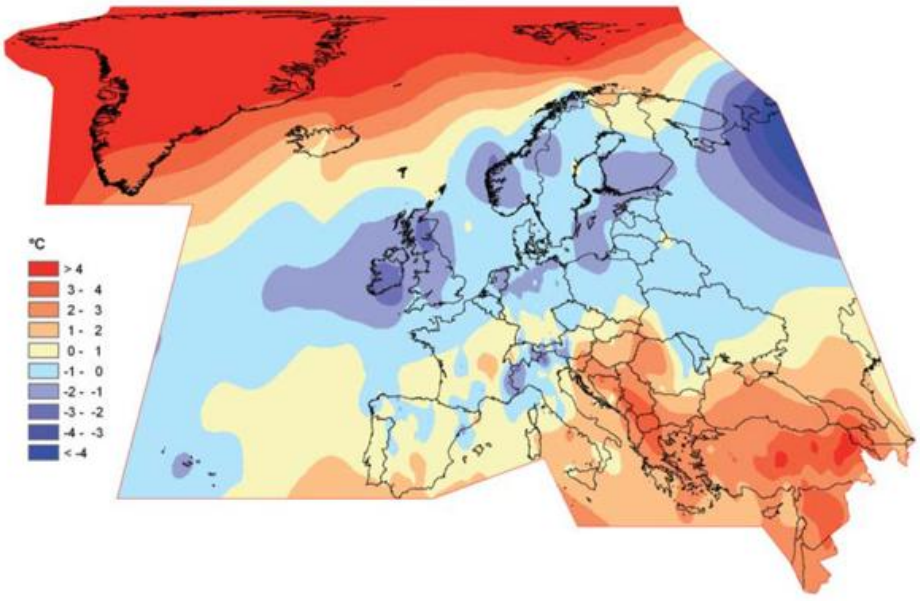

Fig. 12.1: *Monthly mean temperature anomalies in December 2009 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

In the middle of the month, a severe cold snap caused by the dominance of arctic air affected many places in Europe and caused serious traffic problems and loss of life due to freezing. Daily minimum temperatures dropped to around -20°C and below in many places in northern, western, central and eastern Europe and in the higher Alps; in eastern European Russia temperatures dropped below -30°C. In the city of Kazan in European Russia, a new absolute minimum temperature was recorded for the entire 138-year observation series. New daily minimum temperature records compared with the last 60 years or more were also set at several locations in Germany. In Switzerland, Geneva recorded -12.6°C, the lowest temperature for December since 1968. Eurostar trains between Brussels, Paris and London were cancelled over a three-day period. Temperatures across England and Wales, in some places in Ireland (station Mullingar on 25 December) as well as in Belgium and Hungary fell as low as -10°C and below. The last occurrence of a minimum temperature below -10°C in December in Belgium was registered in 1996. In Scandinavia, minima as low as -40°C were recorded, in southern Europe -17°C in northern Italy, and on lower mountains in Spain. Burgos (northern Spain) recorded a new daily minimum record on 20 December since the start of measurements in 1943.

The month started cold in Austria, but the second third of the month was mild, resulting in near normal monthly mean temperatures. In Switzerland, a rapid warming in the final third of the month took place on the northern side of the Alps due to the south foehn.

On average, it was very mild over much of the Mediterranean (including southern and north-eastern Spain, Malta, the Balkan Peninsula, Turkey and Cyprus) and in the Middle East (including the southern Caucasus countries) with anomalies > +2°C (locally > +4°C) over large land areas in south-eastern parts of the Region.

The second half of the month was particularly warm in the south-eastern parts of the Region. Local records for daily maximum temperatures for 23–31 December were broken in Hungary (up to 21.8°C) and Serbia (23.8°C). In Bulgaria, several stations registered record high temperatures on Christmas Day (e.g. 21.2°C in Vratsa). It was the warmest December of the decade 2000–2009 in the whole of Greece; maximum temperatures between 15 and 20°C were

reached in many places. On 25–30 December, record high temperatures were also recorded across central and southern Italy, with temperatures exceeding 25°C. In Azerbaijan, it was particularly warm at the end of the month with maxima of up to 20°C in the highlands.

Precipitation

The high pressure over Scandinavia caused a dry December in much of northern Europe, while most of the rest of Europe, particularly the south, experienced a very wet end of the year (Fig. 12.2).

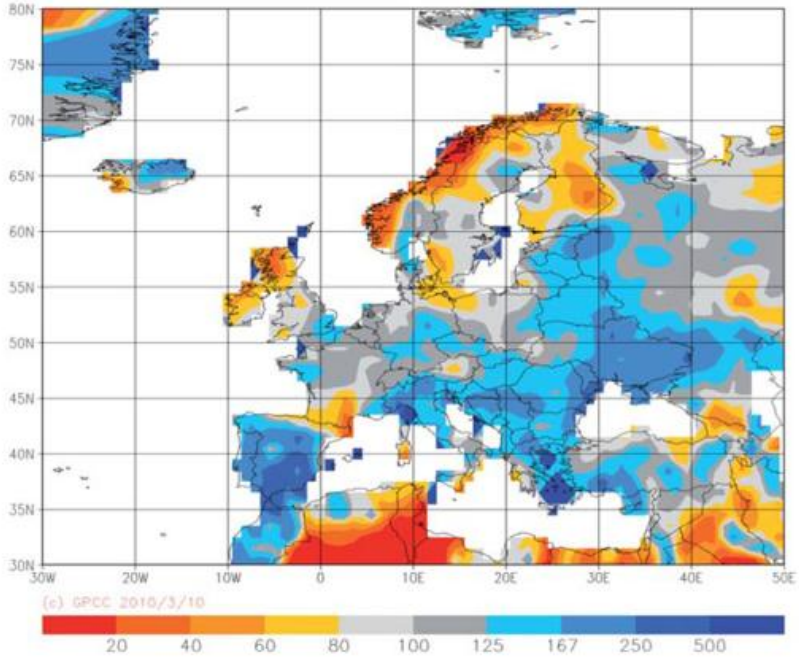

Fig. 12.2: *Monthly precipitation amounts for December 2009 in per cent of the 1951-2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

The Arctic region including parts of eastern Greenland and Iceland was very wet. December rainfall total in Akureyri (northern Iceland) was the highest since the start of continuous measurements in 1927.

Most parts of northern and north-western Europe were very dry. It was much drier than normal particularly along the west coast of Norway, in Ireland and Scotland. In many places there, less than half the normal monthly totals were reached. Parts of the Norwegian west coast received less than 15% of its December precipitation normal 1961–90, owing to the low frequency of westerly airflows. All parts of Finland, too, were much drier than normal. Some northern and central areas of European Russia also received only low precipitation.

Most of the other parts of the Region saw a wet December. The Baltic countries were wet due to several heavy precipitation events; December precipitation levels in Estonia and Latvia were 130–140% of the 1961–1990 normal.

In western Europe, France saw some heavy precipitation in various parts of the country, but monthly totals were mainly not much above normal; in southern France, totals were even much below. Most of central Europe had levels of precipitation slightly above-normal.

It was particularly wet in southern Spain, due to heavy rain events in the second half of the month. Local rain record amounts fell over the month in many places. Large parts of western and southern Iberia received 200 mm of precipitation or more, while extended areas over Andalucía received more than 300 mm, causing widespread flooding. In most of Iberia, December precipitation was more than twice the normal. Portugal had the wettest December of the century, and even the Azores Islands had totals well above the normal (230–250 mm).

Several stations in northern Italy recorded their wettest or second wettest December in nearly 90 years, mainly due to intense precipitation around Christmas. Monaco saw its wettest December since 1983 (175 mm), receiving more than twice the long-term average 1969-1998. Slovenia and Croatia, too, received well above normal precipitation, more than twice the normal in several places, as did Malta; western Slovenia received three times the normal. It was the second wettest December ever recorded on the mountain Kredarica and at the coast of Slovenia. Local records for monthly totals were broken in Serbia. Due to frequent rain and snow melting during the last days of December, high water levels were recorded for rivers in parts of south-eastern Europe, e.g. in Slovenia, northern Hungary and eastern Serbia.

Another area of high precipitation during the month was the north-west coast of the Black Sea, where precipitation exceeded 250% of the normal. The Ukraine received heavy precipitation particularly in the first half of the month.

An exceptional local 24-hour precipitation record was set in Makrinitsa in central Greece, where 417.2 mm fell on 10 December. This is equivalent to nearly half of the total rainfall for 2009 at this station. Some other places in Greece also saw exceptional precipitation on that day, resulting in significant flooding and widespread damage. Cyprus experienced heavy precipitation several times during the month, including a heavy hailstorm on 16 December, resulting in a monthly average total of almost 150% of the normal. Similar levels were recorded in parts of the southern coast of Turkey.

Georgia in the southern Caucasus was very dry; some parts had only half of the normal total and eastern parts had rain on only 5–7 days. North-eastern Turkey was also much drier than normal, in contrast to the rest of the country.

Snow

December was particularly snowy in northern Iceland; Akureyri reached a December record depth of 90 cm.

Snowfall was widespread and locally heavy, especially in the middle of the month in western and central Europe, but also in the south. Deep snow accumulated over high ground from Spain to central and eastern France, northern England and southern Scotland. The Netherlands also experienced unusually heavy snowfall, with depths of up to 30 cm on 17–20 December; road and rail transport were seriously affected. At the German North Sea coast, depths up to 25 cm on 22 December partly were new local records for December. The United Kingdom and the Netherlands including some coastal areas of the North Sea experienced a white Christmas for the first time in nearly 30 years in some places, but a following mild period caused a rapid melting of the snow cover before the end of the year.

High snow depths were also recorded in eastern parts of the Region including the Baltic countries. In Estonia, snow depths of 43 cm at the end of December set a new record for this month. A snowstorm in north-west Latvia in the middle of the month caused considerable increases in snow depth. Heavy snowfall at the end of December was also experienced in Moscow, when 19 cm fell within 24 hours. The Ukraine saw heavy snow storms in the first half of December and again at the end of the year, causing widespread damage to buildings, traffic and electricity lines.

The Alps already had above normal snow depths at the beginning of the month due to snowfall in late November. Further snowfalls occurred during the month, particularly on the southern side of the Alps in the final third.

The Lombardy region in northern Italy had deep snow in the cities Milan and Piacenza. About 30% of the land area of Italy was covered by snow. However, subsequent warming and continuous rainfall in northern Italy resulted in rapid melting causing extensive flooding in Tuscany just before Christmas.

The Balkan Peninsula received snowfall locally to depths of half a metre or more. There was even some snow in coastal regions of Slovenia on 19 December (Fig. 12.3). In some parts, e.g. in Montenegro, the snowfalls caused disruptions of electricity, road and air traffic.



Fig. 12.3: *High tide and a little bit of snow on the Slovenian coast on 19 December 2009*
Source: Environmental Agency of the Republic of Slovenia

Later, just as in Italy, in parts of south-eastern Europe, e.g. in northern Hungary, large accumulations of snow which had fallen in mid-December melted away rapidly and caused rivers to flood. Eastern Serbia recorded the highest river water levels in history for that time of the year and widespread flooding occurred in several parts of the country.

Snow even fell in Cyprus, over the highest parts of the mountain Troodos.

Significant weather events

December 10–12:	A large eastern Mediterranean low pressure system caused thunderstorms with heavy rain on the southern Turkish coast. 186 mm of rain fell in Antalya in 24 hours, mostly during the night 10–11 December. Greece, too, had heavy rain with flooding.
December 14:	There was a violent thunderstorm with funnel clouds over Catania (Sicily, Italy).
December 16:	A winter storm caused 89 cm of snow at Vindafjord in Norway.
December 16:	Heavy rain, hail and strong winds affected all areas of Cyprus. Trees were uprooted and buildings damaged, mainly around Larnaka. Storms and hail also occurred in Turkey.
December 16–17:	There was a snowstorm in north-west Latvia. Snow cover increased by 70 cm and more in places due to this event (Fig. 12.4).

December 18-20: Severe cold spell over large parts of Europe. People died by the cold. 7 victims were reported by Germany around the 20th, overall perhaps more than 80 people died across Europe.



Fig. 12.4: *Snowed-up residential house in Kolka (north-west Latvia) on 17 December 2009 Source: http://weatherfoto.wordpress.com, provided by Latvian Environment, Geology and Meteorology Centre*

December 18: Severe glaze and rime (up to 60 mm thick) was experienced over a 20-hour period in southern European Russia (Stavropol region).

December 18–25: Snowstorm with heavy precipitation in northern Italy, followed by a sudden sharp increase in temperature and further precipitation including freezing rain. Roads and railways were severely affected. Locally more than 600 mm of precipitation fell during this event. The city of Venice was flooded.

December 19–22: An Atlantic storm affected Iberia with torrential rain near the strait of Gibraltar.

December 21–31: Persistent heavy rain left hundreds of homes flooded around Andalucía, southern Spain. The record rainfall, which saw over 400 mm falling in many areas in a week, caused dozens of rivers to burst their banks. The highest local rainfall was 709 mm during 10 days starting on December 21. In total, over two cubic kilometres of water entered the reservoirs in Andalucía over these ten days. This is 20% of the total capacity for the region.

December 21–27: Extremely high precipitation levels were experienced in Slovakia, causing flooding in the Hron river basin. 100 mm within two days fell in Banská Bystrica. There was also abundant precipitation in Slovenia and several rivers were flooded. Summer-like showers and rainstorms were reported in all parts of Hungary, particularly on 26 December.

December 21–31: Extended period of rain in Romania, with particularly heavy rain on the last two days of the year in the western parts of the country. Rainfall levels locally exceeded 150 mm during the final third of the month (Fig. 12.5)

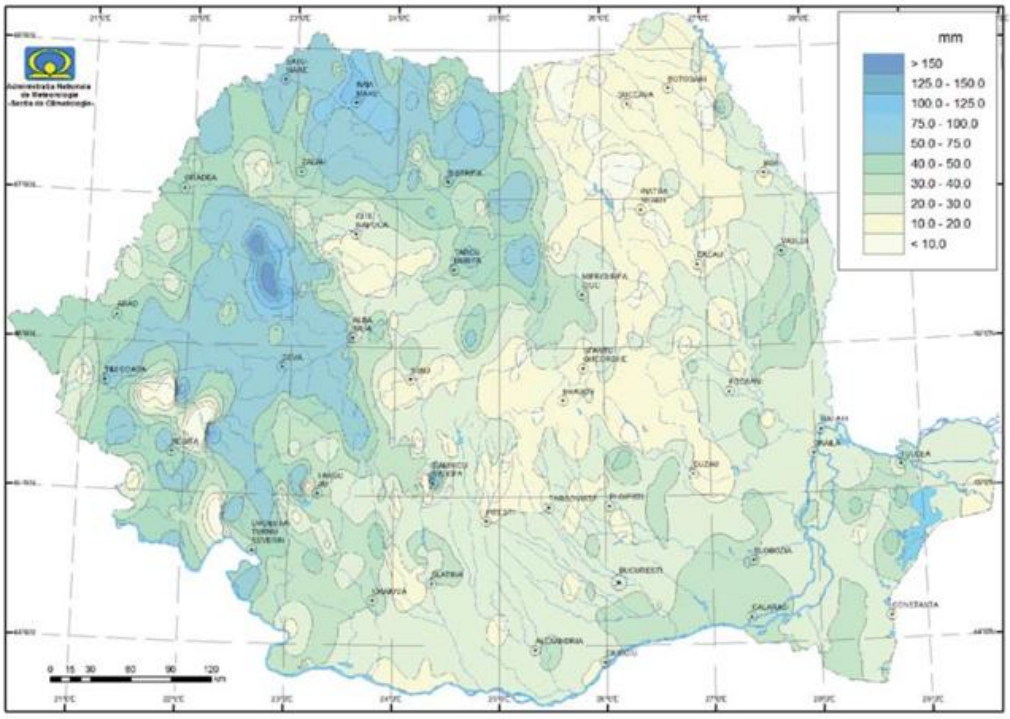

***Fig. 12.5**: Precipitation totals on 21–31 December 2009 in Romania*
Source: National Meteorological Administration, Dep. of Climatology, Romania

ECSN Activities Report 2009

Support and co-operation in best climate practices

Responsible Member: KNMI; Programme Manager: Aryan van Engelen

The objective of ECSN, the **European Climate Support Network**, an optional Programme of EIG EUMETNET (in 2009, EUMETNET was transformed into an Economic Interest Group, a legal entity), is to support its 25 members in their climate practices in order to provide better products and services to the European user community for the benefit of the environment, safety, economy and health.

In 2009, this objective was realised by a range of activities: running new **programmes** and **projects** (ECA&D, S-EUROGRID/EUMETGRID, ECSM/EuCLIS, PEP725, Climate Change Services and HIST-EU), focusing on a better understanding of Europe's past, present and future climate and the provision of data and products, **participating** in or collaborating with major EU research projects: ENSEMBLES, MILLENNIUM and EURO4M, **communicating** and **co-operating** with other parties such as WMO, WMO-RAVI, EEA, ESA, EUMETSAT, EUMETNET-EUCOS, EUMETNET-SRNWP and **co-ordinating** activities: preparing and organizing the climatology programme of the EMS-ECAM 2009, the ECSN Data Management Workshop 2009 and the EMS-European Conference on Applied Climatology 2010.

S-EUROGRID (SMHI) & **EUMETGRID** (Met.no, http://eumetgrid.eu)

The main objective of EUMETGRID is to develop and maintain a sustainable pan-European data infrastructure for accessing and distributing gridded climate information, based on the NMHS's sustainable observational network, databases and meteorological infrastructure. The EUMETGRID programme aims to build an operational platform for the production and distribution of high-resolution gridded climate data based on the best available national and international high-resolution gridded data sets in Europe. Given that the activity is based on already existing and planned national operations and national and international infrastructure, this project will provide crucial input to climate change/variability assessments, decision support and adaptation. EUMETGRID will develop specifications and implement a data infrastructure for the exchange of gridded climate data based on national contributions through distributed databases. This will ensure access to the best available gridded climate information for any point in Europe.

Highlights:

- S-EUROGRID, the preceding pilot of EUMETGRID, successfully completed.
- EUMETGRID proposal accepted by EIG EUMETNET GA.

EuCLIS/ECSM (DWD, http://www.dwd.de/ecsm)

The aim of EuCLIS/ECSM is to build a sustained operational Web-platform for climate monitoring products in WMO-RA VI. These efforts complement successful regional climate monitoring activities such as the RA VI Bulletin, the European contribution to the annual BAMS Article on the State of the Climate, European contributions to the annual WMO Statement on the Status of the global Climate, ECA&D etc. All these activities together provide basic components of a systems-approach for a co-ordinated operational climate monitoring in WMO

RA VI. Based on the analysis of a questionnaire on RA VI operational climate monitoring requirements (Gocheva, Hechler, Dec 2007), the systems-approach aims at implementing a RA VI RCC (Regional Climate Centre) node for climate monitoring.

Highlights

- 20 countries contribute to ECSM.
- EuCLIS will be the future technical platform of the RCC on Climate Monitoring, currently is in the official pilot phase.

ECA&D-ENSEMBLES/MILLENNIUM/EURO4M (KNMI, http://eca.knmi.nl)

The European Climate Assessment and Data set (ECA&D) aims to create and maintain a pan-European data set of high-quality daily observational series and, on the basis of derived climate change indices, to produce assessments of Europe's changing climate. ECA&D is based on a dataset (E-OBS) which currently comprises approx. 3300 stations and over 12.700 time series. E-OBS is the baseline dataset serving the EU FP projects EMSEMBLES, MILLENNIUM and EURO4M. Like EuCLIS, it will serve as a platform for a RA VI Regional Centre on Climate Data.

Highlights

- EURO4M, an EU FP7 proposal, received funding, the project started in January 2010.
- When the ECA&D became operational, “The European Climate Assessment & Dataset (ECA&D) Report 2008 - towards an operational system for assessing observed changes in climate extremes” was published and disseminated among project participants.
- ECA&D will be the technical platform of the RCC on Climate Data, currently in the official pilot phase.

PEP725 (ZAMG, www.zamg.ac.at/cost725)

Phenology is the study of the timing of recurring biological events in the animal and plant world, such as leaf unfolding and flowering of plants in spring, fruit ripening, colour changing and leaf fall in autumn, as well as the arrival and departure of migrating birds and the timing of animal mating. During the past decade, phenology has rapidly become an important tool for climate change impact studies.

Under Cost Action 725, a prototype database of European phenological records was set up. An ECSN project proposal under the name PEP725 aims at the establishment and sustainable management of a full-scale phenological database.

Highlights

- PEP725 proposal accepted by EUMETNET GA.

EIG EUMETNET Framework for Climate Services on Climate (Change) Information (KNMI)

EUMETNET GA decided to commission a review (to be co-ordinated by ECSN) in the context of a growing European requirement for providing climate services across EIG EUMETNET Members, taking account of the outcomes of the following events:

- The initiative to establish a Global Framework for Climate Services, announced by WMO and discussed and elaborated at the third World Climate Conference (WCC3), early September in Geneva.
- An international workshop "Climate change information services for decision making and adaptation" (KNMI, De Bilt, 10-11 Sept.).
- The RA VI-XV meeting (Brussels, 18-24 Sept.), where the establishment of RCCs was discussed.

The Assembly agreed to establish the Climate Change Services Working Group, co-ordinated by KNMI and ECSN, which should work in close co-operation with WMO and take into account the capabilities of EIG EUMETNET Members, including the Regional Climate Centres, in order to assess how to improve the co-ordination of existing institutions and infrastructure in the domain of Climate Services in Europe.

HIST-EU (ZAMG)

The responsible member of the successfully completed HRT-GAR project (ZAMG) launched this initiative in order to extend the current HIST-ALP project (aiming at the creation of a database of long-term monthly homogenised series over the Greater Alpine Region) to the whole of Europe, with the following two main objectives:

- To extend HIST-ALP to HIST-EU with a climatological network described as long-term, of appropriate density, quality-improved, homogenised and of European relevance.
- To support data rescue activities to achieve an optimal European station density.

A proposal for the ongoing EUMETGRID / ECA&D / EURO4M projects is currently being fine-tuned. An appropriate proposal should be submitted to EUMETNET GA in 2010.

WMO-RA VI –XV, Brussels, 18-24 September 2009

The co-operation of ECSN with the WMO RA VI Working Group on Climate Related Matters (WG CRM) resulted in the RA VI RCC Network Implementation plan that was submitted and accepted at the RA VI-XV session (Brussels, 18-24 Sept. 2009). This plan describes the establishment of Regional Climate Centres (RCC) with the ECSN projects EuCLIS (DWD, RCC on climate monitoring) and ECA&D (KNMI, RCC on climate data) as nuclei. As a next step, ECSN will support the designation of a RCC on Long-Range Forecasting (Météo France and Roshydromet/Russian Federation).

ECSN's support of the Task Team Redesign RBSN/RBCN will be based on requirements originating from the ECSN data projects.

9th EMS Annual Meeting and 9th European Conference on Applications of Meteorology (ECAM), Toulouse, Météo France, 28 September – 2 October 2009

ECSN prepared the session's programme on climatology, the theme was as follows: "Climatology - new services responding to climate change", encompassing 4 topics:

- Climate observations and data management, climate monitoring, reconstruction and mapping, applications for decision support on adaptation and mitigation, climate change and society.
- Climate change assessments of trends and variability.
- Climate prediction and scenarios from seasons to century.
- Documentary and natural proxy data for the study of climate anomalies and hydro-meteorological extremes.

10th EMS Annual Meeting and 9th European Conference on Applied Climatology (ECAC), Zürich, ETH, 13-17 September 2010

In line with the EIG EUMETNET Framework for Climate Services on Climate (Change) Information, ECSN prepared the session programme for ECAC 2010 already in 2009. The theme of the session was: "High-resolution Climatology – towards climate change services".

The session programme deals with the following four major topics, which have been agreed with WMO GFCS:

- Monitoring: towards a reference climate and monitoring change.
- Understanding: processes and climate change.
- Services: translating science to users.
- Plenary discussions: topics include communication and adaptation strategies for climate change.

ECSN Data Management Workshop 2009, Copenhagen, DMI, 4-6 November 2009

At this workshop, European NMSs presented challenges, national experiences & practices in the field of climatological data. The workshop session programme focused on the following topics:

- Data management (behind the colourful maps), encompassing Databases, Dataflow, Quality Control, Data, Observational Practices & Strategy and Present Challenges.
- Products, tools & users.

A special session was devoted to major issues such as EUMETGRID, RCC etc.

Detailed proceedings can be obtained at: http://ecsn2009cph.dmi.dk/

The Ozone Layer over Central Europe in 2009

Wolfgang Steinbrecht, Hans Claude, and Ulf Köhler - Deutscher Wetterdienst

The 2009 total ozone annual mean fell within the expected range. At Hohenpeissenberg, it amounted to 326 DU, clearly higher than the 316 DU observed in 2008. Comparable behaviour was seen over much of the Northern hemisphere. In 2009, the slow recovery of the ozone layer from the large depletion caused by anthropogenic chlorine (from Chloro-Fluoro-Carbons or CFCs) continued. Fig.13.1 shows the long-term development of the annual means of the ozone column at Hohenpeissenberg. In the early to mid-1990s, ozone depletion was exacerbated by the large stratospheric aerosol loading from the Mt. Pinatubo volcanic eruption. Because chlorine loading is still very high, the risk of very low total ozone after a large volcanic eruption will continue for the next 10 to 20 years.

Apart from chlorine and aerosol loading, ozone variations are related to several other factors: The 11-year solar cycle, with an ongoing solar minimum in 2009, favoured low total ozone. The quasi-biennial oscillation (QBO) was easterly at 20 hPa through most of 2009, favouring high ozone. In 2008 the QBO was westerly at 20 hPa, which tends to result in low ozone. The polar winter vortex was disrupted by a record-breaking stratospheric warming in January 2009. This also contributed to high total ozone. In contrast, the vortex was fairly stable in 2008, favouring low ozone. Other meteorological factors, e.g. the North-Atlantic Oscillation, play a role as well.

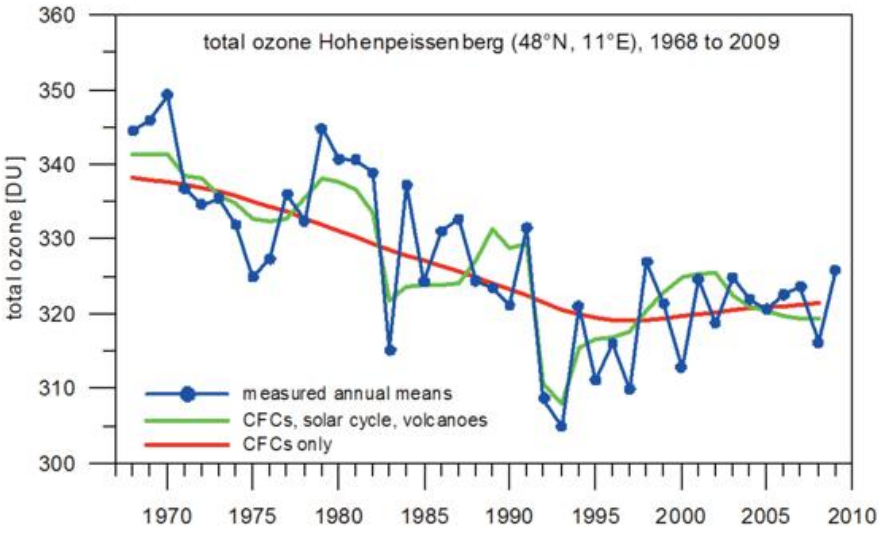

Fig. 13.1: *Blue curve: Total ozone annual means (DU) measured at Hohenpeissenberg. Red curve: Long-term variation attributed to anthropogenic chlorine (from CFCs). Green line: Long-term evolution attributed to chlorine, volcanoes, and 11-year solar cycle. Red and green curves are estimated by multiple linear regression.*

The records of daily column observations at Hohenpeissenberg (Fig. 13.2) reveal significant details between the relatively high annual mean of 2009 and the low annual mean of 2008. The largest differences between these two years occurred in January, February, and December – all winter months. Whereas the northern winter 2007/2008 was a “normal” winter with a fairly stable stratospheric winter vortex, the winter 2008/2009 was characterized by the earlier mentioned stratospheric warming in late January 2009. This major warming was accompanied by enhanced transport of ozone rich air from the tropics northwards, as well as by enhanced descent of ozone rich air over the polar region. In addition, the QBO favoured extratropical downwelling in 2009, but not in 2008. All this resulted in high ozone columns over much of the northern hemisphere in 2009. At Hohenpeissenberg, total ozone in 2009 (red line in Fig. 13.2)

was often above the 67% percentile from January to March (and also in December). On some days values were even near the overall maxima. In contrast, total ozone in 2008 was often below the 33% percentile from January to March, sometimes even near the overall minima. Other Central European stations obtain similar results. This shows that the substantially different ozone annual means in 2008 and 2009 were mainly caused by the different winter conditions in these two years.

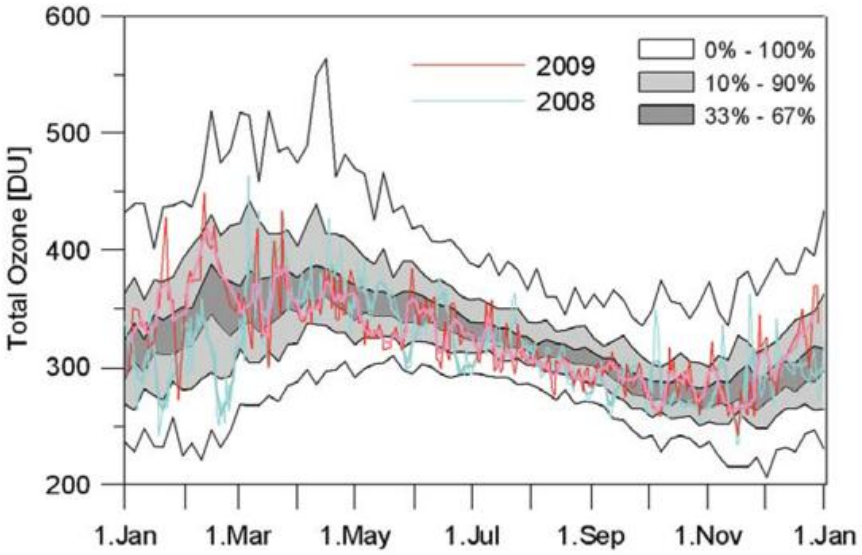

Fig. 13.2: *Red: Daily mean total ozone values observed at Hohenpeissenberg (47.8°N, 11.0°E) in 2009. Pink: 5-day running mean. Light blue/blue-grey: Same for 2008. Shaded ar-eas: Dark grey: 33% to 67% percentile range of all daily mean values observed from 1968 to 2009. Light grey: 10% to 90% percentile range. White range: Minimum to maximum observed daily means (=0% to 100% percentile range).*

The behaviour in the summers is quite different: From May to September, total ozone values in both 2008 and 2009 were usually below the 33% percentile, and sometimes even close to their overall minima. These low values through much of summer are due to the long-term ozone depletion caused by chlorine levels still being high and the ongoing solar minimum. They might also be connected to climate change, because a warmer troposphere and a higher tropopause favour lower total ozone. On sunny days, such low ozone values will result in enhanced UV-radiation at the earth's surface. At wavelengths shorter than 300 to 310 nm the UV-enhancement can be substantial (>30%).

The Bulletin is a summary of contributions provided by the National Meteorological and Hydrological Services. The authors do not warrant, guarantee or take any responsibility regarding correctness, accuracy, reliability, or any other aspect concerning the characteristics or use of the information presented.

The Network of European Meteorological Services
European Climate Support Network

World Meteorological Organization
World Climate Data and Monitoring Programme

Deutscher Wetterdienst
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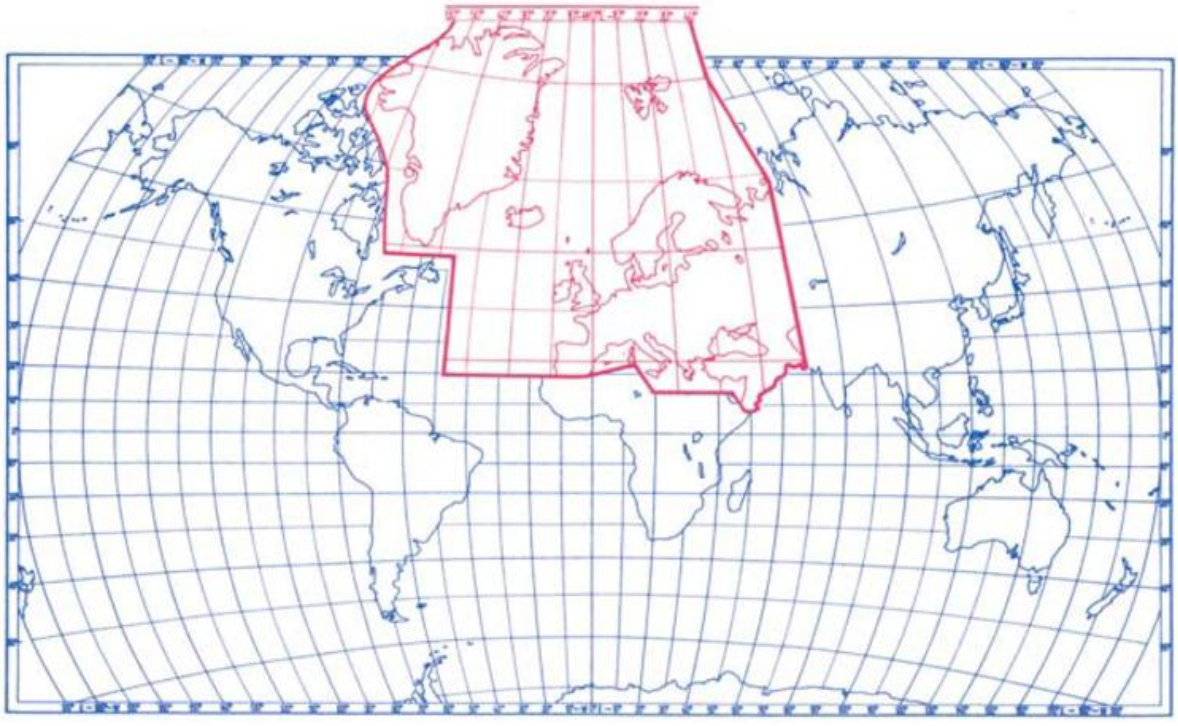
Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2010



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Annual Bulletin on the Climate in WMO Region VI
- Europe and Middle East -
2010

The Bulletin is a summary of contributions
from the following National Meteorological and Hydrological Services
and was co-ordinated by the Deutscher Wetterdienst, Germany

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Foreword

Climate was again a hot topic in 2010, also in RA VI. This time, it was not only the global warming, but also the extreme winter cold spells which attracted much attention from the public. In fact, large parts of Europe experienced a cold and snowy winter 2009/10 and once more an outstandingly cold and snowy December 2010. On the other hand, an extremely long and intense heat wave affected particularly the European part of Russia and neighbouring countries in summer, and mild weather in the Arctic region caused again a very low sea ice extent.

It has become clear that the extremely negative values of the Arctic Oscillation were a main contributor to annual climate variability. In this context, the year 2010 showed very clearly that even in a time of global warming, extreme warm and cold periods can still occur repeatedly, which has to be considered when talking about adaptation strategies.

In terms of precipitation, some areas were equally affected by repeated extremes, such as flooding in eastern central Europe in May and in August and September. As for storms, we still have not forgotten the storm Xynthia crossing France and Germany in late February 2010.

All these examples show that a good co-operation of the national meteorological and hydrological services of our Region in climate issues is essential for monitoring and, as far as possible, forecasting regional climate variability. The development of a Regional Climate Centre (RCC) Network in RA VI is the right step in this direction. I was very pleased to attend the "WMO Workshop on Climate Monitoring including the implementation of climate watch systems in RA VI", which was jointly organised by the WMO and the Deutscher Wetterdienst (DWD) in Germany in 2010, and where representatives of the members of the RCC-Network and of the National Meteorological and Hydrological Services as well as other interested participants came together. The Network is now in its pilot phase, with the designation procedure in progress.

The Annual Bulletin on the Climate in RA VI, which is on its 17th issue this year, continues to be an important backbone within the RCC product suite. Considering the requests of some of our Members to extend our assessments beyond the area of our Region, a global overview of temperature and precipitation anomalies has been added. As in previous years, the Annual Bulletin also presents an extensive summary of all important climate events of 2010 in our Region, compiled from the excellent material provided by many of our Members.

Once again, it is a pleasure for me to thank all the Members for their contributions. My special thanks go to the editorial team of DWD, namely Dr Peter Bissolli, for compiling and writing all the texts and Volker Zins for his technical support as well as to all reviewers.

I wish you a pleasant reading and hope this Bulletin will be helpful for your work in climatology.



Ivan Cacic
President of WMO Regional Association VI

Outstanding Events and Anomalies in 2010

Temperature

- Long and intense heat wave in July and August in European Russia and adjacent areas
- Cold winter 2009/10 and cold December 2010 in large parts of Europe

Precipitation

- Several flooding events in eastern central Europe (May, August, September)
- Long summer drought periods in central European Russia and in the Middle East
- Extensive snow cover in large parts of Europe in winter 2009/10 and in December 2010

Storm

- Heavy storm (Xynthia) over south-western, western and central Europe at the end of February 2010

Annual Survey

1. Atmospheric circulation

The main features of the global atmospheric circulation in 2010 were a transition from El Niño to a very strong La Niña and a strongly negative Arctic Oscillation and North Atlantic Oscillation in particular during the cold season in RA VI, associated with the domination of meridional patterns over Europe.

1.1. El Niño / La Niña

2010 started with El Niño conditions stronger than those at the end of 2009. They were most distinct in February and then weakened rapidly in early spring (Fig. 0.1). A typical feature of El Niño is the stronger subtropical jet and a dislocation of the Icelandic low to a far more southerly position, which was very pronounced in February. As a consequence, wet conditions prevailed over Iberia and the Mediterranean in the winter 2009/10, whereas it was cold and dry particularly in northern Europe.

In April 2010, the Southern Oscillation index entered into a La Niña phase, which became gradually stronger during the course of the year. Full La Niña conditions had arrived in August 2010. The highest value was achieved in December with 2.9 (standardised), which is also the highest value ever reached in at least 60 years (according to data from NOAA) and was assessed as one of the five strongest La Niña events since the beginning of the 20th century. Nevertheless, the impact on the surface pressure field over the North Atlantic and Europe was masked by a strong negative North Atlantic Oscillation and Arctic Oscillation.

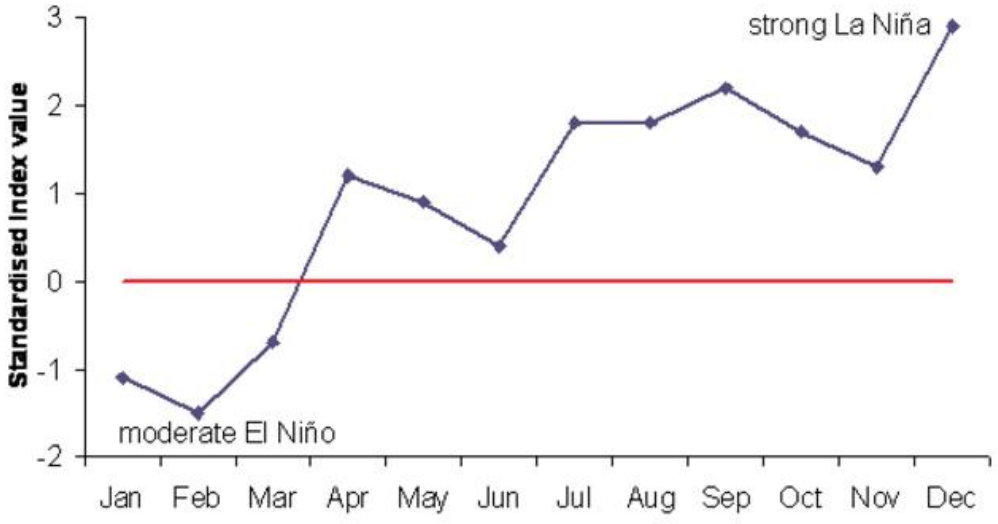

Fig. 0.1: *Standardised Southern Oscillation index for 2010, as expressed by the difference of standardised sea level pressure anomalies in Tahiti and Darwin (Australia)*
Source: NOAA, www.cpc.ncep.noaa.gov/data/indices/soi, 8 February 2012

1.2. Arctic Oscillation (AO) and North Atlantic Oscillation (NAO)

The Arctic Oscillation index (Fig. 0.2) was highly negative during the winter months January and February 2010 and once again at the beginning of the next winter in December 2010. This implies that a mainly meridional circulation pattern prevailed in the northern hemisphere during all winter months. As a consequence, there was a strong meridional exchange of Arctic air masses and milder air masses from more southern latitudes. Thus, most of Europe saw colder winter months than normal, whereas the Arctic was relatively mild. During the rest of the year, the AO index was close to zero, implying only weak impact. Averaged over the whole year 2010, however, the pressure gradient between middle and high latitudes of the northern hemisphere decreased compared to 2009.

The NAO index was negative during almost the whole year, except July when the index was close to zero. This implied the existence of a stronger-than-normal meridional circulation component over the North Atlantic; westerly airflows from the Atlantic to Europe were quite rare. Annual mean air pressure was up to 10 hPa higher in Greenland and the Icelandic low was dislocated towards Newfoundland while the Azores high was weaker than normal. Sea level pressure in Iceland reached its highest annual average on record since 1823 (1014 hPa). Like the AO, the NAO too had an extremely negative phase in the winter months, when the impact of the NAO on Europe is very strong. Iceland was often dominated by high pressure whereas low pressure prevailed over the Azores, which is the quite the reverse of normal conditions. This facilitated the arrival of cold continental air from the east in western Europe and prevalence of moist conditions over the Mediterranean countries.

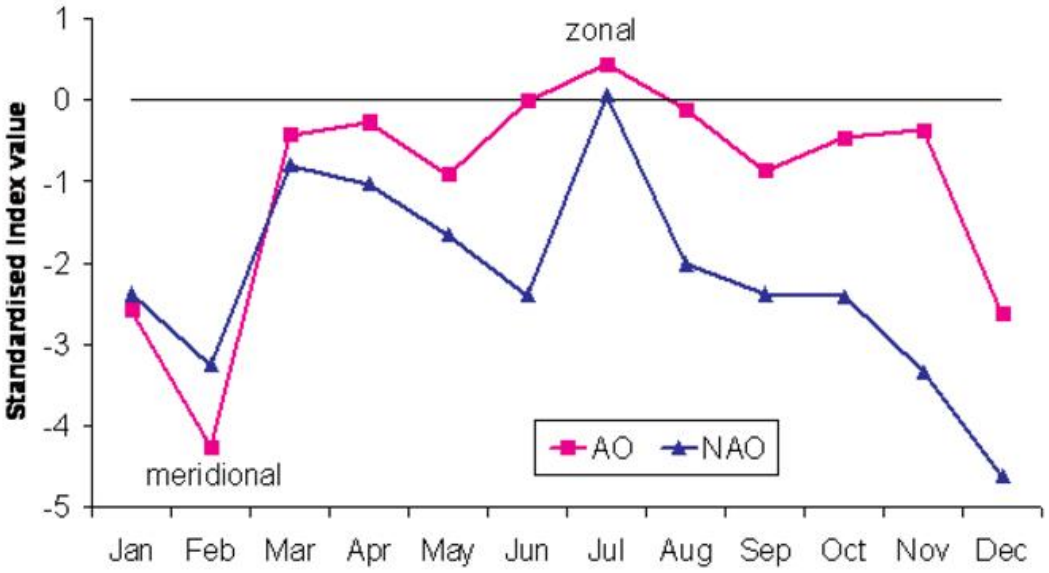

Fig. 0.2: *Standardised Arctic Oscillation (AO) index and North Atlantic Oscillation (NAO) index for 2010, as expressed by the difference of standardised sea level pressure anomalies between southern and northern latitudes over the whole northern hemisphere (AO) and the North Atlantic (NAO).*
Sources (which can also be referred to for more information on the definitions on AO and NAO):
NOAA, www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/ao.shtml
Climate Research Unit, University of East Anglia, United Kingdom,
http://www.cru.uea.ac.uk/~timo/datapages/naoi.htm

1.3. Zonality over the North Atlantic and Europe

Like AO and NAO, the zonal index over the North Atlantic and Europe (Fig. 0.3) also reflects the very extreme meridional situation in January, February and December 2010. In March, however, the zonality returned to normal conditions, and followed more or less the typical annual cycle until October, though with a systematic deviation towards a more meridional mean pattern, particularly in September. In November and even more in December, however, the annual cycle shifted again towards unusual meridional conditions. This shows that mainly the winter months had greatly contributed to a stronger meridionality and thus to a significant cooling in Europe, compared to normal conditions.

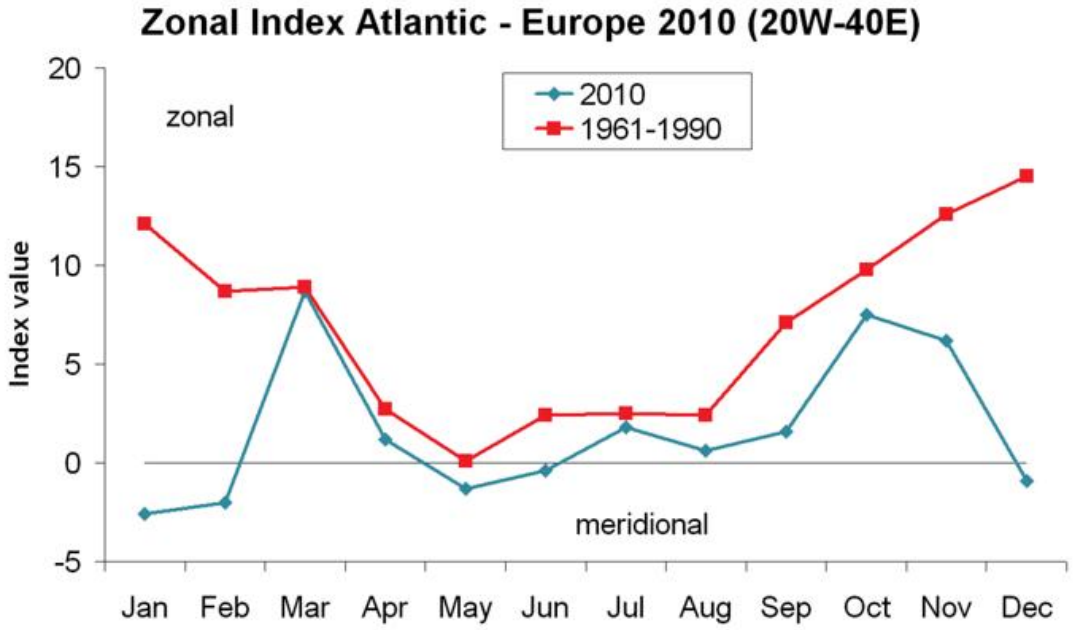

Fig. 0.3: *Zonal index over the North Atlantic and Europe (20°W–40°E) for 2010, as expressed by zonally averaged sea level pressure difference between southern and northern latitudes Source: Deutscher Wetterdienst, www.dwd.de/GWL*

1.4. Sub-regional Overview

1.4.1. Central and eastern North Atlantic

The weather over the North Atlantic was conditioned by a negative NAO almost throughout the year. This resulted either in a meridional warm airflow from south or south-west to the north (in most parts of the year) or in a cold easterly flow from the European continent particularly in the winter months February and December. Zonal airflows from west to the east only dominated in July and partly in autumn.

1.4.2. Arctic regions of Europe

The Arctic Oscillation was negative almost throughout the year, which implies an enhanced meridional exchange of arctic and warmer air masses. Especially the western European Arctic, particularly western Greenland, was influenced by a strong flow of warmer air from the south almost over the whole year.

The whole European Arctic saw considerably stronger-than-normal high pressure conditions and subsiding dry air. Only the eastern parts experienced some longer low pressure periods, especially in March and November.

1.4.3. Northern Europe (Baltic countries, northern European Russia, Scandinavia)

Northern Europe was particularly influenced by the negative Arctic Oscillation, especially in the three winter months (January, February and December 2010), but partly also in March and November when cold and dry air came either from the Arctic region or the cold continent in northern Russia. The summer half year, too, saw some periods when cold Arctic air moved to northern Europe, especially in May, June and October.

Several times over the year, large parts of northern Europe were under strong high pressure influence, with occasional low pressure systems occurring especially in spring and early summer or late summer in the southern parts.

1.4.4. Western and central Europe (Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxembourg, the Netherlands, Poland, Slovakia, Switzerland, United Kingdom)

Western and central Europe was also strongly influenced by the negative AO and NAO, though not as much as northern Europe. Prolonged periods with blocked weather patterns, and an associated absence of westerly airstreams, resulted in a year that was colder, drier and sunnier than average in most of the western areas. The most extreme months were again the winter months, when cold air masses reached all parts of western and central Europe and many low pressure systems with snow moved over central and western Europe, especially in December 2010.

The rest of the year showed quite a large variability, with high pressure situations (particularly in April) alternating with some intense low pressure systems.

1.4.5. Iberia

From January to March, Iberia was frequently affected by southerly frontal zones resulting from the stronger subtropical jet caused by El Niño.

The rest of the year was characterised by a large variability of cold and warm spells due to many meridional situations. Cold air from the north frequently reached Iberia, partly in spring and especially in autumn. In July and August, intense high pressure influence prevailed particularly in Portugal, partly as a result of a strong subtropical high associated with a developing La Niña.

1.4.6. Mediterranean (including Italy, Monaco and Malta)

In the winter 2009/10, the whole Mediterranean region was affected by a strong subtropical jet and more and stronger low pressure systems, triggered by El Niño. Throughout the year, frequently occurring meridional patterns brought cold air as far southwards as the western Mediterranean, especially in winter due to the highly negative Arctic Oscillation. Conversely, the Eastern Mediterranean was mainly affected by warmer air from the south and often under the influence of high pressure.

1.4.7. Balkan Peninsula (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Slovenia)

The Balkan Peninsula was mostly influenced by warm air from the south. Cold air masses from more northerly parts of Europe reached these parts rarely, except in September and October and on some occasions also in the winter months. However, low pressure systems affected the peninsula frequently throughout the year.

1.4.8. Eastern Europe (Belarus, western Kazakhstan, Moldova, Romania, central and southern European Russia, Ukraine) and South Caucasus region (Armenia, Azerbaijan, Georgia)

In January, eastern Europe was strongly affected by cold continental air, particularly in the north. Meridional air mass exchange began to develop in February and the area was dominated by warmer air masses. However, especially in spring, temporarily colder air masses reached the South Caucasus. In summer, high pressure and warm and mostly dry air dominated the weather in eastern Europe, particularly in Russia where it caused an extremely long hot and dry period. High pressure conditions continued also in early autumn, but cold air masses came to central parts of eastern Europe particularly in October. In November, a southerly airflow advecting warm air from the south dominated, whereas polar air arrived from the north and extended southwards in December.

1.4.9. Middle East (Cyprus, Israel, Jordan, Lebanon, Syria, Turkey)

The Middle East was mainly affected by warm air from the south throughout the year. Intrusion of colder air from the north was very rare, mostly affecting only parts of Turkey. However, intense low pressure systems with abundant rain occurred at times, especially over Turkey in the cold months.

2. Temperature

2.1. Global Overview

According to WMO information, the year 2010 ranked as the warmest year on record, together with 2005 and 1998 since, at least, 1850. Data received by the WMO show no statistically significant difference between global temperatures in 2010, 2005 and 1998 (Fig. 0.4). The global mean temperature has increased by +0.7°C during the period 1881–2010 (linear trend).

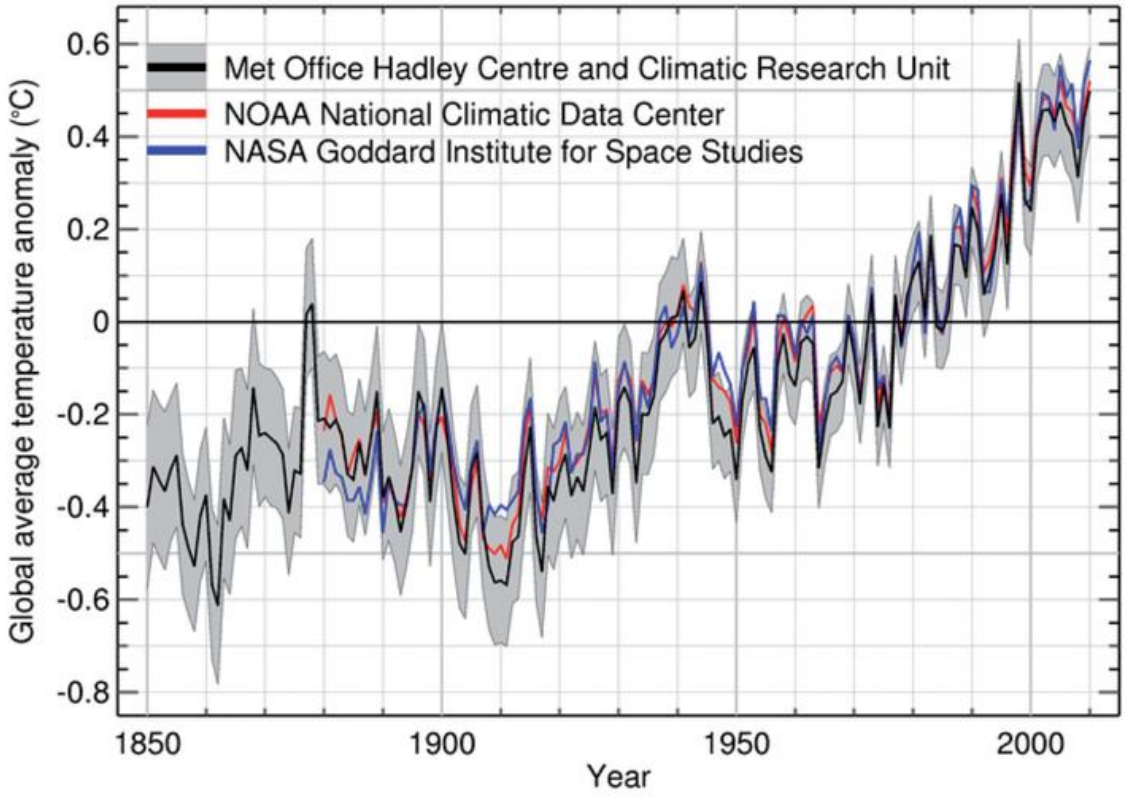

Fig. 0.4: *Mean global annual temperature anomalies 1850–2010 (reference period 1961–1990) Source: WMO, http://www.wmo.int/pages/mediacentre/press_releases/images/906_2010dataset.PNG*

The global annual mean temperature anomaly in 2010 was +0.53°C. This value is 0.01°C above the nominal temperature in 2005, and 0.02°C above 1998. The difference between the three years is less than the margin of uncertainty (± 0.09°C) in comparing the data. These statistics are based on data sets maintained by the UK Meteorological Office Hadley Centre/Climatic Research Unit (HadCRU), the U.S. National Climatic Data Center (NCDC), and the U.S. National Aeronautics and Space Administration (NASA). Highest anomalies were recorded in March (warmest March on record), lowest in December. The global mean temperature itself was 14.53°C in 2010.

In the northern hemisphere, the year 2010 was the warmest year on record; not so in the southern hemisphere, however, where the year nevertheless was still among the five warmest years.

For global land areas, a global anomaly of +0.92°C was computed according to NOAA data (Fig. 0.5). This was the second highest since 1880, behind 2007 (+0.96°C). In 2010, the earth's oceans were +0.37°C warmer than normal, making it the third warmest year since 1880 according to NOAA, following slightly behind 2003 (+0.39°C) and 1998 (+0.39°C).

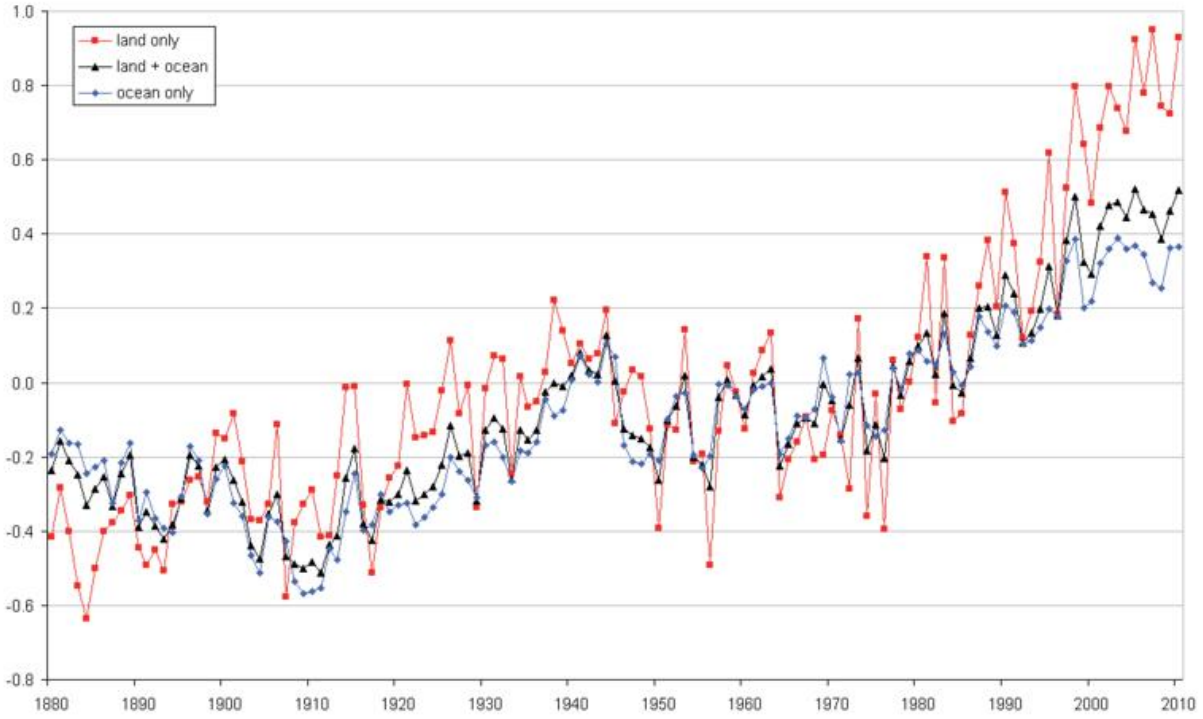

Fig. 0.5: *Mean global annual temperature anomalies 1880–2010 (recomputed to the reference period 1961–1990) over land, oceans, and land and oceans combined.*
Source: NOAA/NCDC, http://www.ncdc.noaa.gov/cmb-faq/anomalies.html#anomalies

2010 was warmer than normal over most of the global land areas (Fig. 0.6). The highest anomalies were reported for eastern Canada (more than +5°C on Baffin Island) and western Greenland. Other far warmer-than-normal areas (> +2°C) were northern Africa, the Middle East and north-eastern Russia. In some of these areas, this was the warmest year on record (western Africa, Sahara and Arabic Peninsula, Mediterranean, southern Asia, central and south-western Asia, Greenland and northern Canada). Exceptional heat waves in summer in several parts of Eurasia contributed largely to the high annual temperature level.

It was colder than normal particularly over northern and western Europe, central Russia, central and eastern Australia, parts of the Antarctic and a few smaller areas in north and south America, locally below -1°C.

Especially the spatial distribution of anomalies over the northern hemisphere reflects prevailing meridional circulation patterns associated with a highly negative Arctic Oscillation, particularly in winter. This circulation pattern modulated the general global warming by cooling parts of Europe and Asia due to meridional exchange of air masses whereas parts of North America were additionally warmer than expected from the global warming trend.

The sea surface temperatures were lower than normal in the eastern Pacific (due to La Niña), but above normal in most of the other regions (Fig. 0.6a). The tropical Atlantic was especially warm, with large parts recording their highest sea surface temperature ever, just like the ocean region around Australia.

Over the ten years from 2001 to 2010, global temperatures have averaged 0.46°C above the 1961–1990 average, and were the highest ever recorded for a 10-year period since the beginning of instrumental climate records. Recent warming was especially strong in Africa, parts of Asia, and parts of the Arctic, with many subregions registering decadal mean temperatures 1.2 to 1.4°C above the long-term average.

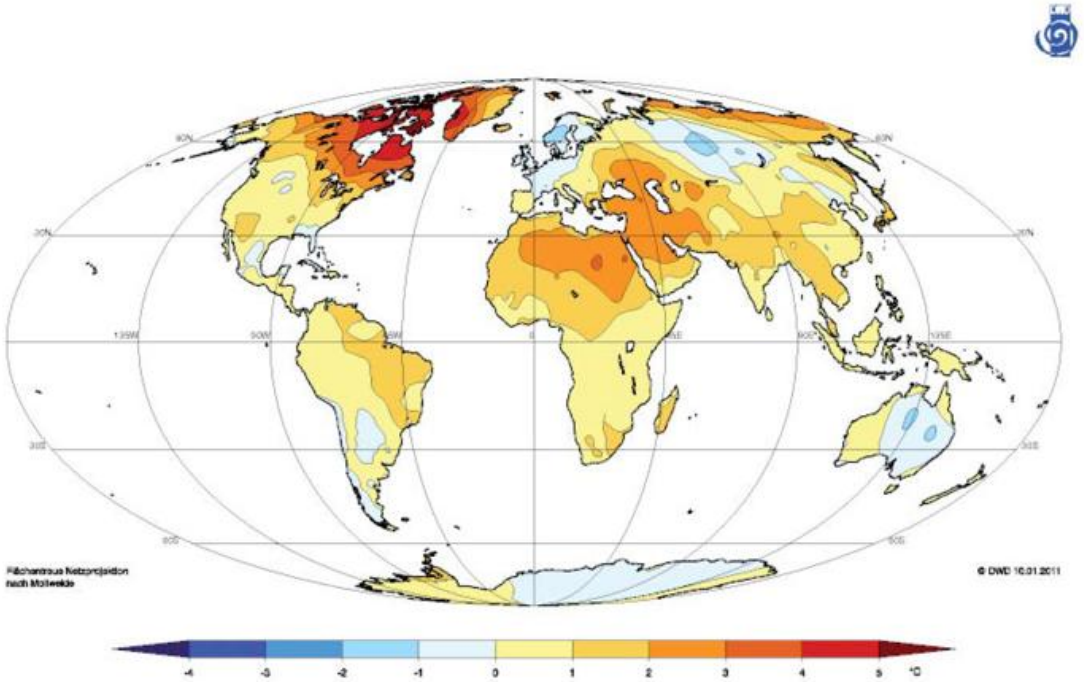

Fig. 0.6: *Mean global annual land temperature anomalies in 2010 (reference period 1961–1990; interpolation of CLIMAT data)*
Source: Deutscher Wetterdienst, Germany

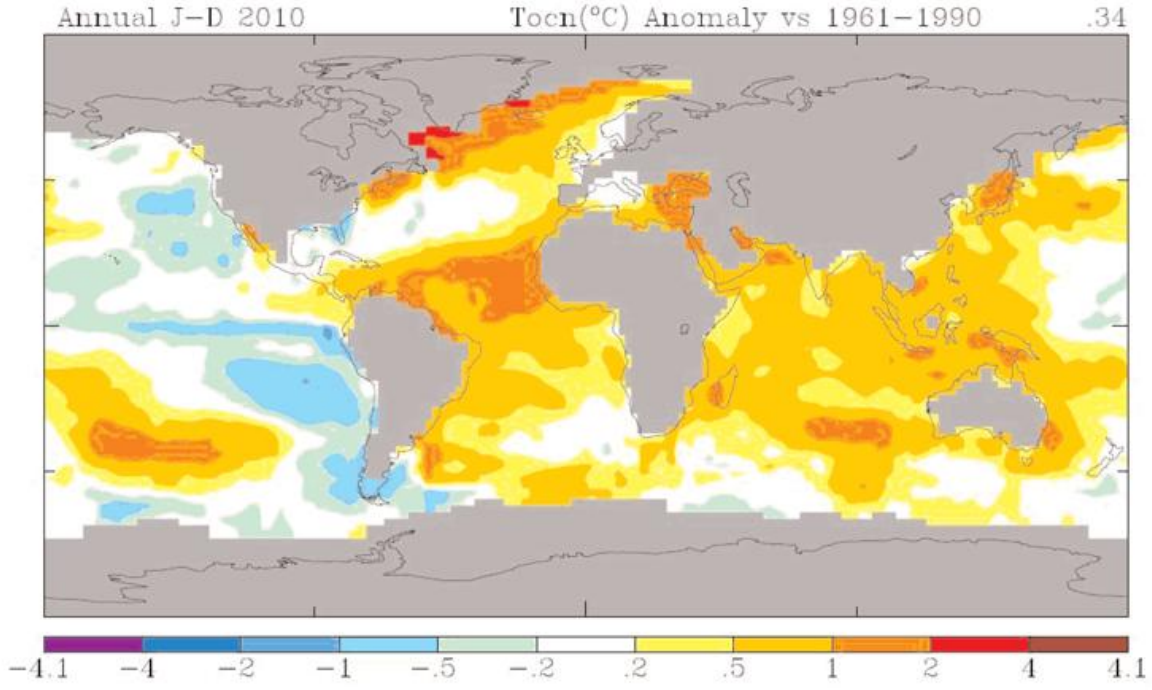

Fig. 0.6a: *Mean global annual sea surface temperature anomalies in 2010 (reference period 1961–1990; data of January 1961 – November 1981 based on ship and buoy data, afterwards on satellite data). Gray areas imply no data.*
Source: NASA Goddard Institute for Space Studies (GISS), http://data.giss.nasa.gov/gistemp/maps

2.2. RA VI Overview

The anomalies observed in 2010 in the RA VI Region cannot be considered as representative for the whole globe. The areal mean for the European continent as well as the areal mean land surface temperature for the smaller area 35°–75°N, 10°W–30°E, both based on data from the Met Office Hadley Centre, were above normal in 2010 (+0.68°C, Fig. 0.7 and +0.24°C +/- 0.13°C, respectively), but clearly colder than all the other years of the decade 2001–2010. The last year in Europe that, as a whole, was colder than 2010 was 1998. Nevertheless, 2010 was still warmer than what is to be expected from a linear trend since 1900. After all, summer 2010 was the warmest summer on European average since 1900 (+2.1°C anomaly) and July and August 2010 were the warmest months for the same period (+2.9°C and +2.3°C, respectively). On the other hand, the cold months January, February, October and December 2010 were all colder than normal in contrast to the other months including the whole warm half year (April–September) which were warmer than normal.

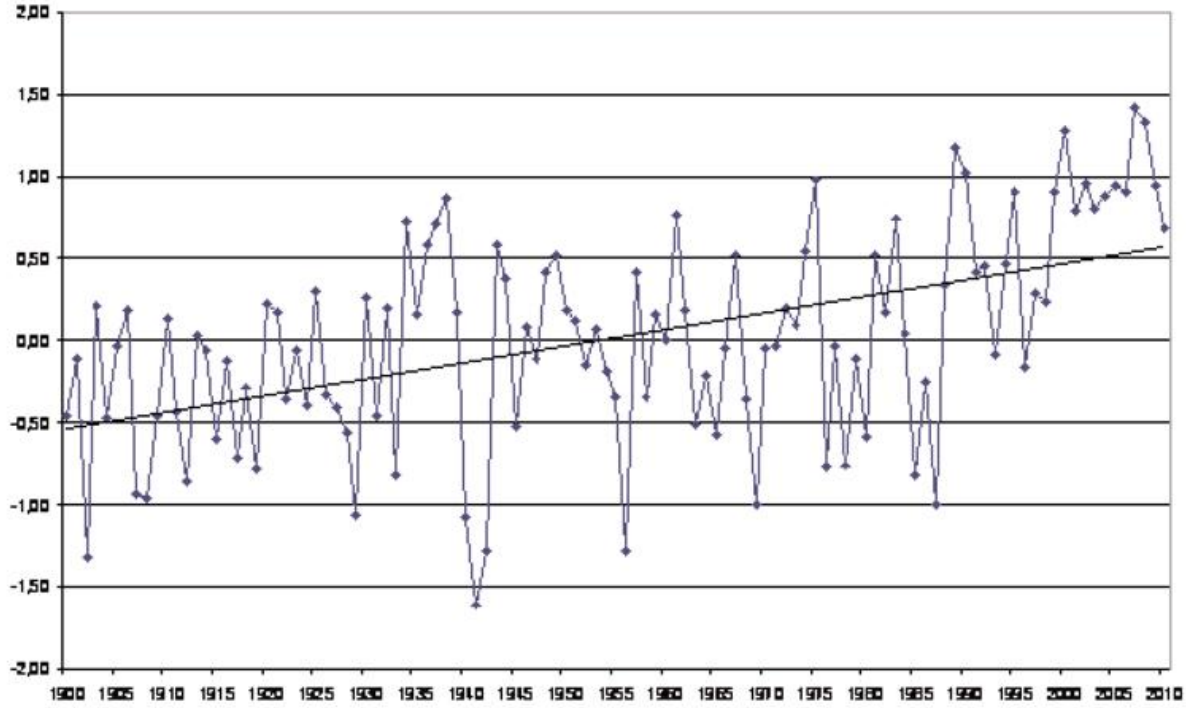

Fig. 0.7: *Mean annual temperature anomalies for the European continent (land areas of geographical continental Europe without islands) for 1900–2010 (reference period 1961–1990), based on data from Met Office Hadley Centre (United Kingdom)*
Source: Australian Bureau of Meteorology

On average, 2010 was colder than normal almost all over northern, north-western, western and central Europe, but only slightly colder in most areas (Fig. 0.8). Highest negative anomalies were recorded in Norway and Sweden, with values below -1°C. This was in contrast to most years of the recent decade during which nearly the whole Region was warmer than the 1961–1990 average. In most of northern, western and central Europe, 2010 was the coldest year since at least 1996 (Tab. 0.1). In some countries, in Germany for instance, the areal mean was below normal for the first time after 13 consecutive warmer-than-normal years.

During many months of the year, most of these parts of Europe were colder than normal, particularly January, February, May and September to December. March and June were cold in northern Europe.

Country	2010 was the coldest year since	2010 was the coldest year for ... years
Norway	1985	25
Sweden	1987	23
Finland	1987	23
Denmark	1996	14
Faroe Islands	1999	11
Latvia	1996	14
Lithuania	1996	14
Ireland	1986	24
United Kingdom	1986	24
Netherlands	1996	14
Belgium	1996	14
Luxembourg	1996	14
France	1996	14
Germany	1996	14
Switzerland	1996	14
Austria (summit regions)	1996	14
Poland	1996	14
Spain	1997	13

Tab. 0.1: *The cold year 2010 in northern, western and central Europe in historical perspective*
Source: Reports from National Meteorological and Hydrological Services

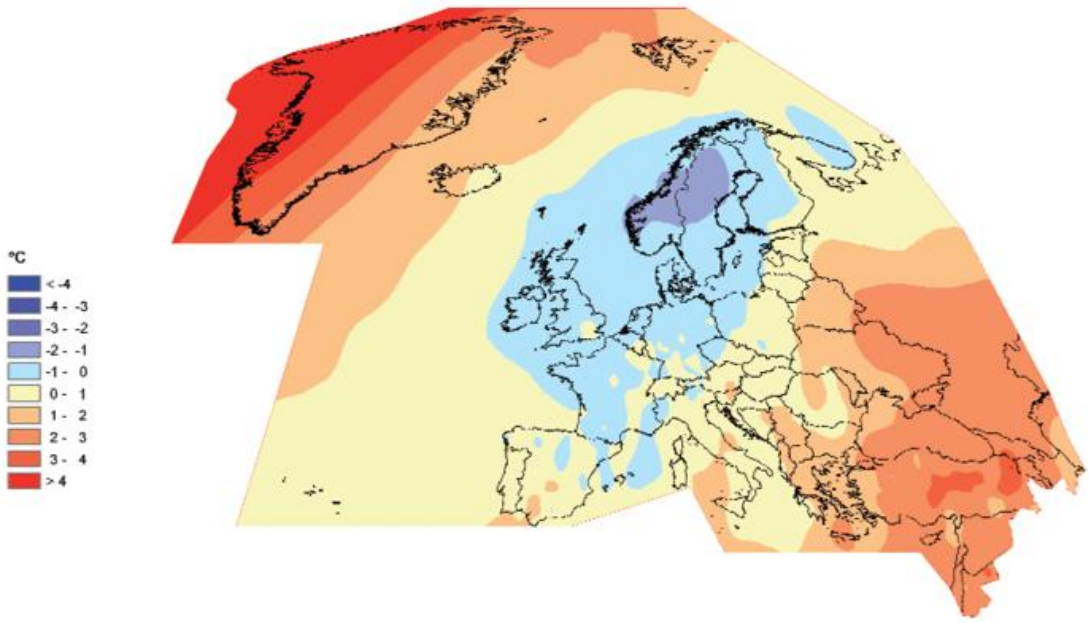

Fig. 0.8: *Mean annual temperature anomalies in 2010 (reference period 1961–1990) in WMO Region VI (interpolation of CLIMAT data)*
Source: Deutscher Wetterdienst, Germany

The rest of the Region was warmer than normal. Highest anomalies were recorded over western Greenland (> +4°C). Most of the other parts of the Arctic and also the south-eastern parts of the Region (southern European Russia, eastern parts of the Ukraine, western Kazakhstan, most of the southern Caucasus, Turkey, Cyprus and the Middle East) were more than +2°C warmer than normal. In most of these areas, the warming persisted more or less throughout almost the whole year, with only short interruptions.

2.3. European Arctic region

On average, the year 2010 was warmer than normal in the whole Arctic region. Annual anomalies ranged from near zero in the east up to +5°C in western Greenland.

While western Greenland was warmer than normal during the whole year, the other parts of the Arctic also saw some colder-than-normal periods, the more to the east, the more frequently. Svalbard, for instance, was colder than normal in March, August and November, though only slightly.

Greenland recorded its warmest decade (2001–2010, anomaly +1.4°C) since the beginning of modern measurements. Most stations in Greenland, except those in the east, recorded their warmest year ever in 2010 (Fig. 0.9).

The average temperature in Reykjavík (Iceland) was 5.9°C (anomaly +1.6°); it has only once been higher and that was in 2003. The temperature has now been above normal for 15 years in a row.

2.4. Northern Europe

Most of northern Europe was colder than normal (Norway, Denmark including the Faroe Islands, Sweden, Finland and western parts of the Baltic countries). Annual anomalies were below -1°C (locally below -2°C) in southern and central Norway and in central Sweden. Especially the cold months were far below normal (January, February, December; Fig. 0.12 for Norway). It was also cold nearly all over northern Europe in June, and partly in March, May and October.

On average, 2010 was warmer than normal in Iceland and in north-eastern Europe (northern European Russia and the Baltic countries). Highest positive anomalies in northern Europe were recorded in Iceland (> +1°C), which was colder than normal only in February, April and November. At +1.6°C, Iceland's capital Reykjavik saw its second warmest year on record. In Lithuania, only February, October and December were below normal.

2010 was the coldest year since at least 1996 in most of the countries in northern Europe, partly even since 1985 or 1987 (Tab. 0.1, Fig. 0.10 and 0.11). This means, it was also the coldest year in the decade 2001–2010. For most of northern Europe (except for the major parts of the Baltic countries), it was also the first year in the 21st century with a negative anomaly compared to the 1961–1990 reference. Even in the north-eastern countries, which were warmer than normal in 2010, it was far colder than in 2009, e.g. almost -1°C anomaly in Lithuania.

However, for whole decade 2001–2010 was the warmest decade on record in many places,for example in Finland since records began in the 1840's, and in Tórshavn on the Faroe Islands since 1890.

2.5. North Atlantic

The northern North Atlantic was +1 to +2°C warmer than normal, whereas the central North Atlantic and the Azores Islands were also warmer, but less than +1°C. Especially the warm half year (April to October) was clearly warmer than normal; the winter months were partly colder, particularly February.

While the minimum temperatures on the Azores were higher than normal, the maxima proved to be lower. In particular, there were more tropical nights than normal in the months July to September.

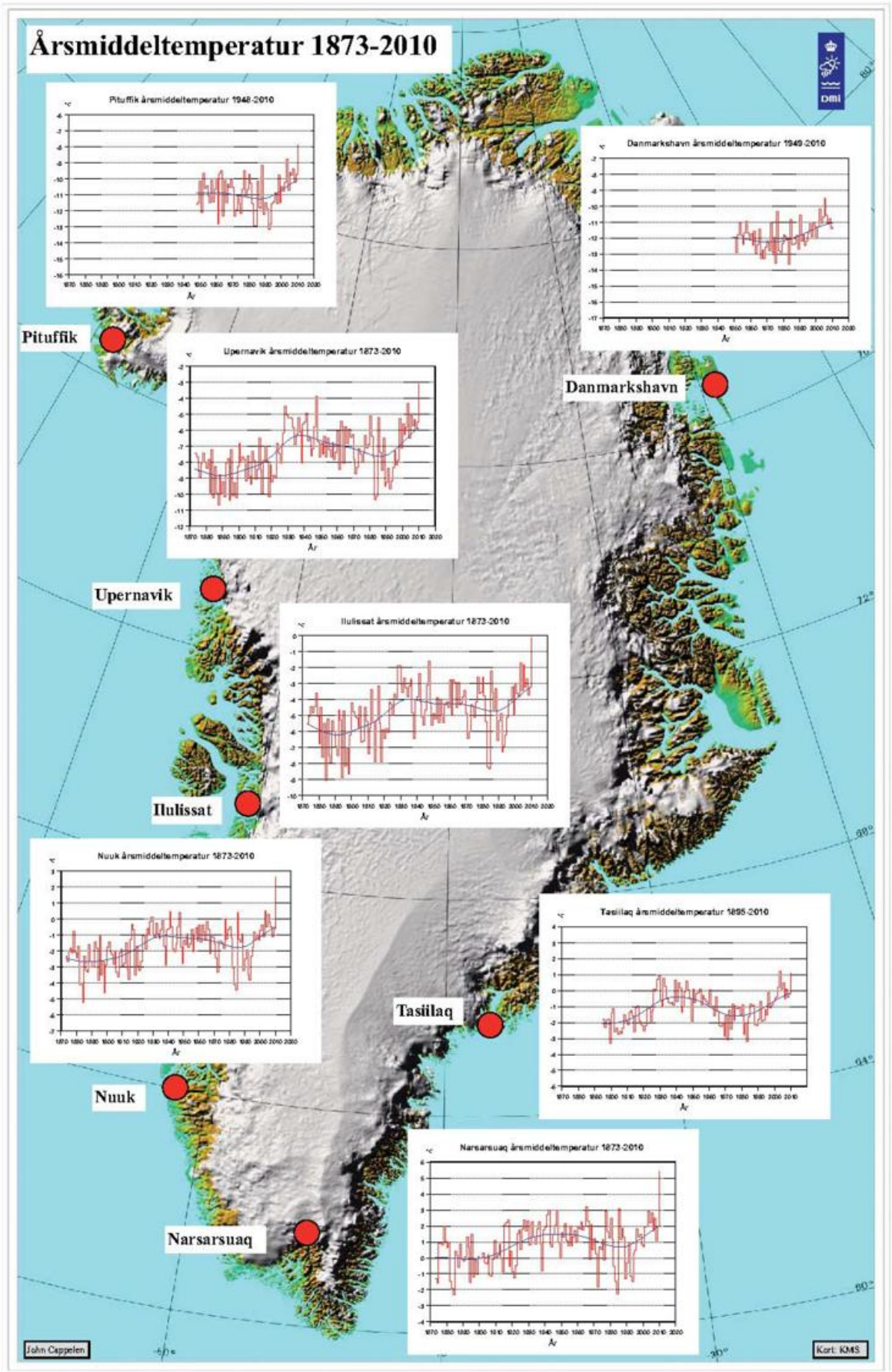

Fig. 0.9: *Mean annual temperature 1873–2010 at various stations in Greenland*
Source: Danish Meteorological Institute

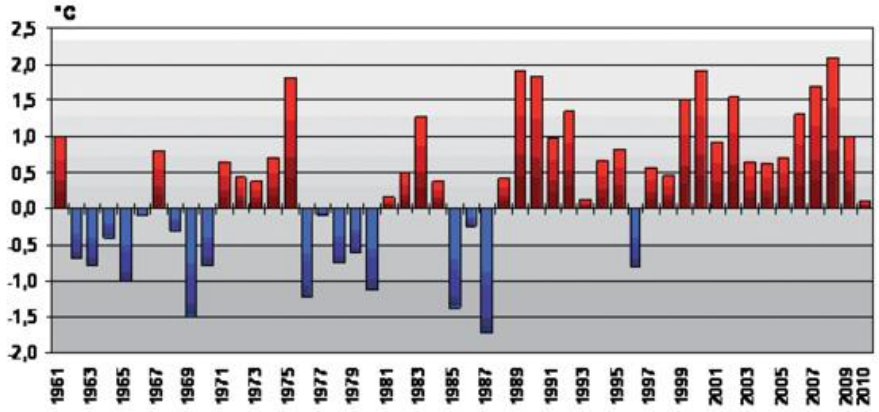

Fig. 0.10: *Mean annual temperature anomalies in 1961–2010 (reference period 1961–1990) in Lithuania*
Source: Lithuanian Hydrometeorological Service

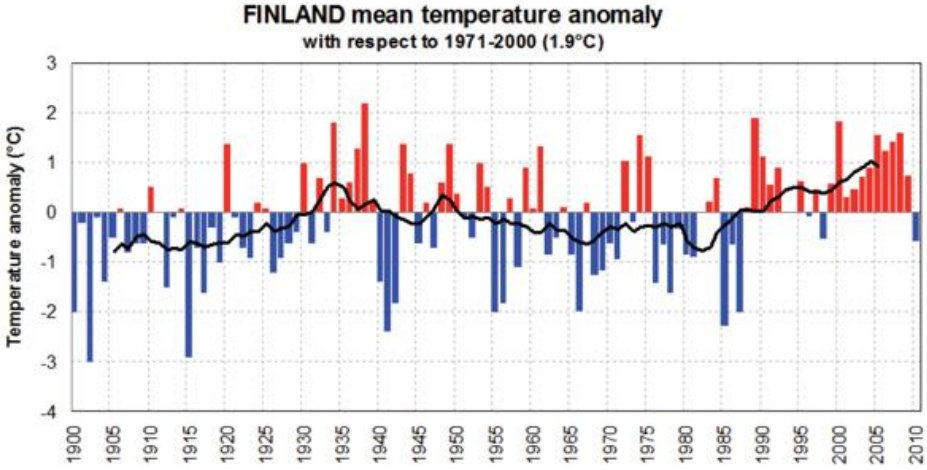

Fig. 0.11: *Mean annual temperature anomalies in 1900–2010 (reference period 1971–2000) in Finland*
Source: Finnish Meteorological Institute

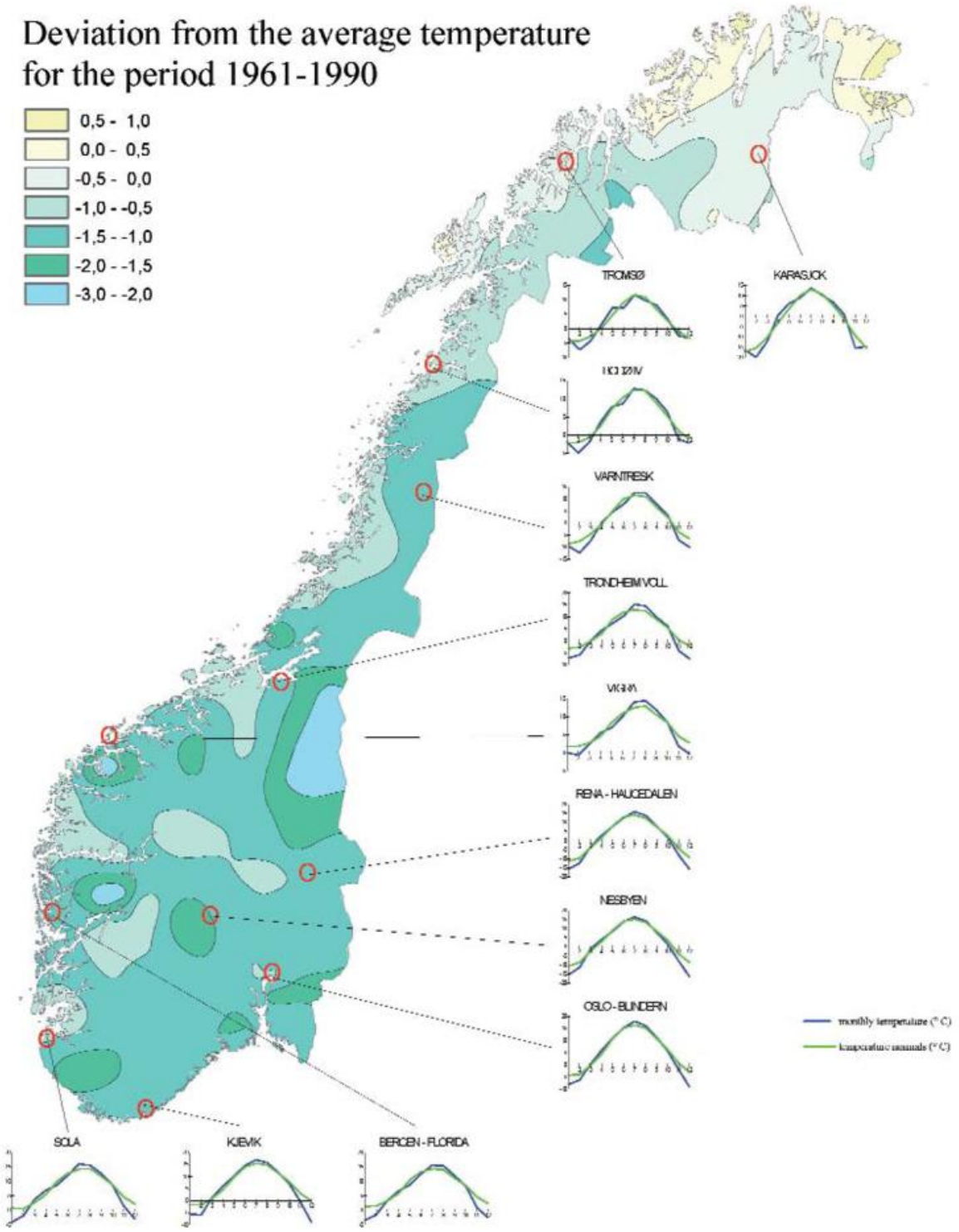

Fig. 0.12: *Mean annual temperature anomalies in 2010 (reference period 1961–1990) in Norway*
Source: Meteorologisk Institutt met.no, Norway

2.6. Central and Western Europe and the Alpine region

All over western and in most parts of central Europe (except for the east and the Alpine region), it was slightly colder than normal (between 0 and -1°C), mainly due to the cold months January, May and December.

In these areas, the cold year 2010 was characterised by a high number of extremely low mean daily temperatures, frost and ice days. In the United Kingdom, this was revealed, for example, by the daily Central England Temperature (CET) time series, which displayed several extremely low mean daily temperatures particularly at the end of the year (Fig. 0.13). Germany saw an extended frost period from 2009 until March 2010; peaks of minimum temperature were below -24°C locally in eastern and south-eastern Germany. The number of ice days was more than twice as high as usual. De Bilt in the Netherlands had 29 ice days (normal: 8) and 88 frost days (normal: 58), but also a number of warm days (maximum temperature 20°C or more) that was greater than normal (90 compared to 77). Belgium, too, had a very high number of frost days (74 in Uccle, 1981–2010 normal: 46) and ice days (27 compared to 7). In western Europe and most of central Europe, 2010 was also the coldest year since 1996 (Fig. 0.14 to 0.16).

Eastern central Europe and the Alpine region were slightly warmer than normal, with Slovenia having recorded a temperature of up to around +1.5°C above the normal. However, 2010 was nevertheless the coldest year of the decade 2001–2010 and the coldest year since 1996 in Poland, especially in the western half of the country.

Many months were colder than normal over the whole or almost the whole area, namely January, February, May, September, October and December (e.g. in Poland, Fig. 0.17). Late November was also very cold, marking an unusually early start of the winter weather with very low temperatures until just after Christmas. This was only partly compensated by the relatively warm months April, June and July. In the south-eastern parts of central Europe, on the other hand, November was also very mild on average.

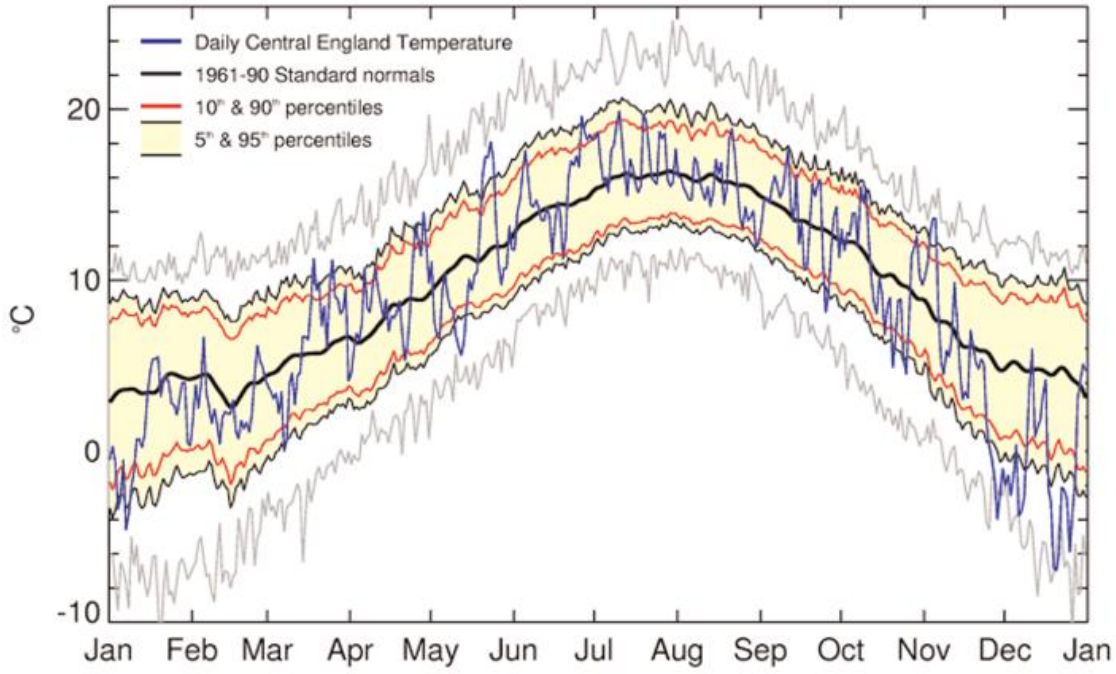

Fig. 0.13: *Mean daily Central England temperature (CET) for 2010. 1961–90 normals are smoothed. The light grey lines represent the highest and lowest values of mean CET in the daily record since 1772.*
Source: UK Met Office

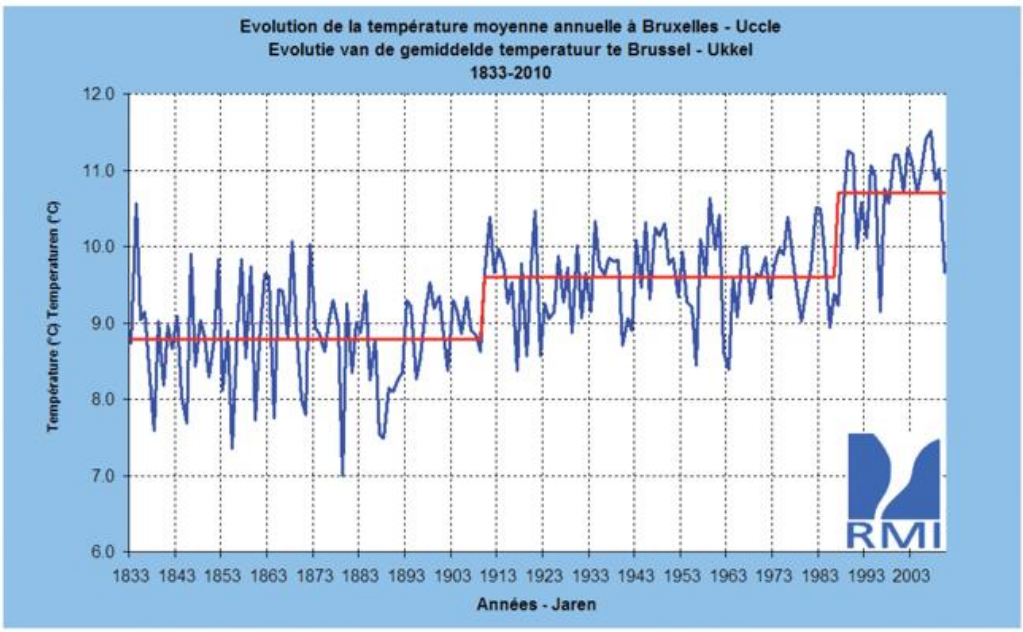

Fig. 0.14: *Mean annual temperature 1833–2010 in Brussels-Uccle (Belgium) and averages over subperiods (red line)*
Source: Royal Meteorological Institute (RMI) Belgium

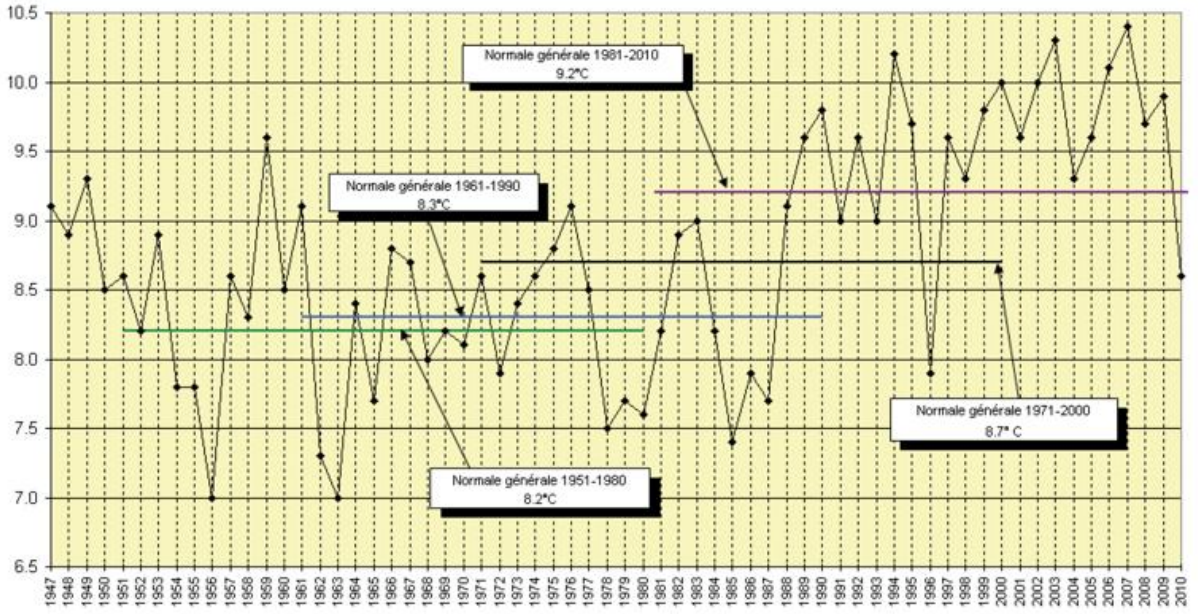

Fig. 0.15: *Mean annual temperature 1947–2010 in Luxembourg, compared to several long-term averages*
Source: Service Météorologique de Luxembourg

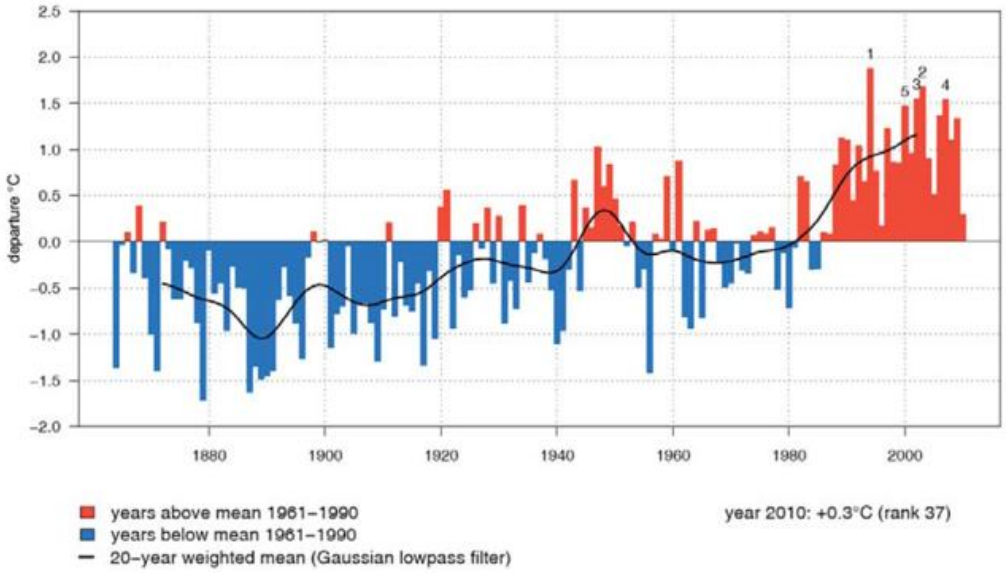

Fig. 0.16: *Mean annual temperature anomalies 1864–2010 in Switzerland (1961–1990 reference)*
Source: MeteoSwiss, Switzerland

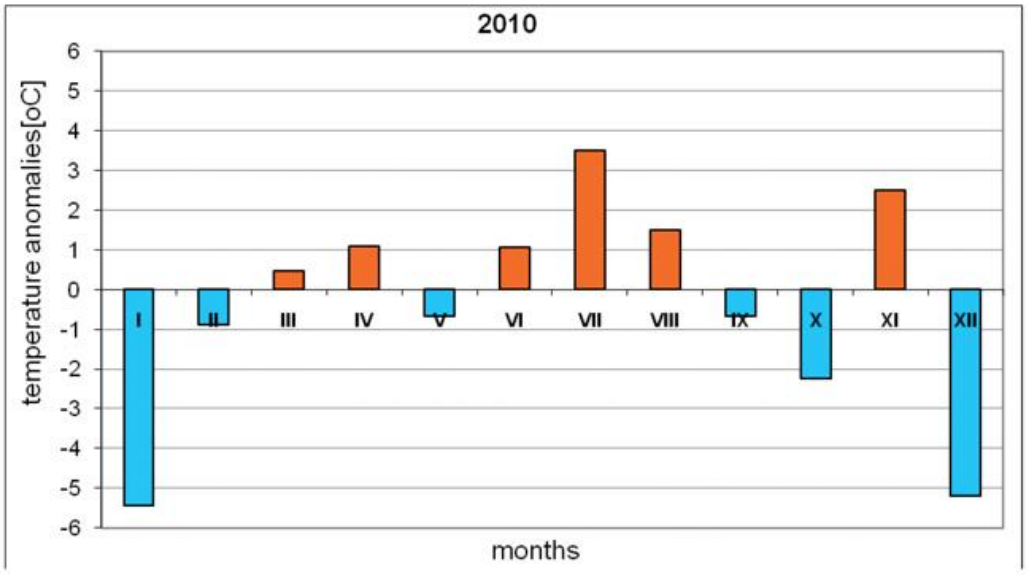

Fig. 0.17: *Mean monthly temperature anomalies in 2010 (reference period 1971–2000) in Poland (average for 20 stations)*
Source: Centrum Monitoringu Klimatu Polski IMGW, Poland

2.7. Iberia

All over Iberia, 2010 was slightly warmer than normal on average (mostly 0 to +1°C). It was particularly warm in April, July and August. The other months were partly colder than the 1961-90 normal; October and November were colder over almost the whole peninsula.

Four heat waves occurred in Portugal in May, July and August. Nevertheless, 2010 was the coolest year since 1997 in Spain.

2.8. Mediterranean, Italian and Balkan Peninsulas

Almost the whole Mediterranean, Italy and the Balkan Peninsula were warmer than normal, but not as warm as the temperatures recorded for most of the previous years of the last decade. Annual anomalies were close to zero over the western Mediterranean and highest in the eastern Mediterranean (more than +2°C). Annual mean temperatures at several stations in Serbia and Bosnia and Herzegovina exceeded the 90th percentile. Athens in Greece had its warmest year since at least 1897, with an annual average of 20°C. Only the Balearic Islands were slightly colder than normal.

In the western Mediterranean region, nearly all months were slightly colder than normal, except April and July. Over the eastern Mediterranean, all months were warmer than normal. The Balkan Peninsula was colder than normal in September and October, in the northern parts also in December; the other months were mostly warmer or around normal; the summer months and November were extremely warm.

The whole decade 2001–2010 was the warmest since the middle of the 19th century in Ljubljana, Slovenia (Fig. 0.18), and Zagreb, Croatia (Fig. 0.19). In Bulgaria, it was the 13th consecutive year with higher temperatures than normal.

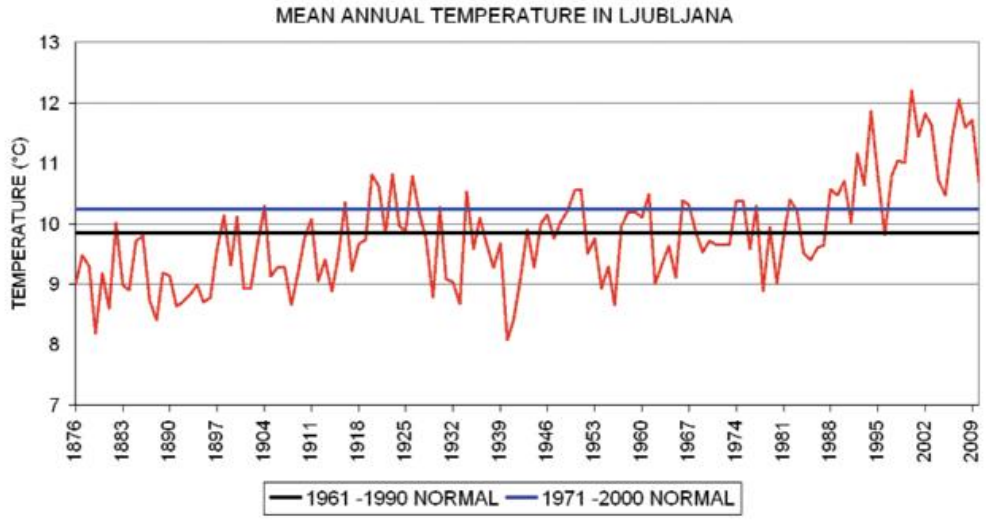

Fig. 0.18: *Mean annual temperature 1876–2010 in Ljubljana (Slovenia)*
Source: Environmental Agency of Slovenia

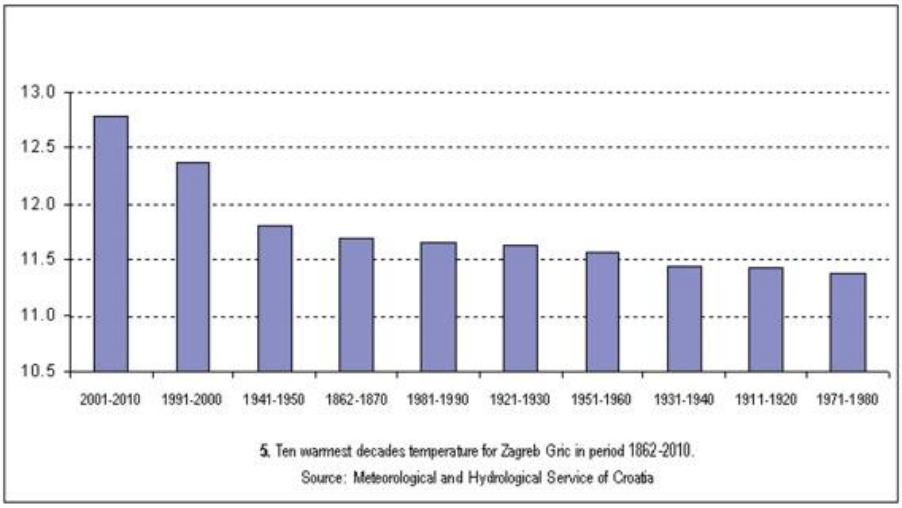

Fig. 0.19: *The ten warmest decades in Zagreb Gric (Croatia) in the period 1862–2010 and their mean temperatures in °C*
Source: Meteorological and Hydrological Service of Croatia

2.9. Eastern Europe and South Caucasus region

All over eastern Europe, the average temperature in 2010 was warmer than normal. The highest annual anomalies were to be found locally in the South Caucasus region and in Turkey (between +3 and +4°C). Anomalies were lower towards the north and the west of eastern Europe. The mean anomaly over European Russia was +1.4°C (mainly due to a heat wave in summer), which is slightly higher than 2009, but less than in other recent years. 2010 was one of the warmest years in the Ukraine, although the anomalies were smaller than further in the east (+1 to +2.7°C).

2010 was the warmest year in the South Caucasus since regular records began more than 80 years ago. It was the warmest year in Armenia since 1929 (Fig. 0.20) and west Georgia since 1951 (Fig. 0.21). 2010 also marked the 17th consecutive year with positive annual temperature anomalies in Armenia. The decade 2001–2010 ranks there as the warmest since 1900.

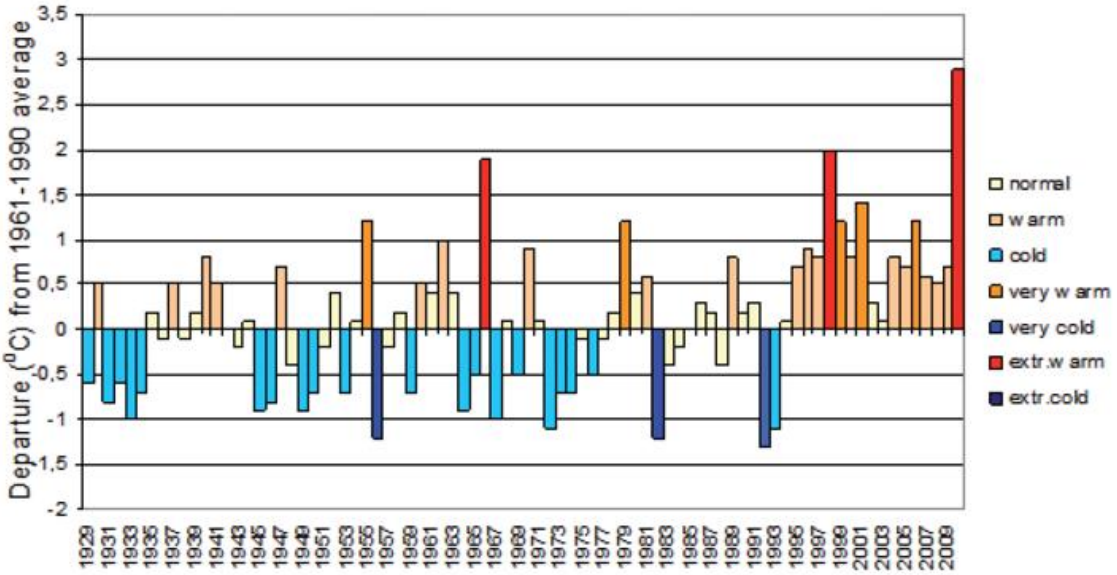

Fig. 0.20: *Mean annual temperature anomalies (1961–1990 reference) 1929–2010 in Armenia*
Source: Armstatehydromet

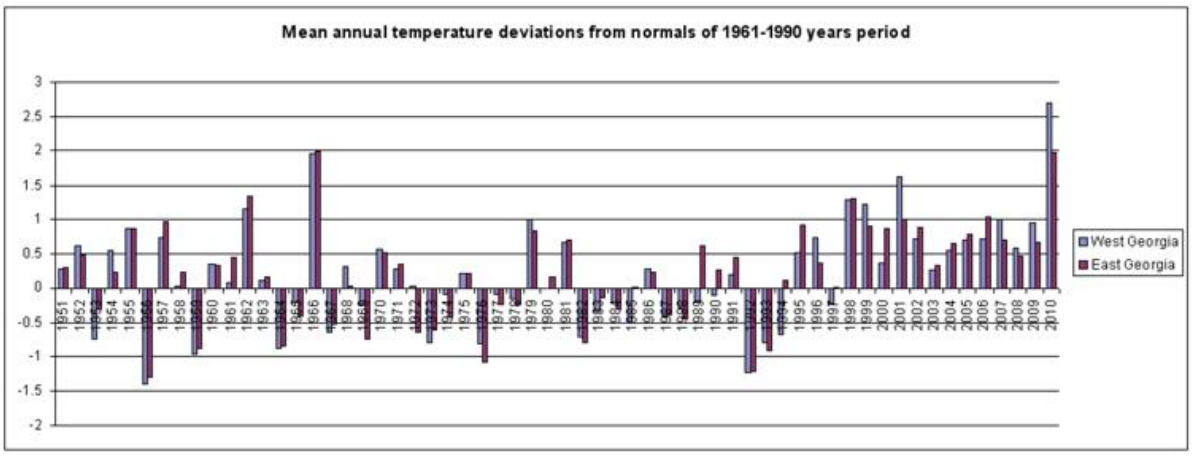

Fig. 0.21: *Mean annual temperature anomalies (1961–1990 reference) 1951–2010 in west and east Georgia*
Source: Department of Hydrometeorology of Georgia

Some months show extremely high positive anomalies (mostly above +4°C) almost all over eastern Europe: for example the summer months June–August as well as November in the Ukraine (Fig. 0.22). Other months were at least very warm in the South Caucasus and southern European Russia (January–March, September, October and December). The northern and western parts of eastern Europe (Belarus, Ukraine, Romania, Moldova, central European Russia and west Kazakhstan) had a few cold months compared to normal, particularly January, October and December.

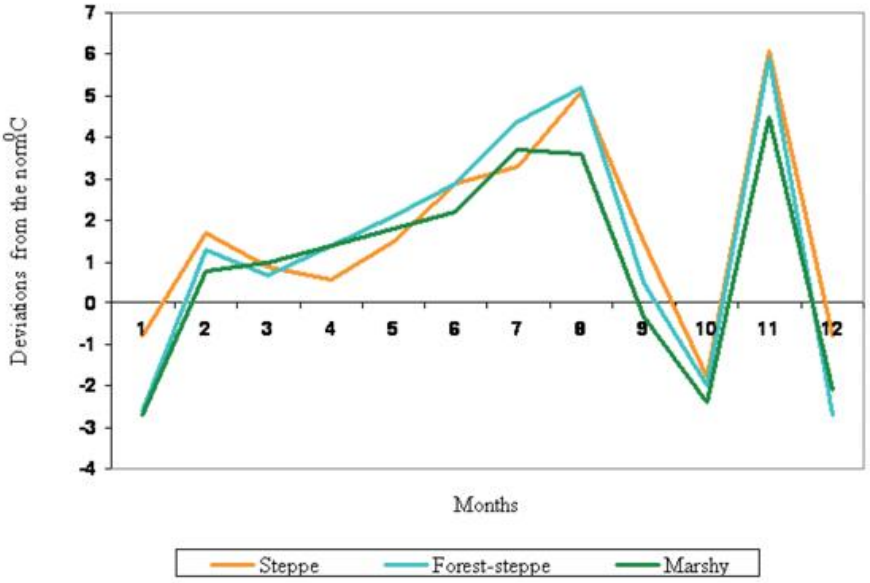

Fig. 0.22: *Mean monthly temperature anomalies 2010 (1961–1990 reference) in various vegetation zones in the Ukraine*
Source: Hydrometeorological Service, Ukraine

2.10. Middle East

The Middle East was much warmer than normal in 2010. Annual anomalies reached or exceeded +2°C almost everywhere, except in western Turkey, where they were slightly lower than that. Some places that normally are known to be the coldest areas in south-eastern Turkey show anomalies of up to +5°C. In Turkey, 2010 was the warmest year on record since 1940, much warmer than the previous years and exceeding an annual mean of 15°C (Fig. 0.23). 209 Turkish stations registered record-breaking monthly maximum temperatures at several occasions (particularly in December), and 14 stations in Turkey set new, absolute all-time daily maxima. The highest temperature in Turkey was 46.7°C in August. Heat wave conditions also prevailed in Cyprus several times, especially in August. Jordan reported seven heat waves in 2010, from May to October, and had its warmest year since 2001. Israel had its warmest January to March and August to November periods on record and recorded the highest annual mean temperature (20.3°C) since 1950 in Jerusalem (Fig. 0.24). These warm periods caused severe damage to agriculture, especially citrus and tomatoes.

The whole area was warmer than normal throughout the year. Only during the period April–June and once more in October, the anomalies were partly lower, or even negative in north-western Turkey.

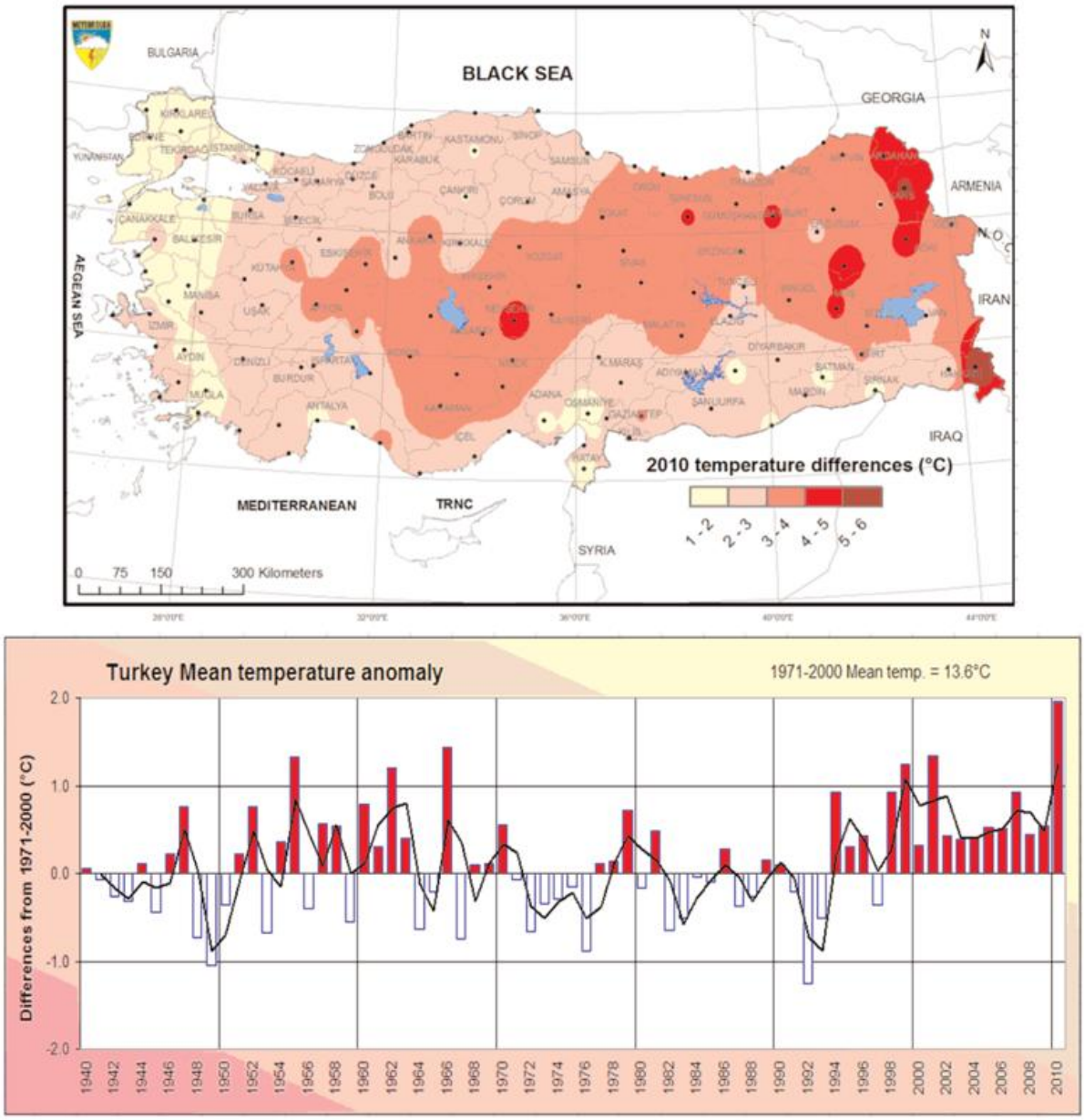

Fig. 0.23: *Annual mean temperature anomalies (reference period 1971–2000) in Turkey. Left: spatial distribution 2010, right: time series 1940–2010 Source: Turkish State Meteorological Service*

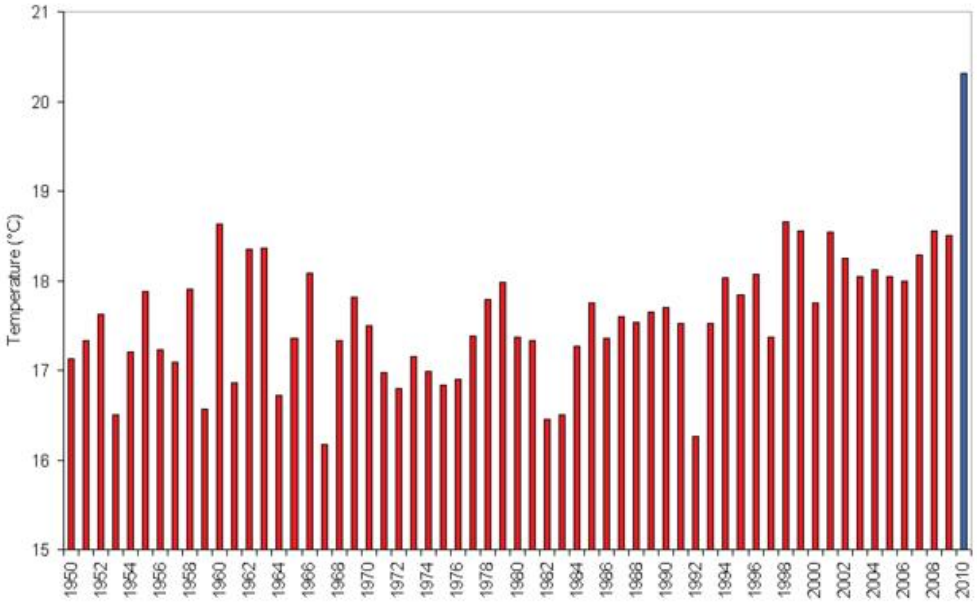

Fig. 0.24: *Annual mean temperature 1950–2010 in Jerusalem*
Source: Israel Meteorological Service

3. Precipitation

3.1. Global Overview

According to an analysis by the United States National Climatic Data Center, globally averaged land precipitation in 2010 was the highest on record since 1900, 52 mm above the 1961–1990 average annual total of 1,033 mm. The previous wettest years, 1956 and 2000, also coincided with strong La Niña events like in 2010. An analysis by the Global Precipitation Climatology Centre (GPCC) ranked 2010 among the top ten in 110 years.

Across all continents, some land surfaces were wetter than normal in 2010 (Fig. 0.25). Several areas were outstandingly wet compared to the normal in terms of absolute and relative anomalies: especially the far north of South America, some eastern and south-eastern parts of Europe, most of India, Indonesia and eastern Australia. Some anomalies are clearly related to La Niña, which developed over the year and caused high precipitation totals over Australia, India / Pakistan and China / North Korea. Flood events in Pakistan (July/August) and eastern Australia (December) caused the death of thousands of people and made millions of people homeless.

Drier-than-normal areas were to be found, e.g. in southern Greenland, north-western Europe, parts of northern and southern America, southern Africa, the Middle East and western Australia.

3.2. RA VI Overview

Within the RA VI Region, much of the land area was also wetter than normal in 2010, especially on the European continent, although the deviations from normal were small in most parts (about two thirds) of that area (Fig. 0.26).

The relative totals for 2010 were particularly high (>125% of the normal, in some regions locally >150%) over large parts of eastern central Europe, the Balkan Peninsula, western Turkey, Italy, the western Mediterranean and southern Iberia. Some places in Turkey, Serbia and Moldova

reported their wettest year on record. Wet periods occurred throughout the whole year, with some extraordinarily wet spells in February in Italy and over the Balkan Peninsula and in May, August and September in eastern central Europe (flooding events).

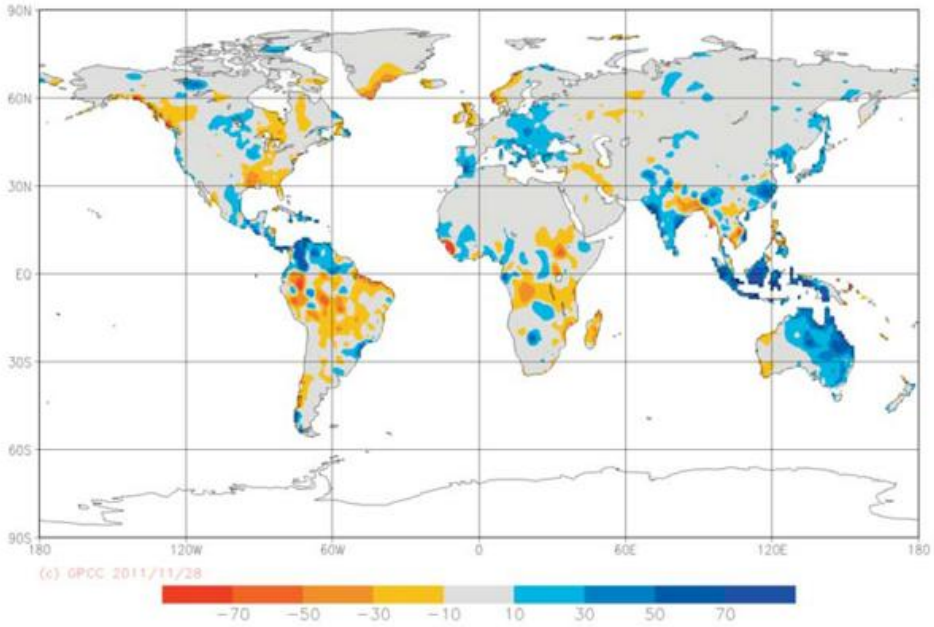

Fig. 0.25: *2010 annual global precipitation anomalies in mm (1951–2000 reference)*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

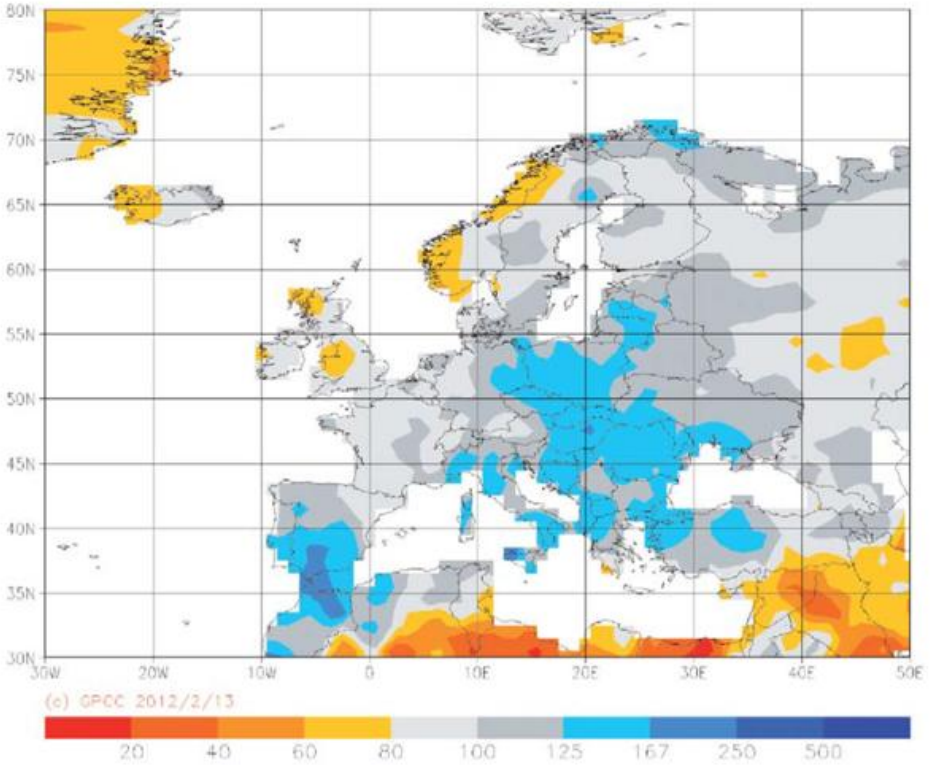

Fig. 0.26: *2010 annual precipitation amounts in WMO Region VI in per cent of the 1951–2000 normal*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Extraordinarily dry areas, however, were located in places particularly in the Arctic region (Greenland, Iceland, Svalbard), but also over the western parts of the United Kingdom and the Norwegian west coast, mostly with less than 80% of the annual total. This was mainly due to the frequent meridional circulation patterns or, expressed conversely, the absence of westerly patterns. It was also very dry in parts of European Russia, Georgia (especially due to a very dry summer) and near the eastern Mediterranean in Cyprus and in the Middle East, especially in the Lebanon, Israel and Syria.

3.3. Northern Europe and the Arctic

Most of the Arctic region was drier than normal. It was particularly dry at the coast of south-eastern Greenland, locally with less than 60% of the normal annual total. Western Iceland and parts of Svalbard also had quite low totals (<80% of the normal). The annual total in Reykjavík (592 mm) was the second lowest ever registered.

Most of northern Europe saw near-normal precipitation or was drier than normal. It was much drier than normal on the Norwegian west coast (locally <80% of the normal), particularly in the cold months.

Only a few places were much wetter than normal (>125%); these were located in northern Lapland, Sweden and the Baltic countries. Locally in parts of southern and south-eastern Sweden, it was the wettest year on record. 2010 was the 2nd rainiest year in Latvia in 87 years (behind 1928) and by far the wettest in the decade 2001–2010 (Fig. 0.27). Annual rainfall in Latvia exceeded 800 mm on average, which had last occurred 20 years ago. Lithuania was wetter than normal especially during the warm season from May to August, but also in December, whereas January, April and October were drier than normal.

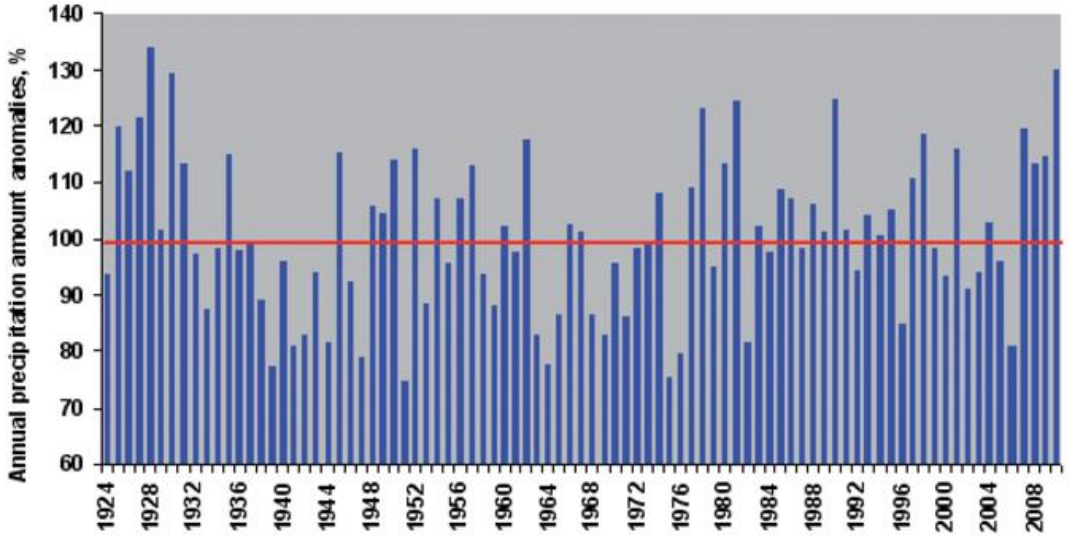

Fig. 0.27: *Annual precipitation amounts 1924–2010 in Latvia in per cent of the 1961–1990 normal*
Source: Latvian Environment, Geology and Meteorology Centre

3.4. Western and central Europe

Western Europe was drier than normal, especially across Ireland, the United Kingdom and most of France, but also western Switzerland. Less than 80% of the normal total was reached in the western parts of the UK. It was the driest year since 2003 in the UK. The first half of the

year was particularly dry, the driest such period since 1953 in the UK in general and since 1929 in north-west England and north Wales. In eastern England, the dry spell continued into July, causing considerable concern about water resources in these areas.

Most of central Europe was wetter than normal. The western parts of central Europe were close to normal (e.g. Belgium and the Netherlands) due to relatively few thunderstorms throughout the year, but abundant precipitation in August. Based on the annual totals, the eastern parts of central Europe were very wet. More than 125% of normal precipitation was recorded in large parts of eastern Germany, Poland and the Czech Republic, more than 160% in southern Poland, Slovakia and Hungary. Much of this was due to heavy precipitation events with flooding in May and early June and again in August and September. The damage caused by the two flooding events in August and September in Germany was estimated at several hundred million euro. The number of days with heavy precipitation (daily totals >30 mm) was considerably higher than normal; especially in eastern Germany which in places saw more than three times the normal precipitation, partly even the highest number on record. 2010 was by far the wettest year in Slovakia since 1881 (areal annual average of 1255 mm, locally far more, Fig. 0.28) and in Hungary since 1901. A station in the northern medium-high mountains in Hungary (Miskolc-Lilafüred Jávorkút) reached a new annual record with more than 1500 mm (Fig. 0.29).

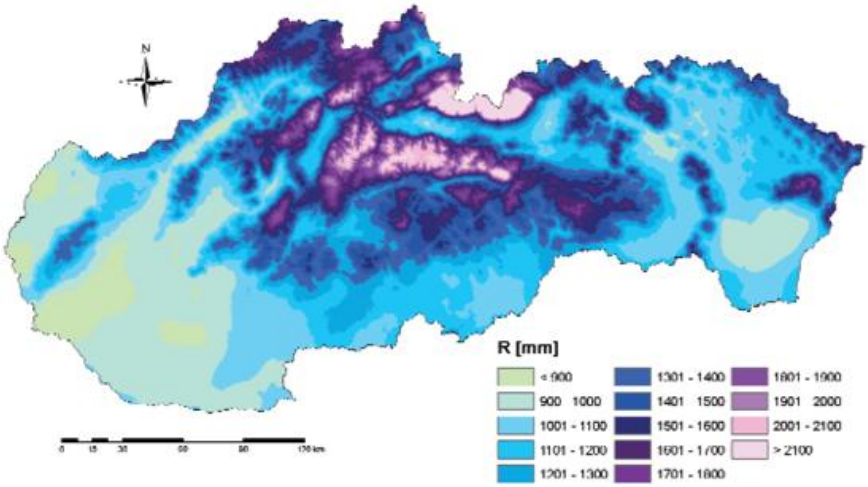

Fig. 0.28: *2010 annual precipitation totals in Slovakia*
Source: Slovenský Hydrometeorologický Ústav (SHMI), Slovakia

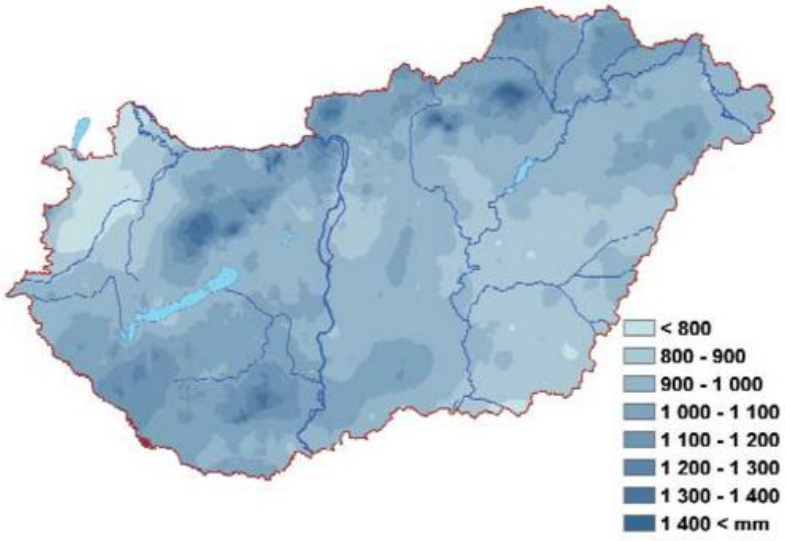

Fig. 0.29: *2010 annual precipitation totals in Hungary*
Source: Hungarian Meteorological Service

3.5. Iberia

Most of Iberia was wetter than or near to normal. The south of the peninsula was particularly wet, with locally more than 200% in Andalusia (Spain, Fig. 0.30) and more than 180% of the 1971–2000 average in Lisbon (Portugal, Fig. 0.31), which with an annual total of 1598 mm suffered its wettest year since 1870. Portugal also had its wettest year of the whole decade 2001–2010 (1063 mm = 120% of the normal). It was especially wet over most of Iberia in

January–March (with around twice the normal for that period) and December, in Portugal also in October. To the contrary, dry conditions prevailed in the summer half year. It was the driest July and August and the second driest September in more than 20 years in Portugal.

Similarly, the annual precipitation totals were well above normal over the Azores Islands. The rainiest months were January–April and December.

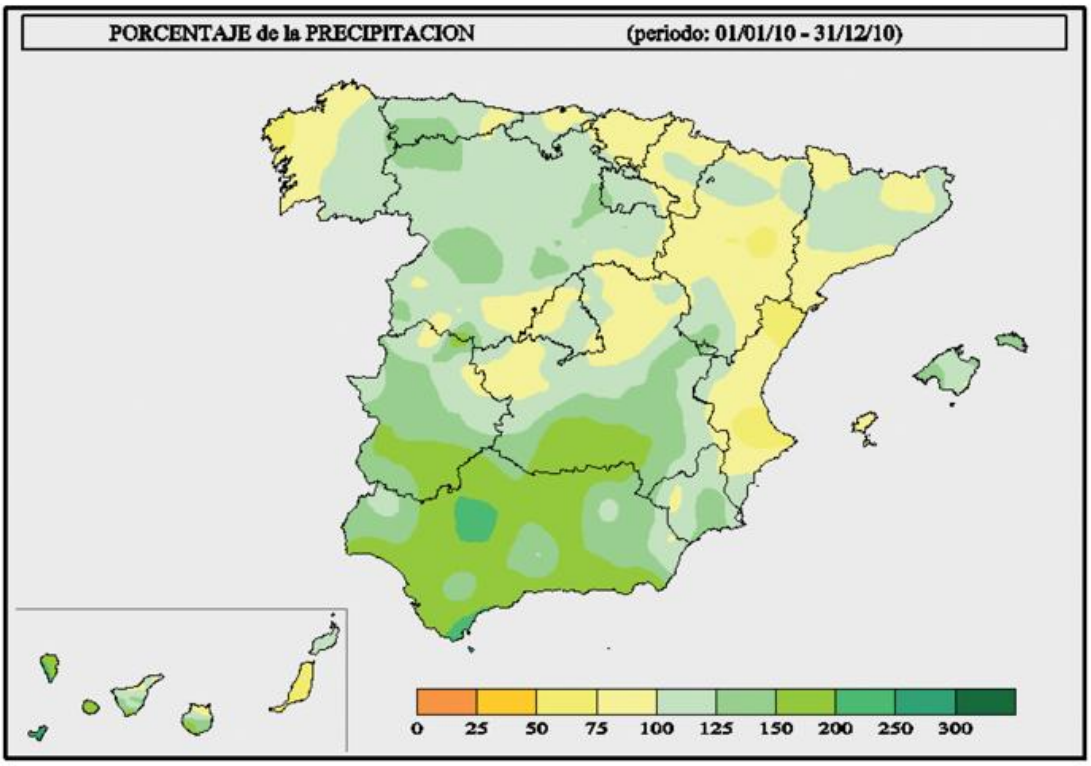

Fig. 0.30: *2010 annual precipitation totals in Spain in per cent (1961–1990 reference)*
Source: Agencia Estatal de Meteorología, Spain

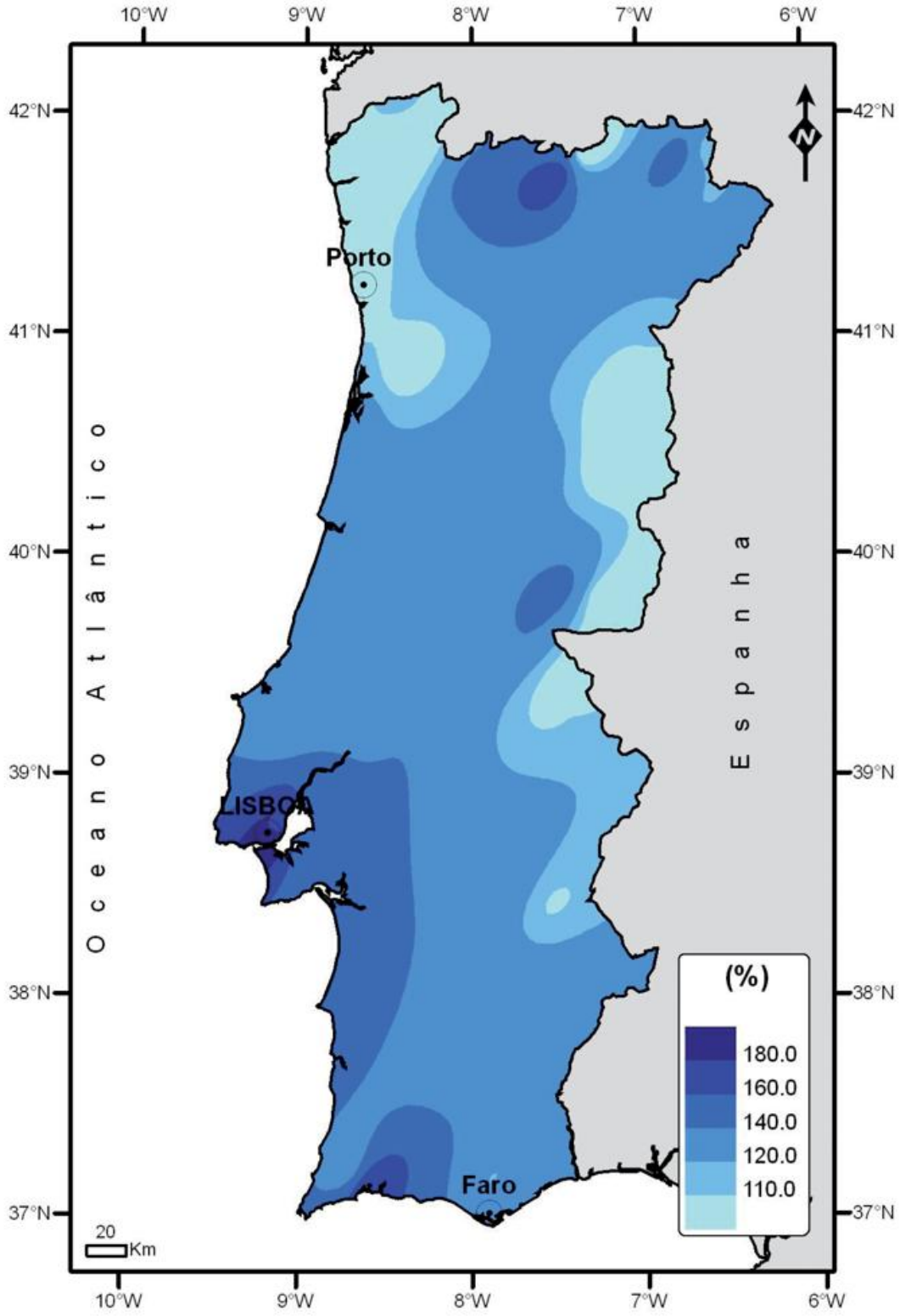

Fig. 0.31: *2010 annual precipitation totals in Portugal in per cent (1971–2000 reference)*
Source: Instituto de Meteorologia, Portugal

3.6. Italian and Balkan Peninsulas, Mediterranean region

Italy, the Balkan Peninsula and most of the other parts near to the Mediterranean were wetter than normal and some periods of heavy rain occurred. Large areas received more than 125% of the normal annual total, locally 175%. This was particularly due to occasional to frequent heavy precipitation (partly causing flooding and landslides) in January, February, and May–November.

Some places on the Balkan Peninsula saw their highest or second highest annual precipitation totals. With 1798 mm, Ljubljana in Slovenia recorded its second highest annual total since the beginning of measurements. Herzegovina had its wettest period in 2010 since the beginning of measurements, with Mostar station reporting an annual precipitation total of around 2500 mm. Extremely heavy precipitation events were frequent in the southern parts of Bosnia and Herzegovina, causing flooding of Neretva and Drina rivers at the end of November and the beginning of December. At least five main meteorological lowland stations in Serbia registered their highest annual total in the past 60 years, partly exceeding 1000 mm. At more than 170% of the 1961–1990 normal, some stations in Montenegro received the highest or second highest precipitation total on record (Fig. 0.32).

It was a dry year in Malta and in southern Greece. Malta had very low precipitation in the colder months (January, February, November, December) and in April, and had hardly any rain in summer.

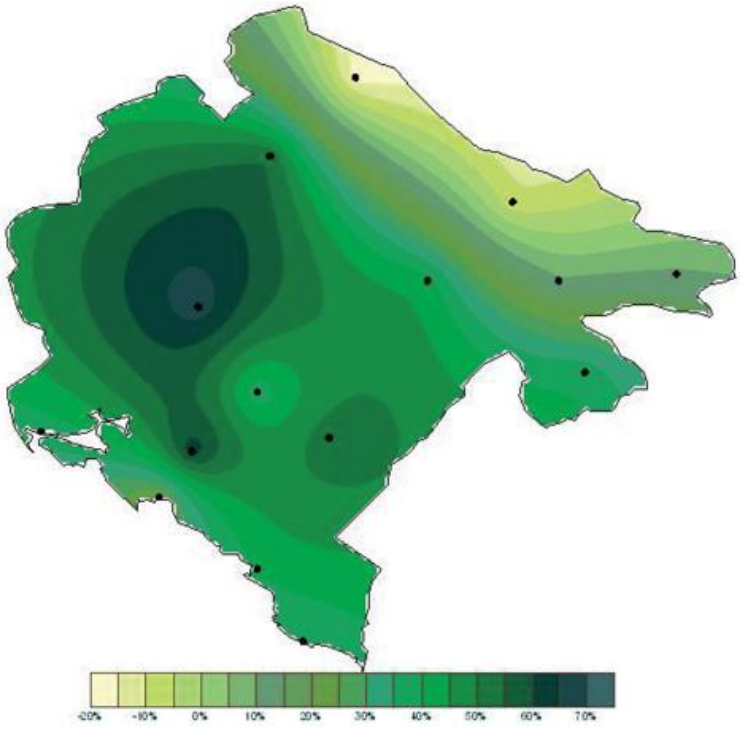

Fig. 0.32: *2010 annual precipitation totals in Montenegro in per cent (1961–1990 reference)*
Source: Hydrometeorological Institute of Montenegro

3.7. Eastern Europe and South Caucasus region

Eastern Europe was wetter than normal in its western parts and mostly dry or near normal in the east. It was particularly wet (>125% of the normal) in the western and southern Ukraine, Romania and Moldova. There were many very wet months in that area in all seasons, namely January, February, May, June, August, September, October (in the south only), November and December.

In Romania, the largest precipitation excesses of the year occurred in May and June, which climatologically are anyway among the wettest months in that country (Fig. 0.33). This excess precipitation fell over a soil which was already soaked due to the fact that previous months had also been wetter or around normal, which at times led to severe flooding.

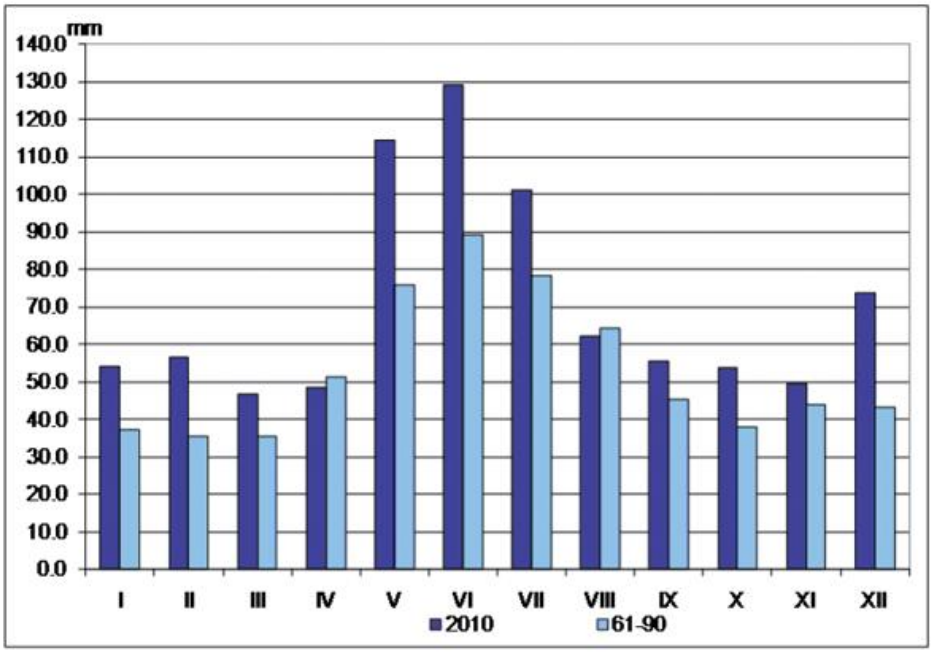

Fig. 0.33: *Monthly mean precipitation totals in Romania 2010 compared to the 1961–1990 normal*
Source: National Meteorological Administration of Romania

Moldova was also affected by high quantities of precipitation during the period May–July (300–510 mm, i.e. 60–80% of the annual normal fell during these three months), especially in the northern parts, but partly also in the south of the country. Such high amounts were registered for the first time since the beginning of observations in Moldova. The highest total in Moldova for May–July 2010 (510 mm) was recorded at the station Briceni, exceeding twice the normal for these three months (Fig. 0.34). The consequences of the high quantities were flooding of rivers and damage to houses and farmlands as well as power supply disruptions.

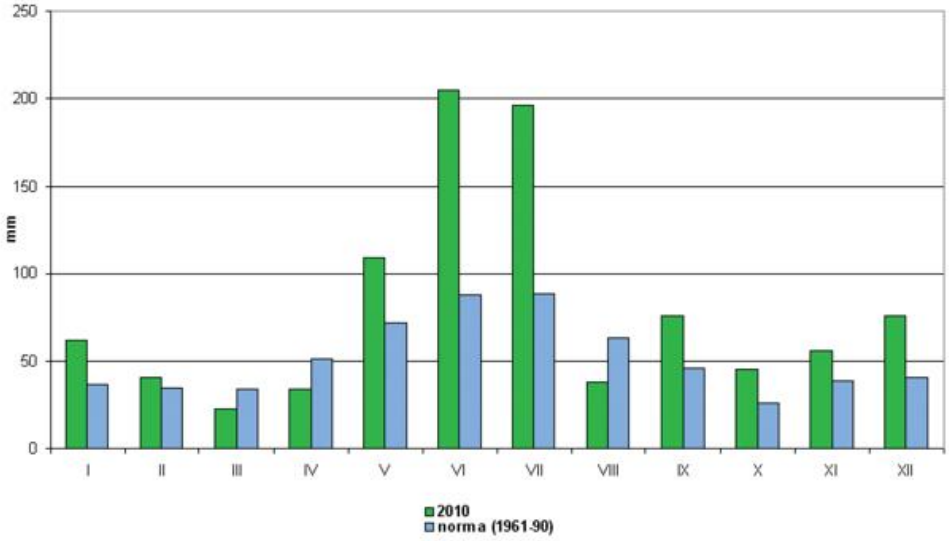

Fig. 0.34: *Monthly mean precipitation totals at the station Briceni in Moldova 2010 compared to the 1961–1990 normal*
Source: State Hydrometeorological Service of the Republic of Moldova

Some places in Southern European Russia received very much precipitation, 300–500% of the normal in some months.

Dry areas (locally less than 80% of the normal) were to be found in central European Russia, west Kazakhstan and the South Caucasus. Main contributors in Russia were the months April and June–August, in the South Caucasus June, August as well November and December in particular. It is noteworthy that during November and December most parts of the South Caucasus region did not receive any single drop of rain, although climatologically these two months are the second rainy period in that area after April–May. However, several heavy rainfalls and subsequent flooding occurred in Azerbaijan from April to June, the heaviest ones in May. The Kura river in Azerbaijan had high water levels from the end of April until the end of June; several villages were flooded. Thunderstorms with severe hail occurred very often in the South Caucasus from May to July. Overall, 19 days with hail were recorded at different locations in Armenia, with hailstones sometimes reaching 25 mm in diameter. Hail caused significant losses to agriculture due to the damaged crops. Wet conditions also prevailed in January and October in the South Caucasus.

In general, the weather conditions during the vegetation season in 2010 were very unfavourable for agriculture in Armenia. Extensive rainfalls in April damaged most of the blossoming fruit trees in the Ararat Valley; later, frequent hailstorms and heavy rainfall with dry periods in between caused significant losses to agriculture.

3.8. Middle East

Western Turkey saw a wet year (>125% of the annual total), whereas most of the other areas were drier than normal.

Turkey had some relatively very wet months, namely January, February, June, October and partly December, especially in the west. Some locations in Turkey saw hazardous flood events, e.g. Bursa, which had the wettest year on record (at 1328 mm nearly twice the normal). Cyprus also reported heavy rain and flooding, especially in January, February and April, as well as severe hail storms in April, May and December.

On the other hand, especially eastern Syria was very dry, recording local annual totals of less than 40% of the normal. More than a third of the stations in Jordan received less than 75% of the normal total.

It was extremely dry in the Middle East in spring and exceptionally dry in November. Israel had an extremely dry period around Haifa, the driest on record for August to November in at least 70 years. The long drought period caused a large forest fire in northern Israel in early December.

4. Snow

Unusually small amounts of snow fell in south-western Iceland. Reykjavík had its lowest annual number of days with snow cover (only 16 days) since observations started in 1921.

In contrast, 2010 was a year of abundant, widespread and long-lasting snow across large parts of northern, western and central Europe, particularly in the winter months January, February and December.

In the UK, snow depths accumulated to more than 50 cm across the high ground of eastern England and eastern Scotland in both January and December.

Uccle station in Belgium had an exceptionally high number of 53 snow days (compared to the 1981–2010 normal of 19), the highest number since the start of observations in 1901.

Locally record-breaking snow depths were measured in Germany in all three winter months; even in the lowlands such deep snow covers had not been seen for a long time. Since the 1960s, many places in Germany had not seen as many snow days.

In the plains of Switzerland, frequent snowfalls continued to occur even in the first half of March. In summer and autumn, it often snowed in the western Alps and by November it started to snow again in the plains of Switzerland.

Beside the Austrian alpine regions, the amount of fresh snow in Austria exceeded the 1971–2000 averages by around 30–60%.

Poland reported at least 70 days with snow from October 2009 to April 2010 in most of the country; in the west, this was more than twice the 1971–2000 normal. The mean snow depth in Poland was also high that season, 200–500% of the normal. On the other hand, in 2010 most of European Russia had fewer days with snow cover than normal.

5. Sunshine duration

Sunshine duration anomalies in 2010 showed much greater spatial variability than in the previous year (Fig. 0.35). Averaged over the Region, sunshine duration was around normal, but relatively sunny and relatively dull areas were still to be found in all its parts.

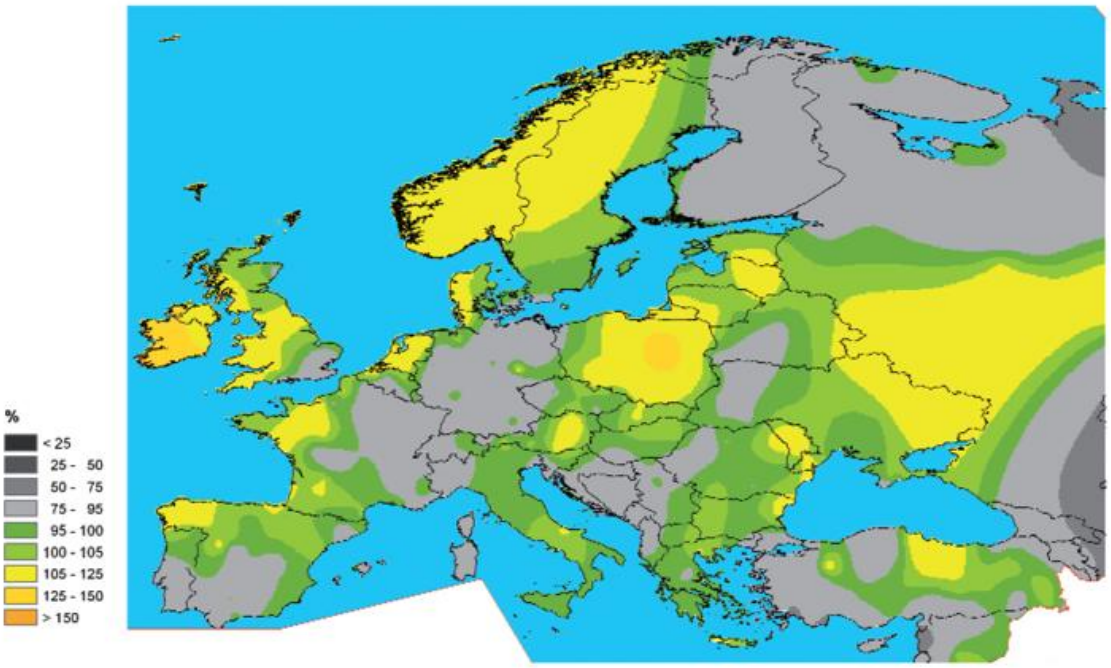

Fig. 0.35: *Annual sunshine duration in 2010 in per cent of the 1961–1990 normal in WMO Region VI (interpolation of CLIMAT data)*
Source: Deutscher Wetterdienst, Germany

The year was sunnier than normal in the Arctic region (Greenland, Iceland, Svalbard) and over almost the whole of north-western Europe (Ireland, United Kingdom, north-western France, the Netherlands) and the western parts of northern Europe (Norway, western Sweden, Denmark with the Faroe Islands). Although summer was quite dull in most of these areas (except Ireland and the Netherlands), the other seasons had a considerable surplus of sunshine.

The three winter months January, February and December 2010 were record-breaking sunny on the Faroe Islands. Southern Ireland received more than 1,500 hours of sunshine in 2010, which is more than 125% of the normal, and it was the sunniest winter on record in western and southern parts of Ireland. Several months were very sunny in parts of the United Kingdom, notably January, March, April, June and October to December. However, July and August were dull summer months in most areas of the United Kingdom. In Northern Ireland and western Scotland, 2010 was amongst the sunniest years on record.

The Netherlands had 1,772 hours of sunshine on average (normal 1550), locally up to 1,900 hours, but less than the average in 2009. 2010 had the sunniest December on record in Denmark, with a total of 81 hours of sunshine on average for the country.

In contrast, north-eastern Europe (Finland, northern European Russia) had a dull year, particularly towards the east, where less than 75% of the annual total was recorded. Sunshine was lacking especially in autumn.

Large parts of central Europe were also quite dull, namely eastern France, southern Belgium and large parts of Germany. Compared to the normal, there was a lack of sunshine already in all winter months, but also in May, August, September and November. Germany experienced its third dullest January and February since 1951, and winter 2009/10 was the second dullest behind 1969/70. Uccle in Belgium saw its dullest February (29 hours of sunshine duration) since the beginning of heliographic measurements in 1887. May was the dullest month on record (since 1951) in Germany (locally also in Austria), August the second dullest. The other months were mostly very sunny, particularly April (third sunniest April in Germany behind 2007 and 2009), which, however, did not compensate the deficit.

Large parts of eastern central and eastern Europe saw a sunny year, particularly Poland, eastern Austria, eastern Latvia, Moldova and central European Russia. Some locations in Poland received more than 1800 hours of sunshine in 2010, which is more than 250 hours above the 1971–2000 normal. Only February, May and December were dull in almost all these eastern parts. Over the whole year 2010, parts of eastern Austria had more than 125% sunshine than normal, but 2010 was also the year with the lowest sunshine duration in Austria since 1996 due to frequent rainfall in the summer months and an extremely low annual mean air pressure (Fig. 0.36).

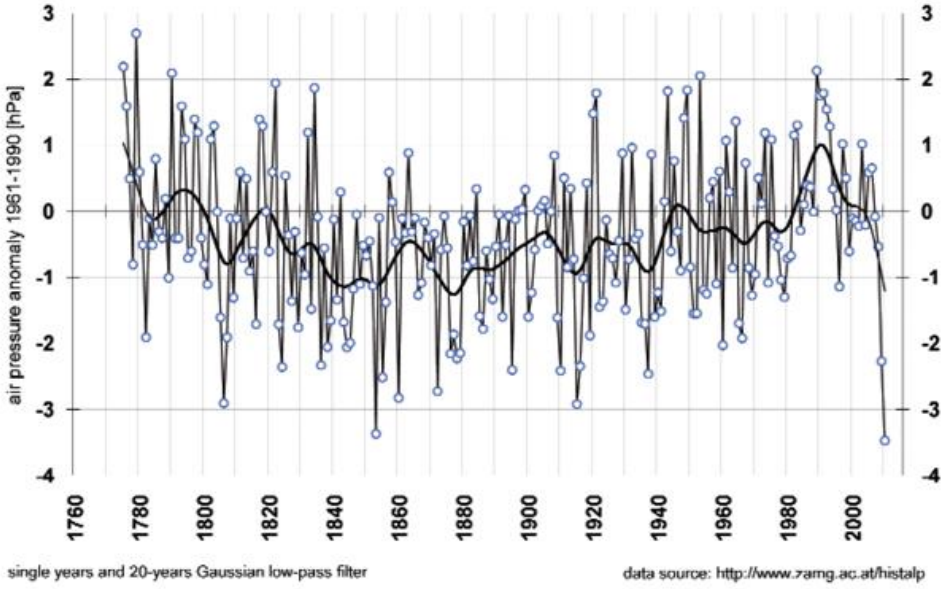

Fig. 0.36: *Anomalies (1961–1990 reference) of the Austrian air pressure stations 1775–2010 Source: Central Institute for Meteorology and Geodynamics (ZAMG), Austria*

Western Kazakhstan and the South Caucasus region had far below-normal sunshine, with less than 75% of the annual total in the east. Just the end of the year (November and December) brought above-normal sunshine to the South Caucasus.

The Mediterranean region and most of Iberia had around normal or below normal sunshine. Spring and summer were mostly sunny, but the winter and autumn months were mostly dull.

6. Wind

Globally, the tropical storm activity in 2010 was lowest since at least 1970, with a total of 67 storms, 38 of which developed to typhoons/hurricanes. Only the North Atlantic had an above-average activity (19 storms / 12 hurricanes vs. a long-term mean of 10 / 6) during the season from end of June to the beginning of November due to high sea surface temperatures in its tropical area. This was triggered by La Niña conditions due to weak vertical wind shear and by the continued warm mode of the Atlantic Multidecadal Oscillation (AMO). However, the strongest storm was typhoon Megi (central pressure 885 hPa) over the Philippines and China in October. Other tropical storms (Giri in Myanmar also in October and Agatha in central America in May) caused at least 150 deaths each. Only one tropical storm reached the RA VI Region as extratropical cyclone: storm Danielle moved from the central Atlantic towards the north-east and dissipated south of eastern Greenland on 03 September without causing any damage in RA VI.

In Europe, due to the frequent meridional circulation patterns, westerlies were rare, and with it also the number of intense cyclones.

Windstorms were markedly fewer than usual in Iceland. The average wind speed at all stations in Iceland was the lowest since 1965.

In winter 2009/10, many stations in Ireland registered record-low mean wind speeds.

Latvia measured the lowest wind speeds for almost 50 years for January, and also in February wind speeds were very low. Gusts up to 119 km/h were recorded in August.

Lithuania reported one strong squall line and one tornado in summer.

In Poland, geostrophical winds up to 81 km/h occurred in January and once more in November.

One extensive storm, Xynthia in February/March, affected large parts of France and Germany.

Several heavy thunderstorms and tornadoes occurred in Germany, particularly between late May and early July.

In Portugal, tornadoes and water spouts were seen in April (Lisbon, Tavira and Sintra), causing damage on buildings, and December (in central parts), when several people were injured and great damage caused at several locations.

Malta recorded its highest wind gusts since 1947 in July.

There were very few Etesian wind patterns in Greece (e.g. N–NW winds prevailing over the Aegean Sea). Cyprus saw some strong wind events in February, October and December, and also tornadoes in January–March, May and December.

Strong winds were recorded quite often in the South Caucasus in January and February, with mean winds up to 140 km/h and gusts up to 170 km/h in Armenia. Azerbaijan reported some severe storm events from January to March, with gusts up to 108 km/h, locally even more. Georgia reported wind gusts up to 115 km/h, highest in February, March and September.

7. Sea ice

7.1. Arctic sea ice

(Text kindly provided by the National Snow and Ice Data Center, University of Colorado, Boulder, USA, http://nsidc.org/arcticseaicenews/, 05 January 2011, added by text from NCDC: http://www.ncdc.noaa.gov/sotc/hazards/2010/9.)

Despite a late date of the maximum in winter 2009/10 sea ice extent, the minimum sea ice extent for September 2010 (4.6 million km²) was third lowest in the 1979 to 2010 satellite record, above only 2007 (the record low) and 2008 (Fig. 0.37). The average extent for September (4.9 million km²) was 30.4 percent less than the 1979–2000 average. Regarding the total amount of Arctic sea ice, according to the University of Washington's Polar Science Center (using a model that has compared well with observations), sea ice volume for September reached an all-time monthly low in 2010. The reported volume of 4,000 km³ was 70 percent below the 1979–2009 September average of 13,400 km³. Sea ice volume accounts for sea ice extent as well as the thickness of the ice.

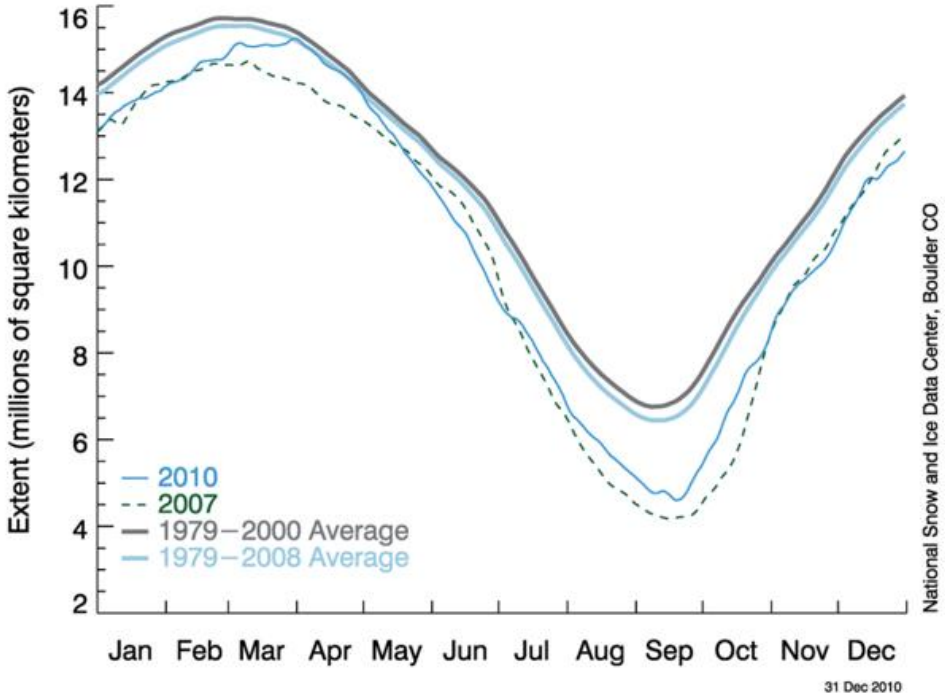

Fig. 0.37: *Arctic sea ice extent in 2010, compared to the 1979 to 2000 and 1979 to 2008 climatologies and the year 2007.*
Source: National Snow and Ice Data Center, University of Colorado, Boulder, USA

The late summer of 2010 saw an open Northwest Passage: this year, the deep water channel (the northern route) from M'Clure Strait to Lancaster Sound was navigable. The Northern Sea Route along the Siberian coast also became briefly navigable. It was the first time in modern history that both the Northern Sea Route and the Northwest Passage were navigable in a single season.

2010 started out with a highly negative phase of the Arctic Oscillation, an atmospheric pattern that in the past has favoured the survival of old ice through the winter, and more ice at the end of this summer. But this tendency seems to be changing. A recent study led by Julienne Strove of NSIDC showed that while wind patterns linked with the strongly negative Arctic Oscillation winter of 2009–2010 transported much old ice into the southern Beaufort and Chukchi Seas, most of this ice later melted. It may be that with a warmer Arctic, old rules regarding links between the atmospheric pressure patterns and sea ice extent no longer hold.

On 5 August, an ice mass of 251 km² broke down from the Petermann Glacier in north-west Greenland.

Freezing in autumn 2010 also was unusually slow due to far above-average temperatures. Arctic sea ice extent averaged over December 2010 was 12.00 million km². This was the lowest December ice extent recorded in satellite observations from 1979 to 2010, 270,000 km² below the previous record low of 12.27 million km² set in 2006 and 1.35 million km² below the 1979 to 2000 average. As in November, ice extent in December 2010 was unusually low in both the Atlantic and Pacific sides of the Arctic, but particularly in Hudson Bay, Hudson Strait (between southern Baffin Island and Labrador), and in Davis Strait (between Baffin Island and Greenland). Normally, these areas are completely frozen over by late November, but in 2010, Hudson Bay was not totally frozen till the end of the year. In the middle of December, the ice extent stopped increasing for about a week, an unusual but not unique event.

The low ice conditions in December occurred again in conjunction with above-average air temperatures in regions where ice would normally expand at this time of year. Air temperatures over eastern Siberia were +6 to +10°C above normal in December. Over the eastern Canadian Arctic Archipelago, Baffin Bay/Davis Strait and Hudson Bay, temperatures were at least +6°C higher than average. Southern Baffin Island had the largest anomalies, with temperatures over +10°C higher than normal. By sharp contrast, temperatures were lower than average (-4 to -7°C) over the Alaska-Yukon border, north-central Eurasia, and Scandinavia.

The warm temperatures in December came from two sources: unfrozen areas of the ocean continued to release heat to the atmosphere, and an unusual circulation pattern brought warm air into the Arctic from the south. Although the air temperatures were still below freezing on average, the additional ocean and atmospheric heat slowed ice growth.

As in winter 2009/10, a strongly negative phase of the Arctic Oscillation dominated the middle and high latitudes of the Northern Hemisphere in December 2010, bringing higher-than-normal pressures to the Arctic region, with lower-than-normal pressures in middle latitudes. However, unlike December 2009, when higher-than-normal pressures centered near the central Arctic, in December 2010 higher pressures centered near Iceland and the eastern tip of the Aleutians in the Pacific, and yielded a different pattern of winds. As a result, different areas experienced warm anomalies in 2010, and a different pattern of ice extent emerged.

7.2. Baltic Sea

(Text kindly provided by J. Vainio et al., taken from Bundesamt für Seeschifffahrt und Hydrographie (BSH, Federal Maritime and Hydrographic Agency of Germany), Baltic Sea Ice Services, http://www.helcom.fi/BSAP_assessment/ifs/ifs2010/en_GB/iceseason, 14 October 2010, shortened)

After a slow start in autumn 2009, very cold weather conditions over Scandinavia ensured a rapid development of the ice cover at the beginning of 2010. On January 8, the entire Bay of Bothnia was covered with ice; a week later the amount of ice also increased in the Gulf of Finland and the Gulf of Riga. During this period, ice also started to form along the coast in the Sea of Bothnia and in the Stockholm archipelago.

An intense low pressure system passing over Scandinavia on 27–28 January brought southerly gale force winds which pressed most of the ice in the Skagerrak towards the Norwegian coast. In the Bay of Bothnia, the ice drifted rapidly to the north/north-east, causing severe pressure in the ice field. Conditions were so severe that the area was temporarily closed for all traffic. After the storm, the cold weather came back and ice growth speeded up again, particularly in the Sea of Bothnia, the northern Baltic Sea and the Kattegat. Ice started to form outside the archipelagos in the northern Baltic Sea and along the east coast of Gotland.

In the southern Baltic Sea, ice formation resumed in the eastern waters in early January and spread quickly westward on the sheltered inner coastal waters. Ice formation continued until mid-February. By the end of January, new ice had also formed on the outer coasts, and the Pomeranian Bight was completely covered with ice.

On February 17, the area covered with ice expanded to 244,000km², marking the maximum area for the winter. This took place almost two weeks earlier than normal. At that time, the Gulf of Finland and the Gulf of Bothnia were covered with ice, with the exception of an approximately 6,500 km²-wide area in the eastern Sea of Bothnia off Rauma and Pori. The Gulf of Riga was also thoroughly covered with ice. In the northern Baltic Sea the ice edge ran from near Almagrundet to Glotovi and further on to the south/south-west. The central Baltic Sea off the coastline had a thin ice cover north of Öland and Klaipeda. The southern Baltic Sea off the coast of Germany was covered with thin fast ice in the insular areas. There was also thin ice and new ice in the Kattegat and Skagerrak.

In winter 2009/2010, the temperature remained below zero for an unusually long period of time without a break – a total of 60 days. The frosty winter ended on February 26 and, with the winds blowing from the south, the frozen area began to decrease.

In the Sea of Bothnia, the strong winds ripped large holes into the ice field in the northern part, and caused ridging and rafting in the south. During this time ice pressure in the southern Sea of Bothnia and the Sea of Åland was so severe that it caused substantial problems for traffic. On 3-4 March, conditions were particularly difficult in the Sea of Åland. A brash ice barrier outside of the Stockholm archipelago caught a number of passenger ferries and commercial ships, and icebreaking activities were intense.

The North Sea coast, its tributaries, and the Kiel Canal were completely free of ice by 7 March, the Baltic Sea waters of Schleswig-Holstein by 20 March, and the bodden waters along the coast of Mecklenburg-Vorpommern by 25 March. The numbers of days with ice varied considerably in the different areas: in the river Weser near Brake, ice occurred only on one day, compared to 96 days in the harbour of Neuendorf on the island of Hiddensee. Only a few stations, most of them located in the German Bight, remained free of ice throughout the winter of 2009/10.

In April, the sea ice continued to melt. The melting process proceeded rapidly also in the south and the Baltic Sea coast south of Stockholm was ice free around April 15. Lake Vänern was ice free around the 18th.

The remaining ice of the Sea of Bothnia disappeared at the end of April, while in the Gulf of Finland and the Bay of Vyborg it melted on May 2.

In mid-May, there was an unusually long and widespread heat wave, considering the time of year. The impact of the heat continued and, consequently, made the water warm and the ice to melt. Last ice in the Bay of Bothnia melted at the end of May and the Bay of Bothnia was ice free on May 31.

The time of the final melting, compared to normal, varied greatly. In the coastal waters of the northern Bay of Bothnia the final disappearance of ice took place two to four weeks earlier than average and in the Gulf of Finland about one week to more than a month later than average.

The duration of the ice winter in the northern Bay of Bothnia was over a month shorter than average. In the southern Bay of Bothnia and in the Vaasa archipelago the ice winter was one and a half to two weeks shorter than average, whereas it in the Quark was two weeks longer than average. In the other sea areas surrounding Finland the length of the ice winter was a week (the metropolitan area) to more than a month (western Gulf of Finland) longer than normal.

In the Finnish part of the Bay of Bothnia, the maximum thickness of the fast ice was between 40 and 85 cm, in the Sea of Bothnia between 30 and 60 cm, in the Archipelago Sea between 15 and 50 cm and in the Gulf of Finland between 20 and 60 cm. The thickness of the ice in the pelagic Bay of Bothnia was 30–60 cm, in the Sea of Bothnia 10–40 cm, in the Gulf of Finland 30–45 cm, in the Sea of Åland 10–35 cm and in the northern Baltic Sea 10–35 cm.



Fig. 0.37a: *Sea ice off Helsinki on the 7th March 2010 (Courtesy of Dr. Stefan Hendricks, AWI)*
Source: http://www.helcom.fi/BSAP_assessment/ifs/ifs2010/en_GB/iceseason

Seasonal Survey

Temperature

After a cold winter 2009/10 particularly in northern Europe, the other seasons in 2010 became warm, especially in the east of the Region with an outstanding hot summer particularly in Russia. Autumn was colder again in the western half of Europe. Greenland and the Middle East were much warmer than normal in all seasons.

Winter 2009/10 was cold in most of Europe, especially in the north, but mild in the Arctic, in south-eastern Europe and the Middle East (for figures see section “Seasonal Maps”, Fig. S1).

It was mild in the whole Arctic region. Anomalies amounted to +7°C in Svalbard; Greenland was more than +5°C warmer on average, locally exceeding the 90th percentile.

Northern, eastern, central, western and north-western Europe saw an exceptionally cold winter with hard frosts during all three winter months. The number of ice days (Tmax < 0°C) was higher than normal all over northern and central Europe. The negative temperature deviations from normal were highest in central Scandinavia and north-eastern European Russia (< -3°C, Fig. 0.38 e.g. for Sweden) and below the 10th percentile.

It was the coldest winter for at least 14 years in several countries of central Europe, in northern Europe and the Alps even for more than 20 years (Tab. 0.2). It could, however, not compete with the record cold winters of the 1940s or 1960s. Winter was particularly exceptional in north-western Europe (coldest for at least 30 years) and the Alps. High mountain stations in Switzerland registered the coldest winter in around 30 years. At the Jungfraujoch and Grosser St. Bernhard, it was even the coldest winter in 40 years. The long-term warming trend was one reason that winter 2009/10 was still milder than comparable spells in past decades, particularly in central Europe.

Country	Winter 2009/10 was the coldest since	Winter 2009/10 was the coldest for ... years
Sweden	1986/87	23
Finland	1986/87	23
Ireland and Scotland	1962/63	47
England and Wales	1978/79	31
Netherlands	1995/96	14
Belgium	1995/96	14
Germany	1995/96	14
Switzerland	1986/87	23

Tab. 0.2: *Last winter which was colder than that of 2009/10 in various countries/areas in northern, north-western and central Europe*
Source: Report of National Meteorological and Hydrological Services

Generally, the long duration of cold conditions during that winter was more unusual rather than any local extremes. There was a very long period with below-zero temperatures in central Sweden. Locally, it was the longest such period in more than 120 years of measurements. Helsinki in Finland had its longest cold spell since 1947. In Finland, the lowest temperature of that winter was -41.3°C in Kuhmo in the north. Some areas in Estonia also had the longest period without any above-zero temperatures ever registered, e.g. 76 days in Johvi. In Lithuania, the winter 2009/2010 was almost 4°C colder than the previous winter. Denmark recorded 74 frost days on average (normal is 53 days).

In north-western Europe, temperatures regularly fell well below -10°C in the Scottish glens and, at times, in some places in Ireland. The coldest spell was in early January, when night-time temperatures fell as low as -22.3°C in the Scottish Highlands, the lowest UK temperature since December 1995. Irish inland stations registered a total of 70–80 days with ground frosts; monthly mean temperatures were around 2°C below normal.

Winter in western and central Europe, too, was characterised by several notable cold waves. Belgium suffered three cold waves during all winter months. The winter in France was not exceptional (-1.2°C anomaly), but several cold waves occurred in January and February.

In Iberia, the winter season was slightly colder than normal on most of the peninsula (anomaly of -0.3°C in Spain), although not as cold as in the rest of most of western and northern Europe. It was characterised by frequent cold spells. February was the coldest month in Spain. Only the southern parts were warmer than normal.

Most of south-eastern Europe, the eastern Mediterranean, the Caucasus region and the Middle East had a mild winter. Anomalies ranged between +1 and +2°C in south-eastern Europe and exceeded +2°C across almost the entire Middle East, where the 90th percentile was exceeded; they were highest in eastern Turkey and the South Caucasus region (up to +5°C). It was the second warmest winter in the South Caucasus since 1935, behind 1965/66, and, in particular, also the second warmest winter on record in Armenia. Western Kazakhstan was only slightly warmer than normal.

All three winter months December 2009, January 2010 and February 2010 had a similar anomaly distribution; they differed only in terms of intensities (the strongest negative anomalies over the whole European continent were observed in January) and location of the lowest values.

This quite unusual temperature distribution resulted from extremely high negative values of both the North Atlantic Oscillation (NAO) and the Arctic Oscillation (AO) in all three winter months, and the subsequent frequent attenuation of westerly airflow. The mean surface air pressure distribution was characterised by an extended low pressure area centered over the North Atlantic east of Newfoundland and a large high pressure area over Asia. This facilitated the intrusion of cold Arctic air into Europe and caused flow of cold continental air from the east to prevail. A compensating flow led warm subtropical air to Turkey and the South Caucasus region. The NAO mean index for the three winter months (-3.1) was the lowest winter NAO since records began in 1821 (data from Climate Research Unit, UK) and ranges even below the values for the winters 1962/63 (very cold winter in western Europe) and 1968/69 (very cold in the east). The NAO index was strongly negative in all winter months, particularly in December 2009 and February 2010.

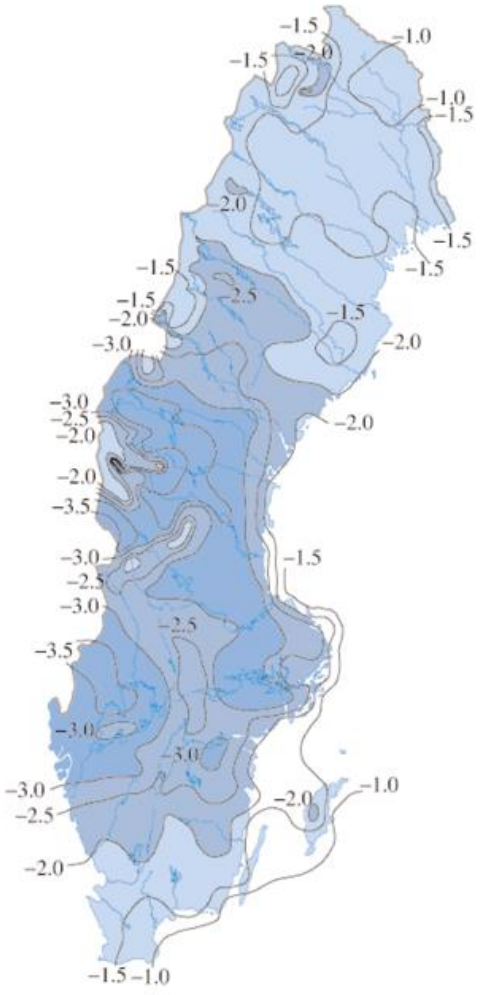

Fig. 0.38: *Temperature anomalies (1961–1990 reference) for winter 2009/10 in Sweden*
Source: Swedish Meteorological and Hydrological Institute (SMHI)

Spring 2010 was warmer than normal in almost the whole Region, except for a few small areas in various parts of Europe (Seasonal Maps, Fig. S2).

It was warmer than normal in the Arctic region. Western Greenland was still more than +5°C warmer than normal, whereas in other parts of the Arctic, the anomalies remained considerably smaller compared to the previous winter. The 98th percentile was exceeded in southern Greenland.

In most of Europe (except the Arctic and the south-east) and over the North Atlantic, the seasonal warming in spring was generally quite high after the cold winter and the temperature anomalies were positive almost everywhere; only locally they were slightly below zero. Especially April was warm in most of Europe, whereas March and May were cold in some parts.

Spring anomalies were only slightly above or around zero in most of northern, western and central Europe. In Sweden, weather varied between warm and cold spells during March and April, which prevented a rapid snow melt. No summer days (25°C or more) were recorded in Denmark. The Netherlands had a mild start of spring, but an extremely cool May.

The strongest warming occurred over eastern Europe, particularly in Russia in April and May (except the south, which was warm in March). Seasonal anomalies were higher than +2°C in parts of European Russia and exceeded the 90th percentile. In other parts of north-eastern and eastern Europe, seasonal anomalies were higher than +1°C. All spring months were warmer than normal in most of eastern Europe except the north-east, which had a cold March.

Almost all over Iberia and Italy, it was also warmer than normal, partly even more than +1°C and exceeding the 90th percentile. Especially April and partly May were warm, particularly in western and southern Iberia. Even so, spring 2010 was the second coldest spring in Spain since 1996 (behind 2004).

South-eastern Europe, the eastern Mediterranean and the Middle East, too, were warmer than normal, though not as much as in winter. Highest anomalies (>3°C) were to be found in eastern Turkey, where the 90th percentile was surpassed. March was exceptionally warm in the whole Middle East region. Spring in the Caucasus region was only slightly warmer than normal on average due to a warm March, but saw near-normal or slightly below normal temperatures in April and May.

Both the North Atlantic Oscillation and Arctic Oscillation continued to show negative values in all three spring months, which means that meridional circulation patterns were strongly prevailing, causing a stronger-than-normal seasonal warming in most of the Region. However, the spatial variability of surface air pressure was much lower than in the preceding winter. The Icelandic low was stronger than normal, but dislocated far to the south-west. Both the Azores high and the Asia high were weaker than normal.

Summer 2010 was also warmer than normal in almost the whole Region, except over the western Mediterranean, the Norwegian Sea and the Barents Sea, which showed negative anomalies between 0 and -1°C (Fig. S3). Averaged over the European continent, summer 2010 was the hottest on record. The most extreme conditions occurred in western Russia.

Greenland was mostly more than +2°C and large parts of the North Atlantic more than +1°C warmer than normal. The summer was the warmest ever registered in Reykjavík (Iceland). The 98th percentile was reached over all these areas.

Most of the western half of the continent was around +1°C warmer than normal, exceeding the 90th percentile. Several countries saw some longer warm periods, but not the whole summer was warm. June was colder than normal across Fennoscandia, but July and August were hot. In the United Kingdom, the monthly mean temperature deviation decreased from +1.5°C in

June to -0.1°C in August. Generally, western and central Europe recorded a warm first half of the summer, but August was around or slightly cooler than normal. Switzerland experienced a hot summer period from mid-June to mid July.

The highest anomalies occurred again in eastern Europe and the Middle East, but they were much higher than in spring and higher than the 98th percentile. New daily maximum temperature records were set in many locations in eastern Europe and Finland. Summer in Estonia started with cooler-than-normal temperatures, but became very warm in July and August, resulting in an anomaly of +2.6°C. The mean summer temperature in Tartu was 18.7°C, the highest value since 1866. Latvia saw its warmest summer for 87 years (+2.7°C anomaly), with 23 hot days (maximum >= 30°C) peaking in an absolute daily maximum of 34.8°C on 13 July. Lithuania, too, was especially warm in July and August (summer anomaly +2.8°C); highest maxima exceeded 35°C on 18 July and 15 August.

Highest deviations were above +4°C during all summer months in European Russia (Fig. 0.39) and adjacent areas in Belarus, the Ukraine and western Kazakhstan; highest seasonal anomalies in European Russia reached +5°C, daily anomalies even reached more than +10°C, temperature maxima exceeded 40°C at several stations south-east of Moscow. It was the warmest summer in European Russia for the whole 130-year period of instrumental observations; possibly it was even one of the hottest in eastern Europe for about 500 years. This was mainly due to an exceptionally long and strong heat wave in July and August centered in Russia, partly also already in June. New daily maximum temperature records were set in all summer months until 19 August. Over most of European Russia, daily maxima above 30°C lasted for more than one month during July/August and both months were the hottest since at least 1939 averaged over the whole area. The high temperatures triggered massive forest and peat fires in European Russia, with smoke and smog adversely affecting tens of millions of people. Thousands of people (an estimated number of around 50,000) lost their lives, half of them around Moscow alone. A land area of more than 1700 km² burned down. The Russian crop production decreased by about one third compared to 2009 and the world market price for wheat rose to twice as high as before. Economic losses amounted to 15 billion US dollars. The Ukraine, Belarus and Finland, too, had new record maximum temperatures. Maxima of air temperature reached 38-42°C in the Ukraine, soil temperatures in 10 cm depth 25-33°C, causing poor conditions both for late summer harvest and sowing winter crops.

Parts of the Balkan Peninsula were also extremely warm. The number of hot days was above normal throughout Slovenia. Several places in Bosnia and Herzegovina exceeded the 98th percentile. In all three summer months, several heat waves were recorded in the mainland of Greece with highest monthly anomalies in August. Extreme heat was also recorded in Turkey, with maxima of 46.7°C e.g. in Mut. Mean temperatures were above normal in all three summer months in the eastern Mediterranean and the Middle East (up to > +2°C), but particularly high in August. Israel also reported several heat waves, especially in August.

In the South Caucasus region, too, summer was much warmer than normal, with seasonal anomalies locally between around +4 and +6°C. It was the hottest summer in Georgia since at least 1957 and the second warmest on record in Armenia behind 2006. The South Caucasus was especially affected by a large number of hot days since it was influenced by very warm air masses coming from the south over a long time. Baku in the coastal area of Azerbaijan counted more than 40 days with more than 35°C, normally there are only a few.

Iberia also had a hot July and August, with this two-month period being the second warmest since 1960. Portugal had its second highest mean summer maximum temperature since 1931. July and August were exceptionally warm, particularly in Portugal and eastern Spain. Anomalies in the whole Mediterranean region were mostly positive, rising up to +2°C. Outbreaks of cold air occurred only occasionally.

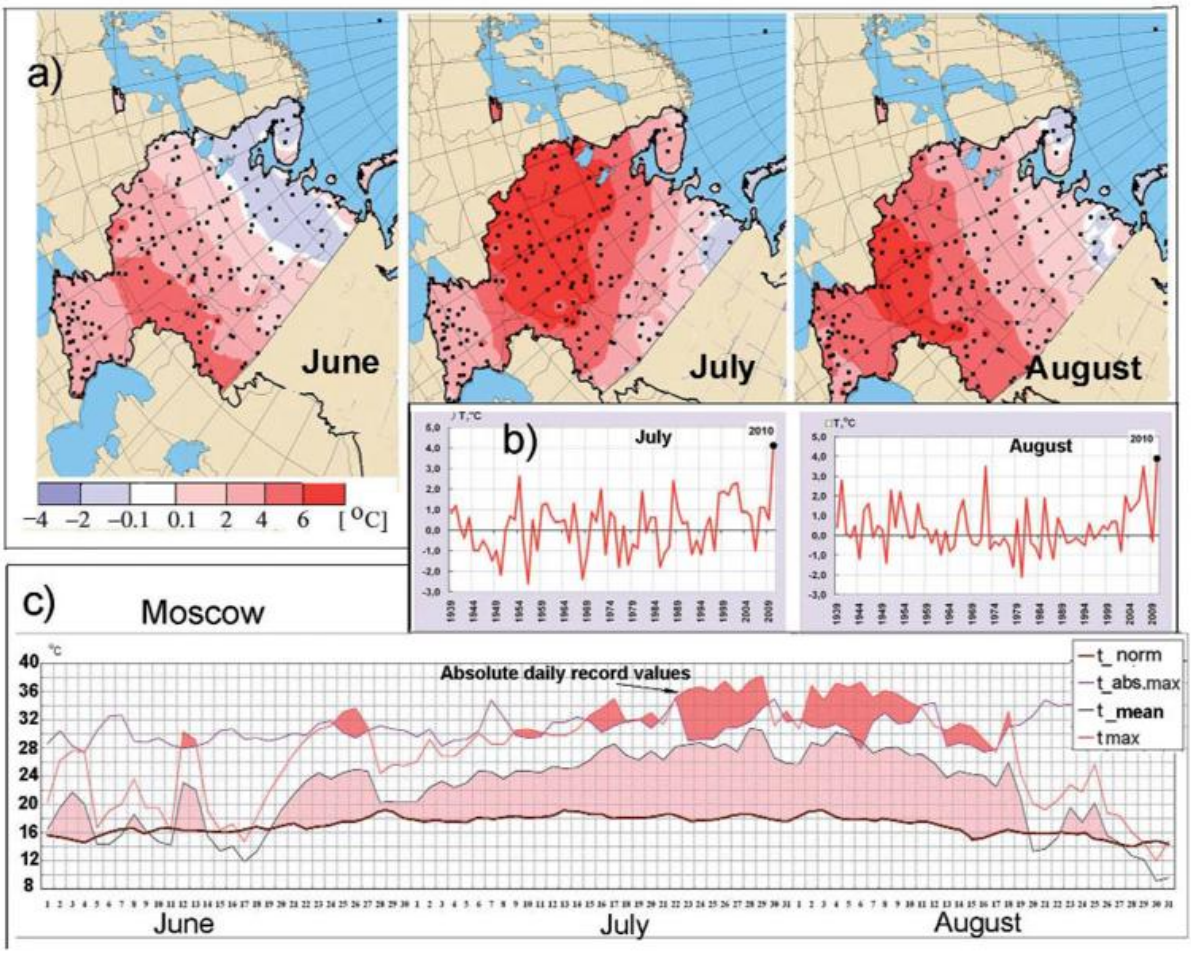

Fig. 0.39: *a) Monthly mean temperature anomalies (1961–1990 reference) in the summer months 2010 in European Russia*
b) Time series of monthly mean temperature anomalies averaged over European Russia in July and August 1939–2010
c) Daily mean (t_mean) and maximum (tmax) air temperature in Moscow June-August 2010, daily normal 1961–1990 (t_norm) and absolute daily maxima ever recorded (t_abs.max)
Source: Roshydromet, Russia

The mean minimum temperature was also much higher (> +3°C) than normal, especially over large parts of south-western, southern and eastern Europe. Some stations in Serbia saw new records for the number of nights warmer than 20°C.

The main reasons for the extraordinary hot summer were strong high pressure influence, particularly in eastern parts of the Region, but also dominating high pressure over the northern North Atlantic, especially in June and August (strongly negative North Atlantic Oscillation index in both months). During the summer, the Icelandic low was quite weak on average.

The high pressure area over Russia implied a blocking event in the northern hemisphere jet stream, which kept weather patterns almost stationary for more than one month. Russia is disposed toward blocking events during summer, and many of its prior heat waves also were associated with such blocking patterns. According to NOAA, the blocking pattern of summer 2010 was the most extreme and longest lasting one since 1920.

Autumn 2010 was cold in the western parts of Europe, but still warm in the east and in the Arctic ("Seasonal Maps", Fig. S4).

Once again, it was more than +1°C warmer than normal in the Arctic region and over most of the North Atlantic. Again, highest anomalies were to be found over western Greenland with more than +4°C, exceeding the 98th percentile.

Northern, western, central and south-western Europe were slightly colder than normal and locally below the 10th percentile. Anomalies were below -1°C over large parts of southern and eastern Norway and central Sweden, with the largest contribution from a very cold November. Denmark had its coldest autumn since 1998. Especially in the western parts of Europe (United Kingdom, Ireland, Spain), September was mild, but lower-than-normal temperatures occurred towards the end of autumn. In central Europe, it was the reverse: most of central Europe saw negative anomalies in September and October, whereas November was warmer than usual. The Baltic countries, too, were only slightly colder than normal and had a mild November. The whole season, however, was colder than autumn 2009 (difference at least about -1°C).

In the south-eastern parts of central Europe (especially Austria, Czech Republic, south-eastern Poland, Slovakia, Hungary), in Italy and on the northern Balkan Peninsula, November was extremely mild, whereas September and October were cold, resulting in a seasonal anomaly around zero.

Most of eastern and south-eastern Europe and especially the Middle East and the southern Caucasus saw a warm autumn, first in September (except for the Balkan Peninsula) and particularly in November. Only October was colder in most of eastern and south-eastern Europe. Large areas in the south-east of the Region were more than +2°C warmer than normal, surpassing the 90th percentile. Highest anomalies were to be found near the eastern Mediterranean with more than +3°C, e.g. in southern Turkey and partly in the Middle East. In these areas, all three autumn months were far warmer than normal, and likewise in the South Caucasus. It was the hottest autumn ever recorded in Armenia.

This season was again characterised by a highly negative North Atlantic Oscillation index and thus dominated by meridional circulation patterns, causing a cold airflow to prevail over western Europe and a warm airflow over the North Atlantic and eastern Europe. The Azores high was weak, the Icelandic low dislocated to the south.

Precipitation

Winter was especially wet in the south; the other seasons were particularly wet in eastern central Europe. Winter and autumn were dry in the north, spring in the west and summer in the east.

Winter 2009/10 was mostly drier than normal in northern, north-eastern, western and central Europe (except for parts of the Arctic and the Baltic countries), but wet in the southern parts of the Region. In most of western and central Europe, average winter precipitation was near normal, except for the south-eastern parts of central Europe (Fig. S5).

Especially Norway and Scotland, with their exposed locations for precipitation, saw a relatively dry winter, partly with less than 20% of the normal. Western Norway had its driest winter on record. Norway as a whole had around half of its normal seasonal precipitation totals and its second driest winter on record, surpassed only by winter 1899/1900. The Norwegian coast, large parts of Ireland and western parts of the United Kingdom were drier than normal in all three winter months. Dublin Airport had its driest winter since 1963/64. At most stations in Ireland, however, it was not as dry as in the winter of 2005/06.

Most of the southern half of the Region received a lot of precipitation, especially Iberia, the Mediterranean region, the Balkan Peninsula, Hungary and Slovakia as well as the areas around the Black Sea. Spain had seasonal totals exceeding 250% of the normal, particularly in the south, due to a persisting period of rainy weather originating from wet Atlantic air masses and many heavy rain events. It was the third wettest winter in Spain since 1947. At 1379 mm, Gibraltar set a new winter precipitation record. The station Lisbon in Portugal also hit a new record of winter precipitation (775 mm) for the time series since 1870 and a new all-time record for the period December 2009 to March 2010 (958 mm). As a consequence of the unusually rainy winter season, large areas of southern and south-western Iberia were affected by floods, particularly along the Guadalquivir river, with important socioeconomic impacts on agriculture, road/rail traffic, buildings and infrastructure. Floods were directly responsible for nine fatalities and for displacing about 1000 people.

On the Balkan Peninsula, Bosnia and Herzegovina reported seasonal totals locally exceeding 300% of the normal while places in Slovenia and northern Serbia reached more than 200% due to some heavy rainfall, particularly in February. Winter precipitation was also far above average throughout Romania and Moldova in all three winter months. The eastern Mediterranean, Turkey, most of the South Caucasus and western Kazakhstan were wetter than normal, with above 125% of the normal over large parts.

This distribution of precipitation resulted from a dominating high pressure influence in the north and low pressure influence in the south, reflecting the strongly negative Arctic Oscillation.

That winter was also characterised by a thick and persistent snow cover in large parts of northern, north-western and central Europe (Fig. 0.40). Over these areas, most of the winter precipitation, though mostly below normal in quantity, fell as snow, and there were new local snow depth records. The number of snow days was higher than normal, especially in south Scandinavia and central Europe, and it was one of the snowiest winters also in western Europe. Even Spain reported snowfall several times.

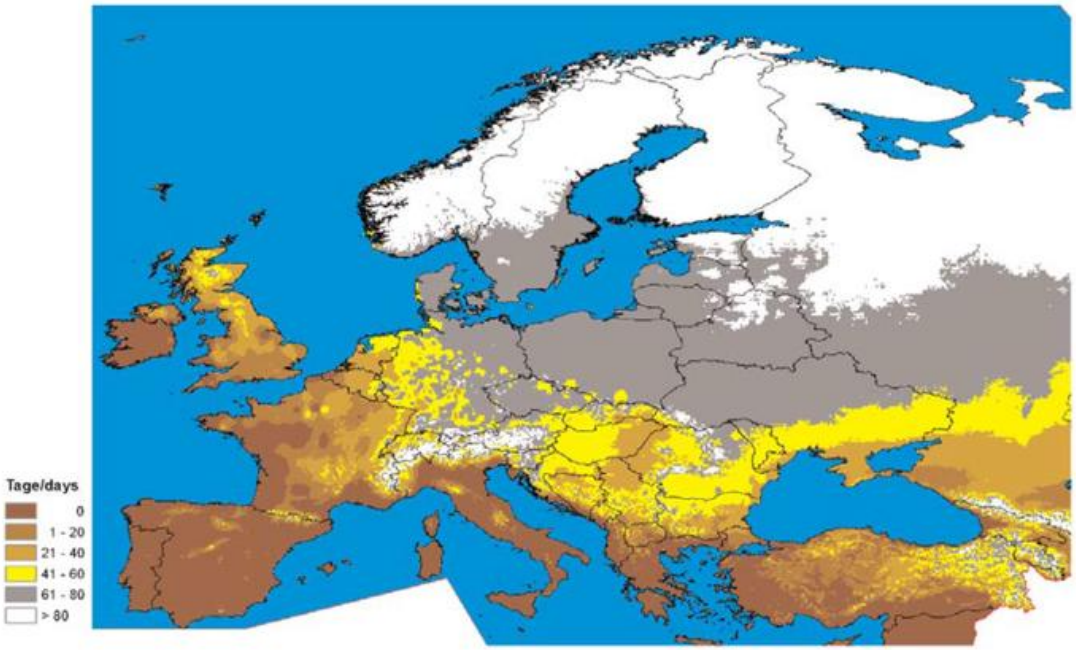

Fig. 0.40: *Number of snow days (number of days with a snow cover of at least 1 cm on the ground) in Europe in winter 2009/10*
Source: Deutscher Wetterdienst, Germany

In contrast, snow was relatively rare in Iceland. Reykjavík recorded 47 consecutive snow-free days from January to February, the longest snow-free period ever observed during this time of the year.

Significant snowfalls occurred in the United Kingdom from mid-December until the end of February and partly into spring. Snow depths in the UK reached up to 70 cm in Aberdeenshire. These were the most widespread snowfalls since the mid-1980s, affecting all forms of traffic as well as electricity and water supply. Ireland saw 20–30 days with snow in many places, mainly in form of showers, but snowfall accumulations were generally slight except on high ground.

In central Europe, very large numbers of snow days were to be noted. The Netherlands had 42 days with snow cover on average, more than three times the long-term average of 13. Such a large number of days with snow had not been seen for more than 30 years since the winter 1978/79. Uccle in Belgium had 31 snow days, the third highest number since 1901. It was one of the snowiest winters in the last 30 years in France, although the snow depths remained below historical records. Snow was also abundant in Germany; locally the highest depths on record and up to 73 snow days were recorded in the northern and eastern parts of the country, around twice as much as normal.

There was also more snow than usual in southern Finland because of the long lasting cold spell. Helsinki had not had so much snow since 1970, recording its maximum snow depth of that winter at 73 cm in late February, which, however, remained far below its highest record of 109 cm in 1941.

In Latvia and Lithuania, a steady snow cover began to form in the second decade of December and lasted almost the entire winter, except at the seaside. The snow cover in Latvia was two to three times deeper than normal most of that time. In the Ukraine, too, it was one of the snowiest winters in the past decade, with the highest maximum depth over the entire observation series.

In contrast, the snow cover duration was significantly lower than normal in most of European Russia. Even in the mountain regions of northern Caucasia, the snow cover persisted not as long as it usually does. The maximum snow depths, however, were higher than normal due to a rather large amount of precipitation as well as an absolute absence of thaws in central European Russia as had not been recorded for several decades.

Spring 2010 was dry in western Europe as well as over most of Russia and the eastern Mediterranean region, but wet in most of northern and eastern central Europe and over the western Mediterranean (Fig. S6).

It was a mostly dry spring in the Arctic region, namely in Svalbard and parts of Greenland.

Most of Scandinavia saw a wet spring (except for the southern parts), partly with more than 125% of the normal, with some heavy precipitation events causing locally severe mud slides, especially in late spring. Places in northern Norway received more than 200% of the normal, while stations in the southernmost parts of the country recorded only 50% of the normal. Southern Iceland and southern Sweden, too, were drier than normal, and Denmark also had a small precipitation deficit.

Likewise, many of the western countries of Europe (Ireland, the United Kingdom, the Low Countries, France, western Germany, Switzerland, northern Spain) were drier than normal, partly with totals of less than 80% of the normal, locally even less than 60%. It was the driest spring in the UK since 1984, due to the particularly dry April and May months with about 50% of the 1961–1990 normal in England and Wales. Uccle in Belgium had only 33 precipitation days in spring (normal: 49 days), the lowest number since 1990.

Most of Iberia and the western Mediterranean had a wetter-than-normal spring, except the north of Spain. Local areas in northern Iberia received less than 80% of the climatological average, whereas the southern parts received up to 125%. Lisbon in Portugal saw its rainiest spring of the last 51 years.

In most of eastern central Europe, spring was wet, too, although April was very dry. Especially Poland, the eastern Czech Republic, Slovakia and Hungary partly had around twice the normal amount. A large contribution to this anomaly came from a flooding event in May. In many areas, the number of days with a daily total > 20 mm was higher than normal. Large parts of the Balkan Peninsula were also wetter than normal due to some heavy thunderstorms in April and May, except for the south.

Precipitation was also above normal in the Baltic countries. In addition, melting of snow and ice blockages caused local floods in parts of Estonia and Latvia.

Central European Russia and parts of the eastern Ukraine were dry, locally with less than 60% of the normal, whereas the northern and southern parts of European Russia and the southern Caucasus region were wet.

The eastern Mediterranean region and the Middle East were extremely dry during the whole spring, mostly with less than 40% of the normal. March and April were unusually dry months in Greece. In contrast, the southern Caucasus region and west Kazakhstan were wetter than normal.

The reason for this large-scale precipitation distribution was a prevailing strong meridional circulation pattern, with frequent low pressure activity over eastern central Europe and high pressure influence west and east of it.

Summer 2010 was wetter than normal in most parts of Europe, but very dry in the east (Seasonal Maps, Fig. S7). The large number of days with daily totals >20 mm in many parts of Europe implies a large number of convective events.

The Arctic region was very dry, namely Greenland and Svalbard, but summer precipitation totals were between 125% and 150% of the normal in large parts of the Nordic and Baltic countries, except Iceland and southern Finland. Northern Norway experienced its second wettest summer on record, together with 1995 and behind 1921. Latvia experienced its third wettest summer for 87 years. Lithuania, too, had extraordinarily rainy weather that summer, which included 10 heavy rainfall and 3 large hail events.

Summer rainfall was close to average in western Europe, though with high spatial and temporal variability due to various wet and dry spells over the three summer months.

In most areas of Europe, the seasonal totals were only slightly higher than normal. However, over large parts of eastern central Europe (eastern Germany, Poland, the Czech Republic, Slovakia, Hungary), some parts of eastern Europe (western Ukraine, Romania), northern Europe and also west and south of the Black Sea, the totals exceeded 125% of the normal, in Latvia and Lithuania 150%, in parts of Slovakia even 200%.

There were a number of heavy rainfall events in various parts of Europe. Central Europe was particularly affected, especially the eastern areas. Two exceptional flooding events concerned especially eastern Germany, Poland and the Czech Republic. Germany recorded several periods of heavy rain with daily totals of more than 100 mm (such daily totals had not been measured in Germany in the previous years 2008 and 2009). Slovakia recorded its wettest summer in its history of precipitation measurements since 1881.

The Balkan Peninsula, too, received much heavy rain. In Slovenia, precipitation was abundant in the north-west. Many other parts had below-normal precipitation but also very intense thunderstorms during summer. Heavy precipitation in Romania between 20 June and 14 July caused severe flooding in many parts of the country. The rest of the eastern parts of the Balkan Peninsula were also wetter than normal as opposed to drier parts in the west.

Southern Spain, which already had received much precipitation in spring, also saw a lot of precipitation in summer, in places close to twice the normal, whereas other parts of Spain, Portugal, southern and western France were very dry. June was relatively wet in Spain, but July and partly also August were drier than normal. Average July precipitation over Spain (generally low in summer) was only around 50% of average. In southern Europe, it was generally very wet in June 2010, but became very dry in August.

In the Mediterranean, it was wet over Corsica and Sardinia, but dry over Sicily and Malta, in particular, which received only 1.4 mm during the whole summer and all of June (summer normal is 10.6 mm).

It was dry over most of European Russia and some adjacent areas (including southern Finland and most of the South Caucasus), particularly during the heat wave in this area in July and August. Some parts of eastern European Russia received less than 20% of the seasonal normal. Numerous forest and peat fires with subsequent air pollution occurred in many places; several settlements burnt down completely. It was the worst drought since 1972.

The main reason was the strong high pressure influence particularly over Russia, whereas low pressure systems were blocked over eastern central Europe.

The DWD drought index (Fig. 0.41) shows extreme drought conditions for the very dry areas in Russia and the Middle East and severe drought conditions over southern Portugal for that summer. Anomalies of this drought index imply that only the drought area in Russia showed an extreme deviation from normal.

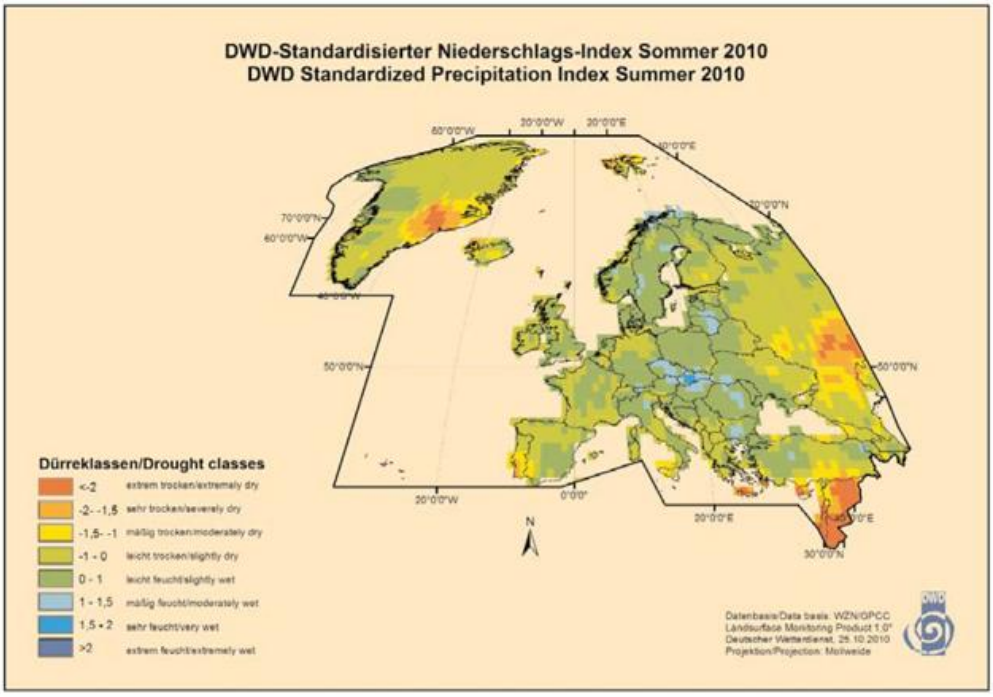

Fig. 0.41: *Standardized precipitation index (DWD version) for summer 2010*
Source: Deutscher Wetterdienst, Germany

Autumn 2010 was wet or around normal in most of Europe, but very dry in Scandinavia (except for the southern parts), the Arctic, the northern Alps and particularly the Middle East (Seasonal Maps, Fig. S8).

Especially Norway and most of Sweden were very dry, mostly with less than 80% of the normal precipitation, locally less than 40%.

Precipitation was close to normal in most of western Europe as a result of a dry October, but a wet November. However, several heavy rain events caused high above-normal anomalies in some places in France.

Some larger parts of central, eastern and southern Europe (eastern Germany, Poland, eastern Ukraine, most of Italy and the Balkan Peninsula) were particularly wet; partly they received around twice the normal seasonal precipitation. Especially September and November totals were mostly above normal across central Europe, but these wet spells were interrupted by a mostly dry October, with some local exceptions.

Autumn was wet in northern Spain, whereas the Spanish Mediterranean regions were drier than normal. However, the number of days with totals >20 mm was much larger than normal over the Mediterranean and northern Italy.

It was very dry in the Middle East and in Cyprus. That area received less than 40% of its normal precipitation, which means a prolongation of the dry summer period.

The distribution of precipitation reflects a centre of intense low pressure activity over eastern central Europe, the Balkan Peninsula and the central Mediterranean.

Seasonal Maps

Surface temperature anomalies

December 2009 - February 2010

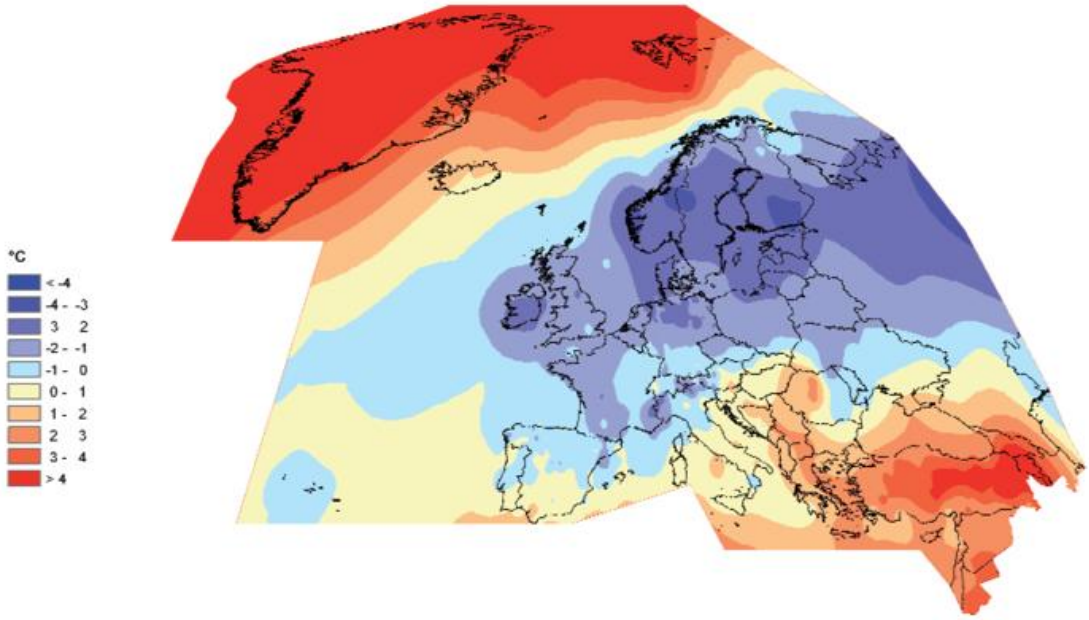

Fig. S1: *Surface temperature anomalies (reference period 1961–1990) for winter 2009/10*
Source: Deutscher Wetterdienst, Germany

March 2010 - May 2010

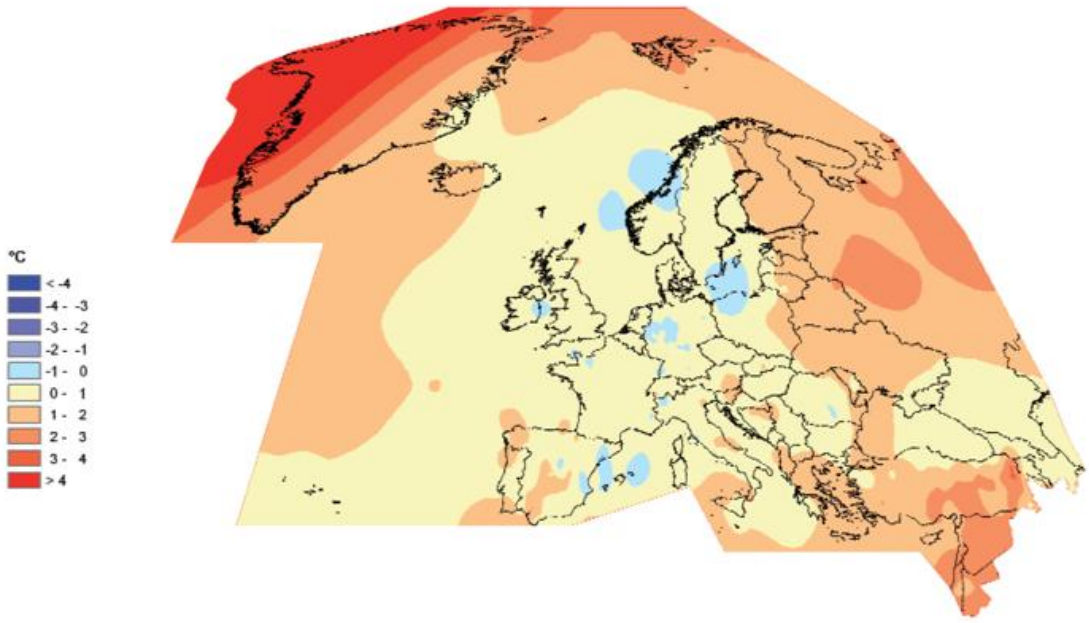

Fig. S2: *Surface temperature anomalies (reference period 1961–1990) for spring 2010*
Source: Deutscher Wetterdienst, Germany

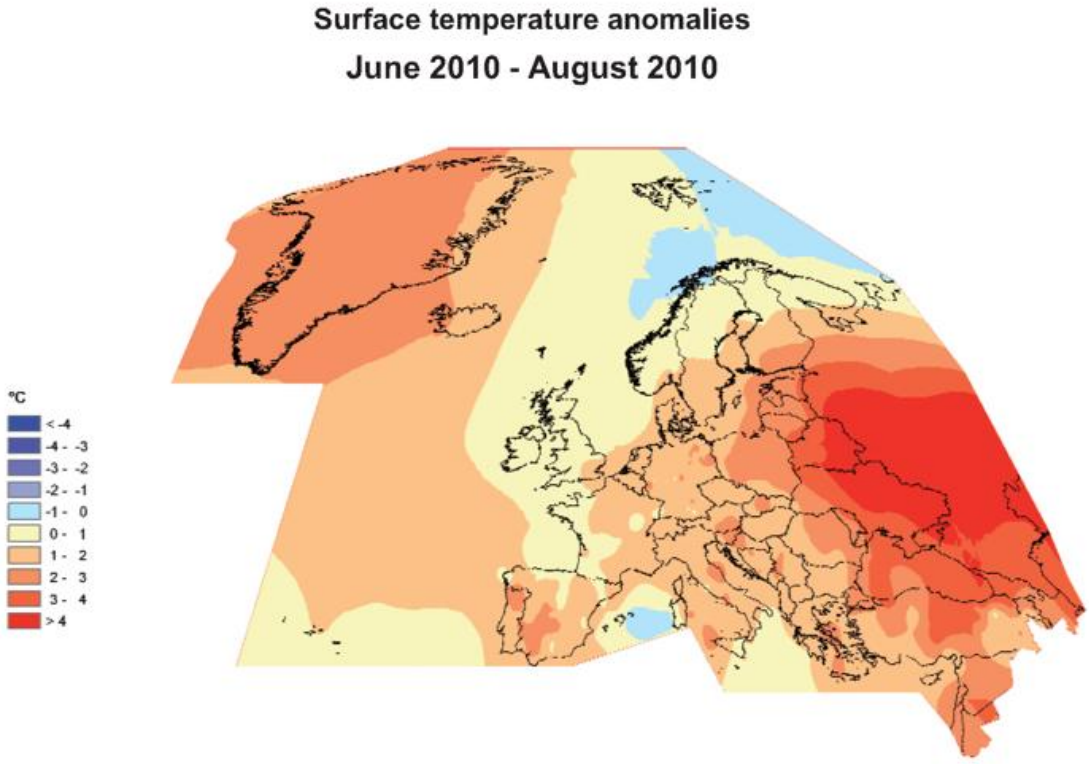

Fig. S3: *Surface temperature anomalies (reference period 1961–1990) for summer 2010*
Source: Deutscher Wetterdienst, Germany

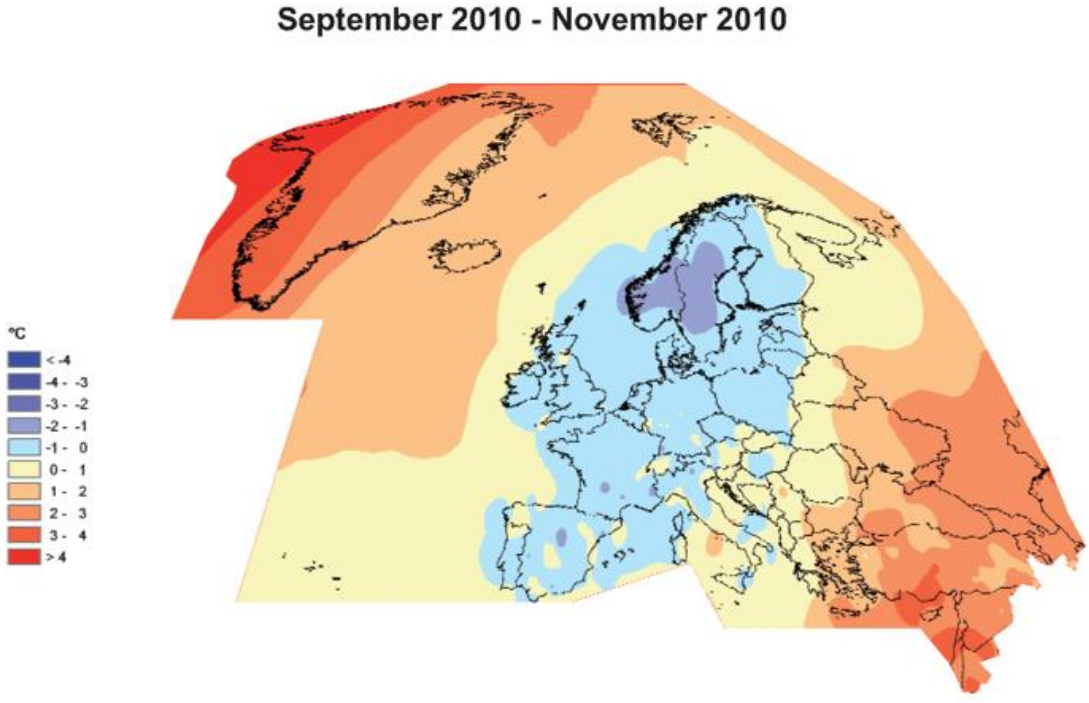

Fig. S4: *Surface temperature anomalies (reference period 1961–1990) for autumn 2010*
Source: Deutscher Wetterdienst, Germany

Precipitation in per cent of normal

December 2009 - February 2010

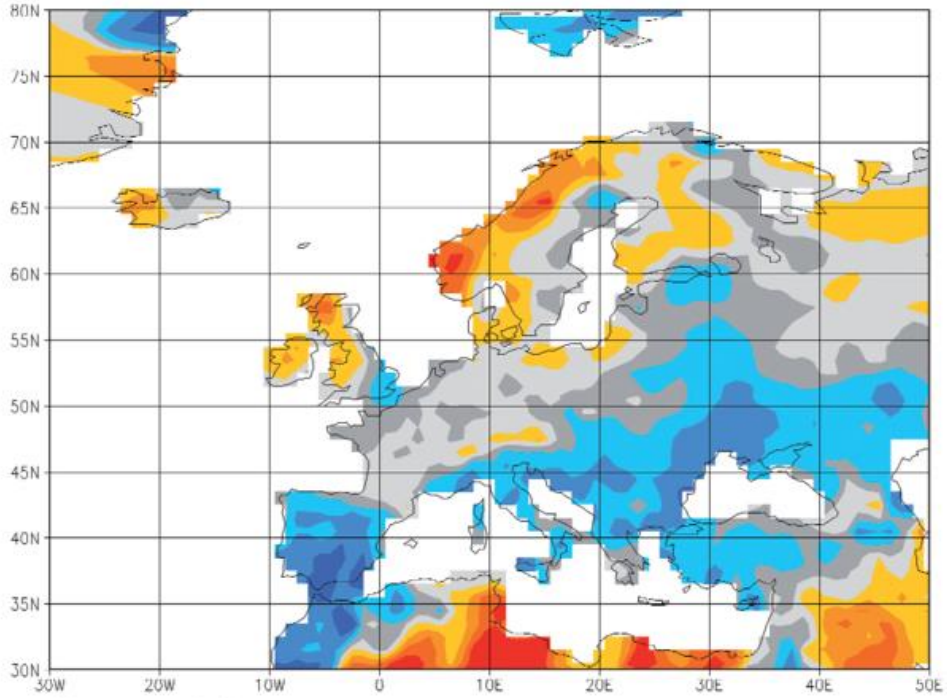

Fig. S5: *Precipitation in per cent of normal (reference period 1951-2000) for winter 2009/10. Gauge-based analysis 1.0 degree*
Source: GPCC / Deutscher Wetterdienst, Germany

March 2010 - May 2010

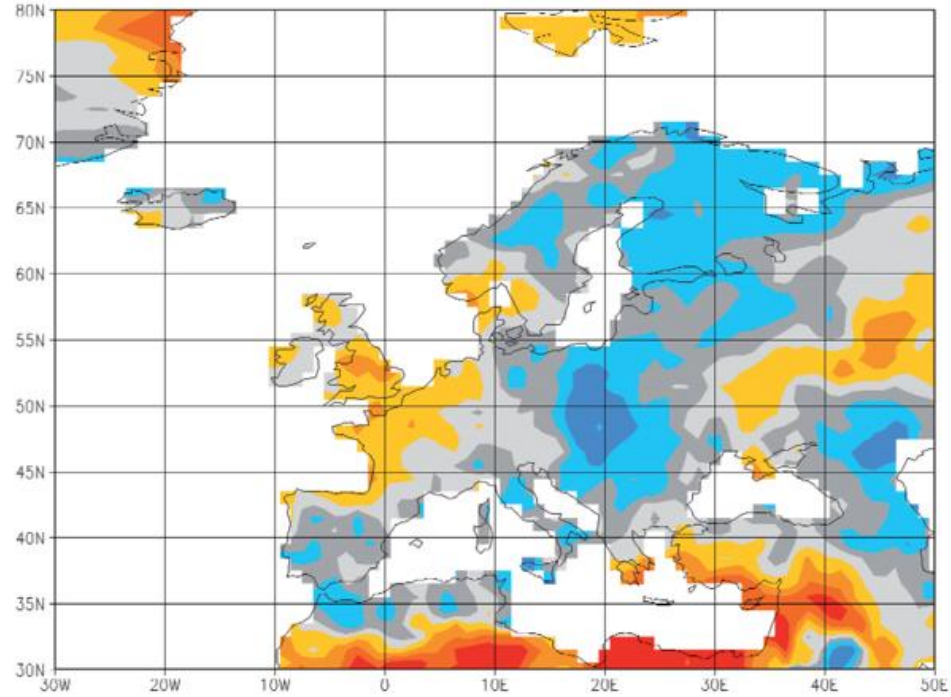

Fig. S6: *Precipitation in per cent of normal (reference period 1951-2000) for spring 2010. Gauge-based analysis 1.0 degree*
Source: GPCC / Deutscher Wetterdienst, Germany



Precipitation in per cent of normal

June 2010 - August 2010

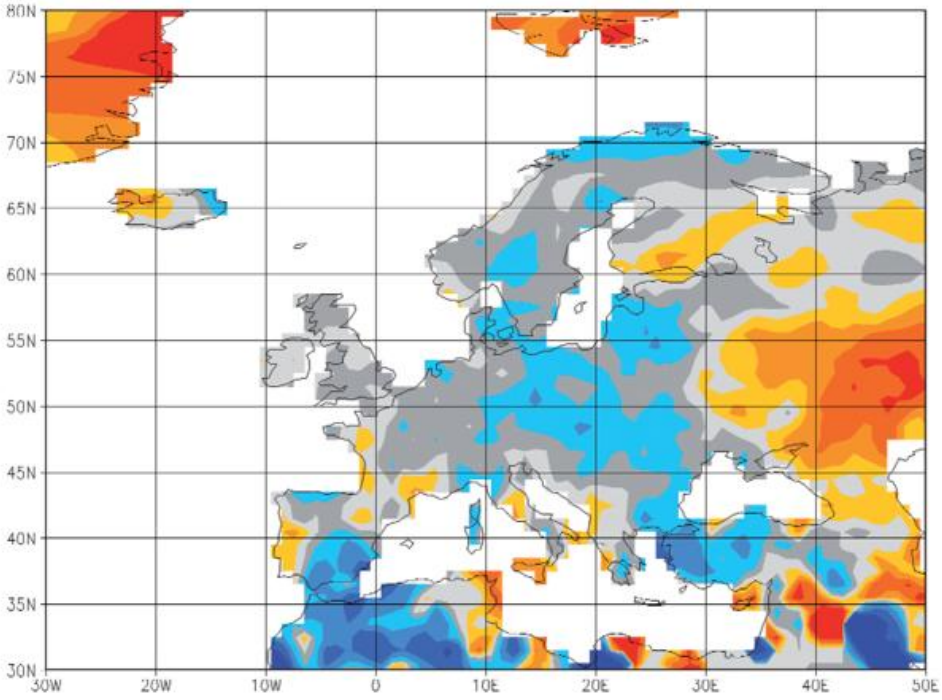

Fig. S7: *Precipitation in per cent of normal (reference period 1951-2000) for summer 2010. Gauge-based analysis 1.0 degree*
Source: GPCC / Deutscher Wetterdienst, Germany

September 2010 - November 2010

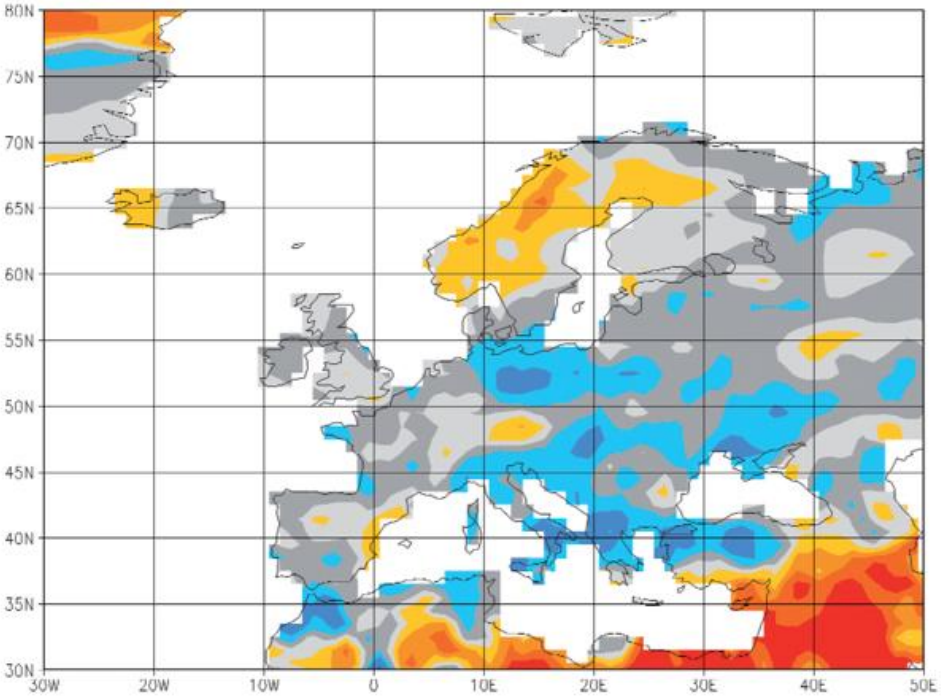

Fig. S8: *Precipitation in per cent of normal (reference period 1951-2000) for autumn 2010. Gauge-based analysis 1.0 degree*
Source: GPCC / Deutscher Wetterdienst, Germany



Monthly and Annual Tables

Temperature and precipitation values with deviations from the 1961-1990 normal
(some stations have shorter reference periods)

WMO No.	Station	January 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	February 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-7.2	8.2	69	55	-10.3	5.4	1	-18
01025	Tromsø	-2.9	1.1	77	-4	-7.4	-3.7	58	-28
01492	Oslo	-8.1	-3.8	14	-35	-6.3	-2.3	37	1
02196	Haparanda	-13.8	-1.7	17	-27	-14.9	-3.6	50	18
02485	Stockholm	-7.0	-4.2	26	-13	-5.2	-2.2	29	2
02836	Sodankylä	-14.6	0.5	12	-19	-17.5	-3.9	29	4
02974	Helsinki	-12.4	-5.5	22	-19	-9.1	-2.3	50	19
03091	Aberdeen	2.1	-0.6	73	-8	1.8	-1.1	86	35
03772	London	2.3	-1.9	52	0	4.4	-0.1	100	65
03967	Dublin Casement Aerodrome	1.4	-3.0	44	-22	2.3	-2.1	37	-14
04030	Reykjavik	2.4	2.9	91	15	0.0	-0.4	26	-46
04339	Scoresbysund	-12.4	1.9	32	3	-17.5	-2.5	25	-4
06186	Copenhagen	-2.4	-2.9	7	-44	-1.1	-1.6	21	-10
06260	De Bilt	-0.5	-2.7	41	-25	1.6	-0.9	77	28
06447	Brussels	0.1	-2.5	44	-23	2.5	-1.0	76	23
06590	Luxembourg	-2.1	-2.1	35	-36	1.0	-0.1	89	27
06660	Zurich	-1.9	-1.4	39	-28	0.9	0.0	35	-35
06700	Geneva	0.4	-0.4	47	-33	2.0	-0.3	97	16
07510	Bordeaux	3.5	-2.3	78	-22	5.8	-1.3	54	-32
07650	Marseilles	4.8	-1.9	89	42	6.9	-1.0	59	5
08222	Madrid	5.4	-0.7	61	15	6.4	-1.1	112	68
08314	Mahón/Minorca	10.0	-0.5	74	8	10.5	-0.2	75	18
08495	Gibraltar	13.9	0.5	386	265	14.8	1.0	485	385
08515	Santa Maria/Azores	15.0	0.6	181	81	14.3	0.3	176	90
08535	Lisbon	11.5	0.1	194	84	11.1	-1.2	298	187
10384	Berlin-Tempelhof	-4.5	-4.3	21	-22	0.3	-0.5	23	-11
11035	Vienna	-1.9	-0.9	56	18	0.8	-0.2	20	-22
11518	Prague	-4.5	-2.1	25	2	-1.7	-0.9	9	-14
11903	Sliač	-3.3	0.6	66	22	-1.1	0.0	48	4
12160	Elblag	-7.4	-5.0	19	-28	-2.0	0.2	21	-4
12375	Warsaw	-8.0	-4.7	25	3	-1.8	0.2	37	16
12843	Budapest	-2.0	-0.4	52	20	0.7	-0.4	50	18
13274	Belgrade	0.7	0.3	92	43	3.7	1.0	113	69
14015	Ljubljana	-1.5	-0.4	125	43	1.3	-0.1	145	65
14445	Split	6.8	-0.6	140	57	8.5	0.4	164	96
14654	Sarajevo	0.4	1.3	161	90	1.5	0.0	96	29
15420	Bucharest	-3.6	-1.2	64	24	-0.5	-0.4	94	58
15614	Sofia	0.1	1.7	28	1	1.6	1.1	56	23
16206	Grosseto	6.9	-0.1	109	45	8.5	0.5	64	7
16597	Luqa	13.4	1.2	57	-32	13.8	1.4	16	-45
16716	Athens	11.1	0.9	31	-13	12.8	2.2	38	-5
16754	Heraklion/Crete	13.4	1.4	141	51	14.9	2.8	11	-66
17040	Rize	9.0	2.7	312	89	9.3	2.7	159	-12
17062	Istanbul	7.2	1.6	186	87	8.6	2.7	141	74
17170	Van	0.1	4.5	52	18	1.4	5.2	39	6
17300	Antalya	10.9	1.0	340	101	12.3	2.0	289	93
17609	Larnaca	14.0	2.5	131	66	13.8	2.1	120	63
22113	Murmansk	-12.2	-0.5	17	-16	-12.5	-1.3	30	8
26038	Tallinn	-11.0	-5.5	27	-18	-7.7	-2.0	50	21
26629	Kaunas	-10.2	-5.2	20	-17	-3.9	0.4	39	12
26730	Vilnius	-10.4	-4.3	23	-18	-4.1	0.7	44	6
26850	Minsk	-11.1	-4.2	40	0	-4.8	1.0	55	21
27612	Moscow	-14.5	-5.2	18	-27	-8.4	-0.7	64	27
33345	Kiev	-8.8	-3.2	54	7	-3.3	0.9	62	16
33815	Kishinev	-5.2	-1.9	86	46	-0.9	0.8	62	24
34300	Kharkiv	-9.7	-2.8	45	1	-4.2	1.5	59	27
34880	Astrakhan	-6.6	-1.2	25	12	-5.5	-0.6	9	-1
35188	Astana	-19.4	-3.6	20	3	-20.0	-4.1	10	-4
37789	Yerevan	2.8	6.0	52	23	4.5	5.5	56	18
40007	Aleppo	8.9	3.2	49	-15	9.3	2.0	81	29
40080	Damascus	9.4	3.5	36	7	10.7	2.8	16	-8
40180	Tel Aviv	15.6	3.3	67	-82	16.7	3.8	157	59
40199	Eilat	18.4	3.2	20	15	20.1	3.2	4	-1
40265	Mafraq	10.5	3.3	40	6	11.5	2.8	43	12
60030	Las Palmas/Grand Canary	19.3	1.8	60	43	20.3	2.7	30	8

WMO No.	Station	March 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	April 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-15.8	-1.1	13	-8	-7.7	4.0	5	-7
01025	Tromsø	-4.3	-2.1	89	25	1.5	0.8	51	-9
01492	Oslo	0.3	0.5	66	20	6.0	1.4	32	-10
02196	Haparanda	-7.5	-0.7	58	23	1.8	2.3	23	-6
02485	Stockholm	-0.2	-0.3	21	-5	6.4	1.8	23	-7
02836	Sodankylä	-10.3	-1.8	55	30	1.2	3.3	20	-4
02974	Helsinki	-2.7	0.2	56	22	4.7	1.8	54	17
03091	Aberdeen	5.5	1.0	47	-11	8.0	1.7	34	-19
03772	London	7.5	1.0	40	-7	10.7	1.8	23	-22
03967	Dublin Casement Aerodrome	5.4	-0.6	59	10	8.3	0.5	33	-14
04030	Reykjavik	3.1	2.6	55	-27	2.8	-0.1	36	-22
04339	Scoresbysund	-17.3	-1.9	32	9	-8.5	1.8	27	6
06186	Copenhagen	3.4	0.8	40	-2	8.0	1.4	25	-17
06260	De Bilt	6.4	1.4	55	-8	9.7	1.7	31	-21
06447	Brussels	6.7	1.2	50	-4	10.3	1.5	16	-41
06590	Luxembourg	5.0	1.0	65	-5	10.0	2.5	18	-43
06660	Zurich	4.6	0.4	54	-15	10.1	2.3	34	-53
06700	Geneva	5.6	0.5	61	-18	11.0	2.2	22	-43
07510	Bordeaux	8.8	0.0	68	-8	13.8	2.5	27	-45
07650	Marseilles	9.7	-0.5	59	15	14.3	1.1	25	-23
08222	Madrid	9.3	-0.7	60	27	14.3	2.1	48	-6
08314	Mahón/Minorca	11.0	-0.6	19	-36	13.1	-0.2	58	8
08495	Gibraltar	15.3	0.3	187	112	16.8	0.6	82	22
08515	Santa Maria/Azores	14.6	0.0	252	173	15.5	0.3	103	48
08535	Lisbon	13.4	-0.3	193	124	17.1	2.0	89	25
10384	Berlin-Tempelhof	5.1	0.9	39	2	9.8	1.2	16	-25
11035	Vienna	6.0	1.0	18	-23	10.8	0.9	91	40
11518	Prague	3.8	0.8	15	-13	8.9	1.2	37	-1
11903	Sliač	4.0	1.0	21	-21	9.8	1.3	62	15
12160	Elblag	3.0	0.9	37	2	7.8	1.0	10	-32
12375	Warsaw	3.9	1.9	24	-4	9.5	1.7	39	7
12843	Budapest	6.6	1.0	19	-10	12.0	0.9	43	5
13274	Belgrade	8.2	1.0	47	-3	13.4	1.0	44	-15
14015	Ljubljana	6.2	0.8	35	-63	11.5	1.6	82	-27
14445	Split	10.6	0.2	69	-6	15.4	1.5	88	22
14654	Sarajevo	5.2	0.1	63	-7	10.2	0.8	59	-15
15420	Bucharest	4.7	-0.1	47	9	11.5	0.2	45	-1
15614	Sofia	5.5	0.9	74	36	10.5	0.6	54	4
16206	Grosseto	9.6	-0.6	49	-23	13.4	0.7	65	-4
16597	Luqa	14.1	0.7	71	30	17.0	1.5	1	-22
16716	Athens	13.9	1.3	8	-33	17.7	1.6	11	-14
16754	Heraklion/Crete	15.3	1.9	37	-19	17.6	1.3	6	-24
17040	Rize	8.6	0.7	219	73	11.5	-0.1	109	7
17062	Istanbul	9.1	1.6	70	8	13.7	1.7	48	-1
17170	Van	5.8	4.9	38	-4	8.4	1.1	46	-8
17300	Antalya	16.1	3.4	9	-94	17.6	1.5	14	-32
17609	Larnaca	15.7	2.4	1	-48	18.7	1.3	2	-9
22113	Murmansk	-7.9	-1.1	47	27	1.7	3.6	26	5
26038	Tallinn	-1.8	0.4	51	22	4.9	1.5	36	0
26629	Kaunas	0.1	0.3	30	-2	7.4	1.4	59	16
26730	Vilnius	0.2	0.8	47	8	7.6	1.9	36	-10
26850	Minsk	0.1	1.5	28	-14	8.5	2.5	27	-15
27612	Moscow	-1.1	1.1	22	-12	8.3	2.5	31	-9
33345	Kiev	1.4	0.7	20	-19	10.3	1.6	42	-7
33815	Kishinev	4.0	1.1	29	-6	11.0	0.8	45	3
34300	Kharkiv	0.2	0.5	20	-7	10.3	1.4	24	-12
34880	Astrakhan	2.7	1.4	20	6	10.7	-0.4	42	24
35188	Astana	-6.7	1.4	39	25	5.8	0.9	20	-2
37789	Yerevan	9.2	-0.4	17	24	11.2	-0.4	128	77
40007	Aleppo	13.8	2.8	16	-29	17.6	1.8	16	-20
40080	Damascus	14.5	3.5	2	-15	18.1	2.6	0	-11
40180	Tel Aviv	18.6	3.7	22	-40	20.1	1.9	3	-20
40199	Eilat	22.8	2.8	<1	-4	26.4	2.2	<1	-4
40265	Mafraq	14.9	3.4	2	-27	17.9	2.1	0	-10
60030	Las Palmas/Grand Canary	20.3	1.9	0	-10	21.0	2.3	<1	-6

WMO No.	Station	May 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	June 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	0.0	3.7	7	1	3.5	1.3	4	-6
01025	Tromsø	7.2	2.3	44	-4	7.2	-2.1	116	63
01492	Oslo	11.0	0.2	25	-27	15.3	0.1	91	26
02196	Haparanda	10.2	4.1	56	25	11.9	-0.9	25	-16
02485	Stockholm	11.3	0.6	31	1	15.7	0.1	33	-12
02836	Sodankylä	8.1	3.1	63	28	10.9	-0.7	29	-27
02974	Helsinki	11.9	2.0	80	45	15.1	0.2	32	-12
03091	Aberdeen	9.3	0.3	58	-1	13.2	1.1	23	-30
03772	London	12.5	0.0	21	-30	17.8	2.1	12	-39
03967	Dublin Casement Aerodrome	10.3	-0.2	45	-13	14.8	1.5	45	-3
04030	Reykjavik	8.2	1.9	30	-14	11.4	2.4	30	-20
04339	Scoresbysund	-1.9	1.0	16	4	2.0	-0.4	8	-18
06186	Copenhagen	10.6	-1.4	49	6	15.4	-0.7	67	13
06260	De Bilt	10.5	-1.8	66	5	16.4	1.2	18	-50
06447	Brussels	11.2	-1.7	67	-4	17.4	1.7	30	-49
06590	Luxembourg	10.9	-0.9	111	30	17.5	2.6	72	-10
06660	Zurich	11.5	-0.6	140	37	16.9	1.7	126	2
06700	Geneva	13.0	0.0	108	31	17.6	1.1	77	-12
07510	Bordeaux	14.9	0.3	41	-36	19.2	1.4	102	46
07650	Marseilles	16.9	-0.2	43	1	21.6	0.7	56	28
08222	Madrid	16.2	0.2	23	-18	21.1	0.4	59	33
08314	Mahón/Minorca	15.8	-1.0	48	11	19.8	-1.0	11	-3
08495	Gibraltar	19.0	0.5	27	-8	21.8	0.7	14	3
08515	Santa Maria/Azores	17.0	0.3	39	9	19.4	0.7	10	-12
08535	Lisbon	18.1	0.7	38	-1	20.4	0.2	32	11
10384	Berlin-Tempelhof	11.6	-2.3	72	16	18.4	1.0	2	-73
11035	Vienna	14.6	0.0	169	108	19.2	1.3	120	46
11518	Prague	11.8	-0.9	78	1	16.8	0.9	56	-17
11903	Sliač	14.8	1.1	152	88	19.0	2.4	165	80
12160	Elblag	11.3	-1.6	86	45	16.0	0.6	23	-71
12375	Warsaw	13.6	0.2	116	57	17.8	1.2	87	15
12843	Budapest	15.9	-0.1	163	108	20.0	0.9	133	70
13274	Belgrade	17.9	0.7	86	15	21.1	1.0	182	92
14015	Ljubljana	15.3	0.7	102	-20	20.3	2.5	124	-31
14445	Split	18.5	0.1	98	42	23.5	1.3	64	13
14654	Sarajevo	14.4	0.3	93	11	17.9	1.0	182	91
15420	Bucharest	16.4	-0.3	78	8	21.1	0.9	120	43
15614	Sofia	15.7	1.4	66	-7	18.6	0.9	77	5
16206	Grosseto	16.6	-0.3	69	25	21.4	0.8	18	-10
16597	Luqa	19.4	0.3	12	5	22.9	-0.1	1	-2
16716	Athens	21.8	1.2	21	5	26.1	1.0	11	4
16754	Heraklion/Crete	21.5	1.7	5	-11	24.8	1.3	6	3
17040	Rize	17.7	1.9	107	6	23.2	3.3	250	125
17062	Istanbul	19.3	2.8	13	-18	22.7	1.6	104	83
17170	Van	13.3	0.5	73	23	19.8	2.2	41	20
17300	Antalya	21.5	1.2	19	-9	25.0	0.0	21	13
17609	Larnaca	22.1	1.2	<1	-7	25.4	1.1	6	5
22113	Murmansk	6.2	2.4	40	8	9.0	-0.4	52	-1
26038	Tallinn	11.0	1.3	64	27	13.8	-0.7	43	-10
26629	Kaunas	13.7	1.0	95	39	16.5	0.5	127	52
26730	Vilnius	14.0	1.5	113	51	16.7	0.9	142	65
26850	Minsk	14.6	1.7	136	74	18.4	2.3	146	63
27612	Moscow	16.7	3.8	59	1	18.8	2.2	62	-14
33345	Kiev	17.3	2.2	55	2	22.0	3.8	25	-48
33815	Kishinev	16.8	0.7	69	18	21.0	1.6	85	10
34300	Kharkiv	18.0	2.4	47	0	23.2	4.3	19	-39
34880	Astrakhan	20.0	1.7	29	5	26.2	3.3	5	-17
35188	Astana	14.1	1.0	32	-1	21.6	2.6	8	-27
37789	Yerevan	15.9	3.8	96	36	24.4	2.5	33	4
40007	Aleppo	23.1	1.9	4	-15	26.7	0.9	0	-2
40080	Damascus	22.8	2.6	0	-4	26.4	2.0	0	0
40180	Tel Aviv	22.9	1.8	2	-1	26.4	2.4	1	1
40199	Eilat	30.0	1.6	0	-1	33.3	1.6	0	0
40265	Mafraq	21.5	1.7	<1	-3	24.4	1.7	0	0
60030	Las Palmas/Grand Canary	21.4	1.5	4	2	22.7	1.3	0	0

WMO No.	Station	July 2010 Temp. mean	July 2010 (°C) dev.	July 2010 Prec. total	July 2010 (mm) dev.	August 2010 Temp. mean	August 2010 (°C) dev.	August 2010 Prec. total	August 2010 (mm) dev.
01008	Svalbard Airport	6.6	0.6	13	0	4.8	0.0	13	-12
01025	Tromsø	11.5	-0.2	102	30	9.8	-1.1	65	-17
01492	Oslo	18.0	1.6	109	25	16.1	0.9	152	62
02196	Haparanda	16.5	1.0	34	-16	12.8	-0.5	71	8
02485	Stockholm	21.2	4.0	74	2	17.2	1.0	103	37
02836	Sodankylä	15.8	1.7	132	67	11.4	0.2	55	-8
02974	Helsinki	22.4	5.8	15	-58	17.7	2.7	71	-9
03091	Aberdeen	14.5	0.7	110	50	13.8	0.2	48	-27
03772	London	20.0	2.2	18	-28	17.4	0.0	89	38
03967	Dublin Casement Aerodrome	15.9	1.0	82	28	13.9	-0.7	44	-34
04030	Reykjavik	13.0	2.4	43	-9	12.1	1.8	55	-7
04339	Scoresbysund	6.0	0.7	5	-33	5.9	1.3	31	-2
06186	Copenhagen	20.6	3.4	26	-43	17.5	0.5	168	105
06260	De Bilt	19.9	3.1	77	2	16.8	0.1	155	84
06447	Brussels	20.5	3.0	63	-12	17.0	-0.3	187	124
06590	Luxembourg	20.5	3.6	47	-21	16.6	0.2	178	106
06660	Zurich	20.0	2.4	132	15	17.2	0.5	121	-12
06700	Geneva	22.1	3.0	14	-53	18.7	0.5	122	43
07510	Bordeaux	22.1	1.9	15	-32	20.4	0.5	17	-37
07650	Marseilles	26.1	2.3	2	-12	24.0	0.8	43	14
08222	Madrid	27.4	3.0	15	2	26.0	2.1	3	-6
08314	Mahón/Minorca	24.3	0.1	<1	-4	23.5	-1.0	17	-9
08495	Gibraltar	24.4	0.7	2	1	25.7	1.5	6	0
08515	Santa Maria/Azores	21.8	1.0	7	-18	22.6	0.4	38	-2
08535	Lisbon	24.2	1.8	0	-5	25.0	2.2	2	-4
10384	Berlin-Tempelhof	23.3	4.5	56	4	18.9	0.5	142	81
11035	Vienna	22.3	2.6	88	25	19.4	0.5	123	65
11518	Prague	20.7	3.2	128	62	17.8	0.8	121	51
11903	Sliač	22.0	3.8	93	34	18.8	1.5	118	49
12160	Elblag	21.3	4.5	65	-29	19.4	2.7	115	34
12375	Warsaw	21.9	4.0	92	25	19.7	2.4	143	80
12843	Budapest	23.6	2.7	41	-11	21.0	0.7	82	31
13274	Belgrade	24.1	2.4	41	-25	24.0	2.7	54	2
14015	Ljubljana	22.8	2.9	112	-10	20.3	1.2	176	32
14445	Split	27.2	1.8	23	-5	26.3	1.1	10	-40
14654	Sarajevo	20.7	1.8	29	-50	21.4	2.9	44	-27
15420	Bucharest	22.8	0.8	69	5	23.5	2.3	32	-26
15614	Sofia	21.2	1.2	53	-3	22.5	3.1	41	-11
16206	Grosseto	26.1	2.5	5	-15	23.8	0.3	52	15
16597	Luqa	26.7	0.8	0	0	27.2	0.9	0	-7
16716	Athens	29.5	1.7	0	-5	30.8	3.2	0	-5
16754	Heraklion/Crete	27.4	1.7	0	-1	28.3	2.7	0	-1
17040	Rize	25.9	3.7	189	55	27.0	4.8	342	156
17062	Istanbul	25.7	2.5	43	24	27.7	4.7	2	-24
17170	Van	24.0	2.1	0	-4	23.2	2.0	1	-3
17300	Antalya	27.6	-0.5	0	-3	30.2	2.5	4	3
17609	Larnaca	27.8	0.9	0	0	30.0	2.9	0	0
22113	Murmansk	14.0	1.2	103	43	10.3	-0.7	97	32
26038	Tallinn	21.5	5.2	147	68	17.7	2.4	54	-30
26629	Kaunas	21.9	4.8	101	33	19.7	3.4	113	50
26730	Vilnius	21.8	4.9	208	130	19.8	3.5	116	44
26850	Minsk	22.6	5.3	95	7	20.9	4.4	86	14
27612	Moscow	26.0	7.9	12	-80	21.8	5.4	68	-6
33345	Kiev	24.4	5.1	104	16	24.6	6.0	25	-44
33815	Kishinev	23.3	2.4	71	2	24.9	4.4	53	8
34300	Kharkiv	25.7	5.4	61	1	26.1	6.6	16	-34
34880	Astrakhan	29.1	3.8	<1	-23	27.3	4.0	<1	-19
35188	Astana	19.5	-1.8	32	-18	21.5	3.8	9	-31
37789	Yerevan	27.1	2.7	25	11	26.6	3.9	<1	-6
40007	Aleppo	29.7	1.4	0	0	32.2	4.1	0	-1
40080	Damascus	28.8	2.5	0	0	30.6	4.6	0	0
40180	Tel Aviv	27.6	1.9	0	0	29.5	3.4	0	0
40199	Eilat	34.1	1.2	0	0	36.2	3.4	0	0
40265	Mafraq	26.2	2.1	0	0	28.8	4.6	0	0
60030	Las Palmas/Grand Canary	24.0	0.7	<1	<1	25.4	1.3	0	0

WMO No.	Station	September 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	October 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	2.0	1.5	8	-15	-2.9	2.6	36	21
01025	Tromsø	8.1	1.3	51	-43	3.5	0.6	230	105
01492	Oslo	11.3	0.5	89	-1	5.7	-0.7	84	0
02196	Haparanda	8.9	1.0	57	-6	3.8	1.3	45	-19
02485	Stockholm	12.1	0.9	73	18	6.4	-1.1	34	-16
02836	Sodankylä	6.9	1.0	51	-4	2.0	2.3	53	2
02974	Helsinki	11.5	1.5	54	-19	5.1	-0.3	29	-44
03091	Aberdeen	12.1	0.4	39	-29	9.1	-0.8	62	-15
03772	London	15.3	0.3	38	-13	11.9	0.2	75	17
03967	Dublin Casement Aerodrome	13.4	0.4	103	34	10.1	-0.2	38	-30
04030	Reykjavik	10.2	2.8	92	25	6.3	1.9	41	-45
04339	Scoresbysund	2.6	2.0	101	48	-3.1	2.5	20	-36
06186	Copenhagen	13.4	-0.2	42	-20	8.8	-1.1	41	-18
06260	De Bilt	13.6	-0.4	90	23	10.4	-0.1	88	16
06447	Brussels	14.2	-0.3	110	51	10.6	-0.3	71	1
06590	Luxembourg	13.0	-0.4	81	11	8.8	-0.3	53	-22
06660	Zurich	13.2	-0.6	89	-3	8.7	-0.6	46	-23
06700	Geneva	14.4	-0.5	36	-45	10.1	0.0	31	-46
07510	Bordeaux	17.9	0.0	24	-50	13.5	-0.5	93	5
07650	Marseilles	19.4	-0.9	30	-17	15.5	-0.6	78	0
08222	Madrid	21.3	0.8	12	-18	14.1	-0.7	58	13
08314	Mahón/Minorca	21.2	-1.0	90	36	18.2	-0.3	171	87
08495	Gibraltar	23.0	0.2	11	-4	19.5	0.0	72	8
08515	Santa Maria/Azores	22.1	0.7	52	-5	19.6	0.3	56	-28
08535	Lisbon	21.5	-0.2	5	-21	17.5	-1.0	262	182
10384	Berlin-Tempelhof	13.7	-0.9	87	41	8.6	-1.4	20	-16
11035	Vienna	14.2	-0.9	65	20	7.8	-2.1	23	-18
11518	Prague	12.2	-1.1	73	33	6.8	-1.5	12	-18
11903	Sliač	13.0	-0.4	115	59	6.7	-1.6	36	-14
12160	Elblag	13.0	0.3	53	-17	6.3	-2.6	17	-36
12375	Warsaw	12.4	-0.8	89	46	6.1	-2.2	3	-35
12843	Budapest	14.7	-1.7	144	104	8.4	-2.5	30	-4
13274	Belgrade	17.8	0.1	52	1	10.5	-1.9	49	9
14015	Ljubljana	14.7	-0.8	425	295	9.5	-0.9	105	-10
14445	Split	21.1	-0.3	79	18	16.0	-0.9	58	-21
14654	Sarajevo	14.9	-0.2	126	56	8.6	-1.8	81	-7
15420	Bucharest	16.8	-0.1	24	-18	8.0	-2.8	54	22
15614	Sofia	16.3	0.5	47	8	8.6	-1.8	90	53
16206	Grosseto	20.2	-0.2	19	-46	15.6	-0.5	29	-58
16597	Luqa	24.0	-0.1	75	35	20.6	-0.1	230	140
16716	Athens	25.2	1.0	31	21	19.2	-0.1	108	56
16754	Heraklion/Crete	25.1	2.0	<1	-18	21.7	2.0	70	-6
17040	Rize	22.9	3.5	187	-36	16.7	1.3	461	188
17062	Istanbul	22.1	2.4	16	-25	15.4	0.1	278	207
17170	Van	19.5	2.7	4	-6	12.6	2.5	46	-2
17300	Antalya	26.9	2.4	10	-1	21.7	2.1	67	-3
17609	Larnaca	27.4	2.3	0	0	23.4	2.1	3	-16
22113	Murmansk	8.0	1.3	56	4	2.9	1.9	79	37
26038	Tallinn	11.6	0.8	56	-26	4.5	-1.8	39	-31
26629	Kaunas	12.0	-0.1	63	4	4.7	-2.2	31	-20
26730	Vilnius	11.4	-0.2	80	15	4.4	-2.2	42	-11
26850	Minsk	11.9	0.2	79	19	4.4	-1.9	21	-28
27612	Moscow	11.7	0.8	70	6	3.8	-1.2	42	-16
33345	Kiev	14.9	1.0	51	4	6.3	-1.8	35	0
33815	Kishinev	16.1	-0.1	46	-2	7.5	-2.6	69	42
34300	Kharkiv	15.8	1.7	117	76	6.0	-1.3	80	45
34880	Astrakhan	19.9	2.6	3	-23	9.6	0.5	75	58
35188	Astana	13.6	1.6	14	-10	5.5	2.7	6	-24
37789	Yerevan	23.7	2.4	3	-6	15.2	2.4	83	51
40007	Aleppo	27.4	2.2	2	0	21.2	1.6	11	-11
40080	Damascus	26.5	3.3	0	-1	22.0	3.9	4	-8
40180	Tel Aviv	27.9	3.1	<1	<1	25.6	3.6	6	-20
40199	Eilat	32.6	2.2	0	0	29.7	3.0	0	-4
40265	Mafraq	25.4	2.7	0	-1	22.3	3.2	0	-7
60030	Las Palmas/Grand Canary	24.9	1.1	6	-2	23.5	1.0	25	15

WMO No.	Station	November 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.	December 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-11.0	-0.5	10	-3	-11.6	1.7	9	-3
01025	Tromsø	-2.2	-1.4	61	-43	-2.9	0.1	127	23
01492	Oslo	-2.0	-2.7	24	-51	-9.2	-6.4	15	-41
02196	Haparanda	-8.1	-4.0	25	-33	-12.6	-3.1	24	-18
02485	Stockholm	0.3	-2.3	56	3	-6.5	-5.5	37	-9
02836	Sodankylä	-11.4	-4.0	8	-31	-15.2	-2.1	9	-22
02974	Helsinki	-1.7	-1.8	78	6	-8.9	-4.8	56	-2
03091	Aberdeen	4.3	-0.7	92	17	0.0	-3.5	61	-12
03772	London	6.7	-0.5	32	-23	1.4	-3.7	20	-37
03967	Dublin Casement Aerodrome	4.9	-1.8	120	50	-0.4	-5.7	66	-11
04030	Reykjavik	0.6	-0.5	38	-35	0.7	0.9	57	-22
04339	Scoresbysund	-12.3	-1.5	0	-44	-9.2	5.2	70	6
06186	Copenhagen	3.9	-1.6	53	-9	-3.1	-5.3	27	-31
06260	De Bilt	5.8	-0.1	83	2	-1.1	-4.3	43	-37
06447	Brussels	6.1	0.0	125	49	-0.7	-4.2	76	0
06590	Luxembourg	5.0	1.2	85	2	-2.5	-3.5	85	5
06660	Zurich	5.3	1.4	81	-1	-0.8	-1.4	105	32
06700	Geneva	6.3	1.3	102	10	0.3	-1.5	95	8
07510	Bordeaux	9.2	0.1	215	121	4.5	-1.9	80	-19
07650	Marseilles	10.5	-0.2	93	35	6.5	-0.8	34	-22
08222	Madrid	8.6	-0.8	28	-36	6.2	-0.2	78	27
08314	Mahón/Minorca	14.0	-0.4	185	108	11.2	-0.6	32	-42
08495	Gibraltar	15.2	-0.9	294	153	15.1	1.0	333	187
08515	Santa Maria/Azores	17.4	0.0	73	-29	15.0	-0.4	378	283
08535	Lisbon	13.9	-0.6	87	-27	11.8	0.0	162	54
10384	Berlin-Tempelhof	5.4	0.5	102	53	-4.0	-5.4	48	-5
11035	Vienna	7.5	2.9	36	-14	-2.3	-3.2	42	-1
11518	Prague	4.9	2.1	51	19	-5.3	-4.7	36	10
11903	Sliač	7.0	4.0	130	61	-4.6	-2.9	60	3
12160	Elblag	4.5	1.2	112	56	-6.2	-6.5	70	18
12375	Warsaw	5.8	2.6	109	67	-5.4	-4.5	34	2
12843	Budapest	8.0	3.2	76	24	-1.7	-2.1	41	1
13274	Belgrade	12.3	5.3	45	-9	2.5	0.2	61	3
14015	Ljubljana	8.1	3.5	186	51	-0.4	-0.4	182	81
14445	Split	13.9	1.7	198	90	8.2	-0.5	134	34
14654	Sarajevo	9.7	4.9	139	48	1.4	1.6	113	49
15420	Bucharest	9.5	4.3	18	-31	-0.7	-0.9	92	49
15614	Sofia	10.2	5.2	28	-19	0.6	0.1	105	66
16206	Grosseto	12.0	0.8	117	23	8.0	0.1	72	7
16597	Luqa	18.2	1.2	19	-61	14.5	0.7	31	-81
16716	Athens	18.2	2.7	36	-14	13.7	1.5	22	-49
16754	Heraklion/Crete	18.8	2.2	50	-9	15.9	2.1	105	31
17040	Rize	14.1	2.5	8	-242	12.3	4.0	111	-127
17062	Istanbul	15.8	4.2	15	-74	10.6	2.5	162	40
17170	Van	4.3	0.3	0	-44	2.1	3.2	10	-24
17300	Antalya	19.5	4.7	27	-107	14.5	3.1	141	-86
17609	Larnaca	19.8	3.4	0	-44	16.2	3.0	79	3
22113	Murmansk	-6.3	-1.2	45	5	-9.9	-0.6	35	-3
26038	Tallinn	0.5	-0.7	106	38	-6.2	-3.3	75	20
26629	Kaunas	4.0	1.9	57	4	-7.8	-5.4	64	20
26730	Vilnius	3.7	2.5	54	-3	-7.5	-4.6	56	1
26850	Minsk	4.2	3.4	54	2	-7.4	-3.6	63	10
27612	Moscow	2.7	3.8	75	17	-7.6	-1.5	79	27
33345	Kiev	7.9	5.8	72	21	-4.2	-1.9	58	6
33815	Kishinev	10.3	5.9	40	1	-2.1	-1.8	83	45
34300	Kharkiv	7.9	6.6	42	-2	-1.6	1.8	66	21
34880	Astrakhan	8.8	5.5	2	-17	3.3	5.2	8	-7
35188	Astana	0.2	6.1	39	17	-12.6	0.0	22	5
37789	Yerevan	9.0	4.5	0	-30	5.0	4.5	2	-24
40007	Aleppo	14.7	2.5	0	-35	9.3	2.1	48	-11
40080	Damascus	14.6	2.8	0	-22	8.7	1.5	41	15
40180	Tel Aviv	21.6	3.6	0	-68	16.9	3.1	99	-39
40199	Eilat	25.1	3.6	<1	-3	18.6	2.0	4	-2
40265	Mafraq	17.0	3.5	0	-17	10.6	1.8	19	-9
60030	Las Palmas/Grand Canary	21.9	1.5	38	17	20.8	2.5	11	-10

WMO No.	Station	Year 2010 Temp. mean	(°C) dev.	Prec. total	(mm) dev.
01008	Svalbard Airport	-4.1	2.3	188	5
01025	Tromsø	2.4	-0.4	1071	98
01492	Oslo	4.8	-0.9	738	-31
02196	Haparanda	0.7	-0.4	485	-67
02485	Stockholm	6.0	-0.6	540	1
02836	Sodankylä	-1.1	-0.1	516	16
02974	Helsinki	4.5	0.0	597	-54
03091	Aberdeen	7.8	-0.1	733	-50
03772	London	10.7	0.2	520	-79
03967	Dublin Casement Aerodrome	8.4	-0.9	716	-19
04030	Reykjavik	5.9	1.5	594	-204
04339	Scoresbysund	-5.5	0.8	367	-61
06186	Copenhagen	7.9	-0.7	566	-70
06260	De Bilt	9.1	-0.3	824	19
06447	Brussels	9.7	-0.2	915	115
06590	Luxembourg	8.6	0.3	919	44
06660	Zurich	8.8	0.3	1002	-84
06700	Geneva	10.1	0.5	812	-142
07510	Bordeaux	12.8	0.1	814	-108
07650	Marseilles	14.7	-0.1	611	66
08222	Madrid	14.7	0.4	557	101
08314	Mahón/Minorca	16.1	-0.6	781	183
08495	Gibraltar	18.7	0.5	1899	1124
08515	Santa Maria/Azores	17.9	0.4	1365	590
08535	Lisbon	17.1	0.3	1362	609
10384	Berlin-Tempelhof	8.9	-0.5	628	44
11035	Vienna	9.9	0.2	851	244
11518	Prague	7.7	-0.2	641	115
11903	Sliač	8.8	0.9	1066	380
12160	Elblag	7.2	-0.4	628	-62
12375	Warsaw	8.0	0.2	798	279
12843	Budapest	10.6	0.2	874	356
13274	Belgrade	13.0	1.1	866	182
14015	Ljubljana	10.7	0.9	1799	406
14445	Split	16.3	0.4	1125	300
14654	Sarajevo	10.5	1.0	1186	268
15420	Bucharest	10.8	0.2	737	142
15614	Sofia	11.0	1.3	719	156
16206	Grosseto	15.2	0.3	668	-34
16597	Luqa	19.3	0.7	513	-40
16716	Athens	20.0	1.5	317	-52
16754	Heraklion/Crete	20.4	1.9	432	-69
17040	Rize	16.5	2.6	2454	282
17062	Istanbul	16.5	2.4	1078	381
17170	Van	11.2	2.6	350	-28
17300	Antalya	20.3	1.9	941	-125
17609	Larnaca	21.2	2.1	343	14
22113	Murmansk	0.3	0.4	627	149
26038	Tallinn	4.9	-0.2	748	81
26629	Kaunas	6.5	0.1	799	191
26730	Vilnius	6.5	0.5	961	278
26850	Minsk	6.9	1.1	830	153
27612	Moscow	6.5	1.6	602	-86
33345	Kiev	9.4	1.7	603	-46
33815	Kishinev	10.6	0.9	738	191
34300	Kharkiv	9.8	2.3	596	77
34880	Astrakhan	12.1	2.2	219	-1
35188	Astana	3.6	0.9	251	-67
37789	Yerevan	14.6	3.1	496	128
40007	Aleppo	19.5	2.2	227	-110
40080	Damascus	19.4	2.9	99	-47
40180	Tel Aviv	22.5	3.0	358	-209
40199	Eilat	27.3	2.5	30	-2
40265	Mafraq	19.2	2.7	105	-54
60030	Las Palmas/Grand Canary	22.1	1.6	175	58

Monthly Surveys

January

- **Very cold in most of Europe, warm in the Arctic and in the south-east**
- **Dry in northern and western Europe, mostly wet in the south**
- **Heavy snowfalls in many parts of Europe**

Atmospheric circulation characteristics

As a continuation of the weather conditions in December 2009, the year 2010 started with a strong negative North Atlantic Oscillation (NAO) and Arctic Oscillation (AO) with only rare westerly flows over the North Atlantic and Europe. Instead, an extremely strong high pressure area extended from Siberia far into the west, reaching north-western Europe and even Greenland and causing a flow of cold and mostly dry continental air from the east to the west, which spread out more or less over the whole of Europe. The cold conditions were intensified by a persistent widespread snow cover. At the beginning of the month, a relatively stable, large cold trough extended from Scandinavia and north-western Russia to Iberia, causing low pressure conditions and frequent snowfall over large parts of Europe.

Over the North Atlantic, the Icelandic Low was shifted far to the south-west to a position south of Greenland and east of Newfoundland, causing a prevailing meridional airflow from the south which led mild air to the Arctic region.

The south-east of the Region was mostly affected by warm subtropical air masses from the south. Within these warm air masses, but also in a strong frontal zone between warm and cold air in more northern latitudes, cyclonic activity was increased, leading to frequent precipitation. At the end of the month, a polar low pressure pattern moved far to the south into the South Caucasus region, causing a cold and wet spell with snow and heavy rains.

Temperature

The Arctic region was very mild. Anomalies were highest over Spitsbergen, with more than +8°C. In southern Greenland, anomalies were between +4 and +6°C, and the 90th percentile[1] was exceeded. The minimum temperature in Reykjavík (Iceland) was above freezing for 21 consecutive days. This was the longest known such period at that location.

In contrast, large parts of the European continent were very cold (Fig. 1.1), as a continuation of December 2009. Deviations from normal were below -4°C over parts of eastern Europe (Baltic countries, eastern Germany, most of Poland, Belarus, European Russia) and southern Scandinavia and partly below the 10th percentile. Monthly anomalies were even below -6°C in southern Finland and large parts of the Baltic countries, particularly in Estonia (Fig. 1.2) and Latvia; they were below -8°C in central European Russia (central Chernozem region).

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[1] Monthly percentiles for temperature and precipitation have been taken from surface observation data of the Climate Prediction Center (CPC) of the US National Centers for Environmental Prediction (NCEP): http://iridl.ldeo.columbia.edu/maproom/.Global/.Atm_Temp/Percentiles.html . Reference period is 1961-1990.

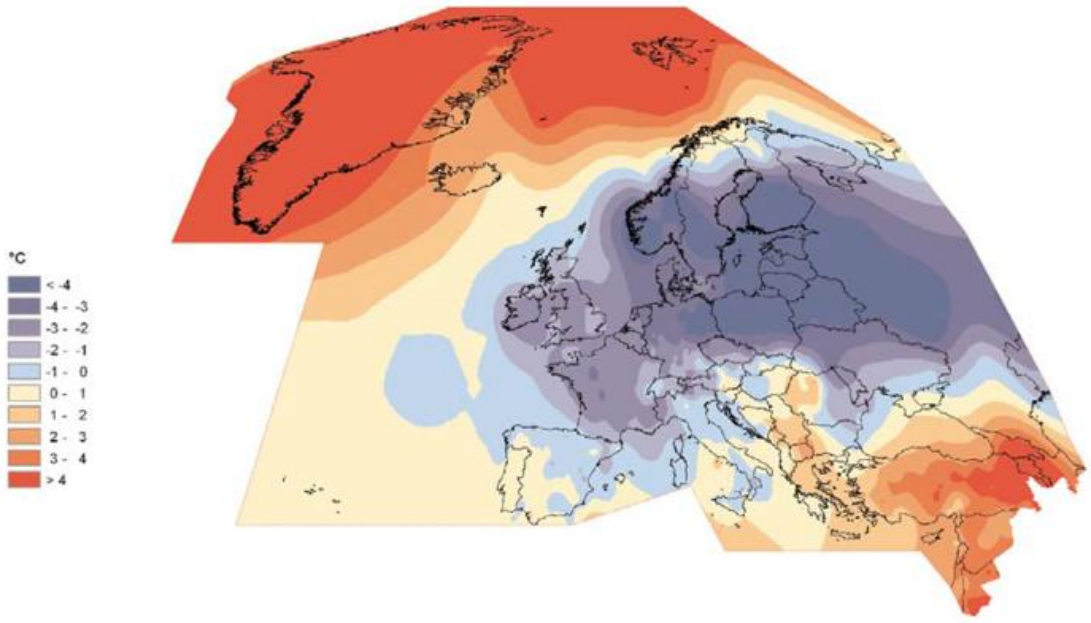

Fig. 1.1: *Monthly mean temperature anomalies in January 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

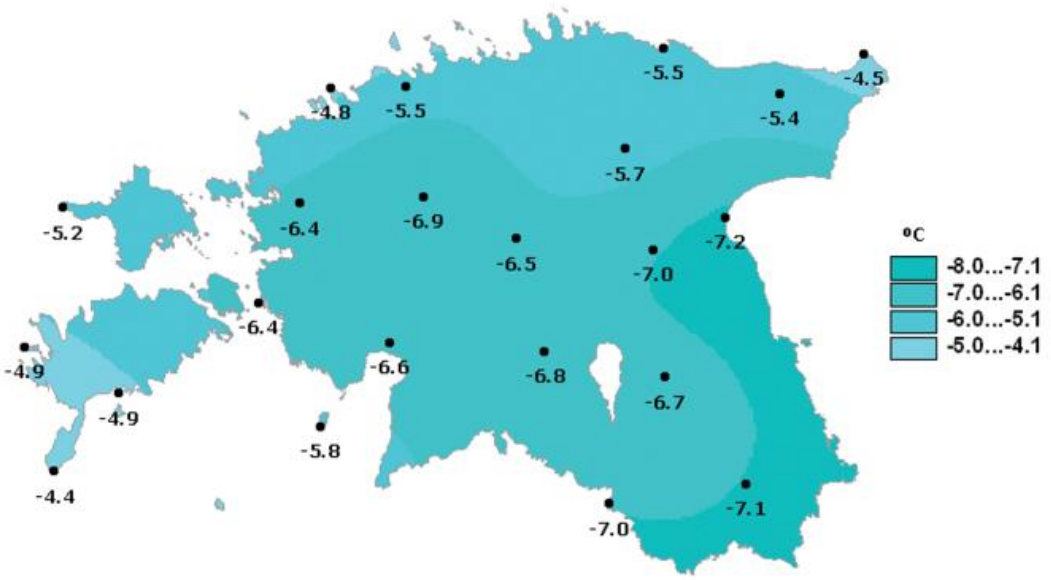

Fig. 1.2: *Monthly mean temperature anomalies in January 2010 (reference period 1961–1990) in Estonia*
Source: Estonian Meteorological and Hydrological Institute

Most of Scandinavia started the year with colder-than-normal temperatures; especially the southern parts were much colder than usual. The lowest minimum temperature in Norway was -42.4°C on 8 January. In Sweden, temperatures remained below 0°C during the whole January in Stockholm, which last happened in 1829. Minima in southern parts of Sweden were down at -30°C (e.g. in Gävle), the lowest since the 1960s.

Western parts of Europe also saw a frosty January. It was the coldest January over the United Kingdom since 1987, with anomalies around -2°C and sharp frosts; minima regularly fell well below -10°C in the Scottish Highlands and reached -22.3°C on 8th, the lowest UK temperature since 1995. Ireland also had a cold spell during the first 10 days of January (continued from December 2009); it was the most extreme cold spell over Ireland since early 1963. Taken as a whole, it was the coldest January since 1985 in Ireland and the coldest since 1963 in the Dublin area. Most places in Ireland recorded 22–27 days with ground frosts, compared to 12-18 days normally. For the first time since 1997, the monthly average temperature in De Bilt (Netherlands) was below 0°C. In France, too, it was the coldest January for the last 20 years and minima fell down to around -20°C south of Ile-de-France.

Central Europe also had an extremely cold month, especially in its eastern parts. It was the coldest January in Germany since 1987. Temperatures in Germany remained below zero most of the month; in eastern Germany, minima dropped below -20°C in late January. The lowest minimum was -24.3°C on 27 January. In Switzerland, it was the coldest January in 23 years; daily temperatures were not extremely low there, but they remained below average for almost the entire month. Poland had an anomaly of -5.4°C below the 1971–2000 normal, the daily minimum of that month (and year) was -30.3°C.

The cold weather in January was much more extreme in north-eastern parts of Europe, especially in the Baltic countries and central European Russia. It was the coldest January in Latvia since 1987. Starting on 6 January, temperatures in the whole of Latvia remained continuously below zero during the rest of the month; such a long frost period had last occurred 54 years ago. Likewise, there was almost a complete absence of thaws in Lithuania and central European Russia, as was last the case several decades ago; instead, severe frosts occurred in large areas, particularly in the second half of the month. The end of the month was especially cold in Estonia (with a minimum of -32.4°C at Jogeva) and Lithuania (with minimum temperatures between -25 and -30°C in many places and locally breaking all-time records for these days of the year). The Ukraine, further in the south, recorded less negative anomalies than the northern east European countries, but minimum temperatures were nevertheless quite low, down to -34°C in the Ivano-Frankovsk region.

The cold weather even reached some northern parts of the Balkan Peninsula, although only temporarily. In Slovenia, the monthly mean temperature was close to normal; anomalies were significantly negative only in the mountains, particularly during the last third of the month. Romania was only slightly colder than normal due to a very mild period from 6-12 January, but was very cold especially in eastern, central and southern parts from 24–28 January with new daily minimum temperature records (partly below -25°C). This cold spell also affected Bulgaria.

The western and central Mediterranean region and Iberia had monthly mean temperatures around normal, but also some temporary cold spells. A pronounced cold spell occurred in Spain from 7–11 January due to an invasion of continental cold air from the north-east. A minimum temperature of -16.0°C was recorded in Burgos on 10 January and other sites in the highland regions in the interior of Spain also saw minima below -10°C. Temperature anomalies in Italy were largely within the natural variability, slightly lower than normal in the north and a bit higher in southern parts. However, a cold outbreak of Arctic air occurred in Italy during the “giorni della merla” (“days of the blackbird”, 29–31 January), making these days the coldest of the year.

The Middle East including the South Caucasus region as well as large parts of the Balkan Peninsula and the southern and eastern Mediterranean were very mild. Monthly anomalies were around +2–3°C above normal in and near the Middle East and the 90th percentile was exceeded over large parts of the area. It was particularly mild at the beginning of the month. In Greece, the New Year's Day was the warmest ever recorded in January in 50 years, with a maximum temperature of 29.8°C at Heraklio on Crete island. Malta reached a daily maximum of 20.3°C on 7 January and Bar at the Adriatic coast in Montenegro set a new record (21.2°C) on 8 January. In the South Caucasus, up to 22°C were reached in Georgia, and 16–18°C in the lowlands of Armenia. Azerbaijan also had a very mild period at the beginning of January, with a new maximum temperature record of 26.6°C at the station Astara, but then saw a cold spell at the end of the month. In many parts of Israel, it was the warmest January since measurements began.

Precipitation

The Arctic region was partly wetter than normal, especially in Svalbard and parts of Greenland, locally with more than 200% of the normal. However, most of Greenland was dry.

Northern, western and large parts of central Europe saw a very dry January (Fig. 1.3). Monthly precipitation totals were below 40% of the normal over large parts of northern Europe; in northern Iceland and western Norway even below 20%. Several stations in Norway registered a new monthly low precipitation record for January. The totals were below the 10th percentile over most areas of northern Europe. Little precipitation was also recorded in the northern half of European Russia due to prevailing anticyclonic conditions, with 20–40% of the monthly normal in individual central regions. Most of western and central Europe received less than 80% of the normal, locally even much less.

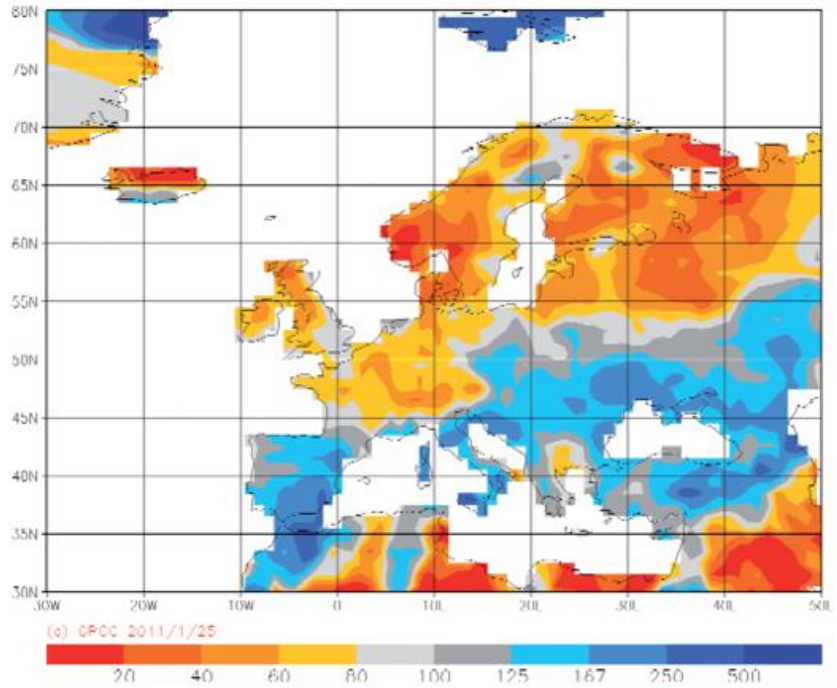

Fig. 1.3: *Monthly precipitation amounts for January 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Shannon Airport in Ireland received just 30 mm of precipitation over the whole month, which was the lowest January total since 1963. On the other hand, there were also some heavy rains in Ireland, e.g. a daily total of 58 mm was measured in Valentia on 12 January, the highest for January on record.

Most of southern Europe and southern parts of eastern central and eastern Europe were wet, including eastern and south-eastern Austria, the Czech Republic, Slovakia and Hungary. Especially the areas around the Mediterranean and the Black Sea received locally more than twice the monthly precipitation totals. The 80th percentile was exceeded over most of these areas, locally also the 90th percentile.

Some special extraordinary precipitation anomalies were recorded in Italy and on the Balkan Peninsula. Heavy precipitation at the beginning of the month caused flooding and mudslides in Italy. In Slovenia, too, most of the precipitation fell during the first third of the month; partly, it was abundant, with locally more than 200% of the normal. Places in Bosnia and Herzegovina received more than 300% of the normal. Serbia was partly extremely rainy in its northern parts, and especially the number of precipitation days was high, in some places even record-breaking. Flooding due to heavy rain took place in Montenegro at the Skadar Lake and in Bojana in early January. Bulgaria recorded 6 days with thunder activity, which was unusual for this time of year.

Highest precipitation totals (300–400 mm) were reached on Sicily, in southern Montenegro and northern Albania, where a severe flooding occurred. Generally, many places around the coasts of the central and eastern Mediterranean received high monthly precipitation totals of 100 mm or more. The same was observed for western and southern Iberia and for the southern and eastern coast of the Black Sea, parts of the mountain regions of the north Caucasus and eastern Turkey. Up to more than 500% (219 mm) of the normal monthly precipitation fell in east Georgia, more than 400% in the basin of Lake Sevan in Armenia and more than 200% in places of southern European Russia. Heavy rains hit Georgia at the beginning and Azerbaijan at the end of the month. Locally, more than 125–250% of the normal precipitation fell in places of the Middle East. Israel was rainy in the north and the south, mostly due to a heavy rain event from 17 to 21 January.

Snow

Due to the low temperatures, snow persisted for the whole month over large parts of northern, central and eastern Europe and some western and southern parts of Europe. Snow, freezing weather and ice caused widespread disruption to transportation and energy supply. More than 177 people died in Europe due to freezing conditions or accidents.

The monthly mean snow depth was higher than 20 cm over large parts of northern Europe, locally much higher. However, there was less snow than normal in the northern part of Norway and the western mountains in the southern part of the country opposed to more snow than normal in south-eastern Norway. The snow depths by the end of January were the lowest in 40 years in parts of the northern Norwegian counties Troms and Nordland. In contrast, some provinces in the Baltic countries received as much snow as they had not seen for approximately 25 years.

The UK Met Office reported January snowfalls as the most significant and widespread across the UK since the mid-1980s. Thousands of schools were closed; there was severe disruption to transport networks, the water and electricity supplies to thousands of homes and businesses were interrupted frequently, and a number of fatal accidents occurred that were related to the freezing weather conditions. In early January, daytime temperatures across the UK often failed to rise above freezing, significantly prolonging the period of lying snow. 57 cm of lying snow was reported from Westgate (County Durham) on 7 January. A spell of heavy snow affected western

areas of Ireland on 13 January (Fig. 1.4), but when temperatures rose slowly to near-normal values in the middle of the month, snow turned increasingly to sleet or rain, bringing flooding in some southern areas of Ireland.



Fig. 1.4: *Heavy snow at the observing station at Knock Airport, Ireland on 13 January 2010 Source: Irish Meteorological Service, from a series of pictures courtesy Mary Beston, Gerard Griffith, Liam Newman*

Frequent snowfall also occurred in France and Germany during the first half of the month (particularly after the snowstorm Daisy on 10 January), some snowfall also occurred later in the month, partly interrupted by freezing rain periods. At the end of the month, Germany was mainly snow-covered with more snow in the north-east of the country than in the south. 30 cm of snow fell in one night in Rostock (north-eastern Germany) from 29–30 January during a heavy snowfall event, which affected the whole of Germany. Some stations in north-eastern Germany had near 50 cm and new snow depth records were set.

In Switzerland, it often snowed in the plains north of the Alps, but the amounts were usually small. Zürich broke its record, with 16 days of measurable new snowfall. Geneva airport, which services the busy Alpine ski resorts, was forced to close over the weekend of 8 January due to heavy snow. Heavy snowfall covered western Switzerland again in mid-January; and towards the end of the month, even greater amounts fell in the eastern part of the country.

In north-east Poland, the snow cover was 48 cm deep, the same in Ljubljana in Slovenia. In an area around Leszno in Poland, snow even accumulated to a depth of 150 cm; about 200,000 houses were left without power. Snow depth reached 280 cm on the Slovenian mountain Kredarica only on the last day of the month. Romania had snow depths of up to 147 cm in the mountain area and 20–50 cm in the rest of the country; Bulgaria also had intense snowfalls of up to 4 m due to snowstorms. 30 cm fell in Varna near the Black Sea. In north-western Turkey, snowfall was 13 cm at Edirne and 5 cm at Tekirdag on 19 January after a wintry spell.

There was also snowfall in extended areas across the northern and interior parts of Spain and even in some places in Andalucia and coastal areas of Portugal at low altitudes, where such events are rare. For the first time in 50 years, snow was reported as far south as Seville in Spain. Widespread snowfall occurred over northern Italy at the end of the month from 29–31 January.

Due to high snow precipitation in the North Caucasus, avalanche hazards persisted there throughout the month. In the South Caucasus, it was snowy all over Georgia during the first two thirds of the month, but with interruptions. Snow depth was about 3 m in the mountains of Georgia. Azerbaijan received snow at the end of the month.

Significant weather events[2]

January 01:	Strong south-westerly winds of up to 130 km/h over southern and western Italy (Sardinia, Sicily and Tyrrhenian regions); sea storm along the exposed coasts.
January 03:	After heavy snowfall during several days in Switzerland, 4 people died due to avalanches.
January 03–04:	Heavy hail in eastern Georgia on 03 January; tornado in the coastal zone of Georgia on 04 January, causing serious material losses.
January 07:	UK almost entirely covered by lying snow, with depths exceeding 30 cm in many northern areas and more than 50 cm in some places.
January 08–11:	Strong winds in Bulgaria (up to 122 km/h in Kurdzhali).
January 09–13:	Snow and very cold temperatures particularly affected Switzerland, Germany and Poland and caused the closure of Geneva airport, cancellation of more than 90% of flights at Frankfurt airport and trains in Germany, as well as blocked roads, broken roofs and people frozen to death particularly in Poland, state of emergency on the coasts and islands of the Baltic Sea due to coincidence of snow masses, flooding and wind (gusts > 120 km/h). This event was caused by a Mediterranean low (Daisy) that led humid air from the Mediterranean to the Balkan Peninsula and to eastern and central Europe. Albania had a severe flooding in the districts of Shkodra and Lezha. Local flooding occurred on the Sava River in Serbia due to frequent precipitation.
January 17–18:	Heavy rain (up to 111 mm in 24 hours) and thunderstorms in Greece over the Aegean Sea; flash flood on Crete island.
January 17–21:	Israel and Jordan suffered from flash floods due to heavy rain. These were probably the worst floods in over a decade in Israel. 30–80 mm widely fell in the Negev Desert in Israel on 17 and 18 January, 2–4 times more than the monthly average. This rainfall was record-breaking with regard to daily totals for many stations in the Negev. The floods claimed the lives of 15 people and approximately 700 houses were engulfed.
January 21–29:	Glaze ice and hoarfrost accretion (35-80 mm) in the northern Caucasus (southern European Russia).
January 26–28:	Snow and very low temperatures severely affected many countries (Germany, Austria, Poland, Romania, Bulgaria and Turkey). In Romania and Poland, people froze to death; in Frankfurt, Germany, flights were cancelled and Bulgaria had a snow depth of more than 4 m due to snowdrift.
January 27:	125.6 mm of daily precipitation were measured in Norway (station Lurøy).
January 28:	Estonia reported very low water levels on the Baltic Sea coast. Germany reported that snowfall and low temperatures caused many accidents and affected the air traffic again. The Island of Rügen was isolated and the surrounding Baltic Sea was frozen.

[2] *Significant weather events of recent months are also presented in the Event Calendar of the WMO RA VI Regional Climate Centre on Climate Monitoring (RCC-CM) on the RCC-CM website of Deutscher Wetterdienst: http://www.dwd.de/rcc-cm - Products - Significant Weather Events – Monthly calendar*

End of January: Cold and wet spell with snow and heavy rains in Azerbaijan; gusts up to 118 km/h in some places. The wave height at the oil rocks station on the Caspian Sea was up to 7.3 m, which is very rare.

February

- **Cold over northern, western and central Europe, warmer than normal in the Arctic and in the south-east**
- **Dry in north-western and central Europe, wet in north-eastern, eastern and southern Europe**
- **Severe storm Xynthia over south-western, western and central Europe**

Atmospheric circulation characteristics

Like the other months of winter 2009/10, February 2010 was also characterised by very strong negative NAO and AO indices, even more extreme than in January. Cold continental air from the east continued to move into Europe, reaching even the south. This month, however, the main airflow affected more the northern areas of the continent. Westerly low pressure systems were quite rare, but at the end of the month, a severe storm (Xynthia) reached south-western Europe and crossed western and central Europe, while at the same time a south-westerly airflow brought some warmth to north-eastern Europe.

Over the North Atlantic, high pressure dominated over Iceland and low pressure over the subtropics, which is the very opposite of normal conditions. The result was that the prevailing easterly flow continued even over the North Atlantic and produced a cooling there.

Also in the south-east, there was no overall change of the circulation conditions compared to January. Especially the Middle East was still affected by an ongoing warm airflow from the south, particularly in the second half of the month. Cyclonic activity was still enhanced over southern Europe and the Mediterranean. The southern Mediterranean, however, profited from a ridge over its central regions in the middle of the month.

Over eastern Europe, a quasi stationary front formed west of the Russian blocking high, causing an area of higher-than-normal precipitation.

Temperature

It was still mild in the Arctic, with anomalies above +4°C (Fig. 2.1), as a continuation of the mild conditions in January, in Greenland even up to +8°C at the west coast. Again, the 90th percentile was exceeded over southern Greenland. Daily temperature maxima reached 3–7°C at the west coast of Greenland.

February was also another cold winter month over large parts of Europe. The highest negative anomalies between -5 and -7°C were recorded in northern parts of Scandinavia, largely with absolute monthly minimum temperatures below -30°C. The cooling was below the 20th percentile over whole Scandinavia. Large parts of southern Norway recorded their coldest February at least since 1994.

It was continuously cold in north-western Europe, though with weaker anomalies than in northern Europe (down to -2°C below normal in the north of the United Kingdom and in Ireland). Yet it was the coldest February over the UK since 1991.

It was the coldest February on record in northern and north-eastern European Russia, with extremely low daily minima. On 19 February, the air temperature dropped to -52°C (or 27°C below normal) in the north-eastern regions of European Russia, which was below the absolute February minimum for the entire period of record. Another location in north-eastern European

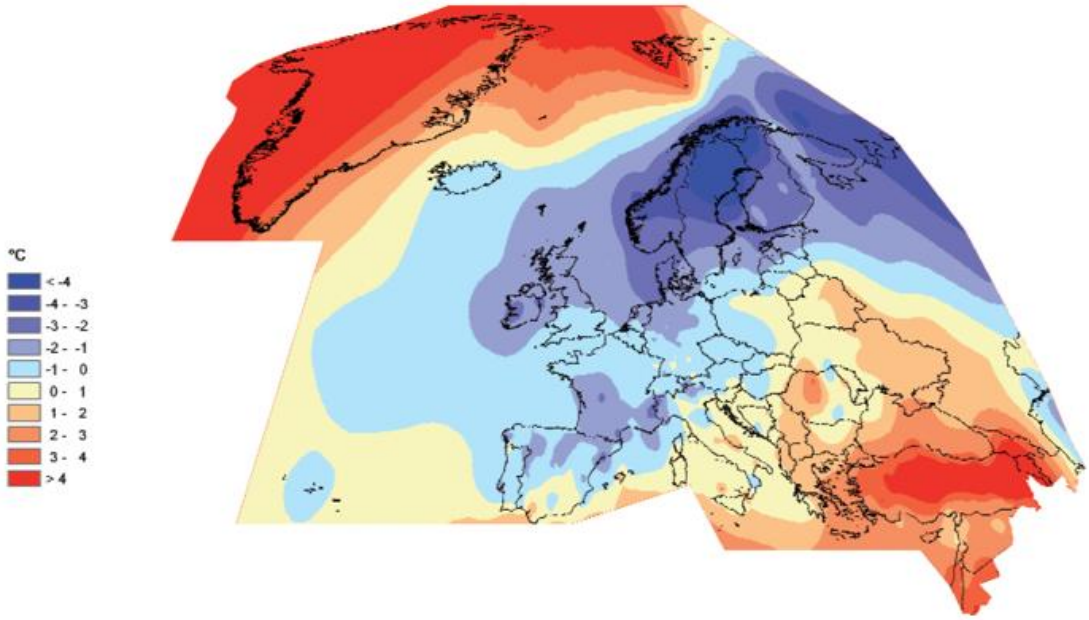

Fig. 2.1: *Monthly mean temperature anomalies in February 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

Russia (station Hoseda-Hard, Nenets Autonomous District) registered the second lowest minimum ever recorded in Europe at -57.0°C (behind -58.1°C in December 1978 in the Komi Republic in north-eastern European Russia).

Different from January, monthly means in central Europe were close to normal (mean anomalies around -2°C to 0°C) due to a milder second half of the month and despite some low temperature events. Daily minima dropped below -20°C in Poland on 10 February.

The Alps saw cold weather especially in early periods of February. The first few days of February were extremely cold in Switzerland, with temperatures down to -35.6°C (La Brévine) and -25 to -30°C in Engadin. Except for one short foehn phase, the cold winter weather continued through the middle of February. In Austria, especially the first half was also very wintry before foehn brought mild temperatures.

Even parts of Iberia and the North Atlantic including Iceland and Azores were colder than normal, though not significantly (anomaly of -0.6°C in Spain). Italy, too, was slightly colder than normal, especially over northern and southern regions, and quite close to average elsewhere.

Similar to January, the Middle East and some adjacent areas were warmer than normal, with the warmer-than-normal conditions, however, extending further to south-east Europe. Deviations from normal exceeded +4°C, locally even +7°C particularly in Turkey and the South

Caucasus. The warming was higher than the 90th percentile in whole Turkey and further south. In the South Caucasus, up to 25°C were reached in Georgia, 20°C in Armenia. In Azerbaijan, the first half of February was cold, with temperatures below the freezing point, the second half, on the contrary, was very mild, with maximum temperatures up to 28°C in Astara (near to the Iran border). Israel had a prolonged heat wave of more than two weeks with highest daily maximum temperatures up to 33°C and record-high daily minima up to around 18°C. It was also more than +1°C warmer than normal over the southern Mediterranean. At 24.2°C, Luqa Airport in Malta recorded its 2nd highest February maximum temperature, the station Iraklion in Greece had 28.8°C on 20 February.

Precipitation

Due to the lack of westerly airflow and high pressure over the Arctic, it was far drier than normal especially at the west coast of Norway, in Ireland and the western parts of the United Kingdom, as well as in the Arctic region and southern Iceland (Fig. 2.2). Monthly totals were less than 40% of the normal over large parts and even less than 20% at the southern west coast of Norway, locally also in the Arctic. Precipitation was below the 10th percentile over Greenland, Iceland and Norway. Nuuk in west Greenland received just 1.3 mm during the whole month. Some Norwegian stations registered a new record for the lowest monthly precipitation total for February.

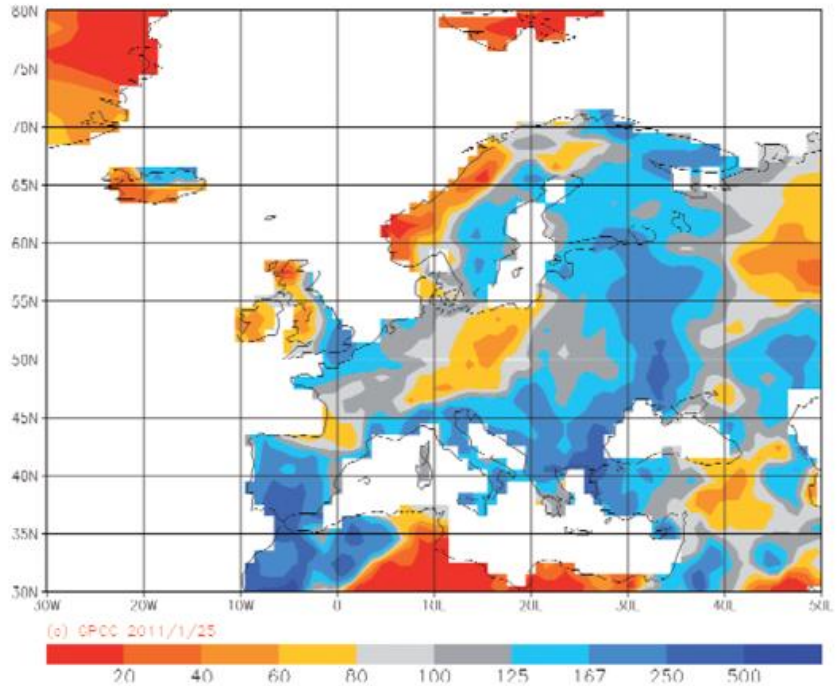

Fig. 2.2: *Monthly precipitation amounts for February 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

It was also dry in large parts of eastern central Europe and in the Alpine region, north-eastern European Russia, eastern Turkey, most of Armenia, northern Syria and Malta, locally with less than 60% of the normal.

The other parts of the Region, especially most of south-eastern central, southern and eastern Europe and most of the southern Middle East were mainly wetter than normal, mostly exceeding the 90th percentile, locally more than the double of the normal total (e.g. in most of Iberia, Hungary, north and west of the Black Sea and in Jordan).

It was the rainiest February for the last 24 years in Portugal. Monthly totals exceeded historic records at many stations in southern Spain. Italy had quite high precipitation in Calabria in the south, but also in the north in the Po Valley and northern Tuscany. New records of monthly precipitation were also set on the Balkan Peninsula after some heavy rainfall events, e.g. in Montenegro. A new local daily total record for February was achieved in Belgrade (Serbia) on 25 February at 39 mm. Bulgaria reported three days of hail, which is unusual for this time of year.

In the South Caucasus, western Georgia had up to more than 250% of the monthly normal (320 mm). Azerbaijan recorded heavy precipitation during the first half of the month, especially in mountain areas, causing landslides and floods.

Snow

Similar to January, February also saw a persistent snow cover during most of the month over large parts of northern, central and eastern Europe, but also in some places in the west and south. In the middle of the month, however, mild air masses caused widespread thaw in central Europe.

In the first two weeks of February, there was almost no snow in Iceland, but snow appeared later in the month even for a few days in the south-west of the island, causing disruption to land and air traffic.

There was less snow than normal in northern Norway and the mountains of western Norway, whereas snow depths were above normal in the lower parts and along the coast of southern Norway.

There were 100-year-record or near-record-breaking snow depths in southern parts of Sweden in late February, with depths over 40 cm. At times, train and road traffic was heavily disrupted due to heavy snowfall. In contrast, snow depths were relatively small in the northern mountains of Sweden due to low precipitation. Large portions of the Baltic Sea and the Swedish west coast were covered by ice. Around 17 February, the ice extent had reached its largest since 1987.

In the United Kingdom, there were heavy snowfalls in northern England, northern Ireland and Scotland in late February, with depths up to 70 cm at a lower lying station (283 m elevation) in Aberdeenshire on 26 February.

Exceptionally high snow depths were also recorded in the Baltic countries, with new records of 78 cm at two stations in north-eastern Estonia. Large amounts of snow caused much damage to roofs and frequent disruption to road and rail traffic. In Lithuania, the monthly mean snow depth reached 26–38 cm. In north-east Poland, the snow depth rose to 65 cm that month.

In Germany, snow depths accumulated to more than 25 cm in Hamburg, 38 cm in Berlin-Dahlem (highest value since winter 1969/70) and even more than 60 cm near the Baltic Sea. Road salt stocks became short. Most German inland harbours were closed due to thick ice layers. Many flights were cancelled in Frankfurt and Munich. The roofs of several buildings collapsed.

In the higher Alps, there have been quite some accidents due to avalanches.

Slovenia, too, had widespread snow, more than normal in the lowlands and the mountains. Ljubljana registered 27 days with snow cover and a maximum depth of 43 cm. The Kredarica Mountain had 390 cm.

Romania recorded some snowy periods in the southern half of the country and in the mountain area, where the snow depth reached 183 cm.

Italy saw the rather rare event of snow in the city of Rome (Fig. 2.3) and over the coasts of the central Tyrrhenian Sea on 12 February, which is extremely unusual in that region.

Due to heavy snowfall, the mountains of the north Caucasus reported avalanche-hazardous conditions. In Georgia in the South Caucasus, a stable snow cover only persisted in high mountains with a maximum depth of 175 cm.

Snow was also to be found in Jordan (up to 22 cm in Rass Munef from 03–05 February) and Israel in the mountains in the north at the same time.



Fig. 2.3: *St. Peter in Rome under snow on 12 February 2010*
Source: National Weather Service CNMCA, Italy

Significant weather events

February 01–03:	A low developed between Iceland and Denmark and moved to Germany, causing heavy precipitation and a snow storm in northern and north-eastern Germany. Snow depths at eastern German lowland stations reached new records on 03 February (Hiddensee 45 cm, Teterow 51 cm).
February 03–05:	30–50 mm of precipitation fell in the Negev Desert in Israel with flooding, but no serious damage.
February 09–17:	Abundant rain caused some of Bulgaria's major rivers to overflow (e.g. Tundzha in its lower part near the Turkish border and Ropotamo in the south-east of the country). On 16–17 February, Tundzha flooded agricultural land in the region of Straldzha and 42 towns and villages were without electricity.
February 10–11:	Strong southern winds with gusts of up to more than 100 km/h, heavy rain and thunderstorms over the Aegean Sea, Crete and Skiros islands in Greece; heavy rain with flooding in central and eastern Macedonia (Greece). Dust advection from Africa affected the whole of Greece.
February 12:	Unusual snowfalls over Rome and over the coasts of the central Tyrrhenian Sea (Fig. 2.3).
February 15:	Heavy rainfalls over southern Italy (Sicily and Calabria) with flooding and landslides. 2300 people had to leave their homes due to landslide risk.

February 20–21: In Moscow, a snowstorm produced a snow depth of 63 cm and thus broke the previous record of 62 cm set in 1966. Nearly 4,500 km of railway track had to be cleared of snow.

February 22: Flooding in Bosnia and Herzegovina (Sanski Most).

February 22–23: Wind gusts up to 108 km/h, coupled with extensive precipitation (up to 50 mm) on February 22 caused damage to houses and roads in Tbilisi, Georgia. Strong winds also in west Kazakhstan.

February 25–28: More than 100 mm of precipitation in 24 hours were recorded in places in Jordan (station Swaileh) and Israel (in the Judean Mountains).

February 27–28: Storm Xynthia affected several countries in south-western, western and central Europe at the end of the month, causing sea dikes at the French Atlantic coast to break and much damage by falling trees, etc. The mean sea level pressure was 969 hPa at its centre, when the storm arrived at the French Atlantic coast. Gusts reached up to 160 km/h along the coastline, 232 km/h on the Pic du Midi Mountain (2877 m altitude) in the Pyrenees, and exceeded 120 km/h in several places in France (Fig. 2.4), Germany, Switzerland and Spain, and 100 km/h in Portugal. Xynthia also led humid and very mild air masses to Germany (16°C near the upper Rhine valley) and 20 mm of rain in 12 hours fell around Saarbrücken (western Germany). Much damage was caused to buildings, trees and power lines; road, rail and air traffic was temporarily affected. In the French coastal town La Rochelle, streets were flooded by 1.5 m. It was one of the worst storms in coastal western Europe since 1999, although less intensive than storm Klaus in January 2009 in France. Xynthia was associated with a very high sea-level and large local tides. More than 60 people died Europe-wide, many of them during a storm surge at the Atlantic coast in western France resulting from the exceptional flooding. More than a million of people were temporarily without electricity. Further damage occurred across Spain, Belgium, the Netherlands, south-east England, Switzerland and Austria, whereas the storm reached Lithuania in a weakened state and without causing any extreme weather phenomena.

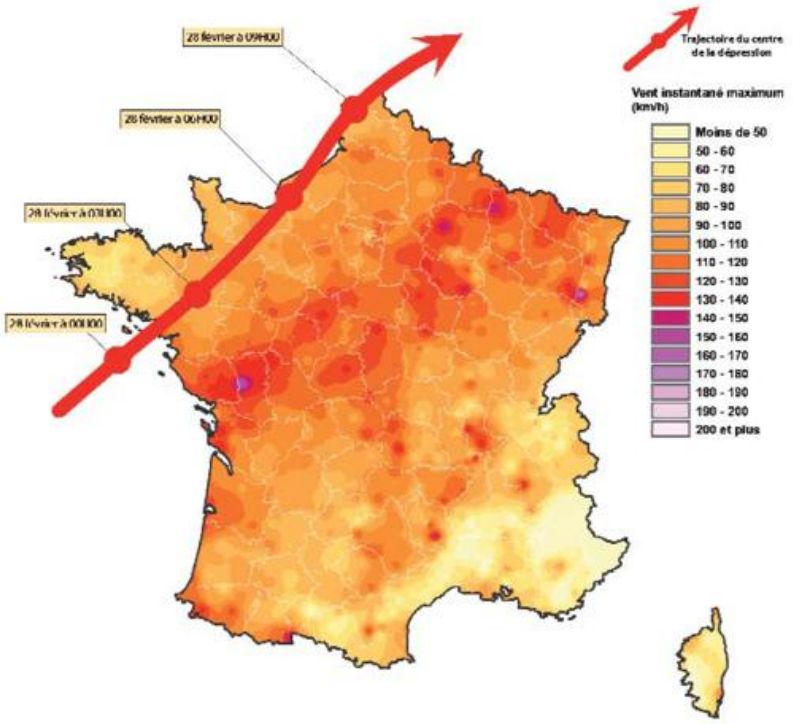

Fig. 2.4: *Track of the centre of storm Xynthia (red arrow) and highest wind gusts in km/h (map) on 27–28 February 2010 in France*
Source: Météo France

March

- **Mostly warm, colder in northern and parts of western Europe**
- **Mostly wet in the north and parts of the south, dry in parts of central Europe, the Alpine region, the Arctic and at the coasts of the eastern Mediterranean**

Atmospheric circulation characteristics

In March, both the NAO and the AO became much weaker compared to the extreme negative conditions of the preceding winter. This marked the beginning of the seasonal transition. However, both the Icelandic low and the Azores high were still weaker than normal.

Quite a strong Arctic low developed over north-eastern Europe, causing cold and wet weather conditions with snow in that area. Spring warmth arrived in Lithuania due to a south-westerly airflow only in the second half of the month.

In most of the other parts of the Region, cyclonic activity occurred from time to time. Especially in central Europe, the first half of the month was characterised by arctic air masses with widespread snowfall and frosts, the second half by a south-westerly flow of subtropical air masses. Apart from storm Xynthia, which developed at the end of February and lasted until the

beginning of March, only a few thunderstorms occurred in central Europe and the Alpine region at the end of the month. However, unstable weather dominated especially in southern parts of Europe.

In the easternmost parts of the Region, an upper-level ridge predominated at the beginning of the month, causing high temperatures; later, an upper-level trough caused a cyclone over the Black Sea and led to colder weather.

Temperature

It was very mild in western Greenland, with anomalies up to +8°C, and over the western North Atlantic. In contrast, eastern Greenland and the eastern European Arctic were colder than normal; the regions with sea ice extended south, reaching as far as about 65°N in the east of Greenland and 75°N around Spitsbergen.

Northern Scandinavia and northern European Russia were also colder than normal, with minima around -35°C, but the anomalies were far smaller than those for the winter months, mostly between -1 and -2°C, locally below -3°C in parts of northern Norway. Nevertheless, they were below the 20th percentile. The northern part of the Baltic Sea was still frozen, as were the Barents Sea and the White Sea. However, it was slightly warmer than normal on average in the Baltic countries, since the last decade of March was +2°C to +4°C warmer than normal in Latvia and record temperatures up to 20°C were reached in Lithuania.

The rest of the Region was mostly warmer or around normal, although partly with high daily maxima and low daily minima (e.g. -18.5°C and 24.1°C in Poland, -22.2°C and 24°C in Germany, -9.4°C and 25.4°C in Bulgaria). This was due to a first wintry and a warm second half of the month in these areas. The lowest minima were measured around 07 March following a cooling of snow covered surfaces; the highest maxima occurred around 25 March due to warm air advection. Northern Greece reported frost between -3 and -5°C in the first days of March.

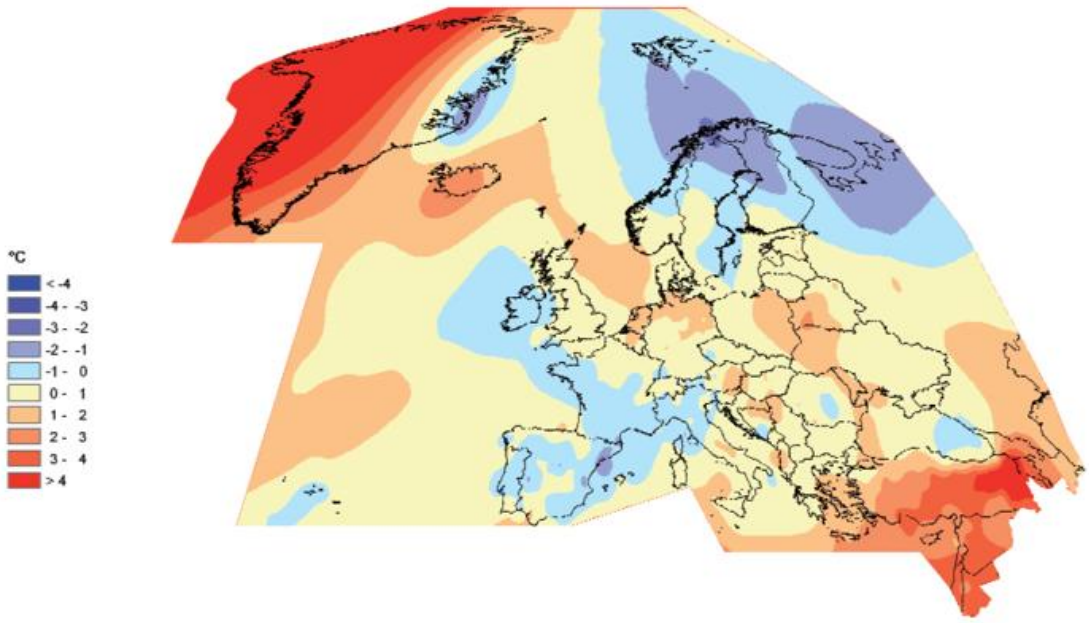

Fig. 3.1: *Monthly mean temperature anomalies in March 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

The sequence of cold and warm periods was very similar in many parts of Europe. It was rather cold in the United Kingdom, particularly during the first two weeks with some night frosts, but warmer from mid-month. In Germany, too, wintry conditions continued until the middle of March, when a warm period began, which was again followed by a strong temperature drop at the end of the month. Likewise, daily maxima in Switzerland stayed below freezing in the first half of the month, and the shores of Lake Geneva and Lake Neuchâtel were frozen solid from the spray of waves blown up by strong winds. However, temperatures reached 23°C in the central plains of Switzerland on 25 March due to the warm air masses coming in from the south-west and foehn. Such temperatures had last occurred there in March in 1990, and they dropped down after an advance of cold air one day later.

Some larger areas in western and south-western Europe saw monthly mean temperatures that were slightly below normal, especially Ireland, southern France, Iberia and northern Italy. Portugal had its coldest March of the last 24 years.

Only in the north was Italy colder than normal, whereas the other parts of the country were warmer than normal. The highest warming was recorded along the coastal areas of the southern Tyrrhenian Sea, especially in north-west Sicily and southern Calabria.

Once again, it was very warm for this time of year in the eastern Mediterranean, the Middle East and the South Caucasus. Monthly anomalies were highest over eastern Turkey and parts of the South Caucasus (e.g. in the basin of Lake Sevan in Armenia), exceeding +4°C or locally even +5°C and the 90th percentile. It was the third warmest March in the South Caucasus since 1966. West Georgia recorded maxima of up to 27°C in the lowlands. The southern Mediterranean also continued to be warmer than normal. Luqa Airport in Malta had its 3rd highest March temperature since 2000 (23.9°C). Temperatures reached up to 38°C in Israel, but were not record-breaking; however, there were some extraordinary long sequences of hot days (e.g. 8 consecutive days with maxima above 32°C in the Negev Desert) last recorded in March at least in the 1940s.

Precipitation

March was characterised by quite a high spatial variability of precipitation anomalies (Fig. 3.2). The Arctic region was mostly dry, except western Greenland which was very wet. It was likewise wetter than normal in most of northern and north-eastern Europe, locally exceeding twice the monthly precipitation total and the 90th percentile. The region of Varanger (Norway, county Finnmark) registered its highest March total since 1920.

In the United Kingdom, the first two weeks were dry, but the second half saw more changeable weather with rain at times.

In most of western, southern central and parts of eastern Europe, dry conditions were prevailing, mostly with less than 80% of the normal precipitation. Especially the Alpine region was dry and mostly below the 20th percentile, despite a few thunderstorms at the end of the month. In easternmost parts of Austria (Burgenland), March 2010 was the driest March since at least 1936 (station Neusiedl am See).

Most of the southern parts of the Region were wetter than normal, namely Iberia, the western Mediterranean region, most of the Balkan Peninsula including Romania, the low Volga and the Caucasus region and western Kazakhstan. Especially in Spain, the 90th percentile was exceeded. In Portugal, it was the third wettest March of the last 30 years. Southern Italy, too, was very wet, with heavy rain especially in Sicily. Malta received more than twice its normal precipitation, west Georgia in the South Caucasus up to more than 400% (313 mm). In southern European Russia, spring floods were recorded in rivers in the last third of the month. In Romania, March was the third consecutive month with above-normal precipitation, particularly in the south.

The eastern Mediterranean and the Middle East were mostly very dry for this time of year; partly they saw less than 20% of the normal precipitation, staying below the 10th percentile. In northern Israel, monthly totals were only 5–15 mm (10% of the normal), making March 2010 one of the three driest March months in the last 70 years besides 1962 and 2004.

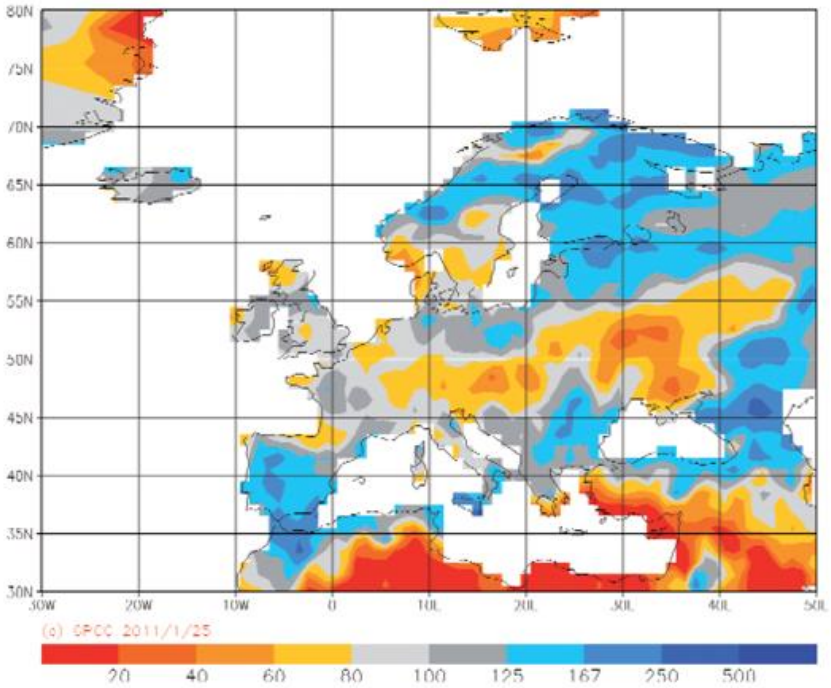

Fig. 3.2: *Monthly precipitation amounts for March 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Snow

March had a persistent snow cover in northern and eastern Europe. By the end of the month, however, there was considerably less snow than normal in most of the mountainous areas of Norway. Along the coast of southern Norway, there was more snow than normal, which melted at the end of the month in the lower parts of south-eastern Norway.

Late March was notable for prolonged snow across higher parts of Scotland and Northern Ireland. In contrast, a warm late March caused an intensive thaw in Latvia.

Some spells of snow also occurred in western, central and parts of southern Europe, especially in the first half of the month. Southern France (Provence) experienced a snowfall event from 7–9 March, which then moved towards the Pyrenees region. At the same time, heavy snowfalls also occurred in parts of Germany and Spain, producing in Germany (except in the north-east) another temporary closed snow cover, which disappeared shortly afterwards in the lowlands. Barcelona saw the heaviest snowfalls since 1962, whereas the southern Pyrenees had little snow left.

Intensive snowfalls likewise occurred in Switzerland in the first half of March. On 10 March, it also snowed down into the plains of southern Tessin. Another intense snowfall period started on 26 March; snow fell below 900 meter on the northern side of the Alps, and the high crests of the southern Alps received the considerable amount of 90 cm. In Austria, frequent avalanches were reported, especially during the first two thirds of the month.

In northern Italy, up to 30 cm of snow were measured near Bologna on 09 and 10 March, up to 50 cm on the surrounding hills and up to 75 cm in the Apennines.

In the mountain areas of Romania, snow fell during the whole month. The maximum depth was measured at 254 cm in Fagaras Massif. The remainder of the country temporarily had snow. Bulgaria reported snow on 08 and 09 March. Even Greece (including the Ionian coasts) had significant snow, particularly in northern and central parts.

In the South Caucasus, a steady snow cover persisted in high mountains during the whole month, with measured depths up to 171 cm.



Fig. 3.3: *Tree knocked down by snow in Ferrara (Italy) on 09 and 10 March. Source: ARPA-SIMC, Italy*

Significant weather events

March 01: Flash floods on the eastern Azores in the early morning.

March 03: 8 m high waves hit a cruise ship in the western Mediterranean Sea. 2 people died and 6 were injured.

March 04: Dozens of ships were stuck in the ice in the Baltic Sea.

March 06–11: An intense cyclogenesis over the Tyrrhenian Sea caused intrusion of cold air from the east, causing exceptional snowfall and high wind speed in several countries, namely France, Germany, Austria, Italy, Bulgaria, northern Greece, even Spain, as well many accidents and traffic disruptions (Fig. 3.3). High sea levels along the Adriatic coast with intense storms over the same area. A blizzard-like cold outbreak occurred in southern Romania. A daily total of 120 mm of precipitation was measured in Trikala (Greece) on 07 March. In north-eastern Europe, night temperatures locally dropped below -20°C in eastern Lithuania on 07–08 March.

March 08: Greece was affected by dust from the Sahara desert.

March 09: Storm of hurricane force (gusts up to 136 km/h) in Novorossisk (Krasnodar, southern European Russia).

March 09–11: Snowfalls over northern Italy and heavy rain over Ionian coasts and southern Sicily due to an Atlantic storm moving to Italy on a relatively low-latitude track. Slovenia was also affected by a snowstorm with gusts up to 200 km/h in the Primorska region.

March 22: Bulgaria reported Saharan dust and warned people suffering from asthma or similar diseases.

March 26–30: Germany reported a severe thunderstorm on 26 March passing from the west to the east, with heavy rain, hail and wind gusts > 80 km/h (locally >120 km/h), a second thunderstorm with heavy rain occurred in northern Germany on 30 March. Austria reported high wind gusts on both days, causing fallen trees and emergency for 3 boats on Lake Neusiedl. Switzerland reported high wind gusts on the 26th as well as some thunderstorms.

March 31: After Britain had seen its coldest winter for three decades, heavy rain, snow and gale-force winds pounded Scotland and Northern Ireland, killing one person and leaving tens of thousands without power.

April

- **Warmer in nearly the whole Region**
- **Mostly dry**

Atmospheric circulation characteristics

Similar to March, the NAO index was still negative in April. The Azores high was weak. High pressure conditions and sunny weather prevailed over nearly the whole of Europe, except in the north-east. The beginning of the month (around Easter) saw low pressure conditions, causing showers especially in central Europe.

A south Caspian cyclone, however, caused high precipitation around the Caspian Sea especially in the middle of the month.

Temperature

April was warmer than normal over nearly the whole Region (Fig. 4.1). The highest anomalies were recorded over the Arctic and in north-eastern European Russia (>+4°C, up to +8°C in north-western Greenland). Daily maximum temperatures at the coasts of Greenland and on the Arctic islands exceeded 0°C. Record-breaking maximum temperatures were registered in some north-western and eastern parts of European Russia in early April. However, the northern part of the Baltic Sea and the White Sea were still at least partly frozen. Slightly below-average temperatures in Iceland were related to the eruption of the volcano Eyjafjallajökull in the middle of the month.

Over most of Europe and the Middle East, the monthly temperature deviations were greater than +1°C, in both south-western and north-eastern Europe they were between +2 and +4°C. In parts of northern and western Europe and locally on the Balkan Peninsula, the 90th percentile was exceeded. Daily maxima exceeded 20°C in the United Kingdom (although minimum temperatures were around normal and there were some frosts), and it was the warmest April in 100 years. It was also the warmest April in central England since records began in 1659. Daily maxima exceeded 25°C in central Europe and 30°C in Greece.

In western and central Europe, however, April 2010 was not as warm as April 2007 and 2009. Cold weather with minima around the freezing point dominated in the first half of April in Germany and Switzerland, but temperatures often rose above 20°C in the second half, locally even above 25°C at the end of the month. The last third of April was also warm on the Balkan Peninsula, e.g. in Slovenia and Serbia.

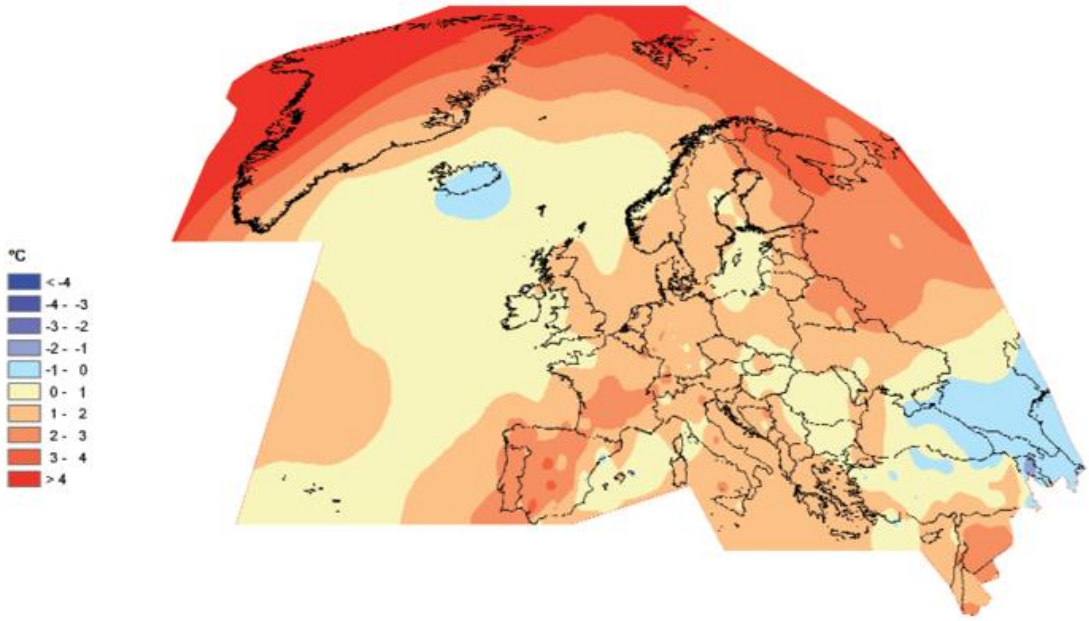

Fig. 4.1: *Monthly mean temperature anomalies in April 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

In Portugal, it was in fact the warmest April of the last 13 years regarding maximum temperature.

It was slightly colder than normal on Iceland and in the east in western Kazakhstan and the Caucasus region. In some regions of east Georgia, minimum temperatures dropped down to 1°C in the lowlands.

Precipitation

Most of the Region saw a dry April (Fig. 4.2). It was mostly dry in the Arctic, particularly in the southern areas of Greenland. Over large parts of western and central Europe and locally in the north and east, less than 40% of the monthly totals were recorded. Over France and Germany, in the eastern Ukraine and some places in Russia, the totals were below the 10th percentile and widespread below 40% of the normal; long dry periods were interrupted by only very short thunderstorms and rain, mainly at the beginning of the month.

In the United Kingdom, however, it was not as dry as in April 2007 due to an unsettled first week with some heavy rainfalls in places. Germany had its second driest April since 1893 behind 2007. There was no measurable rain for two weeks in parts of northern Germany.

Dust storms occurred in the steppe zone of the Ukraine; they resulted in damage to the rising crops.

It was particularly dry in the southern and eastern Mediterranean. Malta received only 1.2 mm the whole month (normal is 22.5 mm). Locally, Greece and the Middle East received less than 20% of the normal. At most stations in Israel, monthly totals were less than 5 mm.

It was wetter than normal (though mostly not significantly) in some places in the north and north-east (around twice the normal in north-east European Russia and some Norwegian areas), in the eastern Alpine region and most of Italy, in Hungary, over most of the Balkan Peninsula (except Slovenia), in the east over the lower reaches of the Volga as well as in west Kazakhstan and the South Caucasus region. Convective events with large hail, heavy rain, strong wind or even tornadoes occurred occasionally in the Mediterranean area and the Balkan countries.

Serbia was extremely wet especially in its central, southern and south-eastern parts and new local records for daily precipitation totals in April were set on 20 April (stations Kraljevo 50 mm, Kopaonik 44 mm).

In the South Caucasus, various areas in Georgia received around 300% of the monthly normal (up to 377 mm in western parts), in Armenia up to 250%. Heavy rainfall and flooding of rivers occurred especially in the highlands of Azerbaijan.

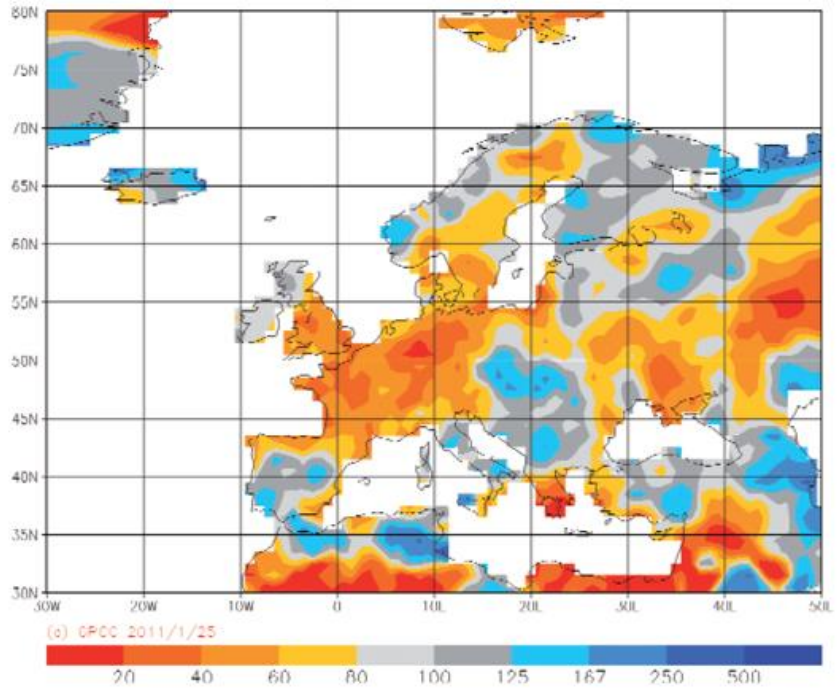

Fig. 4.2: *Monthly precipitation amounts for April 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Snow

In April, only most of Scandinavia, northern European Russia and the high mountains were covered with snow throughout the month. Snow disrupted traffic in north-eastern Iceland during the first days of the month. Scottish highlands reported up to 39 cm of lying snow on 1 April due to heavy snowfalls at the end of March. On the other hand, high temperatures caused rapid snowmelt even in parts of northern Europe, e.g. in Estonia, followed by severe flooding in the Tartumaa district.

There was some local snow even in Slovenia at the beginning of the month, but only for 3 days in the lowlands, whereas it persisted the whole month in the mountains (450 cm on Kredarica on 19 April and thus the annual maximum in this place). Romania had snow in mountain regions above 1700 m altitude. In the South Caucasus, snow persisted locally on high mountains in western Georgia. In the other regions, it melted in the middle of the month.

Significant weather events

April 07: Heavy storm around Sliven region in Bulgaria with gusts of 122 km/h.

April 14–20: Volcano ash from the eruption of Eyjafjallajökull on Iceland on 14 April was spread across Europe by upper-level winds. Although the eruption seldom rose above the tropopause, it stopped air traffic during several days, which was the largest disruption since World War II. Up to 23 European countries were affected; more than 100,000 flights were cancelled. As a consequence of the eruption, glacier surrounding of the volcanic crater partly melted, causing flash floods that destroyed the infrastructure of the region (flooding of local roads and risk of damage to bridges). Almost 800 people had to leave their homes in a small town situated beneath the glacier and some farmland was devastated, but no fatalities were reported.

April 24: Eleven events of avalanching in the Republic of north Ossetia (northern Caucasus, southern European Russia).

April 27–28: Late frost in Bulgaria caused some damage to fruit trees.

April 30: Southern Germany and Austria were hit by heavy rainfall with more than 30 mm in 24 hours at several stations. The highest 24-hour sum was reported for Waging am See: 51.6 mm.

May

- **Cold in north-western, western and central Europe, warm in the Arctic and in the east**
- **Mostly wet, dry in the west and the east**
- **Severe flooding in eastern central Europe**

Atmospheric circulation characteristics

In May, a meridional circulation pattern prevailed again particularly in the first half of the month. This time, most of Europe was under low pressure influence with partly intense convective phenomena, whereas high pressure dominated over the Arctic, the eastern North Atlantic in the west and over Russia in the east. The Icelandic low was dislocated far to the south-west. Cold and dry air masses from the north flowed continuously to western Europe, while warm air from the south brought warm Mediterranean air masses through eastern Europe to the polar cycle.

In western and central Europe, warmer air masses dominated in the second half due to a more pronounced zonal component.

Temperature

The Arctic region was around +2 to +3°C warmer than normal; even the northern North Atlantic was partly +2°C warmer than average. In Greenland, daily maximum temperatures exceeded 20°C at one station during the first decade of May 2010 (Kangerlussuaq in 67°N), and at three stations during the third decade. The arctic station Hopen on Svalbard set a new highest mean monthly temperature record for May and several stations in northern Norway (county Finnmark) registered the highest maximum temperature since the measurements started in the second half of the 19th century. All ice in the Gulf of Bothnia, most of the ice in the White Sea and much of the ice in the Arctic Sea had melted.

May was colder than normal over southern Scandinavia, north-western, western and large parts of central Europe including the North Sea and parts of the western Mediterranean (Fig. 5.1).

Especially the first half of the month was cold in western and central Europe, but the second half was warm. The United Kingdom, for instance, had cool weather with frosts in the first half of the month, but a warm spell from 20-24 May; Oxford had a maximum of 28.9°C and new May records were set in Scotland.

The beginning of the month (4–5 May) was also exceptionally cold in southern France, with maxima of 6–8°C in the lowlands. The second half of May, however, saw temperatures exceeding 24°C on several days over wide areas. France had its coldest May since 1996, the Netherlands and Germany since 1991. Particularly north-western Germany was cold on average, with anomalies below -2°C, which was below the 10th percentile; there were widespread frosts in the first third of the month in the northern and eastern parts of Germany as well as in northern and north-western Poland. Later in the month, temperatures in Germany reached up to 29°C on 24 and 25 May, in Slovenia up to 30°C on 25 May (station Bizeljsko). In Austria, it was the second coldest May since 1991, behind 2004.

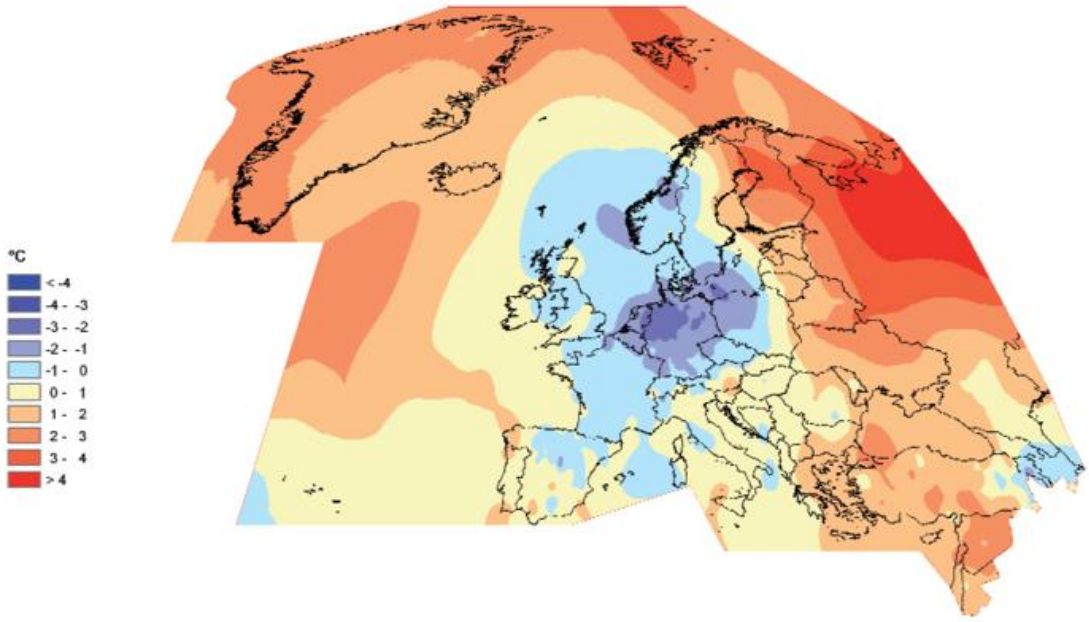

Fig. 5.1: *Monthly mean temperature anomalies in May 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

Most of the other parts of the Region were warmer than normal, particularly the north-east. The highest maximum of that month in Finland was 29.6°C. Places in south-eastern Finland recorded their highest number of summer days ever seen in May. Around the middle of the month (14th, 15th), several summer days (maximum temperature of 25°C or more) were registered in Finland, Estonia and northern Russia. On 18 May, the maximum temperature rose as high as 26.4°C in Murmansk in north-western Russia, which was nearly +5°C higher than the previous record of 1984. In Lithuania, 22–27°C were measured in the second half of the month.

Anomalies were highest over northern European Russia (> +4°C), exceeding the 90th percentile. Record-breaking maximum temperatures were registered as early as at the beginning of May in several parts of northern and central European Russia, reaching 28–31°C in the central Chernozem region (near the Ukraine), i.e. +7 to +9°C above normal. The high temperatures were accompanied by hot winds and forest fires. Similar anomalies were recorded in the Volga region.

The eastern Mediterranean and almost the whole of the Middle East were at least +1°C warmer than normal. The warming was underlined by some warm spells with quite high daily maximum temperatures. Greece had a 5-day heat wave at the end of the month, with maxima exceeding 35°C. Israel and Jordan had a number of hot spells with temperatures up to 43°C in the Jordan Valley. The South Caucasus and some places in eastern Turkey were an exception in that area, recording just around normal monthly averages or even slightly colder temperatures.

Precipitation

It was very dry in most of Greenland and Iceland, western parts of Europe and southern Norway, particularly near the North Atlantic, locally with less than 40% of the normal precipitation, but also with locally heavy showers in Norway (Fig. 5.2). It was the driest May across the UK since 1991, despite some heavy showers at the beginning of the month, especially over Scotland and Northern Ireland.

Most of the other parts of Europe were wetter than normal. Large parts of northern Europe (except western parts) received more than 125% of the normal monthly average. Thunderstorms with heavy showers were recorded in many parts of Estonia, locally resulting in monthly totals of more than twice the normal.

Particularly over eastern Germany, Poland, eastern Czech Republic, Slovakia, Hungary, western parts of eastern Europe and some northern parts of the Balkan Peninsula, more than 250% of the normal was registered, exceeding the 90th percentile. In places across eastern Germany, southern Poland and Slovakia, even more than 400% were measured. This was mainly due to one heavy precipitation event in that area in the second half of the month. Large parts of eastern central Europe received monthly totals of more than 100 mm, near the border between Poland and Czech Republic even more than 300 mm, locally up to nearly 600 mm. Extreme flooding occurred especially in the catchments of the large rivers in eastern central Europe (Odra, Vistula, Danube and Tisza). However, the water levels stayed below those of the flooding event in 1997.

It was by far the wettest May on record in Slovakia and locally the wettest May in Poland. Intensive downpours over Poland and Slovakia caused serious devastation; many areas were flooded. The areas east of the Alpine region were also extreme in terms of heavy rain that month. Over large areas from Austria to Hungary, May 2010 was among the wettest ever registered, with both the precipitation totals and the number of rain days considerably higher than normal. Slovenia was particularly wet in its western parts, with locally more than 200% of the normal (Goriško), whereas some other parts of Slovenia were quite dry (50-60% of the normal).

The area with extreme precipitation extended even farther south. In Serbia, it was extremely rainy in the north (Vojvodina), with a monthly total of 195 mm measured at the station Sombor and a May record broken in Kikinda with 202 mm. In Italy, a station south of Parma recorded the wettest May since 1940 and extremely high historical values were also reached in several other places across the country.

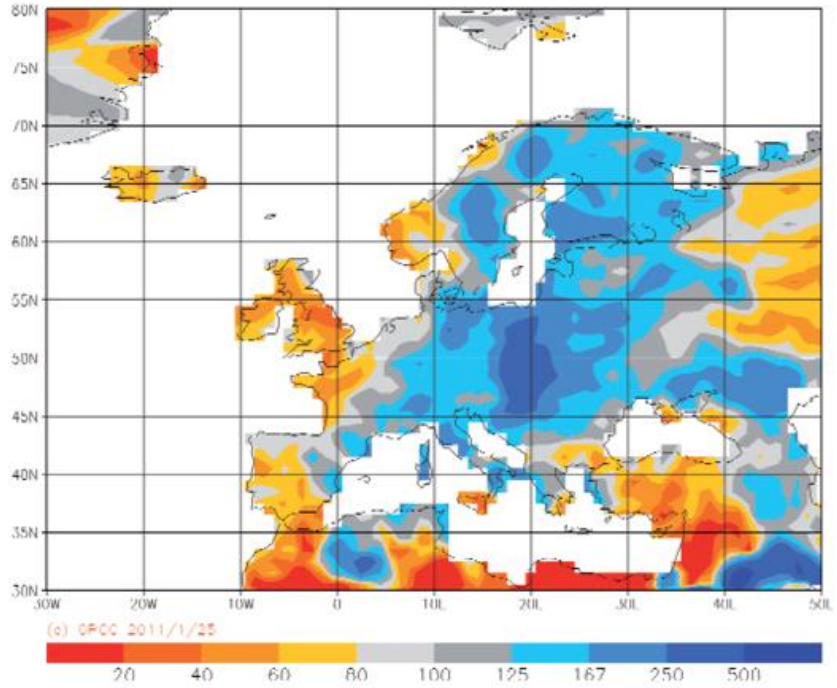

Fig. 5.2: *Monthly precipitation amounts for May 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Some eastern areas of the Region, e.g. eastern European Russia (except the south) and most of the Middle East were very dry. In all these dry areas, however, the monthly totals were below the 20th percentile only in some places. Heavy thunderstorms occurred occasionally on the central Aegean Sea.

Frequent convective precipitation with hail up to 20 mm in diameter occurred in parts of southern European Russia near the Caucasus, leading to monthly totals of twice the normal and more. The Ukraine was mostly very wet, too. May precipitation was close to normal in most of the South Caucasus, but heavy rainfall with hail occurred in places especially in Armenia (resulting in monthly totals locally up to 250% of the normal) and also in Azerbaijan, where several villages around the Kura River were flooded and many houses, bridges, roads, agricultural crops and power lines damaged (estimated worth: about 62.5 million US $). The river had risen at the fastest rate of the century.

Snow

There was still a snow cover at some stations in northern and central Scandinavia and on higher mountains in central Europe. At the beginning of the month, a cold spell produced snow even in the lowlands of southern France. In the middle and at the end of the month, snow fell in higher regions of the northern United Kingdom and Austria.

In other parts of the Region, snow had mostly melted. However, the first days of May brought some snowfall in the highlands of Azerbaijan, with depths of more than 20 cm. The high mountains in Georgia also had some snow until 8 May.

Significant weather events

May 03-04: A depression over the western Mediterranean Sea caused strong winds at the southern coast of France, with wind gusts of more than 110 km/h at several locations, partly even more than 130 km/h. The coastline of the Cote d'Azur was hit by waves up to 7 m high (mean wave height: 4 m). The cold air with maximum temperatures of only 6°–8°C was exceptional for the season and much snow fell in the Pyrenees and the Massif Central (30 cm above 1000 m altitude, 50–70 cm between 1500 and 1700 m and 50–100 cm between 1700 and 2000 m). Snow was even observed in Carcassonne and Narbonne.

Up to 200 mm of rainfall was recorded in the north of Mallorca Island in the western Mediterranean during this event.

May 07: A heavy thunderstorm caused the flooding of parts of the town of Shumen (north-east Bulgaria).

May 10-13: The Alpine region was affected by heavy rain and storm. South-western France, Switzerland, southern Germany and Austria were hit. Severe hail and high wind gusts occurred in Switzerland on the 11th. In Austria, the rain of the 13th caused the enormous damage due to landslides and flooding. 60 mm rain in one hour was recorded in the northern districts of Vienna, which were partly flooded.

May 12: Heavy rainfall in Yerevan (Armenia): 47 mm in 12 hours.

May 15-22: Outstanding flooding in Poland (Wisla), the north-eastern Czech Republic, Slovakia, northern Hungary, Croatia, Bosnia and Herzegovina, Serbia and Bulgaria, which was connected with very high and repeated rainfall especially in the catchment area of Wisla and Odra in Poland. Local precipitation totals for the period 15–18 May exceeded 375 mm. On 16 and 17 May, up to 200 mm of rain fell over southern Poland and the Czech Republic within 24 hours. The rains and subsequent overflowing rivers brought the worst flooding in more than a decade to Poland. Large areas of land were under water, river dams partly broke, several people died in the floods and thousands had to leave their homes. At the end of the month, the flooding also reached Germany (Oder). Some heavy rainfalls with thunderstorms and squalls, which caused trees to fall and ripped roofs from buildings, also occurred in southern Lithuania (up to 60 mm in 6 hours on 17 May). Wind speeds of 110 km/h were reported north of Budapest, Hungary.

May 17: Flooding of the Tiber River in Italy after a rapid cyclogenesis over the central Tyrrhenic Sea and intense, but not convective rainfall of about 120-240 mm within 36 hours. The peak water level in the river was 8.90 m on 15 May, but not record-breaking. However, new records of daily precipitation were set at two stations in Lazio (Italy).

May 18-21: Flooding of the Kura River in Azerbaijan, the biggest transboundary river in the Caucasus region as a result of heavy rainfalls in April and May. The water level reached its maximum from 18–21 May, but it continued to stay high until the end of June (Fig. 5.3).

May 22–23: Thunderstorms and heavy rainfall (21 mm per hour) with hailstone size up to 2.5 cm in diameter occurred in places of southern Finland, causing sudden flooding with several hundred thousand euro worth of damage to properties, agriculture and transport.

May 22–23: Heavy thunderstorm with hail and local floods in the Sporades region, Greece.

May 24: (Whit Monday tornado). A tornado in eastern Germany (Fujita scale F2–F3) caused severe damage to roofs, trees, power lines masts and cars. Flooding of cellars due to accompanying rain and hail were reported. A little girl died in a car that was hit by a tree.

May 25–26: Heavy rain fell in France (108 mm in Dinard, Ille-et-Vilaine, Brittany, with 67 mm within 1 hour). Hail hit Austria (e.g. Großmugl, Gänserndorf, east of Vienna), causing extended damage to wine yards and crop fields, and the south-east of Bavaria in Germany (reported hail size about 3 cm). Wind gusts also caused severe damage to roofs of buildings (Neusiedl am See).



Fig. 5.3: *Damage on railways caused by flooding of the Kura River in Azerbaijan, with maximum water level from 18–21 May 2010.*
Source: National Hydrometeorological department of Azerbaijan

June

- **Mostly warm, but cold in Scandinavia**
- **Dry in north-western and central Europe and in parts of Russia, wet in most of northern and southern Europe**

Atmospheric circulation characteristics

Cold arctic air moved southwards and affected particularly northern Europe where prevailing low pressure conditions caused much rain.

Over the North Atlantic, a stronger-than-normal subtropical high extended far to the north and frequently caused dry and warm conditions over much of north-western and central Europe, interrupted by occasional heavy thunderstorms. The Icelandic low was still dislocated south-westwards as in May.

High pressure influence also dominated over eastern European Russia, whereas other parts of eastern Europe and the Balkan Peninsula were much affected by intense convective events.

Most of southern Europe, in contrast, was affected by frequent and intense cyclonic activity. A cold air outbreak associated with a strong cut-off low occurred in Italy at the end of June.

Temperature

June was also warmer than normal in the Arctic region and over the North Atlantic. Anomalies exceeded +2°C and the 80th or 90th percentile over most of Greenland, western Iceland and large parts of the northern North Atlantic (Fig. 6.1). The June warmth in Iceland was particularly unusual. It was the warmest June on record both in Reykjavík (from 1871) and Stykkishólmur (1845).

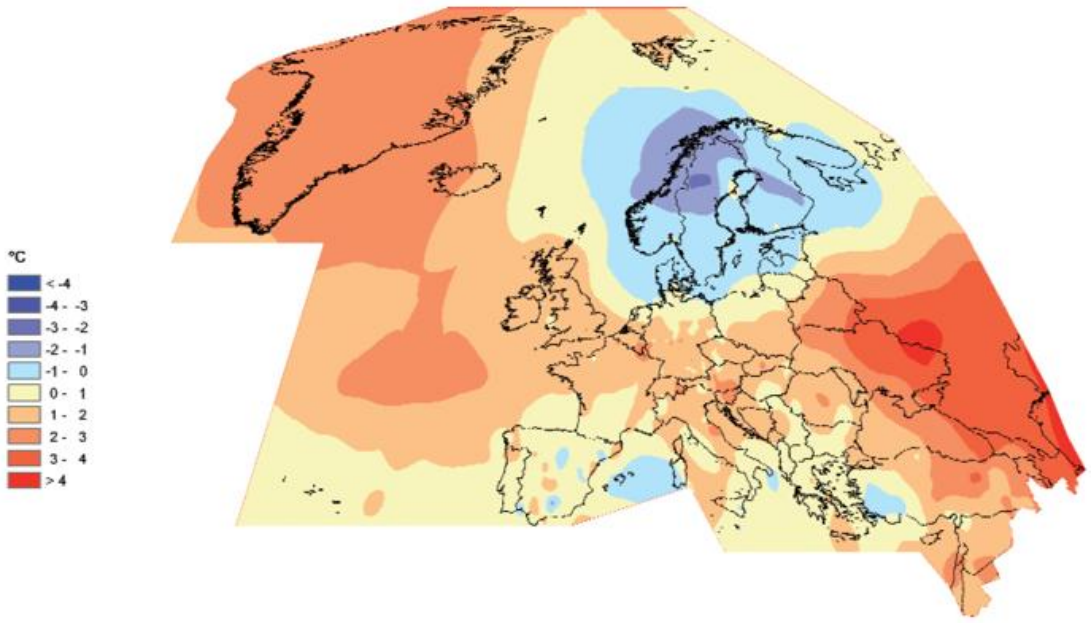

Fig. 6.1: *Monthly mean temperature anomalies in June 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

It was colder than normal across almost the whole of northern continental Europe (except small areas in northern Norway as well as southern and eastern parts of the Baltic countries) and over adjacent sea areas, with highest negative anomalies over central Sweden at around -2°C and thus below the 20th percentile. Northern parts of Scandinavia and European Russia still had frosts. However, a heat wave occurred at the end of the month in north-eastern Europe; in Estonia, it was by far the most remarkable heat wave in the 144-year time series of Tartu. Denmark also had its first summer day (25°C or more) just at the end of month on 28 June.

The other parts of the Region including the water surfaces were nearly all warmer than normal except a few areas in the south. Most of north-western, western and central Europe, the northern Balkan Peninsula and the Middle East had monthly anomalies of more than +1°C,

large parts of eastern Europe more than +3°C, in the Volga region more than +5°C, in the South Caucasus locally up to +6°C. All anomalies there were above the 80th percentile, partly even above the 90th percentile.

Some daily temperatures were relatively high in north-western and central Europe. Daily maxima exceeded 30°C locally in the United Kingdom. Central Europe saw a heat wave around 10 June, particularly near the Alps in southern Germany (Munich City 33.5°C) and in the northern plains of Switzerland due to an unusually strong foehn. Another warm spell occurred in central Europe at the end of the month, but was interrupted by a cold spell around the 20 June with local ground frosts e.g. in eastern Germany, which resulted in lower positive monthly mean anomalies compared to parts of western and eastern Europe.

South-eastern Europe generally had a hot June. Serbia had a heat wave from 7–14 June in most of its parts and a higher-than-normal number of tropical days and nights especially in the southern parts of the country; new daily maximum temperature records were set at some mountain stations. The period 10–15 June was also particularly warm in Romania, setting new highest local daily minimum and maximum temperature records, whereas the end of the month was cold in the south and east of the country. After a cool beginning of June, Bulgaria and Greece had a 3-day heat wave in the middle of the month, with maximum temperatures up to 37.6°C in Bulgaria and up to 41°C in Greece (long-term mean maximum for June at Ierapetra (Crete) is 29°C).

The third ten-day period was particularly hot in most of central and eastern parts of European Russia, with daily maxima up to 41°C in the Astrakhan region. This was the beginning of an extreme and extended heat wave in Russia, which continued during most of the summer. On 25 June, a maximum temperature record for June was established in Moscow with 32.8°C. The south of European Russia experienced the hottest June that had ever been recorded in 120 years of regular meteorological observations. Western Kazakhstan was also hot, especially in the middle of the month with maxima above 40°C.

The South Caucasus had some extreme positive temperature anomalies. Maxima in west Georgia reached up to 39°C. In Baku (Azerbaijan), daily anomalies were locally record-breaking, e.g. +8°C on 5 June.

In the Middle East, June was warmer than normal in Israel and was characterised by a large number (5–7) of Sharav days with a most extreme temperature of 46.6°C in the Jordan Valley. In the last 50–60 years, a similar number of Sharav days in June occurred only once in 1993. The Sharav reached even the coastal strip of Israel, which was rather unusual for the time of year.

In south-western Europe, June temperatures were near normal in Iberia and over the western Mediterranean. It was the coolest June since 1997 in Spain. A few places in the Mediterranean region were slightly colder than normal.

Precipitation

It was a dry June in the Arctic (except parts of western Greenland), and also in north-western and over large parts of central Europe, with widely less than 50% of the normal (Fig. 6.2) and thus less than the 10th percentile. The dry weather in Iceland affected the vegetation in some areas and local water shortages were reported.

Most of northern Scandinavia was mainly wet. At the northern coast of Lapland, the monthly totals were higher than 100 mm or more than 250% of the normal, which was more than the 90th percentile. For all northern Norway, it was the third wettest June on record. In contrast, southern and western Norway received very little precipitation, making it partly the driest June there since at least 1900. Southern Sweden, Denmark and Finland were likewise dry. Locally

heavy rainfall was reported from Estonia, with intensities of up to 52 mm in 24 hours. In Denmark, it rained mainly in the first half of the month, with high intensities especially on 7 and 8 June.

Parts of central Europe were extremely dry in June. Stations in Berlin (Germany) only received 2–3 mm during the whole month, which caused the driest June on record there (since 1908 in Berlin-Dahlem). Some stations in eastern Germany did not receive any rain for 2–3 weeks. Nevertheless, some intense thunderstorms were reported, particularly near the Alpine region and in eastern central Europe. Several rainfalls and thunderstorms with hail caused damage and flooding in northern Austria. In eastern parts of Austria, June 2010 brought up to 200% of the average precipitation, in Hungary about 150% of the country's average. Most of Slovakia was also very wet.

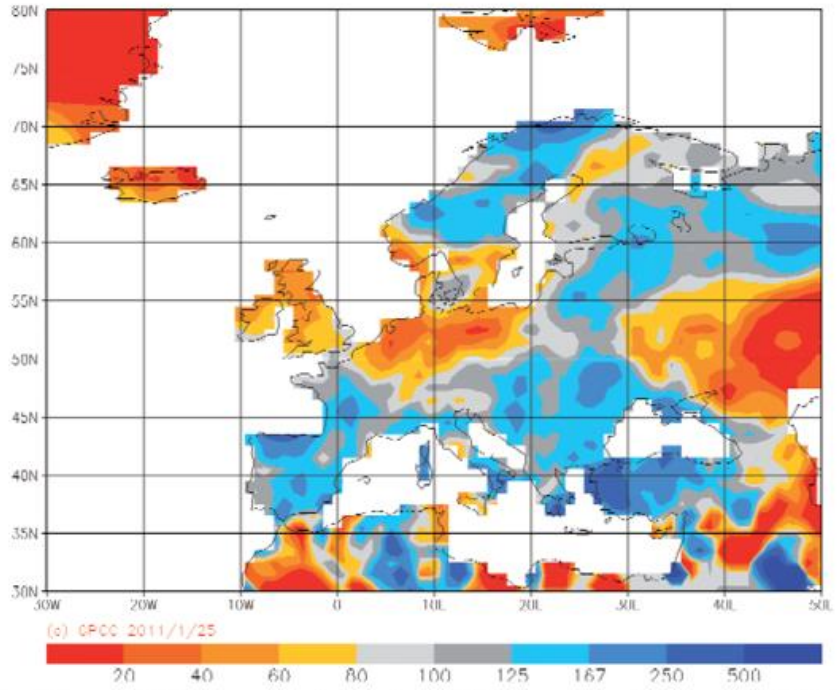

Fig. 6.2: *Monthly precipitation amounts for June 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

South-western and southern Europe, too, were mostly wet with frequent convective precipitation. The 90th percentile was exceeded in many places, especially in parts of Spain, Italy, most of the Balkan Peninsula and western Turkey, locally with more than twice the normal monthly totals, e.g. in Italy in some places near the Po river. The monthly total at Ferrara was the highest of the time series starting in 1924. In south-east France, monthly totals were up to 400 mm (more than 500% of the normal) due to a heavy storm on 15 June. Only a few areas in the Mediterranean region were dry (e.g. Sicily, Malta, Cyprus).

Another area with high precipitation extended from the Balkan Peninsula northwards to the Baltic countries and northern Russia, due to a slow moving depression at the beginning of the month. On the Balkan Peninsula, totals in Bosnia and Herzegovina as well as in Serbia locally rose to more than 300% of the normal and the number of precipitation days was correspondingly high in Serbia. During the third week of June, heavy rains in Bosnia led to more than 30 landslides and caused river floods. New monthly precipitation records were set, e.g. at the Serbian station Sombor with 240 mm, 113 mm of which fell just on one day (22 June,

setting a new record for June). Monthly totals in Romania were also high (over 100 mm) in most parts of the country, in the north-east even more than 300 mm, which was more than twice the June normal in some areas.

A larger, very dry area was to be found over central and southern European Russia, western Kazakhstan and the South Caucasus region. Parts of southern European Russia received less than 20% of the normal precipitation, which was less than the 10th percentile. A particularly critical situation existed in the last ten-day period of June, when central areas of European Russia and the Volga region received no rainfall at all or only a few mm. Some places in west Kazakhstan did not have any precipitation during the whole month. On the other hand, intensive convective activity in places with hail occurred in the North Caucasus region throughout the month, with monthly totals of 150–300% of the normal. The South Caucasus, particularly the eastern parts, and west Kazakhstan saw a dry June, partly with less than 40% of the normal. Places in east Georgia and Azerbaijan had around 30%, Armenia down to 14% of the normal. Other places, especially mountainous parts of western Georgia as well as places in the south-east of the country and in northern and central Armenia, had abundant rainfall, partly combined with hail in the second decade of the month. Azerbaijan saw intensive rainfall only in the first part of the month, causing severe countrywide flooding.

The Middle East, too, was partly very dry, but was not completely without rain. In Israel, there was some rainfall of a few mm on 24 and 25 June, which is rather unusual there for a summer month, but generally the country was in the midst of one of its longest and most severe droughts since the 1920s.

Snow

In June, there was hardly any snow in the Region except on some high mountains. On 20 June, however, snowfall in the Alps came down to 1000 m altitude within a cold spell due to a cut-off low which extended far to the south. On the Kredarica Mountain in Slovenia, the snow depth decreased considerably from its highest monthly value (235 cm) to only 35 cm at the end of the month.

Significant weather events

June 01–05: A quasi-stationary upper tropospheric depression over the northern Balkan Region (low Angela) caused heavy and long lasting rainfall, with flooding in southern Germany (Bavaria) due to 48-hour precipitation amounts between 80 and 208 mm and 24-hour amounts between 54 and 155 mm. 80 mm in 24 hours fell near Salzburg (Austria). In Hungary, the same depression caused between 50 and 120 mm in 72 hours in the southern and northern regions of the country and 30–47 mm in 48 hours in the northern region. High wind gusts occurred also (maximum 135 km/h). Bosnia and Herzegovina reported heavy rainfall on the 1st of June, with 79 mm at Gradacac. Croatia, Slovakia, the Czech Republic and Poland were also affected by high water levels in rivers and flooding. Further north, Lithuania reported heavy rain accompanied by thunderstorm and hail on the 3rd and 4th, with a maximum total of 84 mm in 8 hours at Elektrenai. Estonia reported precipitation amounts of 20–58 mm over the period 02–05 June.

June 07–08: Heavy rainfall in Mozdok (Republic of north Ossetia, southern European Russia). 140 mm of precipitation fell in one night, which is twice the monthly precipitation normal.

June 08: Heavy rains, which had affected Istanbul (Turkey) the days before, caused a river on the city's Asian side to burst its banks, inundating dozens of houses.

June 09–13: Thunderstorms with intense rain, hail, storm and tornadoes developed in a warm and moist air mass over central Europe and affected Germany, Switzerland and Austria seriously. Hailstones up to 3 cm were reported. Wind gusts up to 150 km/h (under foehn conditions) occurred in Switzerland. 30–50 mm of rain within short time intervals were reported for Germany and Austria.

June 11–19: Thunderstorms with heavy precipitation occurred in various parts of Europe. Heavy rainfalls in northern Spain (Galicia and Asturia) caused flooding at the beginning of the second decade of the month. In France, the region Provence - Alps - Côte d'Azur was hit by an exceptional event with precipitation amounts from more than 150 mm up to nearly 400 mm especially on 15 June. This is close to the amount that typically falls in a six-month period in this area. Flash flooding killed at least 25 people and left hundreds of others stranded in cars, houses or on rooftops. The rainfall event and subsequent flooding was the worst on record since 1827. The following days until the 17th brought further precipitation to Switzerland, southern Germany and Austria, and heavy hail to Slovenia. Hungary reported severe thunderstorms with heavy rain (60mm/2h in Kiskunmajsa), hail and high wind speeds (possibly a tornado north of Szeged). Bulgaria had large hail on 16 June. Even in northern Europe (Denmark) reported a heavy thunderstorm with hail on the 15th. Sweden saw heavy precipitation up to 126 mm in 48 hours on the 18th and 19th, causing flooding and landslides.

June 20–21: A remarkable change of the circulation with a cut-off low in the Mediterranean area brought a temperature fall of about 10 degrees to the northern and central Adriatic regions (even in Milano, the temperature fell from 25–27°C to 14–16°C from 19 to 20 June, which was followed by a sudden increase on 21 June). The Alps had snowfall above 1500 m and widespread thunderstorms occurred in northern and central Italy.

June 22–25: Heavy rain with flooding extended over the northern Balkan Peninsula to the east. Bosnia and Herzegovina reported heavy rain with close to 100 mm on 22 June, causing river flooding, landslides and broken roads; thousands of homes had to be evacuated. Many Bosnians feared that land mines planted during the Bosnian War in the 1990s could have been shifted by the floods. Also in Serbia, a great flood was recorded in the basin of the rivers Kolubara and Jadar, which lasted until 5 July and caused significant material damage. Heavy rainfalls unleashed floods in northern and eastern Romania (maximum 24-hour precipitation reported: 163 mm). Numerous people were killed and hundreds had to be evacuated from their homes. Several roads and hundreds of hectares of farmland were inundated, dozens of houses destroyed and several bridges damaged. Moldavia was also sincerely affected by floods due to some partly intense, partly enduring rainfall episodes. Rainfall led to sudden high water levels, especially on the River Prut. 4000 people had to be evacuated, more than 1000 houses were destroyed and agriculture and forestry were severely affected. The economic damage added to 0.15 % of the gross domestic product (BIP). Western Ukraine was affected as well.

June 23: Abundant rain in Georgia caused flash floods and damage to houses and roads, washing away bridges and farmlands. Two deaths were reported in the basin of Gldanula.

June 29: Heavy storm around Botev region in Bulgaria with gusts of 100 km/h.

July

- **Warm in nearly the whole Region**
- **Extreme heat wave in Russia and adjacent countries**
- **North-western, central and northern Europe mostly wet, south-western Europe and Russia very dry**

Atmospheric circulation characteristics

Low pressure systems, though with relatively warm air, crossed particularly north-western Europe within a strong frontal zone. Both the Icelandic low and the Azores high were stronger than normal this month, causing much rain over Ireland and the United Kingdom, but dry conditions over south-west Europe.

A very strong and extended Russian high caused an extreme heat wave over Russia and, to a lesser extent, in other countries, particularly in eastern Europe. A strong and persistent ridge also extended over Fennoscandia, leading to exceptionally warm and dry conditions there.

Some low pressure systems with convective activity also crossed central and parts of eastern and south-eastern Europe, but were blocked by the Russian high.

The Mediterranean region was first influenced by quite strong high pressure and advection of subtropical continental air masses over the central Mediterranean and Italy. Later in the month, a north-westerly flow prevailed, which brought cooler mid-latitude maritime air into the area.

Temperature

Nearly the whole Region had a warmer-than-normal July (Fig. 7.1). Averaged over the European continent, July 2010 was the warmest on record since 1900. The anomalies were higher than +1°C over nearly all land areas, in many cases they were even much higher, e.g. in large parts of eastern Europe more than +4°C (partly more than +5°C, e.g. in the Baltic countries and Belarus) or +6°C (locally even more) in European Russia. The 90th percentile was exceeded nearly throughout the Region, at least over land areas (with exception of Ireland and the United Kingdom and some areas near the coasts). Only parts of Svalbard and a small area over the eastern Arctic Sea were slightly colder than normal. The widespread warmth was due to a strong heat wave centred over Russia and was characterised by high daily and monthly means, maxima and minima as well as an exceptionally long duration. Tropical nights occurred more often than normal, particularly in southern Russia, but also in western and central Europe and in the southern parts of the Region (with minima even >25°C, e.g. in Portugal).

In northern Europe, July was one of the warmest ever in southern and western Iceland. Norway had positive anomalies of about +1 to +2°C, but no extremely high maxima; its highest daily temperature for the month and year was recorded on 10 July at 28.7°C. Anomalies were higher towards the east and south. Denmark measured a peak temperature of 34.1°C on 11 July on the island Bornholm, which was the highest value in Denmark since 1994. A couple of stations in southern Sweden reported new all-time high temperatures since measurements began in the mid-nineteenth century. The highest temperature in Sweden this month (and summer) was 35°C and thus the highest since 1994. In Finland, the highest monthly temperature was 37.2°C at Joensuu Airport on 29 July, the highest ever measured in Finland. Finland also set a new record in the number of summer days (>=25°C): 28 days in Lahti and Puumala in the south-east of the country. Monthly average temperatures, too, reached new all-time records in many places

of Finland (the highest was again in Puumala at 23.0°C). In the Baltic countries, Estonia had the highest mean in 60 years; daily maxima exceeded 30°C for up to 14 days and several stations set new maximum temperature records. Latvia had its warmest July for 87 years. In Lithuania, it was the warmest July over the last 50 years, with maximum temperatures up to 35.5°C. Belarus recorded its highest temperatures in 100 years.

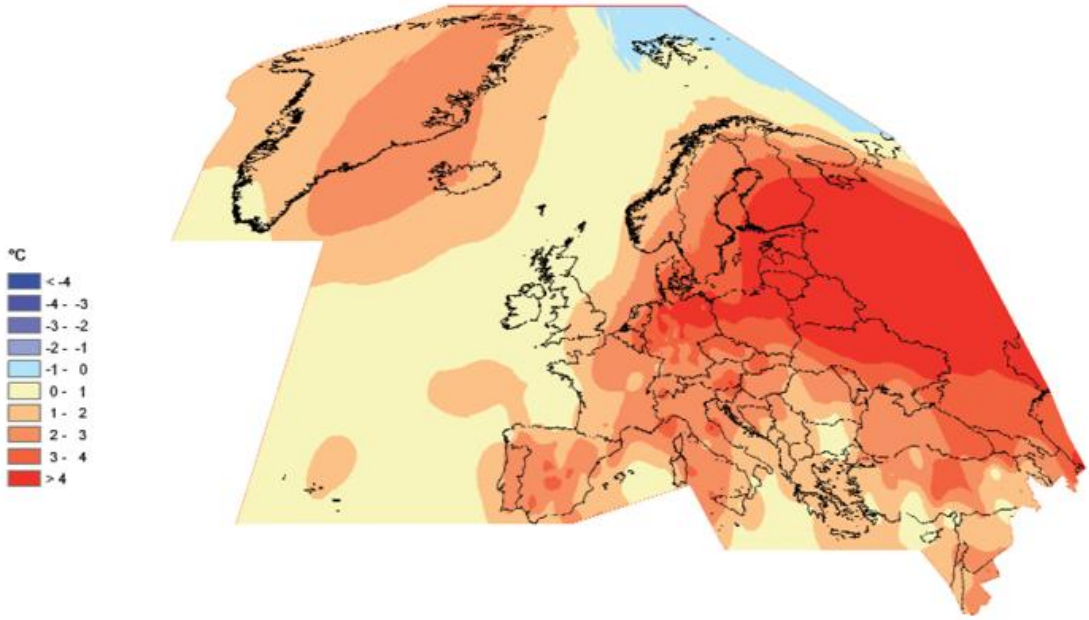

Fig. 7.1: *Monthly mean temperature anomalies in July 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

In western and central Europe, high temperatures were recorded during the first half of the month in particular. Daily maximum temperatures reached more than 30°C or even more than 35°C at many places. At 31.7°C, the United Kingdom had their highest daily maximum in 2010 on 9 July. The Netherlands were +1.5°C warmer than normal, and the highest daily maximum in the country was 36.2°C, here, too, on 9 July. Belgium had a one-week heat wave during 07–14 July. Luxembourg airport had 7 days with daily maxima of 30°C or more, which is far above the 1971-2000 normal of 2.3 days. France was +1.9°C warmer than normal averaged over the whole country, which means that July 2010 was by far not as warm as July 2006. Germany saw some new maximum records on 3 July in Bremerhaven (34.1°C) and Osnabruck (36.9°C), but the highest official value in Germany was 38.8°C in Bendorf (near Rhine River). Water temperatures in the German Baltic Sea exceeded 23°C at times. Switzerland recorded a long heat wave from 8–21 July, with daily temperatures of over 30°C, but no absolute records. It was the second warmest July at the station Lugano in Tessin since measurements began in 1864. Local new records were broken in Austria, e.g. the station Graz University registered the highest July average since the beginning of measurements in 1837 (+3.6°C local anomaly). During a 15-day heat wave, the loss of ice at the tongue of the largest glacier in Austria (Pasterze) was approximately 6 cm per day. The Czech Republic generally had a warm July, too, followed by a sudden drop of temperature at the end of the month due to a strong cold front.

In the second half of the month, the eastern countries of Europe were hot. Highest deviations from normal were to be found over Russia due to a long lasting and very intense heat wave. It was the hottest July ever recorded in European Russia, particularly in Moscow (+7.6°C anomaly). Many daily maximum temperature records were broken in European Russia (Moscow 38.2°C on 29 July) and many hot days were recorded, partly with temperature maxima of more

than 40°C, and also many tropical nights. Temperatures above 40°C were also recorded in west Kazakhstan. The hot weather had deadly consequences. More than 1,600 drowning deaths were reported in July as people tried to escape the heat across Russia.

The South Caucasus was also hot, with maxima up to 39°C in various parts of Georgia. A heat wave in Armenia set an all-time record of 10 consecutive days with temperatures above 38°C. Large parts of the South Caucasus were +2 to +3°C warmer than normal compared to the monthly average.

Extremely high maxima and anomalies were also recorded in the Middle East. Jordan had its highest daily maximum at 45.6°C on 31 July at Azraq (+8.2°C anomaly). Israel, too, had a heat wave at the end of the month, with daily maxima up to 44°C in the Jordan Rift and minima up to 33°C at the Dead Sea. In the coastal plain of Israel, minima reached 27–28°C, which was a new all-month record.

The Balkan Peninsula was affected by notable warm spells, too. Slovenia had two heat waves (10–17 and 21–23 July); in some parts of the country, the temperature rose up to 37°C. High maxima above 40°C were measured in Montenegro, e.g. 40.1°C at the station Podgorica on 16 July during a strong heat wave, which was abruptly terminated on 24 July when the local daily maximum dropped from one day to the next from 35°C to around 20°C. Serbia was very hot, too, and the majority of its stations reported record-numbers of tropical nights. High temperatures in Romania during the second half of the month were related with high humidity. The highest maximum in Bulgaria was 37.4°C. Greece had two heat waves on 14 and 15 July and from 24–26 July with maxima up to 38–40°C on the mainland (long-term mean maximum for July: 32–33°C).

In the central Mediterranean, Malta had its warming peak on 24 July (38.3°C), but became much cooler in the last week of the month.

Portugal, too, had two major heat waves that month (5–8 July and 26–31 July), with temperature maxima above 40°C, and recorded its highest mean daily maximum temperature for July since 1931.

Precipitation

Most of the Arctic region saw a dry July. Especially eastern Greenland received less than 25% of its monthly totals.

July was wetter than normal over Ireland and most of the United Kingdom (except the south-east of the country), most of Scandinavia, western and southern parts of the Baltic countries and large parts of eastern central Europe and the eastern and southern Balkan Peninsula (Fig. 7.2). Monthly totals were locally higher than twice the normal (e.g. in some areas of Norway, large parts of the United Kingdom except south-eastern parts, Lithuania and southern Poland) and exceeding the 90th percentile at least locally due to some heavy thunderstorm events.

Ireland and most of the United Kingdom were hit by large amounts of rain, whereas large parts of the French coasts were significantly dry. Germany was especially dry in its north-eastern parts, locally with less than 20% of the normal and extreme forest fire risk. In contrast, some thunderstorms with heavy rain caused a wetter-than-normal southern half of the country (locally twice the normal), especially in the last third of the month. Switzerland was dry in the west, whereas thunderstorms were concentrated over the country's east and the mountains as well as Austria and Slovenia. Golf ball-sized hail fell in southern Austria in the middle of the month; the hail zone had a length of 40 km. In Slovenia, most of the precipitation occurred during the last third of the month, and it was most abundant in western parts of the country; more than

twice the monthly normal fell on the coast. Heavy rain, hail and local flooding also occurred in Romania and Greece, resulting in twice the normal monthly total. The southern Ukraine saw an extreme flooding event in the catchment of the Danube River.

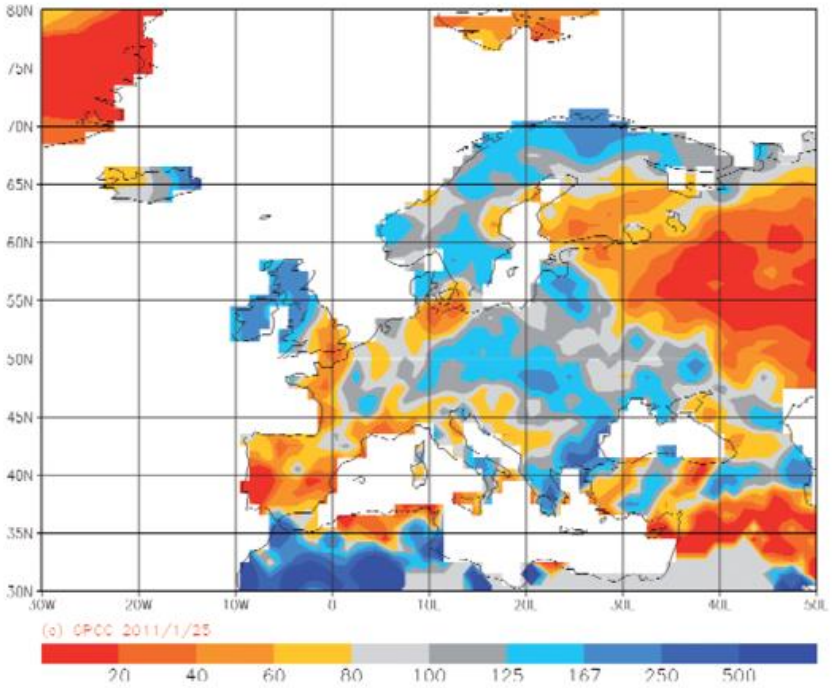

Fig. 7.2: *Monthly precipitation amounts for July 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

In contrast, it was extremely dry over southern Finland, eastern Estonia, most of European Russia, western Kazakhstan and western parts of the South Caucasus. Some areas of Russia, Georgia and western Kazakhstan received less than 10 mm precipitation; this was as little as 20% of the normal and clearly below the 10th percentile. These drought conditions, the worst since 1972, destroyed nine million hectares of crop in Russia and thus an estimated 20 percent of the nation's agricultural production, including grain, vegetables and fodder. Additionally, a state of emergency was declared in Russia when 948 forest and peat bog fires covering 26,000 hectares were burning in 18 provinces. Several villages were completely destroyed, leaving thousands of people homeless. Forty people were reported killed by the wildfires. Large areas including the capital Moscow were affected by smoke, which even reached Finland, largely affecting the air quality there due to high carbon monoxide levels.

In the South Caucasus region, Georgia was mainly dry (especially in the first and second ten days of the month), though with heavy rain in places, whereas Azerbaijan and Armenia were mostly wet or near normal due to unstable weather with frequent rainfalls and thunderstorms, partly with hail. Turkey also had some areas with high rainfall, especially near mountain sites. The Middle East was generally very dry.

It was also very dry in most of the Mediterranean region, on the western Balkan Peninsula, in Iberia (around 50% of its normal) and western and southern France. Southern Sicily (Italy) registered no precipitation at all. In contrast, precipitation was abundant in various other parts of Italy. In Iberia, it was the driest July in Portugal in the last 24 years.

Snow

Snow was recorded only in a few places in northern Scandinavia and in the higher Alps. Toward the end of July, the snowline in Switzerland fell below 2500 m.

Significant weather events

July 05: Austria was hit by heavy rain with thunderstorms. 145 mm in 24 hours (including 50 mm within 1 h) fell at a location in the Salzkammergut.

July 06: Heavy rain in Tallinn (Estonia) with 57 mm in 24 hours (70% of the monthly normal), causing damage to shopping centres.

July 06–07: Portugal reported a remarkable event at the southern Algarve coast in connection with a depression over the Atlantic between Madeira and Northern Africa. The sea surface pressure suddenly fell by 3-4 hPa and the sea surface level increased by 30 cm ('meteorological tsunami').

July 08: Finland reported a thunderstorm with heavy rain of 34 mm/h in the area of Helsinki. Hail of up to 2.5 cm in diameter caused traffic disruption in eastern Finland.

July 10: Switzerland reported a heavy thunderstorm with wind gusts up to 110 km/h, and heavy rain of around 60 mm in 1 hour (St. Bernhard, Zürich-Affoltern).

July 11: A violent thunderstorm occurred in western Austria (Vorarlberg) in the evening. Due to a debris flow which accumulated gravel and soil masses up to 8 meter high, some homes had to be evacuated.

July 12–13: Heavy thunderstorm over south-eastern Norway with locally very intense precipitation, e.g. 12 mm in 5 minutes in the Oslo area. Strong gusts in Norway and Sweden. Vinga station in Sweden reported a wind gust of 122 km/h, the highest gust ever reported in Sweden in July (mountain top stations excluded).

July 12: A downburst hit the island of Helgoland (Germany) in the North Sea. At least 8 people were injured on a campsite, two of them seriously. The campsite, where about 100 people were staying, was destroyed and a light aircraft on the nearby airfield knocked over. Wind gusts of more than 100 km/h were measured in several places in western Germany (e.g. in Aachen).

July 13: Lithuania reported heavy rain of 54 mm in 12 hours (Lazdijai) and 59 mm in 9 hours (Babtai).

July 14–15: A series of low pressure systems passed the UK on the 14th and 15th, bringing localised flooding and strong winds to parts of Cornwall, Devon and Wales. Severe gale force winds and gusts as high as 135 km/h brought down branches, trees and even roof tiles. Uprooted trees blocked roads and power lines came down - leaving around 1,500 people without electricity.

July 14: France reported heavy thunderstorms with many lightning strikes along a track from Paris to Eure et Loire. 40 mm of precipitation in 3 hours and wind gusts of more than 90 km/h were recorded at 6 stations, more than 125 km/h at 2 stations and more than 140 km/h at Saint-Hilaire-sur-Help. Similarly heavy thunderstorms hit Belgium at the end of a heat wave, producing 30 mm in 2 hours and wind gusts up to 135 km/h (Elsenborn). In the Netherlands, a campsite at Vethuizen was hit by severe wind gusts of a thunderstorm downburst. 2 people died and several were injured.

July 14–16: Heavy rainfall in the village Tsakhkavan in the north-east of Armenia: 58 mm in 4 hours on 14 July and 39 mm in 2 hours on 16 July.

July 15: Many fires in Estonia due to thunderstorms.

July 15–16: Another thunderstorm with heavy rain hit Austria and southern Germany. 88 mm in 12 hours were reported for Preitenegg (Kärnten), 52 mm in 1 hour for St. Michael/Leoben. Hailstones up to 9 cm diameter were seen near Starnberg (southern Germany).

July 16: Slovenia reported heavy rain: 48 mm within 45 min, a once-in-50-years event.

July 17: Heavy precipitation records were reported by Austria: 94 mm for Kalwang (Styria), 82 mm for Puchberg (Lower Austria) and more than 100 mm in the Kitzbühel Alps. In Tyrol, heavy rain and hail caused enormous damage around Innsbruck. Streets were flooded up to 50 cm high due to hailstones blocking the drains. Vegetable crops over an area of 400 hectares were destroyed in eastern Innsbruck. Similar daily totals also fell in southern Germany.

July 18–19: 101 mm of 24-hour rainfall had been recorded at Seathwaite (Cumbria) in the United Kingdom.

July 21: The centre of Perth (Scotland) had been seriously affected by flooding after 40 mm of rain fell during the morning.

July 22: Finland reported heavy rain with 60 mm/day in Sodankylä.

July 22–26: Several heavy rainfalls with thunderstorms hit Germany: Germany reported heavy rain for its regions Bavaria, Thuringia and Saxony, with totals around 50 mm in 1 hour at several stations. The region between the Allgäu and the Berchtesgadener Land in southern Germany received more than 100 mm within 3 days. Thunderstorms with heavy rain on 26 July brought locally even around 100 mm in 24 hours. A severe hailstorm was reported by Austria (south-eastern Styria) on 23 July, with an estimated damage to agriculture of 4 million euros. Golf ball-sized hailstones damaged roofs and vehicles heavily. In Italy, heavy thunderstorms with heavy rain and wind gusts also occurred in the eastern Po valley after a persistent period of hot weather and a following cut-off low.

July 23–24: Heavy rain in western Lithuania (85 mm in 11 hours) with hail (hailstones 3 cm in diameter) and a tornado.

July 26: Severe hailstorm damaged fields in central Estonia.

July 26–27: Twenty-six forest fires and 34 peat fires were burning in the Moscow region on 26 July, producing dangerous air pollution. Smog levels were five to eight times greater than normal. On 27 July, pollutant levels increased by about 50 per cent and were ten times higher than normal.

July 26: Heavy storm around Kaliapka region (Bulgaria) with gusts of 136 km/h, water spout near Sozopol (Black Sea, Bulgaria).

July 29–30: Finland reported heavy thunderstorms and downbursts in the south and middle of the country, with an extremely large number of lightning strikes and wind gusts up to 105 km/h during night time, which is very exceptional. Extensive damage due to falling and broken trees in central Finland.

August

- **Very warm in large parts of the Region, colder than normal in parts of the Arctic and western Europe**
- **Continuation of strong heat wave in eastern Europe and extension to the Middle East**
- **Very wet in central Europe, dry in most of the north, east and south**
- **Again severe flooding in eastern central Europe**

Atmospheric circulation characteristics

In August, a mainly meridional circulation pattern was dominating again. The North Atlantic as well as eastern Europe and the Middle East were mostly under high pressure influence and warm air advection, whereas low pressure systems crossed north-western and central Europe frequently from the north-west, bringing cold air which partly extended as far south as the Mediterranean. The airflow became more zonal in the second half of the month.

Cold and dry air from the eastern Arctic region only affected the northernmost parts of northern Europe.

Temperature

The North Atlantic, Greenland and Iceland as well as most of southern Scandinavia were mostly more than +1°C warmer than normal this August (Fig. 8.1). Southern Greenland was even more than +3°C warmer, exceeding the 90th percentile.

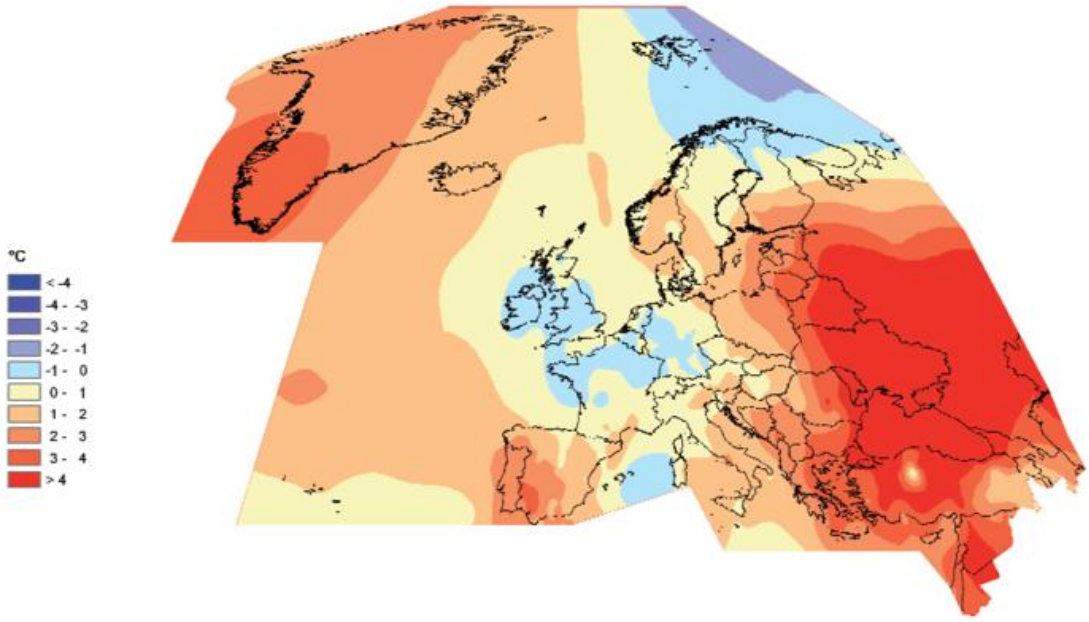

Fig. 8.1: *Monthly mean temperature anomalies in August 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

Towards the east, the eastern Arctic Sea, the northernmost parts of northern Europe and Svalbard were colder than normal, with anomalies mostly between 0 and -1°C, in the east even below.

North-western, western and most of central Europe as well as the western Mediterranean had monthly mean temperatures near normal, partly slightly colder. It was the coolest August in the United Kingdom since 1993. Frost of -1.3°C was recorded in the highlands of the country on 26 August.

The Alpine region was warmer than normal. In the night 6–7 August, unusually high 25°C occurred over large parts of Switzerland due to warm air masses from the south-west. Up to 29°C had been measured in Basel at midnight.

Iberia profited much from subtropical high pressure influence and experienced a hot month. Portugal had its second highest mean maximum temperature for August since 1931. Especially in southern Spain, anomalies reached more than +3°C, which was more than the 90th percentile. Daily maximum temperatures exceeded historic records for August at several stations in the eastern half of Spain. Highest annual maxima for Spain were recorded from 25–27 August, reaching 44°C at several sites near the eastern coast in the provinces of Murcia, Alicante and Valencia. Italy was warmer than normal over most of the southern regions, Sardinia and the eastern Po Valley, whereas the rest of the country was within the natural variability of temperature.

It was extremely warm over most of north-eastern, eastern and south-eastern Europe, the South Caucasus, the eastern Mediterranean and the Middle East due to the ongoing strong heat wave, which had started at the end of June. In the whole of eastern Europe and the Middle East, the monthly mean was above the 90th percentile.

In eastern Europe, several stations measured new local daily maximum temperature records. The highest value in Estonia was 35.4°C, only 0.2°C less than the absolute country record. 35.8°C were reached in Lithuania on 15 August, and record-breaking daily maximum temperatures were reached on four days in a row (13–16 August). Belarus broke its all-time high-temperature record on 7 August with 38.9°C in Gomel in the south-west of the country. The Ukraine also saw a new absolute maximum temperature record of 42.0°C in Lugansk on 12 August. Highest anomalies (>+6°C) with daily maxima above 40°C and continued smog due to wildfires were to be found in the eastern Ukraine and south-western European Russia. West Kazakhstan, too, registered again maxima above 40°C. European Russia experienced its hottest August ever, with many new maximum temperature records, like the more than 38°C measured in July in Moscow. Maxima in Moscow were +15°C above average during the first half of August 2010. The two-month long heat wave finally broke on August 19th, when a cold front moved across western Russia, bringing rain and much cooler temperatures and clearing the thick smog that had hovered over Moscow for weeks. In the last decade of August, temperatures declined and the first frost occurred in north-western European Russia and in the upper Volga regions.

In the South Caucasus, maxima reached up to 42°C in west Georgia. There was also a large number of hot days, e.g. in Azerbaijan, with corresponding impacts on people's health. 160 cases of sunstroke were registered in Azerbaijan, nearly three times as many as in the previous year 2009. On 21 August, however, temperatures locally dropped to -4.5°C below normal.

Generally, this large heat spell with high monthly anomalies extended further south compared to July. Montenegro once again experienced a heat wave with maxima above 37°C later in the month and many fires were triggered in the hottest regions of the country. Bulgaria reported three heat waves with maxima up to 39°C, causing human discomfort and triggering forest and field fires especially in the south-east of the country. August was even warmer than July in Bulgaria.

In the central and eastern Mediterranean region, the heat wave went on for a longer time. Malta had its highest temperature on 21 August (36.0°C, Fig. 8.2) and its mean August maximum was almost +1°C higher than normal. Many Greek stations recorded both their highest ever monthly mean temperature and mean maximum temperature. High daily maxima were measured in Greece during heat waves from 13–17 August and 26–27 August at 38–41°C at many stations. The station Mut in Turkey reached a local record-breaking daily maximum of 46.7°C. On Cyprus, the station Athalassa recorded a maximum temperature of 45.6°C on 1 August, which was +8.4°C higher than normal, while the minimum temperature was at 29.0°C (+7°C above normal). This was the highest maximum temperature in Cyprus for 100 years. Monthly anomalies in Cyprus were also extremely high (around +3°C), which is considerably more than in June and July. In most parts of Israel, August was the warmest on record, mainly due to two major heat waves, partly with record-breaking temperatures up to 49°C. At times, the high temperatures were accompanied by high relative humidity. Minimum temperatures in Israel were also record-breaking and reached up to 30.0°C. Jordan also had two heat waves with the highest maximum at 48.8°C (+9.9°C anomaly from normal maximum temperature) in the Jordan Valley on 20 August.

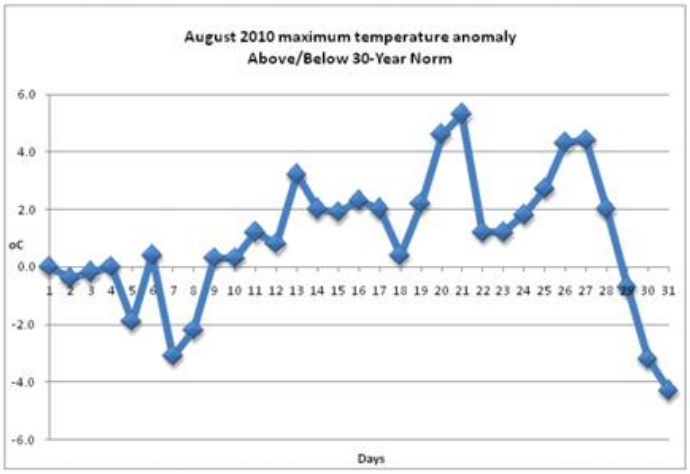

Fig. 8.2: *Daily anomalies of maximum temperature in August 2010 (reference period 1961–1990) at Luqa Airport, Malta*
Source: Malta Airport Met Office

Precipitation

The Arctic region (except western Greenland) and most of the northern parts of Scandinavia and Russia were dry, locally with less than 40% of the normal precipitation (Fig. 8.3), which was less than the 10th percentile. River levels in north-western Iceland were unusually low and there was water shortage in places.

Due to high pressure influence from the North Atlantic, it was also very dry in south-western France, northern Spain and particularly in Portugal. Less than 10 mm, which is less than 20% of the normal, was registered across the whole of Portugal, making it the driest August of the last 23 years. In most of these areas, especially those near to the coasts, the totals were below the 10th percentile.

South-eastern Spain, in contrast, was very wet that month with up to more than 400% of the monthly total at the south-eastern coast. This was mainly due to a heavy precipitation event on 16 August, which particularly affected some localised areas of central Andalucia just in the middle of the dry season.

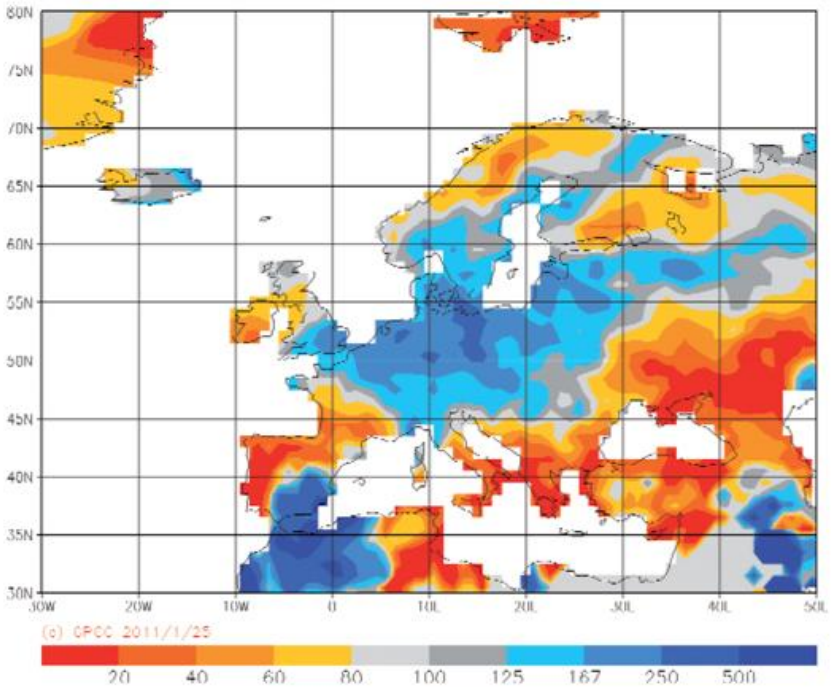

Fig. 8.3: *Monthly precipitation amounts for August 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Large parts of central Europe and much of the adjacent areas (as far as south-east England in the west, southern Scandinavia in the north, some parts of Russia in the east and northern Italy in the south) were also very wet, all with totals higher than the 90th percentile due to some heavy rain events, which were locally related to storms, heavy hail and flooding.

Several places in south-eastern Norway, parts of the south-eastern United Kingdom and northern France received more than twice the normal monthly precipitation total. Some Norwegian stations registered a new August record for monthly or daily precipitation. It was the second wettest August on record in East Anglia (United Kingdom).

August was extremely wet all over central Europe. It was the wettest or second wettest August in many parts of central Europe, with heavy thunderstorms. The Netherlands saw its second wettest August since 1901 (behind 2006), with 170 mm on average, i.e. nearly three times the normal. The wettest August since 1881 was recorded in Germany, with an areal mean of more than 200% of the 1961-1990 normal, locally more than 400% (Fig. 8.4). Poland received about twice the monthly normal on average. Particularly high totals of more than 200 mm (more than 250% of the normal, locally up to 500%) were measured in the border region of Germany, Poland and the Czech Republic, mostly due to a heavy precipitation event in early August. Precipitation totals were also very high in parts of eastern Austria and Slovakia.

The Baltic countries saw an outstanding wet August, too. Ruhnu Island in Estonia received 236 mm (more than 400% of the normal), which include one heavy rain event with 97 mm in 24 hours. Most parts of Estonia were very wet, especially during the second ten days of the month. It was the third wettest August in Latvia for 87 years. Heavy downpours, squalls, thunder- and hailstorms and even tornadoes also occurred in Lithuania.

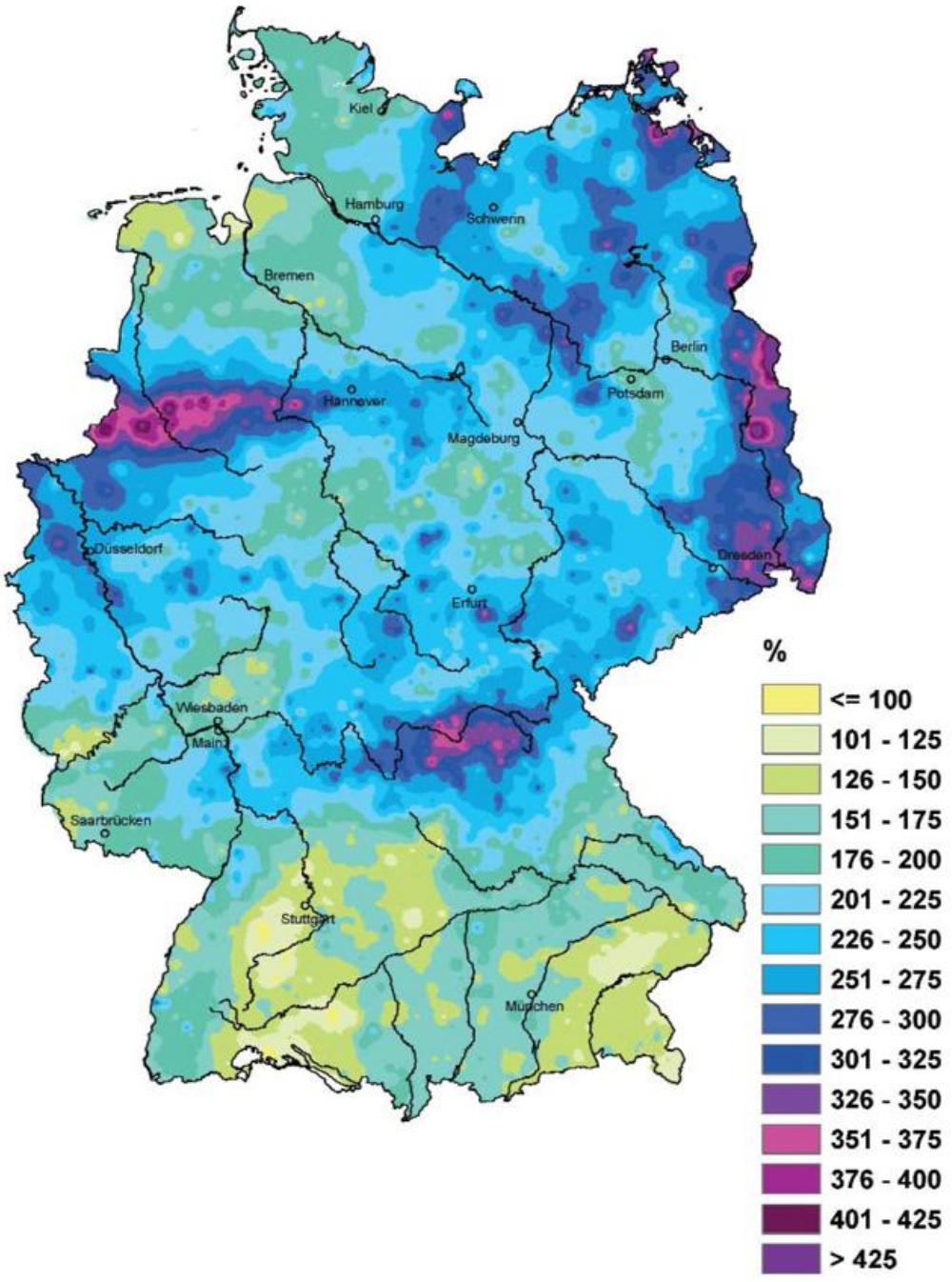

Fig. 8.4: *Monthly precipitation amounts for August 2010 in per cent of the normal 1961–1990 in Germany*
Source: Deutscher Wetterdienst, Germany

Towards the south, northern parts of Italy and the Balkan Peninsula were also affected by high precipitation that month. Rainfall totals in Italy were above normal over most of the northern regions and Tuscany. Locally, Serbia received up to three times the normal, with a new local record for the August monthly total set at Novi Sad (168.5 mm). Even in Romania, August precipitation was above normal in the mountainous and western regions.

Generally, it was also very dry over a large area around the Black Sea, namely in eastern Romania, Moldova, the eastern Ukraine, southern European Russia, northern parts of the South Caucasus, Turkey, the Middle East, Cyprus and even large parts of the southern Balkan Peninsula and central and southern Italy, locally with less than 20% of the normal monthly precipitation and mostly below the 10th percentile. Some of these areas were even without any rain at all or received only a few mm in the whole month, which was unusual except for the eastern Mediterranean area. The Ukraine received less than half of the normal precipitation throughout the country. There were more than 600 wildfires and 948 forest fires in 18 counties of western Russia at the beginning of August, with thousands of people made homeless. Forest fires also occurred in parts of Azerbaijan and agriculture suffered from drought there, but several days in the last third of the month were characterised by thunderstorms.

Snow

Snow was recorded in higher altitudes of the Alps only. On the first days of August, the snowline was as low as 2100 m in eastern Switzerland, covering the higher passes with a thin layer of wet snow. At the end of the month, the snowline went down to 1200 m altitude in the eastern Alps, and up to 40 cm of fresh snow was measured in the higher mountains.

Significant weather events

August 01: Nicosia in Cyprus reached a daily maximum of 45.6°C, which was the highest value recorded since the beginning of the 20th century.

August 04: The beginning of August 2010 was still characterised by the great heat in the east. Stations in Russia, Belarus and Ukraine reported very high temperatures. Moscow had 36.6°C, St. Petersburg 33.3°C, Luhansk nearly 40°C.

August 04: Thunderstorm with heavy gusts and large hails in central Finland, causing damage due to fallen trees; people were injured at the camping site of Uurainen.

August 04: Severe thunderstorms with very strong winds and hail up to tennis ball size in north-western Bosnia and Herzegovina (Bosansaka Krupa). Huge damage to infrastructure and losses in agricultural production.

August 05: In north-west Greenland, a huge chunk of ice broke off the Petermann Glacier into the Nares Strait. The ice floe was 251 km² in size, which equals a quarter of the floating ice shelf of the Petermann Glacier. It was the largest break-up in the Arctic since 1962.

August 06-09: Very high precipitation amounts fell in eastern Austria, eastern Germany, the Czech Republic and Poland, partly as long enduring rain and partly as very intense precipitation. This led to severe flooding of the Neisse and Elbe Rivers as well as smaller rivers like the Spree (Bautzen, east Germany). In the morning of 08 August, the water level in Görlitz (eastern Germany) of the Neisse River (707 cm, i.e. about 4.5 m above its normal level) exceeded the previous record of 21 July 1981; parts of the town were flooded. More than 1,400 residents had to leave their homes. In Poland, a water reservoir dam broke. Houses were flooded and streets and bridges damaged. Most of the rain fell in the Czech Republic, where the water level of the Elbe raised to 6 m, i.e. three times the normal value. Values of up to 200 mm in 24 hours were reported there. At least 11 people died in eastern central Europe. Damages were estimated to be over 215 million U.S. dollars in the Czech Republic alone. Southern Germany and Switzerland also had high precipitation amounts.

August 08: Wind gusts of up to 108 km/h, heavy rain (locally 69 mm in 8 hours) and hail (diameter 2 cm) in connection with intense convective activity was reported from western Lithuania in the afternoon. It was one of the stormiest and damaging meteorological phenomena of the decade 2001–2010. A squall line formed within a tropical air mass over southern and central Lithuania. Forests (about 4 million Euro), power lines and buildings were damaged and 4 people lost their lives. The thunderstorm also affected Estonia and Finland. In Estonia, gusts reached 144 km/h and weak tornadoes occurred, causing significant damage in towns, villages and on 1,100 hectares of forests. Electricity was disrupted in 60,000 households. Several people were wounded, one person killed. Hailstones of 6–8 cm size fell during a severe thunderstorm in Pirkanmaan (Finland) and gusts up to 115 km/h were measured in the western parts of the country. Never before had Finland reported hailstones bigger than these. This was the most severe thunderstorm in a series of days with highly convective activity. Beside fallen trees and flooding which affected air and road traffic, lightning strikes caused a power blackout to 21,000 households. Several people were injured at a music festival in Pori and one died.

August 08–09: Forest fires in Russia and prevailing south-easterly airflow brought dense smoke to the whole of southern Finland. The peak concentration of PM2.5 particles was measured as high as 241 μg/m³ in Imatra (south-eastern Finland), which was more than 20 times the average.

August 11–13: Fires broke out in northern Portugal, spreading to northern Spain near the borders of Spain and Portugal during hot and dry weather.

August 13–17: Large parts of central Europe reported intense precipitation. Daily totals were around 50 mm or more at many stations. Uccle in Belgium recorded a 48-hour total of 103.6 mm on 15 and 16 August, and precipitation was also intense in north-eastern France. Denmark was hit by heavy precipitation on the 17th, with 24-hour values of 138 mm for Billund and 157 mm for Blahoj Kirkeby. In Austria, thunderstorms on the 13th brought 64 mm in 1 hour in Eisenstadt (Burgenland), an event with a probability of once in 25-30 years. Public traffic in Vienna had to stop its service for one hour due to heavy rain, flooding of streets, and broken branches blocking railway tracks. Heavy precipitation also caused widespread damage in some regions of eastern Germany and central and eastern Slovakia, with destructive flash floods.

August 14–16: Thunderstorms with widespread and intense precipitation that produced daily totals up to more than 80 mm particularly over northern and central Italy due to a cut-off low.

August 16: Lithuania reported that the temperatures exceeded the highest August temperature maxima ever recorded at 12 stations. On this day, the maximum temperatures reached 28.3°C (Zoseni) to 33.1°C (Daugavpils).

August 16: At least 2 tornadoes were observed in Hungary.

August 16: Russia's two-month long record heat wave and drought was set to come to a dramatic end by a severe storm. In St. Petersburg, 100,000 were left without power, rail services were halted and trees fell in high winds. Temperatures around Moscow dropped to about 24°C, after nearing 40°C for weeks.

August 16: Heavy precipitation in central Andalucia (Spain). The episode, unusual for that season, locally brought over 200 mm of rain in just a few hours and caused three deaths and damage to infrastructure, mainly houses and transport networks (road and rail).

August 21–22: Strong N-NW wind over the Aegean Sea caused a fire at the palm-tree forest of Preveli (in the south of Crete Island). Forest fires also occurred in western Turkey.

August 23: Gusts of violent storm in south-western Denmark and northern parts of central Europe. Thunderstorms with heavy precipitation occurred in western Germany (up to more than 50 mm/day) and central parts of the country (more than 30 mm/day in the Rhön Mountains). Tornadoes occurred in various parts of Germany and in Belgium. During the early morning hours, a hailstorm affected the north-west of Poland, bringing down trees and power lines. Properties and homes were damaged and 3 people were injured. The hailstorm was followed by torrential rain.

August 25–26: In Turkey, the station Rize at the Black Sea coast reported 167 mm in 24 hours on the 25th. The same station had some additional 52 mm on the next day. 13 people died due to a mudslide, 168 houses were destroyed due to distorted urbanisation. 1729 hectares of field, roads and water pipes were damaged. Total economic loss was calculated to 20 million USD.

August 26: France reported daily maximum temperatures in the south-west between 39°C and up to 41.1°C. Switzerland reported very high night temperatures from the 26th to the 27th between 20°C and up to 23.8°C over most of the country. The mountainous stations also had night time values between 10°C and 18°C.

August 26–27: Up to more than 130 mm of precipitation fell in 24 hours in a wide band over the middle of the Netherlands. Many places experienced large-scale flooding. The eastern Netherlands and western Germany also received high precipitation totals of more than 100 mm up to 162 mm (about 200% of the monthly August normal) in 24 hours in a frontal band, which was relatively narrow in north-south direction. Swansea in the United Kingdom recorded a 24-hour total of 64 mm in the morning of 26 August.

August 29: Copious amounts of rain triggered floods and mudslides that killed at least 12 people in the northern Turkish town of Gundogdu. Dozens of homes were destroyed and several roads closed.

August 31: The last day of August 2010 brought snowfall in the Austrian Alps: 40 cm in 2000 m and 10 cm even down to altitudes of 1300 m.

August 31: Heavy storm in Botev and Kurdjali region (Bulgaria), gusts up to 144 km/h.

September

- **Cold in central Europe, warm over Greenland and in the east**
- **Wet with frequent heavy rain in eastern central Europe and over the central Mediterranean, still very dry in Portugal and in the east**

Atmospheric circulation characteristics

Both the Icelandic low and the Azores high were more intense and had a more westerly position than normal in September. Thus, warm air dominated over the North Atlantic and was also led to Iceland and Greenland.

A meridional circulation pattern, however, persisted over the European continent and cold and moist air from the north extended particularly to western and central Europe, temporarily also to the western and central Mediterranean.

High pressure influence dominated over the eastern parts of the Region, and warm and dry air particularly affected the Middle East and continued to move to areas in the north-east, especially in the second half of the month.

Temperature

September was still warm over the North Atlantic and particularly over Greenland and Iceland, with anomalies of more than +3°C (Fig. 9.1), which exceeded the 90th percentile. Towards the east, the anomalies were lower; over the eastern Arctic sea, they were even slightly negative.

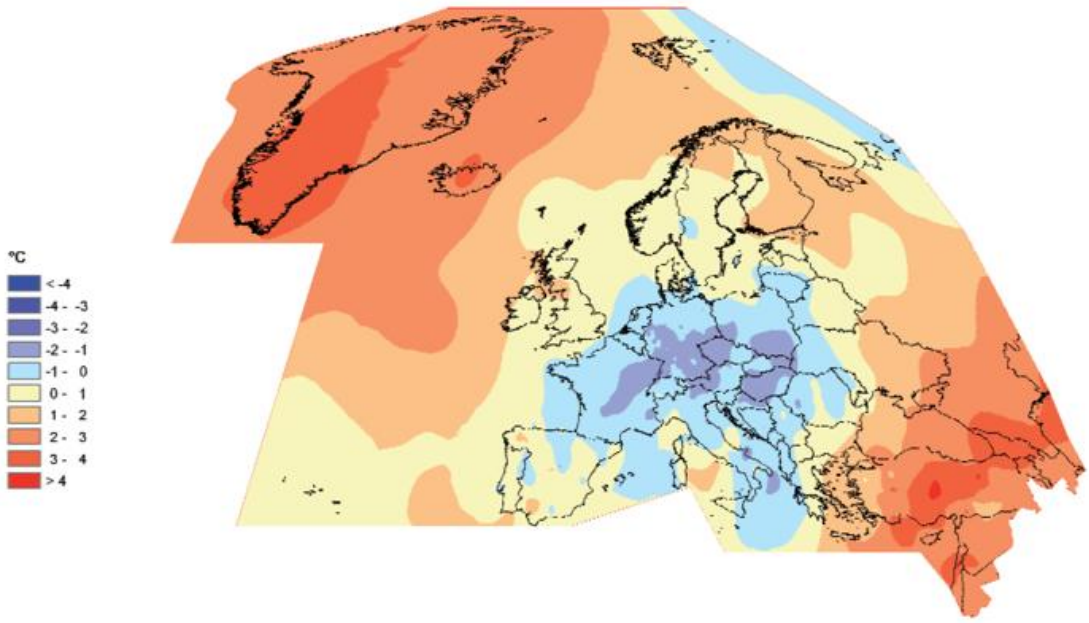

Fig. 9.1: *Monthly mean temperature anomalies in September 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

With 24.9°C, a new daily maximum temperature record for September was reached on 2 September in Greenland at the station Nuuk Airport. Iceland recorded the same peak maximum (24.9°C) on 4 September. It was the highest daily maximum of the whole year 2010 and most unusual to occur so late in the summer half year.

Northern Europe, Ireland and the United Kingdom were also warmer than normal, though with smaller deviations from the normal (less than +2°C), partly due to some cold nights. The United Kingdom saw some localised frost, but also daily maxima up to 24.6°C. Further to the south of the Region, most of Iberia also had slightly-above-normal temperatures, but the temperatures were also below the normal in some places.

Large parts of western and central Europe (including the southern North Sea) were colder than normal as well as parts of the western and central Mediterranean, Italy and the western Balkan Peninsula. Anomalies were partly below -1°C, particularly in southern central Europe, where even some local frosts occurred; but these were no extreme deviations. Temperatures reached 25°C only rarely in Germany.

It was still warmer than normal in eastern Europe, the eastern Mediterranean region and the Middle East, but the strong and extended heat area of the preceding summer in eastern Europe was retreating to the south-east. Anomalies still exceeded +2°C and thus the 90th percentile in southern European Russia, west Kazakhstan, the South Caucasus region, Turkey, the eastern Mediterranean and the Middle East. Locally in Turkey, the anomalies were higher than +4°C. Daily maxima reached up to 37°C in Greece south of the Aegean Sea and 40°C in west Georgia at the beginning of the month. Israel had once more record-breaking minimum temperatures up to more than 30°C at the Dead Sea.

Precipitation

It was wetter than normal over eastern Greenland, parts of Iceland, Ireland and parts of the United Kingdom (Fig. 9.2). The 90th percentile was only exceeded in eastern Greenland and parts of Ireland. In the United Kingdom, it was particularly wet in Northern Ireland, the wettest September there since 1999.

Because of missing westerly airflow conditions, the Norwegian coast and large parts of northern Scandinavia were very dry, as was most of the Arctic region, locally receiving less than 40% of the normal and below the 20th percentile. Places in northern Norway experienced the driest September in 25 years.

It also continued to be very dry in Portugal due to continuous high pressure influence, resulting in the second driest September of the last 22 years in this country. Monthly totals were below 10 mm in nearly the whole of Portugal, which was below the 10th percentile. The coasts of Spain, some southern parts of France and the western Mediterranean including its islands were also far drier than normal, whereas the interior of Spain was wet.

It was very wet in the whole eastern part of central Europe (except in some areas, e.g. in southern Germany and upper Austria), parts of the Baltic countries and north-eastern European Russia and, towards the south, in the north-western Balkan Peninsula and the central Mediterranean region, locally with more than 300% of the normal monthly precipitation (e.g. in eastern Germany and northern Croatia) due to some heavy convective precipitation events. In most of eastern central Europe and the north-western Balkan Peninsula, the 90th percentile was exceeded. River water levels were critically high in places and extensive flooding with significant damage occurred in Slovenia. At many Slovenian stations, precipitation was among the most abundant ever observed (up to 300% of the normal and up to more than 300 mm).

Most of European Russia, especially the eastern and southern parts, as well as west Kazakhstan, Turkey, Cyprus and the Lebanon were very dry, although this is not rare in these areas for this time of year. On the other hand, there was more than 250–500% of the normal rain locally in southern Syria and Jordan. Some places in the South Caucasus region also saw some higher-than-normal rainfalls, whereas especially Armenia received only 30–50% of the normal precipitation.

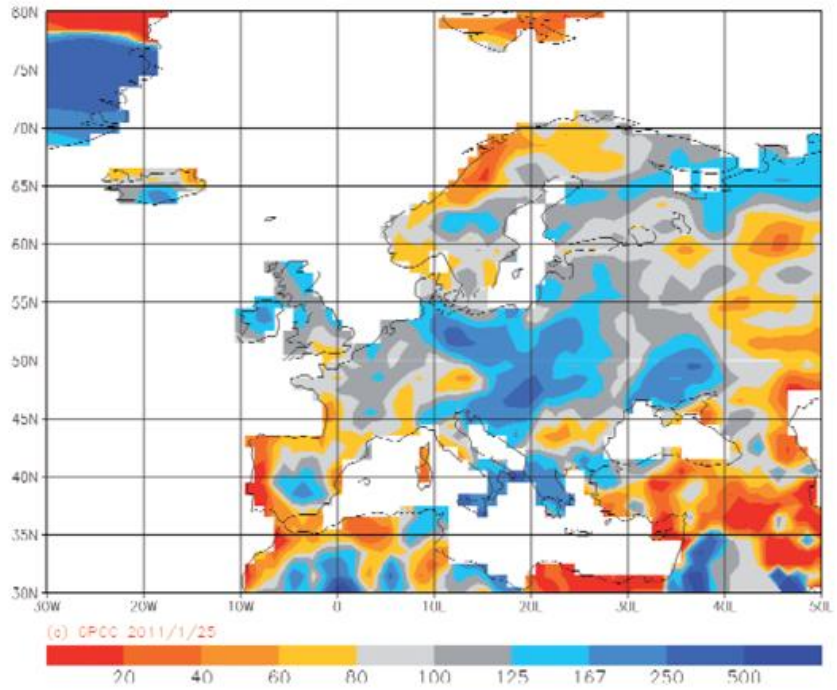

Fig.9.2: *Monthly precipitation amounts for September 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Snow

Snow was only to be found in the Alps and in higher elevations of the Carpathian Mountains. Wendelstein Mountain in southern Germany (1800 m altitude) had one snow day in September, with 2 cm of snow. The highest German mountain, Zugspitze (nearly 3000 m altitude), still had 4 days without any snow. Kredarica Mountain in Slovenia had 9 days of snow, with a maximum depth of 12 cm on 28 September. Romania had snow above 1700 m altitude at the end of the month.

Significant weather events

September 01–02:	Heavy precipitation hit Poland, the Ukraine and the Czech Republic. The Czech Republic reported heavy precipitation during the night from 31 August to 1 September with daily amounts of 100 mm or more at several stations.
September 02–04:	At least 3 tornadoes were observed over northern and eastern Germany.
September 03:	Heavy storm in Botev region (Bulgaria) with gusts of 90 km/h.
September 06–08:	Along with an Atlantic frontal system, intense rainfall occurred in southern France and brought about 90 mm and more at 7 stations (maximum 310 mm at Conquerac, Gard) on 6 September, and more than 100 mm

at 13 stations (maximum 254 mm) on 7 September. Overall, 20 stations had more than 100 mm within the 2 days; the highest 2-day sum was registered at Cardet, with 354 mm (half of the usual annual mean). Over 200 mm fell in 4 hours at Cavaillon (Vaucluse).

September 09: Heavy rain caused severe damage at the Italian Amalfi coast. Generally, the regions of Genoa, Liguria, Amalfi, Campania and Friaul received heavy rain.

September 11–12: Heavy rain (up to 117 mm in 24 hours) and flooding in Thessalia (central Greece).

September 14: Turkey and Georgia reported heavy precipitation, locally more than 100 mm in 24 hours.

September 15–16: Gusts up to 110 km/h in Denmark and northern Germany, causing disruptions of the ship traffic between Germany and the North Sea islands.

September 17–19: Severe precipitation hit Slovenia, resulting in catastrophic floods in many parts of the country. Former records were broken at many stations; it was the heaviest precipitation event for 60 years. On 18 and 19 September, 11 and 7, respectively, out of 18 stations reported more than 100 mm in 24 hours. One station near Idrija had more than 500 mm in 2 days; it was the most severe precipitation event in the last 60 years in Slovenia. During this precipitation episode, northern Italy also had heavy rain with flooding of the Seveso River. Metro stations in Milan had to be closed for a week due to 7–8 m high accumulation of debris. Several more countries were affected by heavy rain during this episode: Switzerland, Austria, Hungary, Bosnia and Herzegovina, Greece and Spain.

September 25–27: Heavy and long lasting precipitation of partly more than 50 mm per day and local flooding was reported by Germany, Poland, the Czech Republic, Switzerland, Liechtenstein, Austria, Slovenia, Croatia, Bosnia and Herzegovina, Romania, Bulgaria, Macedonia and Greece. The water levels of some rivers in eastern Germany rose and caused flooding of streets and agricultural areas in some places. Wind gusts in Bulgaria (regions Musala, Mouragash) of 100 km/h.

September 26: A daily precipitation total of 179 mm was measured in south-eastern Iceland.

October

- **Cold in nearly the whole of Europe, warm in the Arctic and in the Middle East**
- **Dry in most of northern, central and eastern Europe, wet in parts of the Arctic, southern Europe and around the Black Sea**
- **Heavy rain events in the Mediterranean region and in south-eastern Europe**

Atmospheric circulation characteristics

A large low pressure zone affected the Arctic and the northernmost parts of Scandinavia. The Icelandic low itself was not well developed, but mild air masses from the North Atlantic flowed to the Arctic region. The Azores high was centred south-west of the Azores and weaker than normal.

High pressure influence dominated over large parts of northern, western, central and eastern Europe; occasionally, cold air advection from the north reached these areas with localised snowfalls in the second half of the month, but also a few warm spells occurred due to southerly or Atlantic airflow, and foehn north of the Alps.

Further in the south, there was much cyclonic activity around the Black Sea and the Mediterranean. A Mediterranean mesocyclone, originating from a cut-off low, affected the western Mediterranean basin during the second week of October.

The Middle East was still affected by warm and dry air masses from the south.

Temperature

It was very mild over the North Atlantic and throughout the Arctic region (Fig. 10.1) due to continued high sea surface temperatures. Anomalies in the Arctic increased up to +4°C. The 90th percentile was exceeded in southern Greenland, Iceland and Svalbard. Especially the first half of October was unusually warm in Iceland. The northernmost parts of Scandinavia were more than +2°C warmer than normal, whereas southern parts were colder than average.

Temperatures were close to normal on average in the United Kingdom. However, for about 10 days from mid-month, it was colder there, with northerly winds and some very low overnight temperatures. This was compensated, however, by milder air due to frontal systems from the west and also because of some warm days with up to 23.1°C due to high pressure influence.

Most of the European continent, southern Scandinavia, Ireland and most of the western and central Mediterranean were colder than or near to normal. The highest negative anomalies were to be found over eastern central Europe and the northern Balkan Peninsula (around -3°C). In eastern central Europe, temperatures were lower than the 10th percentile. It was the coldest October in Vienna since 1974. The first third of the month was still warm in central Europe; maxima continued to exceed 25°C in south-western Germany and the Alpine region in early October due to foehn. However, first frosts occurred in the lowlands of Germany and in Denmark in the middle of October. Northern Italy was also particularly colder than normal in the second half of the month.

October temperatures were below normal in most of European Russia. In the first ten-day period of the month, slight frosts were recorded locally in its western and central parts, in some places with new minimum temperature records. On the other hand, northern and north-eastern European Russia was warm in October. In Murmansk, the air temperature attained 12.4°C on 6 October, which became a new absolute record-breaking value for this time of year.

The South Caucasus region, eastern Turkey, the Middle East and the eastern Mediterranean were at least +1°C warmer than normal. Most of these areas recorded temperatures higher than the 90th percentile. In some parts of the Middle East, the anomalies were higher than +3°C. Daily maxima still reached up to 32°C in west Georgia at the end of the month, when other parts of the South Caucasus were already affected by cold air masses. Jordan experienced three heat waves in October, with highest daily maxima at 42–44°C in the Jordan Valley (anomalies +8°C or more); the conditions were similar in Israel, with up to 42°C even in the coastal plain, where the highest October temperatures for the last 50-60 years were reached.

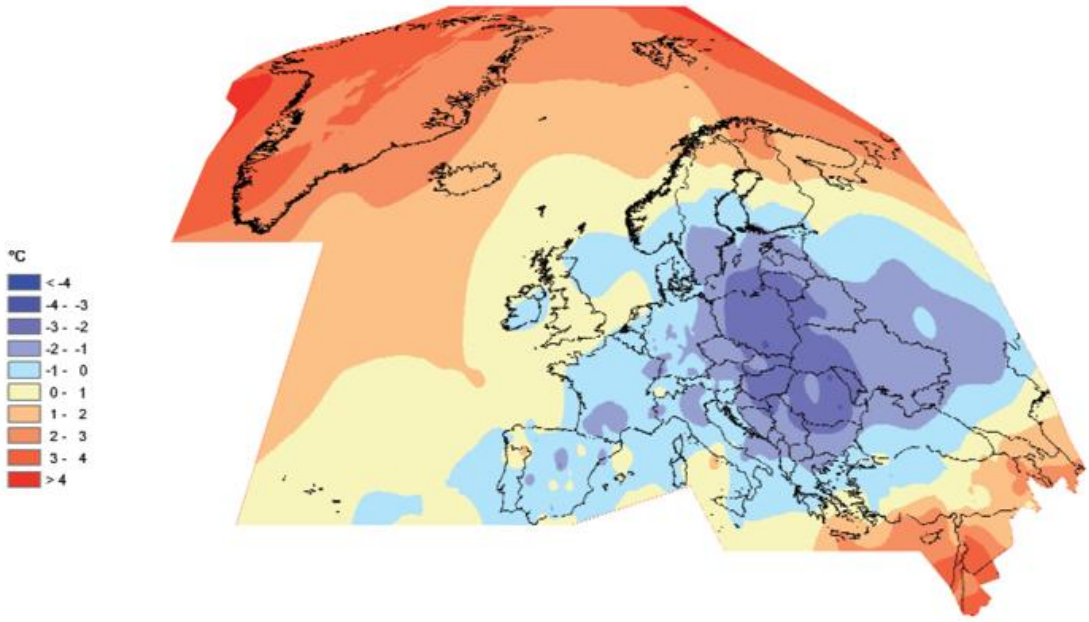

Fig. 10.1: *Monthly mean temperature anomalies in October 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

Precipitation

It was wetter than normal in most of the Arctic region, especially in Svalbard (240% of the normal) and the northernmost parts of Scandinavia (Fig. 10.2).

In the United Kingdom, precipitation was close to normal in many areas, but it was drier than average in the west.

Nearly all other areas in northern, western, central and eastern Europe were drier than or close to normal. Fog was very frequent and long-lasting, especially near water surfaces in central Europe. The largest relative precipitation deficits were to be found in eastern Germany, Poland and central Sweden, with totals of 20% of the normal or less. In these two areas, the totals were lower than the 10th percentile.

Western parts of Iberia, France and the western Alps were wetter than normal, partly with more than 125% of the month's normal total, in southern France even 200–300% and in Lisbon in Portugal more than 300% of the normal precipitation.

The areas around the Black Sea and further east as far as west Kazakhstan as well as most of the Mediterranean region were also wetter than normal due to some heavy rain events. For the areas around the Black Sea, the 90th percentile was exceeded. Many of these areas

received more than 200% of the normal, e.g. some locations in Greece (Fig. 10.3). Locally, the totals were much higher, up to more than six times the normal in Turkey (e.g. Ankara). Malta had its 3rd wettest October since 1951.

The Middle East and Cyprus saw a very dry October (only 3 mm in Larnaca (Cyprus) compared to the normal of 19 mm; 4 mm in Damascus (Syria), normal: 12 mm). Israel and Jordan mostly received less than 60% of their normal total, locally less than 20% or even no precipitation at all.

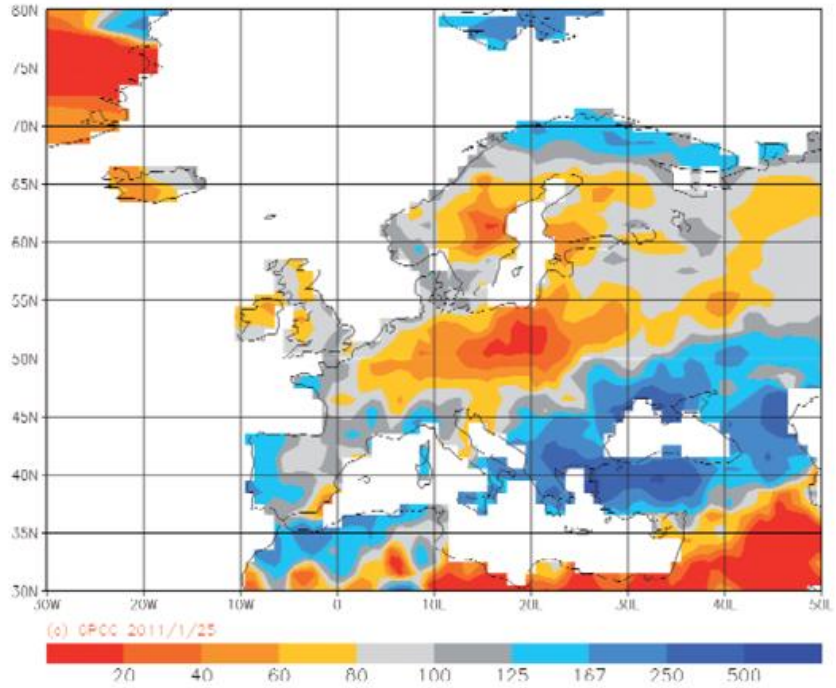

Fig.10.2: *Monthly precipitation amounts for October 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

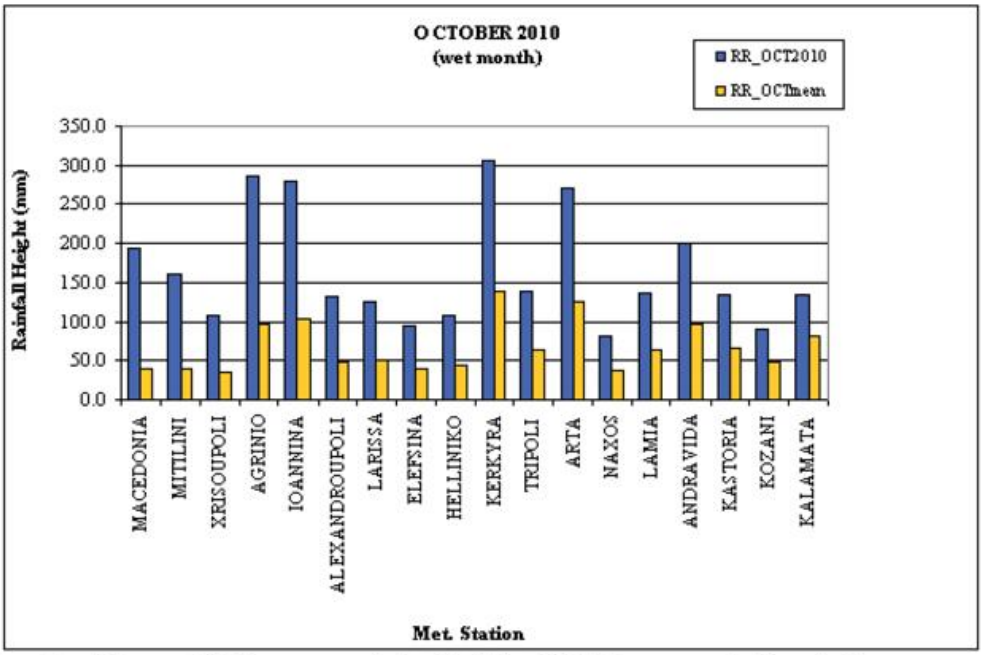

Fig. 10.3: *Monthly precipitation amounts for October 2010 for some stations in Greece compared to the long-term mean (various reference periods)*
Source: Hellenic National Meteorological Service (HNMS), Greece

Snow

Snow fell over most areas in Scandinavia and northern Russia as well as on the higher and lower mountains in central and parts of southern Europe. On 21 October, first snow fell in southern Germany down to 800 m altitude; on 25 October, first snowfall occurred in some alpine valleys down to 500-700 m altitude, with up to 20 cm of fresh snow in Carinthia (Austria). There were 18 days of snow on Kredarica Mountain in Slovenia (depth of 65 cm on 26 October). Azerbaijan in the South Caucasus region had some snow in the highlands, with depths up to 21 cm at the end of the month.

Significant weather events

October 05:	Italy reported heavy rain at the Ligurian coast. 3-hourly precipitation values in some places (Pero, Monte Gazzo and Pegli, all around 300–400 mm in 24 hours) exceeded the mean monthly values. On Monte Gazzo, one third of the mean annual precipitation amount fell within 6 hours.
October 09–12:	Rainy episodes in southern France led to several-day precipitation sums of more than 200 mm.
October 12–14:	Dust advection from Africa with wet deposition affected the whole country of Greece.
October 13–14:	123 mm rainfall in 24 hours was recorded in Bursa (Turkey). The return period of such an event is about 200 years. Lots of flooding and landslides occurred. Schools were closed for two days.
October 15–16:	Heavy rain (47–93 mm) and flooding of the rivers (water level 340–916 cm) in southern Krasnodar (southern European Russia) caused the death of 15 people. Mudflows in the mountains.
October 18–19:	Greek authorities declared a state of emergency on the Aegean Sea islands of Ikaria and Chios after flash floods left two people dead. Another ten people were trapped in their cars and had to be rescued. Authorities received 450 calls from owners of flooded homes and businesses. The daily precipitation sums of Naxos (55 mm) and Mytilini (82 mm) were well above the 50-year-return amounts for October based on the 1990-2009 time series. Islands of Xios and Ikaria received more than 200 mm in 24 hours.
October 25:	In Austria, the weight of the snow (up to 50 cm in mountainous regions) caused power lines in the Tyrol region to break.
October 26–28:	Heavy rain and thunderstorms in central and eastern Macedonia (Greece), with up to more than 200 mm in 24 hours. Heavy rainfalls also in Turkey, resulting in many flood and landslide events. Schools were closed for two days.
October 29–30:	Heavy rain hit Lisbon in Portugal with a daily total of 79 mm, 71 mm of which fell within 3 hours. Streets and places of the city were flooded.
October 30–31:	France reported an episode of extreme rain, with more than 100 mm of rain in 48 hours in the south-east of the country. The values partly were comparable or exceeded the mean monthly precipitation sums of October.

November

- **Cold in western and northern Europe, particularly in Scandinavia, very warm in central, eastern and south-eastern Europe and the Middle East**
- **Most of Europe wet, but very dry in the north and in the Middle East**
- **Early cold spell and widespread snow at the end of the month**

Atmospheric circulation characteristics

Cold Arctic air extended to most of Scandinavia, but came under prevailing high pressure influence. South of this high pressure zone, cold air from the north-east also moved temporarily to central, western, north-western and even south-western Europe, especially during the last week of November, leading to significant snowfalls and hard frosts at the end of the month. In addition, several deep Atlantic low pressure systems came from westerly directions and crossed north-western, western, central and eastern Europe, some of them were quite extended and intense. Numerous cyclonic disturbances also reached the Mediterranean area and Italy. During the first half of the month, mild subtropical air masses reached central and eastern Europe.

The Middle East and the South Caucasus region, temporarily also eastern and south-eastern Europe, continued to be mostly under the influence of high pressure and warm air.

Western Greenland was affected by a prevailing southerly flow of mild air from the North Atlantic and the Greenland high was stronger than usual.

Temperature

It was mild in western Greenland, with anomalies > +4°C; the central North Atlantic was also warmer than normal (Fig. 11.1). In southern Greenland, the 90th percentile was exceeded.

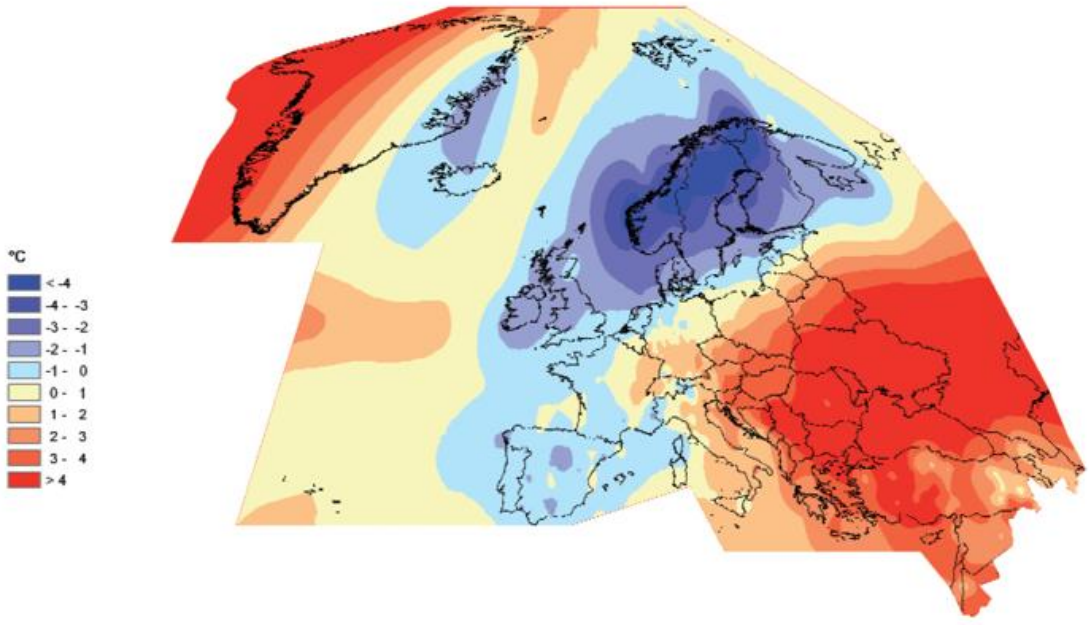

Fig. 11.1: *Monthly mean temperature anomalies in November 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

Northern and large parts of western Europe were colder than normal, including the Arctic Sea. Especially the northern half of Scandinavia was very cold, with anomalies below -5°C, in Norway locally below -7°C. Temperatures were below the 10th percentile in nearly the whole of Norway (except the coasts) and most of Sweden (except the north-east). There was already ice on the Arctic Sea north of 78N. Norway had its coldest November since 1919, the United Kingdom since 1993.

Central Europe was mostly warmer than normal, in southern and eastern parts even between +1 and +4°C; only north-western Germany, the Netherlands and Luxembourg were slightly colder than normal.

The month started very mild in western and central Europe. During the first ten-day period of November 2010, it was unusually warm in several western and central European countries. On 4 November, high daily maximum temperatures of up to 19°C were recorded locally in the United Kingdom and widespread in Germany (except in the north of the country); later, on 14 November, 20°C were exceeded in Dresden in eastern Germany, which set a new local record for that time of year. Poland's maximum temperature reached up to more than 21°C, and Austria reported up to 23.7°C, both on 5 November; locally, these were new November records. The northern plains of Switzerland had up to 18°C, some valleys up to 21°C in the middle of the month due to foehn.

The cooling came particularly towards the end of the month in northern, western and central Europe. The Scandinavian countries reported very low temperatures that time, with a lowest minimum in Norway of -35°C at Karasjok-Markannjarga on 27 November. At many Norwegian stations, the records of the monthly mean temperatures and the absolute minimum temperatures were broken in the days 26–30 November. Similarly extreme low minimum temperatures were reported from Sweden with -36.6°C in Nikkaluokta in Lapland on 24 November or -34.4°C in Kvikkjokk-Arenjarka on 25 November (which was the lowest value since measurements started in 1888). Storlien-Visjövalen had -24°C on 28 November and thus its lowest temperature in November since 1962. Finland, too, experienced the coldest November days ever recorded. In Mariehamn on the Åland islands, the temperature was as low as -20°C.

The night of 27 to 28 November also brought extremely low temperatures to the UK; many November low temperature records were broken. In Wales, -18°C was recorded, in Scotland 15°C. Low temperatures were also measured in western France, with -10.1°C on 29 November at Mauron (Morbihan) or -15.3°C at Orleans (Loiret). Some stations in Germany, too, recorded very low temperatures at the end of November, locally less than -15°C on 30 November in south-east Germany. The Swiss station La Brévine registered -31.4°C on 30 November (a new record in 45 years); Poland recorded -14°C on 28 November.

Even Spain reported lowest minimum temperatures of -9.6°C on 29 November at Soria and -7.2°C at Leon-Virgen del Camino. These values were the lowest measured since 1942 and 1938, respectively. Portugal also reported lowest temperatures between -5 and -7°C on 29 November. The whole month was slightly colder than normal in almost whole Iberia and the western Mediterranean.

Most of eastern and south-eastern Europe, including south-eastern parts of central Europe (Slovakia, Hungary), Italy, the eastern Mediterranean as well as the Middle East and the South Caucasus region and the south-eastern Baltic countries were considerably warmer than normal. The 90th percentile was exceeded in almost all these areas. Lithuania had daily maxima up to 15°C in many places, breaking all previous records for November.

Anomalies were widespread above +4°C in south-eastern parts of the Region; they were highest in the eastern Ukraine, southern Russia and west Kazakhstan (Fig. 11.2) as well as in eastern Montenegro and parts of Israel, with more than +6°C; locally in Belarus, the Ukraine, Moldova, Serbia (Fig. 11.3), Bulgaria and at high elevations in Armenia, they were more than +5°C.

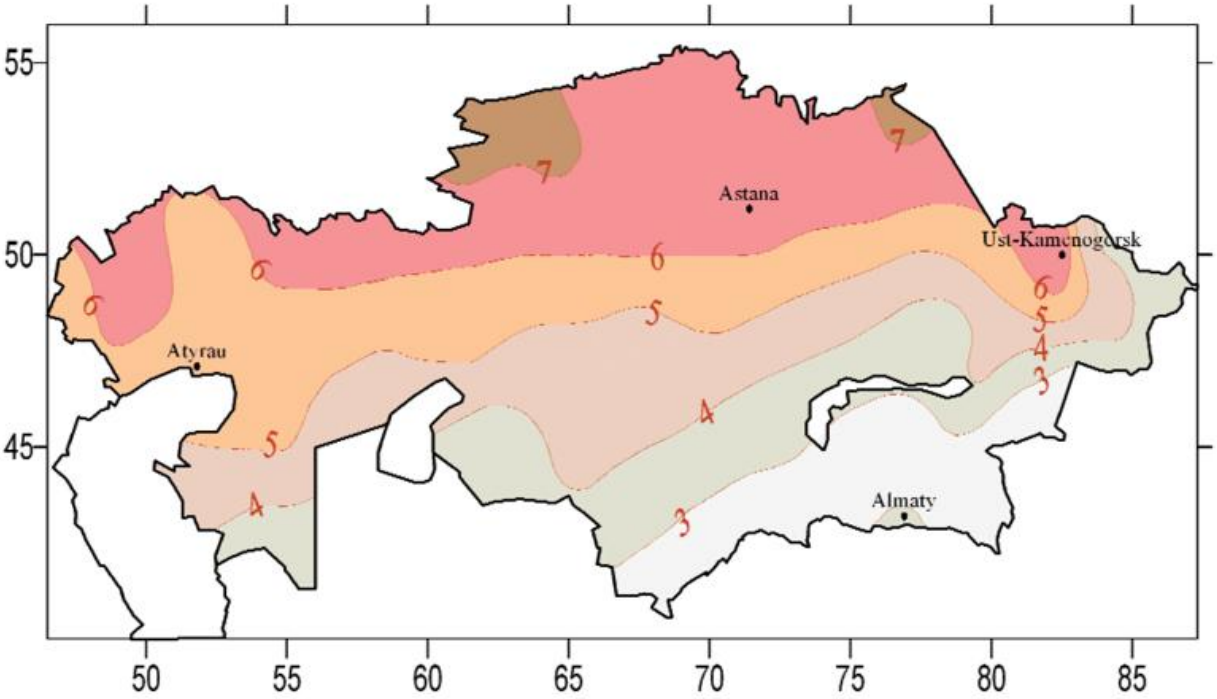

Fig. 11.2: *Monthly mean temperature anomalies in November 2010 (reference period 1971–2000) in Kazakhstan*
Source: Kazhydromet, Kazakhstan

The warm November in south-eastern Europe was characterised by several heat waves, which resulted in the high November averages. On 9 and 10 November already, warm air masses from Africa led to exceptionally high temperatures in that area. In Bosnia and Herzegovina, November was warmer than October, as had last been the case in 1963. It was the warmest November in 50 years in eastern, south-eastern and central Serbia, although no new records of maximum temperature were set. Instead, the duration of the heat was long; a 15-day heat wave took place in Serbia during the first two ten-day periods of the month. New maximum temperature records for November were set at 19 stations in southern and south-western Romania as well as at many stations in Bulgaria (highest maximum 28.9°C).

The first ten-day period was also particularly warm over most of European Russia and November temperature records were exceeded in many of its cities. In Moscow, 14.4°C was reached on 10 November, breaking an old record of 1927 (12.6°C) for that day of the year. Sochi, which is located at the Russian Black Sea coast, attained 22.1°C on 29 November, 1°C above the previous local record for that day of the year in 1990. During the first half of November, temperatures in European Russia were around +10°C above average. The extreme temperatures meant that badgers and hedgehogs could not go into hibernation and some species of hares and red squirrel did not receive their warmer winter coats. This can negatively affect the animals when regular temperatures return.

In the South Caucasus, daily maxima in west Georgia and Azerbaijan still reached up to 27°C. It was the warmest November since 1966 in Armenia.

In the Middle East, it was the warmest November on record in the mountain region of Israel, and up to 37°C were reached in the coastal plain and the Negev.

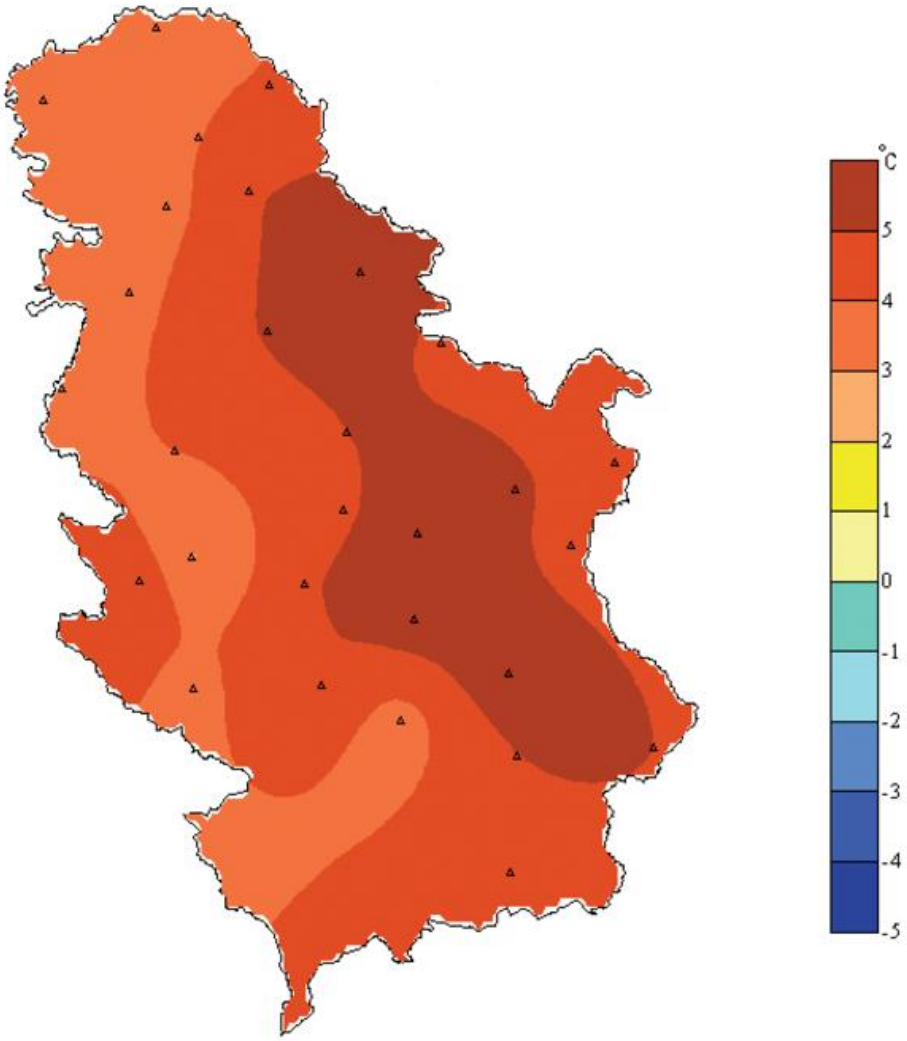

Fig. 11.3: *Monthly mean temperature anomalies in November 2010 (reference period 1961–1990) in Serbia*
Source: Republic Hydrometeorological Service of Serbia

Precipitation

It was mostly very dry in the Arctic region, in northern and central Scandinavia and on the Kola Peninsula (Fig. 11.4). Monthly precipitation totals were below the 10th percentile in nearly all these areas and locally less than 20% of the normal, in Greenland even below 10%. For south-eastern Norway, November 2010 was the second driest in the series going back to 1900.

In most of western, central and eastern Europe, including a large area around the southern Baltic Sea, precipitation was above normal. South-eastern Sweden was affected by heavy rain with some flooding. The United Kingdom was not so wet on average (close to normal in most areas), but heavy rain occurred in the first half of November. Several flooding events affected south-west England, northern France and Belgium. Locally, Germany and Poland, received more than 300% of the normal and high totals of 100–200 mm fell in many places in western parts of Europe. The 90th percentile was reached especially in eastern Germany, Poland, south-eastern Belarus and parts of western Russia.

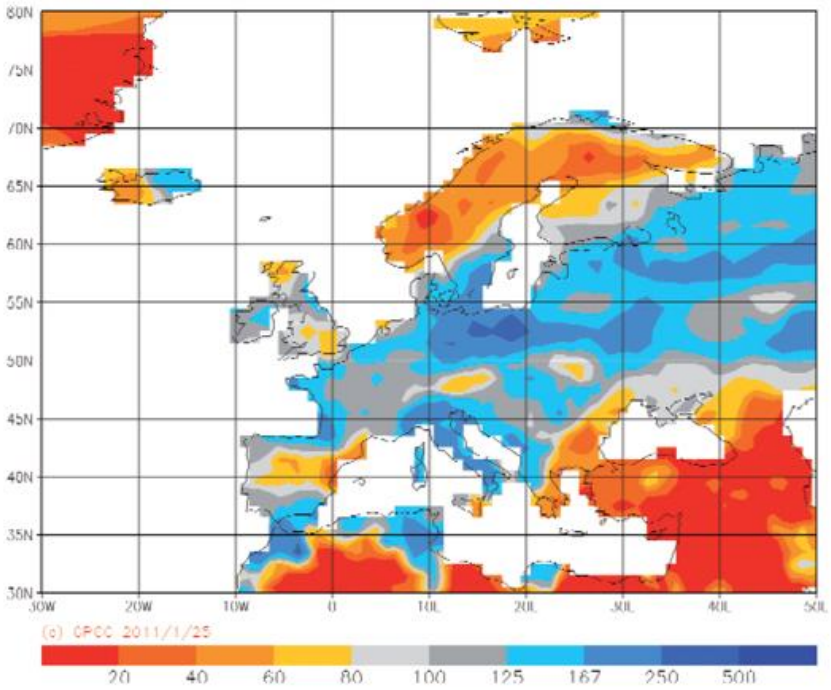

Fig.11.4: *Monthly precipitation amounts for November 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Southern Spain, the central Mediterranean, most of Italy and most of the Balkan Peninsula (except the east) were wet, with more than 125% of the normal totals. Three new monthly precipitation records were set in Italy, one of them at a station close to Piacenza, which had its highest monthly total of the time series starting in 1921, another one in Napoli with a monthly record total of 415 mm. More than 200% of the normal fell in places in Slovenia and Bosnia and Herzegovina, and almost as much in Montenegro. Especially in the second half of the month, heavy precipitation occurred in Montenegro and Bosnia and Herzegovina, in the former case within a series of 14 rainy days. 12 municipalities in Montenegro (out of 21) were continuously flooded, water levels in the lakes and rivers rose rapidly and more than 1,600 people had to leave their homes.

It was very dry near the Black Sea, over large parts of Greece (except the Epirus region in the north-west, which was very wet due to heavy rain especially at the end of the month), in the Caucasus region (north and south), Turkey, Cyprus, the Middle East, Malta and parts of north-eastern Spain, mostly with less than 20% of the normal precipitation. The totals were below the 10th percentile in the Caucasus region, Turkey and the Middle East. Many of these areas had only a few mm of precipitation or set new low precipitation records for November. Barcelona received only 6 mm of precipitation (8% of the 1961–90 normal). None of the stations in eastern Georgia received more than 5 mm; partly, there was no precipitation at all, like in places in Azerbaijan, Armenia, Turkey and Cyprus. It was the driest November in Cyprus since 1901 and the driest on record in Armenia, where not even a trace of rain was reported during the whole month, although November–December normally is the second rainy period there beside April–May. Several places in the Middle East (Syria, Lebanon, Israel, Jordan) were also completely rainless, which was not normal for that season. It was one of the three driest November months in Israel in the last 70 years; only 1946 and 1966 were also rainless at such a large scale.

Snow

In nearly all parts of Scandinavia and northern Russia, there was a snow cover during almost the whole month.

Snowfall was unusually heavy in northern Iceland during the middle of the month, whereas the south and west of the country only had light snowfall. A snow depth of 85 cm was reported at the station Kråkemåla in southern Sweden, setting a new November record for this area. Early heavy snowfall also affected large areas of northern and western Estonia due to the lake effect. Several Estonian stations measured new November snow depth records.

Since most of the month was very mild, snow came late in the month to most of the medium and lower regions of north-western, western, central and eastern Europe and was widespread in the last week of November. In central Europe, snow started to fall on low sites on 22 November. The United Kingdom saw its most significant and widespread late-November snowfalls (more than 40 cm) since 1965, particularly in eastern Scotland and north-east England, and its earliest widespread snowfall since 1993. At the end of the month, many countries were mostly snow-covered. In Germany, mountains of about 1,000 m altitude had 30–60 cm of snow, and even locations in the northern lowlands received up to 40 cm, the international airports Berlin, Munich and Leipzig between 1 cm and 16 cm. There were 200 flight cancellations at Frankfurt airport, Europe's third busiest international airport.

In the Alps, there was some snowfall already early in the month. Switzerland reported snowfall with up to 30 cm above 1,500 m altitude. Later, snowfall also occurred in lower areas and it snowed down to 600 m altitude locally on the southern side on the Alps. Austria, reported snowfall in lower places, too, e.g. in Bregenz (8 cm), Eisenstadt (10 cm) and Klagenfurt (20 cm). Kredarica Mountain in Slovenia had 275 cm on 30 November, setting new snow depth record for November since the beginning of measurements at that station. In the high mountains of Slovenia, snow persisted the whole month; at the end of the month, it also arrived in the lowlands, except the regions near to the coast.

Romania had a thin snow layer in some areas during the last ten days of the month; the depth exceeded 35 cm in some mountain areas.

In Montenegro, a long period of rain combined with higher-than-normal temperatures led to a rapid snowmelt in the mountainous regions.

In the south, there was some snow on higher and lower mountains, even in Iberia. Portugal reported snow at the stations Villa Real, Viseu, Braganca and Penha Duradas.

Significant weather events

November 01–02: Flooding in Veneto (Italy) after cyclogenesis over northern Italy and intense precipitation, locally exceeding 300–350 mm in three days. An area of about 140 km² was flooded; more than 6,500 people were isolated or displaced. The motorway between Verona and Vicenza was closed for a few days.

November 04: Heavy rain in the northern half of Germany, locally more than 70 mm in 48 hours, with flooding of streets in Hamburg. Strong wind gusts at the coasts and on mountains (141 km/h on the Brocken Mountain in Germany).

November 08–11: Heavy rain led to a flood situation in the Italian province of Salerno. 300 people had to be evacuated. Greece also had a heavy storm in Kerkira and north Peloponnese, with precipitation and flooding at daily totals up to 127 mm on 09 November. Heavy rain in Montenegro caused the water level in Morača (Podgorica) to rise by 10 m in just 48 hours.

November 08–12: Two deep areas of low pressure affected the United Kingdom and Ireland, the first bringing the lowest November mean sea level pressure to Heathrow Airport since its records began in 1949. Rain from the first system caused flooding in Emsworth in Hampshire. Homes were also flooded on the Isle of Wight, roads were closed and two schools were forced to shut. The second system brought a lot of damage and disruption due to the wind. Gale-force winds and torrential rain caused damage, with power lines brought down and bridges closed. The worst hit areas were northern England, north Wales and Northern Ireland, with gusts of around 130 km/h. Some 6,000 people in Northern Ireland were left without power. All ferry sailings across the Irish Sea were cancelled for a time. There was some localised flooding in Scotland.

November 11–14: A depression north of Ireland ("Carmen") brought intense rain and strong wind to large parts of northern France. In Granville (France), 48 mm of rain fell in 24 hours. The United Kingdom and Ireland also reported high wind speeds of > 100 km/h in gusts, with a maximum wind gust above 165 km/h at Capel Curig (Conwy, UK). The same low Carmen caused heavy rain in large parts of central Europe, due to a very stable zonal cold front. 2 people drowned in a flood in the Beaumont region (Belgium). In central and western Belgium, rivers and creeks flooded cellars and streets in many locations. Rail traffic was also affected. The station Uccle had 40 mm of precipitation on 13 November and accumulated 100 mm from 09 to 13 November, causing inundations especially in the centre of the country. In two days, Belgium received as much rainfall as it normally gets in a month. The Netherlands reported between 30 and 80 mm between 12 and 14 November, for Suid-Limburg 90–100 mm. The rain caused flooded streets and land-slides. Germany received heavy rain as well, with 48-hour values between 50 and more than 90 mm in a band between the Eifel and the Elbe east of the Harz Mountains. Highways near Dortmund and the fish market in Hamburg-Altona were flooded.

November 15–16: Ben Gurion International Airport in Israel had to be closed for several hours during the night due to visibility limitations. Seven consecutive nights with heavy mist and fog occurred in the coastal plain, which is uncommon for that area and time of year.

November 16–17: Heavy rainfall in the southern United Kingdom (Cornwall and parts of Wales) caused flooding and landslides. In Cornwall, streets and the mainline railway were closed and flash flooding affected over 100 houses. Heligan (Cornwall) received over 40 mm of rain in 2 hours. Ireland also reported localised flooding. Although damage was widespread, no fatalities or injuries were reported.

November 16: Germany received rain over a wide frontal band (depressions Ditte in the southern Baltic Sea and Emilya in the Mediterranean Sea), peaking to about 35 mm in 24 hours in Thuringia and northern Bavaria. The higher mountains had snow.

November 23: Thunderstorm with isolated hail at some locations in Romania (Calarasi, Medgidia, Videle).

November 27: Hail was registered in 19 out of 27 administrative regions of Bulgaria.

November 27–28: Southern Spain and the Baleares received heavy rain (e.g. Murcia 191 mm, Menorca 88 mm in 24 hours) due to a deep trough extending far south.

November 27–30: A lot of flights were cancelled due to snowfall in western and central Europe. 1,700 car accidents were counted in the German region of Northrhine-Westfalia. Many streets were closed throughout the country. Wind partly caused additional problems. The relatively warm southern Baltic Sea fed additional moisture into the air and caused even more snowfall in the eastern Holstein area (northern Germany), causing public traffic to break down and schools to be closed. In south-eastern Austria (Burgenland) and Hungary, the snowload was so heavy that trees and power lines broke and many thousands of households were without electricity.

November 29–30: Heavy storms in Bulgaria in the regions Morungash, Cherni and Botev, with gusts up to 122 km/h.

December

- **Very cold over most of Europe, warmer than normal in Greenland and the south-east of the Region**
- **Dry in northern and north-western Europe and in the South Caucasus region, wet in south-western, central and eastern Europe**
- **Long duration of snow cover in central Europe**

Atmospheric circulation characteristics

Similar to the previous winter 2009/10, December 2010 also saw extremely high negative North Atlantic Oscillation and Arctic Oscillation indices. High pressure was dominating over Greenland and Iceland, low pressure in the Azores region, which is the reverse of normal conditions. As a result, there was no westerly flow, but cold air from the Arctic spread out over nearly the whole European continent. A quasi-stationary front over central Europe persisted for several days, separating cold air from the north and milder air in the south. Especially in middle latitudes and in southern Europe, there was much low pressure activity, initiating frequent precipitation which came often as snow due to the low temperatures, temporarily in the southern half of central Europe also as rain.

Only some parts of south-eastern Europe, the Middle East and the South Caucasus region were mostly affected by warm and dry air from the south.

Temperature

It was warmer than normal in the Arctic, particularly in Greenland as well as in Svalbard, the very north of Norway, Iceland and large parts of the North Atlantic (Fig. 12.1). Anomalies in western Greenland exceeded +7°C and the 90th percentile.

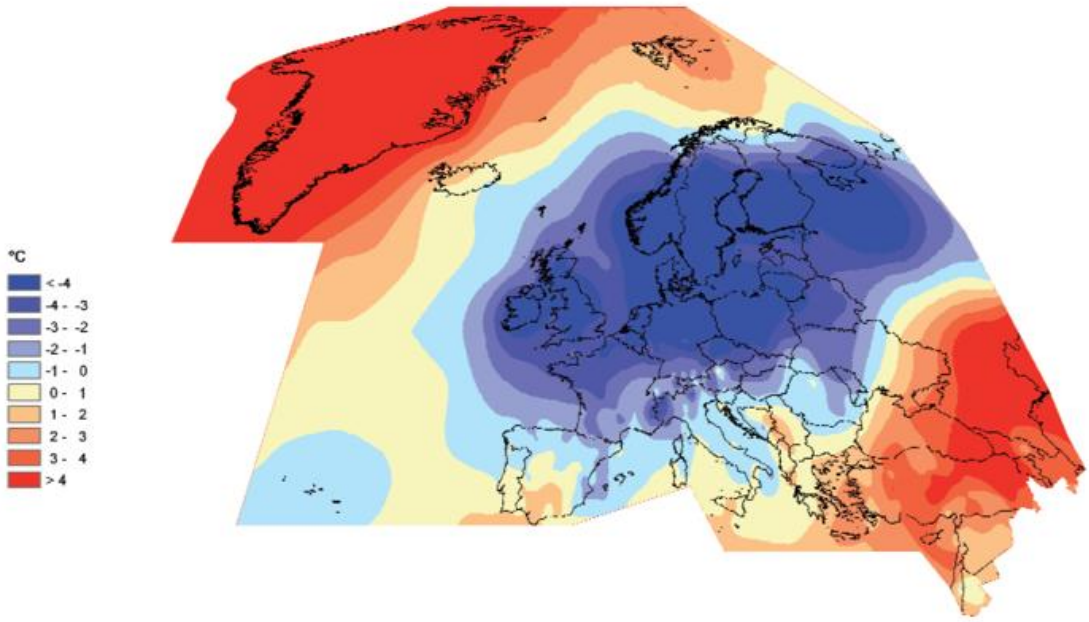

Fig. 12.1: *Monthly mean temperature anomalies in December 2010 (reference period 1961–1990) in WMO Region VI*
Source: Deutscher Wetterdienst, Germany

Most of Europe, including adjacent ocean areas, experienced a very cold December, particularly during the first three weeks, except some parts of the south and south-east. Temperatures were below the 10th percentile over a large area covering the southern parts of northern Europe, the whole of north-western, western and central Europe and the northern parts of eastern Europe. In large parts of northern and central Europe, the anomalies were below -5°C, in many places even below -6°C. Highest negative monthly anomalies were as much as -10°C below normal at some locations in Norway and Sweden. High mountains in Switzerland (Jungfraujoch, Säntis) were around -3°C colder than normal.

Many places in Scandinavia had their coldest December on record. Some stations in southern Sweden also experienced the lowest minimum temperature, e.g. the station Linköping/Mamslätt reported -27.6°C on 23 December and a monthly mean of -8.2°C. The lowest temperature in Sweden in 2010 was -42.1°C at the station Nikkaluokta on 20 December. The harsh winter weather caused widespread problems for railway and road traffic, just like in January and February 2010. At -23.0°C on 22 December, the station Holbaek recorded the lowest temperature in Denmark since 1987. For Denmark as a whole, it was the second coldest December on record (only slightly behind 1981).

It was the coldest December in the United Kingdom in the last 100 years; the central England temperature record displayed its coldest December since 1890. In large parts of western and central Europe (Netherlands, Belgium, France, Germany), it was the coldest December in more than 40 years, in south-eastern parts of central Europe only since 1996 (e.g. in Vienna, Austria).

Minimum temperatures were also very low in western and central Europe and some local records were broken. Temperature minima in the United Kingdom dropped well below -15 °C in several locations between 18 and 25 December and remained below freezing during the day. On 23 December, Castlederg (County Tyrone) recorded -18.7°C, which was the lowest temperature ever recorded in Northern Ireland.

The lowest temperature in the whole of the Netherlands was -16.9°C on 20 December. Daily minima down to -18°C were recorded in north-eastern France. Daily minima below -20°C were measured in Germany and Poland, causing deaths due to freezing. The Czech Republic reported on 5 December that 68 of 151 stations recorded the lowest minimum temperatures for many years. In the higher Alps (altitude 3440m in Austria), minima were below -30°C; similarly low temperatures had last been measured there in 1981.

The number of frost days (minimum temperature <0°C) was also outstandingly high in western and central Europe. It was the highest number for December in the United Kingdom for over 50 years. Southern parts of northern Europe and northern parts of central Europe had frost almost the whole month (e.g. Luxembourg, Germany, Denmark, Poland, Lithuania), which was far above the normal of e.g. 17 days in Luxembourg or 15 days in Denmark.

In the south, even the Azores islands were colder than normal as a consequence of colder-than-normal sea surface temperatures due to an ongoing strong La Niña. Furthermore, northern Spain, the western Mediterranean, most of Italy and the northern Balkan Peninsula were colder due to several cold spells reaching the south throughout the month. Anomalies in northern Italy were below -2°C in places. A daily minimum of -48.3°C was recorded at Pale di San Martino on 27 December, the lowest temperature ever recorded in Italy. Like in Croatia, it was only slightly colder than normal on average in Slovenia because of two mild spells during the month.

In contrast, the south-east of the Region and the southern Mediterranean saw once more a mild month. It was warmer than normal in southern parts of the Balkan Peninsula, Turkey, the Black Sea, the eastern Ukraine, southern European Russia, west Kazakhstan, the South Caucasus region, Cyprus and the Middle East. The monthly mean temperatures were higher than the 90th percentile in nearly all of that area, partly even higher than the 98th percentile.

High temperature maxima were measured in southern Italy and on the Balkan Peninsula, locally with new records, e.g. in southern Italy and at Mostar in Bosnia and Herzegovina, the latter with 19.4°C on 9 December (previous record in 1971). Maxima up to 23°C were reached in Bulgaria. Especially the first half of the month was mild in Greece. In the second half, some extremely cold days were also recorded in south-eastern Europe. Zabljak in Montenegro had a daily maximum of -10.7°C on 14 December, the lowest daily maximum for that day of the year in 50 years. Similarly, Western Macedonia, too, had cold temperatures even below -12°C; even Greece experienced a considerable cooling later in the month.

In contrast, high monthly anomalies were observed in southern European Russia (> +7°C in individual regions) and in west Kazakhstan, Azerbaijan, Armenia and central Turkey, all up to +5°C or +6°C. Daily maximum temperatures near the Black Sea coast in European Russia and west Georgia reached up to 25°C (at the Russian station Wladikawkas in the North Caucasus even 27.1°C on 6 December, a new winter maximum temperature record for Russia), and roses bloomed in the north Ossetia valleys in the North Caucasus. On 26 December, Stavropol (also in the near area of the North Caucasus) still reached 17.1°C, exceeding the previous temperature record of 1954 by +6°C.

The eastern parts of the South Caucasus region also registered a new 100-year record of 22.7°C in Baku (Azerbaijan) on 12 December (previous record was in 1906). Similarly, Armenia recorded 20–24°C in the lowlands of its very southern and north-eastern parts.

Israel was especially warm on the first days of the month, with temperatures reaching up to 31°C in the coastal plain, the Negev and the Jordan Rift.

Precipitation

Nearly the whole of the Arctic region (except western Greenland), northern European Russia, Scandinavia, the United Kingdom and Ireland were far drier than normal (Fig. 12.2). The monthly totals were mostly smaller than the 10th percentile. Locally, they were less than 20% of the normal.

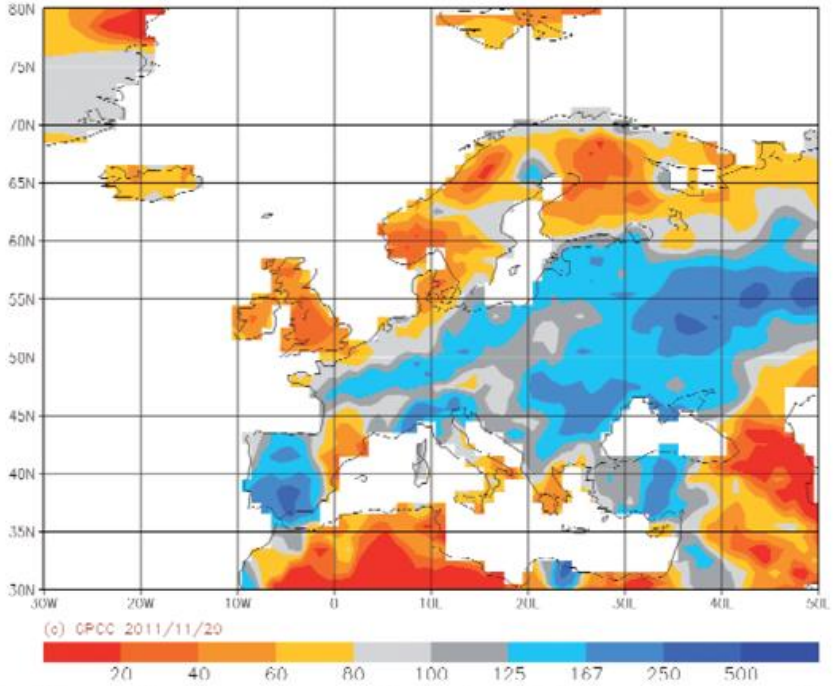

Fig.12.2: *Monthly precipitation amounts for December 2010 in per cent of the 1951–2000 normal in Europe and adjacent areas*
Source: Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst, Germany

Less than a third of the average rainfall was recorded over large parts of the United Kingdom. It was the driest December over the UK since 1963 and the third-driest in the 100-year series.

Large parts of western, central and eastern Europe were mostly wetter than normal. Strasbourg in eastern France had more than 300% of its normal precipitation due to a quasi-stationary cold front. The 90th percentile was exceeded only in some areas of central and eastern European Russia (around 400% of the normal in Kasan), the Ukraine and Romania. Latvia saw its wettest December for 87 years. Monthly precipitation totals in Lithuania amounted up to 95–120 mm in the western border regions, which was 150–200% of the normal. There was a huge flooding on the rivers of Transcarpathia, causing damage to settlements and infrastructure; historically high water levels were reached.

Some areas in the southern parts of the Region were wetter as normal, such as the Azores Islands, most of Iberia, northern Italy, most of the Balkan Peninsula except the south and most of the western half of Turkey due to some heavy rain events. Monthly precipitation in Iberia was among the highest in Europe and thus consistent with the tendency for above-normal precipitation in this region during negative NAO periods. On the Azores Islands as well as locally on the Balkan Peninsula (e.g. in Bosnia and Herzegovina), monthly totals were close to 400% of the normal or more; in southern Spain, they were higher than 300%, exceeding the 90th percentile. The wet weather also led to flooding of the north Hungarian rivers. In Serbia, the number of precipitation days was high, whereas the monthly totals remained within their normal range in most parts of the country.

On the other hand, many parts of the Mediterranean region (eastern Spain, central and southern Italy, Malta, Greece and Cyprus) were dry, partly with totals of less than 60% of the normal, although heavy downpour occurred and caused floods in the Greek regions Epirus and Crete.

A large area in the south-east of the Region (western Kazakhstan, southern European Russia, South Caucasus region, eastern Turkey and eastern Syria) was very dry, locally with less than 20% of the normal. The totals were below the 10th percentile particularly in western Kazakhstan and the South Caucasus region. It was the driest December on record (since 1966) in Armenia; only 2 mm of precipitation were registered in Yerevan, less than 10% of the normal. Other places of the Middle East (in the Lebanon, northern Israel, Jordan) were wetter than normal.

Snow

Heavy snowfalls disrupted traffic severely in many parts of Europe. Large areas of northern and central Europe, including the Alps, were covered by snow almost the whole month, partly reaching depths of more than 40 cm in the lowlands of central Europe, which is quite rare. Snow depths were even higher than at the beginning of the year. Roads, railways and air traffic were severely affected. Airports were forced to close in the Netherlands, Belgium, France, Germany and Switzerland. Many schools were closed, too.

Snowfalls occurred in almost all areas of the United Kingdom, especially in the first week, reaching depths of over 40 cm in parts of north-east England and eastern Scotland; 30 to 40 cm fell locally in parts of central Scotland in the morning of 6th. There was further widespread snow across the UK from mid-month to Christmas. The snowfalls were comparable to those experienced in January 2010, and were the most widespread and significant in December since 1981.

The Netherlands had just two days which were completely free of snow. Uccle in Belgium had 21 snow days that month, the highest number ever recorded since 1901. In France, particularly over Ile-de-France, such conditions of frequent snowfall and very low temperatures had not been observed for the last 30 years. It snowed for 14 days in Paris-Montsouris, leading to a total depth of 12 cm, the highest depth at this station since 1980; other French stations reached similar records.

Large areas of central Europe saw a white Christmas, which is unusual in the lowlands. Germany had its first white Christmas in most of the area since 1981. On 25 December, even the area near the Rhine River reached snow depths above 25 cm, which is quite extraordinary for that region. Around Berlin, the maximum snow depths of December 2010 were partly the highest December depths ever measured in more than 100 years. For the first time ever, Denmark saw a second nationwide white Christmas in a row (after 2009).

The Alpine region received a lot of snow, too. At 31 cm, a December snow depth record was broken in Geneva (Switzerland), forcing the airport to close for hours. Bern and Zürich also got new local snow depth records for December (57 and 58 cm, respectively). Before, such depths of fresh snow had been measured only in 1962 and 1979. Another snowstorm hit the plains of Switzerland on 17 December, bringing a widespread layer of 10 cm or more. On Christmas Day, the lowlands of northern Switzerland from Geneva to Lake Constance were covered in white and that remained until the end of the year. Snow also lay over the whole country of Austria already from the beginning of the month, reaching extraordinary depths also at lower stations. In Vienna, a maximum snow depth of 28 cm was measured, which happens approximately every 20 years and had not occurred for the last 29 years. Likewise, about 30 cm of snow fell in the Czech capital Prague on 2 December. On Kredarica Mountain in Slovenia, a maximum depth of 400 cm was recorded on 25 December, which was the highest depth ever measured there in December. Snow was also to be found in the lowlands of Slovenia for a period of 2–4 days; 35 cm were registered in Ljubljana.

In north-eastern parts of Europe, there were also unusually large amounts of snow in coastal areas in southern Finland. In the Helsinki area, the recorded snow depth of 67 cm was close to the deepest ever recorded. Estonia reported record-breaking snow depths from 20 out of 31 stations, with depths of 37–60 cm on 10 December. These values were the highest since December 1965 or earlier. The monthly average snow cover in Latvia was four times the normal, and it was the second snowiest December there for 87 years. At Christmas, however, a warmer spell with freezing rain occurred, causing an ice layer covering almost the whole country. Trees falling on power lines due to icing caused prolonged power failures. In Lithuania, a record-breaking mean depth of 39–56 cm was reached at the end of the month. Poland had a snow cover on all days of the month at most of the stations, with maximum snow heights of typically about 20–40 cm.

Even in the south of the Region, there was some snow, at least temporarily. Portugal had some snowfall in the highest areas of its northern and central parts. Italy saw depths of 10–30 cm. The Italian Isle of Capri experienced its first snow in 25 years on 3 December. On the Balkan Peninsula, a sudden heavy snowfall occurred across Bosnia-Herzegovina after a cold front passage in early December. From 17–19 December, it snowed in the whole of Montenegro. Further temporary snowfalls occurred in Macedonia and northern Greece; the station Larissa in eastern Greece received 30 cm of fresh snow on 16 December. Turkey had a widespread snow cover on two days. By the end of the month, a thin snow cover of 22 cm had formed on the slopes of the Aragats Mountain in Armenia at altitudes higher than 3000 m. In west Kazakhstan, heavy snowfall combined with temporary strong cooling occurred at the beginning of the month. Some non-accumulating snow was measured even locally in Jordan.

Significant weather events

December 02–05: In Israel, a large forest fire in the Carmel Mountains near Haifa broke out after a very dry 9-month period. It caused the death of at least 44 people. Continuous dry weather and strong winds prompted it to become one of the biggest wildfire in Israeli history and made it difficult to extinguish the fire. Over 41 people died in a bus caught in the flames. Around 17,000 people had to leave their homes and almost 5,000 hectares of land were burned.

December 02–05: A powerful Mediterranean cyclone first brought strong southern winds and then abundant rain to the west and the north of Bulgaria. The rivers coming downhill from the steep mountain of Vitosha into the capital city of Sofia flooded the freshly built ring highway. In the aftermath of the heavy rain, a part of the main road that links Sofia to Greece came to collapse, practically cutting the south-west of Bulgaria off from Sofia for as long as one week (Fig. 12.3).

Flooding and mudslides were also reported from northern Albania; more than 12,000 people had to leave their homes and 14,000 hectares of farmland were destroyed. Locally, the River Drina rose to its highest level in more than a century. Streets in the town of Shkodra were inundated by six and a half feet (two meters) of water. The only ways into or out of town were by boat or helicopter. Extremely heavy precipitation was also registered in eastern and southern parts of Bosnia and Herzegovina on 2 December; it was the wettest period on record there since beginning of measurements (Fig. 12.4). In northern Bosnia, the heavy rains triggered a landslide in the city of Tuzla, three people were killed. In southern Croatia, the River Neretva reached its highest level in 50 years, flooding 700 homes in the town of Metkovic.



Fig. 12.3: *Bridge over the river of Dzherman (south-west Bulgaria) destroyed during passage of a powerful cyclone on 02–05 December 2010*
Source: bTV, provided by the National Institute of Meteorology and Hydrology, Bulgaria



Fig. 12.4: *Flooding in Gorazde (Bosnia and Herzegovina) after extremely heavy precipitation on 02 December 2010*
Source: Gorazde.tvsa.ba, provided by the Federal Hydrometeorological Institute, Bosnia and Herzegovina

December 03: High tides in Venice (Italy) reached 1.36 m above sea level, flooding more than half of the lagoon city, including the central St Mark's Square. The water level marked a record high for Venice. The tide was pushed up by a combination of heavy rains and strong winds that hit large parts of northern Italy.

December 04: Overflowing of the lake of Ioannina city (western Greece) due to successive rainfall events starting already in November.

December 05–08: Heavy precipitation affected extended areas in western Iberia, especially central and north Andalusia. 4-day totals ranged between 160 and 334 mm, and daily totals of 100 mm or more fell on 07–08 December in Andalucia (regions of Cordoba and Seville). The Guadalquivir River caused severe flooding near Seville, where dozens of homes had to be evacuated and at least 2 people died. A tornado developed in Portugal near Serta and devastated an industrial area (even a hall made of metal). The tornado was classified category EF3 on the extended Fujita scale.

December 06–13: 113 settlements in the Ulyanovsk region (central European Russia) were cut off from electricity because of glaze ice layers of 18–50 mm, causing state of emergency.

December 07–09: Snowstorm Monika and its very active slow moving front caused abundant precipitation in large parts of central Europe. The front separated cold air masses in the north with frequent snowfall and warmer air masses in the south with rain. On 09 December, freezing rain caused the temporary closure of Frankfurt Airport (Germany). Storm Monika also contributed to a considerable increase in snow depth in Estonia (e.g. 38 cm in 24 hours in Väike-Maarja). Road and rail transport was seriously affected. The snow load caused much damage to roofs, trees and power lines.

December 09: During a strong cold front at the station Kab-hegy in Hungary, a record wind gust of 170 km/h was measured.

December 10: Severe rain and flooding forced hundreds to leave their homes in the western Ukraine. The worst affected region was Zakarpattia.

December 11–13: Strong northern winds with gusts over 100 km/h over various islands in the Aegean Sea within an extratropical cyclone. Heavy rain and floods affected particularly Greece, western Turkey, later also the Lebanon and Israel, especially the coasts and harbours. On the Greek island of Samos, coastal roads were closed due to fallen rocks. Along the coast of Lebanon, waves up to 10 m high were observed. Stormy wind and high sea motion caused a transport ship to sink near the coast of Israel and heavy damage to areas close to the sea shore. Five people lost their lives. In Israel, the winds also knocked out power to hundreds of people and downed trees. In Jordan, highways were closed as winds reached speeds above 90 km/h and sand limited visibility severely. On a positive note, the storm ended a lengthy drought in Lebanon, Syria, and Israel.

December 15: Sorvaag (Faeroe Islands) had winds up to 135 km/h with 150 km/h gusts (on nearby hill) within snow squalls on passage of a powerful cold front. The temperature fell from 9°C to -5°C with a wind chill below -15°C. Conditions were less extreme on Shetland and Orkney, yet still harsh with freezing gales and bursts of snow.

December 15–18: Abundant snowfall in Italy after an intense cold spell (temperatures between -12 and -15°C in the region of Friul) and due to a frontal system with strong warm advection in the middle troposphere moving from north-western to south-eastern Italy. Florence had 10 cm of snow and even the coasts saw some snow which lasted just for one or two hours on 17 December. Greece and Macedonia also had very low temperatures (below -12°C in western Macedonia) and snowfall. A station on Crete (Greece) reported 41 mm of daily precipitation on 16 December.

December 18: Heathrow Airport in London was closed in the run-up to Christmas due to heavy snowfall.

December 23–24: Ship traffic in the harbour of Hamburg (Germany) was affected by ice. Parts of the islands Fehmarn and Rügen in the German Baltic Sea were cut off from the outside world. Just before Christmas, snow and freezing rain affected air and road traffic considerably in northern and eastern Germany.

December 25–26: Freezing rain in central European Russia. Operation of Moscow airports was brought to a standstill owing to ice. Hundreds of settlements were cut off from electricity.

December 30: Heavy storm in Botev region (Bulgaria) with gusts of 100 km/h.

ECSN Activities Report 2010

Support and co-operation in best climate practices

Responsible Member: KNMI; Programme Manager: Aryan van Engelen

The objective of ECSN, the European Climate Support Network, an optional Programme of EIG EUMETNET, is to support its members in their climate practices in order to provide better products and services to the European user community for the benefit of the environment, safety, economy and health.

In 2010, this objective was realised by a range of activities: running new programmes and projects (ECA&D, ECSM/RCC-CM, EUMETGRID, PEP725, Climate Change Services and HIST-EU), focusing on a better understanding of Europe's past, present and future climate and the provision of data and products, participating in or collaborating with major EU research projects: ENSEMBLES, MILLENNIUM and EURO4M, communicating and co-operating with other parties, such as WMO, WMO-RAVI, EEA, ESA, EUMETSAT, EUMETNET-EUCOS, EUMETNET-SRNWP, and co-ordinating activities: preparing and organizing the climatology programme of the EMS-ECAC 2010 and the ECSN Data Management Workshop 2011.

EIG EUMETNET

As of 1 January 2010, all (EUMETNET) activities (including ECSN) were transferred to the new EIG EUMETNET, which now has the legal status enabling it to sign contracts with third parties, bid for EU projects and employ staff. The three strategic goals over the next (10) years are: to improve efficiency by means of programme activities and changing to shared services, to invest collectively in science, technology and skills and to be an essential partner for EU/EC whenever capabilities and services from the meteorological community are required. It has been recognized that there is a need for more extensive European climate (change) services than are currently offered by EUMETNET. A new working group on Climate Change Services (co-ordinated by KNMI) was established to survey the European needs and the role to be played by EUMETNET and its Members, taking account of the Members' capabilities which include the Regional Climate Centres. The ECSN programme was extended by another year until 1 January 2012 and the PM ECSN was appointed as Interim Programme Manager Climate.

EUMETGRID (Met.no, http://eumetgrid.eu)

The main objective of EUMETGRID is to provide seamless access to the best available high-resolution gridded data sets in Europe and their related products and services. To achieve this goal, a main task is to develop and maintain a sustainable pan-European data infrastructure for accessing and distributing gridded climate information, based on the NMHS's sustainable observational networks, databases and meteorological infrastructures.

Highlights:

- EUMETGRID started with a kick-off meeting in Oslo on 25-26 January 2010.
- 24 European countries participate in EUMETGRID.
- EUMETGRID wiki has been established.

ECSM/RCC-CM (DWD, http://www.dwd.de/rcc-cm)

The aim of ECSM (European Climate System Monitoring) was to build a sustained operational Web platform for climate monitoring products in WMO RA VI. These efforts complement successful regional climate monitoring activities, such as the RA VI Bulletin, the European contribution to the annual BAMS Article on the State of the Climate, European contributions to the annual WMO Statement on the Status of the Global Climate, ECA&D, etc. All these activities are basic components of a systems approach for co-ordinated operational climate monitoring in WMO RA VI. Based on the analysis of a questionnaire on RA VI operational climate monitoring requirements (Gocheva, Hechler, Dec. 2007), the systems approach aims at implementing a RA VI RCC (Regional Climate Centre) node for climate monitoring.

Highlights

- 24 countries contribute to ECSM/RCC-CM.
- ECSM has been integrated into the technical platform of the RCC on Climate Monitoring (RCC-CM), which is currently in its official pilot phase.

ECA&D-ENSEMBLES/MILLENNIUM/EURO4M (KNMI, http://eca.knmi.nl)

The European Climate Assessment and Dataset (ECA&D) is aimed at creating and maintaining a pan-European set of high-quality daily observational data series and, on the basis of derived climate change indices, at producing assessments of climate change in Europe. ECA&D is based on a data set (E-OBS), which currently includes approx. 4,800 stations and over 26,000 time series. It was originally developed as part of the ENSEMBLES and MILLENNIUM projects (EU-FP6) and is now maintained and elaborated as part of the EURO4M project (EU-FP7). Like ECSM, it will serve as a platform for a RA VI Regional Climate Centre on Climate Data (RCC-CD).

Highlight

- ECA&D will be the technical platform of the RCC on Climate Data, currently in the official pilot phase.

PEP725 (ZAMG, www.zamg.ac.at/cost725)

Phenology is the study of the timing of recurring biological events in the animal and plant world, such as leaf unfolding and flowering of plants in spring, fruit ripening, colour changing and leaf fall in autumn, as well as the arrival and departure of migrating birds and the timing of animal mating. During the past decade, phenology has rapidly become an important tool for climate change impact studies.

Under Cost Action 725, a prototype database of European phenological records was set up. An ECSN project under the name PEP725 aims at the establishment and sustainable management of a full-scale phenological database.

Highlights

- Work plan and work packages have been defined.
- Kick-off in Dublin on 17 June 2010

Roadmap for embedding observation requirements from climatology in EUCOS

The roadmap aims to define a EUCOS Surface Climate Land Station Network (ESCLSN) as the climate counterpart of the EUCOS Synoptic Surface Land Station Network (ESSLSN). Key considerations of the roadmap are:

- The observational network should provide data sets that serve climate impact assessment and adaptation to climate variability and change.
- The network should become part of the EUCOS concept.
- The network should cover the whole of RA VI.
- The network should include terrestrial in-situ surface observations.
- The network sites should be available for electronic access (E-VCOMP).
- The design should be based on expert selection of stations from existing networks (WMO-SYNOP, EUCOS, RBSN, RBCN, GSN, ECA&D) and fulfil the demands of the major (European) climate services and projects, such as GMES, RCC, CCS, ECA&D, EUMETGRID, EuCLIS, SRNWP etc.
- Selection should be made according to the site and instrument criteria arising from the mentioned services, WMO and WMO-GCOS.
- Highest priority should be given to climatological reference stations.

HIST-EU (ZAMG)

The Responsible Member of the successfully completed HRT-GAR project (ZAMG) launched this initiative in order to extend the current HIST-ALP project (aiming at the creation of a database of long-term monthly homogenised series over the Greater Alpine Region) to the whole of Europe, with the following two main objectives:

- To extend HIST-ALP to HIST-EU with a climatological network described as long-term, of appropriate density, quality-improved, homogenised and of European relevance.
- To support data rescue activities to achieve an optimal European station density.

Highlights

- A questionnaire on potential user requirements was distributed and obtained a very positive response.
- Proposal elaborated.

10th EMS Annual Meeting and 8th European Conference on Applied Climatology (ECAC), Zürich, ETH, 13-17 September 2010

The theme of the conference was: “High-resolution climatology – towards climate change services”.

The session programme dealt with the following four major topics, which had been agreed with WMO GFCS:

- Monitoring for a reference climate and monitoring change
- Understanding processes and climate change
- Services translating science to users
- Plenary sessions on communication and adaptation strategies for climate change

The conference attracted a large number of experts (630) from 44 countries and high-quality contributions. Especially the Climate Services session and the Plenary sessions on Communication on Climate appeared to be very attractive.

ECSN Data Management Workshop (DMWS) 2011, Edinburgh, UKMO, October 2011

UK Met Office offered to host the DMWS 2011 in Edinburgh from 12-14 October 2011.

The Ozone Layer over Central Europe in 2010

Wolfgang Steinbrecht, Hans Claude, and Ulf Köhler - Deutscher Wetterdienst

2010: Highest ozone columns in 25 years

The annual mean ozone column for 2010 substantially exceeded the long-term mean since 1968 for the first time again after many years. At nearly 340 DU, the annual mean for 2010 reached the same high level as recorded in the 1980s, as shown by Dobson and Brewer measurement series at Hohenpeissenberg station in southern Germany (Fig. 13.1). The last time Hohenpeissenberg recorded similarly high annual means was in 1984, i.e. 26 years ago. Practically all monthly means of 2010 are above the long-term median (50th percentile), partly even above the 67th percentile.

Satellite data from Bremen University in Germany and from KNMI in the Netherlands showed that this distinctly positive development was not only observed at Hohenpeissenberg, but also for almost the whole northern hemisphere.

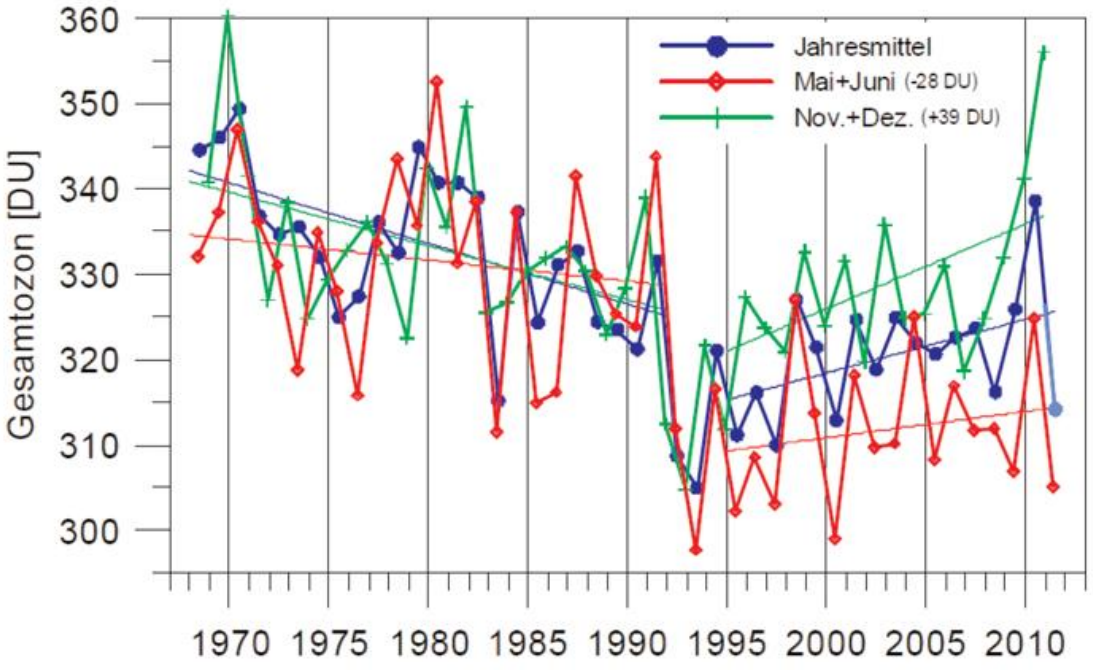

Fig. 13.1: *Ozone columns above Hohenpeissenberg. Blue: Annual mean ozone levels. Red: Mean ozone for May and June, shifted downwards by 28 DU. Green: Mean ozone for December and January, shifted downwards by 39 DU. The annual mean for 2011 is only an estimate (data for November and December of 2011 not yet available). Source: Deutscher Wetterdienst, Germany*

On average, the ozone columns in 2010 remained below normal only between 0°N to 20°N, from central America across the Atlantic to northern Africa, over wide areas of the tropics, and also in some parts of the southern hemisphere. In general, the spatial distribution of the 2010 ozone anomalies suggests increased transport of ozone from the tropics towards northern latitudes due to an increased Brewer Dobson circulation (in particular during the first half of the year). The importance of the quasi-biennial oscillation (QBO) of stratospheric winds over the equator should not be underestimated: easterly wind shear (between 50 and 20 hPa) in the tropics, if persisting from the end of the previous year into late spring, causes the Brewer-Dobson circulation to increase in strength.

As a result, more ozone than normal is transported northwards (e.g. in 2010, 1998, 1994). If there is a westerly wind shear, however, less ozone will be transported polewards (e.g. in 2008, 2002, 1997). The difference between the easterly and westerly phase of the QBO can reach up to 20 DU (see the years 2010 and 2008 in Fig. 13.1). In Europe, ozone columns also correlate highly with the North Atlantic oscillation (NAO) index, which roughly describes the distribution of high and low pressure areas over the North Atlantic. Positive index values are accompanied by low ozone levels above central Europe, and vice versa. In 2010, the values of the NAO index were as negative as in the 1960s. This coincided with frequent trough situations and low pressure activity over central Europe down to the Mediterranean and with high ozone columns. On the contrary, the local ozone minimum in western Russia probably resulted from the stationary, high-altitude anticyclone residing there in the summer (record summer with continuous heat-wave and forest fires).

What about the effects of chemistry? Ozone-depleting chlorine and bromine in the stratosphere have been decreasing for around 10 years now. Model computations show that from the chemical viewpoint no such large ozone increase can be expected from one year to the next. The chemical ozone increase induced by declining chlorine would only result in ozone columns that are about 4 DU higher than those of the mid-1990s, and almost equal to those of 2008 and 2010. Even though we do not yet know, or fully understand, all the factors that are responsible for the high ozone columns in 2010, it is a pleasure to finally be able to report again about 'good ozone columns', such as those during the 1980s – although the levels decreased again in 2011. The beginning chemical recovery of the ozone layer certainly has its share in this increase, despite the fact that globally – but not in Europe – the year 2010 was one of the warmest in terms of surface temperature.

Ash cloud from Eyjafjallajökull volcano affects ozone over Bavaria, Germany

The volcanic eruption of Iceland's Eyjafjallajökull ('island mountain') glacier in April 2010 is not the first volcanic event in the last two years to become clearly visible in the measurements taken at DWD's Hohenpeissenberg Meteorological Observatory. Already in August 2008, and again from the beginning of July 2009, the lidar at Hohenpeissenberg had recorded plumes of ash from the volcanic eruptions of Kasatochi (Aleutian Islands) and Sarychev (Kuril Islands). Unlike Eyjafjallajökull, these two volcanoes ejected their ash clouds high into the lower stratosphere (up to approx. 20 km). From there, stratospheric winds rapidly dispersed the aerosol clouds across the northern hemisphere, carrying them as far as central Europe despite the large distance. In comparison with the much more violent eruption of Mount Pinatubo on the Philippines, however, their impact on climate and ozone layer is negligible.

However, with a maximum height of only 10 km, the ash plume from Eyjafjallajökull did not reach the stratosphere. But due to Iceland's geographic location, it did enter the mid-latitude west wind drift and was rapidly carried to central Europe. During the first days of this extraordinary event, there were no means to directly and quantitatively measure the concentration of dust in the air. Instead, indirect methods were used to determine at least height and extent of the cloud.

Ozone being a highly reactive gas (which oxidises and decomposes very readily on almost all surfaces), it should be possible to detect volcanic ash by the effect it would have on the vertical distribution of ozone. This is why, extra ozone sondes were launched in addition to the DWD's regular ozone measurement programme. One of these supplementary sondes launched on 17 April 2010 must have flown through the ash cloud between about 3,000 m and 6,500 m. In fact, the ozone concentrations recorded showed a dramatic decrease, down to nearly 0 ppmV, before rapidly increasing again.

Conclusion: tropospheric ozone concentrations over Hohenpeissenberg were severely reduced due to increased surface reactions within the volcanic ash cloud. This means that it is possible to make qualitative statements about the presence of volcanic ash clouds and their dispersion. Other measurements have shown, however, that the impact of sulphur dioxide or other air pollutants on the ozone measurements should be small (see DWD Ozone Bulletin No. 126 (2010) for more details: www.dwd.de/ozonbulletin).

List of Sources

This bulletin is an extended version of the publication

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The following other sources have been used:

- Monthly Bulletins on the climate in WMO Region VI, provided by Deutscher Wetterdienst (DWD) (www.dwd.de/rcc-cm) on the basis of online information from National Meteorological and Hydrological Services (NMHSs) in WMO Region VI.
- Annual climate summaries, provided by NMHSs by e-mail, fax or post mail.
- WMO statement on the status of the global climate in 2010. WMO-No. 1074.
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- Various other sources for figures as indicated in the captions.
- Special sea ice information sources as indicated in the text.
- Guest contributions from the European Climate Support Network of EUMETNET and the DWD's Hohenpeissenberg Meteorological Observatory (Germany).

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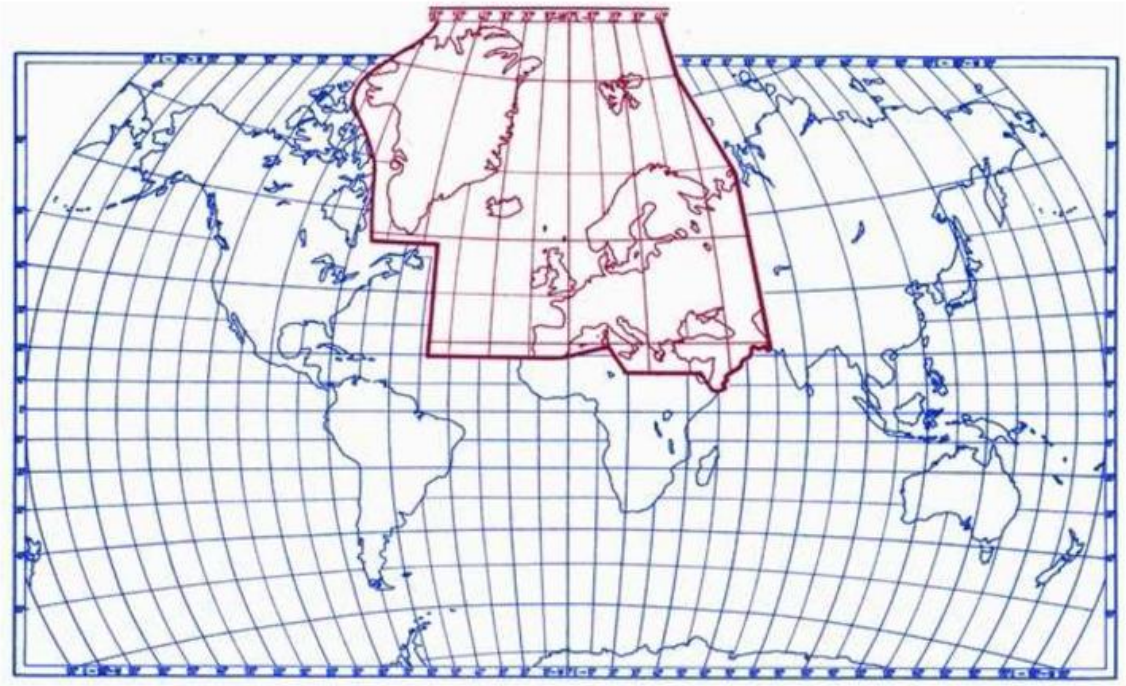
WMO RA VI RCC-Network Node on Climate Monitoring

Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2011



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Outline

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI NMHSs as well as general climate monitoring information from their official Websites. Supported by the European Climate Support Network and WMO's World Climate Data and Monitoring Programme the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's ***Annual Statement on the Status of the Global Climate*** and the Special Supplement to the Bulletin of the American Meteorological Society (BAMS) ***State of the Climate***. The evolution of the RA VI Regional Climate Centre Network (RCC-Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ amongst the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the Webpages of the RA VI RCC-Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

Notes:

- (1) This version of the Bulletin is an interim version, which will be further developed in the years to come. It has a new design and will be provided in .pdf format only. The aim is to optimise the content of the Annual Bulletin to achieve a high consistency of European climate monitoring information across publications, such as the recently introduced Monthly Bulletin on the Climate in WMO Region VI (cf. www.dwd.de/rcc-cm) and others. Furthermore, we are optimising the workflow to accelerate the Annual Bulletins production, saving time and money. The life blood of the Bulletin, however, will always be the national contributions from ideally all RA VI Members. Accordingly, we will continue inviting RA VI Members for national contributions.
- (2) Maps of the RA VI RCC-Network are based on the following data sources:
  - - Temperature: CLIMAT data and ship observations provided by the Global Collection Centre (GCC), run by Deutscher Wetterdienst
  - - Precipitation: Global Precipitation Climatology Centre (GPCC), run by Deutscher Wetterdienst
  - - Sunshine: CLIMAT data.

  Subregional monthly maps are provided by the Eastern Mediterranean Climate Centre (EMCC) and the Southeast European Drought Management Centre (DMCSEE)

The following subregions are used in the Bulletin:

Central and western Europe: *Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, Netherlands, Poland, Slovakia, Switzerland, United Kingdom*
Nordic and Baltic Countries: *Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden*
Iberia: *Portugal, Spain*
Mediterranian, Italian and Balkan Peninsula: *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, Serbia, Slovenia, Republic of Macedonia, Montenegro, Turkey* ***Eastern Europe:*** *Belarus, European Russia, Moldova, Romania, Ukraine*
Middle East: *Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, western Kasakhstan*

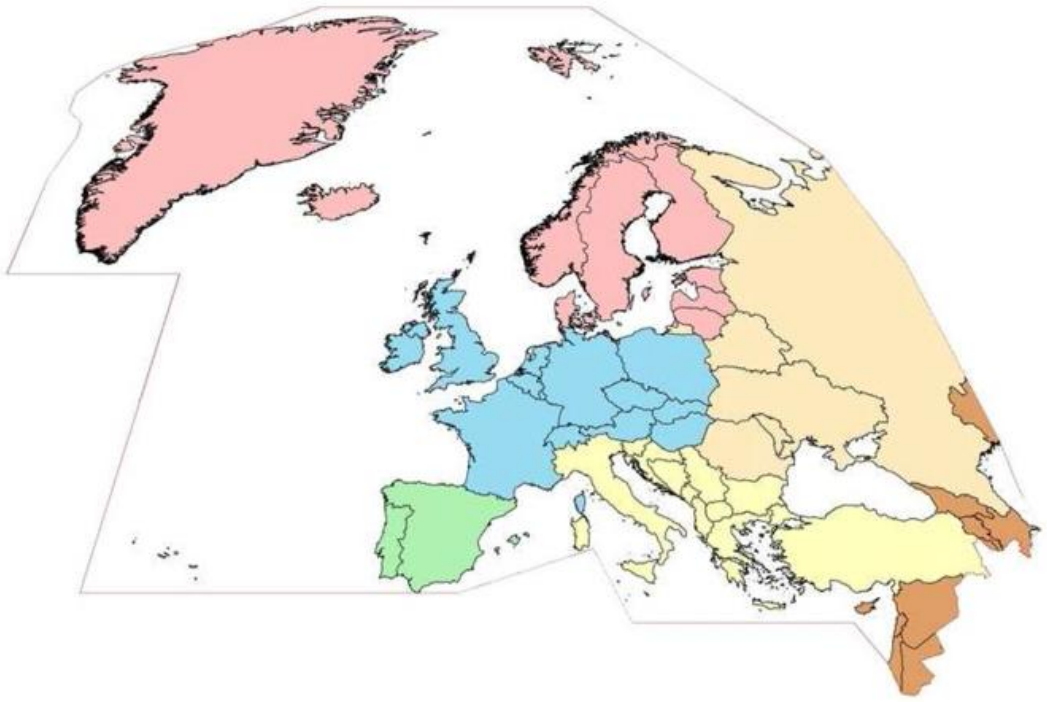

Fig. 1.1: *Definition of the 6 subregions within WMO RA VI*

References:

Note: *Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2011 edition of the Bulletin are listed on page 3 above. Many contributions or also additional information may as well be found on the web, see below.*

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Outstanding Events and Anomalies

Temperature

- The warmest year on record since more than 100 years in Norway(together with 1990 and 2006), Belgium, France, Switzerland and the higher mountains of Germany, Austria, Slovenia.
- Warmest winter on record at 5 stations on Greenland
- Warmest spring since 1659 in Central England (together with 1893), 2nd mildest since 1706 in The Netherlands, since 1910 in UK, since at least 1900 in France and since 1961 in Spain.
- Warmest summer since 1866 in Estonia (together with 2010) and since the early part of the 19th century in Helsinki, Finland. But coldest summer in places since 25 to 74 years in Ireland.
- Warmest autumn since 1900 in Norway and as well in places in Ireland (Dublin since 150 years) and the 2nd warmest at least since 1900 in France.

Precipitation

- The wettest year on record in Norway (since 1900, start of registrations) and locally in northern and southern Sweden. The wettest year since 1890 for Torshavn on the Faroer Islands.
- Highest number of snowdays in Uccle, Belgium.
- Driest spring in France since at least 1959. Driest spring in at least a century in The Netherlands and partly driest spring since 1910 in UK.
- Wettest summer since at least 1906 in The Netherlands

Sunshine Duration

- Sunniest spring in Uccle, Belgium since 1887 and for at least a century in The Netherlands.

Other Anomalies

- Largest ice extent in the Baltic Sea since 1987
- 2 major drought phases: in spring in western and central Europe and in autumn mainly on the Balkan

Events

- Unusually wide-ranging dust transport from Africa to Scandinavia in April
- Extraordinarily extreme precipitation on 2 July in Denmark (in Kopenhagen more than 100 mm/day at all stations) and southern Sweden
- Extremely heavy rainfall on 25/26 October with intensities resp. totals of 153 mm within 1 hour, 328 mm within 3 hours, 472 mm within 6 hours, 511 mm within 12 hours, 539 mm within 24 hours, 542 mm within 30 hours for Brugnato in the Ligurian province La Spezia, Italy.
- Storm ROLF on 3 to 8 November in western Mediterranian Sea area had tropical character and brought daily totals up to 200 mm, 2-day totals between 300 and 500 mm and locally 9-day totals up to 800 mm in southeastern France as well as extremely intense precipitation on 4 November in Geneva (Liguria) with intensities per 3 resp. per 6 hours with return periods between 200 and 500 years.
- 2 storms in December: JOACHIM on 15-16 December with gusts of 20 m/s or more on more than a quarter of the area of France and DAGMAR on 26 December with vast damage in southern Scandinavia.

Annual Survey

Atmospheric Circulation

1.1 El Niño/La Niña

The year 2011 started with a strong La Niña which ended in late spring (Fig. 2.1). During La Niña the tendency in late winter is for a positive North Atlantic Oscillation (NAO) pressure pattern, with mild and wet conditions in northern Europe and the UK and cold and dry conditions in southern Europe. Also very typical for La Niña is a strong extended Azores high. In fact, it was already in January 2011, when high pressure conditions developed over western and southern central Europe. This went on in February and in spring, when high pressure extended far to the north and east. As a result, much of Europe, especially western and central parts, saw an outstandingly warm and dry spring.

Another similarly strong La Niña developed at the end of the year. Again, the Azores high became strong in December 2011 and extended to the north and east. As a result, Iberia and the western Mediterranean saw a very dry December in contrast to many other parts of Europe.

Further information: UK MetOffice: La Nina 2011 NOAA NCEP CPC: ENSO regressions

1.2 Arctic Oscillation (AO) and North Atlantic Oscillation (NAO)

From January to May 2011, the NAO shows strong fluctuations between the positive and negative phase, and to a lesser extent also the AO. This was due to temporary relocations of the Icelandic low to the west or southwest, particularly in January, and to a lesser extent also in March. The positive phase was prevailing during that period, triggered by La Niña. On the other hand, high pressure conditions extended from the Azores high far into the European continent. The result was a strong warm airflow to the Arctic region, and also western and central Europe saw a mild late winter and a warm spring. NAO was strongest in February, but due to a blocking high over eastern Europe, it was mild in the west, but cold and dry in the east that month. Middle latitudes were mostly dry especially in spring, whereas most of the precipitation occurred in the north, but also in southern Europe due to some cyclonic activity in the Mediterranean.

In the summer months (June to August), both AO and NAO indices were negative. The Icelandic low was either missing or very weak or relocated eastwards, whereas high pressure over Greenland became stronger and extended, leading to further Arctic warming and dry weather there, whereas northern and temporarily also central Europe often had cyclonic conditions. Eastern Europe and the Mediterranean, in contrast, had prevailing high pressure and saw a warm and dry summer.

For the rest of the year (September to December), AO and NAO switched again to a positive mode. There was a zonal circulation over the North Atlantic, but similarly like in spring, high pressure conditions developed over the European continent and the frontal zone was over northern Europe. This development culminated to an extensive high over Europe, leading to an extremely dry November, and warm air flow in western Europe and cold air in the southeast. In December in contrast, this pattern was replaced by a zonal westerly flow with mild and wet weather over northern and middle latitudes, whereas the Mediterranean area became very dry.

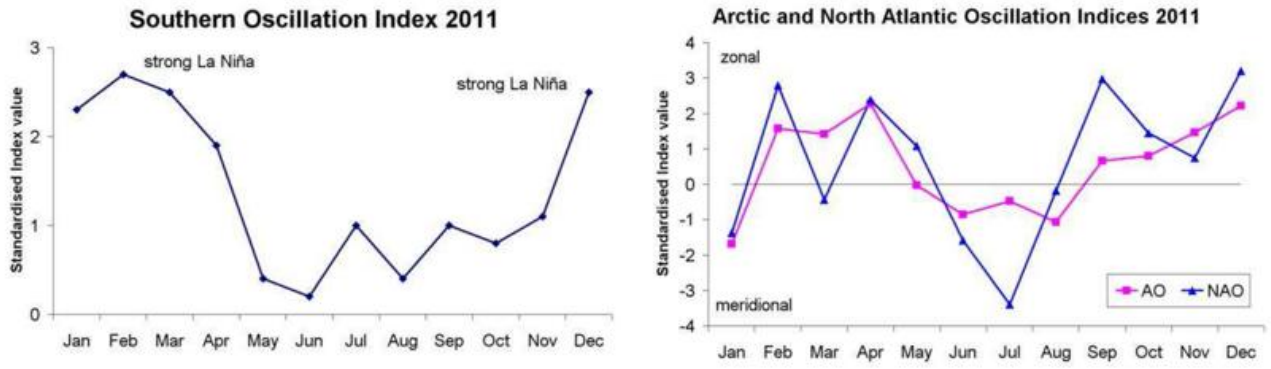


Fig. 2.1:
Left graph:
Southern Oscillation Index for 2011, as expressed by the difference of standardised sea level pressure anomalies in Tahiti and Darwin (Australia)
Source: NOAA, http://www.cpc.ncep.noaa.gov/data/indices/soi
data taken on 16 March 2012
Right graph:
Standardised Arctic Oscillation (AO) Index and North Atlantic Oscillation (NAO) Index for 2011, as expressed by the difference of standardised sea level pressure anomalies between southern and northern latitudes over the whole northern hemisphere (AO) and the North Atlantic (NAO). For more details to the definitions of the indices, see sources below
Source: NOAA(AO)
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/ao.shtml
and Climate Research Unit, University of East Anglia, United Kingdom (NAO),
http://www.cru.uea.ac.uk/~timo/datapages/naoi.htm

Temperature, Precipitation and Sunshine Duration

Annual Maps

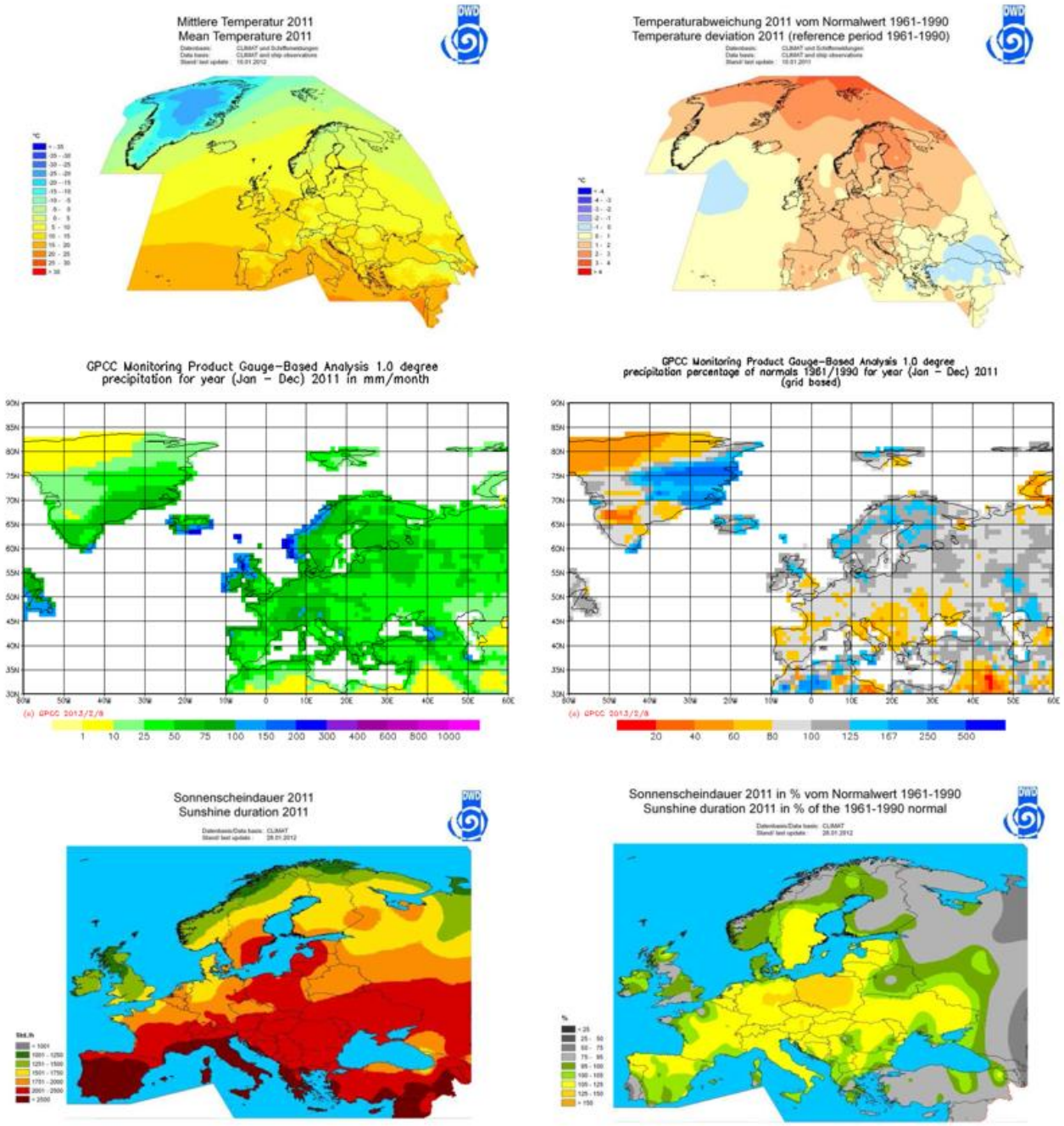


Fig. 2.2: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in 2011*

Monthly and Annual Tables

Temperature and precipitation values and departures from their 1961-1990 means (CLIMAT Data)

WMO No.	Station	January 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.	February 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	-15.2	0.2	10	-4	-12.7	3.0	19	0
01025	Tromso	-3.5	0.5	82	1	-4.0	-0.3	51	-35
01492	Oslo	-3.5	0.8	47	-2	-4.9	-0.9	53	17
02196	Haparanda	-10.6	1.5	55	11	-15.9	-4.6	22	-10
02485	Stockholm	-1.9	0.9	33	-6	-4.2	-1.2	38	11
02836	Sodankyla	-13.4	1.7	26	-5	-19.0	-5.4	16	-9
02974	Helsinki	-5.4	1.5	55	14	-11.3	-4.5	29	-2
03091	Aberdeen	3.3	0.6	43	-38	4.8	1.9	94	43
03772	London	5.3	1.1	77	25	7.6	3.1	43	8
03967	Dublin Casement Aerodrome	3.6	-0.8	34	-32	7.0	2.6	76	25
04030	Reykjavik	1.6	2.1	62	-14	2.1	1.7	108	36
04360	Ammasslik	-6.0	1.5	89	-23	-4.1	3.6	102	11
06186	Copenhagen	0.4	-0.1	28	-23	0.2	-0.3	22	-9
06260	De Bilt	3.5	1.3	87	21	4.6	2.1	63	14
06447	Brussels	4.0	1.4	91	24	5.4	1.9	44	-9
06590	Luxembourg	1.9	1.9	67	-4	2.7	1.6	32	-30
06660	Zurich	1.2	1.7	47	-20	2.7	1.8	22	-48
06700	Geneva	2.5	1.7	45	-35	3.1	0.8	16	-65
07510	Bordeaux	5.8	0.0	27	-73	7.9	0.8	62	-24
07650	Marseilles	6.6	-0.1	19	-28	8.3	0.4	21	-33
08222	Madrid	6.4	0.3	41	-5	8.4	0.9	30	-14
08314	Mahon/Menorca	10.5	0.0	78	12	10.8	0.1	86	29
08495	Gibraltar	14.2	0.8	107	-14	14.3	0.5	46	-54
08515	Santa Maria/Azores	14.6	0.2	102	2	14.9	0.9	49	-37
08535	Lisbon	11.2	-0.2	103	-7	12.7	0.4	167	56
10384	Berlin-Tempelhof	1.9	2.1	34	-9	0.1	-0.7	25	-9
11035	Vienna	1.1	2.1	32	-6	0.7	-0.3	10	-32
11518	Prague	-0.9	1.5	23	0	-1.5	-0.7	5	-18
11903	Sliac	-3.3	0.6	21	-23	-1.5	-0.4	11	-33
12160	Elblag	-0.9	1.5	43	-4	-4.5	-2.3	37	12
12375	Warsaw	-0.5	2.8	39	17	-3.8	-1.8	21	0
12843	Budapest	-0.1	1.5	16	-16	0.1	-1.0	4	-28
13274	Belgrade	1.5	1.1	48	-1	0.9	-1.8	56	12
14015	Ljubljana	1.5	2.6	50	-32	1.5	0.1	31	-49
14445	Split	8.1	0.7	22	-61	9.3	1.2	19	-49
14654	Sarajevo	0.1	1.0	38	-33	0.6	-0.9	36	-31
15420	Bucharest	-2.4	0.0	48	8	-2.5	-2.4	19	-17
15614	Sofia	-1.4	0.2	13	-14	0.0	-0.5	20	-13
16158	Pisa	6.7	0.6	48	-27	7.2	0.1	88	15
16597	Luqa	12.9	0.7	106	17	11.8	-0.6	90	29
16716	Athens	10.5	0.3	72	28	10.9	0.3	108	65
16754	Heraklion/Crete	13.0	1.0	72	-18	12.9	0.8	131	54
17040	Rize	7.6	1.3	275	52	6.4	-0.2	277	106
17062	Istanbul	6.8	1.2	40	-59	6.4	0.5	14	-53
17170	Van	-1.3	3.1	14	-20	-0.8	3.0	28	-5
17300	Antalya	12.1	2.2	77	-162	12.6	2.3	115	-81
17609	Larnaca	13.1	1.6	111	46	12.9	1.2	28	-29
22113	Murmansk	-11.3	0.4	39	6	-16.6	-5.4	15	-7
26038	Tallinn	-3.5	2.0	51	6	-9.6	-3.9	22	-7
26629	Kaunas	-2.9	2.1	41	4	-7.4	-3.1	38	11
26730	Vilnius	-3.3	2.8	43	2	-7.5	-2.7	36	-2
26850	Minsk	-3.8	3.1	54	14	-8.2	-2.4	30	-4
27612	Moscow	-7.5	1.8	37	-8	-11.0	-3.3	38	1
33345	Kiev	-2.4	3.2	23	-24	-6.1	-1.9	33	-13
33815	Kishinev	-1.6	1.7	31	-9	-3.2	-1.5	18	-20
34300	Kharkiv	-7.0	-0.1	32	-12	-8.9	-3.2	17	-15
34880	Astrakhan	-3.8	1.6	16	3	-6.7	-1.8	21	11
35108	Uralsk	-11.0	1.9	17	-8	-17.0	-4.5	27	9
37789	Yerevan	-0.4	3.1	27	6	0.0	1.0	41	17
40007	Aleppo	7.1	1.4	50	-14	8.3	1.0	30	-22
40080	Damascus	8.0	2.1	19	-10	8.8	0.9	58	34
40180	Tel Aviv	14.7	2.4	116	-33	15.0	2.1	49	-49
40199	Eilat	16.7	1.5	2	-3	18.5	1.6	<1	-5
40265	Mafraq	9.2	2.0	17	-17	9.8	1.1	53	22
60030	LasPalmas/Grand Canary	18.8	1.3	48	31	18.3	0.7	4	-18

WMO No.	Station	March 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.	April 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	-12.7	2.0	44	23	-5.8	5.9	17	5
01025	Tromso	-1.2	1.0	143	79	3.2	2.5	111	51
01492	Oslo	0.6	0.8	25	-21	9.4	4.8	33	-9
02196	Haparanda	-4.9	1.9	25	-10	2.7	3.2	22	-7
02485	Stockholm	1.2	1.1	11	-15	9.2	4.6	10	-20
02836	Sodankyla	-6.0	2.5	26	1	2.6	4.7	31	7
02974	Helsinki	-1.8	1.1	24	-10	6.0	3.1	24	-13
03091	Aberdeen	6.2	1.7	68	10	10.3	4.0	14	-39
03772	London	8.1	1.6	15	-32	14.1	5.2	2	-43
03967	Dublin Casement Aerodrome	6.3	0.3	15	-34	10.9	3.1	30	-17
04030	Reykjavik	0.2	-0.3	102	20	4.1	1.2	139	81
04360	Ammasslik	-9.4	-1.2	135	47	-2.6	1.5	124	51
06186	Copenhagen	3.6	1.0	17	-25	11.1	4.5	16	-26
06260	De Bilt	6.0	1.0	24	-39	13.1	5.1	8	-44
06447	Brussels	7.7	2.2	22	-32	14.1	5.3	26	-31
06590	Luxembourg	7.1	3.1	15	-55	13.3	5.8	25	-36
06660	Zurich	6.6	2.4	21	-48	12.7	4.9	24	-63
06700	Geneva	7.2	2.1	21	-58	13.2	4.4	20	-45
07510	Bordeaux	10.8	2.0	34	-42	16.2	4.9	11	-61
07650	Marseilles	11.0	0.8	58	14	15.8	2.6	5	-43
08222	Madrid	10.0	0.0	50	17	16.7	4.5	58	4
08314	Mahon/Menorca	12.1	0.5	46	-9	15.7	2.4	23	-27
08495	Gibraltar	15.1	0.1	169	94	17.9	1.7	84	24
08515	Santa Maria/Azores	14.3	-0.3	57	-22	15.4	0.2	44	-11
08535	Lisbon	13.7	0.0	89	20	18.7	3.6	136	72
10384	Berlin-Tempelhof	5.5	1.3	16	-21	13.1	4.5	37	-4
11035	Vienna	6.3	1.3	36	-5	13.0	3.1	43	-8
11518	Prague	4.7	1.7	29	1	11.3	3.6	13	-25
11903	Sliac	4.7	1.7	53	11	11.9	3.4	25	-22
12160	Elblag	2.6	0.5	18	-17	9.9	3.1	40	-2
12375	Warsaw	3.3	1.3	8	-20	11.1	3.3	34	2
12843	Budapest	6.6	1.0	22	-7	13.5	2.4	7	-31
13274	Belgrade	7.8	0.6	28	-22	14.1	1.7	14	-45
14015	Ljubljana	7.1	1.7	87	-11	13.5	3.6	38	-71
14445	Split	11.2	0.8	46	-29	17.0	3.1	7	-59
14654	Sarajevo	5.2	0.1	41	-29	10.9	1.5	33	-41
15420	Bucharest	4.5	-0.3	5	-33	10.2	-1.1	36	-10
15614	Sofia	5.0	0.4	29	-9	9.8	-0.1	16	-34
16158	Pisa	9.8	0.3	87	11	14.0	1.5	24	-55
16597	Luqa	13.0	-0.4	55	14	16.4	0.9	29	6
16716	Athens	11.8	-0.8	21	-20	15.5	-0.6	48	23
16754	Heraklion/Crete	13.6	0.2	63	7	15.7	-0.6	60	30
17040	Rize	8.1	0.2	144	-2	9.7	-1.9	162	60
17062	Istanbul	8.2	0.7	46	-16	10.3	-1.7	76	27
17170	Van	2.3	1.4	31	-11	8.6	1.3	133	79
17300	Antalya	14.1	1.4	24	-79	16.6	0.5	135	89
17609	Larnaca	14.5	1.2	38	-11	17.3	-0.1	21	10
22113	Murmansk	-3.5	3.3	17	-3	2.1	4.0	33	12
26038	Tallinn	-1.0	1.2	23	-6	5.3	1.9	10	-26
26629	Kaunas	0.1	0.3	14	-18	9.0	3.0	25	-18
26730	Vilnius	-0.2	0.4	13	-26	8.7	3.0	31	-15
26850	Minsk	-0.3	1.1	7	-35	8.2	2.2	20	-22
27612	Moscow	-2.0	0.2	21	-13	6.4	0.6	44	4
33345	Kiev	1.5	0.8	7	-32	10.2	1.5	23	-26
33815	Kishinev	3.9	1.0	16	-19	10.2	0.0	58	16
34300	Kharkiv	-0.5	-0.2	6	-21	8.5	-0.4	47	11
34880	Astrakhan	1.1	-0.2	14	0	9.5	-1.6	74	56
35108	Uralsk	-6.9	-1.9	52	32	6.1	-1.6	49	30
37789	Yerevan	6.4	0.6	26	-6	11.9	-0.8	89	52
40007	Aleppo	11.8	0.8	17	-28	15.9	0.1	43	7
40080	Damascus	11.7	0.7	12	-5	15.8	0.3	29	18
40180	Tel Aviv	15.8	0.9	108	46	18.9	0.7	40	17
40199	Eilat	20.9	0.9	0	-4	24.5	0.3	5	1
40265	Mafraq	12.1	0.6	14	-15	15.9	0.1	10	0
60030	LasPalmas/Grand Canary	18.3	-0.1	10	0	19.7	1.0	17	11

WMO No.	Station	May 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.	June 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	-1.6	2.1	11	5	4.8	2.6	1	-9
01025	Tromso	6.7	1.8	41	-7	11.1	1.8	29	-24
01492	Oslo	11.3	0.5	84	32	15.9	0.7	142	77
02196	Haparanda	6.8	0.7	47	16	14.9	2.1	68	27
02485	Stockholm	11.9	1.2	34	4	17.4	1.8	55	10
02836	Sodankyla	6.5	1.5	51	16	14.5	2.9	80	24
02974	Helsinki	10.8	0.9	27	-8	17.4	2.5	41	-3
03091	Aberdeen	10.4	1.4	44	-15	12.4	0.3	105	52
03772	London	14.4	1.9	25	-26	15.9	0.2	84	33
03967	Dublin Casement Aerodrome	11.4	0.9	52	-6	12.4	-0.9	65	17
04030	Reykjavik	6.9	0.6	66	22	9.2	0.2	15	-35
04360	Ammasslik	1.2	0.6	31	-26	5.2	1.1	5	-47
06186	Copenhagen	12.7	0.7	58	15	16.8	0.7	53	-1
06260	De Bilt	14.0	1.7	31	-30	16.1	0.9	114	46
06447	Brussels	14.8	1.9	23	-48	16.8	1.1	72	-7
06590	Luxembourg	15.1	3.3	49	-32	16.5	1.6	106	24
06660	Zurich	15.3	3.2	90	-13	16.8	1.6	79	-45
06700	Geneva	16.3	3.3	36	-41	17.8	1.3	65	-24
07510	Bordeaux	18.4	3.8	8	-69	19.0	1.2	21	-35
07650	Marseilles	19.9	2.8	<1	-42	21.4	0.5	97	69
08222	Madrid	19.1	3.1	61	20	22.8	2.1	29	3
08314	Mahon/Menorca	18.9	2.1	11	-26	21.1	0.3	16	2
08495	Gibraltar	20.0	1.5	38	3	22.6	1.5	5	-6
08515	Santa Maria/Azores	16.2	-0.5	17	-13	19.2	0.5	5	-17
08535	Lisbon	20.5	3.1	85	46	21.2	1.0	8	-13
10384	Berlin-Tempelhof	15.6	1.7	18	-38	19.0	1.6	54	-21
11035	Vienna	16.0	1.4	55	-6	19.8	1.9	113	39
11518	Prague	13.8	1.1	33	-44	17.3	1.4	65	-8
11903	Sliac	14.8	1.1	30	-34	18.4	1.8	149	64
12160	Elblag	13.2	0.3	56	15	17.4	2.0	48	-46
12375	Warsaw	14.4	1.0	48	-11	19.0	2.4	49	-23
12843	Budapest	16.8	0.8	64	9	20.6	1.5	82	19
13274	Belgrade	17.5	0.3	67	-4	22.0	1.9	41	-49
14015	Ljubljana	17.0	2.4	98	-24	20.0	2.2	145	-10
14445	Split	20.2	1.8	68	12	25.1	2.9	20	-31
14654	Sarajevo	13.8	-0.3	104	22	18.7	1.8	76	-15
15420	Bucharest	15.8	-0.9	107	37	20.7	0.5	47	-30
15614	Sofia	14.8	0.5	31	-42	19.1	1.4	14	-58
16158	Pisa	18.1	1.8	8	-51	21.7	1.9	47	3
16597	Luqa	18.9	-0.2	11	4	23.4	0.4	4	1
16716	Athens	20.2	-0.4	43	27	25.4	0.3	15	8
16754	Heraklion/Crete	19.6	-0.2	56	40	24.3	0.8	<1	-3
17040	Rize	15.3	-0.5	78	-23	20.7	0.8	259	134
17062	Istanbul	16.7	0.2	25	-6	22.1	1.0	16	-5
17170	Van	12.4	-0.4	63	13	18.7	1.1	30	9
17300	Antalya	20.2	-0.1	70	42	25.4	0.4	25	17
17609	Larnaca	21.2	0.3	5	-2	25.2	0.9	<1	<1
22113	Murmansk	5.7	1.9	45	13	11.3	1.9	25	-28
26038	Tallinn	10.2	0.5	50	13	16.8	2.3	81	28
26629	Kaunas	12.7	0.0	47	-9	18.1	2.1	54	-21
26730	Vilnius	12.9	0.4	79	17	18.3	2.5	40	-37
26850	Minsk	13.6	0.7	81	19	18.8	2.7	69	-14
27612	Moscow	14.6	1.7	25	-33	19.0	2.4	38	-38
33345	Kiev	16.7	1.6	27	-26	21.1	2.9	132	59
33815	Kishinev	16.8	0.7	56	5	20.1	0.7	149	74
34300	Kharkiv	17.8	2.2	28	-19	21.1	2.2	121	63
34880	Astrakhan	18.3	0.0	78	54	24.3	1.4	36	14
35108	Uralsk	16.7	0.6	34	13	19.2	-1.0	63	26
37789	Yerevan	16.3	-1.2	75	32	22.3	0.4	24	3
40007	Aleppo	20.9	-0.3	18	-1	26.4	0.6	0	-2
40080	Damascus	20.5	0.3	8	4	24.9	0.5	0	0
40180	Tel Aviv	22.1	1.0	11	8	24.9	0.9	0	0
40199	Eilat	28.5	0.1	0	-1	31.8	0.1	0	0
40265	Mafraq	19.9	0.1	0	-3	23.0	0.3	0	0
60030	LasPalmas/Grand Canary	21.4	1.5	0	-2	23.8	2.4	0	0

WMO No.	Station	July 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.	August 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	6.9	0.9	14	1	6.9	2.1	8	-17
01025	Tromso	11.3	-0.4	62	-10	12.1	1.2	34	-48
01492	Oslo	18.0	1.6	106	22	16.1	0.9	198	108
02196	Haparanda	17.7	2.2	27	-23	14.0	0.7	30	-33
02485	Stockholm	19.4	2.2	13	-59	17.4	1.2	90	24
02836	Sodankyla	16.5	2.4	87	22	12.5	1.3	34	-29
02974	Helsinki	20.9	4.3	55	-18	16.9	1.9	86	6
03091	Aberdeen	13.4	-0.4	76	16	13.3	-0.3	125	50
03772	London	17.2	-0.6	50	4	17.6	0.2	69	18
03967	Dublin Casement Aerodrome	14.1	-0.8	53	-1	13.6	-1.0	52	-26
04030	Reykjavik	12.2	1.6	45	-7	11.2	0.9	23	-39
04360	Ammasslik	7.4	1.0	33	-16	6.8	0.8	67	6
06186	Copenhagen	17.8	0.6	155	86	17.2	0.2	108	45
06260	De Bilt	15.9	-0.9	179	104	16.9	0.2	96	25
06447	Brussels	16.0	-1.5	56	-19	17.3	0.0	189	126
06590	Luxembourg	15.9	-1.0	54	-14	17.8	1.4	82	10
06660	Zurich	16.5	-1.1	199	82	19.2	2.5	114	-19
06700	Geneva	17.8	-1.3	102	35	20.2	2.0	71	-8
07510	Bordeaux	19.5	-0.7	60	13	21.3	1.4	89	35
07650	Marseilles	22.9	-0.9	85	71	24.1	0.9	10	-19
08222	Madrid	25.1	0.7	0	-13	25.9	2.0	10	1
08314	Mahon/Menorca	23.6	-0.6	19	15	25.2	0.7	4	-22
08495	Gibraltar	24.3	0.6	0	-1	25.4	1.2	2	-4
08515	Santa Maria/Azores	21.3	0.5	4	-21	23.6	1.4	5	-35
08535	Lisbon	21.3	-1.1	<1	-5	22.1	-0.7	36	30
10384	Berlin-Tempelhof	18.1	-0.7	185	133	19.0	0.6	74	13
11035	Vienna	19.2	-0.5	84	21	21.1	2.2	28	-30
11518	Prague	16.8	-0.7	143	77	18.5	1.5	54	-16
11903	Sliac	19.0	0.8	143	84	20.5	3.2	25	-44
12160	Elblag	18.2	1.4	149	55	18.0	1.3	102	21
12375	Warsaw	18.0	0.1	295	228	18.9	1.6	62	-1
12843	Budapest	20.8	-0.1	69	17	22.7	2.4	15	-36
13274	Belgrade	23.9	2.2	95	29	24.5	3.2	14	-38
14015	Ljubljana	21.1	1.2	157	35	22.8	3.7	43	-101
14445	Split	26.0	0.6	133	105	27.6	2.4	1	-49
14654	Sarajevo	20.4	1.5	134	55	21.4	2.9	5	-66
15420	Bucharest	23.2	1.2	65	1	22.0	0.8	53	-5
15614	Sofia	21.9	1.9	111	55	21.4	2.0	45	-7
16158	Pisa	23.1	0.3	23	0	24.4	1.9	<1	-57
16597	Luqa	26.7	0.8	<1	<1	26.8	0.5	0	-7
16716	Athens	29.6	1.8	0	-5	29.4	1.8	0	-5
16754	Heraklion/Crete	27.2	1.5	0	-1	26.6	1.0	0	-1
17040	Rize	24.7	2.5	165	31	23.8	1.6	160	-26
17062	Istanbul	26.3	3.1	8	-11	24.6	1.6	14	-12
17170	Van	22.6	0.7	11	7	21.1	-0.1	<1	-4
17300	Antalya	28.6	0.5	0	-3	29.8	2.1	0	-1
17609	Larnaca	27.9	1.0	<1	<1	28.3	1.2	2	2
22113	Murmansk	14.1	1.3	96	36	11.0	0.0	81	16
26038	Tallinn	20.1	3.8	160	81	16.6	1.3	54	-30
26629	Kaunas	19.6	2.5	146	78	17.5	1.2	152	89
26730	Vilnius	19.6	2.7	155	77	17.3	1.0	101	29
26850	Minsk	20.2	2.9	152	64	17.9	1.4	79	7
27612	Moscow	23.4	5.3	71	-21	18.7	2.3	62	-12
33345	Kiev	21.7	2.4	153	65	19.3	0.7	53	-16
33815	Kishinev	23.0	2.1	16	-53	21.8	1.3	16	-29
34300	Kharkiv	24.1	3.8	131	71	21.1	1.6	11	-39
34880	Astrakhan	28.4	3.1	7	-16	24.9	1.6	21	2
35108	Uralsk	26.5	4.0	1	-37	21.1	0.7	61	36
37789	Yerevan	27.0	1.0	26	16	24.9	-0.3	10	3
40007	Aleppo	29.9	1.6	0	0	29.5	1.4	0	-1
40080	Damascus	28.5	2.2	0	0	27.4	1.4	0	0
40180	Tel Aviv	27.5	1.8	0	0	27.8	1.7	<1	<1
40199	Eilat	34.7	1.8	0	0	33.8	1.0	0	0
40265	Mafraq	26.2	2.1	0	0	25.3	1.1	0	0
60030	LasPalmas/Grand Canary	24.1	0.8	0	0	24.4	0.3	0	0

WMO No.	Station	September 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.	October 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	4.4	3.9	25	2	-2.6	2.9	18	3
01025	Tromso	10.0	3.2	50	-44	6.0	3.1	141	16
01492	Oslo	12.7	1.9	142	52	7.6	1.2	75	-9
02196	Haparanda	10.7	2.8	121	58	4.7	2.2	77	13
02485	Stockholm	14.0	2.8	60	5	8.5	1.0	44	-6
02836	Sodankyla	8.7	2.8	42	-13	2.9	3.2	90	39
02974	Helsinki	12.9	2.9	81	8	7.6	2.2	86	13
03091	Aberdeen	13.5	1.8	90	22	10.8	0.9	68	-9
03772	London	16.9	1.9	35	-16	14.2	2.5	18	-40
03967	Dublin Casement Aerodrome	14.0	1.0	76	7	11.7	1.4	166	98
04030	Reykjavik	9.4	2.0	73	6	5.0	0.6	104	18
04360	Ammasslik	5.4	2.3	55	-13	-0.2	0.6	34	-48
06186	Copenhagen	14.9	1.3	56	-6	10.2	0.3	36	-23
06260	De Bilt	15.6	1.6	89	22	11.4	0.9	68	-4
06447	Brussels	16.5	2.0	83	24	12.1	1.2	49	-21
06590	Luxembourg	16.1	2.7	46	-24	10.2	1.1	30	-45
06660	Zurich	16.4	2.6	74	-18	9.5	0.2	75	6
06700	Geneva	17.2	2.3	45	-36	11.0	0.9	36	-41
07510	Bordeaux	19.6	1.7	25	-49	14.8	0.8	40	-48
07650	Marseilles	22.1	1.8	17	-30	17.2	1.1	55	-23
08222	Madrid	22.7	2.2	<1	-30	17.2	2.4	30	-15
08314	Mahon/Menorca	23.4	1.2	77	23	19.9	1.4	17	-67
08495	Gibraltar	22.9	0.1	11	-4	20.7	1.2	65	1
08515	Santa Maria/Azores	22.4	1.0	82	25	20.7	1.4	100	16
08535	Lisbon	21.9	0.2	21	-5	20.7	2.2	38	-42
10384	Berlin-Tempelhof	16.5	1.9	56	10	10.6	0.6	35	-1
11035	Vienna	17.7	2.6	21	-24	10.0	0.1	73	32
11518	Prague	15.6	2.3	32	-8	8.6	0.3	25	-5
11903	Sliac	16.6	3.2	5	-51	8.0	-0.3	18	-32
12160	Elblag	14.6	1.9	49	-21	9.3	0.4	45	-8
12375	Warsaw	15.1	1.9	7	-36	8.5	0.2	9	-29
12843	Budapest	19.9	3.5	4	-36	10.8	-0.1	29	-5
13274	Belgrade	22.5	4.8	48	-3	12.0	-0.4	36	-4
14015	Ljubljana	19.4	3.9	64	-66	10.0	-0.4	181	66
14445	Split	25.4	4.0	18	-43	17.2	0.3	94	15
14654	Sarajevo	18.9	3.8	39	-31	9.1	-1.3	69	-19
15420	Bucharest	19.6	2.7	7	-35	9.2	-1.6	34	2
15614	Sofia	19.3	3.5	24	-15	9.2	-1.2	62	25
16158	Pisa	21.9	2.4	35	-54	16.0	0.7	19	-101
16597	Luqa	25.2	1.1	7	-33	20.1	-0.6	85	-5
16716	Athens	27.0	2.8	2	-8	17.8	-1.5	52	0
16754	Heraklion/Crete	25.0	1.9	6	-12	18.9	-0.8	92	16
17040	Rize	21.0	1.6	338	115	15.8	0.4	493	220
17062	Istanbul	22.9	3.2	10	-31	15.0	-0.3	70	-1
17170	Van	18.0	1.2	53	43	9.9	-0.2	82	34
17300	Antalya	27.4	2.9	59	48	20.1	0.5	73	3
17609	Larnaca	26.3	1.2	1	1	21.9	0.6	5	-14
22113	Murmansk	9.4	2.7	30	-22	4.1	3.1	64	22
26038	Tallinn	13.1	2.3	87	5	8.2	1.9	67	-3
26629	Kaunas	13.6	1.5	74	15	7.4	0.5	22	-29
26730	Vilnius	13.3	1.7	62	-3	6.6	0.0	13	-40
26850	Minsk	13.7	2.0	28	-32	6.2	-0.1	36	-13
27612	Moscow	12.1	1.2	75	11	6.6	1.6	63	5
33345	Kiev	15.8	1.9	18	-29	7.7	-0.4	77	42
33815	Kishinev	19.1	2.9	8	-40	9.4	-0.7	36	9
34300	Kharkiv	15.7	1.6	13	-28	7.8	0.5	27	-8
34880	Astrakhan	18.1	0.8	23	-3	10.7	1.6	9	-8
35108	Uralsk	14.2	0.1	56	29	6.8	1.7	31	1
37789	Yerevan	20.3	-0.4	4	-6	12.8	-0.4	22	-5
40007	Aleppo	26.9	1.7	1	-1	19.2	-0.4	11	-11
40080	Damascus	24.9	1.7	0	-1	18.6	0.5	7	-5
40180	Tel Aviv	26.6	1.8	2	2	23.6	1.6	2	-24
40199	Eilat	31.7	1.3	0	0	27.1	0.4	0	-4
40265	Mafraq	23.7	1.0	0	-1	18.8	-0.3	0	-7
60030	LasPalmas/Grand Canary	24.5	0.7	0	-8	23.8	1.3	0	-10

WMO No.	Station	November 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.	December 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	-6.0	4.5	27	14	-6.6	6.7	5	-7
01025	Tromso	4.0	4.8	156	52	-0.5	2.5	71	-33
01492	Oslo	4.6	3.9	19	-56	0.8	3.6	74	18
02196	Haparanda	1.6	5.7	34	-24	-0.7	8.8	120	78
02485	Stockholm	6.1	3.5	15	-38	2.5	3.5	75	29
02836	Sodankyla	-2.1	5.3	43	4	-3.7	9.4	70	39
02974	Helsinki	4.2	4.1	27	-45	2.1	6.2	167	109
03091	Aberdeen	8.8	3.8	34	-41	4.1	0.6	51	-22
03772	London	10.7	3.5	29	-26	6.9	1.8	63	6
03967	Dublin Casement Aerodrome	9.9	3.2	55	-15	5.8	0.5	53	-24
04030	Reykjavik	4.3	3.2	90	17	-1.9	-1.7	78	-1
04360	Ammasslik	-1.7	3.0	109	13	-9.4	-2.2	54	-49
06186	Copenhagen	7.3	1.8	4	-58	4.7	2.5	50	-8
06260	De Bilt	7.2	1.3	11	-70	6.5	3.3	139	59
06447	Brussels	8.6	2.5	9	-67	6.1	2.6	152	76
06590	Luxembourg	6.1	2.3	10	-73	4.0	3.0	188	108
06660	Zurich	5.1	1.2	0	-82	3.6	3.0	169	96
06700	Geneva	6.5	1.5	19	-73	4.2	2.4	145	58
07510	Bordeaux	12.4	3.3	36	-58	9.4	3.0	175	76
07650	Marseilles	13.8	3.1	135	77	9.1	1.8	8	-48
08222	Madrid	11.2	1.8	65	1	6.9	0.5	5	-46
08314	Mahon/Menorca	16.9	2.5	200	123	13.0	1.2	15	-59
08495	Gibraltar	16.4	0.3	168	27	14.6	0.5	6	-140
08515	Santa Maria/Azores	16.7	-0.7	97	-5	16.2	0.8	75	-20
08535	Lisbon	14.7	0.2	155	41	12.2	0.4	27	-81
10384	Berlin-Tempelhof	5.0	0.1	1	-48	5.0	3.6	78	25
11035	Vienna	3.4	-1.2	0	-50	3.8	2.9	18	-25
11518	Prague	2.8	0.0	1	-31	2.9	3.5	30	4
11903	Sliac	0.8	-2.2	1	-68	0.0	1.7	63	6
12160	Elblag	4.2	0.9	15	-41	2.9	2.6	35	-17
12375	Warsaw	3.0	-0.2	0	-42	2.6	3.5	32	0
12843	Budapest	3.2	-1.6	0	-52	2.6	2.2	61	21
13274	Belgrade	4.3	-2.7	5	-49	5.4	3.1	48	-10
14015	Ljubljana	3.8	-0.8	3	-132	3.3	3.3	101	0
14445	Split	13.3	1.1	107	-1	10.6	1.9	49	-51
14654	Sarajevo	3.4	-1.4	24	-67	2.1	2.3	94	30
15420	Bucharest	2.7	-2.5	2	-47	2.6	2.4	46	3
15614	Sofia	2.6	-2.4	2	-45	1.3	0.8	38	-1
16158	Pisa	11.7	1.3	27	-97	9.0	2.2	94	9
16597	Luqa	17.4	0.4	132	52	14.1	0.3	73	-39
16716	Athens	12.1	-3.4	<1	-50	11.8	-0.4	63	-8
16754	Heraklion/Crete	14.5	-2.1	20	-39	13.2	-0.6	30	-44
17040	Rize	8.4	-3.2	237	-13	8.4	0.1	126	-112
17062	Istanbul	9.2	-2.4	16	-73	9.1	1.0	97	-25
17170	Van	0.8	-3.2	19	-25	-0.6	0.5	12	-22
17300	Antalya	14.9	0.1	20	-114	12.5	1.1	126	-101
17609	Larnaca	15.4	-1.0	126	82	13.3	0.1	98	22
22113	Murmansk	-1.0	4.1	58	18	-2.1	7.2	22	-16
26038	Tallinn	5.0	3.8	46	-22	2.0	4.9	125	70
26629	Kaunas	3.5	1.4	22	-31	1.9	4.3	37	-7
26730	Vilnius	2.9	1.7	16	-41	1.2	4.1	46	-9
26850	Minsk	2.3	1.5	17	-35	1.1	4.9	42	-11
27612	Moscow	0.2	1.3	45	-13	-0.1	6.0	76	24
33345	Kiev	2.4	0.3	5	-46	2.2	4.5	29	-23
33815	Kishinev	2.9	-1.5	<1	-39	2.9	3.2	23	-15
34300	Kharkiv	0.5	-0.8	8	-36	1.3	4.7	53	8
34880	Astrakhan	-1.1	-4.4	14	-5	-1.2	0.7	9	-6
35108	Uralsk	-5.3	-3.2	31	-4	-8.9	-0.5	9	-20
37789	Yerevan	2.4	-4.1	14	-8	-2.1	-2.3	9	-14
40007	Aleppo	9.1	-3.1	56	21	6.2	-1.0	55	-4
40080	Damascus	9.0	-2.8	13	-9	6.2	-1.0	3	-23
40180	Tel Aviv	16.5	-1.5	128	60	14.4	0.6	31	-107
40199	Eilat	19.2	-2.3	0	-3	16.4	-0.2	0	-6
40265	Mafraq	10.6	-2.9	43	26	8.3	-0.5	9	-19
60030	LasPalmas/Grand Canary	20.7	0.3	1	-20	19.4	1.1	2	-19

WMO No.	Station	Year 2011 Temp.(°C) mean	dev.	Prec. (mm) total	dev.
01008	Svalbard Airport	-3.3	3.1	199	16
01025	Tromso	4.6	1.8	971	-2
01492	Oslo	7.4	1.7	998	229
02196	Haparanda	3.4	2.2	648	96
02485	Stockholm	8.5	1.9	478	-61
02836	Sodankyla	1.7	2.7	596	96
02974	Helsinki	6.7	2.2	702	51
03091	Aberdeen	9.3	1.4	812	29
03772	London	12.4	1.9	510	-89
03967	Dublin Casement Aerodrome	10.1	0.8	727	-8
04030	Reykjavik	5.4	1.0	905	107
04360	Ammasslik	-0.6	1.1	838	-94
06186	Copenhagen	9.7	1.1	603	-33
06260	De Bilt	10.9	1.5	909	104
06447	Brussels	11.6	1.7	816	16
06590	Luxembourg	10.6	2.3	704	-171
06660	Zurich	10.5	2.0	914	-172
06700	Geneva	11.4	1.8	621	-333
07510	Bordeaux	14.6	1.9	588	-335
07650	Marseilles	16.0	1.2	511	-34
08222	Madrid	16.0	1.7	380	-76
08314	Mahon/Menorca	17.6	1.0	592	-6
08495	Gibraltar	19.0	0.8	701	-74
08515	Santa Maria/Azores	18.0	0.5	637	-138
08535	Lisbon	17.6	0.8	866	113
10384	Berlin-Tempelhof	10.8	1.4	613	29
11035	Vienna	11.0	1.3	513	-94
11518	Prague	9.2	1.3	453	-73
11903	Sliac	9.2	1.3	544	-142
12160	Elblag	8.7	1.1	637	-53
12375	Warsaw	9.1	1.3	604	85
12843	Budapest	11.5	1.1	373	-145
13274	Belgrade	13.0	1.1	500	-184
14015	Ljubljana	11.7	1.9	998	-395
14445	Split	17.6	1.7	584	-241
14654	Sarajevo	10.4	0.9	693	-225
15420	Bucharest	10.5	-0.1	469	-126
15614	Sofia	10.2	0.5	405	-158
16158	Pisa	15.3	1.2	501	-403
16597	Luqa	18.9	0.3	593	40
16716	Athens	18.5	0.0	425	56
16754	Heraklion/Crete	18.7	0.2	531	30
17040	Rize	14.2	0.3	2714	542
17062	Istanbul	14.8	0.7	432	-265
17170	Van	9.3	0.7	477	99
17300	Antalya	19.5	1.1	724	-342
17609	Larnaca	19.8	0.7	436	107
22113	Murmansk	1.9	2.0	525	47
26038	Tallinn	6.9	1.8	776	109
26629	Kaunas	7.8	1.4	672	64
26730	Vilnius	7.5	1.5	635	-48
26850	Minsk	7.5	1.7	615	-62
27612	Moscow	6.7	1.8	595	-93
33345	Kiev	9.2	1.5	580	-69
33815	Kishinev	10.4	0.8	428	-119
34300	Kharkiv	8.5	1.0	494	-25
34880	Astrakhan	10.2	0.2	322	102
35108	Uralsk	5.1	-0.3	431	107
37789	Yerevan	11.8	-0.3	367	90
40007	Aleppo	17.6	0.3	281	-56
40080	Damascus	17.0	0.5	149	3
40180	Tel Aviv	20.6	1.1	488	-79
40199	Eilat	25.3	0.5	8	-24
40265	Mafraq	16.9	0.4	146	-13
60030	LasPalmas/Grand Canary	21.4	0.9	82	-35

Seasonal and Annual Areal Means of Temperature Anomalies for each country (Reference: 1961-1990)

from gridded data (result of spatial analysis of CLIMAT and SHIP data)

Country	Winter 2010/2011	Spring 2011	Summer 2011	Autumn 2011	Year 2011
Albania	0.8	1.0	1.9	0.7	1.1
Andorra	-0.5	2.5	0.4	2.0	1.4
Armenia	2.0	-0.1	1.2	-1.4	-0.0
Austria	0.2	2.4	1.3	1.2	1.6
Azerbaijan	1.5	-0.2	1.8	-1.0	0.2
Belarus	-0.9	1.1	2.3	1.0	1.6
Belgium	-0.2	3.2	0.1	1.8	1.8
Bosnia and Herzegovina	0.6	1.2	2.3	0.8	1.4
Bulgaria	-0.1	-0.3	1.4	-0.3	0.3
Croatia	0.5	1.7	2.3	0.9	1.6
Cyprus	2.0	0.5	1.1	0.5	0.8
Czech Republic	-0.9	2.2	1.0	0.9	1.4
Denmark	-1.8	2.2	0.9	1.5	1.4
Estonia	-1.8	1.3	2.6	2.5	1.9
Faroer Islands	0.4	1.4	0.1	2.0	1.0
Finland	-2.7	2.1	2.0	3.3	2.2
France	-0.3	2.9	0.2	1.7	1.5
Georgia	1.5	-0.7	1.2	-1.3	-0.2
Germany	-0.8	2.6	0.6	1.0	1.5
Greece	0.7	-0.1	1.3	-0.5	0.3
Greenland	5.7	0.7	1.4	1.6	1.7
Hungary	-0.3	1.4	1.6	0.2	1.0
Iceland	1.7	1.2	0.2	2.0	1.0
Ireland	-1.4	1.4	-0.9	1.4	0.6
Israel	1.7	0.7	1.2	0.1	0.8
Italy	0.2	1.7	1.3	1.4	1.3
Jordan	1.1	0.1	1.2	-0.7	0.2
Kazakhstan	1.0	-0.5	2.0	-0.6	0.1
Latvia	-1.8	1.2	2.0	1.4	1.5
Lebanon	1.6	0.6	1.7	-0.1	0.8
Liechtenstein	-0.0	3.5	1.4	2.7	2.2
Lithuania	-1.8	1.2	2.3	1.9	1.7
Luxembourg	-0.1	3.7	0.6	2.0	2.1
Macedonia	0.6	0.4	1.7	0.2	0.7
Malta	0.3	0.2	1.1	0.3	0.4
Moldova	-0.5	0.5	1.6	0.1	0.9
Montenegro	0.6	1.0	2.1	1.1	1.2
Netherlands	-0.6	2.5	0.1	1.1	1.4
Norway	-0.5	2.4	1.3	3.1	2.1
Poland	-1.4	1.6	1.4	0.6	1.2
Portugal	0.3	2.3	0.4	1.1	1.0
Romania	-0.4	0.3	1.6	-0.4	0.5
Russia	-1.5	1.0	2.0	1.4	1.3
Serbia	0.1	0.7	2.0	0.3	0.9
Slovakia	-0.6	1.7	1.5	0.2	1.1
Slovenia	0.5	2.1	2.1	1.0	1.7
Spain	0.4	2.5	1.0	1.8	1.5
Svalbard	2.0	3.9	1.0	3.8	3.1
Sweden	-2.2	2.1	1.5	2.9	1.9
Switzerland	0.3	3.4	1.1	1.9	2.0
Syria	1.4	0.4	1.2	-0.7	0.3
Turkey	1.9	-0.4	0.8	-1.1	-0.0
Ukraine	-0.2	0.7	2.0	0.1	1.0
United Kingdom	-0.6	2.1	-0.2	2.2	1.3

Seasonal and Annual Areal Means of Temperature Anomalies for each subregion (Reference: 1961-1990)

from gridded data (result of spatial analysis of CLIMAT and SHIP data)

Region	Winter 2010/2011	Spring 2011	Summer 2011	Autumn 2011	Year 2011
Central and western Europe	*0.6*	*2.3*	*0.6*	*1.3*	*1.4*
Nordic and Baltic countries	*2.0*	*1.2*	*1.5*	*2.1*	*1.8*
Iberia	*-0.4*	*2.5*	*0.9*	*1.7*	*1.4*
Mediterranean, Italian and Balkan Peninsula	*-0.7*	*1.0*	*1.8*	*0.6*	*1.1*
Eastern Europe	*1.2*	*0.9*	*2.0*	*1.1*	*1.2*
Middle East	*-0.8*	*-0.1*	*1.5*	*-0.8*	*0.2*

Temperature:

According to BAMS Annual State of the Climate 2011 was together with the year 2007 on rank 1 of the warmest years in Europe. With respect to uncertainties it was at least one of the 6 warmest years since 1850. This result is based upon the CRUTEM3 dataset (Brohan et.al. 2006), see also BAMS July 2012, p. 186. 'Europe' is here defined as the land area within 35°N - 75°N and 10°W - 30°E. For 'Europe' defined as the land area within 35°N - 75°N and 25°W - 45°E and the E-OBS dataset 2011 came out on rank 4 since 1950 (van der Schrier, G., 2013; see also: Climate Indicator Bulletin: European Temperature) with an Europe-average mean temperature 10.9°C (=normal + 1.1°C, compared to CRUTEM3 with +1.23 +/- 0.14°C). This difference is essentially due to the area taken for 'Europe'. E-OBS includes more of the North Atlantic (Iceland) as well as more of Eastern Europe, the Black Sea area and Middle East where the temperature anomalies were smaller or partially even negative (Fig.2.2). Both definitions for Europe do not cover the complete RA VI region. But a dataset covering the complete RA VI area is not yet available.

Locally in northern parts of Sweden 2011 was the warmest year on record. 2011 was as a whole the warmest year on record (for more than 100 years) for Norway (equal to 2006 and 1990), the 2nd warmest year since 1900 in Finland, the warmest since 1900 in France and Switzerland. The Belgian station Uccle recorded the highest annual mean temperature since 1833. Also in southern Europe the year 2011 was a very warm year. At coastal, central and eastern parts of Montenegro 2011 was the warmest year since the beginning of the 20th century.Spain recorded the warmest year since 1961 and Portugal reported the highest mean of the daily maximum temperatures since 1931. In Austria, Germany and Slovenia it was the warmest year on record on the higher mountains.

Most remarkable is that the polar region of the whole northern hemisphere was much warmer than normal. For the Region VI it was warmer than normal through all seasons of the year. The Middle East on the other hand had the smallest positive anomaly of the annual mean temperature. See the table on page 22.

Note: *Small differences between the areal temperature anomalies in the tables on pages 21 and 22 and according values given by individual countries may occur due to the calculation method. The anomalies result from the temperature analysis (see RCC-CM: Products - Monitoring Europe - Temperature).*

Precipitation:

The annual precipitation totals in 2011 (reference 1961-1990) were above normal in Scandinavia, Iceland, eastern Greenland and northern UK and locally in southwestern Mediterranean as well as partially in southeastern Russia. They were below normal partially in southern and western Europe and in Middle East. Remarkable is a large area of drier than normal precipitation spreading from southwestern France and the northern Iberian Peninsula to southwestern Ukraine, including southern England, eastern France and western Germany, Switzerland, Austria, northern Italy, the western Balkan Peninsula and western Romania. The deficit is mostly between 10 and 30 mm, but 30 to 50 mm at the western Adriatic coast. In terms of percentages the largest almost coherent area covers the western Balkan, eastern Austria and northern Italy, where between 60 and 80 percent of the normal annual precipitation fell. Locally it was even less. In the wetter than normal regions especially in the north and east on the other hand the 90 percentile was exceeded (reference 1951-2000).

Sunshine:

It was sunnier than normal in most parts of Central Europe as well as parts of western and southwestern, southern and southeastern Europe and around the southern Baltic Sea. The surplus ranged mostly between 5 and 25 percent and was highest in Poland and southern parts of eastern Germany exceeding the normal by 25 to 50 percent. The other areas were mostly close to normal or slightly below normal. Only northeastern Russia and the region around the Caspian Sea received less than 50 percent of the normal. Spring and autumn largely contributed to the surplus while summer was rather dull.

Drought

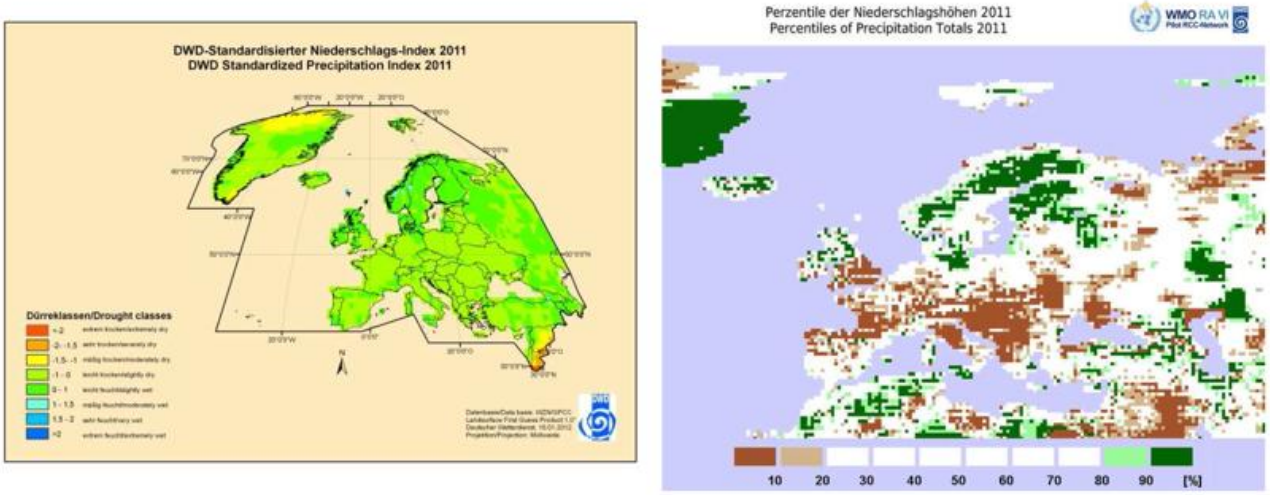


Fig. 2.3: *Annual means of the modified Standardized Precipitation Index (DWD-SPI) and precipitation totals in terms of percentiles 2011 based on GPCC data 1951 to 2000*

Drought Situation:

As the map of the modified Standardized Precipitation Index (SPI)(annual mean of 1-month DWD-SPI) shows, most of Europe was slightly dry over the year. The annual anomalies of the 3-months SPI and even a little more the 6-months SPI (see European Climate Assessment & Dataset - Indices of extremes) even show extremely dry conditions for many stations in western, southern and eastern Europe, including the southern British Isles. The map of the precipitation totals 2011 in terms of percentiles (on the basis 1951-2000) clearly show very dry as well as the very wet regions. The seasons spring and autumn 2011 mostly contributed to this result. Europe suffered from drought conditions during those seasons which were centered during spring in central and western Europe and on the Balkans during autumn. The spatial extent was large (see the maps) and affected regions which usually do not belong to the dry regions. Especially during November 2011 the drought situation spread over most of central, eastern and southeastern Europe and affected even northern Europe. Thus parts of Europe were affected by both drought events as for instance the United Kingdom. There is a Press Release of 8 June 2011 on the first drought episode under Drought conditions in Europe 2011 and a Special Report in Drought and precipitation extremes, in "State of the Climate 2011". Some additional information will be given in part 3 'Monthly Survey in the section for November.

Snow Cover

Fig.2.4 to 2.6 show the maps of first occurrence of snow, last occurrence of snow and duration in the snow period for Europe September 2010 to August 2011 on the basis of SYNOP reports.

Earlier (October/November 2010) than usual (December/January) snow occurred in the northwest and southwest (northern England and Scotland and higher elevated parts of the Iberian Penisula) of the European continent. Snow even occurred in western France and much of the Iberian Peninsula as well as southern Italy, the Ionean and the Aegean parts of Greece and western Turkey where no snow is expected according to the reference 1981/82 - 2010/11. In northern Russia and southern Finland snow fell already in October where it is usually to be expected in November. Snow fell later than usual in southern Russia, the Caucasus region and eastern Turkey.

On the other hand snow in the northwest melted earlier, already in January/February, where it ususally may be expected until February/March. Most of the early snow in the west (France, southern England) melted already in the same month. Snow remained longer than usual in Poland, partly in Ukraine and in western Turkey.

Overall the snow-season 2010/2011 was shorter than in average in eastern and northern Europe and in the Caucasus region while a short snow period occurred in the west where on average no snow occurs at all.

More information about snow conditions may be found on the RCC-CM-Webside (RCC-CM).

The snow cover extent for the entire Northern Hemisphere is operationally evaluated from satellite images by Rutger's Laboratory (see: 2011 Annual Report). The time series for annual snow extent covers 42 years, on a monthly basis up to 46 years. For the Northern Hemisphere the snow extent in 2011 was on rank 26 of 42, for Eurasia it was on rank 27. November 2011 was on rank 4 (of 46 years) of the most extensive snow cover in November on the Northern Hemisphere, in Eurasia it was on rank 5. January was on rank 6 (in Eurasia rank 11) of 45 years.

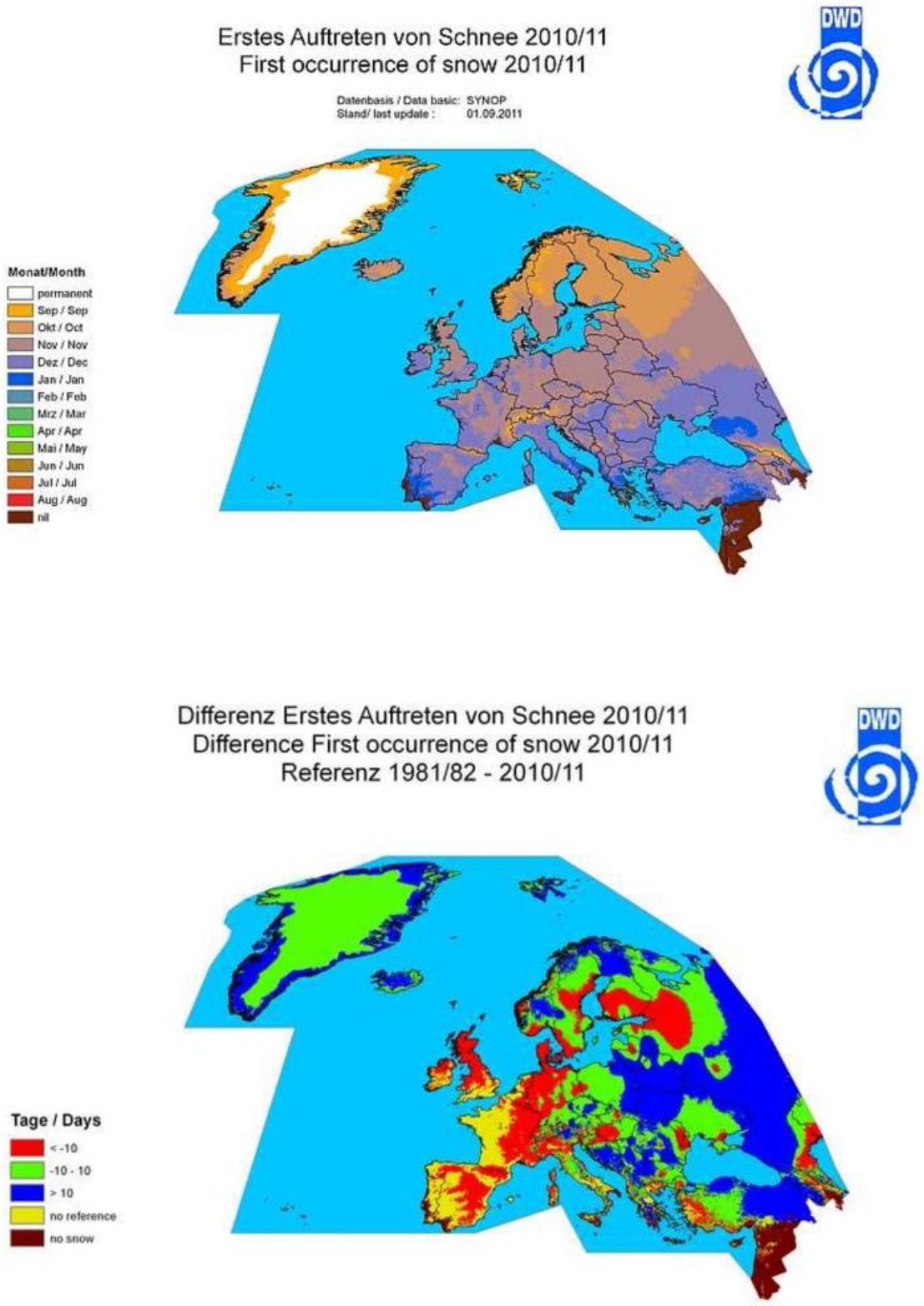
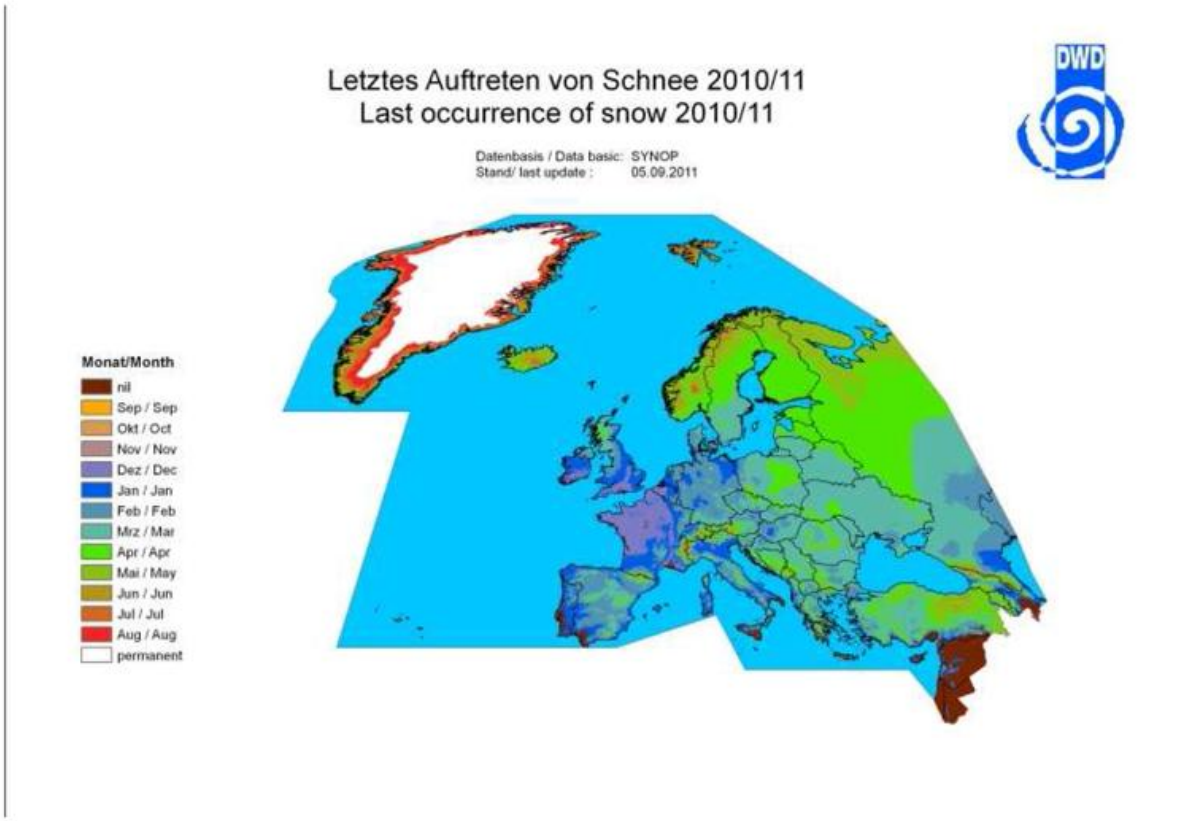


Fig. 2.4: *Upper Figure: Map of first occurrence of snow during the snow-season 2010/2011*
Lower Figure: Map of anomaly of first occurrence of snow (reference 1981/1982 - 2010/2011)



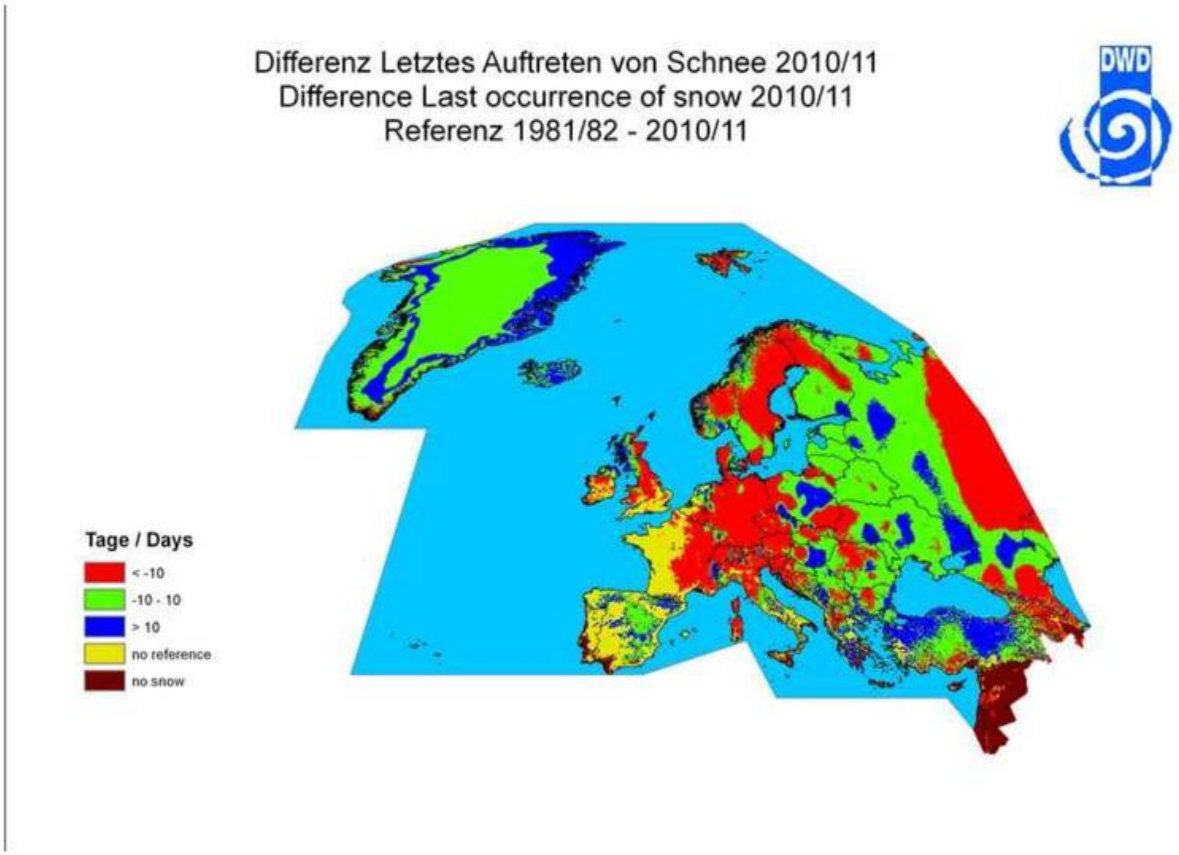
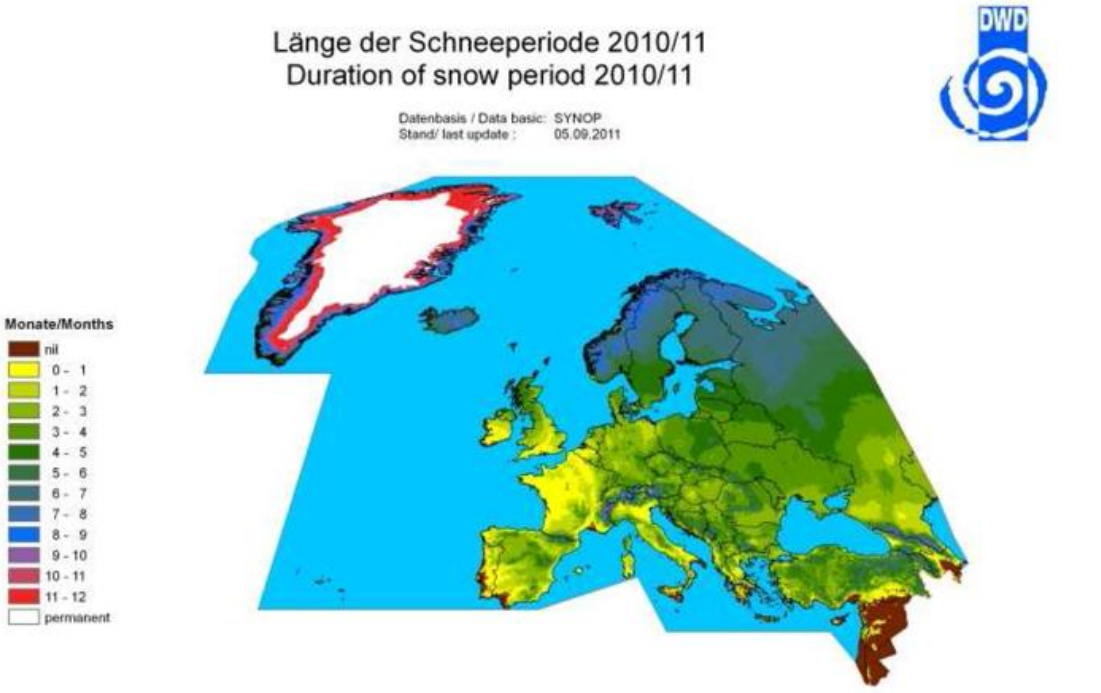


Fig. 2.5: *Upper Figure: Map of last occurrence of snow during the snow-season 2010/2011*
Lower Figure: Map of anomaly of last occurrence of snow (reference 1981/1982 - 2010/2011)



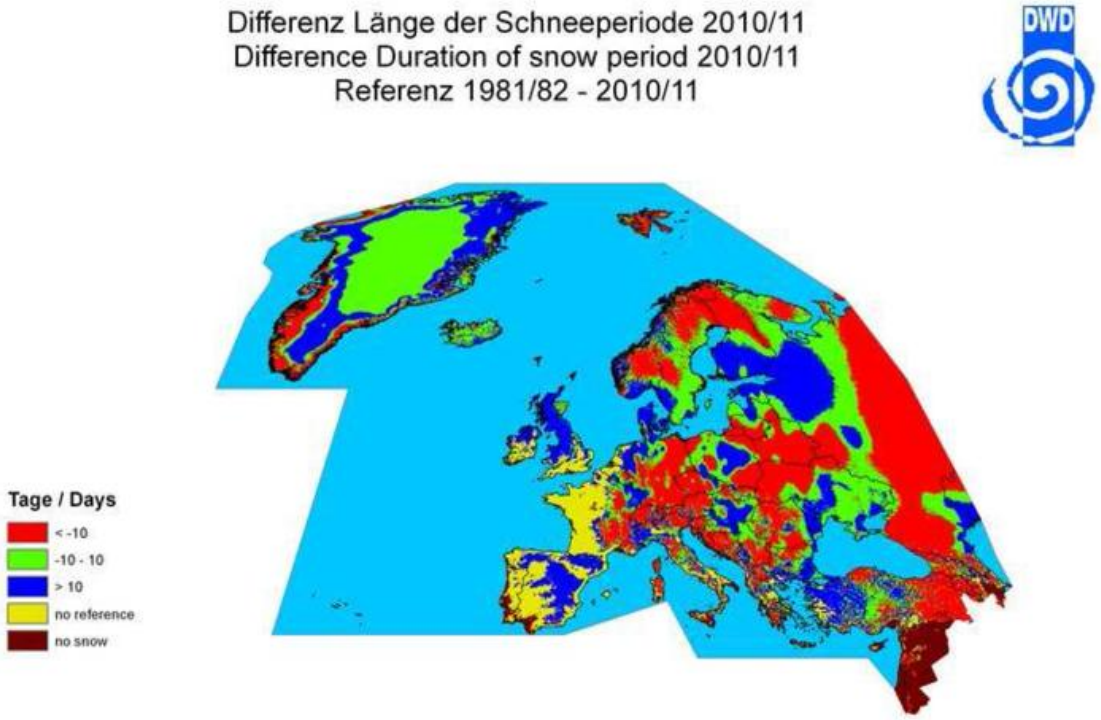


Fig. 2.6: *Upper Figure: Map of duration of snow cover in the snow-season 2010/2011*
Lower Figure:Map of anomaly duration of snow season (reference 1981/1982 - 2010/2011)

The Ozone Layer over Central Europe

(by Wolfgang Steinbrecht, Hans Claude, and Ulf Köhler - Deutscher Wetterdienst, Meteorological Observatory Hohenpeißenberg)

2011 was quite an unusual year for the ozone layer over the northern hemisphere, as was the very large decrease from 2010 to 2011. The major feature of 2011 was the extremely large chemical ozone depletion above the Arctic in spring of 2011. This record depletion, up to approximately 130 DU, exceeded what had previously been observed in the Arctic, e.g., in 1996, 2000, 2005. It was due to the still large levels of anthropogenic chlorine in the stratosphere in combination with an unusually stable and cold polar winter vortex. For the first time, the depletion in the Arctic was comparable in most aspects to the ozone hole occurring regularly above Antarctica. Figure 2.7 clearly shows the unusually low total ozone columns above the Arctic in early 2011 (top left panel). After the breakup of the Arctic vortex in April, ozone-depleted air-masses spread over the Northern hemisphere and contributed to the low total ozone columns observed throughout most of the year (other panels of Fig. 2.7). Additional factors favouring the generally low ozone columns at northern mid-latitudes in 2011 were:

- The phase of the quasi-biennial oscillation of the equatorial stratosphere (QBO) in early 2011. It resulted in high ozone in the tropics and low ozone at mid-latitudes, in the first half of 2011 (top panels of Fig. 2.7).
- The usually positive phase of the Arctic- or North-Atlantic Oscillation (AO or NAO) throughout most of 2011. It contributed to low ozone over the Atlantic sector from about 30°N to 50°N, and high ozone near Greenland / Iceland (right panels of Fig. 2.7). Note that this phase of the AO or NAO contrasted the largely opposite AO phase and high total ozone columns observed throughout 2010. The positive AO/NAO also contributed to the generally warm and sunny weather over much of Central Europe in 2011.

Figure 2.8 shows the time series of observed total ozone annual means (black dots, top) at Hohenpeissenberg in southern Germany (47.8°N, 11.0°E). Hohenpeissenberg results are representative for Central Europe, and are similar to much of the northern mid-latitudes The red line in the top panel of Fig. 2.8, and the lower panels, show ozone variations attributed to several influence factors. This attribution is done by multiple linear regression analysis and can explain about 80% of the variance. The regression result is shown by the grey line in the top panel. On decadal time-scales, total ozone shows a substantial decline from the 1960s until the late 1990s, and a beginning recovery since. This is due to the large increase of anthropogenic chlorine until the mid-1990s and the slow chlorine decline following the end of CFC production initiated by the 1987 Montreal Protocol. In Fig. 2.8 the chlorine related total ozone variation is represented by the red curve for EESC (=Equivalent Effective Stratospheric Chlorine). Another important factor is the 11-year solar cycle (orange line, bottom panel). On the inter-annual time-scale the QBO and the Arctic Oscillation (or North-Atlantic- Oscillation) play major roles (magenta and blue lines in Fig. 2.8). They act on ozone, but are also connected with the intensity of the polar winter vortex. In particular, QBO and AO played a major role in the large swing from high total ozone in 2010 to low values in 2011. Figure 2.8 also give an indication of the ozone columns to be expected over the next decade or so. The beginning slow recovery of the ozone layer should continue. However, large variations are to be expected. Because chlorine levels are still high, winters with a stable and cold polar vortex will result in substantial ozone loss, and even "ozone hole" conditions. Climate change and stratospheric cooling may actually favour such conditions in the future. Substantial ozone loss can result in very high levels of UV-B radiation, particularly on sunny days in spring, and in Central Europe. A major volcanic eruption with substantial aerosol loading in the stratosphere would also result in low ozone levels, comparable to the all-time lows observed in 1992 and 1993, and the low values seen in 2011.

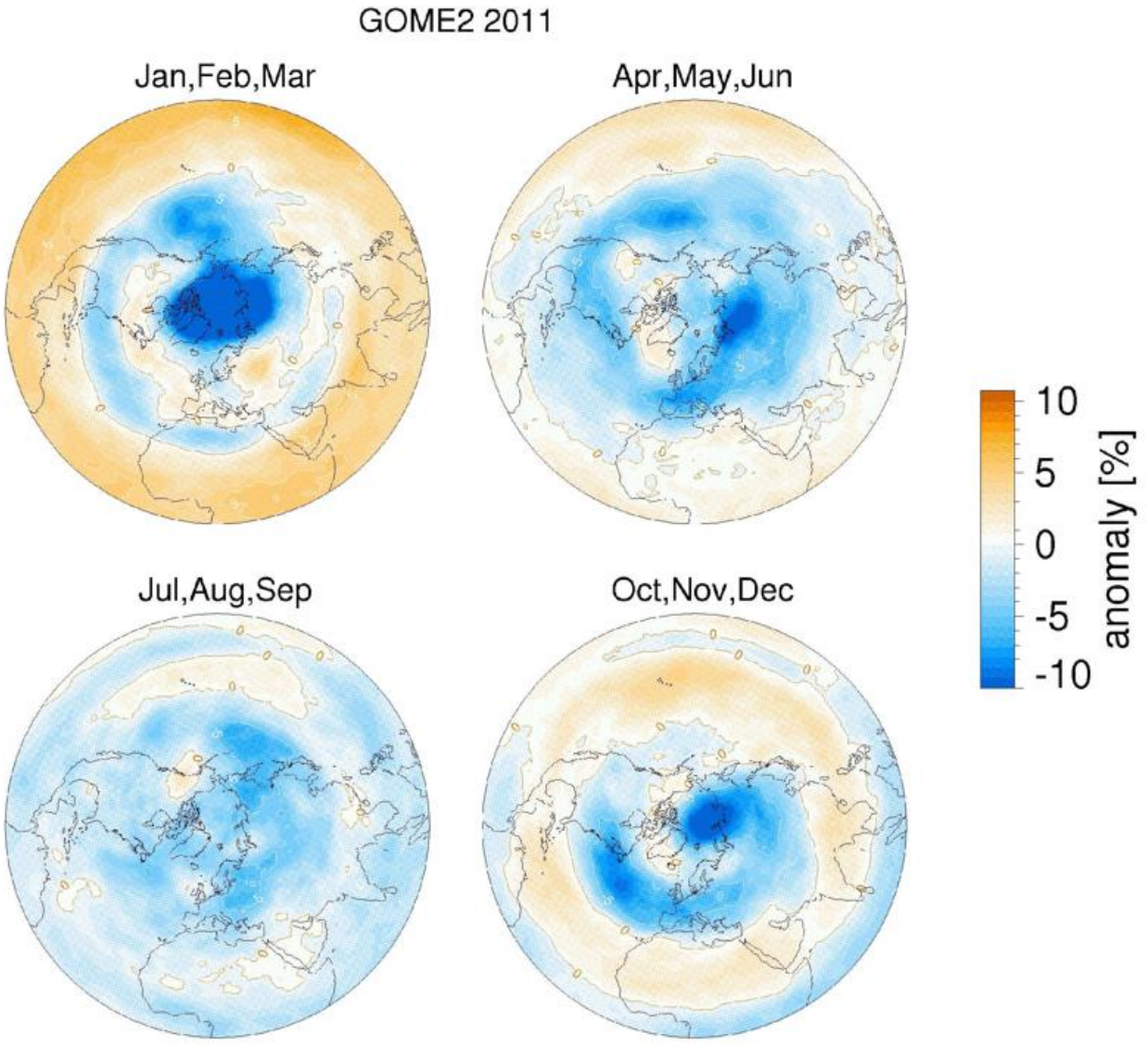


Fig. 2.7: *Relative deviation of the total ozone columns observed by the GOME2 satellite instrument in 2011 from the 1979 to 2010 climatological mean. Data source: www.temis.nl.*

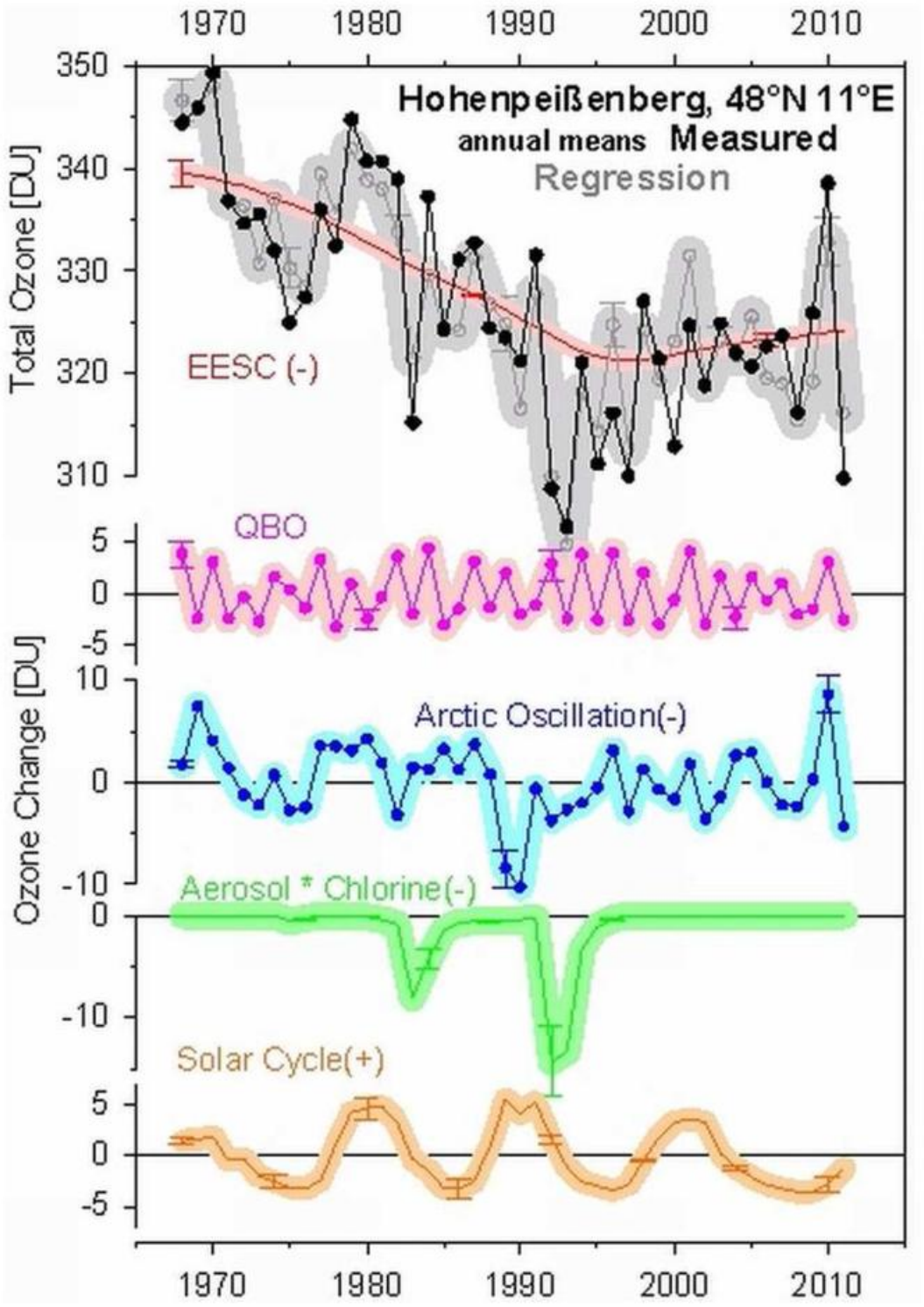


Fig. 2.8: *Annual mean total ozone observed at Hohenpeissenberg (47.8°N, 11.0°E) and variation attributed to influencing factors by multiple linear regression. Top panel, black: Observed annual means. Grey: Multiple linear regression result. Red: Ozone variation attributed to Effective Equivalent Stratospheric Chlorine. Lower panels: Variation attributed to the QBO (magenta), the Arctic-Oscillation (blue), enhanced stratospheric aerosol multiplied by EESC (green), and to the 11-year solar cycle (orange). Error bars (± 1σ) and thickness of the underlying lines give the approximate statistical uncertainty of the linear regression.*

Temporal Evolution of Climate Elements

On the following pages graphs of long time series of temperature, precipitation and sunshine duration as provided by the NMHSs are presented to give an overview of the temporal development of the basic climate elements. The graphs are grouped with respect to the 6 subregiones defined above (Fig. 1.1). The table below informs about the lengths of the time series shown as well as whether they refer to spatial means of the country or single stations. Most time series are temperature time series. Each subregion is at least represented by one country. Time series of precipitation totals are fewer and there is no diagram for the subregion 'Eastern Europe'. Diagrams of long-term annual sums of sunshine duration are only provided by 3 countries and they belong to the subregions 'Central and western Europe' and 'Nordic and Baltic countries'.

Following this section, trend maps representative for the elements temperature and precipitation are shown. As reference period for these trend maps 1951-2011 was chosen. After this, we present examples of the temporal developent of other temperature related phenomena,such as the sea surface temperature in the North Sea and the mass balance of the Austrian Goldberg glacier.

Start of long-term time series of Temperature, Precipitation and Sunshine Duration

	Temperature		Precipitation		Sunshine Duration	
Country	Spatial Mean	Single Station	Spatial Mean	Single Station	Spatial Mean	Single Station
Armenia	1929					
Austria	1851[1]					
Belgium		1833				
Belarus	1881					
Bulgaria	1901					
Croatia		1862				
Denmark	1873		1873		1920	
Estonia		1866		1866		1953-1958, 1967
Finland	1900					
France	1900					
Faroe		1873				
Germany	1900		1900		1951	
Greenland		1873				
United Kingdom	1910		1910		1929	
Hungary	1901		1901[2]			
Italy	1961		1951			
Israel	1991		1940			
Latvia	1924		1924			
Lithuania	1961					
Norway	1900		1900			
Portugal	1931		1931			
Russia	1939					
Slovakia				1876		
Spain	1961		1947			
Sweden			1860			
Switzerland	1864					
Turkey	1941		1941			

1: Mountain Summits; 2: Mean of 58 homogenized stations

Temperature

Note: *Long time series of the mean annual temperature are available for each of the 6 subregions. The number of countries which provided information differs as well as the length of the series and the kind of presentation. The longest time series for areal means were proided by Austria (1851, for mountain summits), Switzerland (1864), Denmark (1873) and Belarus (1881). Most graphs are diagrams of the mean annual temperature over the years. Usually the mean annual temperature is given as a mean for the whole country. In a few cases the diagram refers to one station only. Some countries present the time series in form of anomalies from a reference (mostly the standard WMO reference period 1961-1990, except Belgium (1981-2010), and France, Hungary, Poland, Portugal, Spain, Turkey (all 1971-2000)). In this context this must be reflected when for instance the number of years with annual means above the reference is compared. Taking into account that the temperature is growing with time, the year from which onward the annual mean lies above the reference will be later when the reference is 1971-2000 than compared with the standard normal period 1961-1990. Some countries provide further statistics in their diagrams like a running mean or a trend line. Generally all time series document the rising temperatures with time and the increase of the rise during the last 15 years. Some special aspects will be discussed in the following.*

In **Central and western Europe** Fig 2.9 shows the time series of United Kingdom, Belgium (station Uccle), France and Germany. Fig 2.10 shows time series for the Alpine states Switzerland and Austria and of Hungary. In Austria the diagram refers only to the summits of high mountains. But both graphs, the one of Switzerland and the one of the Austrian summits resemble each other closely though the graph of Switzerland is given as anomalies from the standard WMO reference period 1961-1990. All years since 1986 were warmer than the normal and 2011 was the warmest. Concerning this aspect the graph of France may be considered as equal in result though the anomalies refer to 1971-2000. The temporal evolution at the station Uccle in Belgium, 1833 - 2011, shows 2 points of change of the temperature regime, in 1913 and in 1983. The reason for this effect is not clear as it is not observed similarly in other time series.

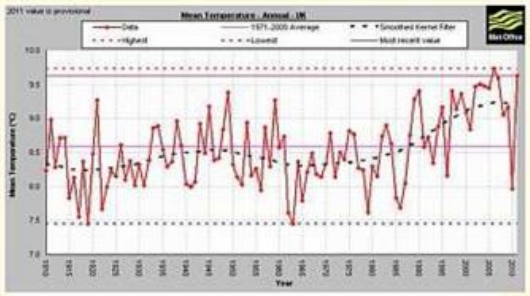
In the **Nordic and Baltic Countries** Fig 2.11 shows the time series of the mean annual temperatures of stations in Greenland and the Faroe Islands compared to Kopenhagen in Denmark. The longest time series start in 1873. The stations on Greenland show a higher temporal variability than Kopenhagen and Torshavn with low values around 1890 and 1985 and high values around 1930 and nowadays in the smoothed curves. The high values nowadays exceed the high values of the 1930er years. In Fig 2.12 we see similar but weaker variations for Norway, Finland and Denmark as country areal means. In any case the temperatures of at least the last decade are higher than formerly. This can as well be seen in Fig 2.13 for the Baltic states Estonia, Latvia and Lithuania were the series is given as anomalies from the standard normal period.

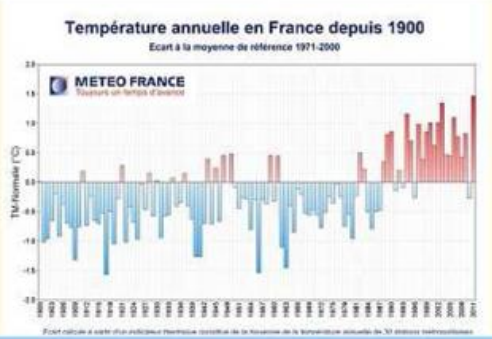
For **Iberia** Fig 2.14 shows the temporal development of the mean annual temperature of Portugal and Spain. In Portugal nearly all years from 1995 on had higher mean, maximum or minimum temperatures than the reference 1971-2000.

Similar results may be seen for **Mediterranean, Italian and Balkan Peninsulas**, see Fig 2.15, 2.16 and for **Eastern Europe** and **Middle East** as well, see Fig 2.17 and 2.18.

Overall 2011 was the warmest year within the shown time series for France, Belgium, Switzerland, Norway and Spain as well as for several stations of western Greenland and for the Austrian summit stations.

Central and Western Europe:







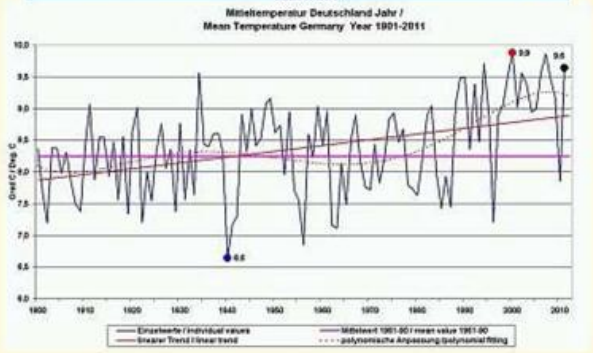
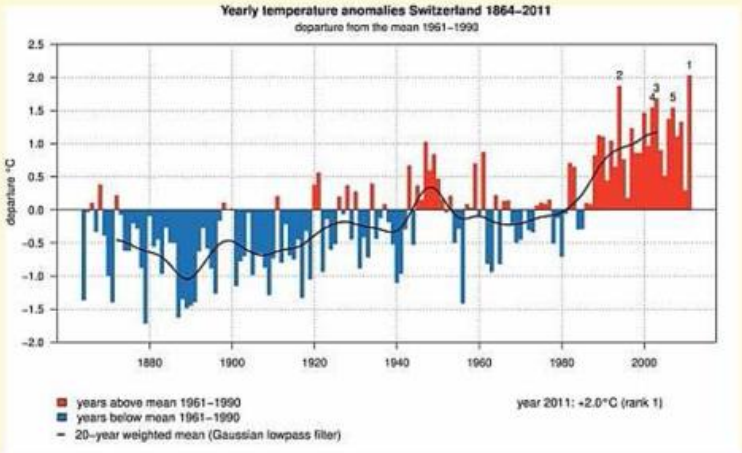
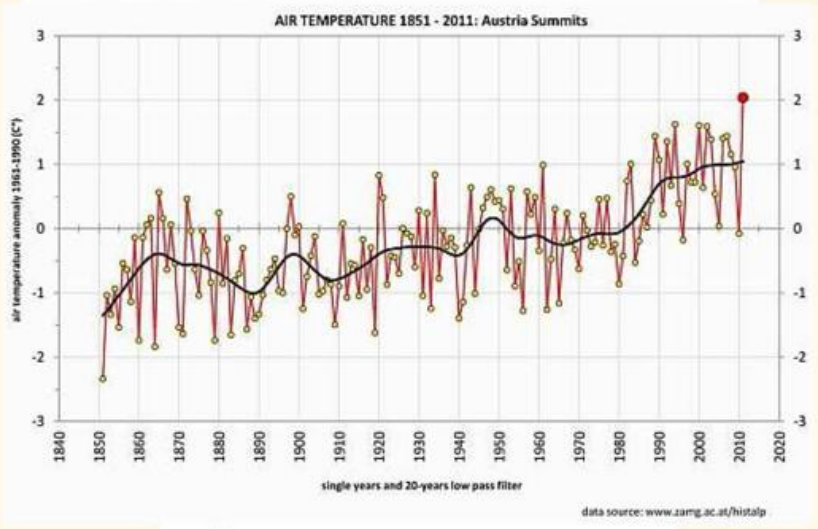


***Fig. 2.9** : Mean annual temperatures in western and central Europe, United Kingdom, France, Belgium and Germany (Diagrams as provided by the NHMSs)*

Central and Western Europe:





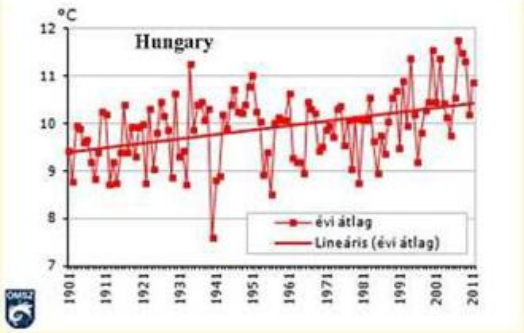


***Fig. 2.10** : Mean annual temperatures in western and central Europe, Switzerland, Austria (summits) and Hungary (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:

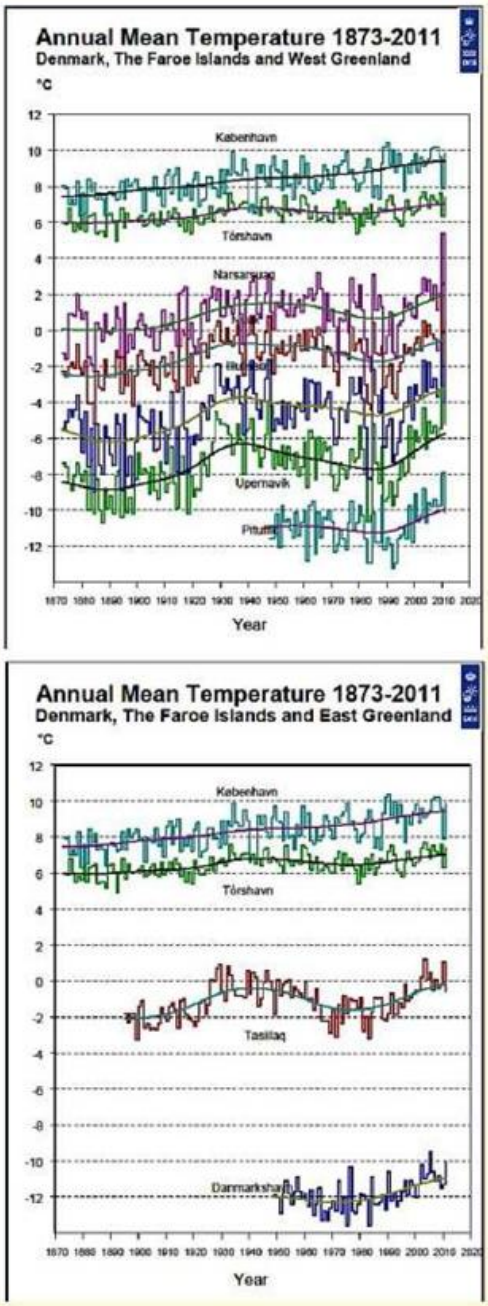
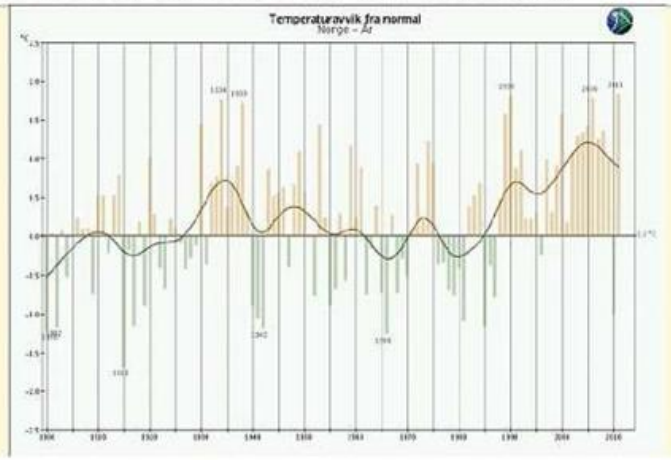


Fig. 2.11 *: Mean annual temperatures for Nordic and Baltic countries - Greenland and Faroer compared to Kopenhagen (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:





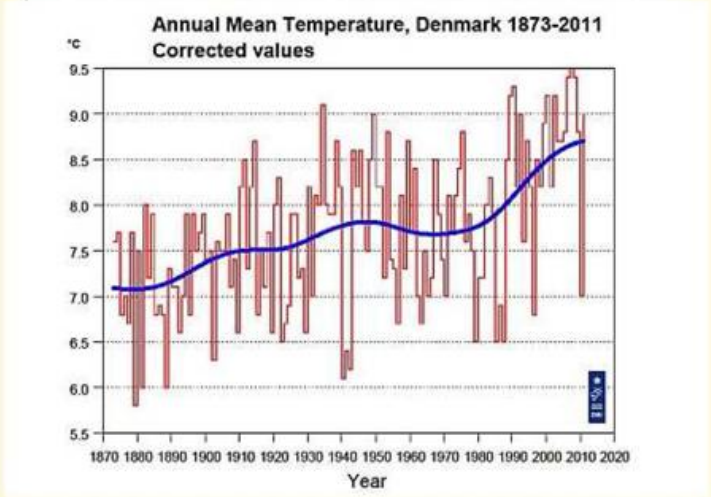


***Fig. 2.12** : Mean annual temperatures for Nordic and Baltic countries - Scandinavia and Denmark (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:

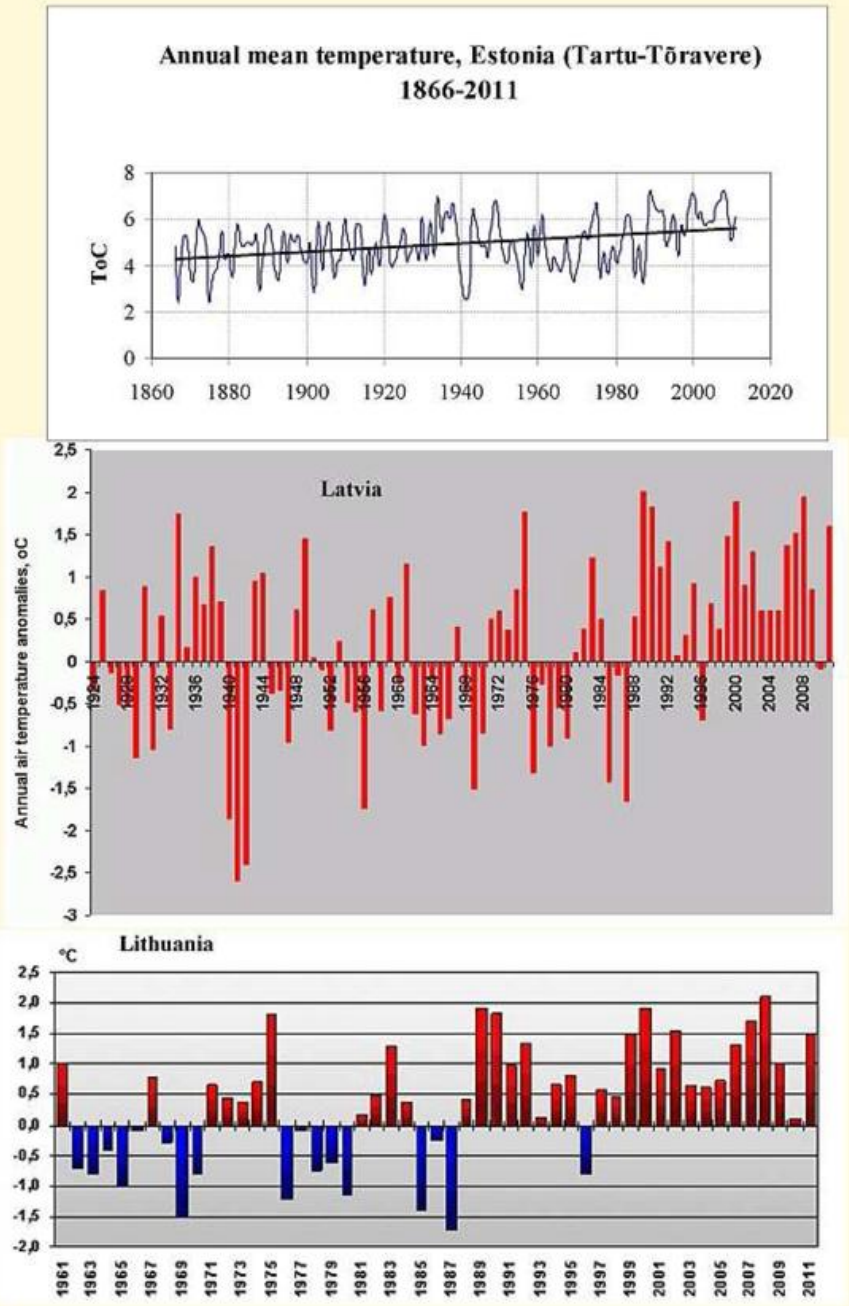


Fig. 2.13 *: Mean annual temperatures for Nordic and Baltic countries - Baltic states (Diagrams as provided by the NHMSs)*

Iberia:



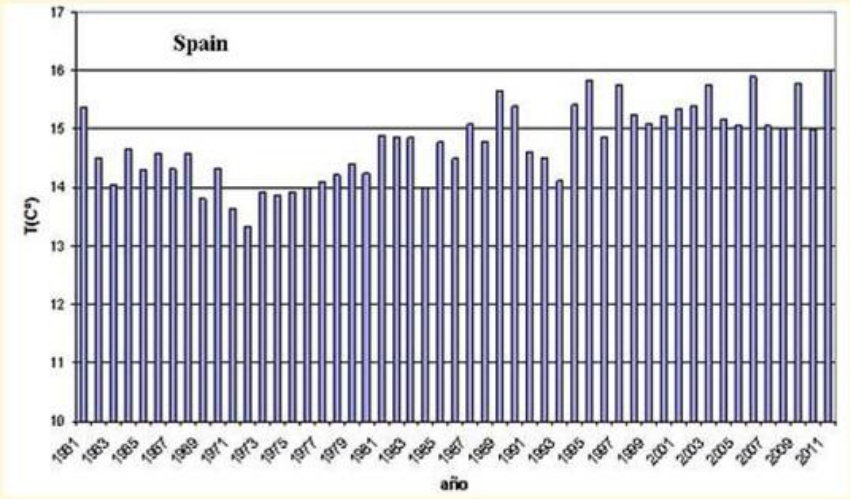
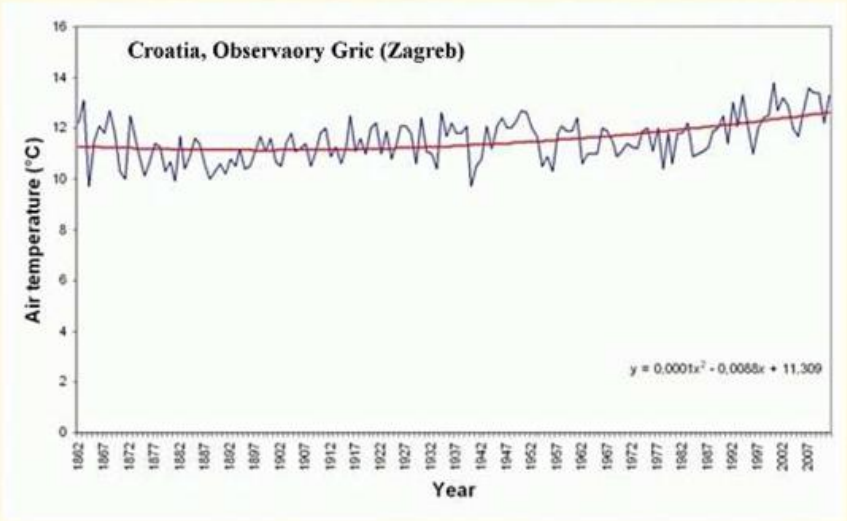


***Fig. 2.14** : Mean annual temperatures in Iberia*
(Diagrams as provided by the NHMSs)

Mediterranean, Italian and Balkan Peninsula:



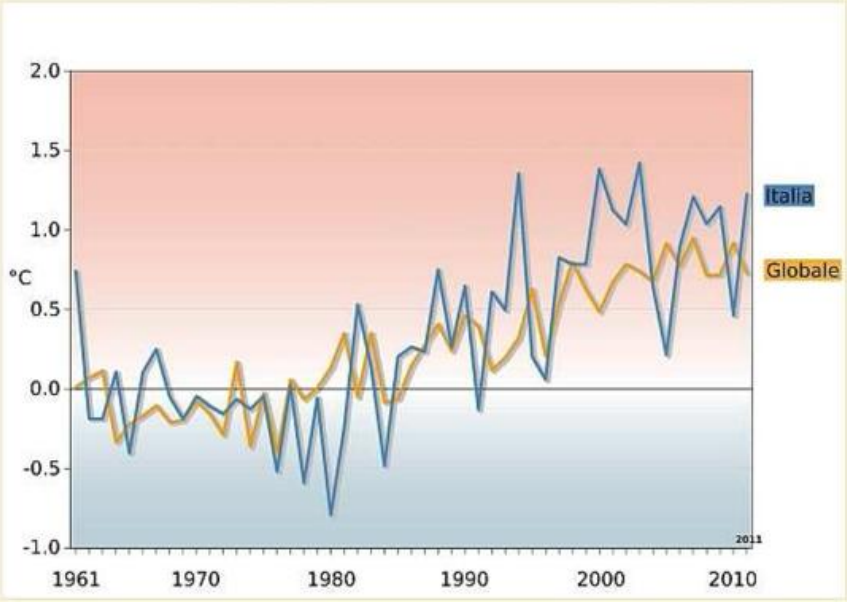
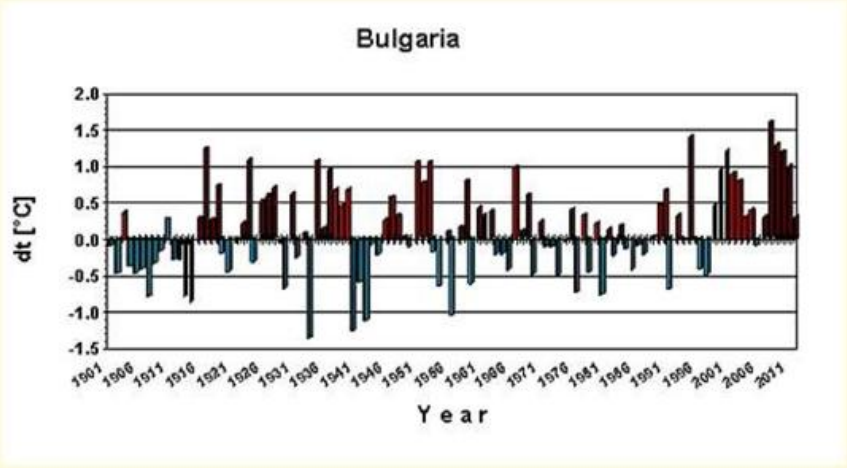


***Fig. 2.15** : Anomalies of mean annual temperatures for the Mediterranean, Italian and Balkan Peninsulas: Italy[1] and Croatia*
[1]kindly provided by ISPRA
(Diagrams as provided by the NHMSs)

Mediterranean, Italian and Balkan Peninsula:



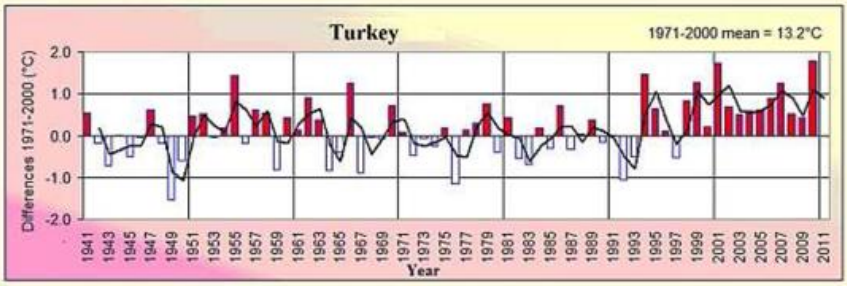


***Fig. 2.16** : Anomalies of mean annual temperatures for the Mediterranean, Italian and Balkan Peninsulas: Bulgaria and Turkey (Diagrams as provided by the NHMSs)*

Eastern Europe:



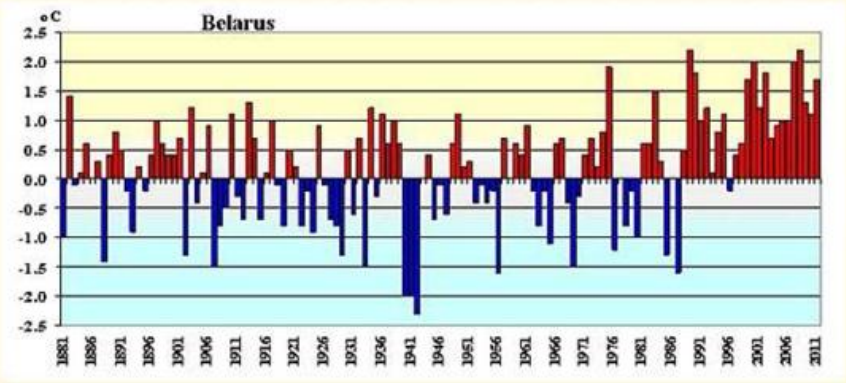


***Fig. 2.17** : Mean annual temperature in Eastern Europe*
(Diagrams as provided by the NHMSs)

Middle East:

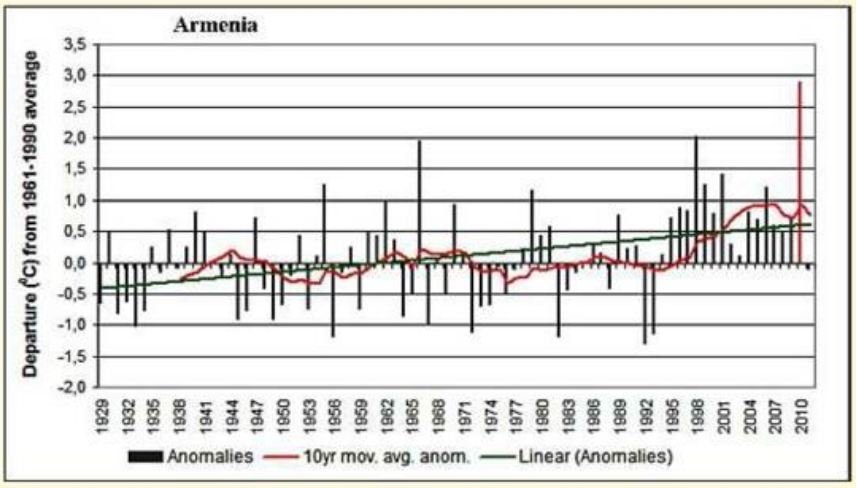




***Fig. 2.18** : Mean annual temperatures for the Middle East*
(Diagrams as provided by the NHMSs)

Precipitation

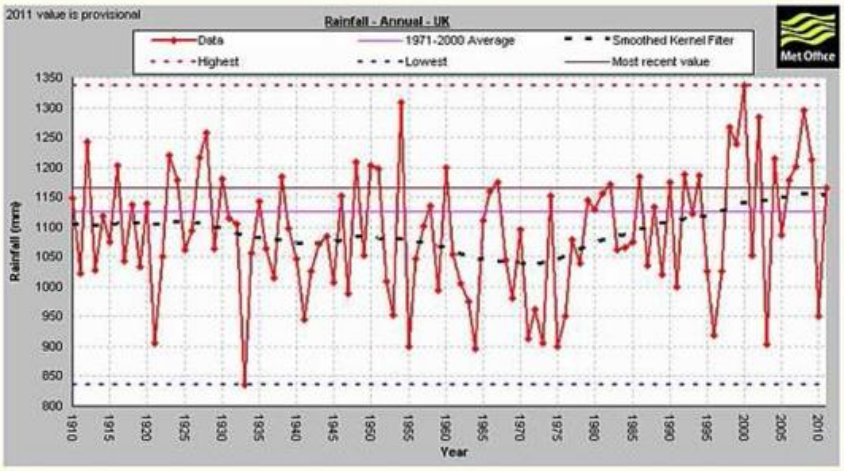
Note: *Most countries refer to the standard normal period or 1971-2000 as for the temperature except Israel, which refers to 1981-2010 resp. 1995-2009 for precipitation.*

For precipitation Fig 2.19 to 2.24 show the available time series for 5 subregions (except Eastern Europe).

For precipitation it is far less easy to draw conclusions from time series of areal means than for temperature. The spatial variability is larger and the spatial distribution of stations may have a decicive influence. So the following conclusions must certainly be taken with great care.

A slight growth of the annual precipitation totals with time can be seen for the United Kingdom and Germany in **Western and Central Europe** and a clear growth with time results for Norway and Denmark in the **Nordic and Baltic Countries**, but not for Latvia. In the other 4 subregions we cannot make a similar statement.

Central and Western Europe:



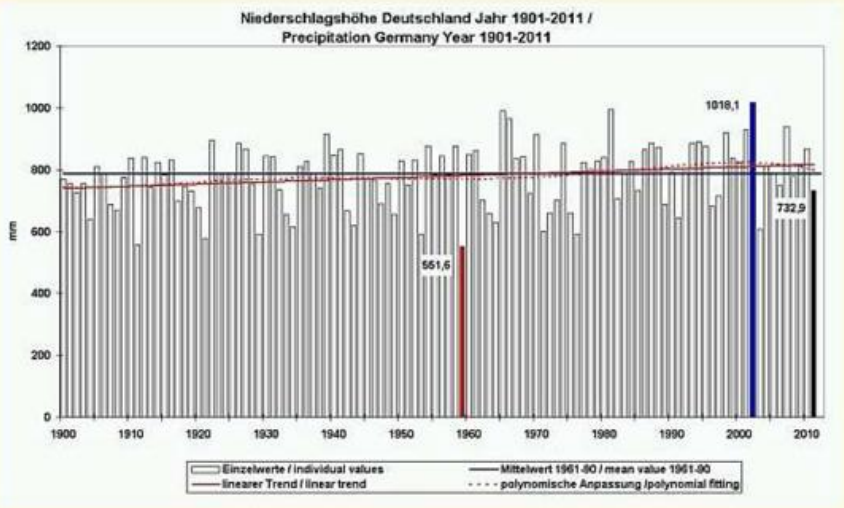
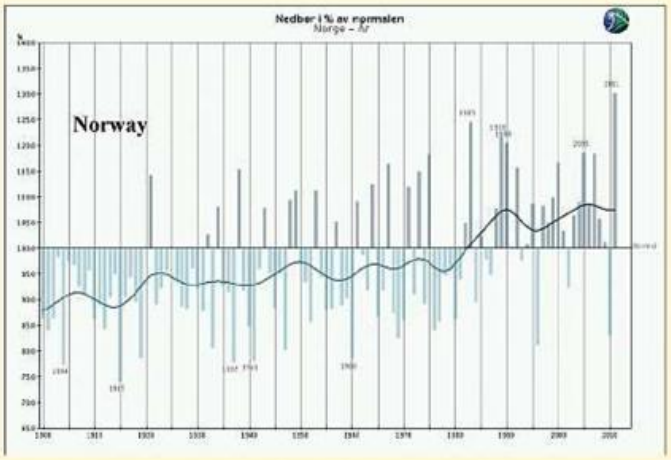
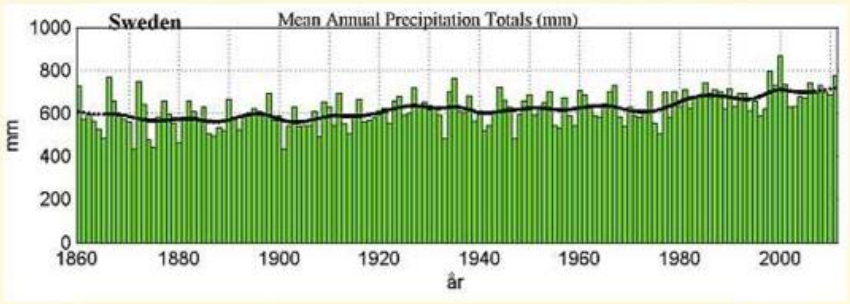


***Fig. 2.19** : Annual precipitation totals in western and central Europe*
(Diagrams as provided by the NHMSs)

Nordic and Baltic Countries:





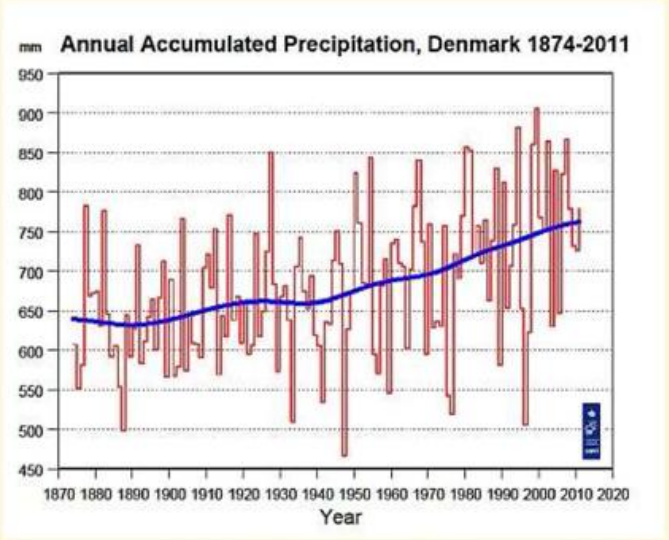
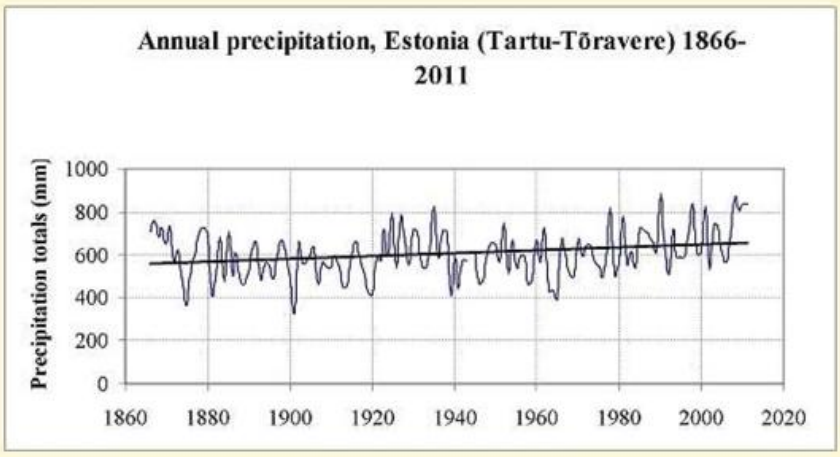


***Fig. 2.20** : Annual precipitation totals resp. anomalies for Nordic and Baltic countries: Scandinavia (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:



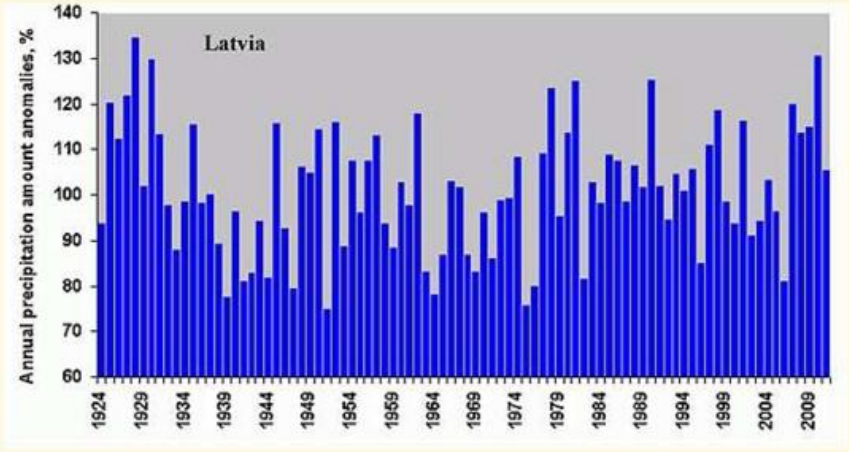


***Fig. 2.21** : Annual precipitation totals resp. anomalies for Nordic and Baltic countries: Baltic states (Diagrams as provided by the NHMSs)*

Iberia:

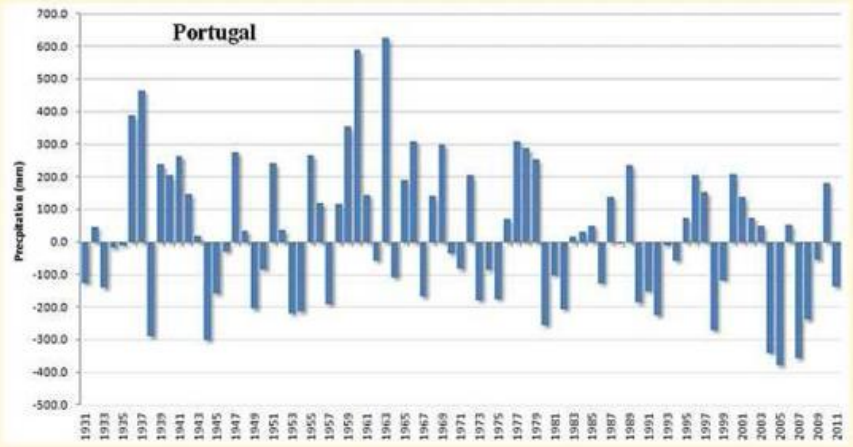
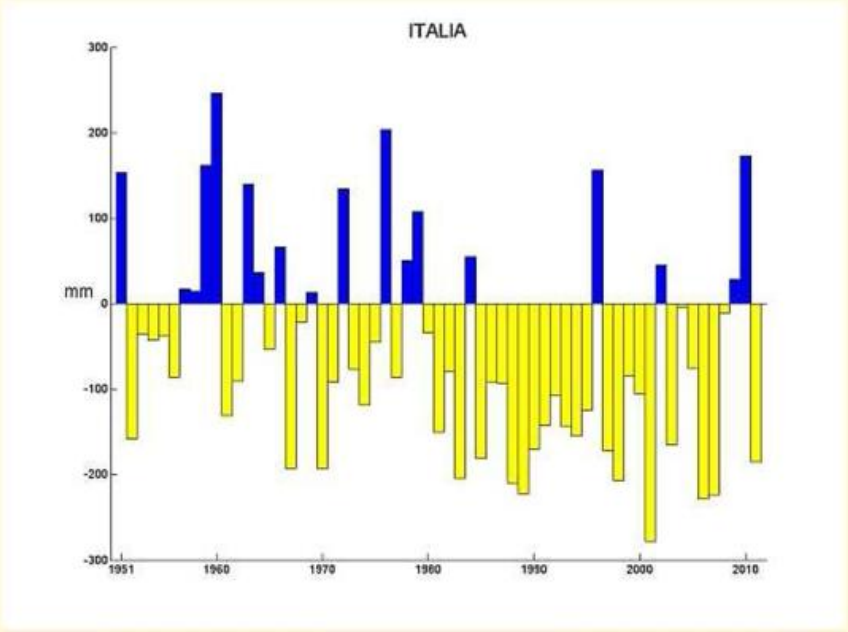


***Fig. 2.22** : Annual precipitation totals in Iberia*
(Diagrams as provided by the NHMSs)

Mediterranean, Italian and Balkan Peninsula:



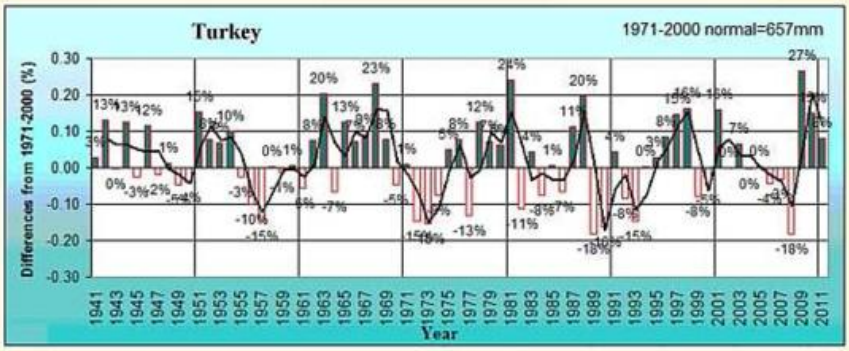


***Fig. 2.23** : Annual precipitation totals for the Mediterranean, Italian[1] and Balkan Peninsulas*
[1]kindly provided by ISPRA
(Diagrams as provided by the NHMSs)

Middle East:

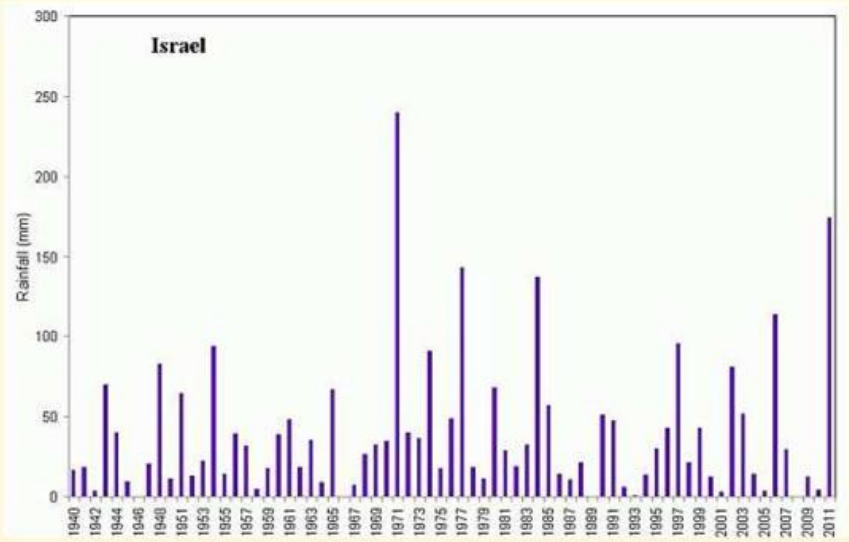


***Fig. 2.24** : Annual precipitation totals for the Middle East*
(Diagrams as provided by the NHMSs)

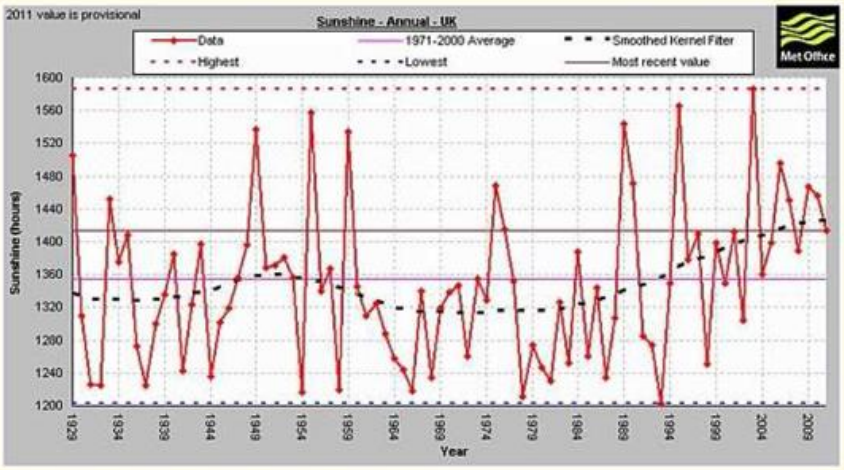
Sunshine

Note:*The sunshine duration time series are generally shorter than those for temperature or precipitation. For the reference periods Cyprus refers to 1981-2010 and France to the short period of 1991-2000.*

Only 4 time series are available for sunshine duration. In **Central and Western Europe** (Fig 2.25) the time series for United Kingdom starts in 1929 and the one for Germany starts in 1951. Both series show the year 2003 to have the highest annual sum of sunshine duration hours in the series. But a clear trend cannot be extracted from the graphs.

In Denmark in the **Nordic and Baltic Countries** (Fig. 2.26) also the year 2003 shows a very high annual sum of sunshine duration hours, the highest since a mimimum in the early eighties. Still a little higher was the value for the mid fourties and only a little less in the mid fifties. The value for 2011 was slightly below the running mean but still does not yet change the rising trend that existed since the mid of the nineteeneighties. The running mean value at the end of the series is more than 150 hours higher than the peak value around the year 1940. The series goes back to 1920. The highest value of the time series is recorded in 2003 in Estonia as well.

Central and Western Europe:



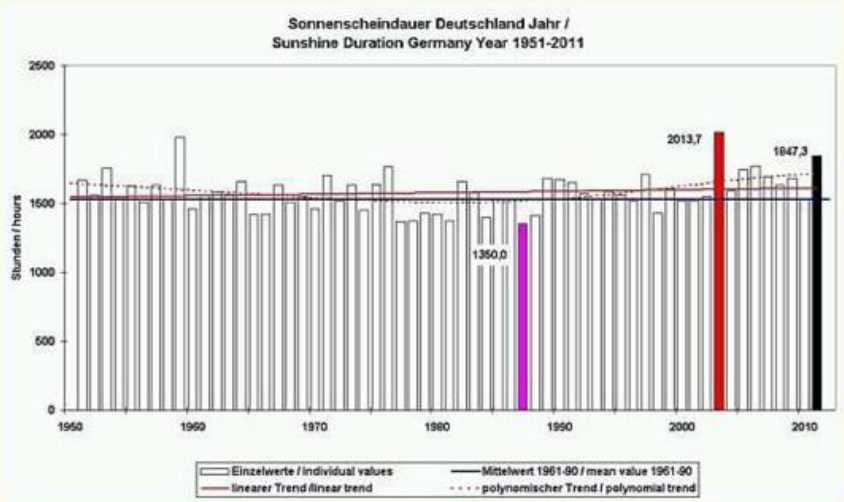
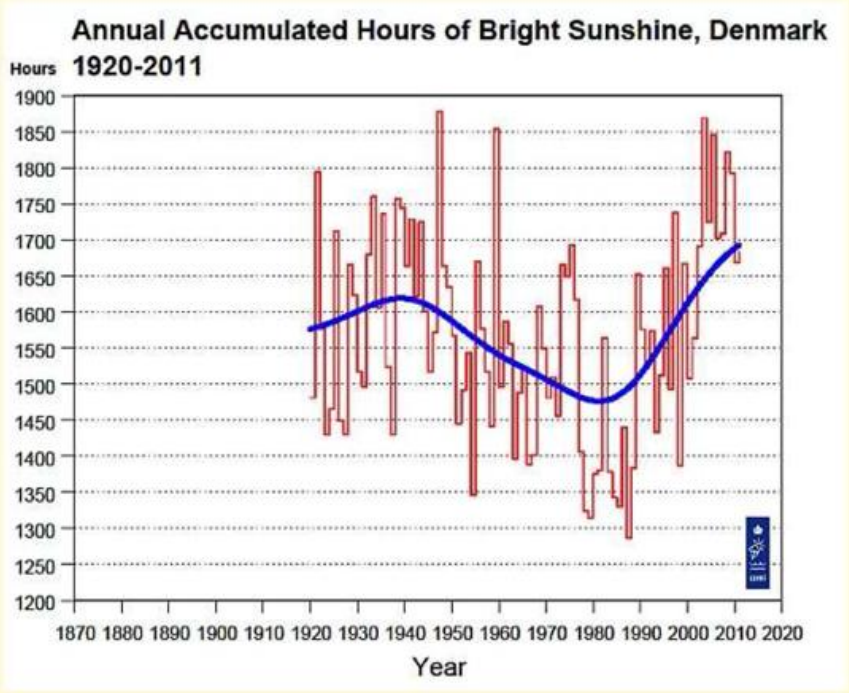


***Fig. 2.25** : Mean annual sunshine duration in western and central Europe*
(Diagrams as provided by the NHMSs)

Nordic and Baltic Countries:



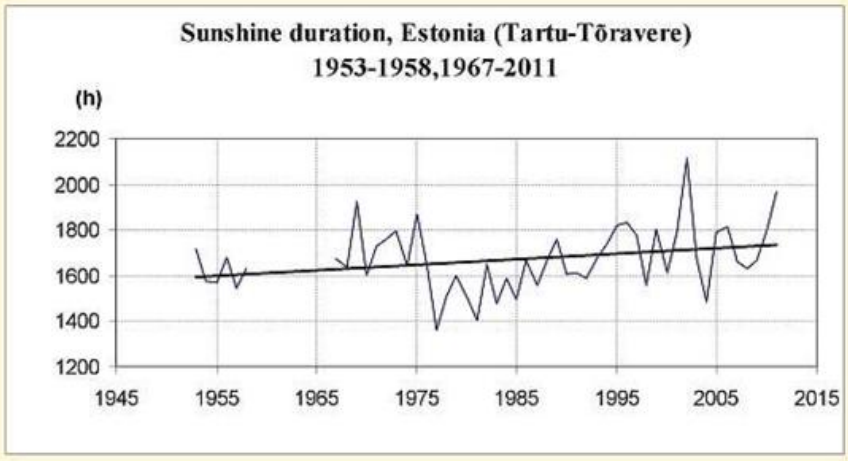


***Fig. 2.26** : Mean annual sunshine duration for Nordic and Baltic countries*
(Diagrams as provided by the NHMSs)

Trends of temperature and precipitation

Figure 2.27 shows the spatial distribution of trends for the mean annual temperature and the annual precipitation total as well as the cold spell duration index and very wet days for the time series 1951 - 2011 for stations in Europe contributing to the ECA&D data set. A warming trend for most of Europe can clearly be seen for the mean annual temperature. A corresponding decrease of the cold spell duration index is more visible for central Europe (perhaps due to the better coverage with stations) whereas elsewhere more stations are not significant.

For the annual totals of precipitation we can state roughly a different behavior between the south (mostly unsignificant) and the north (more slightly positive values) and the regions especially influenced by the North Atlantic seem to show clearer positive trends. This feature may eventually be explained by the influence of a warming North Atlantic. But many stations on the other hand are not sigificant. The distribution of trends for very wet days shows mostly unsignificant values.

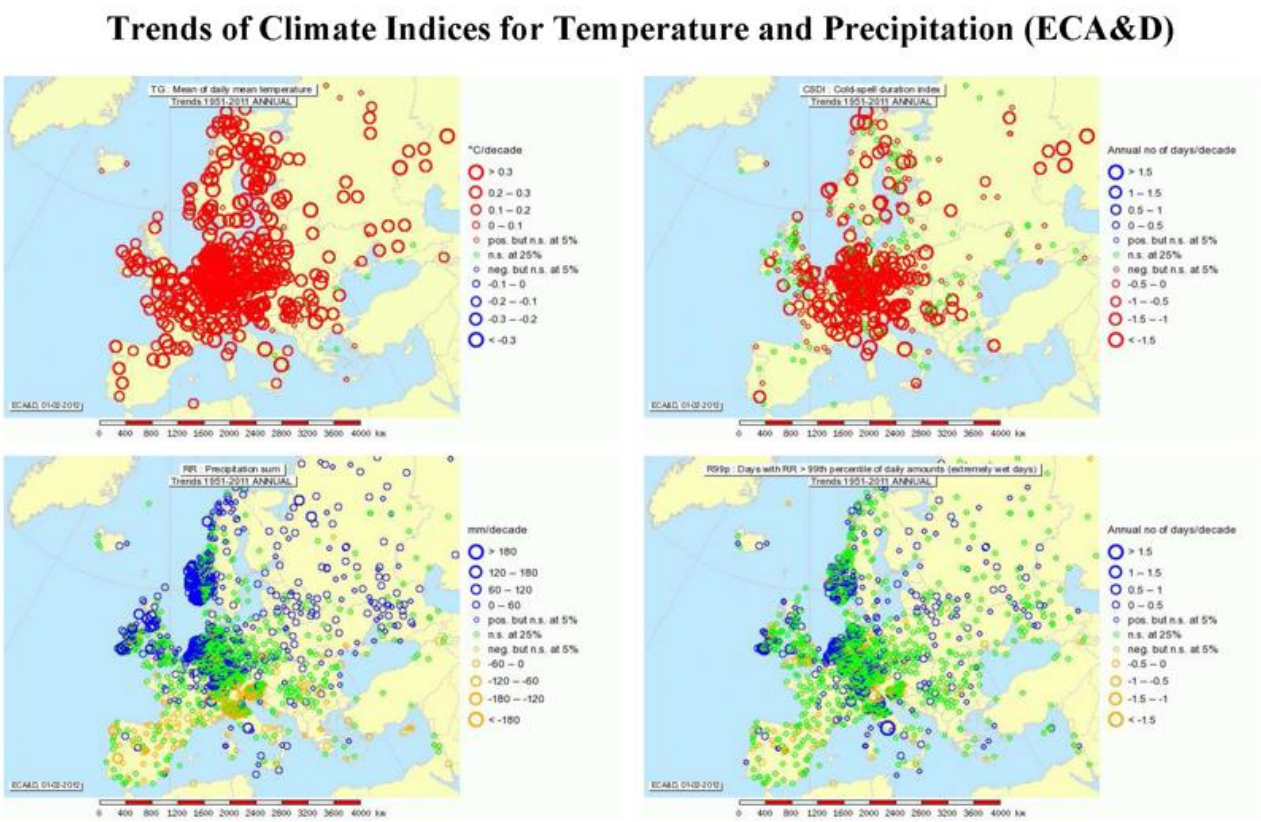


Fig. 2.27: *Trends of Selected Climate Indices 1951 to 2011 (Source: ECA&D, http://www.ecad.eu):*
Upper left: TG (Mean of daily temperature),
Upper right: CSDI (Cold spell duration index),
Lower left: RR (Precipitation sum),
Lower right: RR99p (Days with RR>99th percentile of daily amounts (extremely wet days)

Long-term temporal development of related phenomena

Fig. 2.28 and 2.29 illustrate 2 phenomena that are closely related to the temporal development of the air temperature.

In Fig 2.28 a ranking of the North Sea surface temperature since 1969 is shown. Note that the 'year' in this case refers to December to November. Presented are the ranks of the years 1969 to 2011. From 1988 until now most (all except 5 years) values are warmer than the median while before 1988 most values were colder. 2011 was on the warm side but close to the median.

In Fig. 2.29 the annual mass balance of the Goldberg glacier in Austria (as a representative of Alpine glaciers) is shown starting 1989. There are 6 years with a positive mass balance. All other years have a negative mass balance and the loss in the individual years is in most cases larger than the largest positive gain in individual years. This impressively illustrates the consequences of higher temperatures during the last years. 2011 had the greatest loss after 2003.

Long time series of more temperature related phenomena also on global scale can be found at NOAA/NCDC: Climate indicators

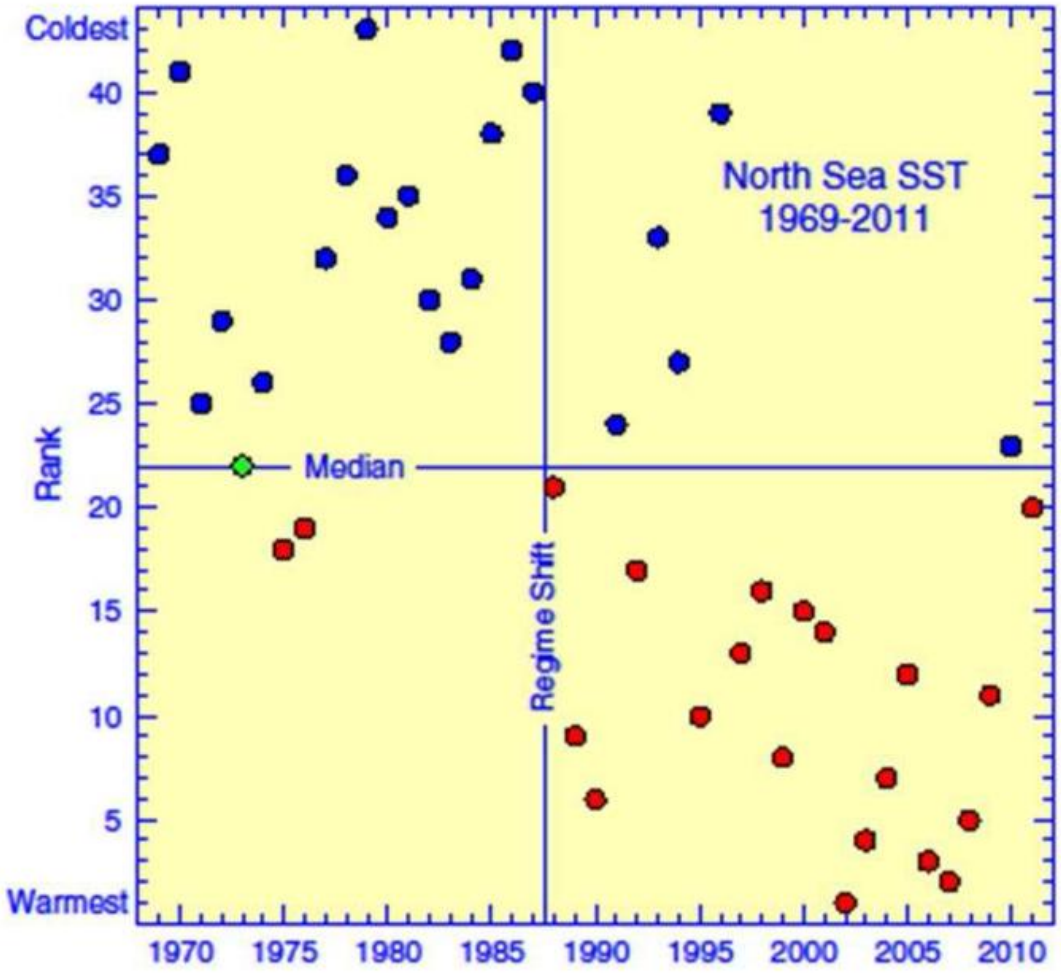


Fig. 2.28: *Rank statistics of the North Sea SST form 1969 to 2011 (Source: Bundesamt für Seeschiffahrt und Hydrographie BSH) (year2011means December 2010 to November2011)*

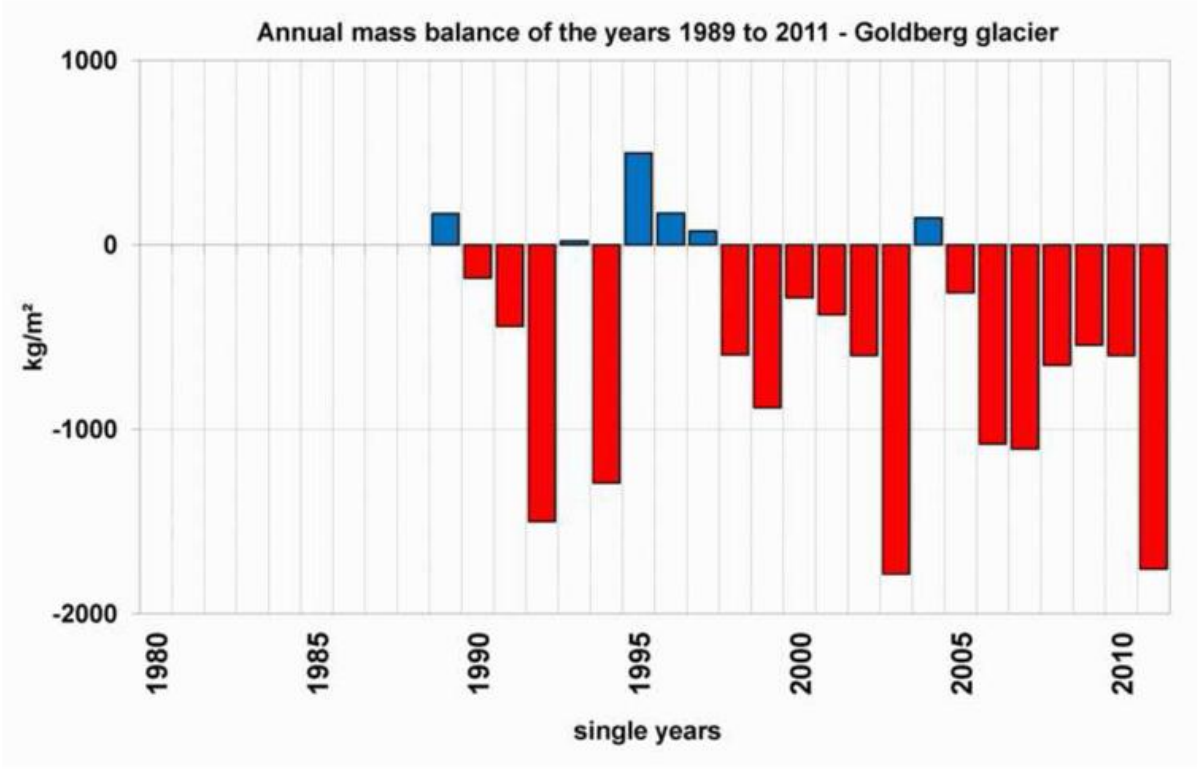


Fig. 2.29: *Mass balance of the Goldberg Glacier (Austria) 1989 to 2011 (Source: ZAMG, http://www.)*

Seasonal Survey

Winter

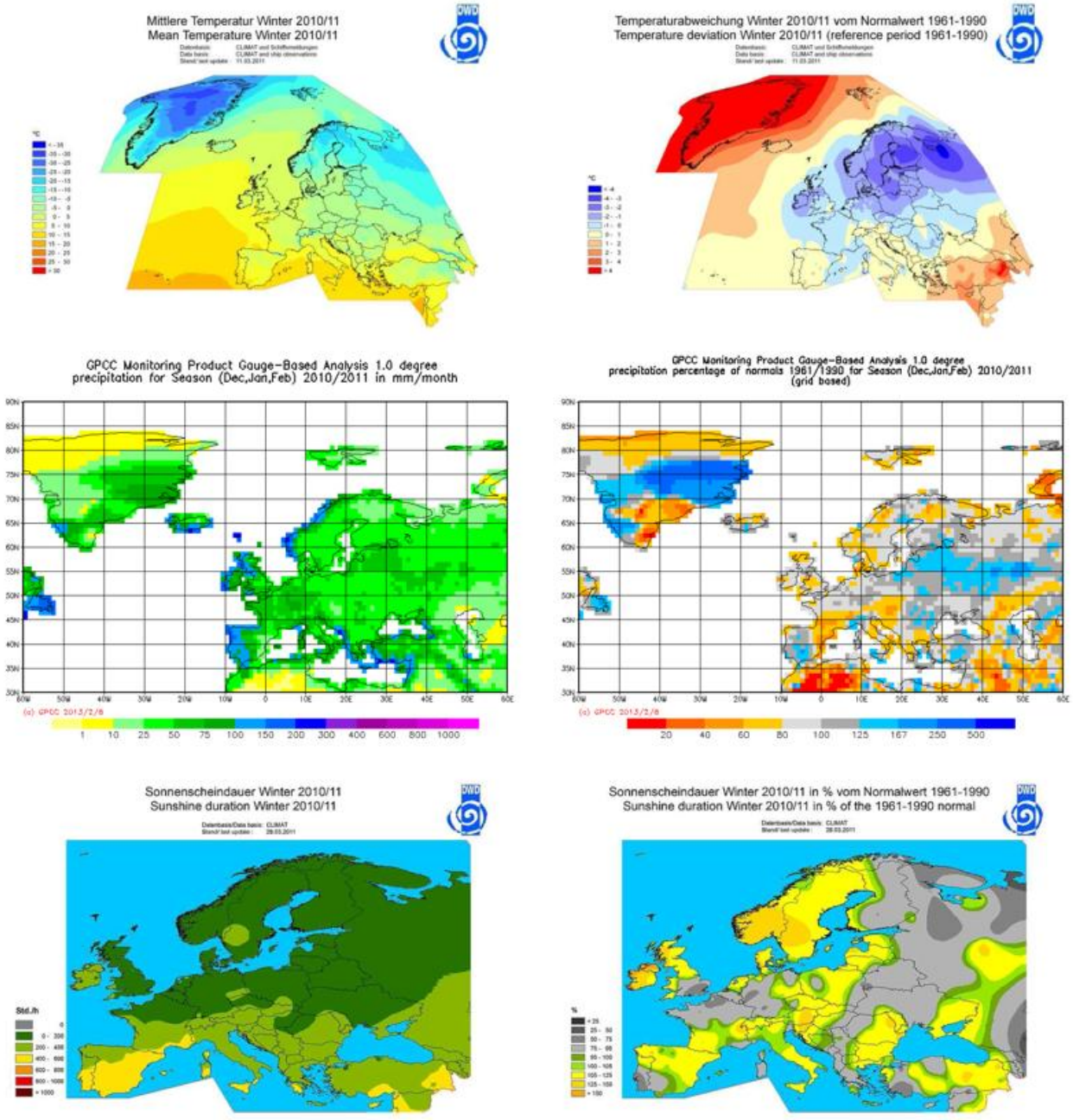


Fig. 2.30: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in winter 2011*
Source: http://www.dwd.de/rcc-cm

Winter

Winter 2010/2011 was in western, central, northern and eastern Europe as well as partly in the Mediterranean region colder than normal. The negative anomalies were largest over Scandinavia, the Baltic states and Russia. This is the western edge of a Siberian cold area where locally negative anomalies of more than 4 K were observed. Mean anomalies for Finland and Sweden resulted in -2.7 K resp. -2.2 K, in -1,8 K for the Baltic states Estonia, Latvia and Lithuania, for Denmark as well and in -1.4 K for Poland and -1.5 K for European Russia (see the table on page 21 and the remarks on the areal means from the spatial temperature analysis). Ireland and northern UK were similarly cold (-1.4 K for Ireland). This cold anomaly is mainly the result of the intense cold spell in December 2010. On the other hand it was warmer than normal in the north and northwest, especially in Greenland, where the areal mean of the anomalies resulted in +5.7 K and locally +6.4 K were reached (http://data.giss.nasa.gov/gistemp/maps). For 5 stations on Greenland it was the warmest winter on record. Also the Middle East and parts of southeastern Europe were clearly warmer than normal.

Precipitation was less than normal in Winter 2010/2011 over the British Isles and close to the North Sea and the Norwegian Sea on one hand and in southern France, around the Adriatic Sea and in Middle East on the other hand. The dry areas in the north may be related to the influence of high pressure in December 2010 and a low amount of water vapour (http://www.dwd.de/rcc-cm) in the atmosphere corresponding to the mentioned cold spell. Southwestern France had less than normal precipitation during each winter month (December 2010, January and February 2011). It was on the other hand wetter than normal on the western Iberian Peninsula as well as in the eastern Baltic Sea region and western Russia.

It was sunnier than normal over the northern North Atlantic, the North Sea and the Baltic Sea, Scandinavia and the eastern Central Europe as well as the western Mediterranean Sea and the Iberian Peninsula. Also the eastern Balkan Peninsula, parts of Turkey and of Russia and the Ukraine had more sunshine than normal.

Drought

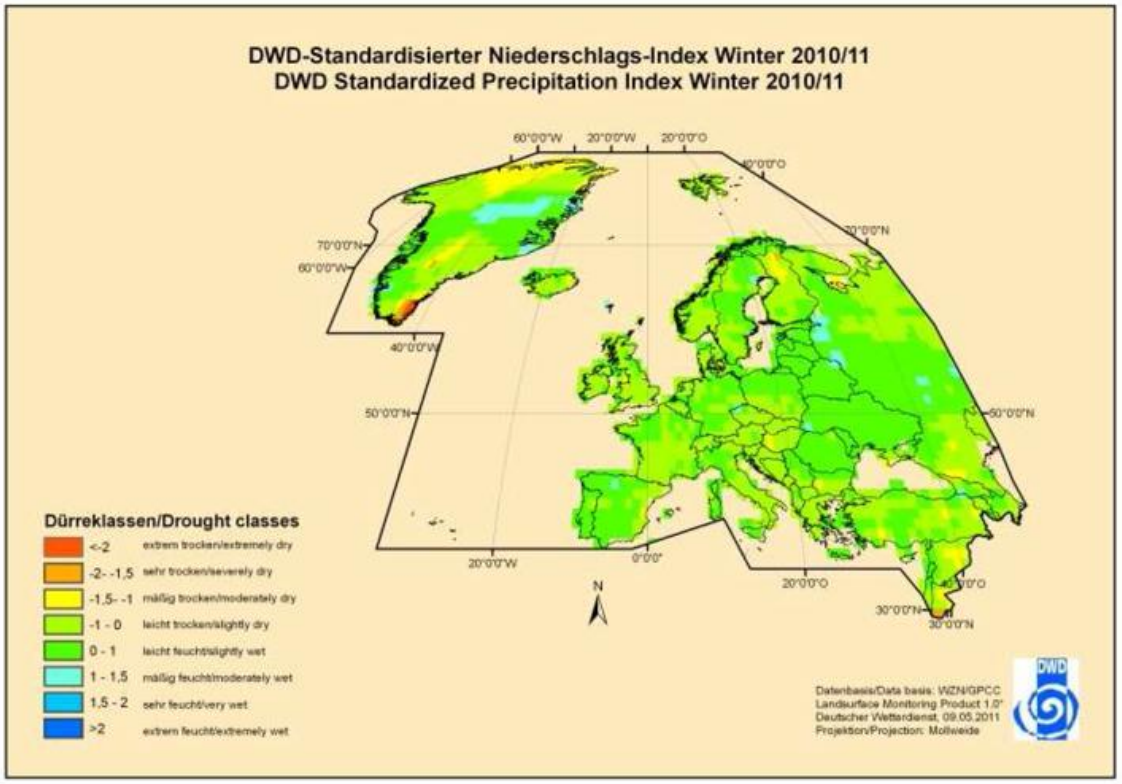


Fig. 2.31: *Means of the modified Standardized Precipitation Index (DWD-SPI), winter 2011*

Spring

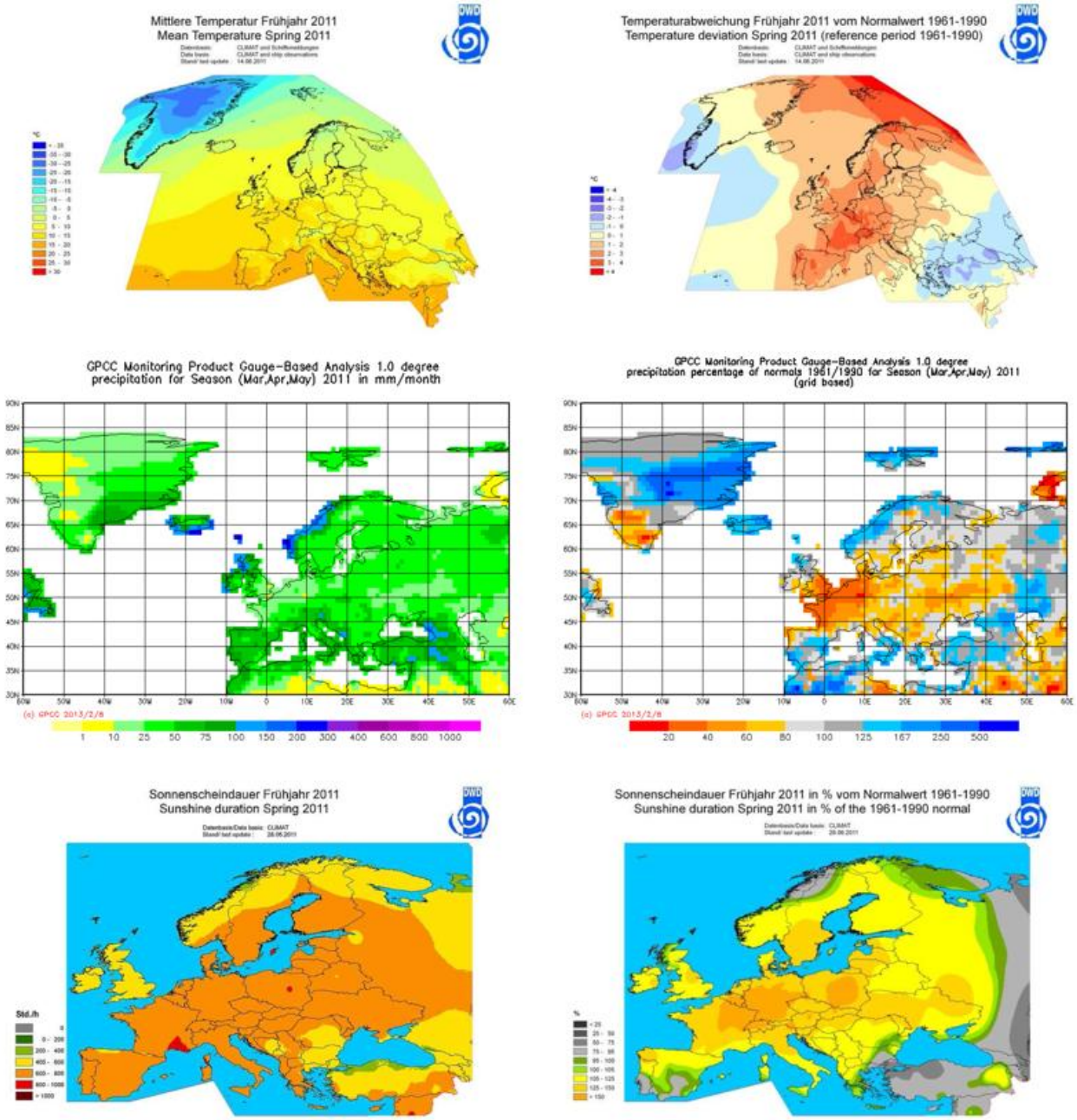


Fig. 2.32: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in spring 2011*
Source: http://www.dwd.de/rcc-cm

Spring

Spring 2011 had a nearly inverse distribution of temperature anomalies compared to the winter season. It was warmer than normal nearly in whole Europe. Only the Middle East and the western North Atlantic with southern Greenland were colder than normal. Overall the highest positive anomaly was located in the Arctic region again but in the northeast. Over northern Russia and the Arctic Ocean positive anomalies up to +6.6 K were analysed. The negative anomalies on the continent were restricted to the region of the Black Sea, Turkey and southern Russia and reached -2 K in Turkey. For central England spring 2011 was the warmest spring since 1659 (together with 1893) and it was the warmest spring since 1910 for whole UK. The Netherlands reported spring 2011 the 2nd warmest since 1706. In Spain it was the warmest spring since 1961.

While the northern parts of Europe (Iceland, Scotland, Norway) as well as partly the Mediterranean Sea and Middle East received more precipitation than normal in spring 2011, western and central Europe and southern England were remarkably drier than normal and drier were as well eastern and parts of southern Europe, the Balkan Peninsula and Belarus, Ukraine and parts of Russia. Mostly all 3 months had less precipitation than normal but the driest month in many countries was April. It was the driest spring in parts of southern England and East Anglia (UK) for 101 years, and the 2nd driest since 1910 in England and Wales, where only 45 % of the mean totals fell. In France spring 2011 was the driest since 1959 and in the Netherlands it was the driest spring for at least a century.

Spring 2011 was sunnier than normal nearly over whole Europe. In Germany, France, Belgium, Austria and Poland the sunshine duration exceeded partly more than 150 percent of the normal. It was the sunniest spring at Uccle (Belgium) since 1887 and the sunniest as well since at least a century in the Netherlands.

Overall spring 2011 was influenced by a slightly stronger than normal Azores high which extended far eastwards.

Drought

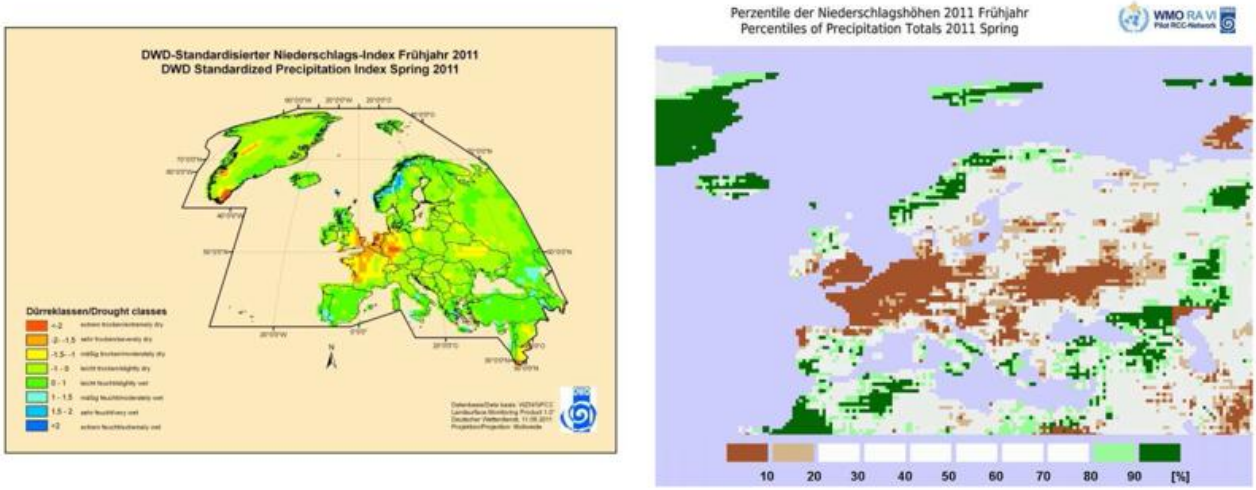


Fig. 2.33: *Means of the modified Standardized Precipitation Index (DWD-SPI) and precipitation totals in terms of percentiles based on GPCC data 1951 to 2000, spring 2011*

The two maps in Figure 2.33 show impressively the extent and spatial distribution of the standardized precipitation index (SPI) and the percentiles of precipitation in spring 2011. Generally the anomalies of the precipitation totals in percent, the SPI and precipitation percentiles tell the same but the precipitation percentiles make the weights of very small precipitation (below the 10th percentile) and the spatial extent of its area especially in eastern and southeastern Europe clearer.

Summer

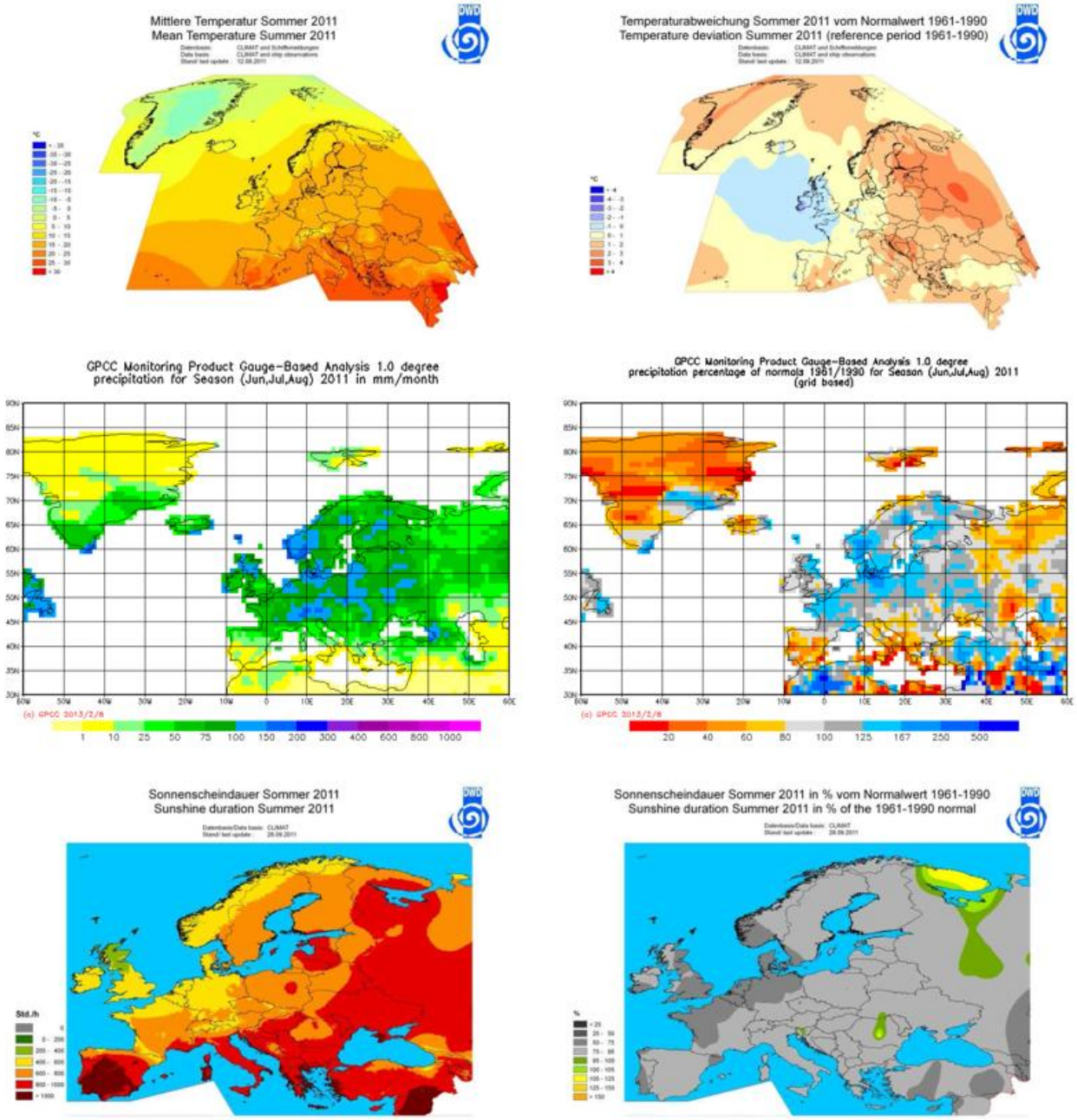


Fig. 2.34: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in summer 2011*
Source: http://www.dwd.de/rcc-cm

Summer

In western Europe the British Isles and France were influenced by a negative temperature anomaly over the Atlantic in Summer 2011. Everywhere else it was warmer than normal. The highest positive anomalies occurred in a small area around Moscow, Russia, where in July the anomalies came up to +5.3 K. Seasonal anomalies of +2 K or more as spatial means over the countries occurred in the Baltic states, Finland, European Russia, Belarus and on the Balkan Peninsula. In Estonia it was the warmest summer since 1866 (together with 2010). For Helsinki, Finland, it was the warmest summer since the early part of the 19th century as well. In contrast it was the coldest summer for 25 to 75 years in places in Ireland with -0.9 K as a spatial mean over the country. The evaluation of anomalies for climate indices (see European Climate Assessment & Dataset - Indices of extremes) shows the following features:

- The southwestern British Isles and Ireland had more cold days (days with a mean temperature below the 10th percentile of daily mean temperatures) than normal.
- the British Isles, southern Norway and the northwestern continent had less warm days (days with a mean temperature above the 90th percentile of daily mean temperature) than normal.
- The number of tropical nights was clearly above normal in the south around the Mediterranean Sea as well as around the Black Sea.
- The warm spell duration index had mostly slightly negative anomalies in western Europe and northern central Europe and slightly positive anomalies in southern and southeastern Europe.

Summer 2011 was wetter than normal mostly in western, central and northern Europe but drier than normal in southern and eastern Europe. It was the wettest summer since at least 1906 in The Netherlands. The evaluation of anomalies for climate indices (see European Climate Assessment & Dataset - Indices of extremes) shows the following features:

- Extremely wet days (days with a precipitation above 99th percentile of daily amounts) were more often in Norway, and close to the southern coasts of the North Sea and the Baltic Sea
- days with very heavy precipitation (equal or above 20 mm) were more often there as well as elsewhere in Central Europe, especially in the Alpine region.
- The highest daily amounts were clearly higher than normal in southern Norway, northeastern Germany and western Poland, the eastern Alps and locally in southern France, Italy and the Aegean Sea.
- In southern Norway, northeastern Germany and western Poland as well as locally the Baltic States, Ukraine and southeastern France also the highest 5-day amounts were remarkably higher than normal.

Summer 2011 had nearly everywhere less sunshine than normal. The dullest region with partly less than 50 percent of the normal was around the North Sea and at the western Atlantic coasts.

Drought

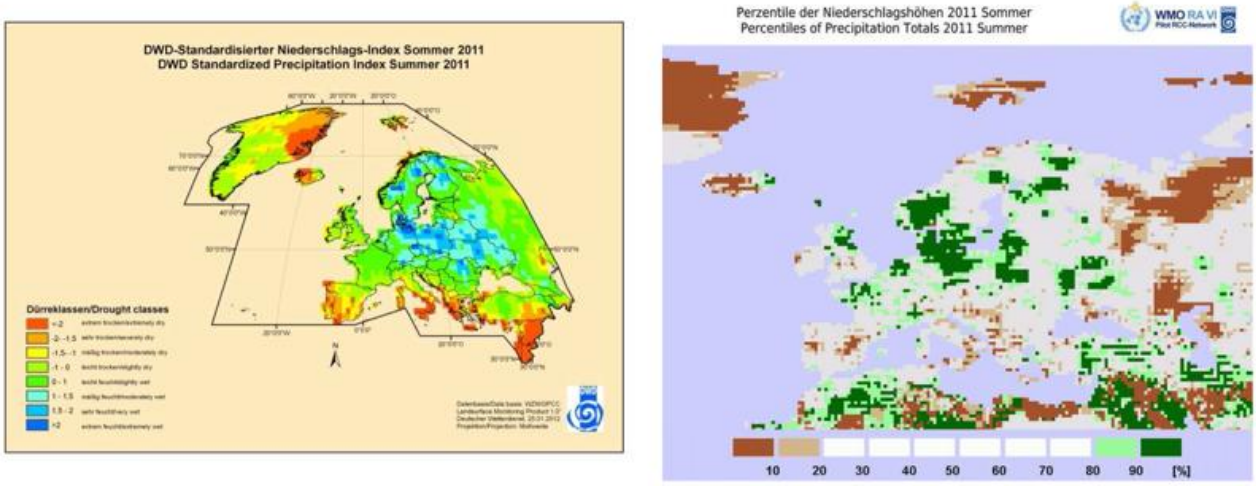


Fig. 2.35: *Means of the modified Standardized Precipitation Index (DWD-SPI) and precipitation totals in terms of percentiles based on GPCC data 1951 to 2000, summer 2011*

In summer 2011 more precipitation than normal fell in areas which were affected by the spring drought. The SPI shows a large area of 'very wet' or 'extremely wet' conditions in eastern central Europe and eastern Europe as well as northern Europe. The percentiles show that the areas of much more than normal precipitation are smaller, meaning that they are often still less than the 80th or 90th percentiles. Also within regions which received close to normal precipitation totals there were still some areas with precipitation below the 20th or even 10th percentiles. Thus water ressources may not have filled up enough during this time.

Autumn

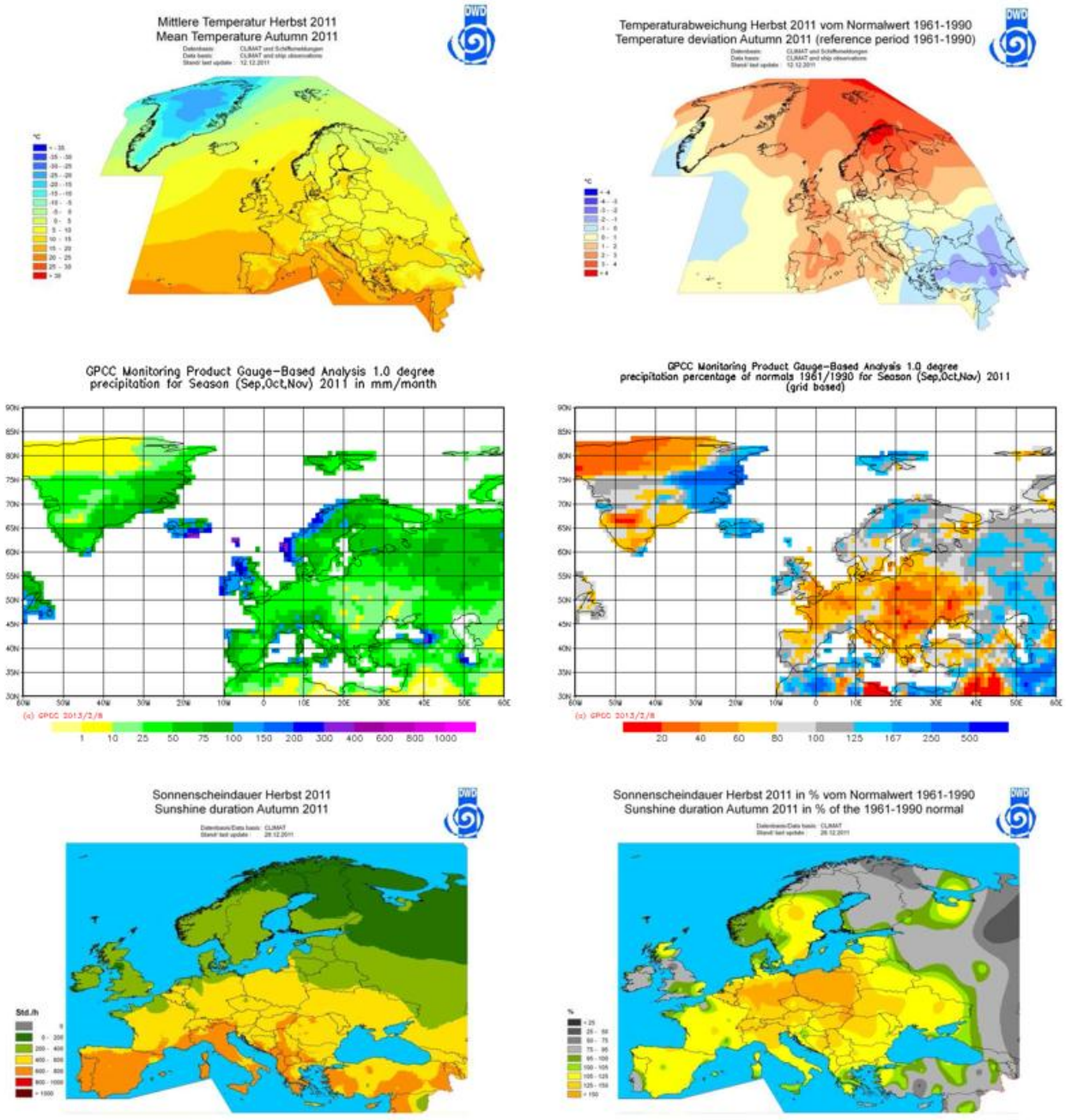


Fig. 2.36: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in autumn 2011*
Source: http://www.dwd.de/rcc-cm

Autumn

The distribution of positive and negative anomalies of autumn 2011 resembles the one of spring 2011. An area centered over the Caucasus with anomalies of -2 K and more over Turkey, the Caucasus countries and southern Russia, was colder than normal. Colder than normal was also the western North Atlantic and the southwesternmost part of Greenland. Everywhere else it was warmer than normal. The highest positive anomalies occurred in northern Scandinavia and the northeastern Arctic. It was the warmest autumn since 1900 in Norway, where the areal mean over the country came up to +3.1 K, and also the warmest autumn on record in places of Ireland (for 150 years in Dublin). Though the ranks are not reported it may be the same in Sweden (areal mean +2.9 K) and Finland (areal mean +3.3 K). Svalbard reached an areal mean of positive anomalies for autumn 2011 of +3.8 K). For the Baltic states the areal means of anomalies ranged from +1.4 K to +2.5 K, UK had +2.2 K, Iceland and the Faroer Islands +2.0 K. Autumn 2011 achieved rank 2 of warm autumn seasons since the beginning of the 20th century in France.

Summer days occurred remarkably more often than normal in southwestern, southern and southeastern Europe and tropical nights occurred locally unusually often in the central and eastern Mediterranean Sea area (see European Climate Assessment & Dataset - Indices of extremes).

Autumn 2011 was drier than normal on most of the continent, namely in central, western and southern Europe and parts of eastern Europe and of the Middle East. The precipitation totals for the season remained below 80 % overall, in eastern Europe and in western and partly central Europe below 60 percent and partly below 40 percent in eastern Europe and on the Balkan Peninsula. The greatest negative absolute anomalies in mm occurred around the Adriatic Sea. During the most outstanding month November 2011 a region extending from the North Sea to the Black Sea received less than 10 mm per month, partly less than 1 mm. This meant up to -70 mm in absolute anomalies (mm) and less than 20 % in relative anomalies. More information on November 2011 will be provided in the section 'Monthly Survey'. It was on the other hand wetter than normal in northern UK and Ireland, Scandinavia, Russia and most of the Middle East. But not only here but also in the dry areas heavy to extremely heavy precipitation fell in places like for instance in northern Italy in late October and in southern France in early November.

Autumn 2011 was sunnier than normal in Central Europe and in most of western, southern and eastern Europe and partly in the south of Scandinavia. See for comparison the maps of the number of days with cloud cover below 2 octa or above 6 octa (see RCC-CM: Products - Monitoring Europe - Cloud Cover.

Drought

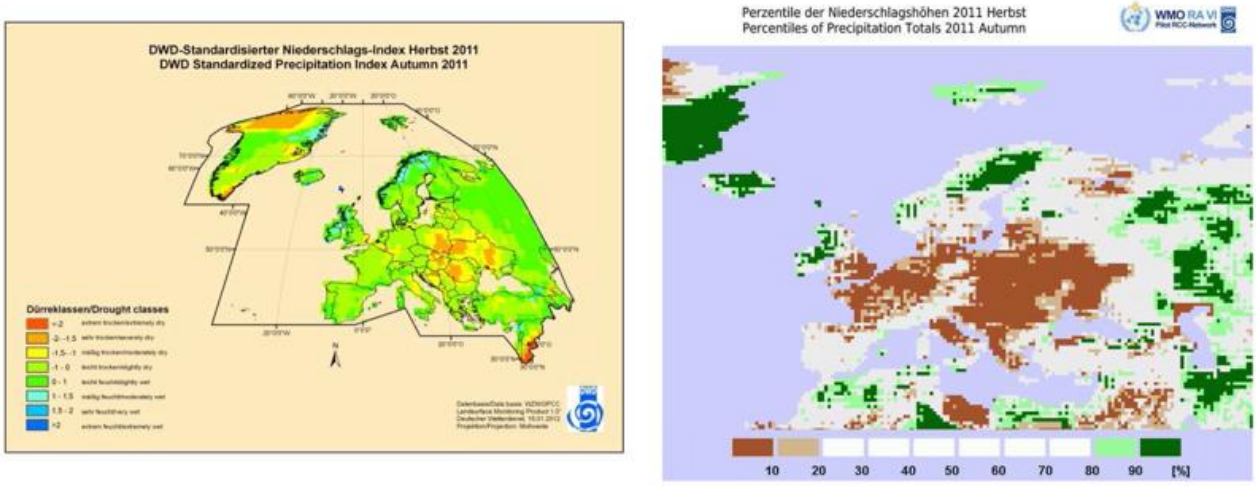


Fig. 2.37: *Means of the modified Standardized Precipitation Index (DWD-SPI) and precipitation totals in terms of percentiles based on GPCC data 1951 to 2000, autumn 2011*

In autumn 2011 the percentile map gives more weight of the dry area to the western and central European countries than the map of the SPI, though both clearly coincide that the largest coherent area with the driest conditions covers the northern Balkan Peninsula, eastern central Europe and western central Russia.

Monthly Survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2011 on the Climate in WMO Region VI - Europe and Middle East - which are available on Internet under http://www.dwd.de/rcc-cm.

January

Highlights:

- ***Temperatures were above normal in Europe with few exceptions of British Isles, southwestern France and western Mediterranean Sea.***
- ***Wet in northern Russia and Finland, mostly neutral or dry in western, central and southern Europe***
- ***Dull in northern and northeastern Europe, mostly sunny elsewhere***

Overview:

Temperature:

January 2011 had above normal temperatures in RA VI with few exceptions. It was cooler than normal for Ireland (with an anomaly of -1 to -2 K), parts of Britain, southwestern France and the western Mediterranean area as well as locally in the eastern Mediterranean, parts of the Black Sea, the Sea of Azov and the southeast of Ukraine. Temperatures of western Greenland were clearly above normal with an anomaly of more than +4 K. Most of Belarus and the northwest of Ukraine had positive anomalies of +3 to +4 K as well as eastern Turkey were even more than +4 K occurred.

Most striking is the positive anomaly of more than 4 K for Greenland. Some stations on Greenland had their warmest January on record. The Swiss mountain station Jungfrau Joch had its 3rd highest January maximum temperature of +0.7 °C.

Precipitation:

Much of the area of interest was dry or normal in January 2011 except northern Russia, Finland and central Russia as well as locations mainly in the central and Eastern Mediterranean sea (Sicily, Greece, western Turkey, Cyprus), west and south of the Black Sea and in the Middle East. It was especially fairly dry for southern France and northern Spain, the Alpes and the northern and western Balkan Peninsula as well as the Caucasus region and relatively dry for the British Isles and Ireland. Some remarkably high daily precipitation sums are reported especially from Norway 109 mm, United Kingdom 103 mm, Austria 110 mm, Portugal 133 mm, Turkey 116 mm and Greece 114 mm.

Lithuania and Latvia reported very high snow depths in January 2011. Lithuania had 60 to 68 cm of snow in the west at tbe beginning of the month. Latvia reported damages caused by the snowload. In Russia St Petersburg had the highest January precipitation total since obserbations began. 84.4 mm correspond to more than twice the normal value.

Sunshine:

The sunshine duration in January 2011 was remarkably below the normal in the north of European Russia, where a large area was nearly completely cloudy with 7 octa over the month (see Satellite-based Regional Climate Monitoring). Also in Germany a large portion of the country was as cloudy. Nearly as cloudy was the rest of central Europe, part of the Baltic Sea, parts of the northern Balkan Peninsula and the Ukraine where the sunshine duration was as well below the normal. Also rather dull was the northern North Atlantic with at least 16 dull days and further north in the Norwegian and the Arctic Sea at least 21 dull days. 6 - 10 fair days occurred for most of the Peninsula Iberica and in the western and the eastern Mediterranean Sea, as well as over the Alpes. Here as well as in a smaller region of northern Spain and the adjacant sea and for the eastern and southeastern Mediterranean even more than 10 fair days occurred but hardly more than 15. The British Isles and Ireland had a little more fair days with up to 10, the same for southern Norway and dull days were below 11 over the British Isles, the North Sea, much of Scandinavia and most of the central and eastern North Atlantic. This distribution of cloudiness corresponds to the positive sunshine duration

anomalies for Ireland and Scotland and southern Scandinavia and it explains also the patchy distribution in the Mediterranean and for the Balkan Peninsula. Only the positive anomaly in Central Europe does not match the cloud distribution well. But this is matter of small differences and possibly of spatial resolution of the satellite data in this case.

Monthly Means or Totals and Anomalies :

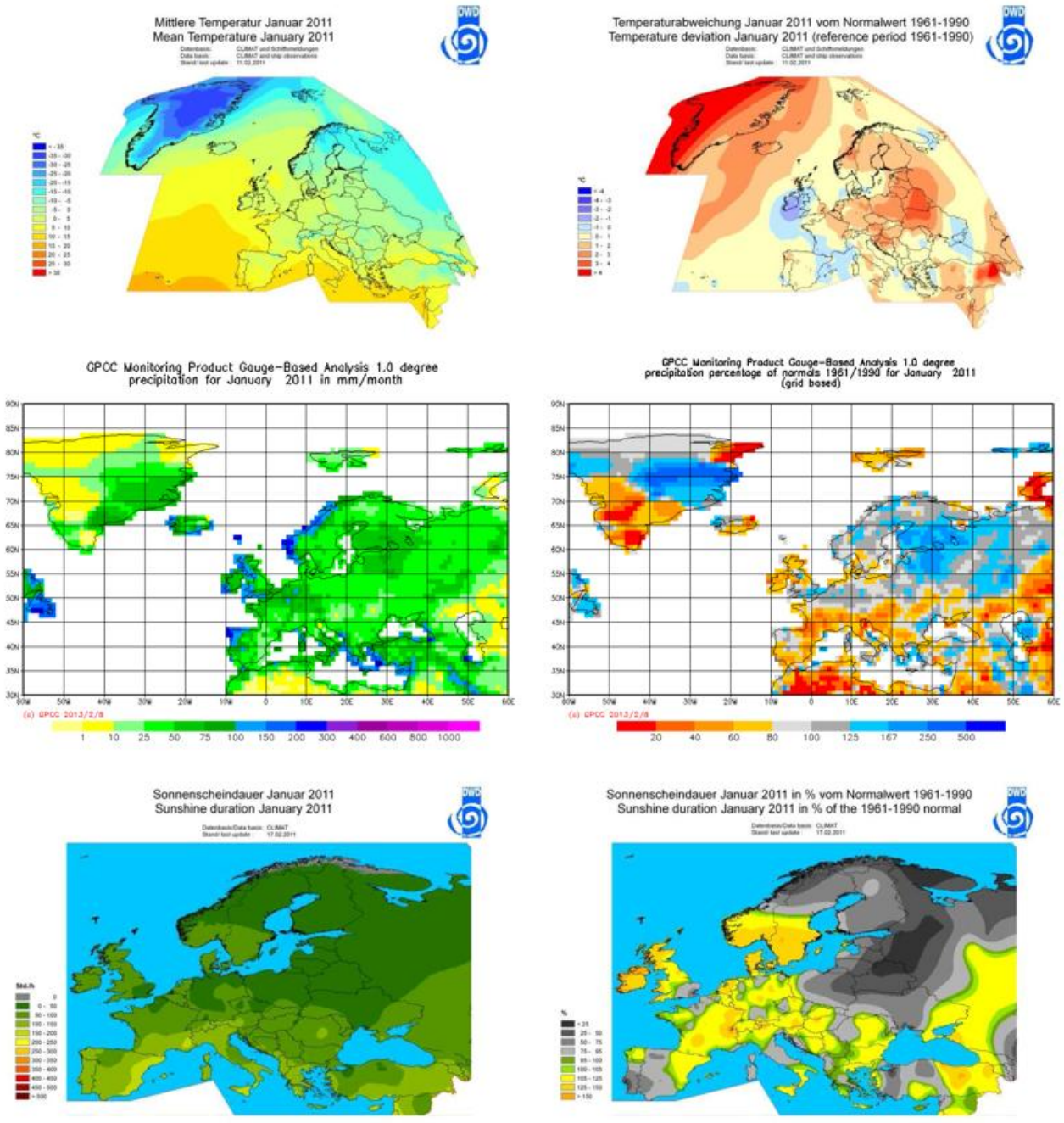


Fig. 3.1: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in January 2011*

Monthly Climate Extremes and Events:

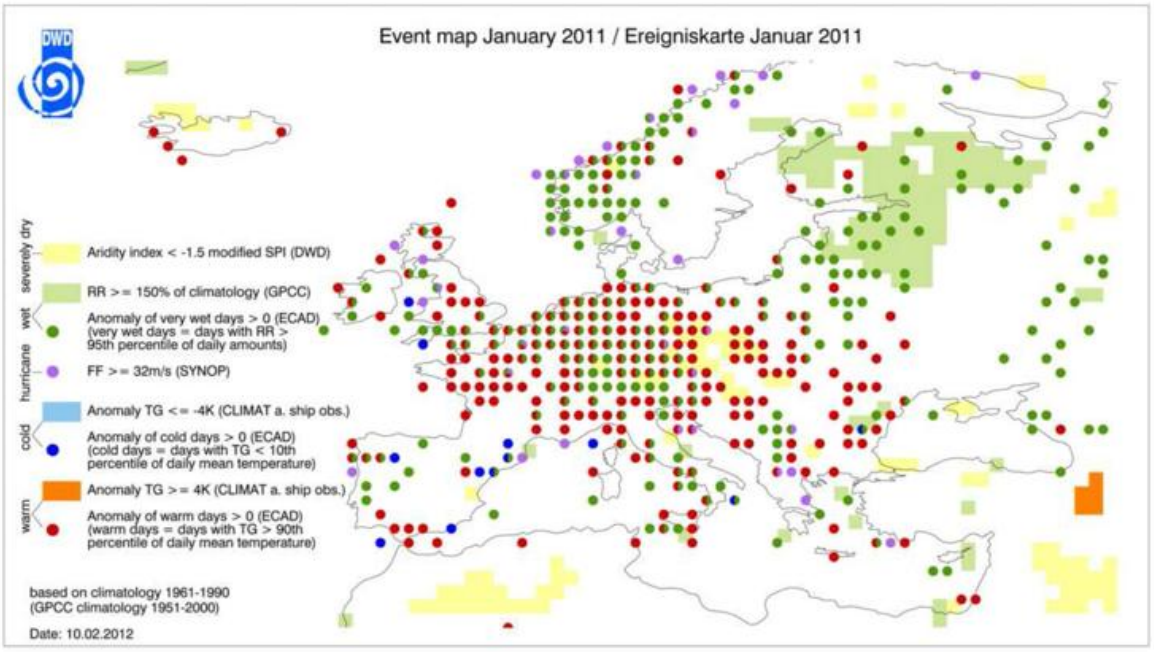


***Fig. 3.2** : Monthly Map of Climate Extremes and Events January 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

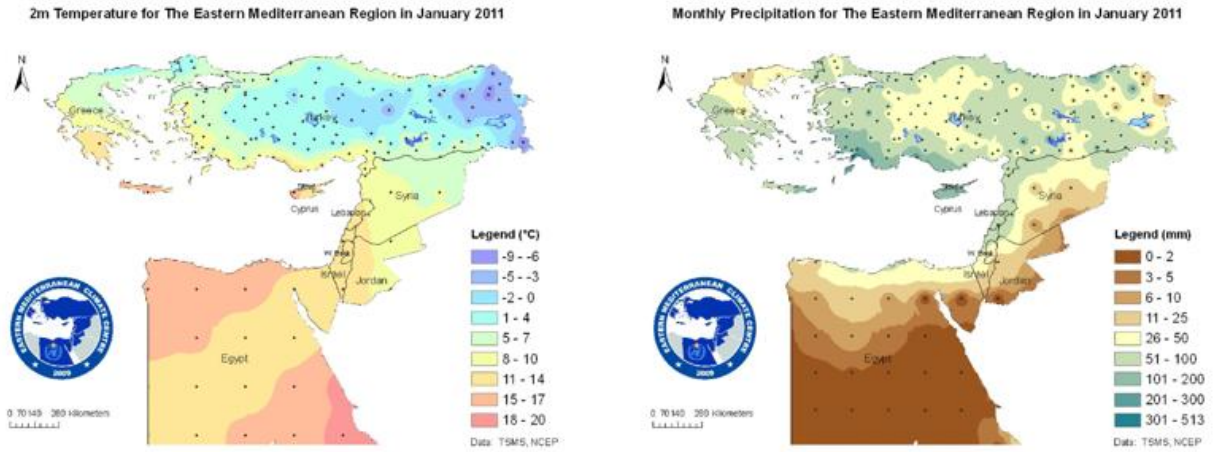


***Fig. 3.3** : Monthly mean temperature (&degC;) and monthly precipitation totals (mm) January 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

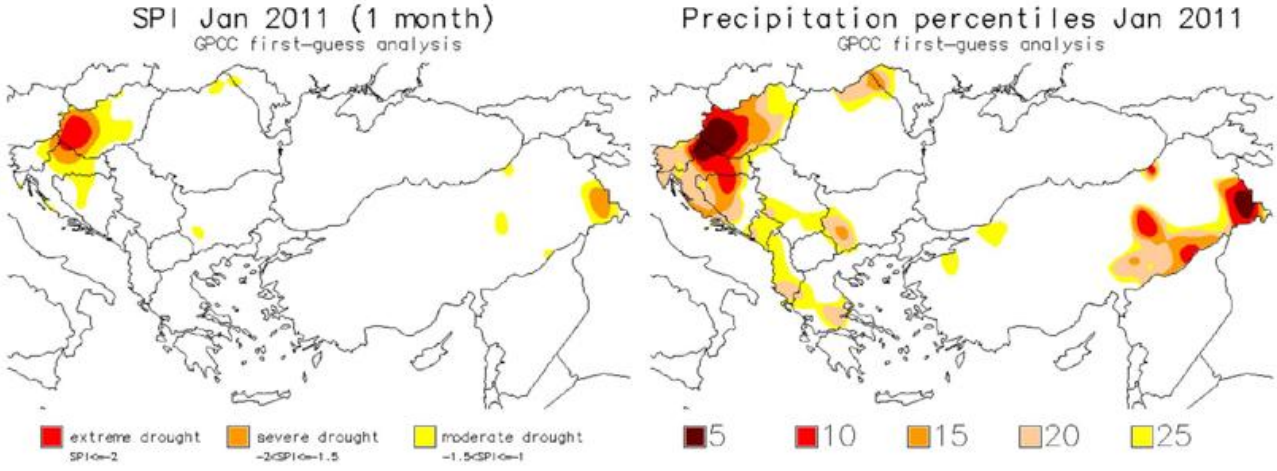


***Fig. 3.4** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
January 2011

February

Highlights:

- ***Very cold in eastern Europe, warm in the west.***
- ***Mostly dry with regional exceptions mainly for the British Isles, the Mediterranean Sea and the Caucasus region.***
- ***Sunny except the northwest of the continent and the British Isles, parts of the Balkan Peninsula and the Caucasus region***

Overview:

Temperature:

February 2011 was warmer than normal on the North Atlantic, in western and southern Europe and in the Middle East as well as over Greenland and the Arctic Sea. The anomalies in the north exceed +4 K, in England there is a secondary maximum of 3-4 K. On the other hand it was very cold in Russia, Finland and northern Sweden with anomalies below -4 K. Generally the negative anomalies also included all Scandinavia, Eastern Europe, the Balkan Peninsula, the Black Sea region and the Caucasus region as well as the central Mediterranean Sea. Rather impressive is the spatial distribution of the anomalies of the number of ice days (see the anomaly map of ECA&D).

It was the warmest February on record on the Faroe Islands and as well for at least on station on Greenland. The Austrian station Reichenau/Rax recorded its 3rd highest temperature maximum of February since start of the time series in 1865 with 20.6 °C. It was on the other hand one of the 10 coldest February months on record for European Russia, with anomalies well below -3 K for the whole region and up to -8 K in the center of the cold. Minimum temperatures of -46 °C were recorded.

Precipitation:

Most of Europe was dry in February 2011 with some exceptions which can partly be related to heavy precipitation like in Ireland, Scotland, Denmark, southern Sweden and northern Germany. Also the Mediterranean Sea received more precipitation than normal and remarkable highest daily totals were reported by Portugal (74 mm), Spain (57 mm), France (136 mm), Italy (151 mm), Greece (135 mm), Turkey (87 mm), Syria (92 mm), Israel (52 mm) and Lebanon (49 mm) (see table). Also the Caucsus area had more precipitation than usually. Georgia reported between 92 and 463 percent of the normal (corresponding 72-696 mm) in the west and 26 to 345 percent of the normal (corresponding ??) in the east.

In Estonia the snow depth was exceptionally high.

Sunshine:

Sunny conditions were prevailing in February 2011 in most of the area except Britain, most of France, Belgium, the Netherlands and western Germany, parts of the Balkan Peninsula, Middle East and the Caucasus region. The sunniest regions were the Baltic states, Finland, northern Russia and northern Sweden and Norway with more than 150 percent of the normal.

Monthly Means or Totals and Anomalies :

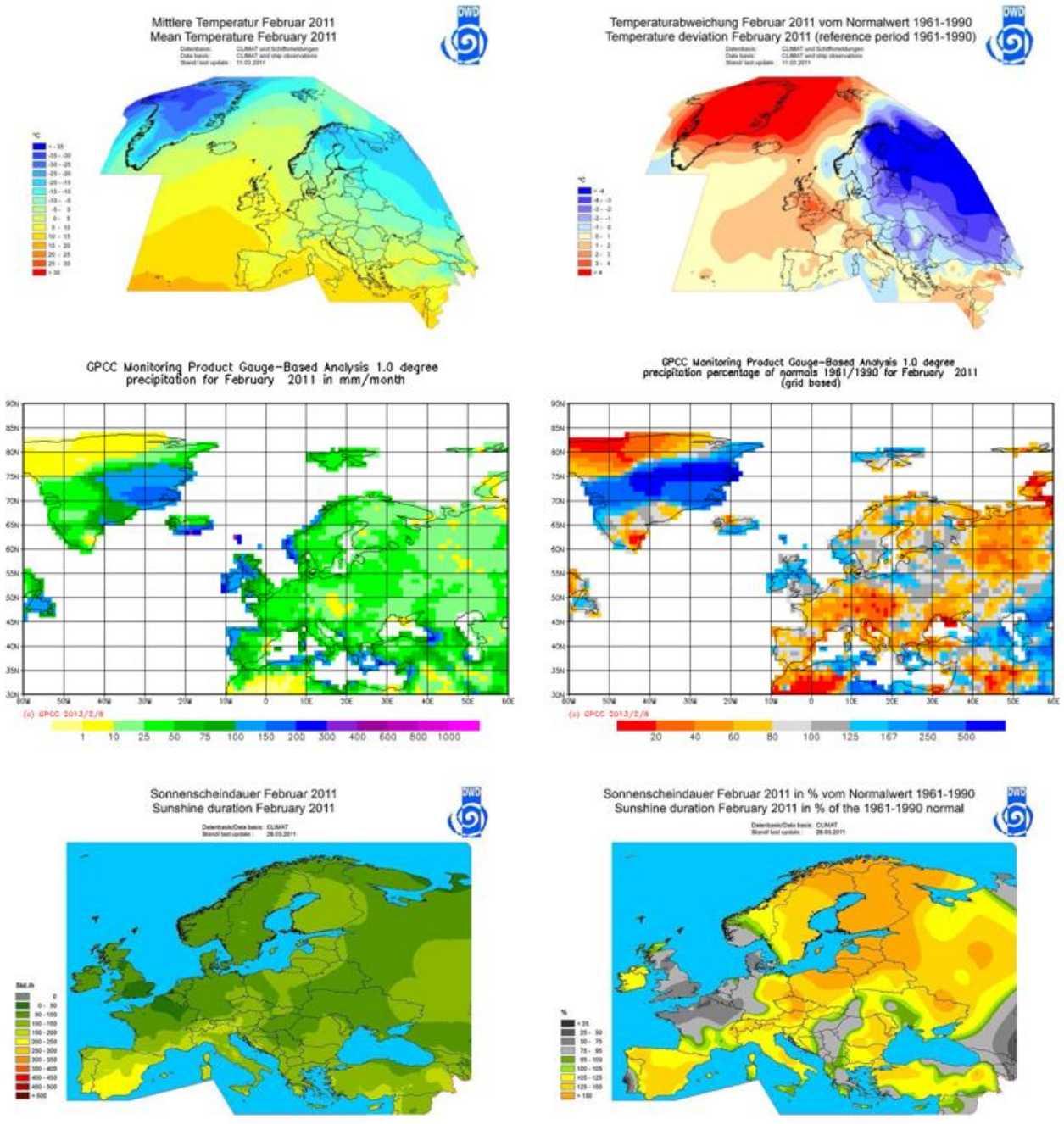


Fig. 3.5: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in February 2011*

Monthly Climate Extremes and Events:

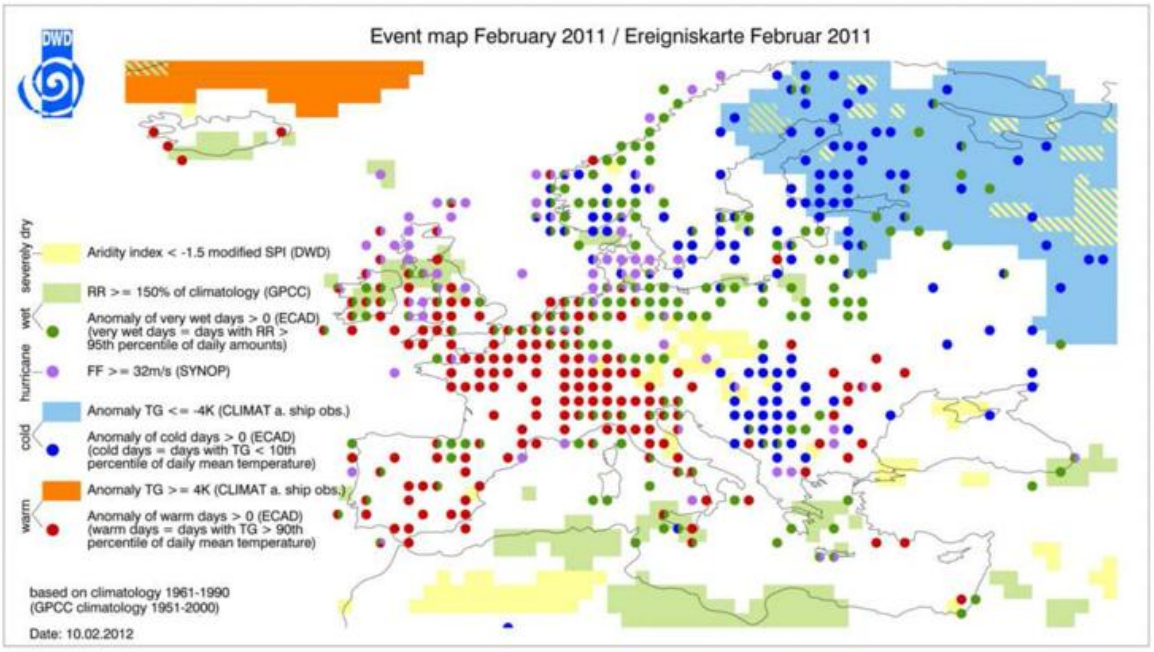


***Fig. 3.6** : Monthly Map of Climate Extremes and Events February 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

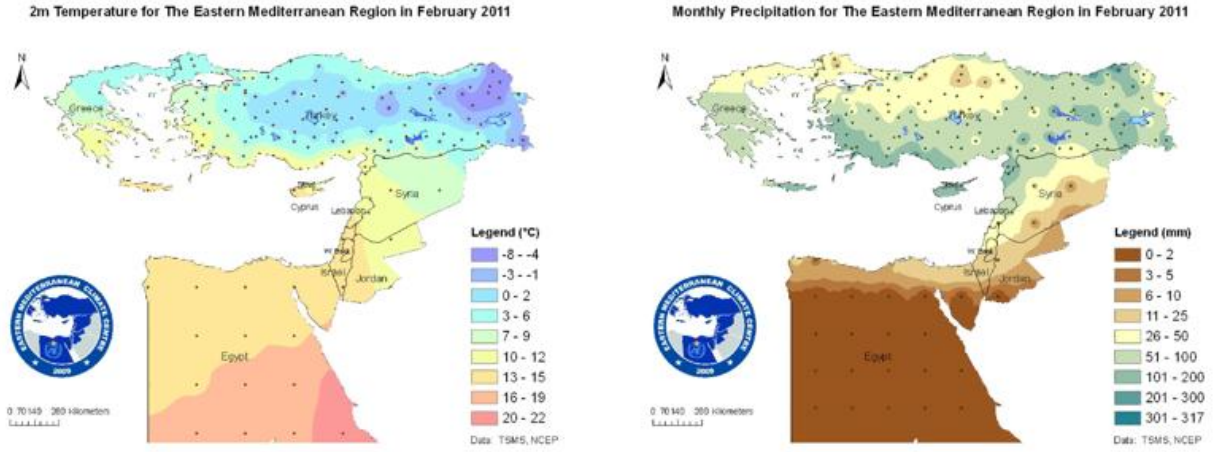


***Fig. 3.7** : Monthly mean temperature (&degC;) and monthly precipitation totals (mm) February 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

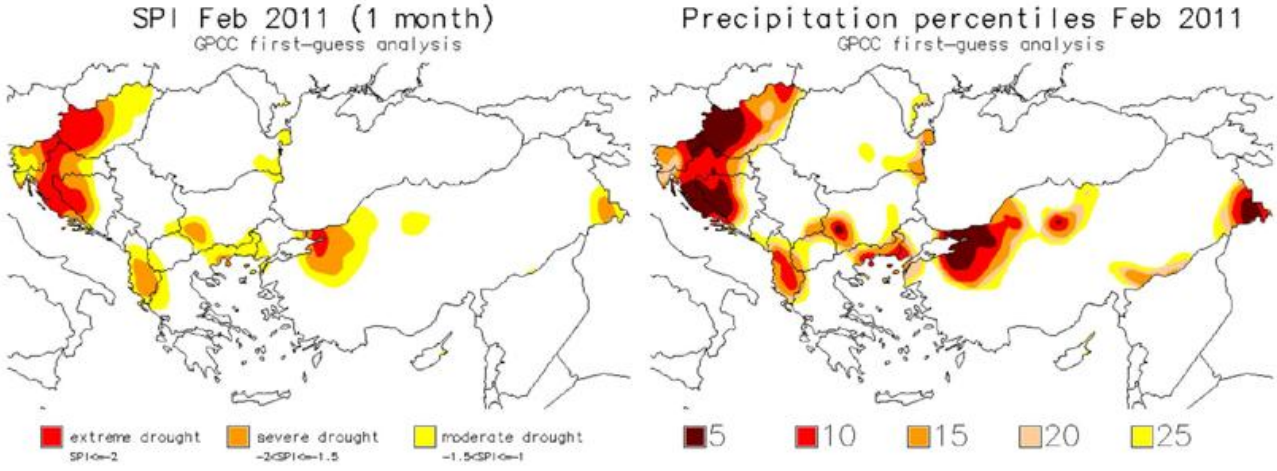


***Fig. 3.8** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
February 2011

March

Highlights:

- ***Mostly warm except parts of the eastern Mediterranean Sea, the Black Sea and the Caucasus and southern Russian region as well as south of Greenland.***
- ***Mostly dry, except the northern North Atlantic and Arctic Sea, the Mediterranean Sea and southern Russia.***
- ***Mostly sunny***

Overview:

Temperature:

March 2011 was relatively warm in most of the region except the southern Balkan Peninsula, the Black Sea region and southern Russia as well as the North Atlantic south of Greenland. The positive anomalies were highest for the Arctic regions but still were in the range of 2-3 K in the Alpine region and southwestern parts of Germany. Maximum temperatures close to 20 degrees C or even above were reached in many central and western European countries and even Denmark, Sweden and Norway achieved maximum values above 15 deg C.

On 10 March the Greek station Helliniko recorded its coldest March minimum temperature with -1.8 °C.

Precipitation:

March 2001 was remarkably dry for most of the region. Only southern Iceland, Scotland and western and northern Norway and parts of the Mediterranean Sea, especially southern Spain and Portugal, southern France, Italy and Lebanon received more precipitation than usual. The latter are related to some extreme events, see the event calendar. The lack of precipitation is on the other hand remarkable for large areas. The DWD standardized Precipitation Index shows areas of the class 'severely dry' or even 'extremely dry' in southern England, the low countries, Germany, Latvia, Belarus and Ukraine and parts of Russia, southwestern Turkey and Eastern Syria and Jordan.

In Germany March 2011 was the 7th driest since 1881.

Estonia and Russia (upper Volga region) reported exceptionally high snow depths. St Peterburg had record-breaking 73 cm of snow on 5 March and Estonia up to 82 cm in the northeastern parts.

Sunshine:

March 2011 was a sunny month almost everywhere except the Peninsula Iberica, western Turkey and eastern Bulgaria and Greece and eastern Russia. Most of Germany, Austria, the lowlands, the adjacent parts of France, Poland, and much of the Ukraine and a smaller part of Sweden had more than 150 percent of the normal. Correspondently the anomalies of the mean cloud cover are negative in March 2011 almost everywhere, except the Peninsula Iberica and the northern Mediterranean Sea area. Large areas in central and southern Europe had more than 6, partly more than 11 fair days and the number of dull days mostly below 10, in the Mediterranea Sea area, over the British Isles and in much of Scandinavia, the Baltic states, Belarus, Ukraine and Molova below 5 days.

In Germany it was the 2nd sunniest March since 1951.

Wind:

On 7-9 March strong gale winds with gusts up to 34.7 m/s occurred over the Aegean Sea.

Monthly Means or Totals and Anomalies :

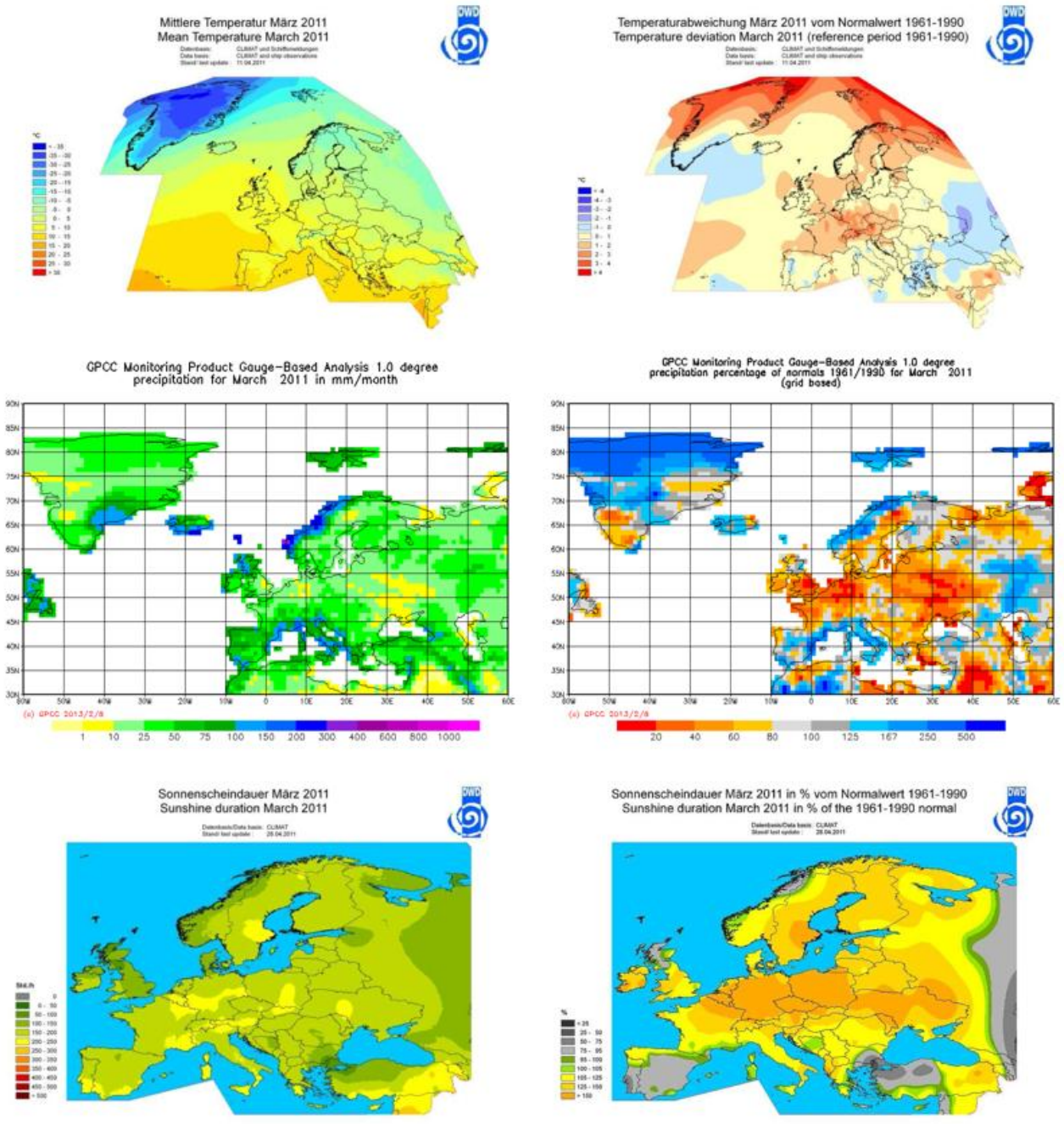


Fig. 3.9: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in March 2011*

Monthly Climate Extremes and Events:

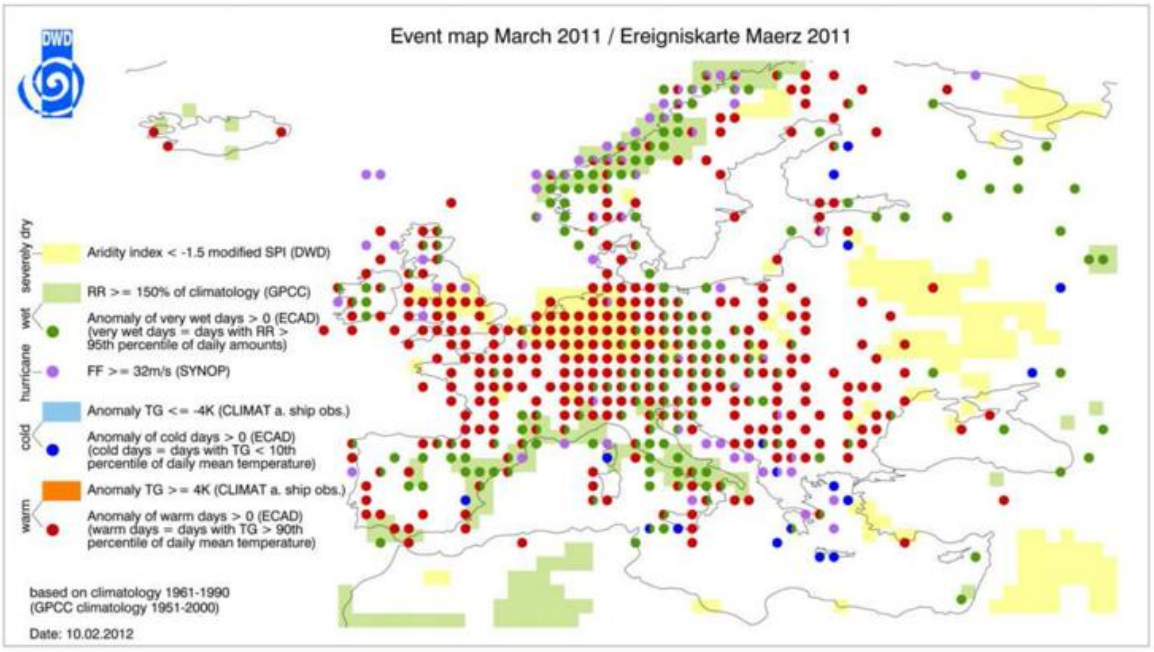


Fig. 3.10 *: Monthly Map of Climate Extremes and Events March 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

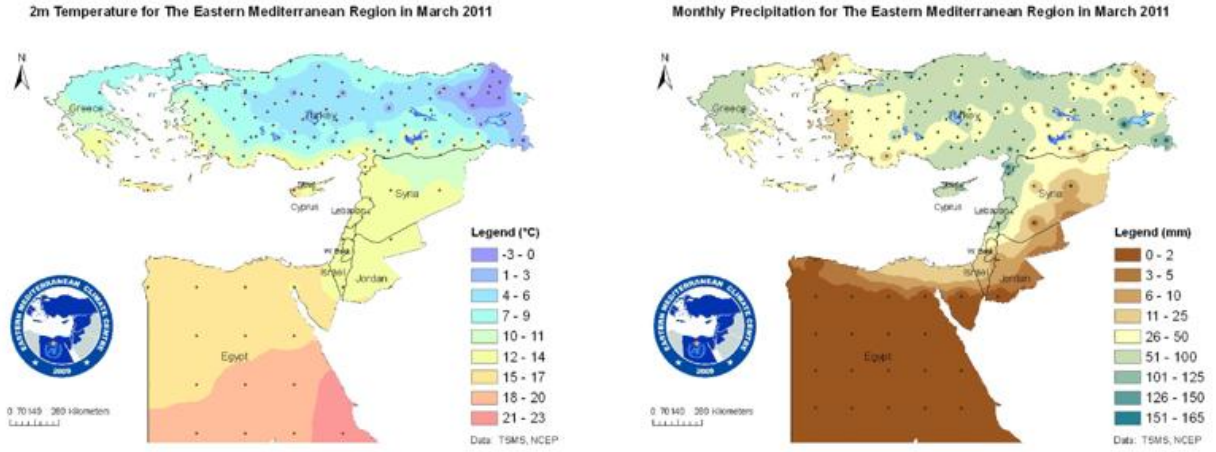


Fig. 3.11 *: Monthly mean temperature (&degC;) and monthly precipitation totals (mm) March 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

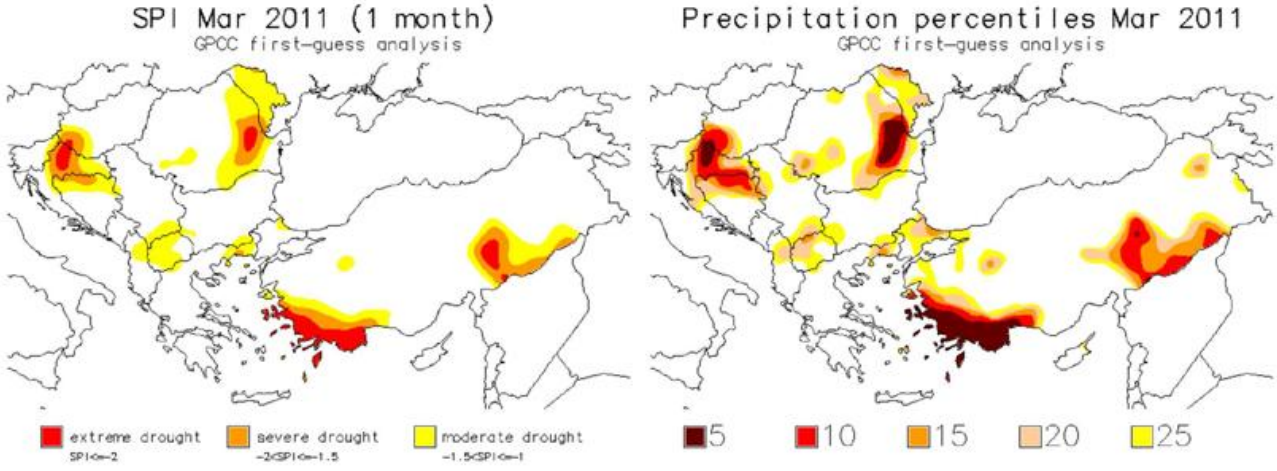


Fig. 3.12 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
March 2011

April

Highlights:

- *Very warm in most of Europe*
- *Very dry in most of Europe*
- *Sunny in most of Europe*

Overview:

Temperature:

April 2011 was warmer than normal in central, southern and northern Europe, but cooler in the eastern Mediterranean, around the Black Sea and in the Caucasus area and the western North Atlantik and western Greenland. The positive anomalies in most of the European countries were above 3 K or even above 4 K on much of the Peninsula Iberica, in France, the Benelux countries, Germany, Poland, Switzerland, the Czech Republic, Denmark, as well as parts of Sweden, Norway, Finland and southern England. Also for the eastern part of Iceland it was one of the warmest April months of record. Many records were broken. Ireland reported the 'warmest April on record' at most of the northern and some southwestern stations. UK registered the warmest April since 1910 and the warmest for over 350 years in central England. In the Netherlands it was the warmest April since 1706 together with April 2007 and 2009. In Denmark it was the warmest April on record. In Norway it was the warmest April since 1900, in Sweden ist was the warmest April on record at several southern as well as northern stations. Also the Faroe Islands had their warmest April.In Germany April 2011 was on rank 2 since 1881 after 2009. In France it was the second warmest April since 1900, after 2007. In Switzerland April 2011 was the second warmest after 2007 since the records started in 1864. In Austria it ranged on the third place since 1800. In Portugal it was the warmest April since 1931.

Slovakia recorded the first 'summer day' on 7 April at most stations in the west and north-east. This is at many stations the earliest recorded 'summer day'. Switzerland as well reported such high temperatures on 7 April. On 9 April even 31.8 °C were recorded in Locarno-Monti. Spain reported 37.4 °C on 9 April in Murcia which means as well a new record.

Precipitation:

April 2011 was dry in most of central, western and eastern Europe as well as in northern Europe except the Norwegian coast. It was on the other hand wet in most of the Mediterranean Sea area, the Black Sea area and the Middle East. The dry weather lasted already the third month and consequences of the drought occurred.

In France it was one of the driest April months in 50 years with below 30 percent of the normal precipitation totals. The years 1982 and 1984 were similarly dry in France. In Montenegro it was the driest April since measurements began for parts of the country. The coastal areas recieved onla 2 percent of the normal precipitation. In Israle on the other hand it was the 2nd or 3rd wettest April of the last 70 years in places and the number of rainfall days was the largest of the last 60 or 70 years.

Sunshine:

The sunshine duration was above normal in April 2011 nearly everywhere except Russia, the Caucasus, the eastern Mediterranean Sea and the Middle East. In most of France, Germany, Switzerland and in parts of the Netherlands, Austria and northern Italy as well as Poland and Lithuania and in central England it came above 150 percent of the normal.

Monthly Means or Totals and Anomalies :

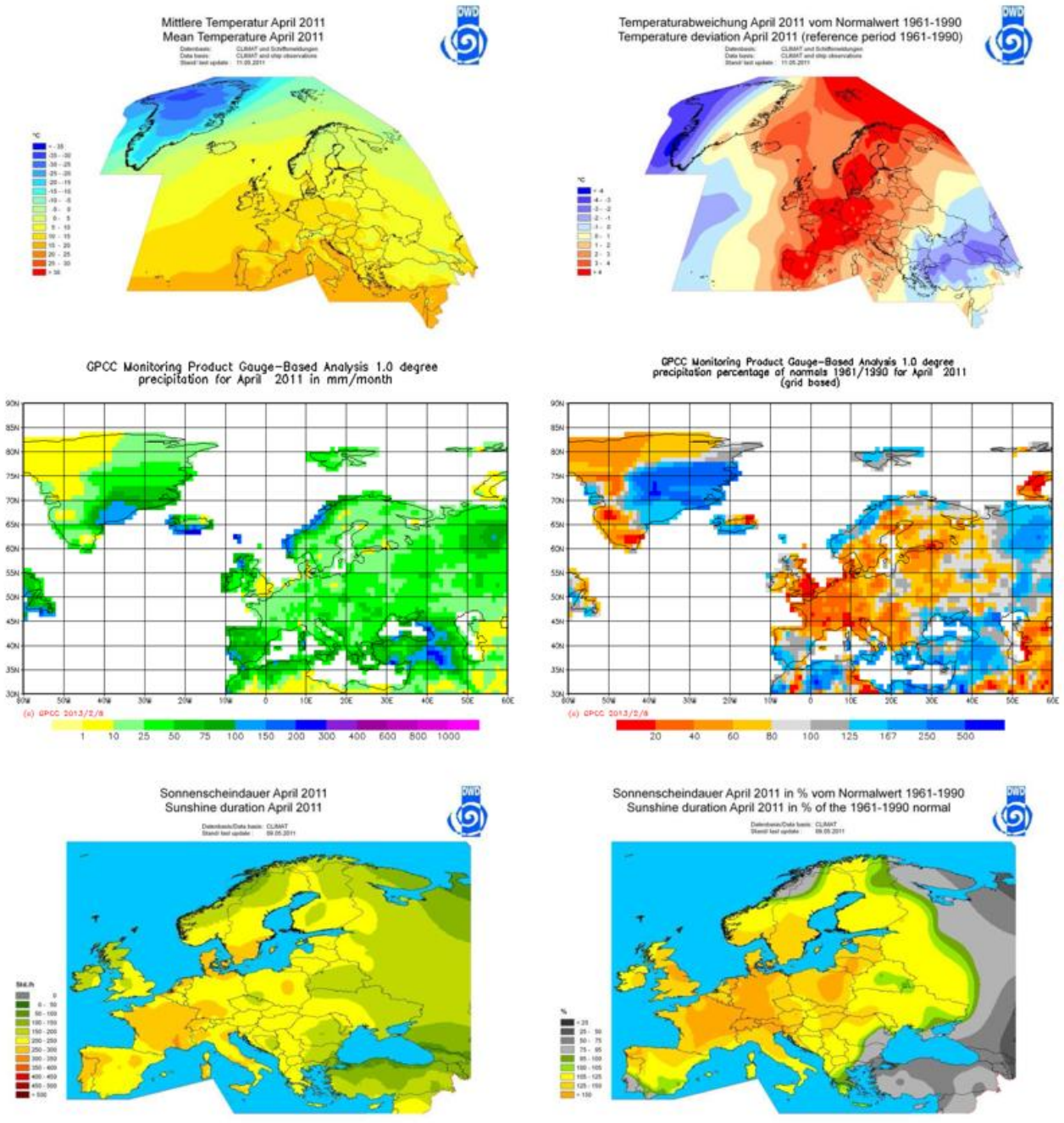


Fig. 3.13: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in April 2011*

Monthly Climate Extremes and Events:

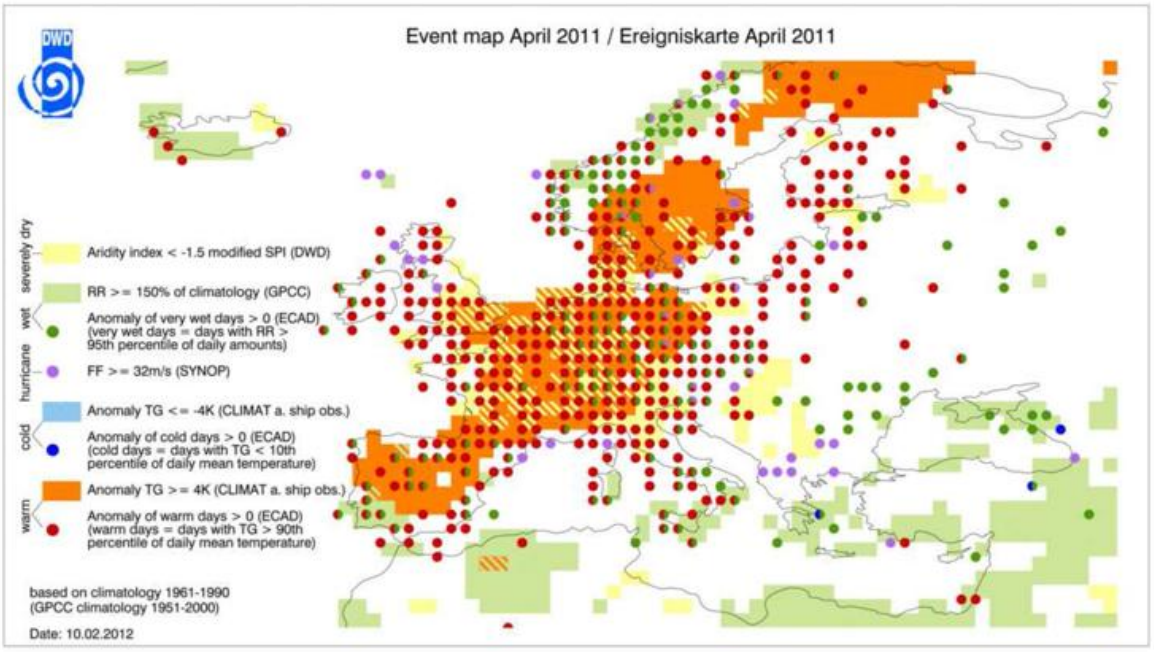


***Fig. 3.14** : Monthly Map of Climate Extremes and Events April 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

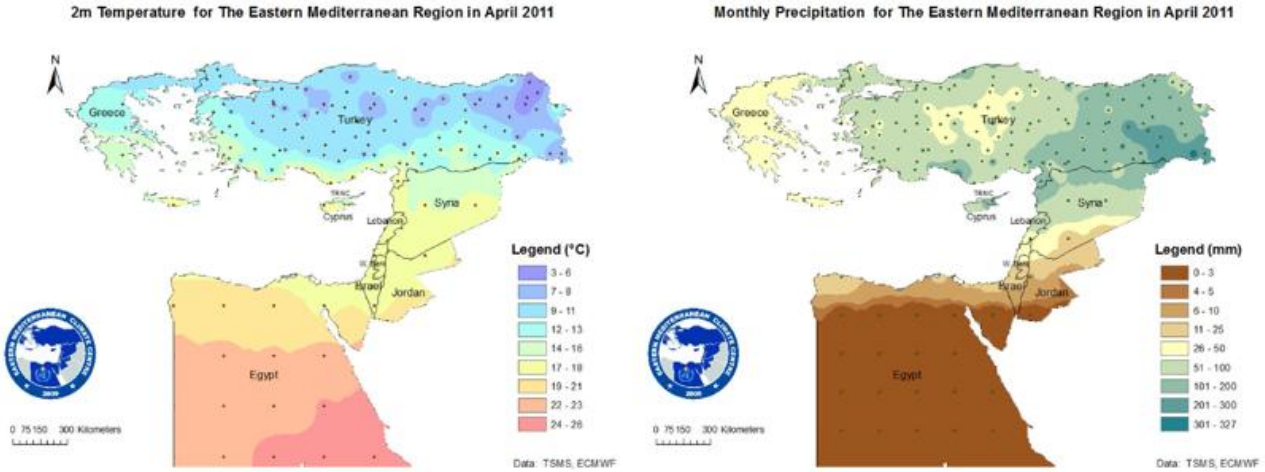


Fig. 3.15 *: Monthly mean temperature (&degC;) and monthly precipitation totals (mm) April 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

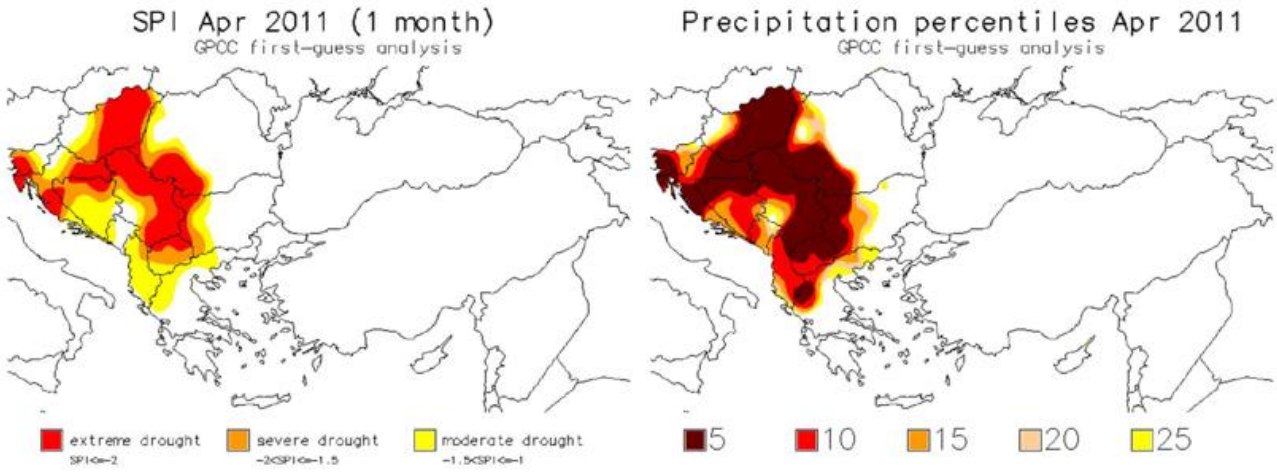


Fig. 3.16 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
April 2011

May

Highlights:

- ***Warm in western and southwestern Europe***
- ***Ongoing drought in western Europe but many heavy precipitation events on the other hand***
- ***Sunny for most of the European continent***

Overview:

Temperature:

Western and southwestern Europe including the east of the British Isles were warmer than normal in May 2011. The anomalies exceeded 3 K in Portugal, parts of Spain and France and Austria. The the eastern Mediterranean area and partly Balkan Peninsula as well as much of the North Atlantic were cooler than normal or close to normal. In central Turkey the negative anomalies range between -1 and -2K. In Poland in Torun with -7.2 °C the lowest May temperature since 1951 was measured.

France recorded its warmest May since 1900. Switzerland had the 3rd warmest May since 1864. Portugal had its warmest May since 1931.

Precipitation:

In western and southern Europe it was mostly extremely dry. The drought lasting from February 2011 on was ongoing (see http://www.wmo.int/pages/mediacentre/news/drought_en.html). Also it was dry in southern Ukraine and central European Russia as well as parts of the Middle East. It was on the other hand wet in Ireland, Scotland, most of Scandinavia and parts of northern Russia as well as the southwestern Mediterranean area and the southern Peninsula Iberica and the northern central and eastern Mediterranean Sea and parts of the Middle East as well as the eastern Black Sea region and southern Russia.

In France it was the driest May of the last 50 years with only 37 percent of the normal.

Sunshine:

Most of the European continent was sunnier than normal. Scandinavia - except in the south - , Ireland and western UK, the southern Iberian Penisula, the eastern Mediterranean Sea, most of the Black Sea reagion, the Caucasus and the southern and northeastern parts of European Russia were slightly dull. In Austria it was the sunniest May since the beginning of measurements in 1884.

Wind:

In Ireland the highest winds during the last 25 years were recorded in places. The station Belmullet in County Mayo registered the absolutely highest windgust ever recorded in May with 40 m/s.

Monthly Means or Totals and Anomalies :

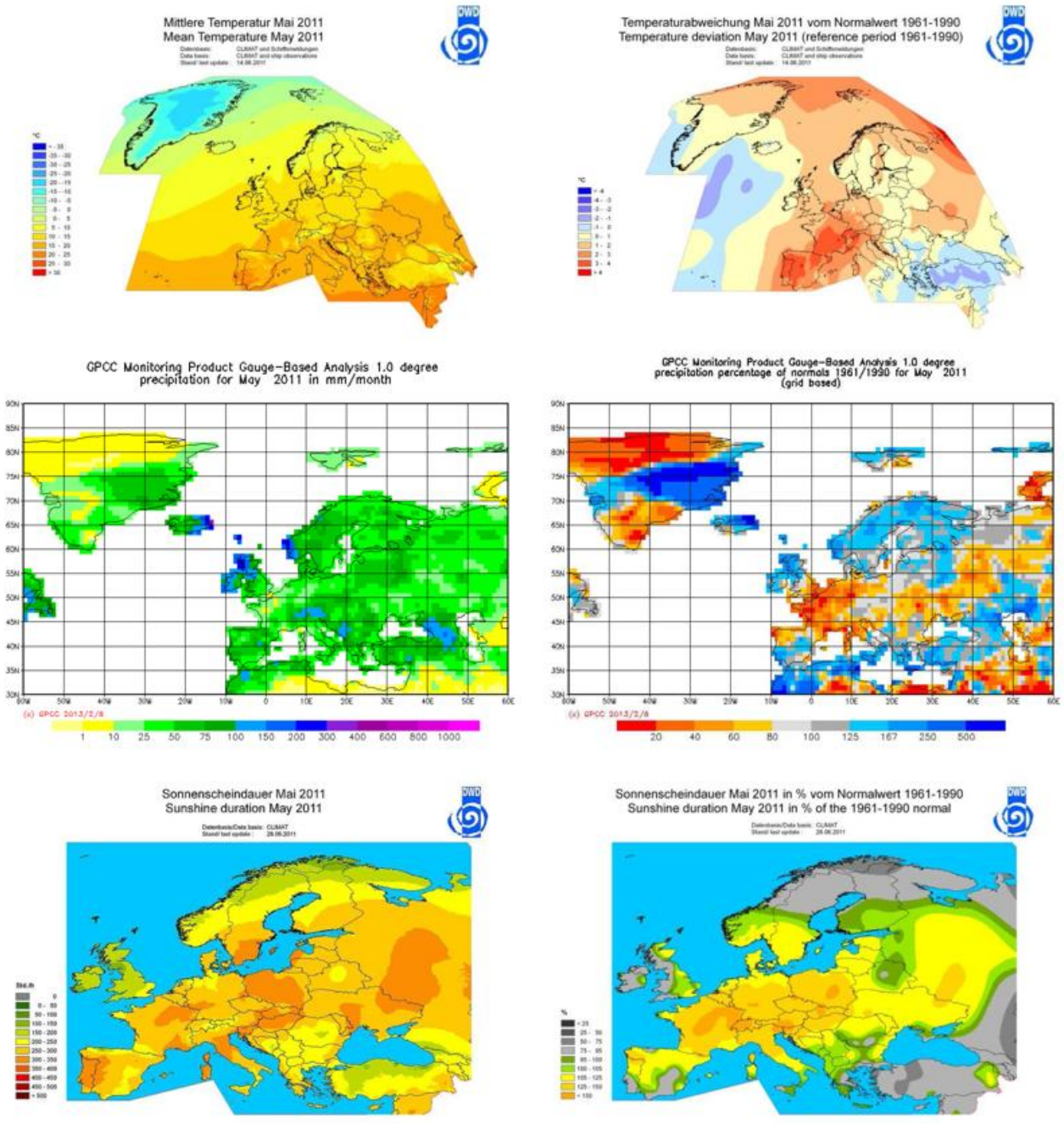


Fig. 3.17: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in May 2011*

Monthly Climate Extremes and Events:

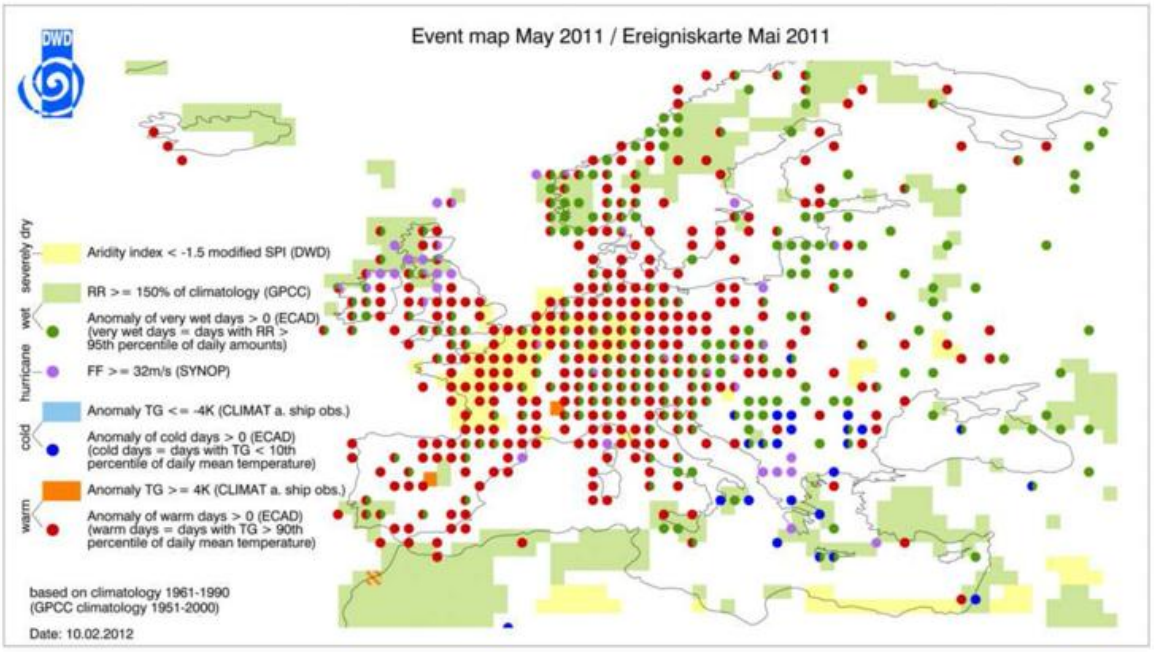


***Fig. 3.18** : Monthly Map of Climate Extremes and Events May 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

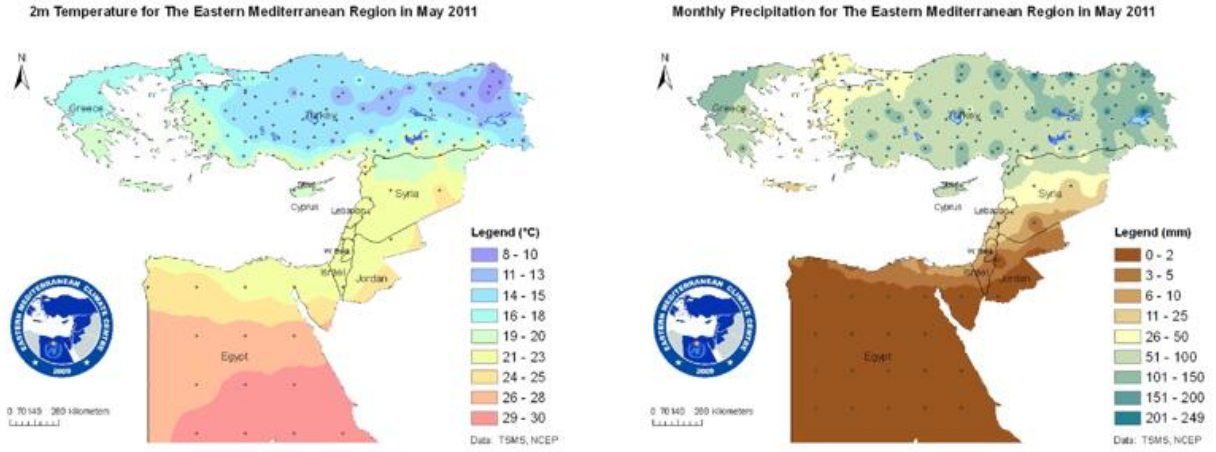


Fig. 3.19 *: Monthly mean temperature (&degC;) and monthly precipitation totals (mm) May 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

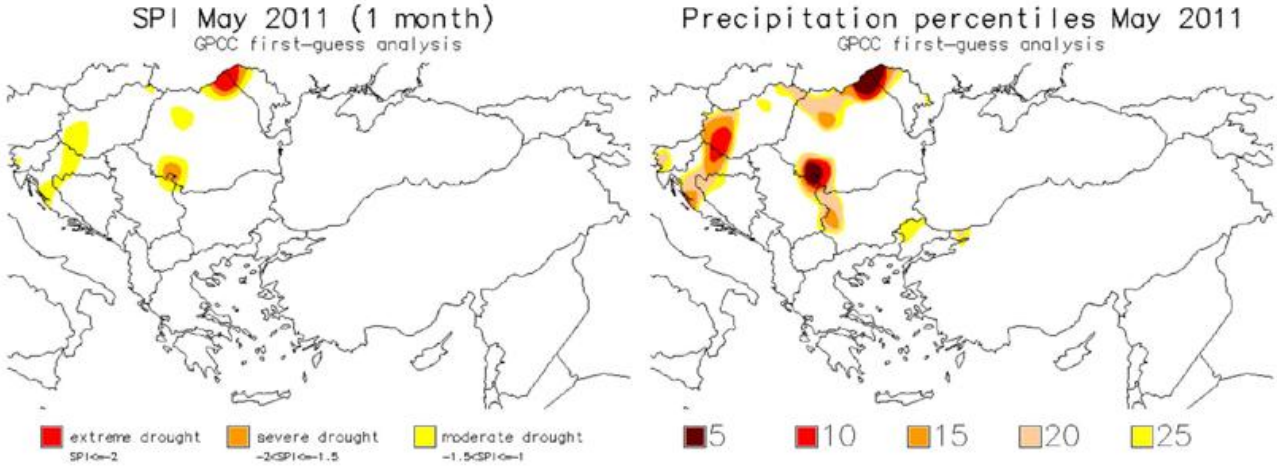


Fig. 3.20 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
May 2011

June

Highlights:

- ***warmer than normal***
- ***More precipitation than normal except in southwestern Europe, eastern and southeastern parts of central Europe and the east***
- ***Mostly fairly sunny in eastern central Europe, western Russia, the Balkan Peninsula and parts of the Mediterranean***

Overview:

Temperature:

The temperature anomalies were close to or above normal everywhere except over the northeastern North Atlantic with negative anomalies below -1 K for western Ireland and for Iceland and 0 to -1 K in most of Turkey. The highest positive anomalies occurred in the Arctic and westernmost Greenland with more than 3 K but on the continent in most of Finland, northern Sweden and Norway, the Baltic states, Poland, Belarus, Ukraine and western and northeastern European Russia as well as partly in the Adria region and on the southern and central Iberian Peninsula the anomalies also exceeded 2 K. Latvia had the 2nd warmest June (and July as well) within 88 years while Israel recorded the coldest June since 1980. It was as well abnormally hot in Murmansk where 29.4 °C were regisered on 8 June.

Precipitation:

Positive anomalies of the total precipitation amount in June 2011 were received by partly the British Isles, the northern and northwestern continent, northern Europe with a maximum in southern Norway and Denmark, western and southern Russia, the eastern Balkan Peninsula, the western Caucasus region and Turkey as well as the Alpes. Less precipitation than normal fell on most of the Iberian Peninsula, in southwestern France, on the western and central Balkan Peninsula, in the Baltic states, northern and partly central and southern Russia and also in parts of central Europe. Much of the precipitation fell as heavy precipitation connected to convective activity.

In Norway it was the 2nd wettest June since 1900 with 170 percent of the normal. On 10 June the Italian station La Stella in the region Emilia-Romagna received precipitation of extreme intensity with 67 mm within 1 hour. On 27-28 June Switzerland received very intense precipitation.

Sunshine:

It was especially sunny in June 2011 in Poland with positive anomalies up to 150 percent of the normal and also fairly sunny for Ireland, the Iberian Peninsula, Italy, the western Balkan states and the east of central Europe except Slovakia, the Baltic states, Belarus and western Russia, southern Sweden and Finland and northern Russia as well as the Netherlands. Elsewhere it was close to normal or slightly dull.

Wind:

On 4 June a downburst of thunderstorms uprooted 100000 m² of wood in Sweden.

Other Phenomena:

Switzerland had heavy thunderstorms and hail in the beginning of June. On 1st of June a remarkable snowfall occurred at the Swiss station Adelboden (1320 m a.s.l.) with 11cm of freshly fallen snow.

Monthly Means or Totals and Anomalies :

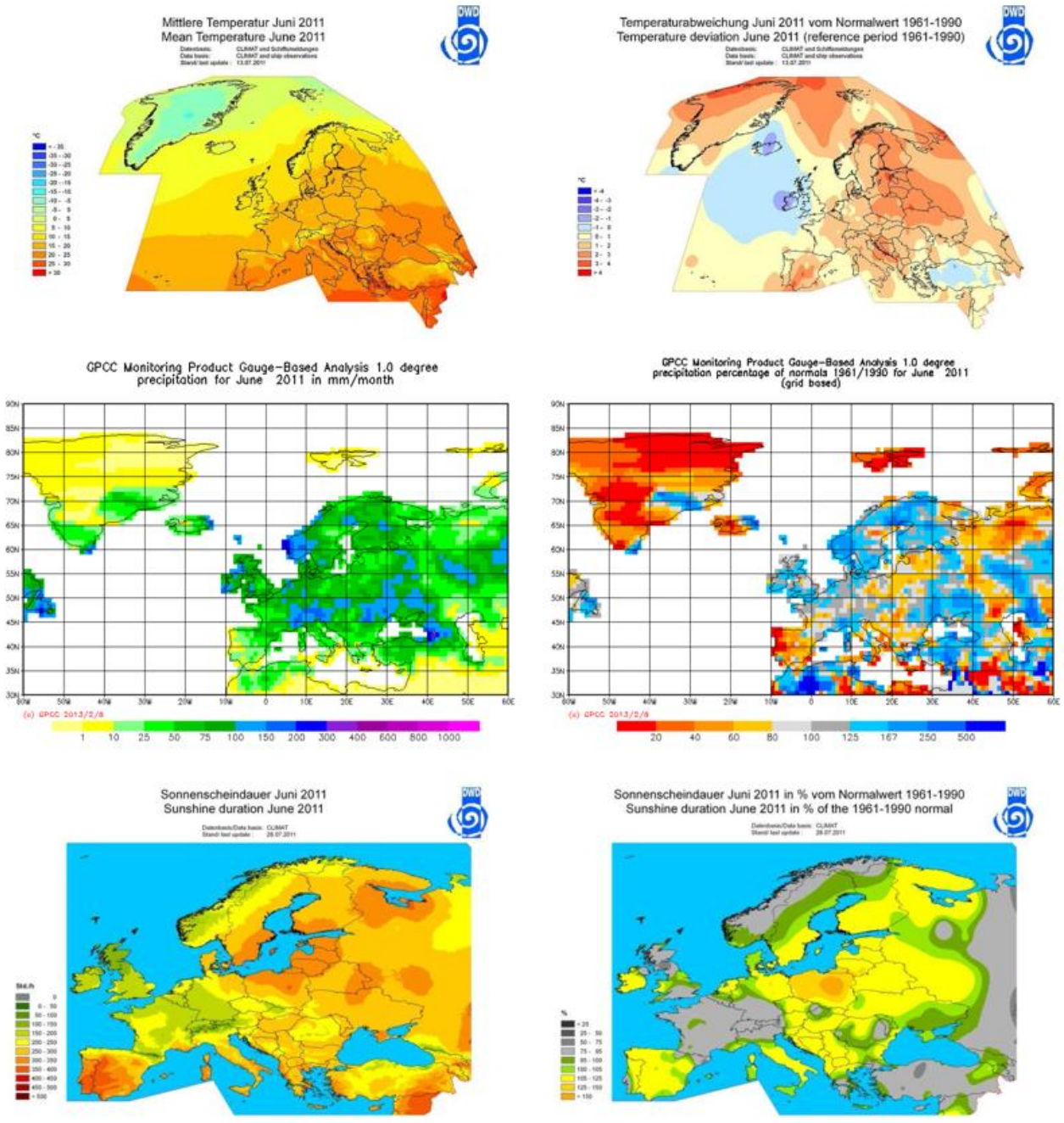


Fig. 3.21: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in June 2011*

Monthly Climate Extremes and Events:

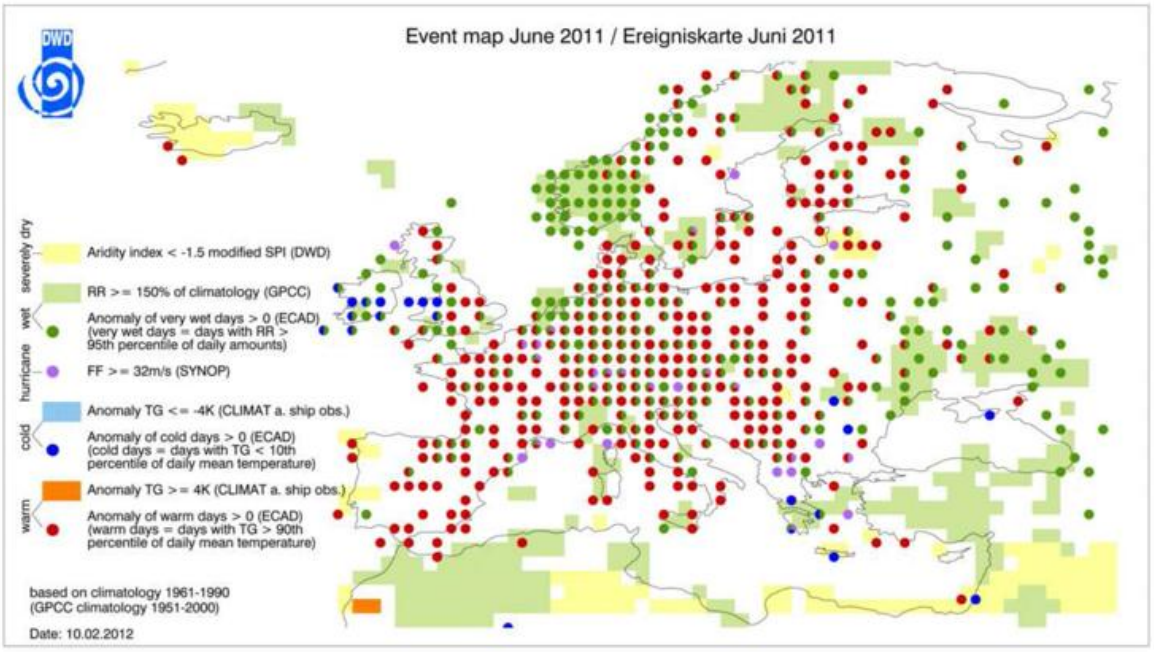


***Fig. 3.22** : Monthly Map of Climate Extremes and Events June 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

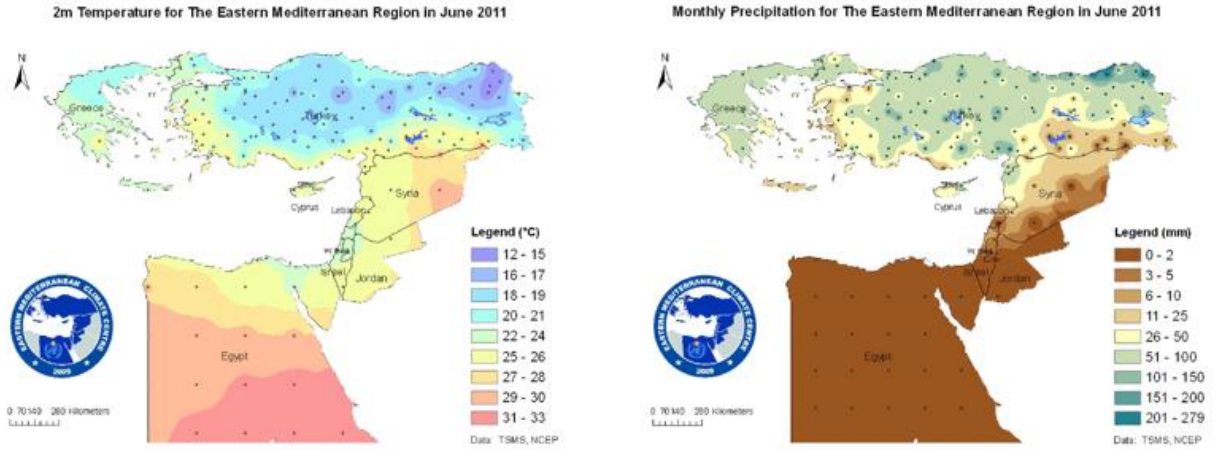


***Fig. 3.23** : Monthly mean temperature (&degC;) and monthly precipitation totals (mm) June 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

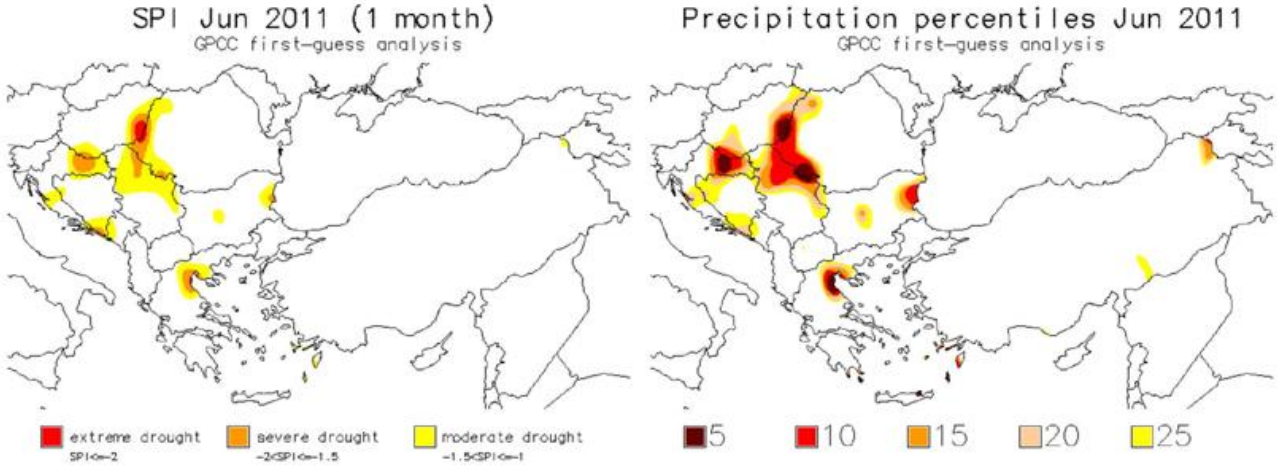


***Fig. 3.24** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
June 2011

July

Highlights:

- ***Colder than normal in western and central Europe, warmer in the north, east and southeast***
- ***Wet to very wet in most of continental Europe***
- ***Mostly dull except in the east and southeast.***

Overview:

Temperature:

In July 2011 central, western and southwestern Europe was colder than normal but northern, eastern and southeastern Europe was warmer. France, Belgium and southwestern Germany had negative anomalies in the range of -1 to -2 K. Russia on the other hand had positive anomalies of more than 4 K. It was the 2nd warmest July of European Russia since the beginning of observations there. In Portugal the station Corvo registered 29.7 °C on 26 July and Punta Delgada on the Acores had 28.8 °C on 24 July. A highest maximum temperature of 44.3° C was reported for Russia. Also in Georgia maximum temperatures of 42 °C were achieved and Armenia had the highest July temperature ever recorded in Armenia on 31 July in Meghry. Such high values also occurred in Israel, Jordan (46.5°C in Rwaished, eastern Jordan) and Syriah (45° C). Sweden reported a tropical night on 23 July for Stockholm. Finland reported July 2011 as one of the warmest July months of the last 50 years and more hot days than normal. In Latvia July 2011 was (like June) the 2nd warmest if the last 88 years.

Precipitation:

Most of the European continent had more precipitation than normal in July 2011. Most striking were the positive anomalies for eastern Germany with more than 500 percent of the normal, but also in Denmark, southeastern Poland, and southern Norway and also smaller areas in France, Switzerland, the Balkan States, the Baltic States and Ukraine. Only the Mediterranean Sea area, most of the British Isles, central Skandinavia, northern, eastern and southern Russian and the Caucasus were dry. Precipitation fell often as convective precipitation with partly extremely high intensities.

In Denmark extremely heavy precipitation occurred on 2 July which brought 135.4 mm in 24 hours in Copenhagen. On 20 July the station Nizhni Novgorod in European Russia received 91 mm precipitation within 2 hours and 47 minutes. In Romania the station Siria received the highest July precipitation total on its record with 235.2 mm. 5 Romanian stations had 24 h precipitation totals which exceeded their former records.

Sunshine:

Most of western, northern and central Europe was dull while the Iberian Peninsula, Scotland and eastern and southeastern Europe were sunnier than normal.

Wind:

In Northern Lithuania a F2 tornado occurred on 27 July.

Monthly Means or Totals and Anomalies :

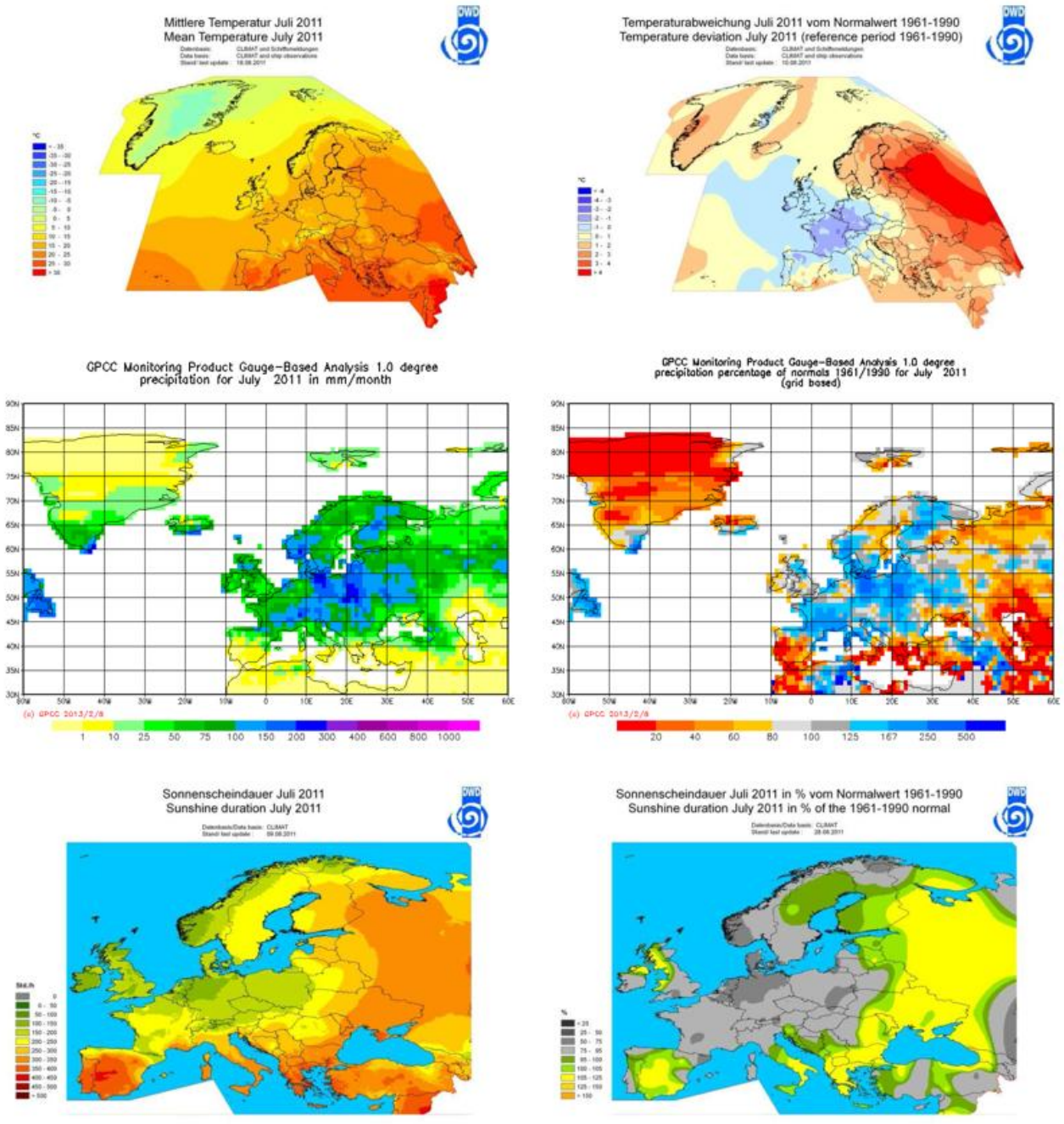


Fig. 3.25: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in July 2011*

Monthly Climate Extremes and Events:

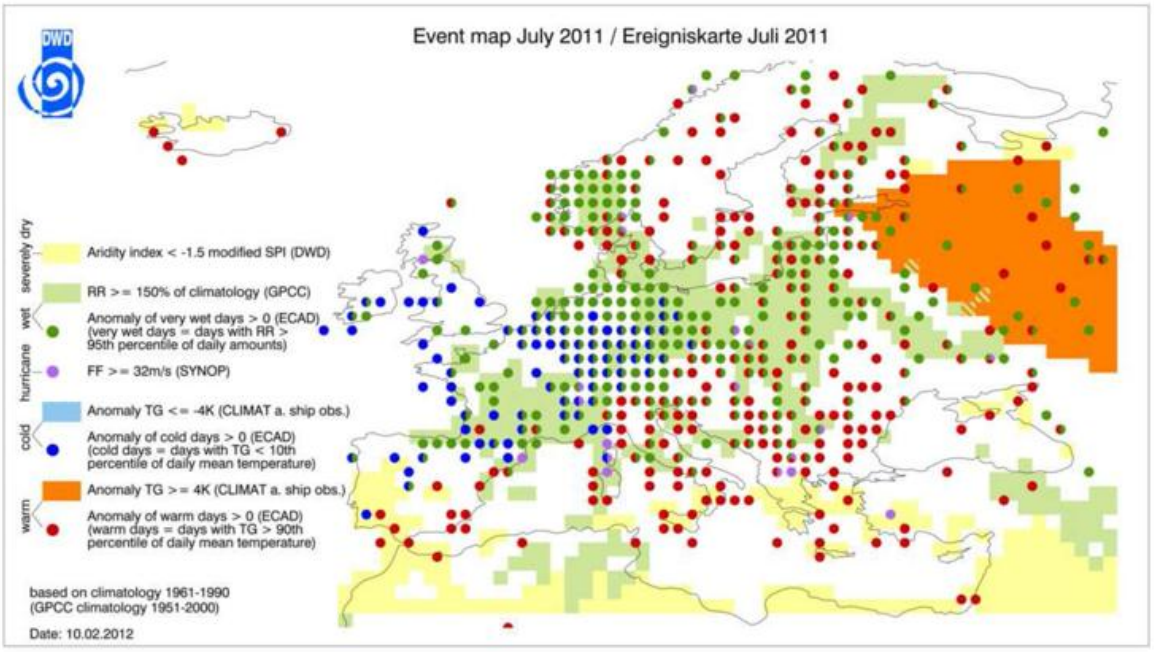


***Fig. 3.26** : Monthly Map of Climate Extremes and Events July 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

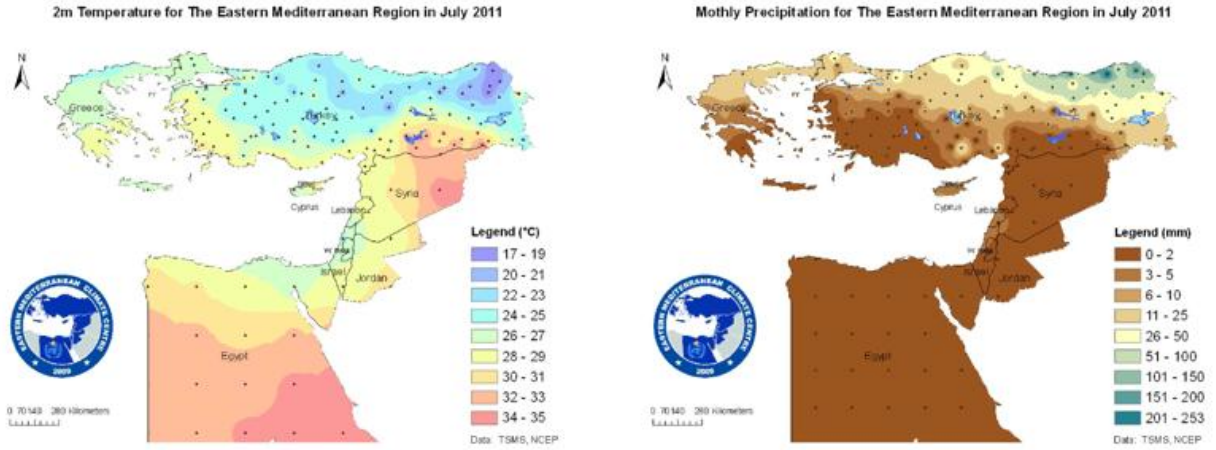


***Fig. 3.27** : Monthly mean temperature (&degC;) and monthly precipitation totals (mm) July 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

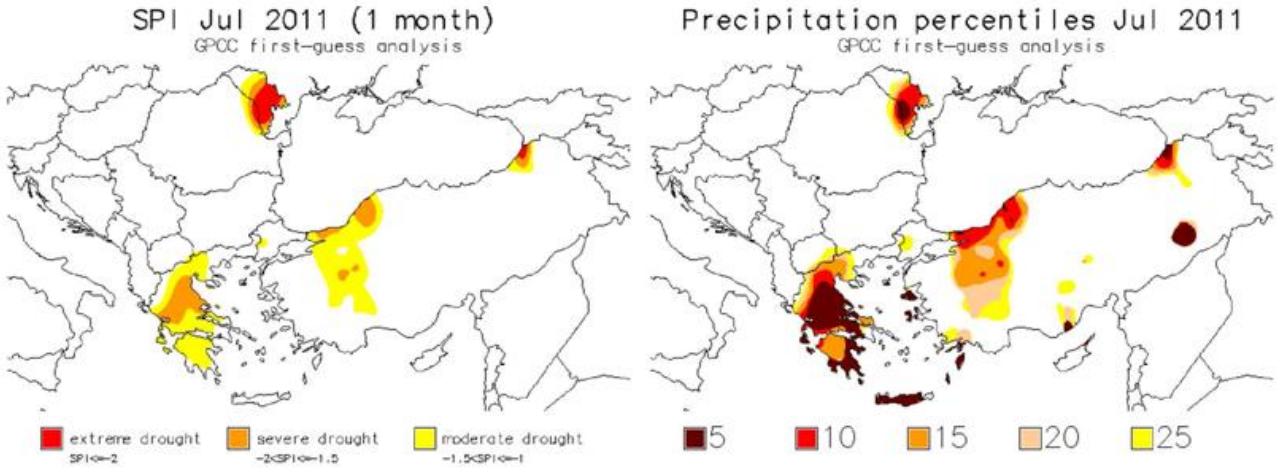


***Fig. 3.28** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
July 2011

August

Highlights:

- ***Cooler than normal in the northwest under influence of the North Atlantic, warmer especially on the Balkan Peninsula***
- ***Mostly dry in the Mediterranean Sea and Balkan regions as well as the Middle East and Russia. Wet in the north and northwest.***
- ***Mostly sunny except in the north and northwest.***

Overview:

Temperature:

August 2011 was warmer than normal on most of the European continent with a maximum of the positive anomalies of up to 4 K over the Adriatic Sea and the adjacent Balkan countries and Italy. Montenegro reported for the station Podgorica 4 consecutive days (23 to 26 august with daily maximum temperatures above 40 °C, which happened for the first time since 60 years. But also Switzerland reported August 2011 to be one of the 10 warmest August months since 1864. Germany reported August 2011 to be on rank 23 since 1881. The British Isles and the central North Atlantic as well as northeastern Russia were on the other hand cooler than normal.

Precipitation:

The western Iberian Penisula, Scotland, the western and northern European continent and most of Scandinavia as well as locally regions around the Black Sea and the Caucasus area received more precipitation than normal, while the western Mediterranean and the Balkan area, most of the countries around the Black Sea as well as central European Russia were dry. So in France the Haute-Normandie had the wettest August of the last 40 years while the Island of corse hat the driest August in the last 40 years. Norther Caucasis, paticularly Dagestan, received 300 to 400 percent of its normal precipitation in August 2012. In spite of the positive precipitation anomalies the soil moisture anomalies are still negative in most of France and southern UK according to the global analysis of the NOAA Climate Precition Center (http://www.cpc.ncep.noaa.gov/cgi-bin/gl_Soil-Moisture-Monthly.sh). The long-term reference is based upon 1979-2007.

Sunshine:

The Alpine Region and the eastern European countries Poland, the Czech Republic and Hungary were mostly very sunny and overall most of Europe except the west and northwest and the Middle East were sunnier than normal.

Monthly Means or Totals and Anomalies :

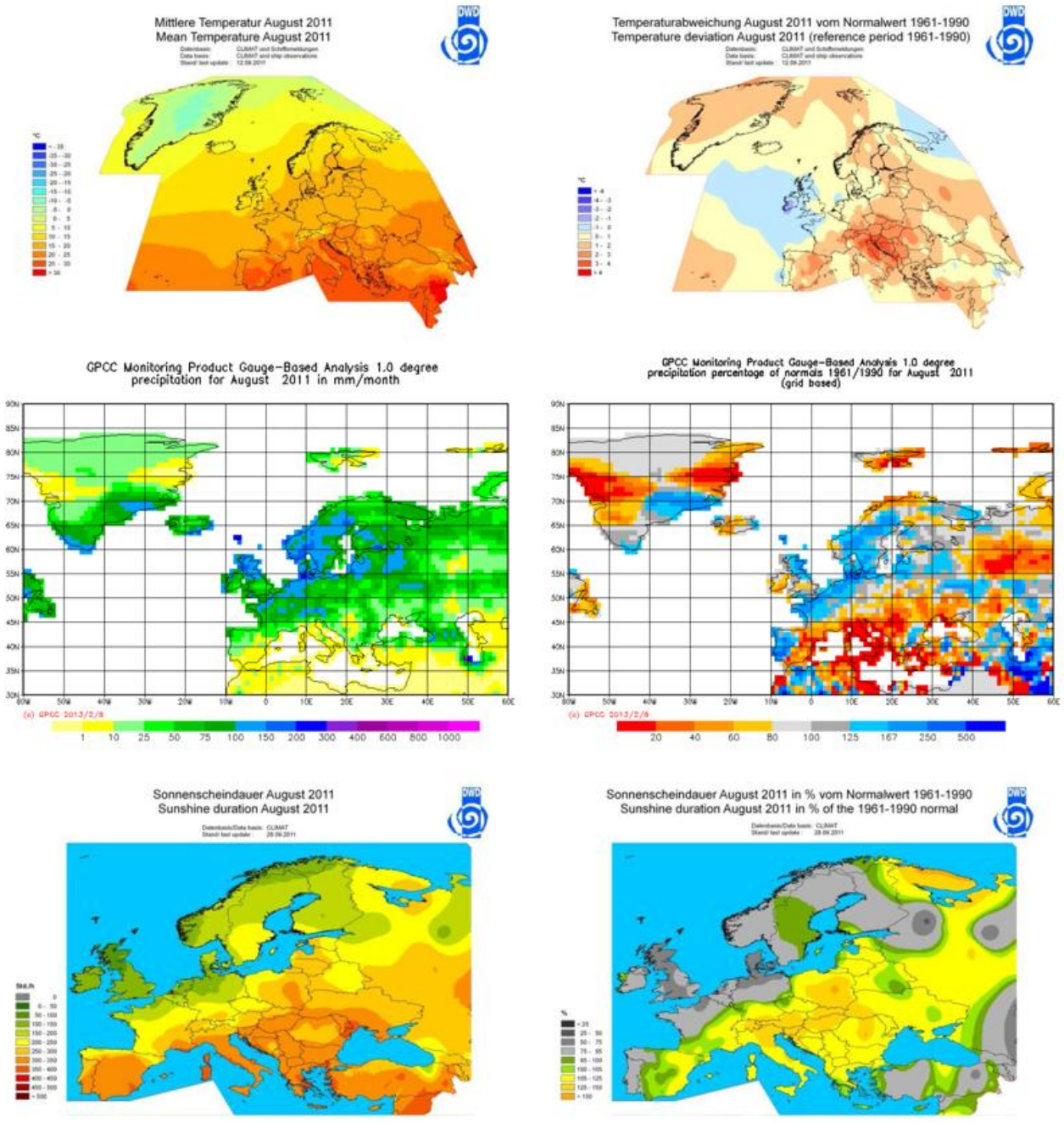


Fig. 3.29: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in August 2011*

Monthly Climate Extremes and Events:

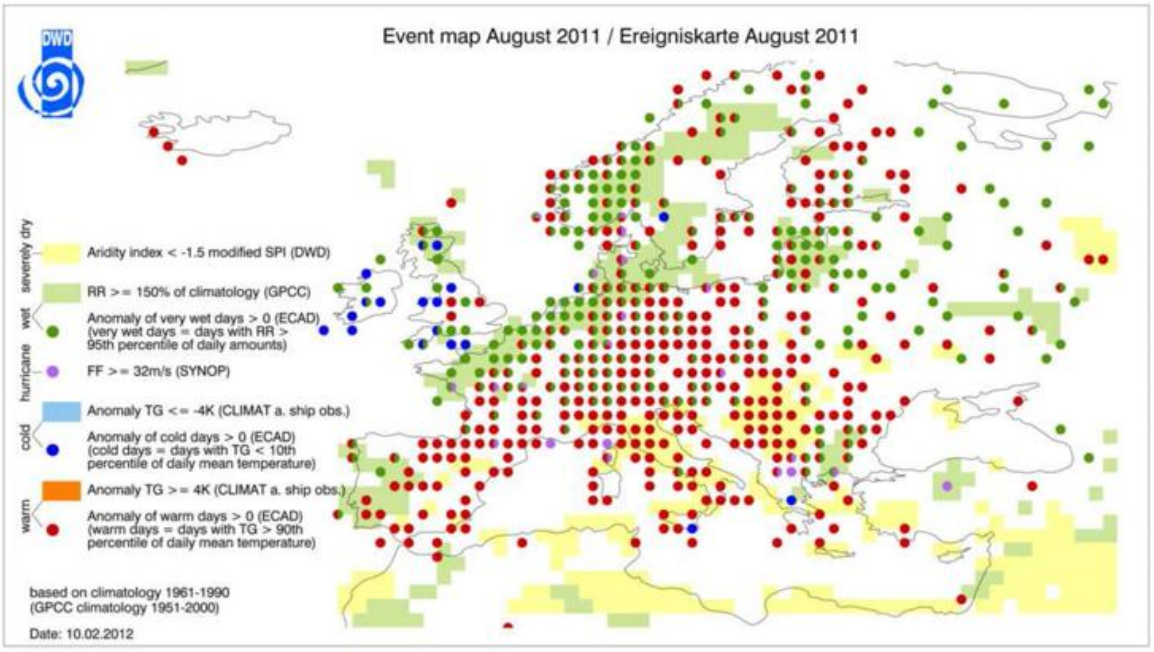


***Fig. 3.30** : Monthly Map of Climate Extremes and Events August 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

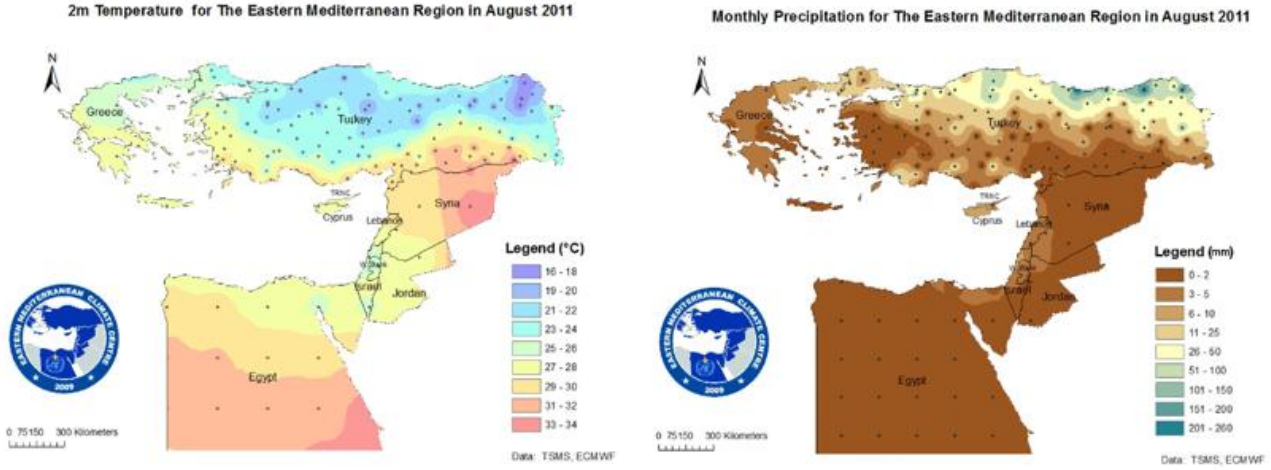


Fig. 3.31 *: Monthly mean temperature (&degC;) and monthly precipitation totals (mm) August 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

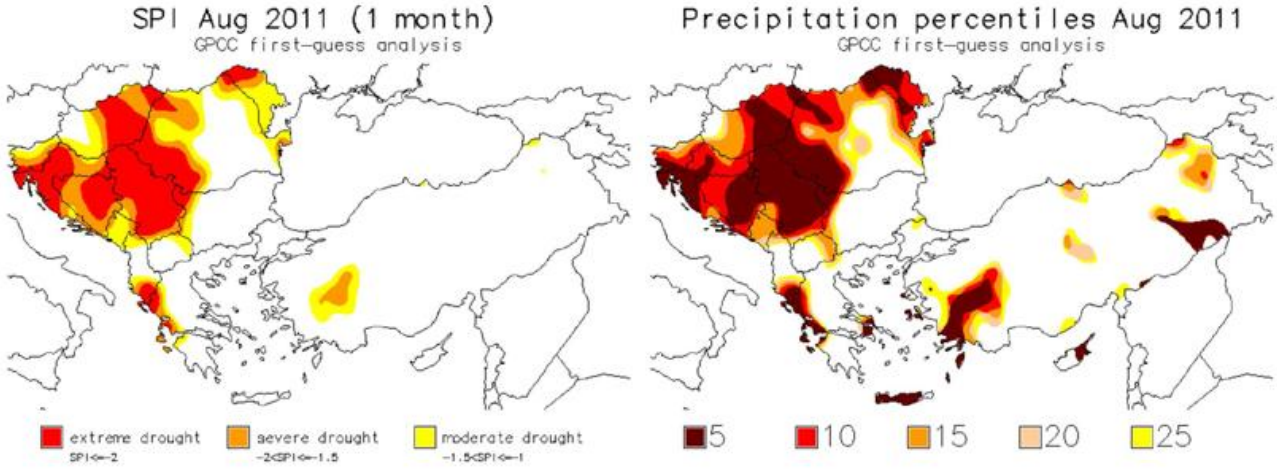


Fig. 3.32 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
August 2011

September

Highlights:

- ***Warmer than normal on the continent as well as in the Arctic Sea***
- ***Drier than normal in the west and southwest, the western Mediterranean, northern Balkan Peninsula and eastern central Europe, wetter than normal for Ireland, Scotland, most of Scandinavia except the north, Russia, the Caucasus, parts of the Eastern Mediterranean and Middle East***
- ***Sunnier than normal over the western and central European continent,the south and the southeast around the Black Sea, less sunny in the north and northeast and the Middle East.***

Overview:

Temperature:

September 2011 was warm except on the central North Atlantik and regionally in the southeast (northeastern Turkey). It was particularly warm on the Balkan Peninsula and the Adriatic Sea as well as in the Arctic Sea. Records were broken in several countries: In UK September 2011 was the warmest September since 2006 and the equal-sixth warmest in the last 100 years. September 2011 was also one of the warmest months ever recorded in northernmost Sweden.In Germany September 2011 was warm on rank 10 since 1091 resp. rank 11 since 1881. In Switzerland it was the 4th warmest and locally the warmest September since 1864. In the southern and southeastern parts of Austria it was the warmest September since the beginning of observations in 1813. Also in the Netherlands rank 10 since 1901 was achieved. Norway had the 5th warmest September since 1900. Record high temperatures were measured during the first days of September at some locations and 29 september the highest temperature ever recorded so late in September occurred at Hudiksvall in central Sweden with 25.6 °C. As well southern Finland was exceptionally warm on 30 September with temperaures over 20 °C. The highest maximum temperature here was recorded at Porvoo with 22.3 °C. Serbia had the hottest September since 1994. Montenegro reported the warmest September since mesurements started. The anomalies ranged between +3.5 K to 5.1 K. During all first 7 days of September the maximum temperature rose above 33 °C in Podgorica for the first time after 60 years. In Bulgaria september was one of the thee warmest months. Croatia was mostly extremely warm (above the 98th percentile, reference 1961-1990). In Slovakia the mean temperatures were mostly on rank 1 to 5 since 1961. In Slovenia daily maximum temperatures broke former records at some stations on 4 September and overall the country reported a record warm September. Sinaia in Romania recorded the highest Spetember maximum temperature in its time series in 14 September 2012 with 27.2 °C.

Precipitation:

September 2011 was drier than normal in western, southwestern, mostly southern, far northern and in eastern central Europe. In Slovakia the monthly precipitation totals only ranked between 41 and 49 out of 51 years since 1961 and in the southeast of the country it was locally the driest September since 1901. It was wetter than normal in northern and northeastern Europe, northern UK and Ireland, partly in Germany and in the Alps and regionally in the central and eastern Mediterranean region and Middle East. The surplus was often caused by heavy precipitation. In Sweden in the rgeion Norrland some stations registered new records of monthly precipitation totlas since 1860 resp. 1876.

Sunshine:

September 2011 was sunny for most of the continent except the northwest, north, east and southeast. It was most sunny in Poland and most dull in northern Russia. In Slovakia for instance the sunshine duration of September 2011 was on rank 1 to 3 since 1961.

Other Phenomena:

In 2011 the lowest September average sea level pressure (995 hPa) on Iceland since measurements started in 1822 was recorded.

Monthly Means or Totals and Anomalies :

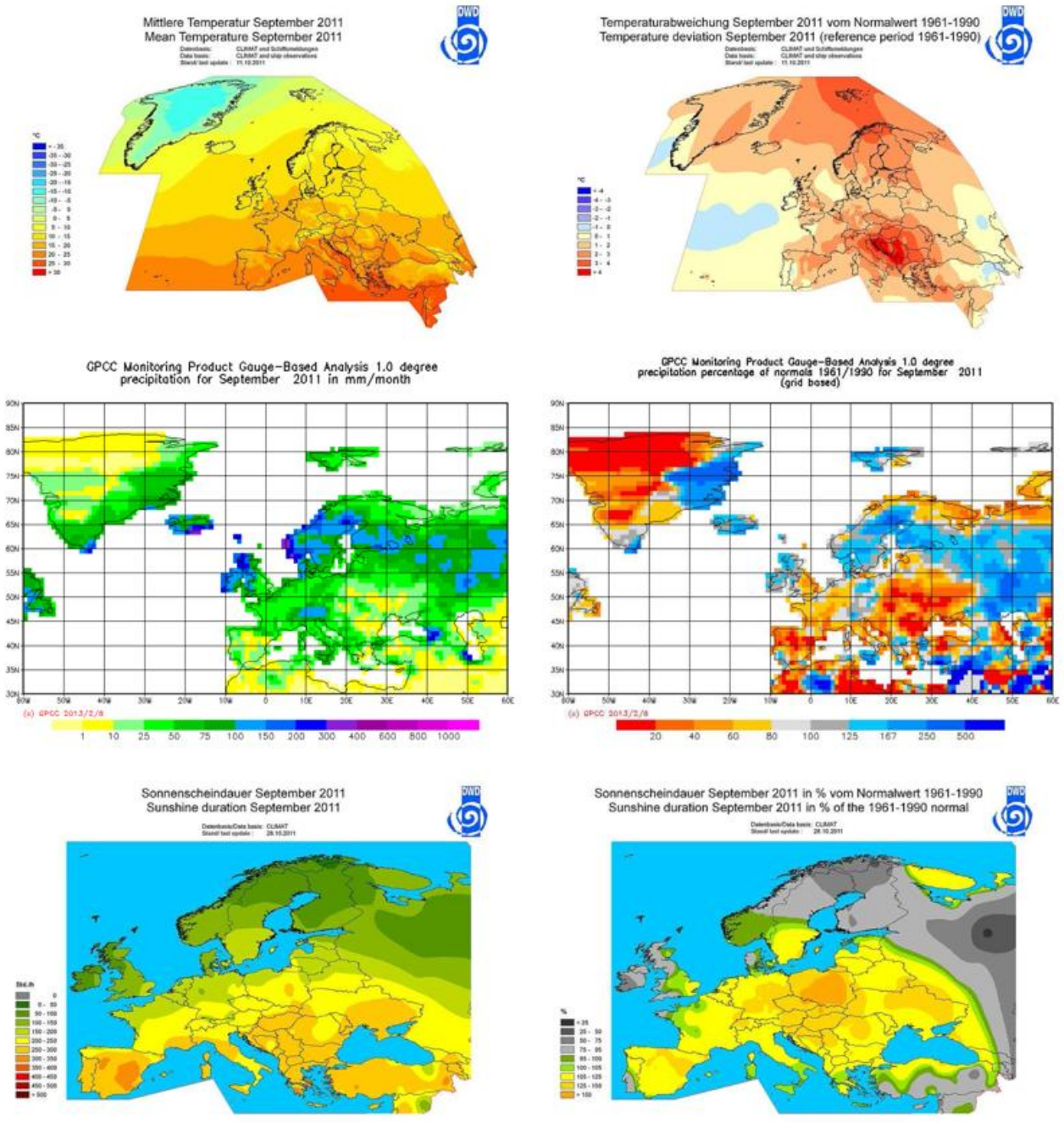


Fig. 3.33: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in September 2011*

Monthly Climate Extremes and Events:

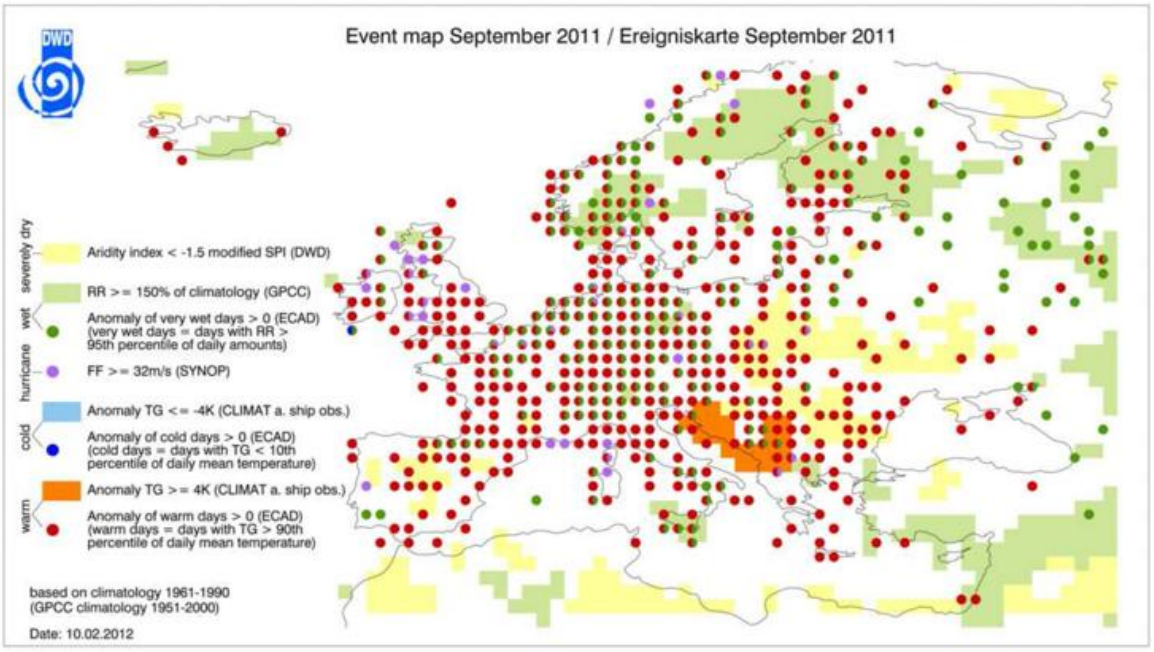


***Fig. 3.34** : Monthly Map of Climate Extremes and Events September 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

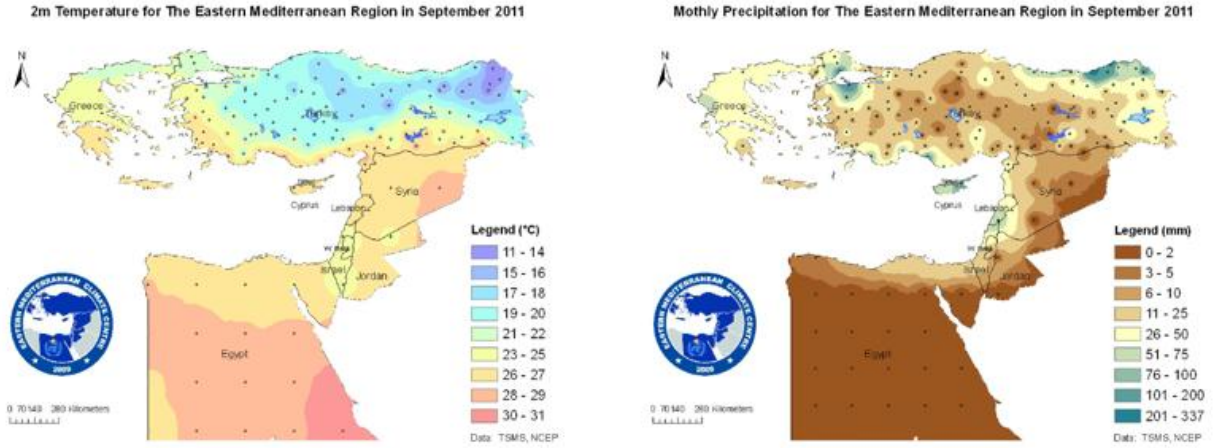


Fig. 3.35 *: Monthly mean temperature (&degC;) and monthly precipitation totals (mm) September 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

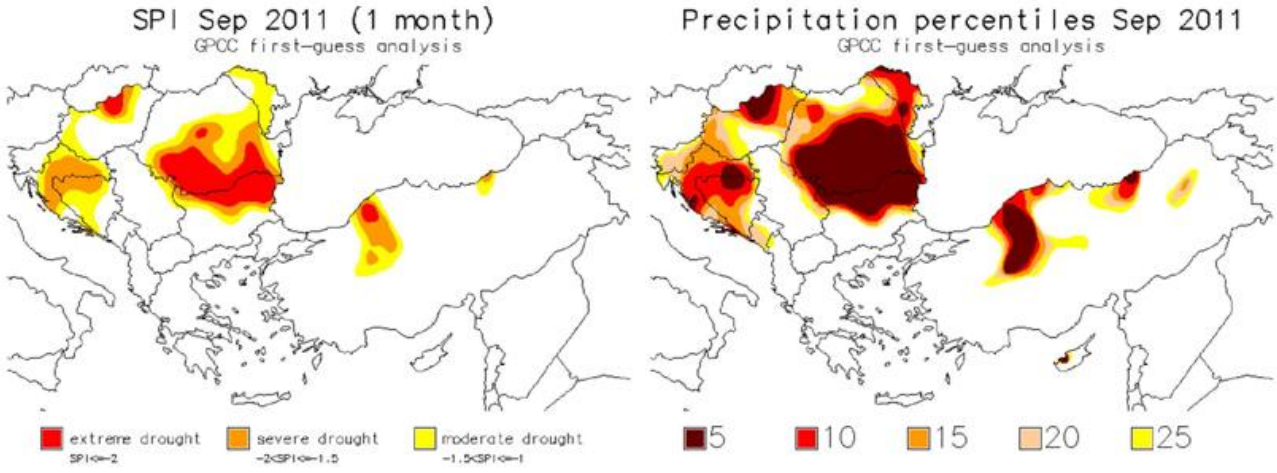


Fig. 3.36 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
September 2011

October

Highlights:

- ***Colder than normal in the southeast, mostly warmer elsewhere***
- ***Widely drier than normal except in the central and eastern Mediterranean Sea, the Black Sea and under northern North Atlantic influence***
- ***Mostly sunny, except in the east and the British Isles.***

Overview:

Temperature:

October 2011 was warmer than normal in northeastern, northern, western and southwestern Europe. The northeast was warmest with anomalies above 3 K. But also in the north for instance in Norway many stations broke their former records for the highest maximum temperatures for October. The British Isles as well as the Peninsula Iberica had anomalies above 2 K and southern England and in southwestern Spain and Portugal the positive anomalies exceeded 2 K. In Portugal October 2011 was the warmest October since 1931. Spain had a new temperature record with 36.5 °C on 12 October in Jerez de l Frontera. Also Russia had a very warm October. Both reported anomalies of more than +4 K. Poland reported an extreme maximum temperature in Opole of 25.7 °C. Slovakia had as well a new record for October with 28.2 °C on 1 October in Dolne Plachtince. Slovenia recorded the 2nd highest October temperatre in Ljubljana with 26.1 °C. In France a heat wave during 25 September to 4 October with more than 30 °C in western and southern parts of the country brought record-breaking temperatures for October at some sites. This was as well the case in UK where the heat wave lasted 28 September to 3 October with more than 28 °C widel in central and western England and the provisionally highest October temperature ever recorded in UK with 29.9 °C in Gravesend on 1 October. 1 October also brought the highest October temperature ever recorded in Denmark (26.9 °C). It was colder than normal in the southeast, mainly the eastern Mediterraenan Sea with Greece, the Aegean Sea, western Turkey, Bulgaria and Romania with anomalies of -1 to -2 K as well as the western North Atlantic. The greatest negative anomalies were registered in northwestern Turkey with anomalies of -2 to -3 K. In Central Europe it was slightly warmer or close to normal.

Precipitation:

October 2011 brought totals of more than 150 mm under Atlantic influence at the western coasts of Scandinavia, in the north and west of the British Isles, on Iceland and in the northwest of the Peninsula Iberica. In Norway more than 400 mm were regionally achieved and several stations broke their former maximum values for October totals and also some stations broke their former records of maximum daily totals for October as well. Totals of more than 150 mm occurred also in the east, the west and south of the Black Sea, in southwestern Turkey, western Greece, southern Italy and in Slovenia and Croatia. This was absolutely (in mm) much more than normal especially in southern Italy and Algeria, in western Turkey and in Bulgaria and Romania, and east and west of the Black Sea as well as for places in Scotland and Northern Ireland, on Iceland and partly in Norway. But also northern Scandinavia received much more precipitation than normal. In terms of relative anomalies (percentages) the surplus around the Black Sea and western Turkey is even more pronounced and moreover the southeast (Irak, Jordan) as well as northwestern Africa had much more precipitation than normal. Much of the precipitation fell as extremely heavy precipitation with daily totals of 50 mm and more. Daily totals of 100 mm were exceeded in Turkey, Slovenia, Croatia, Greece, Bulgaria, Spain, Italy and France. In Italy a desatrous precipitation event occurred in Liguria on 25 October, when rain intensities between 50 mm/h and 153 mm/h occurred in the areas Cinque Terre, Val di Vara and Lunigiana. Borghetto di Vara received more than 50 mm/h during 6 hours and overall a total 472 mm over 6 hours. Much damage occurred and 13 people came to death. It was on the other hand drier than normal in western, southwestern and mostly central Europe. In parts of Poland October 2011 was extremely dry.

Sunshine:

October 2011 was sunnier than normal in northern, central, western and southwestern Europe and most of the Balkan Peninsula, but dull over most of the British Isles, the east and the southeast. The sunshine duration was exceptionally high in some countries (Belgium, Netherlands and Germany ranking below 10 for the sunny October months since time series begun).

Wind:

During 16-18 October desastrous storms with a lot of damages occurred in Bulgaria.

Monthly Means or Totals and Anomalies :

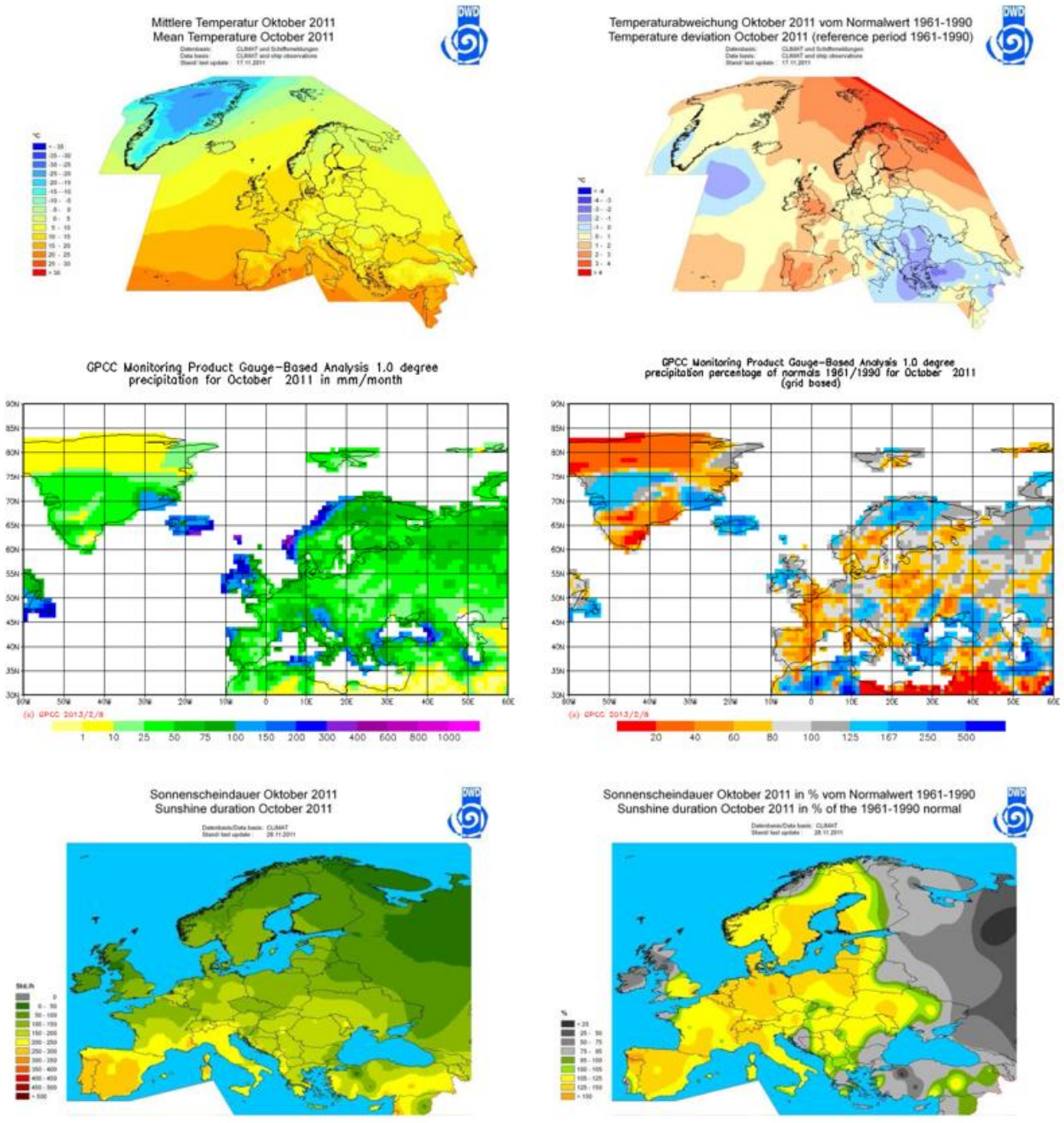


Fig. 3.37: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in October 2011*

Monthly Climate Extremes and Events:

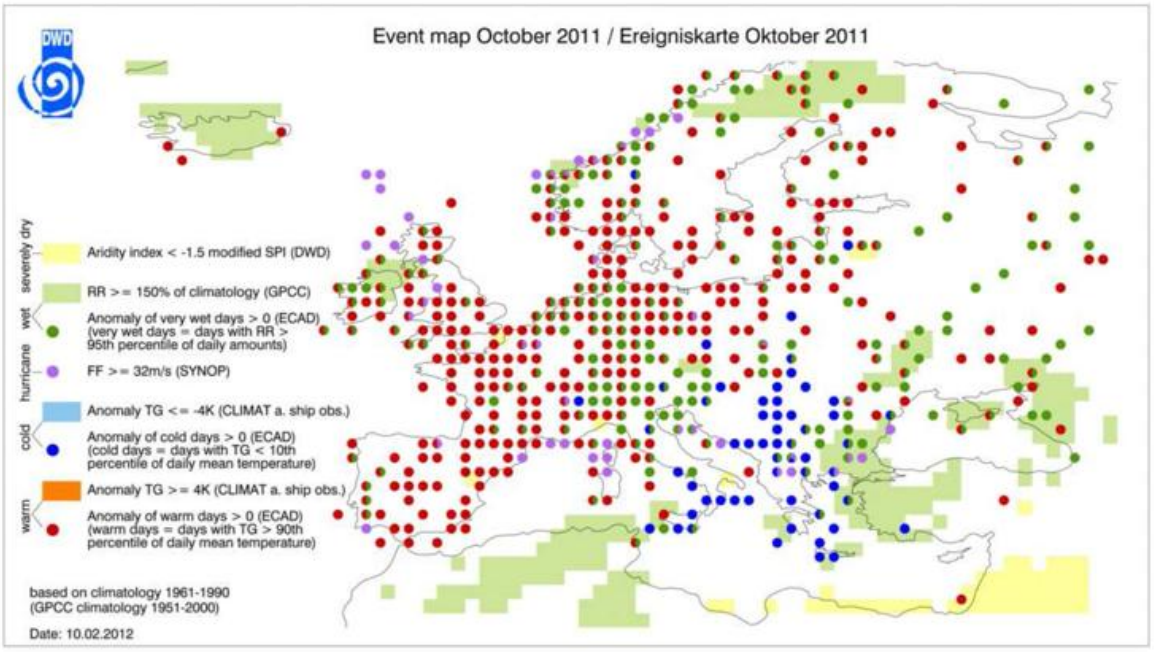


***Fig. 3.38** : Monthly Map of Climate Extremes and Events October 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

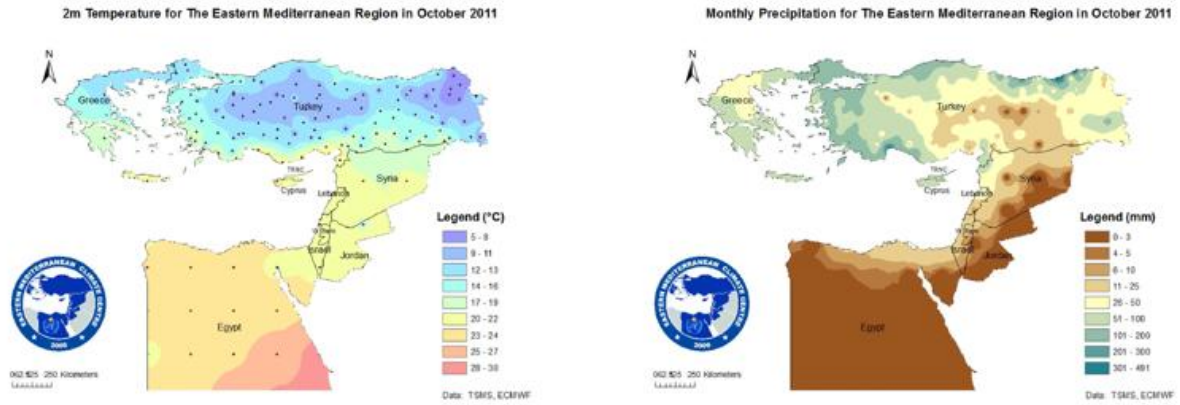


Fig. 3.39 *: Monthly mean temperature (&degC;) and monthly precipitation totals (mm) October 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

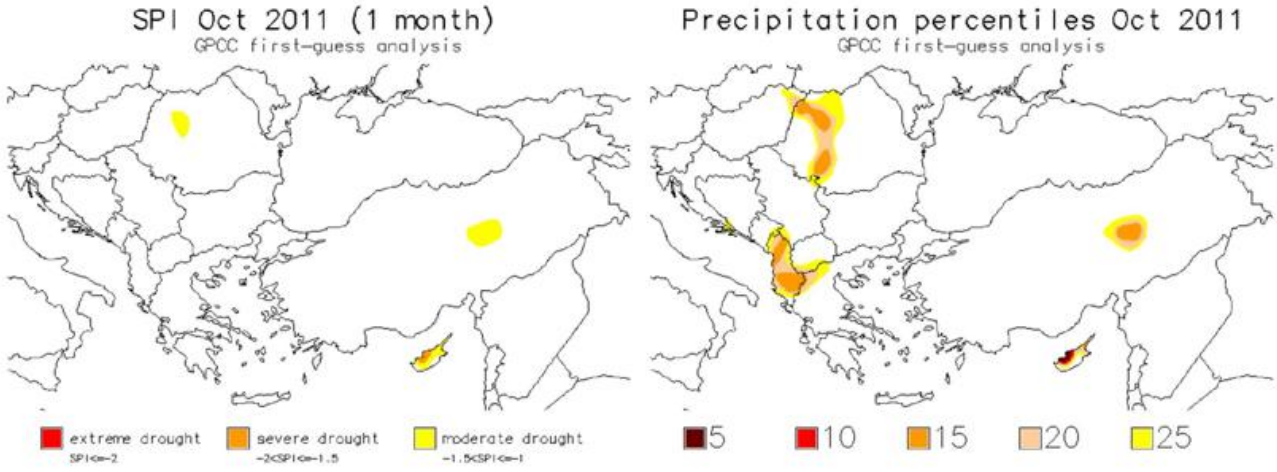


Fig. 3.40 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
October 2011

November

Highlights:

- ***Warmer than normal in the Arctic region and in northern, western and southwestern Europe. Colder in the Middle East.***
- ***Dry on the European continent but partly very wet in coastal regions of the Atlantic and the Mediteranean Sea.***
- ***Mostly sunny on the continent, very sunny in Central Europe.***

Overview:

Temperature:

There is a strong positive temperature anomaly of more than +4 K in the Arctic region and most of Scandinavia and a similarly strong negative anomaly in the Middle East with more than -4 K over Turkey and the eastern Black Sea region as well. Western and southwestern Europe was as well warmer than normal withup to 3-4 K in parts of United Kingdom and western France.

Most striking was the large positive anomaly in the Arctic region. The Faroe Islands for instance had an anomaly of + 8.9K. And Iceland reported 'one of the warmest Novembers on record'. In northern Sweden some locations had their warmest November. November 2011 brought some new records for daily temperature values. So Switzerland reported a maximum temperature of 23.1 °C on 4 November in Altdorf in a Foehn situation and nearly a 'tropical night' (19.7 °C) in Glarus on 3 to 4 November. In Switzerland Nobember 2011 was the mildest November since 1864 in the summit regions. The mountain station Säntis had an anomly of +6 K (reference 1961-1990). Also in Germany it was the warmest November at many summit stations at least since 1900 (at Hohenpeissenberg since 1781). In France it was the 2nd warmest November since 1900 with an anomaly of + 3 K. In Norway it was the warmest November at least since 1900 with an anomaly of +4.6 K. The Norvegian station Svinoy fyr had the highest monthly mean since its start of the time series in 1867. In Sweden it was also the warmest November on record for several stations.

The western North Atlantik was cooler than normal up to -2- -3 K. As well in the Middle East it was colder than normal. So Armenia had the coldest November on record with negative anomalies of -4.5 to -6 K. Similarly cold was November 2011 in the south of european Russia. And in Israel it was the coldest November since 1980.

Precipitation:

Very dry conditions with monthly totals below 10 mm prevailed from the North Sea to the northeastern Mediterranean Sea and Black Sea region in November 2011. This dry period is extraordinary in both aspects, the spatial extent and the amount. The map of precipitation anomalies shows the European continent and southeastern United Kingdom, most of Scandinavia (except the western and northwestern parts, southeastern Europe and the most of the eastern Mediterranean region below 80 percent of the normal (reference 1961-1990) and also the modified SPI (DWD) was in most of the area below -1.5, meaning at least 'severely dry' (figures 3.41 and 3.42). The maps of South Eastern Europe (fig. 3.45) show 'extreme drought' and precipitation percentiles below 5 for most of the Balkan Peninsula, Greece and western Turkey (possible slight differences in the SPI-definition do not result in differences in this case). In Germany the average amount of precipitation in November 2011 was 2.3 mm compared to a normal of 66.4 mm (reference 1961-1990). It was even the driest month over all seasons (ahead of April 1893 with 3.7 mm). In Uccle, Belgium it was the driest November since 1833. Also Denmark and the Netherlands broke their records. Poland as well reported an extremely dry November for the whole country with many stations without any precipitation.

The drought situation is also described in "State of the Climate 2011" (p.197-198). Fig. 3.43 provides some more details concerning the climatological assessments for Greece, Slovakia, Hungary and Bulgaria. Bulgaria had up to 28 (of 30) days without rain in some areas. Moldova reported for the biggest part of the country 0 mm, or 1-3 mm only,as November precipitation totals. This was a new record since the beginning of Moldovian precipitation observations. Romania received only 3 % of the normal precipitation (1.2 mm) in November 2011.Ranking information is provided in the following table:

Country	Rank of dry November months	since (* = beginning of records)
Austria	1	1858*
Belgium	1	1833 (Station Uccle)
Germany	1	1881
Hungary	1	1901
Luxembourg	1	1947*
Slovakia	1	1881
Sweden	1 (locally)	*
Switzerland	amongst driest	1864*

The high temperatures and low precipitation led to a new phenomenon in the Swiss Alps: for the first time since snow measurements began in 1931 the Säntis (2502 m a.s.l.) had no fresh snow in November 2011. In Arosa (1840 a.s.l.) this phenomenon occurred two times before 2011 in the series since 1890, namely 1899 and 1920.

The European Atlantic coasts, the western Mediterranean Sea, the Levante coast and the eastern Black Sea area received on the other hand partly extremely large precipitation totals . France received 300 to 400 percent of the normal in the Pyrenees and the Mediterranean areas and in Italy the area of Liguria received the second devasting rain within only 10 days. In the area of Geneva intensities of 180 mm/h resp. 400 mm/12h occurred and 6 people came to death. The rain intensities between 3 and 6 hours wre estimated to have return periods between 200 and 500 years. This was partly caused by the Mediterranean depression ROLF which had tropical character. The event is as well described in . Wetter than normal conditions in the north coincide with the warmer than normal conditions there. So it was the wettest November for Jan Mayen since the start of registrations there in 1908.

Sunshine:

November 2011 was mostly sunny in Europe except on the Iberian Peninsula, around the North Sea, northern Scandinavia, the easternmost region and the Middle East. In Central Europe it was very sunny with more than 150 % of the normal. For instance in Germany November 2011 became the second in the line of relatively sunny November months since 1951 (behind 1989 and ahead of 1983). In Austria it was the sunniest November since 1884 in large parts of the country. In Switzerland it was the 2nd sunniest November since 1961 at stations in the central and eastern Alps.

Wind:

Greece reported strong gale winds with gusts up to 30.8 m/s in the Aegean Sea on 13-14 November.

Monthly Means or Totals and Anomalies :

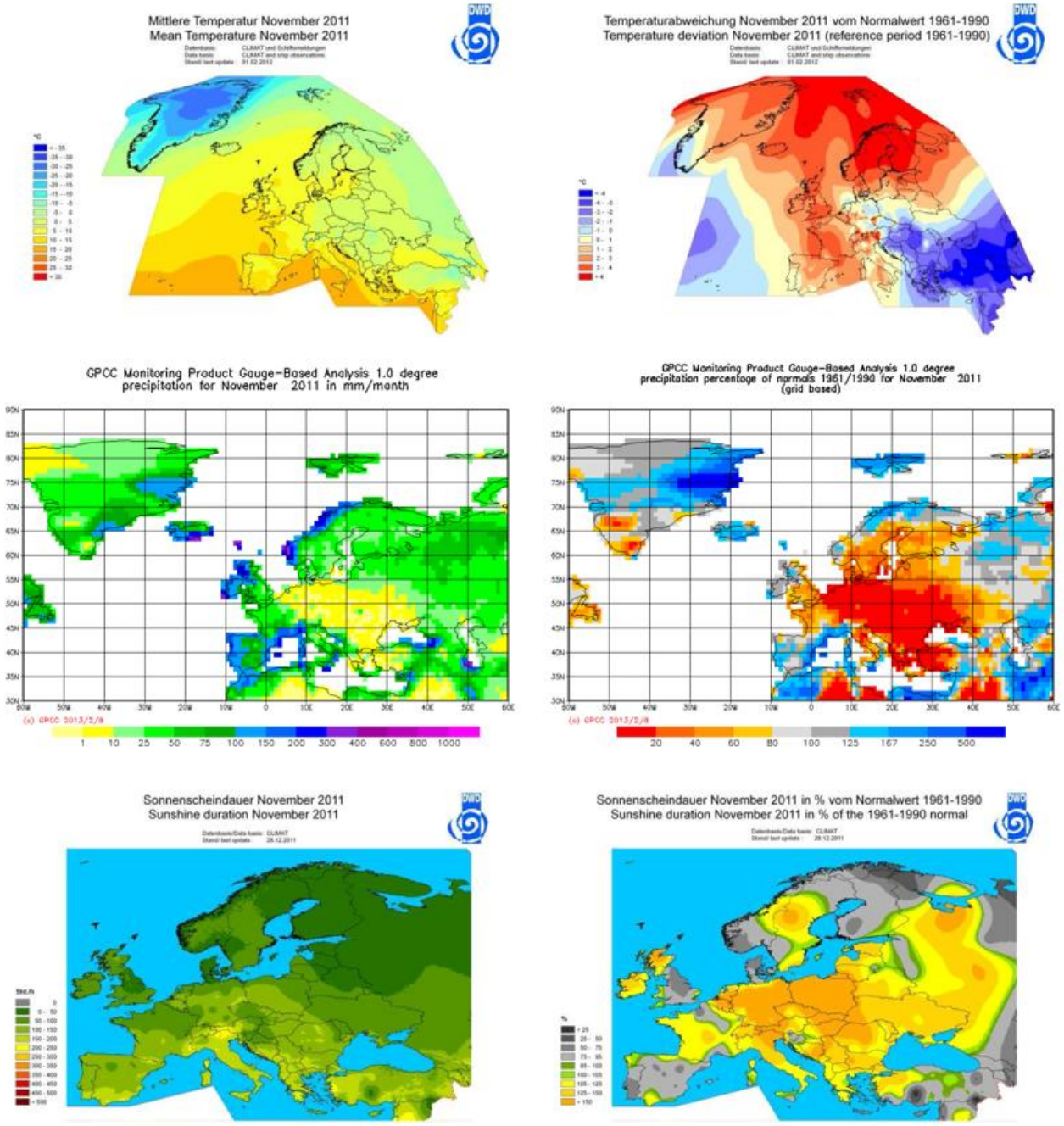


Fig. 3.41: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in November 2011*

Monthly Climate Extremes and Events:

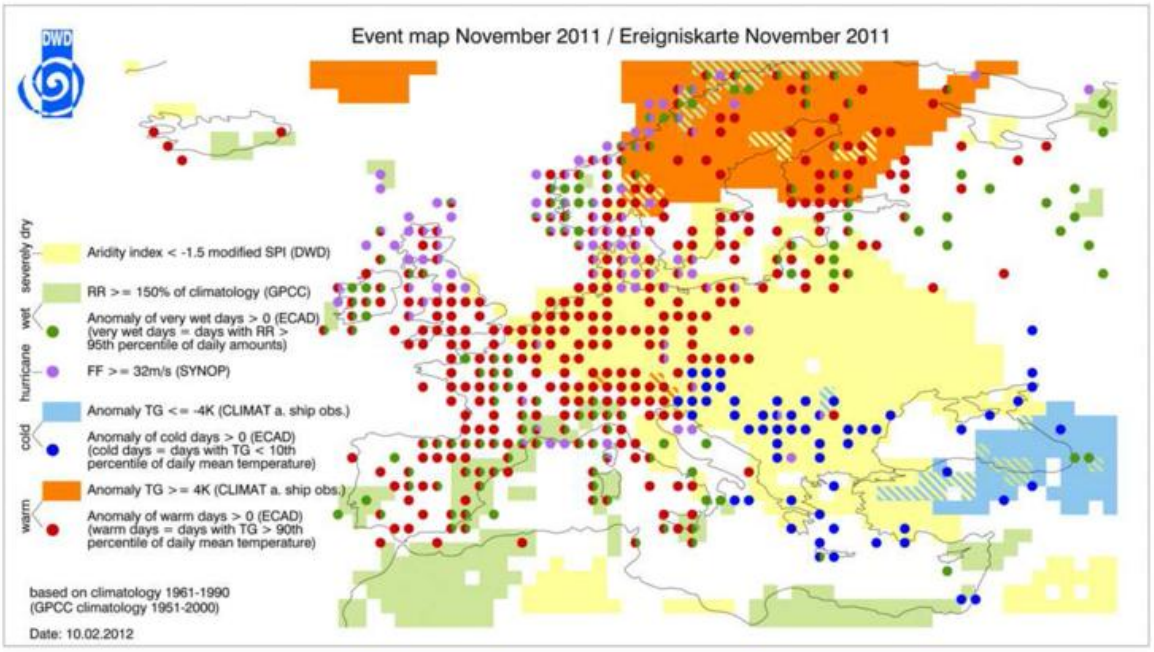


***Fig. 3.42** : Monthly Map of Climate Extremes and Events November 2011*

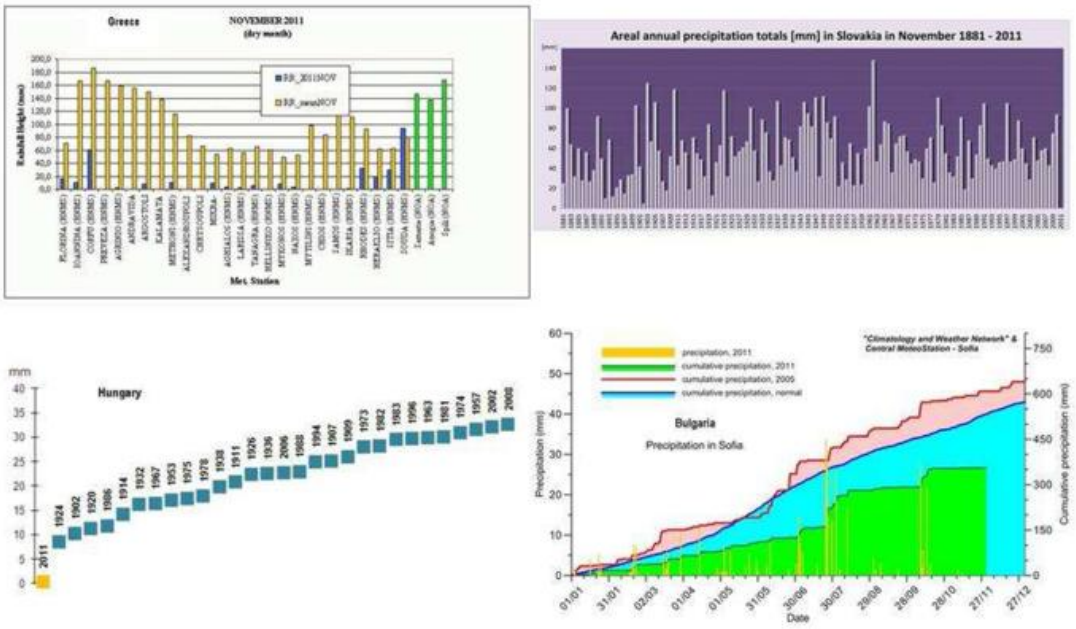


Fig. 3.43 *: Graphs illustrating the extreme low precipitation on the Balkan Peninsula and neighbouring Slovakia: November 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

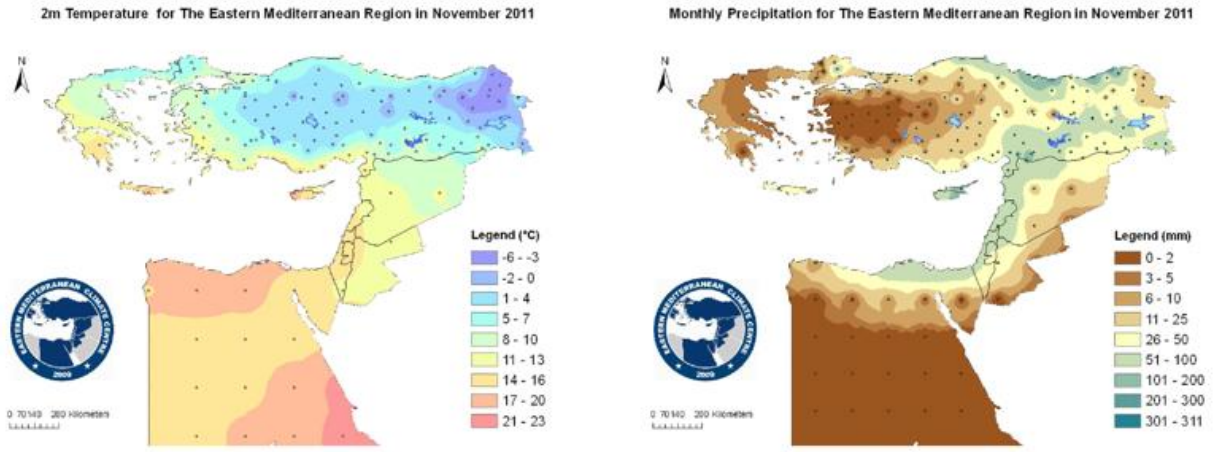


Fig. 3.44 *: Monthly mean temperature (&degC;) and monthly precipitation totals (mm) November 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

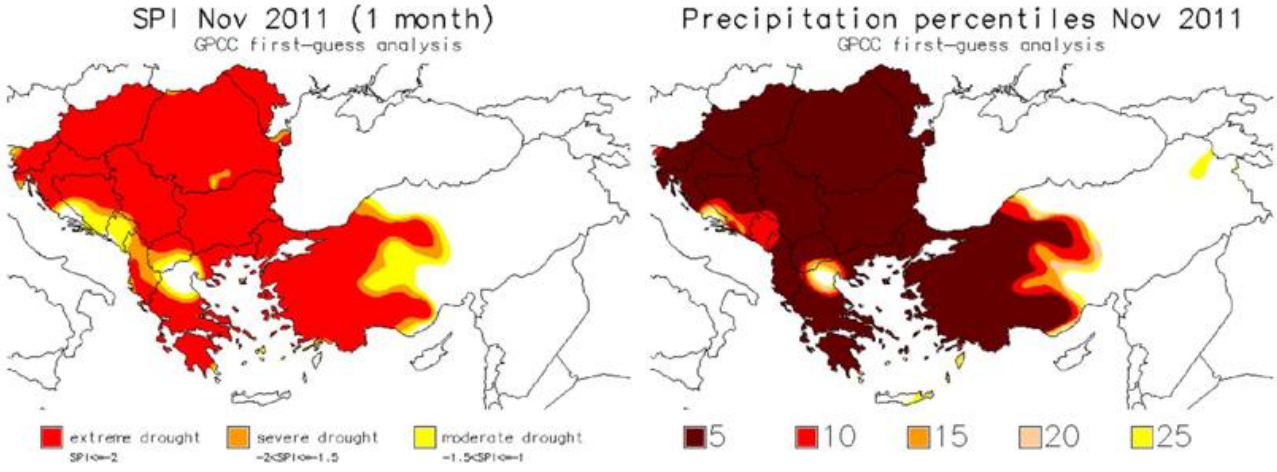


Fig. 3.45 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
November 2011

December

Highlights:

- ***Mostly remarkably warmer than normal except in the Atlantic region and the southeast.***
- ***Wetter than normal in western, central, northern and eastern Europe, dryer than normal mostly in the Mediterranean region.***
- ***Dull in central, northern and eastern Europe, sunny in the Mediterranean Sea region, western Balkan Peninsula and Poland.***

Overview:

Temperature:

December 2011 was warmer than normal in Europe and the Arctic Sea region. Most remarkable is the surplus of more than + 4K for eastern and northern Europe. Lithuania for instance had a positive anomaly (reference 1961-1990) of 4.3 K and recorded record-breaking 8 to 12 °C in many places on 26 and 27 December. Russia reported as well an anomaly of 4.2 K and for the Arctic Franz-Joseph Islands an anomly of +14 K is reported. Fig. 3.48 shows the spatial extent of the warm anomaly in Russia as well as time series of daily temperatures in December and of mean December temperatures over the years for 3 stations. The daily maxium temperatures in Moscow and St. Petersburg in 27 and 28 December were record-breaking. Belarus reported an anomaly of +5 K for December 2011. Armenia reported as well a new record for a December daily maximum temperature in Baku of 22.7 °C. It was colder than normal on the North Atlantic and in the eastern Mediterranean and the Middle East.

December 2011 was the coldest December in over 100 years in United Kingdom and the 2nd coldest since 1659 for 'Central England'.

Precipitation:

December 2011 was wetter than normal in western, central, eastern and most of northern Europe. Heavy precipitation occurred widely spread (see the Map of Climate Extremes below).

In Luxembourg it was the 3rd wettest December since records started in 1947 bringing more than twice the normal total. On 4 December the highest 1 hour precipitation of 15 mm/1 h was observed.

It was on the other hand dry in the western Mediterranean Sea and on the Iberian Peninsula and in the Middle East as well as in the Caucasus region and partly on the Balkan Peninsula and the soil moisture was still below normal in these areas according to the analysis of the Climate prediction Center (http://www.cpc.ncep.noaa.gov/cgi-bin/gl_Soil-Moisture-Monthly.sh). Reykjavik on Iceland reported the longest lasting snow cover since observations started in 1921 with 29 days in Dember 2012.

Sunshine:

Sunshine duration was well below normal in Ireland, western UK, central Europe as well as eastern and northern Europe. It was very dull in central parts of Germany and in European Russia and northern Scandinavia. It was on the other hand rather sunny on the Iberian Peninsula, parts of Italy, mostly in Poland, in Turkey and the Caucasus area. This patchy pattern corresponds fairly well with the anomaly of the fractional cloud cover (http://www.dwd.de/rcc -> products -> clouds).

Wind:

Storm JOACHIM hit France on 15-16 December. Remarkable was the spatial extent of the area with high wind speeds. It covered about one quarter of France with gusts of 25 m/s or more. The highest gusts occurred on the Puy-de-Dôme (up to 59 m/s in 1465 m asl).

Storm DAGMAR was devastating in Sweden on 26 December. UK reported generally stormy weather across Scotland from late November to mid December.

Other Phenomena:

Belgium reported a record number of thunderstorms for December. Uccle had 11 days compared to normal 3 days. Sweden reported the highest thunder activity ever recorded in December.

Monthly Means or Totals and Anomalies :

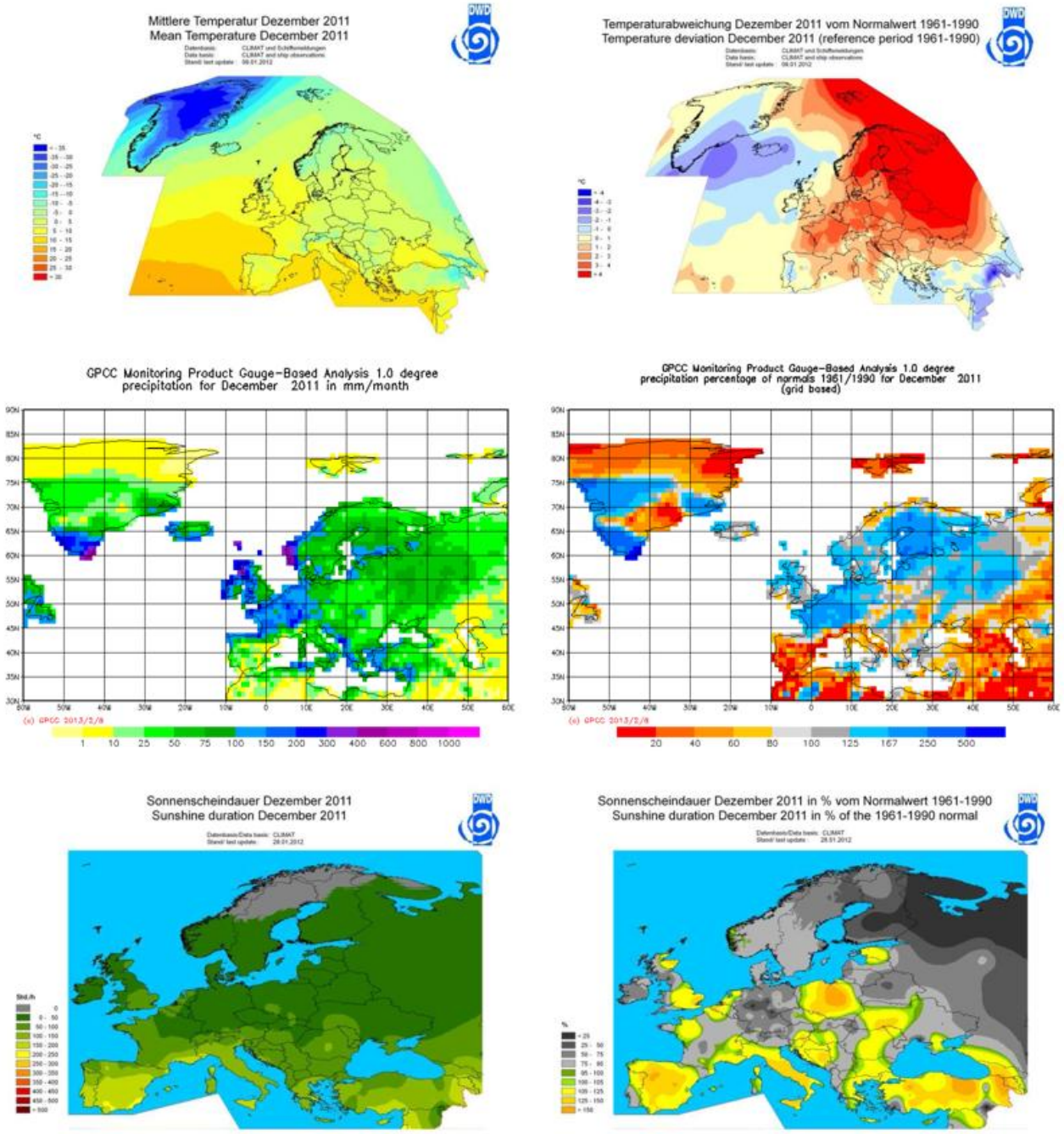


Fig. 3.46: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in December 2011*

Monthly Climate Extremes and Events:

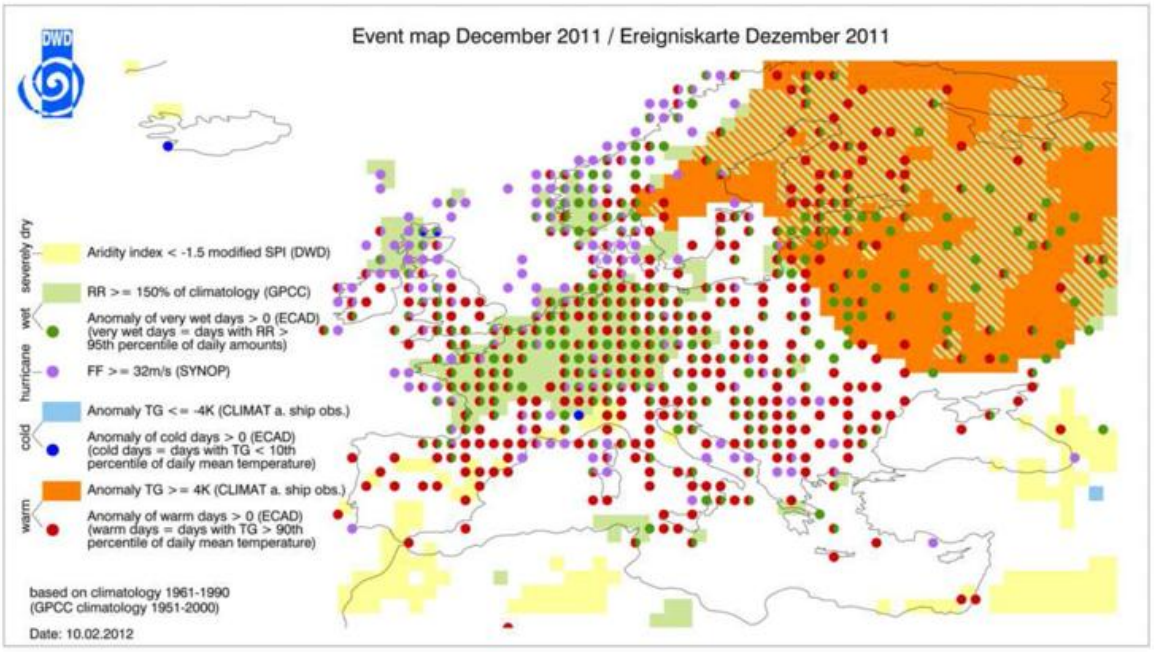


***Fig. 3.47** : Monthly Map of Climate Extremes and Events December 2011*

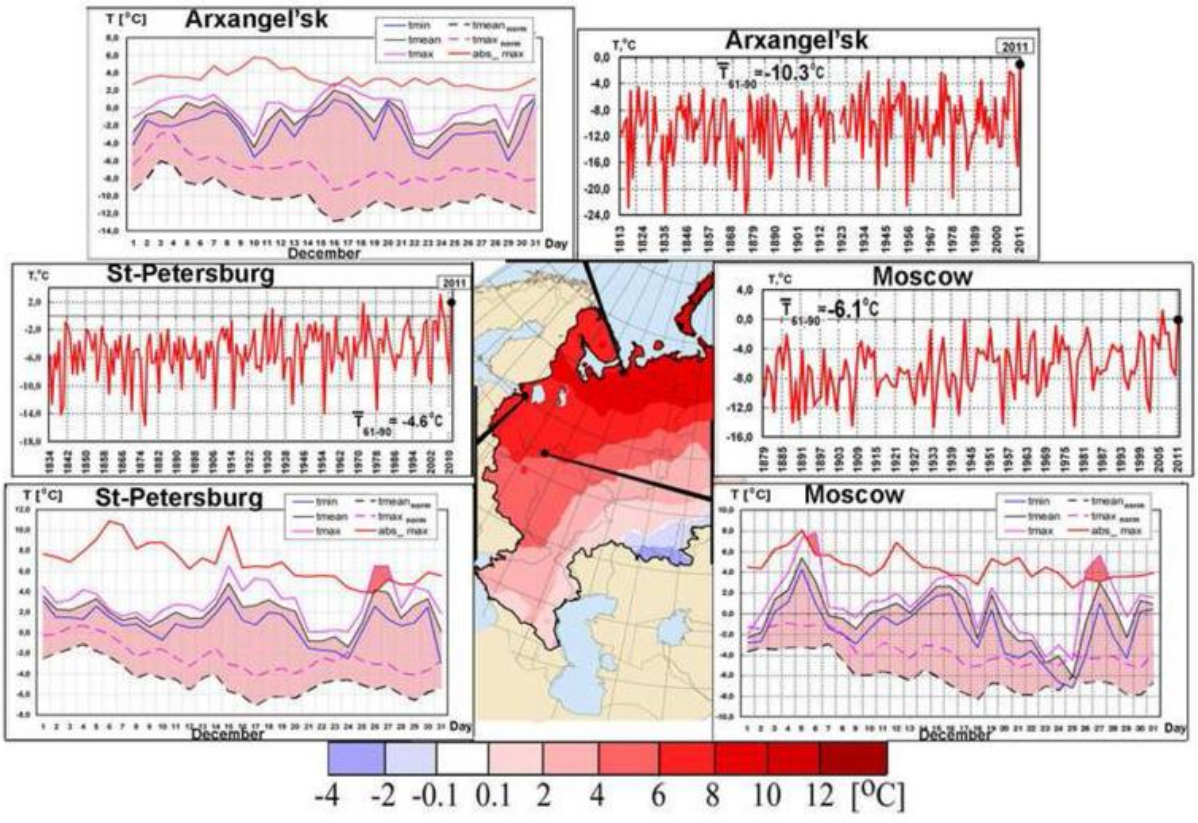


***Fig. 3.48** : Illustration of very warm December 2011 in northern Russia December 2011*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

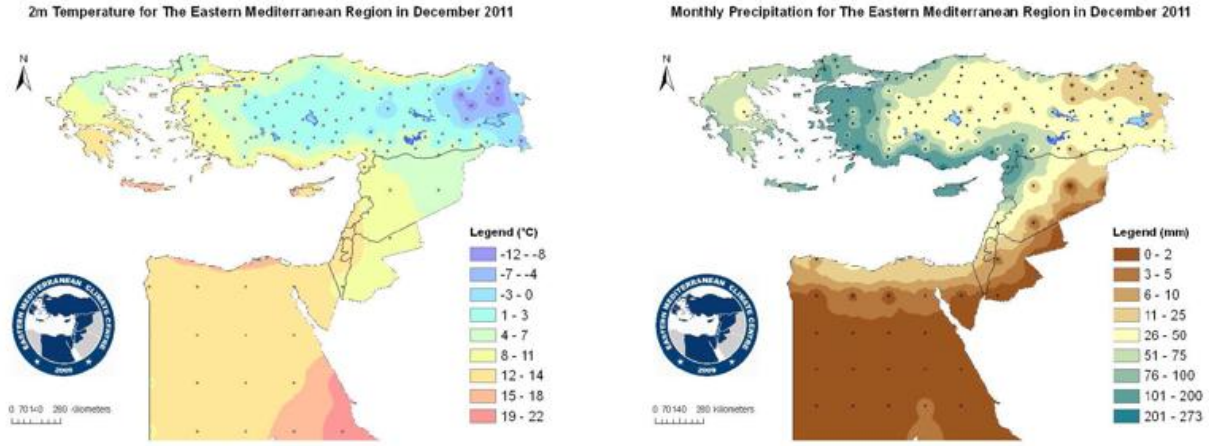


Fig. 3.49 *: Monthly mean temperature (&degC;) and monthly precipitation totals (mm) December 2011 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indizes for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

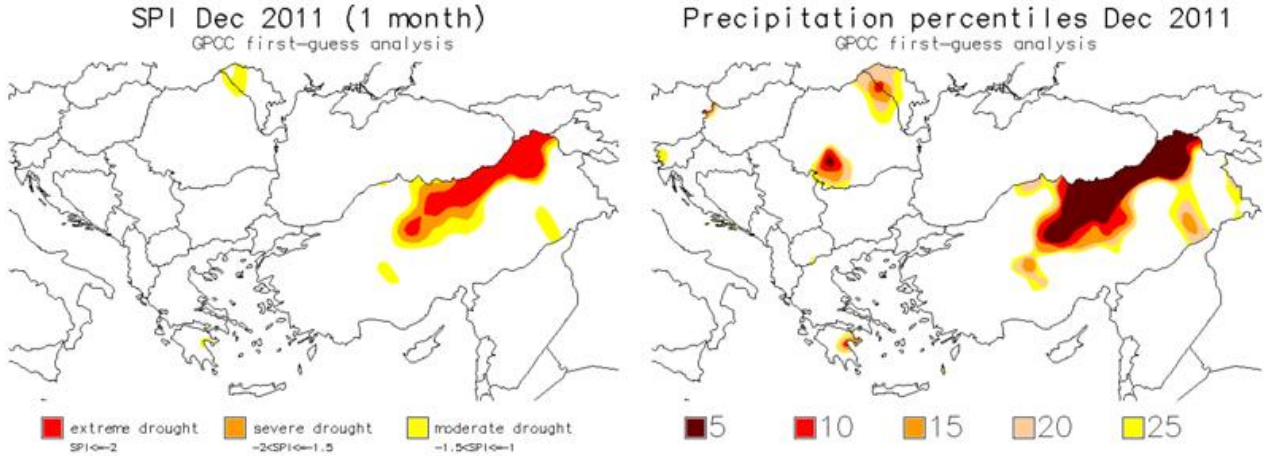
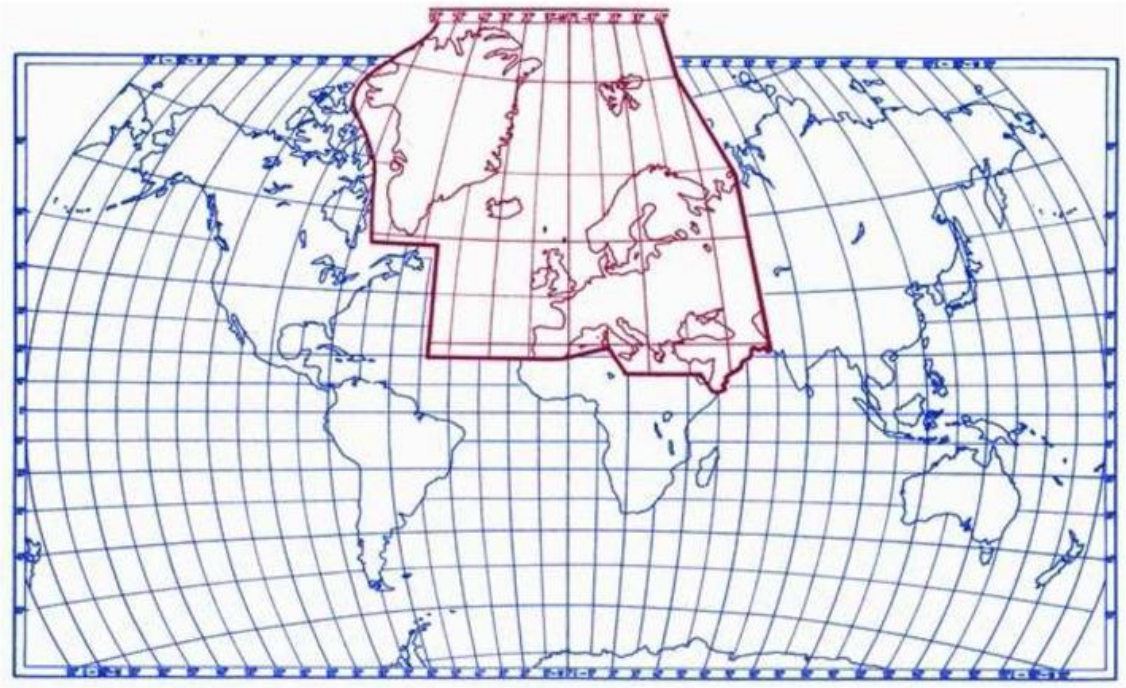


Fig. 3.50 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
December 2011

Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2012



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Turkey
Ukraine
United Kingdom

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Seasonal Survey

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Introduction

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI NMHSs as well as general climate monitoring information from their official Websites. Supported by the European Climate Support Network and WMO´s World Climate Data and Monitoring Programme the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMOs climate system monitoring, complementing and detailing well-known regular global assessments, such as WMOs Annual Statement on the Status of the Climate and the State of the Climate Article published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ amongst the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the Webpages of the RA VI RCC Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

Notes:

- Maps of the RA VI RCC Network are based on the following data sources:
  - Temperature: CLIMAT data and ship observations provided by the Global Collection Centre (GCC), run by Deutscher Wetterdienst
  - Precipitation: Global Precipitation Climatology Centre (GPCC), run by Deutscher Wetterdienst
  - Sunshine: CLIMAT data.
  - Anomaly maps of climate indices are provided by the RCC-CD (ECA&D)
- Subregional monthly maps are provided by the Eastern Mediterranean Climate Centre (EMCC) and the Southeast Drought Management Centre (DMCSEE)

The following subregions are used in the Bulletin:

Central and western Europe: *Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, Netherlands, Poland, Slovakia, Switzerland, United Kingdom*
Nordic and Baltic Countries: *Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden*
Iberia: *Portugal, Spain*
Mediterranian, Italian and Balkan Peninsula: *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, Serbia, Slovenia, Republic of Macedonia, Montenegro, Turkey* ***Eastern Europe:*** *Belarus, European Russia, Moldova, Romania, Ukraine*
Middle East: *Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, western Kasakhstan*

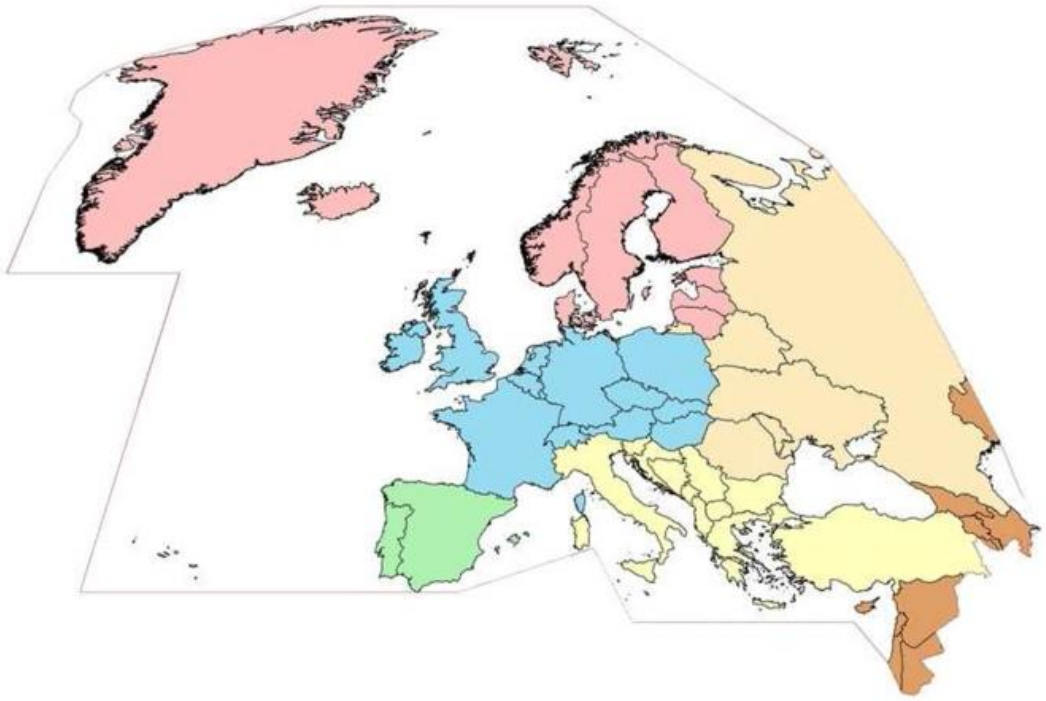

Fig. 1.1: *Definition of the 6 subregions within WMO RA VI*

References:

Note: *Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2011 edition of the Bulletin are listed on page 3 above. Many contributions or also additional information may as well be found on the web, see below.*

National Reports 2012

Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Wien, Austria
Wetterrückblick für 2012
http://www.zamg.ac.at/cms/de/klima/klima-aktuell/jahresrueckblick

Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Wien, Austria
Meldungen zu Unwetter und witterungsbedingten Schäden in der Wirtschaft/Jahresübersicht 2012

Meteorological Service Cyprus (MOA),Cyprus
AVERAGE ANNUAL PRECIPITATION (mm)
http://www.moa.gov.cy/moa/ms/ms.nsf/DMLcyclimate_en/DMLcyclimate_en?opendocument

Royal Netherlands Meteorological Institute (KNMI), DeBilt, Netherlands
Jaaroverzicht van het weer in Nederland, 2012,
http://www.knmi.nl/klimatologie/mow/pdf/jow_2012.pdf

The Irish Meteorological Service (MET eireann), Ireland
Weather Summary of 2012,
http://www.met.ie/climate/monthly_summarys/annual_2012.pdf

The Royal Meteorological Institute of Belgium (KMI), Belgium
Klimatologisch overzicht van 2012
http://www.meteo.be/meteo/view/nl/7609555-2012.html

Federal Meteorolocical Institute (METEOBIH), Bosnia and Herzegovina
KLIMATOLOSKA ANALIZA G O D I N E 2012
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Outstanding events and anomalies

Temperature

- 2012 the 2nd highest mean temperature at Svalbard Airport since 1912, after 2006.
- 2012 was the second coldest year in Sweden.
- The warmest summer on record in Israel together with the summer of 2010.
- Unusually warm March in northern, western and central Europe.
- Highest mean May temperatures since 1891 in southern European Russia.
- Warmest July on record in Hungary as well as in parts of Israel

Precipitation

- One of the wettest years of the last 50 to 150 years in the Nordic and Baltic countries.
- The 3rd rainiest year since 1768 in UK. The wettest in England since 1910.
- The driest winter since 1931 in Portugal
- One of the driest March months in several countries of *Western and Central Europe*.
- The wettest April in the England and Wales precipitation series from 1766 (Alexander and Jones, 2001)
- One of the driest Aprils in the last 70 years in northern Israel.
- The wettest June on record in Stockholm (with precipitation measurements since 1786)
- Exceptional widespread rain in northeastern Israel and unusually high rain totals in southern Israel in June.
- The driest August since 1901 in Hungary.
- The rainiest October for some stations in northeastern parts of Sweden for more than 100 years
- The wettest December on record in Belgium and one of the wettest in the last 100 years in northern and western Scotland

Sunshine Duration

- Highest annual sunshine duration on record in Hungary.
- The sunniest March in England since 1929

Other Anomalies

- A new record of high surface level pressure for Moscow (1025 hPa in late January; previous value 1024 hPa in 1946).
- A new record of high surface level pressure for the month of February in Haparanda, Sweden (1058.0 hPa on 1 February)
- A new record of low surface level pressure for Moscow (958.7 hPa on 6 November)

Events

- January air temperature above 0°C on Kheis Island (Russian Arctic islands),for the first time on record (since 1957).
- 2012 the highest daily precipitation total of the Norwegian Arctic stations on 30 January at Ny Alesund: 98 mm. This has an estimated return period of 200 years.
- Severe cold wave in the 1st half of February in eastern, western, central and southwestern Europe
- New record for the highest official surface air temperature (SAT) of May ever recorded in Greenland in May 24.8°C at Ivittuut/Narsarsuaq on 29 May 2013.
- Rain and several days of thaw have been registered at the ice cap of Greenland with high temperatures late June and several days in a row in July above 0°C.

Annual Survey

Atmospheric Circulation

The chapter on the atmospheric circulation gives information on selected northern hemisphere teleconnection indices which are considered to be relevant for WMO RA VI and it discusses influences of circulation patterns upon anomalies and outstanding events. The information is based upon the Monthly Bulletins on the climate in WMO RA VI and the Global Climate Bulletin (MeteoFrance) and completed by reports of NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/upper troposphere not shown here. See http://www.ncdc.noaa.gov/teleconnections/ and http://www.cpc.ncep.noaa.gov/products/CDB/index.shtml.

STANDARDIZED NORTHERN HEMISPHERE TELECONNECTION INDICES (1981-2010 Clim)

North Atlantic Oscillation (NAO)
East Atlantic Pattern (EA)
East Atlantic/West Russia Pattern (EA/WR)
Scandinavia Pattern (SCA)
Polar/ Eurasia Pattern (POL)
Arctic Oscillation (AO)

Year	Month	NAO	EA	EA/WR	SCA	POL	AO
2012	1	0.86	-1.76	-0.46	0.57	-2.34	-0.220
2012	2	0.03	-1.73	-0.64	0.34	0.19	-0.036
2012	3	0.93	-0.64	1.35	-0.47	-1.42	1.037
2012	4	0.37	-0.28	-1.59	-0.93	-0.97	-0.035
2012	5	-0.79	0.52	-0.47	-0.58	-0.11	0.168
2012	6	-2.25	-0.11	0.01	-1.42	-1.75	-0.672
2012	7	-1.29	1.02	-1.43	-0.56	1.01	0.168
2012	8	-1.39	1.36	1.15	0.85	0.98	0.014
2012	9	-0.43	0.38	-0.49	-0.93	-0.70	0.772
2012	10	-1.73	-0.32	-1.01	-0.28	-0.17	-1.514
2012	11	-0.74	1.15	-0.59	0.68	-0.19	-0.111
2012	12	0.07	0.68	-0.88	2.00	0.35	-1.749

Table 2.1: *Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference and the AO, December 2011 to December 2012*

(Sources:ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table Note that all values are standardized with the reference 1981 to 2010.

The influence of these teleconnection patterns differs with months or seasons. For Europe not only the best known NAO pattern is relevant but for individual months also one of the other teleconnection patterns may have an influence. The annual course of these selected teleconnection indices as well as the Southern Oscillation index (SOI) is as well illustrated in Fig 2.1. The Southern Oscillation (connected to ENSO) has usually little influence in Europe but may occasionally be of some importance. It is presented for completeness here. In Fig. 2.2 maps of the mean sea surface level air pressure are presented.

In **January 2012** high pressure centered close to the Azores as well as over Russia was well pronounced. Low pressure in the northwest was centered between Iceland and southern Greenland. Both pressure patterns - the Azores high and the Icelandic low were better developed than the mean and a distinct gradient zone

between both may be related to the storm events that occurred. The NAO index was positive with 0.86, EA and POL were strongly negative (-1.8 and -2.3). The western European negative precipitation anomaly was very consistent with the circulation pattern.

High pressure over western Europe as well as over Russia was the decisive feature in **February 2012**. The positive anomalies were highest west of the British Isles with more than 16 hPa. More than 12 hPa higher than normal was the sea level pressure on the North Atlantic between 40°N and 55°N, extending nearly to 30°W and including most of the British Isles and western and northern France. Similar anomalies occurred in northeastern Russia. The East Atlantic pattern (EA) was the strongest circulation mode (-1.7) while NAO was neutral.

Though the NAO was positive in **March 2012** (0.93) the distribution of the sea surface level pressure did not show the Icelandic low and the Azores high ideally. The center of the Icelandic low was situated between Iceland and southern Greenland. An extensive trough reached southward to nearly 40 N. A secondary but much weaker low laid over Russia. The latter had a negative anomaly of at least -12 hPa in its center. The anomalies of the Icelandic low were negative as well with at least 8 hPa it its center. The Azores high was shifted northeastward and was centered over northern France and the southerly British Isles. The positive anomalies of the Azores high exceeded 12 hPa. High pressure spread over western and central Europe, northern Africa, and westward on the North Atlantic between 20 N and 40 N. More influence than the NAO had the East Atlantic/West Russia pattern (EA/WR) and the Polar/Eurasia pattern (POL) with values of 1.35 and -1.42. The negative precipitation anomalies in western Europe were quite consistent with the pressure (and geopotential) fields and the induced blocked zonal circulation.

The surface level pressure was in **April 2012** characterized by positive anomalies on the Atlantic and negative anomalies on the European continent. The Azores High was weaker than normal and the Icelandic low was not developed. There was instead high pressure north of Iceland. The NAO index had a mean of 0.37. Also the AO was close to zero (-0.03) as the polar vortex was weak. The strongest circulation mode was EA/WR (-1.59) followed by POL (-0.97). There was no blocking over the region of interest. The positive temperature anomaly over most of the region is remarkable in this context. The negative or close to normal temperature anomalies over western Europe are related to the postive rainfall anomalies here.

In **May 2012** higher than normal sea surface level air pressure extended over the northern North Atlantic, western, central and southwestern Europe, while lower than normal sea level air pressure prevailed over the Azores and northeastern, eastern and southeastern Europe. The NAO index was negative with -0.91. Blocking was detected at the beginning and at the end of the month. The negative precipitation anomalies in Spain as well as the positive precipitation anomalies in southeastern Europe were consistently related to the pressure and geopotential anomalies.

In **June 2012** the Azores high was well developed and influenced the Iberian Peninsula, the western Mediterranean Sea and southern France. High pressure was also prevailant over Greenland while low pressure influenced most of the European continent with minima over the British Isles, Scandinavia and northern Russia as well as the Middle East. In terms of anomalies there were positive anomalies over Greenland and the northern North Atlantic, including Iceland. And there were negative anomalies mostly everywhere else with the minimum centered southwest of Ireland and spreading northeast to southern Sweden and southwest to the western North Atlantic. The NAO was negative and well below the normal (1961-1990) values minus 1 σ throughout the month. The monthly mean resulted to -2.25. The AO index was mostly negative during the first half of the month and close to normal during the second half. The monthly mean was -0.62. Strong were the Scandinavia pattern (SCAND) and the Polar/Eurasia pattern (POL) with -1.42 resp. -1.75. Like already in May the precipitation anomalies reflected the circulation patterns well whereas this is not so to the same extent for the temperature anomalies.

The surface level air pressure was generally close to normal in **July 2012**. There was a slight positive anomaly over the Azores, over Iceland and southern Greenland as well as in the east. The largest negative anomaly of -4 to -8 hPa occurred in a small area between Ireland and England as well as near Newfoundland. The NAO-index was negative with -1.29. Negative values had as well the relatively strong modes East Atlantic pattern (EA), the East Atlantic/West Russia pattern (EA/WR) and the Scandinavia pattern (SCAND) with -1.0 , -1.4 and -0.6. Positive was the Polar/Eurasia pattern (1.0). There was no blocking in July 2012. Again the precipitation anomalies reflected the circulation patterns well whereas the temperature anomalies did less.

The Icelandic low was centered further southward than normal in **August 2012** and the Azores high was weaker. The negative anomalies ranged between -4 and -8 hPa over Ireland and west and southwest of the British Isles. There was as well lower than normal sea level pressure in the eastern Mediterranean, southern Russia and Middle East with anomalies ranging up to -4 hPa. Northern, northeastern, central, southern and southwestern Europe had positive anomalies up to +4 hPa. The NAO index was negative with -1.4 and the East Atlantic mode (EA) was positive (1.4). Higher than normal 500 hPa Geopotential over northern Morocco and the central Mediterranean Sea to the Adriatic Sea were favourable conditions for heat waves over southeastern Europe. Positive anomalies of the heat content of the North Atlantic as well as in the Mediterranean Sea were as well noticeable.

The mean sea surface level air pressure of **September 2012** showsed a pronounced but tilted dipole of the Icelandic low and the Azores high. The Icelandic low was shifted eastward and stronger than normal while the Azores high is shifted westward and was only slightly stronger than normal in intensity or close to normal. The Azores high was extended far eastward but weak so that overall a negative anomaly prevailed. The gradient between both pressure systems was high in a zonal band from North America over the British Isles and the southern Baltic Sea to Russia, allowing low pressure systems to move eastward and bring first storms in the north and northwest. The most active circulation mode was the Scandinavia pattern (SCAND) with a value of -0.9. The strong gradient between the pressure patterns may explain the remarkable contrast in the precipitation anomalies between the highest northern latitudes (wet) and the southward latitudes (drier especially in central and southeastern Europe).

In **October 2012** the sea surface level pressure was lower than normal over most of the region with negative anomalies of -4 to -8 hPa from the central North Atlantic to eastern Europe, including southern Scandinavia and the Baltic Sea and the northwestern Black Sea as well as most of the Iberian Peninsula and the western Mediterranean Sea area. Iceland and Greenland had higher than normal pressure with anomalies of +8 to +12 hPa. The NAO and EA/WR were the most active modes in October with values of -1.7 resp. -1.0.

November 2012 was characterized by low pressure in the north, centered east of Iceland, and high pressure in the south with centers west of the Azores and east of the Caspian Sea. The negative anomalies were strongest with -8 to -12 hPa over the Faroer Islands and ranged between -4 and -8 hPa in a region from the Norwegian Sea and Iceland southward to the Iberian Peninsula. The northern, central, and southern European continent, the Mediterranean Sea and Middle East had negative anomalies between 0 and -4 hPa.EA was the most active mode (1.0) and NAO (-0.7) as well as SCAND (-0.7) show as well some influence.

December 2012 was characterized by low pressure centered on the Northern North Atlantic south of 60°N, high pressure centered southeast of the Azores as well as high pressure over Russia. The anomalies were negative on the North Atlantic with -8 to -12 hPa west of the British Isles and south of Iceland and positive over northern Russia and Scandinavia. The NAO index was close to zero but the AO index was negative with -1.7. The most active mode was SCAND (2.0). The next active modes for Europe were EA/WR (-0.9) and EA (0.7).

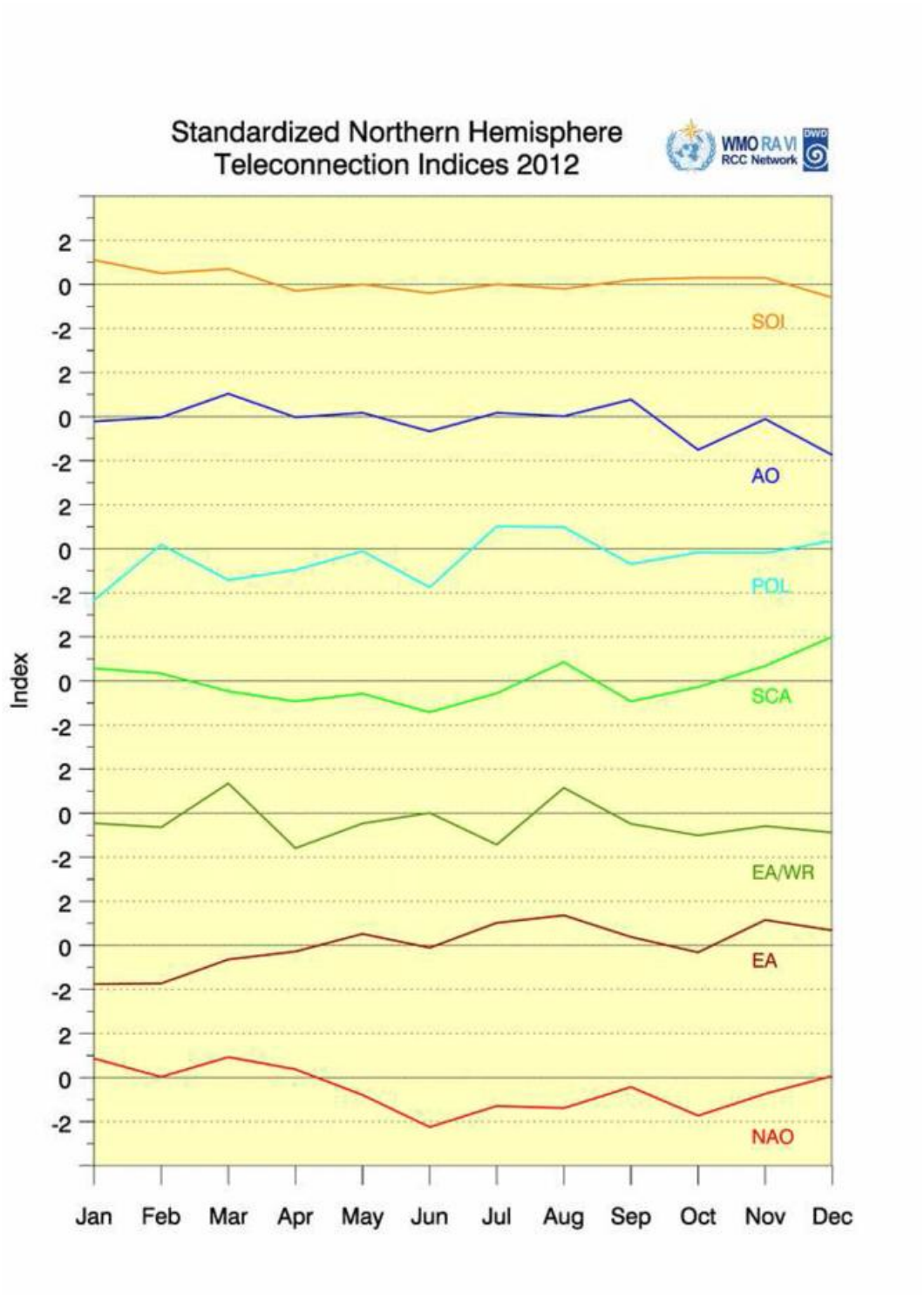
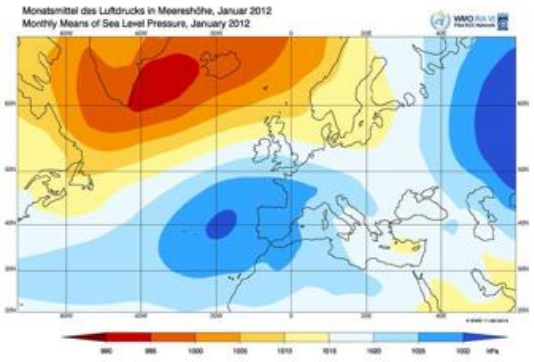
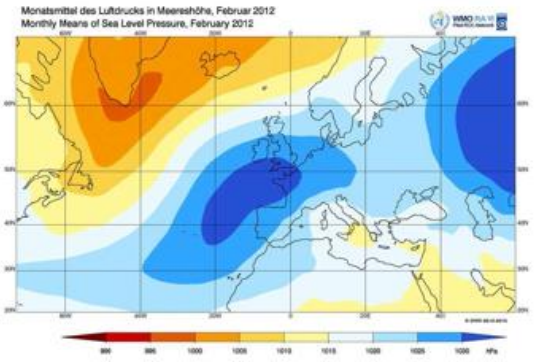
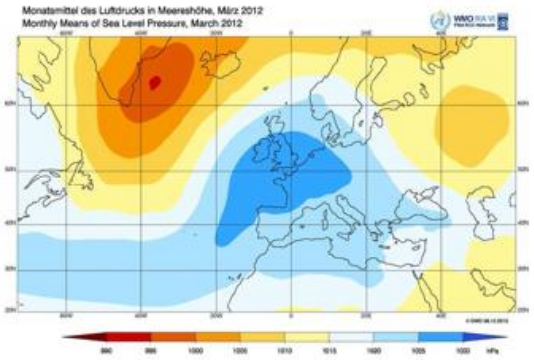
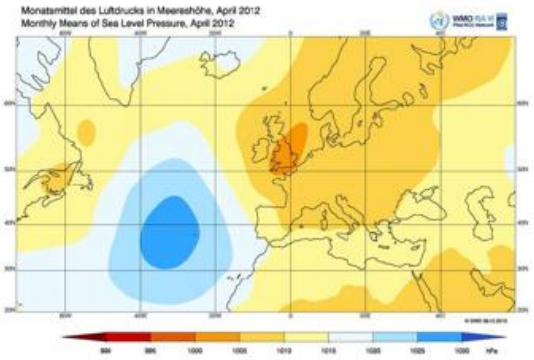


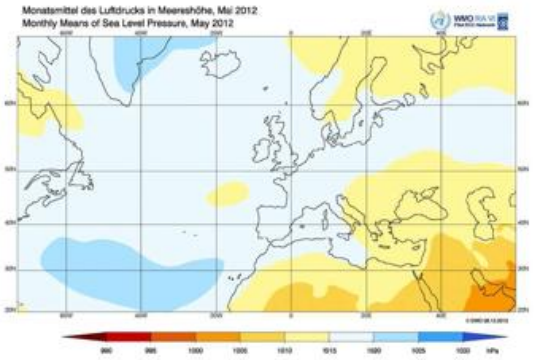
Fig. 2.1: *Annual course of relevant Teleconnection Indices 2012*
Source: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh

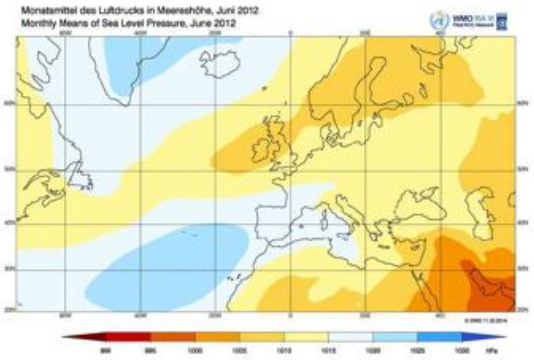

Monatsmittel des Luftdrucks in Meereshöhe, Januar 2012
Monthly Means of Sea Level Pressure, January 2012


Monatsmittel des Luftdrucks in Meereshöhe, Februar 2012
Monthly Means of Sea Level Pressure, February 2012


Monatsmittel des Luftdrucks in Meereshöhe, März 2012
Monthly Means of Sea Level Pressure, March 2012


Monatsmittel des Luftdrucks in Meereshöhe, April 2012
Monthly Means of Sea Level Pressure, April 2012


Monatsmittel des Luftdrucks in Meereshöhe, Mai 2012
Monthly Means of Sea Level Pressure, May 2012


Monatsmittel des Luftdrucks in Meereshöhe, Juni 2012
Monthly Means of Sea Level Pressure, June 2012

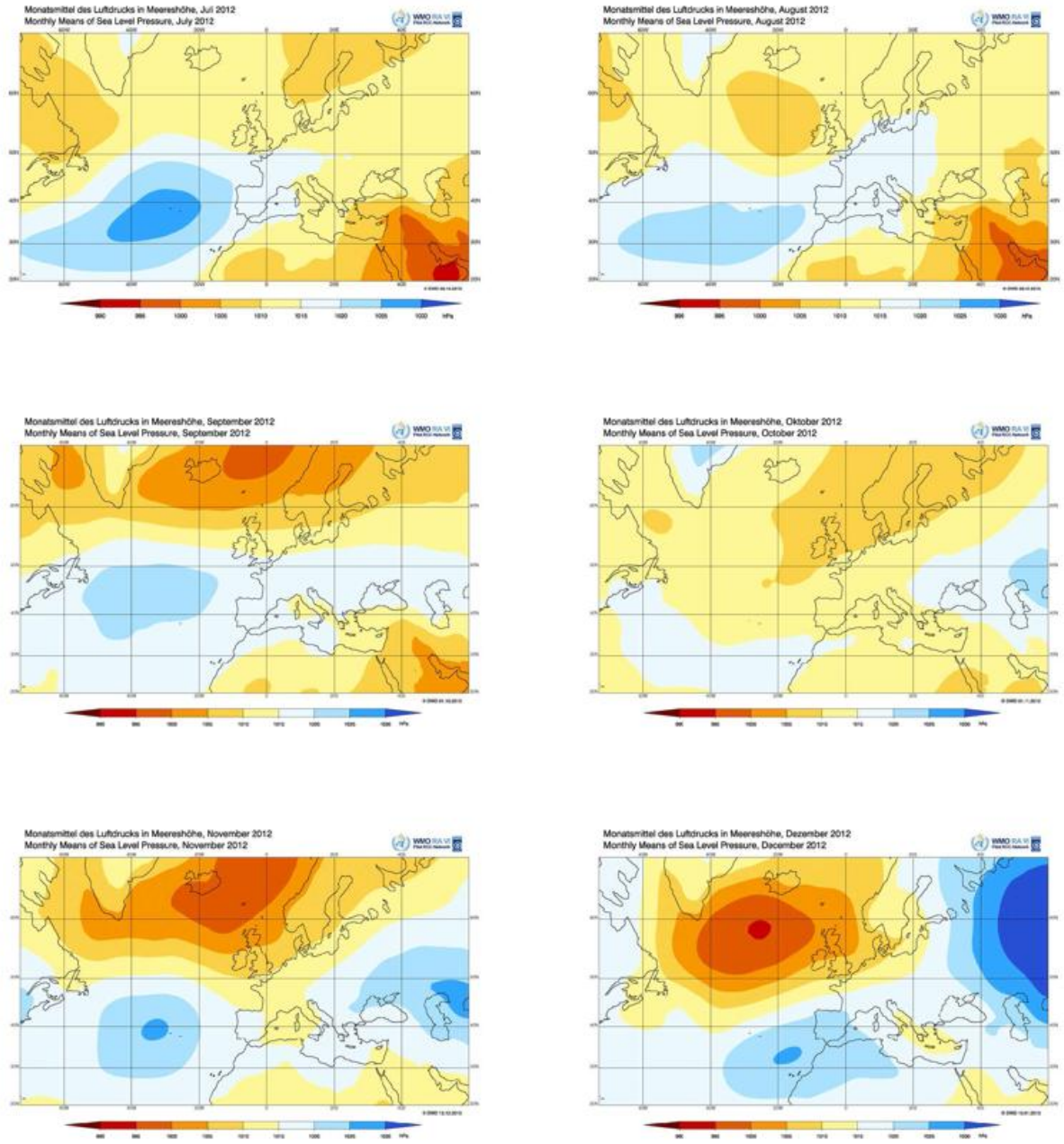


Fig. 2.2: *Mean monthly sea surface level air pressure 2012*

Temperature, Precipitation and Sunshine Duration

Annual Maps

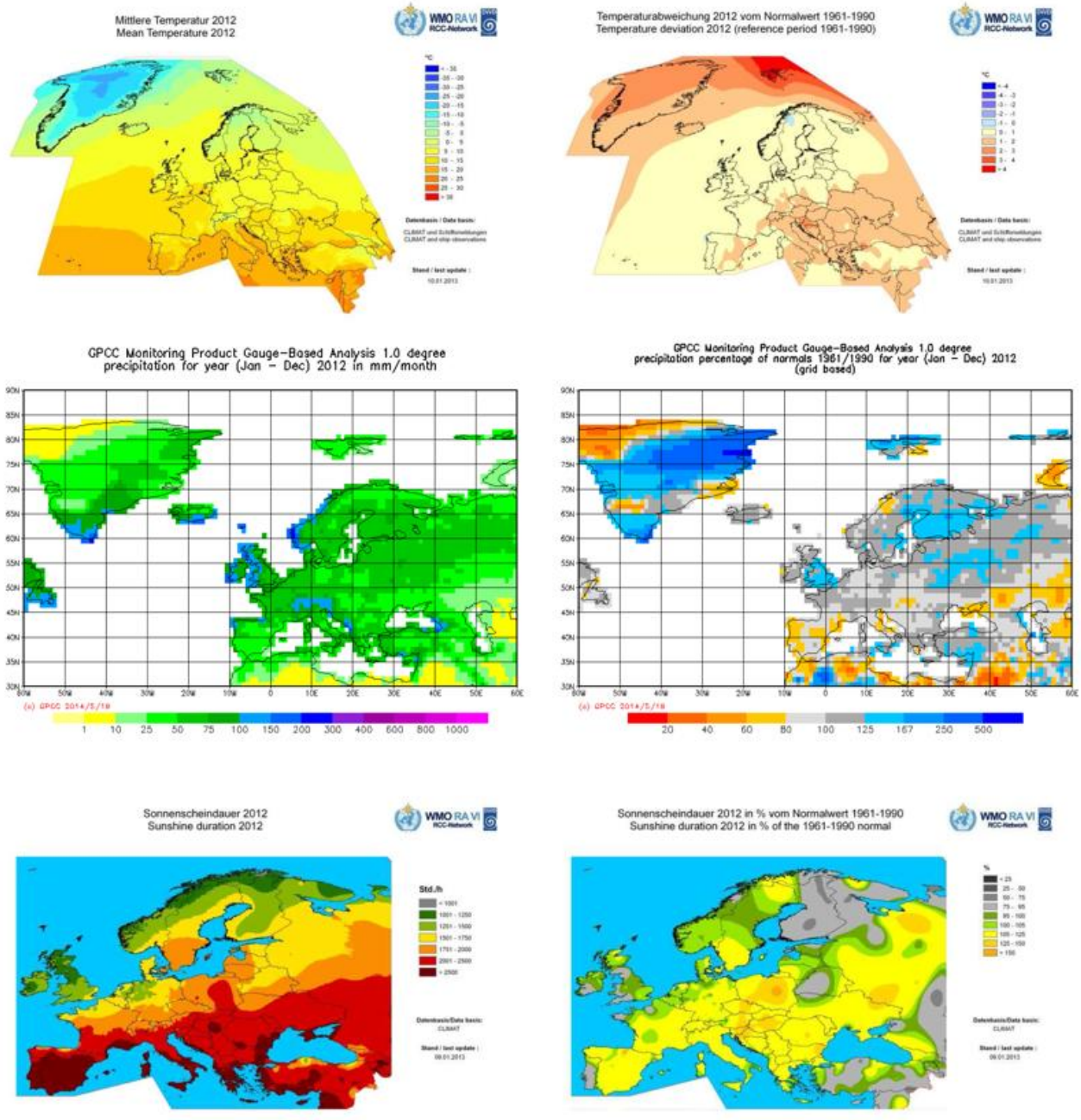


Fig. 2.3: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in 2012*

Monthly and Annual Tables

Temperature and precipitation values and departures from their 1961-1990 means (CLIMAT Data)

WMO No.	Station	January 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.	February 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.
01001	Jan Mayen	0.5	6.2	64	4	-3.7	2.4	72	16
01008	Svalbard Airport	-3.4	12.0	53	39	-5.6	10.1	34	15
01025	Tromso	-3.1	0.9	12	-69	-2.5	1.2	93	7
01492	Oslo	-2.4	1.9	47	-2	-2.2	1.8	14	-22
02196	Haparanda	-9.2	2.9	55	11	-12.8	-1.5	62	30
02485	Stockholm	-1.0	1.8	42	3	-2.8	0.2	45	18
02836	Sodankyla	-12.5	2.6	33	2	-15.8	-2.2	44	19
02974	Helsinki	-5.0	1.9	84	43	-8.1	-1.3	52	21
03091	Aberdeen	3.9	1.2	48	-33	5.7	2.8	23	-28
03772	London	6.7	2.5	34	-18	4.9	0.4	17	-18
03967	Dublin Casement Aerodrome	6.0	1.6	63	-3	6.7	2.3	20	-31
04030	Reykjavik	0.4	0.9	145	69	2.6	2.2	135	63
04224	Egedesminde	-12.0	1.3	36	21	-13.1	2.4	23	8
06186	Copenhagen	2.6	2.1	80	29	0.1	-0.4	20	-11
06260	De Bilt	4.9	2.7	85	19	0.8	-1.7	20	-29
06447	Brussels	5.1	2.5	86	19	0.7	-2.8	30	-23
06590	Luxembourg	3.1	3.1	91	20	-1.5	-2.6	13	-49
06660	Zurich	2.0	2.5	87	20	-3.5	-4.4	10	-60
06700	Geneva	2.9	2.1	82	2	-2.1	-4.4	1	-80
07510	Bordeaux	7.1	1.3	53	-47	2.5	-4.6	6	-80
07650	Marseilles	7.8	1.1	14	-33	2.8	-5.1	2	-52
08222	Madrid	6.7	0.6	6	-40	6.2	-1.3	6	-38
08314	Mahon/Menorca	10.9	0.4	34	-32	7.7	-3.0	66	9
08495	Gibraltar	13.5	0.1	54	-67	12.3	-1.5	34	-66
08515	Santa Maria/Azores	15.3	0.9	57	-43	14.9	0.9	44	-42
08535	Lisbon	11.7	0.3	18	-92	11.0	-1.3	0	-111
10384	Berlin-Tempelhof	2.3	2.5	57	14	-1.3	-2.1	32	-2
11035	Vienna	2.6	3.6	91	53	-2.1	-3.1	27	-15
11518	Prague	1.0	3.4	37	14	-4.4	-3.6	8	-15
11903	Sliac	-2.4	1.5	57	13	-5.2	-4.1	18	-26
12375	Warsaw	-1.0	2.3	47	25	-6.1	-4.1	35	14
12843	Budapest	1.6	3.2	29	-3	-2.4	-3.5	20	-12
13274	Belgrade	2.2	1.8	87	38	-3.1	-5.8	62	18
14015	Ljubljana	1.6	2.7	28	-54	-0.8	-2.2	23	-57
14445	Split	7.5	0.1	27	-56	4.9	-3.2	36	-32
14654	Sarajevo	-1.3	-0.4	81	10	-4.9	-6.4	144	77
15420	Bucharest	-1.6	0.8	84	44	-6.5	-6.4	69	33
15614	Sofia	-2.2	-0.6	50	23	-3.8	-4.3	35	2
16158	Pisa	5.9	-0.2	15	-60	4.1	-3.0	14	-59
16597	Luqa	11.6	-0.6	67	-22	10.2	-2.2	133	72
16716	Athens	7.9	-2.3	31	-13	9.4	-1.2	82	39
17040	Rize	6.4	0.1	205	-18	4.2	-2.4	189	18
17062	Istanbul	5.0	-0.6	104	5	4.2	-1.7	93	26
17170	Van	-1.3	3.1	54	20	-3.4	0.4	44	11
17300	Antalya	8.7	-1.2	307	68	10.5	0.2	136	-60
17609	Larnaca	11.5	0.0	192	127	11.3	-0.4	39	-18
22113	Murmansk	-9.5	2.2	16	-17	-11.1	0.1	18	-4
26038	Tallinn	-4.7	0.8	72	27	-8.1	-2.4	39	10
26406	Liepaja	-1.1	1.9	92	46	-5.9	-2.9	61	30
26730	Vilnius	-3.9	2.2	63	22	-9.8	-5.0	41	3
26850	Minsk	-5.0	1.9	78	38	-10.5	-4.7	45	11
27612	Moscow	-6.8	2.5	58	13	-11.7	-4.0	36	-1
33345	Kiev	-4.0	1.6	57	10	-10.0	-5.8	33	-13
33815	Kishinev	-2.6	0.7	30	-10	-7.6	-5.9	42	4
34300	Kharkiv	-4.7	2.2	49	5	-10.5	-4.8	27	-5
34880	Astrakhan	-5.2	0.2	19	6	-11.9	-7.0	27	17
35108	Uralsk	-10.0	2.9	4	-21	-15.7	-3.2	7	-11
37545	Tiflis	2.7	1.0	2	-17	0.1	-2.8	23	-3
37789	Yerevan	0.5	3.7	13	-15	-3.7	-2.7	58	20
40080	Damascus	6.5	0.6	31	2	7.3	-0.6	20	-4
40103	Tripoli	12.0	-0.7	307	113	11.7	-1.5	183	56
40180	Tel Aviv	12.4	0.1	201	52	13.3	0.4	121	23
40199	Eilat	14.8	-0.4	1	-4	16.8	-0.1	0	-5
40265	Mafraq	6.9	-0.3	51	17	8.1	-0.6	39	8
60030	LasPalmas/Grand Canary	18.0	0.5	2	-15	17.0	-0.6	4	-18

WMO No.	Station	March 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.	April 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.
01001	Jan Mayen	-2.3	3.8	58	2	-4.5	-0.6	16	-25
01008	Svalbard Airport	-5.3	9.4	10	-11	-9.2	2.5	5	-7
01025	Tromso	-0.1	2.1	171	107	-0.1	-0.8	69	9
01492	Oslo	5.6	5.8	18	-28	4.9	0.3	73	31
02196	Haparanda	-2.5	4.3	28	-7	-0.6	-0.1	64	35
02485	Stockholm	4.4	4.3	18	-8	4.9	0.3	63	33
02836	Sodankyla	-5.4	3.1	30	5	-2.2	-0.1	51	27
02974	Helsinki	-0.3	2.6	37	3	3.8	0.9	58	21
03091	Aberdeen	8.6	4.1	15	-43	5.8	-0.5	122	69
03772	London	9.8	3.3	16	-31	9.1	0.2	98	53
03967	Dublin Casement Aerodrome	8.5	2.5	28	-21	6.6	-1.2	95	48
04030	Reykjavik	3.1	2.6	117	35	4.3	1.4	60	2
04224	Egedesminde	-17.3	-1.0	17	-1	-5.8	3.8	37	20
06186	Copenhagen	6.5	3.9	10	-32	7.2	0.6	26	-16
06260	De Bilt	8.3	3.3	20	-43	8.4	0.4	48	-4
06447	Brussels	8.9	3.4	33	-21	8.4	-0.4	104	47
06590	Luxembourg	8.5	4.5	19	-51	7.8	0.3	96	35
06660	Zurich	8.2	4.0	22	-47	9.0	1.2	59	-28
06700	Geneva	8.6	3.5	14	-65	10.2	1.4	112	47
07510	Bordeaux	11.4	2.6	31	-45	10.5	-0.8	179	107
07650	Marseilles	11.9	1.7	11	-33	14.2	1.0	51	3
08222	Madrid	11.9	1.9	22	-11	11.6	-0.6	61	7
08314	Mahon/Menorca	12.4	0.8	31	-24	14.8	1.5	35	-15
08495	Gibraltar	15.2	0.2	9	-66	15.9	-0.3	62	2
08515	Santa Maria/Azores	15.8	1.2	55	-24	15.9	0.7	23	-32
08535	Lisbon	15.5	1.8	59	-10	13.8	-1.3	62	-2
10384	Berlin-Tempelhof	8.0	3.8	9	-28	9.9	1.3	30	-11
11035	Vienna	8.5	3.5	30	-11	11.0	1.1	26	-25
11518	Prague	6.5	3.5	10	-18	8.8	1.1	46	8
11903	Sliac	5.4	2.4	2	-40	10.5	2.0	47	0
12375	Warsaw	4.7	2.7	21	-7	9.4	1.6	55	23
12843	Budapest	8.8	3.2	1	-28	12.5	1.4	20	-18
13274	Belgrade	9.9	2.7	2	-48	14.3	1.9	67	8
14015	Ljubljana	10.1	4.7	22	-76	11.4	1.5	128	19
14445	Split	13.7	3.3	1	-74	14.3	0.4	93	27
14654	Sarajevo	7.0	1.9	13	-57	10.3	0.9	117	43
15420	Bucharest	5.4	0.6	6	-32	13.7	2.4	44	-2
15614	Sofia	6.5	1.9	18	-20	11.9	2.0	60	10
16158	Pisa	10.9	1.4	18	-58	13.5	1.0	124	45
16597	Luqa	13.1	-0.3	58	17	16.2	0.7	22	-1
16716	Athens	12.7	0.1	13	-28	17.6	1.5	35	10
17040	Rize	5.5	-2.4	193	47	13.0	1.4	57	-45
17062	Istanbul	7.7	0.2	48	-14	15.2	3.2	82	33
17170	Van	-2.1	-3.0	78	36	9.2	1.9	42	-12
17300	Antalya	13.7	1.0	50	-53	17.2	1.1	44	-2
17609	Larnaca	13.0	-0.3	33	-16	17.7	0.3	9	-2
22113	Murmansk	-3.5	3.3	24	4	-0.3	1.6	29	8
26038	Tallinn	0.2	2.4	50	21	4.8	1.4	67	31
26406	Liepaja	1.9	2.1	20	-16	6.4	1.8	28	-7
26730	Vilnius	1.3	1.9	34	-5	7.7	2.0	68	22
26850	Minsk	1.0	2.4	39	-3	8.0	2.0	96	54
27612	Moscow	-3.1	-0.9	62	28	8.2	2.4	50	10
33345	Kiev	2.5	1.8	37	-2	11.8	3.1	82	33
33815	Kishinev	4.5	1.6	21	-14	13.3	3.1	15	-27
34300	Kharkiv	-0.5	-0.2	21	-6	13.7	4.8	10	-26
34880	Astrakhan	0.2	-1.1	22	8	16.3	5.2	<1	-18
35108	Uralsk	-5.7	-0.7	26	6	14.9	7.2	17	-2
37545	Tiflis	5.1	-1.8	9	-21	16.5	3.7	17	-34
37789	Yerevan	2.2	-2.9	8	-32	14.4	2.8	35	-15
40080	Damascus	10.2	-0.8	6	-11	18.6	3.1	2	-9
40103	Tripoli	13.0	-1.7	121	5	18.1	0.6	2	-54
40180	Tel Aviv	14.5	-0.4	78	16	19.7	1.5	0	-23
40199	Eilat	19.4	-0.6	<1	-4	25.9	1.7	0	-4
40265	Mafraq	10.2	-1.3	24	-5	17.9	2.1	<1	-10
60030	LasPalmas/Grand Canary	18.7	0.3	0	-10	18.7	0.0	6	0

WMO No.	Station	May 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.	June 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.
01001	Jan Mayen	-0.6	0.1	20	-20	2.4	0.6	7	-29
01008	Svalbard Airport	-2.4	1.3	17	11	3.9	1.7	7	-3
01025	Tromso	4.3	-0.6	118	70	8.8	-0.5	32	-21
01492	Oslo	12.3	1.5	58	6	13.7	-1.5	93	28
02196	Haparanda	6.4	0.3	59	28	11.8	-1.0	73	32
02485	Stockholm	12.2	1.5	20	-10	13.7	-1.9	160	115
02836	Sodankyla	5.9	0.9	31	-4	10.7	-0.9	72	16
02974	Helsinki	11.3	1.4	49	14	13.9	-1.0	100	56
03091	Aberdeen	8.9	-0.1	37	-22	10.8	-1.3	127	74
03772	London	13.9	1.4	25	-26	15.4	-0.3	111	60
03967	Dublin Casement Aerodrome	10.2	-0.3	64	6	13.1	-0.2	179	131
04030	Reykjavik	6.3	0.0	19	-25	10.7	1.7	14	-36
04224	Egedesminde	0.9	2.7	37	22	7.2	4.5	48	29
06186	Copenhagen	13.4	1.4	14	-29	14.1	-2.0	74	20
06260	De Bilt	14.5	2.2	84	23	14.9	-0.3	91	23
06447	Brussels	14.3	1.4	63	-8	15.4	-0.3	133	54
06590	Luxembourg	14.6	2.8	71	-10	15.2	0.3	116	34
06660	Zurich	14.2	2.1	111	8	17.5	2.3	197	73
06700	Geneva	15.1	2.1	76	-1	19.1	2.6	95	6
07510	Bordeaux	17.1	2.5	28	-49	19.4	1.6	65	9
07650	Marseilles	18.1	1.0	74	32	23.5	2.6	14	-14
08222	Madrid	19.2	3.2	34	-7	24.5	3.8	2	-24
08314	Mahon/Menorca	18.4	1.6	7	-30	23.6	2.8	<1	-14
08495	Gibraltar	19.2	0.7	12	-23	22.5	1.4	0	-11
08515	Santa Maria/Azores	17.6	0.9	139	109	19.9	1.2	43	21
08535	Lisbon	19.3	1.9	98	59	20.9	0.7	3	-18
10384	Berlin-Tempelhof	15.9	2.0	35	-21	16.8	-0.6	54	-21
11035	Vienna	17.0	2.4	38	-23	20.5	2.6	69	-5
11518	Prague	14.9	2.2	26	-51	17.0	1.1	37	-36
11903	Sliac	15.8	2.1	14	-50	19.0	2.4	100	15
12375	Warsaw	15.6	2.2	56	-3	17.3	0.7	63	-9
12843	Budapest	17.8	1.8	41	-14	21.7	2.6	52	-11
13274	Belgrade	17.7	0.5	128	57	24.5	4.4	16	-74
14015	Ljubljana	16.1	1.5	124	2	21.3	3.5	130	-25
14445	Split	19.2	0.8	58	2	26.1	3.9	26	-25
14654	Sarajevo	13.4	-0.7	145	63	21.6	4.7	12	-79
15420	Bucharest	17.4	0.7	233	163	22.7	2.5	26	-51
15614	Sofia	14.8	0.5	132	59	21.5	3.8	8	-64
16158	Pisa	15.8	-0.5	62	3	21.7	1.9	15	-29
16597	Luqa	20.3	1.2	<1	-7	25.6	2.6	0	-3
16716	Athens	21.8	1.2	22	6	28.6	3.5	0	-7
17040	Rize	18.5	2.7	50	-51	22.6	2.7	200	75
17062	Istanbul	18.2	1.7	53	22	24.7	3.6	7	-14
17170	Van	14.6	1.8	38	-12	18.6	1.0	8	-13
17300	Antalya	20.5	0.2	45	17	26.4	1.4	19	11
17609	Larnaca	21.4	0.5	30	23	26.0	1.7	<1	<1
22113	Murmansk	6.3	2.5	33	1	9.7	0.3	87	34
26038	Tallinn	10.8	1.1	53	16	12.6	-1.9	99	46
26406	Liepaja	11.2	0.9	55	15	13.6	-0.7	37	-9
26730	Vilnius	13.8	1.3	38	-24	14.9	-0.9	99	22
26850	Minsk	14.7	1.8	44	-18	15.5	-0.6	112	29
27612	Moscow	15.1	2.2	54	-4	17.1	0.5	91	15
33345	Kiev	18.1	3.0	42	-11	20.0	1.8	91	18
33815	Kishinev	19.1	3.0	65	14	23.3	3.9	20	-55
34300	Kharkiv	19.8	4.2	47	0	21.8	2.9	31	-27
34880	Astrakhan	21.8	3.5	2	-22	25.3	2.4	25	3
35108	Uralsk	18.7	2.6	17	-4	23.8	3.6	24	-13
37545	Tiflis	18.7	1.3	267	189	23.2	2.0	40	-36
37789	Yerevan	18.6	2.3	20	-39	23.6	3.0	19	-9
40080	Damascus	22.3	2.1	0	-4	27.5	3.1	0	0
40103	Tripoli	21.8	1.9	<1	-17	25.3	2.0	0	-1
40180	Tel Aviv	23.0	1.9	0	-3	25.9	1.9	0	0
40199	Eilat	30.0	1.6	0	-1	34.0	2.3	0	0
40265	Mafraq	21.1	1.3	0	-3	25.5	2.8	0	0
60030	LasPalmas/Grand Canary	21.8	1.9	0	-2	23.6	2.2	<1	<1

WMO No.	Station	July 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.	August 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.
01001	Jan Mayen	4.8	0.6	18	-29	5.9	0.9	32	-29
01008	Svalbard Airport	6.6	0.6	19	6	5.7	0.9	24	-1
01025	Tromso	10.8	-0.9	80	8	9.8	-1.1	29	-53
01492	Oslo	16.4	0.0	150	66	16.1	0.9	97	7
02196	Haparanda	15.1	-0.4	43	-7	13.4	0.1	47	-16
02485	Stockholm	17.8	0.6	61	-11	16.8	0.6	117	51
02836	Sodankyla	13.9	-0.2	53	-12	12.1	0.9	25	-38
02974	Helsinki	18.0	1.4	67	-6	15.5	0.5	71	-9
03091	Aberdeen	13.3	-0.5	97	37	14.3	0.7	86	11
03772	London	17.2	-0.6	72	26	18.9	1.5	36	-15
03967	Dublin Casement Aerodrome	14.3	-0.6	103	49	15.7	1.1	75	-3
04030	Reykjavik	12.4	1.8	36	-16	12.3	2.0	66	4
04224	Egedesminde	8.8	3.1	32	9	7.4	2.1	46	12
06186	Copenhagen	17.6	0.4	60	-9	18.2	1.2	32	-31
06260	De Bilt	17.3	0.5	91	16	18.5	1.8	92	21
06447	Brussels	17.3	-0.2	116	41	19.2	1.9	22	-41
06590	Luxembourg	17.0	0.1	140	72	19.2	2.8	40	-32
06660	Zurich	17.9	0.3	173	56	19.5	2.8	151	18
06700	Geneva	19.8	0.7	46	-21	20.7	2.5	82	3
07510	Bordeaux	19.8	-0.4	47	0	22.4	2.5	19	-35
07650	Marseilles	24.3	0.5	11	-3	25.6	2.4	9	-20
08222	Madrid	26.1	1.7	8	-5	26.9	3.0	<1	-9
08314	Mahon/Menorca	24.4	0.2	2	-2	26.6	2.1	<1	-26
08495	Gibraltar	25.0	1.3	1	0	25.2	1.0	0	-6
08515	Santa Maria/Azores	20.9	0.1	9	-16	22.0	-0.2	117	77
08535	Lisbon	21.9	-0.5	3	-2	22.8	0.0	10	4
10384	Berlin-Tempelhof	19.2	0.4	142	90	19.4	1.0	59	-2
11035	Vienna	21.5	1.8	130	67	21.6	2.7	41	-17
11518	Prague	18.6	1.1	112	46	19.4	2.4	63	-7
11903	Sliac	21.0	2.8	108	49	20.2	2.9	10	-59
12375	Warsaw	21.1	3.2	73	6	19.1	1.8	35	-28
12843	Budapest	24.1	3.2	83	31	23.7	3.4	3	-48
13274	Belgrade	26.7	5.0	39	-27	26.1	4.8	4	-48
14015	Ljubljana	22.7	2.8	113	-9	23.3	4.2	66	-78
14445	Split	29.2	3.8	6	-22	28.6	3.4	0	-50
14654	Sarajevo	23.2	4.3	37	-42	22.9	4.4	28	-43
15420	Bucharest	26.6	4.6	26	-38	23.2	2.0	51	-7
15614	Sofia	25.0	5.0	41	-15	22.8	3.4	45	-7
16158	Pisa	24.1	1.3	<1	-23	25.3	2.8	36	-21
16597	Luqa	28.5	2.6	<1	<1	28.6	2.3	<1	-7
16716	Athens	31.2	3.4	0	-5	30.5	2.9	0	-5
17040	Rize	25.2	3.0	105	-29	23.8	1.6	263	77
17062	Istanbul	27.4	4.2	2	-17	26.2	3.2	37	11
17170	Van	21.7	-0.2	3	-1	21.6	0.4	2	-2
17300	Antalya	30.2	2.1	0	-3	30.6	2.9	0	-1
17609	Larnaca	29.3	2.4	0	0	29.4	2.3	0	0
22113	Murmansk	12.3	-0.5	74	14	10.2	-0.8	23	-42
26038	Tallinn	17.7	1.4	121	42	15.2	-0.1	82	-2
26406	Liepaja	18.1	1.7	74	0	16.8	0.4	55	-25
26730	Vilnius	19.5	2.6	81	3	16.5	0.2	83	11
26850	Minsk	21.0	3.7	72	-16	17.5	1.0	94	22
27612	Moscow	20.9	2.8	52	-40	17.7	1.3	85	11
33345	Kiev	23.7	4.4	36	-52	20.4	1.8	115	46
33815	Kishinev	26.0	5.1	89	20	23.4	2.9	27	-18
34300	Kharkiv	24.7	4.4	19	-41	22.0	2.5	90	40
34880	Astrakhan	26.6	1.3	18	-5	26.8	3.5	3	-16
35108	Uralsk	24.6	2.1	35	-3	24.3	3.9	29	4
37545	Tiflis	24.6	0.2	100	55	25.9	2.2	9	-39
37789	Yerevan	24.8	0.2	36	22	26.9	3.0	0	-9
40080	Damascus	29.4	3.1	0	0	28.1	2.1	0	0
40103	Tripoli	28.5	3.5	0	0	28.8	3.2	0	-1
40180	Tel Aviv	28.7	3.0	0	0	28.9	2.8	0	0
40199	Eilat	35.5	2.6	0	0	34.7	1.9	0	0
40265	Mafraq	27.2	3.1	0	0	26.0	1.8	0	0
60030	LasPalmas/Grand Canary	24.5	1.2	0	0	25.6	1.5	0	0

WMO No.	Station	September 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.	October 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.
01001	Jan Mayen	3.3	0.4	77	-5	1.0	0.9	35	-48
01008	Svalbard Airport	3.0	2.5	25	2	-2.7	2.8	15	0
01025	Tromso	7.4	0.6	69	-25	2.9	0.0	78	-47
01492	Oslo	11.1	0.3	90	0	5.2	-1.2	129	45
02196	Haparanda	8.7	0.8	119	56	1.8	-0.7	80	16
02485	Stockholm	12.2	1.0	58	3	6.8	-0.7	72	22
02836	Sodankyla	6.9	1.0	98	43	-0.1	0.2	71	20
02974	Helsinki	11.7	1.7	150	77	5.7	0.3	85	12
03091	Aberdeen	12.3	0.6	55	-13	7.4	-2.5	105	28
03772	London	15.1	0.1	41	-10	11.2	-0.5	88	30
03967	Dublin Casement Aerodrome	11.9	-1.1	90	21	8.6	-1.7	84	16
04030	Reykjavik	7.3	-0.1	102	36	4.4	0.0	76	-10
04224	Egedesminde	4.6	2.2	61	27	0.5	2.7	72	46
06186	Copenhagen	14.2	0.6	56	-6	9.2	-0.7	53	-6
06260	De Bilt	14.2	0.2	57	-10	10.5	0.0	103	31
06447	Brussels	14.5	0.0	52	-7	11.1	0.2	119	49
06590	Luxembourg	13.9	0.5	62	-8	9.5	0.4	90	15
06660	Zurich	14.2	0.4	104	12	9.7	0.4	126	57
06700	Geneva	15.5	0.6	78	-3	11.2	1.1	50	-27
07510	Bordeaux	18.7	0.8	59	-15	14.5	0.5	116	28
07650	Marseilles	20.7	0.4	28	-19	17.3	1.2	118	40
08222	Madrid	21.2	0.7	76	46	15.0	0.2	44	-1
08314	Mahon/Menorca	22.6	0.4	28	-26	19.9	1.4	79	-5
08495	Gibraltar	23.0	0.2	129	114	19.3	-0.2	172	108
08515	Santa Maria/Azores	21.2	-0.2	120	63	19.2	-0.1	122	38
08535	Lisbon	22.6	0.9	58	32	18.0	-0.5	145	65
10384	Berlin-Tempelhof	15.5	0.9	26	-20	9.8	-0.2	30	-6
11035	Vienna	16.7	1.6	45	0	10.2	0.3	45	4
11518	Prague	14.1	0.8	55	15	7.6	-0.7	39	9
11903	Sliac	15.9	2.5	35	-21	9.3	1.0	134	84
12375	Warsaw	14.7	1.5	28	-15	8.2	-0.1	58	20
12843	Budapest	19.0	2.6	28	-12	11.5	0.6	65	31
13274	Belgrade	21.5	3.8	31	-20	14.5	2.1	45	5
14015	Ljubljana	17.0	1.5	227	97	11.7	1.3	223	108
14445	Split	22.9	1.5	109	48	18.3	1.4	144	65
14654	Sarajevo	18.0	2.9	90	20	12.0	1.6	91	3
15420	Bucharest	18.7	1.8	54	12	12.9	2.1	25	-7
15614	Sofia	18.9	3.1	48	9	13.8	3.4	40	3
16158	Pisa	20.9	1.4	60	-29	16.8	1.5	167	47
16597	Luqa	25.1	1.0	85	45	23.0	2.3	47	-43
16716	Athens	26.2	2.0	4	-6	22.7	3.4	12	-40
17040	Rize	21.8	2.4	111	-112	19.1	3.7	182	-91
17062	Istanbul	22.9	3.2	18	-23	20.0	4.7	38	-33
17170	Van	18.0	1.2	11	1	12.4	2.3	40	-8
17300	Antalya	26.1	1.6	<1	-11	22.3	2.7	105	35
17609	Larnaca	26.3	1.2	<1	<1	23.3	2.0	27	8
22113	Murmansk	7.9	1.2	73	21	1.9	0.9	80	38
26038	Tallinn	12.3	1.5	132	50	6.2	-0.1	101	31
26406	Liepaja	14.3	1.4	99	21	8.5	0.0	145	71
26730	Vilnius	12.9	1.3	45	-20	6.5	-0.1	78	25
26850	Minsk	13.6	1.9	31	-29	6.9	0.6	70	21
27612	Moscow	12.9	2.0	47	-17	6.5	1.5	138	80
33345	Kiev	16.2	2.3	32	-15	10.1	2.0	51	16
33815	Kishinev	19.2	3.0	39	-9	12.8	2.7	47	20
34300	Kharkiv	16.6	2.5	9	-32	11.0	3.7	117	82
34880	Astrakhan	18.4	1.1	26	0	13.3	4.2	16	-1
35108	Uralsk	14.5	0.4	19	-8	9.2	4.1	18	-12
37545	Tiflis	20.5	0.9	36	0	16.8	3.3	60	22
37789	Yerevan	22.0	2.2	7	-2	16.6	3.8	6	-25
40080	Damascus	25.4	2.2	0	-1	21.0	2.9	6	-6
40103	Tripoli	27.0	2.2	0	-4	23.4	1.2	78	7
40180	Tel Aviv	27.3	2.5	0	0	24.8	2.8	1	-25
40199	Eilat	32.3	1.9	0	0	29.0	2.3	7	3
40265	Mafraq	24.6	1.9	0	-1	21.7	2.6	4	-3
60030	LasPalmas/Grand Canary	24.4	0.6	8	0	23.6	1.1	37	27

WMO No.	Station	November 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.	December 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.
01001	Jan Mayen	-1.1	2.1	93	27	-2.1	3.1	42	-23
01008	Svalbard Airport	-6.4	4.1	13	0	-7.9	5.4	48	36
01025	Tromso	1.0	1.8	79	-25	-3.7	-0.7	7	-97
01492	Oslo	3.2	2.5	131	56	-5.1	-2.3	70	14
02196	Haparanda	-0.4	3.7	85	27	-11.8	-2.3	57	15
02485	Stockholm	4.6	2.0	58	5	-3.0	-2.0	66	20
02836	Sodankyla	-4.1	3.3	70	31	-14.5	-1.4	50	19
02974	Helsinki	3.2	3.1	63	-9	-6.7	-2.6	63	5
03091	Aberdeen	5.6	0.6	48	-27	3.4	-0.1	184	111
03772	London	7.8	0.6	72	17	6.0	0.9	96	39
03967	Dublin Casement Aerodrome	6.2	-0.5	80	10	5.2	-0.1	47	-30
04030	Reykjavik	1.5	0.4	86	14	1.2	1.4	112	33
04224	Egedesminde	-4.7	1.2	53	20	-6.6	3.2	25	1
06186	Copenhagen	6.8	1.3	46	-16	1.0	-1.2	57	-1
06260	De Bilt	6.8	0.9	41	-40	5.0	1.8	147	68
06447	Brussels	7.1	1.0	45	-31	5.1	1.6	173	97
06590	Luxembourg	5.4	1.6	69	-14	2.9	1.9	146	66
06660	Zurich	5.8	1.9	100	18	2.0	1.4	154	81
06700	Geneva	7.0	2.0	181	89	3.0	1.2	155	68
07510	Bordeaux	9.9	0.8	74	-20	8.4	2.0	170	71
07650	Marseilles	12.5	1.8	102	44	7.9	0.6	8	-48
08222	Madrid	9.9	0.5	63	-1	6.8	0.4	10	-41
08314	Mahon/Menorca	15.9	1.5	74	-3	12.3	0.5	11	-63
08495	Gibraltar	16.5	0.4	254	113	14.5	0.4	27	-119
08515	Santa Maria/Azores	15.9	-1.5	31	-71	15.9	0.5	73	-22
08535	Lisbon	13.6	-0.9	174	60	12.6	0.8	114	6
10384	Berlin-Tempelhof	5.9	1.0	51	2	1.1	-0.3	40	-13
11035	Vienna	6.9	2.3	21	-29	0.8	-0.1	52	9
11518	Prague	4.7	1.9	43	11	-0.4	0.2	47	21
11903	Sliac	6.2	3.2	53	-16	-3.9	-2.2	49	-8
12375	Warsaw	5.8	2.6	29	-13	-3.1	-2.2	31	-1
12843	Budapest	7.5	2.7	13	-39	-0.6	-1.0	55	15
13274	Belgrade	10.5	3.5	28	-26	1.9	-0.4	55	-3
14015	Ljubljana	8.8	4.2	156	21	0.8	0.8	98	-3
14445	Split	15.7	3.5	43	-65	8.5	-0.2	197	97
14654	Sarajevo	9.1	4.3	36	-55	0.2	0.4	135	71
15420	Bucharest	6.7	1.5	11	-38	-1.4	-1.6	104	61
15614	Sofia	7.6	2.6	10	-37	-0.8	-1.3	46	7
16158	Pisa	12.6	2.2	200	76	6.7	-0.1	134	49
16597	Luqa	19.4	2.4	62	-18	14.2	0.4	46	-66
16716	Athens	17.3	1.8	60	10	11.5	-0.7	99	28
17040	Rize	14.2	2.6	199	-51	9.5	1.2	298	60
17062	Istanbul	14.8	3.2	48	-41	8.4	0.3	158	36
17170	Van	7.2	3.2	26	-18	1.5	2.6	60	26
17300	Antalya	16.7	1.9	25	-109	12.9	1.5	545	318
17609	Larnaca	19.1	2.7	56	12	14.5	1.3	173	97
22113	Murmansk	-2.3	2.8	45	5	-12.1	-2.8	19	-19
26038	Tallinn	3.3	2.1	67	-1	-6.7	-3.8	53	-2
26406	Liepaja	5.8	2.1	71	-12	-3.1	-2.8	92	25
26730	Vilnius	4.1	2.9	74	17	-5.1	-2.2	61	6
26850	Minsk	3.6	2.8	61	9	-6.1	-2.3	65	12
27612	Moscow	1.6	2.7	89	31	-8.6	-2.5	49	-3
33345	Kiev	4.7	2.6	36	-15	-4.9	-2.6	133	81
33815	Kishinev	5.9	1.5	26	-13	-2.9	-2.6	102	64
34300	Kharkiv	3.6	2.3	14	-30	-5.1	-1.7	57	12
34880	Astrakhan	4.5	1.2	33	14	-3.8	-1.9	26	11
35108	Uralsk	1.5	3.6	31	-4	-8.6	-0.2	23	-6
37545	Tiflis	10.9	2.8	13	-17	4.2	0.4	31	10
37789	Yerevan	9.8	3.2	9	-21	1.6	1.1	59	33
40080	Damascus	14.3	2.5	13	-9	9.5	2.3	26	0
40103	Tripoli	18.1	-0.2	114	1	14.5	0.4	248	68
40180	Tel Aviv	20.5	2.5	122	54	15.7	1.9	104	-34
40199	Eilat	23.4	1.9	18	15	18.0	1.4	0	-6
40265	Mafraq	15.6	2.1	25	8	10.2	1.4	9	-19
60030	LasPalmas/Grand Canary	21.9	1.5	19	-2	19.4	1.1	3	-18

WMO No.	Station	Year 2012 Temp. (°C) mean	dev.	Prec. (mm) total	dev.
01001	Jan Mayen	0.0	1.0	534	-159
01008	Svalbard Airport	-2.0	4.0	270	87
01025	Tromso	3.0	0.0	837	-136
01492	Oslo	6.0	0.0	970	201
02196	Haparanda	1.0	0.0	772	220
02485	Stockholm	7.0	0.0	780	241
02836	Sodankyla	-0.0	0.0	628	128
02974	Helsinki	5.0	0.0	879	228
03091	Aberdeen	8.0	0.0	947	164
03772	London	11.0	0.0	706	107
03967	Dublin Casement Aerodrome	9.0	0.0	928	193
04030	Reykjavik	5.0	1.0	968	170
04224	Egedesminde	-2.0	2.0	488	214
06186	Copenhagen	9.0	0.0	528	-108
06260	De Bilt	10.0	1.0	879	74
06447	Brussels	10.0	0.0	976	176
06590	Luxembourg	9.0	1.0	953	78
06660	Zurich	9.0	1.0	1294	208
06700	Geneva	10.0	1.0	972	18
07510	Bordeaux	13.0	0.0	847	-76
07650	Marseilles	15.0	0.0	442	-103
08222	Madrid	15.0	1.0	333	-124
08314	Mahon/Menorca	17.0	0.0	368	-230
08495	Gibraltar	18.0	0.0	754	-21
08515	Santa Maria/Azores	17.0	0.0	833	58
08535	Lisbon	17.0	0.0	744	-9
10384	Berlin-Tempelhof	10.0	0.0	565	-19
11035	Vienna	11.0	1.0	615	8
11518	Prague	9.0	1.0	523	-3
11903	Sliac	9.0	1.0	627	-59
12375	Warsaw	8.0	1.0	531	12
12843	Budapest	12.0	1.0	410	-108
13274	Belgrade	13.0	2.0	564	-120
14015	Ljubljana	12.0	2.0	1338	-55
14445	Split	17.0	1.0	740	-85
14654	Sarajevo	11.0	1.0	929	11
15420	Bucharest	11.0	0.0	733	138
15614	Sofia	11.0	1.0	533	-30
16158	Pisa	14.0	0.0	846	-58
16597	Luqa	19.0	1.0	522	-32
16716	Athens	19.0	1.0	358	-11
17040	Rize	15.0	1.0	2052	-120
17062	Istanbul	16.0	2.0	688	-9
17170	Van	9.0	1.0	406	28
17300	Antalya	19.0	1.0	1277	211
17609	Larnaca	20.0	1.0	560	231
22113	Murmansk	0.0	0.0	521	43
26038	Tallinn	5.0	0.0	936	269
26406	Liepaja	7.0	0.0	829	139
26730	Vilnius	6.0	0.0	765	82
26850	Minsk	6.0	0.0	807	130
27612	Moscow	5.0	0.0	811	123
33345	Kiev	9.0	1.0	745	96
33815	Kishinev	11.0	1.0	523	-24
34300	Kharkiv	9.0	1.0	491	-28
34880	Astrakhan	11.0	1.0	218	-3
35108	Uralsk	7.0	2.0	250	-74
37545	Tiflis	14.0	1.0	607	109
37789	Yerevan	13.0	1.0	274	-93
40080	Damascus	18.0	1.0	104	-42
40103	Tripoli	20.0	0.0	1054	174
40180	Tel Aviv	21.0	1.0	627	60
40199	Eilat	26.0	1.0	27	-6
40265	Mafraq	17.0	1.0	153	-7
60030	LasPalmas/Grand Canary	21.0	0.0	80	-38

Seasonal and Annual Areal Means of Temperature Anomalies for each country (Reference: 1961-1990)

from gridded data (result of spatial analysis of CLIMAT and SHIP data)

Country	Winter 2011/2012	Spring 2012	Summer 2012	Autumn 2012	Year 2012
Albania	-0.9	1.2	3.1	2.1	1.2
Andorra	-0.8	1.5	2.0	0.6	0.8
Armenia	-0.4	1.1	1.5	2.1	1.2
Austria	0.3	2.3	2.3	1.2	1.4
Azerbaijan	-0.5	2.0	2.0	2.2	1.5
Belarus	0.5	2.0	1.4	1.8	0.8
Belgium	0.9	1.7	0.7	0.4	0.8
Bosnia and Herzegovina	-0.7	1.6	4.3	2.7	1.8
Bulgaria	-1.1	1.5	3.6	2.7	1.5
Croatia	0.3	2.0	3.9	2.3	1.9
Cyprus	-0.1	0.3	2.2	2.1	1.2
Czech Republic	0.6	2.3	1.9	1.0	1.2
Denmark	1.6	2.0	0.2	0.6	0.7
Estonia	1.3	1.6	0.1	1.4	0.4
Faroer Islands	0.9	0.4	-0.4	-0.1	0.2
Finland	2.7	1.4	-0.1	1.5	0.4
France	0.2	1.5	1.0	0.5	0.7
Georgia	-0.9	1.0	1.8	2.5	1.2
Germany	0.9	2.2	0.9	0.4	0.9
Greece	-1.1	1.1	3.2	2.3	1.3
Greenland	1.7	1.3	2.0	2.5	2.1
Hungary	0.2	1.9	3.1	2.0	1.5
Iceland	1.1	1.4	1.1	-0.1	1.1
Ireland	1.5	0.7	-0.1	-0.9	0.3
Israel	-0.2	0.8	2.4	2.1	1.5
Italy	-0.3	1.5	2.8	1.5	1.3
Jordan	-0.7	0.7	2.2	1.7	1.2
Kazakhstan	-1.4	3.0	2.6	2.3	1.5
Latvia	0.8	1.6	0.3	1.5	0.5
Lebanon	-0.3	1.0	3.0	2.2	1.6
Liechtenstein	-0.7	2.5	2.6	1.0	1.3
Lithuania	0.5	1.7	0.7	1.5	0.6
Luxembourg	1.1	2.3	1.0	0.7	1.2
Macedonia	-1.1	1.3	3.6	2.6	1.5
Malta	-0.8	0.6	2.5	1.9	1.1
Moldova	-0.8	2.5	3.9	2.4	1.5
Montenegro	-1.2	1.1	4.2	2.7	1.6
Netherlands	1.1	1.8	0.6	0.2	0.8
Norway	3.8	2.0	0.1	1.2	1.4
Poland	0.4	2.0	1.5	1.1	0.8
Portugal	-0.3	0.8	0.6	0.1	0.4
Romania	-0.6	1.4	3.8	2.2	1.4
Russia	1.6	1.7	1.3	2.2	1.0
Serbia	-0.8	1.5	4.2	2.8	1.7
Slovakia	-0.1	2.0	2.5	1.9	1.3
Slovenia	0.8	2.2	3.2	2.1	1.9
Spain	-0.4	1.3	1.8	0.5	0.8
Svalbard	8.5	4.0	0.8	3.4	4.1
Sweden	2.1	1.6	-0.5	0.6	0.4
Switzerland	0.1	2.3	2.2	1.2	1.4
Syria	-0.7	0.8	2.3	1.9	1.3
Turkey	-1.2	0.3	1.9	2.3	0.9
Ukraine	0.0	2.5	3.0	2.5	1.5
United Kingdom	1.3	1.0	0.1	-0.4	0.4

Seasonal and Annual Areal Means of Temperature Anomalies for each subregion (Reference: 1961-1990)

from gridded data (result of spatial analysis of CLIMAT and SHIP data)

Region	Winter 2011/2012	Spring 2012	Summer 2012	Autumn 2012	Year 2012
Central and western Europe	*-0.9*	*1.2*	*3.1*	*2.1*	*1.2*
Nordic and Baltic countries	*-0.8*	*1.5*	*2.0*	*0.6*	*0.8*
Iberia	*-0.4*	*1.1*	*1.5*	*2.1*	*1.2*
Mediterranean. Italian and Balkan Peninsula	*0.3*	*2.3*	*2.3*	*1.2*	*1.4*
Eastern Europe	*-0.5*	*2.0*	*2.0*	*2.2*	*1.5*
Middle East	*0.5*	*2.0*	*1.4*	*1.8*	*0.8*

Annual Extreme Values

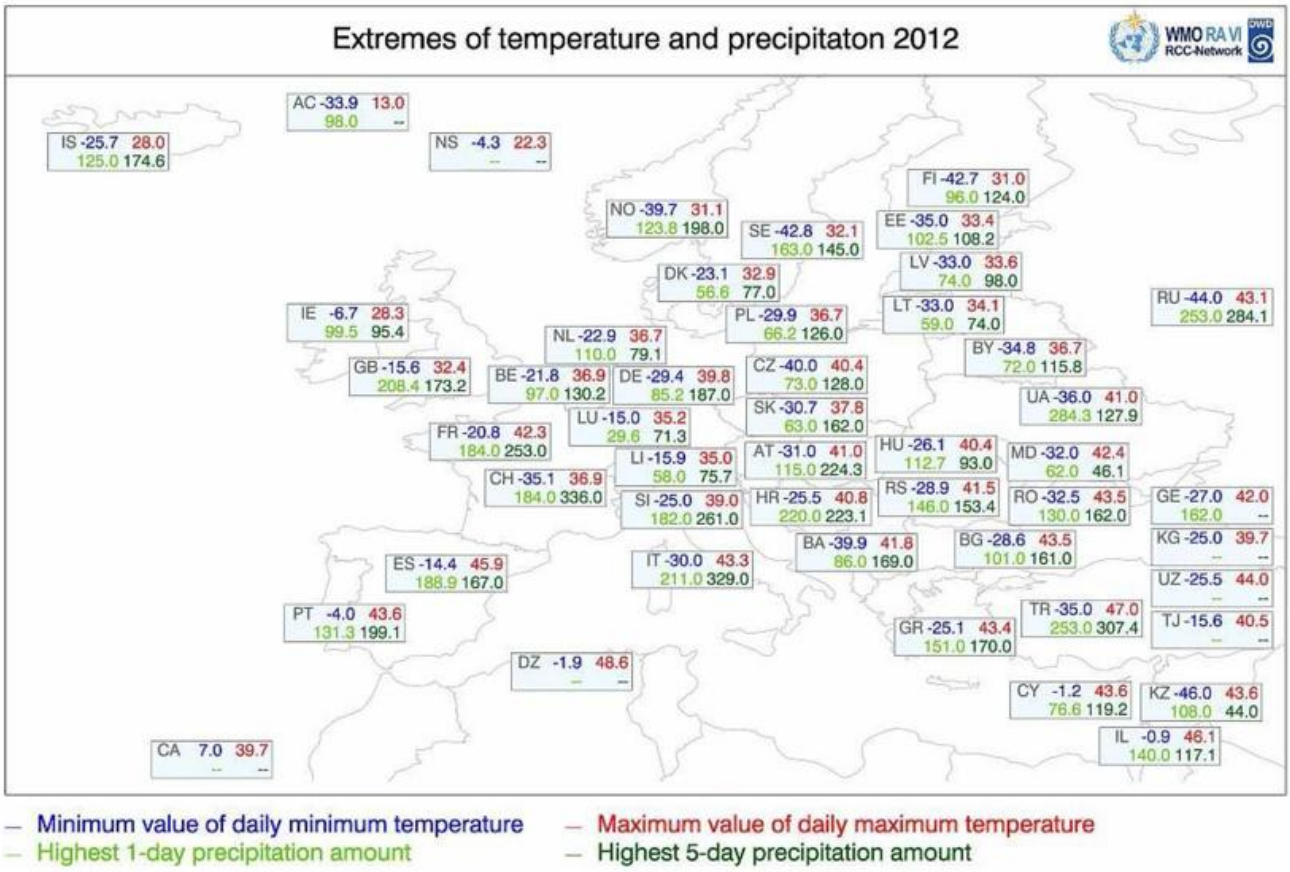


Fig. 2.4: *Annual extreme values for each country: highest daily precipitation total (mm), highest 5-daily precipitation total (mm), highest daily maximum temperature (°C) and lowest daily minimum temperature (°C) 2012*
Data (by order or priority) from reports of NMHSs, GPCC, ECA&D or SYNOP

In Fig. 2.4 the absolute annual extremes for 2012 of temperature (minimum and maximum), daily precipitation total and 5-day precipitation total for each country are given. Sources of this map are by order of priority:

- the reported values by NMHSs
- ECA&D data
- SYNOP data

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The countries are represented by their Internet country codes.

In 2012 some new records were observed.

Temperature:

The year 2012 was in Europe overall warmer than the normal. Remarkable is the positive anomaly in the Arctic with anomalies of +3 K around Spitzbergen and north of it. But also the southern central Europe, the eastern Iberian Peninsula, the Balkan Peninsua, the central and the eastern Mediterranean Sea, Middle East, southern Russia and the Caucasus region had positive anomalies of 1 to 2 K. The European annual mean of the daily temperature 2012 was 10.6°C +/-0.91 compared to the mean over the normal period 1961-1990 of 9.8°C. Thus 2012 became the rank of 11 for the time series since 1950. The mean daily mmaximum temperature was on rank 12 with 15.5°C +/- 0.87 and the mean daily minimum was on rank 9 with 6.0°C +/-0.91. So for 2012 the night temperatures on the average were relatively warmer than the normal than the daytime temperatures and the daily means. These values are the result of the E-OBS dataset where 'Europe' is defined as the land area within 35°N - 75°N and 25°W - 45°E (van der Schrier, G., 2013; see also: Climate Indicator Bulletin: European Temperature). This area does not completely cover the WMO RA VI area. The highest mean annual anomaly is calculated for the subregion 'Eastern Europe' with + 1.5 K, closely followed by the subregion 'Mediterranean, Italian and Balkan Peninsula' with + 1.4 K. 'Iberia' and 'Central and western Europe' had a positive anomaly of 1.2 K and 'The Nordic and Baltic countries' as well as 'Middle East' had a positive anomaly of +0.8 K (see table of seasonal and annual means of anomalies of temperature).

Note: *Small differences between the areal temperature anomalies in the tables on pages 21 and 22 and according values given by individual countries may occur due to the calculation method. The anomalies result from the temperature analysis (see RCC-CM: Products - Monitoring Europe - Temperature).*

Details for individual countries or stations are as following:

- In the capital Nuuk on Greenland, the annual mean temperature was 0.1°C, which is 1.5°C warmer than normal (normal -1.4°C), but only 0.2°C warmer than the 2001-2010 average. The highest temperature 20.3°C occurred in July and the lowest temperature -22.3°C in March.
- 2012 the 2nd highest mean temperature at Svalbart Airport since 1912, after 2006.
- In Germany 2012 reached rank 16 of the warm years since 1881.
- In Switzerland 2012 was on rank 9 of warm years since 1864.
- In Austria the year 2012 was the seventh warmest since the start of low land temperature measuring in the year 1767.
- In Hungary on the base of the homogenized, interpolated data this year has been the 4th warmest since 1901 (behind years 2007, 2000 and 2008).
- For the first time excess of the mean annual temperature by 2 C° was recorded in southern Ukraine.
- According to the Meteorological Station of Chisinau (observation period 118 years), the average temperature for the year was +11,2°C (1,7°C to above normal) and took fourth place in the ranked list of high average annual temperatures.
- The year 2012 has been the 13th warmest year in Spain since 1961.
- Also in Slovenia 2012 ranked among the few warmest years ever.
- In Israel 2012 was one of the warmest in the last 60 years, yet it lagged far behind 2010.
- 2012 was the 10th warmest year over Armenia since 1929.
- In Sweden the national averaged mean temperature was slightly above the reference value for 1961-90, but still it was the second coldest year so far this century.
- In the 21st century year 2012 was the second coolest in Latvia.
- In Denmark out of the last 25 years in Denmark, 22 years including 2012 have been warmer than normal (1961-90).

Precipitation:

The annual precipitation totals of 2012 were overall close to normal. The existing positive or negative anomalies were small. They show generally a zonal pattern with positive anomalies north of 50°N on Greenland and the Arctic, in England and Wales, southern Sweden, Finland, the Baltic states, Belarus and partly Russia and negative anomalies on the Iberian Peninsula and southern France, Italy, Hungary and the northeastern Black Sea region and Middle East.. The southeastern Mediterranean region had partly positive anomalies. Absolute positive as well as negative anomalies did not ecxeed 30 mm generally, with a spatially limited exception in northern Portugal. But on shorter timescales of with respect to special aspects some noteworthy peculiarities occurred:

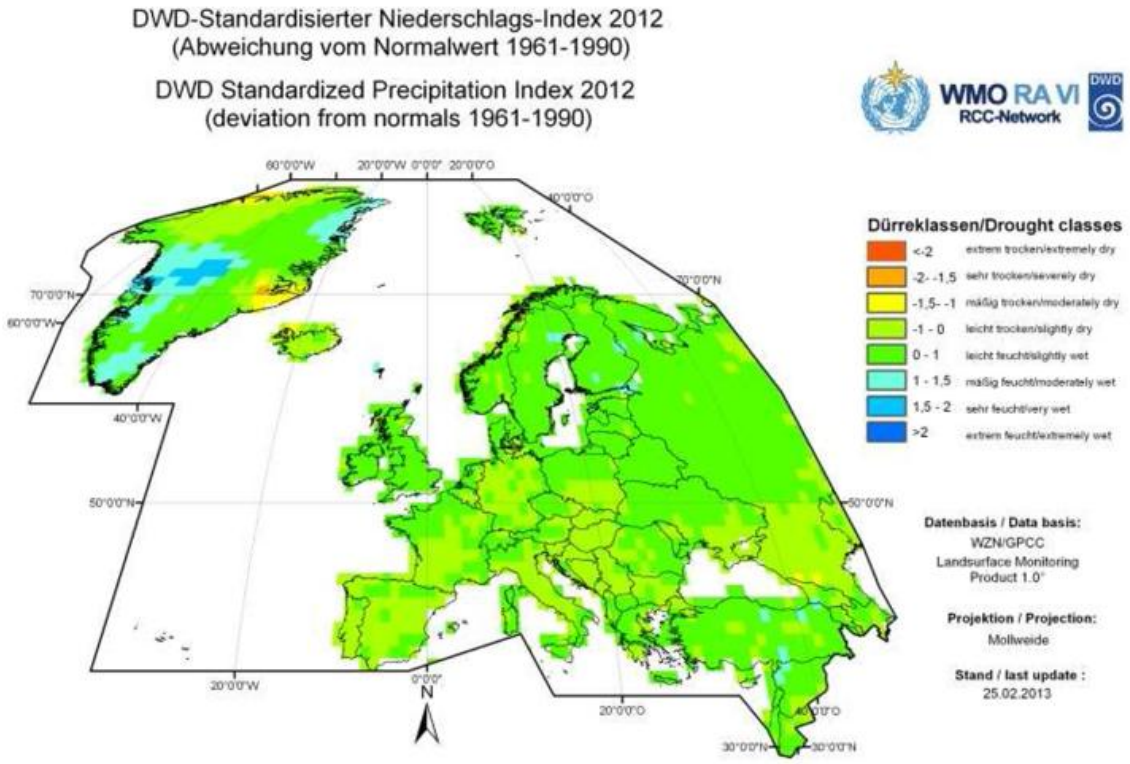
- It was the second wettest year since measurements started in 1890 in Nuuk on Greenland. Precipitation in Nuuk was 1.211 mm against the normal 752 mm, 459 mm or 61% above normal. The wettest year was 2005 with 1.221 mm.
- Year 2012 was the third rainiest in Sweden during the last 150 years. Some stations in central and northern Sweden with more than 150 years of measurements reported new all-time records for highest annual precipitation amount.
- The national average precipitation in 2012 is the highest in Finland since the start of the gridded precipitation data set in 1961, this means since at least 50 years.
- With a yearly precipitation amount of 832 mm (127% of normal) the year 2012 was the 4th wettest in the last 90 years and the second wettest in the 21st century in Latvia.In 2012, in ten months of twelve, the precipitation amount was above normal. The precipitation from December 2011 to July 2012 was continuously above normal (Fig.4). Such a long precipitation-rich period (8 months) was recorded for the first time in Latvia's precipitation measurement history .
- The year 2012 in Estonia was the wettest in 50 years.
- UK annual rainfall total of 2012 was 1331mm (121% of average), the second highest in the series, narrowly beaten by 2000 (1337mm).
- With an excess of 11 % to the average of 1961-1990 the year 2012 was one of the wettest since the last 35 years (stdev 9%) in Austria. In the alpine regions the deviation to the long term mean was 22%. So the year 2012 was here the wettest year since 1966.
- 2012 was again a very dry year in Hungary, the ninth-driest since records began in 1901.
- Moldova had a significant insufficient precipitation in June - September
- The rainfall amount was the highest ever recorded for a calendar year since 1902 in Cyprus.

Sunshine:

2012 was a sunny year in most of the European continent. The sunniest region was eastern Poland where locally a surplus of more than 150 % was achieved. Absolutely in the southeast the anomalies exceeded 400 hours. Dull were Finland and northern Russia, Belarus, southern Russia and Middle East as well as partly England, Ireland and Portugal. The following noteworthy peculiarities were reported:

- Hungary experienced its highest annual sunshine duration. Both the national average record (2404 hours) and the station record (2645 hours) were broken in 2012.
- The year 2012 was the sixth sunniest year in Austria since the beginning of the Austrian sunshine series in 1884.
- It was the 14th sunniest year in Germany since 1951.
- In Ljubljana, Slovenia, 2012 was the sunniest year ever.

Drought



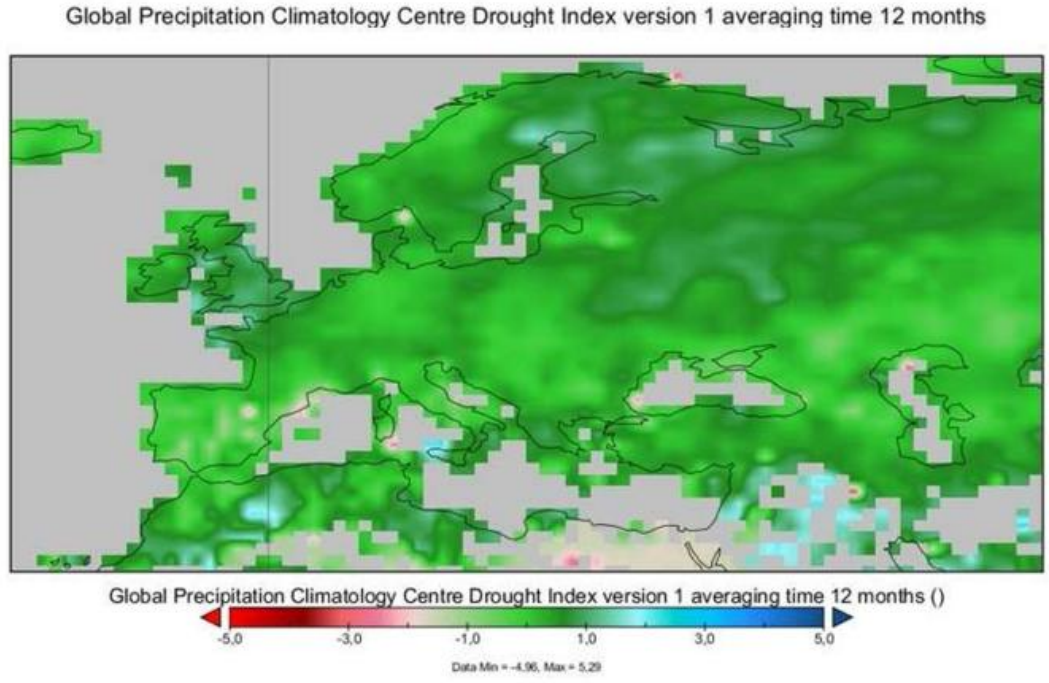


Fig. 2.5: *Annual anomalies of the modified Standardized Precipitation Index (DWD-SPI) and 12-month GPCC-Drought-Index 2012*

Drought Situation:

Over the year 2012 the anomalies of the mean 1-month DWD drought index shows slightly higher dryness than normal on the Iberian Peninsula and southwestern France, Germany, Italy, the northern Balkan Peninsula and southeastern central Europe as well as southern Russia and southeastern Ukraine. The 12-month GPCC drought index shows a very similar pattern with some higher dryness for the Iberian Peninsula.

Reports on longer lasting dry periods from the countries:

- Overall ist was the 8th driest year since 82 years in Portugal. In 2012 mainland Portugal was characterized by a drought situation, that started in the end of 2011 and remained for almost the entire year of 2012. The period with the highest drought intensity was in late winter and early spring (months of February and March), with almost the whole territory in the most intense classes of PDSI index, severe and extreme classification. For instance Portugal had precipitation totals for the period October 2011 to February 2012 mostly below 75 percent of the 1971-2000 reference (Boletim climatologico mensal - fevereiro 2012)
- Spain had well below 100 percent, mostly below 75 percent and partly below 50 percent of the normal precipitation for the period 01 September 2011 to 10 April 2012 (http://www.aemet.es/es/serviciosclimaticos/vigilancia_clima/balancehidrico).Spain reported the lowest precipitation total since 1947 for the 3-month period January to March and the driest summer season since 60 years.
- 2012 was also a very dry year in Hungary, the ninth-driest since records began in 1901. November 2011, March and August 2012 were the driest November, March and August on record. Furthermore the eleven-month period ended in September 2012 was the driest November-September period ever.
- Lack of precipitation was observed in the first 3 months of the year in Slovenia. On the coast drought persisted also during spring. Severe drought was observed in summer, it was the most pronounced on the coast.
- In the Ukraine in May, June and July the southeastern part of the country experienced long periods (up to 3 months) without rain against a background of high-temperature. Such conditions led to fierce drought.
- In Moldova precipitation deficits during June - September 2012 on the whole territory of the Republic of Moldova, contributed to the preservation during a long period of atmospheric and soil drought, attributing it to the category of very strong, as noted in an average of once in 20 years. Taking into account the affected area, the drought of 2012 is classified as a catastrophic one. This coincides well with the anomalies of the 6-month SPI and the anomalies of the maximum number of consecutive dry days (with RR < 1 mm) by ECA&D for 2012.
- In Armenia during a 4-month period (from August till November) the country experienced a severe shortage of rainfall which varied within the range of 30 to 60% of normal values.

Snow Cover

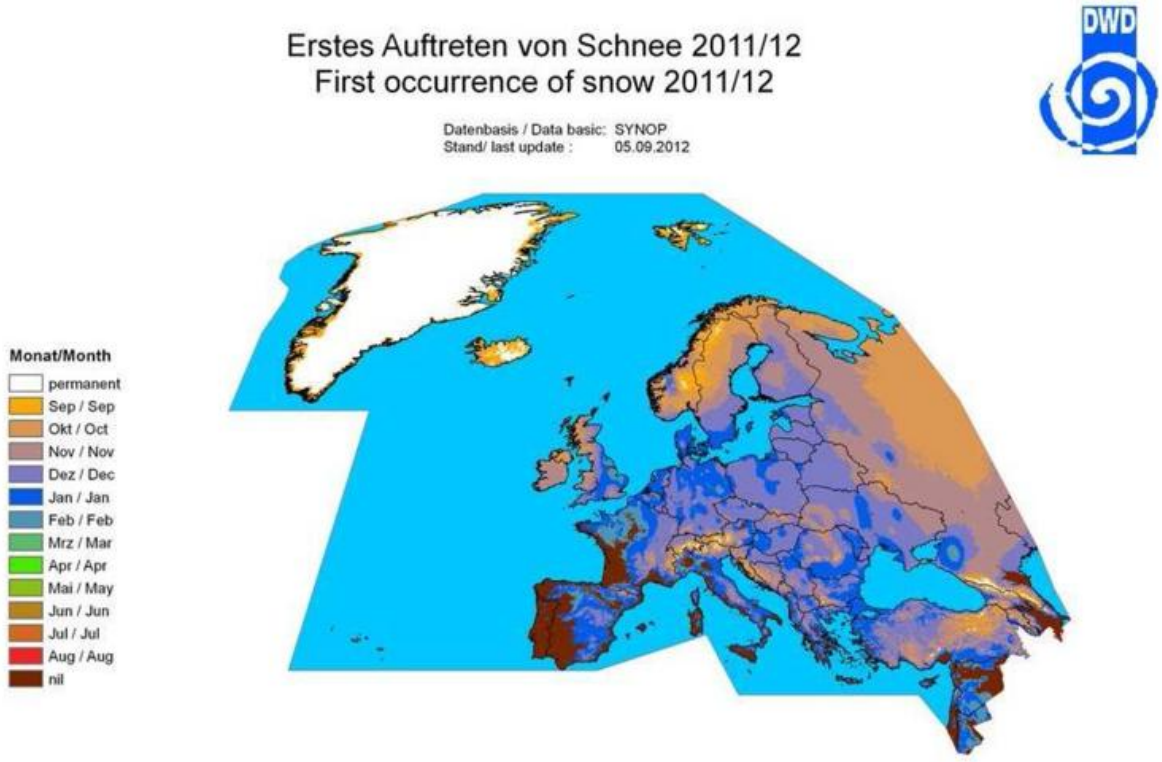
Fig.2.6 to 2.8 show the maps of first occurrence of snow, last occurrence of snow and duration in the snow period for Europe September 2011 to August 2012 on the basis of SYNOP reports and their anomaly referring to the last 30 years (1981/82-2011/12). Snow fell earlier than on average on most of the continent except the British Isles and northern France and parts of the Mediterranean region, southeastern Sweden and southeastern European Russia and Middle East. The snow season ended on the other hand earlier than on average in eastern central Europe, southeastern Sweden, parts of the Italian and Balkan Peninsula, Middle East and southern Russia. Over most of European Russia as well as in the higher mountains of Georgia the snow continues until the first decade of April. So overall the snowseason 2011/2012 was shorter than on average in most of Europe.

The snow cover extent for the entire Northern Hemisphere is operationally evaluated from satellite images by Rutger's Laboratory (see: 2012 Annual Report). The time series for annual snow extent covers 43 years, on a monthly basis up to 47 years. The annual snow cover extent over the Northern Hemisphere ranked 2012 as having the 12th least extensive cover on record (for 43 years). For Eurasia it was on rank 15 of the largest snow covered area resp. rank 29 of the least extensive cover. February 2012 on rank 3 of the most extensive snow covered area of 46 February months and December 2012 on rank 2 of the most extensive snow covered area of 47 December months were the most remarkable months of the year 2012.

More information about snow conditions may be found on the RCC-CM-Webside (RCC-CM).

Peculiarities as reported by the countries:

- In Russia Yekaterinburg received as little as 14mm of precipitation in February for the entire winter. This is the second time, when such low-snow winter is recorded for 120-year observations.
- In Latvia on 27th October snow height in some parts of Eastern Latvia was up to 35 cm. Such thick snow in October in Latvia is rare - on average once every 20 years.
- In Georgia the unprecedented maximum snow depth (354sm) was recorded in Khulo (Ajara) in March.
- In Slovenia it was snowing in most of the lowland already in the last third of October, but in December it was snowing also on the coast, where the snow cover depth reached 11 cm, which is a quite rare phenomenon on the coast.



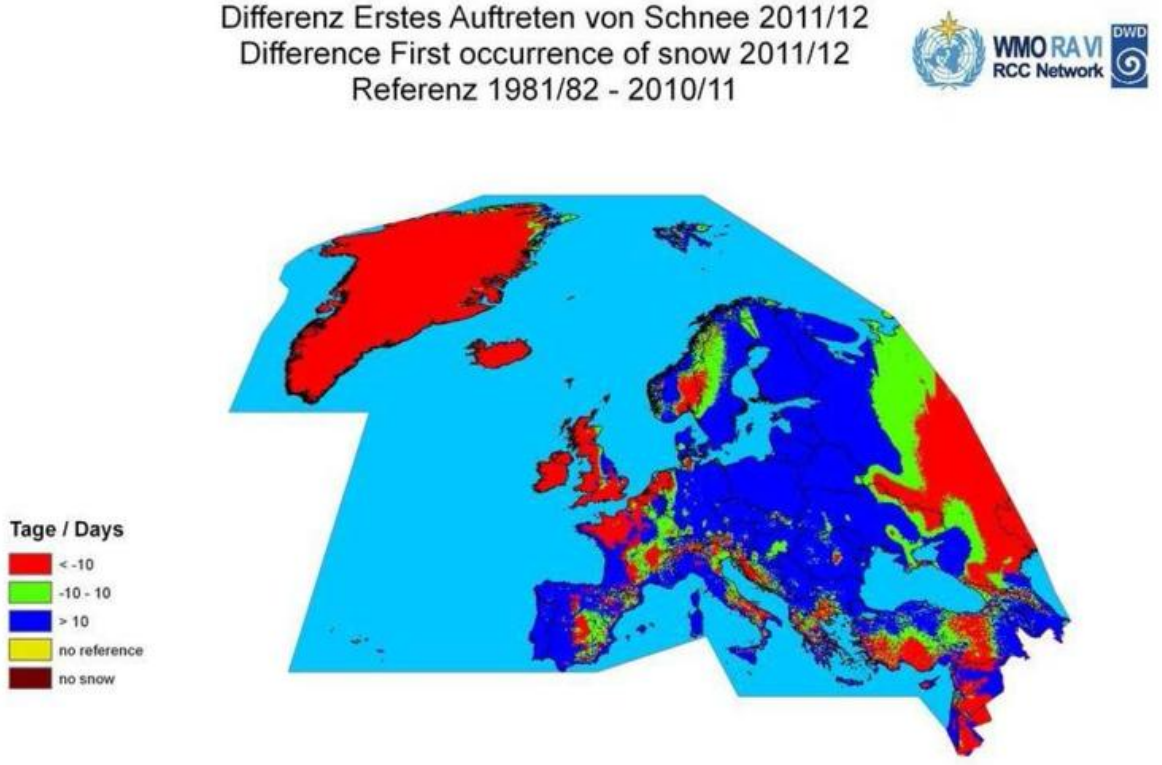


***Fig. 2.6**: Upper Figure: Map of first occurrence of snow during the snow-season 2011/2012*
Lower Figure: Map of anomaly of first occurrence of snow (reference 1981/1982 - 2010/2011)

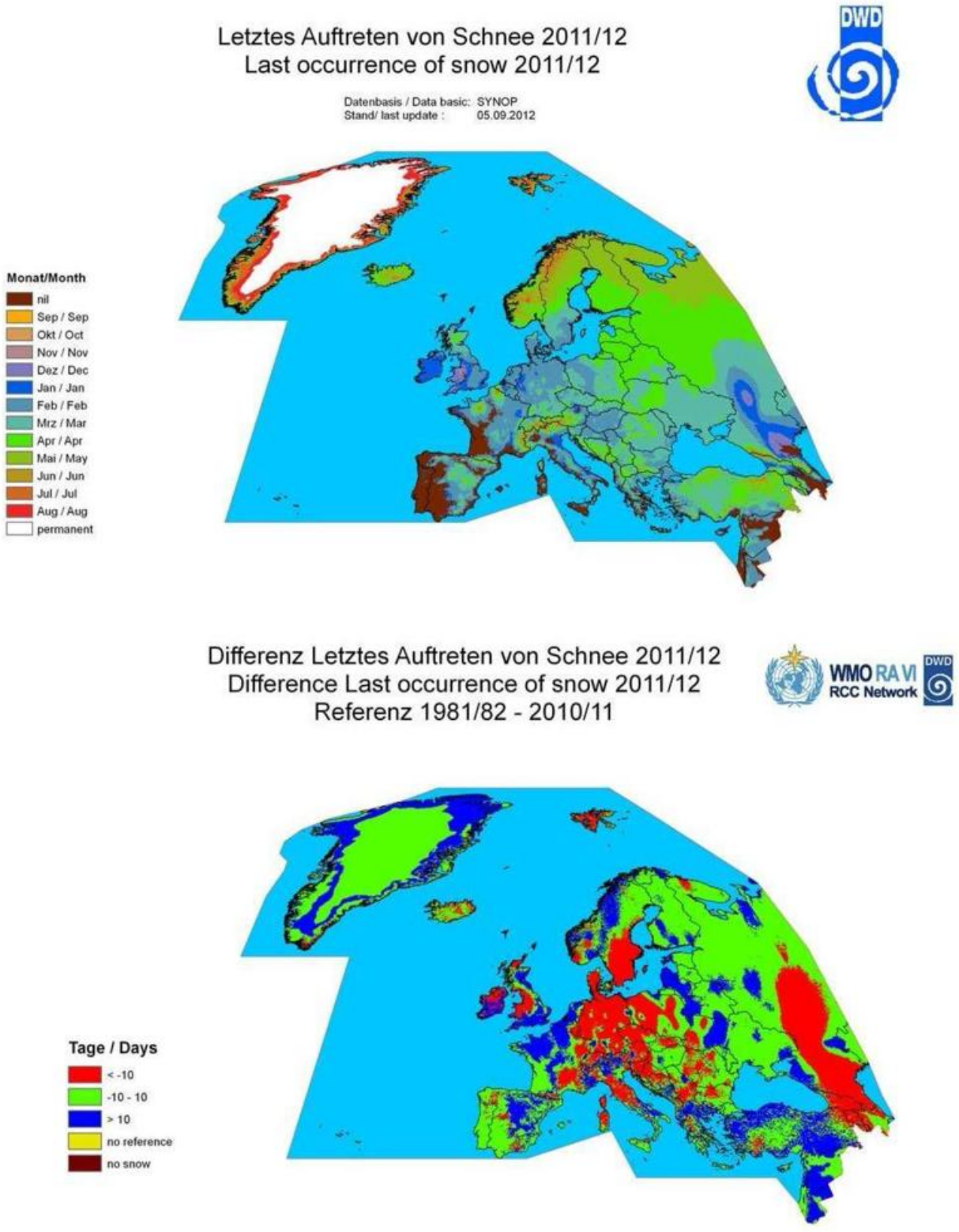


Fig. 2.7: *Upper Figure: Map of last occurrence of snow during the snow-season 2011/2012*
Lower Figure: Map of anomaly of last occurrence of snow (reference 1981/1982 - 2010/2011)

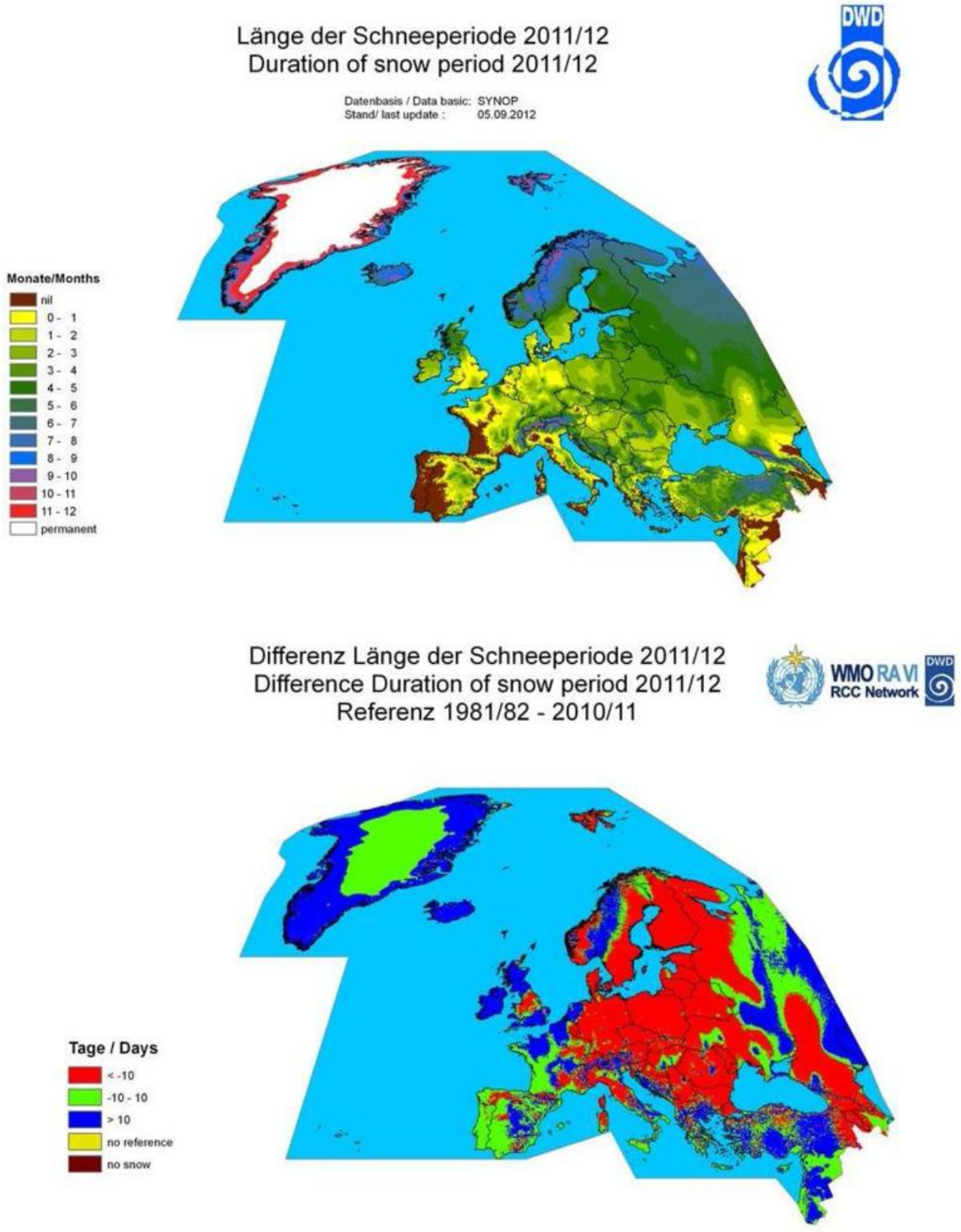


Fig. 2.8: *Upper Figure: Map of duration of snow cover in the snow-season 2011/2012*
Lower Figure:Map of anomaly duration of snow season (reference 1981/1982 - 2010/2011)

Temporal Evolution of Climate Elements

On the following pages graphs of long time series of temperature, precipitation and sunshine duration as provided by the NMHSs are presented to give an overview of the temporal development of the basic climate elements. The graphs are grouped with respect to the 6 subregions defined above (Fig. 1.1). The table below informs about the lengths of the time series shown as well as whether they refer to spatial means of the country or single stations. Most time series are temperature time series. Each subregion is at least represented by one country. Time series of precipitation totals are fewer but including a time series of the maximum daily precipitation total for the Upper Galilee in Israel there is as well each subregion represented with at least one time series for precipitation. Diagrams of long-term annual sums of sunshine duration are provided by 4 countries and they belong to the 4 subregions 'Central and western Europe' and 'Nordic and Baltic countries' Mediterranean, Italian and Balkan Peninsula and Eastern Europe. Some countries contributed time series which were not available in 2011. Other time series that were available in 2011 are not available in 2012 on the other hand. So for Iceland a series of annual mean temperature since 1798 is now available for the station Stykkisholmur.

Following this section, trend maps representative for the elements temperature and precipitation are shown. As reference period for these trend maps 1951-2012 was chosen. After this, we present examples of the temporal developent of other temperature related phenomena,such as the sea surface temperature in the North Sea and sea level anomalies at the Polish station Wladyslawowo.

Start of long-term time series of Temperature, Precipitation and Sunshine Duration

	Temperature		Precipitation		Sunshine Duration	
Country	Spatial Mean[1]	Single Station	Spatial Mean	Single Station	Spatial Mean	Single Station
Armenia	1929					
Belgium		1833				
Denmark	1873		1873		1920	
Finland	1900					
Faroe		1873				
Georgia	1961		1961			
Germany	1900		1900		1951	
Greenland		1873				
Iceland		1798				
Italy	1961		1951			
Israel	1951		1949			
Latvia	1924		1924			
Lithuania	1961	1778				
Norway	1900		1900			
Poland	1951					
Portugal	1931		1931			
Russia	1939		1966		1961	
Slovakia	1901		1901		1934	
Slovenia		1951		1951		1951
Spain	1961					
Switzerland	1864		1869			
Turkey	1940		1940			

1 evtl. for a subregion

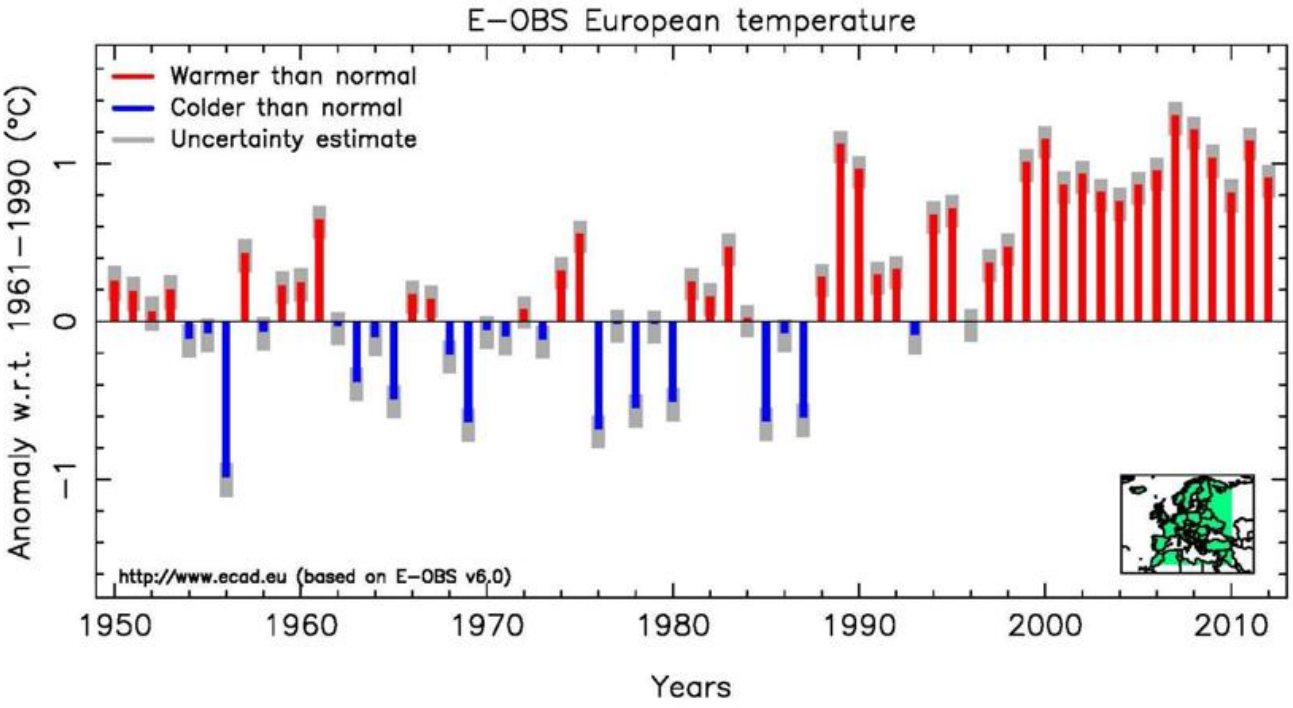


Fig. 2.9: *Time series of mean annual temperature anomalies for Europe (land area; 30 °W - 30 ° E; 30 ° N - 80 ° N) after Verver et. al. 2013*

Temperature

Note:

Long time series of the mean annual temperature are available for each of the 6 subregions. The number of countries which provided information differs as well as the length of the series and the kind of presentation. The longest time series for areal means were provided by Switzerland (1864) and Denmark (1873). Most graphs are diagrams of the mean annual temperature over the years. Usually the mean annual temperature is given as a mean for the whole country. In a few cases the diagram refers to one station only. The longest station series presented here has Stykkisholmur on Iceland, starting 1798.(Similarly long or even longer time series for stations exist as wll for more countries but the main focus here lies upon areal means.) Some countries present the time series in form of anomalies from a reference (mostly the standard WMO reference period 1961-1990, except Poland, Portugal, Spain and Turkey (all 1971-2000)). In this context this must be reflected when for instance the number of years with annual means above the reference is compared. Taking into account that the temperature is growing with time, the year from which onward the annual mean lies above the reference will be later when the reference is 1971-2000 than compared with the standard normal period 1961-1990. Some countries provide further statistics in their diagrams like a running mean or a trend line. Generally all time series document the rising temperatures with time and the increase of the rise during the last 15 years. Some special aspects will be discussed in the following.

In most series of all subregions 2012 was warmer than normal though the positive anomalies were smaller than in 2011. Exceptions were Italy and southern Slovakia. Extremes indices (number of hot days, number of tropical nights) may differ in behavior from the mean annual temperature (Turkey, Slovenia).

Central and Western Europe:

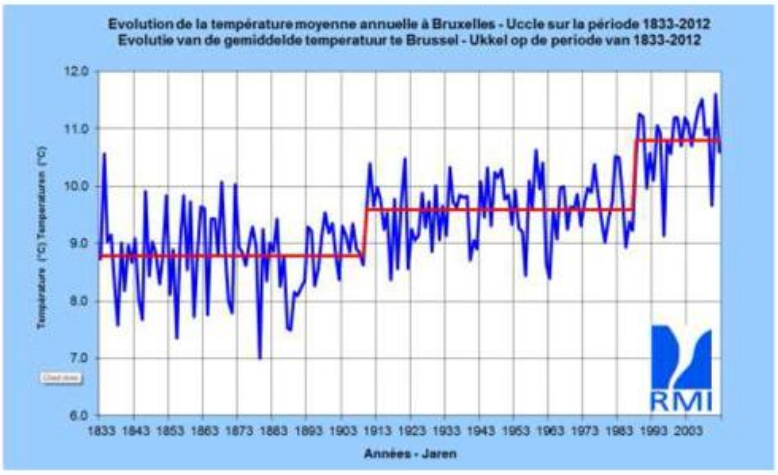


***Fig. 2.10** : Time series of annual temperature anomalies Ukkle (Belgium)*
(Diagrams as provided by the NHMSs)

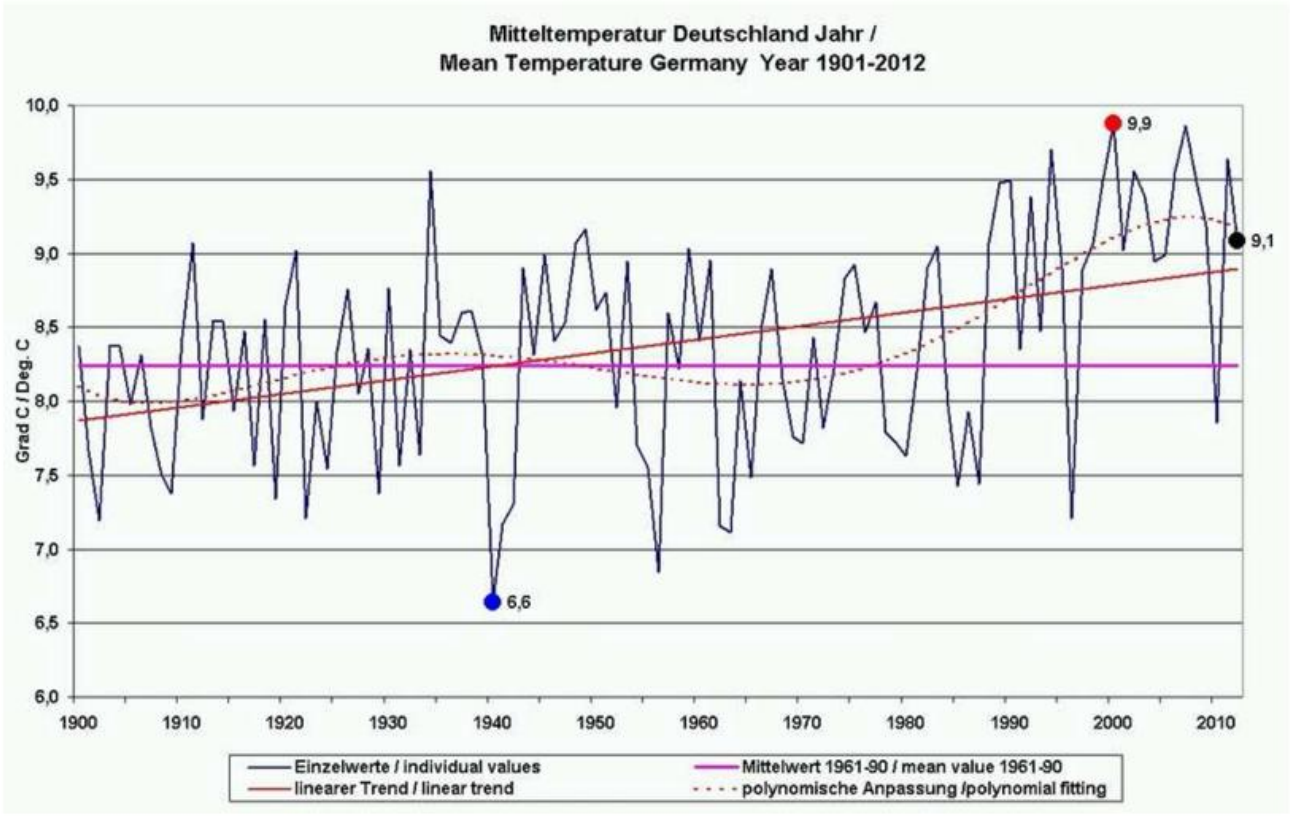


***Fig. 2.11** : Time series of annual temperature anomalies Germany*
(Diagrams as provided by the NHMSs)

Central and Western Europe:

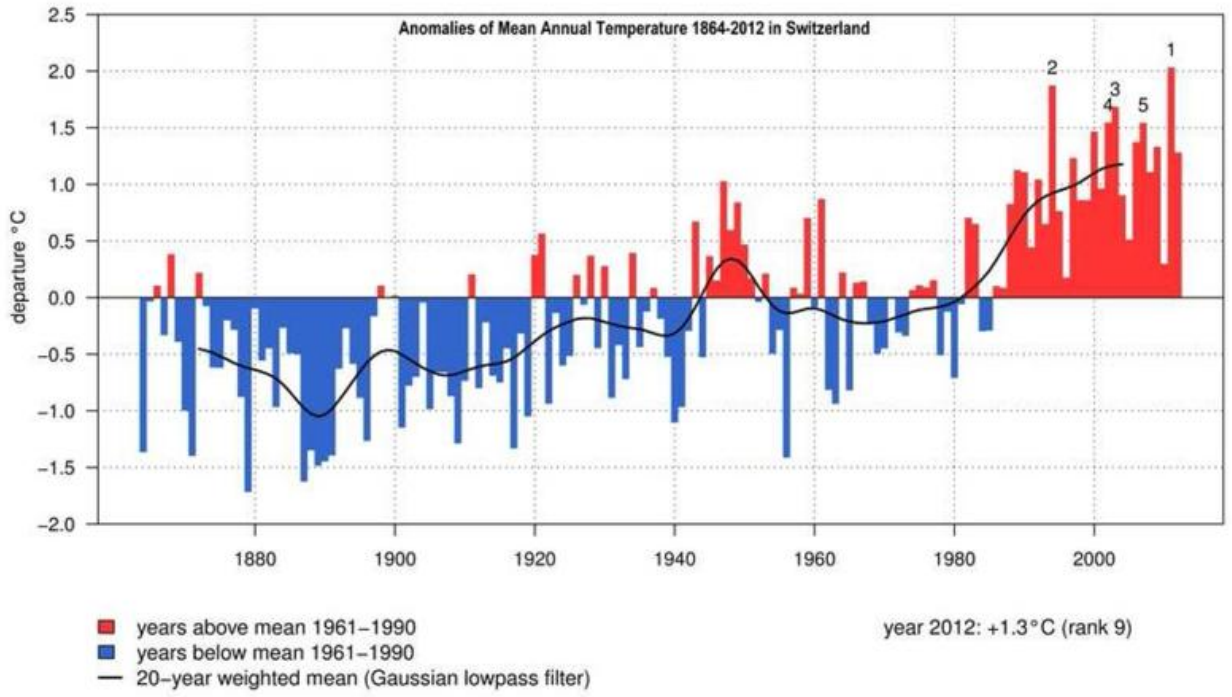


***Fig. 2.12** : Time series of annual temperature anomalies Switzerland*
(Diagrams as provided by the NHMSs)

Central and Western Europe:

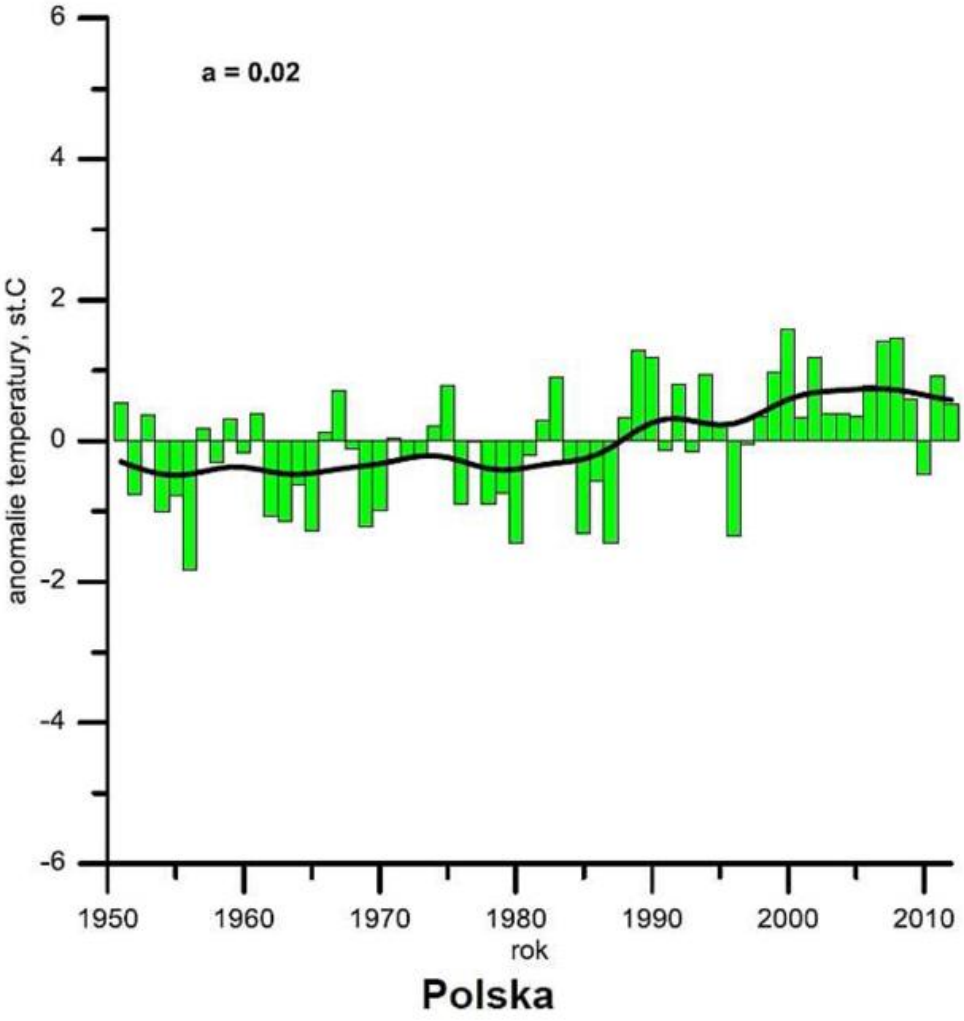


***Fig. 2.13** : Time series of annual temperature anomalies Poland*
(Diagrams as provided by the NHMSs)

Central and Western Europe:

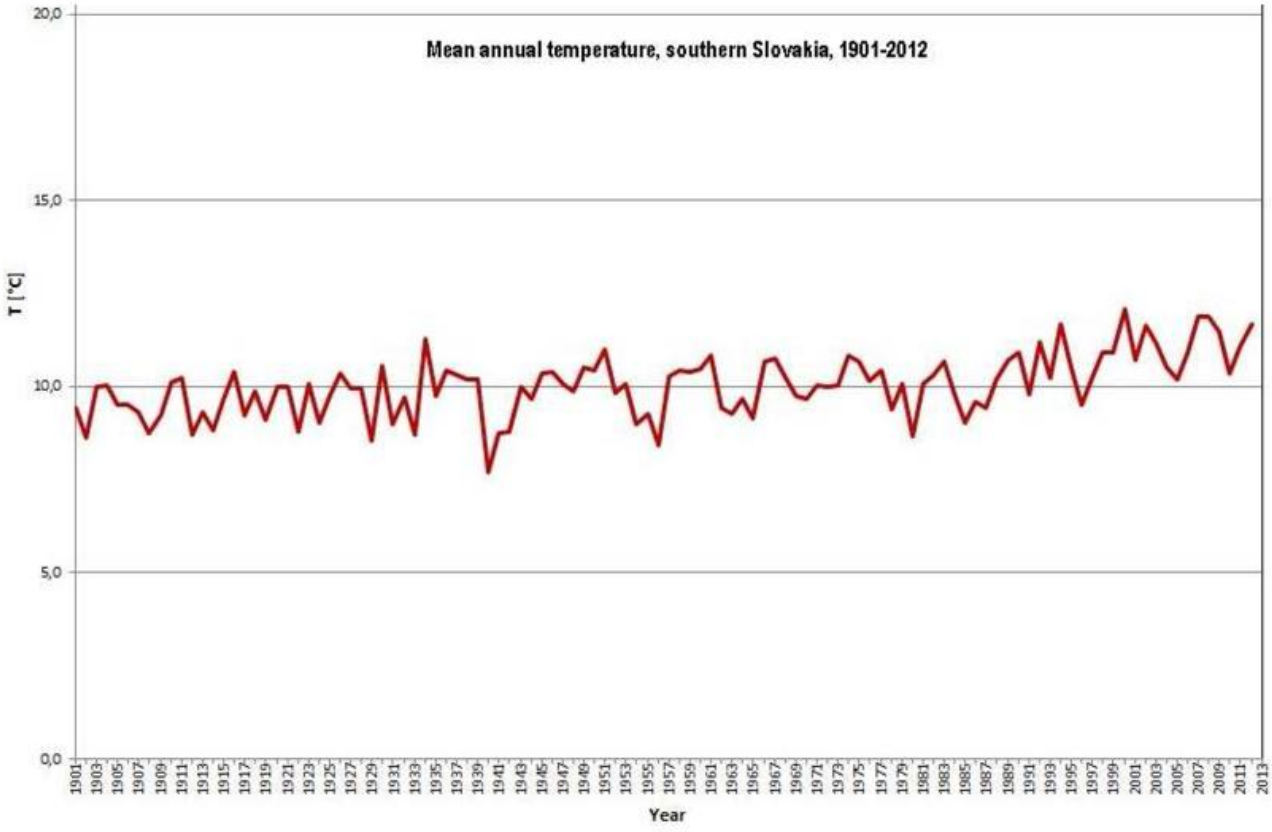


Fig. 2.14 *: Time series of mean annual temperature or anomalies for southern Slovakia (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:

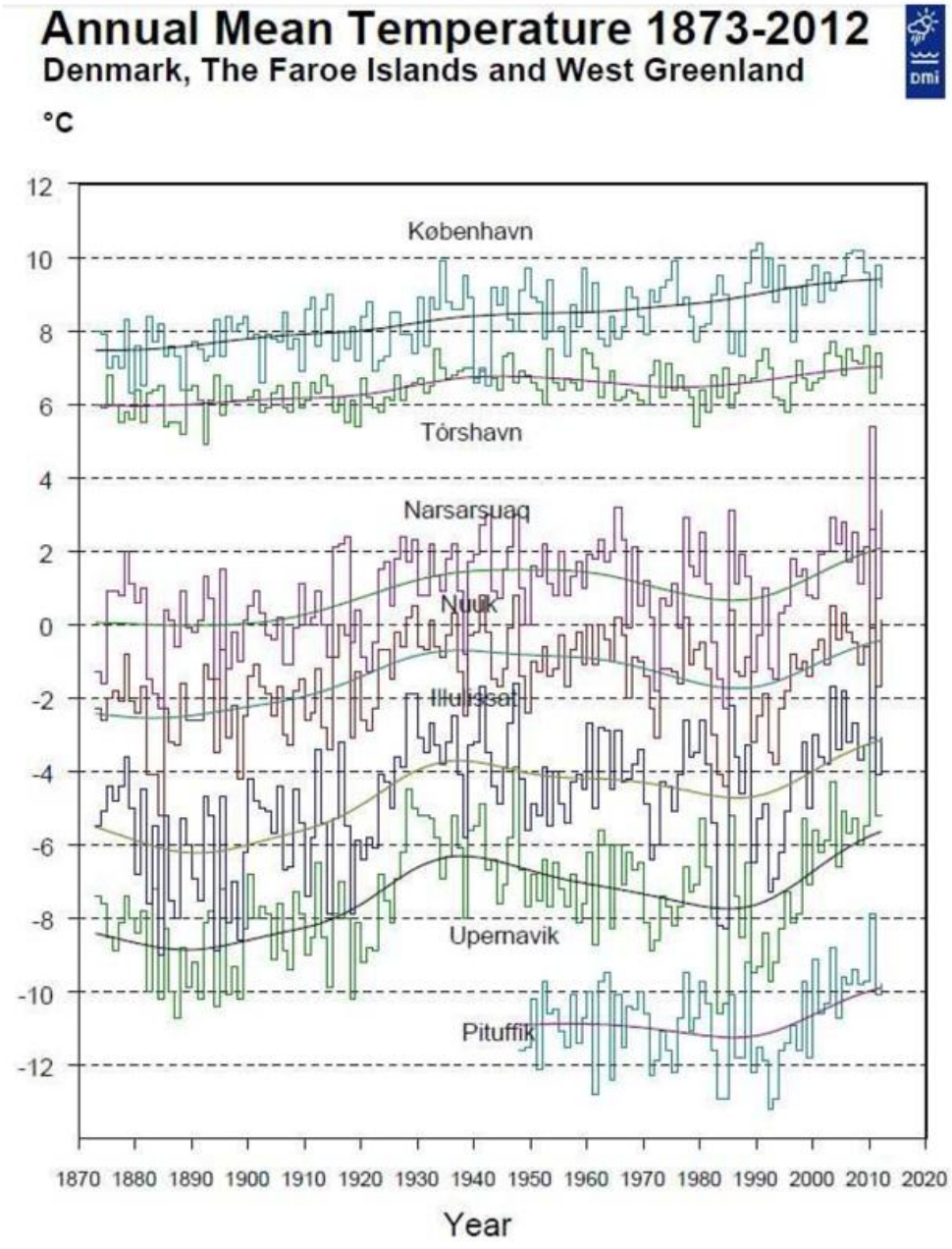


***Fig. 2.15** : Time series of anual mean temperatures for the Faroe Island and West Greenland compared to Kopenhagen (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:

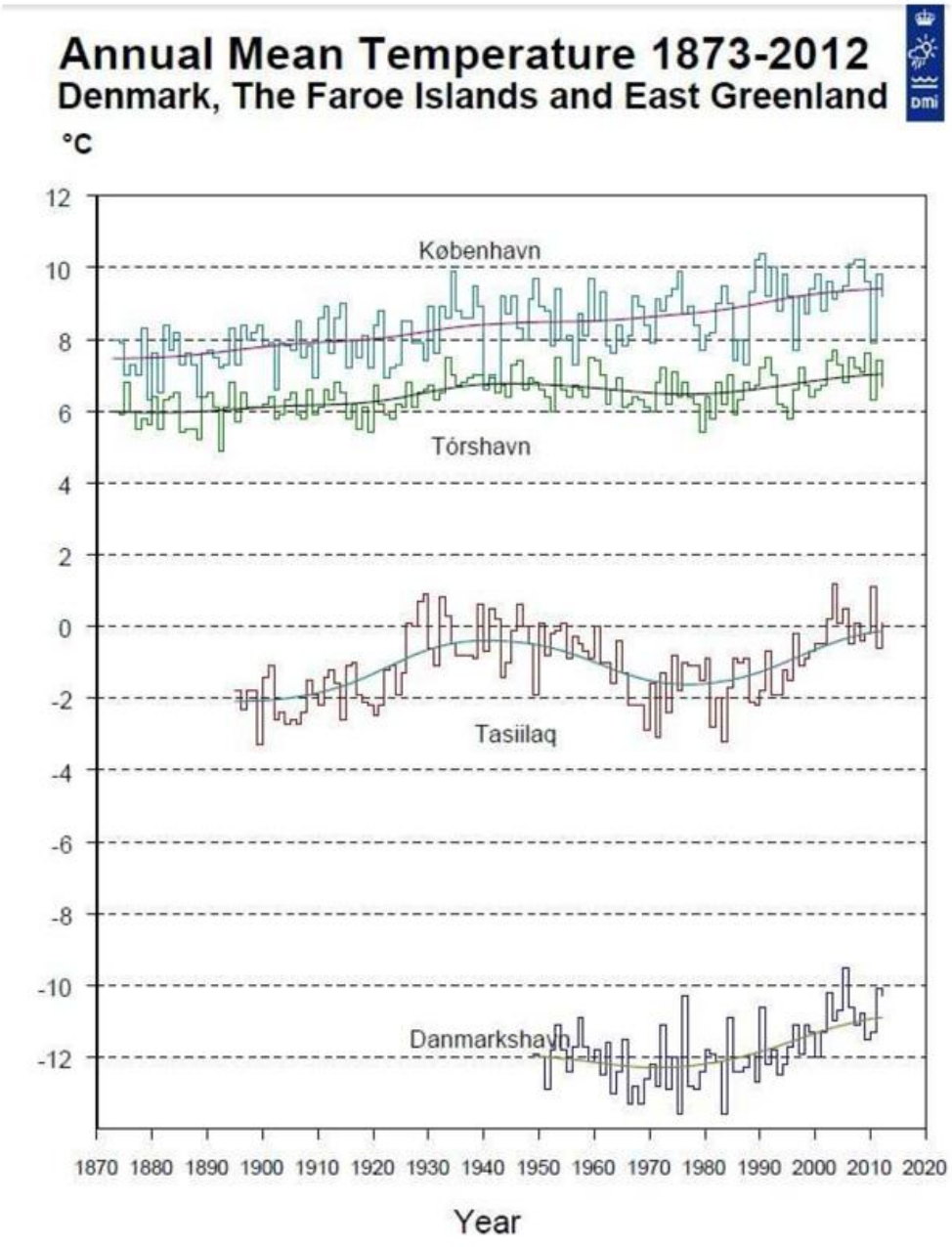


***Fig. 2.16** : Time series of anual mean temperatures for the Faroe Island and East Greenland compared to Kopenhagen (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:

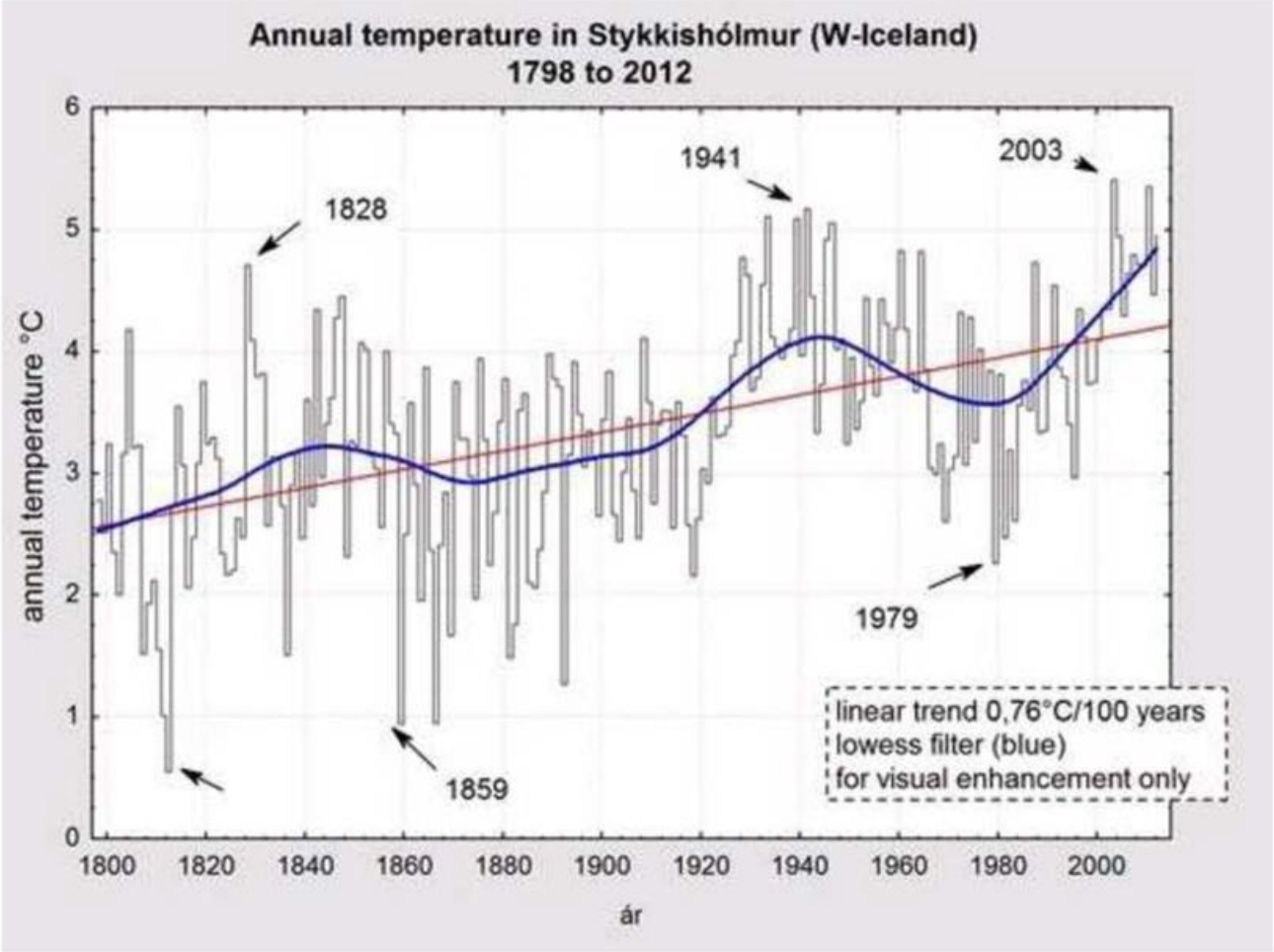


***Fig. 2.17** : Time series of annual mean temperature Stykkisholmur, western Iceland (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:

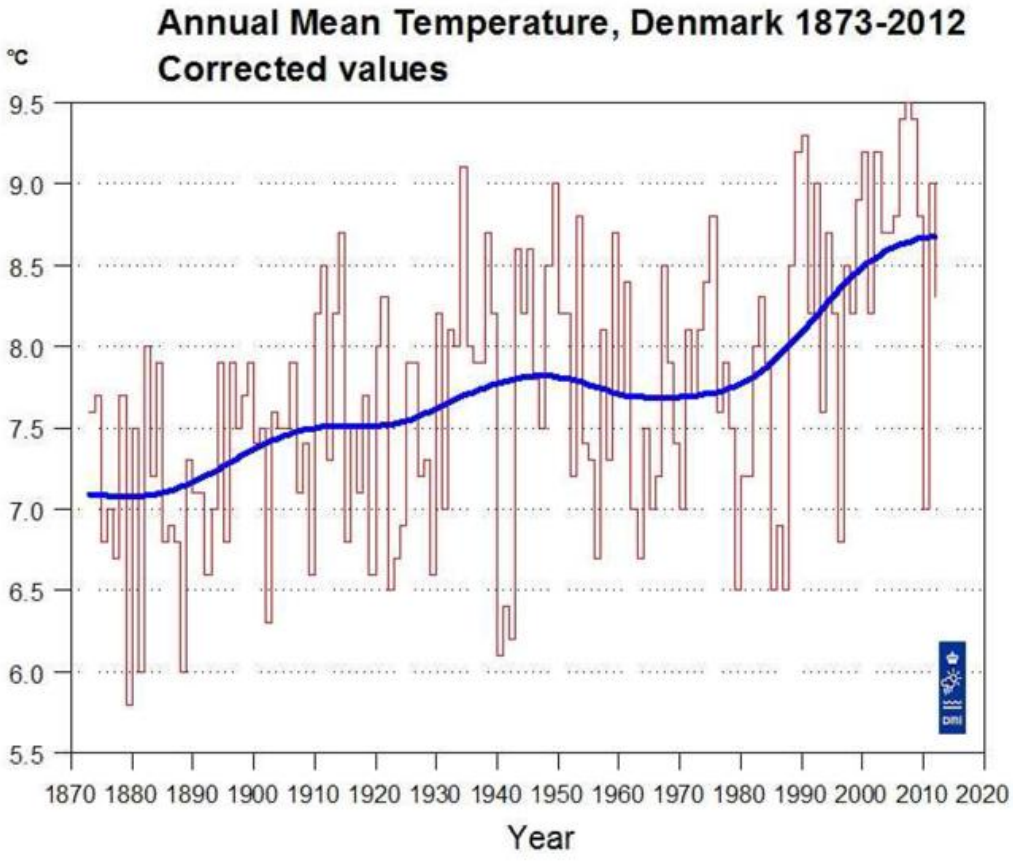


***Fig. 2.18** : Time series of annual mean temperature Denmark*
(Diagrams as provided by the NHMSs)

Nordic and Baltic Countries:

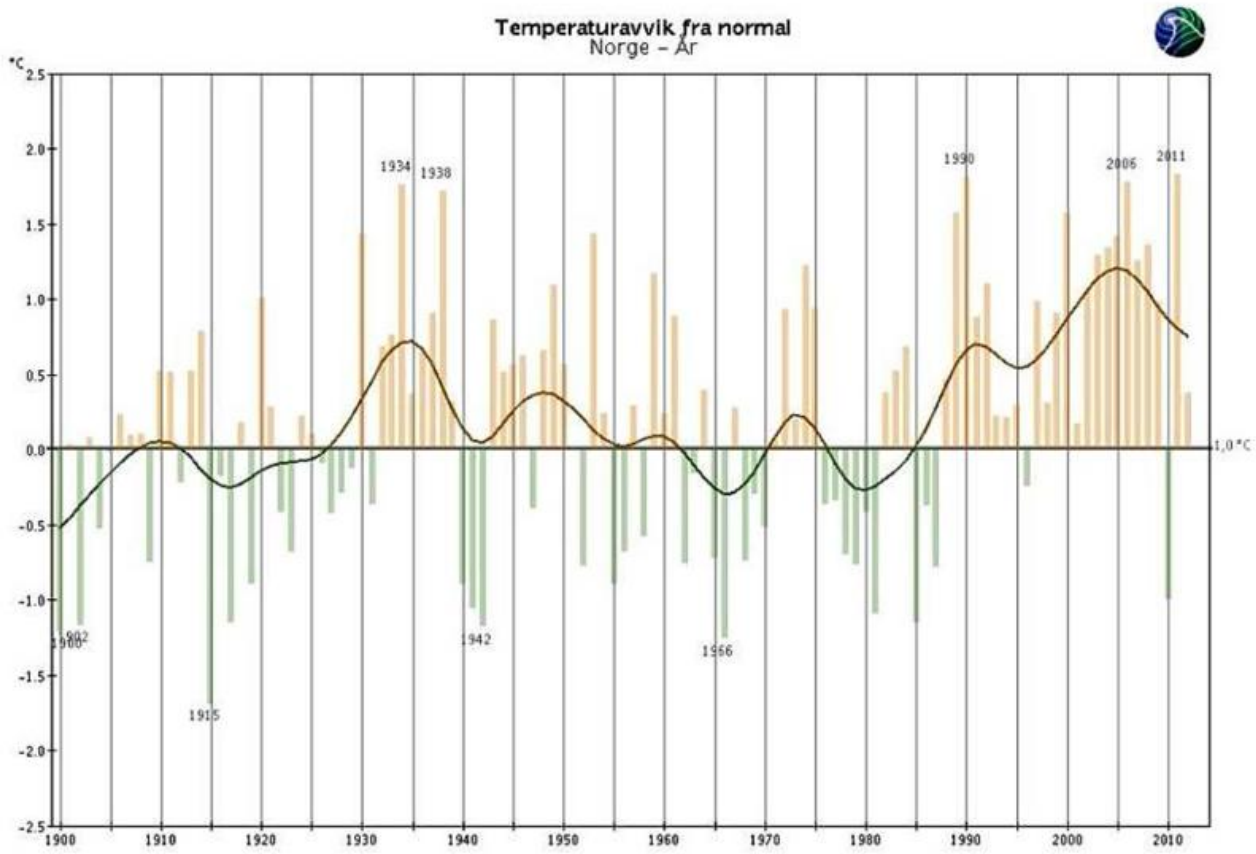


***Fig. 2.19** : Time series of annual mean temperature Norway*
(Diagrams as provided by the NHMSs)

Nordic and Baltic Countries:

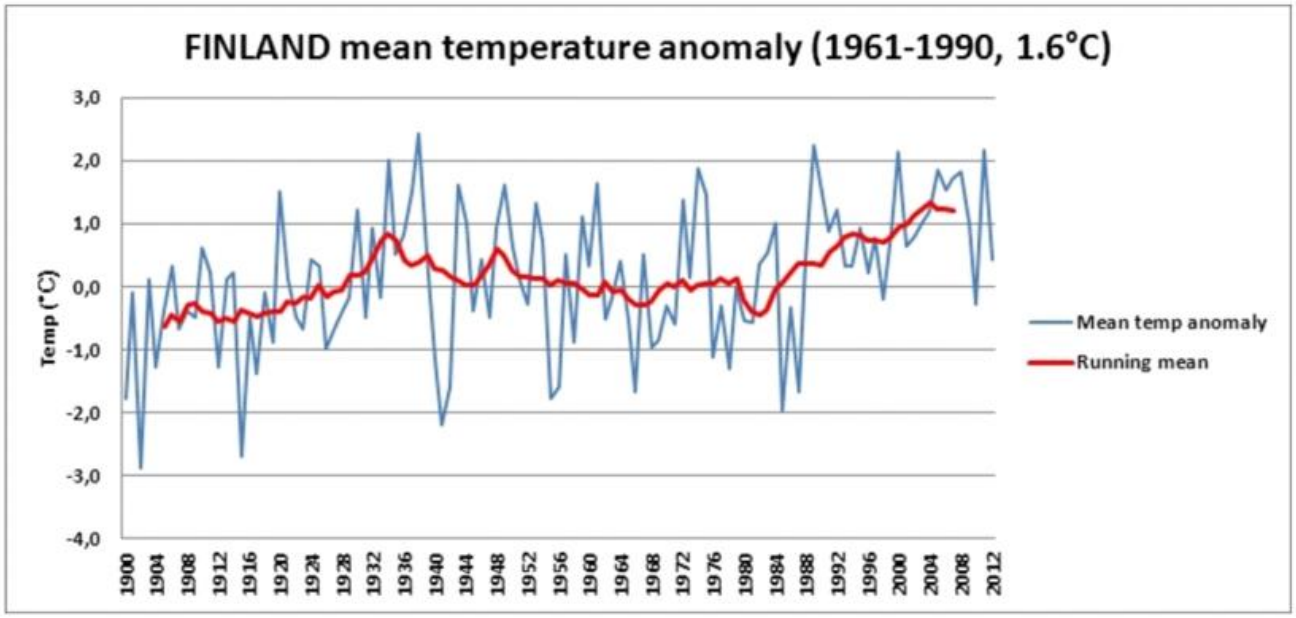


***Fig. 2.20** : Time series of annual mean temperature Finland*
(Diagrams as provided by the NHMSs)

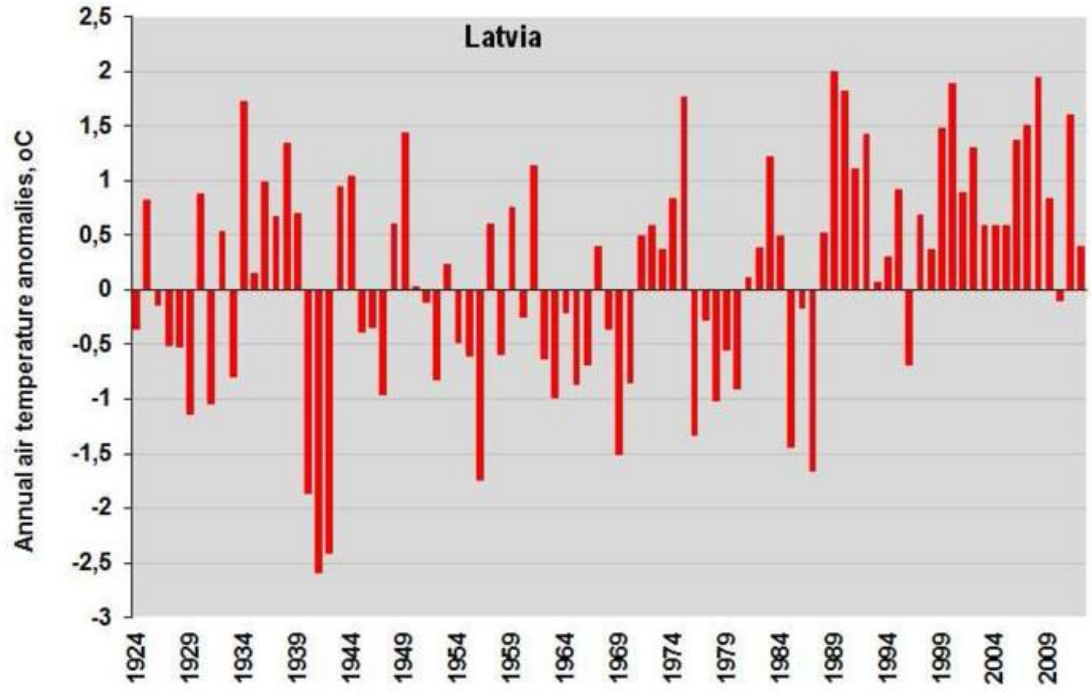


***Fig. 2.21** : Time series of annual mean temperature Latvia*
(Diagrams as provided by the NHMSs)

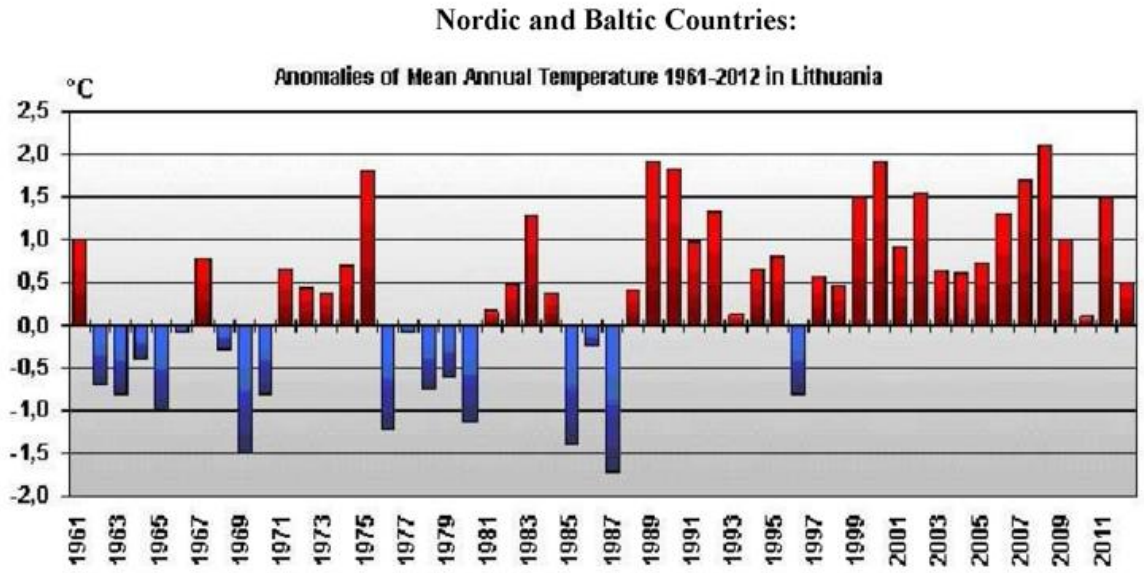


***Fig. 2.22** : Time series of annual mean temperature Lithuania*
(Diagrams as provided by the NHMSs)

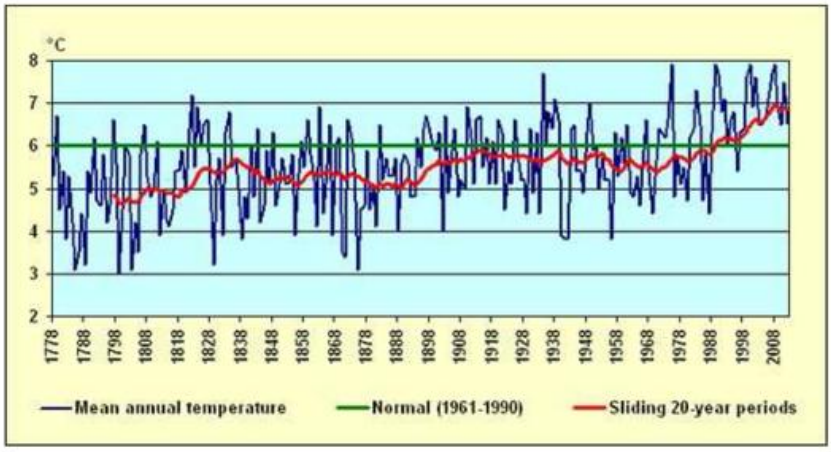


***Fig. 2.23** : Time series of annual mean temperature Lithuania (Vilnius)*
(Diagrams as provided by the NHMSs)

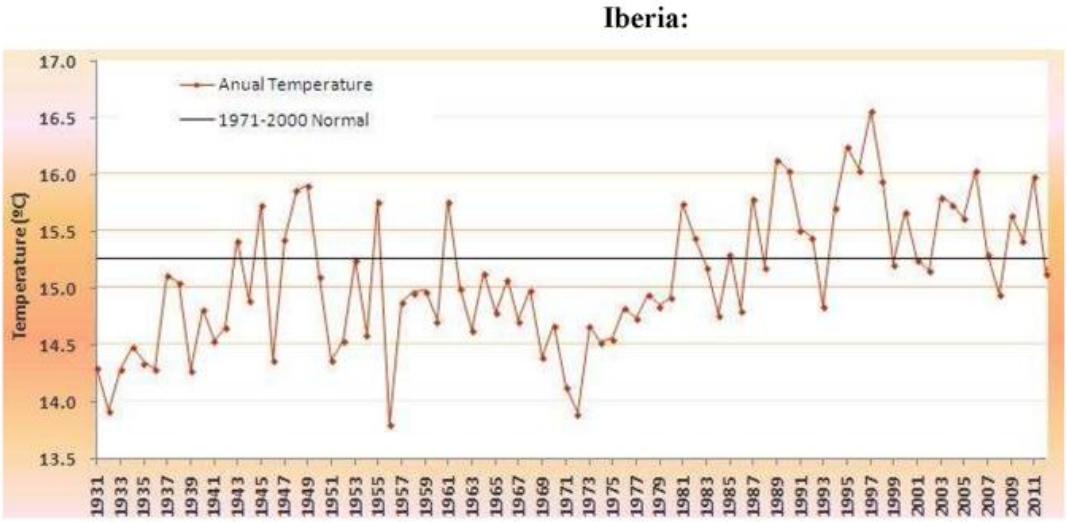


Fig. 2.24 *: Time series of mean annual temperature or anomalies for Portugal (Diagrams as provided by the NHMSs)*

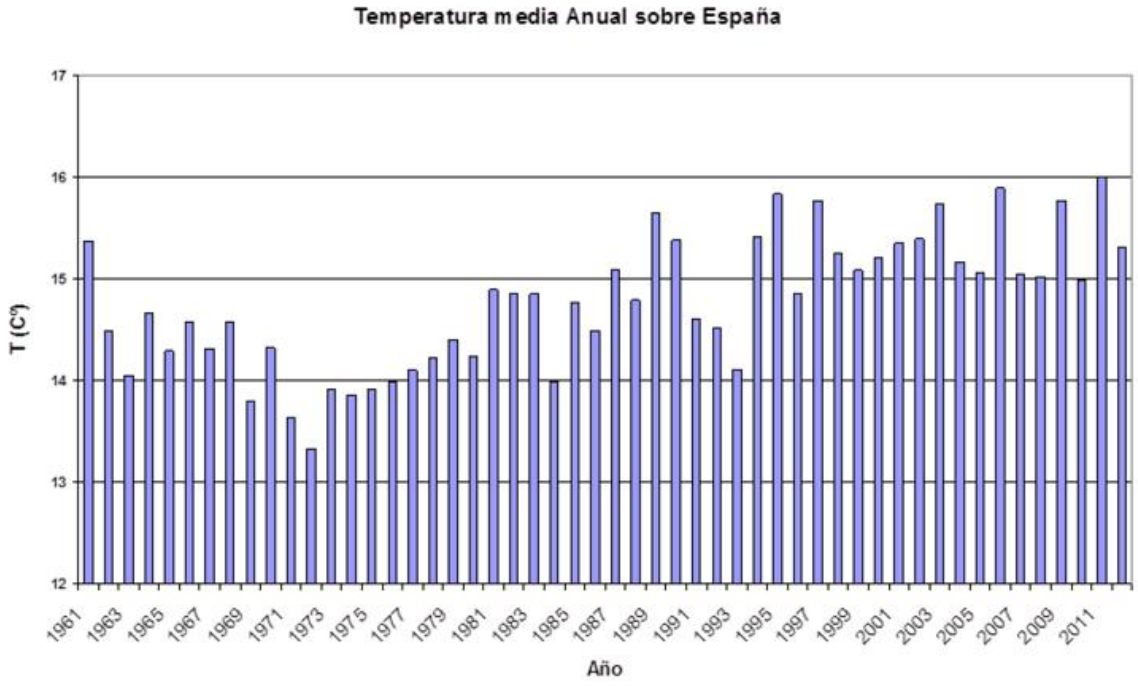


Fig. 2.25 *: Time series of mean annual temperature or anomalies for Espania (Diagrams as provided by the NHMSs)*

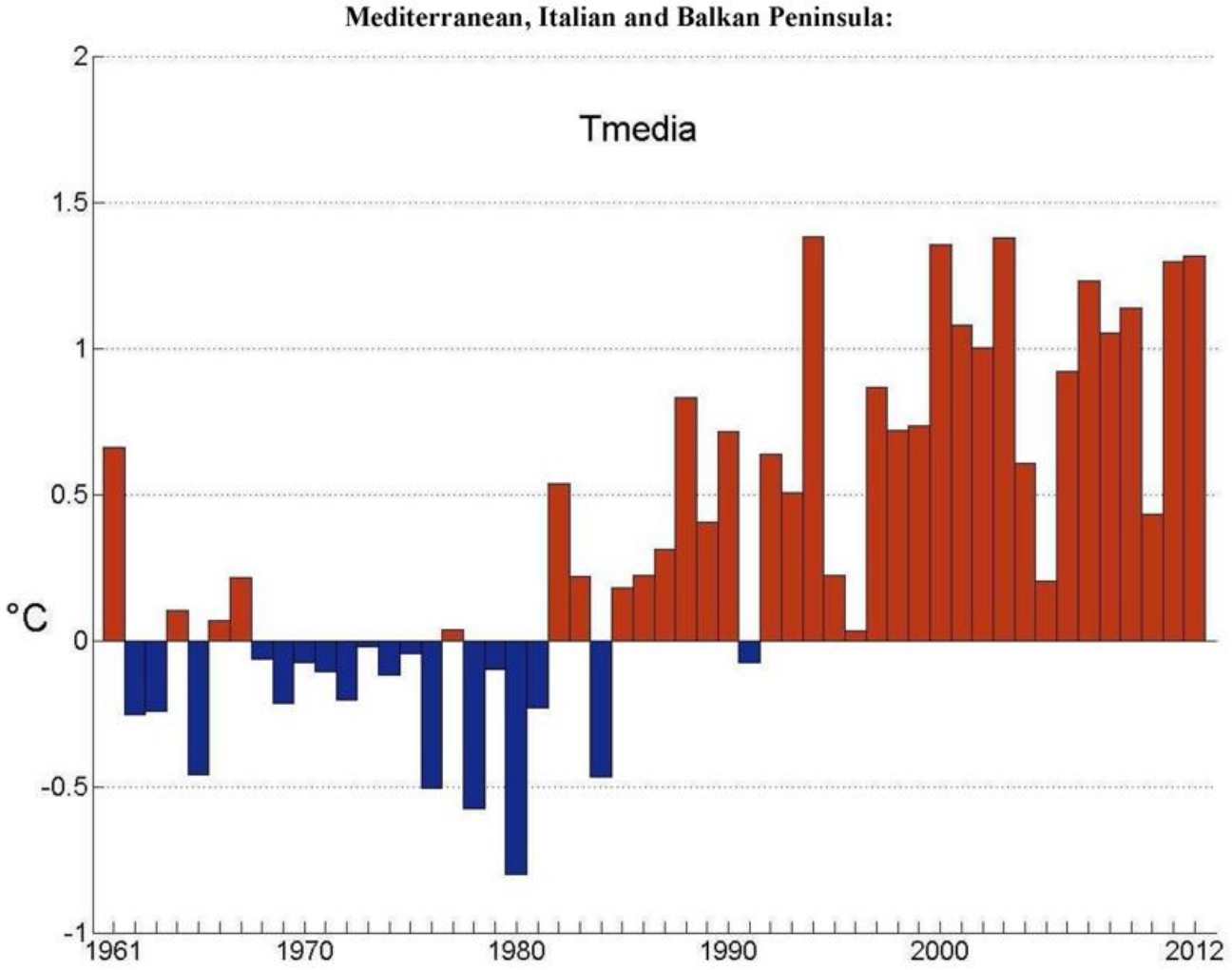


***Fig. 2.26** : Time series of mean annual temperature or anomalies for Italy*
(Diagrams as provided by the NHMSs)

Mediterranean, Italian and Balkan Peninsula:

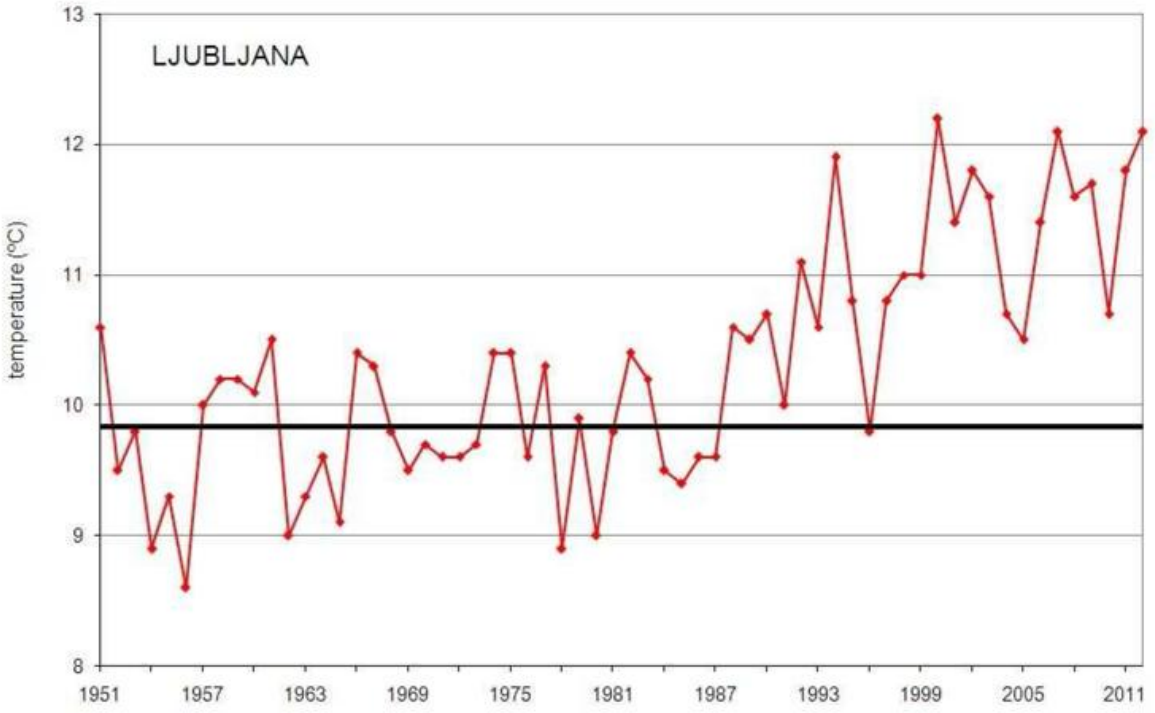


***Fig. 2.27** : Time series of annual mean temperature at Ljubljana Slovenia (Diagrams as provided by the NHMSs)*

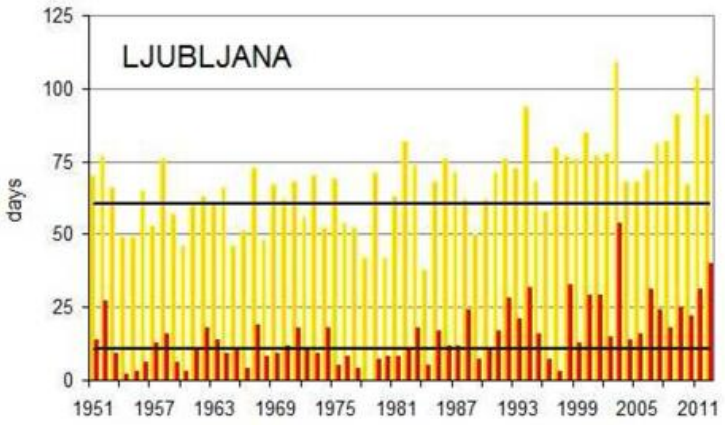


***Fig. 2.28** : Time series of annual number of summer days and hot days at Ljubljana Slovenia (Diagrams as provided by the NHMSs)*

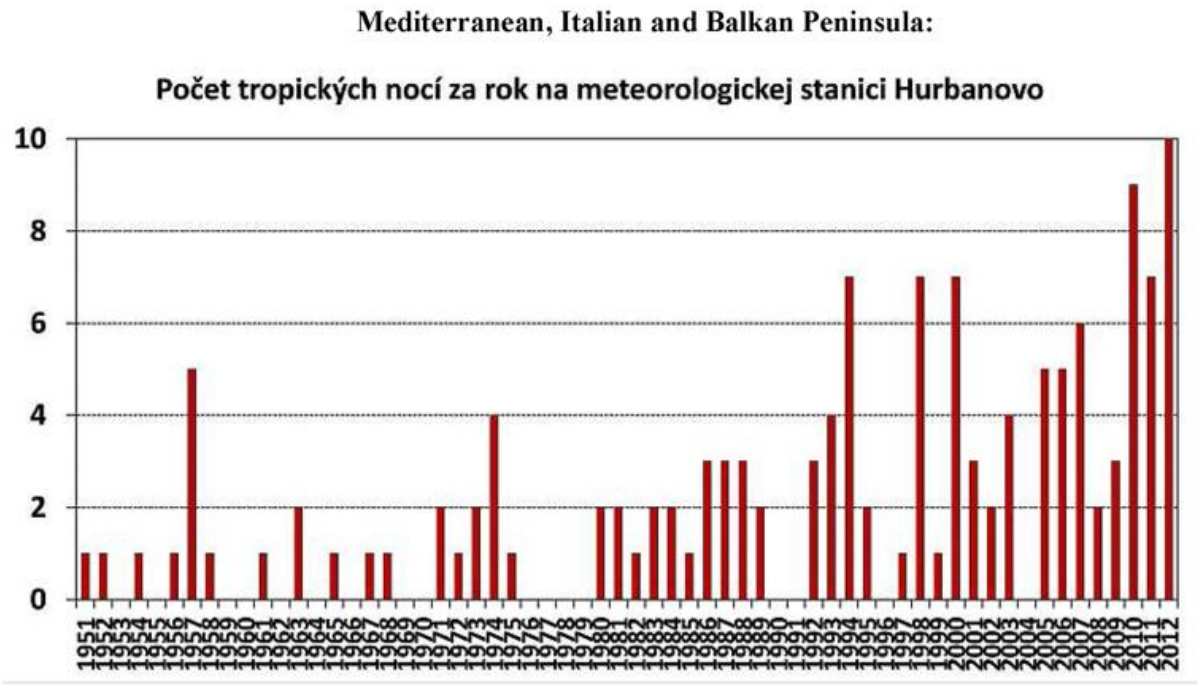


***Fig. 2.29** : Time series of annual number of tropical nights at Hurbanovo Slovenia (Diagrams as provided by the NHMSs)*

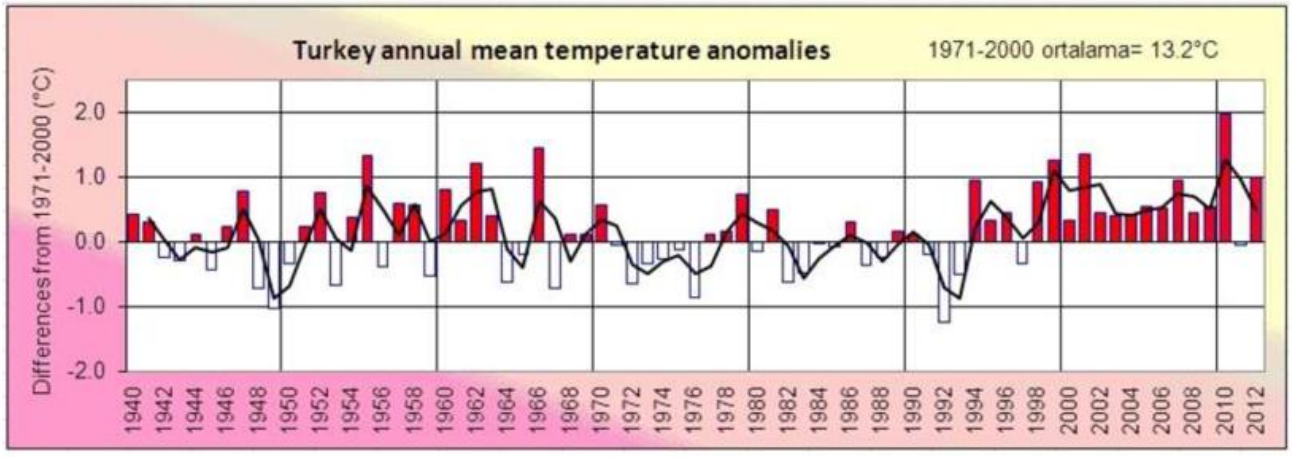


***Fig. 2.30** : Time series of mean annual temperature or anomalies for Turkey (Diagrams as provided by the NHMSs)*

Eastern Europe:

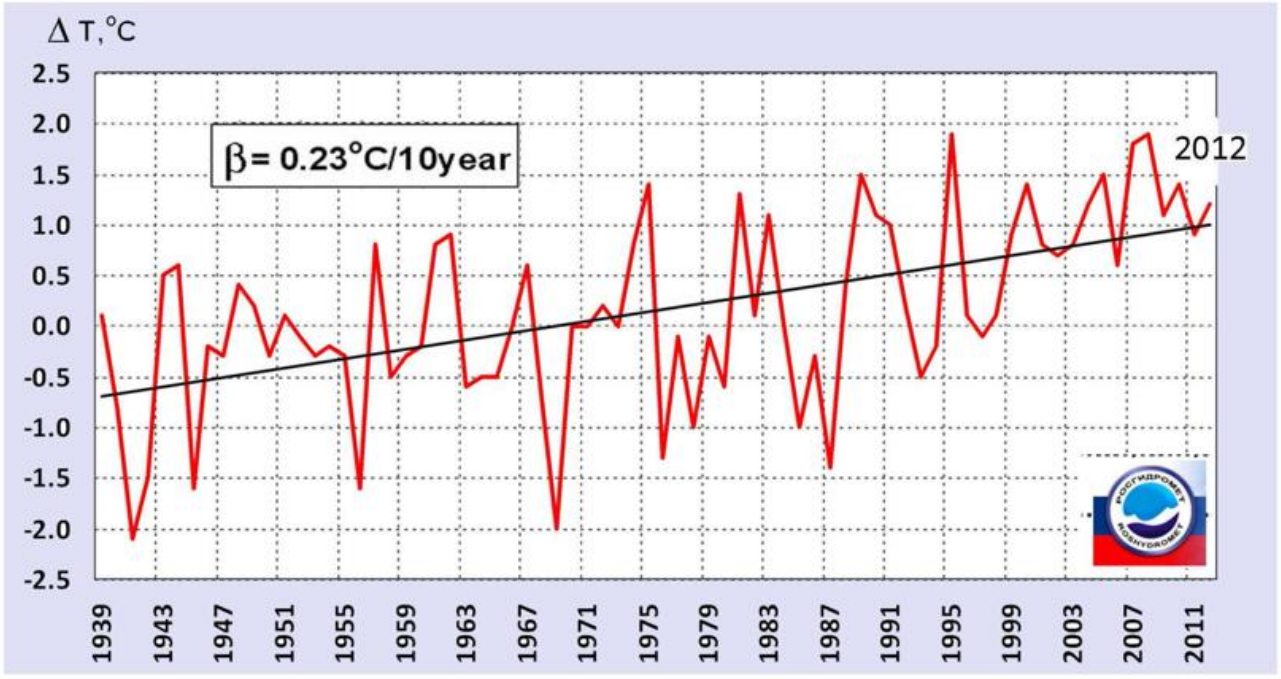


***Fig. 2.31** : Time series of annual mean temperature European Russia (Diagrams as provided by the NHMSs)*

Middle East:

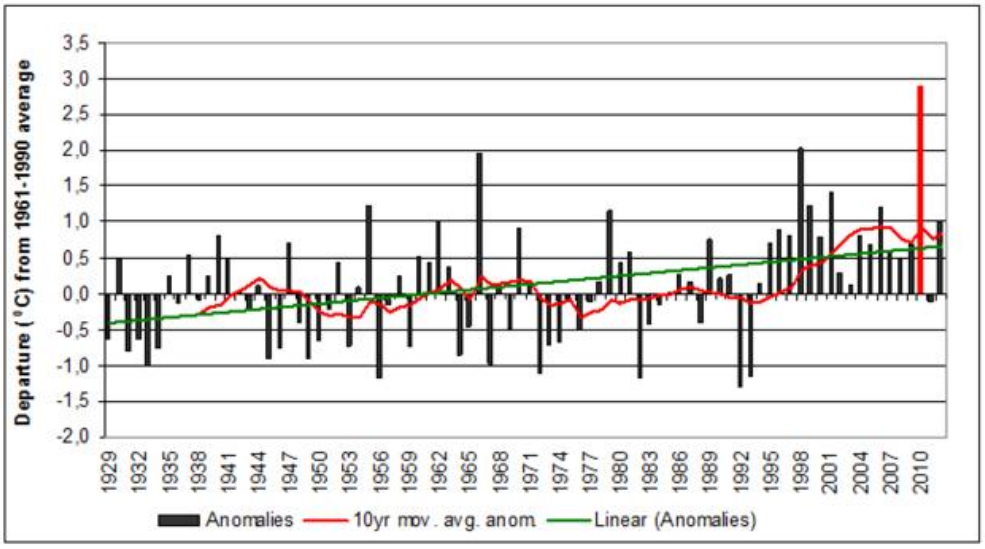


***Fig. 2.32** : Time series of annual mean temperature or anomalies Armenia*
(Diagrams as provided by the NHMSs)

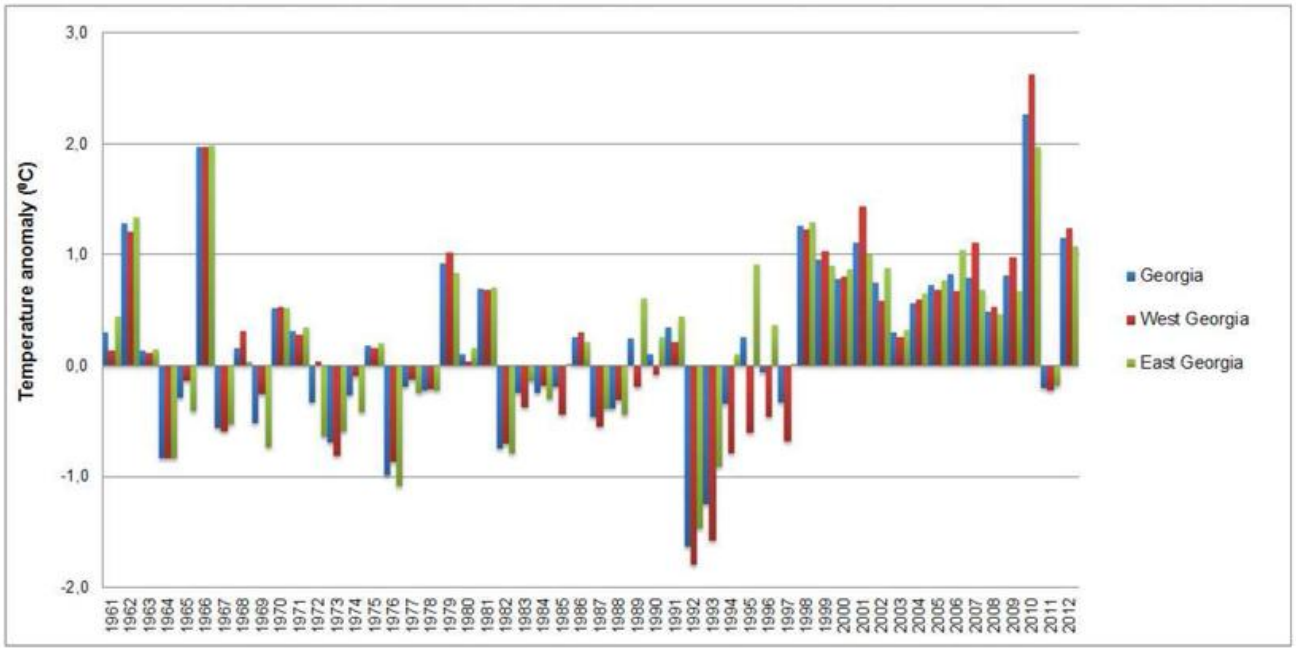


***Fig. 2.33** : Time series of annual mean temperature or anomalies Georgia*
(Diagrams as provided by the NHMSs)

Middle East:

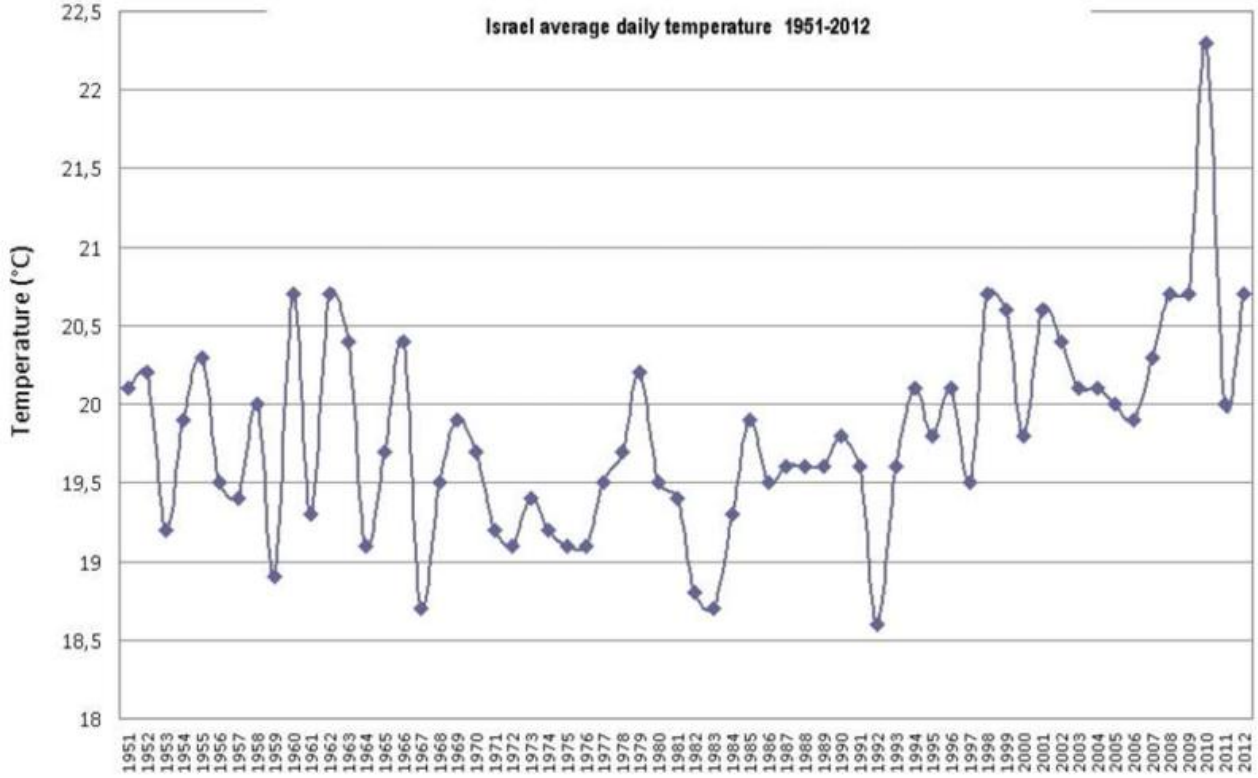


***Fig. 2.34** : Time series of annual mean temperature or anomalies Israel*
(Diagrams as provided by the NHMSs)

Precipitation

Note: *Denmark, Germany and Slovakia present annual precipitation totals while the other countries present anomalies from a reference period. Most countries refer to the period 1971-2000 for precipitation anomalies or the line of normal precipitation except Germany (1961-1990).*

For precipitation Fig 2.35 to 2.48 show the available time series for the 6 subregions.

With some caution the graphs give the information that precipitation has a rising trend in northern, western, central and eastern Europe but not in the Baltic states and not in the Mediterranean region and Middle East. The graphs for Iberia and the Italian Peninsula show a falling trend. The annual rainfall for Denmark has risen about 100 mm since 1870s. The lowest annual precipitation for the country as a whole was 464 mm in 1947, and the highest was 905 mm in 1999 For Switzerland 2 graphs are presented to show the differences between the north and the south. For northern Switzerland the annual precipitation is rising at least since 1940 while the graph of southern Switzerland undulates around the reference line. Israel contributed a time series of the annual maximum daily total in the Upper Galilee region which shows the highest value of 140 mm in 2012 in a series since 1949. This is related to the rain event in June .

Central and Western Europe:

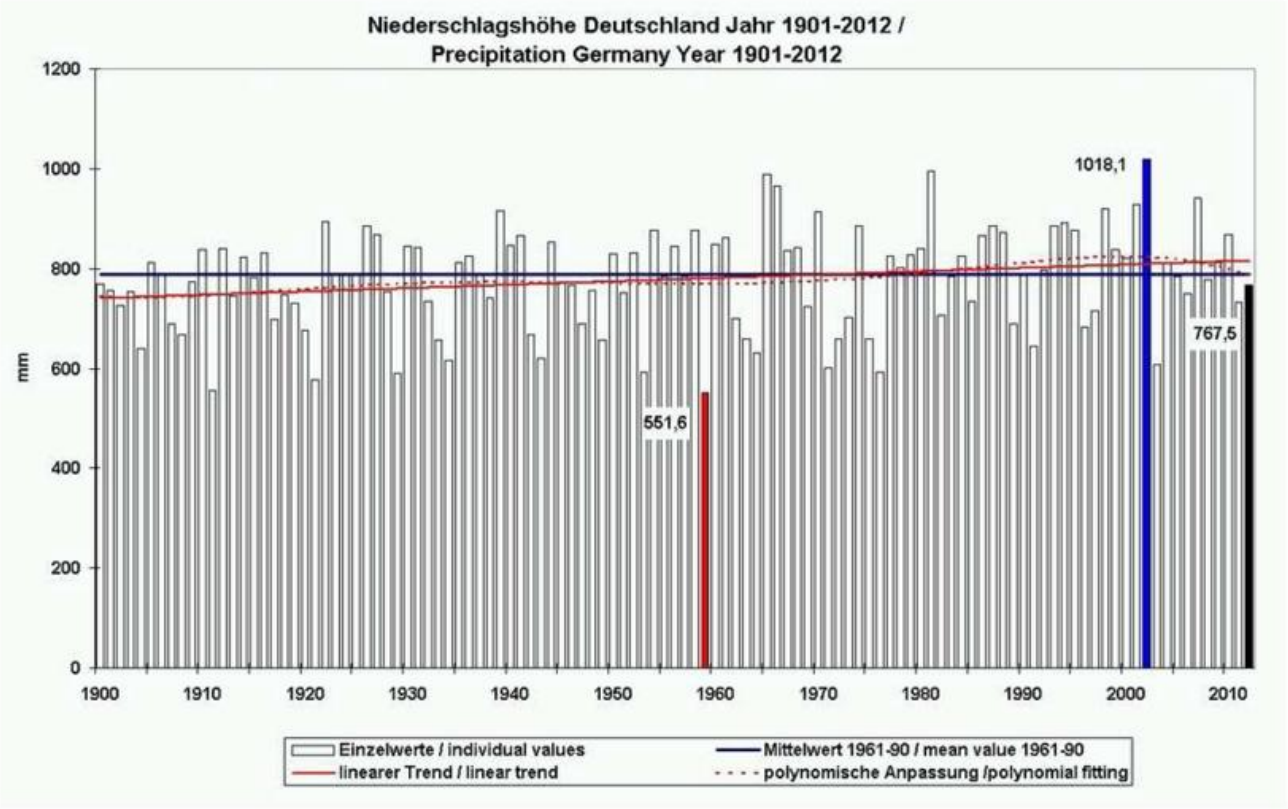


***Fig. 2.35** : Time series of annual precipitation totals Germany*
(Diagrams as provided by the NHMSs)

Central and Western Europe:

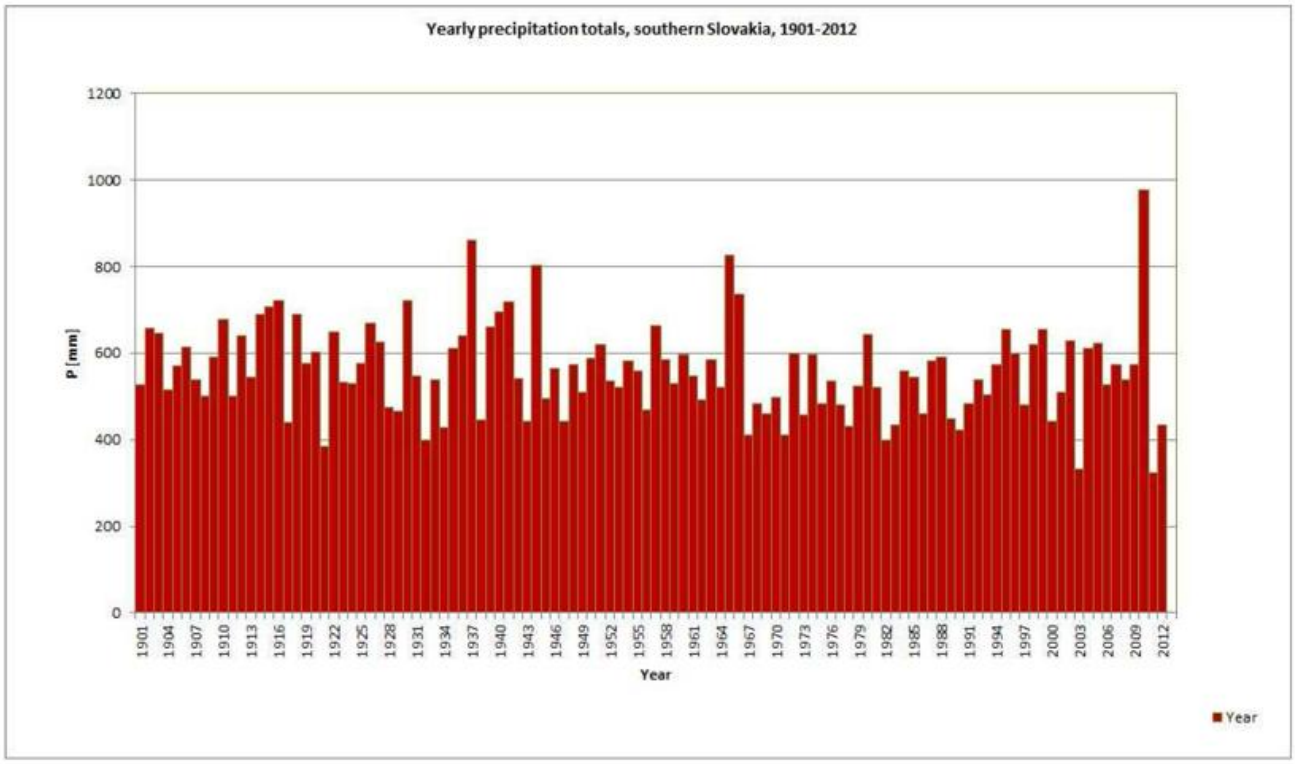


***Fig. 2.36** : Time series of annual precipitation totals or anomalies for southern Slovakia (Diagrams as provided by the NHMSs)*

Central and Western Europe:

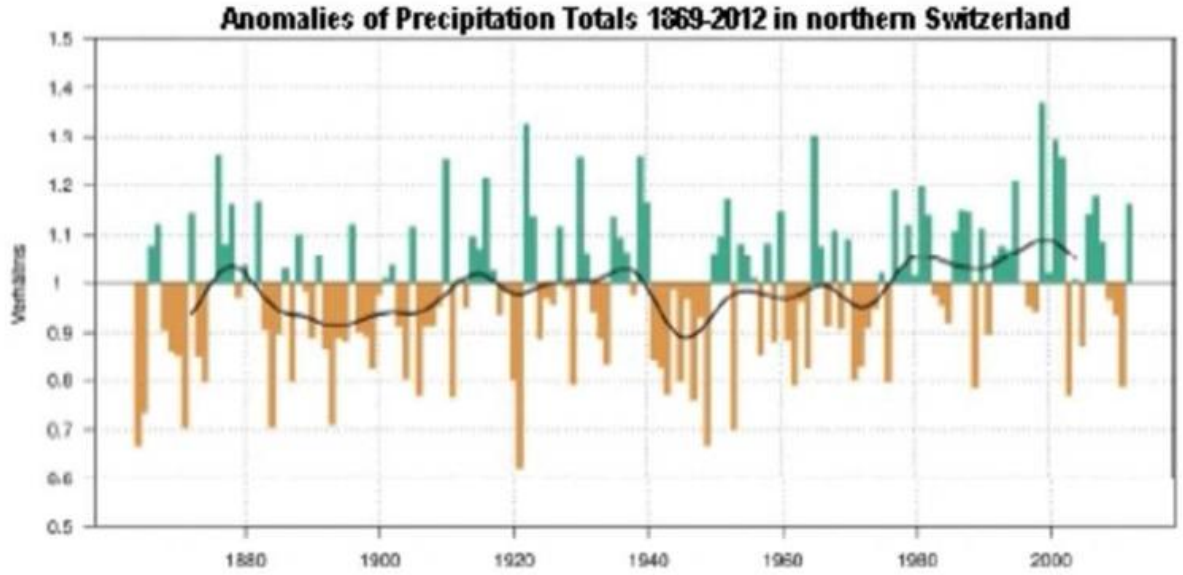


***Fig. 2.37** : Time series of annual precipitation totals northern Switzerland (Diagrams as provided by the NHMSs)*

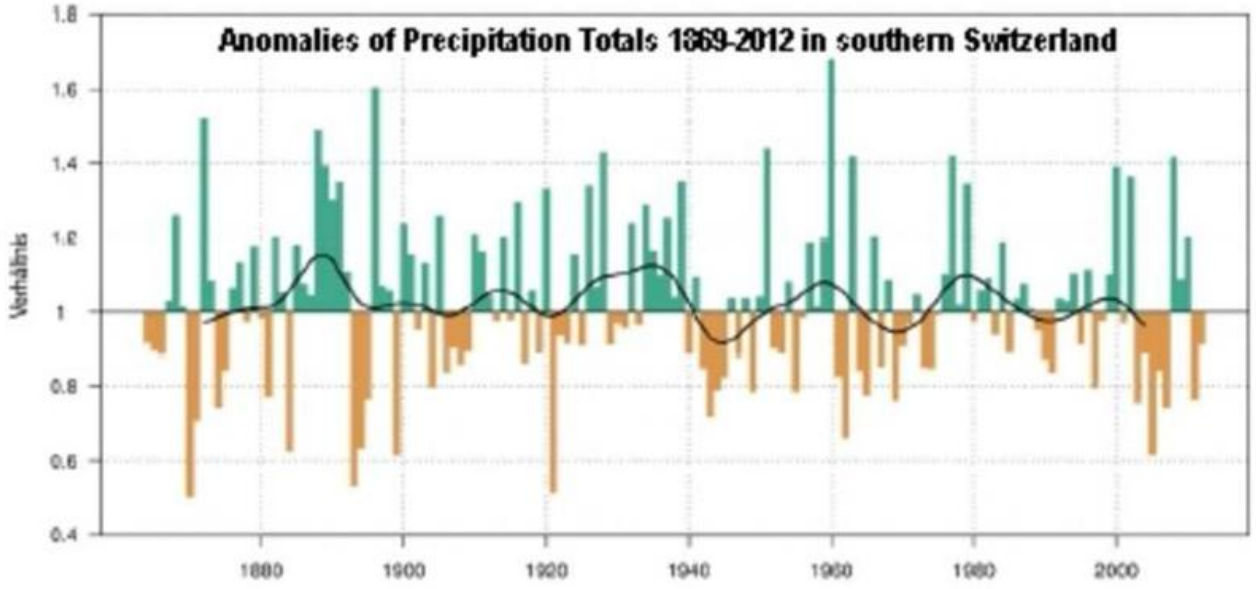


***Fig. 2.38** : Time series of annual precipitation totals southern Switzerland (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:

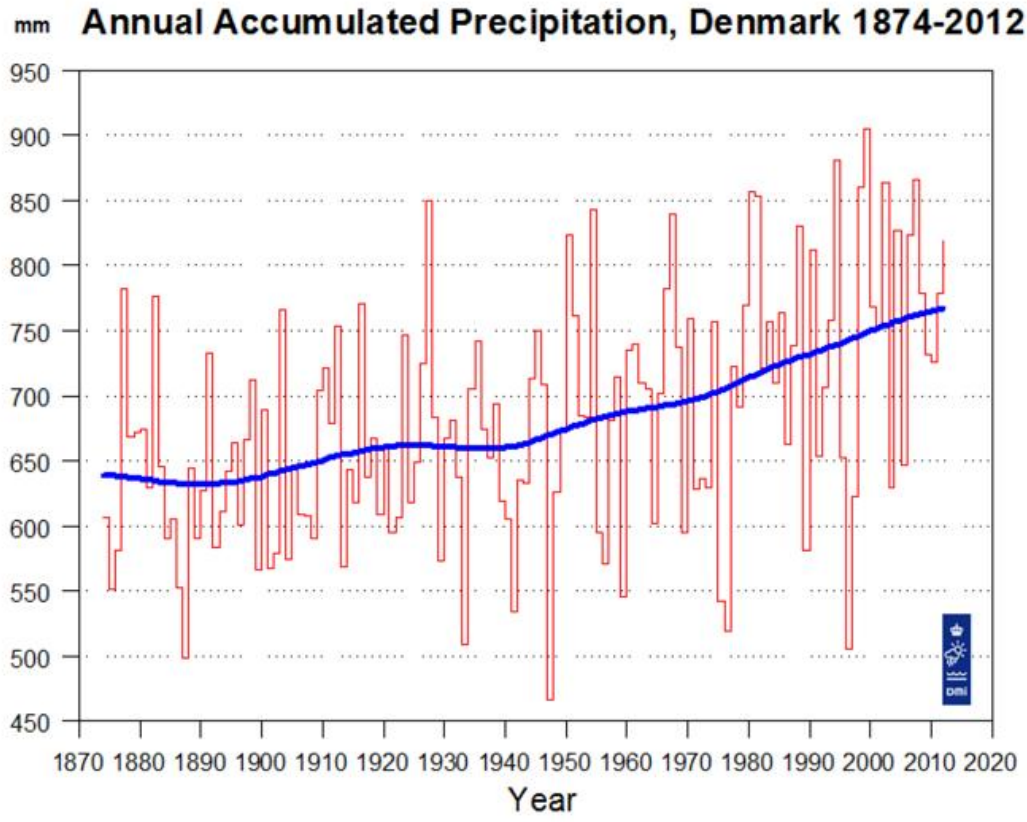


***Fig. 2.39** : Time series of annual precipitation totals Denmark*
(Diagrams as provided by the NHMSs)

Nordic and Baltic Countries:

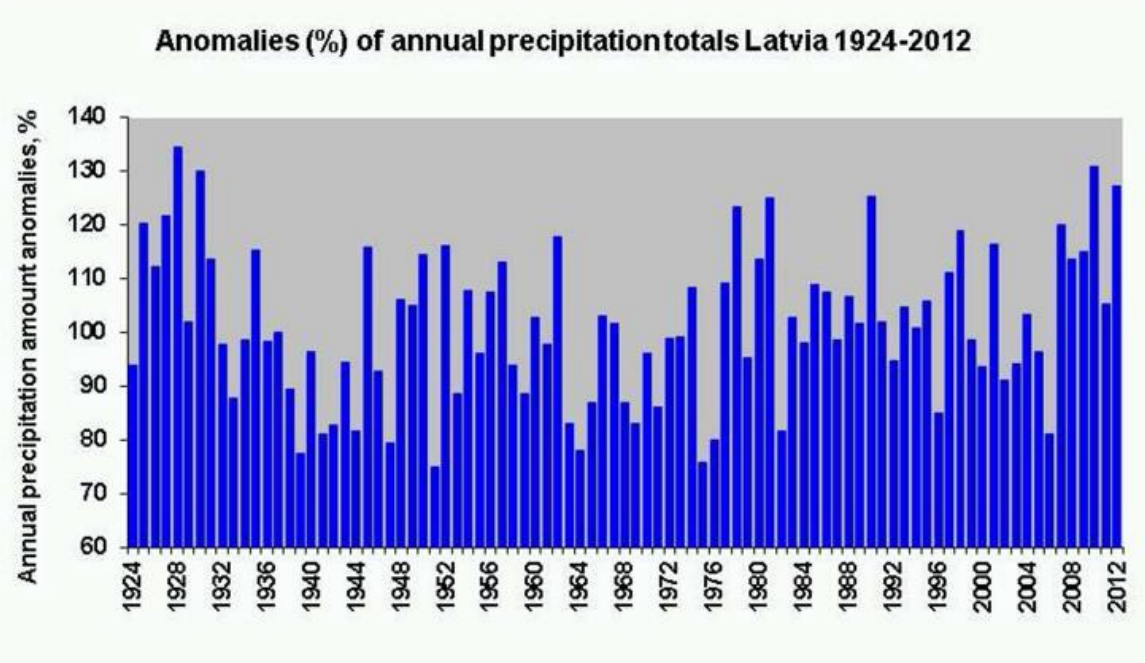


***Fig. 2.40** : Time series of annual precipitation totals Latvia*
(Diagrams as provided by the NHMSs)

Nordic and Baltic Countries:

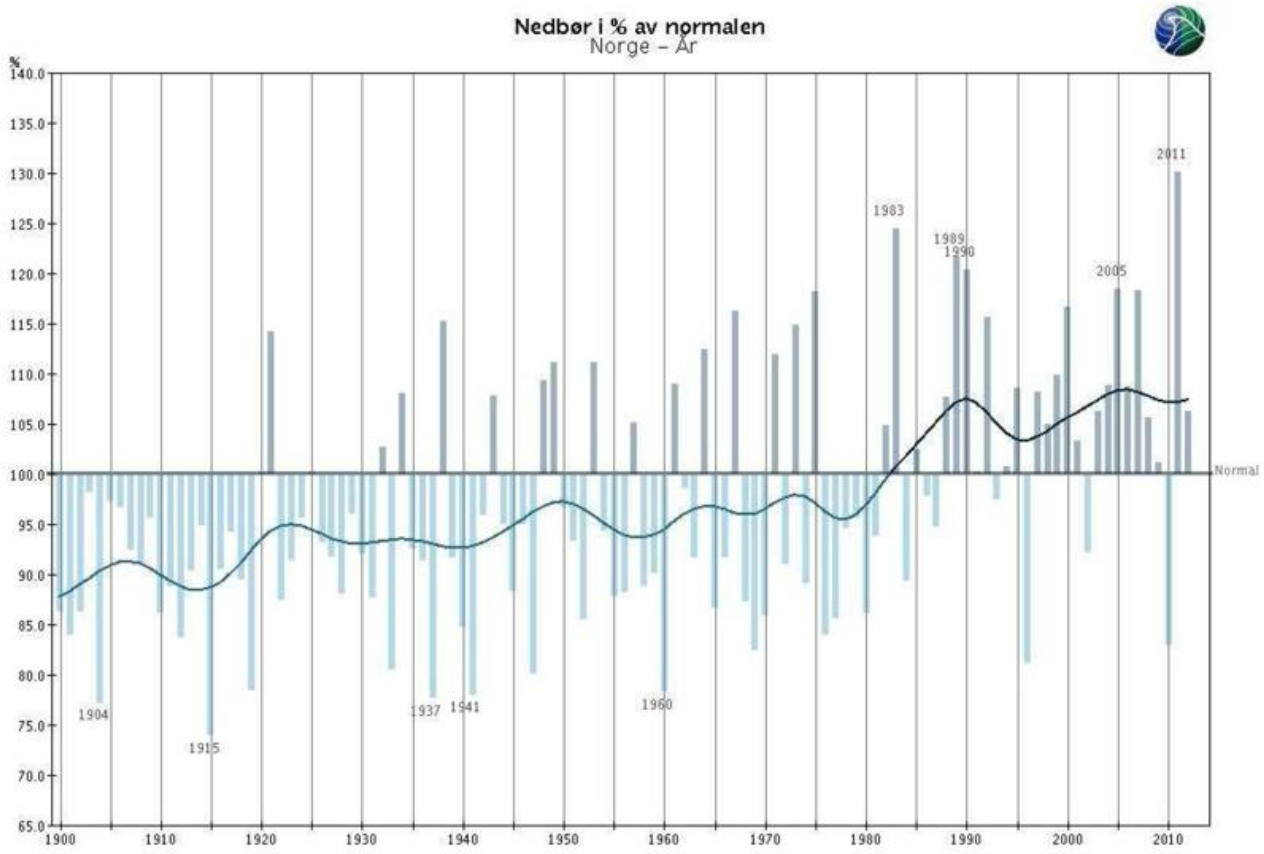


***Fig. 2.41** : Time series of annual precipitation totals Norway*
(Diagrams as provided by the NHMSs)

Iberia:

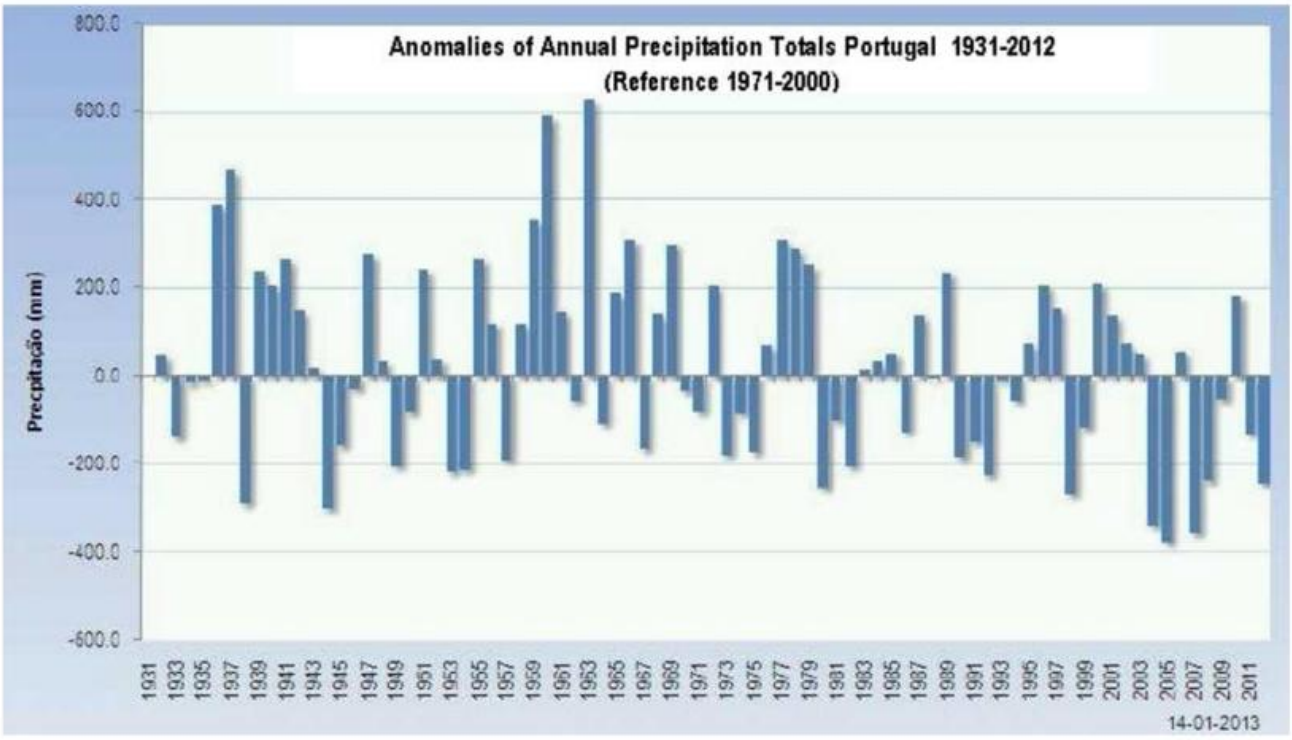


***Fig. 2.42** : Time series of annual precipitation totals or anomalies for Portugal (Diagrams as provided by the NHMSs)*

Mediterranean, Italian and Balkan Peninsula:

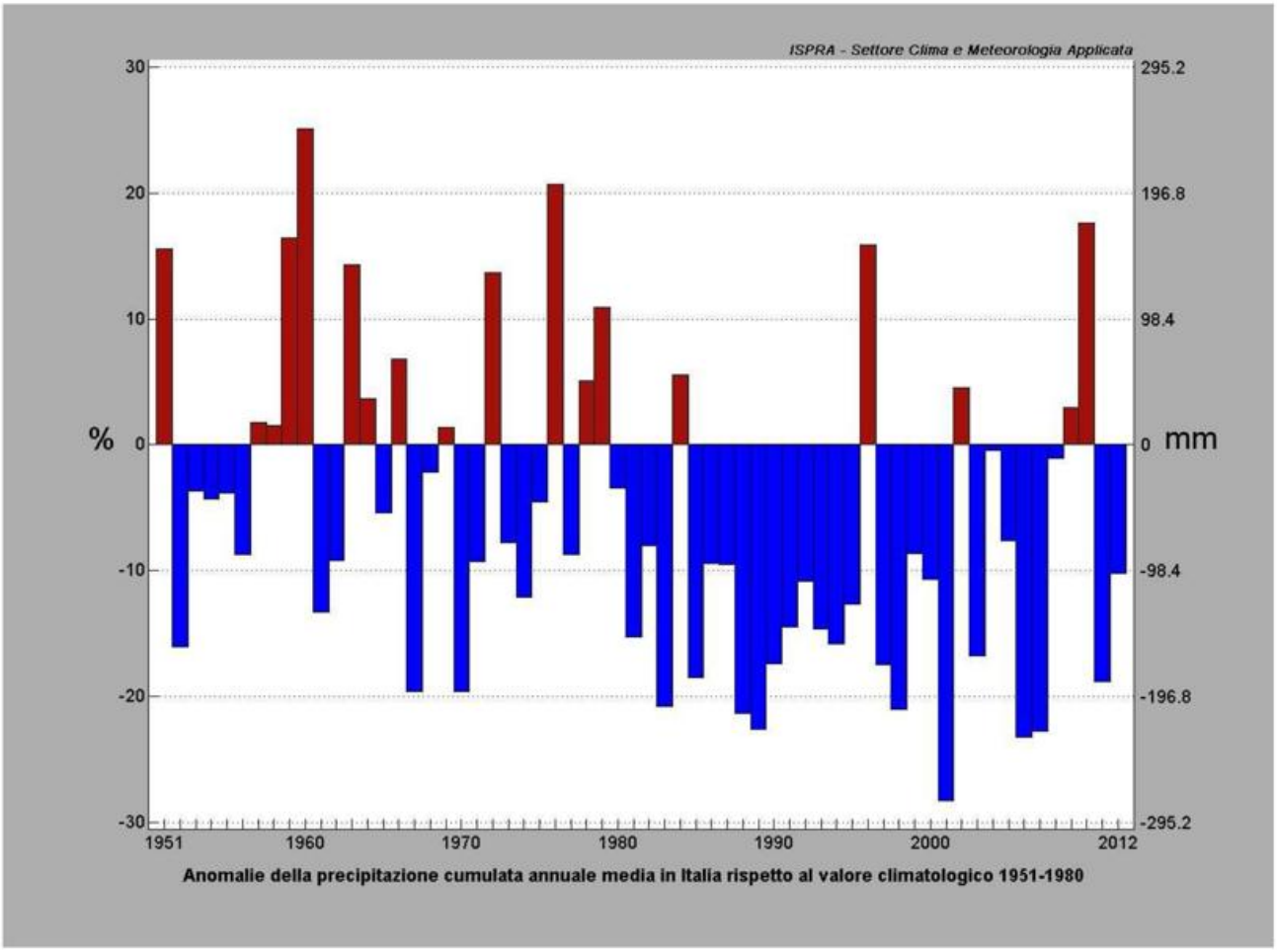


Fig. 2.43 *: Time series of annual precipitation totals or anomalies for Italy (Diagrams as provided by the NHMSs)*

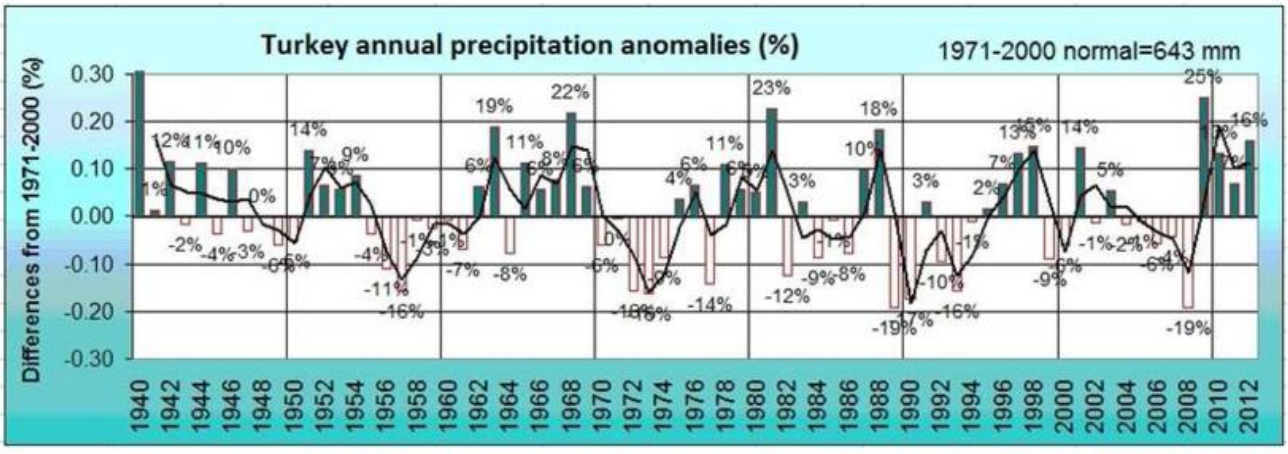


Fig. 2.44 *: Time series of annual precipitation totals or anomalies for Turkey (Diagrams as provided by the NHMSs)*

Mediterranean, Italian and Balkan Peninsula:

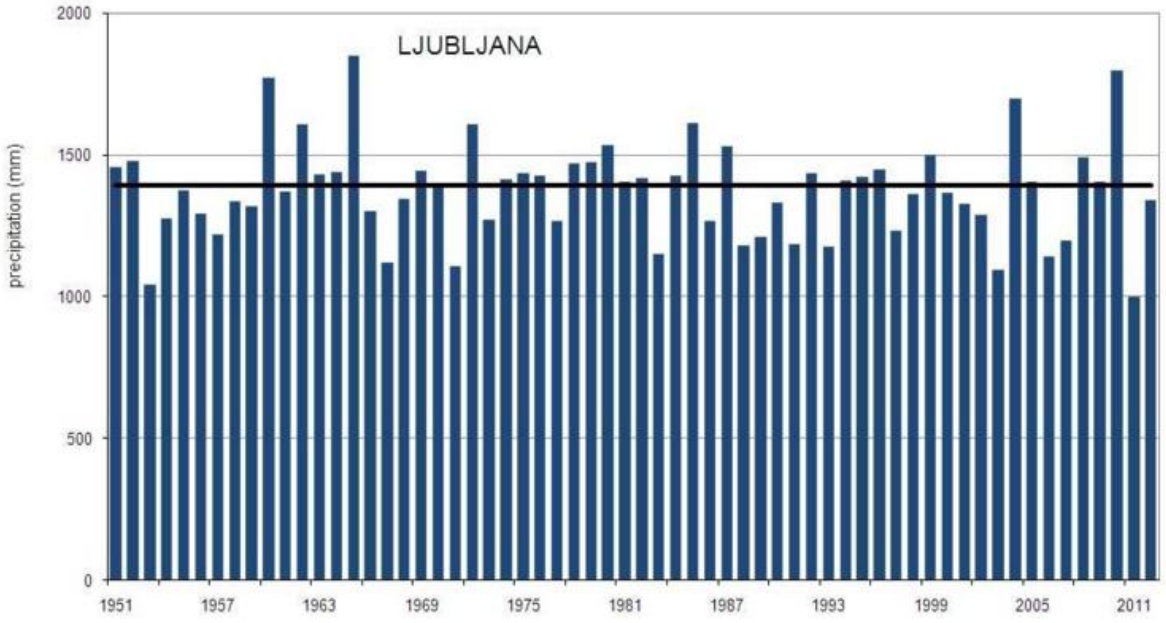


***Fig. 2.45** : Time series of annual precipitation totals for Ljubljana, Slovenia (Diagrams as provided by the NHMSs)*

Eastern Europe:

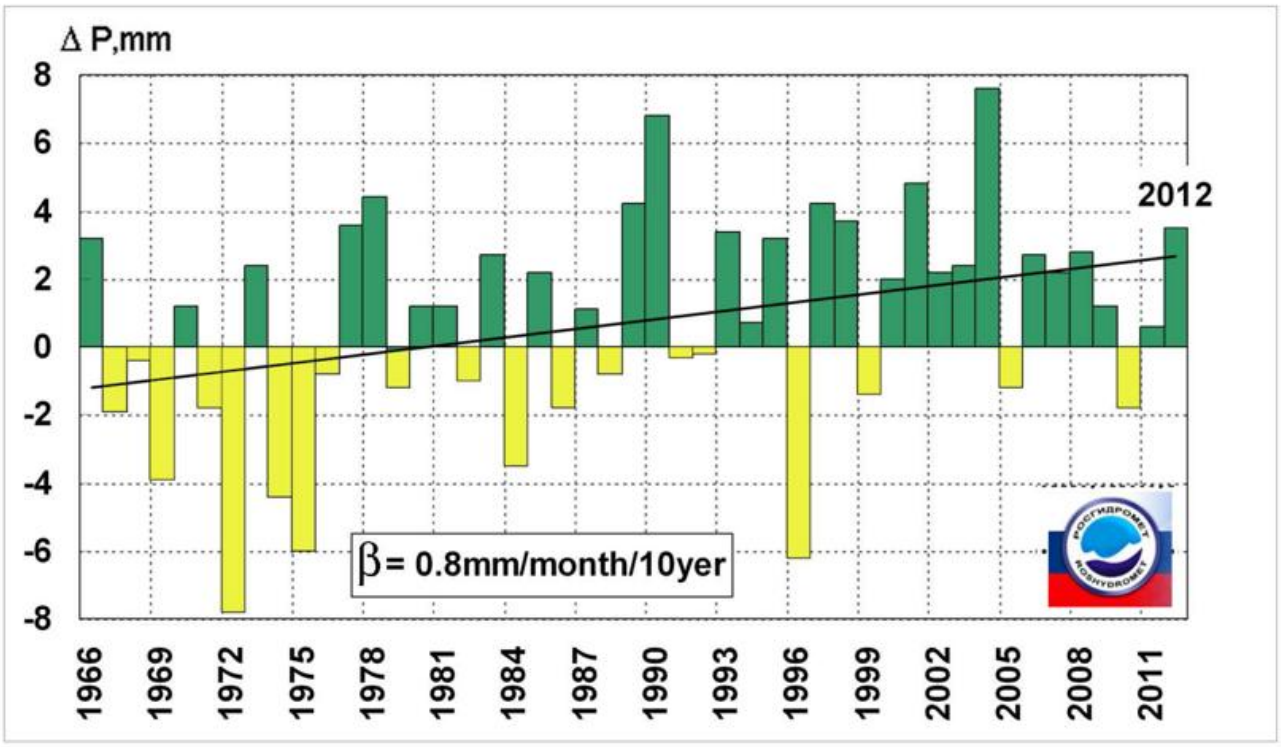


***Fig. 2.46** : Time series of annual precipitation totals European Russia (Diagrams as provided by the NHMSs)*

Middle East:

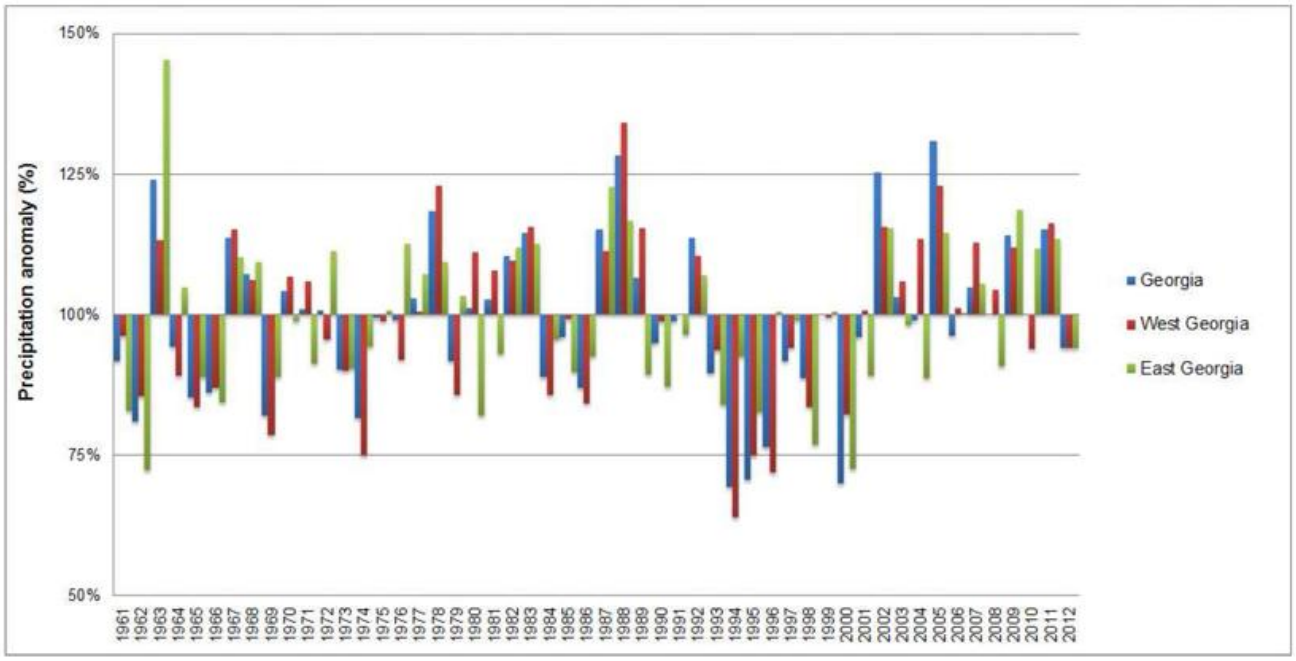


***Fig. 2.47** : Time series of precipitation totals or anomalies Georgia*
(Diagrams as provided by the NHMSs)

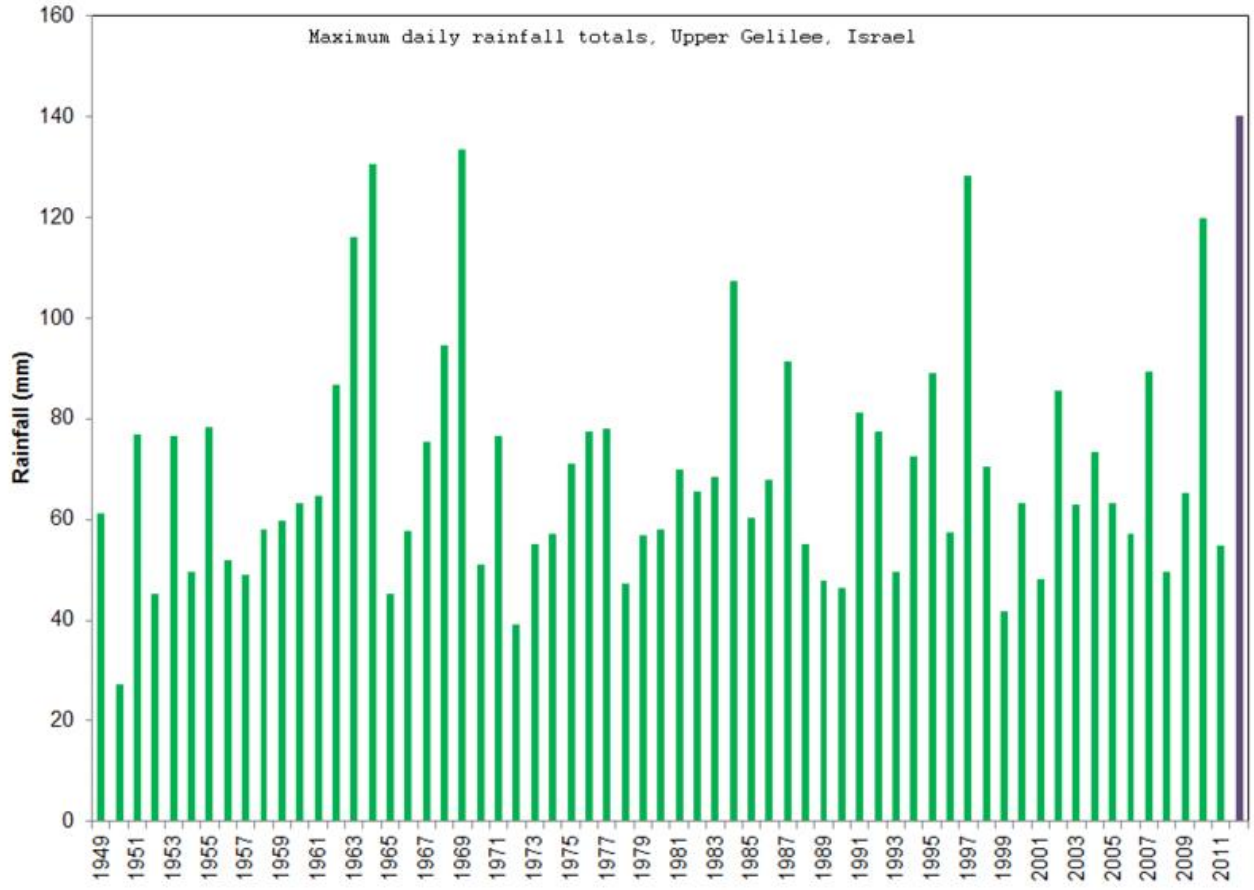


***Fig. 2.48** : Time series of maximum daily precipitation totals for Upper Galilee, Israel*
(Diagrams as provided by the NHMSs)

Sunshine

Note:*The sunshine duration time series (Fig 2.49 to 2.53) are generally shorter than those for temperature or precipitation. Germany, Denmark and Slovakia provide annual totals of the sunshine duration while Russia provided anomalies from the normal period 1961-1990.*

All graphs show a rising trend of the sunshine duration at least since 1980, partly longer. Denmark has the longest time series starting 1920 which shows the strong possible variability. The sunniest year was 1947, with 1.878 hours, and the least sunny was 1987, with 1.287 hours. Since 1980, the trend has been towards more hours of sunshine and on the other hand less cloud cover. Considering time series of sunshine duration changes in observing techniques may cause some problems in comparing older and newer observations as is stated by Denmark with the following remark: "DMI has since 2002 observed the hours of bright sunshine using measurements of global radiation instead of measurements from a traditional Campbell-Stokes sunshine recorder. For that reason "new" and "old" hours of bright sunshine cannot directly be compared. It should also be noted that all values before 2002 are adjusted as best as possible ensuring comparability to the new level. For details on that, see DMI Technical 02-25: Ellen Vaarby Laursen, Stig Rosenørn: New hours of bright sunshine normals for Denmark, 1961-1990.
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2002/tr02-25.pdf"

Central and Western Europe:

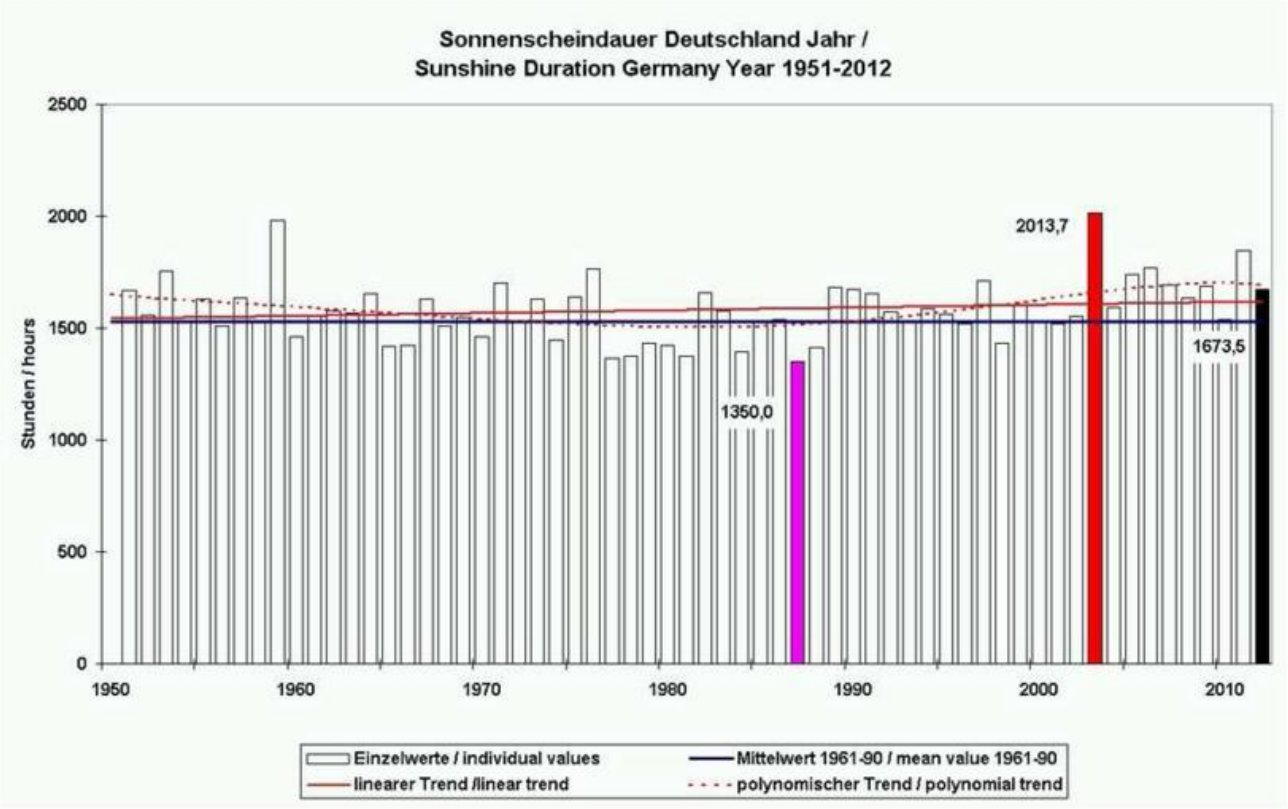


***Fig. 2.49** : Time series of annual sunshine duration totals Germany*
(Diagrams as provided by the NHMSs)

Central and Western Europe:

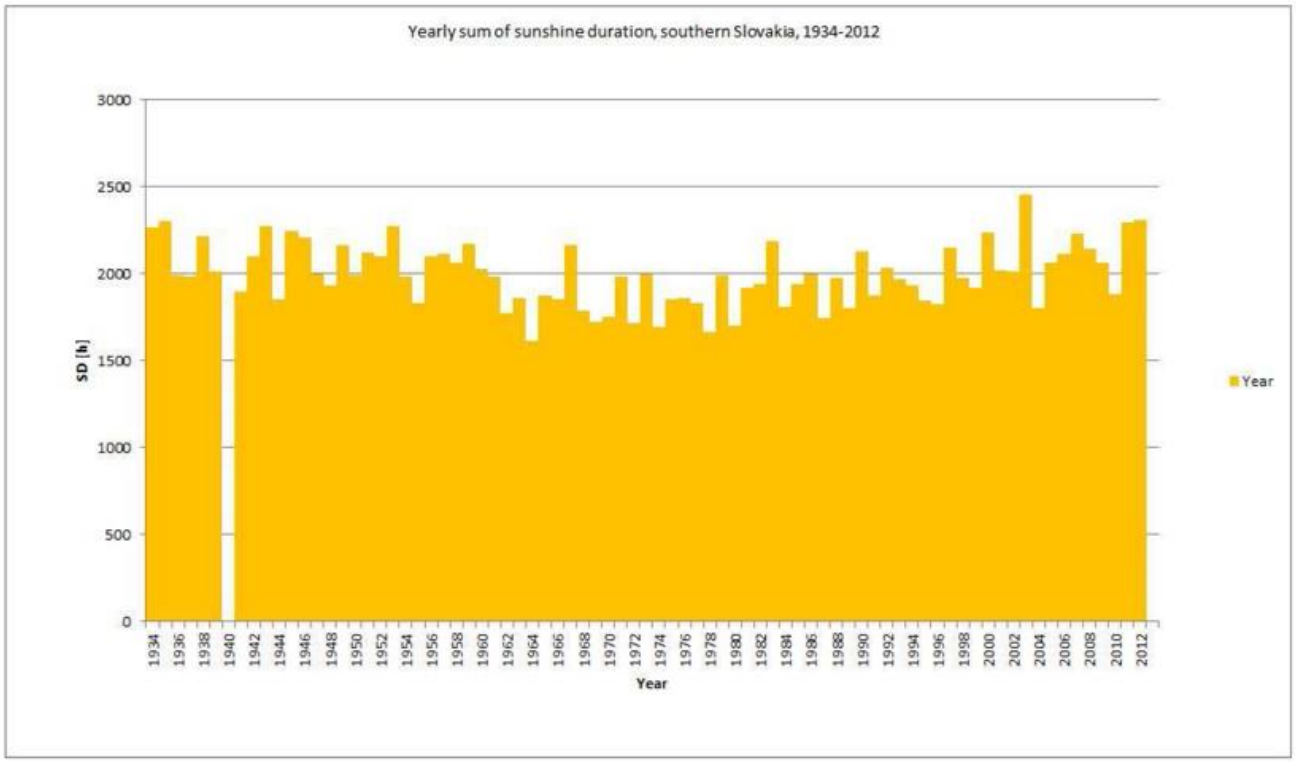


***Fig. 2.50** : Time series of annual sunshine duration or anomalies for southern Slovakia (Diagrams as provided by the NHMSs)*

Nordic and Baltic Countries:

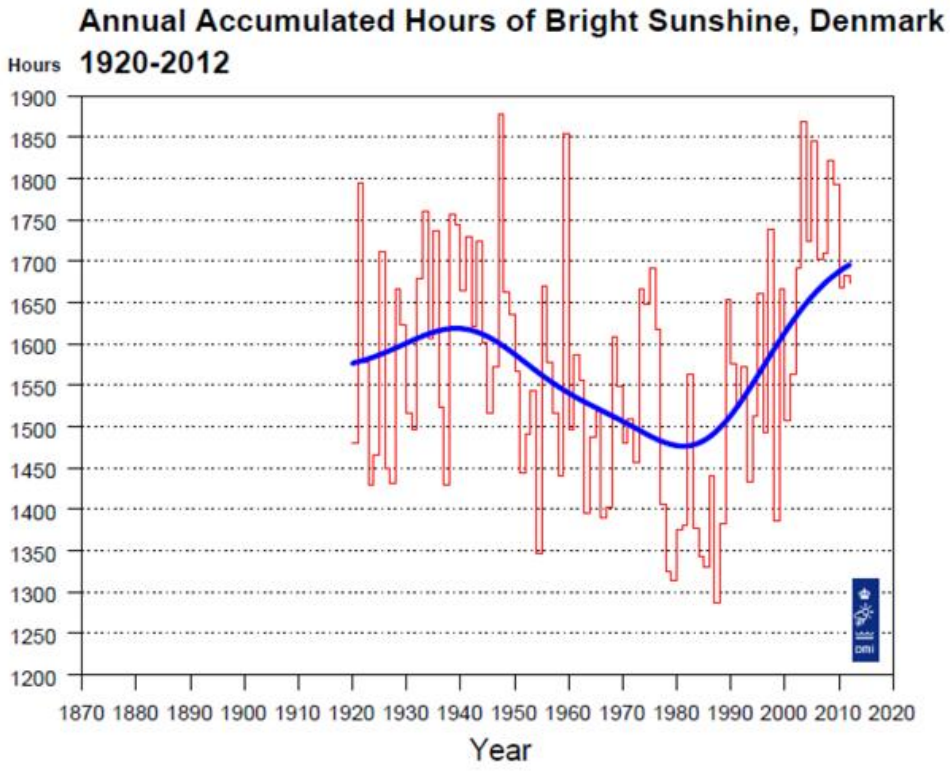


***Fig. 2.51** : Time series of annual sunshine duration Denmark*
(Diagrams as provided by the NHMSs)

Mediterranean, Italian and Balkan Peninsula:

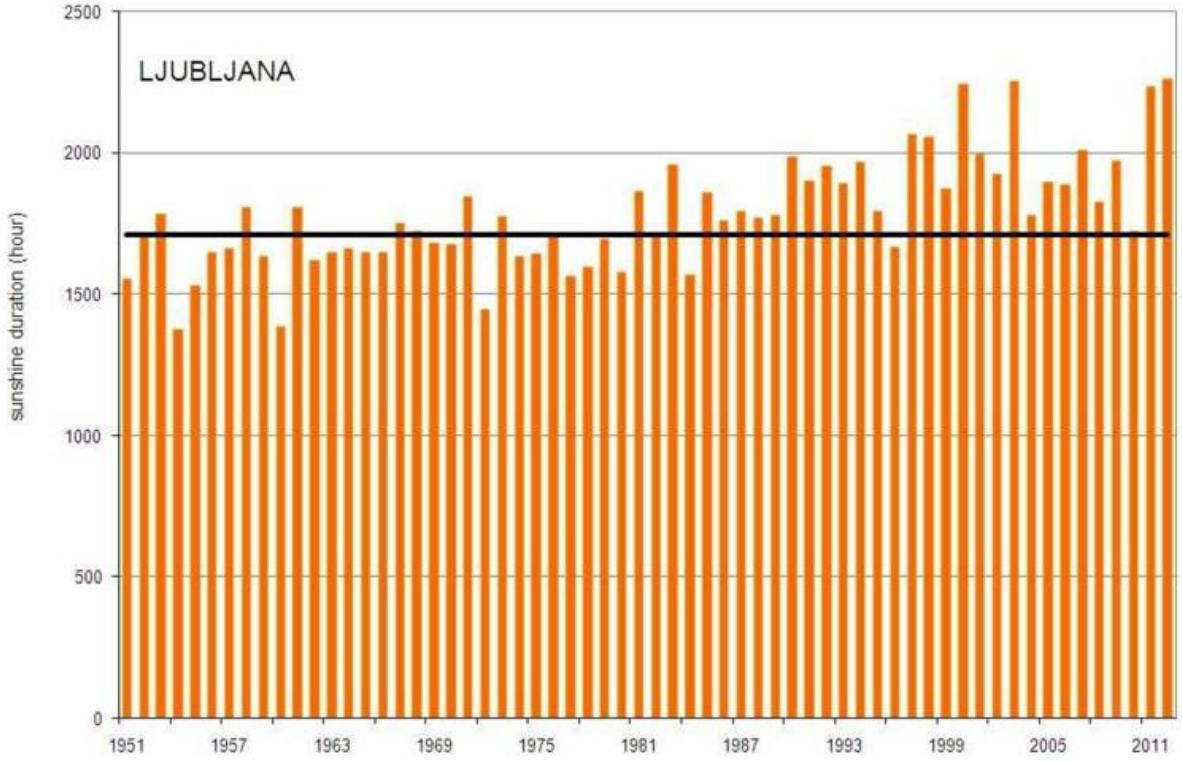


***Fig. 2.52** : Time series of annual sunshine duration for Ljubljana, Slovenia*
(Diagrams as provided by the NHMSs)

Eastern Europe:

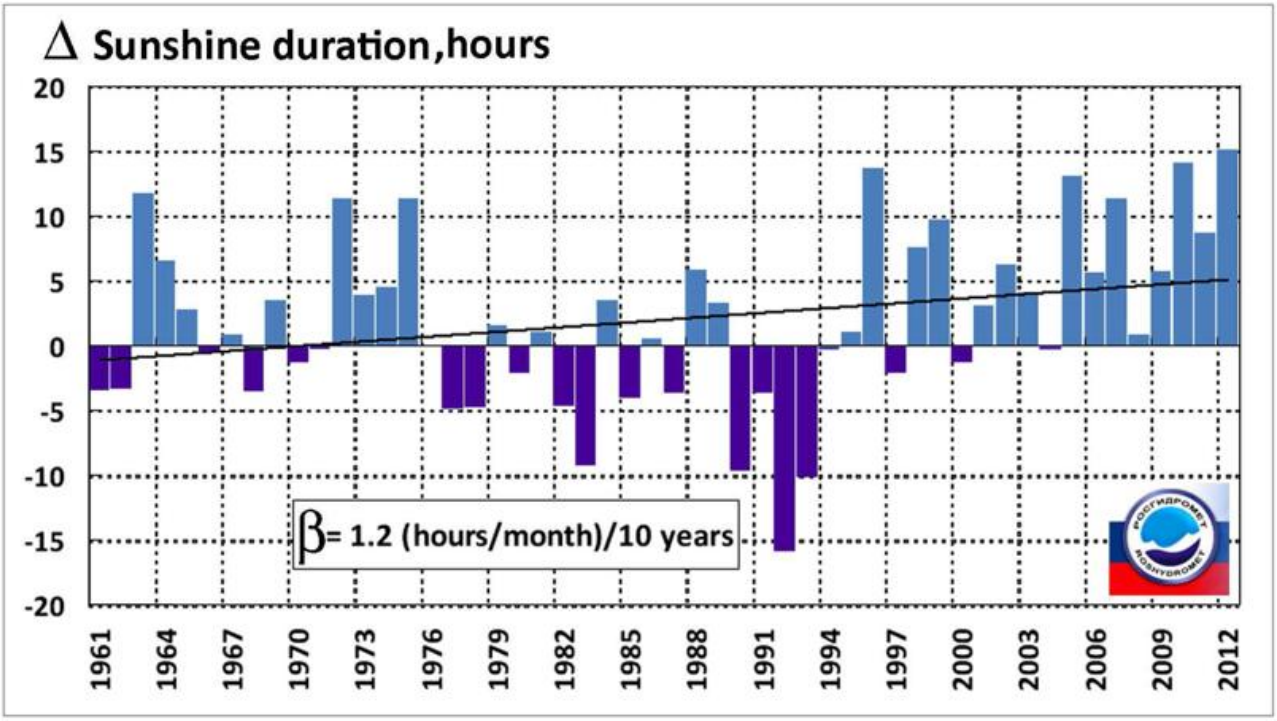


***Fig. 2.53** : Time series of annual sunshine duration totals European Russia (Diagrams as provided by the NHMSs)*

Trends of temperature and precipitation

Figure 2.54 shows the spatial distribution of trends for the mean annual temperature and the annual precipitation total as well as the cold spell duration index and very wet days for the time series 1951 - 2012 for stations in Europe contributing to the ECA&D data set. Less stations than in 2011 are presented but the result ist not different. A warming trend for most of Europe can clearly be seen for the mean annual temperature. Corresponding to this warming trend the trend of the cold spell duration index (CSDI) is negative for many stations on the continent.

For the annual totals of precipitation we can state roughly a different behavior between the south (often unsignificant but partly cearly negative) and the north (more positive values) and the regions especially influenced by the North Atlantic seem to show clearer positive trends. This feature may eventually be explained by the influence of a warming North Atlantic. The distribution of trends for extremely wet days shows a generally similar pattern with differences at single stations.

Trends of Climate Indices for Temperature and Precipitation (ECA&D)

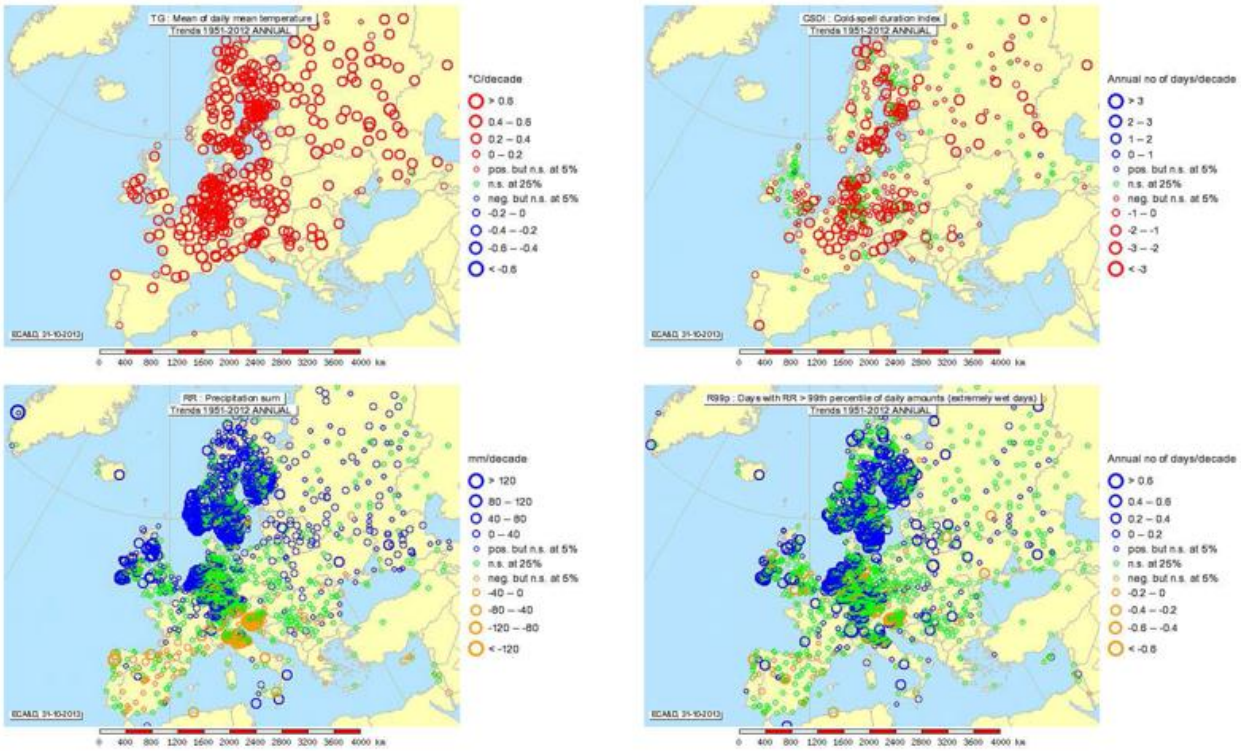


Fig. 2.54: *Trends of Selected Climate Indices 1951 to 2012 (Source: ECA&D, http://www.ecad.eu):*
Upper left: TG (Mean of daily temperature),
Upper right: CSDI (Cold spell duration index),
Lower left: RR (Precipitation sum),
Lower right: RR99p (Days with RR>99th percentile of daily amounts (extremely wet days)

Long-term temporal development of related phenomena

Fig. 2.55 and 2.57 illustrate phenomena that are closely related to the temporal development of the air temperature.

In Fig 2.55 a ranking of the North Sea surface temperature since 1969 is shown. Note that the 'year' in this case refers to December to November. Presented are the ranks of the years 1969 to 2012. From 1988 until now most (all except 5 years) values are warmer than the median while before 1988 most values were colder. 2012 was on the warm side and warmer than 2011..

In Fig 2.56 the anomalies (reference 1971-2000) of the mean sea level at the station Wladyslawowo in Poland is shown. A positive trend of 0.22 cm per year results from this time series. The rising mean sea level is a climate indicator for global warming. The sea level increase is caused by melted ice and warmer water. Sea level is observed in many countries with coastal stations. For instance Sweden has 23 stations for observation and the longest series is Stockholm with measurements since 1774. Though a graph is not available for 2012 consistent results are for instance presented on the Web (http://www.smhi.se/polopoly_fs/1.8963!Swedish_Sea_Level_Series_-_A_Climate_Indicator.pdf).

DMI has observed the surface air temperature (SAT) at Summit in the middle of the Greenland ice cap in 3.2 km altitude since 1991 (Fig 2.57). DMI's observations show that the temperatures typically range from -60 to -50°C in winter and from -10 to 0°C in summer. It is not unusual to observe positive temperatures on a few days during a year. It is a fact in 10 different years out the 18 years of observations. Observations from July 2012 (Fig. 3.29 in the monthly survey) showed that temperature for several days in a row exceeded 0°C, not seen before. In the days of 11 - 14 and 16th July the temperatures were above 0 °C. The observations confirm the NASA satellite observations of melting in these days.

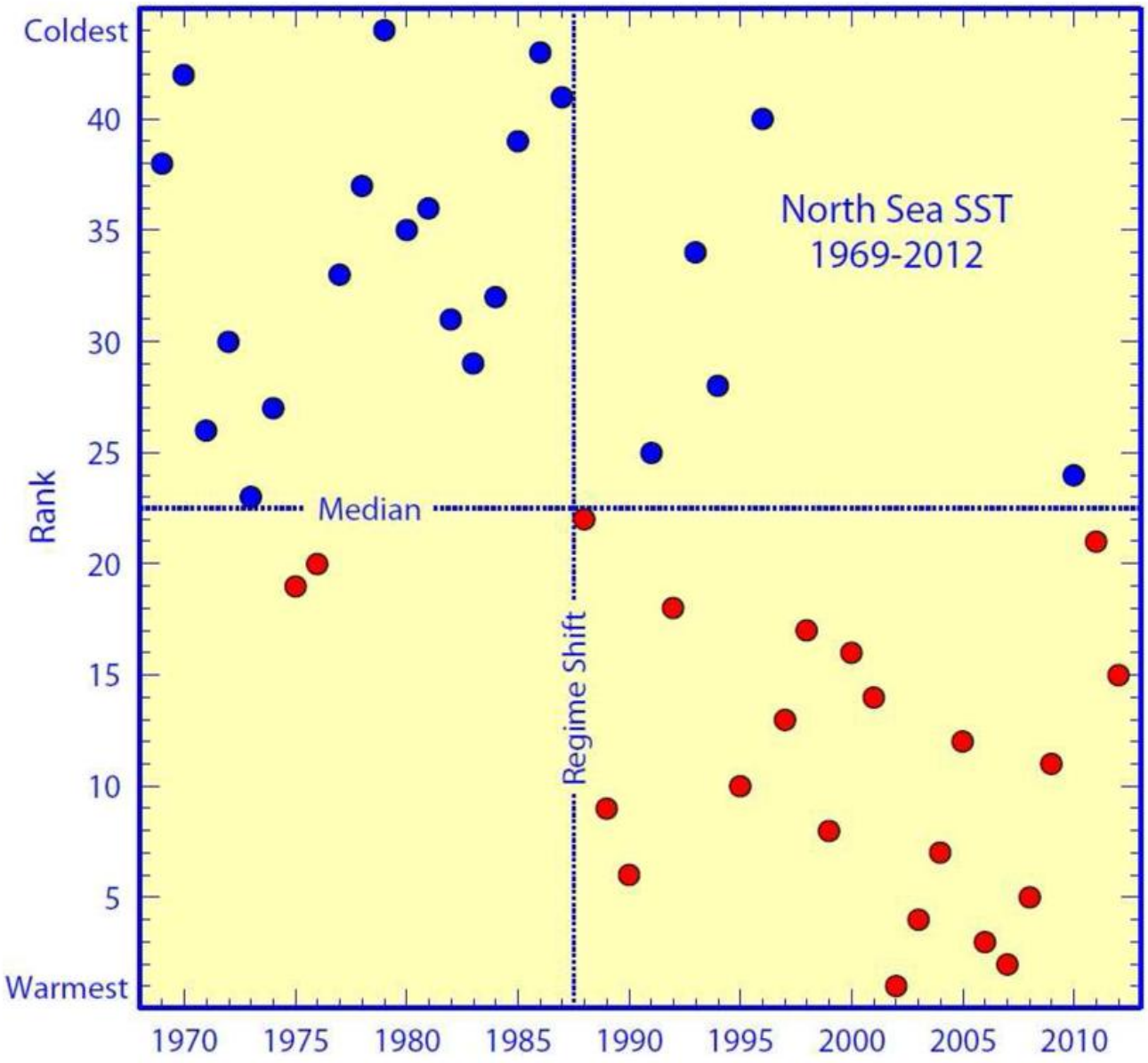


Fig. 2.55: *Rank statistics of the North Sea SST form 1969 to 2012*
(Source: Bundesamt für Seeschiffahrt und Hydrographie BSH)
(year2012 means December 2011 to November2012)

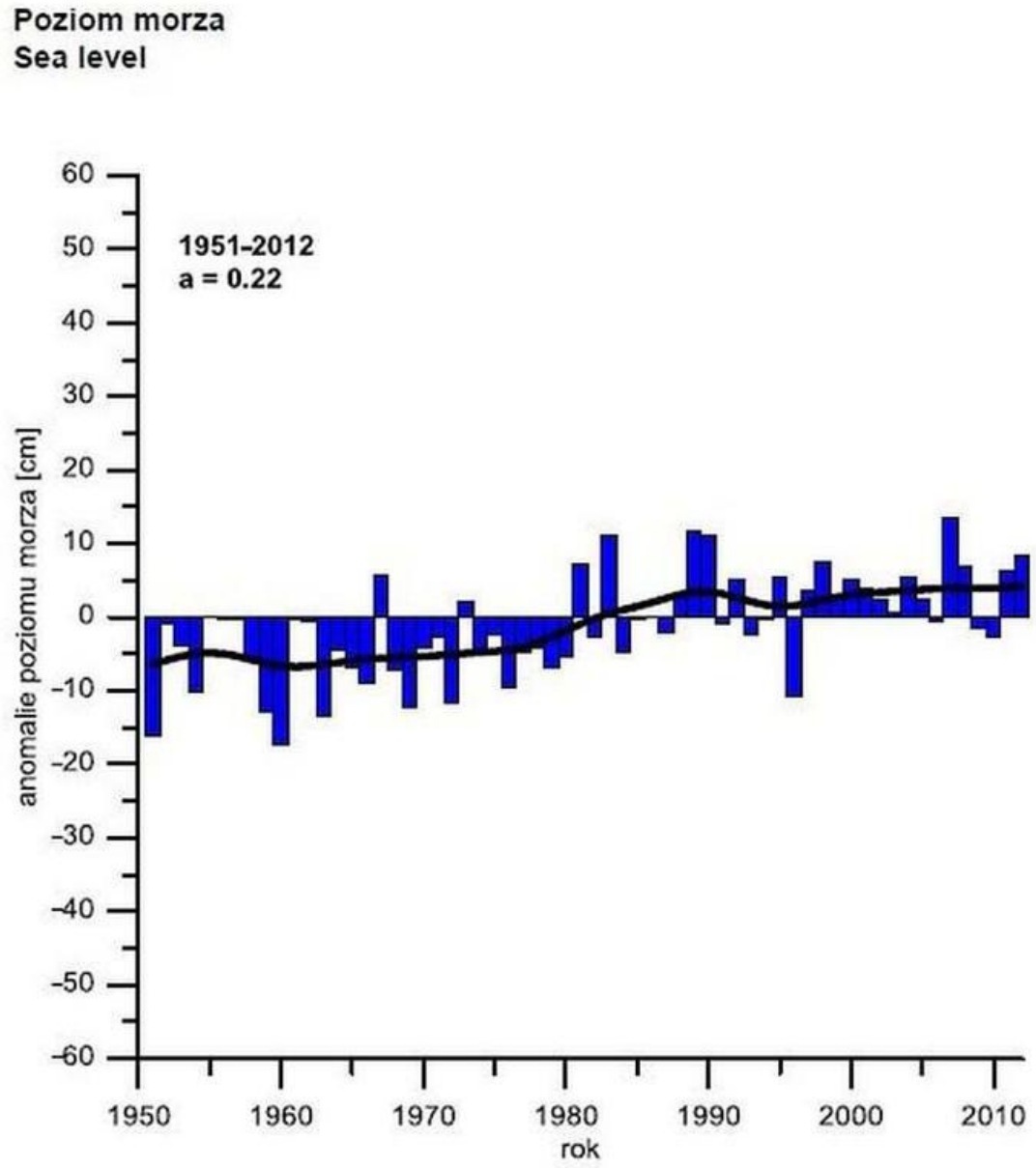


Fig. 2.56: *Mean annual sea level anomalies in Wladyslawowo (1951-2012) in relation to normal values 1971-2000 smoothed by 10-years Gaussian fileter (black line) and the value of linear trend (cm/year)*

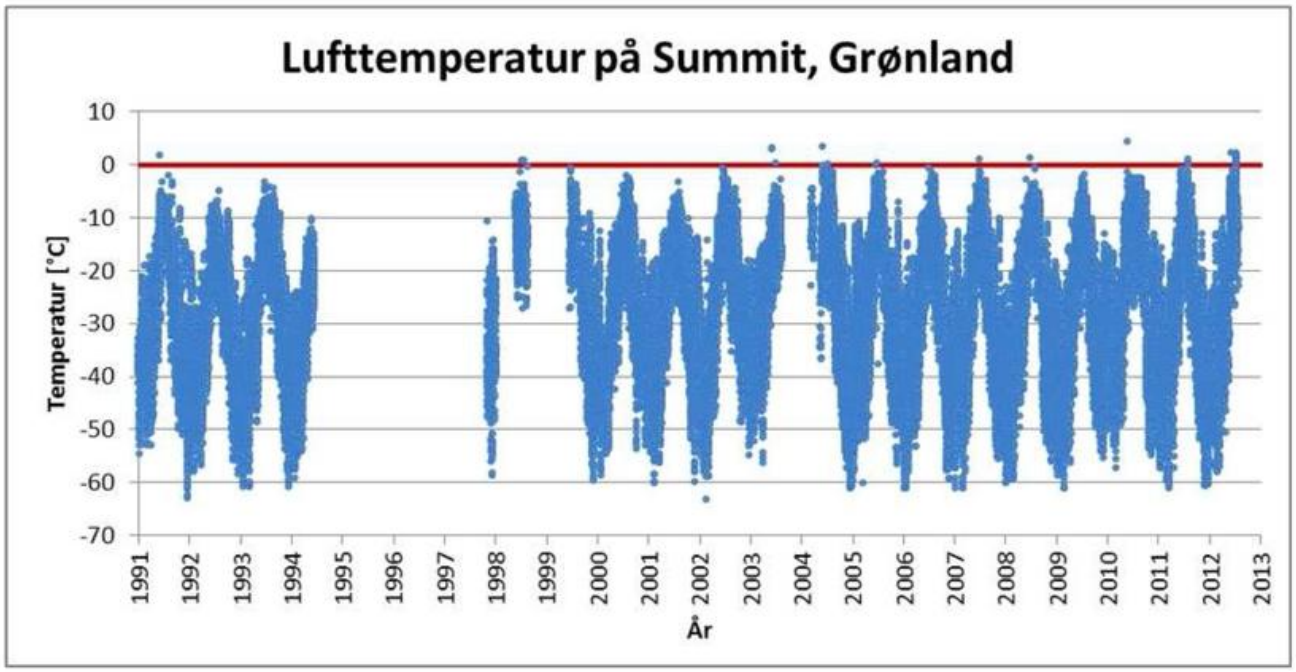


Fig. 2.57: *Surface air temperature (SAT) at Summit in the middle of the Greenland ice cap in 3.2 km altitude since 1991, by DMI (see also Fig 3.29).*

Socio-economical Impacts of Extreme Climate or Weather Events:

Countries have reported socioeconomic impacts of climate extremes or weather events. This was done partly in a given structure (WMO guiding table for country submission of information on extreme climate events) or the information is part of the regular monthly reports on the internet or it was seperately reported. Still this information is heterogeneous and does by far not give a complete overview. Not only do the administrative structures differ so that the information cannot easily be gathered but also many kinds of impact is difficult to be estimated. In the following only a short extract will be given.

Figure 2.58 shows the percentages of casualties (fatalities or injured persons) due to 6 kinds of events. Numbers of casualties were the only numbers that can be presented in form of a diagram. Conclusions should be drawn only with caution. The total number of cases for the figure was 511 which will be certainly underestimated. Moreover the reported numbers were in some cases not fix but like 'hundreds' or 'few'. In this case '100' resp. 'zzz' was taken to produce the graph. The economic damage was estimated as well by some countries but the information is not sufficient to be presented with any reliability of representativeness. The figures of economic damages will be summarized individually below.

The largest portion in Figure 2.58 is 'Flood'. This includes floods by all kinds of causes as precipitation of longer duration, influence of snow melt or extreme precipitation with high intensity. The report of Russia contributed the largest number here. The next large portion is 'Cold'. Reports came from Bosnia and Herzegovina, Poland, Czech Republic, Germany, Austria and Romania. This was mainly the intense and spatially extended cold spell in January/February and had probably in 2012 a much greater portion than in other years but the reports do certainly not cover all victims. 'Heat' on the other hand is surely underestimated in the graph because only one country reported a vague number. 'Lightning' was relatively often reported by several countries (Germany, Georgia, Turkey). 'Storm' includes storm depressions of synoptic scale as well as tornadoes. Two severe tornadoes (Portugal and Poland) make most of this number in 2012. 'Snow' includes snowload and snowdrift. The report came from Bulgaria.

Much economic damage is usually connected with floods, storm, cold spells (all kinds of frost, snow or ice), hail, drought or extreme heat. There are some figures which are summarized in the following but much of this kind of damage cannot be estimated.

- Thunderstorms with hail or lightnings caused nearly 100 Mio Euro damage in Georgia and Austria, most of it in Georgia (90 Mio).
- Flooding caused about 12 Mio Euro together in Finland (6 Mio), Austria and Bulgaria
- Economic damage by drought was estimated by Hungary to 1.8 Mio Euro.
- Economic damage due to forest fires was reported by Bosnia-Herzegovina with 65 Mio Euro.
- Economic damage due to snow was estimated by Austria to 32 Mio Euro.
- Economic damage due to local storm was estimated by Cyprus with 40 000 Euro.

The economic damage especially of drought cannot be given in reliable figures. The only figure stems from Hungary. But many other countries reported of unfigured damage on the agricultural sector. Beside the agricultural sector drought as well caused water shortages for households, hampered shipping on rivers or affected live in rivers or lakes due to lack of oxygen. Also in the case of forest fires there are other kinds of descriptions of the impact that cannot easily be transformed into Euro: Bulgaria reported a burned area of 63 Mio km² and Greece reported a burned area of 18 Mio km².

No figures are available for instance for the economic impact caused by snow and ice upon the sector of traffic (on railway, roads or in the air).

Turkey is the only country that gives graphs of percentages of the occurrence of types of extreme climate or weather events in 2012 (Fig. 2.60) as well as a time series of the development of weather related damages starting in 1940 (Fig. 2.59). 'Weather related damages' is here given in number of cases not in a monetary value.

RCC-CM has developed a 'Knowledge database on euROpeaN climatE extRemes' (KRONER) which integrates information from several already existing and well-known databases and completes them. Figure 2.61 shows the relation of the four kinds of reported events 'Cold', 'Flood', 'Heat' and 'Drought' in 2012 as extracted from this database. 60 country-specific events (mainly taken from EM-DAT) build the collective. Cold spells (37 countries) have the greatest relative part in 2012 followed by floods (14 countries), heat (6 countries) and drought (3 countries).

KRONER gives also numbers for fatalities for 'Cold' (855) and 'Flood' (33). This makes the uncertainty of figures for socioeconomic impacts obvious: the figures based upon the reports of NMHSs were 144 resp. 198.

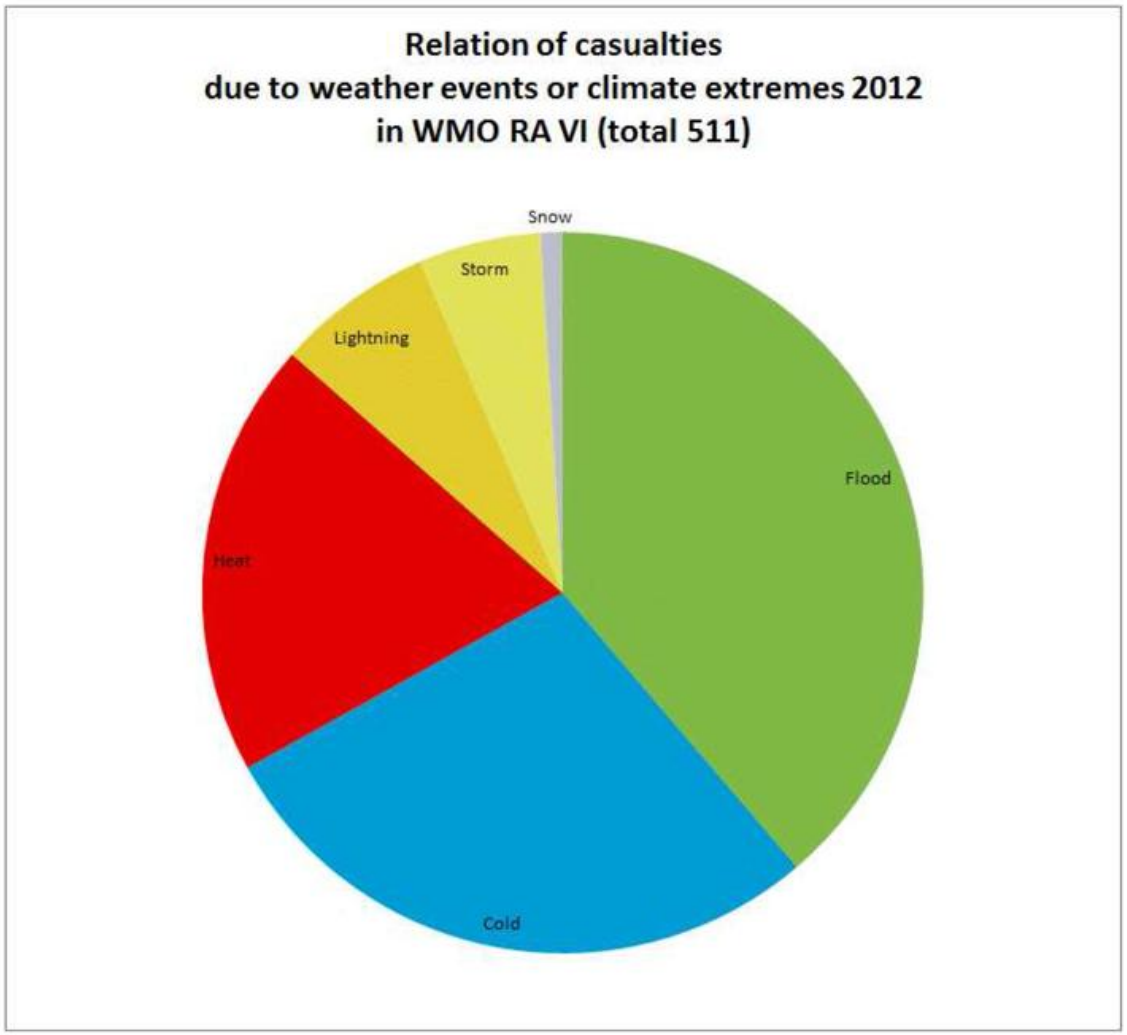


Fig. 2.58: *Relation of casualties due to extreme events based on NMHSs reports 2012*

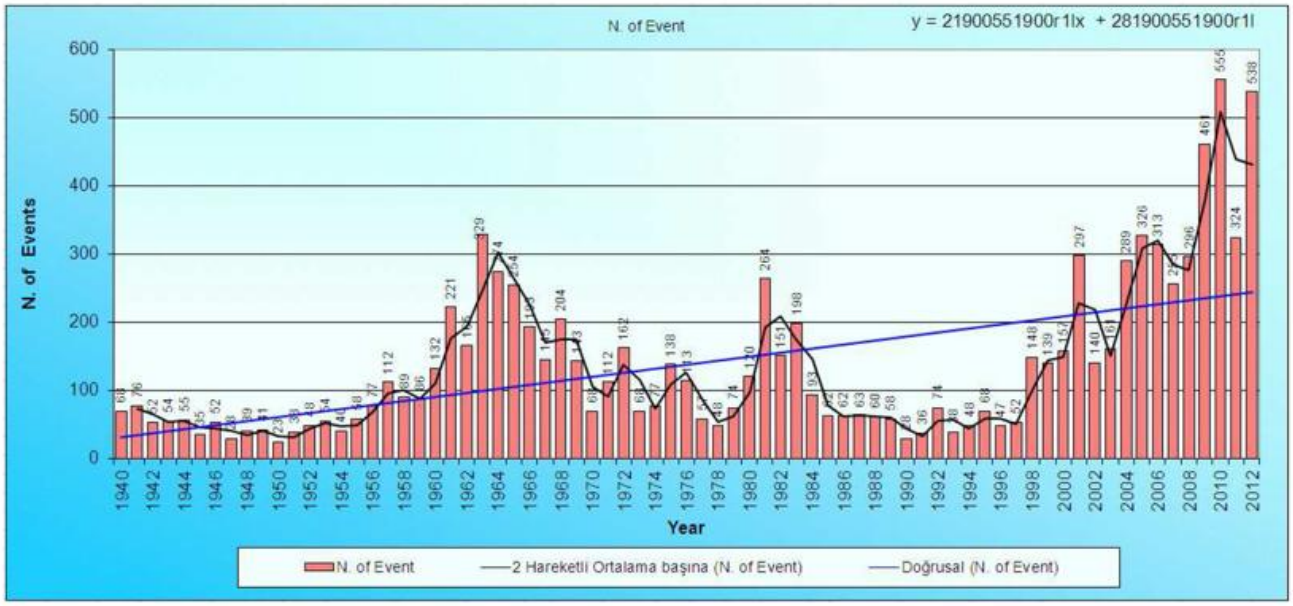


Fig. 2.59: *Temporal Development of the occurrence of weather-related damages in Turkey 2012*
(Source: Turkey http://www.dmi.gov.tr)

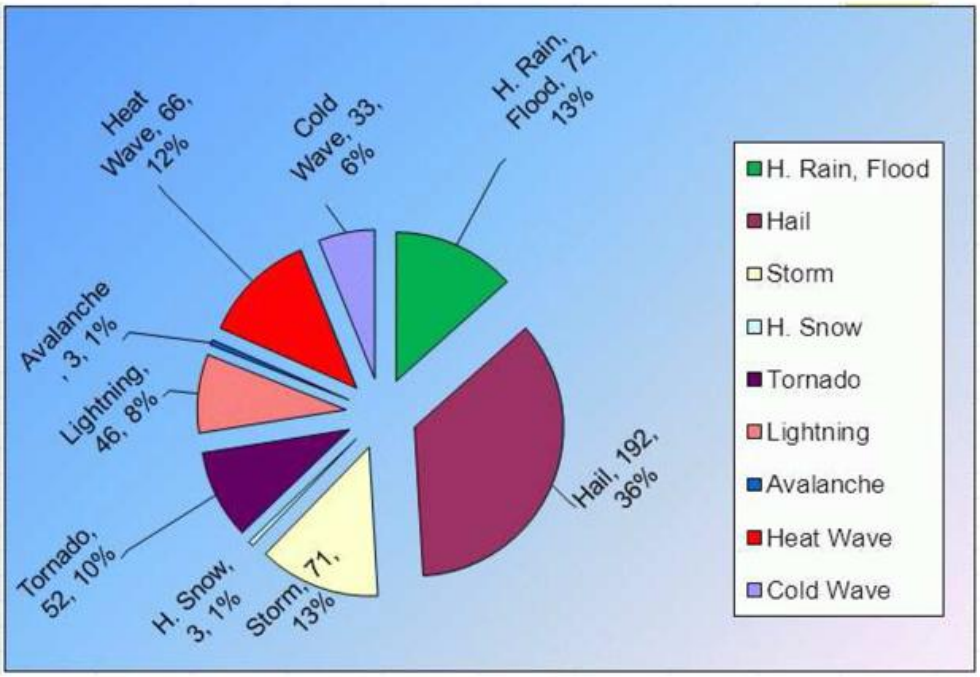


Fig. 2.60: *Percentages of the occurrence of extreme climate or weather events 2012*
(Source: Turkish State Meteorological Service)

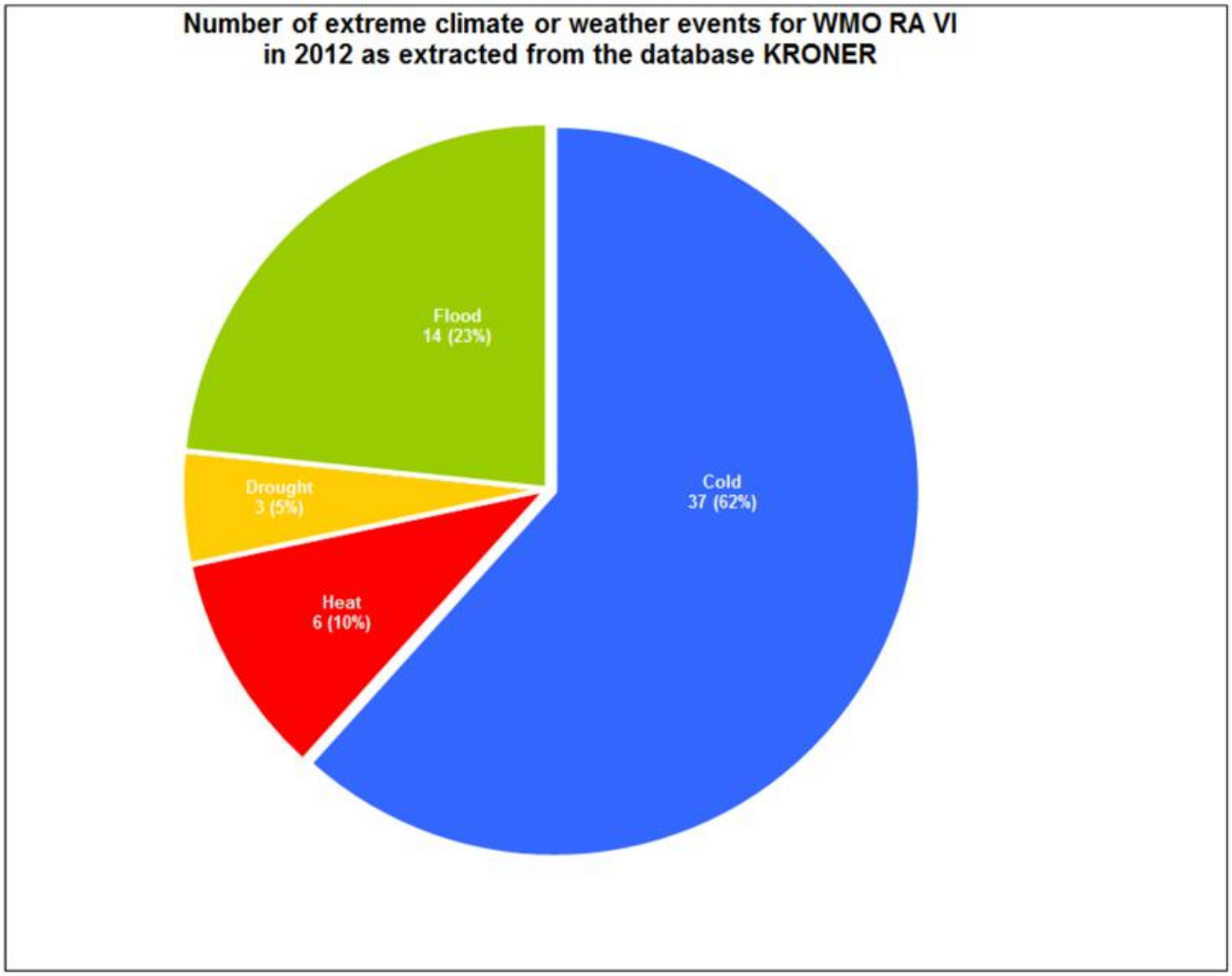


Fig. 2.61: *Percentages of selected climate-related extreme Events in WMO RA VI 2012 (Source: RCC-CM)*

Seasonal Survey

Winter

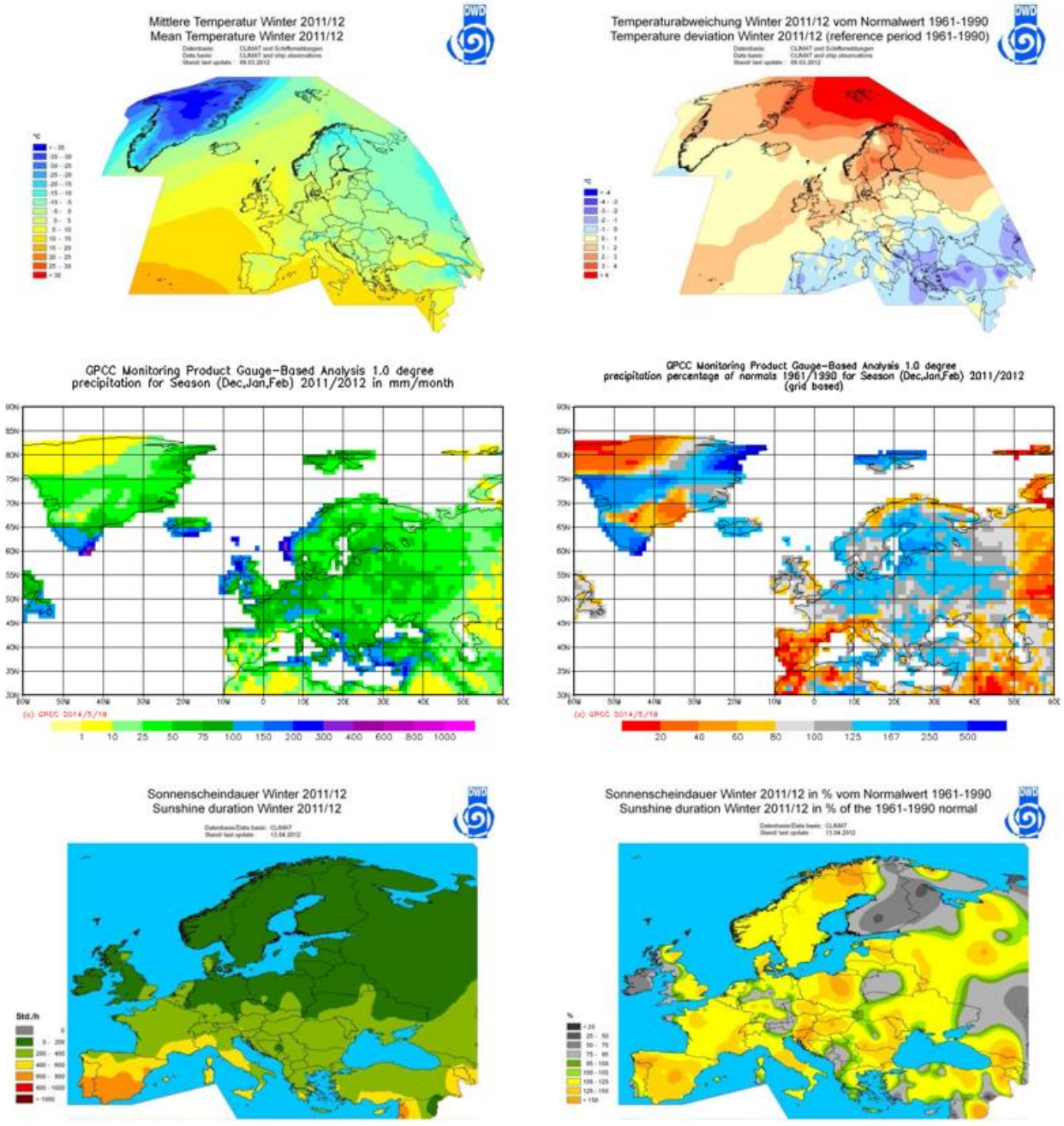


Fig. 2.62: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in winter 2012*
Source: http://www.dwd.de/rcc-cm

Temperature:

Winter was warmer than normal as a mean over Europe according to the analysis from E-OBS data but only on rank 32 in the time series from 1951 to 2012 for the mean daily mean of the temperature. With respect to the daily maximum and minimum temperature winter 2011/2012 was on rank 36 resp. 26. The spatial mean of the daily mean temperature was 0.7°C +/- 0.54. With respect to the defined subregions 'Central and western Europe' had the greatest negative anomaly with -0.9 K followed by 'Nordic and Baltic countries' with -0.8 K. The subregion 'Middle East' had the highest positive anomaly of +0.5 K and the 'Mediterranean, Italian and Balkan Peninsula had a mean positive anomaly of +0.3 K. The anomaly fields for the temperature changed completely during winter 2012. In December 2011 there were positive anomalies over Russia, continental Europe, Scandinavia and the Arctic. In January 2012 there were mostly everywhere positive anomalies, especially in the Arctic, except in the Mediterranean Sea area. And in February there was an extent area of negative anomalies covering Russia, continental Europe and the Mediterranean. Again it was very warm in the Arctic and warm over the North Atlantic. The winter mean shows negative anomalies in southern Europe and the Middle East and warm anomalies northward with values of >= 4 K in the Arctic region. From the last decade of January 2012 to mid of February lasted a severe and extended cold spell which cost about 600 people their lives. The anomaly of the cold spell index for the complete winter shows impressively the surplus of cold spell days. But during the 2nd half of February it became very warm so that winter 2012 is characterized by a great temperature range. In UK for instance between 11 February (-15.6 °C) and 23 February (+17.7 °C) the rather unusul difference of 33.3 K was recorded at Lincolnshire. Austria reported an even larger range of -23.5 °C for the minimum temperaturea on 8 February to +20.9 °C for the maximum temperature on 24 February (a difference of 44.4 K) at the station Güssing. In some parts of eastern Spain it was the most important cold wave since February 1956.

Precipitation:

The winter season had drought conditions especially on the Iberian Peninsula, southern England and the western Mediterranean Sea region. For instance Portugal had precipitation totals for the period October 2011 to February 2012 mostly below 75 percent of the 1971-2000 reference (Boletim climatologico mensal - fevereiro 2012), February 2012 was the driest February since 1931 and winter 2011/2012 was the driest since 1931 in Portugal as well. As well in southern and eastern UK the winter precipitation totals were below 70 % of the norm.(http://www.metoffice.gov.uk/climate/uk/2012/winter.html). Under influence of the North Atlantic Ireland and Scotland as well as the westcoast of Scandinavia received much precipitation as well as the central and the eastern Mediterranean Sea. Also central Europe, eastern Europe and the Balkan Peninsula were wetter than normal. In Latvia winter 2011/2012 in total was the wettest in the last 90 years.

Sunshine Duration:

Winter 2011/2012 was sunny to very sunny in most of Europe with exception of Finland and northern Russia, parts of Belarus, parts of Germany, the western Alps and the southern Adriatic Sea, Ireland and western UK, and the Middle East and southern Russia. Eastern England and the British Midlands had one of their sunniest winters on record, while Ireland had one of its dullest. In the Netherlands the 1st decade of February was the sunniest in more than 100 years. Sunshine duration in Denmark was nearly 50 % above normal making winter 2011/2012 the sunniest in 49 years and the 2nd sunniest since 1920.

Drought

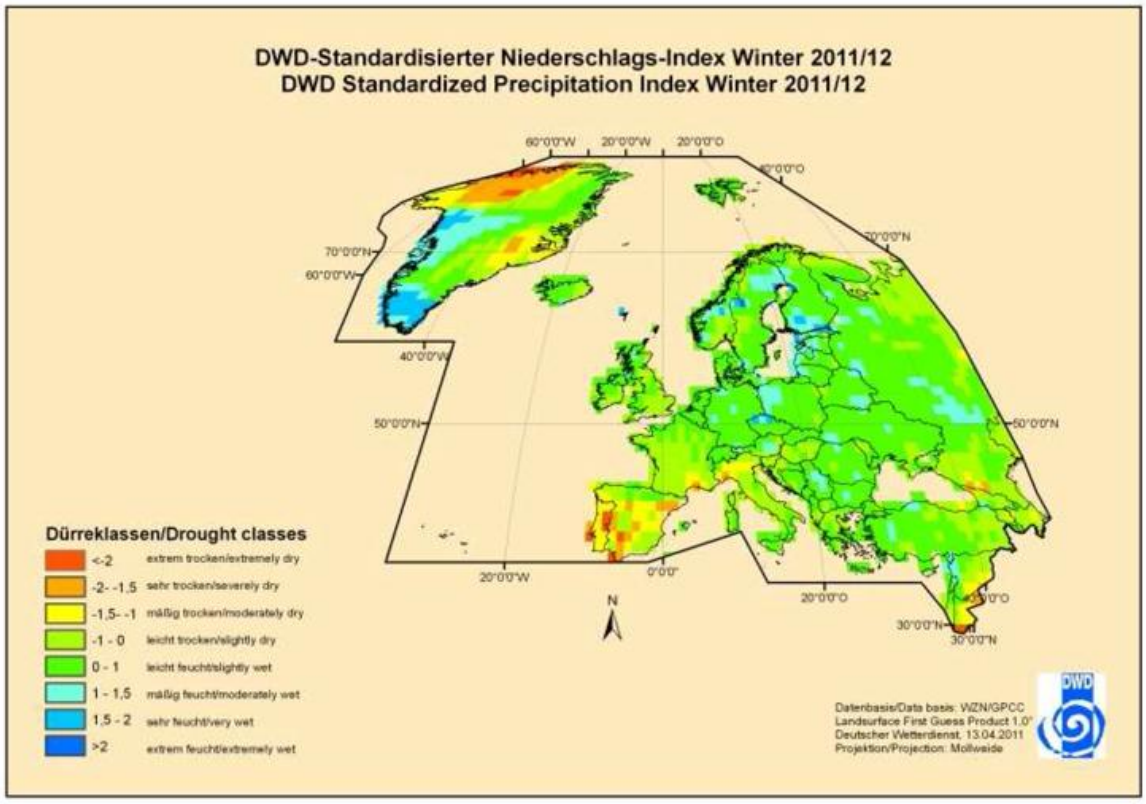


Fig. 2.63: Means of the modified Standardized Precipitation Index (DWD-SPI), winter 2012

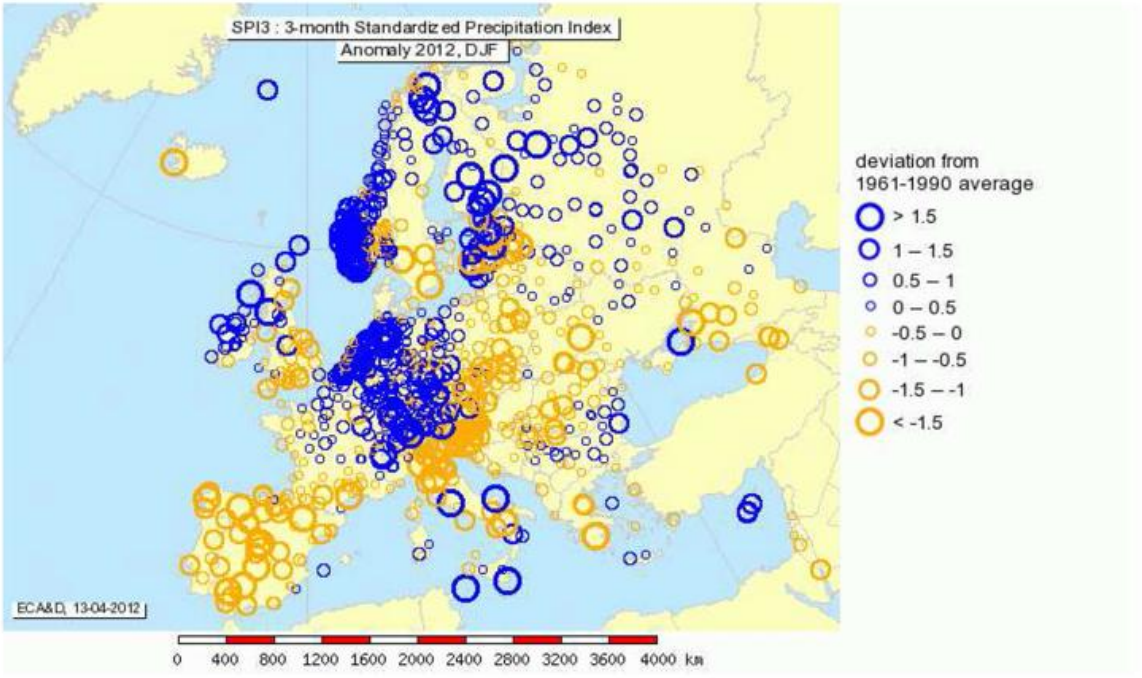


Fig. 2.64: Anomalies of the 3-month SPI (ECA&D) in Winter 2012

The winter season had moderate to partly extreme drought conditions especially on the Iberian Peninsula, southern France,Middle East and southern Eastern Europe.

- Portugal reported the driest February since 1931 and the driest winter since 30 to 70 years for some stations.
- In European Russia the vast area, from the White Sea to the southern Ural, received below-normal precipitation. Substantial precipitation deficit (5-30% of monthly normal) was recorded in the Ural region in February.Yekaterinburg received as little as 14mm of precipitation for the entire winter. This is the second time, when such low-snow winter is recorded for 120-year observations.

On the Iberian Peninsula the drought is mostly anomulous (Fig. 2.63, 2.64).

Spring

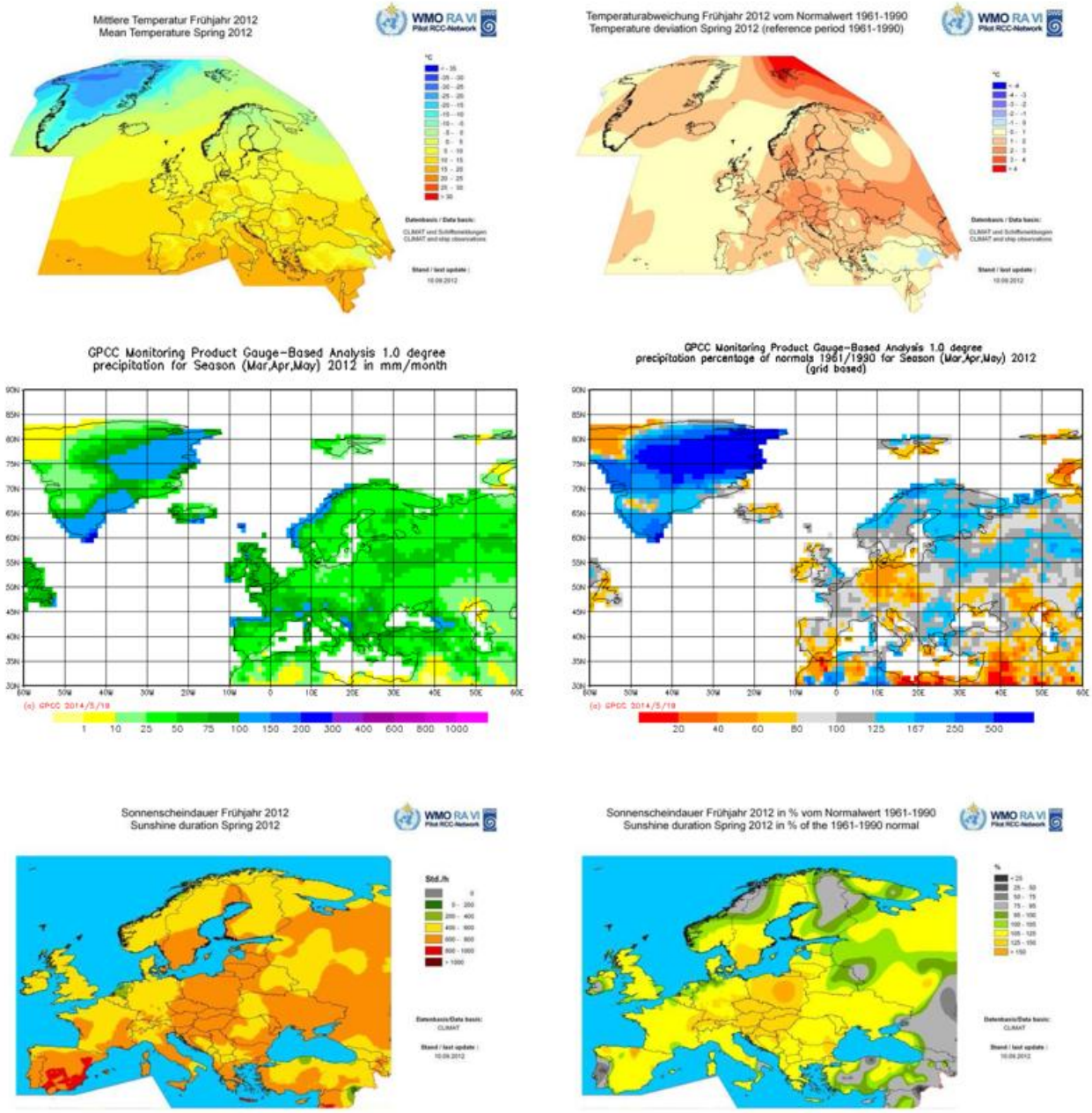


Fig. 2.65: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in spring 2012*
Source: http://www.dwd.de/rcc-cm

Temperature:

Spring 2012 was warmer than normal over the whole RA VI area.According to the E-OBS analysis spring 2012 was on rank 6 of the spring daily mean temperature since 1950. The mean daily maximum temperature as well as the mean daily minimum temperature were on rank 5. The anomalies ranged from 0.3 K to 4 K for the individual countries (result of the DWD temperature analysis). According to the DWD temperature analysis the highest positive mean anomaly for spring 2012 was computed for the region 'Mediterranean, Italian and Balkan Peninsula' with +2.3 K. With +2.0 K the positive anomalies of the regions 'Middle East' and 'Eastern Europe' were the next warmest. The 'Nordic and Baltic countries' were relatively slightly warmer than 'Central and western Europe' with anomalies of +1.5 K resp. +1.2 K. The smallest positive anomaly is computed for 'Iberia' (+1.0 K).

In Norway spring 2012 was the 15th warmest spring since 1900. Warm days occurred remarkably more often than normal . Much less frostdays than normal were registered in Denmark. Extraordinarily warm was **March 2012** in many countries. In Lithuania March was remarkable by its higher warmth (2.3° warmer than normal), and especially in the middle, when daily temperature rose to a record high. Sporadic high temperature records were observed also in April and May. The coldest nights of spring in Lithuania, as appropriate, were observed in early March (locally to -17 °C). In the end of April the absolute maximum temperature record of Lithuania was exceeded (31 °C measured in Alytus). Switzerland reported summer temperatures with locally record-breaking values in **April 2012** while **May 2012** on the other hand brought low temperatures and snow even in 600 m asl. Southern Russia had the warmest May since 1891 and new records for the daily maximum temperature at stations were reported by Sweden and Romania.

Precipitation:

Spring 2012 was drier than normal in central, northwestern and southwestern Europe and the Middle East. Wetter than normal were the Balkan Peninsula, Norway, the Baltic region, parts of Russia as well as partly the western Mediterranean Sea region, UK and France.

Spring was the second wettest in Estonia since 1961.

March 2012 was drier than normal in most of the Region except in Norway as well as the Baltic States, European Russia and the Caucasus region. In several countries March 2012 was one of the driest March months for many years. In UK it was provisionally the driest March since 1953 and the fifth driest since 1910. In Germany March 2012 was on rank 4 of dry March months since 1881. Central Europe, the Balkan Peninsula and the Middle East as well as much of Norway were drier than normal also in **April 2012** when the other parts of the region were wetter than normal, especially western and southern Europe. In **May 2012** again central Europe but also southwestern, western and eastern Europe were drier than normal while southeastern Europe, especially the Balkan Peninsula was wetter than normal. Thus central Europe remained drier than normal troughout the whole season.

Sunshine Duration:

Spring 2012 was a sunny season in most of the RA VI area except the Middle East and some regions in the northwest, north and northeast. The map of sunshine duration and the maps of the number of fair or dull days correspond nicely. The sunshine surplus of the season was mostly determined by March and May. **March 2012** was unusually sunny especially in UK, southern Scandinavia, France, Germany, Austria, Switzerland, Italy, Poland, the Czech Republic, Slovakia, Hungary, Croatia and the Balkan Peninsula. Shannon Airport in Ireland recorded the highest spring sunshine duration since 1938 (when the station opened) and on **25 May 2012** its highest daily sunshine duration of 15.6 hours.

Drought

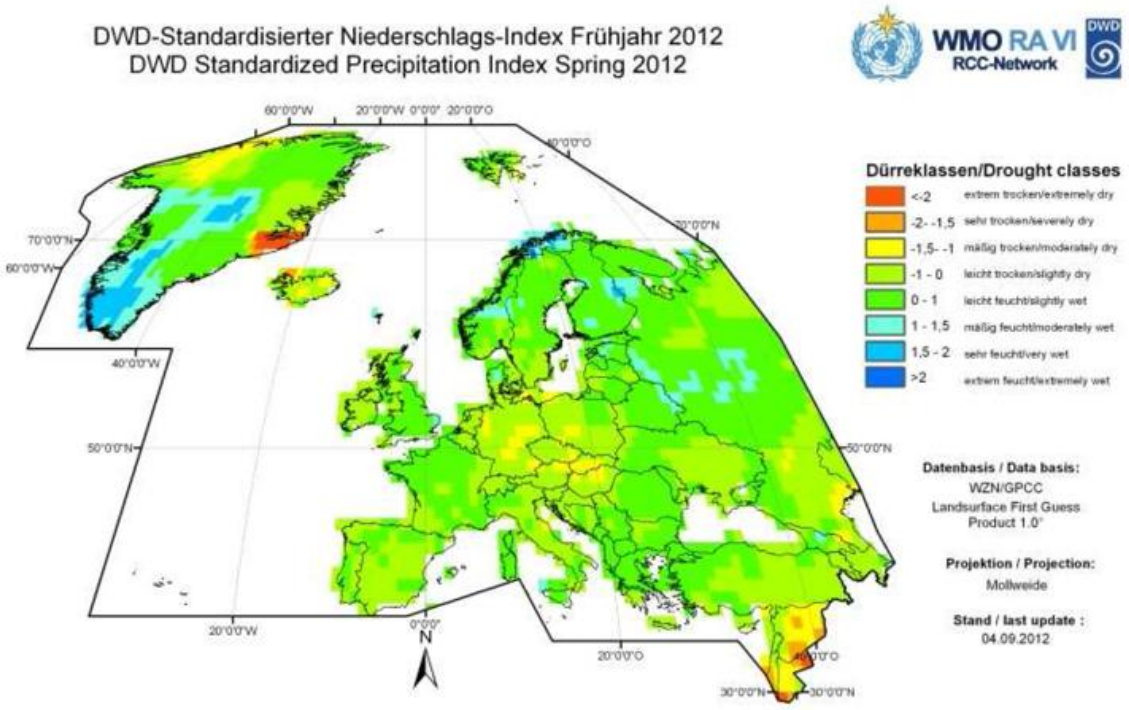


Fig. 2.66: *Means of the modified Standardized Precipitation Index (DWD-SPI), spring 2012*

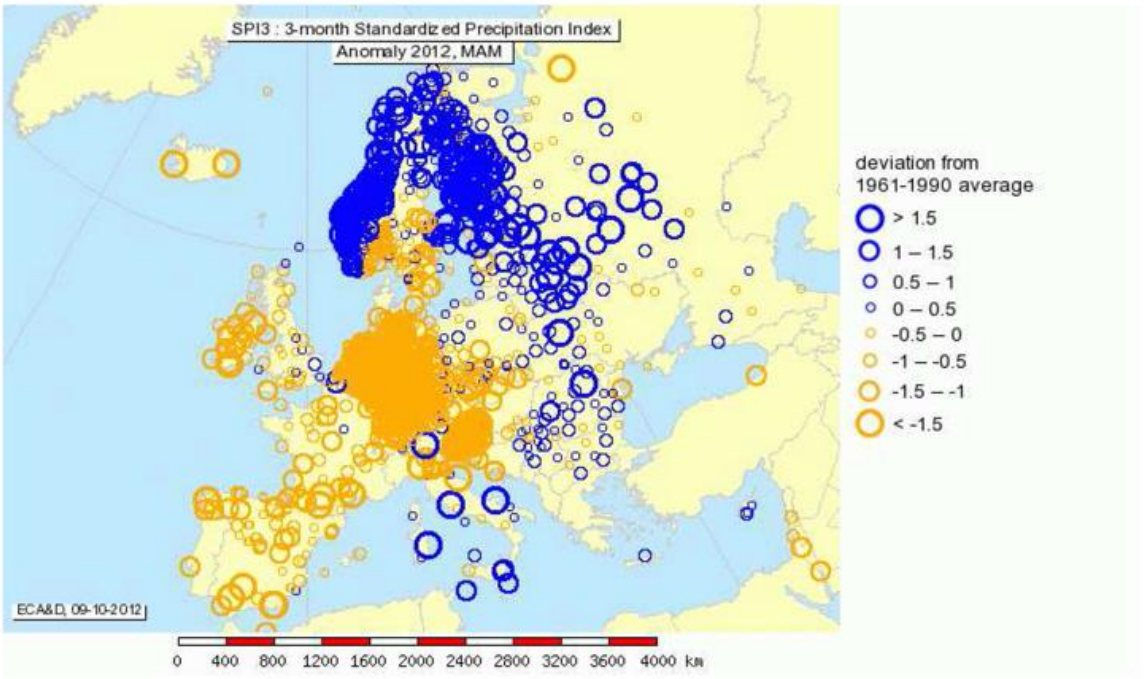


Fig. 2.67: *Anomalies of the 3-month SPI (ECA&D) in Spring 2012*

Spring 2012 was slightly to moderately dry in parts of Central Europe and southern Eastern Europe as well as on Iceland and slightly dry on the Iberian Penisula and on Ireland. It was moderately to severely dry in Middle East (Fig.2.66). Overall western, southwestern and central Europe and southern Scandinavia were anomalously dry in spring 2012 (Fig. 2.67).

Summer

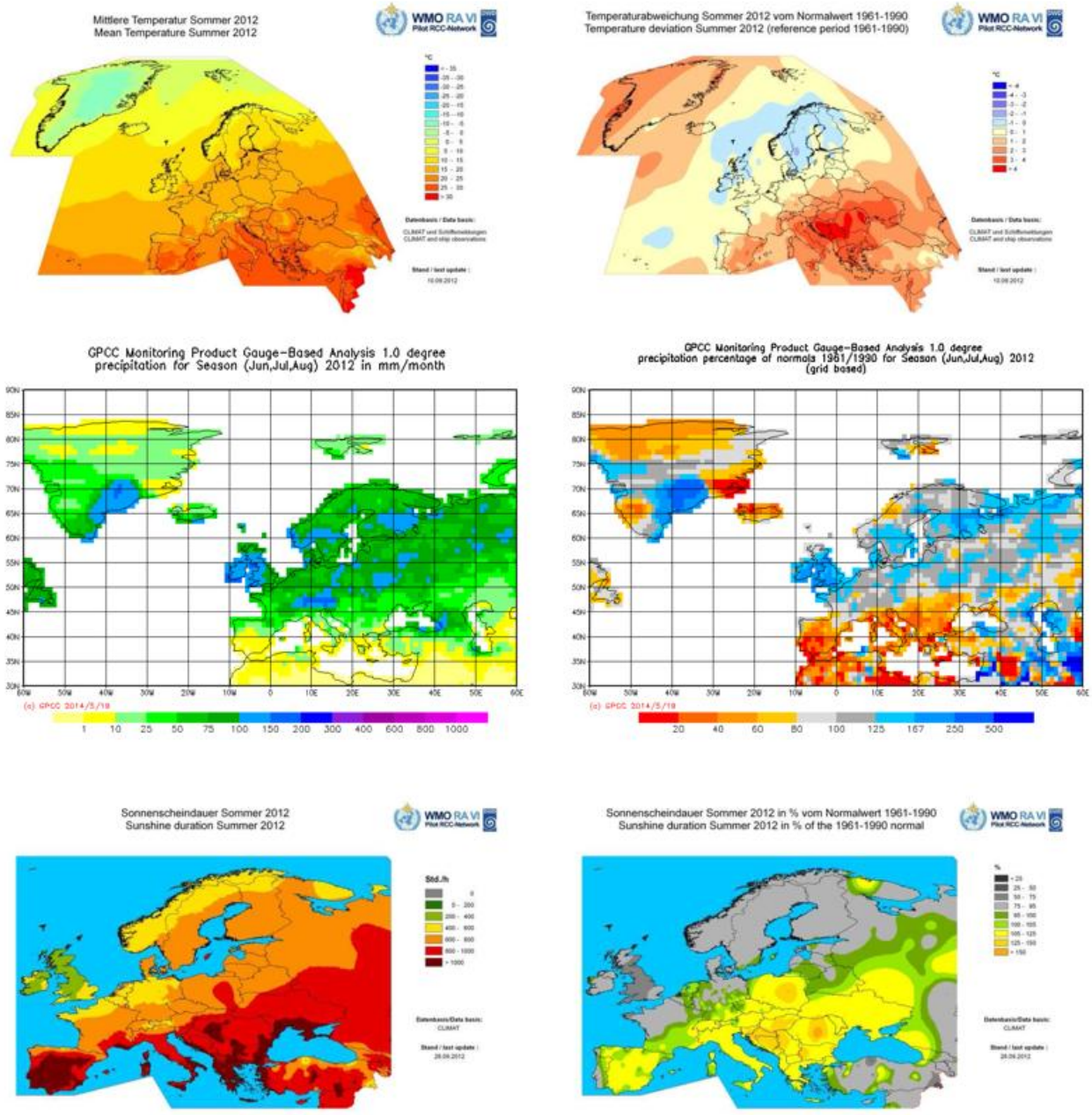


Fig. 2.68: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in summer 2012*
Source: http://www.dwd.de/rcc-cm

Temperature:

Summer 2012 was warmer than normal in southern, southeastern Europe and Middle East as well as on Greenland and the northwestern North Atlantic. The positive anomalies were highest in Italy, the Balkan Peninsula and the Ukraine. According to the E-OBS analysis summer 2012 was on rank 3 since 1950 for rthe daily mean temperature as well as for the mean minimum teperature. For the mean maximum temperature it was on rank 6. According to the DWD analysis the mean anomalies of summer 2012 for the subregions were highest for 'Central and western Europe' (+3.1 K) and lowest for 'Middle East (+1.4 K). The positive seasonal anomalies were mostly determined by June and August. Summer 2012 was especially unusual warm in Greenland. Record breaking and near to record breaking summer and single months occurred in many places (in Upernavik (20.3°C) and Ittoqqortoormiit (18.6°C) in July), but also a single record breaking cold June 2012 at Tasiilaq at the east coast were seen! In August it became really hot in Switzerland when hot days were recorded in locations up to 500 m asl during a heat wave. Moldova was characterized by an abnormally hot summer. On August 7, on 50% of the area was recorded the highest maximum temperature of +37,2°C to 42,4°C for the entire observation period in the summer season which is 0,2-0,9°C higher than the former absolute highest values.

In Turkey 31 stations had broken their extreme maximum temperature record in summer 2012. Tropical days have occurred (Tmax >30°C) in 122 stations. Moreover in 40 cities, maximum temperatures exceeded 40°C. The summer 2012 was the warmest on record together with the summer of 2010 in Israel. Slightly colder than normal were large parts of Scandinavia and the northern British Isles, the northern North Atlantic and northern central Europe where June and July were relatively cold and only August was warmer.

Precipitation:

Summer 2012 was drier than normal in the Mediterranean region including the Iberian Peninsula as well as the Balkan Peninsula. It was as well dry on Iceland and the northern part of Greenland. A significant lack of precipitation during summer 2012 in south-east Greenland was also observed (e.g. 0 mm at Tasiilaq, 0.7 mm at Narsarsuaq and 21.6 mm at Qaqortoq in June 2012, and only 1.4 mm at Tasiilaq in July 2012). In Tasiilaq the summer precipitation was the third lowest on record (since 1895). In Danmarkshavn in north-east the summer precipitation was 8.2 mm, the second lowest on record (since 1949) together with summer 2003. It was on the other hand wetter than normal or close to normal in western, central, northern and eastern Europe and much of the Middle East. 5-daily precipitation totals fairly above the normal values occurred in the north around the Baltic Sea as well as in the drier Mediterranean region (Northern Italy and the Alps as well as on the Balkan Peninsula.

Sunshine duration:

Summer 2012 was sunnier than normal on the Iberian, the Italian and Balkan Peninsulas as well as eastern central Europe and the southwestern parts of eastern Europe. Northern and northwestern Europe and the Middle East on the other hand had less sunshine than normal. The dullest region was the United Kingdom except the northernmost and southeasternmost areas. More sunshine than normal was registered in southern Europe through all 3 months. The Balkan Peninsula received more sunshine than normal especially in June and July. On the British Isles and in central Europe especially June 2012 was the month with a high deficit of sunshine.

Drought

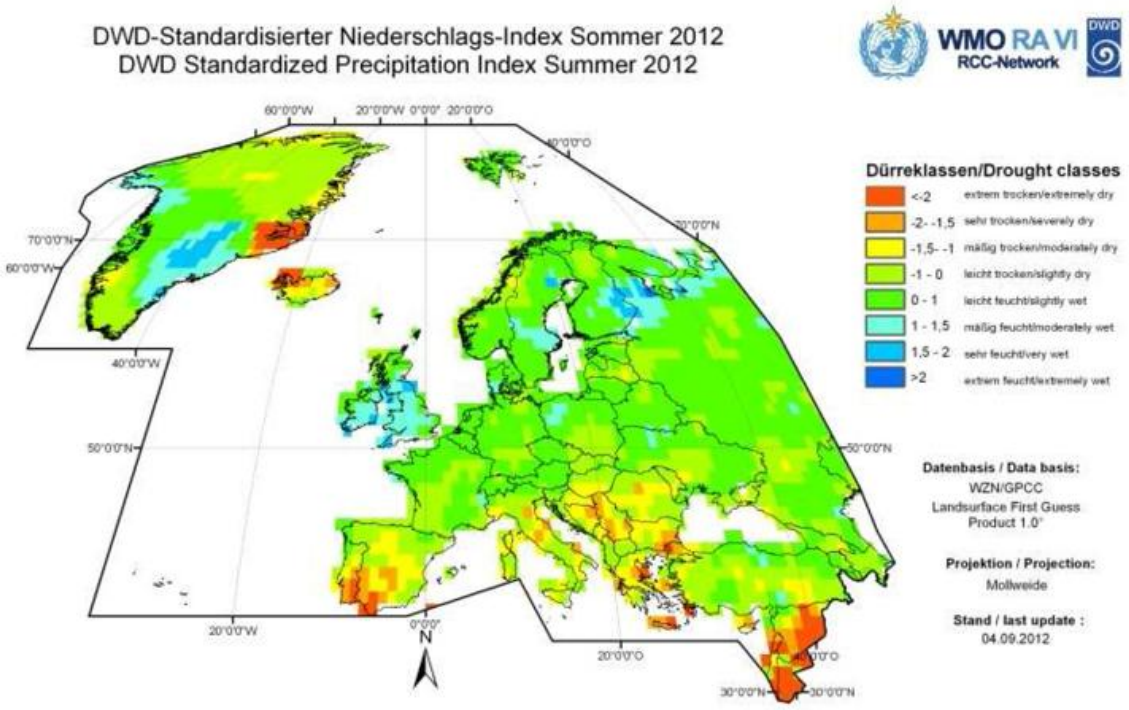


Fig. 2.69: *Means of the modified Standardized Precipitation Index (DWD-SPI), summer 2012*

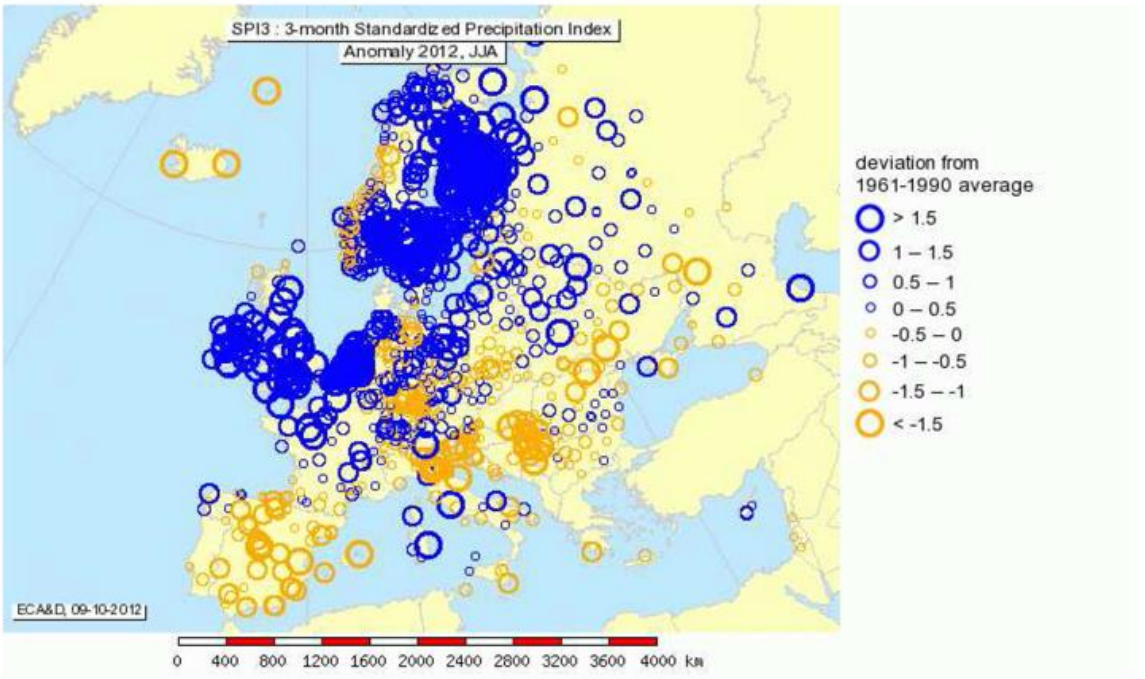


Fig. 2.70: *Anomalies of the 3-month SPI (ECA&D) in Summer 2012*

Summer 2012 was severely to extremely dry on Iceland, the southern Iberian Peninsula, partly the Italian and the Balkan Peninsula and in Middle East (Fig 2.69). It was overall on the Iberian Peninsula, on most of the Italian and Balkan Peninsula and also in parts of central and eastern Europe as well as on Iceland and the western coast of Scandinavia drier than normal. The anomalies of the 3-month SPI in the dry regions showed considerable dry deviations from the normal (<-1.5) on the Iberian Peninsula and the Mediterranean Sea region, the Alpine region, the Balkan Peninsula and southeastern Europe but also partially in central Europe.(Fig.2.70). In Moldova the total duration of rainless days per season reached 60 days, and the longest duration of continuous rainless days 26 days.

Autumn

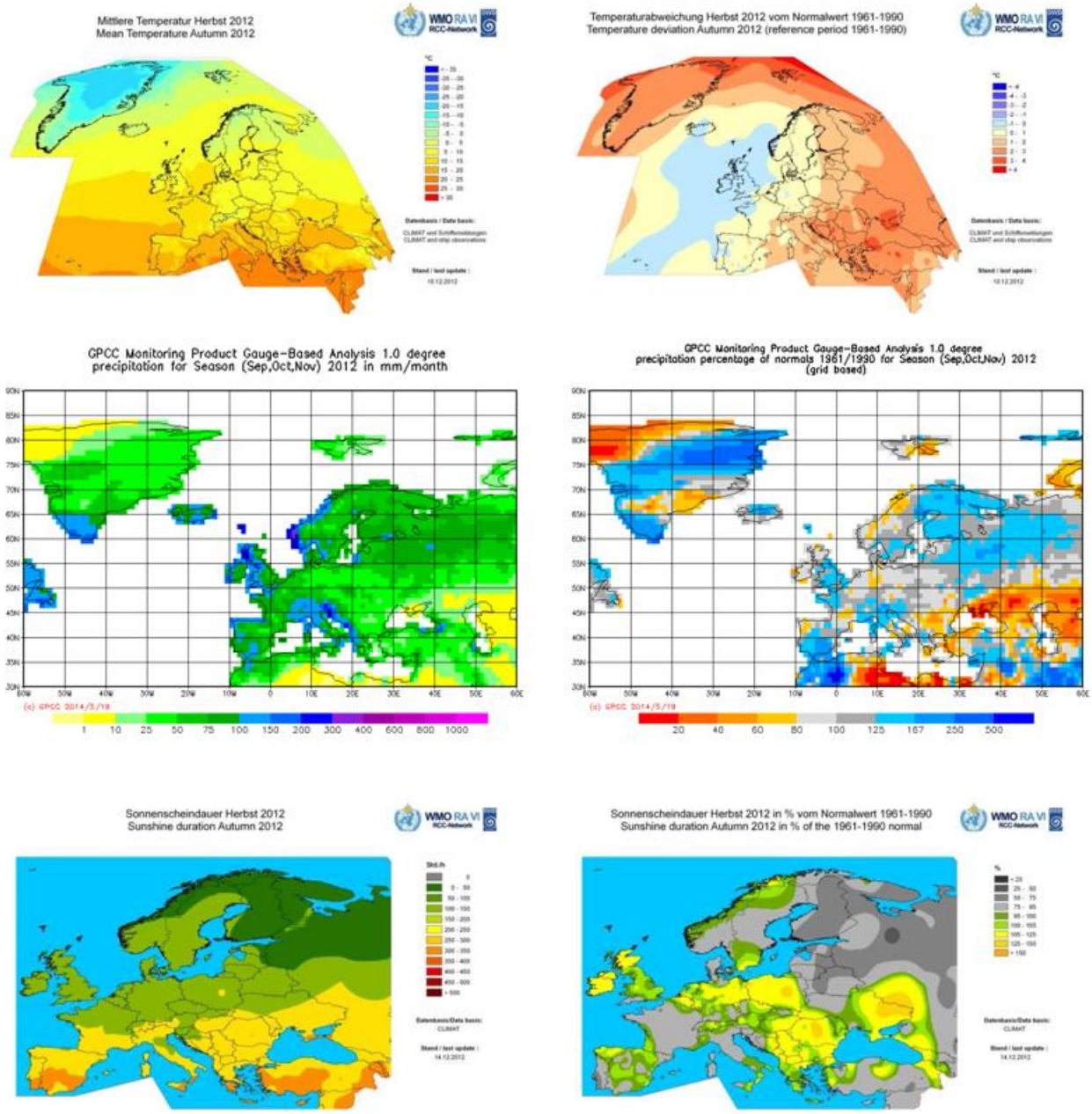


Fig. 2.71: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in autumn 2012*
Source: http://www.dwd.de/rcc-cm

Temperature:

In **autumn 2012** Greenland, the Arctic and most of continental Europe except the westernmost parts were warmer than normal while only the eastern North Atlantic with the British Isles and Iceland was colder. All 3 months were not very different concerning the anomaly pattern.

According to the E-OBS analysis autumn 2012 was on rank 2 since 1950 for the mean daily temperature, the mean maximum temperature and the mean minimum temperature as well.In Armenia autumn 2012 ranked 3rd warmest autumn on record. The highest positive anomaly was computed from the DWD analysis for the subregion 'Eastern Europe' (+2.2 K) closely followed by 'Central and western Europe' and 'Iberia' with +2.1 K. The smallest positive anomaly was computed for the subregion 'Nordic and Baltic countries' with +0.6 K.

September 2012 brought high maximum temperatures of more than 30 °C for instance in Austria, Poland and Moldavia. UK reported the provisionally coldest October since 2003.

Precipitation:

Autumn 2012 brought more precipitation than normal to the southeastern British Isles as well as to the southern Iberian Peninsula, the central and partly the eastern Mediterranean Sea area and to northern Europe as well as the Middle East. This surplus was caused to a good part by extremely wet days, resp. extreme precipitation events as the "map of anomalies of the precipitation fraction due to extremely wet days" shows. There is a special report on the extreme events in the Mediterranean Sea area for autumn 2012 available (see the list of links below). This coincides with the distribution of the mean sea level air pressure that shows low pressure centered over the Norwegian Sea reaching far southward over central Europe and only weak high pressure over the central North Atlantic and over southeastern Europe. Thus the dipole of the Icelandic low and the Azores high is poorly developed and nearly the whole European area had less than normal pressure. Relatively dry conditions occurred mainly in southern Russia, the Carpathian region and on the Balkan Peninsula and western Turkey.
Autumn was the wettest since 2001 in Denmark.

In **September 2012** especially in the Mediterranean Sea area some places received heavy to extremely heavy precipitation for 2 or 3 consecutive days so that large precipitation totals amounted within relative short time. In the Alps September brought early snowfall. **October 2012** in the northernmost part of the Swedish east coast the month of October was the rainiest on record with some local flooding.In the Mediterranean Sea region several phases with extremely heavy precipitation occurred in connection with low pressure systems. Switzerland reported that in mid-October the eastern slopes of the Alps had an uninterrrupted snow cover above 800 m asl and end of October snow height at some stations reached new October records. In **November 2012** many extremes of precipitation totals occurred in several episodes on different time scales from high several-day totals to extremely high daily totals especially in the Mediterranean Sea area and on Madeira but also for instance in England, were one week in November was the wettest since 50 years. Austria reported on 11 November 2012 125 mm in 24 hours at the station Loiblpass which is more than half of the month's normal. Switzerland reported heavy snowfall end of November so that the winterseason 2013 started with rather deep snow cover even at southern places.

Sunshine Duration:

Autumn 2012 was sunnier than normal for the British Isles, partly the Iberian Peninsula, central, eastern and southeastern Europe eastern Ukraine and southwestern Russia. For Poland the station Warszawa reported the highest seasonal total of 424.2 hours. elsewhere it was dull or close to normal. Autumn 2012 was the least sunniest autumn in Denmark since 2001.

Drought

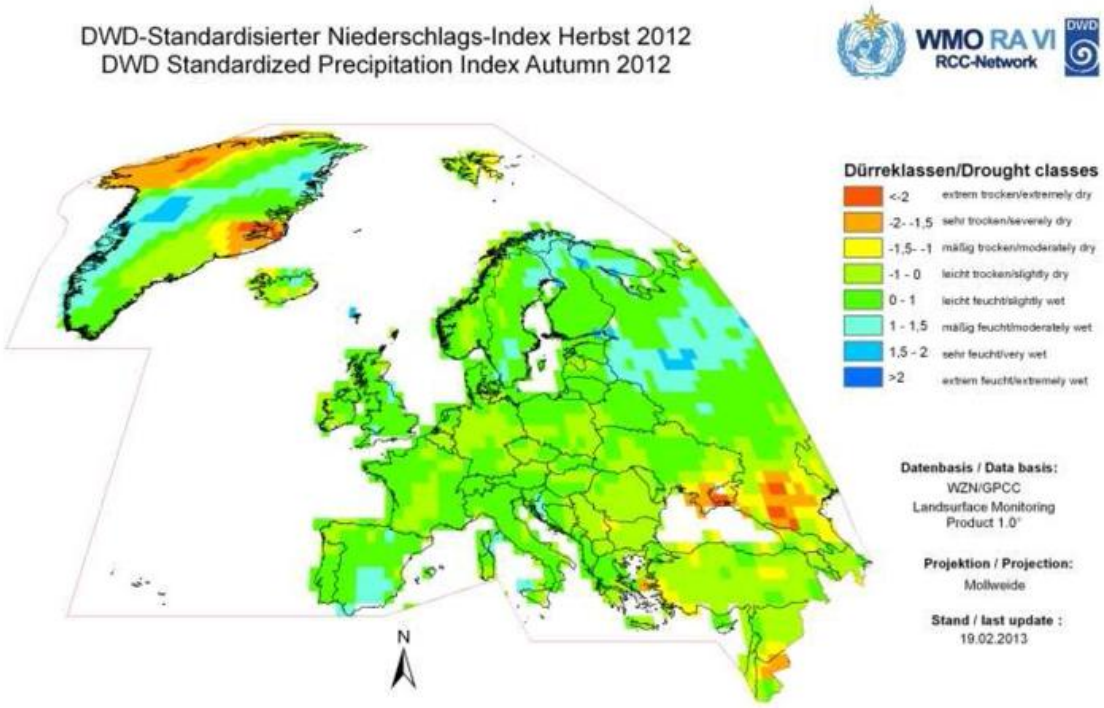


Fig. 2.72: *Means of the modified Standardized Precipitation Index (DWD-SPI), autumn 2012*

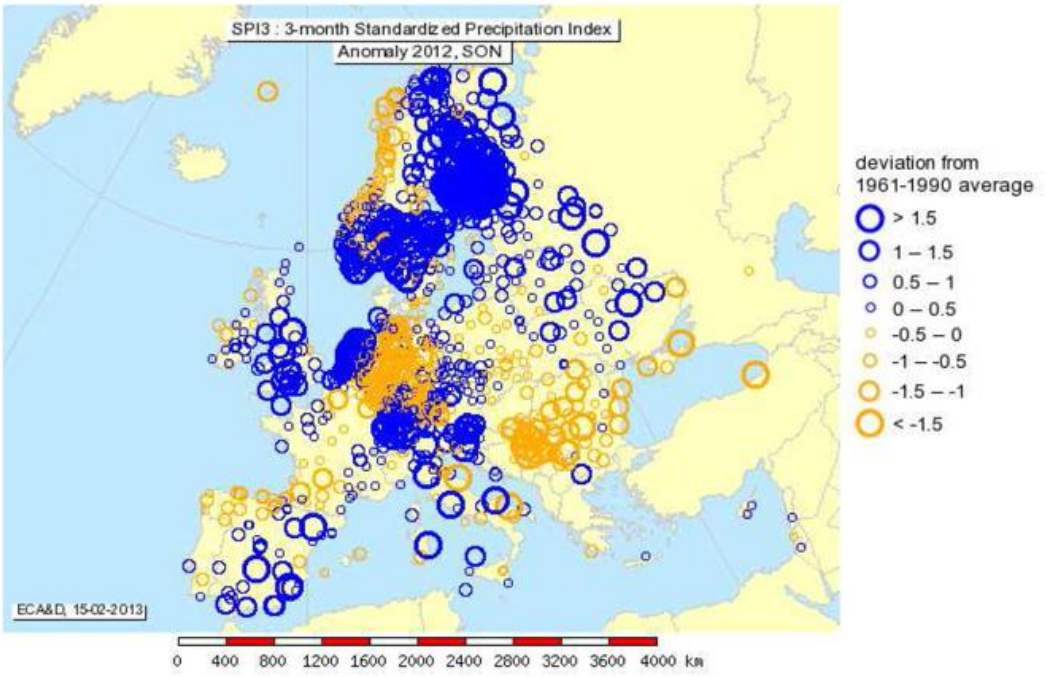


Fig. 2.73: *Anomalies of the 3-month SPI (ECA&D) in Autumn 2012*

Autumn 2012 was severely to extremely dry in the south of Eastern Europe and partly in Middle East (Fig. 2.72). This is severely drier than normal according to Fig. 2.73. Autumn 2012 was also slightly dry - and clearly drier than normal - in central Europe and on the Balkan Peninsula.

Monthly Survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2012 on the Climate in WMO Region VI - Europe and Middle East - which are available on Internet under http://www.dwd.de/rcc-cm.

January

Highlights:

- ***In the Arctic Sea region, western Greenland and northern Russia positive temperature anomalies exceeded 4 K. In southeastern Europe the negative temperature anomalies were partly below -3 K.***
- ***Very wet January 2012 in Israel. Outstanding daily precipitation total at Ny Alesund.***
- ***Positive sunshine duration anomaly for much of the European area***

Overview:

Temperature:

January 2012 was warmer than normal mostly except in the southeast and partly in the southwest. In the Arctic Sea region, western Greenland and northern Russia it was particularly warm. Anomalies here exceeded 4 K. On the other hand it was colder than normal in southeastern Europe. The anomalies were partly below -3 K.Very low temperatures occurred on the eastern Balkan Peninsula and the eastern Mediterranean Region.

Precipitation:

January 2012 was wetter than normal in central, eastern and southeastern as well as much of northern Europe but drier than normal in the west and southwest, in the south and in the north and northeast. It was particularly wet in eastern Central Europe parts of the Baltic states and western Central Russia, on the Balkan Peninsula and in Turkey. It was on the other hand drier than normal in western and southwestern Europe inclusively the western Mediterranean region, in the Middle East in the east and at the northwesterly coasts of Scandinavia though anomalously many very wet days also occurred here as well as in southern Norway. Portugal reported for Madeira the driest December and January in the series since 1950 and a comparable dry total for October to January like 1983.

Sunshine:

The sunshine duration anomaly was in January 2012 positive for much of the European area though this seems partly surprising in central and northern Europe compared to the areas of precipitation surplus. But is has to be considered that these areas do not have much sunshine in wintertime generally so that a small absolute surplus makes a high positive anomaly expressed in percentages.

Events:

- In late January the air pressure in Moscow attained 1025 hPa. The former record of 1024 hPa occurred in January 1946.
- The highest daily precipitation total of the Norwegian Arctic stations occurred on 30 January at Ny Alesund with 98 mm. This event has an estmated return period of 200 years.
- Storm depression ULLI on the British Isles, Germany and Denmark
- Storm depression ANDREA from the British Isles over central Europe to the Balkan Peninsula
- Cold wave in Europe at the end of the month (continuing in February)
- In northwestern Israel 27 consecutive rainfall days occurred (4 to 31 January)

Monthly Means or Totals and Anomalies :

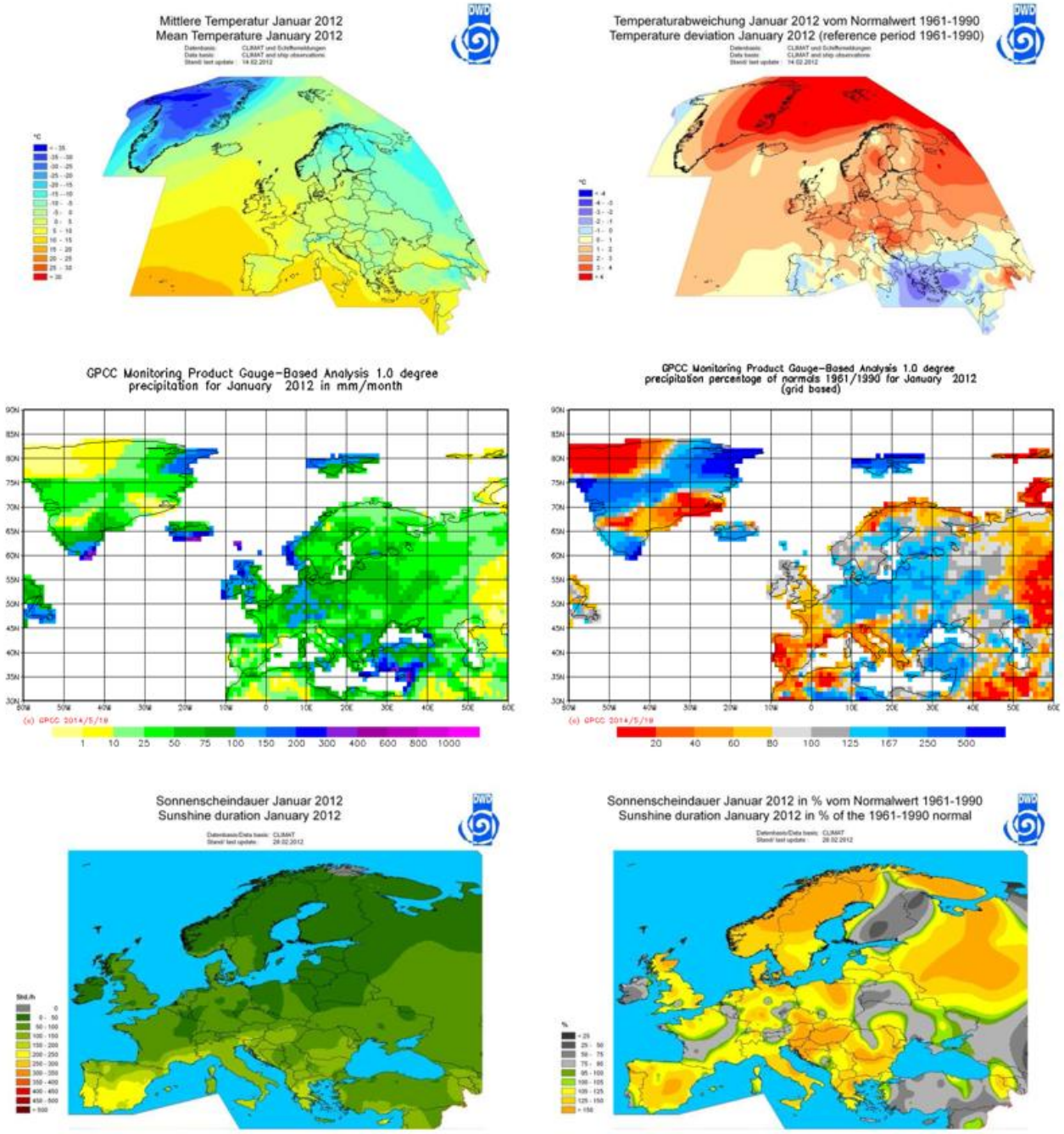


Fig. 3.1: Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in January 2012

Monthly Climate Extremes and Events:

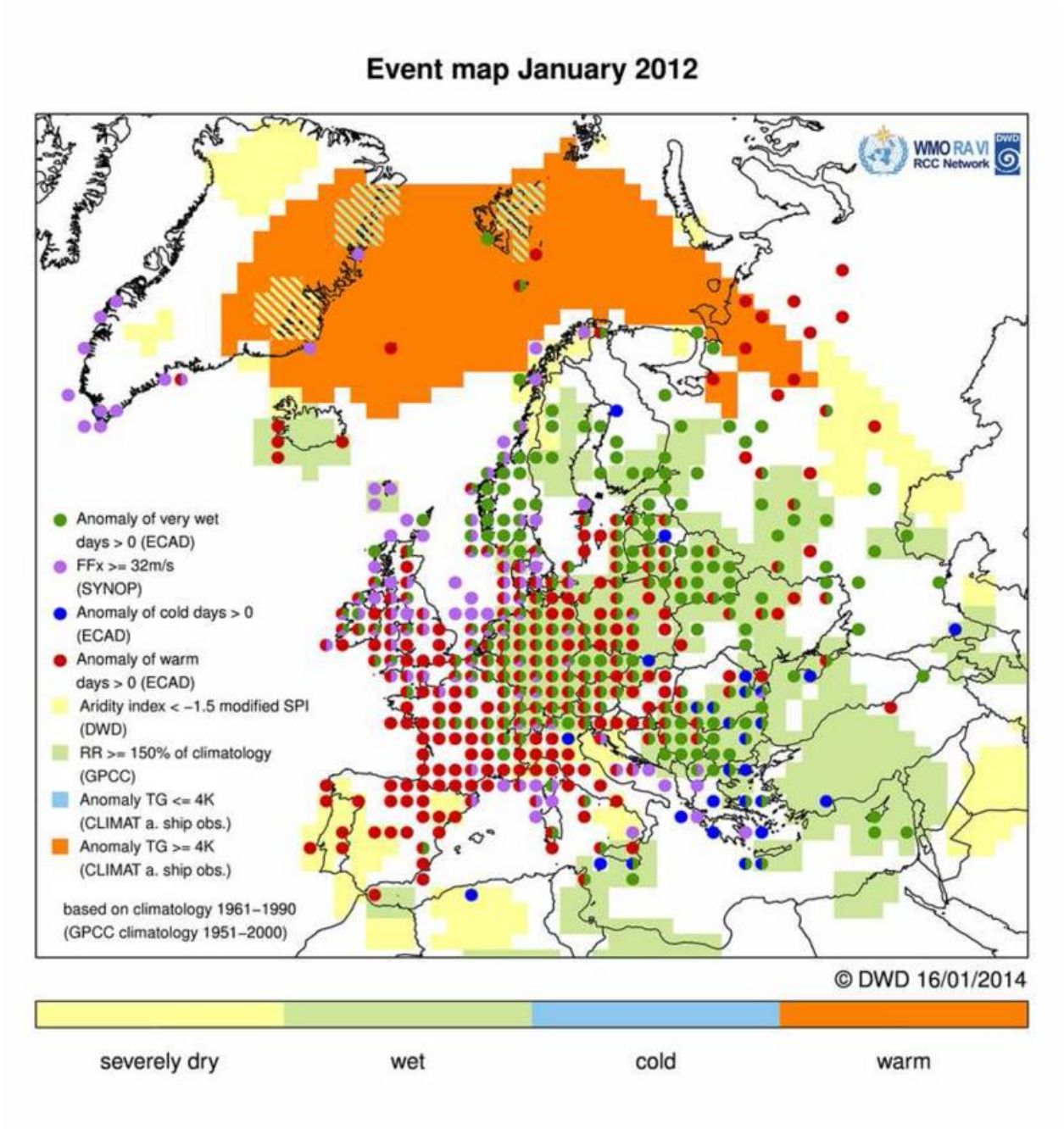


***Fig. 3.2** : Monthly Map of Climate Extremes and Events January 2012*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

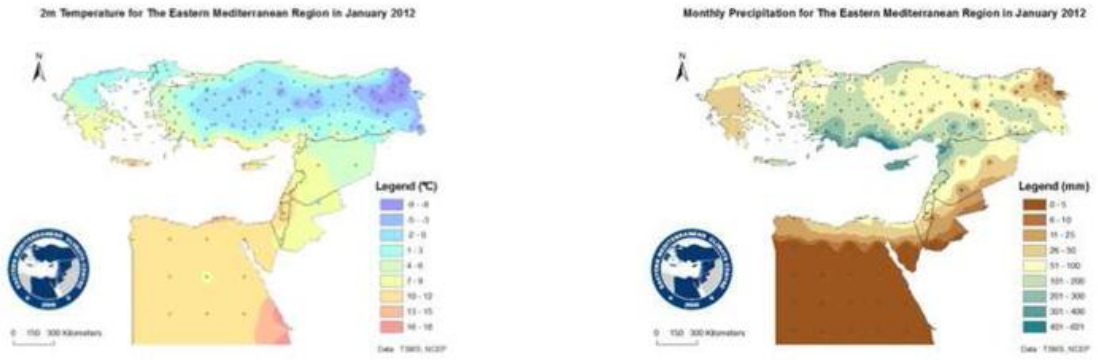


***Fig. 3.3** : Monthly mean temperature (°C) and monthly precipitation totals (mm) January 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

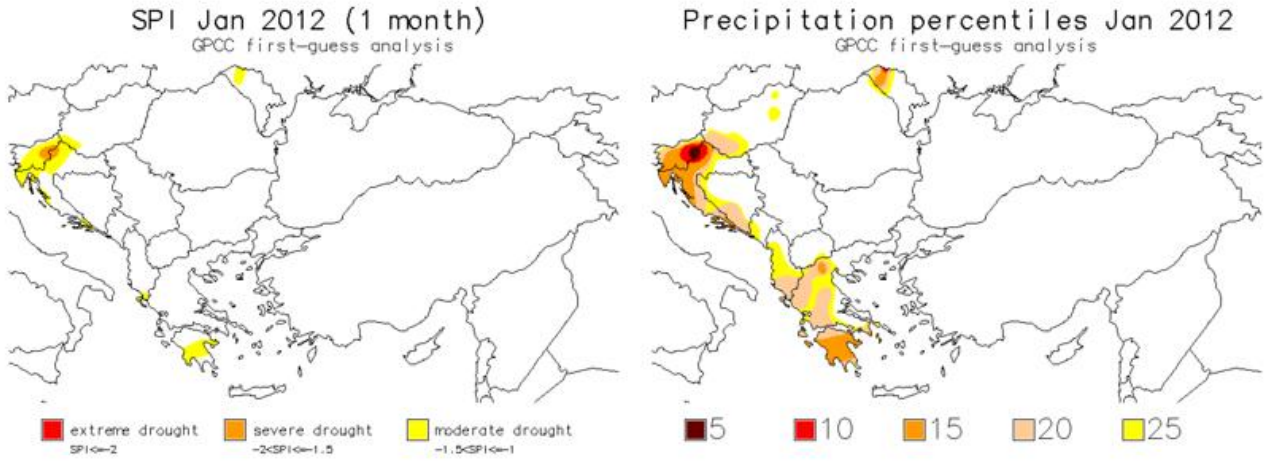


***Fig. 3.4** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
January 2012

February

Highlights:

- ***A severe cold spell during the first half of the month over central, western, eastern and southwestern Europe placed February 2012 among the 15 coldest February months of the last 130 to 150 years in central Europe.***
- ***Below 30 % of normal February precipitation in the Ural region caused the 2nd lowest snow winter since 120 years there.***
- ***The 1st decade of February was the sunniest in more than 100 years in the Netherlands with more than half of the normal monthly total.***

Overview:

Temperature:

February 2012 was a cold month in most of continental Europe, Russia and the Middle East.Negative anomalies of -4 K or more occurred in France, the Alpine region, Poland, the Baltic states, Belarus, Ukraine, the Balkan states, parts of Russia and in Turkey. It was for instance on rank 10 of coldest February months since 150 years in Switzerland and on rank 15 of coldest February months since 1881 in Germany. Only the British Isles and southern Scandinavia were on the warm side. The Arctic Sea region had the highest positive anomalies of +4 K and more.

Precipitation:

In February 2012 it was dry in western, southwestern, and most of central Europe as well as southern Scandinavia. But the Scandinavian west coast as well as the central and eastern Mediterranean coast received partly remarkable precipitation surplus.

Sunshine:

Sunshine duration in February 2012 was nearly everywhere over the normal except most of the British Isles, the western Balkan Peninsula and southern Italy.

Events:

- Severe cold spell continuing until mid of February (see Fig. 3.7 and 3.8)
- On 1 February Haparanda reported a surface pressure of 1058.0 hPa which is a new Swedish record for February
- In the Netherlands the 1st decade of February 2012 was the sunniest since more than 100 years with more than half the monthly total
- Severe Aegean depression JULIA 6 to 8 February with storm, snow and floodings

Monthly Means or Totals and Anomalies :

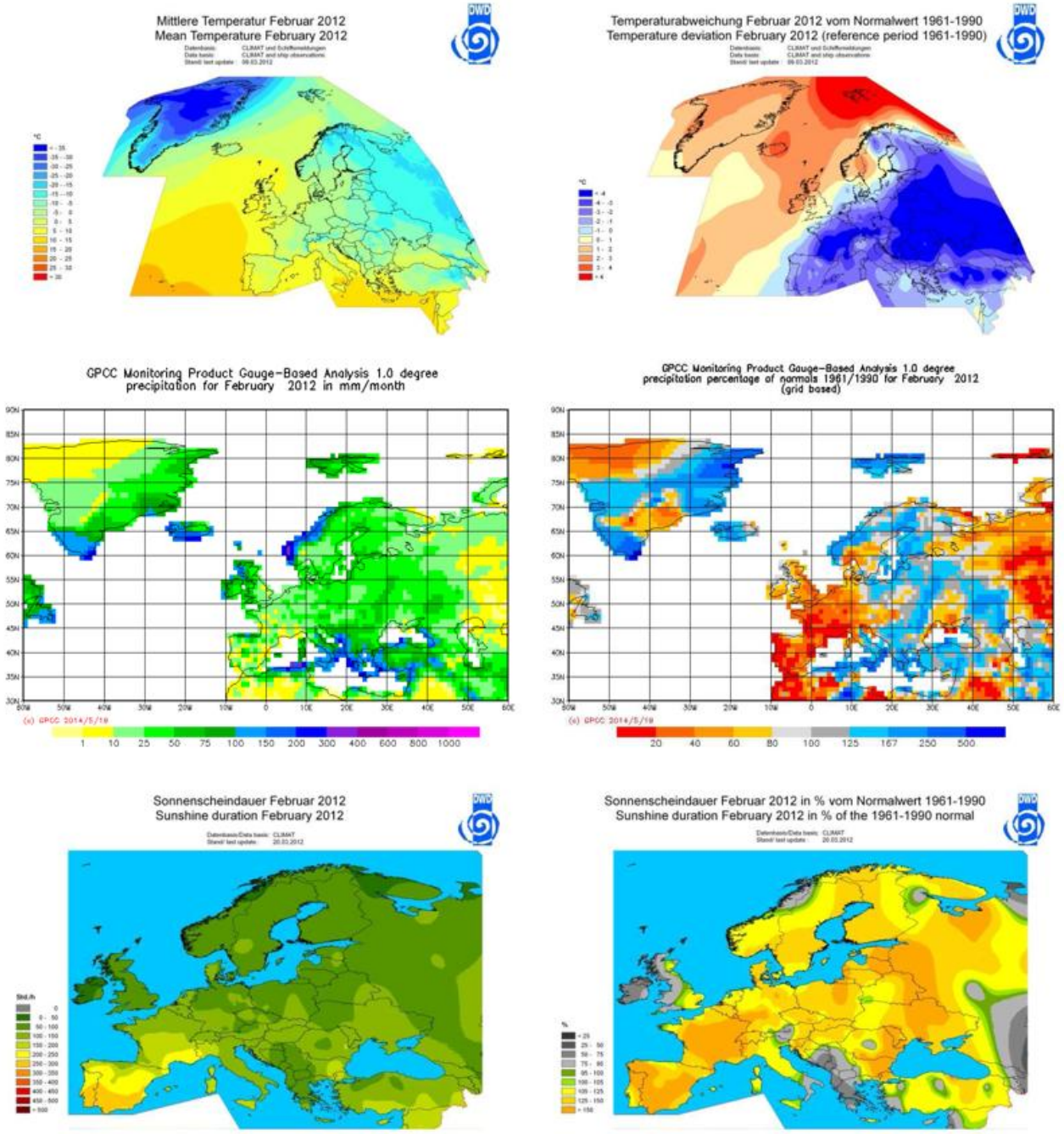


Fig. 3.5: Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in February 2012

Monthly Climate Extremes and Events:

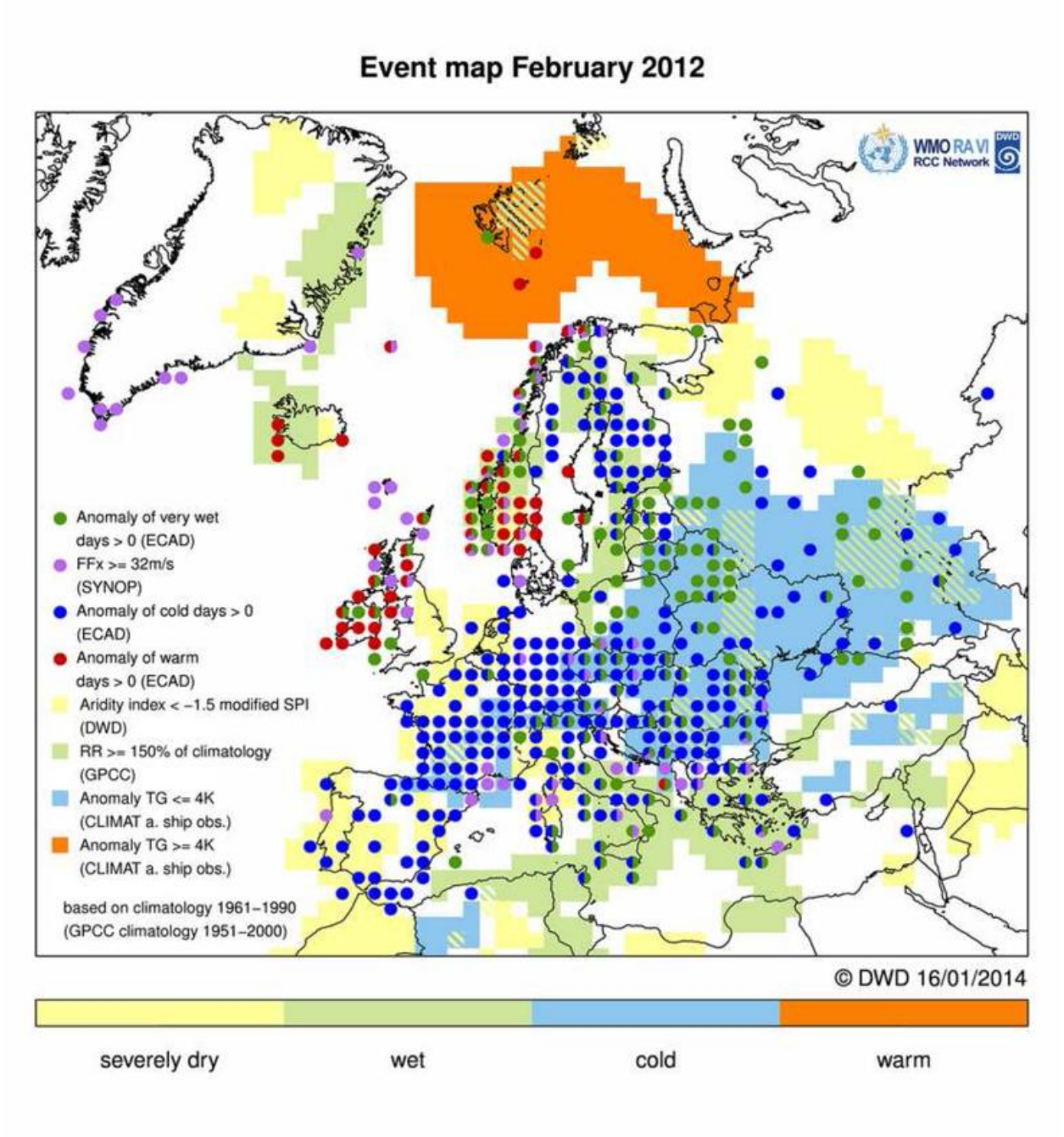


***Fig. 3.6** : Monthly Map of Climate Extremes and Events February 2012*

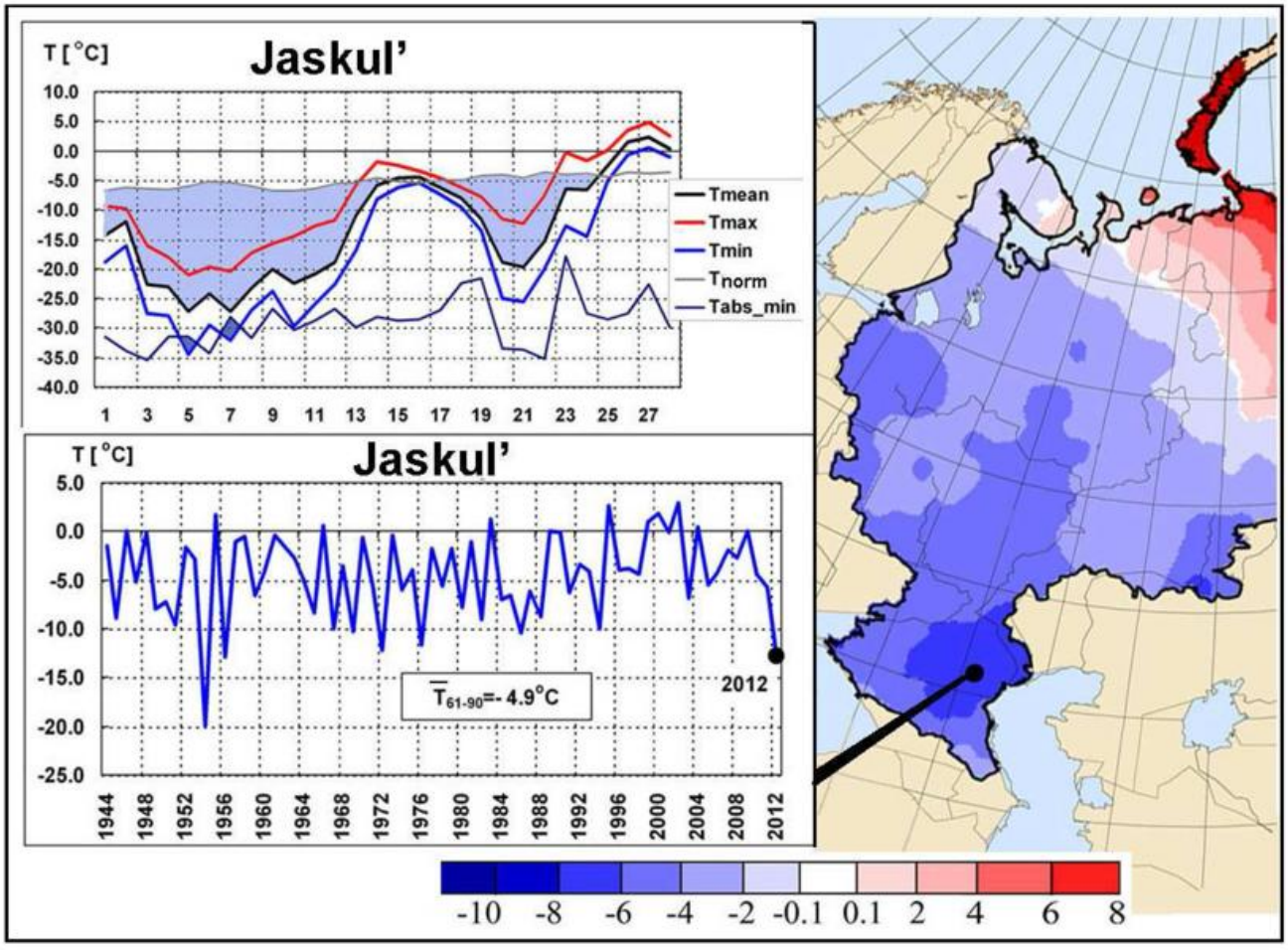


Fig. 3.7 : Character of the severe cold wave in Russia February 2012

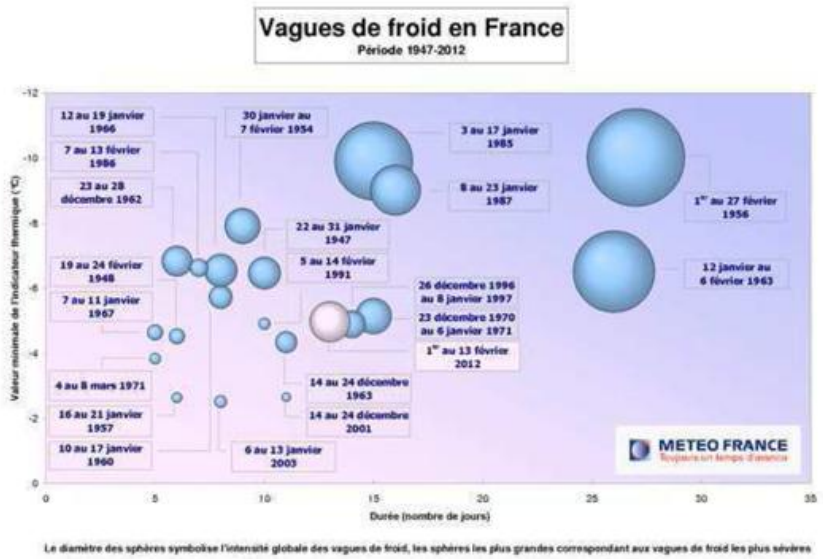


Fig. 3.8 : The cold wave in comparison to other cold waves in France February 2012

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

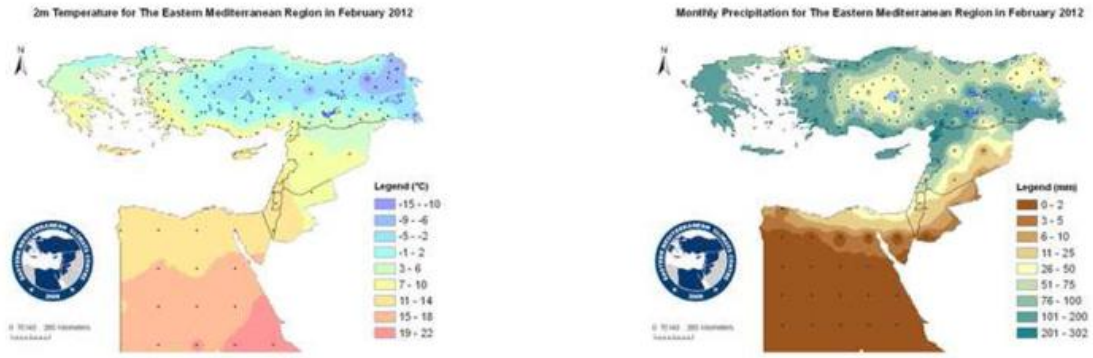


***Fig. 3.9** : Monthly mean temperature (°C) and monthly precipitation totals (mm) February 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

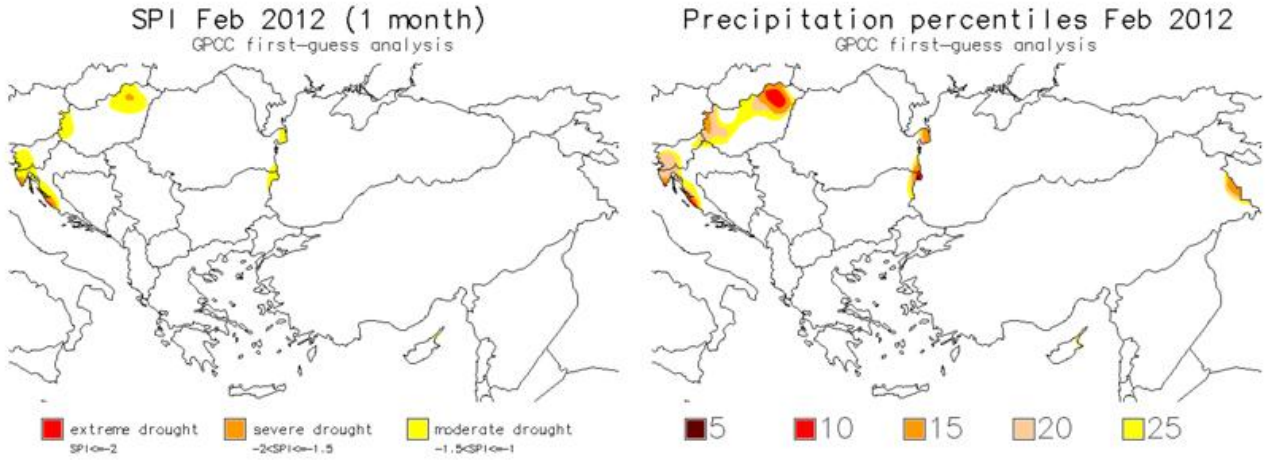


***Fig. 3.10** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
February 2012

March

Highlights:

- ***March 2012 one of the 3 warmest March months on record in many European countries***
- ***One of the 5 driest March months since about 100 years or more in western and central Europe.***
- ***One of the 5 sunniest March months in western and central Europe since 60 to 130 years.***

Overview:

Temperature:

Compared to the situation in February March 2012 was warmer than normal over most of Europe, Scandinavia, the northern North Atlantic inclusively eastern Greeland and in the Arctic Sea. Only the Middle East and European Russia were colder. In many European countries March 2012 was one of the 3 warmest March months since their timeseries started. In Norway it was the warmest March since 1900:

```
Norway:          rank 1  since 1900
United Kingdom:  rank 3  since 1910
France:          rank 3  since 1900
Germany:         rank 3  since 1881
Austria:         rank 3  since 1767
Denmark:         rank 4  since 1874
Netherlands:     rank 3  since 1900 (together with March 1957)
Switzerland:     rank 1  since 1864 in the southern parts
Sweden:          rank 1 on record in the central parts
```

Precipitation:

Most of western, southern, southeastern and central Europe as well as southern Scandinavia were dry. For UK it was the driest March since 1953, resp. the 5th of the dry March months since 1910. In Portugal March 2012 was on rank 6 of dry March monts since 1931 and in Spain it was the driest March since 1997. Also in Austria it was one of the driest March months since the records started. In Carinthia water shortage occurred. In Germany March 2012 was on rank 3 of dry March months since 1881. This precipitation deficit prolonged the drought situation for the UK (where water shortage was reported) as well as on the Iberian Peninsula and the western Mediterranean. More precipitation than normal fell on the other hand in Norway as well as the Baltic States, European Russia and the Caucasus region.

Sunshine:

March 2012 was also unusually sunny especially in UK, southern Scandinavia, France, Germany, Austria, Switzerland, Italy,Poland, the Czech Republic, Slovakia, Hungary,Croatia and the Balkan Peninsula. Some ranks of sunny March months are listed below.

```
United Kingdom: rank 1  since 1929
Austria:        rank 3  since 1880
Denmark:        rank 9  since 1920
Germany:        rank 5  since 1951
France:         rank 3  since 1950 (together with 1961 and 1953)
```

Events:

- High temperatures and low precipitation promoted wildfires in Bulgaria and in Austria as well
- High temperatures caused mud flows by snowmelting as well as avalanches in Austria
- A new record for daily maximum temperature for March occurred on 22 March in Uppsala, Sweden (19°C). The old record was of 1840.

Monthly Means or Totals and Anomalies :

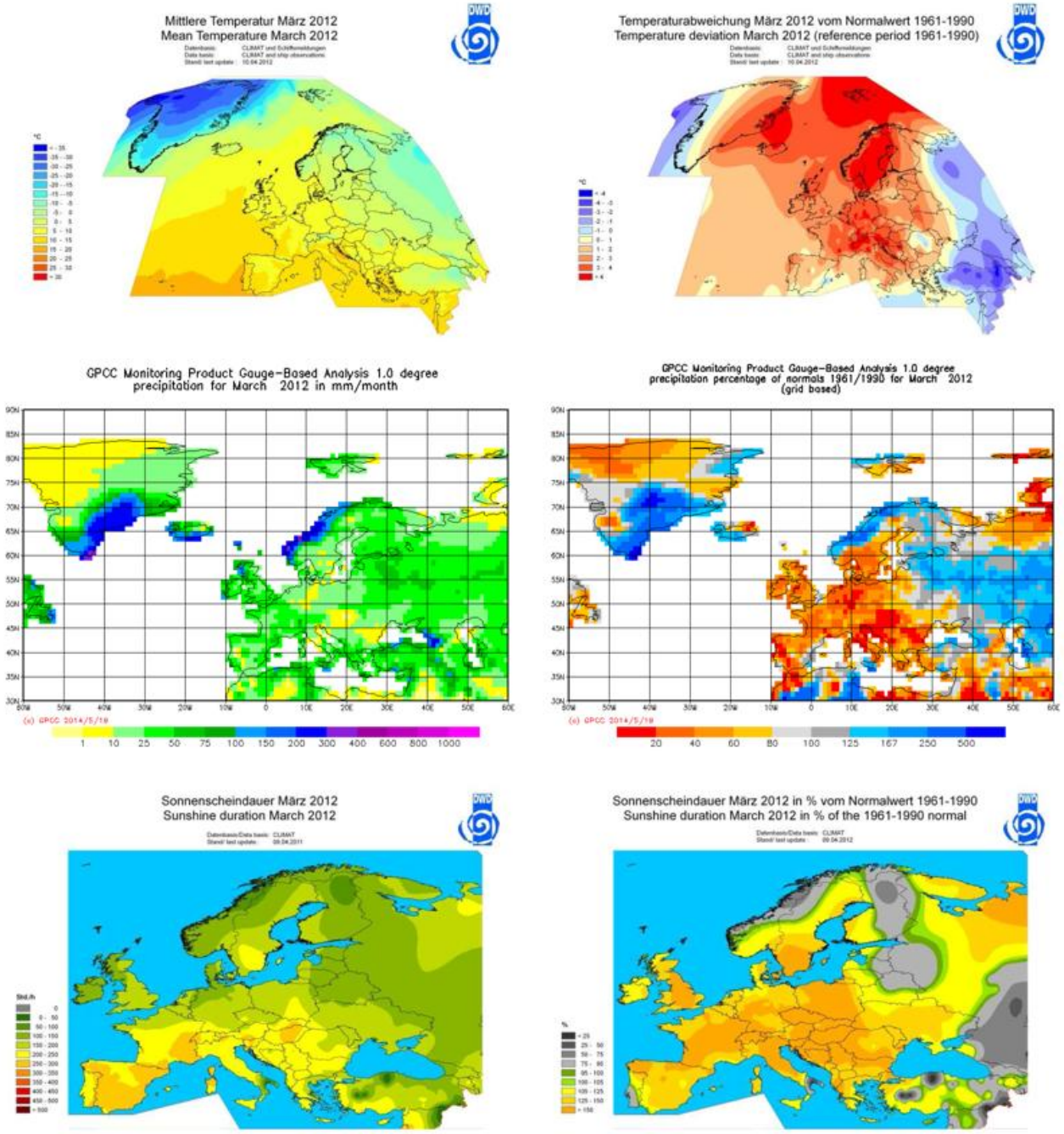


Fig. 3.11: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in March 2012*

Monthly Climate Extremes and Events:

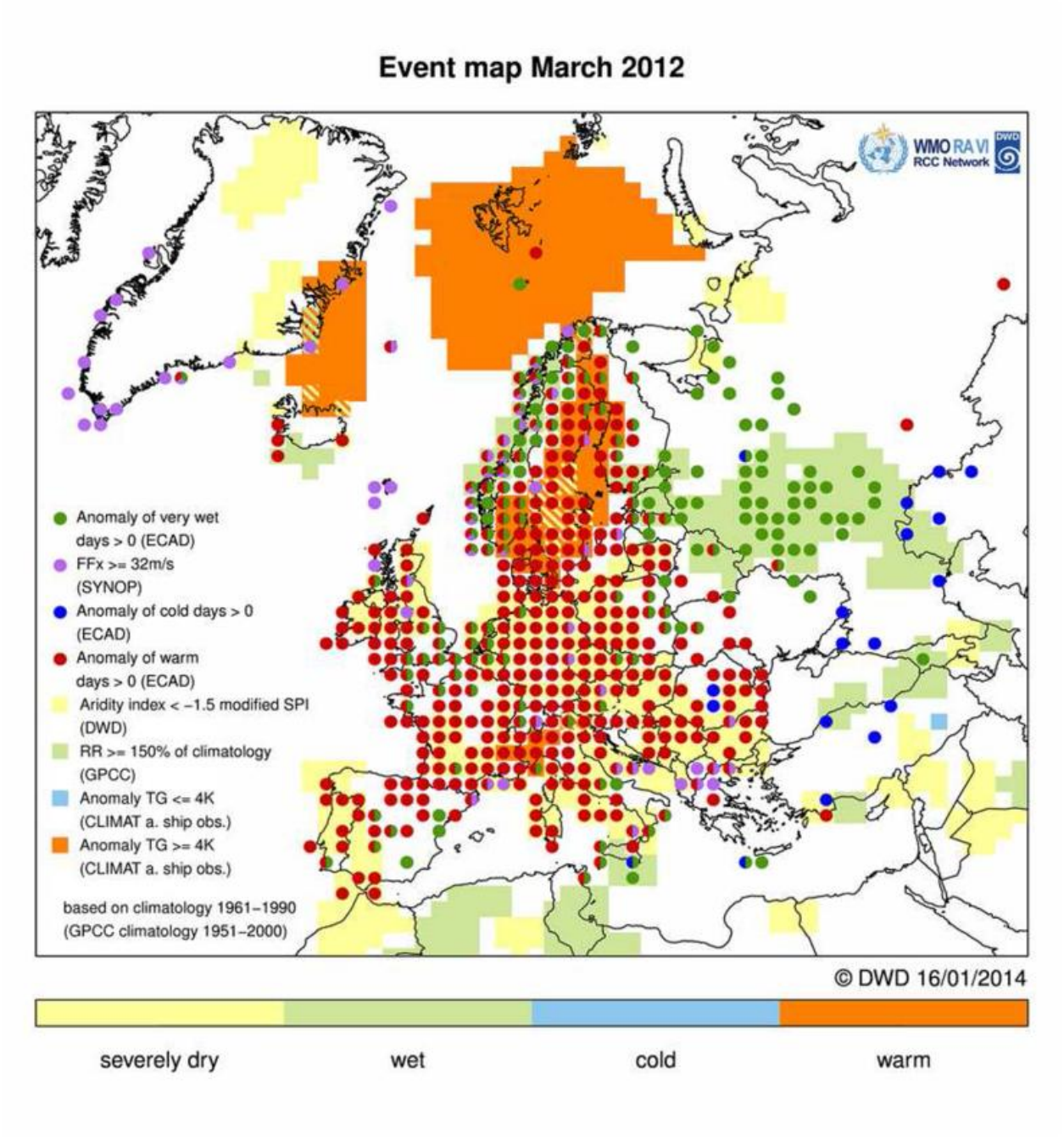


Fig. 3.12 : Monthly Map of Climate Extremes and Events March 2012

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

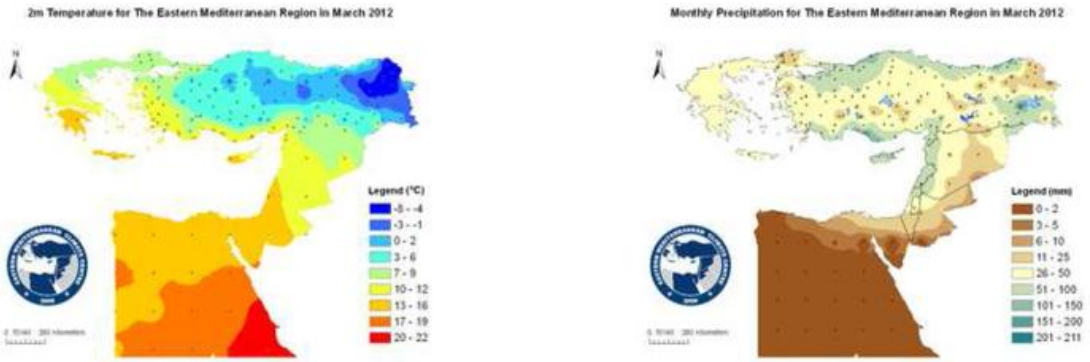


***Fig. 3.13** : Monthly mean temperature (°C) and monthly precipitation totals (mm) March 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

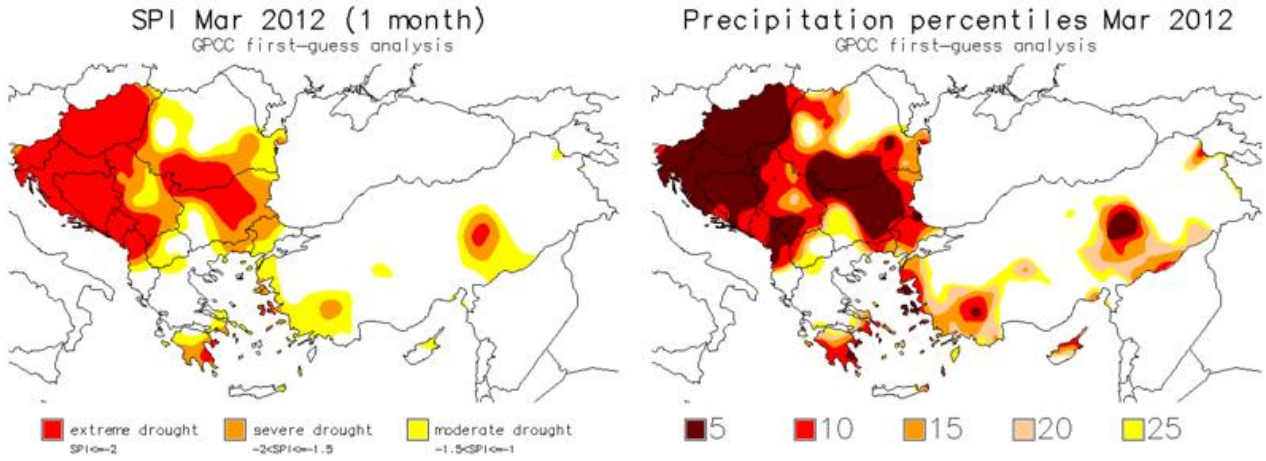


***Fig. 3.14** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
March 2012

April

Highlights:

- ***Western Europe colder than normal but new records of the daily maximum temperature at many single stations in European Russia, Lithuania, Romania and Austria.***
- ***Wettest April since 1766 in England and Wales but one of the driest April months since 70 years in northern Israel.***

Overview:

Temperature:

In April 2012 the northern and eastern North Atlantic and the western parts of Europe including much of Norway, the British Isles, western France and the western Iberian Peninsula were colder than normal. Eastern Europe, the Middle East and the Mediterranean were warmer than normal. The positive anomalies exceeded 4 K in southern Russia and the eastern Caucasus. The negative anomalies were regionally between -2 and -1 K in Portugal and Spain.

Precipitation:

Most of Europe received more precipitation than normal in April 2012. Exceptions were the Middle East, southern Russia, the Caucasus and the Black Sea Region, which were rather dry, as well as central Europe and the west of Norway and southern Spain. The surplus of precipitation was highest on the southern British Isles and western France, northern Spain, southeastern France and around the southern Adria.

Sunshine Duration

Sunshine duration anomalies in April 2012 were mostly negative in western Europe, positive in eastern central Europe, the Baltic states, the Balkan Peninsula, Turkey, the Ukraine and the Caucasus and slighly negative in the east and northeast.

Events:

- At the end of April several new records of the daily maximum temperature occurred: in Moscow, Russia: 28.9°C; in Alytus, Lithuania: 31°C; at Waidhofen/Ybbs in lower Austria; 32°C and as well at 52 Romanian stations

Monthly Means or Totals and Anomalies :

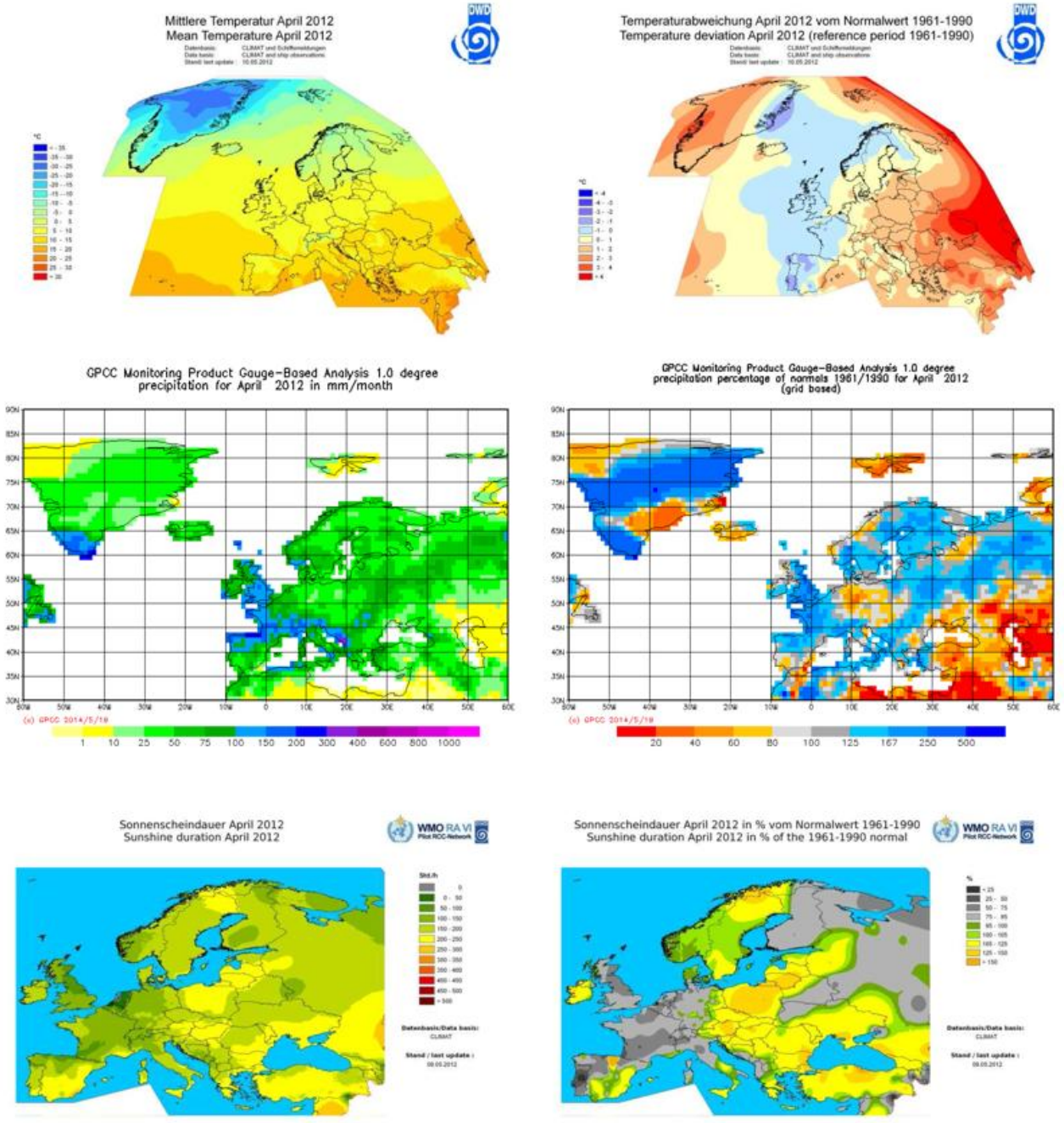


Fig. 3.15: Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in April 2012

Monthly Climate Extremes and Events:

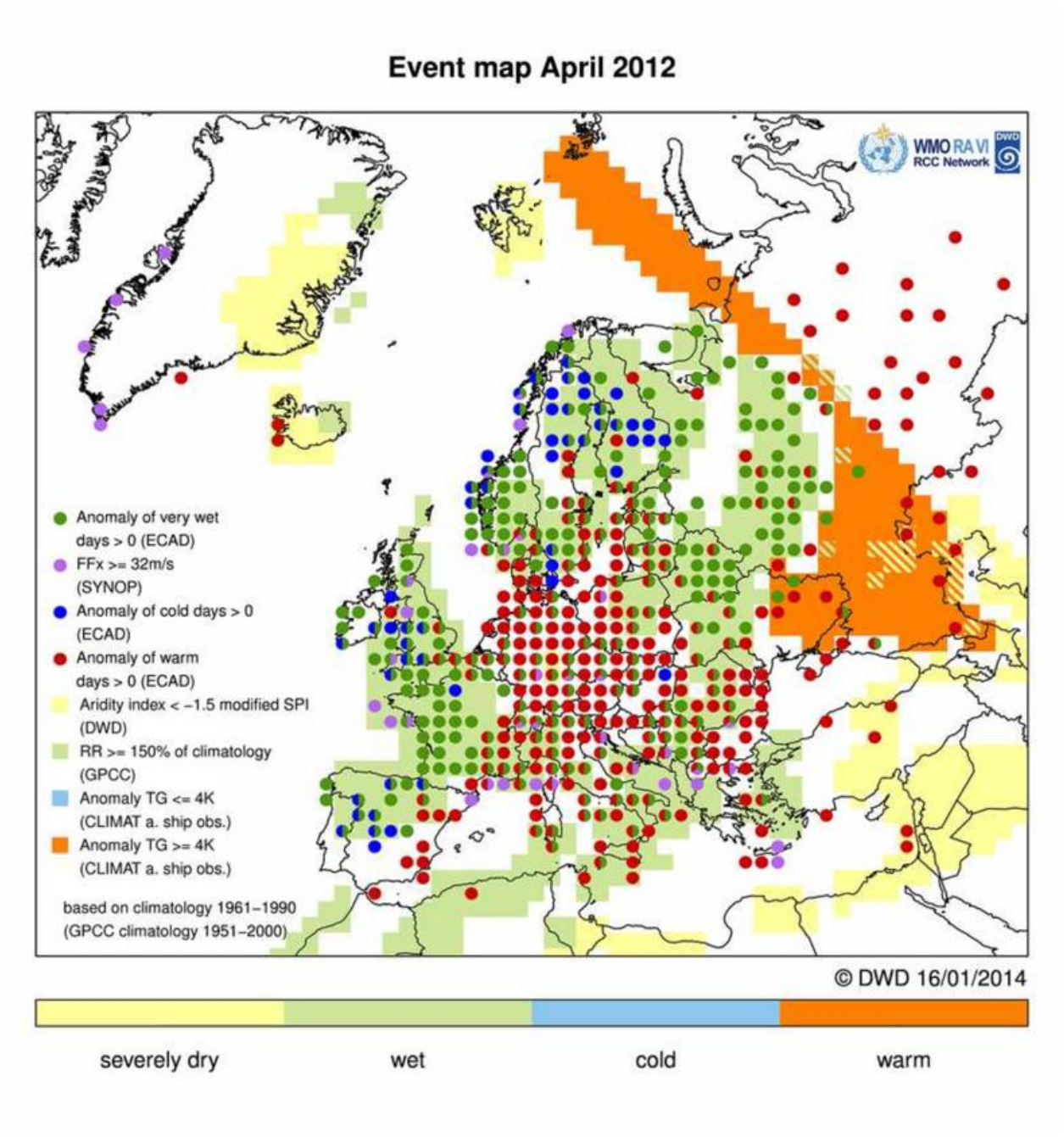


***Fig. 3.16** : Monthly Map of Climate Extremes and Events April 2012*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

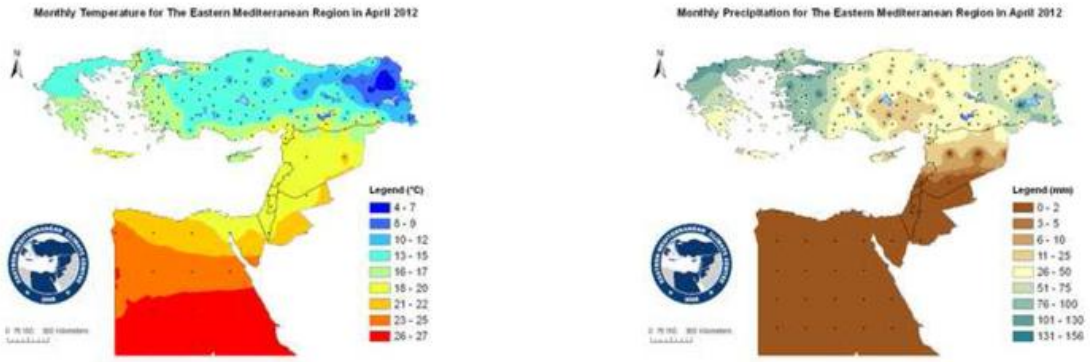


***Fig. 3.17** : Monthly mean temperature (°C) and monthly precipitation totals (mm) April 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

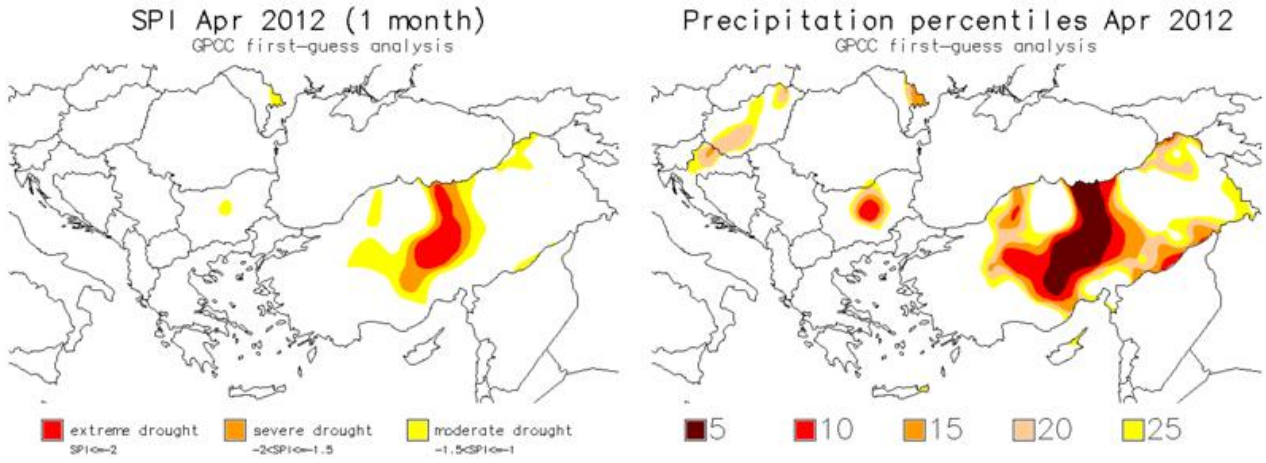


***Fig. 3.18** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
April 2012

May

Highlights:

- ***Highest mean May temperature since 1891 in southern European Russia and new records of daily maximum temperatures for May at stations in Romania and Sweden.***

Overview:

Temperature:

In May 2012 it was warmer than normal with few exceptions over the North Atlantic (especially the Northern North Atlantic with the greatest negative anomaly of -1 to -2 K at the northern Norwegian coast,Faroer Islands: anomaly of -0.9 K), western Turkey and locally Italy and Bosnia and Herzegovina. The positive anomalies were highest in the southern Ukraine (+3 to +4 K). Southern Russia had the warmest May since 1891. A secondary maximum (+2 to +3 K) is located in Spain. Portugal reported record-braking maximum temperatures for several stations and night temperatures well above 20°C during 14-16 May. The warm anomalies of May 2012 were not only restricted to Europe but extended globally. Norway, Sweden and Romania reported new records of the maximum temperatures for May at stations. Denmark reported 3 consecutive summerdays during the 3rd decade of the month. Ireland recorded the highest maximum temperature of 27.8 °C since 1938 on 25 May at Shannon Airport .In the Netherlands on 22 May the first summer day of 2012 was registered at De Bilt and on 23 May even a hot day was registered in eastern parts of the country.

Precipitation:

Higher than normal precipitation totals were registered on the Balkan Peninsula, western Turkey and the Caucasus region as well as partly in Scandinavia and in northern Russia. Much of this precipitation fell as heavy rain. With local exceptions it was drier than normal or close to normal elsewhere.

Sunshine Duration:

May 2012 was mostly sunnier than normal with a surplus up to >150% in central Poland and southern Russia. Less sunshine than normal occurred mainly on the Balkan Peninsula, Turkey and the Caucasus region as well as parts of Sweden, Norway, southern UK and Ireland and Portugal.

Events:

- On 29 May 2012 a new record for the highest temperature ever recorded on Greenland occurred at Ivittuut/Narsarsuaq: 24.8°C.

Monthly Means or Totals and Anomalies :

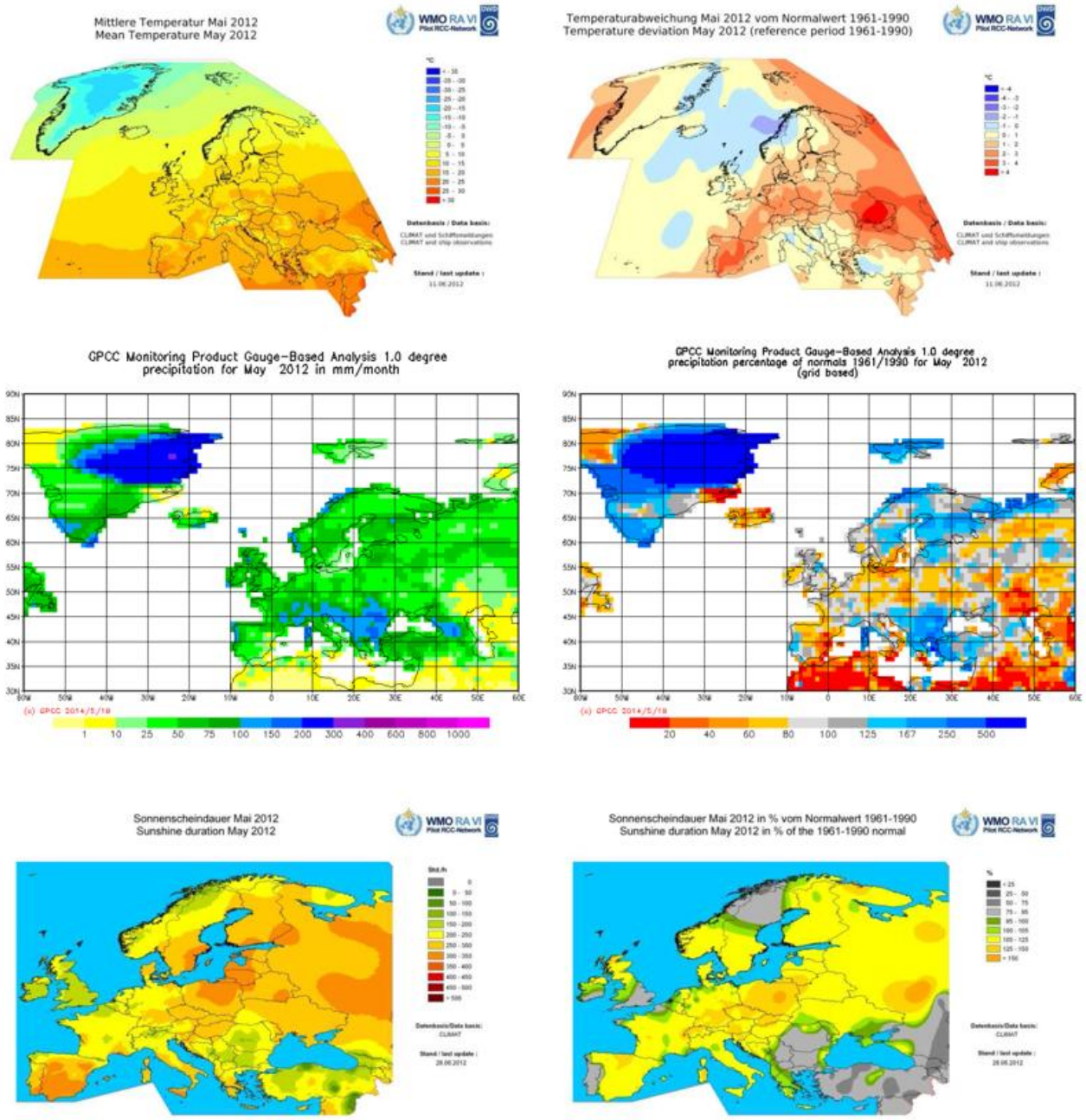


Fig. 3.19: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in May 2012*

Monthly Climate Extremes and Events:

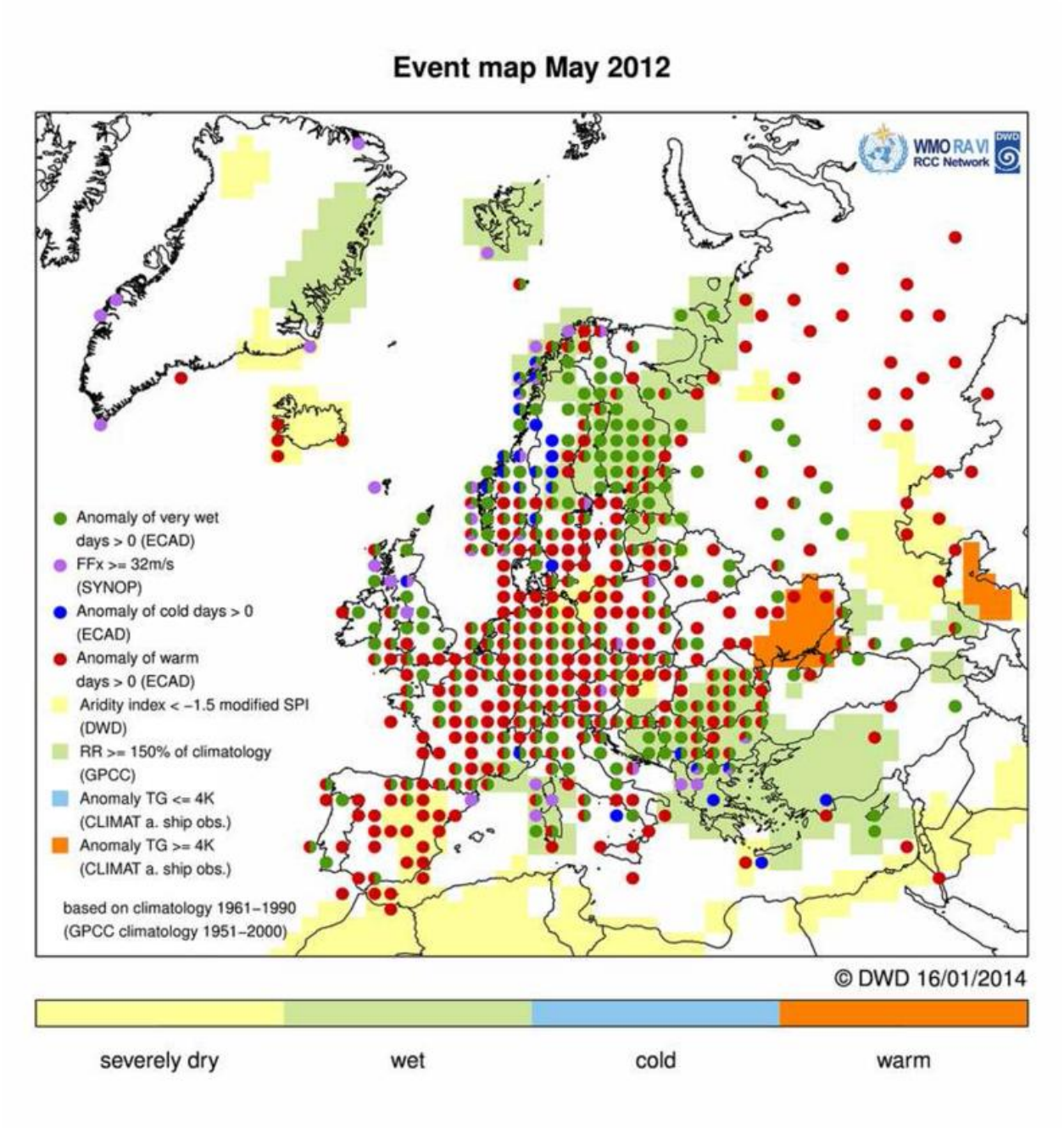


Fig. 3.20 *: Monthly Map of Climate Extremes and Events May 2012*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

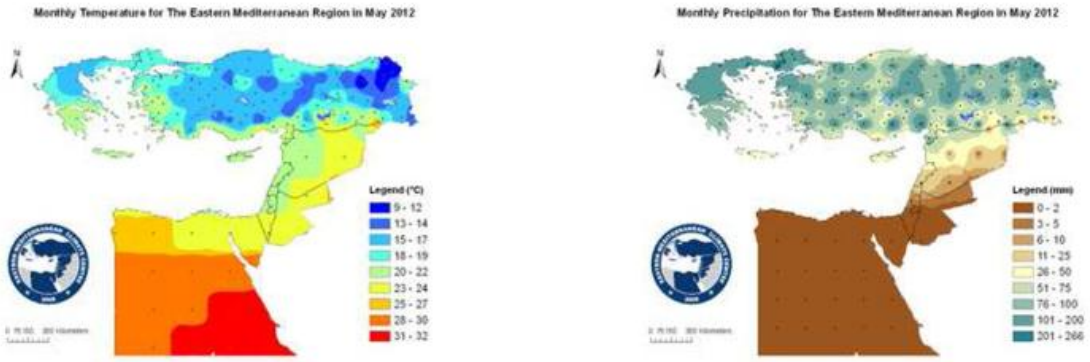


***Fig. 3.21** : Monthly mean temperature (°C) and monthly precipitation totals (mm) May 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

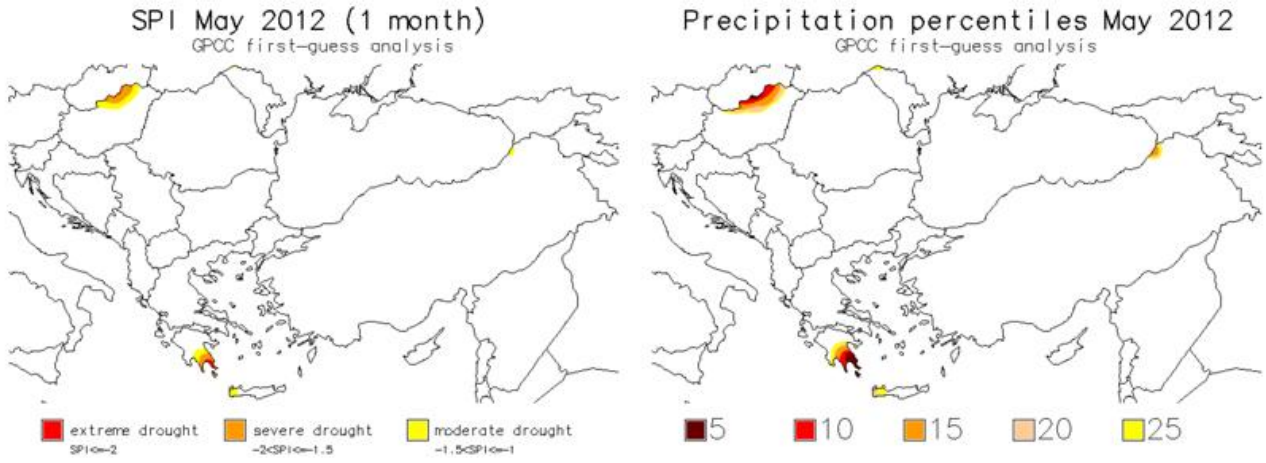


***Fig. 3.22** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
May 2012

June

Highlights:

- ***Unusually hot in Israel in mid of the month with maximum temperature up to 45°C in the Jordan valley and minimum teperatures around 30°C at the Dead Sea.***
- ***Wettest June since 1766 in England and Wales and widespread rainfall with unusually high totals in southern Israel.***
- ***Dullest June since 1929 in UK but up to more than 150 percent of the normal in Romania.***

Temperature

June 2012 was colder than normal in the northwest, north and northeast, warmer than normal in the south, southeast and east and in the Arctic region. The highest maximum temperatures were mostly below the normals in Scandinavia, Ireland, UK, Denmark and Germany. It was the coolest June since 1991 in UK and in Denmark as well as for 2 stations in Ireland. Stockholm registered its coolest June weekend in 84 years at the beginning of the month. Denmark reported rimfrost with a minimum temperature of 1.1°C near Aarhus on 15 June. On the other hand on the Iberian Peninsula, in the Mediterranean Sea region, partly on the Balkan Peninsula and around the Black Sea many stations had more tropical nights (minimum temperature above 20°C), and there were clearly more summer days (maximum temperature above 25°C) than normal. Maximum temperatures of 40°C occurred often.

Precipitation

June 2012 was wetter than normal in the west, north and northeast with exception of the coastal regions of the northern North Atlantic, Norwegian Sea and Arctic Sea. It was drier than normal around the Mediterranean Sea and the Black Sea region. Locally the Middle East was wetter than normal. It was by far the rainiest June on record since 1786 in Stockholm, Sweden. It was the wettest June across the UK in the series from 1910 (wetter than June 2007), and the equal-wettest June in the England and Wales series from 1766 (shared with June 1860). In Ireland the majority of stations across the country reported their wettest June on record. More days with very heavy rain (>=20 mm) than normal were recorded at many stations on Ireland and northern England, in Sweden, in the Alpine region and Belarus and western Russia. Highest 1-day precipitation amounts were partly remarkably above the normal values. On the other hand in the Mediterranean Sea region, the Iberian Peninsula, the Balkan Peninsula and most of the Black Sea area and southern Russia the monthly precipitation totals were often below 25 mm, on the southern Iberian Peninsula and the Mediterranean Sea and Middle East below 10 mm or partly even below 1 mm.

Sunshine Duration

June 2012 was sunnier than normal mainly around the western Mediterranean Sea, on the Balkan Peninsula and the southern Ukraine. Romania with partly more than 150 % of the normal was sunniest, but overall also the Balkan Peninsula was very sunny. Elsewhere it was close to normal or dull. In UK it was provisionally the second dullest June in the series from 1929. The far north-west of Scotland was the sunnier exception. Germany for instance had the 12th dullest June since 1951.

Events

- On 8 June hail with diameters between golf ball to tennis ball at Wieselburg (district Scheibbs) in Austria caused estimated economic damage of 3 millions Euro.
- A heat wave from 14 to 18 June in Israel brought maximum temperatures of 43°C to 45°C around the Dead Sea and Arava region, 40°C to 42°C in the Jordan Valley and 38°C to 40°C in the Negev and 35°C to 37°C in the mountains. On 17 to 18 June minimum temperatures fell only to 26°C to 28°C and around the Dead Sea and Eilat to 30°C to 32°C. Only 3 times during the last 60 years higher night-time minima occurred.
- On 16 June cloudbursts occurred in the southeast of the Moscow region. The places Kolomna and Kashra received 116 mm and 89 mm within 12 hours.
- On 22 June it rained in northeastern Israel, around the Dead Sea and in the Negev. Precipitation totals of 10-20 mm were recorded widely and the higest daily total was 35mm
- On 28 June severe thunderstorms brought locally torrential rain, large hailstones and flooding to parts of the Midlands and northern England with 40 to 50 mm within 2 to 3 hours at some places

Monthly Means or Totals and Anomalies :

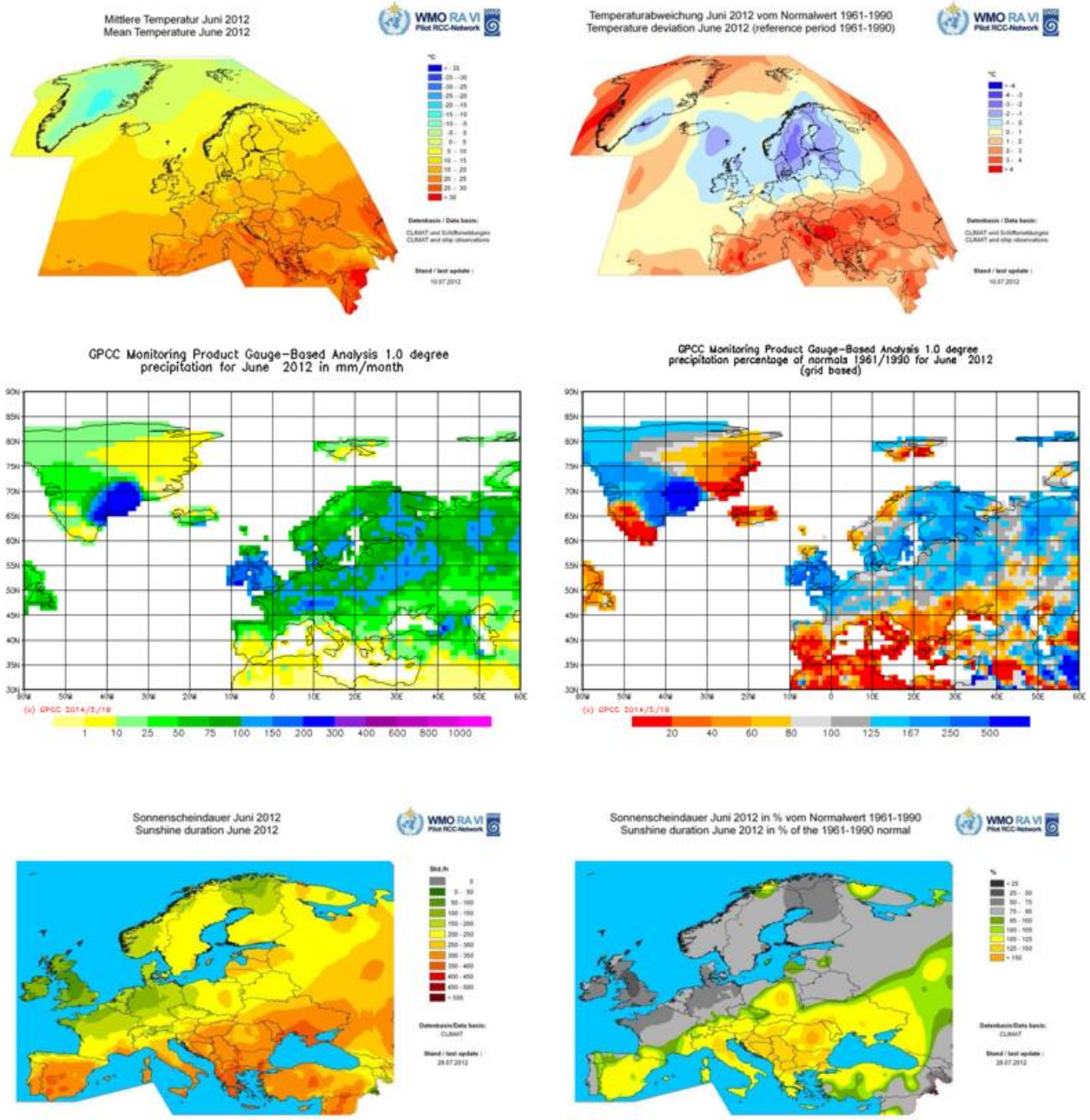


Fig. 3.23: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in June 2012*

Monthly Climate Extremes and Events:

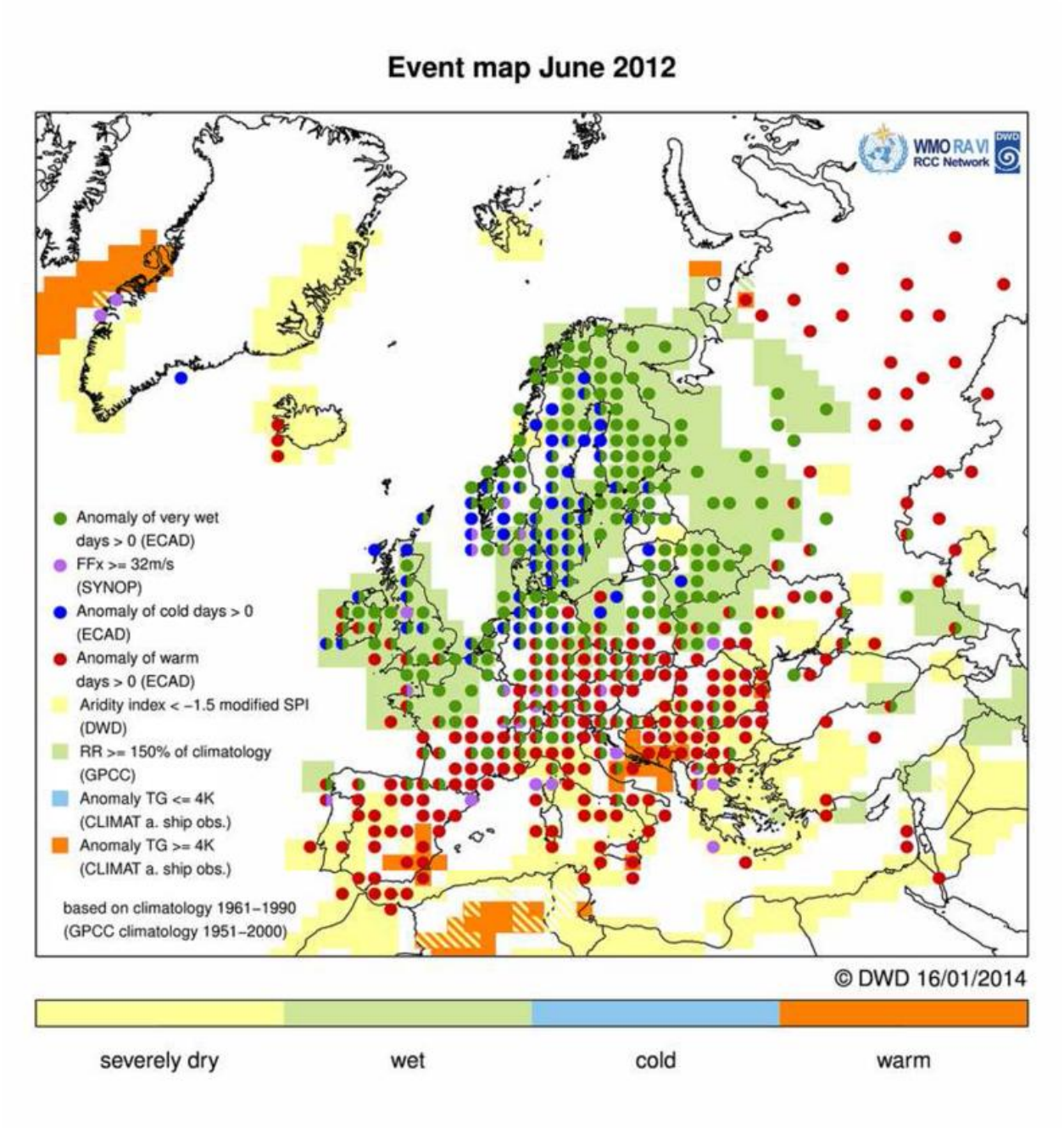


***Fig. 3.24** : Monthly Map of Climate Extremes and Events June 2012*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

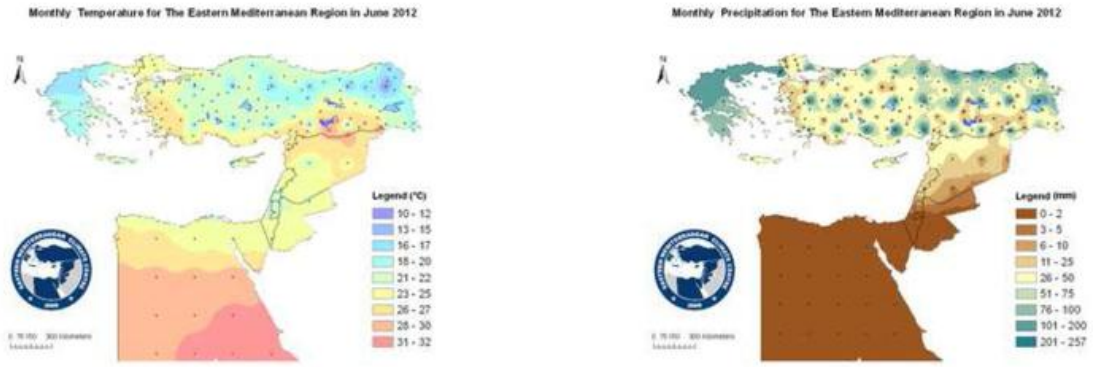


***Fig. 3.25** : Monthly mean temperature (°C) and monthly precipitation totals (mm) June 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

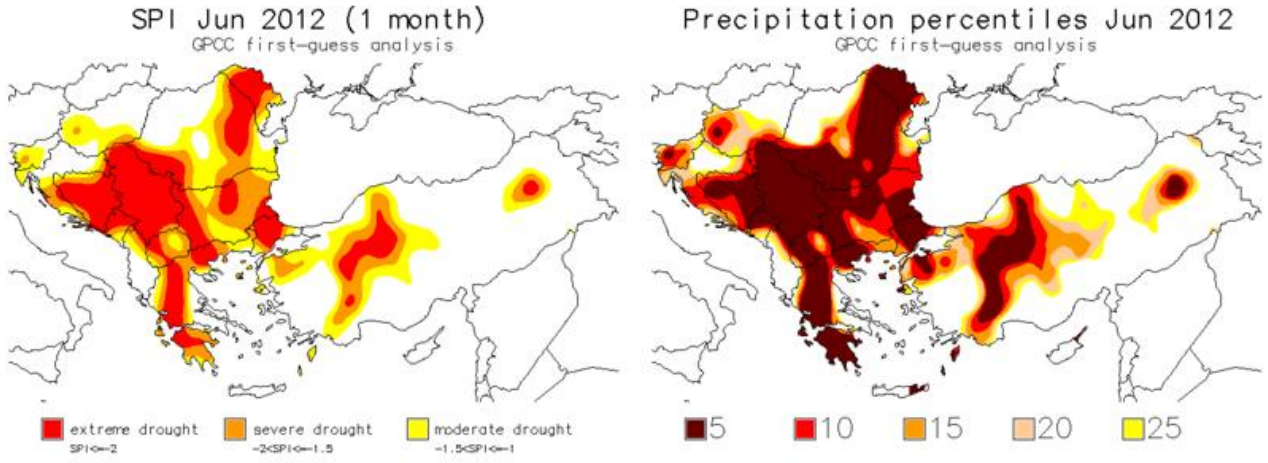


***Fig. 3.26** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
June 2012

July

Highlights:

- ***Several days with temperatures above 0°C in Kangerlussac on Greenland.***
- ***Unusually extreme rainfall events in Sweden, in Austria and in southern European Russia.***

Temperature

On the whole Northern Hemisphere most of the land area and the western North Atlantic were warmer than normal.

Warmer than normal conditions were prevailing except in the west and north of Europe under the influence of the North Atlantic. Most striking was the positive anomaly of more than 4 K on the Balkan Peninsula and Ukraine. Also where the positive anomalies were less or it was overall colder than normal, partially more warm days than normal occurred. Many hot days and days with more than 40°C occurred in southern and southeastern Europe.It was the warmest July on record in Hungary as well as in parts of Israel. Several days with temperatures above 0°C occurred on Greenland (Kangerlussaq).

Precipitation

It was wetter than normal in western, central, northern and northeastern Europe as well as the Middle East and drier in the southwest, south, east and southeast. The relatively wettest areas are on the British Isles, northern and eastern parts of Central Europe and the eastern Alps, northern parts of Russia, the central Mediterranean and partly the Middle East. It was the 3rd wettest July since 1858 in Austria. At many Austrian stations, predominantly in the south and southeast new records for the July precipitation totals were achieved. In Mallnitz (Carinthia) July 2012 brought 325 mm, 82 mm more than in 2005. The series started 1895. Much of the surplus was caused by more than usual wet days. It was on the other hand very dry especially around the Mediterranean Sea except the region around southern Italy and the Thyrranean Sea.

Sunshine Duration

Sunshine duration was above normal in southern and southeastern Europe. The greatest positive anomalies occurred on the Balkan Peninsula and in Poland. This corresponds to the low number of dull days and in the Mediterranean Sea and on the Iberian Peninsula to the high number of fair days. This of course supported the high temperatures in the area.

Events

- Rain and several days of thaw have been registered at the Arctic ice cap with high temperatures late June and several days in a row in July above 0°C. mm (see Fig. 3.29).
- 20 of 31 days with weather-related damages in Austria with one of the most intense hailstorms (hailstones of up to 8 cm in diameter) in recent years in Austria on 8 July
- On 20 July large parts of the district Lietzen (in Styria, Austria) were a desaster area after long-lasting heavy rainfall. A mudslide buried 70 houses of St. Lorenzen in the Paltental. Vehicles piled up to 10 meters high. The entire infrastructure, drinking water and electrcity supply was detroyed. The cleaning and rebuilding work lasted until the end of the year.
- Torrential melting waters destroyed a bridge in Kangerlussac, Greenland
- 163 mm daily precipitation total on 7 July in Hinshult, southeastern Sweden; the 5th highest daily amount ever recorded in Sweden.

- Destructive flooding in the Krasnodar territory with daily totals of the order of six-month totals for the region. On 6 July 2012 Gelendzhik received 253 mm. Novorossisk and Krymsk received 187 resp. 156 mm.
- In Romania the Thermal Heat Index (THI) reached or exceeded a critical value almost every day.

Monthly Means or Totals and Anomalies :

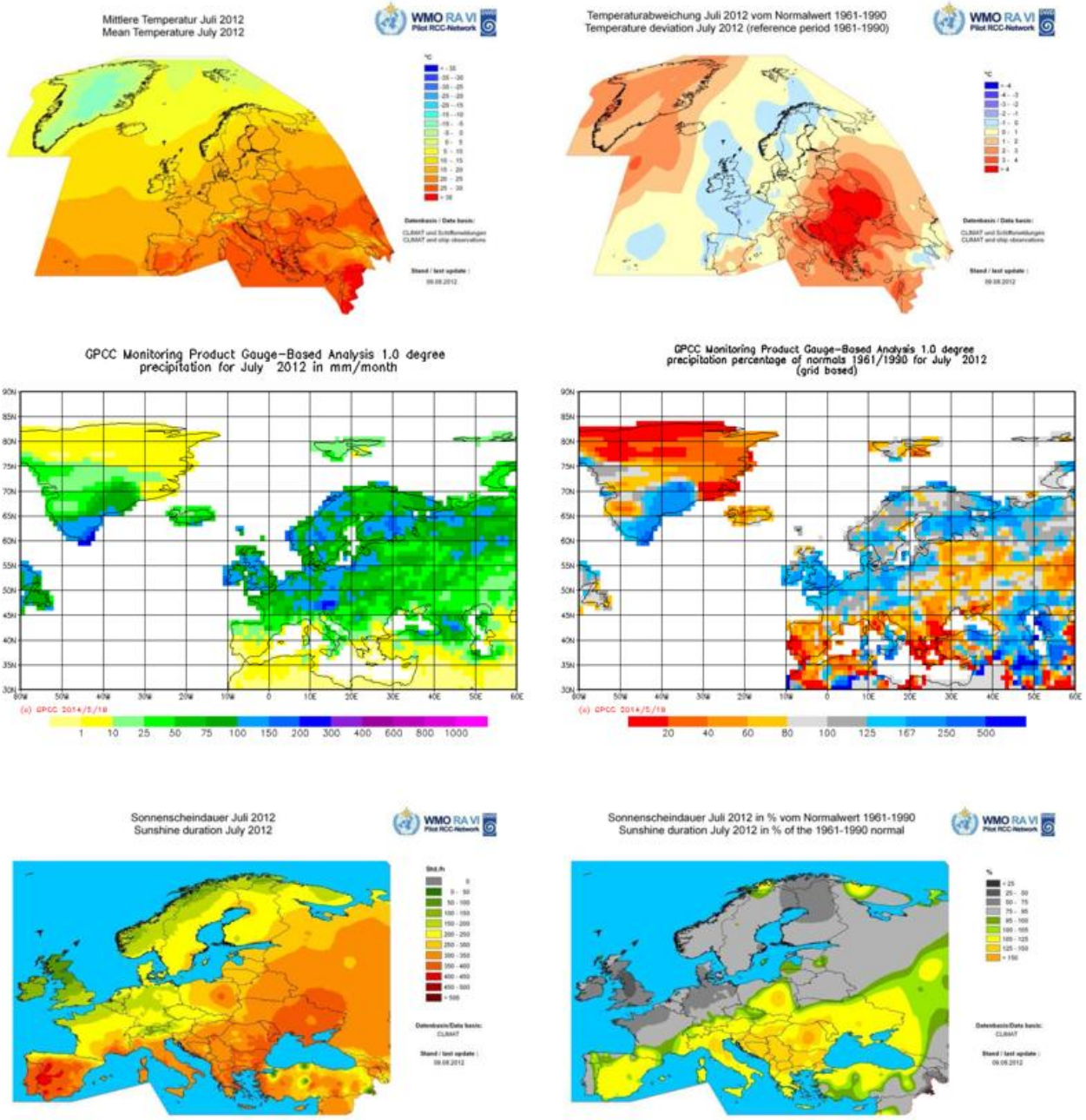


Fig. 3.27: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in July 2012*

Monthly Climate Extremes and Events:

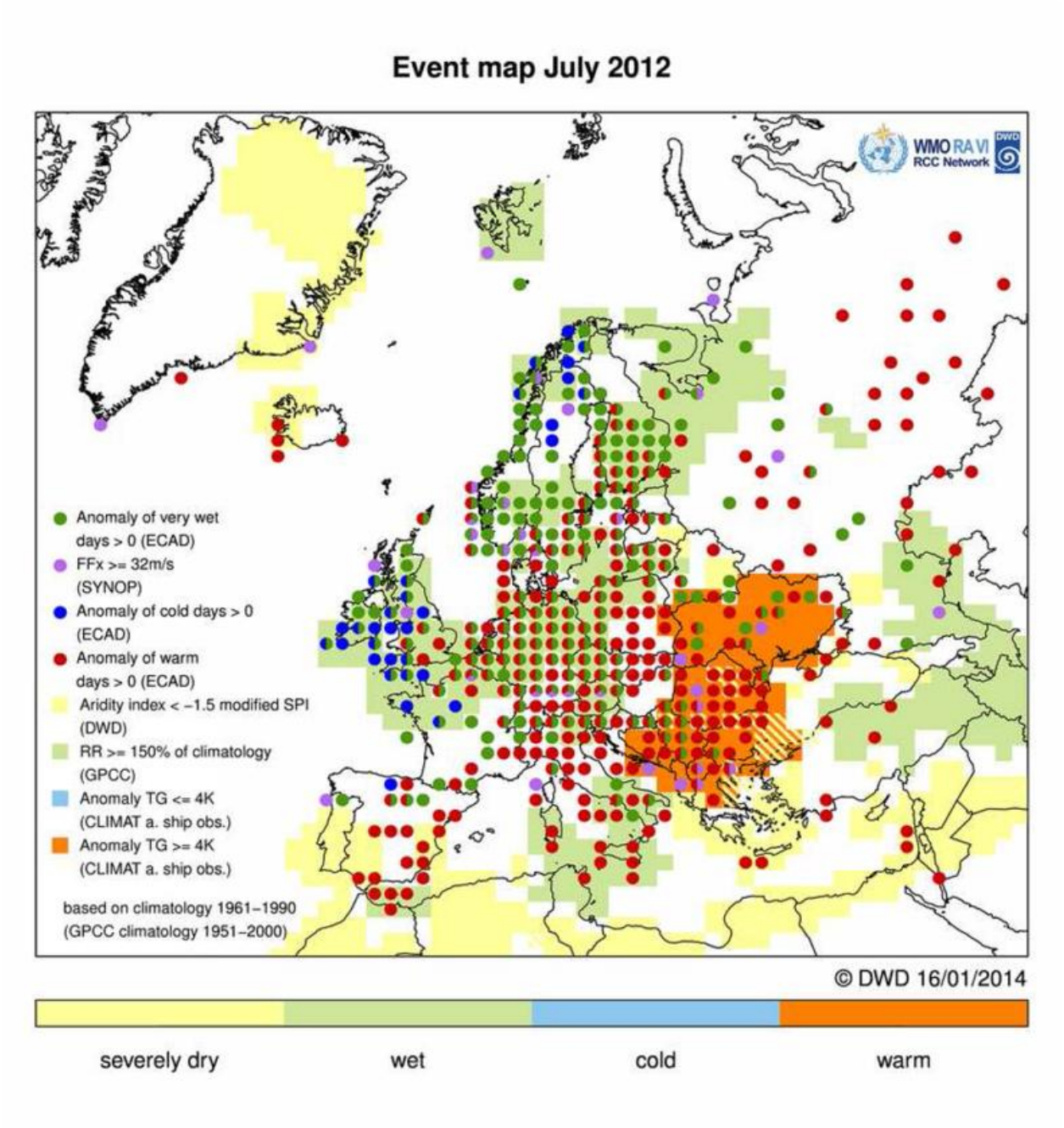


***Fig. 3.28** : Monthly Map of Climate Extremes and Events July 2012*

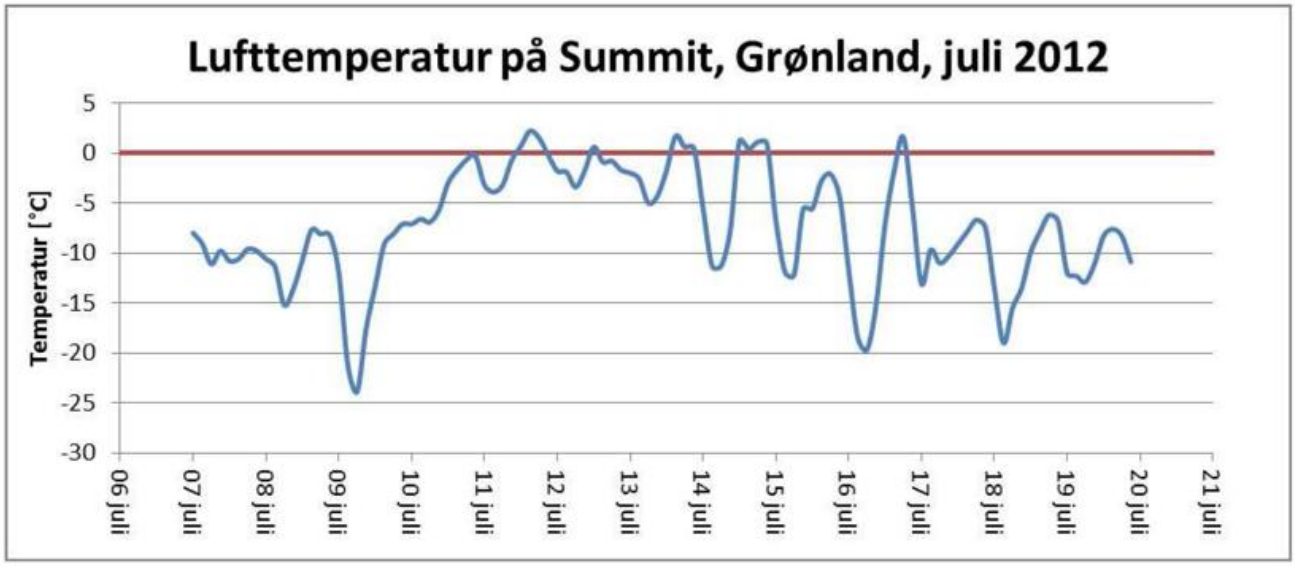


Fig. 3.29 *: DMI has observed the surface air temperature (SAT) at Summit in the middle of the Greenland ice cap in 3.2 km altitude since 1991. DMI's observations show that the temperatures typically range from -60 to -50°C in winter and from -10 to 0°C in summer. It is not unusual to observe positive temperatures on a few days during a year. It is a fact in 10 different years out the 18 years of observations. Observations from July 2012 (lower figure) showed that temperature for several days in a row exceeded 0°C, not seen before. In the days of 11 - 14 and 16th July the temperatures were above 0 °C. The observations confirm the NASA satellite observations of melting in these days. July 2012*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

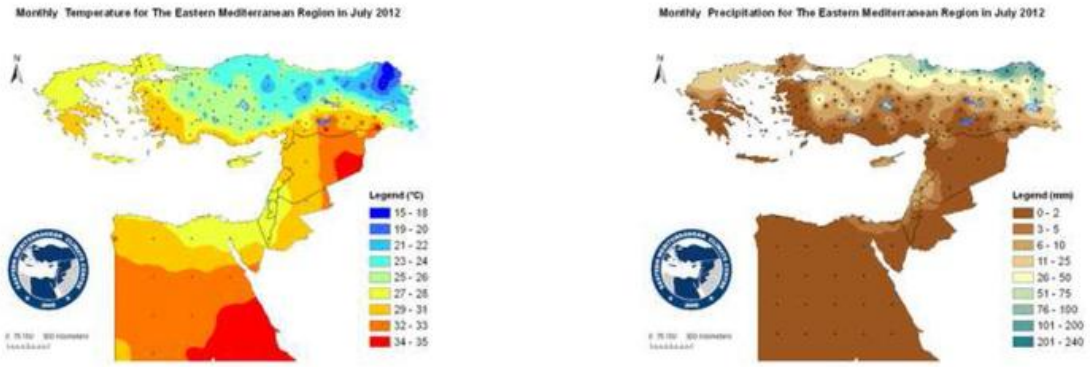


Fig. 3.30 *: Monthly mean temperature (°C) and monthly precipitation totals (mm) July 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

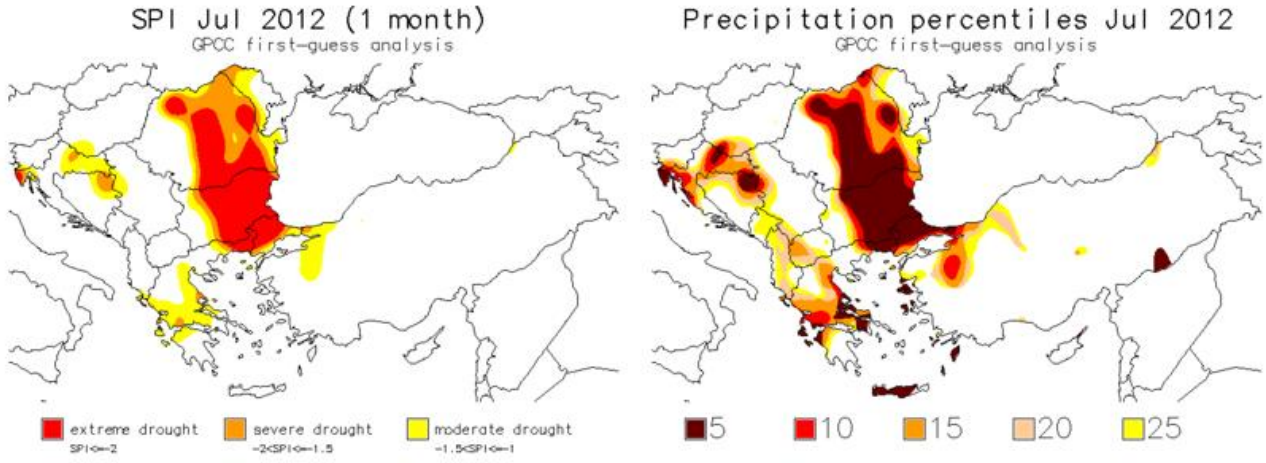


Fig. 3.31 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
July 2012

August

Highlights:

- ***In 24 countries in the region daily maximum temperatures of 40°C or more were reached or exceeded, highest maximum of 45.9°C in Spain.***
- ***Lowest rainfall total for July since 1901 in Hungary***

Overview:

Temperature

August 2012 was warmer than normal nearly in the whole area with exception of slightly colder areas on the North Atlantic, the Norwegian Sea, the Baltic countries and parts of northern Russia and Finland. The positive anomalies reached or exceeded 4 K on the Balkan Peninsula and the Adriatic Sea and in Italy as well as parts of eastern Spain. In many countries (24 in the region) on the Iberian Penisula, the Balkan Peninsula, in the eastern Mediterranean region as well as in Italy and in France daily maximum temperatures of 40°C or more were reached or exceeded (see Fig 3.34 for the heat wave in France). Most of the other countries had at least one station with a hot day (30 °C or more) with exception of Ireland, the Faroer Islands, Greenland, Iceland, Norway, Finland, Estonia and Latvia.

Precipitation

In August 2012 it was very dry on the Balkan Peninsula, in Italy, southeastern France and northwestern France, most of the Iberian Peninsula except the west coast, parts of the eastern Mediterranean and Middle East. Precipitation totals were below 20 percent of the normal in the driest areas especially on the Balkan Peninsula, much of Italy and the Iberian Peninsula. It was the driest August since 1901 in Hungary. Less than normal precipitation was as well observed in central Europe, northern Norway and Finland, partly around the Baltic Sea and in northern Russsia. Also Iceland and southern Greenland were very dry. Wetter than normal were western and northern parts of the British Isles, Netherlands and Denmark, southern Scandinavia, the Alps, Poland, and much of Russia as well as some areas in Greece and Turkey.

Sunshine

In August 2012 it was sunnier than normal in most of the western, central and southern European continent and in northern Scandinavia. It was on the other hand very dull in parts of the Turkish Black Sea area and rather dull in southwestern UK.

Events

- Spain reported the highest maximum temperature of 45.9°C.

Monthly Means or Totals and Anomalies :

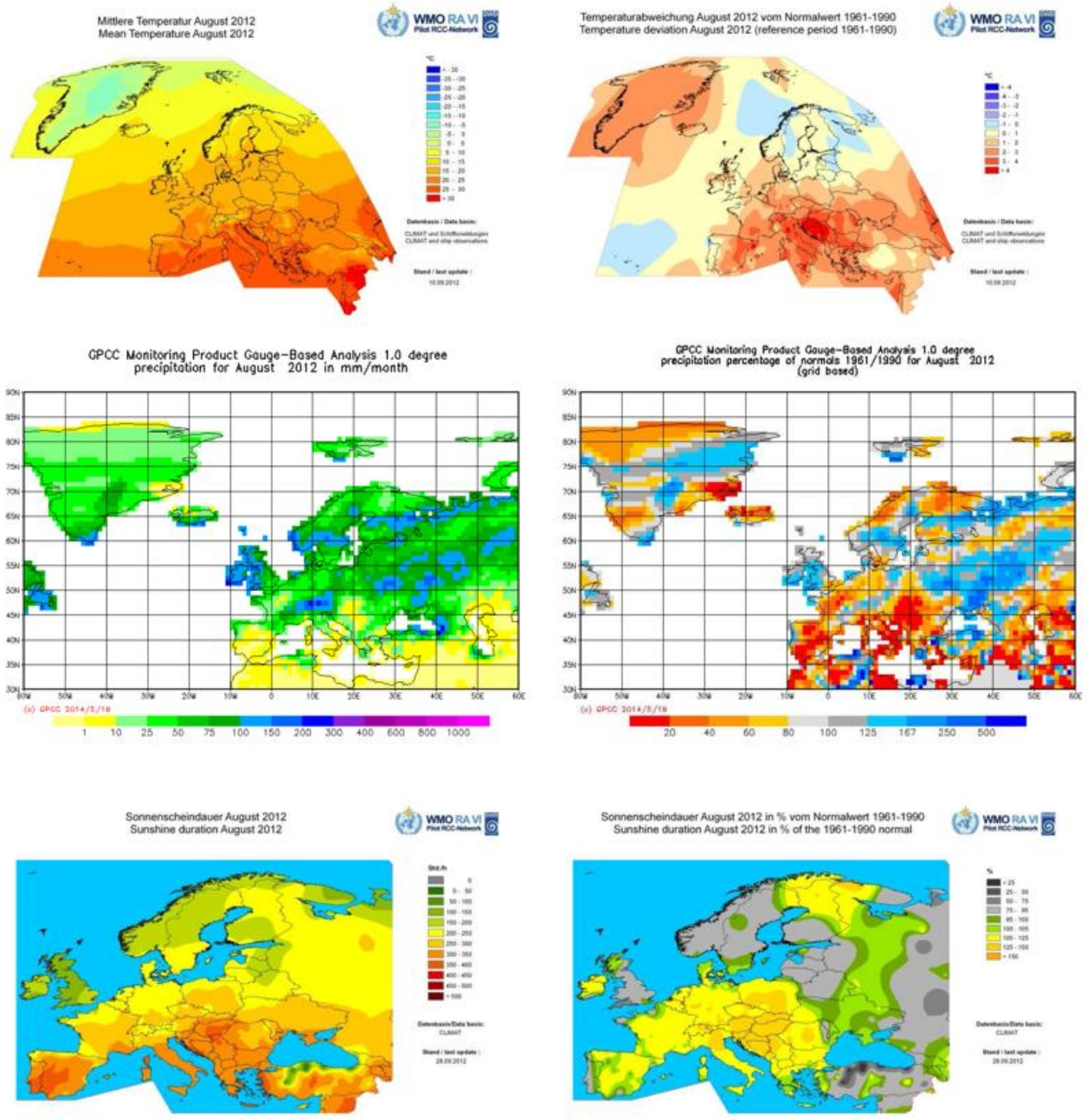


Fig. 3.32: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in August 2012*

Monthly Climate Extremes and Events:

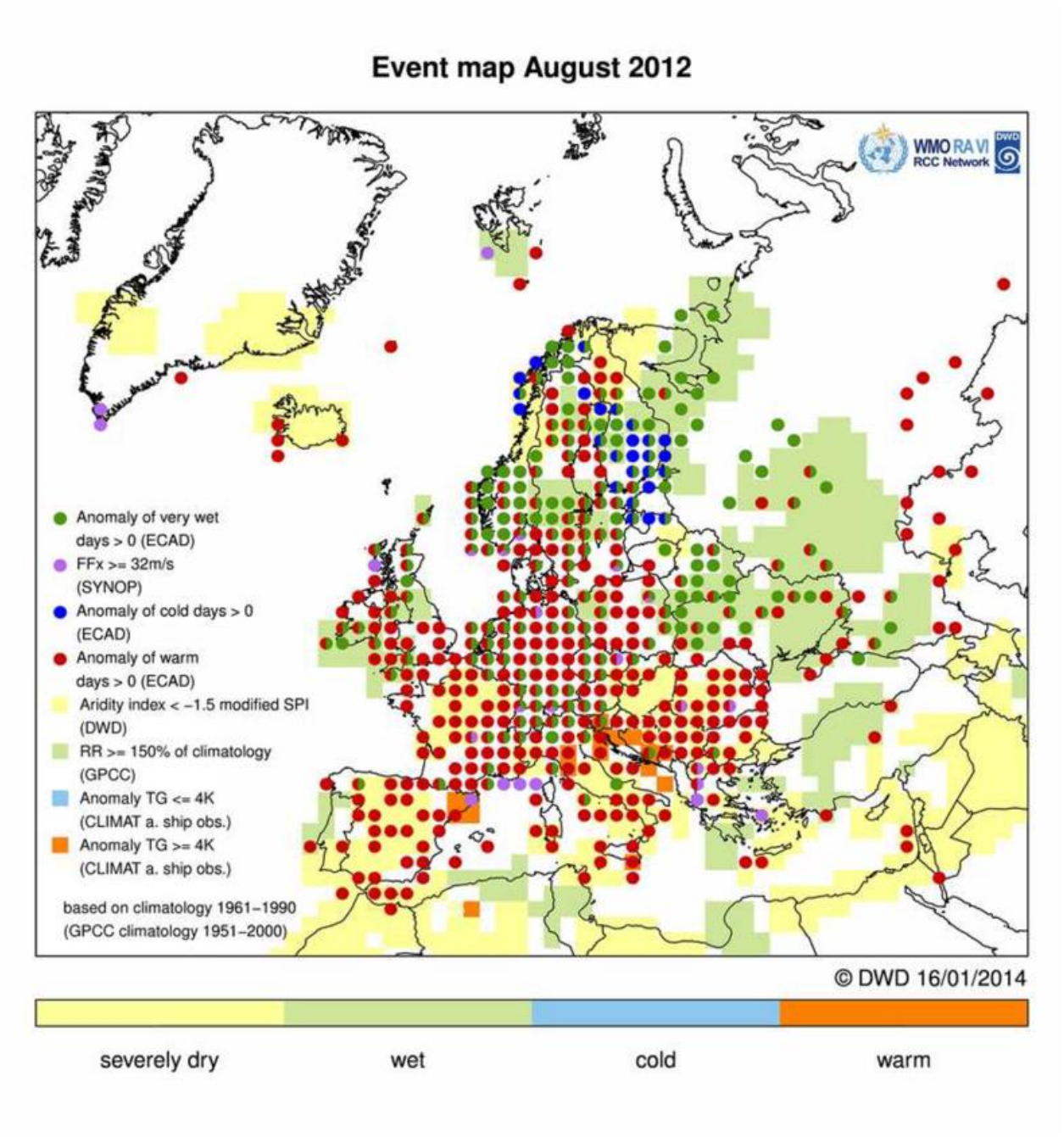


Fig. 3.33 *: Monthly Map of Climate Extremes and Events August 2012*

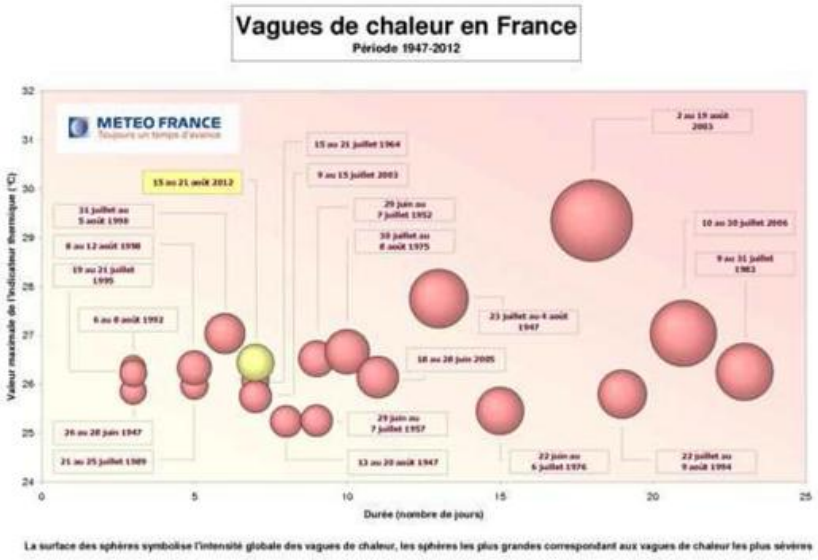


Fig. 3.34 *: The heat wave in August in comparison to earlier heat waves in France August 2012*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

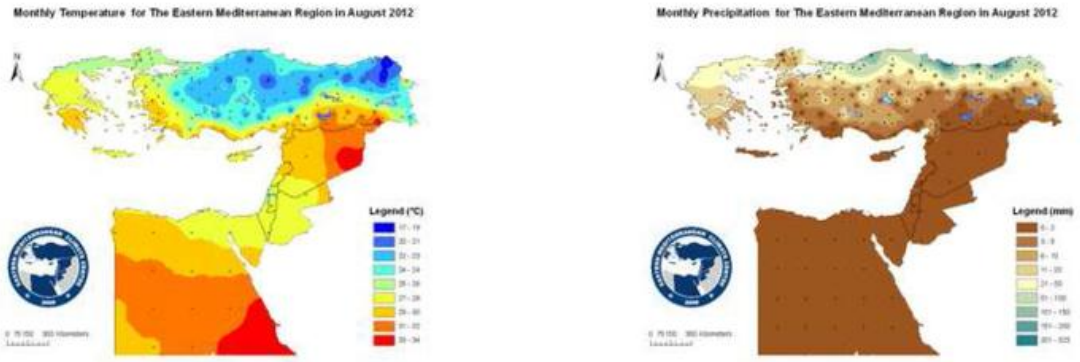


Fig. 3.35 *: Monthly mean temperature (°C) and monthly precipitation totals (mm) August 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

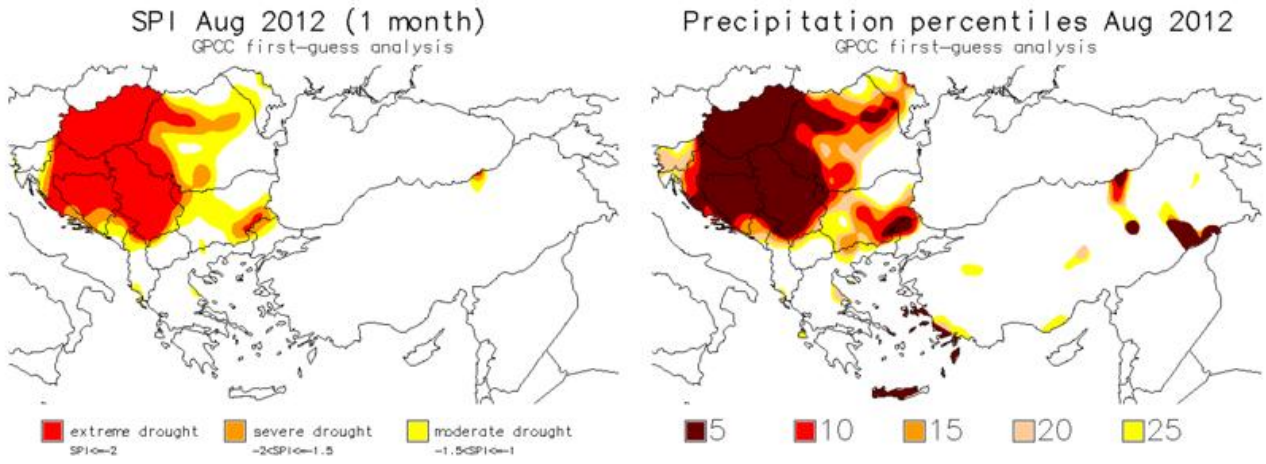


Fig. 3.36 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
August 2012

September

Highlights:

- ***Extremely heavy precipitation in southern Spain and Italy***

Overview:

Temperature

Most of the region was warmer than normal except the North Atlantic and the adjacent countries: northwestern France, the British Isles and southwestern Scandinavia. The Balkan Peninsula in the southwest and the Arctic region and Greenland in the north had the highest positive anomalies of +2 to +3, partly over +3 K.

Precipitation

Much of central, eastern and southeastern Europe and the Middle East were drier than normal. The Mediterranean Sea area especially in its central part as well as the southern Iberian Peninsula and northern and northwestern Europe partly received more precipitation than normal. This surplus was often caused by extremely heavy precipitation. Especially in the Mediterranean Sea area some places received heavy to extremely heavy precipitation for 2 or 3 consecutive days so that large precipitation totals amounted within relative short time.

Sunshine Duration

It was sunnier than normal mostly in central, western, southeastern and southern Europe except the central Mediterranean Sea region. It was less sunny on the other hand in most of the north: northern Germany, Scandinavia except southern and central Sweden and northern Russia. The sunniest country was Poland with positive anomalies up to more than 150 percent of the normal.

Events

- Valencia in Spain recorded a daily total of 188.9 mm on 28 September.
- Extremely heavy rain events in Tuscany, Italy on 19 and 30 September 2012

Monthly Means or Totals and Anomalies :

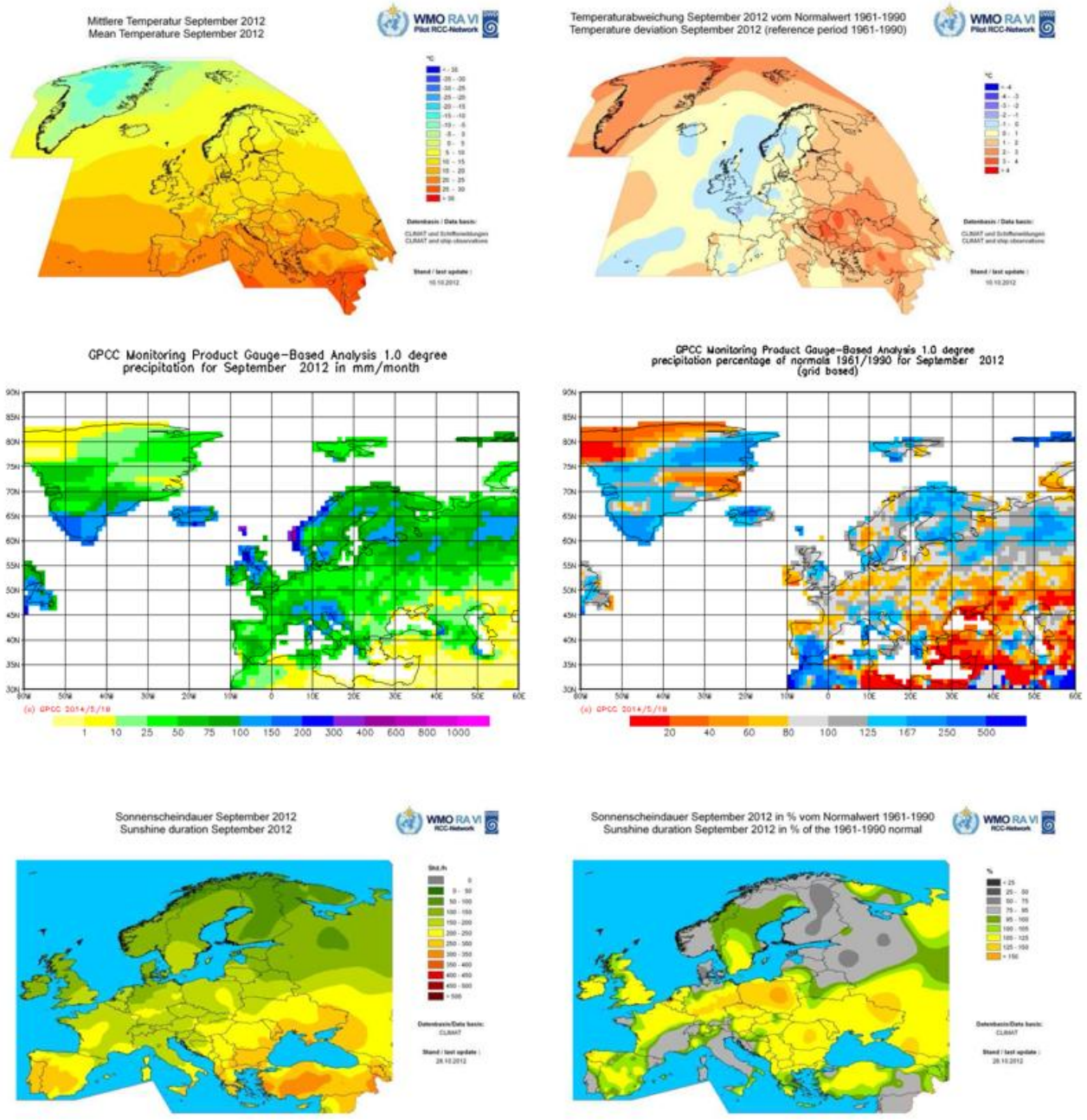


Fig. 3.37: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in September 2012*

Monthly Climate Extremes and Events:

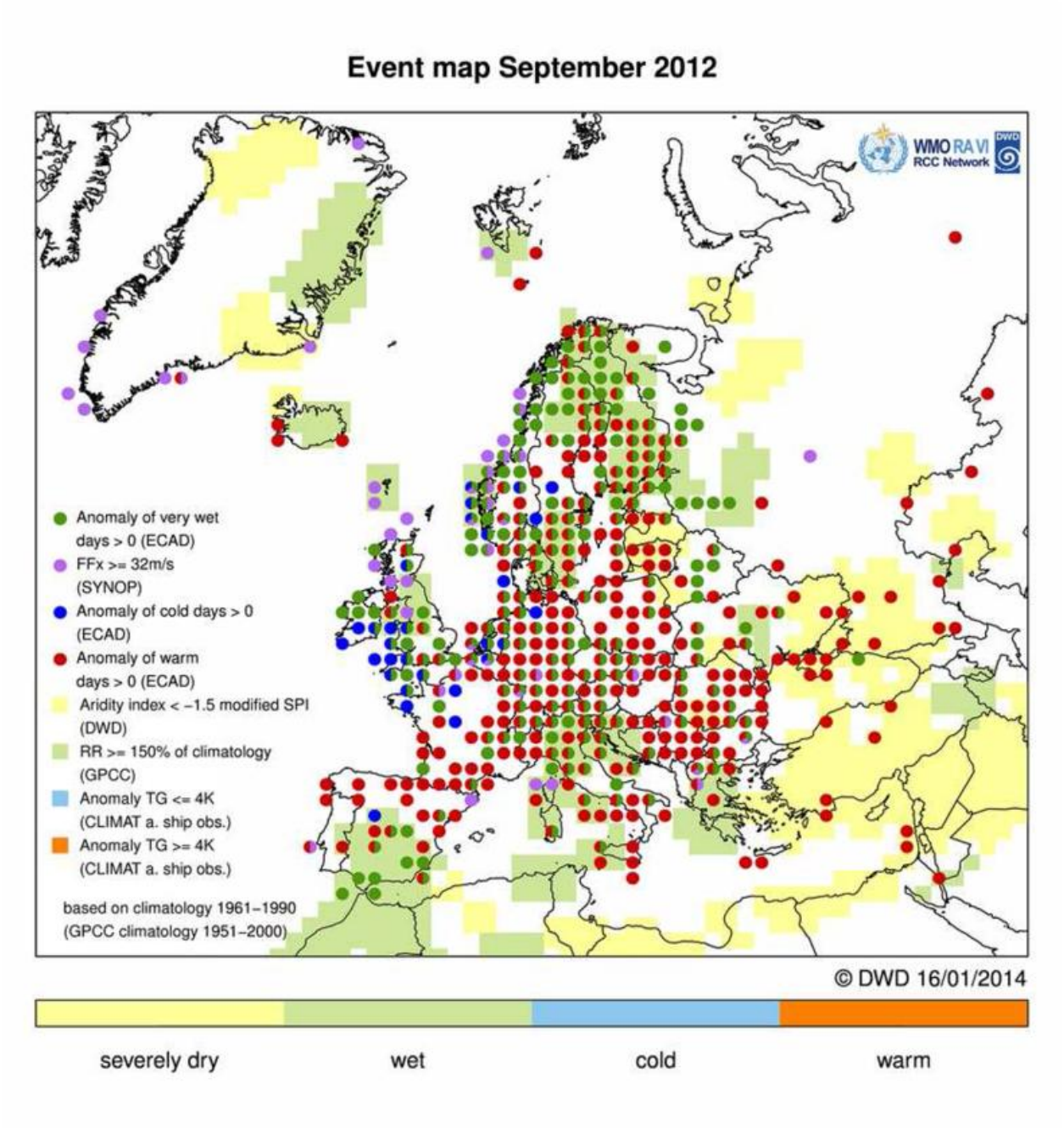


***Fig. 3.38** : Monthly Map of Climate Extremes and Events September 2012*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

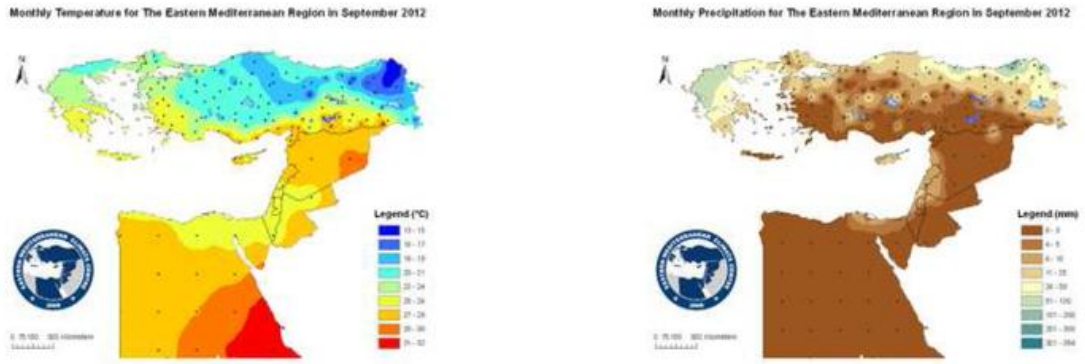


***Fig. 3.39** : Monthly mean temperature (°C) and monthly precipitation totals (mm) September 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

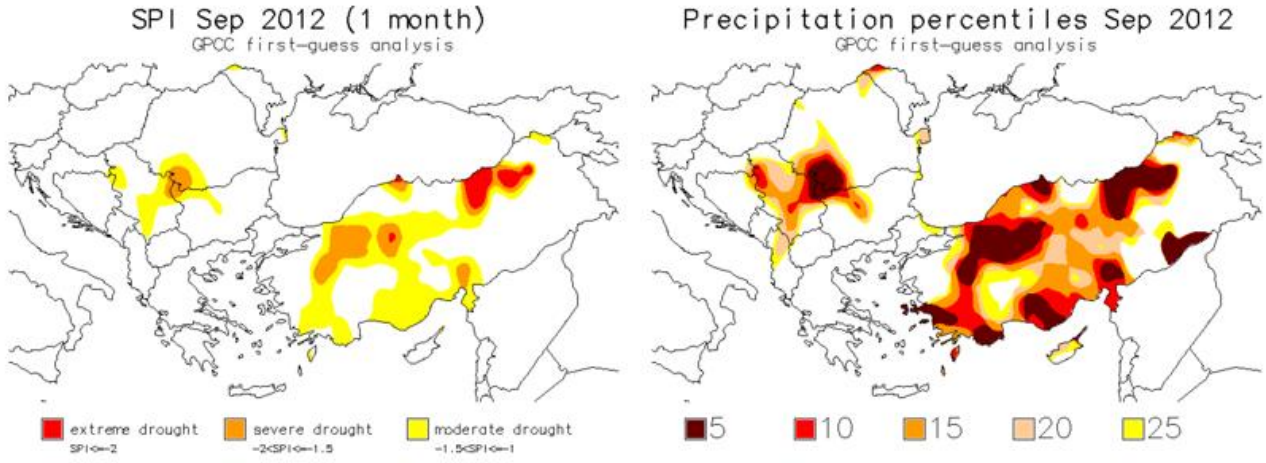


***Fig. 3.40** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
September 2012

October

Highlights:

- ***New records of October maximum temperatures at stations in Sweden, Latvia, Austria, Romania and European Russia***
- ***For some stations in northeastern Sweden the rainiest October on record for more than 100 years.***

Overview:

Temperature

In October 2012 it was mostly colder than normal or close to normal on the eastern North Atlantic, the British Isles, the western Iberian Peninsula, Norway and Sweden except the farest north, Netherlands, Denmark, Germany, Poland and much of the Baltic Sea area. Ireland and northern UK as well as large parts of Norway and western Sweden were coldest with anomalies up to -3 K. UK reported the provisionally coldest October since 2003. It was on the other hand warmer than normal in the south, southeast, east, north and northwest with the highest positive anomalies above 4 K in the Black Sea area and above 3 K from the Aegean Sea northeastwards to southern Russia, southern Ukraine and the Caucasus region as well as in the Barents Sea and northern Greenland.

Precipitation

October 2012 was wetter than normal on most of the western, southern, northern and eastern to northeastern continent, except the eastern Black Sea, the Caucasus region and the Caspian Sea region, the Atlantic region, parts of the Mediterranean Sea region and central Europe (mostly Germany), which were drier. Much more precipitation than normal fell in western France, on the southern Iberian Peninsula, at the Adriatic coast, in the northern Baltic Sea region and in the eastern parts of European Russia as well as in southwestern Greenland. Sweden reported that "in the northernmost part of the Swedish east coast the month of October was the rainiest on record (since more than 100 years) with some local flooding". Especially in the Mediterranean Sea region several phases with extremely heavy precipitation occurred in connection with low pressure systems. Heavy to very heavy precipitation also occurred in the north.

Sunshine Duration

October 2012 was sunnier than normal on the British Isles, the southern Iberian Peninsula, central and eastern central Europe, partly southern and western Scandinavia and on the Italian and Balkan Peninsulas. Elsewhere it was close to normal or dull. Lesser sunshine than normal was especially observed in northwestern France and southeastern UK, partly in Portugal, in northeastern Russia as well as in Finland, the eastern Baltic Sea region and Belarus.

Events

- New records of October maximum temperatures occurred on 1-2 October in Romania, on 20 October in Sweden, Latvia and Austria and end of October in European Russia.
- Heavy rain led to exceptional autumn flooding in western parts of Finland
- During 10 to 13 October heavy to extremely heavy rain in the Adriatic Sea and western Balkan Peninsula accumulated to 3-day totals between 50 and 200 mm.
- On 20 October the cave of Lourdes in France became flooded after heavy rain
- During a storm a maximum windgust of 43.9 m/s was recorded on 30 October 2012 in Izaña (Teneriffa).

Monthly Means or Totals and Anomalies :

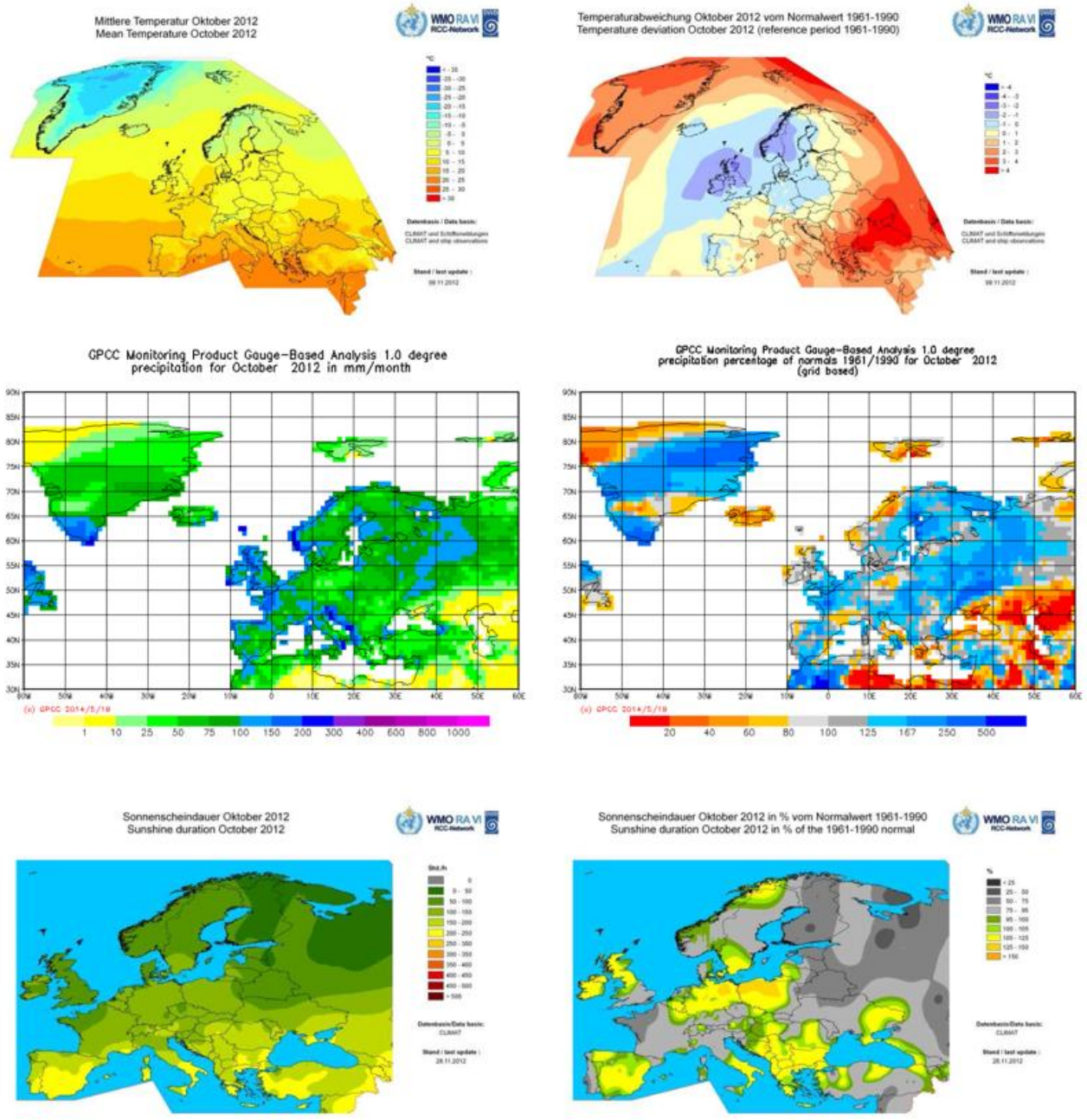


Fig. 3.41: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in October 2012*

Monthly Climate Extremes and Events:

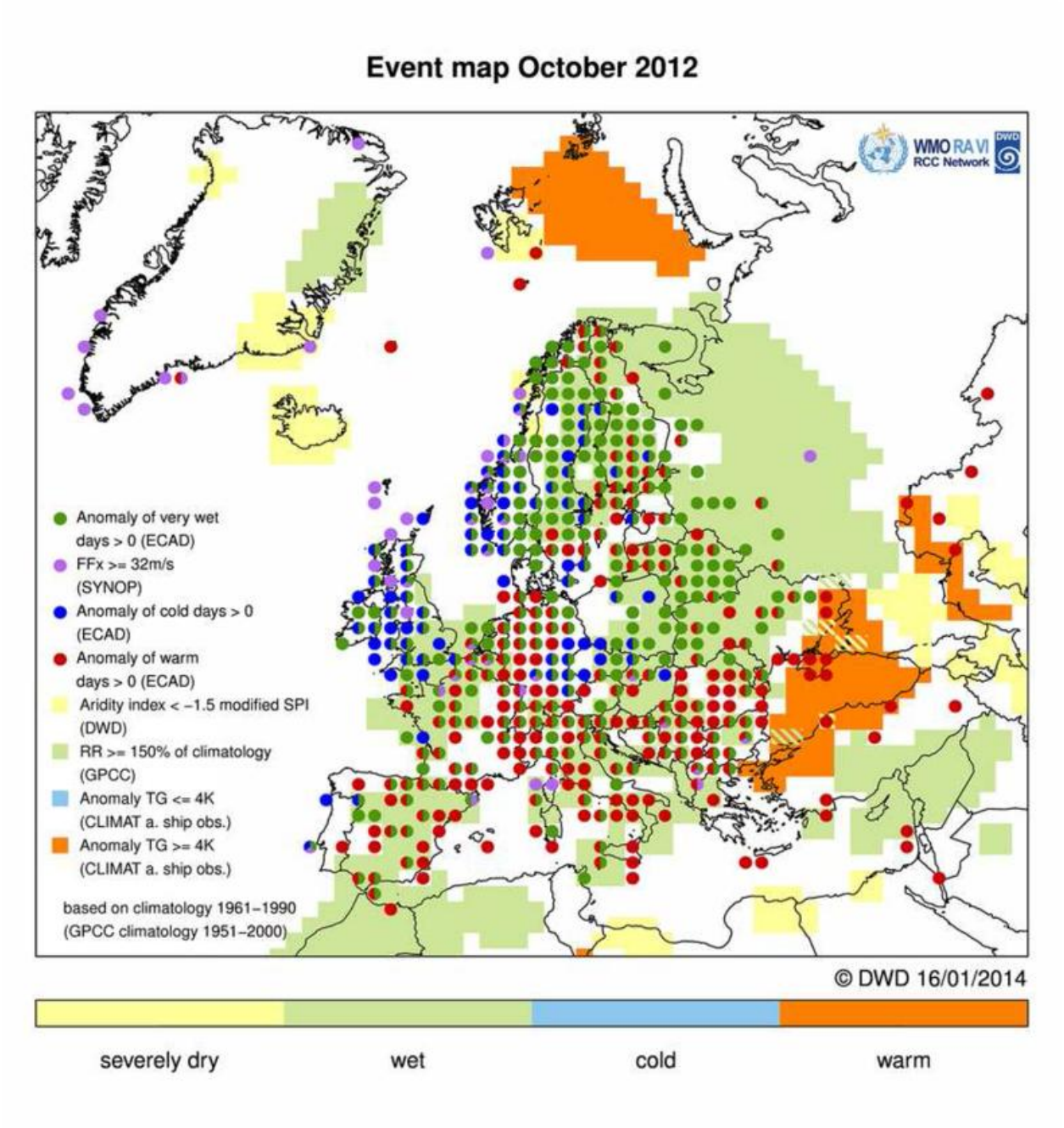


Fig. 3.42 : Monthly Map of Climate Extremes and Events October 2012

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

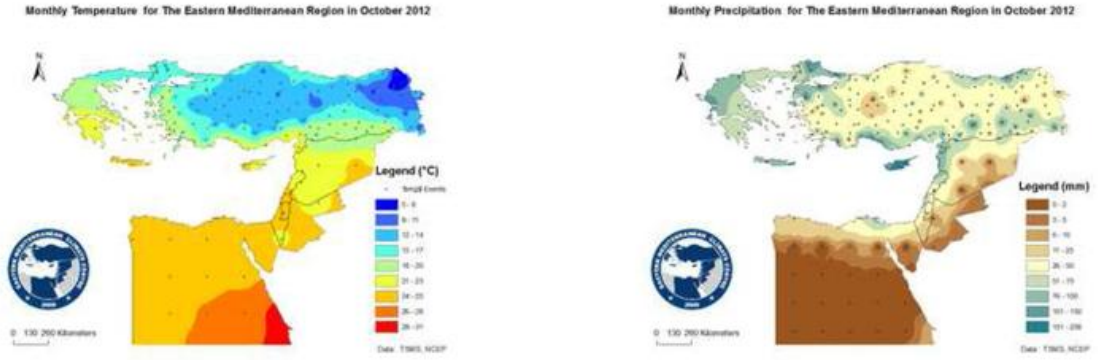


Fig. 3.43 *: Monthly mean temperature (°C) and monthly precipitation totals (mm) October 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

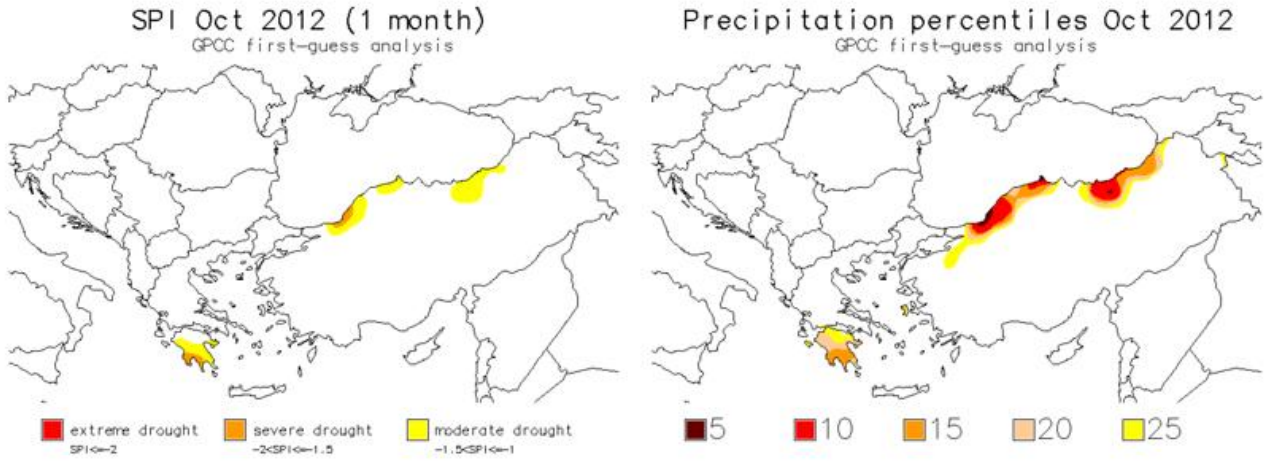


Fig. 3.44 *: Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
October 2012

November

Highlights:

- ***Previous records of November maximum temperature were broken at stations in European Russia (9°C in Ufa on 8 November) and in Romania (Calimani on 12 November).***
- ***Many events of extreme heavy precipitation***

Overview:

Temperature

November 2012 was warmer than normal in the Arctic region and on most of the continent except the westernmost parts of the British Isles, France and the Iberian Peninsula. It was colder than normal on the Atlantic. The positive anomalies were higher than +4 K in the Arctic region and at many stations above +3 K in Slovakia.

Precipitation

It was wetter than normal on the southern Iberian Peninsula, the Middle East, northern Italy and the Alpes, northern parts of European Russia and Finland as well as southern Scandinavia and the southern British Isles. Drier than normal on the Balkan Peninsula around the Black Sea and in southern Russia as well as on the northwestern European continent and parts of Scandinavia. Many extremes of precipitation totals occurred in several episodes on different time scales from high several-day totals to extremely high daily totals especially in the Mediterranean Sea area and on Madeira but also for instance in England, were one week in November was the wettest since 50 years.

Sunshine Duration

November 2012 was sunnier than normal on the northern part of the Balkan Peninsula and north of the Black Sea (partly more than 150 percent of the normal) as well as over the Alpes, parts of Germany and the Netherlands, the westernmost parts of the continent and southeastern and northern UK and Ireland and as well parts of western Scandinavia. It was mostly dull elsewhere with less than 50 percent of the normal in the east.

Events

- A strong blizzard in the southern parts of Finland and the Gulf of Finland with significant wave heights of 5.2 meters which was above the previous record.
- A F3/T6 tornado in the Algarve region in Portugal (at Lagoa, Silves) with wind in the range 256-295 km/h resp. 71.1-81.9 m/s.
- Extensive flooding in Slovenia on 5 to 6 November.
- On 6 November an extremely low air pressure (728 mm Hg resp. 970.6 hPa) was recorded in Moscow.
- A '100-year' flooding of the river Drau on 11 November in Austria, district Wolfsberg. The water stood 2 m high in the city of Lavamünd.
- Flooding in Tuscany and northern Italy, with precipitation totals of 320 mm during 6 to 13 November (compared to a mean monthly total of 80 mm) in the area of Florence. the 6th highest water level in Venice since 1872.
- Extremely heavy precipitation with a daily total of 200 mm (170 mm within 3 hours) in Carrara, Italy, on 27 November

Monthly Means or Totals and Anomalies :

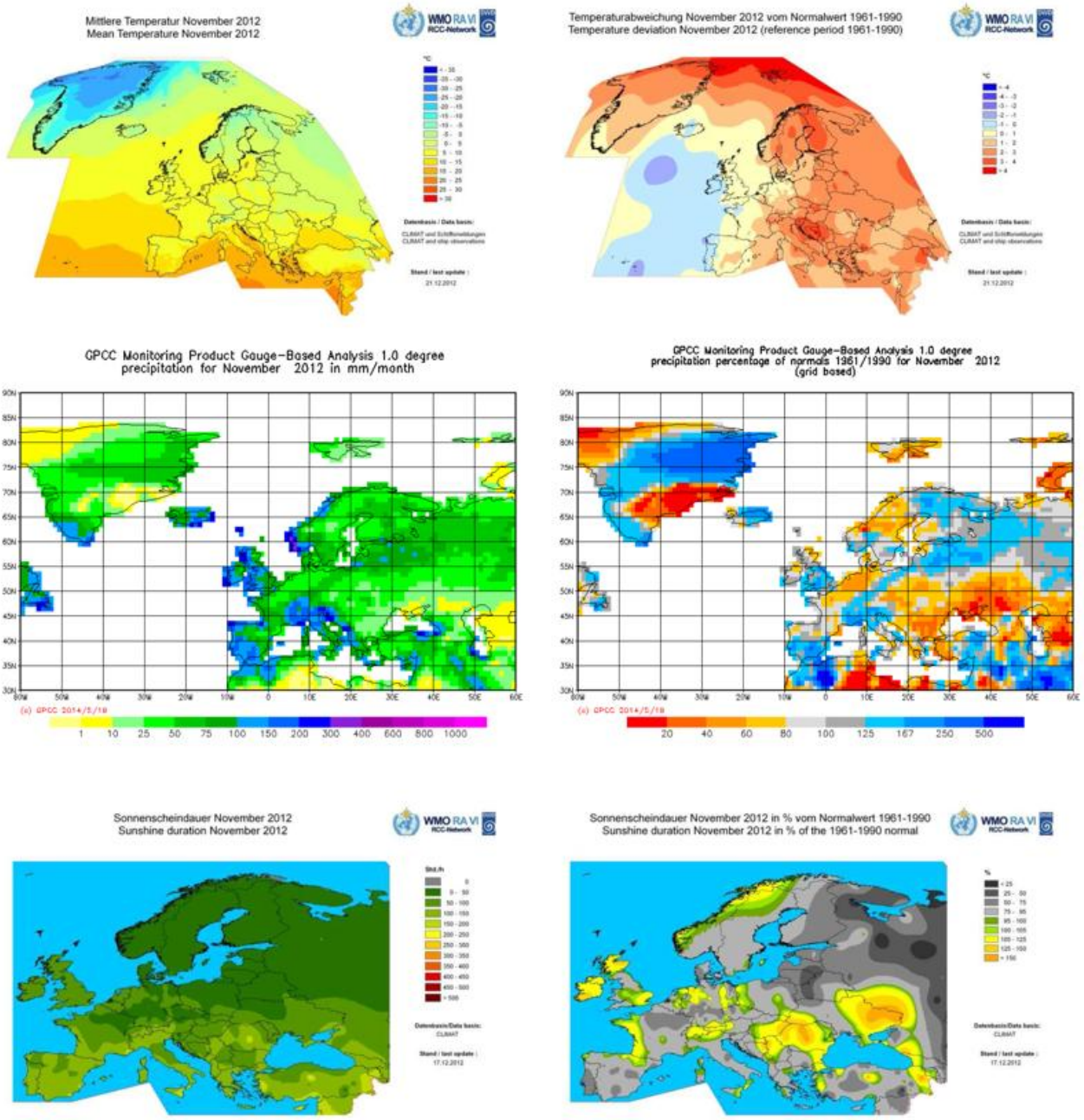


Fig. 3.45: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in November 2012*

Monthly Climate Extremes and Events:

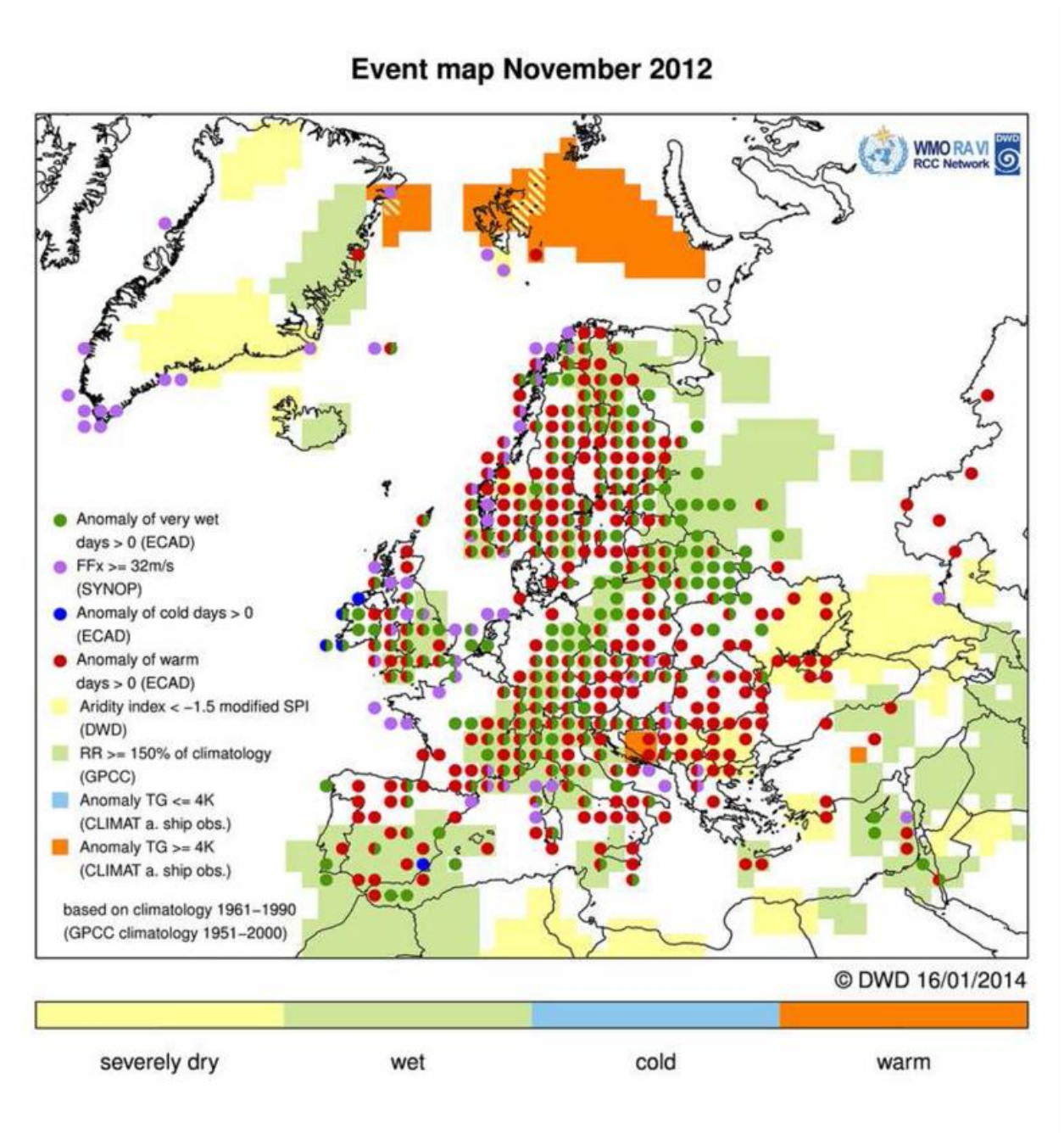


***Fig. 3.46** : Monthly Map of Climate Extremes and Events November 2012*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

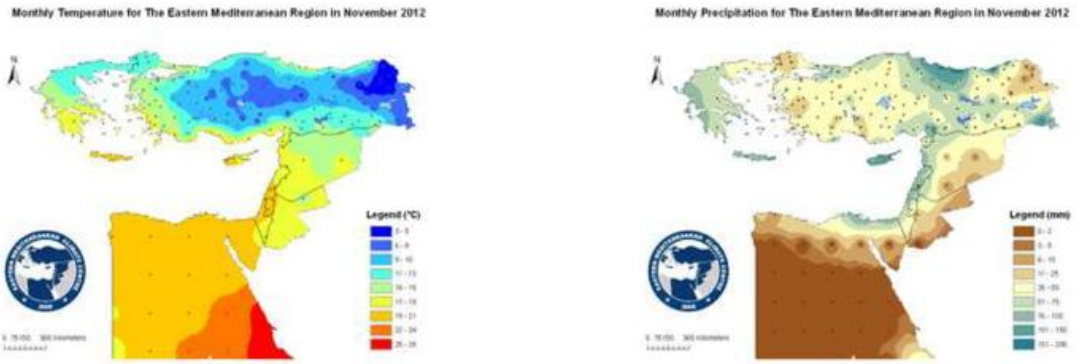


***Fig. 3.47** : Monthly mean temperature (°C) and monthly precipitation totals (mm) November 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

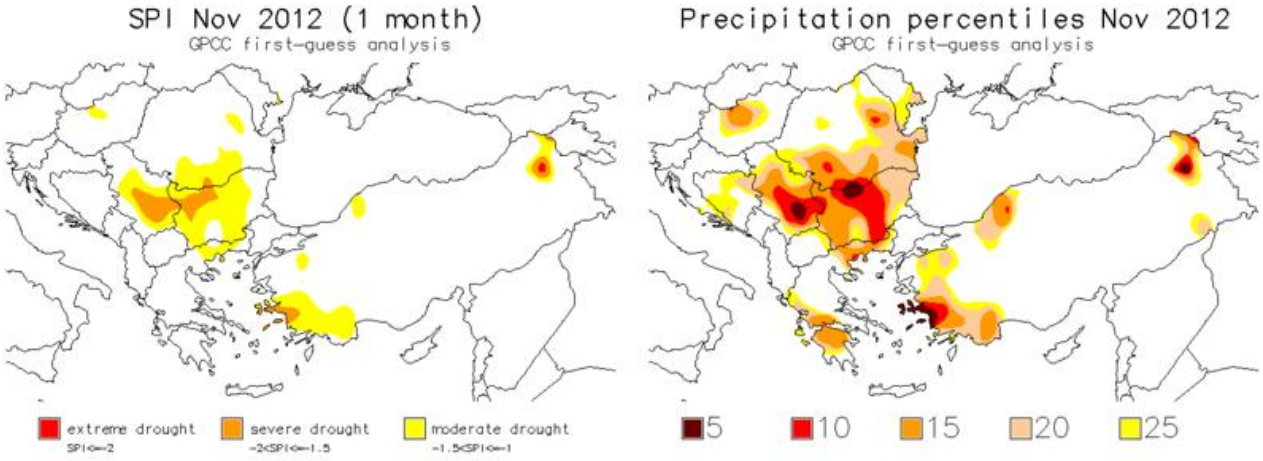


***Fig. 3.48** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
November 2012

December

Highlights:

- ***A severe cold spell in eastern Europe and the warmest Christmas since 60 years in Austria.***
- ***Wettest December in Belgium, December the wettest month of the year in the Netherlands and new records of daily rainfall totals at stations in Western Galilee, Israel***

Overview:

Temperature

December 2012 was warmer than normal in the Arctic, the North Atlantic, the western, central and southwestern European continent and the Middle East. It was colder than normal in Scandinavia, Russia, the eastern central European continent, the Balkan Peninsula and Italy. The warm anomalies in the Arctic exceeded +4 K and the cold anomalies in Russia exceeded -4 K. In eastern Europe the cold came unexpectedly early and strong.

Precipitation

While December 2012 was drier than normal in northern and western Scandinavia, northern Russia, the Baltic states and the Caucasus, the Iberian Peninsula and western Mediterranean, it was partly remarkably wetter than normal elsewhere. In eastern UK, northern France, Belgium and the Netherlands it was about twice of the normal and in eastern Romania and southern Ukraine as well as in parts of the Middle East more than 250% of the normal were observed.This was the wettest December so far in the records of Belgium. In the Netherlands December 2012 was the wettest month during the year.

Sunshine

Sunshine duration was clearly higher than normal for Poland, the Czech Republic and partly the eastern Alps as well as in Russia while most of central Europe, te western Iberian Peninsula, moste of Scandinavia, the western Balkan Penisula, the baltic states, Belarus, Ukraine and the Middle East were dull.

Events

- On 20 December stations in Western Galilee, Israel received daily rainfall totals of 135-140 mm. These were the highest daily totals ever recorded.

Monthly Means or Totals and Anomalies :

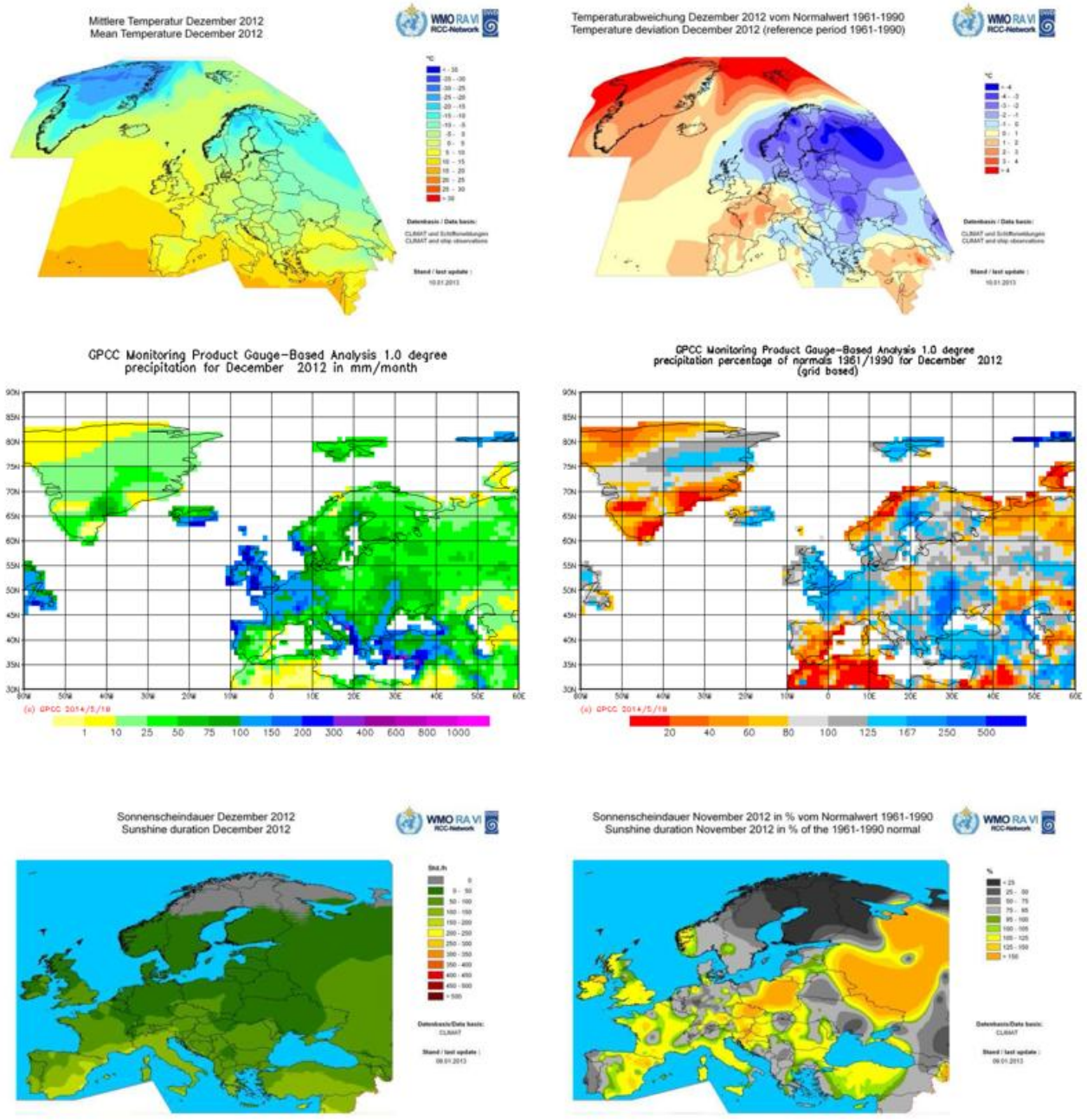


Fig. 3.49: *Means and anomalies (reference 1961-1990) of temperature, precipitation and sunshine duration in December 2012*

Monthly Climate Extremes and Events:

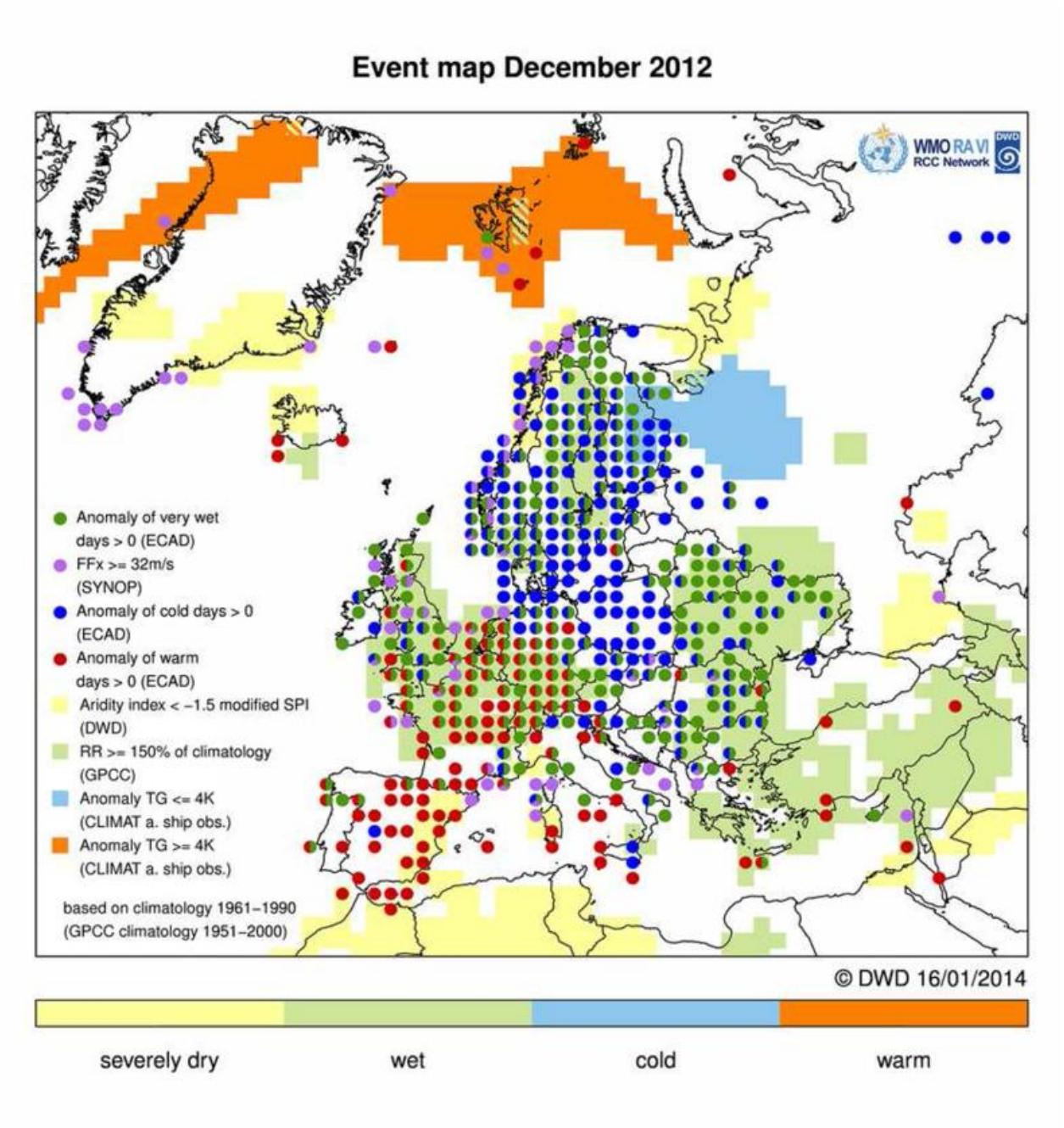


Fig. 3.50 *: Monthly Map of Climate Extremes and Events December 2012*

Monthly Temperature and Precipitation in the Eastern Mediterranean Subregion:

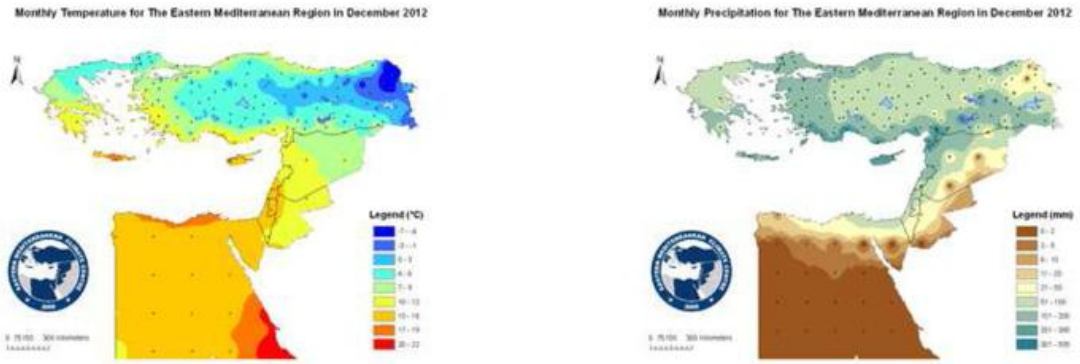


***Fig. 3.51** : Monthly mean temperature (°C) and monthly precipitation totals (mm) December 2012 as provided by the Eastern Mediterranean Climate Center (EMCC)*

Drought Indices for the Southern European Subregion as provided by the Drought Management Centre for Southeastern Europe (DMCSEE):

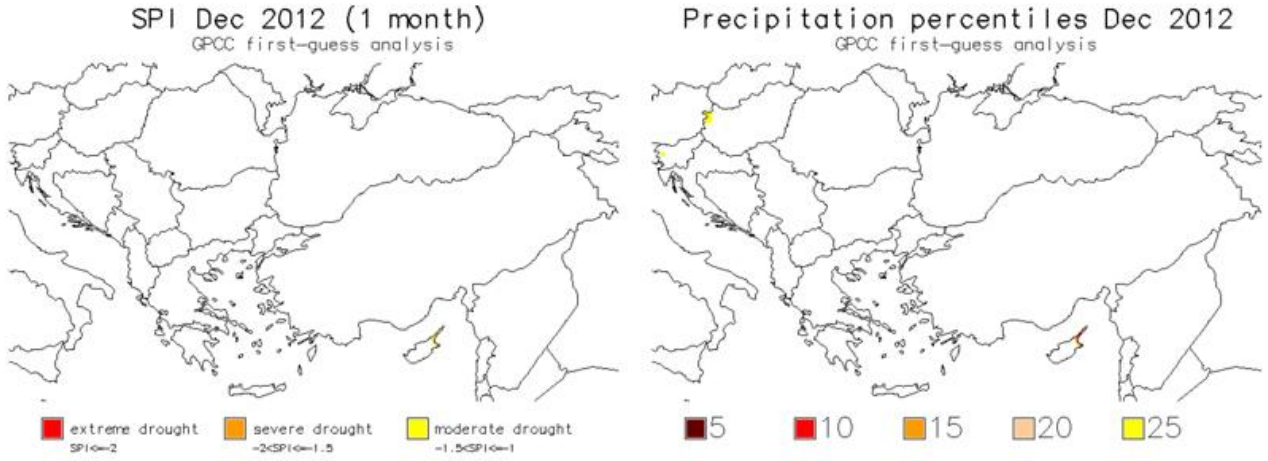


***Fig. 3.52** : Monthly Drought Indices (1-month SPI and low precipitation percentiles) as provided by the Drought Management Centre for Southeastern Europe (DMCSEE)*
December 2012

WMO RA VI
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Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

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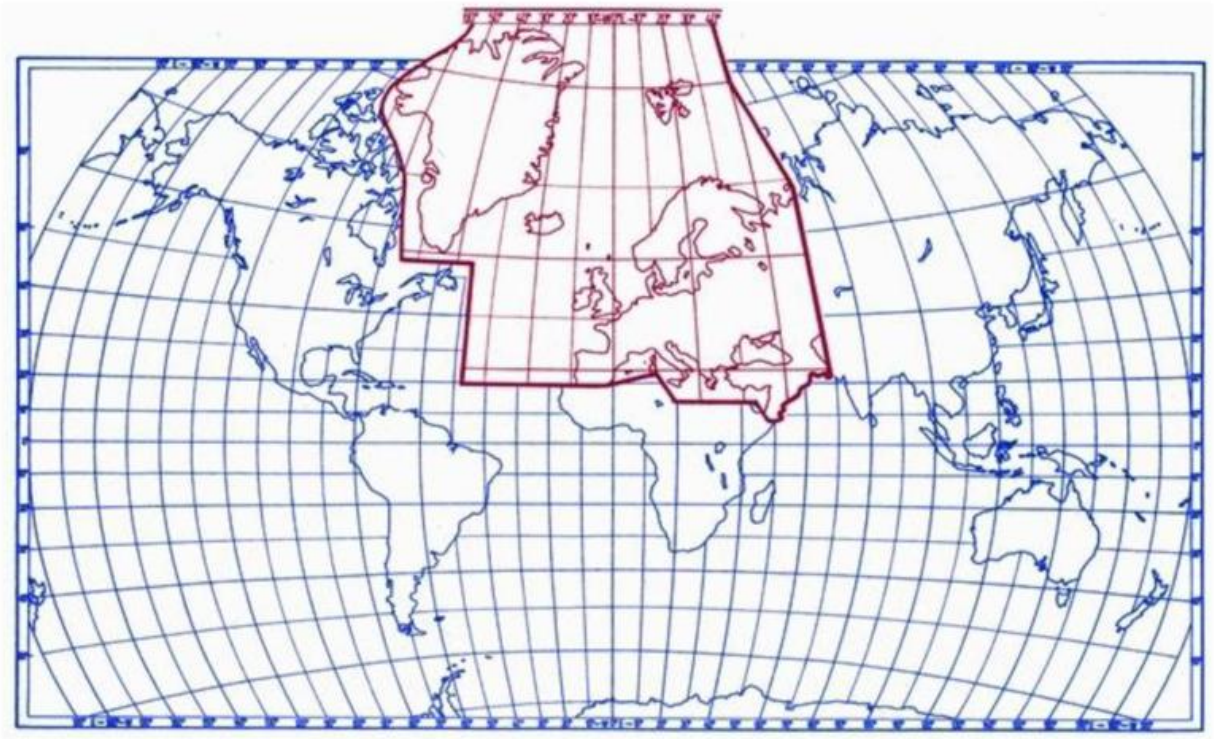

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Turkey
Ukraine
United Kingdom

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1 Introduction

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official Websites. Supported by the European Climate Support Network (ECSN) and WMO´s World Climate Data and Monitoring Programme (WCDMP) the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's Annual Statement on the Status of the Climate and the State of the Climate Article published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ amongst the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the Webpages of the RA VI RCC Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

Notes:

Maps of the RA VI RCC Network are based on the following data sources:

- Temperature: CLIMAT data and ship observations provided by the Global Collection Centre (GCC), run by Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC), run by Deutscher Wetterdienst
- Sunshine: CLIMAT data.
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC-CD) via the European Climate Assessment & Dataset project (ECA&D) run by Royal Netherlands Meteorological Institute (KNMI)

Subregional monthly maps are provided by the Eastern Mediterranean Climate Centre (EMCC) and the Southeast Drought Management Centre (DMCSEE)

The following subregions are used in this Bulletin:

Central and western Europe: *Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, Netherlands, Poland, Slovakia, Switzerland, United Kingdom*

Nordic and Baltic Countries: *Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden*

Iberia: *Portugal, Spain*

Mediterranean, Italian and Balkan Peninsula: *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, Serbia, Slovenia, Macedonia, Montenegro, Turkey*

Eastern Europe: *Belarus, European Russia, Moldova, Romania, Ukraine*

Middle East: *Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, western Kazakhstan*

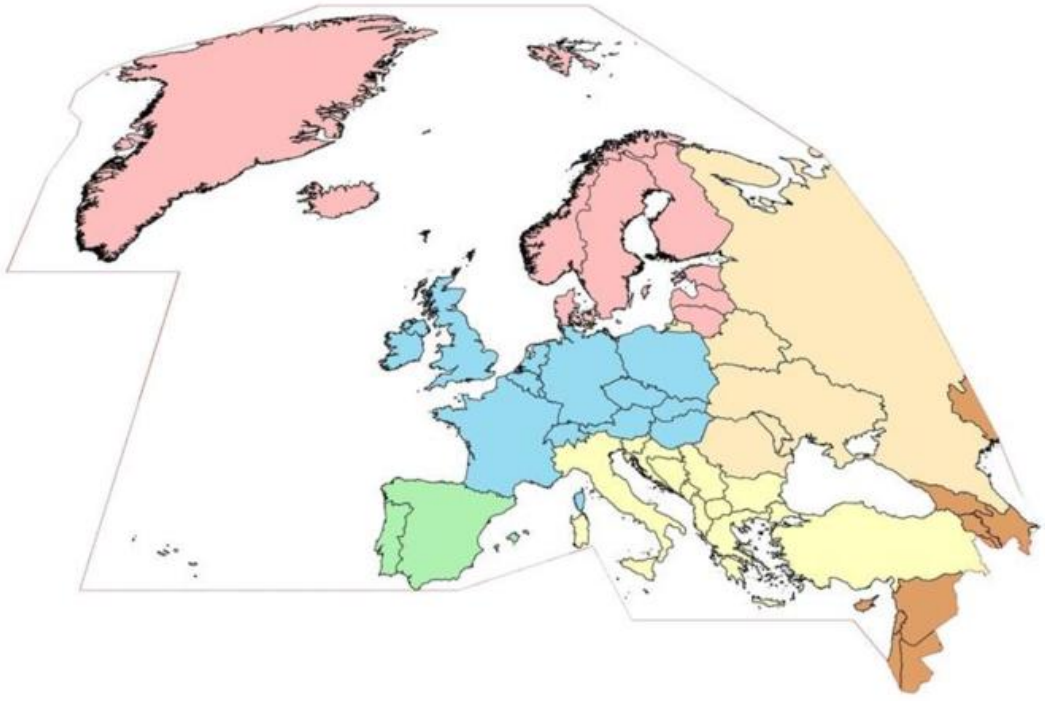


Figure 1.1: Definition of the 6 subregions used in this bulletin.

Box 1

Notable anomalies and events 2013

Anomalies

Temperature

- A record breaking warm March (since 1948) at Pituffik/Thule AFB on Greenland.
- Winter comeback in March in Central and North Europe,
- New station record temperature record for Greenland with a peak value of 25.9°C in July at Manitsoq, West Greenland coast.

Precipitation

- Catastrophic flooding in Central Europe in May-June 2013 followed by an
- Extreme drought for nearly the same region
- The driest July since 1853 in Austria

Sunshine Duration

- Highest sunshine duration in July since 1884 in Austria.
- Record lack of sunshine winter 2012/2013 since 1951 in Germany.
- Record lack of sunshine January-May since 1864 in Switzerland at station Zurich.

Other Anomalies

- Strong negative phase of North Atlantic Oscillation (NAO) in March,
- Highest monthly mean sea level pressure for March since 1962 over Iceland.
- A record-breaking period with 594 days without storm winds (>= 25 m/s) in Sweden ended on 28 October when Hallands Väderö recorded a mean wind speed of 31 m/s.

Events:

- Hail storm on 28 August in Germany near Reutlingen with hail stones of 14 cm diameter and a weight of 360 g.
- Catastrophic flooding in Romania and Ukraine in September 2013
- Severe autumn storm cyclone CHRISTIAN in the North Sea on 28 October 2013
- Depression CLEOPATRA in the western Mediterranean Sea with extreme flooding on Sardinia in November 2013 caused 18 fatalities.
- 3 Severe winter storm depressions (XAVER, DIRK, ERICH) in December 2013

2 Annual survey

The climate of 2013 was characterised by a broad range of spatial and temporal anomalies outlined in Box 1 and Figure 2.5. This section presents an overview of the spatial patterns of mean annual climate conditions in 2013 and anomalies related mainly to the normal period 1961-1990 of the selected essential climate variables: sea surface pressure, surface temperature, precipitation, sunshine duration and snow. Sub-section 2.1.4 reveals climate extremes for each participant countries. More detailed insight to the long-term variability of the mentioned parameter from the individual participant countries offers sub-section 2.2. Trends in temperature and precipitation indices are given in sub-section 2.2.4.

2.1 Annual averages and anomalies of selected essential climate variables

2.1.1 Sea level pressure

Generally, long-term mean annual sea level pressure distribution over the Region VI is dominated by a low pressure trough in the polar area (with exception Greenland) with the Icelandic low centred near Iceland and by the subtropical high pressure belt extended from the centre over Azores (Azores high) across southern, western and central Europe to European Russia.

2013 the mean sea surface pressure differs in some extend from the long-term mean with a reduced pressure especially within the subtropical high pressure belt and higher values over northern Europe. This is visible in the anomaly field for 2013 in respect to the normal period 1961-1990 (Figure 2.1 right). The anomaly configuration resemble especially the unusually pressure distribution in later winter and early spring (for more details cf. section 3.1.1 and 4.1).

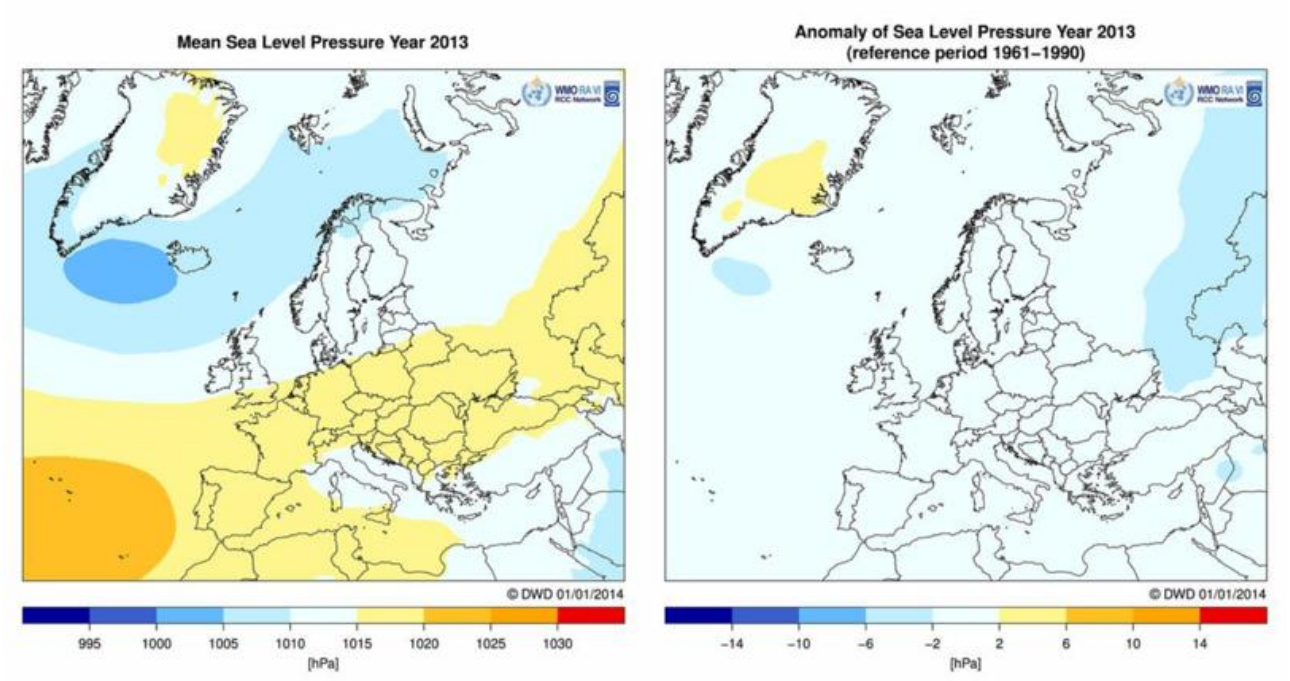


Figure 2.1: Annual mean of sea level pressure (left) and anomalies (right) for the year 2013 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm)

2.1.2 Temperature

Generally, the year 2013 was overall warmer than normal. It ranked on place 6 in the time series of E-OBS for the land area between 35°N and 75°N and 25°W and 45°E and the period 1950-2013 (van der Schrier et al., 2013). The mean temperature was calculated to 10.8°C. This value was very close to that of the year 2009 on rank 7. Warmer than 2013 were the years 2007, 2008, 2000, 1989 and 2011. The result for 2013 was mainly influenced by the warm summer and autumn 2013 (cf. section 3.1.2).

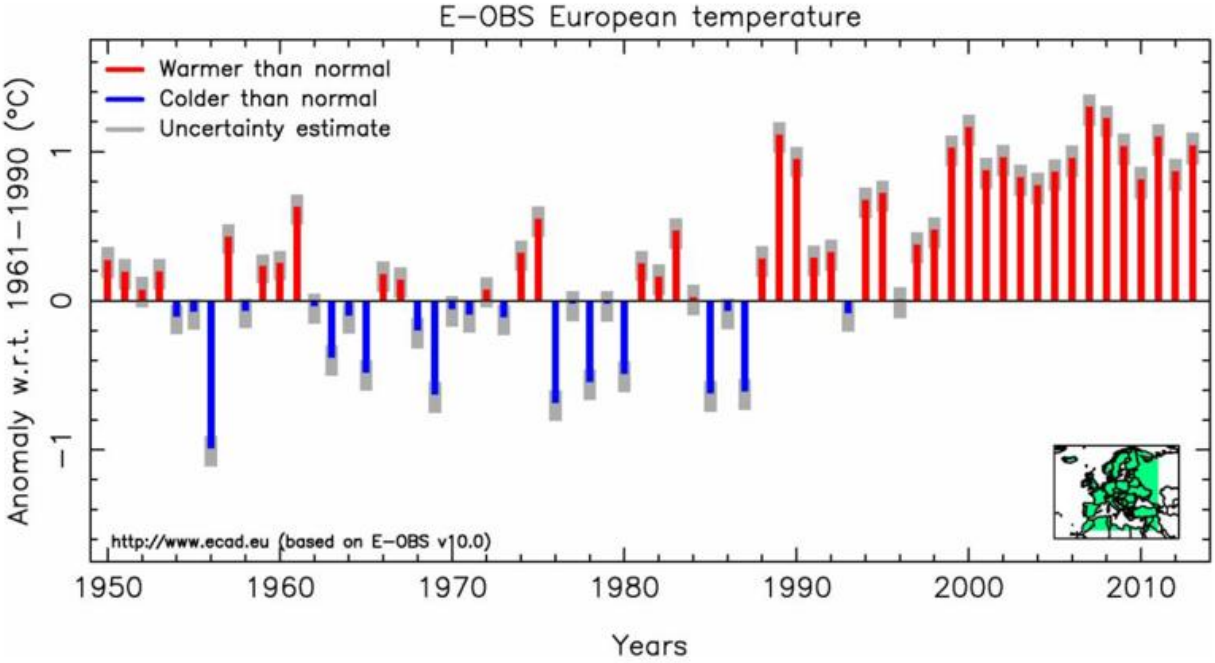


Figure 2.2: Mean annual temperature anomalies 1951-2013 for Europe (land area; 35°N - 75°N and 25°W - 45°E, source: **www.ecad.eu**, van der Schrier et al. 2013)

The mean annual temperature distribution is generally characterised by South-North temperature gradient. The spatial pattern of the annual temperature anomalies in 2013 related to the normal period 1961-1990 was dominated by negative or normal values in central and western Europe as well as positive values in northern and eastern Europe (cf. **Table 4.2**).

In many countries 2013 ranked within the top ten warmest years since the beginning of observations e.g.:

- In Bulgaria the 2nd warmest year since 1901.
- In Armenia the 2nd warmest year since 1935.
- In Finland the 5th warmest year with anomalies of 1°C - 2°C related to the period 1981-2010.
- In Serbia the 7th warmest year since 1951.
- In Austria the 9th warmest year since the start of record in 1767.
- In Hungary the 9th warmest year since 1901.

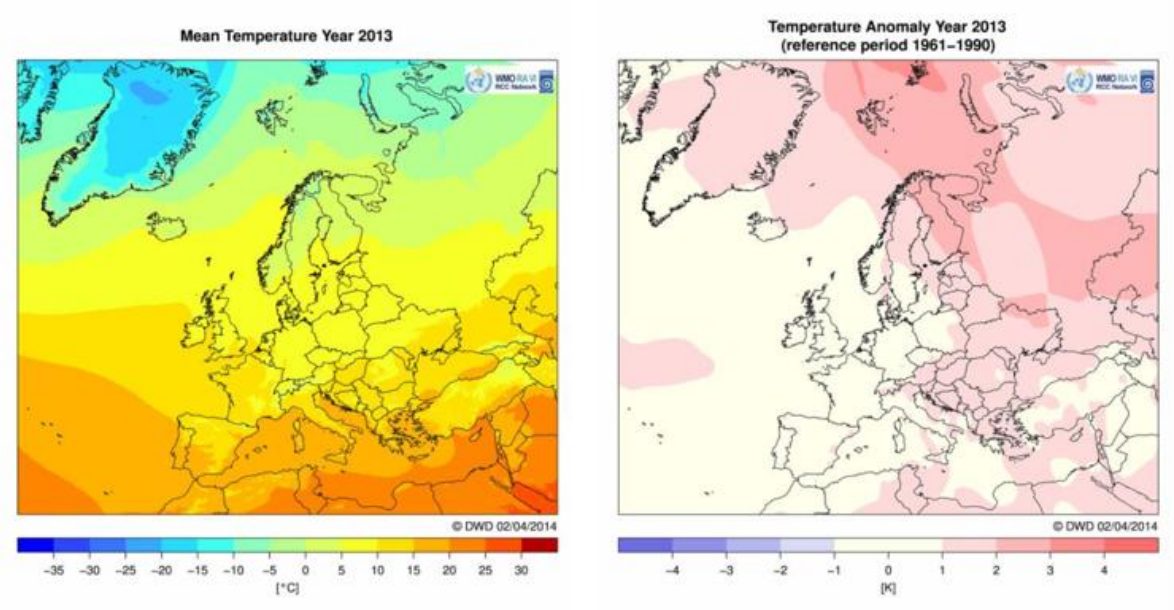


Figure 2.3: Mean annual temperature in °C (left) and anomalies (right) for 2013 (reference period 1961-1990). (Source: http://www.dwd.de/rcc-cm)

2.1.3 Precipitation

The annual precipitation totals of 2013 were overall close to normal like in the year 2012. The existing anomalies ranged between -30 and 30 mm. Only south-eastern Europe was drier than normal. This pattern (Figure 2.4) understated the situation in south-eastern Central Europe where in May and June, after heavy precipitation and floods a dry period in June and July occurred.

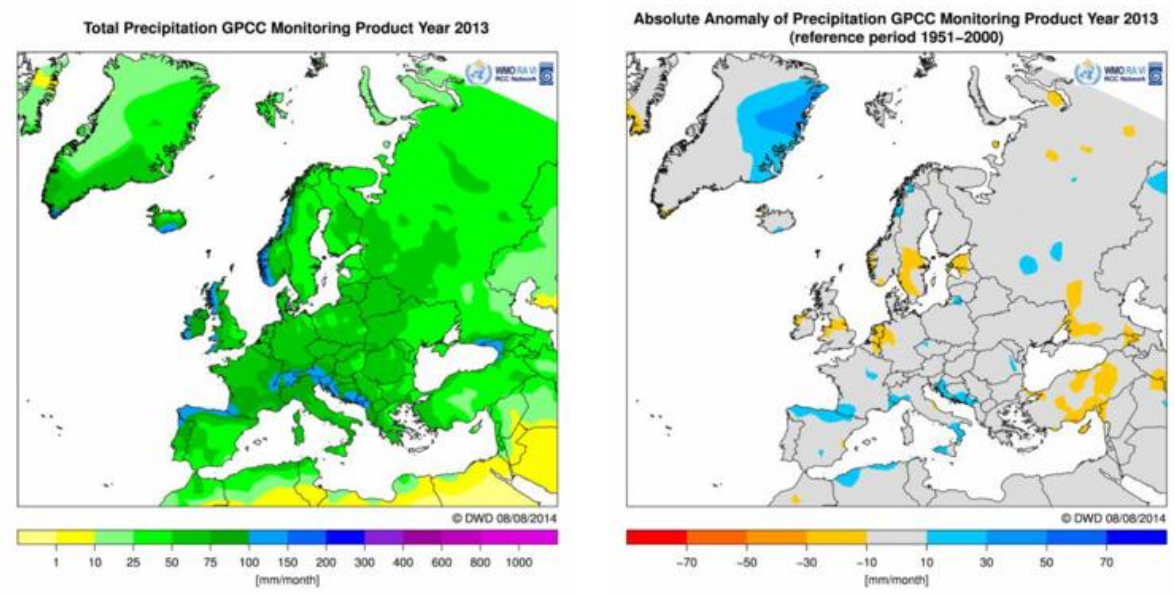


Figure 2.4: Total precipitation (left) and absolute anomalies (right) for 2013 in mm/month (reference period 1951-2000). (Source: http://www.dwd.de/rcc-cm)

- In Germany 2013 was the 65th wettest or the 69th driest year since 1881.
- Turkey mean total precipitation in 2013 was 564 mm and this amount is 13% below normal (646 mm for 1971-2000).

- The average precipitation for the year 2013 (Jan-Dec) in Cyprus is 291 mm which is the fourth highest yearly average precipitation ever recorded since 1902.

2.1.4 Annual extreme values of temperature and precipitation

Absolute annual extreme values for 2013 of temperature (minimum and maximum), maximum of total daily precipitation and maximum of total 5-day precipitation for each country are given in Figure 2.5.

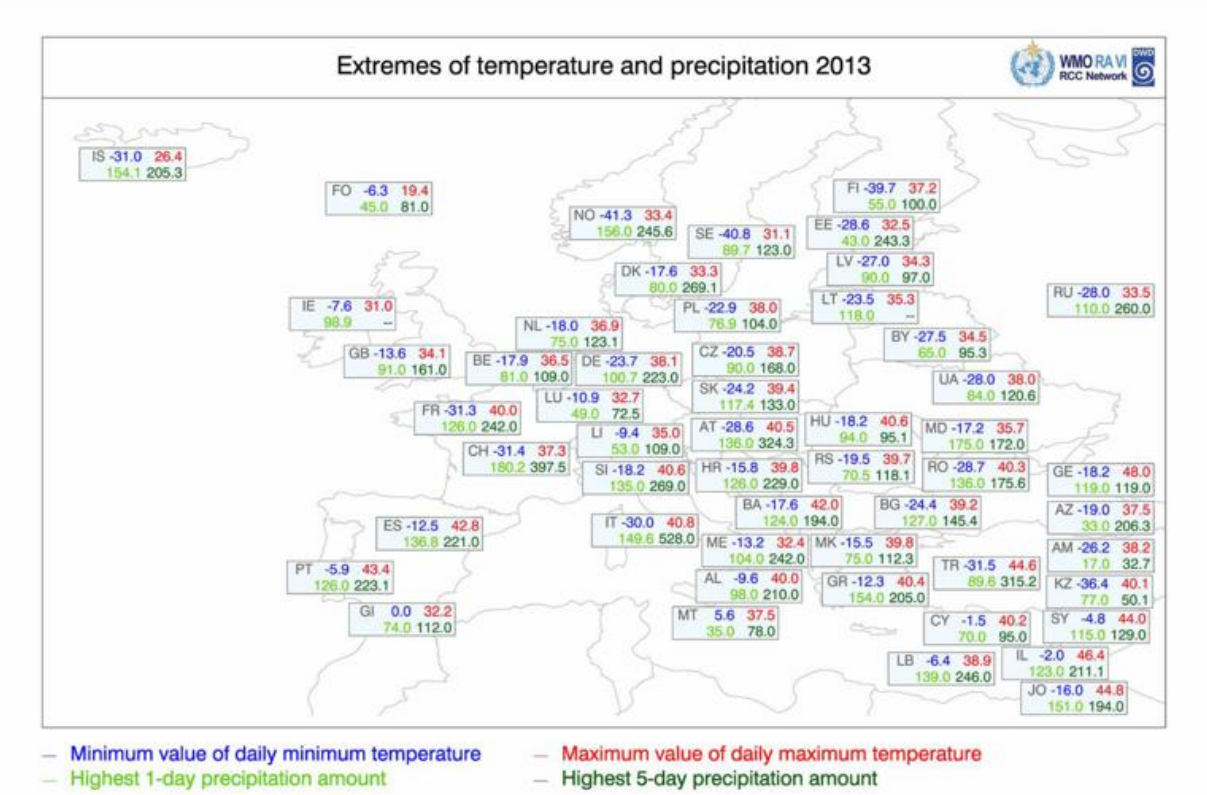


Figure 2.5: Annual extreme values for each country: highest daily precipitation (mm), highest 5-daily precipitation totals (mm), highest daily maximum temperature (°C) and lowest daily minimum temperature (°C) in 2013.
Note: Data (by order or priority) from reports of NMHSs, GPCC, ECA&D or SYNOP; the countries are represented by their Internet country codes. (Source: http://www.dwd.de/rcc-cm)

2.1.5 Sunshine duration

As expected, the annual sum of sunshine duration 2013 showed from the South to the North generally gradual decreasing values. More than normal sunshine hours have been primarily noted in northern eastern and southern Europe.

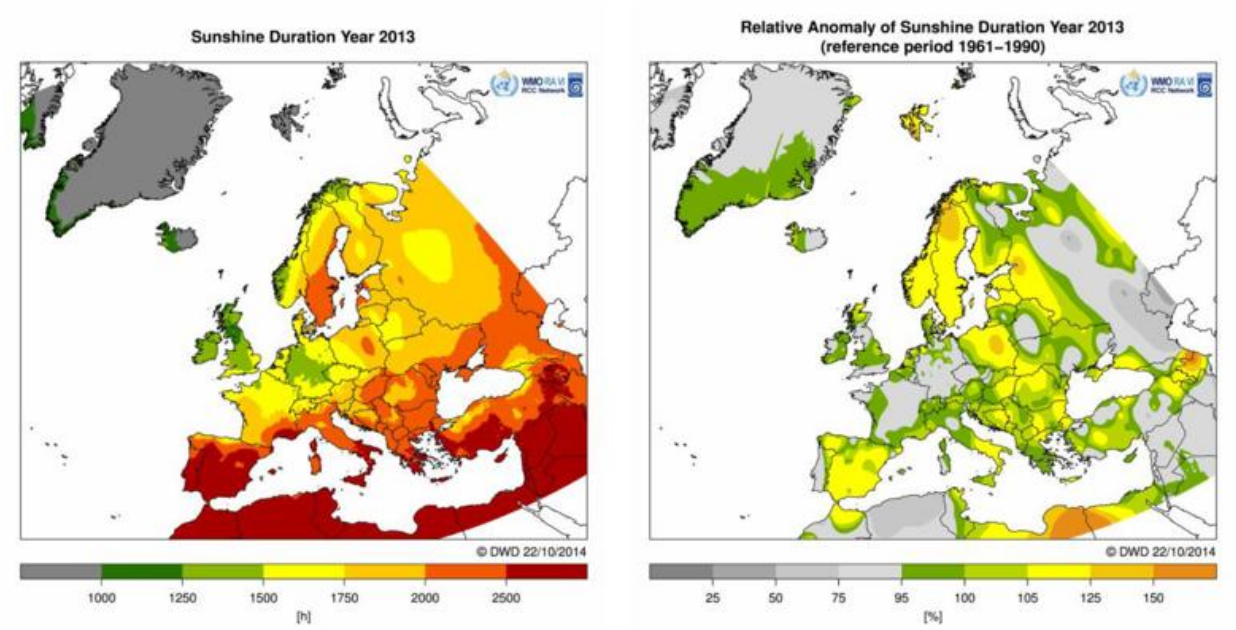


Figure 2.6: Annual sum of sunshine duration (left) and relative anomalies (right) for the year 2013 in hours with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm)

- The annual sum of sunshine duration in 2013 in Poland was in some areas more than 200% above the normal for the period 1971-2000.
- In Sweden 2013 was the sunniest year on record at several stations for example Karlstad and Uppsala.
- 2013 has been the 15th poorest year in sunshine since 1951 in Germany and therefore falls into the lower third of the distribution for this parameter.

2.1.6 Drought situation

The year 2013 as a whole showed no significant droughts. Longer drier periods occurred in July 2013 in southern Scandinavia and eastern Central Europe. The drought in eastern Central Europe affected several countries: Austria, Germany, Hungary, Poland, Rumania, Slovakia and Slovenia. There was also a drought in Portugal in November.

For details see section 3.1.5.

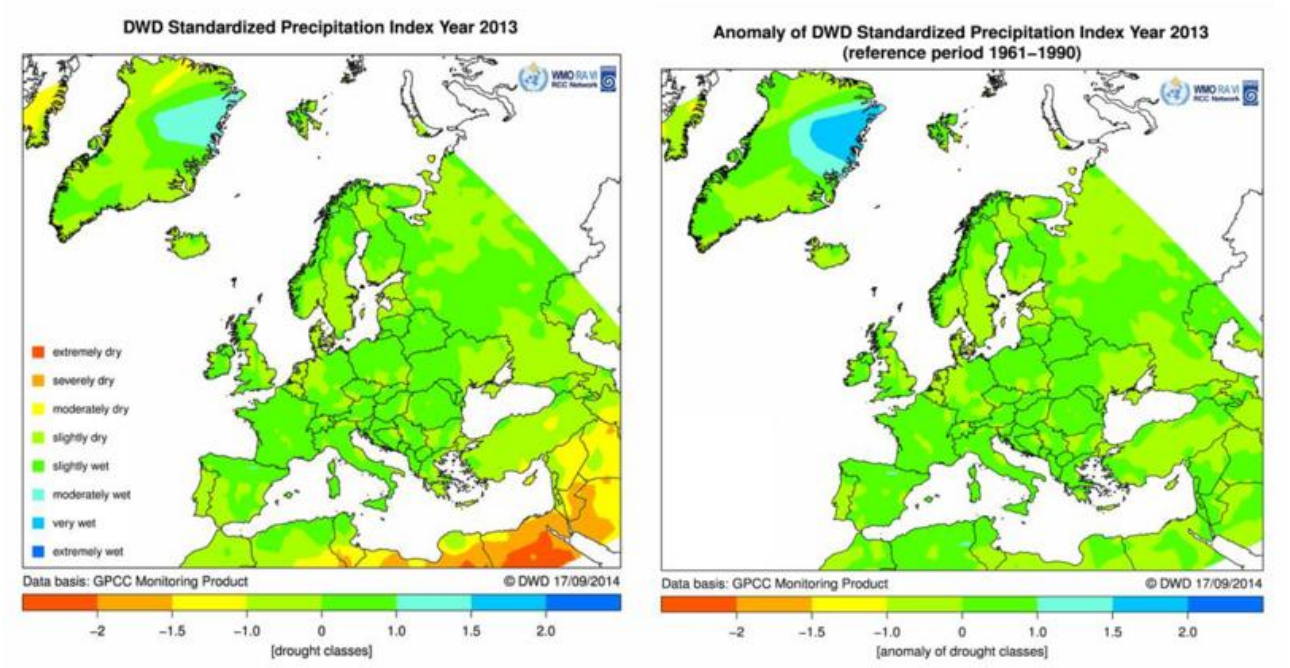


Figure 2.7: Annual modified Standardized Precipitation Index (DWD-SPI) for the year 2013 (left) and its anomalies (right) with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm)

2.1.7 Snow cover

For an assessment of the snow cover occurrence and duration, the time span from 1st September 2012 to 31st August 2013 is used. Apart from the mountains regions, the first snow in October was recorded from the south part of Germany across Austria and Poland to the central and northern Russia. In this area the snow cover lasted 5-6 months.

Annual snow cover extent (SCE) over Eurasia lands averaged 14.6 million km^2 in 2013 (from 31.2 in January (rank 6) to 0.2 million km^2 in August (rank 38), Rutgers Laboratory, 2013).

Between February 5th and 11th there was persistent snowfall, especially in the south and in the west of Austria. Station Bregenz (Vorarlberg) recorded 52 cm fresh snow within 24 hours (maximum value within 48 years).

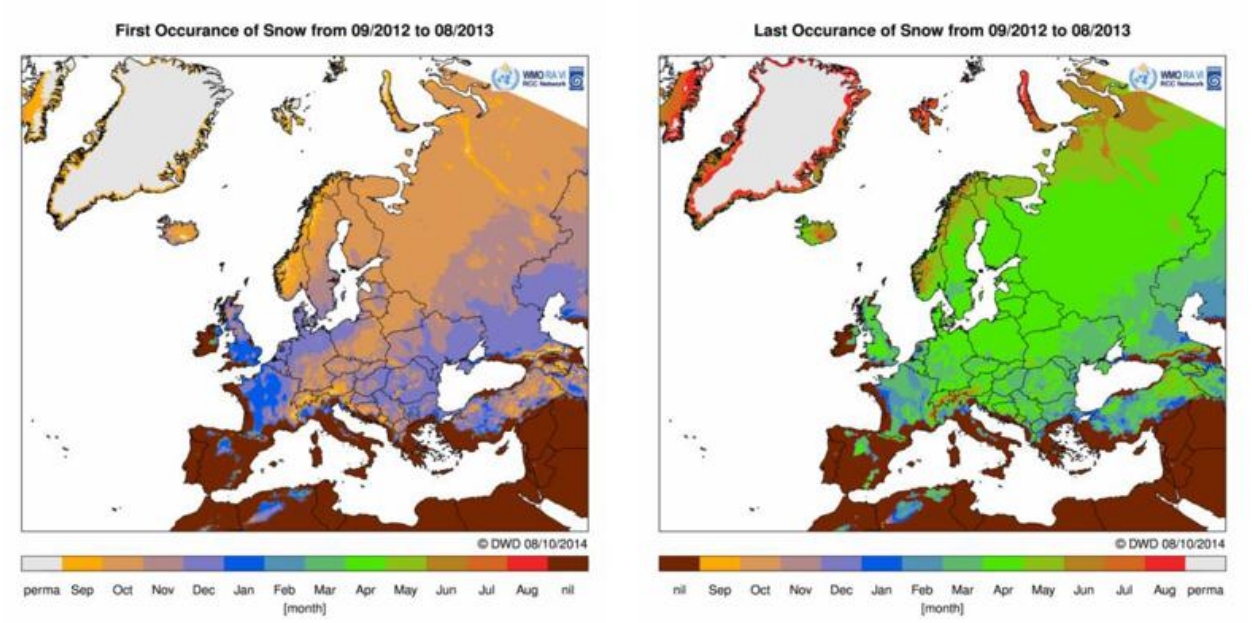


Figure 2.8: First occurrence of snow (left) and last occurrence of snow (right) during the snow-season 2012/2013. (Source: http://www.dwd.de/rcc-cm)

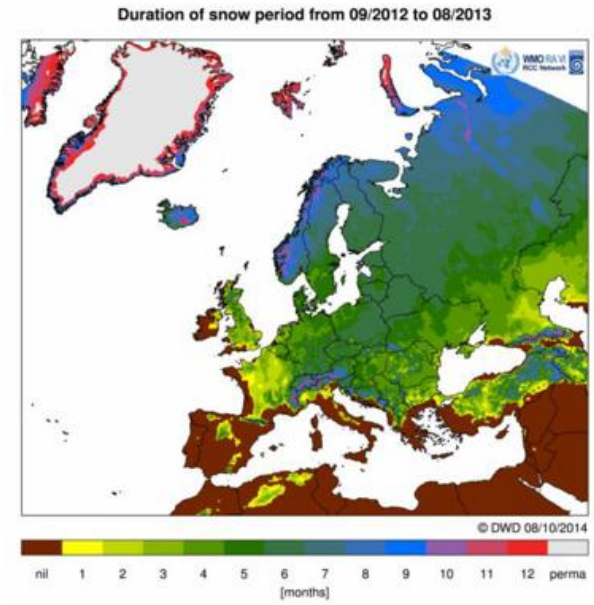


Figure 2.9: Duration of snow cover in the snow-season 2012/2013. (Source: http://www.dwd.de/rcc-cm)

2.2 Long-term variability of the selected climate parameters - Regional examples

On the following pages graphs of long time series of temperature, precipitation and sunshine duration as provided by the national meteorological services (NMHSs) are presented to give an overview of the temporal development of the basic climate elements. The graphs are grouped with respect to the 6 subregions defined above (Figure 1.1). The table below informs about the lengths of the time series shown as well as whether they refer to spatial means of the country or single stations. Most are temperature time series. Each subregion is at least represented by one country. Time series of precipitation totals are fewer but including a time series of the maximum daily precipitation total for the Upper Galilee in Israel there is as well each subregion represented with at least one time series for precipitation. Diagrams of long-term annual sums of sunshine duration are provided by 4 countries and they belong to different subregions. Some countries contributed time series which were not available in 2012. Other time series that were available in 2012 are not available in 2013 on the other hand.

Following this section, trend maps representative for the elements temperature and precipitation are shown. As reference period for these trend maps 1951-2013 was chosen. After this, we present examples of the temporal development of other temperature related phenomena, such as the sea surface temperature in the North Sea and sea level anomalies at the Polish station Wladyslawowo.

Table 2.1: Availability of the long-term records of temperature, precipitation and sunshine duration from some participant countries.

		Temperature		Precipitation		Sunshine Duration	
Subregion	**Country**	**Spatial Mean1**	**Single Station**	**Spatial Mean**	**Single Station**	**Spatial Mean**	**Single Station**
Central and Western Europe	Belgium		1833				
	France	1900					
	Germany	1900		1900		1951	
	Luxembourg	1947					
	Poland	1951					
	Switzerland	1864		1869		1959	
Nordic and Baltic Countries	Denmark	1873		1873		1920	
	Finland	1900					
	Greenland		1873				
	Latvia	1924		1924			
	Lithuania	1961					
	Norway	1900		1900			
	Sweden	1860					
Iberia	Portugal	1931		1931			
	Spain	1961					
Mediterranean, Italian and Balkan Peninsula	Bulgaria	1901					
	Croatia		1862				
	Italy	1961		1951			
	Slovenia		1876		1866		
	Turkey	1971		1971			
Eastern Europe	Belarus	1881		1891			
	Russia	1939		1966			
Middle East	Armenia	1929					
	Georgia	1961		1961			
	Israel	1951					

2.2.1 Temperature

Central and Western Europe – annual temperature series

Belgium, France, Luxembourg, Germany, Poland, Switzerland

Belgium

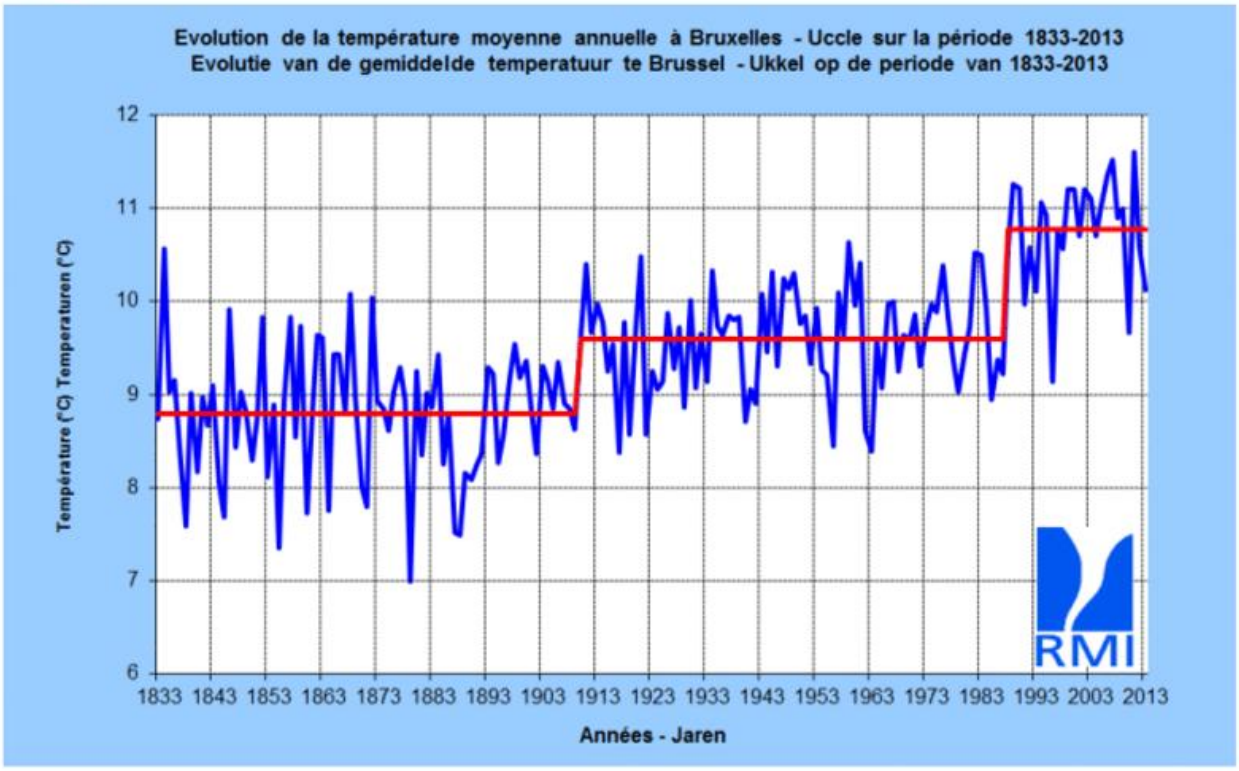


Figure 2.10: Time series of annual mean temperature for Belgium (Diagram as provided by the NHMS)

France

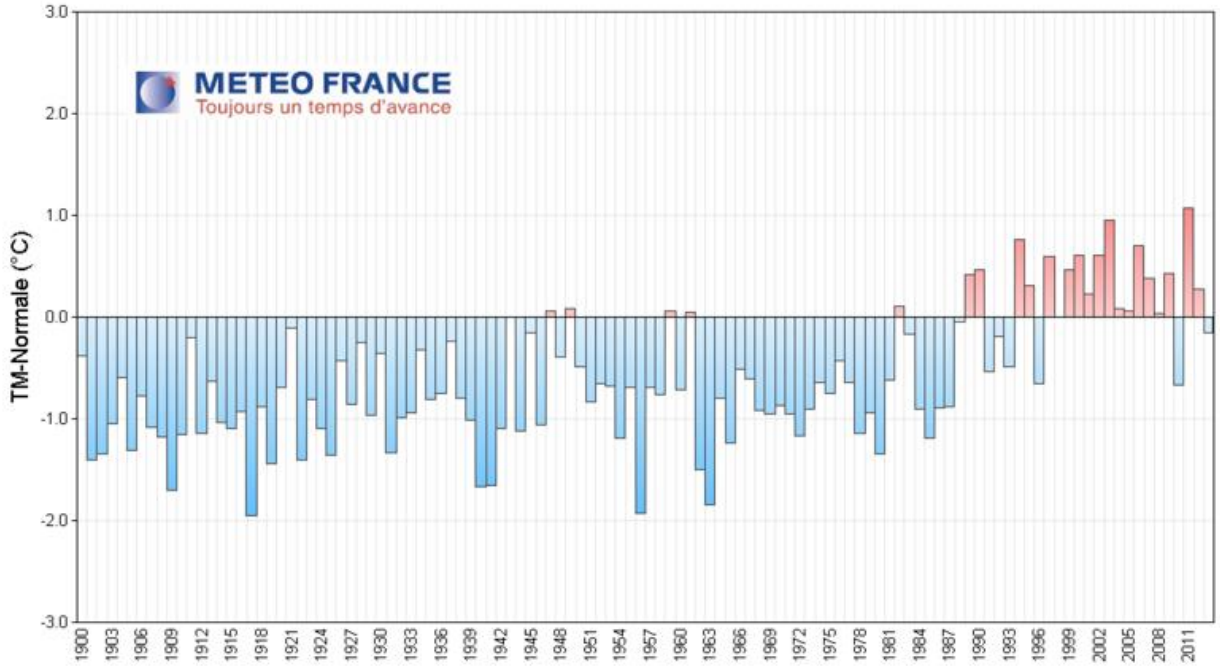


Figure 2.11: Time series of annual temperature anomalies for France (reference period 1981-2010; diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Germany

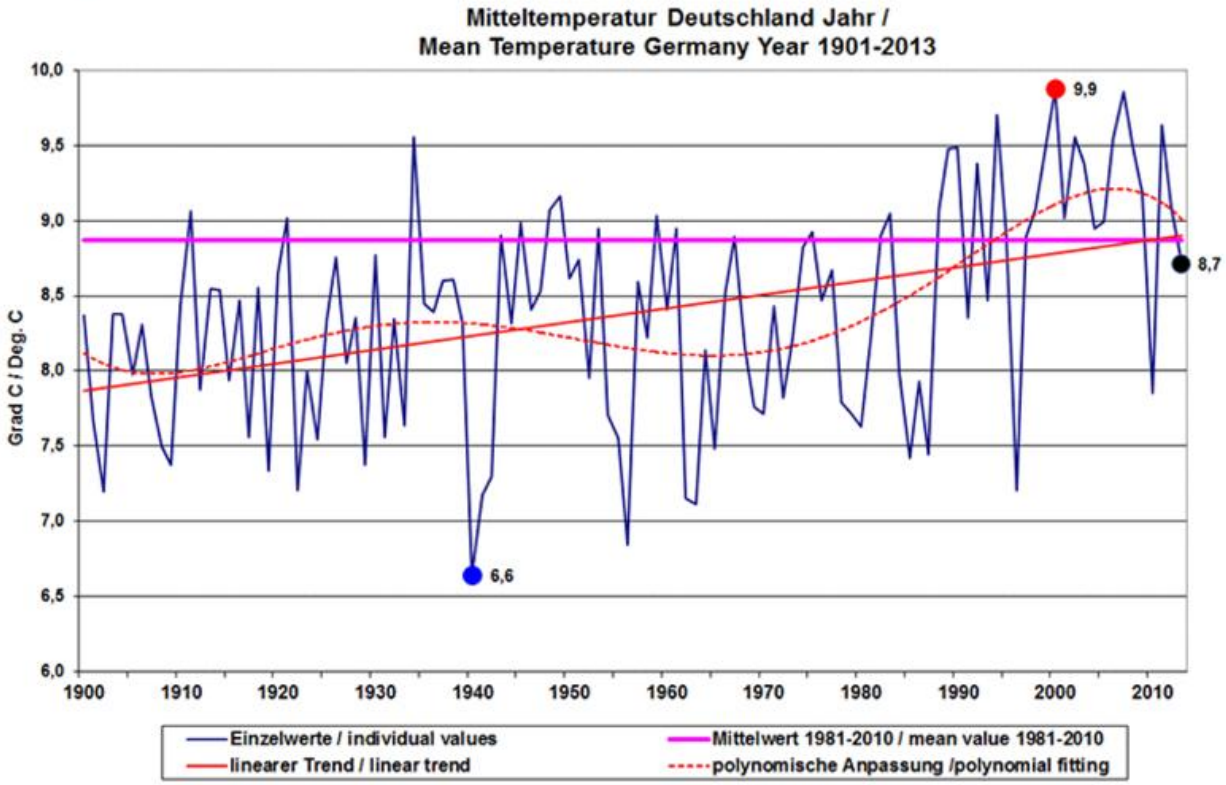


Figure 2.12: Time series of annual mean temperature for Germany (Diagram as provided by the NHMS)

Luxembourg

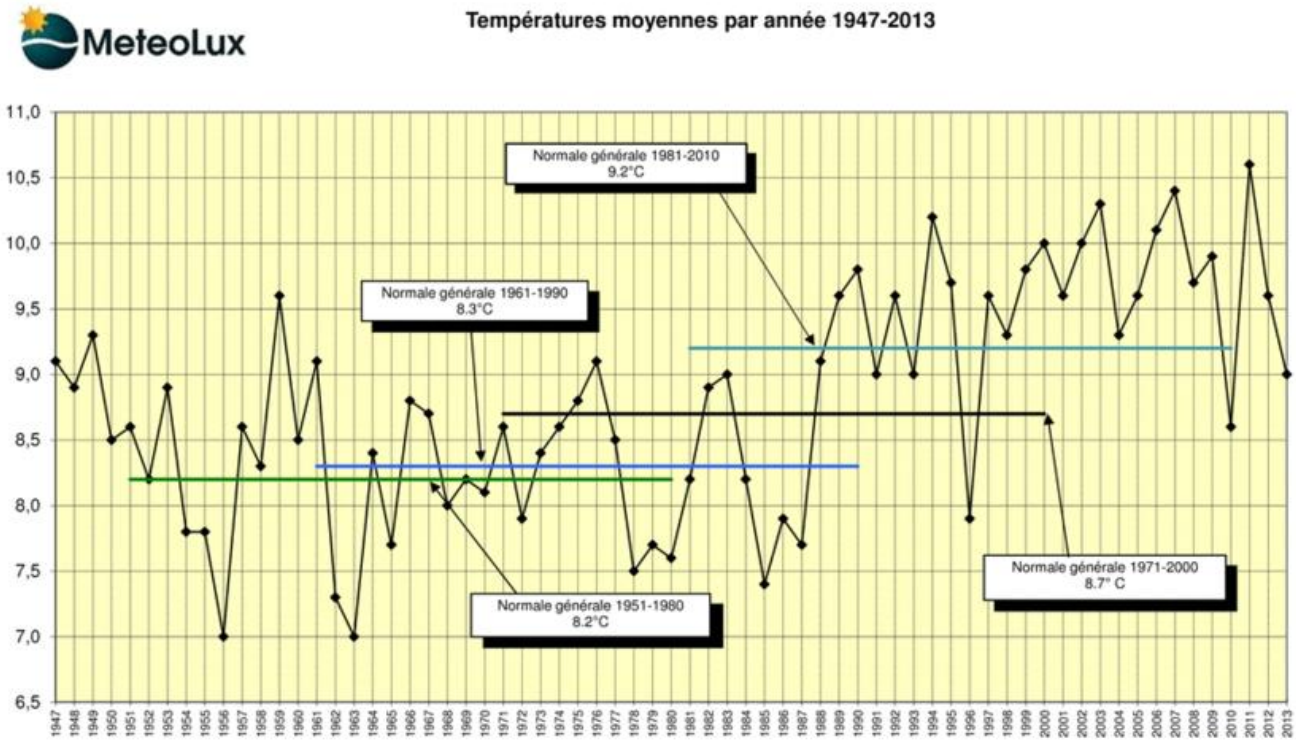


Figure 2.13: Time series of annual mean temperature for Luxembourg (Diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Poland

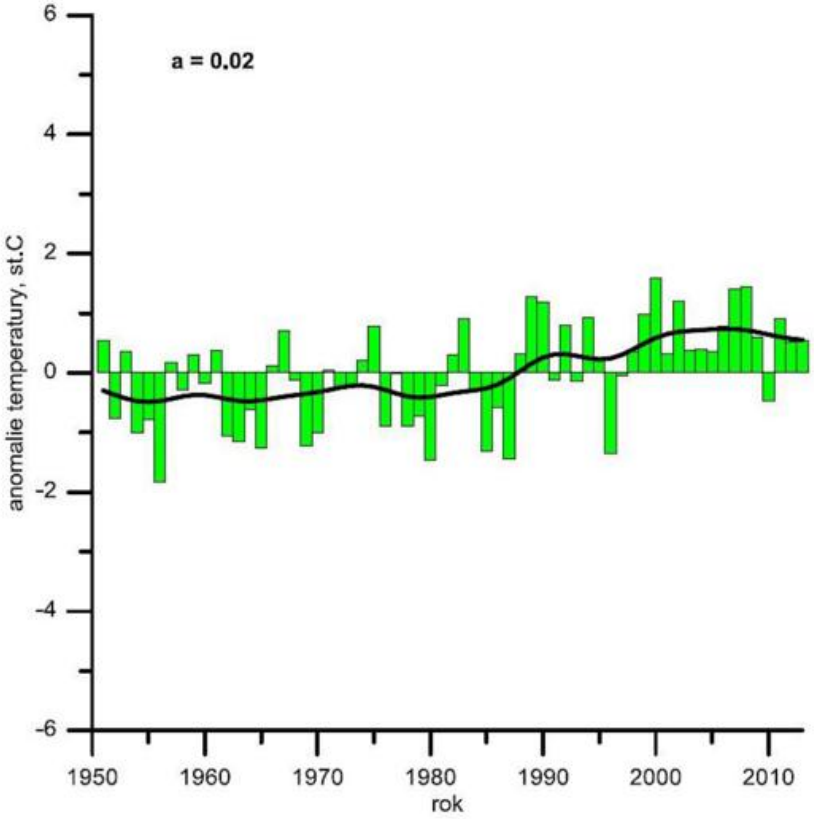


Figure 2.14: Time series of annual temperature anomalies Poland (reference period 1971-2000; diagram as provided by the NHMS)

Switzerland

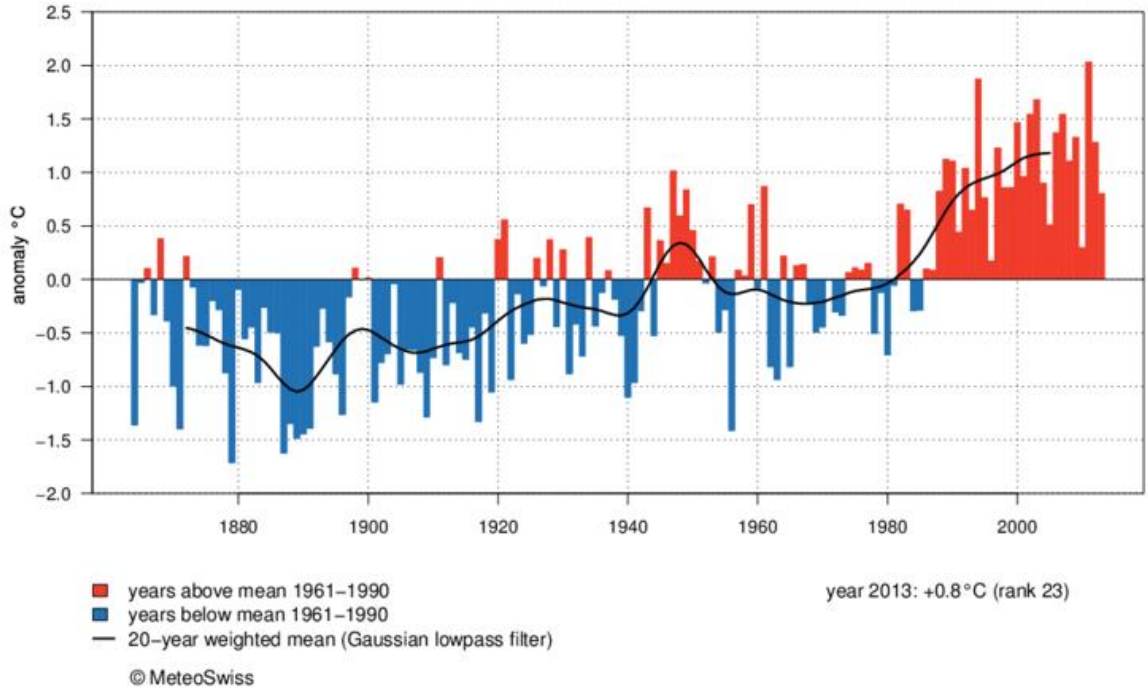
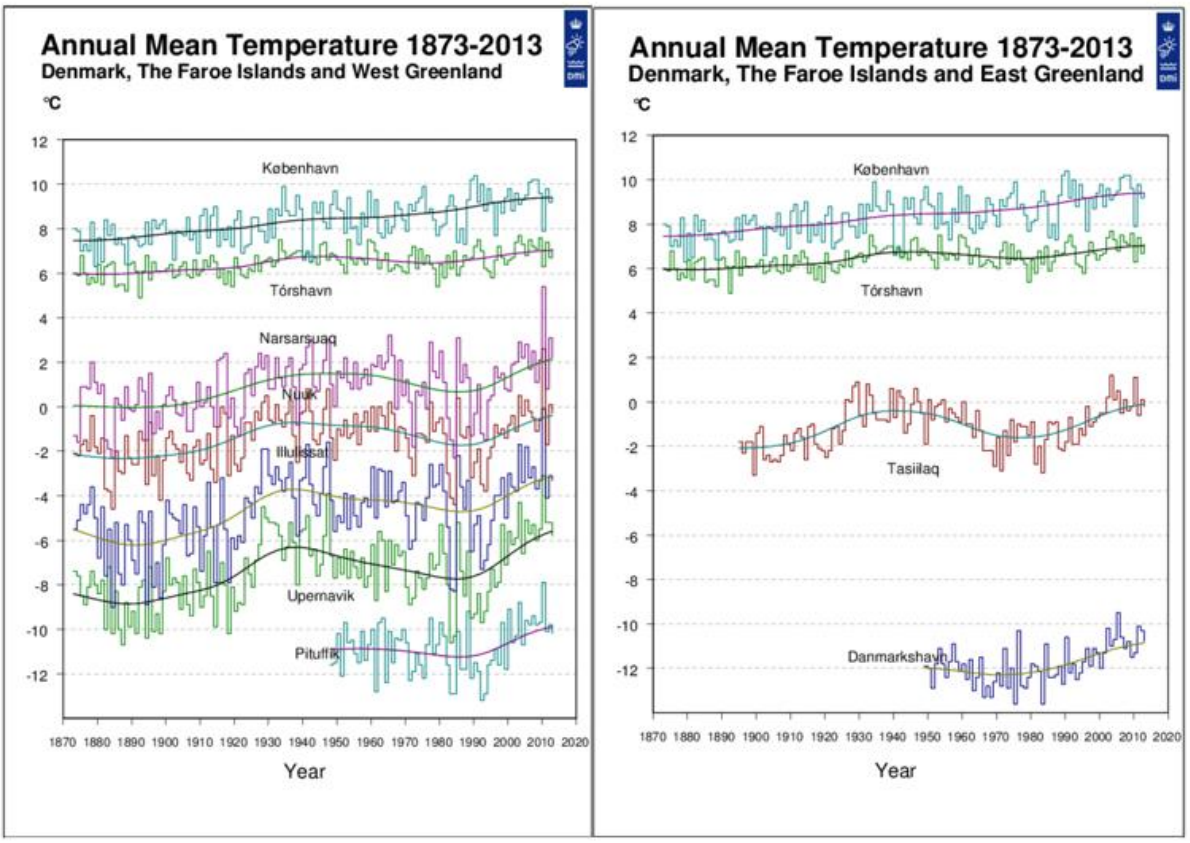


Figure 2.15: Time series of annual temperature anomalies for 12 representative and homogenized stations in Switzerland (reference period: 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Denmark, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden

Denmark, Greenland



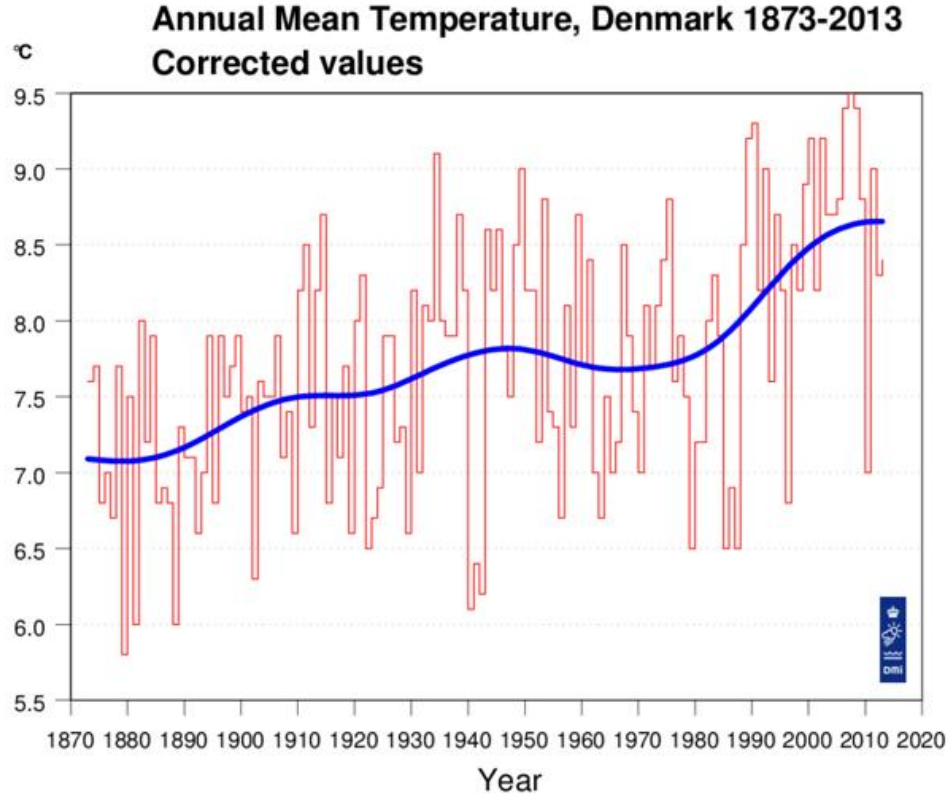


Figure 2.16: Time series of annual temperature for Faroe Islands, Greenland (top) and Denmark (bottom, Diagrams as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Denmark, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden

Finland

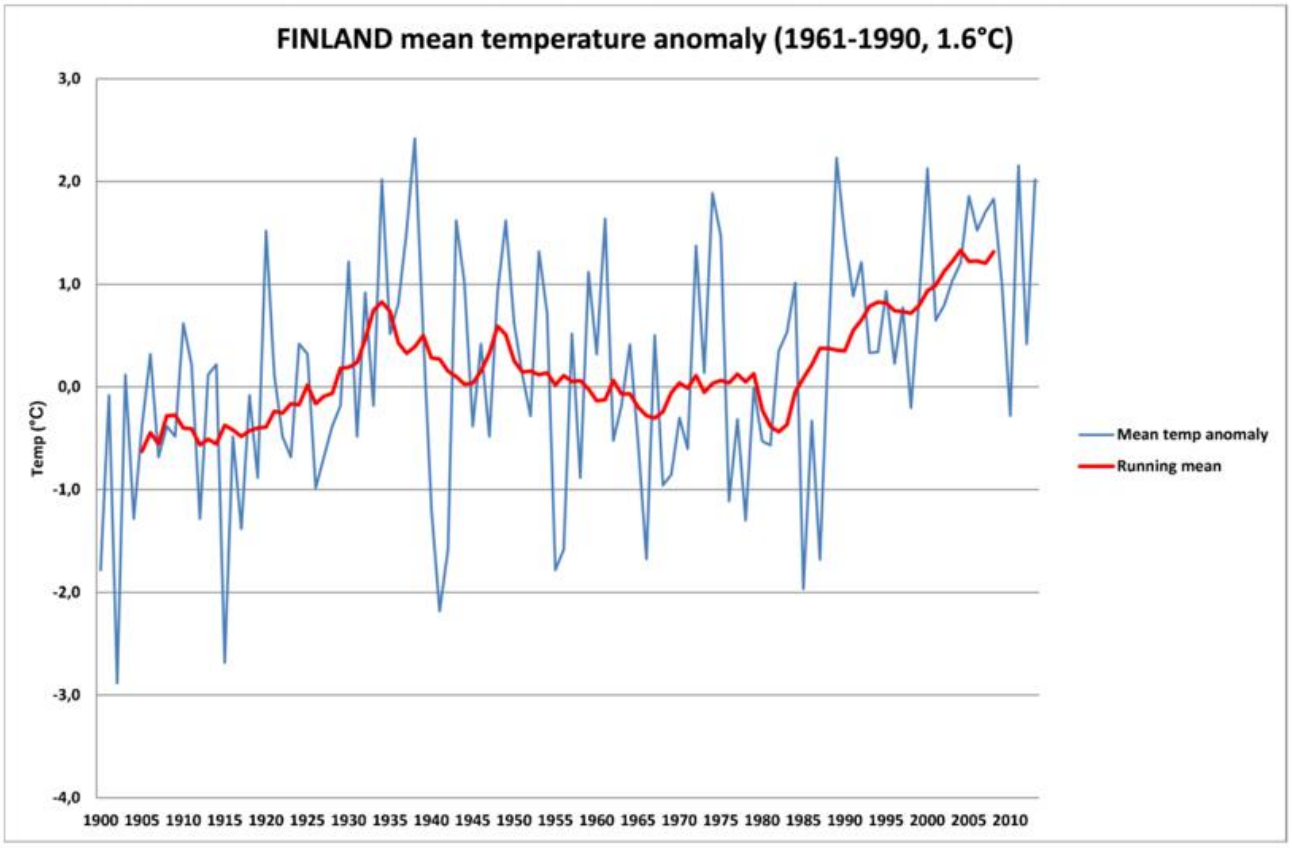


Figure 2.17: Time series of annual temperature anomalies for Finland (reference period: 1961-1990; diagram as provided by the NHMSs)

Latvia

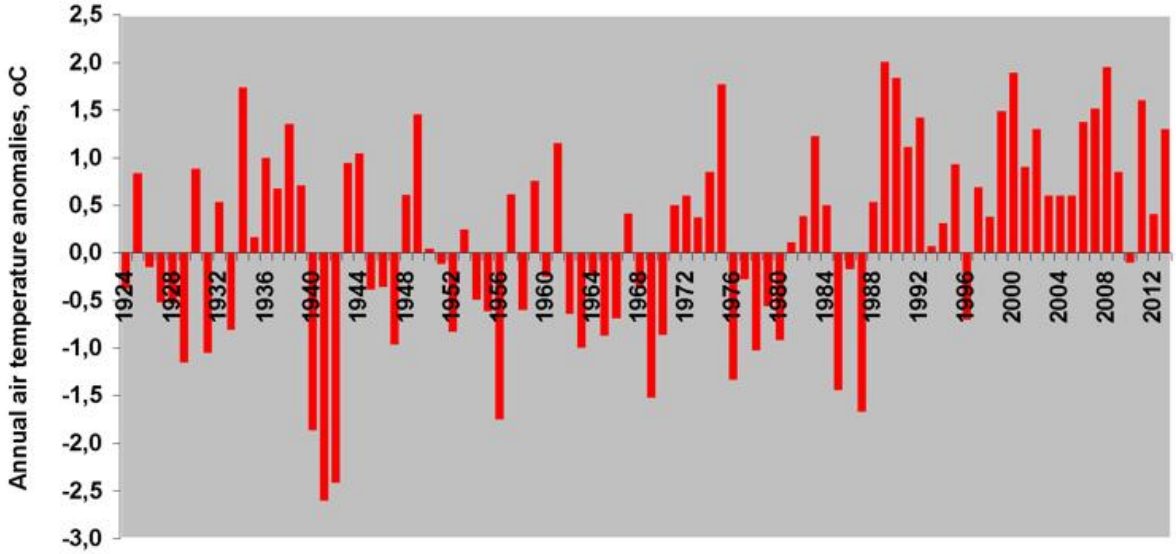


Figure 2.18: Time series of annual temperature anomalies for Latvia (reference period: 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Lithuania

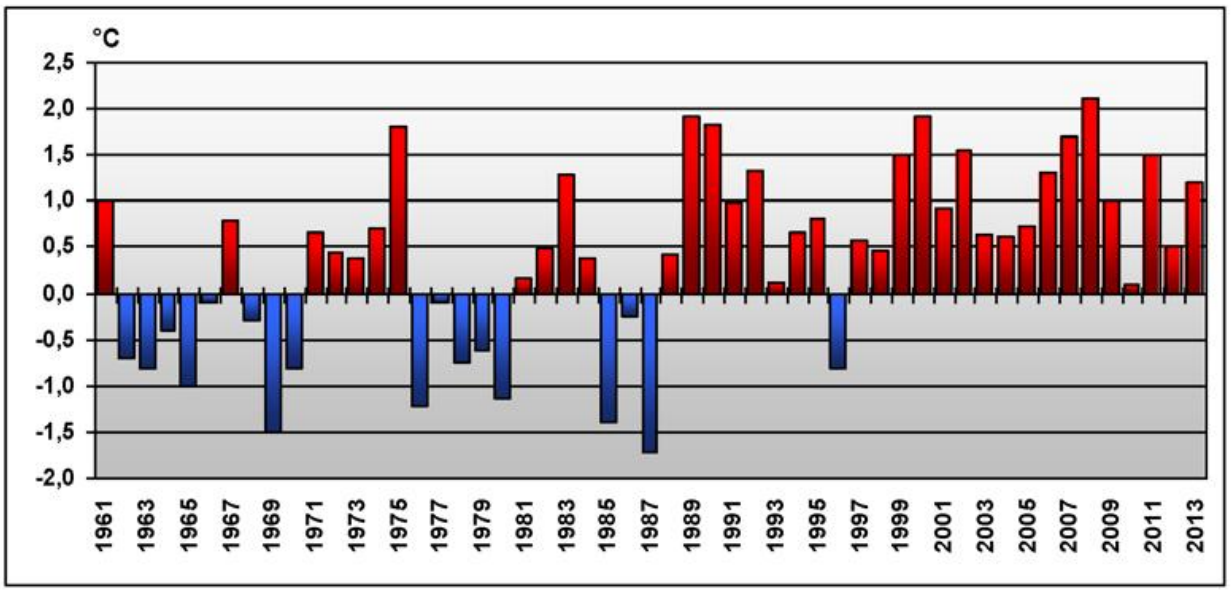


Figure 2.19: Time series of annual temperature anomalies Lithuania (reference period: 1961-1990; diagram as provided by the NHMS)

Norway

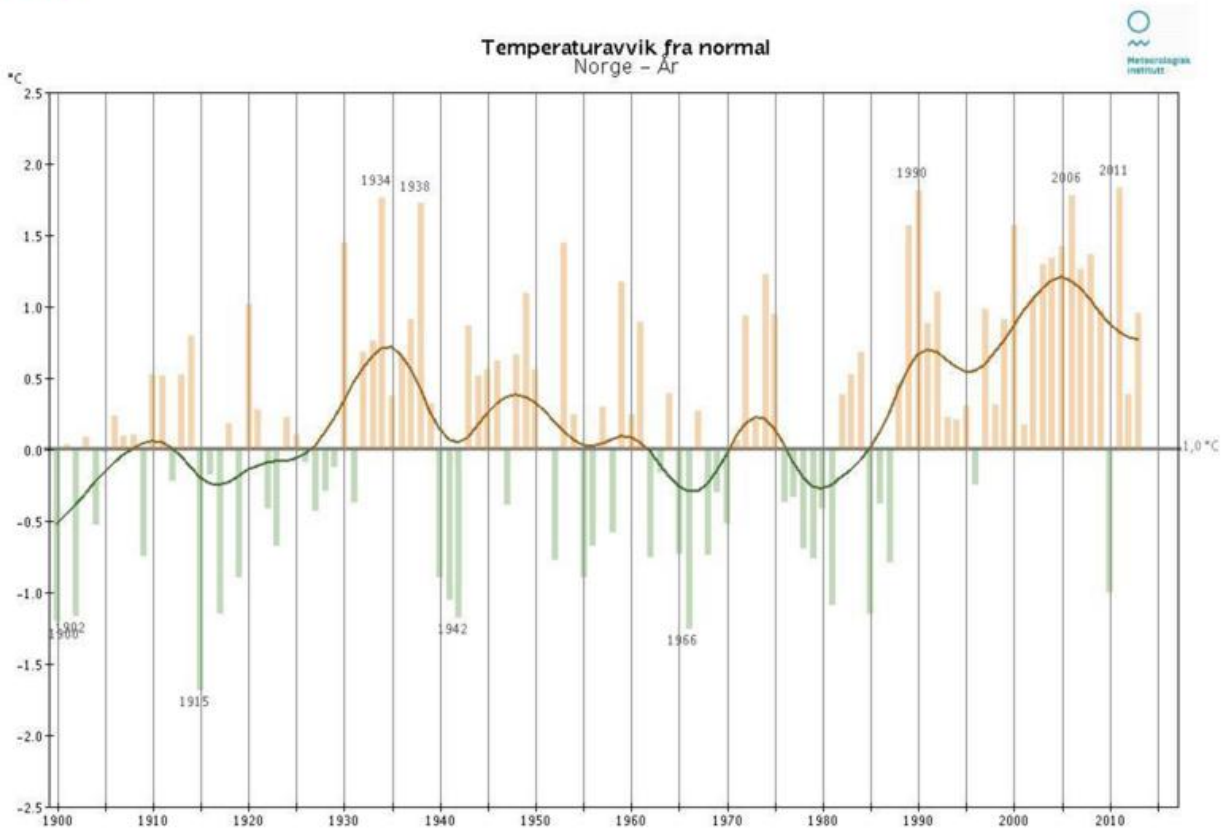


Figure 2.20: Time series of annual temperature anomalies Norway (reference period: 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Sweden

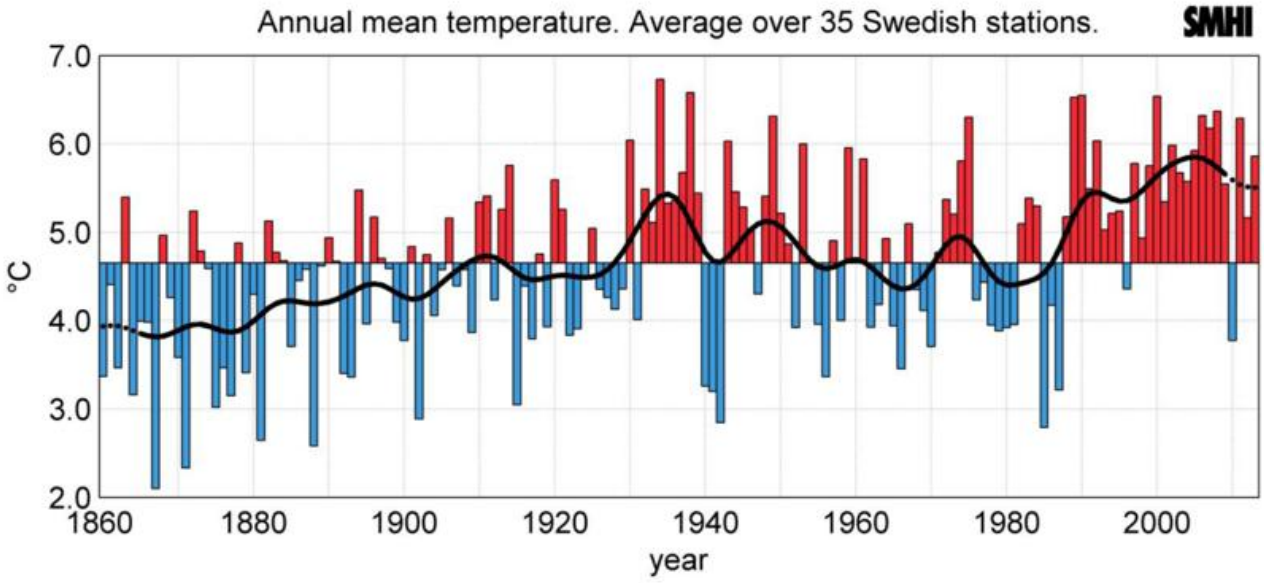


Figure 2.21: Time series of annual temperature for Sweden (Diagram as provided by the NHMS)

Iberia – annual temperature series

Portugal, Spain

Portugal

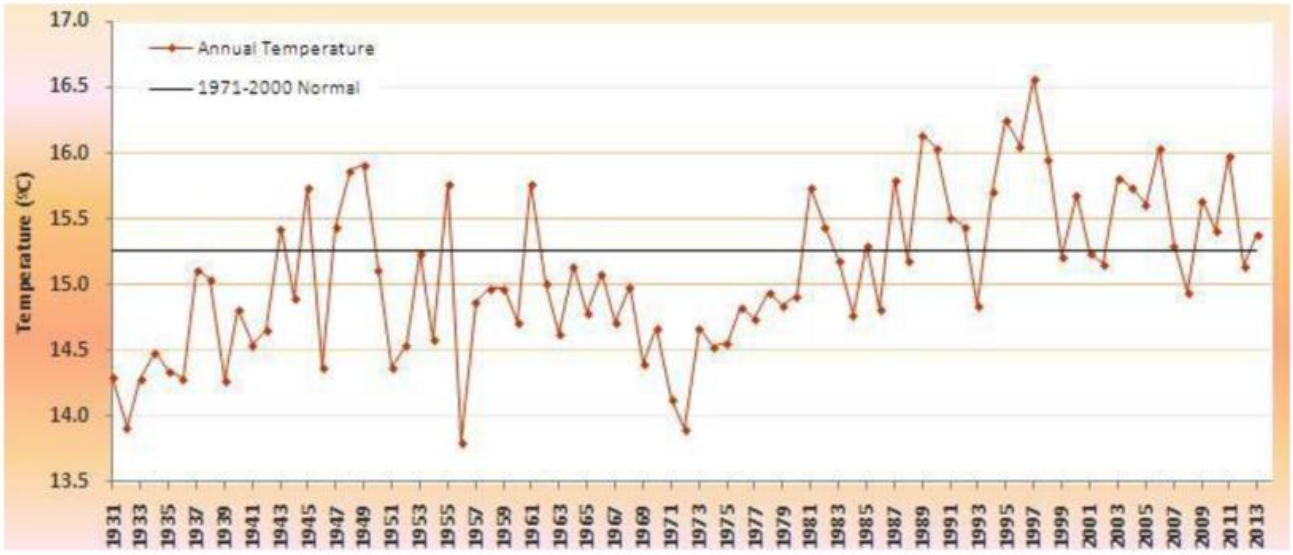


Figure 2.22: Time series of annual mean temperature Portugal (Diagram as provided by the NHMS)

Spain

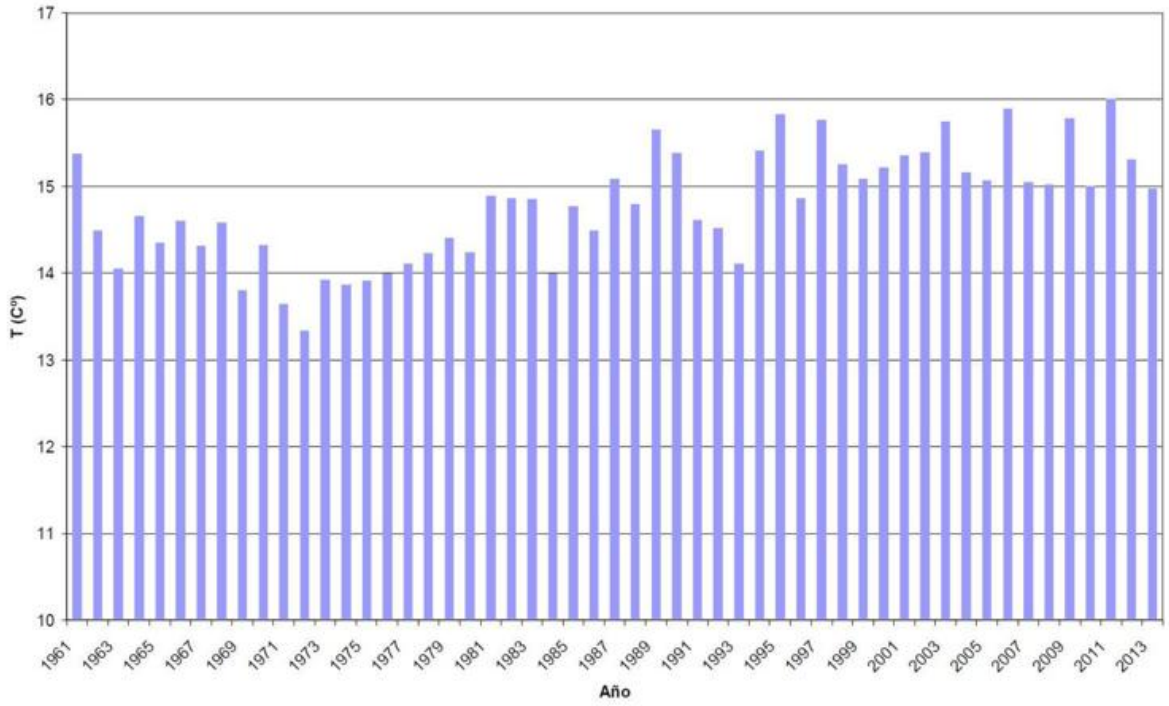


Figure 2.23: Time series of annual mean temperature Spain (Diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Bulgaria, Croatia, Italy, Slovenia, Turkey

Bulgaria

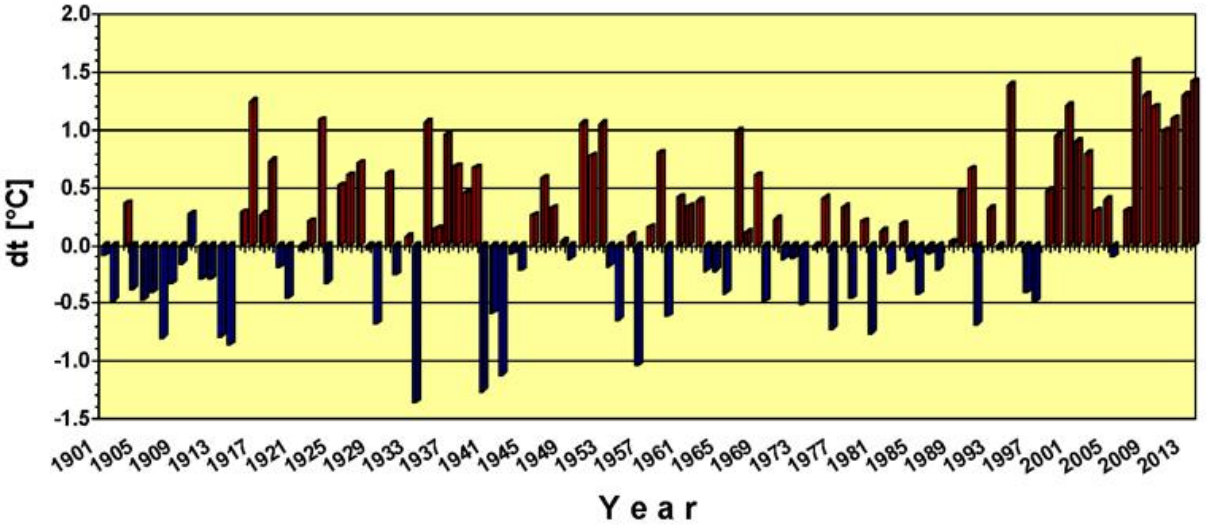


Figure 2.24: Time series of annual temperature anomalies Bulgaria (reference period: 1961-1990; diagram as provided by the NHMS)

Croatia

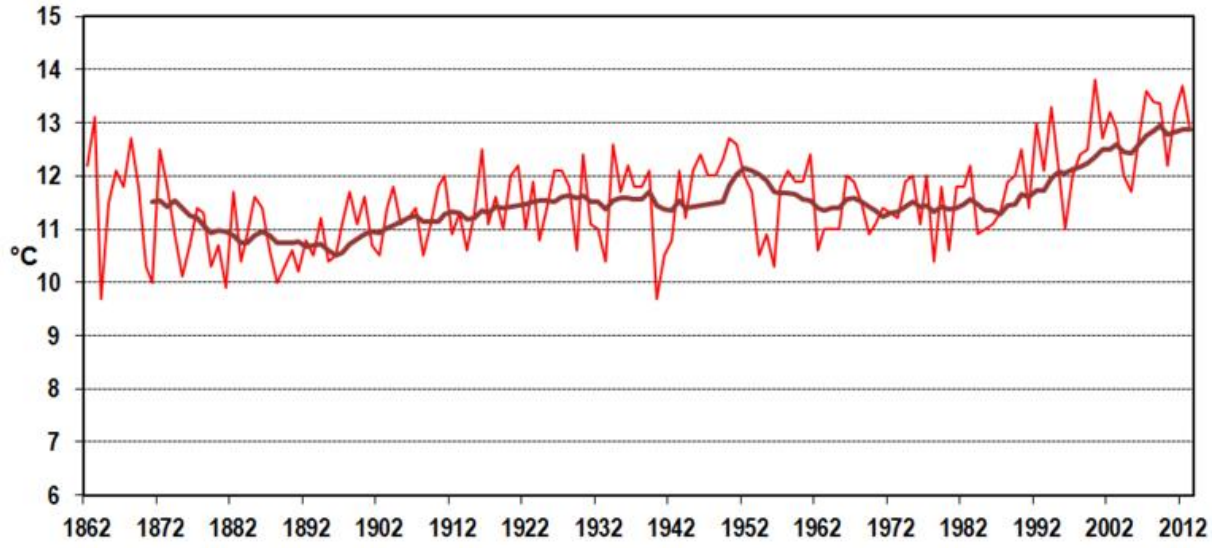


Figure 2.25: Time series of annual mean temperature for Croatia (Diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Italy

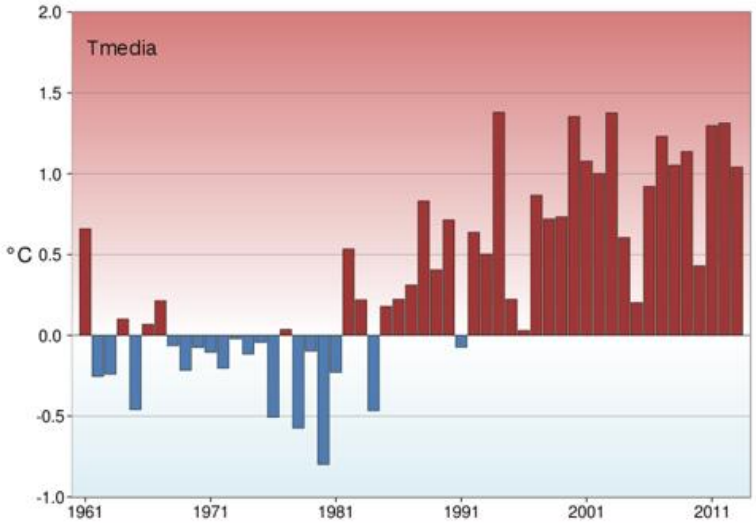


Figure 2.26: Time series of annual temperature anomalies Italy (reference period: 1961-1990; diagram as provided by the NHMS)

Slovenia

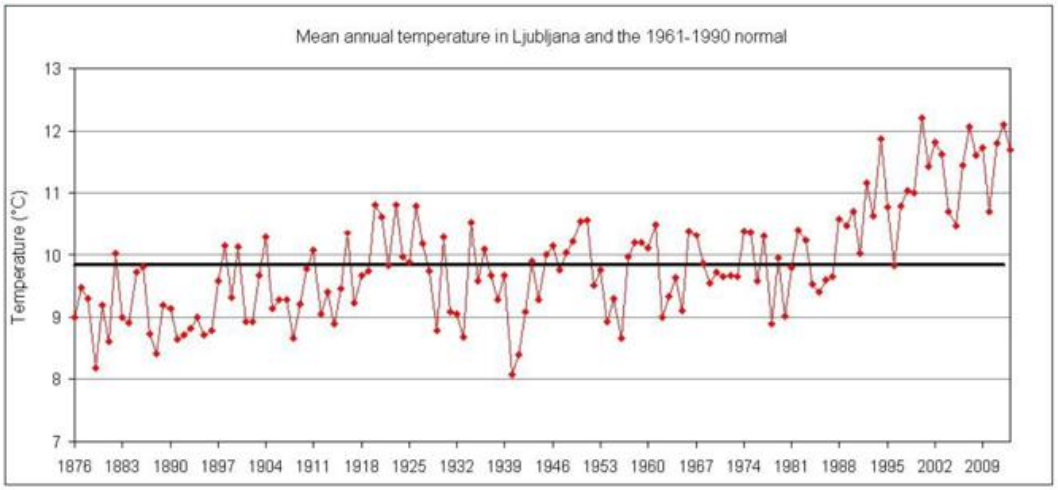


Figure 2.27: Time series of annual temperature for Ljubljana, Slovenia (Diagram as provided by the NHMS)

Turkey

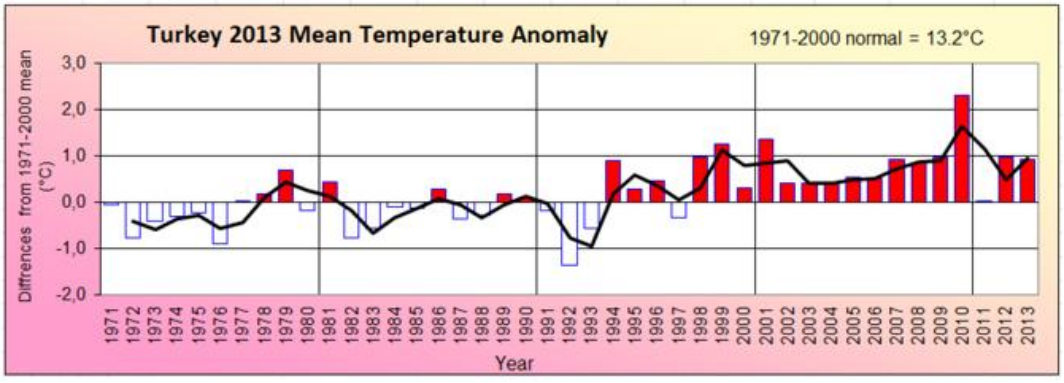


Figure 2.28: Time series of annual mean temperature anomalies Turkey (reference period 1971-2000; diagram provided by the NHMS)

Eastern Europe – annual temperature series

Belarus, European Russia

Belarus

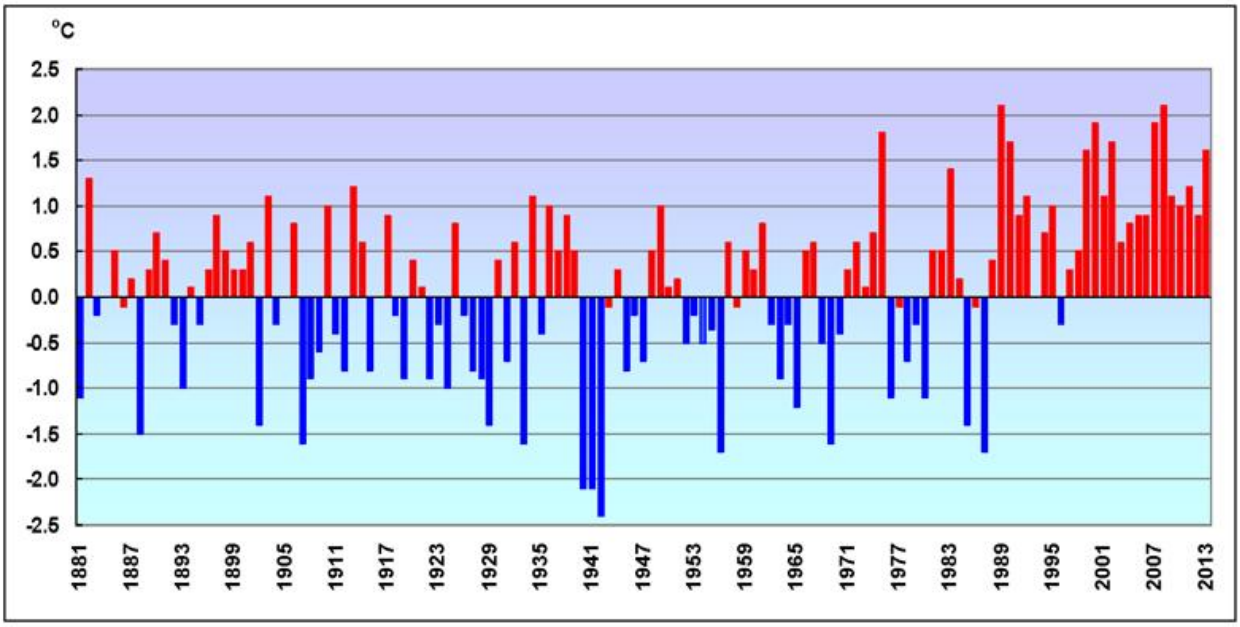


Figure 2.29: Time series of annual mean temperature anomalies Belarus (reference period: 1961-1990; diagram provided by the NHMS)

European Russia

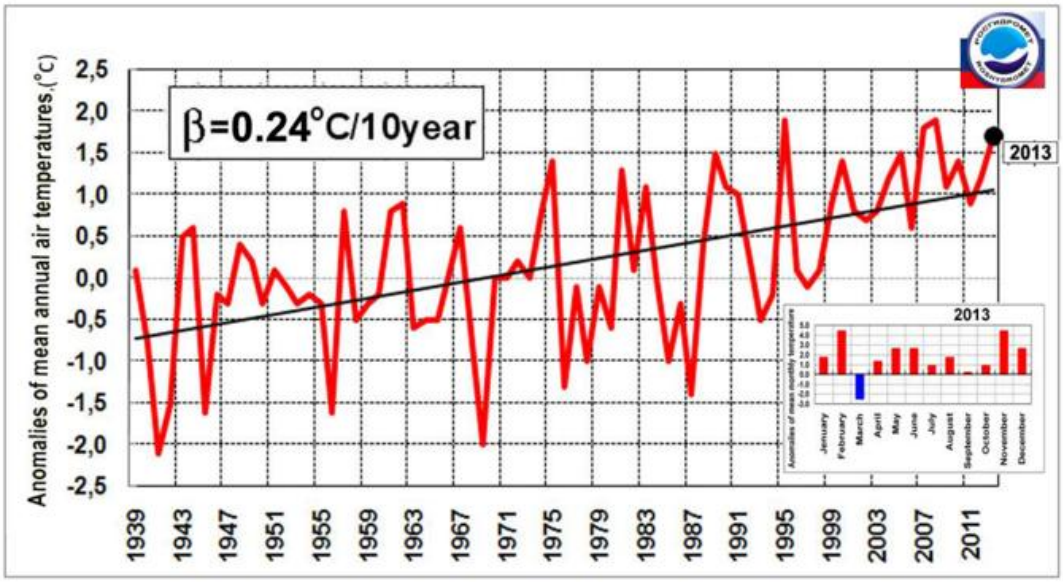


Figure 2.30: Time series of annual mean temperature anomalies for European Russia (reference period: 1961-1990; diagram provided by the NHMS)

Middle East – annual temperature series

Armenia, Georgia, Israel

Armenia

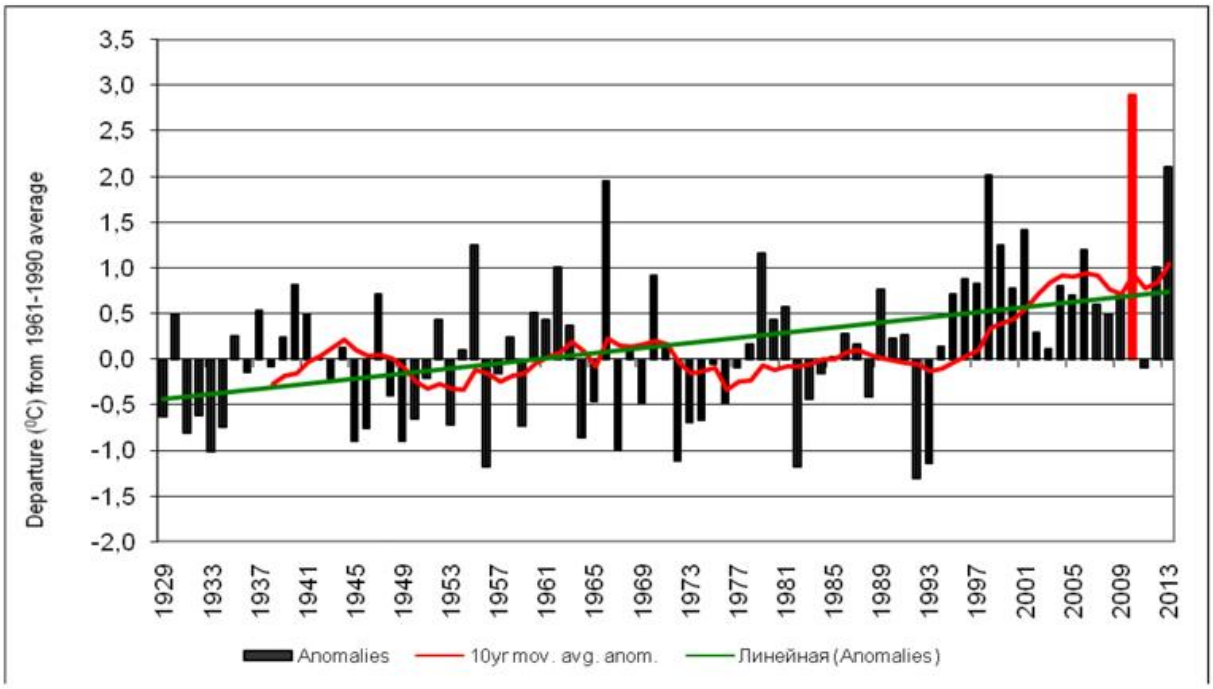


Figure 2.31: Time series of annual mean temperature anomalies Armenia (reference period: 1961-1990; diagram provided by the NHMS)

Georgia

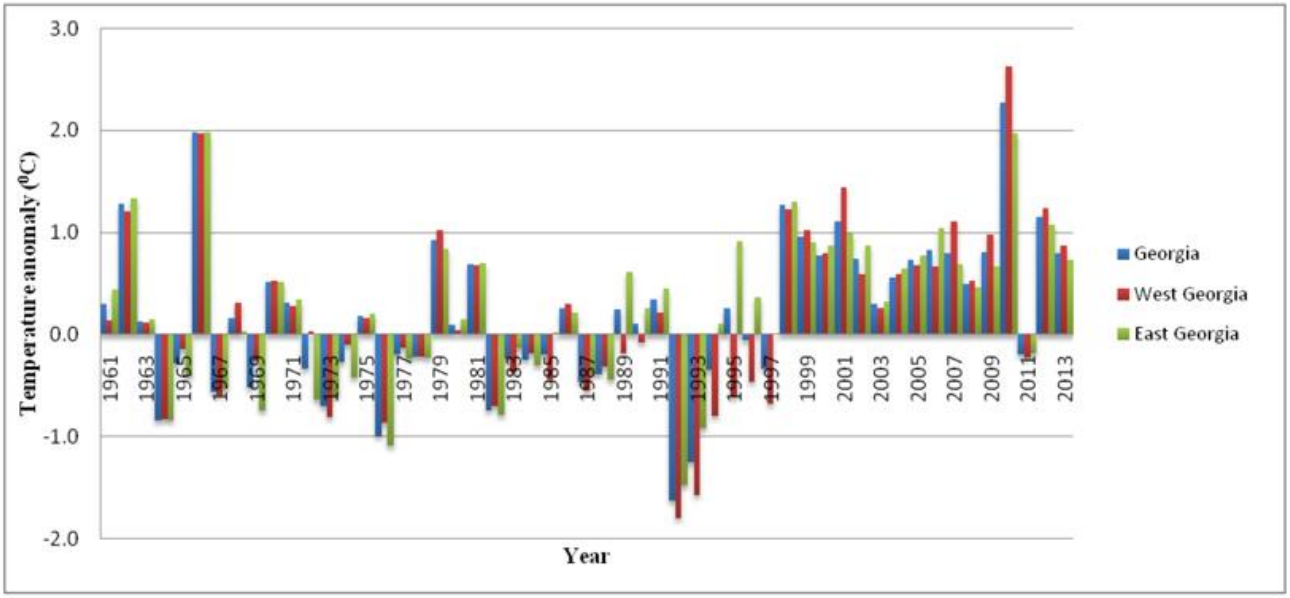


Figure 2.32: Time series of annual mean temperature anomalies for Georgia, the western and eastern part (reference period 1971-2000; diagram provided by the NHMS)

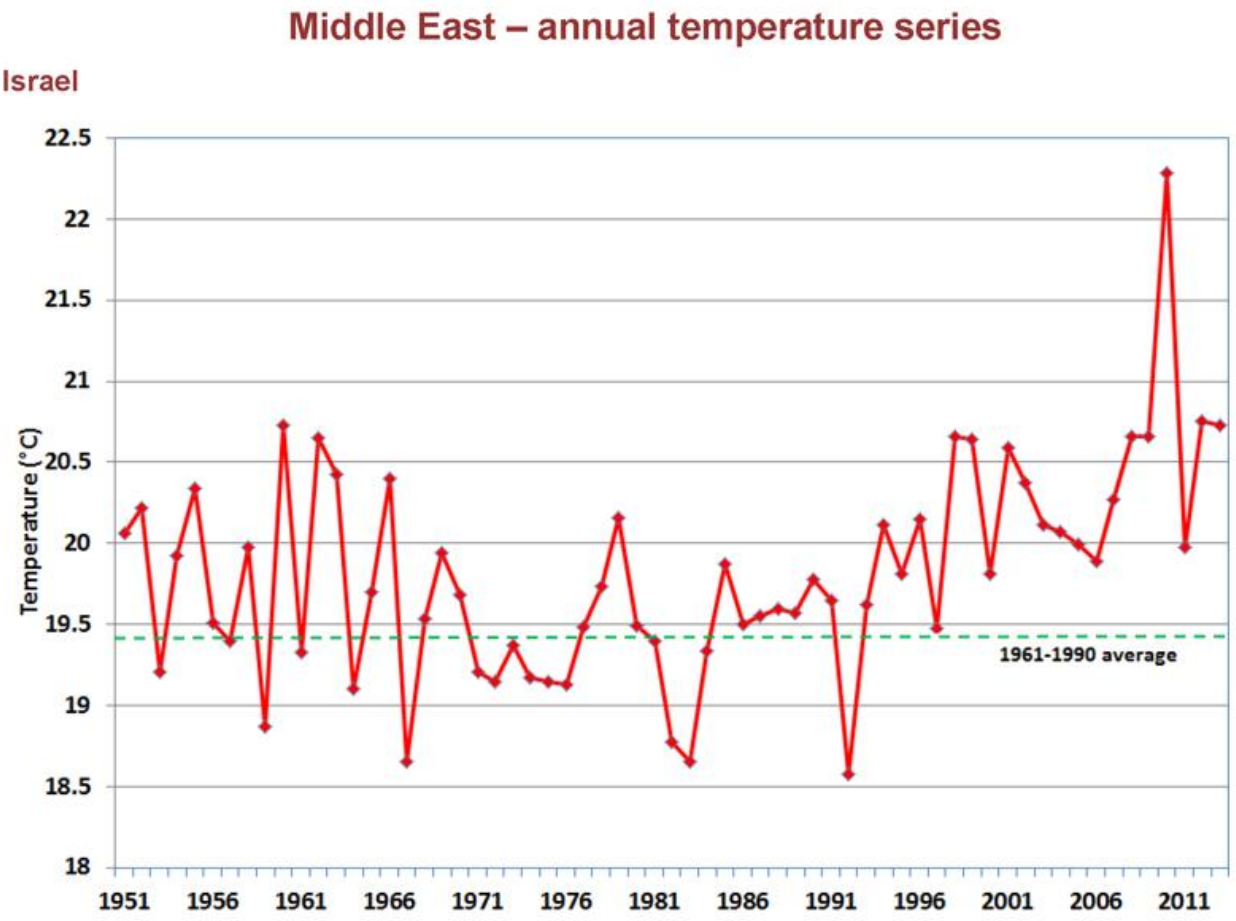


Figure 2.33: Time series of annual mean temperature for Israel (based on the average of five stations, Diagrams provided by the NHMS)

2.2.2 Precipitation

Central and Western Europe - precipitation totals and anomalies

Germany, Switzerland

Germany

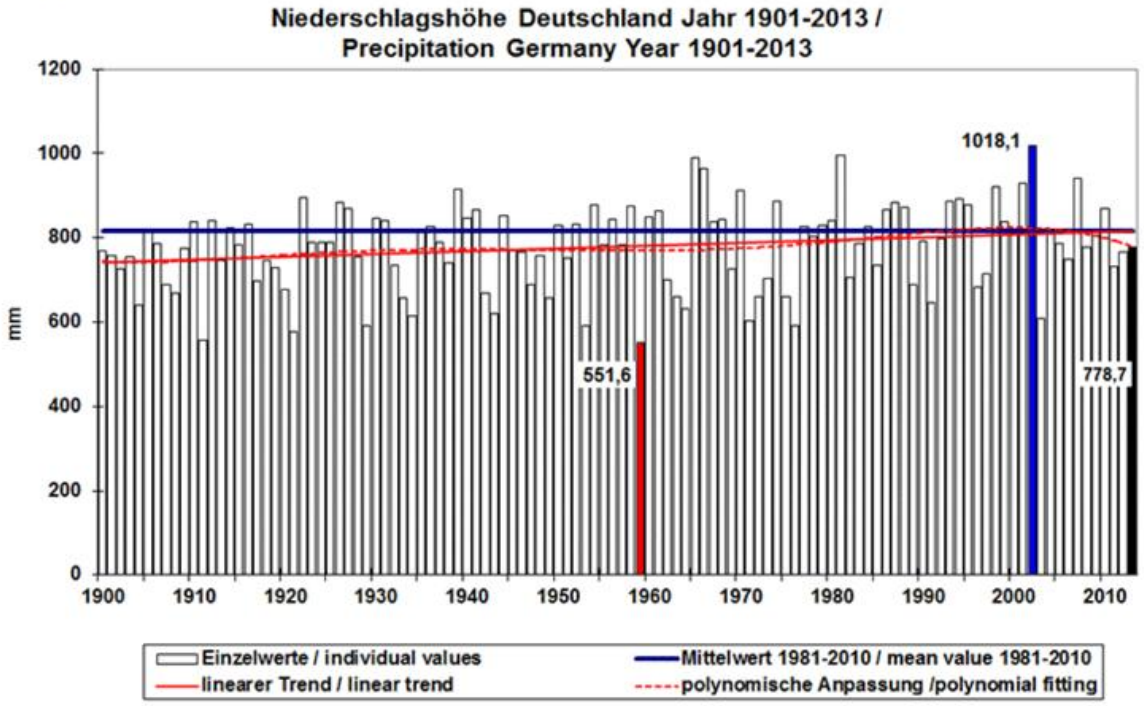


Figure 2.34: Time series of annual precipitation totals Germany (Diagram as provided by the NHMS)

Switzerland

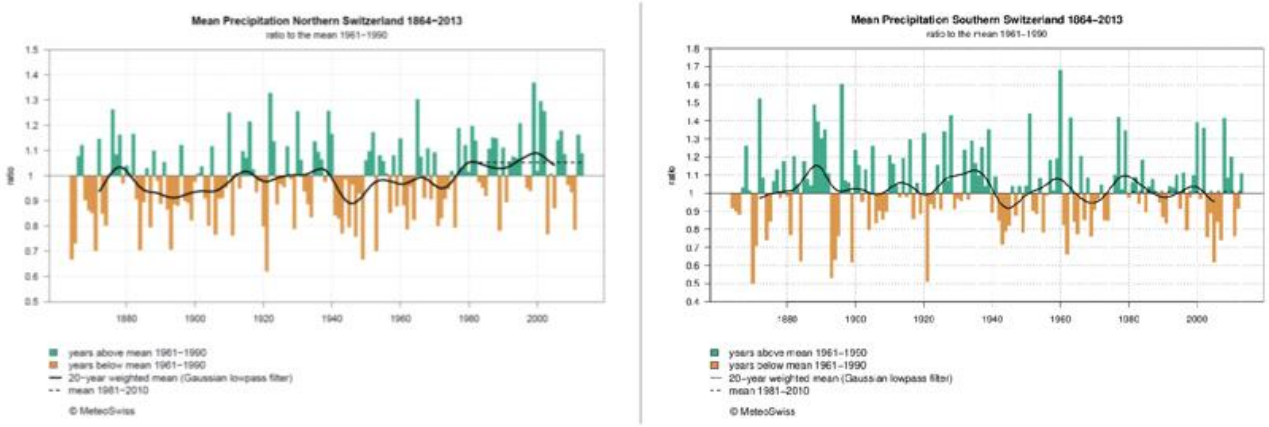


Figure 2.35: Time series of annual precipitation anomalies in relation to the mean of 1961-90 for northern (left) and southern (right) Switzerland (diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Denmark, Latvia, Norway

Denmark

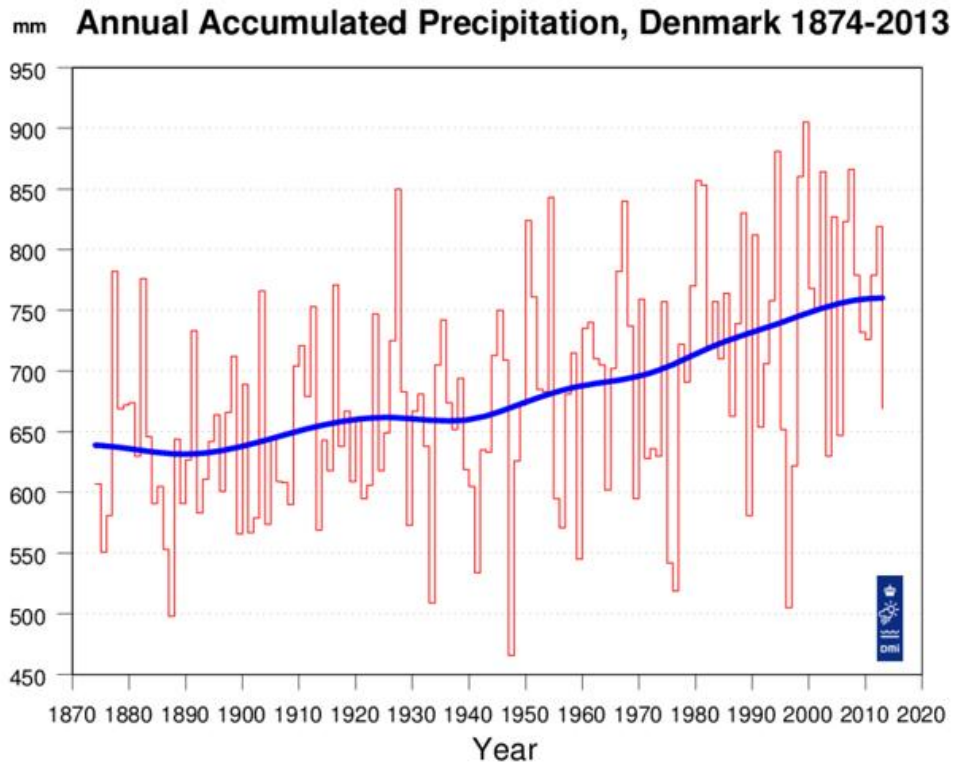


Figure 2.36: Time series of annual precipitation sums for Denmark (Diagram as provided by the NHMSs

Latvia

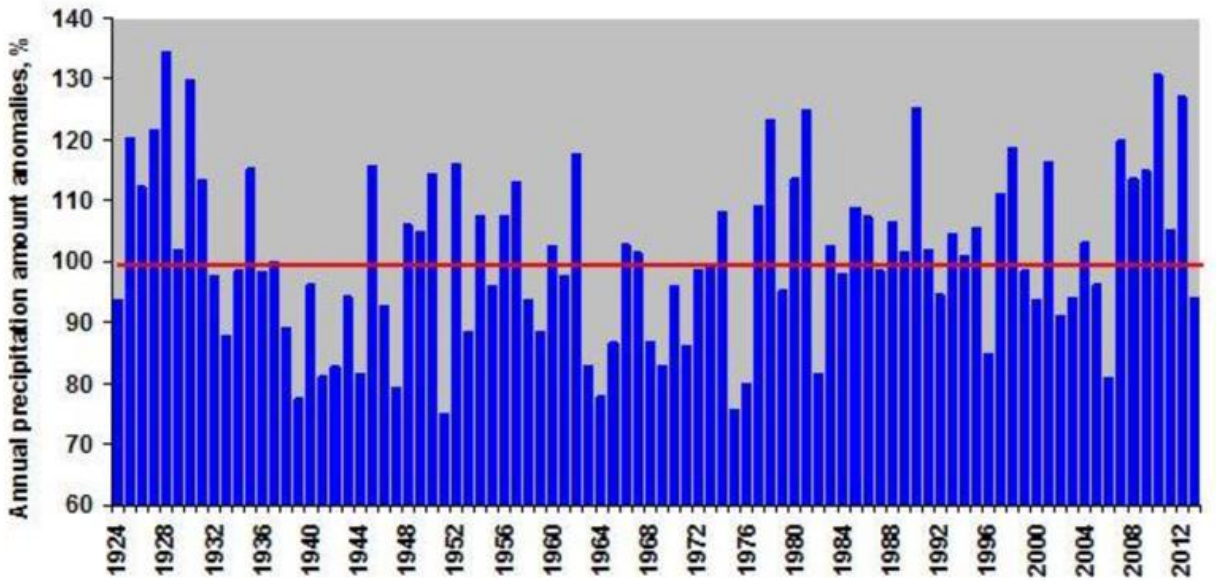


Figure 2.37: Time series of relative annual precipitation anomalies for Latvia (reference period: 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation anomalies

Norway

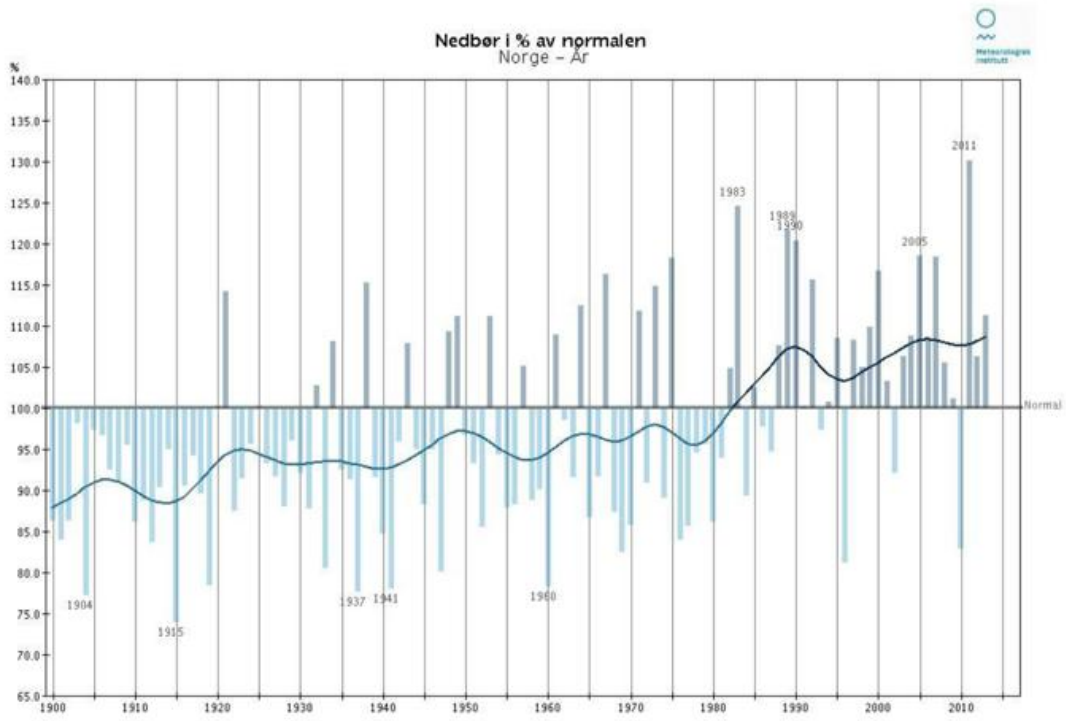


Figure 2.38: Time series of relative annual precipitation anomalies for Norway (reference period: 1961-1990; diagram as provided by the NHMS)

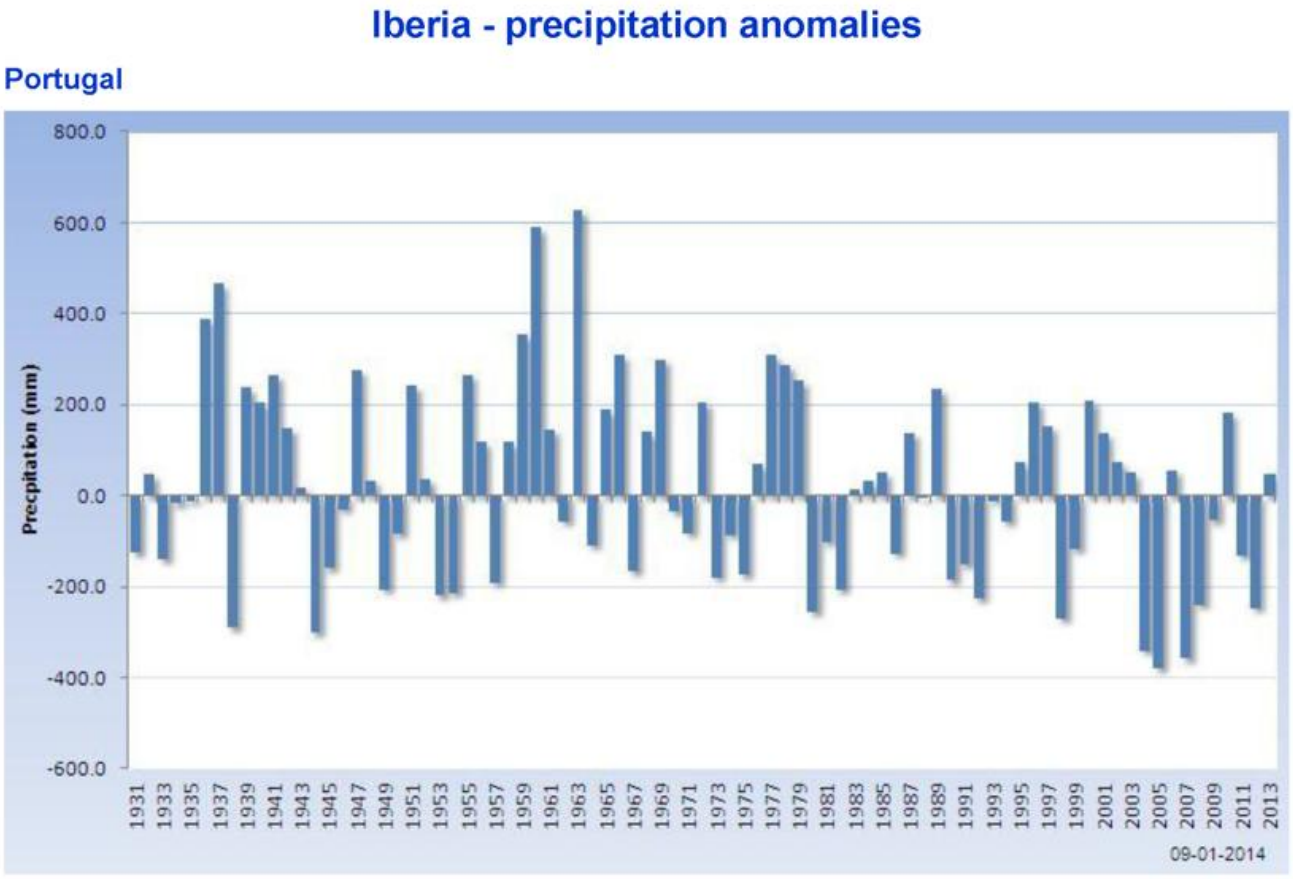


Figure 2.39: Time series of annual precipitation anomalies for Portugal (reference period 1971-2000; diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Italy, Slovenia, Turkey

Italy

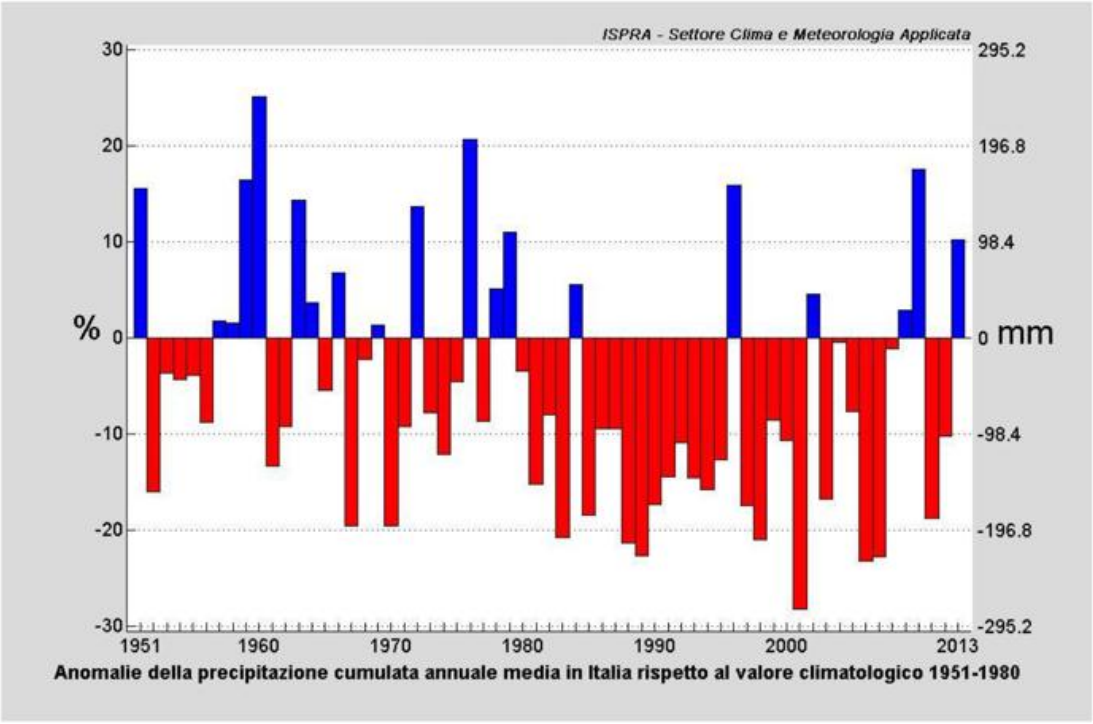


Figure 2.40: Time series of relative annual precipitation anomalies for Italy (reference period: 1951-1980; diagram provided by the NHMSs)

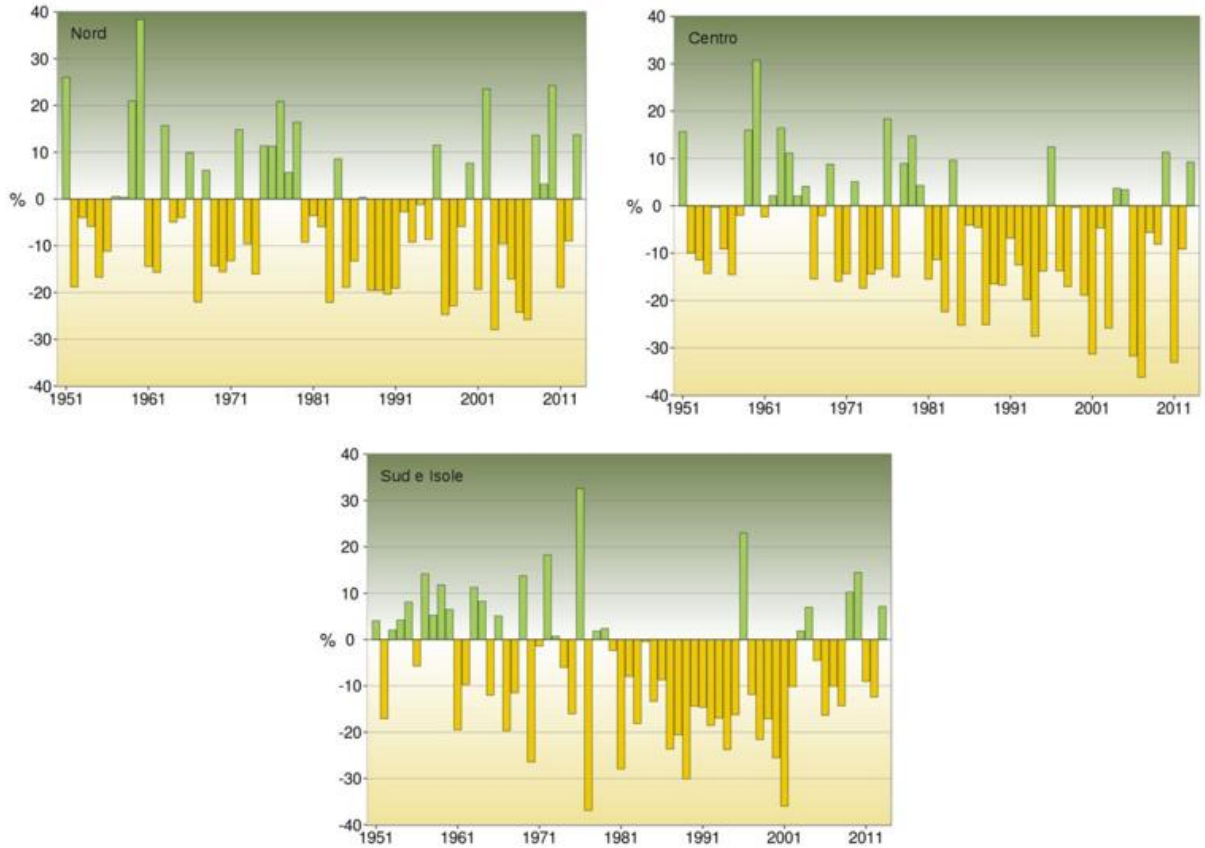


Figure 2.41: Time series of relative annual precipitation anomalies for Northern Italy (left), Centre Italy (right) and Southern Italy (bottom, reference period: 1951-1980; diagram as provided by the NHMSs)

Mediterranean, Italian and Balkan Peninsula - precipitation totals and anomalies

Slovenia

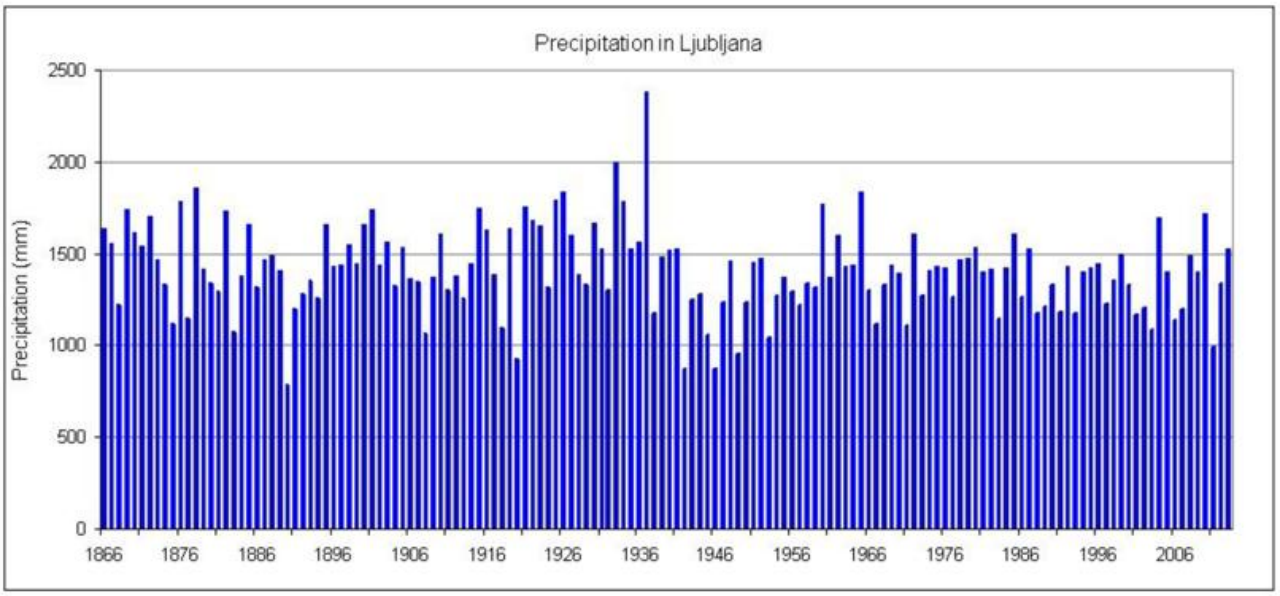


Figure 2.42: Time series of annual precipitation sums for Ljubljana, Slovenia (Diagram as provided by the NHMS)

Turkey

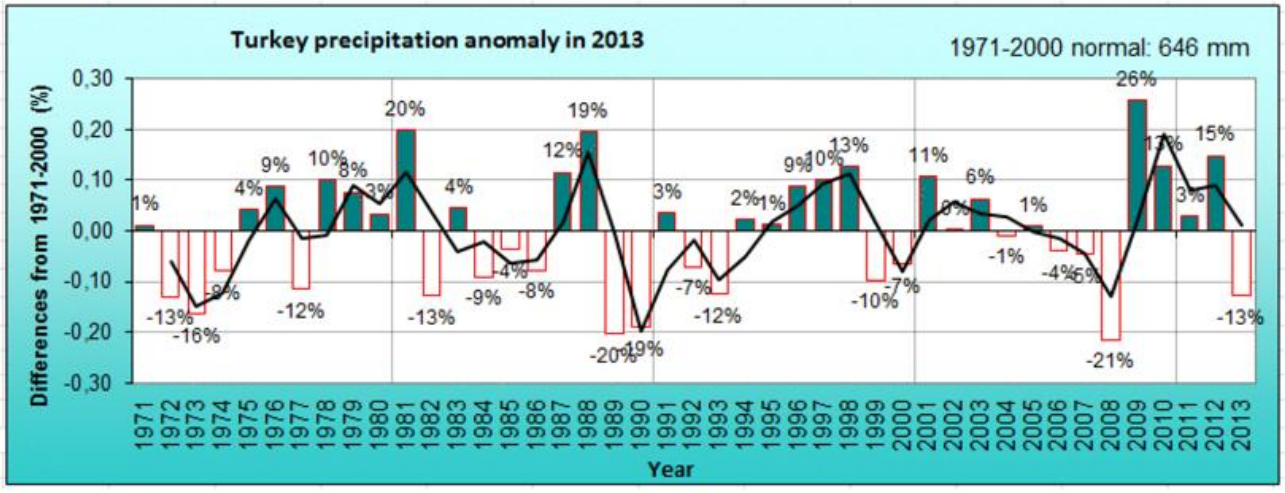


Figure 2.43: Time series of relative annual precipitation anomalies Turkey (reference period 1971-2000; diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Belarus, European Russia

Belarus

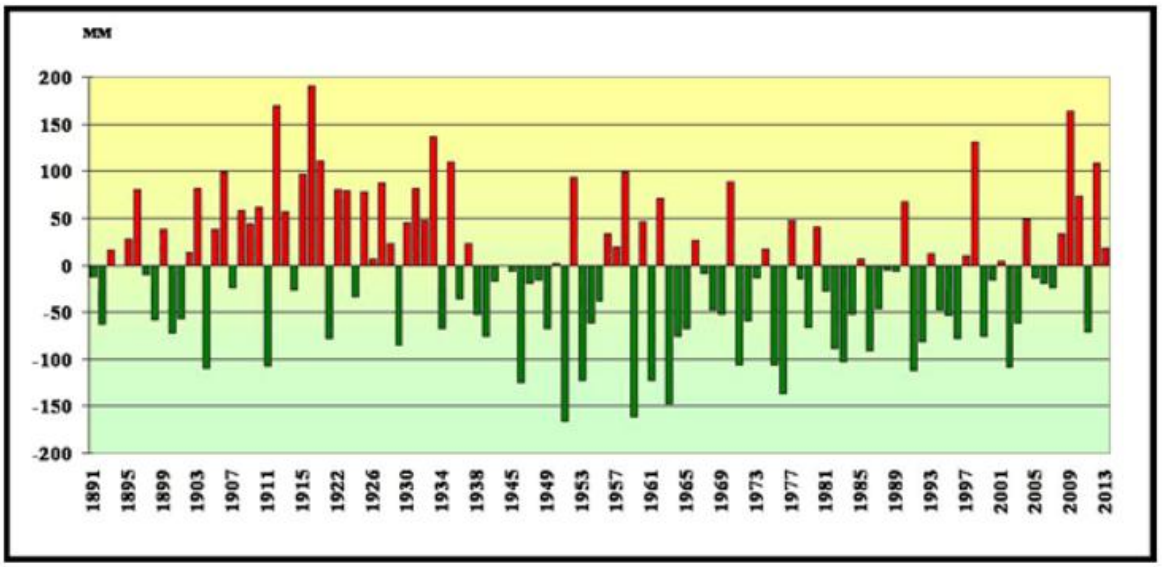


Figure 2.44: Time series of relative annual precipitation anomalies for Belarus (reference period: 1961-1990; diagram as provided by the NHMS)

European Russia

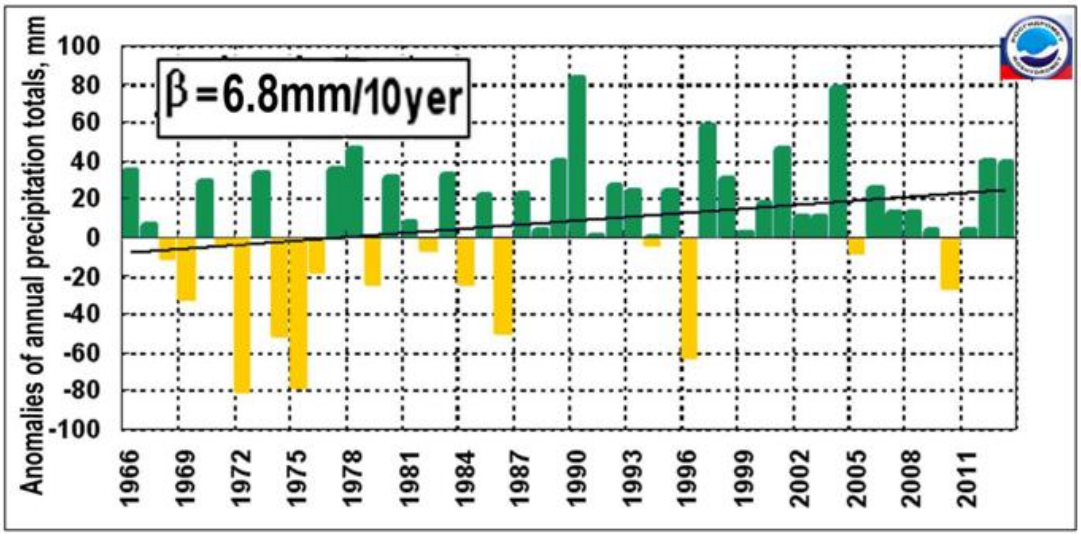


Figure 2.45: Time series of relative annual precipitation anomaliesfor European Russia (reference period: 1961-1990; diagram as provided by the NHMS)

Middle East - precipitation anomalies

Georgia

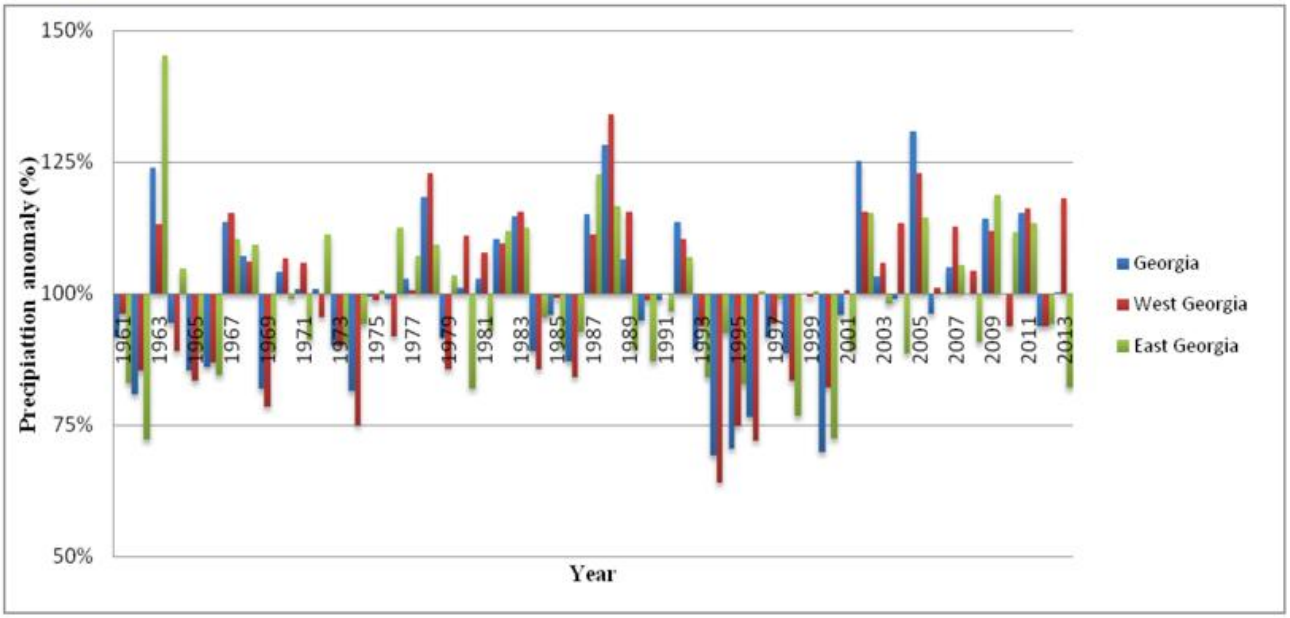


Figure 2.46: Time series of relative annual precipitation anomalies for Georgia (reference period 1971-2000; diagram as provided by the NHMS)

2.2.3 Sunshine duration

Central and Western Europe - sunshine duration anomalies

Germany, Switzerland

Germany

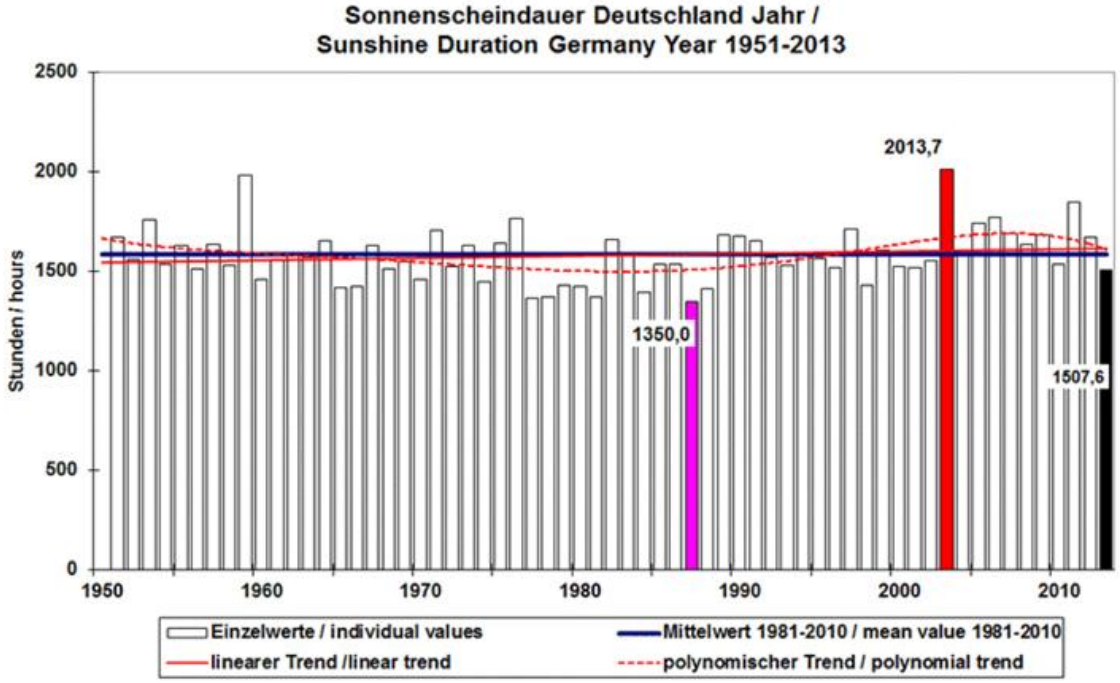


Figure 2.47: Time series of annual sum of the sunshine duration in hours for Germany (Diagram as provided by the NHMS)

Northern and Southern Switzerland

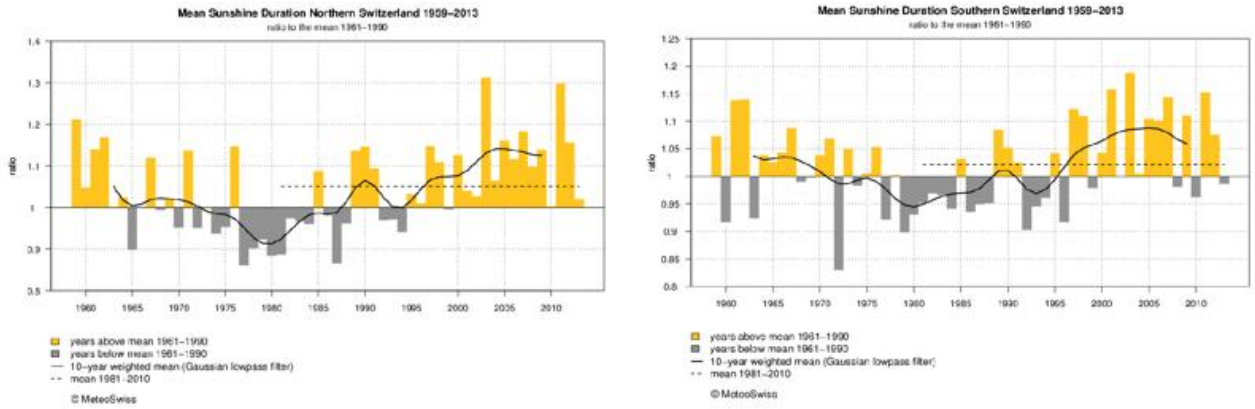


Figure 2.48: Time series of annual sunshine duration anomalies as ratio of the mean 1961-1990 for Northern (left) and Southern (right) Switzerland (reference period: 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries - sunshine duration

Denmark

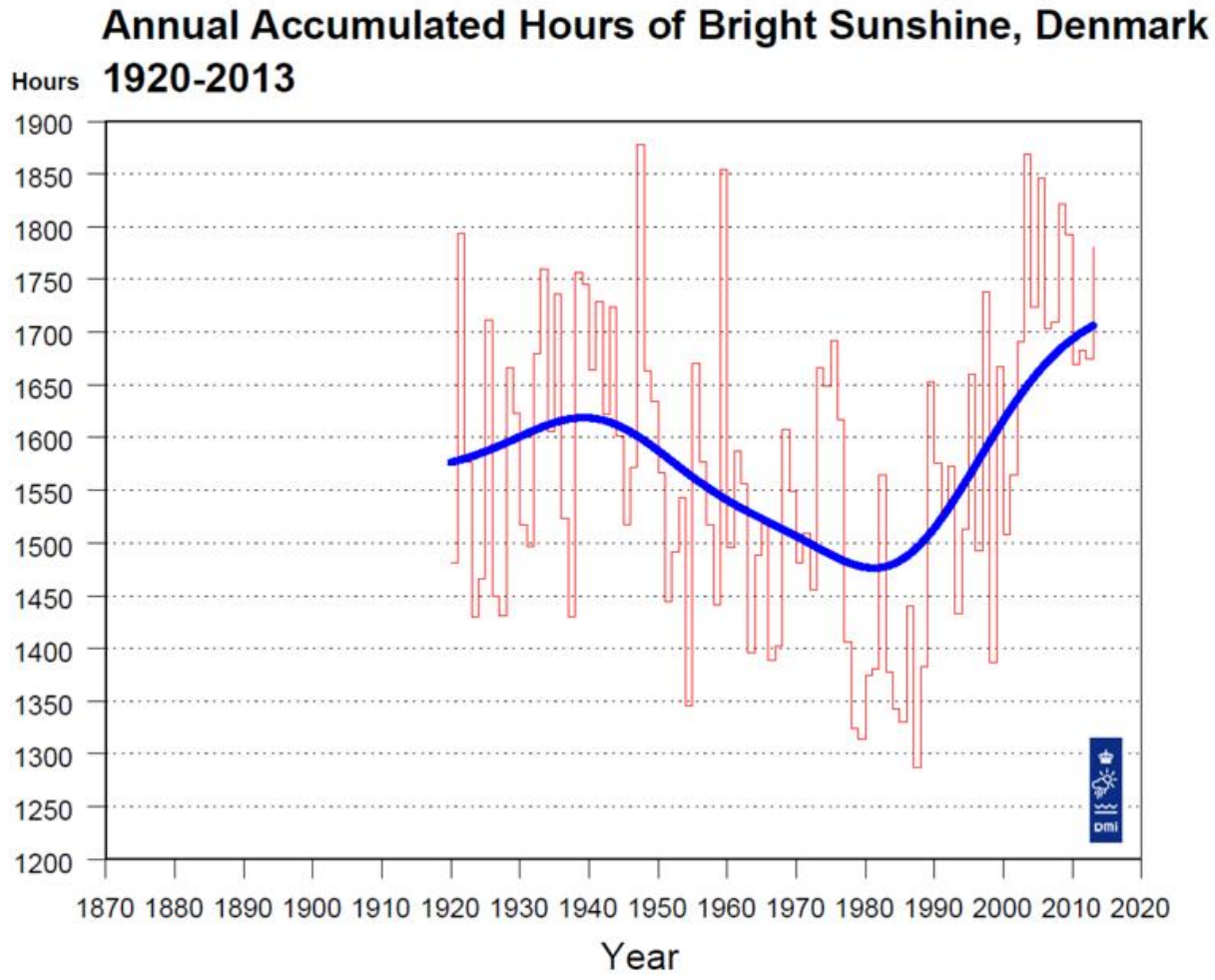


Figure 2.49: Time series of annual sunshine duration in hours for Denmark (Diagram as provided by the NHMS)

Note: DMI observed since 2002 the hours of bright sunshine using measurements of global radiation instead of measurements from a traditional Campbell-Stokes sunshine recorder. For that reason "new" and "old" hours of bright sunshine cannot directly be compared. It should also be noted that all values before 2002 are adjusted in the best way possible ensuring comparability to the new level. For details on that, see DMI Technical 02-25: Ellen Vaarby Laursen, Stig Rosenørn: New hours of bright sunshine normals for Denmark, 1961-1990. http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2002/tr02-25.pdf

2.2.4 Trends of temperature and precipitation indices 1951-2013

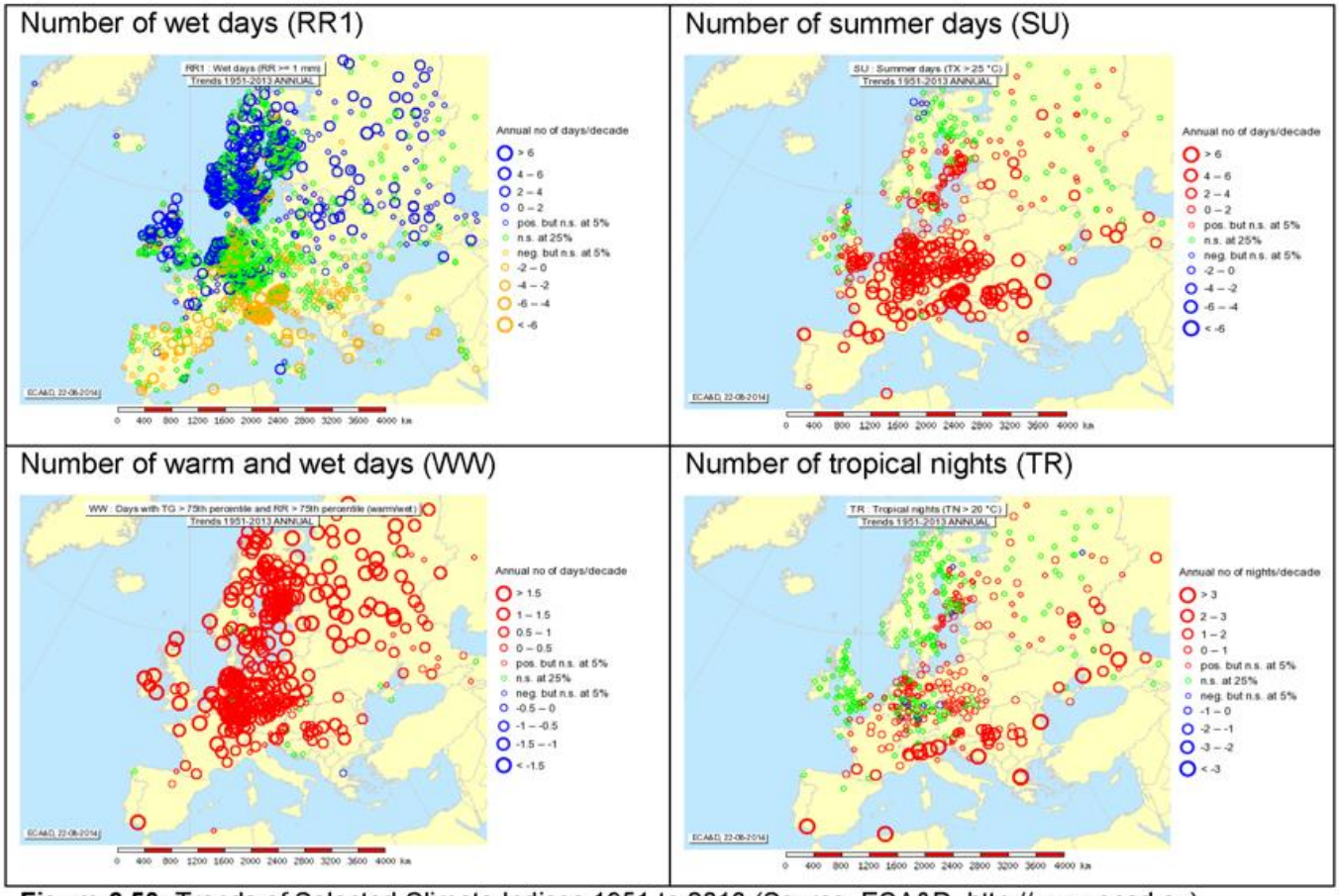


Figure 2.50: Trends of Selected Climate Indices 1951 to 2013 (Source: ECA&D, http://www.ecad.eu)

2.2.5 Other climate related variables

Sea surface temperature of the North Sea

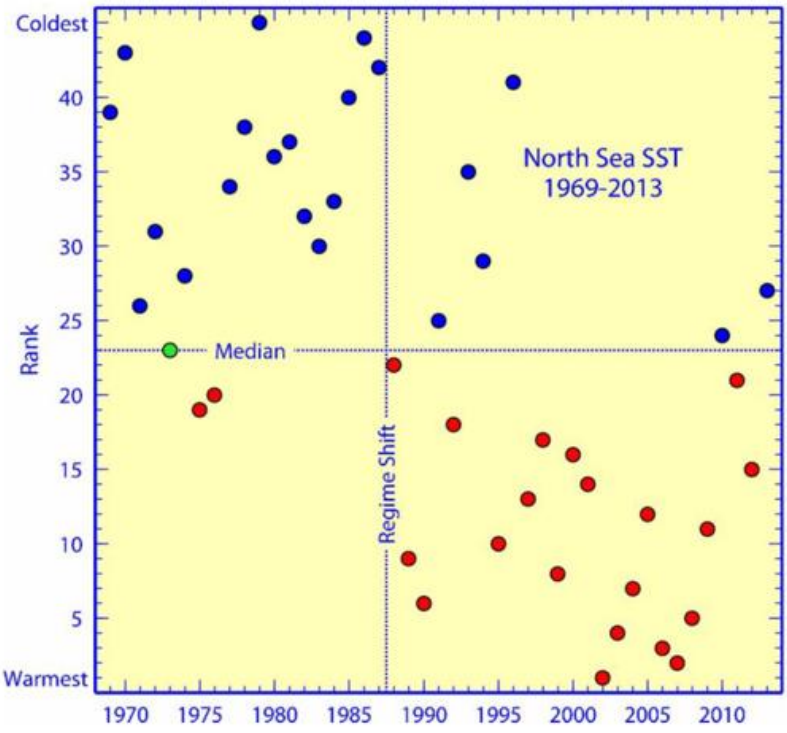


Figure 2.51: Rank statistics of the North Sea SST form 1969 to 2013 (Source: Bundesamt für Seeschiffahrt und Hydrographie BSH; year2013 means December 2012 to November 2013)

Sea level of the Baltic Sea (Poland)

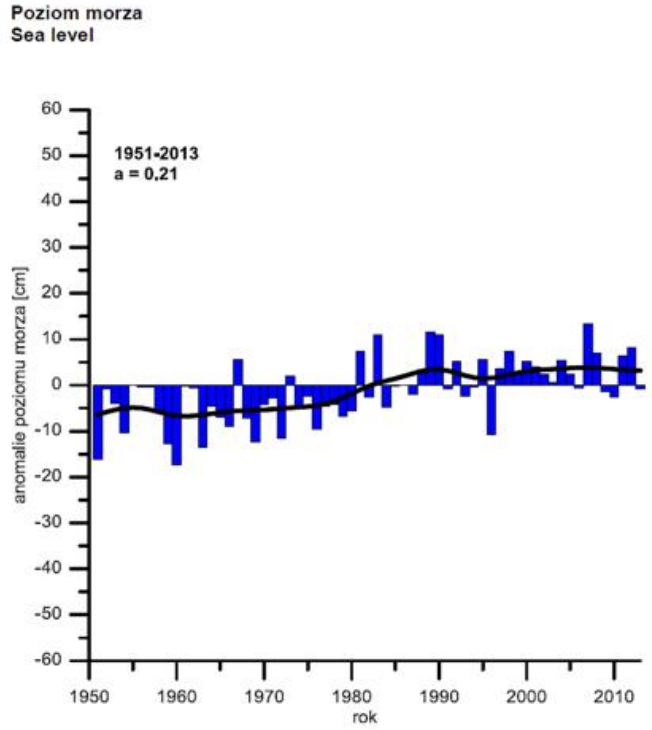


Figure 2.52: Mean annual sea level anomalies of the Baltic Sea in Wldyslawowo (1951-2013) in relation to the reference 1971-2000, smoothed by 10-years Gaussian filter (black line) and the value of the linear trend (cm/year).

Snow

Snow depth (Switzerland)

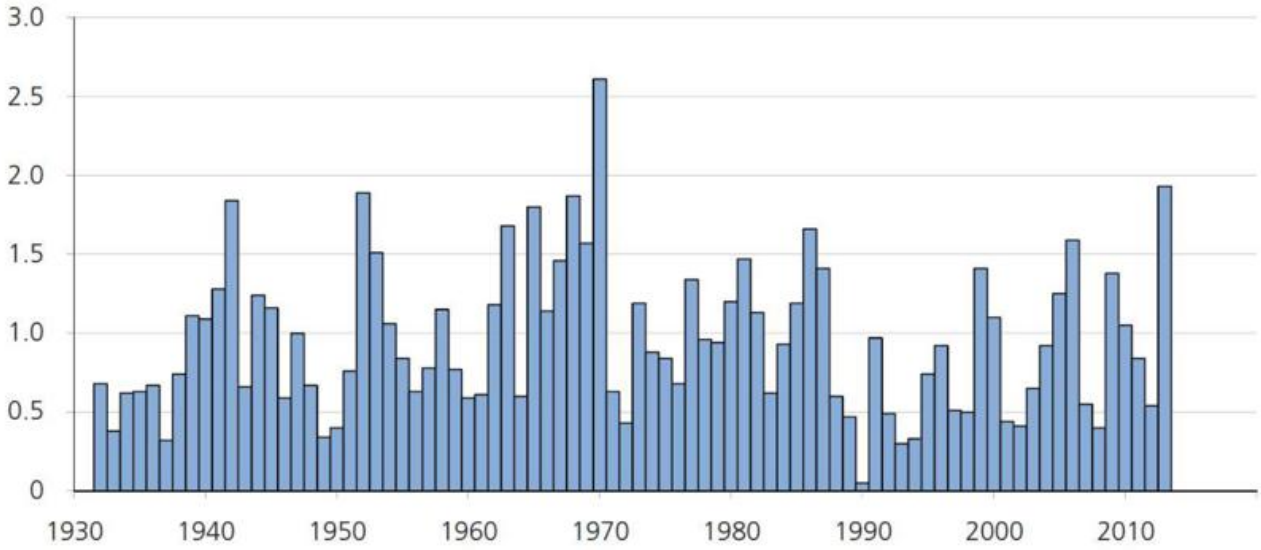


Figure 2.53: Fresh fallen snow during the snow-period in Zürich-Fluntern (Switzerland, 556 m NN) for the period 1931/32 until 2012/13.

Snow depth (Russia)

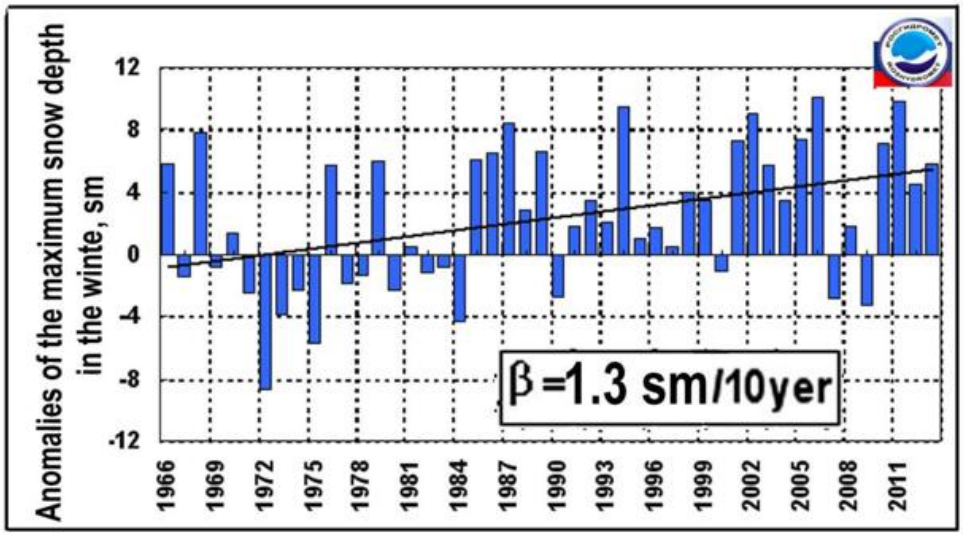


Figure 2.54: Anomalies of the maximum snow depth in the winter over European Russia for the period 1966-2013 (reference period: 1961-1990)

2.3 Socio-economic impacts of extreme climate or weather events

Several countries reported socioeconomic impacts of climate extremes or weather events. This was done partly given in a standardized structure (WMO guiding table for country submission of information on extreme climate events) or the information was part of the regular monthly reports on the internet or it was separately submitted. However, this information is heterogeneous and does by far not give a complete overview. Not only do the administrative structures differ so that the information cannot easily be gathered but also many kinds of impact are difficult to estimate. In the following only a short extract will be given.

Figure 2.55 shows the number of observed extreme weather or climate event as reported by the NMHSs in 2013 that can be presented in form of a diagram. Conclusions should be drawn only with caution because some of the events were reported by several countries. The total number of cases for this figure was 196. No diagrams were shown for the injured persons and fatalities as well as the economic losses because the number of reports were too few (about 3, 9 resp. 5). In some cases the reported numbers were not fix but like 'hundreds' or 'few'. The economic damage was estimated as well by some countries but the information is not sufficient to be presented with any reliability of representativeness. The reported of economic damages will be summarized individually below.

The most frequent events in 2013 were according to Figure 2.55 'Heat Waves' with 26% that occurred in most of the countries, Serbia reported 6 and Israel 7 heat waves. The second one with 20% is 'Extreme Precipitation' that also happened in most of the countries. The third often event were 'Wind Storms' that mainly occurred in the Nordic countries together with extreme precipitation. About 8 % of the extreme events were 'Floods' and 'Droughts'. One major flood event from the end of May until beginning of June 2013 occurred in eastern Central Europe and affected 6 countries. Afterwards most of these countries reported a drought with less agricultural production.

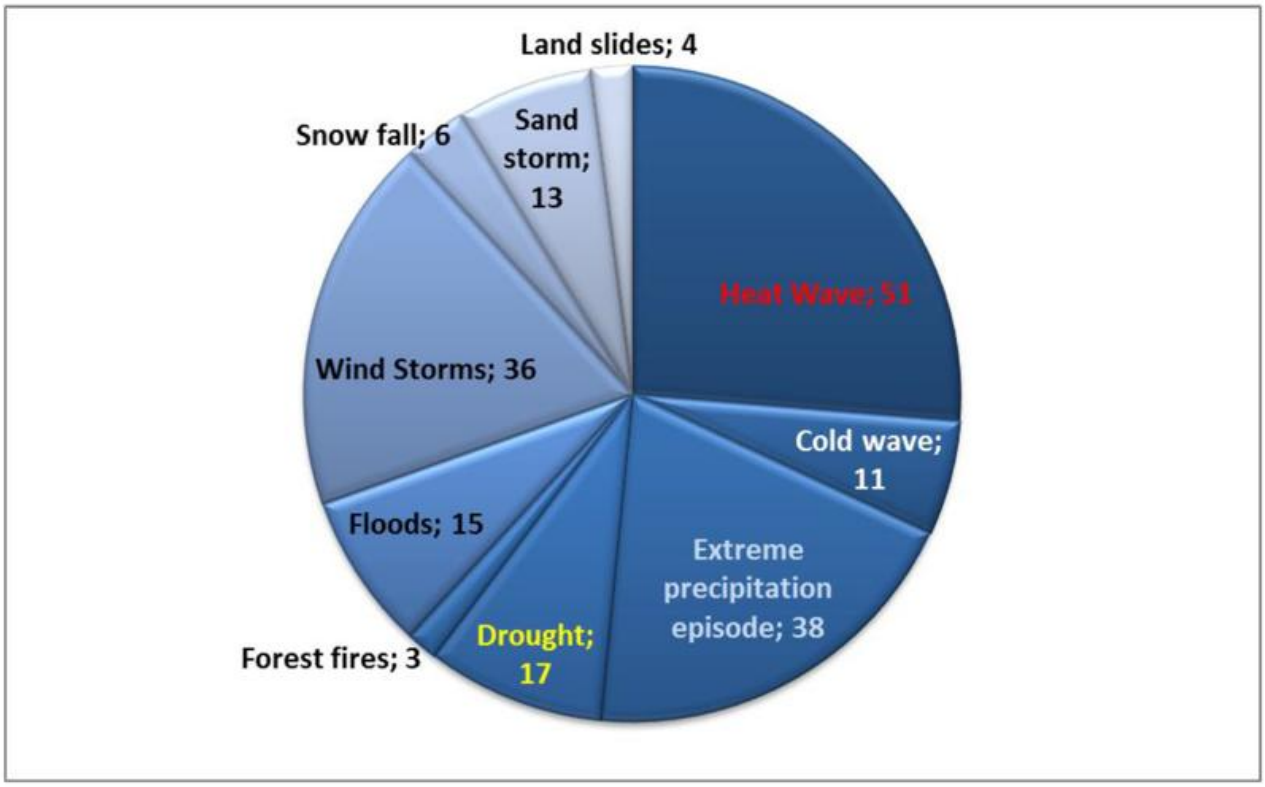


Figure 2.55: Relation of observed extreme weather or climate events in 2013 based on 36 reports from NMHSs (total events reported for 2013: 196)

Much economic damage is usually connected with floods, storm, cold spells (all kinds of frost, snow or ice), hail, drought or extreme heat. There are some figures which are summarized in the following but much of this kind of damage cannot be estimated (by meteorologists).

- The snowfall in **Austria** during the Easter holidays esp. on 30th and 31st March caused many trees to break due to wet snow. The falling trees cut power lines too. Because of the unusual long-lasting wintry weather conditions, the fully saturated meadows and fields could not be cultivated.
- The flood in **Latvia** was due to temperature rising in the second 10-days of **April**, thick snow melted very quickly – in 6-9 days. The heat was rapidly breaking up ice and forming ice jams in rivers as well. These effects together resulted in a significant increase in water level and intense and extensive flooding. The highest water level rise was observed in the Ogre River near the town of Ogre. Estimates suggest that the maximum water level (24.5 m, which is 4 meters above the long-term average) had a probability of 0.5%, i.e. once every 200 years. Economic losses due to floods in Latvia were estimated of 5.2 million €.
- On **22 May**, the Tula Region, **Russia**, was attacked by windspout that wrecked significant destruction: roofs torn down, trees toppled and power transmission lines broken. Twenty two people, including five children, were injured. The damage was estimated to be 150 million rubles (~2 million €).
- The rainfall of the last few days in **May** and beginning of June 2013 led to one of the worst floods and flood disasters in recent years in east **Central Europe** with 6 countries involved. In Lower Austria, the Danube reached north of Vienna a water level of 11 meters. On 4th June 2013 the flooded regions along the rivers Inn and the Danube reached its greatest extent and the flood-bearing rivers, the highest water levels. The river Inn reached in Upper Austria a water level of 10.7 meters (in 2002 there was the value 8.7 meters - the standard level of the Inn is there 4 meters). Communities were flooded up to four meters high. On 6th June along the rivers Danube and Morava a water level of 7.44 meters was recorded (in comparison in the year 2002 there was a water level of 7.28 meters). The total flood damages were estimated by 100 million € in the Danube Valley of Lower Austria, alone (Trachte et al. 2014). On the fields around Vienna there was a crop failure by 30 percent.
- **July** 2013 was marked by very dry and warm weather conditions in **Austria**. During the third decade of July, the prevailing drought caused huge agricultural losses. One third of the fields in the states of Salzburg, Styria and Carinthia had drought damage. The pastures were suffering from the drought. On the fields around Vienna there was a crop failure by 30 percent. The other involved countries also reported less agricultural production after the flooding and the drought period in August.

Turkey is the only country that gives graphs of percentages of the occurrence of types of extreme climate or weather events in 2013 (Figure 2.56) as well as a time series of the development of weather related damages starting in 1941 (Figure 2.57). 'Weather related damages' is here given in number of cases not in a monetary value.

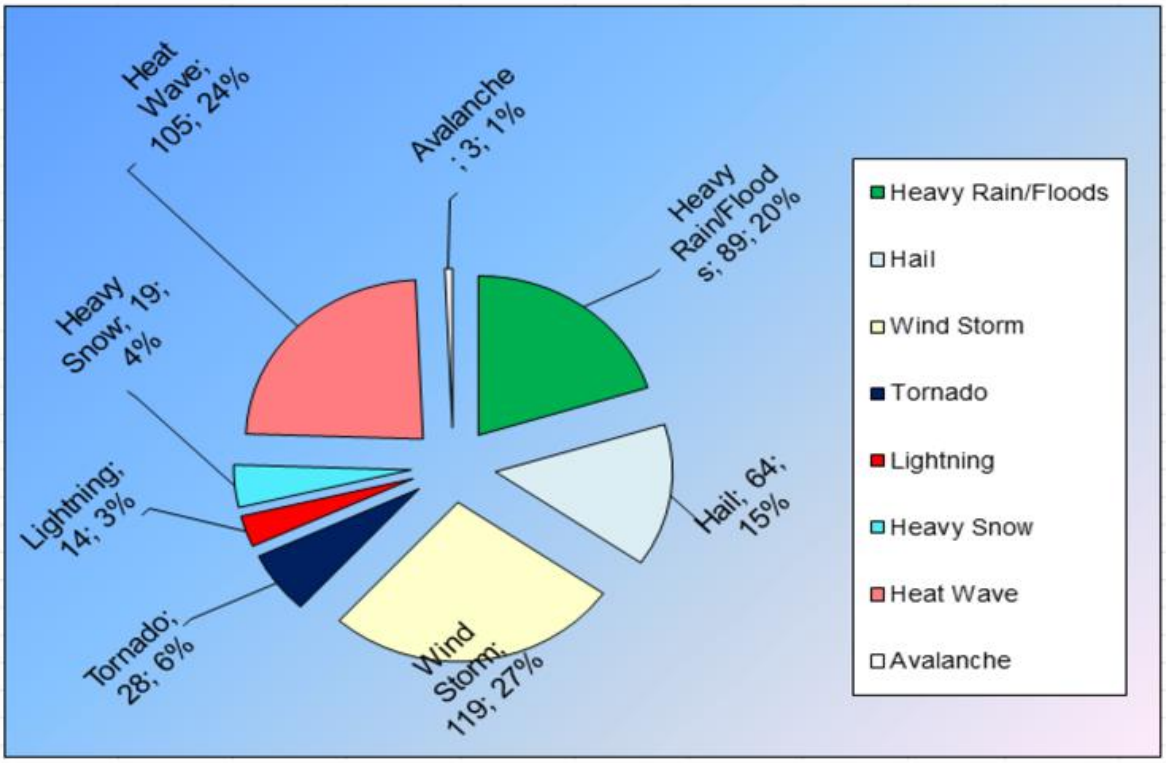


Figure 2.56: Percentages of the occurrence of extreme climate or weather events in the year 2013 in Turkey (Source: Turkish State Meteorological Service http://kardelen.mgm.gov.tr/BultenGenel/Klima/fevkGlnYeni.aspx)

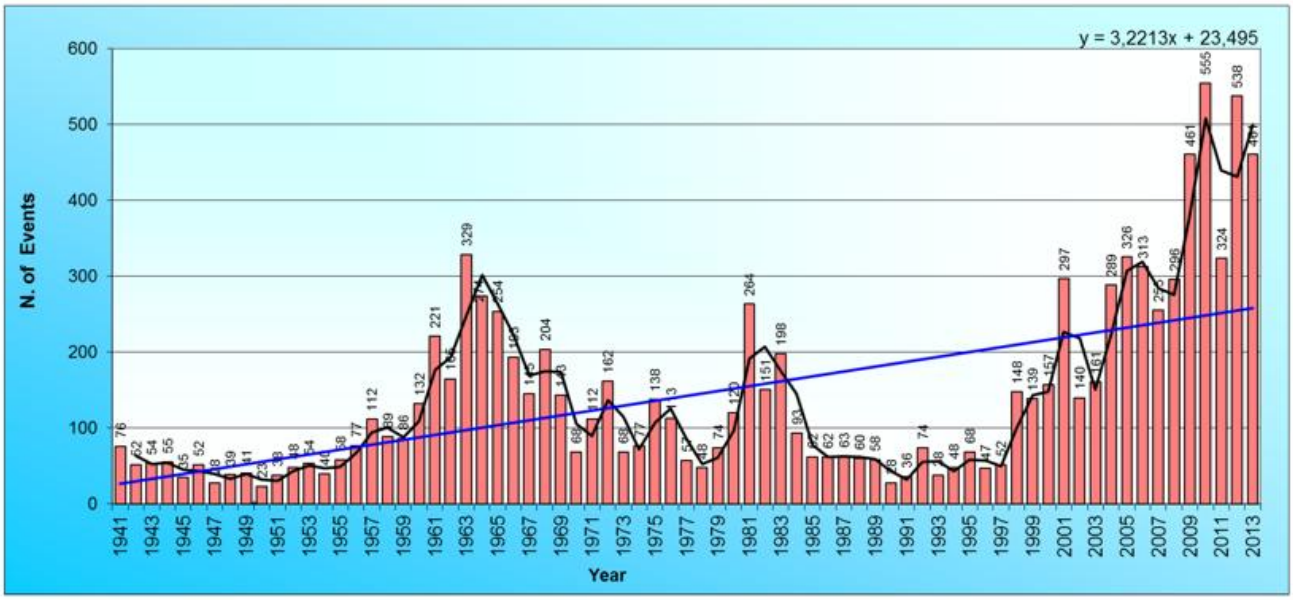


Figure 2.57: Temporal development of the occurrence of weather-related damages in Turkey for the period 1941-2013 (Source: Turkey http://kardelen.mgm.gov.tr/BultenGenel/Klima/fevkGlnYeni.aspx)

3 Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2013 and anomalies related mainly to the normal period 1961-1990 of the selected essential climate variables: sea surface pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1 Seasonal averages and anomalies of selected essential climate variables

3.1.1 Sea surface pressure and circulation indices

The seasonal sea surface pressure anomalies show in some extent unusually spatial patterns. **Winter** pattern was dominated by a stronger Azores high extended to western coast of Europe and a more intensive high pressure centre over Russia separated by a band of lower than normal pressure from Scandinavia across Central Europe to Italy and Balkan Peninsula.

Increased pressure in the polar low depression and a broad, diagonal from western Europe to southern Russia oriented, band of negative anomalies were the most prominent features of the **Spring** sea surface pressure anomalies pattern.

Summer was characterised by a north-south contrast of anomalies: more intensive as normal polar low depression and increased pressure in the belt from Central Europe including North Sea and Scandinavia across eastern Europe to Russia.

In **Autumn** dominated a west-east contrast in the pressure anomalies pattern: Positive anomalies over East Atlantic southwards of Iceland including western Europe and Iberian Peninsula, negative anomalies over East Europe and Russia. The polar low pressure trough was displeased more to the North. Remarkably was the anomalies pattern over South-East Europe: Positive anomalies over Turkey, negative anomalies over eastern Mediterranean and Balkan region.

In terms of the seasonal mean values of the circulation indices, the circulation over the Region VI was not very different from long-term mean (Tab. 2.1). However, the moderate, negative AO and negative NAO index in **winter** and **spring** indicated prevailed north-easterlies over Central and West Europe. The NAO and AO reached in March their strongest negative phase (cf. Tab. 4.1). The positive SCA phase reflected positive pressure anomalies especially in February over Scandinavia. The negative POL index in **spring** resulted from a weaker than average polar vortex. EA/EW negative phase in **summer** was associated with higher than normal pressure anomalies over Russia.

Table 3.1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference

	NAO	EA	EA/WR	SCA	POL	AO
Winter 2012/2013	-0.33	0.57	-0.57	1.03	-0.39	**-1.12**
Spring 2013	-0.30	0.40	-0.05	-0.40	**-1.17**	-0.79
Summer 2013	0.88	0.54	**-1.47**	-0.18	-0.11	0.23
Autumn 2013	0.10	0.30	-0.28	0.12	0.58	0.61

NAO = North Atlantic Oscillation, EA = East Atlantic Pattern, EA/WR = East Atlantic/West Russia Pattern, SCA = Scandinavia Pattern, POL = Polar/Eurasia Pattern, AO = Arctic Oscillation.
Note that all values are standardized with the reference 1981-2010; bold: index values > |±1| corresponds to moderate positive/negative phase of the leading NH circulation modes.
(Definition and sources: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

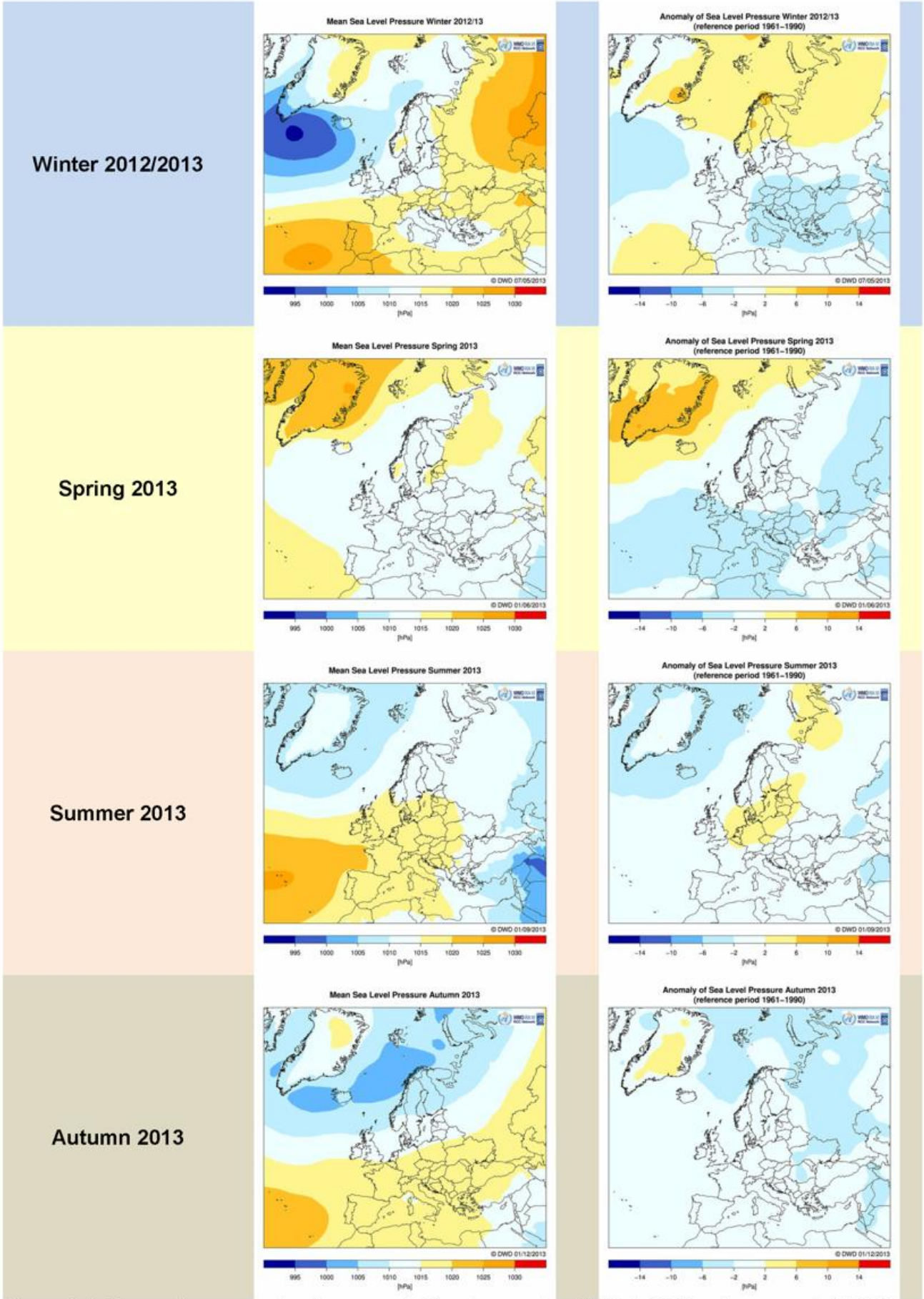


Figure 3.1: Seasonal mean sea level pressure (left) and anomalies (right) in 2013, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

3.1.2 Temperature

In average of the whole Region VI the winter 2012/2013 was warmer, the spring cooler, the summer and autumn warmer in respect to normal period 1961-1990. In regional view, however, some differences existed (Tab. 3.2).

Table 3.2: Seasonal and annual areal average of temperature anomalies in °C for each sub-region in the year 2013 (reference period: 1961-1990)

Region	Winter 2012/2013	Spring 2013	Summer 2013	Autumn 2013	Year 2013
Central and western Europe	0.08	-0.67	1.52	0.81	0.57
Nordic and Baltic countries	1.55	0.91	0.89	1.25	1.30
Iberia	0.40	-0.03	1.08	0.86	0.48
Mediterranean, Italian and Balkan Peninsula	0.71	1.40	1.78	1.33	1.40
Eastern Europe	1.47	0.55	2.06	1.64	1.89
Middle East	1.90	1.76	0.80	0.76	1.19

Data source: Gridded data (result of spatial analysis of CLIMAT and SHIP data; http://www.dwd.de/rcc-cm)

Winter 2012/2013 was colder than normal in central, northern, southern and partly western Europe while it was warmer than normal in the northwest, in the Arctic and in the east and southeast. The negative anomalies were largest (-1 to -2 K) in southern Norway and the positive anomalies were largest (more than +4 K) in the Arctic region. Remarkable were for instance the negative anomalies of frost days on Iceland and the Balkan Peninsula.

Spring 2013 was colder than normal on the northern North Atlantic, the British Isles, and the western and northern European continent including the south of Scandinavia. The strongest negative anomalies of -1 to -2 K occurred on the British Isles, northern France, Belgium, the Netherlands and northern Germany as well as parts of northern Russia. Mainly the month of March dominated the seasonal mean. Warmer than normal were the Arctic and Greenland as well as the eastern Mediterranean Sea, the Balkan Peninsula, Southern Russia and the Middle East.

Summer 2013 was warmer than normal over the continent and only on the North Atlantic partly slightly colder than normal. Warmest overall was the Northeast. Between 2 to 3 K warmer than normal were parts of the Alps, parts of the Balkan Peninsula and parts of eastern Europe. It was the 7th warmest summer since 1864 in Switzerland and the 3rd warmest summer since 1813 in south-eastern Austria. Also in Germany it was one of the 10 warmest summers since 1881. Especially in the Mediterranean and Black Sea region there were much more tropical nights than normal. The warm spell duration index was clearly higher than normal for northern Italy, the eastern Alps and the Balkan Peninsula.

Autumn 2013 was again warmer than normal nearly over the whole Region VI. Generally, the autumn temperatures varied considerably. Some countries in northern or central Europe registered even maximum temperatures of 30°C on single days which is unusual in autumn. For instance, in Austria on 6 September in Innsbruck 30.3°C were observed and also De Bilt (Netherlands) recorded on the same day 32.7°C. In Germany autumn 2013 was the 23th warmest since 1881. In Estonia it was the 5th warmest since 1961 with a seasonal mean of 8.2°C. On the other hand, it gave already frosty weather and first snowfall in the Alps for few days in September and October. The lowest temperature in autumn 2013 occurred in Austria on 27 November with -26.9°C at the station Brunnkogel (3438 m asl).

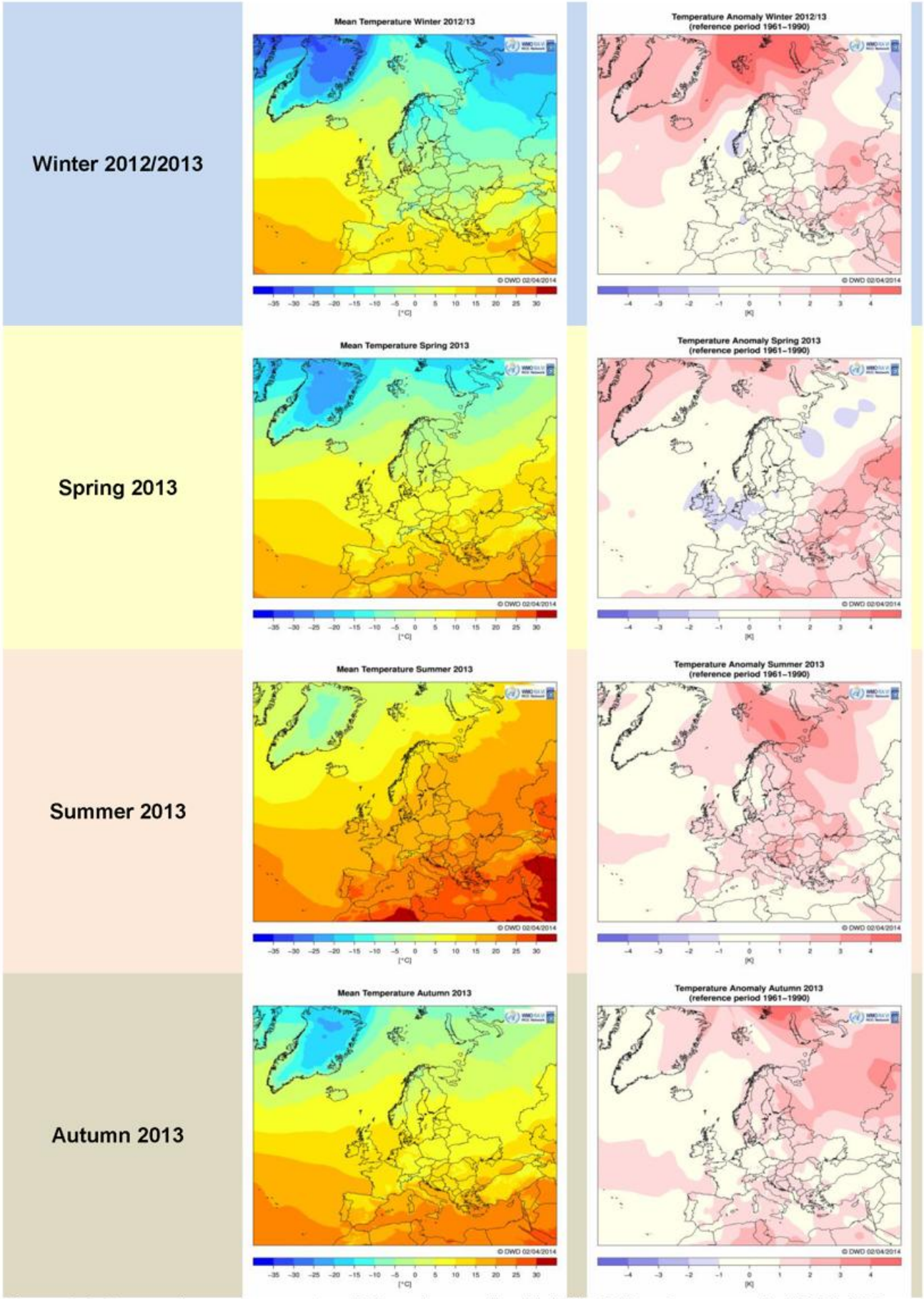


Figure 3.2: Seasonal mean temperature (left) and anomalies (right) in 2013, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

3.1.3 Precipitation

In winter, predominantly close to mean conditions with more than normal precipitation especially in eastern Mediterranean, northern Spain and western France were observed (Figure 3.3). Dominant for spring was a belt of higher than normal precipitation extended from Iberia to central-northern Russia, accompanied by bands of drier conditions northwards and southwards. In summer the basic pattern of precipitation anomalies opposite to spring spatial existed. Autumn was characterised by predominantly wetter or close to normal conditions.

In **winter** 2012/2013 especially the Balkan Peninsula and southern Europe as well as Middle East received more precipitation than normal. The Italian Peninsula had locally more very wet days than normal. Generally only Scandinavia, the western Mediterranean with the eastern Iberian Peninsula and southern France as well as the Caucasus area received less precipitation than normal. In combination with the low temperatures there was partly much snow (which is not well reflected in the anomaly maps due to the partly coarse station coverage).

In **spring** 2013 the Iberian Peninsula, southern France, the western Mediterranean, the Italian and Balkan Peninsula and Eastern Europe as well as locally Norway were wetter than normal. Some Norwegian stations recorded new records of March precipitation since 100 years. March was as well dominant for the seasonal precipitation anomalies. Drier than normal were the northern parts of the European continent, most of Scandinavia and the eastern Mediterranean Sea and Middle East.

The **summer** 2013 was wetter than normal in the Arctic region, on eastern Greenland and Norway, partly also in Italy, the Black Sea region, the eastern Ukraine and southern and northern Russia. It was drier than normal on the British Isles, the Iberian Peninsula, in most of central Europe, on the Balkan Peninsula and in eastern Ukraine, eastern Mediterranean and Middle East as well as in central parts of European Russia. In eastern Central Europe, which was effected by an extraordinary flooding at the beginning of the season, the seasonal totals were slightly above the normal. The 1-month SPI (DWD adjusted SPI) was highest on the western Balkan Peninsula, in the eastern Mediterranean and Middle East. The 3-month SPI index was remarkably below the mean on the whole Iberian Peninsula, in southern UK, and in the Netherlands, and northern Germany, on the Balkan Peninsula and in parts of Italy and parts of the Alps.

In **autumn** 2013 it was wetter than normal in western, central and eastern Europe, in southern parts of eastern Europe and locally in the Mediterranean Sea area as well as in parts of Middle East. In the Netherlands autumn 2013 was the 5th wettest since 1906, in Germany it was the 18th wettest since 1881. Precipitation surplus was partly caused by remarkable precipitation events. In Denmark the highest daily total in autumn 2013 was 55.5 mm at Oby. It was drier than normal partly on Iceland and Ireland, on the southern and eastern Iberian Peninsula and on the southern French coast, in the eastern Mediterranean, in most of Turkey and much of Middle East. It was as well drier than normal in southern Scandinavia and in parts of the Baltic Sea states. Most of the British Isles, the northern half of the Iberian Peninsula and western France, northern and eastern Europe and the Balkan Peninsula were close to normal.

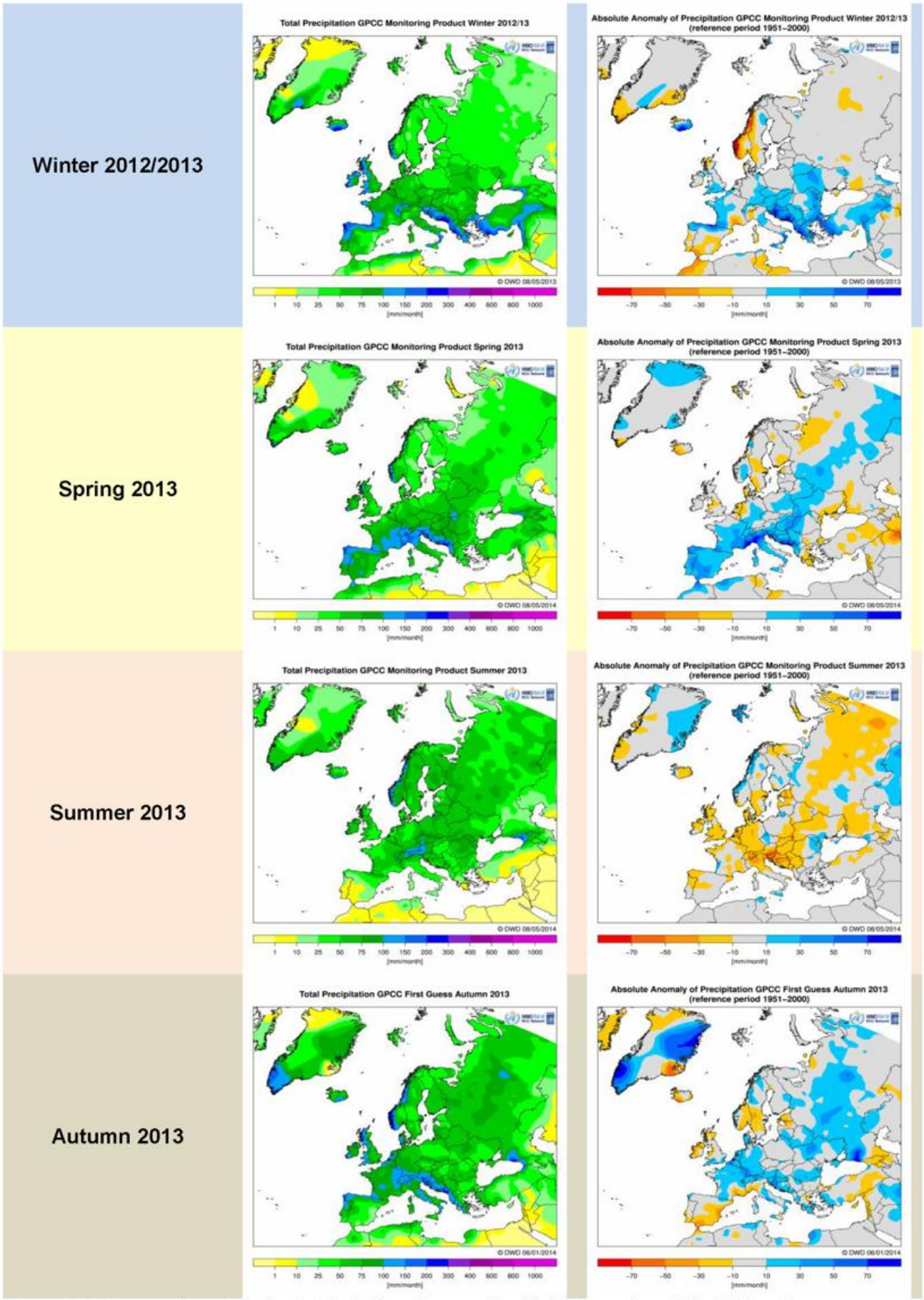


Figure 3.3: Seasonal precipitation totals (left) and anomalies (right) in mm/month in 2013, reference period1951-2000 (Source: http://www.dwd.de/rcc-cm)

3.1.4 Sunshine duration

In most parts of Europe cloudy weather conditions dominated in winter and continued in spring in Central Europe. In contrast, eastern Europe and Russia received more than normal sunshine. The summer was sunnier in whole Europe. In autumn large part of western and eastern Europe observed deficits of sunshine duration, while in the areas from Scandinavia over Poland to the Balkan Peninsula positive anomalies of sunshine duration occurred.

In **winter 2012/2013** the low sunshine duration was remarkable in central Europe. This is as well reflected in the anomaly map of the number of cloudier days which are much more frequent than normal.

Spring 2013 was sunny in Scandinavia, the Baltic countries and northern Russia and cloudy in western Europe especially in UK, partly over Iberian Peninsula, southern Russia and the Caucasus region.

Summer 2013 was sunniest in Poland and the eastern Alps with more than 125% of the 1961-1990 normal. In Poland it was locally even above 150%. With respect to a 1971-2000 reference it exceeded there even 175%, with a seasonal total of 1064 hours at Warsaw. In Austria summer 2013 was on rank 1 together with 1887 and 1904 in the north, in the southeast and on the summits it was the 2nd sunniest summer. It was generally sunnier than normal with patchy regional exceptions over the continent. It was cloudy in the eastern Mediterranean and Middle East. On the coast and in central Slovenia summer 2013 was the second sunniest summer so far.

In **autumn 2013** the relative sunshine duration was below normal or close to normal over large parts of the area except in Spain, Scandinavia, Denmark and the northern part of the British Isles, most of Turkey, the Caucasus area and a narrow band from Poland southwards to the Balkan Peninsula. In Germany autumn 2013 was the 13th cloudiest autumn since 1951. The relative surplus in Spain of 105 to 125% resp. in southern and middle Sweden of 105 to 150% corresponds to an absolute surplus of up to 20 to 50 hours. In Poland and on the Balkan Peninsula the absolute surplus did not exceed 20 hours. Most of eastern Europe was clearly cloudier.

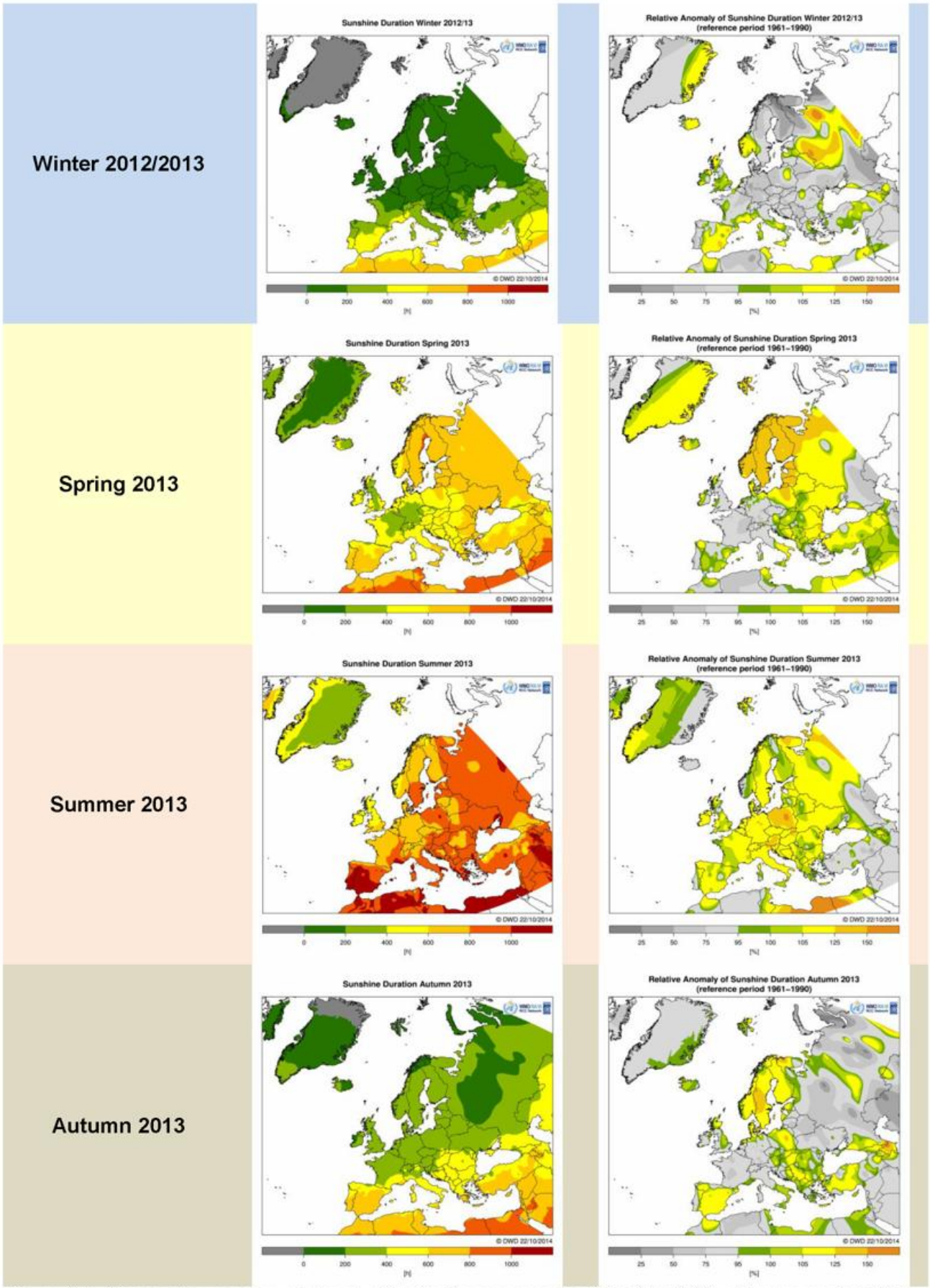


Figure 3.4: Seasonal sums of sunshine duration (left) and anomalies (right) in 2013, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

3.1.5 Drought

Reports on longer lasting dry periods from the National Meteorological and Hydrological Services:

Denmark received in July 2013 only 19 mm rain as an area mean. It is 47 mm or 71% below the normal for 1961-1990. A comparison with the past 10 years-normal 2001 to 2010 of 77 mm also provides a very dry July 2013 the entire 58 mm or 75% below. It was the fourth driest July since the nationwide precipitation measurements began in 1874.

Although in **Hungary** the precipitation amount in 2013 was 114% of the average amount of 1971-2000 all three summer months were drier than usual, especially July, which was the 6th driest on record with only 37% of the normal amount. The end of the year was again extremely dry: some regions had no precipitation at all in December, which was the second driest on record with only 8% of the average amount.

In **Austria** July 2013 was the driest since 1853, the precipitation sum was 65% lower than normal. Though the precipitation in May and June was unusually high, combined with floods, the absence of rain in July led to a drought that caused serious damages in agriculture.

The drought in **Slovakia** was most significant in western and central part of the country. Mean monthly precipitation amount was 26% of the average and the lowest in the last 50 years.

The year 2013 in **Slovenia** was marked by abundant precipitation in the first 3 months, and catastrophic drought in summer. The summer drought coincided with the extreme heat period. The most critical period for drought was from 11 June to 10 August.

Portugal notified the 4th driest November of the last 83 years. In the 2nd half of the month no precipitation was recorded in almost the whole territory.

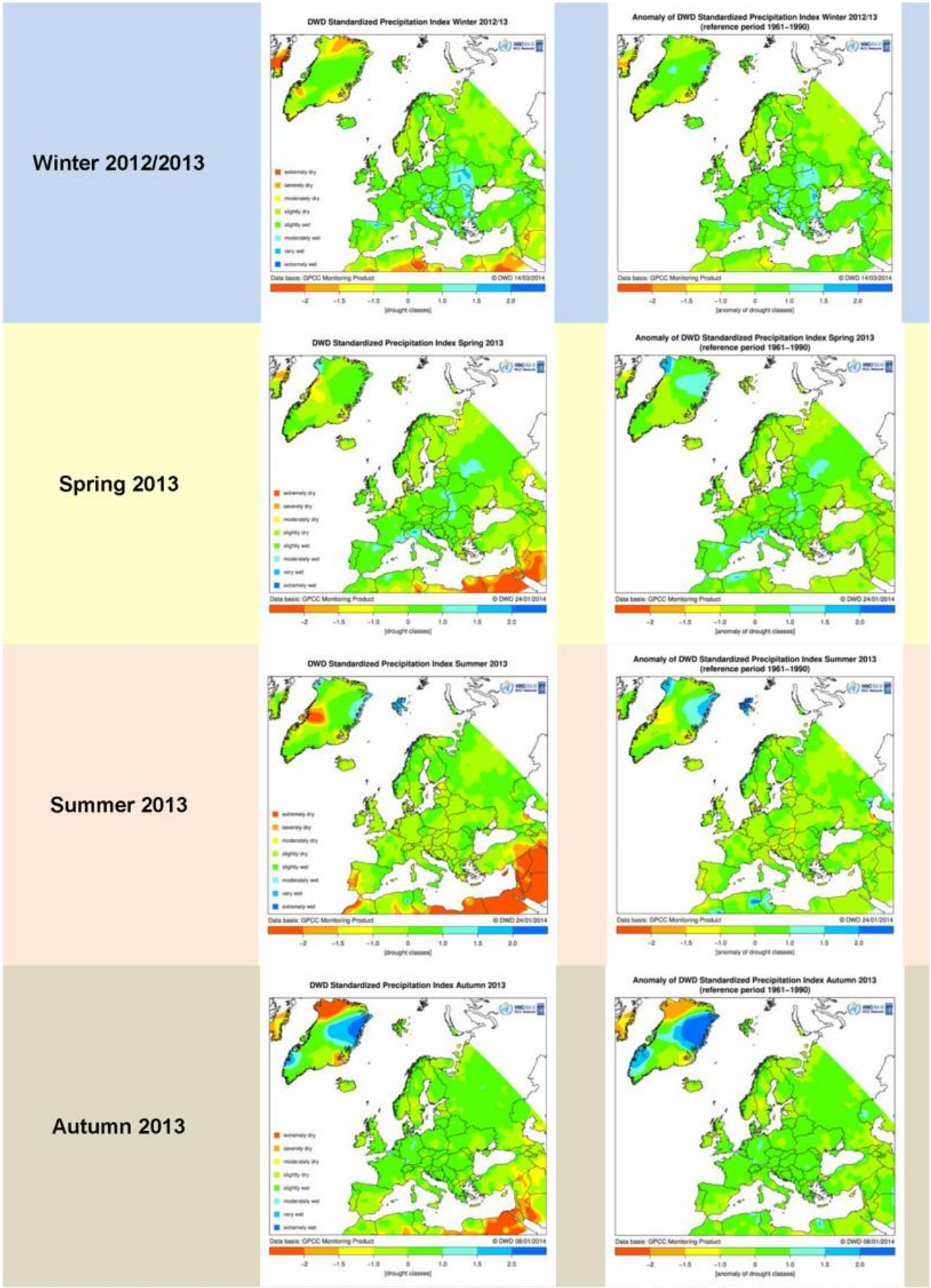


Figure 3.5: Seasonal mean of the modified Standardized Precipitation Index (DWD-SPI, left) and anomalies (right) in 2013, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

4 Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2013 on the Climate in WMO Region VI - Europe and Middle East (available on http://www.dwd.de/rcc-cm).

It contains highlights, means and anomalies of sea level pressure, temperature, precipitation, sunshine duration for each months as well as monthly overview of extremes and notable events.

4.1 Sea surface pressure and circulation indices

This chapter about the atmospheric circulation provides information on selected northern hemisphere teleconnection indices which are considered to be relevant for WMO RA VI and it discusses influences of circulation patterns upon anomalies and outstanding events. The information is based upon the Monthly Bulletins on the climate in WMO RA VI and the Global Climate Bulletin (MeteoFrance) and completed by reports of NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/upper troposphere not shown here. (See http://www.ncdc.noaa.gov/teleconnections/ and http://www.cpc.ncep.noaa.gov/products/CDB/index.shtml)

Table 4.1: Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference and the AO, for January 2013 to December 2013

Year	Month	NAO	EA	EA/WR	SCA	POL	AO
2013	1	-0.11	0.88	0.46	0.08	-1.86	-0.61
2013	2	-0.96	0.14	-1.28	1.00	0.34	-1.01
2013	3	**-2.09**	-0.24	**2.31**	-0.57	-1.90	**-3.19**
2013	4	0.60	1.31	-0.40	-1.10	-1.64	0.32
2013	5	0.58	0.14	**-2.06**	0.48	0.02	0.49
2013	6	0.83	0.66	**-2.30**	0.30	-0.01	0.55
2013	7	0.70	0.63	-0.17	-0.03	-0.30	-0.01
2013	8	1.12	0.34	-1.94	-0.82	-0.03	0.15
2013	9	0.38	-0.57	-0.58	0.38	-1.59	-0.46
2013	10	-0.88	1.39	0.63	0.67	0.75	0.26
2013	11	0.81	0.09	-0.88	-0.70	**2.58**	**2.03**
2013	12	0.79	1.20	-0.36	-0.73	-0.83	1.48

Note that all values are standardized with the reference 1981 to 2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**:ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

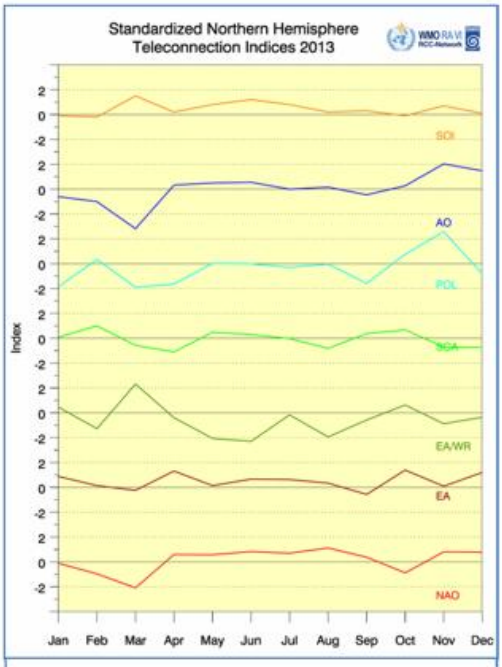


Figure 4.1: Annual course of relevant Teleconnection Indices 2013

In **January** 2013 the anomaly of the sea-level pressure was negative nearly over the whole area of interest except in the Norwegian Sea and over western Scandinavia and on the North Atlantic, west of northern Africa with a center north of the Canary Islands where it was positive (+4 to +8) giving an monthly mean in the range of +1025 hPa to 1030 hPa. The lowest mean for the month was 990 hPa south of Greenland where the anomalies ranged from -8 hPa to -12 hPa. The mean gradient between both mean pressure centres was strongest on the northern North Atlantic in the area west of the British Isles, roughly between 40°W and 20°W and 45°N to 55°N. The negative anomalies ranged between -4 and -8 hPa in Russia and southeastern Europe and around the Italian Peninsula. The NAO- and AO-indices were relatively small but the Polar/Eurasian Pattern

had a negative value, indicating high pressure north of Alaska. There was only weak to medium blocking around the 0 meridian during the month (source: http://www.cpc.ncep.noaa.gov).

Lower than normal sea-level pressure prevailed over southern and southeastern Europe and Middle East in **February** 2013. The largest negative monthly anomalies ranged from -4 to -8 hPa in the Tyrrhenian Sea. Northern and western Europe had on the other hand positive anomalies in the range of +4 to +8 hPa on the North Atlantic from the Norwegian Sea southwards close to the Azores. Westward the anomalies were negative again with up to -4 hPa southeast of Greenland. This refers to a low pressure system south of Greenland while Iceland was on its eastern edge. There was increasing blocking between 0 and 30 E from about 9 to 18 February and - more intense - around 0 E from 19 to the end of the month (see http://www.cpc.ncep.noaa.gov). The pressure pattern corresponds quite well with the observed anomalies of temperature and precipitation. The NAO index, EA/WR and AO were of the same order of magnitude of -1.0.

March 2013 is characterised by high pressure over Greenland, Iceland and Scandinavia and low pressure on the mid-latitude North Atlantic with anomalies of -12 to -16 hPa in the Azores region and -8 to -12 hPa over southern Russia and more than +16 hPa over Greenland. Since both centers of action were less intense the NAO index was -2.09 and the AO index -3.176. Remarkable was the value of the EA/WR mode with 2.31.

During **April** 2013 the lowest negative sea-level pressure anomalies occurred west of the British Isles and the Norwegian Sea that ranged between -4 and -8 hPa. The Icelandic Low was shifted to the north-east. On the North Atlantic, over the North Sea and Scandinavia, over western North Africa and the western Mediterranean Sea as well as in the Middle East and Eastern Europe negative anomalies prevailed. Positive anomalies occurred on the western North Atlantic. The NAO index changed around the middle of the month from negative to positive values consistent with the temperature changes in western and central Europe. Therefore the NAO for the whole month was not well developed. The negative anomalies in the western and eastern Mediterranean Sea correspond with phases of intense precipitation. The gradient over the Norwegian Sea were not very high but the pressure distribution allowed the development of storm tracks normal for the season. The East Atlantic Pattern (EA) and the Polar/Eurasia Pattern (POL) were in opposite phase.

The NAO index was positive during the first half of **May** 2013. This reflects the strong Icelandic low and Azores high especially during that time. In fact, a first cooling in central Europe started around 10 May (Ice Saints), when the NAO index reached its maximum. The second cooling period in western and central Europe, which was even more intense than the first one came in the last third of the month when the circulation pattern became more meridional, which is displayed by a switch to a negative mode of the NAO. The AO index was also positive during the first half of the month, which means relatively little exchange of air masses between the polar region and mid-latitudes. In the second half of May, the AO oscillated around normal. Both the Icelandic low and the Azores high were stronger than normal, and the Icelandic low was extended eastwards to the North Sea. As a result, there was a strong north-westerly flow of cold and moist air to the western half of Europe. Large parts of central Europe and adjacent areas had prevailing cyclonic conditions, explaining the high positive anomalies of precipitation. On the other hand, high pressure dominated over north-eastern Europe. At the south-eastern flank of that high pressure area, warm and dry air moved far to the north.

In **June** 2013 the NAO index was positive most of the month, resulting in a slightly positive monthly mean of 0.83, similar to April and May 2013. This reflects both the more intense Icelandic low and Azores high. The AO index, too, was mostly slightly positive, indicating relatively small air mass exchange between polar and central latitudes most of the month.

In **July** 2013 the Azores high was extended northeastwards over the northwestern, central and southwestern European continent. The anomalies were positive from Scandinavia and northern Russia over the northwestern, central, southern and southeastern continent and the central Mediterranean region and negative on the Atlantic, including the Iberian Peninsula, in the eastern Mediterranean, the Middle East, the Caucasus region and Russia except the north.

In **August** 2013 the Icelandic low and the Azores high were well pronounced. The Azores high was extended northeastwards over the European continent to western Russia. The positive anomalies

were in the range of 0 to +4 hPa. Over the northern (including the northern British Isles) and western Atlantic Ocean, the southern North Atlantic, the eastern Mediterranean Sea, the Middle East and southern Russia the anomalies were negative, mostly in the range of 0 to -4 hPa. The negative anomalies over Iceland ranged -4 to -8 hPa. The NAO index was positive with 1.12.

The sea-level pressure in **September** 2013 was below the normal over most of the European continent and the Mediterranean Sea. The strongest negative anomalies in the range of -4 to -8 hPa were located in southern Russia and southeastern Ukraine. Negative anomalies occurred as well over Iceland and over the western North Atlantic. Positive anomalies were over the northern UK and Ireland, Scandinavia and northern Russia with the highest values in the range of +4 to +8 hPa over northern Scandinavia and northern Russia. The NAO index was 0.38 and the AO index was -0.461.

In **October** 2013 there were negative anomalies over the central North Atlantic including the Azores of up to -12 hPa and slightly positive anomalies over Greenland and the northern North Atlantic including Iceland as well as over the southern North Atlantic, northern Africa and most of the Mediterranean Sea and further northward over the Balkan Peninsula and most of the Black Sea to Poland. The high pressure corresponds with the dry weather in northern Africa and much of the Mediterranean as well as on the Balkan Peninsula while low pressure corresponds to the wet conditions in western, central, northern and northeastern Europe. The NAO-index was below zero during 12 to 25 October and the negative values were below the mean minus 1 sigma. It turned positive at the end of the month. At that time the AO was positive well above the mean plus 1 sigma.

November 2013 was dominated by a strongly positive AO of 2.03 and a positive NAO of 0.81. A strong mean depression with its center north of Scandinavia had a mean sea-level pressure below 995 hPa. It dominated the north of the area from west of Greenland to Russia. High pressure on the North Atlantic with its center over the Azores and east of them (mean sea-level pressure 1025 to 1030 hPa) and high pressure over Kazakhstan and southern Russia with a mean pressure of 1020 to 1025 hPa were connected by a high pressure bridge over western, southern central and southeastern Europe and Middle East. Most of the Mediterranean Sea except the western part had slightly low pressure below 1015 hPa. The anomalies were mostly negative except over the North Atlantic where they were positive with 2 to 6 hPa over the British Isles western France and the western Iberian Peninsula and 6 to 10 hPa west of the European continent. In the Arctic the negative anomalies exceeded -10 hPa and even -14 hPa in the polar region. Negative anomalies below -2 hPa reached from west of Greenland to central European Russia and as well over the central and eastern Mediterranean Sea, the Italian and Balkan Peninsula and Middle East.

December 2013 was characterised by intense and extended low pressure centered over Iceland with a mean sea-level pressure below 995 hPa reaching from southern Greenland to northern Norway and high pressure in the south and southeast from the Azores (mean pressure in the range 1020 to 1025 hPa) eastwards and northeastwards. The highest mean pressure of 1025 to 1030 hPa was over the Iberian Peninsula and over the northern Balkan Peninsula. Lower pressure but not very low (1015 to 1020 hPa) was over the eastern Mediterranean Sea and adjacent southern and eastern countries. The highest positive anomalies of 6 to 10 hPa was over the central Mediterranean, the Balkan Peninsula and the Black Sea whereas the highest negative anomalies of -14 hPa and lower occurred around Iceland. The strongest gradients between the low and the high pressure occurred between northern France and Scotland and the gradient zone remained rather sharp also over northern central Europe and northern Sweden. The frequent and strong winter storms in December are closely related to this. Many low pressure cyclones accompanied the frequent far southward reaching troughs and brought heavy to extremely heavy precipitation to the Mediterranean Sea and Balkan Peninsula. The NAO index for December 2013 of only 0.79 reflects the large extent of the low pressure in the north. A higher positive value of 1.475 resulted for the AO index.

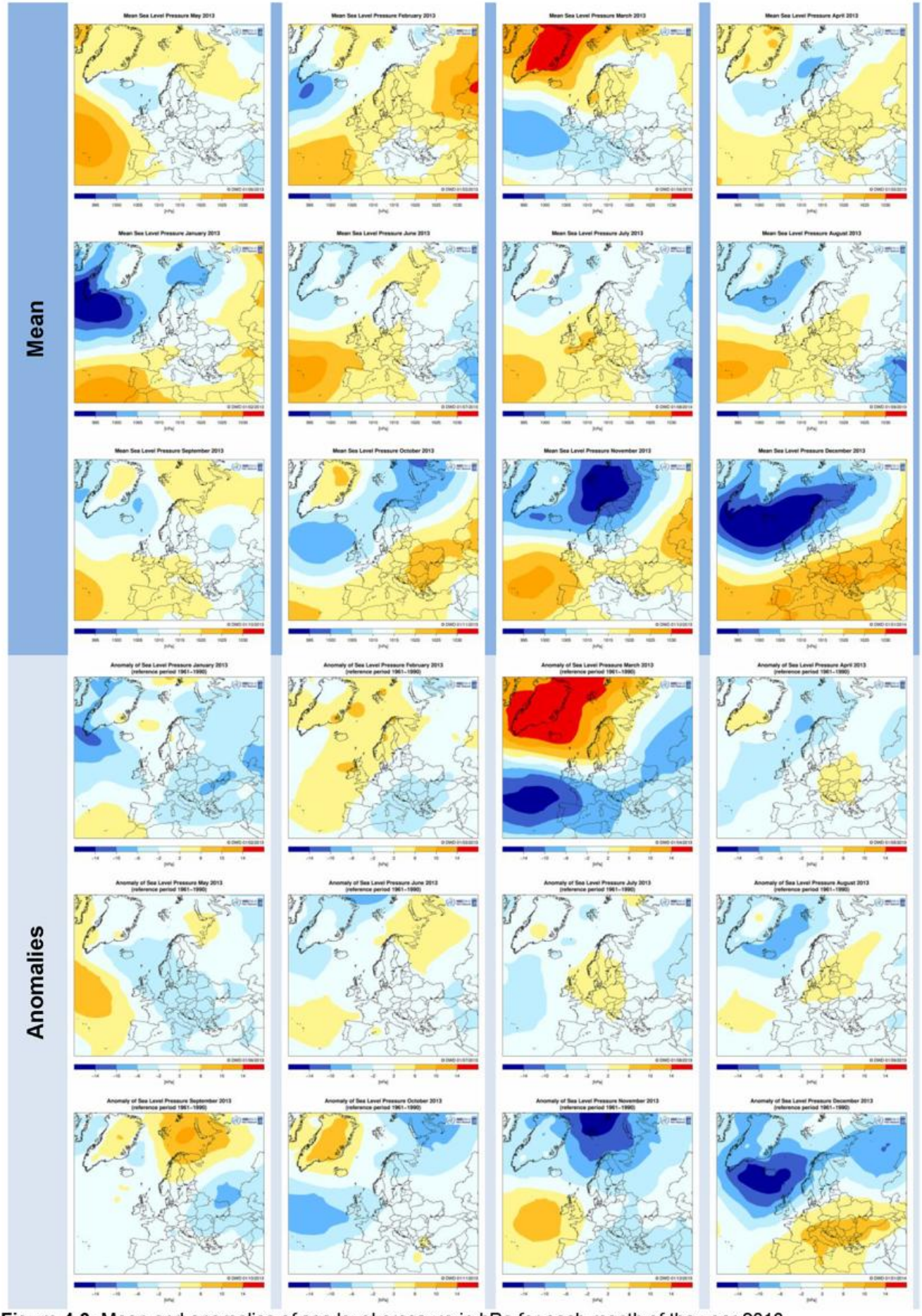


Figure 4.2: Mean and anomalies of sea level pressure in hPa for each month of the year 2013.

4.2 Temperature

In most of the months and subregions 2013 was warmer than normal except of March.

Table 4.2: Monthly and annual area average of temperature anomalies in °C for each sub-region in the year 2013 (reference period: 1961-1990)

	year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Central and western Europe	0.57	0.53	-0.59	-2.33	0.60	-0.30	0.50	2.52	1.54	0.02	1.69	0.72	1.93
Nordic und Baltic Countries	1.30	2.43	1.19	-0.72	0.56	1.32	1.41	0.48	0.79	1.46	0.88	1.42	2.81
Iberia	0.48	1.01	-0.74	-0.32	0.55	-1.02	0.00	1.76	1.48	1.08	1.79	-0.29	-0.19
Mediterranean	1.40	1.83	0.73	-0.51	2.49	1.27	1.11	1.72	2.79	0.72	1.49	1.79	0.41
Eastern Europe	1.89	2.27	4.57	-2.14	1.42	3.26	3.09	1.07	2.02	-0.10	0.96	4.05	3.11
Middle East	1.19	1.99	3.39	-0.36	1.13	2.01	1.30	0.34	0.77	0.01	-0.29	2.55	-1.03

January 2013 was colder than normal in the North Sea with the adjacent countries western UK, northern France, Belgium, the Netherlands, north-western Germany and southern Norway and in the Baltic countries with southern Sweden, north-eastern Poland and most of Belarus. As well colder than normal were parts of southern France. Elsewhere it was warmer than normal, with anomalies of more than +4 K in the Arctic and northern Norway and northern Russia and more than +3 K on Iceland, in southern Russia and in Austria and parts of Bosnia and Herzegowina and Serbia.

February 2013 was colder than normal in western, central and southern Europe. The largest negative anomalies spread over western and south-western France with anomalies in the range of -2 to -3 K and locally more than -3 K. Negative anomalies in the range of -2 to -1 K extended remarkably far southward in the Mediterranean Sea. Northern, eastern central, eastern and south-eastern Europe and the Middle East were warmer than normal. Positive anomalies of +4 K and more were observed from Finland southward to the Caucasus area. Warmer than normal was as well the Arctic Sea with +4 K for Spitsbergen and +2 to +3 K on Iceland and south-eastern Greenland. Iceland reported February 2013 to be the 2nd to 4th warmest February since observations started in the 19th century.

March 2013 was colder than normal in most of Europe except the central and eastern Mediterranean, the Middle East and the Caucasus area. The negative anomalies were larger than -4 K in northern Russia and the eastern Baltic States as well as in large parts of Germany and Poland. In Germany March 2013 was on rank 4 of cold March months since 1901 and on rank 5 since 1881. In Ireland some locations recorded the coldest March of the last 50 to 70 years. In the Netherlands March 2013 was on rank 7 of the coldest March months since 1901. UK recorded the 2nd coldest March since 1910 and the coldest since 1962. In France it was the coldest March for 25 years. It was as well the coldest March since the start of the series in 1980 together with March 1996 at the station Ekofisk in the Norwegian Sea. In Latvia rivers and lakes had an ice cover of 20 to 28 cm. In Minsk, Belarus, March 2013 was on rank 8 of the cold March months since 1945. The second half of March 2013 was extremely cold in the entire territory of Slovakia. At Hurbanovo the mean temperature of the period of 16 – 31 March 2013 was the second lowest recorded since 1901 with deviation 5.4°C below the 1961 – 1990 average.

April 2013 was still colder than normal on the Northern North Atlantic and southern Scandinavia and the Baltic states, while it was warmer than normal in the Arctic region, in eastern Europe and in south-eastern and most of southern Europe. Temperatures rose by the middle of the month corresponding to the change of the NAO regime (see the graphs of the time series below). Interesting is again the good correspondence of the anomalies of the vertically integrated water vapour (Total precipitable water, TPW, see in http://www.dwd.de/rcc-cm under products - water vapour).

Cold polar air moved frequently to the western parts of Europe in **May**, whereas warm tropical air masses flowed into the eastern parts far to the north. The highest negative anomalies below -2°C were recorded in France and northern Spain. It was the coldest May in Switzerland since 1991, in the United Kingdom and Ireland since 1996, in Spain since 1985; France recorded its lowest maximum temperature since 1984. On the other hand, there were very high positive anomalies above +4°C in the Ukraine and western Russia, and even in northern Scandinavia, where temperature records for May were broken at several stations. The difference between west and east was especially extreme in the last week of the month, when minimum temperatures in western Europe fell near to the freezing point, while maxima in Finland exceeded 30°C.

June 2013 was at least +1°C warmer than normal in the Arctic region and in eastern Europe. In eastern parts of the European Arctic region, anomalies exceeded +4°C. It was the warmest June since 1999 in Finland. Highest maximum in Finland this June was 32.4°C. In Belarus the return time of such a warm June is about 20 years. Northern Norway recorded its third warmest June with a highest daily maximum of 29.8°C. Akureyri in northeastern Iceland had its warmest June since 1953 with 11.4°C on monthly average, and maxima exceeded 20°C in places. Turkey had some new local June maxima records (35-40°C) around 5 June. Parts of the western half of Europe and the North Atlantic were slightly cooler than normal. This concerns especially the sea areas of the North Sea, eastern regions of the North Atlantic and the western Mediterranean, and the corresponding coastal regions. Anomalies were mostly between 0 and -1°C, only few exceptions below -1°C, e.g. locally in the Pyrenees region. Spain had its coldest June since 1997. This happened for the first time since 1985. However, in the United Kingdom, the previous two Junes were even colder than this one. Central Europe was slightly warmer than normal due to an intense but short heat wave with maxima up to above 35°C, which also affected most of the other parts in Europe. Some local records occurred around 19 June in central Europe. The heat wave ended after arrival of a cold front causing an abrupt temperature decrease at the end of the month.

July 2013 was warmer than normal on the European continent except partly in Turkey and the Caucasus area. The mean monthly anomalies exceeded +2 K in central and western Europe and were in the range of +3 to +4 K in parts of France, Germany, eastern Austria and its neighbours and locally in UK and north-western Spain. In France the heat wave of 13 days (15 to 27 July) was moderate but its length was on rank 6 since 1947. In Spain it was the 5th warmest July since 1961 and Norway reported the 5th warmest July since 1900. UK reported July 2013 as the 3rd warmest since 1919, France as well. Germany had the 6th warmest July since 1901.In Ireland it was the warmest July at several places for more than 60 years and at the Valentia Observatory it was the warmest since 1893. Hot days occurred in all central, southern, south-western and south-eastern Europe except in the high mountains and as well in southern UK. Summer days occurred on the whole continent except on the higher mountains, northern Scandinavia and Russia. Days with maximum temperatures over 40°C occurred in south-western Spain and Portugal as well as in parts of Italy, south-eastern Europe and the Middle East, mainly Syria (see the table). The highest temperature in Spain was 41.8 °C in Jerez de la Frontera. Tropical nights occurred not only in southern Europe but also in eastern Germany, in Poland and in easternmost Austria and its neighbouring countries.

August 2013 was warmer than normal, especially on the Balkan Peninsula as well as in the eastern Arctic Sea. Tropical nights occurred rather often in the Mediterranean Sea region (compare also the map of sea surface temperatures) and in the northern Black Sea region but as well in northern Germany, Denmark and the Baltic States. Hot days occurred in central, western, southern and south-eastern Europe, the Middle East and southern Russia and the Caucasus except in the higher mountains. On the southern Iberian Peninsula, in Greece and western and southern Turkey as well as in Syria, Lebanon, Israel and Jordan and in southern Russia more than

25 days of the month were hot days. Extremely hot days (above 40°C) occurred mainly in southern Spain and in Syria and Jordan but locally also in other countries. 17 of 58 countries reported that a maximum temperature of 40 °C or more was registered in August 2013. The highest value occurred in Jordan with 45 °C. In Spain 44.1 °C was the highest value. Only a few frost days occurred in the Alps at higher locations but more often in the mountains of southern Norway and Sweden. The high temperatures partly caused deformations of streets (i.e. Portugal, Germany, Austria).(Consider that temperatures close to the surface may exceed the air temperatures arbitrarily under sunshine conditions). Together with the dry conditions they lead to forest or bushfires especially in the southern regions (Portugal, Austria).

September 2013 was warmer than normal over the Arctic region with positive anomalies of +3 to +4 K. It was as well warmer than normal in western Europe and the Mediterranean region. September 2013 war colder than normal in eastern Europe and Middle East with negative anomalies of -1 to -2 K on the eastern Balkan Peninsula, in southern Poland, in the Ukraine and southwestern Russia. Southeastern Ukraine had the strongest negative anomalies (-2 to -3 K).

In **October** 2013 it was warmer than normal with exception of the eastern Mediterranean and Middle East as well as the northeastern Arctic region and parts of the North Atlantic south of Greenland. In Spain it was the 6th warmest October since 1961, in places even the warmest October since 1869. It was also the 6th warmest October since 1900 in France. Several places had their highest monthly mean since the last 90 years. Cap Corse (Haute-Corse) had a monthly mean of 20.8 °C (record since 1917). In the Netherlands it was the warmest October in De Bilt since 1901. In Germany it was the 11th warmest October since 1881 as a mean over the country.

November 2013 was warmer than normal in the Arctic and on Greenland, in northern, eastern central, in eastern and south-eastern Europe and in Middle East. A large area over most of European Russia and parts of Belarus, the Ukraine and Moldova had positive anomalies of 4 K or more. It was only slightly colder in most of western and western central and south-western Europe and on the North Atlantic. In north-eastern Portugal partly 13 to 15 days (2nd half of the month) had minimum temperatures of 0°C or below.

December 2013 was warmer than normal on most of the northern, western, central and eastern part of the continent and colder than normal in Turkey and Middle East. The highest positive anomalies of more than 4 K occurred over eastern Norway, Sweden, Finland, the Baltic States and the northern part of European Russia. Also the Arctic regions had partly positive anomalies above 4 K. The negative anomalies in Turkey and the Middle East were above -4 K partly as well. The month therefore has been the 10th warmest December since the beginning of the 20th century and also since 1881 in Germany. In Denmark it was the 2nd warmest December since 1874. In the Netherland December 2013 was the 6th warmest December since 1901. In Ireland it was the warmest December at single stations since 22 to 25 years. On 12th December Malin Head recorded its highest maximum temperature for December since 58 years (15.2°C).In UK it was the warmest December since 1988. In Norway December 2013 was the 8th warmest December for the whole country since 1900 with an anomaly of 4.2 K (locally 6-8 K). In the region Ostland it was the 3rd warmest after 2006 and 1924.

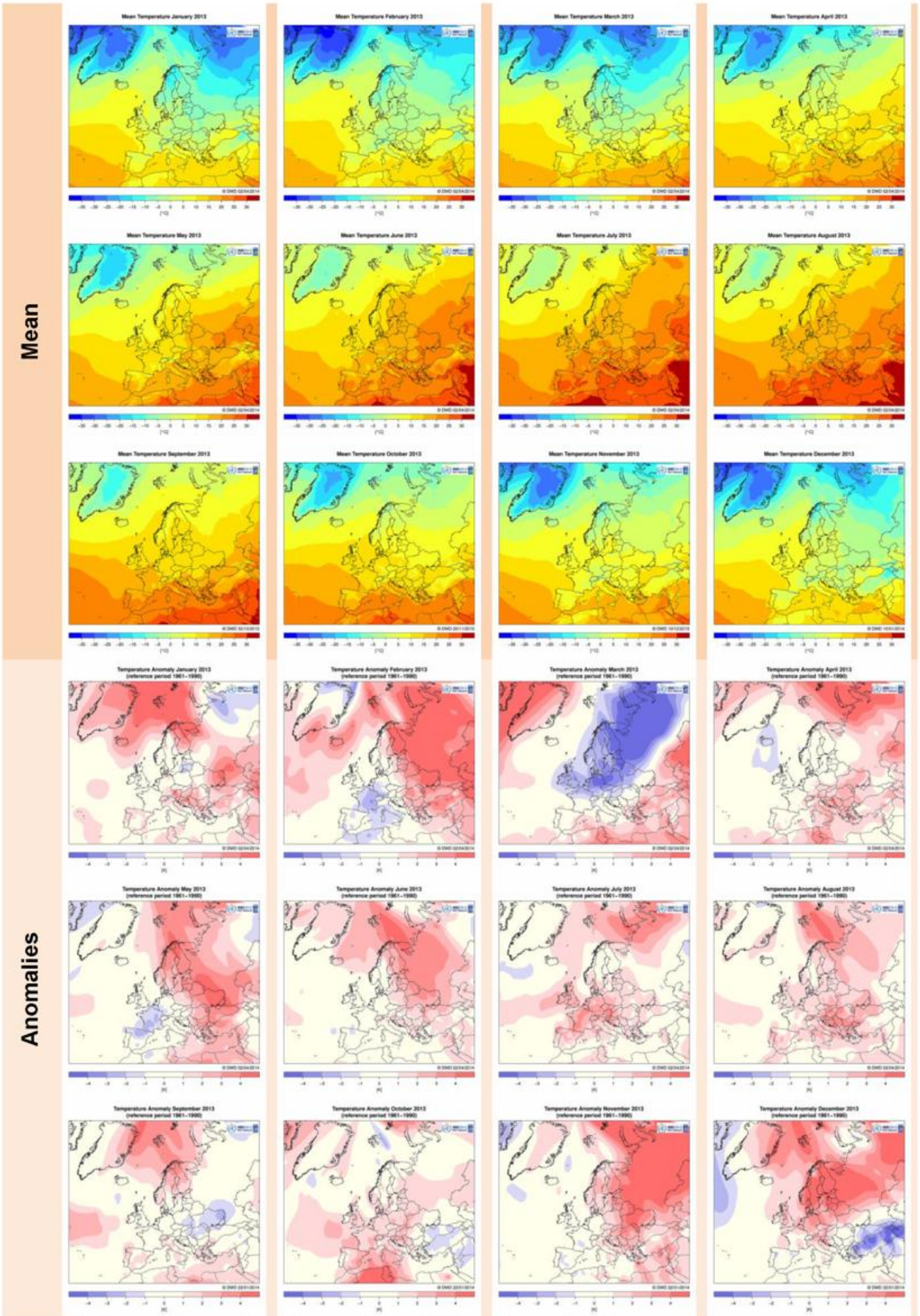


Figure 4.3: Mean and anomalies of temperature in °C for each month of the year 2013.

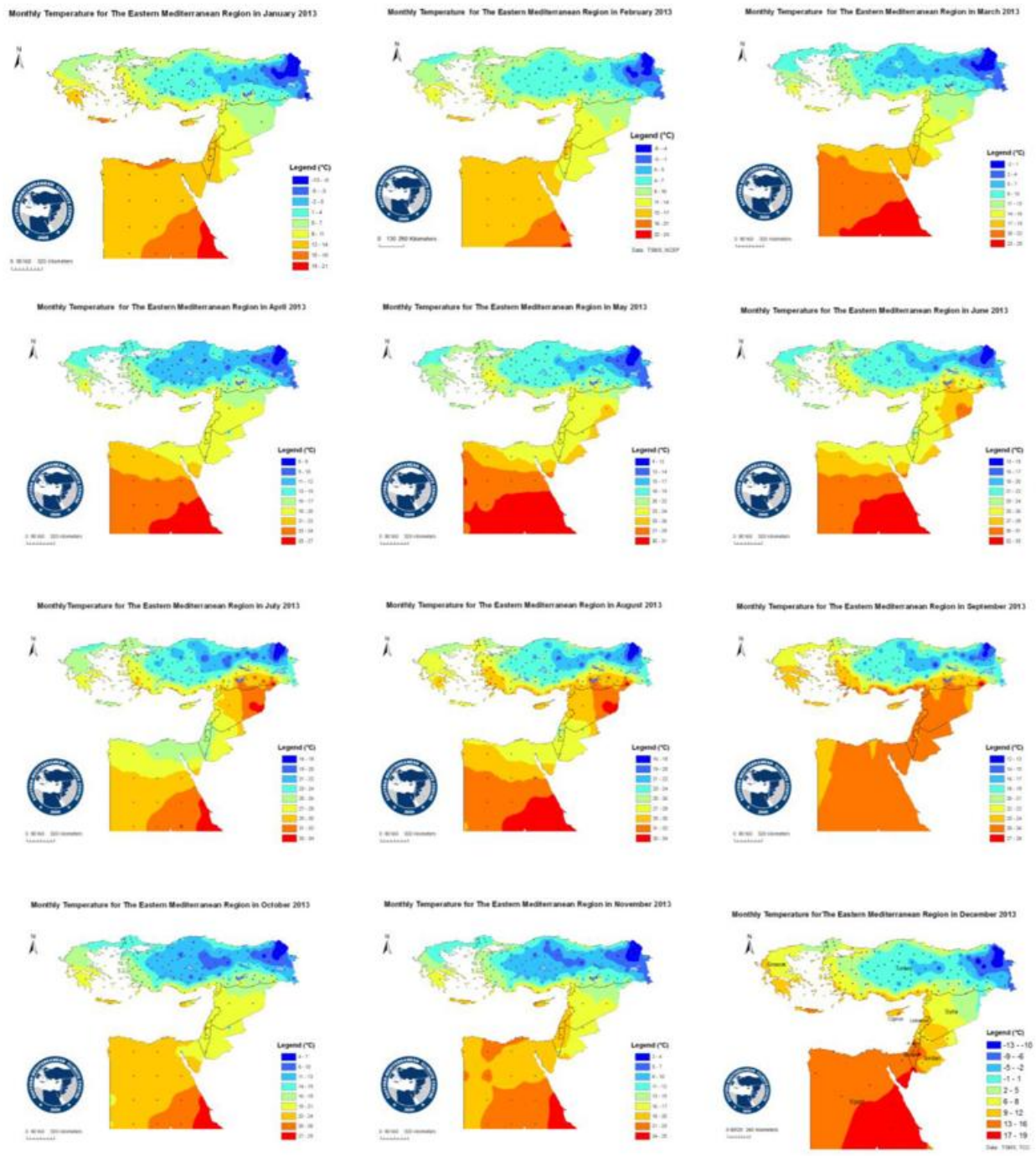


Figure 4.4: Monthly mean temperature (°C) for the Eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC)

4.3 Precipitation

In **January** 2013 the countries under the influence of the Atlantic as well as in the central and eastern Mediterranean Sea and in Middle East received partly much more precipitation than normal. More precipitation than normal was as well registered in eastern and south-eastern Europe and southern Russia. On the other hand much of UK, southern Scandinavia, the western central Europe, the western Mediterranean region, southern Turkey and northern Russia and Finland had less precipitation than normal. This pattern is widely consistent with the circulation anomalies.

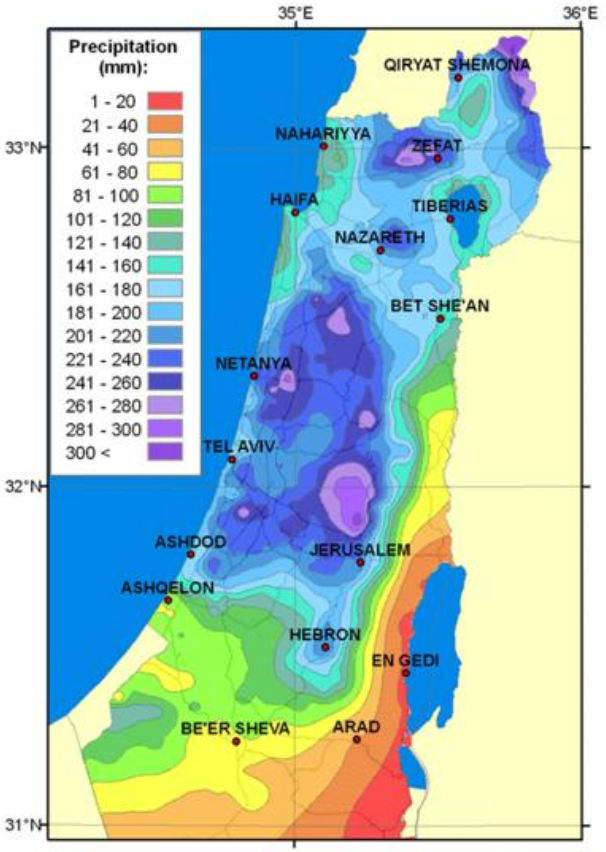


Figure 4.5 Precipitation totals (mm) in Israel for the episode 4 to 10 January 2013

Wetter than normal conditions existed in **February** on the northern Iberian, the Italian and western Balkan Peninsula as well as in western Turkey. Drier than normal were northern, western and central Europe as well as southern Russia and the Caucasus, the eastern Mediterranean area and the Middle East.

In **March** 2013 there was a broad band of higher than normal precipitation from the Iberian Peninsula over the western Mediterranean Sea, Italy, the Balkan Peninsula, the Ukraine and the Black Sea region to Russia. Also southern UK and northwestern France as well as the northwestern coast of Scandinavia were partly wetter than normal. Dry was on the other hand Iceland, most of UK and Ireland, Scandinavia, Denmark, Germany, Poland, the Baltic States, northern Russia as well as the southern and eastern Mediterranean Sea and the Middle East. In Spain it was the wettest March since 1947 with about 300% of its normal value. Also in Norway some stations recorded new records of March precipitation totals since 100 years or more.

In **April** 2013 there were positive anomalies of precipitation totals in the western Mediterranean Sea and southern (and central) France, in the eastern Mediterranean Sea, at the Atlantic coasts (except Portugal), especially in Scotland and southern Norway. As well regionally positive anomalies can be found in northern Scandinavia, the Baltic states and in Russia. Drier than normal were Portugal, UK except Scotland, northern central Europe, the Balkan states, Italy, the Ukraine, the Caucasus and southern Russia and the Middle East except the Mediterranean coasts. The surplus of the precipitation is partly related to events of heavy precipitation, see the events part below. Dry regions in northern Germany, in southern Scandinavia and in the east of the Black Sea coincide with regions of negative soil moisture anomalies (http://www.cpc.ncep.noaa.gov/).

Most of Europe, especially western and central Europe and even parts of the east saw a wet **May 2013**. Monthly totals exceeded 100mm or 125% of the May normal over much of that area. Particularly high precipitation fell in the Alpine region. Germany recorded its second wettest May since 1881 behind 2007, and Austria had one of the 5 wettest months of May since beginning of measurements. There was much rainfall throughout most of the month, but especially in the last week heavy precipitation caused an extreme flooding situation in eastern central Europe. Another area of high precipitation was located over the North Atlantic, affecting especially southern and southeastern coasts of Greenland and Iceland, northwestern Scotland and Ireland, and southern Norway (reaching new precipitation records there). Also in the Middle East there was more precipitation than normal. The northernmost parts of the European continent, on the other hand, were relatively dry, and so was also Iberia and areas around the Black Sea. Some locations north

of the Black Sea and in west Kazakhstan received less than 10mm of monthly precipitation, which was less than 20% of the normal; also southern Sicily was very dry.

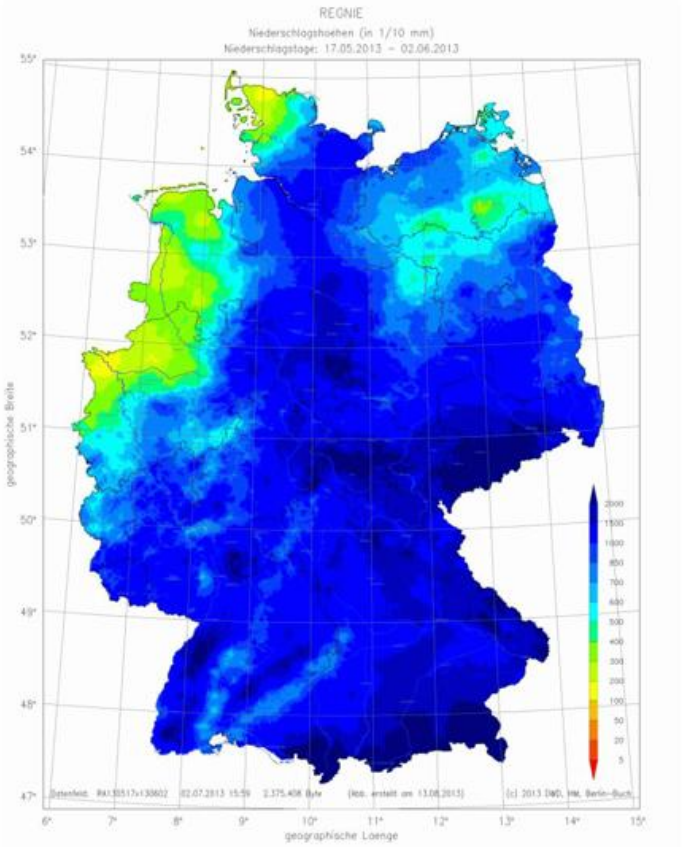


Figure 4.6: Precipitation totals (mm) in Germany for the period 17 May to 2 June 2013



Figure 4.7: High water marks in Passau, 2013, the second from the top (provided by Mrs Helga Nitsche, 10/08/2014)

Due to an extremely heavy precipitation situation with flooding especially in the Elbe and Danube River catchments at the beginning of **June**, monthly totals were very high especially in eastern central Europe, and new local records were achieved in several places. 48-hour totals on 2-3 June reached at least up to 275mm in Germany, exceeding clearly the normal for the whole June. Also some heavy rain after thunderstorms in the last third of the month contributed to a wet month there. Highest monthly totals fell in northern Austria with a local maximum of 475mm in Bregenz and new local June records. It was also very wet west of the Black Sea, in Scandinavia and over the eastern Atlantic and its coasts in southern Ireland, western France and northern Spain with monthly totals above 100 mm, locally above 150 mm or around twice the normal; in Bulgaria locally more than 300% of the normal, partly accompanied by large hail. Norway and the northern half of Austria received each 160% of its normal June total. It was the third wettest month on record in eastern Norway behind 2011 and 1987. In south-western France, much of the rain was contributed by heavy thunderstorms on 17-20 June. In Moldova, more than 100 mm fell on 30 June within a few hours. On the other hand, there were some quite dry areas as well that month, such as Iceland, United Kingdom, the Azores islands, most of Iberia, the Mediterranean and also large parts of eastern Europe, although several thunderstorms with heavy precipitation and large hail occurred in Russia and other parts of eastern Europe. Southern Iberia and southern parts of the Mediterranean regions received less than 10 mm that month, which was locally less than 20% of the June normal. It was also very dry near to the southern slopes of the Alps. Villach in southern Austria had its driest June since beginning of measurements in 1888. Turkey had less than 80% of the normal rain; however, it was not so dry like in June 2012.

July 2013 was drier than normal in Central Europe, on the Balkan Peninsula, on most of the Iberian Peninsula and most of the Middle East. It was wetter than normal in the northern North Atlantic/Arctic Ocean and adjacent countries, partly in eastern Europe and partly in the

Mediterranean countries. Highly convective situations with heavy to extremely heavy precipitation were often, not only in the wetter-than-normal areas. There are as well reports of extreme precipitation intensities of more than 50 mm within one or two hours (France). The convective events were partly accompanied with hail of up to 10 cm size especially in the last week of the month (Germany, France).

August 2013 was mostly drier than normal except in the Arctic Sea region, the western Mediterranean Sea region, and parts of Russia. Drought contributed to the development of forest fires. As well drought-related damages to agriculture occurred as reported for instance by Austria. Surplus of precipitation in the western Mediterranean, partly in the Alps and Germany, in Norway, northern and southern Russia in eastern central Europe and parts of the Middle East was often caused by heavy to extremely heavy precipitation.

September 2013 was wetter than normal in most of central and eastern Europe, in parts of the Mediterranean Sea and of the southern Iberian Peninsula and in parts of Greenland. It was on the other hand drier than normal in most of Scandinavia (except parts of Sweden), northern Russia, the British Isles, most of the western and the eastern Mediterranean Sea and Middle East. Especially around the Black Sea extremely heavy precipitation occurred and caused flooding. On September 13 at station Cahul, Moldova, 172 mm during 12 hours were registered, which is rank two for the entire observation period. At the same station during the 11-13.September 246 mm (50% of annual rate) the greatest amount of precipitation on the territory of Moldova during 1-3 days were measured, for the entire observation period the amount was 282 mm. A series of cyclones brought excessive rainfall in many areas of the Ukraine - from 265 % - 390 % of monthly normals. In some areas the monthly rainfall exceeded the rate of 4-5 times. The highest rainfall was recorded in Kyiv - 211 mm, and Zhytomyr – 202 mm. Wind gusts reached 15-23 m /s.

October 2013 was wetter than normal in northern Scandinavia and northern European Russia, on the British Isles except northern Scotland and western Ireland (Mullingar recorded its wettest October since the station opened in 1950), in western and central Europe, around the North Sea and in Denmark and southern Sweden, on the western Iberian Peninsula, northern Italy, around the Black Sea and in western Turkey, the eastern Balkan Peninsula and southern European Russia. In De Bilt, Netherlands October 2013 was one of the 5 wettest October months within 100 years. It was drier than normal in central Scandinavia, in the western Mediterranean and around the Adriatic Sea, in eastern central Europe and western central European Russia and the Baltic states and in Middle East.

November 2013 was drier than normal on Iceland, the British Isles, most of the Iberian Peninsula, the eastern Mediterranean Sea, around the Black Sea, in southern Russia and in western Kazakhstan. It was wetter than normal in Norway, western and partly southern continental Europe, Italy and the western Balkan Peninsula, the Middle East and northern European Russia. 200 to 300 mm and locally more than 300 mm fell at the Norwegian coast, in northern Spain, at the Adriatic coast and in southern Italy. Norway reported many new records of November daily precipitation totals. Most of them occurred on 16 November. Monthly totals of less than 10 mm were recorded in parts of the Iberian Peninsula, at the eastern Mediterranean coasts, in the southern Ukraine, in southern Russia and eastern Kazakhstan.

December 2013 was wetter than normal on Greenland (except the southernmost part), on the British Isles, in Scandinavia and northern Russia. It was also wetter than normal in eastern European Russia and the Middle East. In Denmark it was the 2nd wettest December since 1874. In Ireland it was the wettest December at single stations since 7 to 24 years. In Norway December 2013 was the 2nd wettest since 1900 (after 1975) for the whole country and in the region Agder it was the wettest. In Scotland it was the wettest December since 1910. Precipitation totals and precipitation surplus were partly remarkable with above 300 mm resp. above 167 % in some areas. On the other hand much of central Europe and most of southern, eastern central and south-eastern Europe was drier than normal. Montenegro reported only 2% to 35% of the climatologically mean. In the Mediterranean Sea area the spatial variability between wetter and drier regions was great. In the dry areas on the Balkan Peninsula and Middle East partly monthly totals were below 10 mm.

A severe storm with high precipitation totals and significant snowfall amounts occurred in **Israel** on 10-14 December, 2013. An upper air trough, with extremely cold air from North Russia and a low level depression, affected the Eastern Mediterranean. These systems prevailed for 3 days, enabling the conditions for significant rainfall and snowfall.

The precipitation was more significant in the central and southern parts of the country with amounts of 150-250 mm. In the southern coastal plain, 250-300 mm were measured, with a few stations receiving more than 300 mm. In the northern parts of the country the rainfall amounts were 70-150 mm (**Figure 4.8**).

Comparison of this event's accumulated rainfall to the accumulated rainfall (for 4-5 days) in previous years, reveals that in most stations in the southern coastal plain and the Judean Mountains, similar or more significant rainfall occurred only once since records began in the 1940s-1950s. That happened in late November through early December 1991.

In addition, significant snowfall occurred in the mountain regions. In central Israel mountains (the Judean mountains, Jerusalem and part of Samaria) the snow began in the morning hours of December 12th, ceased later and then resumed during the evening hours. The snowfall continued throughout the night and the following day, December 13th, with extremely low temperatures. It continued until December 14th. The snow depth in Jerusalem reached 50 cm (elevation of 800 m). In higher places like the Hebron Mountains and surroundings (elevation of 900-1000m) the snow depth was 50-70 cm, and in the peaks of northern Judea and Samaria, there were reports of 70-90 cm of snow (**Figure 4.9**).

The snowfall was very unique regarding its depth and the time of the year it occurred. Snowfall does occur in the mountain regions every year or two, but usually its depth is no more than a few cm. 10-30 cm of snow is less frequent and falls, generally, in January or February.

Snowfall reports in Jerusalem date back to the 19th century and since then such a significant snowfall has not been recorded in the first half of December (it happened only once at the end of the month, on the 28-29th of December 1879). Regarding all the winter months, there were only three other events with similar or more significant snow depth since the beginning of the 20th century (1920, 1950 and 1992, all in February).

In the northern mountains, the snow fell mostly on December 13, reaching a depth of 40-60 cm in the northern Golan and 30-50 cm in the Upper Galilee. There were also reports of 1 meter of snow in the peaks of the Upper Galilee. In all regions, temperatures remained very low after the storm had ceased, resulting in a slow melting rate of the snow, which remained on the ground for more than a week after the end of the event. The severe amounts of snow caused heavy infrastructure damage, including power outages in tens of thousands of homes and road closures with many drivers stranded.

During the event, extremely low temperatures were measured. On December 13th, the maximum daily temperatures were 12-13°C below December's daily maximum average, reaching as low as 7-8°C in the coastal plains and about 0°C on the northern and central mountains picks. This deviation from the monthly mean was very exceptional taking into account the maritime characteristics of the Mediterranean climate. In Zefat - Har Kenaan, temperatures were below 0°C all day long (minimum -1.2°C and maximum -0.3°C). Since records began in 1939, there were only three occasions in Zefat with lower or similar maximum daily temperatures, none of them in December (February 1950, January 1992 and February 1992).

After the storm passed and the sky cleared, a rapid nighttime cooling occurred and in the early morning of December 15th, extremely low minimum temperatures were measured. In the Merom Golan Picman station (in the Golan Heights), the minimum temperature was as low as -13.6°C, a record-breaking low since records began there in 1978 .

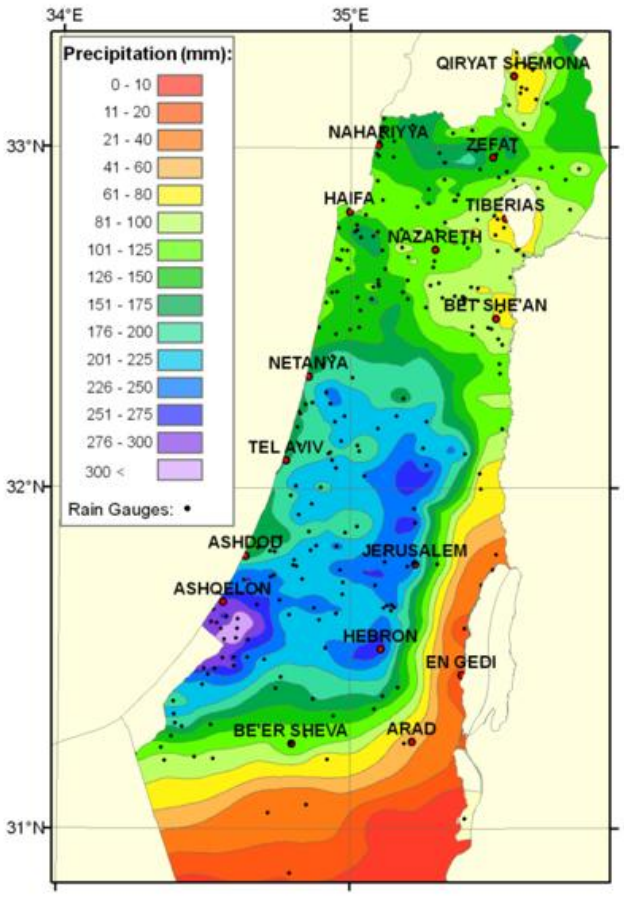


Figure 4.8: Accumulated precipitation (mm) in Israel on 10th-14th December 2013.

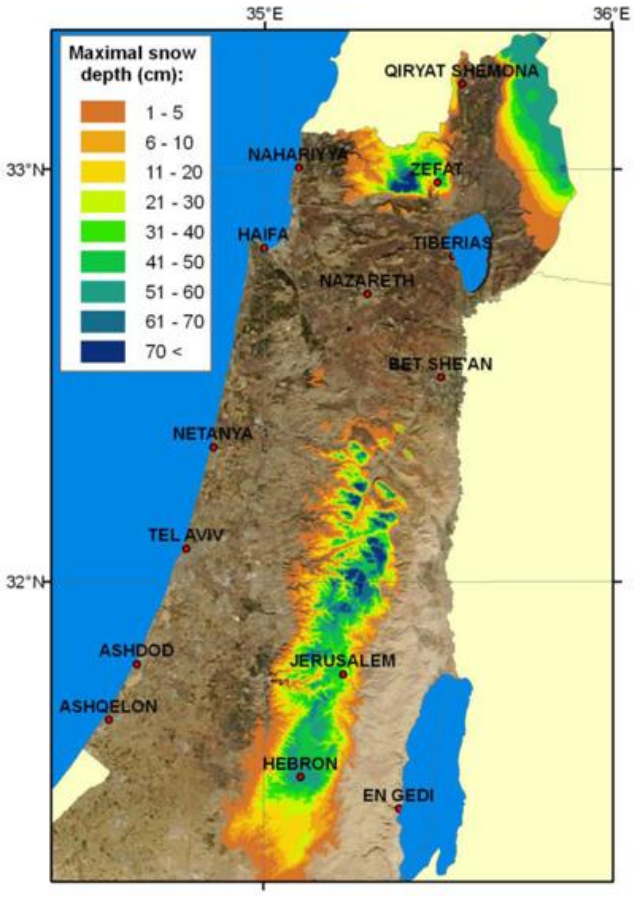


Figure 4.9: Maximal snow depth (cm) 11-14 December 2013

The map in **Figure 4.9** is based on a model that links between altitude and snow depth according to reports of about 50 observers. This basic model underwent minor changes especially in the marginal areas of the snow, based on reports regarding the presence or absence of snow in these areas. (for more information see http://www.ims.gov.il/IMSEng/TRAINING/Reports+and+Publications/Reports+and+Publications

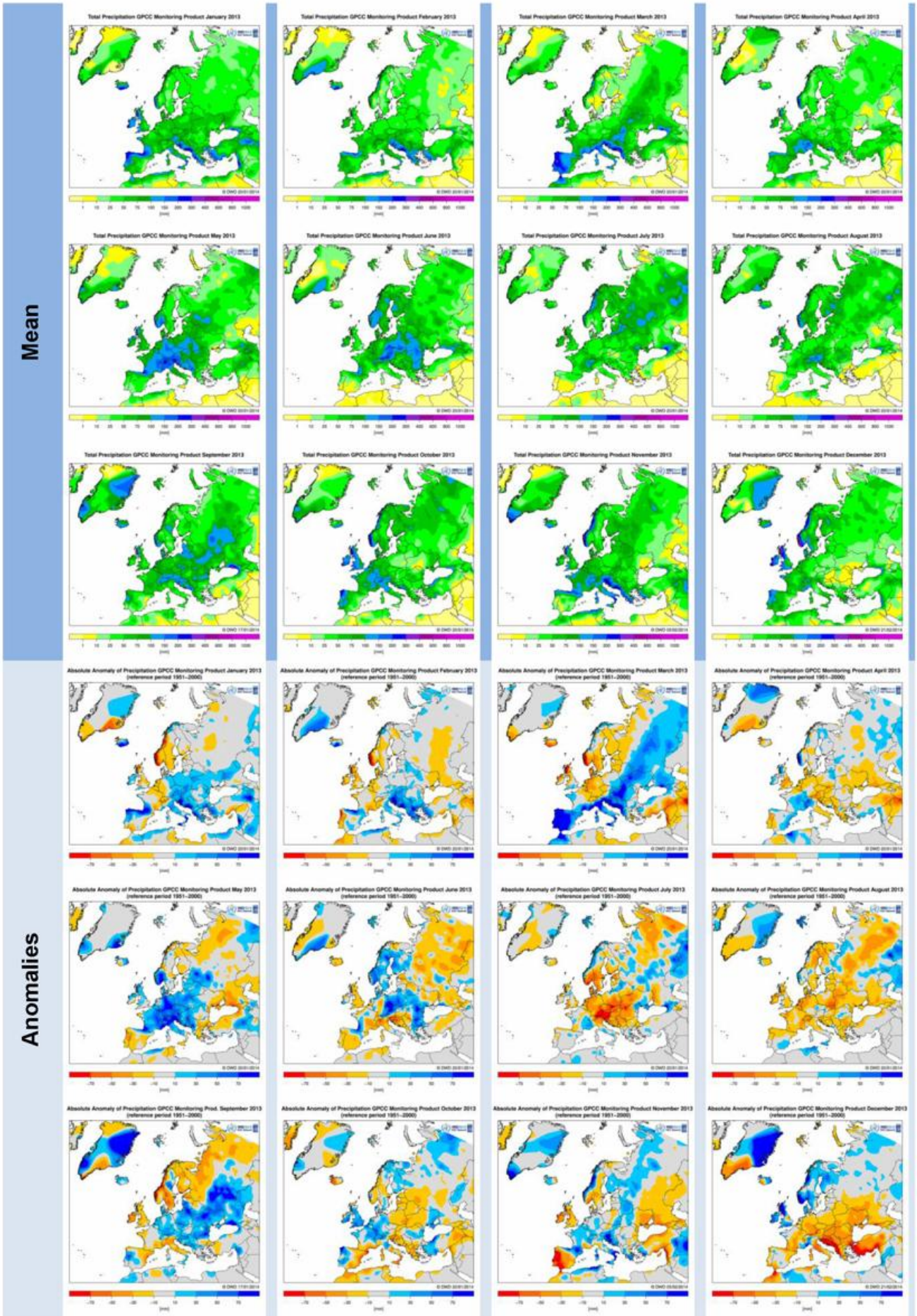


Figure 4.10: Monthly precipitation totals and anomalies in mm/month for each month of the year 2013.

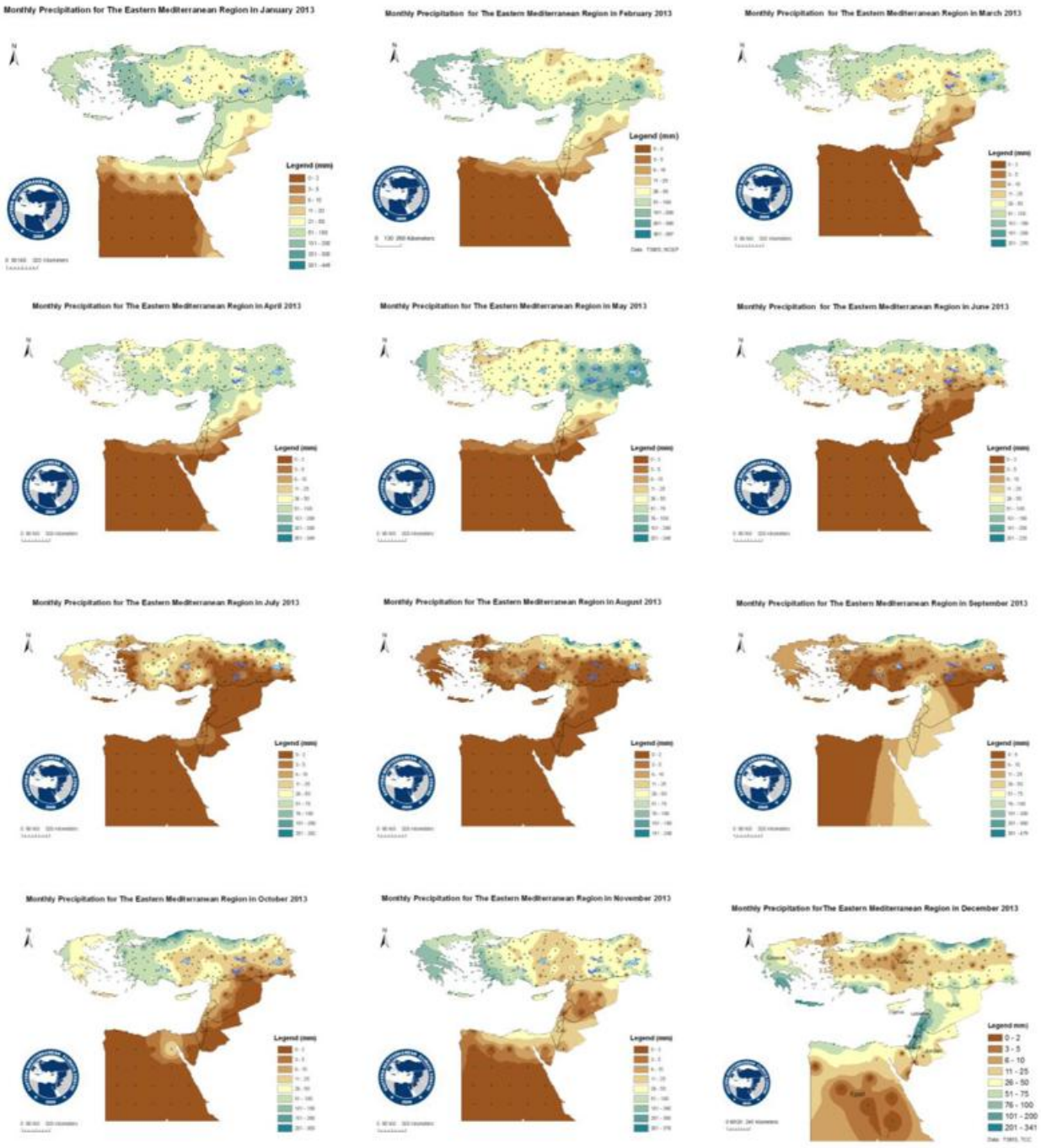


Figure 4.11: Monthly precipitation totals (mm) for the Eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC)

4.4 Sunshine duration

January 2013 was remarkably dull in Europe except in the Mediterranean region and Middle East, central and eastern Europe, the north of Europe and the southern Ukraine had less than 25 percent of the normal while the south-eastern Iberian Peninsula, southern France and partly Middle East received 150 % of the normal. In France January 2013 was one of the dullest January months since 1950, together with January 2004and January 1970. In Germany January 2013 was the dullest since 1951.

February 2013 was dull in most of the area with few exceptions: more sunshine than normal was recorded on the British Isles, most of the Iberian Peninsula and south-western France, southern and northern Norway, the Baltic States and Turkey. The dull areas over central and eastern central Europe as well as in northern Russia correspond to a monthly mean of 7 to 8 octas for the cloud cover. Remarkable is the 'sunny' area in northern Norway and Sweden which corresponds to an area of less than 2 octas of cloud cover as a monthly mean. This value is comparable to the Mediterranean Sea but in this season the monthly totals remain here below 50 hours.

In **March** 2013 the north with Scandinavia, the Baltic States and northern Russia as well as northern Germany and Denmark, Poland and the Ukraine had higher than normal sunshine. Most of the other countries were close to normal or partly dull. The dullest area was southern Russia. It was also the sunniest March on record at several Swedish stations.

Less than normal sunshine duration in **April** 2013 was measured over southern France, Switzerland, north-western Italy, central and southern Germany and western Czech Republic corresponds to the low pressure in the western Mediterranean Sea. The monthly mean of the cloud cover here was 6 octa or more (www.dwd.de/rcc-cm, products-cloud cover).The regions with higher than normal sunshine duration correspond to not more than 10 dull days. In Denmark April was very sunny, the second sunniest since 1920.

Due to frequent cloudiness with precipitation, **May** 2013 was very dull throughout western and central Europe. Especially most of France, Switzerland and Germany received less than 150 hours of sunshine, which is less than 75% of the normal, locally less than 100 hours or 50%. More than half of France had new records of low sunshine in May. In contrast, it was sunnier than normal in most of northern and eastern Europe and in the Middle East, partly also in southern Europe. Highest durations of sunshine in Europe were recorded in eastern Sweden and at the northern coasts of the Black Sea with more than 350 hours or more than 125% of the normal.

It was very sunny in most of eastern Europe and the Arctic region, locally with more than 125% of the climate mean. On 6 **June** 2013, sunshine duration in northern Lapland was nearly 24 hours. Also parts of central Europe, the western Mediterranean, Iberia and southern Ireland saw a relatively sunny month. Sunniest areas were in Russia and southern Iberia, both with more than 350 hours of sunshine. In contrast, it was mostly dull over north-western and western Europe. Reykjavik (Iceland) had the dullest June since 1995. Turkey and the Middle East, too, were much duller than normal.

July 2013 was mostly sunnier than normal on the European continent except partly in the Mediterranean countries and in northern Scandinavia and the Baltic countries. Less sunshine than normal occurred partly in the eastern Mediterranean countries and the Middle East and in western European Russia. The sunshine surplus reached exceptional values in some countries, for instance in the northern parts of France (45 to 63 percent, based on the 1991-2010 reference). In Germany July 2013 was the 2nd sunniest July since 1951. Slovakia reported an absolute record in monthly sunshine duration in its observational history at station Bratislava with 390 hours.

August 2013 was mostly sunnier than normal except on the British Isles, the eastern Mediterranean Sea and the Middle East and parts of Russia. The surplus of sunshine duration was most impressive for Poland where the absolute anomaly amounted up to 60 hours. Also rather high positive anomalies occurred in Scandinavia around the northern Baltic Sea as well as in the northernmost regions of Russia.

September 2013 was sunnier than normal in northern Europe except northern Sweden and in Spain and southern France and Italy. It was dull in eastern Europe, especially in Russia where only less than 50 percent of the normal sunshine duration or even less were achieved in the central parts. It was as well dull in most of central and western Europe.

October 2013 was sunny in most of Scandinavia, from Poland southward to Greece and southern Italy, in Spain and in Turkey and Middle East. Elsewhere it was dull or normal.

November 2013 was relatively sunny for most of Scandinavia, the British Isles, Denmark and northern Germany as well as northern parts of the Baltic States, on most of the Iberian Peninsula, most of Turkey, eastern Hungary, Romania and Moldova, south-eastern Ukraine and southern Russia. Elsewhere it was mostly relatively dull. The dullest area covered northern Russia with partly below 50 or locally even below 25 percent.

In good consistency with the mean sea surface pressure **December** 2013 was sunnier than normal from most of the Iberian Peninsula over the western European continent and south-eastern UK, central, southern, south-eastern and parts of eastern continental Europe. It was less sunny than normal over Ireland and northern UK, Denmark and southern and northern Scandinavia, most of Russia and Middle East. December 2013 has been the 7th richest December in sunshine since 1951 in Germany. Relative sunshine surplus was above 150 percent in parts of the sunnier-than-normal area whereas northern Russia received less than 25 percent of the 1961-1990 normal.

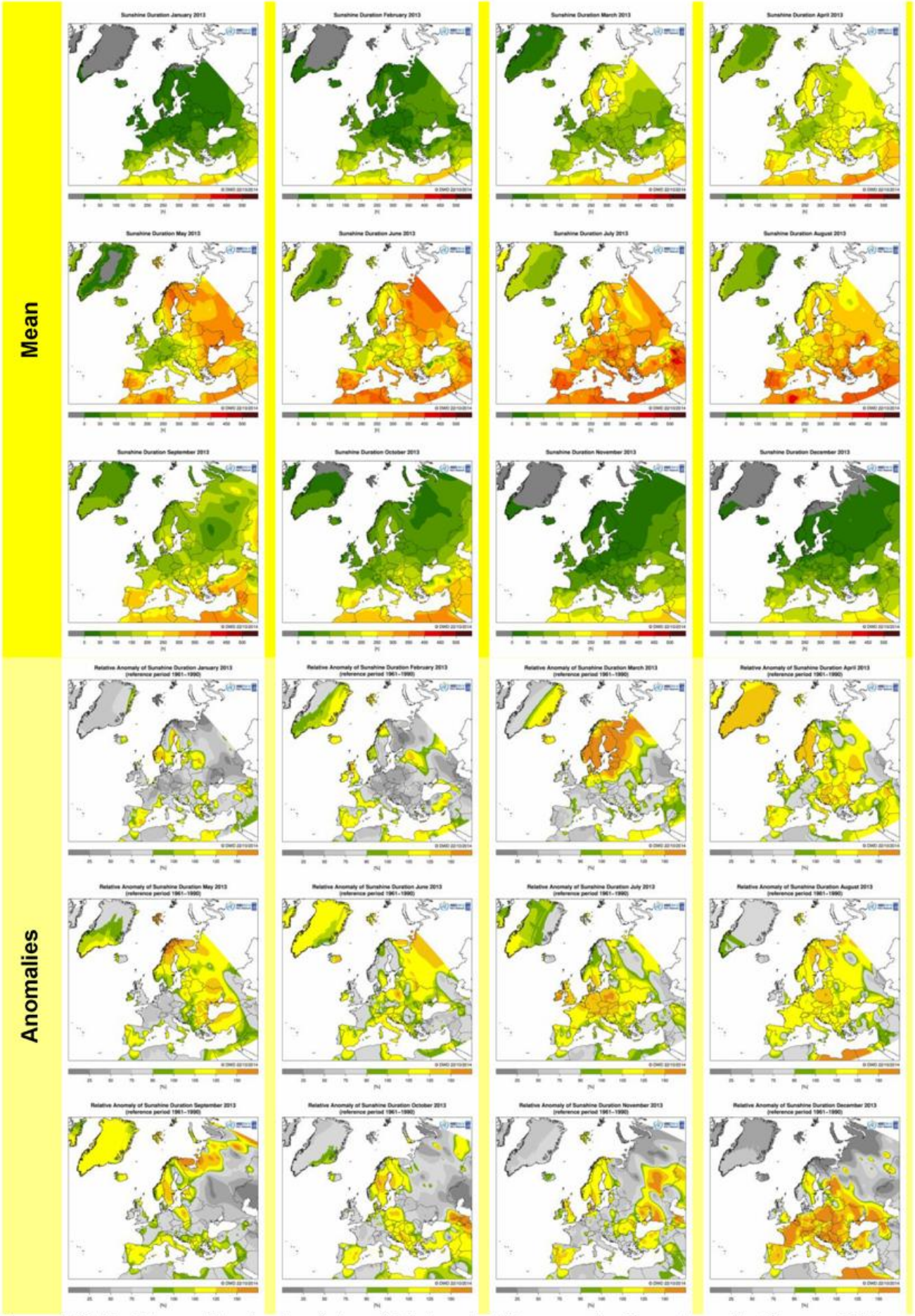


Figure 4.12: Monthly sunshine duration (in hours) totals and relative anomalies for each month of the year 2013.

4.5 Monthly climate extremes and events

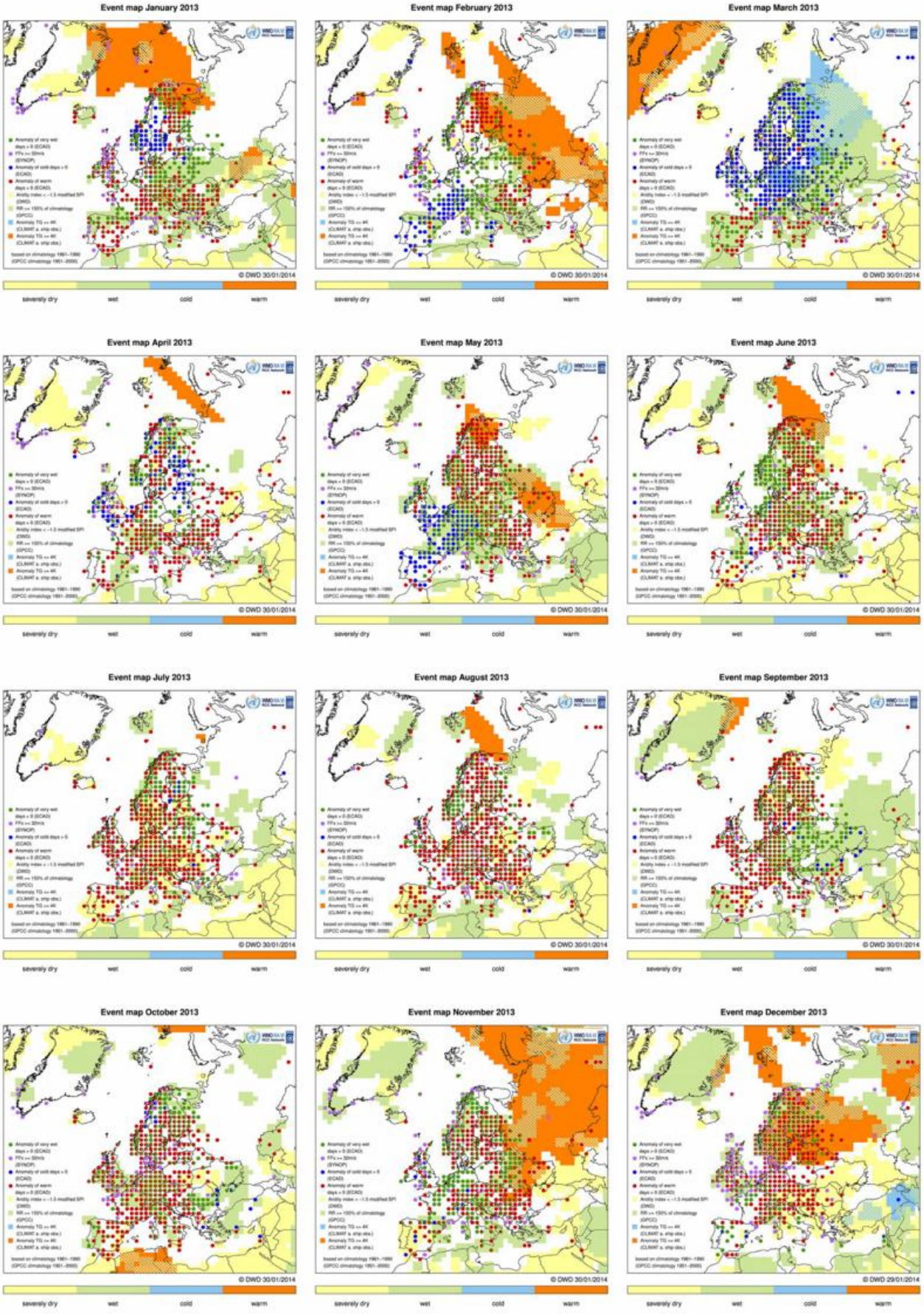


Figure 4.13: Map of Climate Extremes for each month of the year 2013.

5 Annex: Monthly and annual tables

Table 5.1: Statistical values of **annual** mean temperature and total precipitation and their deviations from the long term mean (1961 – 1990, CLIMAT Data) for several stations of the RA VI region.

WMO-No.	Country	Station name	Temp. (°C) mean	Temp. (°C) dev.	Precip. (mm) total	Precip. (mm) dev.
01001	NOR	Jan Mayen	0.2	1.6	582	-111
01008	NOR	Svalbard Airport	-3.5	2.9	249	66
01025	NOR	Tromso	4.0	1.2	1098	125
01492	NOR	Oslo	6.7	1.0	753	-16
02196	SWE	Haparanda	3.2	2.0	576	24
02485	SWE	Stockholm	7.8	1.2	453	-86
02836	FIN	Sodankylä	1.1	2.1	487	-13
02974	FIN	Helsinki	6.5	2.0	561	-90
03091	GBR	Aberdeen	8.7	0.8	704	-79
03772	GBR	London	11.2	0.6	529	-70
03967	IRL	Dublin Casement Aerodrome	9.6	0.3	659	-76
04030	ISL	Reykjavik	5.0	0.6	840	42
04320	GRL	Danmarkshavn	-10.8	1.5	252	111
06186	DNK	Copenhagen	9.4	0.8	501	-135
06260	NLD	De Bilt	9.8	0.4	828	23
06447	BEL	Brussels	10.1	0.2	817	17
06590	LUX	Luxembourg	9.0	0.7	962	87
06660	CHE	Zurich	9.1	0.6	1094	8
06700	CHE	Geneva	10.2	0.6	1047	93
07510	FRA	Bordeaux	13.2	0.5	1050	127
07650	FRA	Marseilles	15.0	0.2	541	-4
08222	ESP	Madrid	15.0	0.7	373	-84
08314	ESP	Mahon/Menorca	17.2	0.6	635	37
08495	GBR	Gibraltar	18.4	0.2	574	-201
08515	PRT	Santa Maria/Azores	17.8	0.3	837	62
08535	PRT	Lisbon	16.9	0.1	949	196
10384	DEU	Berlin-Tempelhof	9.9	0.5	592	8
11035	AUT	Vienna	10.8	1.1	740	133
11518	CZE	Prague	8.2	0.4	672	146
11903	SVK	Sliac	9.5	1.5	916	230
12375	POL	Warsaw	8.9	1.1	612	93
12843	HUN	Budapest	11.9	1.4	536	18
13274	SRB	Belgrade	13.6	1.8	602	-82
14015	SVN	Ljubljana	11.6	1.8	1548	155
14445	HRV	Split	17.3	1.4	969	144
14654	BIH	Sarajevo	11.0	1.6	931	13
15420	ROU	Bucureşti	11.7	1.1	587	-9
15614	BGR	Sofia	11.3	1.6	501	-62
16158	ITA	Pisa	14.7	0.6	1027	123
16597	MLT	Luqa	19.7	1.1	480	-74
16716	GRC	Athens	19.1	1.4	504	127
17040	TUR	Rize	15.0	1.1	1915	-257
17062	TUR	Istanbul	16.2	2.1	450	-248
17170	TUR	Van	9.9	1.3	337	-41
17300	TUR	Antalya	19.9	1.6	952	-115
17609	CYP	Larnaca	20.4	1.3	160	-169
22113	RUS	Murmansk	2.4	2.5	503	25
26038	EST	Tallinn	6.6	1.5	574	-93
26406	LVA	Liepaja	7.9	1.2	606	-84
26730	LTU	Vilnius	7.3	1.2	675	-8
26850	BLR	Minsk	7.4	1.6	663	-14
27612	RUS	Moscow	6.7	1.8	891	203
33345	UKR	Kiev	9.4	1.7	804	155
33815	MDA	Kishinev	11.1	1.5	531	-16
35300	UKR	Kharkiv	9.5	2.1	557	38
34880	RUS	Astrachan	11.7	1.7	233	13
35108	KAZ	Uralsk	7.7	2.3	363	39
37545	GEO	Tbilisi (Tiflis)	13.8	0.8	473	-25
37789	ARM	Yerevan	12.5	0.4	314	37
40080	SYR	Damascus	17.9	1.4	140	-7
40103	LBN	Tripoli	20.0	0.7	678	-202
40180	ISR	Tel Aviv	21.5	2.0	393	-175
40199	ISR	Eilat	26.0	1.2	19	-13
40265	JOR	Mafraq	17.6	1.1	154	-5
60030	ESP	Las Palmas/Gran Canary	21.7	1.2	72	-45

Table 5.2: Statistical values of **monthly** mean temperature and total precipitation and their deviations from the long term mean (1961 – 1990, CLIMAT Data) for several stations of the RA VI region.

WMO-No.	Country	Station name	January				February				March			
			Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
			mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
01001	NOR	Jan Mayen	-1.6	4.1	22	-38	-2.1	4.0	46	-10	-5.8	0.3	32	-24
01008	NOR	Svalbard Airport	-8.3	7.1	18	4	-10.8	4.9	10	-9	-14.3	0.4	4	-17
01025	NOR	Tromso	-2.0	1.2	128	47	-3.1	1.2	131	45	-4.2	1.2	91	27
01492	NOR	Oslo	-4.9	-0.6	36	-13	-3.2	0.8	18	-18	-2.1	-1.9	9	-37
02196	SWE	Haparanda	-9.1	3.0	57	13	-6.9	4.4	20	-12	-9.5	-2.7	16	-19
02485	SWE	Stockholm	-3.3	-0.5	27	-12	-1.3	1.7	30	3	-2.2	-2.3	3	-23
02836	FIN	Sodankylä	-11.5	3.6	41	10	-9.4	4.2	24	-1	-13.2	-4.7	5	-20
02974	FIN	Helsinki	-5.9	1.0	36	-5	-2.8	4.0	33	2	-6.6	-3.7	6	-28
03091	GBR	Aberdeen	3.5	0.8	76	-5	3.3	0.4	46	-5	2.4	-2.1	62	4
03772	GBR	London	4.5	0.3	49	-3	3.9	-0.6	33	-2	4.1	-2.4	53	6
03967	IRL	Dublin Casement Aerodrome	5.1	0.7	70	4	4.3	-0.1	45	-6	3.1	-2.9	63	14
04030	ISL	Reykjavik	2.7	3.2	120	44	3.9	3.5	104	32	1.2	0.7	41	-41
04320	GRL	Danmarkshavn	-19.8	3.3	16	5	-25.4	-1.1	2	-10	-21.4	2.0	6	-10
06186	DNK	Copenhagen	0.8	0.3	51	0	0.2	-0.3	17	-14	0.1	-2.5	2	-40
06260	NLD	De Bilt	2.0	-0.2	59	-7	1.7	-0.8	48	-1	2.5	-2.5	37	-26
06447	BEL	Brussels	2.1	-0.5	54	-13	1.4	-2.1	55	2	3.0	-2.5	64	10
06590	LUX	Luxembourg	0.4	0.4	39	-32	-0.6	-1.7	30	-32	1.6	-2.4	47	-23
06660	CHE	Zurich	0.6	1.1	60	-7	-1.3	-2.2	63	-7	2.5	-1.7	60	-9
06700	CHE	Geneva	1.3	0.5	52	-28	0.4	-1.9	61	-20	4.2	-0.9	78	-1
07510	FRA	Bordeaux	6.3	0.5	138	38	5.7	-1.4	77	-9	9.2	0.4	71	-5
07650	FRA	Marseilles	5.9	-0.8	38	-9	5.2	-2.7	8	-46	10.3	0.1	57	13
08222	ESP	Madrid	6.5	0.4	26	-20	6.9	-0.6	22	-22	9.4	-0.6	100	67
08314	ESP	Mahon/Menorca	11.1	0.6	66	0	9.5	-1.2	63	6	13.2	1.6	63	8
08495	GBR	Gibraltar	14.2	0.8	58	-63	12.7	-1.1	119	19	15.1	0.1	178	103
08515	PRT	Santa Maria /Azores	15.6	1.2	65	-35	15.0	1.0	52	-34	14.9	0.3	261	182
08535	PRT	Lisbon	12.2	0.8	155	45	11.3	-1.0	70	-41	13.1	-0.6	267	198
10384	DEU	Berlin-Tempelhof	0.3	0.5	56	13	0.5	-0.3	30	-4	-0.5	-4.7	18	-19
11035	AUT	Vienna	0.6	1.6	105	67	1.3	0.3	56	14	2.9	-2.1	40	-1
11518	CZE	Prague	-1.2	1.2	36	13	-1.1	-0.3	29	6	-0.6	-3.6	14	-14
11903	SVK	Sliac	-3.0	0.9	131	87	-0.7	0.4	80	36	1.5	-1.5	119	77
12375	POL	Warsaw	-3.5	-0.2	49	27	-0.4	1.6	25	4	-1.8	-3.8	23	-5
12843	HUN	Budapest	0.2	1.8	51	19	2.4	1.3	76	44	3.8	-1.8	113	84
13274	SRB	Belgrade	3.2	2.8	77	28	4.4	1.7	53	9	6.6	-0.6	95	45
14015	SVN	Ljubljana	2.0	3.1	91	9	0.9	-0.5	205	125	3.9	-1.5	189	91
14445	HRV	Split	9.1	1.7	91	8	8.3	0.2	98	30	10.6	0.2	175	100
14654	BIH	Sarajevo	1.9	2.8	128	57	2.3	0.8	132	65	5.3	0.2	89	19
15420	ROU	Bucureşti	-1.5	0.9	53	13	2.4	2.5	45	9	4.8	0.0	50	12
15614	BGR	Sofia	0.6	2.2	40	13	2.7	2.2	54	21	5.3	0.7	39	1
16158	ITA	Pisa	6.7	0.6	206	131	5.1	-2.0	107	34	9.3	-0.2	241	165
16597	MLT	Luqa	13.3	1.1	50	-39	12.3	-0.1	52	-9	15.1	1.7	16	-25
16716	GRC	Athens	10.6	1.3	81	37	11.7	1.9	190	142	13.8	2.1	12	-30
17040	TUR	Rize	8.0	1.7	212	-11	9.1	2.5	116	-55	10.3	2.4	201	55
17062	TUR	Istanbul	7.6	2.0	84	-15	9.0	3.1	54	-13	10.9	3.4	48	-14
17170	TUR	Van	-1.3	3.1	65	31	0.1	3.9	40	7	3.7	2.8	39	-3
17300	TUR	Antalya	11.7	1.8	353	114	13.2	2.9	130	-66	14.6	1.9	17	-86
17609	CYP	Larnaca	12.2	0.7	49	-16	13.7	2.0	35	-22	15.2	1.9	9	-40
22113	RUS	Murmansk	-6.5	5.2	48	15	-7.6	3.6	23	1	-9.6	-2.8	48	28
26038	EST	Tallinn	-4.4	1.1	44	-1	-2.4	3.3	38	9	-5.9	-3.7	12	-17
26406	LVA	Liepaja	-4.4	-1.4	53	7	-0.8	2.2	32	1	-3.1	-2.9	5	-31
26730	LTU	Vilnius	-7.0	-0.9	47	6	-1.8	3.0	41	3	-4.8	-4.2	15	-24
26850	BLR	Minsk	-7.3	-0.4	49	9	-2.0	3.8	44	10	-4.9	-3.5	51	9
27612	RUS	Moscow	-8.5	0.8	45	0	-3.5	4.2	39	2	-6.6	-4.4	77	43
33345	UKR	Kiev	-4.3	1.3	56	9	-0.6	3.6	78	32	-1.7	-2.4	113	74
33815	MDA	Kishinev	-1.9	1.4	53	13	1.3	3.0	26	-12	2.5	-0.4	24	-11
35300	UKR	Kharkiv	-3.3	3.6	52	8	-1.3	4.4	19	-13	-0.8	-0.5	70	43
34880	RUS	Astrachan	-2.4	3.0	19	6	-0.1	4.8	3	-7	4.0	2.7	26	12
35108	KAZ	Uralsk	-11.4	1.5	37	12	-9.9	2.6	22	4	-2.3	2.7	47	27
37545	GEO	Tbilisi (Tiflis)	3.2	1.5	30	11	6.4	3.5	17	-9	8.1	1.2	9	-21
37789	ARM	Yerevan	-1.2	2.3	35	14	3.1	4.1	33	9	8.0	2.2	31	-1
40080	SYR	Damascus	7.2	1.3	43	14	10.7	2.8	5	-19	13.9	2.9	<1	-17
40103	LBN	Tripoli	12.2	-0.5	212	18	14.3	1.1	81	-46	16.1	1.4	34	-82
40180	ISR	Tel Aviv	13.2	0.9	208	59	15.6	2.7	0	-98	18.8	3.9	0	-62
40199	ISR	Eilat	16.7	1.5	2	-3	18.9	2.0	16	11	22.6	2.6	0	-4
40265	JOR	Mafraq	8.4	1.2	77	43	10.9	2.2	6	-25	14.3	2.8	2	-27
60030	ESP	Las Palmas /Gran Canary	18.6	1.1	1	-16	18.4	0.8	8	-14	19.7	1.3	17	7

Table 5.2: continued

WMO-No.	Country	Station name	April				May				June			
			Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
			mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
01001	NOR	Jan Mayen	-4.2	-0.3	26	-15	0.8	1.5	61	21	4.4	2.6	43	7
01008	NOR	Svalbard Airport	-9.3	2.4	9	-3	-1.5	2.2	19	13	4.4	2.2	21	11
01025	NOR	Tromso	1.0	1.2	50	-10	8.7	1.2	15	-33	11.7	1.2	49	-4
01492	NOR	Oslo	4.3	-0.3	41	-1	12.8	2.0	90	38	15.0	-0.2	126	61
02196	SWE	Haparanda	-0.3	0.2	47	18	10.2	4.1	30	-1	15.2	2.4	87	46
02485	SWE	Stockholm	4.9	0.3	27	-3	13.2	2.5	17	-13	16.5	0.9	47	2
02836	FIN	Sodankylä	-0.9	1.2	33	9	9.5	4.5	21	-14	14.2	2.6	110	54
02974	FIN	Helsinki	2.7	-0.2	34	-3	13.5	3.6	20	-15	18.1	3.2	32	-12
03091	GBR	Aberdeen	6.3	0.0	27	-26	9.6	0.6	48	-11	12.6	0.5	31	-22
03772	GBR	London	9.0	0.1	34	-11	12.1	-0.4	42	-9	15.7	0.0	12	-39
03967	IRL	Dublin Casement Aerodrome	6.9	-0.9	48	1	10.1	-0.4	53	-5	13.5	0.2	43	-5
04030	ISL	Reykjavik	1.9	-1.0	42	-16	5.8	-0.5	45	1	9.9	0.9	66	16
04320	GRL	Danmarkshavn	-16.9	0.4	0	9	-6.7	-0.1	9	4	1.7	1.0	7	1
06186	DNK	Copenhagen	7.0	0.4	20	-22	13.7	1.7	42	-1	16.3	0.2	48	-6
06260	NLD	De Bilt	8.1	0.1	23	-29	11.5	-0.8	87	26	15.3	0.1	50	-18
06447	BEL	Brussels	9.0	0.2	26	-31	11.1	-1.8	133	62	15.8	0.1	55	-24
06590	LUX	Luxembourg	8.4	0.9	59	-2	10.6	-1.2	165	84	15.9	1.0	113	31
06660	CHE	Zurich	8.8	1.0	106	19	10.9	-1.2	181	78	16.1	0.9	96	-28
06700	CHE	Geneva	10.3	1.5	107	42	11.5	-1.5	113	36	17.0	0.5	55	-34
07510	FRA	Bordeaux	12.1	0.8	57	-15	12.9	-1.7	88	11	17.3	-0.5	132	76
07650	FRA	Marseilles	13.4	0.2	62	14	15.8	-1.3	67	25	21.2	0.3	11	-17
08222	ESP	Madrid	12.8	0.6	53	-1	14.9	-1.1	28	-13	21.3	0.6	6	-20
08314	ESP	Mahon/Menorca	14.6	1.3	84	34	16.1	-0.7	30	-7	20.7	-0.1	4	-10
08495	GBR	Gibraltar	16.7	0.5	68	8	18.3	-0.2	9	-26	20.5	-0.6	1	-10
08515	PRT	Santa Maria/ Azores	15.7	0.5	42	-13	16.3	-0.4	53	23	18.7	0.0	8	-14
08535	PRT	Lisbon	15.4	0.3	43	-21	16.8	-0.6	16	-23	20.5	0.3	6	-15
10384	DEU	Berlin-Tempelhof	9.4	0.8	21	-20	14.4	0.5	79	23	17.9	0.5	65	-10
11035	AUT	Vienna	11.7	1.8	14	-37	15.0	0.4	130	69	18.6	0.7	145	71
11518	CZE	Prague	8.7	1.0	23	-15	11.9	-0.8	130	53	16.0	0.1	141	68
11903	SVK	Sliac	10.6	2.1	30	-17	14.9	1.2	156	92	18.8	2.2	103	18
12375	POL	Warsaw	8.0	0.2	48	16	15.5	2.1	133	74	18.6	2.0	85	13
12843	HUN	Budapest	12.9	1.8	29	-9	16.8	0.8	67	12	20.4	1.3	36	-27
13274	SRB	Belgrade	14.8	2.4	21	-38	19.0	1.8	104	33	21.1	1.0	50	-40
14015	SVN	Ljubljana	12.4	2.5	91	-18	14.7	0.1	217	95	19.8	2.0	105	-50
14445	HRV	Split	16.6	2.7	64	-2	18.9	0.5	74	18	23.4	1.2	54	3
14654	BIH	Sarajevo	12.2	2.8	64	-10	15.1	1.0	136	54	18.0	1.1	64	-27
15420	ROU	Bucureşti	13.4	2.1	33	-13	18.7	2.0	73	3	21.5	1.3	107	30
15614	BGR	Sofia	12.3	2.4	33	-17	17.6	3.3	32	-41	18.7	1.0	132	60
16158	ITA	Pisa	13.7	1.2	89	10	15.7	-0.6	61	2	19.4	-0.4	16	-28
16597	MLT	Luqa	17.7	2.2	19	-4	20.5	1.4	1	-6	23.4	0.4	<1	-3
16716	GRC	Athens	17.8	2.4	2	-27	22.9	2.8	6	-12	25.5	0.9	9	-1
17040	TUR	Rize	12.7	1.1	44	-58	18.7	2.9	17	-84	21.8	1.9	67	-58
17062	TUR	Istanbul	14.2	2.2	21	-28	20.4	3.9	16	-15	23.4	2.3	37	16
17170	TUR	Van	9.5	2.2	36	-18	13.6	0.8	49	-1	18.5	0.9	8	-13
17300	TUR	Antalya	18.4	2.3	67	21	22.9	2.6	56	28	25.6	0.6	<1	-8
17609	CYP	Larnaca	18.7	1.3	11	0	23.0	2.1	3	-4	26.0	1.7	0	-1
22113	RUS	Murmansk	0.4	2.3	30	9	8.0	4.2	10	-22	13.9	4.5	34	-19
26038	EST	Tallinn	3.1	-0.3	33	-3	11.7	2.0	22	-15	16.9	2.4	40	-13
26406	LVA	Liepaja	4.3	-0.3	39	4	13.5	3.2	40	0	16.4	2.1	42	-4
26730	LTU	Vilnius	5.5	-0.2	57	11	16.2	3.7	59	-3	18.3	2.5	64	-13
26850	BLR	Minsk	6.6	0.6	31	-11	16.6	3.7	88	26	19.3	3.2	67	-16
27612	RUS	Moscow	6.1	0.3	64	24	16.9	4.0	92	34	19.8	3.2	49	-27
33345	UKR	Kiev	10.3	1.6	33	-16	18.9	3.8	40	-13	21.6	3.4	89	16
33815	MDA	Kishinev	12.5	2.3	27	-15	19.2	3.1	50	-1	21.2	1.8	70	-5
35300	UKR	Kharkiv	11.3	2.4	7	-29	20.4	4.8	42	-5	22.2	3.3	38	-20
34880	RUS	Astrachan	11.9	0.8	2	-16	21.1	2.8	5	-19	24.5	1.6	14	-8
35108	KAZ	Uralsk	10.3	2.6	8	-11	19.2	3.1	9	-12	22.1	1.9	42	5
37545	GEO	Tbilisi (Tiflis)	13.8	1.0	3	-48	19.1	1.7	110	32	22.7	1.5	97	21
37789	ARM	Yerevan	14.0	1.3	37	0	17.4	-0.1	101	58	22.1	0.2	15	-6
40080	SYR	Damascus	16.4	0.9	0	-11	23.4	3.2	1	-3	25.7	1.3	0	0
40103	LBN	Tripoli	17.8	0.3	69	13	22.4	2.5	35	18	24.9	1.6	0	-1
40180	ISR	Tel Aviv	20.3	2.1	39	16	23.6	2.5	<1	-3	26.1	2.1	0	0
40199	ISR	Eilat	25.2	1.0	0	-4	31.0	2.6	<1	<1	32.8	1.1	0	0
40265	JOR	Mafraq	16.4	0.6	0	-10	22.0	2.2	2	-1	23.8	1.1	0	0
60030	ESP	Las Palmas/ Gran Canary	20.9	2.2	<1	-6	21.0	1.1	3	1	22.2	0.8	<1	<1

Table 5.2: continued

WMO-No.	Country	Station name	July				August				September			
			Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
			mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
01001	NOR	Jan Mayen	5.4	1.2	54	7	5.9	0.9	74	13	5.3	2.4	81	-1
01008	NOR	Svalbard Airport	7.4	1.4	43	30	7.2	2.4	59	34	3.7	3.2	33	10
01025	NOR	Tromso	11.8	1.2	123	51	11.9	1.2	93	11	9.7	1.2	27	-67
01492	NOR	Oslo	18.4	2.0	27	-57	16.3	1.1	116	26	12.0	1.2	38	-52
02196	SWE	Haparanda	15.3	-0.2	65	15	14.8	1.5	19	-44	10.8	2.9	33	-30
02485	SWE	Stockholm	18.4	1.2	43	-29	17.9	1.7	55	-11	13.0	1.8	39	-16
02836	FIN	Sodankylä	14.6	0.5	35	-30	13.9	2.7	42	-21	9.1	3.2	21	-34
02974	FIN	Helsinki	18.3	1.7	22	-51	17.3	2.3	91	11	11.9	1.9	32	-41
03091	GBR	Aberdeen	16.3	2.5	85	25	15.4	1.8	63	-12	12.7	1.0	35	-33
03772	GBR	London	21.1	3.3	25	-21	19.3	1.9	33	-18	15.4	0.4	50	-1
03967	IRL	Dublin Casement Aerodrome	17.8	2.9	43	-11	15.9	1.3	63	-15	13.2	0.2	35	-34
04030	ISL	Reykjavik	10.9	0.3	72	20	10.1	-0.2	86	24	7.1	-0.3	90	24
04320	GRL	Danmarkshavn	4.9	1.2	15	0	3.4	1.0	34	19	-0.3	3.9	119	108
06186	DNK	Copenhagen	19.3	2.1	17	-52	18.4	1.4	34	-29	13.9	0.3	57	-5
06260	NLD	De Bilt	19.2	2.4	40	-35	18.1	1.4	27	-44	14.4	0.4	114	47
06447	BEL	Brussels	20.2	2.7	66	-9	18.6	1.3	48	-15	14.8	0.3	58	-1
06590	LUX	Luxembourg	20.6	3.7	65	-3	18.3	1.9	47	-25	14.0	0.6	89	19
06660	CHE	Zurich	20.7	3.1	82	-35	18.7	2.0	69	-64	14.7	0.9	106	14
06700	CHE	Geneva	21.5	2.4	126	59	20.0	1.8	36	-43	15.9	1.0	70	-11
07510	FRA	Bordeaux	24.2	4.0	83	36	20.9	1.0	37	-17	18.5	0.6	95	21
07650	FRA	Marseilles	25.7	1.9	46	32	24.6	1.4	6	-23	20.9	0.6	48	1
08222	ESP	Madrid	27.2	2.8	4	-9	26.7	2.8	<1	-9	22.4	1.9	23	-7
08314	ESP	Mahon/Menorca	25.4	1.2	<1	-4	25.5	1.0	12	-14	22.6	0.4	31	-23
08495	GBR	Gibraltar	24.2	0.5	0	-1	24.6	0.4	0	-6	23.6	0.8	27	12
08515	PRT	Santa Maria/Azores	20.7	-0.1	18	-7	22.2	0.0	4	-36	21.3	-0.1	42	-15
08535	PRT	Lisbon	23.1	0.7	0	-5	24.0	1.2	0	-6	22.1	0.4	52	26
10384	DEU	Berlin-Tempelhof	21.4	2.6	36	-16	19.7	1.3	51	-10	13.6	-1.0	75	30
11035	AUT	Vienna	22.9	3.2	11	-52	21.3	2.4	60	2	15.1	0.0	92	47
11518	CZE	Prague	19.9	2.4	50	-16	18.0	1.0	145	75	12.6	-0.7	34	-6
11903	SVK	Sliac	20.7	2.5	13	-46	21.0	3.7	101	32	13.1	-0.3	49	-7
12375	POL	Warsaw	20.1	2.2	20	-47	19.7	2.4	60	-3	12.4	-0.8	92	49
12843	HUN	Budapest	23.9	3.0	2	-50	23.5	3.2	54	3	15.3	-1.1	31	-9
13274	SRB	Belgrade	24.1	2.4	3	-63	25.1	3.8	40	-12	17.3	-0.4	59	8
14015	SVN	Ljubljana	23.5	3.6	22	-100	22.5	3.4	105	-39	16.2	0.7	217	87
14445	HRV	Split	27.6	2.2	<1	-28	27.6	2.4	6	-44	22.0	0.6	70	9
14654	BIH	Sarajevo	20.3	1.4	27	-52	21.5	3.0	38	-33	15.3	0.2	77	7
15420	ROU	Bucureşti	22.7	0.7	15	-49	23.5	2.3	22	-36	16.2	-0.7	123	81
15614	BGR	Sofia	20.8	0.8	60	4	22.8	3.4	13	-39	16.2	0.4	21	-18
16158	ITA	Pisa	24.2	1.4	4	-19	24.3	1.8	10	-47	20.7	1.2	96	7
16597	MLT	Luqa	26.6	0.7	0	0	27.5	1.2	26	19	25.2	1.1	32	-8
16716	GRC	Athens	28.3	1.3	0	-3	28.7	2.0	0	-4	24.6	1.3	0	-12
17040	TUR	Rize	23.2	1.0	168	34	24.2	2.0	58	-128	20.0	0.6	386	163
17062	TUR	Istanbul	25.3	2.1	3	-16	26.4	3.4	<1	-26	21.8	2.1	14	-27
17170	TUR	Van	23.1	1.2	0	-4	21.8	0.6	0	-4	17.4	0.6	9	-1
17300	TUR	Antalya	28.7	0.6	0	-3	29.7	2.0	0	-1	26.1	1.6	30	19
17609	CYP	Larnaca	27.8	0.9	<1	<1	28.7	1.6	<1	<1	25.7	0.6	3	3
22113	RUS	Murmansk	14.7	1.9	68	8	14.3	3.3	42	-23	9.6	2.9	35	-17
26038	EST	Tallinn	17.6	1.3	22	-57	16.7	1.4	121	37	12.1	1.3	25	-57
26406	LVA	Liepaja	17.5	1.1	84	10	18.0	1.6	44	-36	13.1	0.2	127	49
26730	LTU	Vilnius	18.0	1.1	110	32	17.5	1.2	61	-11	11.9	0.3	68	3
26850	BLR	Minsk	18.6	1.3	94	6	18.1	1.6	19	-53	11.8	0.1	47	-13
27612	RUS	Moscow	18.9	0.8	118	26	18.3	1.9	78	4	10.3	-0.6	183	119
33345	UKR	Kiev	20.8	1.5	18	-70	19.9	1.3	51	-18	12.4	-1.5	211	164
33815	MDA	Kishinev	21.7	0.8	102	33	22.6	2.1	44	-1	14.4	-1.8	88	40
35300	UKR	Kharkiv	21.2	0.9	81	21	21.1	1.6	50	0	12.3	-1.8	121	80
34880	RUS	Astrachan	25.6	0.3	46	23	23.9	0.6	14	-5	17.1	-0.2	65	39
35108	KAZ	Uralsk	23.0	0.5	26	-12	21.9	1.5	29	4	14.6	0.5	71	44
37545	GEO	Tbilisi (Tiflis)	24.1	-0.3	73	28	23.6	-0.1	46	-2	19.7	0.1	18	-18
37789	ARM	Yerevan	25.2	-0.8	12	2	24.5	-0.7	5	-2	21.1	0.4	7	-3
40080	SYR	Damascus	27.1	0.8	0	0	27.9	1.9	0	0	24.2	1.0	0	-1
40103	LBN	Tripoli	26.9	1.9	0	0	27.7	2.1	0	-1	25.8	1.0	66	62
40180	ISR	Tel Aviv	27.0	1.3	0	0	28.0	1.9	0	0	26.4	1.6	<1	<1
40199	ISR	Eilat	33.2	0.3	0	0	33.9	1.1	0	0	31.3	0.9	0	0
40265	JOR	Mafraq	24.9	0.8	0	0	25.5	1.3	0	0	23.3	0.6	0	-1
60030	ESP	Las Palmas/ Gran Canary	24.1	0.8	0	0	26.4	2.3	1	1	24.5	0.7	6	-2

Table 5.2: continued

WMO-No.	Country	Station name	October				November				December			
			Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
			mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
01001	NOR	Jan Mayen	0.7	0.6	32	-51	-5.0	-1.8	60	-6	-1.9	3.3	51	-14
01008	NOR	Svalbard Airport	-4.7	0.8	14	-1	-8.0	2.5	8	-5	-8.1	5.2	11	-1
01025	NOR	Tromso	3.0	1.2	131	6	-0.2	1.2	153	49	-0.5	1.2	107	3
01492	NOR	Oslo	7.5	1.1	94	10	2.4	1.7	50	-25	2.0	4.8	108	52
02196	SWE	Haparanda	2.8	0.3	59	-5	-2.1	2.0	48	-10	-3.2	6.3	95	53
02485	SWE	Stockholm	8.7	1.2	54	4	4.3	1.7	60	7	3.4	4.4	51	5
02836	FIN	Sodankylä	0.4	0.7	63	12	-5.9	1.5	41	2	-8.2	4.9	51	20
02974	FIN	Helsinki	6.6	1.2	79	6	3.4	3.3	114	42	1.3	5.4	62	4
03091	GBR	Aberdeen	10.5	0.6	94	17	5.7	0.7	67	-8	6.2	2.7	70	-3
03772	GBR	London	13.9	2.2	50	-8	7.8	0.6	50	-5	7.1	2.0	98	41
03967	IRL	Dublin Casement Aerodrome	11.8	1.5	97	29	6.2	-0.5	21	-49	6.8	1.5	78	1
04030	ISL	Reykjavik	4.2	-0.2	19	-67	2.2	1.1	93	21	-0.5	-0.3	62	-17
04320	GRL	Danmarkshavn	-12.8	0.8	4	-8	-19.1	0.8	4	-8	-17.2	4.6	36	21
06186	DNK	Copenhagen	11.7	1.8	87	28	6.6	1.1	61	-1	5.3	3.1	65	7
06260	NLD	De Bilt	12.2	1.7	161	89	6.7	0.8	115	34	5.9	2.7	67	-13
06447	BEL	Brussels	12.8	1.9	78	8	6.4	0.3	103	27	6.1	2.6	77	1
06590	LUX	Luxembourg	11.1	2.0	151	76	4.4	0.6	100	17	3.4	2.4	57	-23
06660	CHE	Zurich	11.3	2.0	113	44	4.0	0.1	124	42	1.7	1.1	34	-39
06700	CHE	Geneva	12.8	2.7	140	63	5.9	0.9	108	16	1.5	-0.3	101	14
07510	FRA	Bordeaux	15.9	1.9	87	-1	9.1	0.0	116	22	6.5	0.1	69	-30
07650	FRA	Marseilles	18.6	2.5	59	-19	10.3	-0.4	52	-6	8.5	1.2	87	31
08222	ESP	Madrid	16.4	1.6	43	-2	9.2	-0.2	14	-50	6.3	-0.1	53	2
08314	ESP	Mahon/Menorca	21.5	3.0	24	-60	14.0	-0.4	192	115	12.0	0.2	65	-9
08495	GBR	Gibraltar	21.3	1.8	28	-36	16.1	0.0	14	-127	14.0	-0.1	72	-74
08515	PRT	Santa Maria/Azores	19.9	0.6	47	-37	17.6	0.2	64	-38	16.2	0.8	181	86
08535	PRT	Lisbon	18.9	0.4	240	160	13.9	-0.6	17	-97	11.7	-0.1	83	-25
10384	DEU	Berlin-Tempelhof	11.5	1.5	64	28	5.6	0.7	54	5	4.5	3.1	43	-10
11035	AUT	Vienna	11.0	1.1	27	-14	6.4	1.8	42	-8	3.2	2.3	18	-25
11518	CZE	Prague	9.2	0.9	38	8	4.2	1.4	29	-3	1.3	1.9	3	-23
11903	SVK	Sliac	10.7	2.4	30	-20	5.8	2.8	81	12	0.2	1.9	23	-34
12375	POL	Warsaw	10.4	2.1	30	-8	5.6	2.4	28	-14	2.4	3.3	19	-13
12843	HUN	Budapest	13.2	2.3	23	-11	7.7	2.9	51	-1	2.2	1.8	3	-37
13274	SRB	Belgrade	15.2	2.8	52	12	9.8	2.8	40	-14	3.0	0.7	8	-50
14015	SVN	Ljubljana	13.2	2.8	37	-78	7.3	2.7	208	73	2.8	2.8	61	-40
14445	HRV	Split	18.2	1.3	136	57	14.1	1.9	138	30	11.0	2.3	62	-38
14654	BIH	Sarajevo	12.7	2.3	57	-31	7.3	2.5	113	22	0.6	0.8	6	-58
15420	ROU	Bucureşti	10.7	-0.1	33	1	7.9	2.7	32	-17	-0.4	-0.6	<1	-43
15614	BGR	Sofia	11.6	1.2	41	4	7.1	2.1	31	-16	0.3	-0.2	5	-34
16158	ITA	Pisa	17.7	2.4	97	-23	12.2	1.8	75	-49	7.1	0.3	25	-60
16597	MLT	Luqa	23.5	2.8	21	-69	17.5	0.5	182	102	14.1	0.3	80	-32
16716	GRC	Athens	19.0	0.7	23	-27	15.9	1.4	121	70	10.3	-0.9	60	-6
17040	TUR	Rize	13.3	-2.1	242	-31	13.3	1.7	160	-90	5.5	-2.8	244	6
17062	TUR	Istanbul	15.1	-0.2	78	7	13.7	2.1	34	-55	7.0	-1.1	60	-62
17170	TUR	Van	9.9	-0.2	21	-27	6.5	2.5	36	-8	-3.7	-2.6	34	0
17300	TUR	Antalya	20.4	0.8	162	92	16.2	1.4	74	-60	11.5	0.1	62	-165
17609	CYP	Larnaca	21.3	0.0	2	-17	19.4	3.0	1	-43	12.7	-0.5	46	-30
22113	RUS	Murmansk	1.1	0.1	92	50	-3.4	1.7	31	-9	-5.8	3.5	42	4
26038	EST	Tallinn	7.5	1.2	69	-1	4.5	3.3	80	12	2.3	5.2	68	13
26406	LVA	Liepaja	9.6	1.1	36	-38	6.6	2.9	75	-8	4.2	4.5	29	-38
26730	LTU	Vilnius	8.0	1.4	40	-13	4.4	3.2	68	11	0.9	3.8	45	-10
26850	BLR	Minsk	7.9	1.6	28	-21	4.6	3.8	105	53	0.0	3.8	40	-13
27612	RUS	Moscow	6.6	1.6	30	-28	4.0	5.1	62	4	-1.7	4.4	54	2
33345	UKR	Kiev	9.7	1.6	15	-20	6.4	4.3	83	32	-0.2	2.1	17	-35
33815	MDA	Kishinev	11.0	0.9	9	-18	8.5	4.1	30	-9	0.0	0.3	8	-30
35300	UKR	Kharkiv	8.0	0.7	48	13	5.2	3.9	15	-29	-1.8	1.6	14	-31
34880	RUS	Astrachan	9.9	0.8	12	-5	5.9	2.6	8	-11	-1.5	0.4	19	4
35108	KAZ	Uralsk	6.8	1.7	36	6	3.0	5.1	15	-20	-4.6	3.8	21	-8
37545	GEO	Tbilisi (Tiflis)	13.2	-0.3	40	2	10.3	2.2	25	-5	1.6	-2.2	5	-16
37789	ARM	Yerevan	13.1	-0.1	13	-14	9.1	2.6	12	-10	-6.8	-7.0	13	-10
40080	SYR	Damascus	17.3	-0.8	6	-6	14.3	2.5	20	-2	6.2	-1.0	64	38
40103	LBN	Tripoli	20.5	-1.7	21	-50	19.2	0.9	0	-113	12.0	-2.1	160	-20
40180	ISR	Tel Aviv	22.9	0.9	4	-22	21.4	3.4	<1	-68	14.1	0.3	140	2
40199	ISR	Eilat	26.1	-0.6	0	-4	23.5	2.0	0	-3	16.6	0.0	<1	-6
40265	JOR	Mafraq	18.2	-0.9	3	-4	15.9	2.4	24	7	7.9	-0.9	40	12
60030	ESP	Las Palmas/ Gran Canary	23.6	1.1	2	-8	21.3	0.9	13	-8	19.8	1.5	20	-1

6 References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2013 edition of the Bulletin, are listed on page 3 above. Many contributions or also additional information may as well be found on the web, see below.

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8 Abbreviations

AO	Arctic Oscillation (circulation indices)
BAMS	Bulletin of the American Meteorological Society
CLIMAT	monthly climatological data provided by the NMHSs via GTS
DMCSEE	Southeast Drought Management Centre
DWD	Deutscher Wetterdienst (German Meteorological Service)
EA	East Atlantic Pattern (circulation indices)
EA/WR	East Atlantic/West Russia Pattern (circulation indices)
ECA&D	European Climate Assessment & Dataset, located at Royal Netherlands Meteorological Institute (KNMI)
EMCC	Eastern Mediterranean Climate Centre
E-OBS	daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D information
GCC	Global Collection Centre run by Deutscher Wetterdienst
GPCC	Global Precipitation Climatology Centre located at Deutscher Wetterdienst
GTS	Global Telecommunication System
NAO	North Atlantic Oscillation (circulation indices)
NMHSs	national hydro-meteorological services
POL	Polar/Eurasia Pattern (circulation indices)
RCC-CM	WMO Regional Climate Centre Network (RA VI) Offenbach Node on Climate Monitoring
SCA	Scandinavia Pattern (circulation indices)
SCE	Annual snow cover extent
SYNOP	surface synoptic or weather observations provided by the NMHSs via GTS
WCDMP	World Climate Data and Monitoring Programme
WMO RA VI	WMO Regional Association VI (Europe and Middle East)
WMO	World Meteorological Organization

WMO RA VI
RCC Network

DWD

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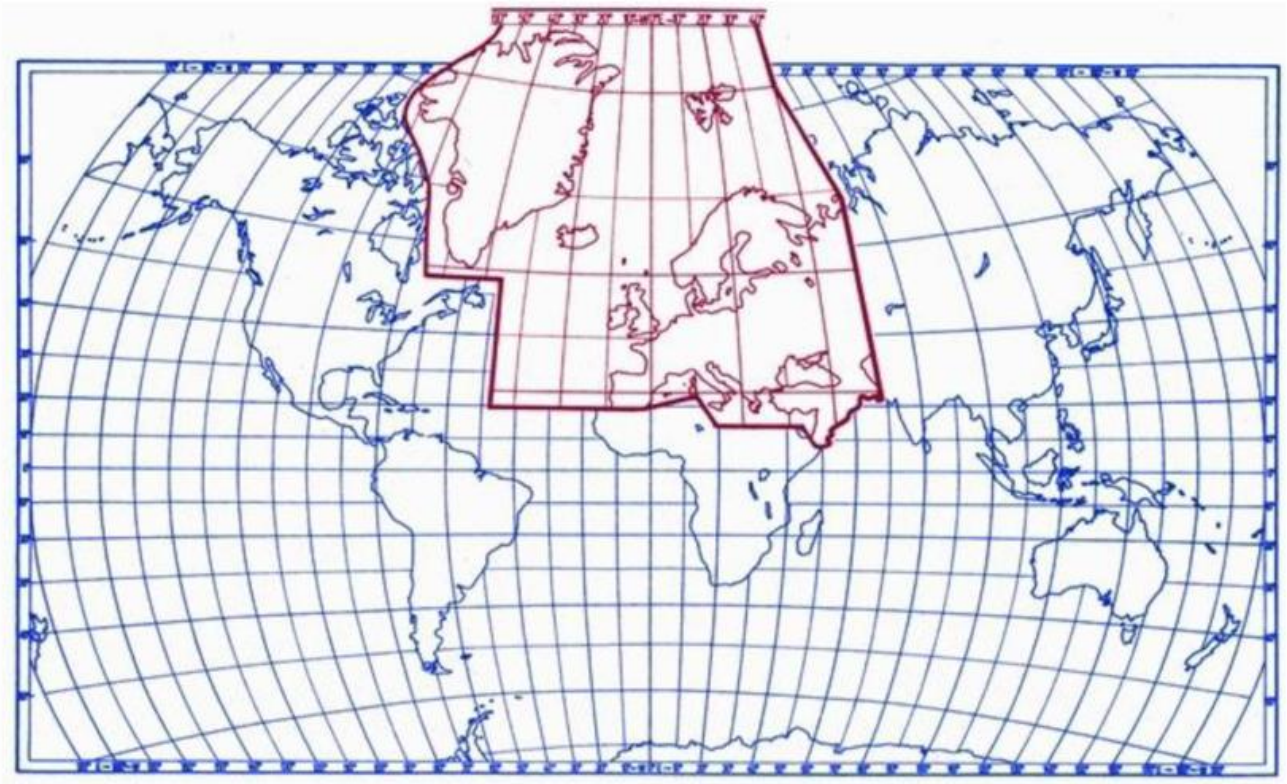

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Turkey
Ukraine
United Kingdom

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1. Introduction

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East with 52 individual countries) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official Websites. Supported by the European Climate Support Network (ECSN) and WMO´s World Climate Data and Monitoring Programme (WCDMP) the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's Annual Statement on the Status of the Climate and the State of the Climate Article published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ amongst the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the Webpages of the RA VI RCC Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

This annual bulletin includes 4 parts: the annual, seasonal and monthly survey of the climate state in 2014 as well as contributions of the NMHSs to the long-term variability of selected parameters up to 2014 (section 5).

Notes:

Maps of the RA VI RCC Network are based on the following data sources:

- Temperature: CLIMAT data and ship observations provided by the Global Collection Centre (GCC), run by Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC), run by Deutscher Wetterdienst
- Sunshine: CLIMAT data.
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC-CD) via the European Climate Assessment & Dataset project (ECA&D) run by Royal Netherlands Meteorological Institute (KNMI)

Sub-regional monthly maps are provided by the Eastern Mediterranean Climate Centre (EMCC).

Box 1

Notable anomalies and events 2014

Anomalies

Temperature

- A record breaking year in many European countries (see **Table 2.1)**.
- This year was globally the warmest year on record, according to four independent surface temperature observational analyses.

Precipitation

- Record snow south of the Alps in January and February of up to 7 meters
- Long drought within the rainy season in Israel and Jordan.
- 12th-17th May extremely heavy precipitation over the Balkan (Croatia, Bosnia and Herzegovina, Slavonia, Serbia) with catastrophic floods.
- In September Italy was affected by frequent thunderstorms and heavy convective precipitation. The country reported a record-breaking monthly rainfall total of 479.3 mm along the Adriatic coast and on 3rd September a record-breaking daily total of 167.2 mm.

Sunshine Duration

- Sweden experienced its sunniest September on record, with 243 sunshine hours observed in southern and central Sweden.

Other Anomalies

- In January and February the western and northern coasts of the Iberian Peninsula were affected by strong winds and high swell waves of up to 15 m, on 9 February, caused by a storm whose core pressure was falling ~29 hPa in 24 hours.
- 12 winter storms form December 2013 until February 2014 over the North Atlantic affecting Western Europe (Ireland, the UK, northern Iberia and western France) with damages, heavy precipitation and flooding.
- Catastrophic flood over the Balkans in 12–20 May 2014. From the flood in the lower Sava river basin eastern Croatia, northern Bosnia and Serbia were affected.

Events:

- On 2nd March an intense dust storm occurred over the eastern Mediterranean Sea and was visible in satellite images.
- On 8th and 11th March Norway and Sweden were affected by two storms within a few days, with wind gusts of up to 49.6 m/s at station Tarfala (in Sweden on 8th March).
- Extreme precipitation and floods recorded in southern France during 16–20 and on the 29th September 2014 (Montpellier 299.5 mm/24 hours on the 29th).

The following sub-regions are used in this Bulletin:

Central and western Europe (14 countries): *Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, the Netherlands, Poland, Slovakia, Switzerland, United Kingdom*

Nordic and Baltic Countries (9 countries): *Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden*

Iberia (2 countries): *Portugal, Spain*

Mediterranean, Italian and Balkan Peninsula (12 countries): *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Slovenia, Turkey*

Eastern Europe (5 countries): *Belarus, European Russia, Moldova, Romania, Ukraine*

Middle East (9 countries): *Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, western Kazakhstan*

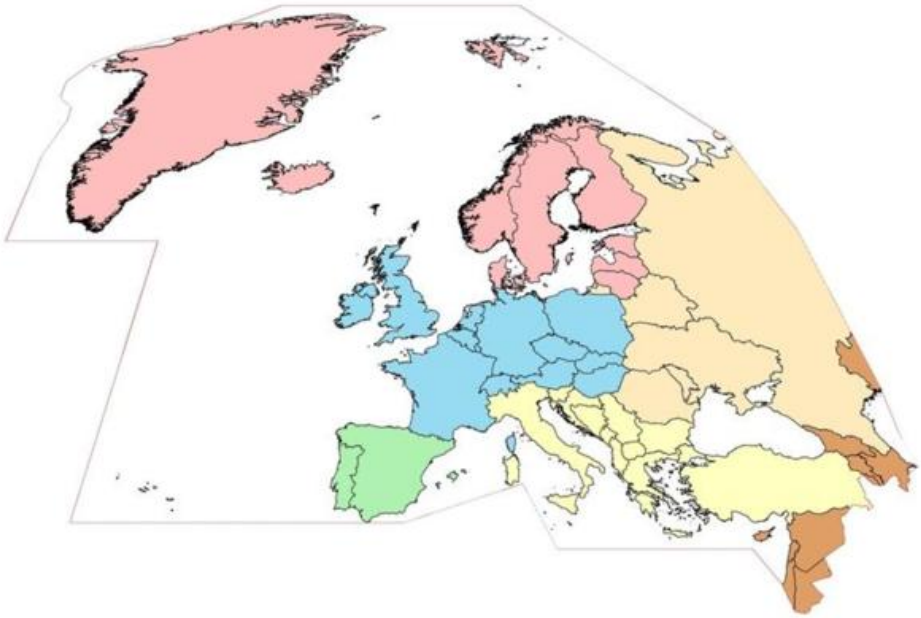


Figure 1.1: Definition of the 6 sub-regions used in this bulletin.

2. Annual survey

The climate of 2014 was characterised by a broad range of spatial and temporal anomalies outlined in Box 1 and Figure 2.5. This section presents an overview of the spatial patterns of mean annual climate conditions in 2014 and anomalies related mainly to the normal period 1961-1990 of the selected essential climate variables: sea surface pressure, surface temperature, precipitation, sunshine duration and snow. Sub-section 2.1.4 reveals climate extremes for each participant country. Long-term trends in temperature and precipitation indices were offered in section 2.2.

More detailed insight into the long-term variability of the temperature and precipitation and also some other parameters from the individual participant countries are presented in the section 5.

2.1. Annual averages and anomalies of selected essential climate variables

2.1.1. Sea level pressure

Generally, long-term mean annual sea level pressure distribution over the Region VI is dominated by a low pressure trough in the polar area (with exception Greenland) with the Icelandic low centred near Iceland and by the subtropical high pressure belt extended from the centre over Azores (Azores high) across southern, western and central Europe to European Russia.

2014 the mean sea surface pressure differs in some extend from the long-term mean with a reduced pressure especially in a region from Greenland to the British Isles with anomalies of -2 to -6 hPa and higher values over northern Europe (of more than 2 hPa). This is visible in the anomaly field for 2014 in respect to the normal period 1961-1990 (Figure 2.1 right). The anomaly configuration resemble especially the unusually pressure distribution in autumn (for more details cf. section 3.1.1 and 4.1).

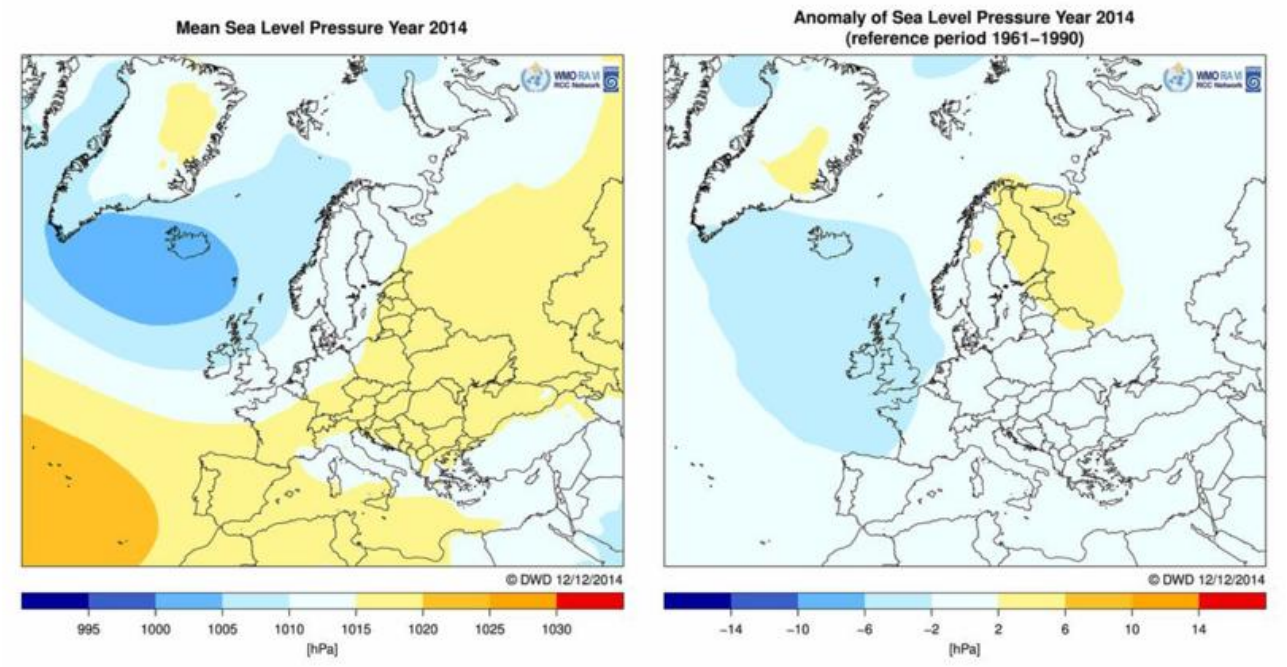


Figure 2.1: Annual mean of sea level pressure (left) and anomalies (right) for the year 2014 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm)

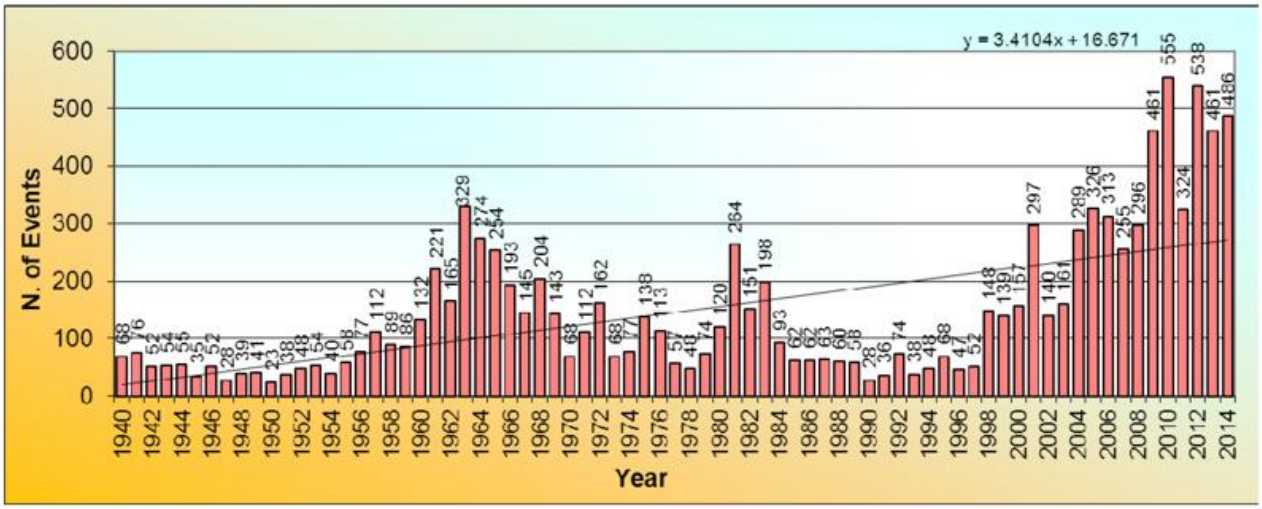


Figure 2.12: Annual count of extreme events occurred in Turkey from 1940 - 2014 (Diagram as provided by the NHMS).

The number of extreme events in 2014 has been reached to 486. (Figure 2.12). There is an increasing trend in extreme event (34events/decade).

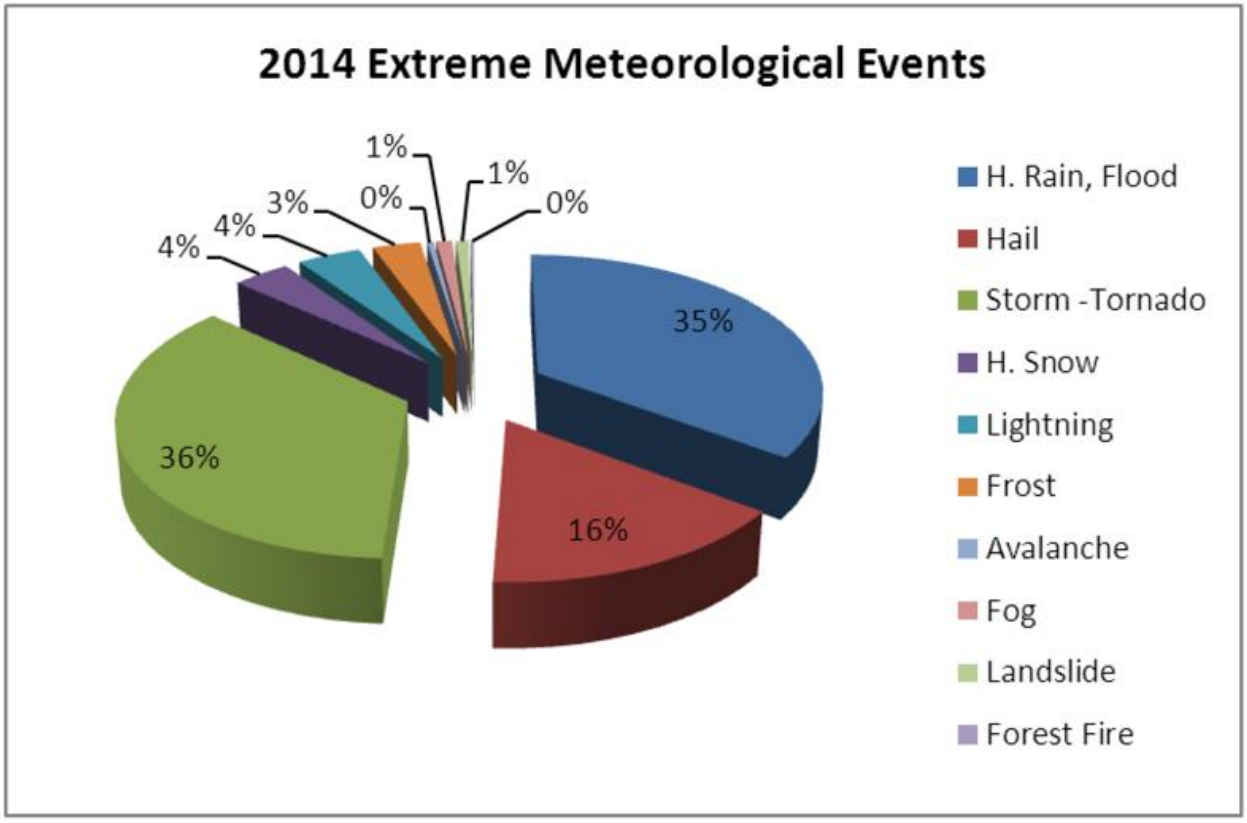


Figure 2.13: Distribution of extreme events occurred in Turkey in 2014.

During the year 2014 most hazardous extreme events in Turkey have been wind storm-tornado (36%), heavy rain/flood (35%), hail (16%), heavy snow and lightning (4%) and frost (3%) respectively (Figure 2.13). Although it's occurring rarely, 2 avalanches and 4 landslides also occurred in 2014.

2.1.2. Temperature

In the entire European region (35°–75°N, 10°W–30°E) the year 2014 was the warmest since 1950 with an anomaly of 0.9°C above the reference period 1981–2010 and of 1.46 related to 1961-1990. Many of the European countries reported new records (Table 2.1).

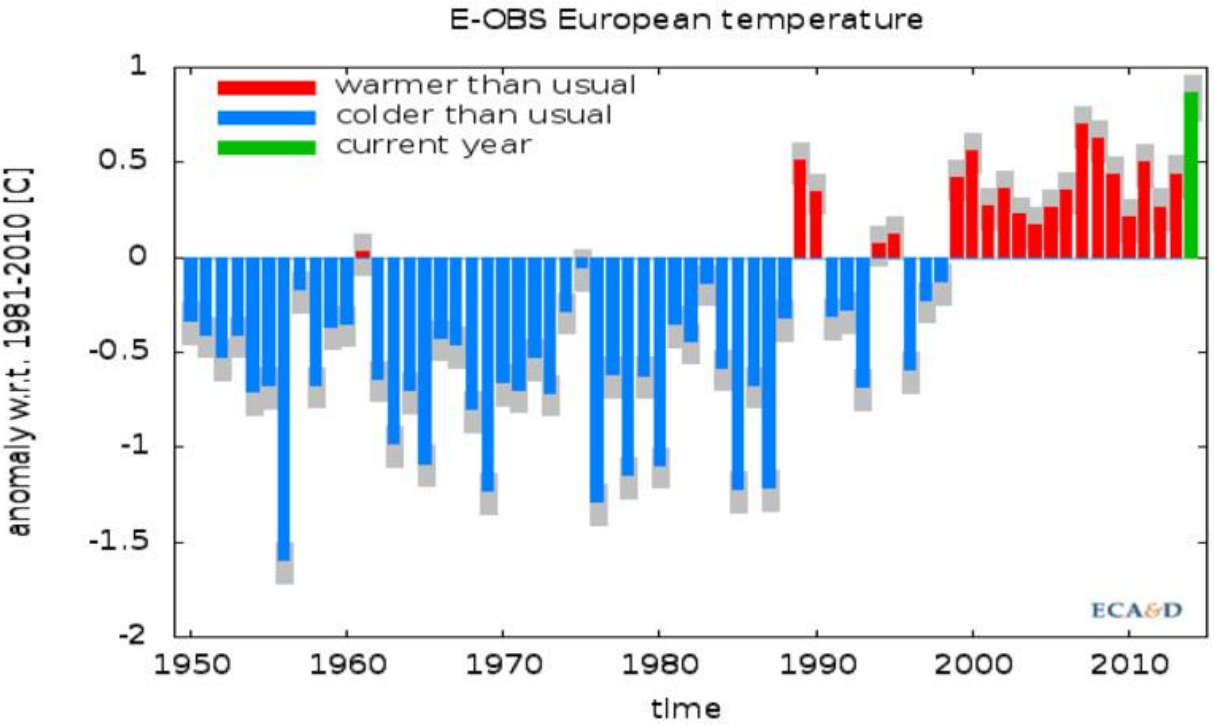


Figure 2.2: Annual temperature anomalies 1950-2014 for Europe (land area; 35°N - 75°N and 25°W - 45°E, reference period 1981–2010; source: www.ecad.eu, van der Schrier et al. 2013)

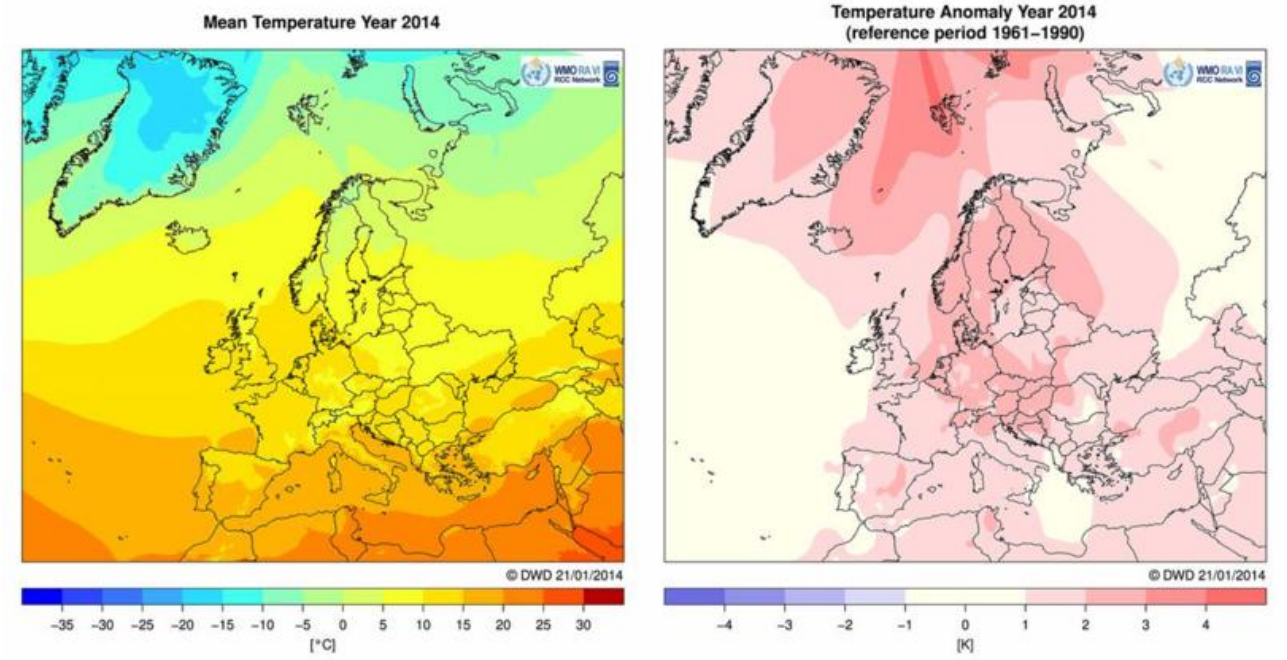


Figure 2.3: Mean annual temperature in °C (left) and anomalies (right) for 2014 (reference period 1961-1990. source: http://www.dwd.de/rcc-cm)

The highest annual anomaly of 2.09°C referred to 1961-1990 has been observed in the sub-region Nordic and Baltic countries followed by Central and western Europe (1.85°C) the Mediterranean,

Italian and Balkan and sub-region Eastern Europe (about 1.6°C). The sub-region Middle East showed the lowest anomalies of 1.26°C (Table 3.2). Nearly all months of the year were warmer than normal (1961-1990) with remarkably consistent deviations of +2 to +3°C especially in winter and spring across Central and Eastern Europe as well as Scandinavia (cf. section 3.1.2 and 4.2).

The global annual temperature average for 2014 increased also to a record high 0.57 ± 0.09 °C above the 1961–1990 average (WMO 2015, Blunden und Arndt 2015)

A summary of the annual temperature time series and the historical rating can be drawn from section 5. The rank statistics are listed together with the start of the time series and the anomaly for the year 2014 as provided by the as provided by the NHMS.

Table 2.1: Rank statistics and anomalies of annual temperature in 2014 from some participant countries as reported by National Meteorological and Hydrological Services (NMHSs).

Country	Rank of annual temperature in 2014	start of time series	Anomaly in °C	Reference period
Europe (35°–75°N, 10°W–30°E, E-OBS)	**1**	**1951**	**1.46**	**1961-1990**
Austria	1	1767	2.4	1961-1990
Belarus	3	1881	2	1961-1990
Belgium	1	1833	1.4	1981-2010
Bosnia and Herzegovina	~1		1.2-2.6	1961-1990
Croatia	1 (with 2000)	1862 (Zagreb and other stations)	1.1-2.5.	1961-1990
Cyprus	normal		0.8	1981-2010
Czech Republik	1	1961	1.9	1961-1990
Denmark	1	1874	2.3	1961-1990
Estonia	4	1961	1.9	1961-1990
Finland	2	1900	2.3	1961-1990
France	1	1900	1.2	1981-2010
Georgia	3	1961	1.5	1961-1990
Germany	1	1881	1.4	1981-2010
Hungary	1	1901	2.0	1961-1990
Iceland	1-3	1874	1.4-2.6	1961-1990
Ireland	2	1900	0.6	1961-1990
Israel	2	1951(average of 5 stations)	1.4	1961-1990
Italy	1	1961	1.6	1961-1990
Jordan			1.2	1961-1990
Latvia	6 (with 1934)	1924	1.7	1961-1990
Lithuania	6 (with 2007)	1961	1.7	1961–1990
Luxembourg	1	1947	2.5	1961–1990
Malta	3	1923		
Moldova	7	120	1.3	
Montenegro	1		1-3.7	1961-1990
Netherlands	1	1706 (de Bilt)/1901	1.6	1981-2010
Norway	1	1900	2.2	1961-1990
Poland	1	1950	1.7	1971-2000
Portugal	12	1931	0.5	1971-2000
Romania	6	1961	1.3	1961-1990
Serbia	2	1951		1961-1990
Slovakia	1	1901	2.5	1961-1990
Slovenia	1-2	1951	~2	1961-1990
Spain	2	1961	0.7	1981-2010
Sweden	1	1860		1961-1990
Switzerland	1	1864	2.1	1961-1990
Turkey	2	1971	1.4	1981-2010
United Kingdom	1	1910	1.6	1961-1990

2.1.3. Precipitation

The annual precipitation amount was close to normal over most of the continental Europe except for the Balkan region and parts of Italy, where significantly higher totals (>150% of normal) were recorded. Parts of northern and eastern Europe, eastern Spain, South Caucasus, and the Middle East showed drier conditions (totals <80%, locally <60% of normal). The annual figures of the year 2014 give only rough hints of the regions with outstanding precipitation events. Detailed descriptions such as the flood in Balkan in May 2014 can be found in the seasonal (3.1.3) and monthly survey (4.3).

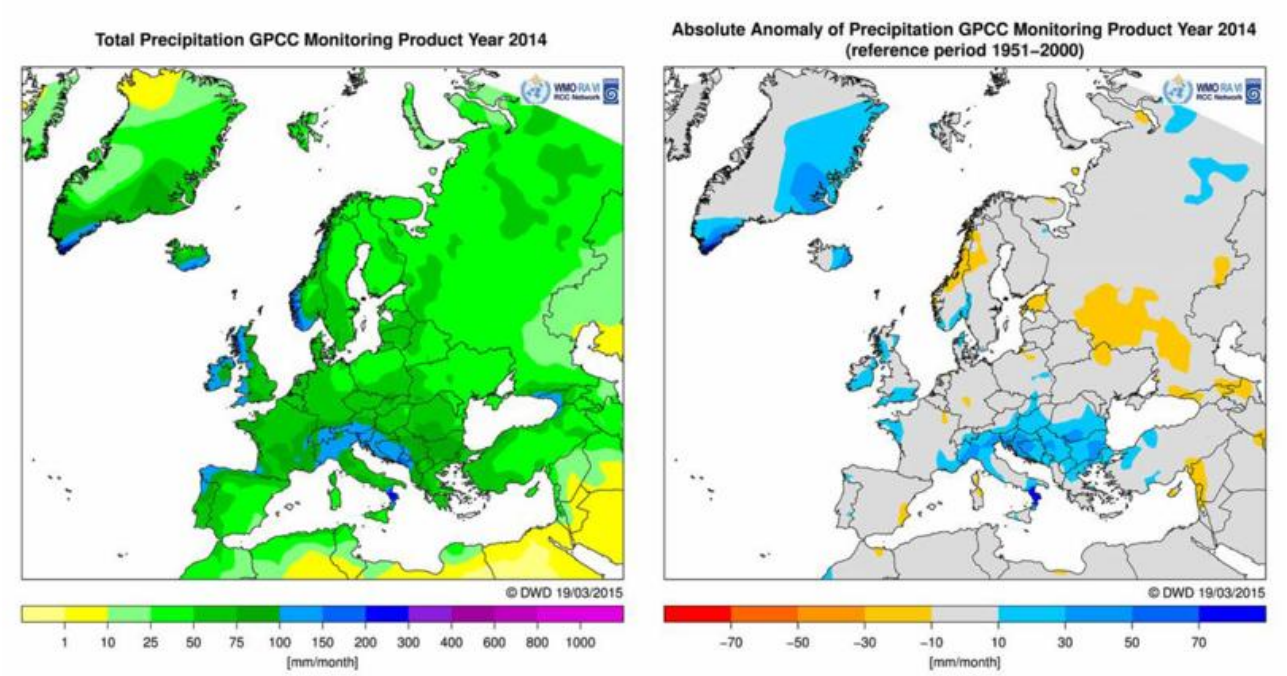


Figure 2.4: Total precipitation (left) and absolute anomalies (right) for 2014 in mm/month (reference period 1951-2000; source: http://www.dwd.de/rcc-cm)

2.1.4. Annual extreme values of temperature and precipitation

In this section an overview is given for the temperature spread and the extreme precipitation for each country. Absolute annual extreme values for 2014 of temperature (minimum and maximum), maximum of total daily precipitation and maximum of total 5 consecutive days with precipitation for each country in the WMO Region VI are given in Figure 2.5.

The spatial pattern of extreme temperature corresponds roughly to those of the temperature anomalies of 2014. The highest extremes (above 40°C) occurred primarily in sub-regions Middle East, Mediterranean, Italian, Balkan and Iberian Peninsula. Maximum temperature higher than 35°C are reported from most of the countries in central and western Europe, but also from some of Nordic and Baltic Countries. The one-day precipitation total (RX1) of more than 150 mm for individual countries documented in several sub-regions; the highest values occurred in France (299 mm/day) and Italy (330 mm/day). Highest total precipitation from 5 consecutive days (RX5) (above 300 mm) had been measured in Switzerland (476.6 mm), Italy (358 mm) followed by Austria (350 mm).

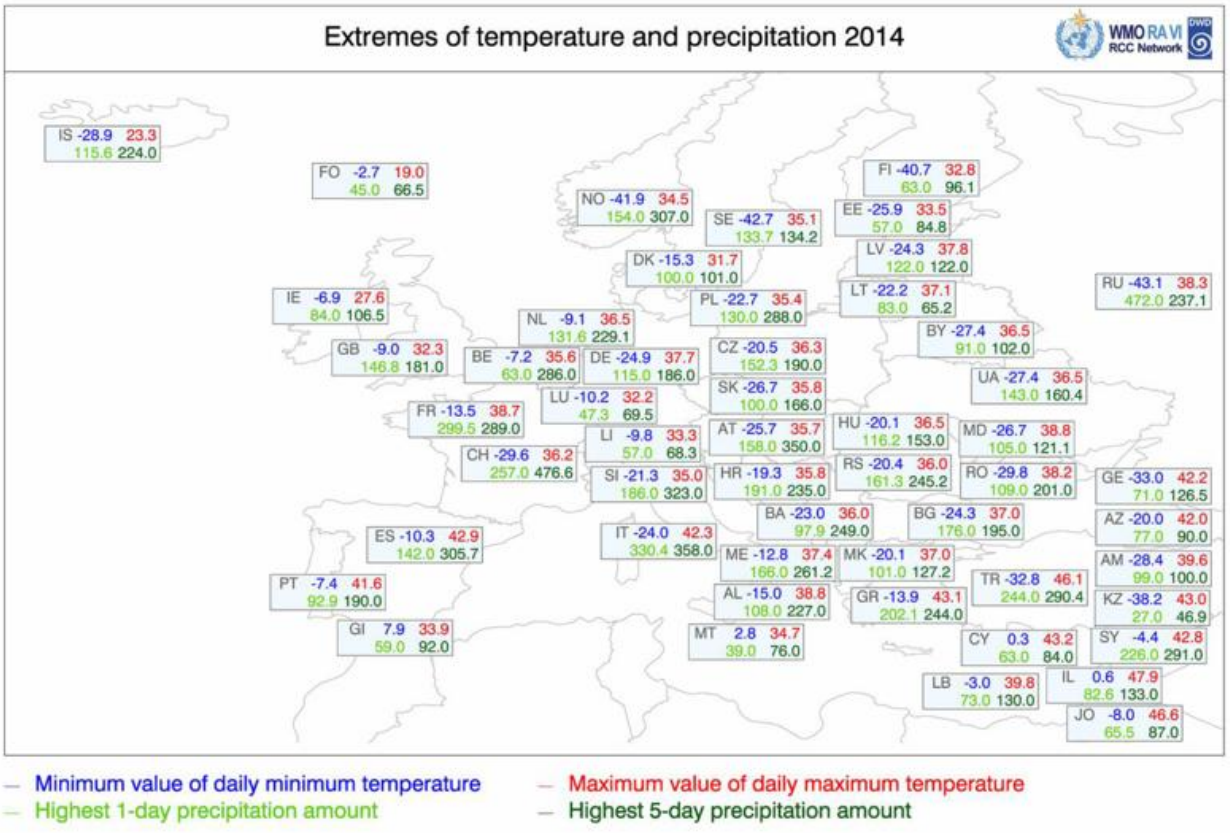


Figure 2.5: Annual extreme values for each country in 2014: first row: Internet country code, lowest daily minimum temperature (in °C, blue) and highest daily maximum temperature (in °C, red); second row: maximum daily precipitation totals (in mm, light green) and maximum 5-daily consecutive precipitation totals (in mm, dark green).

Note: Data (by order or priority) from reports of NMHSs, GPCC, ECA&D or SYNOP; the countries are represented by their Internet country codes. (Source: http://www.dwd.de/rcc-cm)

2.1.5. Sunshine duration

As expected, the annual sum of sunshine duration 2014 showed from the South to the North generally gradual decreasing values. More than normal sunshine hours have been primarily noted in most parts of Europe except in Portugal, northern and central Italy as well as in south-eastern and north-eastern Europe. Poland, Belarus and Ukraine showed in every season above normal sunshine.

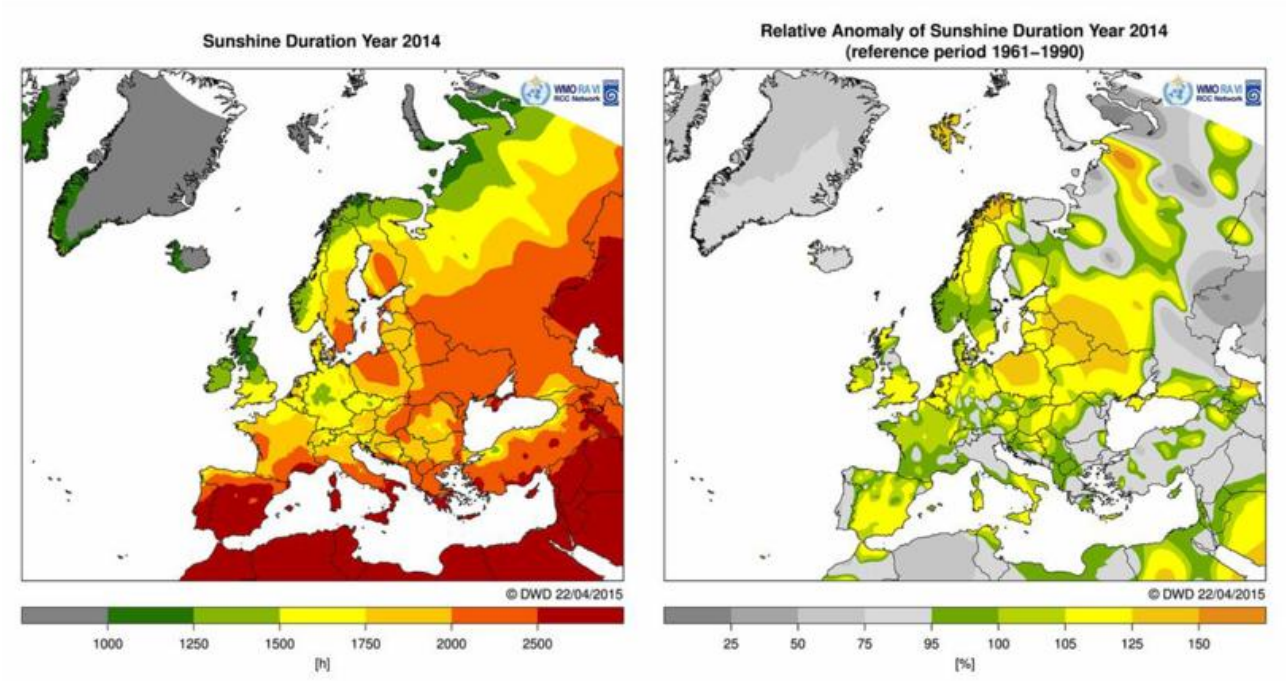


Figure 2.6: Annual sum of sunshine duration (left) and relative anomalies (right) for the year 2014 in hours with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm)

2.1.6. Drought situation

The drought index (SPI) in 2014 differs only slightly from its normal values. The anomalies in Central and Eastern Europe were slightly below normal and the Balkan region and northern Italy were moderate wet. In these areas annual precipitation was above normal linked with floods.

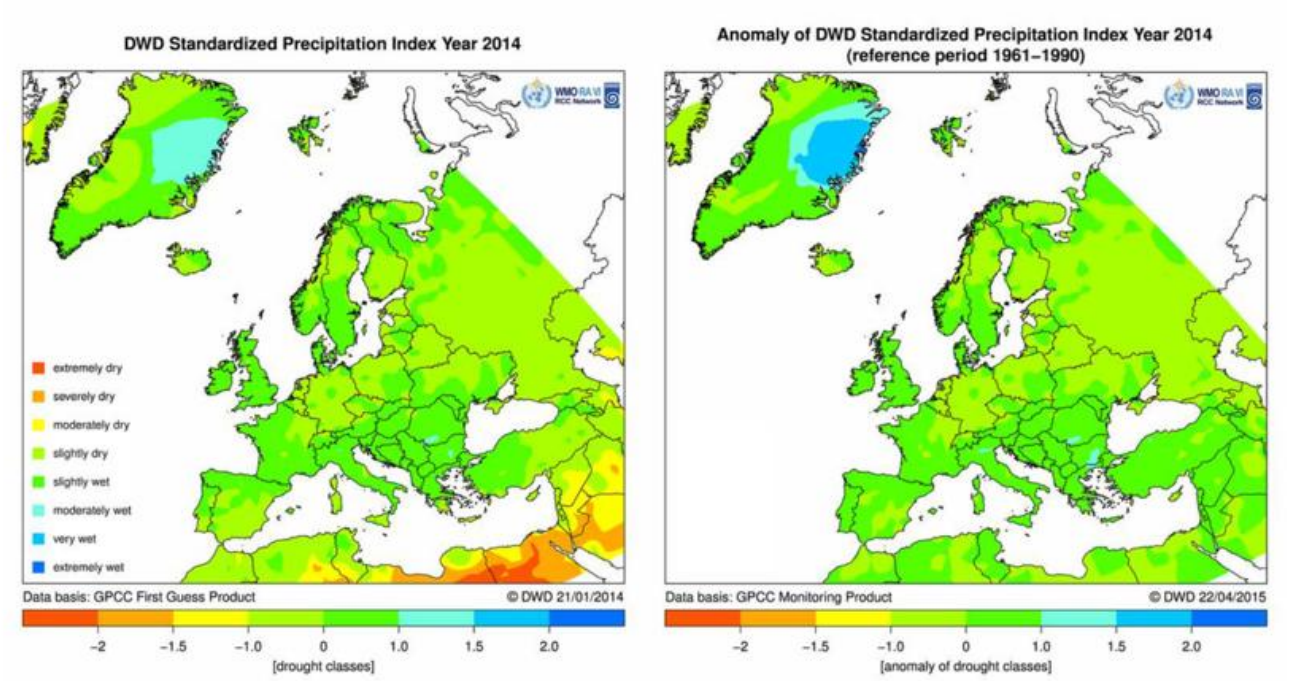


Figure 2.7: Annual modified Standardized Precipitation Index (DWD-SPI) for the year 2014 (left) and its anomalies (right) with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm)

2.1.7. Snow cover

The snow-season 2013/2014 (September 2013–August 2014) was warmer than normal. Therefore in many low land areas in west and south Europe no snow occurred at all. Apart from mountain areas, in the central Europe the partly occasional snow fall events occurred in January and February. As expected, towards the northern and eastern Europe the snow cover duration was longer and ended in early summer.

However, remarkable snow conditions prevailed in Austria and Switzerland.

The snow cover over most parts of **Austria** was well below average. Except in the upper parts of Carinthia and East Tyrol the snow conditions in January and February were remarkable. At some locations the amount of fresh snow was three times higher than the average.

In **Switzerland** the three winter months brought hardly any snow to the northern lowland regions. The meteorological station Zurich-Fluntern registered only 1 cm of new snow in January. It was the winter with the least amount of snow in the Zurich measurement series spanning over more than 80 years. In addition, the winter half-year ranked second in terms of lack of snow – there was only some additional snowfall amounting to 25 cm in November 2013. This was in strong contrast to the previous year when Zurich recorded a winter half-year with the most new snow for over 40 years (slightly above 2 m).

Record snow in Switzerland south of the Alps

From mid-December 2013 to February 2014 south-westerly and southerly currents were predominant in the Alpine regions. They brought enormous amounts of rain and snow to the areas south of the Alps. Lugano recorded by far the highest amount of precipitation since observations

started 151 years ago. It amounted to 698 mm - one third more than the total in the former record winter of 1950/1951. In Locarno-Monti the total even amounted to 754 mm. Here slightly less precipitation (722 mm) had been recorded in the previous record winter of 1950/1951.

As a result of the copious precipitation, a huge total of new snow was observed in higher regions south of the Alps. At the meteorological station Bosco-Gurin in the Ticino Mountains almost 7 m of new snow was recorded between December and February. This is the highest value in the measurement series available since 1961. Segl-Maria in the Upper Engadine received a total of 4 m in the three winter months, representing the second-highest value in the measurement series spanning 150 years. However, the record winter of 1950/1951 brought far higher new snow totals (up to 7 m) to these regions.

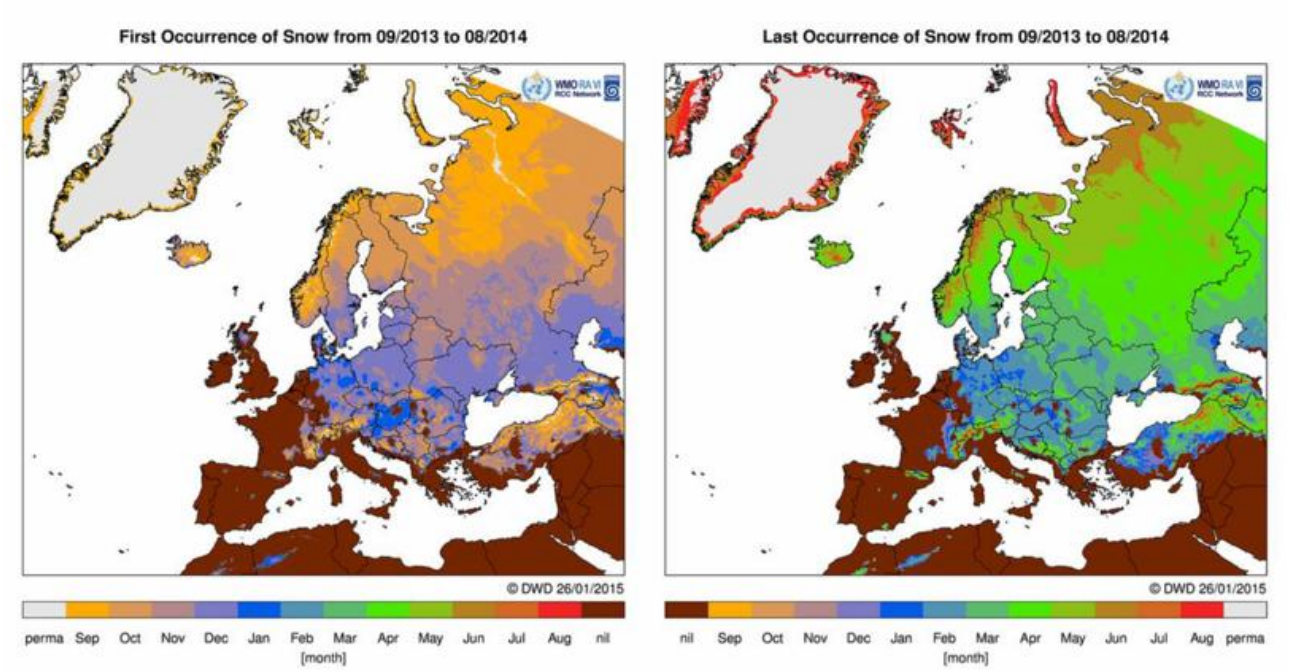


Figure 2.7: First occurrence of snow (left) and last occurrence of snow (right) during the snow-season 2013/2014. (Source: http://www.dwd.de/rcc-cm)

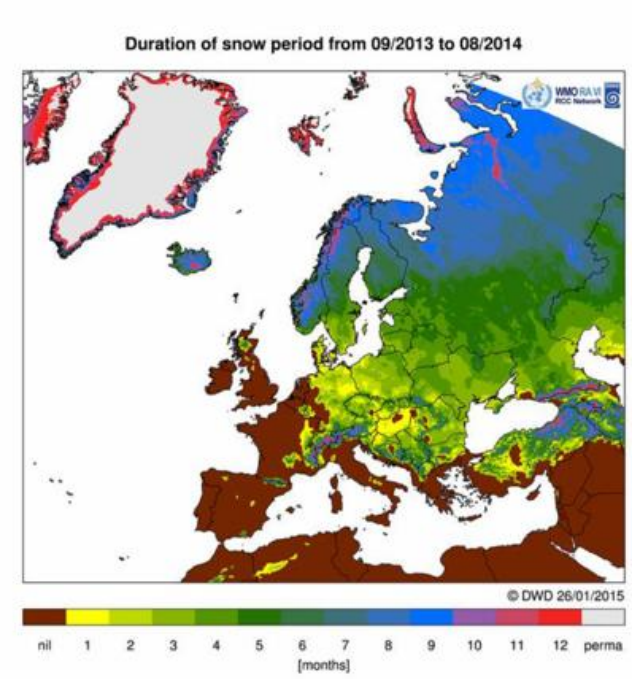


Figure 2.8: Duration of snow cover in the snow-season 2013/2014. (Source: http://www.dwd.de/rcc-cm)

2.2. Trends of temperature and precipitation indices 1951-2014

In this section, trend maps representative for the elements temperature and precipitation are shown. As reference period for these trend maps 1951-2014 was chosen.

In the north, northwest and eastern Europe most stations show an increase in the annual number of wet days (RR1) for the last 64 years while in southern Europe a decreasing trend prevails. The decreasing and increasing trend at neighbouring stations indicate inhomogeneities in the time series. The number of warm and wet days (WW) increased over whole Europe with exception of Greece. The annual number of summer days (SU) increased in Central and southern Europe while in the northwest they are not significant. The annual numbers of tropical nights (TR) show some tendencies of increasing in the south-east while in the north-west part the trends are insignificant.

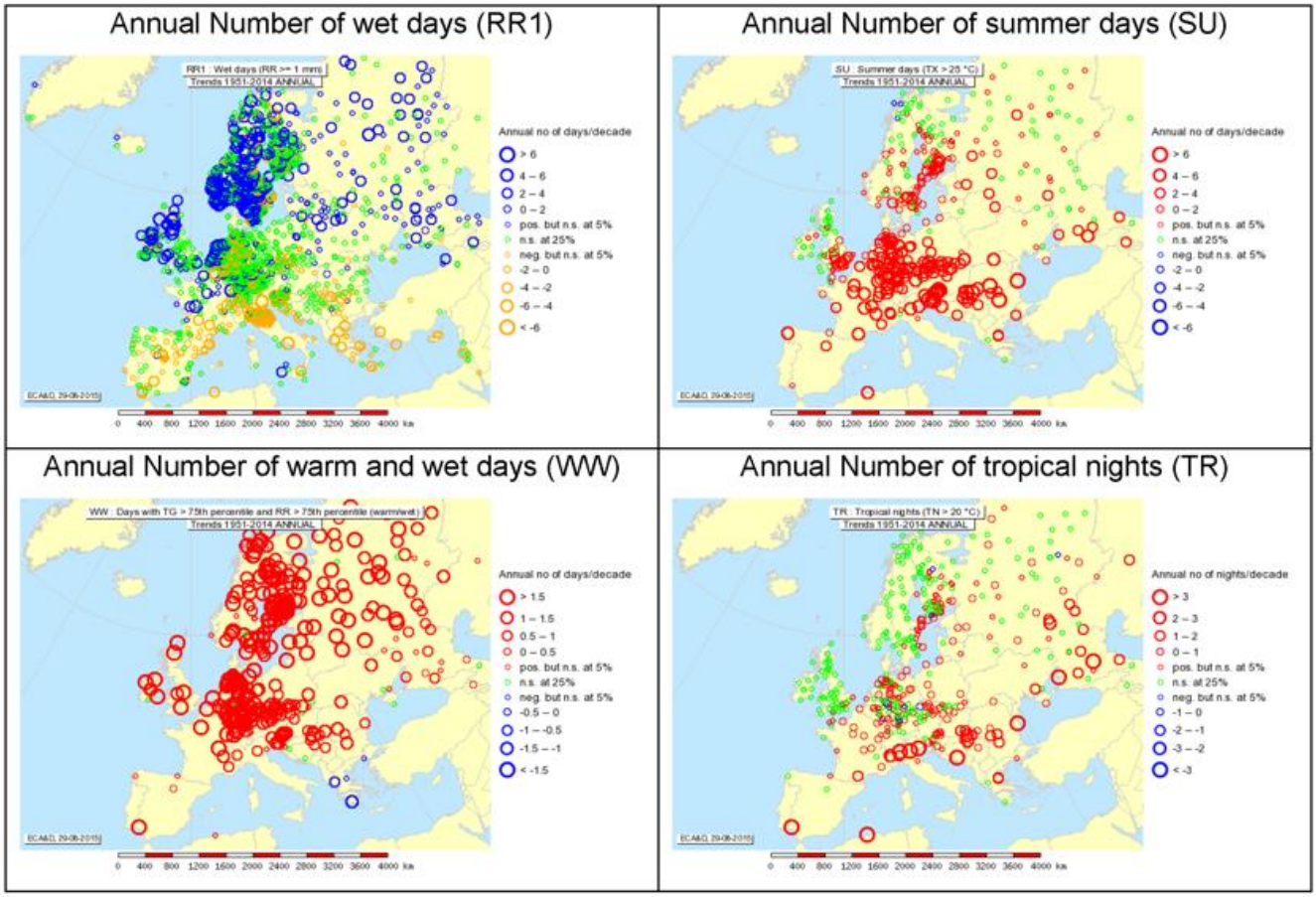


Figure 2.9: Trends of Selected Climate Indices 1951 to 2014 (Source: ECA&D, http://www.ecad.eu)

1. **RR1, Number of wet days**: count of days where RR (precipitation > 1 mm)
   Precipitation below 1 mm/day has no effect on vegetation because it normally evaporates on the same day and is locally effected.
2. **SU, Number of summer days**: count of days where TX (daily maximum temperature) > 25°C
3. **WW, Number of warm and wet days:** days with TG (daily mean temperature) > 75th percentile and RR > 75th percentile
4. **TR, Number of tropical nights**: count of days where TN > 20°C

2.3. Socio-economic impacts of extreme climate or weather events

Several countries reported socioeconomic impacts of climate extremes or weather events. This was done partly given in a standardized structure (WMO guiding table for country submission of information on extreme climate events) or the information was part of the regular monthly reports on the internet or it was separately submitted. However, this information is heterogeneous and does by far not give a complete overview. Not only do the administrative structures differ so that the information cannot easily be gathered but also many kinds of impact are difficult to estimate. In the following only a short extract will be given.

The following figure (Figure 2.10) shows the number of observed extreme weather or climate event as reported by the NMHSs in 2014 that can be presented in form of a diagram. Conclusions should be drawn only with caution because some of the events were reported by several countries. The total number of cases for this figure was 399. No diagrams were shown for the injured persons and fatalities as well as the economic losses because the number of reports were too few (about 9, 10 resp. 11). In some cases the reported numbers were not fix but like 'hundreds' or 'few'. The economic damage was estimated as well by some countries but the information is not sufficient to be presented with any reliability of representativeness. The reported economic damages will be summarized individually below.

The most frequent events in 2014 were 'Extreme Precipitation' with 108 events or 27% that also happened in most of the countries with reported 30 fatalities and 138 injured. The second one with 20.5% or 82 events were 'Wind Storms' that mainly occurred in winter in the western part of Europe together with extreme precipitation. Rank three were 'Heat Waves' with an occurrence of 15% or 60 events mostly in Central, southern and eastern Europe, Serbia, Russia and Israel reported 4 heat waves. The next extreme events were 'Floods' (13 %, 158 persons injured, 10 fatalities) and 'Droughts' (7%).

Dec 2013 – Feb 2014. The area from **Spain** to **Ireland** and **United Kingdom** was hit by 12 **storm** surges. It has been the wettest winter in the England and Wales Precipitation (EWP) series going back to 1766, with 435 mm. This huge amount of rain saturated the ground and caused **landslides** and **floods**. Villages were cut off for four weeks. Munich Re estimated the damage of about 1.300 Mio. €.

13 – 30. May 2014 Parts of the Balkan Peninsula (**Serbia, Croatia, Bosnia and Herzegovina**, **Romania**) was concerned by **Floods** and **landslides** The days of heavy rainfall from a slow-moving storm led to historic widespread flooding. The floods caused land mines hidden more than 20 years ago to appear. A warning was issued to residents about the possibility of land mines uncovered by mudslides and flood waters. More than 3.1 million were affected and 86 fatalities. The overall losses were estimated to 3.300 Mio. €.

On 9 and 10 June 2014 with maximum temperature of more than 37°C in south **Germany** heavy **thunderstorms** moved from eastern France to western Poland. In the Rhine-Ruhr-Area to Kassel and Göttingen wind gusts of up to 144 km/h were measured (40m/s at station Düsseldorf Airport). Most affected were Dusseldorf and the Ruhr area, where a downdraft with heavy precipitation combined with hail and floods caused a lot of damage. In the city of Düsseldorf nearly 20 000 trees were uprooted, similar situation in other cities at the district. A total of six people were killed. About 30 people were seriously and 37 slightly injured. The damage estimated by the Munich Reinsurance Company was 3200 Mio. €.

November, 03.–19., 2014 A series of severe **storms** together with high wind speeds and **tornadoes** hit **France, Italy and Switzerland** with very high amounts of precipitation. The rainfall has exceeded 250 mm in many areas from southeast France into northern Italy and southern Switzerland. During these two weeks over 600 mm has fallen in Genoa (Italy), and 420 mm in Nice (France). In Genoa, this is almost half of the yearly average rainfall. 20 persons died and the monetary loss was about 240 Mio. €.

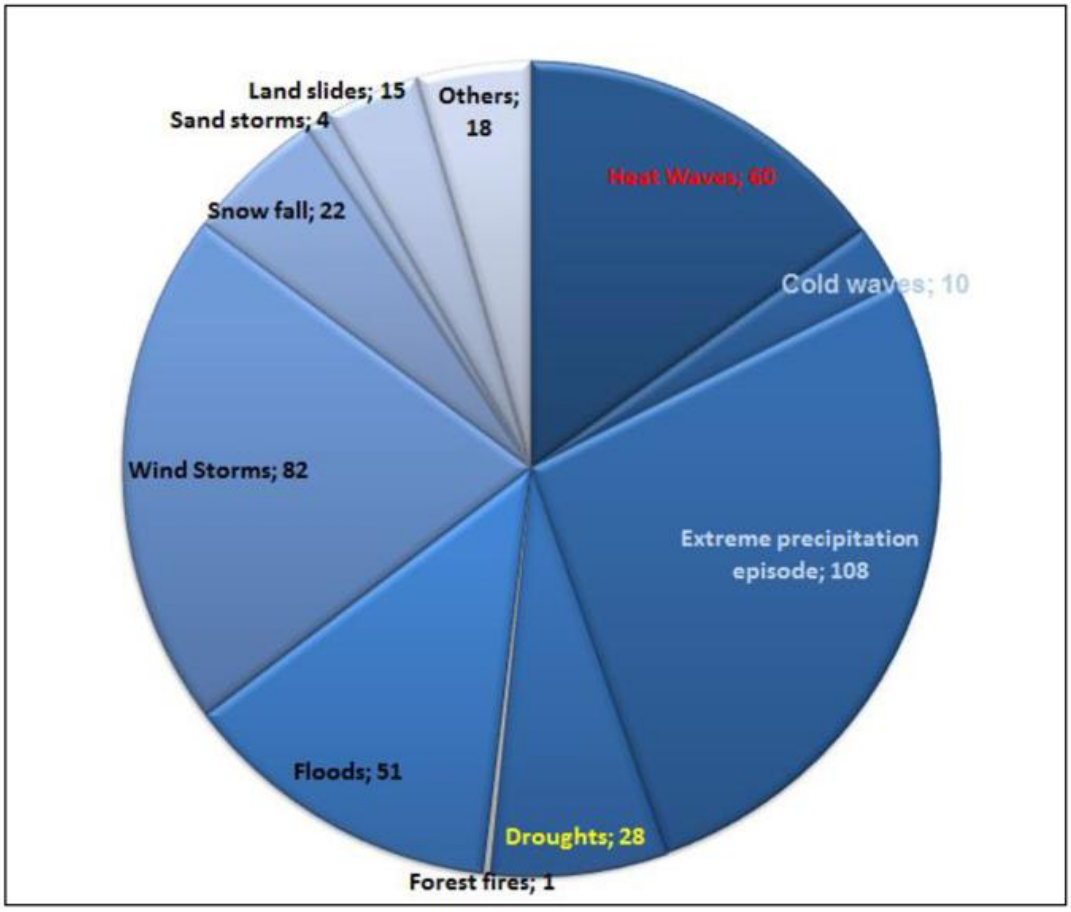


Figure 2.10: Relation of observed extreme weather or climate events in 2014 based on 35 reports from NMHSs (total events reported for 2014: 399)

Much economic damage is usually connected with floods, storm, cold spells (all kinds of frost, snow or ice), hail, drought or extreme heat. There are some figures which are summarized in the following but much of this kind of damage cannot be estimated (by meteorologists).

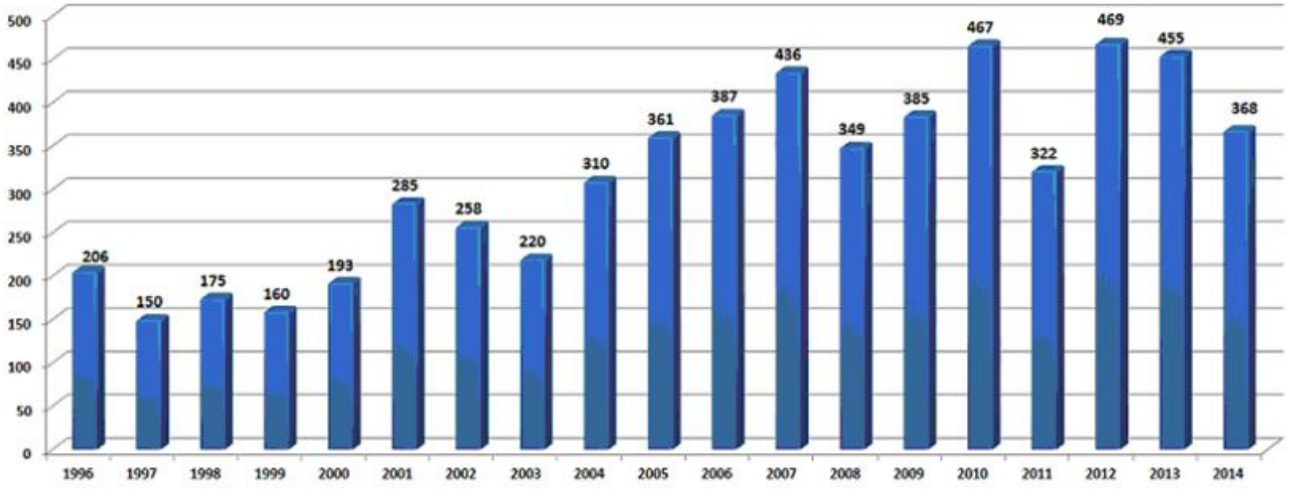


Figure 2.11: Number of severe weather events caused damage from Russia Federation, 1996-2014 (Diagram as provided by the NHMS).

3. Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2014 and anomalies related mainly to the normal period 1961-1990 of the selected essential climate variables: sea level pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1. Seasonal averages and anomalies of selected essential climate variables

3.1.1. Sea level pressure and circulation indices

Winter 2013/2014 was dominated by a strong Icelandic low with a core pressure below 995 hPa (−18 hPa sea level pressure anomalies) and was centred south of Iceland. The low pressure extended over the whole North Atlantic from the east coast of North America to the west coast of Europe and from the Norwegian Sea to southwest of the British Isles. In Ireland storm force winds occurred on 12 different days – on the 5th/14th/18th/24th/26th/27th December 2013, 3rd/25th/26th January and 1st/8th/12th February 2014. This series of storms led to an increase in rainfall amounts of between 1.5-2 times above normal and to saturated or waterlogged ground throughout the country. The most severe windstorm occurred on the 12th February 2014 and was associated with an active depression off the south coast that tracked steadily north-eastwards over the country. The Azores high was shifted south-westwards so that the Azores lay outside the centre with more than 1025 hPa mean sea level pressure. The negative anomalies exceeded an absolute amount of 14 hPa. The Azores high and the Asian high were connected over most of the European continent and the Mediterranean Sea. The positive anomalies were in the range of 2 to 6 hPa in the Azores region and in south-eastern Europe and Middle East and in the Russian Arctic region.

The lowest sea level pressure in the WMO Region VI of 948.1 hPa was registered at station Gufuskálar in the West of Iceland on 9 December.

The mean sea level pressure of **spring 2014** was close to normal. Low pressure in the Arctic Sea reached southward in the Norwegian Sea and northern Russia with negative anomalies below -14 hPa. The Icelandic low with a centre pressure below 1005 hPa was located west of Iceland and had negative anomalies below -6 hPa.

The sea level pressure distribution for **summer 2014** was quite normal. The exception was the high pressure over Greenland and the Norwegian Sea with positive pressure anomalies of more than 6 hPa over Greenland. This was the cause of the negative NAO-index. The Azores high was located above the Azores with a pressure of more than 1020 hPa.

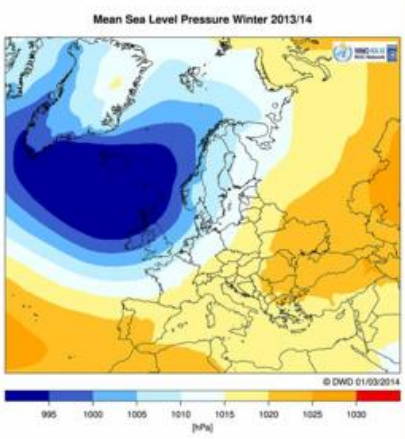
The circulation pattern in **autumn 2014** was marked by a strongly developed Iceland low with the core located southwest of Iceland (under 1000 hPa) and a Russian-high with a central pressure from 1020 to 1025 hPa. The negative anomalies ranged from Greenland to the Iberian Peninsula with values less than -6 hPa southwest of Ireland. The Azores high was shifted west to the Atlantic. Positive pressure deviations were found over Scandinavia and northern Russia with values of more than 6 hPa.

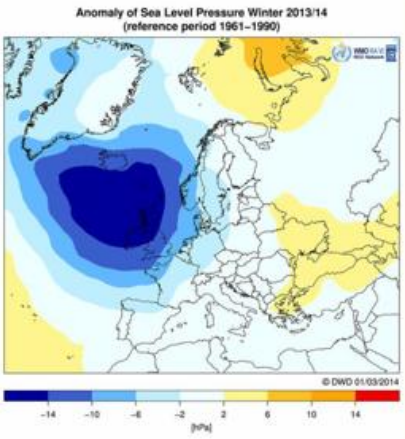
Table 3.1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference

	NAO	EA	EA/WR	SCA	POL	AO
Winter 2013/2014	0.56	1.60	-1.20	0.71	-1.16	0.18
Spring 2014	-0.06	0.61	-0.11	-0.54	0.68	0.88
Summer 2014	-0.91	0.10	-0.66	0.39	0.21	-0.46
Autumn 2014	0.48	0.55	0.46	1.34	0.61	-0.52

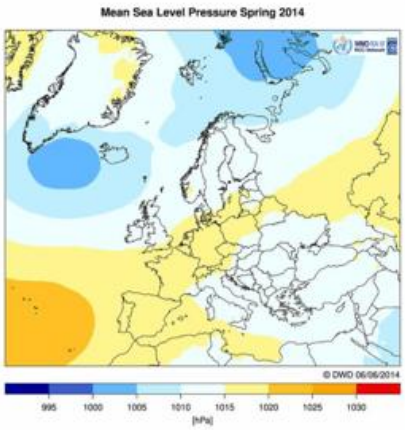
Note that all values are standardized with the reference 1981 to 2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**:ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

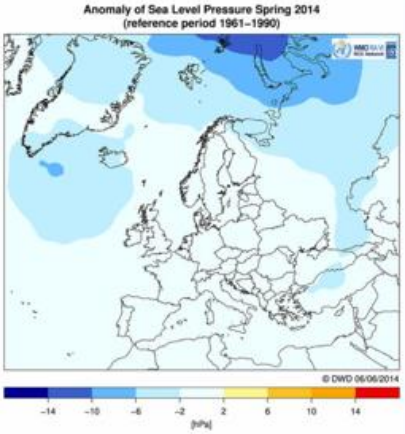
Winter 2013/2014



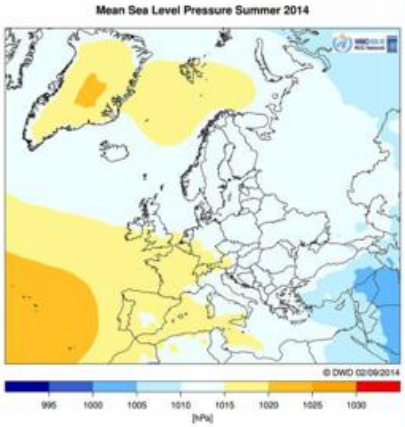


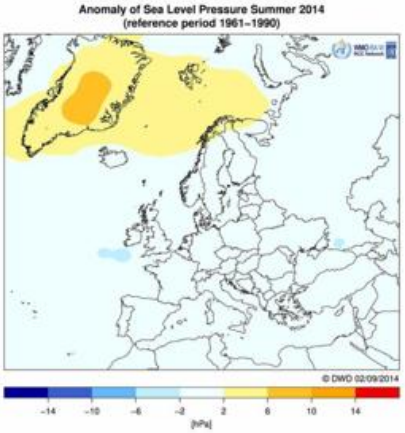
Spring 2014



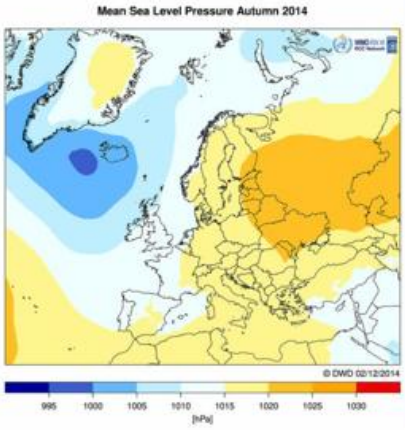


Summer 2014





Autumn 2014



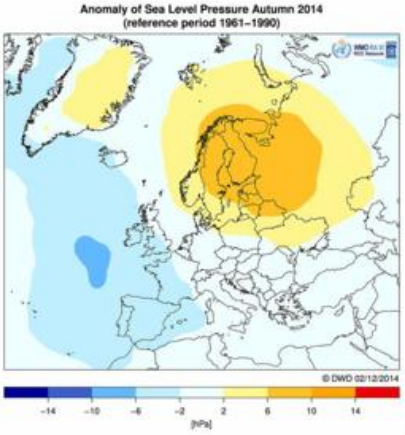


Figure 3.1: Seasonal sea level pressure (left, in hPa) and anomalies (right, in hPa) in 2013/2014, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

3.1.2. Temperature

On average for the whole WMO Region VI and sub-regions the temperature in all seasons in 2013/2014 except Eastern Europe in autumn was warmer than the normal period 1961-1990. In regional view, however, some differences existed (Tab. 3.2).

Table 3.2: Seasonal and annual average of temperature anomalies over land areas in °C for each sub-region in the year 2014 (reference period: 1961-1990)

Sub-Region	Winter 2013/2014	Spring 2014	Summer 2014	Autumn 2014	Year 2014
Central and western Europe	2.51	2.10	0.89	2.06	1.85
Nordic and Baltic countries	3.23	2.24	1.40	1.78	2.09
Iberia	0.69	1.98	0.73	2.03	1.39
Mediterranean, Italian and Balkan Peninsula	2.25	1.32	0.83	1.36	1.56
Eastern Europe	2.65	2.58	1.31	0.13	1.58
Middle East	0.57	2.05	1.55	-0.09	1.26

Winter 2013/2014 was warmer than normal on Greenland, the European Arctic Sea and the Norwegian Sea, Scandinavia and northern European Russia, Central and Western Europe, and most of the Mediterranean Sea and the Balkan Peninsula. Colder than normal was an area on the western North Atlantic as well as a small region in eastern Turkey and Iran as well as a part of northern Russia (already outside RA VI). The warm anomalies were partly exceptional.

Some ranks of warm winters based on web-available bulletins by NMHSs are given below:

Table 3.3: Seasonal rank statistics for winter mean temperature (2013/2014) as provided by the NMHSs.

Country	Rank	Time series available since
Europe (35°–75°N, 10°W–30°E, E-OBS)	1	1950
Austria	2	1767
Denmark	5	1874
France	2	1900
Germany	4	1881
Montenegro	1	1951
Hungary	3	1901
Luxembourg	2	1947 (together with winter 1989/1990)
Netherlands	2	1706, together with 1990
Norway	8	1900, regionally (Vestlandet) rank 1
Poland	7	1952
Portugal	15	1932
Slovakia	3	1951
Switzerland	3	1864
United Kingdom	5	1981

Croatia classified the winter 2013/2014 as very warm in the northeastern part and extremely warm in the western part (based on the normal period, 1961-1990).

Most of the region was warmer than normal during all three months. Several countries reported each month as one of the 10 warmest months in their long time-series either for the whole country of for regions or at least for stations.

Spring 2014 was overall warmer than normal and one of the warmest spring seasons in several countries (2nd warmest since 1706 in the Netherlands, the warmest since 1900 in Norway, on rank 9 of warm spring seasons since 1931 in Portugal, provisionally the UK's third warmest spring in a series from 1910, the 3rd warmest since 1880 in Germany, the 3rd warmest in Belgium since 1837, the 3rd warmest in Poland since 1951, the 7th warmest spring since 1767 in Austria, among the 10 warmest since 1864 in Switzerland). Poland and Switzerland highlighted unusually early phenological phases for spring 2014 in their seasonal bulletins. The map of the anomaly of days with night temperatures above the 90 percentile shows remarkably positive values nearly everywhere.

Summer 2014 was warmer than normal in many European countries. Anomalies of 2-3°C occurred north of Iceland, from Norway to Denmark and east of the Black Sea. For Norway the summer temperature anomaly was 1.9°C, in some parts even 3-4°C above normal.

Three heat waves in summer 2014 in Lithuania

(as provided by the NMHSs of Lithuania)

Summer was much warmer than usually (1.2°C positive anomaly). The only month that turned out to be rather cool was June (-1.2°C negative anomaly). Very warm was the month of July (even 3.5°C positive anomaly), also warm was August (1.4°C positive anomaly). The hottest day of summer was 4 August, when the absolute record temperature of that month was observed, reaching 37.1ºC.

Summer saw totally 6 severe and 1 disastrous meteorological phenomena. Most of them (3) were heat waves: on 6–10 July, 24–31 July and 2–8 August.

All heat waves (when 30ºC and higher temperature persists 3 days in a row) were related to tropic air influx to Lithuania from North Africa or Southeast Europe. *Heat wave on 6–10 July* was local-scale and mostly affected seaside and western part of the country, rising temperature to 30-32.5ºC. Such tropical heat was brought in by Azores anticyclone. The heat mostly affected people on sea shore.

The second heat wave reached Lithuania by the *end of July and was the longest, lasting for 8 days*. Such duration was determined by two anticyclones: one moving over Scandinavia pushed tropical air to the Baltic States and then merged with another southern anticyclone moving by Russia. 29 July was the hottest day of that month with maximum temperature reaching 30–34.7ºC. UV index was also high, between 5–6, and heat index showed great discomfort (perceptive temperature for humans reached 35–39ºC). That period was both hot and unsettled with thunderstorms and squalls and showers here and there every day. Prolonged sweltering heat caused people suffer.

After only a single day of relief, tropical *heat returned on 2 August* and the heat wave lasted until 8 August. Such heat was brought to Lithuania from Southeast Europe by anticyclone stopped by Southwest Russia. The temperature reached its peak on 3–4 August, when it was record-high all over Lithuania (between 32–37°C): almost all meteorological stations reached or exceeded maximum temperature records for those days. On 4 August in many places the temperature was over 35°C, and *in the south of the country (in Druskininkai) it measured as much as 37.1°C. This is an absolute temperature record in August in Lithuania*, replacing the previous 35.8°C (in 1992). Very warm were also the nights, often featuring minimum temperature falling as little as to 16-20°C, in seaside to 21–23°C.

The thermal conditions in **autumn of 2014** were divided in two parts, the western part of Europe reveales above average temperature anomalies while Russia was colder than normal. In some areas of western Europe anomalies showed values of more than 3°C.

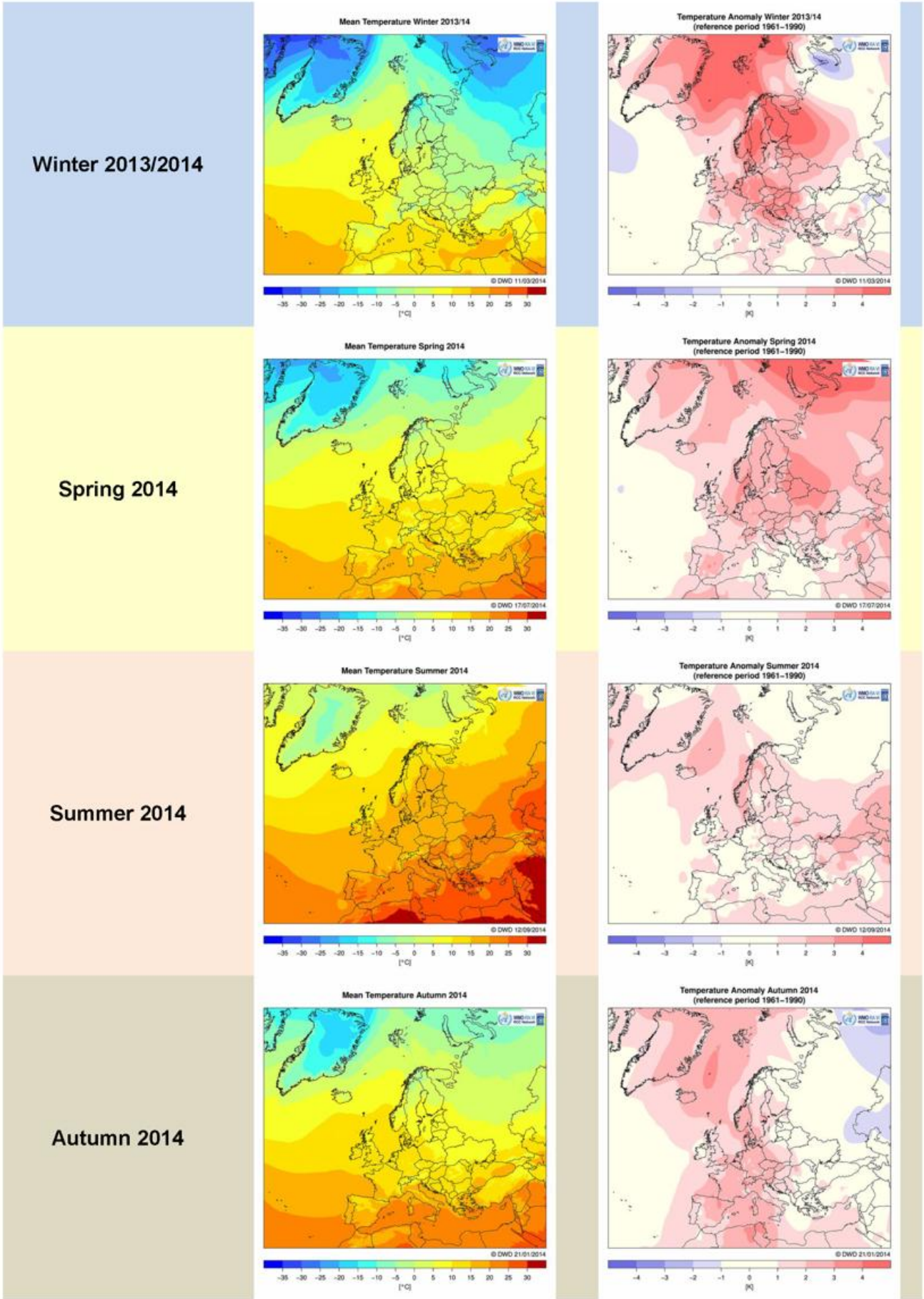


Figure 3.2: Seasonal mean temperature (left, in °C) and anomalies (right, in K) in 2013/2014, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

3.1.3. Precipitation

Winter 2013/2014 was wetter than normal in UK, western France and the northern Iberian Peninsula under Atlantic influence. It was as well wetter than normal in southern Norway, partly in southern Sweden and Denmark. Wetter than normal was also the southern Alpine region, and parts of the Adriatic coast, the western Italian Peninsula and western Sicily and partly the eastern Balkan Peninsula. Smaller parts of European Russia mostly in the north were wetter than normal as well. Drier than normal were western Iceland, parts of Norway, parts of central Europe, most of Germany, western parts of the Balkan Peninsula, eastern Ukraine and southern Russia and the Caucasus region and most severely Turkey and the Levante coast. Israel reported that the period from mid December 2013 to end of February 2014 was the driest for more than 70 years. Most other regions were around normal.

The contrasts north and south of the Alps were high: In Austria the northern parts received the lowest precipitation since the winter 1857/1858. Germany was dry, the Netherlands were drier than normal.

Table 3.4: Rankings of total precipitation (in mm) for winter 2013/2014 for some of the wettest regions.

Country	rank	total precipitation	area averaged time series since
United Kingdom	1	545 mm (177% of the 1961-1990 average)	1910
United Kingdom	1	446 mm (178% of the 1961-1990 average)	1766 for the England&Wales series
Northern Ireland	2	489 mm (159% of the 1961-1990 average)	1910
France	1	995 mm at station Guiscriff (206 % of the 1961-1990 average)	1959, for the regions Bretagne and Provence-Alpes-Cotes D'Azur
Switzerland	1	698 mm at station Lugano (198% of the 1981-2010 average)	1764, for the southern part of the country
Portugal	17		1932
Austria	1	370 mm at station Klagenfurt (355% of the 1981-2010 average)	1813

Outstanding was the precipitation surplus on the Balkan Peninsula in **spring 2014**. The map of the absolute anomalies gives a more realistic characterization than the relative anomaly in this case. The map of the anomalies of the highest 5-day precipitation totals shows that the catastrophic flooding event in May 2014 mainly caused this surplus (For details see section 4.3 or the Seasonal Bulletin for Serbia, Spring 2014).

Summer 2014 was wetter than normal in southern and Central Europe with exception of the Iberian Peninsula. The highest positive anomalies occurred from the Balkan states to the north-western part of Turkey. In Croatia the precipitation surplus was more than 70mm and the relative anomalies range from 100% to 302% of the multi-annual average for this season.

The **autumn of 2014** was drier in the north and wetter in the south of the WMO region VI. The precipitation deficit reached values below -30 mm/month (100 mm/season) or below 40% in northern Poland, Belarus, European Russia, Estonia and northern Norway and northern Sweden. More than normal precipitation was observed in southern Europe, especially in western Iberia, southern France, northern and southern Italy, the Balkan and Turkey. The province of Genova (Italy) was hit by an intense thunderstorm on 9th-10th October with maxima cumulated rain over the two days of 569.6 mm at the station of Geirato. A low pressure system west of France brought warm and moist air masses from the Mediterranean. From mid-September to late November, 10 episodes of particularly violent rains hit the southeast of France. Accumulated records for the season were beaten with e.g. 722 mm at station Bormes-les-Mimosas (Var), 916 mm in Prades-le-Lez (Hérault) and 1826 mm in Barnas (Ardèche).

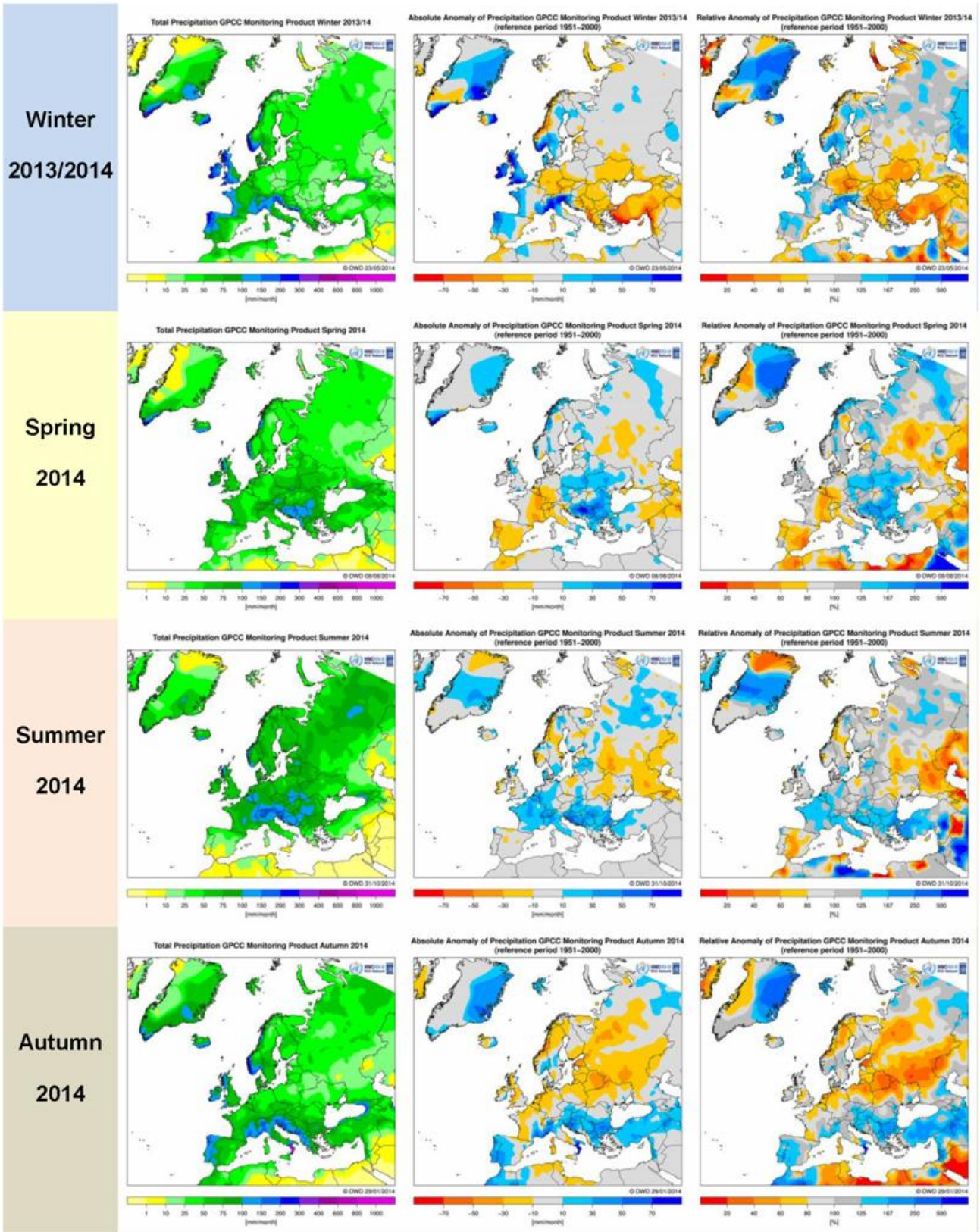


Figure 3.3: Seasonal total precipitation (left, in mm/mon), absolute anomalies (middle, in mm/mon) and relative anomalies (right, in %) in 2013/2014, reference period 1951-2000
(Source: http://www.dwd.de/rcc-cm)

3.1.4. Sunshine duration

Winter 2013/2014 was sunnier than normal in southern UK, western and central Europe, most of the Balkan Peninsula, Turkey and Middle East. It was less sunny than normal in most of northern and eastern Europe as well as the western Mediterranean region. In Germany winter 2013/2014 was on rank 11 of the sunny winters since 1951.

Parts of western and central Europe were 25% to 50% sunnier than normal in **spring 2014** while north-eastern Europe and the Middle East were dull with partly below 50% of the normal. In Belgium at station Ukkel sunshine duration in spring 2014 was 572 hours that is about 123% of the normal value of 463 hours. Especially March was very sunny with a total of 197 h, which is well above the normal value of 114 h. Therefore March was the second sunniest month of the year after June with 206 h. March also leaved behind July (194 h) and of August (150 h).

The **summer of 2014** was sunnier than normal in northern and central Europe as well as in Spain and southern Italy. The surplus reached more than 25% in Poland and more than 50% in Finland. Middle Europe and Lithuania had a sunshine deficit of up to 25%, Turkey even up to 50%.

In 2014 the **autumn** was sunnier than normal in northern and western Europe while the south-eastern part had a deficit. Values of more than 150% of the relative anomaly were dominated in Poland, Belarus, Ukraine and western Russia.

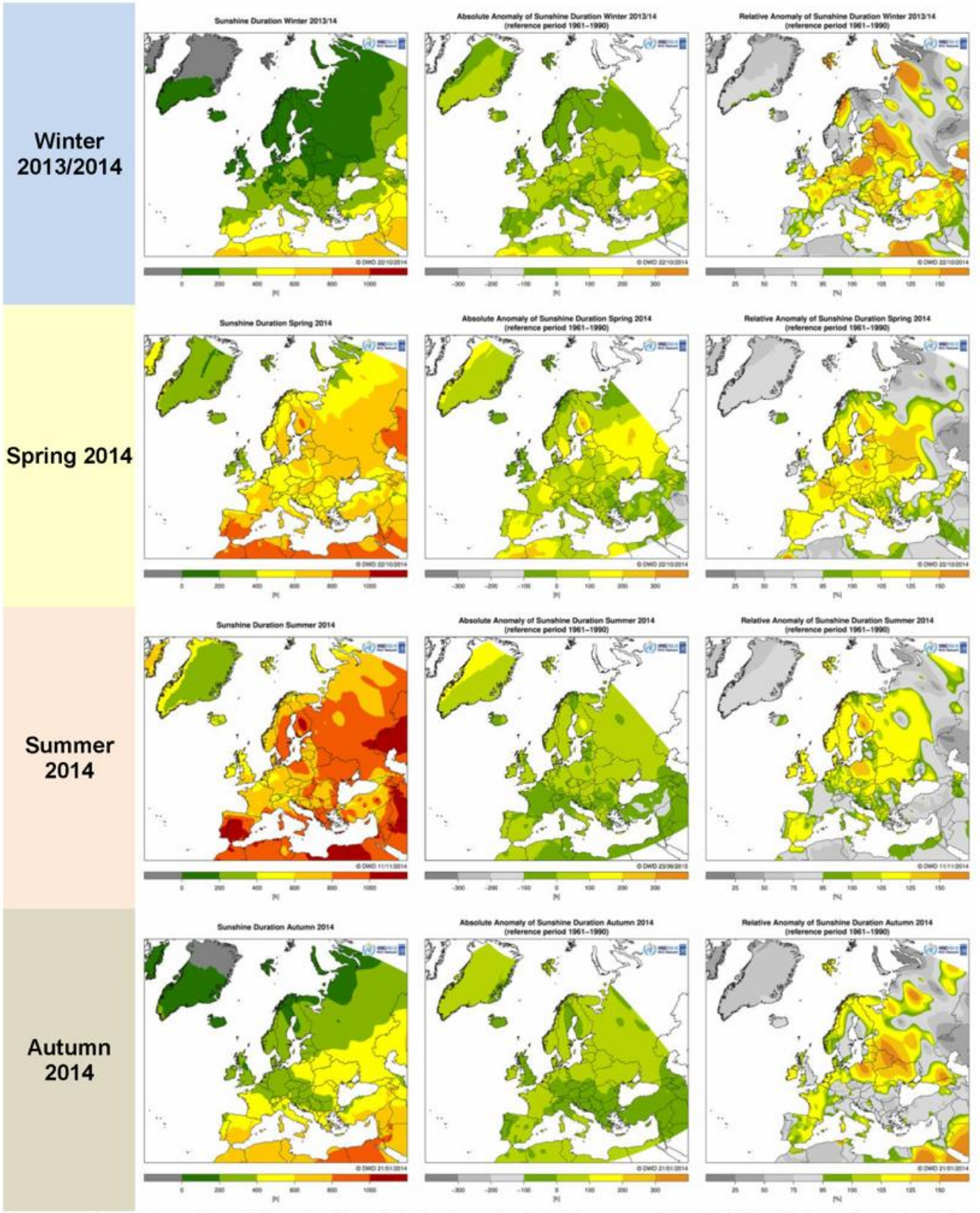


Figure 3.4: Seasonal sunshine duration (left, in hours), absolute anomalies (middle, in hours) and relative anomalies (right, in %) in 2013/2014, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

3.1.5. Drought

The Winter 2013/14 was drier than normal (see below) in Turkey and Middle East while the British Iles, northern Spain, the Alps and southern Norway were wetter than normal. In spring the Balkan was very wet resulting in floods whereas Central Europe and Spain were dry. Turkey was partly very wet in summer and autumn. In autumn eastern Europe was drier than normal.

Reports on longer lasting dry periods
from the National Meteorological and Hydrological Services:

In **Israel** the main months of the rainy season are December, January and February. However, the two and a half months period from mid-December 2013 until the end of February 2014 provided very little precipitation, making it the driest since records began more than 70 years ago (Figure 3.5). In the first part of December three precipitations systems crossed the Eastern Mediterranean, including the extreme snow storm just before mid-December. Since then there were no significant systems in the region. The few systems that did cross the Eastern Mediterranean resulted in local and limited precipitation amounts.

Precipitation totals were less than 20% of normal in many parts of the country. The Galilee mountains (northern Israel) received 50-100 mm from mid-December 2013 until the end of February 2014 compared with an average of 350-450 mm for the period 1981-2010, and in other areas the amounts were even smaller. In the Judean Mountains precipitation totals were merely 10-30 mm, which is less than 10% of normal (1981-2010**,** Figure 3.6**).**

Comparison of the precipitation totals in the aforementioned two and a half month period to the same period totals in previous years reveals that in most stations the extremely small amounts of rainfall this season are record breaking. It is even more remarkable when compared to the previous records (Figure 3.6). There are differences of more than 50 mm between the present record and the previous one (which was set in most of the northern parts of the country in 1978/79 and in most of the southern parts, in 1959/60). The comparison was performed with stations that have precipitation records for more than 70 years, some of them even more than 100 years (rainfall reports in Jerusalem date back to the mid-19th century).

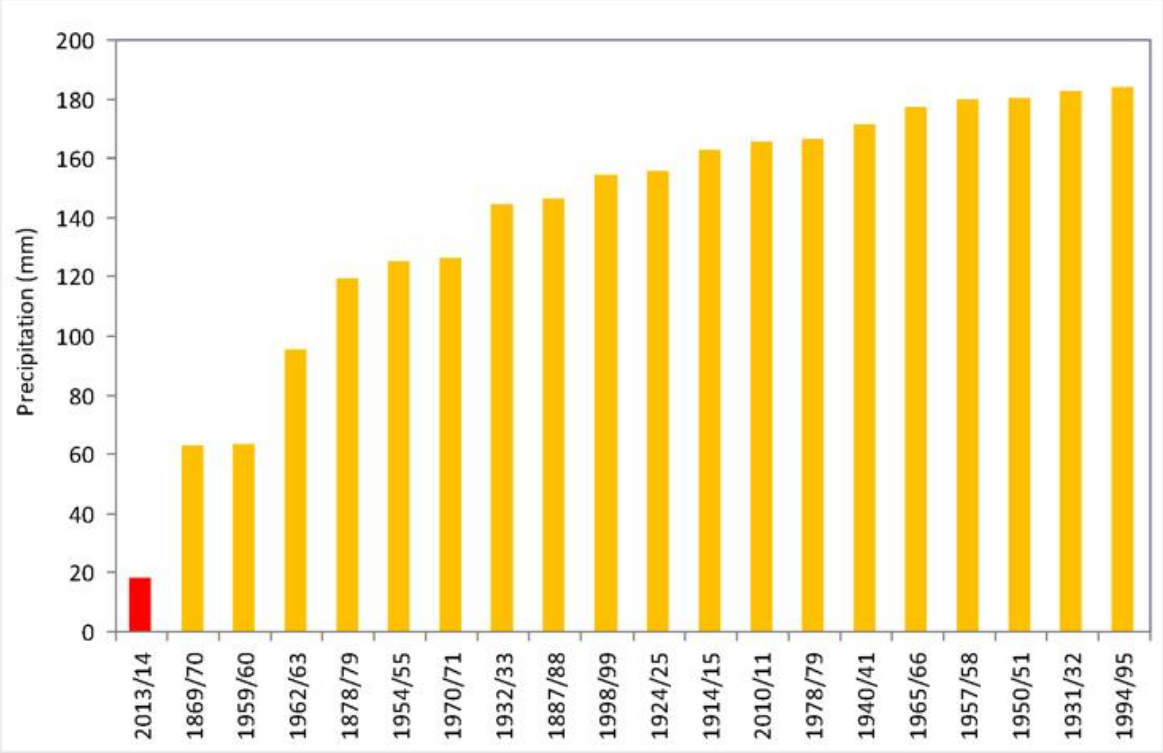


Figure 3.5: The 20 lowest accumulated precipitation totals (mm) in Jerusalem for the period December 15th until February 28/29th 1861/62-2013/14 (Source: Israel Meteorological Service)

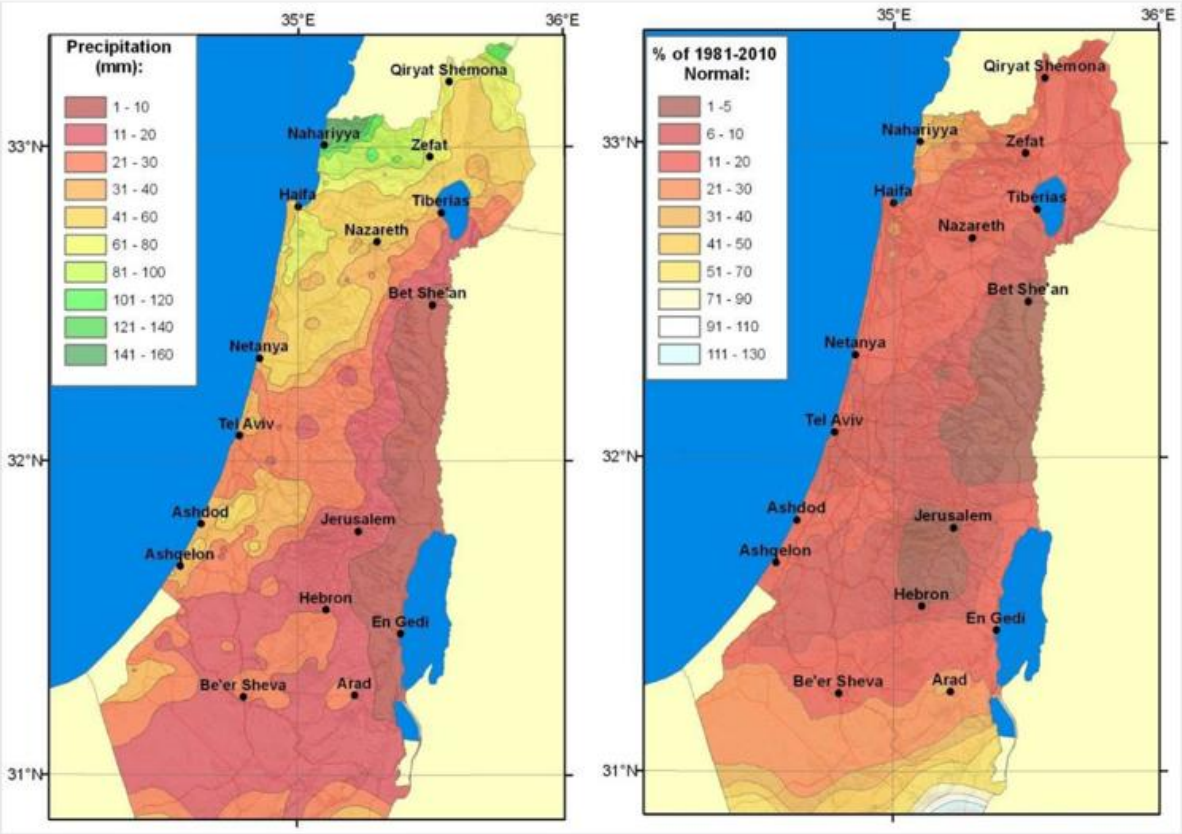


Figure 3.6: Accumulated precipitation (left; in mm) and percent of normal (right in %) for December 15th 2013 to February 28th 2014 (Source: Israel Meteorological Service)

A similar drought situation also occurred in the neighbouring country **Jordan**. The precipitation deficit in January and February in Jordan was about 30 mm of the long term mean for 1961-1990 (Figure 3.7, Figure 4.11)

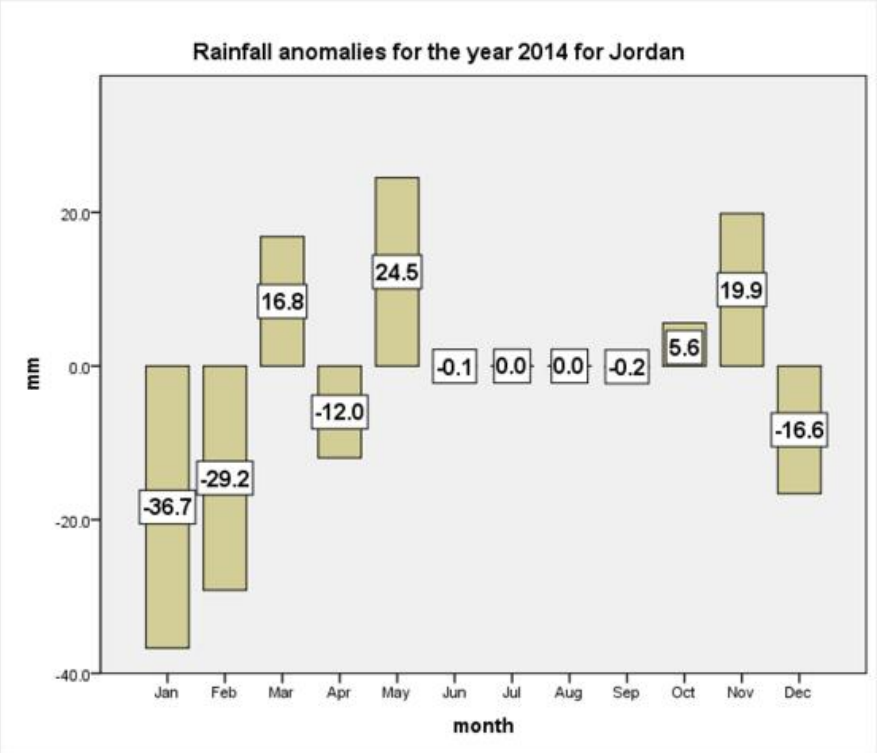
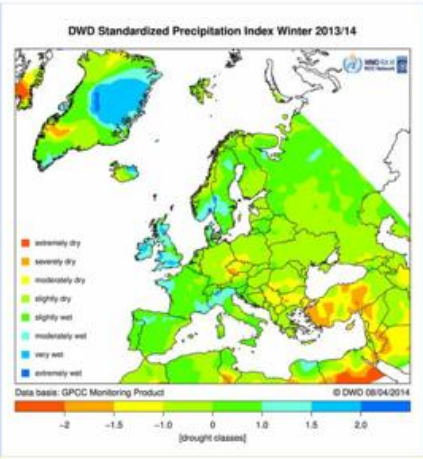
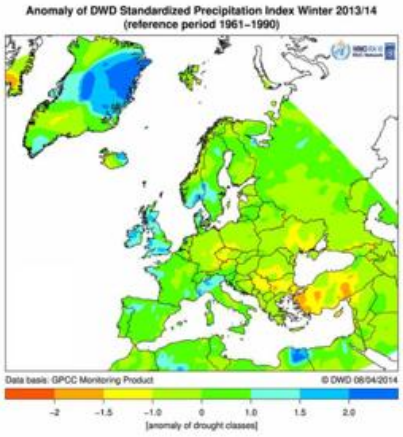


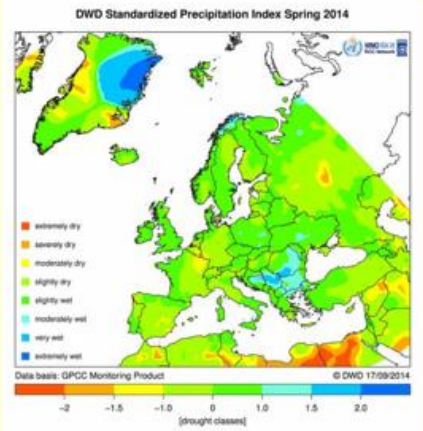
Figure 3.7: Monthly precipitation anomalies for Jordan for the year 2014 (in mm, source: Jordan Meteorological Department)

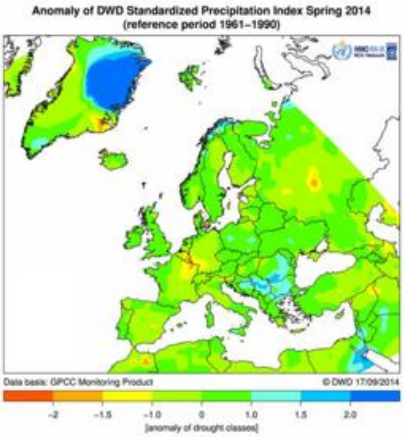
Winter 2013/2014



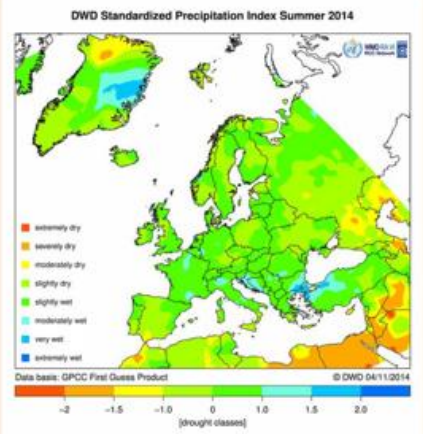


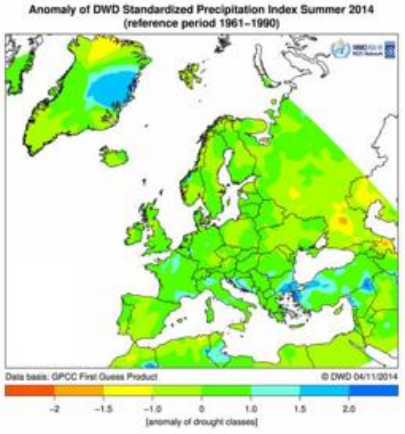
Spring 2014



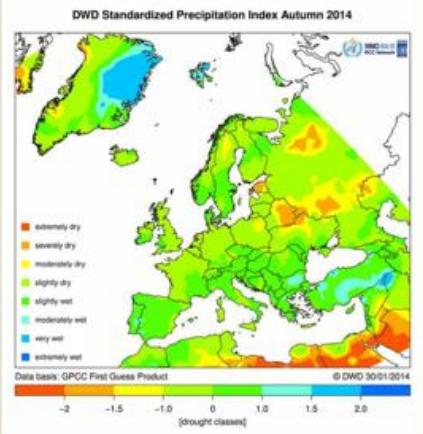


Summer 2014





Autumn 2014



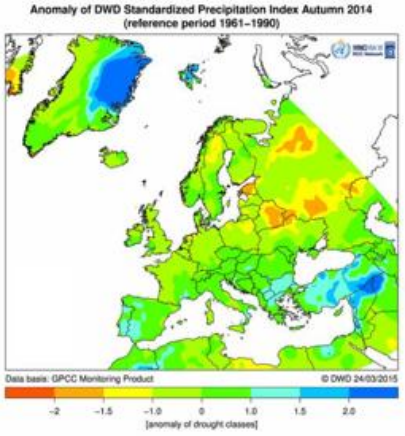


Figure 3.8: Seasonal standardized precipitation index (SPI, left, in drought classes) and anomalies (right) in 2013/2014, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

4. Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2014 on the Climate in WMO Region VI - Europe and Middle East (available on http://www.dwd.de/rcc-cm).

It contains highlights, means and anomalies of sea level pressure, temperature, precipitation, sunshine duration for each months as well as monthly overviews of extremes and notable events.

4.1. Sea surface pressure and circulation indices

This chapter about the atmospheric circulation provides information on selected northern hemisphere teleconnection indices which are considered to be relevant for WMO RA VI and it discusses influences of circulation patterns upon anomalies and outstanding events. The information is based upon the Monthly Bulletins on the climate in WMO RA VI and was completed by reports of the NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/upper troposphere not shown here. (See http://www.ncdc.noaa.gov/teleconnections/ and http://www.cpc.ncep.noaa.gov/products/CDB/index.shtml)

Table 4.1: Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference and the Arctic Oscillation, for January 2014 to December 2014

Year	Month	NAO	EA	EA/WR	SCA	POL	AO
2014	1	-0.17	1.37	-1.32	1.75	-0.79	-0.969
2014	2	1.07	2.23	-1.93	1.10	-1.86	0.044
2014	3	0.44	0.92	-0.11	-0.47	0.04	1.206
2014	4	0.19	0.52	1.23	-0.66	1.02	0.972
2014	5	-0.80	0.38	-1.45	-0.49	0.98	0.464
2014	6	-0.67	-1.03	0.03	0.19	-0.01	-0.507
2014	7	0.21	0.58	-0.31	1.56	-0.93	-0.489
2014	8	-2.28	0.75	-1.69	-0.59	1.57	-0.372
2014	9	1.72	0.2	0.47	1.14	1.1	0.102
2014	10	-0.87	1.02	-0.37	1.11	-1.03	-1.134
2014	11	0.58	0.43	1.28	1.77	1.75	-0.530
2014	12	1.63	-0.59	-0.44	-0.4	-0.93	0.413

Note that all values are standardized with reference to the period1981-2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**:ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

In ***January 2014*** the Icelandic low was extended far southwards with a mean pressure below 995 hPa enclosing most of Ireland and Scotland. This means a negative anomaly of more than 14 hPa for the British Isles and northwest of them. Low pressure extended far onto the European continent with negative anomalies in the range of -2 to -6 hPa over most of central and southern Europe and -6 to -10 hPa for the west of the continent. Northern, eastern and south eastern Europe had higher mean pressure that causes an high Scandinavia Pattern index of 1.75. The positive anomalies were highest over northern Scandinavia and the Arctic Sea with 10 to 14 hPa. The strong gradients between the North Atlantic low and the Azores high allowed several cyclones to affect the British Isles and the west of the continent with high wind speeds, high sea waves and extreme precipitation that last until February.

February 2014 was characterized by low sea surface pressure below 995 hPa as monthly mean on the North Atlantic. Low pressure extended also over the western and northern European continent. The Azores high was weak and shifted southwards. The negative anomalies exceeded -14 hPa. High pressure was centred over the east with more than 1020 hPa as a mean over the eastern Ukraine, Russia and the Caucasus region and Middle East. The positive anomalies of more than 10 hPa were centred over northern Russia.

Storm on 12th February 2014 over Ireland (as provided by the Irish Meteorological Service)

The most severe windstorm occurred on the 12th February 2014 and was associated with an active depression off the south coast of Ireland that tracked steadily north-eastwards. Kinsale Energy Gas Platform recorded its highest maximum wave height of 25 m on the same day.

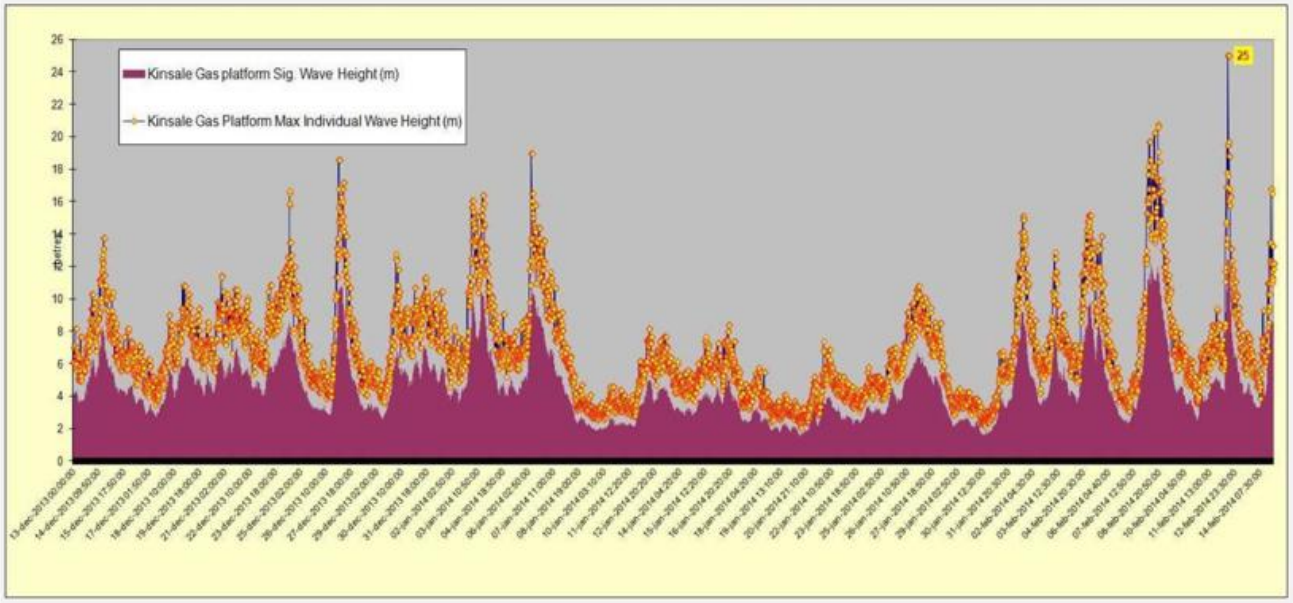


Figure 4.1: Significant and maximum wave height at Kinsale Energy Gas Platform as recorded from 13.12.2013 – 14.02.2014 (as provided by the Irish Meteorological Service).

Winds: Southeast to south gale to strong gale force 9 in the morning off the south coast, increasing to storm force 10 at midday and veered west in the evening. Increased to violent storm force 11 for a time in the south and west; backed west to southwest overnight and steadily decreased to force 5-7 by morning. Hurricane force 12 winds off the west coast

Weather: Moderate rain at first, showers merged to longer spells of rain, some wintry and thundery.

Significant Weather Event: Hurricane force winds were recorded at Mace Head, a mean 10-minute wind speed of 65 kts.

Maximum gust recorded was 86 kt, at Shannon Airport. Shannon also recorded a 10-minute mean wind speed of 61kts, its highest since records began in 1945.

Historical Context: The distinguishing feature of the weather this winter was the seemingly unending series of vigorous Atlantic storms that crossed the country. Nevertheless only one individual storm, on the 12th Feb 2014, was exceptional but not without parallel. We have had more violent storms in the past such as Hurricane Debbie in 1961, where the maximum gusts were between 70 and 85 knots generally with a maximum of 93 kt

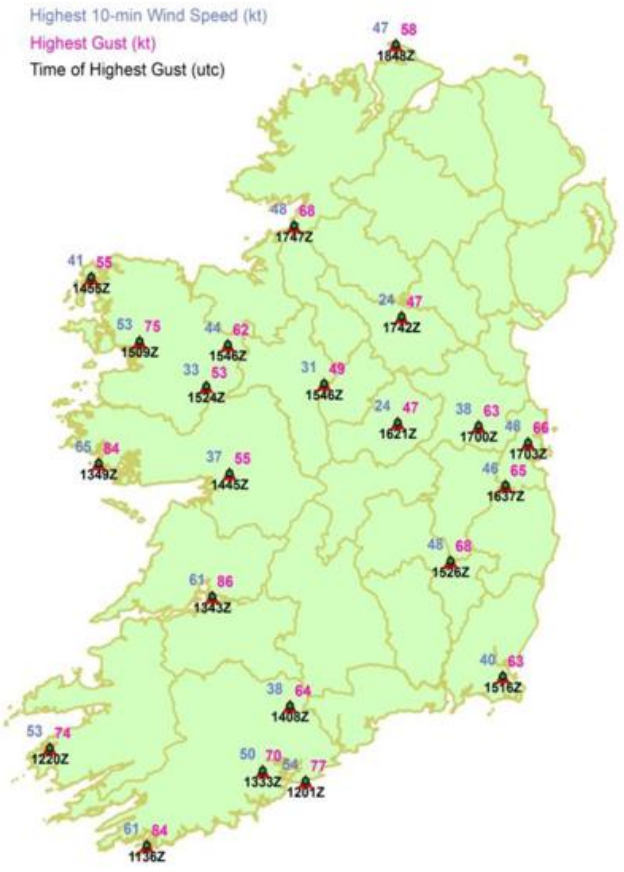


Figure 4.2: Highest 10-min wind speed (in kts), highest gust (in kts) and time of highest gust during 12th February 2014 over Ireland (as provided by the Irish Meteorological Service).

reported in the northwest. The more recent storms of 26th December 1998 and 24th December 1997 were also of greater intensity. In February 1990, an unusually long series of vigorous storms crossed the country producing record winds and rainfall amounts.

March 2014 was characterized by low pressure in the north with 2 centres, one south of Greenland below 995 hPa and another over Novaja Semlja below 1000 hPa and an Azores high above 1025 hPa shifted south-westwards. The anomalies were negative in the north and northeast with -14 hPa for the low pressure over Novaja Semlja, less than -6 hPa over Greenland and the northern North Atlantic as well as the Arctic Sea and Russia and less than -2 hPa over northern and eastern Europe. The positive anomaly of the Azores high was weak with 2 to 6 hPa.

In **April 2014** the Icelandic low was centred southeast of Greenland with 1000 to 1005 hPa and higher pressure (1015 to 1020 hPa) prevailed over the Azores and the southern North Atlantic, most of the Iberian Peninsula and parts of the western Mediterranean, western Europe, the North Sea, the Baltic region and southern Russia and the Caucasus region. The anomalies were negative over the north (down to -14 hPa) and the west. Referred to 1961-1990 nearly the whole European continent had no significant anomalies.

The anomalies of the sea level pressure in **May 2014** were positive in an area east of the Azores, over Greenland and the northern North Atlantic. They were negative in a region southeast of Greenland.

In ***June 2014*** positive anomalies above 2 hPa prevailed over the northern North Atlantic including Greenland, the British Isles and western Scandinavia. Northeast of Iceland and over parts of Greenland the positive anomalies exceeded 6 hPa. Slightly negative anomalies occurred in an area north of the Azores (-2 to -6 hPa). Except these anomalies the sea level pressure was normal.

July 2014 had higher than normal sea level pressure over northern Europe and Greenland with positive anomalies of +6 to +10 hPa over northern Russia. The anomalies over western, central and south-eastern Europe were negative as well as for Iceland.

August 2014 had lower than normal sea level pressure over the entire RA VI Region except Greenland where positive anomalies of +6 to +10 hPa occur. The lowest anomalies showed values below -6 hPa over South Norway. The NAO with an index value of -2.28 was significantly low.

In ***September 2014*** lower than normal sea level pressure were found over Southern Europe as well as the Arctic Region. Positive anomalies with values of more than +6 hPa appeared in a band from UK over Scandinavia to Estonia accompanied by positive temperature and sunshine anomalies as well as lower than normal precipitation.

October 2014 was characterized by a lower (below -6 hPa) than normal Icelandic low that was shifted to the south. In Southern Europe the pressure was normal. In north Scandinavia and Greenland the pressure anomalies reached values of more than 10 hPa. These high pressure anomalies induced positive anomalies of sunshine duration mainly above Scandinavia.

November 2014 the Icelandic Low and Azores High was more intense than normal (-14 hPa/+6 hPa) but both centres were shifted to the south-west, which resulted in a weaker influence on north-western and central Europe. Exceptional high pressure prevailed in Eastern Europe and Scandinavia with anomalies of more than 14 hPa. This pressure anomaly pattern was responsible for higher than normal temperature anomalies in western and Central Europe as well as wetter conditions in western and south-western Europe and positive sunshine duration anomalies especially in Russia.

The mean sea level pressure (slp) in **December 2014** showed an anomaly-pattern similar to the mean slp. This means that the centres of action, the Icelandic low and the Azores high were more intense than normal and shifted to the north-east. This was indicated also by the high NAO-index value of 1.63. This circulation pattern was accompanied by flow of warm air to Central Europe and heavy precipitation at the coast of the British Isles and Scandinavia. Due to the warm Mediterranean sea surface temperature more than 20 tornadoes have been observed in the Aegean Sea.

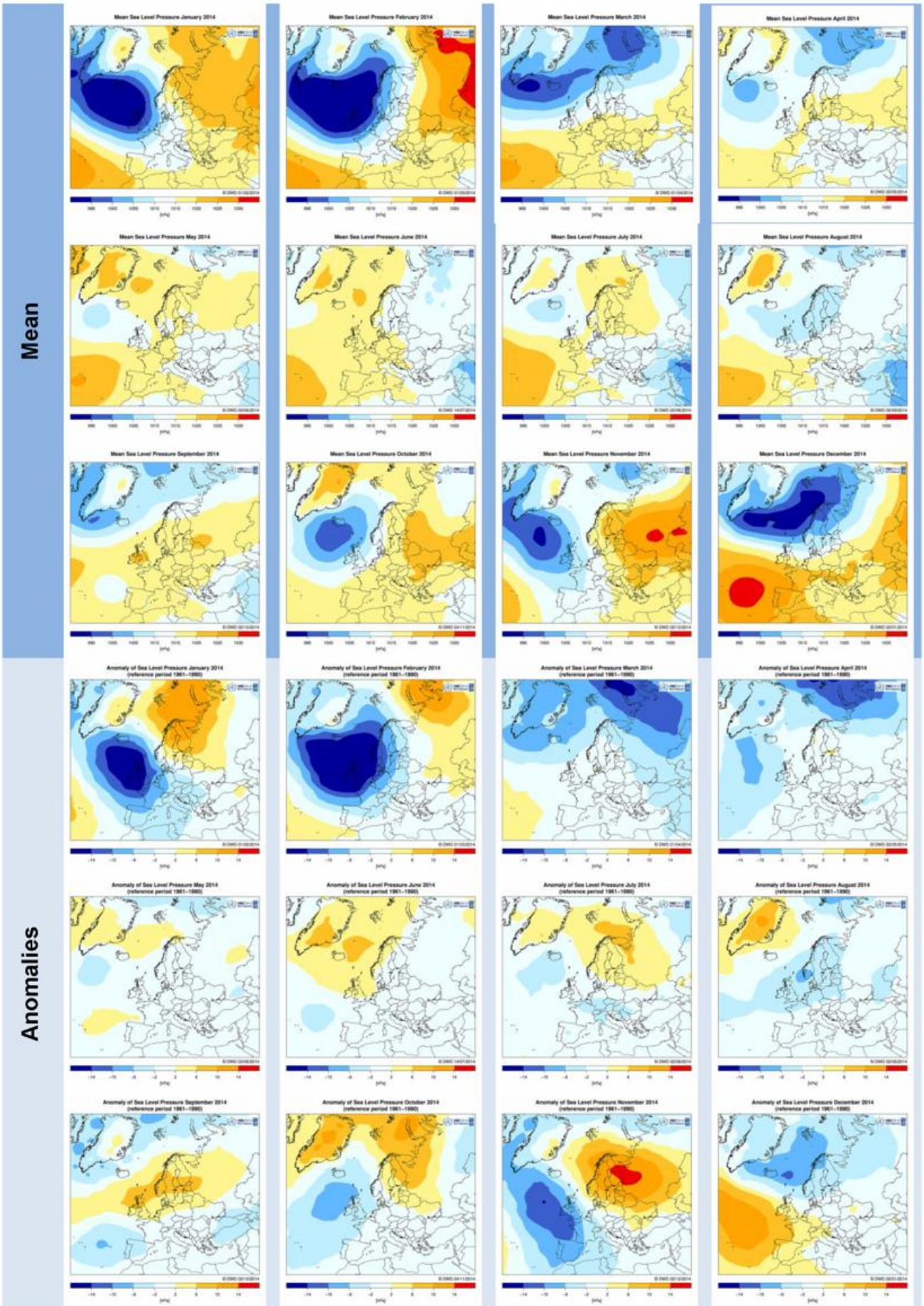


Figure 4.3: Mean and anomalies of sea level pressure in hPa for each month of the year 2014. (First column January, February, March, April)

4.2. Temperature

In most of the months and sub-regions 2014 was warmer than normal especially the winter month as can be seen from Table 4.2. In the Nordic und Baltic Countries, Iberia and the Mediterranean area each month of the year 2014 had positive anomalies.

Table 4.2: Monthly and annual area average of temperature anomalies in °C for each sub-region in the year 2014 (reference period: 1961-1990)

Region	year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Central and western Europe	1.85	2.54	3.06	3.01	2.76	0.53	1.25	1.73	-0.30	1.45	2.17	2.55	1.47
Nordic und Baltic Countries	2.09	2.69	4.20	3.83	1.74	1.16	0.55	1.89	1.76	1.92	1.03	2.39	1.88
Iberia	1.39	1.93	0.35	1.12	3.30	1.51	1.32	0.11	0.76	1.22	3.02	1.84	0.19
Mediterranean	1.56	3.23	3.18	2.49	1.32	0.16	1.17	0.27	1.07	0.36	1.38	2.33	1.81
Eastern Europe	1.58	0.94	3.91	4.34	1.08	2.33	-0.11	1.35	2.68	1.28	-1.17	0.28	2.01
Middle East	1.26	1.64	1.09	2.73	1.35	2.06	1.02	0.80	2.83	0.78	-0.06	-0.98	1.86

In **January 2014** it was warmer than normal nearly over the complete RA VI area with exception of the south-eastern Baltic Sea and parts of northern Scandinavia. Most remarkable is the positive anomaly over the Balkan Peninsula as well as over the Norwegian Sea and the Arctic Ocean with more than +4°C. On Iceland in the eastern part it was in places the 2nd warmest January since measurements started in 1873. In France it was the warmest January since 1900 together with 1988 and 1936. Also in the Netherlands January 2014 was one of the 10 warmest Januaries since 1901. In Portugal it was the 3rd warmest January since 1931 together with 1955 and 1966. It was also the 3rd warmest January since 1961 in Spain. In Austria it was the 5th warmest January since 1768. In Switzerland January 2014 ranked on place 9 of the warm Januaries since 1864. The lower level places of Switzerland north of the Alps did not register a single ice day (maximum temperature below 0°C) which is rather seldom. It was the 4th warmest January since 1961 on Malta.

In **February 2014** it was again warmer than normal in the whole WMO RA VI region. The positive anomalies were above 4°C from the Arctic Sea over Scandinavia to eastern Central Europe, eastern Europe and parts of the Balkan Peninsula as well as partly in eastern Turkey. Several Arctic stations registered new records of high February mean temperatures. The positive anomalies ranged from 4.9°C (Jan Mayen) to 14.5°C (Svalbard Lufthavn). For Jan Mayen February 2014 was the 3rd warmest on record and also the station Ekofisk in the Norwegian Sea. In Norway the positive anomalies were 6 K above normal for the whole country and it was the 2nd warmest February since 1900. In Belarus the mean temperature was 4-6°C above the normal February mean in the whole country. In Sweden several stations broke their warm February records since 1800. Latvia reports February 2014 as the 8th warmest on their record. The Netherlands report February 2014 on place 4 of the warm Februaries since 1901 (based on the station de Bilt). In Austria February 2014 was on rank 9 of the warm Februaries for 247 years.

March 2014 was much warmer than normal in Europe. In parts of Sweden it was the warmest March since 1859. Several stations registered new records of March maximum temperatures. It was the 3rd warmest March since 1900 in Norway, in Germany together with March 2002 since 1881 and in the Netherlands after 1990 and 1991 since 1901. At the station Ekofisk in the Norwegian Sea it was the 3rd warmest March since 1980. The water temperature observed here was the warmest (together with March 1990) since the start of measurements in 1980. It was the

4th warmest March since 1864 in Denmark. Also in France it was one of the 10 warmest March months for 50 years. In Austria it was the 2nd warmest March for 247 years. In Belarus it was the 2nd warmest March for more than 100 years. The mean monthly anomalies exceeded 4°C in the Arctic and the Norwegian Sea, in northern and eastern Europe except the Atlantic coastal region and southern Europe.

April 2014 was like March 2014 mostly warmer than normal. It was the 7th warmest April since 1900 in Norway (with the station Utvira fyr having the warmest April since 1868.) and 4th warmest April in Denmark (since 1883), the Netherlands since 1901, Germany (since 1881), and in Belgium (since 1960). In Austria it was the 10th warmest April in 247 years. In France it was the 5th warmest since 1900. In Portugal it was the 4th warmest April since 1961 (together with 1995).

May 2014 was warmer than normal mostly in the Arctic region and in the North Sea region including the British Isles and Denmark, in eastern Europe, in the southwest and in the southeast. In Central Europe, in the south and in Sweden it was around normal. The highest positive anomalies of more than +3°C were reached or exceeded in western European Russia. Though the monthly mean temperatures were close to normal in central and western Europe there were widely spread more warm days than normal.

June 2014 was warmer in most of the Europe except of Scandinavia and the Baltic countries with negative anomalies between -1 and -2°C. The highest positive anomalies occurred in southern France, north-western Spain, south-western Germany, Switzerland, north-eastern Italy and partly in the western Mediterranean Sea with 2 - 3°C. Similarly positive anomalies are as well recorded in the northern North Atlantic including Iceland.

June average temperature in **Israel** was close to normal, though two extreme Sharav events were recorded. On June 4th temperatures reached 42-43°C (11-12°C above the long term mean) in the coastal plain and the northwestern Negev. The Sharav continued to prevail at night, so at midnight (June 4-5th) 32-34°C were measured in the coastal plain and the northern valleys and in areas like Haifa region and the Lower Galilee, midnight temperatures reached 35-38°C. Such high temperatures at night are very unusual (Figure 4.4). The second Sharav event, on June 27-29th, was a prolonged one. The warmest areas during this event were the eastern Valleys, where 42-45°C were measured (5-7°C above average). In Elat, at the southern end of the eastern valleys, a new high record for June was set: 47.9°C. This value is also the second highest for the whole year.

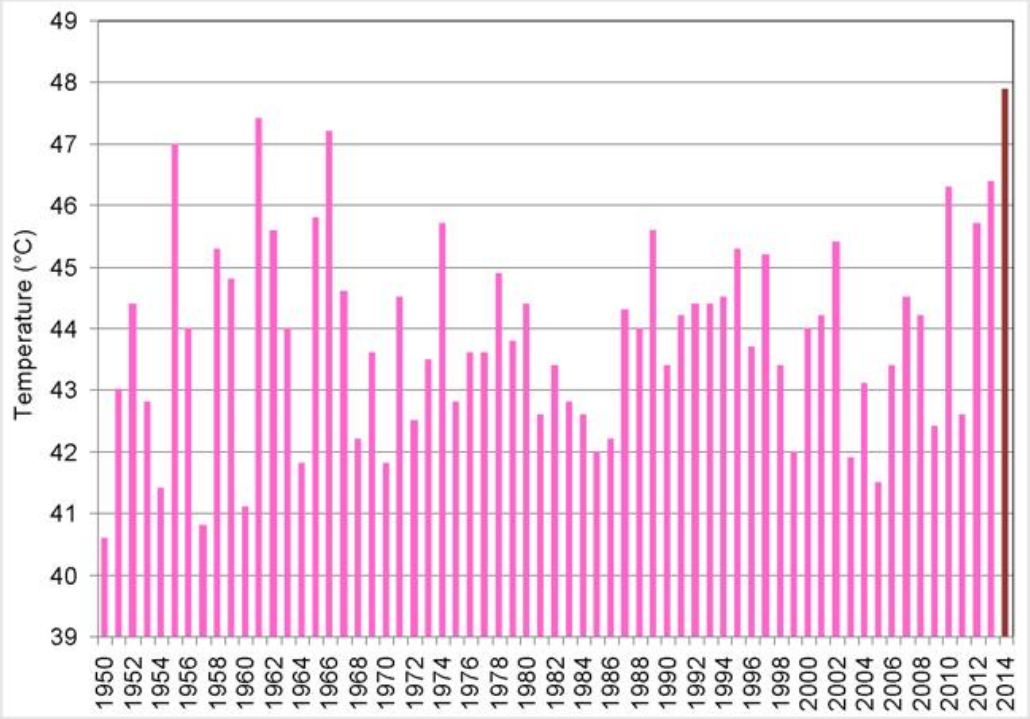


Figure 4.4: Highest maximum temperature (°C) in Elat (southern Israel) for each year in June 1950-2014 (Source: Israel Meteorological Service)

July 2014 was warmer than normal in northern, central and south-eastern Europe and colder than normal in north-eastern Europe. Slightly colder or close to normal was southern Europe. The highest positive anomalies of more than 4°C were registered in Scandinavia. On Iceland July was the 2nd warmest July since 1984 in the north and the 3rd warmest since 1972 in southern parts. In Norway it was the warmest July since 1900 with a positive anomaly of +4.3°C. In Denmark July 2014 was the 2nd warmest since 1874.

August 2014 was warmer than normal in northern, eastern and southern Europe, colder than normal or normal in central Europe. The highest positive anomalies of more than 4°C were registered around the Caspian Sea.

The temperature for **September 2014** showed for the whole WMO Region VI positive anomalies. The highest positive anomalies of more than 3°C were registered in Iceland and parts of Africa. In Ireland the Valentia Observatory and Cork Airport reported 1.7°C and 1.6°C above their average mean temperature, the warmest September for Valentia since 1991 (23 years) and since Cork Airport opened in 1962 (52 years).

The temperature for **October 2014** showed for western and southern Europe positive anomalies. The highest positive anomalies of more than 3°C were registered in Spain, Switzerland, Germany and Denmark. In Norway it was the warmest October since 10 years. The average monthly temperature in Denmark was 12.1°C therefore this was the second warmest October since measurements began (1874). This was only 0.1°C below the warmest October in the year 2006, which was 12.2°C. This October was also the third-warmest since measurements began in Germany with anomalies of 2.1°C.

The temperature in **November 2014** showed for most of the area positive anomalies. The highest anomalies of more than 4°C were registered in northern Italy, Austria and Iceland. Negative anomalies were found in East Europe with values below -4°C.

In Austria the November 2014 was 3.6°C warmer than the average for 1981-2010. This was the warmest November in the 248-year temperature measurement followed by the November of 1926 with 3.4°C.

Several stations in Switzerland also observed all-time records of temperature. Monthly mean temperature in Reykjavík, Iceland, was 5.5°C or 4.3°C warmer than the average for the period 1961-1990 and 3.2°C above the average of the last 10 years. Thus it was the second in the rank of the warmest Novembers since the beginning of measurements. In Akureyri the averaged monthly temperature was 3.4°C, that was 3.7°C above the 1961-1990 average.

The temperature in **December 2014** showed for most of the area positive anomalies. The highest anomalies of more than 4°C were registered in Finland, the arctic Russia and Turkey. Negative anomalies exist only in southwest Europe and Kazakhstan. The last days of December in many parts of Europe, except Northern Europe and Turkey were conditioned by a cold snap.

In December 2014 the central western part of Finland was more than 4.0°C warmer than the average for 1981-2010.

In Lugano (Switzerland) the December temperature reached 2.6°C above normal (1981-2010), the highest December mean since measurements began in 1864, and was 0.4°C above the last record from December 1953.

In Turkey at stations Florya and Edremit new all-time records of maximum temperature were observed.

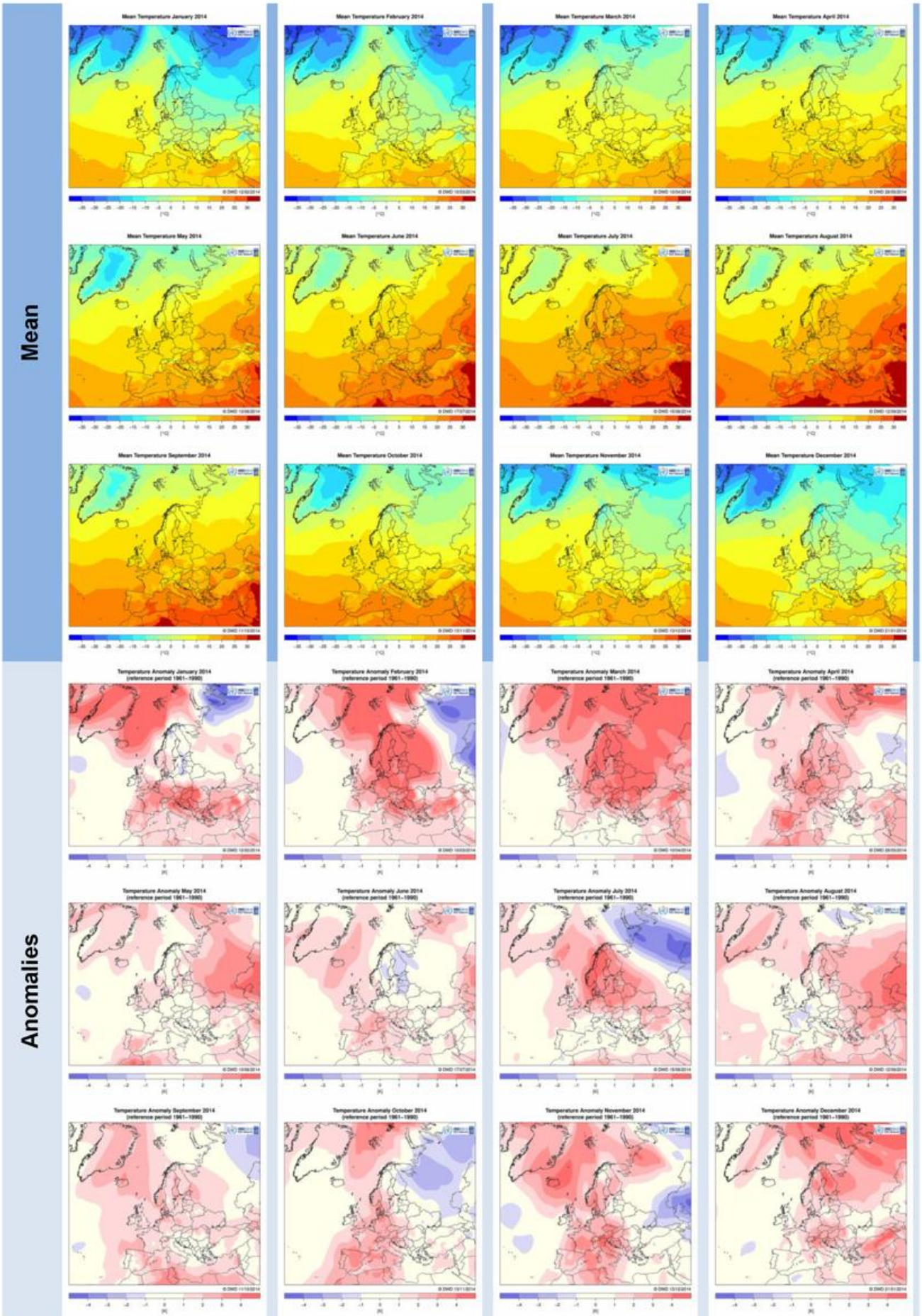


Figure 4.5: Mean and anomalies of temperature (in °C) for each month of the year 2014. (First column January, February, March, April)

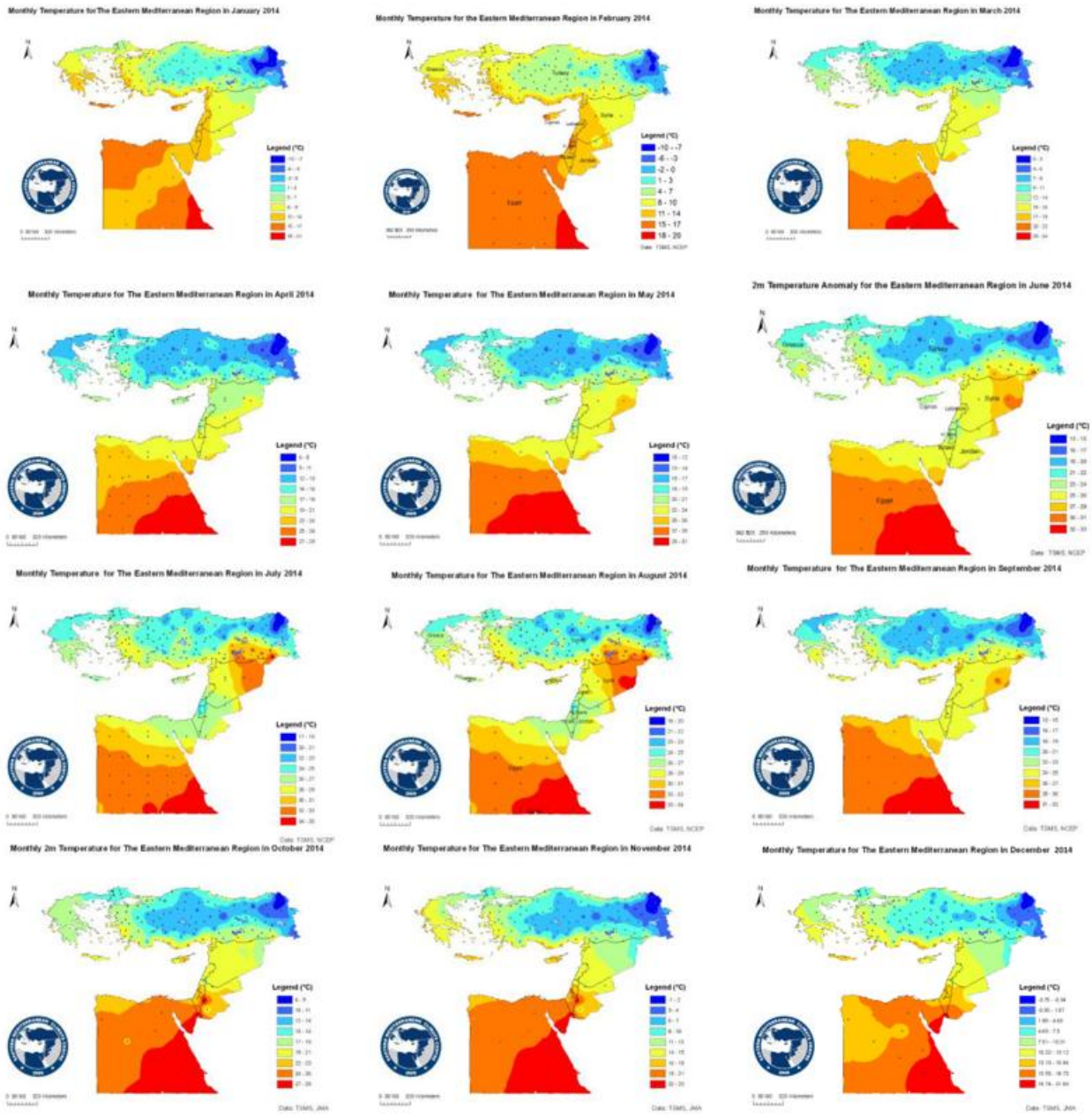


Figure 4.6: Monthly mean temperature (°C) for the Eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC)

4.3. Precipitation

In ***January 2014*** more precipitation than normal fell over the northern North Atlantic, the North Sea, in western and southwestern Europe including the Iberian Peninsula, the western Mediterranean Sea with the Adriatic Sea, in eastern Central Europe, the eastern Balkan Peninsula and southern Russia. It was drier than normal in most of northern Europe, in Central Europe and on the western northern Peninsula as well as in Turkey and the eastern Mediterranean Sea. The positive anomalies were remarkably high at the Atlantic coasts, in southern France and the southern Alpine region and the eastern Adriatic coast where heavy rainfall contributed much to flooding.

The UK overall received 151% of average rainfall making it the third wettest January in the series. A broad region from east Devon to Kent and up to the central midlands received 200 % and some locations 300%. Parts of eastern Scotland were also similarly wet, with in excess of twice the normal rainfall. It was also the wettest January in the England and Wales precipitation series that is based on a much smaller network of rain gauges, but extends back to 1766, with January 1948 being the closest comparable to January 2014. It was not wet everywhere parts of northern

Scotland were significantly drier than average. In France January 2014 was overall one of the 10 wettest Januaries since 1959. In parts of Austria (Osttirol, Oberkärnten) it was the wettest January since 1917 while easterly parts of the country were drier than normal. The last decade of January 2014 brought cold air from Russia and Scandinavia to Central Europe and precipitation fell as snow so that the covered area grew compared to December 2013 in northern, central and eastern Europe. Generally there was not much snow in January 2014 in the northern Alps but episodes of very intense snowfall led to higher totals of freshly fallen snow than the mean of 1981-2010 for instance in places in Austria or Switzerland in the southern Alps.

February 2014 was wetter than normal in western and southern Europe, in Sweden, southern Norway and Denmark as well as in eastern parts of the Baltic States and in northern Russia. It was also wetter than normal in the southern Alpine region and the north-western Adria, especially in Slovenia. Switzerland reported monthly totals close to new records for February at some stations. At Lugano the 2nd highest total was registered since 1864. The region Bretagne in northwestern France had its wettest February since 1959 with 200% to 300% of the long-term mean. For the whole country it was the 4th wettest February since 1959. It was as well the 4th wettest February in UK with 184% of the 1981-2010 long-term reference. Valentia Observatory in Ireland reported its wettest February since records began in 1866 (148 years) with 292.4mm and 236% of the long-term average. In southern Norway more than 300% of the normal February rainfall was recorded as well and in a smaller region even 400% were exceeded. In Slovenia at the beginning of February 2014 4-day totals between 130 mm and 400 mm occurred. It was drier than normal in eastern Central Europe as well as on the eastern Balkan Peninsula, southern Ukraine and southern Russia, the eastern Mediterranean and Middle East. In parts of eastern Central Europe, north of the Black Sea in Middle East (cf. Figure 4.7) and in parts of the Levante monthly totals were below 10 mm, partly even below 1 mm. Rather dry was as well most of Norway. Due to the warm temperatures southern Sweden, western, central and southern Europe, the Mediterranean, most of the Balkan Peninsula and most of Middle East had few snow. Exceptions were the Alps and eastern Romania.

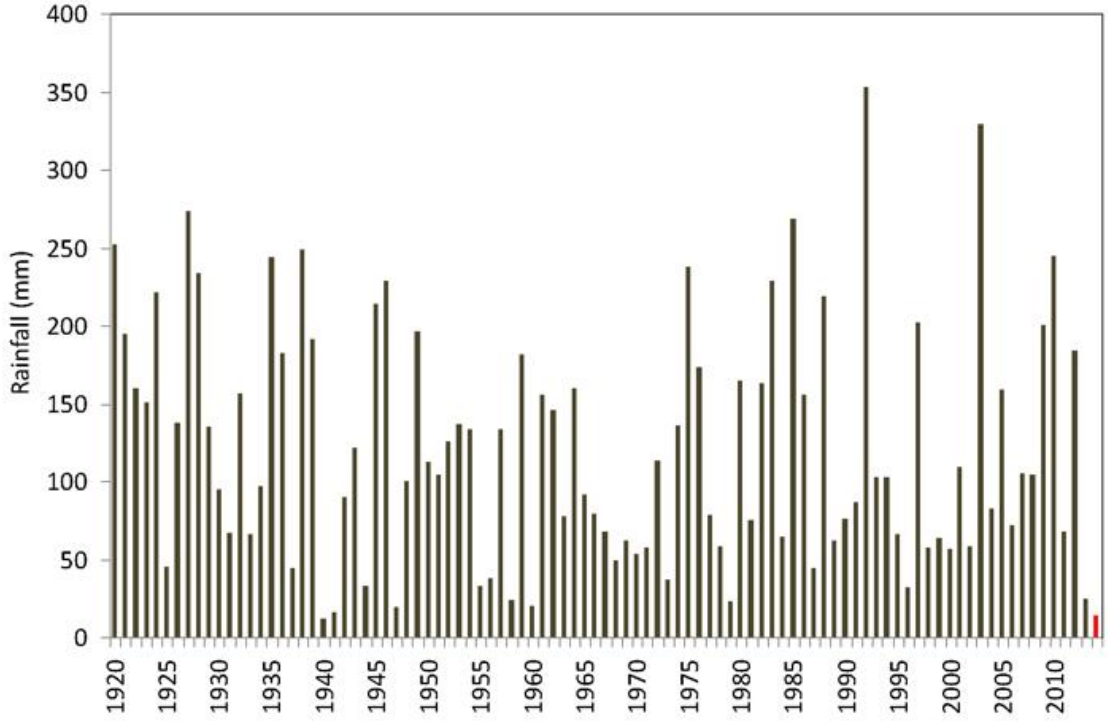


Figure 4.7: Monthly rainfall (mm) in Jerusalem in February 1920-2014 (Source: Israel Meteorological Service)

March 2014 was very dry in western and central Europe, the northern Balkan Peninsula, most of the Iberian Peninsula and eastern Europe and western Russia. In France, the Netherlands and Germany precipitation was below 40% of the normal, partly in Germany and France even below

20%. March 2014 was in France not as dry as in 2012 but in the region of the Alsace it was the driest March since 1959. March 2014 has been the 5th driest March in Germany since 1881. In northern Spain it was partly wetter but the whole country resulted close to normal. A daily total of 121 mm occurred in Puerto de Navacerrada on 1 March. The Norwegian coastal region, Poland and the eastern Balkan Peninsula, southern Russia and Middle East as well as the eastern Mediterranean were wetter than normal. For Norway 2014 was the 7th wettest March since 1900.

April 2014 was wetter than normal on the Balkan Peninsula and southern Italy as well as in Scandinavia at the Atlantic coasts and in eastern parts of European Russia. It was drier than normal mainly in central Europe, in the central parts of Sweden and in southern Finland and western European Russia as well as the Baltic states, in Belarus and in the eastern Mediterranean Sea and Middle East. Elsewhere it was close to normal. For instance in Austria the station Retz had the lowest precipitation total for the period October to April since 1895. In France it was the 14th driest April since 1959. In Germany it was the 41st driest April since 1901 and the 49th driest since 1881. April 2014 brought partly heavy thunderstorms with heavy to extremely heavy precipitation (partly as snow) in the Mediterranean region (inc. the Iberian Peninsula) and the Balkan Peninsula. The precipitation surplus on the Balkan Peninsula corresponds to totals above the 80th percentile (based on the 1981-2010 reference).

May 2014 was wetter than normal in western and central Europe, most of the northern European continent as well as on the Balkan Peninsula, western Turkey and the eastern Mediterranean Sea area. Drier than normal were Iceland, western Scandinavia, the Iberian Peninsula, southern France and northern Italy, Greece, most of western European Russia and Middle East. The precipitation surplus in the southeast as well as in the northwest exceeded the 80th percentiles (1981-2010 reference). They were due to very heavy to extremely heavy precipitation events.

Report from the Republic Hydrometeorological Service of Serbia

May 2014 in Serbia was marked by precipitation that was significantly above the average values. Record breaking daily precipitation sums were registered at Valjevo, Loznica and Belgrade principal meteorological stations. Total 3-day precipitation amount exceeded 1000-year return period sum, in parts of western and central Serbia.

The total May amount of precipitation compared to the normal for the 1961-1990 base period was in a range between 134% in Kursumlija and 394% in Belgrade.

The highest precipitation amount was recorded in the period 14 – 16 May 2014, when the sums ranged between 26.3 mm in Kursumlija and 213.2 mm in Loznica.

The highest 3-day precipitation sums were registered in western and parts of central Serbia (above 100 mm) which is above the average for May (Figure 4.8).

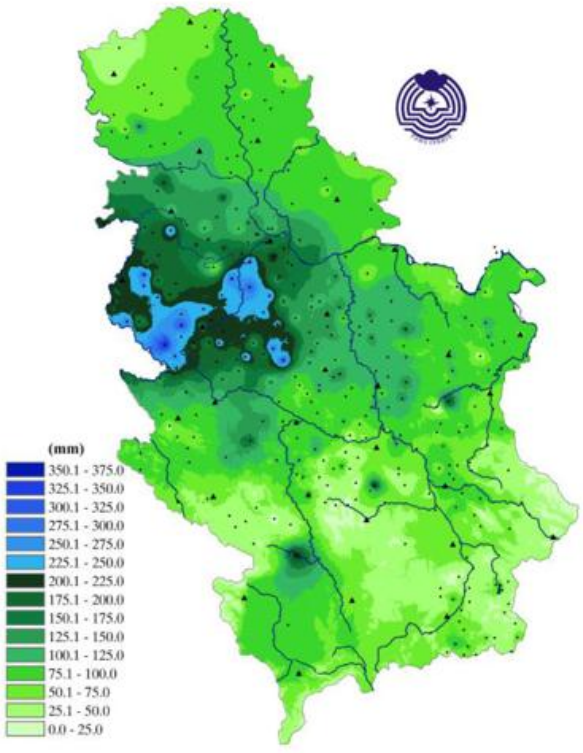


Figure 4.8: Spatial distribution of 3-day precipitation sums for the period 14 - 16 May 2014 in Serbia based on the data obtained from meteorological, climatological and precipitation stations (Source: Republic Hydrometeorological Service of Serbia)

June 2014 was drier than normal in central, western and south-western Europe. In Germany it was the 11th driest June since 1901 and the 14th driest since 1881. In the southern part of Germany

the drought conditions were classified as severely dry. More - partly much more - precipitation than normal fell in western Turkey and on the Balkan Peninsula, especially in Romania as well as in European Russia and the Baltic states.

In ***July 2014*** was wetter than normal in western and south-eastern continental Europe and most of central and southern Europe and parts of Middle East. Wetter than normal was also the eastern part of European Russia. Drier than normal were the British Isles, most of northern and eastern Europe and southern Iberia, Sicily and western Turkey. July 2014 was the 9th wettest July since 1901 and the 10th wettest since 1881 in Germany. July 2014 brought many heavy precipitation events in connection with convective activity which mostly contributed to the precipitation surplus.

August 2014 August 2014 was wetter than normal in most parts of Europe except southern Europe, and parts of Middle East, and the southern part of Russia and Ukraine. A precipitation affected the northwest quarter of France with an amount reaching one and a half to three times of the normal.

September 2014 was drier than normal in western, northern and eastern Europe. In the UK it was the second driest September in a series from 1910, and only 1959 was drier. In Portugal several stations reported more than 300% of relative precipitation, also the absolute values ranges between 100 and 160 mm. From central Europe over the Balkan Peninsula and Turkey a band of high monthly precipitation totals occurred with more than 300 mm in Italy even 479.3 mm at station Monte S. Angelo. The relative precipitation anomalies show also dramatic values of 400% above normal in this region. In Montenegro the monthly precipitation totals ranged from 137 to 503 mm or 168% to 455%.

The precipitable water anomalies show for the whole Mediterranean values of up to 8 mm or more than 3 standard deviations. Two peaks are remarkable one above Costa Brava/Gulf of Lions and the other western off the Spanish/French Atlantic coast.

October 2014 was drier than normal in eastern Spain, southern France and Italy. In northern Scandinavia and Russia as well as over an area extended from Poland, Belarus, Ukraine and Russia till Kazakhstan, lower precipitation amounts were observed.

Some of the Norwegian stations registered more than 250% of the normal precipitation resulting in many floods. The Balkan and Turkey received more than normal precipitation, locally more than 200%. In Italy were also heavy precipitation registered at some stations eg. at station Termoli, both the daily extreme increased from 65.1 to 91.6 mm, and the monthly extreme, increased from 130.8 to 168.8 mm.

9-10 October: the province of Genova was hit by an intense thunderstorm with maxima cumulated rain over the two days of 569.6 mm at the station of Geirato. During this event several rivers overflew and the event was followed by several other minor local intense event and floods which produced a substantial destabilization of the slopes, making the territory more vulnerable.

13 October: the province of Parma (Emilia-Romagna) was hit by an intense thunderstorm. Maximum intensities recorded during the event were 81.8 mm in 1 hour at Marra, but many station over the Apennines in this province recorded more than 30 mm in 1 hour for several consecutive hours. Maximum daily accumulated precipitation in that day reached a maximum of 302.4 mm at the station of Marra. (as provided by the Servizio Idro-Meteo-Clima ARPA EMILIA-ROMAGNA)

The anomalies in **November 2014** showed negative values in Central and Eastern Europe. In Portugal, Spain, southern France, Switzerland, southern Austria and northern Italy observed higher precipitation.

The surplus amounted in Austria of up to 254% at station Kötschach-Mauthen. The precipitation sum observed in Switzerland reached at station Lugano 587 mm or 462%. Many other stations reported heavy precipitation as a result floods occurred at Lago Maggiore and Lago di Lugano.

In southern France five episodes of heavy precipitation were observed with up to 500 mm. Many monthly records were broken eg. 318 mm in Oletta, 387 mm in Lanas, 563 mm in Nice and 575 mm in Bormes-les-Mimosas.

According to TSMS's Flash Flood Guidance System (FFGS), heavy precipitation was expected in Marmaris on 13 November 2014 at 18:00 UTC. This forecast was published as warning by TSMS. Marmaris's normal rainfall for November is 171mm. But on 13 November 244mm rainfall received in one day. Due to this heavy rainfall, Beldibi River overflowed; landslides occurred on some village roads, muddy water covered some of the shops and basements, urban traffic was disrupted temporarily. There were no casualties but some property damages.

Table 4.3 Rainfall intensity analysis of Marmaris on 13.11.2014 **(**as provided by the Turkish State Meteorological Service**,** TSMS**)**

Start Date	Start Time	End Date	End Time	Duration (min)	Amount (mm)	Intensty (mm/ha)
13.11.2014	20:10	13.11.2014	20:14	5	**19.6**	235.20
13.11.2014	20:10	13.11.2014	20:19	10	**36.8**	220.80
13.11.2014	20:05	13.11.2014	20:19	15	**50.2**	200.80
13.11.2014	19:50	13.11.2014	20:19	30	**80.8**	161.60
13.11.2014	19:20	13.11.2014	20:19	60	**135.8**	135.80
13.11.2014	18:23	13.11.2014	20:22	120	**158.4**	79.20
13.11.2014	18:09	13.11.2014	21:08	180	**168.6**	56.20
13.11.2014	17:29	13.11.2014	21:28	240	**170.2**	42.55
13.11.2014	16:48	13.11.2014	21:47	300	**172.0**	34.40
13.11.2014	16:15	13.11.2014	22:14	360	**172.8**	28.80
13.11.2014	19:03	14.11.2014	03:02	480	**191.6**	23.95
13.11.2014	17:16	14.11.2014	05:15	720	**240.8**	20.07
13.11.2014	11:55	14.11.2014	05:54	1080	**244.0**	13.56
13.11.2014	06:00	14.11.2014	05:59	1440	**244.0**	10.17

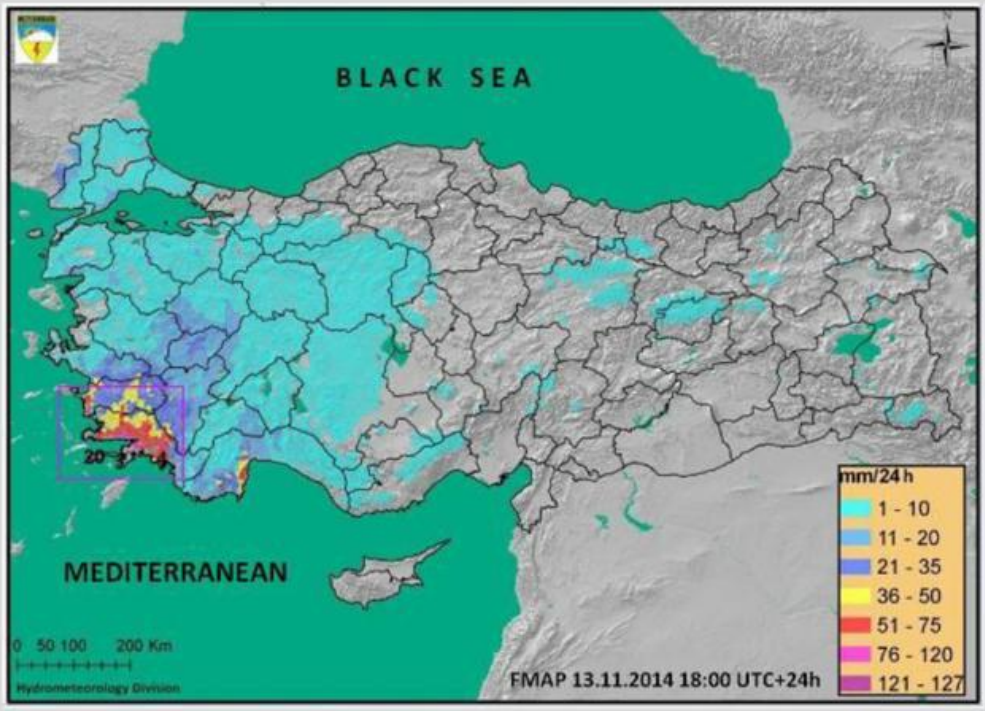


Figure 4.9: 24-hour areal precipitation forecast (left), rainfall intensity analysis of Marmaris (as provided by the Turkish State Meteorological Service, TSMS)

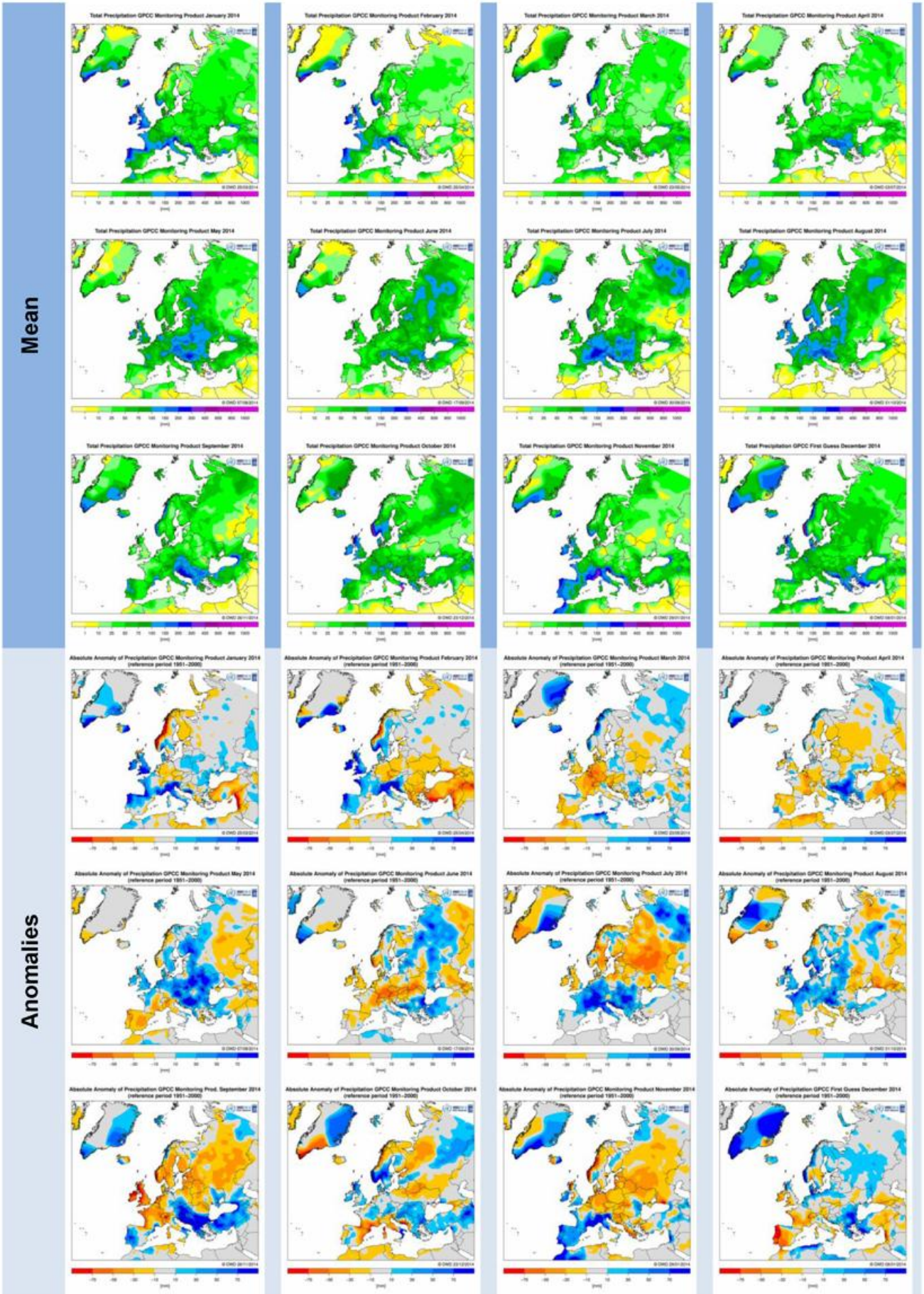


Figure 4.10: Mean and anomalies of precipitation (in mm/month) for each month of the year 2014. (First column January, February, March, April)

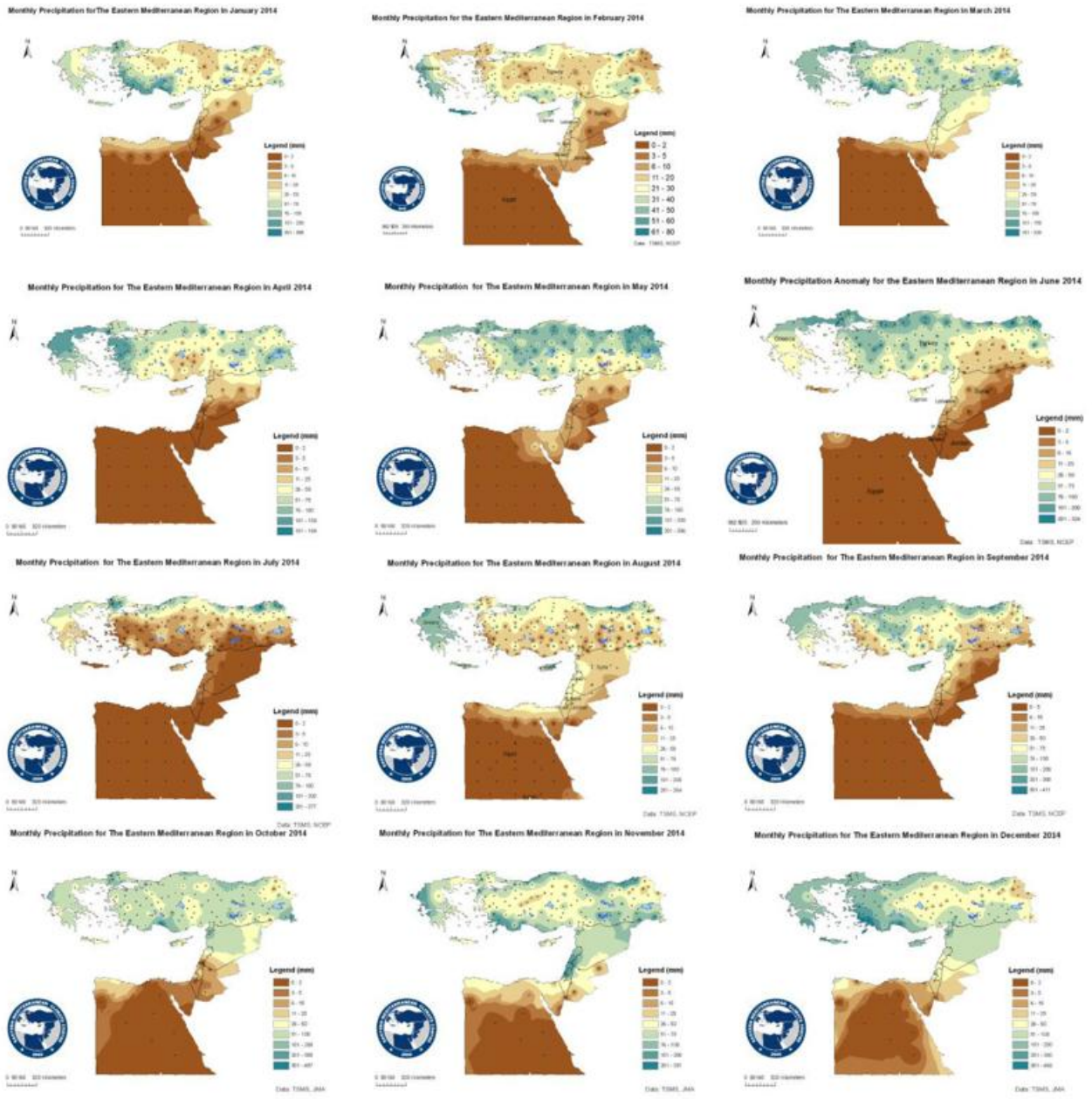


Figure 4.11: Monthly precipitation totals (mm) for the Eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC)

4.4. Sunshine duration

January 2014 was sunnier than normal mainly over European Russia and the eastern parts of the Baltic Sea area. In western Central Europe, the south of the British Isles, parts of the Balkan Peninsula, on Sicily and eastern Turkey it was partly sunnier than normal as well but the pattern was very variable. Less sunshine than normal prevailed in the northwest, in the west, in the south and in the southeast of the region.

February 2014 was mostly sunnier than normal from western Europe to the Middle East, while it was dull in Scandinavia and most of eastern Europe as well as in the southwest and south. France received less sunshine than normal except the north-western part of the country. In Poland and eastern Germany the sunshine surplus exceeded 150% as well as in parts of Turkey and Middle East. Below 25% of sunshine were recorded in Finland and adjacent parts of Russia. The cloudy conditions reduced the outgoing longwave radiation and Finland observed the second warmest February on record with temperature anomalies of up to +8.2°C

Most of the European continent was sunnier than normal in **March 2014**. In south-eastern UK, central, northern and eastern France, the Netherlands, most of Germany, eastern Austria and central Poland and parts of the Czech Republic, Slovakia and Hungary as well as in eastern Ukraine and southwestern Russia the anomalies were above 50%. March 2014 has been the sunniest March in the Netherlands since 1901 and in France the sunniest since 1950. It was the 3rd richest March in sunshine since 1951 in Germany.

April 2014 was sunnier than normal in large parts of the European continent with exception of the far north, the east, the Balkan Peninsula and mostly the Atlantic west coast. It was sunniest around the Baltic Sea. The monthly sunshine duration in Lithuania amounted to 240–290 hours or 60–98 h longer than normal.

May 2014 was sunnier than normal on the Iberian Peninsula and the western Mediterranean, in northern Scandinavia, in eastern central Europe and on the northern Balkan Peninsula as well as in most of European Russia except the north. It was dull in Ireland and on the British Isles, in central Europe, the Baltic States, around the Black Sea and in Middle East. In Ireland sunshine totals were all below average with percentage of LTA values and total sunshine hours ranging from 56% and 98.7 hours.

June 2014 was sunnier than normal in most of western, central and eastern central Europe as well as in most of central Finland. More than 125% of the normal sunshine duration was registered in western England, eastern France, southern Germany, in Poland, Austria, Slovakia and parts of Hungary as well as in central Finland. It was less sunny than normal around the North Sea, in the North, in Eastern Europe, the Balkan Peninsula and Middle East. June 2014 in Austria was the sunniest since the year 2003. The sunshine duration was 28 % above the average 1961-1990.

July 2014 was sunnier than normal in northern and eastern central Europe as well as northern Europe. In Sweden, Norway, Finland and Poland the surplus partly exceeded 50%. Denmark recorded the 7th sunniest July since 1920. Sweden registered more sunshine than normal at all stations. Most sunshine had station Luleå with 407 hours. Eastern Europe and also parts of France, Switzerland and Italy received less than 75% of the normal sunshine duration.

August 2014 was sunnier than normal in northern, and Eastern Europe. In parts of Siberia the surplus partly exceeded 25%. Remarkably less than normal sunshine was recorded in central Europe and also parts of France. Turkey received less than 25% of the normal sunshine duration.

September 2014 was sunnier than normal in northern, and Eastern Europe. In Sweden a new record of sunshine duration in Stockholm (the series started 1908) and other stations were registered. In Finland and Poland the surplus partly exceeded 50%. Remarkably less than normal sunshine was recorded in central and southeastern Europe. Parts of Kazakhstan received less than 50% of the normal sunshine duration. New record for sunshine was recorded in Sweden with 243 hours.

In ***October*** higher than normal sunshine duration was measured in eastern Spain, southern France, Italy, northern Scandinavia, Baltic countries, Poland, Belarus, Ukraine and western Russia.

In a band from UK across Central Europe, the Balkan to Turkey the sunshine duration was below normal.

Higher than normal sunshine occurred in ***November*** in a band from the Netherland and Belgium through northern Germany, Poland, Belarus, Ukraine to western Russia. In southern Europe the sunshine duration was below normal and accompanied by rainy clouds.

The UK received 152% of the average sunshine hours, and it was the second sunniest **December** in a series from 1929 whereas Northern Europe showed a lack of sunshine receiving only 25% of the long term mean. In southern Scandinavia, Iberia, the Balkan, Ukraine and Belarus the anomalies of the sunshine duration showed values of more than 150%.

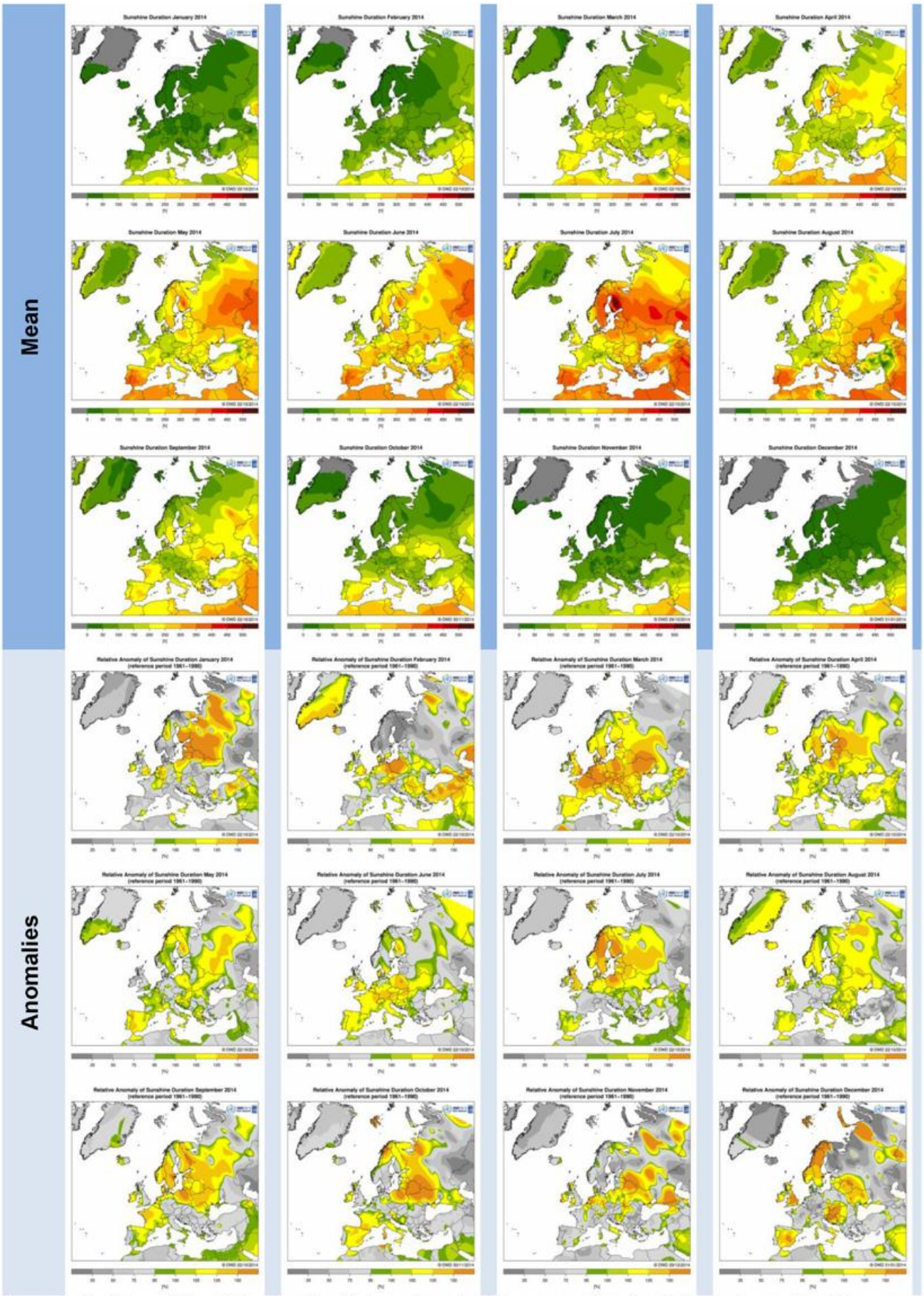


Figure 4.12: Mean of Sunshine duration (in hours) and relative anomalies (in %) for each month of the year 2014. (First column January, February, March, April)

4.5. Monthly climate extremes and events

The following maps are based on different data (as noted in parentheses) and should summarize the weather conditions in each month of the year 2014.

From January to March 2014 in Northern and Central Europe the monthly temperature anomalies were 4°C warmer than the normal and the number of warm days (exceeding the 90th percentile) were above normal. The areas at the Atlantic costs and the British Isles were affected by strong wind gusts.

In April and May in the Balkan the number of wet days (exceeding the 95th percentile) was higher than normal and caused flooding.

In June in many parts of Scandinavia the number of cold days (below the 10th percentile) was above the long term mean while the remaining parts of Europe showed more number of warm days.

Eastern Russia and the western Mediterranean showed in July cold anomalies and more number of cold days than usual. Most of Europe showed also a higher number of wet days.

In August Western Europe was affected by more cold days while Central and Northern Europe showed again higher number of wet days.

Greenland and Norway was affected in September by strong wind gusts. Central and Northern Europe showed again higher number of warm and wet days that continued in October.

During November and December most parts of Europe showed a higher number of warm and wet days. Norway, the Baltic States and in the Gulf of Lions were affected by strong wind gusts in November and December.

The Monthly Event Map contains information about the extreme anomalies of temperature, precipitation and wind gusts. Point are calculated from station data and represent the number of very warm or cold days, the locations of strong wind gusts (>=32 m/s) and days with precipitation. If more than one extreme anomaly occurs at the same location, the point is subdivided into several different colours. Coloured areas are based on interpolated gridded data for temperature (land and ocean) and precipitation (only land areas). If more than one extreme anomaly occurs at the same grid, the area is shaded.

Legend of Figure 4:13:

- Anomaly of very wet days > 0 (ECAD)
- Wind gusts (>=32 m/s) (SYNOP)
- Anomaly of warm days > 0 (ECAD)
- Anomaly of cold days > 0 (ECAD)
- Anomaly of TG ≤ -4K (CLIMAT and ship obs.)
- Anomaly of TG ≥ 4K (CLIMAT and ship obs.)
- Aridity index < -1.5 modified SPI (GPCC)
- RR ≥ 150% of climatology (GPCC)

Based on climatology 1961-1990 (GPCC climatology: 1951-2000)

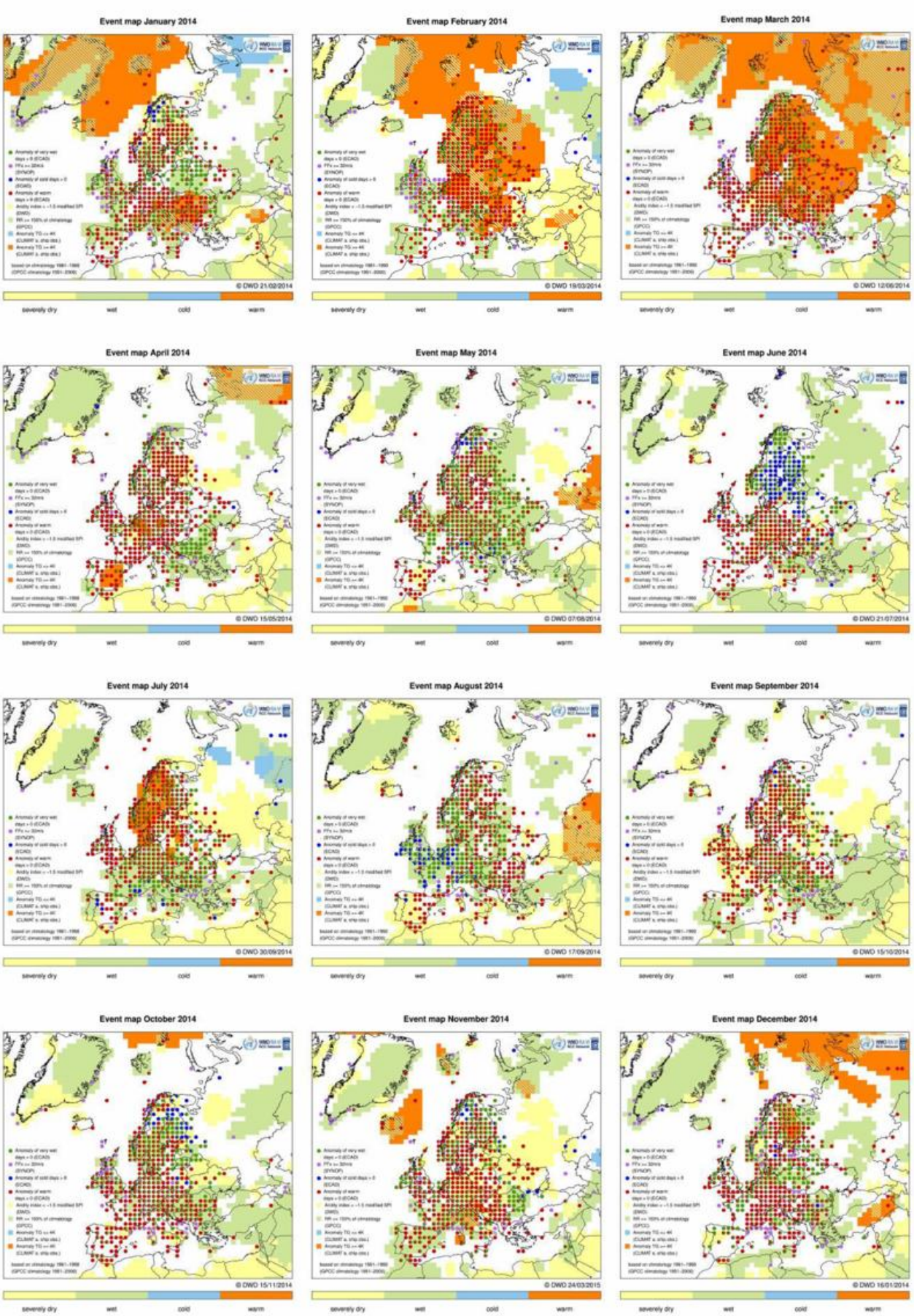


Figure 4.13: Map of Climate Extremes for each month of the year 2014.

5. Long-term variability of the selected climate parameters - Regional examples

On the following pages graphs of long time series of temperature, precipitation and sunshine duration as provided by the national meteorological services (NMHSs) are presented to give an overview of the temporal development of the basic climate elements. The graphs are grouped with respect to the 6 sub-regions defined above (Figure 1.1). An overview about the contributed countries, the time series lengths and the area representativeness can be found in Table 5.1. Most are temperature time series. Each sub-region is at least represented by one country. Time series of precipitation totals are fewer but each sub-region is represented with at least one time series for precipitation. Diagrams of long-term annual sums of sunshine duration are provided by 4 countries and they belong to different sub-regions.

After this, we present examples of the temporal development of other temperature related phenomena, such as the sea surface temperature in the North Sea and sea level anomalies at the Polish station Władysławowo.

Table 5.1: Availability of the long-term records of temperature, precipitation and sunshine duration from some participant countries.

		Temperature		Precipitation		Sunshine Duration	
Sub-region	**Country**	**Spatial Mean1**	**Single Station**	**Spatial Mean**	**Single Station**	**Spatial Mean**	**Single Station**
Central and Western Europe	Austria	1768					
	Belgium		1833				
	France	1900					
	Germany	1881		1881		1951	
	Hungary	1901		1901			
	Luxembourg	1947					
	Poland	1951					
	Switzerland	1864		1864		1959	
Nordic and Baltic Countries	Denmark	1873		1874		1920	
	Finland	1900					
	Greenland		1873				
	Iceland		1871				
	Latvia	1924		1924			
	Lithuania	1961					
	Norway	1900		1900			
	Sweden	1860		1860			
Iberia	Portugal	1931		1931			
	Spain	1961					
Mediterranean, Italian and Balkan Peninsula	Croatia		1862				
	Italy	1961		1951			
	Slovenia		1951		1951		
	Turkey	1971		1971			
Eastern Europe	Belarus	1881		1891			
	Russia	1939		1966			
Middle East	Georgia	1961	1881	1961	1881		
	Israel	1951					

5.1. Temperature

Central and Western Europe – annual temperature series

Austria, Belgium, France, Hungary, Germany, Luxembourg, Poland, Switzerland

Austria

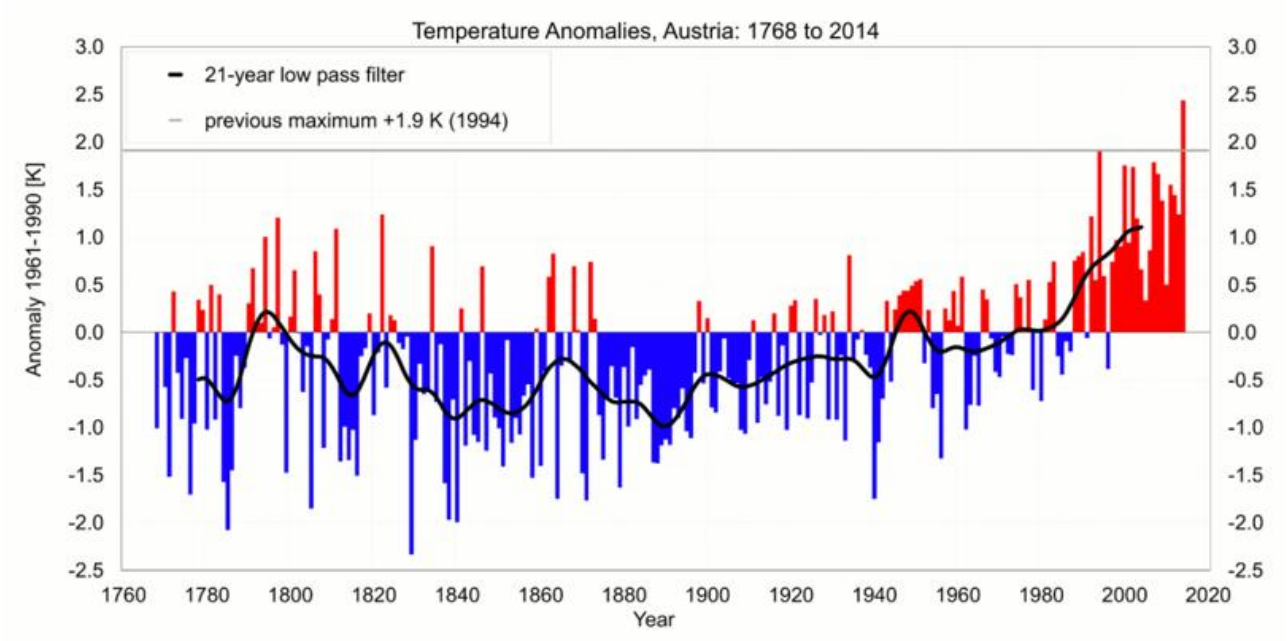


Figure 5.1: Time series of annual mean temperature for Austria (Diagram as provided by the NHMS)

Belgium

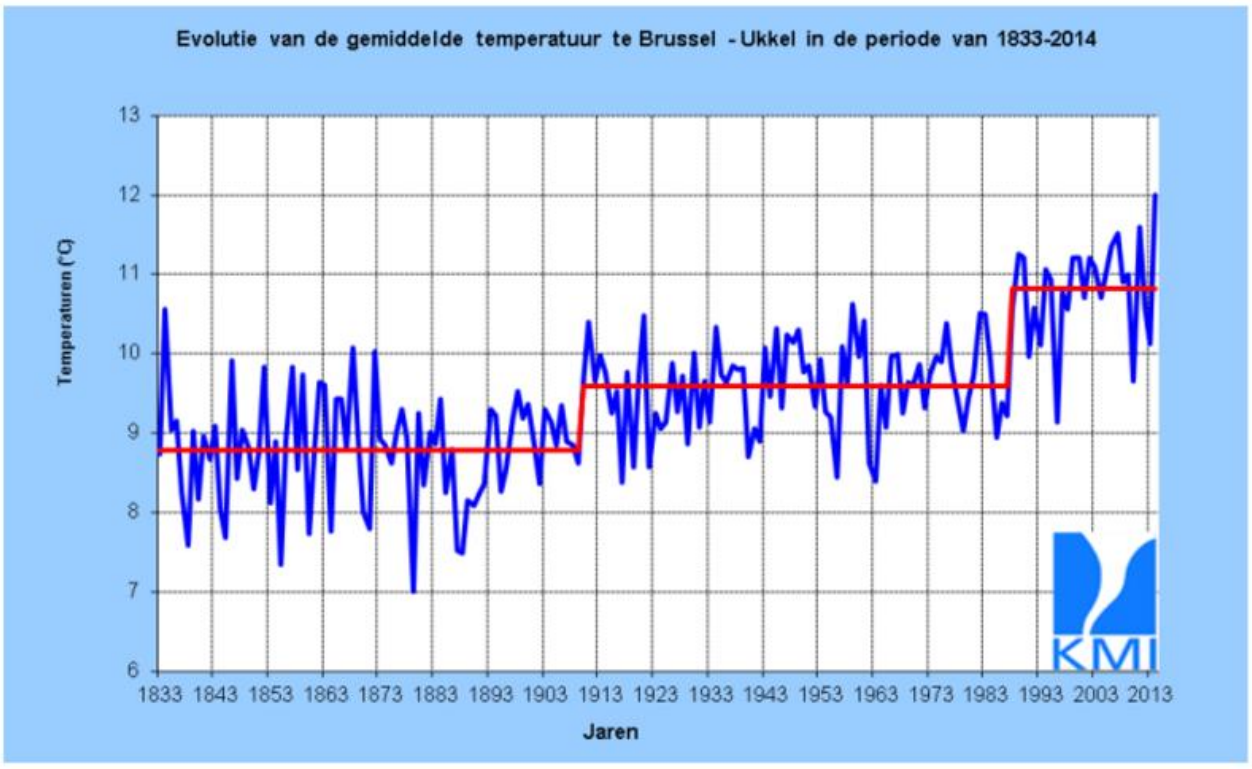


Figure 5.2: Time series of annual mean temperature for Belgium (Diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

France

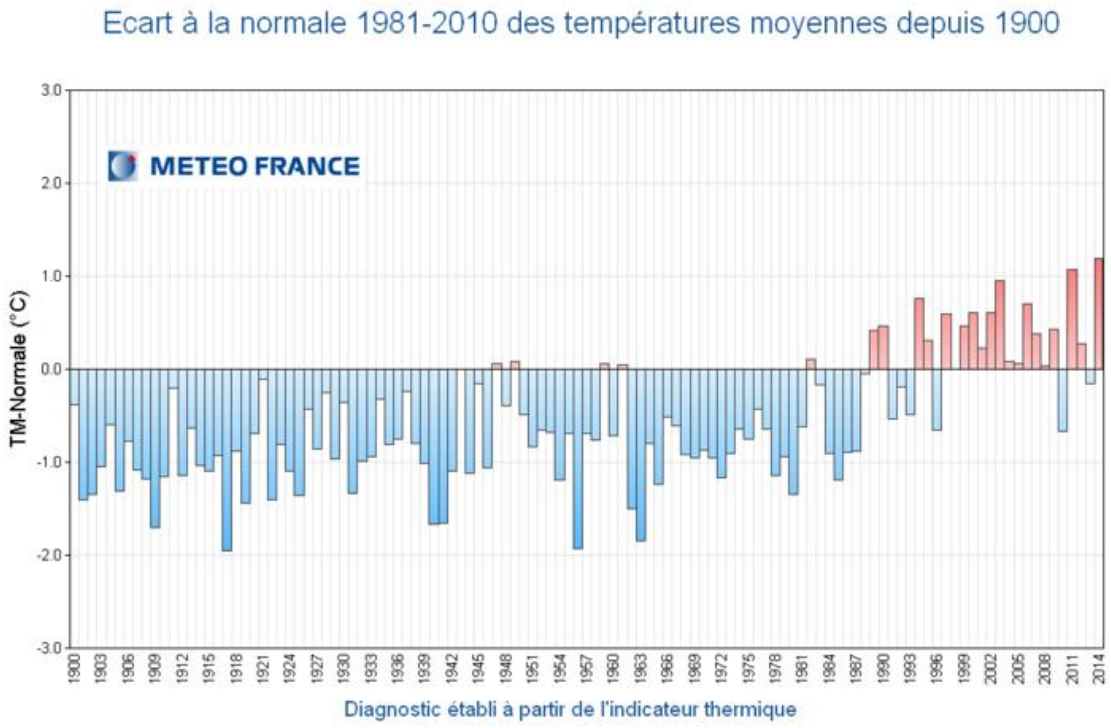


Figure 5.3: Time series of annual temperature anomalies for France (reference period 1981-2010; diagram as provided by the NHMS)

Germany

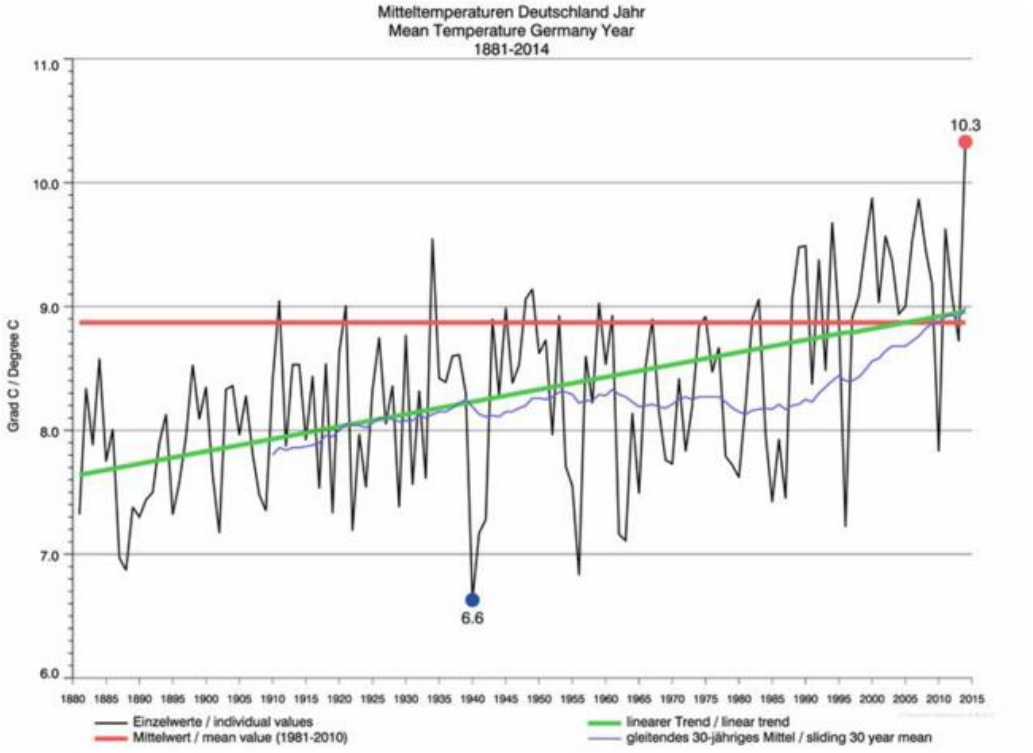


Figure 5.4: Time series of annual mean temperature for Germany (Diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Hungary

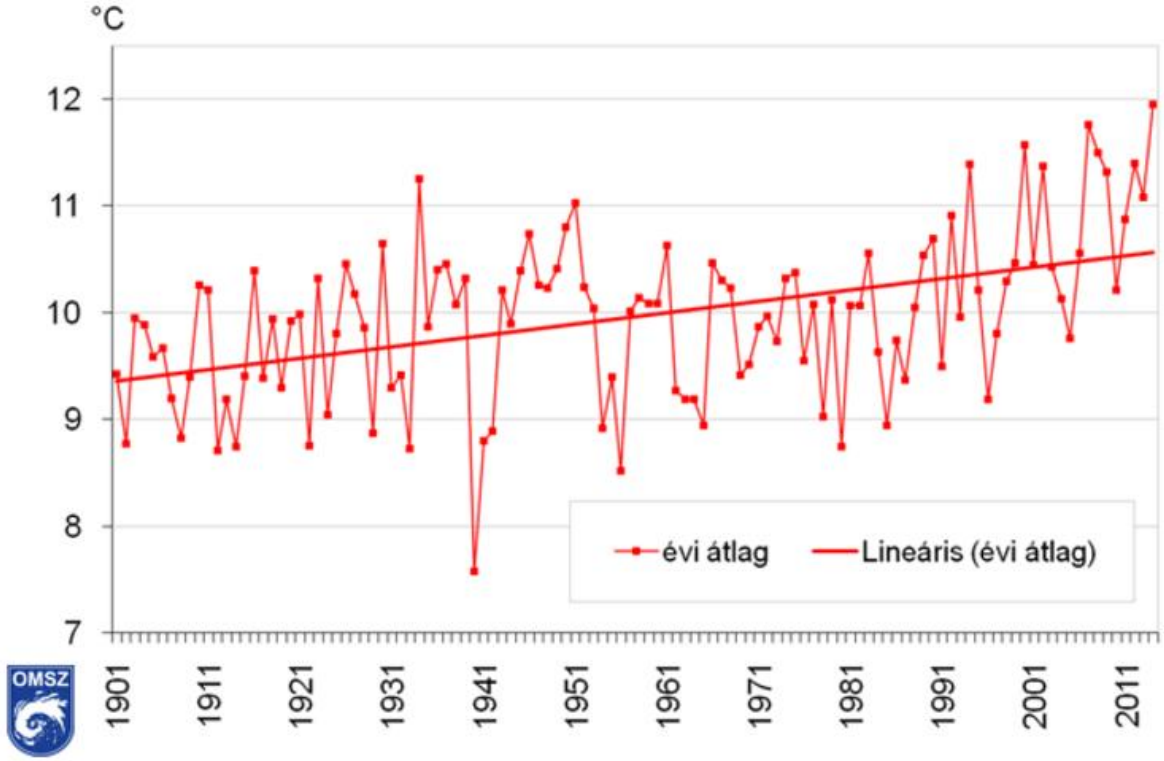


Figure 5.5: Time series of annual average temperature for the period 1901-2014 for Hungary (58 station based on data from homogenized, interpolated; Diagram as provided by the NHMS)

Luxembourg

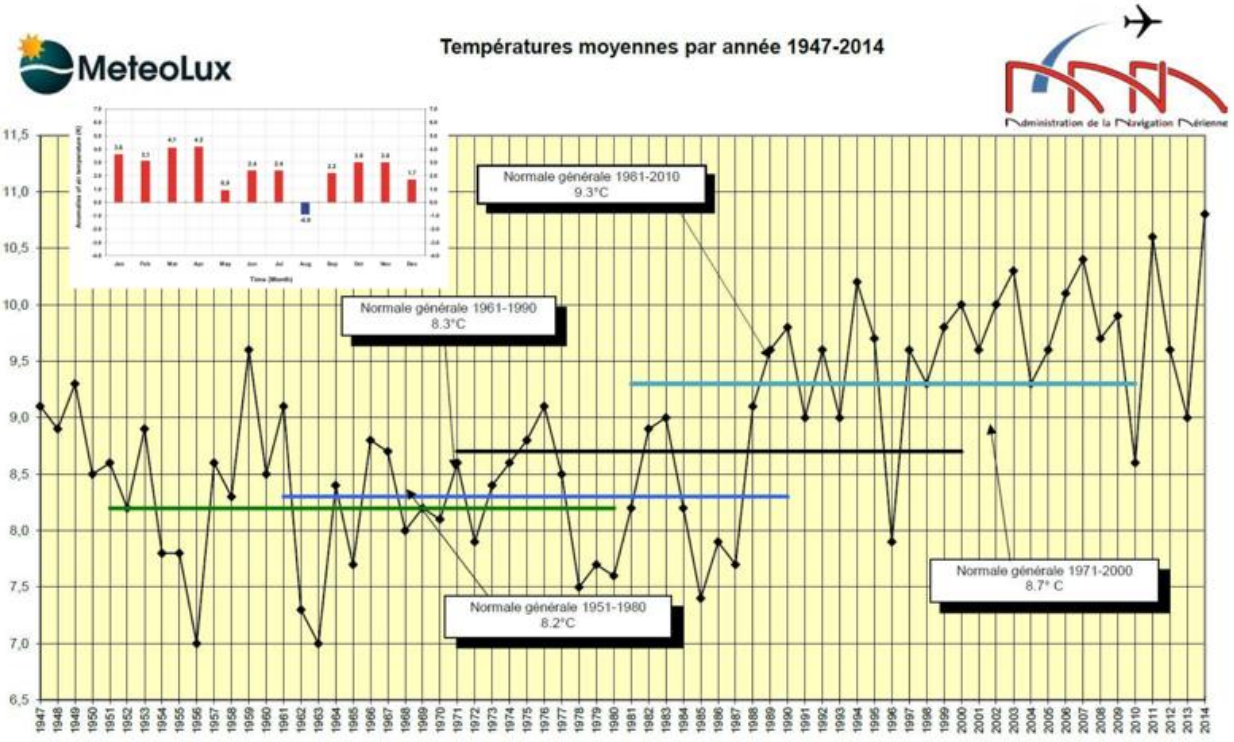


Figure 5.6: Time series of annual average temperature for the period 1947-2014 for Luxembourg (Diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Poland

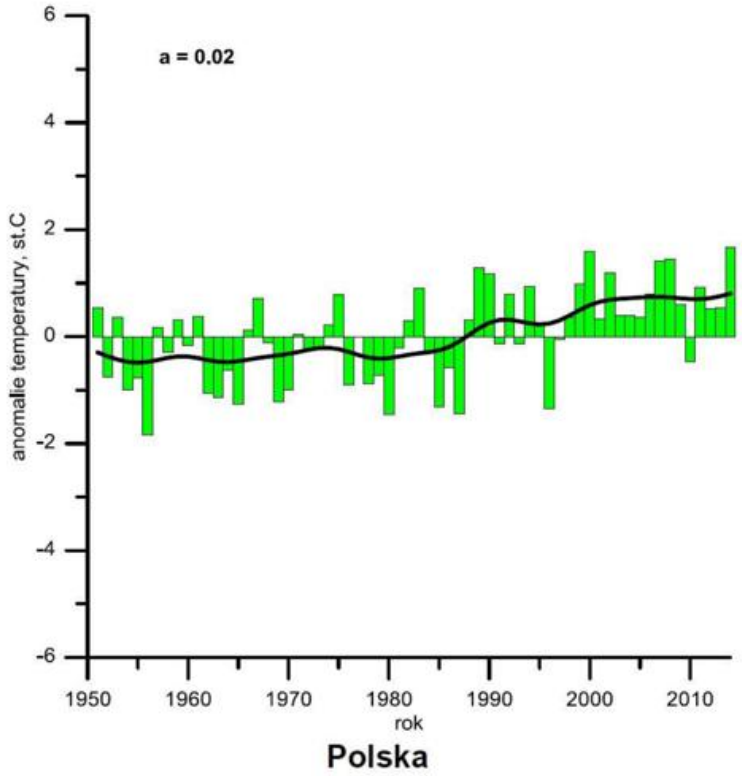


Figure 5.7: Time series of annual temperature anomalies for the period 1951-2014 for Poland (base period: 1971-2000; smoothed by 10-years Gaussian filter (black line) and the values of linear trend (°C/year); diagram as provided by the NHMS)

Switzerland

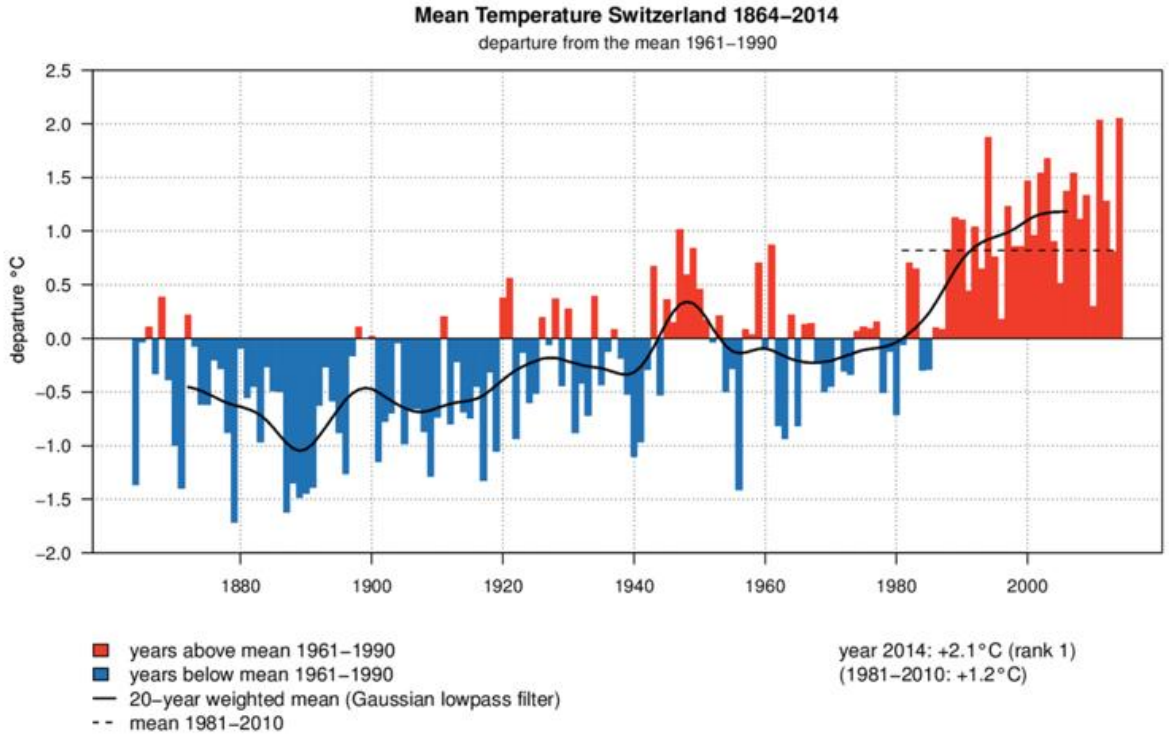
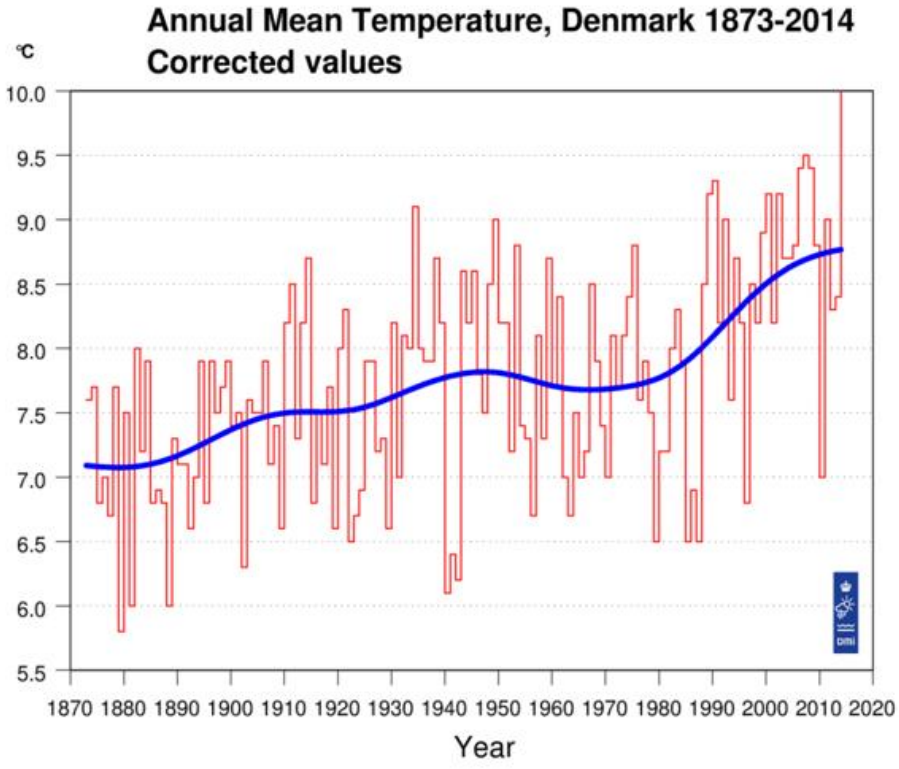


Figure 5.8: Time series of annual temperature anomalies for the period 1864-2014 for Switzerland (base period: 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Denmark, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden

Denmark, Greenland



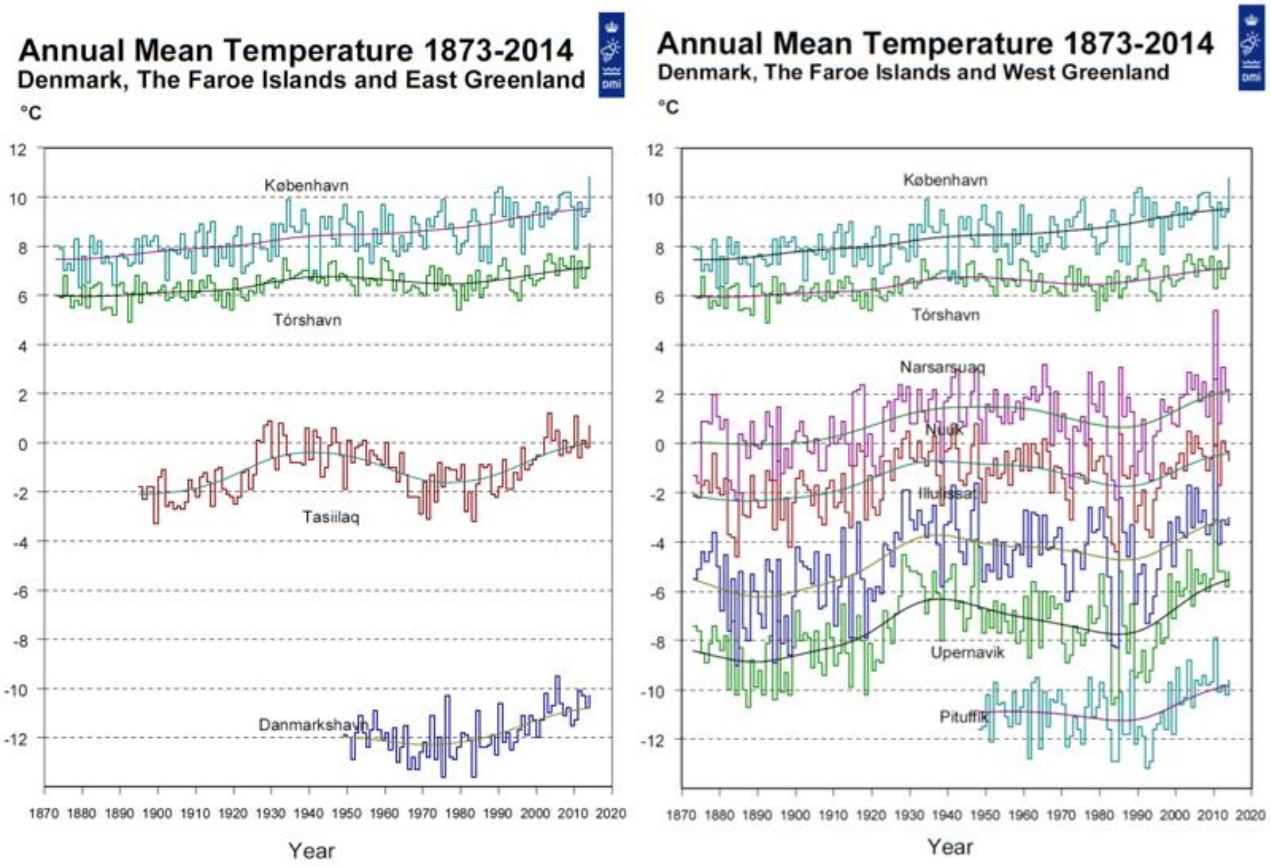


Figure 5.9: Time series of annual temperature for the period 1873-2014 for Denmark (top) and Faroe Islands and Greenland (bottom, diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Finland

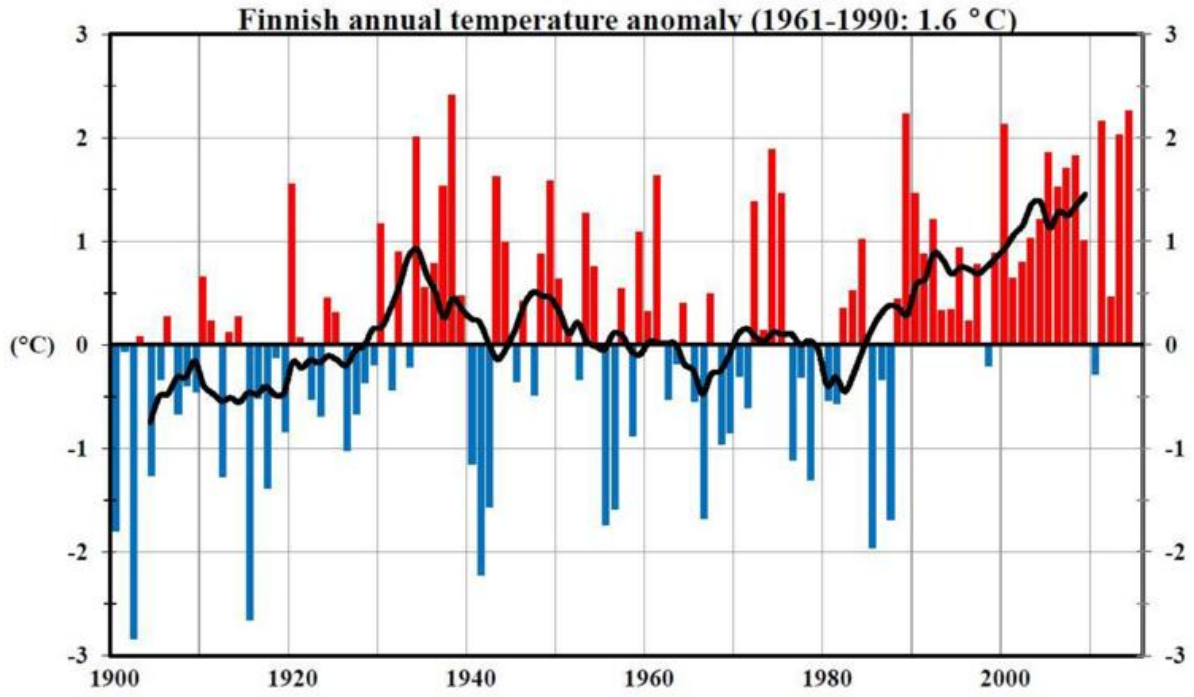


Figure 5.10: Time series of annual temperature anomalies for the period 1900-2014 for Finland (base period: 1961-1990; diagram as provided by the NHMS)

Iceland

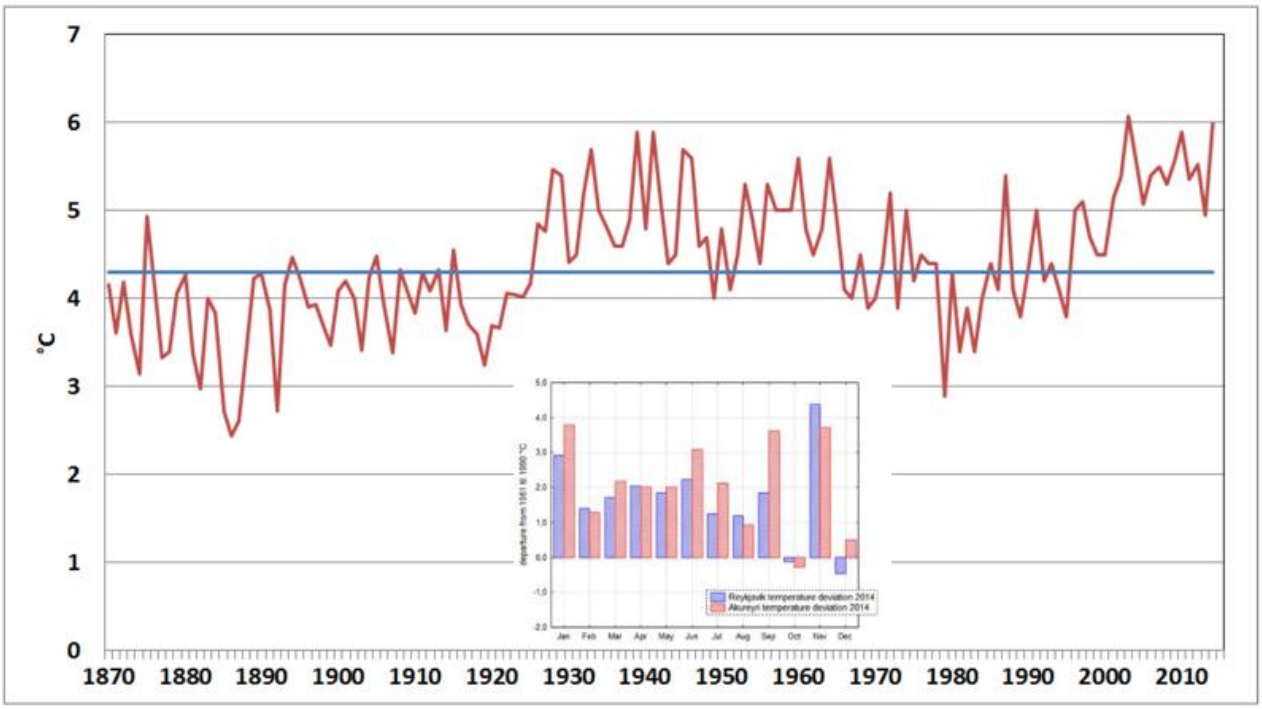


Figure 5.11: Time series of annual average temperature for the period 1870-2014 for Reykjavík (blue line: reference period 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Latvia

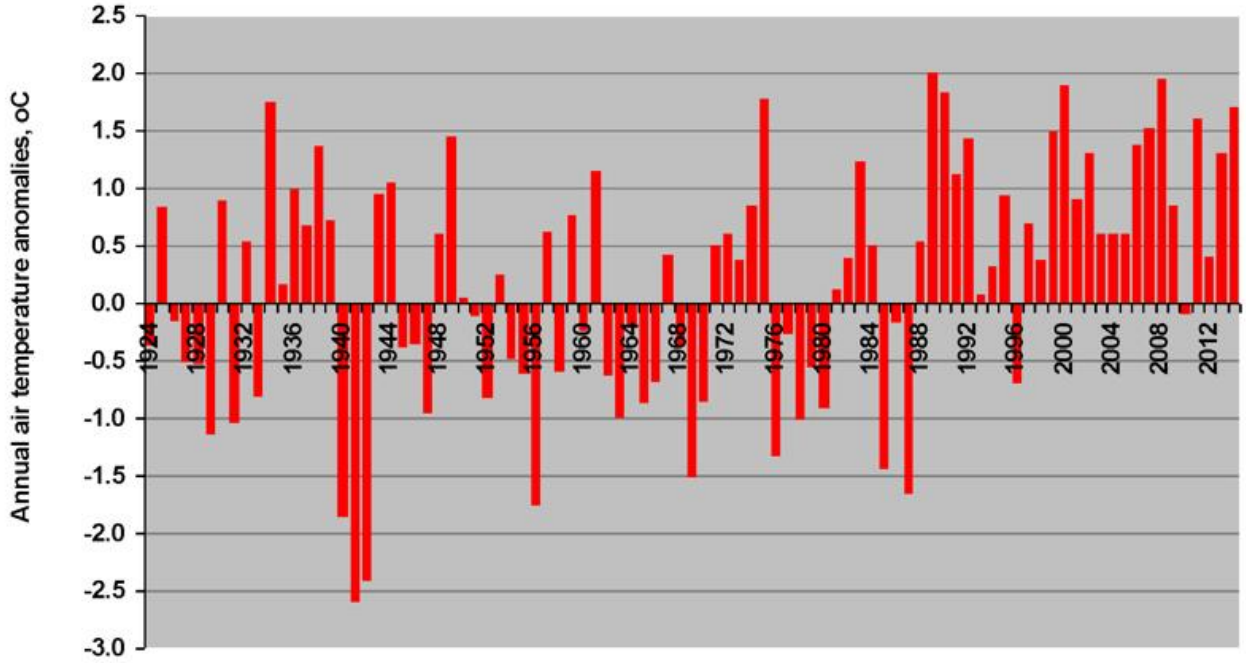


Figure 5.12: Time series of annual temperature anomalies for the period 1924-2014 for Latvia (reference period 1961-1990; diagram as provided by the NHMS)

Lithuania

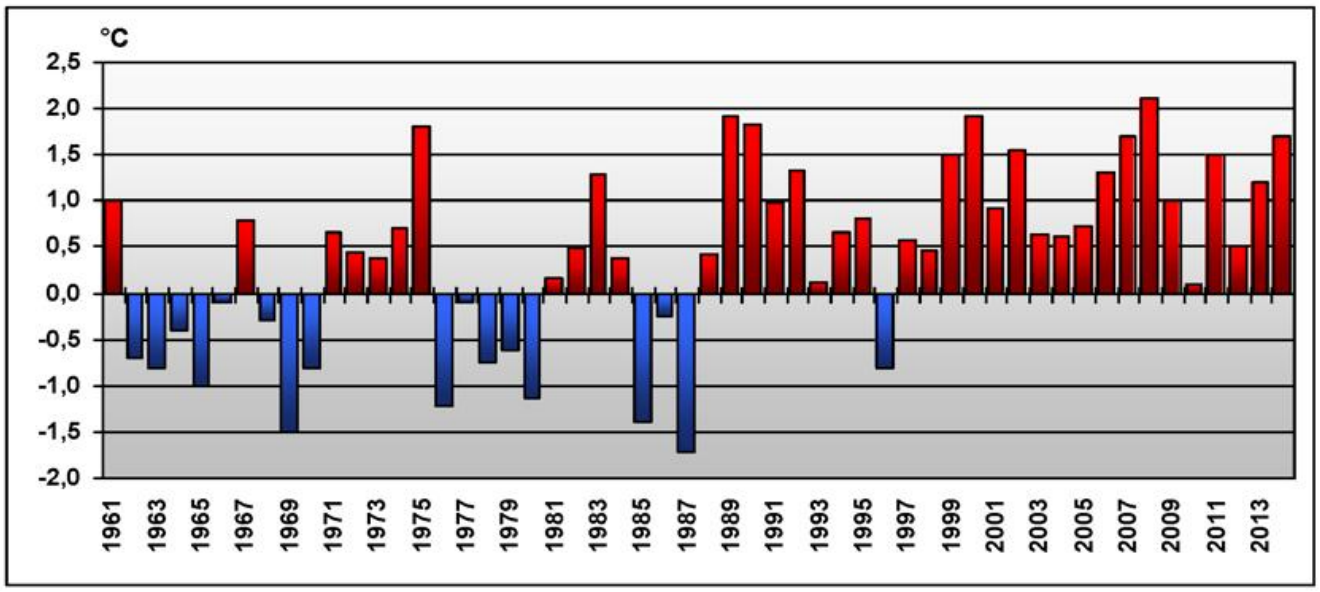


Figure 5.13: Time series of annual temperature anomalies for the period 1961-2014 for Lithuania (reference period 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Norway

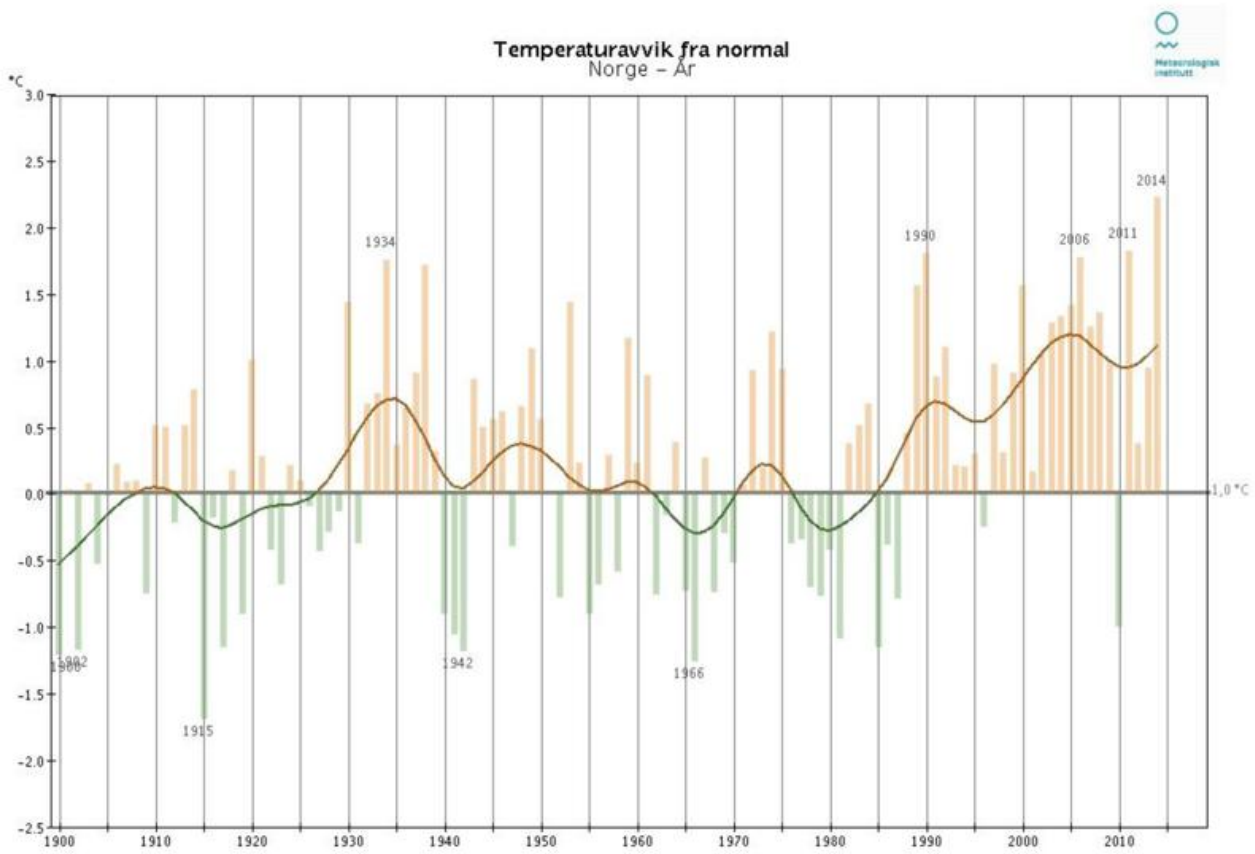


Figure 5.14: Time series of annual temperature anomalies for the period 1900-2014 for Norway (reference period 1961-1990; diagram as provided by the NHMS)

Sweden

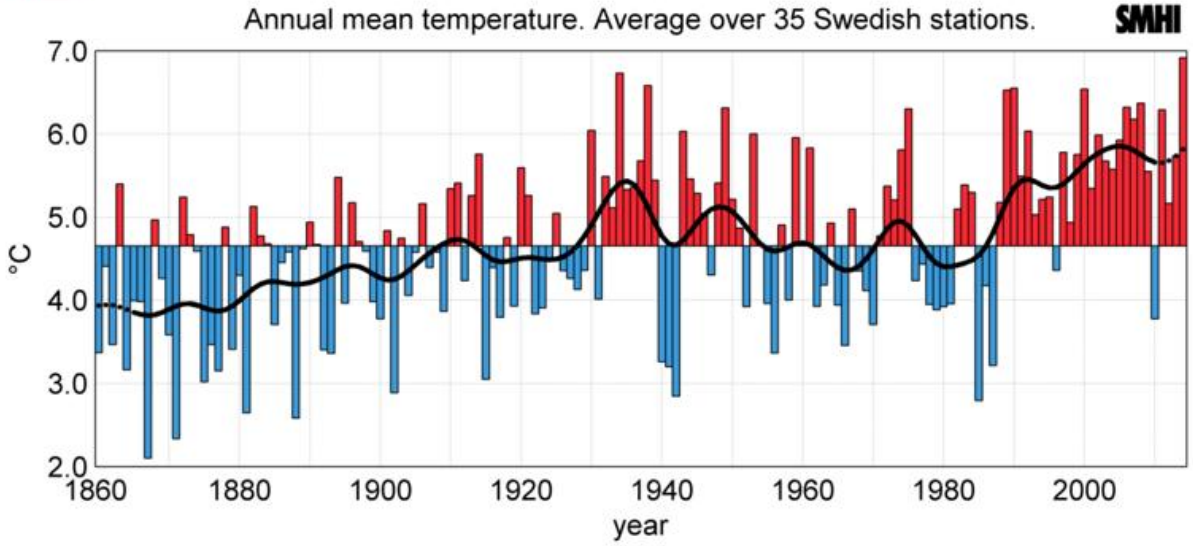


Figure 5.15: Time series of annual average temperature for the period 1900-2014 for Sweden (diagram as provided by the NHMS)

Iberia – annual temperature series

Portugal, Spain

Portugal

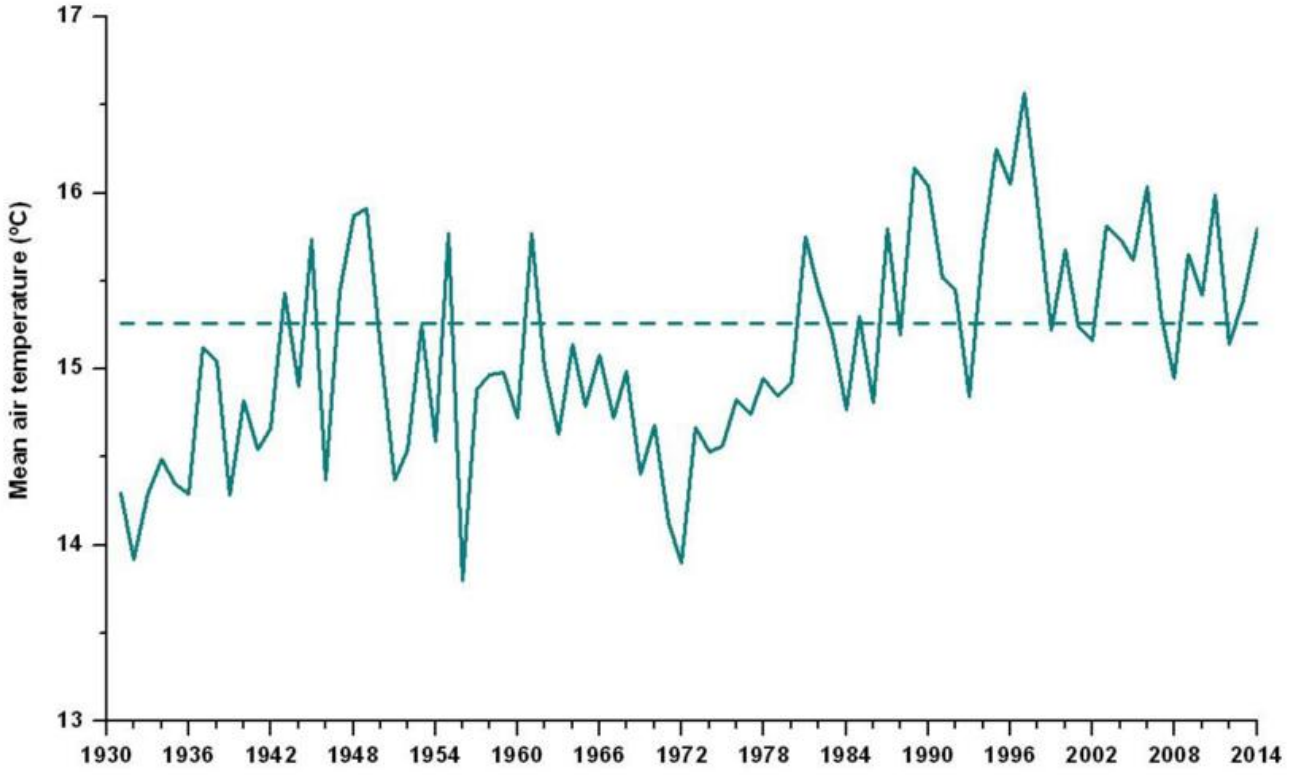


Figure 5.16: Time series of annual average temperature for the period 1931-2014 for Portugal (diagram as provided by the NHMS)

Spain

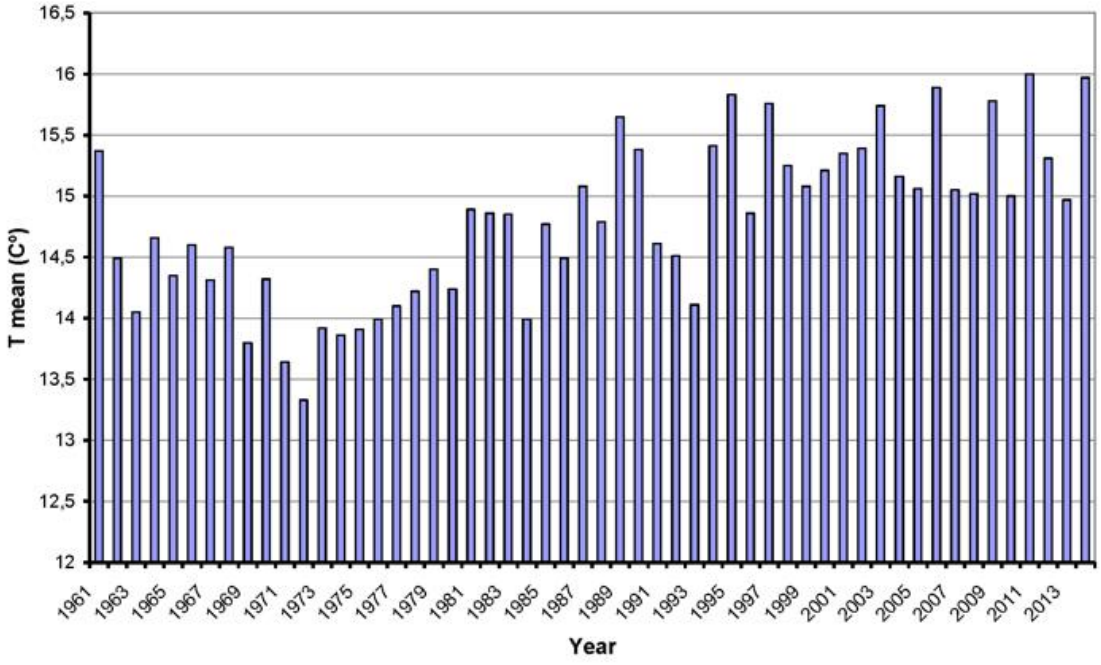


Figure 5.17: Time series of annual average temperature for the period 1961-2014 for Spain (diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Croatia, Italy,Slovenia, Turkey

Croatia

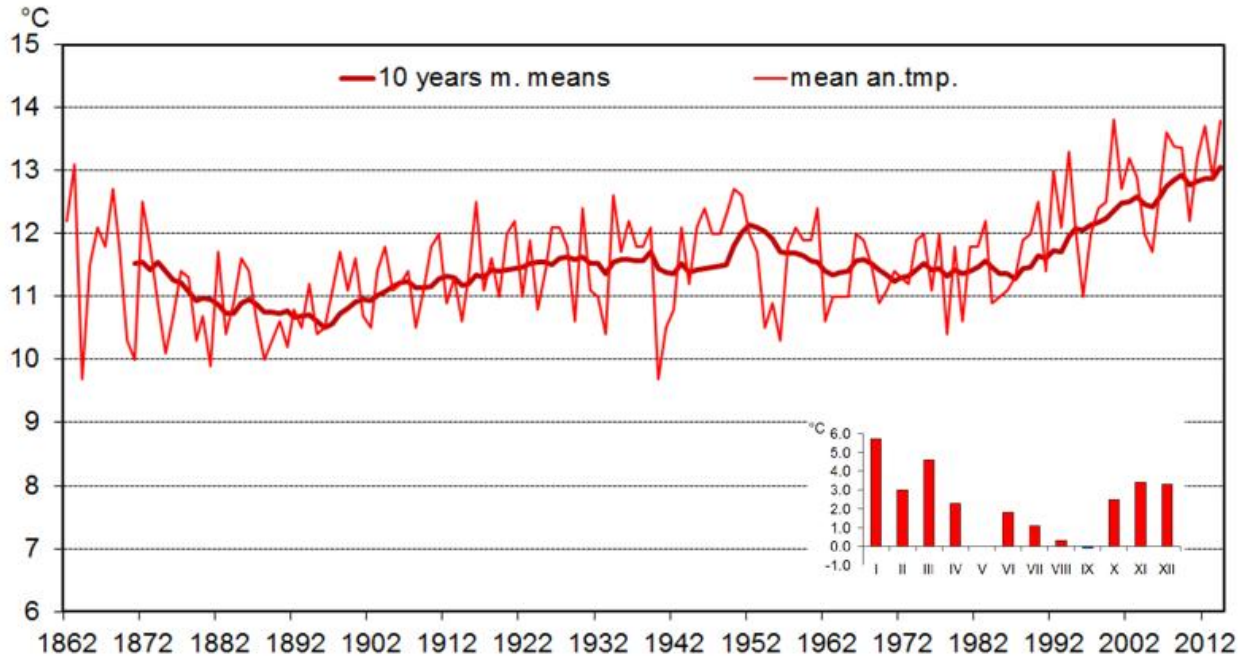


Figure 5.18: Time series of annual average temperature for Zagreb Grič (Croatia) for the period 1862-2014 with 10-year running mean and monthly anomalies for the year 2014 (diagram as provided by the NHMS)

Italy

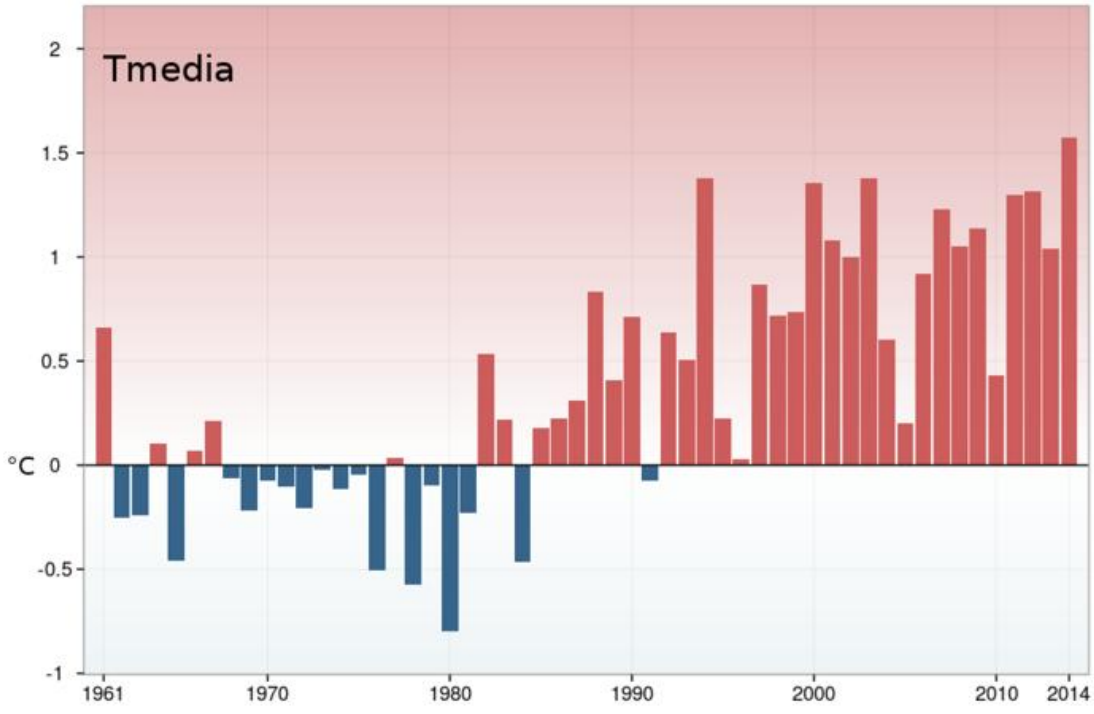


Figure 5.19: Time series of annual temperature anomalies for Italy for the period 1961-2014 (reference period 1961-1990; diagram as provided by ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Slovenia

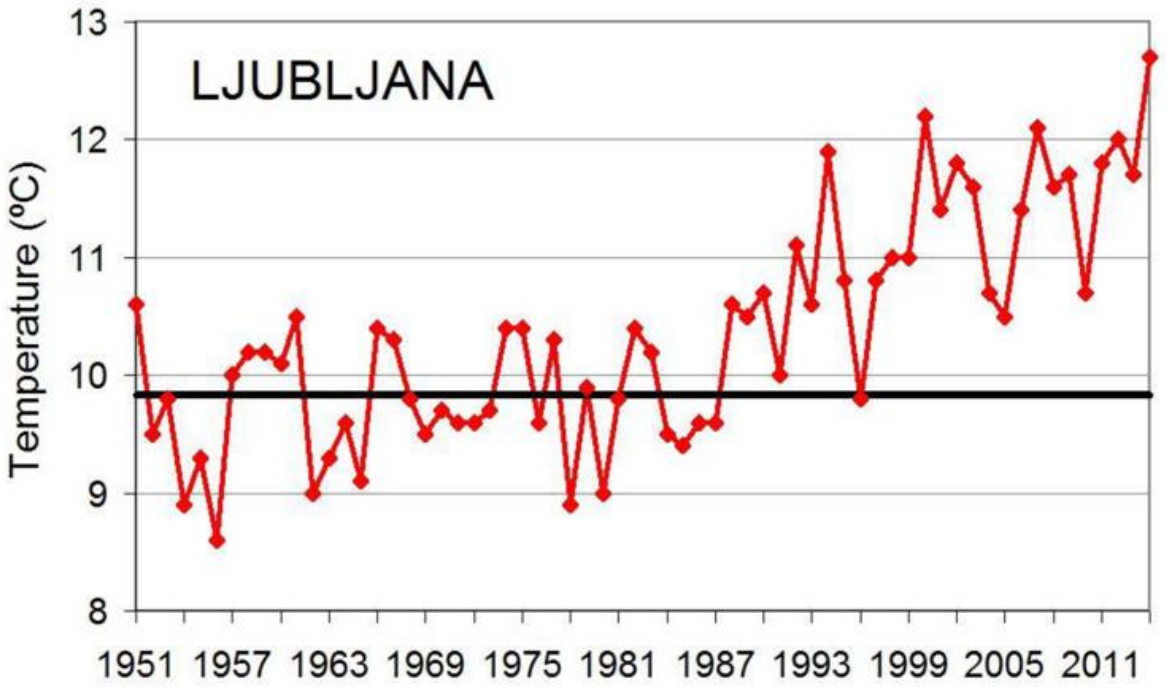


Figure 5.20: Time series of annual average temperature for Lublijana (Slovenia) for the period 1951-2014 (diagram as provided by the NHMS)

Turkey

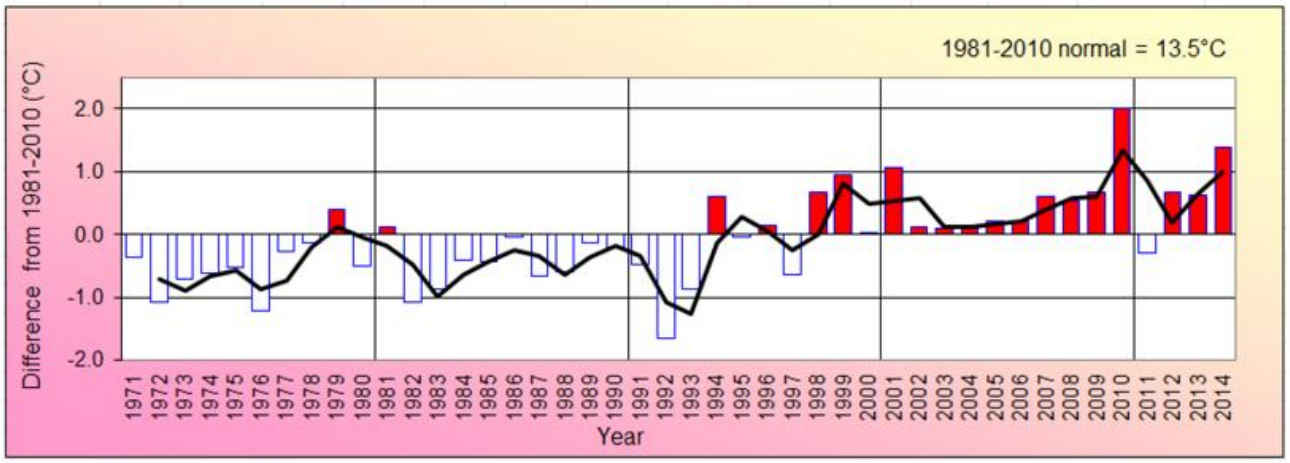


Figure 5.21: Time series of annual temperature anomalies for Turkey for the period 1971-2014 (reference period 1981-2010; diagram as provided by the NHMS)

Eastern Europe – annual temperature series

Belarus, Russia

Belarus

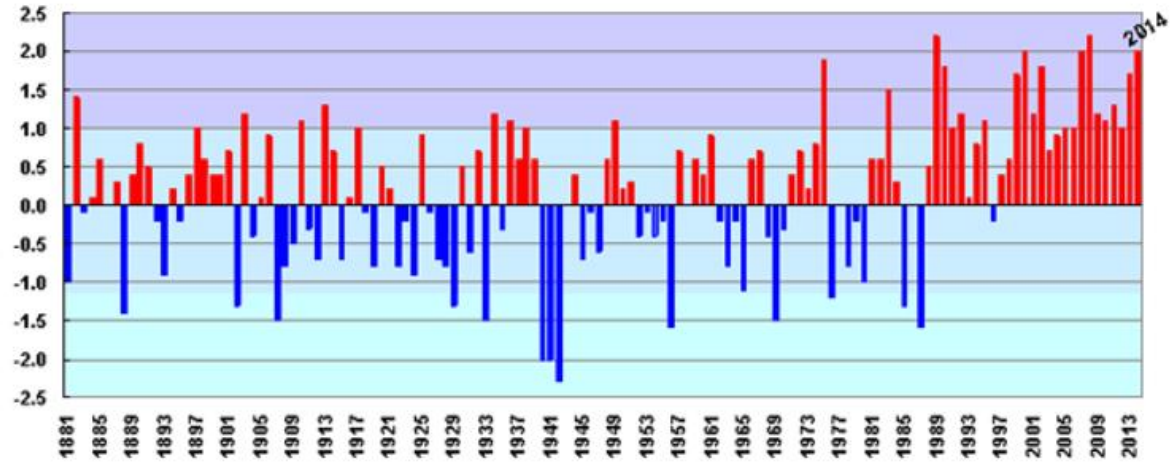


Figure 5.22: Time series of annual temperature anomalies for Belarus for the period 1881-2014 (reference period 1961-1990; diagram as provided by the NHMS)

Russia

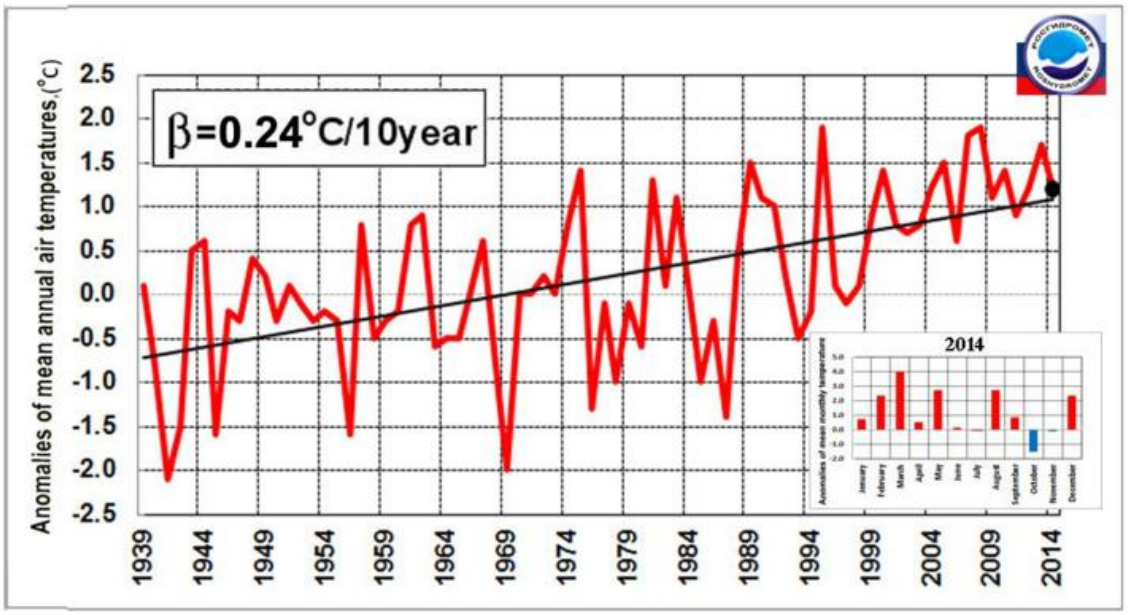


Figure 5.23: Time series of annual temperature anomalies for European Russia for the period 1939-2014 (reference period 1961-1990; diagram as provided by the NHMS)

Middle East – annual temperature series

Georgia, Israel

Georgia

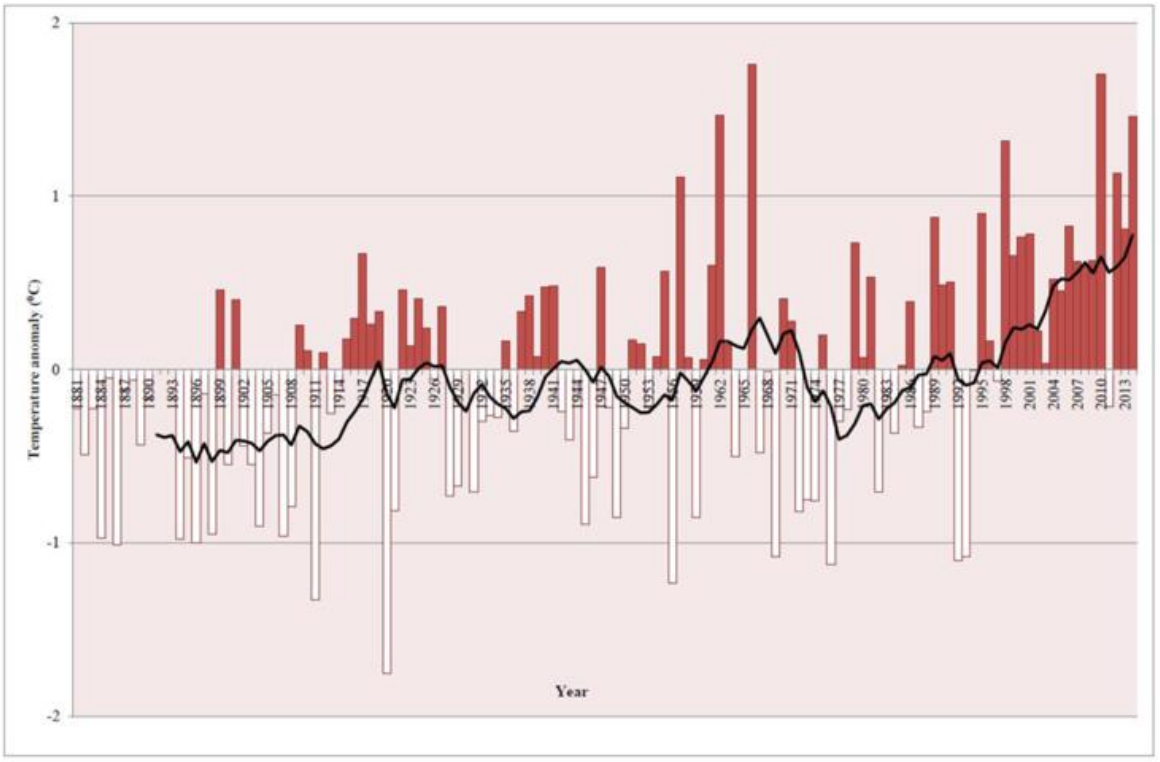


Figure 5.24: Time series of annual temperature anomalies and 11-yr moving averages for Tbilisi (Georgia) for the period 1881-2014 (reference period 1961-1990; diagram as provided by the NHMS)

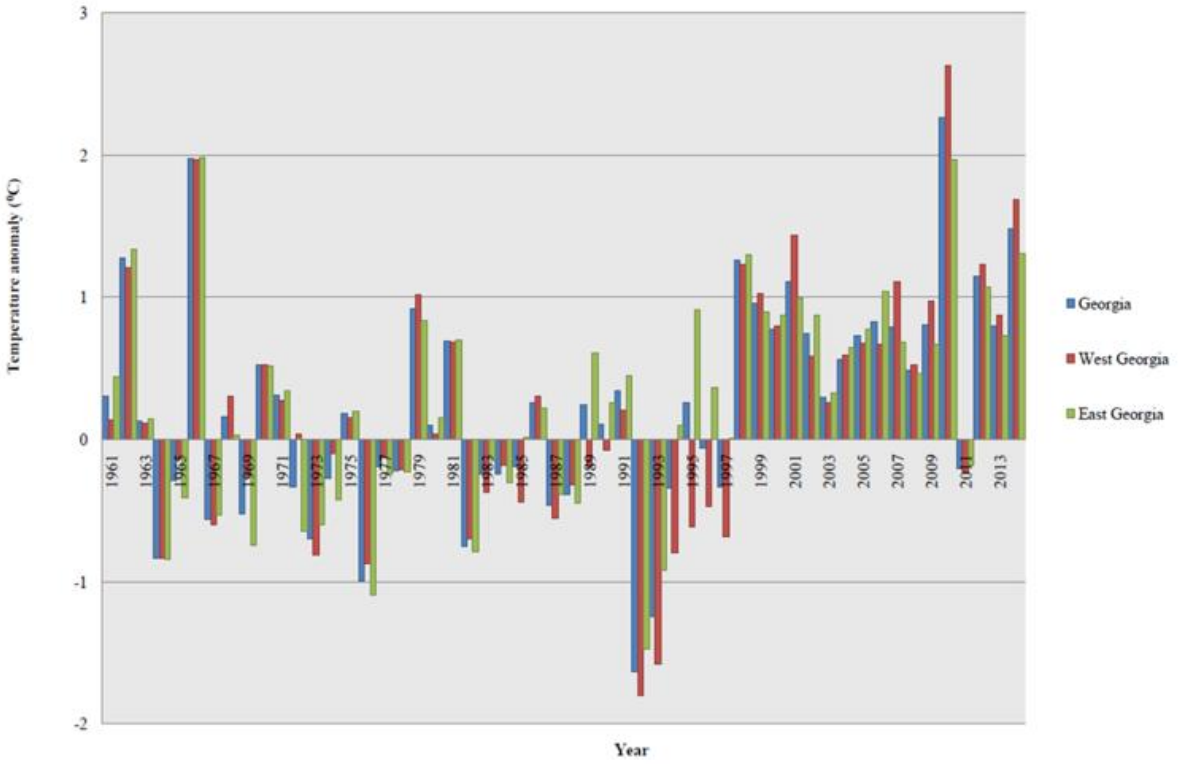


Figure 5.25: Time series of annual temperature anomalies for Georgia for the period 1961-2014 (reference period 1961-1990; diagram as provided by the NHMS)

Middle East – annual temperature series

Israel

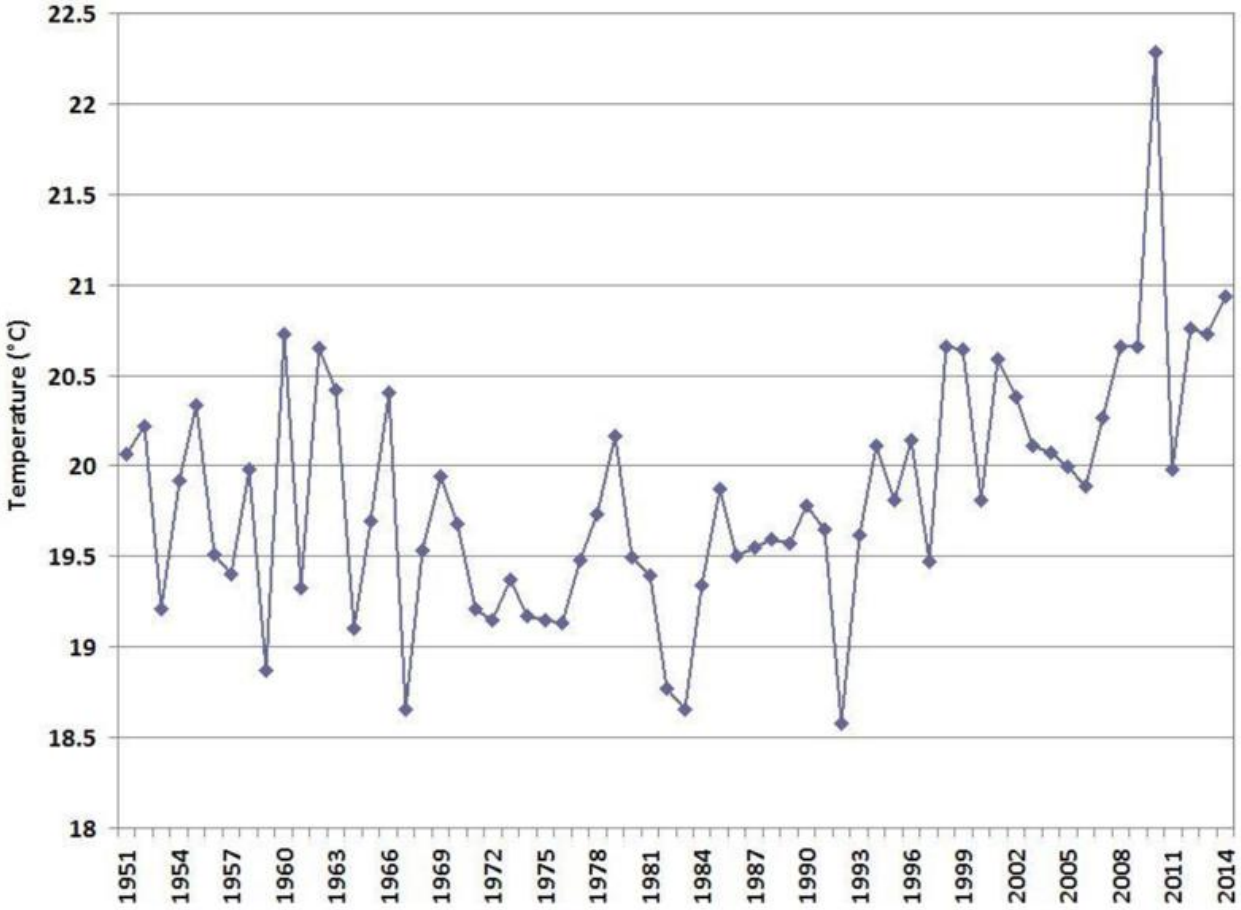


Figure 5.26: Time series of annual temperature for Israel (based on five stations) for the period 1951-2014 (diagram as provided by the NHMS)

5.2. Precipitation

Central and Western Europe - precipitation totals and anomalies

Germany, Hungary, Switzerland

Germany

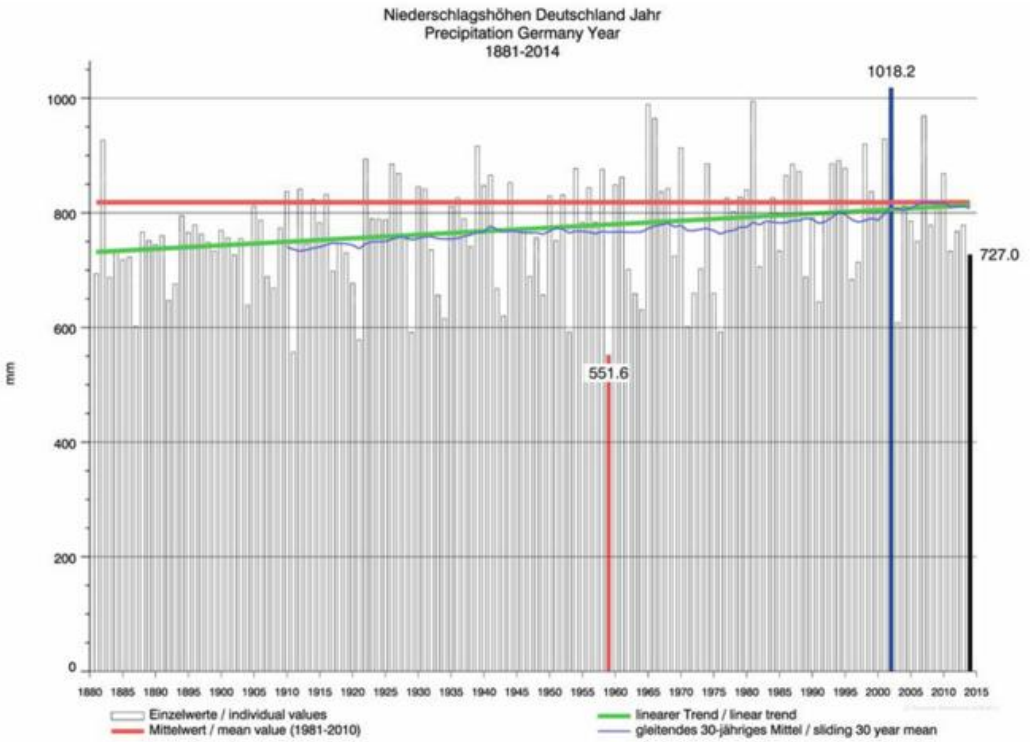


Figure 5.27: Time series of annual precipitation totals in mm/year for Germany (Diagram as provided by the NHMS)

Hungary

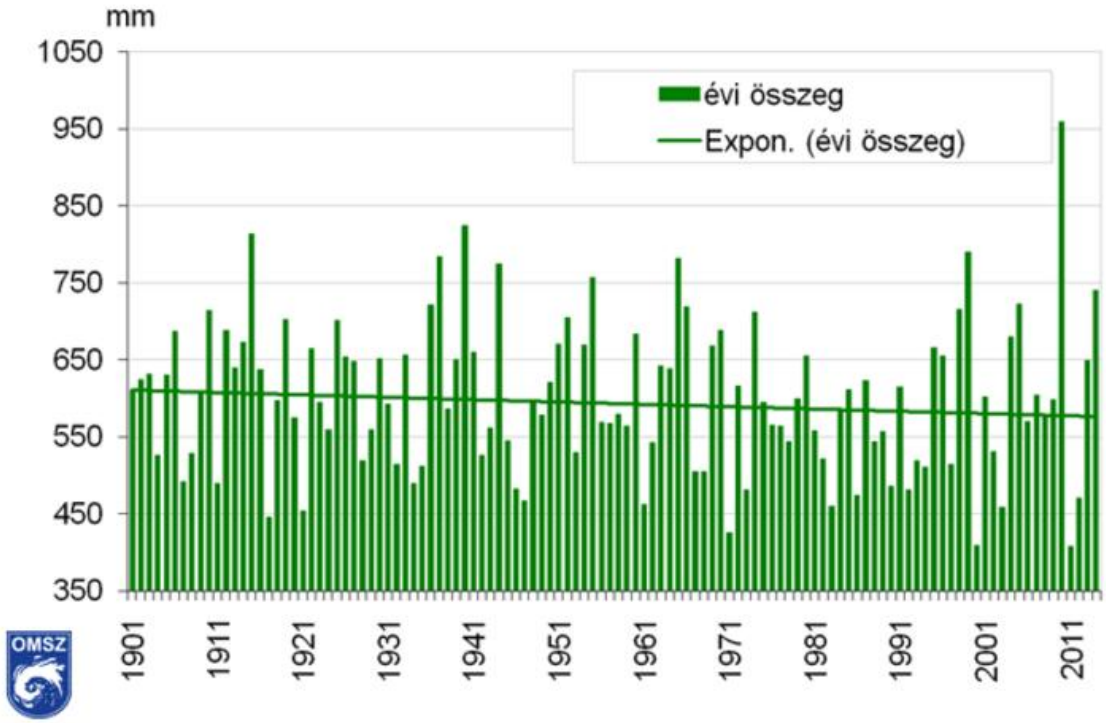
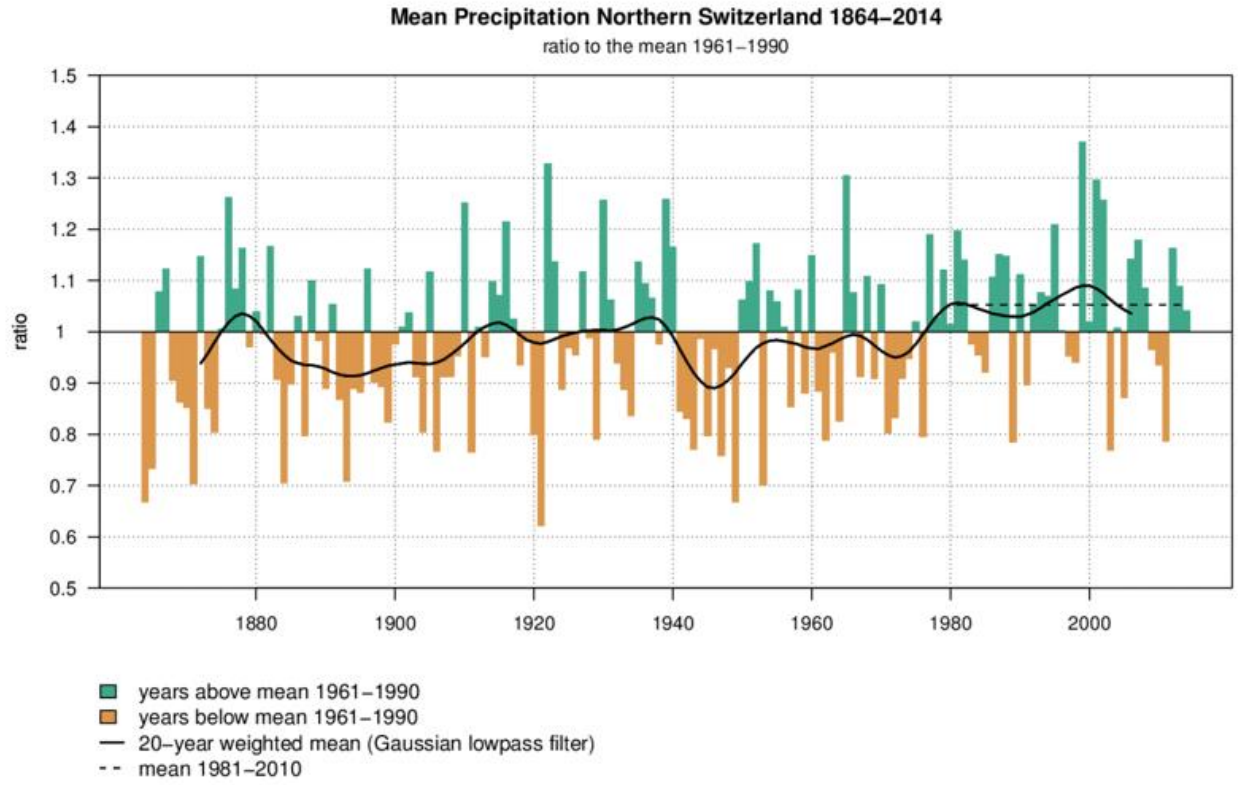


Figure 5.28: Time series of annual precipitation totals in mm/year for Hungary (Diagram as provided by the NHMS)

Central and Western Europe - precipitation totals and anomalies

Switzerland



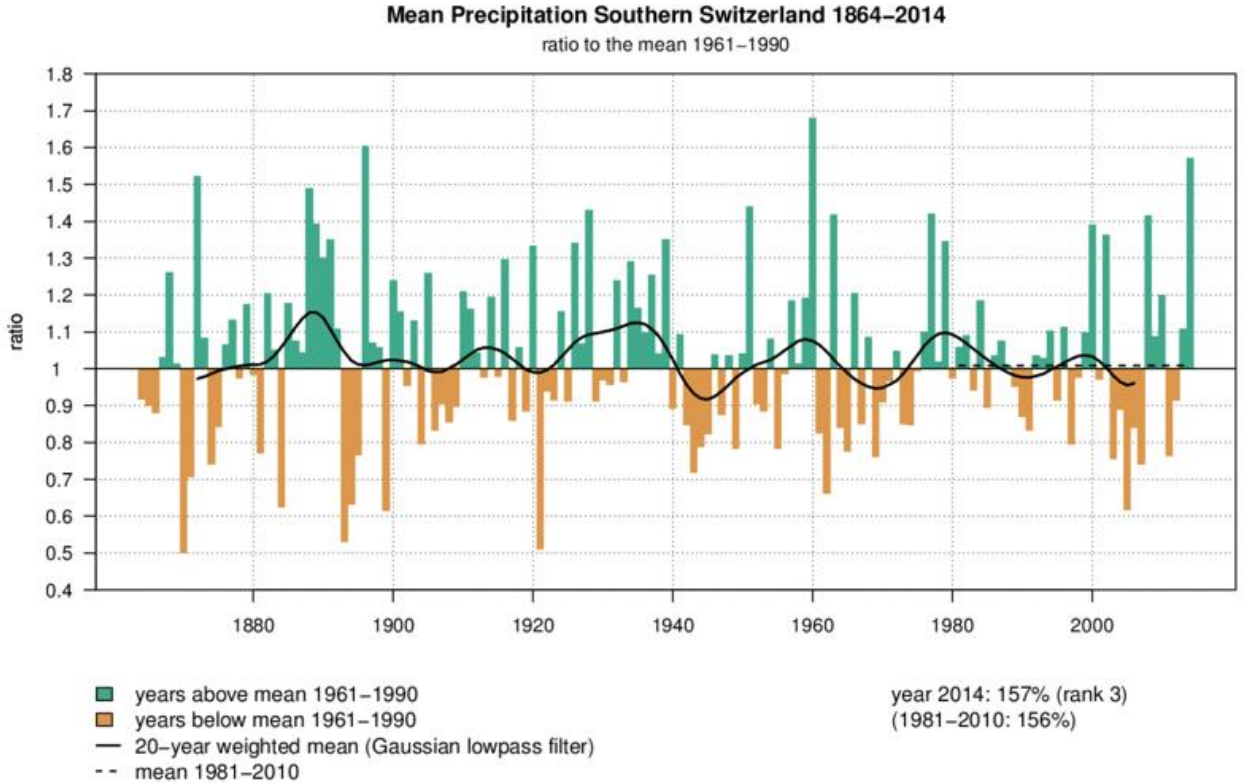


Figure 5.29: Time series of annual precipitation anomalies in relation to the mean of 1961-90 for northern (top) and southern (bottom) Switzerland (diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Denmark, Latvia, Norway, Sweden

Denmark

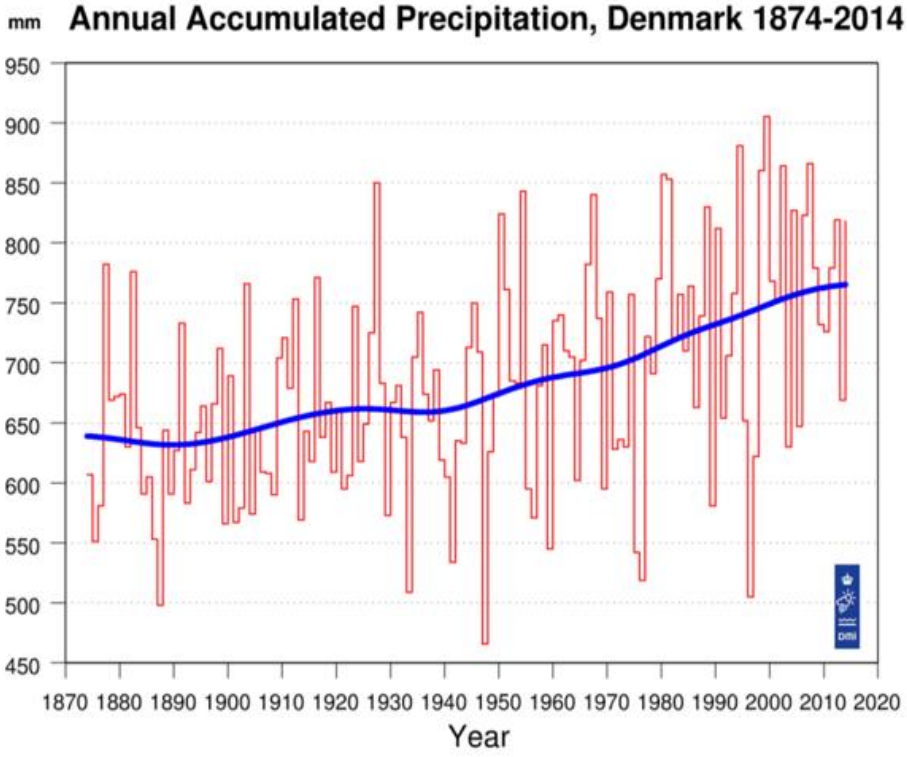


Figure 5.30: Time series of annual precipitation totals in mm/year for Denmark (Diagram as provided by the NHMS)

Latvia

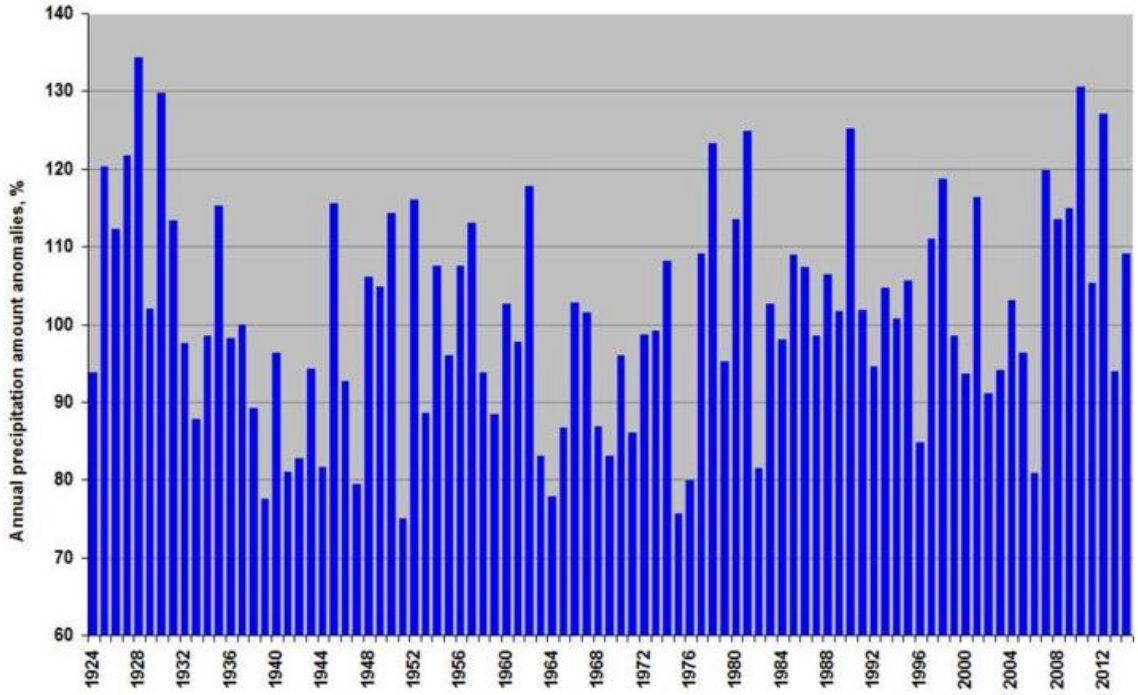


Figure 5.31: Time series of annual precipitation totals in relation to the mean of 1961-90 for Latvia (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Norway

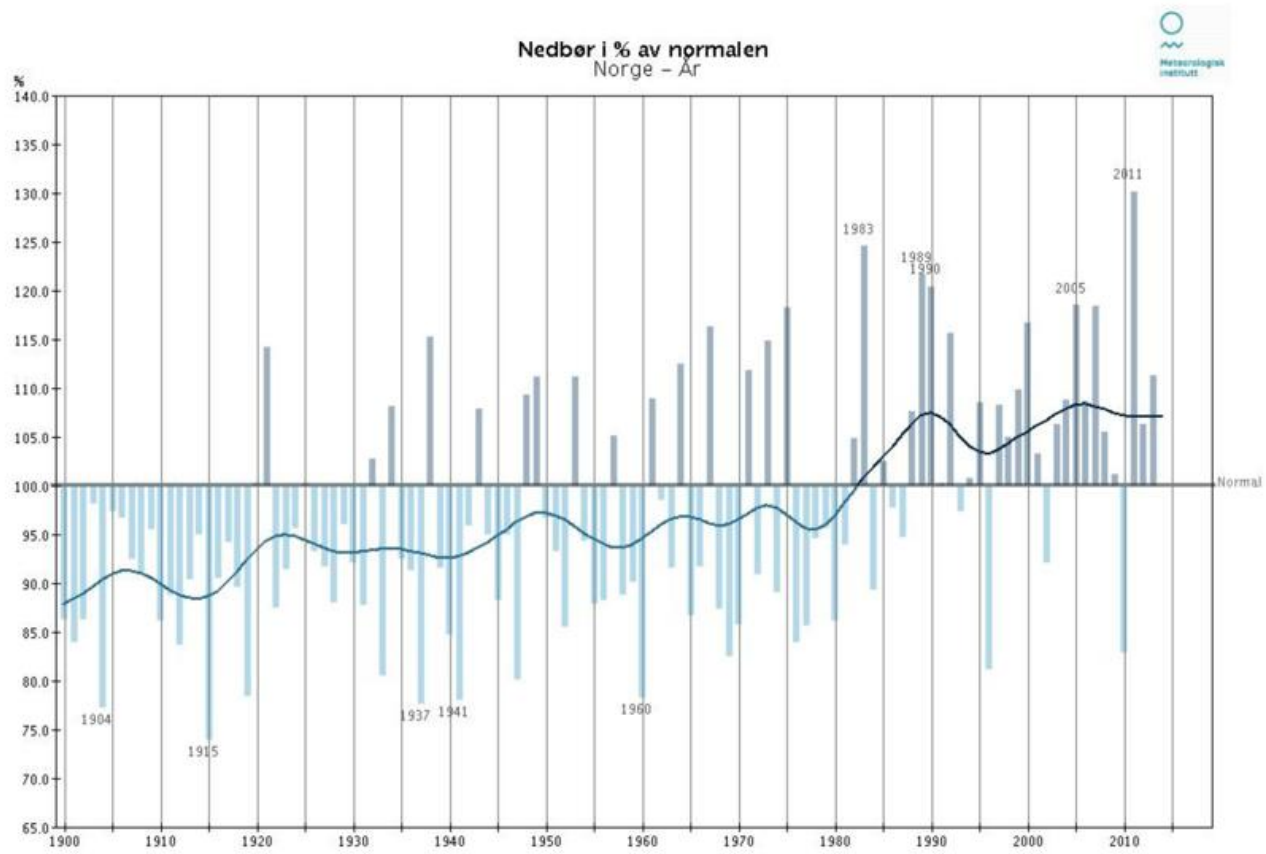


Figure 5.32: Time series of annual precipitation totals in relation to the mean of 1961-90 for Norway (Diagram as provided by the NHMS)

Sweden

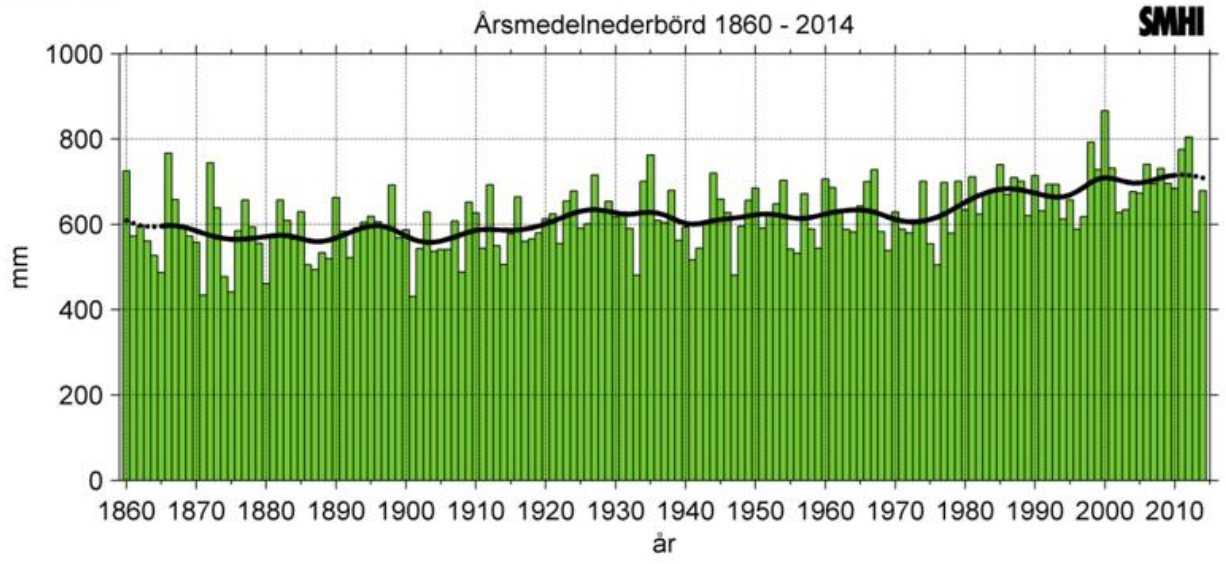


Figure 5.33: Time series of annual precipitation totals in mm/year for Sweden (Diagram as provided by the NHMS)

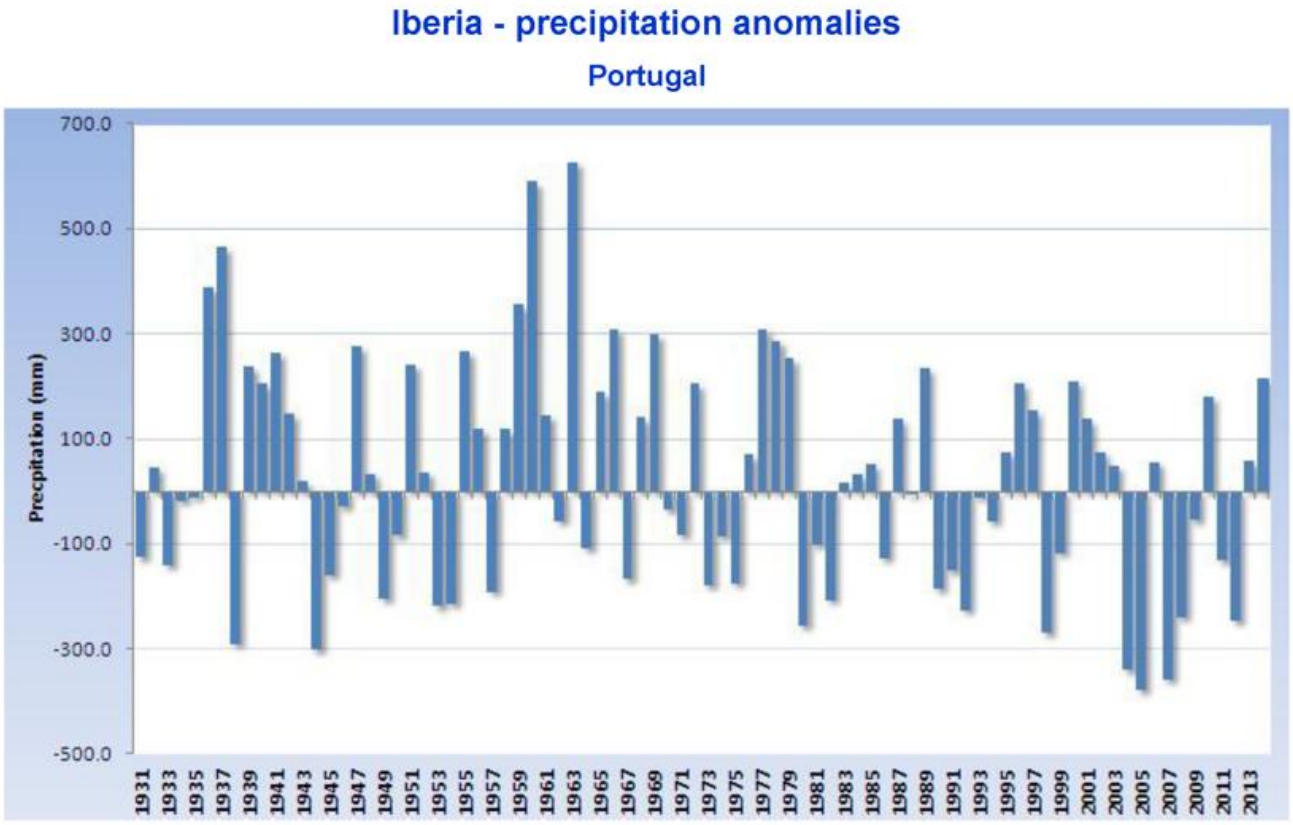


Figure 5.34: Time series of annual precipitation totals in mm/year (deviations from the mean of 1971-2000) for Portugal (Diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Italy, Slovenia, Turkey

Italy

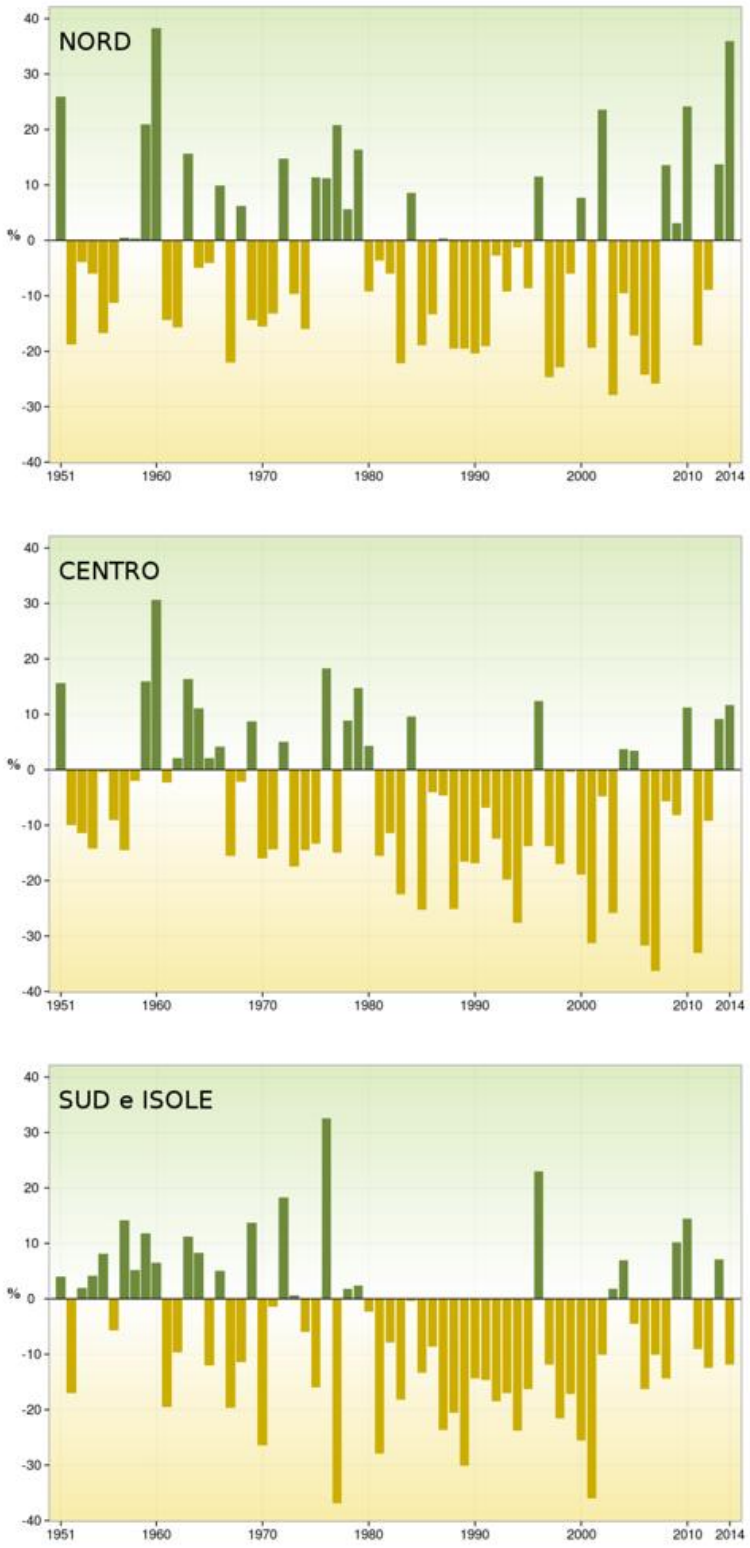


Figure 5.35: Time series of annual precipitation totals in relation to the mean of 1951-80 for northern (top), middle and southern (bottom) Italy for the period 1951-2014 (diagrams as provided by ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Slovenia

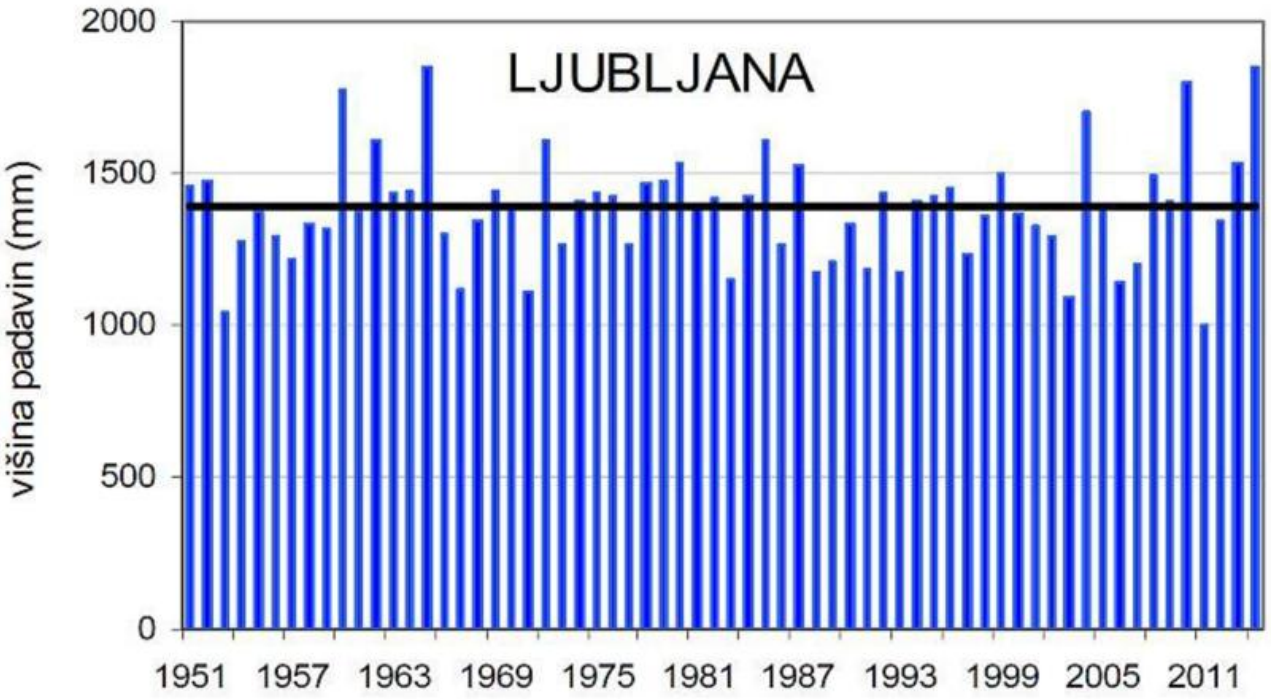


Figure 5.36: Time series of annual precipitation totals in mm/year for station Ljubljana (Slovenia, diagram as provided by the NHMS)

Turkey

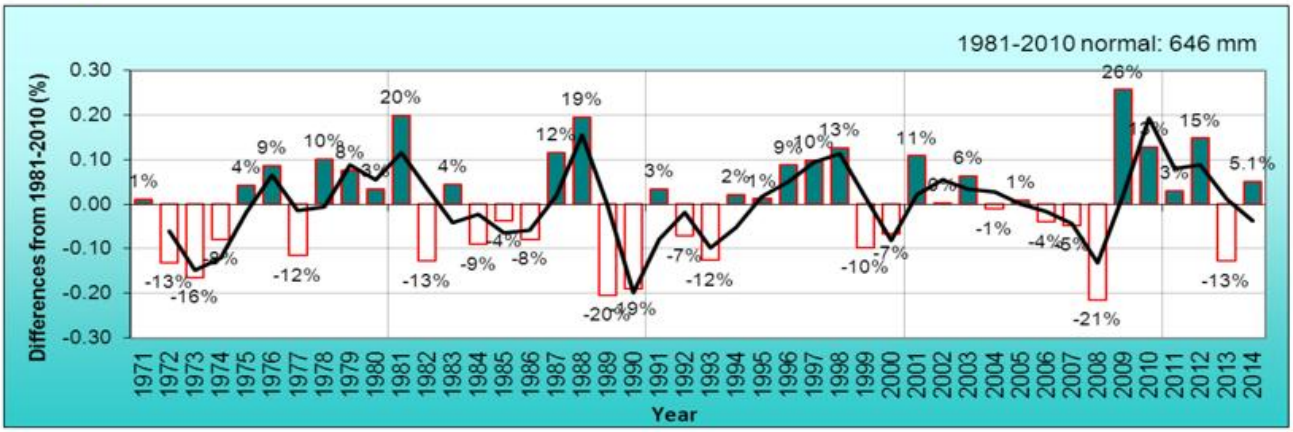


Figure 5.37: Time series of annual precipitation totals in relation to the mean of 1981-2010 for Turkey (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Belarus, European Russia

Belarus

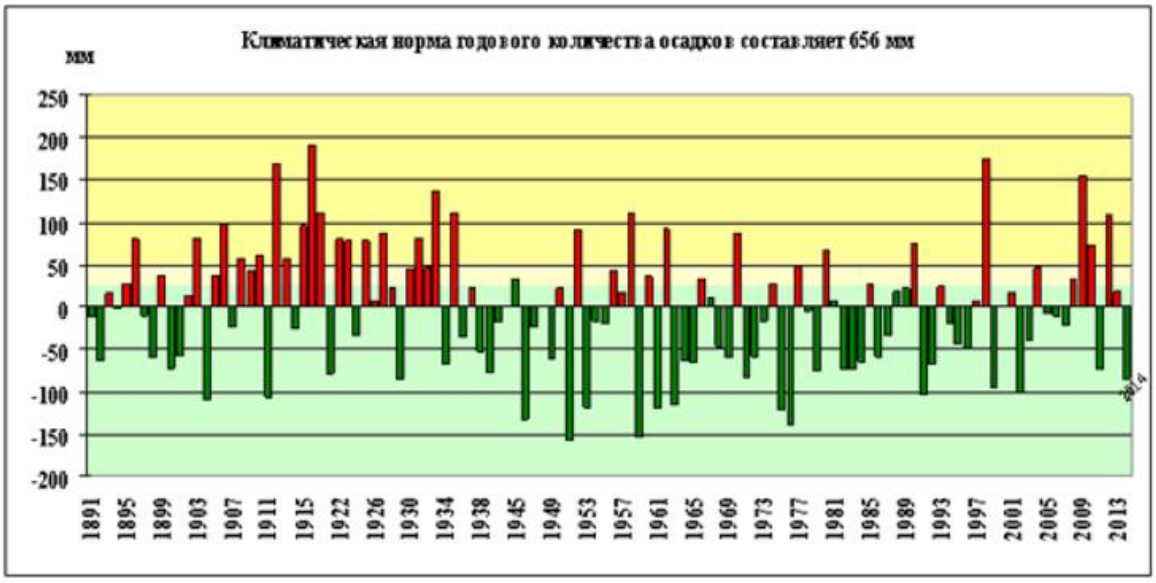


Figure 5.38: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Belarus (Diagram as provided by the NHMS)

European Russia

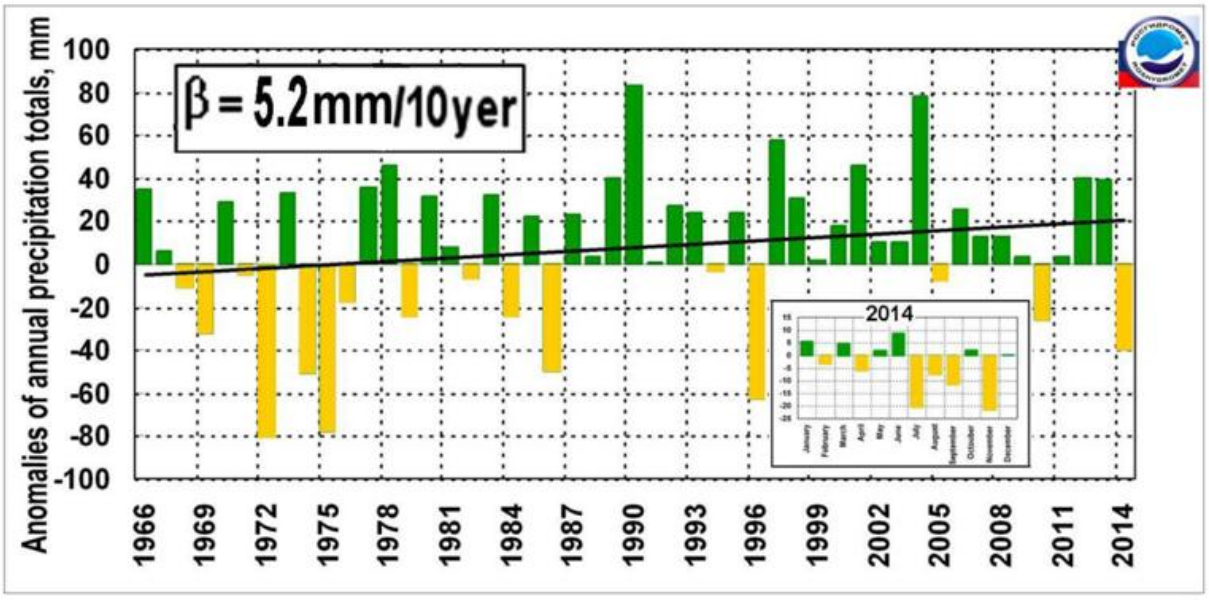


Figure 5.39: Time series of annual precipitation totals in relation to the mean of 1961-1990 for European Russia (Diagram as provided by the NHMS)

Middle East - precipitation anomalies

Georgia

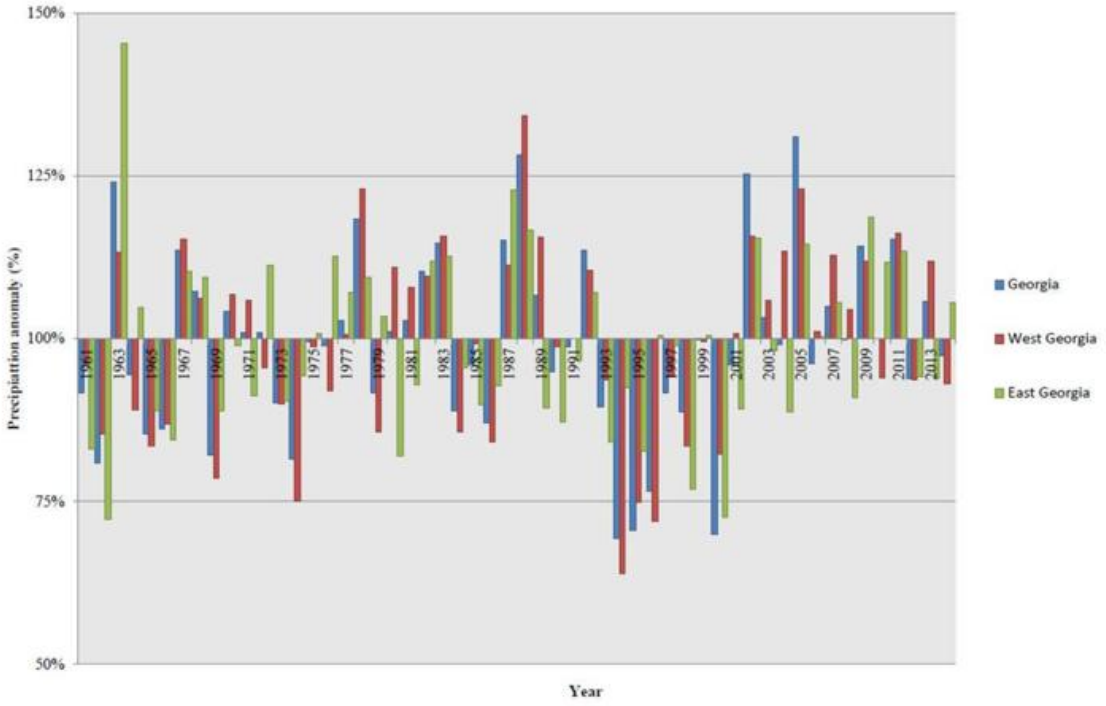


Figure 5.40: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Georgia (Diagram as provided by the NHMS)

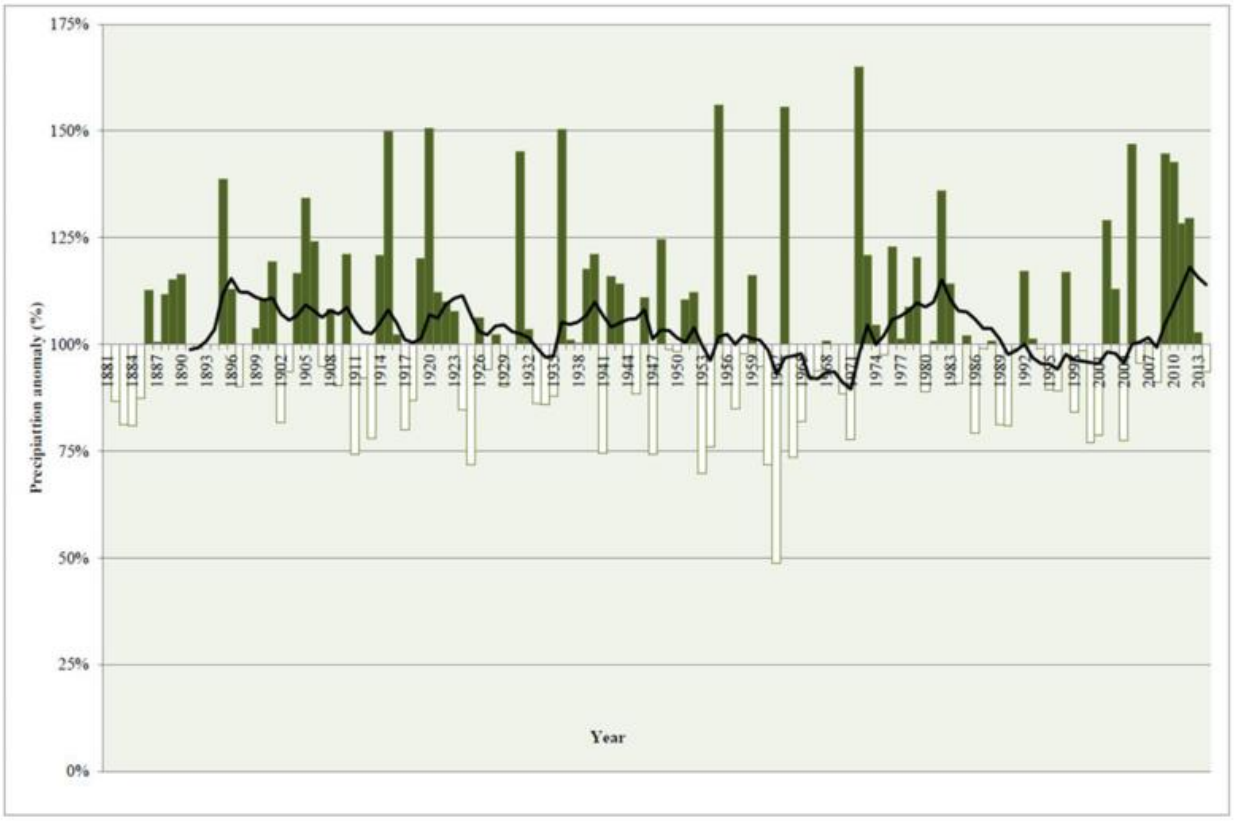


Figure 5.41: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Tbilisi, Georgia (Diagram as provided by the NHMS)

5.3. Sunshine duration

Central and Western Europe - sunshine duration anomalies

Germany, Switzerland

Germany

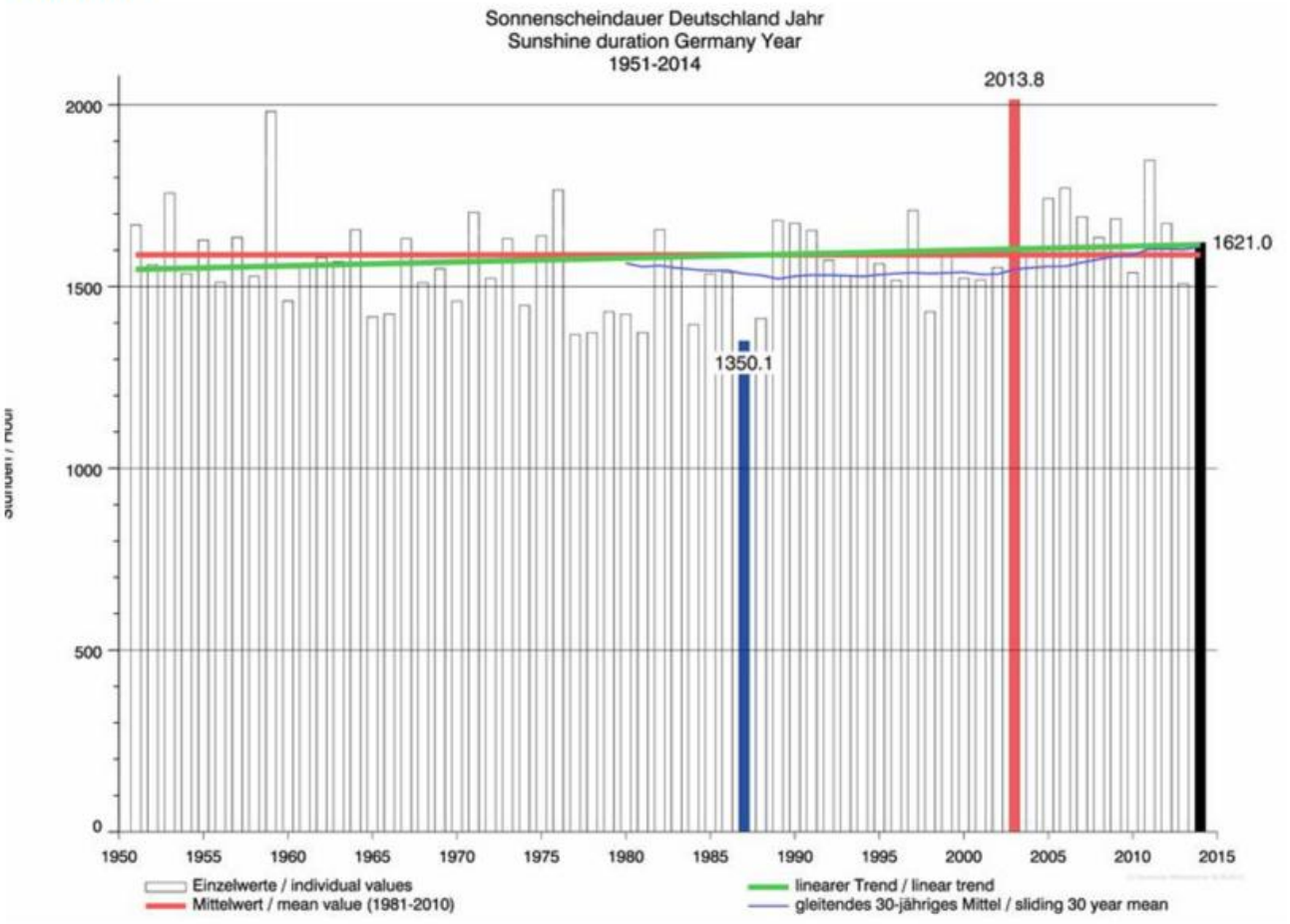


Figure 5.42: Time series of annual sum of the sunshine duration in hours for Germany (Diagram as provided by the NHMS)

Northern and Southern Switzerland

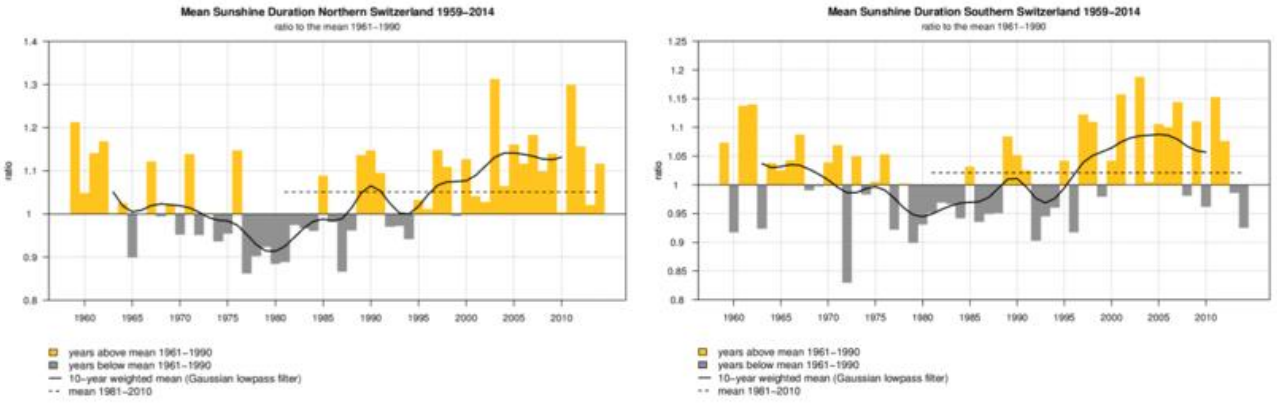


Figure 5.43: Time series of annual sunshine duration anomalies as ratio of the mean 1961-1990 for Northern (left) and Southern (right) Switzerland (reference period: 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries - sunshine duration

Denmark

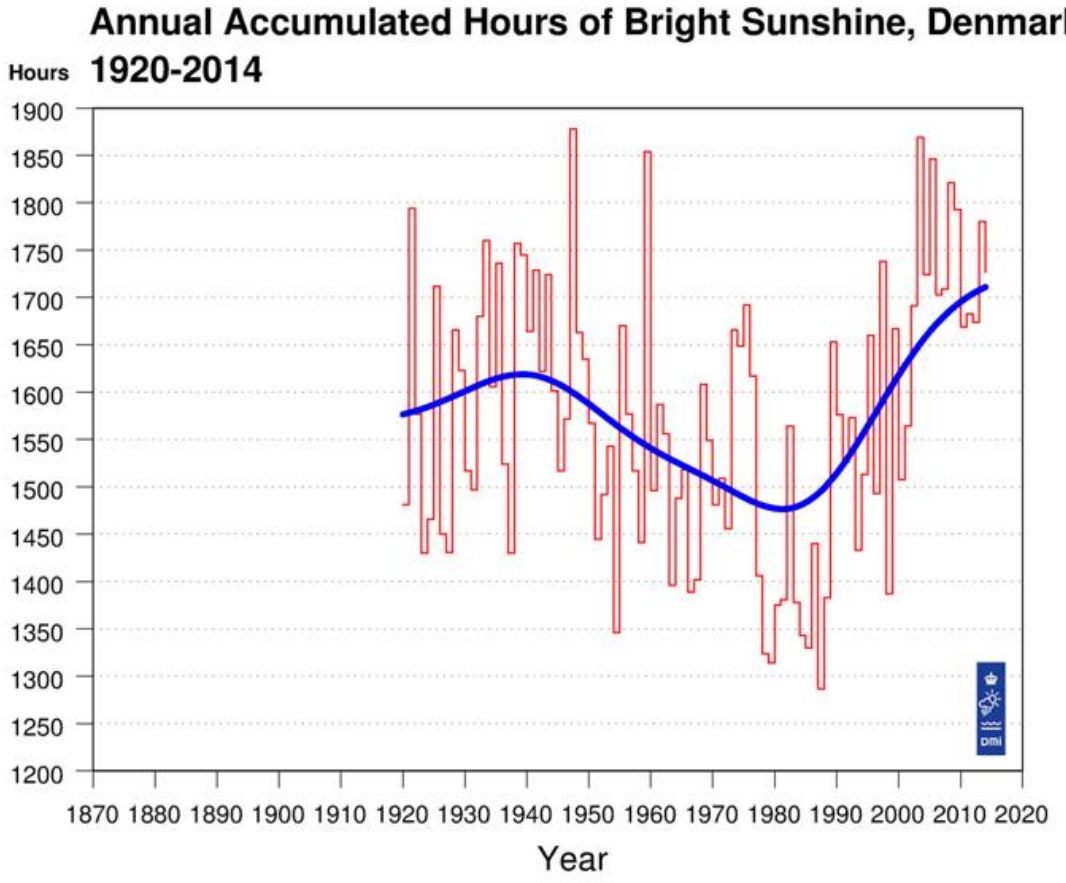


Figure 5.44: Time series of annual sunshine duration in hours for Denmark (Diagram as provided by the NHMS)

Note: DMI observed since 2002 the hours of bright sunshine using measurements of global radiation instead of measurements from a traditional Campbell-Stokes sunshine recorder. For that reason "new" and "old" hours of bright sunshine cannot directly be compared. It should also be noted that all values before 2002 are adjusted in the best way possible ensuring comparability to the new level. For details on that, see DMI Technical 02-25: Ellen Vaarby Laursen, Stig Rosenørn: New hours of bright sunshine normals for Denmark, 1961-1990. http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2002/tr02-25.pdf

5.4. Other climate related variables

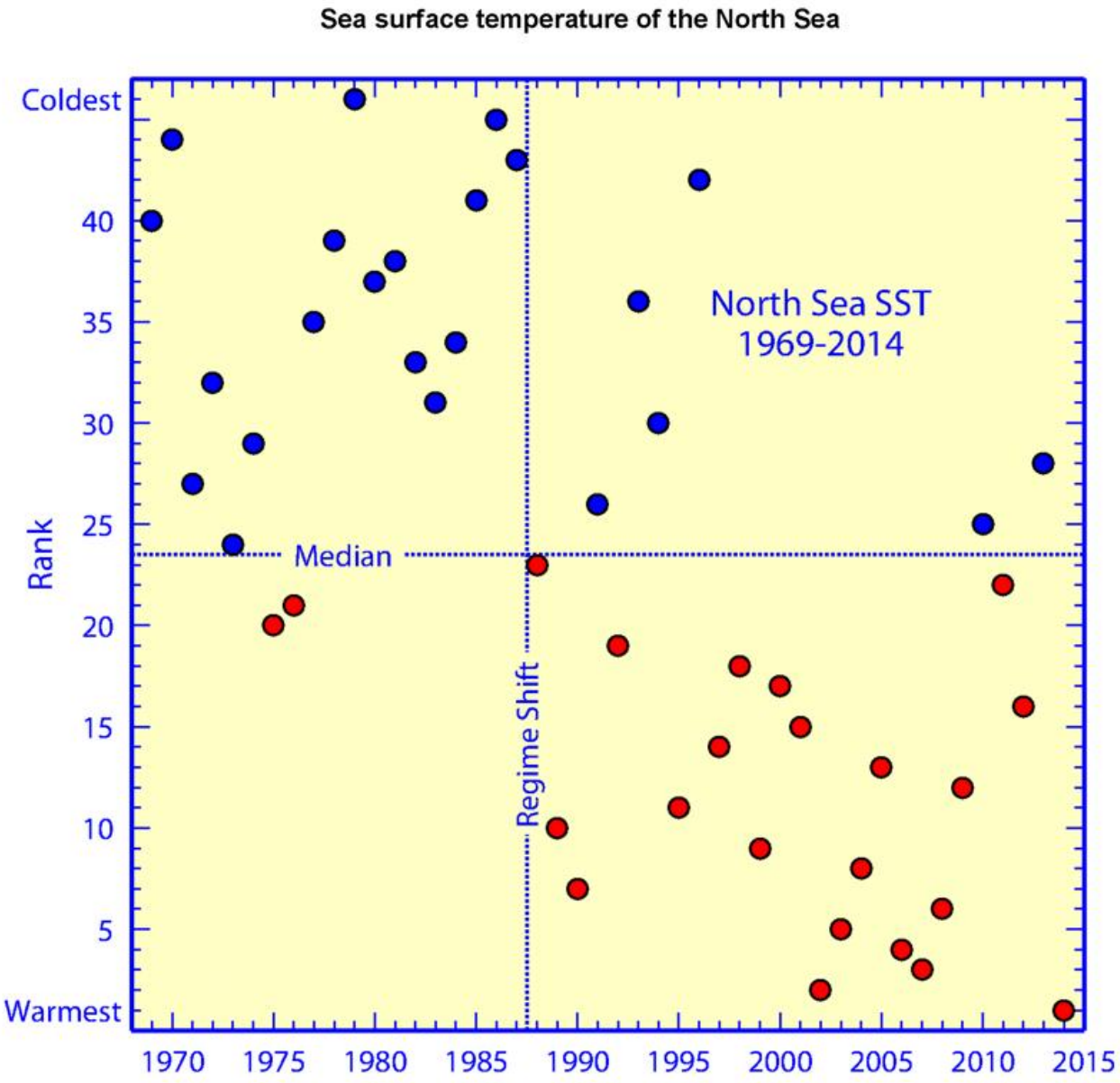


Figure 5.45: Rank statistics of the North Sea SST form 1969 to 2014 (Source: Bundesamt für Seeschifffahrt und Hydrographie BSH; year2014 means December 2013 to November 2014)

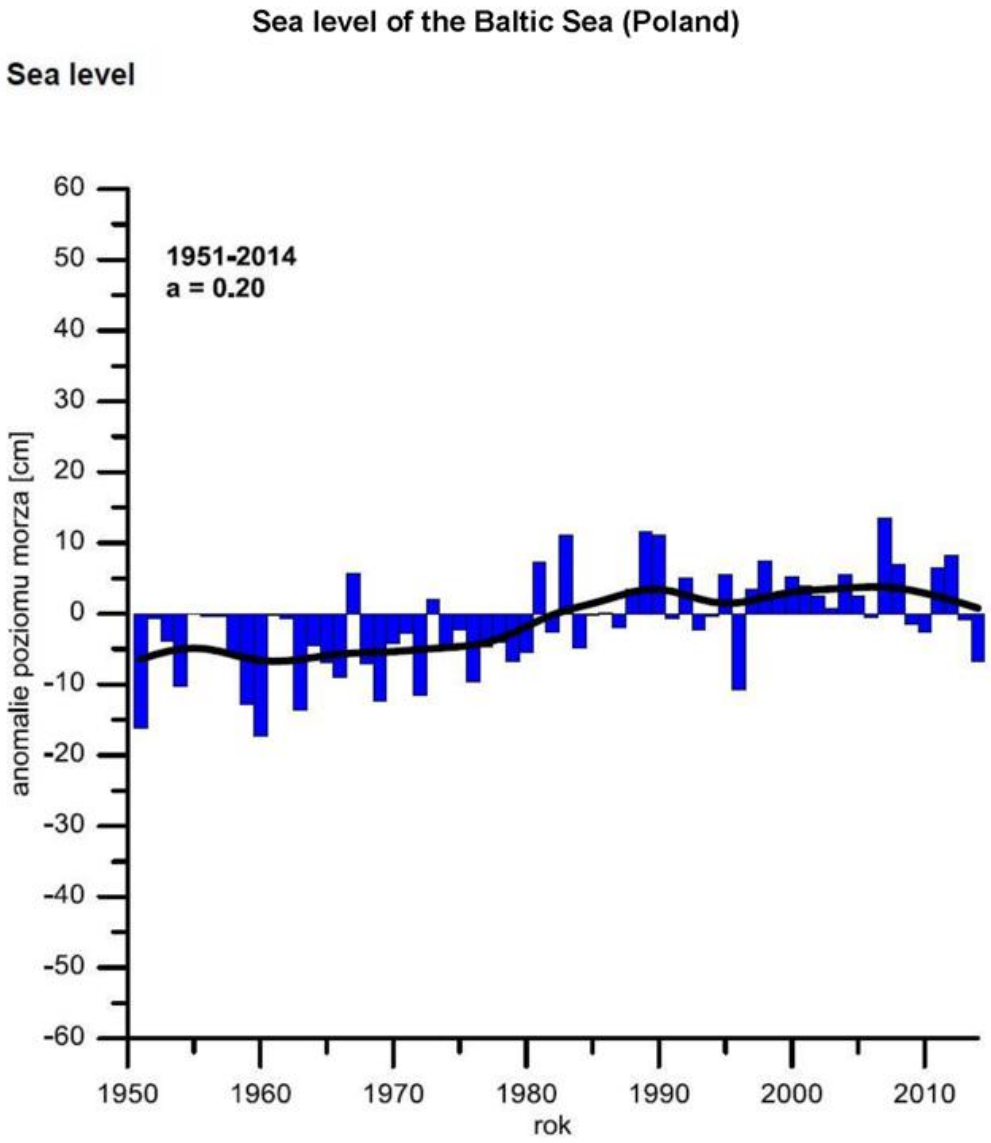


Figure 5.46: Mean annual sea level anomalies of the Baltic Sea in Władysławowo (1951-2014) in relation to the reference 1971-2000, smoothed by 10-years Gaussian filter (black line) and the value of the linear trend (cm/year, diagram as provided by the NHMS).

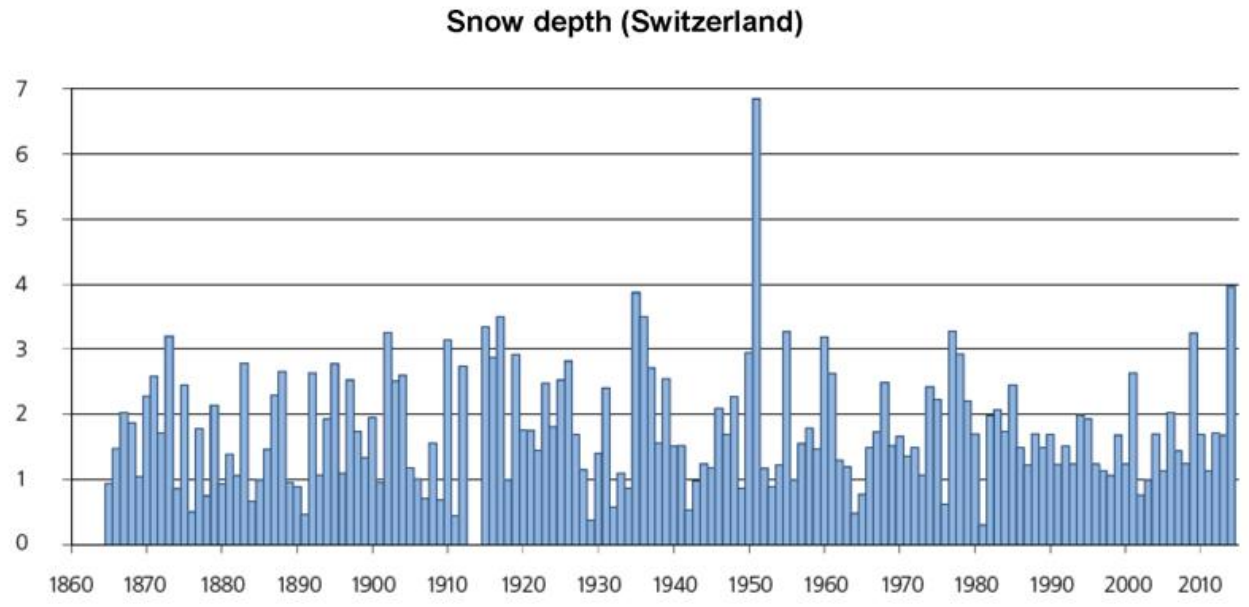


Figure 5.47: Fresh fallen snow during the snow-period (December – February in meters) at Segl-Maria (Switzerland, 1804 m NN) for the period 1864/65 until 2013/14 (Diagram as provided by the NHMS).

6. Annex: Monthly and annual tables

Table 6.1: Statistical values of **annual** mean temperature and total precipitation and their deviations from the long term mean (1961 – 1990, CLIMAT Data) for several stations of the RA VI region.

WMO-No.	Country	Station name	Temperatur (°C) mean	Temperatur (°C) dev.	Precipitation (mm) total	Precipitation (mm) dev.
01001	NOR	Jan Mayen	1.9	3.3	537	-156
01008	NOR	Svalbard Airport	-2.1	4.3	273	90
01025	NOR	Tromso	3.6	0.8	793	-180
01492	NOR	Oslo	8.3	2.6	1028	259
02196	SWE	Haparanda	4.0	2.8	565	13
02485	SWE	Stockholm	8.8	2.2	608	69
02836	FIN	Sodankylä	1.5	2.5	553	53
02974	FIN	Helsinki	6.7	2.2	634	-17
03091	GBR	Aberdeen	9.6	1.7	974	191
03772	GBR	London	12.7	2.1	865	266
03967	IRL	Dublin Casement Aerodrome	10.1	0.8	947	212
04030	ISL	Reykjavik	6.0	1.7	964	166
04320	GRL	Egedesminde	-2.9	2.0	404	130
04312	GRL	Nord (AWS)	-14.3	2.5	317	146
06186	DNK	Copenhagen	10.7	2.1	832	196
06260	NLD	De Bilt	11.7	2.3	873	68
06447	BEL	Brussels	11.9	2.0	784	-16
06590	LUX	Luxembourg	10.8	2.5	856	-19
06660	CHE	Zurich	10.6	2.1	1076	-10
06700	CHE	Geneva	11.7	2.1	1006	52
07510	FRA	Bordeaux	14.5	1.8	1001	78
07650	FRA	Marseilles	16.6	1.8	688	143
08222	ESP	Madrid	16.1	1.7	419	-37
08314	ESP	Mahon/Menorca	18.1	1.5	555	-44
08495	GBR	Gibraltar	18.9	0.7	630	-145
08515	PRT	Santa Maria/Azores	17.9	0.4	479	-296
08535	PRT	Lisbon	17.2	0.4	1085	332
10384	DEU	Berlin-Tempelhof	11.5	2.1	421	-163
11035	AUT	Vienna	12.0	2.3	765	158
11518	CZE	Prague	9.9	2.0	625	99
11903	SVK	Sliac	10.8	2.8	793	107
12160	POL	Elblag	8.5	0.8	509	-181
12375	POL	Warsaw	9.8	2.0	559	40
12843	HUN	Budapest	12.7	2.2	916	398
13274	SRB	Belgrade	13.9	2.1	1103	411
14015	SVN	Ljubljana	12.7	2.9	1851	458
14445	HRV	Split	17.4	1.5	1209	384
14654	BIH	Sarajevo	11.6	2.1	1172	254
15420	ROU	Bucureşti	11.3	0.7	841	246
15614	BGR	Sofia	11.1	1.4	1071	508
16158	ITA	Pisa	15.6	1.6	1209	305
16597	MLT	Luqa	19.9	1.3	506	-48
16716	GRC	Athens	18.9	1.3	518	141
16754	GRC	Heraklion/Crete	19.8	1.4	410	-91
22113	RUS	Murmansk	1.3	1.4	541	63
26038	EST	Tallinn	6.7	1.6	565	-102
26406	LVA	Liepaja	8.3	1.6	747	57
26629	LTU	Kaunas	8.2	1.8	635	27
26730	LTU	Vilnius	7.7	1.7	612	-71
26850	BLR	Minsk	7.7	1.9	607	-70
27612	RUS	Moscow	6.9	1.9	488	-200
33345	UKR	Kiev	9.4	1.7	546	-103
33815	MDA	Kishinev	10.9	1.3	604	57
34300	UKR	Charkow/Kharkiv	8.9	1.5	487	-32
34880	RUS	Astrachan	11.0	1.1	144	-76
37789	ARM	Yerevan	13.6	1.5	339	62
17062	TUR	Istanbul	16.9	2.7	701	4
17130	TUR	Ankara	13.5	1.9	495	88
17170	TUR	Van	10.6	2.0	416	38
17300	TUR	Antalya	19.7	1.3	1225	159
17609	CYP	Larnaca	20.5	1.4	256	-73
35108	KAZ	Uralsk	6.1	0.8	236	-93
37545	GEO	Tbilisi (Tiflis)	14.5	1.5	456	-42
40080	SYR	Damascus	18.1	1.6	113	-34
40103	LBN	Tripoli	20.4	1.1	604	-277
40180	ISR	Tel Aviv	21.3	1.8	551	-17
40199	ISR	Eilat	26.2	1.4	43	11
40265	JOR	Mafraq	17.8	1.3	132	-28
60030	ESP	Las Palmas/ Gran Canary	21.7	1.2	130	13

Table 6.2: Statistical values of **monthly** mean temperature and total precipitation and their deviations from the long term mean (1961 – 1990, CLIMAT Data) for several stations of the RA VI region.

WMO -No.	Country	Station name	January				February				March			
			Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
			mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
01001	NOR	Jan Mayen	1.5	7.2	37	-23	-1.2	4.9	14	-42	-1.9	4.2	46	-10
01008	NOR	Svalbard Airport	-4.1	11.3	13	-1	-1.7	14.0	3	-16	-8.6	6.1	16	-5
01025	NOR	Tromso	-5.9	-1.9	1	-80	-0.1	3.6	28	-58	-0.4	1.8	153	89
01492	NOR	Oslo	-2.6	1.7	74	25	1.9	5.9	137	101	4.3	4.5	50	4
02196	SWE	Haparanda	-10.3	1.8	27	-17	-1.8	9.5	55	23	-0.9	5.9	35	0
02485	SWE	Stockholm	-1.5	1.3	39	0	2.3	5.3	35	8	4.5	4.4	43	17
02836	FIN	Sodankylä	-15.1	0.0	35	4	-4.0	9.6	32	7	-3.9	4.6	34	9
02974	FIN	Helsinki	-7.4	-0.5	42	1	-0.4	6.4	29	-2	1.6	4.5	30	-4
03091	GBR	Aberdeen	4.7	2.0	165	84	5.3	2.4	104	53	7.2	2.7	35	-23
03772	GBR	London	7.1	2.9	162	110	7.7	3.2	90	55	9.3	2.8	28	-19
03967	IRL	Dublin Aero.	5.5	1.1	111	45	5.6	1.2	122	71	6.8	0.8	57	8
04030	ISL	Reykjavik	2.4	2.9	64	-12	1.7	1.3	14	-58	2.1	1.6	115	33
04320	GRL	Egedesminde	-7.3	6.0	38	23	-10.1	5.4	11	-4	-13.7	2.6	11	-7
04312	GRL	Nord (AWS)	-26.3	3.8	10	1	-25.4	5.1	17	9	-27.2	2.9	28	16
06186	DNK	Copenhagen	1.9	1.4	67	16	4.3	3.8	54	23	6.6	4.0	26	-16
06260	NLD	De Bilt	5.7	3.5	62	-4	6.5	4.0	66	17	8.4	3.4	26	-37
06447	BEL	Brussels	6.1	3.5	70	3	6.6	3.1	66	13	9.3	3.8	18	-36
06590	LUX	Luxembourg	3.6	3.6	77	6	4.2	3.1	69	7	8.1	4.1	12	-58
06660	CHE	Zurich	3.1	3.6	47	-20	4.1	3.2	65	-5	7.3	3.1	26	-43
06700	CHE	Geneva	4.1	3.3	93	13	4.8	2.5	121	40	7.8	2.7	39	-40
07510	FRA	Bordeaux	9.1	3.3	184	84	8.8	1.7	130	44	10.5	1.7	88	12
07650	FRA	Marseilles	9.9	3.2	131	84	9.9	2.0	96	42	11.5	1.3	22	-22
08222	ESP	Madrid	8.0	1.9	64	18	7.3	-0.2	50	6	11.6	1.6	23	-10
08314	ESP	Mahon/Menorca	12.0	1.5	72	6	11.5	0.8	30	-27	12.2	0.6	54	-1
08495	GBR	Gibraltar	14.1	0.7	117	-4	13.4	-0.4	74	-26	15.2	0.2	52	-23
08515	PRT	Santa Maria/Az.	14.7	0.3	52	-48	14.5	0.5	20	-66	14.9	0.3	85	6
08535	PRT	Lisbon	12.6	1.2	195	85	12.0	-0.3	158	47	13.7	0.0	65	-4
10384	DEU	Berlin-Tempelhof	0.7	0.9	30	-13	5.3	4.5	9	-25	8.1	3.9	18	-19
11035	AUT	Vienna	2.3	3.3	8	-30	4.2	3.2	20	-22	9.2	4.2	13	-28
11518	CZE	Prague	0.5	2.9	15	-8	2.7	3.5	1	-22	6.9	3.9	37	9
11903	SVK	Sliac	2.0	5.9	54	10	3.5	4.6	57	13	7.8	4.8	35	-7
12160	POL	Elblag	-4.2	-1.8	52	5	1.8	4.0	13	-12	5.1	3.0	48	13
12375	POL	Warsaw	-2.6	0.7	48	26	1.9	3.9	14	-7	7.0	5.0	35	7
12843	HUN	Budapest	2.9	4.5	20	-12	4.8	3.7	44	12	10.4	4.8	11	-18
13274	SRB	Belgrade	5.3	4.9	24	-25	7.6	4.9	20	-24	10.8	3.6	49	-1
14015	SVN	Ljubljana	5.4	6.5	172	90	4.4	3.0	281	201	10.0	4.6	35	-63
14445	HRV	Split	11.0	3.6	107	24	12.0	3.9	151	83	13.0	2.6	50	-25
14654	BIH	Sarajevo	4.9	5.8	55	-16	7.9	6.4	20	-47	8.0	2.9	67	-3
15420	ROU	Bucureşti	-0.6	1.8	61	21	1.4	1.5	2	-34	8.6	3.8	41	3
15614	BGR	Sofia	0.9	2.5	25	-2	5.0	4.5	10	-23	7.9	3.3	65	27
16158	ITA	Pisa	8.9	2.8	239	164	10.6	3.5	133	60	11.0	1.5	61	-15
16597	MLT	Luqa	14.2	2.0	58	-31	14.1	1.7	59	-2	13.7	0.3	45	4
16716	GRC	Athens	12.3	3.0	113	69	12.3	2.5	22	-26	13.4	1.7	54	12
16754	GRC	Heraklion/Crete	14.0	2.0	24	-66	13.7	1.6	61	-16	14.4	1.0	60	4
22113	RUS	Murmansk	-13.4	-1.7	21	-12	-4.2	7.0	11	-11	-2.6	4.2	31	11
26038	EST	Tallinn	-6.6	-1.1	54	9	-0.1	5.6	27	-2	1.9	4.1	28	-1
26406	LVA	Liepaja	-4.2	-1.2	61	15	1.3	4.3	21	-10	3.7	3.9	55	19
26629	LTU	Kaunas	-5.2	-0.2	53	16	0.1	4.4	28	1	5.2	5.4	21	-11
26730	LTU	Vilnius	-6.4	-0.3	46	5	-0.5	4.3	39	1	5.1	5.7	34	-5
26850	BLR	Minsk	-7.4	-0.5	52	12	-1.0	4.8	19	-15	5.4	6.8	20	-22
27612	RUS	Moscow	-8.6	0.7	41	-4	-1.9	5.8	19	-18	2.8	5.0	18	-16
33345	UKR	Kiev	-4.8	0.8	40	-7	-0.5	3.7	12	-34	6.8	6.1	16	-23
33815	MDA	Kishinev	-1.9	1.4	63	23	-1.2	0.5	9	-29	8.1	5.2	16	-19
34300	UKR	Charkow/Kharkiv	-6.8	0.1	45	1	-2.1	3.6	17	-15	5.2	5.5	12	-15
34880	RUS	Astrachan	-4.2	1.2	6	-7	-3.7	1.2	<1	-10	4.5	3.2	21	7
37789	ARM	Yerevan	-4.2	-0.7	42	21	2.3	3.3	8	-16	9.1	3.3	75	43
17062	TUR	Istanbul	9.5	3.9	38	-61	9.5	3.6	36	-31	11.4	3.9	64	2
17130	TUR	Ankara	3.1	3.1	33	-8	5.9	4.2	15	-21	8.3	2.3	58	22
17170	TUR	Van	-1.5	2.9	28	-6	-1.2	2.6	12	-21	4.2	3.3	38	-4
17300	TUR	Antalya	11.1	1.2	203	-36	13.2	2.9	34	-162	14.7	2.0	230	127
17609	CYP	Larnaca	14.0	2.5	37	-28	13.5	1.8	34	-23	15.9	2.6	12	-37
35108	KAZ	Uralsk	-11.1	1.8	26	1	-14.1	-1.6	12	-6	-0.2	4.8	24	4
37545	GEO	Tbilisi (Tiflis)	3.7	2.0	37	18	3.4	0.5	6	-20	8.6	1.7	37	7
40080	SYR	Damascus	7.6	1.7	<1	-29	8.7	0.8	21	-3	13.8	2.8	27	10
40103	LBN	Tripoli	13.5	0.8	25	-169	13.4	0.2	46	-81	16.2	1.5	136	20
40180	ISR	Tel Aviv	14.2	1.9	3	-146	14.7	1.8	8	-90	17.2	2.3	77	15
40199	ISR	Eilat	16.7	1.5	4	-1	18.4	1.5	8	3	22.1	2.1	15	11
40265	JOR	Mafraq	9.3	2.1	<1	-34	9.8	1.1	5	-26	14.1	2.6	37	8
60030	ESP	Las Palmas Can.	18.3	0.8	18	1	18.0	0.4	27	5	18.9	0.5	4	-6

Table 6.2: continued

WMO-No.	Country	Station name	April				May				June			
			Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
			mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
01001	NOR	Jan Mayen	-1.9	2.0	51	10	0.4	1.1	6	-34	4.7	2.9	8	-28
01008	NOR	Svalbard Airport	-9.7	2.0	3	-9	-2.0	1.7	9	3	3.8	1.6	6	-4
01025	NOR	Tromso	1.3	0.6	110	50	4.5	-0.4	30	-18	8.6	-0.7	38	-15
01492	NOR	Oslo	7.7	3.1	55	13	12.0	1.2	58	6	15.7	0.5	112	47
02196	SWE	Haparanda	1.4	1.9	15	-14	7.4	1.3	31	0	11.9	-0.9	18	-23
02485	SWE	Stockholm	7.5	2.9	25	-5	11.1	0.4	35	5	14.1	-1.5	28	-17
02836	FIN	Sodankylä	-0.2	1.9	31	7	5.4	0.4	55	20	10.6	-1.0	54	-2
02974	FIN	Helsinki	5.7	2.8	16	-21	10.9	1.0	67	32	13.6	-1.3	66	22
03091	GBR	Aberdeen	8.5	2.2	45	-8	10.8	1.8	56	-3	14.0	1.9	53	0
03772	GBR	London	11.8	2.9	58	13	13.9	1.4	85	34	17.3	1.6	41	-10
03967	IRL	Dublin Aero.	9.5	1.7	39	-8	11.6	1.1	98	40	13.9	0.6	32	-16
04030	ISL	Reykjavik	4.9	2.0	56	-2	8.2	1.9	48	4	11.2	2.2	116	66
04320	GRL	Egedesminde	-9.2	0.4	21	3	-1.3	0.5	11	-4	5.3	2.6	20	1
04312	GRL	Nord (AWS)	-20.5	2.5	24	13	-7.4	2.6	19	12	0.4	1.1	7	-5
06186	DNK	Copenhagen	9.7	3.1	23	-19	13.1	1.1	59	16	16.1	0.0	46	-8
06260	NLD	De Bilt	12.1	4.1	58	6	13.2	0.9	102	41	16.2	1.0	30	-38
06447	BEL	Brussels	12.4	3.6	20	-37	13.5	0.6	54	-17	16.5	0.8	95	16
06590	LUX	Luxembourg	11.7	4.2	14	-47	12.7	0.9	70	-11	17.3	2.4	34	-48
06660	CHE	Zurich	10.9	3.1	88	1	12.6	0.5	116	13	18.0	2.8	147	23
06700	CHE	Geneva	11.8	3.0	60	-5	13.5	0.5	73	-4	19.1	2.6	55	-34
07510	FRA	Bordeaux	14.0	2.7	83	11	14.7	0.1	71	-6	20.6	2.8	67	11
07650	FRA	Marseilles	15.6	2.4	9	-39	18.0	0.9	6	-36	23.3	2.4	39	11
08222	ESP	Madrid	16.2	4.0	59	5	18.1	2.1	12	-29	22.4	1.7	14	-12
08314	ESP	Mahon/Menorca	15.9	2.6	32	-18	17.3	0.5	57	20	22.7	1.9	2	-12
08495	GBR	Gibraltar	17.8	1.6	69	9	19.8	1.3	8	-27	22.5	1.4	18	7
08515	PRT	Santa Maria/Az.	15.1	-0.1	42	-13	17.8	1.1	3	-27	19.4	0.7	8	-14
08535	PRT	Lisbon	16.0	0.9	66	2	18.5	1.1	31	-8	20.5	0.3	32	11
10384	DEU	Berlin-Tempelhof	12.1	3.5	21	-20	13.9	0.0	86	30	17.6	0.2	40	-35
11035	AUT	Vienna	12.6	2.7	67	16	14.9	0.3	192	131	19.6	1.7	34	-40
11518	CZE	Prague	10.6	2.9	31	-7	12.1	-0.6	121	44	16.3	0.4	21	-52
11903	SVK	Sliac	11.0	2.5	45	-2	14.4	0.7	81	17	18.2	1.6	44	-41
12160	POL	Elblag	9.1	2.3	28	-14	12.1	-0.8	53	12	13.9	-1.5	95	1
12375	POL	Warsaw	10.7	2.9	44	12	14.5	1.1	90	31	16.4	-0.2	74	2
12843	HUN	Budapest	13.5	2.4	35	-3	16.1	0.1	113	58	20.8	1.7	21	-42
13274	SRB	Belgrade	13.5	1.1	85	26	16.9	-0.3	280	209	21.2	1.1	60	-30
14015	SVN	Ljubljana	13.0	3.1	99	-10	15.7	1.1	94	-28	20.2	2.4	131	-24
14445	HRV	Split	15.6	1.7	121	55	18.3	-0.1	45	-11	23.8	1.6	127	76
14654	BIH	Sarajevo	10.2	0.8	148	74	13.3	-0.8	186	104	17.5	0.6	125	34
15420	ROU	Bucureşti	11.5	0.2	118	72	16.0	-0.7	105	35	19.4	-0.8	132	55
15614	BGR	Sofia	10.6	0.7	151	101	14.4	0.1	148	75	18.2	0.5	115	43
16158	ITA	Pisa	13.4	0.9	30	-49	16.1	-0.2	17	-42	21.6	1.8	35	-9
16597	MLT	Luqa	17.0	1.5	13	-10	19.6	0.5	6	-1	24.3	1.3	2	-1
16716	GRC	Athens	16.3	0.9	32	3	20.6	0.5	5	-13	25.4	0.8	20	10
16754	GRC	Heraklion/Crete	17.6	1.3	8	-22	20.9	1.1	3	-13	24.9	1.4	5	2
22113	RUS	Murmansk	-0.2	1.7	37	16	4.2	0.4	36	4	8.3	-1.1	94	41
26038	EST	Tallinn	5.3	1.9	11	-25	10.7	1.0	47	10	12.7	-1.8	81	28
26406	LVA	Liepaja	8.1	3.5	12	-23	11.6	1.3	28	-12	13.1	-1.2	104	58
26629	LTU	Kaunas	9.1	3.1	21	-22	13.4	0.7	84	28	14.7	-1.3	56	-19
26730	LTU	Vilnius	8.8	3.1	16	-30	13.5	1.0	71	9	14.5	-1.3	48	-29
26850	BLR	Minsk	8.6	2.6	33	-9	14.4	1.5	80	18	15.8	-0.3	68	-15
27612	RUS	Moscow	7.0	1.2	22	-18	16.0	3.1	70	12	16.1	-0.5	74	-2
33345	UKR	Kiev	10.3	1.6	29	-20	16.9	1.8	172	119	18.2	0.0	53	-20
33815	MDA	Kishinev	11.6	1.4	41	-1	16.8	0.7	86	35	19.5	0.1	36	-39
34300	UKR	Charkow/Kharkiv	9.4	0.5	39	3	18.9	3.3	54	7	18.5	-0.4	138	80
34880	RUS	Astrachan	10.9	-0.2	12	-6	22.3	4.0	14	-10	24.5	1.6	9	-13
37789	ARM	Yerevan	14.0	1.3	20	-17	19.2	1.7	48	5	22.7	0.8	23	2
17062	TUR	Istanbul	15.0	3.0	32	-17	19.0	2.5	51	20	22.7	1.6	80	59
17130	TUR	Ankara	13.3	2.1	43	-5	16.2	0.6	88	33	19.7	0.1	65	28
17170	TUR	Van	9.9	2.6	67	13	14.8	2.0	21	-29	17.9	0.3	23	2
17300	TUR	Antalya	17.2	1.1	31	-15	20.3	0.0	88	60	25.4	0.4	5	-3
17609	CYP	Larnaca	18.6	1.2	5	-6	21.2	0.3	35	28	25.4	1.1	2	1
35108	KAZ	Uralsk	6.7	-1.0	22	3	19.1	3.0	16	-5	20.9	0.7	33	-4
37545	GEO	Tbilisi (Tiflis)	13.6	0.8	93	42	19.8	2.4	78	0	22.8	1.6	51	-25
40080	SYR	Damascus	18.8	3.3	4	-7	22.0	1.8	28	25	25.8	1.4	0	0
40103	LBN	Tripoli	18.7	1.2	1	-55	21.6	1.7	<1	-17	25.1	1.8	0	-1
40180	ISR	Tel Aviv	20.6	2.4	0	-23	23.2	2.1	44	41	25.6	1.6	<1	<1
40199	ISR	Eilat	26.6	2.4	0	-4	29.6	1.2	13	12	32.5	0.8	0	0
40265	JOR	Mafraq	18.2	2.4	0	-10	20.8	1.0	10	7	23.5	0.8	0	0
60030	ESP	Las Palmas Can.	20.4	1.7	2	-4	21.7	1.8	2	0	23.0	1.6	0	0

Table 6.2: continued

WMO-No.	Country	Station name	July				August				September			
			Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
			mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
01001	NOR	Jan Mayen	7.4	3.2	75	28	7.1	2.1	36	-25	5.8	2.9	66	-16
01008	NOR	Svalbard Airport	7.2	1.2	29	16	6.4	1.6	11	-14	1.6	1.1	31	8
01025	NOR	Tromso	14.5	2.8	34	-38	11.4	0.5	64	-18	7.6	0.8	92	-2
01492	NOR	Oslo	20.8	4.4	51	-33	15.8	0.6	109	19	13.1	2.3	42	-48
02196	SWE	Haparanda	19.0	3.5	35	-15	15.6	2.3	110	47	10.0	2.1	22	-41
02485	SWE	Stockholm	20.7	3.5	44	-28	17.4	1.2	115	49	13.7	2.5	83	28
02836	FIN	Sodankylä	18.3	4.2	84	19	13.9	2.7	54	-9	7.6	1.7	46	-9
02974	FIN	Helsinki	20.4	3.8	43	-30	17.4	2.4	120	40	12.3	2.3	53	-20
03091	GBR	Aberdeen	15.6	1.8	57	-3	13.3	-0.3	140	65	13.4	1.7	29	-39
03772	GBR	London	20.4	2.6	50	4	17.2	-0.2	98	47	17.1	2.1	11	-40
03967	IRL	Dublin Aero.	16.4	1.5	42	-12	13.9	-0.7	142	64	13.7	0.7	13	-56
04030	ISL	Reykjavik	11.8	1.2	89	37	11.4	1.1	58	-4	9.2	1.8	153	87
04320	GRL	Egedesminde	7.0	1.3	13	-10	6.7	1.4	133	99	3.2	0.8	28	-6
04312	GRL	Nord (AWS)	4.2	0.9	11	-10	3.3	1.2	5	-12	-6.7	2.2	50	28
06186	DNK	Copenhagen	20.8	3.6	36	-33	17.1	0.1	168	105	15.0	1.4	48	-14
06260	NLD	De Bilt	19.8	3.0	137	62	16.1	-0.6	149	78	15.9	1.9	21	-46
06447	BEL	Brussels	19.3	1.8	117	42	16.2	-1.1	136	73	16.5	2.0	15	-44
06590	LUX	Luxembourg	19.2	2.3	114	46	15.5	-0.9	201	129	15.6	2.2	18	-52
06660	CHE	Zurich	17.6	0.0	191	74	16.4	-0.3	112	-21	15.2	1.4	69	-23
06700	CHE	Geneva	18.4	-0.7	176	109	18.0	-0.2	53	-26	16.7	1.8	40	-41
07510	FRA	Bordeaux	20.9	0.7	51	4	19.4	-0.5	80	26	20.2	2.3	22	-52
07650	FRA	Marseilles	23.9	0.1	10	-4	23.2	0.0	89	60	21.8	1.5	75	28
08222	ESP	Madrid	24.9	0.5	3	-10	25.6	1.7	0	-9	21.8	1.3	25	-5
08314	ESP	Mahon/Menorca	24.4	0.2	3	-1	25.4	0.9	<1	-26	24.8	2.6	48	-6
08495	GBR	Gibraltar	23.9	0.2	0	-1	24.4	0.2	0	-6	23.5	0.7	19	4
08515	PRT	Santa Maria/Az.	21.5	0.7	41	16	23.8	1.6	18	-22	21.1	-0.3	58	1
08535	PRT	Lisbon	22.0	-0.4	6	1	22.2	-0.6	0	-6	21.5	-0.2	118	92
10384	DEU	Berlin-Tempelhof	21.9	3.1	61	9	18.2	-0.2	32	-29	16.6	2.0	27	-19
11035	AUT	Vienna	21.9	2.2	92	29	19.0	0.1	112	54	15.9	0.8	110	65
11518	CZE	Prague	19.6	2.1	163	97	16.4	-0.6	55	-15	14.8	1.5	81	41
11903	SVK	Sliac	20.5	2.3	171	112	17.5	0.2	111	42	15.5	2.1	89	33
12160	POL	Elblag	20.1	3.3	29	-65	16.8	0.1	54	-27	14.1	1.4	30	-40
12375	POL	Warsaw	21.4	3.5	73	6	18.2	0.9	68	5	15.1	1.9	8	-35
12843	HUN	Budapest	22.8	1.9	183	131	20.3	0.0	203	152	17.5	1.1	134	94
13274	SRB	Belgrade	22.8	1.1	251	185	22.6	1.3	64	12	18.2	0.5	126	75
14015	SVN	Ljubljana	20.8	0.9	130	8	19.6	0.5	205	61	16.2	0.7	204	74
14445	HRV	Split	24.6	-0.8	110	82	25.7	0.5	44	-6	20.9	-0.5	181	120
14654	BIH	Sarajevo	19.4	0.5	73	-6	19.7	1.2	169	98	14.8	-0.3	140	70
15420	ROU	Bucureşti	22.4	0.4	42	-22	22.7	1.5	42	-16	17.4	0.5	41	-1
15614	BGR	Sofia	20.4	0.4	119	63	21.2	1.8	77	25	15.8	0.0	198	159
16158	ITA	Pisa	22.4	-0.4	186	163	22.4	-0.1	4	-53	20.4	0.9	63	-26
16597	MLT	Luqa	26.2	0.3	<1	<1	27.2	0.9	<1	-7	26.3	2.2	<1	-40
16716	GRC	Athens	27.8	0.8	26	23	28.7	2.0	2	-2	24.0	0.7	13	1
16754	GRC	Heraklion/Crete	26.7	1.0	0	-1	27.6	2.0	0	-1	24.9	1.8	24	6
22113	RUS	Murmansk	13.6	0.8	70	10	12.8	1.8	101	36	7.5	0.8	35	-17
26038	EST	Tallinn	19.4	3.1	47	-32	17.3	2.0	115	31	12.6	1.8	15	-67
26406	LVA	Liepaja	20.2	3.8	18	-56	18.0	1.6	154	74	14.0	1.1	54	-24
26629	LTU	Kaunas	20.6	3.5	71	3	17.7	1.4	111	48	13.5	1.4	21	-38
26730	LTU	Vilnius	20.1	3.2	68	-10	17.8	1.5	117	45	13.0	1.4	48	-17
26850	BLR	Minsk	20.8	3.5	56	-32	18.9	2.4	169	97	12.9	1.2	27	-33
27612	RUS	Moscow	21.1	3.0	4	-88	19.2	2.8	82	8	12.3	1.4	38	-26
33345	UKR	Kiev	22.1	2.8	75	-13	21.3	2.7	42	-27	15.3	1.4	45	-2
33815	MDA	Kishinev	23.0	2.1	85	16	23.2	2.7	54	9	18.6	2.4	16	-32
34300	UKR	Charkow/Kharkiv	22.4	2.1	40	-20	22.1	2.6	47	-3	15.4	1.3	36	-5
34880	RUS	Astrachan	25.7	0.4	4	-19	27.7	4.4	<1	-19	17.7	0.4	25	-1
37789	ARM	Yerevan	26.3	0.3	2	-8	27.9	2.7	11	4	22.3	1.6	15	5
17062	TUR	Istanbul	26.1	2.9	21	2	26.5	3.5	42	16	22.1	2.4	94	53
17130	TUR	Ankara	25.5	2.6	9	-5	25.7	3.1	21	9	19.2	0.9	60	41
17170	TUR	Van	23.1	1.2	11	7	23.9	2.7	4	0	18.5	1.7	19	9
17300	TUR	Antalya	27.7	-0.4	0	-3	29.2	1.5	2	1	25.7	1.2	46	35
17609	CYP	Larnaca	27.4	0.5	<1	<1	28.2	1.1	<1	<1	26.2	1.1	13	13
35108	KAZ	Uralsk	21.9	-0.6	8	-30	24.1	3.7	21	-4	13.7	-0.4	10	-17
37545	GEO	Tbilisi (Tiflis)	26.1	1.7	29	-16	28.0	4.3	0	-48	21.1	1.5	40	4
40080	SYR	Damascus	27.4	1.1	0	0	28.0	2.0	0	0	24.2	1.0	0	-1
40103	LBN	Tripoli	27.3	2.3	0	0	28.2	2.6	0	-1	26.8	2.0	10	6
40180	ISR	Tel Aviv	27.3	1.6	0	0	28.3	2.2	0	0	26.8	2.0	0	0
40199	ISR	Eilat	34.1	1.2	0	0	34.6	1.8	0	0	31.6	1.2	0	0
40265	JOR	Mafraq	24.9	0.8	0	0	26.0	1.8	0	0	22.9	0.2	0	-1
60030	ESP	Las Palmas Can.	24.2	0.9	<1	<1	25.5	1.4	<1	<1	25.6	1.8	<1	-8

Table 6.2: continued

WMO-No.	Country	Station name	October				November				December			
			Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
			mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
01001	NOR	Jan Mayen	3.0	2.9	82	-1	1.4	4.6	46	-20	-3.6	1.6	70	5
01008	NOR	Svalbard Airport	-1.9	3.6	45	30	-6.4	4.1	49	36	-9.6	3.7	58	46
01025	NOR	Tromso	3.5	0.6	69	-56	0.5	1.3	66	-38	-1.9	1.1	108	4
01492	NOR	Oslo	8.9	2.5	220	136	4.1	3.4	92	17	-2.2	0.6	28	-28
02196	SWE	Haparanda	2.1	-0.4	93	29	-2.1	2.0	47	-11	-4.8	4.7	77	35
02485	SWE	Stockholm	9.5	2.0	87	37	5.5	2.9	32	-21	0.5	1.5	42	-4
02836	FIN	Sodankylä	-1.0	-0.7	29	-22	-5.7	1.7	30	-9	-8.4	4.7	69	38
02974	FIN	Helsinki	5.8	0.4	35	-38	2.1	2.0	39	-33	-1.3	2.8	94	36
03091	GBR	Aberdeen	10.7	0.8	144	67	8.3	3.3	119	44	3.5	0.0	27	-46
03772	GBR	London	14.3	2.6	76	18	9.8	2.6	128	73	6.2	1.1	38	-19
03967	IRL	Dublin Aero.	11.2	0.9	88	20	7.5	0.8	139	69	5.3	0.0	64	-13
04030	ISL	Reykjavik	4.3	-0.1	84	-2	5.5	4.4	57	-16	-0.7	-0.5	110	31
04320	GRL	Egedesminde	-1.5	0.7	33	7	-4.6	1.3	14	-19	-8.9	0.9	71	47
04312	GRL	Nord (AWS)	-16.8	2.6	88	70	-24.4	1.5	30	13	-24.7	3.2	28	11
06186	DNK	Copenhagen	12.3	2.4	152	93	8.2	2.7	50	-12	3.4	1.2	103	45
06260	NLD	De Bilt	13.4	2.9	75	3	8.2	2.3	47	-34	4.8	1.6	100	21
06447	BEL	Brussels	13.6	2.7	58	-12	8.8	2.7	41	-35	4.3	0.8	94	18
06590	LUX	Luxembourg	12.1	3.0	115	40	6.8	3.0	61	-22	2.7	1.7	71	-9
06660	CHE	Zurich	12.4	3.1	82	13	6.6	2.7	79	-3	3.1	2.5	54	-19
06700	CHE	Geneva	13.7	3.6	142	65	8.2	3.2	108	16	4.3	2.5	46	-41
07510	FRA	Bordeaux	16.7	2.7	41	-47	12.6	3.5	130	36	6.6	0.2	54	-45
07650	FRA	Marseilles	18.7	2.6	21	-57	14.6	3.9	146	88	8.9	1.6	44	-12
08222	ESP	Madrid	18.2	3.4	72	27	11.2	1.8	74	10	7.3	0.9	23	-28
08314	ESP	Mahon/Menorca	21.5	3.0	11	-73	17.3	2.9	112	35	11.9	0.1	133	59
08495	GBR	Gibraltar	21.3	1.8	21	-43	17.0	0.9	212	71	14.2	0.1	40	-106
08515	PRT	Santa Maria/Az.	19.9	0.6	88	4	16.8	-0.6	44	-58	15.4	0.0	20	-75
08535	PRT	Lisbon	20.8	2.3	90	10	15.1	0.6	294	180	11.6	-0.2	30	-78
10384	DEU	Berlin-Tempelhof	12.9	2.9	38	2	7.2	2.3	6	-43	3.0	1.6	53	0
11035	AUT	Vienna	12.2	2.3	38	-3	8.1	3.5	35	-15	3.9	3.0	44	1
11518	CZE	Prague	10.5	2.2	54	24	5.9	3.1	22	-10	2.2	2.8	24	-2
11903	SVK	Sliac	10.7	2.4	48	-2	6.6	3.6	17	-52	1.7	3.4	41	-16
12160	POL	Elblag	9.2	0.3	13	-40	3.8	0.5	21	-35	-0.4	-0.7	73	21
12375	POL	Warsaw	9.7	1.4	7	-31	4.8	1.6	16	-26	0.9	1.8	82	50
12843	HUN	Budapest	12.5	1.6	66	32	7.3	2.5	26	-26	3.0	2.6	60	20
13274	SRB	Belgrade	14.1	1.7	61	21	9.6	2.6	9	-45	4.5	2.2	66	8
14015	SVN	Ljubljana	13.6	3.2	163	48	8.8	4.2	249	114	3.9	3.9	88	-13
14445	HRV	Split	18.1	1.2	11	-68	15.3	3.1	130	22	10.2	1.5	132	32
14654	BIH	Sarajevo	11.8	1.4	59	-29	8.7	3.9	47	-44	2.6	2.8	83	19
15420	ROU	Bucureşti	10.7	-0.1	76	44	5.0	-0.2	41	-8	0.9	0.7	140	97
15614	BGR	Sofia	11.2	0.8	68	31	6.2	1.2	35	-12	1.7	1.2	60	21
16158	ITA	Pisa	17.4	2.1	70	-50	14.0	3.6	246	122	9.4	2.6	125	40
16597	MLT	Luqa	22.2	1.5	82	-8	18.9	1.9	89	9	14.9	1.1	150	38
16716	GRC	Athens	18.9	0.6	36	-14	14.9	0.4	36	-15	12.7	1.5	159	93
16754	GRC	Heraklion/Crete	20.7	1.0	99	23	17.4	0.8	28	-31	15.0	1.2	98	24
22113	RUS	Murmansk	0.2	-0.8	40	-2	-3.3	1.8	27	-13	-7.2	2.1	38	0
26038	EST	Tallinn	6.1	-0.2	28	-42	1.9	0.7	38	-30	-0.4	2.5	74	19
26406	LVA	Liepaja	8.4	-0.1	106	32	3.7	0.0	22	-61	1.3	1.6	112	45
26629	LTU	Kaunas	7.4	0.5	90	39	2.8	0.7	30	-23	-0.9	1.5	49	5
26730	LTU	Vilnius	6.8	0.2	40	-13	1.8	0.6	29	-28	-2.0	0.9	56	1
26850	BLR	Minsk	6.2	-0.1	20	-29	0.9	0.1	10	-42	-2.6	1.2	53	0
27612	RUS	Moscow	3.7	-1.3	36	-22	-1.3	-0.2	20	-38	-3.9	2.2	64	12
33345	UKR	Kiev	7.7	-0.4	21	-14	1.7	-0.4	13	-38	-2.1	0.2	28	-24
33815	MDA	Kishinev	9.8	-0.3	43	16	3.6	-0.8	121	82	-0.1	0.2	34	-4
34300	UKR	Charkow/Kharkiv	6.2	-1.1	15	-20	0.6	-0.7	9	-35	-2.7	0.7	35	-10
34880	RUS	Astrachan	7.9	-1.2	16	-1	0.3	-3.0	24	5	-1.2	0.7	12	-3
37789	ARM	Yerevan	13.9	0.7	26	-1	6.0	-0.5	49	27	3.6	3.4	20	-3
17062	TUR	Istanbul	17.4	2.1	43	-28	12.6	1.0	76	-13	10.5	2.4	124	2
17130	TUR	Ankara	13.3	0.7	32	5	6.5	-0.6	27	-6	5.7	3.2	44	-5
17170	TUR	Van	11.4	1.3	76	28	4.0	0.0	67	23	2.4	3.5	50	16
17300	TUR	Antalya	21.6	2.0	96	26	16.5	1.7	164	30	13.4	2.0	326	99
17609	CYP	Larnaca	22.1	0.8	14	-5	17.2	0.8	21	-23	15.7	2.5	82	6
35108	KAZ	Uralsk	5.0	-0.1	21	-9	-4.2	-2.1	3	-32	-6.8	1.6	35	6
37545	GEO	Tbilisi (Tiflis)	13.6	0.1	26	-12	7.1	-1.0	43	13	5.7	1.9	16	-5
40080	SYR	Damascus	19.0	0.9	10	-2	12.3	0.5	14	-8	9.1	1.9	8	-18
40103	LBN	Tripoli	22.0	-0.2	111	40	16.5	-1.8	209	96	15.0	0.9	65	-115
40180	ISR	Tel Aviv	23.0	1.0	43	17	18.7	0.7	311	243	16.4	2.6	64	-74
40199	ISR	Eilat	27.2	0.5	0	-4	22.1	0.6	0	-3	19.1	2.5	3	-3
40265	JOR	Mafraq	19.1	0.0	15	8	13.2	-0.3	30	13	11.4	2.6	34	6
60030	ESP	Las Palmas Can.	24.1	1.6	6	-4	21.8	1.4	45	24	19.3	1.0	24	3

7. References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2014 edition of the Bulletin, are listed on page 3 above. Many contributions or also additional information may as well be found on the web, see below.

Austria: Zentralanstalt für Meteorologie und Geodynamik (**ZAMG**), Wien, Wetterrückblick

Belgium: The Royal Meteorological Institute of Belgium (**KMI**), Klimatologisch overzicht

Bosnia and Herzegovina: Federal Meteorolocical Institute (**METEOBIH**), Bilten 2014.

Croatia: Meteorological and Hydrological Service (**DMHZ**) Annual reports

Czech Hydrometeorological Institute (**ČHMÚ**) News

Denmark: Danish Meteorological Institute (**DMI**), Vejret i Danmark

Estonian Weather Service: Estonian weather events in 2014

Finnish Meteorological Institute (FMI) Climate statistics

France: Météo-France, Toulouse, Bilan climatiques

Germany: Deutscher Wetterdienst (**DWD**), Klimatologische Jahresübersicht

Greece: Hellenic National Meteorological Service, Climatic bulletin

Greece: National Observatory of Athens, Meteorological bulletin

Hungarian Meteorological Service (**OMSZ**) Climate retrospective

Icelandic Met Office: The weather in Iceland 2014- Climate summary

Ireland: The Irish Meteorological Service (**MET Éireann**), Weather Summary

Israel Meteorological Service (**IMS**): Weather summary in Israel

Italy: Servicio **Meteo AM**, Bolletino annuale - Report Italy

Italy: L'Agenzia Regionale per la Protezione dell'Ambiente Ligure (**ARPA**), Rapporti annuali

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Russia: Hydrometeorological Centre of Russia (**Roshydromet**) Annual bulletin

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9. Abbreviations

AO	Arctic Oscillation (circulation indices)
BAMS	Bulletin of the American Meteorological Society
CLIMAT	monthly climatological data provided by the NMHSs via GTS
DWD	Deutscher Wetterdienst (German Meteorological Service)
EA	East Atlantic Pattern (circulation indices)
EA/WR	East Atlantic/West Russia Pattern (circulation indices)
ECA&D	European Climate Assessment & Dataset, located at Royal Netherlands Meteorological Institute (KNMI)
EMCC	Eastern Mediterranean Climate Centre
E-OBS	daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D information
GCC	Global Collection Centre run by Deutscher Wetterdienst
GPCC	Global Precipitation Climatology Centre located at Deutscher Wetterdienst
GTS	Global Telecommunication System
NAO	North Atlantic Oscillation (circulation indices)
NMHSs	national hydro-meteorological services
POL	Polar/Eurasia Pattern (circulation indices)
RCC-CM	WMO Regional Climate Centre Network (RA VI) Offenbach Node on Climate Monitoring
SCA	Scandinavia Pattern (circulation indices)
SCE	Annual snow cover extent
SYNOP	surface synoptic or weather observations provided by the NMHSs via GTS
WCDMP	World Climate Data and Monitoring Programme
WMO RA VI	WMO Regional Association VI (Europe and Middle East)
WMO	World Meteorological Organization

WMO RA VI
RCC Network

DWD

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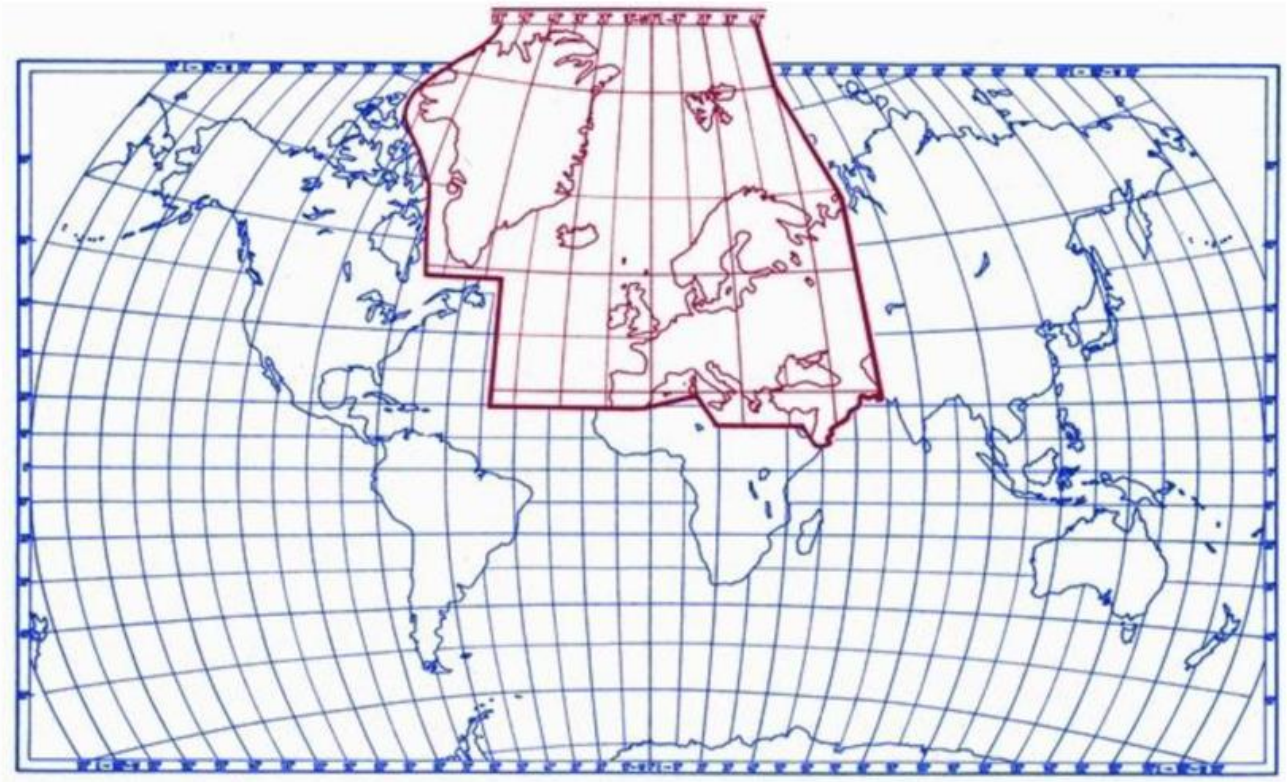

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and was co-ordinated by the Deutscher Wetterdienst (DWD), Germany

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1. Introduction

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East with 52 individual countries) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official Websites. Supported by the European Climate Support Network (ECSN) and WMO´s World Climate Data and Monitoring Programme (WCDMP) the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's Annual Statement on the Status of the Climate and the State of the Climate published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ amongst the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the Webpages of the RA VI RCC Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

This annual bulletin includes 4 parts: the annual, seasonal and monthly survey of the climate state in 2015 as well as contributions of the NMHSs to the long-term variability of selected parameters up to 2015 (section 5).

Notes:

Maps of the RA VI RCC Network are based on the following data sources:

- Temperature: CLIMAT data and ship observations provided by the Global Collection Centre (GCC), operated by the Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC), operated by the Deutscher Wetterdienst
- Sunshine: CLIMAT data.
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC Node-CD) via the European Climate Assessment & Dataset project (ECA&D) run by Royal Netherlands Meteorological Institute (KNMI)

Sub-regional monthly maps are provided by the Eastern Mediterranean Climate Centre (EMCC).

The following sub-regions are used in this Bulletin:

Central and western Europe (14 countries): *Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, the Netherlands, Poland, Slovakia, Switzerland, United Kingdom*

Nordic and Baltic Countries (9 countries): *Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden*

Iberia (2 countries): *Portugal, Spain*

Mediterranean, Italian and Balkan Peninsula (12 countries): *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Slovenia, Turkey*

Eastern Europe (5 countries): *Belarus, European Russia, Moldova, Romania, Ukraine*

Middle East (9 countries): *Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, western Kazakhstan*

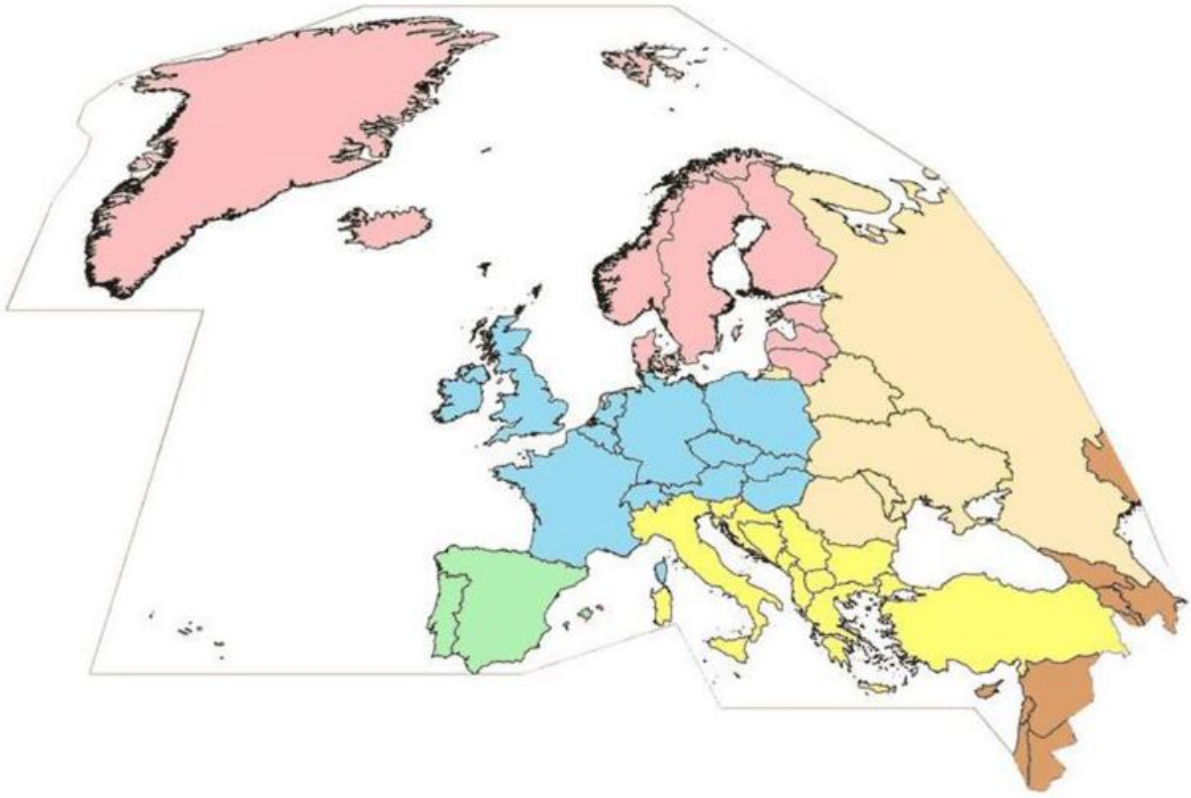


Figure 1.1: Definition of the 6 sub-regions used in this bulletin.

Box 1

Notable anomalies and events 2015

Anomalies

Temperature

- Record breaking year in many European countries (see **Table 2.1)**.
- 2015, followed by the year 2014 was globally the warmest year on record, according to several surface temperature observational analyses.
- Unusually temperatures in Israel in April.
- Heat wave over central and southern Europe from June to September.

Precipitation

- In January 2015 extreme monthly precipitation totals in Scandinavia with up to 400% of the normal at some stations; at Eikemo (Norway) 782.3 mm (279 % of the normal).
- Second wettest May since 1900 in Scandinavia.
- Several extremely intense rain-storm episodes of in the southeast of France in August, September and October.
- Long lasting drought and heat in summer extended over an area from southwestern and central Europe up to southwestern Russia.

Sunshine Duration

- Austria experienced its sunniest December on record with 190 % of normal.

Other Anomalies

- Lowest Arctic sea ice extent for March 2015 according to satellite records
- High pressure over Scandinavia in August 2015 accompanied by higher than normal temperatures.

Events:

- Several storm series passed Europe in March 2015
- Extreme precipitation and floods recorded in northern UK during December 2015 (Honister Pass (Cumbria) 341.4 mm/24 hours on the 5th).

2. Annual survey

The climate of 2015 was characterised by a broad range of spatial and temporal anomalies outlined in Box 1 and Figure 2.5. This section presents an overview of the spatial patterns of mean annual climate conditions in 2015 and anomalies related mainly to the normal period 1961-1990 of the selected essential climate variables: sea surface pressure, surface temperature, precipitation, sunshine duration and snow. Sub-section 2.1.4 reveals climate extremes for each participant country. Long-term trends in temperature and precipitation indices offers section 2.2.

More detailed insight into the long-term variability of the temperature and precipitation and also some other parameters from the individual participant countries are presented in section 5.

2.1. Annual averages and anomalies of selected essential climate variables

2.1.1. Sea level pressure

Generally, long-term mean annual sea level pressure distribution in 2015 over the WMO Region VI is dominated by a low pressure trough in the polar area with the Icelandic low that extend from southern Greenland over Iceland to northern Scandinavia. The second pressure system the subtropical high pressure belt extended from the centre over Azores (Azores high) across southern, western and central Europe to European Russia.

2015 the mean sea surface pressure differs to some extent from the long-term mean with a reduced pressure especially in a region west and northeast of Iceland with anomalies of -4 to -6 hPa. Higher pressure anomalies of +2 to +4 hPa occurred above southern and central Europe as can be seen from Figure 2.1 (right; normal period 1961-1990) which indicated in mean a stronger than normal NAO.

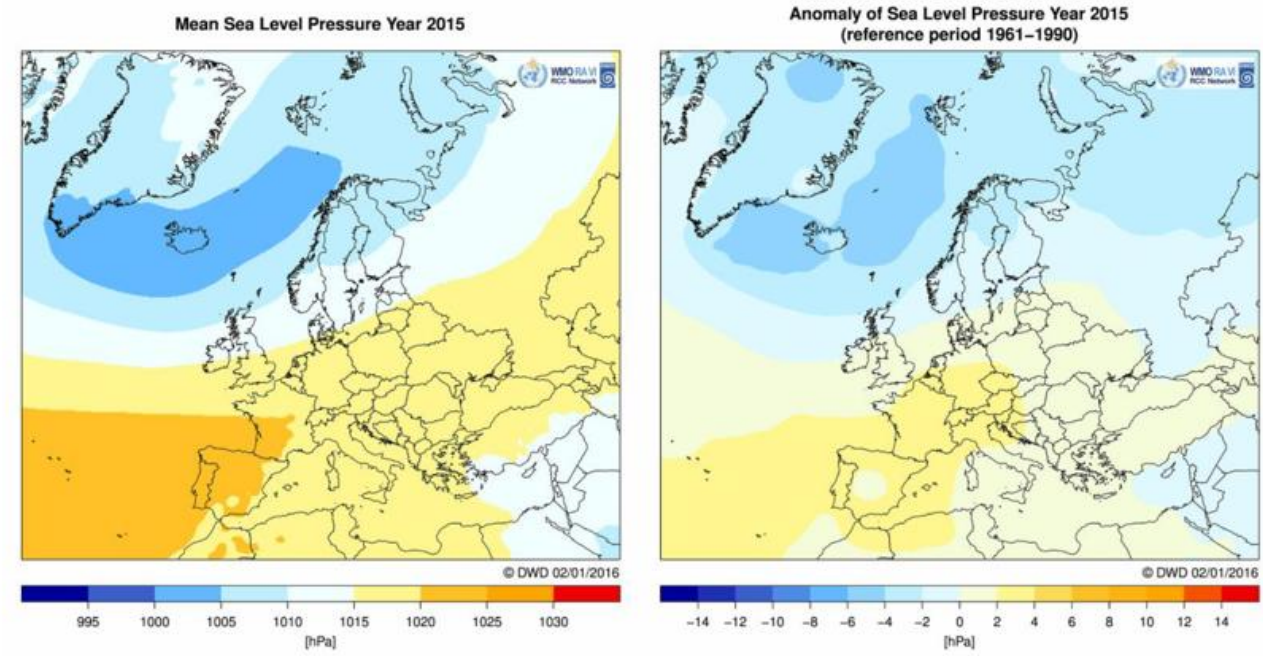


Figure 2.1: Annual mean of sea level pressure (left) and anomalies (right) for the year 2015 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm)

2.1.2. Temperature

In the entire European region (35°–75°N, 25°W–45°E) the year 2015 was the warmest since 1950 (slightly warmer than 2014) with an anomaly of 0.9°C above the reference period 1981–2010 or of 1.46°C related to 1961-1990. Many of the European countries reported new records (Table 2.1).

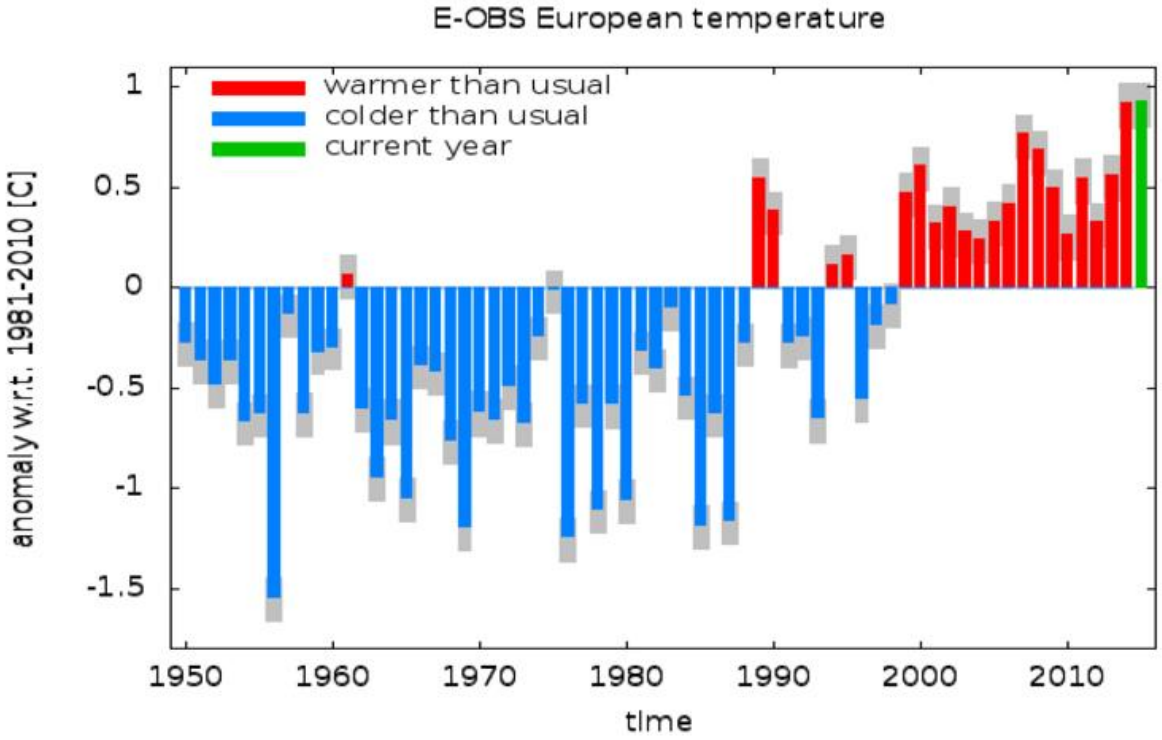


Figure 2.2: Annual temperature anomalies 1950-2015 for Europe (land area; 35°N - 75°N and 25°W - 45°E, reference period 1981–2010; source: www.ecad.eu, van der Schrier et al. 2013)

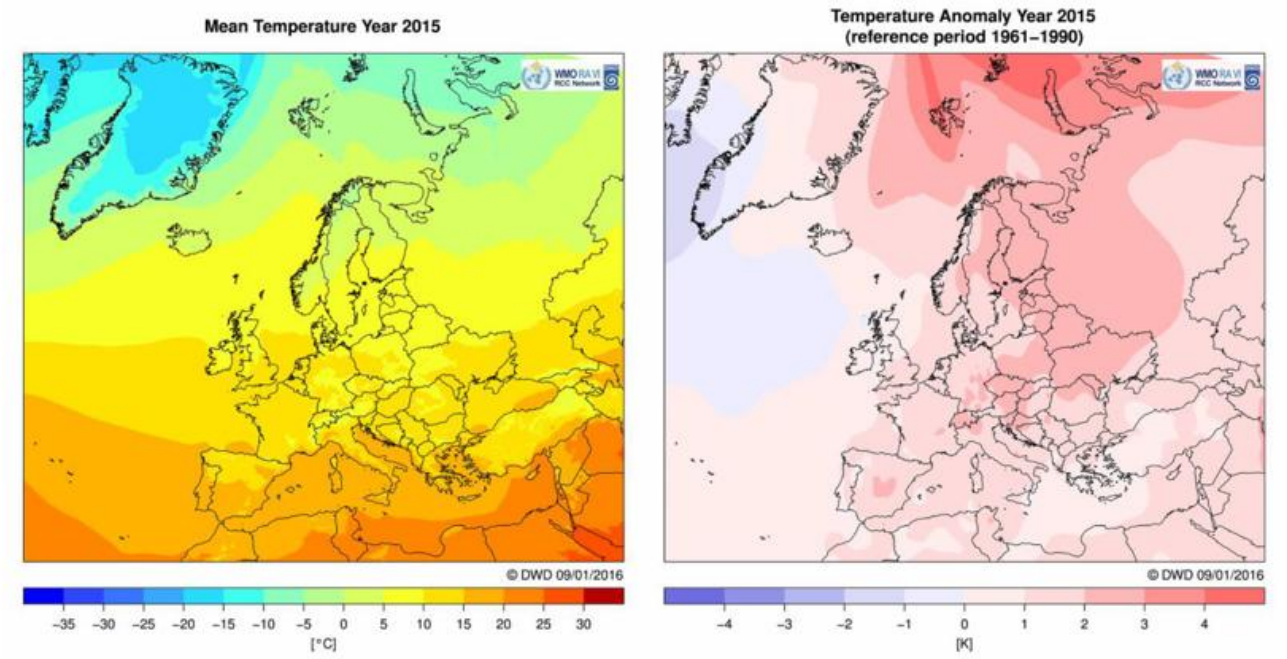


Figure 2.3: Mean annual temperature in °C (left) and anomalies (right) for 2015 (reference period 1961-1990. source: http://www.dwd.de/rcc-cm)

The highest annual anomaly of 2.29°C referred to 1961-1990 was observed in the sub-region Eastern Europe followed by Central and Western Europe (1.59°C), the Middle East (1.51), Mediterranean, Italian and Balkan Peninsula (1.48°C) and Iberia (1.41). The sub-region Nordic and

Baltic countries showed the lowest anomalies of 1.26°C (Table 3.2). Most of the months in 2015 were warmer than normal (1961-1990) with remarkably consistent deviations of +2 to +3°C especially from winter to summer across Iberia as well as the Mediterranean, Italian and Balkan Peninsula in winter and summer (cf. section 3.1.2 and 4.2).

The global annual temperature average for 2015 increased also to a record high 0.76 ± 0.09°C above the 1961–1990 average (WMO 2016, Blunden und Arndt 2016)

A summary of the annual temperature time series and the historical rating can be drawn from section 5. The rank statistics are listed together with the start of the time series and the anomaly of the year 2015 as provided by the NHMS are outlined in the following table.

Table 2.1: Rank statistics and anomalies of annual temperature in 2015 from some participant countries as reported by the National Meteorological and Hydrological Services (NMHSs).

Country	Rank of annual temperature in 2015	start of time series	Anomaly in °C	Reference period
Europe (35°–75°N, 10°W–30°E, E-OBS)	**1**	**1951**	**1.46**	**1961-1990**
Armenia	3	1961	1.8	1961-1990
Austria	2	1767	2.2	1961-1990
Belarus	1	1881	2.6	1961-1990
Belgium	6	1833	0.8	1981-2010
Bulgaria	2	1901	1.57	1961-1990
Croatia	2 (with 2012)	1862 (Zagreb and other stations)	1.0-2.2	1961-1990
Cyprus	slightly above normal		0.7	1981-2010
Czech Republic	1 (with 2014)	1961	1.9	1961-1990
Denmark	9 (with 1934)	1874	1.4	1961-1990
Estonia	1	1961	2.4	1961-1990
Finland	1	1900	1.9	1981-2010
France	3	1900	1.0	1981-2010
Georgia	4	1950	1 - 3	1961-1990
Germany	2 (with 2000, 2007)	1881	1.7	1961-1990
Greece			0,82	1971-2000
Hungary	2	1901	2.05	1961-1990
Iceland			0.5	1961-1990
Israel	3	1951		1961-1990
Italy	1	1961	1.6	1961-1990
Jordan			1.2	1961-1990
Kazakhstan	3	1936		1961-1990
Latvia	1	1924	2.1	1961-1990
Lithuania	1	1961	2.1	1961–1990
Luxembourg	3 (with 2007)	1947	2.1	1961–1990
Moldova	1-2		2.1-2.7	1961-1990
Montenegro	1-5		1.5-3.1	1961-1990
Netherlands	5	1901(de Bilt)	0.8	1981-2010
Norway	3	1900	1.8	1961-1990
Poland	1	1950	1.8	1971-2000
Portugal	7	1931	0.75	1971-2000
Romania	1	1901	1.96	1961-1990
Russia, European	1	1939	2.07	1961-1990
Serbia	3	1951	1.6	1961-1990
Slovakia	2	1951	2.0	1961-1990
Slovenia	2-3	1951	2-3	1961-1990
Spain	1 (with 2011)	1961	0.9	1981-2010
Sweden	3	1860		1961-1990
Switzerland	1	1864	1.29	1981-2010
Turkey	5	1971	0.8	1981-2010
Ukraine	1	1951	2.4	1961-1990
United Kingdom	16 (near average)	1910	0.4	1981-2010

2.1.3. Precipitation

The annual precipitation amount was close to normal over many parts of continental Europe except for Ireland, northern UK, Denmark, most parts of Scandinavia and south-eastern Europe, where positive anomalies above 10 mm/month were recorded. Parts of Iberia, France, the region around the Alps and parts of eastern Europe showed drier conditions with anomalies below -10 mm/month and also values below the 0.1 percentile indicating a drought situation. The annual figures of the year 2015 give only rough hints of the regions with outstanding precipitation events. Detailed descriptions can be found in the seasonal (3.1.3) and monthly survey (4.3).

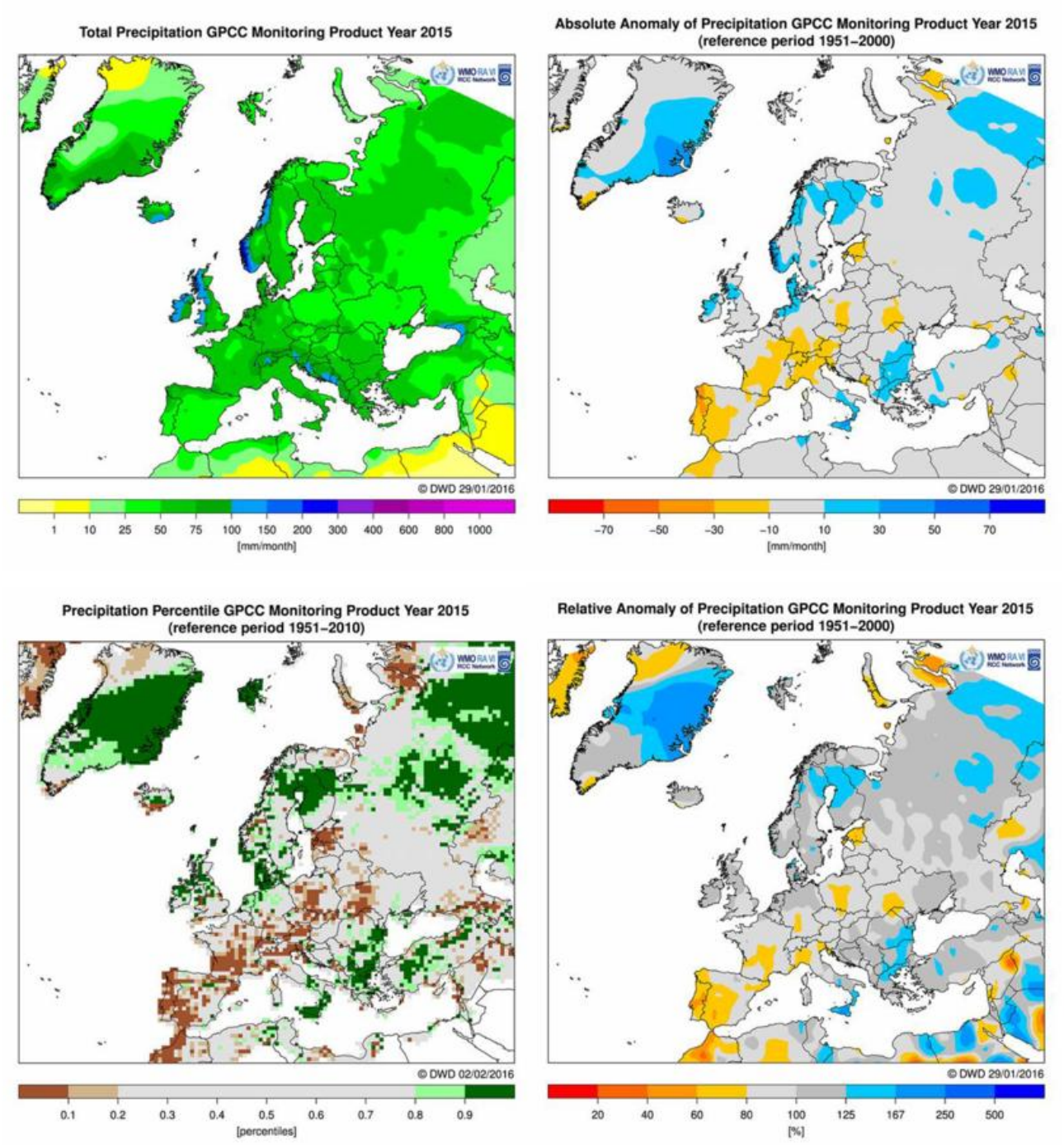


Figure 2.4: Total precipitation (left, top), absolute anomalies (right, top) in mm/month, percentiles (left, bottom) and relative anomalies in % (right, bottom) for 2015 (reference period 1951-2000; source: http://www.dwd.de/rcc-cm)

2.1.4. Annual extreme values of temperature and precipitation

In this section an overview is given for the temperature spread and the extreme precipitation for each country. Absolute annual extreme values for 2015 of temperature (minimum and maximum), maximum of total daily precipitation and maximum of total 5 consecutive days with precipitation for each country in the WMO Region VI are given in Figure 2.5.

The spatial pattern of extreme temperature corresponds roughly to those of the temperature anomalies of 2015. The highest maximum temperatures (above 40°C) occurred primarily in sub-regions Middle East, Mediterranean, Italian, Balkan, some countries of Central Europe and Iberian Peninsula. Maximum temperatures higher than 35°C were reported from most of the countries in central and eastern Europe, but also from some of Nordic and Baltic Countries. The one-day precipitation totals (RX1) of more than 150 mm for individual countries are documented in several sub-regions; the highest values occurred in Italy (481 mm/day, at a local station) and Great Britain (341 mm/day). Highest total precipitation from 5 consecutive days (RX5) (above 300 mm) was measured in Great Britain (381 mm), Greece (358.6 mm), Italy (358 mm, only synoptic stations), Austria (350 mm) followed by Slovenia (323 mm).

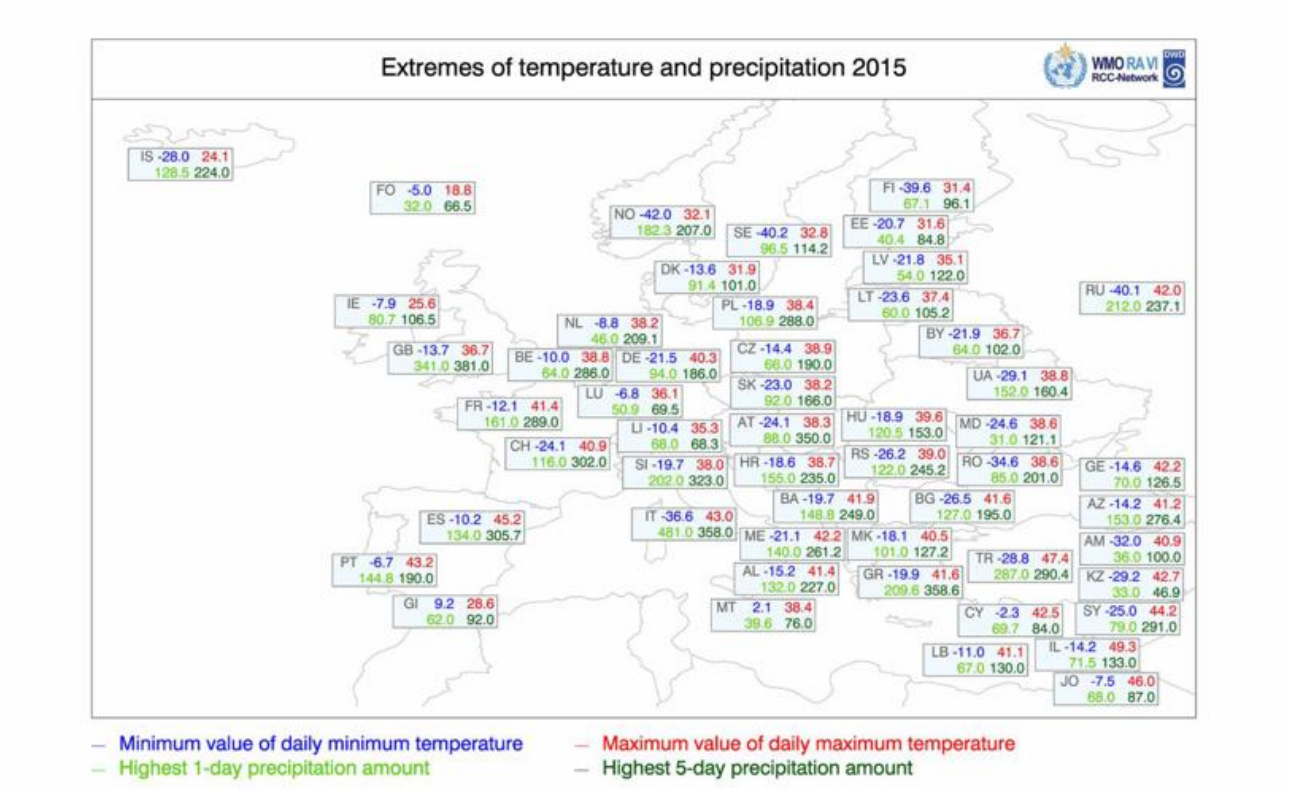


Figure 2.5: Annual extreme values for each country in 2015: first row: Internet country code, lowest daily minimum temperature (in °C, blue) and highest daily maximum temperature (in °C, red); second row: maximum daily precipitation totals (in mm, light green) and maximum 5-daily consecutive precipitation totals (in mm, dark green).

Note: Data (by order or priority) from reports of NMHSs, GPCC, ECA&D or SYNOP; the countries are represented by their Internet country codes. (Source: http://www.dwd.de/rcc-cm)

2.1.5. Sunshine duration

As expected, the annual sum of sunshine duration 2015 showed from the south to the north generally gradual decreasing values. More than normal sunshine hours have been primarily noted in most parts of Europe except in Portugal, southern Italy as well as in Turkey and north-eastern Europe. Svalbard, Poland and southern Russia showed in almost every season above normal sunshine (>125 %). Positive anomalies of the same range were also noted in Svalbard.

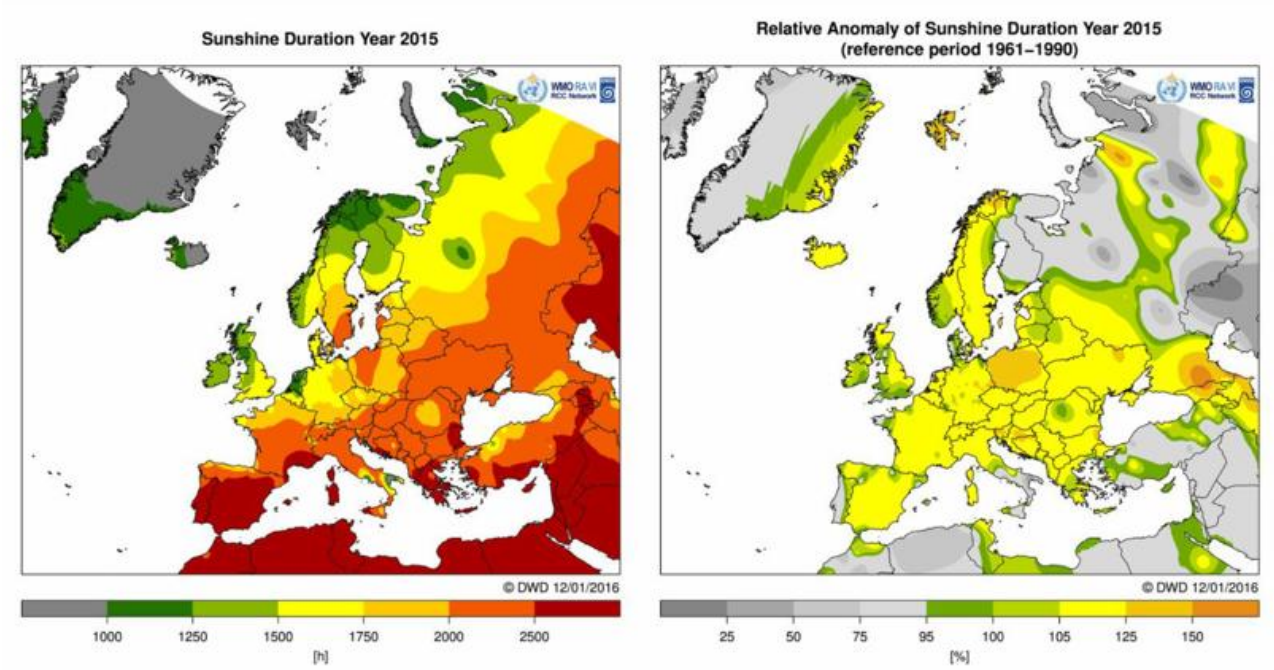


Figure 2.6: Annual sum of sunshine duration (left) and relative anomalies (right) for the year 2015 in hours with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm)

2.1.6. Drought situation

The drought index (SPI) in 2015 differed only slightly from its normal values. The anomalies from Spain over central Europe to Russia were slightly below normal while northern Europe and south-eastern Europe were slightly wetter. In these areas annual precipitation was above normal linked with floods.

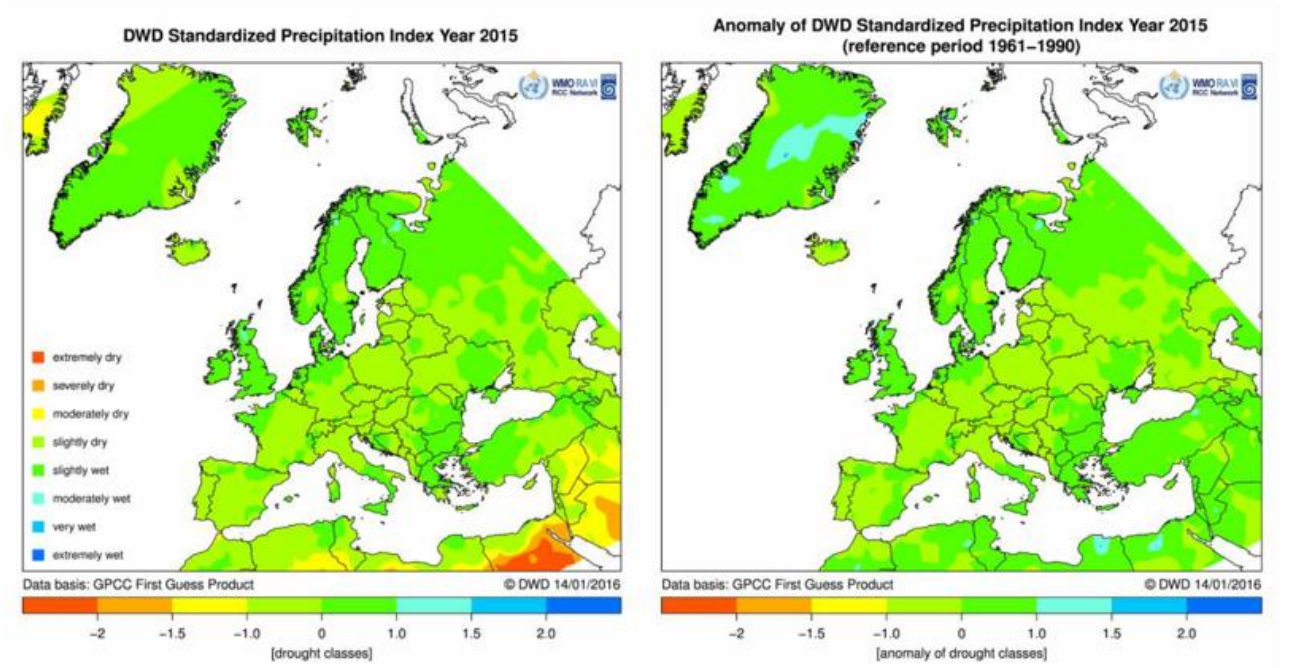


Figure 2.7: Annual modified Standardized Precipitation Index (DWD-SPI) for the year 2015 (left) and its anomalies (right) with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm)

2.1.7. Snow cover

The snow-season 2014/2015 (September 2014–August 2015) was warmer than normal and consequently in many low land areas in west and south Europe no snow occurred at all. Apart from mountain areas, in the central Europe the partly occasional snow fall events occurred in December. As expected, towards the northern and eastern Europe the snow cover duration was longer and ended in April and May.

However, late snow prevailed in Austria and Switzerland.

In the second half of January 2015 north-westerly and northerly currents brought the winter to **Switzerland**. Even at low altitudes snow fell on both sides of the Alps. In February there was also snowfall down to low altitudes in many parts on both sides of the Alps with colder than normal temperatures. Especially south of the Alps, snowfall was substantial. In mid-February 16 cm of fresh snow fell in Locarno-Monti within two days. In Airolo (1100 m a.s.l.) and San Bernardino (1640 m a.s.l.) snowfall amounted to 63 cm, in Bosco-Gurin (1500 m a.s.l.) as much as 96 cm. One week later a cold air front from northwest covered almost the whole of Switzerland in fresh snow. In low altitude areas north of the Alps amounts remained under 10 cm. South of the Alps 10 to 20 cm of fresh snow were recorded even at low altitudes while at higher altitudes over half a meter was measured.

In winter the absence of snow in **Austria** was remarkable. In the lower parts of the country the days with snow cover was 40 % below the average, because it was the 8th warmest winter on record. Due to the high temperature the larger parts of the precipitation fell in form of rain.

In 2015 the number of days with snow cover in Poland was significantly below the normal and ranged from several days in North and West, through 10-45 days in central part of Poland to above 100 days in the mountains. Snow cover at Kasprowy Wierch (1991 m a. s. l.) in Tatra Mountains was observed on 209 days. The maximum snow depth across the country did not exceeded 20 cm. In the mountains it was higher, reaching 217 cm at Kasprowy Wierch in Tatra Mountains.

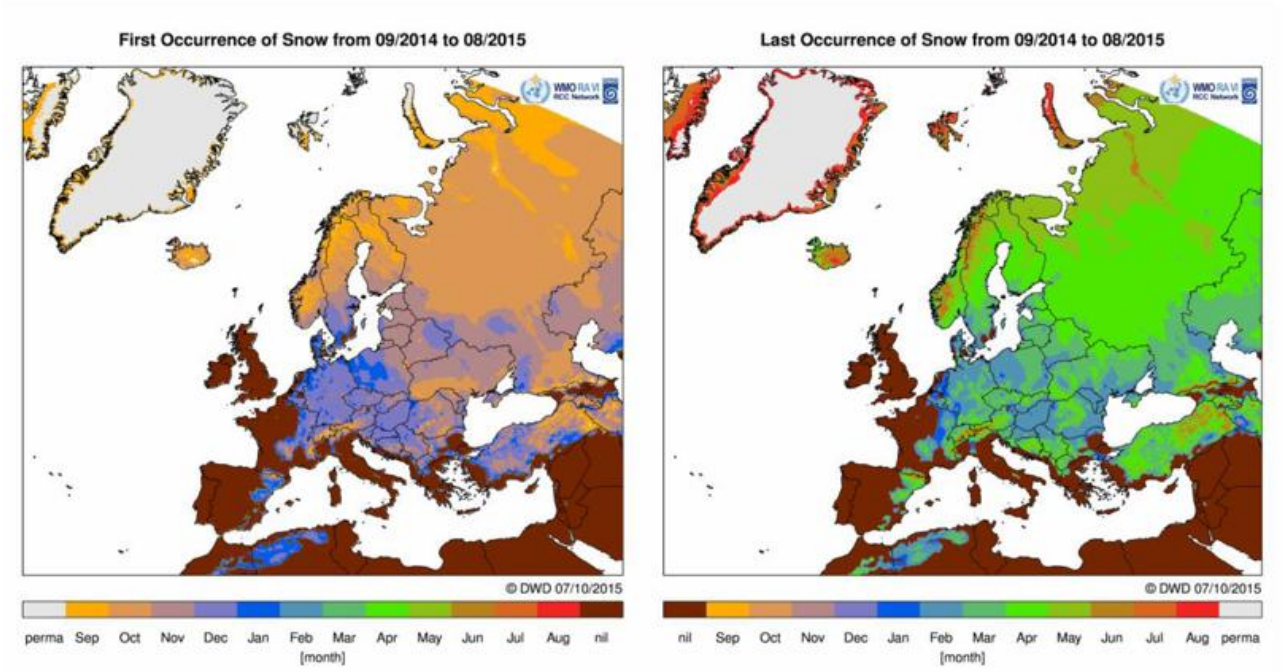


Figure 2.8: First occurrence of snow (left) and last occurrence of snow (right) during the snow-season 2014/2015. (Source: http://www.dwd.de/rcc-cm)

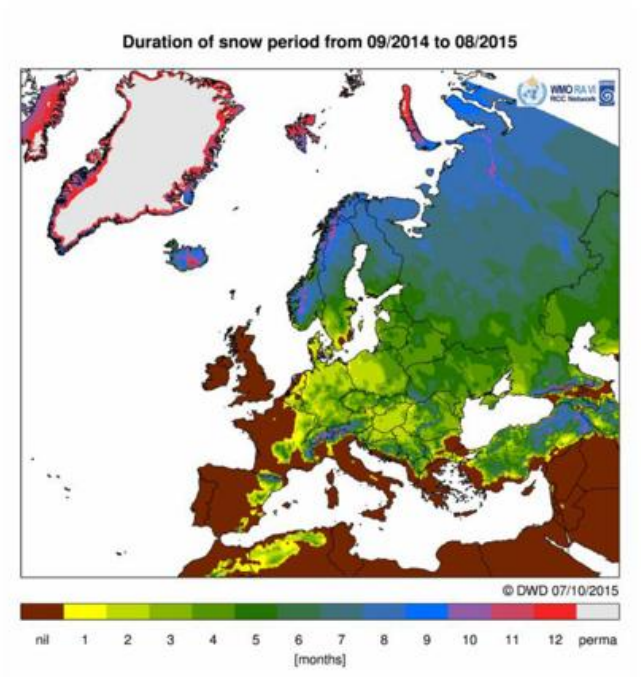


Figure 2.9: Duration of snow cover in the snow-season 2014/2015. (Source: http://www.dwd.de/rcc-cm)

2.2. Trends of temperature and precipitation indices 1951-2015

This section presents trends for selected temperature and precipitation indices for the period 1951-2015.

In the northern, north-western and eastern Europe most stations showed an increase in the annual number of wet days (RR1) for the last 65 years while in southern Europe a decreasing trend prevailed. The decreasing and increasing trend at neighbouring stations, however, indicate inhomogeneities in the time series. The number of warm and wet days (WW) increased over whole Europe with exception of Greece. The annual number of summer days (SU) increased in Central and southern Europe while in the north-western and northern Europe no significant changes were observed. The annual numbers of tropical nights (TR) showed increasing tendencies in the south-east part of Region VI while the north-west part noted no significant changes.

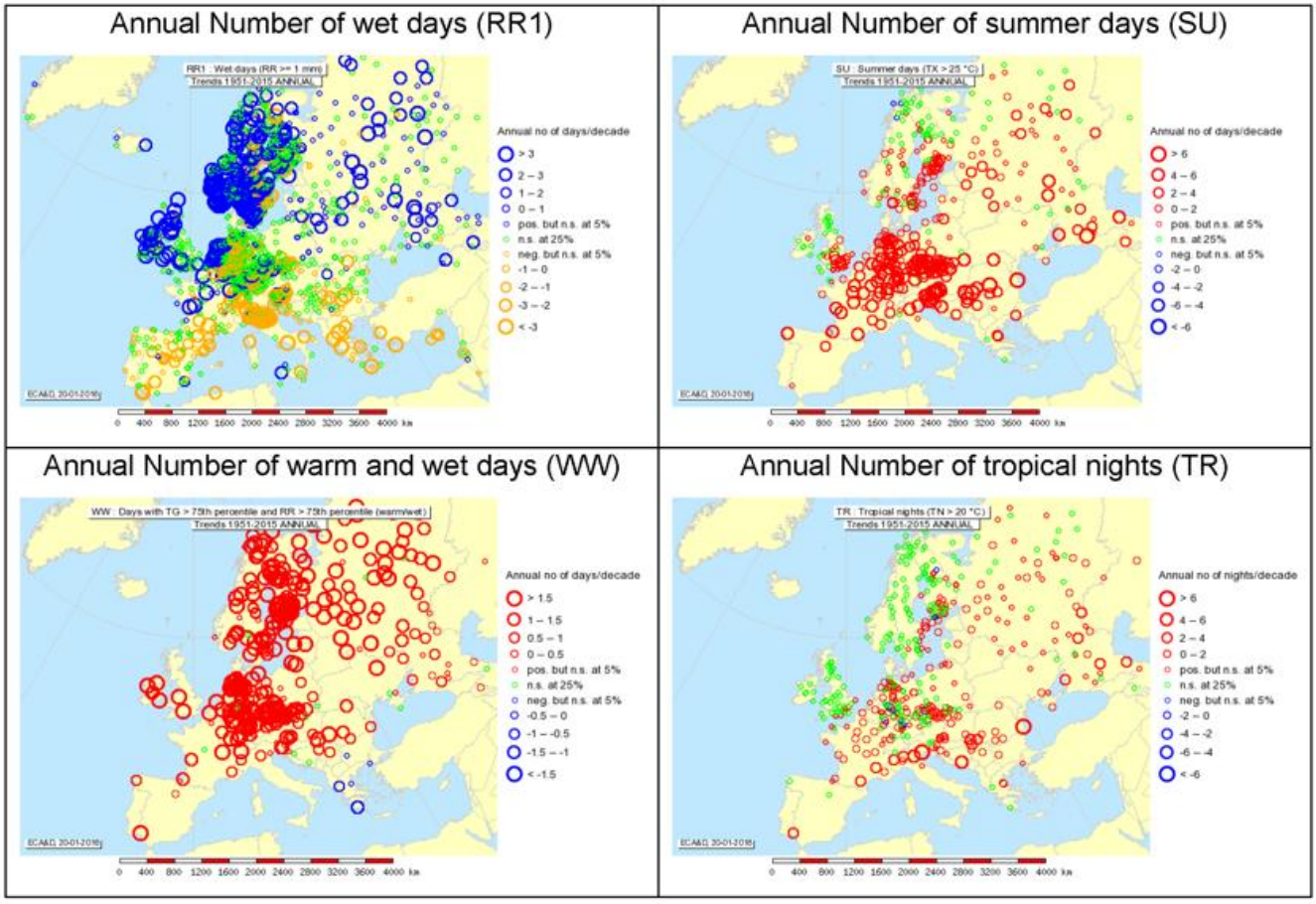


Figure 2.10: Trends of Selected Climate Indices 1951 to 2015 (Source: ECA&D, http://www.ecad.eu)

Legend of Figure 2.10:

1. **RR1, Number of wet days**: count of days where RR (precipitation > 1 mm)
   Precipitation below 1 mm/day has no effect on vegetation because it normally evaporates on the same day and is locally effected.
2. **SU, Number of summer days**: count of days where TX (daily maximum temperature) > 25°C
3. **WW, Number of warm and wet days:** days with TG (daily mean temperature) > 75th percentile and RR > 75th percentile
4. **TR, Number of tropical nights**: count of days where TN > 20°C

2.3. Socio-economic impacts of extreme climate or weather events

Several countries reported socioeconomic impacts of climate extremes or weather events. This was done partly given in a standardized structure (WMO guiding table for country submission of information on extreme climate events) or the information was part of the regular monthly reports on the internet or it was separately submitted. However, this information is heterogeneous and does by far not give a complete overview. Not only due to the different administrative structures the information cannot easily be gathered but also many kinds of impact are difficult to estimate. In the following only a short extract will be given.

The following figure (Figure 2.11) shows the number of observed extreme weather or climate event as reported by the NMHSs in 2015. Conclusions should be drawn only with caution because some of the events were reported simultaneously by several countries. The total number of cases for this figure was 316. No diagrams were shown for the injured persons and fatalities as well as the economic losses because the number of reports were too few (about 6, 11 resp. 5). In some cases the reported numbers were not fix but like 'hundreds' or 'few'. The economic damage was estimated as well by some countries but the information is not sufficient to be presented with any reliability of representativeness. The reported economic damages will be summarized individually below.

The most frequent events in 2015 were 'Extreme Precipitation' with 87 events or 25% that also happened in most of the countries with reported 75 fatalities and 56 injured. The second one with 20% or 62 events were 'Heat Waves' that mainly occurred in Central, southern and eastern Europe (Serbia and Portugal reported 7 heat waves, Slovenia 5). Rank three were 'Wind Storms' with an occurrence of 17% or 53 events mostly in winter in the western part of Europe together with extreme precipitation. The next extreme events were 'Floods' (10%, 27 persons injured, 15 fatalities) and 'Droughts' (7%).

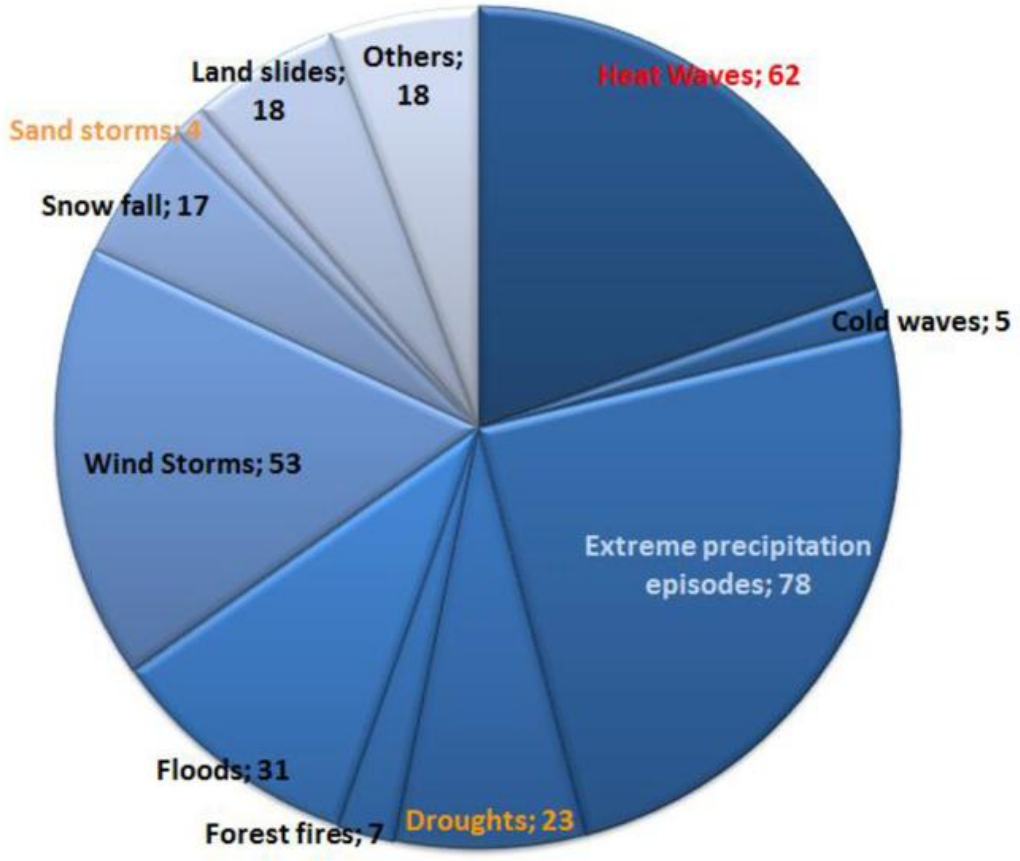


Figure 2.11: Relation of observed extreme weather or climate events in 2015 based on 35 reports from NMHSs (total events reported for 2015: 316)

High economic damage is usually connected with floods, storm, cold spells (all kinds of frost, snow or ice), hail, drought or extreme heat. There are some figures which are summarized in the following but much of this kind of damage cannot be estimated (by meteorologists).

From 8th to 11th January the winter storms Elon and Felix hit mainly Germany, Scandinavia and the UK with high wind speeds, thunderstorms, hail, heavy rain and snowfall. Thousands of buildings, schools, houses were damaged. Many weather–related accidents occurred, air and rail traffic were also affected. The overall loss amounted to 500 Million €.

South-central and eastern Bulgaria as well as northwest Greece was hit by an extreme precipitation episode from 1st to 3rd February 2015. The geographical extent in Bulgaria was 23,300 km^2 (5 districts). On February 1st the highest daily precipitation amount was 210 mm, recorded in Kirkovo (Bulgaria) corresponding to the double of the monthly normal mean. In Greece a 3 day precipitation of 359 mm was observed at station Derviziana during 30, 31st January and 1st February 2015. Greece also reported wind gusts of 46 m/s. This heavy rain caused flooding especially in the eastern Rhodopes area (Bulgaria) accompanied by landslides. More than 2,300 houses were damaged, roads and farmland flooded. 14 people lost their lives and the loss summed up to 660 Million Euro.

Snowfall affected southern Bulgaria from 5th to 7th March 2015 on a geographical extent of 23000 km^2 (6 districts). During these three days maximum wind gusts of 24 m/s in Burgas or 34 m/s in Sliven, torrential rain and snowfall in Momchilgrad with 238 mm in 48 h, Krumovgrad with 148 mm in 48 h and Haskovo with 125 mm in 48 h were measured. The total snowfall for two days varied from 200% (Krumovgrad) to 420% (Momchilgrad, Kardjali region) of snowfall average. The snow reached heights up to 1.5-2 m. Landslides were activated especially in south-central and southwestern Bulgaria. Above 1120 towns and villages were left without electric supply in south-central Bulgaria and 30 electrical towers were broken. The estimated damages were about 16 Mio. € and 4 people died.

On 8th July 2015 extremely severe thunderstorms and hailstorms broke out in the western, central and southern parts of Austria. Most damages were registered in Carinthia. According to the regional insurance company, it was the worst natural disaster according to economic losses in Carinthia in their 150 year history. Due to the extreme storms 11 were injured and damages around 150 Mio. € were caused.

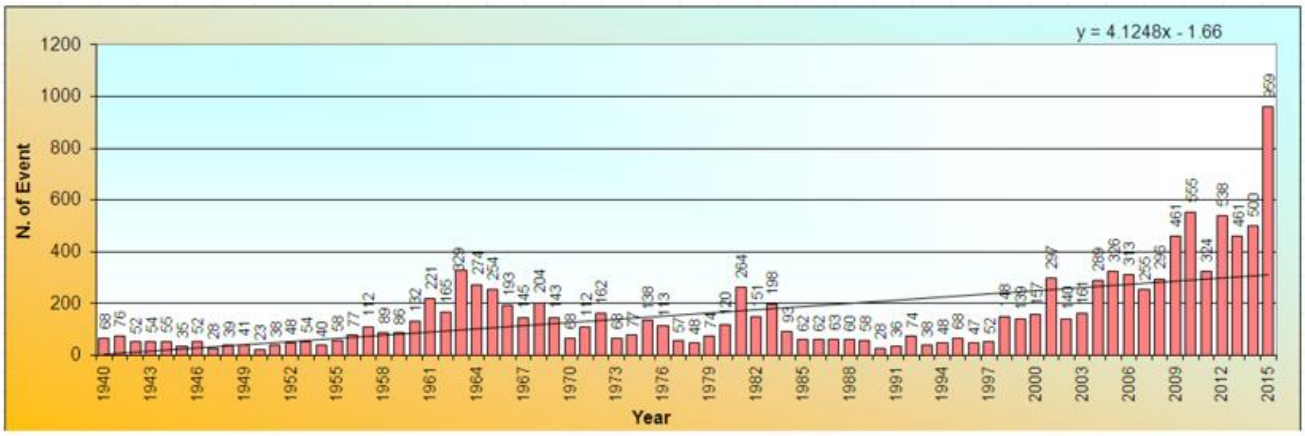


Figure 2.12: Annual count of extreme events occurred in Turkey from 1940-2015 (Diagram as provided by the NHMS).

The number of extreme events in Turkey in 2015 reached 959. (Figure 2.12). There is an increasing trend in extreme events (41 events/decade).

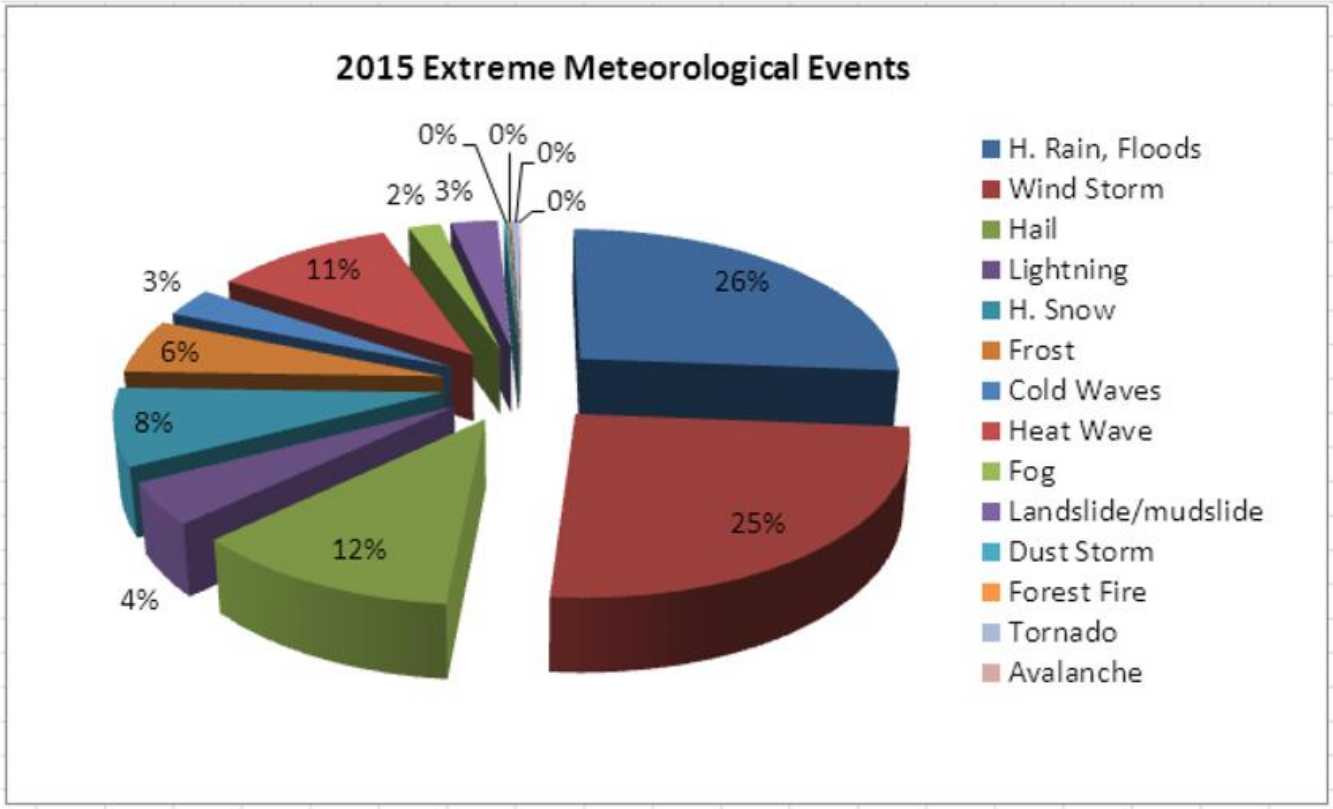


Figure 2.13: Distribution of extreme events occurred in Turkey in 2015 (Diagram as provided by the NHMS).

During 2015 most hazardous extreme events were heavy rain/floods (26%), wind storm (25%), hail (12%), heat wave (11%), heavy snow (8%), frost (6%), lightning (4%), cold wave (3%), landslide/mudslide (3%) and fog (2%) respectively (Fig. 14). Although rare, 1 forest fire, 2 dust storm, 1 avalanche and 4 tornados also occurred in 2015.

3. Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2015 and anomalies related mainly to the normal period 1961-1990 of the selected essential climate variables: sea level pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1. Seasonal averages and anomalies of selected climate variables

3.1.1. Sea level pressure and circulation indices

The pressure distribution in **winter 2014/2015** showed similar patterns for the mean and the anomalies. In seasonal average the Icelandic low possessed a core pressure below 995 hPa and the Azores high a core pressure above 1030 hPa. This indicates that the two pressure centres were intensified in relation to the reference period. This can also be seen in the North Atlantic Oscillation index (NAO) with values above 1.0 in all three winter months (Table 4.1) associated with several storms in northern Europe. In Eastern Europe and the eastern Mediterranean the negative pressure anomalies were associated with several low pressure systems.

In **spring 2015** both circulation centres, the Icelandic low and Azores high were well distinct. The Icelandic low with a centre pressure below 1000 hPa (or anomalies of -8 hPa related to 1961-1990) was located west of Iceland. The Azores high was situated southwest of the Azores. The positive anomaly above 4 hPa was located above France.

In spring the NAO index was only moderate but positive. The EA/WR index changed between April and May from positive to negative values. In May the situation changed. The negative SCA is characterized by higher temperatures than normal in western Europe, below normal precipitation in southern Europe and wet conditions over Scandinavia. All the indices fit together and confirm the maps below.

Table 3.1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference

	NAO	EA	EA/WR	SCA	POL	AO
Winter 2014/2015	1.42	0.16	-0.53	0.32	0.38	0.85
Spring 2015	0,65	0.93	-0.04	-1.08	0.10	1.27
Summer 2015	-1.33	0.79	0.29	-0.59	0.11	-0.46
Autumn 2015	0.73	0.64	-0.17	0.44	-0.42	0.51

Note that all values are standardized with the reference 1981 to 2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

In **summer 2015** both circulation centres were shifted southwards. Therefore high pressure over Greenland could establish with anomalies of more than 8 hPa. Most of Europe showed above normal pressure anomalies coincided with above normal sunshine duration and below normal cloud cover leading to several heat waves. Highest anomalies of more than 2 hPa dominated above the Baltic States and Belarus reflecting the situation of August. Only northern and western Europe as well as the eastern Mediterranean Sea showed below normal anomalies.

The calculated CPC-NAO index with -3.14 for July 2015 was very extreme. Only once in the 66 years an identical index value was calculated in 1993. This must be seen in combination with the East Atlantic/West Russia Pattern (EA/WR) indicated below normal pressure in northern Russia.

The circulation pattern in **autumn 2015** was marked by a well-developed Iceland low with the core west of Iceland (below 1000 hPa). The anomalies around Greenland reached values below -4 hPa. Below normal pressure occurred also in a band from south Italy to southern Russia. The Azores-high was also well developed together with a second high over Kazakhstan with core pressure above 1020 hPa. One centre of above normal pressure anomalies was located over Scandinavia and the other over northern Russia with values above 4 hPa.

The circulation indices in **autumn 2015** with values below ±1 were not representative because the monthly values showed different signs.

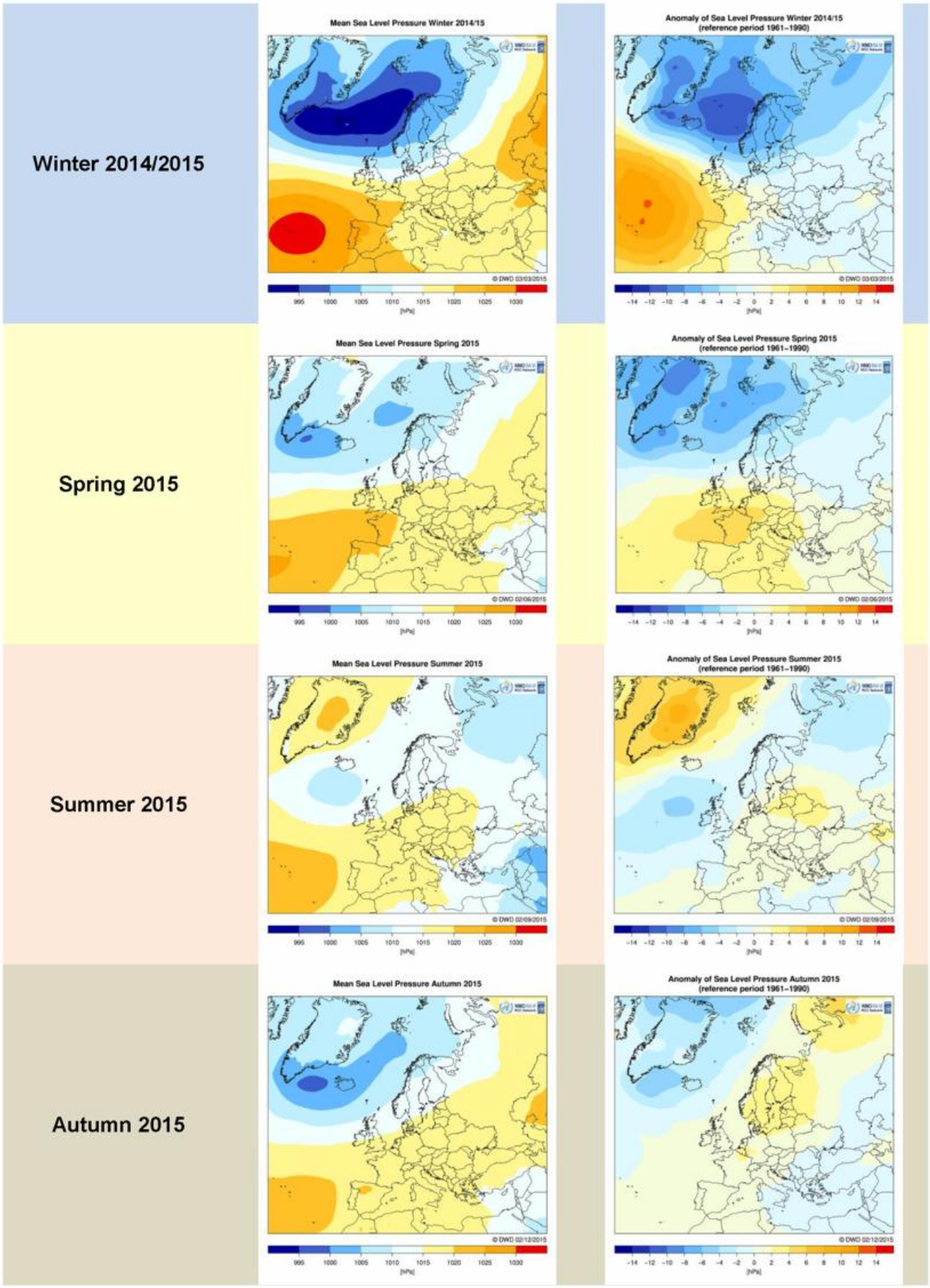


Figure 3.1: Seasonal sea level pressure (left, in hPa) and anomalies (right, in hPa) in 2014/2015, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

3.1.2. Temperature

On average for the whole WMO Region VI and sub-regions the temperature in all seasons in 2014/2015 (except Iberia in winter) was warmer than the normal period 1961-1990. In regional view, however, some differences existed (Tab. 3.2).

Table 3.2: Seasonal and annual average of temperature anomalies over land areas in °C for each sub-region in the year 2015 (reference period: 1961-1990)

Sub-Region	Winter 2014/2015	Spring 2015	Summer 2015	Autumn 2015	Year 2015
Central and western Europe	1.37	1.18	2.03	0.80	1.59
Nordic and Baltic countries	2.13	0.58	0.62	1.74	1.26
Iberia	-0.29	2.24	2.33	0.67	1.41
Mediterranean, Italian and Balkan Peninsula	1.36	1.04	2.35	1.39	1.48
Eastern Europe	3.21	2.18	1.01	0.80	2.29
Middle East	1.70	0.81	1.80	1,97	1.51

The temperature anomalies for **winter 2014/15** showed values lower than normal only in southwest Europe and values higher than normal in northern, central and eastern Europe. The positive anomalies reached values of more than 4°C in Scandinavia, northern Russia and in the area between Turkey and Armenia.

Some ranks of warm winters based on web-available bulletins by NMHSs are given below:

Table 3.3: Seasonal rank statistics for winter mean temperature (2014/2015) as provided by the NMHSs.

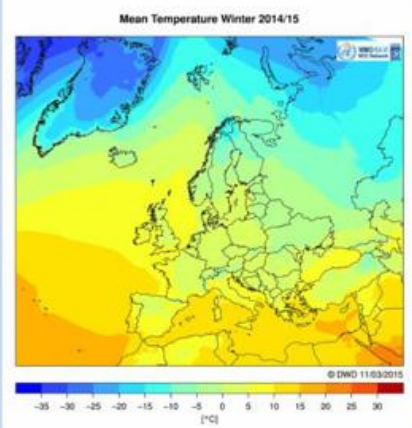
Country	Rank	Time series available since
Europe (35°–75°N, 10°W–30°E, E-OBS)	1	1950
Global	1	1880/1881
Austria	8	1767
Belarus	5	1945
Denmark	13	1874
Estonia	4	1961/62
Switzerland	2	1864

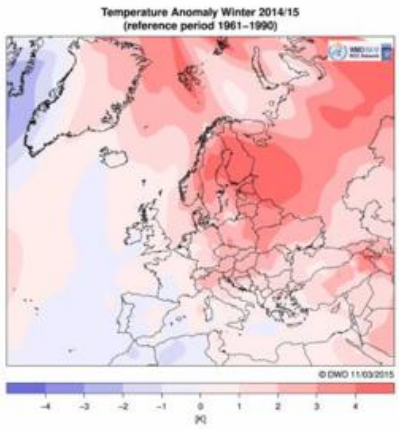
Spring 2015 was in most parts of Europe more than 1°C warmer than the reference period 1961-1990. Especially Spain and southern France showed anomalies of more than 2°C, northern Scandinavia more than 3°C and northern Russia more than 4°C. Only central Turkey, Ireland, Greenland and western Iceland noted normal or below-normal temperatures.

Summer 2015 was characterized by a long lasting heat wave from end of May to end of August. The temperature anomalies pattern for summer revealed a belt of positive values of more than 3°C from Spain to Ukraine while northern Europe and the British Isles noted normal or below normal temperature.

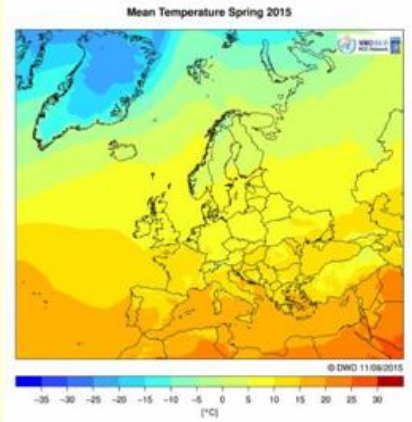
Autumn 2015 was characterized by warmer conditions than normal in nearly whole Europe. Especially the region north of Spitzbergen and Russia was partly more than 4°C warmer. Turkey and Scandinavia, especially Finland, had also higher temperatures with anomalies of more than 3°C above the reference period 1961-1990.

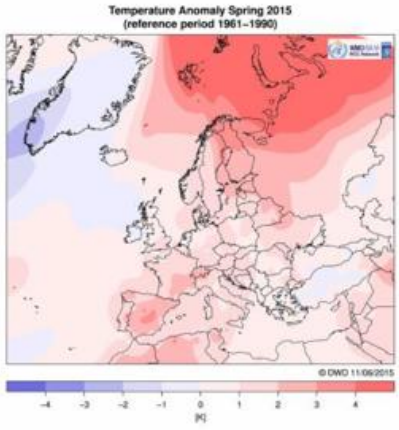
Winter 2014/2015



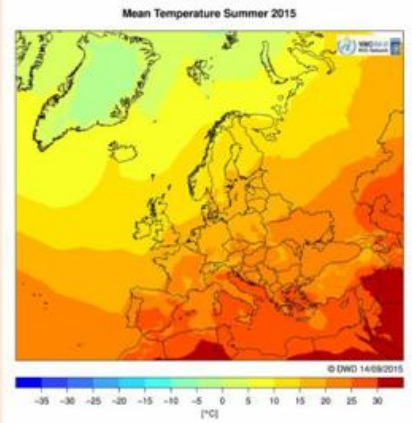


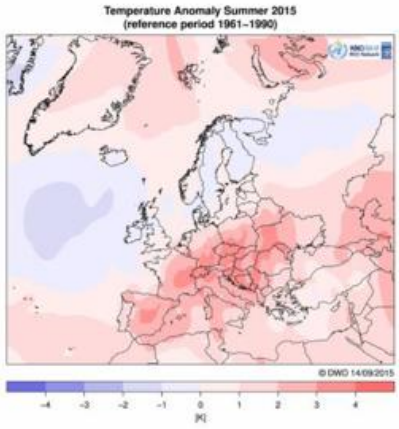
Spring 2015



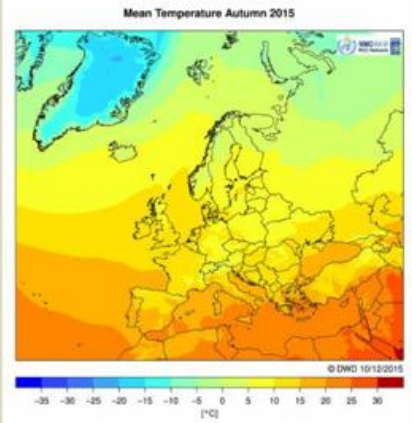


Summer 2015





Autumn 2015



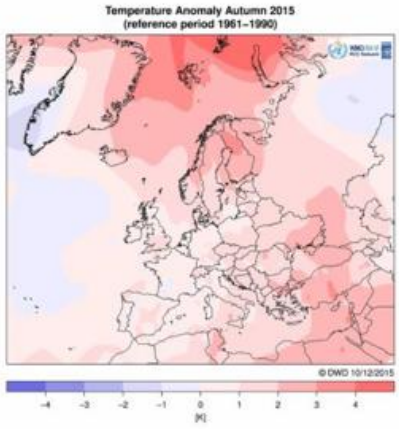


Figure 3.2: Seasonal mean temperature (left, in °C) and anomalies (right, in K) in 2014/2015, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

3.1.3. Precipitation

In **winter 2014/15** most regions of Europe received normal or above normal precipitation. Some regions like northern Spain (partly more than 300%), Scotland, southern Norway, the Balkan and eastern Mediterranean area received up to 250% of their seasonal precipitation amount. Ireland reported the highest seasonal total of 702.0 mm (148 % of the long term mean) at Newport, the lowest seasonal total with 150.0 mm (68% of the long term mean) at station Carlow (Oak Park). In Croatia the precipitation amount for winter 2014/2015 was within the range from 71% to 225% of the multi-annual average. In Montenegro the total amount of precipitation ranged from 196 mm in Rozaje to 1522 mm in Cetinje. In Norway precipitation was very variable this winter and ranged from more than 300% (in the west) down to 25% in the east (lee side). The highest daily and seasonal precipitation sum with 147.5 mm (19th February 2015) resp. 1846 mm was recorded at station Hovlandsdal. The predominance of northerly and north-westerly winds in the Biscay resulted in heavy precipitation along the Pyrenees with up to 300 % of the normal. Precipitation in the winter months was higher than usual in Finland with more than 200 mm in western and central areas.

A precipitation deficit noted Portugal, southern Spain, southern France and Georgia.

Precipitation anomalies for **spring 2015** showed more than normal precipitation in northern and western Europe. Scandinavia and Ukraine recorded partly more than 150%. In some parts in western Norway the precipitation was 2-2.5 times higher than normal. The wettest station was Hovlandsdal with 1150 mm (209% of normal). At this station also the highest daily precipitation was measured on 8th March with 123.8 mm. In the UK existed a high contrast between western Scotland (with totals of more than 130% or 900 mm) and southern England (less than 70% or around 90 mm). For Scotland it was the second wettest spring since 1910.
In north-western Spain and northern Portugal less than 60% precipitation occurred. In Portugal 3 heat waves brought only 45% of normal precipitation. Precipitation deficit exhibited (<60%) also southern France, central Germany and the Middle East. France registered nearly 20% less precipitation than normal.

Precipitation anomalies for **summer 2015** showed above normal precipitation in western and northern Europe and in Russia of partly more than 150%. The surplus in Turkey was even more than 250%. Western and southern France as well as north-eastern Spain received due to some extreme precipitation events above normal precipitation. In France new records were set in August at station Gonneville (Brittany) with 178.4 mm (more than three times the normal amount) and Montpellier with 234.2 mm (nearly seven times the normal amount). Due to the higher than normal pressure combined with a long lasting heat wave below normal precipitation was observed especially in central Europe. Western and southern Iberia had a precipitation deficit that lasted since the beginning of the year. The affected area of Portugal by drought on August 31 was for severe and extreme drought categories 74% that is the 2nd worst in 70 years (100% in 2005 and 73% in 2012). Since 1st June, Warsaw received less than half of the normal precipitation (172 mm). A total of 47 mm of rain has fallen in Belgrade during the same time, which is less than 30% of normal. In the Ukraine the precipitation deficit caused low river levels. In Germany this summer was the driest of the last 50 years.

Precipitation anomalies for **autumn 2015** showed higher precipitation than normal in the Balkan, parts of southern Italy, northern Germany, Denmark and parts of Finland. In nearly entire Serbia the sums of autumn precipitation exceeded the mean of the 1961-1990 period; station Negotin recorded 358.5 mm or 234%, for example. In Greece precipitation amount for autumn was higher than normal due to some heavy precipitation events accompanied by floods and tornadoes which caused a lot of damage. Northern Germany was also wetter than normal. With 101 mm mean precipitation in November 2015 it was 34.6 mm or 52.1% above the reference period 1961-1990.
In contrast, most parts of western Europe, Iceland, northern Italy, the Baltic States and parts of Scandinavia were drier than normal. Spain obtained in autumn 165 mm precipitation that is 18% less than normal. France was also drier, the rainfalls were about 15% less than normal. In UK September and October were very mild, precipitation anomalies for September were 56% and for October 57% only November with 145% was wetter than normal.

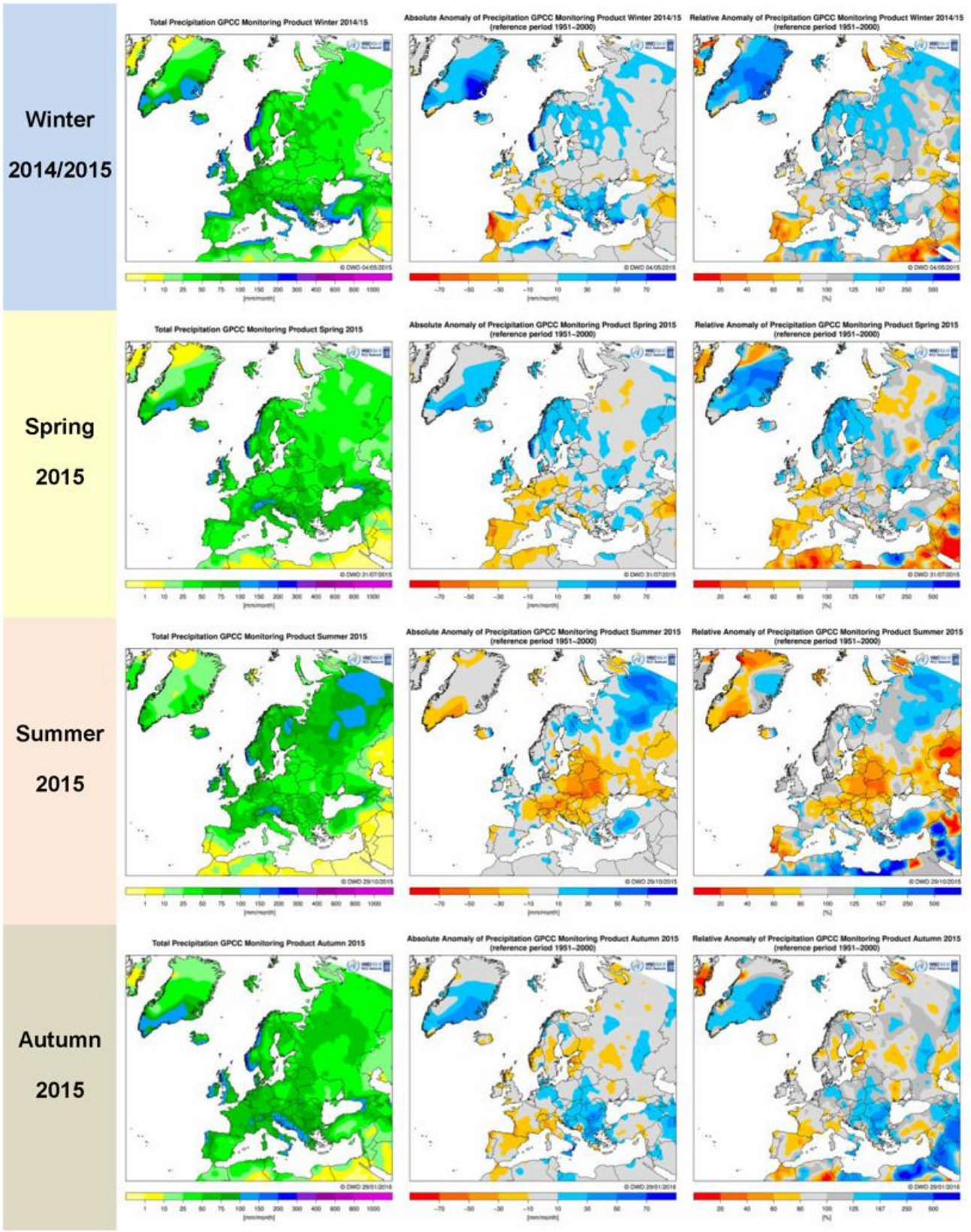


Figure 3.3: Seasonal total precipitation (left, in mm/mon), absolute anomalies (middle, in mm/mon) and relative anomalies (right, in %) in 2014/2015, reference period 1951-2000
(Source: http://www.dwd.de/rcc-cm)

3.1.4. Sunshine duration

In **winter 2014/2015** the sunshine duration in many parts of Europe dropped below 100 %. Only Spain, southern Italy, the Balkan States, western Poland and northern Scandinavia were sunnier than normal. It is very remarkable that Svalbard and northern Scandinavia had a sunshine duration above 150 %. The cloud cover in winter was nearly everywhere below normal.

In **spring 2015** most of Europe registered above normal sunshine duration. Sunshine deficit revealed Finland, northern Sweden, south Italy, parts of Turkey and parts of Russia. The cloud cover in spring was also below normal.

Most of Europe reported in **summer 2015** above normal sunshine duration, except Russia, northern Finland and eastern Mediterranean. Only some parts of Great Britain received the normal amount of sunshine. The cloud cover was also below normal.

In **autumn 2015** most of Europe registered above normal sunshine duration, except Russia, Romania, parts of Turkey, south Italy, Portugal, southern Great Britain, Ireland, northern France and western Germany. The cloud cover was from Germany to the Black Sea normal and in the other parts of Europe below normal.

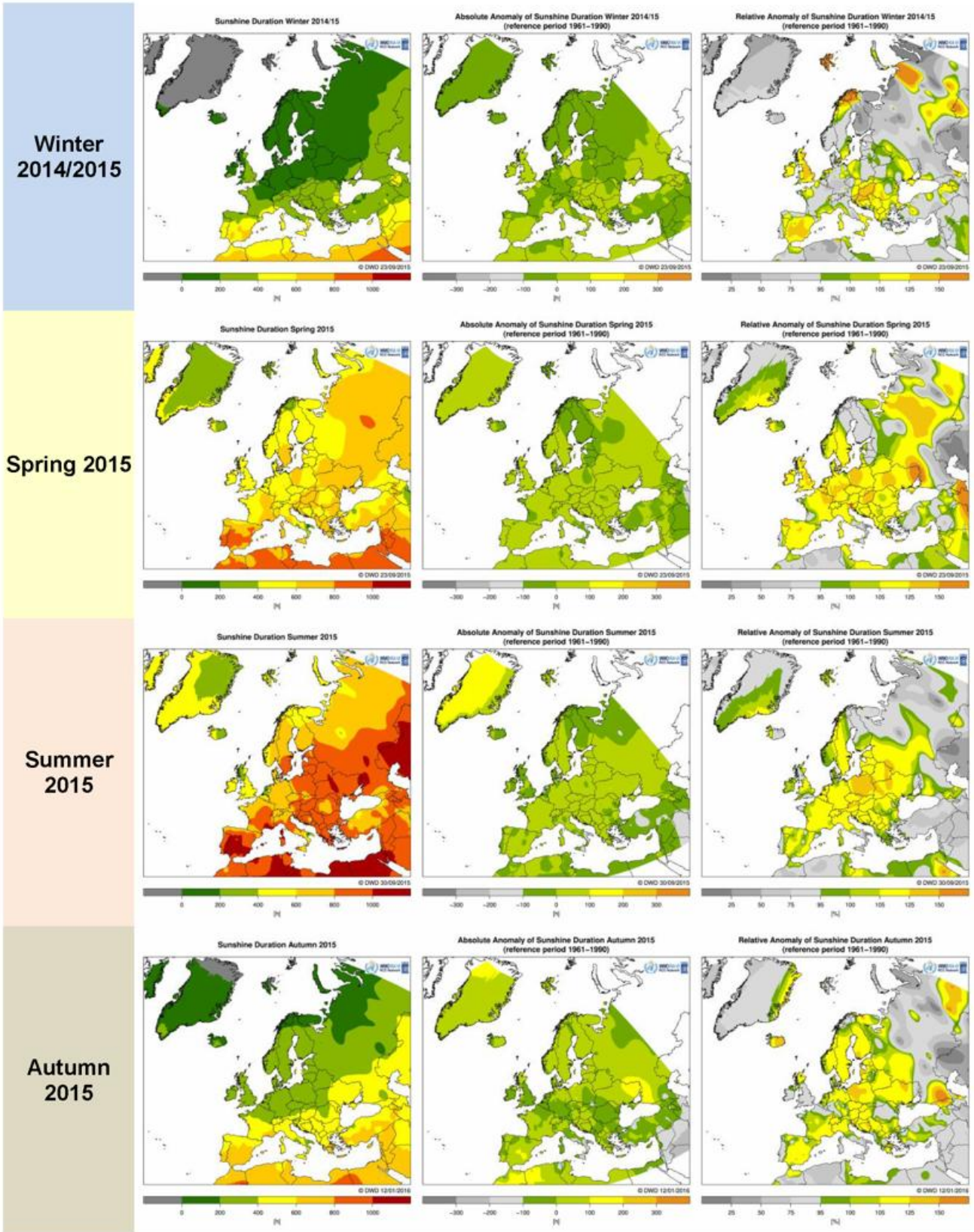


Figure 3.4: Seasonal sunshine duration (left, in hours), absolute anomalies (middle, in hours) and relative anomalies (right, in %) in 2014/2015, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

3.1.5. Drought

The **Winter 2014/15** was in most parts of Europe normal. Only Greenland, northern Spain, northern UK and some regions in Scandinavia and Balkan were wetter than normal.

In **Spring 2015** Scandinavia, Ukraine, northern UK and Greenland were very wet whereas Central and south-western Europe was dry.

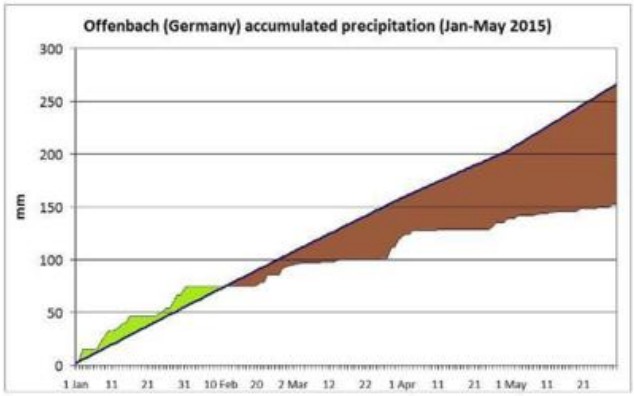
The Baltic countries, Belarus, the Ukraine, southern Spain and Portugal were severely dry in summer. In autumn the Balkan was wetter than normal.

From April to August a severe drought covered an area from the Baltic States across Poland, Belarus and Ukraine to Romania. The loss calculated by MunichRe sums up to 1,500 Million Euro. The dry conditions with lack of rain affected the water supply, fisheries, tourism and about 16,600 km^2 of farmland. August was extremely dry in Belarus (the driest ever measured), only 11 mm or 16% of the normal was measured. The monthly precipitation for August in Ukraine was 24 % of the normal (15 mm). It was the driest month in the series going back to 1891 in Ukraine.

Drought over southwestern and central Europe

In **May** the area with precipitation deficit extended from western Poland across Germany, France, Spain and Portugal. The relative precipitation anomaly for May showed values below 40% and in central Spain values below 20%. In Offenbach (Germany) a deficit existed since mid of February 2015. During February and May only 80 mm instead of 194 mm was registered or 41 % of the normal value.

In Spring the situation in north-western Spain was very dry and the weather service of Portugal published following overview.

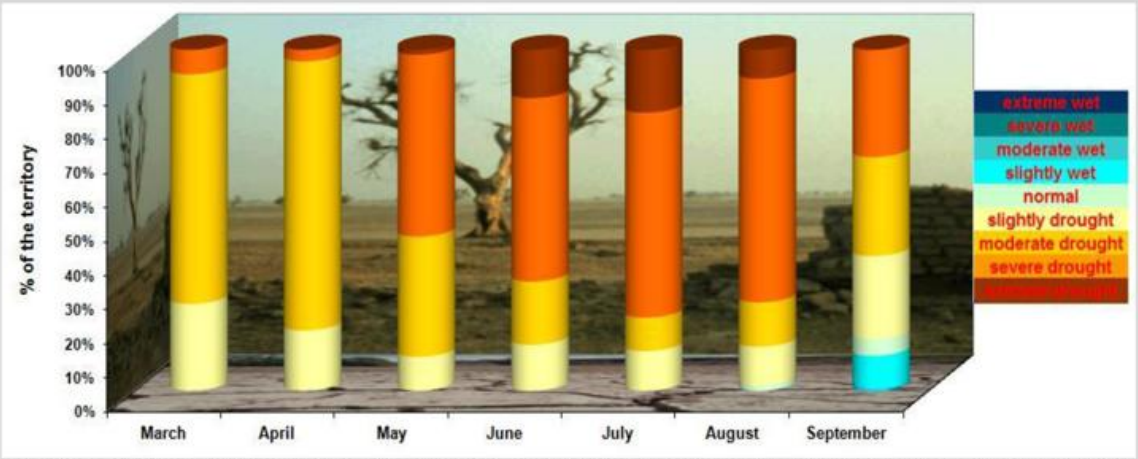


Accumulated precipitation from January to May 2015 in Offenbach (Germany, source: DWD)

Drought Situation in Portugal:

The drought began in March, in the whole territory, intensifying until the end of July, maintaining in August in almost the entire territory and starts to decreasing in September.

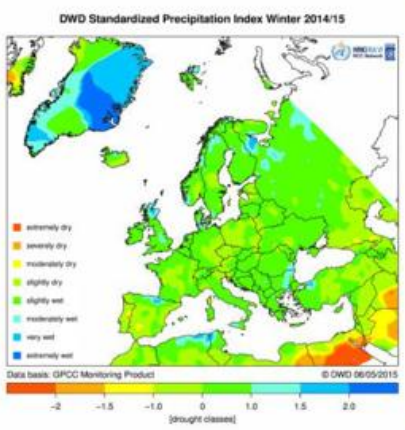
The months with higher severity were from May to July, with almost the entire territory in the classes of moderate to extreme drought, according to PDSI index.

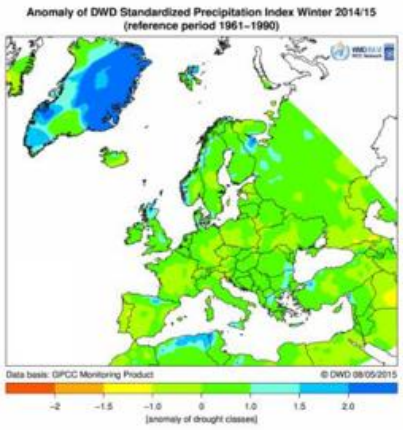


Percentage of territory (area) in the different classes of meteorological drought index PDSI between March and September 2015

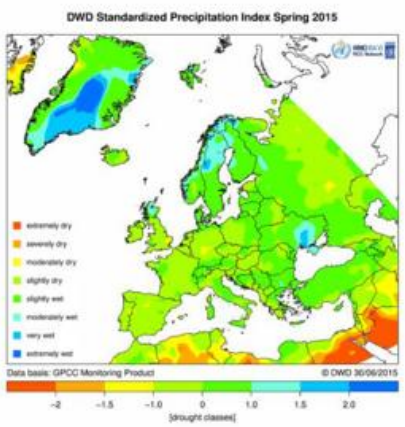
PDSI - Palmer Drought Severity Index - meteorological drought index, it responds to weather conditions that have been abnormally dry or abnormally wet. It is based on the supply-and-demand concept of the water balance equation, taking into account more than just the precipitation deficit at specific locations.

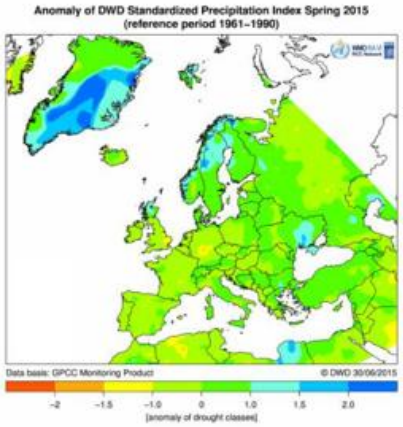
Winter 2014/2015



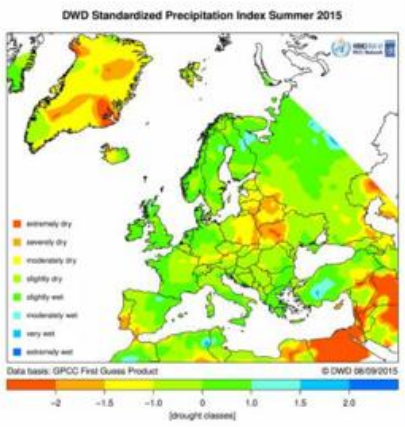


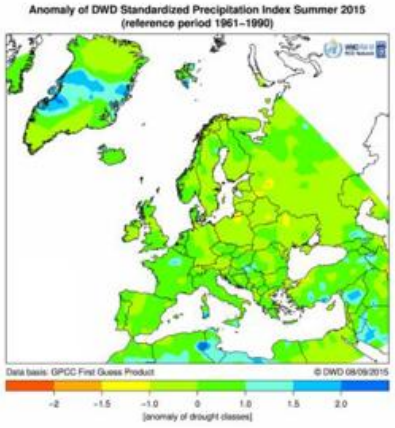
Spring 2015



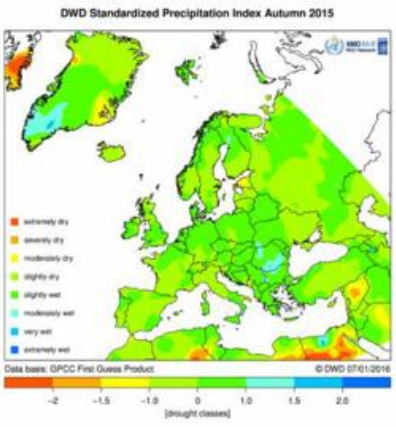


Summer 2015





Autumn 2015



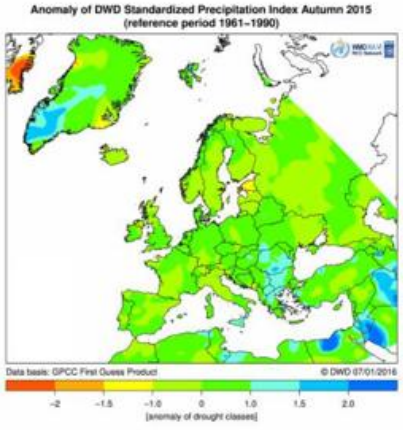


Figure 3.5: Seasonal standardized precipitation index (SPI, left, in drought classes) and anomalies (right) in 2014/2015, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm)

4. Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2015 on the Climate in WMO Region VI - Europe and Middle East (available on http://www.dwd.de/rcc-cm).

It contains highlights, means and anomalies of sea level pressure, temperature, precipitation and sunshine duration for each months as well as monthly overviews of extremes and notable events.

4.1. Sea surface pressure and circulation indices

This chapter about the atmospheric circulation provides information on selected northern hemisphere teleconnection indices which are considered to be relevant for WMO RA VI and it discusses influences of circulation patterns upon anomalies and outstanding events. The information is based upon the Monthly Bulletins on the climate in WMO RA VI and was completed by reports of the NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/upper troposphere not shown here. (See http://www.ncdc.noaa.gov/teleconnections/ and http://www.cpc.ncep.noaa.gov/products/CDB/index.shtml)

Table 4.1: Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference and the Arctic Oscillation, for January to December 2015

Year	Month	NAO	EA	EA/WR	SCA	POL	AO
2015	1	1.57	1.11	-0.24	-0.18	-0.03	1.092
2015	2	1.05	-0.04	-0.92	-0.37	2.09	1.043
2015	3	1.12	1.20	0.27	0.39	0.68	1.837
2015	4	0.64	0.88	1.12	-1.49	-0.88	1.216
2015	5	0.19	0.71	-1.50	-2.15	0.50	0.763
2015	6	0.24	1.06	-0.78	-1.52	-0.20	0.427
2015	7	-3.14	0.22	2.01	-1.11	0.39	-1.108
2015	8	-1.10	1.08	-0.37	0.87	0.13	-0.689
2015	9	-0.49	0.15	-1.67	1.09	-0.13	-0.165
2015	10	0.99	0.22	0.59	0.62	-0.47	-0.250
2015	11	1.70	1.55	0.56	-0.40	-0.66	1.945
2015	12	1.99	3.14	1.28	0.08	0.58	1.444

Note that all values are standardized with reference to the period1981-2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**:ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

January 2015 started with a high North Atlantic Index (NAO) where both, the Azores high and the Icelandic low were more intensive than normal. Both were also shifted to north-east. This leads to more westerly winds and higher temperature anomalies (see section on temperature). Two storms passed **Scandinavia** Svea (2nd January 2015) and Egon (10th January 2015) with wind gusts of nearly 40 m/s. Two low pressure systems (Elon, Felix) with high wind speeds, thunderstorms, hail, heavy rain and snowfall crossed UK, Germany and Scandinavia. Thousands of buildings, schools, houses were damaged. Weather–related accidents occurred; air and rail traffic was affected. The airport of Helgoland, Germany was also damaged. After MunichRe the loss of this two winter storms was estimated to about 500 Million Euro and caused 3 fatalities.

From 30th January – 03rd February 2015, a severe weather event caused extending floods over the west (mainly northwest) part of **Greece**, **Albania** and **Bulgaria**. As a result of the heavy rain flooding occurred; in Bulgaria an area of about 23300 km^2 and in Greece about 70 km^2 of farmland was flooded. The 3 day precipitation at station Zlatograd, Bulgaria, summed up to 123 mm while at station Derviziana, Greece 358.6 mm/72h was measured and a wind speed of 46 m/s at station

Paximada, Greece on 31st January. In Greece more than 2300 houses were damaged with 14 fatalities. The loss was estimated to about 660 Million Euro after MunichRe.

In **February 2015** the Azores high was more intense than normal with sea level pressure anomalies of more than +10 hPa. The Icelandic low was also more intense with anomalies below -14 hPa and shifted to the north. In eastern and southern Europe negative pressure anomalies prevailed. Both, the North Atlantic Oscillation (NAO) and Arctic Oscillation (AO) index showed values of more than 1. In Lithuania strong winds of up to 29 m/s were observed at the 8th of February in Ventspils. A deep low pressure, which was renamed to Ole of the Norwegian weather service, drew in the northernmost part of Scandinavia on 7th and was accompanied by strong winds. In Katterjåkk in Lapland (Sweden) 20 cm of snow was observed, the strongest wind was reported from Stekenjokk (Sweden) with 38 m/s in average and 43 m/s in the wind gusts.

In **March 2015** the two pressure centres were more intensive. The Icelandic low had anomalies of -14 hPa and the Azores high of more than +8 hPa. The second high pressure centre over Russia was about 8 hPa higher than the long term mean. Therefore the North Atlantic Oscillation index (NAO) with 1.12 and the East Atlantic Pattern (EA) with 1.20 showed above normal values. The Arctic Oscillation (AO) with an index value of 1.837 was very high.

Several storm series passed Europe

The storm Anton affected between 4th and 7th March 2015 **UK**, **France**, **Corsica**, **Italy** and **Croatia** in combination with the Bora and caused damages by storm gusts. In western parts of Scotland the storm was combined with flooding, exacerbated by snowmelt. Three other storms between 22th and 31st March 2015 (Isegrim, Mike and Niklas) crossed **UK**, **Netherlands**, **Denmark**, **Germany**, **France**, **Spain**, **Italy**, **Slovenia**, **The Former Yugoslav Rep. of Macedonia**, **Greece**, **Turkey, Romania** up to the **Ukraine** with locally damages, flooding and hail. In France from 29th to 31st March 2015 several monthly records were broken with wind speed above 35 m/s. Storm Niklas from 30st March and 1st April 2015 caused 11 fatalities and a loss of more than 1,400 Million Euro (after MunichRe). Due to the high wind speed of more than 30 m/s trains and cars were damaged, rail traffic disrupted and the air traffic were also affected.

April 2015 was characterized by a secondary high pressure centre over Western Europe (in addition to the Azores high) on monthly average. At the **Swiss** station Zürich-Fluntern a new record for April since 55 years was measured with a station pressure of 968.2 hPa (1036.5 hPa reduced to mean sea level). High pressure influence dominated over the whole Mediterranean region except eastern parts (Middle East, eastern Turkey and South Caucasus). In contrast, low pressure extended from northern to eastern Europe.

In **May 2015** sea level pressure anomalies were highest between the Azores high and Iberia with values of +2 to +4 hPa. The Icelandic low was more intense and shifted to the east with anomalies below -10 hPa above Scandinavia. In Eastern Europe negative pressure anomalies prevailed. Both, the North Atlantic Oscillation (NAO) and Arctic Oscillation (AO) index showed nearly normal values. But the Scandinavia Pattern (SCA) with a value of -2.15 explains much of the circulation. The negative SCA is linked with drier and warmer weather in Iberia and colder and wetter conditions in Scandinavia.

In **June 2015** sea level pressure anomalies were positive in the area between Iceland and Greenland and over central Europe indicating a north-eastward shift of the Azores high. The Icelandic low was also shifted north-eastward. For June the dominant circulation pattern for Europe was the Scandinavia Pattern (SCA) with an index value of -1.52.

In **July 2015** the two Atlantic pressure centres were more intensive. The Iceland low had anomalies of below -6 hPa and was shifted to the south. The Azores high had anomalies of up to +2 hPa. The second high pressure centre over Greenland was more than 12 hPa higher than the long term mean. A second low pressure system over north-eastern Europe with a central pressure below 1000 hPa and anomalies below -10 hPa resulted in a negative North Atlantic Oscillation index (NAO) of -3.14 the lowest value in the time series of CPC since 1950 (together with July 1993). The Arctic Oscillation (AO) with an index value of -1.108 was also negative.

In **August 2015** the Icelandic low was more intensive with a core pressure below 1005 hPa and was shifted to the south. The pressure anomalies were lowest between Iceland and the British Isles with values below -6 hPa. The high pressure over Scandinavia is striking with values of more than 1020 hPa and anomalies of more than +6 hPa. This high pressure was responsible for the highest temperatures in Scandinavia during this summer.

During **September 2015** the Iceland low was shifted to the west located at the southern edge of Greenland with anomalies below -2 hPa. The pressure anomalies of the Azores high ranged from below -2 hPa up to +2 hPa. The second high pressure centre located over Kazakhstan had a similar core pressure like the Azores high (above 1020 hPa). The positive anomalies were centred over north Scandinavia with more than 6 hPa above than the long term mean and ranged from the British Isles to European Russia. The North Atlantic Oscillation index (NAO) of -0.49 and the Arctic Oscillation (AO) of -0.165 were not very remarkable but the East Atlantic/West Russia Pattern (EA/WR) with a value of -1.67 and the Scandinavia Pattern (SCA) with 1.09.

In **October 2015** the Iceland low had a core pressure below 1000 hPa that was below his long term average. The high pressure centre was located over Scandinavia and East-Europe. The positive pressure anomalies were centred above Scandinavia with values of more than 6 hPa. This pressure distribution caused more sunshine and little precipitation. The NAO-Index of about 1.0 was above normal although the Azores high was not well developed. In southern Europe the pressure anomalies were below normal with values of -4 hPa west of Portugal.

In **November 2015** the Iceland low was shifted to the north-east located between Iceland and Scandinavia with anomalies below -12 hPa. The pressure anomalies of the Azores high ranged from below -2 hPa up to +6 hPa. The second high pressure centre located over eastern Russia had a similar core pressure like the Azores high (above 1025 hPa). The anomalies were centred over north Siberia with more than 6 hPa above the long term mean. The pressure anomalies in Scandinavia, east Europe and Middle East were below normal. The North Atlantic Oscillation index (NAO) of 1.7 and the Arctic Oscillation (AO) of 1.9 were remarkable high.

In **December 2015** the Icelandic low was very strong with a core pressure below 995 hPa. Its core was located west of Iceland and the Azores high was shifted to the Mediterranean area. The high had a strong core pressure above 1030 hPa. The positive anomalies over the Mediterranean area were above 14 hPa and the negative anomalies over Iceland below -14 hPa. This high pressure caused less precipitation over southern Europe. The NAO-Index with 1.1 was above normal which reflected this strong low and high pressure system.

The low pressure over the North Atlantic was accompanied by winter storms. Those named Desmond and Eva brought high wind speeds, heavy rain, coastal and river flooding, channels burst their banks and more than 7000 houses were damaged. Bridges were damaged, roads blocked and tens of thousands of houses were without electricity. 5 people died and a loss of about 2600 Million Euro in UK, Ireland was estimated by MunichRe.

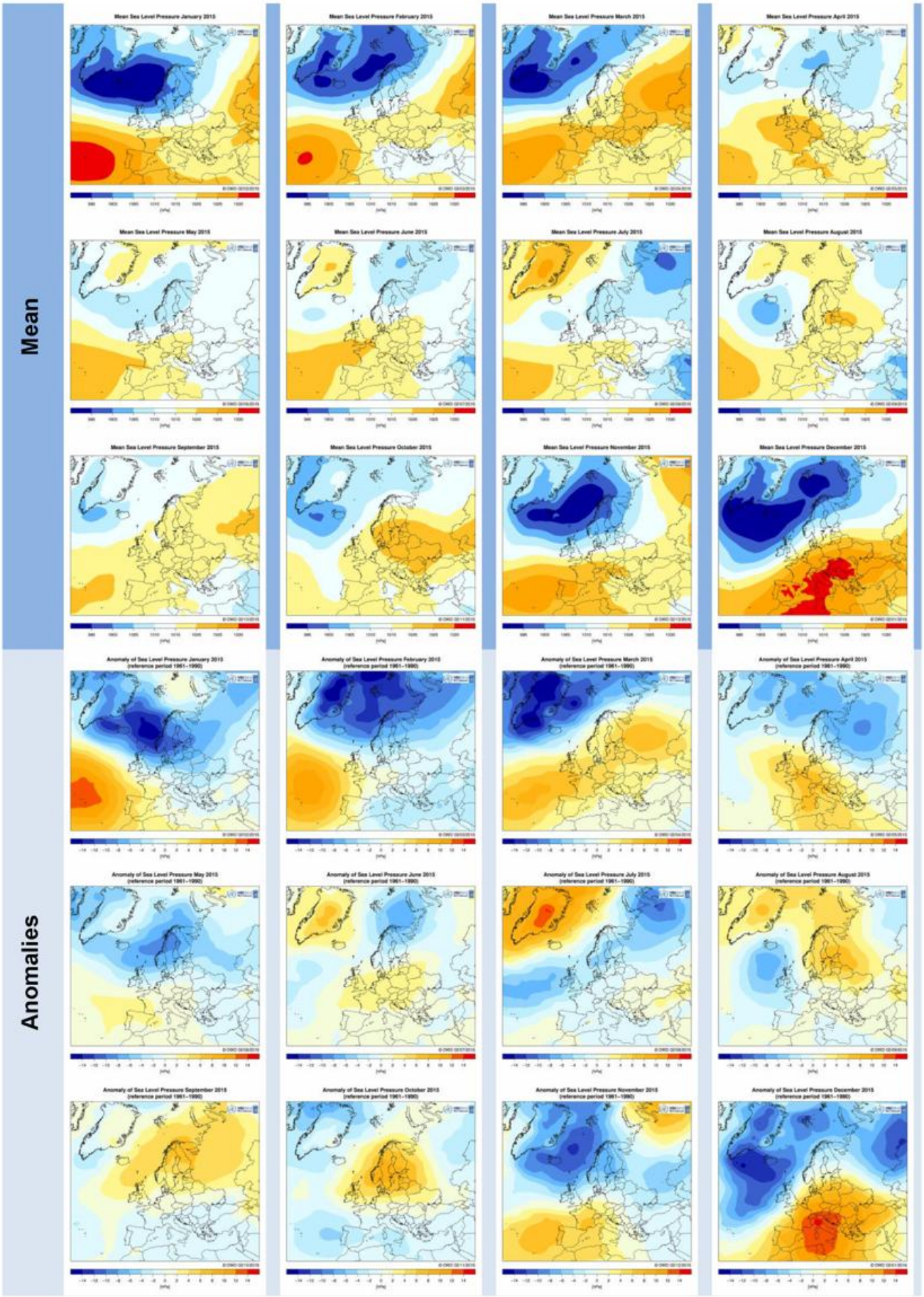


Figure 4.1: Mean and anomalies of sea level pressure in hPa for each month of the year 2015. (First row January, February, March, April)

4.2. Temperature

In most of the months and sub-regions it was warmer than normal as can be seen from Table 4.2. The Mediterranean area had positive anomalies throughout the whole year 2015 and in Eastern Europe anomalies above 3°C occurred in four month.

Table 4.2: Monthly and annual area average temperature anomalies in °C for each sub-region in the year 2015 (reference period: 1961-1990)

Region	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Central and western Europe	1,59	2,19	0,44	1,56	1,41	0,58	1,18	2,25	2,68	-0,07	-0,39	2,86	4,44
Nordic und Baltic Countries	1,26	2,87	1,63	1,62	1,34	-1,22	0,24	0,60	1,02	1,86	1,35	2,00	1,84
Iberia	1,41	-0,14	-0,91	1,32	2,33	3,07	2,66	3,07	1,27	-0,64	0,76	1,91	2,26
Mediterranean	1,48	1,76	0,52	0,80	0,48	1,86	1,26	3,36	2,42	1,70	0,58	1,88	1,15
Eastern Europe	2,29	2,99	4,61	3,96	0,65	1,94	1,84	-0,17	1,36	3,40	-0,21	2,20	4,85
Middle East	1,51	1,24	2,00	1,58	-0,33	1,18	1,89	1,46	2,07	3,39	1,38	1,13	1,12

In **January 2015** Eastern Europe showed anomalies above 3°C up to above 4°C. Only western Spain and Portugal had negative anomalies. In Norway some stations reported 5 to 7°C higher temperature than normal, for the whole country it was 2.6°C above normal. Latvia reported monthly mean air temperature between -1.7°C and +1.0°C that is 4°C – 5°C above normal. The temperature anomaly in Austria was 2.7°C which is rank 17 in the 248 year long time series. At station Graz-Strassgang (Austria) a new record for January maximum temperature was set with 21.7°C. In Lucerne (Switzerland), the daily mean temperature reached 15.1°C (daily maximum 19.3°C), which has never been registered in the available measurement series since 1871 in winter months (December to February). For the first time maximum temperatures above 20°C in January were registered in Germany.

Monthly temperature for **February 2015** showed very high positive anomalies in the North-East with more than 4°C and negative anomalies in the South-West down to about -2°C to -3°C. The average air temperature in Latvia was -0.2°C in February which was 4.6°C warmer than normal and the thirteenth warmest February in observational history. February was abnormally warm over most of European Russia, with mean monthly air temperature anomalies of 6°C -8°C.

The monthly temperature for **March 2015** showed positive anomalies for most of Europe. Highest anomalies occurred in the North-East with more than 4°C. With an average temperature of 3.4°C in Latvia, this month was 4.7°C warmer than normal. This was the third warmest March in Latvia ever recorded. Estonian average temperature was 2.5°C and consequently 3.6°C higher than normal. The anomalies in Finland reached partly more than 4°C above the long term mean and 3.3°C to 4.9°C in Lithuania. For whole Norway the anomalies were 3.8°C above normal but in the northern part they reached values of 5°C - 7°C. In Sweden several stations observed new records and topped those from last year. Some Arctic stations recorded monthly temperature anomalies for March 2015 of more than +8°C above their long term mean (Svalbard Airport, Barentsburg).

March 2015 globally the warmest March since 1891

The Tokyo Climate Center estimated the monthly anomaly of the global average surface temperature for March 2015 (i.e. the average of the near-surface air temperature over land and the

SST) to +0.31°C related to the 1981-2010 average (+0.76°C above the 20th century average), and therefore the warmest March since 1891.

NOAA also declared March 2015 as the warmest in the 136-year period of record (12.7°C, mean global land and ocean surface temperatures), surpassing the previous record of 2010 by 0.05°C. The Northern Hemisphere had its second highest March temperature on record, behind only 2008, while the Southern hemisphere tied with 2002 for third highest.

Lowest Arctic sea ice extent for March 2015 in the satellite record

Arctic sea ice extent for March 2015 averaged 14.39 million square kilometres. This is the lowest March ice extent in the satellite record. It is 1.13 million square kilometres below the 1981 to 2010 long-term average of 15.52 million square kilometres. It is also 60,000 square kilometres below the previous record low for the month observed in 2006.

Links/References:
Arctic: Arctic Sea Ice News & Analysis (http://nsidc.org/news/newsroom/archive/2015-03/)
Japan: Global temperature March 2015 (http://ds.data.jma.go.jp/tcc/tcc/products/gwp/temp/mar_wld.html)
USA (NOAA): http://www.ncdc.noaa.gov/sotc/global#temp

Monthly mean temperature anomalies in **April 2015** were positive in the west and negative in the east part of Region VI and ranged from -4°C in eastern Turkey up to more than +4°C in Algeria. Norway's Finnmark recorded values of up to +4°C, Svalbard Airport even 6.9°C above normal. At the 20th of April at several stations new record breaking temperature were registered with up to 24.2°C. In southern Finland the anomalies were about 1°C and 2°C to 3°C in Lapland.

Unusually temperatures in Israel in April

An unseasonably late winter weather system occurred on April 10th-12th. Northern Israel received 50-100 mm and central Israel 30-70 mm precipitation. Snow piled up on Mount Hermon in the North (at an altitude of ~2000 meters) accumulating to around 20 centimetres and snow was also reported on Mount Meron (1200 meters). Some areas in northern Israel experienced heavy hail storms on April 12th in the afternoon and the hail remained on ground overnight. The event was outstanding for mid-April, with only 3-4 such winter-like weather events in the last 60 years. Temperatures were exceptionally low – a maximum daily temperature of 15-16°C in the coastal plain and less than 10°C in the mountain regions - more than 12°C below average. These low temperatures are unusual, the last time they occurred in 1997 (Figure 4.2 left). The cold spell was preceded by a Sharav on April 8th with daily temperatures of 37-38°C in the coastal plain and 30°C at midnight. It was followed by a rapid cooling of 17-18°C on the next day (Figure 4.2 right).

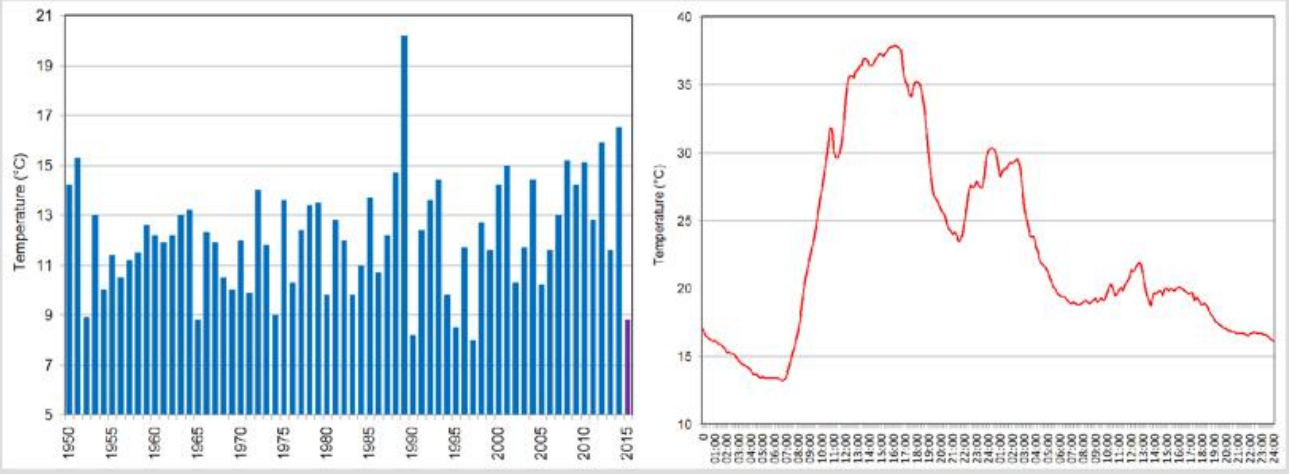


Figure 4.2: Lowest daily maximum temperature (°C) in Jerusalem for each year in April 1950-2015 (left) and Temperature (°C) in Bet Dagan (central coastal plain) on April 8-9th 2015 (left, Source: Israel Meteorological Service)

Another late and cool event occurred on April 21st-23rd. Precipitation amounts were small, yet snow fell over Mount Hermon, accumulating to several centimeters. Light snowfall was reported from

Mount Meron. This snowfall is very unusual for late April. The daily minimum temperature in Zefat (Upper Galilee) on April 24th was 3°C, the lowest ever recorded during this period (**Figure 4.3**, left).

A short time after this cold spell, a Sharav event occurred on April 27th-29th. In the Jordan Valley and the Arava temperatures were above 40°C. Elat had a maximum temperature of 43.3°C, very close to the April absolute maximum of 43.4°C from 2008 (**Figure 4.3**, right).

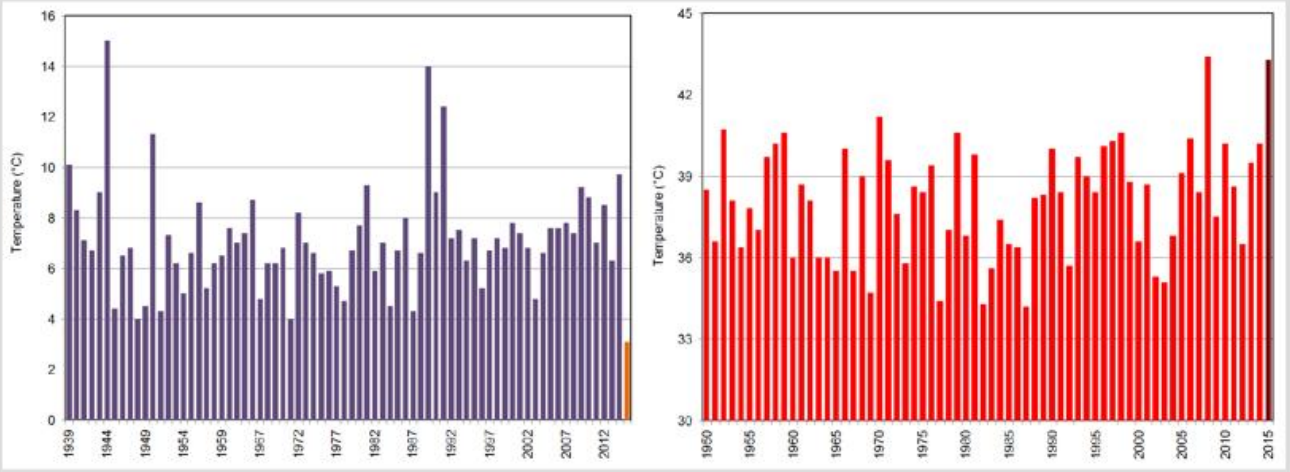


Figure 4.3: Lowest minimum temperature in April's third decade (21st - 30th) for each year in Zefat (Upper Galilee) 1939-2015 (right) and absolute maximum temperature in Elat in April 1950-2015 (left, Source: Israel Meteorological Service)

Monthly temperature for **May 2015** showed very high positive anomalies in the northern Russia and Spain with more than 4°C and negative anomalies in the north-west (from Ireland across Scandinavia, the Baltic States and Belarus) down to about -2°C to -1°C. At single days the temperature in Iberia reached more than 40°C, in Spain up to 42.6°C.

Monthly temperature for **June 2015** showed very high positive anomalies of more than 4°C in northern and southern Russia. The other area of high positive anomalies concentrated on south-western Europe with values of up to 4°C. Negative anomalies prevail from Ireland in the north-west across Scandinavia and northern Central Europe to the Baltic States with a minimum of -3°C in Sweden. At several days the temperature in Spain reached up to 43.7°C and in Portugal up to 41.6°C.

The monthly temperature for **July 2015** was dominated by very high positive anomalies of more than 4°C in south-western and central Europe. Negative anomalies occurred from Ireland in the north-west across Scandinavia, northern-central Europe to the Baltic States and northern Russia with a minimum of -3°C in northern Russia. In contrast during several days the temperature in southern Europe reached more than 40°C. In July several heat waves propagated from Iberia across central to Eastern Europe. Therefore July 2015 became the warmest July in many European countries.

Monthly temperature for **August 2015** showed very high positive anomalies especially in central Europe of more than 4°C. Negative anomalies occurred in Ireland, over the east Atlantic and north-eastern Russia. At single days the maximum temperature reached values of 40.3°C in Germany, 38.4°C in Poland or 41.5°C in Portugal. In Austria the monthly mean temperature ranked on the fourth place of the warmest August since measurements started in 1767 with 2.7°C above the mean. Only the August of the years 1807, 1992 and 2003 were warmer. From 1st to 4th August, Jordan saw temperatures nearly 8°C above normal, reaching 47.0°C at Wadi Elrayyan (WMO statement on the status of the global climate in 2015).

Heat waves over south-western and central Europe

At the beginning of **May** warm air came from Africa to Europe. Station Decimomannu in Sardinia (Italy) registered 38.4°C, the highest temperature in Europe on the 05th. During the second week, on the 14th May, remarkable temperature conditions were observed in Spain and Portugal with temperatures of 40°C to 44°C. In Portugal station Beja reported on the 14th May 40°C and on the consecutive 19 days maximum temperatures above 30°C, 14 days more than normal. The mean daily maximum temperature in Portugal of 25.46°C was +4.5°C higher than normal, being the highest value for May since measurements begun in 1931. At station Sevilla San Pablo (Spain) the maximum temperature in May reached every day above 25°C (summer days) and at 24 days values above 30°C (hot days) which are a new record. Even Lanzarote airport (Canary Islands, 13th of May) outperformed its May record with 42.6°C by +6°C. Agadir-Al Massira (Morocco) registered a maximum temperature of 45.6°C.

During **June**, temperature in Iberia, France and Italy were above normal, especially in the first decade and the last days of the month when extremely high temperature were recorded in both the daily maximum and night minimum. In these episodes record breaking heat waves reached the Iberian Peninsula and propagated to central Europe and Italy and further eastwards.

In **Portugal** June 2015 was the hottest of the last 10 years and the 5th warmest since 1931. The monthly average temperature was 21.8°C and +2.4°C higher than the normal value. The monthly mean of the maximum temperature with 29.0°C was +3.6°C higher than the long term mean, being the 3rd highest value for June since 1931. The absolute maximum temperature in Portugal was registered with 43.2°C at station Beja on the 29th June 2015.

June in **Spain** was also very warm, with an average temperature of 22.5°C or 1.4 K above the long term mean of this month (period: 1981-2010). Therefore it was the sixth warmest June since 1961 below the average temperature for the years 2003, 2004, 2005, 2009 and 2012.

In **Italy** the first ten-day period was the warmest of the month, especially in the central and northern regions, where the average anomalies of the maximum temperature exceeded the long term mean by 5°C, and at some places even by 7°C. Apart from Sicily, during this first ten-day period minimum temperature was higher in the central and northern part of Italy where the average deviation was about +3°C and even exceeded +6°C in some stations.

In **France** temperature in June remained with 1.5°C above normal during almost all the month. From 28th June onwards the maximum temperatures were 4°C -8°C warmer than normal over most of the country. On June 30th, they exceeded seasonal values by +12°C in the western part where records were broken with local peaks in the south-western France with 40.7°C in Arcachon (Gironde).

In **Austria** temperature anomalies were +1.4°C above normal. This was the 10th warmest June since 1767 for Austria. The absolute maximum temperature was 34.5°C at station Gars am Kamp (267 m a.s.l.)

In **Switzerland** it was the 4th warmest June with 33.2°C since beginning of measurements in 1864. The whole country was 1.8°C warmer than in mean of 1981–2010.

In **Germany** the maximum temperature of 35.0°C was recorded on the 5th June. However, the monthly mean temperature of 16.0°C was only 0.6°C or 0.3°C higher than the mean of the reference period (1961-1990 or 1981-2010).

The heat also reached **United Kingdom** with a record breaking maximum temperature of 32.5°C on the 30th at Heathrow-Airport (Greater London).

Hot air from Africa induced several heat waves in **July** with very high maximum temperatures as shown in the table below. The first heat wave reached on the 1st July the **United Kingdom** with the highest temperature since August 2003. The maximum temperature of 36.7°C at Heathrow (Greater London) was a new UK record for July. The heat wave reached also **Scandinavia** for some days and the mercury climbed to more than 30°C. In **Germany** the heat wave reached on the 5th July its peak with a new record breaking value of 40.3°C (at station Kitzingen). During the next days **Switzerland** registered its maximum value of 39.7°C on the 7th July and **Hungary**

39.3°C on the 8th. This first heat wave ended with severe thunderstorms and winds gusts, heavy rain and hail (of 3-4 cm diameter) in central Europe.

After a break of 2 days the next heat wave reached France on the 10th July but still remains in southern Europe.

On the 16th July the heat intensified again and culminated in new record breaking values in **Portugal** (42.1°C at station Mirandela) and **France** (41.4°C at station Brive) and propagated to the north and east. On the 18th July the heat reached the Black Sea. This third heat wave persisted in western Europe until the 24th and 25th in eastern Europe. In south Europe the heat wave lasted until the end of the month.

In **Austria** the highest temperature of 38.3°C was recorded on 19th July at 2 stations: Krems (203 m) and Langenlebarn (175 m). This was the first time in Austrian history that the morning temperature at 8 o'clock (06 UTC) was above 30°C (at stations Seibersdorf, Pottschach and Wiener Neustadt). Station Ljubljana (**Slovenia**) registered 21 hot days (T >30.0°C) that is a new record. Several other Slovenian stations documented also all-time records of hot days.

The implications of these high temperatures have not only caused strong thunderstorms with heavy rain, hail and flooding or damages at houses by lightning and forest fires. The long duration of this heat caused a precipitation deficit leading to shrinking water reservoirs and also low river levels (as reported from Poland, Russia and Germany). The agriculture had crop losses due to early harvesting as reported from Moldova and Germany.

Table 4.3: Selected countries and their statistics for July 2015 (as reported by the NMHSs)

Country	Rank	time series	Anomaly (°C)	Reference period	Absolute maximum in °C	Day of occurrence
Austria	1	1767	+3.1	1981-2010	38.3	19
France	3.	1900	+2.0	1981-2010	41.4	16
Germany	7.	1881	+1.4	1981-2010	40.3	5
Hungary	-	-	-	-	39.3	8
Italy	-	-	-	-	42.8	31
Norway	-	1900	-0.7	1961-1990	31.4	2
Poland	-	-	-	-	36.4	4
Portugal	13.	1931	+1.0	1971-2000	42.1	16
Romania	-	-	-	-	38.6	30
Serbia	2.	1950	+3 to +5	1961-1990	38.4	19
Spain	1.	1961	+2.5	1981-2010	45.2	6
Sweden	-	-	-	-	32.8	2
Switzerland	1	1864	+3.6	1981-2010	39.7	7
United Kingdom	-	-	-0.7	1981-2010	36.7	1

Notes: ranking of the country mean temperature and the start of this time series, as well as the anomalies with respect to the reference period as available by the national meteorological services

The average global land surface temperature for **August** 2015 was +1.14°C above the 20th century average (NOAA National Centers for Environmental Information, State of the Climate: Regional Analysis for August 2015, published online September 2015, retrieved on September 25, 2015 from http://www.ncdc.noaa.gov/sotc/global-regions/201508). It was the highest August value in the 1880-2015 record, exceeding the previous record set in 1998 by +0.13°C. For Europe the land surface temperature in August 2015 exceeded by +2.25°C the reference mean of 1910-2000 and was the warmest August since 1910 (start of the time series). In many European countries this August breaks several records.

In **Austria** it was the 4th warmest **August** since measurements began in 1767. **Germany** reported the 2nd highest mean monthly temperature for August since 1881. Also Wroclaw (**Poland**) experienced with 38.9°C an all-time high August temperature on the 8th. The 12th of August was the ninth consecutive day in Warsaw with a temperature of 32.2°C or higher. At the same time a great part of Europe had a rainfall deficit. Since 1st June, Warsaw has received less than half of the normal precipitation (172 mm). During the same time Belgrade recorded 47 mm total rain amount, which is less than 30% of the normal. In the **Ukraine** the precipitation deficit caused low river levels. In **Germany** this summer was the driest of the last 50 years. The affected area in **Portugal**

by drought on August 31st was for severe and extreme drought categories 74% that is the 2nd worst in 70 years (100% in 2005 and 73% in 2012).

This high temperature in combination with precipitation deficit stimulated wildfires in every country around the Mediterranean Sea e.g. Spain, Portugal (http://forest.jrc.ec.europa.eu/effis/).

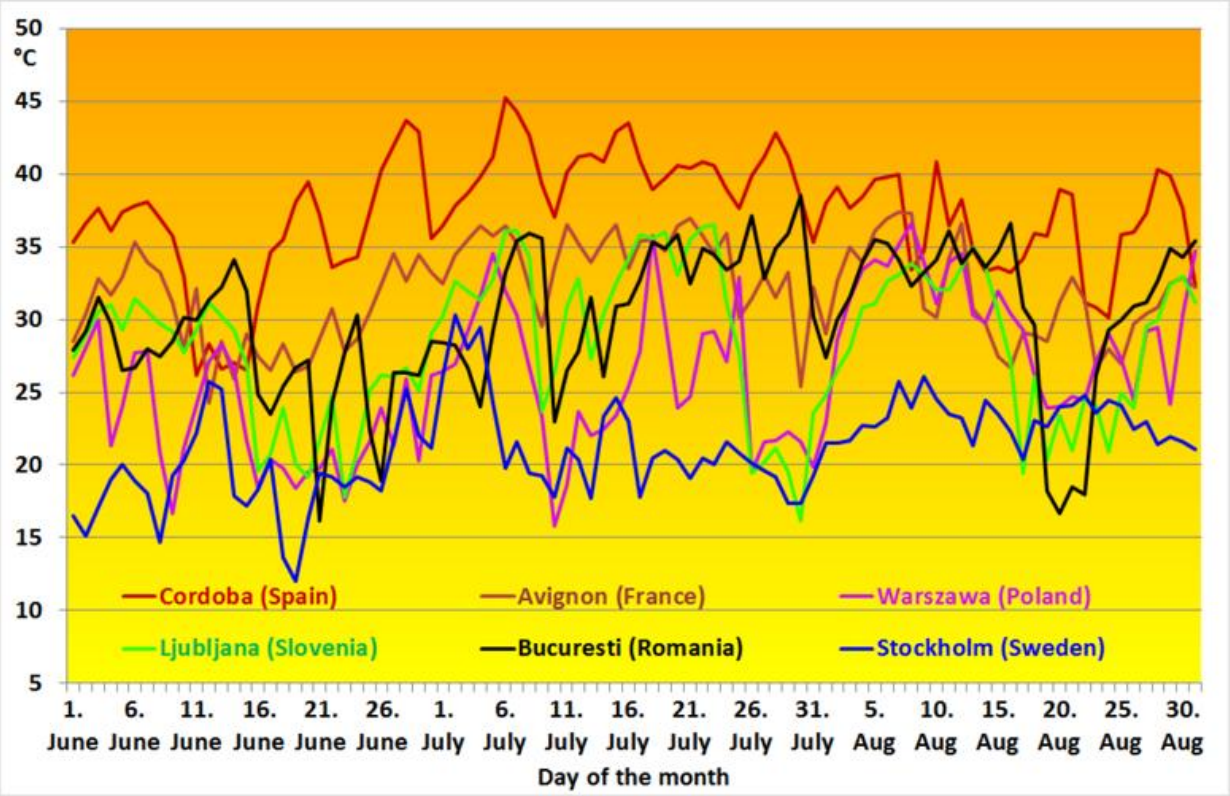


Figure 4.4: Daily maximum temperature (in °C) for several European SYNOP-stations from June to August 2015

From June to August 2015 several heat waves passed over different regions at different times. Southern Spain (at station Cordoba) noted most of the time more than 35°C and on the 6th of July even 45.2°C. In Avignon (southern France) the maximum temperature remained above 30°C from 25th June until 13th August (with the exception of 3 days). In Central Europe (at station Warszawa) and the Balkan (at station Ljubljana) 5 heat waves (maximum temperature above 30°C) were observable, at the beginning of June, at the beginning and in mid-July as well as at the beginning and the end of August. In eastern Europe (in Bucharest) the heat waves arrived some days later. In contrast, the heat wave reached northern Europe only on 2nd July with a maximum temperature in Stockholm (Sweden, the country wide maximum was 32.8°C) of 30.3°C.

Links/References:

Austria: http://www.zamg.ac.at/cms/de/wetter/news/extreme-hitze
Austria: Hitzewellen: 2015 eines der extremsten Jahre der Messgeschichte
Austria: HISTALP - Österreich Sommerbericht 2015
Central Europa: Hitze/heftige Gewitter Mitteleuropa - 03.08.-16.08.2015
France: https://donneespubliques.meteofrance.fr/?fond=produit&id_produit=129&id_rubrique=29
Germany: Agrarwetter im Sommer 2015
Slovenia: Heat and storms during the period from 11 to 26 July 2015
Switzerland: Abschluss Hitzewelle Juli 2015
Switzerland: Hitzewelle - Stufe 4 auf der Alpensüdseite
Switzerland: Hitzewelle: Eine klimatologische Betrachtung
United Kingdom: Heatwave 1st July 2015
USA (NOAA): Summer heat wave arrives in Europe
Global: NOAA National Centers for Environmental Information, State of the Climate

The anomaly pattern of the temperature in **September 2015** was divided in two parts. The western part of Europe was colder than normal with anomalies below -2°C in France and above +4°C in the Ukraine, southern Russia and Turkey. The heat wave was shifted eastwards with maximum temperature above 40°C in Turkey and some new station records. In Israel, at Sedom, the minimum temperature on the 9th September was 36.5°C, which is the highest daily minimum temperature ever recorded in Israel. This temperature broke the record of Tiberias (36.0°C) from 1936 (WMO statement on the status of the global climate in 2015).

Most of central and eastern Europe had in **October 2015** negative temperature anomalies of down to -2°C. Scandinavia, the United Kingdom, Ireland and southern Europe showed positive anomalies of up to +4°C in central Turkey and Middle East. In the North between Greenland and Novaya Zemlya the anomalies reached values of more than +4°C.

Temperature anomalies in **November 2015** showed overall positive values of more than +4°C in central Europe, Finland and the extreme North. Some countries reported new records like Germany. In Germany the elevated stations had anomalies of more than +4°C (e.g. Hohenpeißenberg 4.3°C above the reference period 1981-2010). On average over France, it was +2.7°C warmer than normal, ranking the 3rd November among the warmest since 1900, behind 1994 and 2014. November was also exceptionally warm in a large part of Finland. At several observational stations in the southern and western parts of Finland, the month was even record mild.

In **December 2015** nearly whole Europe was more than +4°C warmer. Colder as normal it was in Greece, Turkey and parts of the Middle East (locally below -3°C) as well as southern and western Greenland and the northern Atlantic showed negative anomalies, especially in central Turkey, southern Greenland and the northern Atlantic. Germany observed with +5.6°C above normal (+0.8°C) its warmest December on record. The UK also noted the warmest December in a series from 1910. With 7.9°C it was 1.0°C warmer than the previous warmest December. It was also easily the warmest December in the Central England temperature (CET) series from 1659. Switzerland had the warmest December since the beginning of the measurements 1864, with record temperatures anomalies between 5.6 and 5.8 K above normal (1981-2010) on Jungfraujoch (3580 m a.s.l.), Säntis (2502m a.s.l.) und Grosser St. Bernhard (2472 m a.s.l.) which is 2°C above the last records. Estonia reported a monthly mean temperature +3.3ºC (anomaly 6.1ºC), the second place since 1961.

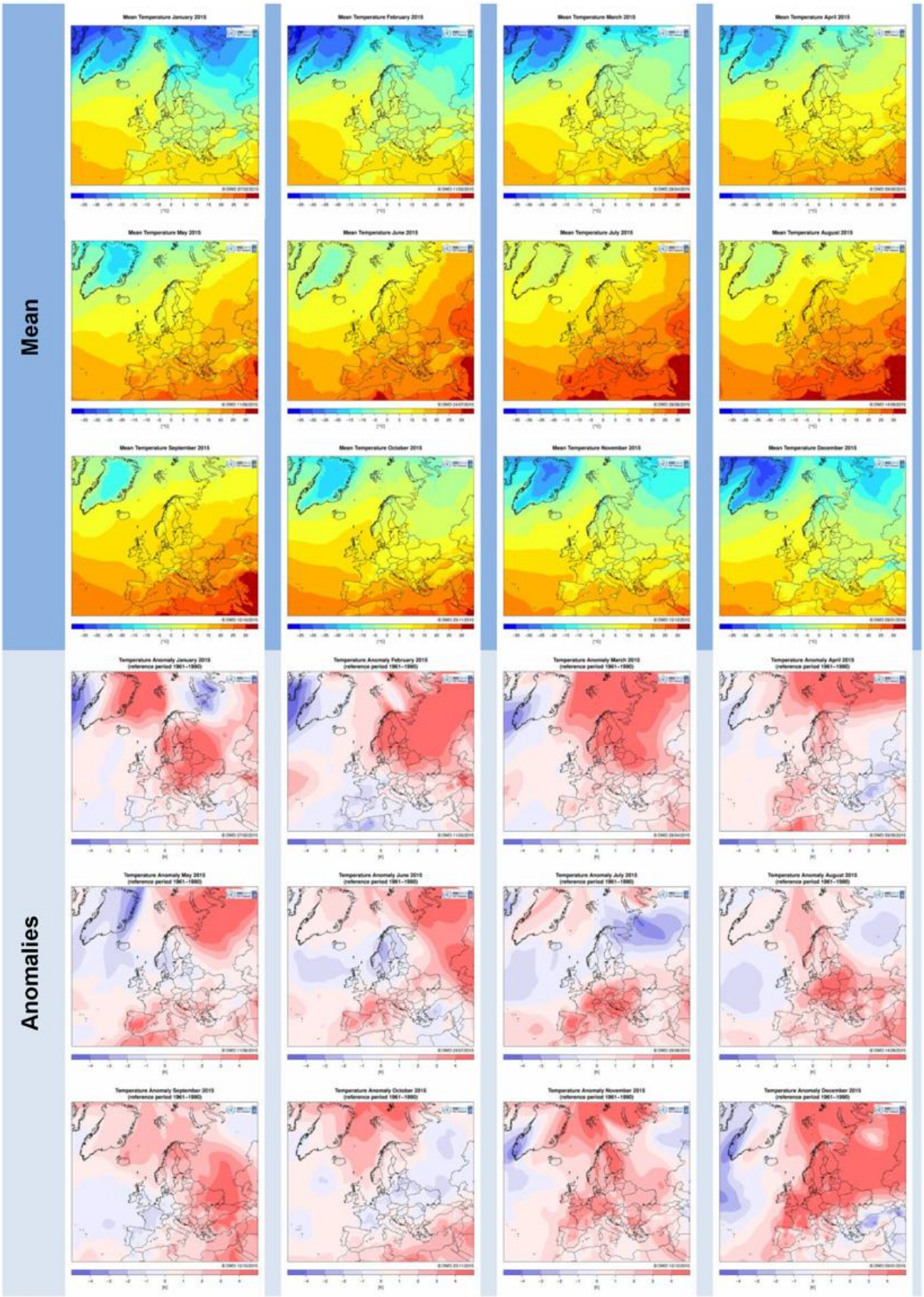


Figure 4.5: Mean and anomalies of temperature (in °C) for each month of the year 2015. (First row January, February, March, April)

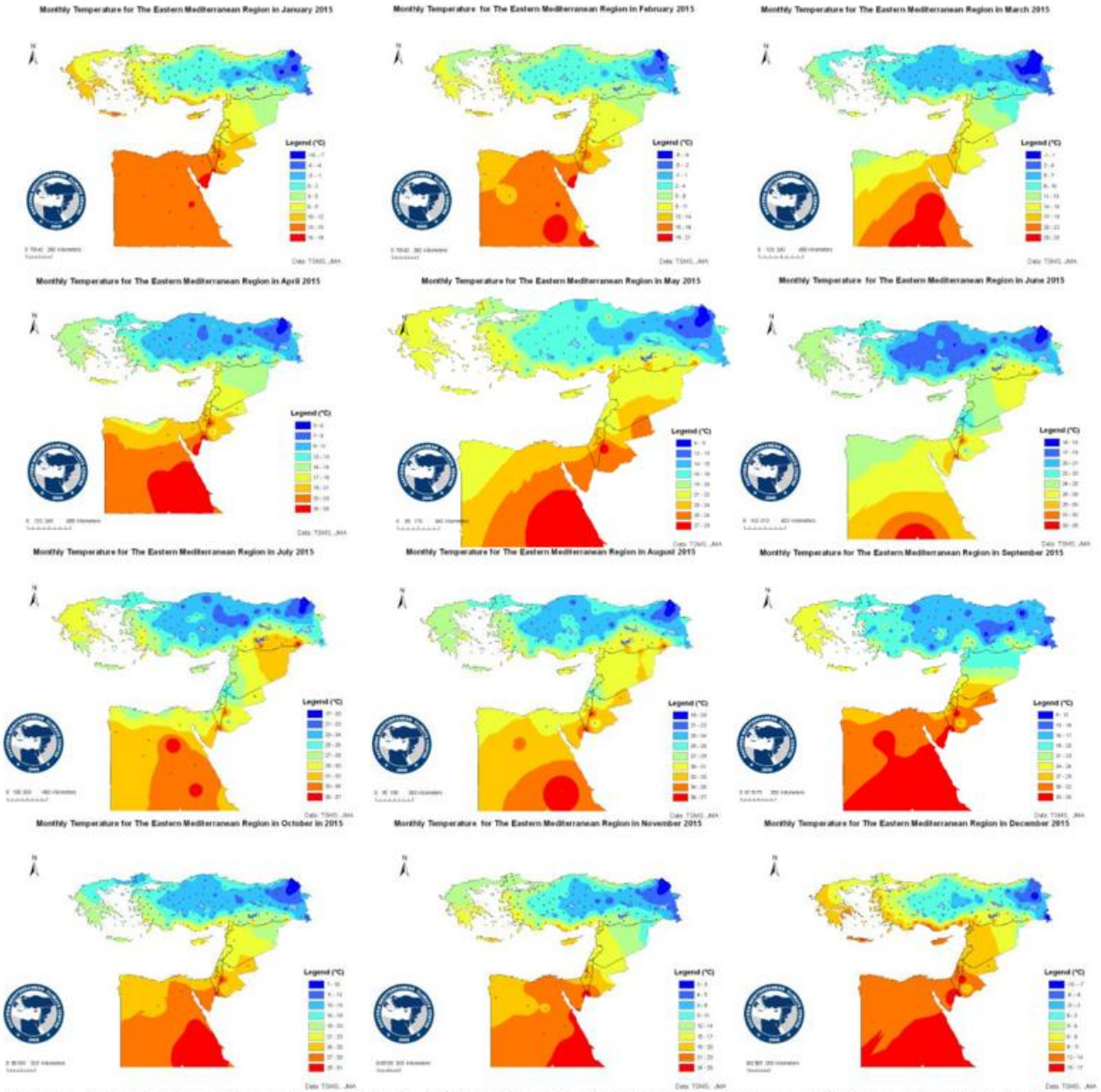


Figure 4.6: Monthly mean temperature (°C) for the Eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC).

4.3. Precipitation

According to the sunshine duration in **January 2015** most of central, eastern and northern Europe show higher than normal precipitation with values of more than 250% in Scotland, although it was very sunny. The overall UK rainfall total was 126% of the average. The West-Mediterranean was drier than normal except the coastal zone of northern Spain with partly more than 300 mm as reported by the national weather service AEMet. There was also widespread heavy rain over Cyprus that caused flooding and landslides (WMO statement on the status of the global climate in 2015).

Extreme precipitation in Scandinavia

In Finland precipitation levels for **January** were exceptionally high close to the western coastline and also in the area stretching from Kainuu to Sea Lapland. Precipitation volumes in these areas were nearly twice as high as normal for January. In western parts of the country many weather observation stations recorded the highest precipitation levels for January since 1961.

During January in a larger part of Lithuania registered 60-80 mm of rain and up to 85-110 mm in the western part, equivalent to 150–200% of the long term mean.

In Norway the monthly total precipitation was 140% at some stations up to 400% of the normal; at Eikemo 782.3 mm (279% of the normal).

In Sweden station Piteå reported a new record of 133.6 mm for January since 1860. In this month also several other station records were broken in Sweden.

Links/References:
Finnish Meteorological Institute: January saw high precipitation and wide temperature fluctuations.
Norway: Været i Norge - Klimatologisk månedsoversikt - Januar 2015

In **February 2015** most of central Europe, southern Scandinavia, the Baltic States and south-west Iberian Peninsula were drier than normal with values less than 20% of the long term mean. South-eastern Europe, Norway and the British Isles were wetter than normal. Most parts of Austria reported a precipitation deficit of more than 50%, at station Kollerschlag only 8% of the long term mean was registered. Monthly precipitation totals for whole Norway were 135% of the normal. Some stations received between 250% and 350% and others in the south only 25% of the normal. The highest amount was measured at station Lurøy with 467.0 mm or 237%. The relative precipitation anomaly in Portugal ranged from values of 10% in Castelo Branco to 100% in Portimão Compared with the average values the accumulated monthly precipitation in northern Spain exceeded 200%, at some stations even 300%. The precipitation amount in Croatia for February ranged between 37% and 300% or 15 and 99 mm. Heavy rain also affected countries in southern Europe with flooding in parts of Albania, the Former Yugoslav Republic of Macedonia, Greece and Bulgaria (WMO statement on the status of the global climate in 2015).

In **March 2015** most of western Europe and Russia were drier than normal with values less than 50% of the long term mean. South-eastern Europe, Norway and Scotland were wetter than normal. The precipitation amount for Portugal in March were much lower than the respective normal values throughout the country and ranged from 0.4 mm in Vila Real to 55.4 mm in Viana do Castelo. The percentage values were less than 50% relative to the normal in the north and central part and less than 75% in much of the southern region. In France the precipitation deficit was 20% below normal, locally in the centre of Brittany about 50%. In contrast, in Corsica the precipitation amount often exceeded 250 mm, at station Campile a new record was set with 406 mm (normal for March 63 mm). The average rainfall of Spain was calculated to 58 mm, which exceeded the average of the month (reference period: 1981-2010) by about 25%. In the east of Spain the precipitation amount reached values of more than 300% and led to new all-time record of precipitation for March at the observatories in Castellon de la Plana, Teruel and Almeria. Romania registered in the south-eastern part precipitation amounts of 150-200% of the long term means (1981-2010).

In **April 2015** precipitation was lowest at some places in the central and eastern Mediterranean such as Sicily, southern Greece, southern Turkey, parts of the Middle East, but also at few places in Hungary with less than 10 mm for the whole month of April 2015. In Austria at Klagenfurt the

second driest April since 1813 were registered, which led to forest fires (WMO 2015). Highest precipitation totals were measured in northwest Spain, southern France and near eastern coasts of the Black Sea with more than 100 mm in April, locally more than 150 mm. Northern and eastern Europe received more precipitation than normal, in some regions more than 250%. Some stations in Northern Norway received 2.5 to 3.5 times of the normal precipitation.

Precipitation anomalies for **May 2015** were heterogeneous distributed. Most parts of western Europe from Poland, Czech Republic, France, and Iberian Peninsula were drier than normal with values less than 20% of the long term mean in Spain. Most of Italy, Albania, and from Greece to eastern Romania and Moldova was also drier than normal. Scotland, Scandinavia, the Alpine region with western Balkan as well as Slovakia, eastern Poland, the Ukraine and parts of Belarus and Russia showed positive precipitation anomalies. In northern Europe precipitation was caused by cyclonic activities whereas in southern parts precipitation was mainly caused by thunderstorms.

Very wet May in Scandinavia

Precipitation in Finland ranged from below 100% in the south-east to more than 225% in the north and west parts of the country.

Monthly precipitation for Norway was 175% of the normal, and it was the second wettest **May** in a series that stared in 1900, surpassed only by the May of the year 1949. Some stations in the north and the southeast received more than 3 times of the normal rainfall. It was relatively dry in parts of northern and central Norway with 50% to 75% of the normal precipitation. The wettest station was Hovlandsdal with 363.4 mm (265% of normal).

In Sweden May was very wet or extremely wet for almost the entire country. Several stations with more than 100-year long measurement series hit their old monthly record. In Stockholm it was the wettest May since 200 years.

Links/References:
Finland: May 2015 Statistics
Norway: Klimatologisk månedsoversikt Mai 2015

Monthly precipitation for **June 2015** showed high positive anomalies in Scandinavia and northern Russia of more than 70 mm. In the south-eastern part of Europe also high positive anomalies occurred with peaks over central Turkey and north of the Black Sea with values of more than 70 mm. A band of above normal precipitation extended from the Black Sea through Ukraine to northern Russia. Central and eastern Europe received partly below 25 mm or a deficit of up to 75 mm from Croatia through Austria and Hungary up to the Baltic States and northern Russia. While the Pyrenees recorded above normal precipitation, the rest of Spain and Portugal still had a precipitation deficit and drought.

Monthly precipitation for **July 2015** showed high positive anomalies of more than 70 mm in UK, Ireland, northern Germany, Scandinavia and northern Russia. Southern Europe (Serbia, Italy, Spain and Portugal) received partly below 25 mm or locally a relative anomaly of below 20%. While the north-eastern part of Spain measured above normal precipitation, the rest of Spain and Portugal, France, and a band from southern Germany up to the Ukraine still had a precipitation deficit and drought. On the 4th and 5th July severe thunderstorms with hail crossed the Netherlands, Belgium and northern Germany with 2 fatalities and a loss of 400 Million Euro (MunichRe). This low pressure system with storm (26.2 m/s at station Münster/Osnabrück, Germany), hail (9 cm in diameter) and heavy rain caused flash floods, and damage on numerous houses and vehicles.

Precipitation anomalies for **August 2015** were above normal in most parts of western and southern Europe while northern and eastern Europe were drier than normal. It rained less than normal in an area from Massif Central (France), Switzerland, Austria, southern Germany, Czech Republic, Poland to Scandinavia and from the Baltic Sea to the Black Sea with values less than 20% of the long term mean. Central Russia was wetter than normal with anomalies of more than 70 mm. While in southern Norway precipitation amount reached up to 341.9 mm (197% of normal) at station Sand i Ryfylke (Rogaland), central Norway received at station Skjomen–Stiberg (Nordland) only 18.1 mm or 26% of the normal. In France new records were set at station Gonneville (Brittany)

with 178.4 mm (more than three times of the normal amount) and Montpellier with 234.2 mm (nearly seven times of the normal amount)

In **September 2015** western Europe from Portugal to Norway was drier than normal. Eastwards of this band a second band of above normal precipitation was located from France to northern Finland. The next band with drier conditions followed from south Germany and Czech Republic, Poland, the Baltic States to northern Russia joined by a wetter zone from Greece and Turkey to Belarus and Russia. The southern part of Russia and eastern Ukraine were dominated by a precipitation deficit. Most of these precipitations were due to thunderstorms with severe rainfall. The precipitable water anomaly maps showed for the whole Mediterranean values of up to 8 mm or more than 3 standard deviations. Two peaks were remarkable one above Costa Brava/Gulf of Lions and the other western off the Spanish/French Atlantic coast. In Ireland, stations in Galway and Mayo saw September-record 24 hour rainfall totals over 100 mm on 11th and 13th September leading to flooding (WMO statement on the status of the global climate in 2015).

Scandinavia received in **October 2015** little precipitation, except central and northern Norway. The region of the deficit ranged from the Baltic States, northern Poland to Belarus, eastern Ukraine and western Russia with monthly totals below 10 mm. In southern Norway and Sweden new extreme low precipitation records were broken by many stations. Western Europe and eastern Spain received below normal precipitation, partly below 40%. In Ireland almost all stations reported their driest October in five to 12 years and also Estonia had its driest October since 1961. In contrast, south-eastern Europe the relative precipitation anomalies were partly above 250%. In mid-October, heavy rain in Bosnia-Herzegovina led to flooding in Mostar and Stolac city (WMO 2015).

In **November 2015** most of northern Europe received above normal precipitation. In Norway total precipitation of more than 700 mm/month was measured. Southern Europe showed a precipitation deficit below 40%, especially central and northern Italy as well as the western Balkan, Iberia and Turkey. Austria received only 50% of the precipitation amount, at some places even 2%.

In **December 2015** the precipitation pattern over Europe was divided in two parts of opposite precipitation anomalies.. The very dry part was extended from the Mediterranean to France, Germany, Poland and Ukraine with less than 20% precipitation. Austria noted its second driest December since 1858; Hungary its 3rd driest since 1901 The wetter part encompassed UK, Ireland, northern Greenland, Denmark, Norway, Finland, southeastern Caucasus and Russia with anomalies of more than 150%. In Ireland most stations across the country reported 2-3 times of their normal rainfall for December. Wettest conditions were in county Cork where nearly all stations measured more than 300% of normal. Roche's Point reported the highest percentage of average with 342 % (340.6 mm), and its highest measured value at this station for December since 1955. In Norway the monthly precipitation was 165% of its normal. It was the 4th wettest December since 1900. Some stations in southern and western Norway measured between 300% and 400% of normal precipitation.

Extreme precipitation and floods in northern UK in December 2015

December was a record-breaking month in the UK, dominated by unseasonably mild and moist tropical maritime air masses and a marked absence of frost, particularly in the south. Frequent deep depressions and frontal systems - including storms Desmond, Eva and Frank - brought strong winds and heavy rain to the north at regular intervals. In detail they brought record-breaking rainfall over much of Scotland, Wales and northern England. Severe flooding affected Cumbria for much of December, and became widespread across North Wales, northern England and Scotland after Christmas. With 198% of average rainfall, it was the wettest December, and calendar month, in the UK series. Rainfall reached 2 to 4 times the average in the west and north. 341.4 mm fell at Honister Pass (Cumbria) in 24 h on the 5th, a new UK record for any 24-hours. In fact of the storms and the high precipitation fallen trees and power cables leading to power cuts. Record-breaking rainfall totals brought widespread flooding of roads and rail routes, several bridges were washed away and many properties were flooded. In January, the Association of British Insurers (ABI) estimated the final bill for the flood damage caused by storms Desmond, Eva and Frank to homes, businesses and motor vehicles to be £1.3 billion.

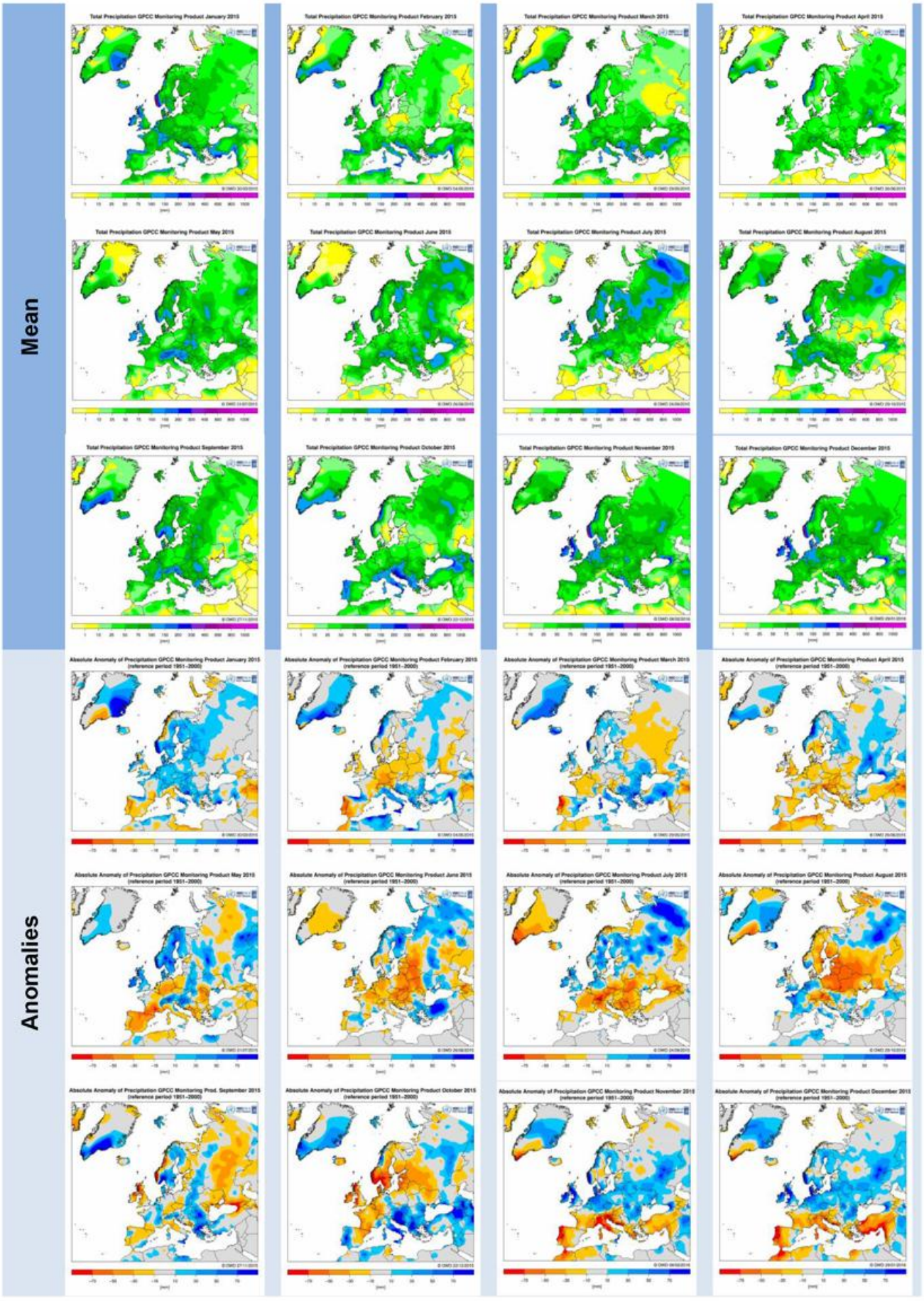


Figure 4.7: Mean and anomalies of precipitation (in mm/month) for each month of the year 2015. (First column January, February, March, April)

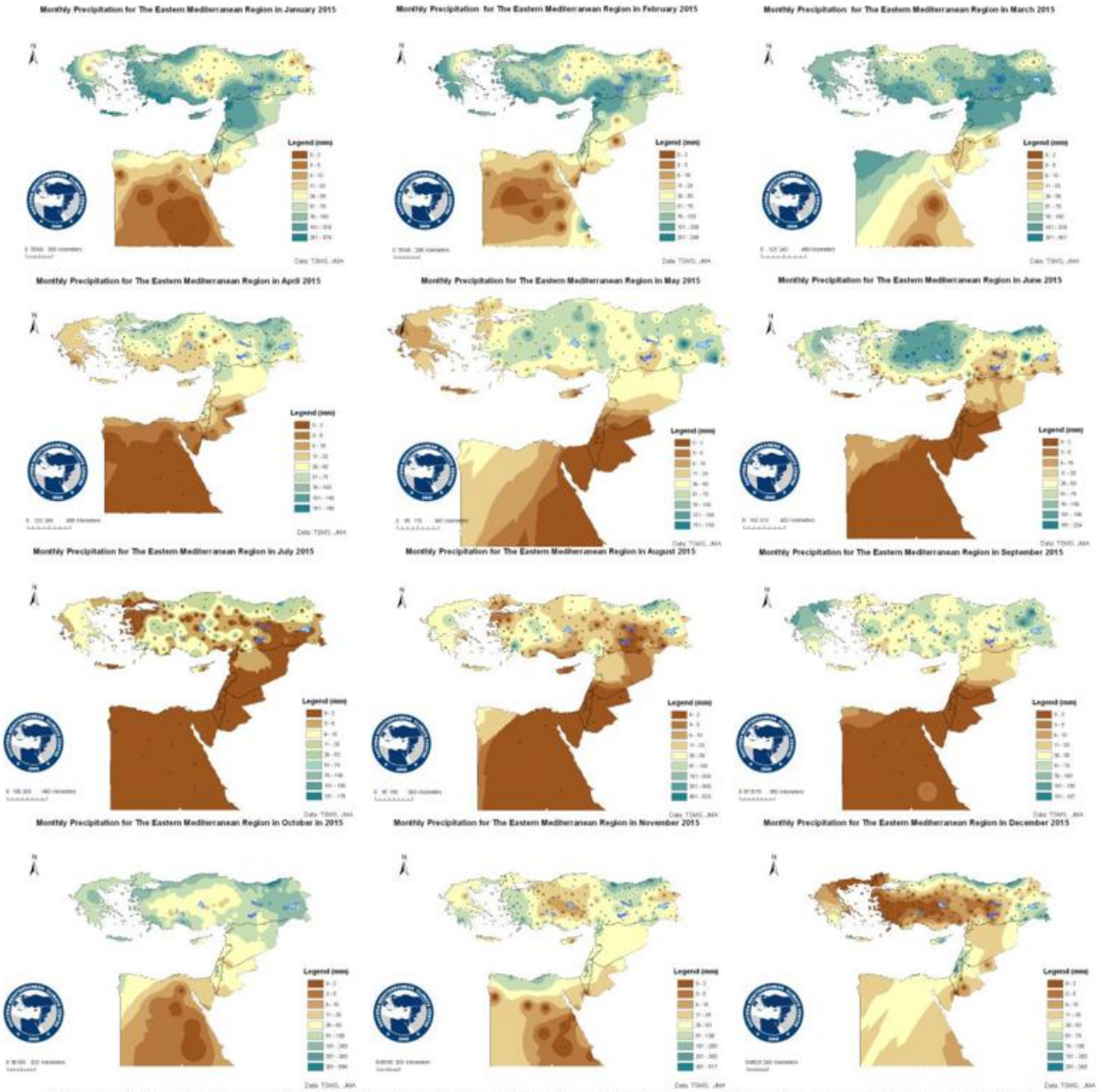


Figure 4.8: Monthly precipitation totals (mm) for the Eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC).

4.4. Sunshine duration

In **January 2015** most of central, eastern and northern Europe had lower than normal sunshine. The Mediterranean from Iberia to Turkey showed positive anomalies of the sunshine duration with values of more than 150% in Spain, Sardinia and Romania. In the United Kingdom the sunshine was well above normal in most places, especially eastern areas, and the UK received 126% of average sunshine hours. It was the UK's equal- 5th sunniest January in a series from 1929.

In **February 2015** more sunshine than normal showed central Europe with a maximum of more than +50% an area at the border between Germany and Poland. Austria reported at station Hohenau an der March (Hohenau upon March) a surplus of +44% while in the south-western part of Austria stations showed a deficit of -30% to -37%.

March 2015 was characterised by positive anomalies of sunshine duration over a large part of Europe except southern France and south- eastern Europa. South-western France had a deficit below 50% of normal and a surplus of 30% in the north-west. On 20 March 2015 there was a partial solar eclipse.

In **April 2015** the prevailed high pressure over western Europe determined positive anomalies of sunshine duration covered the western part of Region VI. UK received 143% of the average sunshine hours; that was the sunniest April since 1929. Germany received 134% of the normal sunshine hours. The north-eastern part of Europe had less sunshine than normal.

In **May 2015** positive anomalies of sunshine duration - accompanied by warmer and drier condition - covered mainly the eastern part of Region VI. For example, the highest reported sum of sunshine duration in Portugal was approximately 360 hours that is somewhat below the maximum value of northern Russian with 370 hours.

In **June 2015** the dry air from Africa induced positive sunshine anomalies in southwest and central Europe while Scandinavia and east Mediterranean obtained less sunshine than normal.

In **July 2015** southern and central Europe received more sunshine while northern (except Norway) and western Europe registered less than the average. The highest reported sum of sunshine duration in Greece was 418 hours.

In **August 2015** the high pressure over Scandinavia resulted in above normal sunshine duration over most of Scandinavia, the Baltic States, Poland and north-western Russia with values of more than 50% or 100 hours. This caused also above normal temperature and precipitation deficit in this region. For Stockholm results show that the current sunshine duration was only one hour below the record from 1955.

In **September 2015** in most parts of Europe the sunshine duration was below normal except the United Kingdom, Spain, western France, Poland, Scandinavia, east Ukraine and west Russia. In Wales obtained 170.2 hours or 137% of the 1961-1990 averages and West-Scotland 144.3 hours or 142% of the normal. In western Poland shone the sun more than 190 hours 60 hours (+25%) longer compared to the long term mean (1961-1990). Southern Sweden was also sunnier than normal with 235 hours at station Hoburg.

In **October 2015** the high pressure over Scandinavia together with the subsidence caused lower cloud amounts and more sunshine. This weather situation resulted in relative anomalies of more than 150% in Sweden and Finland. Sweden reported new records of sunshine duration for several stations like Umeå (162 h or 172%).These positive anomalies extended to the Black Sea, while the rest of Europe received less sunshine than normal in conjunction with above normal precipitation.

In **November 2015** most of southern Europe showed above normal sunshine. The Balkan received locally more than 150% of sunshine. In Austria it was the sunniest November since the nationwide sunshine measurements began in 1925.

In **December 2015** most parts of Europe recorded positive anomalies between 105% and more than 150% of normal sunshine duration. In Austria it was the sunniest December on record with 190% of normal. The station Villacher Alpe measured 233 h, which was 76% more than normal. Germany noted its second sunniest December on record since 1951. There were many other European countries which measured a record December. Sunshine deficit reported Ireland, UK, western Greenland, Portugal, parts of Spain, some places in the Mediterranean region, Denmark, and Hungary. Western Romania had a sunshine duration below 95%, parts of Russia and Finland actually below 25%.

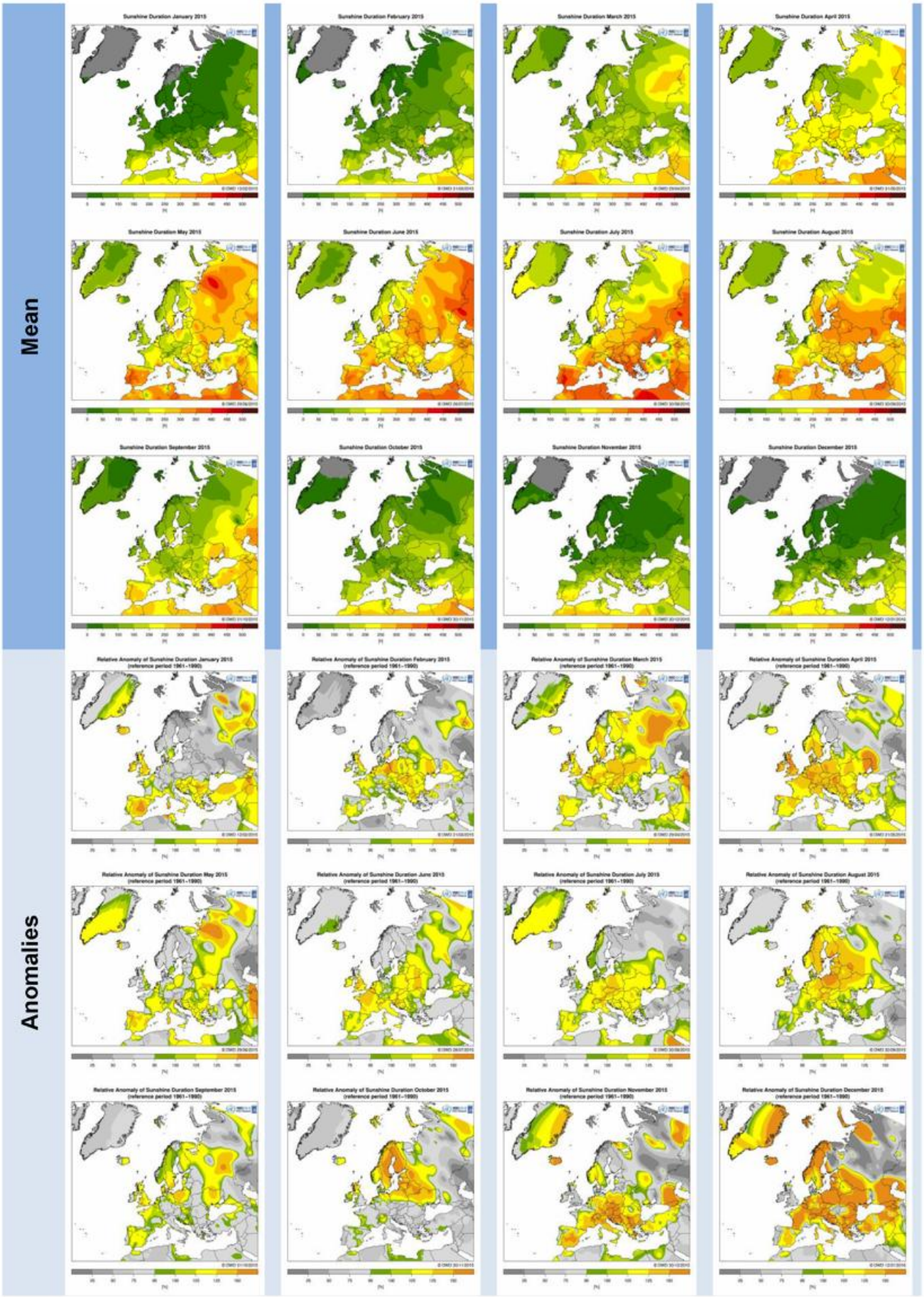


Figure 4.9: Mean of sunshine duration (in hours) and relative anomalies (in %) for each month of the year 2015. (First column January, February, March, April)

4.5. Maps of monthly climate extremes and events

The following maps are based on different data (as noted the legend in parentheses) and should summarize the weather conditions in each month of the year 2015.

From **January to March** 2015 in northern and eastern Europe the monthly temperature were 4°C warmer than normal and also the number of warm days were above normal. The areas at the Norwegian and Greenland coasts were affected by strong wind gusts. In **February** the Iberian and France had more colder days than normal.

In nearly whole Europe **April** had more warmer days than normal.

In **May** and **June** northern, central, western and southern Europe was wet and warm but had also a few colder days than normal.

In **July** it became warmer and dryer than normal in the south part of Europe while Scandinavia and the UK had more wetter and colder days as usual.

Whole Europe had more warm and wet days in **August** with anomalies above 4°C in Balkan, Poland and Ukraine.

In **September** western Europe was affected by more cold days while central and northern Europe showed again higher number of wet and warm days.

Central Europe showed in **October** more cold days than usual. The Balkan and southern Europe noted a higher number of very wet and sometimes warm days. While northern Europe had more warm days than normal with strong wind gusts at the Atlantic coast.

During **November** most parts of Europe showed a higher number of warm and wet days. Norway, the UK, Denmark, the Bretagne and in the Gulf of Lions were affected by strong wind gusts in November.

The **December** showed in whole Europe again more warm days than normal, but northern Europe was wetter and southern Europe dryer than normal. There were also strong wind gusts in Scandinavia, the UK and Greenland.

The Monthly Event Map contains information about the extreme anomalies of temperature, precipitation and wind gusts. Points are calculated from station data and represent the number of very warm or cold days, the locations of strong wind gusts (>=32 m/s) and days with precipitation. If more than one extreme anomaly occurs at the same location, the point is subdivided into several different colours. Coloured areas are based on interpolated gridded data for temperature (land and ocean) and precipitation (only land areas). If more than one extreme anomaly occurs at the same grid, the area is shaded.

Legend of Figure 4.10:

- Anomaly of very wet days > 0 (ECAD)
- Wind gusts (≥ 32 m/s) (SYNOP)
- Anomaly of warm days > 0 (ECAD)
- Anomaly of cold days > 0 (ECAD)
- Anomaly of TG ≤ -4K (CLIMAT and ship obs.)
- Anomaly of TG ≥ 4K (CLIMAT and ship obs.)
- Aridity index < -1.5 modified SPI (GPCC)
- RR ≥ 150% of climatology (GPCC)

Based on climatology 1961-1990 (GPCC climatology: 1951-2000)

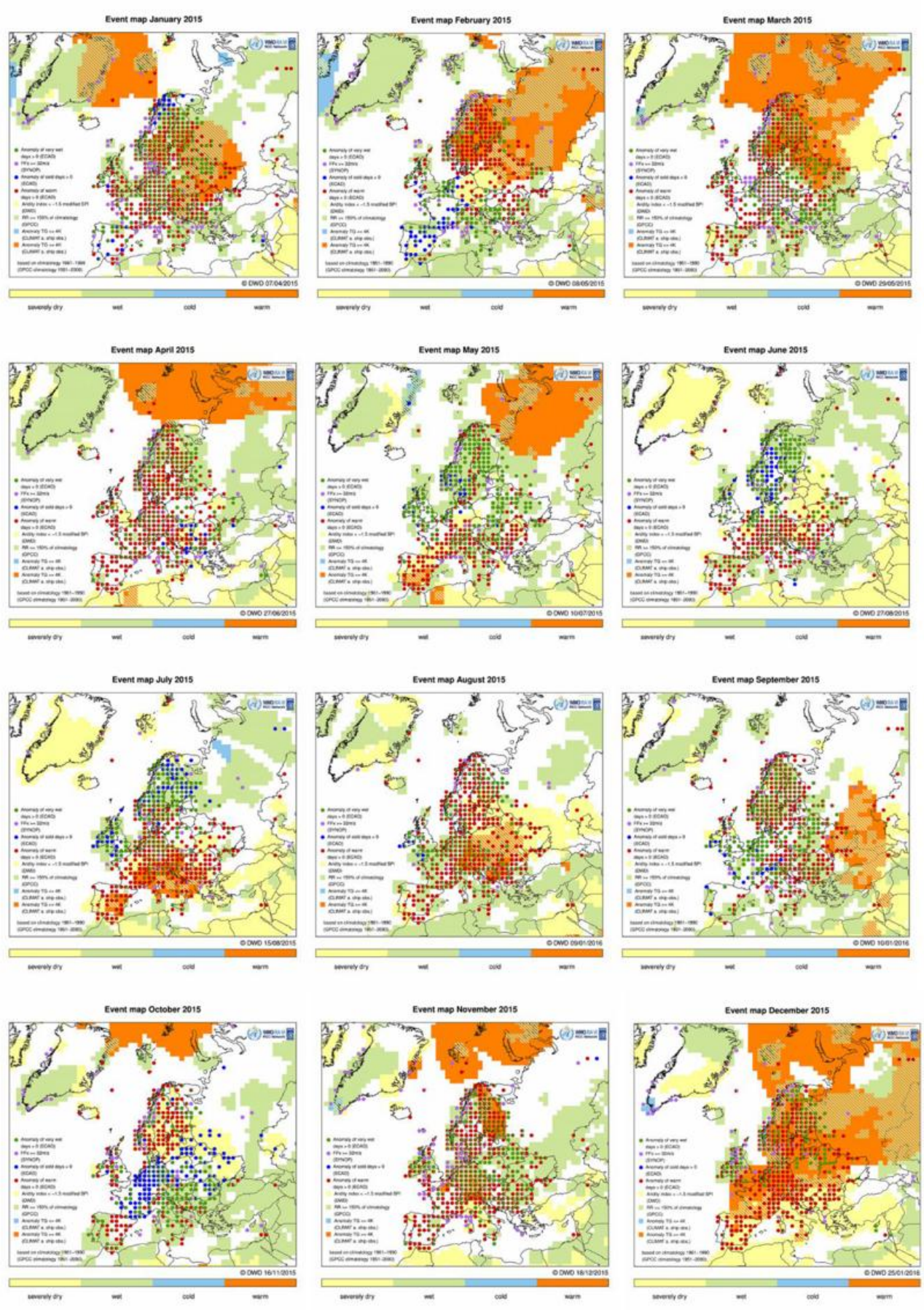


Figure 4.10: Maps of Climate Extremes for each month of the year 2015.

5. Long-term variability of the selected climate parameters - Regional examples

On the following pages graphs of long time series of temperature, precipitation and sunshine duration as provided by the national meteorological services (NMHSs) are presented to give an overview of the temporal development of the basic climate elements. The graphs are grouped with respect to the 6 sub-regions defined above (Figure 1.1). An overview about the contributed countries, the time series lengths and the area representativeness can be found in Table 5.1. Most are temperature time series. Each sub-region is at least represented by one country. Time series of precipitation totals are fewer but each sub-region is represented with at least one time series for precipitation. Diagrams of long-term annual sums of sunshine duration are provided by 4 countries and they belong to different sub-regions.

After this, we present examples of the temporal development of other temperature related phenomena, such as the sea surface temperature in the North Sea and sea level anomalies at the Polish station Władysławowo.

Table 5.1: Availability of the long-term records of temperature, precipitation and sunshine duration from some participant countries.

Sub-region	Country	Temperature		Precipitation		Sunshine Duration	
		Spatial Mean	Single Station	Spatial Mean	Single Station	Spatial Mean	Single Station
Central and Western Europe	Austria	1768					
	Belgium		1833				
	France	1900					
	Germany	1881		1881		1951	
	Hungary	1901		1901			
	Luxembourg	1947					
	Netherlands	1910					
	Poland	1951					
	Switzerland	1864		1864		1959	
	United Kingdom	1910		1910		1929	
Nordic and Baltic Countries	Denmark, Greenland, Faroer	1873		1874		1920	
	Estonia		1866		1866		1953
	Finland	1847			1900		
	Iceland		1871				
	Latvia	1924		1924			
	Lithuania	1961					
	Norway	1900		1900			
	Sweden	1860		1860			
Iberia	Portugal	1931		1931			
	Spain	1965					
Mediterranean, Italian and Balkan Peninsula	Bulgaria	1901					
	Croatia		1862				
	Italy	1961		1951			
	Slovenia		1951		1951		
	Turkey	1971		1971			
Eastern Europe	Belarus	1881		1891			
	Russia	1939		1966			
Middle East	Georgia	1961	1881	1961	1881		
	Israel	1951					
	Kazakhstan	1936					

5.1. Temperature

Central and Western Europe – annual temperature series

Austria, Belgium, France, Germany, Hungary, Luxembourg, the Netherlands, Poland, Switzerland

Austria

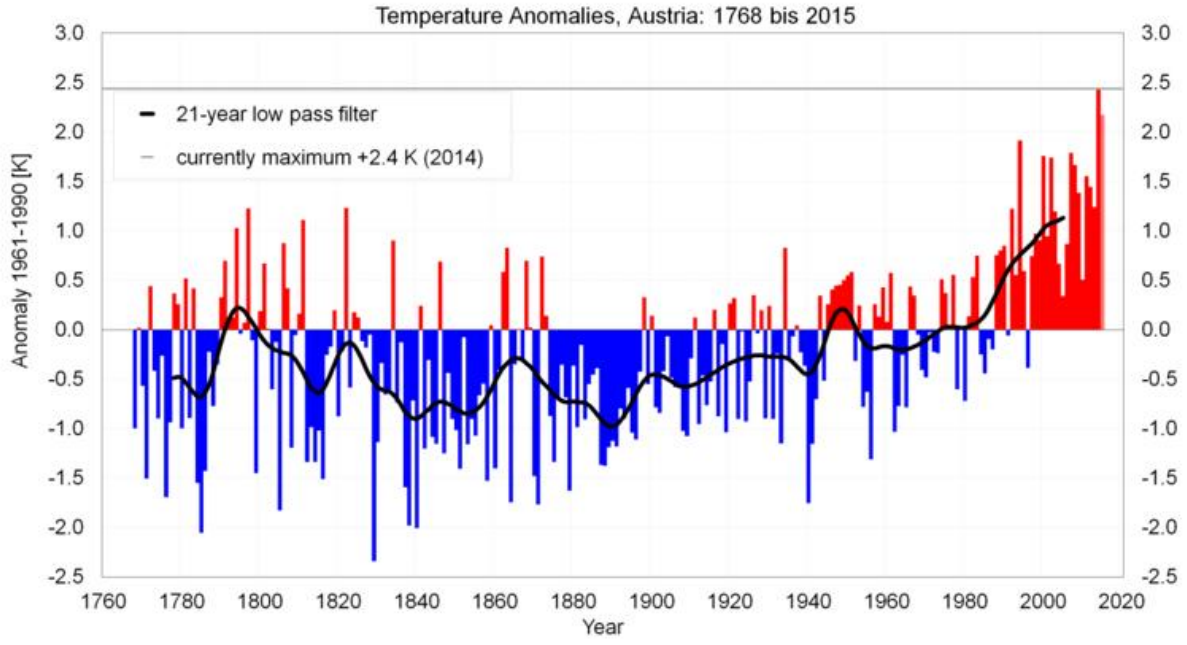


Figure 5.1: Time series of annual temperature anomalies for Austria (reference period 1961-1990, diagram as provided by the NHMS)

Belgium

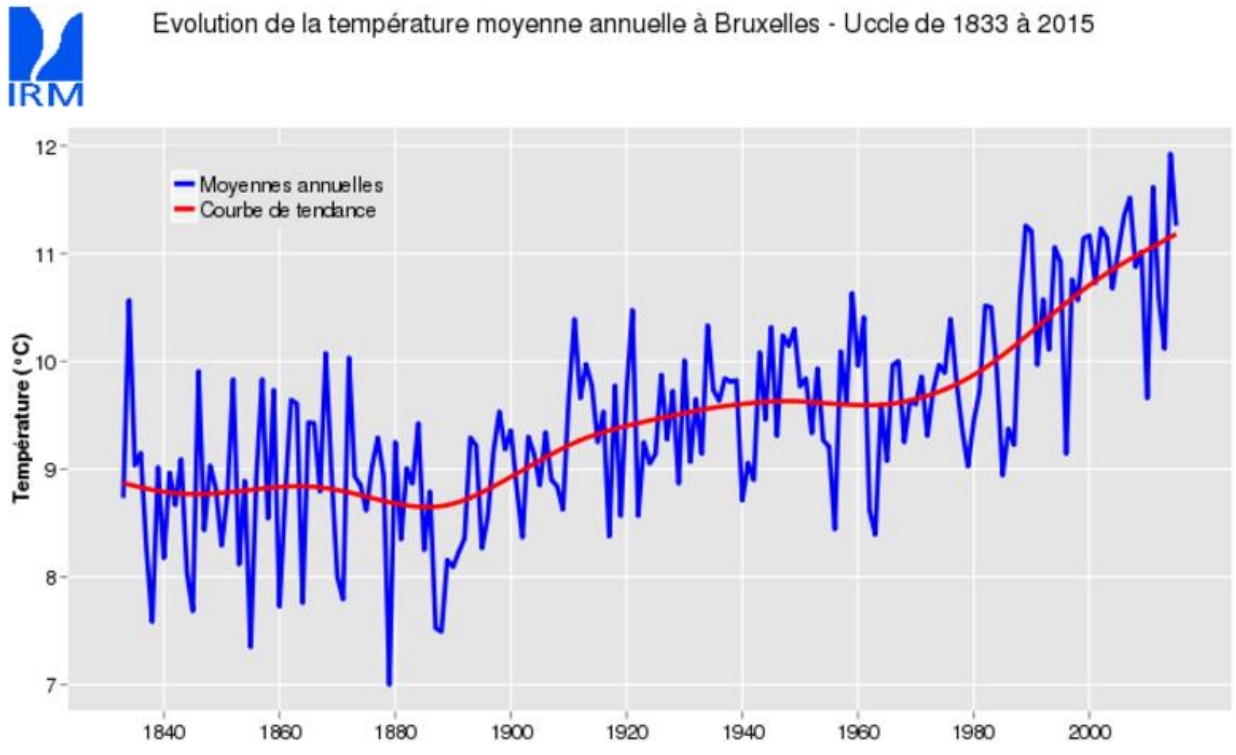


Figure 5.2: Time series of annual mean temperature for Uccle, Belgium (Diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

France

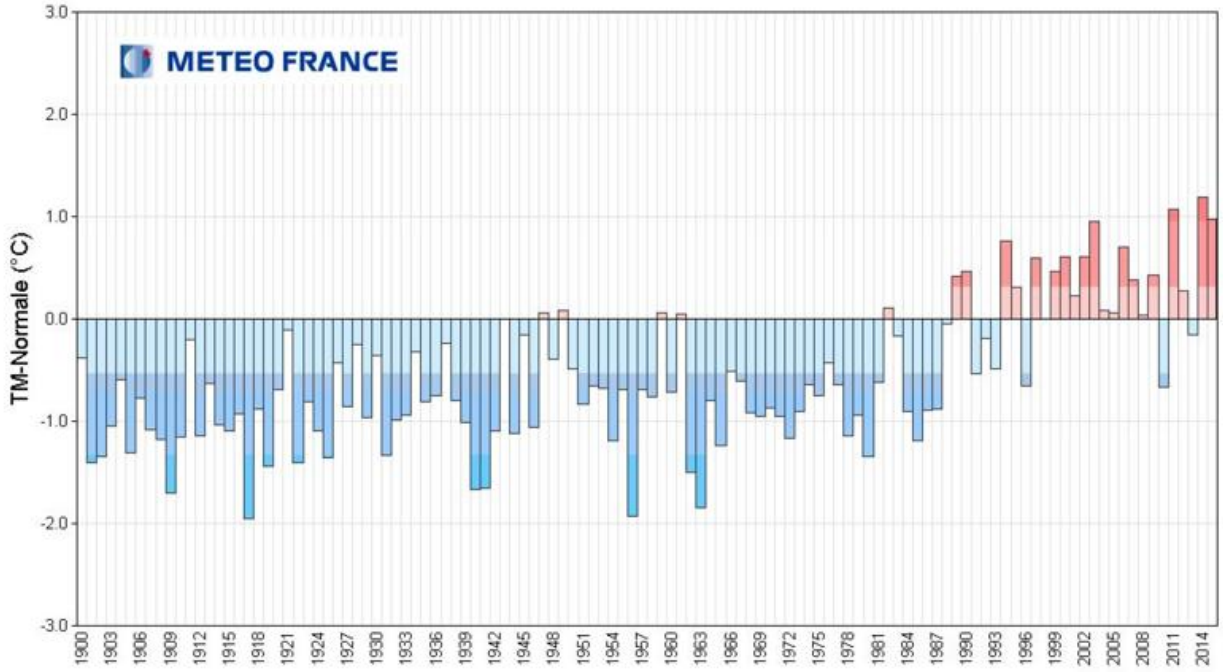


Figure 5.3: Time series of annual temperature anomalies for France for the period 1900-2015 (reference period 1981-2010; diagram as provided by the NHMS)

Germany

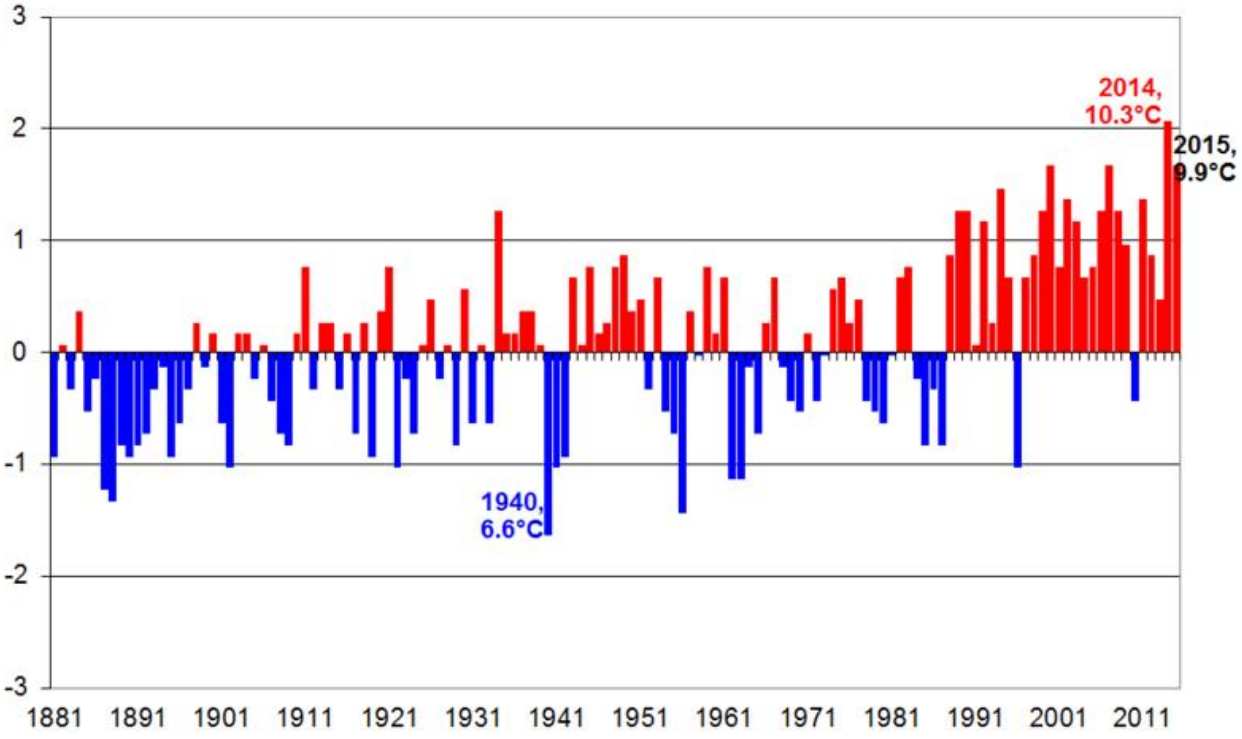


Figure 5.4: Time series of annual temperature anomalies for Germany for the period 1881-2015 (reference period 1961-1990, diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Hungary

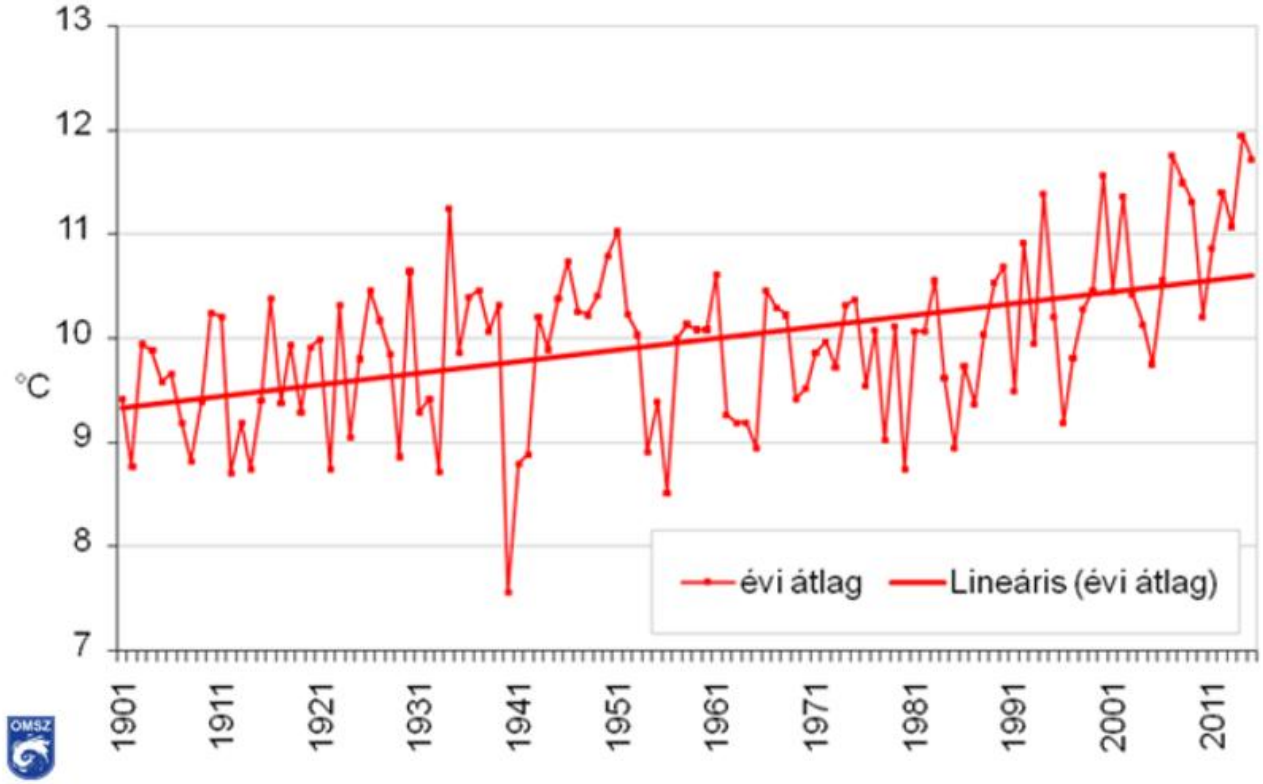


Figure 5.5: Time series of annual average temperature for the period 1901-2015 for Hungary (58 station based on data from homogenized, interpolated; Diagram as provided by the NHMS)

Luxembourg

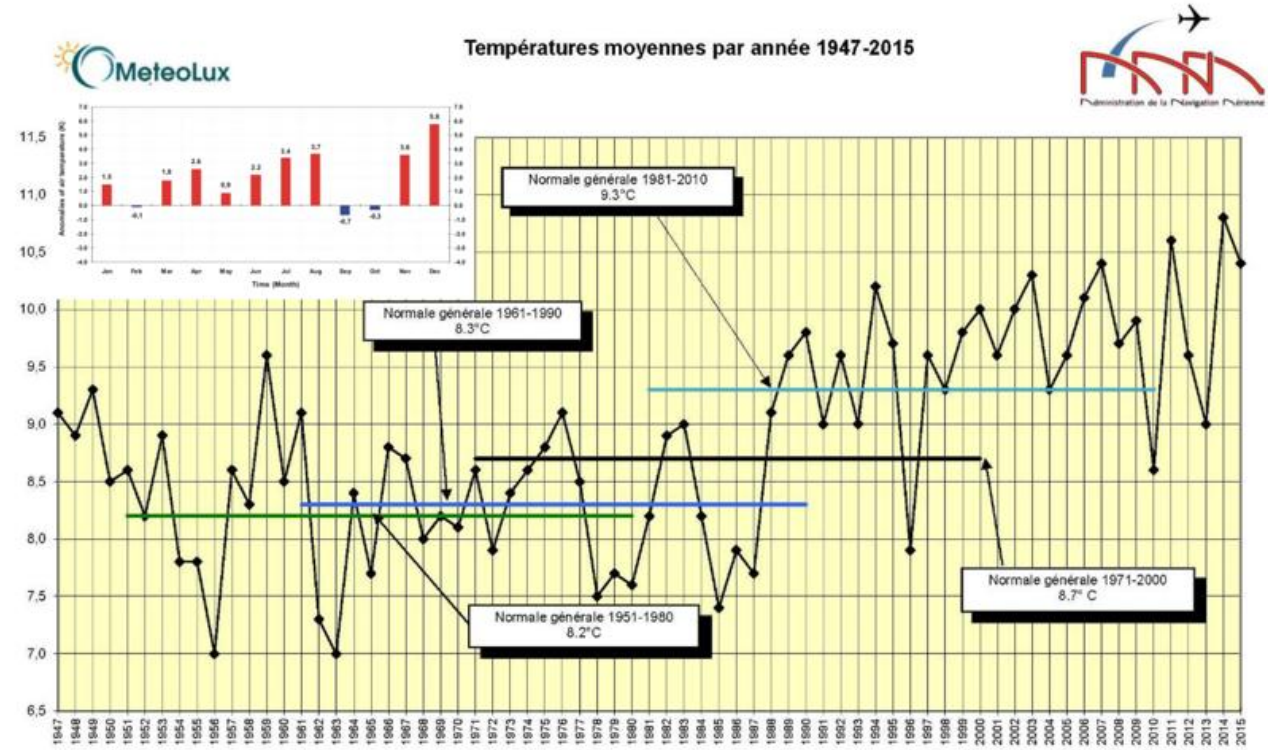


Figure 5.6: Time series of annual average temperature for the period 1947-2015 for Luxembourg (Diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

The Netherlands

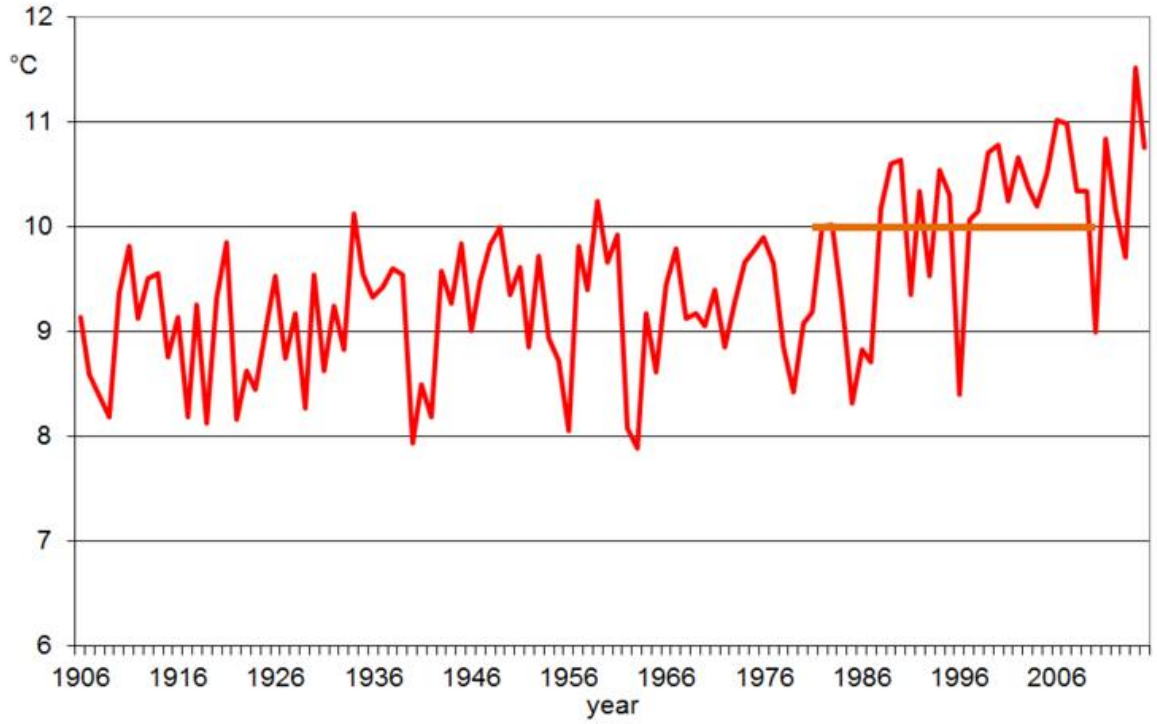


Figure 5.7: Time series of annual average temperature for the period 1906-2015 for the Netherlands (Central Netherlands Temperature v6, mean of 6 stations, data as provided by the NHMS)

Poland

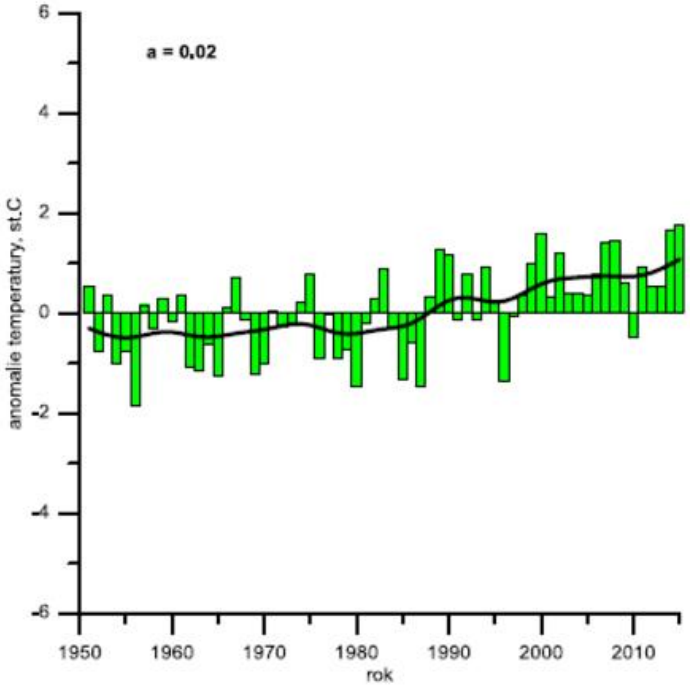


Figure 5.8: Time series of annual temperature anomalies for the period 1951-2015 for Poland (base period: 1971-2000; smoothed by 10-years Gaussian filter (black line) and the values of linear trend (°C/year; diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Switzerland

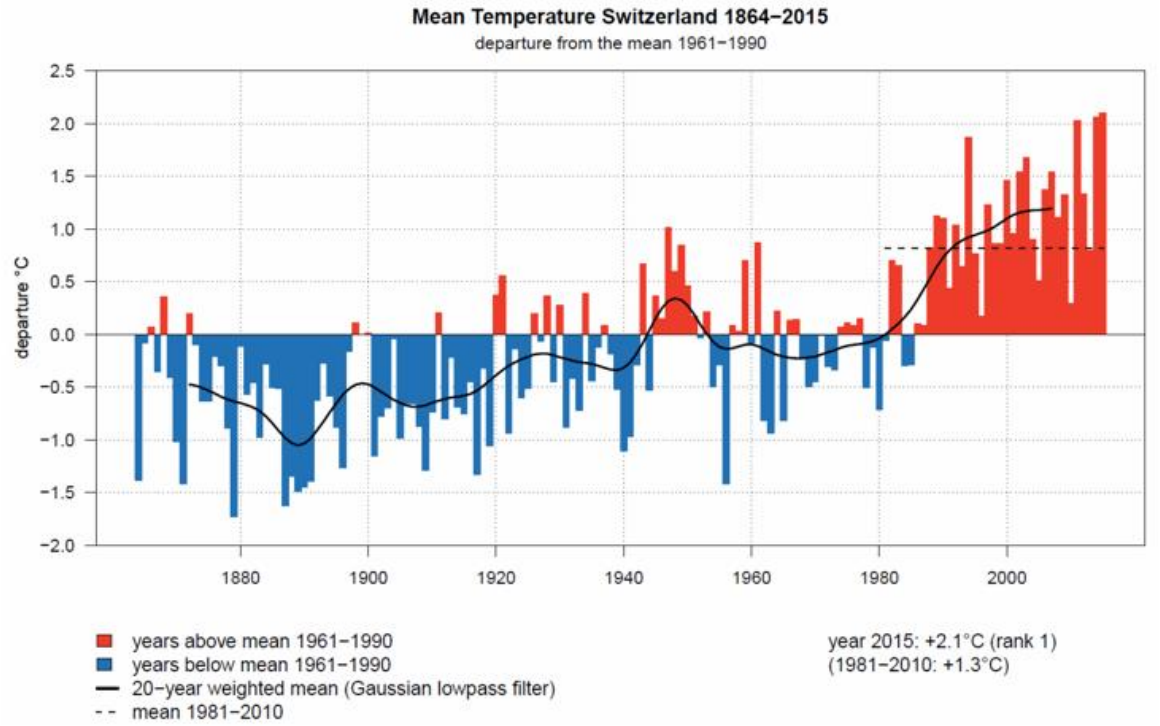


Figure 5.9: Time series of annual temperature anomalies for the period 1864-2015 for Switzerland (reference period 1961-1990, diagram as provided by the NHMS)

United Kingdom

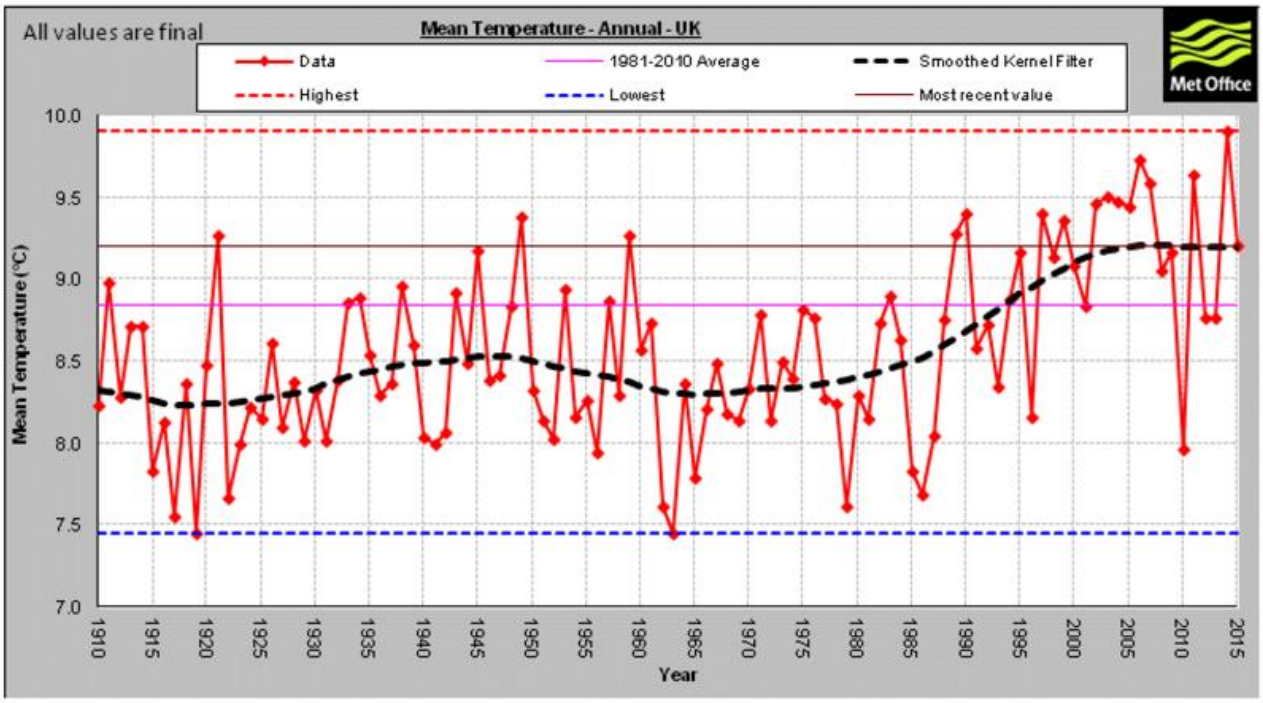
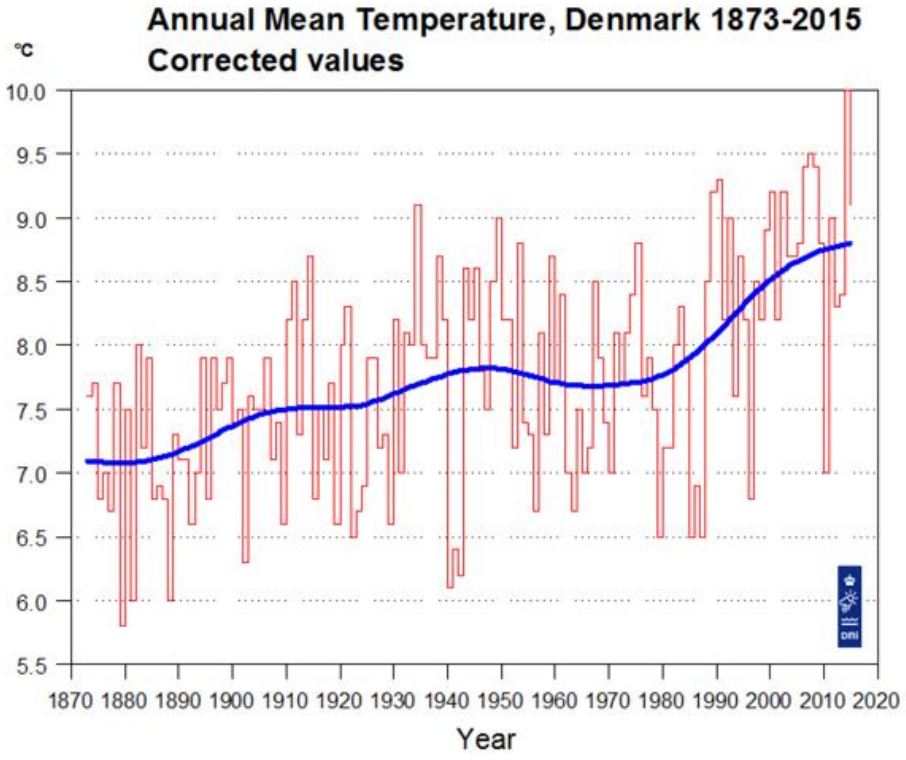


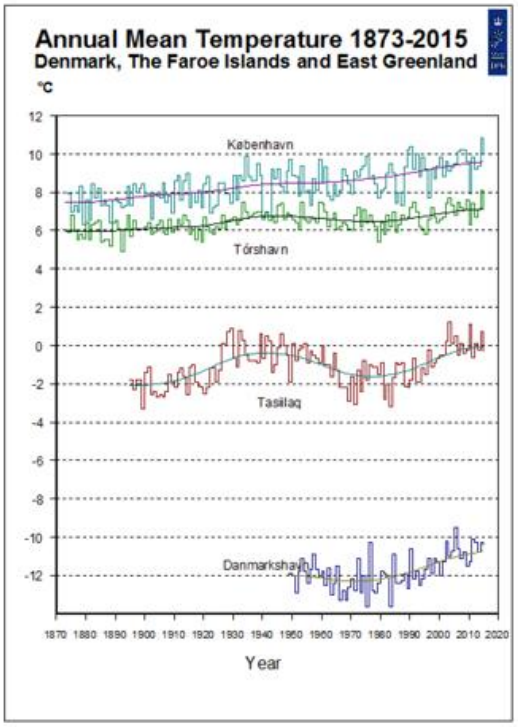
Figure 5.10: Time series of annual temperature for the period 1910-2015 for the United Kingdom (Diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden

Denmark, Greenland, the Faroe Islands





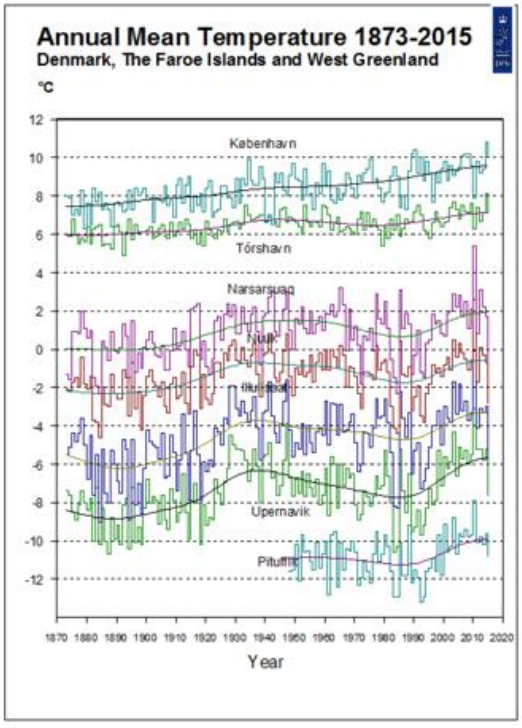


Figure 5.11: Time series of annual temperature for the period 1873-2015 for Denmark (top), the Faroe Islands and Greenland (bottom, diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Estonia

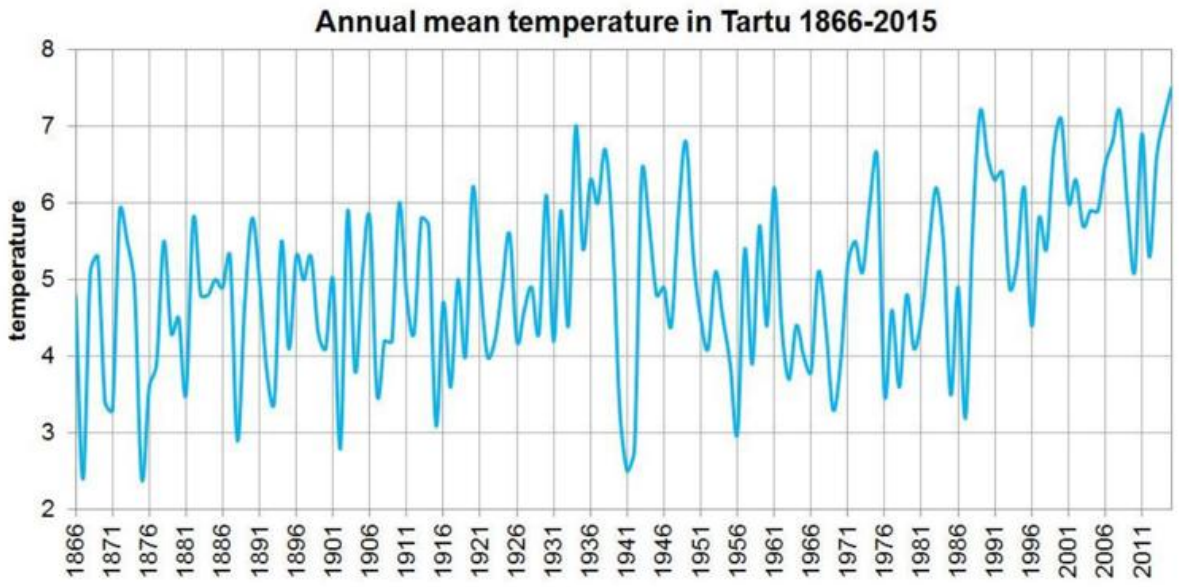


Figure 5.12: Time series of annual temperatures for the period 1866-2015 for station Tartu, Estonia (diagram as provided by the NHMS)

Finland

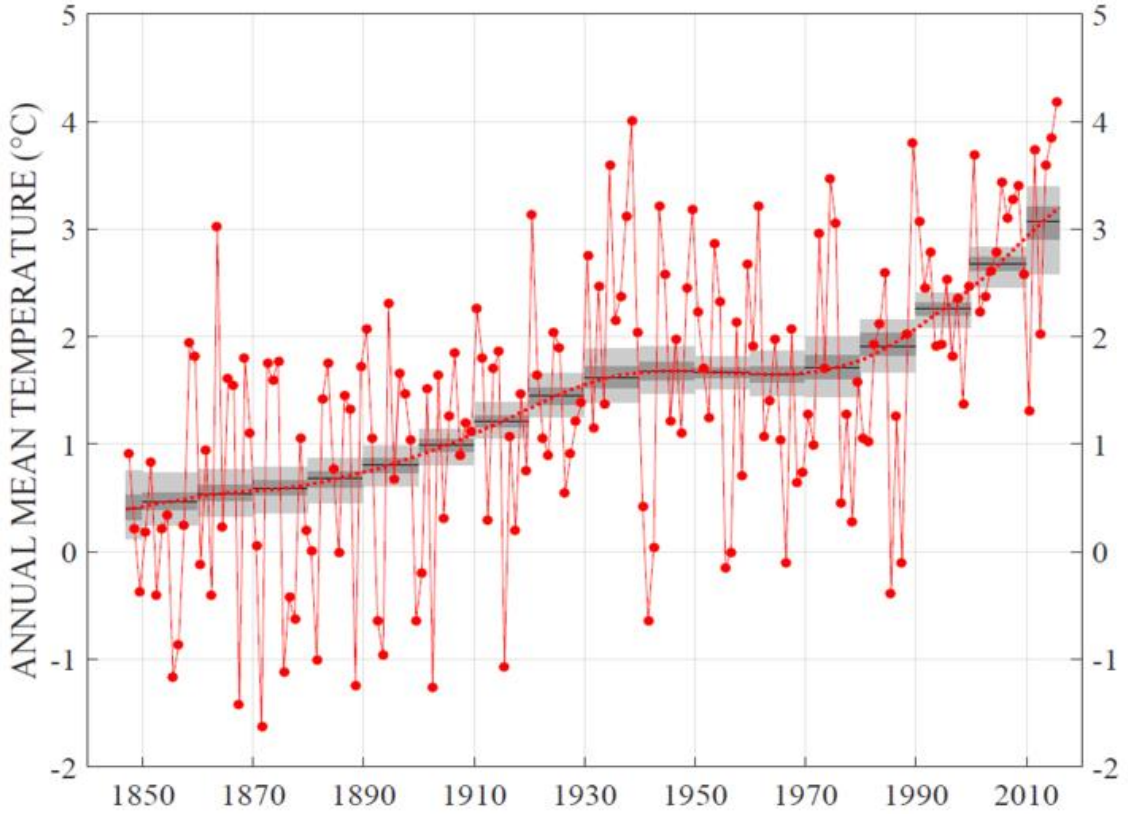


Figure 5.13: Time series of annual temperatures for the period 1848-2015 for Finland (in **red** and decadal averages (in black) with uncertainties in grey; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Iceland

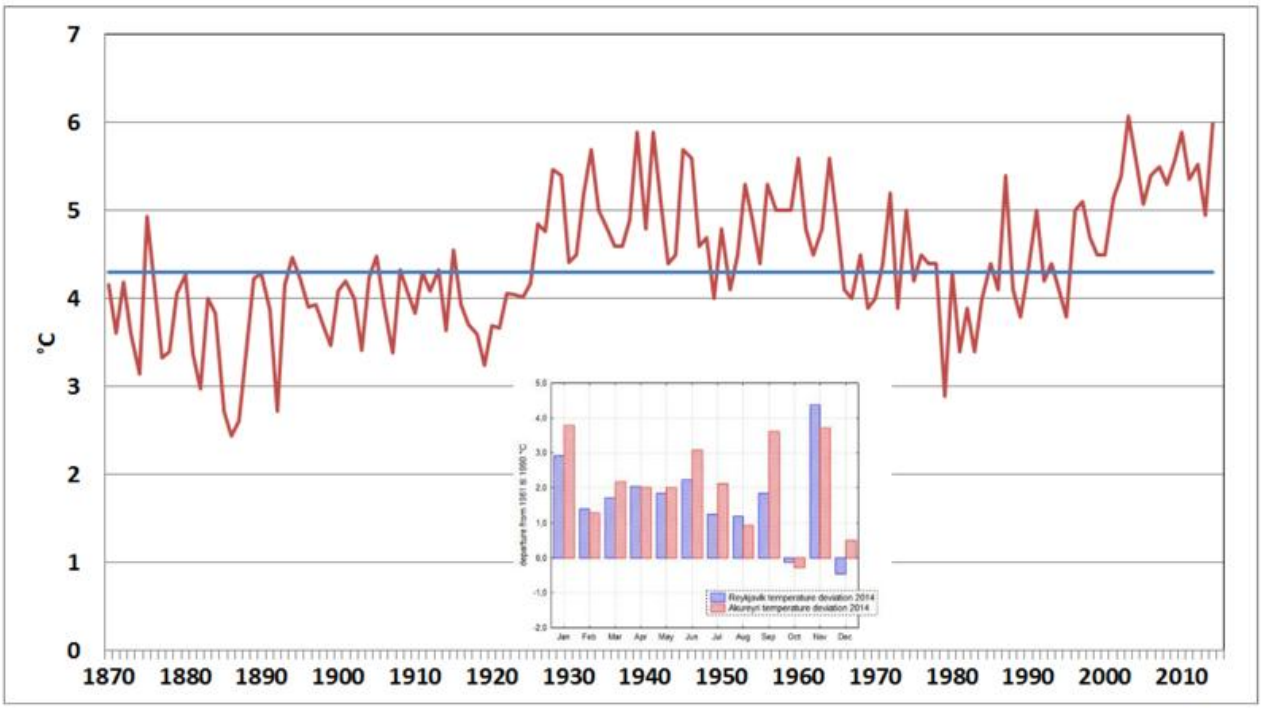


Figure 5.14: Time series of annual average temperature for the period 1870-2015 for station Reykjavík, Iceland (blue line: reference period 1961-1990; data as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Latvia

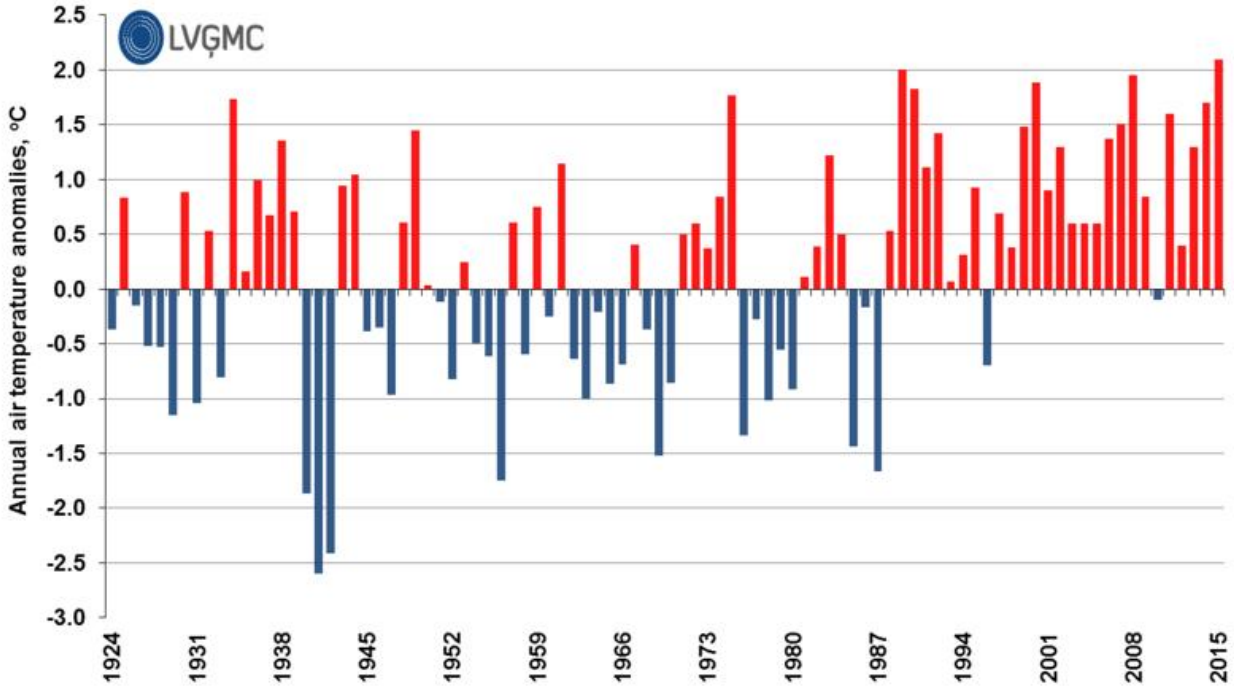


Figure 5.15: Time series of annual temperature anomalies for the period 1924-2015 for Latvia (reference period 1961-1990; diagram as provided by the NHMS)

Lithuania

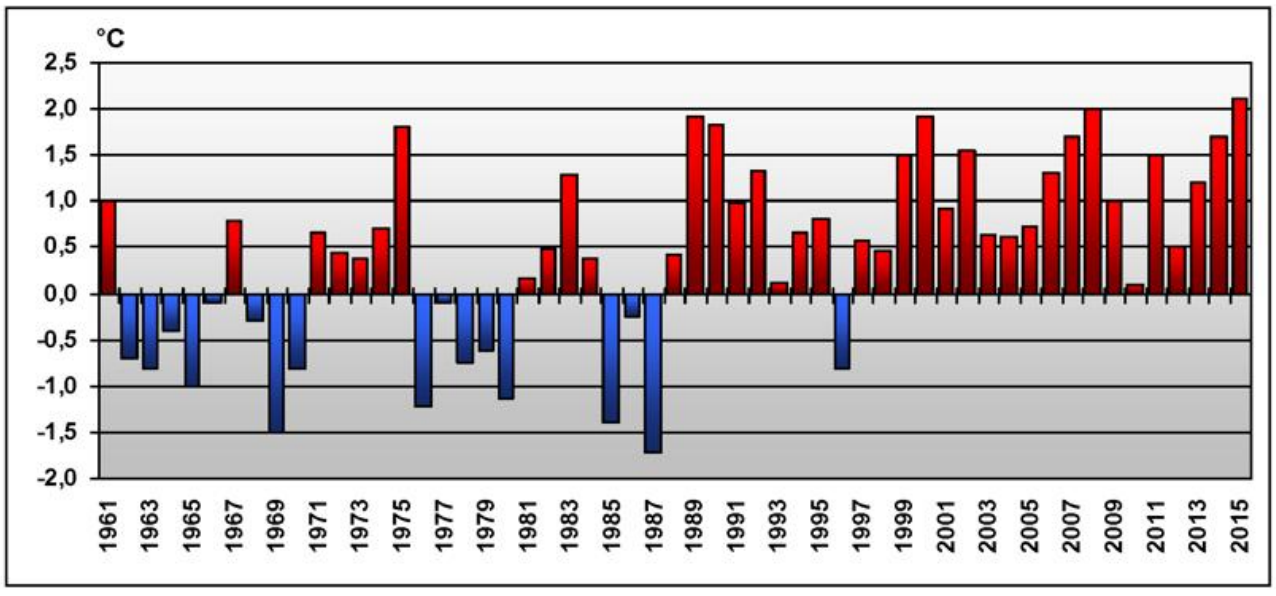


Figure 5.16: Time series of annual temperature anomalies for the period 1961-2015 for Lithuania (reference period 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Norway

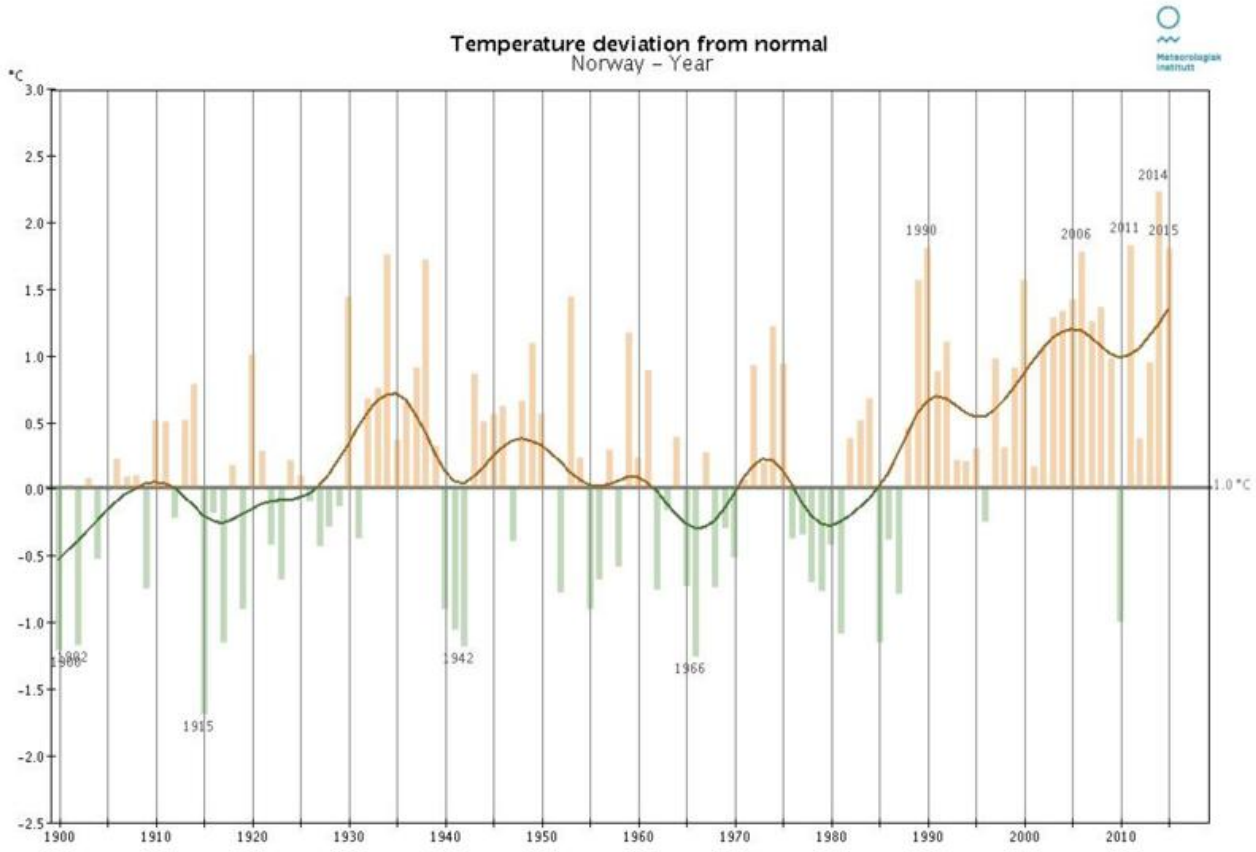


Figure 5.17: Time series of annual temperature anomalies for the period 1900-2015 for Norway (reference period 1961-1990; diagram as provided by the NHMS)

Sweden

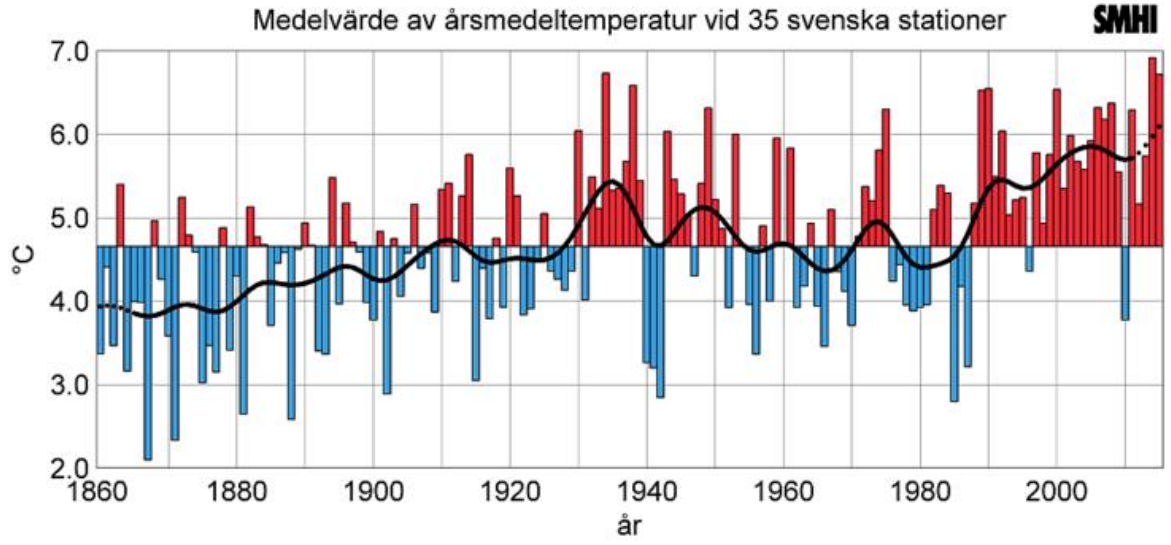


Figure 5.18: Time series of annual average temperature for the period 1900-2015 for Sweden (diagram as provided by the NHMS)

Iberia – annual temperature series

Portugal, Spain

Portugal

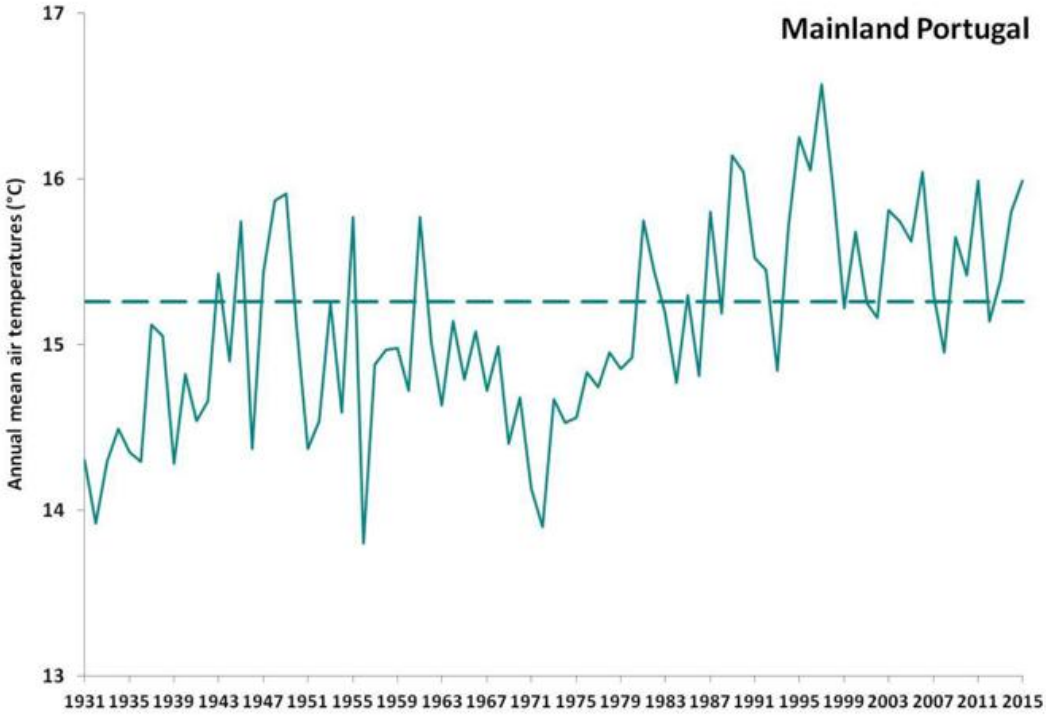


Figure 5.19: Time series of annual average temperature for the period 1931-2015 for Portugal (diagram as provided by the NHMS)

Spain

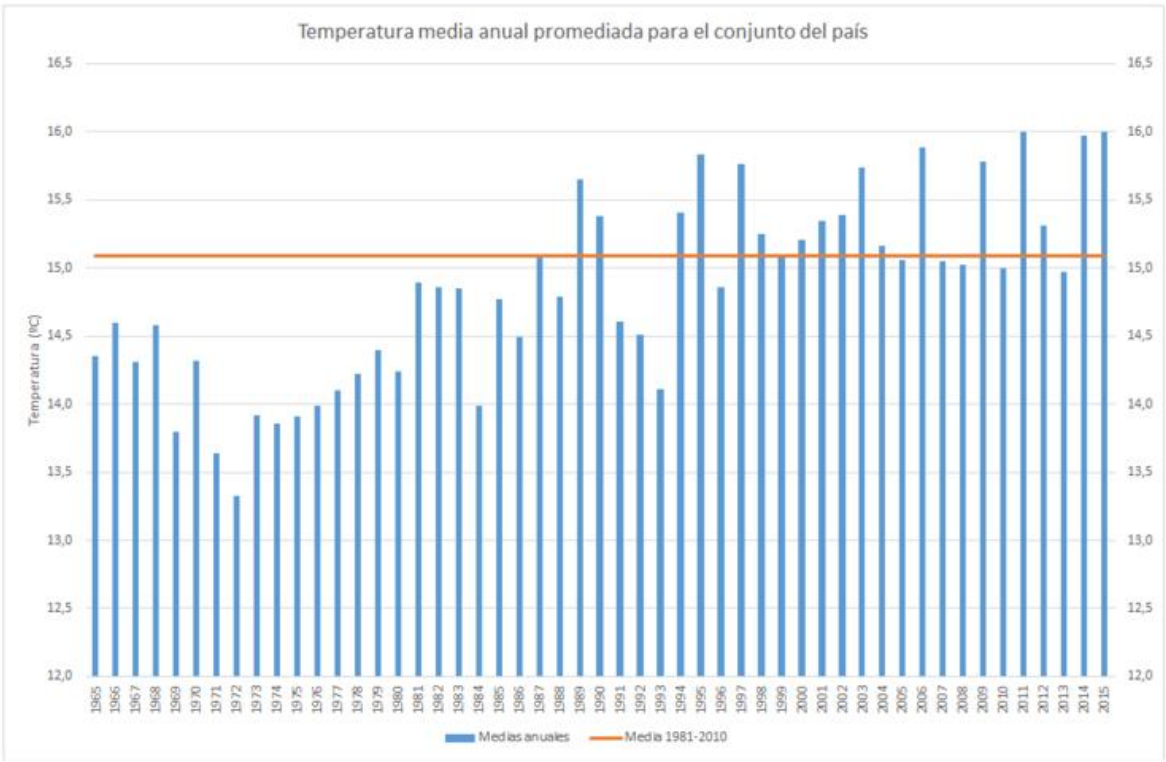


Figure 5.20: Time series of annual average temperature for the period 1965-2015 for Spain (diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Bulgaria, Croatia, Italy, Slovenia, Turkey

Bulgaria

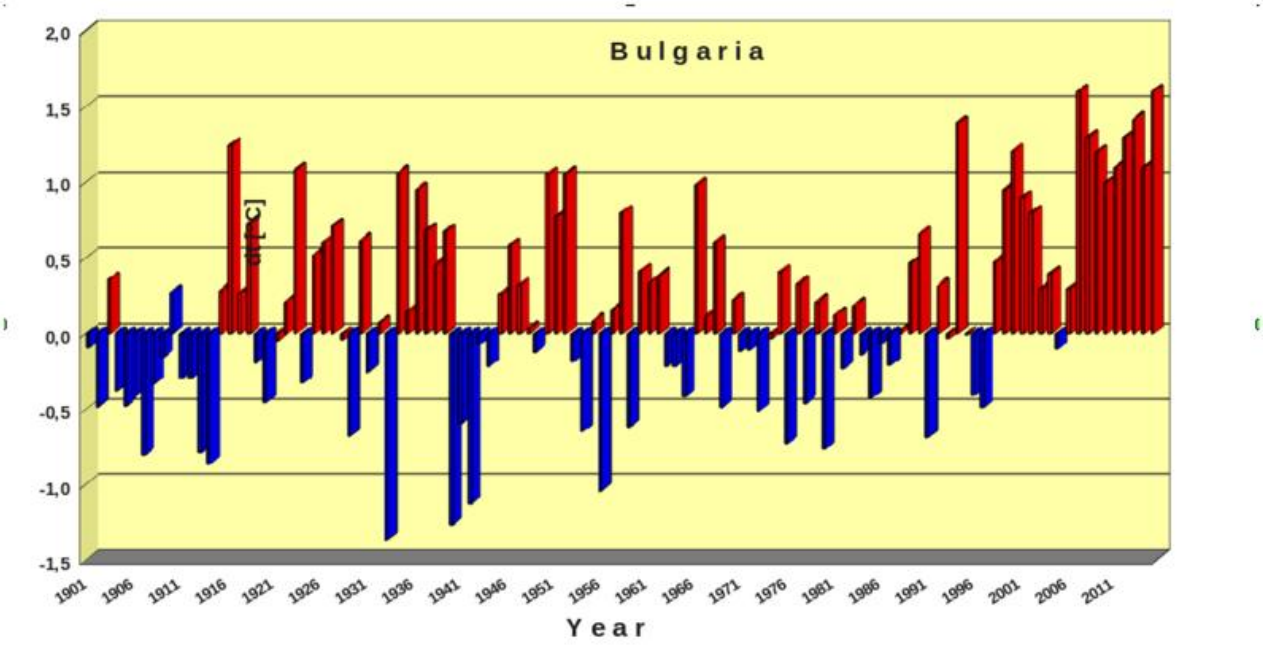


Figure 5.21: Time series of annual temperature anomalies for the period 1901-2015 for Bulgaria (reference period 1961-1990; diagram as provided by the NHMS)

Croatia

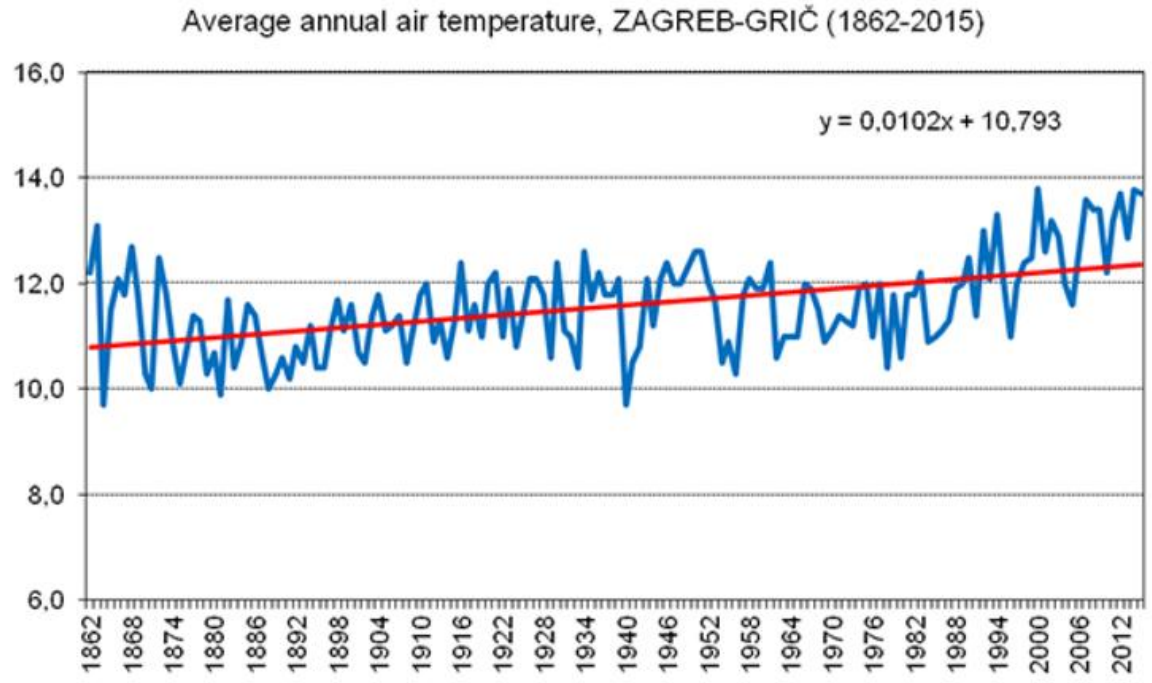


Figure 5.22: Time series of annual average temperature for Zagreb Grič (Croatia) for the period 1862-2015 (diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Italy

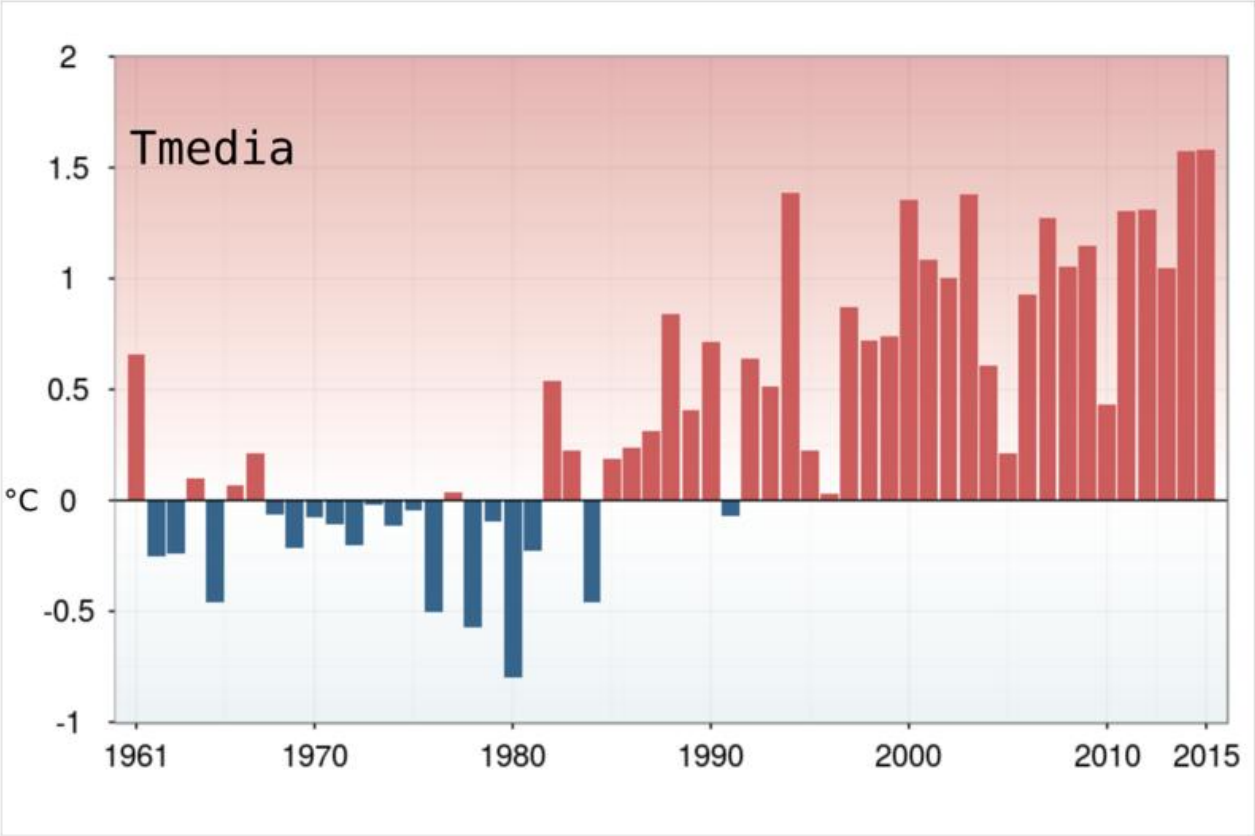


Figure 5.23: Time series of annual temperature anomalies for Italy for the period 1961-2015 (reference period 1961-1990; diagram as provided by the NHMS)

Slovenia

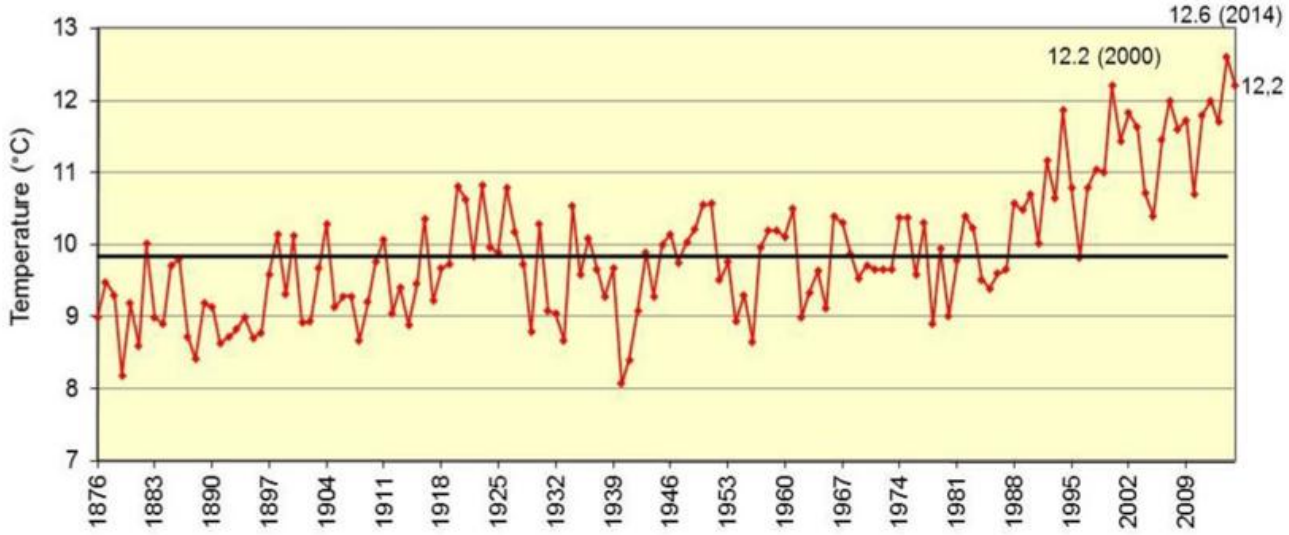


Figure 5.24: Time series of annual temperature anomalies for Ljubljana (Slovenia) for the period 1876-2015 (black line is the mean of the period 1961-1990; diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Turkey

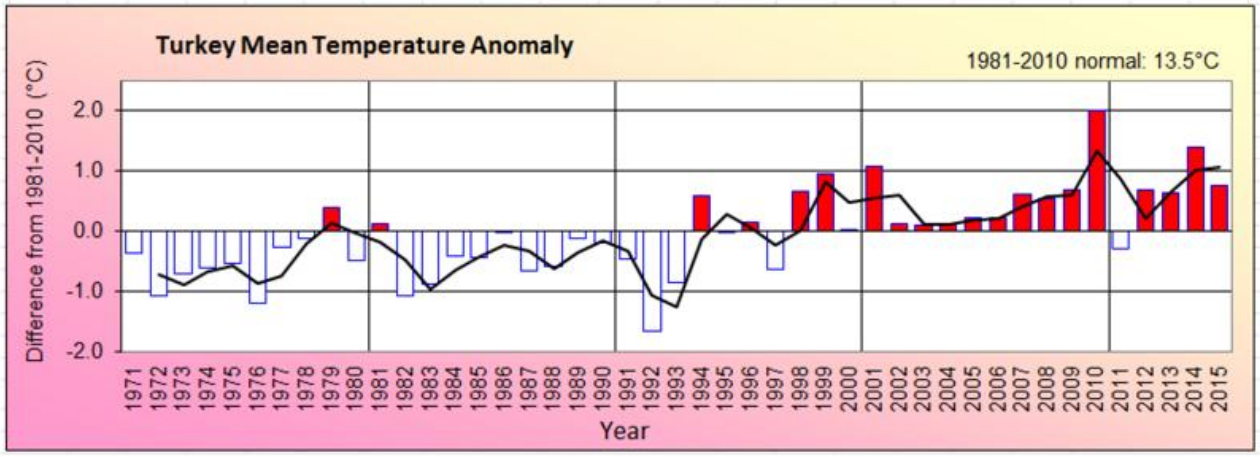


Figure 5.25: Time series of annual temperature anomalies for Turkey for the period 1971-2015 (reference period 1981-2010; diagram as provided by the NHMS)

Eastern Europe – annual temperature series

Belarus, Russia

Belarus

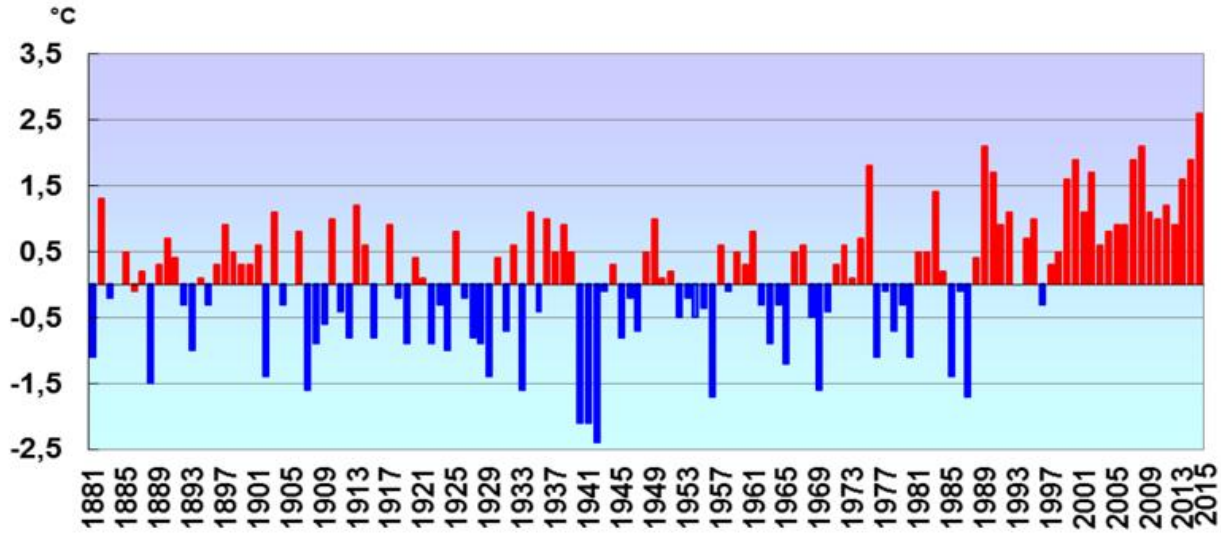


Figure 5.26: Time series of annual temperature anomalies for Belarus for the period 1881-2015 (reference period 1961-1990; diagram as provided by the NHMS)

European Russia

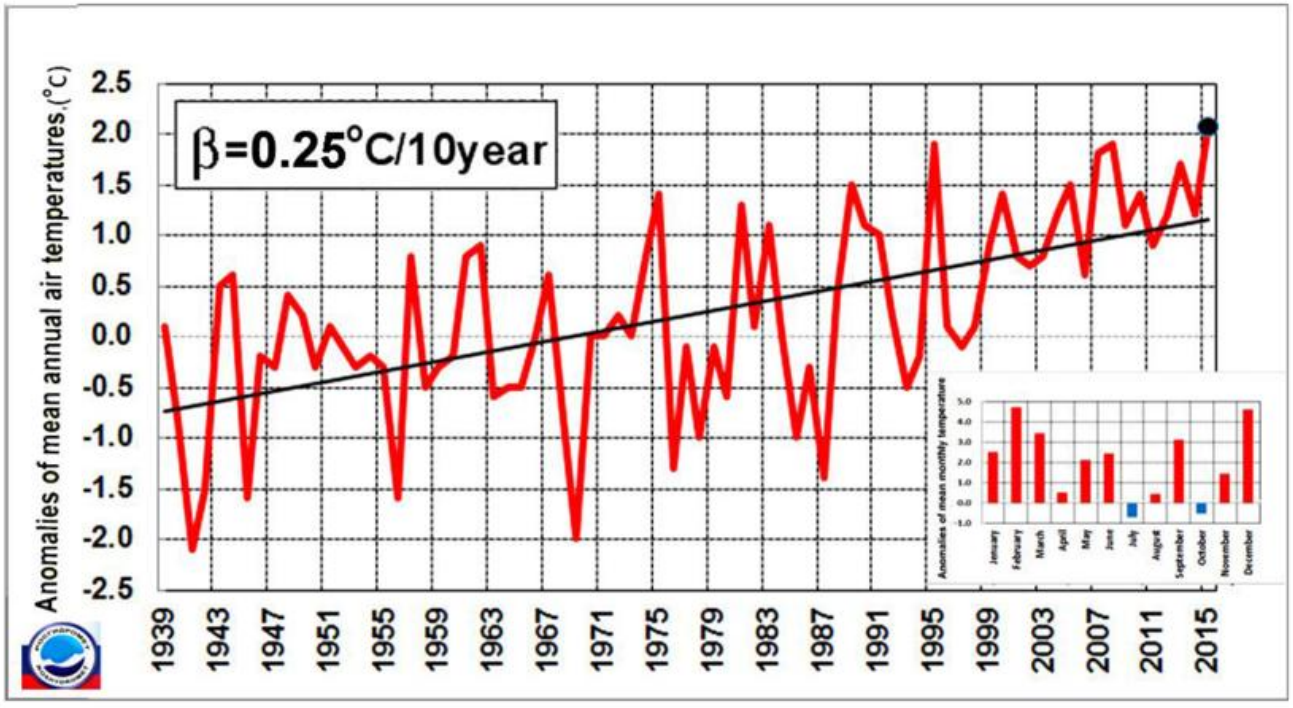


Figure 5.27: Time series of annual temperature anomalies for European Russia for the period 1939-2015 (reference period 1961-1990; diagram as provided by the NHMS)

Middle East – annual temperature series

Georgia, Israel, Kazakhstan

Georgia

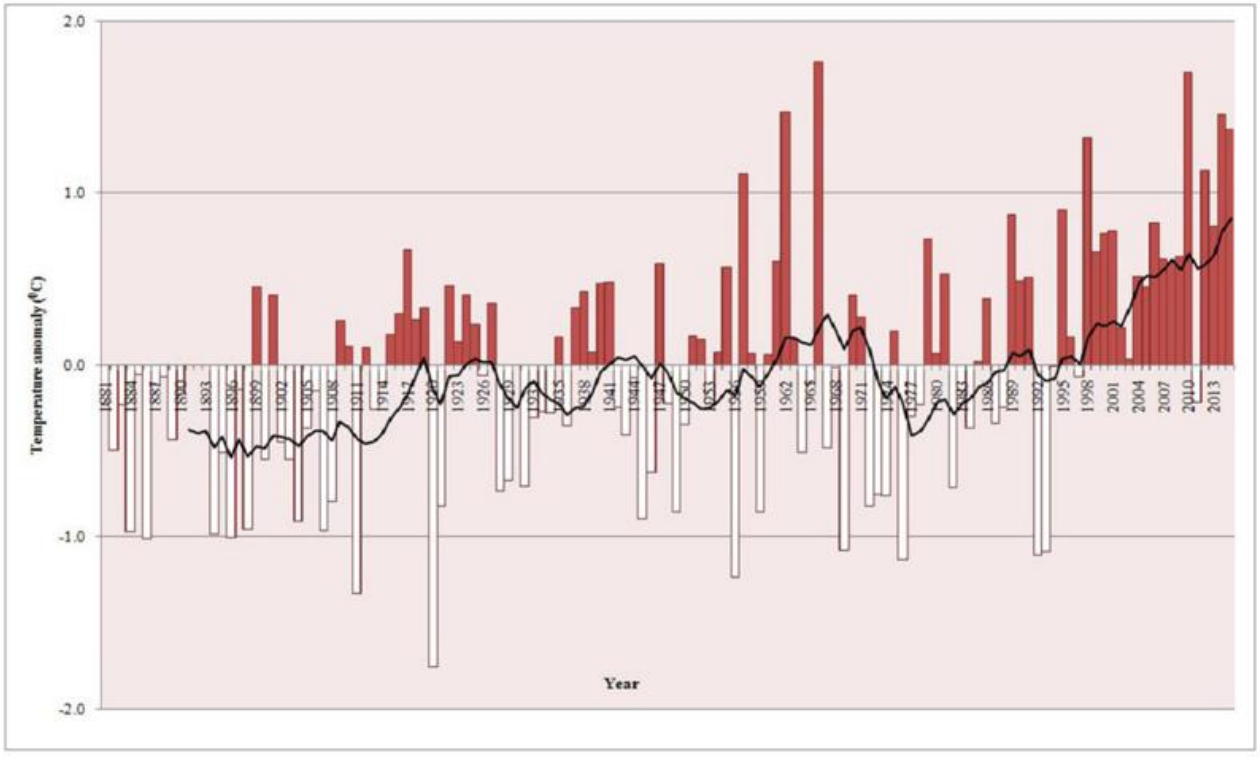


Figure 5.28: Time series of annual temperature anomalies and 11-yr moving averages for Tbilisi (Georgia) for the period 1881-2015 (reference period 1961-1990; diagram as provided by the NHMS)

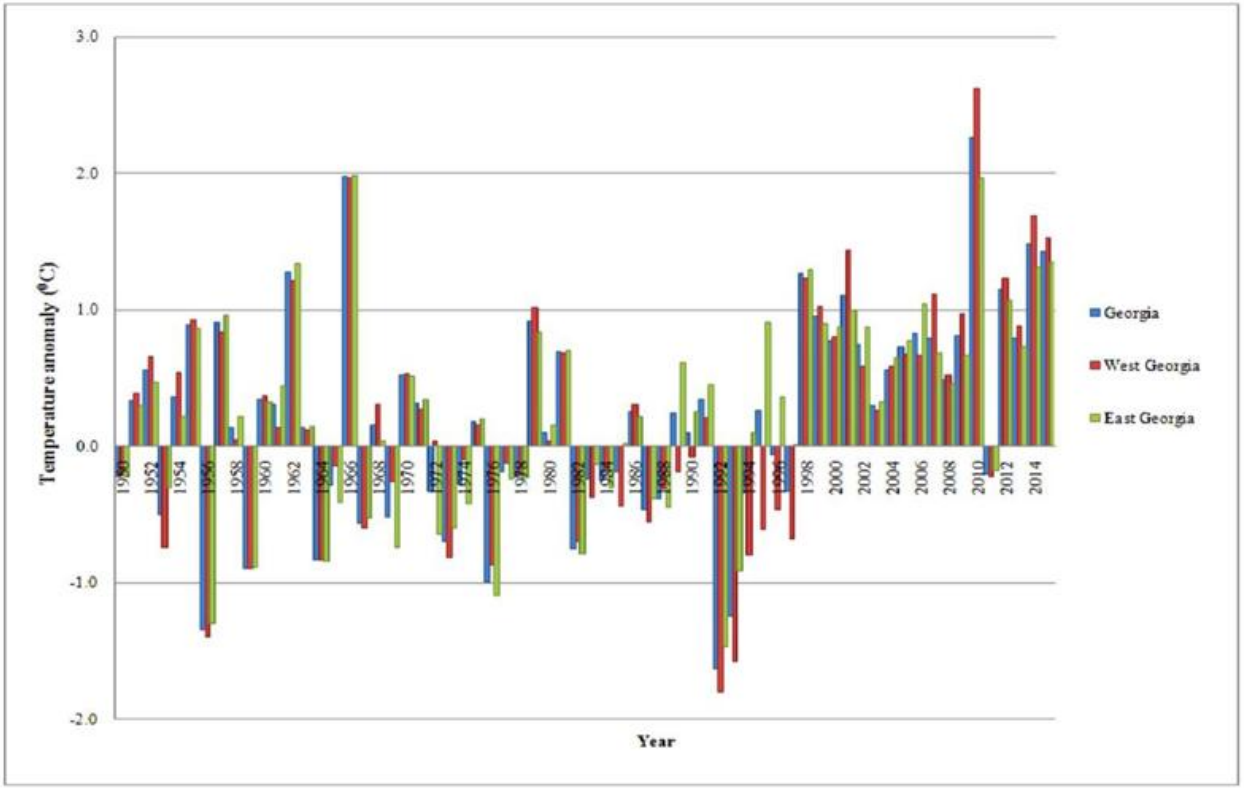


Figure 5.29: Time series of annual temperature anomalies for Georgia for the period 1961-2015 (reference period 1961-1990; diagram as provided by the NHMS)

Middle East – annual temperature series

Israel

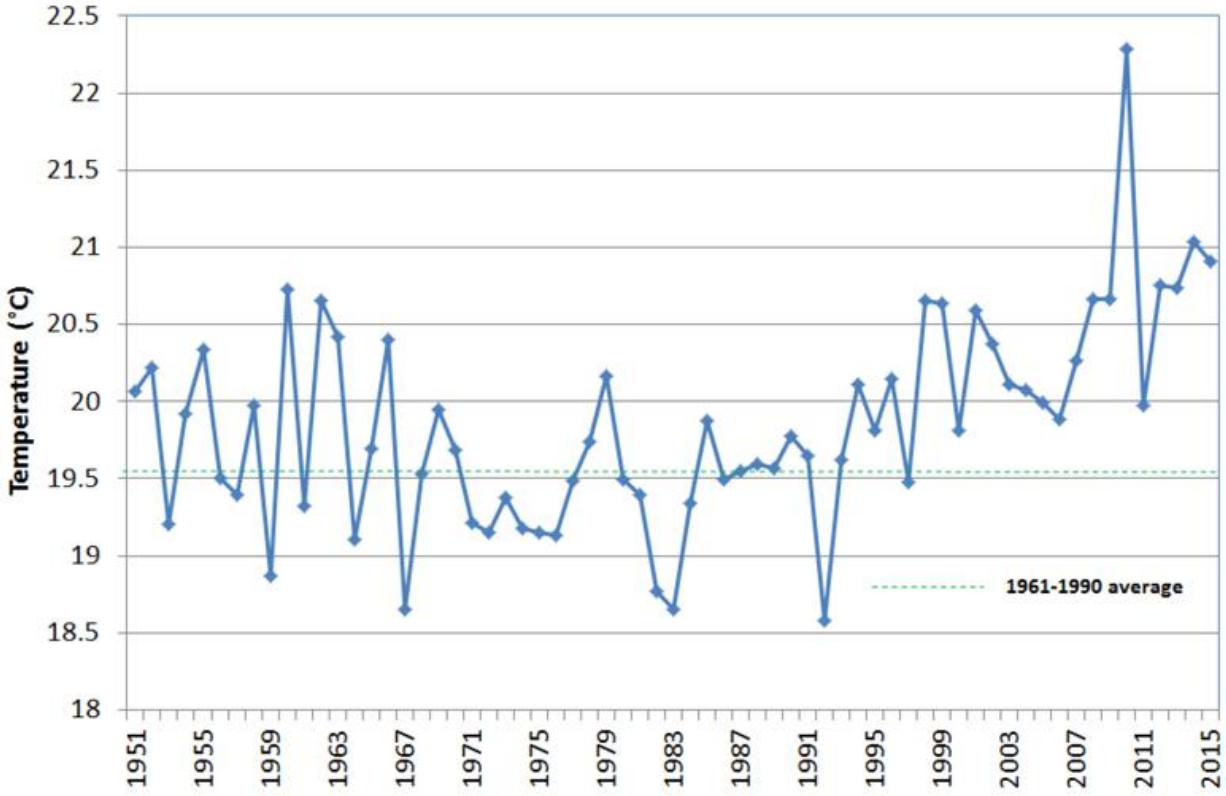


Figure 5.30: Time series of annual temperature for Israel (based on five stations) for the period 1951-2015 (diagram as provided by the NHMS)

Kazakhstan

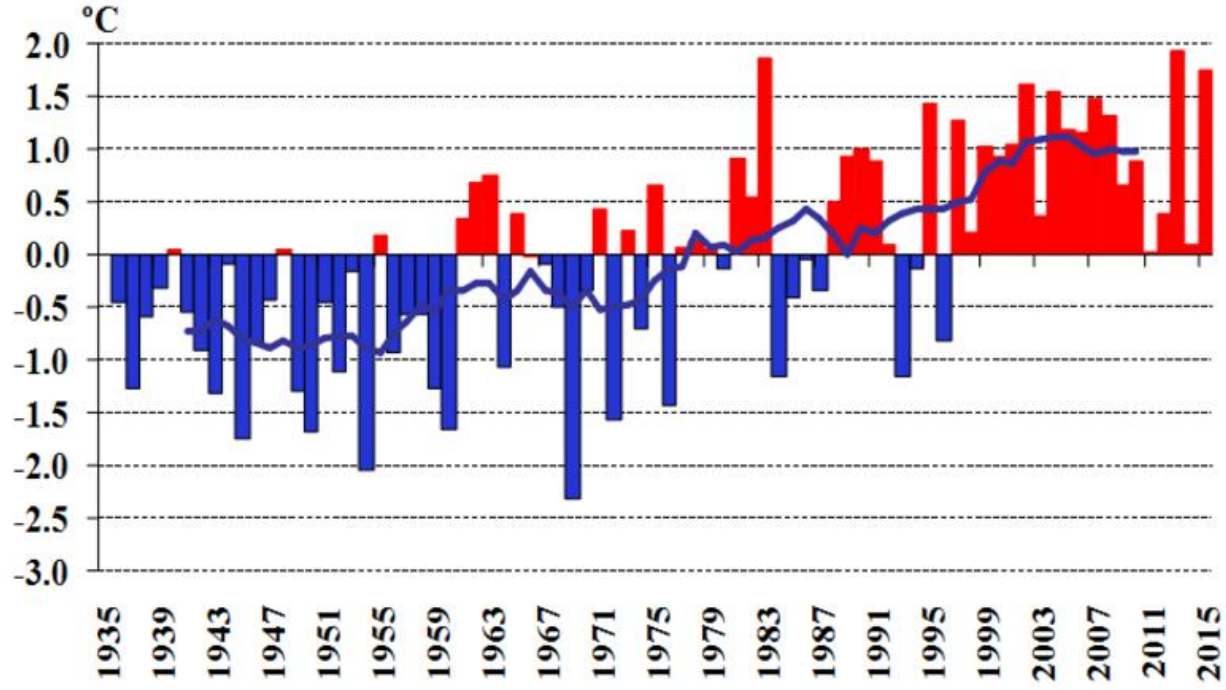


Figure 5.31: Annual average temperature anomalies for Kazakhstan for the period 1936-2015 with 11-year running mean (reference period 1961-1990, diagram as provided by the NHMS)

5.2. Precipitation

Central and Western Europe - precipitation totals and anomalies

Germany, Hungary, Switzerland, United Kingdom

Germany

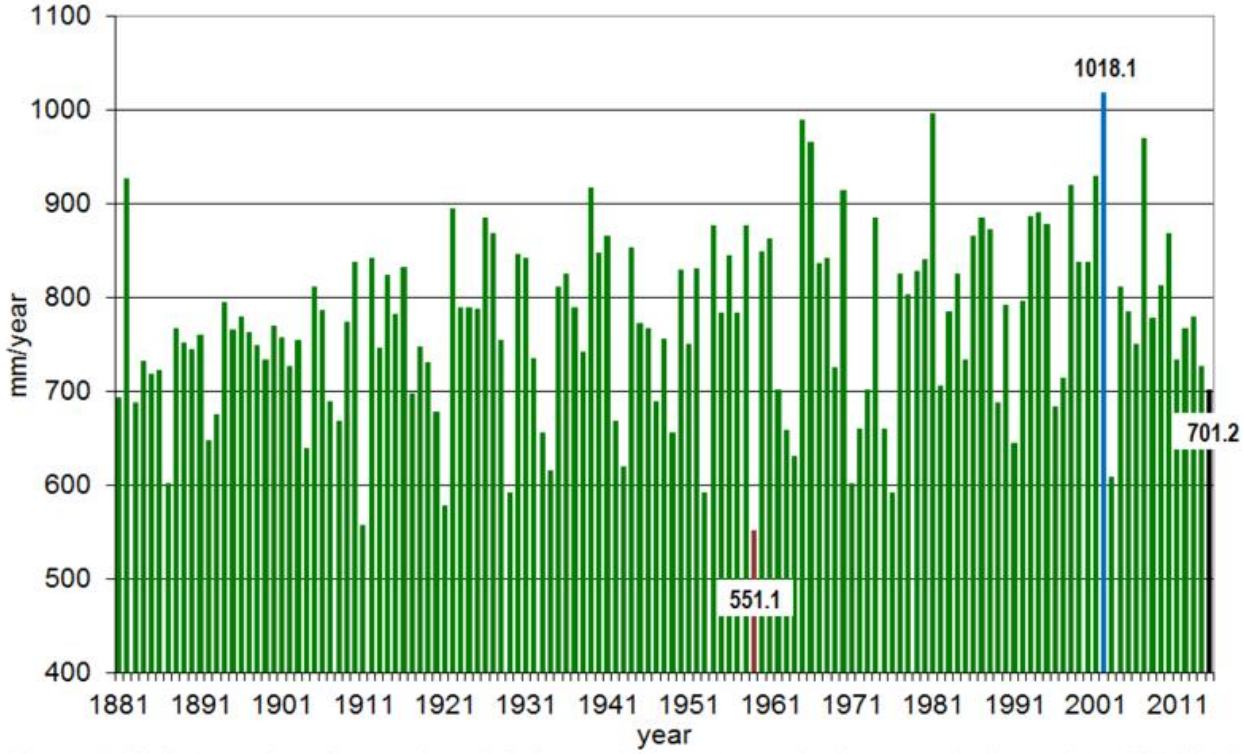


Figure 5.32: Time series of annual precipitation totals in mm/year for Germany for the period 1881-2015 (Diagram as provided by the NHMS)

Hungary

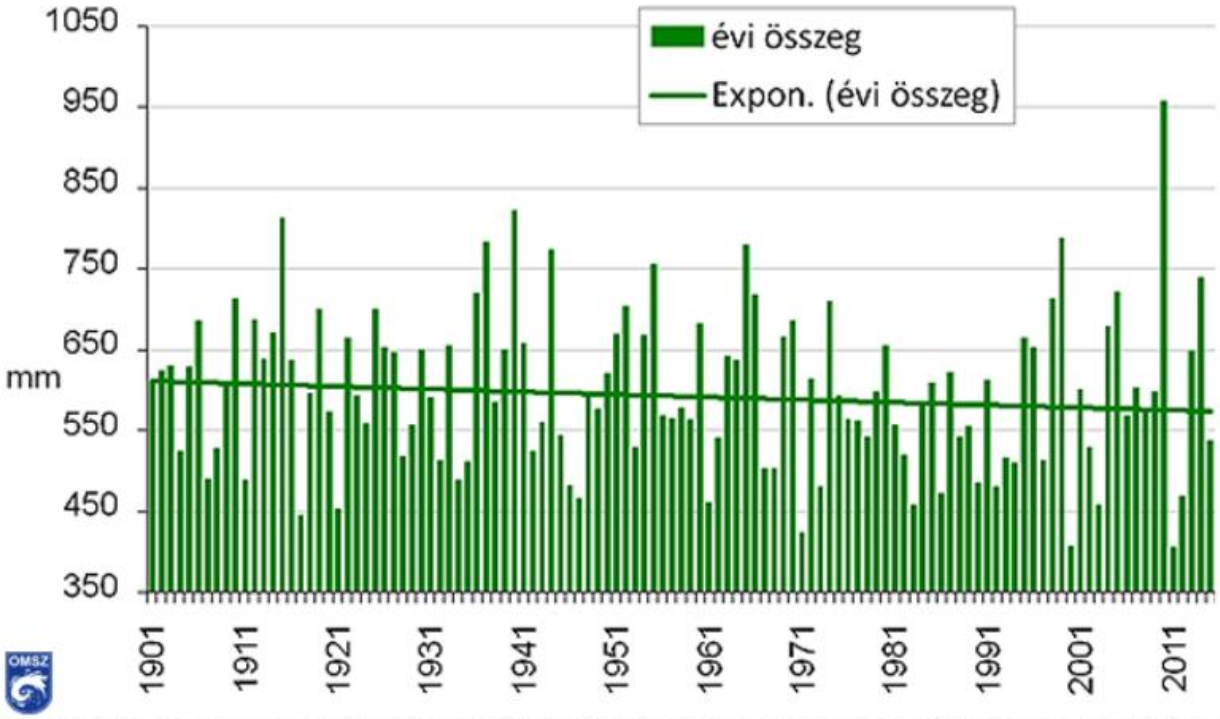
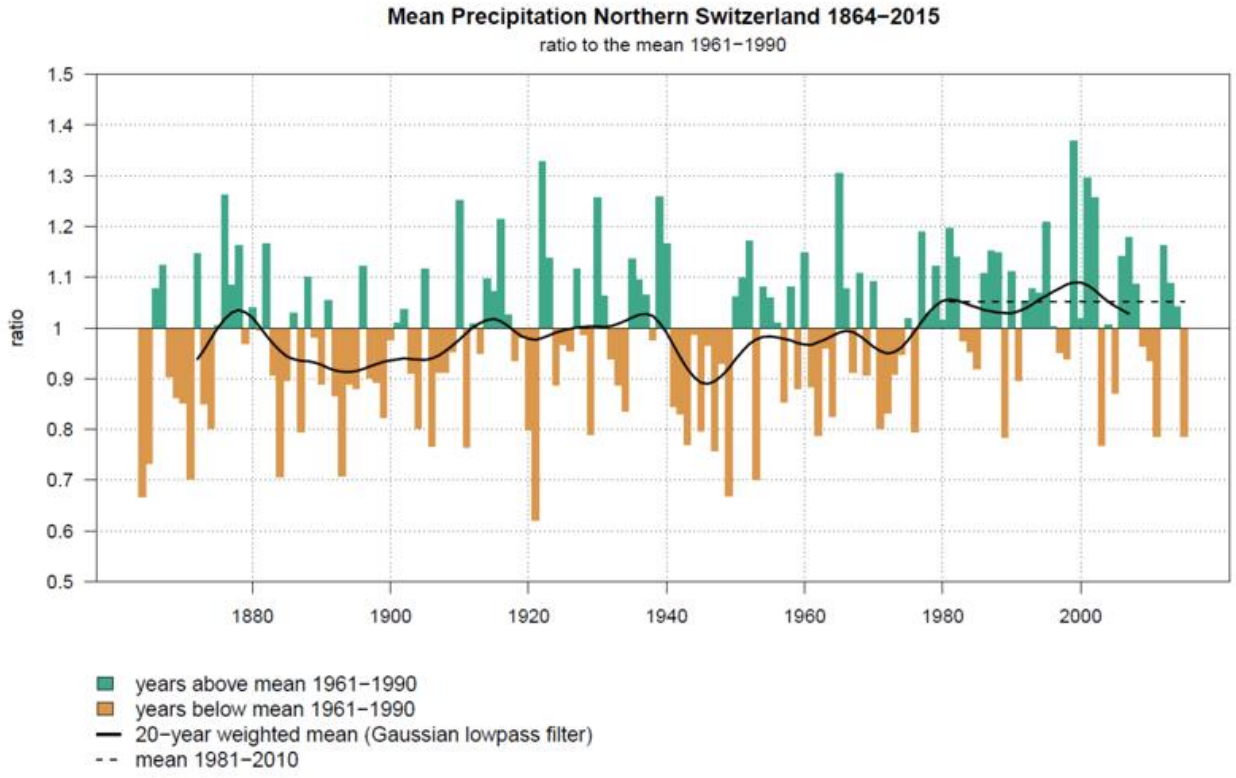


Figure 5.33: Time series of annual precipitation totals in mm/year for Hungary (Diagram as provided by the NHMS)

Central and Western Europe - precipitation totals and anomalies

Switzerland



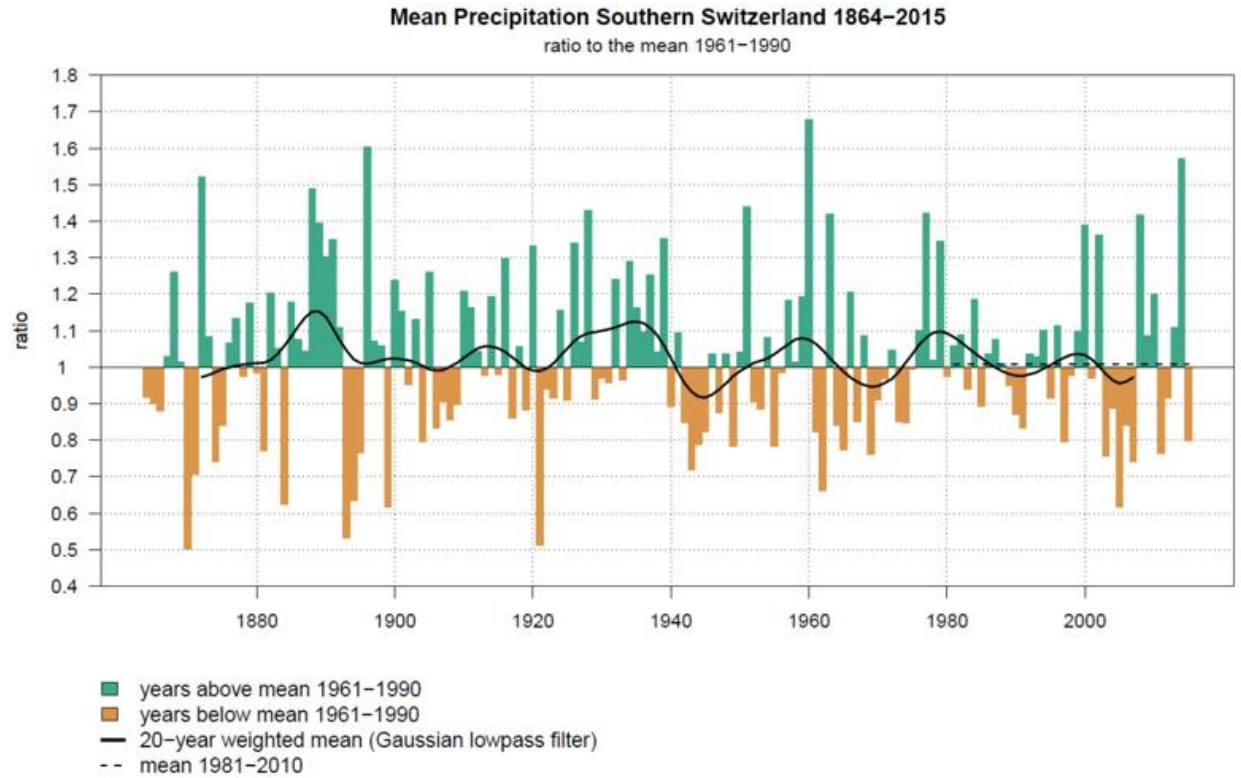


Figure 5.34: Time series of annual precipitation anomalies in relation to the mean of 1961-90 for northern (top) and southern (bottom) Switzerland (diagram as provided by the NHMS)

Central and Western Europe - precipitation totals and anomalies

United Kingdom

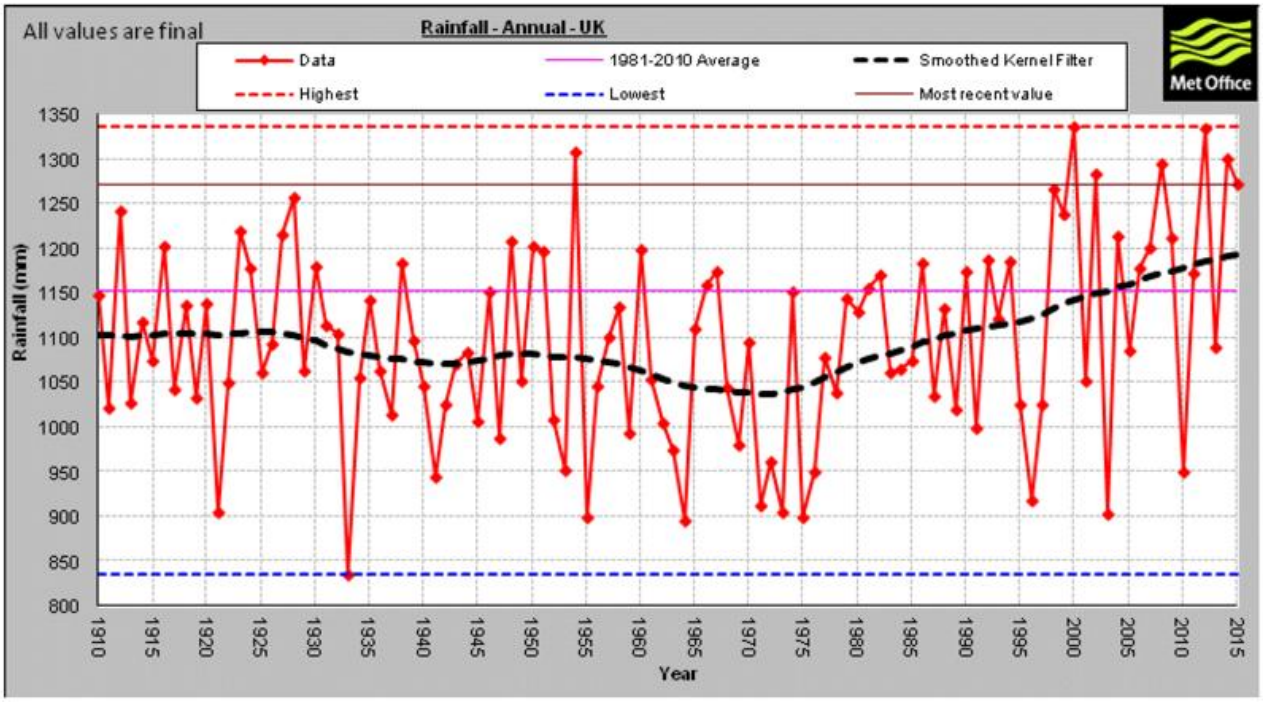


Figure 5.35: Time series of annual precipitation totals in mm/year for the United Kingdom (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Denmark, Finland, Latvia, Norway, Sweden

Denmark

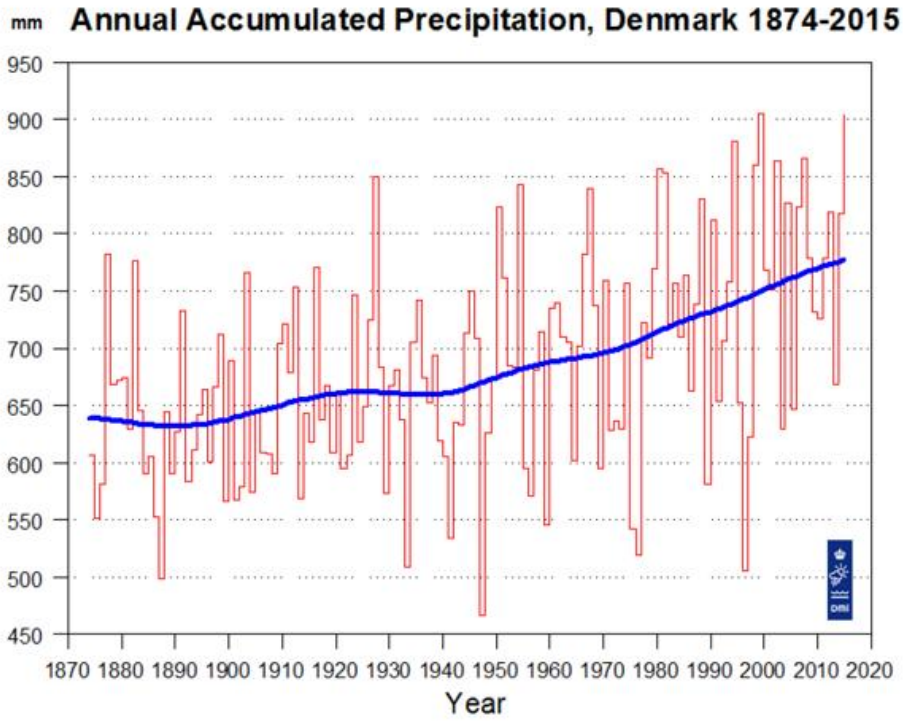


Figure 5.36: Time series of annual precipitation totals in mm/year for Denmark (Diagram as provided by the NHMS)

Finland

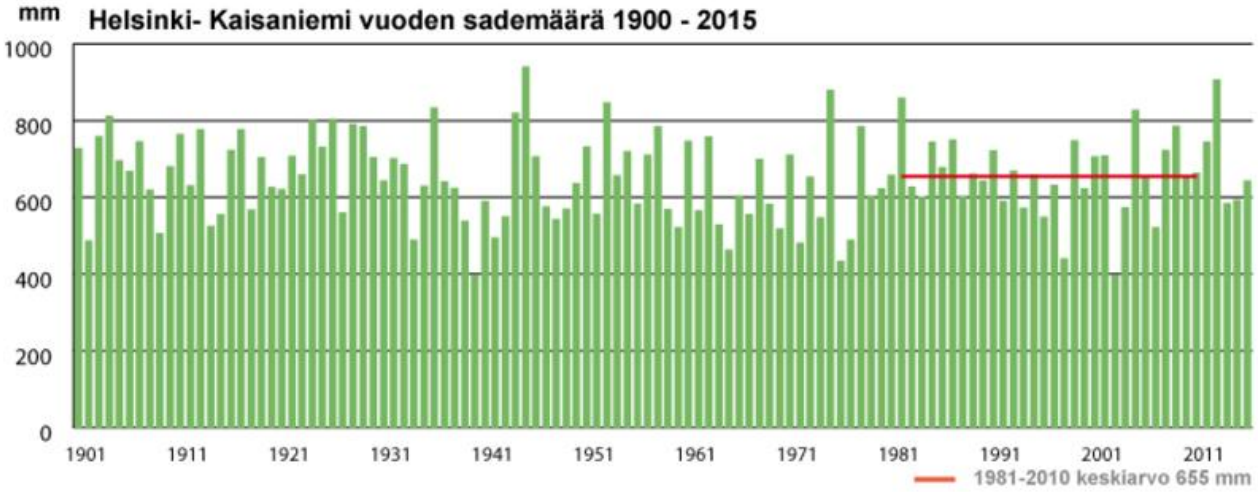


Figure 5.37: Time series of annual precipitation totals in mm/year at station Helsinki, Finland (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Latvia

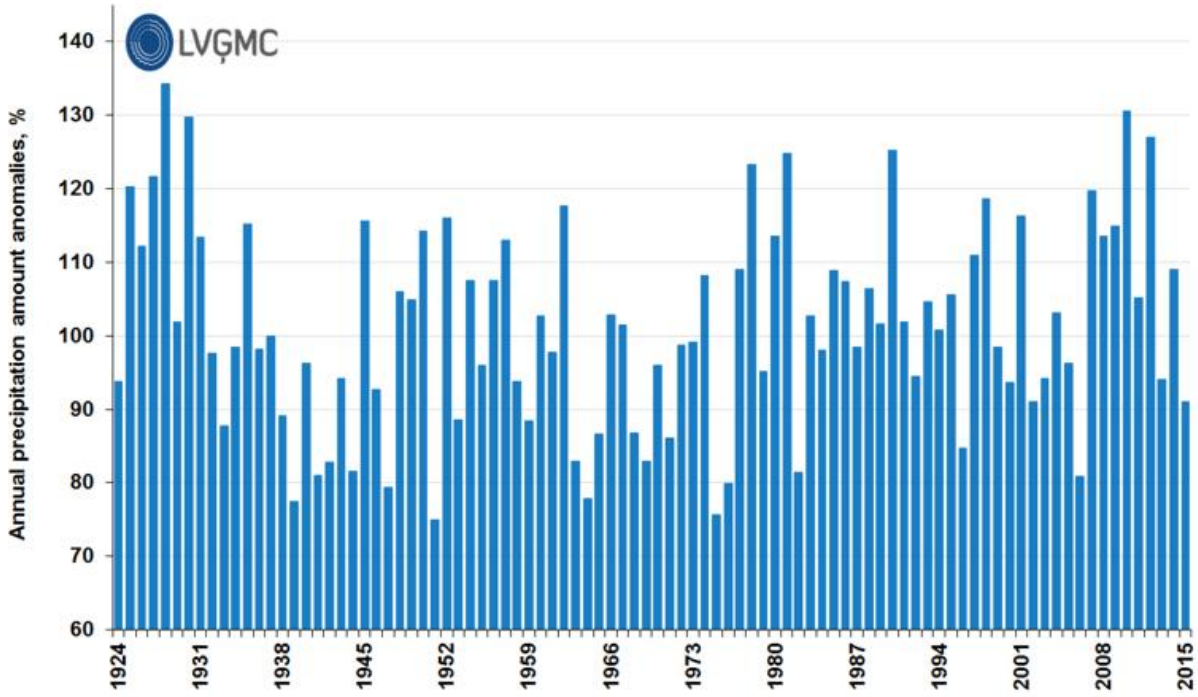


Figure 5.38: Time series of annual precipitation totals in relation to the mean of 1961-90 for Latvia (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Norway

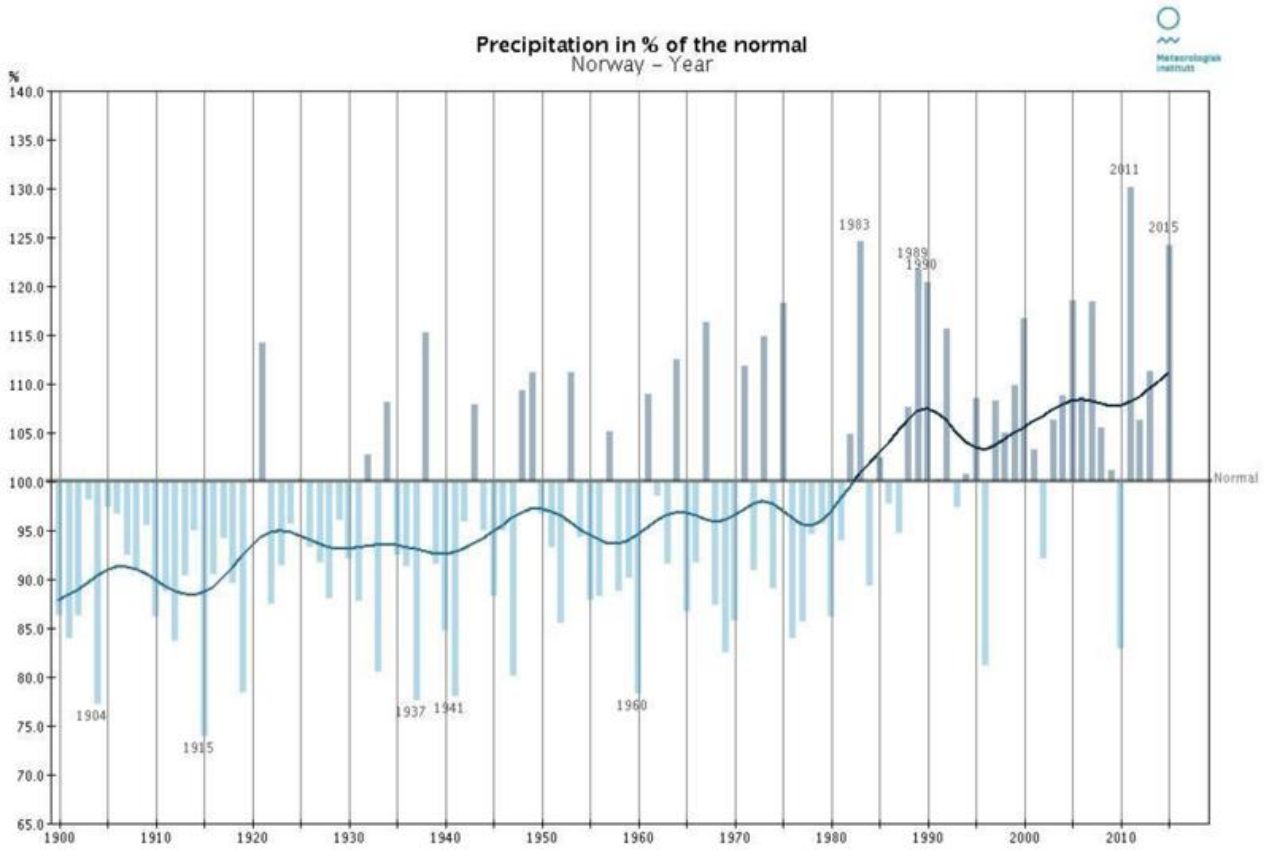


Figure 5.39: Time series of annual precipitation totals in relation to the mean of 1961-90 for Norway (Diagram as provided by the NHMS)

Sweden

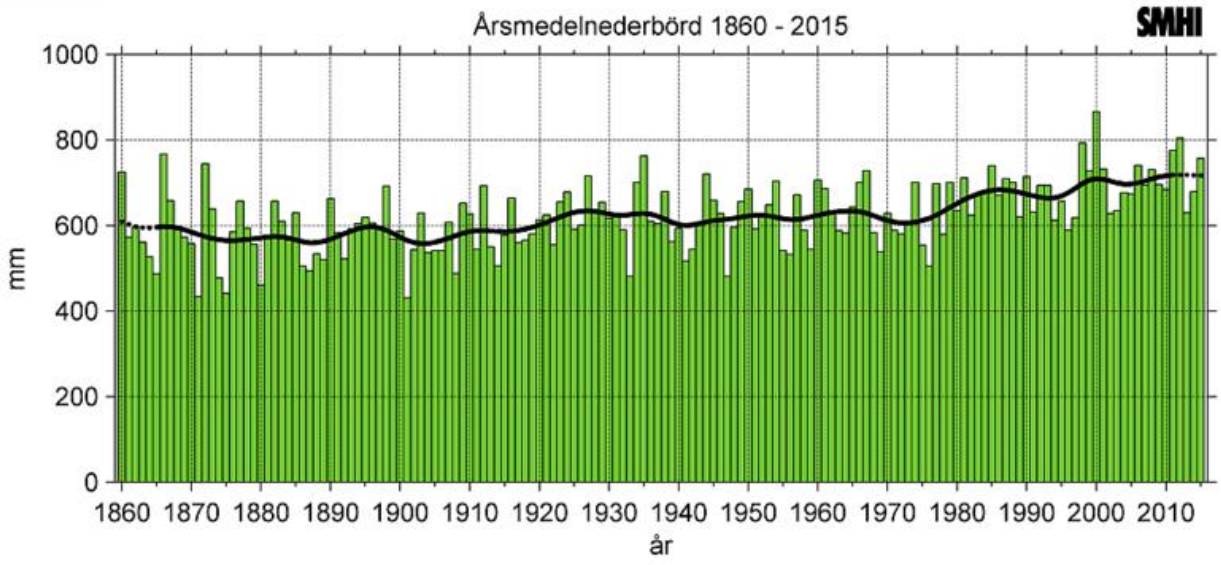


Figure 5.40: Time series of annual precipitation totals in mm/year for Sweden (Diagram as provided by the NHMS)

Iberia - precipitation anomalies

Portugal

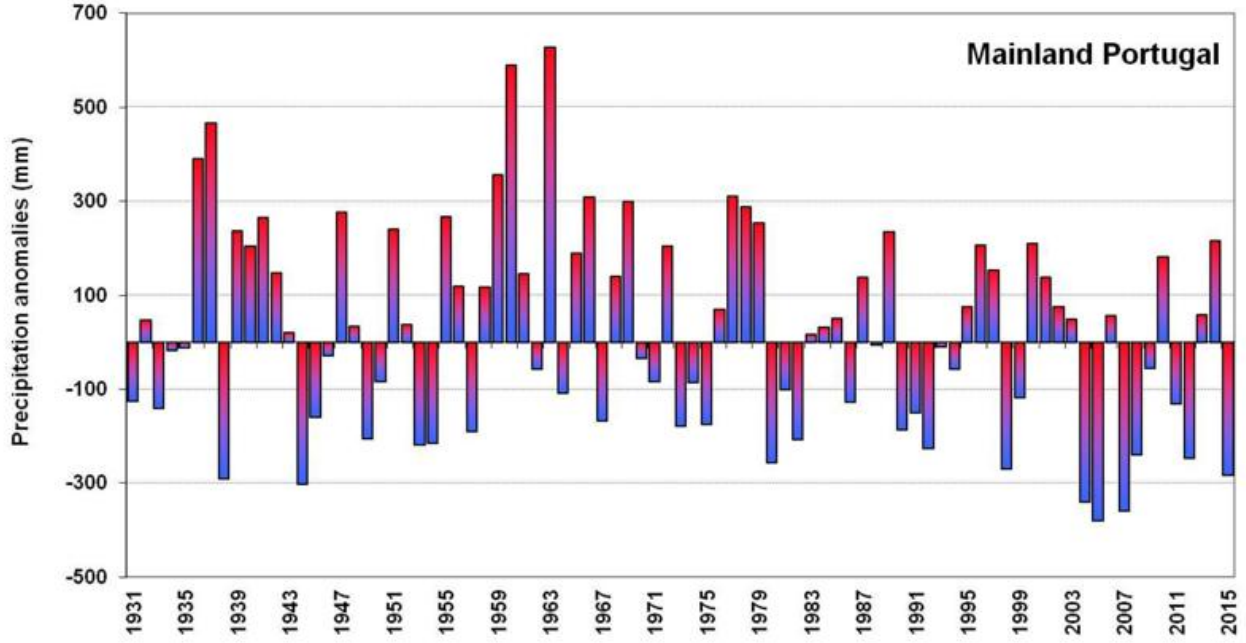


Figure 5.41: Time series of annual precipitation totals in mm/year (deviations from the mean of 1971-2000) for Portugal (Diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Italy, Slovenia, Turkey

Italy

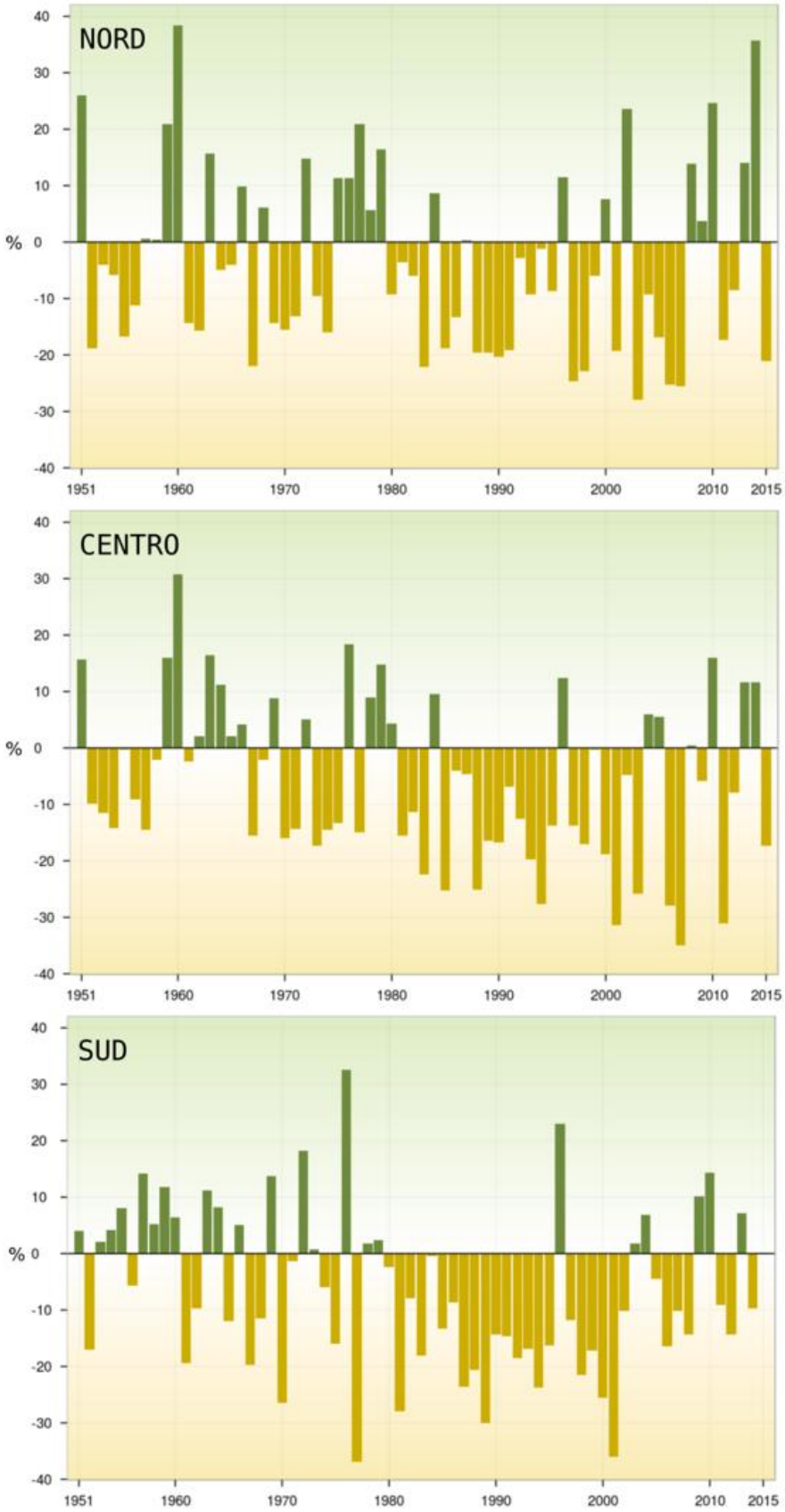


Figure 5.42: Time series of annual precipitation anomalies in relation to the mean of 1961-90 for north (top), Central (middle) and southern Italy (bottom, diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Slovenia

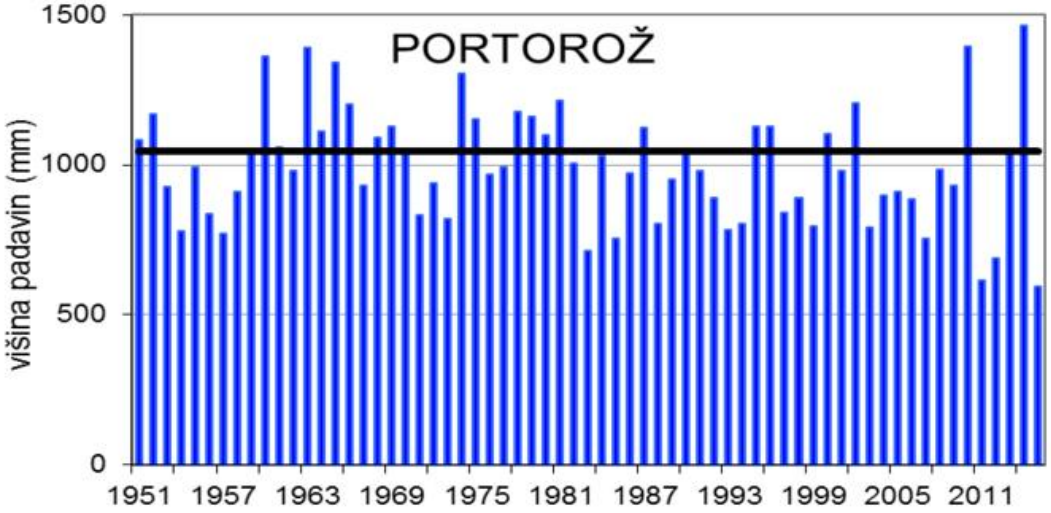


Figure 5.43: Time series of annual precipitation totals in mm/year for station Portorož (diagram as provided by the NHMS)

Turkey

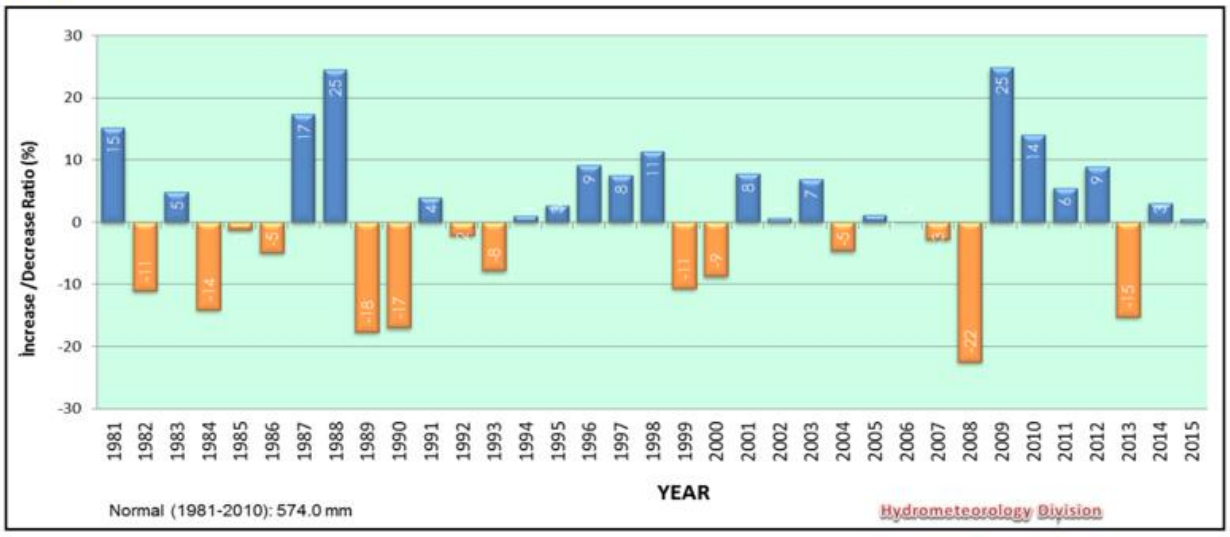


Figure 5.44: Time series of annual precipitation anomalies in relation to the mean of 1981-2010 for Turkey (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Belarus, European Russia

Belarus

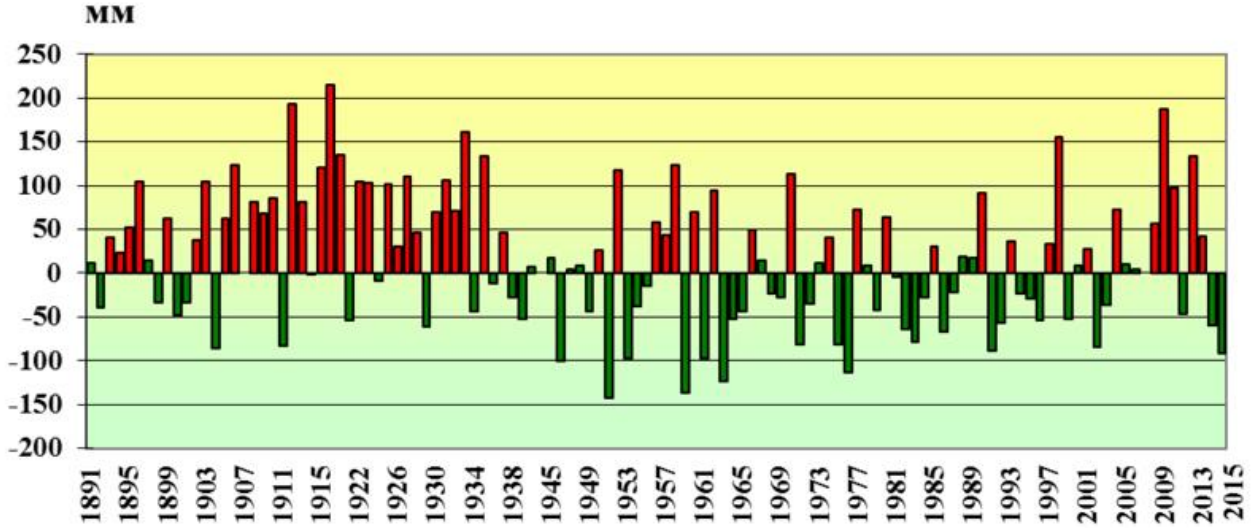


Figure 5.45: Anomalies of annual precipitation totals for Belarus (base period: 1961-1990; Diagram as provided by the NHMS)

European Russia

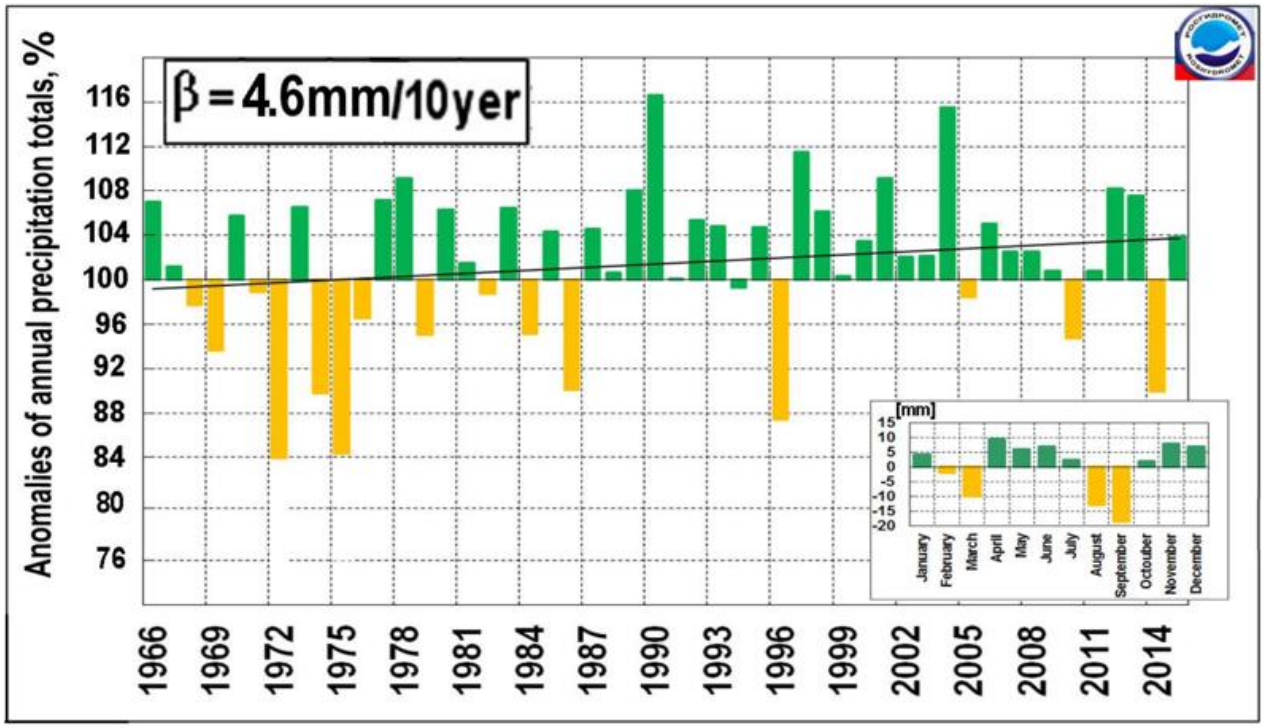


Figure 5.46: Time series of annual precipitation totals in relation to the mean of 1961-1990 for European Russia (Diagram as provided by the NHMS)

Middle East - precipitation anomalies

Georgia

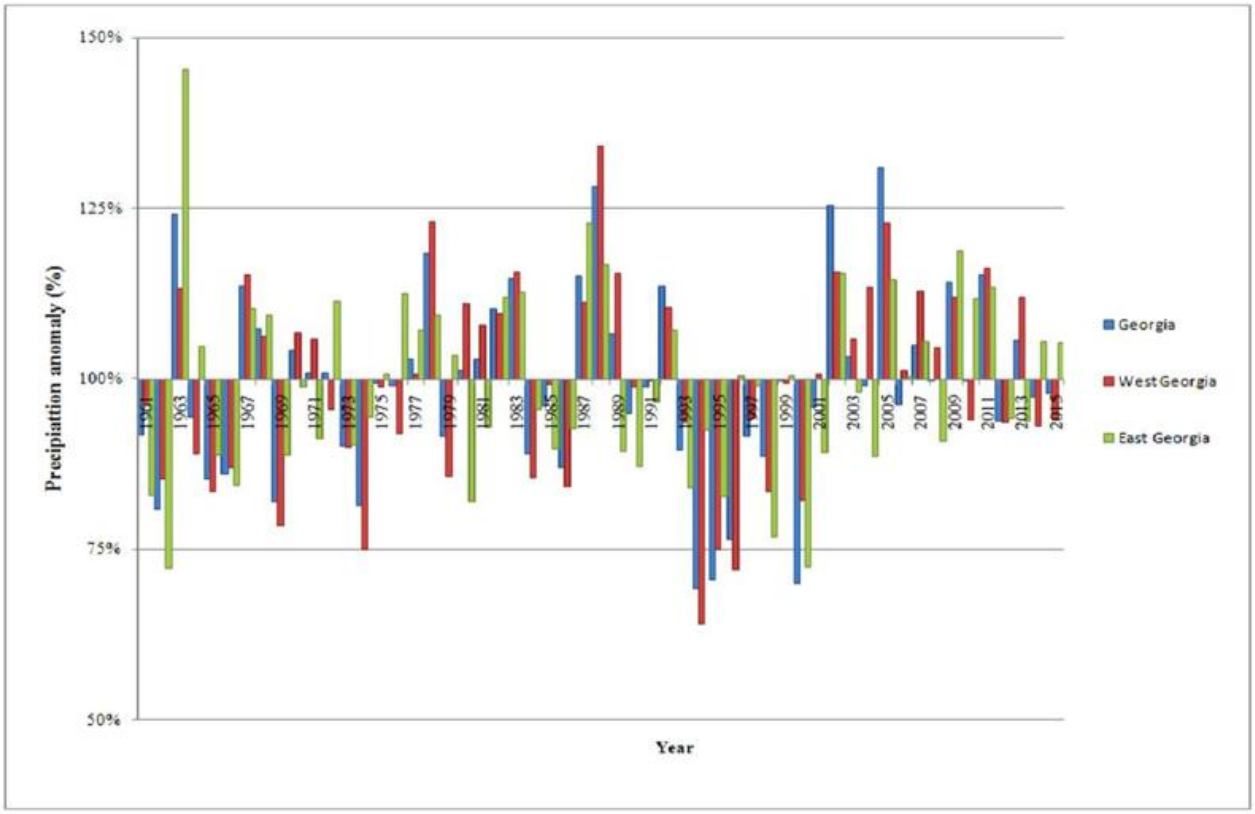


Figure 5.47: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Georgia (Diagram as provided by the NHMS)

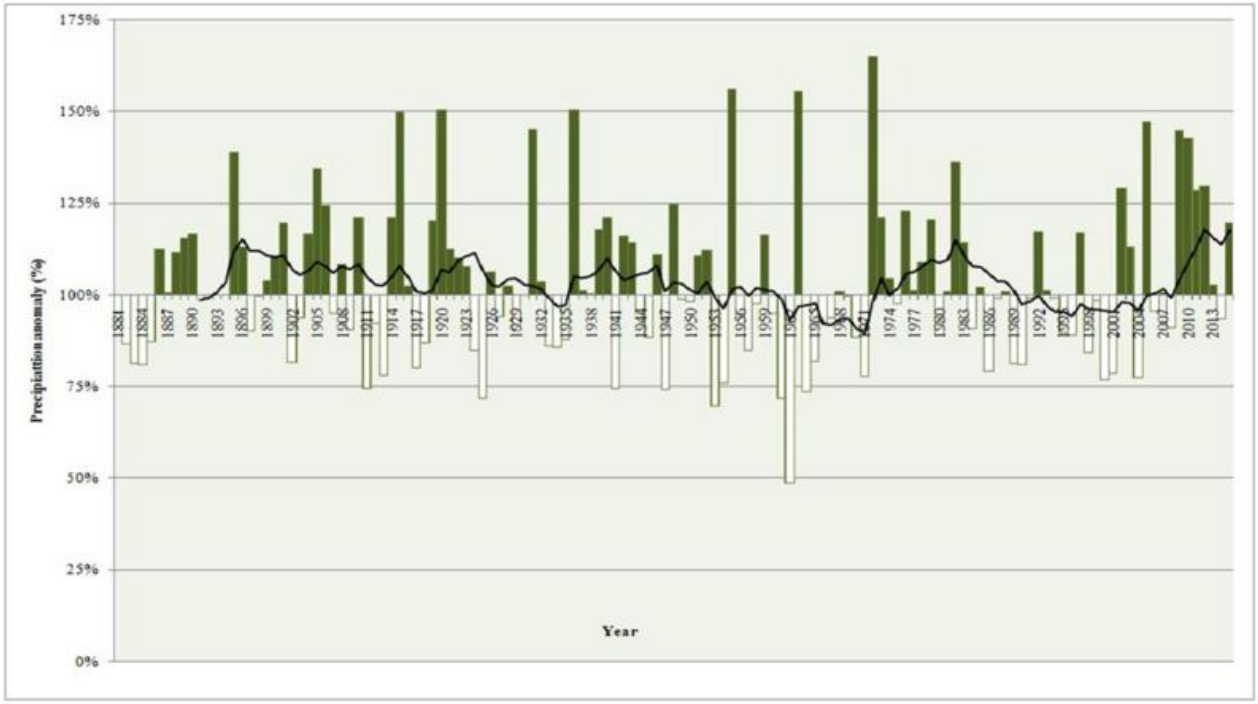


Figure 5.48: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Tbilisi, Georgia (Diagram as provided by the NHMS)

5.3. Sunshine duration

Central and Western Europe - sunshine duration anomalies

Germany, Switzerland, United Kingdom

Germany

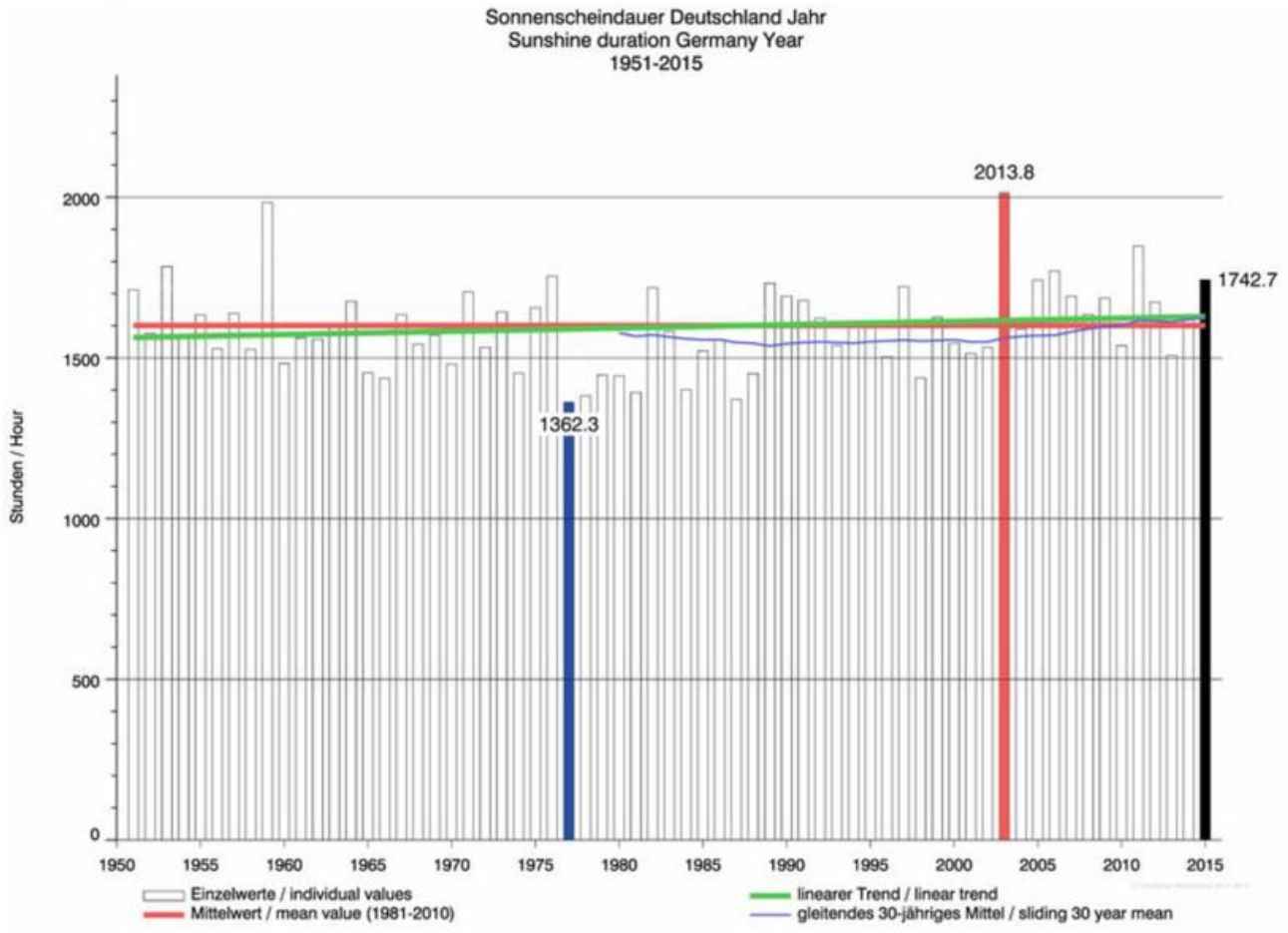


Figure 5.49: Time series of annual sum of the sunshine duration in hours for Germany (Diagram as provided by the NHMS)

Northern and Southern Switzerland

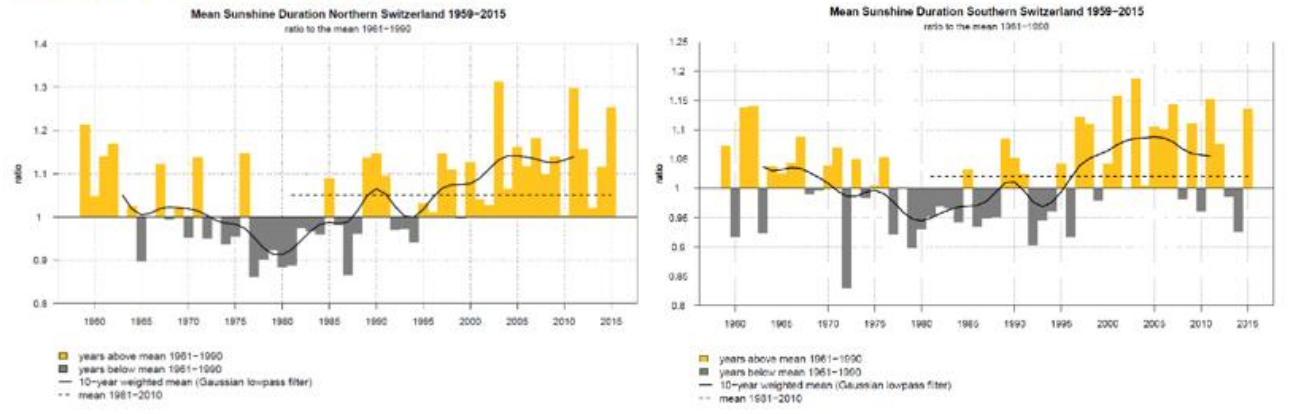


Figure 5.50: Time series of annual sunshine duration anomalies as ratio of the mean 1961-1990 for Northern (left) and Southern (right) Switzerland (reference period: 1961-1990; diagram as provided by the NHMS)

Central and Western Europe - sunshine duration anomalies

United Kingdom

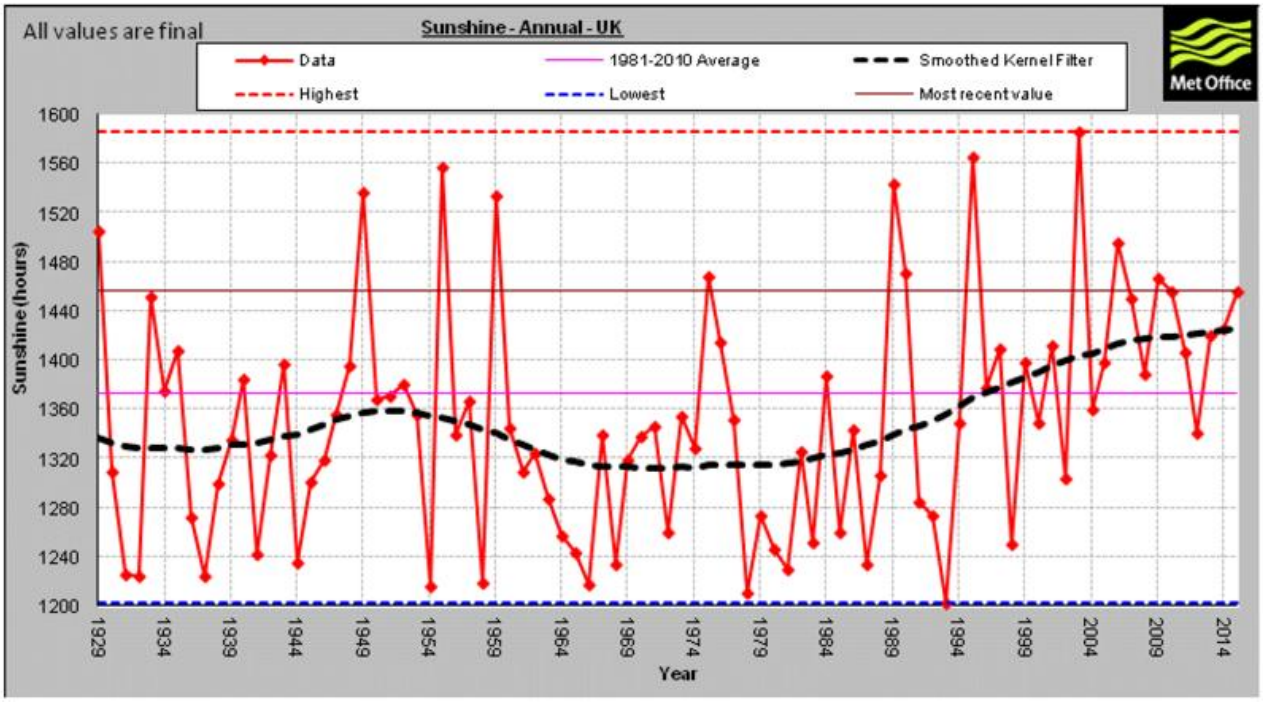


Figure 5.51: Time series of annual sum of the sunshine duration in hours for United Kingdom (Diagram as provided by the NHMS)

Nordic and Baltic Countries - sunshine duration

Denmark

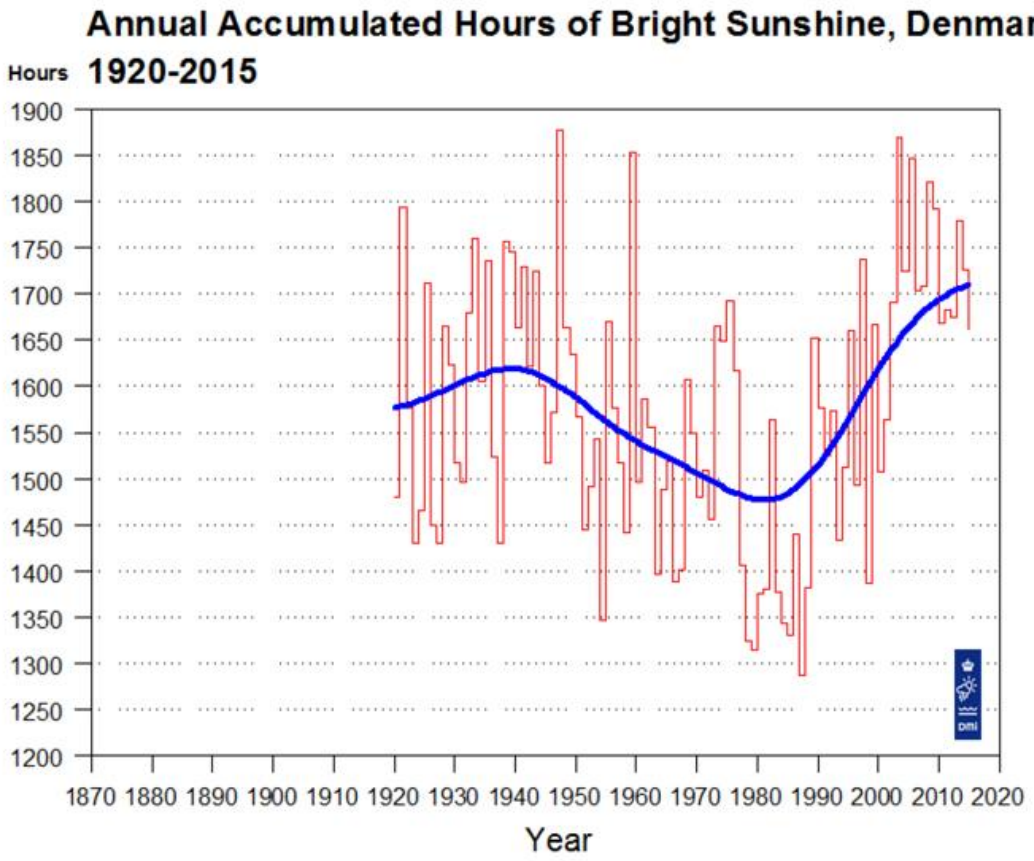


Figure 5.52: Time series of annual sunshine duration in hours for Denmark (Diagram as provided by the NHMS)

Note: DMI observed since 2002 the hours of bright sunshine using measurements of global radiation instead of measurements from a traditional Campbell-Stokes sunshine recorder. For that reason "new" and "old" hours of bright sunshine cannot directly be compared. It should also be noted that all values before 2002 are adjusted in the best way possible ensuring comparability to the new level. For details on that, see DMI Technical 02-25: Ellen Vaarby Laursen, Stig Rosenørn: New hours of bright sunshine normals for Denmark, 1961-1990.
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2002/tr02-25.pdf

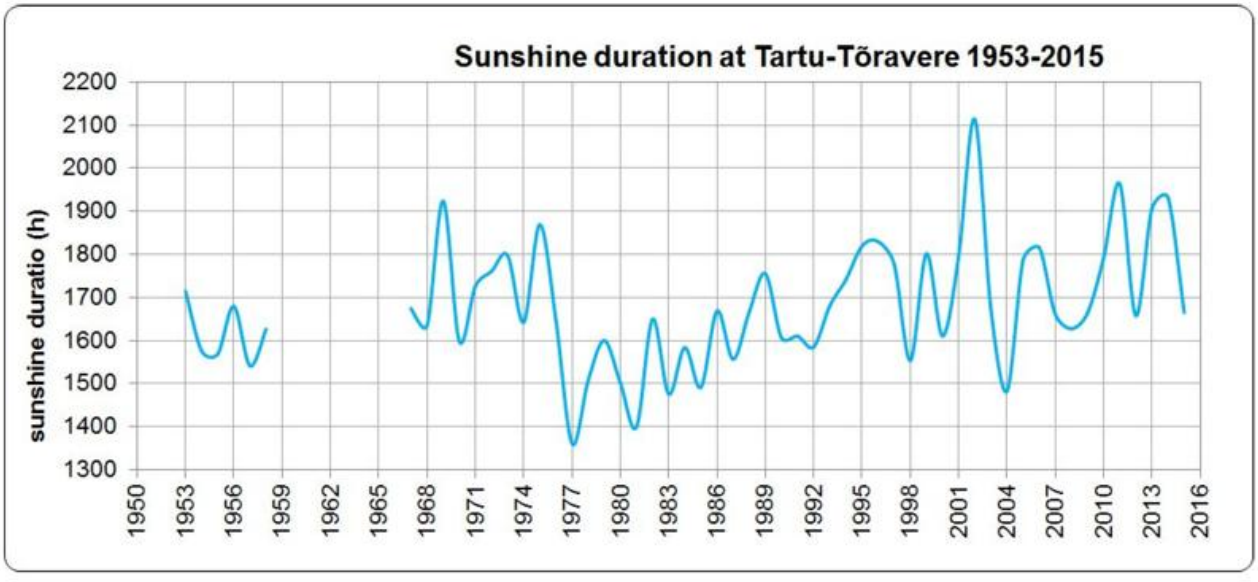


Figure 5.53: Time series of annual sunshine duration in hours for Estonia (station Tartu-Töravere, diagram as provided by the NHMS)

5.4. Other climate related variables

Sea level of the Baltic Sea (Poland)

Sea level

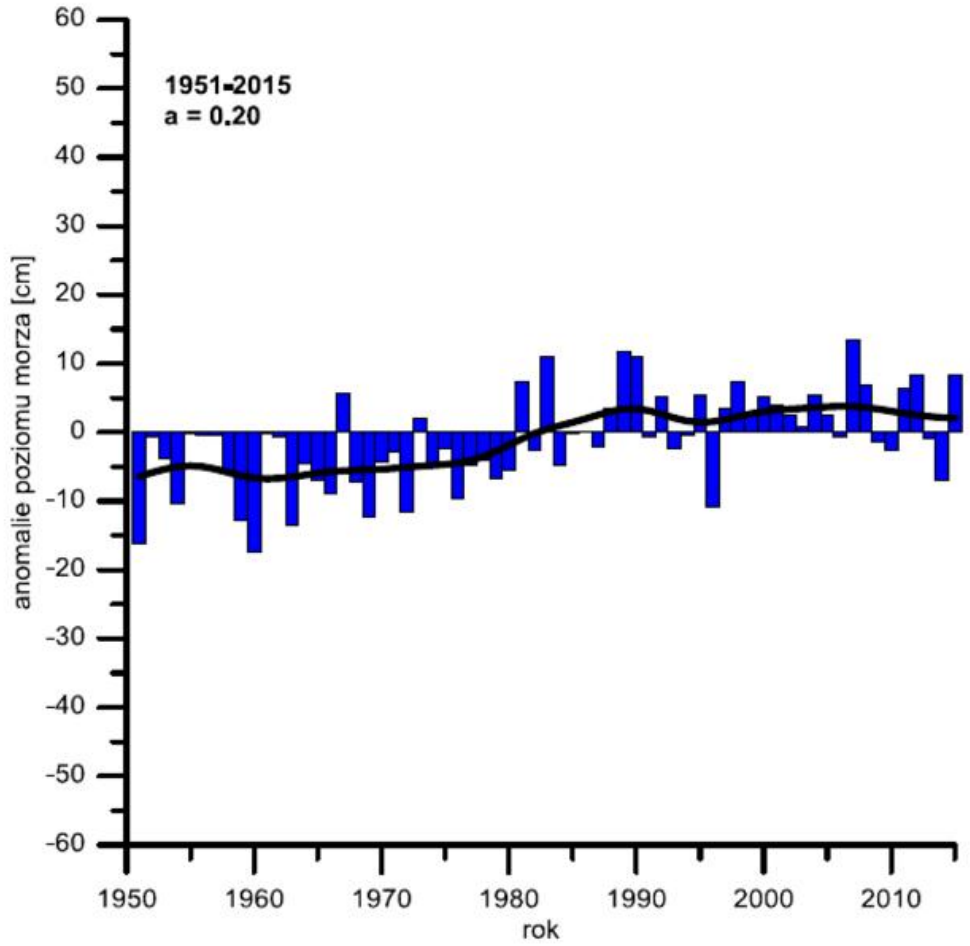


Figure 5.54: Mean annual sea level anomalies of the Baltic Sea in Władysławowo (1951-2015) in relation to the reference 1971-2000, smoothed by 10-years Gaussian filter (black line) and the value of the linear trend (cm/year, diagram as provided by the NHMS).

Recent decrease in the Caspian Sea level and consequences for the Kazakhstan's coastal zone

According to the observation data, the Caspian sea level has recently experienced wide fluctuations. During the last 35 years two periods can be singled out: 1) a sharp rise in the period 1978-1995; 2) a gradual fall in the period 1996-2015 (Figure 5.55). In 2015 the mean annual sea level was minus 27.96 m in the Baltic System of Elevations (BS), which is a decline of 1.34 m during the last twenty years.

This drop of the sea level can mainly be assigned to a change in the Volga River discharge, which results from the decrease in the precipitation over its catchment area due to climate change. In average for the period 1978-2005 the runoff of the Volga River during the first half of a year (phase of spring raising water and a high level of runoff) amounted to 165 km^3. But in 2015 it was less than 103 km^3.

Sea level reduced by more than 1 meter led to a change in the position of Caspian coastline in Kazakhstan's territory. In this Caspian region the sea bottom and the surrounding surface land have a very small slope, and even small changes in the sea level can lead to significant coastal flooding or drainage.

It should be noted that decrease in the sea level to a mark lower than minus 28.00 m will have a lot of negative consequences for its ecosystem. The shallowing of ducts, reduction of spawning areas, increase in salinization will lead to reduction of the areas of fish fodder grounds, and consequently to decrease in a fish crop, and as a result, to the problems for the fishing enterprises. Also decrease in sea level can significantly complicate economic activity in shallow coastal zones, especially as it concerns port constructions and shipping business.

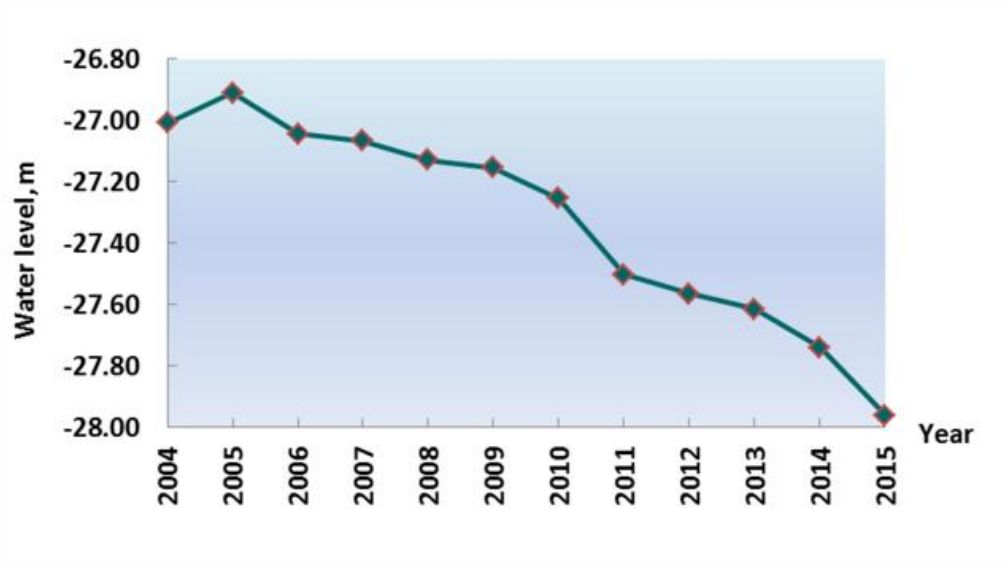


Figure 5.55: Annual Caspian Sea level from in situ observations during period 2004-2015 (m, Baltic System of Elevations)

6. Annex: Monthly and annual tables

Table 6.1: Statistical values of **annual** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

WMO-No.	Station name	Country	Temperature (°C)		Precipitation (mm)	
			mean	dev.	total	dev.
1001	Jan Mayen	NOR	0.9	2.3	677	-16
1008	Svalbard/Spitzb.	NOR	-2.0	4.4	382	199
1025	Tromsoe	NOR	4.2	1.5	1140	167
1492	Oslo	NOR	7.6	1.9	917	148
2196	Haparanda	SWE	4.0	2.9	813	261
2485	Stockholm	SWE	8.7	2.1	657	118
2836	Sodankylä	FIN	1.6	2.6	664	164
2974	Helsinki	FIN	7.2	2.7	643	-8
3091	Aberdeen	GBR	8.9	1.0	869	86
3772	London	GBR	12.2	1.6	562	-37
3967	Dublin	IRL	9.5	0.2	826	91
4030	Reykjavik	ISL	4.5	0.2	1025	227
4360	Angmagssalik	GRL	-0.4	1.2	1070	138
6186	Kopenhagen	DNK	10.0	1.3	786	150
6260	De Bilt	NLD	10.9	1.5	855	50
6447	Brüssel	BEL	11.3	1.4	741	-59
6590	Luxemburg	LUX	10.4	2.1	631	-244
6660	Zuerich	CHE	10.6	2.1	919	-167
6700	Genf	CHE	11.6	1.9	686	-268
7510	Bordeaux	FRA	14.1	1.4	596	-327
7650	Marseille	FRA	16.1	1.3	530	-16
8222	Madrid	ESP	16.6	2.2	281	-176
8314	Mahon/Menorca	ESP	17.6	1.0	607	9
8495	Gibraltar	GBR	19.0	0.8	462	-313
8515	Santa Maria/Azoren	PRT	18.0	0.5	730	-45
8535	Lissabon	PRT	17.5	0.6	433	-320
10384	Berlin-Tempelhof	DEU	11.2	1.8	508	-76
11035	Wien	AUT	12.1	2.3	519	-88
11518	Prag	CZE	10.1	2.2	382	-144
11903	Sliac	SVK	10.2	2.3	668	-18
12160	Elbing	POL	8.5	0.8	650	-40
12375	Warschau	POL	10.3	2.5	404	-115
12843	Budapest	HUN	12.2	1.8	575	57
13274	Belgrad	SRB	14.0	2.1	686	2
14015	Ljubljana	SVN	12.1	2.4	1090	-304
14445	Split	HRV	17.5	1.6	799	-26
14654	Sarajevo	BIH	10.7	1.2	766	-152
15420	Bukarest	ROU	11.9	1.3	688	93
15614	Sofia	BGR	11.4	1.7	728	165
16158	Pisa	ITA	15.5	1.4	863	-41
16597	Luqa	MLT	19.6	1.0	556	3
16716	Athen	GRC	19.2	0.7	353	-17
16754	Heraklion/Kreta	GRC	19.2	0.8	437	-65
22113	Murmansk	RUS	2.2	2.3	508	30
26038	Tallinn	EST	7.5	2.4	592	-75
26406	Liepaja	LVA	8.7	2.0	633	-57
26629	Kaunas	LTU	8.6	2.2	552	-56
26730	Vilnius	LTU	8.2	2.2	593	-90
26850	Minsk	BLR	8.7	2.9	562	-115
27612	Moskau	RUS	7.4	2.5	717	29
33345	Kiew	UKR	10.5	2.8	452	-197
33815	Kisinev	MDA	12.0	2.4	431	-116
34300	Kharkiv (Charkow)	UKR	9.7	2.2	528	9
34880	Astrachan	RUS	11.8	1.8	182	-39
37789	Yerevan	ARM	14.0	1.9	361	84
17030	Samsun	TUR	15.5	1.2	751	60
17062	Istanbul-Bölge	TUR	16.0	1.9	833	136
17130	Ankara	TUR	12.6	1.0	512	105
17170	Van	TUR	10.3	1.6	472	94
17300	Antalya	TUR	19.6	1.2	954	-112
17609	Larnaka	CYP	20.3	1.2	434	105
35108	Uralsk	KAZ	7.3	1.9	323	-1
37545	Tbilisi	GEO	14.3	1.3	553	55
40080	Damaskus	SYR	18.0	1.5	88	-58
40103	Tripoli	LBN	20.2	0.9	887	7
40180	Tel Aviv	ISR	21.1	1.6	593	26
40199	Eilat	ISR	26.2	1.4	16	-17
40265	Mafraq	JOR	17.8	1.3	163	4
60030	Las Palmas Canaries	ESP	21.8	1.3	166	49

Table 6.2: Statistical values of **monthly** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

Country	Station name	January				February				March			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
NOR	Jan Mayen	-1.2	4.5	55	-5	-4.9	1.2	54	-2	-1.8	4.3	79	23
NOR	Svalbard Airport	-7.3	8.1	32	18	-13.9	1.8	40	21	-6.8	7.9	95	74
NOR	Tromso	-3.8	0.2	16	-65	-1.5	2.2	125	39	1.3	3.5	79	15
NOR	Oslo	-0.3	4.0	111	62	0.3	4.3	30	-6	3.5	3.7	59	13
SWE	Haparanda	-8.8	3.3	118	74	-3.2	8.1	29	-3	-1.0	5.8	57	22
SWE	Stockholm	0.9	3.7	68	29	1.3	4.3	39	12	3.9	3.8	58	32
FIN	Sodankylä	-14.1	1.0	50	19	-6.5	7.1	17	-8	-2.3	6.2	48	23
FIN	Helsinki	-2.0	4.9	57	16	-0.1	6.7	47	16	1.8	4.7	61	27
GBR	Aberdeen	3.7	1.0	83	2	4.3	1.4	25	-26	5.9	1.4	36	-22
GBR	London	5.7	1.5	63	11	5.0	0.5	39	4	7.9	1.4	24	-23
IRL	Dublin Aero.	4.7	0.3	63	-3	3.9	-0.5	31	-20	5.7	-0.3	48	-1
ISL	Reykjavik	-0.3	0.2	127	51	-0.1	-0.5	93	21	0.7	0.2	137	55
GRL	Angmagssalik	-5.3	2.2	66	-46	-8.8	-1.1	171	80	-3.7	4.5	143	55
DNK	Copenhagen	3.1	2.6	84	33	2.1	1.6	28	-3	5.2	2.6	52	10
NLD	De Bilt	4.0	1.8	116	50	3.5	1.0	61	12	6.2	1.2	60	-3
BEL	Brussels	3.5	0.9	124	57	3.3	-0.2	58	5	6.6	1.1	53	-1
LUX	Luxembourg	1.5	1.5	74	3	1.0	-0.1	45	-17	5.9	1.9	40	-30
CHE	Zurich	1.9	2.4	90	23	-0.5	-1.4	36	-34	6.4	2.2	82	13
CHE	Geneva	2.6	1.8	81	1	1.7	-0.6	52	-29	7.3	2.2	52	-27
FRA	Bordeaux	6.3	0.5	94	-6	6.0	-1.1	80	-6	9.9	1.1	40	-36
FRA	Marseilles	7.6	0.9	71	24	6.5	-1.4	78	24	11.2	1.0	55	11
ESP	Madrid	6.2	0.1	17	-29	7.0	-0.5	22	-22	11.8	1.8	37	4
ESP	Mahon/Menorca	10.8	0.3	60	-6	9.2	-1.5	129	72	12.3	0.7	92	37
GBR	Gibraltar	13.5	0.1	39	-82	12.5	-1.3	96	-4	15.3	0.3	65	-10
PRT	Santa Maria/Az.	14.4	0.0	14	-86	14.6	0.6	12	-74	15.0	0.4	26	-53
PRT	Lisbon	10.9	-0.5	91	-19	11.2	-1.1	15	-96	14.0	0.3	23	-46
DEU	Berlin-Tempelhof	3.3	3.5	78	35	2.1	1.3	7	-27	6.3	2.1	45	8
AUT	Vienna	3.0	4.0	73	35	2.3	1.3	37	-5	6.6	1.6	40	-1
CZE	Prague	1.7	4.1	18	-5	0.3	1.1	2	-21	5.0	2.0	31	3
SVK	Sliac	0.4	4.3	67	23	-1.3	-0.2	18	-26	5.1	2.1	56	14
POL	Elblag	0.2	2.6	58	11	0.3	2.5	4	-21	4.3	2.2	57	22
POL	Warsaw	1.4	4.7	39	17	1.1	3.1	6	-15	5.5	3.5	30	2
HUN	Budapest	2.0	3.6	71	39	2.7	1.6	28	-4	7.2	1.6	15	-14
SRB	Belgrade	3.8	3.4	49	0	4.0	1.3	52	8	8.1	0.9	133	83
SVN	Ljubljana	2.8	3.9	70	-12	2.4	1.0	64	-16	7.6	2.2	105	7
HRV	Split	8.6	1.2	60	-23	8.7	0.6	125	57	11.3	0.9	38	-37
BIH	Sarajevo	0.7	1.6	113	42	1.7	0.2	57	-10	5.2	0.1	80	10
ROU	Bucureşti	-1.0	1.4	43	3	1.7	1.8	36	0	6.0	1.2	86	48
BGR	Sofia	0.6	2.2	32	5	1.5	1.0	52	19	4.4	-0.2	116	78
ITA	Pisa	7.8	1.7	80	5	8.0	0.9	77	4	11.0	1.5	62	-14
MLT	Luqa	12.9	0.7	50	-39	12.0	-0.4	113	52	13.6	0.2	64	23
GRC	Athens	10.5	0.3	38	-6	10.3	-0.3	41	-2	12.6	0.0	90	49
GRC	Heraklion/Crete	12.3	0.3	196	106	12.2	0.1	81	4	13.7	0.3	46	-10
RUS	Murmansk	-11.8	-0.1	43	10	-5.8	5.4	12	-10	-0.9	5.9	30	10
EST	Tallinn	-0.9	4.6	69	24	0.2	5.9	33	4	2.8	5.0	29	0
LVA	Liepaja	1.0	4.0	79	33	1.1	4.1	21	-10	4.1	4.3	43	7
LTU	Kaunas	-0.4	4.6	74	37	0.0	4.3	13	-14	4.6	4.8	46	14
LTU	Vilnius	-1.1	5.0	61	20	-0.4	4.4	16	-22	3.9	4.5	38	-1
BLR	Minsk	-1.3	5.6	62	22	-1.1	4.7	21	-13	4.0	5.4	27	-15
RUS	Moscow	-4.4	4.9	62	17	-2.2	5.5	40	3	2.0	4.2	14	-20
UKR	Kiev	-0.7	4.9	56	9	-0.7	3.5	35	-11	5.1	4.4	50	11
MDA	Kishinev	-0.5	2.8	27	-13	0.6	2.3	34	-4	5.2	2.3	58	23
UKR	Charkow/Kharkiv	-3.0	3.9	26	-18	-2.5	3.2	53	21	3.3	3.6	43	16
RUS	Astrachan	-4.1	1.3	9	-4	-2.5	2.4	15	5	3.6	2.3	7	-7
ARM	Yerevan	0.1	3.6	15	-6	4.4	5.4	7	-17	7.5	1.7	64	32
TUR	Samsun	7.7	0.8	129	68	9.0	1.8	84	34	8.8	0.8	72	16
TUR	Istanbul	7.4	1.8	138	39	7.7	1.8	139	72	9.2	1.7	31	-31
TUR	Ankara	1.4	1.4	54	13	3.4	1.7	29	-7	7.1	1.1	96	60
TUR	Van	-2.0	2.4	46	12	0.7	4.5	8	-25	3.5	2.6	58	16
TUR	Antalya	11.0	1.1	288	49	12.0	1.7	186	-10	14.2	1.5	147	44
CYP	Larnaca	11.9	0.4	147	82	12.3	0.6	55	-2	15.1	1.8	65	16
KAZ	Uralsk	-11.8	1.1	24	-1	-8.9	3.6	7	-11	-4.4	0.6	3	-17
GEO	Tbilisi (Tiflis)	3.5	1.8	0	-19	5.7	2.8	39	13	8.1	1.2	49	19
SYR	Damascus	6.3	0.4	32	3	8.4	0.5	23	-1	13.4	2.4	6	-11
LBN	Tripoli	11.7	-1.0	226	32	12.9	-0.3	187	60	15.6	0.9	43	-73
ISR	Tel Aviv	12.2	-0.1	205	56	13.9	1.0	85	-13	17.5	2.6	8	-54
ISR	Eilat	15.4	0.2	4	-1	17.7	0.8	<1	-5	22.8	2.8	<1	-4
JOR	Mafraq	7.7	0.5	52	18	9.3	0.6	28	-3	13.3	1.8	9	-20
ESP	Las Palmas Can.	18.6	1.1	2	-15	17.6	0.0	9	-13	18.8	0.4	18	8

Table 6.2: continued

Country	Station name	April				May				June			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
NOR	Jan Mayen	-1.8	2.1	50	9	0.1	0.8	14	-26	2.6	0.8	19	-17
NOR	Svalbard/Spitzb.	-5.3	6.4	32	20	-2.2	1.5	3	-3	4.6	2.4	8	-2
NOR	Tromsoe	2.1	1.4	73	13	5.9	1.0	31	-17	7.6	-1.7	99	46
NOR	Oslo	7.1	2.5	17	-25	9.0	-1.8	111	59	14.2	-1.0	64	-1
SWE	Haparanda	2.5	3.0	14	-15	6.4	0.3	88	57	11.4	-1.4	95	54
SWE	Stockholm	7.4	2.8	11	-19	10.2	-0.5	107	77	14.5	-1.1	61	16
FIN	Sodankylä	0.9	3.0	10	-14	6.3	1.3	102	67	10.2	-1.4	71	15
FIN	Helsinki	5.1	2.2	56	19	9.6	-0.3	44	9	13.7	-1.2	67	23
GBR	Aberdeen	7.8	1.5	58	5	9.2	0.2	84	25	12.0	-0.1	49	-4
GBR	London	11.1	2.2	16	-29	13.2	0.7	42	-9	16.8	1.1	12	-39
IRL	Dublin	8.1	0.3	56	9	9.9	-0.6	95	37	13.3	0.0	17	-31
ISL	Reykjavik	2.4	-0.5	48	-10	4.6	-1.7	32	-12	9.1	0.1	21	-29
GRL	Angmagssalik	-3.1	1.0	114	41	0.8	0.2	91	34	4.7	0.6	28	-24
DNK	Kopenhagen	8.3	1.7	31	-11	11.2	-0.8	66	23	14.5	-1.6	60	6
NLD	De Bilt	9.0	1.0	21	-31	12.4	0.1	46	-15	15.6	0.4	33	-35
BEL	Brüssel	10.3	1.5	24	-33	13.1	0.2	63	-8	16.5	0.8	53	-26
LUX	Luxemburg	10.1	2.6	50	-11	12.7	0.9	26	-55	17.0	2.1	43	-39
CHE	Zuerich	10.1	2.3	146	59	13.8	1.7	161	58	17.9	2.7	141	17
CHE	Genf	11.2	2.4	64	-1	15.3	2.3	96	19	19.9	3.4	45	-44
FRA	Bordeaux	14.2	2.9	27	-45	16.1	1.5	34	-43	20.8	3.0	44	-12
FRA	Marseille	14.2	1.0	51	3	18.9	1.8	1	-41	23.7	2.8	84	56
ESP	Madrid	15.1	2.9	47	-7	20.3	4.3	<1	-41	24.7	4.0	45	19
ESP	Mahon/Menorca	14.8	1.5	2	-48	19.0	2.2	12	-25	23.3	2.5	37	23
GBR	Gibraltar	17.3	1.1	29	-31	20.5	2.0	2	-33	22.1	1.0	2	-9
PRT	Santa Maria/Azoren	15.6	0.4	59	4	17.1	0.4	42	12	19.3	0.6	25	3
PRT	Lissabon	16.7	1.6	73	9	20.1	2.7	3	-36	22.2	2.0	12	-9
DEU	Berlin-Tempelhof	9.7	1.1	28	-13	13.9	0.0	16	-40	17.2	-0.2	50	-25
AUT	Wien	11.2	1.3	22	-29	15.3	0.7	50	-11	20.0	2.1	25	-49
CZE	Prag	8.3	0.6	33	-5	12.9	0.2	41	-36	16.1	0.2	33	-40
SVK	Sliac	9.3	0.8	21	-26	14.8	1.1	88	24	19.1	2.5	26	-59
POL	Elbing	6.7	-0.1	68	26	10.9	-2.0	31	-10	14.0	-1.4	38	-56
POL	Warschau	8.6	0.8	35	3	13.4	0.0	39	-20	17.7	1.1	20	-52
HUN	Budapest	11.8	0.7	6	-32	16.6	0.6	60	5	20.8	1.7	32	-31
SRB	Belgrad	13.2	0.8	31	-28	18.8	1.6	81	10	21.8	1.7	39	-51
SVN	Ljubljana	11.8	1.9	47	-62	16.9	2.3	115	-7	20.6	2.8	150	-5
HRV	Split	14.4	0.5	62	-4	20.4	2.0	86	30	24.3	2.1	49	-2
BIH	Sarajevo	9.1	-0.3	44	-30	15.8	1.7	53	-29	17.6	0.7	91	0
ROU	Bukarest	11.1	-0.2	58	12	17.9	1.2	24	-46	20.5	0.3	48	-29
BGR	Sofia	9.8	-0.1	41	-9	17.0	2.7	39	-34	17.6	-0.1	104	32
ITA	Pisa	12.8	0.3	53	-26	17.1	0.8	20	-39	22.0	2.2	22	-22
MLT	Luqa	15.9	0.4	5	-18	20.7	1.6	21	14	23.6	0.6	<1	-3
GRC	Athen	16.3	0.2	12	-13	21.9	1.3	7	-9	24.8	-0.3	9	2
GRC	Heraklion/Kreta	16.4	0.1	20	-10	20.8	1.0	1	-15	23.4	-0.1	<1	-3
RUS	Murmansk	0.9	2.8	36	15	7.0	3.2	53	21	9.8	0.4	82	29
EST	Tallinn	5.1	1.7	51	15	9.8	0.1	36	-1	13.5	-1.0	54	1
LVA	Liepaja	5.9	1.3	58	23	9.9	-0.4	50	10	13.7	-0.6	14	-32
LTU	Kaunas	7.1	1.1	46	3	11.5	-1.2	44	-12	15.4	-0.6	18	-57
LTU	Vilnius	6.8	1.1	60	14	11.4	-1.1	80	18	15.6	-0.2	16	-61
BLR	Minsk	7.3	1.3	60	18	12.7	-0.2	66	4	17.6	1.5	13	-70
RUS	Moskau	6.1	0.3	44	4	14.2	1.3	120	62	17.9	1.3	93	17
UKR	Kiew	9.7	1.0	5	-44	16.0	0.9	79	26	20.4	2.2	13	-60
MDA	Kisinev	10.2	0.0	47	5	17.7	1.6	15	-36	21.5	2.1	36	-39
UKR	Kharkiv (Charkow)	9.0	0.1	61	25	16.1	0.5	34	-13	21.4	2.5	72	14
RUS	Astrachan	10.9	-0.2	36	18	18.5	0.2	36	12	27.0	4.1	2	-20
ARM	Yerevan	13.9	1.2	49	12	17.6	0.1	48	5	24.6	2.7	11	-10
TUR	Samsun	10.6	-0.8	96	34	16.1	0.6	30	-19	21.1	1.1	80	35
TUR	Istanbul-Bölge	11.1	-0.9	122	73	19.2	2.7	56	25	21.9	0.8	90	69
TUR	Ankara	9.1	-2.1	25	-23	16.8	1.2	67	12	18.3	-1.3	134	97
TUR	Van	8.8	1.5	52	-2	13.4	0.6	69	19	18.8	1.2	5	-16
TUR	Antalya	16.1	0.0	22	-24	21.3	1.0	19	-9	23.9	-1.1	8	0
CYP	Larnaka	16.8	-0.6	12	1	22.0	1.1	<1	-7	24.3	0.0	1	0
KAZ	Uralsk	7.5	-0.2	36	17	16.9	0.8	25	4	25.3	5.1	27	-10
GEO	Tbilisi	11.0	-1.8	90	39	17.7	0.3	50	-28	23.9	2.7	151	75
SYR	Damaskus	15.8	0.3	2	-9	22.5	2.3	0	-4	24.2	-0.2	0	0
LBN	Tripoli	17.3	-0.2	53	-3	21.8	1.9	28	11	24.3	1.0	0	-1
ISR	Tel Aviv	18.4	0.2	45	22	23.3	2.2	<1	-3	24.6	0.6	0	0
ISR	Eilat	24.5	0.3	<1	-4	29.9	1.5	0	-1	30.9	-0.8	0	0
JOR	Mafraq	15.0	-0.8	8	-2	21.4	1.6	0	-3	22.4	-0.3	0	0
ESP	Las Palmas Can.	19.1	0.4	0	-6	22.0	2.1	0	-2	22.2	0.8	<1	<1

Table 6.2: continued

Country	Station name	July				August				September			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
NOR	Jan Mayen	5.8	1.6	28	-19	7.1	2.1	85	24	5.9	3.0	108	26
NOR	Svalbard/Spitzb.	8.1	2.1	5	-8	7.3	2.5	37	12	2.8	2.3	38	15
NOR	Tromsoe	11.1	-0.6	30	-42	12.7	1.8	49	-33	9.2	2.4	73	-21
NOR	Oslo	16.2	-0.2	89	5	16.5	1.3	131	41	12.5	1.7	158	68
SWE	Haparanda	14.4	-1.1	52	2	14.8	1.5	65	2	11.3	3.4	88	25
SWE	Stockholm	17.0	-0.2	92	20	18.3	2.1	17	-49	13.5	2.3	113	58
FIN	Sodankylä	12.0	-2.1	89	24	13.5	2.3	54	-9	9.5	3.6	72	17
FIN	Helsinki	16.3	-0.3	84	11	17.3	2.3	36	-44	12.7	2.7	49	-24
GBR	Aberdeen	13.7	-0.1	126	66	14.5	0.9	92	17	12.0	0.3	51	-17
GBR	London	18.8	1.0	72	26	18.2	0.8	117	66	14.4	-0.6	50	-1
IRL	Dublin	14.4	-0.5	63	9	14.3	-0.3	68	-10	12.0	-1.0	26	-43
ISL	Reykjavik	11.3	0.7	35	-17	10.9	0.6	66	4	9.1	1.7	77	11
GRL	Angmagssalik	7.0	0.6	9	-40	6.5	0.5	5	-56	4.8	1.7	211	143
DNK	Kopenhagen	17.4	0.2	54	-15	18.6	1.6	50	-13	14.3	0.7	75	13
NLD	De Bilt	18.4	1.6	92	17	18.5	1.8	114	43	13.4	-0.6	89	22
BEL	Brüssel	19.0	1.5	36	-39	19.4	2.1	69	6	13.5	-1.0	59	0
LUX	Luxemburg	20.3	3.4	30	-38	20.1	3.7	77	5	12.7	-0.7	122	52
CHE	Zuerich	22.2	4.6	40	-77	20.4	3.7	61	-72	13.2	-0.6	44	-48
CHE	Genf	24.2	5.1	29	-38	20.8	2.6	63	-16	14.8	-0.1	118	37
FRA	Bordeaux	22.4	2.2	35	-12	21.7	1.8	90	36	17.0	-0.9	35	-39
FRA	Marseille	27.0	3.2	<1	-14	24.6	1.4	55	26	20.1	-0.2	51	4
ESP	Madrid	29.7	5.3	4	-9	25.6	1.7	3	-6	20.7	0.2	9	-21
ESP	Mahon/Menorca	27.1	2.9	1	-3	25.8	1.3	14	-12	22.1	-0.1	181	127
GBR	Gibraltar	26.0	2.3	0	-1	24.8	0.6	0	-6	22.0	-0.8	2	-13
PRT	Santa Maria/Azoren	22.7	1.9	42	17	22.7	0.5	49	9	21.8	0.4	83	26
PRT	Lissabon	22.7	0.3	2	-3	22.8	0.0	2	-4	20.5	-1.2	4	-22
DEU	Berlin-Tempelhof	20.4	1.6	67	15	22.6	4.2	26	-35	14.8	0.2	32	-14
AUT	Wien	24.1	4.4	35	-28	23.6	4.7	45	-13	16.1	1.0	49	4
CZE	Prag	20.6	3.1	48	-18	22.0	5.0	63	-7	13.9	0.6	9	-31
SVK	Sliac	22.0	3.8	121	62	22.0	4.7	31	-38	15.9	2.5	59	3
POL	Elbing	16.5	-0.3	71	-23	19.8	3.1	12	-69	13.7	1.0	97	27
POL	Warschau	20.2	2.3	59	-8	23.1	5.8	8	-55	15.4	2.2	58	15
HUN	Budapest	24.1	3.2	63	11	23.9	3.6	95	44	17.7	1.3	83	43
SRB	Belgrad	26.5	4.8	11	-55	25.9	4.6	50	-2	20.1	2.4	101	50
SVN	Ljubljana	24.4	4.5	118	-4	22.3	3.2	96	-48	16.5	1.0	152	22
HRV	Split	29.5	4.1	14	-14	27.7	2.5	52	2	22.8	1.4	63	2
BIH	Sarajevo	23.0	4.1	9	-70	21.7	3.2	57	-14	17.6	2.5	60	-10
ROU	Bukarest	24.4	2.4	64	0	22.8	1.6	46	-12	18.6	1.7	103	61
BGR	Sofia	23.4	3.4	10	-46	22.4	3.0	63	11	18.7	2.9	86	47
ITA	Pisa	25.8	3.0	56	33	23.6	1.1	246	189	20.1	0.6	14	-75
MLT	Luqa	28.1	2.2	<1	<1	27.9	1.6	36	29	25.9	1.8	16	-24
GRC	Athen	29.3	1.5	14	9	29.2	1.6	1	-4	26.0	1.8	39	29
GRC	Heraklion/Kreta	26.3	0.6	0	-1	27.2	1.6	25	24	25.4	2.3	10	-8
RUS	Murmansk	9.9	-2.9	33	-27	12.5	1.5	76	11	9.6	2.9	40	-12
EST	Tallinn	15.9	-0.4	95	16	16.6	1.3	37	-47	13.0	2.2	48	-34
LVA	Liepaja	16.6	0.2	75	1	18.8	2.4	19	-61	14.4	1.5	93	15
LTU	Kaunas	17.4	0.3	72	4	20.2	3.9	7	-56	14.3	2.2	57	-2
LTU	Vilnius	17.3	0.4	68	-10	20.1	3.8	25	-47	13.7	2.1	55	-10
BLR	Minsk	18.7	1.4	52	-36	21.2	4.7	6	-66	14.5	2.8	100	40
RUS	Moskau	18.3	0.2	119	27	17.6	1.2	14	-60	13.8	2.9	88	24
UKR	Kiew	21.9	2.6	52	-36	22.6	4.0	3	-66	17.8	3.9	25	-22
MDA	Kisinev	24.4	3.5	41	-28	24.7	4.2	9	-36	20.0	3.8	26	-22
UKR	Kharkiv (Charkow)	21.4	1.1	106	46	21.6	2.1	2	-48	18.7	4.6	8	-33
RUS	Astrachan	26.5	1.2	10	-13	24.9	1.6	<1	-19	20.8	3.5	3	-23
ARM	Yerevan	27.7	1.7	0	-10	27.1	1.9	18	11	24.1	3.4	4	-6
TUR	Samsun	23.7	1.0	<1	-29	25.6	2.9	16	-17	23.2	3.6	40	-10
TUR	Istanbul-Bölge	25.5	2.3	<1	-19	26.7	3.7	8	-18	23.9	4.2	99	58
TUR	Ankara	24.3	1.4	5	-9	24.6	2.0	26	14	23.3	5.0	6	-13
TUR	Van	22.5	0.6	<1	-4	21.7	0.5	29	25	19.6	2.8	2	-8
TUR	Antalya	28.3	0.2	<1	-3	29.5	1.8	<1	<1	26.4	1.9	74	63
CYP	Larnaka	27.4	0.5	1	1	29.5	2.4	0	0	27.6	2.5	<1	<1
KAZ	Uralsk	22.7	0.2	24	-14	20.3	-0.1	10	-15	17.4	3.3	32	5
GEO	Tbilisi	25.4	1.0	6	-39	26.1	2.4	47	-1	22.8	3.2	0	-36
SYR	Damaskus	27.9	1.6	0	0	28.9	2.9	0	0	27.4	4.2	0	-1
LBN	Tripoli	26.6	1.6	0	0	28.8	3.2	0	-1	27.8	3.0	<1	-4
ISR	Tel Aviv	27.1	1.4	0	0	29.3	3.2	0	0	28.5	3.7	0	0
ISR	Eilat	34.2	1.3	0	0	35.8	3.0	0	0	33.7	3.3	0	0
JOR	Mafraq	25.7	1.6	0	0	27.7	3.5	0	0	26.6	3.9	0	-1
ESP	Las Palmas Can.	25.5	2.2	0	0	25.7	1.6	5	5	25.2	1.4	8	0

Table 6.2: continued

Country	Station name	October				November				December			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
NOR	Jan Mayen	2.6	2.5	75	-8	-0.6	2.6	70	4	-2.9	2.3	40	-25
NOR	Svalbard/Spitzb.	-1.8	3.7	31	16	-3.4	7.1	13	0	-6.0	7.3	48	36
NOR	Tromsoe	4.4	1.5	213	88	1.9	2.7	171	67	0.0	3.0	181	77
NOR	Oslo	7.2	0.8	8	-76	3.2	2.5	76	1	2.1	4.9	63	7
SWE	Haparanda	3.0	0.5	27	-37	1.2	5.3	131	73	-3.5	6.0	49	7
SWE	Stockholm	8.1	0.6	3	-47	5.0	2.4	65	12	4.1	5.1	23	-23
FIN	Sodankylä	0.6	0.9	38	-13	-2.5	4.9	72	33	-8.9	4.2	41	10
FIN	Helsinki	5.4	0.0	21	-52	4.6	4.5	64	-8	2.1	6.2	57	-1
GBR	Aberdeen	9.8	-0.1	93	16	6.9	1.9	67	-8	6.7	3.2	105	32
GBR	London	12.6	0.9	40	-18	10.9	3.7	48	-7	11.5	6.4	39	-18
IRL	Dublin	10.3	0.0	39	-29	8.6	1.9	114	44	8.6	3.3	206	129
ISL	Reykjavik	5.2	0.8	160	74	1.8	0.7	129	57	-0.2	0.0	100	21
GRL	Angmagssalik	0.2	1.0	115	33	-3.3	1.4	65	-31	-4.9	2.3	52	-51
DNK	Kopenhagen	10.2	0.3	22	-37	7.8	2.3	162	100	6.9	4.7	102	44
NLD	De Bilt	9.9	-0.6	33	-39	9.9	4.0	148	67	9.6	6.4	42	-38
BEL	Brüssel	10.2	-0.7	41	-29	10.1	4.0	104	28	9.7	6.2	57	-19
LUX	Luxemburg	8.8	-0.3	26	-49	7.5	3.7	68	-15	6.9	5.9	30	-50
CHE	Zuerich	9.2	-0.1	44	-25	7.8	3.9	64	-18	4.4	3.8	10	-63
CHE	Genf	10.1	0.0	36	-41	7.1	2.1	37	-55	3.9	2.1	13	-74
FRA	Bordeaux	13.3	-0.7	52	-36	12.3	3.2	52	-42	9.7	3.3	13	-86
FRA	Marseille	15.2	-0.9	53	-25	12.3	1.6	24	-34	11.8	4.5	6	-50
ESP	Madrid	15.8	1.0	61	16	12.1	2.7	31	-33	9.8	3.4	4	-47
ESP	Mahon/Menorca	18.6	0.1	43	-41	14.7	0.3	35	-42	13.2	1.4	1	-73
GBR	Gibraltar	20.5	1.0	139	75	17.7	1.6	79	-62	16.2	2.1	9	-137
PRT	Santa Maria/Azoren	19.0	-0.3	162	78	17.7	0.3	58	-44	15.9	0.5	158	63
PRT	Lissabon	18.5	0.0	141	61	16.0	1.5	29	-85	13.9	2.1	38	-70
DEU	Berlin-Tempelhof	9.0	-1.0	60	24	8.1	3.2	75	26	7.4	6.0	24	-29
AUT	Wien	9.9	0.0	80	39	8.4	3.8	38	-12	4.2	3.3	25	-18
CZE	Prag	8.2	-0.1	51	21	6.6	3.8	44	12	5.1	5.7	9	-17
SVK	Sliac	9.0	0.7	118	68	4.7	1.7	54	-15	1.7	3.4	9	-48
POL	Elbing	6.8	-2.1	23	-30	4.8	1.5	109	53	3.4	3.1	82	30
POL	Warschau	7.5	-0.8	40	2	5.3	2.1	53	11	4.7	5.6	17	-15
HUN	Budapest	10.2	-0.7	99	65	7.1	2.3	20	-32	2.7	2.3	3	-37
SRB	Belgrad	12.3	-0.1	72	32	9.1	2.1	63	9	4.2	1.9	4	-54
SVN	Ljubljana	11.0	0.6	127	12	6.8	2.2	45	-90	2.6	2.6	<1	-101
HRV	Split	17.3	0.4	208	129	13.6	1.4	42	-66	11.0	2.3	0	-100
BIH	Sarajevo	11.0	0.6	125	37	5.7	0.9	75	-16	-0.6	-0.4	2	-62
ROU	Bukarest	10.4	-0.4	70	38	7.1	1.9	108	59	2.9	2.7	2	-41
BGR	Sofia	10.3	-0.1	124	87	8.7	3.7	60	13	2.1	1.6	1	-38
ITA	Pisa	15.7	0.4	208	88	12.2	1.8	12	-112	9.3	2.5	13	-72
MLT	Luqa	22.5	1.8	102	12	18.0	1.0	102	22	14.4	0.6	46	-66
GRC	Athen	20.0	0.7	79	27	17.4	1.9	22	-28	11.9	-0.3	<1	-71
GRC	Heraklion/Kreta	21.6	1.9	29	-47	17.6	1.0	20	-39	14.0	0.2	8	-66
RUS	Murmansk	2.6	1.6	34	-8	-2.1	3.0	22	-18	-5.8	3.5	47	9
EST	Tallinn	5.9	-0.4	10	-60	4.8	3.6	57	-11	3.3	6.2	73	18
LVA	Liepaja	7.2	-1.3	6	-68	6.8	3.1	121	38	4.8	5.1	54	-13
LTU	Kaunas	6.2	-0.7	18	-33	4.9	2.8	96	43	2.5	4.9	61	17
LTU	Vilnius	5.6	-1.0	14	-39	3.9	2.7	98	41	1.6	4.5	62	7
BLR	Minsk	5.4	-0.9	32	-17	3.8	3.0	82	30	1.6	5.4	41	-12
RUS	Moskau	4.4	-0.6	21	-37	0.8	1.9	41	-17	0.2	6.3	61	9
UKR	Kiew	7.3	-0.8	40	5	4.7	2.6	69	18	1.9	4.2	25	-27
MDA	Kisinev	9.9	-0.2	63	36	7.1	2.7	73	34	3.0	3.3	2	-36
UKR	Kharkiv (Charkow)	5.8	-1.5	5	-30	4.0	2.7	62	18	0.4	3.8	56	11
RUS	Astrachan	8.8	-0.3	5	-12	4.9	1.6	17	-2	2.1	4.0	41	26
ARM	Yerevan	14.5	1.3	103	76	7.2	0.7	13	-9	-0.2	-0.4	29	6
TUR	Samsun	17.4	1.8	72	-13	14.5	2.0	31	-58	8.4	-0.8	100	18
TUR	Istanbul-Bölge	17.1	1.8	92	21	14.5	2.9	24	-65	8.2	0.1	33	-89
TUR	Ankara	14.5	1.9	42	15	8.7	1.6	22	-11	0.0	-2.5	6	-43
TUR	Van	12.6	2.5	113	65	5.4	1.4	48	4	-1.9	-0.8	41	7
TUR	Antalya	22.5	2.9	66	-4	16.2	1.4	128	-6	13.2	1.8	15	-212
CYP	Larnaka	23.5	2.2	34	15	18.9	2.5	<1	-44	13.8	0.6	117	41
KAZ	Uralsk	4.5	-0.6	26	-4	0.3	2.4	77	42	-2.4	6.0	32	3
GEO	Tbilisi	14.1	0.6	76	38	8.3	0.2	42	12	5.1	1.3	3	-18
SYR	Damaskus	21.0	2.9	9	-3	13.0	1.2	14	-8	6.8	-0.4	2	-24
LBN	Tripoli	23.9	1.7	129	58	18.2	-0.1	99	-14	13.0	-1.1	121	-59
ISR	Tel Aviv	24.5	2.5	76	50	20.2	2.2	63	-5	14.0	0.2	110	-28
ISR	Eilat	29.0	2.3	8	4	23.7	2.2	2	-1	16.3	-0.3	0	-6
JOR	Mafraq	21.9	2.8	16	9	14.6	1.1	20	3	8.5	-0.3	30	2
ESP	Las Palmas Can.	24.2	1.7	114	104	22.5	2.1	5	-16	20.6	2.3	4	-17

7. References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2015 edition of the Bulletin, are listed on page 3 above. Many contributions or also additional information may as well be found on the web, see below.

Austria: Zentralanstalt für Meteorologie und Geodynamik (**ZAMG**), Wien, Wetterrückblick

Belgium: The Royal Meteorological Institute of Belgium (**KMI**), Klimatologisch overzicht

Bosnia and Herzegovina: Federal Meteorological Institute (**METEOBIH**), Bilten 2015.

Croatia: Meteorological and Hydrological Service (**DMHZ**) Annual reports

Czech Hydrometeorological Institute (**ČHMÚ**) News

Denmark: Danish Meteorological Institute (**DMI**), Vejret i Danmark

Estonian Weather Service: Estonian weather events in 2015

Finnish Meteorological Institute (FMI) Press release

France: Météo-France, Toulouse, Bilan climatiques

Germany: Deutscher Wetterdienst (**DWD**), Klimatologische Jahresübersicht

Greece: Hellenic National Meteorological Service, Climatic bulletin

Greece: National Observatory of Athens, Meteorological bulletin

Hungarian Meteorological Service (**OMSZ**), Climate retrospective

Icelandic Met Office: The weather in Iceland 2015- Climate summary

Ireland: The Irish Meteorological Service (**MET Éireann**), Weather Summary

Israel Meteorological Service (**IMS**): Weather summary in Israel

Italy: Servicio **Meteo AM**, Bolletino annuale - Report Italy

Italy: Agenzia Regionale per la Protezione Ambientale (**ARPA**), Rapporti annuali

Latvian Environment, Geology and Meteorology Centre Monthly bulletins

Luxembourg: MeteoLux, Bilans climatologiques annuels (http://meteolux.lu/fr/produits-et-services/bilans-climatologiques/bilans-climatologiques-annuels/)

Lithuanian hydrometeorological Service (**Lhmt**) http://www.meteo.lt/lt/web/guest/naujienos

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Montenegro: Hydrological and Meteorological Service of Montenegro Annual reports

Netherlands: Royal Netherlands Meteorological Institute (**KNMI**), DeBilt, Jaaroverzicht van het weer in Nederland

Norway: Det Norske Meteorologiske institutt (**DNMI**), Klimatologisk månedsoversikt

Poland: Institute of Meteorology and Water Management National Research Institute (**IMGW**), Monthly climate monitoring bulletin (supplement)

Portugal: Instituto portuguesa do mar e da atmosfera (**ipma**), Bolletim Climatológico Anual

Romania: Administrația Națională de Meteorologie, Monitorizare climatica

Russia: Hydrometeorological Centre of Russia (**Roshydromet**) Annual bulletin

Serbia: Republic Hydrometeorological Service of Serbia (**RHMZ**) Annual Bulletin for Serbia

Slovak hydrometeorological institute (**SHMU** Slovenský hydrometeorologický ústav) Bulletin Meteorológia a Klimatológia

Slovenian Environment Agency (**ARSO,** Agencija Republike Slovenije za okolje): Mesečni bilten ARSO

Spain: Agencia Estatal de Meteorología (**AEMET**), Resumen anual climatologico

Swedish Meteorological and Hydrological Institute (**SMHI**), Året (year)

Switzerland: Federal Office of Meteorology and Climatology **MeteoSwiss**, Klimabulletin

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United Kingdom: **Met Office** Climate summaries

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9. Abbreviations

AO	Arctic Oscillation (circulation indices)
BAMS	Bulletin of the American Meteorological Society
CLIMAT	monthly climatological data provided by the NMHSs via GTS
DWD	Deutscher Wetterdienst (German Meteorological Service)
EA	East Atlantic Pattern (circulation indices)
EA/WR	East Atlantic/West Russia Pattern (circulation indices)
ECA&D	European Climate Assessment & Dataset, located at Royal Netherlands Meteorological Institute (KNMI)
EMCC	Eastern Mediterranean Climate Centre
E-OBS	daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D information
GCC	Global Collection Centre operated by the Deutscher Wetterdienst
GPCC	Global Precipitation Climatology Centre located at the Deutscher Wetterdienst
GTS	Global Telecommunication System
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (Italian National Institute for Environmental Protection and Research)
m a.s.l.	Meter above sea level
NAO	North Atlantic Oscillation (circulation indices)
NMHSs	National Hydro-Meteorological Services
POL	Polar/Eurasia Pattern (circulation indices)
PDSI	Palmer Drought Severity Index
RCC-CM	WMO Regional Climate Centre Network (RA VI) Offenbach Node on Climate Monitoring
SCA	Scandinavia Pattern (circulation indices)
SCE	Annual snow cover extent
SYNOP	surface synoptic or weather observations provided by the NMHSs via GTS
WCDMP	World Climate Data and Monitoring Programme
WMO RA VI	WMO Regional Association VI (Europe and Middle East)
WMO	World Meteorological Organization

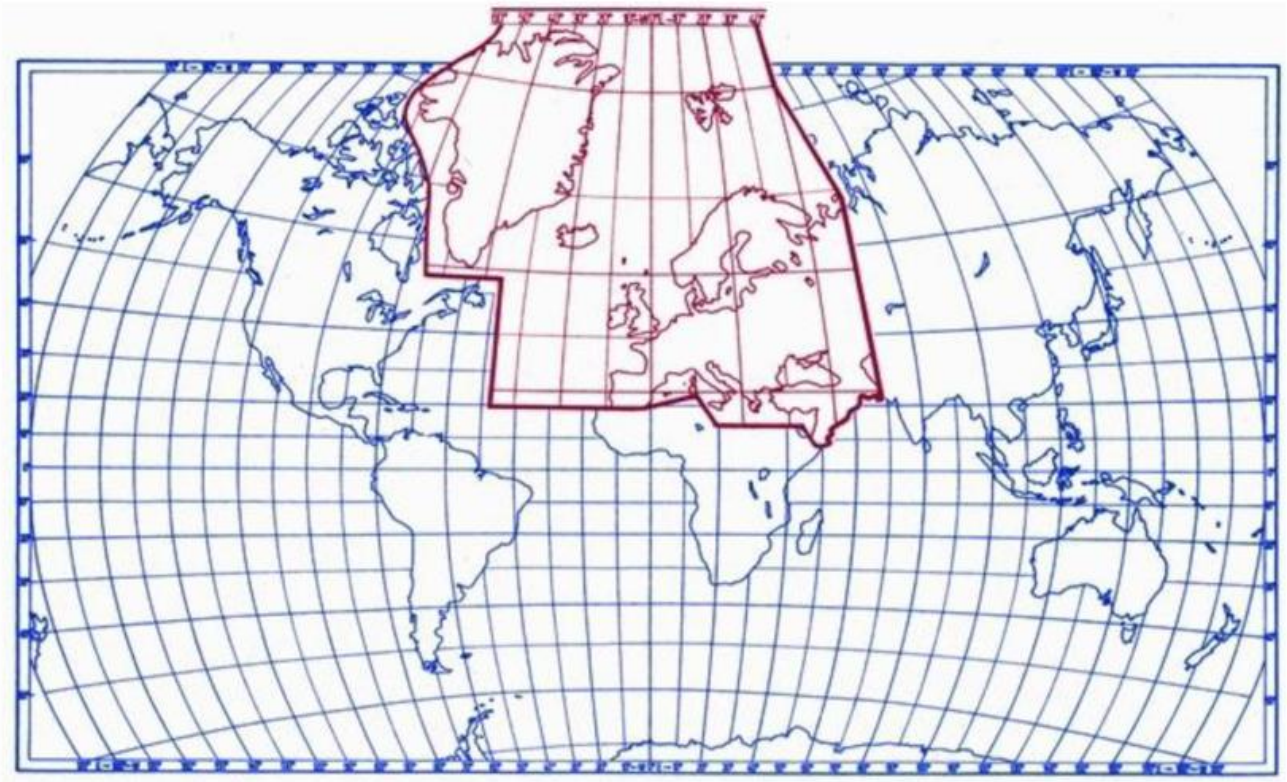
WMO RA VI
RCC Network

DWD

Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2016



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1. Introduction

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East with 50 Members) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official Websites. Supported by the European Climate Support Network (ECSN) and WMO´s World Climate Data and Monitoring Programme (WCDMP) the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's Annual Statement on the Status of the Global Climate and the State of the Climate published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ among the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the Webpages of the RA VI RCC Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

This annual bulletin includes 4 parts: the annual, seasonal and monthly survey of the climate state in 2016 as well as contributions of the NMHSs to the long-term variability of selected parameters up to 2016 (section 5).

Notes:

Maps of the RA VI RCC Network are based on the following data sources:

- Temperature: CLIMAT data and ship observations provided by the Global Collecting Centre (GCC), operated by the Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC), operated by the Deutscher Wetterdienst
- Sunshine: CLIMAT data.
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC Node-CD) via the European Climate Assessment & Dataset project (ECA&D) run by Royal Netherlands Meteorological Institute (KNMI)

Sub-regional monthly maps are provided by the Eastern Mediterranean Climate Centre (EMCC).

The following sub-regions are used in this Bulletin:

Central and western Europe (14 countries): *Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, the Netherlands, Poland, Slovakia, Switzerland, and United Kingdom*

Nordic and Baltic Countries (9 countries): *Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, and Sweden*

Iberia (2 countries): *Portugal, and Spain*

Mediterranean, Italian and Balkan Peninsula (12 countries): *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Slovenia, and Turkey*

Eastern Europe (5 countries): *Belarus, European Russia, Moldova, Romania, and Ukraine*

Middle East (9 countries): *Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, and Western Kazakhstan*

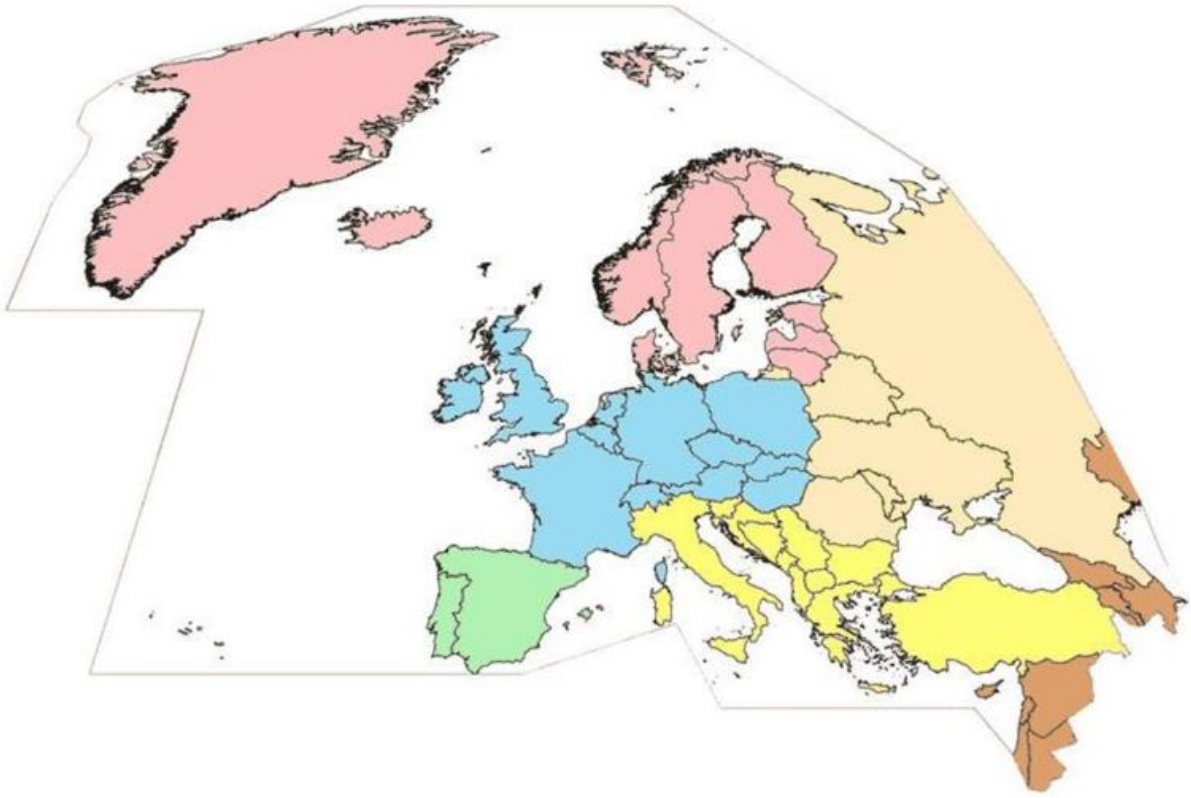


Figure 1.1: Definition of the 6 sub-regions used in this bulletin.

Box 1

Notable anomalies and events 2016

Anomalies

Temperature

- Record breaking year in many European countries (see Table 2.1).
- Cold spell at the end of April 2016 in Central Europe and the Balkans with significant agricultural damage.
- July to September extremely warm period in Portugal.
- Heat waves in Israel in April 2016.
- Several heat waves over central and southern Europe from June to September (The highest temperatures of 45.4°C was recorded at Cordoba, southern Spain, on 6 September).

Precipitation

- For Scotland, Wales and Northern Ireland the wettest, or equal-wettest winter on record.
- Extreme precipitation with flash floods in Central Europe during May and June.
- France noticed its driest July and August on record.
- Up to 600% of rain in Eastern Europe in October.

Sunshine Duration

- Central Europe experienced a very sunny December with more than 200% of normal.

Other Anomalies

- Early melting of Greenland's ice sheets due to record high temperatures.
- New pressure record of 1050.7 hPa in October 2016 in Sweden.

Events:

- Several winter storm series passed Europe from January to March 2016.
- Intense thunderstorms, extreme precipitation and floods in Central Europe in May and June 2016.

2. Annual survey

The climate of 2016 was characterised by a broad range of spatial and temporal anomalies outlined in Box 1 and Figure 2.5. This section presents an overview of the spatial patterns of mean annual climate conditions in 2016 and anomalies related mainly to the normal period 1961-1990 of the selected essential climate variables: sea level pressure, surface air temperature, precipitation, sunshine duration and snow. Sub-section 2.1.4 reveals climate extremes for individual countries. Long-term trends in temperature and precipitation indices offers section 2.2.

More detailed insight into the long-term variability of temperature, precipitation and also some other parameters from the individual countries are presented in section 5.

2.1. Annual averages and anomalies of selected essential climate variables

2.1.1. Sea level pressure

Generally, mean annual sea level pressure distribution in 2016 over the WMO Region VI is dominated by a low pressure trough in the polar area with the Icelandic low that extended from southern Greenland to Iceland. The second pressure system, the subtropical high pressure belt, extended from the centre over the Azores (Azores high) across southern and central Europe to European Russia.

In 2016 the mean sea surface pressure differs to some extent from the long-term mean with a reduced pressure especially in a region over and surrounding Greenland with anomalies of -2 to -4 hPa. South-eastern Europe also shows below normal anomalies. Higher pressure anomalies of up to +2 hPa occurred over southern and central Europe as can be seen from Figure 2.1 (right; normal period 1961-1990) indicating a stronger than normal NAO.

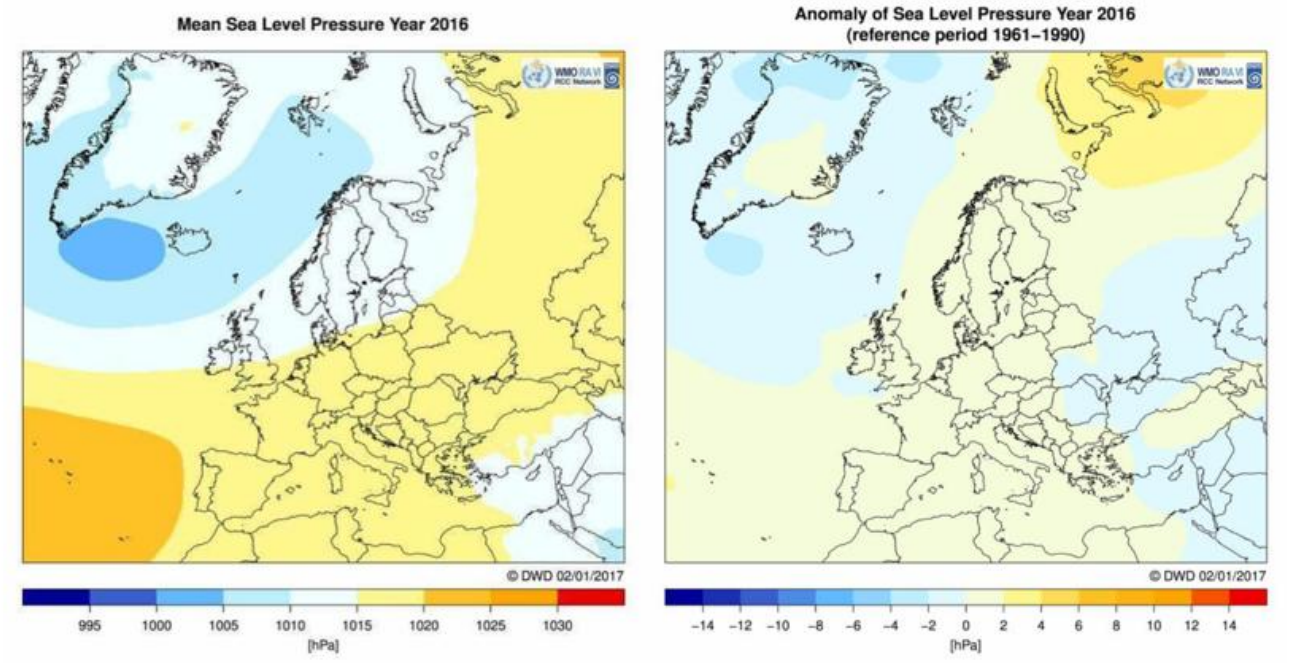


Figure 2.1: Annual mean of sea level pressure (left) and anomalies (right) for the year 2016 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.2. Temperature

In the entire European region (35°–75°N, 25°W–45°E) the year 2016 was warmer than normal with an anomaly of +0.58°C (base period 1981-2010) according to the E-OBS dataset. Many of the European countries reported new records (Table 2.1).

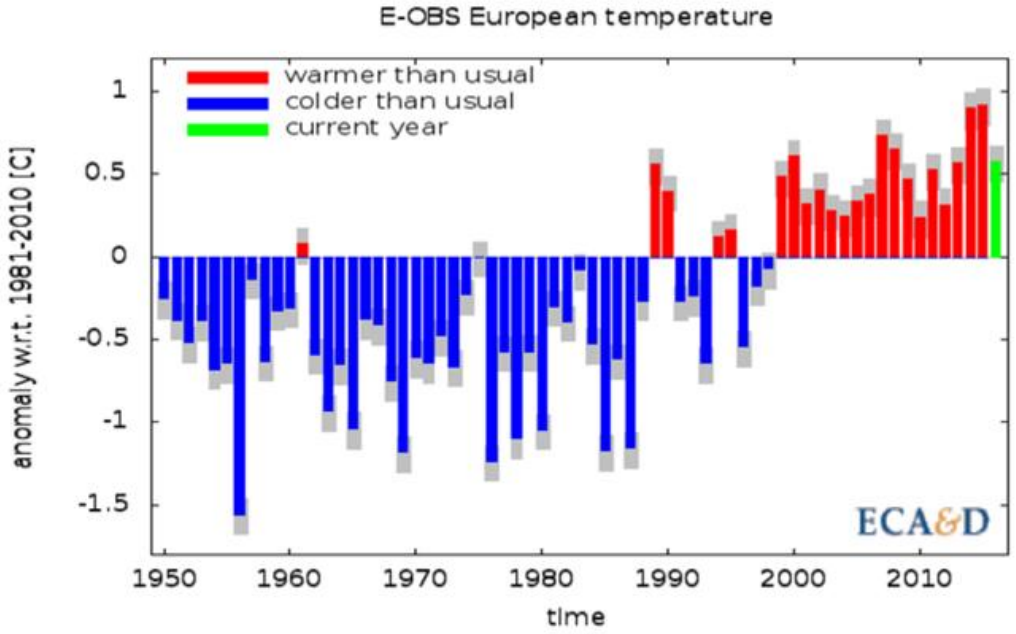


Figure 2.2: Annual temperature anomalies 1950-2016 for Europe (land area; 35°N-75°N and 25°W-45°E, reference period 1981–2010; based on the E-OBS dataset, van der Schrier et al. 2013). Grey bars indicate uncertainty of the value. (Source: Royal National Meteorological Institute Netherlands, KNMI).

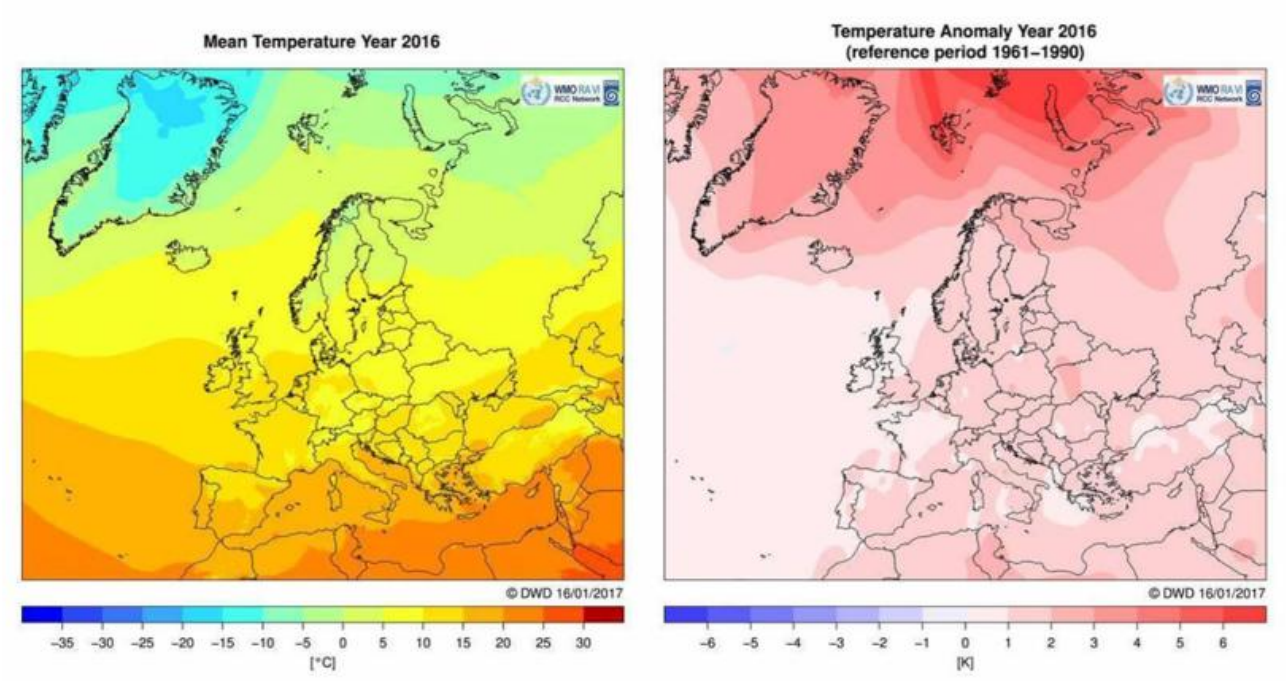


Figure 2.3: Mean annual temperature in °C (left) and anomalies (right) for 2016. (reference period 1961-1990, source: http://www.dwd.de/rcc-cm).

The highest annual anomaly of 2.71°C referred to 1961-1990 was observed in the sub-region Nordic and Baltic countries followed by Eastern Europe (1.89°C), the Middle East (1.46°C), Mediterranean, Italian and Balkan Peninsula (1.37°C) and Central and Western Europe (1.22°C). The sub-region Iberia showed the lowest anomalies of 1.21°C (Table 3.2). Most of the months in 2016 were warmer than normal (1961-1990) with remarkably consistent deviations of more than +4°C especially in northern Europe (cf. section 3.1.2 and 4.2).

The global annual land and ocean surface temperature for 2016 increased also to a record high 0.45°–0.56°C above the 1981–2010 average (Blunden und Arndt 2017) or 0.83°C ± 0.1 0°C warmer than the average for the 1961–1990 reference period (WMO 2017).

Table 2.1: Rank statistics and anomalies of annual temperature in 2016 from some participant countries as reported by the National Meteorological and Hydrological Services (NMHSs).

Country	Rank of annual temperature in 2016	start of time series	Anomaly in °C	Reference period
Europe (35°–75°N, 25°W–45°E, E-OBS)	6	1951	0.58	1981-2010
Armenia	-		0.8	1961-1990
Austria	4	1767	1.8	1961-1990
Belarus	8	1881	1.0	1961-1990
Belgium	19	1883	0.2	1981-2010
Bosnia and Herzegovina	10	1888 (Sarajevo)	1.4	1961-1990
Croatia		1862 (Zagreb)	1.6	1961-1990
Cyprus			1.1	1981-2010
Denmark	11 (with 1949, 1992, 2011)	1874	1.3	1961-1990
Estonia			1.6	1961-1990
Finland	11	1900	1.8	1981-2010
France	10	1900	0.5	1981-2010
Georgia			0.0–2.0	1961-1990
Germany	8 (with 1934, 1989, 1990, 1999, 2006 and 2008)	1881	1.3	1961-1990
Hungary	11	1901	0.9	1961-1990
Iceland	2 (with 2014)	1871 (Reykjavík)	1.7	1961-1990
Ireland	17	1900		
Israel	2	1951	~1.6	1961-1990
Kazakhstan	5	1936	1.8	1961-1990
Latvia	11	1924	1.5	1961-1990
Lithuania			0.7	1981-2010
Luxembourg			1.5	1961-1990
Moldova	4	1887 (Chisinau)	1.6	1961-1990
Netherlands	10	1901(de Bilt)		
Norway	10	1900	1.5	1961-1990
Portugal	11	1931	0.65	1971-2000
Romania		1901	0.7	1981-2010
Russia, European	6	1939	1.75	1961-1990
Serbia	12	1951	0.82	1961-1990
Slovakia	6-7	1872	1.6	1961-1990
Slovenia		1951	0.5–1.5	1961-1990
Spain	6	1965	0.7	1981-2010
Sweden	14	1860		1961-1990
Switzerland	8	1864	1.5	1961-1990
Turkey	4	1971	1.0	1981-2010
Ukraine	5	1951	1.7	1961-1990
United Kingdom	below 10	1910	0.5	1981-2010

2.1.3. Precipitation

The annual precipitation amount was close to normal over many parts of continental Europe except for northern Scandinavia and parts of eastern and south-eastern Europe, where positive anomalies above 10 mm/month were recorded. Parts of Iberia, France, Italy, southern Scandinavia and southern Turkey showed drier conditions with anomalies below -10 mm/month and also values below the 0.1 percentile indicating a drought situation. The annual figures of the year 2016 give only rough hints of the regions with outstanding precipitation events. Detailed descriptions can be found in the seasonal (3.1.3) and monthly survey (4.3).

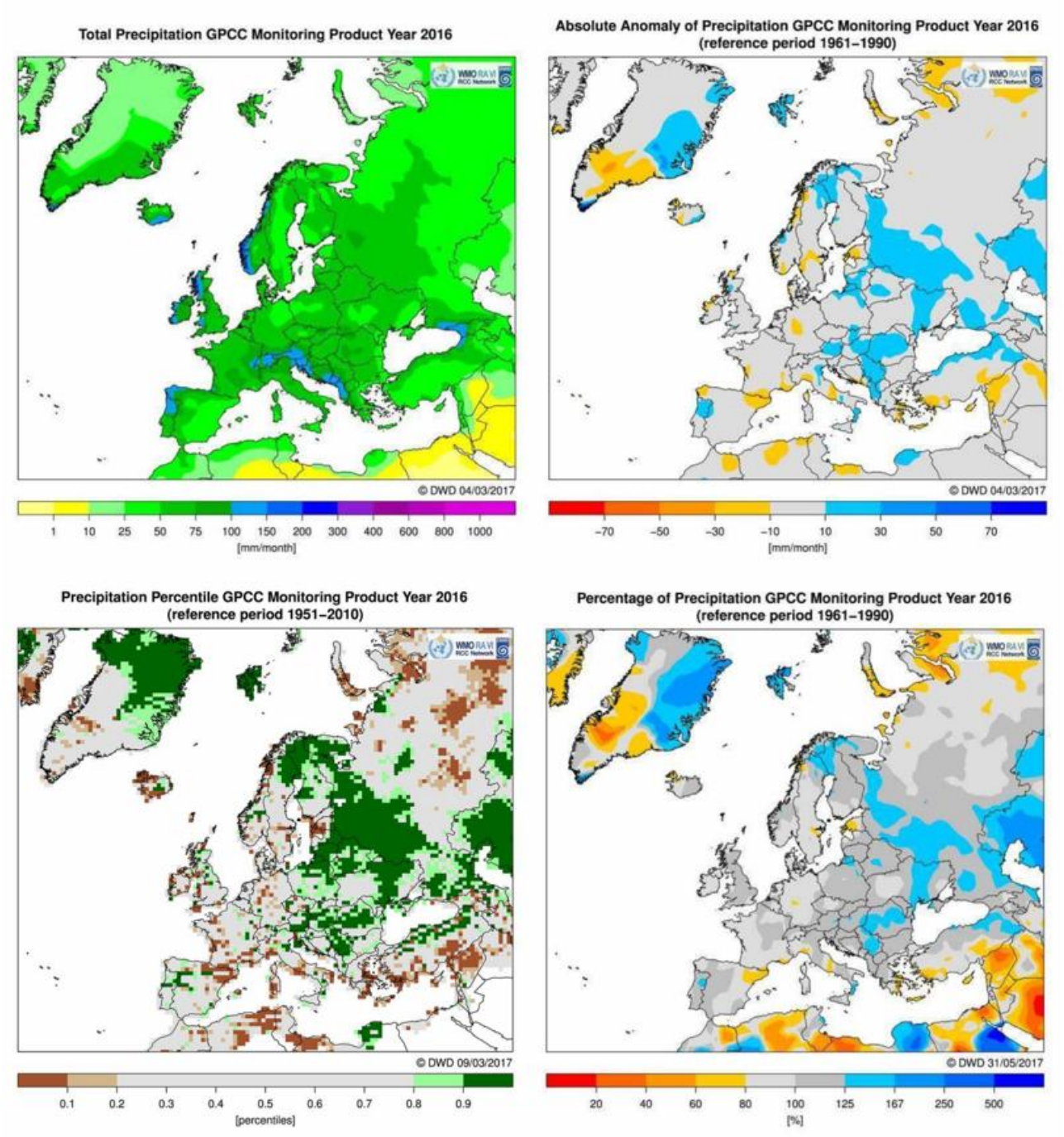


Figure 2.4: Total precipitation (left, top), anomalies (right, top) in mm/month, percentiles (left, bottom) and percentage of precipitation in % (right, bottom) for 2016. (reference period 1961-1990; source: http://www.dwd.de/rcc-cm).

2.1.4. Annual extreme values of temperature and precipitation

In this section an overview is given for the temperature spread and the extreme precipitation for each country. Absolute annual extreme values for 2016 of temperature (minimum and maximum), maximum of total daily precipitation and maximum of total 5 consecutive days with precipitation for each country in the WMO Region VI are given in Figure 2.5.

The spatial pattern of extreme temperature corresponds roughly to those of the temperature anomalies of 2016. The highest maximum temperatures (above 40°C) occurred primarily in sub-regions Middle East, Mediterranean, Italian, France and Iberian Peninsula. Maximum temperatures higher than 35°C were reported from most of the countries in central and eastern Europe, but also from the Balkans. The one-day precipitation totals (RX1) of more than 150 mm for individual countries are documented in several sub-regions; the highest value occurred in Slovenia (236 mm/day). Highest total precipitation on 5 consecutive days (RX5) (above 300 mm) was measured in Slovenia (429 mm), Italy (366 mm, only synoptic stations), Portugal (355 mm), France (354 mm), Turkey (334 mm) followed by Spain (321 mm).

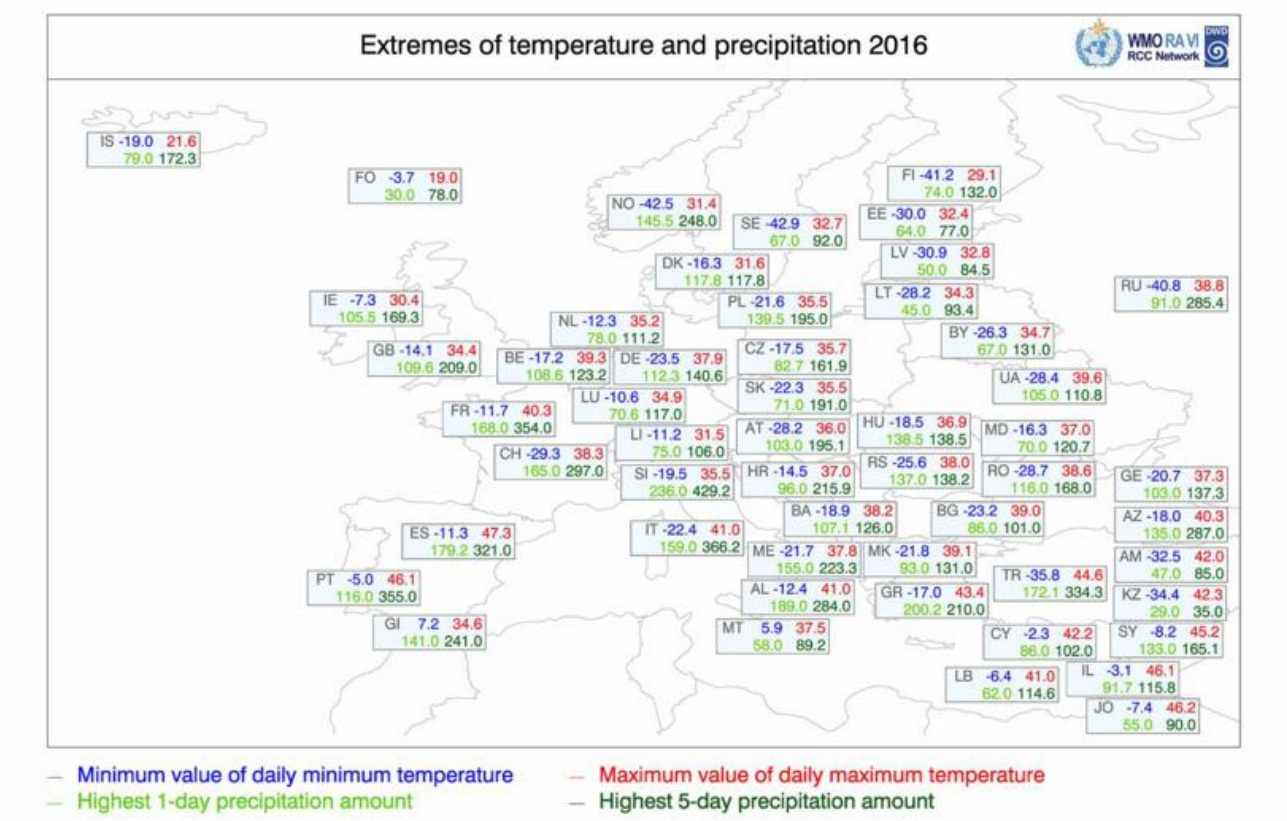


Figure 2.5: Annual extreme values for each country in 2016: first row: Internet country code, lowest daily minimum temperature (in °C, blue) and highest daily maximum temperature (in °C, red); second row: maximum daily precipitation totals (in mm, light green) and maximum 5-daily consecutive precipitation totals (in mm, dark green).

Note: Data (by order or priority) from reports of NMHSs, GPCC, ECA&D or SYNOP; the countries are represented by their Internet country codes. (Source: http://www.dwd.de/rcc-cm)

2.1.5. Sunshine duration

As expected, the annual sum of sunshine duration in 2016 showed from the south to the north generally gradual decreasing values. More than normal sunshine hours have been primarily noted in western, Central and southern Europe except in Portugal. Finland and north-eastern Europe had a sunshine deficit.

2016 was a sunny year in the Netherlands with a country-average of 1881 hours of sunshine, compared to the long time average of 1643 hours. June was the only month of the year with below average number of sunshine hours. The coastal station of Den Helder in the northwestern part of the Netherlands was the sunniest place. 2046 hours were recorded, almost 300 hours more than normal.

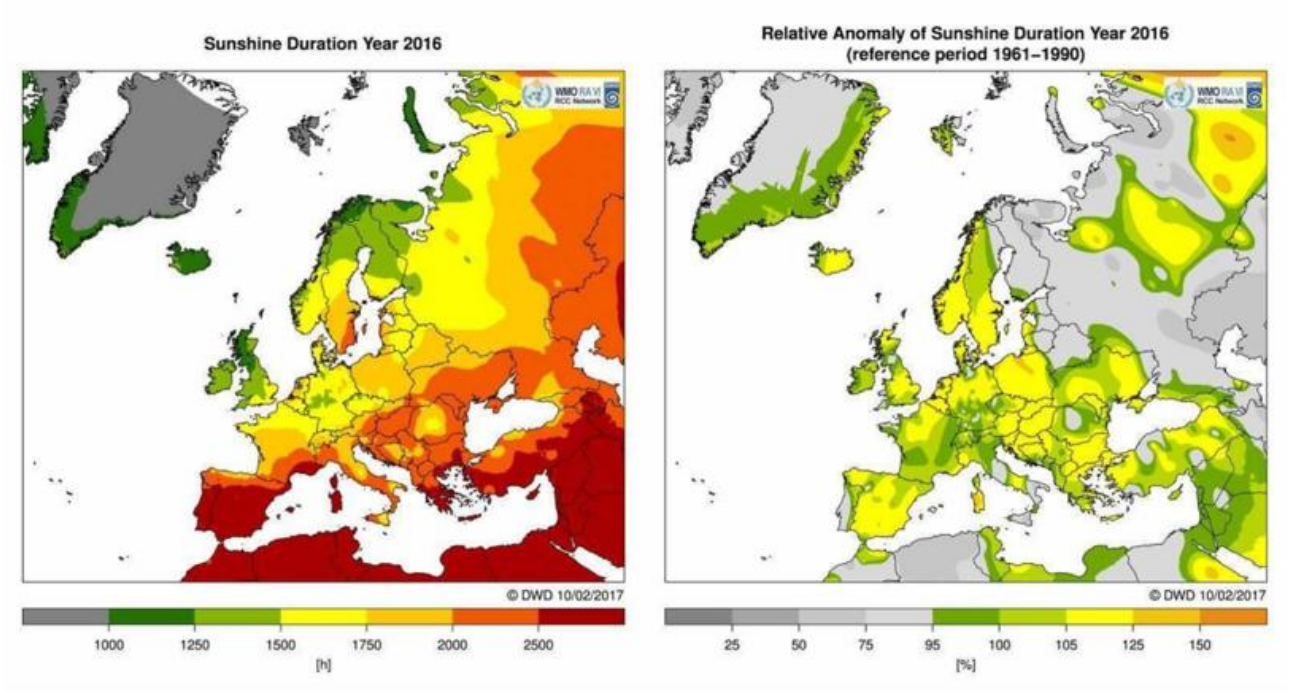


Figure 2.6: Annual sum of sunshine duration (left) and relative anomalies (right) for the year 2016 in hours with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.6. Drought situation

The drought index (SPI) in 2016 differed only slightly from its normal values. The anomalies in southern Europe, northern Germany and southern Sweden were slightly below normal while most of Europe was slightly wetter. In these areas annual precipitation was above normal linked with floods.

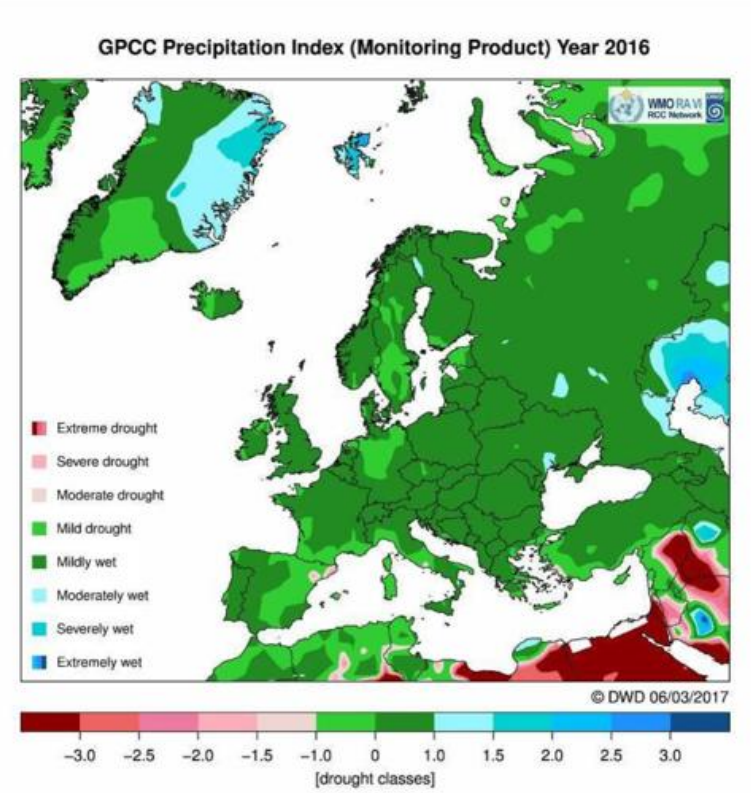


Figure 2.7: Annual modified Standardized Precipitation Index (DWD-SPI) for the year 2016 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.7. Snow cover

The snow-season 2015/2016 (September 2015 – August 2016) was warmer than normal and consequently in many low land areas in western and southern Europe no snow occurred at all. Apart from mountain areas, in central Europe partly occasional snow fall events occurred in November. As expected, towards northern and eastern Europe snow cover duration was longer and ended in April and May. In Switzerland, towards the end of the year, a stable zone of high pressure with a record lack of precipitation led to a significant lack of snow in mountains.

Last snow in low land areas over central Europe and Balkans occurred during last decade of April 2016 due to a cold wave in these regions. On April 28th the air temperature in Austria dropped below 0°C and in the lowlands of Carinthia and Styria a fresh snow cover was observed. In Klagenfurt (450 m) the depth of the snow cover was 15 cm. In these regions such an amount of fresh snow at the end of April was measured at last about 30 years ago.

Due to the high temperature in January in Austria the amount of days with snow cover below an elevation of 1000 m were 50 % lower than the average. However, the amount of fresh snow in the alpine regions north of the alpine ridge was 30 to 40 % above the average.

At the end of January 2016 there was a snow layer in Romanian mountains of up to 117 cm (Bâlea Lake), in southern Wallachia and northern Dobrudja (less than 8 cm). At the end of March, snow

layer was still present in high mountain areas of Romania, above 2000 m.a.s.l. measuring up to 155–160 cm.

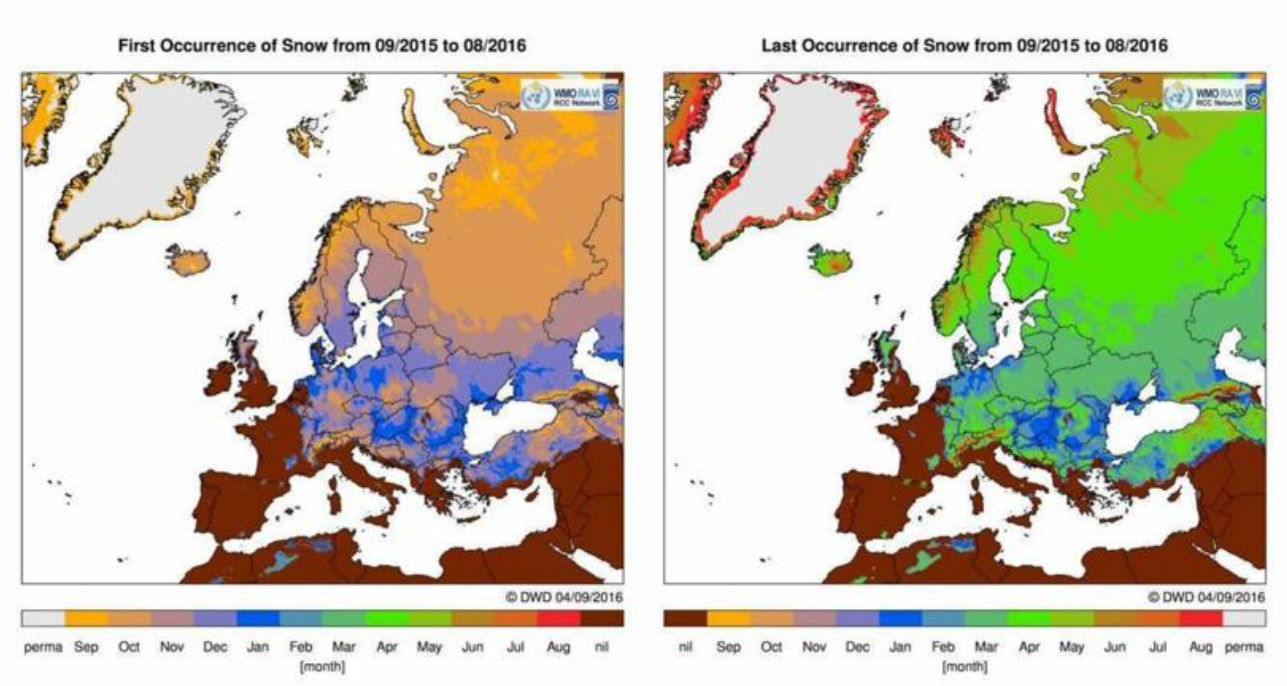


Figure 2.8: First occurrence of snow (left) and last occurrence of snow (right) during the snow-season 2015/2016. (Source: http://www.dwd.de/rcc-cm).

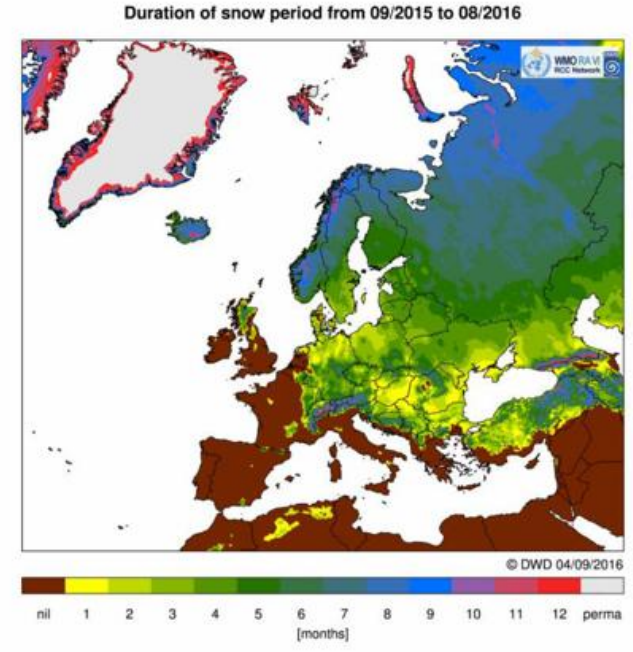


Figure 2.9: Duration of snow cover in the snow-season 2015/2016. (Source: http://www.dwd.de/rcc-cm).

2.2. Trends of temperature and precipitation indices 1951-2016

This section presents trends for selected temperature and precipitation indices for the period 1951-2016.

In northern, north-western and eastern Europe most stations showed an increase in the annual number of wet days (RR1) for the last 66 years while in southern Europe a decreasing trend prevailed. The decreasing and increasing trend at neighbouring stations, however, indicate inhomogeneities in the time series. The number of warm and wet days (WW) increased over whole Europe with exception of Greece. The annual numbers of summer days (SU) increased in Central and southern Europe while in north-western and northern Europe no significant changes were observed. Annual numbers of tropical nights (TR) showed increasing tendencies in the south-east part of Region VI while the north-western part noted no significant changes.

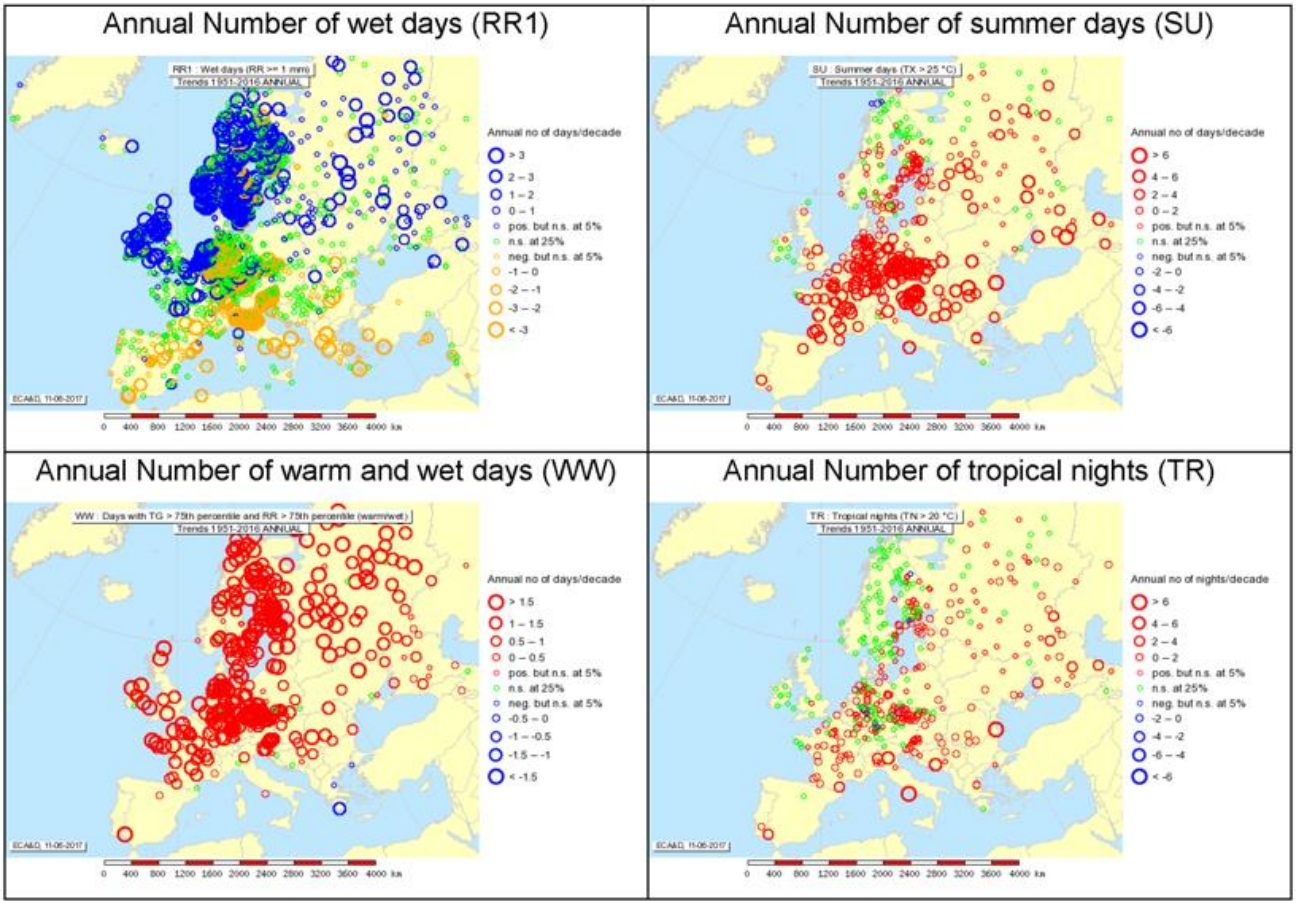


Figure 2.10: Trends of Selected Climate Indices 1951 to 2016 (Source: ECA&D, http://www.ecad.eu).

Legend of Figure 2.10:

1. **RR1, Number of wet days**: count of days where RR (precipitation > 1 mm)
   Precipitation below 1 mm/day has no effect on vegetation because it normally evaporates on the same day and is locally effected.
2. **SU, Number of summer days**: count of days where TX (daily maximum temperature) ≥ 25°C
3. **WW, Number of warm and wet days:** days with TG (daily mean temperature) > 75th percentile and RR > 75th percentile
4. **TR, Number of tropical nights**: count of days where TN ≥ 20°C

2.3. Socio-economic impacts of extreme climate or weather events

North of Belgium (Flanders) was recognized as disaster area due to continuous and intense rainfall between the 27th of May and the 26th of June. Three persons were surprised by flash floods and died. The total amount of the damages was estimated at € 248.000.000 (90 % of the damages caused by flooding were agricultural damages).

27.-30.5.2016: Flash floods with severe storms: Germany, France and Netherlands; 8 people died. Overall loss was summed up by Munich Re to 1,400 Million US$. Dozens of houses, businesses, public buildings were damaged or destroyed. Bridges were destroyed, highways, roads, railways were blocked. Automobile plant flooded, production suspended. Crops were damaged or destroyed.

30.5.-8.6.2016: Floods in France; 5 people died. Overall loss was summed up by Munich Re to 2,400 Million US$. Rivers (Seine, Loing, Yonne) burst their banks. Numerous towns and villages were flooded. Thousands of buildings and businesses were damaged. Power outages, 25,000 customers without electricity. Farmland, vineyards were destroyed.

31.5.-7.6.2016: Flash floods and severe storms: Germany, Belgium and Switzerland; 9 people died Overall loss was summed up by Munich Re to 2,200 Million US$. Torrential rain, rivers burst their banks. Thousands of houses were damaged. Basements, underground car parks were flooded. 9,000 customers were without electricity.

22.-24.6.2016: Hailstorm Netherlands and Germany. Overall loss was summed up by Munich Re to 1,900 Million US$. Hundreds of vehicles were damaged. Solar panels were destroyed. Damage to greenhouses and agriculture.

The whole island of Madeira (Portugal) was stricken by forest fires on the 8th to 10th of August, with major impact in urban areas around Funchal. Economic losses were estimated to about 60 million Euros. Hundreds of homeless persons, thousands of displaced persons and a lot of damages (buildings, infrastructures, …)

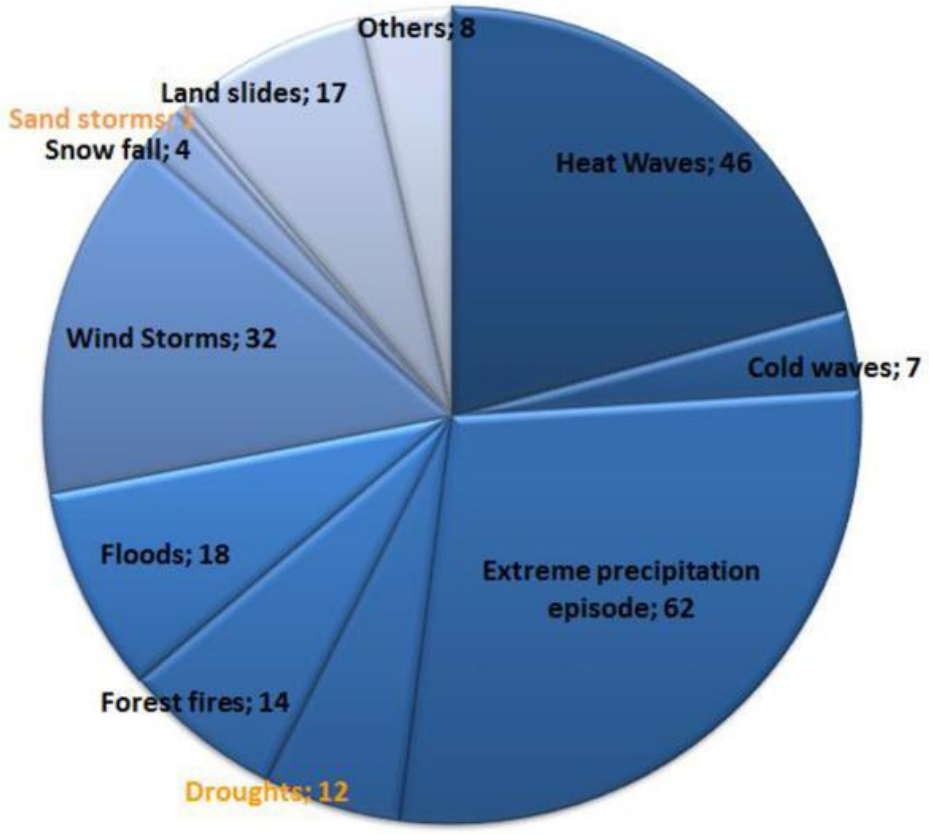


Figure 2.11: Observed extreme weather or climate events in 2016 based on 29 reports from NMHSs (total events reported for 2016: 221).

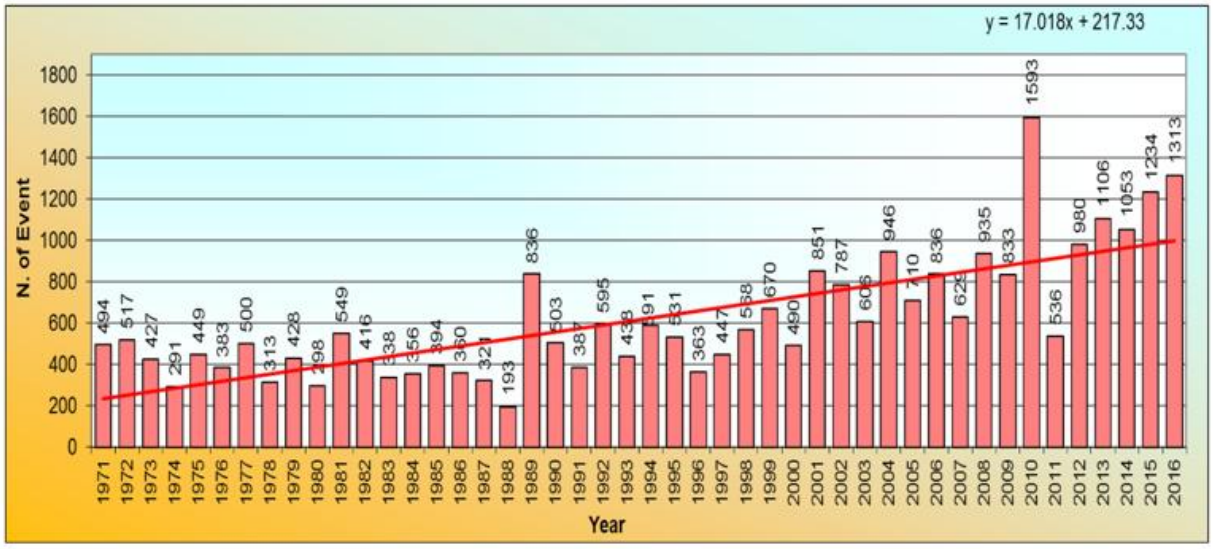


Figure 2.12: Annual count of extreme events per station occurred in Turkey from 1971-2016 (Diagram as provided by the NHMS).

The number of extreme events in Turkey in 2016 reached 1,313. (Figure 2.12). There is an increasing trend in extreme events (+17.0 events/year), possibly partly also due to improved observations and communication means.

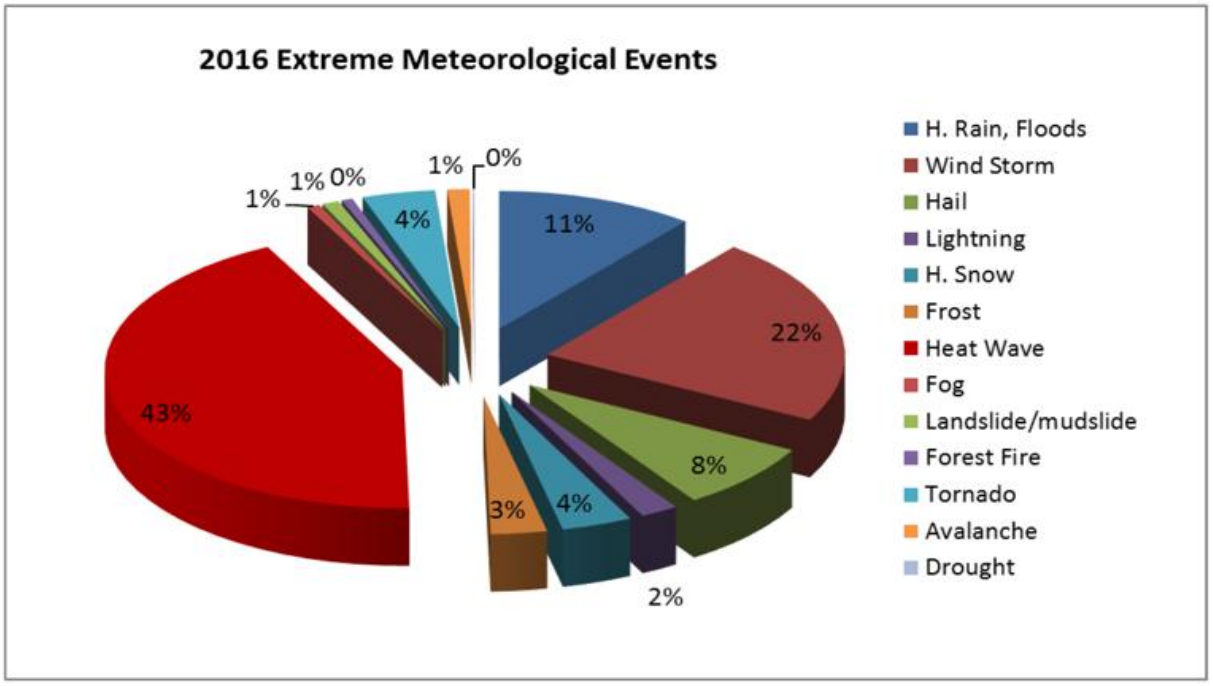


Figure 2.13: Distribution of extreme events occurred in Turkey in 2016 (Diagram as provided by the NHMS).

During 2016 most hazardous extreme events in Turkey were heat waves (43%), wind storms (22%), heavy rain/floods (11%), hail (8%), heavy snow (4%), tornadoes (4%), avalanches (3%), frost (3%) and lightning (2%). Also in addition 8 forest fires occurred in 2016.

3. Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2016 and anomalies related mainly to the normal period 1961-1990 of the following selected essential climate variables: sea level pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1. Seasonal averages and anomalies of selected climate variables

3.1.1. Sea level pressure and circulation indices

Pressure distribution in **winter 2015/2016** showed similar patterns for mean and anomalies. On seasonal average the Icelandic low showed a core pressure below 995 hPa and the Azores high a core pressure above 1025 hPa. This indicates that the two pressure centres were intensified compared to the reference period, but shifted to the south and associated with several storms in northern Europe. This explained, together with negative pressure anomalies in north-eastern Europe the high value of the East Atlantic Pattern (EA) of 2.0 (in December 2015 its value was 3.14). Ireland noted six named storms with season's highest gust of 37 m/s reported at both Belmullet, Co Mayo on December 23rd (Storm Eva) and Sherkin Island, Co Cork on February 8th (Storm Imogen).

In **spring 2016** both circulation centres, the Icelandic low and Azores high, were not well distinct. The Icelandic low with a centre pressure below 1010 hPa (or anomalies of more than +2 hPa related to 1961-1990) was located west of Iceland. The Azores high was less intense with negative anomalies.

Table 3.1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference.

	NAO	EA	EA/WR	SCA	POL	AO
Winter 2015/2016	0.99	2.00	-0.54	-0.38	-1.46	-0.01
Spring 2016	-0.01	0.63	-0.74	0.24	-0.73	-0.27
Summer 2016	-1.36	1.44	-2.05	-0.70	0.37	0.29
Autumn 2016	0.46	1.15	-0.71	0.00	-2.34	-0.58

Note that all values are standardized with the reference 1981 to 2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

In **summer 2016** both circulation centres were shifted southwards. Therefore high pressure over Greenland could develop with anomalies of more than 6 hPa. Most of Europe showed above normal pressure anomalies coincided with above normal sunshine duration and below normal cloud cover leading to several heat waves. Only northern and western Europe showed below normal anomalies. Above normal pressure anomalies ranged from the Azores high to northern Russia. The anomalous high pressure over Greenland extended to Iceland and north-western Scandinavia with anomalies of more than 8 hPa. The negative anomalies over central North Atlantic showed values below -2 hPa.

The calculated CPC- EA/WR (East Atlantic/West Russia Pattern) index with -3.30 for August 2016 was very extreme. Only once in the past 66 years a lower index value was calculated in March 1970 with -4.17. This negative index indicates higher precipitation over northern Russia.

The circulation pattern in **autumn 2016** was marked by a well-developed Icelandic low with its centre west of Iceland (below 1000 hPa). The anomalies around Greenland reached values below -4 hPa. The Azores-High was also well developed together with a second high over Russia and Kazakhstan with a core pressure above 1020 hPa. The centre of above normal pressure anomalies was located over the Barents and Kara Sea with values above 10 hPa.

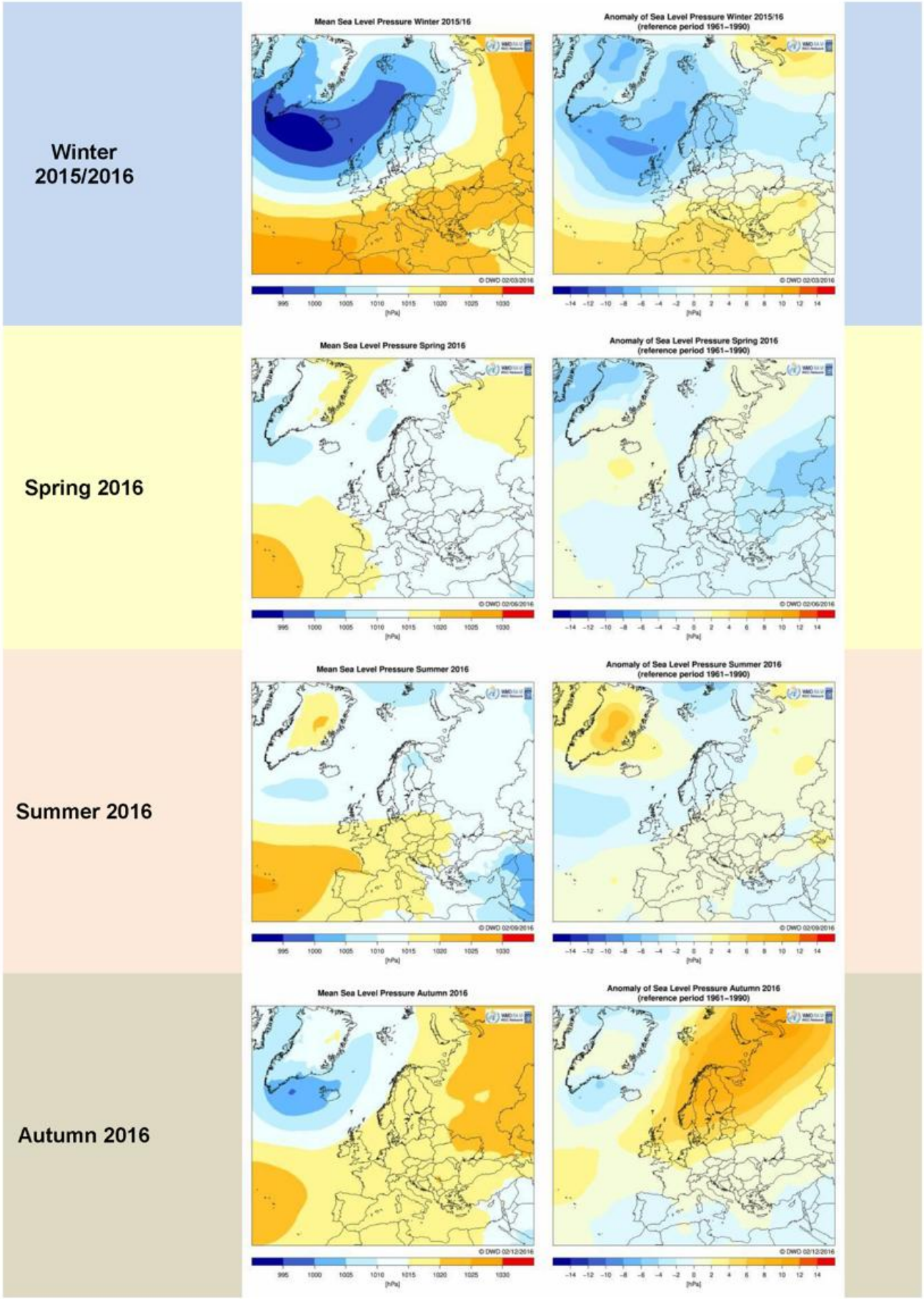


Figure 3.1: Seasonal sea level pressure (left, in hPa) and anomalies (right, in hPa) in 2015/2016, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.2. Temperature

On average for whole of WMO Region VI and sub-regions the temperature in all seasons in 2015/2016 (except Eastern Europe in autumn) was warmer than the normal period 1961-1990. In regional view, however, some differences existed (Tab. 3.2).

Table 3.2: Seasonal and annual average of temperature anomalies over land areas in °C for each sub-region in the year 2016 (reference period: 1961-1990)

Sub-Region	Winter 2015/2016	Spring 2016	Summer 2016	Autumn 2016	Year 2016
Central and western Europe	2.92	0.88	1.45	0.78	1.22
Nordic and Baltic countries	2.85	2.91	1.83	2.66	2.71
Iberia	1.82	0.23	2.08	1.12	1.21
Mediterranean, Italian and Balkan Peninsula	2.23	1.45	1.70	0.70	1.37
Eastern Europe	3.82	2.84	2.44	-0.05	1.89
Middle East	2.19	2.23	2.18	0.18	1.46

Temperature anomalies for **winter 2015/16** show lower than normal values only over the North Atlantic Ocean. All continental Europe showed higher than normal values. The highest positive anomalies occurred in the far North and East. For example Svalbard Lufthavn reported a temperature anomaly for winter of +9.9°C (+10.6 in February 2016) and Barentsburg +8.5°C. The observed temperatures in February in Finland were about +5°C higher than usual in many areas, in the east even 6-7°C higher than usual.

The winter season 2015/2016 was extremely warm for the whole territory of Slovakia up to +3.8°C (2.1°C-3.8°C) above normal (1961-1990). The winter in Switzerland was characterised by a temperature anomaly of +3.1°C compared to the normal values 1961–1990 and therefore the second warmest winter after the record winter 2006/2007. Above all the record warmth in December 2015 was outstanding, with a temperature anomaly of +4.6°C above normal values 1961–1990. It was more than +1°C above the previous December record from the year 1868.

Some ranks of warm winters based on web-available bulletins by NMHSs are given below:

Table 3.3: Seasonal rank statistics for winter mean temperature (2015/2016) as provided by the NMHSs.

Country	Rank	Anomaly in °C	Start of time series
Austria	2	+2.7	1767
Denmark	10	+1.7	1874
Germany	2	+2.7	1881
France	1	+2.6	1900
Hungary	6	+2.4	1901
Netherlands (station De Bilt)	2	+2.9	1706
Norway	30	+1.8	1900
Portugal	3	+1.25	1931
European Russia	3	+2.31	1939
Switzerland	2	+3.1	1864
United Kingdom	3	+1.8	1910

Spring 2016 was more than 2°C warmer in eastern and northern Europe than the reference period 1961-1990. Especially Arctic stations observed temperatures anomalies of more than +6°C. For example Svalbard Lufthavn reported a temperature anomaly for spring of 6.8°C. Only Spain and France showed normal or below-normal temperatures.

In **summer 2016** temperature anomalies for Europe were mostly positive with a maximum of more than +6°C over North-Eastern Europe. Due to higher cloud amounts Scandinavia and Western Europe showed the lowest temperature anomalies.
The temperature in Portugal in summer 2016 was after 2005 the second highest (since 1931) and climbed up to 44.8°C at station Mora on the 8th August. In Spain this summer reached the third rank (since 1956, after 2003 and 2015) with a maximum temperature of 42.3°C at Seville and Morón de la Frontera on 19th July.
During summer 2016 Swedish weather was variable. One of the most interesting features was a very warm spell in late August. Norrköping reported 32.7°C on 26 August. This was the highest temperature in Sweden during 2016 and the highest temperature ever recorded in Sweden that late in the season. Summer air temperatures in 2016 over European Russia were +2.31°C higher than the long-term average. This value ranks third in the period 1939-2016.

July to September extremely warm period in Portugal

(Contribution from IPMA, Instituto Português do Mar e da Atmosfera)

In July, the average monthly maximum and minimum air temperature values exceeded or equalled the previous highest values at some meteorological stations (Table 3.4). However, no daily maximum or minimum air temperature records were reported.

Table 3.4: Highest average monthly maximum and minimum air temperature values, July 2016

Maximum Temperature (°C)			*Minimum Temperature. (°C)*		
Meteorological station	**July 2016**	**Historical highest**	**Meteorological station**	**July 2016**	**Historical highest**
Miranda Douro (1943)	34.4	33.4 /2015	**P. Douradas (1941)**	16.9	16.8 /2006
Bragança (1941)	32.3	32.2 /2013	**Elvas (1941)**	17.8	17.5 /1946
Fundão (1959)	35.0	34.6 /2010	**Beja (1941)**	18.9	18.6 /1989
Anadia (1941)	32.4	31.6 /2010	**Faro (1966)**	16.3	15.8 /2010
Mora (1956)	36.6	35.2 /1990			
Lisboa/ I.G. (1941)	31.1	30.9 /2010			
Pegões (1941)	34.6	34.4 /1946			
Setúbal (1941)	32.8	32.1 /2010			
Alvalade (1941)	35.2	34.9 /1946			
Elvas (1941)	38.0	36.6 /2010			
Beja (1941)	35.9	35.9 / 1974			

During this month and in particular between days 14 and 19 and from 23 to 29 maximum and minimum temperature values were higher than normal daily values, being even higher than the 90th percentile.

In the second half of July there was persistence of very high daily temperature values, which only for short periods of time were interrupted.

This extremely warm weather situation continued in August (Figure 3.2). From 5th to 14th occurred a prolonged period of warm weather, daily average maximum temperature for mainland Portugal was above 31°C. On 7th and 8th the country's average surpassed 38°C, and in some regions daily temperature values greater than 43°C (Figure 3.3) were recorded.

On August 7th, historical highest values of maximum temperature were exceeded in Porto/P.R, Porto/S. Gens, Braga, Leiria and Mora. The highest value of minimum air temperature, 27.9°C, occurred in Lisbon/Geofísico on 7th and equalled previous historical maximum on 2nd of August 2003.

On August 7th and 8th, tropical nights occurred in about half of the territory, which associated with very hot or extremely hot days (maximum temperature ≥35 or 40°C) contributed to a marked and prolonged heat discomfort.

Between August 5th and 13th, there was a heat wave (duration between 8 and 9 days) in the regions of Lisbon and Setúbal (Torres Vedras/Dois Portos, Lisboa/Geofísico, Santarém/Fonte Boa, Setúbal and Alcácer do Sal), North (Braga), and Centre (Lousã and Anadia).

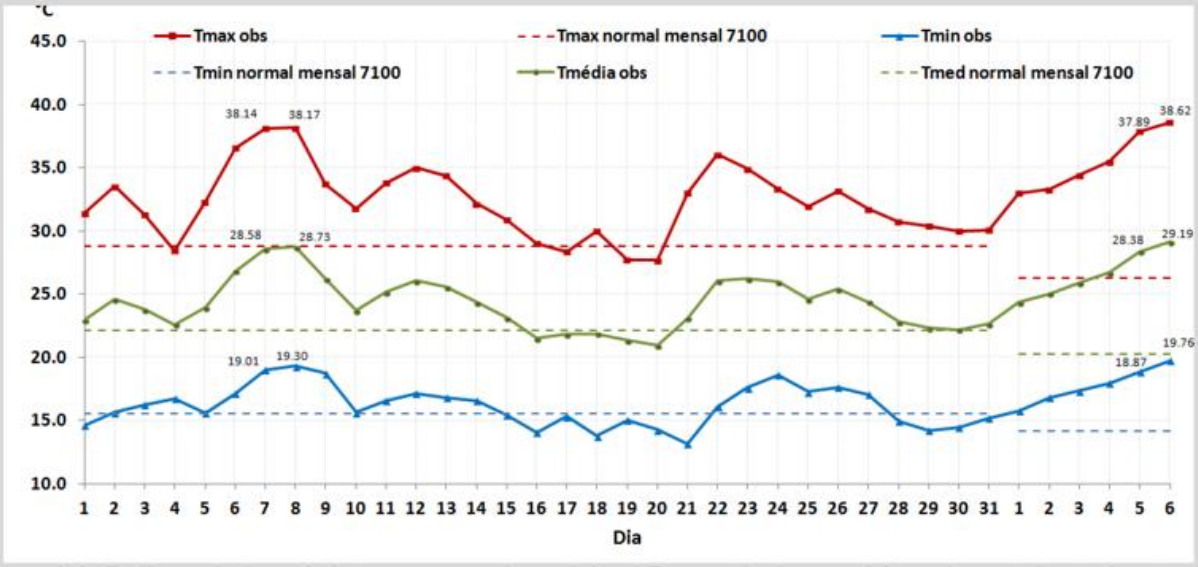


Figure 3.2: Daily evolution of air temperature in mainland Portugal, observed from August 1st to September 6th2016, (Tmax, Tmédia and Tmin respectively designate maximum, mean and minimum temperature; the dashed line represent the monthly normal 1971-2000 values).

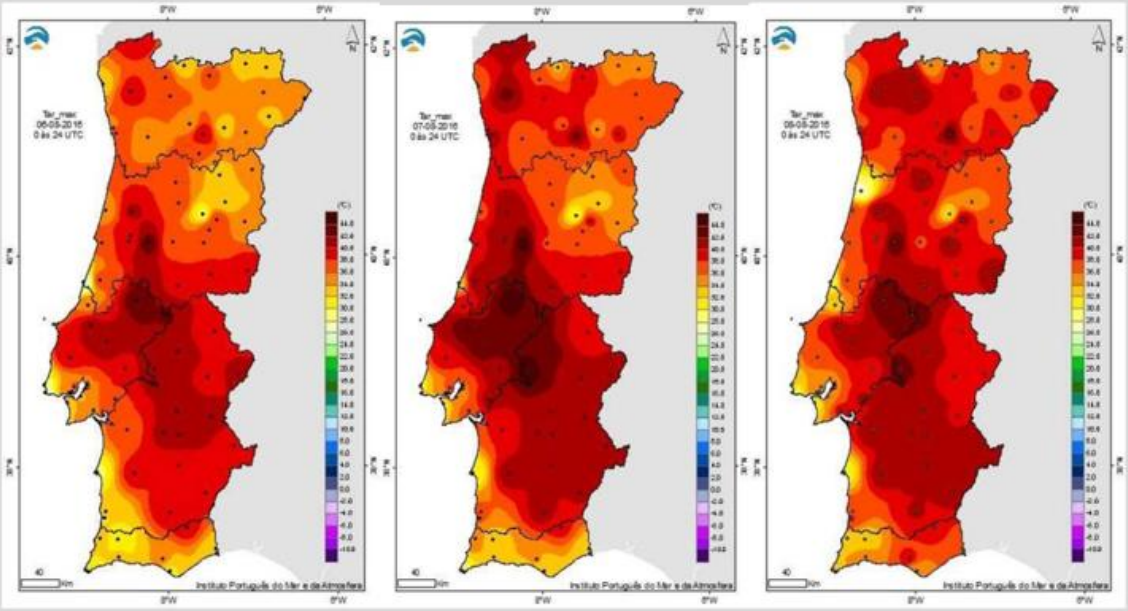
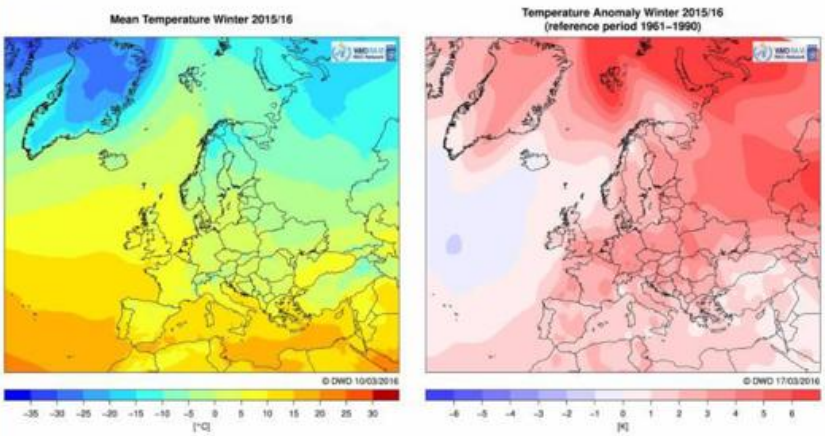


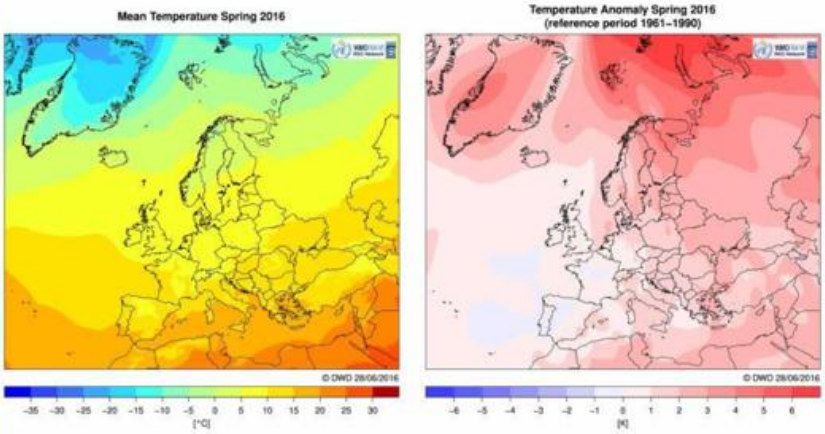
Figure 3.3: Daily maximum air temperature maps, August 6th, 7th, and 8th (left to right).

Autumn 2016 was characterized by warmer than normal conditions in nearly whole Europe. Especially the region north of Spitzbergen and Russia was partly more than +6°C warmer. Svalbard Lufthavn, for example, reported a temperature anomaly for autumn of +7.4°C and Isfjord Radio of +6.4°C. Only Eastern Europe with temperature anomalies below 0°C was colder than the reference period 1961-1990.

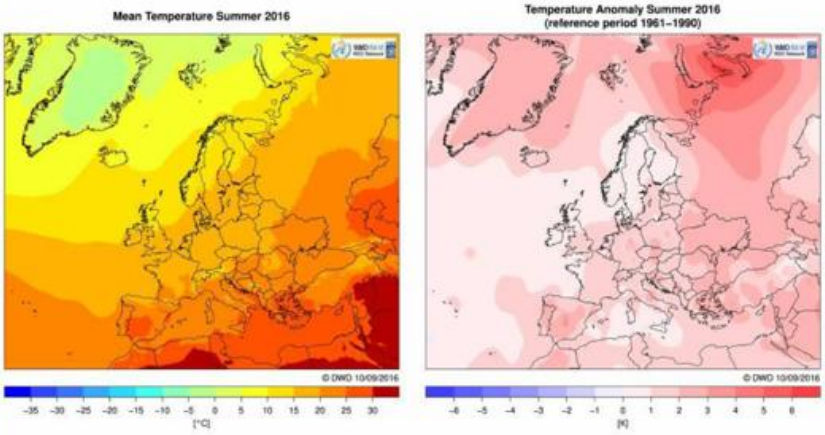
Winter 2015/2016



Spring 2016



Summer 2016



Autumn 2016

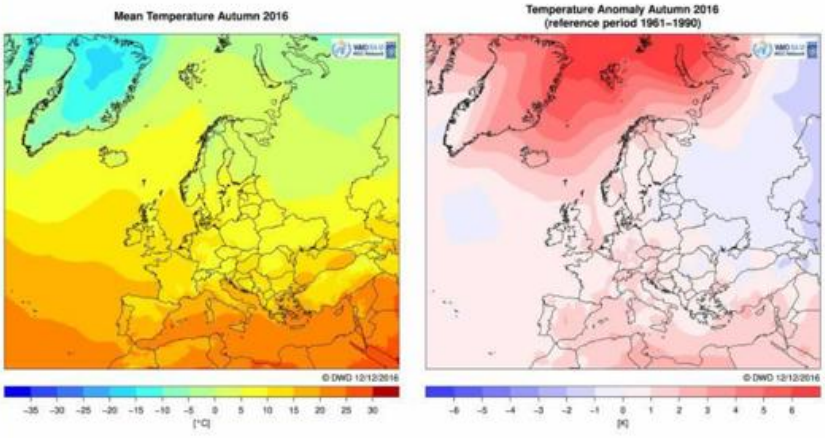


Figure 3.4: Seasonal mean temperature (left, in °C) and anomalies (right, in K) in 2015/2016, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.3. Precipitation

Precipitation anomalies in **winter 2015/16** showed higher than normal values in East Europe as well as in southern Norway, Ireland, western and northern UK, also in northern Iberia. The precipitation amount in Central Europe was around normal while southern Europe received less than normal. In the United Kingdom winter 2015/16 was second-wettest in a series from 1910, with only winter 2013/14 being wetter. In all three winter months above normal precipitation amounts were registered. For Wales, Scotland and Northern Ireland, it was the wettest or equal-wettest winter in the series. Rainfall totals for the winter varied from less than 150 mm across parts of East Anglia to more than 1000 mm across upland areas in the north and west; Capel Curig recorded over 2000 mm. Ireland reported that over half of stations measured their wettest winter on record. Seasonal percentage of the long term mean rainfall values ranged from 134% at Mace Head (total seasonal rainfall 514.2 mm) to 248% at Roche's Point, Co Cork (total seasonal rainfall 682.8 mm). The northern part of Portugal reported more than 150% of precipitation although for the whole country the amount was quite normal. On 13th February station Lamas de Mouro measured 184.2 mm/24h. In the north the winter totals amounted at station Cabril to 1054 mm. Station Faro in southern Portugal received only 87 mm as winter totals or 36% of normal. Southern Europe and the Mediterranean region showed this winter a precipitation deficit visible in the relative precipitation anomalies.

Ice conditions on the Caspian Sea in 2016

(Source: Kazakhstan Hydrological and Meteorological Service)

Winter season of 2015-2016 on the Caspian Sea was soft with an unstable ice cover in a northern shallow part of the Caspian Sea. Formation of the young shore ice begun on November 1, and primary types of ice appeared on November 9. Landfast ice along all northeast coast of the sea formed at the end of December 2015. Maximum ice thickness (17 cm) was observed at the northeast coast of the Northern Caspian Sea. At the eastern coast of the Caspian Sea, the ice cohesion was constantly changing. But no observations of ice thickness in this area were made.
In the third decade of January 2016 process of the ice formation reached the central deep-water part of the Northern Caspian Sea. Maximum ice thickness in this area reached 7 cm.
Exemption from the ice in the middle part of the Caspian Sea started on February 16, 2016. The northern coast of the Caspian Sea was completely freed from ice on March 10, 2016.
The ice season of winter 2016-2017 began on 3rd of November 2016 when the first ice phenomena were recorded. It should be noted that it was the earliest appearance of an ice cover for the last 30 years. Before 2016, the earliest date was November 6 (1988).

Precipitation anomalies for **spring 2016** showed more than normal precipitation in Eastern Europe, the Balkans, France and western Iberia. Northern and Central Europe as well as the Middle East showed some precipitation deficit. The surplus in Spain was 34% above the average coming from several episodes of intense rainfall.

Precipitation anomalies in **summer** were highest in northern Scandinavia and northern European Russia with more than 150%. Southern Italy and Greece as well as eastern Turkey were wetter than normal due to convection. Iberia, France, Germany, Ukraine, Bulgaria and western Turkey showed a precipitation deficit.
The relative anomaly for whole of Spain was 51%. In Germany violent thunderstorms brought catastrophic quantities of rain to some areas in early June. In 48 hours from 1 to 2 June, Simbach/Inn reported more than 180 mm and in a flash flood seven people died. The highest daily amount of 150.7 mm was recorded on 23 June in Groß Berßen.

Precipitation anomalies for **autumn 2016** were below normal in most of Europe and Middle East. Only Balkans, Eastern Europe and southern Italy showed wetter conditions. For Romania monthly precipitation amount for October was 103.6 mm (138% of the normal, 1981–2010). Most anomalies at weather stations exceeded 100% and anomalies were extremely large in Moldavia, where they exceeded 350%. The highest anomaly was recorded at Galaţi weather station, 802% or 294.7 mm.

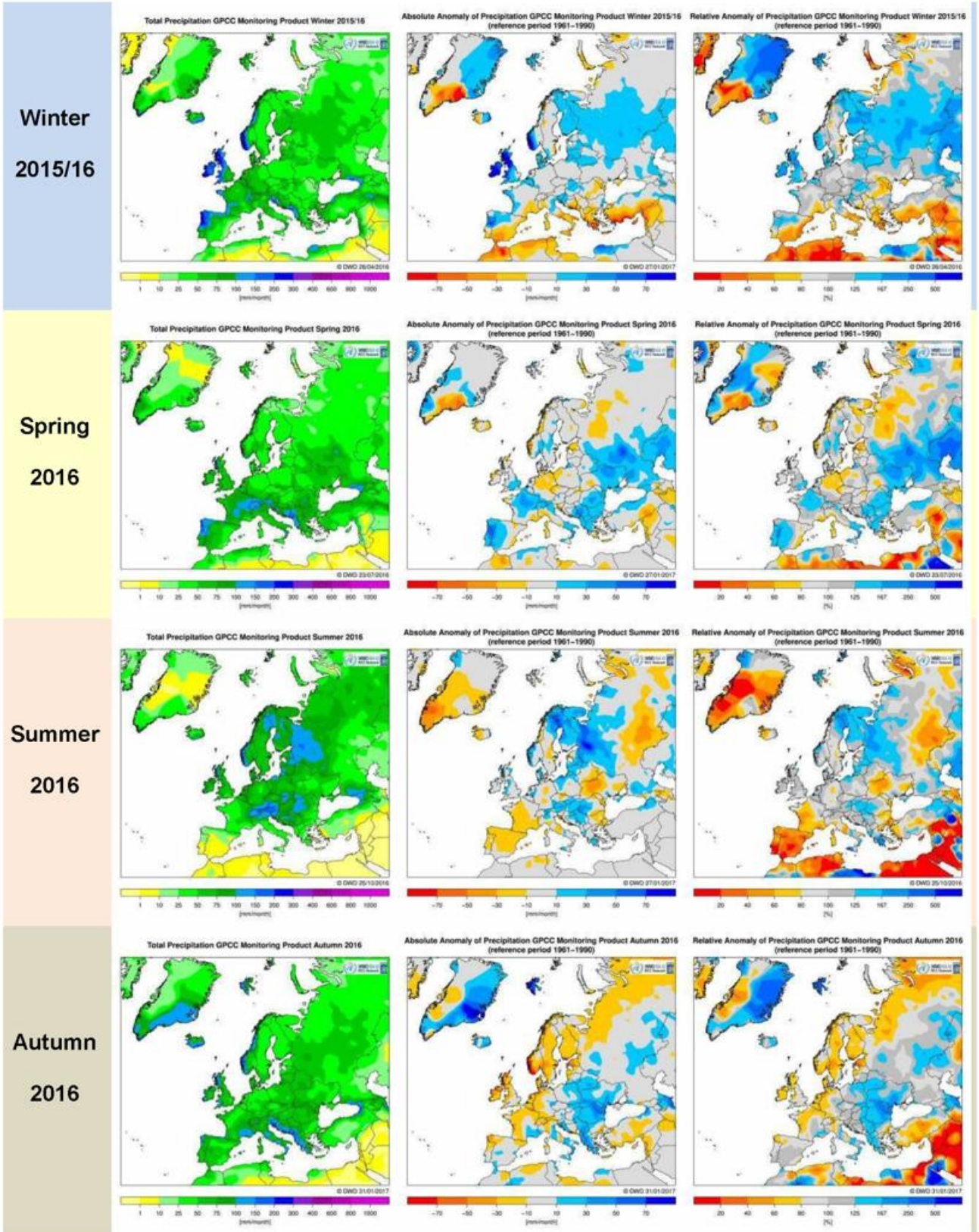


Figure 3.5: Seasonal total precipitation (left, in mm/mon), absolute anomalies (middle, in mm/mon) and relative anomalies (right, in %) in 2015/2016, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.4. Sunshine duration

Many parts of Europe received more than average sunshine in **winter 2015/16**. Only western Iberia, United Kingdom, Finland and Russia noted below normal sunshine. This coincided well with above normal cloud cover in Western Europe. South-western Europe showed less clouds and more sunshine than normal in winter 2015/16.

In **spring 2016** most of Europe registered above normal sunshine duration. Sunshine deficit is reported for southern European Russia, Romania, France and southern Germany. Poland experienced a surplus of sunshine of more than 160 hours at the coastal areas of the Baltic Sea.

Due to higher pressure in **summer 2016** over most of Europe sunshine duration anomalies were also positive with up to 125% in Iberia and Eastern Europe. Only the Baltic States, Finland, northern Scandinavia and Western Europe showed less sunshine and more cloud cover.

In **autumn 2016** most of Western Europe and Middle East registered above normal sunshine duration. Cloud cover in Eastern Europe was above normal and related to the extreme precipitation. The Netherlands' average of about 432 hours of sunshine (normal 320 hours) in autumn ends in the top ten of sunniest autumns since the beginning of observations. All three autumn months were sunnier than normal.

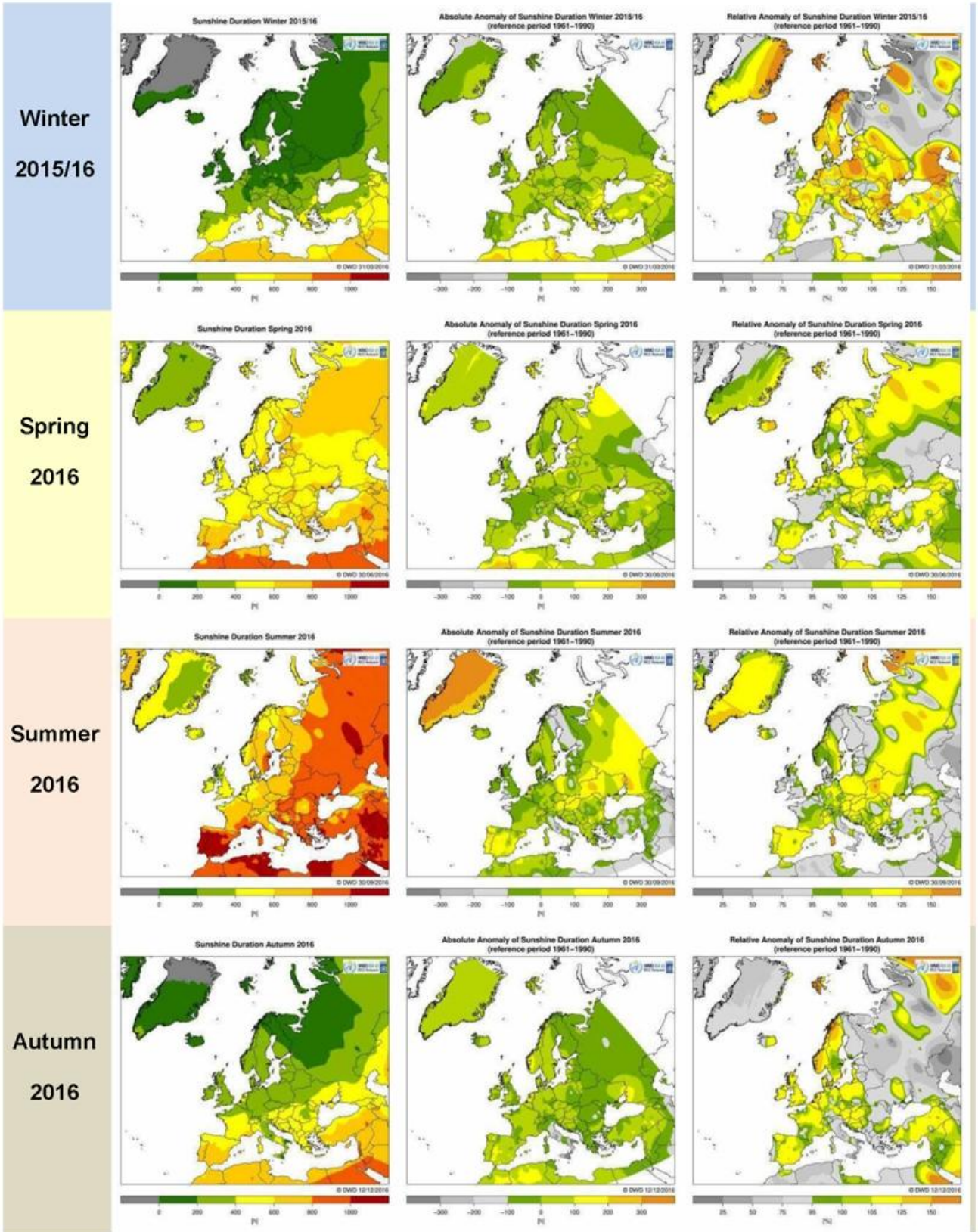


Figure 3.6: Seasonal sunshine duration (left, in hours), absolute anomalies (middle, in hours) and relative anomalies (right, in %) in 2015/2016, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.5. Drought

Winter 2015/16 was wet in Western and Eastern Europe. In Central Europe, Mediterranean and Balkans this winter was drier than normal.

Spring 2016 was very wet and the mean precipitation over Spain was 34% higher than normal. Mean precipitation for this season exceeded its normal value in most of Spain but it was lower than normal on some southeast peninsular areas, south of Aragón, Ibiza and Canary Islands.

Summer in Spain was, as a whole, very dry, with an average precipitation value almost half of its normal value. August was the driest month. Rainfall was below normal over most of Spain.

A severe drought occurred in France from July to September when only 45% of normal rain fell. The drought was accompanied by frequent fires in southern France with burned houses and forests. With an average precipitation deficit of 60% for France August 2016 was the driest August months in the period 1959-2016, followed by 1991, 1962 and 1961.
From late summer to mid-October there was a drought in Ukraine. Northern, north-western and central regions were mostly affected by the drought. It was an abnormal phenomenon for these areas. The total rainfall during August - September amounted to 20-40% of the norm, in many parts of Zhytomyr, Vinnytsia, Kyiv, Khmelnytsky, Ternopil, Cherkasy and Kirovohrad regions the rainless period was 45-58 days. Due to drought dry soils formed extremely adverse conditions for sowing winter crops for 2017 harvest year.
In August, south-eastern and Ural regions of European Russia experienced precipitation deficit. The Orenburg, Chelyabinsk, Samara and Astrakhan Regions, as well as Kalmykia and Dagestan received less than 40% of monthly precipitation normal, which gave rise to the onset or exacerbation of drought in these regions. According to the Ministry of Agriculture, in the Orenburg Region alone, the drought-related damage was about 23.5 Mio €.

On the whole, **autumn** was dry in Spain. It began with a very dry September, with a mean precipitation 46% lower than normal, followed by a little bit less dry October, and ending with a wet November with monthly average precipitation 33% higher than normal.

October in Israel was warmer than average and dry with exception of a short significant weather event in the south. Except for some rainfall amounts at the beginning and at the end of the month, November was almost also entirely dry. The drought in Israel from October to November 2016 with rainfall amount of only 5-15% of the average for the same period is a rare event in Israel. Damage was very high especially due to wildfires and urban fires. The firefighting services had to deal with more than 1500 fires, and at least 39 of them were major ones. The largest fire occurred in Haifa, where hundreds of apartments were completely destroyed leaving 1600 people homeless. 75,000 residents, about a quarter of the city's population, were evacuated from 11 neighbourhoods. The cost of damages from the fire in Haifa was estimated at more than US$100 million.

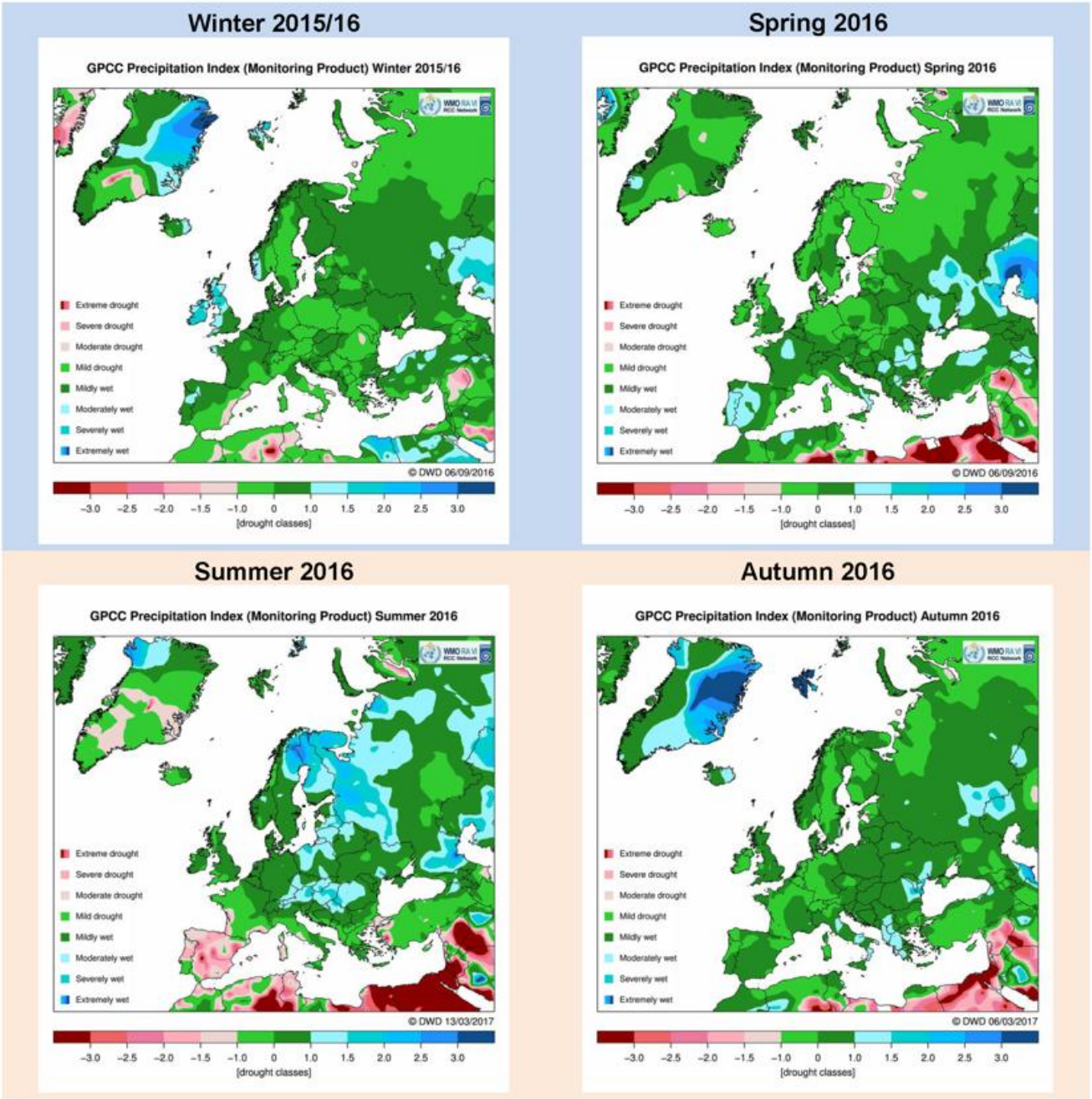


Figure 3.7: Seasonal standardized precipitation index (SPI, left, in drought classes) and anomalies (right) in 2015/2016, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

4. Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2016 on the Climate in WMO Region VI - Europe and Middle East (available on http://www.dwd.de/rcc-cm).

It contains highlights, means and anomalies of sea level pressure, temperature, precipitation and sunshine duration for each month as well as monthly overviews of extremes and notable events.

4.1. Sea surface pressure and circulation indices

This chapter about atmospheric circulation provides information on selected northern hemisphere teleconnection indices which are considered to be relevant for WMO RA VI and it discusses influences of circulation patterns upon anomalies and outstanding events. The information is based on the Monthly Bulletins on the Climate in WMO RA VI and was completed by reports of the NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/upper troposphere not shown here. (See http://www.ncdc.noaa.gov/teleconnections/ and http://www.cpc.ncep.noaa.gov/products/CDB/index.shtml)

Table 4.1: Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference and the Arctic Oscillation, for January to December 2016.

Year	Month	NAO	EA	EA/WR	SCA	POL	AO
2016	1	-0.37	1.01	-0.5	-0.68	-2.63	-1.449
2016	2	1.35	1.85	-2.39	-0.54	-2.33	-0.024
2016	3	0.37	0.71	0.26	-0.23	-0.23	0.28
2016	4	0.26	0.97	-0.5	-0.11	-1.59	-1.051
2016	5	-0.67	0.22	-1.99	1.05	-0.36	-0.036
2016	6	-0.13	0.41	-1.85	-0.95	-1.07	0.313
2016	7	-1.72	1.82	-1.01	-0.7	-0.24	0.085
2016	8	-2.24	2.08	-3.30	-0.44	2.43	0.472
2016	9	0.74	3.48	0.13	-0.99	-1.31	0.781
2016	10	0.96	0.42	-1.33	1.05	-2.94	-1.917
2016	11	-0.31	-0.45	-0.93	-0.06	-2.78	-0.611
2016	12	0.35	0.87	1.52	-1.18	-1.1	1.786

Note that all values are standardized with reference to the period1981-2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**:ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

Very intense winds were observed during 9th and 10th **January 2016** at several locations over northern *Italy*, with observed wind maxima reaching values of 46 m/s at Lago Scafaiolo, 42 m/s at Loiano and 36 m/s at Madonna dei Fornelli, indicating hurricane strength wind over a large area of the region.
Strong wind and persistent precipitation from January 3rd to 11th occurred in *Portugal*. In the 3 day period ending on January 11th, maximum gusts equal to or greater than 19 m/s (70 km/h) observed at surface stations were recorded in 38% of the meteorological stations, with the highest values occurring in Guarda (31 m/s or 111 km/h) and Mogadouro (103 km/h). In more than 60% of the stations there was a mean wind speed greater than or equal to 30 km/h. The Azores Islands were hit on the 15th by Hurricane Alex (category I) that last for 12 hours, first tropical cyclone formed in the Atlantic basin during January since 1938.
During 29th–31st January Winter Storm Marita (Gertrude) passed Western Europe from *Ireland* (Malin Head 36 m/s on 29th), the *United Kingdom* (47 m/s at Lerwick and Baltasound (both Shetland) on the 29th) to Scandinavia. High wind speeds with gusts of up to 47 m/s (170 km/h) occurred together with heavy rain inducing flash floods and landslides. Several houses, schools,

hotels damaged. The Overall losses were summed up by Munich Re to 160 Million US$. Fallen trees caused road closures with rail and ferry traffic disrupted.

On **February** 1st storm Norkys (Henry) came with highest wind gusts of 36 m/s. Followed by storm Ruzica (Imogen) on 7th and 8th with highest gusts of 38 m/s at Sherkin Island (*Ireland*). The following days storm Ruzica reached Central Europe. The overall losses were summed up by Munich Re to 220 Million US$. High wind speeds, heavy rain, high waves up to 19 m and floods were observed.
A storm hit on 14.02.2016 the west coast, Centre and south regions of *Portugal* with maximum gusts of 33 m/s (at Porto) together with hail and thunderstorms. Approximately 75% of the stations registered maximum wind gusts above 19 m/s (70 km/h). The highest values, above 28 m/s (100 km/h) occurred in the highest altitude sites of the Centre and South and the western coastal regions of *Portugal*. During 12-15, 19, 26 February, meteorological station Zhalanashkol (Almaty region, *Kazakhstan*) – measured hurricane wind from southeast with gusts up to 34-36 m/s, 9-25 hours long.

On 2nd **March** 2016 highest wind gust with 37 m/s (133 km/h) at Mace Head (*Ireland*) was measured during storm Aloisia (Jake). The highest 10-minute wind speed occurred at the same location with 27 m/s. At the same day a wind gust of 36 m/s was recorded at Aberdaron (Wales, UK). Storm Jeanne passed northwestern *France* during March 27 and 28 with wind gusts ranging from 30 to 40 m/s over the coasts of the English Channel and generally between 25 and 30 m/s in interior areas with 35 m/s at station la Hague. The north side of the Alps saw on the 31st March a foehn storm with gusts of 49 m/s (176 km/h) at station Zugspitze (*Germany*) or 27 m/s at station Sonnblick (*Austria*) and 25 m/s at station Saentis (Switzerland).

Seven days in **April** (1st, 6th, 10th, 11th, 25th, 26th and 28th) had gale-force winds in *Ireland* with the strongest and most widespread winds reported on the 6th. Both the highest 10-minute mean wind speed and highest gust were recorded at Mace Head on this date with 19 m/s (70 km/h) and 27 m/s (96 km/h), respectively. From 4-9 April 2016 two depressions (named in Germany Luana and Myrna) moved from *Norway* via eastern *Scotland*, *France* (24 m/s on 06th at Boulogne-sur Mer) and *Switzerland* to the south of *Spain* with locally heavy rainfall and northerly winds. From 10-16 April 2016 again two depressions (named in Germany Ortrun and Petra) with low temperatures brought rain and snow to Western Europe. Western *France* (42 m/s on 10th Ile d'Ouessante) and northern *Spain* observed extreme wind gusts, flooding, and damages.

In **May 2016** thunderstorms occurred in Southern Europe with high winds. At station Penhas Douradas (*Portugal*) a maximum wind speed of 33 m/s on 7th May was registered. In *Spain* a wind gust of 27 m/s was observed on 8th May at station Puerto de Navacerrada. The mistral and the tramontana have frequently blown on the Mediterranean regions. They were violent on 1st May, exceeding 100 km/h in the lower Rhone valley with 31 m/s (111 km/h) at station Orange and in Roussillon with 42 m/s (152 km/h) at station Cape Béar (Pyrénées-Orientales).

In **June 2016** thunderstorms continued in Central Europe with locally extreme precipitation, flooding and tornadoes.

On **July** 21st 2016 a tornado with category F2 hit Karlstein (Waldviertel region, state of Lower *Austria*). With wind gusts up to 61 m/s (220 km/h) many trees were uprooted or snapped. Additionally hailstorms with hailstone sizes up to 4 cm drew a line of massive damage in the same region (agriculture loss estimated to be 1 million Euro on 3.500 ha).

Severe storm in southern part of Lithuania on 11 July 2016

(as provided by the Lithuanian Hydrometeorological Service)

In July, several surges of tropical air into Lithuania formed strong convection phenomena. The most outstanding of them was a very violent storm in the south of the country in the afternoon on 11 July (Figure 4.1).



Figure 4.1: The development of Arcus cloud shelf over Vilnius, 11 July, 2016 (Photo: Tadas Kantautas, LHMS).

After a very warm (15-17 °C) and a rather stuffy night on 11 July, daytime air warmed up quickly. Tropical air surge into Lithuania formed, in the cyclone's warm sector, a convergence zone with thunderstorm cells, which moved from seaside to eastern regions. Maximum temperature in the southern and eastern regions jumped to 25...30 °C, in the western - to 22...24 °C. In the evening, convection became especially active in the hottest south-eastern part of the country. On 11 July at about 18h, Vilnius was approached by impressive shelf cloud formed of powerful Cumulonimbus arcus, which caused a squall followed by severe thunderstorm and heavy rain. Daily amount of precipitation varied greatly: in many places between 2-14 mm, in the south-eastern part of the country in locally 7-25 mm and 16-22 mm in the western part. During the thunderstorms in south-eastern regions, squalls reached 15-20 m/s. And after the passage of storm clouds, air temperature fell by 6-8 degrees within 3 hours. In addition, during the storm, meteorological stations in Kaunas and Vilnius recorded small hail. That entirety of dangerous phenomena conformed to the criteria of a disastrous meteorological phenomenon – severe storm. Luckily no significant damage has been done.

In the evening, the warm front and mesoconvectional system left our country, and by night Lithuania was approached by a cold front moving from the west.

A strong windstorm (Rauli) on **August** 27th caused forest damage in southern and central parts of *Finland* with approximately 200,000 households without power at some points. Strongest gusts with 24.9 m/s were measured in Vaasan Klemettilä and Kuopio Maaninkaa (http://www.ilmastokatsaus.fi/2016/08/29/rauli-nousi-myrskyjen-raskaaseen-sarjaan/).

Sea level pressure in **September** 2016 was dominated by several systems. The Azores high was shifted to the south with a core pressure of more than 1025 hPa. The Icelandic low showed a core pressure below 1000 hPa. A second low was located over southern Russia. Above normal

pressure anomalies ranged from the Azores high and Scandinavia to northern Russia with values above 4 hPa over the Baltic States. The negative anomalies over central North Atlantic showed values below -8 hPa and those over southern Russia and Kazakhstan values below -6 hPa. The East Atlantic Pattern (EA) with an index value of 3.48 was exceptionally high.

October 2016 was dominated by high pressure in Sweden with a reading of 1050.7 hPa at Sveg on 5th October. This is the highest air pressure ever recorded in Sweden in October. In Denmark a high pressure of 1045.5 hPa at Skagen on 5th October, also break the October record. A storm reached on 25.10.2016 the northern region of Portugal with a maximum gust of 28 m/s.

On 21 **November**, windstorm (to 34 m/s) was recorded in Cherkessk (North Caucasus, Russia) during two hours and 52 minutes. Power and water supply was disrupted, roofs were damaged and trees were toppled.

Corvo Islands (Portugal, Eastern North Atlantic) was hit by a storm on 8th of **December** with a maximum gust of 41 m/s. Storm "Barbara" hit Ireland during the 23rd and 24th of December with highest wind gust of 31 m/s and storm "Conor" the following days (December 25th and 26th) with highest wind gust of 32 m/s. During the same days a storm named "Urd" hit the northwestern parts of Jutland (*Denmark*) with wind gusts of up to 37.8 m/s at station Torsminde. Windstorm "Theresa" caused a number of damages in *Austria* at the beginning of December, while cyclone "Barbara" occurred from December 27th to 28th. For both events the majority of damage, like uprooted trees and damaged roofs, was reported in the eastern part of Austria.

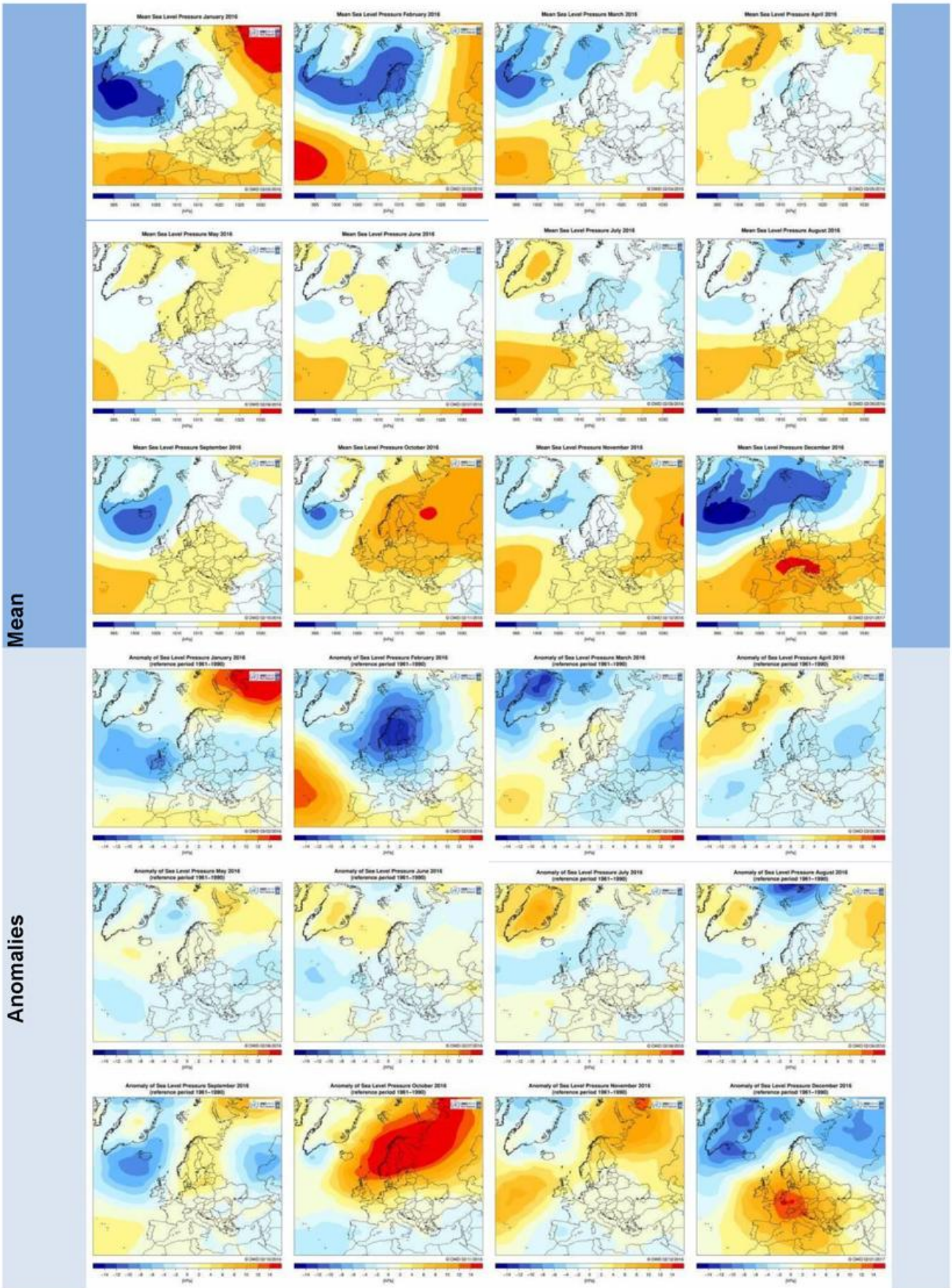


Figure 4.2: Mean and anomalies of sea level pressure in hPa for each month of the year 2016. (First row January, February, March, April; reference period 1961-1990).

4.2. Temperature

In most of the months and sub-regions it was warmer than normal as can be seen from Table 4.2. The Nordic und Baltic Countries had positive anomalies throughout the whole year 2016 and in Eastern Europe anomalies above +7°C occurred.

Table 4.2: Monthly and annual area average temperature anomalies in °C for each sub-region in the year 2016 (reference period: 1961-1990).

Region	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Central and western Europe	1.22	1.61	2.72	0.71	0.68	1.25	1.51	1.49	1.37	2.67	-0.53	0.21	1.02
Nordic und Baltic Countries	2.71	2.67	4.06	4.52	2.38	1.84	1.83	2.28	1.39	2.53	2.59	2.86	3.58
Iberia	1.21	2.42	0.78	-0.36	0.54	0.50	1.79	2.28	2.17	1.47	1.60	0.28	1.09
Mediterranean	1.37	1.30	4.25	1.46	2.75	0.15	1.88	2.02	1.21	1.14	0.18	0.79	-0.65
Eastern Europe	1.89	-0.84	7.44	3.35	2.99	2.17	1.44	2.68	3.19	1.02	-0.07	-1.11	0.44
Middle East	1.46	0.94	4.52	3.07	2.58	1.03	1.80	1.32	3.43	0.41	0.57	-0.45	-1.75

From 24 to 26 **January** 2016 the *United Kingdom* was in an unusually mild south-westerly airflow, reminiscent of the situation through much of December 2015. On 24 January daily maximum temperatures approached or exceeded 15.0°C in the London area, around Chester, Carlisle, Edinburgh and Inverness and were particularly high in the north-west Highlands with 16.5°C at Achnagart, Highland. New national daily minimum temperature records were set: For Wales, 12.5°C at Gogerddan, Ceredigion on 25th exceeded 12.4°C at Rhyl (Denbighshire) on 10 January 1971. For Scotland, 12.6°C at Achnagart, Highland on 25th exceeded 12.2°C at Elgin (Moray) on 10 January 1971 and Strathallan (Perthshire) on 10 January 1998. For Northern Ireland, 13.1°C at Magilligan, (Londonderry) on 25th exceeded 12.6°C at Belfast, Danesfort on 10 January 1998. January in Sweden was cold with -42.9°C at Nikkaluokta on 7 January, which was the lowest temperature in Sweden during 2016 and also the lowest temperature in the country since 2001.

In **February** several unusually warm episodes occurred in *Switzerland*. At Berne the fifth-highest February daily maximum since observations began in 1864 was registered (16.4°C). With regard to minimum values, a remarkable cold spell occurred from 15 to 20 of February, due to an invasion of polar cold air that affected all of *Spain* including Canary Islands. On 17th February the coldest temperatures were registered with -11.3ºC at Puerto de Navacerrada station, -9.8 ºC at Teruel, -9.3 ºC at Molina de Aragón, -8.2 ºC at Burgos airport and -8 ºC at Soria.
Well-above-normal temperature (monthly mean temperature in the area *Czech Republic*) was recorded in February (+4.1°C above normal 1961-90). February was from strongly up to extremely warm for the whole territory of Slovakia up to +6.0°C (3.1-6.0°C) above normal (1961-1990). Absolute daily maximum for Slovakia was exceeded for February (20.3°C) measured in south west of Slovakia. In the Former Yugoslav Republic of Macedonia February was characterized with highest values for mean monthly air temperature and the deviation was +5°C to +7°C. The absolute maximum temperature for February was exceeded in Skopje, Kriva Palanka and Berovo 24.3°C, 22.0°C, 21.7°C, respectively. During this month the deviation of the mean monthly maximum and minimum temperature was also evident, exceeding 8°C on some stations.
The anomalous warm weather was observed in *Moldova* in February, when the average air temperature was +3.3 to +5.5ºC, which is 6-7°C above the norm, and observed for the first time on 60% of the territory of Moldova, and for the second time during the whole period of observations across the rest of the territory. In *Romania* during 2-3; 13-16; 22-23 February positive deviations of

the mean air temperature of more than 4°C from the climatological normal occurred countrywide (highest deviation was 7.3°C at Sf. Gheorghe, south-eastern Transylvania); the maximum temperature monthly record was exceeded at 43 weather stations.
The highest air temperature anomalies in the *Ukraine* were recorded in February (+5.0°C to +8.0°C). February was the warmest for the entire period of meteorological observations. Maximum temperatures reached +15°C to +23°C, which was above absolute maximum in many regions. A vast heat island formed in the north of Western Siberia covering entire *European Russia* and Siberia in February. Maximum positive anomalies of mean monthly air temperature in the center of the island exceeded +10°C. On 2nd February, for example, daily temperature absolute maxima were exceeded in Lipetsk and Maikop; the previous temperature record in Maikop in 2010 was exceeded by 4.1°C, now being 23°C. It was the 2nd warmest February since 1961 in most parts of Georgia, with very high deviations of +3 up to +6°C in the central and southern regions.

March 2016 was the warmest in the northern part of *Sweden*. The heat culminated on 15th when the temperature at station Haparanda, whose measurement series started in 1859, set a new heat record for March with 11.8°C. In *Norway* 11 stations registered new March records. Mean temperature for March 2016 in the *Arctic* were partly more than 10°C above normal. At station Svalbard Lufthavn monthly mean temperature was -6.9°C (8.8 °C above normal), station Hopen (Norway) registered -4.4°C (9.3°C above normal), station Barentsburg -6.5°C (8.0°C above normal), Isfjord Radio -5.4°C (6.6°C above normal) and Ny-Ålesund -7.5°C (6.7°C above normal).
Russia reported the fifth warmest March since records begun and new daily temperature records. In St-Petersburg, on 28 March, the record was broken that persisted for more than 100 years, since 1903. Diurnal air temperatures attained 13.9°C. Temperature anomalies in *Kazakhstan* reached values of up to +9°C, in *Moldova* about +5 to +7°C above the long term mean and the absolute maximum temperature reached +24.4°C on 31th March at station Ceadîr-Lunga.

Cold wave over central Europe and the Balkan during the last decade of April 2016

Polar air reached central Europe and the Alps on 24th of **April**, causing minimum daily air temperatures to drop below 0°C in many parts of Germany and north-eastern France. On 25th of April, the cold air mass with negative temperatures arrived in Austria and affected major parts of the Czech Republic, Poland, and the Baltic countries. The following day (26th of April) was characterised by negative temperatures in Austria, Poland, Slovakia, the western half of Hungary, Slovenia, Croatia and locally in the central Balkan regions (JRC, 2016). The cold wave, reached Austria, from 25th to 29th of April 2016 with frost causing agricultural losses of more than 305 Mio €.
The most remarkable event in Slovenia was a cold spell towards the end of April. After an exceptionally warm period in the first twenty days of April a cold spell due to the intrusion of polar air masses brought snow in lowland and fruit trees, vines and some crops were seriously affected. Phenological development of fruit plants was exceptionally early; therefore the most temperature sensitive phenological phases of opening of flower buds, full flowering and young fruits coincided with freezing air temperatures recorded during the night of April 26. At the end of April (20.-30.4.2016) a period of ground frost occurred in Slovakia and caused extensive damages on crops and fruit trees and it was recorded as a significant period of spring frost in Slovak history.

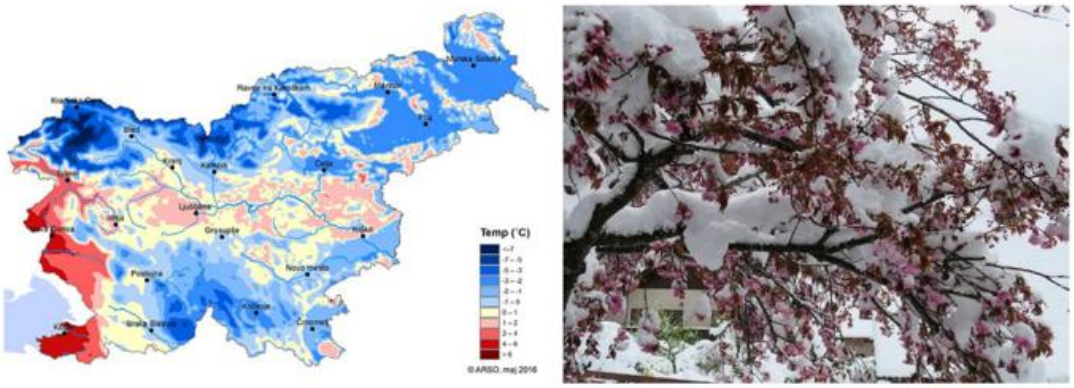


Figure 4.3: Minimum air temperatures (left) recorded on April 26, 2016, that caused spring frost of fruit trees, vine and crops (provided by the Slovenian Meteorological Service)

Heat waves in Israel in April 2016

(Text as provided by the Israel Meteorological Service)

April was much warmer than normal in Israel. The average daily maximum temperature was 3-5°C above normal and the daily minimum 2-4°C above it. In the Coastal Plain, Jezreel Valley and the Negev it was the warmest April ever recorded regarding daytime temperatures (figure 4). Two prolonged heat waves occurred during the month, the first one on April 1-10th and the second one on April 19-27th. Each one included Sharav events. On April 8-9th temperatures reached 35-36°C in the Coastal Plain and the Negev and 37-39°C in the Arava. In the second heat wave 35-37°C were recorded in the Coastal Plain and the Negev and 37-39°C in the northern and eastern valleys on April 19-21st. The most significant Sharav was on April 26th with 39-40°C in the Coastal Plain, the Negev and the Jordan Valley.

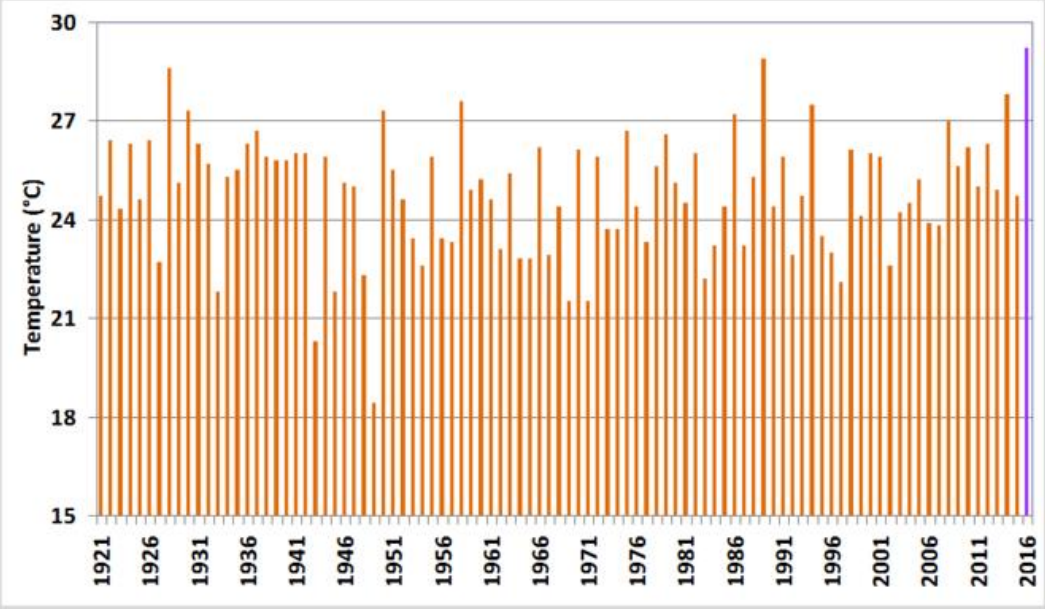


Figure 4.4: Average daily maximum temperature (°C) in Bet Jimal (Judean Foothills) in April 1921-2016 (Source: Israel Meteorological Service).

On 17th and 18th of **April** the highest daily maximum air temperature in *Serbia* of 32.0°C was registered in Loznica and Negotin, respectively. Negotin observed record-breaking maximum air temperature for the month of April, breaking the previous record of 31.0°C set on April 27, 1930. 17 April 2016 marks as the warmest 17 April in Serbia since the records at 23 main meteorological stations began. Maximum air temperature in *Moldova* on 18th of April exceeded for the first time during the whole period of observations in the second decade the extreme value of +28°C ..+31°C.

This **May** the Arctic was again warmer than in the reference period. Svalbard Airport (Spitsbergen, *Norway*) noted a new record high average temperature of 1.4°C (or 5.6°C above normal). Bear Island (Bjørnøya, Norway) was the mildest Norwegian Arctic station with a mean temperature of 2.8°C, 4.2°C above normal and the hottest May recorded at this station. Station Isfjord Radio registered 4.4°C and Ny-Ålesund 5.0°C above normal (also the hottest May ever). According to the *Finnish* Meteorological Institute (FMI), the average temperature in May was 3-5°C higher than usual in most parts of Finland. Except for the western part, deviations were exceptional and occurred on average once every 30 years. The all-time record for the average temperature in May was broken at about 20 observational stations. In *Sweden* several stations registered new monthly temperature records for May. Denmark registered the 3rd warmest May since 1874 (with 1993). The country wide average temperature was 12.9°C, which is 2.1°C above the 1961-90 reference period.

A significant heat wave occurred in **Israel** on May 14th -16th. At its peak, temperatures reached 40-42°C in the Coastal Plain, 42-43°C in the Negev and the Northern Valleys and 45-46°C in the Jordan Valley and the Arava. The daily maximum temperatures are not record-breaking, yet the 3-day length of the heat wave is unusual. Spring time is usually characterized by short-term Sharav events that usually prevail for no more than 24-36 hours. It should also be noted that nocturnal temperatures were high with daily minimum temperatures of 30-32°C in the Dead Sea Region, 28-29°C in the Judean and Samarian Mountains and 24-26°C in the Galilee. The daily minimum temperature of 28.5°C in Jerusalem on May 16th is a record high for May in Jerusalem for more than 100 years.

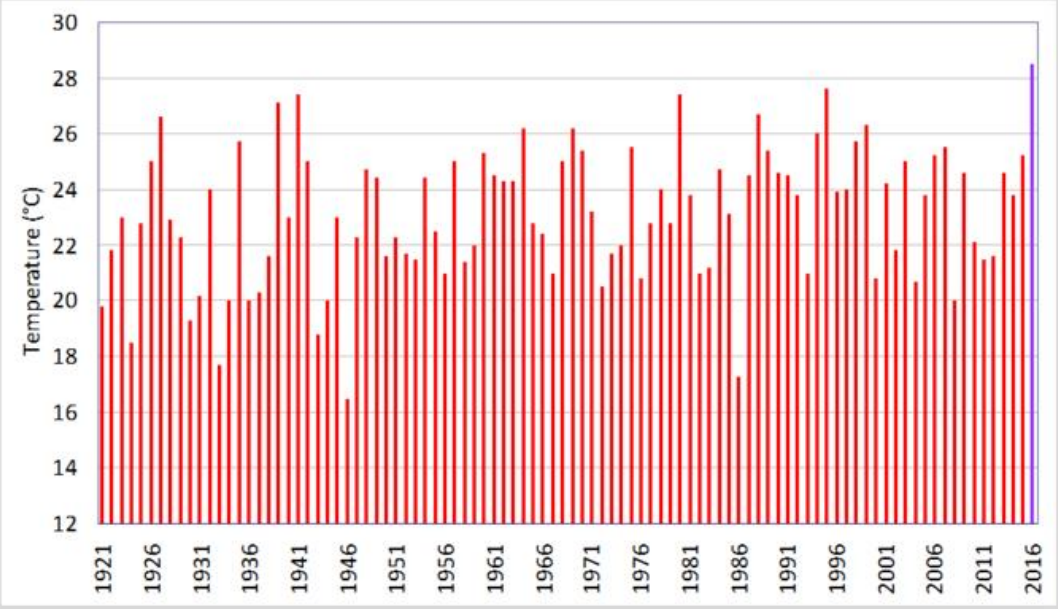


Figure 4.5: Highest daily minimum temperature (°C) in Jerusalem for each year in May 1921-2016 (Source: Israel Meteorological Service)

June started with high temperature in northern Europe. The Baltic States noted anomalies of up to +7°C. On the 9th of June a new record braking temperature was measured at station Nuuk, Greenland, with 24.8°C. From the 15th until the end of June Eastern Europe reported high temperature anomalies of more than +9°C. A second wave moved from Spain on the 22th June 2016 northward reaching on 24th Poland and on 26th the Baltic States with anomalies of more than +10°C. In *Lithuania* many stations registered temperatures of more 30°C, at stations Alytus and Pasvalyje even 35°C. This heat affected also Belarus, Ukraine, Moldavia, Romania, the Balkans, Turkey and the Middle East. During 18-21 June 2016, a 4-day heat wave event (Tmax ≥ 40°C) affected the eastern part of the *Greek* mainland with a maximum temperature of 43.4°C at station Sparti (Lakonia). June was also much warmer than normal in Israel and in most stations it ranks as the warmest on record. The average daily maximum temperature was 2.5-3.5°C above normal and in many stations it was more than 1°C higher than the previous record.

A heat wave occurred in *Slovakia* from 21.-26.6.2016 therefore June was from strongly up to extremely warm for the whole territory of Slovakia up to +4.2°C (1.8-4.2°C) above normal (1961-1990). The anomalous hot weather, on the territory of the republic of *Moldova*, was also observed in the third decade of June, when the average air temperature per decade was with 4-6°C above the norm, which in this decade is observed for the first time during the whole period of observations.

After one of the hottest June 2016 in the history of *Russia*, the heat continued to intensify in **July**. This was especially noticeable in the European part and above all in the Russian North. In southern Russia the temperature climbed to +40°C and more. New temperature records came from the Barents Sea. In northern Russia this July was hottest in history of meteorological observations and anomalies from long term mean exceeded 4-8°C. In the Arctic at Svalbard Airport (*Norway*) monthly average temperature was 9.0°C (3.1°C above normal). For Svalbard Airport this was the warmest July since July 1998 (8.2°C). Ny-Ålesund also had a record warm July with average temperature of 6.9°C (2.0°C above normal). A heat wave from 24-26 July occurred in

northern and southern parts of Lithuania with maximum temperatures of 30-35.4°C. In *Moldova* the maximum temperature reached values of 37°C at station Dubasari and the numbers of hot days (maximum temperature ≥ 30°C) summed up to 13-20 (3-10 days for the reference period). The average maximum temperature in *Portugal* in July, 32.19 °C, was well above normal with an anomaly of +3.47 °C; it was the highest value since 1931 (the previous warmest month of July occurred in 1989).

August 2016 was the warmest August in the western **Kazakhstan** for the period 1936-2016. The positive anomalies were 5-6°C above the reference period 1961-1990. From 8th of August onwards until 14th (with short interruptions) the maximum temperatures were 40°C-43°C over most of western Kazakhstan. From 8-10, 12-14 August, Atyrau region, suffered by very strong heat (maximum temperatures of +40 up to +42°C) and from 13-14 August, West-Kazakhstan region, very strong heat, +40 … +43 °C.

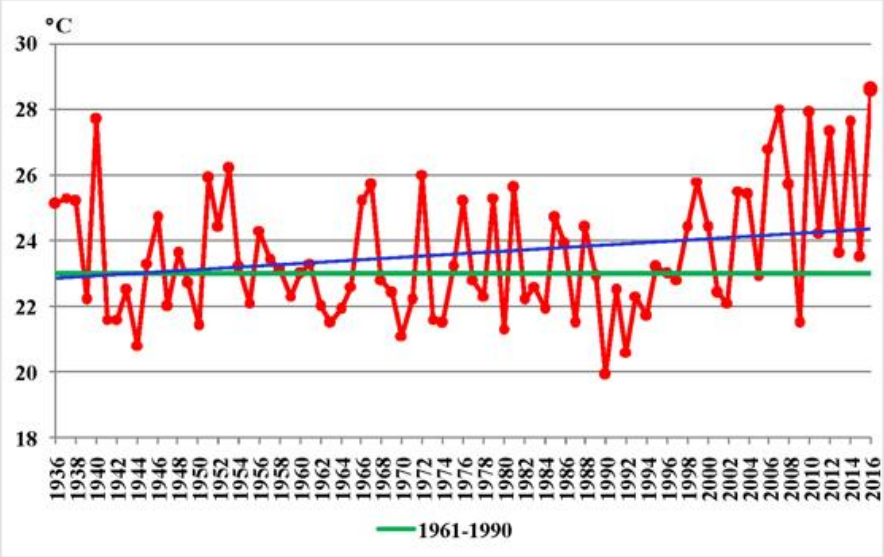


Figure 4.6: Monthly mean temperature (°C) in Taipak (western Kazakhstan) in August from 1936-2016 (Source: Kazakhstan Hydrological and Meteorological Service)

Between 5th and 13th of **August** a heat wave occurred in *Portugal* (duration of 8 to 9 days) in North, Centre, Lisbon and Setúbal regions. On 7th and 8th of August, almost half of Portuguese territory recorded tropical nights, combined with very hot or extremely hot days (maximum temperature ≥35 or 40 °C), which lead to a pronounced and extended heat distress.

The heat wave reached *France* from 23rd to 27th of August with 35 to 38°C. Temperatures in Paris have passed twice the previous record for a late August. They reached 36.6°C on the 24th, an unprecedented value in the capital after 20th of August since the beginning of the recordings in 1873.

A heat wave also occurred from 23rd to 28th of August 2016 in *Luxembourg*. The maximum air temperature of 34.9°C recorded on the 26th of August at Findel Airport is the highest air temperature ever recorded during the third 10-day period of August since 1947.

From 22nd of August onward a high pressure zone from the west moved over Middle Europe and remained in place until 28th of August. In *Switzerland* north of the Alps, helped by the maximum of sunshine duration, daily maximum temperatures rose up to 30°C and above from 25th of August onwards in many places. There were record values for the period from 25 to 31 August. In Geneva the daily maximum reached 33.5°C on 27 August, in Basel 33.8°C. In Geneva it was clearly the highest value for end of August since observations started in 1864. Basel had a similarly high daily maximum with 33.7°C on 28 August 1992.

Extremely hot weather occurred in *Portugal* during the 5th and 6th of **September** when 72% of meteorological stations reported new daily historical records. September 6th was the warmest day of the year in Portugal with average mean air temperature of 29.2°C; the average maximum and minimum air temperatures, 38.6 °C and 19.8 °C, respectively, were the highest values of 2016. The most remarkable event in *Spain* in September 2016 was the significant high temperatures

spell in the beginning of September that mostly affected Peninsular area and Baleares islands. In this period 36 principal Spanish meteorological stations exceeded their maximum absolute temperatures ever recorded in September, and at several stations these values were exceeded by more than 3ºC. Likewise, many meteorological stations registered their peak maximums of the astronomic Summer in this period, reaching up 45.4ºC in Córdoba-airport on 6th of September, 44.8 ºC in Sevilla-airport on 5th of September and 44.6ºC in Murcia, also on 5th of September. In many south peninsular stations and stations located in the interior of Galicia the maximum temperatures were higher than 40 ºC during this spell.

A short heat wave from 12th to 15th of September brought exceptionally high temperatures to south-east England, accompanied by some torrential downpours causing flash flooding. On 13 September, Gravesend (Kent) recorded 34.4°C, the *UK*'s highest temperature of the year and the highest September temperature since 1911; this value being around 14°C above the long-term (1981-2010) average. Daily minimum temperatures for 14 September were also exceptionally high, at a few locations exceeding 20°C. The heat was associated with a southerly flow of air from France and Spain, with the humidity leading to thunderstorms bringing intense downpours and causing flash-flooding. Several locations recorded hourly totals exceeding 30 mm.

Monthly mean air temperature of 17.4 °C recorded at Findel Airport is the second highest value recorded in September since 1947 in *Luxembourg*, nearly breaking the existing record from 2006 (17.5 °C). The *Netherlands* registered the third warmest September since the beginning of regular measurements in 1706. This year the monthly temperature of the area average for *Germany* was 16.9°C, together with the year 2006 the highest value ever observed since 1881. Highest daily maxima were observed in the west of Germany at station Trier-Petrisberg with 34.2°C on the 12th and 13th of September and a number of 16 summer days. In *Norway* September 2016 was the warmest since measurements begun in 1900. 43 stations reported new records for September mean temperature and 16 stations new records for maximum temperature. In *Denmark* too September 2016 was the warmest (with September 1999 and 2006) since measurements begun in 1874. September was warmer than August, which has only happen once since 1874, in 1949. In *Sweden* September was warm or very warm, especially in the middle of the month with a maximum temperature of 28.2°C at station Målilla on the 15th. Locally September was warmer than August which is an unusual feature. Monthly mean temperature over the area of the *Czech Republic* in September was + 3.0°C above normal (1961-90). A heat wave also occurred in *Slovakia* from 7.9.-16.09.2016, therefore September was very warm and in the south west part extremely warm up to 4.3°C (1.1 - 4.3°C) above normal. Monthly mean of maximum temperature was up to 5.0°C above normal 1961-1990 and monthly mean of minimum temperature was up to 4.5°C above normal 1961-1990. Station Dudince registered a maximum temperature of 32.4°C on 12th of September.

South of the Alps, in the Valais and in western *Switzerland*, continuous high pressure influence in the first half of the month led in parts to the warmest September since observations began in 1864. New September records were the result: Locarno-Monti registered +3.6°C above the normal values 1961–1990, Sion +3.8°C and Neuchâtel +3.0°C. In Lugano the record of +3.1°C was again reached while in Geneva the record of +3.2°C was closely missed (2016: +3.1°C). In lower altitudes of northern Switzerland it was – overall – the fourth-warmest September since observations started in 1864.

At the beginning of **October** a strong high pressure area was established over *Scandinavia* and northern Russia guiding cold air to Europe. Therefore, this October was in many parts of Europe colder than normal. The cold period started from the 3rd of October and ended on 22nd. The colder period remained for ten days in the Alpine region and moved then to the east. In *Switzerland* the anomalies reached for several days 5-6°C below the long term mean, in higher elevations even -9°C. The snow line reached the 1000 m level in Switzerland and also in Austria. The monthly average temperature in *Germany* for October was 8.6°C or -0.6°C below the 1981-2010 reference period and therefore it was the first month in 2016 below the long term mean. At station Crni Vrh (*Serbia*) it was the second coldest October on record since the measurements began at that meteorological station. The average air temperature in *Latvia* was 4.9°C or -1.9°C below the monthly norm. At station Daugavpils both absolute monthly maximum and absolute monthly minimum temperature were observed with +19.7°C on 2nd and -6.2°C on 13th of October, respectively. The temperature anomalies in *Lithuania* were 1.5°C-2.5°C below the mean of the reference period. In October, the heat island above north-eastern regions of *Russia*, which formed

as early as September, became more intensive. Mean monthly air temperature anomalies in the Nenets Autonomous Area and Novaya Zemlya attained 6-7°C. Heat ridge dropped on the Upper- and Mid-Volga regions; however, mean monthly air temperature anomalies in these regions were not higher than 1°C. The rest of European Russia was slightly colder than is usually recorded, with mean monthly air temperature anomalies being -0.5 to -1.5°C. It was particularly cold late in the second ten-day period in Northern Caucasia; heavy snowfalls occurred in individual regions of Kabardino-Balkaria, Chechnya and Dagestan.

In Northern and Eastern Europe **November** was colder than normal. At station Folldal-Fredheim (*Norway*) the minimum temperature reached -33.5°C on the 8th of November. In *Latvia* ten new daily minimum temperature records were broken in November.Over most of European *Russia*, November was cold with monthly air temperature anomalies of 2-4°C below normal. In St-Petersburg, the first ten-day period was the coldest for the last 46 years. At the same time, air temperature rose to record-breaking values in southern European Russia due to penetration of subtropical air masses. On 9th of November, temperature records were broken in many cities of Northern Caucasia. Temperature in polar regions, e.g. at Vize-Island (Kara Sea, Russia), with a monthly mean of -4.3°C, showed the highest deviation from normal with +16.8°C.

Scandinavia in **December** was much warmer than normal with monthly temperature anomalies e.g. of +7.4°C above the reference period of 1961-1990 at station Fagernes (*Norway*). Anomalies of more than +6°C occurred also in Sweden, in northern Sweden even +8.4°C at station Kvikkjokk-Årrenjarka. The Arctic stations also showed anomalies above +7°C or more. Svalbard airport had a mean monthly temperature of -6.0°C (+7.4°C above normal).

The spatial distribution of temperature anomalies showed an area of negative values in eastern European *Russia* with maximum anomalies in the center of the area attaining -12°C. At the end of the second ten-day period, mean daily air temperature were 15-20°C below normal. On the coastal regions around the Black Sea temperature anomalies were below normal for example at station Constanta (Romania) -2.0°C, in Odessa (*Ukraine*) -1.2°C. In Greece the monthly temperatures were well below the climatic values. The temperature dropped in the last decade of the month below -3°C, with snowfall in several regions of the country, including areas of Attica. Athens reported a monthly temperature of 9.0°C and an anomaly of -3.0°C. Tiran (*Albania*) measured a temperature anomaly of -3.7°C. In *Spain* there was a could spell during the two last days of December with -11.0°C in Molina de Aragón on 30th of December, -8.2°C in Burgos on 31st of December and -7.3°C in Valladolid airport also on 31st of December.

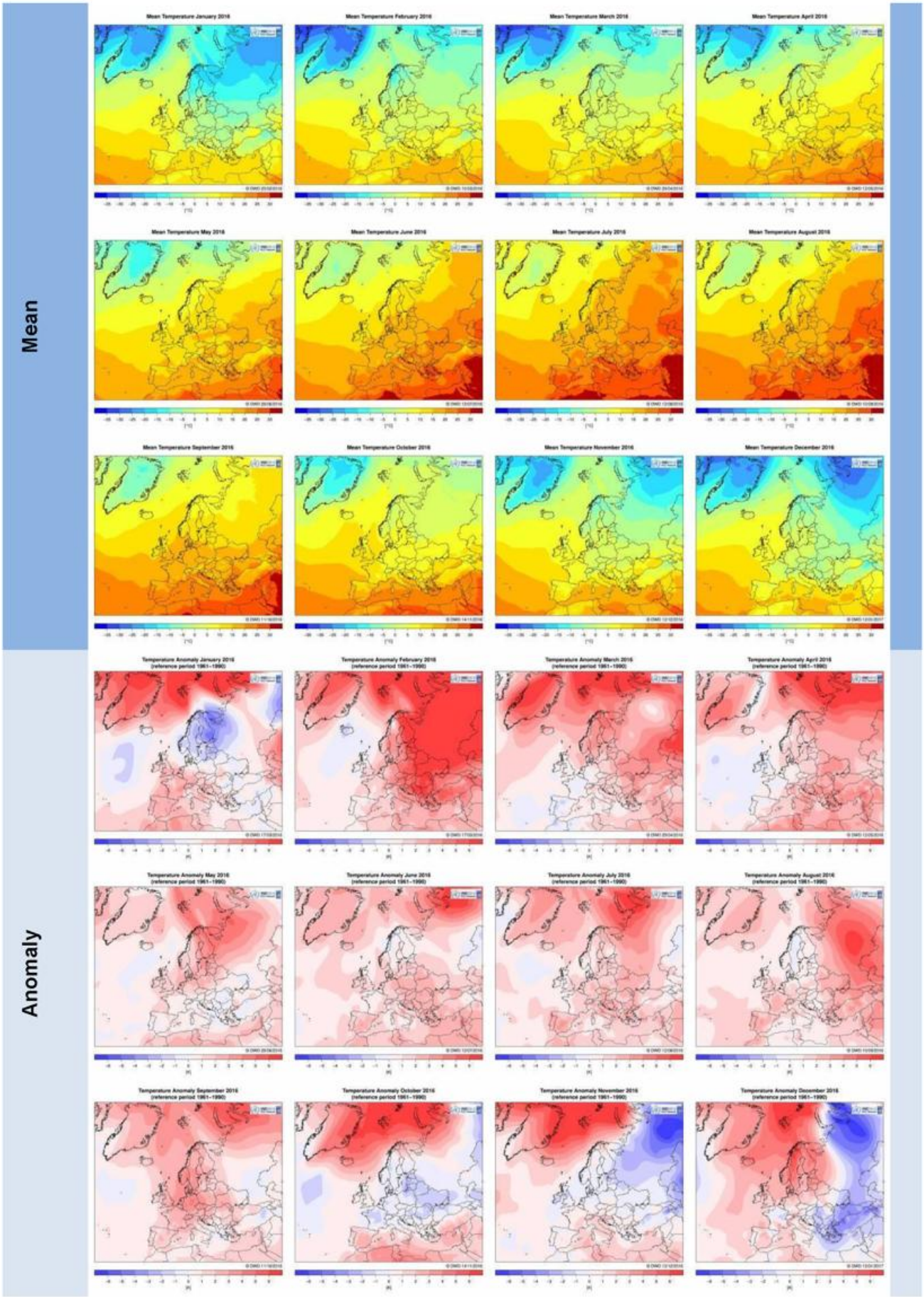


Figure 4.7: Mean and anomalies of temperature (in °C) for each month of the year 2016. (First row January, February, March, April, …; reference period: 1961-1990).

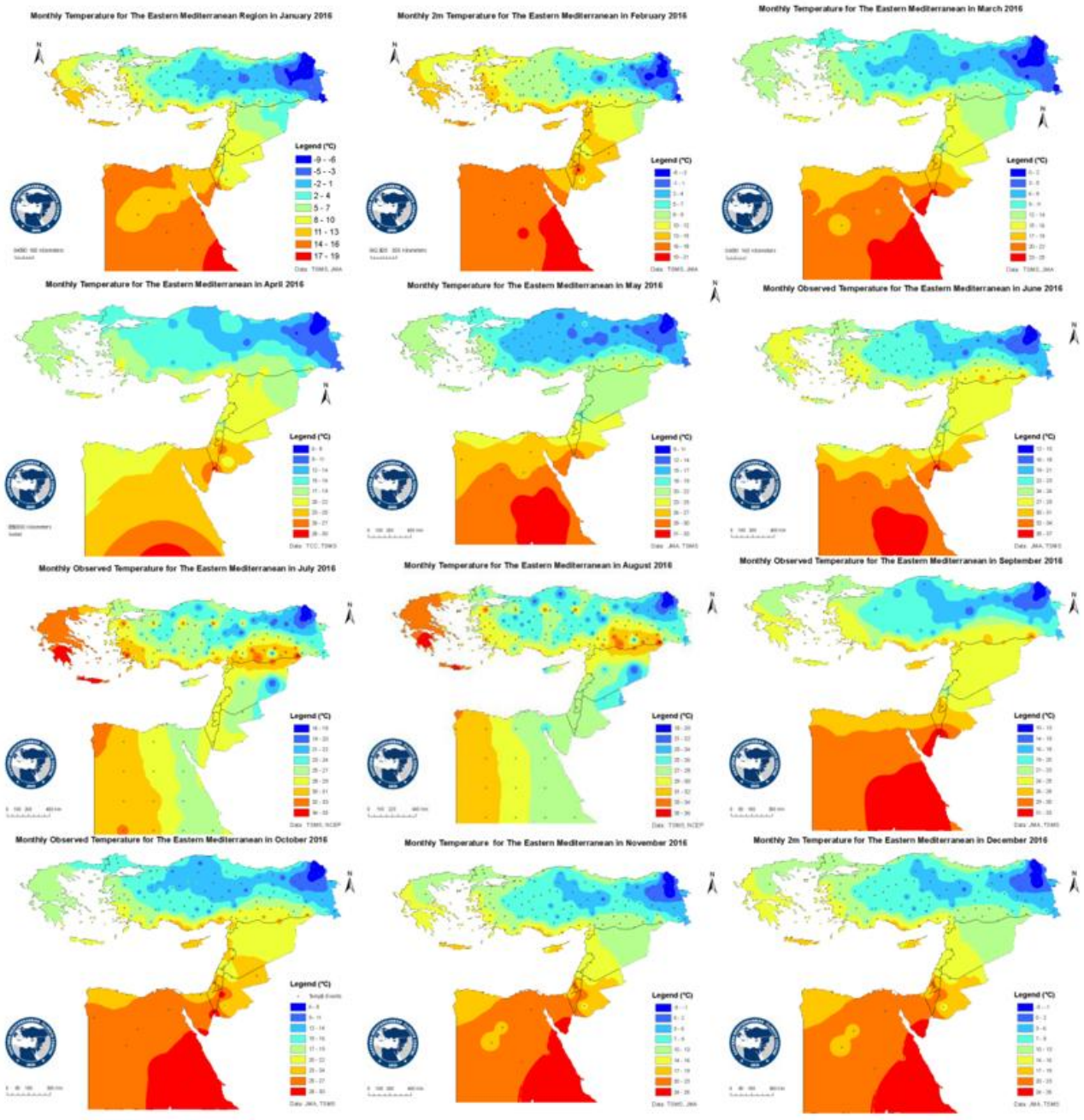


Figure 4.8: Monthly mean temperature (°C) for the Eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC).

4.3. Precipitation

From 9th to 11th of **January** 2016 an extreme precipitation episode in *Portugal* occurred with 120 mm/48h. On 12th January Flores Island (Azores, Portugal) saw an exceptional precipitation event of 96 mm/24h. The first week of January saw persistent rain affecting parts of the *British Isles*, particularly eastern Scotland and north east England. Parts of Aberdeenshire exceeded their monthly average January rainfall in the first three days of the month and two to three times the normal monthly rainfall by the 7th. Widespread flooding affected these regions. It was the wettest January on record for eastern Scotland. In *Serbia*, stations Nis and Zajecar observed the highest precipitation totals since the records at these main meteorological stations began. The previous January record of 98.1 mm for Nis was set in January 2012, whilst the current January record measures 101.3 mm. In January 2016, Zajecar received 105.6 mm of precipitation surpassing the previous January record of 94.7 mm set in 1987. North of the Alps in *Switzerland*, January brought a lot of precipitation with new records at some meteorological stations i.e. Eschenz at Lake of Constance region registered 185 mm, while St. Gall with 164 mm and Basel with 132 mm recorded their second-highest January totals. On 2nd of January in *Austria* freezing rain and black ice caused major traffic interruptions and rear-end collisions in the eastern part of Styria. In some parts of Salzburg and Upper Austria the lack of precipitation led to drinking water scarcity in some townships. From 11th to 12th of January in the southern parts of Carinthia heavy rain and snowmelt were triggering local floods. Record high snow accumulation was measured on January 8th in Merikarvia (Finland). The snow depth rose 73 cm during one day.
In western *Kazakhstan* precipitation up to 24 mm occurred across most parts of the country; 27 to 107 mm in the western parts. On the 2nd January, meteorological station Peshnoy (Atyrau region, western Kazakhstan) registered very heavy snow of 40 mm.

Extreme precipitation episode during 7-8 January 2016 in **Israel** Rainfall amounts of 100-130 mm within less than 24 hours. A significant precipitation event on January 7-8th, was characterized by significant rainfall amounts in the Lower Galilee and Jezreel Valley (Israel, Figure 4.9), where 100-130 mm fell within less than 24 hours (more than 80 mm in 6 hours).

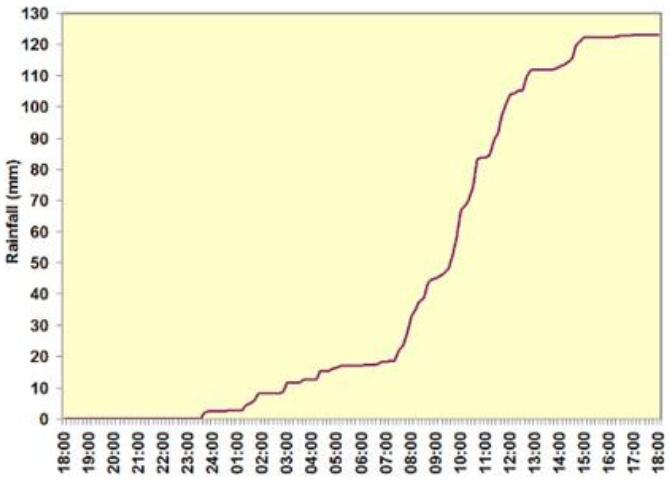


Figure 4.9: Accumulated rainfall (mm) in Newe Yaaar (Jezreel Valley) on January 7-8th 2016 (Source: Israel Meteorological Service).

An extreme precipitation episode on 26th **February** 2016 occurred in *Ireland*. Some Cork stations reported 24-hour rainfall totals of up to 90.9 mm. Record high February precipitation of 131.6 mm measured in Kouvola (*Finland*) narrowly surpassed the old record of 130.8 mm from 1990. Finland experienced the second wettest February, behind only 1990 with an anomaly of 240% of the average. With an average cumulative precipitation amount of 65.9 mm for whole of Latvia, February was the 2nd wettest since 1924. An extreme precipitation episode was also registered in *Portugal* from 10th to 14th February with 200 mm/120h.

In *Spain* **March** 2016 was characterized by several precipitation episodes but most rain fell in the last decade. Station La Coruña measured a total precipitation of 292 mm (200 mm in the last decade). Western France was affected by the same storms and at station Biarritz 183 mm precipitation was registered. Even higher amounts occurred in the Pyrenees at station Bustince-Iriberry with 233 mm.
England and Wales were affected by storms and extreme precipitation at the beginning (Storm Jake on 2nd) and the end (Storm Katie on the 28th) of March with plenty of sunshine in between. Strong winds in England and Wales caused several damages and losses. Roads were closed due to fallen trees, flights were diverted or cancelled. On 17th March Calabria (*Italy*) was affected by heavy rain with storm caused two fatalities after their car crashed in the floods of river Turina. The

wettest March for *Serbia* with maximum precipitation sums surpassed previous records at several stations e.g. Zlatibor with 220.9 mm (last record from 2006 190.4 mm) and 80.3 mm on March 7th. *Greece* was also affected by thunderstorms with gale-force winds of 40 m/s on the 18th. The total rainfall for six days (12-18 March) at station Zagora was 430 mm and for the whole month 501.6 mm. This resulted in floods and damages.

During 15-20 **April** ice jam on the Sukhona River (European *Russia*, Vologda Region) caused flooding. The water level in the Sukhona rose nearly as high as 10 m. The city of Velikyi Ustyug and another 24 human settlements with the population of about 40 thousand people found themselves in the zone exposed to flooding. The total flood-related damage was more than 300 million rubles (0.5 Mio €). From 10.-16.04.2016 two depressions (named Ortrun and Petra in Germany) with low temperatures brought rain and snow to Western Europe. Western *France* and northern *Spain* observed extreme wind gusts, flooding, and damages. At station Guarda in *Portugal* a daily total precipitation of 90.4 mm was measured on the 15th of April.

Unseasonably warm and unsettled weather dominated late **May** in *Sweden*. The station Ed in southwestern Sweden reported 83.1 mm on 24 May. This was the highest daily amount in Sweden during 2016 and one of the highest daily amounts ever for the month of May.
From the end of May until beginning of June disastrous thunderstorms hit Central Europe. 8 people died in *Germany*, *France* and *Netherlands* due to flash floods, severe storms and land slides causing an overall loss of 1400 Million US$ (Munich Re). Dozens of houses, businesses, public buildings and bridges were damaged or destroyed. Highways, roads, railways were blocked. Crops damaged or destroyed and other related impacts. In Germany precipitation of 90 mm within one hour induced a flash flood in Braunsbach on 29th of May with death and a lot of damage.
In *France* from 28 May to 6 June heavy precipitation of 80 to 120 mm caused rivers to rise and other related impacts. Highest five-day totals of 150.7 mm were measured at station Aubigny-sur-Nère and 118.2 mm at Fontainebleau. Such events have a return period of 10 to 50 years, the extreme ones of 100 years. Rivers Seine, Loing and Yonne burst their banks and flooded numerous towns and villages and 5 people died. Thousands of buildings and businesses were damaged. 25,000 customers were without electricity and farmland and vineyards were destroyed. The overall losses were summed up to 2400 Million US$ (Munich Re).
In *Switzerland* locally there were totals of 210% to 225% of normal values. Lucerne registered 270 mm, Château d'Oex 239 mm and Thun 198 mm; at all these stations it was the May with the most precipitation since observations began in the 19th century.
24 hour precipitation in Laneia of 79.9 mm was the highest daily precipitation for May in *Cyprus*, since 1967. In Agios Mamas 67.3 mm was the highest daily precipitation amount for May since 1971. These extreme precipitation events together with severe hailstorms caused a lot of damage.
The highest daily precipitation amount in *Czech Republic* on 31th May was 145.8 mm. The 1 hour precipitation amount (129.3 mm) was probably the highest ever recorded in the area of Czech Republic.

May 2016 was the wettest May in the western **Kazakhstan** with 240% of the long-term mean. Some stations received more than 3 and even 6 times of the normal rainfall (Atyrau, 653%, Figure 4.10).

Heavy precipitation was recorded in southern European *Russia* in May, with most of it falling in the third ten-day period. In the Rostov Region, Krasnodar Territory and Astrakhan Region, monthly precipitation totals were above normal by 2-3

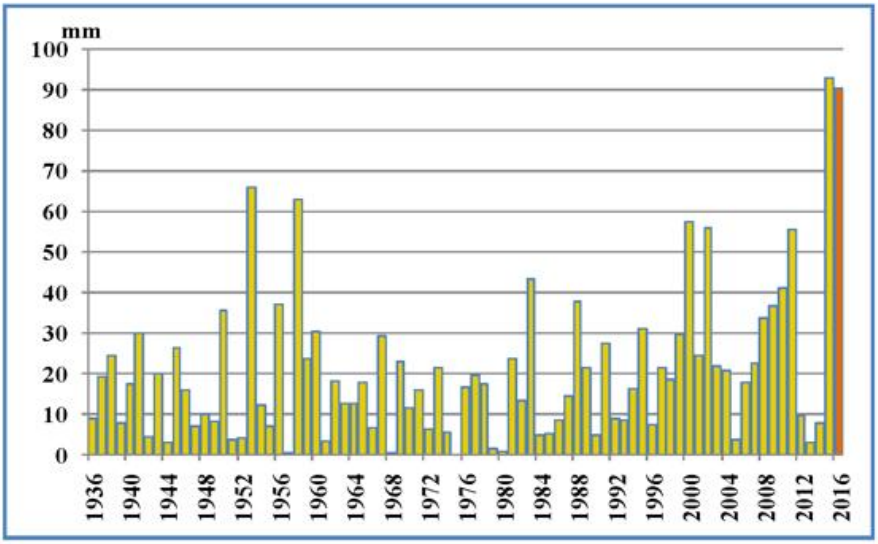


Figure 4.10: Monthly rainfall (mm) in Atyrau (western Kazakhstan) in May (Source: Kazakhstan Hydrological and Meteorological Service).

and even 5-6 times, respectively.

In Central Europe the thunderstorms and extreme rainfall from end of May continued at the beginning of **June 2016**. The high temperatures again induced in the 3rd decade heavy and at times thundery downpours with a lot of damages.
From 31 May until 7 June severe storms with torrential rain that rivers burst their banks together with flash floods occurred in *Germany*, *Belgium* and *Switzerland*. Thousands of houses were damaged. Basements, undergrounds and car parks were flooded. 9,000 customers remained without electricity and 9 people died. The Overall losses for this period were summed up by Munich Re to 2200 Million US$. In Belgium 3 persons were surprised by flash floods on the 2nd, 5th and 6th of June. Flooding due to intense rainfall in the Region Brussels (*Belgium*) on the 7th and the 23rd of June 2016. Continuous and intense rainfall in Belgium between the 27th of May and the 26th of June. The total amount of damages was estimated at 248 Million €. During June 2016 21 thunderstorm days (normal: 12,7d) were observed, the highest value since 1928 and 2 days more than the previous record of 1991. Monthly amount of precipitation for June 2016 in *Luxembourg* was 135 mm, the 4th highest ever recorded for June since 1947.
The Bavarian town Simbach/Inn (*Germany*) will be remembered for a long time as 7 people died after braking of a dam and resulting flooding on 1st of June. On the 3rd June 80 persons were injured on the music festival „Rock am Ring" by lightning strikes. Also several tornadoes were observed during the first days of June in Germany.
From 22nd-24th of June a hailstorm crossed the *Netherlands* and *Germany* with hundreds of vehicles damaged, destroyed solar panels, greenhouses and agriculture. The overall loss was summed up by Munich Re to 1,900 Million US$. June was very wet with record sums of precipitation in *The Netherlands* on some of the stations in the southeastern part of the country. Station Ysselstein (Limburg) recorded 277 mm. On a number of days heavy showers caused substantial damage. On June, 23rd, hail with a diameter of 5-10 cm fell in the province of Brabant, causing damage of approximately 500 Million €. In the *United Kingdom* thunderstorms caused local flooding, lightning damage and related impacts in parts of the country. It was a very wet month in Aberdeenshire, England and Wales, with some regions receiving in excess of twice normal rainfall. It was the fourth wettest June on record for East Anglia.
In Switzerland thunderstorms in first half of the month brought heavy precipitation and local flooding. Towards the middle of the month humid air from the Mediterranean triggered severe precipitation in southern and eastern Switzerland. The surface already soaked by previous June rainfalls reacted with mudslides and flooding to this heavy precipitation, leading to major damage locally. Lake Constance and Walensee overflowed and the Rhine burst its banks. In the last third of the month torrential rains again caused severe weather damage in the eastern half of the Switzerland. In *Denmark* a new rain intensity record of 5.4 mm/min was registered in a thunderstorm on June 23rd.
June was excessively dry in east *Slovakia* (27%-48% of normal 1961-1990), but excessively wet in some parts of west Slovakia where storms occurred (up to 153% of normal 1961-1990). At station Zrenjanin, *Serbia*, record-breaking June precipitation totals of 187 mm was observed, exceeding the previous record of 173.7 mm set in June 1981. During 25-26 June 2016 a barometric low moved from northern part of Africa towards *Greece*, and affected the south Ionian Sea and Peloponnese prefecture causing severe thunderstorms with heavy rainfalls, with daily totals in Tripoli of 157.7 mm and Megalopoli (Arkadia) of 213.0 mm.
In *Romania* precipitation amount (128.3 mm) was 52% higher than the climatological normal. Rain amounts recorded during showers were frequently exceeded 25 mm and sometimes were even in excess of 50 mm. On the 2nd of June, more than 150 mm accumulated in very narrow spots in Moldavia and on the 13th up to 105.5 mm rain fell at Costeşti, Vâlcea county.
In June there were a large number of strong local rains, hail and squalls in the *Ukraine*, in some areas downpours reached the criteria of natural phenomena. The highest monthly rainfall (for the period of observation 1961-2015) was marked on the weather station Voznesensk (Mykolaiv region), 212 mm or 326% of the monthly norm. In *Belarus* on 28th of June a very heavy rain with up to 118 mm/12h was observed. On 5th June, heavy shower took place in Vladikavkaz (North Caucasus, *Russia*); 50.5 mm of precipitation fell in 20 minutes, with the shower being accompanied by large hail (30 mm) and strong wind (28-32 m/s) for 12 minutes. As a result, glass panes and roofs of 699 buildings, as well as cars and agricultural crops on a 365 ha area was damaged and more than 2500 trees were toppled and rooted away. Two persons were injured.

On 7 **July**, heavy shower was recorded in Belaya Kalitva (Rostov Region, *Russia*) that brought 84 mm of precipitation in 40 minutes. The shower was accompanied by hail of 15 mm in diameter and wind as strong as 23 m/s. Precipitation amount in *Georgia* was above the norm by 30-90% approximately, whereas in some mountainous regions of Adjara and west Caucasus 170-380 mm monthly sums were observed that was 2-3 times more than normal. Intensive rainfall (90-100 mm) causing landslides and flooding and significant infrastructure damage was observed in west Georgia regions (Adjara-Guria-Imereti) on 8-9 July. Several hail events occurred in eastern and southern regions at the end of the month. In *Belarus* 03 and 13 very heavy rain occurred with up to 76 mm/8h.

In the night of 6th to 7th of July the amount of precipitation reached 81 mm within 12 hours at Sīļi (south east *Latvia*), which is 110% of July normal precipitation amount, never recorded in the climatological archives (Observations started in 1944) with previous highest daily precipitation amount of 76.7 mm observed in 2001. An extreme precipitation happened on 6 July in *Lithuania* at Skuodas town with 53,4mm/12h.

Heavy precipitation in Northern Poland, 13-14 July 2016

(provided by the Institute of Meteorology and Water Management, IMGW)

Due to the passage from the south of Europe of a deep mesoscale cyclone with very active frontal system heavy precipitation occurred in the whole area of Poland. Specific threat was related to the convection rainfall. The spatial range of Cumulonimbus clouds was enlarging due to the advection of colder air from the Baltic Sea. The tops of clouds associated with the front reached 10-11 km. The Northern Poland was affected by particularly heavy rain, whose daily totals exceeded 100 mm and locally it was even about 150 mm. Late afternoon and early evening the cities of Gdańsk and Gdynia, located on the coast of the Baltic Sea were hit by the torrential rain with total reaching almost 140 mm in Gdańsk Rębiechowo Airport. In some parts of the cities the sum of rain was even greater (e.g. the meteorological station of University of Gdańsk in the central districts of the city recorded above 150 mm of rain). Several places in Gdańsk were flooded, which caused serious damages. It was the highest sum of precipitation recorded in Gdańsk, where the regular meteorological observations have started in the first half of the 18th century. The previous on occurred in July 2001, when the value of 127 mm was recorded, also in Rębiechowo Airport.

The spatial distribution of precipitation totals recorded in Poland on the 13th and 14th July 2016 is presented in following figures.

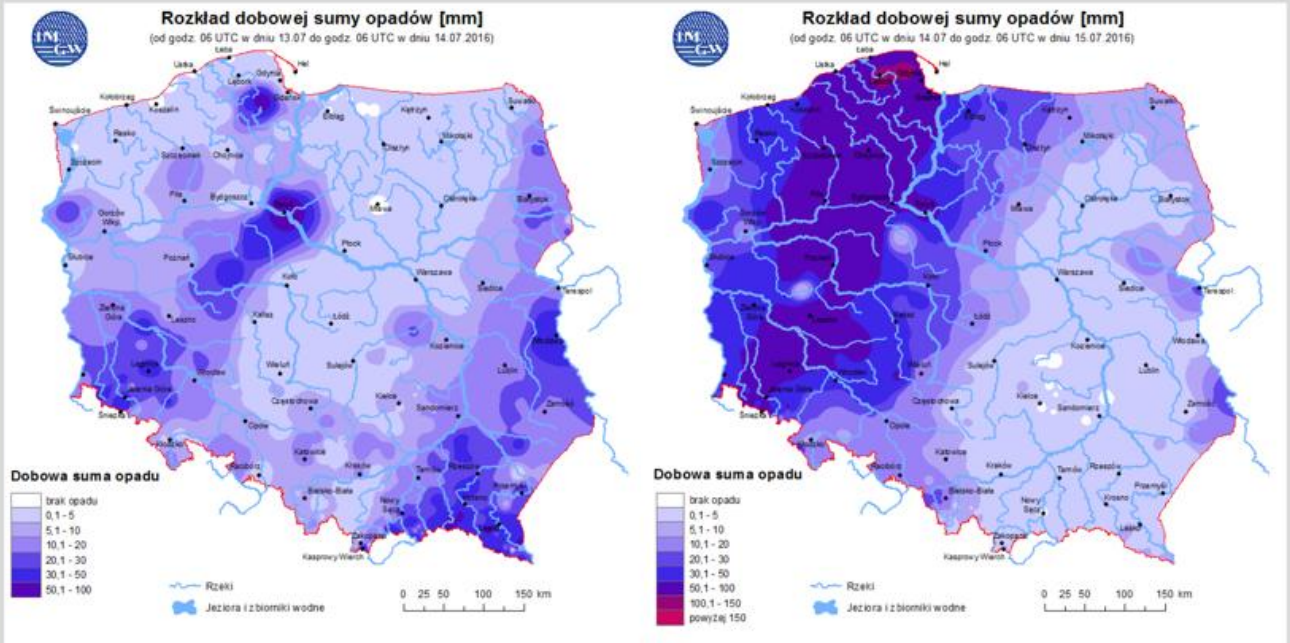


Figure 4.11: Spatial distribution of daily precipitation totals in Poland, 13th (left) and 14th (right) July 2016 (source: provided by the Institute of Meteorology and Water Management, IMGW).

Excessive rainfall and flooding on the 23rd of July in *Belgium* caused 8 entities (Limburg and Flemish-Brabant). On the 21st of July 2016, in *Luxembourg* 3 station records concerning the

precipitation intensity occurred at the station of Findel airport operated by Meteolux (absolute maximum since 1947). The maximum intensity in 60 minutes amounted to 47.5 mm, in 3 hours to 58.1 mm, in 12 hours to 60.4 mm. These intensities are the highest ever recorded since 1947. On the 22nd of July 2016 two station records of precipitation intensity for July occurred (absolute maximum since 1947). The maximum intensity in 30 minutes amounted to 28.4 mm, in 24 hours to 70.6 mm. These intensities are the highest ever recorded for July since 1947 at the Findel station. At station Christnach operated by ASTA, which was closer to the maximum intensity of the event, a daily sum of 68.6 mm has been measured and a maximum intensity of 51.0 mm in one hour and 20.3 mm in 10 minutes. The quasi-stationary convective cell formed above the Ernz Valley and caused thunderstorms with heavy rainfall. Radar-based precipitation values reached about 50 mm with some peak values of 80 mm to 90 mm near the small towns of Medernach and Ermsdorf between 17:30 UTC and 18:45 UTC. Torrential convective rainfall triggered catastrophic flash floods. The river White Ernz flowing through the towns of Ermsdorf, Medernach and Larochette reached exceptionally high water levels of 223 cm at Larochette.
The highest daily precipitation sum in *Serbia* of 137.1 mm was registered in Negotin on July 16, breaking the previous record of 67 mm set on July 5, 1970. July was extremely wet (up to 340% of normal 1961-1990) almost at the whole territory of *Slovakia*. Some extremely daily precipitation totals occurred in July (e.g. station Dolná Poruba) when the intensity of rain reached on 27.07.2016 91 mm/30 min. and 110 mm/1h (128 mm/d) what means occurrence once for 200 up to 500 years. At station Revúca the daily precipitation totals on 29.7.2016 reached 112 mm/d (53.2 mm/1h), at station Zverovka on 31.7.2016 136 mm/d and on 17.07.2016 at station Kremnica 110 mm/d, Kremnické Bane 128 mm/d (79.8 mm/h). This caused flooded houses and streets.

In Former Yugoslav Republic of *Macedonia* monthly sum of precipitation in **August** was below average in Berovo, Stip and Strumica, while in Mavrovo, Ohrid and Bitola twice as the average values and in Skopje and Demir Kapija three times higher than the average. On the 6th of August the wider urban and rural areas of Skopje was under influence of severe weather event with catastrophical consequences associated with torrential rainfall, a lot of thunderstorm lightning and flash flooding. This disaster caused huge material and economy damages and human victims. Daily precipitation amount in Skopje on 6th of August was exceeded, reaching 92.9 mm. The amounts of precipitation that instrument registered were with record- breaking intensity which can appear once in a thousand years.
In central *European Russia*, very heavy rains caused by an active atmospheric front occurred on 14-15 August. In Moscow, along with daily precipitation maximum (25.2 mm in 1887), monthly (59 mm in 2003) and summer (63 mm in 1970) precipitation maxima were also exceeded. In the interval from 18:00 on 14 August through 18:00 on 15 August 102 mm of precipitation were recorded by meteorological station Moscow (Balchug).

Average precipitation sum in **September** in *Latvia* was 21.6 mm, which is 33% of the normal. This was the 2nd lowest monthly precipitation amount in September in Latvia ever recorded (since 1924). Within a few days, Afritz (*Austria*) was affected by several landslides. Following rain events caused local flooding especially on the northern side of the Alps.
During 6-9 September 2016 a cut-off upper level low at the SW of *Greece* affected mainly the west part of Greece and caused severe thunderstorms with heavy rainfalls, floods, landslides, and locally tornadoes with 6 causalities. During the 6th station Kerkira reported a daily amount of 113.3 mm/d and station Kalamata 132.6 mm/d while at station Araxos 66.1 mm/12h occurred and on the 7th at station Geraki 200.2 mm/d. Continuous heavy rainfalls affected several areas of the country causing power outages, large damage to networks, crops, infrastructure, roads and public and private property due to flash floods.
In *Russia* heavy rains in September in the Upper and Mid-Volga Region and the Urals stopped the drought. Monthly precipitation normal was also exceeded substantially in the Krasnodar Territory. For example, Novorossisk received 220 mm of precipitation, which is four times as much as the monthly normal. In *Belarus* September was the driest month, with 24 mm of precipitation, or 42% of the norm. Therefore fires occurred from 05 to 21.09. in Gomel and Brest region.

From 4-6 **October** *Belarus* experienced very heavy rain with up to 100 mm/48h at station Zhitkovichi. On 11-13 October due to a cyclone moving from the Balkans there were long and very strong storms and wind up to 25-31 m/s in the *Ukraine*. In Mykolaiv and Odessa 50-78 mm of rain fell during 12 hours. In Odessa and Bolgrad (Odessa region) during 20-26 hours fell up to 104-107

mm of rain. Houses were flooded, traffic was interrupted, numerous cases of fallen trees and tall cranes, and losses of lives were recorded. The state of emergency was declared in Odessa. In Odessa and Bolgrad (Odessa region) during the month fell up to 700% of the monthly rainfall – 180 and 201 mm, respectively. These weather stations recorded daily maximum of rainfall - 104 mm (Bolhrad) and 103 mm (Odesa), amounting up to 4 times the monthly norms.

The amount of precipitation in *Moldova* for the month was on the territory 85-185 mm, which surpassed 3-6 times the monthly norm and on 60% of the territory in this month was observed for the first time during the whole period of observations. The mean monthly precipitation amount at country level in *Romania* (103.6 mm) was 138% larger than the climatological normal (1981–2010). Positive deviations were very large, exceeding 100% at most weather stations and extremely large in Moldavia, where they exceeded 350%. The widest deviation was recorded by Galaţi weather station, 802% or 207.8 mm with 90.6 mm at 11th October followed by flooding. The highest monthly precipitation amount recorded in Romania in October 2016 was 294.7 mm at station Cudalbi, in Galaţi county.

On the 3rd October 2016 *Ireland* experienced an extreme precipitation event in the Kerry region with daily totals at station: Roads (Kells Bay) 159.4mm (opened 1996), Derriana 156.5mm (opened 1993), The Glen (Ballinskelligs) 166.5mm (opened 1985), Knightstown 182.0mm (opened 2006), Cloone Lake 198.6mm (highest ever reported for October).

Severe weather event in the South of Portugal, 23rd to 25th October

(as provided by the Instituto Português do Mar e da Atmosfera, IPMA)

In the period 23rd to 25th October 2016, adverse weather conditions occurred, in the north and central coastal regions on 23rd of October and on days 24 and 25 in the southern regions of the Montejunto-Estrela mountain system.

On day 24, the southern regions were affected by instability lines where numerous convective cells were formed successively, most of them with super cell characteristics, with intense electric activity, causing heavy precipitation, strong wind and tornadoes. Some impacts on structures associated with extreme wind events that, due to their occurrence very localized, were not detected in the network of meteorological stations of the IPMA.

In the southern region, the highest precipitation amounts in 24 hours occurred between 11 hours UTC on day 24 and 11 UTC on day 25, and were higher than 50 mm (radar/udometer method), in some locations of the municipalities of Vila do Bispo, Silves, Almodôvar, Loulé and Faro, in the Algarve, and in the municipalities of Beja, Vidigueira and Portel, in the Alentejo. In particular, in the period from 17 to 22 UTC, hourly values were greater than 10 mm, and 3-hourly values greater than 25 mm.

The highest daily rainfall values recorded in the IPMA and APA station network were 27.9 mm in Portel (from 20 to 21 UTC on day 24) and 26.3 mm in Sagres (10 to 11 UTC on day 25). The highest values accumulated in 3 hours were recorded in Portel, 41.4 mm (from 20 to 23 UTC on the 24th) and in São Barnabé 39.9 mm (from 18 to 21 UTC on the 24th).

The highest concentration of atmospheric electrical discharges, about 2/3 of the total recorded in the whole period under analysis, occurred on the 24th, between 19 and 23 UTC.

There was an early start of the snow season in southern *Sweden* early in **November**. Stockholm reported a new record for greatest snow depth in November with 47 cm in the evening of 9 November.

In the period from 22 to 27 of November, due to a cold and unstable air mass, there were heavy showers and thunderstorms in almost whole *Portugal*. In the North and Centre snowfall occurred at altitudes above 1200 m on days 22 and 23, decreasing to 900m on 25 of November.

During 26-30 November 2016 a 5-day severe weather event affected mainly the west and eastern part of *Greece*, including Attica, the capital of *Greece*, and caused extended floods due to continuous rainfalls. on 26-27 at the station Zakinthos 183.4 mm/48h; on 28-29 at station Mitilini 177.2 mm/36h; on 29 at station Kos 86.2 mm/12h. Flooding also affected Athens the capital city of Greece, where several Metro-underground stations and roads had been closed.

Flood of 21-26 November 2016 in Piedmont (northern *Italy*) with 165 mm in 24 hours in Piaggia on 23 November, cumulative value for the 24 November was 385 mm at station Barge. The highest peak in 24 hours throughout the event was reached between the 24. and 25.11., with 436 mm at

station Barge. The highest overall values for this 5 day period: in the upper Val Tanaro the station Piaggia (CN) recorded a total of 632.6 mm/5d.

Forest fires November 22-27th in Israel

(provided by the Israel Meteorological Service)

Widespread fires both in urban areas and wildfires enhanced by conditions of strong easterly winds and extreme dryness Hundreds of apartments completely destroyed mainly in Haifa, 75,000 residents evacuated. Cost of damages estimated at more than $100 million. It was a very dry month with average relative humidity 15%-20% below the long-term average in northern and central Israel, which is record-breaking. In Bet Dagan, for example, the average monthly relative humidity at 08:00 and 20:00 L.T. (06 and 18 UTC) was 50% compared to a long-term average of 68%-70%. This is the lowest value ever recorded for these hours in comparison to all months, not only to November.

The monthly amount of precipitation of 7.3 mm in **December** 2016 is the 2nd lowest ever recorded for December since 1947 in *Luxembourg*. North of the Alps and in the Alps of *Switzerland* a stable high-pressure zone led to the month with the least precipitation in many areas since observations started in 1864. In several regions of the western half of the Plateau and in the Valais December did not receive any precipitation at all.

December was very dry in most of Slovakia but extremely dry in south of middle *Slovakia* (Novohrad and Gemer region) where locally only 2%-4% of normal (1961-1990) rain occurred. Rainfall has experienced a record deficit of about 80% on average across the France. Only Corsica was very wet with a particularly intense episode on the 19th and 20th. On the eastern half of the island, the monthly accumulation exceeded one and a half times the normal. This deficit of precipitation resulted in a very low snow cover on all the massifs, with the exception of the Southern Alps and the Corsican Mountain. December 2016 thus ranks first among the driest December in the period 1959-2016, dethroning December 2015.

Heavy rainfall events from 16th to 22nd December affected to a big area of the southeast *Spain* from Valencia to Almeria, as well to Ibiza and Mallorca Islands. The precipitation accumulated during this event was more than 450 mm in some stations of north Mallorca and more than 350 mm in southeast of Valencia. The maximum values of the series were exceeded in many stations, both the maximum monthly precipitation values and the maximum daily precipitation values. The highest amount of rain accumulated in 24 hours in a principal station was reported on 18th December in Alcantarilla (Murcia) with 112 mm, 109 mm in Murcia and 103 mm in Palma de Mallorca-airport.

December was rainiest since 1992 and coldest since 1994 in *Israel* with monthly totals of 250-300 mm in the northern and central Coastal Plain, which is 200%-250% of normal. Large rainfall amounts in December eliminated the shortage of rainfall at the end of November.

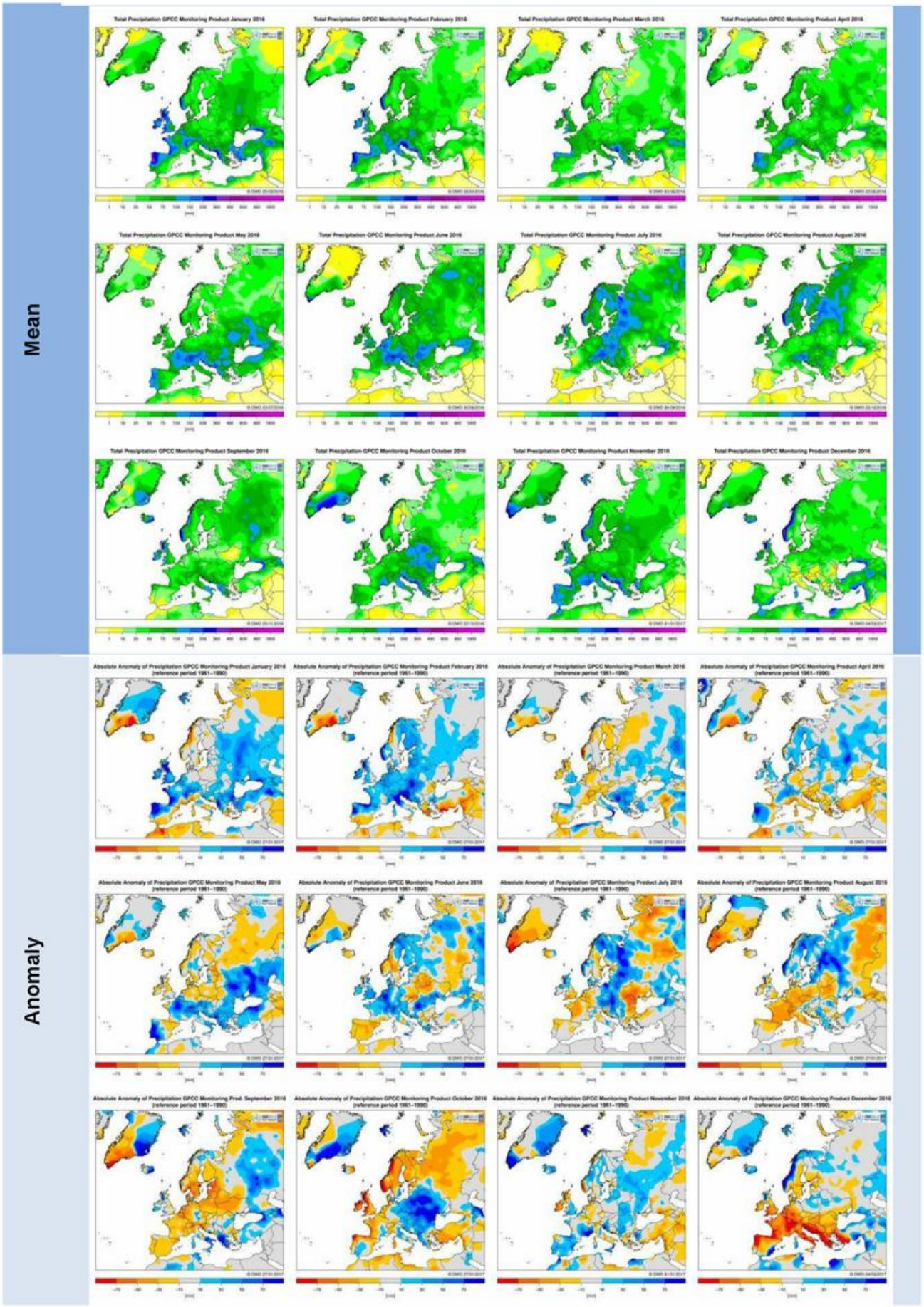


Figure 4.12: Mean and anomalies of precipitation (in mm/month) for each month of the year 2016. (First column January, February, March, April, … ; reference period 1961-1990).

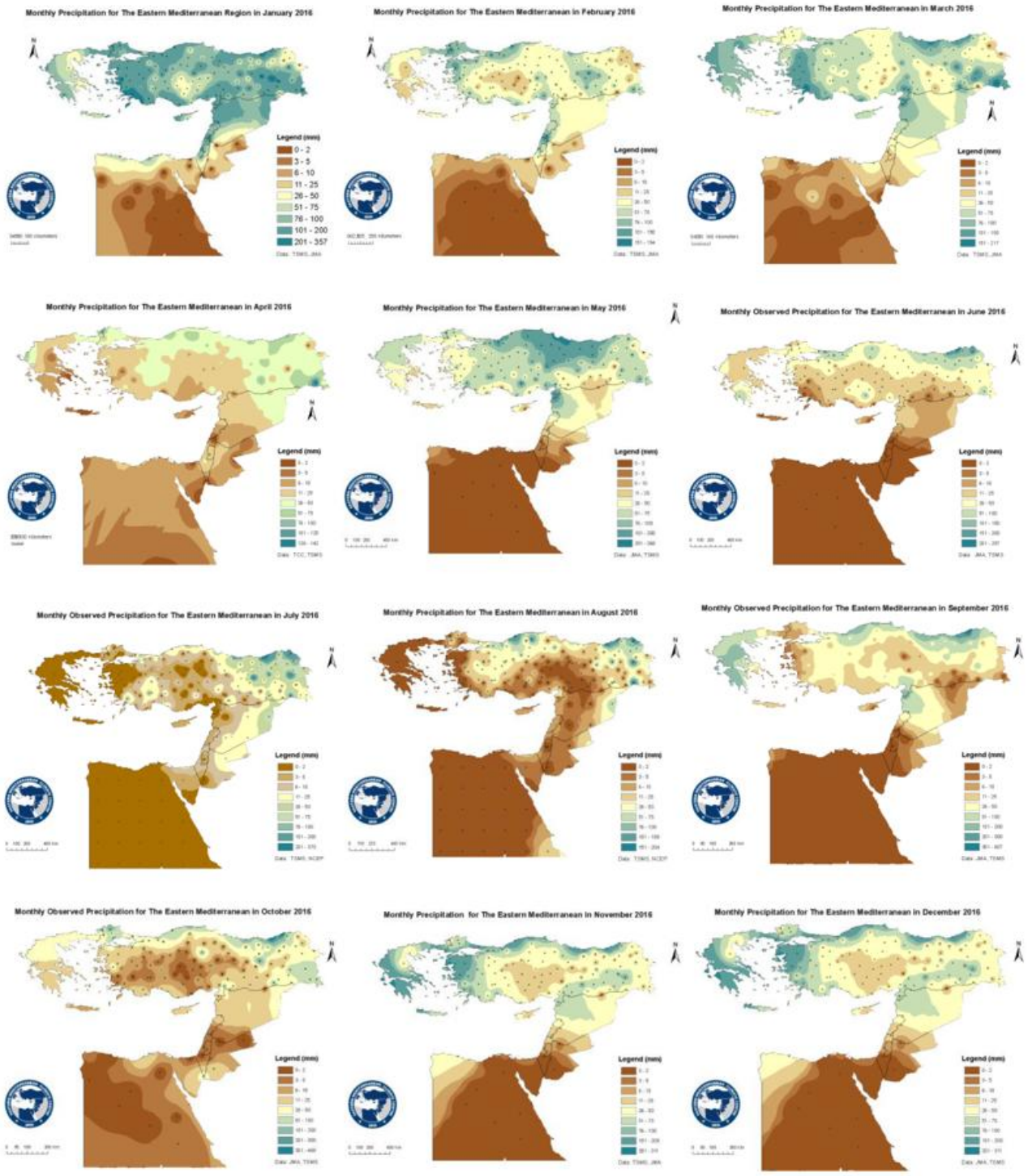


Figure 4.13: Monthly precipitation totals (mm) for the Eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC).

4.4. Sunshine duration

In **January 2016** most of central Europe, southern Scandinavia and the Baltic States had more sunshine than normal. The Mediterranean from Iberia to Turkey showed negative anomalies of sunshine duration, except Central Italy, the Balkans and the region around the Aegean Sea. Northern Scandinavia and parts of Russia actually had only below 25% of normal sunshine. January in *Latvia* with 53.7% more than normal sunshine duration experienced a very sunny month. Reykjavik had 4.7-times more sunshine than the average from 1961-1990.

In **February 2016** sunshine duration showed few areas with positive anomalies over Ireland, the UK, western France, Benelux countries, southern Sweden (with new records in the south), eastern Spain, central Italy, Greece, Bulgaria and Turkey. The other parts received below normal sunshine.

In **March 2016** sunshine duration showed some areas with positive anomalies over Ireland, the UK, western France, Benelux countries, Finland, southern Spain, central and northern Italy, Greece, Bulgaria and Turkey. The other parts received mostly below normal sunshine.

Sunshine duration in **April** showed in great parts above normal anomalies especially in north-west and south-east Europe (Northern Poland measured a surplus of 60 hours). Only France (in the east locally a deficit of 30%), Switzerland and Russia received below normal sunshine.

Monthly sunshine in **May 2016** showed high positive anomalies over the northern half of Europe, United Kingdom, Ireland, Spain, northern part of Central Europe and the Middle East. Estonia registered an average of 375 hours of sunshine, which is 136% of the normal (276 hours).

Sunshine duration in **June** showed below normal values in Central Europe, northern Italy and northern Scandinavia. Iberia and Eastern Europe had a surplus of sunshine of more than 125% in Spain and Poland. In Great Britain sunshine was generally below average except in Shetland and north-west Wales, and it was the dullest June on record in south-east and central southern England. The United Kingdom overall average sunshine was only 81%, making it the seventh dullest June in the series.

Sunshine duration in **July** had a surplus of sunshine in Iberia and Western Europe while central and north-western Europe showed below normal values. Monthly sunshine totals in Ireland were lowest at station Knock Airport with 78.2 h (59% of the long term mean) its dullest July in five years. A band of higher sunshine duration occurred from central Scandinavia to the Balkans and back to northern Russia with a maximum over south-western Ukraine.

In **August** in a band from Iberia and Western Europe to southern Russia a surplus of sunshine occurred while northern Europe showed below normal values. In France several stations reported new records of monthly sunshine hours. Monthly sunshine totals in Ireland were lowest at station Knock Airport with 83.6 hours (67% of the long-term average). Northern Scotland and England also reported higher than normal sunshine duration.

In **September 2016** in most parts of Europe the sunshine duration was above normal except the United Kingdom, western France, the Central Mediterranean and European Russia. In Central Europe the surplus of sunshine was widely more than 50% of the normal. In north-western Poland the sun shone more than 260 hours, 120 hours above the norm. The consequence of this surplus of sunshine was positive temperature anomalies and heat waves.

In **October 2016** most of Europe was cloudy and dull. Only some western parts (Scandinavia, France, the United Kingdom and Ireland) received more sunshine. In Turkey sunshine duration was also above normal.

The map of sunshine duration in **November** shows a very irregular pattern. The mountain regions of the Pyrenees and Alps were very cloudy, also southern Italy and Eastern Europe. United Kingdom reported 130% of the normal, the third sunniest November in a series from 1929. In Malta the bleakest and wettest month in 2016 was November, with only 150.1 hours of sunshine and 90 mm of rain recorded.

In **December 2016** many parts of Europe recorded positive anomalies above 150% of normal sunshine duration because of high-pressure weather. In Austria it was the 2nd sunniest December on record (after December 2015) and at many stations in Switzerland it also was the sunniest December since the beginning of their data series in 1959. In France also several records were broken with more than 200% and even more than 250%.

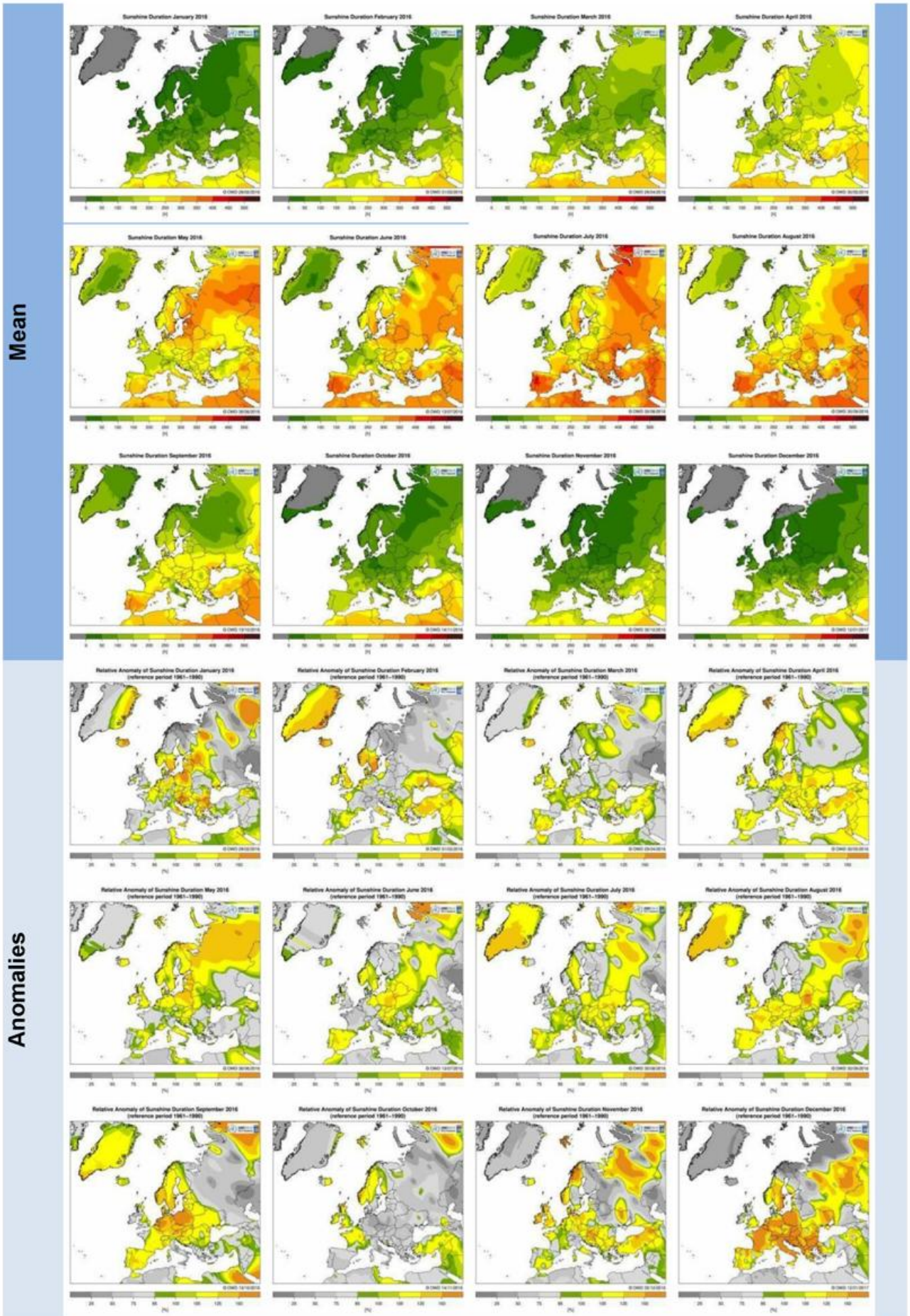


Figure 4.14: Mean of sunshine duration (in hours) and relative anomalies (in %) for each month of the year 2016. (First column January, February, March, April, … ; reference period 1961-1990).

4.5. Maps of monthly climate extremes and events

The following maps are based on different data (as noted in the legends in parentheses), and is meant to summarize weather conditions in each month of the year 2016.

In **January 2016** Scandinavia was down to -4°C colder than normal and the numbers of cold days were above normal. Central and southern Europe showed more warm days than usual. The areas at the Norwegian and Greenland coasts were affected by strong wind gusts and also the Bretagne, the Gulf of Lions and the coast of the Adriatic Sea. Most of Europe was wetter than usual.

In **February** more warm days than normal could be found in Europe in combination with more precipitation and storms on the coasts of Western Europe.

Warmer days in **March** occurred in Northern and Eastern Europe with strong wind gusts at the Atlantic and Mediterranean coasts. In most parts of Europe the very wet days were abnormally high.

In nearly the whole of Europe **April** had more warmer-than-normal-days in combination with very wet days, only in Ireland and western UK cold days were more usual.

In **May** more than usual warm and wet days were registered except over the Balkans where some cold days occurred.

June was wet and warm in many parts but also drier than normal in Iberia.

As several month before **July** became warmer and dryer than normal in the south-west part of Europe while the North and East had more wetter days as usual.

The southern part of Europe had more warm days in **August** with drought situation in France and Iberia. Scandinavia had more wet days and locally some colder days. Eastern Europe had in many parts a precipitation surplus.

In **September** the North Sea coasts were affected by wind gusts and no anomalies of cold days existed.

Central, northern and Eastern Europe showed in **October** more cold days than usual. Eastern Europe noted a higher number of very wet days. The Gulf of Lions and the Aegean Sea were affected by thunderstorms with strong wind gusts.

During **November** southern parts of Europe showed a higher number of warm and wet days. Norway, the UK, Denmark, the Bretagne and in the Gulf of Lions were affected by strong wind gusts in November. Northern observed more cold days than normal

The **December** showed in the western part Europe again more warm days than normal, but northern and Eastern Europe was wetter and southern Europe dryer than normal. Several cyclones with strong wind gusts passed over Scandinavia, the UK, Central Europe up to Greece.

The Monthly Event Map contains information about the extreme anomalies of temperature, precipitation and wind gusts. Points are calculated from station data and represent the number of very warm or cold days, the locations of strong wind gusts (>=32 m/s) and days with precipitation. If more than one extreme anomaly occurs at the same location, the point is subdivided into several different colours. Coloured areas are based on interpolated gridded data for temperature (land and ocean) and precipitation (only land areas). If more than one extreme anomaly occurs at the same grid, the area is shaded.

Legend of Figure 4.10:

- Anomaly of very wet days > 0 (ECAD)
- Wind gusts (≥ 32 m/s) (SYNOP)
- Anomaly of warm days > 0 (ECAD)
- Anomaly of cold days > 0 (ECAD)
- Anomaly of TG ≤ -4K (CLIMAT and ship obs.)
- Anomaly of TG ≥ 4K (CLIMAT and ship obs.)
- Aridity index < -1.5 modified SPI (GPCC)
- RR ≥ 150% of climatology (GPCC)

Based on climatology 1961-1990 (GPCC climatology: 1951-2000)

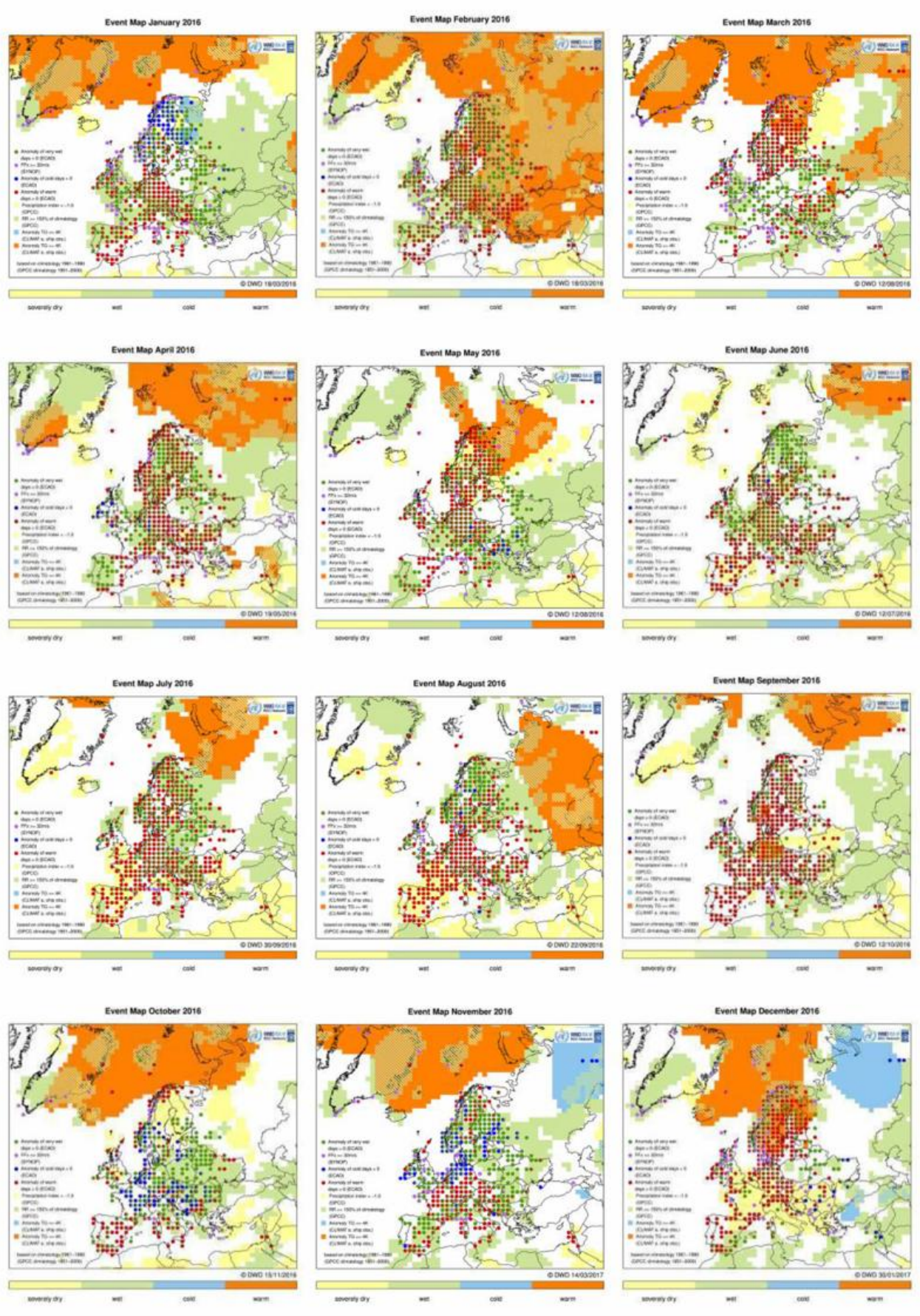


Figure 4.15: Maps of Climate Extremes for each month of the year 2016.

5. Long-term variability of the selected climate parameters - Regional examples

On the following pages graphs of long time series of temperature, precipitation and sunshine duration as provided by the National Meteorological and Hydrological Services (NMHSs) are presented to give an overview of the temporal development of the basic climate elements. The graphs are grouped with respect to the 6 sub-regions defined above (Figure 1.1). An overview of contributing countries, time series' lengths and area representativeness can be found in Table 5.1. Most are temperature time series. Each sub-region is at least represented by one country. Time series of precipitation totals are fewer but each sub-region is represented by at least one time series for precipitation. Diagrams of long-term annual sums of sunshine duration are provided by 4 countries, belonging to different sub-regions.

After this, we present examples of the temporal development of other temperature-related phenomena, such as the sea surface temperature in the North Sea and sea level anomalies at the Polish station Władysławowo.

Table 5.1: Availability of the long-term records of temperature, precipitation and sunshine duration from some participant countries.

Sub-region	Country	Temperature		Precipitation		Sunshine Duration	
		Spatial Mean	Single Station	Spatial Mean	Single Station	Spatial Mean	Single Station
Central and Western Europe	Austria	1768					
	Belgium		1833				
	France	1900					
	Germany	1881		1881		1951	
	Hungary	1901		1901			
	Luxembourg		1947				
	Netherlands	1906			1906		
	Poland	1951					
	Slovakia		1901		1901		
	Switzerland	1864		1864		1959	
	United Kingdom	1910		1910		1929	
Nordic and Baltic Countries	Denmark	1873	1768	1874	1821	1920	1876
	Greenland		1784		1890		
	The Faroe Islands		1873		1890		1922
	Estonia		1866		1866		1953
	Finland	1848			1900		
	Iceland		1931				
	Latvia	1924		1924			
	Lithuania	1961					
	Norway	1900		1900			
	Sweden	1860		1860			
Iberia	Portugal	1931		1931			
	Spain	1965		1965			
Mediterranean, Italian and Balkan Peninsula	Bosnia and Herzegovina		1888				
	Croatia		1862				
	Italy	1961		1951			
	Slovenia		1951		1951		
	Turkey	1971		1981			
Eastern Europe	Belarus	1881		1891			
	European Russia	1939		1966			
	Moldova		1887				
	Ukraine	1891			1891		
Middle East	Georgia	1961	1881	1961	1881		
	Israel	1951					
	Kazakhstan	1936		1963			

5.1. Temperature

Central and Western Europe – annual temperature series

Austria, Belgium, France, Germany, Hungary, Luxembourg, The Netherlands, Poland, Slovakia, Switzerland and United Kingdom

Austria

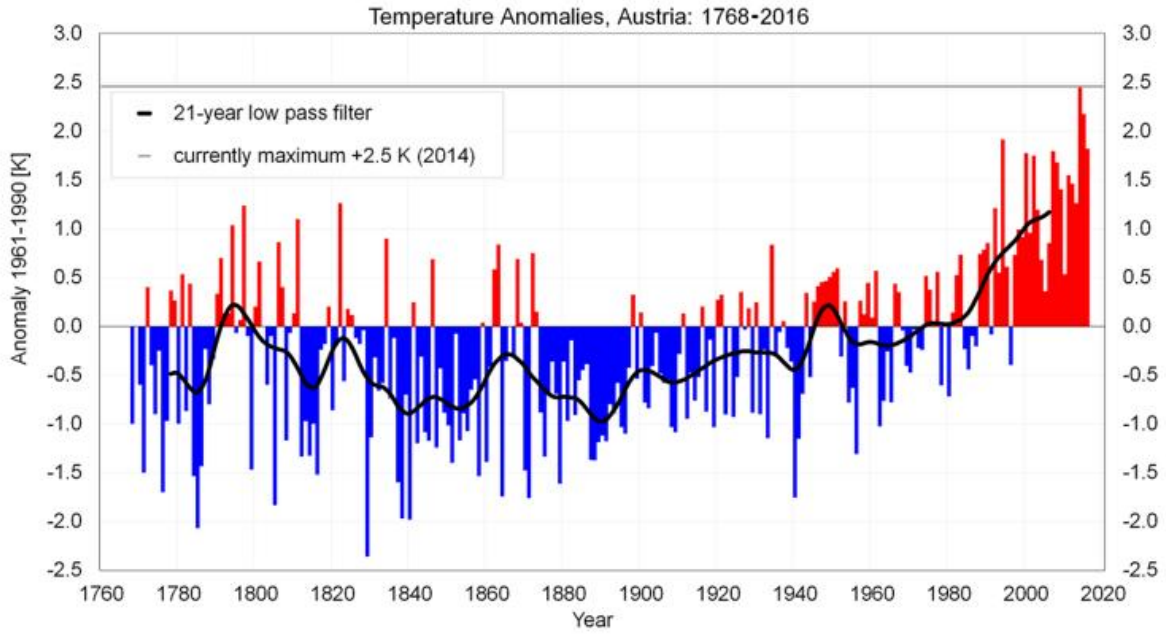


Figure 5.1: Time series of annual temperature anomalies for Austria (reference period 1961-1990, diagram as provided by the NHMS)

Belgium

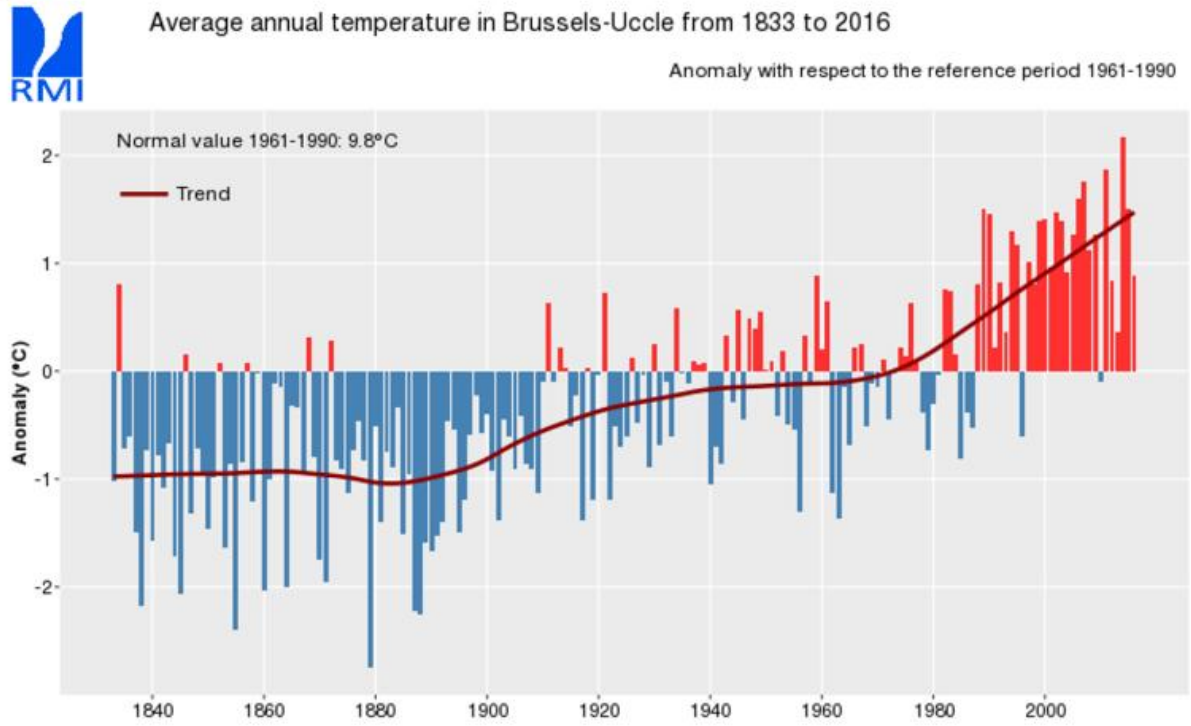


Figure 5.2: Time series of annual mean temperature anomalies for Uccle, Belgium (reference period 1961-1990, diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

France

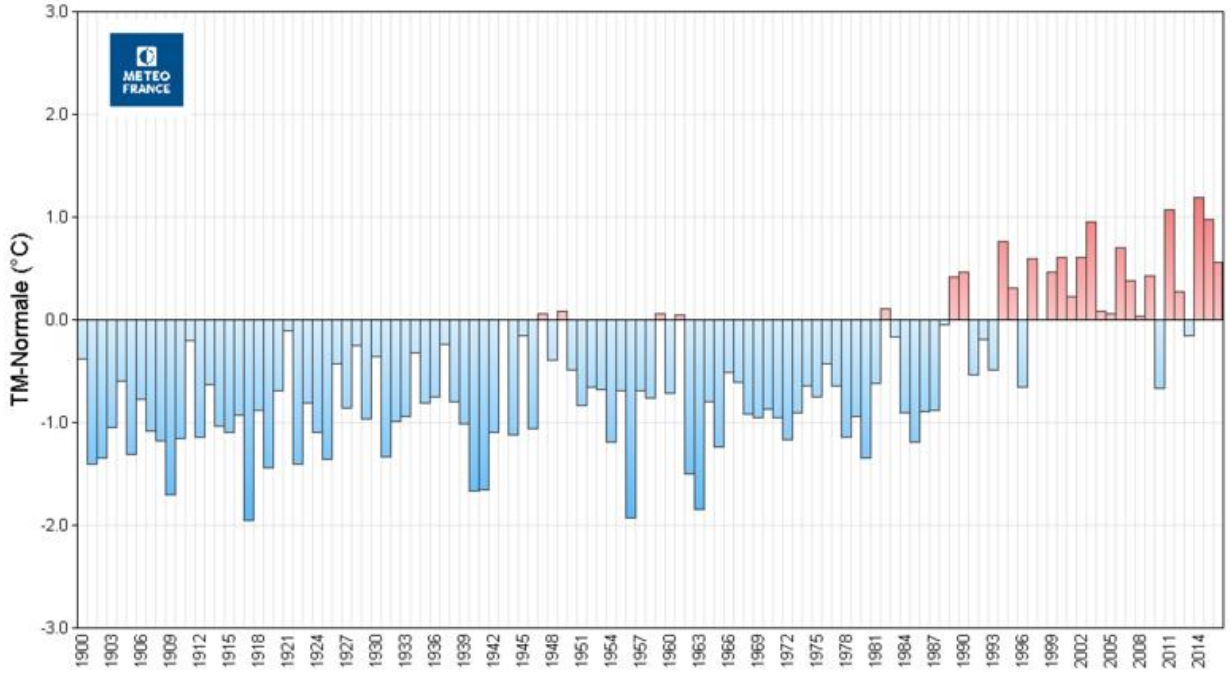


Figure 5.3: Time series of annual temperature anomalies for France for the period 1900-2016 (reference period 1981-2010; diagram as provided by the NHMS)

Germany

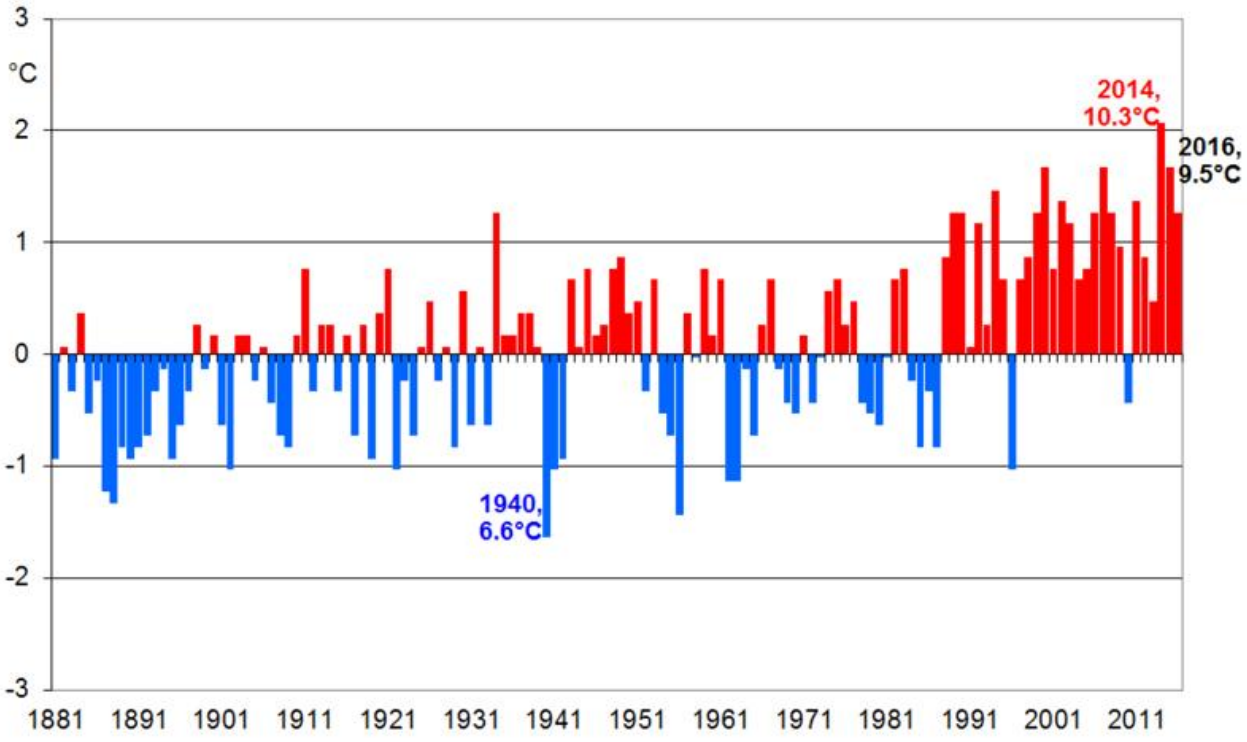


Figure 5.4: Time series of annual temperature anomalies for Germany for the period 1881-2016 (reference period 1961-1990, diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Hungary

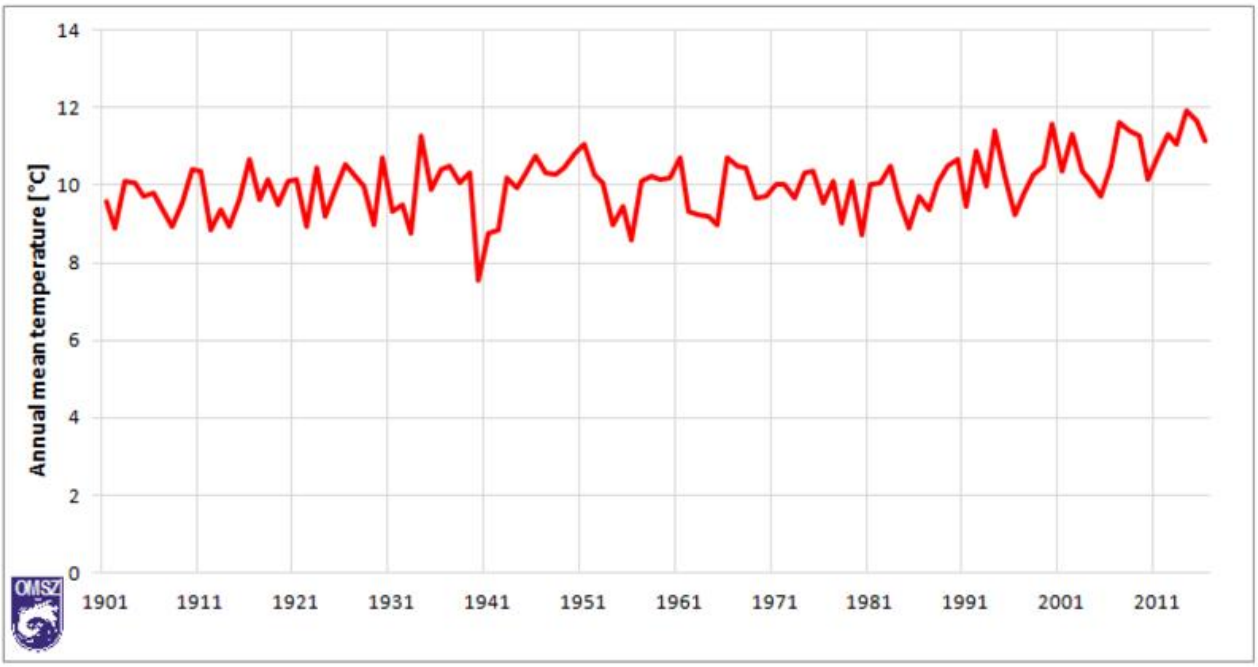


Figure 5.5: Time series of annual average temperature for the period 1901-2016 for Hungary (based on homogenized and interpolated data from 58 stations; Diagram as provided by the NHMS)

Luxembourg

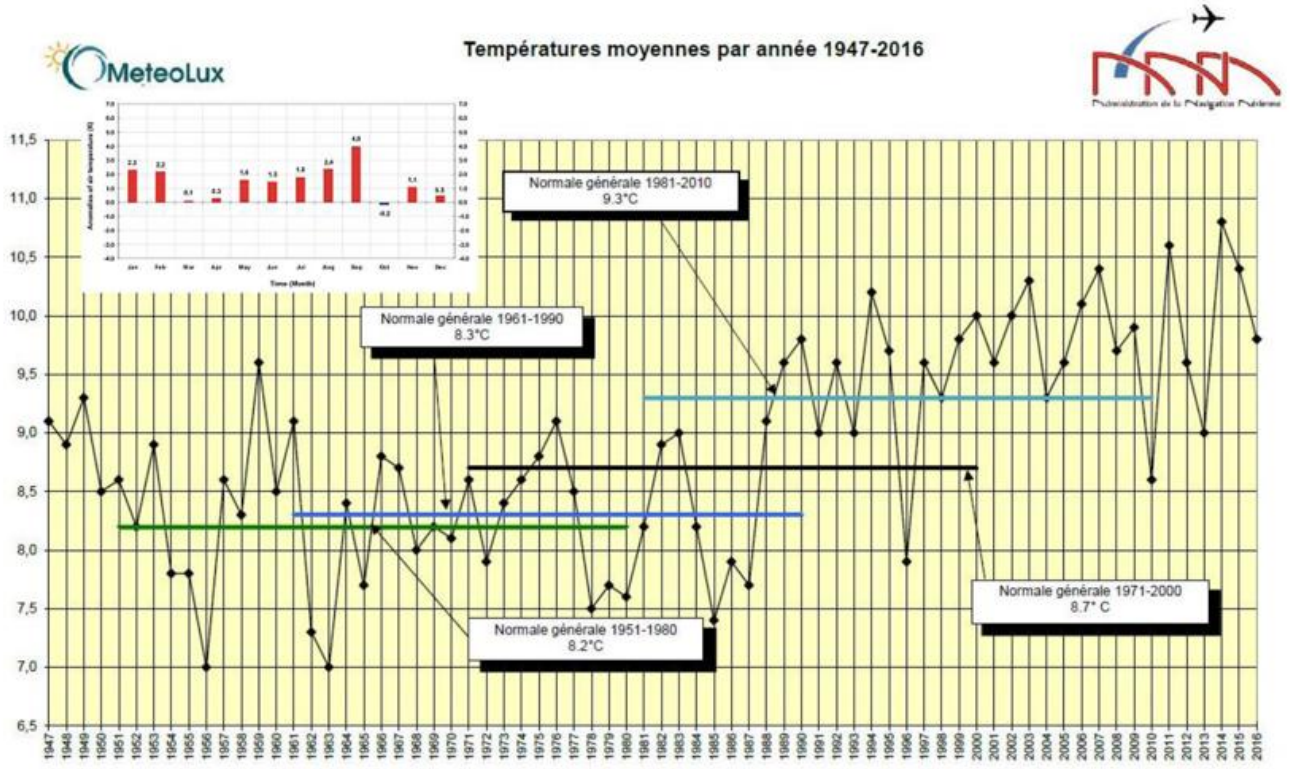


Figure 5.6: Time series of annual average temperature for the period 1947-2016 for station Luxembourg-Findel (Diagram as provided by the MeteoLux)

Central and Western Europe – annual temperature series

The Netherlands

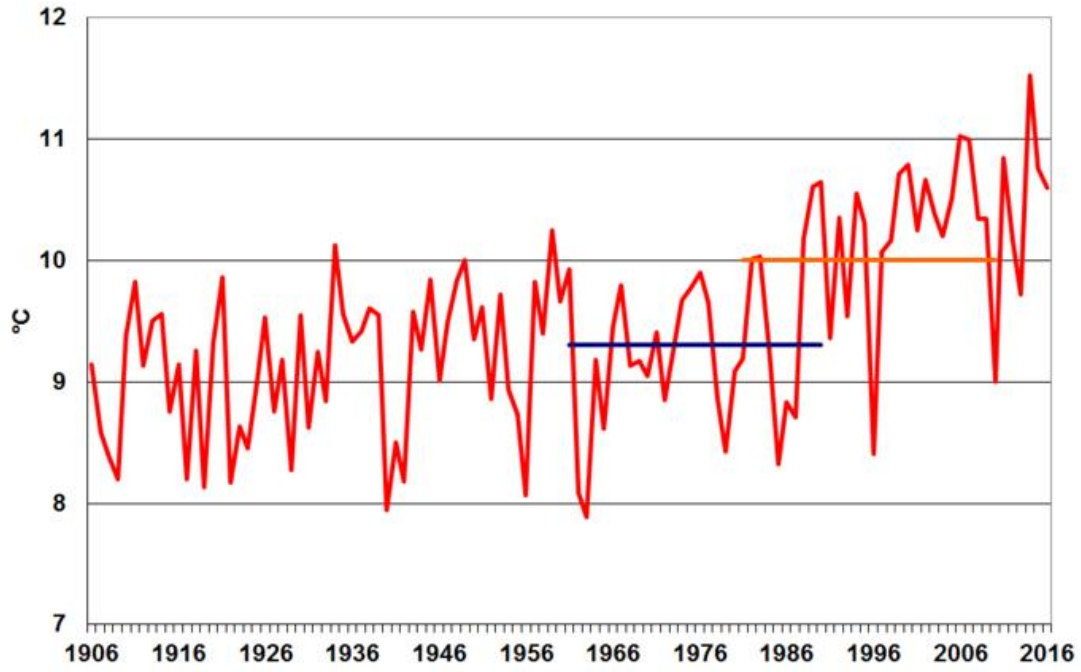


Figure 5.7: Time series of annual average temperature for the period 1906-2016 for the Netherlands (Central Netherlands Temperature v6, mean of 6 stations, blue line: reference period 1961-1990, orange line: 1981-2010; data as provided by the KNMI)

Poland

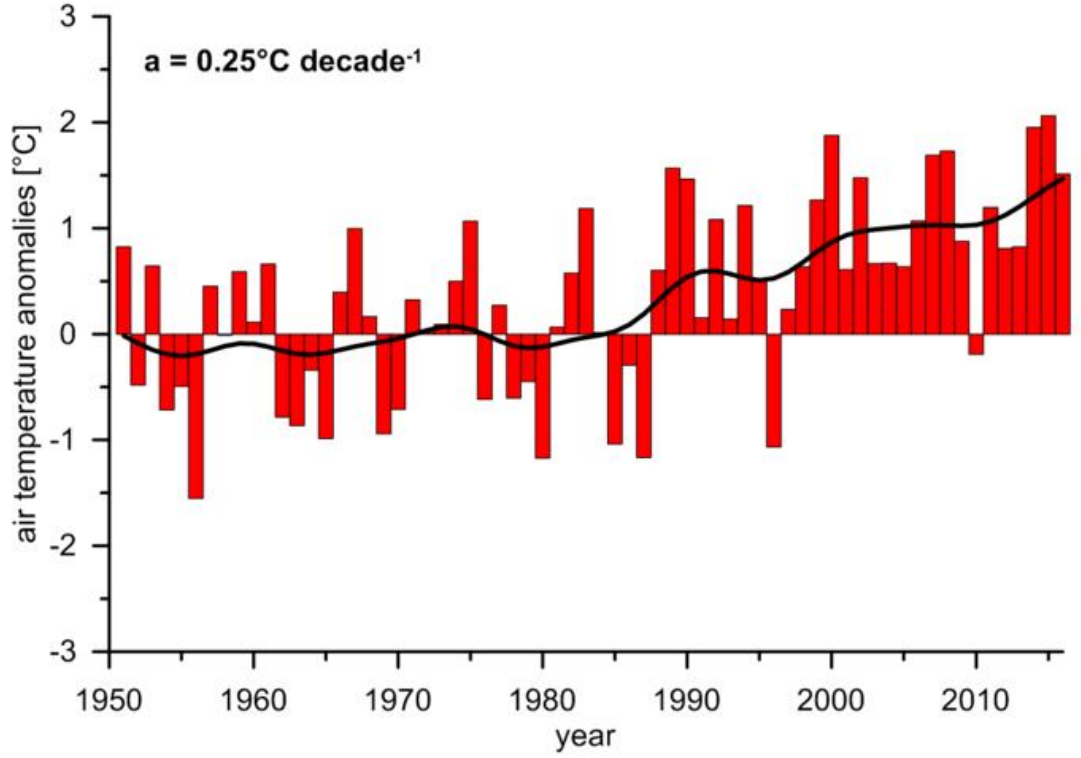


Figure 5.8: Time series of annual temperature anomalies for the period 1951-2016 for Poland (base period: 1971-2000; smoothed by 10-years Gaussian filter (black line) and the values of linear trend (°C/year; diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Slovakia

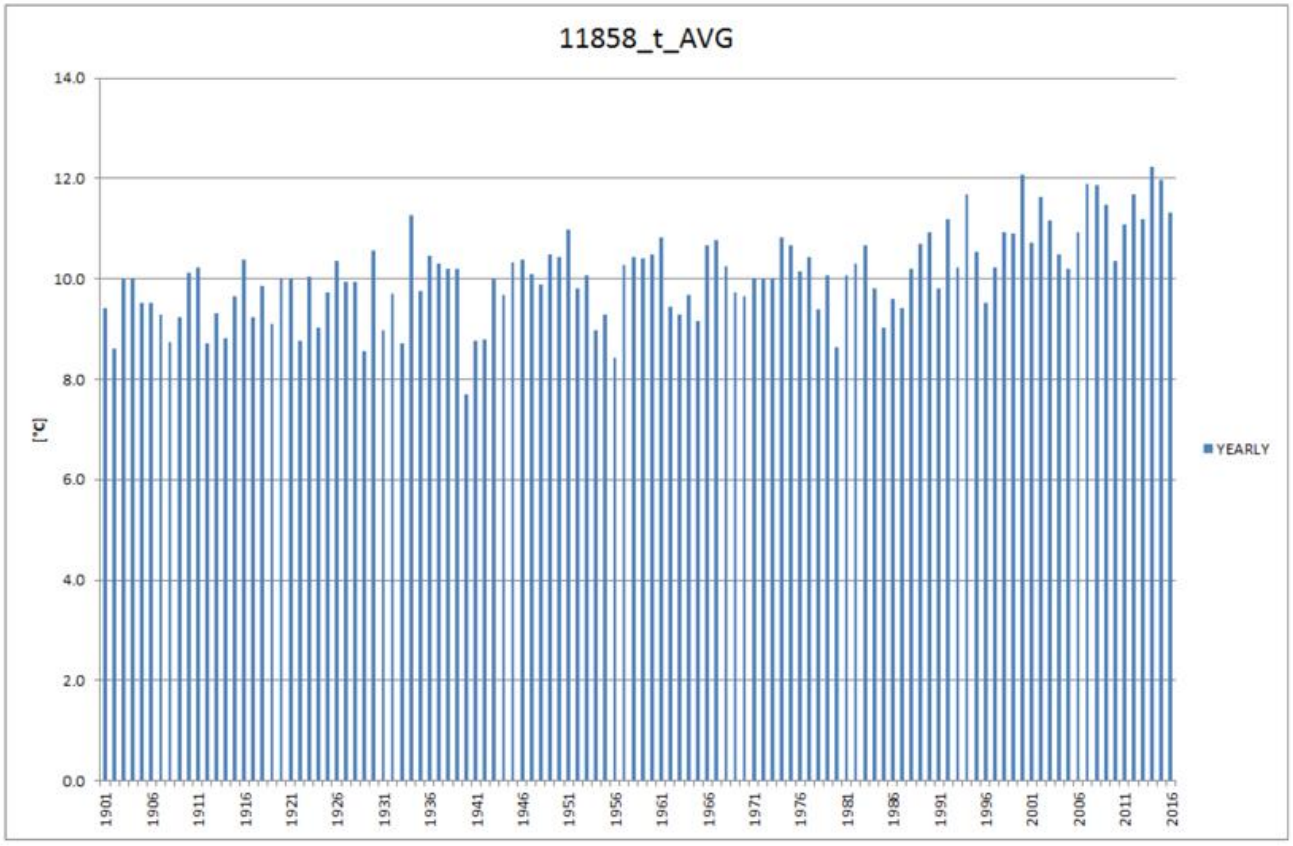


Figure 5.9: Time series of annual temperature for the period 1901-2016 for station Hurbanovo (Slovakia; diagram as provided by the NHMS)

Switzerland

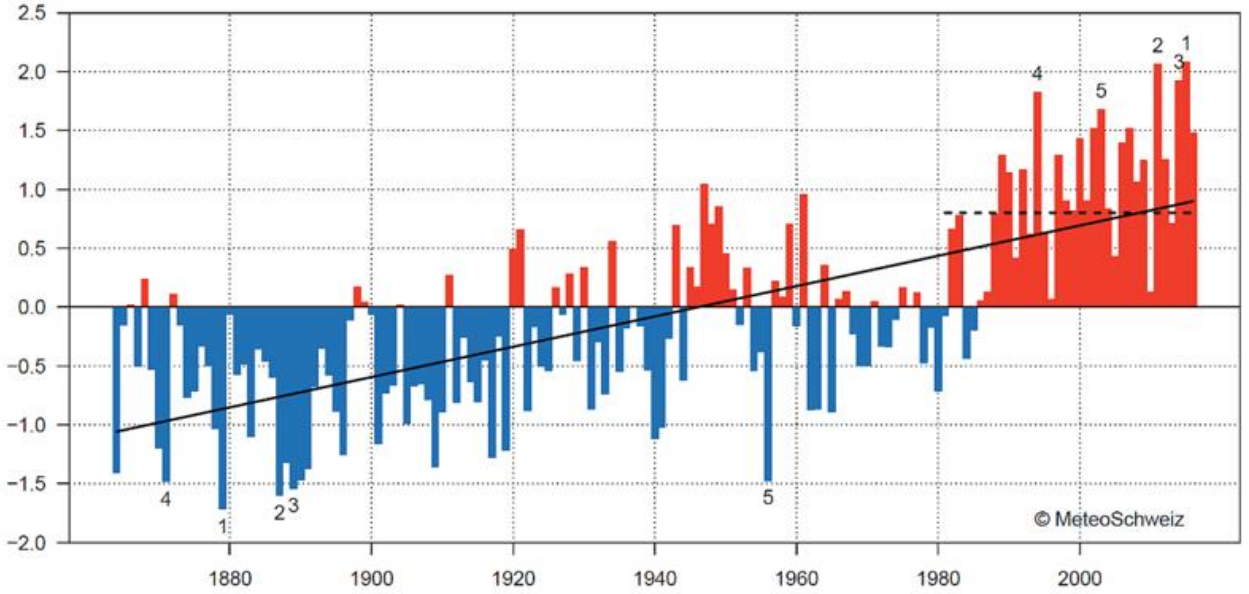


Figure 5.10: Time series of annual temperature anomalies for the period 1864-2016 for Switzerland (reference period 1961-1990, the black line represents the linear significant trend (1.29°C/100y). The black dashed line represents the mean 1981–2010. Source: MeteoSwiss)

Central and Western Europe – annual temperature series

United Kingdom

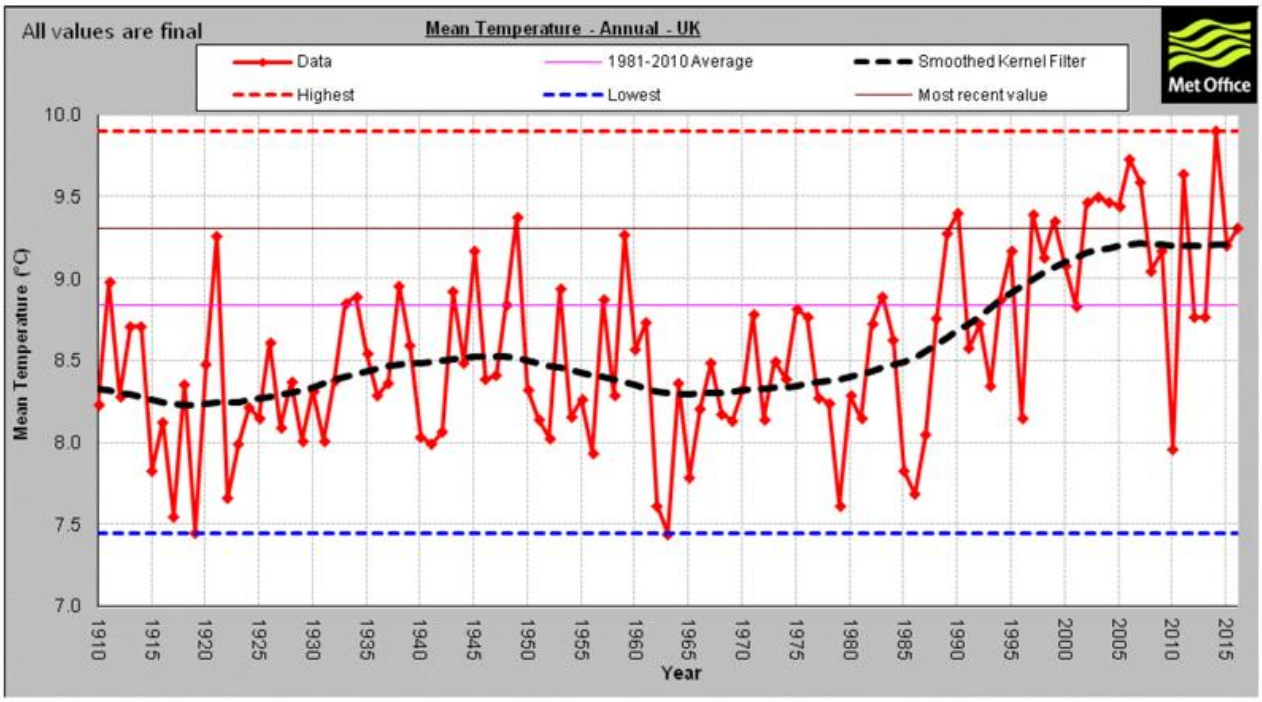


Figure 5.11: Time series of annual temperature for the period 1910-2016 for the United Kingdom (Diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden

Denmark, Greenland, the Faroe Islands

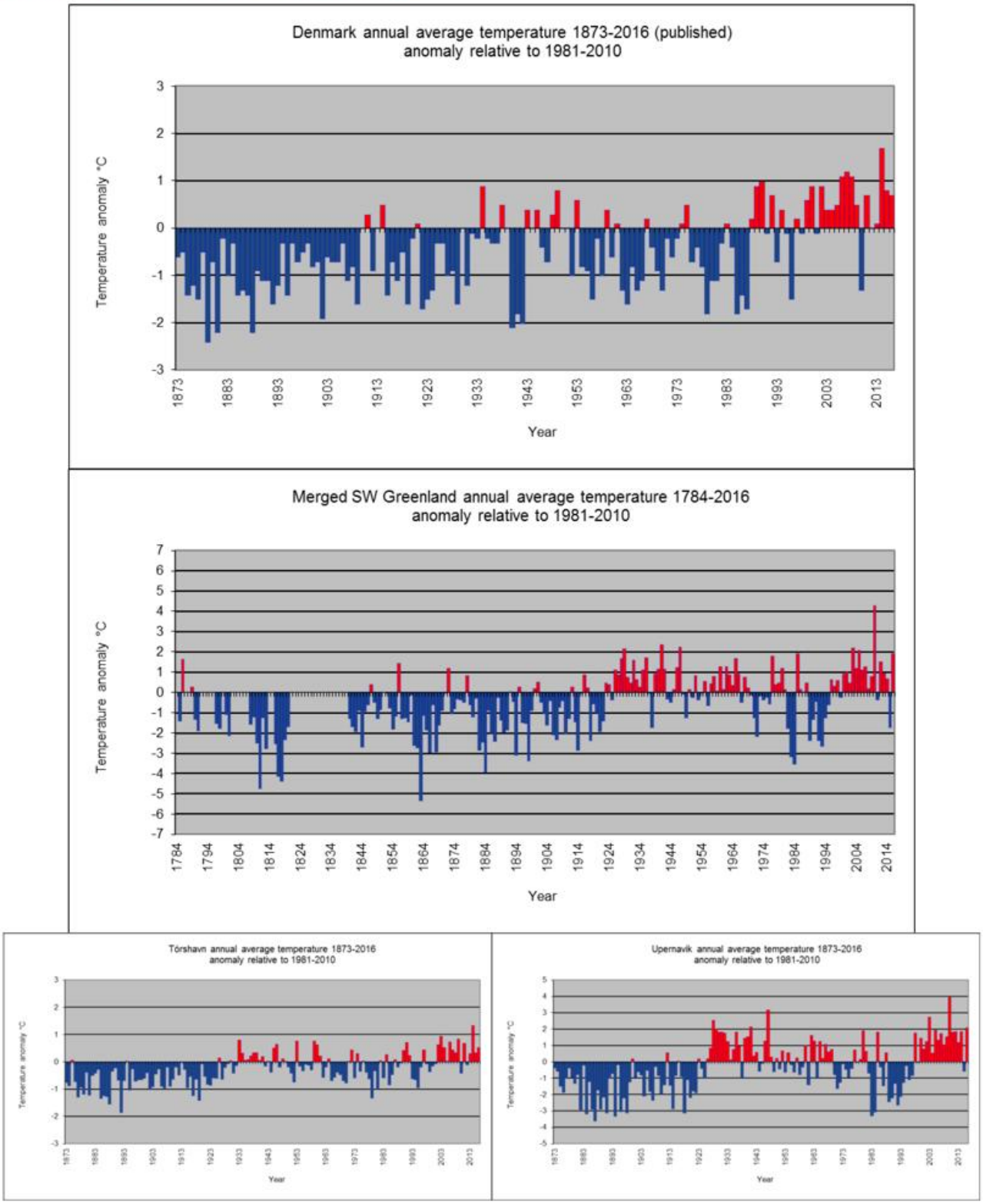


Figure 5.12: Time series of annual temperature anomalies for the period 1873-2016 for Denmark (top), 1784-2016 southwestern Greenland (middle) 1873-2016 the Faroe Islands (bottom left, Tórshavn) and 1873-2016 Greenland (bottom right, Upernavik); diagrams as provided by the NHMS

Nordic and Baltic Countries – annual temperature series

Estonia

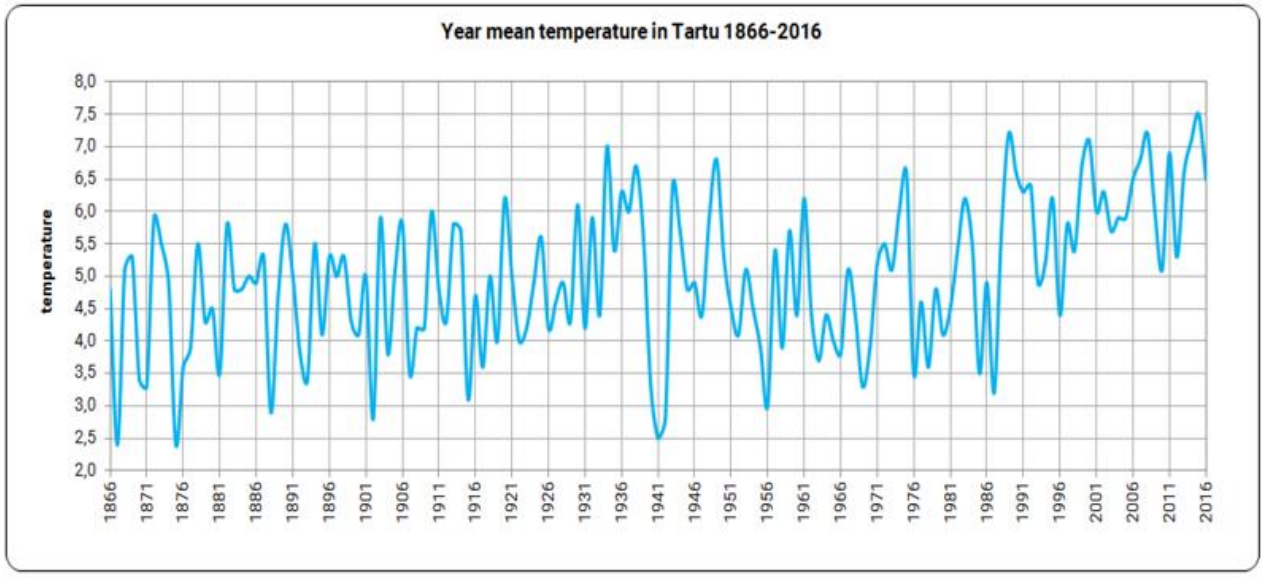


Figure 5.13: Time series of annual temperatures for the period 1866-2016 for station Tartu, Estonia (diagram as provided by the NHMS)

Finland

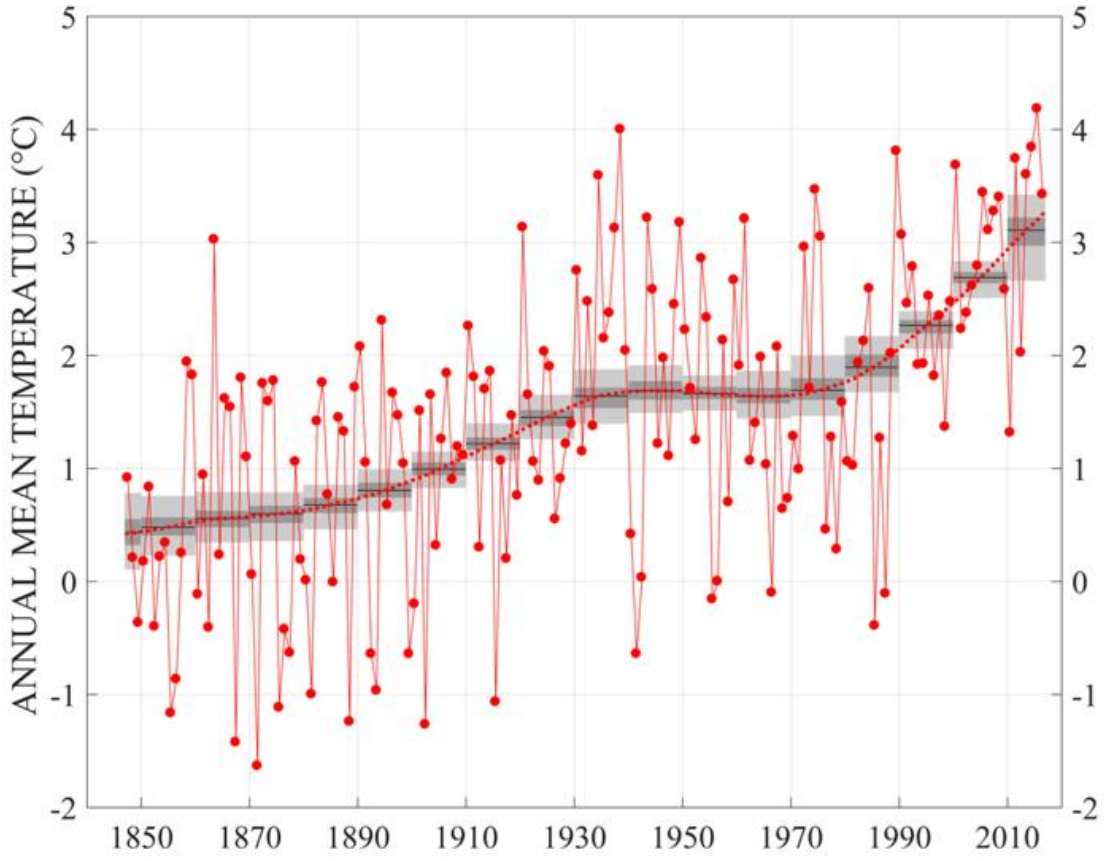


Figure 5.14: Time series of annual temperatures for the period 1848-2016 for Finland (in **red** and decadal averages (in black) with uncertainties in grey; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Iceland

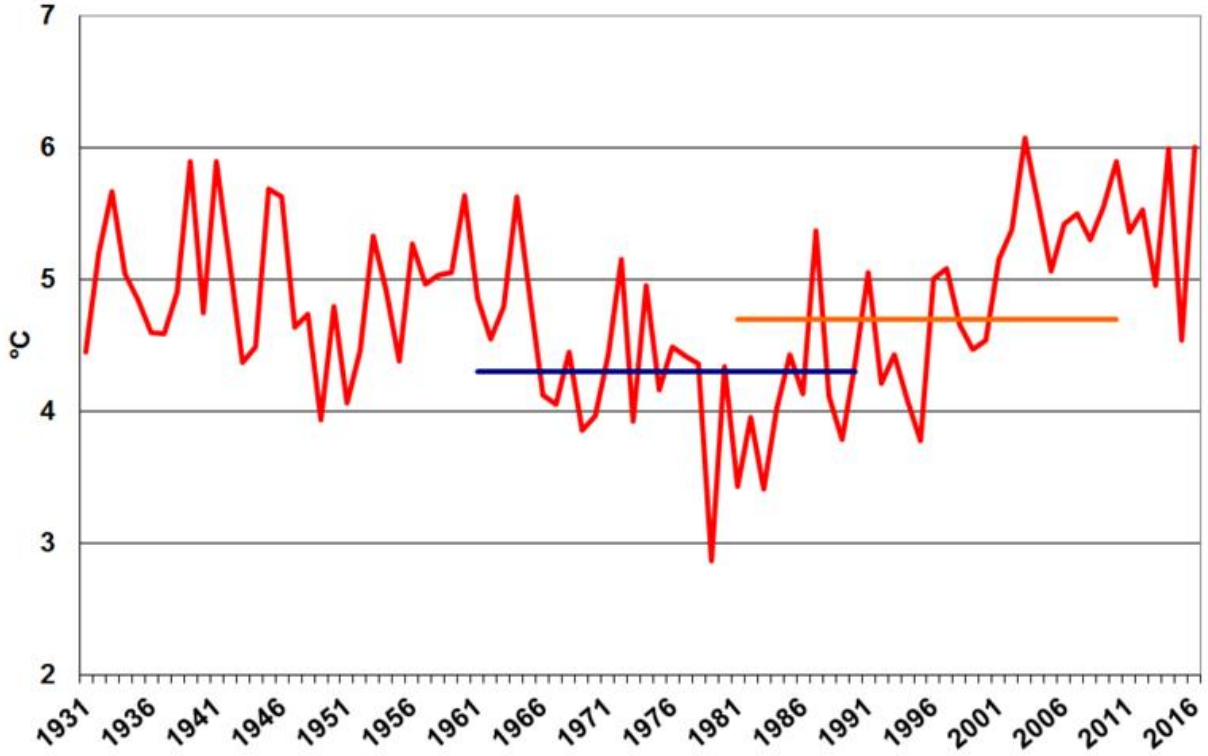


Figure 5.15: Time series of annual average temperature for the period 1931-2016 for station Reykjavík, Iceland (blue line: reference period 1961-1990, orange line: 1981-2010; data as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Latvia

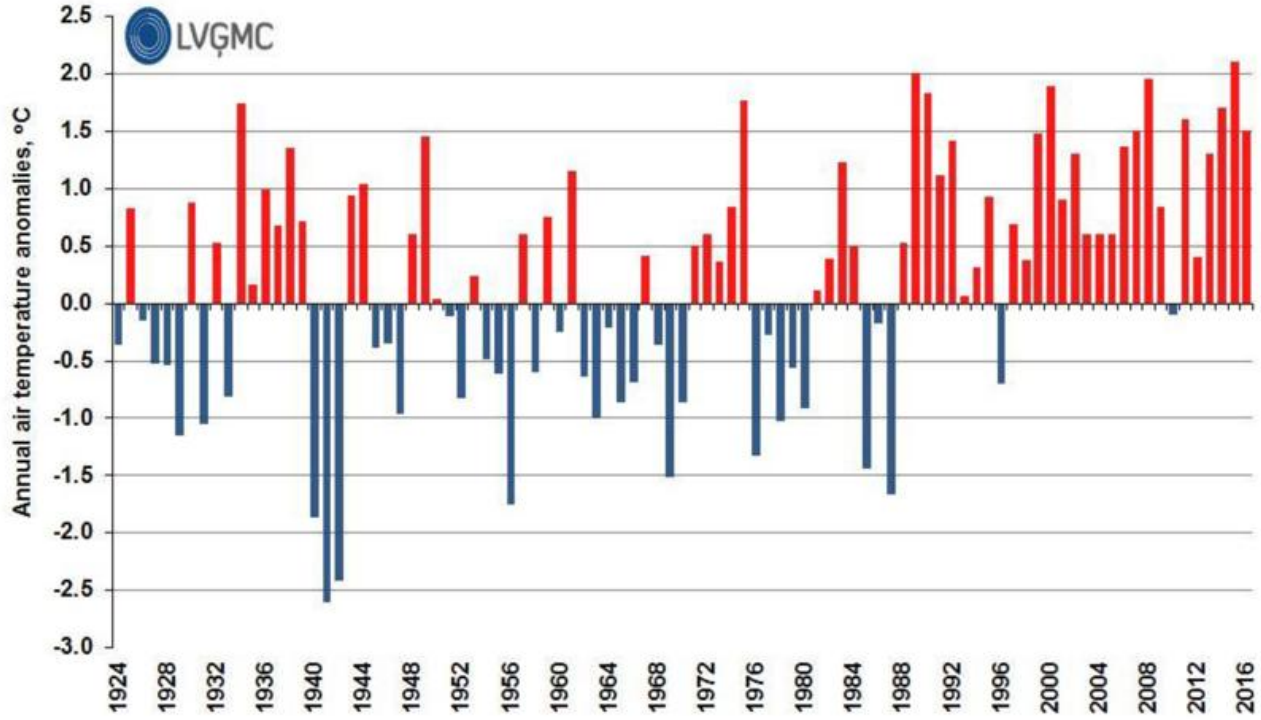


Figure 5.16: Time series of annual temperature anomalies for the period 1924-2016 for Latvia (reference period 1961-1990; diagram as provided by the NHMS)

Lithuania

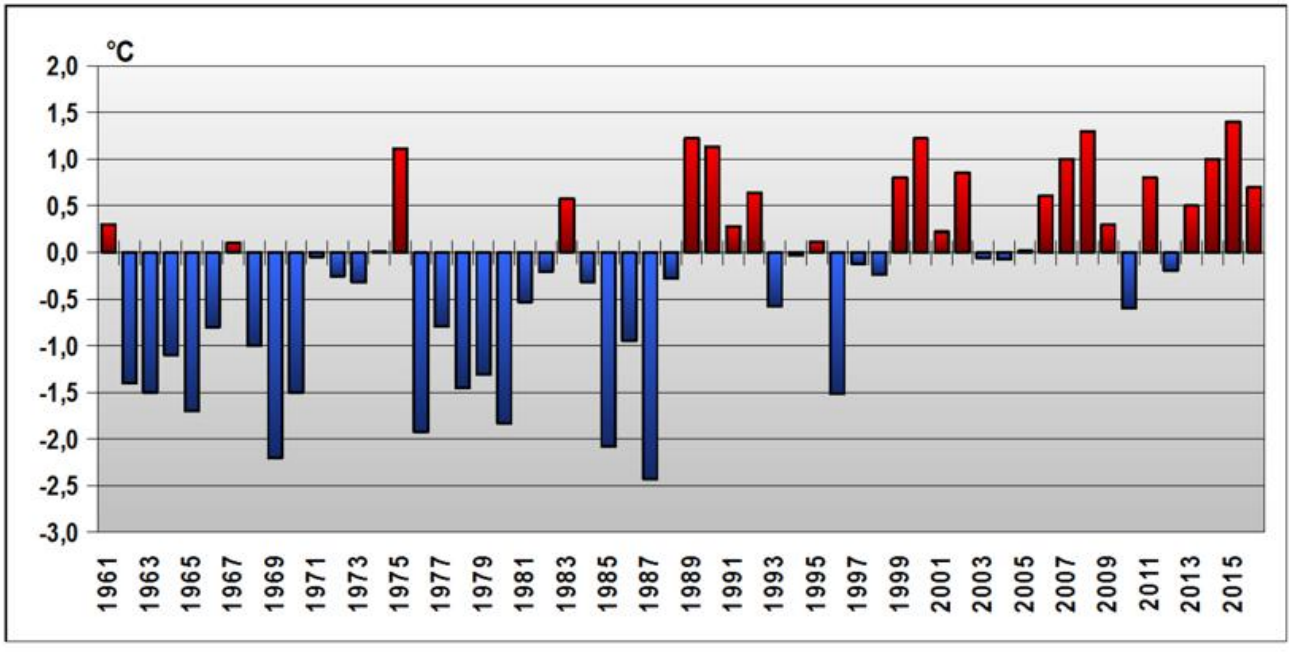


Figure 5.17: Time series of annual temperature anomalies for the period 1961-2016 for Lithuania (reference period 1981–2010; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Norway

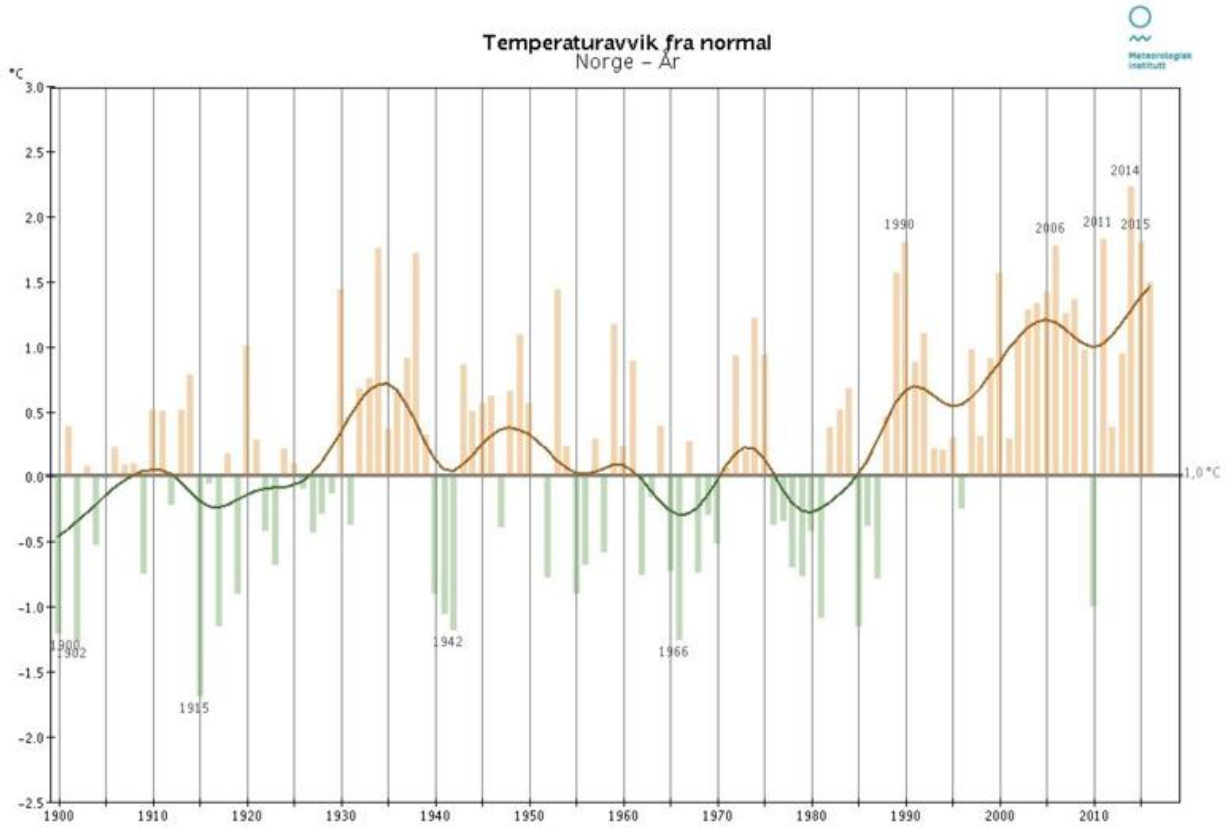


Figure 5.18: Time series of annual temperature anomalies for the period 1900-2016 for Norway (reference period 1961-1990; diagram as provided by the NHMS)

Sweden

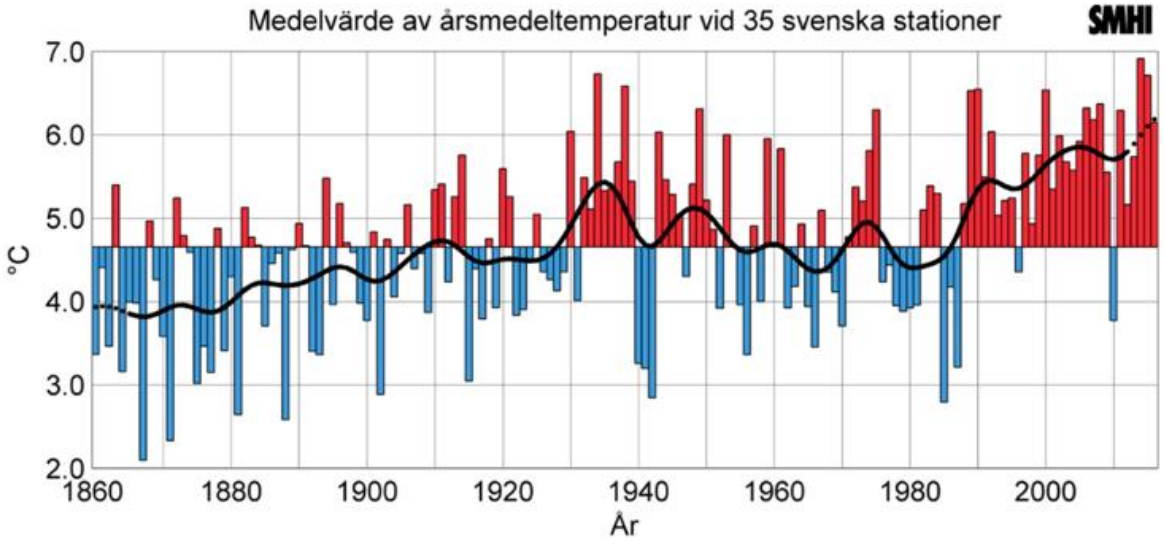


Figure 5.19: Time series of annual average temperature for the period 1860-2016 for Sweden (mean of 35 stations, diagram as provided by the NHMS)

Iberia – annual temperature series

Portugal, Spain

Portugal

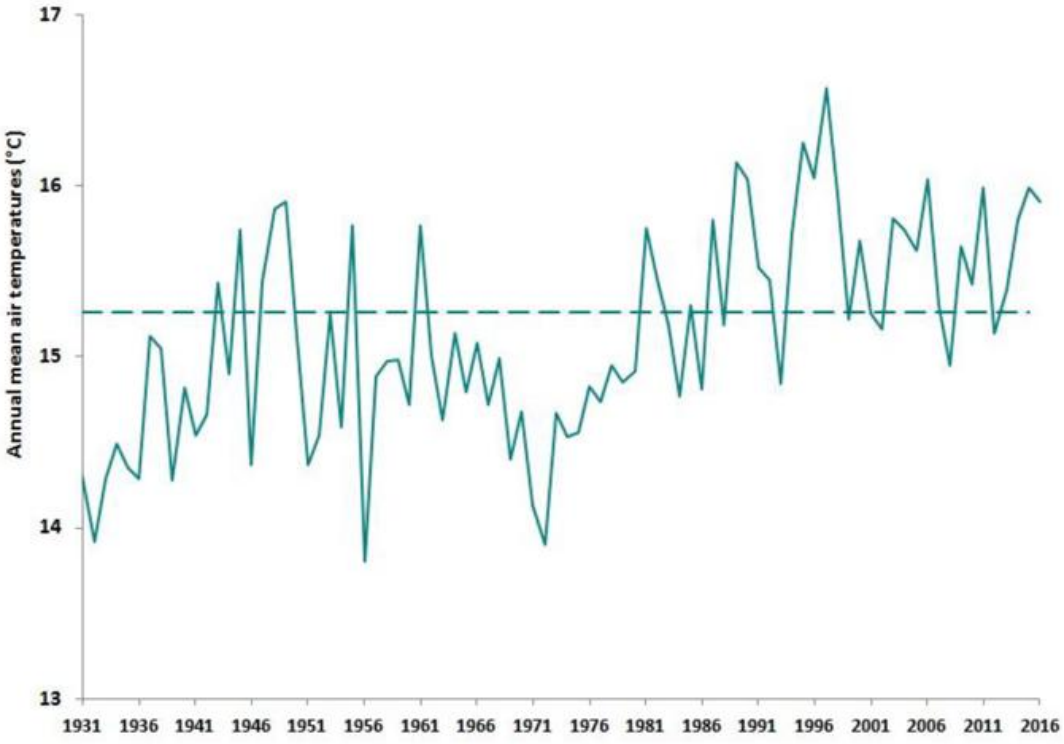


Figure 5.20: Time series of annual average temperature for the period 1931-2016 for Portugal (Dashed line normal 1971-2000, diagram as provided by the NHMS)

Spain

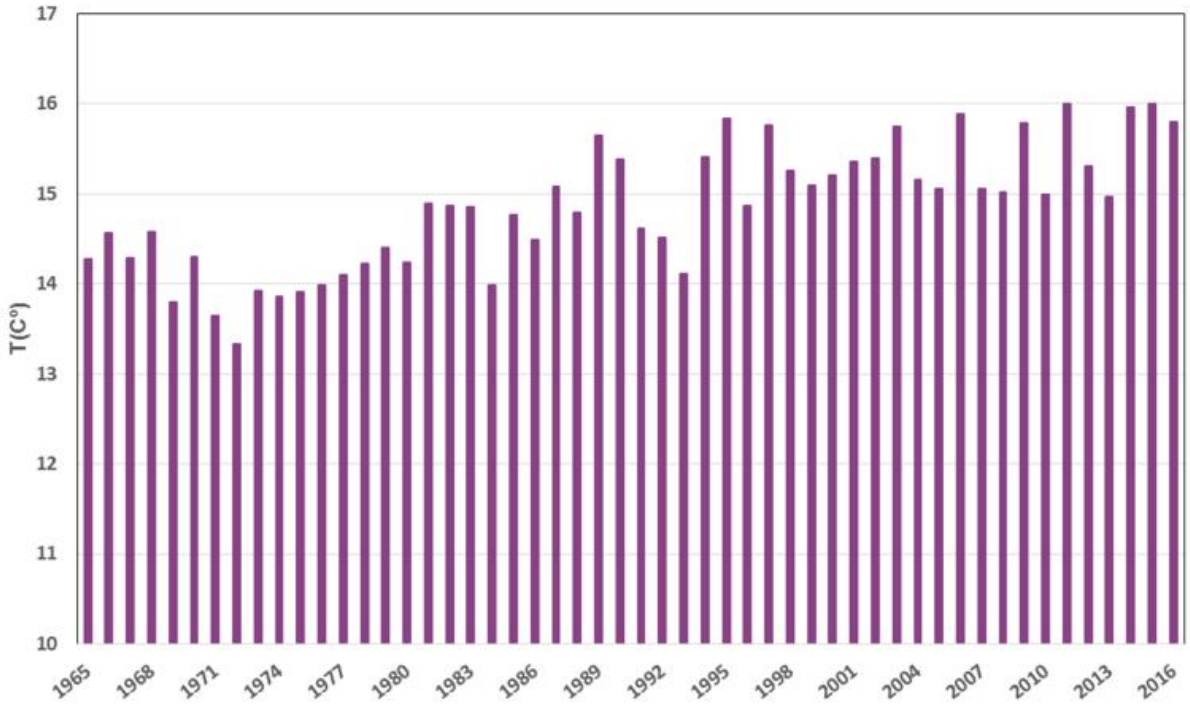


Figure 5.21: Time series of annual average temperature for the period 1965-2016 for Spain (diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Bosnia and Herzegovina, Croatia, Italy, Slovenia, Turkey

Bosnia and Herzegovina

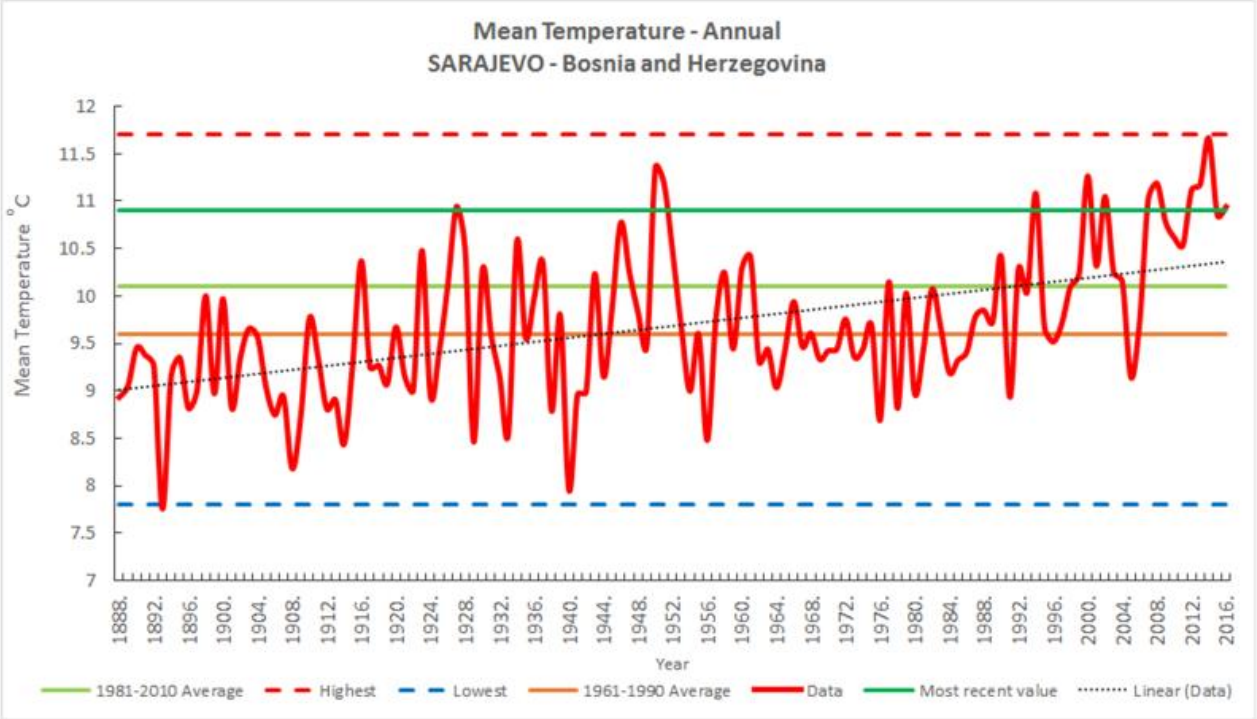


Figure 5.22: Time series of annual temperature for the period 1888-2016 for station Sarajevo, Bosnia and Herzegovina (diagram as provided by the NHMS)

Croatia

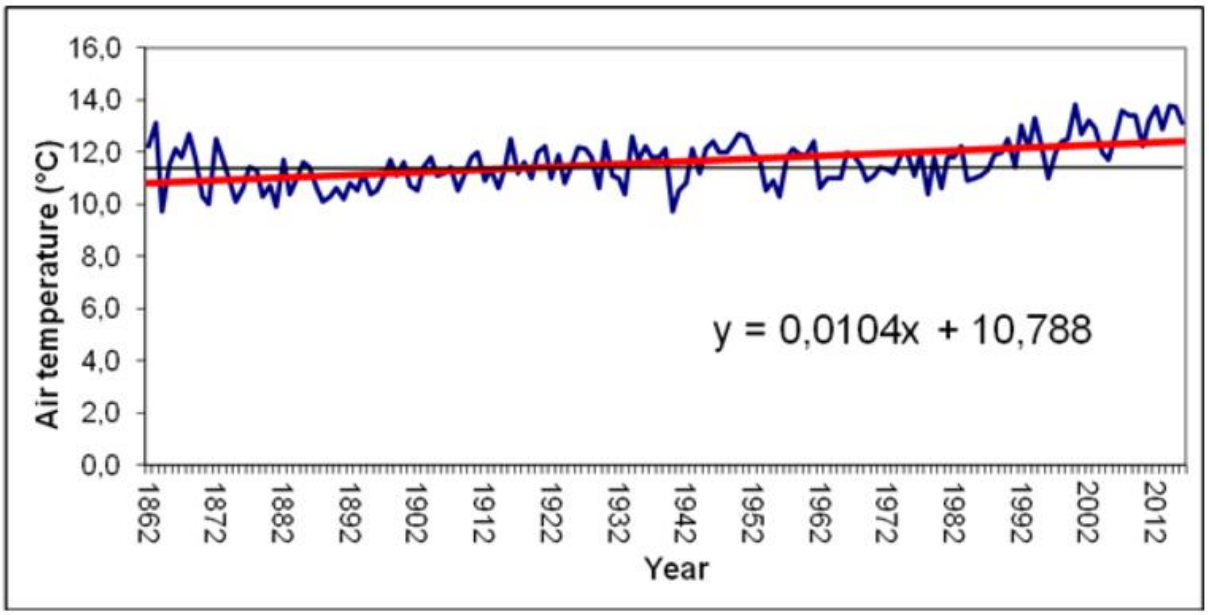


Figure 5.23: Time series of annual average temperature for Zagreb Grič (Croatia) for the period 1862-2016 (diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Italy

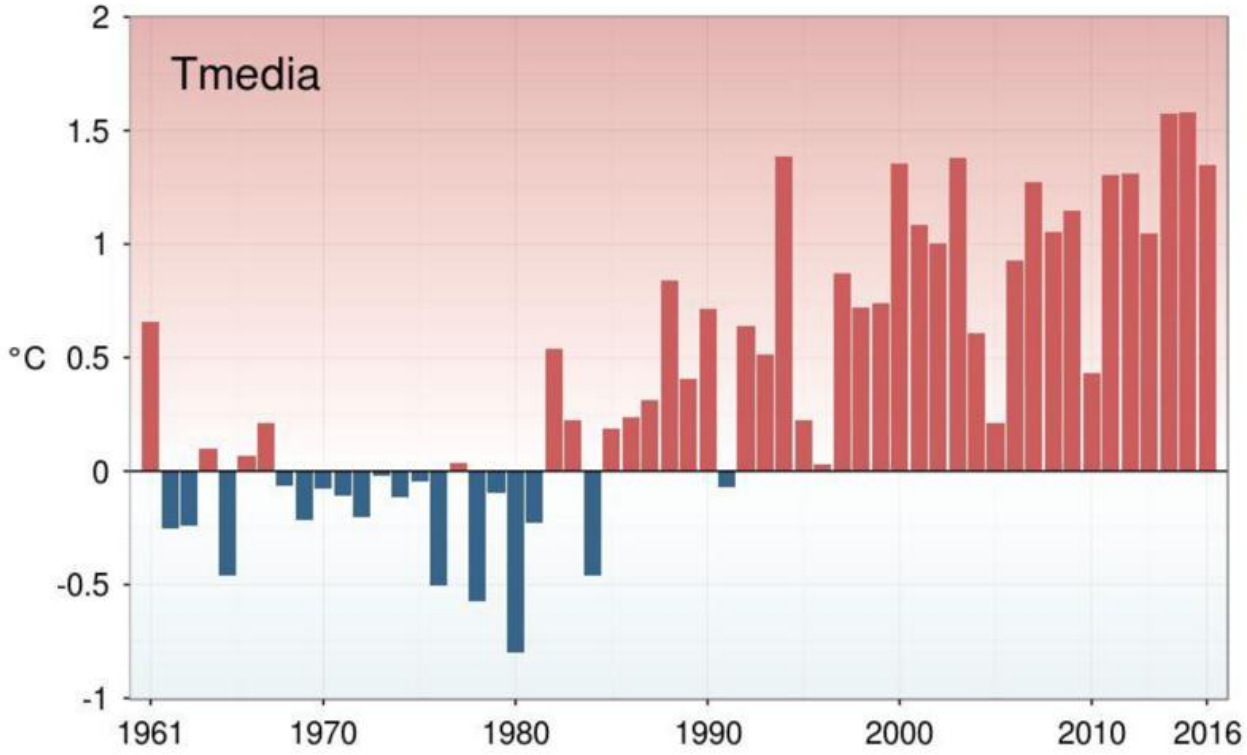


Figure 5.24: Time series of annual temperature anomalies for Italy for the period 1961-2016 (reference period 1961-1990; diagram as provided by the NHMS)

Slovenia

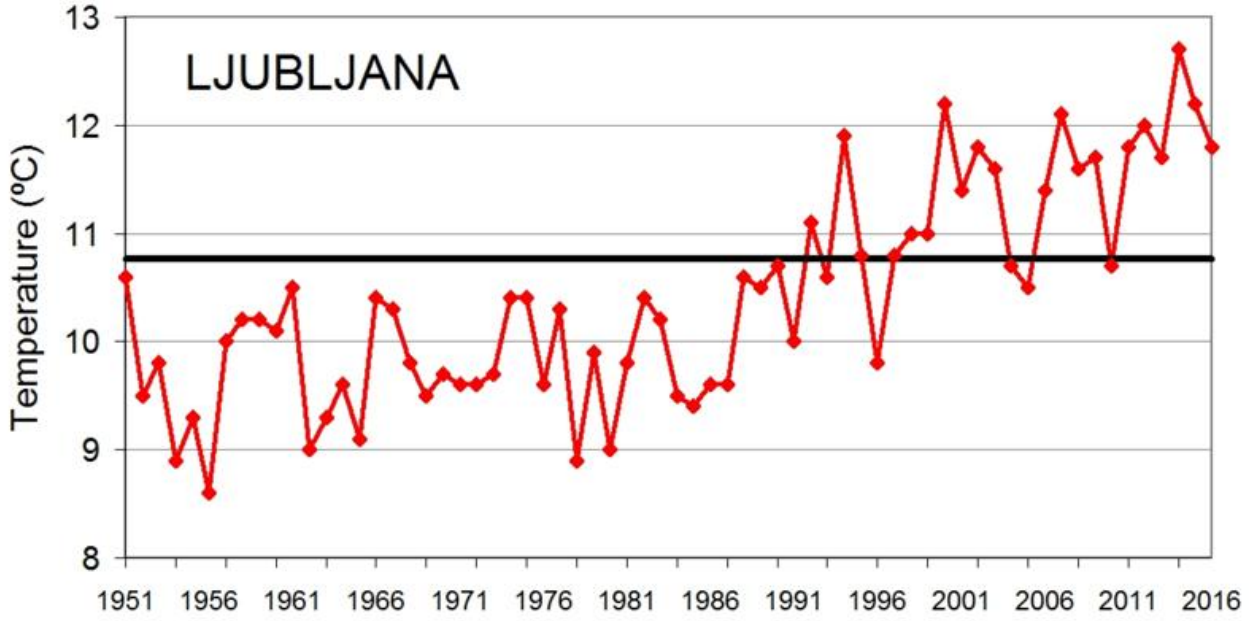


Figure 5.25: Time series of annual temperature anomalies for Ljubljana (Slovenia) for the period 1951-2016 (black line is the mean of the period 1961-1990; diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Turkey

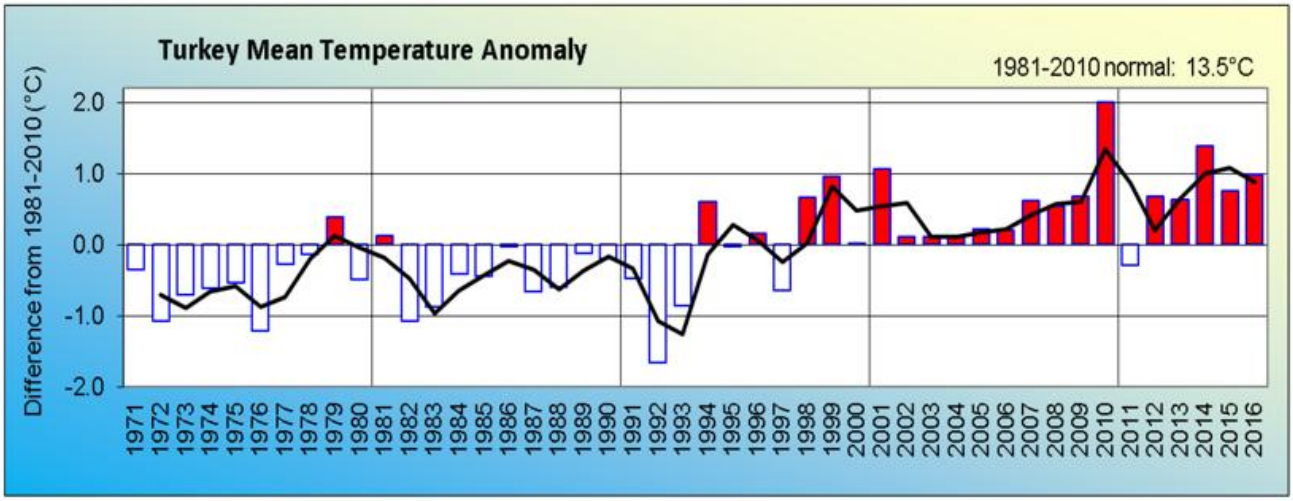


Figure 5.26: Time series of annual temperature anomalies for Turkey for the period 1971-2016 (reference period 1981-2010; diagram as provided by the NHMS)

Eastern Europe – annual temperature series

Belarus, European Russia, Moldova, Ukraine

Belarus

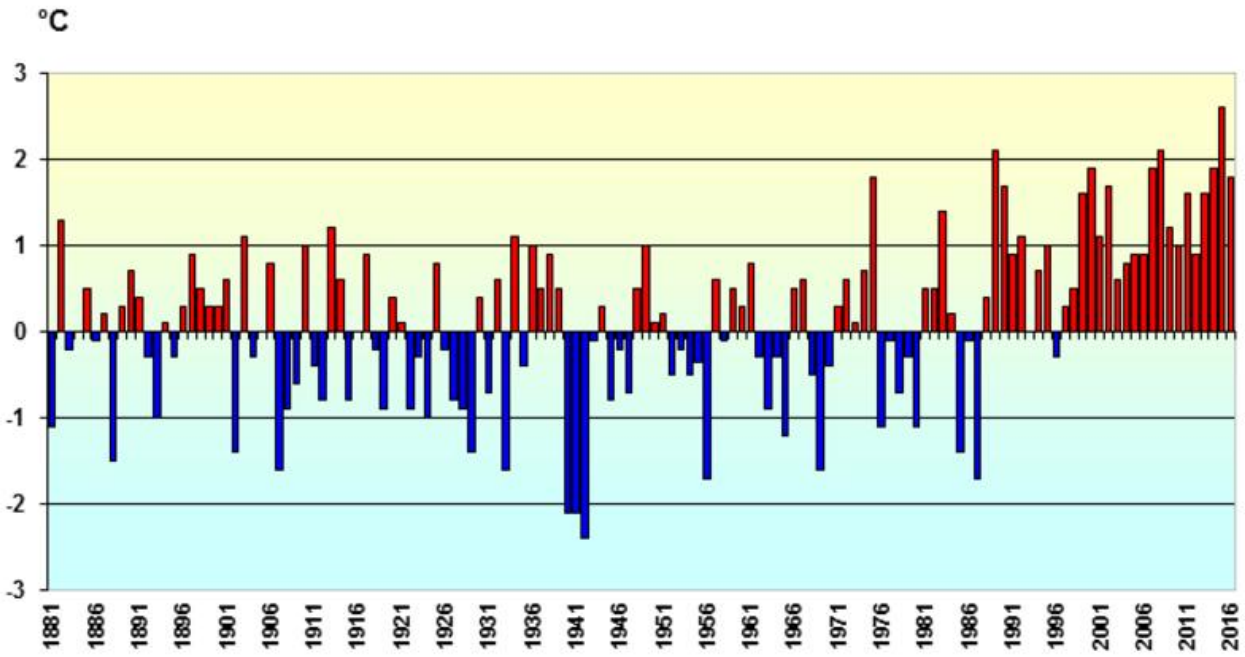


Figure 5.27: Time series of annual temperature anomalies for the Republic of Belarus for the period 1881-2016 (reference period 1961-1990; diagram as provided by the NHMS)

European Russia

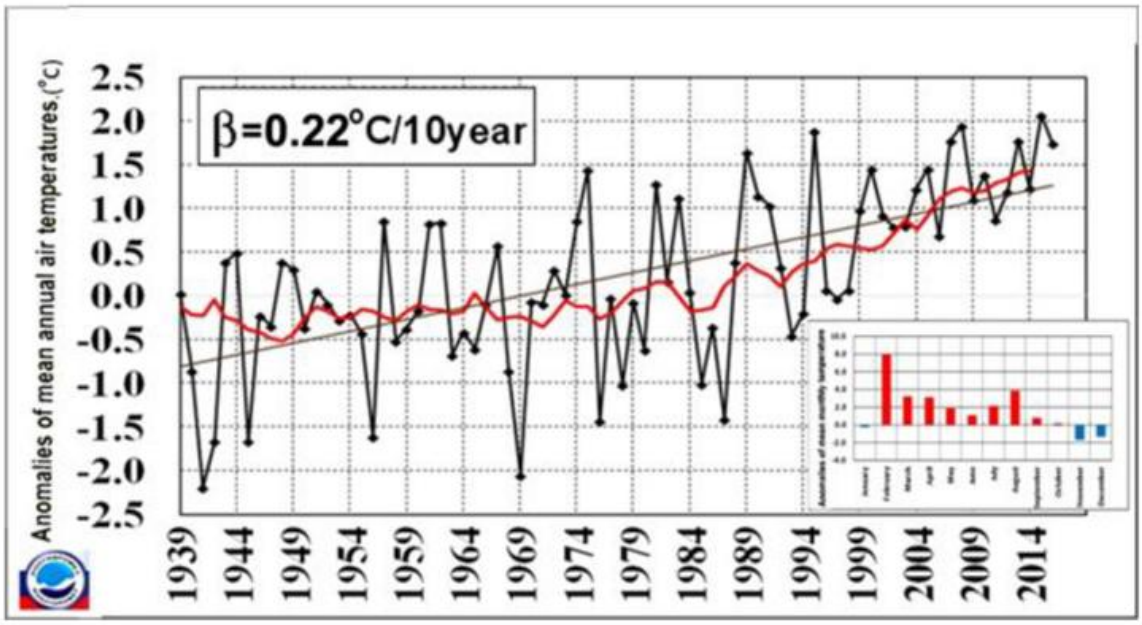


Figure 5.28: Time series of annual temperature anomalies for European Russia for the period 1939-2016 (reference period 1961-1990; diagram as provided by the NHMS)

Eastern Europe – annual temperature series

Moldova

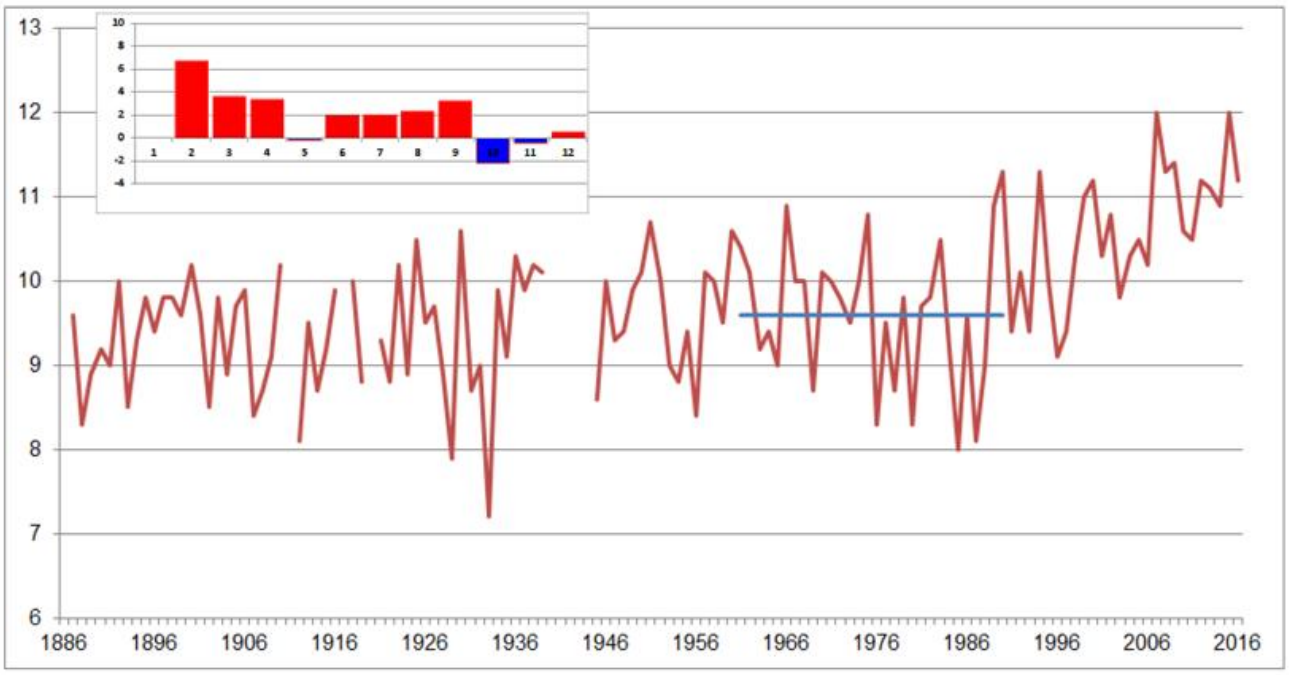


Figure 5.29: Time series of annual temperature for station Chisinau, Moldova for the period 1887-2016 (diagram as provided by the NHMS)

Ukraine

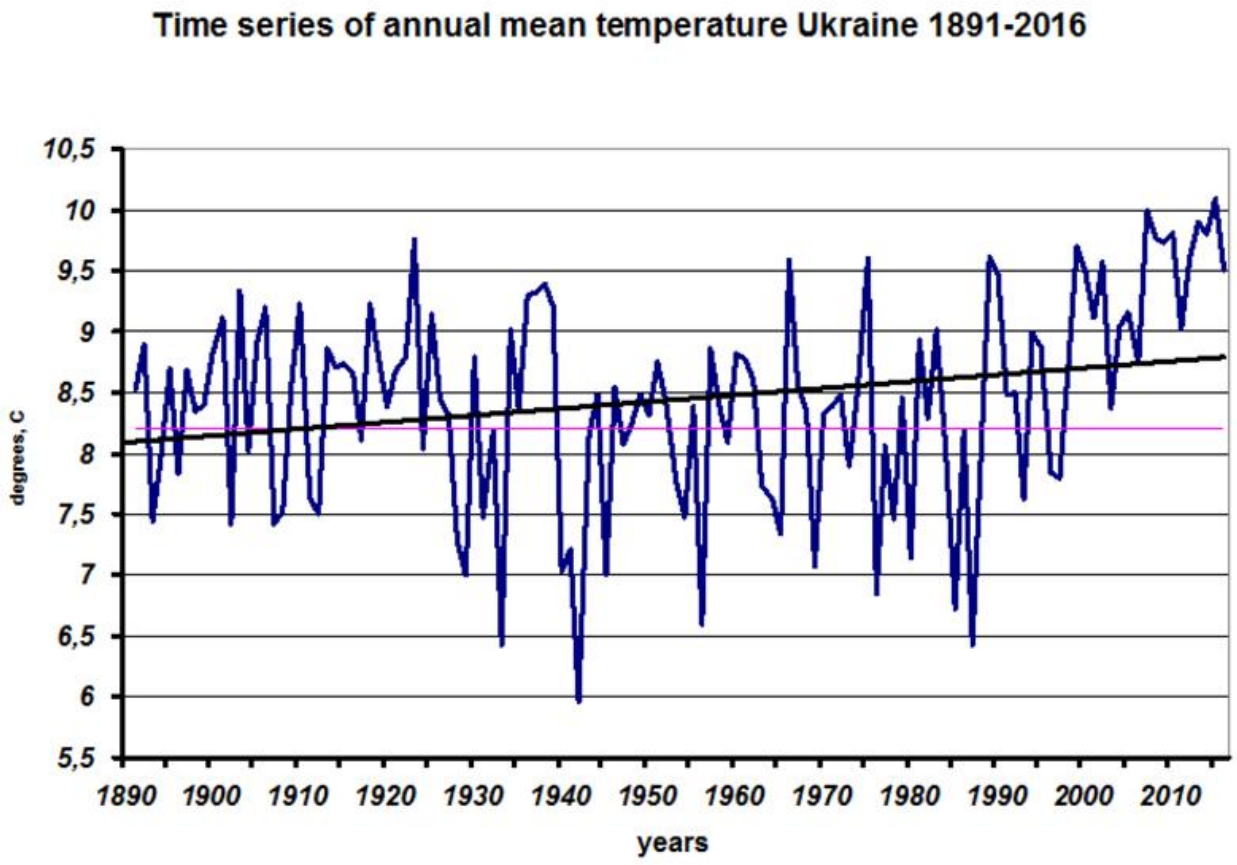


Figure 5.30: Time series of annual temperature for Ukraine for the period 1891-2016 (diagram as provided by the NHMS)

Middle East – annual temperature series

Georgia, Israel, Kazakhstan

Georgia

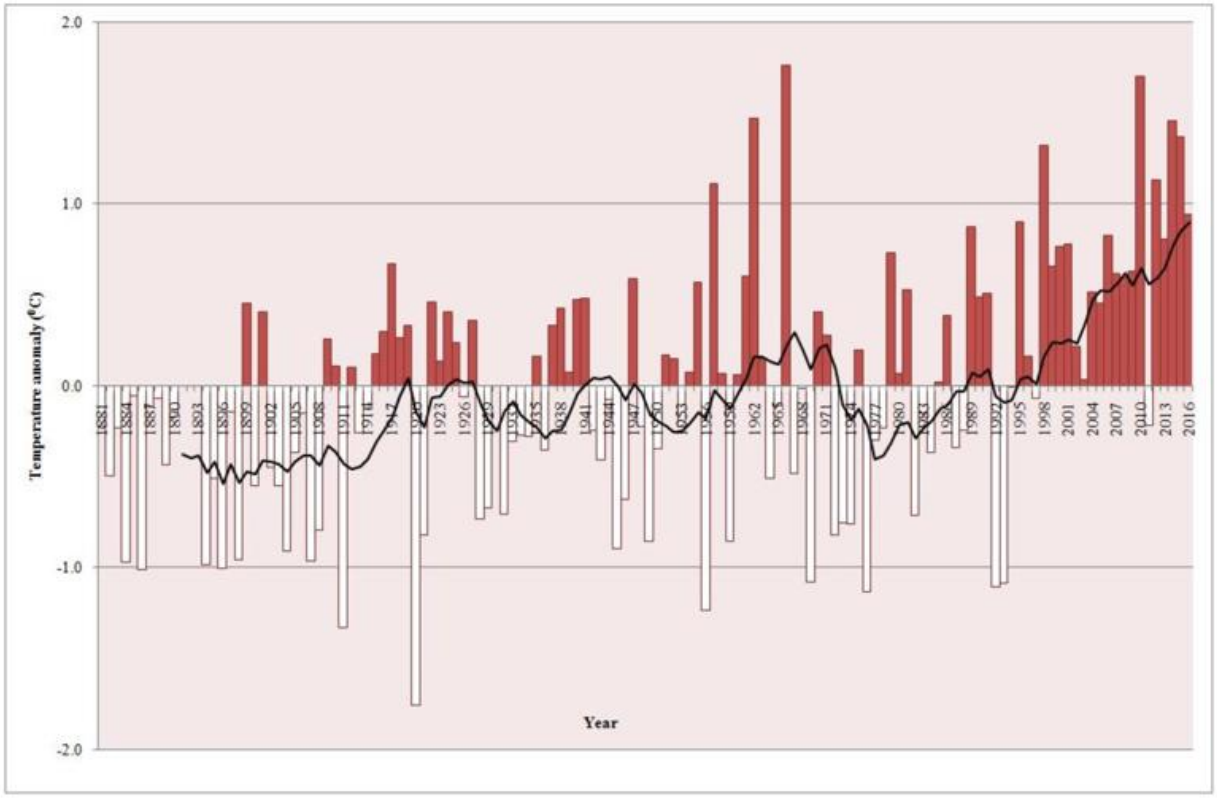


Figure 5.31: Time series of annual temperature anomalies and 11-yr moving averages for Tbilisi (Georgia) for the period 1881-2016 (reference period 1961-1990; diagram as provided by the NHMS)

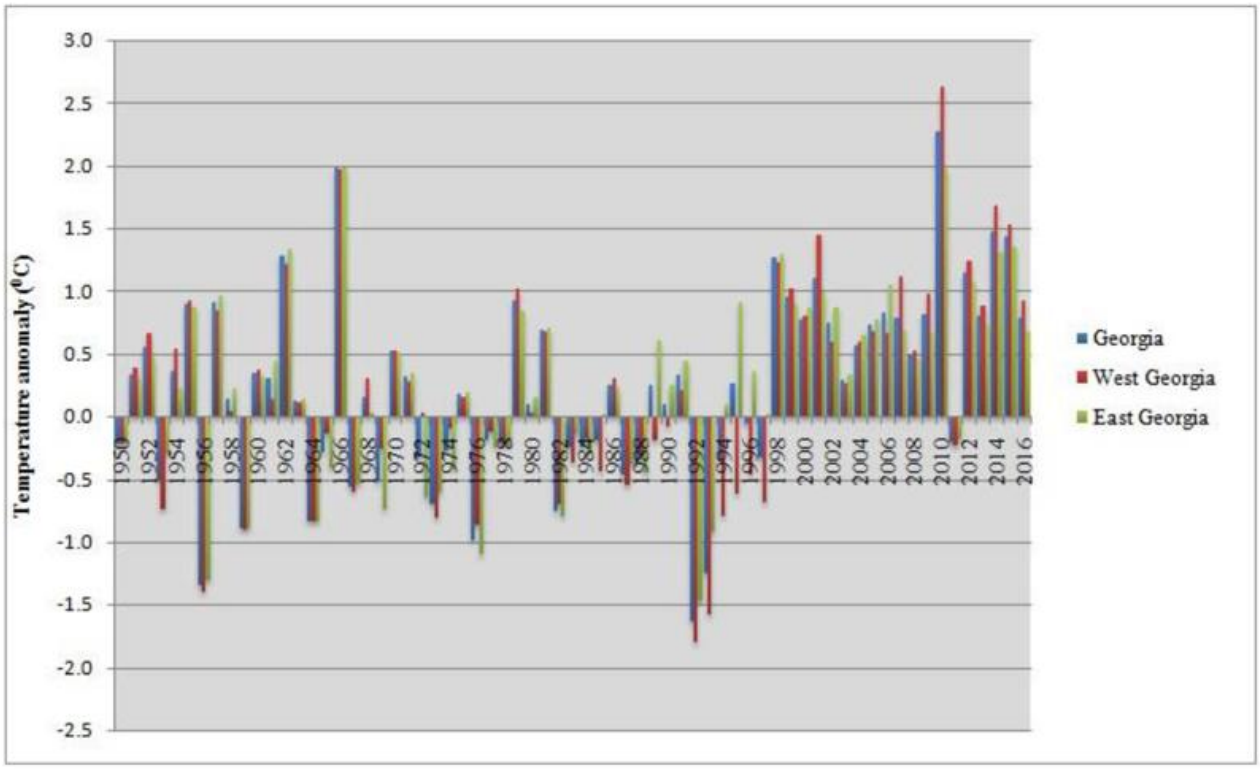


Figure 5.32: Time series of annual temperature anomalies for Georgia for the period 1950-2016 (reference period 1961-1990; diagram as provided by the NHMS)

Middle East – annual temperature series

Israel

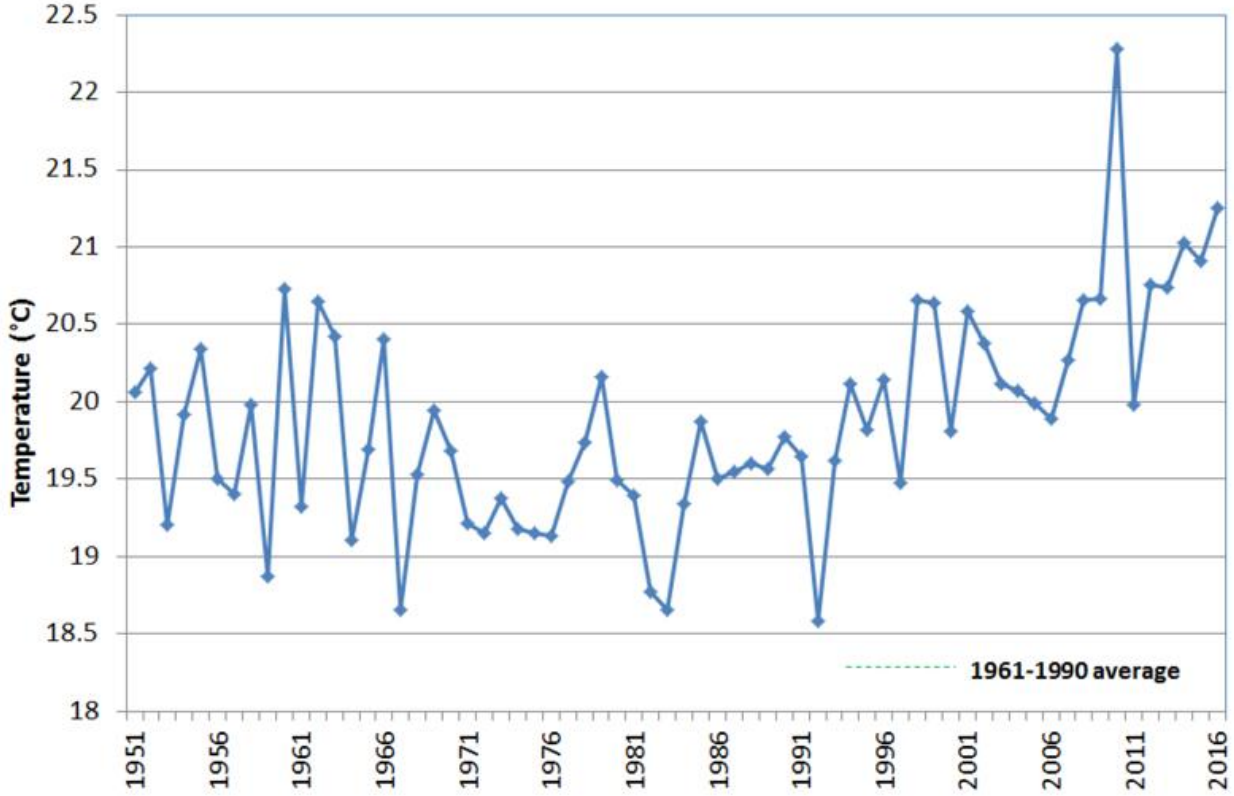


Figure 5.33: Time series of annual temperature for Israel (based on five stations) for the period 1951-2016 (diagram as provided by the NHMS)

Kazakhstan

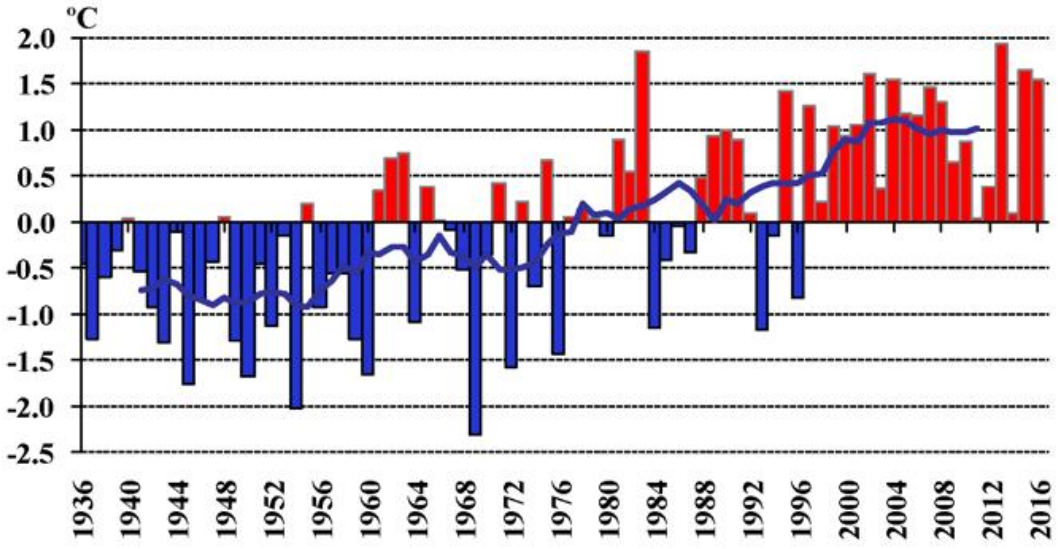


Figure 5.34: Annual average temperature anomalies for Kazakhstan for the period 1936-2016 with 11-year running mean (reference period 1961-1990, diagram as provided by the NHMS)

5.2. Precipitation

Central and Western Europe - precipitation totals and anomalies

Germany, Hungary, Netherlands, Slovakia, Switzerland, United Kingdom

Germany

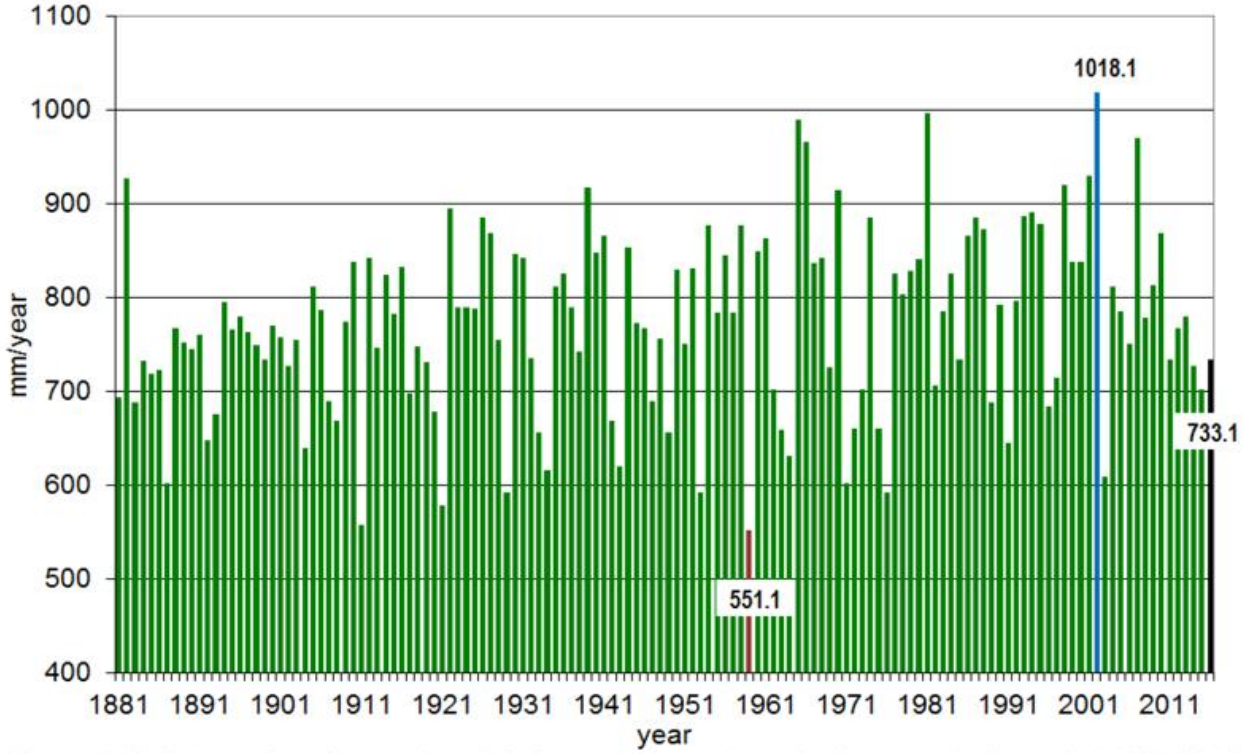


Figure 5.35: Time series of annual precipitation totals in mm/year for Germany for the period 1881-2016 (Diagram as provided by the NHMS)

Hungary

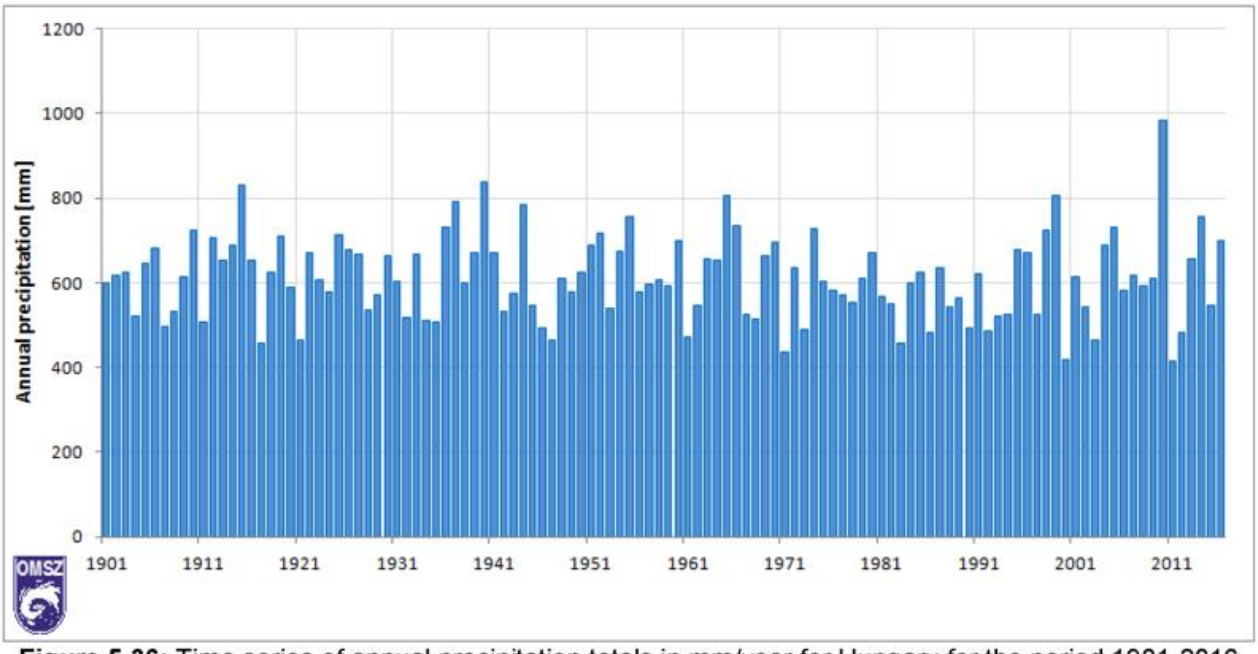


Figure 5.36: Time series of annual precipitation totals in mm/year for Hungary for the period 1901-2016 (Diagram as provided by the NHMS)

Central and Western Europe - precipitation totals and anomalies

The Netherlands

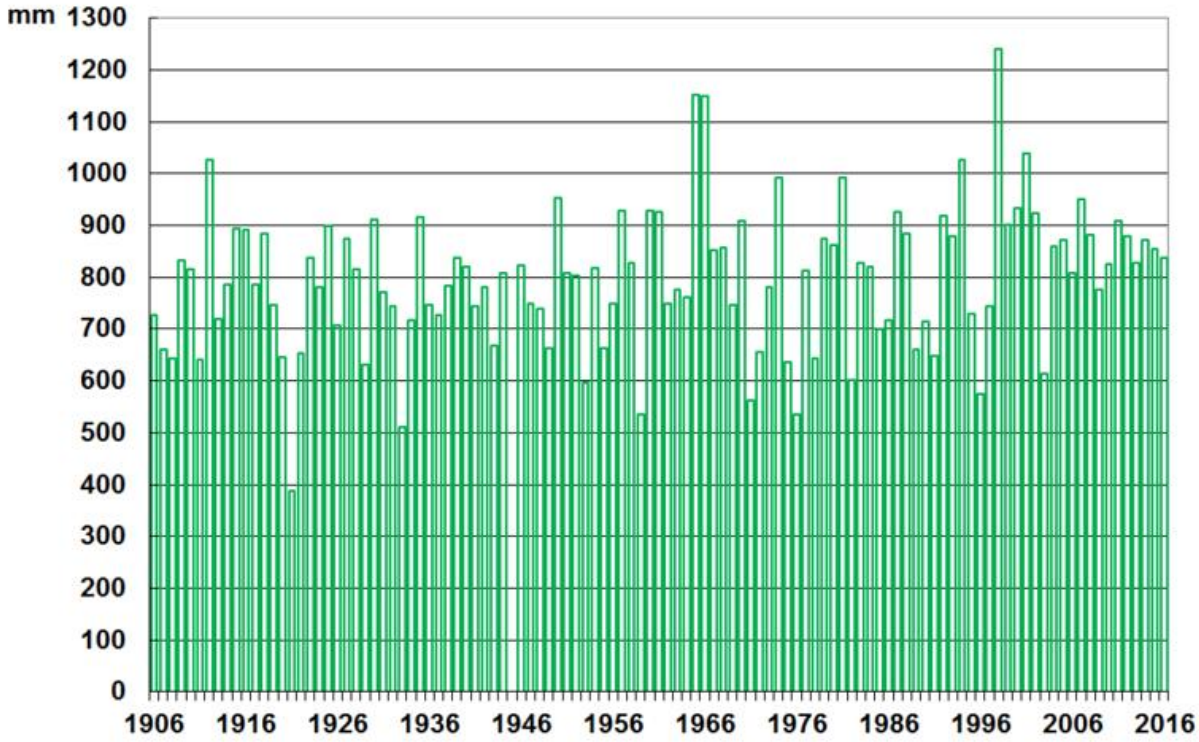


Figure 5.37: Time series of annual precipitation totals in mm/year for the Netherlands (station De Bilt) for the period 1906-2016 (Data as provided by the KNMI)

Slovakia

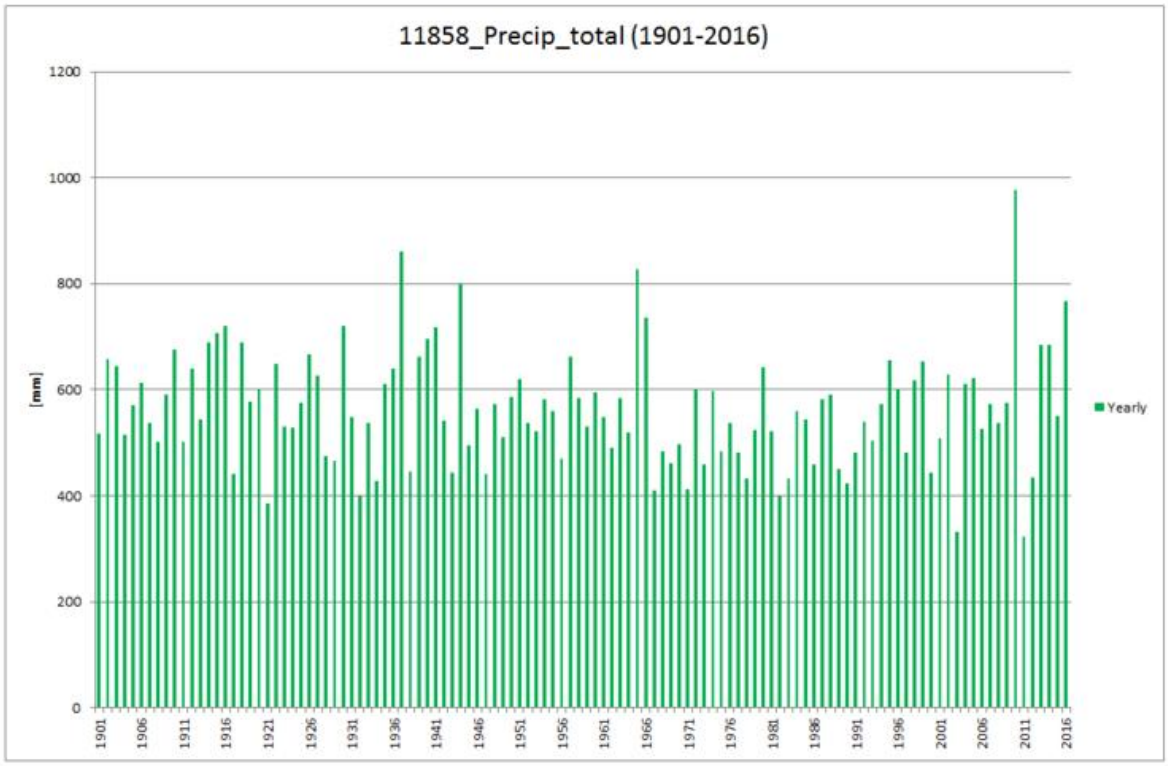


Figure 5.38: Time series of annual precipitation totals in mm/year for Slovakia (station Hurbanovo) for the period 1901-2016 (Diagram as provided by the NHMS)

Central and Western Europe - precipitation totals and anomalies

Switzerland

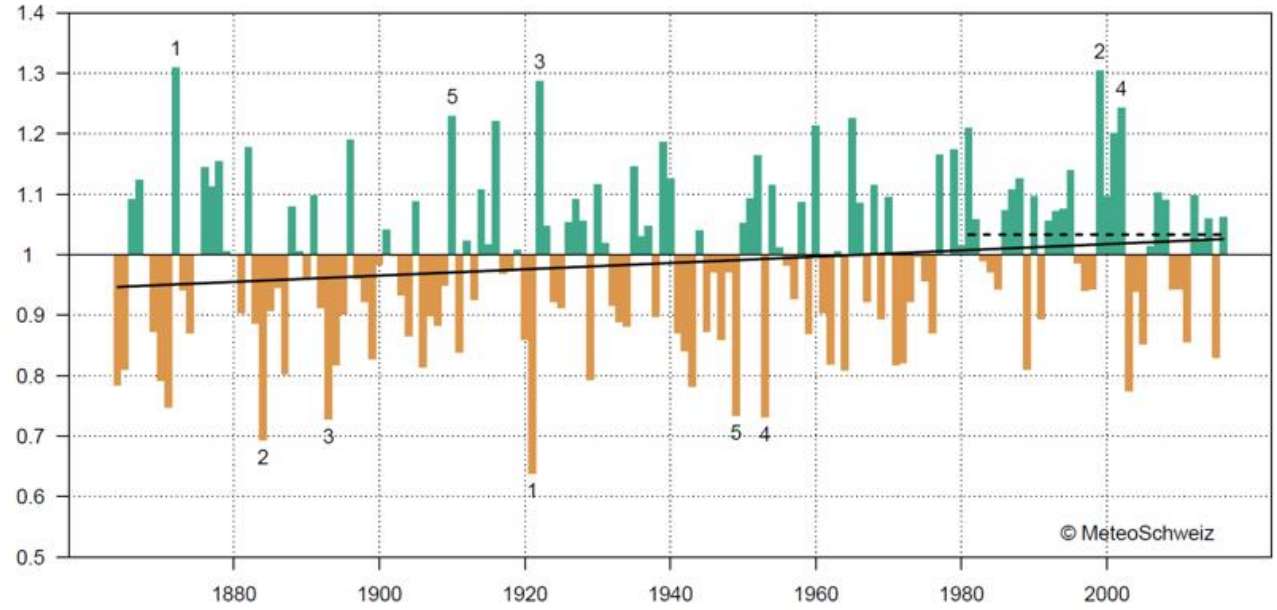


Figure 5.39: Time series of annual precipitation anomalies in relation to the mean of 1961-1990 for Switzerland for the period 1864–2016. Color bars represent anomalies in respect to the long-term mean 1961–1990 and green indicates positive and bronce negative anomalies. The black line represents the linear significant trend (5.2%/100y). The black dashed line represents the mean 1981–2010. (diagram as provided by the NHMS)

United Kingdom

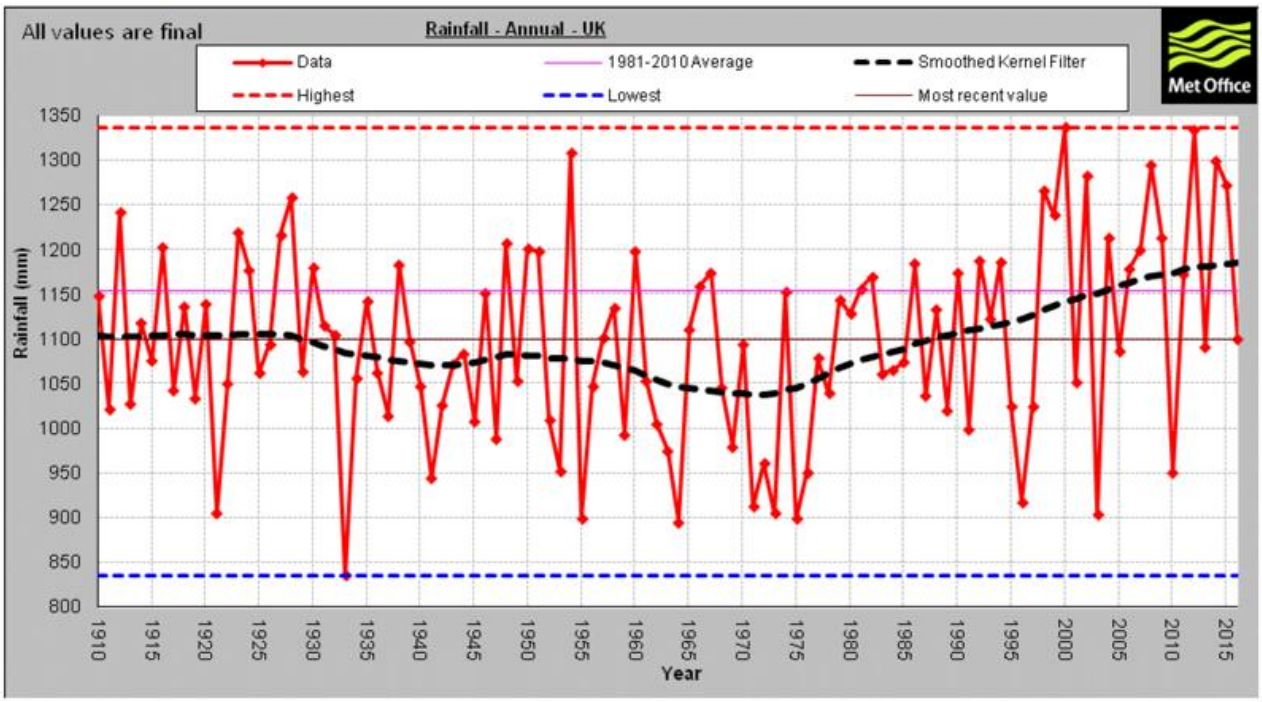


Figure 5.40: Time series of annual precipitation totals in mm/year for the United Kingdom for the period 1910-2016 (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Denmark, Estonia, Finland, Latvia, Norway, Sweden

Denmark

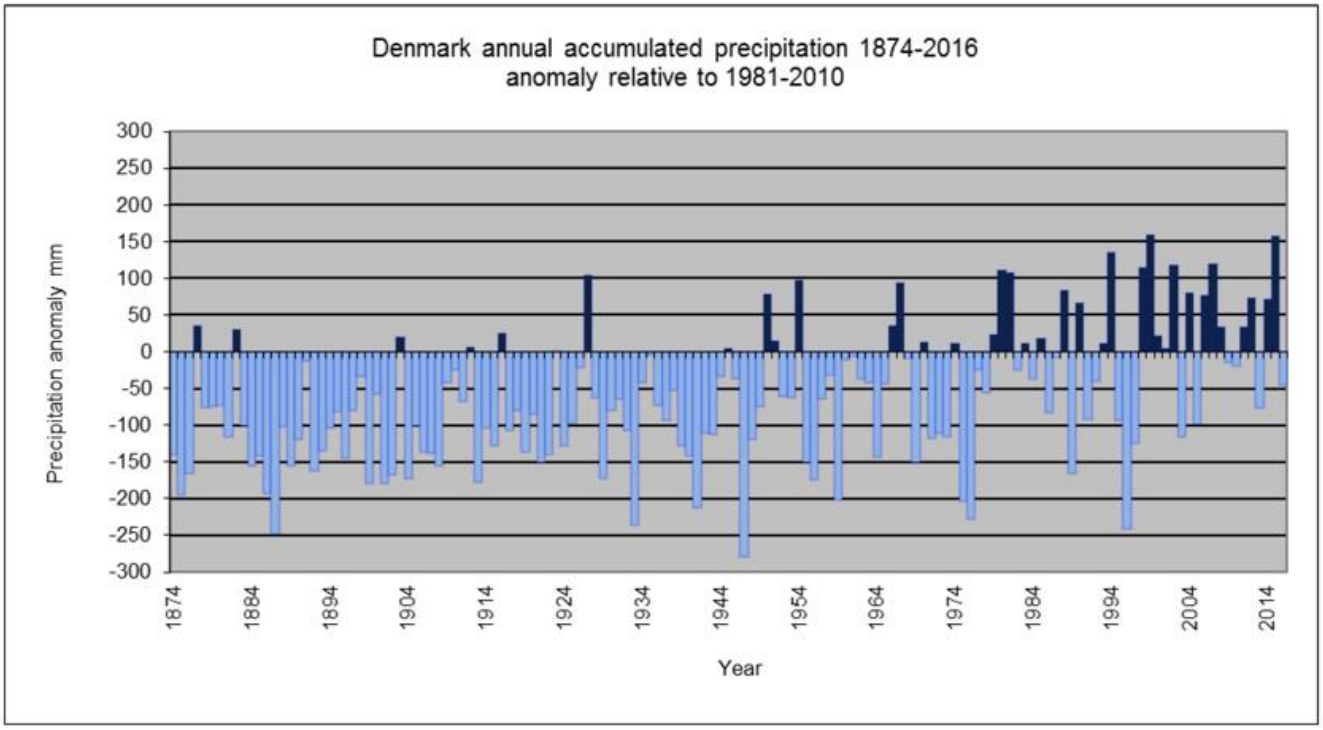


Figure 5.41: Time series of annual precipitation totals in mm/year for Denmark: anomaly relative to 1981-2010 (Diagram as provided by the NHMS)

Estonia

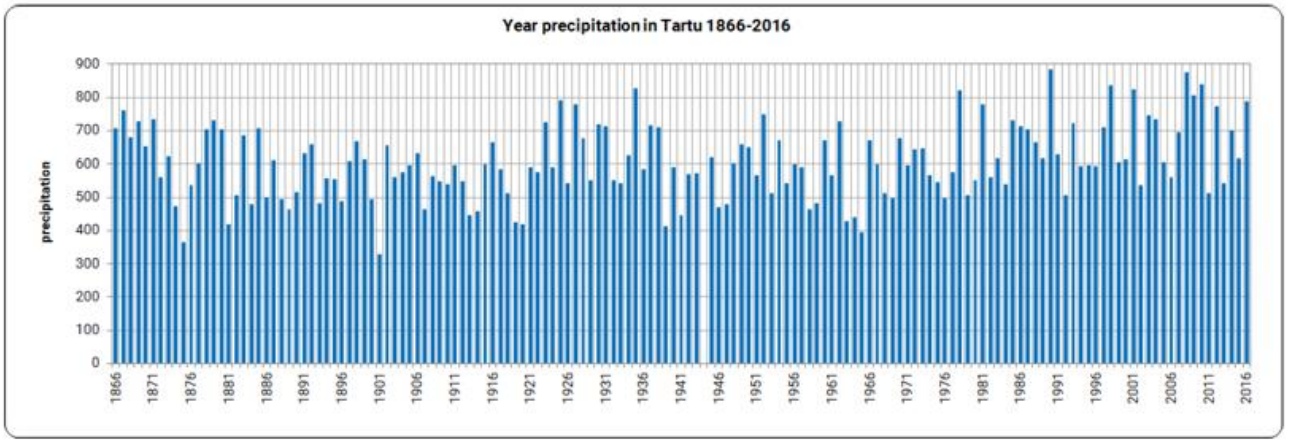


Figure 5.42: Time series of annual precipitation totals in mm/year at station Tartu, Estonia (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Finland

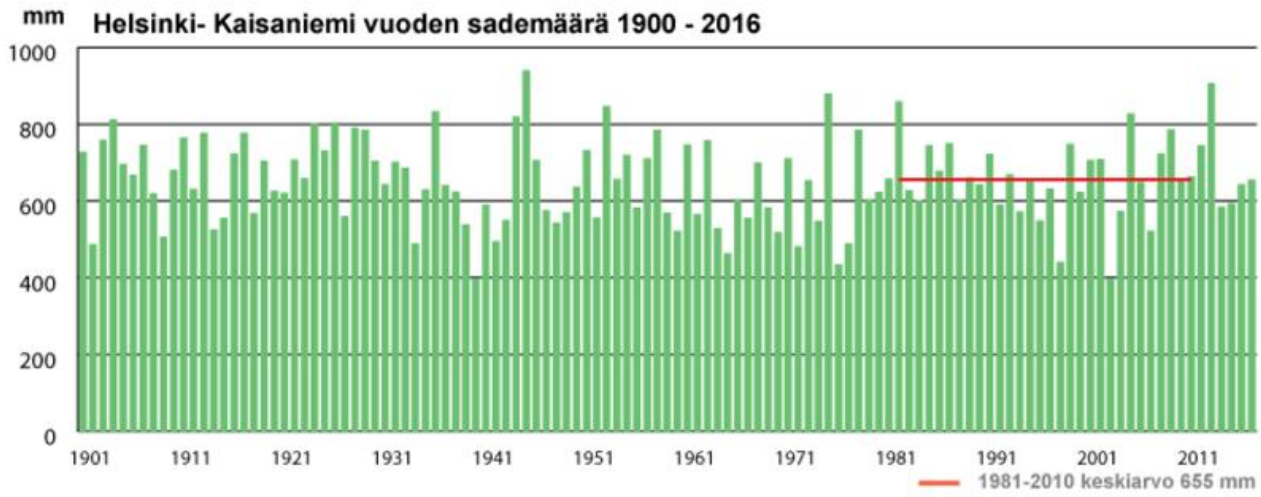


Figure 5.43: Time series of annual precipitation totals in mm/year at station Helsinki, Finland (Diagram as provided by the NHMS)

Latvia

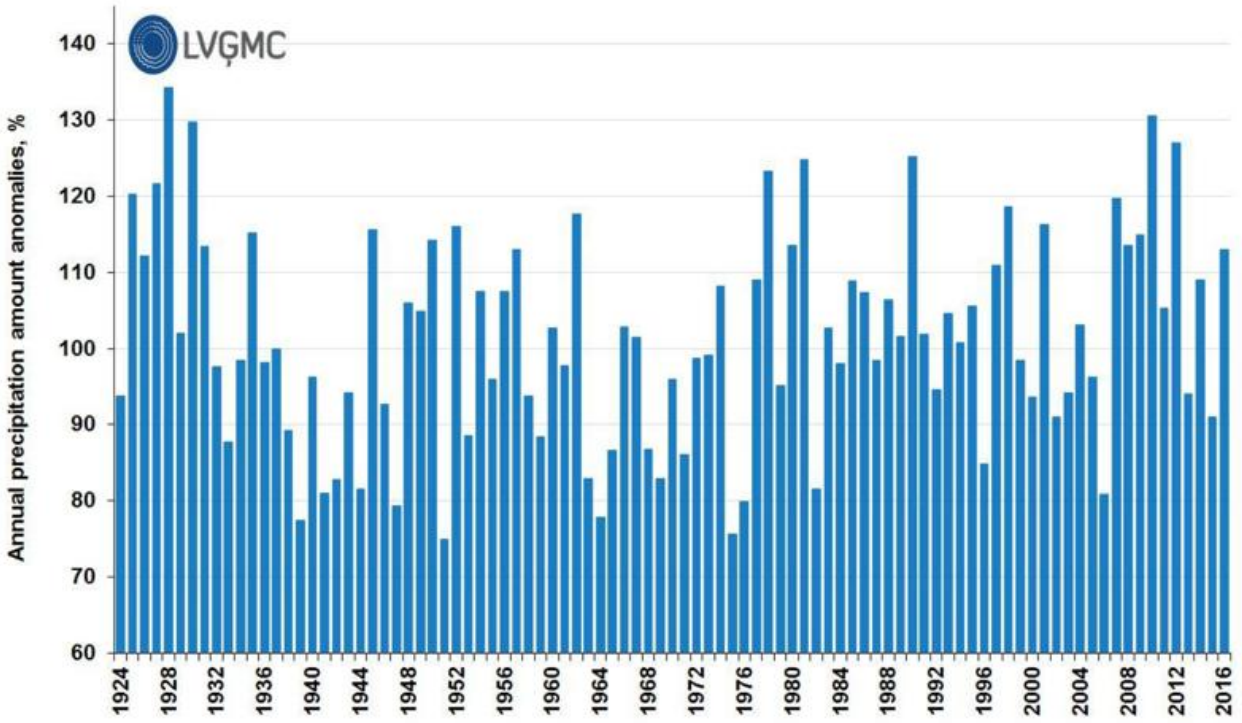


Figure 5.44: Time series of annual precipitation totals in relation to the mean of 1961-90 for Latvia (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Norway

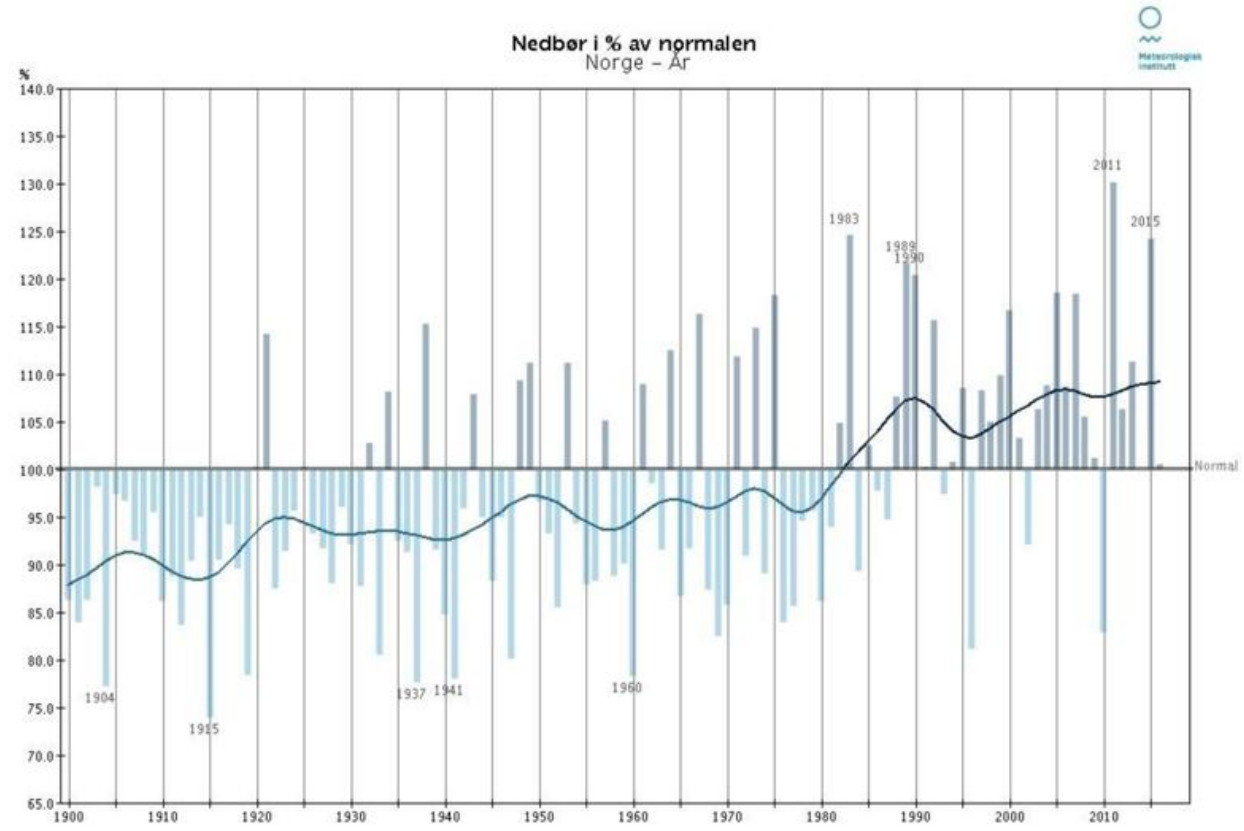


Figure 5.45: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Norway (Diagram as provided by the NHMS)

Sweden

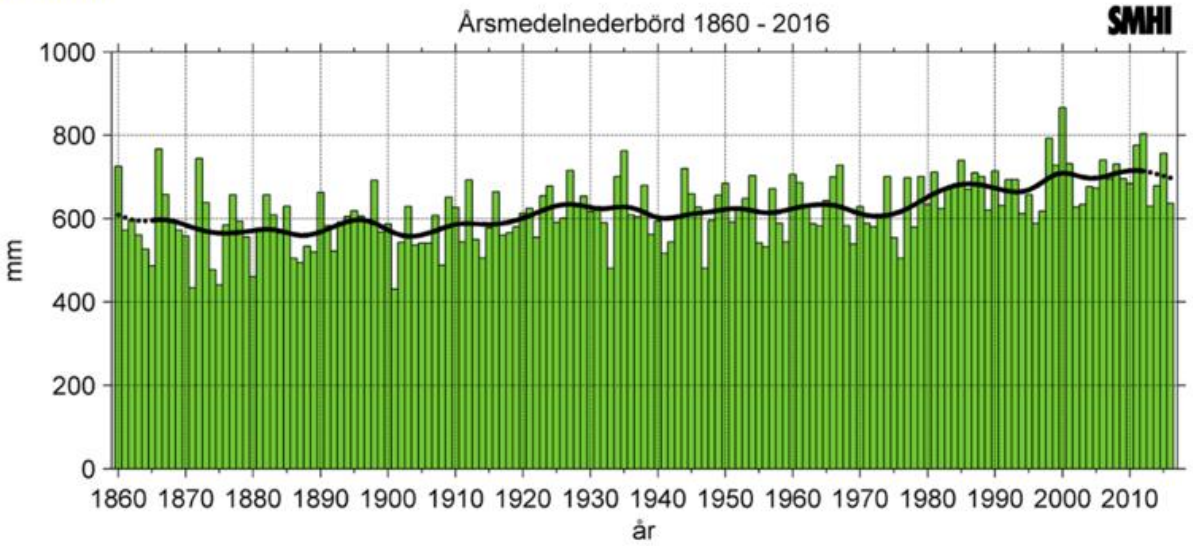


Figure 5.46: Time series of annual precipitation totals in mm/year for Sweden (Diagram as provided by the NHMS)

Iberia - precipitation anomalies

Portugal

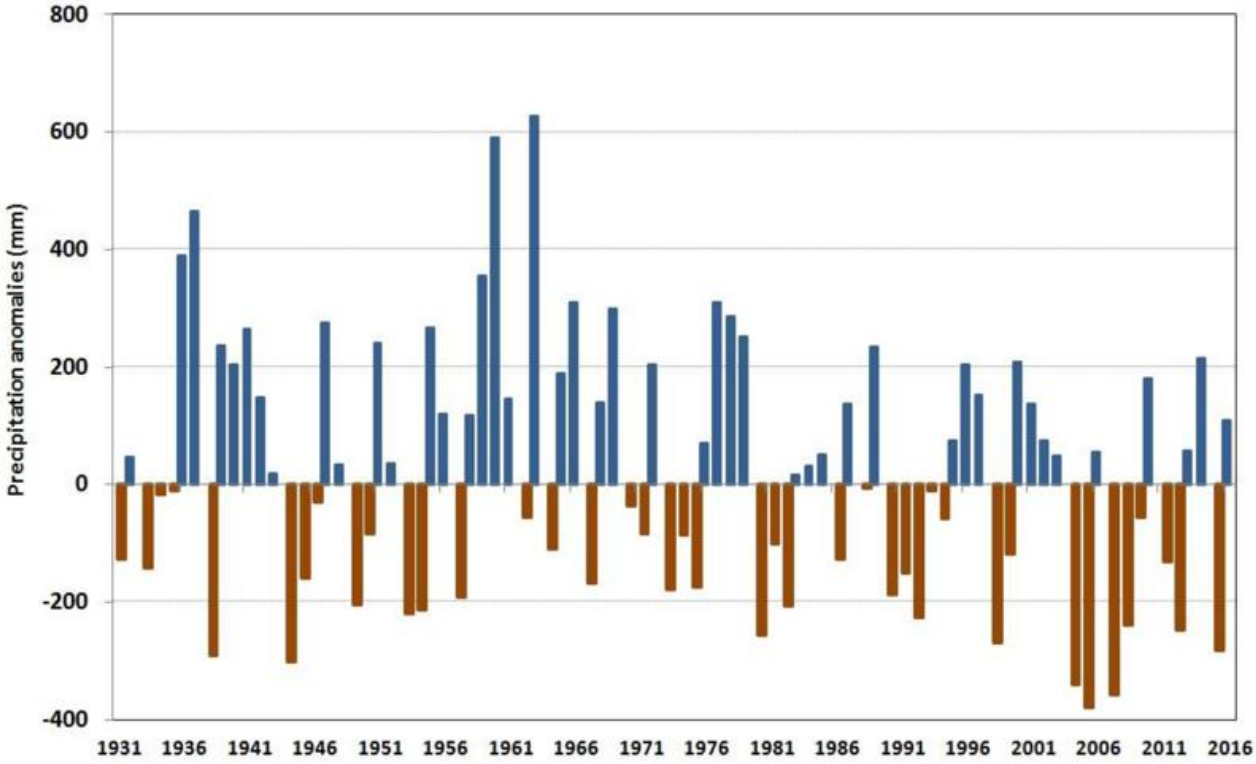


Figure 5.47: Time series of annual precipitation totals in mm/year (deviations from the mean of 1971-2000) for Portugal (Diagram as provided by the NHMS)

Spain

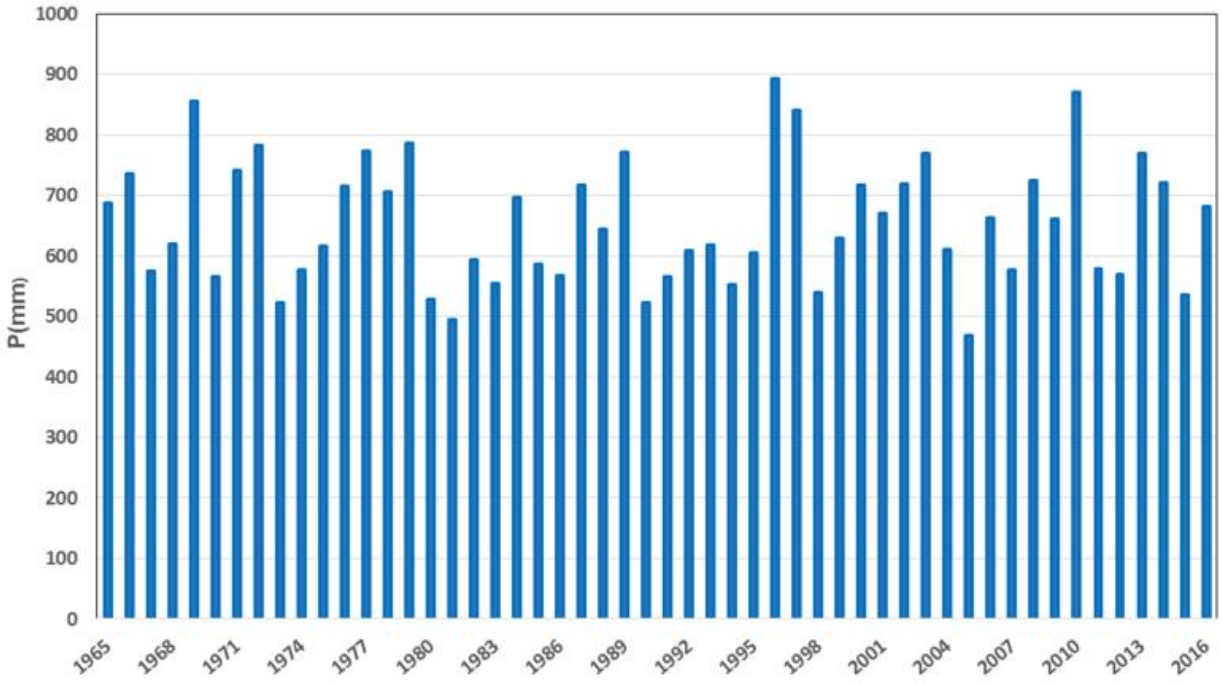


Figure 5.48: Time series of annual precipitation totals in mm/year for Spain (Diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Italy, Slovenia, Turkey

Italy

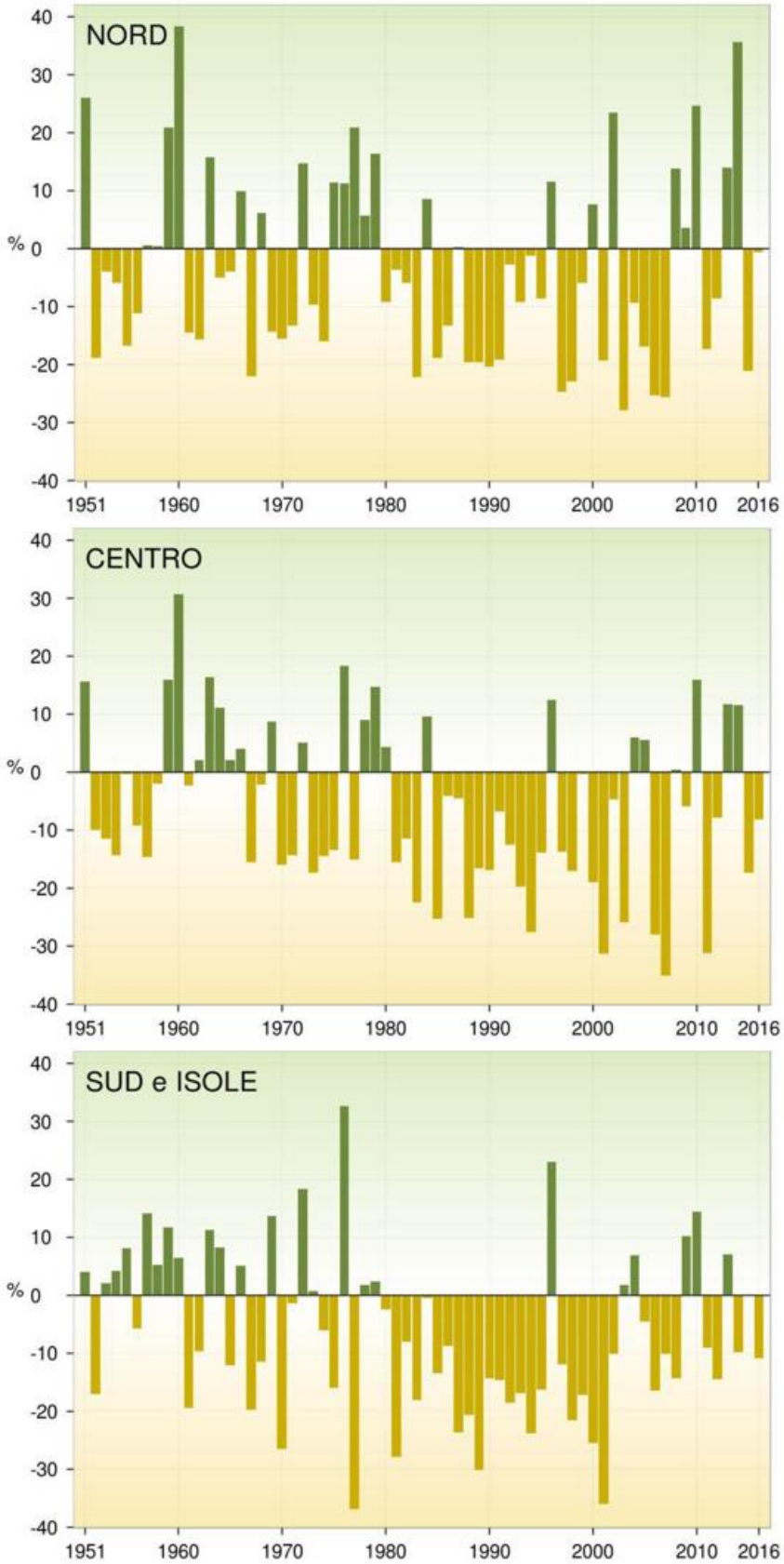


Figure 5.49: Time series of annual precipitation anomalies in relation to the mean of 1961-90 for north (top), Central (middle) and southern Italy (bottom, diagrams as provided by ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Slovenia

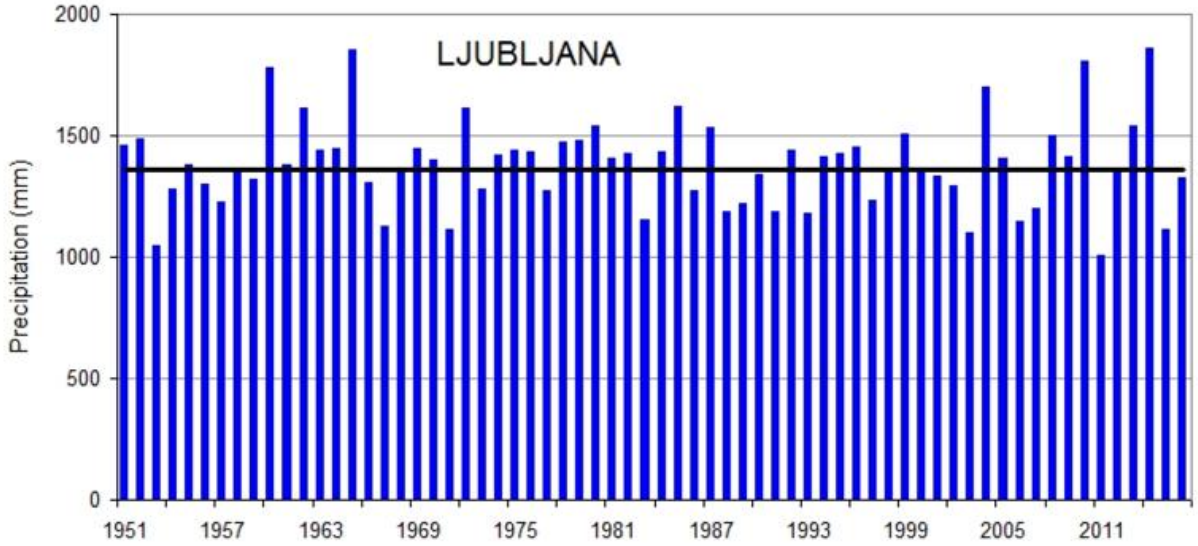


Figure 5.50: Time series of annual precipitation totals in mm/year for station Ljubljana 1951-2016 (diagram as provided by the NHMS)

Turkey

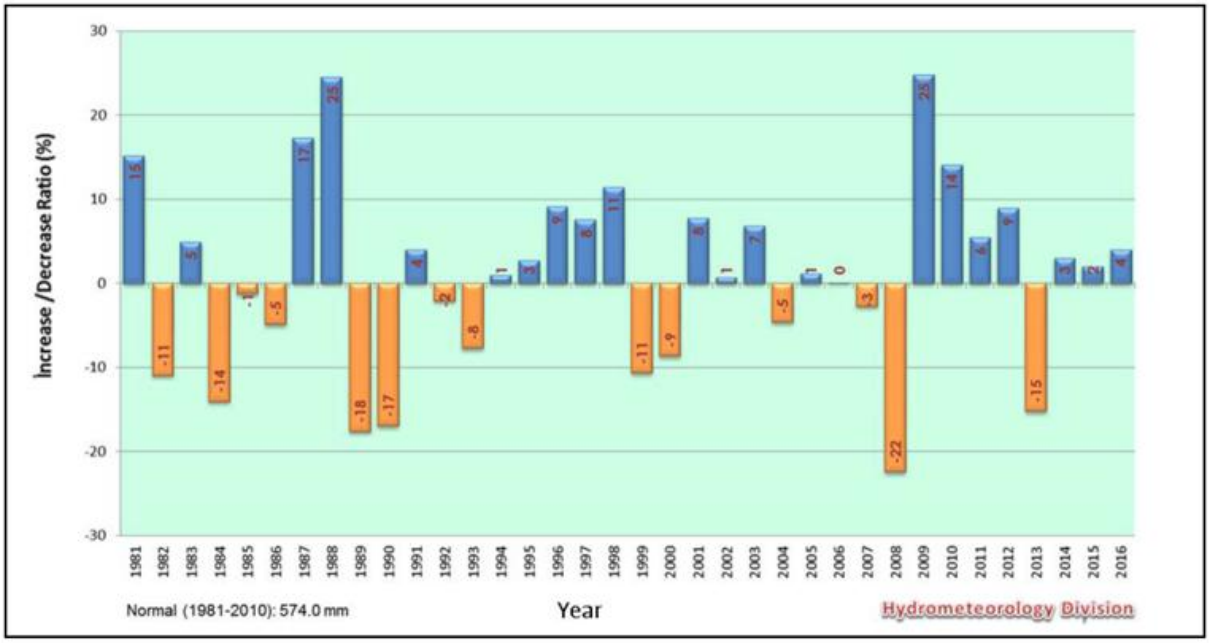


Figure 5.51: Time series of annual precipitation anomalies in relation to the mean of 1981-2010 for Turkey (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Belarus, European Russia, Ukraine

Belarus

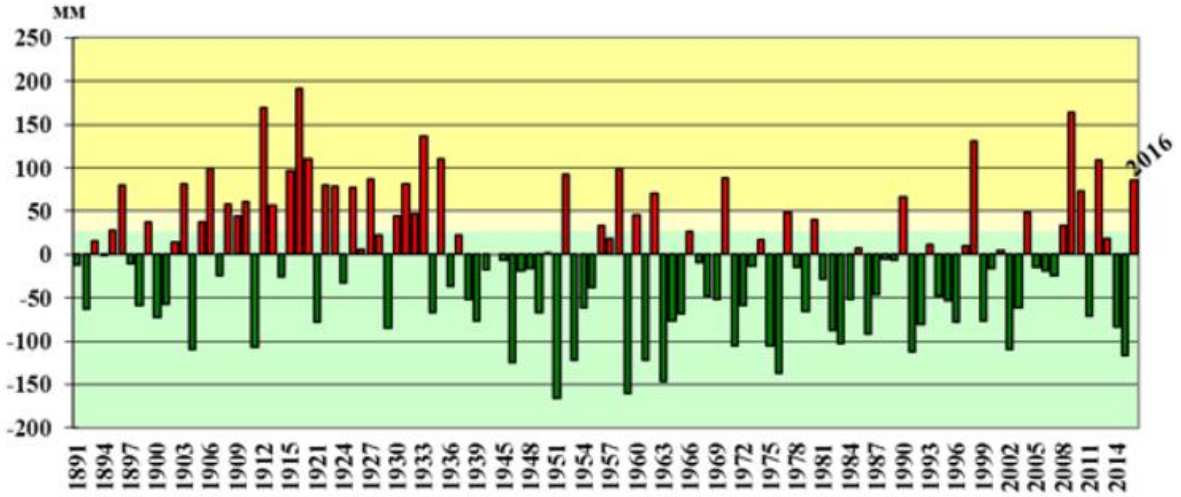


Figure 5.52: Anomalies of annual precipitation totals for Belarus 1891-2016 (base period: 1961-1990; Diagram as provided by the NHMS)

European Russia

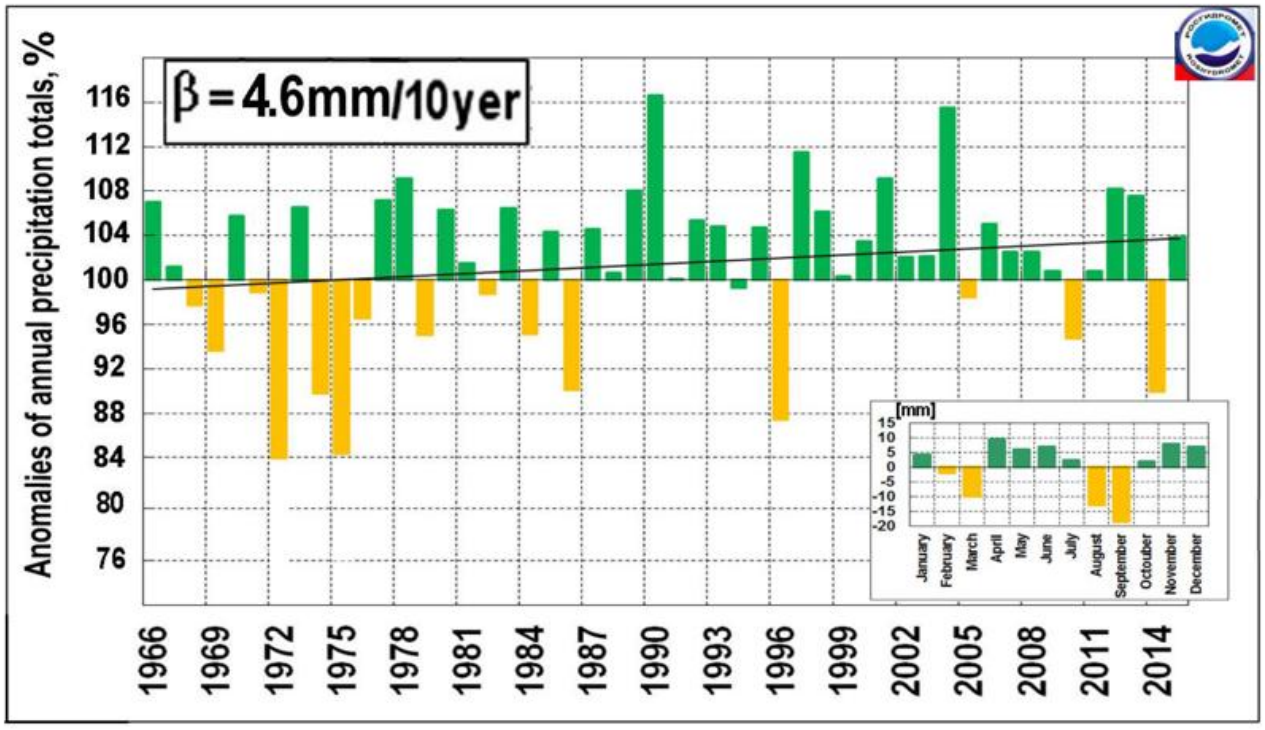


Figure 5.53: Time series of annual precipitation totals in relation to the mean of 1961-1990 for European Russia (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Ukraine

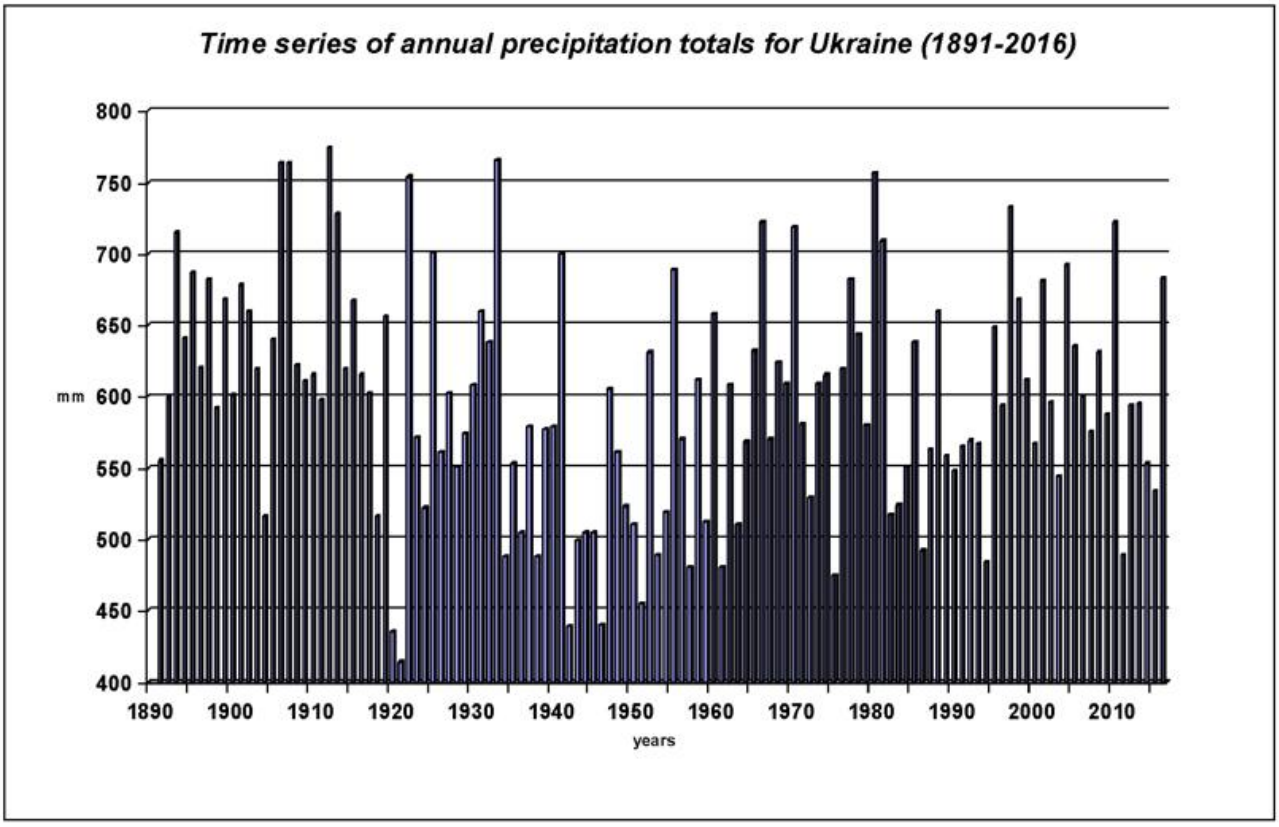


Figure 5.54: Time series of annual precipitation totals for Ukraine (Diagram as provided by the NHMS)

Middle East - precipitation anomalies

Georgia

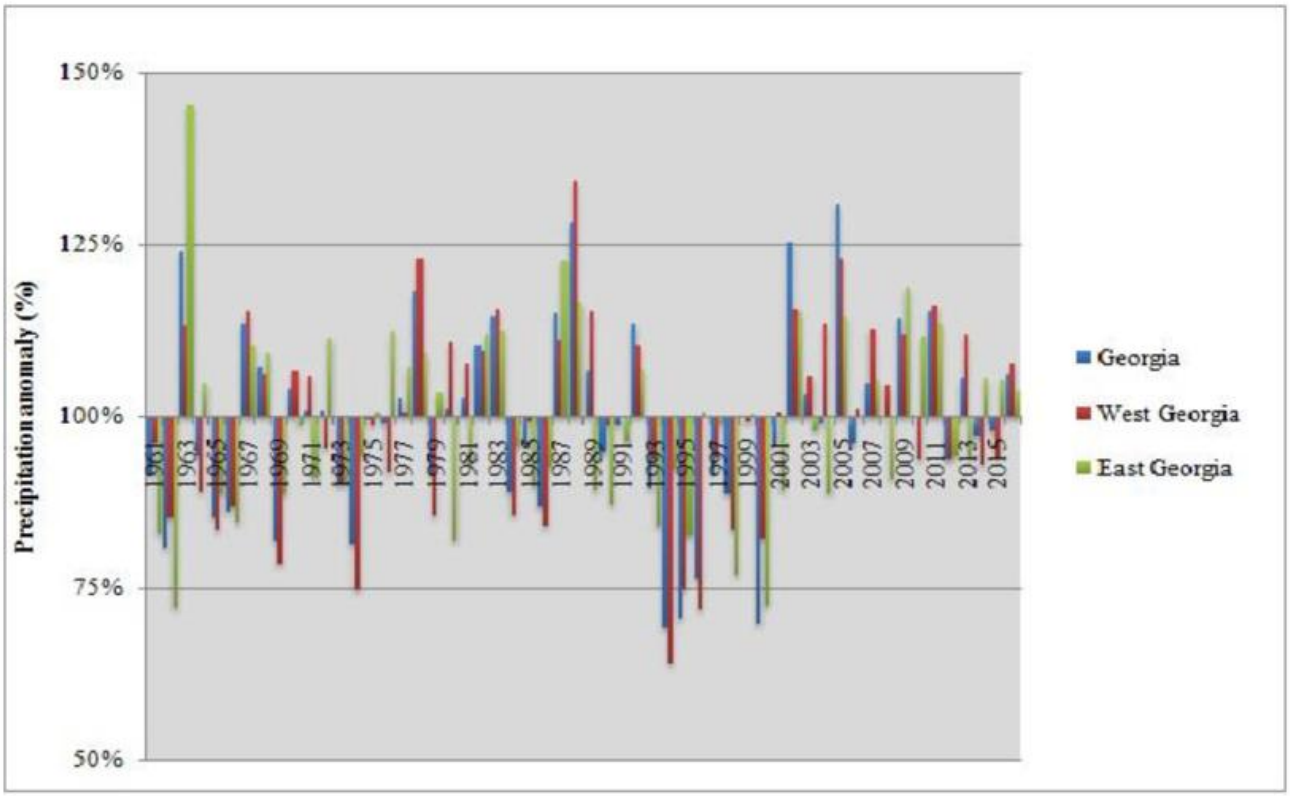


Figure 5.55: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Georgia (Diagram as provided by the NHMS)

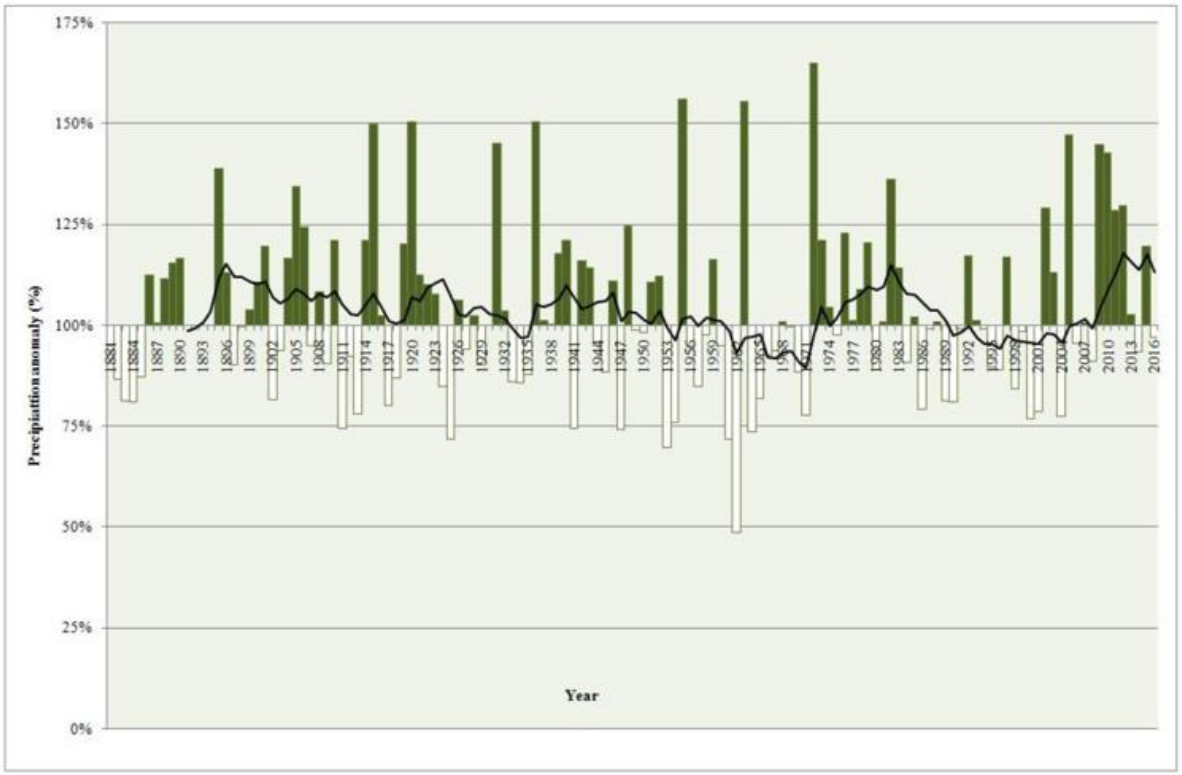


Figure 5.56: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Tbilisi, Georgia (Diagram as provided by the NHMS)

Middle East - precipitation anomalies

Kazakhstan

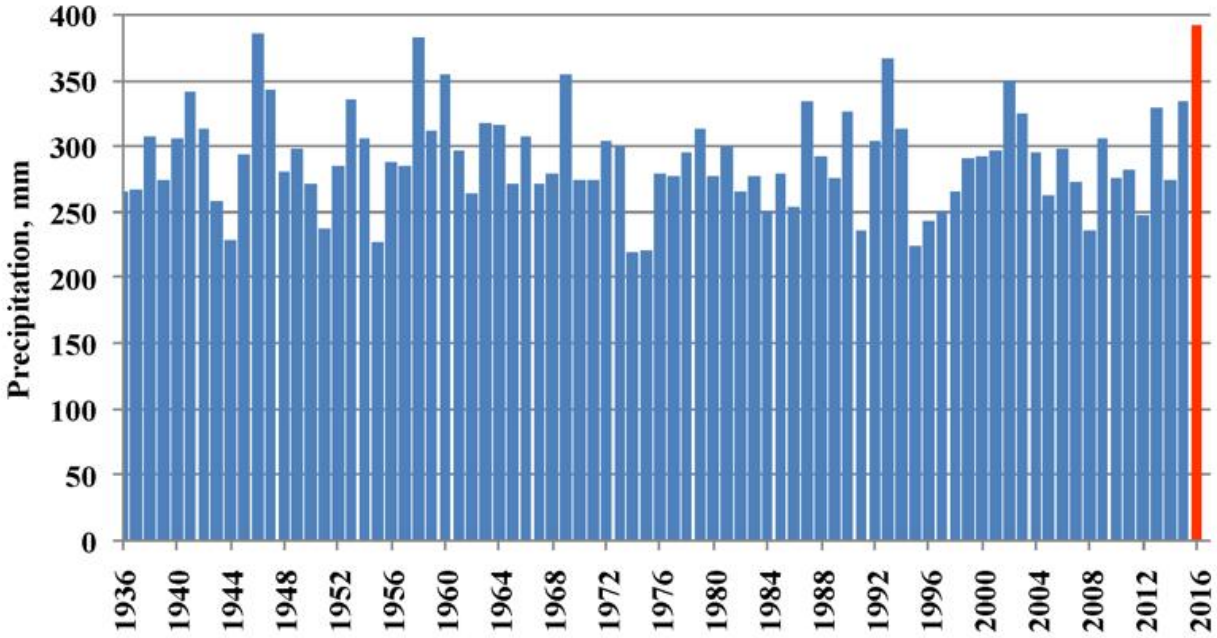


Figure 5.57: Time series of annual precipitation totals across Kazakhstan for the period 1936-2016. The year 2016 was a historical maximum of precipitation (392 mm, or 137%), the previous one was in 1946 (386 mm, or 135%) (Diagram as provided by the NHMS)

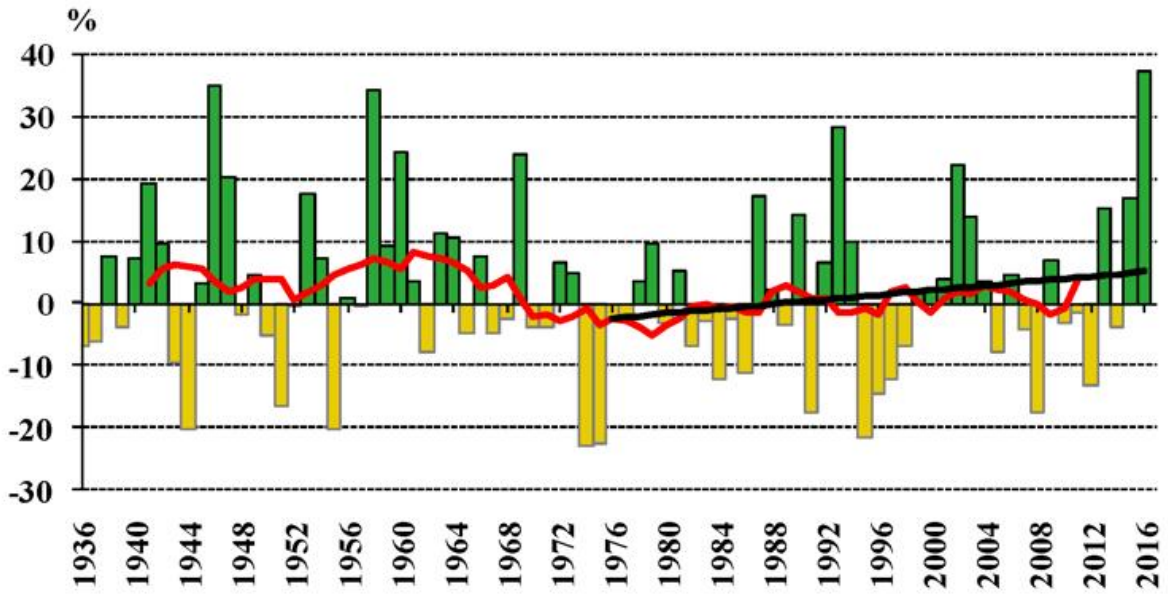


Figure 5.58: Time series of annual precipitation anomalies 1936-2016 across Kazakhstan with 11-year running mean in relation to the mean of 1961-1990 (diagram as provided by the NHMS)

5.3. Sunshine duration

Central and Western Europe - sunshine duration anomalies

Germany, Switzerland, United Kingdom

Germany

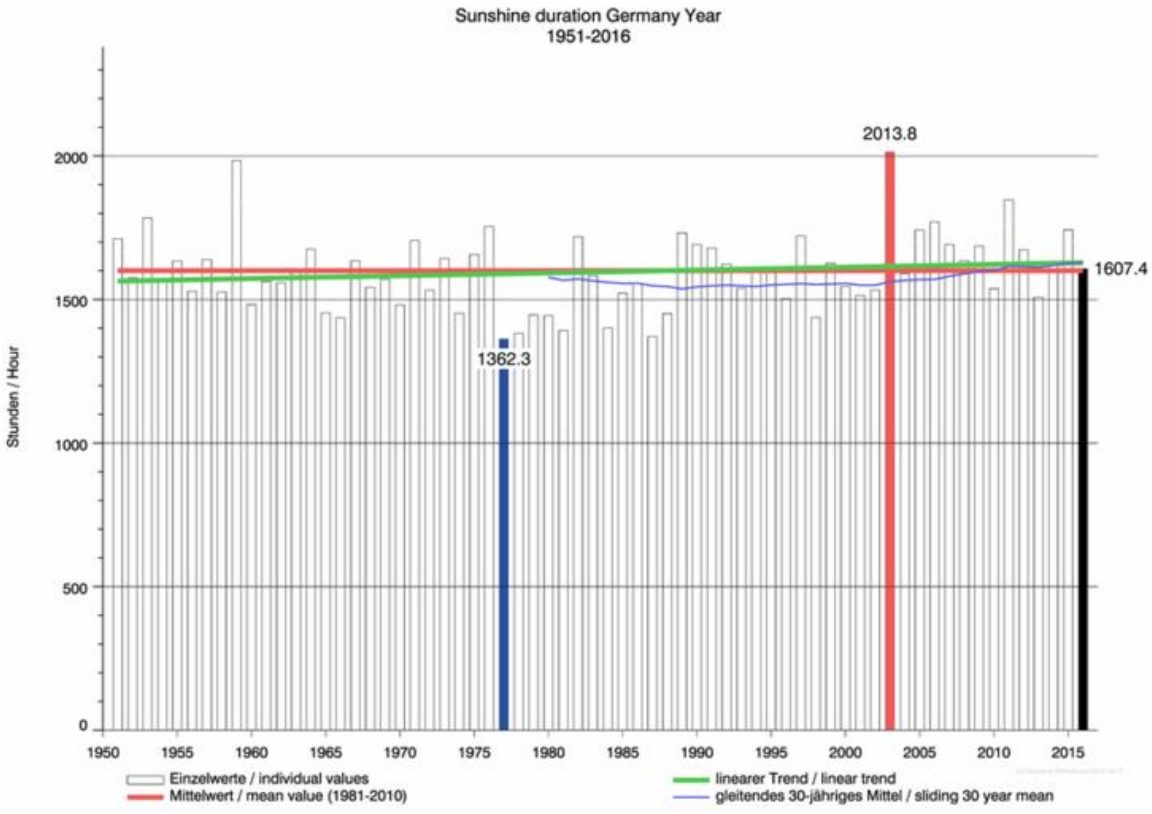


Figure 5.59: Time series of annual sum of the sunshine duration in hours for Germany (Diagram as provided by the NHMS)

Switzerland

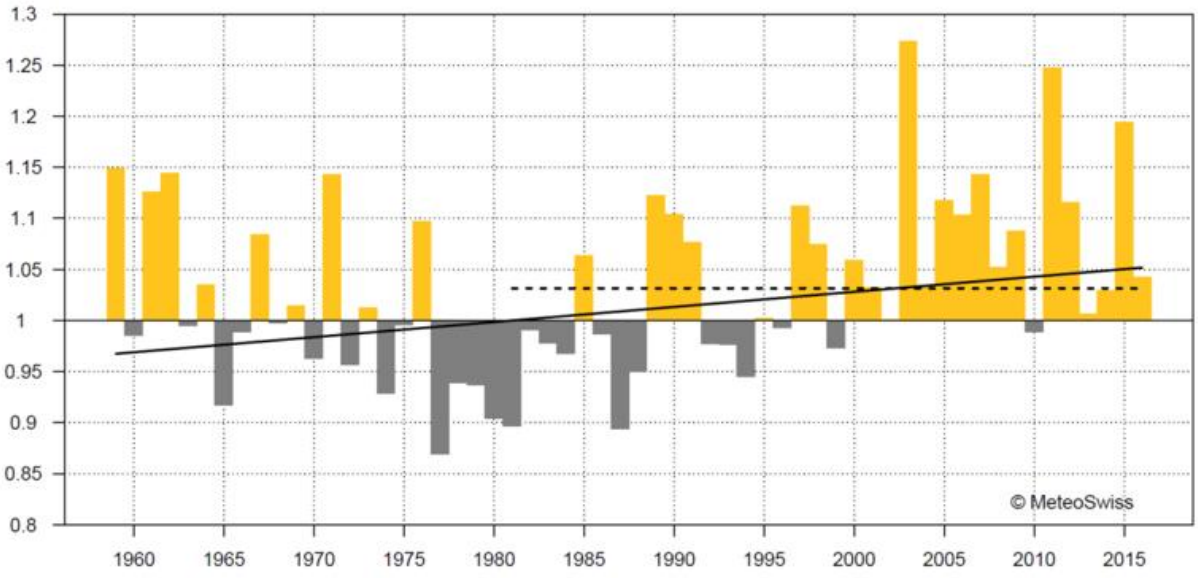


Figure 5.60: Time series of the yearly sunshine duration [ratio] for Switzerland 1959–2016. Color bars represent anomalies in respect to the long-term mean 1961–1990 and yellow indicates positive and grey negative anomalies. The black line represents the linear significant trend (1.48 %/10y). The black dashed line represents the mean 1981–2010 (diagram as provided by MeteoSwiss).

Central and Western Europe - sunshine duration anomalies

United Kingdom

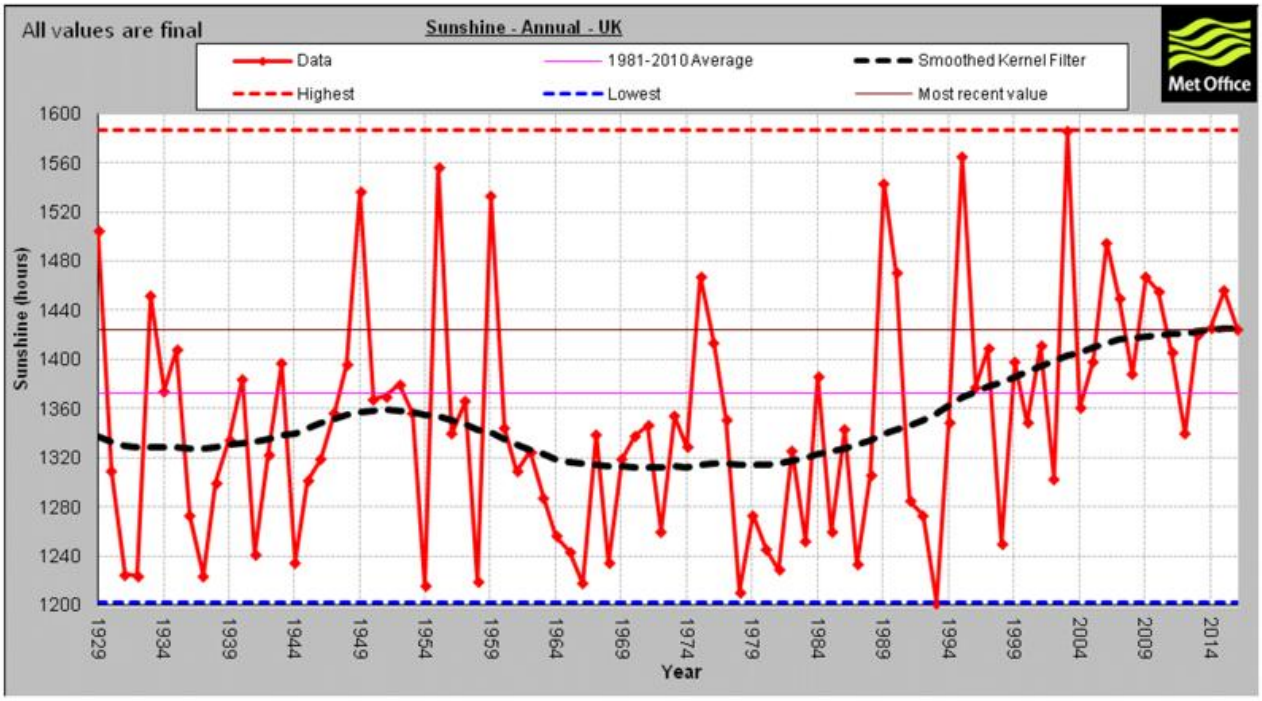


Figure 5.61: Time series of annual sum of the sunshine duration in hours for United Kingdom (Diagram as provided by the NHMS)

Nordic and Baltic Countries - sunshine duration

Denmark

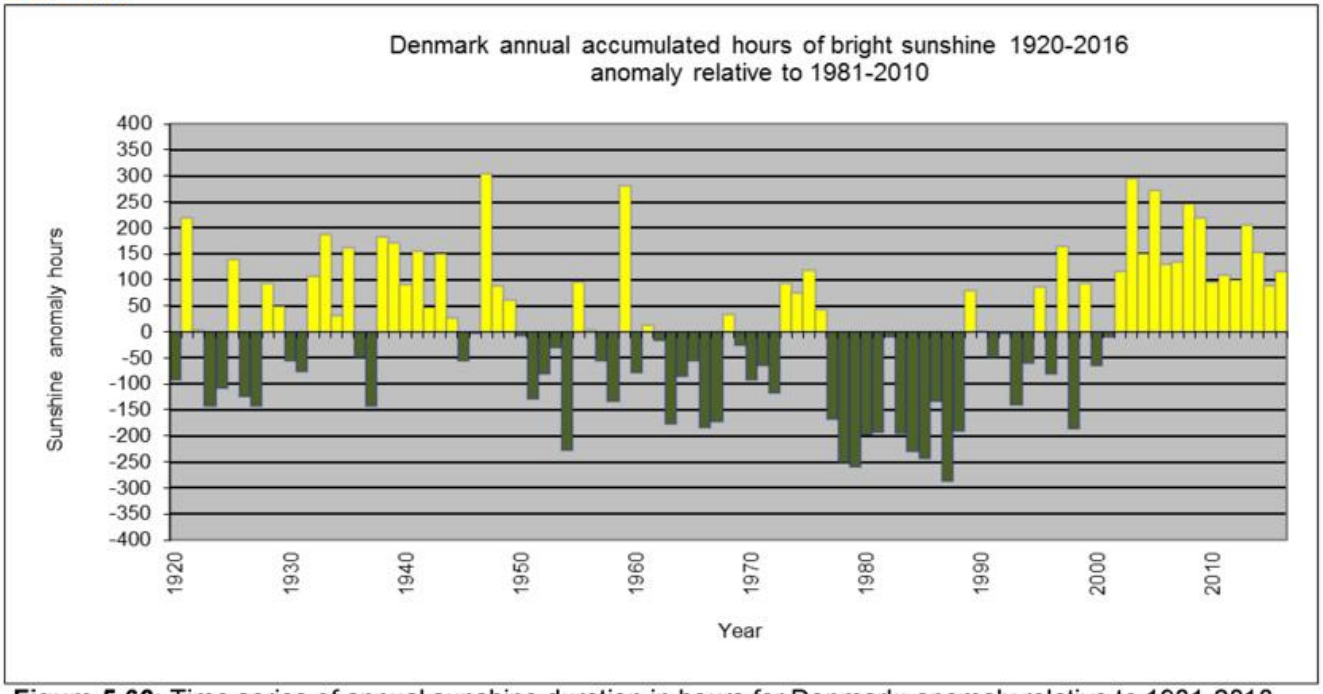


Figure 5.62: Time series of annual sunshine duration in hours for Denmark: anomaly relative to 1981-2010. The values are calculated national average based on a number of selected stations. (Diagram as provided by the NHMS)

Note: *OBS! DMI has since 2002 observed the hours of bright sunshine using measurements of global radiation instead of measurements from a traditional Campbell-Stokes sunshine recorder. For that reason "new" and "old" hours of bright sunshine cannot directly be compared. I should also be noted that all values before 2002 are adjusted ensuring comparability to the new level. For details on that, see DMI Technical 02-25: Ellen Vaarby Laursen, Stig Rosenørn: New hours of bright sunshine normals for Denmark, 1961-1990.*
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2002/tr02-25.pdf
Data up to 2015 are published in DMI report series, No. 16-02 John Cappelen (ed)(2016): Denmark - DMI Historical Climate Data Collection 1768-2015.
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2016/DMIRep16-02.pdf (report)
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2016/DMIRep16_02.zip (data)

Estonia

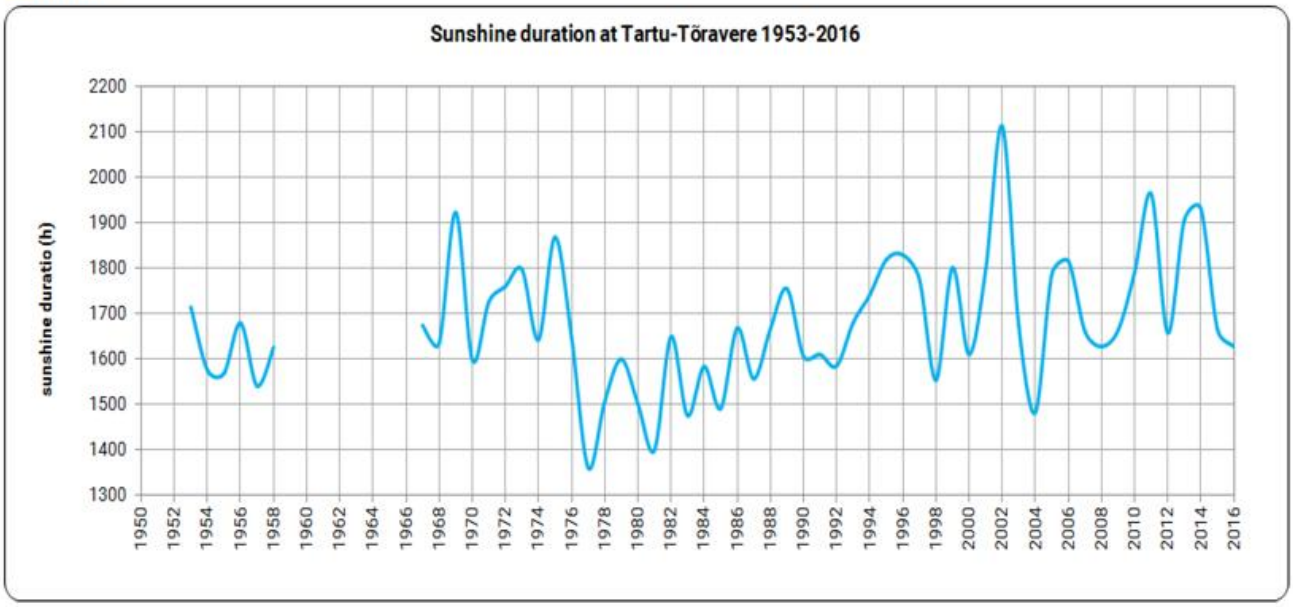


Figure 5.63: Time series of annual sunshine duration in hours for Estonia (station Tartu-Töravere, diagram as provided by the NHMS)

5.4. Other climate related variables

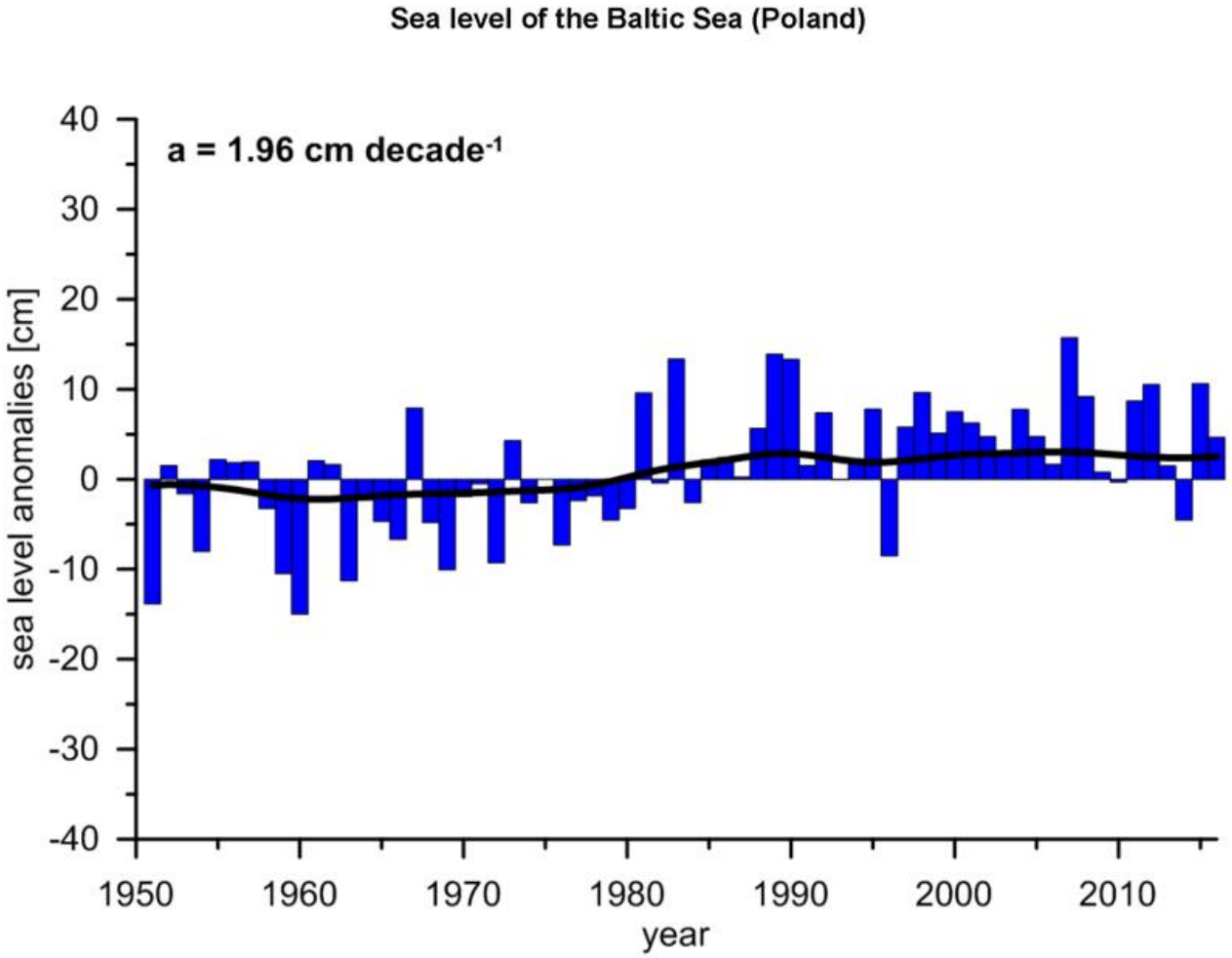


Figure 5.64: Mean annual sea level anomalies of the Baltic Sea in Władysławowo (1951-2016) in relation to the reference 1971-2000, smoothed by 10-years Gaussian filter (black line) and the value of the linear trend (cm/10years, diagram as provided by the NHMS).

6. Annex: Monthly and annual tables

Table 6.1: Statistical values of **annual** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

WMO-No.	Station name	Country	Temperature (°C)		Precipitation (mm)	
			mean	dev.	total	dev.
1001	Jan Mayen	NOR	2.2	3.6	638	-55
1025	Tromsoe	NOR	4.1	1.3	992	19
1028	Bjornoya Island	NOR	1.8	4.1	398	19
1492	Oslo	NOR	7.3	1.5	724	-45
2196	Haparanda	SWE	3.0	1.8	759	207
2485	Stockholm	SWE	8.2	1.6	472	-67
2836	Sodankylä	FIN	1.5	2.5	637	137
2974	Helsinki Airp.	FIN	6.1	1.6	749	98
3091	Aberdeen	GBR	8.9	1.0	906	123
3772	London	GBR	12.0	1.4	592	-7
3967	Dublin/Casement	IRL	9.7	0.5	727	16
4030	Reykjavik	ISL	6.0	1.7	934	136
4224	Aasiaat (Egedesminde)	GRL	-2.0	2.9	297	23
4360	Tasiilaq	GRL	1.7	3.4	811	-121
6186	Copenhagen	DNK	10.0	1.3	616	-20
6260	De Bilt	NLD	10.7	1.3	839	34
6447	Brussels (Uccle)	BEL	10.6	0.7	943	125
6590	Luxembourg	LUX	9.8	1.5	865	-10
6660	Zurich	CHE	9.9	1.4	1298	212
6700	Geneva (Genf)	CHE	11.1	1.4	888	-67
7510	Bordeaux	FRA	14.0	1.2	924	1
7650	Marseille	FRA	16.1	1.4	333	-212
8001	La Coruna	ESP	15.0	0.9	1235	240
8222	Madrid Retiro	ESP	16.0	1.7	485	29
8314	Menorca	ESP	17.9	1.3	350	-249
8495	Gibraltar	GIB	19.1	0.9	790	15
8515	Santa Maria/Azores	PRT	18.1	0.6	696	-79
8535	Lisbon	PRT	17.5	0.7	800	47
10384	Berlin-Tempelhof	DEU	10.8	1.4	477	-107
11035	Wien/Hohe Warte	AUT	11.5	1.8	740	133
11518	Prague	CZE	9.4	1.5	475	-51
11903	Sliac	SVK	9.5	1.5	815	129
12160	Elblag	POL	8.1	0.5	859	169
12375	Warsaw	POL	9.8	2.0	595	76
12843	Budapest	HUN	11.6	1.2	687	169
13274	Beograd	SRB	13.5	1.6	760	76
14015	Ljubljana	SVN	11.7	1.9	1317	-78
14445	Split	HRV	17.1	1.3	721	-105
14654	Sarajevo	BIH	10.9	1.3	1008	76
15420	Bucharest	ROU	11.5	0.9	715	120
15614	Sofia	BGR	11.4	1.7	664	101
16158	Pisa	ITA	15.4	1.4	953	49
16597	Luqa	MLT	20.1	1.5	325	-229
16716	Athens	GRC	19.8	1.3	340	-32
16754	Iraklion	GRC	19.9	1.2	405	-97
22113	Murmansk	RUS	2.5	2.6	659	181
26038	Tallinn	EST	6.6	1.5	772	105
26406	Liepaja	LVA	8.2	1.5	782	92
26629	Kaunas	LTU	7.7	1.4	845	215
26730	Vilnius	LTU	7.4	1.3	685	2
26850	Minsk	BLR	7.8	2.0	758	81
27612	Moscow	RUS	6.7	1.7	882	194
33345	Kiev	UKR	9.5	1.8	654	5
33815	Kisinev	MDA	11.2	1.6	649	102
34300	Kharkiv	UKR	8.9	1.4	746	227
34880	Astrachan	RUS	11.4	1.5	375	155
37789	Yerevan	ARM	12.7	1.3	366	89
17030	Samsun	TUR	15.7	1.4	962	271
17062	Istanbul-Kartal	TUR	16.4	2.3	873	176
17130	Ankara	TUR	13.1	1.4	494	87
17170	Van	TUR	10.1	1.5	565	187
17300	Antalya	TUR	19.8	1.4	592	-475
17609	Larnaka	CYP	20.6	1.5	224	-106
35108	Uralsk	KAZ	7.3	1.8	409	85
37545	Tbilisi	GEO	14.0	1.0	429	-69
40103	Tripoli	LBN	20.4	1.1	630	-250
40180	Tel Aviv	ISR	21.6	2.1	549	-18
40199	Elat	ISR	26.5	1.7	43	11
40265	Mafraq	JOR	18.3	1.8	146	-13
60030	Las Palmas/Gran Canaria	ESP	22.0	1.5	140	23

Table 6.2: Statistical values of **monthly** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

Station name	Country	Januar				Februar				March			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	-1.3	4.4	57	-3	-2.8	3.3	28	-28	-2.3	3.8	36	-20
Tromsoe	NOR	-4.6	-0.6	76	-5	-1.9	1.8	67	-19	-0.1	2.1	60	-4
Bjornoya Island	NOR	-2.1	6.0	15	-15	-2.1	5.5	29	-5	-2.3	5.3	45	16
Oslo	NOR	-5.5	-1.2	37	-12	-0.7	3.3	50	14	3.1	3.3	47	1
Haparanda	SWE	-13.6	-1.5	29	-15	-5.7	5.6	87	55	-2.5	4.3	9	-26
Stockholm	SWE	-4.2	-1.4	25	-14	0.5	3.5	23	-4	3.2	3.1	13	-13
Sodankylä	FIN	-18.1	-3.0	29	-2	-6.3	7.3	65	40	-4.0	4.5	8	-17
Helsinki Airp.	FIN	-10.3	-3.4	44	3	-0.6	6.2	96	65	0.0	2.9	11	-23
Aberdeen	GBR	3.9	1.2	219	138	3.4	0.5	38	-13	5.9	1.4	50	-8
London	GBR	6.5	2.3	75	23	6.3	1.8	44	9	7.1	0.6	73	26
Dublin/Casement	IRL	5.9	1.0	83	14	4.4	-0.2	63	12	5.9	-0.1	39	-15
Reykjavik	ISL	0.2	0.7	62	-14	-0.5	-0.9	65	-7	2.7	2.2	85	3
Aasiaat (Egedesminde)	GRL	-9.0	4.3	40	25	-10.5	5.0	19	4	-7.9	8.4	32	14
Tasiilaq	GRL	-2.5	5.0	64	-48	-4.3	3.4	45	-46	-3.0	5.2	83	-5
Copenhagen	DNK	0.7	0.2	36	-15	3.0	2.5	44	13	4.5	1.9	50	8
De Bilt	NLD	4.8	2.6	116	50	4.6	2.1	82	33	5.4	0.4	55	-8
Brussels (Uccle)	BEL	4.8	2.2	135	68	4.5	1.0	113	60	5.3	-0.2	82	10
Luxembourg	LUX	2.3	2.3	85	14	3.3	2.2	78	16	4.1	0.1	58	-12
Zurich	CHE	2.8	3.3	146	79	3.9	3.0	92	22	4.7	0.5	42	-27
Geneva (Genf)	CHE	4.2	3.4	166	86	5.0	2.7	82	1	5.7	0.6	39	-40
Bordeaux	FRA	8.8	3.0	234	134	8.4	1.3	152	66	9.4	0.6	110	34
Marseille	FRA	9.1	2.4	9	-38	9.8	1.9	58	4	10.7	0.5	39	-5
La Coruna	ESP	12.0	1.8	292	161	11.0	0.5	202	98	11.0	-0.3	197	111
Madrid Retiro	ESP	8.4	2.3	34	-12	8.4	0.9	39	-5	9.6	-0.4	43	10
Menorca	ESP	12.6	2.1	7	-59	12.0	1.3	41	-16	11.9	0.3	48	-7
Gibraltar	GIB	15.3	1.9	115	-6	14.7	0.9	43	-57	14.4	-0.6	18	-57
Santa Maria/Azores	PRT	15.7	1.3	125	25	15.1	1.1	3	-83	15.3	0.7	44	-35
Lisbon	PRT	13.5	2.1	120	10	12.6	0.3	95	-16	12.8	-0.9	45	-24
Berlin-Tempelhof	DEU	0.1	0.3	41	-2	4.2	3.4	45	11	5.2	1.0	23	-14
Wien/Hohe Warte	AUT	0.8	1.8	43	5	6.4	5.4	71	29	6.5	1.5	22	-19
Prague	CZE	-0.5	1.9	25	2	3.3	4.1	31	8	3.8	0.8	20	-8
Sliac	SVK	-3.7	0.2	48	4	3.9	5.0	130	86	5.3	2.3	25	-17
Elblag	POL	-4.2	-1.8	44	-3	1.8	4.0	55	30	2.7	0.6	38	3
Warsaw	POL	-2.9	0.4	21	-1	3.6	5.6	67	46	4.2	2.2	33	5
Budapest	HUN	-1.0	0.6	62	30	5.8	4.7	107	75	7.3	1.7	34	5
Beograd	SRB	2.4	2.0	46	-3	9.0	6.3	38	-6	9.0	1.8	103	53
Ljubljana	SVN	1.1	2.2	76	-6	5.5	4.1	201	121	6.7	1.3	79	-19
Split	HRV	8.6	1.2	104	21	11.5	3.4	113	45	11.6	1.2	60	-15
Sarajevo	BIH	1.0	1.9	47	-24	7.4	5.9	87	20	6.0	0.9	132	62
Bucharest	ROU	-3.8	-1.4	69	29	5.6	5.7	20	-16	7.4	2.6	68	30
Sofia	BGR	-0.9	0.7	90	63	7.2	6.7	45	12	6.9	2.3	73	35
Pisa	ITA	7.9	1.8	135	60	9.7	2.6	191	118	10.6	1.1	46	-30
Luqa	MLT	13.6	1.4	28	-61	15.3	2.9	3	-58	15.0	1.6	23	-18
Athens	GRC	10.8	0.6	22	-23	14.5	4.0	19	-29	14.1	1.7	81	37
Iraklion	GRC	12.8	0.8	56	-36	15.6	3.4	36	-41	15.2	1.6	23	-34
Murmansk	RUS	-16.5	-4.8	47	14	-5.0	6.2	45	23	-2.3	4.5	43	23
Tallinn	EST	-7.2	-1.7	81	36	0.6	6.3	85	56	0.5	2.7	14	-15
Liepaja	LVA	-4.4	-1.4	80	34	2.7	5.7	60	29	2.3	2.5	14	-22
Kaunas	LTU	-6.9	-1.7	42	3	1.6	5.9	68	37	2.1	2.5	47	12
Vilnius	LTU	-7.6	-1.5	36	-5	1.0	5.8	68	30	1.4	2.0	58	19
Minsk	BLR	-7.4	-0.5	52	12	1.0	6.8	51	17	1.5	2.9	34	-8
Moscow	RUS	-10.1	-0.8	77	32	-0.6	7.1	64	27	0.3	2.5	50	16
Kiev	UKR	-5.7	-0.1	59	12	2.0	6.2	60	14	3.9	3.2	34	-5
Kisinev	MDA	-3.3	0.0	47	7	4.7	6.4	20	-18	6.3	3.4	41	6
Kharkiv	UKR	-7.2	-0.3	76	32	1.0	6.7	26	-6	3.5	3.8	42	15
Astrachan	RUS	-3.5	1.9	27	14	1.7	6.6	23	13	5.0	3.7	27	13
Yerevan	ARM	-1.1	2.1	61	40	4.3	5.3	38	14	8.6	3.5	19	-13
Samsun	TUR	7.6	0.7	88	27	11.2	4.0	31	-19	10.4	2.4	110	54
Istanbul-Kartal	TUR	6.8	1.2	147	48	10.8	4.9	97	30	11.1	3.6	75	13
Ankara	TUR	0.4	0.4	92	51	7.3	5.6	40	4	8.0	2.0	86	50
Van	TUR	-3.1	1.3	118	84	1.0	4.8	11	-22	4.2	3.3	61	19
Antalya	TUR	9.5	-0.4	154	-85	14.6	4.3	67	-129	15.3	2.6	93	-10
Larnaka	CYP	11.2	-0.6	52	-13	14.5	2.3	14	-43	15.8	2.3	14	-35
Uralsk	KAZ	-10.9	2.0	45	20	-2.9	9.6	32	14	0.4	5.4	21	1
Tbilisi	GEO	3.1	1.4	14	-5	6.8	3.9	8	-18	9.6	2.7	43	13
Tripoli	LBN	11.7	-1.0	222	28	14.8	1.6	85	-42	16.4	1.7	64	-52
Tel Aviv	ISR	12.2	-0.1	118	-31	15.5	2.6	114	16	18.0	3.1	20	-42
Elat	ISR	15.6	0.4	<1	-5	19.7	2.8	<1	-5	22.5	2.5	4	0
Mafraq	JOR	7.7	0.5	38	4	11.6	2.9	8	-23	14.1	2.6	8	-21
Las Palmas/Gran Canaria	ESP	20.0	2.5	5	-12	18.9	1.3	47	25	18.6	0.2	9	-1

Table 6.2: continued

Station name	Country	April				Mai				June			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	-1.5	2.4	16	-25	1.8	2.5	40	0	4.4	2.6	20	-16
Tromsoe	NOR	2.8	2.1	19	-41	7.6	2.7	52	4	8.5	-0.8	53	0
Bäreninsel	NOR	-1.9	3.5	14	-8	2.8	4.2	51	33	4.3	2.4	8	-16
Oslo	NOR	5.9	1.3	98	56	12.3	1.5	52	0	16.7	1.5	67	2
Haparanda	SWE	1.8	2.3	64	35	9.0	2.9	38	7	12.6	-0.2	93	52
Stockholm	SWE	6.2	1.6	43	13	13.1	2.4	14	-16	16.5	0.9	71	26
Sodankylä	FIN	1.1	3.2	40	16	9.0	4.0	35	0	12.0	0.4	113	57
Helsinki Airp.	FIN	4.8	1.9	79	42	14.3	4.4	18	-17	15.6	0.7	118	74
Aberdeen	GBR	6.0	-0.3	97	44	10.8	1.8	15	-44	12.5	0.4	126	73
London	GBR	9.2	0.3	47	2	14.4	1.9	60	9	16.7	1.0	93	42
Dublin/Casement	IRL	6.6	-0.9	60	10	11.4	1.3	63	6	14.2	1.1	111	58
Reykjavik	ISL	4.3	1.4	30	-28	6.6	0.3	28	-16	10.9	1.9	51	1
Aasiaat	GRL	-2.2	7.4	31	13	0.3	2.1	29	14	4.3	1.6	12	-7
Tasiilaq	GRL	0.6	4.7	20	-53	1.8	1.2	27	-30	6.8	2.7	54	2
Kopenhagen	DNK	7.6	1.0	40	-2	14.7	2.7	25	-18	17.6	1.5	76	22
De Bilt	NLD	8.7	0.7	83	31	14.5	2.2	46	-15	16.8	1.6	155	87
Brüssel	BEL	8.5	-0.3	66	9	14.2	1.3	78	7	16.0	0.3	175	96
Luxemburg	LUX	7.7	0.2	75	14	13.4	1.6	120	39	16.4	1.5	135	53
Zürich	CHE	8.9	1.1	126	39	12.8	0.7	172	69	16.4	1.2	229	105
Genf	CHE	10.0	1.2	94	29	13.3	0.3	77	0	17.7	1.2	133	44
Bordeaux	FRA	11.7	0.4	60	-12	16.0	1.4	93	16	18.8	1.0	75	19
Marseille	FRA	14.6	1.4	13	-35	17.7	0.6	31	-11	22.5	1.6	1	-27
La Coruna	ESP	12.0	-0.1	122	39	15.2	1.1	90	12	17.5	1.1	54	5
Madrid Retiro	ESP	12.3	0.1	93	39	16.4	0.4	55	14	23.8	3.1	1	-25
Menorca	ESP	14.9	1.6	29	-21	17.9	1.1	14	-23	22.6	1.8	3	-11
Gibraltar	GIB	17.3	1.1	37	-23	19.2	0.7	70	35	22.3	1.2	0	-11
Santa Maria/Azoren	PRT	15.6	0.4	119	64	17.4	0.7	35	5	19.3	0.6	33	11
Lissabon	PRT	14.6	-0.5	111	47	17.2	-0.2	117	78	21.6	1.4	1	-20
Berlin-Tempelhof	DEU	9.4	0.8	33	-8	16.2	2.3	43	-13	19.7	2.3	56	-19
Wien	AUT	11.0	1.1	46	-5	15.6	1.0	134	73	20.4	2.5	79	5
Prag	CZE	8.1	0.4	23	-15	13.8	1.1	55	-22	17.6	1.7	74	1
Sliac	SVK	10.6	2.1	35	-12	14.7	1.0	62	-2	19.1	2.5	89	4
Elbing	POL	7.5	0.7	36	-6	14.3	1.4	62	21	16.7	1.3	91	-3
Warschau	POL	9.7	1.9	31	-1	16.1	2.7	28	-31	19.5	2.9	58	-14
Budapest	HUN	13.0	1.9	12	-26	16.4	0.4	70	15	21.2	2.1	59	-4
Belgrad	SRB	15.5	3.1	54	-5	17.4	0.2	71	0	22.4	2.3	152	62
Ljubljana	SVN	12.5	2.6	93	-17	15.3	0.7	157	36	20.0	2.2	175	20
Split	HRV	16.6	2.7	23	-43	18.7	0.3	71	15	24.1	1.9	33	-18
Sarajevo	BIH	13.0	3.6	60	-14	13.8	-0.3	82	0	19.4	2.5	96	5
Bukarest	ROU	13.3	2.0	65	19	15.6	-1.1	94	24	22.0	1.8	88	11
Sofia	BGR	13.9	4.0	57	7	14.2	-0.1	106	33	20.6	2.9	78	6
Pisa	ITA	14.4	1.9	45	-34	16.7	0.4	60	1	20.5	0.7	109	65
Luqa	MLT	18.4	2.9	3	-20	20.1	1.0	12	5	24.2	1.2	33	30
Athen	GRC	19.6	3.6	0	-25	21.3	0.7	9	-5	27.7	2.7	22	16
Heraklion	GRC	19.2	2.6	<1	-30	21.2	0.9	13	-2	25.6	1.3	4	1
Murmansk	RUS	1.8	3.7	33	12	8.9	5.1	35	3	10.6	1.2	82	29
Tallinn	EST	5.3	1.9	62	26	12.6	2.9	11	-26	15.2	0.7	117	64
Liepaja	LVA	6.5	1.9	41	6	13.7	3.4	61	21	15.8	1.5	58	12
Kaunas	LTU	7.4	1.6	40	-2	15.3	2.9	36	-19	17.2	1.4	84	15
Vilnius	LTU	7.1	1.4	41	-5	14.8	2.3	32	-30	17.9	2.1	29	-48
Minsk	BLR	8.3	2.3	56	14	15.4	2.5	55	-7	18.8	2.7	54	-29
Moskau	RUS	8.1	2.3	34	-6	15.0	2.1	63	5	18.2	1.6	62	-14
Kiew	UKR	12.4	3.7	68	19	15.5	0.4	143	90	20.6	2.4	15	-58
Kischinau	MDA	13.1	2.9	40	-2	15.8	-0.3	99	48	21.3	1.9	159	84
Charkiw	UKR	12.1	3.2	52	16	15.6	0.0	146	99	20.2	1.3	54	-4
Astrachan	RUS	13.4	2.3	12	-6	18.9	0.6	113	89	24.0	1.1	70	48
Jerewan	ARM	14.0	2.4	16	-21	17.9	1.6	31	-12	22.1	1.5	35	14
Samsun	TUR	13.9	2.5	51	-11	16.8	1.3	188	139	22.2	2.2	63	18
Istanbul-Kartal	TUR	16.5	4.5	28	-21	18.5	2.0	46	15	24.1	3.0	31	10
Ankara	TUR	14.3	3.1	20	-28	15.2	-0.4	61	6	22.0	2.4	21	-16
Van	TUR	9.1	1.8	34	-20	14.1	1.3	68	18	18.5	0.9	41	20
Antalya	TUR	19.1	3.0	15	-31	20.4	0.1	26	-2	26.9	1.9	23	15
Larnaka	CYP	19.9	3.0	3	-8	21.8	1.4	<1	-7	26.8	2.8	0	-1
Oral	KAZ	10.7	3.0	40	21	16.3	0.2	69	48	20.6	0.4	17	-20
Tiflis	GEO	14.3	1.5	35	-16	17.9	0.5	62	-16	22.4	1.2	72	-4
Tripoli	LBN	19.1	1.6	10	-46	21.7	1.8	30	13	25.5	2.2	0	-1
Tel Aviv	ISR	21.8	3.6	19	-4	23.2	2.1	3	0	27.1	3.1	0	0
Eilat	ISR	27.8	3.6	1	-3	29.5	1.1	0	-1	34.7	3.0	0	0
Mafraq	JOR	19.6	3.8	13	3	20.7	0.9	0	-3	26.0	3.3	0	0
L.Palmas/Gran Can.	ESP	19.8	1.1	<1	-6	21.4	1.5	2	0	24.0	2.6	<1	<1

Table 6.2: continued

Station name	Country	July				August				September			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	6.6	2.4	21	-26	6.8	1.8	56	-5	6.7	3.8	123	41
Tromsoe	NOR	12.1	0.4	100	28	10.4	-0.5	72	-10	9.3	2.5	100	6
Bjornoya Island	NOR	5.8	1.3	35	5	6.2	1.7	32	-7	5.9	3.2	29	-15
Oslo	NOR	17.2	0.8	80	-4	15.5	0.3	144	54	15.0	4.2	41	-49
Haparanda	SWE	17.1	1.6	114	64	13.4	0.1	139	76	9.9	2.0	43	-20
Stockholm	SWE	19.0	1.8	48	-24	16.9	0.7	51	-15	15.3	4.1	23	-32
Sodankylä	FIN	16.8	2.7	111	46	12.2	1.0	68	5	8.5	2.6	76	21
Helsinki Airp.	FIN	17.7	1.1	118	45	16.0	1.0	103	23	12.7	2.7	55	-18
Aberdeen	GBR	14.9	1.1	89	29	14.8	1.2	64	-11	14.2	2.5	25	-43
London	GBR	19.2	1.4	16	-30	19.7	2.3	22	-29	18.0	3.0	42	-9
Dublin/Casement	IRL	15.7	0.5	37	-12	15.6	0.8	64	0	14.3	1.7	75	16
Reykjavik	ISL	12.5	1.9	40	-12	11.8	1.5	33	-29	8.7	1.3	59	-8
Aasiaat (Egedesminde)	GRL	7.2	1.5	4	-19	6.7	1.4	20	-14	2.7	0.3	19	-15
Tasiilaq	GRL	9.1	2.7	0	-49	8.6	2.6	26	-35	5.3	2.2	16	-52
Copenhagen	DNK	18.0	0.8	106	37	17.3	0.3	34	-29	17.1	3.5	27	-35
De Bilt	NLD	18.4	1.6	73	-2	17.9	1.2	72	1	17.3	3.3	18	-49
Brussels (Uccle)	BEL	18.3	0.8	55	-20	18.1	0.8	54	-9	17.5	3.0	18	-41
Luxembourg	LUX	18.7	1.8	144	76	18.8	2.4	21	-51	17.4	4.0	29	-41
Zurich	CHE	19.4	1.8	198	81	19.0	2.3	72	-61	16.8	3.0	53	-39
Geneva (Genf)	CHE	20.8	1.7	63	-4	20.4	2.2	21	-58	18.0	3.1	33	-48
Bordeaux	FRA	21.2	1.0	13	-34	22.3	2.4	11	-43	20.2	2.3	65	-9
Marseille	FRA	25.4	1.6	3	-11	24.7	1.5	6	-23	22.5	2.2	10	-37
La Coruna	ESP	19.8	1.4	1	-24	20.1	1.3	10	-19	18.6	0.5	84	22
Madrid Retiro	ESP	28.1	3.7	11	-2	27.5	3.6	0	-9	23.0	2.5	8	-22
Menorca	ESP	25.5	1.3	0	-4	25.0	0.5	<1	-26	23.4	1.2	43	-11
Gibraltar	GIB	25.3	1.6	1	0	25.4	1.2	0	-6	23.4	0.6	3	-12
Santa Maria/Azores	PRT	22.0	1.2	23	-2	23.0	0.8	28	-12	22.3	0.9	17	-40
Lisbon	PRT	24.3	1.9	1	-4	24.7	1.9	0	-6	22.6	0.9	18	-8
Berlin-Tempelhof	DEU	20.6	1.8	63	11	19.1	0.7	36	-25	18.6	4.0	13	-33
Wien/Hohe Warte	AUT	22.2	2.5	85	22	20.3	1.4	59	1	18.3	3.2	24	-21
Prague	CZE	19.3	1.8	53	-13	18.2	1.2	47	-23	17.3	4.0	31	-9
Sliac	SVK	20.4	2.2	108	49	18.3	1.0	97	28	15.7	2.3	43	-13
Elblag	POL	17.4	0.6	109	15	16.6	-0.1	95	14	14.7	2.0	58	-12
Warsaw	POL	20.0	2.1	71	4	18.8	1.5	61	-2	16.4	3.2	11	-32
Budapest	HUN	22.6	1.7	167	115	20.8	0.5	51	0	18.7	2.3	41	1
Beograd	SRB	24.1	2.4	35	-31	22.2	0.9	61	9	19.8	2.1	48	-3
Ljubljana	SVN	23.2	3.3	86	-36	20.6	1.5	90	-55	18.3	2.8	47	-83
Split	HRV	27.7	2.3	5	-23	25.7	0.5	17	-33	22.4	1.0	56	-5
Sarajevo	BIH	21.0	2.1	104	24	18.5	0.0	106	35	15.5	0.4	71	1
Bucharest	ROU	23.7	1.7	5	-59	22.6	1.4	70	12	17.7	0.8	73	31
Sofia	BGR	22.3	2.3	45	-11	20.9	1.5	39	-13	17.1	1.3	15	-24
Pisa	ITA	24.0	1.2	2	-21	24.0	1.5	23	-34	21.3	1.8	123	34
Luqa	MLT	26.6	0.7	<1	<1	26.6	0.3	12	5	24.9	0.8	26	-14
Athens	GRC	29.8	2.0	<1	-6	29.3	1.7	0	-8	24.8	0.5	30	20
Iraklion	GRC	27.3	1.2	0	-1	27.0	1.1	0	-1	24.7	1.2	20	0
Murmansk	RUS	16.0	3.2	80	20	12.5	1.5	80	15	8.6	1.9	59	7
Tallinn	EST	17.4	1.1	54	-25	15.9	0.6	179	95	12.8	2.0	32	-50
Liepaja	LVA	18.1	1.7	117	43	16.9	0.5	132	52	14.5	1.6	30	-48
Kaunas	LTU	18.0	1.1	164	84	16.9	0.5	115	37	13.5	1.6	23	-33
Vilnius	LTU	18.2	1.3	88	10	17.2	0.9	63	-9	13.2	1.6	36	-29
Minsk	BLR	19.5	2.2	136	48	18.8	2.3	47	-25	13.9	2.2	36	-24
Moscow	RUS	20.9	2.8	121	29	19.5	3.1	167	93	11.4	0.5	58	-6
Kiev	UKR	22.4	3.1	46	-42	21.1	2.5	27	-42	16.1	2.2	5	-42
Kisinev	MDA	23.4	2.5	7	-62	23.1	2.6	31	-14	19.2	3.0	18	-30
Kharkiv	UKR	22.7	2.4	91	31	22.3	2.8	63	13	14.0	-0.1	14	-27
Astrachan	RUS	26.5	1.2	36	13	27.4	4.1	5	-14	17.2	-0.1	11	-15
Yerevan	ARM	25.3	0.7	19	9	27.3	3.4	2	-5	19.9	0.1	21	11
Samsun	TUR	24.6	1.9	38	9	25.9	3.2	12	-21	21.2	1.6	56	6
Istanbul-Kartal	TUR	25.7	2.5	13	-6	26.3	3.3	33	7	22.0	2.3	15	-26
Ankara	TUR	25.0	2.1	0	-14	25.3	2.7	65	53	19.1	0.8	25	6
Van	TUR	22.8	0.9	2	-2	23.1	1.9	0	-4	17.4	0.6	37	27
Antalya	TUR	29.9	1.8	<1	-3	29.1	1.4	0	-1	26.4	1.9	32	21
Larnaka	CYP	28.6	2.0	0	0	28.6	2.0	0	0	26.3	1.7	0	0
Uralsk	KAZ	23.3	0.8	43	5	25.9	5.5	3	-22	13.6	-0.5	50	23
Tbilisi	GEO	25.0	0.6	18	-27	27.5	3.8	8	-40	20.1	0.5	65	29
Tripoli	LBN	27.6	2.6	0	0	28.5	2.9	0	-1	26.2	1.4	7	3
Tel Aviv	ISR	28.0	2.3	0	0	28.4	2.3	0	0	26.8	2.0	0	0
Elat	ISR	34.7	1.8	0	0	34.4	1.6	0	0	31.9	1.5	0	0
Mafraq	JOR	26.1	2.0	0	0	26.9	2.7	0	0	23.5	0.8	0	-1
Las Palmas/Gran Canaria	ESP	26.0	2.7	0	0	26.8	2.7	<1	<1	24.3	0.5	5	-3

Table 6.2: continued

Station name	Country	October				November				December			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	5.9	5.8	75	-8	2.1	5.3	103	37	-0.5	4.7	63	-2
Tromsoe	NOR	4.5	1.6	83	-42	0.1	0.9	45	-59	0.8	3.8	265	161
Bjornoya Island	NOR	5.1	5.5	30	-14	1.5	5.2	50	16	-1.3	5.8	60	29
Oslo	NOR	6.1	-0.3	22	-62	0.7	0.0	66	-9	0.9	3.7	20	-36
Haparanda	SWE	3.4	0.9	5	-59	-3.8	0.3	92	34	-6.0	3.5	46	4
Stockholm	SWE	7.2	-0.3	36	-14	2.0	-0.6	106	53	2.2	3.2	19	-27
Sodankylä	FIN	1.7	2.0	9	-42	-6.1	1.3	49	10	-9.1	4.0	34	3
Helsinki Airp.	FIN	4.6	-0.8	19	-54	-1.0	-1.1	71	-1	-1.0	3.1	17	-41
Aberdeen	GBR	9.6	-0.3	84	7	4.5	-0.5	71	-4	6.1	2.6	28	-45
London	GBR	12.3	0.6	22	-36	7.4	0.2	88	33	7.0	1.9	10	-47
Dublin/Casement	IRL	10.5	0.4	45	-22	5.4	-1.3	38	-29	6.7	1.1	49	-24
Reykjavik	ISL	7.8	3.4	207	121	3.5	2.4	127	55	3.6	3.8	147	68
Aasiaat (Egedesminde)	GRL	-1.7	0.5	15	-11	-5.2	0.7	38	5	-8.7	1.2	38	14
Tasiilaq	GRL	4.2	5.0	264	182	-2.4	2.3	101	5	-3.6	3.6	111	8
Copenhagen	DNK	9.5	-0.4	91	32	4.8	-0.7	48	-14	5.0	2.8	39	-19
De Bilt	NLD	9.9	-0.6	47	-25	5.4	-0.5	75	-6	4.7	1.5	17	-63
Brussels (Uccle)	BEL	9.7	-1.2	51	-19	6.1	0.0	93	17	4.7	1.2	23	-53
Luxembourg	LUX	8.9	-0.2	38	-37	4.9	1.1	75	-8	1.5	0.5	7	-73
Zurich	CHE	8.5	-0.8	65	-4	4.9	1.0	102	20	0.7	0.1	1	-72
Geneva (Genf)	CHE	9.9	-0.2	90	13	6.2	1.2	89	-3	1.4	-0.4	<1	-87
Bordeaux	FRA	13.3	-0.7	12	-76	9.9	0.8	86	-8	7.5	1.1	13	-86
Marseille	FRA	15.9	-0.2	57	-21	12.1	1.4	92	34	8.7	1.4	14	-42
La Coruna	ESP	16.6	0.9	45	-59	13.0	0.4	115	-1	13.0	2.1	23	-105
Madrid Retiro	ESP	17.0	2.2	75	30	9.7	0.3	96	32	8.3	1.9	30	-21
Menorca	ESP	20.3	1.8	13	-71	15.6	1.2	66	-11	13.3	1.5	85	11
Gibraltar	GIB	20.6	1.1	25	-39	16.1	0.0	180	39	15.3	1.2	298	152
Santa Maria/Azores	PRT	19.3	0.0	81	-3	16.2	-1.2	19	-83	15.9	0.5	169	74
Lisbon	PRT	18.9	0.4	54	-26	14.7	0.2	145	31	12.8	1.0	93	-15
Berlin-Tempelhof	DEU	9.1	-0.9	40	4	4.3	-0.6	38	-11	3.4	2.0	46	-7
Wien/Hohe Warte	AUT	9.8	-0.1	89	48	4.9	0.3	58	8	1.4	0.5	30	-13
Prague	CZE	8.3	0.0	72	42	3.1	0.3	20	-12	0.6	1.2	24	-2
Sliac	SVK	8.0	-0.3	100	50	3.3	0.3	68	-1	-1.9	-0.2	10	-47
Elblag	POL	6.3	-2.6	87	34	2.7	-0.6	108	52	1.2	0.9	76	24
Warsaw	POL	7.6	-0.7	110	72	3.2	0.0	41	-1	1.3	2.2	63	31
Budapest	HUN	9.6	-1.3	48	14	5.1	0.3	35	-17	-0.2	-0.6	1	-39
Beograd	SRB	11.2	-1.2	77	37	7.6	0.6	72	18	0.8	-1.5	3	-55
Ljubljana	SVN	10.2	-0.2	135	20	7.0	2.4	177	42	-0.2	-0.2	<1	-101
Split	HRV	16.4	-0.5	110	31	12.8	0.6	128	20	9.6	0.9	<1	-100
Sarajevo	BIH	9.8	-0.5	113	36	6.0	0.7	93	-1	-1.1	-1.4	17	-68
Bucharest	ROU	9.6	-1.2	128	96	5.0	-0.2	32	-17	-0.9	-1.1	3	-40
Sofia	BGR	10.3	-0.1	61	24	5.2	0.2	50	3	-0.5	-1.0	5	-34
Pisa	ITA	15.9	0.6	103	-17	12.1	1.7	109	-15	7.9	1.1	7	-78
Luqa	MLT	23.5	2.8	24	-66	18.5	1.5	99	19	14.4	0.6	61	-51
Athens	GRC	20.3	1.0	33	-15	15.8	0.4	100	49	9.0	-3.0	23	-43
Iraklion	GRC	21.5	1.6	29	-40	17.5	0.9	59	0	11.4	-2.4	164	87
Murmansk	RUS	3.5	2.5	11	-31	-3.8	1.3	31	-9	-4.9	4.4	113	75
Tallinn	EST	5.0	-1.3	45	-25	0.1	-1.1	61	-7	0.9	3.8	31	-24
Liepaja	LVA	6.3	-2.2	38	-36	3.2	-0.5	90	7	3.0	3.3	61	-6
Kaunas	LTU	5.3	-1.8	102	57	1.2	-0.6	67	14	0.4	2.9	57	10
Vilnius	LTU	5.1	-1.5	102	49	0.5	-0.7	65	8	-0.6	2.3	67	12
Minsk	BLR	4.9	-1.4	134	85	-0.2	-1.0	57	5	-1.4	2.4	46	-7
Moscow	RUS	4.4	-0.6	49	-9	-2.7	-1.6	92	34	-4.6	1.5	45	-7
Kiev	UKR	6.5	-1.6	101	66	1.2	-0.9	48	-3	-1.5	0.8	48	-4
Kisinev	MDA	7.9	-2.2	139	112	3.5	-0.9	37	-2	-0.3	0.0	11	-27
Kharkiv	UKR	6.3	-1.0	45	10	0.5	-0.8	87	43	-4.6	-1.2	50	5
Astrachan	RUS	8.3	-0.8	13	-4	2.0	-1.3	20	1	-3.8	-1.9	18	3
Yerevan	ARM	13.0	0.2	25	-2	4.9	-1.7	66	44	-3.5	-4.0	33	10
Samsun	TUR	15.8	0.2	58	-27	12.7	0.2	78	-11	6.0	-3.2	189	107
Istanbul-Kartal	TUR	16.7	1.4	36	-35	12.5	0.9	130	41	5.6	-2.5	222	100
Ankara	TUR	13.7	1.1	4	-23	6.9	-0.2	25	-8	-0.3	-2.8	55	6
Van	TUR	11.7	1.6	84	36	4.2	0.2	32	-12	-1.9	-0.8	77	43
Antalya	TUR	21.7	2.1	6	-64	15.4	0.6	99	-35	9.2	-2.2	76	-151
Larnaka	CYP	23.4	2.1	24	5	17.9	1.0	14	-30	11.8	-1.6	102	26
Uralsk	KAZ	5.1	0.0	22	-8	-3.1	-1.0	27	-8	-11.8	-3.4	40	11
Tbilisi	GEO	12.6	-0.9	53	15	6.8	-1.3	38	8	1.8	-2.0	13	-8
Tripoli	LBN	23.2	1.0	4	-67	17.9	-0.4	37	-76	12.0	-2.1	171	-9
Tel Aviv	ISR	24.5	2.5	4	-22	20.1	2.1	10	-58	13.6	-0.2	261	123
Elat	ISR	28.4	1.7	35	31	22.8	1.3	0	-3	15.8	-0.8	2	-4
Mafraq	JOR	20.8	1.7	0	-7	14.4	0.9	3	-14	8.3	-0.5	76	48
Las Palmas/Gran Canaria	ESP	23.3	0.8	41	31	21.0	0.6	12	-9	19.6	1.3	17	-4

7. References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2016 edition of the Bulletin, are listed on page 3 above. Many contributions or additional information may as well be found on the web, see below.

Austria: Zentralanstalt für Meteorologie und Geodynamik (**ZAMG**), Wien, Wetterrückblick

Belgium: The Royal Meteorological Institute of Belgium (**KMI**), Klimatologisch overzicht

Bosnia and Herzegovina: Federal Meteorological Institute (**METEOBIH**), Bilten 2016.

Croatia: Meteorological and Hydrological Service (**DMHZ**) Annual reports

Denmark: Danish Meteorological Institute (**DMI**), Vejret i Danmark

Estonian Weather Service: Estonian weather events in 2016

Finnish Meteorological Institute (FMI) Press release

France: Météo-France, Toulouse, Bilan climatiques

Germany: Deutscher Wetterdienst (**DWD**), Klimatologische Jahresübersicht

Greece: Hellenic National Meteorological Service, http://www.hnms.gr/hnms/english/climatology/pdf_english/2016_GRsignificantEVENT_en.pdf

Greece: National Observatory of Athens, Meteorological bulletin

Hungarian Meteorological Service (**OMSZ**), Climate retrospective

Icelandic Met Office: The weather in Iceland 2016-Climate summary

Ireland: The Irish Meteorological Service (**MET Éireann**), Weather Summary

Israel Meteorological Service (**IMS**): Weather summary in Israel

Italy: Agenzia Regionale per la Protezione Ambientale (**ARPA**), Rapporti annuali

Latvian Environment, Geology and Meteorology Centre Monthly bulletins

Lithuanian hydrometeorological Service (**Lhmt**) http://www.meteo.lt/en/2017-rugsejis

Luxembourg: MeteoLux, Bilans climatologiques annuels (http://meteolux.lu/fr/produits-et-services/bilans-climatologiques/bilans-climatologiques-annuels/)

Moldova: State Hydrometeorological Service (**SHS**), Caracterizarea conditiilor meteorologice si agrometeorologice din anul

Montenegro: Hydrological and Meteorological Service of Montenegro Annual reports

Netherlands: Royal Netherlands Meteorological Institute (**KNMI**), DeBilt, Jaaroverzicht van het weer in Nederland

Norway: Det Norske Meteorologiske institutt (**DNMI**), Klimatologisk månedsoversikt

Portugal: Instituto portuguesa do mar e da atmosfera (**ipma**), Bolletim Climatológico Anual

Romania: Administrația Națională de Meteorologie, Monitorizare climatica

Russia: Hydrometeorological Centre of Russia (**Roshydromet**) Climate features of the northern hemisphere

Serbia: Republic Hydrometeorological Service of Serbia (**RHMZ**) Annual Bulletin for Serbia

Slovak hydrometeorological institute (**SHMU** Slovenský hydrometeorologický ústav) Bulletin Meteorológia a Klimatológia

Slovenian Environment Agency (**ARSO,** Agencija Republike Slovenije za okolje): Mesečni bilten ARSO

Slovenia: Unusual events http://meteo.arso.gov.si/met/sl/climate/natural-hazards/

Spain: Agencia Estatal de Meteorología (**AEMET**), Resumen anual climatologico

Swedish Meteorological and Hydrological Institute (**SMHI**), Året (year)

Switzerland: Federal Office of Meteorology and Climatology **MeteoSwiss**, Klimabulletin

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9. Abbreviations

AO	Arctic Oscillation (circulation indices)
BAMS	Bulletin of the American Meteorological Society
CLIMAT	monthly climatological data provided by the NMHSs via GTS
DWD	Deutscher Wetterdienst (German Meteorological Service)
EA	East Atlantic Pattern (circulation indices)
EA/WR	East Atlantic/West Russia Pattern (circulation indices)
ECA&D	European Climate Assessment & Dataset, located at Royal Netherlands Meteorological Institute (KNMI)
EMCC	Eastern Mediterranean Climate Centre
E-OBS	daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D information
GCC	Global Collection Centre operated by the Deutscher Wetterdienst
GPCC	Global Precipitation Climatology Centre located at the Deutscher Wetterdienst
GTS	Global Telecommunication System
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (Italian National Institute for Environmental Protection and Research)
JRC	Joint Research Centre's of the European Commission
m a.s.l.	Meter above sea level
NAO	North Atlantic Oscillation (circulation indices)
NMHSs	National Hydro-Meteorological Services
POL	Polar/Eurasia Pattern (circulation indices)
PDSI	Palmer Drought Severity Index
RCC-CM	WMO Regional Climate Centre Network (RA VI) Offenbach Node on Climate Monitoring
SCA	Scandinavia Pattern (circulation indices)
SCE	Annual snow cover extent
SYNOP	surface synoptic or weather observations provided by the NMHSs via GTS
WCDMP	World Climate Data and Monitoring Programme
WMO RA VI	WMO Regional Association VI (Europe and Middle East)
WMO	World Meteorological Organization

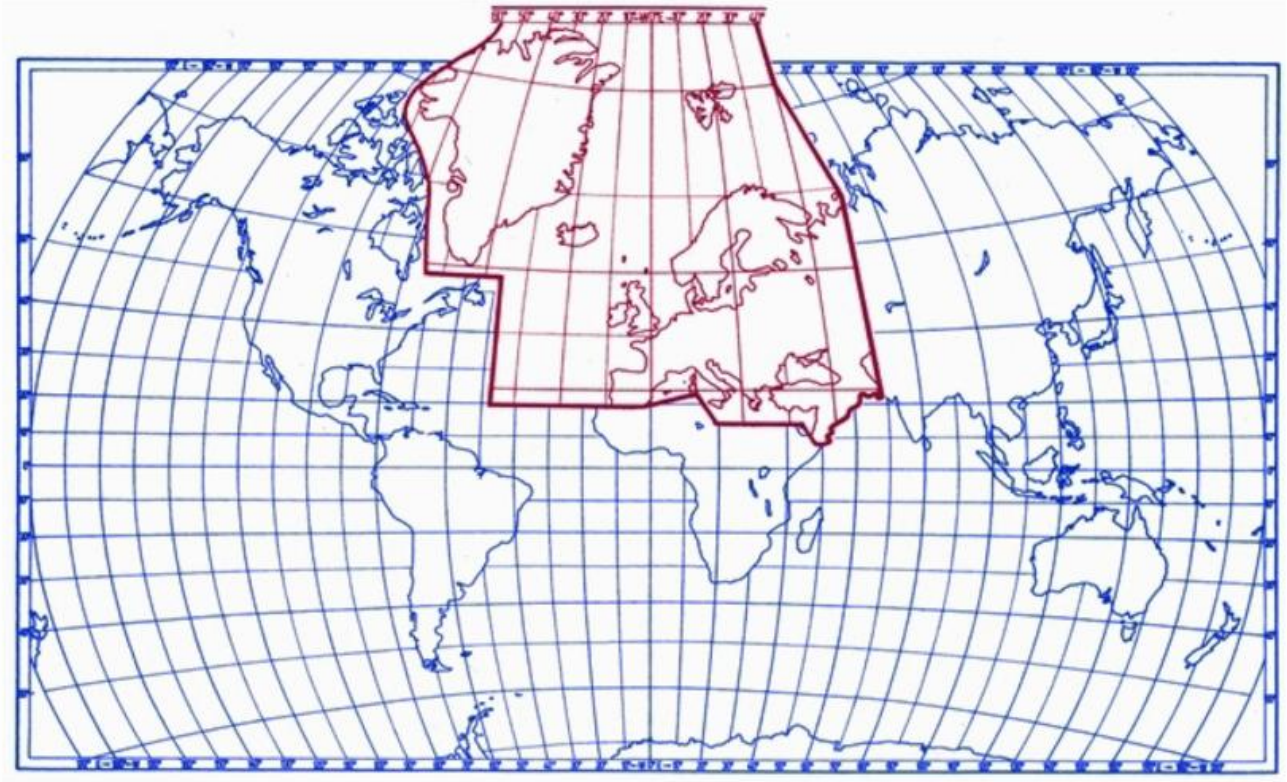
WMO RA VI
RCC Network

DWD

Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2017



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Ukraine
United Kingdom

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1. Introduction

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East with 50 Members) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official Websites. Supported by the European Climate Support Network (ECSN) and WMO´s World Climate Data and Monitoring Programme (WCDMP) the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's Annual Statement on the Status of the Global Climate and the State of the Climate published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ among the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the Webpages of the RA VI RCC Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

This annual bulletin includes 4 parts: the annual, seasonal and monthly survey of the climate state in 2017 as well as contributions of the NMHSs to the long-term variability of selected parameters up to 2017 (section 5).

Notes:

Maps of the RA VI RCC Network are based on the following data sources:

- Temperature: CLIMAT data and ship observations provided by the Global Collecting Centre (GCC), operated by the Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC), operated by the Deutscher Wetterdienst
- Sunshine: CLIMAT data.
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC Node-CD) via the European Climate Assessment & Dataset project (ECA&D) run by Royal Netherlands Meteorological Institute (KNMI)

Sub-regional monthly maps are provided by the Eastern Mediterranean Climate Centre (EMCC).

The following sub-regions are used in this Bulletin:

Central and western Europe (14 countries): *Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, the Netherlands, Poland, Slovakia, Switzerland, and United Kingdom*

Nordic and Baltic Countries (9 countries): *Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, and Sweden*

Iberia (2 countries): *Portugal, and Spain*

Mediterranean, Italian and Balkan Peninsula (12 countries): *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Slovenia, and Turkey*

Eastern Europe (5 countries): *Belarus, European Russia, Moldova, Romania, and Ukraine*

Middle East (9 countries): *Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, and western Kazakhstan*

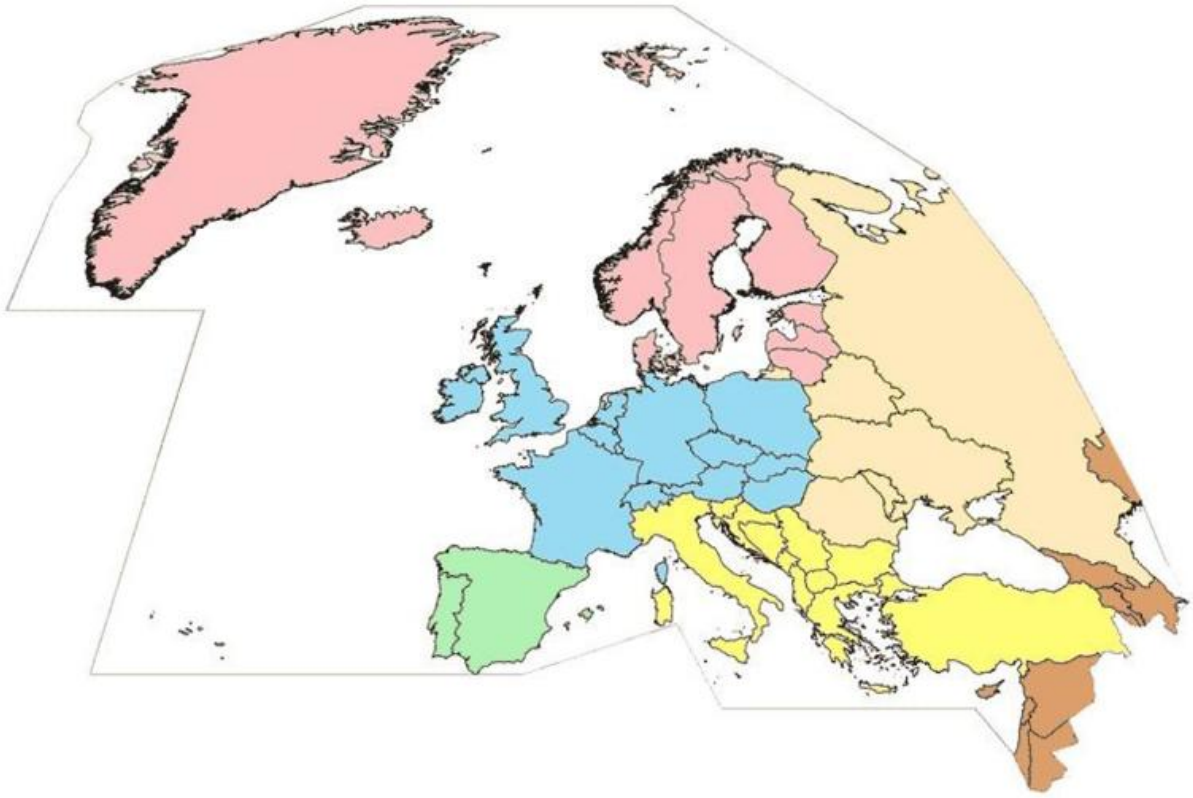


Figure 1.1: Definitions of the 6 sub-regions used in this bulletin.

Box 1

Notable anomalies and events 2017

Anomalies

Temperature

- Record breaking warm year in many European countries (see Table 2.1).
- Cold spell at the end of April 2017 in Central Europe and the Balkans with significant agricultural damage.
- April to December extremely warm and dry period in western and central Mediterranean.
- Several heat waves over central and southern Europe from June to September (The highest temperatures of 46.9°C was recorded at Cordoba airport, southern Spain, on 13th of July).

Precipitation

- Meteorological drought between April and December in Portugal.
- The wettest station in 2017 was Gullfjellet (Bergen, Norway) with 5057 mm.

Sunshine Duration

- Central Europe experienced a very sunny January with more than 200% of normal.

Other Anomalies

- Little snow in winter 2016/17 in the Alps.

Events:

- Several **forest fires** in Portugal in June and October.
- **Medicane** "Numa" in Central Mediterranean in November 2017.
- New Swedish air pressure record was recorded for September with 1044.1 hPa
- In **Slovakia** maximum wind gust of 61.6 m/s (222 km/h) occurred at Lomnický štít (2634 m a.s.l.)
- Ex-Hurricane **Ophelia** crossed Ireland and the United Kingdom with wind speeds of up to 49 m/s

2. Annual survey

The climate of 2017 was characterised by a broad range of spatial and temporal anomalies outlined in Box 1 and Figure 2.5. This section presents an overview of the spatial patterns of mean annual climate conditions in 2017 and anomalies related mainly to the normal period 1961-1990 of the selected climate variables: sea level pressure, surface air temperature, precipitation, sunshine duration and snow. Sub-section 2.1.4 reveals climate extremes for individual countries. Long-term trends in temperature and precipitation indices offers section 2.2.

More detailed insight into the long-term variability of temperature, precipitation and also some other parameters from the individual countries are presented in section 5.

2.1. Annual averages and anomalies of selected essential climate variables

2.1.1. Sea level pressure

Generally, mean annual sea level pressure distribution in 2017 over the WMO Region VI is dominated by a low pressure trough in the polar area with the Icelandic low that extended from southern Greenland to Iceland. The second pressure system, the subtropical high pressure belt, extended from the centre over the Azores (Azores high) across southern and central Europe to European Russia.

In 2017 the mean sea surface pressure differs to some extent from the long-term mean with a reduced pressure especially in a region over Greenland and northern Russia with anomalies of -2 to -4 hPa. Southeastern Europe also shows below normal anomalies. Higher pressure anomalies of more than +2 hPa occurred over southern France and the Bay of Biscay as can be seen from Figure 2.1 (right; normal period 1961-1990) indicating a slightly stronger than normal NAO.

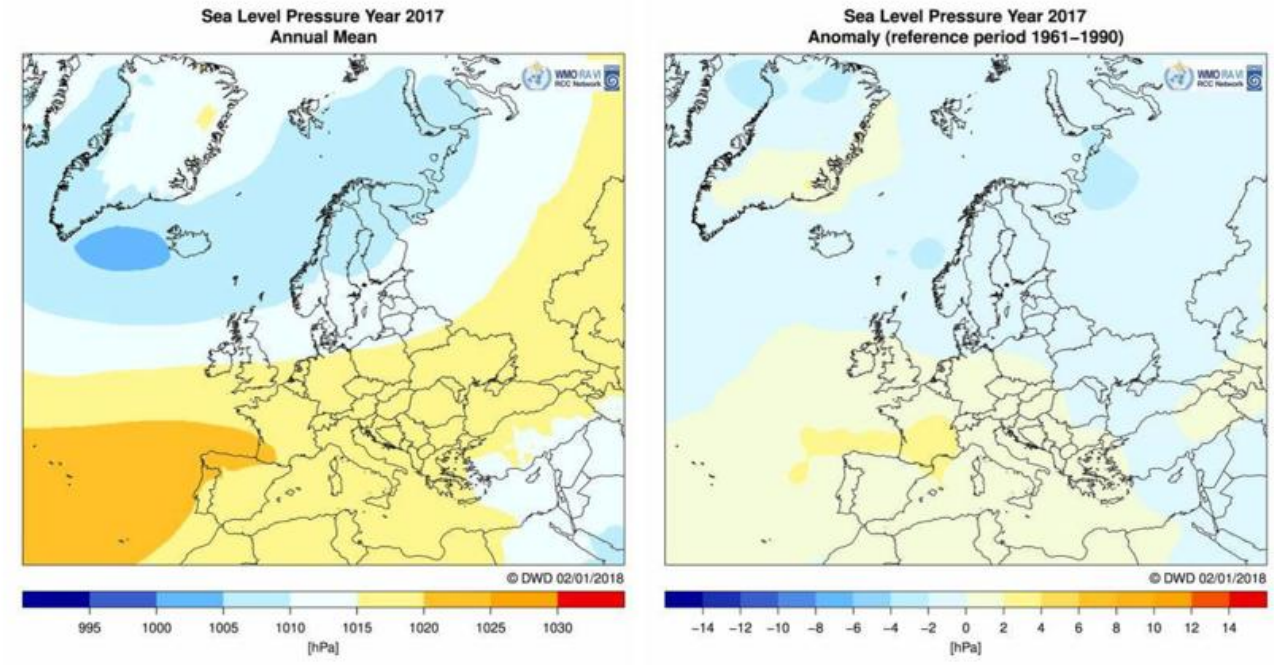


Figure 2.1: Annual mean of sea level pressure (left) and anomalies (right) in hPa for the year 2017 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.2. Temperature

In the entire European region (35°–75°N, 25°W–40°E) the year 2017 was warmer than normal with an anomaly of +0.86°C (base period 1981-2010) according to the E-OBS dataset. Many of the European countries reported new records (Table 2.1).

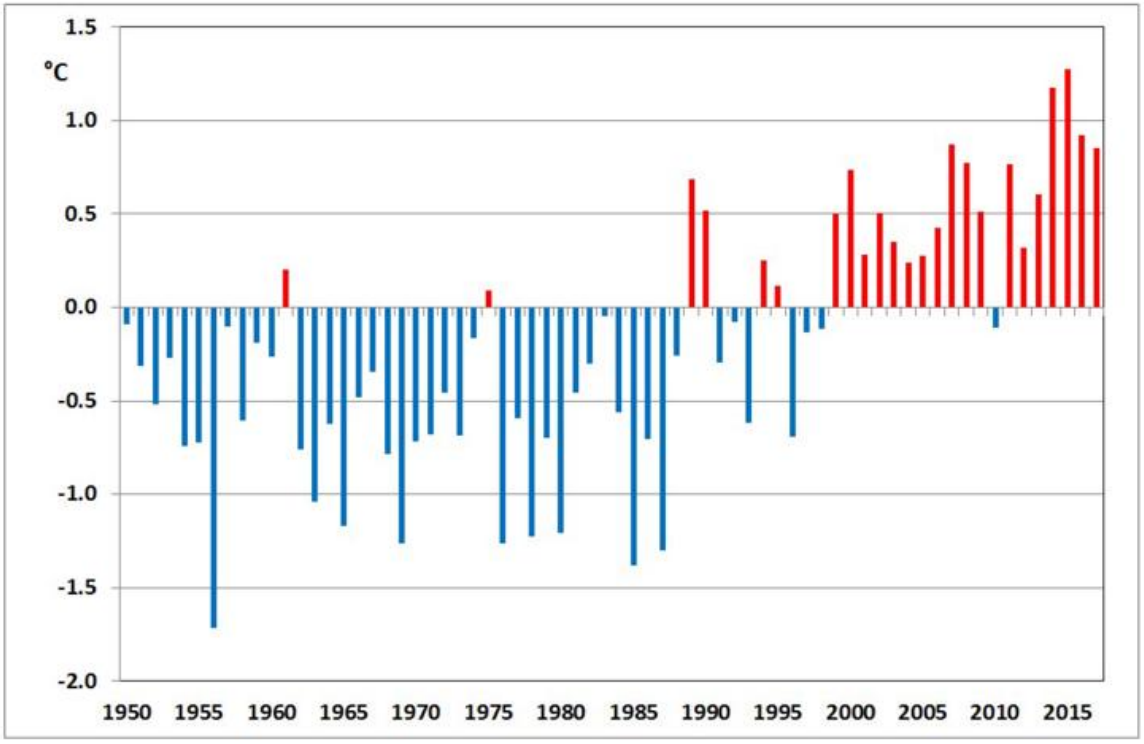


Figure 2.2: Annual temperature anomalies 1950-2017 for Europe (land area; 34°N-71°N and 25°W-40°E, reference period 1981–2010; based on the E-OBS dataset, van der Schrier et al. 2013). (Source: Royal National Meteorological Institute Netherlands, KNMI).

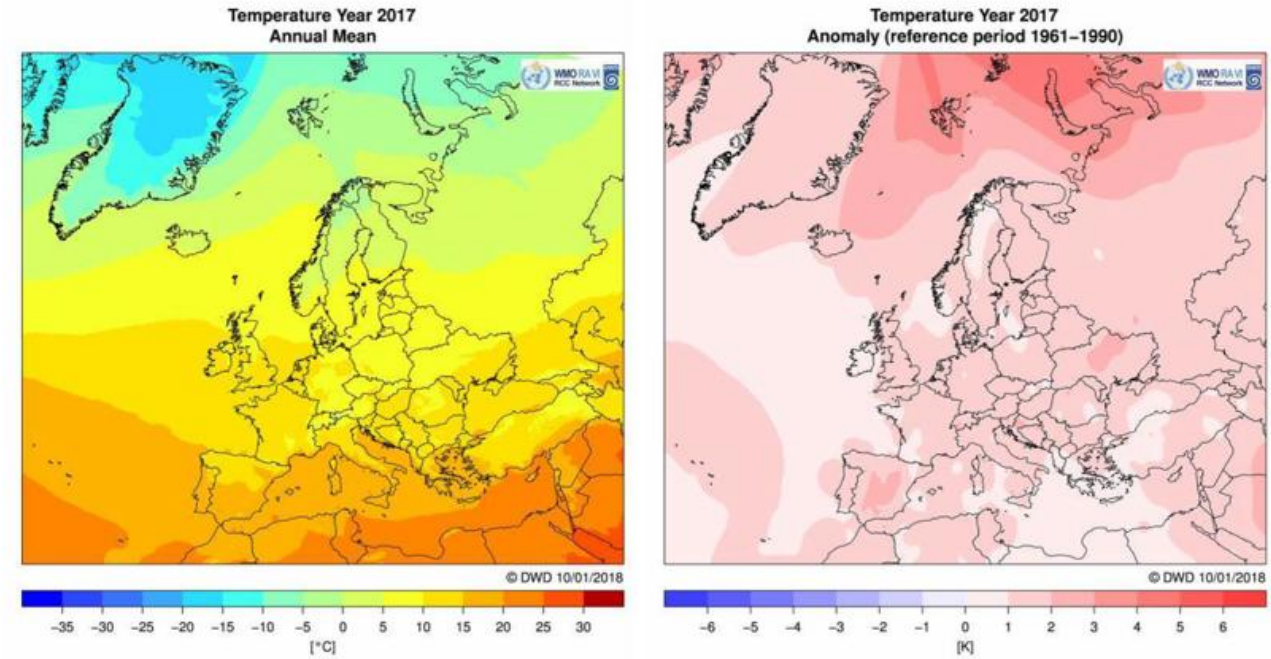


Figure 2.3: Mean annual temperature in °C (left) and anomalies (right) for 2017 (reference period 1961-1990, source: http://www.dwd.de/rcc-cm).

The highest annual anomaly of 1.52°C referred to 1961-1990 was observed in the sub-region Nordic and Baltic countries followed by Iberia (1.49°C), eastern Europe (1.47°C), the

Mediterranean, Italian and Balkan Peninsula (1.44°C) and Middle East (1.42°C). The sub-region Central and Western Europe showed the lowest anomalies of 1.35°C (Table 3.2). Most of the months in 2017 were warmer than normal (1961-1990) with remarkably consistent deviations of more than +4°C especially in northern Europe (cf. section 3.1.2 and 4.2).

The global annual land and ocean surface temperature for 2017 ranked as the second or third highest, depending on the dataset, 0.38° – 0.48°C above the 1981–2010 average (Blunden, Arndt und Hartfield 2018) or 1.1 °C ± 0.1 °C above pre-industrial levels (WMO 2018).

The **Norwegian Arctic** in 2017 was again warmer than usual with an annual mean temperature of -2.2 °C (4.4 °C above normal) in Svalbard airport and -2.2 °C (4.2°C above normal) at Hopen.

This year 9 heat waves were reported from **Portugal**, starting in April and ending in November.

Table 2.1: Rank statistics and anomalies of annual temperature in 2017 from some participant countries as reported by the National Meteorological and Hydrological Services (NMHSs).

Country	Rank of annual temperature in 2017	Anomaly 1961-1990 in °C	Anomaly 1981-2010 in °C	start of time series
Europe (35°–75°N, 25°W–40°E, E-OBS)	15	+0.86	+0.35	1951
Austria	9	+1.6	+0.9	1767
Belarus	9	+1.7		1881
Belgium			+0.8	(Ukkel)
Bosnia and Herzegovina		+0.6 to 2.1		
Bulgaria		+1.2		1980
Croatia	6	+2.1		1862 (Zagreb)
Czech Republic	9 - 10		+0.7	1961
Denmark	17	+1.2	+0.6	1874
Estonia	16-17		+0.5	1961
Finland	23	+1.3		1900
France	5		+0.8	1900
Georgia		+1 to +3°C		
Germany	6-8	+1.4	+0.7	1881
Hungary	11		+0.8	1901
Iceland		+1.4		1871 (Reykjavík)
Ireland			+0.4	1900
Israel	4	+1.3		1951
Latvia	20	+1.2	+0.5	1924
Lithuania	12	+1.3	+0.6	
Luxembourg		+1.9	+0.9	
Moldova	4 (7)		+1.1	1887 (Chisinau)
Netherlands	4		+0.9	1901(de Bilt)
Norway	20	+1.1		1900
Portugal	2	+1.1 (1971-2000)		1931
Romania			+0.7	1901
Russia, European		+1.45		1939
Serbia	12		+0.9	1951
Slovakia	12	+1.3	+0.8	1872
Slovenia			+1.0	1961
Spain	1		+1.1	1965
Sweden	21			1860
Switzerland	6		+0.8	1864
Turkey	9		+0.7	1960
Ukraine	3	+1.8		1881
United Kingdom	5		+0.7	1910

2.1.3. Precipitation

The wettest stations in Norway in 2017 were Gullfjellet (Bergen, Hordaland) with 5057 mm, Kritle (Etne, Hordaland) 4309 mm and Hundseid in Vikedal (Vindafjord, Rogaland) 4238 mm (154 % of the normal).

The 2017/2018 rainfall season in **Israel** had a very dry start with limited rainfall amounts in October, November and December. In most parts of Israel it was the driest start of the rainfall season since 1999. Detailed descriptions can be found in the seasonal (3.1.3) and monthly survey (4.3).

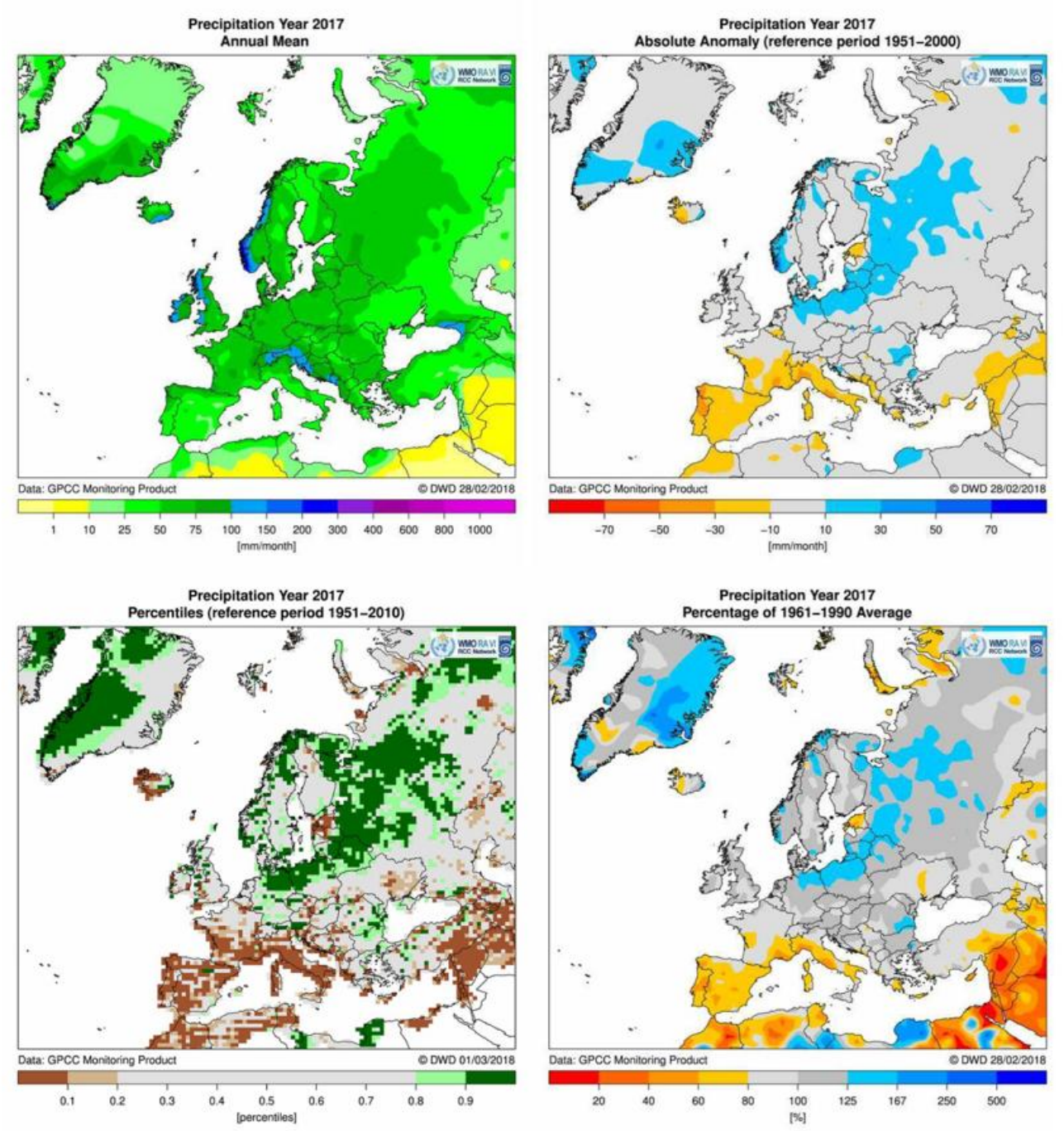


Figure 2.4: Total precipitation (left, top), anomalies (right, top) in mm/month, percentiles (left, bottom) and percentage of precipitation in % (right, bottom, reference period 1951-2010) for 2017 (reference period 1961-1990; source: http://www.dwd.de/rcc-cm).

2.1.4. Annual extreme values of temperature and precipitation

In this section an overview is given for the temperature spread and the extreme precipitation for each country. Absolute annual extreme values for 2017 of temperature (minimum and maximum), maximum of total daily precipitation and maximum of total 5 consecutive days with precipitation for each country in the WMO Region VI are given in Figure 2.5.

The spatial pattern of extreme temperature corresponds roughly to those of the temperature anomalies of 2017. The highest maximum temperatures (above 40°C) occurred primarily in sub-regions Middle East, Mediterranean, Italian, France and Iberian Peninsula, but also from the Balkans. Maximum temperatures higher than 35°C were reported from most of the countries in central and eastern Europe.

The one-day precipitation totals (RX1) of more than 150 mm for individual countries are documented in several sub-regions; the highest value occurred in Italy (359 mm/day). Highest total precipitation on 5 consecutive days (RX5) (above 300 mm) was measured in Slovenia (592 mm), Italy (469.8 mm), Croatia (369.6 mm), Turkey (333 mm) followed by Norway (300 mm).

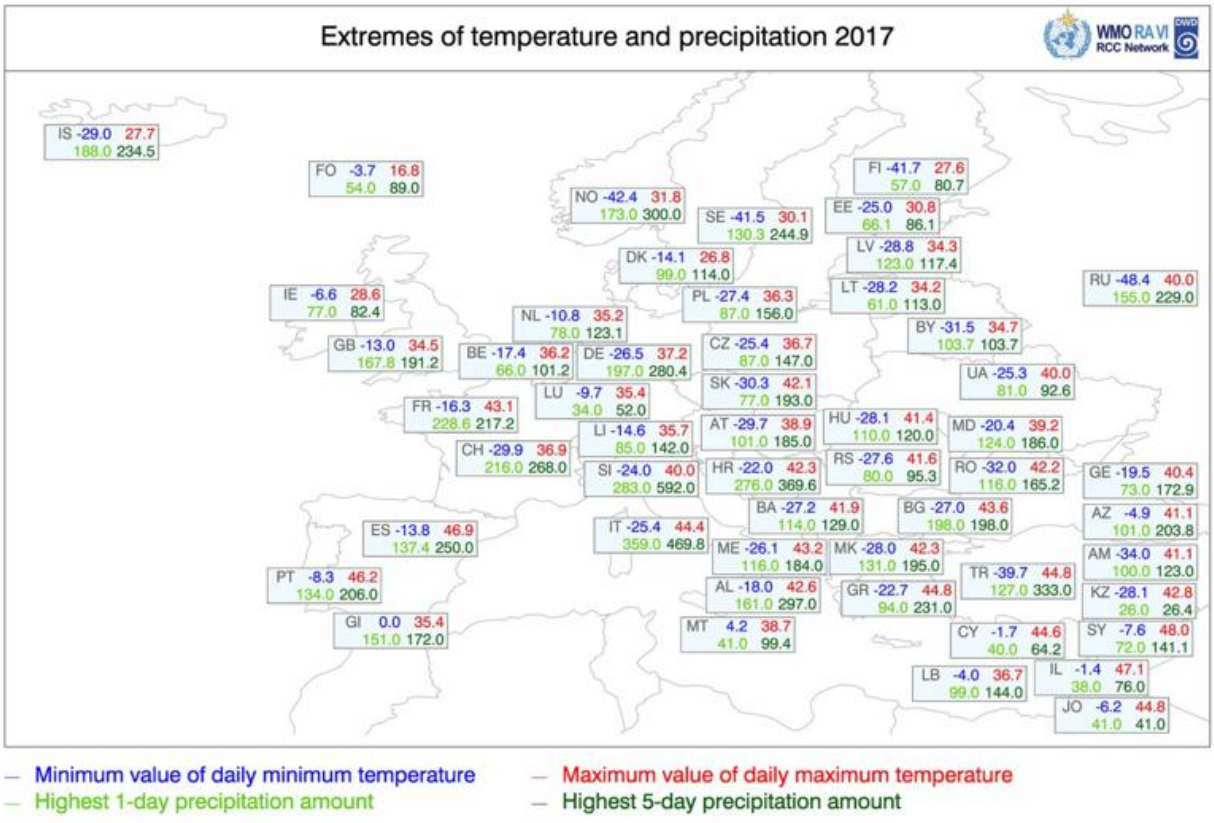


Figure 2.5: Annual extreme values for each country in 2017: first row: Internet country code, lowest daily minimum temperature (in °C, blue) and highest daily maximum temperature (in °C, red); second row: maximum daily precipitation totals (in mm, light green) and maximum 5-daily consecutive precipitation totals (in mm, dark green).

Note: Data (by order or priority) from reports of NMHSs, GPCC, ECA&D or SYNOP; the countries are represented by their Internet country codes. (Source: http://www.dwd.de/rcc-cm)

2.1.5. Sunshine duration

As expected, the annual sum of sunshine duration in 2017 showed from the south to the north generally gradual decreasing values. More than normal sunshine hours have been primarily noted in southern Europe, the western Alpine region, most parts of the Balkans and southern Russia. Finland and northeastern Europe had a sunshine deficit.

North of the Swiss Alps and in southern Ticino the annual total of sunshine duration amounted to 110 % to 120 % of normal values 1981–2010. The other parts of **Switzerland** recorded 100 % to 110 % of normal values. Lugano and Locarno-Monti in Ticino registered the sunniest year, some other regions of Switzerland the third- or fourth-sunniest year in the homogenous measurement series extending over more the 50 years.

The sunshine duration from January to December 2017 in **Austria** was 17 % above the climatological mean.

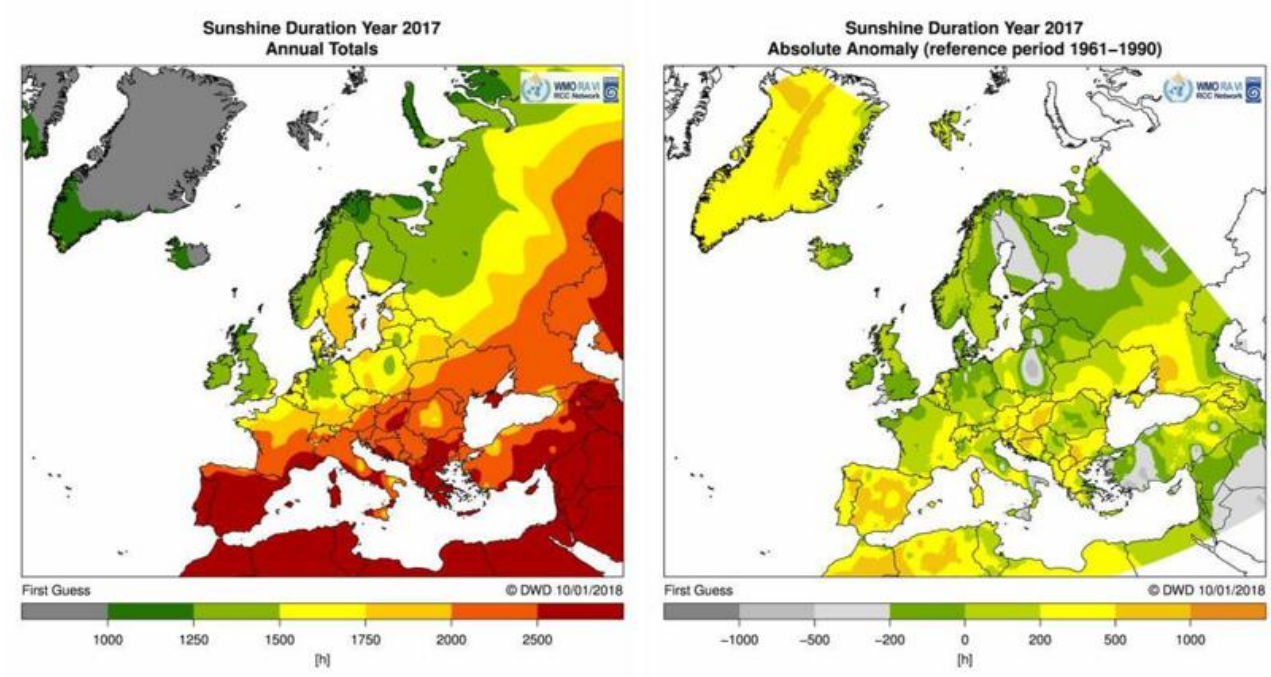


Figure 2.6: Annual sum of sunshine duration (left) and absolute anomalies (right) for the year 2017 in hours with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.6. Drought situation

At the eastern part of the Mediterranean, in **Cyprus**, there was also a drought from February to December 2017. The area average precipitation for February was 14% of normal (1961-90) and therefore the lowest for February since 1901, and Area Average Precipitation for December=33% was among the 10 worst for December also since 1901.

The year 2017 has been very dry in **Spain** as a whole. The annual mean precipitation was about 475 mm, which is around 27% lower than the mean normal value, according to the reference period 1981-2010. This big negative anomaly was mainly due to the rainfall deficit generated along the autumn and the spring quarter. According to the available information, the year 2017 has been the second driest year since the serial beginning in 1965, only below 2005 year with an annual mean precipitation of 468 mm.

Meteorological drought between April and December in Portugal

(Contribution from IPMA, Instituto Português do Mar e da Atmosfera)

The period from April to September 2017 (dry half-year) was extremely warm and extremely dry in mainland Portugal.
In this period, the conjugation of well below normal precipitation values and above normal air temperature values, especially the maximum temperature, resulted in the occurrence of high evapotranspiration values and significant soil moisture deficits. This previous conditions led to the beginning of a drought situation in mainland Portugal.
In the beginning of the new hydrological year (October 2017), the precipitation deficit increased, due to the occurrence of precipitation values well below normal in October and November. The period, from April to November, was the driest since 1931 (precipitation about 30% of normal).
Table 1 shows the percentage of the territory in the different classes of PDSI index between April and December 2017.
This meteorological drought began in April and persisted until the end of the year. This drought situation differs from previous cases since severe classes of the index started later (late June). Due to lack of rain and above normal evapotranspiration the territory percentage affected by severe and extreme drought increased in the beginning of the autumn (by the end of October 100 % of territory was in severe and extreme drought). In previous drought situations autumn precipitation near or above normal led to an effective reduction of drought severity (Figure 2.7).

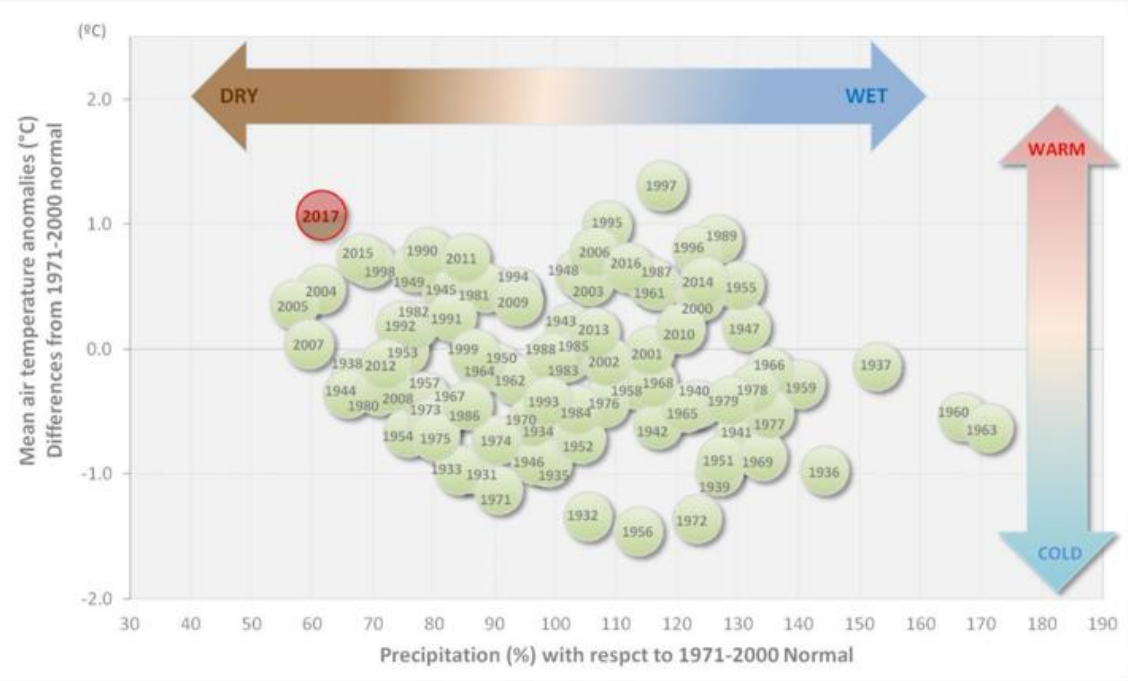


Figure 2.7: Annual mean air temperature and precipitation anomalies (1931 – 2017) (Difference (°C) and percentage (%) from 1971-2000 normal).

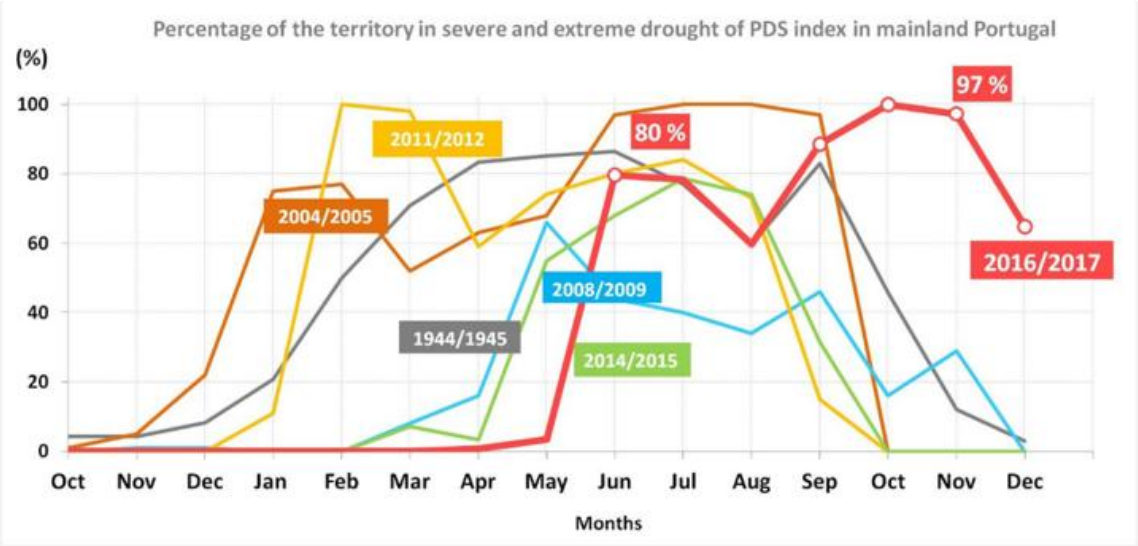


Figure 2.8: Monthly evolution of the percentage of the territory of Portugal in severe and extreme drought, according to the PDSI index, for historical drought situations (1944/45; after 2000: 2004/05, 2008/09, 2011/12, 2014/15 and 2016/17).

In many parts north of the **Swiss** Alps annual precipitation reached 70 to 90 % of the normal values 1981–2010. Alpine areas received mostly 90 to 115%, southern valleys of the Valais, however, only 60% to 80% of normal values. South of the Alps annual precipitation amounted to 80 to 95% of the normal values.

Monthly precipitation amounts between January and June 2017 in **Luxembourg** were all lower than the climate normal (about 34% on average). Most of all, April (5.3 mm) ranked on number two of the driest months at Luxembourg/Findel-Airport since station history in 1947, only exceeded by April 1996 with only 4.9 mm.

Drought also occurred during winter, spring and summer in the most southwestern part of **Slovakia** (1500 km^2) with agricultural losses in crop yields (spring crops, sunflower, maize).

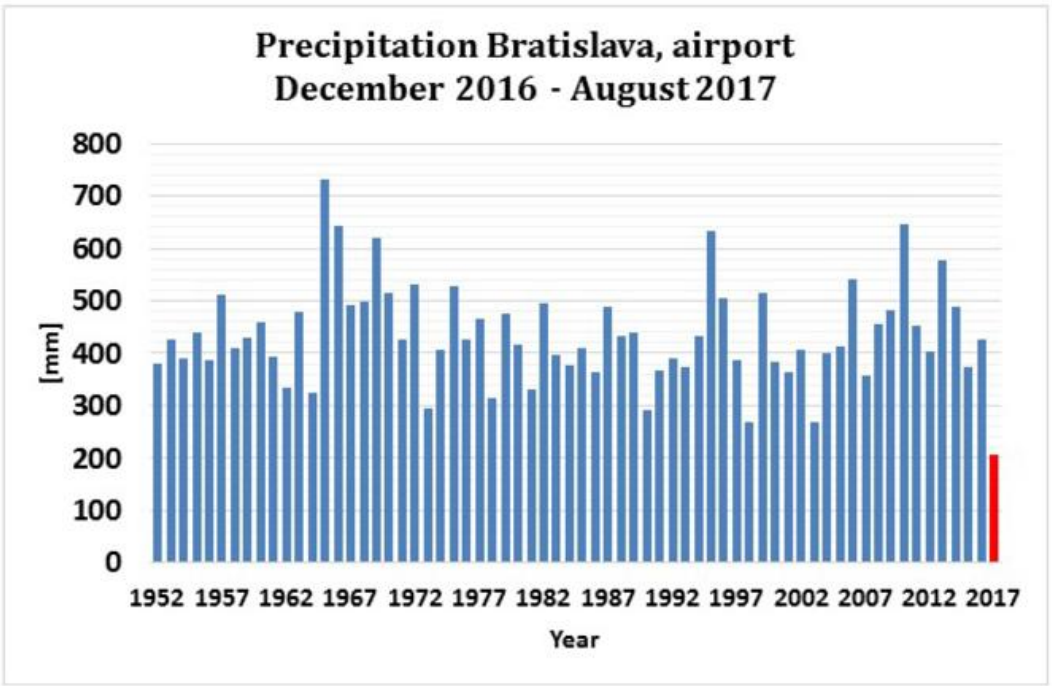


Figure 2.9: Precipitation at Bratislava, airport (Slovakia) for December 2016 - August 2017. (Diagram as provided by the Slovak Hydrometeorological Institute)

In **Italy**, from January to October 2017 below normal precipitation intensified the drought situation with low water levels in rivers and reservoirs and harvest losses.

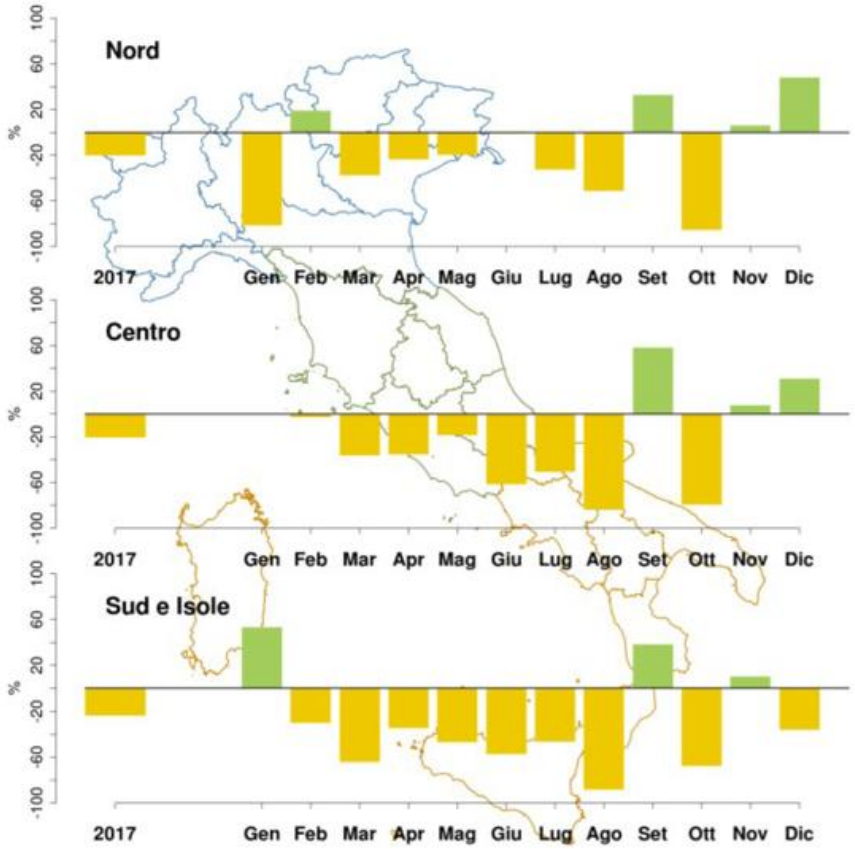


Figure 2.10: Annual and monthly precipitation anomalies for 2017 expressed in percentage of the normal value (1961-1990) for northern, central and southern Italy (including the Islands; diagram as provided by **ISPRA** – Istituto Superiore per la Protezione e la Ricerca Ambientale).

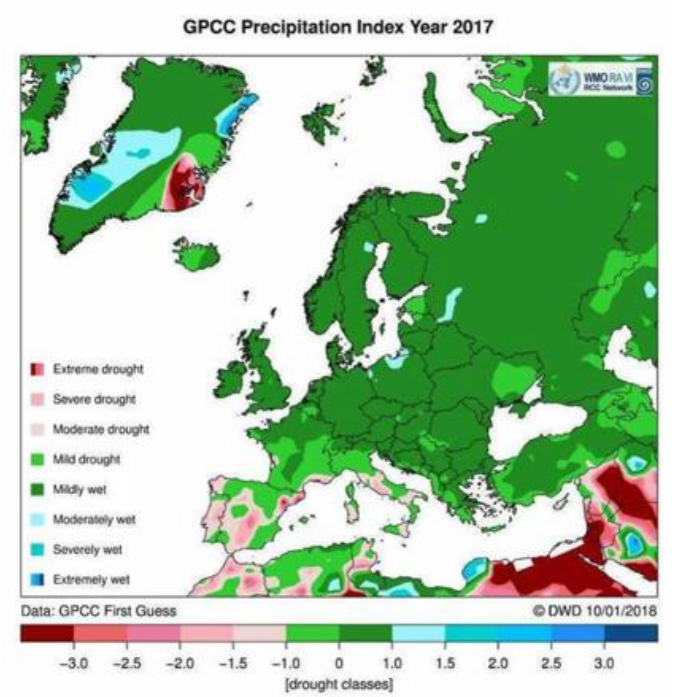


Figure 2.11: Annual modified Standardized Precipitation Index (DWD-SPI) for the year 2017 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.7. Snow cover

The snow-season 2016/2017 (September 2016 – August 2017) was warmer than normal and consequently in many low land areas in western and southern Europe no snow occurred at all. Apart from mountain areas, in central Europe partly occasional snow fall events occurred in November. As expected, towards northern and eastern Europe snow cover duration was longer and ended in April and May. In Switzerland, the thin winter snow cover in 2016/17 was at close to record-breaking levels. In western Switzerland and in the Valais only 30 to 50 % of the normal precipitation (mainly snow) values were recorded.

Last snow in low land areas over central Europe and the Balkans occurred during last decade of April 2017 due to a cold wave in these regions. In April a cold surge led to unusual accumulation of fresh snow in Austria. Especially in the area of the Ybbstaler Alps to the Wienerwald the amount of fresh snow within 24 hours reached from 20 to 125 cm. At the weather station Annaberg (Lower Austria, 911 m) the amount of fresh snow on the 20th of April was 125 cm.

The snow layer in Rumania was present throughout January everywhere in the country, maximum snow depths measured on the platforms of the weather stations, especially on 10 - 11 January reaching up to 175 cm in the mountain area (Făgăraş Mountains), up to 62 cm in Wallachia, up to 41 cm in Transylvania, up to 40 cm in Dobrudja, up to 35 cm in Moldavia, up to 26 cm in Oltenia, up to 22 cm in Maramureş, up to 20 cm in Banat and up to 16 cm in Crişana.

On 20-21 April, when the weather cooled markedly in Rumania and the deviations of the mean daily air temperatures were of the order of -10 ... -15ºC, rainfalls turned into sleet and snow in most part of Moldavia and locally in Transylvania.

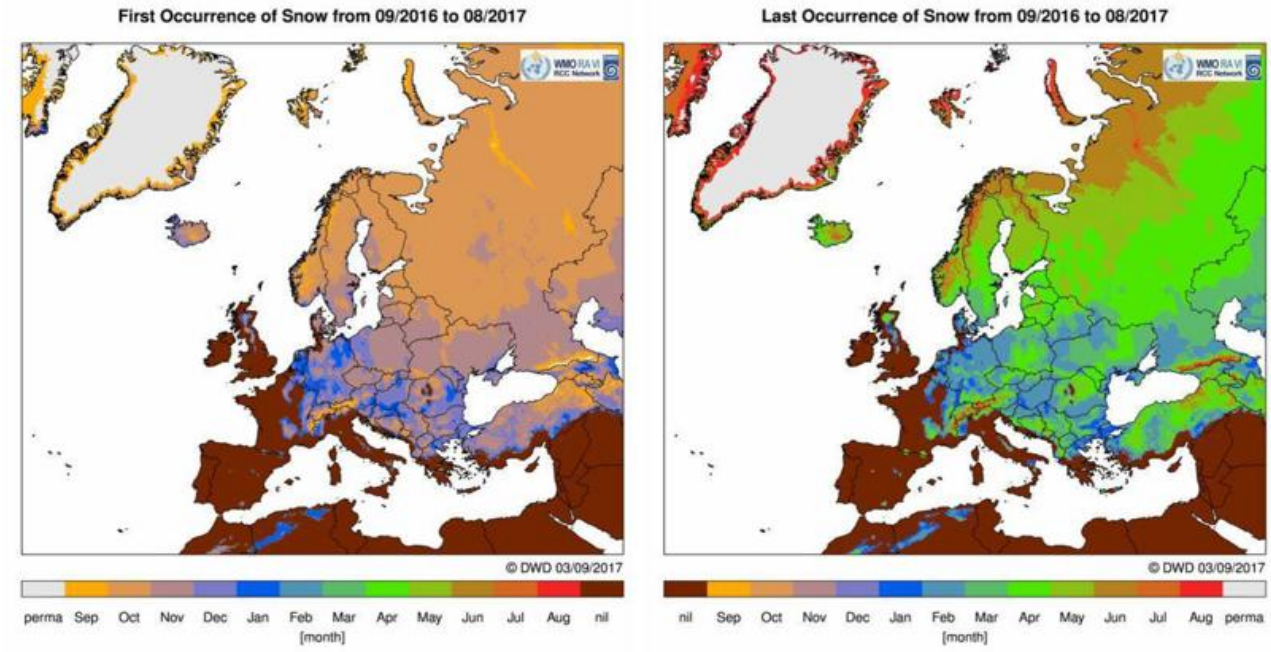


Figure 2.12: First occurrence of snow (left) and last occurrence of snow (right) during the snow-season 2016/2017. (Source: http://www.dwd.de/rcc-cm).

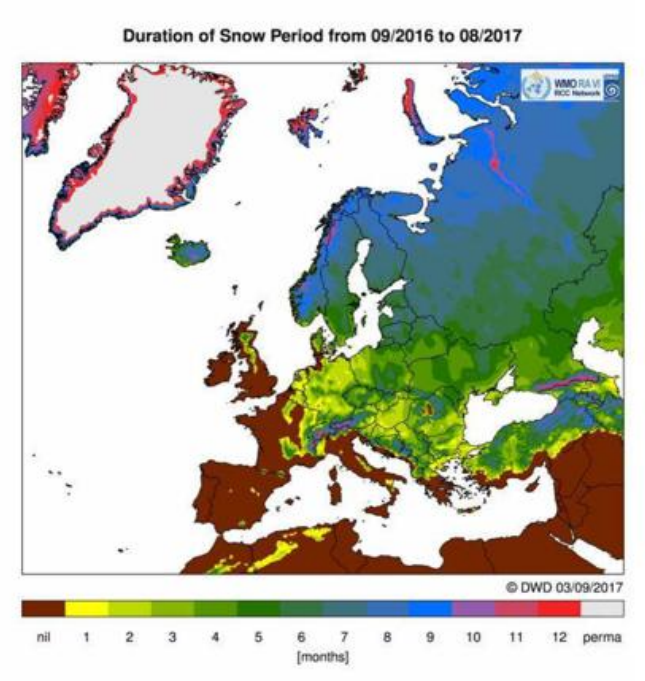


Figure 2.13: Duration of snow cover in the snow-season 2016/2017. (Source: http://www.dwd.de/rcc-cm).

2.2. Selected climate indices for 2017

This section presents selected temperature and precipitation indices calculated based on the station-based ECA&D (European Climate Assessment & Dataset; http://www.ecad.eu) dataset. Annual climate index maps are shown as well as anomaly and trend maps. The following climate indices are considered:

1. **RR1, Number of wet days**: count of days where RR (precipitation > 1 mm) Precipitation below 1 mm/day has no effect on vegetation because it normally evaporates on the same day and is locally effected.

2. **SU, Number of summer days**: count of days where TX (daily maximum temperature) ≥ 25°C

3. **WW, Number of warm and wet days:** days with TG (daily mean temperature) > 75th percentile
   and
   RR > 75th percentile

4. **TR, Number of tropical nights**: count of days where TN ≥ 20°C

The map with the number of wet days (RR1, uppermost left panel) clearly depicts the dry conditions prevailing in 2017 with less than 60 wet days in most parts of Spain and Portugal, but also along the Côte d'Azur and over Italy. The anomalies of the number of rainy days with respect to the 1961 to 1990 mean show that the area with less than normal wet days extends even further north additionally covering France and large parts in southeastern Europe. The northwestern, Central and northeastern part of Europe (for example Great Britain, Netherlands, Germany, Scandinavia) on the contrary experienced more than normal wet days which also resulted in above-normal precipitation amounts (see section 2.1.3).

Looking at the number warm and wet days (WW) it appears that above-normal numbers of WW were registered in most parts of Europe in 2017, also in the (drier) southern part. Only very locally, the number of wet and warm days was fewer than normal.

The anomaly map for the number of summer days (SU) illustrates the longer-than-normal summer conditions in 2017 over large parts of Europe. There is a North-South dipole structure visible dividing the area in a northern part which experienced less than normal summer days (Scandinavia) and a southern part where more than normal summer days were counted (central and southern parts of Europe). A feature that is also visible in the seasonal temperature anomalies for summer shown later (see Figure 3.3).

The anomalies of tropical nights do not show a clear pattern for 2017: there are positive and negative anomalies without a clear discrimination of regions. This suggests that there are only small deviations from the long-term mean and thus near normal numbers of tropical nights. Only a small band along the Mediterranean coast actually experienced a larger positive anomaly of more than 30 tropical nights more than usual.

Figure 2.15 shows the trend maps for the selected climate indices based on the years 1951 to 2017. In northern, northwestern, central and eastern Europe most stations showed an increase in the annual number of wet days (RR1) for the last 67 years (mostly greater than 3 days per year per decade) while in southern Europe a decreasing trend prevails. The decreasing and increasing trends at neighbouring stations, however, indicate inhomogeneities in the time series. The number of warm and wet days (WW) has increased over almost whole Europe by more than 1.5 days per year per decade. Only the Greek stations show negative WW trends of up to -1.5 days per year per decade. The annual numbers of summer days (SU) have increased in central and southern Europe and partly in eastern Europe, while stations in northwestern and northern Europe do not indicate any significant trend. Annual numbers of tropical nights (TR) show an increasing trend in the southeastern part of Region VI but values are generally small with 0 to 2 days per year per decade. In the northwestern part no significant trends are found.

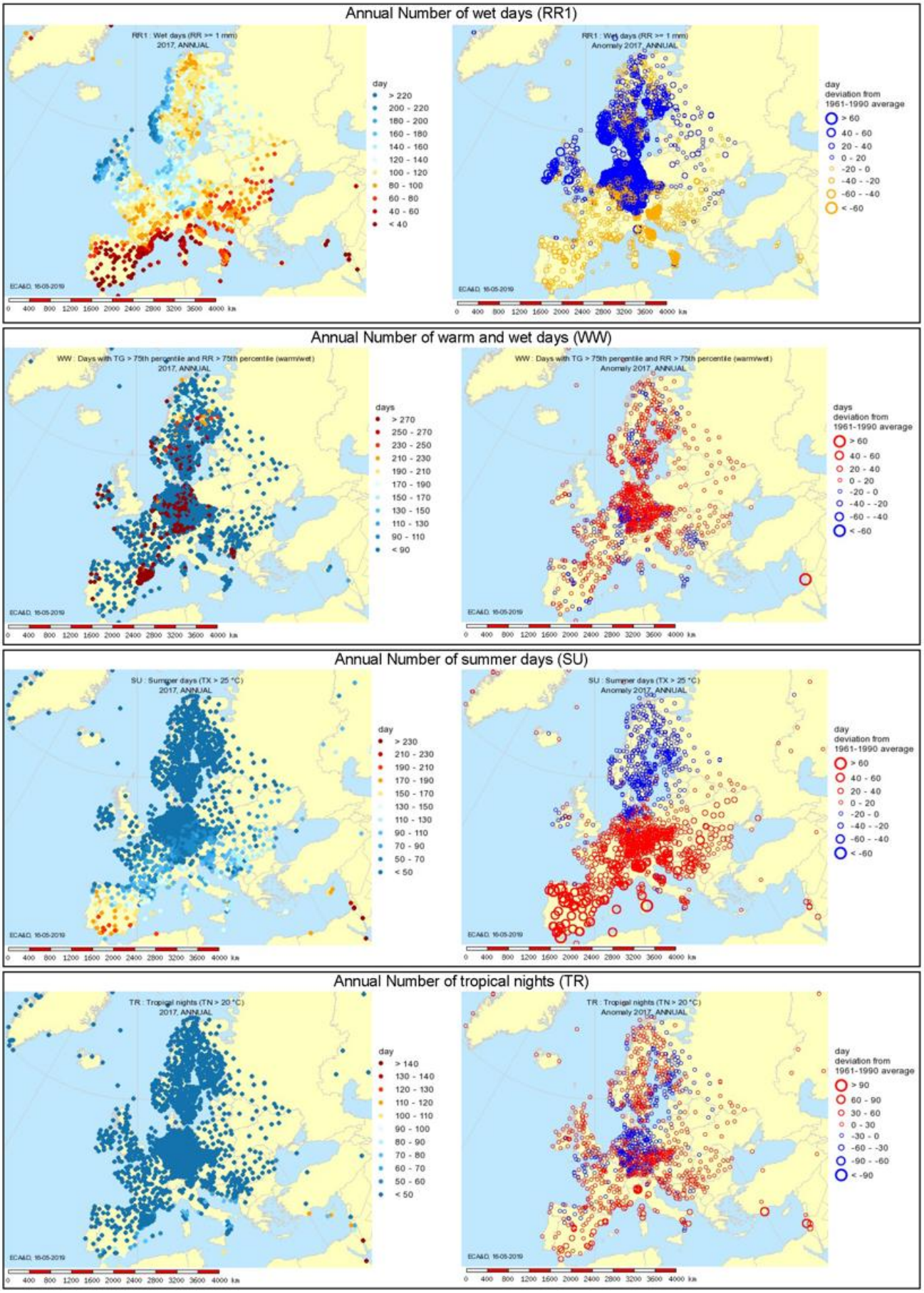


Figure 2.14: Selected Climate Indices for 2017 (left) and their anomalies (right) with respect to the 1961 to 1990 reference period (Source: ECA&D, http://www.ecad.eu).

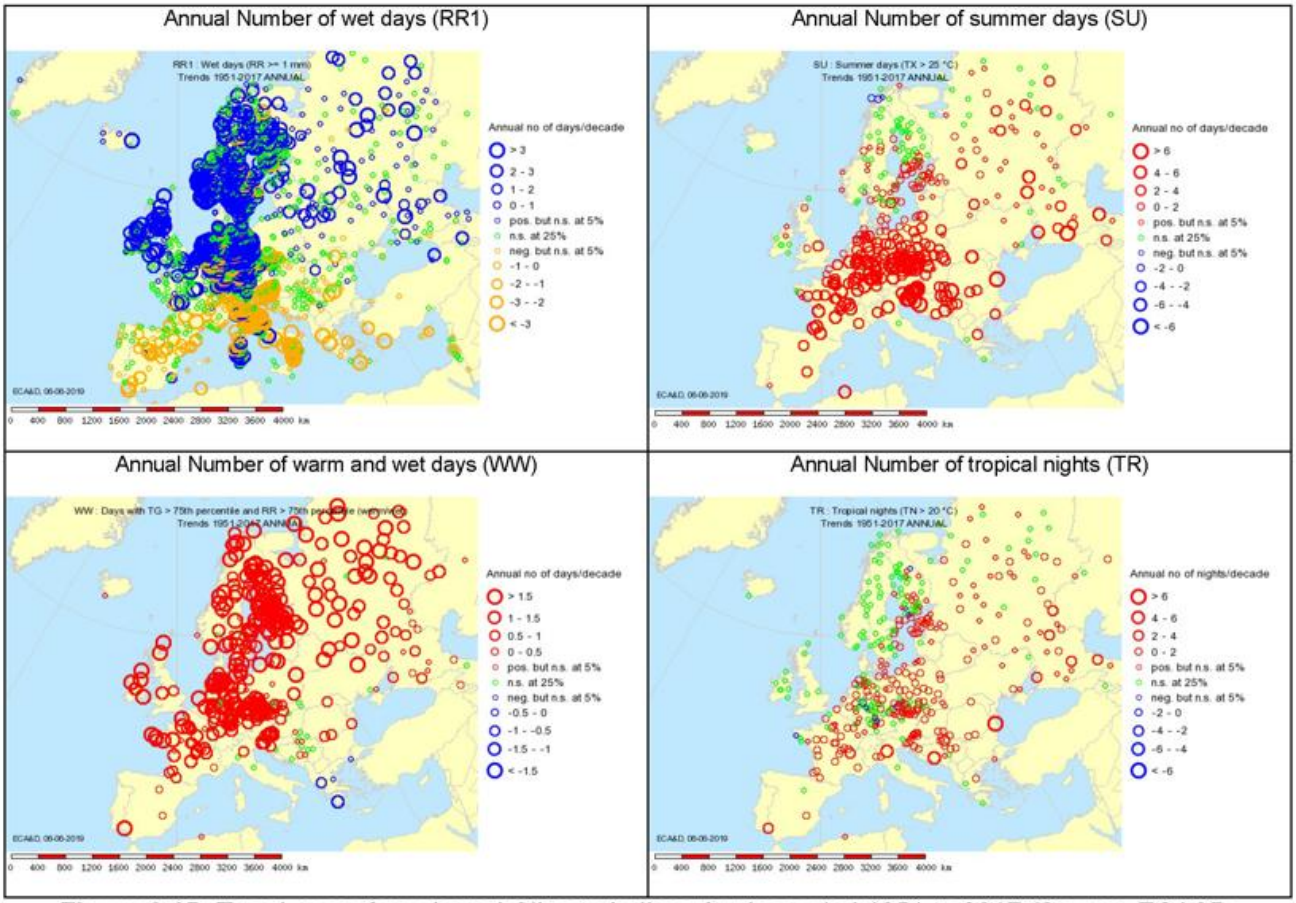


Figure 2.15: Trend maps for selected Climate Indices for the period 1951 to 2017 (Source: ECA&D, http://www.ecad.eu).

2.3. Socio-economic impacts of extreme climate or weather events

From January to October 2017 a severe **drought** occurred in southern Europe (Spain, Italy, and Serbia). MunichRe (2018) estimated the financial loss to 3400 Million €. Dry conditions and heat wave affected most of the agricultural production.

From 15.4. to 9.5.2017 Europe experienced a **cold wave** with frost in central Europe with damages of 3600 Million € (MunichRe 2018). A series of cold spells with low temperatures anomalies (-7°C) and heavy snowfall caused damages at some houses. Severe damages occurred at vineyards, fruit crops, (apples, stone fruits, berries) and vegetables because previous weeks were warm and all the plants were growing and blooming.

Abnormally severe forest fire season in Portugal

(Contribution from IPMA, Instituto Português do Mar e da Atmosfera)

2017 forest fire season was extremely severe and long, with terrific consequences, namely life losses and significant environmental and economic impacts. The accumulated Daily Severity Rating (DSR), obtained from Fire Weather Index (FWI), for 1st of July to 31st of October, was the highest on record (Figure 2.16). Burnt areas exceeded 440 000 ha (ICNF - Portuguese Forest Institute), a new record, even compared to previous extreme 2003 and 2005 fire seasons.

Central regions of mainland Portugal were the most affected by very large fires (> 1000 ha) in several periods namely, 16-21 June (64 casualties and several people were homeless and a financial loss of 180 Million €, after MunichRe, 2018), 16-18 July, 23-26 July, 9-19 August, 23-27 August, 5-9 September and 12-15 October (45 casualties and about 70 wounded and a financial loss of 400 Million €, after MunichRe, 2018). During these periods, the associated meteorological conditions were extremely favourable to fire propagation and very adverse to fire combat, fire weather index (FWI) values were higher than the 90th percentile, in the majority of the regions.

In the particular case of 15th of October, when a burnt area exceeded 200 000 ha, FWI values greater than 99th percentile were recorded due to:

- extremely low soil moisture content;
- a two week period with consecutive hot and dry days following the driest September on record;
- during the day very low humidity values (< 20 %) and wind intensification, with gusts exceeding 50 km/h, in several meteorological stations. The wind intensification was due to the proximity of the hurricane **Ophelia** to the Iberian Peninsula, centred approximately 485 km from Viana do Castelo.

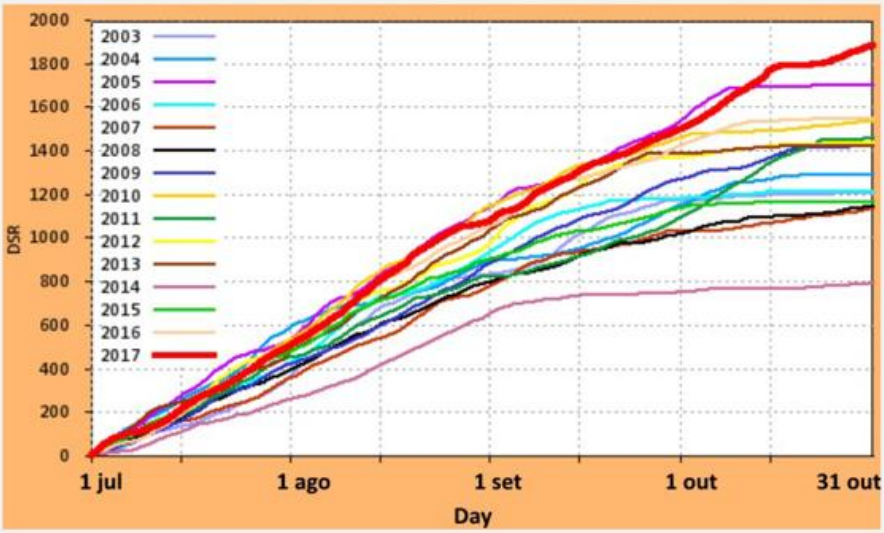


Figure 2.16: Daily severity rate (DSR) average value for mainland Portugal, 1st of July to 31st October from 2003 to 2017 (diagram as provided by IPMA)

Germany was hit by a tornado, severe thunderstorms with hail of up to 8 cm in diameter, heavy rain and wind gusts up to 39 m/s (140 km/h), during 22–23 June. Numerous houses, vehicles,

fruits, vegetables, 500 km^2 of crops and vineyards were damaged and two persons were killed. The damage was estimated to 700 Million € (MunichRe 2018).

Extremely vigorous wildfire in Split, 17-19 July 2017

(Contribution from Meteorological and Hydrological Service of the Republic of Croatia)

An intense heatwave hit Croatia in the first half of July. Extremely high temperatures made the already dry plant cover in Dalmatia even drier, resulting in very high risk of wildfire occurring and spreading. There was almost no precipitation in Dalmatia despite the humid and colder air inflow in mid-July. Driven by the rising anticyclonic ridge from Northwest Europe, strong Bura stormwinds on 15 and 16 July continued to dry out the vegetation. Such weather contributed to the extreme behaviour of the wildfire that broke out near Split on 17 July and was localized on 19 July. Approximately 4300 ha of forest, brush, olive groves and vineyards were burned. The fire front was at times 40 km long and it was one of the biggest wildfires in Croatian history.

The fire was put under control by a joint effort of the firefighters and the military on the afternoon of 18 July, localized and finally extinguished. The damage was substantial, but fortunately there were no human casualties. The authorities declared a state of natural disaster in the Split-Dalmatia County.

Remnants of Hurricane **Ophelia** crossed **Ireland** and the **United Kingdom** with wind speeds up to 49 m/s (175 km/h) on the 16th and 17th of October. Several houses, commercial buildings and 40 schools were damaged with a financial loss of about 90 Million € (MunichRe 2018).

Winter storm **Herwart** hit **Central Europe** on 29th of October with wind speeds up to 40 m/s (145 km/h), heavy rain and flash floods. Houses, roads and railways were damaged. 390,000 customers remained without power. The overall financial loss was estimated to 430 Million €, especially in the forestry (MunichRe 2018).

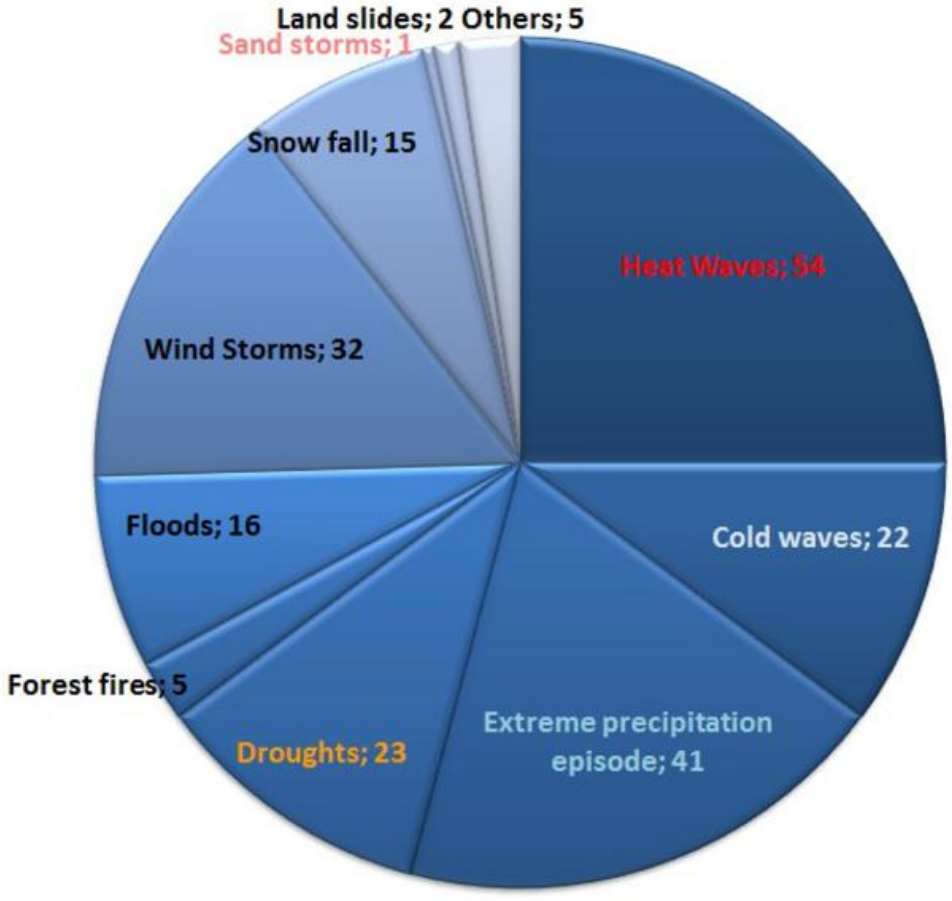


Figure 2.17: Observed extreme weather or climate events in 2017 based on 32 reports from NMHSs (total events reported for 2017: 216).

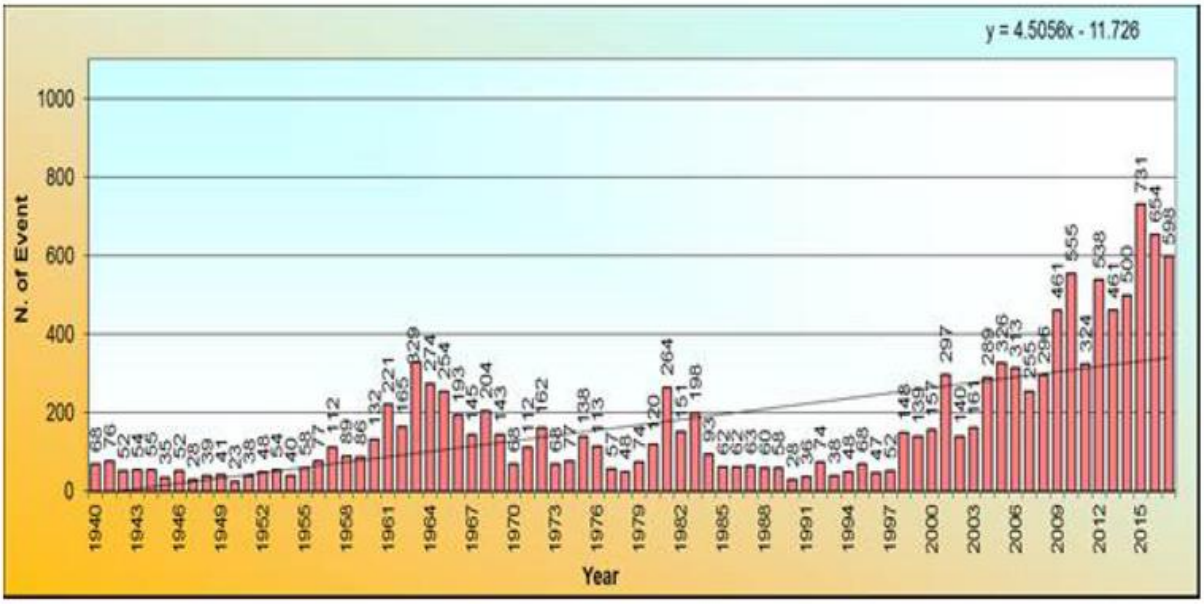


Figure 2.18: Annual count of extreme events per station occurred in Turkey from 1971-2017 (Diagram as provided by the NHMS).

The number of extreme events in 2017 in Turkey reached 598 (Figure 2.18). There is an increasing trend in extreme event occurrences especially during the last two decades (4.0 events/year), possibly partly also due to improved observations and communication means.

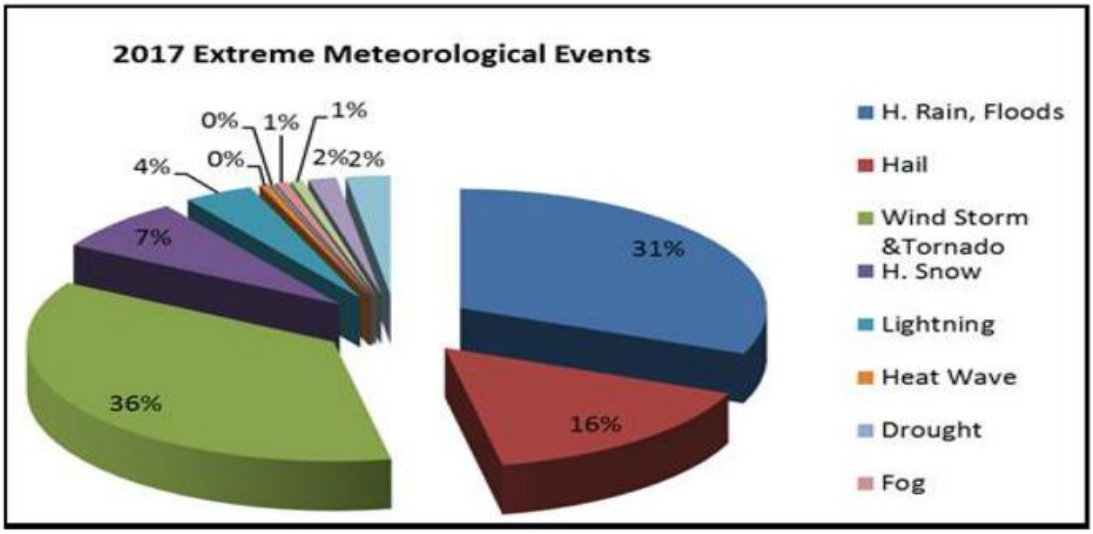


Figure 2.19: Distribution of extreme events occurred in Turkey in 2017 (Diagram as provided by the NHMS).

Most hazardous extreme events recorded in 2017 were wind storms and tornadoes (36%) and heavy rain/floods (31%). The others were hail (16%), heavy snow (7%), lightning (~ 4%), avalanche and frost (~ 1.5%) and heat waves, drought, forest fire and fog (<%1).

3. Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2017 and anomalies related mainly to the normal period 1961-1990 of the following selected climate variables: sea level pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1. Seasonal averages and anomalies of selected climate variables

3.1.1. Sea level pressure and circulation indices

Pressure distribution in **winter 2016/2017** showed a connection between the Azores high and the Russian high. On seasonal average the Icelandic low showed a core pressure below 995 hPa and the Azores high a core pressure above 1025 hPa. The pressure anomalies were above +8 hPa above Central Europe and the zone of below-normal pressure ranged from Greenland and Iceland to the Barents Sea and eastern Europe. This winter the North Atlantic Oscillation (NAO) was not well developed and therefore the East Atlantic/West Russia Pattern (EA/WR) dominated the teleconnections. Several storms affected Europe especially in February 2017. Storm "Urd" crossed Scandinavia during 26-27 December 2016. A mid-Atlantic trough deepened rapidly to a storm (named "Doris" by UK-MetOffice), before crossing Ireland on the 23rd February. This resulted in widespread gales and some disruption.

In **spring 2017** both circulation centres, the Icelandic low and Azores high, were not well distinct. A second low pressure centre was located around the Barents Sea. The Azores and Siberian high were connected with negative anomalies in northern Russia and positive anomalies in central Europe. The northern hemisphere teleconnection indices were small because they had opposite sign in the different months of the season.

Table 3.1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference.

	NAO	EA	EA/WR	SCA	POL	AO
Winter 2016/2017	0.36	0.10	1.10	-0.11	-0.17	1.02
Spring 2017	0.13	0.32	0.39	-0.51	-0.06	0.18
Summer 2017	0.03	1.96	-1.06	-0.99	0.56	0.40
Autumn 2017	0.04	0.77	-1.25	0.23	-1.69	0.04

Note that all values are standardized with the reference 1981 to 2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

Both circulation centres, the Icelandic low and Azores high, were shifted south in **summer 2017.** The anomalies were deepest between Iceland and Great Britain and reaching Scandinavia and northern Russia resulting in a high East Atlantic Pattern (EA) in all three months. This induced colder and wetter conditions in northern Europe. Austria was hit by several thunderstorms with hail and tornadoes during the summer 2017 and two people died; more than 140 persons were injured. The damage was estimated to more than 22 Mio €.

The circulation centres in **autumn 2017** were well pronounced with a core pressure below 1005 hPa around Iceland and above 1020 hPa around the Azores. Above normal pressure anomalies could be detected in south-western and northern Europe while negative anomalies prevailed from Iceland to south-eastern Europe. The dominant circulation patterns were the East Atlantic/West Russia Pattern (EA/WR) and the Polar/Eurasia Pattern (POL). During October and November several low pressure systems crossed western and northern Europe and also Medicane NUMA (a hurricane like cyclone in the Mediterranean) that circulated several days in the Ionian Sea with heavy precipitation, floods and damages in the surrounding countries, not only in Greece (see 4.1).

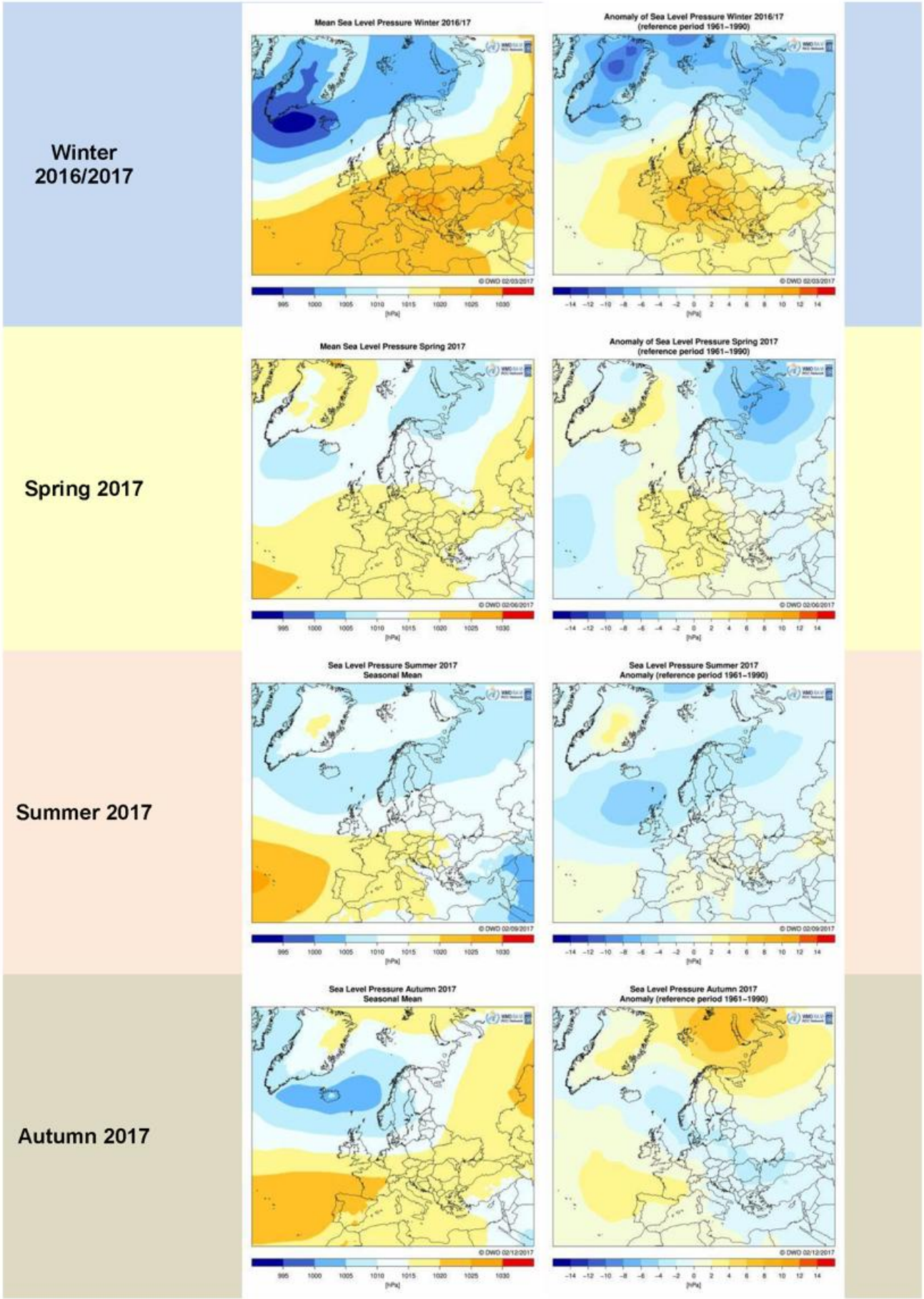


Figure 3.1: Seasonal sea level pressure (left, in hPa) and anomalies (right, in hPa) in 2016/2017, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.2. Temperature

On average for the whole WMO Region VI and sub-regions the temperature in all seasons in 2016/2017 (except in winter in Mediterranean, Italian and Middle East) was warmer than the normal period 1961-1990. In regional view, however, some differences existed (Tab. 3.2). The annual averages of all sub-regions are very similar and ranged between +1.4 and +1.5°C.

Table 3.2: Seasonal and annual average of temperature anomalies over land areas in °C for each sub-region in the year 2017 (reference period: 1961-1990; definitions of the sub-regions see Figure 1.1)

Sub-Region	Winter 2016/2017	Spring 2017	Summer 2017	Autumn 2017	Year 2017
Central and western Europe	0.68	1.99	2.56	0.07	1.35
Nordic and Baltic countries	2.98	0.83	0.65	1.74	1.52
Iberia	0.80	2.51	2.81	0.20	1.49
Mediterranean, Italian and Balkan Peninsula	-0.40	1.74	2.93	0.91	1.44
Eastern Europe	1.66	0.92	0.09	1.74	1.47
Middle East	-0.49	1.19	1.57	2.06	1.42

Temperature anomalies for **winter 2016/17** show lower than normal values in south-eastern Europe and eastern Russia as well as in parts of France and Spain. Northern Scandinavia showed higher than normal values of more than +4°C. The highest positive anomalies occurred in the far North. For example Svalbard Lufthavn reported a temperature anomaly for winter of +7.3°C (+9.3°C in February 2017) and Ny Ålesund +4.9°C. In Porvoo, Finland, the temperature rose to +8.2°C on 14 February, which also was the month's highest temperature in whole Finland.

Some ranks of warm winters based on web-available bulletins by NMHSs are given below (Most countries have not published a rank statistic since the temperature of this winter (2016/17) were for many countries about normal).

Table 3.3: Seasonal rank statistics for winter mean temperature (2016/2017) as provided by the NMHSs.

Country	Rank	Anomaly in °C	Start of time series
Austria	~20 (14 in the mountains)	0.5 (+1.2)	1767
Germany	21	+1.6 (1961-1990)	1881
Norway	8	+3.7 (1961-1990)	1900

The third-warmest **spring 2017** in Switzerland, since measurements started in 1864, was recorded with country wide anomaly of 1.7°C above the normal value 1981–2010. March (the second-warmest since observations began) was 3.3°C, April 0.5°C and May 1.1°C above the normal value. The spring in Spain was extremely warm with an average temperature 1.7 ºC above its normal value. It was the hottest spring since1965, exceeding by 0.1 ºC the highest spring in the series recorded before, the one in 2011. Spring in Spain began with a warm March, with a mean anomaly of +0.9 ºC. April was very warm with an average temperature exceeded by +1.9 ºC its normal value, while May was extremely warm with a mean anomaly of +2.4 ºC.

From Spain, **France** and **Slovenia** 5 heat waves were reported for the **summer 2017**. During summer in **Spain** there were frequent episodes of temperatures higher than normal, both in the

peninsula and in the Balearic and Canary Islands. There were three remarkable heat waves. That from 13th to 21st June, which affected mainly the west, center and northeast of the peninsula; that from 12th to 16th July, when the highest temperatures of the summer were registered and that affected mainly to the south and center of the peninsula; and the one from 2nd to 6th August which affected mainly the south and east of the peninsula and the Balearic Islands. The highest temperatures in principal stations were observed during the first days of the heat wave from 12th to 16th July. In this heat wave it is remarkable the maximum absolute temperature of 46.9 ºC which was observed in Córdoba Airport on 13th. In eight principal stations of the southern half of the peninsula the highest temperature observed exceeded the maximum absolute temperature previously recorded in any summer month. It was the second hottest summer since 1965, only below 2003.

The third-warmest spring in Switzerland was followed by the third-warmest summer since analysis started in 1864. Averaged across the country the summer temperature rose +1.9°C above the normal value 1981–2010. Only the summers of 2015 and the legendary hot summer of 2003 were warmer: the former with +2.3°C, the latter with +3.6°C above the normal value. There were five heat waves in Slovenia during summer, but none of them lasted longer than 8 days.

Summer 2017 in Slovakia, with a country average temperature of 18.5°C, was the 4th warmest summer since 1961 with temperature anomaly +2.7°C compared to 1961-1990 values and +1.7°C compared to 1981-2010 values. Summer temperature at Hurbanovo was the 3rd highest (1901-2017, Figure 3.2).

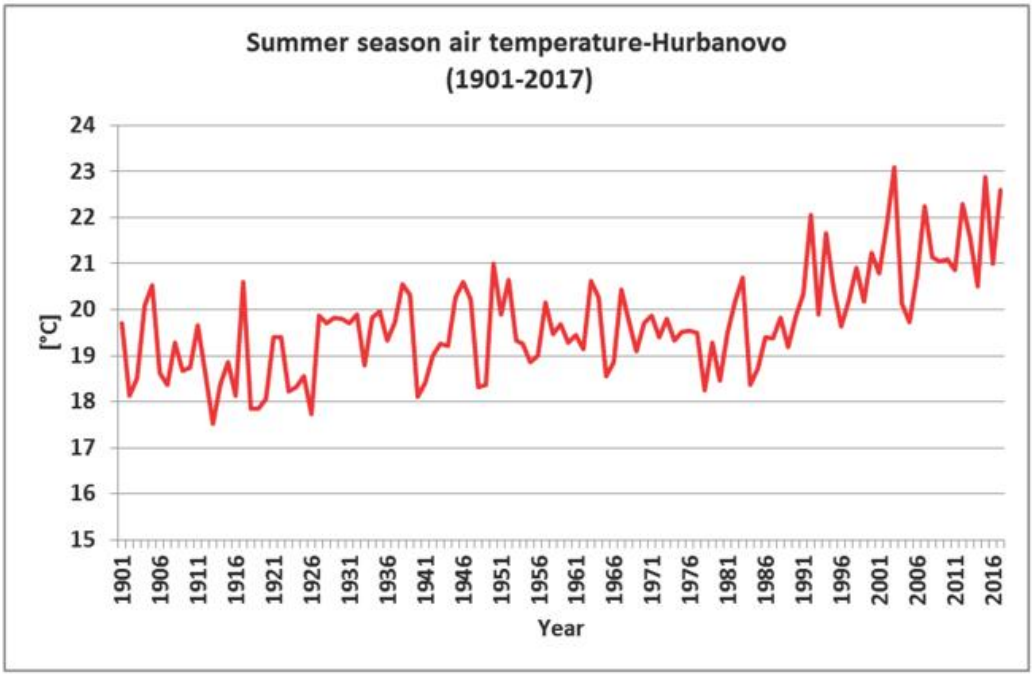


Figure 3.2: Summer temperature at Hurbanovo for 1901-2017

The summer in **Sweden** showed an almost complete absence of really warm spells. The highest temperature in Sweden during the summer was 28.0°C. This is the lowest national maximum temperature for a summer since at least 1922.

Temperatures of **autumn 2017** were normal in most of Europe, around the Mediterranean below normal. In Spain, October was extremely warm, with an average temperature of +2.6 ºC above its normal value. It was the warmest October since the beginning of the analysis in 1965. In Poland the highest autumn temperature occurred at station Rzeszów with 29.1°C on 1.09.2017.

In the Arctic temperatures in autumn were well above normal with anomalies of +5.8°C in Svalbard Lufthavn and 5.7°C in Ny Alesund (Norway).

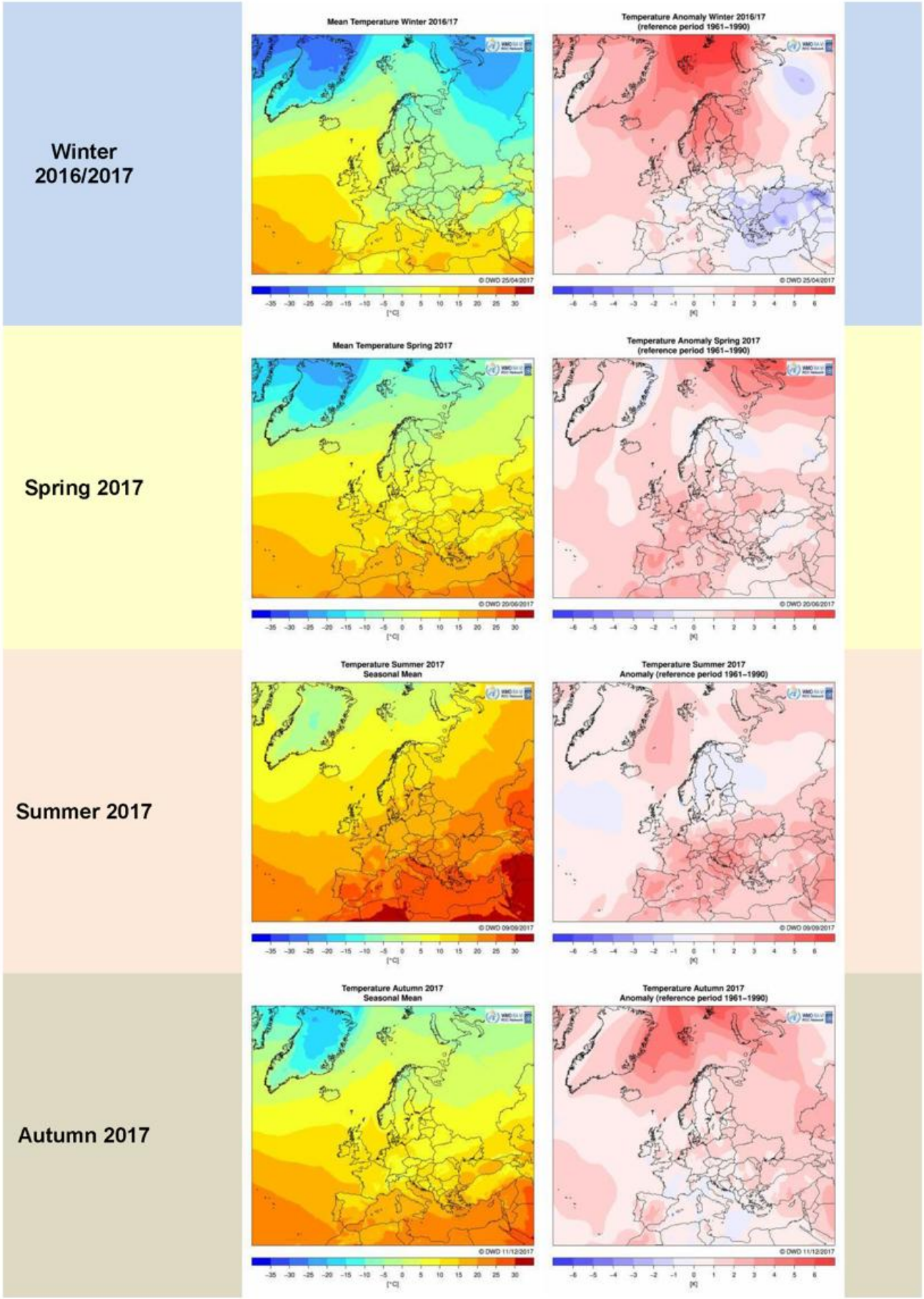


Figure 3.3: Seasonal mean temperature (left, in °C) and anomalies (right, in K) in 2016/2017, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.3. Precipitation

Precipitation anomalies in **winter 2016/17** showed lower-than-normal values in many parts of Europe except in eastern Europe, Norway and south-eastern Spain. Therefore the mean snow depth was also less than normal in many mountains although January was very cold in many parts.

Corsica (France) noted the rainiest and snowiest (several episodes) **winter** (DJF) since 1959 that culminated in a flood from 21-23 January with damages on roads and houses.

In mountain regions of **Switzerland** the thin winter snow cover in 2016/17 was at close to record-breaking levels. Davos for example recorded 27 cm, only 1 to 3 cm more than the winters with the least snow up to now: 2006/07, 1995/96 and 1989/90. Arosa registered – on average from December 2016 to February 2017 - only 31 cm of snow, Segl-Maria even as little as 12 cm. At both stations, only one winter with an even thinner winter snow cover had been observed: in Arosa this was the winter 1989/90 with 28 cm and in Segl-Maria the winter 2001/02 with only 7 cm of average snow cover.

In **spring 2017**, western and southern Europe was drier than normal while eastern Europe and Norway were wetter. **Romania** was affected by several floods in May due to storms and convective phenomena almost everywhere on numerous days during the month. On the 6th, such phenomena led to hail occurrence and flooding in Oltenia, which triggered damage to a number of households. The situation was similar in Arad County, where massive rainfalls disturbed the traffic. Rainfalls continued in the same manner until the 14th in more counties, flooding tens of houses, households, communes and county roads. In the latter half of the month, torrential rainfalls accompanied by hail, thunder and squalls again occurred in several counties and in the Capital city Bucharest, flooding tens of localities. Hundreds of households and agricultural lands were flooded and even completely covered by water, crops were destroyed and more county and national roads were blocked after the water outpoured.

Precipitation anomalies in **summer 2017** were highest in Scandinavia, European Russia, and central Europe with partly more than 150%. Greece and western Turkey were wetter than normal due to convection. Southern France, Italy, the Balkans, eastern Turkey and parts of Iberia showed a precipitation deficit.

The **United Kingdom** received 320 mm of rainfall over the summer (1 June – 30 August), 32.8% more than the 241 mm average. This makes this summer the UK's 11 wettest on record. In Germany the start of the summer saw long periods of dry weather, from the end of June onwards there were frequent thunderstorms and intensive heavy rain events. Berlin Airport measured on 29th of June 197 mm/day (low RASMUND). From 24 to 26 July, low ALFRED moved slowly through central Germany (Harz-region, Lower Saxony and Thuringia) with a precipitation amount of 302 mm/72h inducing floods and damages. Greece was also affected by thunderstorms with highest daily precipitation amount of locally up to 99 mm on 29th of August. Local thunderstorms in Turkey induced local heavy precipitation of 98.4 mm/d in August.

In central and eastern Europe **autumn 2017** was wetter than normal, while western and southern Europe was drier than normal.

In **Latvia**, September with an average precipitation amount of 129.4 mm was the 3rd wettest since 1924, while October with an average of 114.3 mm was 6th wettest on record and 1st wettest in the 21st century. Due to high precipitation amount in September and October, autumn with an average precipitation amount of 313.5 mm was the 2nd wettest in the last 94 years, while in western Latvia in some stations it was the wettest autumn. Monthly precipitation in most parts of **Lithuania** amounted in September and October to about 1.5–2.5 of the norms. Autumn became the most humid season in Lithuania since 1961 (amounting to 345 mm, i.e. more than 1.8 of the norms).

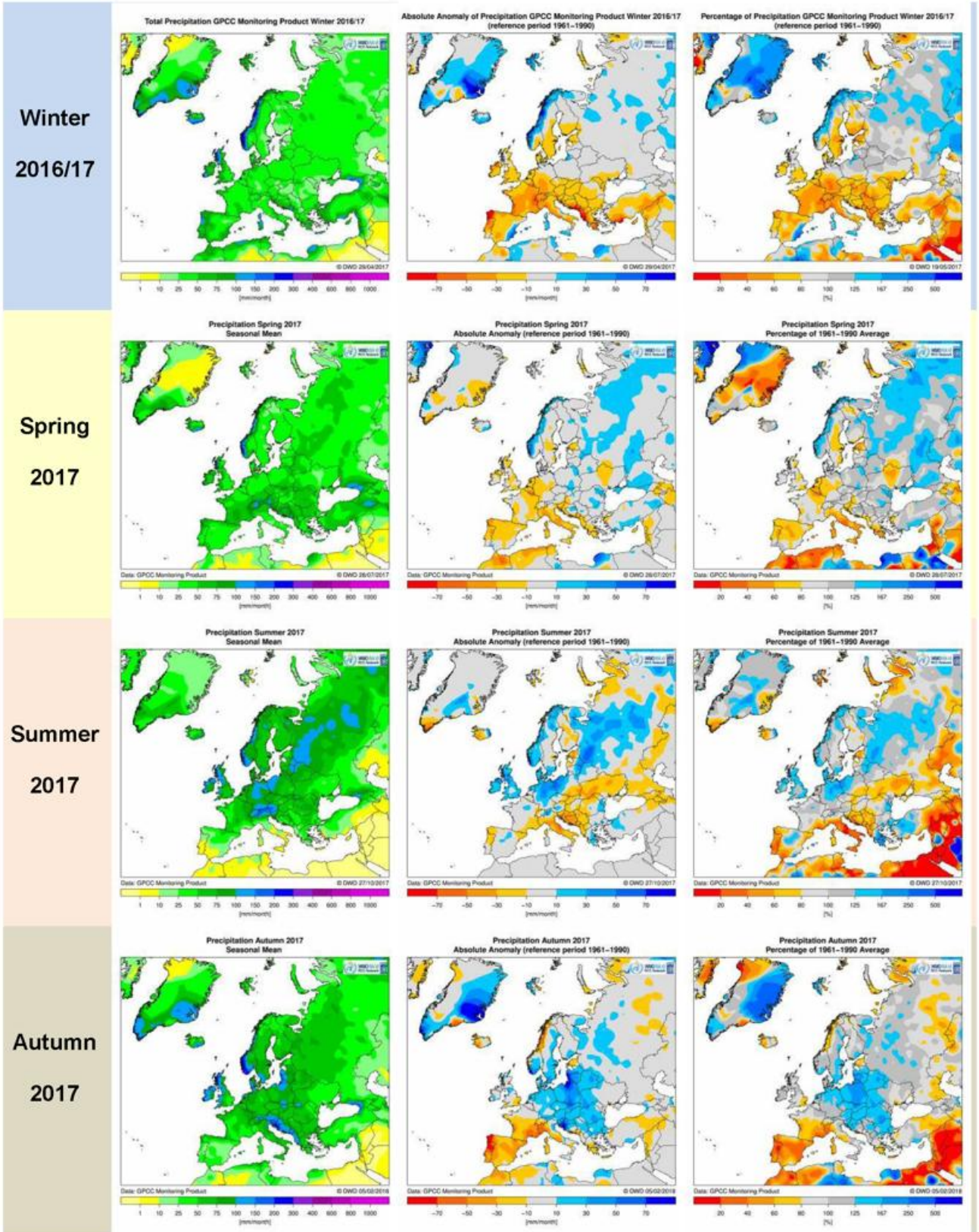


Figure 3.4: Seasonal total precipitation (left, in mm/mon), absolute anomalies (middle, in mm/mon) and relative anomalies (right, in %) in 2016/2017, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.4. Sunshine duration

Many parts of Europe received more than average sunshine in **winter 2016/17**. Only parts of Portugal, the United Kingdom, northern Scandinavia, the Baltic States, Belarus, Ukraine and Russia noted below-normal sunshine. This coincided well with below-normal cloud cover anomalies in most parts Europe. In contrast, the far north showed more clouds and less sunshine than normal in winter 2016/17.

Sunshine duration in winter **Switzerland** amounted to between 110 and 145 percent of normal values 1981–2010 across many parts of the country. In mountain areas the above-average sunny winter of 2016/17 terminated a multi-annual period with mostly below-average sunshine duration. Samedan registered 419 sunshine hours and Davos 409, bringing the winter at these stations up to the second-sunniest since the beginning of homogenous data series in 1959. The sunshine record in December 2016 contributed substantially to this sunshine record. Above-average sunshine was also registered for January 2017. For the winter 2016/17, both meteorological stations registered only a few sunshine hours below the existing record.

In **spring 2017** most of Europe registered above normal sunshine duration. Sunshine deficit was reported for south-eastern and northern Europe.

Southern and Central Europe had positive sunshine duration anomalies in **summer 2017** with up to 125% in the Balkans. Only Scandinavia, the Baltic States, and northern European Russia showed less sunshine and more cloud cover. Due to more radiation several heat waves were observed in southern Europe.

In **autumn 2017** most of Europe registered a sunshine deficit or higher cloud amount which was related to the extreme precipitation. Only south-western and north-western Europe as well as the Caucasus and parts of south-eastern Europe received more sunshine than normal.

In Austria, in this autumn the sun shone 10 % less than on average. Together with the one from 2013 and 2014 this autumn was the dullest in the past 20 years.

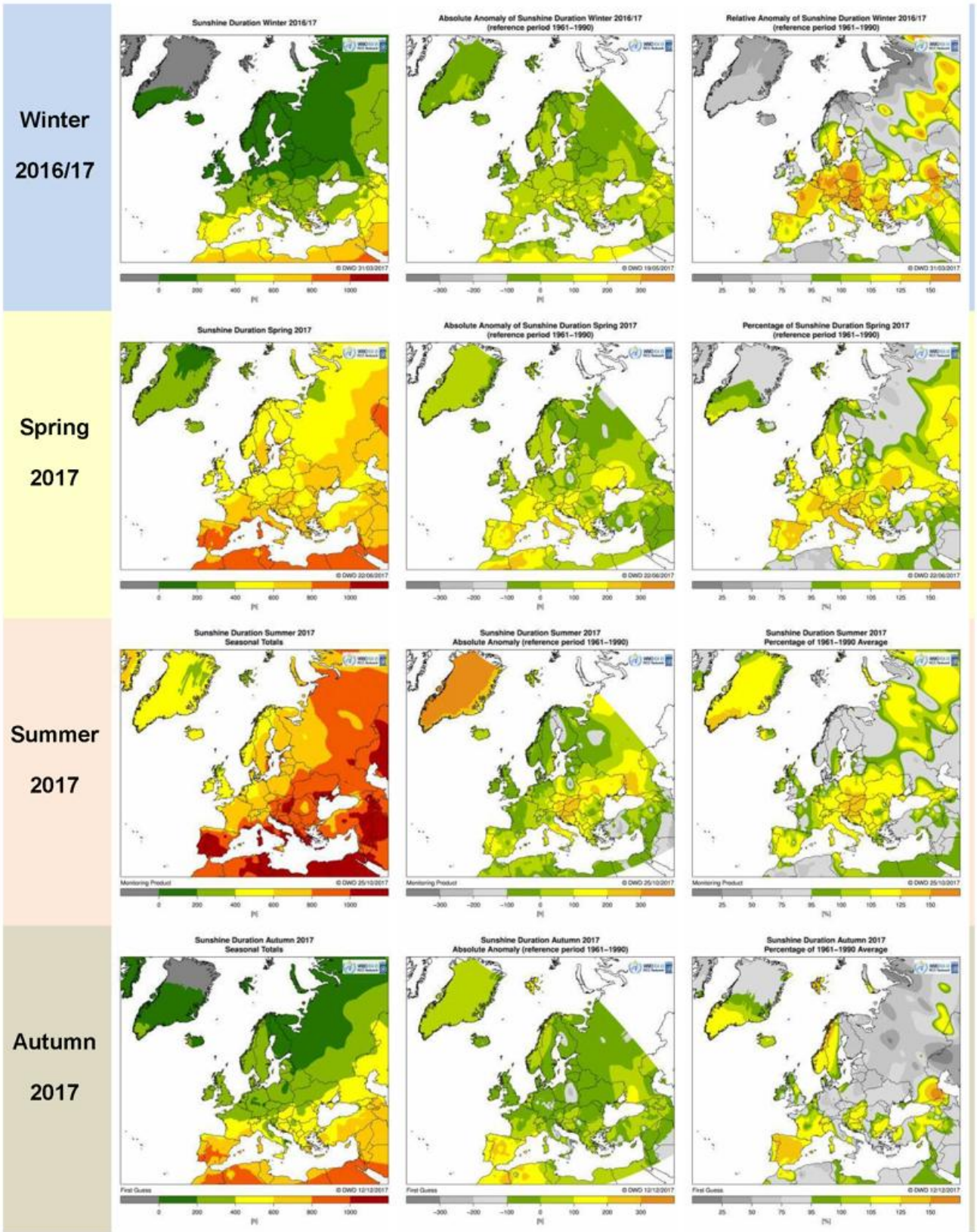


Figure 3.5: Seasonal sunshine duration (left, in hours), absolute anomalies (middle, in hours) and percentage of mean (right, in %) in 2016/17, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.5. Drought

Winter 2016/17 precipitation in **Switzerland** totals from December 2016 to February 2017 reached only half of the normal values 1981-2010 in the nationwide average. In western Switzerland and in the Valais only 30% to 50% of the normal precipitation values were recorded. Western Switzerland observed – in certain regions - a winter with the least precipitation in 45 to 55 years. A comparable winter drought period in the Valais dates back 40 years. Little precipitation also means little snow. Some places south of the Alps registered the thinnest snow cover since measurements began 55 years ago.

In **spring 2017** mild drought occurred in southern, western and northern Europe while eastern Europe was mildly wet. Only central Italy showed severe drought. The monthly amount of precipitation of 5.3 mm recorded at Findel Airport (**Luxembourg**) is the second driest value ever recorded in April since 1947. This event can be referred to as exceptional. Very dry weather was observed in **Lithuania** in May (24% of the norm) and the water level of the rivers reached its minimum due to below normal temperature. **Austria** documented a drought in northern parts from May to 20 July with locally massive harvest losses (especially winter wheat, maize, potatoes) of approximately 40% (in Lower Austria). The drought in the **Czech Republic** last from June until August. In southern Moravia even from January to August 2017 when a precipitation amount of only 284 mm (71 % of normal 1981-2010) was registered which was the 2nd lowest in 1961-2017 (affected area: approx. 8 000 km^2).

In **Belgium**, almost the whole country had a rainfall deficit in 2017. Especially the winter and spring were highly dry. For a limited period of time, pumping water as watering the gardens was prohibited in some areas of Belgium. All this caused a lot of damage on field crops. The spatial distribution of the drought index SPI-3 for April-June 2017 shows that the main part of the country was extremely dry.

Spring and summer atmospheric droughts in the **Ukraine** have gradually evolved since April, intensified and spread in May-June and last until first half of September. Precipitation deficiencies in many areas reached 50-70% of the norm. In June the drought was classified as air-soil one of varying intensity. She has led to essential reduction of the harvest of early grain crops and late crops, namely corn, soybeans, sunflower.

Summer 2017 was extremely dry in many parts of southern Europe. Especially Italy suffers from heat, drought and water scarcity (Figure 3.7). Because of the water crisis in Italy, the government in Rome has declared a state of emergency for Lazio (with the capital Rome) and Umbria. Cooler air from north induced heavy storms with hail in northern Italy (e.g. 9th of August on Lake Garda) and tornadoes (e.g. the 10th August in the seaside resort Cavallino northeast of Venice) and reduced partly the drought.

Very dry **autumn 2017** in south-western Europe. Autumn in **Spain** has been the driest in the XXI century. Mean precipitation was only 84 mm, 59% lower than normal. In the Republic of **Moldova** between August 1st and September 20th it was hot with a significant shortage of precipitation, which contributed to the occurrence of a severe, and sometimes very severe, drought and in this period of the year, it is possible on average once every 15 years.

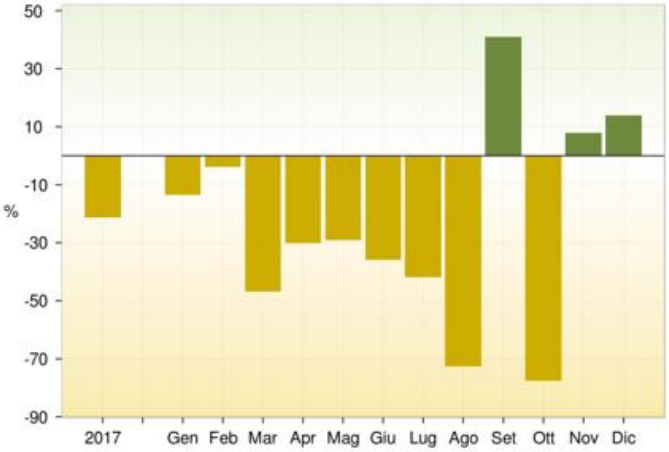


Figure 3.6: Monthly and annual precipitation anomalies for Italy in 2017, expressed as percentage of the normal value 1961-1990 (Diagram as provided by the ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

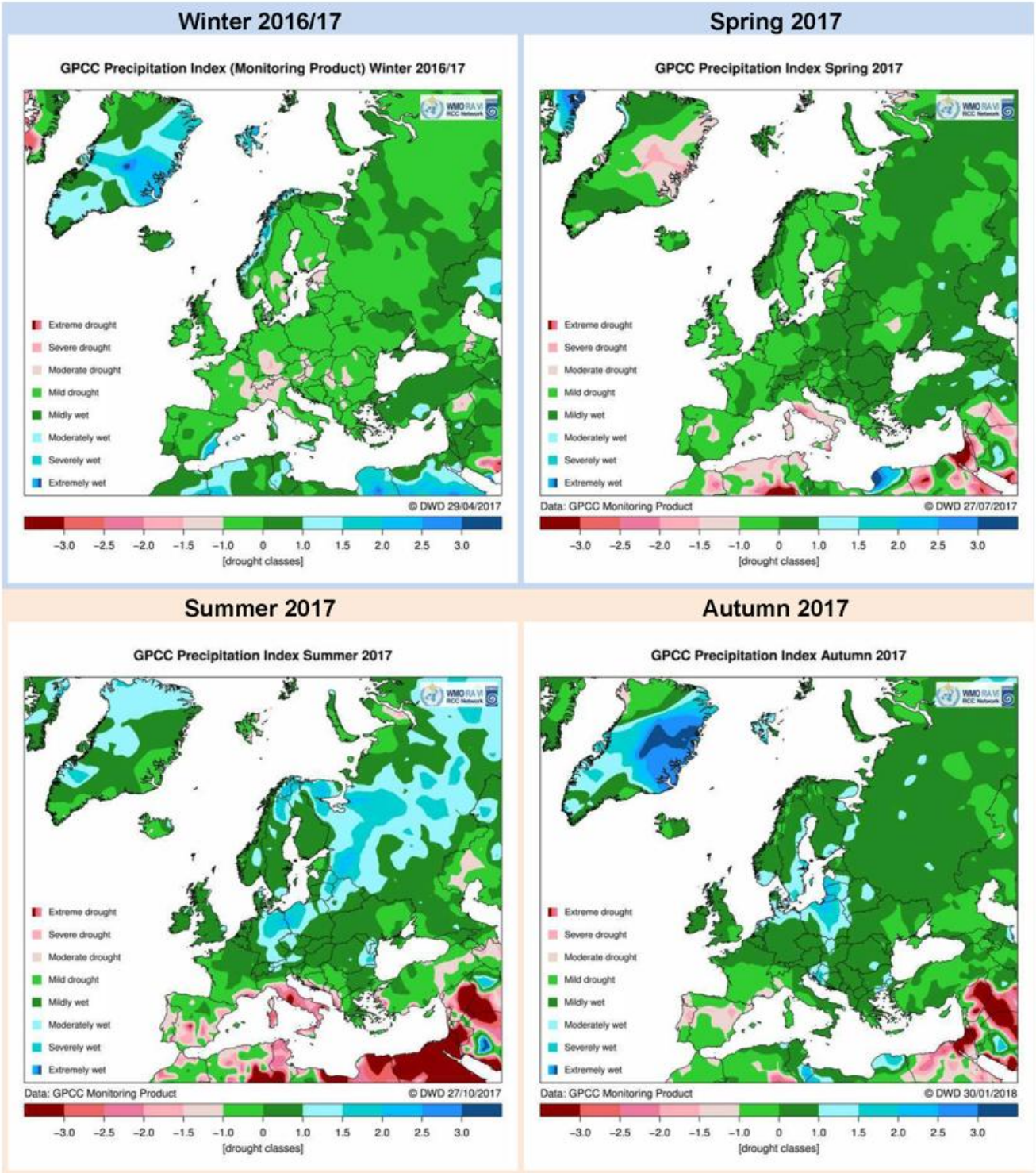


Figure 3.7: Seasonal standardized precipitation index (SPI, in drought classes) in 2016/2017, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

4. Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2017 on the Climate in WMO Region VI - Europe and Middle East (available on http://www.dwd.de/rcc-cm).

It contains highlights, means and anomalies of sea level pressure, temperature, precipitation and sunshine duration for each month as well as monthly overviews of extremes and notable events.

4.1. Sea surface pressure and circulation indices

This chapter about atmospheric circulation provides information on selected northern hemisphere teleconnection indices which are considered to be relevant for WMO RA VI and it discusses influences of circulation patterns upon anomalies and outstanding events. The information is based on the "Monthly Bulletins on the Climate in WMO RA VI" and was completed by reports of the NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/upper troposphere not shown here. (See http://www.ncdc.noaa.gov/teleconnections/ and http://www.cpc.ncep.noaa.gov/products/CDB/index.shtml)

Table 4.1: Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference and the Arctic Oscillation, for January to December 2017.

Year	Month	NAO	EA	EA/WR	SCA	POL	AO
2017	1	0.05	-1.15	0.63	0.17	0.96	0.94
2017	2	0.69	0.58	1.14	0.67	-0.38	0.34
2017	3	0.37	1.03	-1.02	-1.02	0.73	1.37
2017	4	1.74	-0.62	0.71	-1.45	-1.37	-0.09
2017	5	-1.72	0.54	1.48	0.95	0.46	-0.73
2017	6	0.35	2.03	0.34	-1.43	-0.11	0.40
2017	7	1.28	1.83	-0.58	0.03	-0.05	0.63
2017	8	-1.53	2.02	-2.93	-1.57	1.83	0.15
2017	9	-0.45	1.58	-2.52	0.46	-1.66	-0.49
2017	10	0.71	0.62	-0.02	0.30	-1.17	0.69
2017	11	-0.14	0.12	-1.21	-0.08	-2.23	-0.08
2017	12	0.73	-0.50	-1.63	-0.48	-1.95	-0.06

Note that all values are standardized with reference to the period1981-2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**:ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

The winter storm "Egon" affected from 12–13 January 2017 mainly **France** and **Germany** with wind gusts of up to 40 m/s (145 km/h) and heavy snowfall. Rail and air traffic were affected. Several houses and a cathedral were damaged and one person died. The financial loss was estimated to about 350 Million Euro (MunichRe 2018).

On the 18 January in **Sweden** the mountain top station Stekenjokk recorded a mean wind speed of 47.8 m/s. This is a new Swedish record, but due to the extreme exposure of the station it might be regarded as a singular event. During the 3th and 5th storm "Axel" (in German), with wind gusts of 36 m/s (130 km/h) caused fallen trees and traffic disruption in **Austria**. The majority of damage, like uprooted trees and damaged roofs, was reported in the eastern part of Austria. On the **German** coasts storm "Axel" caused storm surges with rock slide, flooding, fallen trees and heavy snow fall.

Several storms affected Europe in February 2017. From 2nd – 5th in **Portugal** a maximum wind gust of 36 m/s (129.6 km/h) was measured in Guarda. **Spain** reported storms from 1st – 4th of February in many provinces with maximum wind gusts of more than 25 m/s (90 km/h). In **Slovakia** the highest maximum wind speed (gusts: 61.6 m/s or 222 km/h) occurred at Lomnický štít (2634 m a.s.l.) in recorded history (at least from 1951) on 24th of February. In **Ireland** storm "Doris" (named by MetOffice; 23rd Feb) brought the month's highest wind gust of 39 m/s (141 km/h) at Mace Head.

Strong wind in February

(Contribution from Instituto Português do Mar e da Atmosfera, I.P.M.A.)

Between the 1st and 5th of February heavy precipitation and strong wind occurred in the territory of Portugal, especially in the northern and central regions.
Between the 2nd and 5th of February the wind was moderate to strong on the west coast, with wind gusts of 60-80 km/h, and strong to very strong in the highlands with wind gusts of 100-110 km/h. During this period, high and persistent values of wind intensity were recorded in some places in the North and Center regions, with values above 100 km/h (Guarda, Penhas Douradas, Mogadouro, Moimenta da Beira and Vila Real stations).

In the early morning and late afternoon of the 3rd and early morning of the 5th of February there was a persistence of high values of wind intensity at more than 10% of the stations, namely with wind mean values above 40 km/h and gusts above 70 km/h (Figure 4.1). The highest value occurred in Guarda weather station at 04:20 UTC, 129.6 km/h, which exceeded the previous maximum (129.2 km/h on January 23rd, 2009).

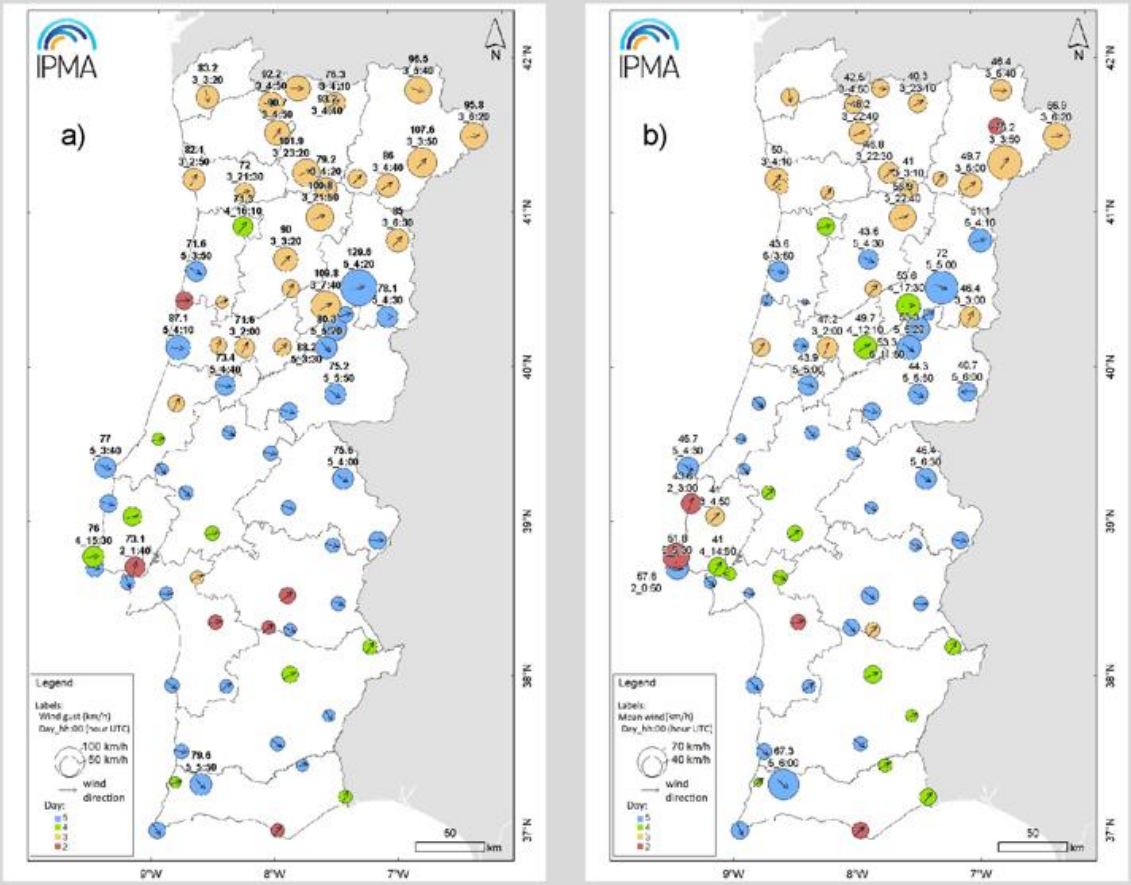


Figure 4.1: Maximum values of instantaneous wind intensity (a) and mean wind (b), respective direction, day and hour of occurrence, in IPMA observation network, 2nd to 5th February, 2017

Europe was affected by several storms in **March 2017**. On March 4, 2017, in **Austria** a heavy Foehn storm on the mountains in Vorarlberg, Tyrol and Salzburg caused numerous storm damages. Numerous trees were uprooted by wind peaks of up to 44 m/s (160 km/h). In Tyrol, railway lines were interrupted by fallen trees. In Salzburg, several ski lifts were closed because of the storm. During the 6th and 7th March storm "**Zeus**" passed **France** with strongest gusts of about 35 m/s in Brittany (tornadoes were also observed and power breakdown). On the coasts, they reached about 40 m/s and even 53 m/s at station Ouessant and 54 m/s at Camaret-sur-Mer, new absolute records. The system moved across the Mediterranean with strongest gusts of about 51 m/s at Saint-Raphaël (near Cannes) and 40 m/s at Calvi (Corsica). Storm "Zeus" was accompanied by heavy precipitation of up to 30 mm/day in south-eastern France, above an elevation of 300 m as snow.

In **April 2017** Europe was still affected by several storms. Especially from 27 to 29.04.2017 low "**Tarek**" affected Europe from southern Spain to Belarus with locally heavy precipitation. In southern **Spain** over 100 mm were accumulated at station Huelva and more than 200 mm in the City of Ceuta (Spanish enclave in Africa). The Alps were also affected by snow and rain. **Switzerland** reported several new records of snow depth for the second half of April. In St. Gallen 35 cm snow were accumulated during 2 days. The maximum precipitation amount in **Germany** also occurred in the Alpine region with 237 mm/month at station Zugspitze. At the end of April the precipitation in south-western **Austria** was also extreme with 256 mm/48hours at station Loiblpass (return period of once in 40 to 50 years) with a monthly total of 340 mm (or 108% of the reference 1981-2010). In **Slovenia**, at station Vogel 626 mm/month and 269 mm/day were registered

On 29 **May 2017**, a hurricane affected Moscow (**Russia**), with wind speed as strong as 29 m/s, caused the greatest number of victims on record: 11 people were killed and 70 were injured. In a few minutes, the wind fell thousands of trees, damaged many cars and roofs of 30 houses, and stopped the operation of above-ground subway and commuter trains.

June 2017 started with some showers in western and Central Europe. Prevailing westerly currents accompanied by thunderstorms, sometimes strong wind gusts and heavy showers reached **France** on the 3rd. The west and the east flank of the Massif Central received a daily rainfall amount of 49.5 mm in Aurillac (Cantal) and 80.2 mm in Coublevie (Isère). During the 3rd the cold front (of low "Heinrich") passed **Germany** with hail and heavy precipitation. An amount of 105.6 mm during several hours at station Ludwigschorgast (Bavaria) causing floods. During the 22nd of June a low pressure trough passed northern **Germany** with showers and thunderstorm. Locally heavy rainfall of 72 mm in Göttingen was measured and 37.8 mm in Potsdam.

Strong thunderstorms from the south-west passed **Switzerland** from the 24th to the 25th of June. At the southern side of the Alps station Lugano measured a rainfall of 81.5 mm within one hour (the last record with 63.8 mm dates back to 12th of September 1994). Until the end of the month several depressions passed the Alps with heavy precipitation. Together with the heavy rainfall at the beginning of the month, the southern side of the Alps and the Engadin received precipitation sums well above the normal 1981-2010. At station Lugano a new June record with a sum of 493.3 mm was registered (measurements started in 1864). At station Crana-Torricella an amount of 33.5 mm was measured during 10 minutes.

In **July 2017** in Austria out of a thunderstorm with heavy rainfall and hail a tornado of the F1 category developed in the vicinity of the airport Vienna-Schwechat with wind peaks up to 50 m/s (180 km/h). Only negligible damage was reported, however, there were some air traffic delays. In addition, hailstones of up to 5.5 cm caused damage to agriculture

In **August 2017** at Osmussaar, (an island) in Northwest Estonia on the 12th a wind gust of 38.2 m/s was measured and in Käravete an F(0) tornado was observed.

At the end of **September 2017**, extremely high air pressure was observed in Sweden. On the 28th, a new Swedish air pressure record was recorded for September with 1044.1 hPa in Lycksele and Åsele in southeast Lapland. Storm „Sebastian" passed Austria in the middle of the month with wind gusts of 31 m/s (110 km/h) causing uprooted trees and unroofed houses.

Ex-Hurricane "**Ophelia**" (named by the US National Hurricane Center) reached on 16th of **October 2017** the British Isles. The strongest winds were around Irish Sea coasts, particularly west Wales, with gusts of 43 m/s (155.6 km/h at Roche's Point, Ireland) with cancelled flights, closed roads and railway lines and disrupted ferry services between Wales and Ireland. On 5th of October 2017, storm "**Xavier**" crossed Germany, with wind gusts up to hurricane force (118 km/h and more) even in the lowlands. In northern Germany heavy rain with locally more than 50 mm/d was noted. In other European countries, such as Netherlands, Poland and the Czech Republic - with the exception of exposed layers - gusts of up to 11 Beaufort (up to 117 km/h) were registered.

During the 29th of October northern Austria was hit by a storm (named "**Herwart**" in Germany and "**Ingolf**" in Scandinavia) with wind gusts of up to 50 m/s (180 km/h) that led to operating delays on some Austrian airports, about 150.000 homes were left without power. The same storm reached also the Czech Republic with wind gusts over 30 m/s in some locations, over 50 m/s in mountain stations (Krkonoše Mountains). The result of "**Herwart**" was a loss of about 20 Million Euro and 3 dead (MunichRe 2018).

Spain reported wind storms from 10-11 November 2017 in many provinces with maximum wind gust of more than 25 m/s (90 km/h). The cyclone "**Ylva**" (named by Met Norway, "Reinhard" in German) affected northern Norway with very strong winds from 22 to 24 November. The strongest wind was recorded at the station Narvik - Fagernesfjellet (Nordland) with a wind speed of 47.5 m/s.

Medicane "Numa" over the Adriatic Sea

(Contribution from Hellenic National Meteorological Service)

On 11 November a cut-off upper low over Tunisia accompanied by a corresponding low pressure center in the sea level pressure field over the Gulf of Syrtis produced widespread thunderstorms across the central Mediterranean region, mainly over Sicily, Malta and north Ionian Sea. On 12 November, the cut-off low moved east northeast and on 13 November affected at first the west Greece and gradually the eastern areas including Attica, Cyclades, Crete, and Dodecanese islands causing locally strong flash flooding (e.g. Symi Island). Also on 13 November a second deep low over the gulf of Genoa (995 hPa surface pressure for 00UTC) pushed polar air towards southern Italy. From 15 November onwards the low widened and moved to the Central Mediterranean. Over the warm Ionian Sea the cold and humid air mass destabilized, under weak vertical wind shear, causing the formation of a Medicane (Mediterranean tropical-like hurricane).

On 15 November major flash floods hit western Attica, after a night of intense rainfall. In particular, flooding hit the towns of Mandra and Nea Peramos. According to the HNMS's radar recordings the 24 hour accumulated precipitation over the wider area of the Mount Pateras (west Attica) during 14 - 15 November was 80 mm approximately (there is no meteorological station in that region). Also the HNMS's radar recorded the intensity of rainfall over west Attica.

The figure below indicates the appearance of a Medicane on 18 November. A whirl of convective cloud and a distinct quasi cloud-free eye is obvious (Figure 4.2). However by the evening of 18 November the Medicane had dissipated.



Figure 4.2: A well-defined eye structure of Medicane over the north Ionian Sea on November 18, 12:00 UTC (Terra MODIS and Suomi NPP VIIRS true-color RGB, source: http://cimss.ssec.wisc.edu/goes/blog/archives/26136).

Several storms affected Europe in December 2017. In western **Norway** on 7 and 8 December storm **Aina** (named by Met Norway, Walter in German) came with a mean wind speed of 33.1 m/s, at Folgefonna Ski Center (Jondal, Hordaland). The station also recorded a wind gust of 40.2 m/s. On 25 December wind speed in Stavropol (**Russia**) reached 30 m/s. As result, trees were fallen, a gas pipeline and cars were damaged, and interruption of power supply was recorded. Storm Dylan on 31st December brought strong winds, and trees downed in the South West of the **United Kingdom** with travel disruption. There were fallen trees also across Northern Ireland. The month's highest gust in **Ireland** was 34 m/s (124 km/h) reported at Malin Head, Co Donegal on the 31st Dec.

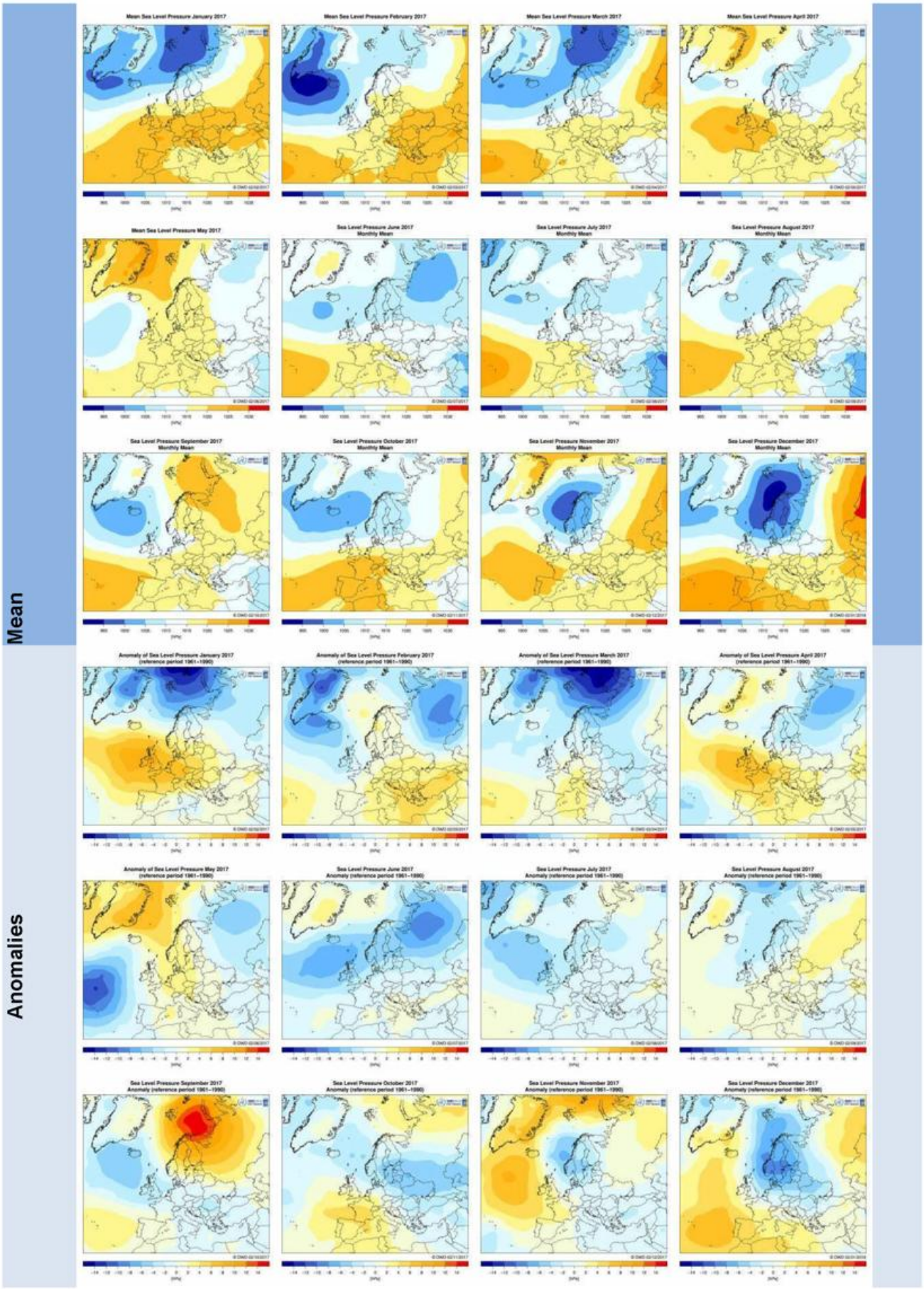


Figure 4.3: Mean and anomalies of sea level pressure in hPa for each month of the year 2017. (First row January, February, March, April; reference period 1961-1990).

4.2. Temperature

In most of the months and sub-regions it was warmer than normal as can be seen from Table 4.2. The Nordic und Baltic Countries had positive anomalies throughout the whole year 2017 and in eastern Europe in March and December anomalies above +4°C occurred.

Table 4.2: Monthly and annual area average temperature anomalies in °C for each sub-region in the year 2017 (reference period: 1961-1990; definitions of the sub-regions see Figure 1.1).

Region	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Central and western Europe	1.35	-1.25	2.26	3.38	0.61	1.99	2.76	2.25	2.68	-0.07	-0.39	0.68	1.34
Nordic and Baltic Countries	1.52	2.30	3.05	2.18	0.14	0.17	0.32	0.60	1.02	1.86	1.35	2.03	3.28
Iberia	1.49	-0.42	1.72	1.79	2.57	3.17	4.08	3.07	1.27	-0.64	0.76	0.49	0.06
Mediterranean	1.44	-2.60	2.03	3.03	0.85	1.34	3.02	3.36	2.42	1.70	0.58	0.45	1.07
Eastern Europe	1.47	2.00	2.54	4.54	-0.26	-1.51	-0.91	-0.17	1.36	3.40	-0.21	2.01	4.80
Middle East	1.42	0.41	-0.15	2.21	0.58	0.77	1.18	1.46	2.07	3.39	1.38	1.40	2.34

In January 2017 a cold wave occurred in central and southern Europe. **Spain** reported a cold wave from 15 provinces with a monthly minimum temperature of -4.0°C and a deviation from normal of -2.5°C. The most significant cold spell of the year occurred from 18th to 20th of January, due to an invasion of a mass continental cold air that affected the Iberian Peninsula and the Balearic Islands, with the lowest temperatures of the year. The coldest temperatures recorded in 2017 at principal stations were observed in Puerto de Navacerrada with -13.8ºC on 18th January, Molina de Aragón with -13.4ºC on the same day, Salamanca Airport on 19th with -10.9ºC and Albacete Air Base with -10.2ºC on 18th.

The first cold wave encompassed **Serbia** from 6 - 12 January 2017. Cold wave first affected Vojvodina and mountain regions on January 6, spreading to the entire country on January 7 and lasting until January 12, 2017. During this cold wave, the departure of the minimum daily air temperature from the mean minimum daily air temperature reached -20.4°C in Leskovac. The second less intensive cold wave was registered from 20 to 24 January 2017 in most of Serbia. The third cold wave was recorded in a period from 27 to 31 January 2017 in Pozega and others.

Greece experienced a cold wave during 7-12 January 2017 with low minimum temperatures (Florina Tmin=-22.7°C on 11th January). Heavy snowfall caused huge problems in transportation; hundreds of vehicles were trapped in highways; public transportation in Thessaloniki collapsed and flights were suspended. Migrants in Greece suffered from very low temperatures and were housed in commercial buildings and ships; one migrant died due to harsh weather conditions.

Minimum temperatures in **Bulgaria** in January 2017 in some parts of western Bulgaria were close to the absolute minimum possible at least once in 50 years (-26°C in Kyustendil and -27°C in Pernik). Seven-day cold spell gripped the most part of Bulgaria in the period 6-13.01.2017 and was caused by the advection of very cold air masses from northern Russia related to the amplification of a ridge over the eastern parts of North Atlantic and a trough downstream which thereafter formed a cut-off low over south-eastern regions of Europe. In the Republic of **Moldova** January 7-9 was extremely cold. The average daily air temperature in these days was -10..-16ºC, which is 8-13ºC below the norm and it is observed in January on average once in 10-20 years.

The mean temperature in **Norway** was +3.9°C above normal, the 12th mildest January month since 1900. A long lasting Foehn wind caused the daily mean temperature at Sunndalsøra to become

13.8 °C, on 25 January. This is equivalent to the daily normal for 4 July, and is probably the highest daily mean temperature ever recorded by a Norwegian weather station in January.

In February 2017 only in the south-eastern part of the RA VI region negative temperature anomalies occurred. According to the temperature anomaly map all other regions showed positive temperature anomalies with its maximum in the north. This is a drastic picture but the rank statistics show that it was in many countries only the 9th warmest year. An overview of the temperature anomalies is shown in the following table.

Table 4.3: Rank statistics, monthly average temperature and anomalies (in °C) from several countries of the RA VI for February 2017.

Country (station)	Monthly average temperature (°C)	Anomaly (°C)	reference period	rank
Austria		+2.9	1981-2010	15th (since 1768)
Belgium (Uccle)	6.1	+2.4	1981-2010	
Denmark	1.9	+1.9	1961-1990	
France		+2.5	1981-2010	10th (since 1900)
Germany	2.9	+2.5	1961-1990	24th (since 1901)
Iceland (Reykjavík)	2.8	+2.5	1961-1990	
Netherlands	4.9	+1.7	1981-2010	
Norway		+2.7	1961-1990	
Portugal	11.05	+1.07	1971-2000	9th (since 1931)
Spain	10.2	+1.6	1981-2010	8th (since 1965)
Svalbard	-6.9	+9.3	1961-1990	
Switzerland		+2.7	1981-2010	
United Kingdom	5.3	+1.6	1981-2010	9th (since 1910)

In **Denmark** the temperature anomaly was +1.9°C above the reference period of 1961-90 but the record was found in the year 1990 with an anomaly of +5.5°C. In **Switzerland** several stations reported new daily maximum temperature records. In **Norway** 12 stations observed new daily maximum temperature records. Extreme monthly temperature anomalies were registered in the Arctic e.g. at Svalbard Lufthavn with a monthly temperature of -6.9°C (or +9.3°C above the normal period 1961 - 1990).

Several stations in **Norway** measured 20 °C or more on 26 March 2017. This is the earliest date with such high temperatures. In Vestfold the record from 26 March 2012 was hit. Together with 2012, March 2017 (8.5 °C) was the warmest March since the beginning of station records in **Luxembourg** in 1947. The March temperature in Germany, with 7.2 °C, was +2.9 °C above the long-term average (reference period 1981-2010). It was therefore the warmest March since the beginning of the analyses in 1881. The month was warmer than normal everywhere - on the coasts locally less than +2 °C (Helgoland +1.6 °C) and isolated in the Alps more than +4 °C (Oberstdorf +4.1 °C).The warmest March of the 251-year observation history in **Austria** was noted with an anomaly of +3.5°C above the long-term average. In second place is March 1994 with a deviation of +3.4°C. In **Switzerland** temperature deviation in March reached +4.1°C and therefore the second rank after March 1994 with +4.3°C. At several stations new records were set since the beginning of measurements.

April 2017 was warm over western and cold over eastern Europe. The first half was warmer than normal in many parts of Europe, the second half much colder except of Iberia and the United Kingdom. At many stations new minimum temperature records were set e.g. in Switzerland, Germany and Austria. In **Austria**, after the warmest March in measurement history and a very mild start of April, the apple blossom started at the beginning of the second week in April. This was the 3rd earliest beginning of the apple blossom since documentation began in 1943. In the midst of April cold air from the north reached **Central Europe** with ground frost that caused widespread frost damage in many fruit cultures. Many farmers tried to protect their fruits by sprinkling water on the trees against the frost. The agricultural damage in Austria summed up to about 45 million Euros. In **Switzerland** it was one of the earliest fruit-tree flowering in the measurement series.

Severe night frosts on 20 and 21 April, however, resulted in a lot of ruin. Substantial damage was caused above all to flowering fruit trees and budding vines. The frost period in **Slovenia** during 21 and 22 April caused considerable damage in agriculture. The fourth cold wave in **Serbia** of 2017 lasted from 18 to 22 April, with the longest duration, of 6 days, between 20-25 April, in Sjenica.

Severe thunderstorms, accompanied by torrential precipitation or hail events, hit many regions in West and Central parts of **Bulgaria** on 15 and 16 April. In some places, a hail precipitation with size about eggs was registered. On 20 April a new snow covers up to 10 cm was observed in non-mountainous parts in North Bulgaria. Low temperatures, snowfall or frost caused considerable damages to the fruit crops.

Spring-like temperatures were recorded during the first half of April in **Finland** with highest temperature (14.4°C) at station Hattula on 10 April. The second half was much colder with snowfall and graupels of 1 to 2 cm in size. In **Estonia** it was the fourth coldest April since 1961 with 3.0°C (together with April 1974 and 1971). In **Russia** in the region around Smolensk minimum temperature falls down to -15°C.

May 2017 was warm in south-western and cold in north-eastern Europe. The highest maximum temperature in **Norway**, 31.8 °C, was recorded on 27 May at Sigdal – Nedre Eggedal (Buskerud). This was a record high temperature for May in Norway and also the highest temperature of the year. In **Sweden** the highest temperature for the year was recorded at Oskarshamn with 30.1°C on 28 May. This is only the third time during the last 100 years that the highest temperature in the nation has been reported in the month of May. From the 9th until 12th of May **Latvia** was affected by a cold wave, when 39 new minimum air temperature records were set. In 8 observation stations new latest snowing records were set (Observations started in 1895) leading to a reduction in harvest of fruits and berries due to late frosts (Figure 4.4).

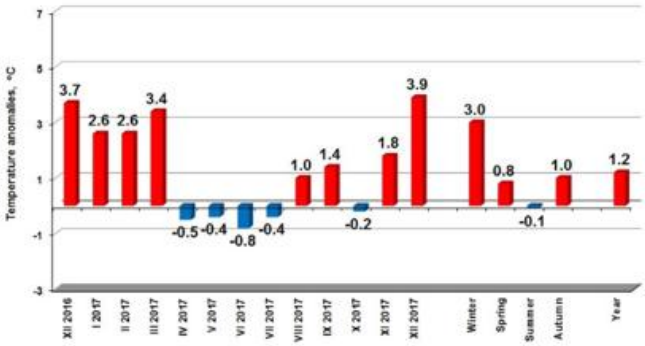


Figure 4.4: Latvian monthly, seasonal and annual mean air temperature for 2017

The weather in **Lithuania** became suddenly cold on May 8: maximum daytime temperature rose merely to 8–13 ºC, and on May 9 at night and in the morning a snowfall was observed in many regions. This extraordinary cooling with winter-related phenomena, such as wet snow-stick, snow cover and even outbreaks of frost, lasted for 6 days. During this period, even the maximum daytime air temperature ranged merely from 5 to 10 ºC, and only on May 13 it jumped locally to above 15 ºC. Mean daily temperature of those six days were typical for the end of March and the beginning of April and did not reach 8 ºC, and on some days even 5 ºC! On May 9–14 many meteorological stations observed morning frost during active plant vegetation. Air temperature dropped to -0.1...-5.5 ºC, and on the soil surface to -1...-6 ºC, on the coldest nights of May 11–12 it fell locally to -7...-8 °C at 2 cm height above the ground. A considerable damage was done to field crops, fruit trees and other plants (Figure 4.5).



Figure 4.5: Unusual snow cover during cold air intrusion on 9-11 of May, 2017 in Lithuania (Photo: from Telsiai meteorological station, provided by the LHMS)

The maximum air temperatures, recorded at **Luxembourg**/Findel-Airport on May 28, 2017 (31.5 °C) and on May 29, 2017 (31.6 °C), exceeded the existing absolute record from May 2009 (30.4°C) on two subsequent days. A heat wave during 12-13 May occurred in the central and southern parts of **Greece**. Many stations over south-eastern mainland recorded temperature records e.g. Argos measured on May 13th, 2017 Tmax = 40.6°C while its monthly average (1981-2017) is 27.0°C.

June 2017 was warm in south-western and cold in north-eastern Europe. From 17 to 21 June **United Kingdom's** temperatures exceeded 28 °C widely across parts of England, with some locations reaching 30 to 32 °C. On 21 June Heathrow (Greater London) recorded 34.5 °C, the UK's highest June temperature since 1976. The heat resulted in some speed restrictions on rail lines to avoid buckling, and there was an increased risk of high air pollution for congested areas such as the East Midlands. The daily maximum air temperature at **Luxembourg**/Findel-Airport of 35.4 °C, recorded on June 22, 2017 is the highest value ever recorded in June since 1947. June 2017 (19.1 °C) is the third-warmest June in station history. With a mean temperature of 21.2°C (2.8°C above normal) June was the 2nd warmest for France with a lot of temperature records being broken.

June was the 3rd warmest for **Serbia**, 2nd warmest for Novi Sad, Zrenjanin and Cuprija. A severe heat wave occurred from 20.06 to 2.07.2017 in **Bulgaria** with maximum temperature up to 42.5°C in Sandanski and 43.6°C in Ruse. The Heat wave in **Greece** persisted between 29 June and 3 July 2017. Most regions of Greece experienced high temperatures; the daily maximum temperatures on June 30, 2017 exceeded 40 °C in many parts especially in July. On 1st July Larissa (airport) reported a maximum daily temperature of 43.2 °C

The heat wave from 12th to 16th **July 2017** in Spain is remarkable as the absolute maximum temperature of 46.9 ºC which was observed in Córdoba Airport on 13th July 2017 turned out the 4th warmest for **Serbia** with two heat waves and record-breaking numbers of tropical nights. **Cyprus** recorded 5 heat waves and July 2017 was the warmest month recorded for at least the last 30 years. Specifically the mean provisional daily maximum temperatures of Athalassa, Prodromos, Pafos Airport, Larnaka Airport and Paralimni are the highest temperatures ever recorded for the last 30 years. From 30 July - 5 August a heat wave was observed in the **Czech Republic** with a maximum temperature 38.3 °C, such an event occurred once per five years, recently more severe heat waves were recorded in 2015, 2013, 2010. The heat wave in the **Greece** mainland last from 11 to 13 July: Maximum daily temperatures were about 40 - 41 °C**July was the warmest July ever recorded in Israel**

(Contribution from Israel Meteorological Service IMS)

Alongside with July 2012 (Figure 4) July 2017 was much warmer than normal - The average daily temperature was 2-2.5°C above normal and in most stations it ranks as the warmest on record alongside July 2012 (figure 4). If we compare July 2017 to the months of August in the past then only August 2010 and August 2015 were warmer.

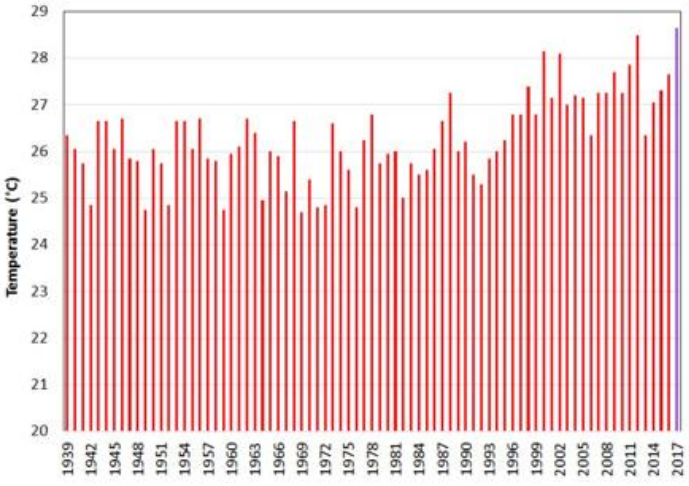


Figure 4.6: Average daily temperature (in °C) in Beit Jimal (Judean Foothills) in July 1939-2017 (Source: Israel Meteorological Service)

During the month there were three heat waves, two of them prolonged ones. The first heat wave of the month was the shorter one (July 1-4th) with temperatures reaching 40-42°C in the Negev, 42-43°C in the northern Valleys and 44-46°C in the Jordan Valley and the Arava. On July 3rd, 47.1°C were measured in Hazeva (Arava) and 46.9°C in Gilgal (the Jordan Valley). The other two heat waves were prolonged ones (on July 10-17th and on July 21-27th) yet the temperatures were not as extreme as in the first one.

The highest temperature in **Finland** in 2017 (27.6 °C in Utsjoki on 28 July) was measured in the northernmost part of the country in Utsjoki and has been this low only twice before since the 1960s (1962 and 1976).

In **Switzerland** in many areas it was one of the ten warmest August 2017 months since observations started in 1864. The warm temperatures prevailed even at night. Some meteorological stations registered the highest August minimum temperatures since measurements began: In Lugano the temperature on 5 August did not fall below 23.5°C, in Neuchâtel on 4 August not below 23°C. In Geneva on 4 August and in Basel on 3 August the minimum was not below 21.8°C respectively. On 5 August Locarno-Monti registered the second-highest August minimum with 23.9°C. All five measurement series span more than 100 years.

In **Serbia** several temperature records were broken, for example: Banatski Karlovac observed air temperature of 40.1°C thereby breaking the previous record of 39.8°C set on August 22, 2000. On August 6, Zrenjanin observed air temperature of 40.4°C besting the previous record of 39.6°C set on August 24, 2012. Absolute maximum air temperature anomalies in **Croatia** for August 2017 were above the corresponding average (1961 - 1990) at the all stations considered and were within the range from 3.5°C to 8.2°C. The historical comparison reveals that in August 2017 13 out of 27 stations exceeded or was on par with the previous maximum air temperature records of the available data series. The highest maximum temperature with 42.3°C was measured at station Knin. **Bulgaria** observed a heat wave in the south during the period 30.07-13.08.2017 (40.8°C in Sandanski) and in the north from 30.07 to 07.08.2017 (40°C in Vidin).

September 2017 was warm over most of eastern Europe and cold in Central Europe. On September 18, station Serres (**Greece**) reported daily maximum temperature of 39.9 °C while its normal monthly value is about 28.0 °C. Furthermore during 10 consecutive days (11-20 September), the maximum temperatures were above 34.0 °C. Also, station's mean monthly maximum temperature was 31.2 °C, which is the second highest mean monthly value in September since 1961 (previous mean monthly record of maximum temperature was 1994 with a value of 33.3 °C). On September 18, Tithorea station located in central mainland of Greece reported daily maximum temperature of 41.0°C.

It was the warmest October 2017 of the last 87 years in mainland **Portugal** and also the highest average maximum temperature was recorded with 27.11 °C or +5.88° C above the normal; extreme temperature values (38.5°C at station Alvega during the 6th) for the month of October were exceeded, especially on the 15th (the hottest day of the month). At the same time **Spain** measured a maximum temperature of 35.8 °C at station Badajoz/aeropuerto. The highest temperatures between were registered in Canary Islands (Spain) during the episode of high temperatures in mid of the month, highlighting the 38.7 °C in Fuerteventura/airport and 38.6°C in Tenerife South/airport measured on day 14. In the extreme north temperature anomalies were also extreme. In the Norwegian arctic Jan Mayen was the mildest station with a mean temperature of 4.7 °C (+4.6 °C above the normal). Svalbard airport had a mean temperature of 0.5 °C (+6.0 °C above the normal).

In November 2017 central and eastern Europe was warmer than normal while the temperature anomalies in southern Europe were normal or below the reference period of 1961-1990. In most parts of **Finland**, November was 1-3 °C warmer than usual. **European Russia** was also warm, particularly in the northeast of the Region, where mean monthly air temperature anomalies exceeded +5°C.

Temperature anomalies in December 2017 were above normal in eastern Europe and below normal in southern Europe. Throughout December, abnormally warm weather was recorded over **European Russia**. From one ten-day period to the other, both the value of positive ten-day anomalies and the area of the warm source were increasing. Record-breaking maximum temperatures were registered in central European Russia, the Black Earth Zone, northern Caucasia, the Crimea and the Volga Region. On 17 December, the absolute air temperature record for the entire period of observations was registered in Moscow: air temperature in the morning was +8°C.

At the beginning of December Alexandroupolis (**Greece**) recorded during 4 consecutive days daily maximum temperature equal or above 18.0 °C while its monthly normal value (1971-2000) is about 10.0 °C. Furthermore, station's mean monthly maximum temperature was 13.5 °C.

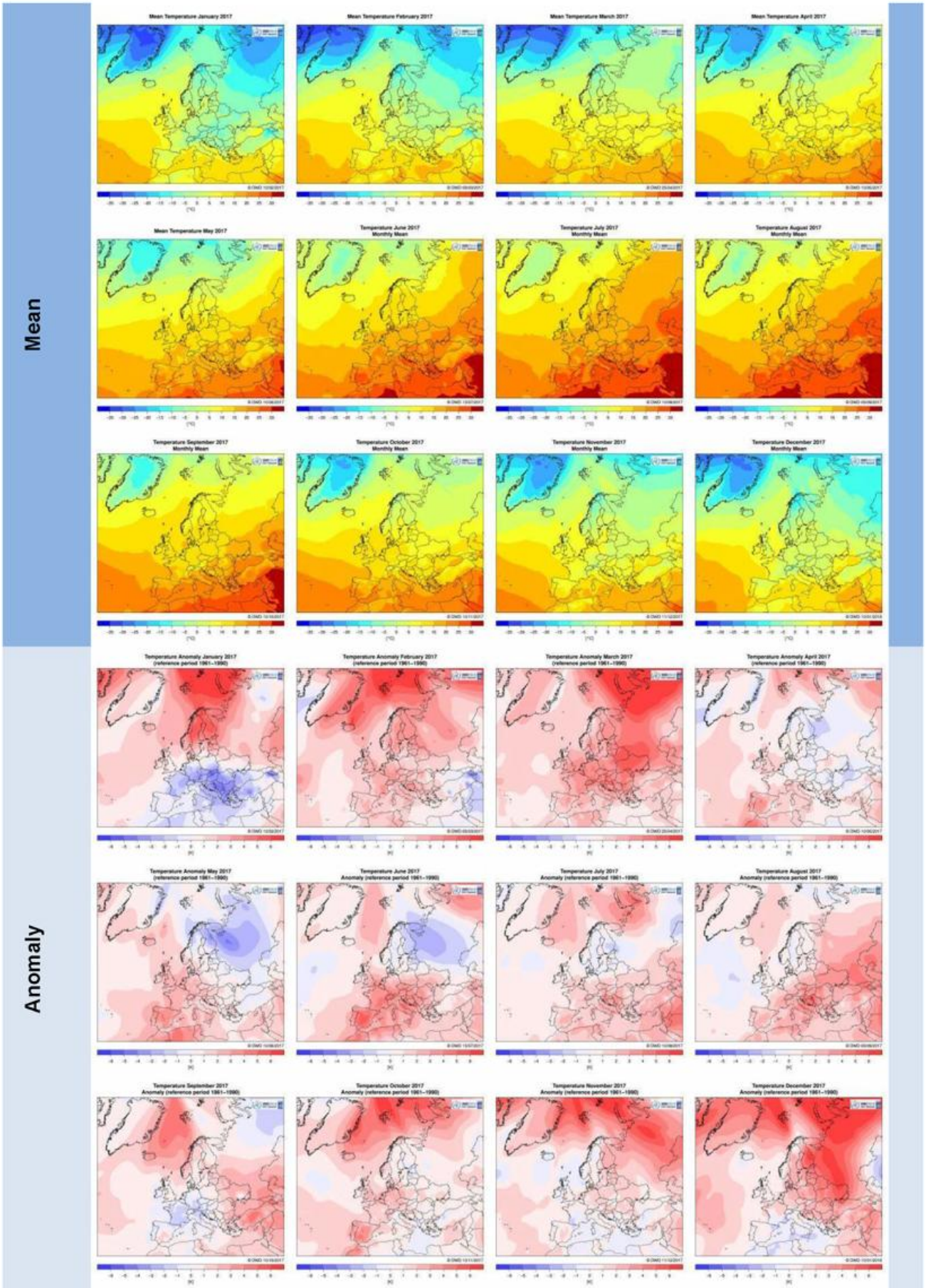


Figure 4.7: Mean and anomalies of temperature (in °C) for each month of the year 2017. (First row January, February, March, April, …; reference period: 1961-1990).

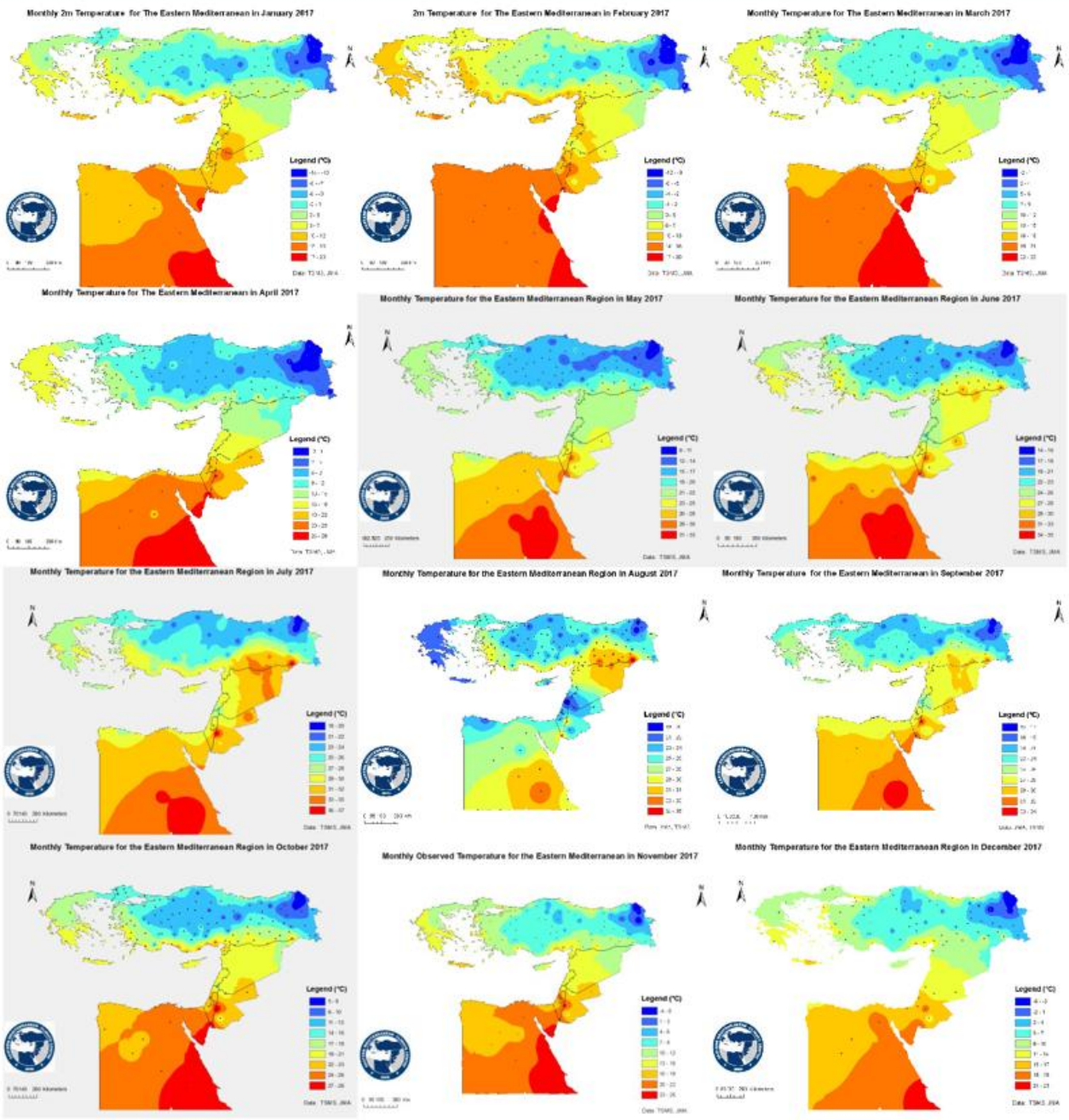


Figure 4.8: Monthly mean temperature (°C) for the eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC http://www.emcc.mgm.gov.tr/prediction.aspx; first row January, February, March, …).

4.3. Precipitation

One of the heaviest rainfalls in **Spain** this year occurred from 18th to 22nd **January 2017** and affected Baleares, Valencia Region, Murcia, Almeria, south and northeast Catalonia, Southeast Aragón and east Castilla-La Mancha, which in many places were snow precipitations. In the far northeast of Alicante and in the north area of Mallorca the accumulated precipitation during this event was more than 250 mm (117 mm/24h recorded in Castellón de la Plana / Almazora on January 19th).

From 27th to 29th January on **Cyprus** snow was observed at mountainous and semi-mountainous areas and reached locally 10 cm and at the highest peak-Olympos 15 cm. Last time of snowfall in Akaki on the 1st January (Nicosia district) was in 1952. January was not only very cold but also a very snowy month in **Bulgaria** with positive precipitation anomalies, especially in East Bulgaria (257% in Omurtag, North-East Bulgaria; 287% in Sredets, South-East Bulgaria). The snow cover reached 1m in Isperih, North-East Bulgaria. Wet conditions dominated in most parts of **Greece** during the second half of January. The precipitation amounts for January were 140 -260 % above climatological normals (1971-2000) for the greatest part of Greece.

From 1th to 6th **February 2017** in **Spain** a heavy precipitation event mainly affected the northern half of the peninsula which accumulated more than 200 mm in some areas of Galicia, and, in the same month, the one from 11th to 13th that affected to the west of the peninsula and were more intensive over the Central System (137 mm/24h recorded in Puerto de Navacerrada on February 12).

Floods on February the 11th in eastern Algarve

(Contribution from Instituto Português do Mar e da Atmosfera, I.P.M.A.)

On February the 11th, strong precipitation occurred in eastern Algarve, especially in the municipality of Vila Real de Santo António. The strong and persistent precipitation and hail caused several floods in this region. The daily precipitation value on this day (00-24UTC) was 98.1 mm, however it was between 14 UTC and 20 UTC that the highest precipitation values occurred and in 1h (18 and 19 UTC) 57.8 mm was observed. Figure 4.9 shows the accumulated precipitation values (mm) in 24 hours, on February 11th, 2017 estimated by a combined method radar/udometer.

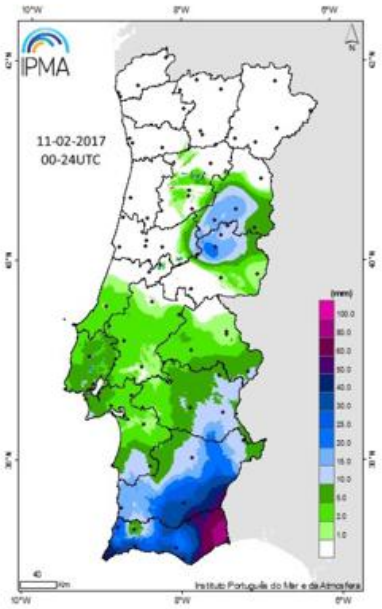


Figure 4.9: Daily precipitation (mm), on 11th of February, 2017, estimated by the combined method radar/udometer.

In **March 2017,** a remarkable precipitation episode in **Spain** from 12th to 13th affected the southeast of the peninsula, with more than 120 mm/month in some areas.

At the beginning of March, in **Lithuania** a 2–13 cm snow cover formed again in many regions, it melted by the middle of the month. The precipitation amount in **Norway** was 130% of the norm. The highest relative amounts could be found in northern Norway, from just over 200 to almost 400% of the normal. Some stations in eastern Norway got less than 50% of normal rainfall. In most countries of the RA VI the precipitation amount in March was around normal without extreme events.

In **April 2017**, the episode from 25 to 29 that affected mostly of **Spain**, with intense rainfall on 27 and 28 in the area of Huelva, Ceuta, southern Cádiz and Málaga with new daily records set in Ceuta on April 28 with 184 mm.

The southern part of Lower **Austria** and Obersteiermark (state of Styria) was affected by heavy snow fall during 19th and 20th of April with more than 750 vehicles caught in traffic jam for hours (even the whole night), temporary more than 25.000 homes were without power.

April was (according to the reference period 1961-1990) exceptionally wet especially in the middle and northeastern part of **Slovakia**. Maximum precipitation amount 425.7 mm that is 432.6% of normal and was measured at Lomnický štít (mountain meteorological station). According to the long time series (historical measurements) since 1901, and individual station precipitation totals in north parts of Slovakia April 2017 was from 1st to 3rd wettest since 1901. The consequence was a flood during 28.4. - 2.5.2017 within the tributaries of the upper Váh and the upper Hron river basins (less than 500 km^2).

In the Republic of **Moldova** very difficult meteorological conditions were observed on most of the territory on April 20-21 in connection with a cyclone - rain, snow, sleet, deposition of wet snow on wires and trees, a strong gusty wind, and frost, which led to disastrous consequences for the country's economy. Amount of precipitations in the form of rain and snow, on 20-21 April, in the central and southern regions reached 35-82 mm (100-230% of the norm for the month), which in some areas in April is observed for the first time for the entire period of observations. For the first time a country wide snow cover in late April was observed. Its maximum height on meteorological sites, on April 21, in northern regions reached 5-14 cm, in the central and southern regions – mostly 20-40 cm. However, in some areas its height reached 47-57 cm, which in the winter season in these places is observed for the first time for the entire period of observations. Similar happened in **Romania** where hundreds of localities were left without electricity; traffic was disturbed along roads and railroads because of the snowfalls and frost damage were registered in many fruit cultures. In most regions of **Lithuania**, April 16 saw a snow cover of 1–5 cm, locally 9–12 cm deep, which thawed during the day.

May 2017 was characterized in **Romania** by storms and convective phenomena almost everywhere on numerous days during the month although on the average, 79 mm of water fell across the country or 19% more than the climatological normal. On the 6th, such phenomena led to hail occurrence and flooding in Oltenia, which triggered damage to a number of houses. Similar happened in different regions of Romania until the end of the month with flooding and damages at houses and crops due to heavy rain and hail. A flash flood reached the capital city of **Hungary**, Budapest on 23rd of May. One hour rainfall exceeded 44 mm and the daily mean precipitation was 55.2 mm. The mean May precipitation is 59.6 mm, thus diurnal rainfall amount almost reached the monthly average. In the afternoon of the 5th May many regions in West **Bulgaria** were hit by severe thunderstorms with strong winds, hail and short heavy precipitation. More than 20 houses were flooded in village Lilyache, Vratsa district. Many roads were blocked by broken trees. Severe convective storm with giant hailstones on 15th of May in the region of Lyubimets and Svilengrad caused significant damages on buildings, vehicles and agricultural crops. Several hailstorm destroyed agricultural crops in **Greece** in May.

In **Sweden** there was an unusually late peak of the snow cover in the northern mountains with a maximum value of 205 cm at Katterjåkk on 2nd May. Snow fall also in **Latvia** from 9th - 11th May, an unprecedented event (historical record): At 8 observation stations new latest snowing records were set (Observations started in 1895).

In **Slovenia**, during the 6th of June 2017 a new daily precipitation record was set at station Vojsko with 200 mm/24h. Between the 1st and 6th of June a series of severe thunderstorms, accompanied by heavy rainfall and hail were registered in many regions in West and Central **Bulgaria**. In some towns and rural areas, they caused local floods and damages on vegetable and fruit crops.

On June 13th, between 17:30h and 22:30h, southern **France** (Haute-Loire) was struck by exceptionally intense and localized rainstorms. Between 20h and 21h, the accumulations exceeded locally 150 mm and up to 300 mm in 4 hours (after radar images). At station Landos-Charbon 226 mm were measured during the episode, 122.7 mm in 1 hour (between 20 and 21h) and 21.5 mm in 6 minutes.

Severe thunderstorms during the 22nd and 23rd with hail of up to 8 cm in diameter, heavy rain and gusts of up to 39 m/s (140 km/h) in western and northern **Germany** caused damages of about 640 Million Euro and two deaths. Numerous houses and vehicles were damaged and delays in air and rail traffic occurred. The affected agricultural area was 500 km^2 with damages in crops, fruits, vegetables and vineyards (MunichRe 2018). A rain band moved from southern **Germany** to the north during the 29th and converged with thunderstorms coming from Poland leading to heavy and

long lasting rainfall. The highest daily totals of 197 mm were measured at the airport Berlin-Tegel (return period of 100 years) and also 73.5 mm in Potsdam. The highest daily total in the history was below 90 mm, measured at a surrounding station near to Berlin. The enormous amounts of water led to flooding and the fire brigades in the capital reported 1830 weather-related missions during this exceptional event.

From 28 - 29 of June an extreme precipitation episode was observed in the **Czech Republic** with more than 100 mm in 2 days, such an event occurred once per five years. In **Austria** thunderstorms with heavy precipitation and hail caused more than 4 Million Euro agricultural damage. In **Lithuania** on 29th of June very severe storm in southeastern regions occurred with very heavy rain (50–65.6 mm/12 hours). From 30 June to 1 July, heavy thundershower (65 mm) accompanied by hail as large as 3-8 mm and strong wind took place in Moscow (**Russia**). Railroad bed in the Moscow Central Circle and motor roads were inundated, 1200 trees were fallen, roofs of nearly 100 houses and nearly 100 cars were damaged. Two people were killed.

High precipitation amounts were measured from Ireland to northern European Russia in **July 2017**. Severe convective storms, associated with hail and strong winds hit northwestern and northcentral parts of **Bulgaria** on 3rd of July. In some meteorological stations more than 4 hail-fall events were registered in the time interval 00:00-05:45 local time (LT). In Mezdra and Levski the giant hail stones with size up to 8 cm were observed. Several locally disastrous rainfalls (>80 mm/12 h) occurred in **Lithuania** on July 1st and 11th. The thunderstorms also affected **Belarus** with 57 mm at Novogrudak on the 13th. During 25th and 26th widespread thunderstorms occurred in **Belarus** with local precipitation amounts of 77.5 mm in Minsk or 103.7 mm (16:00 - 03:00 on 26th) in Samohvalovichi with local floods and damages on houses and infrastructures.

Especially central and eastern **Germany** was affected by continuous rainfall from 24th to 27th with more than 100 mm/day at several stations. The several days lasting rainfall caused flooding and landslides. For example, in Goslar and Wolfenbüttel entire streets were flooded - residents had to be evacuated. Flooded railway lines were blocked and softened dikes secured with sandbags.

On the 27th a severe thunderstorm with wind speeds of up to 28 m/s (100 km/h), hail of up to 9 cm in diameter, heavy rain and flash floods occurred in **Turkey.** More than 90 houses, 150,000 vehicles and 4 planes were damaged. Streets and metro stations were flooded. The overall damage loss was estimated to 500 Million Euro (MunichRe 2018).

On the evening of 1st and in the night to the 2nd **August 2017**, violent thunderstorms erupted in **Switzerland** north of the Alps, accompanied by hail and strong wind gusts. At the northern edge of Switzerland wind gusts attained 25-38 m/s (90 to 135 km/h), locally even up to 53 m/s (190 km/h) brought a new Swiss rain record. At the station of Eschenz a ten-minute total of 36.1 mm fell between 02.40 and 02.50. The previous ten-minute record amounted to 33.6 mm, collected on 29 August 2003 in Locarno-Monti. A comparable ten-minute total of 33.5 mm was registered on 25 June 2017 at the Ticino observation site Crana-Torricella. The previous highest ten-minute total north of the Alps amounted to 32.8 mm, collected on 2nd May 2013 in Schaffhausen.

Heavy thunderstorms in **Austria** caused mudslides with a damage loss of more than 20 million Euro on the road system. Trees were brought down, power outages of 80.000 homes and travel disruption. On the night of 19 August a storms over the northern part of Upper Austria damaged a marquee and killed two people and at least 140 people were seriously injured.

An extreme precipitation episode was observed in southeastern **Estonia** with 84.7 mm (98% of the month's normal) in Räpina and 78.8 mm (94% of the month's normal) in Mehikoorma during 24 hours on the 24th. The heavy precipitation caused floods and washed away roads. This extreme precipitation also affected southeastern part of **Latvia** from 22nd - 24th August causing in the next hours a flash flood in the region that was one of the biggest flash flood events in Latvia on the record. 20 000 ha of agricultural lands were flooded and 17 roads were washed out.

Torrential precipitation in **Bulgaria** with duration of more than 30 hours caused local floods in southeastern parts of Burgas district in **September 2017**. More than 10 villages were flooded. In Gramatikovo the 24-hours precipitation amount of 198 mm was measured on 27th, which was 4 times over the monthly normal. September was (according to the reference period (1961-1990) significantly above-normal in most of **Slovakia**, exceptionally wet in the northern part (Orava,

Kysuce region) and locally in south of Slovakia. Minimum percentage of normal value compared to 1961-1990 was 134.8% at Milhostov (southeastern part), maximum 294.6% at Hurbanovo (southern part of west Slovakia) that was the 4th wettest monthly precipitation total since 1901. According to the long time series (historical measurements) since 1901, and individual station precipitation totals in north parts of Slovakia (Tvrdošín, Dolný Kubín, Čadca) September 2017 was the wettest since 1901.

Precipitation amounts in **Croatia** were within the range of 110% - 470% of the average for this month. In September 2017, the maximum daily precipitation amount observed at 7 a.m. (CET) at the main meteorological station Zadar was 213.4 mm (12th), less than the highest daily precipitation amount on record for Zadar (352.2 mm, 11 September 1986). On 11 September 2017, rain shower started at 4:57 a.m. and lasted till noon, and then rain was recorded till 4:52 p.m. The maximum 10-minute precipitation amount for this day was 18.9 mm while the total precipitation amount during the period in question was 283.4 mm. Such amounts caused torrential floods that led to substantial property damage and declaration of state of natural disaster in the wider Zadar area. Roads, cellars, shopping centres and the hospital in Zadar were flooded, and there was a power outage in parts of the city.

Very wet from north-western to southeastern Europe in **October 2017**. The rainiest month in **Bulgaria** was October with average precipitation of about 2.5-3 times more than monthly normal (692% in Karnobat, Burgas district). A 20-hours heavy precipitation led to overflowing dams and rivers, local floods, great damages on infrastructure and 4 victims. In Karnobat the 24-hours precipitation amount of 178 mm was measured on 25th of October (460% of monthly normal). At three weather stations in **Romania**, Bucharest Băneasa, Videle (631%) and Omu Peak (207 mm), the absolute monthly maximum precipitation amounts in a month of October were exceeded. Monthly precipitation in most parts of **Lithuania** amounted to 80–125 mm (1.5–2 norms), and in some southern and most western regions to 130–260 mm (2.3–2.8 norms), locally to 277 mm (even 3 monthly norms!).

Norway was affected by two heavy precipitation events, the one from 30 September - 2 October and only 100 km eastwards the second one from 20 - 22 October 2017. During the three days of the first event 10 stations reported a total precipitation of more than 200 mm/3d and even two of them more than 280 mm/3d. New precipitation records were set for 1, 2 and 3 days at a number of stations. The highest values were observed at Senumstad with 173.1 mm in a 24-hour period (88% of October monthly normals), 236.7 mm in two days, and 281.8 mm in 3 days. For some water courses this was the largest flood ever recorded in southern Norway. In the areas most affected, both observed rainfall and flood levels exceed 100 years of return periods. The rain induced flooding and landslides. Over 40 roads were closed, several houses were destroyed, tens of thousands of people were evacuated 2000 damages have been reported and the overall losses were estimated to several 10th of millions € (hundred millions of Norwegian Kroner, NOK).

On the 20th of October 2017 a front passed southern **Norway** while a low west of Ireland (storm **Brian**) passed during the 21st Ireland and United Kingdom and moved towards Norway with plenty of rain. In southern Norway during the following days the maximum precipitation amount was registered in Bøylefoss with 192 mm/3 days (return period of 50 years) or 103.8 mm/24h at Eikeland (return period of 50 years). The high precipitation amount caused local floods but the damage and the impact was much smaller than of the event 3 weeks ago. Some roads were closed for a shorter or longer period. For this period a Climate Watch Advisory on above-normal precipitation was issued on 13th of October 2017 for Ireland, United Kingdom and Norway and terminated on 29th of October 2017 after precipitation in these countries had normalized.

High precipitation due to cyclone “Numa” in the Central Mediterranean in **November 2017**. The **Greek** station Kerkyra (airport), located in the north Ionian Sea, reported a total monthly precipitation of 439.0 mm, while its monthly normal value (1971-2000) is 182.0 mm. Also, the station reported its second wettest November since 1955 (previous record of monthly total precipitation was 446.0 mm on November 2000). Moreover on 11th November the station recorded daily (24-hour) precipitation of 94.0 mm. Station Elefsis (airport, Greece), located in west Attica, reported total monthly precipitation of 194.0 mm while its monthly normal value (1971-2000) is about 64.0 mm. Moreover, the 4-day total precipitation measured between 14 and 17 November was also high (108.9mm). Heavy rainfall hit Symi island (Greece) on 13th, causing flash floods and

major problems in infrastructures, such as power and water supply. Greek authorities declared a state of emergency on the island of Symi. On 15th of November, a sudden flash flood over western Attica (Greece) caused 23 fatalities. The flooding came after a severe overnight storm. Roads were turned into muddy rivers and dozens of people were trapped inside their flooded homes. Cars, trucks, and buses were trapped in an inundated underpass in the highway between Athens and Corinth. A state of emergency has been declared in the west Attica region.

On 10/11 **December 2017** the lowest altitude levels south of the **Swiss** Alps received a snow cover of a few centimetres. Meanwhile, in the low areas of the Central Valais record snow totals were measured. Sion registered an extreme value of 60 cm within one day. This is far above the previous maximum value of 43 cm, collected in November 1971. Even the previous highest 2-day totals only amounted to scarcely above 50 cm in Sion. Shortly after mid-month over 170 % of the normal snow totals were registered in many parts of the Alps. In the entire Alpine region of Switzerland conditions for the seasonal ski tourism were ideal.

Heavy precipitation with snow melting affected **Belarus** on 10th with 35-39 mm in 4 hours.

From 4th to 7th December, a strong western and southwest wind (storm **Aina,** named by Met Norway) brought warm and humid air masses to the southern part of western Norway with a lot of precipitation over several days. The strongest wind associated with Aina was measured at Folgefonna with 33 m/s (10 minutes average), and the most powerful windgust was 44.2 m/s. Most precipitation was observed at Gullfjellet, where the 3 days totals were 284.6 mm. Such amounts resulted in floods, landslides and damages at houses and ships. Storm **Birk** (named by Met Norway, Diethelm in German) affected south-western **Norway** with heavy precipitation from 22nd - 24th of December 2017. The largest daily amount during this event was 127.5 mm on Gullfjellet (Bergen) on 23 December and more than 200 mm in 3 days. This amount of precipitation resulted in floods and landslides.

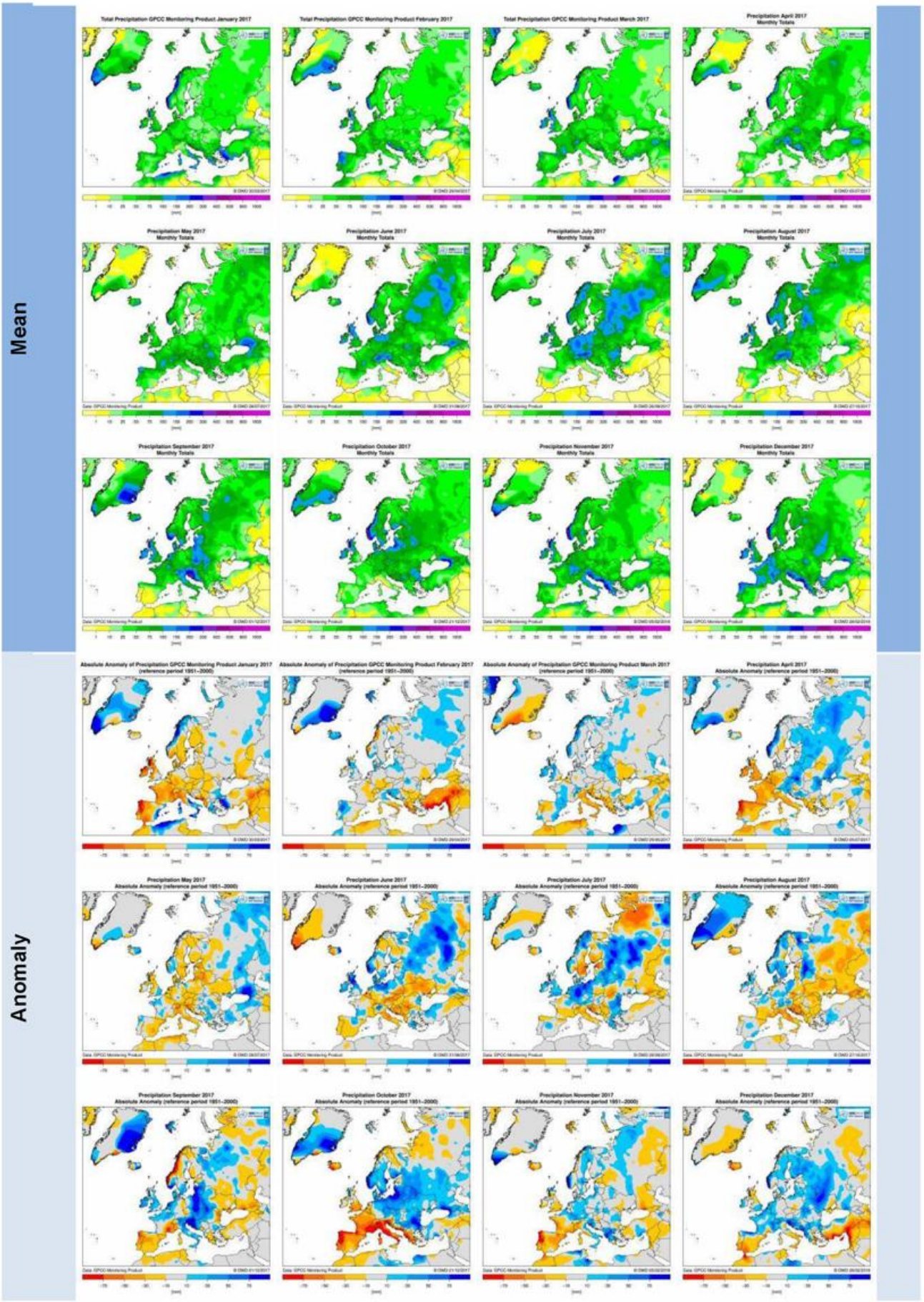


Figure 4.10: Mean and anomalies of precipitation (in mm/month) for each month of the year 2017. (First row January, February, March, April, … ; reference period 1961-1990).

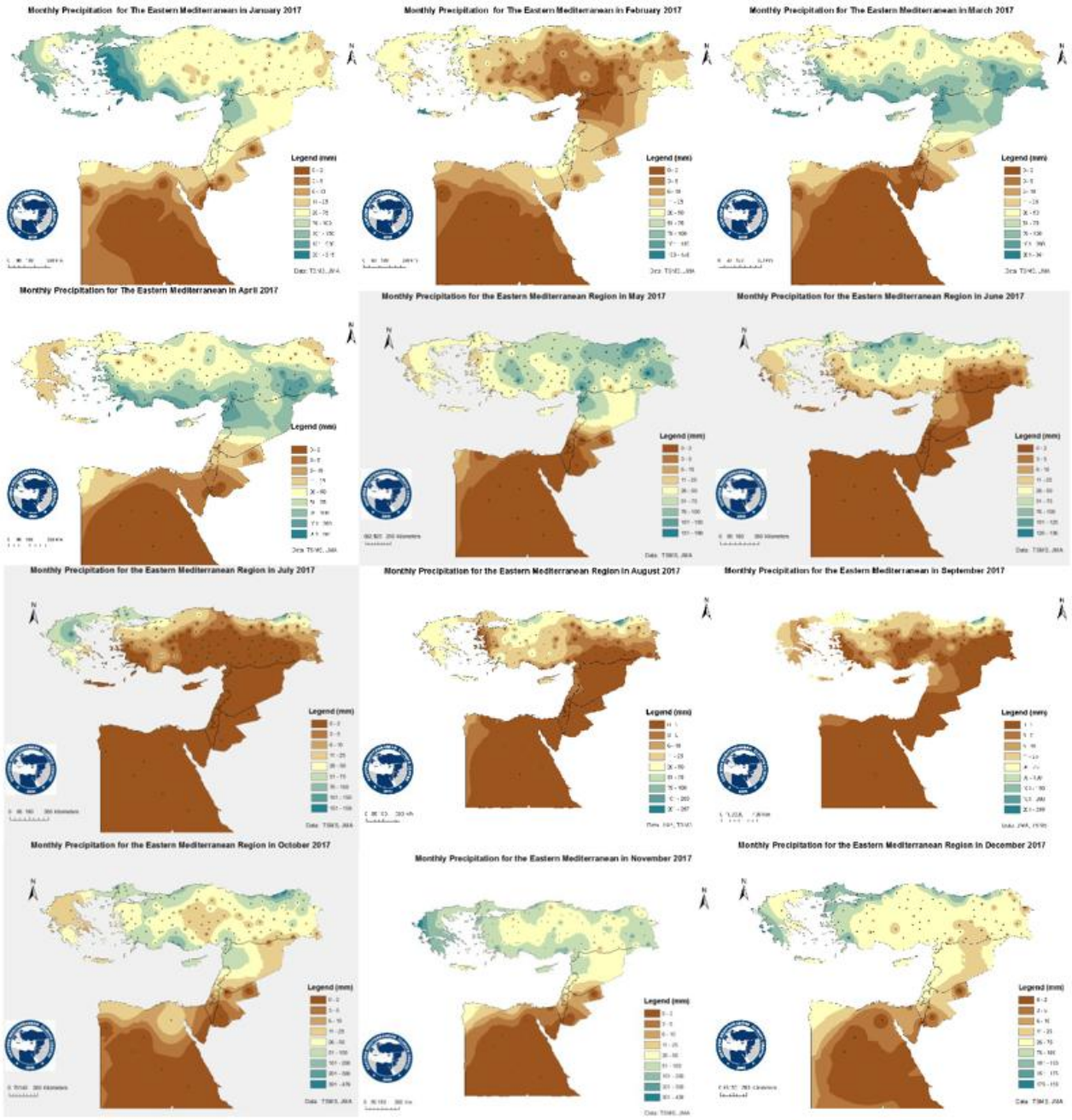


Figure 4.11: Monthly precipitation totals (mm) for the eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC http://www.emcc.mgm.gov.tr/prediction.aspx; first row January, February, March, …).

4.4. Sunshine duration

Monthly sunshine duration in January 2017 in Central Europe was well above normal. In **Slovakia** 6 out of 14 stations measured their highest sunshine duration in this January with more than 200%. In Hurbanovo 119.7 hours or 193% of the normal (1961-1990) was registered (Figure 4.12). In **Germany** most stations reported more sunshine than usual and January became the fourth sunniest since 1951 with 143% from the normal, at some stations even more than 200%.

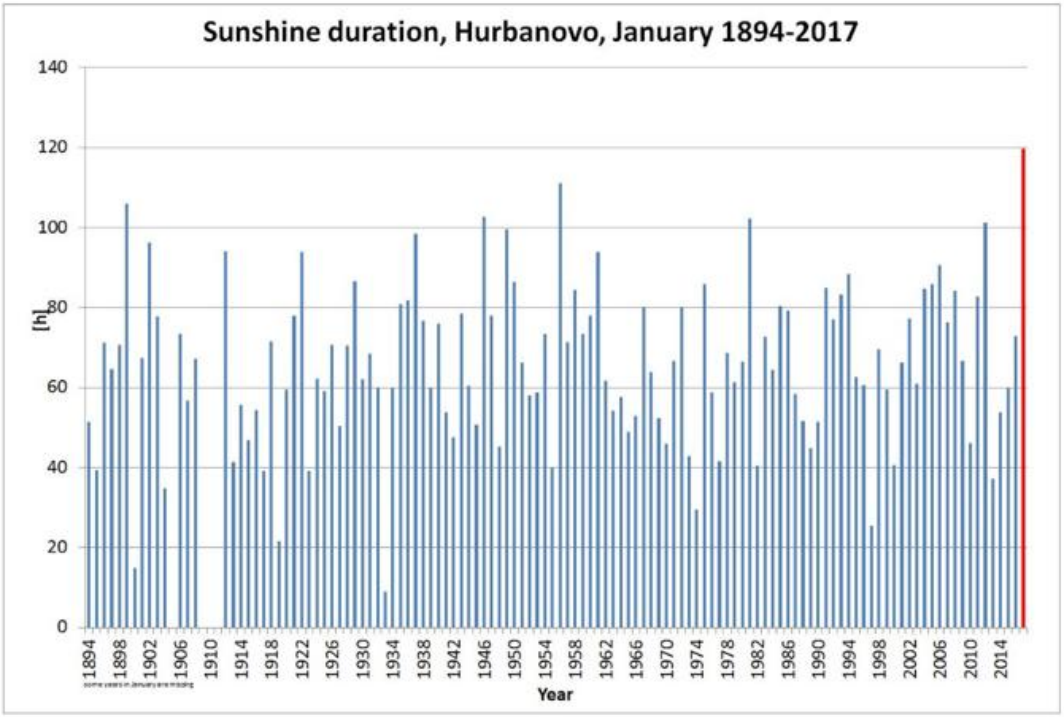


Figure 4.12: Monthly sunshine duration at station Hurbanovo for January 1894-2017 (Source: Slovak Hydrometeorological Institute)

Sunshine duration in March 2017 in **Serbia** ranged from 115% in Leskovac up to 148% in Pozega relative to the normal for the 1981-2010 base period. The insolation ranged from 157.9 hours at Kopaonik to 197.9 hours in Banatski Karlovac.

Sunshine duration for April 2017 in **Spain** was higher than normal (reference period 1981-2010) in all Spanish regions. The relative positive anomalies of sun hours exceeded 50% in a large part of the northern third of the peninsula, rising above 70% in the northeast of Galicia. The maximum sunshine value was observed in Izaña with 339 hours, followed by Zaragoza/Airport with 331 hours and Salamanca/Airport with 329 hours.

In June 2017 sunshine duration was above average in whole **Slovenia**. Most sunshine hours were registered on the coast, in Portorož the sun shone for 323 hours. For the summer months, it is characteristic that in the mountains there is less sunshine than in the lowlands, in Kredarica the sun shone only 225 hours. In Ljubljana, the sun shone 274 hours, which is 15% above the long-term average.

The sunshine deficit in **France** in July 2017 was generally greater than 10% in the western half of the country as well as in the east and often reached 20 to 30% in the south. The sun shone only 140 hours in Brest (Finistère) and 173 hours in Le Mans (Sarthe).

Most measuring stations in **Slovenia** reported in August 2017 a surplus of sunshine between 20% and 30% above the long-term average. A smaller surplus, between 10 and 20%, was in Pomurje, on the coast, in Godnje. Most sunshine hours were measured at the airport in Portorož (352 hours).

The sunshine duration in **Germany** for September 2017 with 121 hours was 18% below the long-term average of 148 hours. Stations on the Baltic Sea exceeded the normal values (Waren 102%).

Sunshine deficit with values below 60% occurred in the mountains (Braunlage 52%). The sun shone from 67 hours on the Kahler Asten to 162 hours in Rostock-Warnemünde.

Around mid-**October 2017** the weather in **Switzerland** was dominated for ten days by high-pressure zones. The autumn sun shone frequently from a cloudless bright blue sky. In the lower areas, daily maximum temperature rose in many parts to between 22 and 25°C. The persistent fair weather brought the Plateau and southern Switzerland the sunniest October, regionally, in the homogenous observation series spanning at least 50 years. At other stations with homogenous observation series of at least 50 years it was the second- or third-sunniest October. In **Spain** sunshine duration was higher than normal (reference period 1981-2010). The relative anomalies of sunshine surpassed 30% in central Spain and were especially significant, above 50% in north-western; reaching over 70% in some points of the provinces of A Coruña and Lugo. The maximum value of insolation was observed in Seville Airport with 289 hours, followed by Huelva Ronda Este with 286 hours and Ciudad Real with 285 hours.

In **November 2017** sunshine duration in **Spain** was more than 10% higher than the normal value (reference period 1981-2010) throughout the Peninsula. The relative anomalies of sunshine exceeded 30% in a large part of the peninsular territory and values higher than 50% were reached in some places in central Spain. The maximum value of sunshine was observed in Castellón Almassora with 246 hours.

December 2017 was dull in the Netherlands. Only 32 hours of sunshine on average over the country instead of 49 hours as in the long-term average. In the west the sun shone the least with only 16 hours. The sunniest station was Terschelling with 47 hours. In De Bilt the sun was shining only 25 hours and on 15 days the sun was not visible.

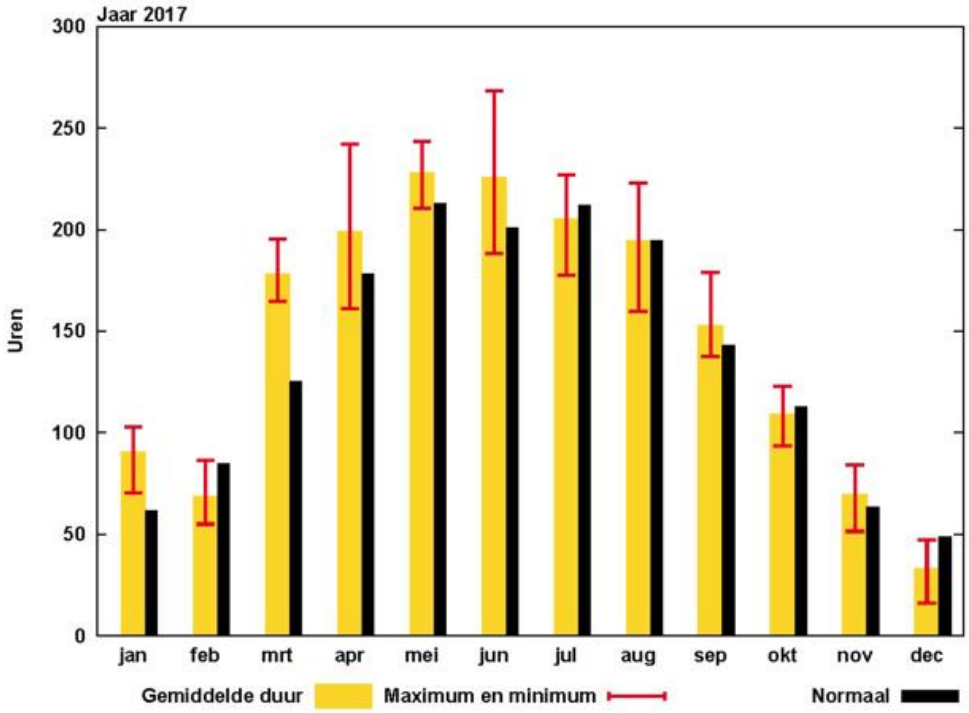


Figure 4.13: Annual cycle of sunshine duration (in hours) for the Netherlands in comparison to the normal values (black bar; source: Koninklijk Nederlands Meteorologisch Instituut, KNMI)

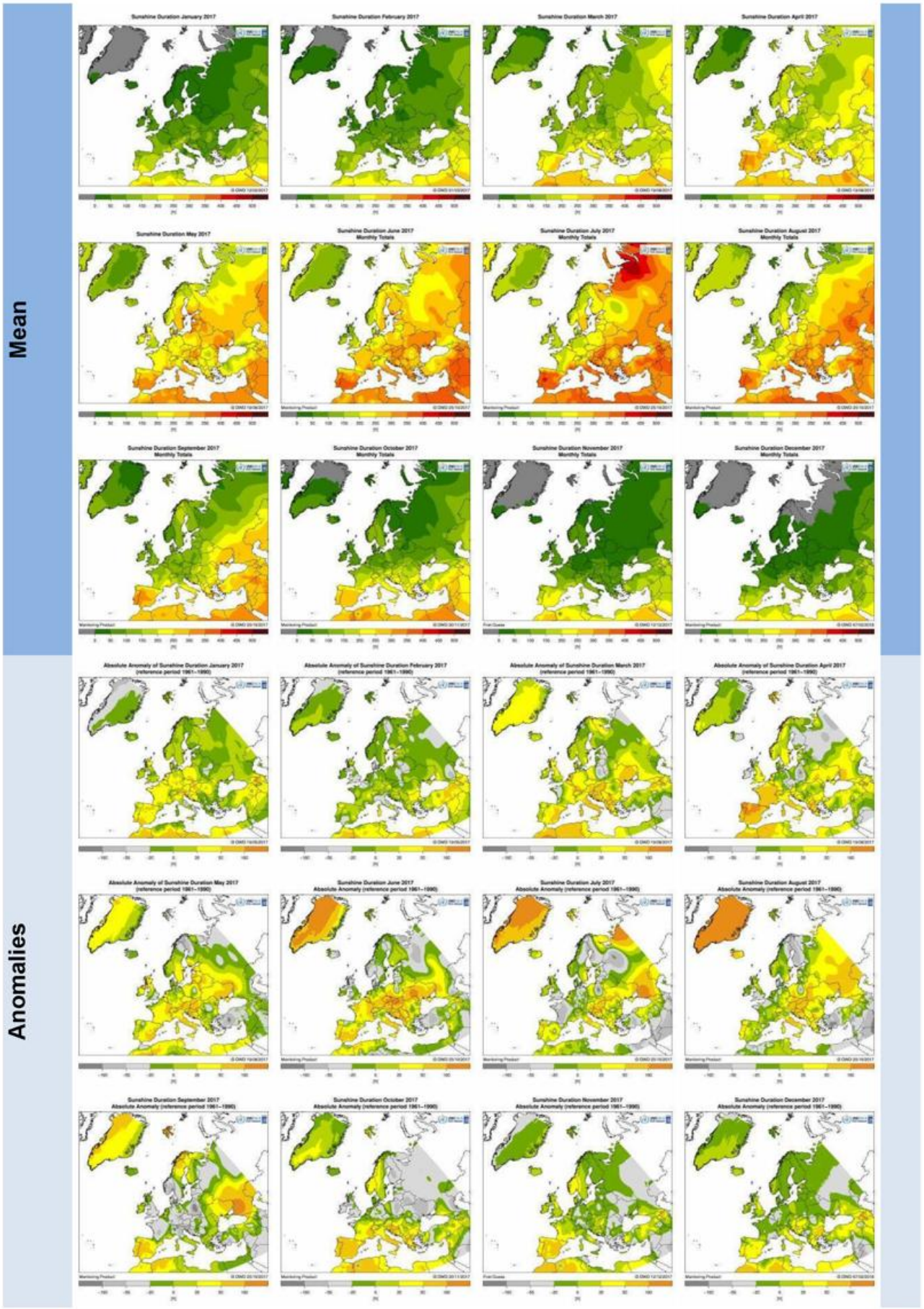


Figure 4.14: Mean of sunshine duration (in hours) and anomalies (in hours) for each month of the year 2017. (First row January, February, March, April, … ; reference period 1961-1990).

4.5. Maps of monthly climate extremes and events

The following maps are based on different data (as noted in the legends in parentheses), and is meant to summarize weather conditions in each month of the year 2017.

In January 2017 Scandinavia was down to +5°C warmer than normal and the numbers of warm days were above normal. Central and southern Europe showed more cold days than usual. The areas at the Norwegian and Greenland coasts were affected by strong wind gusts (storm "Axel", "Doris", "Egon") and also the Bretagne, the Gulf of Lions and the coast of the Adriatic Sea. Most of Europe was wetter than usual.

In February 2017 more warm days than normal could be found in Europe in combination with more precipitation and storms on the coasts of western Europe.

Warmer days in March 2017 occurred almost everywhere in Europe with strong wind gusts at the Atlantic and Mediterranean coasts. In most parts of Europe the very wet days were abnormally high.

In nearly the whole of Europe April 2017 had more warmer-than-normal-days in combination with very wet days; only in northern and southeastern Europe cold days were more usual.

In May 2017 more than usual warm and wet days were registered except in northeastern Europe where some cold days occurred.

June 2017 was wet and warm in many parts except in northeastern Europe where some cold days occurred. It was also drier than normal in southern Iberia.

As several month before July 2017 became warmer than normal in the southern and western part of Europe while the North had more cold days and East Europe had more wetter days as usual.

Europe had more warm days in August 2017 with thunderstorms in France and Iberia. Sweden had more wet days and locally some colder days. Eastern and northern Europe had in many parts a precipitation surplus.

In September 2017 the Mediterranean coasts were affected by wind gusts from thunderstorms and with more cold days. The rest of Europe has above normal wet and warm days.

Central, northern and western Europe showed in October 2017 more warm days than usual and strong wind gusts because Ex-Hurricane "**Ophelia**" and other storms crossed these areas. Eastern Europe noted a higher number of very wet days. The Gulf of Lions and the Aegean Sea were affected by thunderstorms with strong wind gusts.

During November 2017 western parts of Europe showed a higher number of warm and wet days. Norway, the UK, Denmark, the Bretagne and in the Gulf of Lions were affected by strong wind gusts in November. Central, northern and eastern Europe showed more wet days than normal

December 2017 showed in the northern part of Europe more warm days than normal, but in the south more cold days. Eastern Europe was wetter than normal. Several cyclones with strong wind gusts passed over Scandinavia, the UK, Central Europe up to Greece.

The Monthly Event Map contains information about the extreme anomalies of temperature, precipitation and wind gusts. Points are calculated from station data and represent the number of very warm or cold days, the locations of strong wind gusts (>=32 m/s) and days with precipitation. If more than one extreme anomaly occurs at the same location, the point is subdivided into several different colours. Coloured areas are based on interpolated gridded data for temperature (land and ocean) and precipitation (only land areas). If more than one extreme anomaly occurs at the same grid, the area is shaded.

Legend of Figure 4.10:

- Anomaly of very wet days > 0 (ECAD)
- Wind gusts (≥ 32 m/s) (SYNOP)
- Anomaly of warm days > 0 (ECAD)
- Anomaly of cold days > 0 (ECAD)
- Anomaly of TG ≤ -4K (CLIMAT and ship obs.)
- Anomaly of TG ≥ 4K (CLIMAT and ship obs.)
- Aridity index < -1.5 modified SPI (GPCC)
- RR ≥ 150% of climatology (GPCC)

Based on climatology 1961-1990 (GPCC climatology: 1951-2000)

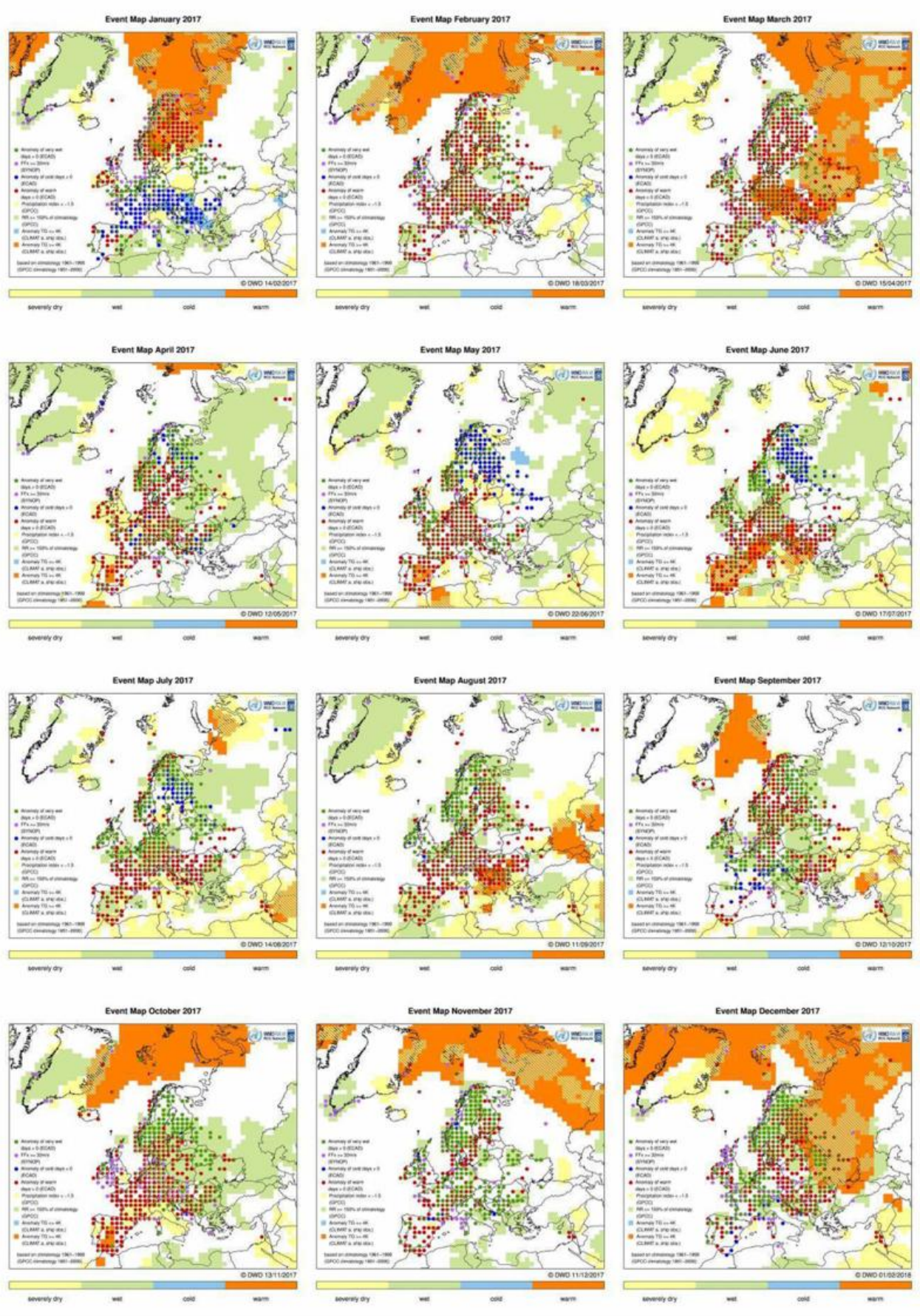


Figure 4.15: Maps of Climate Extremes for each month of the year 2017 (First row January, February, March…).

5. Long-term variability of the selected climate parameters - Regional examples

On the following pages graphs of long time series of temperature, precipitation and sunshine duration as provided by the National Meteorological and Hydrological Services (NMHSs) are presented to give an overview of the temporal development of the basic climate elements. The graphs are grouped with respect to the 6 sub-regions defined above (Figure 1.1**Fehler! Verweisquelle konnte nicht gefunden werden.**). An overview of contributing countries, time series' lengths and area representativeness can be found in Table 5.1. Most are temperature time series. Each sub-region is at least represented by one country. Time series of precipitation totals are fewer but each sub-region is represented by at least one time series for precipitation. Diagrams of long-term annual sums of sunshine duration are provided by 4 countries, belonging to different sub-regions.

After this, we present examples of the temporal development of other temperature-related phenomena, such as the sea surface temperature in the North Sea and sea level anomalies at the Polish station Władysławowo.

Table 5.1: Availability of the long-term records (start year) of temperature, precipitation and sunshine duration from some participant countries.

Sub-region	Country	Temperature		Precipitation		Sunshine Duration	
		Spatial Mean	Single Station	Spatial Mean	Single Station	Spatial Mean	Single Station
Central and Western Europe	Austria	1768					
	Belgium		1833		1833		
	France	1900		1959			
	Germany	1881		1881		1951	
	Hungary	1901		1901			
	Luxembourg		1947				
	Netherlands	1906			1906		
	Switzerland	1864		1864		1959	
	United Kingdom	1910		1910		1929	
Nordic and Baltic Countries	Denmark	1873	1768	1874	1821	1920	1876
	Greenland		1784		1890		
	The Faroe Islands		1873		1890		1922
	Estonia		1866		1866		1953
	Finland	1900		1961			
	Iceland		1931				
	Latvia	1924		1924			
	Lithuania	1923	1777			1961	1916
	Norway	1900		1900			
	Sweden	1860		1860			
Iberia	Portugal	1931		1931			
	Spain	1965		1965			
Mediterranean, Italian and Balkan Peninsula	Croatia		1862		1862		
	Italy	1961		1961			
	Slovenia		1961		1961		
	Serbia	1951					
	Turkey	1971		1981			
Eastern Europe	Belarus	1881		1891			
	European Russia	1939		1966		1961	
	Moldova		1887				
	Ukraine		1881		1891		
Middle East	Georgia	1960	1881	1961	1881		
	Israel	1951			1916		

5.1. Temperature

Central and Western Europe – annual temperature series

Austria, Belgium, France, Germany, Hungary, Luxembourg, The Netherlands, Switzerland and United Kingdom

Austria

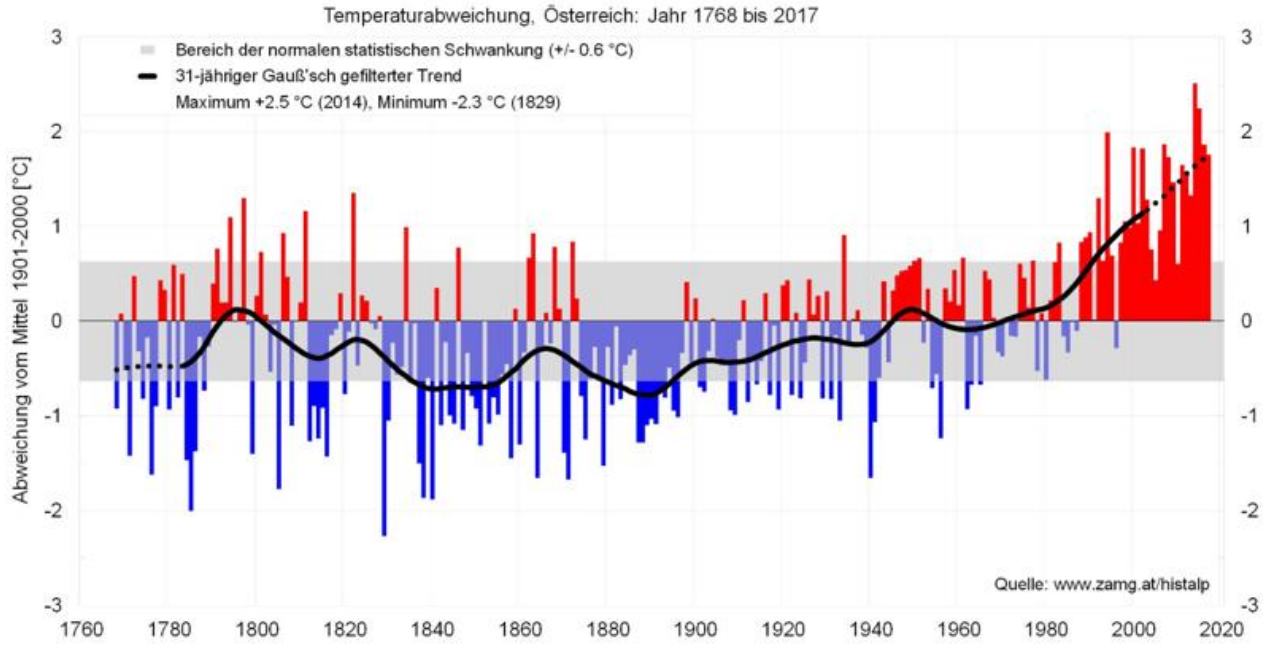


Figure 5.1: Time series of annual temperature anomalies for Austria (reference period 1961-1990, diagram as provided by the NHMS)

Belgium

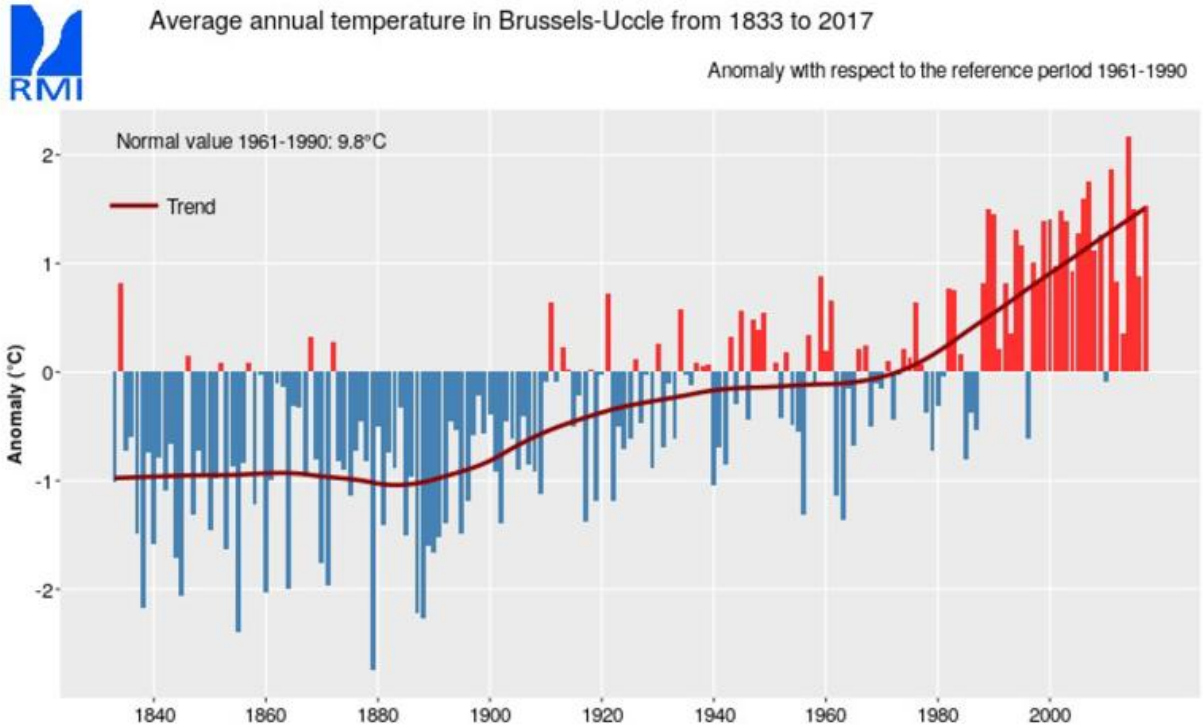


Figure 5.2: Time series of annual mean temperature anomalies for Uccle, Belgium (reference period 1961-1990, diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

France

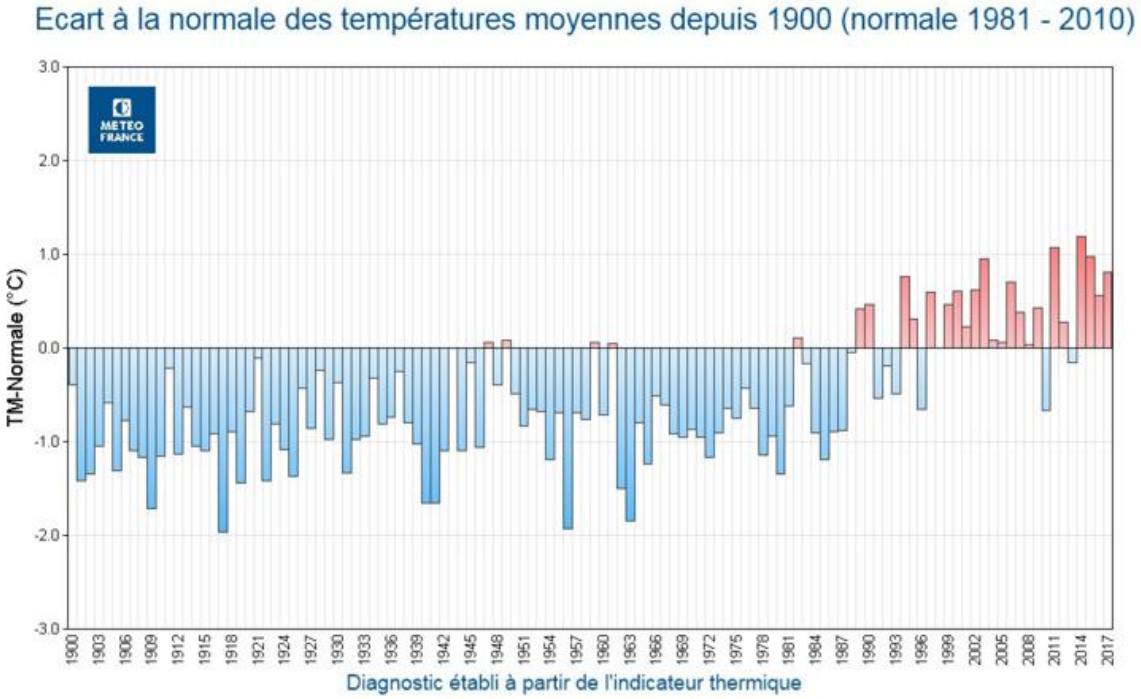


Figure 5.3: Time series of annual temperature anomalies for France for the period 1900-2017 (reference period 1981-2010; diagram as provided by the NHMS)

Germany

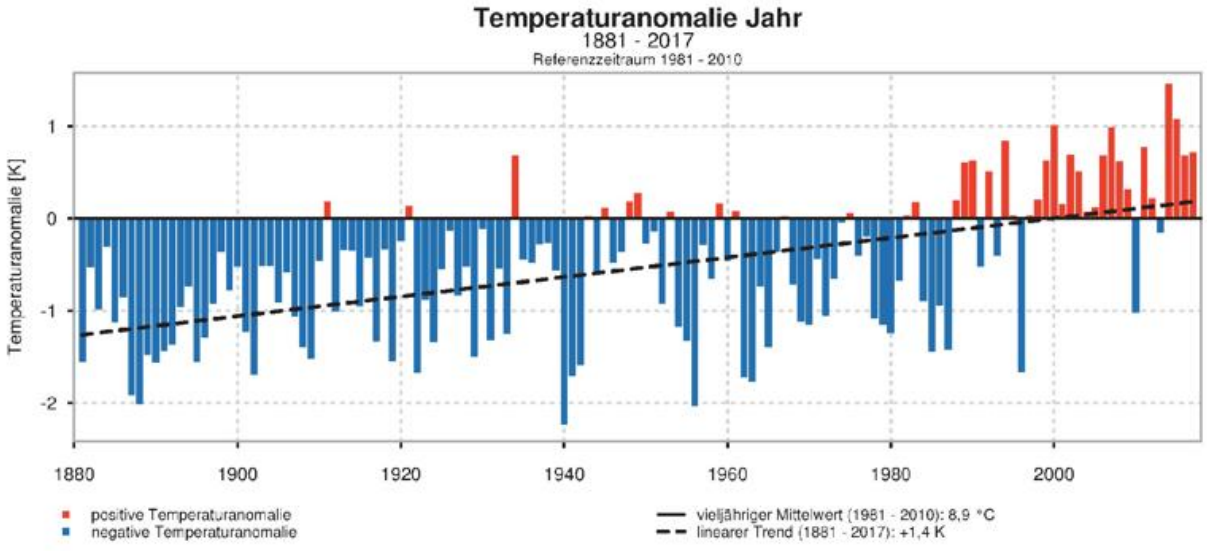


Figure 5.4: Time series of annual temperature anomalies for Germany for the period 1881-2017 (reference period 1981-2010 black line, diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Hungary

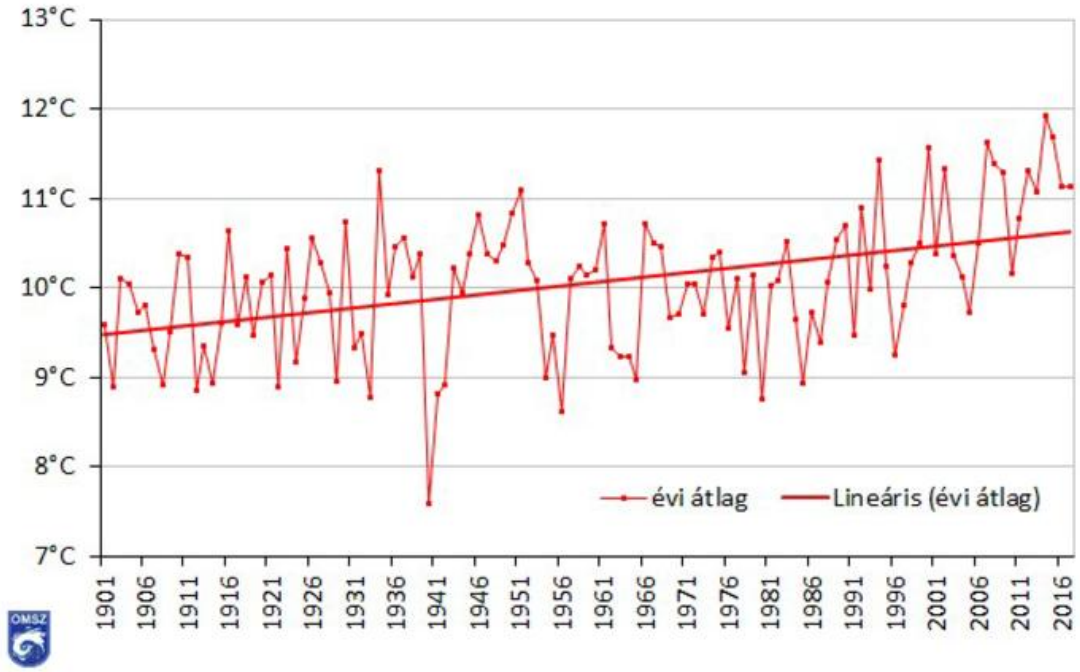


Figure 5.5: Time series of annual average temperature for the period 1901-2017 for Hungary (based on homogenized and interpolated data from 58 stations; Diagram as provided by the NHMS)

Luxembourg

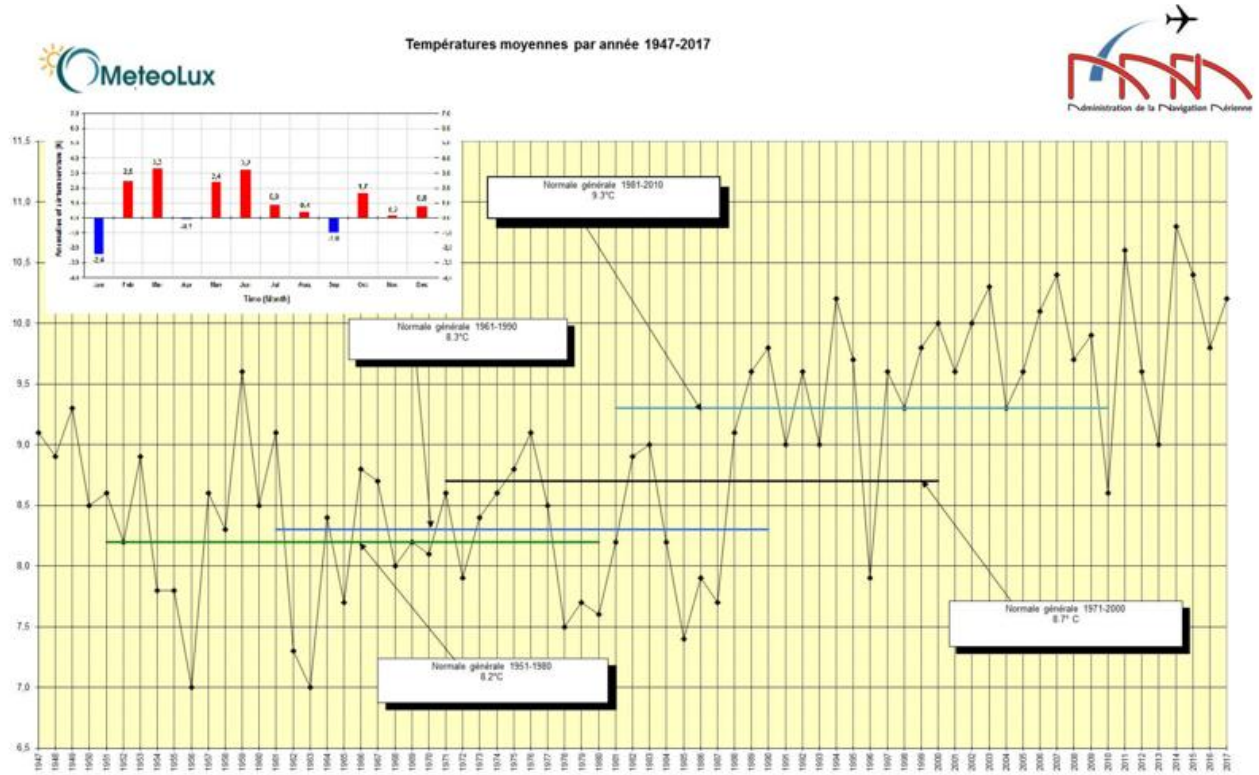


Figure 5.6: Time series of annual average temperature for the period 1947-2017 for station Luxembourg-Findel (Diagram as provided by the MeteoLux)

Central and Western Europe – annual temperature series

The Netherlands

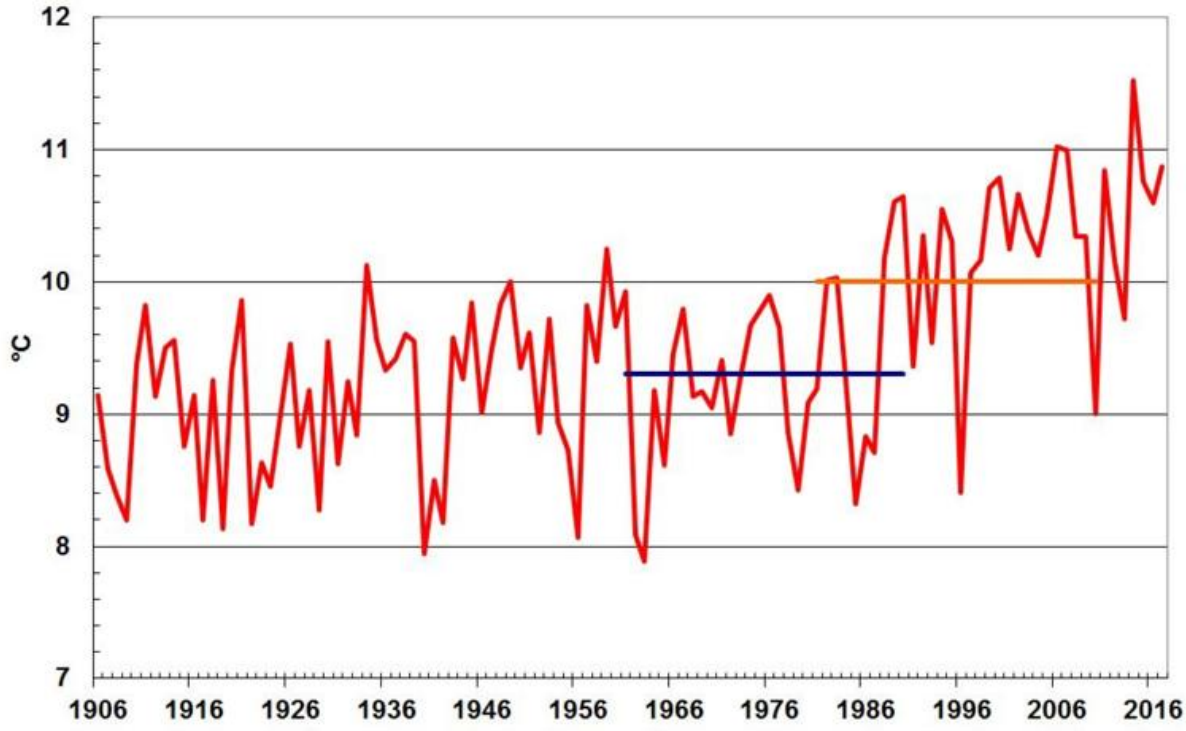


Figure 5.7: Time series of annual average temperature for the period 1906-2017 for the Netherlands (Central Netherlands Temperature v6, mean of 6 stations, blue line: reference period 1961-1990, orange line: 1981-2010; data as provided by the KNMI)

Switzerland

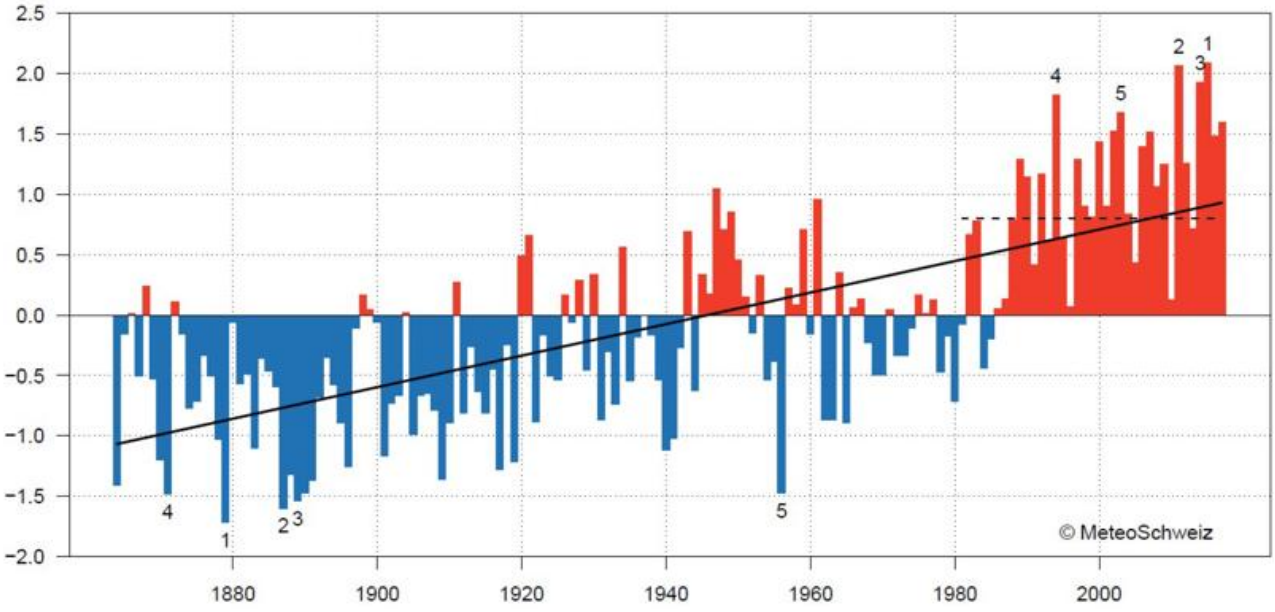


Figure 5.8: Time series of annual temperature anomalies for the period 1864-2017 for Switzerland (reference period 1961-1990, the black line represents the linear significant trend (1.29°C/100y). The black dashed line represents the mean 1981–2010. Source: MeteoSwiss)

Central and Western Europe – annual temperature series

United Kingdom

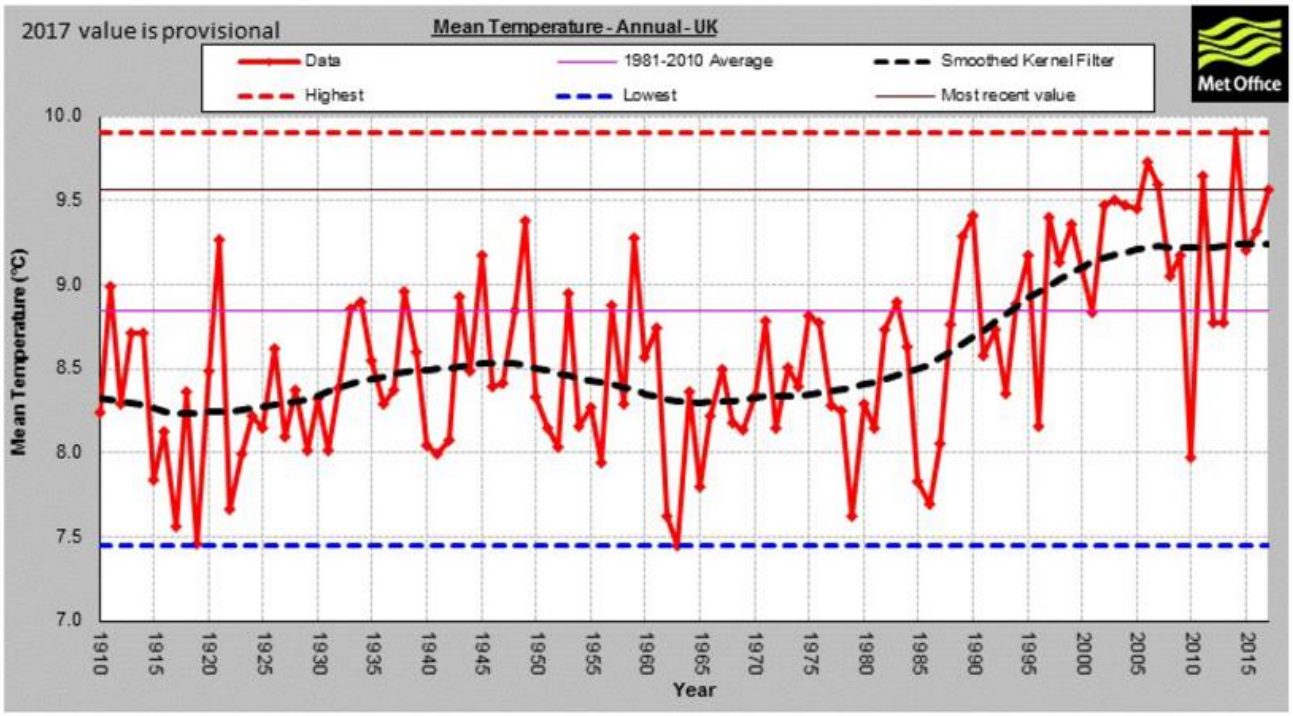


Figure 5.9: Time series of annual temperature for the period 1910-2017 for the United Kingdom (Diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Denmark, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden

Denmark, Greenland, the Faroe Islands

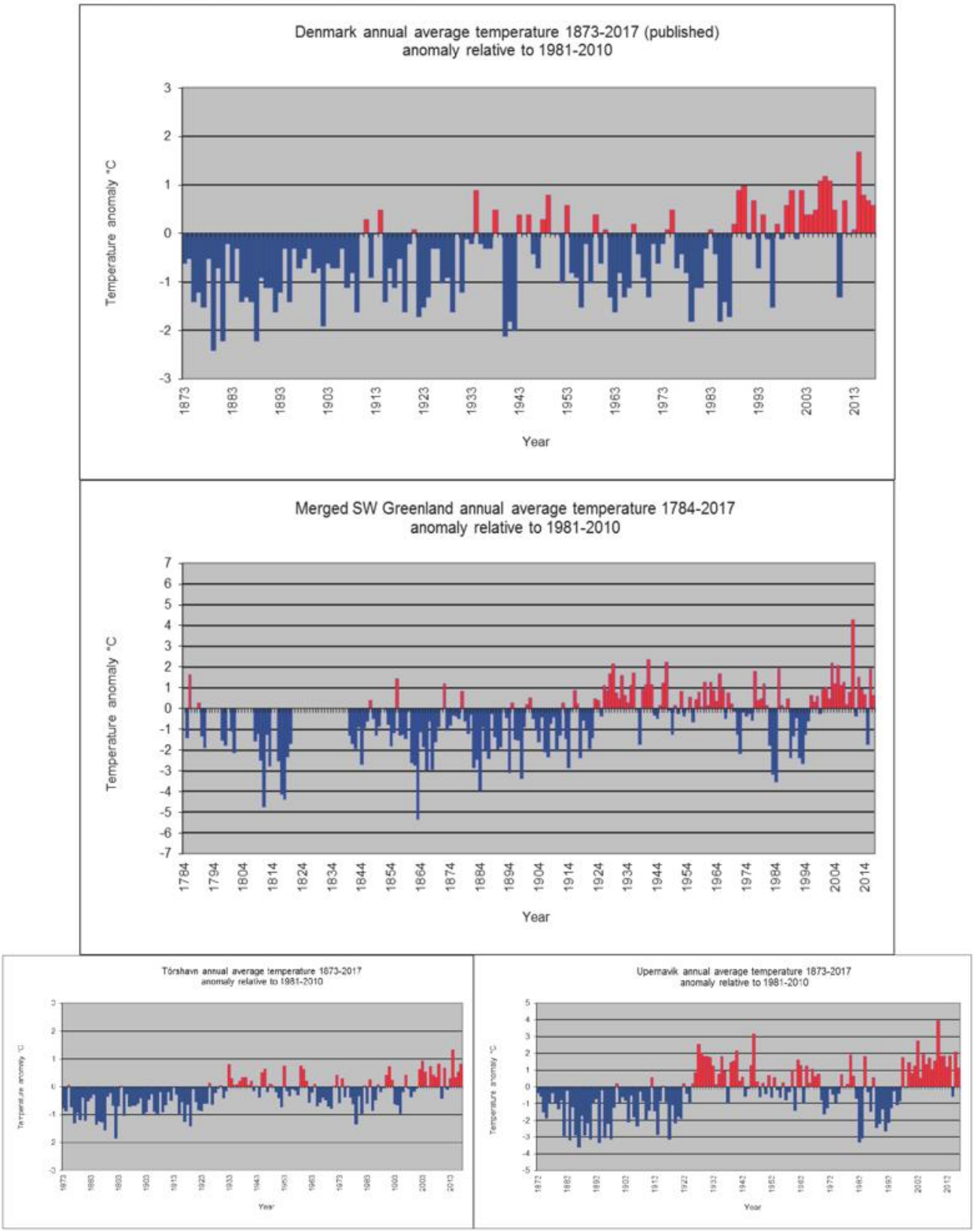


Figure 5.10: Time series of annual temperature anomalies for the period 1873-2017 for Denmark (top), 1784-2017 southwestern Greenland (middle) 1873-2017 the Faroe Islands (bottom left, Tórshavn) and 1873-2017 Greenland (bottom right, Upernavik); diagrams as provided by the NHMS

Nordic and Baltic Countries – annual temperature series

Estonia

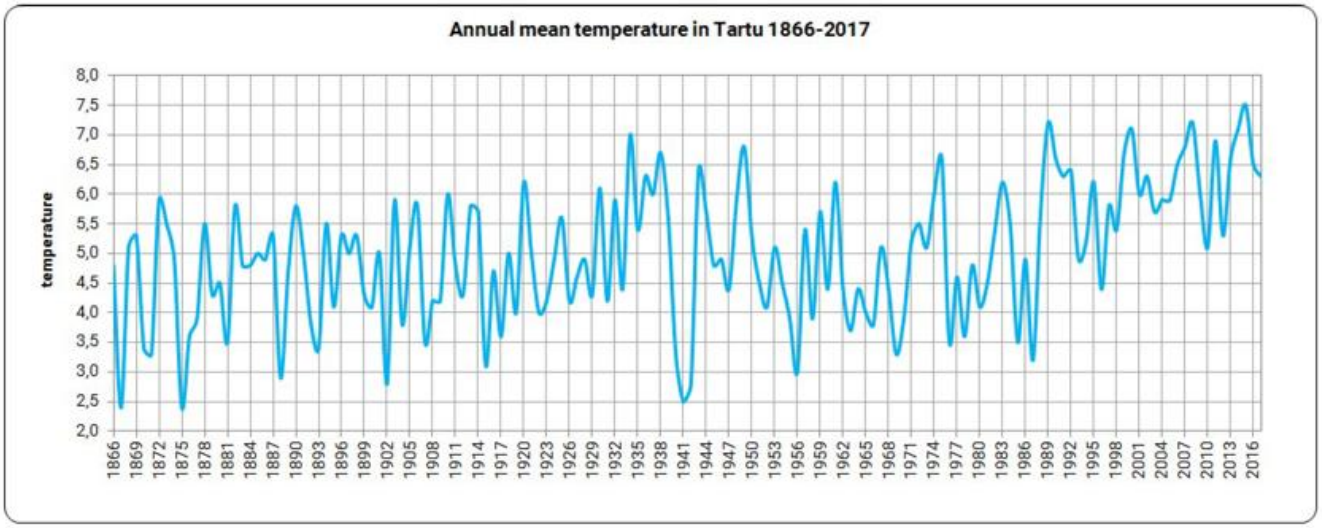


Figure 5.11: Time series of annual temperatures for the period 1866-2017 for station Tartu, Estonia (diagram as provided by the NHMS)

Finland

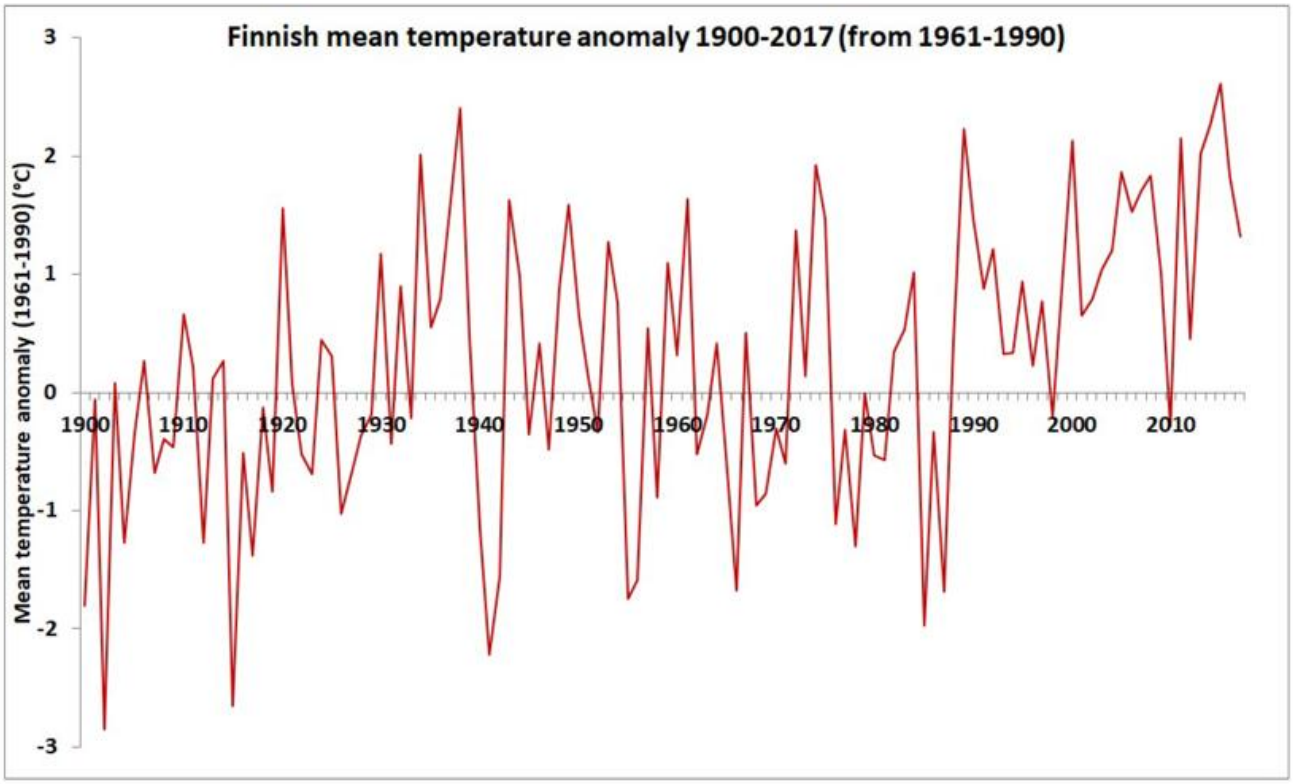


Figure 5.12: Time series of annual temperatures anomalies for Finland (reference period 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Iceland

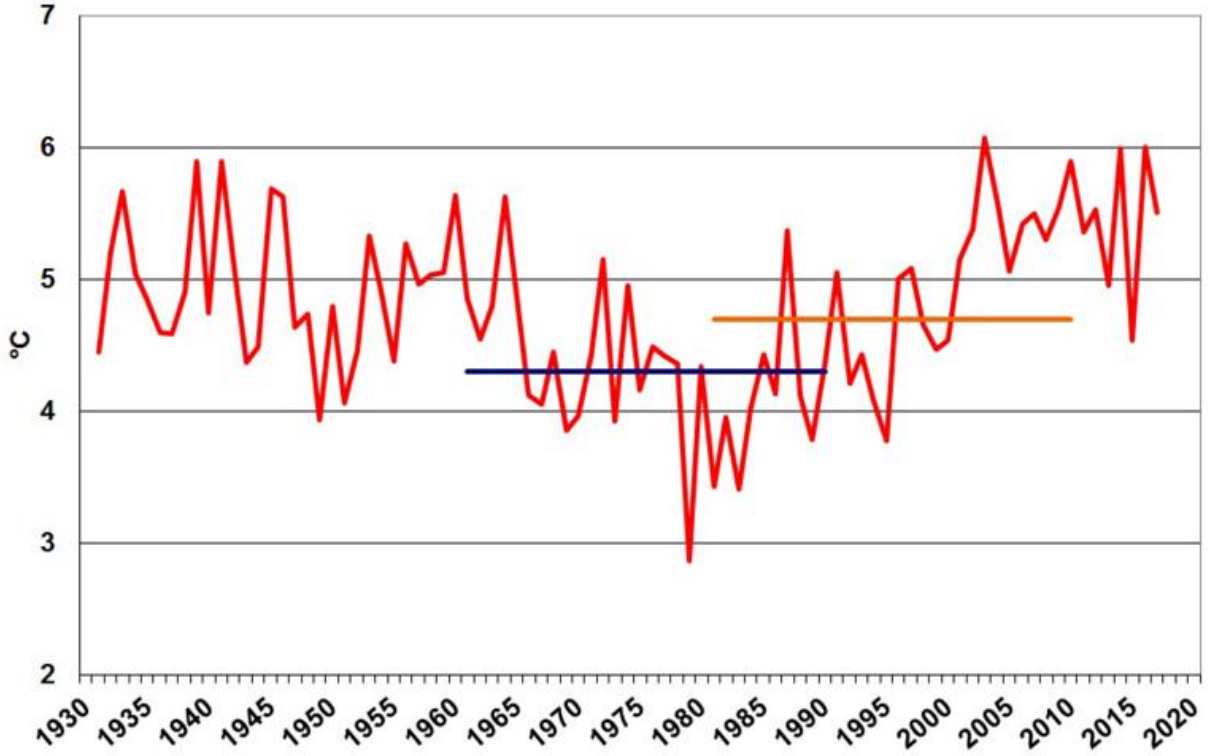


Figure 5.13: Time series of annual average temperature for the period 1931-2017 for station Reykjavík, Iceland (blue line: reference period 1961-1990, orange line: 1981-2010; data as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Latvia

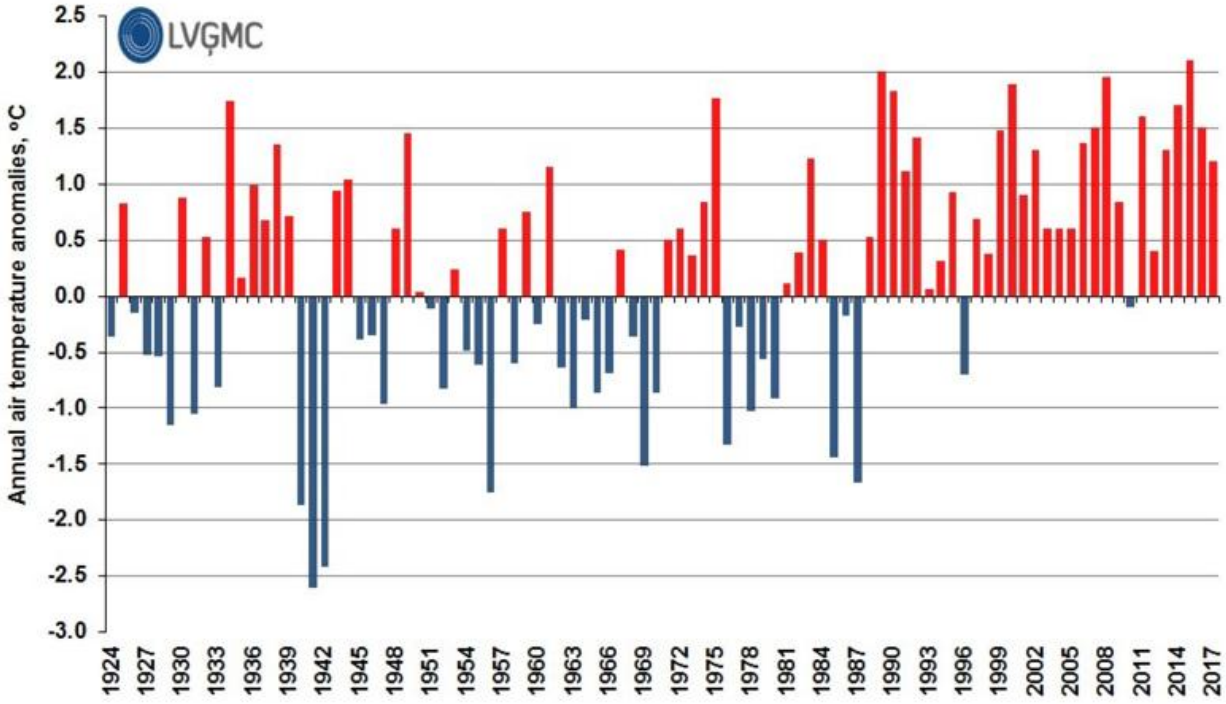


Figure 5.14: Time series of annual temperature anomalies for the period 1924-2017 for Latvia (reference period 1961-1990; diagram as provided by the NHMS)

Lithuania

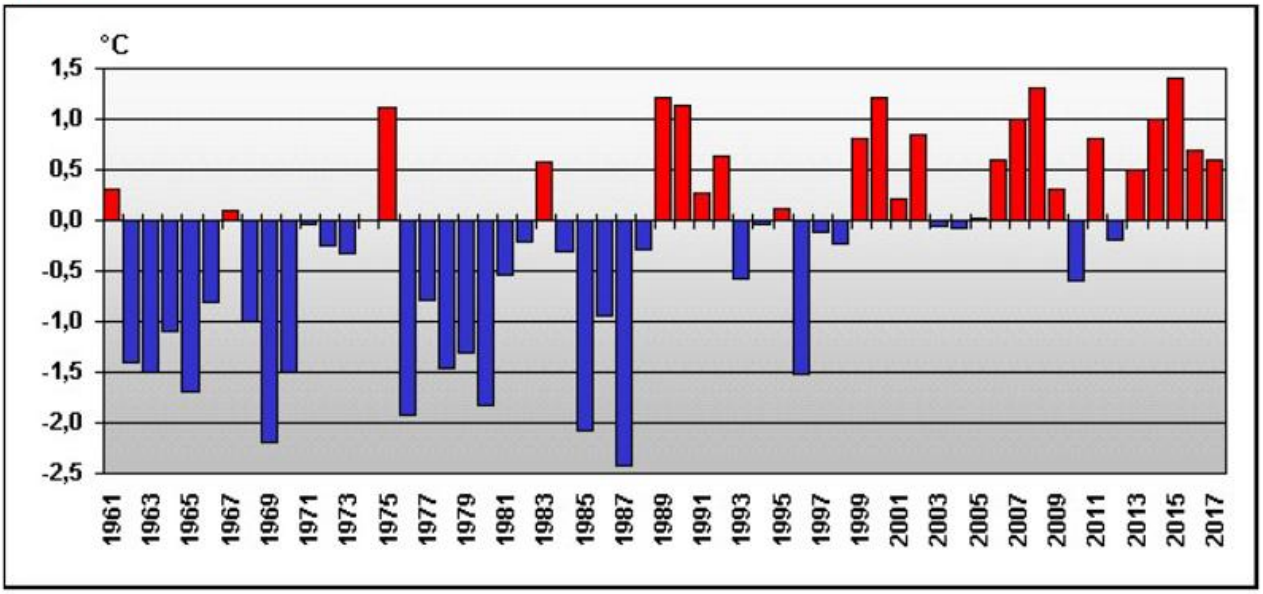


Figure 5.15: Time series of annual temperature anomalies for the period 1961-2017 for Lithuania (reference period 1981–2010; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Norway

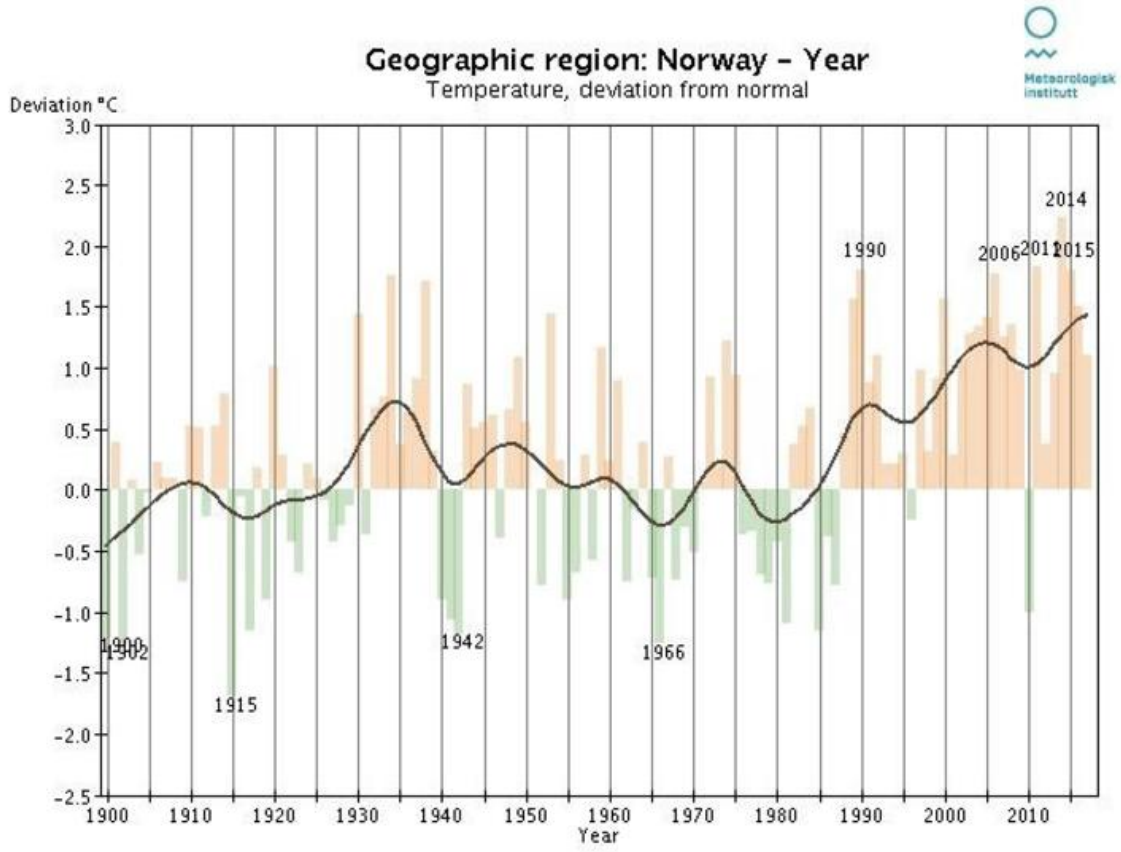


Figure 5.16: Time series of annual temperature anomalies for the period 1900-2017 for Norway (reference period 1961-1990; diagram as provided by the NHMS)

Sweden

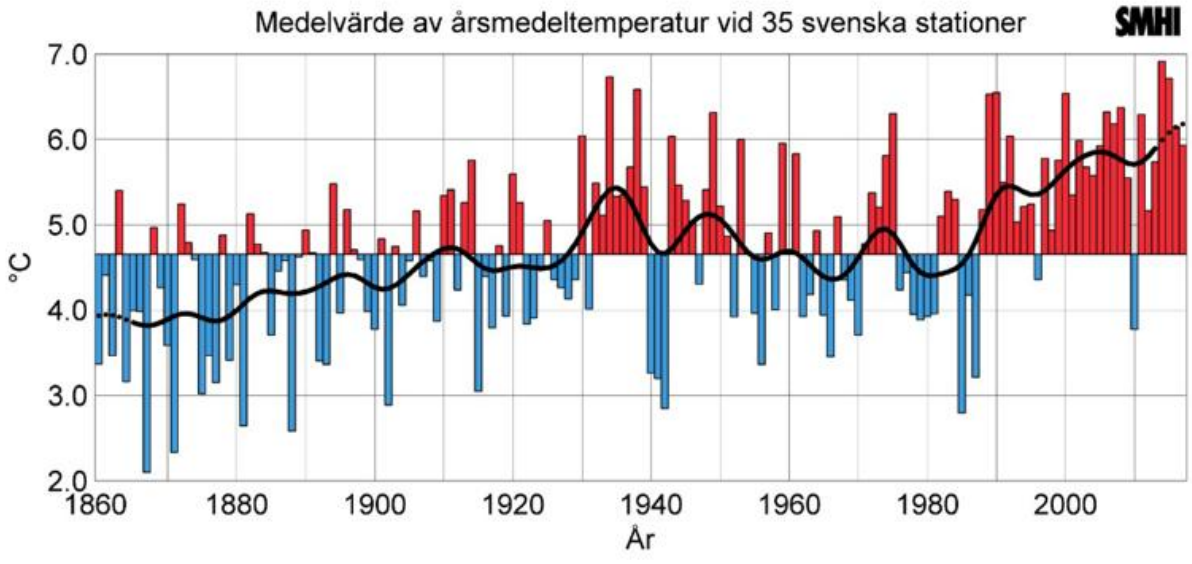


Figure 5.17: Time series of annual average temperature for the period 1860-2017 for Sweden (mean of 35 stations, diagram as provided by the NHMS)

Iberia – annual temperature series

Portugal, Spain

Portugal

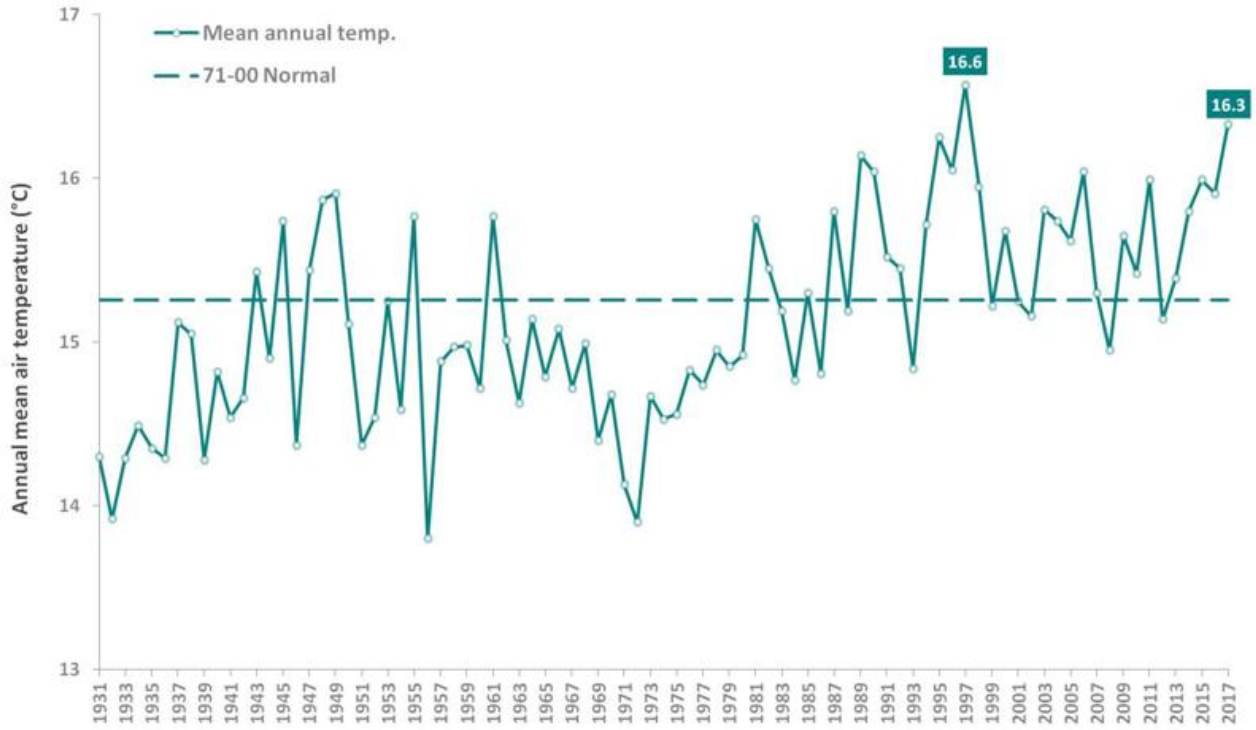


Figure 5.18: Time series of annual average temperature for the period 1931-2017 for Portugal (Dashed line normal 1971-2000, diagram as provided by the NHMS)

Spain

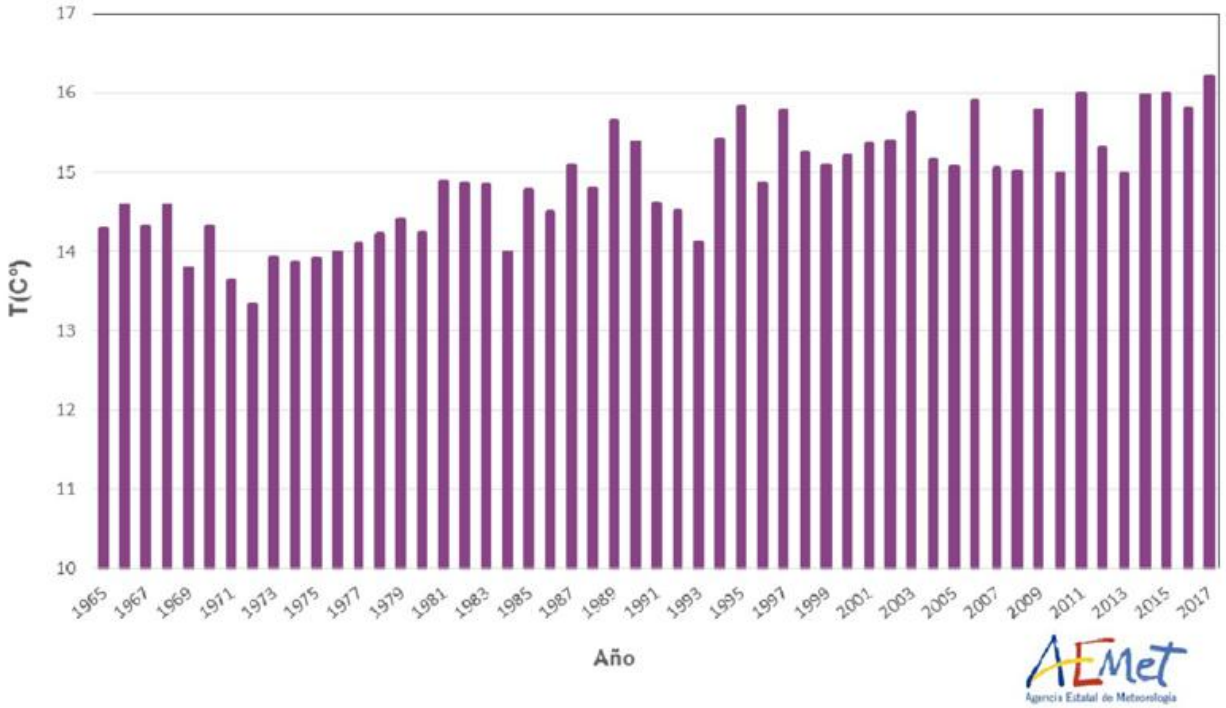


Figure 5.19: Time series of annual average temperature for the period 1965-2017 for Spain (diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Croatia, Italy, Slovenia, Serbia, Turkey

Croatia

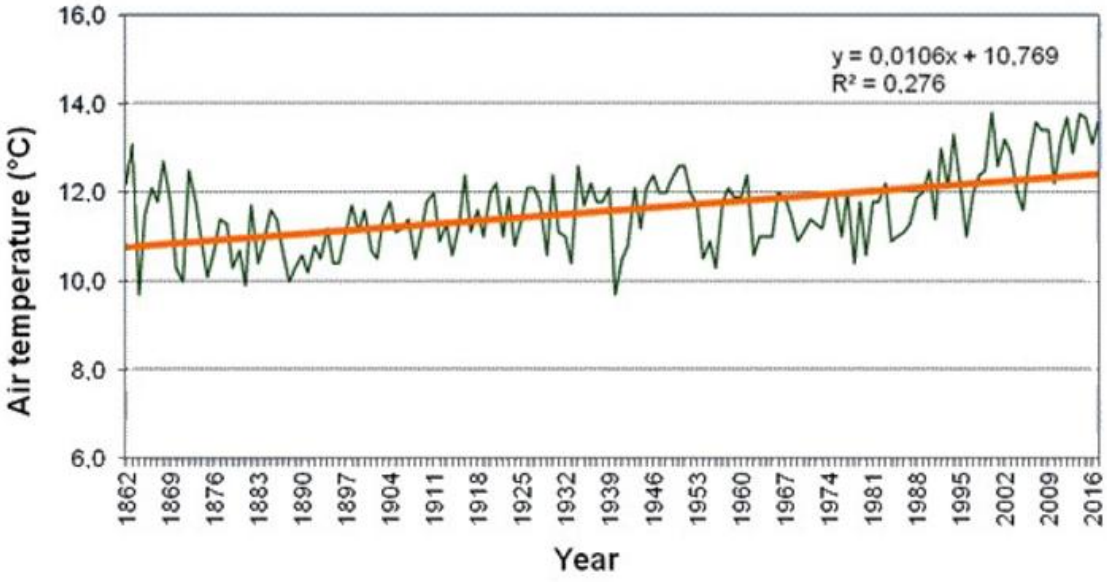


Figure 5.20: Time series of annual average temperature for Zagreb Grič (Croatia) for the period 1862-2017 (diagram as provided by the NHMS)

Italy

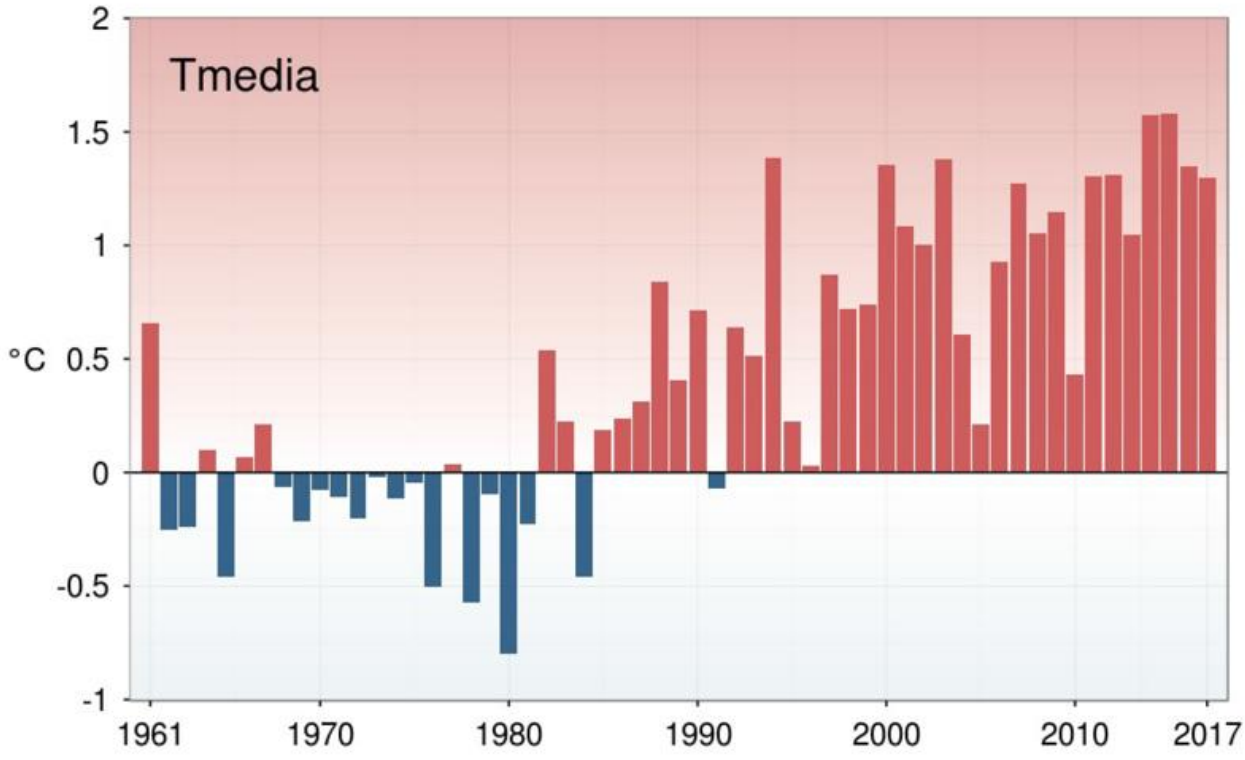


Figure 5.21: Time series of annual temperature anomalies for Italy for the period 1961-2017 (reference period 1961-1990; diagram as provided by ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Slovenia

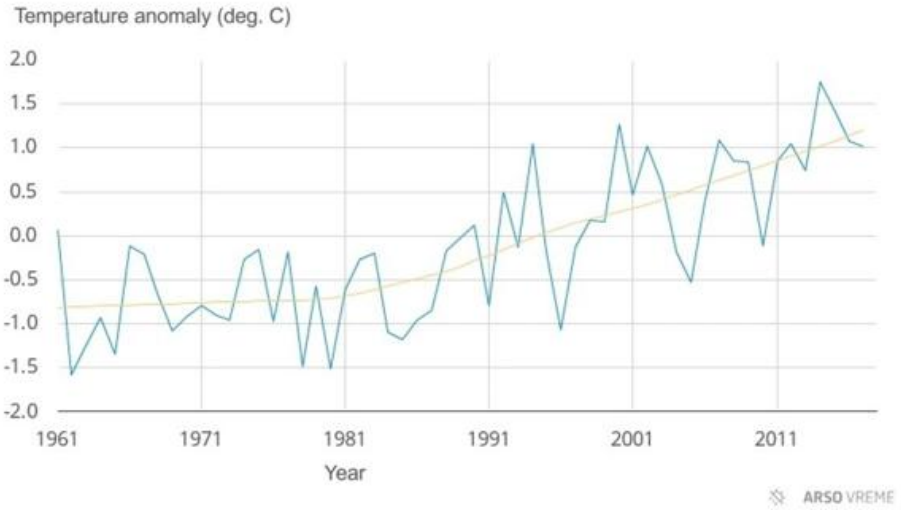
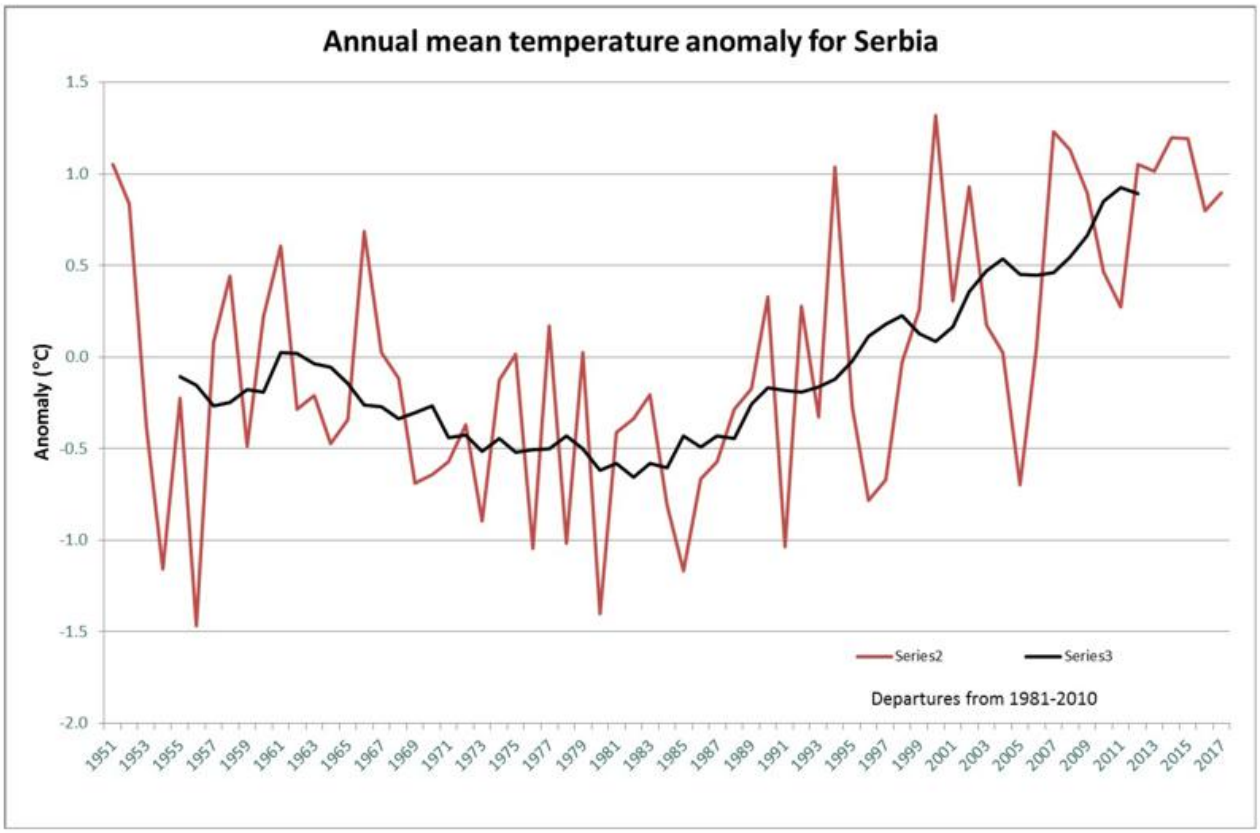


Figure 5.22: Time series of annual temperature anomalies for Slovenia for the period 1961-2017 (reference period 1961-1990; diagram as provided by the NHMS)



Serbia

Figure 5.23: Time series of annual temperature anomalies for Serbia for the period 1951-2017 (reference period 1981-2010; diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Turkey

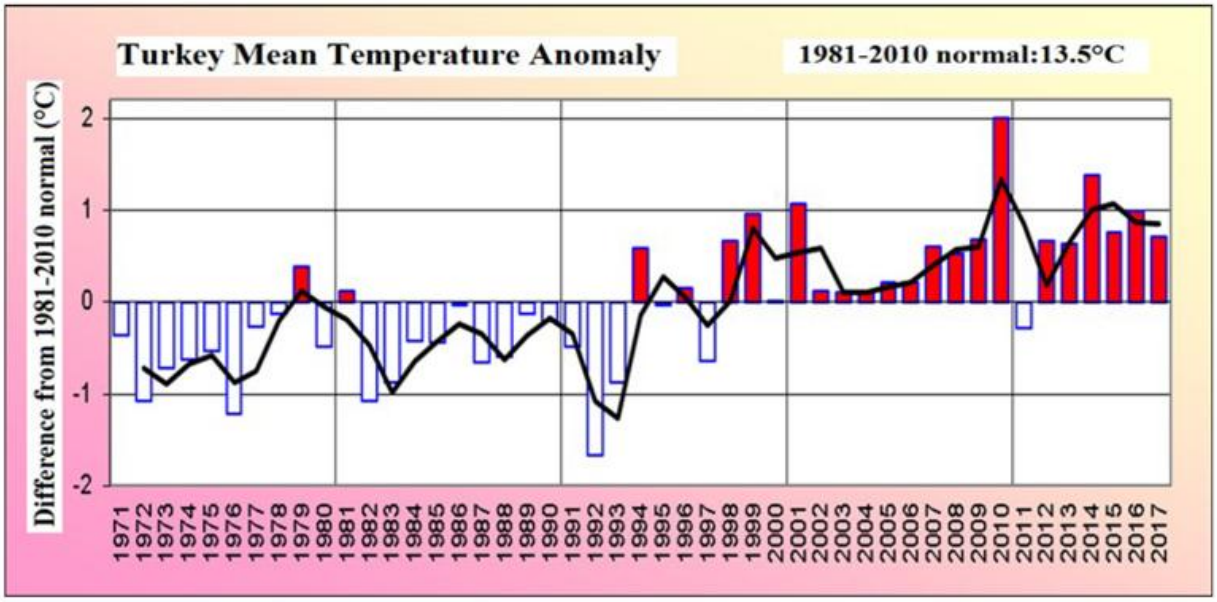


Figure 5.24: Time series of annual temperature anomalies for Turkey for the period 1971-2017 (reference period 1981-2010; diagram as provided by the NHMS)

Eastern Europe – annual temperature series

Belarus, European Russia, Moldova, Ukraine

Belarus

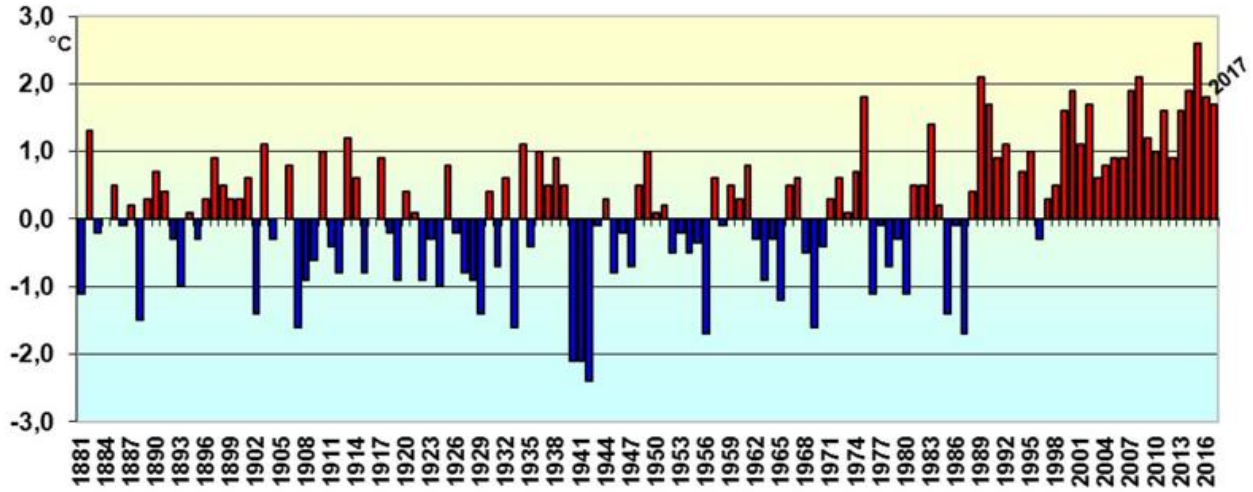


Figure 5.25: Time series of annual temperature anomalies for the Republic of Belarus for the period 1881-2017 (reference period 1961-1990; diagram as provided by the NHMS)

European Russia

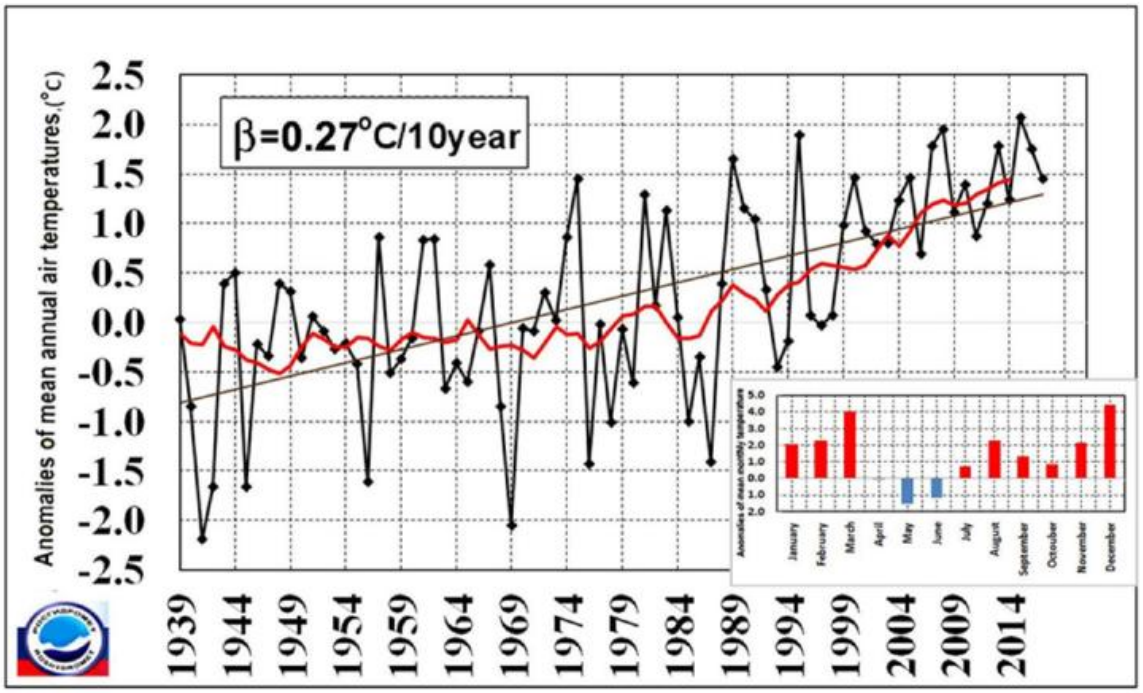


Figure 5.26: Time series of annual temperature anomalies for European Russia for the period 1939-2017 (reference period 1961-1990; diagram as provided by the NHMS)

Eastern Europe – annual temperature series

Moldova

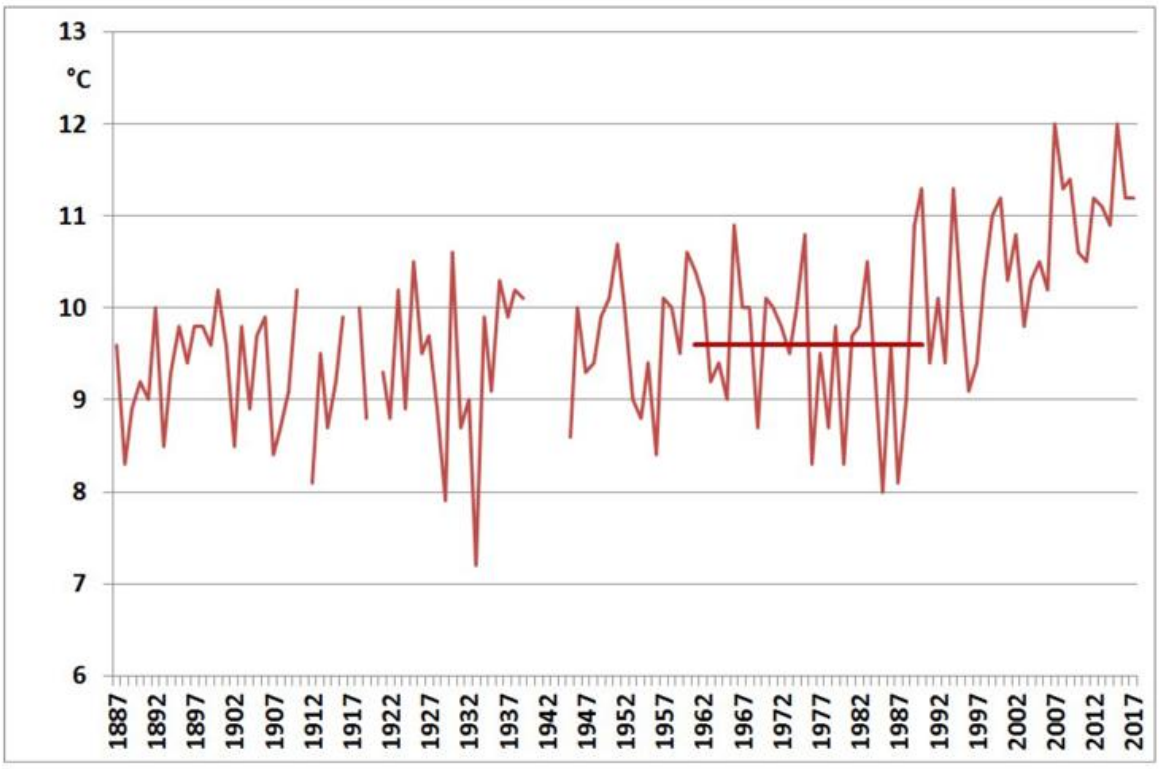


Figure 5.27: Time series of annual temperature for station Chisinau, Moldova for the period 1887-2017 (diagram as provided by the NHMS)

Ukraine

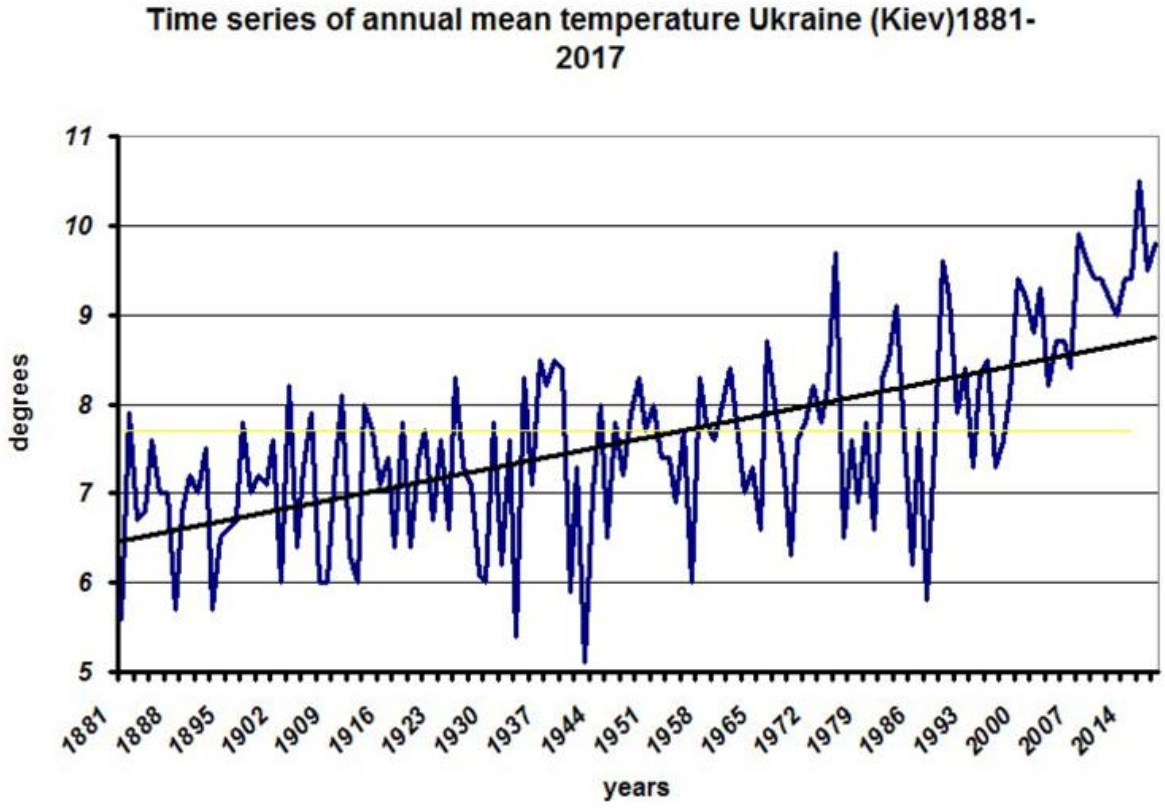


Figure 5.28: Time series of annual temperature for Kiev (Ukraine) for the period 1881-2017 (Diagram as provided by the NHMS)

Middle East – annual temperature series

Georgia, Israel

Georgia

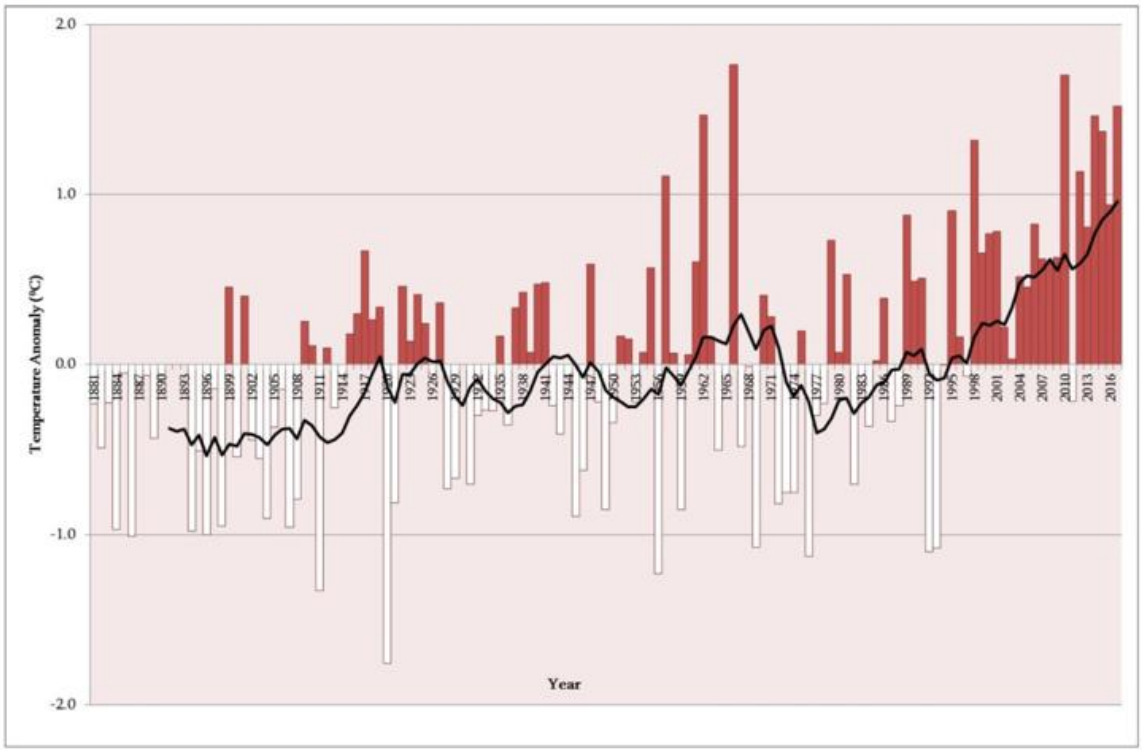


Figure 5.29: Time series of annual temperature anomalies and 11-yr moving averages for Tbilisi (Georgia) for the period 1881-2017(reference period 1961-1990; diagram as provided by the NHMS)

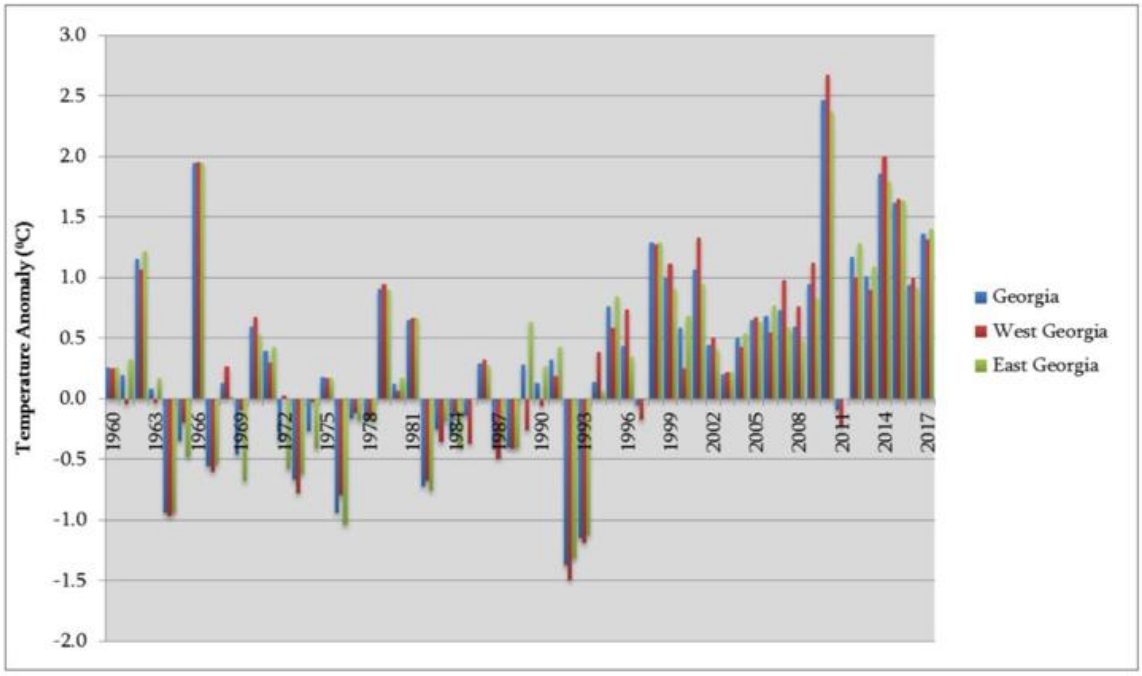


Figure 5.30: Time series of annual temperature anomalies for Georgia for the period 1960-2017 (reference period 1961-1990; diagram as provided by the NHMS)

Middle East – annual temperature series

Israel

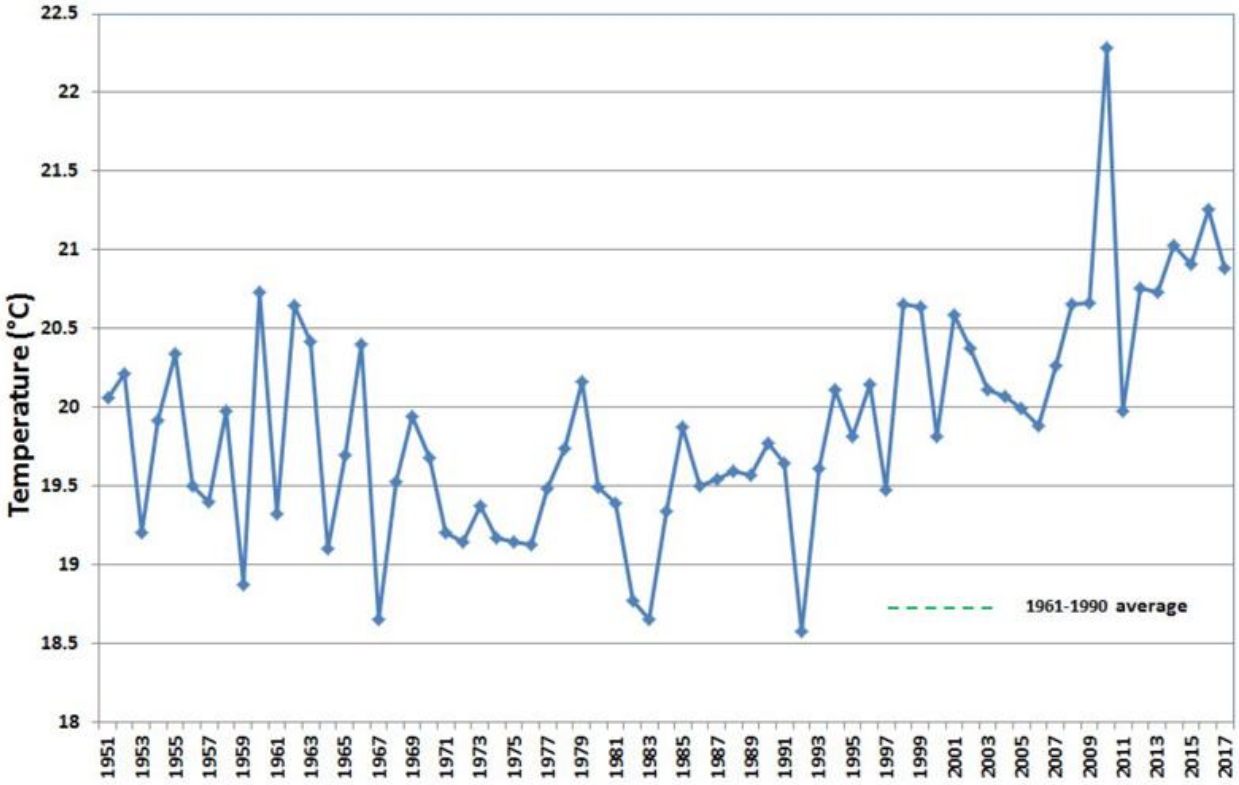


Figure 5.31: Time series of annual temperature for Israel (based on five stations) for the period 1951-2017 (diagram as provided by the NHMS)

5.2. Precipitation

Central and Western Europe - precipitation totals and anomalies

Belgium, France, Germany, Hungary, Netherlands, Switzerland, United Kingdom

Belgium

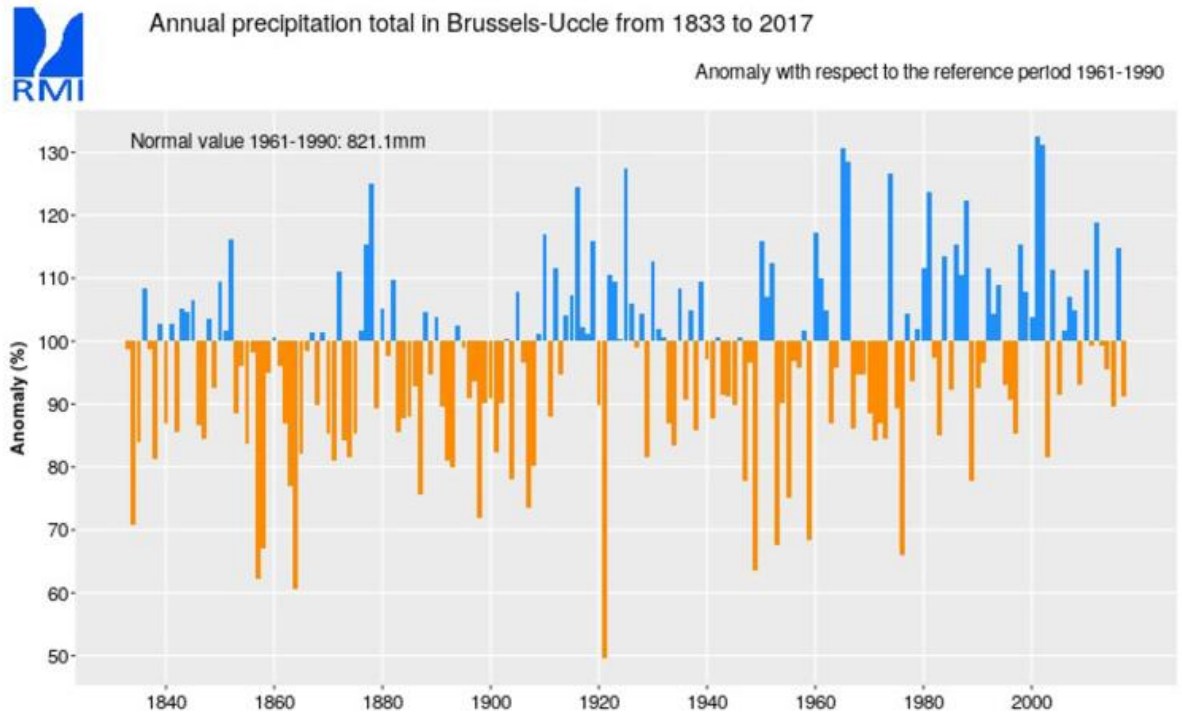


Figure 5.32: Time series of annual precipitation anomalies in relation to the long term mean (1961-1990) for Belgium (station Uccle) for the period 1833-2017 (Diagram as provided by the NHMS)

France

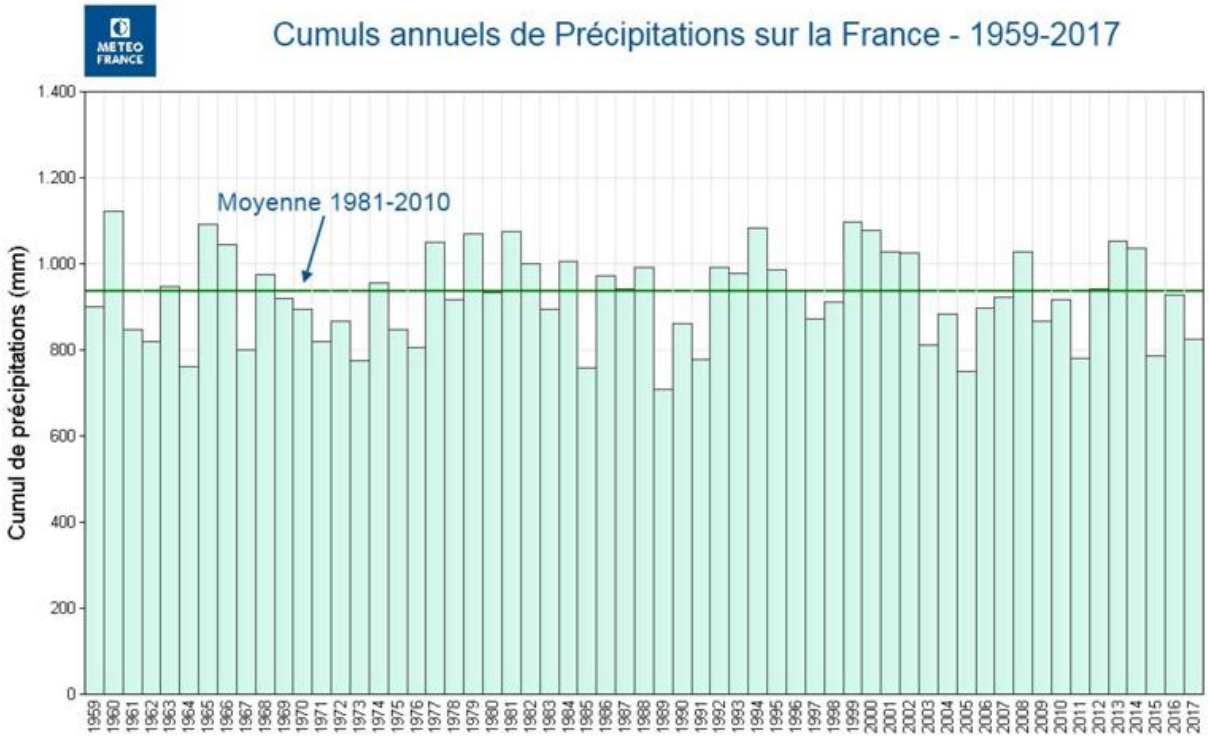


Figure 5.33: Time series of annual precipitation totals in mm/year for France for the period 1959-2017 (green line: long term mean 1981-2010; Diagram as provided by the NHMS)

Germany

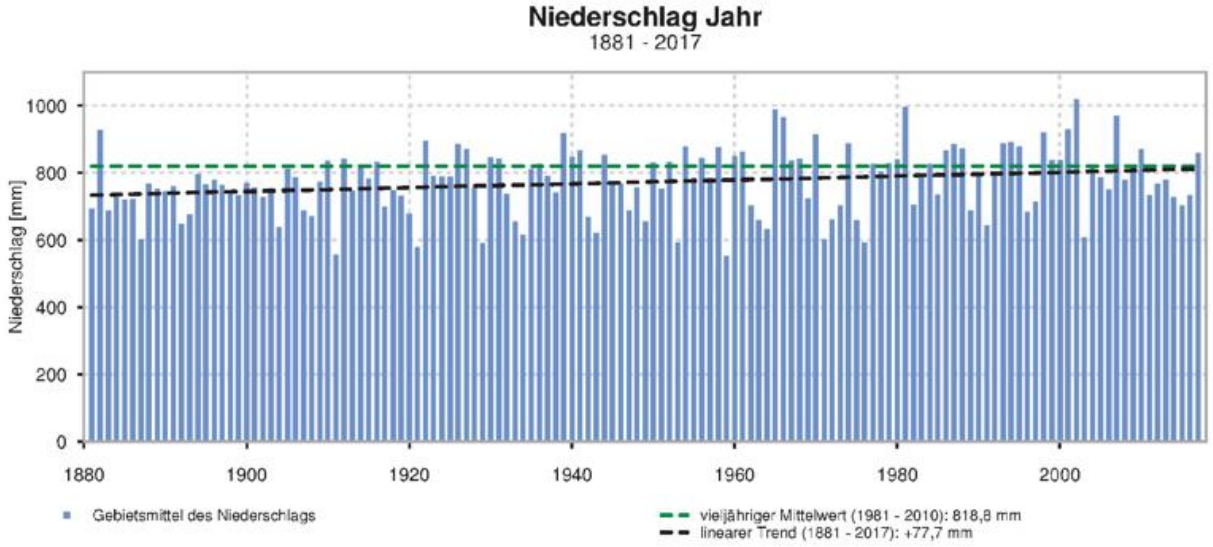


Figure 5.34: Time series of annual precipitation totals in mm/year for Germany for the period 1881-2017 (green line: long term mean; Diagram as provided by the NHMS)

Central and Western Europe - precipitation totals and anomalies

Hungary

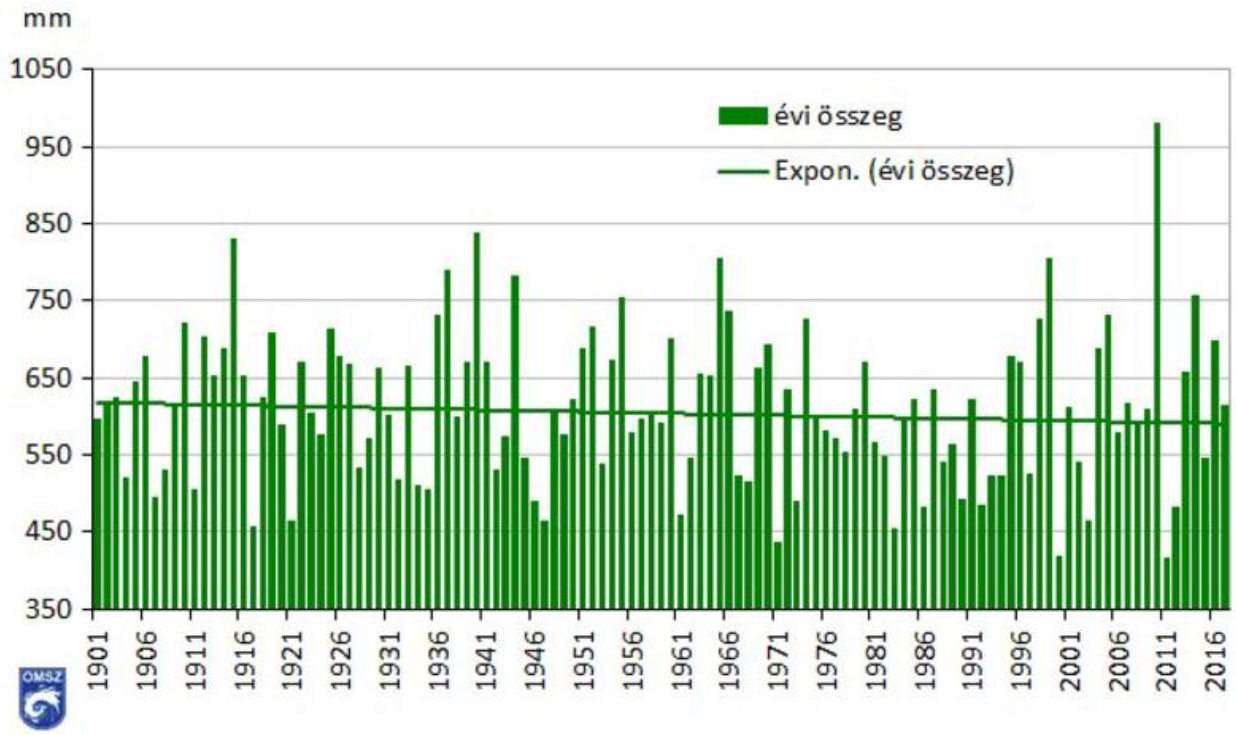


Figure 5.35: Time series of annual precipitation totals in mm/year for Hungary for the period 1901-2017 (Diagram as provided by the NHMS)

The Netherlands

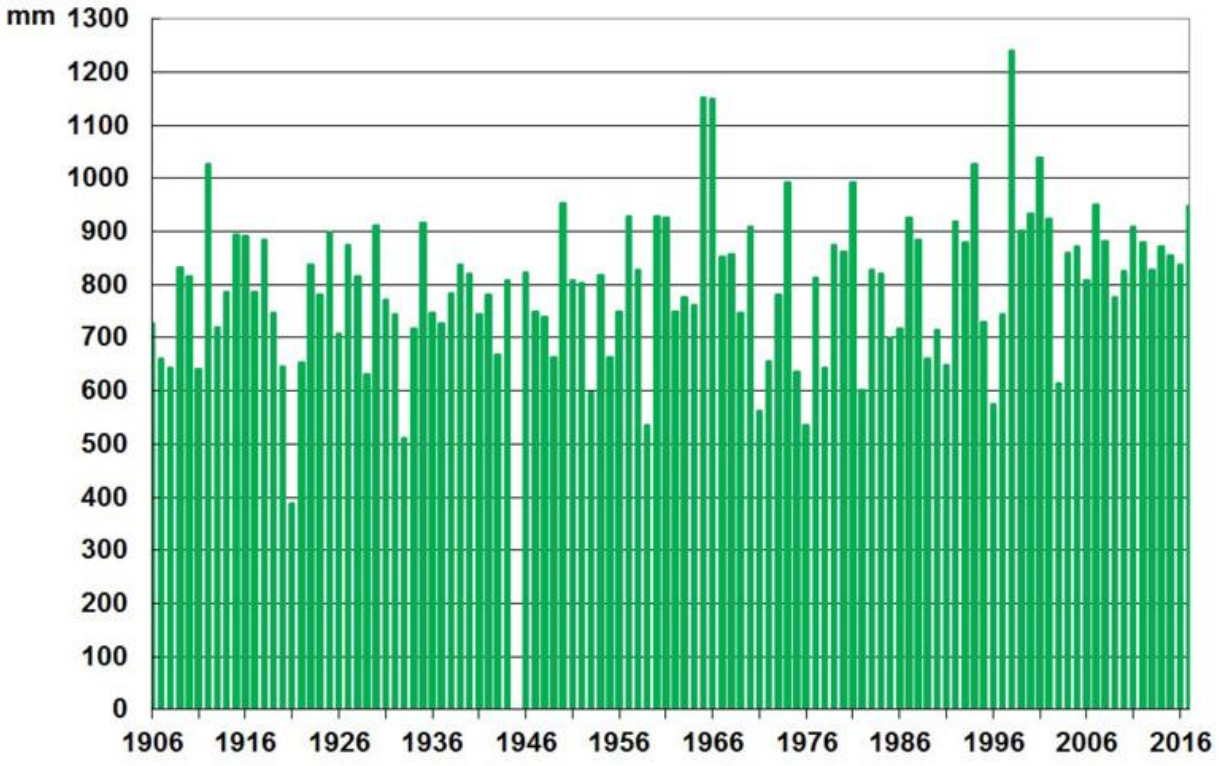


Figure 5.36: Time series of annual precipitation totals in mm/year for the Netherlands (station De Bilt) for the period 1906-2017 (Data as provided by the KNMI)

Central and Western Europe - precipitation totals and anomalies

Switzerland

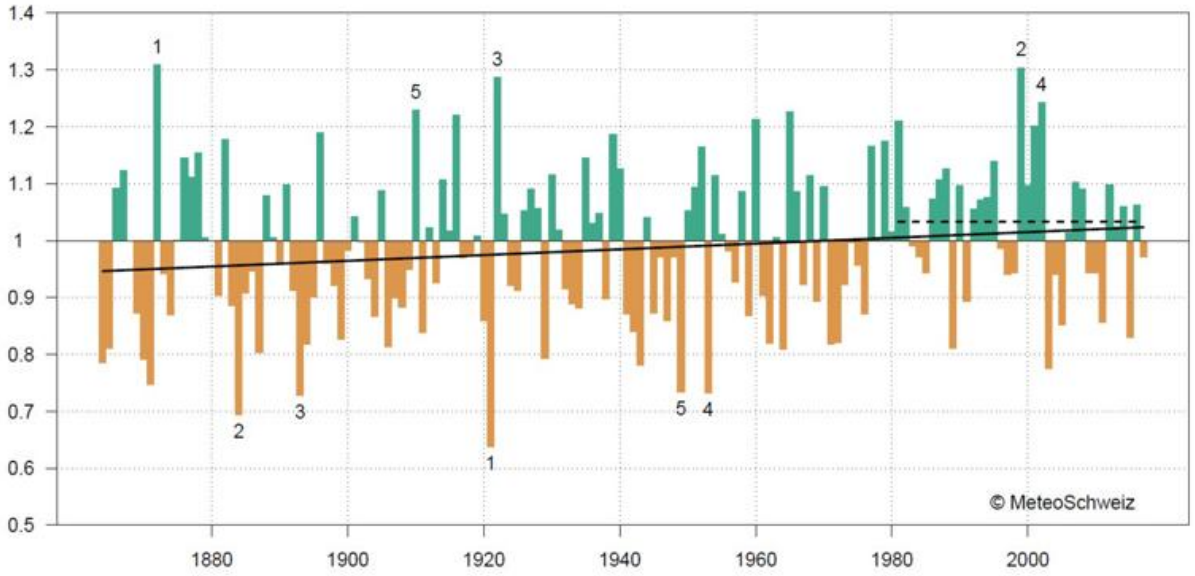


Figure 5.37: Time series of annual precipitation anomalies in relation to the mean of 1961-1990 for Switzerland for the period 1864–2017. Color bars represent anomalies in respect to the long-term mean 1961–1990 and green indicates positive and bronze negative anomalies. The black line represents the linear significant trend (5.0%/100y). The black dashed line represents the mean 1981–2010. (Diagram as provided by the NHMS)

United Kingdom

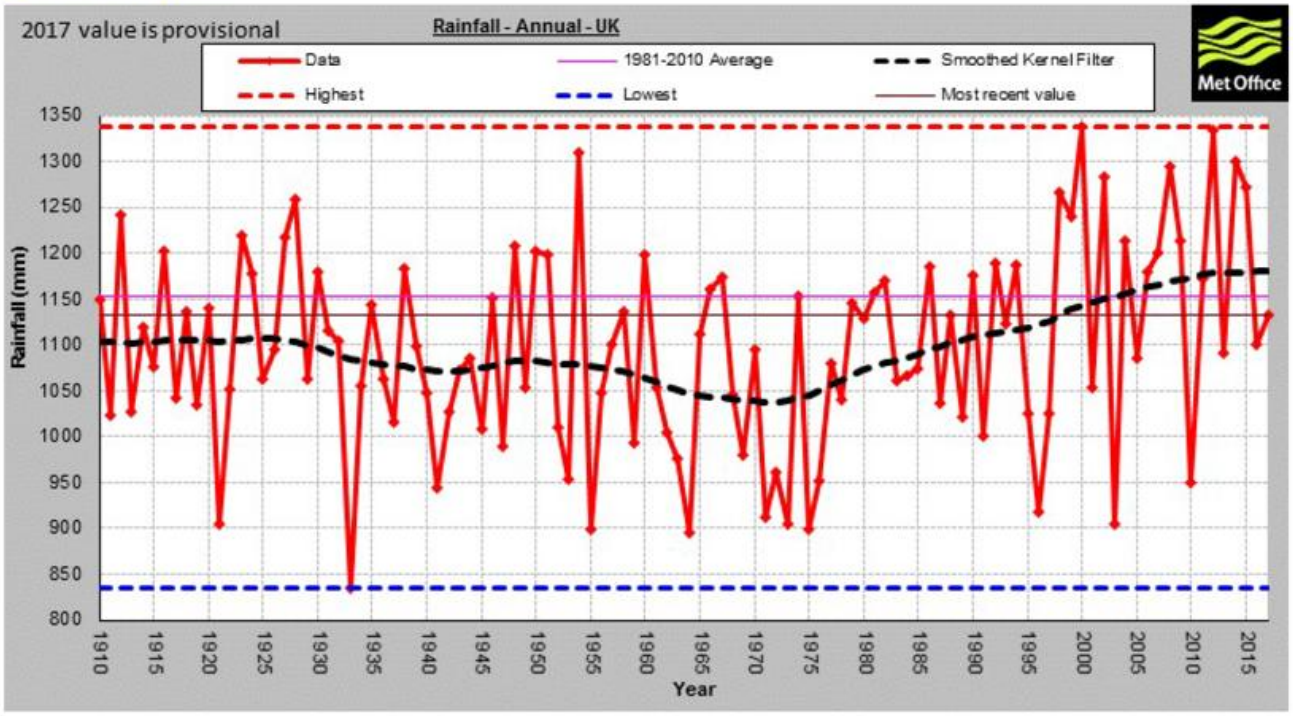


Figure 5.38: Time series of annual precipitation totals in mm/year for the United Kingdom for the period 1910-2017 (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Denmark, Finland, Latvia, Norway, Sweden

Denmark

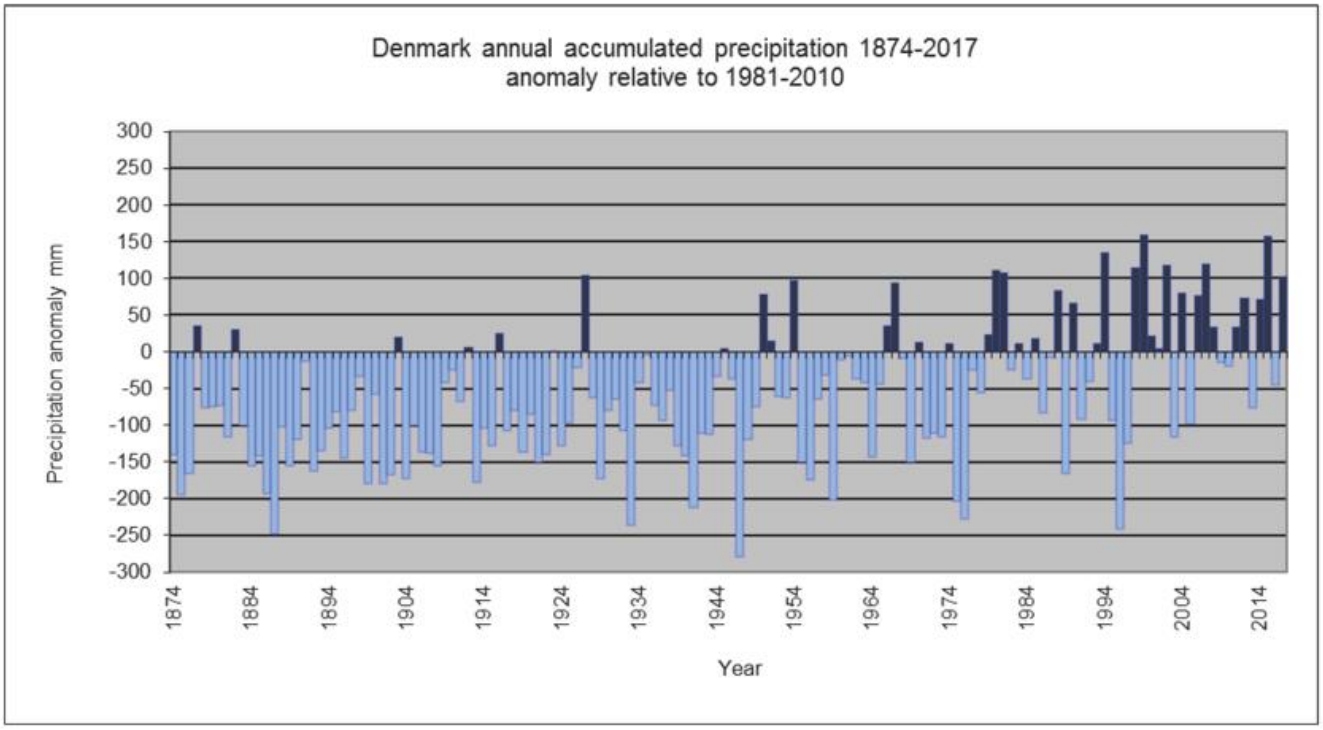


Figure 5.39: Time series of annual precipitation totals in mm/year for Denmark: anomaly relative to 1981-2010 (Diagram as provided by the NHMS)

Estonia

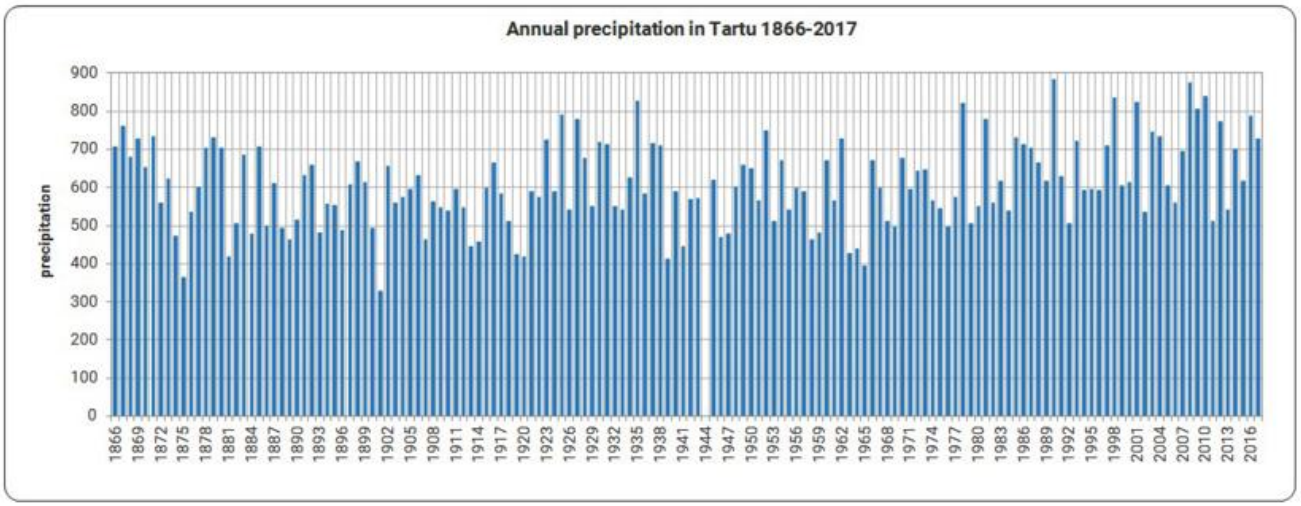


Figure 5.40: Time series of annual precipitation totals in mm/year at station Tartu, Estonia (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Finland

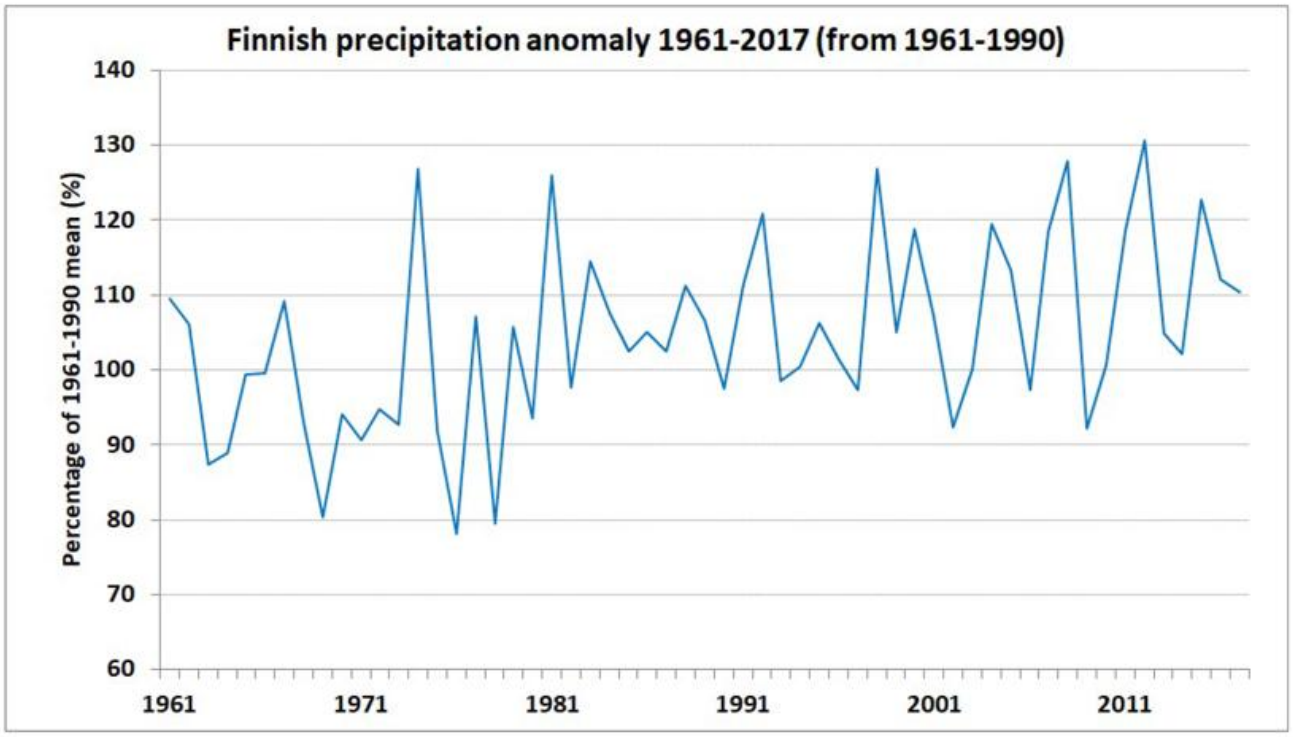


Figure 5.41: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Finland (Diagram as provided by the NHMS)

Latvia

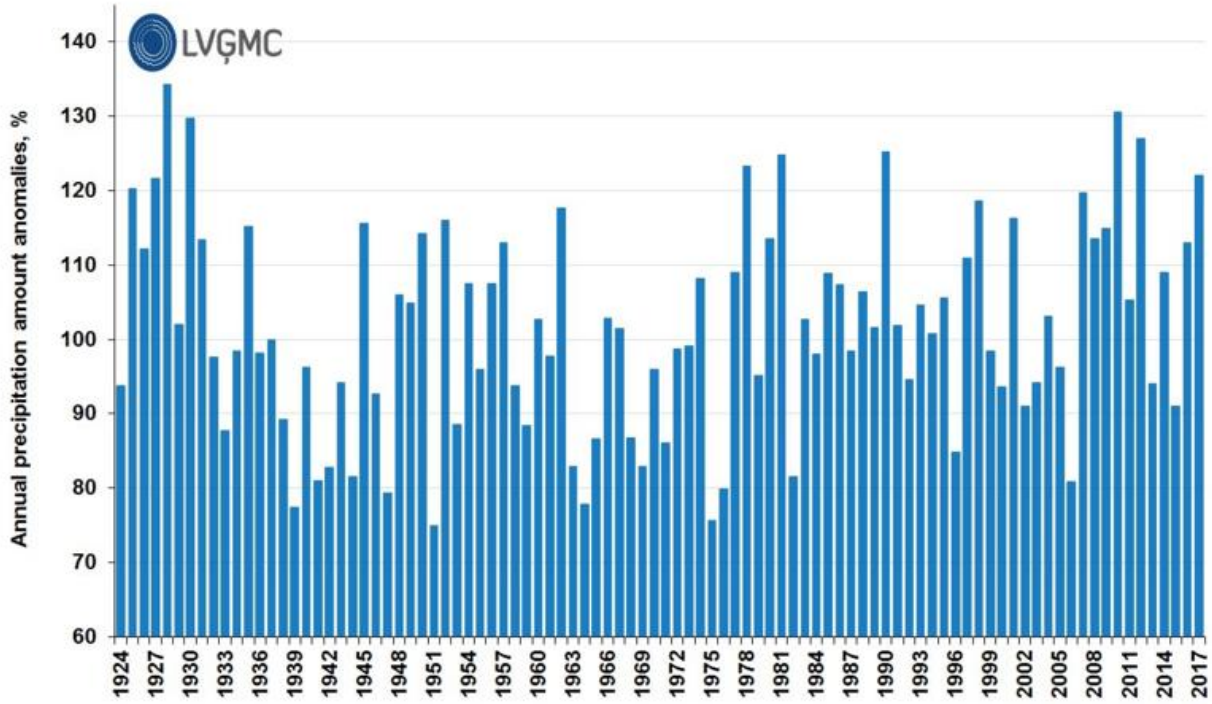


Figure 5.42: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Latvia (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Norway

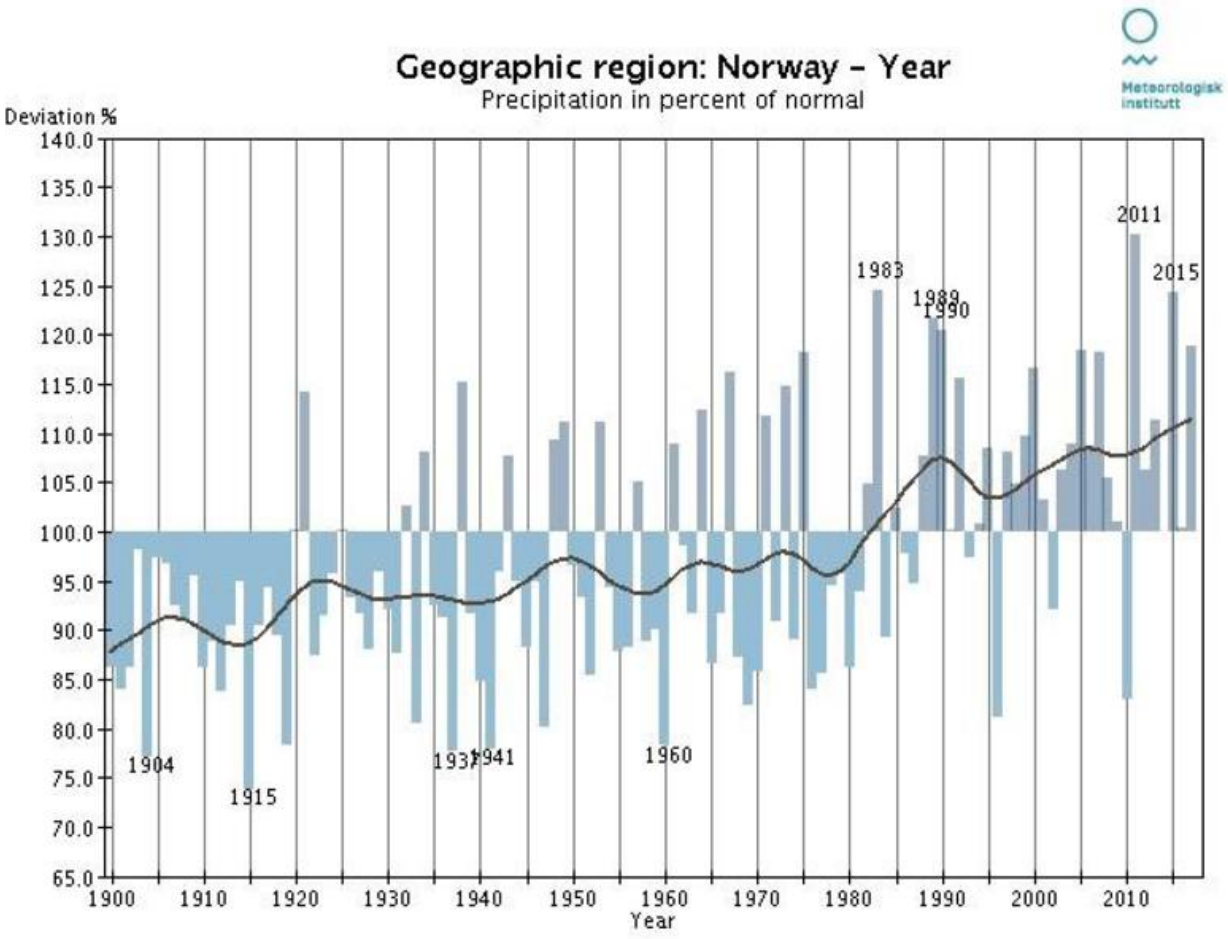


Figure 5.43: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Norway (Diagram as provided by the NHMS)

Sweden

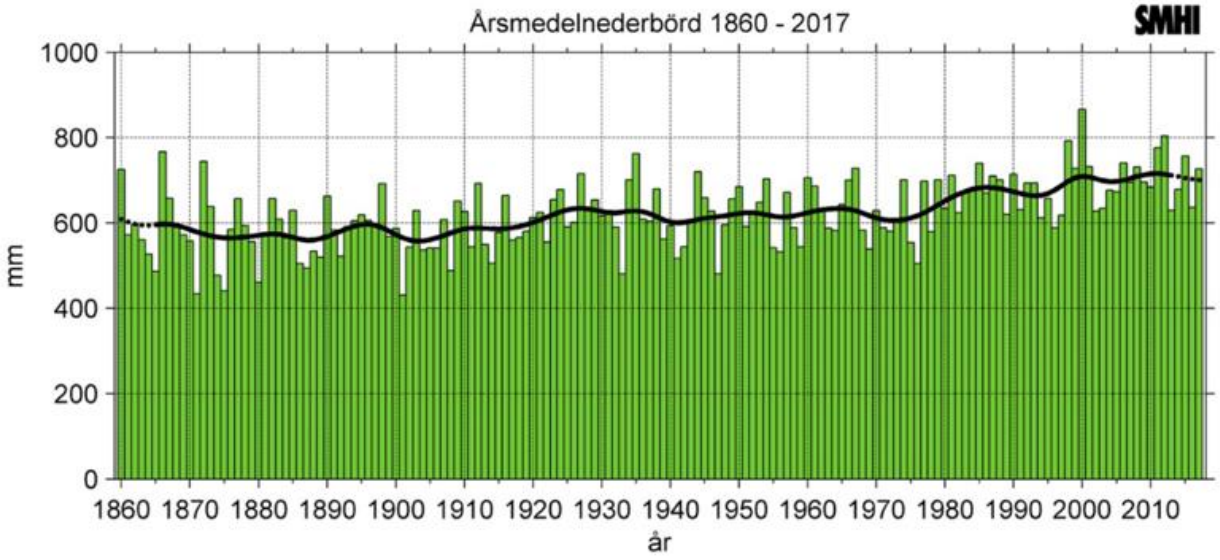


Figure 5.44: Time series of annual precipitation totals in mm/year for Sweden (Diagram as provided by the NHMS)

Iberia - precipitation anomalies

Portugal, Spain

Portugal

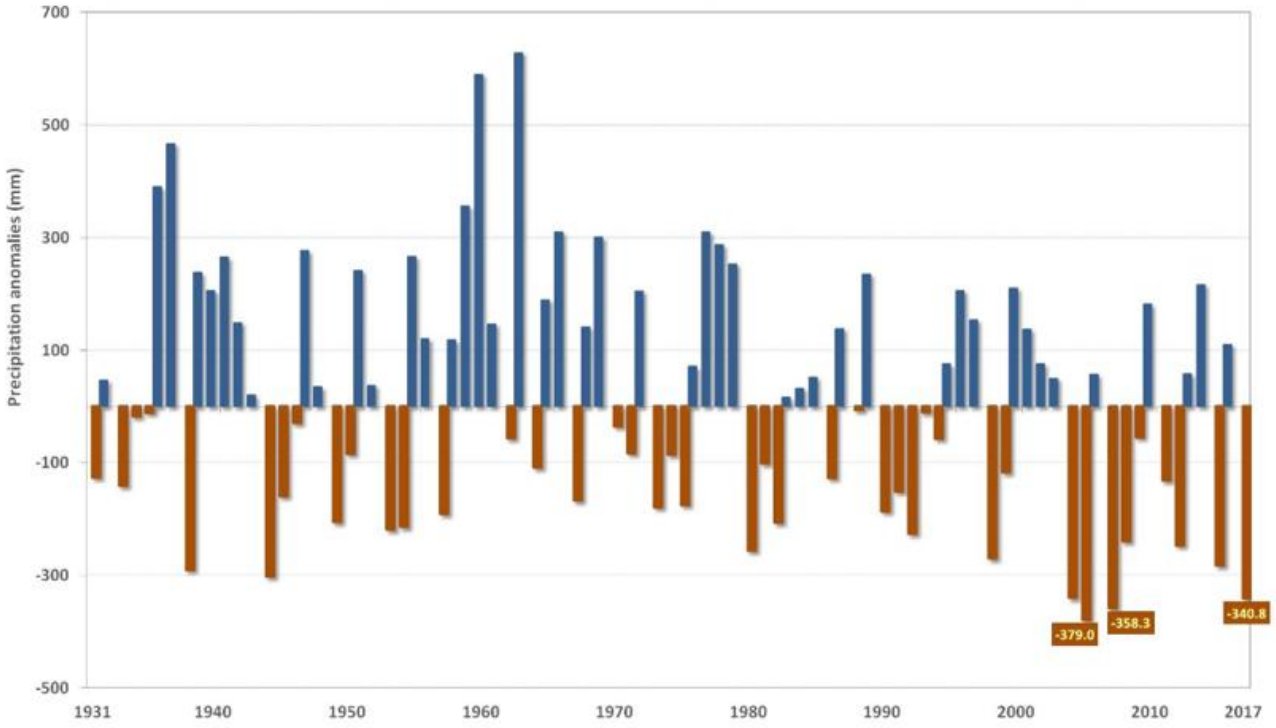


Figure 5.45: Time series of annual precipitation totals in mm/year (deviations from the mean of 1971-2000) for Portugal (Diagram as provided by the NHMS)

Spain

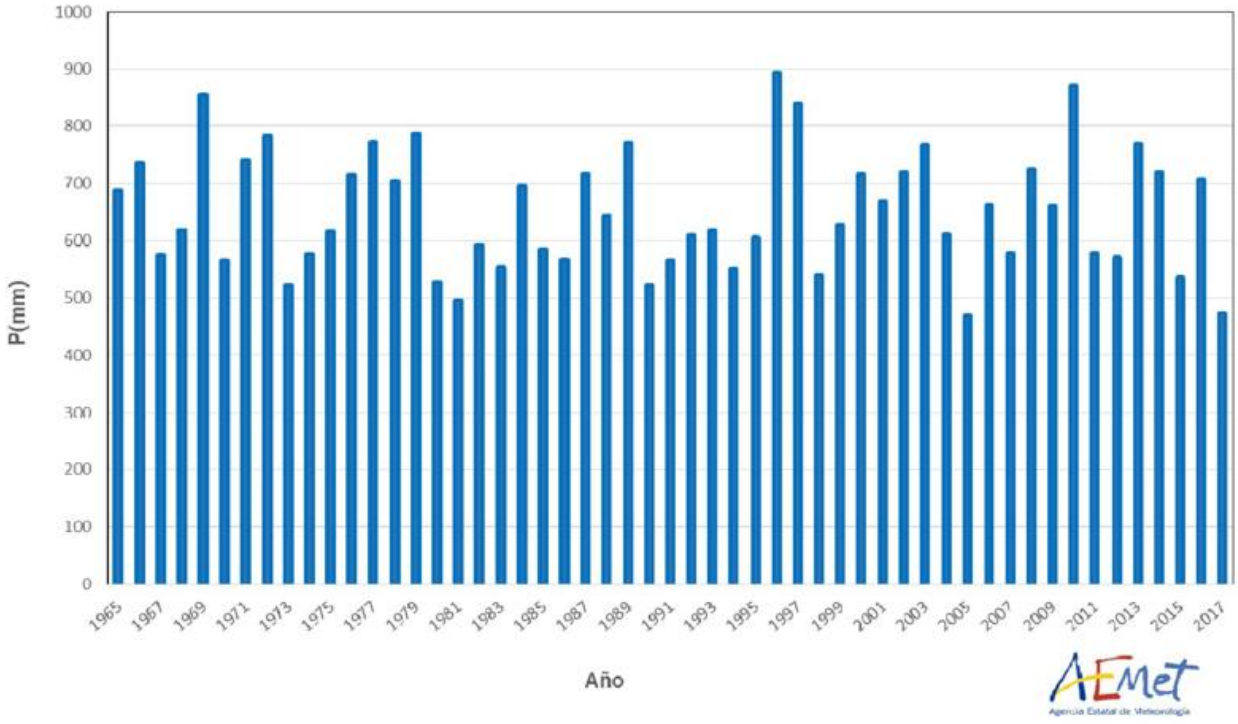


Figure 5.46: Time series of annual precipitation totals in mm/year for Spain (Diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Croatia, Italy, Slovenia, Turkey

Croatia

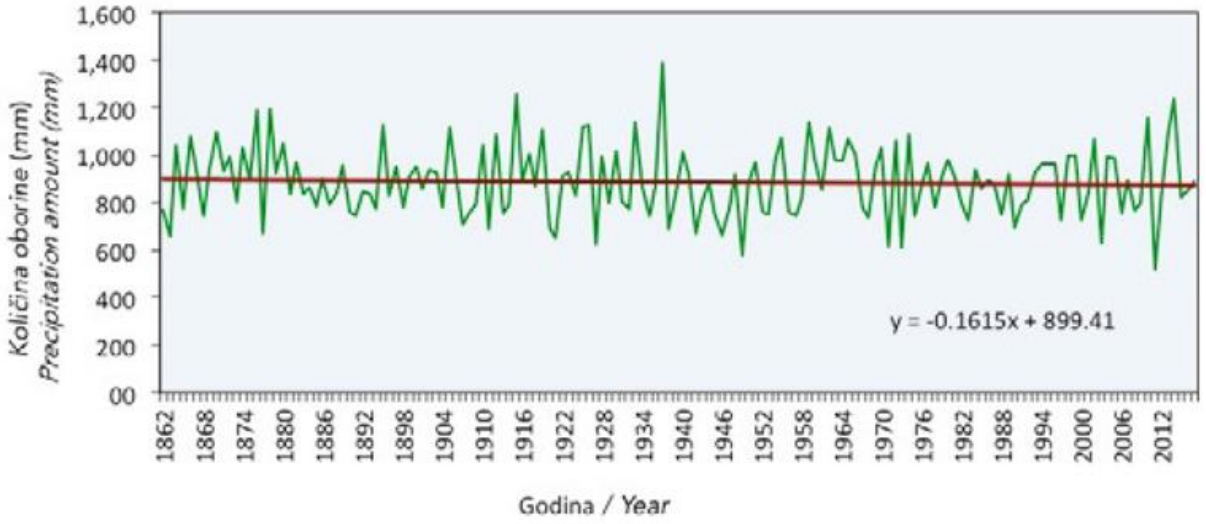


Figure 5.47: Time series of annual precipitation totals in mm/year for Zagreb Grič (Croatia) (Diagram as provided by the NHMS)

Italy

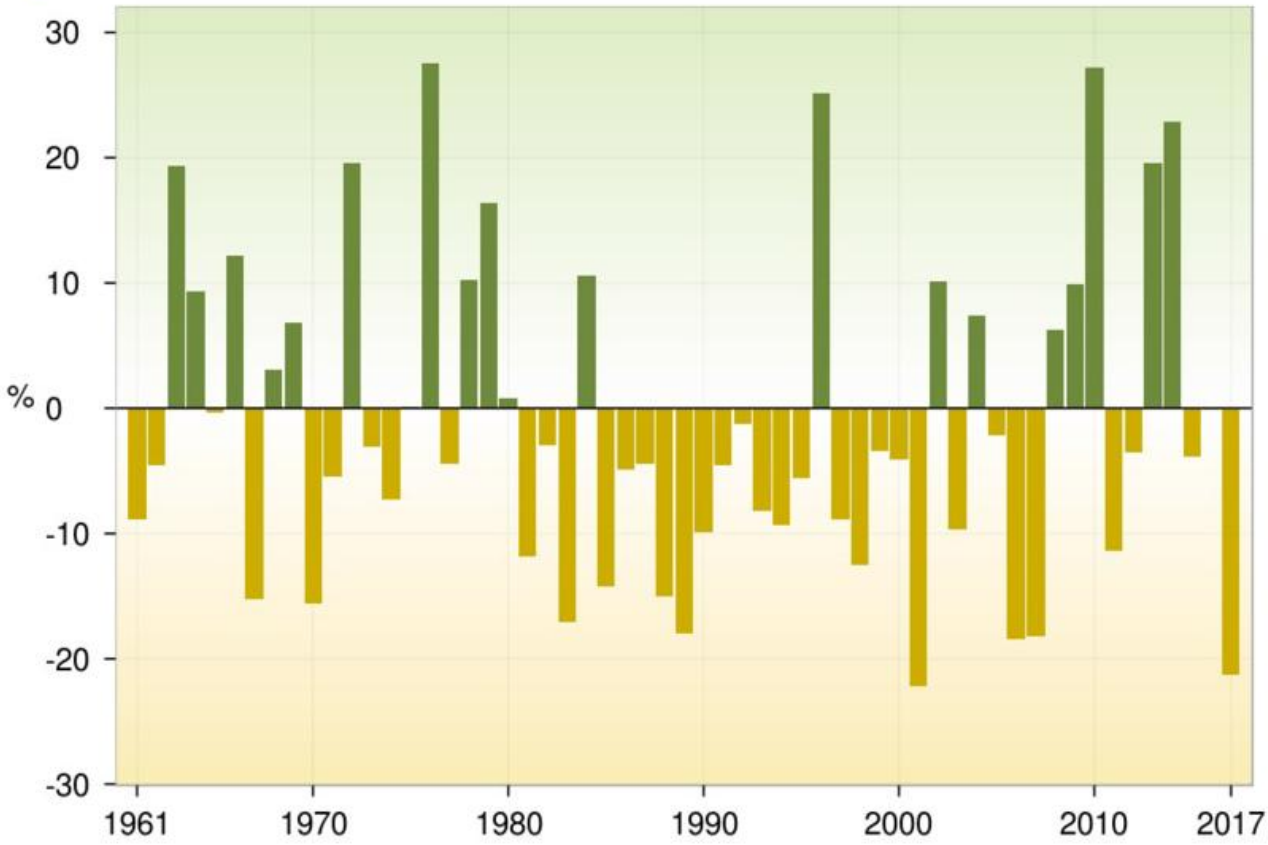


Figure 5.48: Time series of annual precipitation anomalies for 1961 to 2017 in relation to the mean of 1961-90 for Italy (diagram as provided by ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Slovenia

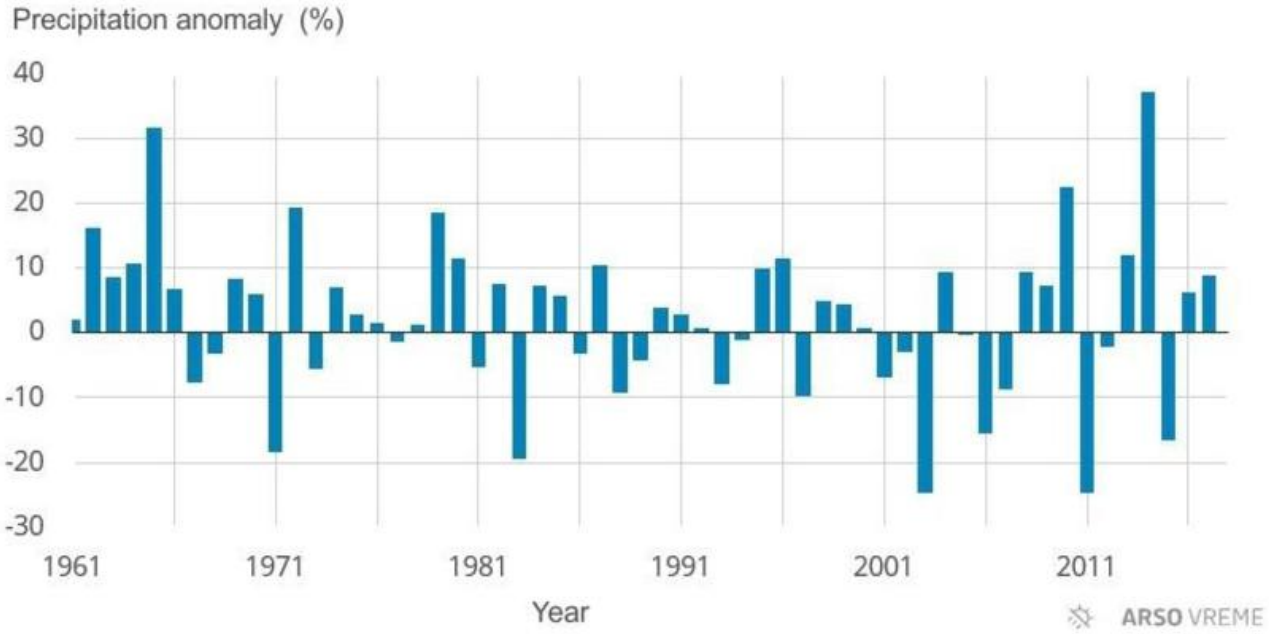


Figure 5.49: Time series of annual precipitation totals in mm/year for Slovenia 1961-2017 (diagram as provided by the NHMS)

Turkey

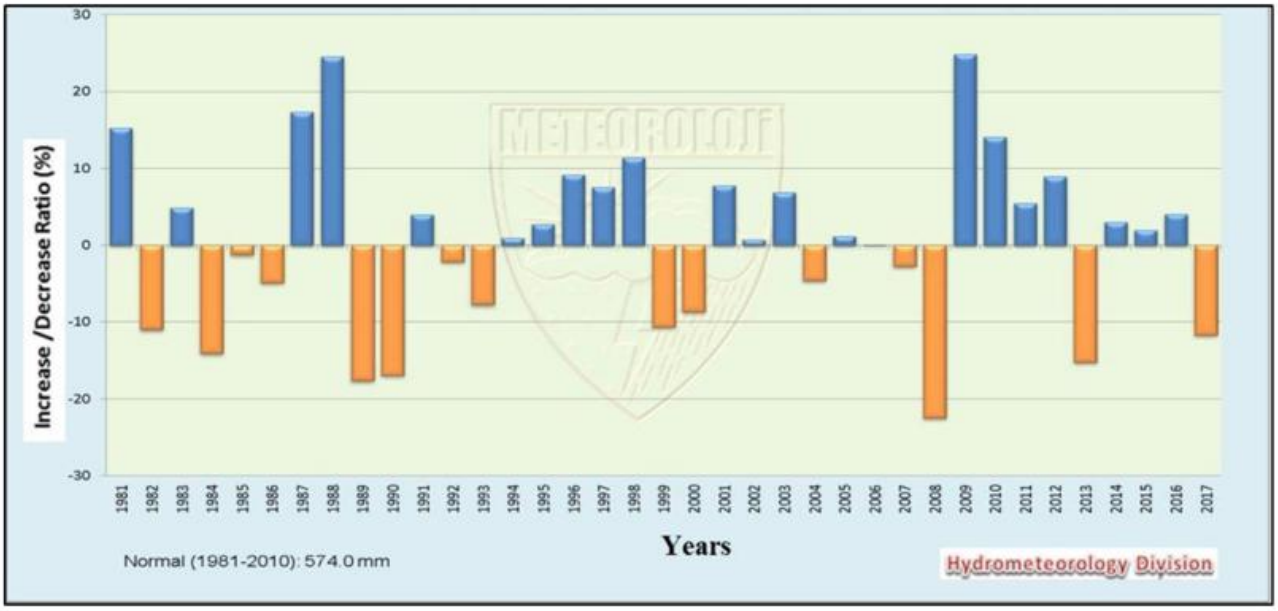


Figure 5.50: Time series of annual precipitation anomalies in relation to the mean of 1981-2010 for Turkey (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Belarus, European Russia, Ukraine

Belarus

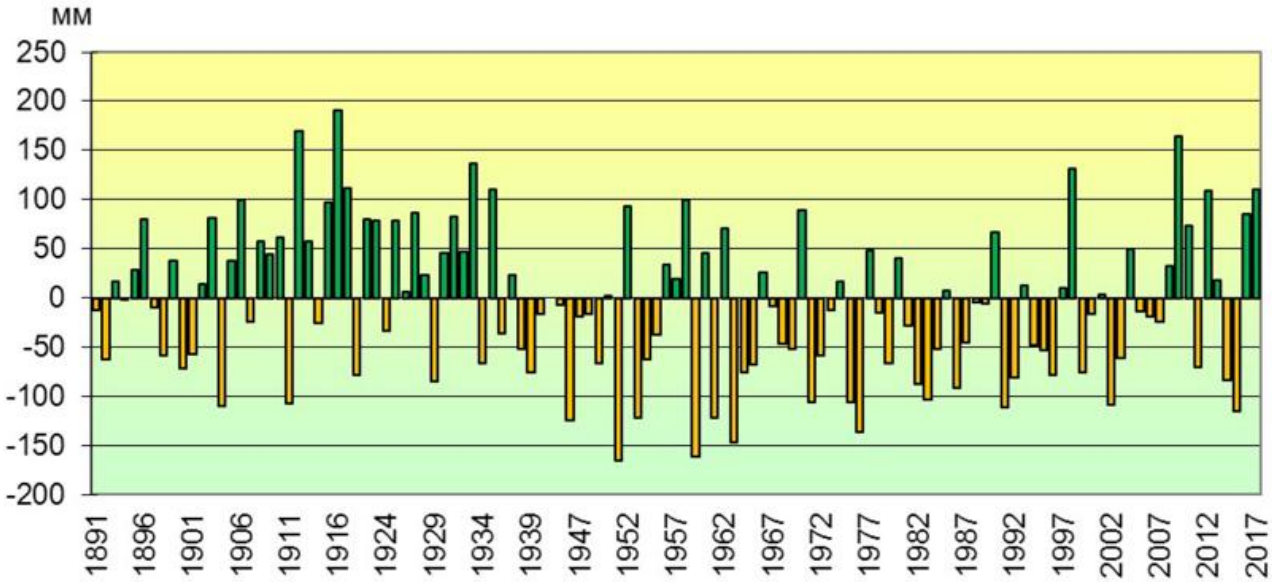


Figure 5.51: Anomalies of annual precipitation totals for Belarus 1891-2017 (base period: 1961-1990; Diagram as provided by the NHMS)

European Russia

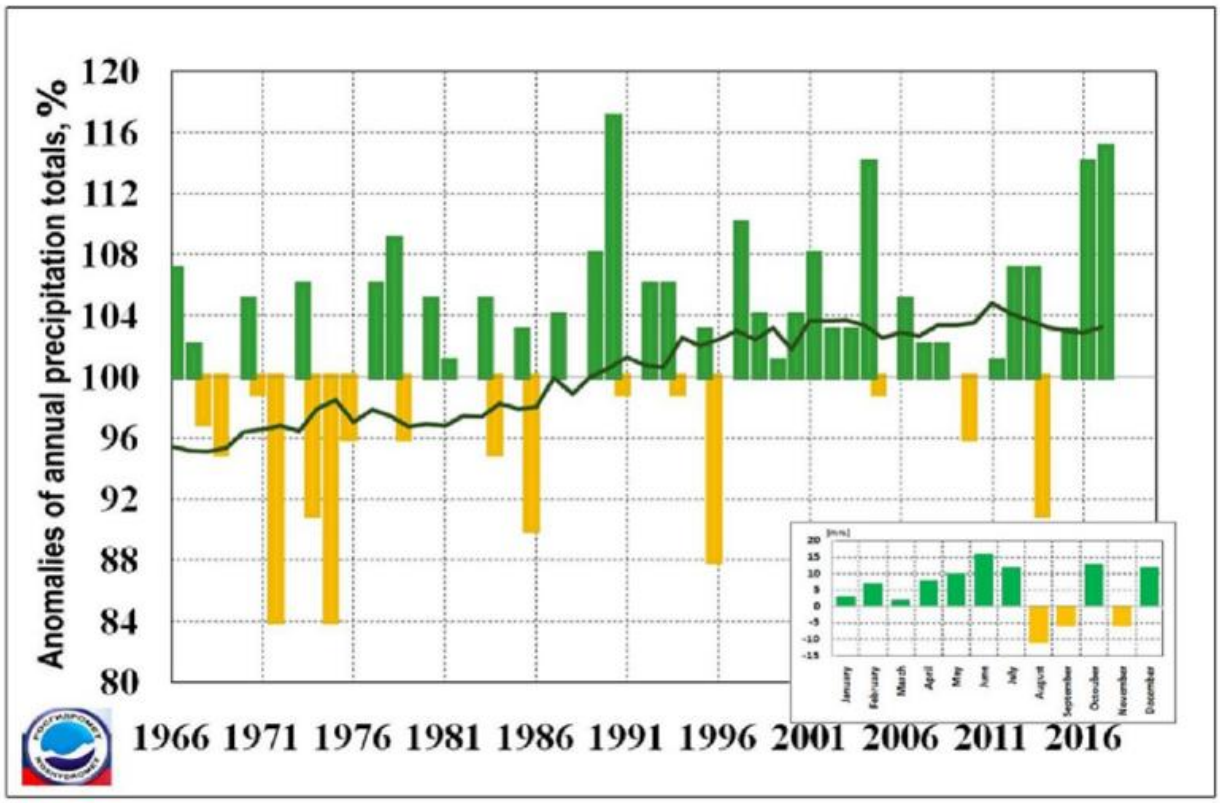


Figure 5.52: Time series of annual precipitation totals in relation to the mean of 1961-1990 for European Russia (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Ukraine

Time series of annual precipitation totals for Kiev, Ukraine (1891-2017)

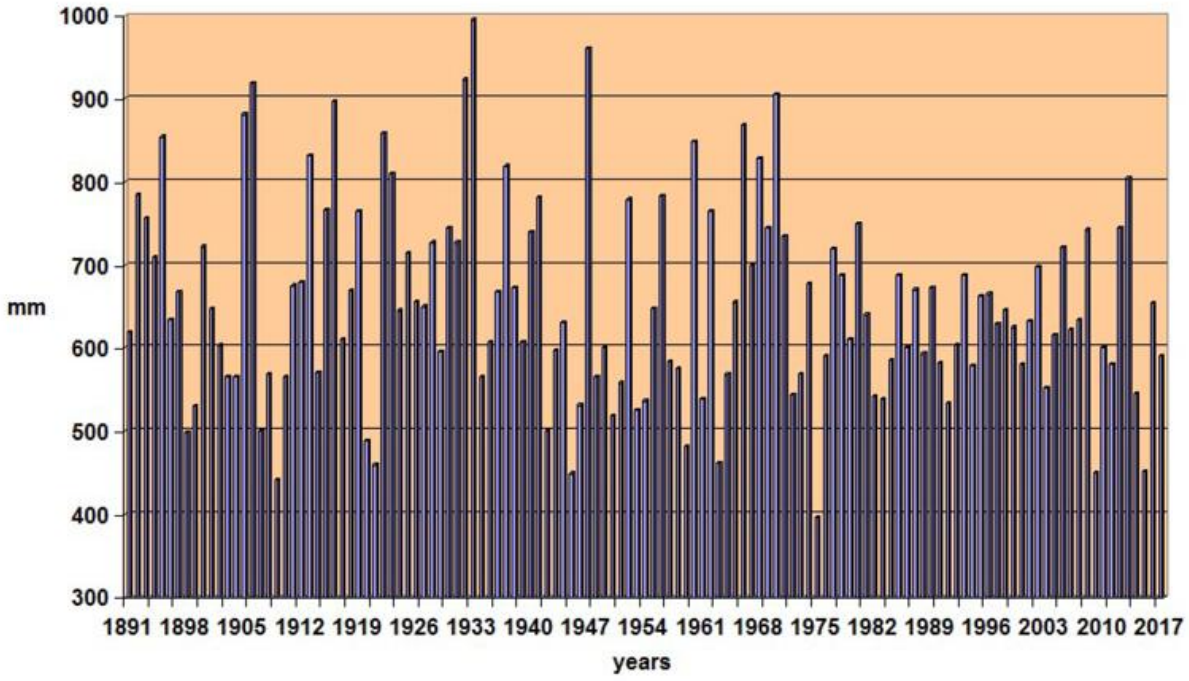


Figure 5.53: Time series of annual precipitation totals for Kiev (Ukraine)
(Diagram as provided by the NHMS)

Middle East - precipitation anomalies

Georgia, Israel

Georgia

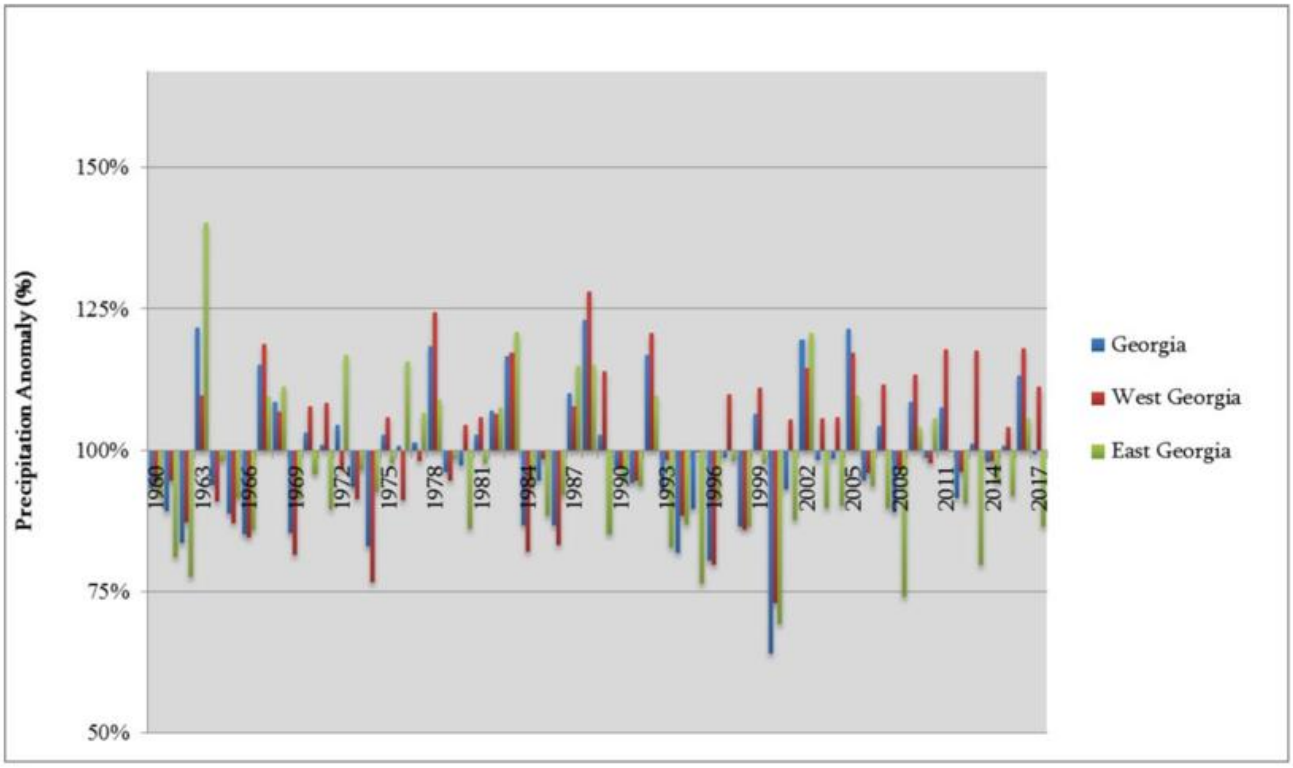


Figure 5.54: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Georgia (Diagram as provided by the NHMS)

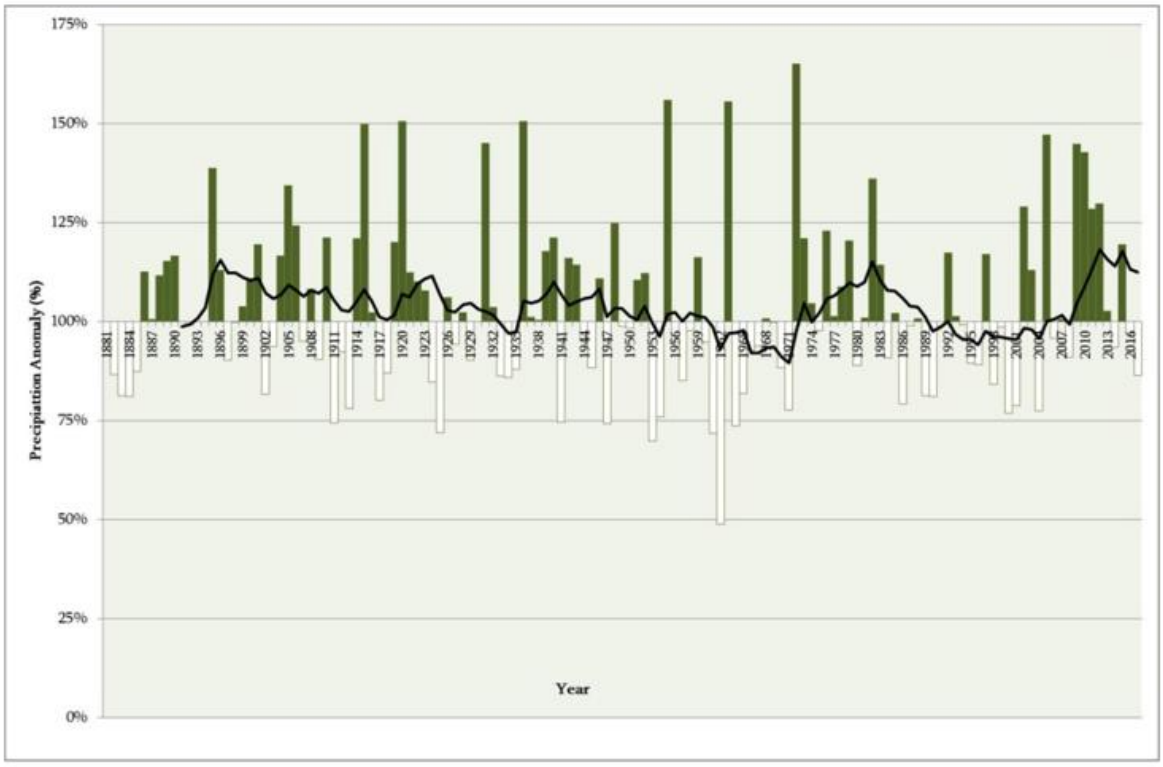


Figure 5.55: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Tbilisi, Georgia (Diagram as provided by the NHMS)

Middle East - precipitation anomalies

Israel

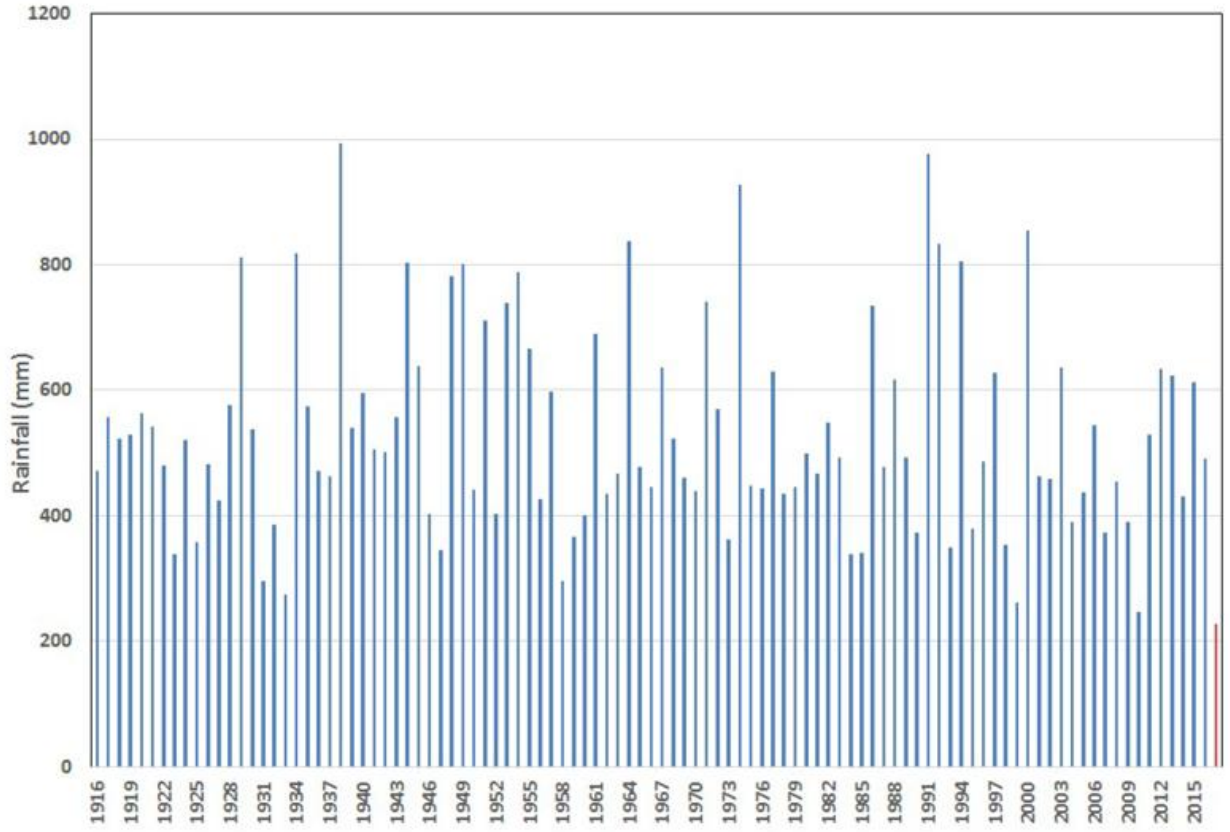


Figure 5.56: Yearly rainfall amounts (mm) in Miqwe Yisrael (Central Coastal Plain) 1916-2017 (diagram as provided by the NHMS)

5.3. Sunshine duration

Central and Western Europe - sunshine duration anomalies

Germany, Switzerland, United Kingdom

Germany

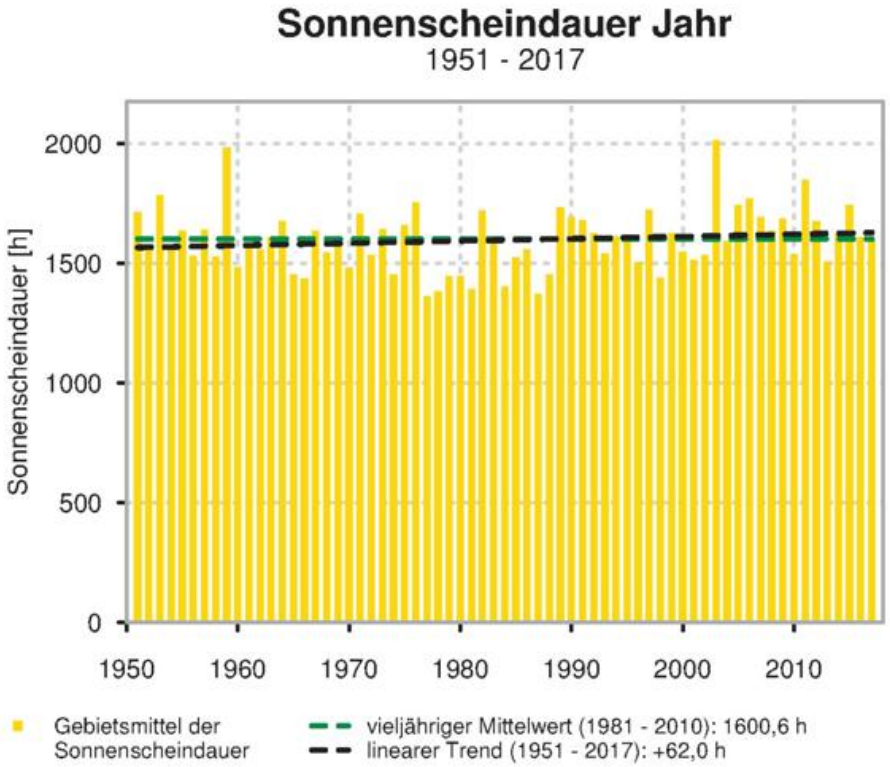


Figure 5.57: Time series of annual sum of the sunshine duration in hours for Germany (green line: long term mean; diagram as provided by the NHMS)

Switzerland

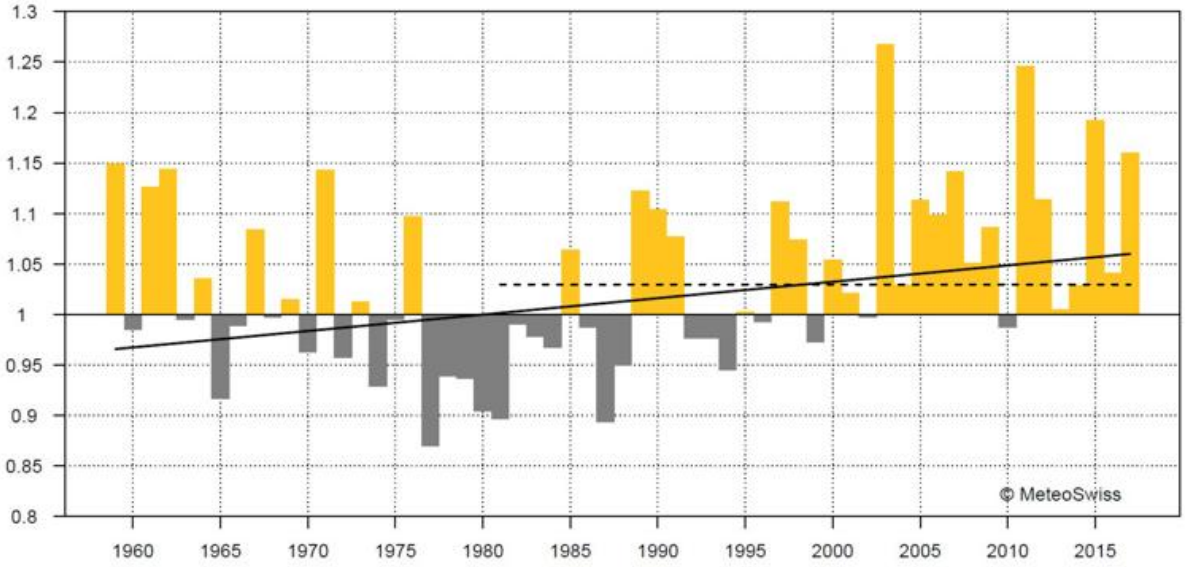


Figure 5.58: Time series of the yearly sunshine duration [ratio] for Switzerland 1959–2017. Color bars represent anomalies in respect to the long-term mean 1961–1990 and yellow indicates positive and grey negative anomalies. The black line represents the linear significant trend (1.48 %/10y). The black dashed line represents the mean 1981–2010 (diagram as provided by MeteoSwiss).

Central and Western Europe - sunshine duration anomalies

United Kingdom

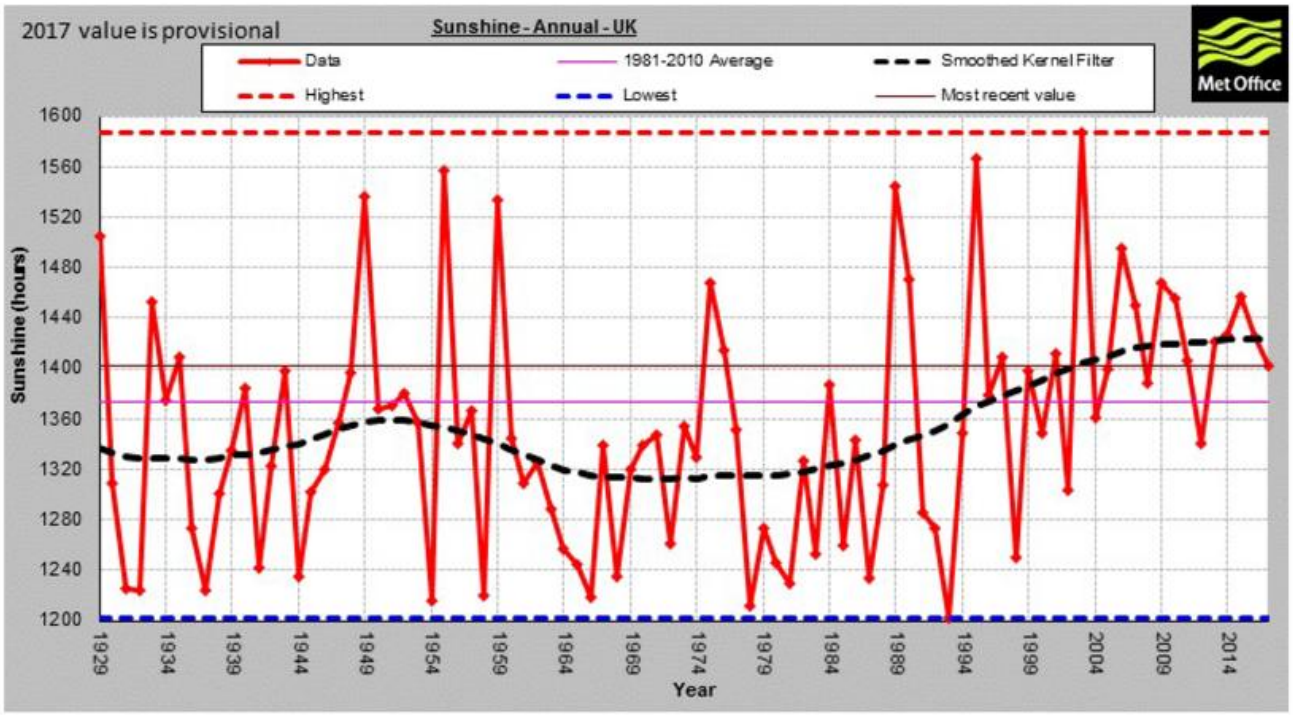


Figure 5.59: Time series of annual sum of the sunshine duration in hours for United Kingdom (Diagram as provided by the NHMS)

Nordic and Baltic Countries - sunshine duration

Denmark

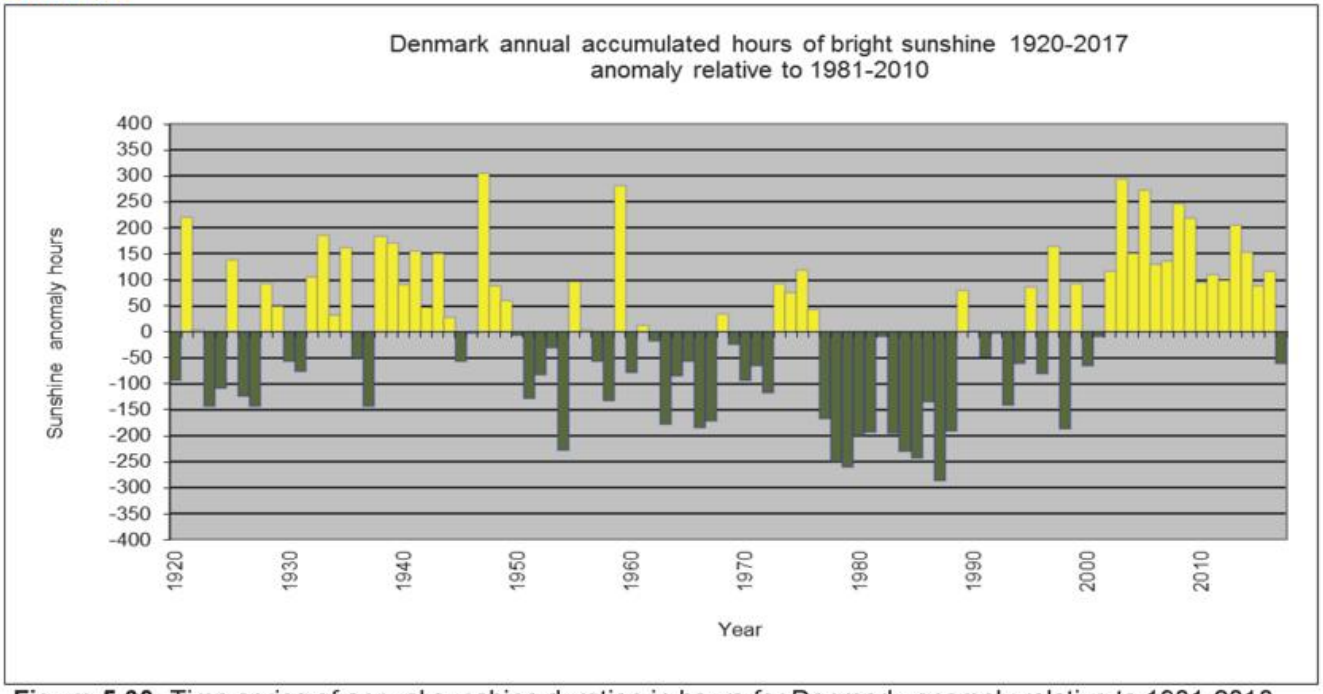


Figure 5.60: Time series of annual sunshine duration in hours for Denmark: anomaly relative to 1981-2010. The values are calculated national average based on a number of selected stations. (Diagram as provided by the NHMS)

Note: *OBS! DMI has since 2002 observed the hours of bright sunshine using measurements of global radiation instead of measurements from a traditional Campbell-Stokes sunshine recorder. For that reason "new" and "old" hours of bright sunshine cannot directly be compared. I should also be noted that all values before 2002 are adjusted ensuring comparability to the new level. For details on that, see DMI Technical 02-25: Ellen Vaarby Laursen, Stig Rosenørn: New hours of bright sunshine normals for Denmark, 1961-1990.*
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2002/tr02-25.pdf
Data up to 2016 are published in DMI report series, No. 17-02 John Cappelen (ed) (2017): Denmark - DMI Historical Climate Data Collection 1768-2016.
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2017/DMIRep17-02.pdf (report)
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2017/DMIRep17-02.zip (data)

Estonia

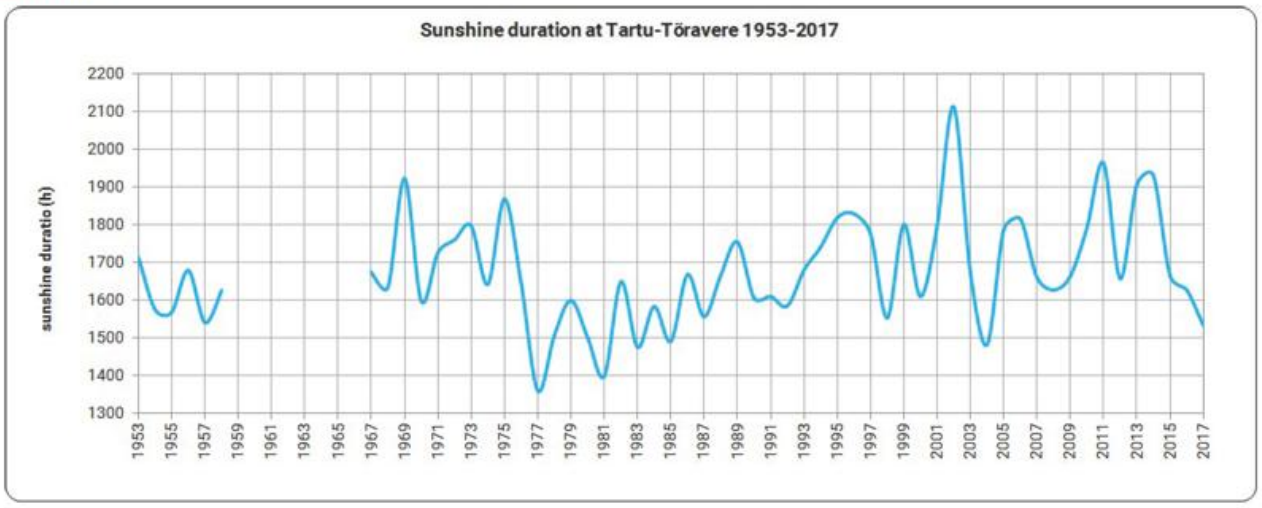


Figure 5.61: Time series of annual sunshine duration in hours for Estonia (station Tartu-Töravere, diagram as provided by the NHMS)

Eastern Europe - sunshine duration

European Russia

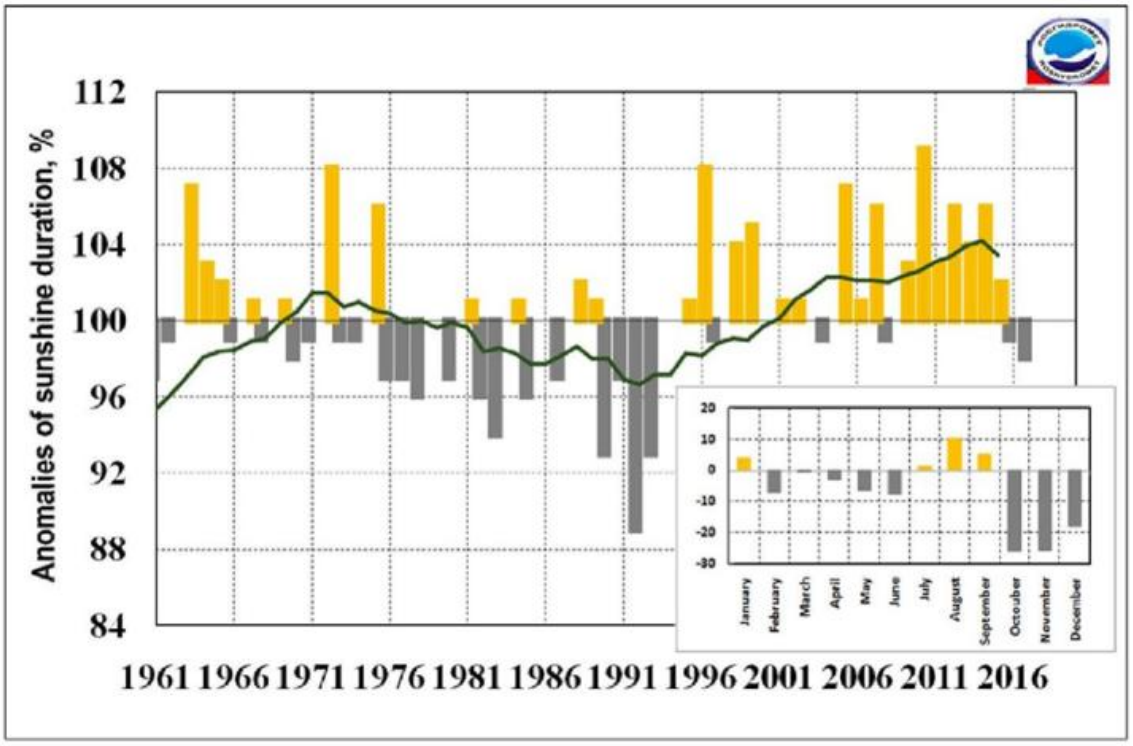


Figure 5.62: Time series of annual sunshine duration in relation to the mean of 1981-2010 for European Russia (Insets show the anomalies of monthly sunshine duration in 2017; Diagram as provided by the NHMS)

6. Annex: Monthly and annual tables

Table 6.1: Statistical values of **annual** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

WMO Nr.	Station name	Country	Temperature (°C)		Precipitation (mm)	
			mean	dev.	total	dev.
1001	Jan Mayen	NOR	1.6	3.0	540	-147
1008	Svalbard	NOR	-2.2	4.2	207	24
1025	Tromsoe	NOR	3.4	0.6	1135	162
1492	Oslo	NOR	6.9	1.2	948	179
2196	Haparanda	SWE	2.3	1.1	603	51
2485	Stockholm	SWE	8.0	1.4	560	21
2836	Sodankylä	FIN	0.3	1.3	446	-54
2974	Helsinki Airp.	FIN	6.1	1.5	818	167
3091	Aberdeen	GBR	9.3	1.3	843	60
3772	London	GBR	12.3	1.7	574	-25
3967	Dublin/Casement	IRL	10.0	0.8	705	-7
4030	Reykjavik	ISL	5.5	1.2	901	103
4320	Danmarkshavn	GRL	-10.4	1.9	160	28
6186	Copenhagen	DNK	9.7	1.1	883	247
6260	De Bilt	NLD	10.9	1.6	948	143
6447	Brussels (Uccle)	BEL	11.3	1.4	750	-68
6590	Luxembourg	LUX	10.2	1.9	725	-150
6660	Zurich	CHE	10.2	1.7	1107	21
6700	Geneva (Genf)	CHE	11.3	1.6	693	-261
7510	Bordeaux	FRA	13.9	1.2	762	-161
7650	Marseille	FRA	16.0	1.2	306	-240
8001	La Coruna	ESP	15.4	1.4	727	-268
8222	Madrid Retiro	ESP	16.7	2.4	256	-200
8314	Menorca	ESP	17.8	1.2	460	-139
8495	Gibraltar	GIB	19.1	0.9	539	-236
8515	Santa Maria/Azores	PRT	18.6	1.1	735	-40
8535	Lisbon	PRT	17.9	1.1	480	-273
10384	Berlin-Tempelhof	DEU	10.6	1.2	797	213
11035	Wien/Hohe Warte	AUT	11.6	1.8	589	-18
11518	Prague	CZE	9.2	1.4	537	11
11903	Sliac	SVK	8.8	0.8	755	69
12160	Elblag	POL	7.7	0.1	1222	532
12375	Warsaw	POL	9.4	1.6	699	180
12843	Budapest	HUN	11.7	1.3	638	120
13274	Beograd	SRB	13.8	1.9	509	-175
14015	Ljubljana	SVN	11.9	2.1	1532	138
14445	Split	HRV	17.0	1.2	560	-265
14654	Sarajevo	BIH	10.8	1.3	937	5
15420	Bucharest	ROU	11.3	0.8	786	191
15614	Sofia	BGR	11.1	1.4	663	100
16158	Pisa	ITA	15.2	1.2	684	-224
16597	Luqa	MLT	19.5	0.9	606	53
16716	Athens	GRC	19.3	0.8	338	-34
16754	Iraklion	GRC	19.2	0.5	373	-129
22113	Murmansk	RUS	0.9	1.0	540	62
26038	Tallinn	EST	6.3	1.2	860	193
26406	Liepaja	LVA	7.9	1.2	922	232
26629	Kaunas	LTU	7.7	1.3	717	111
26730	Vilnius	LTU	7.3	1.3	899	131
26850	Minsk	BLR	7.6	1.8	780	103
27612	Moscow	RUS	6.3	1.3	870	182
33345	Kiev	UKR	9.8	2.1	590	-59
33815	Kisinev	MDA	11.2	1.6	635	88
34300	Kharkiv	UKR	9.5	2.0	421	-98
34880	Astrachan	RUS	11.5	1.6	195	-26
37789	Yerevan	ARM	12.5	1.0	253	-24
17030	Samsun	TUR	15.3	1.0	652	-40
17062	Istanbul-Kartal	TUR	15.9	1.8	697	0
17130	Ankara	TUR	12.9	1.2	378	-29
17170	Van	TUR	9.8	1.2	328	-50
17300	Antalya	TUR	19.2	0.8	625	-442
17609	Larnaka	CYP	20.2	1.2	211	-118
35108	Uralsk	KAZ	6.9	1.5	247	-77
37545	Tbilisi	GEO	14.5	1.5	418	-80
40103	Tripoli	LBN	20.3	1.0	639	-241
40180	Tel Aviv	ISR	21.2	1.7	195	-373
40199	Elat	ISR	26.1	1.6	14	-18
40265	Mafraq	JOR	18.0	1.5	80	-80
60030	Las.Palmas/Gran Can.	ESP	21.8	1.3	58	-59

Table 6.2: Statistical values of **monthly** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

Station name	Country	January				February				March			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	-3.3	2.4	67	6	-1.2	4.9	32	-21	-4.2	1.9	27	-28
Svalbard	NOR	-10.3	5.1	25	11	-6.9	8.8	45	26	-11.6	3.1	16	-5
Tromsoe	NOR	-1.1	2.9	166	85	-2.8	0.9	93	7	-1.6	0.6	141	77
Oslo	NOR	-1.4	2.9	26	-23	-1.5	2.5	64	28	2.6	2.8	42	-4
Haparanda	SWE	-7.2	4.9	38	-6	-7.5	3.8	27	-5	-4.1	2.7	51	16
Stockholm	SWE	-0.3	2.5	34	-5	0.2	3.2	18	-9	3.3	3.2	30	4
Sodankylä	FIN	-10.2	4.9	24	-7	-10.1	3.5	15	-10	-5.6	2.9	27	2
Helsinki Airp.	FIN	-2.9	4.0	35	-6	-3.2	3.6	32	1	0.6	3.5	35	1
Aberdeen	GBR	4.4	1.7	47	-34	5.6	2.7	83	32	6.8	2.3	57	-1
London	GBR	4.3	0.1	60	8	7.5	3.0	38	3	10.5	4.0	26	-21
Dublin/Casement	IRL	5.8	0.9	26	-43	6.4	1.8	64	13	8.0	2.0	66	12
Reykjavik	ISL	1.4	1.9	83	7	2.8	2.4	126	54	1.8	1.3	52	-30
Danmarkshavn	GRL	-24.6	-1.5	10	-1	-20.5	3.8	11	0	-23.6	-0.2	5	-12
Copenhagen	DNK	1.5	1.0	18	-33	2.5	2.0	52	21	5.5	2.9	50	8
De Bilt	NLD	1.6	-0.6	59	-7	5.1	2.6	78	29	8.6	3.6	62	-1
Brussels (Uccle)	BEL	1.1	-1.5	64	-3	6.1	2.6	41	-12	9.6	4.1	48	-24
Luxembourg	LUX	-1.6	-1.6	25	-46	4.1	3.0	54	-8	8.5	4.5	45	-25
Zurich	CHE	-3.0	-2.5	89	22	3.7	2.8	52	-18	8.5	4.3	63	-6
Geneva (Genf)	CHE	-1.2	-2.0	25	-55	4.8	2.5	52	-29	8.7	3.6	57	-22
Bordeaux	FRA	4.1	-1.7	28	-72	9.1	2.0	75	-11	11.6	2.8	65	-11
Marseille	FRA	5.5	-1.2	30	-17	11.3	3.4	21	-33	13.1	2.9	75	31
La Coruna	ESP	10.3	0.1	50	-81	11.8	1.3	126	22	12.9	1.6	130	44
Madrid Retiro	ESP	6.0	-0.1	22	-24	9.2	1.7	45	1	12.2	2.2	19	-14
Menorca	ESP	10.0	-0.5	167	101	12.3	1.6	20	-37	13.8	2.2	30	-25
Gibraltar	GIB	13.2	-0.2	38	-83	15.0	1.2	112	12	15.6	0.6	57	-18
Santa Maria/Azores	PRT	15.6	1.2	142	42	14.8	0.8	25	-61	15.1	0.5	35	-44
Lisbon	PRT	11.1	-0.3	82	-28	13.2	0.9	88	-23	14.4	0.7	84	15
Berlin-Tempelhof	DEU	-0.8	-0.6	38	-5	2.4	1.6	34	0	8.0	3.8	48	11
Wien/Hohe Warte	AUT	-3.4	-2.4	21	-17	3.1	2.1	29	-13	9.3	4.3	42	1
Prague	CZE	-5.4	-3.0	14	-9	1.7	2.5	16	-7	6.8	3.8	31	3
Sliac	SVK	-10.0	-6.1	26	-18	1.4	2.5	35	-9	6.7	3.7	35	-7
Elblag	POL	-3.1	-0.7	31	-16	-1.5	0.7	44	19	4.1	2.0	61	26
Warsaw	POL	-3.7	-0.4	19	-3	-0.8	1.2	39	18	6.2	4.2	39	11
Budapest	HUN	-5.0	-3.4	26	-6	2.7	1.6	34	2	9.7	4.1	41	12
Beograd	SRB	-3.6	-4.0	23	-26	5.2	2.5	24	-20	11.4	4.2	27	-23
Ljubljana	SVN	-3.2	-2.1	56	-26	4.5	3.1	114	34	10.2	4.8	34	-64
Split	HRV	4.4	-3.0	50	-33	10.4	2.3	69	1	13.5	3.1	68	-7
Sarajevo	BIH	-5.1	-4.2	58	-13	5.0	3.5	69	2	8.5	3.4	44	-26
Bucharest	ROU	-5.4	-3.0	49	9	0.6	0.7	39	3	8.6	3.8	51	13
Sofia	BGR	-5.9	-4.3	39	12	2.7	2.2	38	5	8.7	4.1	62	24
Pisa	ITA	5.8	-0.3	44	-31	9.9	2.8	87	16	11.7	2.2	41	-35
Luqa	MLT	11.5	-0.7	154	65	13.6	1.2	149	88	14.6	1.2	24	-17
Athens	GRC	8.4	-1.8	28	-17	11.4	0.9	6	-42	14.2	1.8	69	25
Iraklion	GRC	10.7	-1.3	118	26	12.9	0.7	8	-69	13.8	0.2	98	41
Murmansk	RUS	-7.9	3.8	49	16	-7.6	3.6	31	9	-3.5	3.3	36	16
Tallinn	EST	-1.8	3.7	24	-21	-2.3	3.4	32	3	1.1	3.3	44	15
Liepaja	LVA	-0.5	2.5	37	-9	-0.9	2.1	32	1	2.7	2.9	37	1
Kaunas	LTU	-3.7	1.5	18	-21	-1.5	2.8	30	-1	3.7	4.1	53	18
Vilnius	LTU	-4.6	1.5	29	-12	-2.3	2.5	36	-2	3.4	4.0	61	22
Minsk	BLR	-5.7	1.2	37	-3	-3.1	2.7	25	-9	4.2	5.6	60	18
Moscow	RUS	-7.8	1.5	44	-1	-4.6	3.1	36	-1	2.4	4.6	57	23
Kiev	UKR	-4.9	0.7	32	-15	-2.8	1.4	36	-10	6.2	5.5	18	-21
Kisinev	MDA	-4.2	-0.9	23	-17	-0.5	1.2	32	-6	7.8	4.9	23	-12
Kharkiv	UKR	-5.8	1.1	35	-9	-4.0	1.7	21	-11	5.0	5.3	23	-4
Astrachan	RUS	-2.9	2.5	6	-7	-4.0	0.9	17	7	4.4	3.1	34	20
Yerevan	ARM	-8.7	-5.5	25	4	-6.1	-5.1	17	-7	6.4	1.3	19	-13
Samsun	TUR	6.1	-0.8	79	18	7.5	0.3	40	-10	9.4	1.4	65	9
Istanbul-Kartal	TUR	4.4	-1.2	131	32	7.6	1.7	38	-29	10.0	2.5	56	-6
Ankara	TUR	-1.4	-1.4	33	-8	3.1	1.4	9	-27	8.1	2.1	51	15
Van	TUR	-3.3	1.1	18	-16	-4.4	-0.6	26	-7	3.3	2.4	44	2
Antalya	TUR	8.3	-1.6	133	-106	10.7	0.4	7	-189	13.5	0.8	117	14
Larnaka	CYP	10.8	-1.0	31	-34	11.9	-0.3	1	-56	14.9	1.4	37	-12
Uralsk	KAZ	-10.8	2.1	8	-17	-10.4	2.1	20	2	-2.7	2.3	21	1
Tbilisi	GEO	2.3	0.6	5	-14	3.5	0.6	10	-16	9.7	2.8	10	-20
Tripoli	LBN	11.3	-1.4	288	94	11.8	-1.4	30	-97	15.4	0.7	80	-36
Tel Aviv	ISR	12.7	0.4	39	-110	12.8	-0.1	62	-36	16.5	1.6	2	-60
Elat	ISR	15.3	0.2	0	-5	16.5	-0.3	13	8	21.3	1.5	0	-4
Mafraq	JOR	7.2	0.0	30	-4	8.0	-0.7	12	-19	12.5	1.0	21	-8
Las Palmas/Gran Can.	ESP	18.3	0.8	2	-15	18.6	1.0	7	-15	18.9	0.5	16	6

Table 6.2: continued

Station name	Country	April				May				June			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	-2.1	1.8	29	-11	1.9	2.6	9	-31	4.8	2.8	14	-21
Svalbard	NOR	-8.3	3.4	6	-6	-3.9	-0.2	5	-1	4.6	2.4	6	-4
Tromsoe	NOR	0.0	-0.7	67	7	3.4	-1.5	76	28	9.5	0.2	30	-23
Oslo	NOR	5.2	0.6	46	4	11.6	0.8	79	27	15.1	-0.1	90	25
Haparanda	SWE	-0.4	0.1	46	17	4.6	-1.5	23	-8	12.0	-0.8	24	-17
Stockholm	SWE	4.9	0.3	23	-7	11.3	0.6	12	-18	15.2	-0.4	75	30
Sodankylä	FIN	-2.5	-0.4	28	4	2.6	-2.4	9	-26	10.3	-1.3	37	-19
Helsinki Airp.	FIN	2.3	-0.6	40	3	10.3	0.4	10	-25	13.8	-1.1	100	56
Aberdeen	GBR	8.0	1.7	52	-1	11.3	2.3	24	-35	13.6	1.5	143	90
London	GBR	10.9	2.0	5	-40	15.1	2.6	65	14	18.9	3.2	46	-5
Dublin/Casement	IRL	8.3	0.8	9	-41	12.4	2.3	67	10	14.4	1.3	92	39
Reykjavik	ISL	3.1	0.2	150	92	8.6	2.3	84	40	9.9	0.9	43	-7
Danmarkshavn	GRL	-19.3	-2.0	7	-3	-8.8	-2.2	2	-2	1.2	0.5	5	0
Kopenhagen	DNK	7.3	0.7	72	30	13.3	1.3	18	-25	16.2	0.1	101	47
De Bilt	NLD	8.6	0.6	24	-28	15.0	2.7	36	-25	18.0	2.8	61	-7
Brüssel	BEL	8.8	0.0	15	-42	15.5	2.6	45	-26	19.2	3.5	51	-28
Luxemburg	LUX	8.6	1.1	5	-56	15.3	3.5	38	-43	19.0	4.1	54	-28
Zürich	CHE	8.8	1.0	117	30	14.8	2.7	75	-28	19.9	4.7	86	-38
Genf	CHE	10.5	1.7	40	-25	15.0	2.0	81	4	20.9	4.4	77	-12
Bordeaux	FRA	12.8	1.5	22	-50	17.9	3.3	64	-13	21.4	3.6	137	81
Marseille	FRA	14.3	1.1	56	8	18.6	1.5	27	-15	24.6	3.7	18	-10
La Coruna	ESP	14.3	2.2	15	-68	17.4	3.3	61	-17	18.7	2.3	28	-21
Madrid Retiro	ESP	16.0	3.8	12	-42	20.1	4.1	27	-14	26.4	5.7	5	-21
Menorca	ESP	14.9	1.6	23	-27	19.6	2.8	<1	-37	24.5	3.7	17	3
Gibraltar	GIB	17.6	1.4	173	113	20.0	1.5	14	-21	23.6	2.5	0	-11
Santa Maria/Azoren	PRT	16.2	1.0	88	33	17.1	0.4	75	45	19.5	0.8	7	-15
Lissabon	PRT	18.3	3.2	5	-59	19.7	2.3	60	21	22.7	2.5	1	-20
Berlin-Tempelhof	DEU	8.6	0.0	26	-15	15.5	1.6	16	-40	18.9	1.5	193	118
Wien	AUT	10.0	0.1	72	21	16.6	2.0	44	-17	22.1	4.2	32	-42
Prag	CZE	7.6	-0.1	55	17	14.2	1.5	33	-44	18.5	2.6	117	44
Sliac	SVK	8.3	-0.2	75	28	15.2	1.5	18	-46	19.8	3.2	111	26
Elbing	POL	5.5	-1.3	65	23	12.1	-0.8	25	-16	15.0	-0.4	96	2
Warschau	POL	7.7	-0.1	48	16	14.6	1.2	49	-10	18.5	1.9	86	14
Budapest	HUN	11.0	-0.1	71	33	17.2	1.2	72	17	22.5	3.4	37	-26
Belgrad	SRB	12.6	0.2	52	-7	18.2	1.0	86	15	24.0	3.9	53	-37
Ljubljana	SVN	12.0	2.1	153	43	16.9	2.3	72	-50	21.7	3.9	150	-5
Split	HRV	14.5	0.6	36	-30	20.1	1.7	41	-15	25.8	3.6	4	-47
Sarajevo	BIH	9.1	-0.3	132	58	15.1	1.0	74	-8	20.3	3.4	55	-36
Bukarest	ROU	10.1	-1.2	90	44	16.2	-0.5	77	7	22.0	1.8	42	-35
Sofia	BGR	10.4	0.5	55	5	15.1	0.8	49	-24	20.7	3.0	63	-9
Pisa	ITA	13.9	1.4	21	-58	18.1	1.8	24	-35	23.0	3.2	33	-11
Luqa	MLT	16.4	0.9	13	-10	20.8	1.7	2	-5	25.3	2.3	7	4
Athen	GRC	17.0	1.0	4	-21	21.7	1.1	35	21	26.1	1.1	45	39
Heraklion	GRC	16.8	0.2	16	-14	21.0	0.7	37	22	25.2	0.9	2	-1
Murmansk	RUS	-2.0	-0.1	30	9	2.0	-1.8	34	2	6.9	-2.5	65	12
Tallinn	EST	2.9	-0.5	45	9	9.2	-0.5	12	-25	13.1	-1.4	85	32
Liepaja	LVA	4.3	-0.3	35	0	10.6	0.3	8	-32	14.6	0.3	66	20
Kaunas	LTU	5.6	-0.2	74	32	12.9	0.5	11	-44	15.4	-0.4	80	11
Vilnius	LTU	5.4	-0.3	69	23	12.7	0.2	8	-54	15.4	-0.4	127	50
Minsk	BLR	6.0	0.0	72	30	13.1	0.2	28	-34	16.4	0.3	53	-30
Moskau	RUS	5.3	-0.5	77	37	10.9	-2.0	83	25	14.4	-2.2	139	63
Kiew	UKR	10.4	1.7	25	-24	15.3	0.2	34	-19	20.0	1.8	27	-46
Kischinau	MDA	9.4	-0.8	127	85	16.4	0.3	58	7	21.3	1.9	73	-2
Charkiw	UKR	8.9	0.0	39	3	14.6	-1.0	37	-10	19.6	0.7	18	-40
Astrachan	RUS	11.5	0.4	1	-17	18.2	-0.1	28	4	22.2	-0.7	47	25
Jerewan	ARM	12.5	0.9	14	-23	17.9	1.6	44	1	23.3	2.7	24	3
Samsun	TUR	10.3	-1.1	78	16	15.3	-0.2	71	22	21.0	1.0	45	0
Istanbul	TUR	13.0	1.0	28	-21	17.9	1.4	36	5	23.3	2.2	49	28
Ankara	TUR	11.1	-0.1	23	-25	15.7	0.1	54	-1	20.4	0.8	56	19
Van	TUR	7.7	0.4	62	8	13.1	0.3	81	31	18.4	0.8	<1	-21
Antalya	TUR	16.7	0.6	40	-6	21.4	1.1	42	14	26.5	1.5	3	-5
Larnaka	CYP	18.1	1.2	23	12	21.7	1.3	28	21	25.6	1.6	2	1
Oral	KAZ	8.0	0.3	32	13	14.9	-1.2	14	-7	18.5	-1.7	50	13
Tiflis	GEO	12.6	-0.2	24	-27	17.7	0.3	91	13	22.4	1.2	96	20
Tripoli	LBN	18.2	0.7	41	-15	21.8	1.9	3	-14	24.9	1.6	0	-1
Tel Aviv	ISR	19.8	1.6	16	-7	23.4	2.3	<1	-3	25.7	1.7	0	0
Eilat	ISR	26.1	1.7	<1	-3	30.0	1.8	0	-1	33.1	2.2	0	0
Mafraq	JOR	17.4	1.6	<1	-10	21.5	1.7	0	-3	24.3	1.6	0	0
L.Palmas/Gran Can.	ESP	21.1	2.4	1	-5	22.1	2.2	2	0	23.6	2.2	0	0
Le Lamentin	MTQ	26.8	0.9	133	37	27.6	0.8	180	57	27.7	0.4	184	14

Table 6.2: continued

Station name	Country	July				August				September			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	6.9	2.7	25	-22	7.1	2.2	56	-5	7.6	4.8	74	-8
Svalbard	NOR	6.9	0.9	20	7	6.1	1.3	18	-7	4.9	4.4	21	-2
Tromsoe	NOR	11.1	-0.6	66	-6	10.7	-0.2	109	27	8.9	2.1	6	-88
Oslo	NOR	16.9	0.5	100	16	15.3	0.1	158	68	12.2	1.4	99	9
Haparanda	SWE	14.8	-0.7	34	-16	13.2	-0.1	46	-17	8.8	0.9	49	-14
Stockholm	SWE	17.4	0.2	15	-57	17.0	0.8	70	4	13.1	1.9	67	12
Sodankylä	FIN	15.1	1.0	84	19	11.9	0.7	58	-5	7.2	1.3	27	-28
Helsinki Airp.	FIN	16.1	-0.5	33	-40	16.0	1.0	72	-8	11.2	1.2	67	-6
Aberdeen	GBR	14.5	0.7	75	15	14.5	0.9	77	2	12.3	0.6	72	4
London	GBR	19.4	1.6	90	44	17.8	0.4	59	8	15.1	0.1	59	8
Dublin/Casement	IRL	15.3	0.1	43	-6	14.7	-0.1	65	1	12.5	-0.1	71	12
Reykjavik	ISL	11.7	1.1	37	-15	10.8	0.5	39	-23	9.7	2.3	89	23
Danmarkshavn	GRL	5.7	2.0	1	-13	3.9	1.5	0	-14	-0.8	3.4	76	65
Copenhagen	DNK	16.8	-0.4	107	38	17.4	0.4	105	42	14.2	0.6	134	72
De Bilt	NLD	17.9	1.1	132	57	17.2	0.5	53	-18	13.7	-0.3	121	54
Brussels (Uccle)	BEL	18.6	1.1	58	-17	18.1	0.8	71	8	14.1	-0.4	78	19
Luxembourg	LUX	19.1	2.2	119	51	18.1	1.7	49	-23	12.9	-0.5	86	16
Zurich	CHE	19.2	1.6	172	55	19.5	2.8	102	-31	13.1	-0.7	107	15
Geneva (Genf)	CHE	21.4	2.3	40	-27	21.2	3.0	62	-17	14.1	-0.8	44	-37
Bordeaux	FRA	21.4	1.2	28	-19	21.3	1.4	30	-24	16.8	-1.1	72	-2
Marseille	FRA	25.9	2.1	0	-14	25.4	2.2	5	-24	19.1	-1.2	7	-40
La Coruna	ESP	19.9	1.5	13	-12	19.8	1.0	29	0	18.2	0.1	43	-19
Madrid Retiro	ESP	26.8	2.4	49	36	26.7	2.8	26	17	21.5	1.0	0	-30
Menorca	ESP	25.7	1.5	26	22	26.3	1.8	12	-14	21.5	-0.7	44	-10
Gibraltar	GIB	23.9	0.2	0	-1	25.0	0.8	2	-4	23.1	0.3	1	-14
Santa Maria/Azores	PRT	21.9	1.1	25	0	23.1	0.9	22	-18	22.7	1.3	23	-34
Lisbon	PRT	22.7	0.3	2	-3	23.2	0.4	5	-1	21.0	-0.7	0	-26
Berlin-Tempelhof	DEU	19.2	0.4	137	85	19.5	1.1	70	10	14.3	-0.3	32	-14
Wien/Hohe Warte	AUT	22.2	2.5	67	4	22.5	3.6	43	-15	14.9	-0.2	94	49
Prague	CZE	19.1	1.6	66	0	19.2	2.2	79	9	12.6	-0.7	24	-16
Sliac	SVK	19.2	1.0	86	27	20.3	3.0	56	-13	13.9	0.5	108	52
Elblag	POL	16.0	-0.8	150	56	17.2	0.5	131	50	12.8	0.1	212	142
Warsaw	POL	19.0	1.1	90	23	19.7	2.4	41	-22	14.0	0.8	127	84
Budapest	HUN	22.6	1.7	57	5	23.6	3.3	57	6	15.9	-0.5	91	51
Beograd	SRB	25.5	3.8	26	-40	26.0	4.7	20	-32	18.6	0.9	46	-5
Ljubljana	SVN	23.2	3.3	73	-49	23.2	4.1	60	-85	14.3	-1.2	344	214
Split	HRV	27.5	2.1	3	-25	28.8	3.6	0	-50	20.8	-0.6	92	31
Sarajevo	BIH	21.5	2.6	66	-14	22.4	3.9	39	-32	15.4	0.3	93	23
Bucharest	ROU	22.7	0.7	128	64	23.0	1.8	47	-11	18.2	1.3	28	-14
Sofia	BGR	22.0	2.0	72	16	22.2	2.8	29	-23	17.6	1.8	44	5
Pisa	ITA	24.1	1.3	3	-20	25.3	2.8	2	-58	19.4	-0.1	194	105
Luqa	MLT	27.7	1.8	0	0	28.4	2.1	2	-5	24.5	0.4	42	2
Athens	GRC	29.5	1.7	4	-2	29.8	2.2	<1	-8	25.1	0.8	0	-10
Iraklion	GRC	27.5	1.4	<1	<1	26.9	1.0	0	-1	24.5	1.0	7	-13
Murmansk	RUS	14.2	1.4	40	-20	11.2	0.2	87	22	7.3	0.6	55	3
Tallinn	EST	15.5	-0.8	22	-57	16.1	0.8	180	96	12.1	1.3	90	8
Liepaja	LVA	16.4	0.0	65	-9	16.9	0.5	54	-26	13.7	0.8	186	108
Kaunas	LTU	16.8	-0.1	80	0	17.4	1.0	55	-23	13.4	1.5	87	31
Vilnius	LTU	16.7	-0.2	120	42	17.4	1.1	130	58	13.4	1.8	76	11
Minsk	BLR	17.6	0.3	150	62	18.8	2.3	83	11	13.7	2.0	80	20
Moscow	RUS	17.9	-0.2	103	11	18.8	2.4	68	-6	13.0	2.1	38	-26
Kiev	UKR	20.9	1.6	62	-26	22.4	3.8	57	-12	16.4	2.5	43	-4
Kisinev	MDA	22.4	1.5	78	9	23.7	3.2	22	-23	18.6	2.4	16	-32
Kharkiv	UKR	21.5	1.2	38	-22	23.5	4.0	11	-39	17.1	3.0	24	-17
Astrachan	RUS	26.8	1.5	3	-20	26.6	3.3	2	-17	20.2	2.9	<1	-26
Yerevan	ARM	27.4	2.8	3	-7	28.2	4.3	8	1	24.5	4.7	1	-9
Samsun	TUR	24.2	1.5	<1	-29	25.4	2.7	14	-19	22.3	2.7	30	-20
Istanbul-Kartal	TUR	25.6	2.4	55	36	25.5	2.5	44	18	23.1	3.4	15	-26
Ankara	TUR	25.5	2.6	12	-2	24.7	2.1	17	5	22.6	4.3	4	-15
Van	TUR	22.1	0.2	3	-1	22.5	1.3	3	-1	18.8	2.0	<1	-10
Antalya	TUR	30.4	2.3	<1	-3	29.0	1.3	2	1	26.1	1.6	2	-9
Larnaka	CYP	29.2	2.6	0	0	28.5	1.9	0	0	26.7	2.1	0	0
Uralsk	KAZ	23.3	0.8	6	-32	24.0	3.6	6	-19	16.3	2.2	3	-24
Tbilisi	GEO	26.4	2.0	24	-21	28.0	4.3	0	-48	23.5	3.9	23	-13
Tripoli	LBN	28.4	3.4	0	0	28.3	2.7	0	-1	27.0	2.2	0	-4
Tel Aviv	ISR	28.9	3.2	0	0	28.6	2.5	0	0	27.1	2.3	0	0
Elat	ISR	35.5	3.1	0	0	34.9	2.6	0	0	32.0	1.6	0	0
Mafraq	JOR	28.4	4.3	0	0	26.0	1.8	0	0	25.1	2.4	0	-1
Las .Palmas/Gran Can.	ESP	24.2	0.9	0	0	25.5	1.4	0	0	24.4	0.6	0	-8

Table 6.2: continued

Station name	Country	October				November				December			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	4.7	4.6	106	24	-0.7	2.6	67	1	-2.3	2.9	34	-31
Svalbard	NOR	0.5	6.0	27	12	-3.6	6.9	3	-10	-4.9	8.4	15	3
Tromsoe	NOR	4.3	1.4	141	16	0.2	1.0	110	6	-1.7	1.3	130	26
Oslo	NOR	7.2	0.8	111	27	1.6	0.9	78	3	-1.5	1.3	55	-1
Haparanda	SWE	2.8	0.3	78	14	-2.2	1.9	120	62	-7.3	2.2	67	25
Stockholm	SWE	8.0	0.5	104	54	3.8	1.2	55	2	1.5	2.5	57	11
Sodankylä	FIN	0.4	0.7	42	-9	-5.5	1.9	55	16	-10.1	3.0	40	9
Helsinki Airp.	FIN	5.0	-0.4	172	99	2.7	2.6	109	37	0.7	4.8	113	55
Aberdeen	GBR	10.7	0.8	58	-19	5.2	0.2	105	30	4.2	0.7	50	-23
London	GBR	13.8	2.1	11	-47	8.0	0.8	34	-21	5.9	0.8	81	24
Dublin/Casement	IRL	11.2	1.1	57	-10	6.2	-0.5	80	13	5.2	-0.4	65	-8
Reykjavik	ISL	6.9	2.5	42	-44	0.2	-0.9	92	20	-0.7	-0.5	64	-15
Danmarkshavn	GRL	-6.9	6.7	22	10	-14.2	5.7	19	9	-16.9	4.9	2	-11
Copenhagen	DNK	11.3	1.4	94	35	6.1	0.6	77	15	4.2	2.0	55	-3
De Bilt	NLD	13.3	2.8	85	13	7.3	1.4	74	-7	4.9	1.7	163	84
Brussels (Uccle)	BEL	13.3	2.4	43	-27	6.6	0.5	106	30	4.4	0.9	130	54
Luxembourg	LUX	11.2	2.1	36	-39	4.9	1.1	96	13	2.6	1.6	118	38
Zurich	CHE	11.3	2.0	40	-29	4.8	0.9	89	7	1.3	0.7	115	42
Geneva (Genf)	CHE	11.8	1.7	18	-59	5.7	0.7	64	-28	2.5	0.7	133	46
Bordeaux	FRA	15.6	1.6	13	-75	8.6	-0.5	65	-29	6.7	0.3	163	64
Marseille	FRA	17.3	1.2	<1	-78	10.4	-0.3	41	-17	6.4	-0.9	25	-31
La Coruna	ESP	17.8	2.1	18	-86	13.0	0.4	65	-51	11.2	0.3	149	21
Madrid Retiro	ESP	18.7	3.9	25	-20	10.2	0.8	9	-55	6.8	0.4	17	-34
Menorca	ESP	19.7	1.2	10	-74	14.1	-0.3	47	-30	11.4	-0.4	63	-11
Gibraltar	GIB	20.9	1.4	31	-33	17.0	0.9	50	-91	14.2	0.1	61	-85
Santa Maria/Azores	PRT	21.2	1.9	81	-3	18.6	1.2	177	75	17.8	2.4	35	-60
Lisbon	PRT	21.3	2.8	36	-44	15.1	0.6	64	-50	12.2	0.4	53	-55
Berlin-Tempelhof	DEU	12.0	2.0	91	55	6.2	1.3	69	20	3.9	2.5	43	-10
Wien/Hohe Warte	AUT	12.1	2.2	62	21	6.1	1.5	40	-10	3.1	2.2	43	0
Prague	CZE	10.5	2.2	52	22	4.5	1.7	28	-4	1.5	2.1	22	-4
Sliac	SVK	8.7	0.4	72	22	3.3	0.3	84	15	-1.7	0.0	49	-8
Elblag	POL	8.9	0.0	172	119	3.9	0.6	116	60	1.4	1.1	119	67
Warsaw	POL	10.0	1.7	83	45	4.9	1.7	45	3	2.5	3.4	33	1
Budapest	HUN	11.7	0.8	70	36	6.0	1.2	45	-7	2.6	2.2	37	-3
Beograd	SRB	13.7	1.3	66	26	8.4	1.4	41	-13	5.0	2.7	45	-13
Ljubljana	SVN	12.0	1.6	54	-61	6.2	1.6	204	69	1.9	1.9	218	117
Split	HRV	17.2	0.3	29	-50	12.1	-0.1	88	-20	8.9	0.2	80	-20
Sarajevo	BIH	10.4	0.1	89	12	5.4	0.1	75	-19	2.1	1.8	143	58
Bucharest	ROU	10.5	-0.3	132	100	6.4	1.2	63	14	2.9	2.7	40	-3
Sofia	BGR	10.9	0.5	77	40	5.8	0.8	50	3	2.6	2.1	85	46
Pisa	ITA	14.9	-0.4	6	-117	9.6	-0.8	133	9	6.8	0.0	96	11
Luqa	MLT	20.6	-0.1	103	13	17.2	0.2	64	-16	13.5	-0.3	46	-66
Athens	GRC	19.7	0.4	4	-44	15.5	0.1	106	55	12.6	0.6	36	-30
Iraklion	GRC	20.2	0.3	11	-58	16.5	-0.1	18	-41	14.5	0.7	57	-20
Murmansk	RUS	1.9	0.9	37	-5	-3.8	1.3	43	3	-8.0	1.3	33	-5
Tallinn	EST	5.7	-0.6	153	83	3.0	1.8	85	17	1.1	4.0	88	33
Liepaja	LVA	8.6	0.1	172	98	5.3	1.6	130	47	3.4	3.7	100	33
Kaunas	LTU	7.6	0.5	111	66	3.9	2.1	45	-8	1.1	3.6	73	26
Vilnius	LTU	6.7	0.1	126	73	3.1	1.9	47	-10	0.5	3.4	70	15
Minsk	BLR	6.7	0.4	78	29	2.8	2.0	45	-7	0.5	4.3	69	16
Moscow	RUS	5.0	0.0	93	35	0.0	1.1	46	-12	0.0	6.1	86	34
Kiev	UKR	8.4	0.3	80	45	3.3	1.2	47	-4	1.6	3.9	129	77
Kisinev	MDA	10.8	0.7	76	49	5.5	1.1	34	-5	3.3	3.6	73	35
Kharkiv	UKR	8.1	0.8	49	14	2.2	0.9	53	9	2.8	6.2	73	28
Astrachan	RUS	10.5	1.4	24	7	4.9	1.6	15	-4	-0.1	1.8	17	2
Yerevan	ARM	13.6	0.8	31	4	8.0	1.4	47	25	2.4	1.9	20	-3
Samsun	TUR	16.3	0.7	35	-50	13.3	0.8	59	-30	12.2	3.0	135	53
Istanbul-Kartal	TUR	16.1	0.8	64	-7	13.2	1.6	68	-21	11.1	3.0	113	-9
Ankara	TUR	12.5	-0.1	32	5	7.2	0.1	41	8	4.7	2.2	46	-3
Van	TUR	11.5	1.4	28	-20	5.8	1.8	40	-4	1.8	2.9	22	-12
Antalya	TUR	20.6	1.0	71	1	14.7	-0.1	102	-32	12.3	0.9	105	-122
Larnaka	CYP	22.5	1.2	13	-6	17.7	0.8	62	18	14.9	1.5	14	-62
Uralsk	KAZ	6.0	0.9	29	-1	1.8	3.9	34	-1	-6.2	2.2	24	-5
Tbilisi	GEO	13.6	0.1	95	57	8.8	0.7	15	-15	5.5	1.7	25	4
Tripoli	LBN	22.9	0.7	45	-26	18.1	-0.2	125	12	15.4	1.3	27	-153
Tel Aviv	ISR	23.4	1.4	8	-18	19.3	1.3	15	-53	16.6	2.8	52	-86
Elat	ISR	27.1	0.5	0	-3	21.9	0.8	0	-4	19.4	3.2	0	-6
Mafraq	JOR	19.5	0.4	0	-7	14.5	1.0	4	-13	12.0	3.2	12	-16
L.Palmas/Gran Can.	ESP	24.3	1.8	4	-6	21.9	1.5	4	-17	18.7	0.4	22	1

7. References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2016 edition of the Bulletin, are listed on page 3 above. Many contributions or additional information may as well be found on the web, see below.

Austria: Zentralanstalt für Meteorologie und Geodynamik (**ZAMG**), Wien, Annual Climate Reports

Belgium: The Royal Meteorological Institute of Belgium (**KMI**), Klimatologisch overzicht

Bosnia and Herzegovina: Federal Meteorological Institute (**METEOBIH**), Analiza-godina.

Croatia: Meteorological and Hydrological Service (**DMHZ**) Annual reports

Denmark: Danish Meteorological Institute (**DMI**), Vejret i Danmark

Denmark: Danish Meteorological Institute (**DMI**), Storms in Denmark since 1891

Estonian Weather Service: Estonian weather events in 2017

Finnish Meteorological Institute (FMI) Press release 2017

France: Météo-France, Toulouse, Bilan climatiques

Germany: Deutscher Wetterdienst (**DWD**), Annual, Seasonal and Monthly Summary

Greece: Hellenic National Meteorological Service, http://www.hnms.gr/emy/en/climatology/climatology_extreme

Greece: National Observatory of Athens, Meteorological bulletin

Hungarian Meteorological Service (**OMSZ**), Climate retrospective

Icelandic Met Office: The weather in Iceland 2017-Climate summary

Ireland: The Irish Meteorological Service (**MET Éireann**), Weather Summary

Israel Meteorological Service (**IMS**): Weather summary in Israel

Italy: Agenzia Regionale per la Protezione Ambientale (**ARPA**) Piemonte, Rapporti annuali

Latvian Environment, Geology and Meteorology Centre Monthly bulletins

Lithuanian hydrometeorological Service (**Lhmt**) http://www.meteo.lt/menesio-apzvalgu-archyvas

Luxembourg: MeteoLux, Bilans climatologiques annuels (http://meteolux.lu/fr/produits-et-services/bilans-climatologiques/bilans-climatologiques-annuels/)

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Montenegro: Institute of Hydrometeorology and Seismology (IHMS) Annual reports

Netherlands: Royal Netherlands Meteorological Institute (**KNMI**), Jaaroverzicht van het weer in Nederland

Netherlands: Royal Netherlands Meteorological Institute (**KNMI**), Zware stormen in Nederland sinds 1910

Norway: Det Norske Meteorologiske institutt (**DNMI**), Klimatologisk månedsoversikt

Portugal: Instituto portuguesa do mar e da atmosfera (**ipma**), Bolletim Climatológico Anual

Romania: Administrația Națională de Meteorologie, Monitorizare climatica

Russia: Hydrometeorological Centre of Russia (**Roshydromet**) Climate features of the northern hemisphere

Serbia: Republic Hydrometeorological Service of Serbia (**RHMZ**) Annual Bulletin for Serbia

Slovak hydrometeorological institute (**SHMU** Slovenský hydrometeorologický ústav) Bulletin Meteorológia a Klimatológia

Slovenian Environment Agency (**ARSO,** Agencija Republike Slovenije za okolje): Mesečni bilten ARSO

Slovenia: Unusual events http://meteo.arso.gov.si/met/sl/climate/natural-hazards/

Spain: Agencia Estatal de Meteorología (**AEMET**), Resumen anual climatologico

Spain: Agencia Estatal de Meteorología (**AEMET**), Olas de calor en España desde 1975

Spain: Agencia Estatal de Meteorología (**AEMET**), Olas de frío en España desde 1975

Swedish Meteorological and Hydrological Institute (**SMHI**), Året (year)

Swedish Meteorological and Hydrological Institute (**SMHI**), Stormar i Sverige

Switzerland: Federal Office of Meteorology and Climatology **MeteoSwiss**, Klimabulletin

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9. Abbreviations

AO	Arctic Oscillation (circulation indices)
BAMS	Bulletin of the American Meteorological Society
CLIMAT	monthly climatological data provided by the NMHSs via GTS
DWD	Deutscher Wetterdienst (German Meteorological Service)
EA	East Atlantic Pattern (circulation indices)
EA/WR	East Atlantic/West Russia Pattern (circulation indices)
ECA&D	European Climate Assessment & Dataset, located at Royal Netherlands Meteorological Institute (KNMI)
EMCC	Eastern Mediterranean Climate Centre
E-OBS	daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D information
GCC	Global Collection Centre operated by the Deutscher Wetterdienst
GPCC	Global Precipitation Climatology Centre located at the Deutscher Wetterdienst
GTS	Global Telecommunication System
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (Italian National Institute for Environmental Protection and Research)
JRC	Joint Research Centre's of the European Commission
m a.s.l.	Meter above sea level
NAO	North Atlantic Oscillation (circulation indices)
NMHSs	National Hydro-Meteorological Services
POL	Polar/Eurasia Pattern (circulation indices)
PDSI	Palmer Drought Severity Index
RCC-CM	WMO Regional Climate Centre Network (RA VI) Offenbach Node on Climate Monitoring
SCA	Scandinavia Pattern (circulation indices)
SCE	Annual snow cover extent
SYNOP	surface synoptic or weather observations provided by the NMHSs via GTS
WCDMP	World Climate Data and Monitoring Programme
WMO RA VI	WMO Regional Association VI (Europe and Middle East)
WMO	World Meteorological Organization

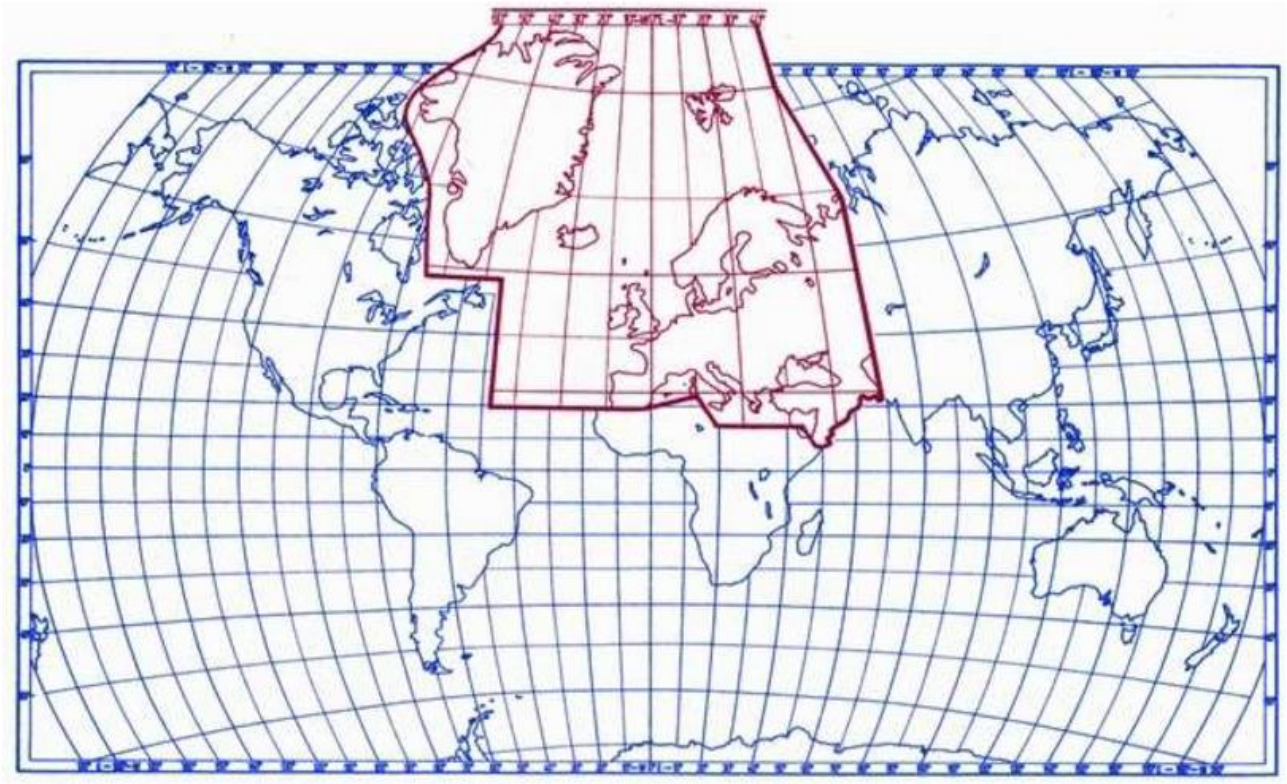
WMO RA VI
RCC Network

DWD

Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2018



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United Kingdom

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1. Introduction

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East with 50 Members) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official Websites. Supported by the European Climate Support Network (ECSN) and WMO´s World Climate Data and Monitoring Programme (WCDMP) the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's Annual Statement on the Status of the Global Climate and the State of the Climate published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ among the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the Webpages of the RA VI RCC Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

This annual bulletin includes 4 parts: the annual, seasonal and monthly survey of the climate state in 2018 as well as contributions of the NMHSs to the long-term variability of selected parameters up to 2018 (section 5).

Notes:

Maps of the RA VI RCC Network are based on the following data sources:

- Temperature: CLIMAT data and ship observations provided by the Global Collecting Centre (GCC), operated by the Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC), operated by the Deutscher Wetterdienst
- Sunshine: Meteosat Satellite data (new in 2018).
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC Node-CD) via the European Climate Assessment & Dataset project (ECA&D) run by Royal Netherlands Meteorological Institute (KNMI)

The following sub-regions are used in this bulletin:

Central and western Europe (14 countries): *Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, the Netherlands, Poland, Slovakia, Switzerland, and United Kingdom*

Nordic and Baltic Region (9 countries/territories): *Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, and Sweden*

Iberia (2 countries): *Portugal, and Spain*

Mediterranean, Italian and Balkan Peninsula (12 countries): *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, Montenegro, North Macedonia, Serbia, Slovenia, and Turkey*

Eastern Europe (5 countries): *Belarus, European Russia, Moldova, Romania, and Ukraine*

Middle East (9 countries): *Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, and Western Kazakhstan*

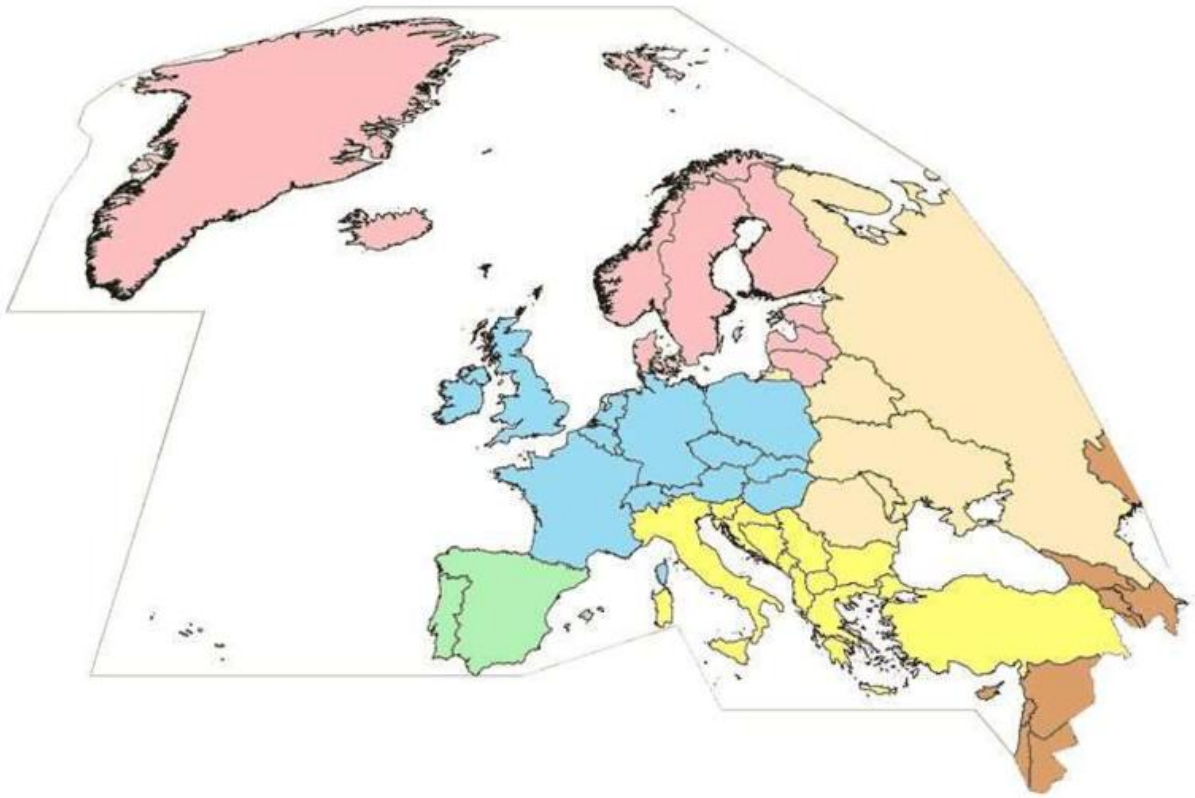


Figure 1-1: Definitions of the 6 sub-regions used in this bulletin.

Box 1 | The climate in 2018 - overview

Anomalies

Temperature

- Warmer-than-normal conditions over the entire RA VI region with an annual mean temperature of +1.25°C above normal for Europe as a whole and largest anomalies occurring over the Arctic region, Central Europe, Finland and the Eastern Mediterranean region with annual mean temperatures of +2°C above normal (w.r.t. 1961-1990), all seasons were warmer than normal

Precipitation

- Drier-than-normal conditions over large parts of the RA VI especially over central and northern Europe with annual precipitation amounts lower than the 10th percentile (w.r.t. 1951-2010) due to an extended period of drought caused by blocked weather patterns

Sunshine Duration

- Sunnier-than-normal conditions over large parts of the RA VI region with anomalies of 105 - 125% (corresponding to 200 -500 hours)

Events:

- several cold spells during February and March in central, northern and eastern Europe making these two months the only ones in 2018 with below-normal temperatures
- Parts of southern Europe experienced a very wet spring with precipitation sums exceptionally above average (> 90th percentile)
- Intense warm period from spring till end of summer over most of the RA VI region, especially over central Europe with temperature anomalies between +2°C and +4°C for the spring and summer season and many new country records set on the monthly scale

2. Annual survey

The climate of 2018 was characterised by a broad range of spatial and temporal anomalies outlined in Box 1 and Figure 2-5. This section presents an overview of the spatial patterns of mean annual climate conditions in 2018 and anomalies related mainly to the normal period 1961-1990 of the selected climate variables: sea level pressure, surface air temperature, precipitation, sunshine duration and snow. Sub-section 2.1.4 reveals climate extremes for individual countries. Long-term trends in temperature and precipitation indices are presented in section 2.2. Section 3 and 4 present the seasonal and monthly patterns and statistics for selected climate variables including also reports from individual countries. More insight into the long-term variability of temperature, precipitation and sunshine duration for the individual countries are given in section 5.

2.1. *Annual averages and anomalies of selected essential climate variables*

2.1.1. Sea level pressure

Generally, mean annual sea level pressure distribution in 2018 over the WMO Region VI was dominated on one hand by low pressure in the polar region with the minimum pressure extending from southern Greenland to Iceland. On the other hand, there was a high pressure belt with maximum pressure in the area of the Azores (Azores High) extending further across southern and central Europe till Russia.

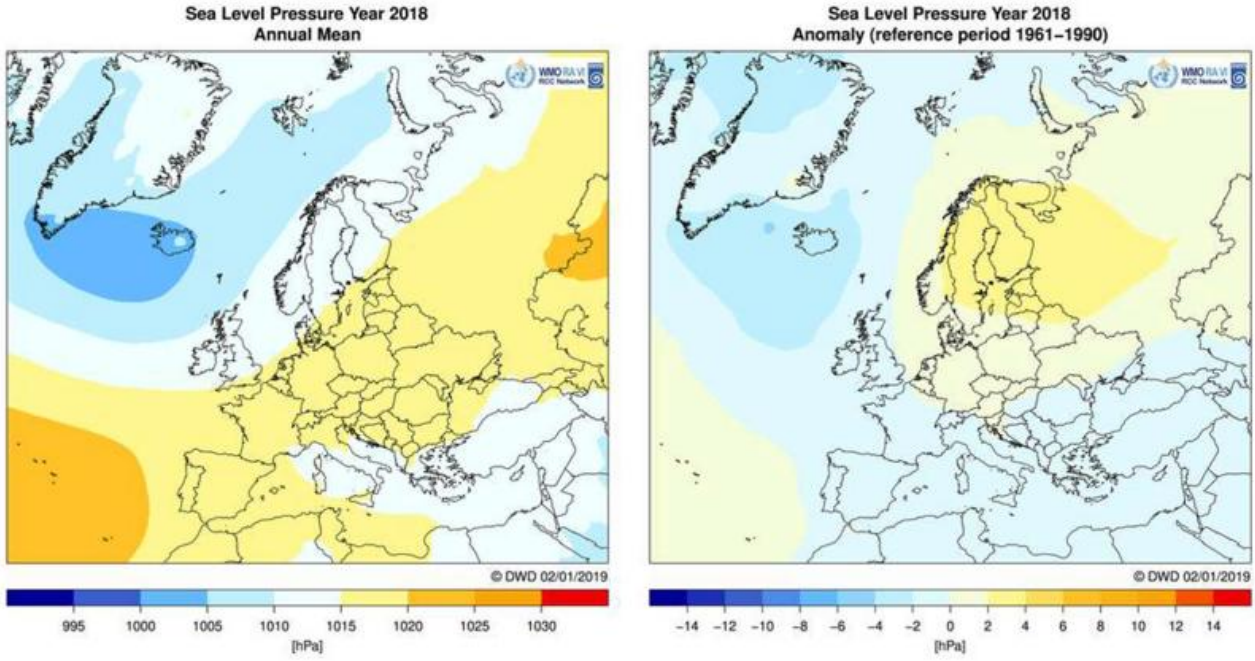


Figure 2-1: Annual mean of sea level pressure (left) and anomalies (right) in hPa for the year 2018 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

The mean sea surface pressure in 2018 differs to some extent from the long-term mean with a reduced pressure in the polar regions and over southern parts of Europe and the Mediterranean Sea

with anomalies generally between 0 to -2hPa as can be seen from Figure 2-1 (right; normal period 1961-1990). Higher-than-normal pressure occurred especially over Central, Northern and Eastern Europe with largest anomalies of +2 to +4hPa over Scandinavia and North-eastern Russia.

2.1.2. Temperature

In 2018, mean annual temperatures were higher than normal (w.r.t. 1961-1990) over the whole RA VI region. Temperature anomalies varied mostly between +1°C and +3°C. Over the European continent largest anomalies occurred over central Europe and eastern Europe as well as over Finland, Turkey and the Middle East with anomalies between +2 to +3°C. Even larger anomalies with values greater than +3°C occurred over the arctic region. These are also documented by several arctic stations located for example on the Norwegian Svalbard archipelago in the Arctic Ocean (see Table 2-1). Largest anomalies were recorded at Svalbard airport with a mean annual temperature of -1.8 °C which is 4.9 °C above the normal and at Hopen with a mean annual temperature of -1.4 °C, which is 5.0 °C above the normal. With these anomalies the year 2018 finished 3rd warmest for Svalbard airport (only 2016 and 2006 were warmer) and 4th warmest for Hopen (2016, 2012 and 2006 were warmer). End of 2018 Svalbard airport had seen 97 consecutive months with above-normal temperatures. Ny-Ålesund and Jan Mayen even recorded the second warmest year since the measurements started in 1972 and 1921, respectively, surpassed only by 2016.

For the European region as a whole, 2018 was one of the two warmest years since at least 1950 considering the E-OBS (Haylock et al. 2008; van der Schrier et al. 2013; Figure 2-3) and the Global Historical Climate Network (GHCN) v3.3.0 datasets (Menne et al. 2012; Bissolli 2019) with an overall anomaly (with respect to the base period 1981-2010) of +1.25°C (E-OBS) and +1.1°C (GHCN). Many countries reported new records (Table 2-2). In Germany, anomalies of +3°C and more with respect to the long-term mean were registered for six months. All seasons were warmer than normal which contributed to 2018 finishing as warmest year since beginning of the measurements in 1881 with an anomaly of +2.2°C w.r.t 1961-1990 (+1.6°C w.r.t. 1981-2010). Besides Germany, also Austria, Czech Republic, France, Hungary, Italy, Luxembourg, Poland, Serbia and Switzerland reported 2018 as their warmest year on record (**Table 2-2**). For many other countries, 2018 finished among the five warmest years on record (see **Table 2-2**).

Globally, 2018 was the fourth warmest year on record (WMO 2019; Blunden and Arndt 2019) with an average global temperature 0.30°–0.40°C above the 1981–2010 average according to four independently constructed in-situ analyses (Sánchez-Lugo et al. 2019) and approximately 1°C above pre-industrial levels (WMO 2019). The 2018 Arctic land surface temperature was 1.2°C above the 1981–2010 average, tying for third highest in the 118-year record, following 2016 and 2017.

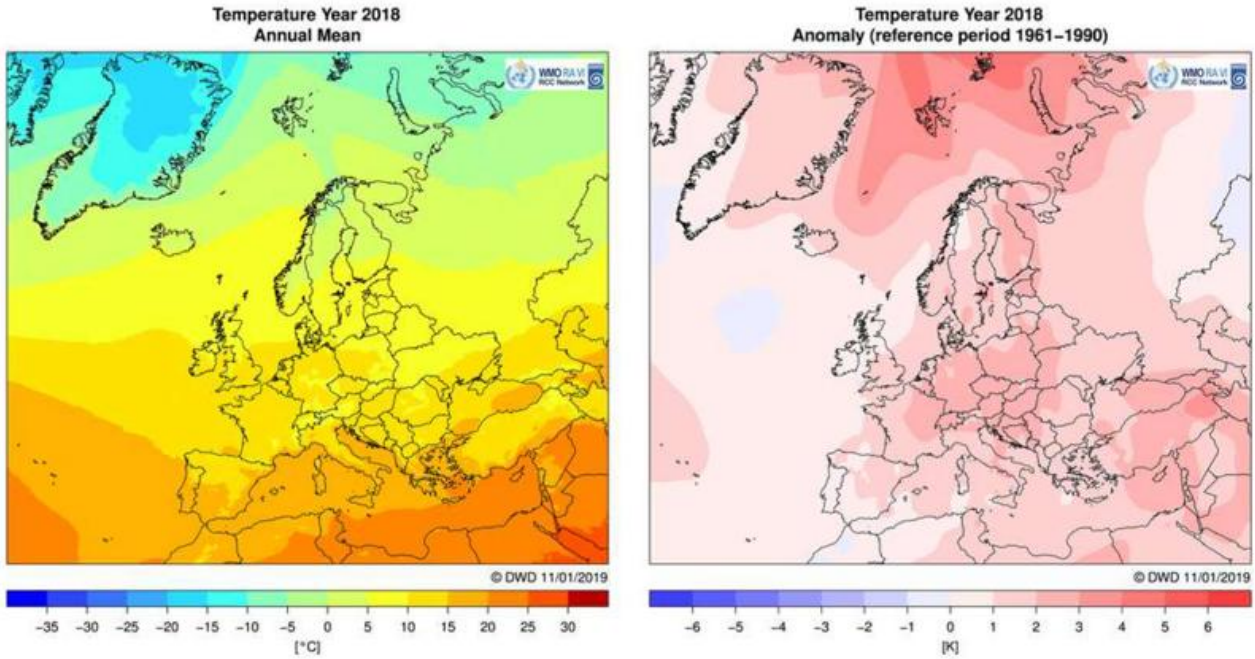


Figure 2-2: Mean annual temperature in °C (left) and anomalies (right) for 2018 (reference period 1961-1990, source: http://www.dwd.de/rcc-cm).

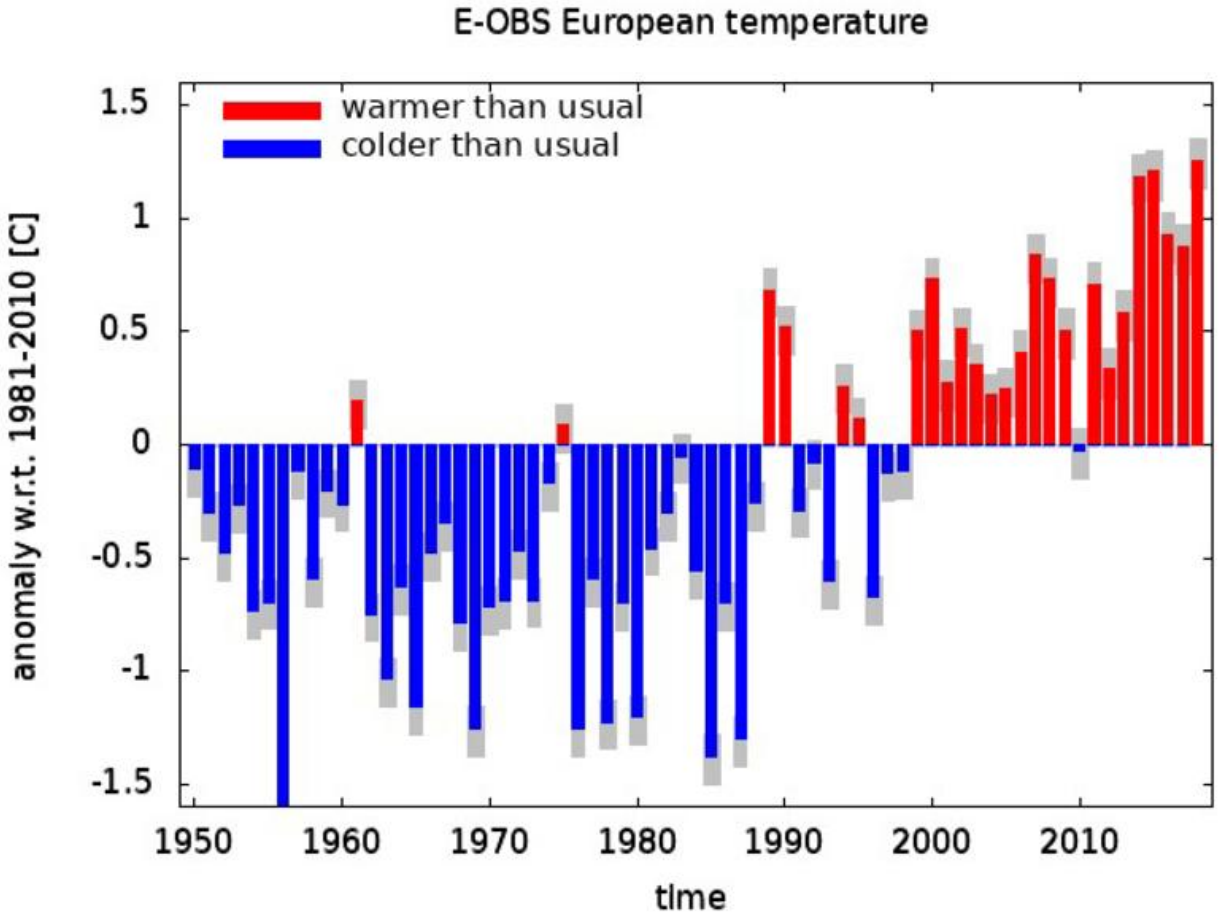


Figure 2-3: Annual temperature anomalies 1950-2018 for Europe (land area; 34°N-71°N and 25°W-40°E, reference period 1981–2010; based on the E-OBS dataset). (Source: Royal National Meteorological Institute Netherlands, KNMI).

Table 2-1 Rank statistics and anomalies of annual temperature in 2018 for the Arctic stations as reported by the Norwegian Meteorological Institute..

Station name	Rank of annual temperature in 2018	Mean annual temperature in 2018	Anomaly in °C	start of time series
Svalbard airport	3	-1.8 °C	+ 4.9 °C	1975
Hopen (Svalbard)	4	-1.4 °C	+5,0 °C	1945
Ny-Ålesund (Svalbard)	2	-2.1 °C	+4.3 °C	1972
Bjørnøya (Svalbard)	3	1.0 °C	+3.4 °C	1910
Jan Mayen	2	2,0 °C	+3,4 °C	1921

Table 2-2: Rank statistics and anomalies of annual temperature in 2018 from some participant countries as reported by the National Meteorological and Hydrological Services (NMHSs) including countries with rankings among the top 5 (*ranks 1–5*) since start of the to time series. Information about all-time temperature records as provided by the individual NMHSs can be found here: https://rcccm.dwd.de/DWD-RCCCM/EN/products/significant/records/download_tabelle.html?nn=500100?

Country	Rank	Annual Anomaly [°C] (1961-1990)	Annual Anomaly [°C] 1981-2010	start of time series
Europe (35°–75°N, 25°W–40°E, E-OBS)	E-OBS:1 ERA5: 3		+1.25 +1.2	1951 1979
Armenia	2	+2.80		x
Austria	1	+2.5		1767
Belarus	4	+2.00	+1.0	1881
Belgium (Brussels-Ukkel)	1	+2.1	+1.4	1833
Bulgaria	5	+1.4		1930
Czech Republic	1	+2.1	+1.7	1961
Denmark	2	+1.8		1873
Estonia	4-5		+1.2	1961
Finland	7		+1.3	1900
France	1		+1.4	1900
Germany	1	+2.2	+1.6	1881
Georgia	2	+2.26	+1.95	1956
Hungary	1		+1.8	1901
Ireland	21		+0.25	1900
Israel	2	1.93	+1.54	1951
Italy	1	+1.77	+1.2	1961
Kazakhstan	28	+0.70		1936
Latvia	3		+1.2	1924
Lithuania	2		+1.2	1961
Luxembourg (Findel)	1		+1.8	1947
Moldova (Chisinau)	4		+1,1	1887
Norway	13	+1.4		1900
Poland	1		+1.6	1951
Portugal	33	+0.33		1931
Romania	**2**	+1.8	+1.4	1961
(European) Russia	12	+1.34		1936

Country	Rank	Annual Anomaly [°C] (1961-1990)	Annual Anomaly [°C] 1981-2010	start of time series
Serbia	1		+1.4	1951
Slovakia	2	+2.4	+1.8	1931
Slovenia	2		+1.5	1951
Spain	12		+0.4	1965
Sweden[1]	8	+1.79		1860
Switzerland	1	+2.3	+1.5	1864
Turkey	2		+1.9	1971
Ukraine	4	+1.70	+1.0	1881
United Kingdom	7	+1.17	+0.61	1884

[1] Anomaly value refers to reference period 1960-2018

2.1.3. Precipitation

Precipitation patterns in 2018 show near-normal conditions over large parts of the RA VI region. Exceptionally dry conditions (< 10th percentile) were observed, however, over central Europe, the Baltic region, southern Finland and Sweden as well as over the European part of Russia and Kazakhstan with precipitation totals 60% - 80% of normal, and even below 60% in Latvia and Estonia. Most of the Mediterranean region, however, received above-normal precipitation (100%-167%), with parts of Spain, Sardinia, the Balkan peninsula, Turkey and Syria receiving exceptionally above average amounts (>90th percentile).

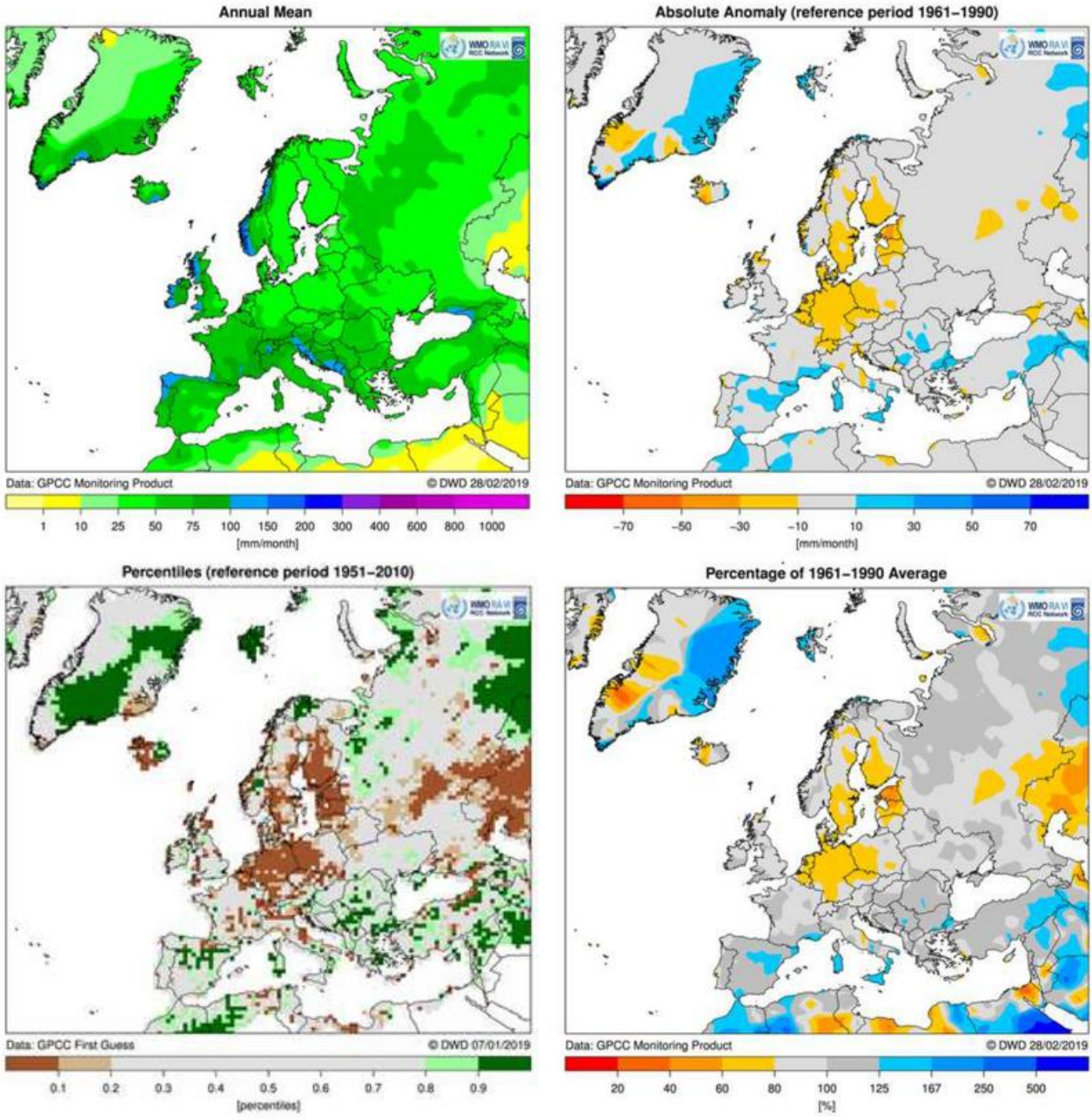


Figure 2-4: Total precipitation (left, top), anomalies (right, top) in mm/month, percentiles (left, bottom) and percentage of precipitation in % (right, bottom, reference period 1951-2010) for 2018 (reference period 1961-1990; source: http://www.dwd.de/rcc-cm).

2.1.4. Annual extreme values of temperature and precipitation

In this section, an overview is given for the temperature spread and the extreme precipitation for each country. Absolute annual extreme values for 2018 of temperature (minimum and maximum), maximum of total daily precipitation and maximum of total 5 consecutive days with precipitation for each country in the WMO Region VI are given in Figure 2-5.

The spatial pattern of extreme temperature corresponds roughly to those of the temperature anomalies of 2018. The highest maximum temperatures (above 40°C) occurred primarily in sub-regions Middle East, Iberia and Mediterranean, Italian and Balkan Peninsula. For most countries maximum temperatures are above 30°C except for Iceland (IS: 24.7°C) and Faroe Islands (FO: 16.6°C). The lowest recorded minimum temperatures occurred in Italy (IT: -48.9°C), Norway (NO: −42.0°C) and Sweden (SE: −40.4°C).

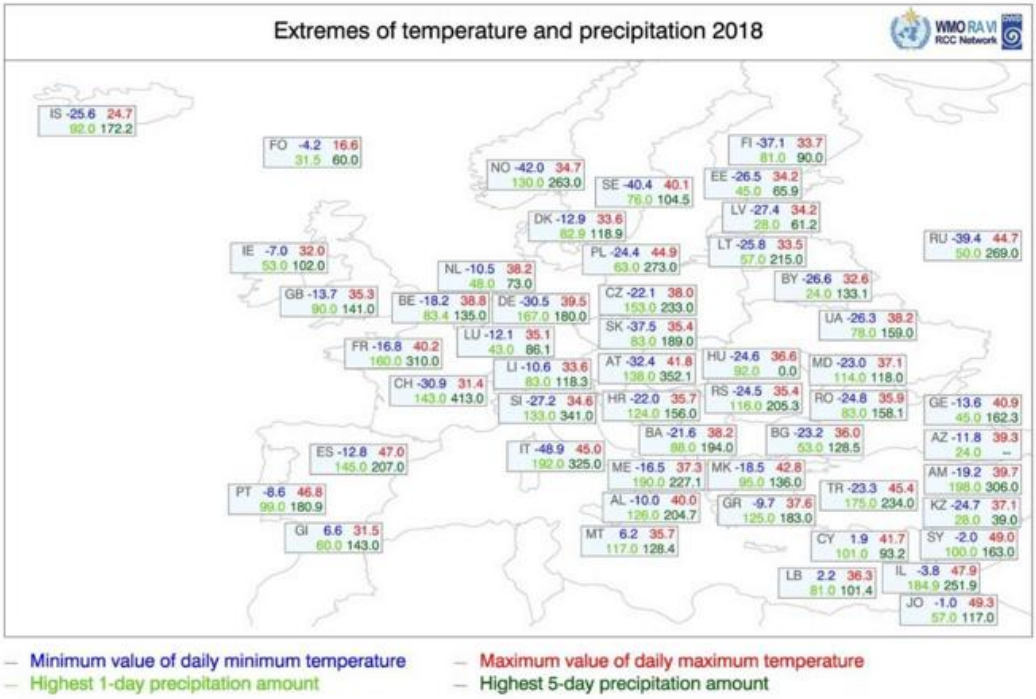


Figure 2-5: Annual extreme values for each country in 2018: first row: ISO 3166 country code (https://en.wikipedia.org/wiki/List_of_ISO_3166_country_codes), lowest daily minimum temperature (in °C, blue) and highest daily maximum temperature (in °C, red); second row: maximum daily precipitation totals (in mm, light green) and maximum 5-daily consecutive precipitation totals (in mm, dark green).

Note: Data (by order or priority) from reports of NMHSs, GPCC, ECA&D or SYNOP; the countries are represented by their ISO 3166 country codes. (Source: http://www.dwd.de/rcc-cm)

The one-day precipitation totals of more than 150 mm for individual countries are documented in several sub-regions; the highest value occurred in Armenia (AM) with 198mm. Highest total precipitation on 5 consecutive days (above 300 mm) was measured in Armenia (AM, 306mm), Italy (IT, 325mm), Slovenia (SI, 341mm), Austria (AT, 352.1mm) and Switzerland (CH, 413mm).

2.1.5. Sunshine duration

Most parts of the RA VI region experienced a surplus of sunshine hours in 2018 (see Figure 2-6). Especially in Central, Northern and Eastern Europe it was exceptionally more sunny than normal (> 90th percentile) with 200 to 500 hours (in relative terms up to 125%) more sunshine hours. Over the Iberian Peninsula, Italy and in the Middle East it was less sunny than normal with deficits mostly in the range of up to 200 hours which corresponds to deficits of up to 25% in relative terms.

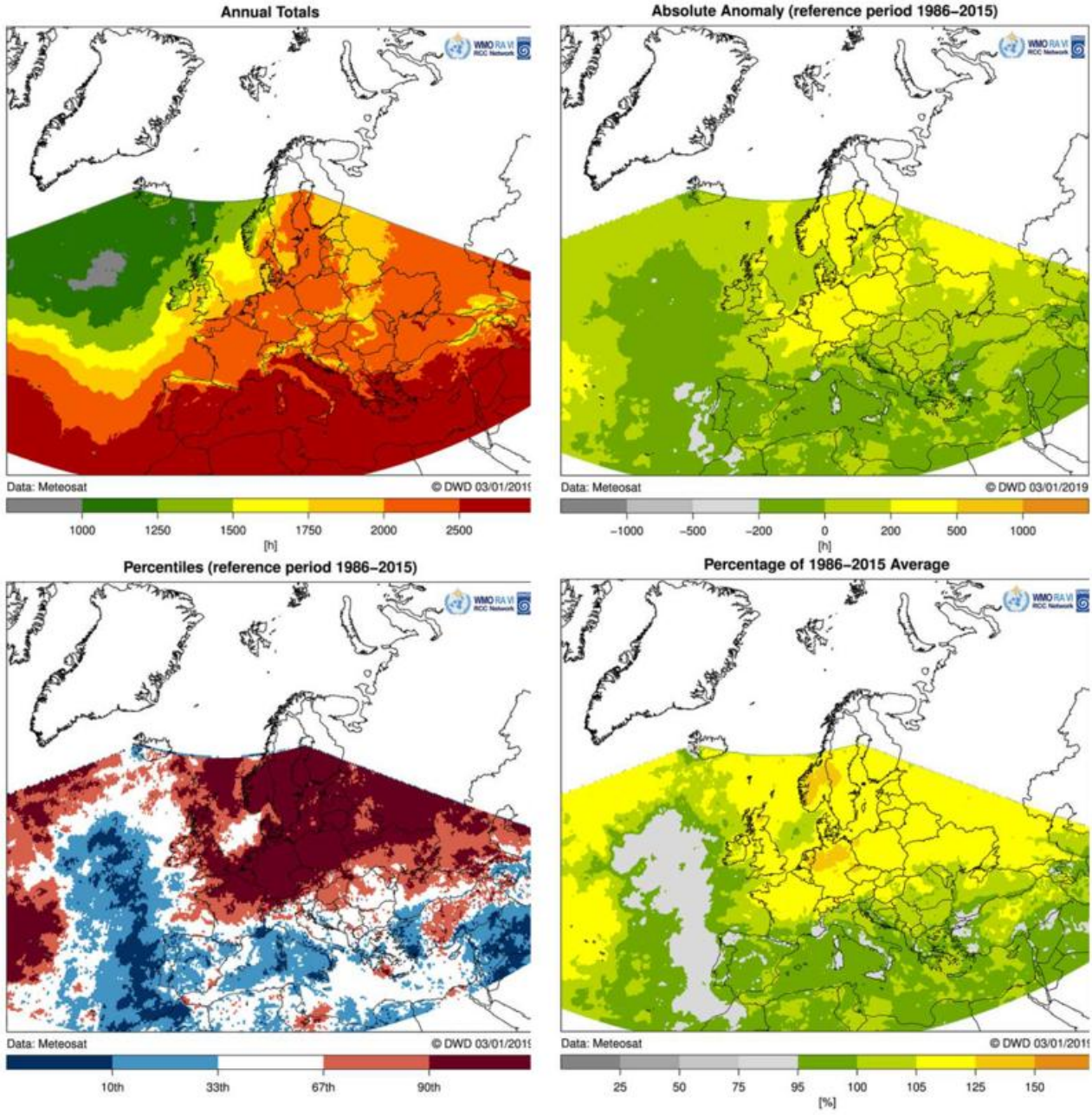


Figure 2-6: Annual sum of sunshine duration (upper left) as well as absolute anomalies (upper right), percentiles (lower left) and percentages of the long-term mean (lower right) with respect to the reference period 1986-2015 for the year 2018. (Source: http://www.dwd.de/rcc-cm).

In Denmark, 2018 was the sunniest year on record with 1905 hours (compared to 1574 hours on average, reference period 1981-2010), thus over 300 hours more (appr. 21% more). In Germany, 2018 was the sunniest year since 1951 with a surplus of 471 (415) hours or 30.5% (26%) with respect

to the 1981-2010 (1961-1990) mean. Several Swedish stations reported new records for annual sunshine duration. The absolute Swedish record for sunshine was also beaten when Svenska Högarna registered 2407 sun hours in 2018. Second place Hoburg came with 2365 hours. In 2015, 2343 hours of sunshine were registered at Hoburg on Gotland. In the Netherlands, with a spatial mean of 2090 sunshine hours, the number of sunshine hours was very close to those in 2003, which is the most sunny year so far with 2099 sunshine hours. In Luxembourg, the year 2018 was also sunnier than average and finished third sunniest on record (after 1959 and 2003). In the UK, the sunshine total for 2018 was 1581 hours, which is 115% of the 1981-2010 average making this the second sunniest year for the UK in a series from 1929, with only 2003 sunnier. East Anglia had its sunniest year on record. In Iceland on the contrary, there was exceptionally little sunshine in the southwest part of the country. The number of sunshine hours in Reykjavik was 1162.8 during 2018, 106 below the 1961 to 1990 mean and lowest number since 1992.

2.1.6. Drought situation

Many countries experience exceptional weather conditions in 2018, with record-breaking warmth and precipitation deficits. As a consequence, prolonged drought periods classified as exceptional or even unprecedented, were observed over several parts of the RA VI region during 2018, especially over Central Europe where the drought period lasted longest, generally from April to November (Germany, Poland, Switzerland, Austria). Drought periods of up to 3 months were observed over Scandinavia and the Baltic countries, Ireland, Belgium and on the Balkan peninsula (e.g. Slovenia, Bulgaria) from May/June to July/August and from August to October over Bulgaria.

In Germany, due an extremely dry period from February to November, the total annual rainfall reached with 586mm only 72% (1981-2010) or 74% (1961-1990) respectively of the long-term average, which corresponds to a deficit of 232 and 202 mm respectively. For Germany, 2018 ended up as the 4th driest year since 1881. In Poland, unprecedented drought conditions lasting from mid-April to early September affected the entire country and at least 15% of arable land resulting in a yield reduction of at least 20% compared to those obtained under average weather conditions. The total annual rainfall reached only 82% of the climate norm (1981-2010). For Latvia, 2018 was even the driest year since 1924. The total annual rainfall in Latvia was 472.7 mm, 32% below the annual norm of 692.3 mm, outperforming the previous record of 484.3 mm in 1964. For Estonia the annual precipitation amount was 506 mm, only 75% of the annual norm (672 mm) – which corresponds to the 4th place in the list of driest years since 1961. Annual sum of precipitation in Lithuania totalled 564 mm and was lower (81 %) than the climatic norm (1981-2010 average of 694 mm).

When looking at the Global Precipitation Climatology Centre Drought Index (GPCC-DI, Ziese et al. 2014) as a metric for characterizing meteorological drought, the values for the year as a whole range mostly between -1 and +1 (see Figure 2-8). The regions with largest precipitation deficits (for example central Europe and Baltic countries, see also 2.1.3) appear here with values between 0 and -1 indicating mild drought conditions on annual average. Over parts of Kazakhstan and Estonia the drought situation is even classified as moderate drought with values up to -1.5. Many countries reported national or local low records of annual precipitation. In Sweden, Stockholm had its driest year since 1892 with only 345 mm. Växjö in Småland and Karlshamn in Blekinge received 414 mm and 402 mm in 2018, which are the lowest amounts since 1886 and 1874 respectively.

Box 2 | Contributions by NMHs - drought

Persistent dryness of top soils over the north-eastern part of France from August to November 2018 (Contribution provided by Météo France)

From August to October, the surface soils have dried up all over France, particularly over a large north-eastern quarter which has suffered an exceptional rainfall deficit since the end of the summer. Despite the passage of several disturbances over France since the end of October, the soils have remained extremely dry from Limousin and northern Auvergne - Rhône-Alpes to Franche-Comté and the Great East. Soil dryness, which has been a record since October in Alsace, Lorraine and Franche-Comté, continued in these regions until late autumn.

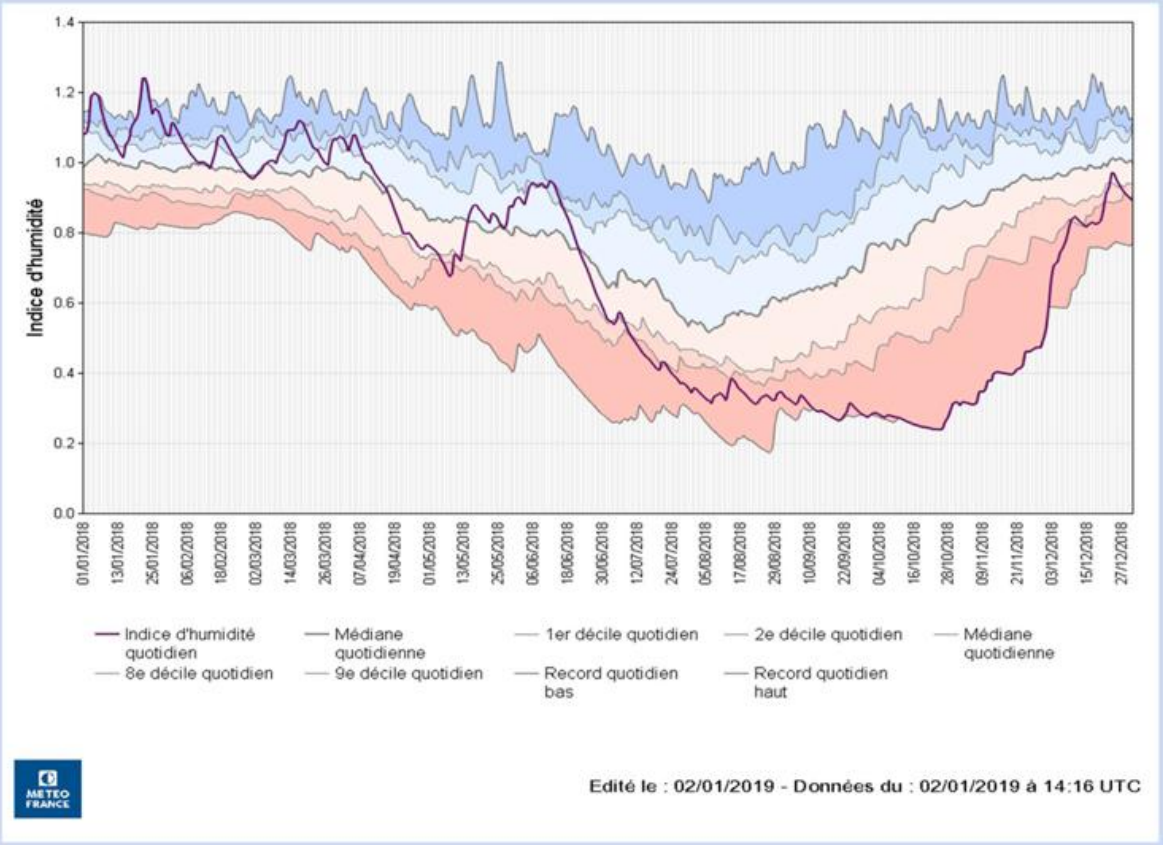


Figure 2-7: Aggregated soil moisture index for the period from 1 January until 31 December 2018 for the region Franche-Compté

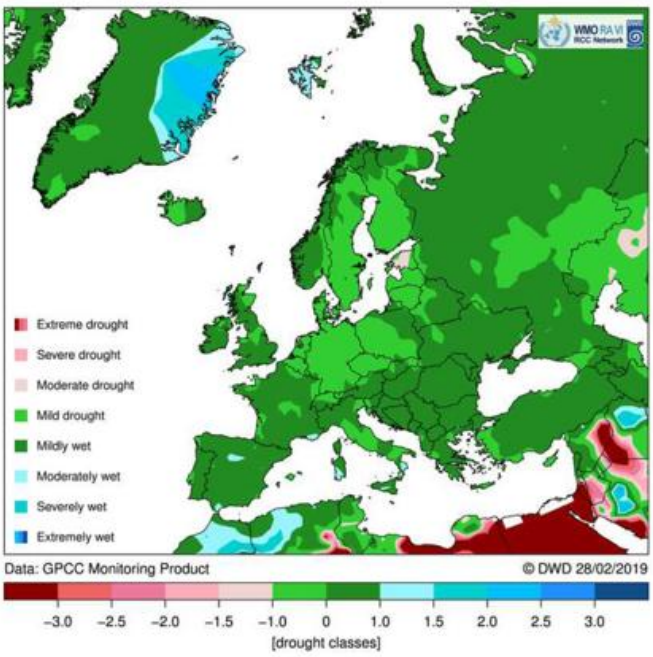


Figure 2-8: Annual GPCC –DI (GPCC-Drought Index) for the year 2018 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.7. Snow cover

The snow-season 2017/2018 (September 2017 – August 2018) was mostly warmer than normal, only February and March 2018 were significantly cooler (relative to 1961 -1990) over almost the entire RA VI region. Last snow in low land areas over central and western Europe and the Balkans occurred therefore mostly in March and resulted in rather long duration of snow cover as larger parts of western and central Europe already saw some first snow occurring in December, including even the UK, Ireland, Spain and Italy.

The rather large extent of snow cover in December was caused by a snow event taking place over parts of western- and central Europe between 9 and 12 December. In an area from the UK via the Netherlands into central Europe, 5 to 15 cm of fresh snow was reported in most places even in the lowlands. More than 30 cm was measured in Wales and in the Benelux Countries, with a maximum value of 43 cm recorded in parts of the Veluwe (eastern part of the Netherlands).

Throughout the month of January, several episodes of heavy rain and snow occurred over Western and Central Europe. These brought snow even to the lowlands not only in the UK but also in Central Europe. In the Alps these events led to several meters of fresh snow in large areas. In Davos at 1600 m altitude the amount of fresh snow reached in January 250 cm, the 4th highest snow accumulation for January since measurements started in 1931. Arosa reported even 285 cm of snow, the 5th largest snow accumulation for January since 1890. This resulted in a high to very high risk of avalanches in large parts of the Alps.

In February, two cold spells hit Central, Northern and Eastern Europe, which experienced almost 28 days (the entire month) with frost. These cold spells caused exceptional snow fall in large parts of Europe. In Ireland a major snow event occurred on 27 February and on the following 4 days, associated with Storm Emma. Observed snow depth estimates were up to 69 cm at Glenmacnass,

County Wicklow on Saturday 3 March 2018. Also the UK was hit by a spell of severe winter weather having occurred in late February and early March. Extreme precipitation fell also over central European Russia. The most severe situation was observed in the Moscow region, where snowfall persisted from February 3 to the night of February 5 and practically paralyzed city traffic and airports. More than monthly norm of precipitation (36 mm for February) was observed during that period at the meteorological station MOSKVA VDNH (55°50'N 37°37'E). In France, from February 5th to 7th, a remarkable snow episode in the region around Paris happened with a snow depth of 15 cm at Chartres and 12 cm at Paris on February 7th. During 26th and 27th of February, snowfall of 8-15 cm occurred in the Provence, on the Côte d'Azur and in Corsica. In Montenegro, due to the cold air from Siberia, snow cover was formed on February 26th in all regions of the country. Its maximum depth was in the range from 4 cm in Podgorica (southern central region) to 115 cm in Zabljak (mountainous region). In Iceland, snow covered the ground for 38 days in Reykjavík, 26 less than on the average 1971 to 2000. The snow cover in Reykjavík was quite heavy in January and February but March was completely without snow cover (for the first time since March 2005).

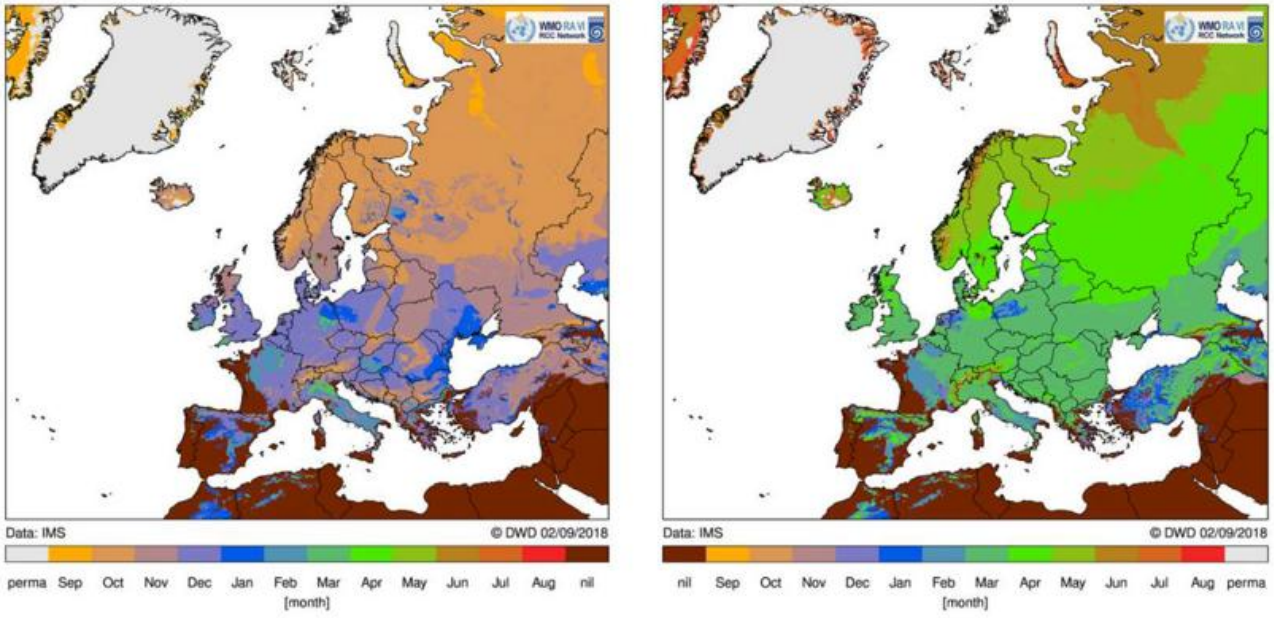


Figure 2-9: First occurrence of snow (left) and last occurrence of snow (right) during the snow season 2017/2018 from 09/2017 to 08/2018. (Source: http://www.dwd.de/rcc-cm).

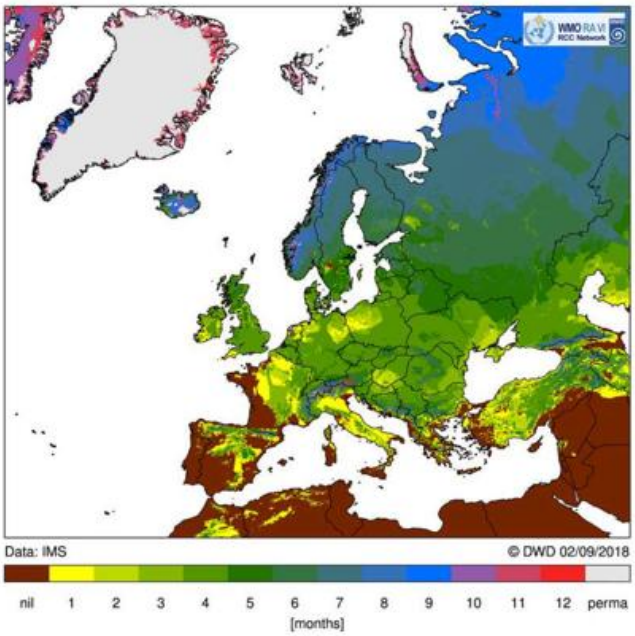


Figure 2-10: Duration of snow cover in the snow season 2017/2018 (from 09/2017 to 08/2018). (Source: http://www.dwd.de/rcc-cm).

2.2. *Selected climate indices for 2018*

This section presents selected temperature and precipitation indices calculated based on the station-based ECA&D (European Climate Assessment & Dataset; http://www.ecad.eu) dataset. Annual climate index maps are shown as well as anomaly and trend maps. The following climate indices are considered:

1. **RR1, Number of wet days**: count of days where RR (precipitation) ≥ 1 mm

Precipitation below 1 mm/day has no effect on vegetation because it normally evaporates on the same day and is locally affected.

2. **SU, Number of summer days**: count of days where TX (daily maximum temperature) ≥ 25°C

3. **WW, Number of warm and wet days**: days with TG (daily mean temperature) > 75th percentile and RR > 75th percentile

4. **TR, Number of tropical nights**: count of days where TN ≥ 20°C

The maps showing the number of wet days (RR1, uppermost left panel in Figure 2-11) clearly depict the dry conditions prevailing in 2018. Over large parts of Central Europe and Scandinavia there were less than 100 wet days which correspond to -20 to -40 and even less rainy days with respect to the 1961 to 1990 mean in these areas. The southern parts of Europe on the contrary experienced more than normal wet days, mostly up to 20 days.

Looking at the number of warm and wet days (WW) it appears that above-normal numbers of WW were registered in most parts of Europe in 2018, also in the drier parts. Only very locally, the number of wet and warm days was fewer than normal.

The anomaly map for the number of summer days (SU, second row from the bottom on the right in Figure 2-11) also illustrates well the longer-than-normal summer conditions in 2018 over large parts of Europe. Over Central Europe there were up to 60 more summer days recorded than normal. In many countries new records were set. In Luxembourg (at Findel) for example, with a total of 76 summer days over the year, 2018 exceeds the former record from 2003 with 63 summer days. In the Netherlands, De Bilt also reported a new record number of summer days (56) since 1901. In the southern and northern parts of Europe less summer days than normal occurred.

Most meteorological stations in lowlands of west Slovakia recorded new record numbers of summer days e.g. Žihárec recorded 140 summer days, which is 71 more than the normal average of the period 1961-1990, respectively 57 days more than in 1981-2010. The second highest number of summer days was measured in Podhájska (139 days), which is 70 more than normal of the period 1961-1990, respectively 58 days more than in 1981-2010.

There were also more than normal tropical nights (TR) in 2018, but the anomaly values are smaller than for SU with mostly up to 30 nights. Locally, there were also less than normal tropical nights throughout the RA VI region.

Figure 2-12 shows the trend maps for the selected climate indices based on the years 1951 to 2018. In northern, northwestern, central and eastern Europe most stations showed an increase in the annual number of wet days (RR1) for the last 68 years (mostly greater than 3 days per year per decade) while in southern Europe a decreasing trend prevails. The decreasing and increasing trends

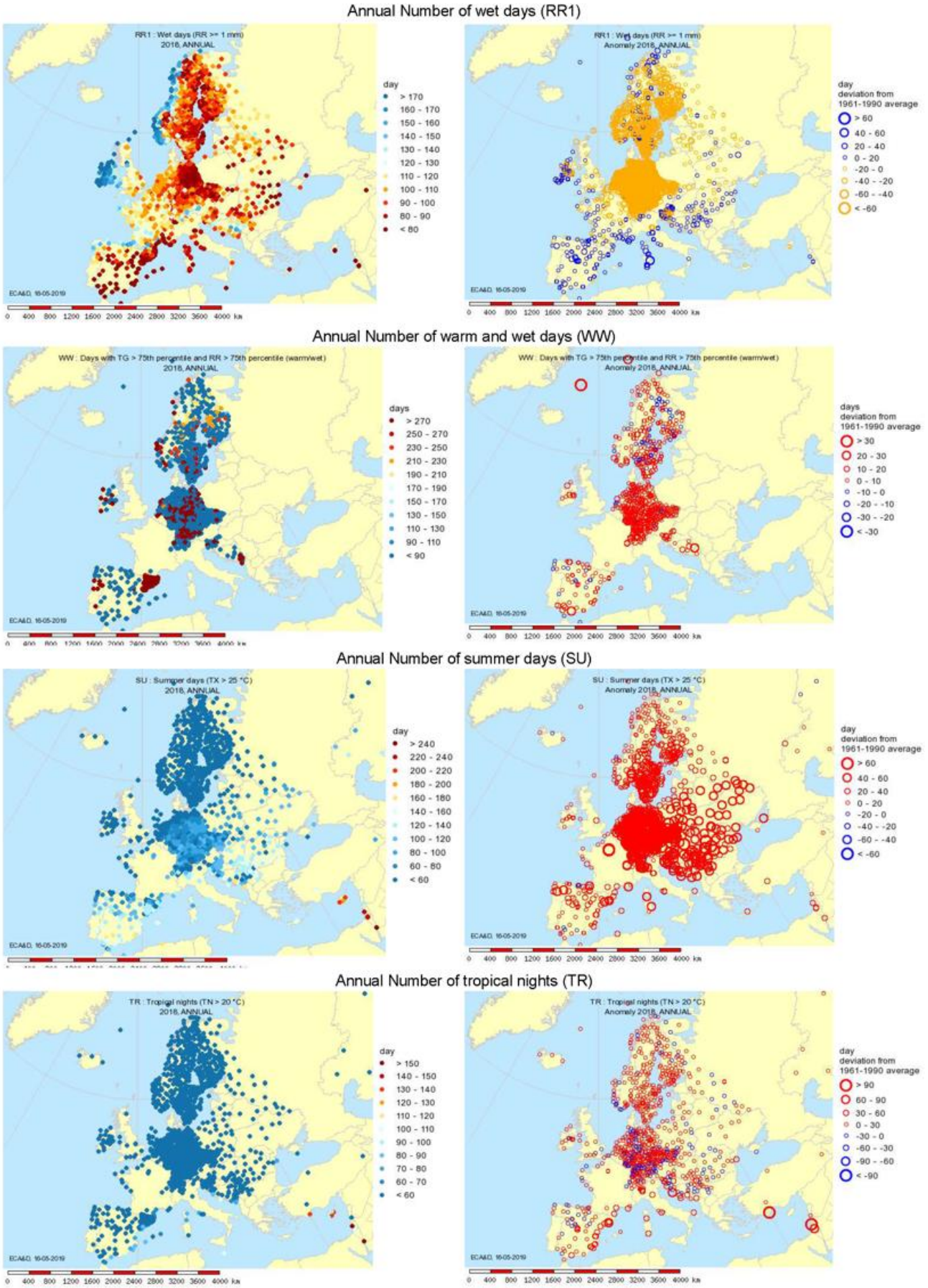


Figure 2-11: Selected Climate Indices for 2018 (left) and their anomalies (right) with respect to the 1961 to 1990 reference period (Source: ECA&D, http://www.ecad.eu).

at neighbouring stations, however, indicate inhomogeneities in the time series. The number of warm and wet days (WW) has increased over almost whole Europe by more than 1.5 days per year per decade. Only the Greek stations show negative WW trends of up to -1.5 days per year per decade. The annual numbers of summer days (SU) have increased in central and southern Europe and partly in Eastern Europe, while stations in northwestern and northern Europe do not indicate any significant trend. Annual numbers of tropical nights (TR) show an increasing trend in the southeastern part of Region VI but values are mostly small with 0 to 2 days per year per decade. In the northwestern part no significant trends are found.

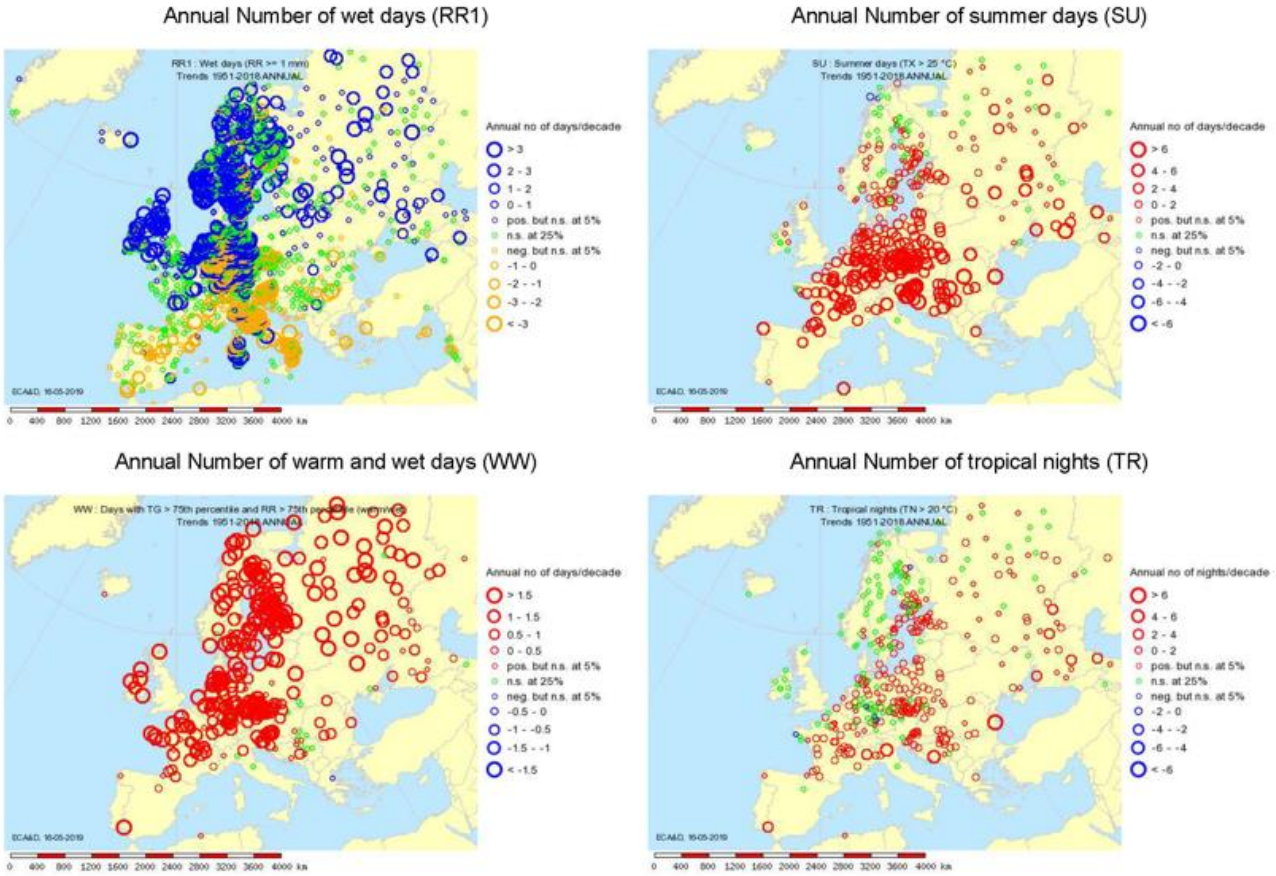


Figure 2-12: Trends of Selected Climate Indices 1951 to 2018 (Source: ECA&D, http://www.ecad.eu).

3. Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2018 and anomalies related mainly to the normal period 1961-1990 of the following selected climate variables: sea level pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1. *Seasonal averages and anomalies of selected climate variables*

3.1.1. Sea level pressure and circulation indices

Pressure distribution in **winter 2017/2018** shows that both circulation centres, the Icelandic Low and Azores High, were stronger than normal with anomalies of -4 to -6 hPa and up to +6 to +8 hPa respectively. That winter the North Atlantic Oscillation (NAO) was positive, but with 1.08 not very pronounced, the AO was in a neutral phase (-0.08). The dominant circulation patterns were the East Atlantic/West Russia Pattern (EA/WR) and the Polar/Eurasia Pattern (POL), with values of -1.55 and -1.89 respectively.

Table 3-1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference. Blue and yellow colors indicate index values lower than -1 and greater than 1 respectively

	NAO	EA	EA/WR	SCA	POL	AO
Winter 2017/2018	1,08	-0,44	-1,55	0,13	-1,89	-0,08
Spring 2018	0,61	0,15	1,02	0,40	-0,50	0,26
Summer 2018	1,74	1,21	-0,96	0,15	-0,36	0,61
Autumn 2018	1,02	0,03	0,04	0,01	-0,02	-0,04

Note that all values are standardized with the reference 1981 to 2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

In **spring** pressure was lower than normal over the entire RA VI region except for Scandinavia. The Icelandic low was shifted south. Largest negative anomalies occurred southwest of Ireland and over Russia.

In **summer** the pressure anomalies were mostly only slightly positive or negative (within -2 to +2hPa). Larger negative anomalies occurred tough over the Arctic including Iceland.

The circulation centres in **autumn** were well pronounced with a core pressure between 1000 and 1005hPa around Iceland and between 1020 to 1025 hPa around the Azores. The latter formed part of high pressure belt extending further across southern and central Europe till western Kazakhstan with one maximum around the Azores and the second one over Eastern Europe. Above-normal pressure anomalies occurred over northeastern Europe, with largest anomaly values in the range of +4 to +6hPa over the Baltic countries. All circulation patterns were in a neutral phase except for the NAO which was positive with a value around 1.

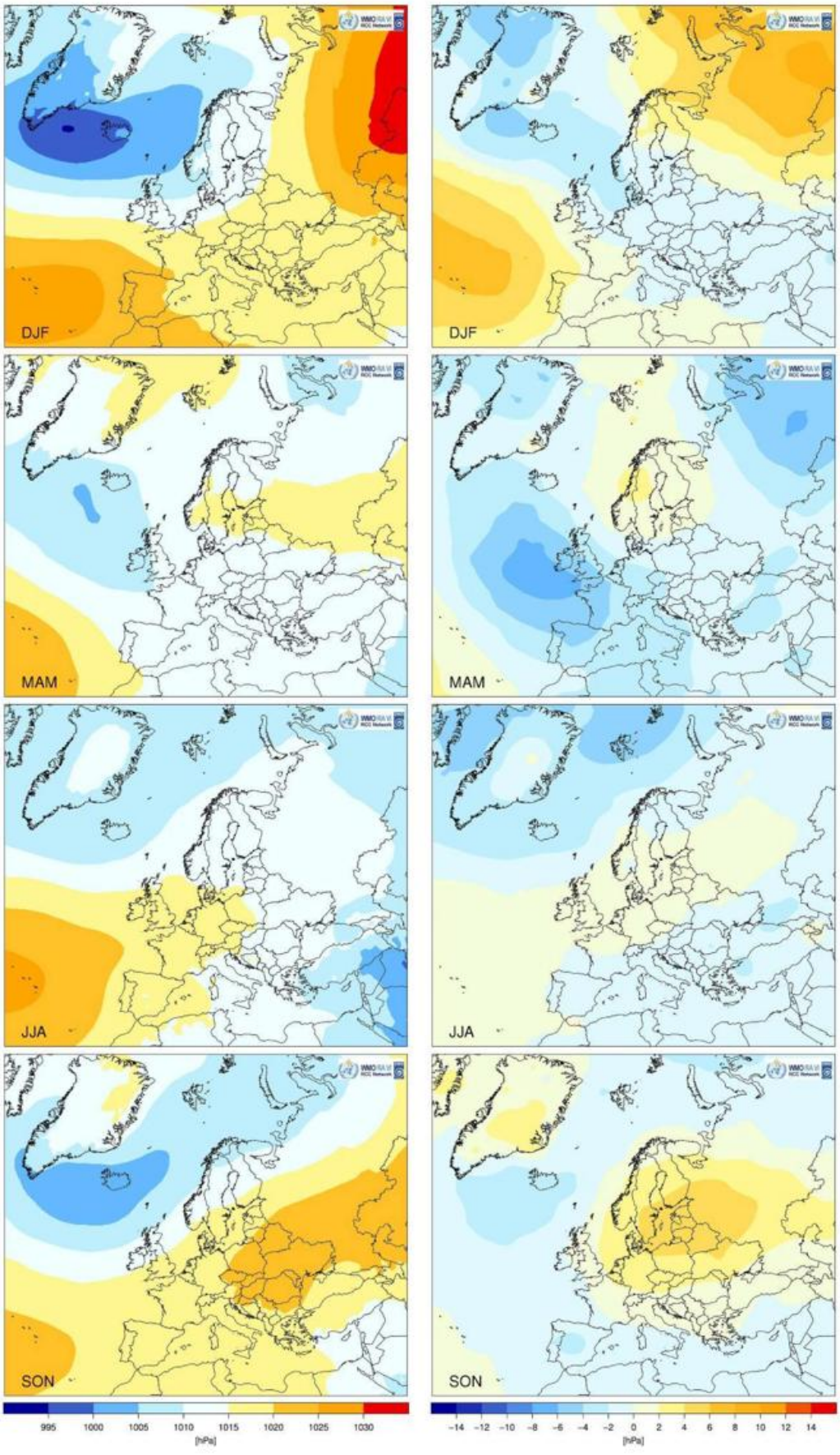


Figure 3-1: Seasonal sea level pressure (left, in hPa) and anomalies (right, in hPa) in 2017/2018, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.2. Temperature

In 2018, mean annual temperatures were higher than normal (w.r.t. 1961-1990) over the whole RA VI region which is reflected by positive anomalies in all sub-regions ranging from +0.9°C over Iberia to +1,95°C over central and western Europe(see Table 3-2). Temperatures were not only higher than normal on an annual basis but also in all seasons except for the winter season over Iberia which was normal with an anomaly value close to zero.

Table 3-2: Seasonal and annual average of temperature anomalies over land areas in °C for each sub-region in the year 2018 (reference period: 1961-1990; definitions of the sub-regions see Figure 1-1)

region	year	winter	spring	summer	autumn
Central and Western Europe	1.95	1.08	2.11	2.79	1.51
Nordic und Baltic Countries	1.62	2.8	1.25	0.84	1.73
Iberia	0.9	-0.04	0.53	1.42	1.2
Med. Italian and Balkan Peninsula	1.84	1.35	2.45	1.87	1.9
Eastern Europe	1.68	3.13	0.69	2.01	2.09
Middle East	1.83	2.33	2.07	1.59	1.64

Temperature anomalies for **winter 2017/18** show higher-than-normal temperatures over large parts of the RA VI region generally ranging from +1°C to +3°C over central and eastern Europe, and the Balkan countries. Over the southwestern part of Europe (Spain, southern France) and over parts of the United Kingdom and Ireland, and northern Scandinavia), however, temperature anomalies were colder than normal. These mostly too warm temperatures are also reflected in the subregional statistics with anomaly values ranging from 1.08°C in Central and Western Europe to 3.13°C Eastern Europe. Within the Nordic and Baltic region, largest anomalies occurred over the arctic part with values up to +6°C and more. In the northeastern part of Greenland for example, winter season (DJF) 2017-2018 was record setting at Kap Morris Jesup, Station Nord and Danmarkshavn in northern and northeastern Greenland. All countries in the Middle East region experienced also well-above-normal temperatures with anomalies >= +1.6°C (w.r.t. 1981-2010); Jordan observed a winter temperature anomaly of +2.6°C (w.r.t. 1981-2010) and Armenia even above +4°C.

Table 3-3: Seasonal rank statistics for temperature (2017/2018) as provided by the NMHSs including countries with rankings among the top 5 (ranks 1–5) since start of the to time series.

Country	Anomaly	Reference period	Rank /Start of time series
		winter	
Georgia	+2.52°C	1981-2010	4th warmest since 1956
		spring	
Bulgaria	+2.4°C	1961-1990	3rd warmest since 1930
Switzerland	+1.6°C	1981-2010	4th warmest since 1864
Georgia	+2.36°C	1981-2010	warmest since 1956
Romania	+2.1°C	1981-2010	warmest since 1961
Belgium (Brussels-Ukkel)	+1.4°C	1981-2010	4th warmest since 1833
		summer	
Germany	+2.4°C	1961-1990	warmest since 1881
Switzerland	+2.0°C	1981-2010	3rd warmest since 1864
Belgium	+2.3°C	1981-2010	warmest since 1833
Estonia	+1.8°C	1981-2010	4th warmest since 1961
France	+2.0°C	1981-2010	warmest since 1900
Denmark	+2.0°C (+2.5°C)	1981-2010 (1961-1990)	warmest since 1874
Finland	+1.9°C	1981-2010	3rd warmest since 1900
Latvia	+1.9°C	1981-2010	2nd warmest since 1924
United Kingdom	+1.39°C (+2.0°C)	1981-2010 (1961-1990)	warmest since 1884
Georgia	1.62°C	1981-2010	5th warmest since 1956
		autumn	
Switzerland	+1.8°C	1981-2010	3rd warmest since 1864
Latvia	+1.9°C	1981-2010	5th warmest since 1924
Estonia	+2,0°C	1981-2010	4th warmest since 1961

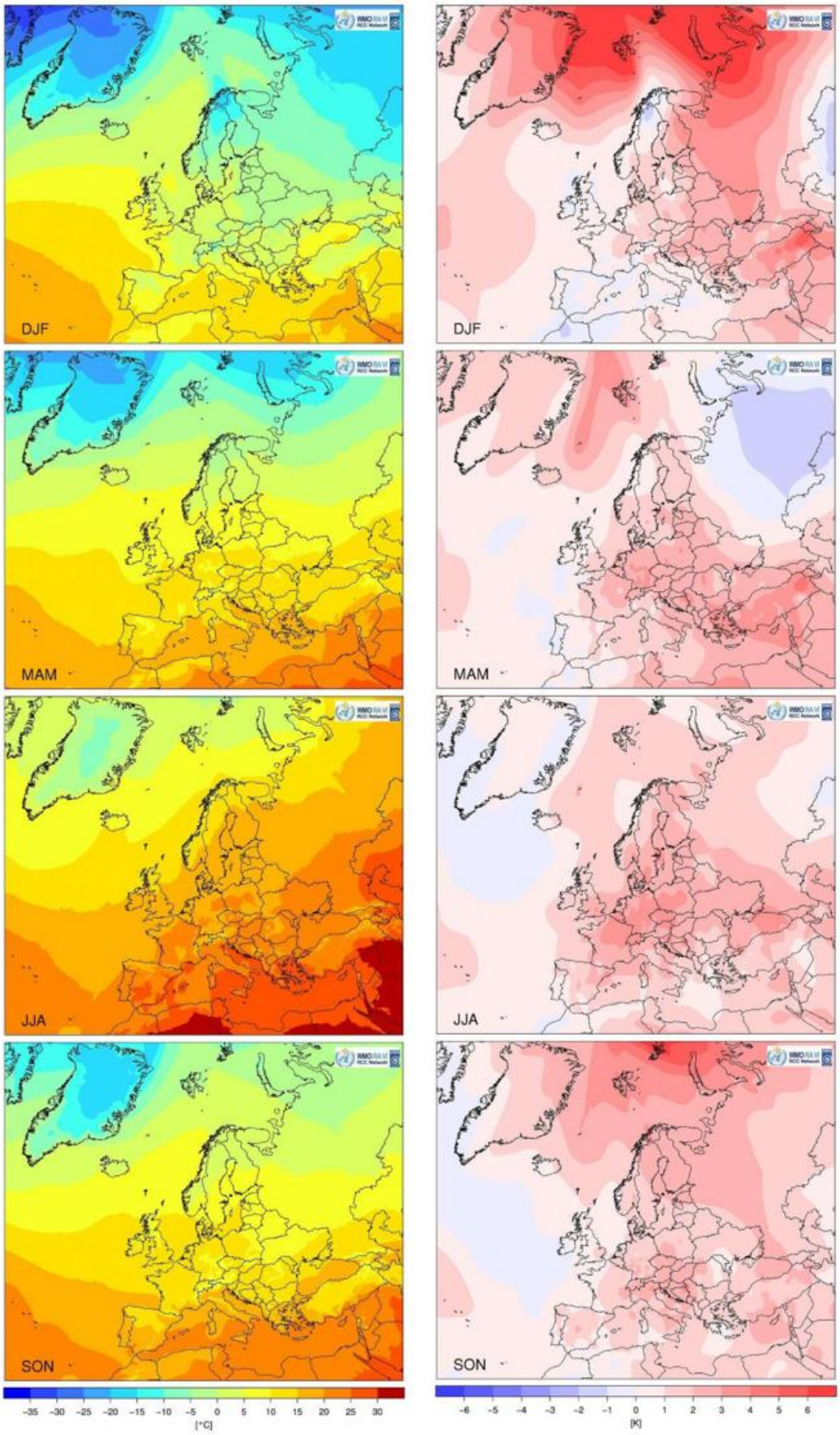


Figure 3-2: Seasonal mean temperature (left, in °C) and anomalies (right, in K) in 2017/2018, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

Spring was warmer than normal over most parts of the RA VI except for northern Russia and Portugal. Largest anomalies occurred over eastern part of the Mediterranean (Greece, Turkey, Syria) which also explains that largest regional anomalies are reached in the region covering the Mediterranean, Italian and Balkan Peninsula with an anomaly value of 2.45°C above normal. But also Central and Western Europe as well as the Middle East were more than 2°C warmer than normal. Except for the Mediterranean coast of Spain, spring was colder than average for the Iberian Peninsula (1981-2010 reference); it was the third coldest spring for Portugal and fourth coldest for Spain since 2000. In Hungary, on the contrary, 2018 was the second hottest spring. In Lithuania, spring was very warm, dry and sunny, so that the active start of plant vegetation (defined by an average daily air temperature reaching ≥10 °C) began very early this year – in the southern part of Lithuania on April 8 (on average 3 weeks earlier). In the northern part – in the middle of April (18 days earlier), on the seaside – 1 week earlier as usually. In Montenegro, the average seasonal temperature in spring was the warmest in the whole country. Serbia had its warmest spring since record-keeping began in 1951 with mean air temperature on average 1ºC above the previous record warm spring of 2007. Slovakia also reported an exceptionally warm spring 2018 with anomalies larger more than 1.5°C compared to air temperatures of the normal period 1981-2010 over the entire territory of Slovakia. In Slovenia, an exceptionally warm April together with well above mean temperatures in May resulted in above-normal spring 2018 mean temperature. On country average the anomaly was 1.7 °C. It was the warmest spring on record for Bosnia and Herzegovina, Bulgaria, Greece, Serbia and Turkey.

Summer was warmer than normal over the entire RA VI region with anomalies ranging from +0.84°C for the Nordic and Baltic countries to +2.79°C for the Central and Western Europe. Within Central and Western Europe, temperatures were locally even up to 4°C above normal (see Figure 2-2). Summer was one of the five warmest on record for many countries in Central Europe: Germany and Poland, warmest (+2.3°C and +2.2°C, respectively); France second (3.2°C) and Switzerland, third (+2.0°C). In Luxembourg, the summer of 2018 was characterized by an average temperature of 20.1°C, placing it in the second rank of the hottest summer seasons ever observed since 1947, the hot summer of 2003 keeping the first rank with an average summer temperature of 20.5 ° C. Findel-Aéroport meteorological station reported a new record of summer days (maximum temperature ≥ 25 ° C): 76 summer days were counted (last summer day on 19/09/2018), surpassing by far the emblematic years of 2003 (63 days), 1976 (54 days) and 1947 (51 days) characterized by strong heat waves or episodes of heat wave (1981-2010 gives an average of 32.5 summer days per year). In the Netherlands, the summer at De Bilt was with a mean temperature of 18.9°C the warmest since 1901. The summer of 2018 was exceptionally warm as well in many parts of northern Europe resulting in new records for Nordic and Baltic countries: warmest for Denmark, Finland, and Norway with anomalies (with respect to 1981-2010) of +2.0°C, +1.9°C and. +1.8°C respectively. Latvia reported its second warmest summer since 1924, when recordkeeping began. In Denmark, the summer season was record breaking warm with heat waves as well as a severe drought lasting from May to the beginning of August. Record breaking number of summer days (Tmax >25 ºC) were recorded. Summer in Estonia was very warm, sunny and drier than normal. The mean temperature of the three summer months was 17.8 °C (anomaly +1.8 °C) – 4th-5th place since 1961. In Lithuania, it was also a very warm season, by 1.9°C warmer than usual. All months were much warmer than normal: July had even +2.1°C anomaly, August +2°C anomaly, it was also warmer in June. The beginning of the meteorological summer in Lithuania (here defined by an average daily air

temperature reaching ≥15 °C), in comparison with the multi-annual data, arrived about 1–1.5 months earlier. This year, the meteorological summer throughout the country lasted on average 137 days (even 2 months longer than usually). Summer temperatures were also much warmer than average across several locations in the Arctic Circle recording maximum temperatures 30.0°C or higher. According to the World Meteorological Organization, Norway set a new national maximum temperature record when temperatures soared to 33.5°C (92.3°F) on 17 July in Badufoss. Similarly, the highest temperature of the year in Finland, 33.7°C, was recorded in Klemettilä, Vaasa, on 18 July. In Slovakia, summer 2018 (mean season temperature) 2018 was thermally exceptionally above normal (deviations more than 1.5°C compared to the normal period 1981-2010 in all the territory of Slovakia). Most meteorological stations (lowlands of west Slovakia) recorded a maximum number of summer days (e.g. in Žihárec up to 140 summer days, which is 71 more than the normal average of the period 1961-1990, respectively 57 days more than in 1981-2010, the second highest was measured in Podhájska with 139 days, which is 70 more than normal from the period 1961-1990, respectively 58 days more than in 1981-2010. In Slovenia, summer 2018 was 1.6 °C warmer than normal on national average and mostly ranking among 4 to 7 warmest on record. In the Middle East, summer temperatures were closer to normal; only Israel and southern Jordan had anomalies above +1°C (w.r.t 1981-2010).

Box 3 | Contributions by NMHS – Seasonal temperature: summer

Exceptional summer in France (Contribution from MeteoFrance)

The average summer temperature in France of 21.2 °C exceeded the normal (1981-2010) by +2°C. The summer of 2018 was ranked second warmest, far behind 2003 (+3.2 °C) but ahead of 2017 (+1.5 °C). After a first heat wave from 24 to 27 July, that mainly affected northern France, a second peak affected the entire country from July 30 to August 8, including the south-east quarter where the maximum exceeded 40 °C on 4th of August with 41.3 °C in Beziers (Herault), a new monthly record. These heat waves caused about 150 0 deaths according to the French Ministry of Health.

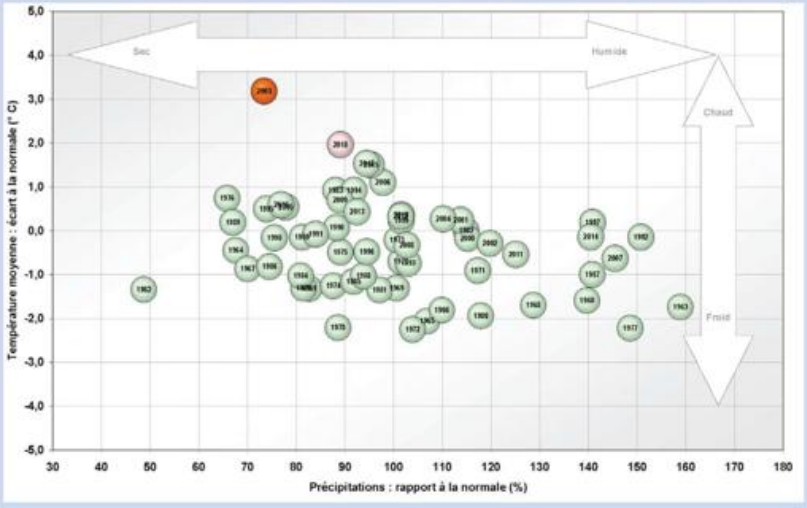


Figure 3 3: Temperature and precipitation in France for summer of 1959 - 2018 (provided by METEO-FRANCE)

Autumn temperatures in 2018 continued above normal for almost the entire RA VI region. Largest anomalies occurred again over the arctic region with anomalies up to 5°C and more. The anomaly values for the subregions were all above 1.5°C ranging from 1.51°C for central and western Europe to 2.09°C for Eastern Europe. Overall, autumn was one of the warmest on record in many countries in Central Europe: Hungary, second (+2.1°C); Switzerland, third (+1.8°C); Austria, third (+1.9°C); Belgium, third (+1.7°C); Poland, third (+1.6°C) and France, fourth (+1.2°C). Autumn was also much warmer than normal for Nordic and Baltic countries, especially in northern Norway, Finland, and Sweden, with November anomalies of +3°C to +5°C. At Summit Station on the Greenland ice cap, a new record low minimum temperature of −55.4°C for October was set on 26 October, surpassing the previous record by 0.2°C. Anomalies of 1.5°C and larger also occurred over large parts of the Balkan Peninsula: in Slovenia, autumn 2018 was on national average 2.0 °C warmer than on average in the reference period 1981–2010; in Slovakia, autumn 2018 was thermally exceptionally above normal compared to the normal period 1981-2010 with anomalies larger than 1.5°C.

3.1.3. Precipitation

Precipitation anomalies in **winter 2017/18** show normal to above-than-normal values in most parts of the RA VI region except for the southwestern parts of the Iberian Peninsula and the Middle East region as well as west Kazakhstan where partly even less than 40% of normal precipitation amounts were recorded. In Portugal, winter average precipitation was only 240.0 mm, 68 % of normal, and February was the 11th consecutive month with monthly precipitation values below the 1971-2000 normal and at the end of the month 83 % of the territory was in severe drought and 1 % in extreme drought, according to PDSI index. In Spain, winter was also dry in the south (below 60% of normal) but wet in the north (above 150%) where exposure to low-pressure systems was greater. Large surpluses of precipitation occurred as well over the Alps, along the Western coast of the Balkan Peninsula and also over France, which experienced a very wet and stormy winter, wettest winter on record even in several parts of France, along with floods especially in January. Overall, 40% surplus classifies it 3rd wettest winter since 1959. Burgundy even reported its wettest winter of the 1959–2018 period, with seasonal total anomalies ≥300 mm. Two exceptional snow fall events, 5-7 February in the North, and 26-27 February in Provence - Alpes -Cote d'Azur and Corsica. Winter was wet especially in the Balkans. Serbia and Slovenia each reported their fourth wettest winter with precipitation 160%–170% of normal. Winter was also wet in Azerbaijan which received a precipitation surplus up to 250% of normal. In Serbia, the registered number of days with snow cover was 8 to 23 days below the winter average in most of the country, apart from Kopaonik with 4 days above the winter average.

Spring 2018 was for most parts of the RA VI region the start of a very dry period. Especially in central, northern and eastern parts of Europe, precipitation amounts were below normal. The station in Visby (Sweden) reported only 38% of normal precipitation for the season, with a new low monthly record for May of only 1.7 mm of precipitation, breaking the previous record of 2.8 mm set in 1866. In Latvia, all stations measured below-average precipitation, making it the second driest spring since the beginning of the century and 12th driest since 1924. Total precipitation was less than 60% of normal, which was similar to Estonia. Above-normal precipitation amounts occurred over the Iberian Peninsula, along the Mediterranean coast in France (167 to 200 % of normal) and over Russia. In France abundant rains fell in the Mediterranean with rain amount almost double the normal. Spring

was very wet on the Iberian Peninsula. Under the dominant influence of low pressure reaching far to the south, four consecutive storms passed over the Peninsula. Consequently, in Portugal, spring of 2018 was extremely rainy with an average precipitation of 429.0 mm, which is about 200 % of normal and was the 3rd rainiest since 1931 (after 1936 and 1956). In central and northern Italy, precipitation ranged between 200% and 300% of normal, and in the cities of Lucca, Florence, Arezzo, and Livorno (all in Italy) seasonal totals were the highest since records began in 1955, locally exceeding 500 mm.

In **summer 2018** the dry conditions that started in spring continued over large parts of the RA VI region. Largest precipitation deficits occurred over Central and Western Europe (especially in Germany, Switzerland, the Czech Republic, and western Poland), over the Baltic countries, Russia and Kazakhstan with only 40-60% of normal rain (locally even larger with 20-40% of normal). Seasonal deficits were locally also large in Germany, e.g., with totals of 24% of normal or below, despite multiple low-pressure systems bringing heavy convective precipitation. The Netherlands reported one of its driest summers since records began in 1906: 105-mm precipitation received compared to its normal of 225 mm, with July the driest month observed since records began. Ireland reported its driest summer since 1962, with June and July each record dry (driest summer at Phoenix Park in Dublin since records began in 1850). In the UK; some rain gauges in southern England recorded more than 50 consecutive dry days. In Finland, dry summer kept the annual rainfall historically low at several observation stations. Particularly in the area from the western part of Finland to Sea Lapland, the annual rainfall was exceptionally low, occurring less frequently than once in 30 years. Various observation stations (in Finland) measured record low rainfall as a result of the dry summer. For example, in Merikarvia's Tuorila it only rained 425.5 mm (62%), while the typical precipitation is 683 mm. In Merikarvia, 2018 was the driest summer in the 50 years of measurement history. Many parts of Sweden also received only 40%–80% of normal precipitation for the season. At the beginning of summer, Latvia had a severe drought. For 75% of the reporting stations, the period of 4 May–20 June was the driest since 1961. Eastern Azerbaijan was also drier than normal during summer with precipitation totals as low as 20% of normal locally with only a few millimeters received in all summer months in contrast with the rest of the South Caucasus region (Georgia and Armenia), which mostly received near-normal precipitation. Much above-normal precipitation amounts were however recorded over the Italian and Balkan Peninsula and over Turkey where some parts received 200% and more of normal precipitation amounts. Summer in France was wet in the south, with Cevennes in Var and South Corsica receiving up to three times their normal, while northern and northeastern France had just 30%–60%.

Dry conditions also continued in **autumn 2018** over most parts already affected by drought, namely, central and western Europe as well as the Nordic and Baltic countries. Additionally Balkan Peninsula also only received less-than-normal precipitation. In France, persistent dryness persisted in the uppermost soil layers in the NE part from August to November (Alsace, la Lorraine and Franche-Compte). In Germany, in summer and autumn only 50 % of the usual rain amount was recorded. MeteoLux recorded for Findel, Luxembourg, only 86 mm in autumn, thus significantly lower than the normal (239 mm) at Findel-Airport, and number of precipitation days (RR≥ 0.1 mm) in autumn 2018 reached 28, thus significantly lower than the normal (48 days). Autumn was also very dry in the South Caucasus region, largely receiving only 60% to 80% of normal except for eastern Armenia. As with summer, an overall precipitation deficit was contrasted by some local records of heavy rain. Along the northern Mediterranean (e.g. Mediterranean region of France) and the western coasts of

Norway several intense rainstorms in October and November resulted in precipitation totals 1.5 to 2.5 times the normal. Several stations in Western Norway and in Nordland received from 150 to up to 200 % of the normal. A few stations in Eastern Norway and in Trøndelag received from 50 to 75 % of the normal precipitation. In Slovenia only 79 % of the precipitation fell in comparison with the average precipitation in the period 1981–2010. Also southern and eastern Spain reported above-normal precipitation while the rest of the Peninsula was near normal

Table 3-4: Seasonal rank statistics for precipitation (2017/2018) as provided by the NMHSs including countries with rankings among the top 5 (ranks 1–5) since start of the to time series.

Country	Anomaly	Reference period	Rank /Start of time series
		winter	
France	+40%		3rd wettest since 1959
Switzerland	158%	1981-2010	4th wettest since 1864
		spring	
Spain	190%	1981-2010	wettest since 1965
Estonia	-32.3mm	1981-2010	5th-6th driest since 1961
		summer	
Bulgaria	+96.4mm/155%	1961-1990	4th wettest 1930

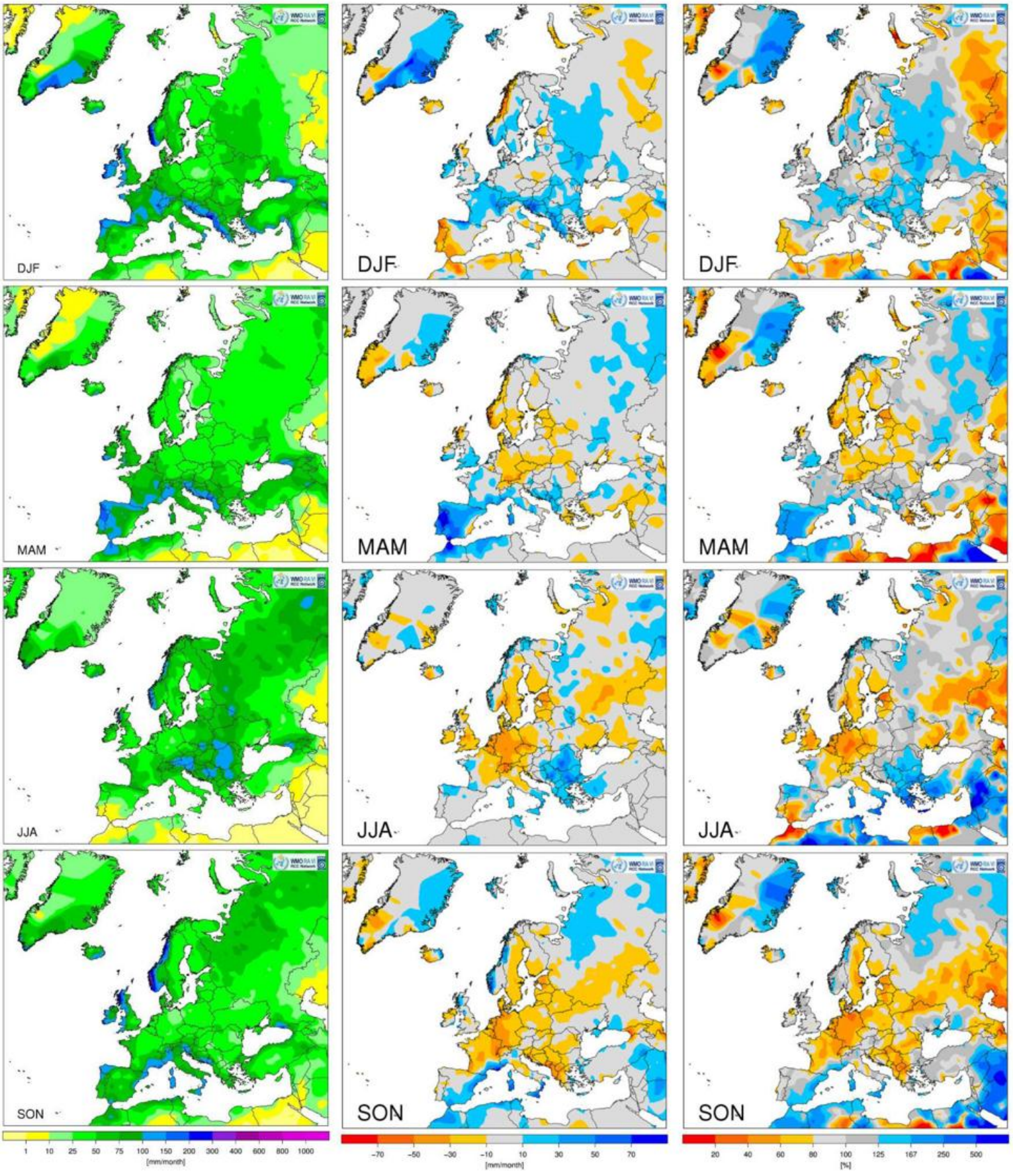


Figure 3-3: Seasonal total precipitation (left, in mm/month), absolute anomalies (middle, in mm/month) and relative anomalies (right, in % of normal) in 2017/2018, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.4. Sunshine duration

The year 2018 as a whole was exceptionally sunny with annually accumulated sunshine hours above the 90th percentile in many places of the RA VI region, especially in central, western, northern and eastern Europe (see section 2.1.5). This surplus of sunshine hours stems from seasonal surpluses in spring, summer and autumn which saw over large parts of the area 125% (summer) or even up to 150% (spring and autumn) of normal sunshine hours.

Winter 2017/18 is the only season where most parts of the RA VI region only recorded below-normal durations of sunshine (generally between 75 to 95 %). But there were also still some places which received more sunshine than normal: for example the UK, the Benelux countries as well as the Iberian peninsula, where mostly up to 125% of normal sunshine hours were recorded.

From **spring** onwards a long sunny, warm and dry period started for many places in the RA VI. Spring brought the largest surplus in terms of absolute sunshine hours to Scandinavia with a surplus of more than 200 hours and new records being set in many countries. In Lithuania, sunshine duration in most parts of the country was extremely long (358–399 hours), by 102 hours longer than the normal. The mean seasonal sunshine duration in Estonia was 774.1 hours (normal 596.5 hours) making it the second sunniest spring since 1961.

In **summer,** largest surpluses of sunshine hours were recorded in Norway with more than 200 hours. In Denmark it was the sunniest summer on record for the country as whole with more than 180 hours extra. In Estonia, the mean seasonal sunshine duration was 874.6 hours (normal 790.4 hours) - 10th sunniest since 1961.

In **autumn**, largest anomalies in sunshine hours occurred over central Europe, Russia and the Balkan Peninsula (between 100 and 200 hours more). In these regions, the surpluses correspond to percentages ranging between 125% and 150% of normal. Also in autumn, many new records were set. In the Netherlands for example, autumn 2018 was the sunniest autumn since 1901.

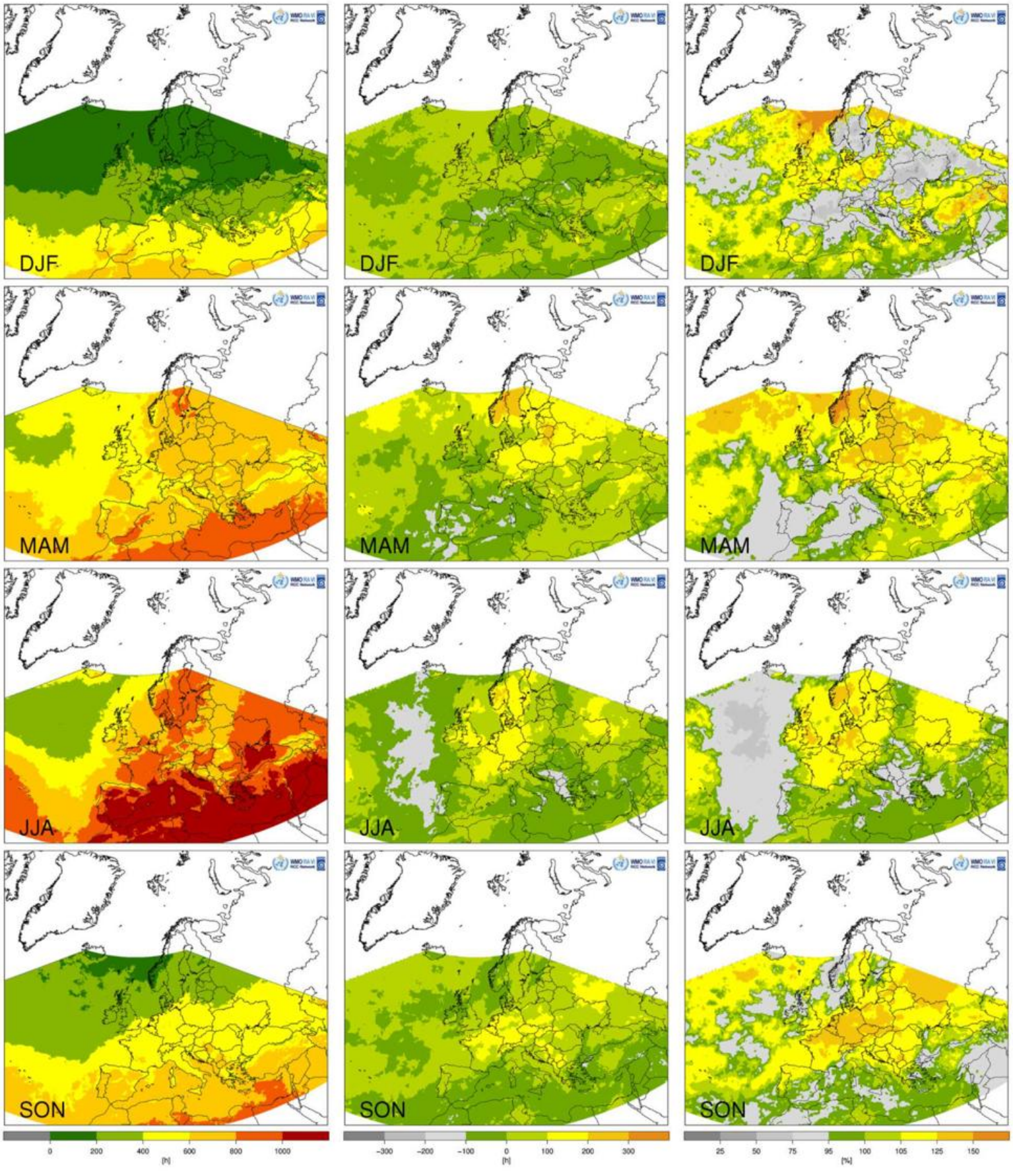


Figure 3-4: Seasonal sunshine duration (left, in hours), absolute anomalies (middle, in hours) and percentage of mean (right, in %) in 2017/18, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.5. Drought

In 2018, many countries were affected by a prolonged drought period (as mentioned in 2.1.6). The seasonal maps of the GPCC-DI (GPCC-Drought Index, Ziese et al. 2014) give a more detailed look at the situation to identify the seasons most affected by the drought conditions.

In **Winter 2017/18,** precipitation deficits were most severe in the Middle East where partly even less than 40% of normal precipitation amounts were recorded (see section 2.1.3). These are the regions for which the GPCC-DI indicates moderate drought conditions with values between -1 and -1.5. And small area affected by moderate drought is also visible in the southern part of Poland. Mild drought conditions (GPCC-DI values between 0 and -1) occurred over Western and Northern Europe, which also received less-than-normal precipitation. The rest of the RA VI region experienced mildly wet conditions

Spring was the start of an unusually long and severe drought period for many places. According to the GPCC-DI, mild drought extended in spring from Central to Northern and eastern Europe. Lowest GPCC-DI values occurred in Estonia (-1 to -1.5) indicating a moderate drought level.

In **summer,** mild drought conditions continued over Central Europe and further extended towards the West (UK, France) and South (Iberian Peninsula, Italy). Also Eastern Europe was affected again. In both regions moderate drought occurred locally (e.g. Germany, Kazakhstan). In France, rain deficits reached up to 30 - 60% in the North and North East. In Germany, in summer and autumn only 50 % of the usual rain amount was recorded. In Ireland, the summer of 2018 was one of the hottest and driest on record, with heat wave and drought conditions affecting many parts of the country. Many places had half its normal rainfall. The prolonged dry spell led to water restrictions and a fodder crisis. Drought conditions prevailed from early June until late July. The combined June and July rainfall total at Dublin (Phoenix Park) was 19,5 mm and was the lowest on record (since 1850). Summer soil moisture deficits up to 93 mm have been recorded in South and East. Apart from Latvia, where moderate drought was indicated by GPCC-DI during the summer season, heat and drought anomalies were also observed in other Baltic and Nordic countries. Thus, in August 2018 the Nordic-Baltic meteorological cooperation association (NORDMET) issued a joint statement on the weather anomalies observed in the summer of 2018, highlighting the severity of climate change in the region and the need for adaptation.

In **autumn,** mild drought conditions extended from France over Germany until Eastern Europe, in Germany still moderate conditions in some areas.

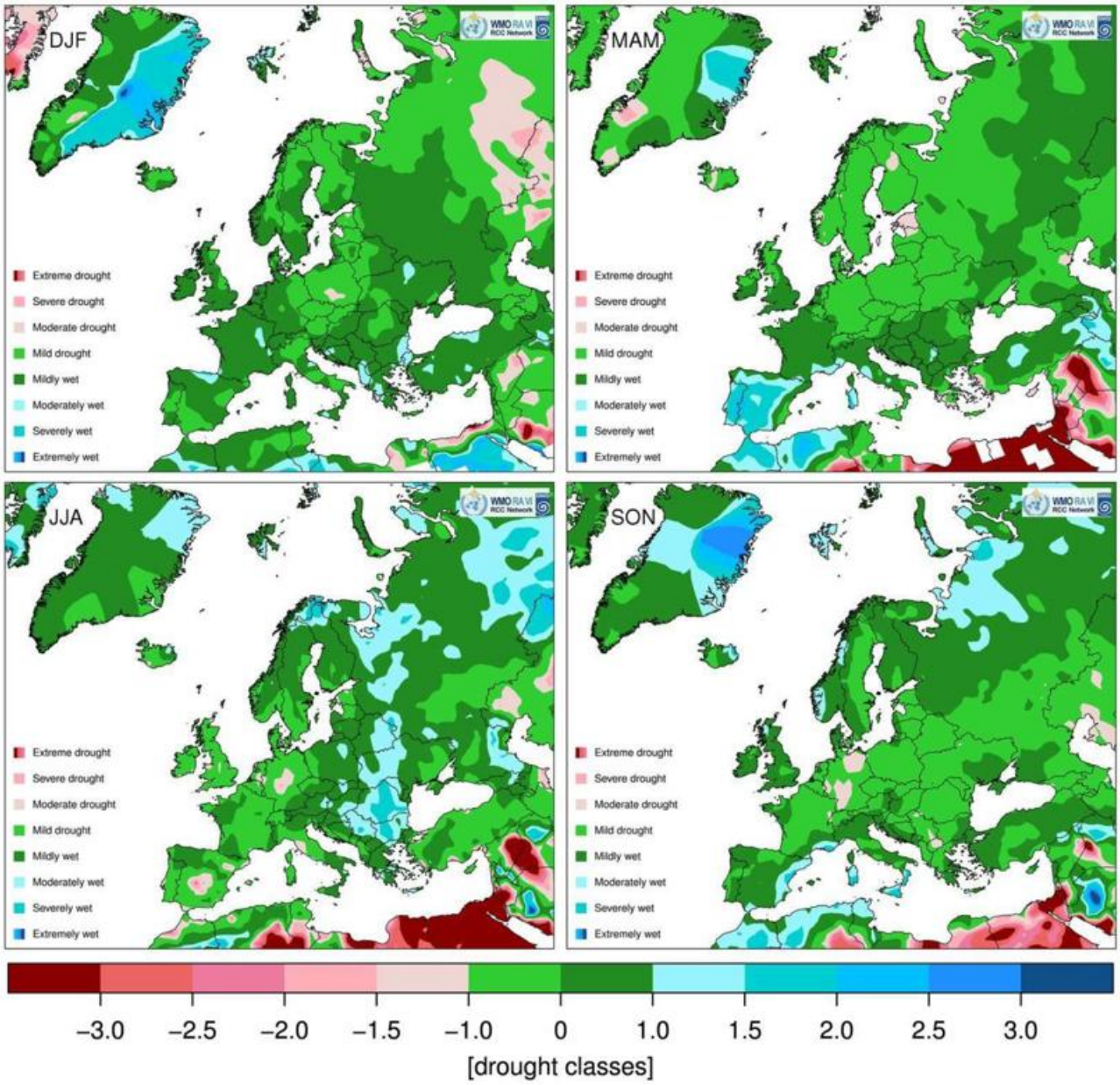


Figure 3-5: Seasonal GPCC-DI (GPCC-Drought Index, in drought classes) in 2017/2018, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

4. Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2018 on the Climate in WMO Region VI - Europe and Middle East (available on http://www.dwd.de/rcc-cm).

It contains highlights, means and anomalies of sea level pressure, temperature, precipitation and sunshine duration for each month as well as monthly overviews of extremes and notable events.

4.1. *Sea surface pressure and circulation indices*

This chapter about atmospheric circulation provides information on selected northern hemisphere teleconnection indices relevant for WMO RA VI and discusses influences of circulation patterns upon anomalies and outstanding events. The information is based on the "Monthly Bulletins on the Climate in WMO RA VI" and was completed by reports of the NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/ upper troposphere not shown here. (See http://www.ncdc.noaa.gov/teleconnections/ and http://www.cpc.ncep.noaa.gov/products/CDB/index.shtml)

Table 4-1: Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference including the Arctic Oscillation, for January to December 2018.

Year	Month	NAO	EA	EA/WR	SCA	POL	AO
2018	1	1,17	0,55	-1,62	0,44	-1,48	-0,28
2018	2	1,34	-1,38	-1,4	0,43	-2,24	0,11
2018	3	-1,38	-0,62	4,03	-0,81	0,07	-0,94
2018	4	1,2	1,13	0,49	0,32	-1,3	0,54
2018	5	2,02	-0,07	-1,45	1,69	-0,28	1,18
2018	6	1,41	-0,54	-0,24	-0,77	-0,93	0,38
2018	7	1,42	2,36	-2,16	2,27	-0,15	0,61
2018	8	2,4	1,82	-0,47	-1,05	0,01	0,84
2018	9	1,78	0,15	-1,76	-0,74	0,48	0,59
2018	10	1,53	-0,39	0,36	-1,11	-1,31	0,41
2018	11	-0,25	0,32	1,51	1,89	0,76	-1,12
2018	12	0,48	1,44	-0,43	1,35	1,54	0,11

North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

In **January**, the North Atlantic Oscillation (NAO) was only moderate with a value of 1.17 although several storms passed Europe and the Icelandic low as well as the Azores high were more intense than normal with anomalies of -6hPa for the Icelandic low and up to +8hPa and even more for the Azores high. The other circulation indices of the European sector were not well pronounced except for the East Atlantic/West Russia Pattern (EA/WR) with a value of -1.62. The negative EA/WR phase is marked by low pressure over the North Sea and high pressure over Eastern Europe.

During most of **February**, the NAO was positive but at the end of the month it became negative as a cold wave reached Europe. The monthly average of the NAO was 1.34. The Icelandic low as well

as the Azores high were again more intense than normal in the monthly pressure field. The cold spell end of February was caused by a shift in the polar vortex and the development of a strong high-pressure system over Scandinavia, extended from the Russian High, clearly visible in the anomaly map with values of +12hPa and more. This positive pressure anomaly in northern Scandinavia explains the positive phase of the Scandinavia Pattern (SCA) and the strong negative phase of the Polar/Eurasia Pattern (POL).

In **March,** the Icelandic low as well as the Azores high were both shifted to the south with the core of the Icelandic low being located south of Ireland. Both circulation indices, the NAO and the Arctic Oscillation (AO) were negative at the beginning of the month and increased to around zero at the end of March. The index with most significant impact was the EA/WR with a value of 4.03. This high value occurred for the first time since the beginning of the calculation of these indices in 1950. It resulted from significant high-pressure anomalies over Greenland/Iceland and low-pressure anomalies over western Russia, and caused inflow of cold arctic air into Europe.

In **April,** the NAO was only moderate with a value of 1.20. The Icelandic low as well as the Azores high were shifted again to the south while above normal pressure anomalies were situated above the Balkans. The East Atlantic Pattern (EA) with 1.13 was in the same order as the NAO. The EA is marked by higher pressure over the Balkans and lower pressure over the Atlantic between Iceland and Ireland.

May 2018 was dominated by high pressure over Scandinavia blocking the propagation of the intensive action centres over the North Atlantic into Europe. The anomalies in the area of the Azores high were more than +4 hPa above normal. The anomalies between Greenland and Iceland were below -12 hPa making the NAO the dominating index for the North Atlantic with a monthly value of 2.02. The other circulation indices sticking out in May, were the EA/WR with a value -1.45, which is characterized by higher pressure over western Russia and lower pressure west off the British Isles, and the positive SCA pattern (+1.69) due to the blocking high over Scandinavia.

In **June** 2018, both North Atlantic circulation centres were shifted to the north. Therefore positive pressure anomalies of more than +4 hPa occurred between Iceland and the United Kingdom and negative anomalies in the north with values below -6 hPa. In the eastern Mediterranean, below-normal pressure anomalies were observed as well. The NAO was still the dominating index for June with a monthly value of 1.41 while the other circulation indices were all below 1.

In **July** 2018, the Azores high was shifted to the north-west and the Icelandic low was more intense than usual. In northern Europe higher-than-normal pressure occurred while below-normal pressure anomalies were observed in the eastern Mediterranean. The dominant indices in July were the EA, the EA/WR and the SCA with monthly values of +2.4, -2.2 and +2.3 respectively.

In **August** 2018 the Azores high was shifted to the north again and influenced most parts of Europe. The Icelandic low was more intense than usual with a second low pressure centre located in the Barents Sea. Therefore, the NAO was the dominant index with a monthly value of +2.4 related to warm and dry conditions in Western and Central Europe due to extension of the Azores high to the continent. The second highest index was the EA with a monthly value of 1.82 related to above normal temperature in southern Europe, especially in the Balkans.

In **September** 2018 the Icelandic Low was slightly more intense than normal; its main core was shifted to the European Arctic Sea. The Azores High extended far north and was more intense than normal over Europe. As a result, a strong pressure gradient built up over the North Atlantic and southern parts of Northern Europe with cyclonic conditions over Scandinavia and prevailing high-pressure influence over the European middle latitudes. NAO and AO continued their positive phase since April (though with fluctuations on daily scale) with monthly values of 1.78 and 0.59 respectively. The Mediterranean was rather cyclonic.

In **October**, the Icelandic Low with its low pressure zone extending to the Arctic Sea was more intense than normal, while the Azores High was shifted to the north. This resulted in a strong pressure gradient between Iceland and Scotland, with Scotland and western Norway being particularly affected by a moist westerly flow. NAO and to a lesser extent also AO have been in a positive phase since April 2018 (7 successive months!), but turned to a negative phase in the last week of October 2018, leading to cold spells in parts of Europe. The middle latitudes remained most of the time in a large high-pressure zone extending from the North Atlantic to Russia, causing a continuation of mostly warm and dry weather by subsidence, even in southeastern Europe. Particularly the western Mediterranean sub-region had rather cyclonic conditions in October causing frequently heavy precipitation events.

In **November,** the Icelandic Low was very strong with pressure values more than 14 hPa below normal and relocated towards the south. The Azores High also was more intense than normal, but only slightly. As a result, a strong airflow from the North Atlantic was directed to Iberia and the Mediterranean, where much cyclonic activity took place. Another strong sea level pressure pattern was the Russian High, which extended very far into Europe with high intensity. Therefore, much of Northern, Central and Eastern Europe were under high-pressure influence most of the month with only short interruptions. NAO and AO indices were both in a neutral phase during the first two thirds, oscillating around zero. In the last third, however, both patterns turned to a negative, meridional phase, mostly with high pressure over Northern or Eastern Europe. This produced a blocking, and warm air could flow very far to the north.

In **December**, the Azores High was more intense than normal as well as the Icelandic Low, which additionally had a large extension to the south. This resulted in a stronger-than-normal westerly flow over the eastern North Atlantic bringing mild air to Europe. It was most effective on early days of the month, as reflected by a highly positive NAO phase, which turned to neutral conditions after the first ten days. Especially southwestern Europe was under high pressure influence most of the month. The Russian High advanced far to the west, up to Scandinavia, blocking the westerly flow and redirecting the warm air to northern Europe. Low-pressure anomalies occurred over south-eastern parts of RA VI due to frequent low-pressure systems passing over the Eastern Mediterranean.

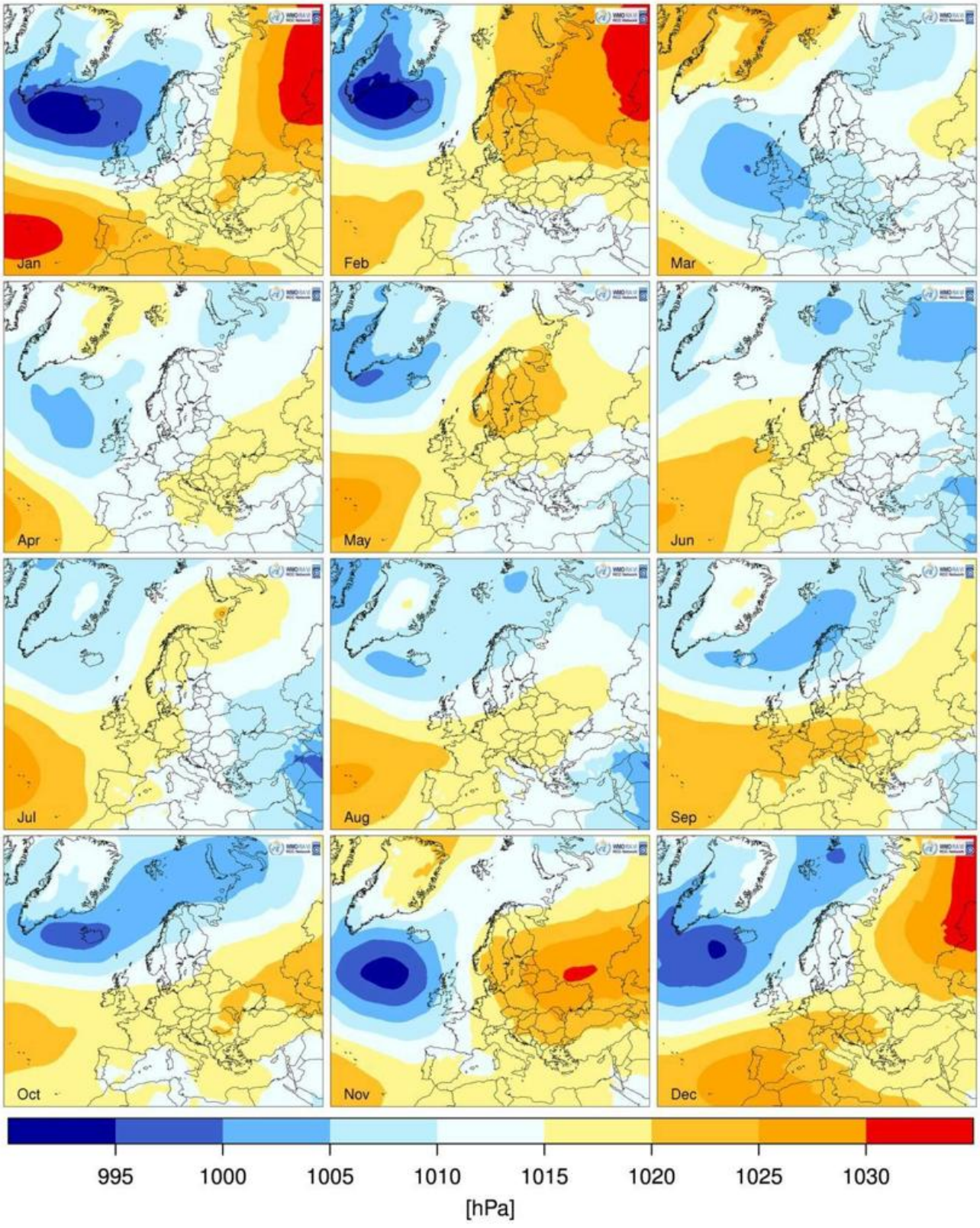


Figure 4-1: Monthly mean sea level pressure in hPa for the year 2018 (reference period 1961-1990).

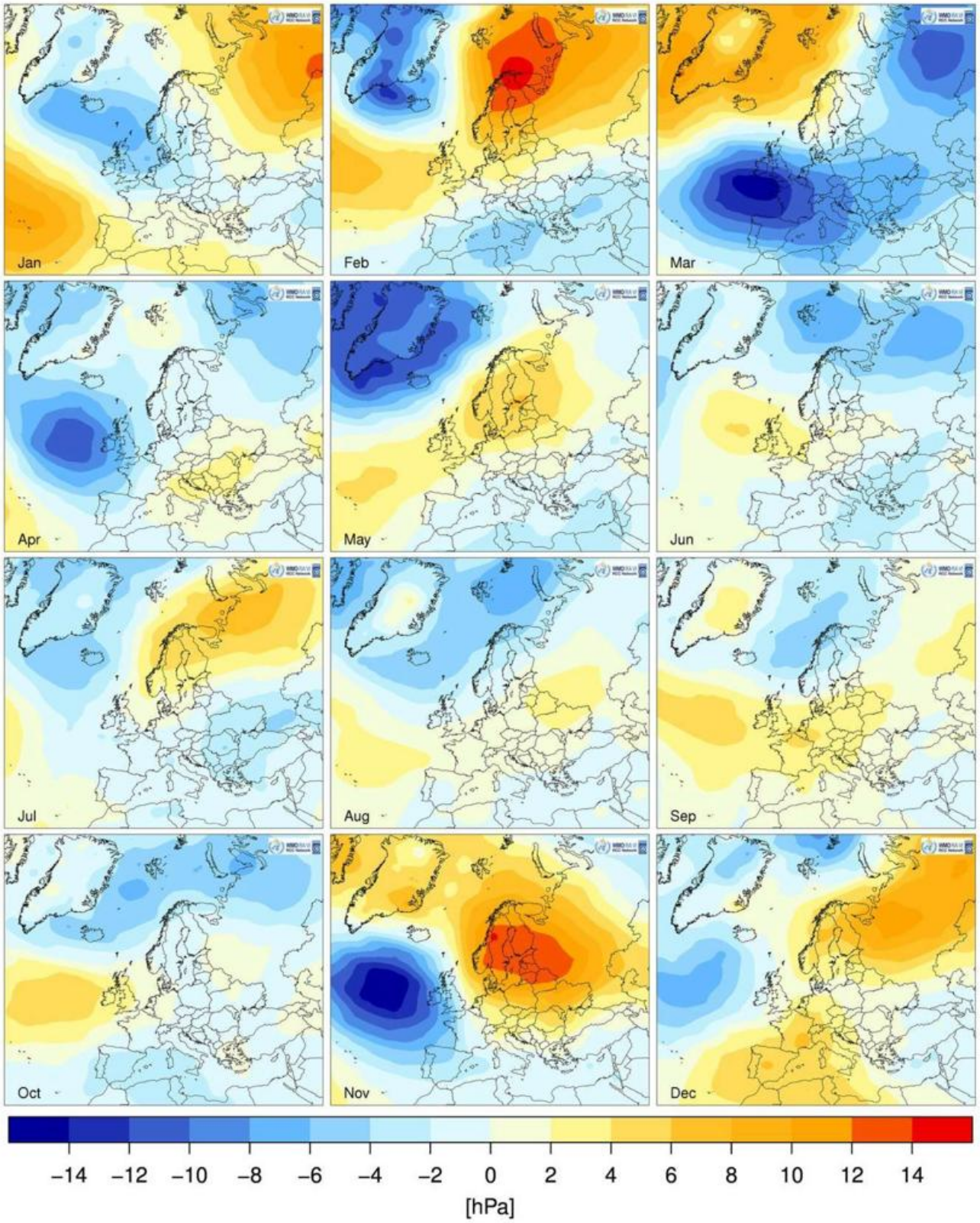


Figure 4-2: Monthly anomalies of sea level pressure in hPa for the year 2018 (reference period 1961-1990).

4.2. *Temperature*

In most of the months and sub-regions it was warmer than normal as can be seen from Table 4-2, with February and March being the only two months with temperatures below normal in some regions, namely Central and Western Europe, Iberia and Eastern Europe. Largest anomalies with anomaly values exceeding +4°C occurred in Eastern Europe in January and over Central and Western Europe as well as over the Mediterranean, Italian and Balkan Peninsula in April.

Table 4-2: Monthly and annual area average temperature anomalies in °C for each sub-region in the year 2018 (reference period: 1961-1990; definitions of the sub-regions see Figure 1-1).

Region	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Central and western Europe	1.95	3.55	-1.78	-0.87	4.08	3.11	2.48	3.02	2.86	1.64	1.45	1.45	2.38
Nordic und Baltic Countries	1.62	2.74	2.38	0.77	1.46	1.53	-0.2	1.49	1.24	1.25	1.24	2.69	2.8
Iberia	0.9	1.2	-1.38	-0.41	1.28	0.71	1.08	0.67	2.51	2.47	0.39	0.72	1.55
Med., Italian and Balkan Peninsula	1.84	2.93	0.05	0.65	4.06	2.63	1.66	1.52	2.42	1.72	2.2	1.79	0.44
Eastern Europe	1.68	4.43	0.16	-2.88	1.92	3.02	0.8	2.64	2.59	2.96	2.38	0.93	1.21
Middle East	1.83	1.69	2.95	2.64	1.13	2.45	1.29	2.35	1.14	2.08	2.5	0.34	1.37

Table 4-3: Rank statistics, monthly average temperature and anomalies (in °C) from several countries of the RA VI for the individual months 2018 including countries with rankings among the top 5 (*ranks 1–5*) since start of the to time series.

Country (station)	Monthly average temperature (°C)	Anomaly (°C)	reference period	rank
		January		
France		+3.4	1981-2010	warmest since 1900
Switzerland	0.5	+3.1	1981-2010	warmest since 1864
Austria		+3.8	1981-2010	3rd warmest since 1768
		February		
Spain	6,9	-1.6	1981-2010	6th coldest since 1965
		March		
Georgia	9.2	+3.4	1981-2010	2nd warmest since 1956
		April		
Austria		+4.7	1981-2010	2nd warmest since 1767
Romania	14.1	+4.9	1981-2010	Warmest since 1961
France	13.8	+2.7	1981-2010	3rd warmest since 1900
Switzerland	7.8	+3.9	1981-2010	2nd warmest since 1864
Bulgaria	14.5	+4.1	1961-1990	Warmest since 1930
Latvia	7.8	+2.1	1981-2010	3rd warmest since 1924
Moldova (Chisinau)	15.1	+4.7	1981-2010	Warmest since 1886

Country (station)	Monthly average temperature (°C)	Anomaly (°C)	reference period	rank
Belgium (Brussels-Ukkel)	13.0	+3,2	1981-2010	3rd warmest since 1833
		May		
UK		+2.3	1961-1990	3rd warmest since 1884
Austria		+5.7	1981-2010	warmest since 1858
Germany		+3.0		warmest since since 1881
Latvia	15.3	+3.9	1981-2010	warmest since 1924
Denmark	15.0	+3.8	1981-2010	warmest since 1874
Estonia	14.3	+4.0	1981-2010	warmest since 1961
Finland	11.6	+4.2	1981-2010	warmest since 1900
Norway		+4.4	1961-1990	warmest since 1900
Israel	25.4	+3.0	1981-2010	warmest since 1951
Switzerland	10.4	+1.9	1981-2010	5th warmest since 1864
Moldova (Chisinau)	19.4	+3.0	1981-2010	4th warmest since 1886
Romania	17.3	+2.5	1981-2010	2nd warmest since 1961
Belgium (Brussels-Ukkel)	16.3	+2.7	1981-2010	2nd warmest since 1833
		June		
United Kingdom		+2.2	1961-1990	3rd warmest since 1884
Switzerland	13.8	+2.0	1981-2010	4th warmest since 1864
Georgia	18.0	+2.7	1981-2010	warmest since 1956
		July		
Latvia	19.8	+2.4	1981-2010	3rd warmest since 1924
Estonia	19.9	+2.5	1981-2010	4th warmest since 1961
Norway		+4.3	1961-1990	warmest since 1900
Finland		+4.0	1981-2010	warmest since 1900
United Kingdom		+2.9	?	2nd warmest since 1884
Switzerland	16.2	+2.0	1982-2010	5th warmest since 1864
Georgia	24.6	+2.5	1981-2010	2nd warmest since 1956
Belgium (Brussels-Ukkel)	22.0	+3.6	1981-2010	2nd warmest since 1833
		August		
Portugal	24.5	+2.35	1971-2000	2nd warmest since 1931
Latvia	18.7	+2.2	1981-2010	5th warmest since 1924t
Estonia	18.3	+2.0	1981-2010	3rd warmest since 1961
Switzerland	15.9	+2.1	1981-2010	3rd warmest since 1864
Spain	25.6	+1.7	1981-2010	2nd warmest since 1965
		September		
Latvia	14.6	+2.9	1981-2010	2nd warmest since 1924
Estonia	14.2	+2.7	1981-2010	1st-2nd warmest since 1961
Spain	23.0	+2.4	1981-2010	warmest since 1965
Portugal	23.0	+2.78	1961-1990	warmest since 1931

Country (station)	Monthly average temperature (°C)	Anomaly (°C)	reference period	rank
(European) Russia		+2.68	1961-1990	3rd warmest since 1936
Romania	21.7	+2.1	1981-2010	2nd warmest since 1961
October				
Romania	11.6	+2.1	1981-2010	2nd warmest since 1961
November				
Norway		+3.7	1961-1990	4th warmest since 1900

January temperatures were warmer than normal over the entire RA VI region except for west Kazakhstan. In several countries new records were set or the month ended up among the five warmest on records: e.g. France, warmest at +3.4°C above normal w.r.t. 1981-2010, Switzerland (warmest since 1858; +3.1°C) and Austria (third; +3.8°C). In all subregions the monthly temperatures were much warmer than normal with anomalies ranging from +1.2°C for Iberia to +4.43°C for Eastern Europe. The latter is also the region were the overall largest anomalies were reached: over northern European Russia January temperatures were more than +6 °C above normal, mainly due to the first ten-day period, which was abnormally warm with anomalies of mean ten-day temperatures being 6-13°C. Also in several Mediterranean and Balkan countries, anomalies ranged between +3°C and +4°C (w.r.t 1981-2010). In Slovakia, for example, monthly mean temperatures for January were thermally +3.6 °C to +5 °C above normal (w.r.t 1981-2010), especially in west and east of Slovakia and in the utmost north.

After a such mild January, a significant change took place in February. Due to a high-pressure system over Scandinavia easterliy winds brought cold air from Siberia and thereby several periods of cold weather to most areas. As a consequence, **February** temperatures were well below normal across all central and western Europe (regional anomaly of -1.78°C) as well as over the Iberian Peninsula (regional anomaly of -1.38°C), Scandinavia and Baltic countries. The cold weather period lasted mostly until the first decade of March. Many countries reported anomalies between -1°C and -3°C (w.r.t 1960-1990), for example Slovakia up to −2.4°C, Switzerland –3.0°C, and Germany −2.8°C. In Luxembourg, at Findel station, monthly mean air temperatures in February decreased to -1.3°C, thus 2.9 °C below normal of the reference period 1981 to 2010. February was the coldest month of the season in the Nordic and Baltic countries with widespread anomalies of around −2.0°C, resulting in the third and fourth coldest February of the twenty-first century in Latvia and Sweden respectively. In Latvia, the cold wave lasted from end of February to early March, 13 days in total (21 February to 5 March). It was the strongest cold wave in the last 5 years. During this time, the thickest snow cover of this year was registered - 31 cm at Stende on February 26. In the last decade of February (from February 21 to February 28) the average air temperature was on average -11 °C below the norm. In Estonia, the monthly mean temperature was −6.9 °C (anomaly −2.4 °C). Especially cold was the last decade of February with new cold records were being set at some stations. The mean temperature for the country in the third decade was −13.2 °C (anomaly −9.1 °C) – the second place since 1961. The mean temperature at Tartu station in the third decade was −15.3 °C (anomaly −10.7 °C) – the 1st place since 1866. In Lithuania, the third decade of February was extremely cold as well: mean temperature fell to values between -10,5°C and -15,6 °C (even 10,7° lower than norm). During the 24 – 28 February spell, also Romania was affected by a cold wave, so

that the weather was frosty in all regions. February was also cold over the Iberian Peninsula resulting in below-average temperatures for most of Spain and slightly-below-normal for Portugal. February was the third coldest since 2000 and the ninth coldest since 1931 for Portugal. Spain reported its sixth coldest February since 1965. The southeastern part of the RA VI region on the contrary experience above normal temperatures, for example Albania, North Macedonia, Bulgaria and Turkey. In the South Caucasus and Middle East region all regions expecienced well-above normal temperatures as well. At many stations exceptionally high monthly average temperatures were reported: e.g. Lattakia (Syria) and Ma'an Airport (Jordan) stations reported February as their warmest on record. In the arctic region, February also continued warmer than normal, for example in north and northeastern Greenland (Denmark) with even new station records being set (see also box below with contribution by Contribution from Danish Meteorological Service). These warm temperatures are the reason why the regional anomaly for the Nordic and Baltic Countries regions stays positive, despite the cold temperatures over Scandinavia and the Baltic.

March was also unusually cold over western Europe, the Iberian Peninsula and eastern Europe with regional anomalies of -1.78°C (central and western Europe), -0.41°C and even -2.88°C respectively, featuring two cold waves in many countries. In other parts, however, above-normal temperature continued such as in the Middle East region with regional anomalies of +2.95°C. Israel reported its warmest March on record for the central and southern parts of the country with daily maximum temperatures +4 to +5°C above normal and daily minimum temperatures +2 to +2.5°C above normal. It was the warmest March since records began for day-time temperatures in central and southern Israel. In Azerbaijan and Georgia widespread anomalies of +4°C to +5°C (w.r.t. 1981-2010) occurred, even larger in Armenia.

April and **May** were then both very warm across the entire RA VI region with largest anomalies occurring over central and western Europe (+4.08°C) and the Balkan Peninsula (+4.06°C) in April and over southern Scandinavia in May with anomalies of more than +4°C above normal. Many new station and national records were set. Slovakia had its warmest April since records began in 1901, with temperature anomalies between +4.5°C and +6.1°C (w.r.t.1981-2010). The first summer day (Tmax ≥ 25 °C) was recorded on 9 April. Austria reported its second warmest April since records began in 1767, with +4.7°C above normal, only cooler than that recorded in April 1800 (+5.7°C above normal) and an unusually high number of summer days (temperature ≥25°C), with many regions breaking their record. Hungary had the warmest April and May (since 1901) as well, making spring 2018 as a whole the second warmest on record. Within the Mediterranean and Balkan peninsula region Malta reported a record warm April and also in Greece monthly temperature anomalies of up to +5°C and, in the northern parts, up to +7°C were recorded (w.r.t. 1981-2010). Many Greek weather stations registered the warmest April since 1960. Monthly maximum temperature anomalies were +4 to +5 °C above-normal values (1971-2000) in mainland while locally in northern parts anomalies exceeded 6-7°C. In Montenegro, the average temperature in April was the highest since the beginning of measurements anomalies (w.r.t. 1961-1990) in the range of 4.1 °C in Ulcinj (southern part of coastal region) to 6.1°C in Rozaje (eastern part of mountainous region). In the Republic of Moldova, the average monthly air temperature ranged from +14.0°C to +15.5ºC, which is +4°C to +5°C above normal and was observed for the first time over the entire observation period. The beginning of the meteorological summer (defined by average daily air temperatures above 15ºC) occurred in most of the republic's territory on 9 to 11 April, which is a month ahead of normal periods

Box 4 | Contributions by NMHSs – Temperature February

In Greenland (Denmark), winter season 2017-2018 was record setting at Kap Morris Jesup, Station Nord and Danmarkshavn in north and northeastern Greenland. February was particularly warm (up to +14.4ºC above the mean at Kap Morris Jesup. New record set at Kap Morris Jesup, Station Nord, Danmarkshavn, Daneborg and Ittoqqortoormiit. At Aputiteeq February was second warmest, only second to February 2018. Remarkable four times during February the temperatures at Kap Morris Jesup, the world's northernmost station, was above zero for shorter and longer periods due to foehn conditions, up to +6.2 ºC on February 25, which on the other hand not broke the record (+7.8 ºC) set February 11, 2011.

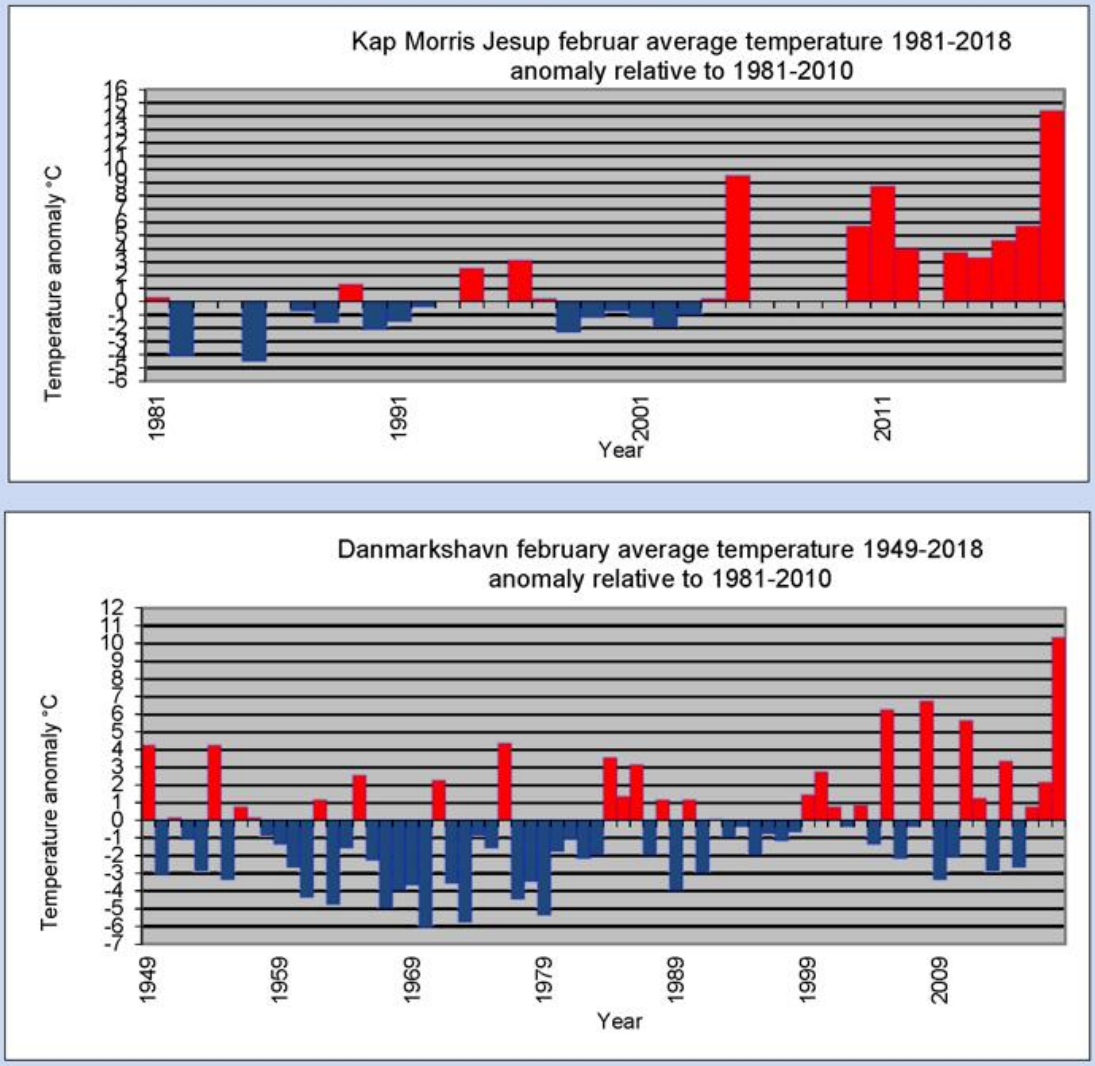


Figure 4 3: Monthly average temperature anomaly for February during 1949-2018 relative to 1981-2010 at Kap Morris (top) and Danmarkshavn (bottom).

and is observed on average once every 30 years. In Romania, the mean air temperature in April over the country as a whole was 14.1°CºC, thus +4.9ºC higher than the climatological normal (1981-2010), making the month the warmest April in the last 60 years.The largest positive deviations, above 5.5ºC, were recorded in the mountain area, the highest value, 6.0ºC being recorded at Sinaia 1500 m weather station. Serbia also had its warmest April since the measurements started, passing the

previous record from 2000 by 2 degrees basis. Record-breaking numbers of summer days were registered at 9 main meteorological stations, and the maximum daily air temperature in April was measured in Sombor.

May 2018 was the warmest on record for several countries in central and western Europe: for example in the Netherlands, Luxembourg, Austria (+5.7°C) and Germany (+3.0°C). The United Kingdom reported its second warmest May. For the region as a whole (central and western Europe) the May temperature was +3.11°C above normal. Under dominating high pressure, exceptionally high anomalies between +3°C and +4°C were also observed in the northern and Baltic states in May, with some parts of Norway and Sweden even exceeding anomalies of +5°C. It was the warmest May on record for Latvia, Lithuania, Denmark, Estonia, Finland, Norway (+4.2°C), and Sweden. Norway broke its previous record of 2013 by 1.7°C. Highest temperatures were reached in Etne outside Bergen with 32,7°C on 30 May. Record high temperatures were also recorded in May at all regular Svalbard meteorological stations in the Norwegian archipelago, including the composite series from Longyearbyen that began in 1898 where a mean temperature of 1.8°C was recorded, which is +6°C above normal. Also the other Norwegian Arctic islands experienced a warm May, the institute reports. Bjørnøya in the Barents Sea was the warmest with a mean temperature of 3.7°C. That is 5.1°C above normal. Hopen was +5°C above normal, while Jan Mayen had +5,1°C warmer than normal for May. Ny-Ålesund, further north on Spitsbergen, had a mean temperature of 1,6°C, which is +5,6°C above normal for the month. During May, lowest (coldest) minimum temperature records were broken two times at the summit on the Greenland ice cap with the final record being −46.5°C.

June was warmer than normal in most parts of the RA VI region, like the two previous months. Anomalies were a bit smaller though with regional values ranging between +0.8°C for Eastern Europe and +2.48°C for Central and Western Europe. Only northern Scandinavia and Greenland as well as parts of European Russia experienced temperatures up to -2°C colder than normal. These cooler-than-normal temperature make the Nordic and Baltic countries region the only one with a negative anomaly value in June: -0.2°C.

Due to a blocked weather pattern over Europe with a vast anticyclone over Scandinavia, many countries experienced an intense heatwave in **July** with many new records being set. Temperatures were warmer than normal over the whole RA VI region with regional anomalies ranging from +0,67°C for Iberia to +3,02°C for central and western Europe. Temperature anomalies were largest (greater than +3°C) over Scandinavia, western Europe (especially Benelux countries and northern France) as well as over the southern Caucasus region (see Figure 4-4). In Armenia, anomalies were as high as +4°C and made July 2018 become the hottest July in the entire history of observation. The heat wave was recorded from June 29 to July 12 2018, when the average daily air temperature was by + 4-7°C above normal, locally even up to +9°C. At Yerevan (Armenia), a new local maximum temperature record of 43.7°C was set on 12 July, tying with the countrywide maximum temperature set on 31 July 2011 in Meghri. Also in Kazakhstan, new temperature records (since 1936) were set at several stations: Sam (32.1°C), Fort Shevchenko (29.7°C), Beyneu (33.2°C). Temperatures were +3°C above normal in Georgia and Azerbaijan. In Norway, the monthly mean temperature was +4.3°C above normal. This is, together with 2014, the warmest July recorded in Norway, in the series that starts in 1900. Latvia saw its second heat wave during the second half of July and early August, during which around 60 new highest maximum temperature records were set: Ainažu (+ 33.7 °C) and Cape (+ 32.1°C). The heat also caused several forest and bog fires. As a result of the heat

wave, July became the 3rd warmest on record. In the Netherlands, July was the second warmest since 1901 with mean temperarature of 20,7°C and also over European Russia the monthly mean air temperature in July was +2 to +3°C above normal. The focus of heat was in the northwestern areas, and even inside the Arctic circle, in the Murmansk Region, daily air temperature rose above 30°C.

During **August,** daily minimum, average, and maximum temperatures were also exceptionally above normal throughout Europe, especially over central and eastern Europe where largest anomalies occurred ranging mostly between +3°C and +4°C, locally even above. On the regional scale, temperature anomalies were larger than 1°C for all regions ranging from +1,14°C for the Middle East to +2,86°C for central and western Europe. In Hungary, there were three severe heatwave periods in the summer that Hungary suffered between 30 July – 5 August, 7-10 August and 21-23 August, thus August was the fourth warmest month and summer the sixth warmest since 1901. In Moldova, average monthly air temperature was 21.8 to 24.7 ºC, which is + 2.5-3.5 ºC above the norm with the number of days with the maximum air temperature ≥30ºC in August was on the territory mainly 15-25 days (norm of 3-10), which in most of the territory is observed on average once every 10-30 years. This number reached even 27-30 days in places, which in August was registered for the first time in the entire period of instrumental observations. August was also very warm, with an anomaly of +1.7°C, for Spain, and Portugal reporting its second warmest August in its 88-year record (after 2003). Record-breaking temperatures were observed in both Spain and Portugal, particularly during 1–7 August when new summer records of daily minimum temperature were set at eight stations in Spain, and three of the main stations of AEMET (Spanish Meteorological Service) reported record high absolute maximum temperatures. The highest value among the Spanish main stations in 2018 was 45.1°C in Cordoba on 4 August. In mainland Portugal, 4 August was the hottest day of the twenty-first century, with a daily maximum of 46.8°C in Alvega. In Portugal, it was the secondwarmest

August since 1931 (highest in 2003), with an anomaly of +2.35 °C above normal (w.r.t. 1971-2000). During the period from 1 to 6 of August, a heat wave occurred that covered almost the whole territory, except coastal areas and some areas of northern inner region. Maximum air temperature values (mainland mean) were above 40 °C on three consecutive days (40.1 °C, 40.9 °C and 41.6 °C, respectively on August 2, 3 and 4) exceeding the absolute extremes of maximum air temperature in at more than 40 % of stations, and at 25 % of stations the highest values of minimum air temperature were exceeded.

September was again a very warm month, the warmest September on record for Europe according to data published by the NOAA National Centers for Environmental Information (https://www.ncdc.noaa.gov/cag/). with an anomalies of 2.11°C relative to 1910-2000. In September largest anomalies occurred over Western Russia and adjacent countries to the west (e.g. Baltic countries) as well as over the Iberian Peninsula with anomalies up to +4°C and locally even higher. This is also reflected in the regional anomalies with the highest anomaly found over Eastern Europe with +2.96°C and Iberia (+2.47°C). Latvia reported its second warmest September since 1934, with a mean of 14.6°C. For the first time, a temperature of 30°C was observed during the second half of the month in the country. Finland observed temperatures exceeding 20°C after the middle of the month. Spain and Portugal reported their warmest September with an anomaly of +2.4°C and +2.78°C above normal respectivly. Additional new records were set at Santiago de Compostela (Lavacolla) and Reus Airport on 2 and 3 September, respectively, with the highest daily minimum

temperatures of autumn since records began. At Coruña Station, a new record maximum temperature of 31.9°C was recorded on 2 September. At some Portuguese stations (inner Centre and South region) the number of hot days was about 2 to 3 times the average value.

The main part of Europe was dominated by high pressure weather in **October** and average temperatures were therefore above normal in largest parts of the RA VI region, this time especially over the Balkan Peninsula and the southern part of Euopean Russia with anomalies up to +3°C above normal. Largest regional anomalies are found therefore over the Mediterranean, Italtian and Balkan Peninsula (+2.2°C), Eastern Europe (2.38°C) as also over the Middle East (2.5°C). Bosnia and Herzegovina and Serbia observed their warmest and third warmest October on record respectivly. In Romania, the mean all-country air temperature (11.6ºC) exceeded by +2.1ºC the climatological normal (1981–2010) making it the second warmest on record. Over Central Europe, anomalies were between +1.0°C and +2.0°C. A new record was set in Locarno-Monti, Switzerland, which reported a high temperature of 30.5°C on 24 October.

November brought exceptionally warm and dry weather to northern Scandinavia. This time temperatures were also above normal over Greenland, which made the Nordic and Baltic countries region the one with the highest anomaly (+2.69°C). In Norway, Finnmarksvidda and the mountains in southern Norway had deviations of +6°C to +8°C above the normal. Several stations with long series in Troms and Finnmark set a record for the highest monthly temperature. Vardø, with measurements back to 1829, beat the old record from 1967. Below-normal temperatures were observed over Eastern Europe and western Kazakhstan.

The winter continued warmer than normal with daily minimum, average, and maximum temperatures in **December** exceptionally above average, particularly in Western and Central Europe and the Nordic countries. On the regional scale these two regions had the highest anomalies with values of +2.38°C (central and western Europe) and +2.8°C (Nordic and Baltic countries).

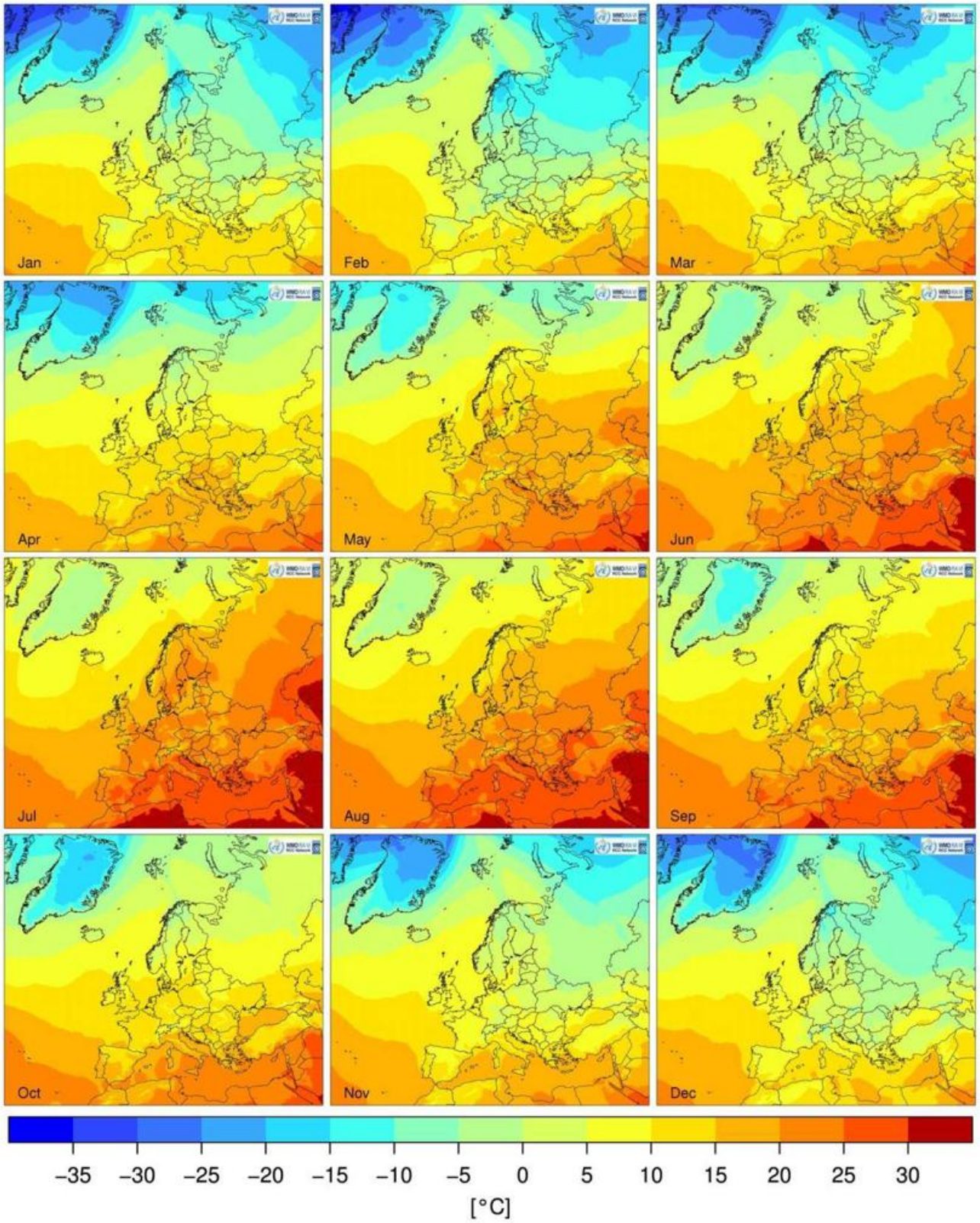


Figure 4-3: Monthly mean temperature (in °C) for the year 2018.

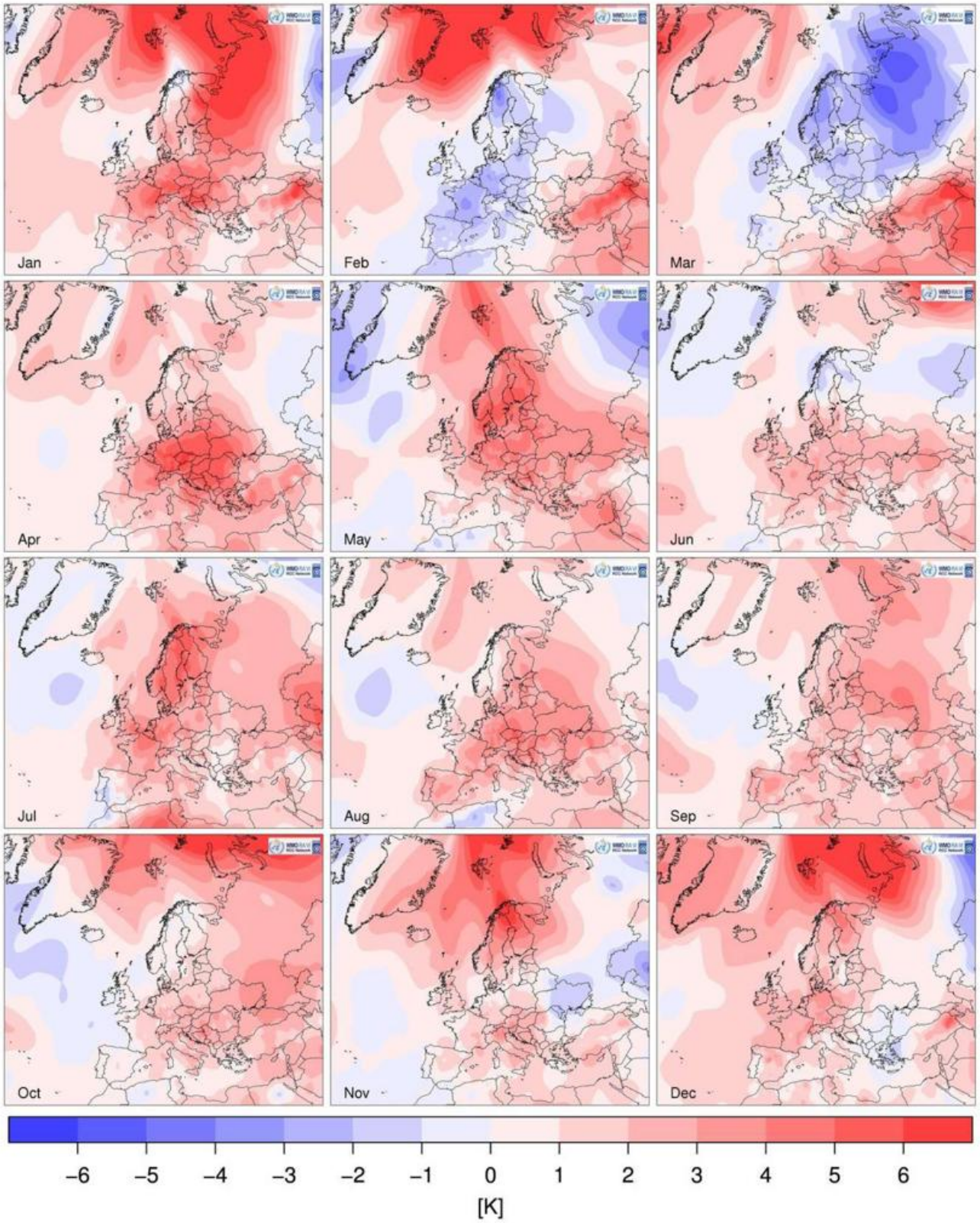


Figure 4-4: Monthly anomalies of temperature (in °C) for the year 2018 (reference period: 1961-1990).

4.3. *Precipitation*

January was wetter than normal over most of central and western as well as over the Nordic and Baltic countries, except for Estonia, which only received 70% of normal. With multiple storms passing over Europe, northern Germany received 125% to 167% of normal precipitation while southwestern Germany, Switzerland and northern France received even up to 250%. Over the Middle East it was also wetter than normal: In Israel, it was especially rainy in northern Israel where monthly totals were 250-350 mm, which is twice the monthly normal. A prolonged precipitation event occurred on January 22nd-27th with totals of 100-160 mm in northern Israel and the Coastal Plain and 30-50 mm in the Judean Mountains. Due to significant rainfall intensities on January 25th and 26th, flooding occurred in several places, e.g. in the coastal cities of Hadera and Netanya. January was on the other hand drier than normal over the Italian and Balkan Peninsula with Italy, Greece, North Macedonia, and Bulgaria reporting precipitation totals as low as 60% of normal. Portugal recorded a precipitation deficit of -76.5 mm (which corresponds 65 % of normal). At the end of the month 56 % of the territory was in severe drought, 40% in moderate drought and 4% in slightly drought, according to PDSI index.

In **February,** a high-pressure system over Scandinavia brought cold, dry air from the east, making the month drier than normal for Western Europe (France, BeNeLux, and the United Kingdom) and over Central Europe. Germany, Poland (totals below 20% of normal for eastern Germany and western Poland), the Czech Republic, and Switzerland were exceptionally dry. Saxony (Germany) reported its driest February since 1881, when records began. February was also very dry in the Nordic and Baltic countries: precipitation totals were <20% of normal in northern Norway and Sweden as well as in many parts of Finland. Latvia reported its third driest February in the twenty-first century. Portugal only received 65% of normal precipitation. By the end of the month, 84 % of the territory was in severe and extreme drought, according to PDSI index. Conversely, Pituffik (Greenland) experienced a record wet winter. The station Ittoqqortoormiit (Greenland) reported winter as their its third wettest in history. February was the wettest winter month in the Balkans, Italy, and Greece with precipitation totals ranging between 167% and 250% over large parts. February was also unusually wet over parts of Eastern Europe: At the Bucharest–Băneasa, Bucharest–Afumaţi, Brăila, and Stolnici stations in Romania, February precipitation records were broken, and at the station in Urziceni, Romania, a new 24-h precipitation record was set.

In **March** precipitation was much above (75-90 percentile range) or exceptionally above (>90 percentile range) the 1981-2010 average in Southern and Eastern Europe. In Bulgaria, March was very wet with average precipitation about 2.4 times more than normal (343% in Karnobat, Burgas district; 340% in Novachene, Pleven district). In Montenegro, precipitation in March 2018 was highest on record (?) in Herceg Novi (northern part of coastal region), and the second in rank for many parts of the country. In the Republic of Moldova, the amount of precipitation of the month at 65% of the territory was 75-120 mm (270-400% of the norm), which is observed on average once in 20-30 years in March, and isolated - for the first time over the entire observation period. The rest of the territory received 45-70 mm (150-260% of the norm). Over European Russia, in March, a vast over-wetting zone covered southern and eastern regions, where monthly precipitation norm was exceeded two- to threefold, and in individual regions of North Caucasus, by the factor of 3.5-4. In Serbia, it was the second wettest March since … with a record-breaking number of days with precipitation at 8 main meteorological stations. In Portugal, March was extremely wet with monthly precipitation amount of

272.1 mm, which was about 4 times the monthly average, being the second rainiest March since 1931 (rainiest in 2001). In some meteorological stations it was the rainiest March since the beginning of the respective time series. By the end of March, meteorological drought that occurred in mainland Portugal ended. March was also wetter than normal over almost the whole Iberian Peninsula, showing widespread precipitation values well above 250% of normal. Penhas Douradas in Portugal reported a record 585 mm of precipitation, the most rain received since 1968 (516 mm). It was the second wettest March in Portugal. Spring started also wet for Romania, Moldova, Ukraine, the southern parts of European Russia, and west Kazakhstan, with March precipitation totals 170% of normal. In eastern, central, and southern Ukraine, new monthly precipitation records were set (observations starting in 1961), at 250% to 450% of normal. In Romania, six weather stations reported new monthly total precipitation records, and four stations set new records for maximum 24-h precipitation totals in March. During March, also southern England and France received up to 170% of normal precipitation. France reported one of its wettest Marches of the 1959–2018 record, especially in Provence-Alpes-Côte d'Azur and Corsica, where it was the second wettest March following 2013.Slovakia and southern Austria, too, received up to 170% of normal precipitation while below-average precipitation continued across many parts of Germany, Poland as well as over the Nordic and Baltic countries. In the Middle East region, March was very dry as well, with either no rain or only a few millimetres across large parts of Syria, Israel, and Jordan, which was unusual for that time of year. In Israel, in the northern mountains, rainfall amounts in March were only 15-35 mm compared to an average of 70-110 mm and in central Israel only 5-15 mm (the average being 50-100 mm).

In **April,** southern central Europe, the Mediterranean, Italian and Balkan Peninsula as well as parts of Eastern Europe observed below-average precipitation (20%–60%, locally even less) while Northern, Central and Western Europe, the Iberian Peninsula and western Russia were wetter than normal (locally up to 250%). The deficit in Greece during April was exceptional—with little to no rain reported at many stations. In Bulgaria, April was the driest month of the year / on record (?) (on average 27% of the normal). In Montenegro, monthly precipitation sum was below the climatological mean for the period 1961-1990, and mostly in the classes dry, very dry and normal, expressed in % from climatological mean 1961-1990, the amount of precipitation ranged from 11% in Ulcinj (southern part) to 73% in Rozaje (eastern part of mountainous region). In the Republic of Moldova, the amount of precipitation of the month for 80% of the territory did not exceed 1-7 mm (5-15% of the norm). In Romania, the mean monthly precipitation amount countrywide was 19.7mm, 61% less than the climatological normal (1981–2010). The South Caucasus region was also affected by dryness around the Black Sea with precipitation totals as low as 60%-80% of normal. In the northern part of Norway, a few stations in Troms and Finnmark received from 30 to 50 % of the normal while in the rest of the country normal or above-normal amount of precipitation was recorded.

A dominant high-pressure system developed over Scandinavia in **May** and caused below or exceptionally below-average precipitation sums in many parts of Eastern, Western and Central Europe as over the Nordic and Baltic states where only 40%–60% of normal precipitation was observed, in Southwest Russia and Kazakhstan even less. The Novy Ushtogan Station in Kazakhstan set a local record for low precipitation with no measured precipitation at all. In European Russia, the Low Volga region also recorded a significant precipitation deficit (less than 40% of monthly norm) with some of the meteorological stations (e.g. Elton) not registering any precipitation

Box 5 | Contributions by NMHSs – Precipitation April

Intense rainfall event over Israel (Contribution from the Meteorological Service of Israel)

A major weather event occurred on April 25-27th featuring intense rainfall, severe hail, thunderstorms and heavy wind gusts. Flash floods resulted in casualties.

The synoptic situation: An upper-level low which was located over the Sinai Peninsula on April 25th and moved slowly to the east, accompanied by a low-level trough with warm and humid air. This resulted in severe atmospheric instability and the creation of well-developed Cumulonimbus clouds (see figure below). These clouds affected various regions in Israel on April 25th-26th and to a lesser extent on April 27th. They caused very intensive rainfall, mainly for short periods of 10-15 minutes over widespread areas in the country. Many stations received more than 15 mm within 10 minutes and some more than 20 mm (in Hafez Haim, southern Coastal Plain, 24 mm within 10 minutes were measured on April 25th, in Tel Aviv 22 mm (in 10 minutes) fell on the same day and in Eden Farm, north east Israel, 20 mm were measured within 10 minutes on April 26th). The rainfall intensities are considered rare to exceptional in many areas and in a few places they were unprecedented (return periods of more than 100 years).

Flash floods hit Israel due to the intensive rains, on 25 and 26 April, especially in the arid zones of the Judean Desert, the Arava and the Negev. The flash floods caused at least 13 deaths. Additionally, the rainfall, the hail and the strong winds that accompanied the well-developed Cumulonimbus clouds also resulted in property damage. Agricultural infrastructure was damaged in northern Israel and several cities (Jerusalem, Tel Aviv, Rishon LeZion) experienced flooding with road closures and traffic jams.

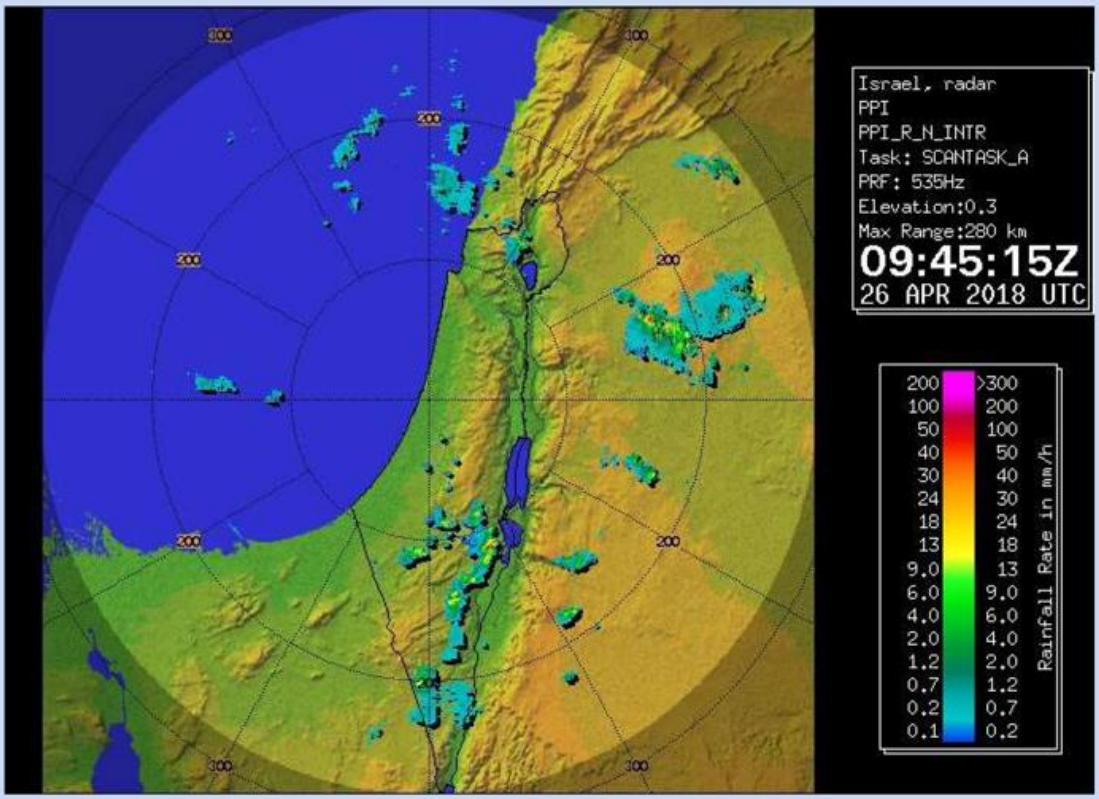


Figure 4-5: Radar images of Israel (PPI basic scan) on 26/04/2018, 09:45 UTC (12:45 LT). The arrow indicates the area near Zafit Stream where the the flash floods with casualties occurred as a result of rapid development of Cumulonimbus clouds (Source: Israel Meteorological Service)

at all. A rainless May was also recorded in the Crimea. In the Republic of Moldova, the amount of precipitation of the month for 75% of the territory of the republic did not exceed 10-35 mm (20-75% of the norm). In Norway, the monthly precipitation was 70 % of the normal. Several stations in Southern Norway received below 50 % of the normal precipitation. In Portugal, May was very dry ith only 54% of normal. However, severe thunderstorms caused large spatial differences in precipitation amounts and locally even exceptionally above average rainfall. Portions of France, Italy and Turkey as well as the Middle East region received above-normal precipitation.

Many parts of Europe were drier than normal in **June,** especially in Western and Central Europe, the Baltic countries as well as European Russia and Western Kazakhstan. In Lithuania, June was very dry receiving only 42 % of normal precipitation. In European Russia, the Volga region received precipitation that is 40% below monthly norm (thus significant precipitation deficit). A particularly serious problem of moisture deficit was experienced in the Low Volga region (which also experienced sign. precipitation deficit in May), Kalmykia and the Rostov Region, where monthly precipitation total was as low as 3-7% of normal. In the third decade, southern regions faced soil drought accompanied by strong dry winds. In contrast to these dry regions, it was very wet over the southeastern part of the RA VI region: multiple cyclones crossed southern Italy and the southeastern Balkans, bringing heavy precipitation accompanied by thunderstorms and hail. For example in Greece, almost all stations registered monthly total precipitation of more than 200 % of the normal values (1971-2000), some stations reaching multiples of their monthly normals in only a few days. For example, on 26 and 27 June, Argostoli received 83.5 mm of precipitation, which is 12 times its monthly normal. In Portugal, June was also very rainy: average precipitation in June was above normal (150 %), being the second rainiest since 2000 (after 2007). In Romania, the mean precipitation amount across the country in June was 155.9 mm, 84% more than the climatological normal (1981 – 2010). The monthly precipitation amounts in June were higher than 100 mm in most of the country's areas. The largest amounts, larger than 150 mm, were mainly recorded in the hill and mountain areas. At seven weather stations (four in Wallachia, two in Transylvania and one in northern Moldavia) departures of the precipitation amounts were recorded higher than 200%, with a peak of 257% at Turnu Măgurele weather station. At 11 weather stations from the centre and west of the country the corresponding absolute monthly maximum precipitation amounts were exceeded.

The exceptionally high-pressure anomalies in **July** also resulted in an intensification of the drought conditions in large parts of central and northern Europe. Norway had its second driest July since national records began in 1900, receiving only 55% of its normal July precipitation total. July 1901 is the driest July on record with 50% of normal precipitation. Wetter-than- normal conditions occurred, however, over the Balkans and adjacent eastern European countries such as Romania, Ukraine and Moldova. Exceptional precipitation totals were recorded at stations in the Ukraine districts of Ternopil, Chernivtsi, Ivano-Frankivsk, and Zaporizhzhya: 200%–360% above normal. In the districts of Zaporizhzhya and Kherson, new daily maximum rainfall records were set. Also in July, five stations in Romania exceeded previous monthly precipitation totals, and two stations set new records for 24-h precipitation.

August was drier than normal over large parts of the RA VI region with largest deficits over the Iberian Peninsula, central Europe (Germany and Poland) and eastern Europe ranging between 20% and 40% of normal. Eastern Ukraine and Moldova even received less than 20% of normal. In Romania, the mean monthly precipitation amount for August at country level was 34.2 mm, 47% less

than the climatological normal (1981 – 2010). Above-average precipitation amounts occurred only over Norway and in the Mediterranean region.

September was over large parts of the RA VI area drier than normal. Especially the parts of Europe within persisting high pressure influence were very dry, such as western Iberia, much of France, parts of Central Europe and the Balkans. Less than 20% of normal precipitation was registered locally. In Portugal, it was not only the warmest but also the driest September of the last 87 years in mainland Portugal, with a total precipitation of only 2.0 mm, about 5% of average value. Many parts of northern Spain received less than 50% of normal. September was also very dry in the Balkans. Ulcinj (Montenegro) and Vranje (Serbia) stations, each observed a monthly precipitation total of only 1 mm, making it the driest September on record at both stations. Serbia reported its third driest October and Bulgaria its second driest, with precipitation <20% of normal. In Moldova, the amount of precipitation of the month on 55% of the territory was 20-35 mm (35-70% of the norm). In Romania, the mean monthly precipitation amount (26.1 mm) was 52% less than the climatological normal (1981 – 2010). September 2018 was France's third driest September since the start of the record in 1959, following 1977 and 1985. In Norway, on the other hand, September was among the wettest such months since 1900 (tying with the Septembers of 1931, 1975, and 1982) with a monthly precipitation total of 150 % of the normal. A few stations in Western Norway recorded 300 to 400 % of the normal.

October was wetter than normal over northern Italy, eastern parts of Spain and southern France with most of the precipitation falling during intense and often stormy events. For example, during 18–19 October, a 1-h total of more than 150 mm was registered in Vinarós (Castellón) and on 20–21 October, a 24-h total of 335 mm (including 118 mm in 1 hour) was recorded in Alpandeire (Málaga). Over large parts of the Balkans very dry conditions dominated in October with deficits up to 20% to 40% of normal. October was also very dry in parts of Eastern Europe, e.g. in Romania, eastern Ukraine, and Moldova, with the latter mostly receiving only 5%–30% of normal. At Fort-Shevchenko Station, it was the driest autumn since 1937.

November was drier than normal over large parts of Central, Northern and Eastern Europe with locally only 20% of normal precipitation. In Lithuania, November was exceptionally dry with only 33 % of the norm. In Norway, the monthly precipitation was 85 % of the normal, but many stations in Western Norway and Trøndelag recorded less than 25% of the normal. In Poland only 32 % of normal precipitation w.r.t. 1981-2010 was recorded. Latvia observed its fourth driest November since 1924, with only 19.2 mm of precipitation (31% of normal).

The year ended with above-average precipitation in **December** for most of central Europe, parts of Eastern Europe (Belarus, Ukraine and Romania) and Turkey, terminating the drought of the previous two seasons in many areas. In Norway, the monthly precipitation was close to normal, however, a few stations in Eastern Norway and Southern Norway received 200-300% of the normal. Several stations in Western Norway recorded less than 50 % of the normal precipitation. In Poland, a precipitation anomaly of 147% was recorded for December w.r.t. 1981-2010. December was also very wet in the Middle East region, especially in Cyprus, along the Mediterranean coast, and northern Syria, due to frequent cyclonic activity over the eastern Mediterranean. Monthly precipitation totals were more than 200mm along the coast of northern Syria, and anomalies were +70mm or more over these areas, with some localized monthly totals up to above 500% of normal. In Israel, December was very rainy in northern and central Israel with monthly totals of 250-350 mm which is 1.5-3 times

the monthly average. In Southern Europe, Croatia and Slovenia, and parts of Northern Europe, on the contrary, precipitation was (much or exceptionally) below average.

Box 6 | Contributions by NMHSs – Precipitation October

Intense and persistent precipitation over Italy (Contribution from the Italian Meteorological Service)

From 27th-30th October intense and persistent precipitation occurred over the whole region (as part of a system extended to a great fraction of the national territory). Maximum cumulated precipitation over the event: 340,4 mm recorded at Casoni di S.Maria di Taro (PR, 853 m asl). At the highest areas of the basin of the Trebbia river, mostly included in Emilia-Romagna, maximum precipitation totals of 620.4 mm and 567.4 mm were recorded at Torriglia (GE, 769 m asl) and Cabanne (GE, 848 m asl). Over the Taro basin return periods for precipitation intensities cumulated over 3h were locally greater than 100 years values at Bardi (66.2 mm) and Noveglia (75.6 mm), precipitation intensities over 6h were locally greater than 200-year data at Bardi (93.6 mm) and Noveglia (108.8 mm), and greater than 100-year values at Valdena (134.8 mm), precipitation intensities cumulated over 12h and 24h were greater than 50-year values at Bardi (105.4 and 132.0 mm) and Noveglia (75.6122.8 and 148.0 mm). In these days, the winds were very intense with gusts reaching 38.3 m/s at Loiano (BO, 741 m asl), 37.7 m/s at Varsi (PR, 451 m asl) and 33.1 m/s at Teruzzi (PC, 1077 m asl) associated with an intense coastal storm with 4m waves producing significant coastal erosion along the sea shore. In Figure 4-7 shows the precipitation rate at two instants on the 29th of October when the cold front was sweeping the western part of Italy.

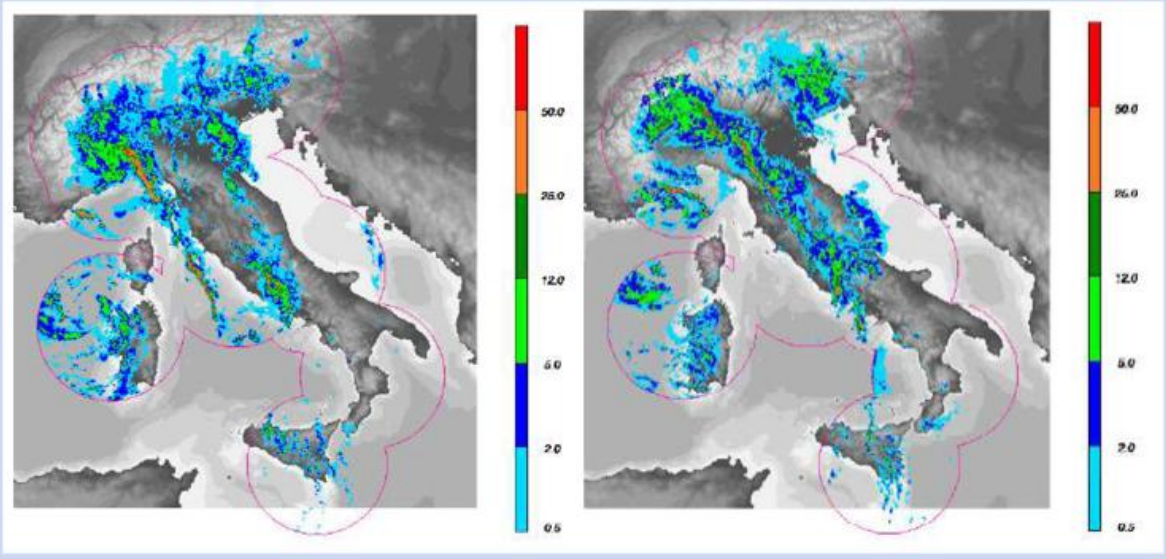


Figure 4-6: National radar composite of precipitation rate (mm/h) on the 29th October 2019 at 13:30 UTC (left) and at 15 UTC (right) (Courtesy of the National Civil Protection Agency).

Table 4-4: Rank statistics, monthly average precipitation (mm) and anomalies (mm or %) from several countries of the RA VI for the individual months in 2018 including countries with rankings among the top 5 (*ranks 1–5*) since start of the to time series.

Country (station)	Monthly average precipitation (mm)	Anomaly (mm or %)	reference period	rank
		January		
Switzerland	196	236%	1981-2010	wettest since 1901
		February		
Bulgaria	99.1	+53.3mm/ 216%	1961-1990	3rd wettest since 1930
		March		
Bulgaria	103.8	+57.1mm/ 222%		2nd wettest since 1930
Moldova (Chisinau)	103	294mm		2nd wettest since 1891
Spain	171	363%	1981-2010	wettest since 1965
Romania	70.3	+32.6 mm// +87%	1981-2010	4th wettest since 1961
		April		
Georgia	42	-35mm/55%	1981-2010	3rd driest since 1956
Moldova (Chisinau)	4	10mm	1982-2010	3rd driest since 1891
		June		
Switzerland	71	53% of normal	1981-2010	5th driest since 1901
Bulgaria	128	+55.1mm/ 176%	1961-1990	3rd wettest since 1939
Romania	155.9	71.4mm/ +84%	1981-2010	2nd wettest since 1961
Belgium (Brussels-Ukkel)	15.8	-56.0mm	1981-2010	3rd driest since 1833
		July		
Norway		53% of normal		2nd driest since 1900
Bulgaria	120	+64.5mm/ 216%	1961-1990	2nd wettest since 1930
		August		
Norway		161%		2nd wettest since 1900
Moldova (Chisinau)	1	2mm	1891	driest since 1891
Estonia	25.4	-46.6mm	1981-2010	4th driest since 1961
		September		
Norway		152%	1961-1990	wettest since 1900
		October		
Moldova (Chisinau)	2	5mm	1981-2010	3rd driest since 1891
		November		
Estonia	23,6	-39,4	1981-2010	2nd driest since 1961

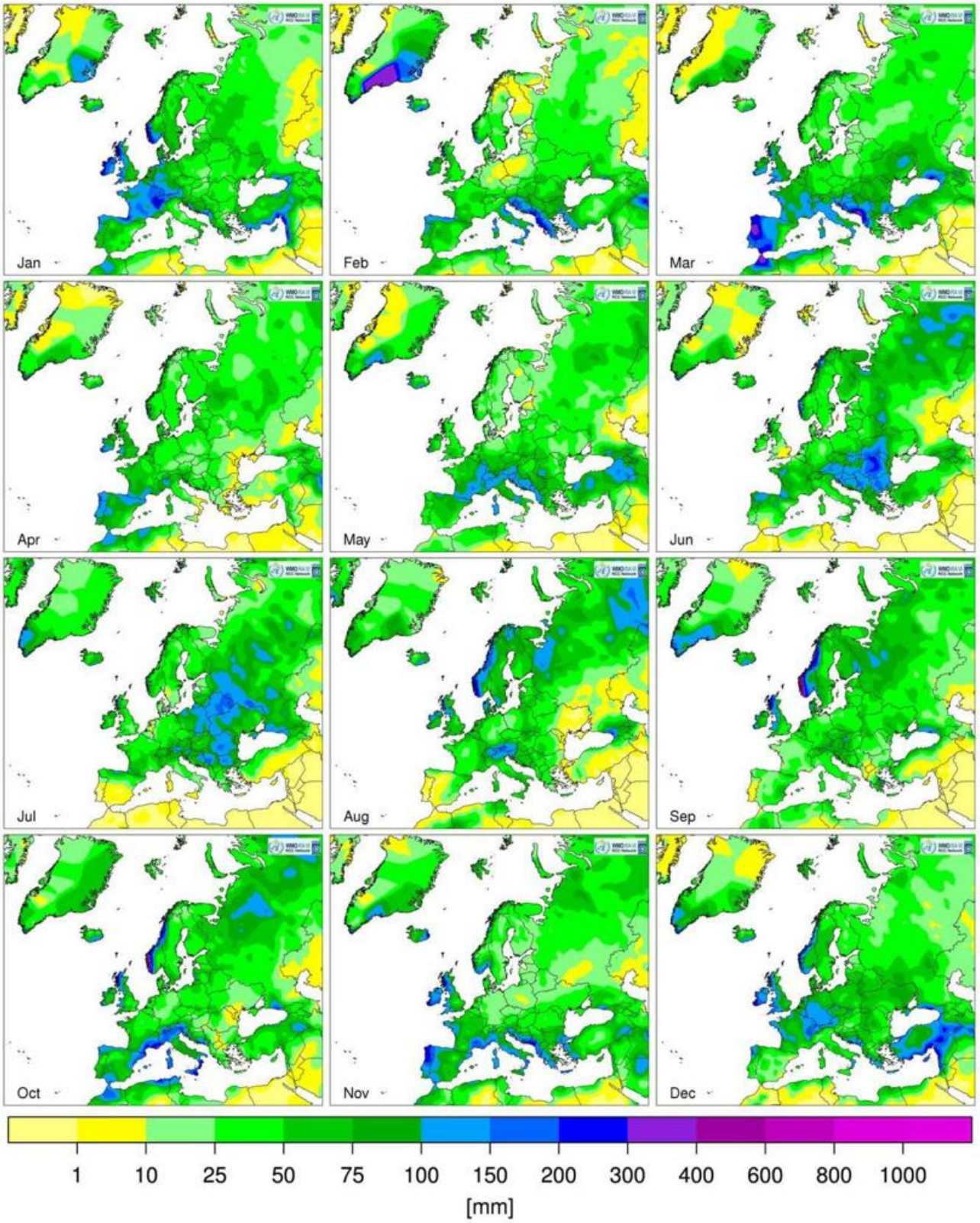


Figure 4-7: Monthly mean precipitation (in mm/month) for the year 2018.

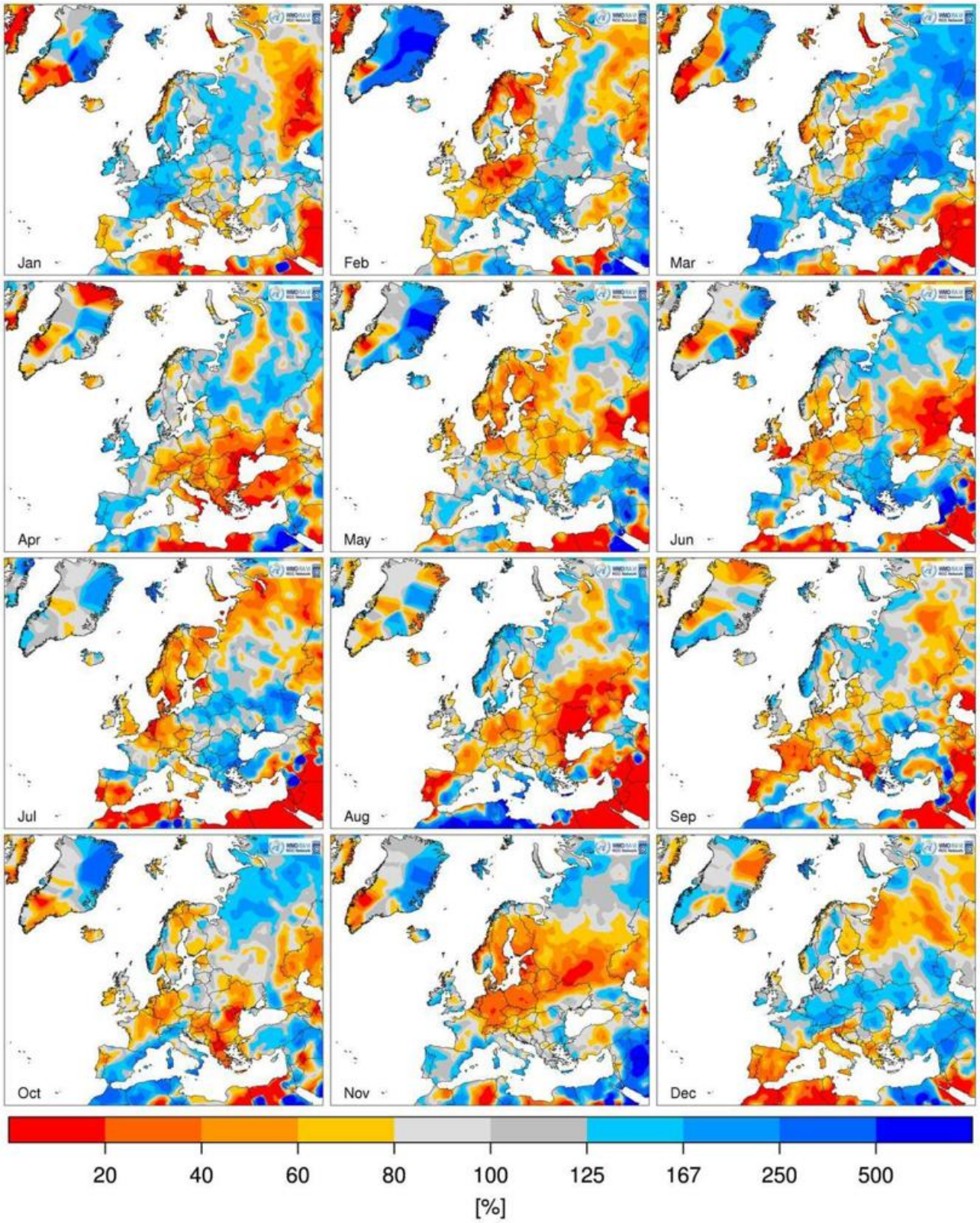


Figure 4-8: Monthly anomalies of precipitation (in mm/month) for the year 2018 (reference period 1961-1990).

4.4. *Sunshine duration*

Monthly sunshine duration in **January** was below normal over large parts of central and western Europe, the Nordic and Baltic countries as well as over eastern Europe with mostly 20 hours less of sunshine. Both southeastern and southwestern parts of Europe, on the contrary received a surplus of largely 20 to 50 sunshine hours.

In **February** the anomaly pattern was reversed compared to January situation with sunshine deficits in the southern parts of Europe and surpluses over the northern parts with anomalies of up 50 to 100 hours more sunshine, especially over Germany and the BeNeLux countries.

For the southern parts of Europe **March** continued with less sunshine than normal and anomalies of up to 50 to 100 sunshine hours less than normal. Largest surpluses occurred over Russia, Scandinavia and the Baltic countries with 50 to 100 hours more sunshine than normal.

April was not only much warmer than normal but much more sunny over large parts of the RA VI region. In an area extending from Germany to western Russia and towards the south to Greece and Turkey 50 to 100 hours more sunshine than normal was recorded, locally even more. Only in the most western parts of Europe, April closed with a deficit in sunshine hours with anomalies up to 50 hours less than normal.

May continued very sunny over most parts of Europe except for southern parts. Largest surpluses occurred over Scandinavia and the Baltic countries with more than 100 hours of sunshine more than normal: In Denmark, May 2018 was the month with the most sunshine ever since 1920, when the Danish Meteorological Institute (DMI) began recording sunshine hours. There were on average 11.5 hours of sunshine daily. May was also the sunniest on record for the UK. Estonia recorded a monthly total of sunshine of 408.4 hours which is 148% of normal – the 1st place since 1961.

June closed with more than normal sunshine hours over most parts of the RA VI region with largest surpluses again over Scandinavia but also over UK and Ireland as well as over southern parts of European Russia. However, the anomalies were smaller compared to May reaching maximum values in the range of 50 to 100 hours more sunshine than normal. The number of sunshine hours in Reykjavik (Iceland), on the contrary, was only 70 which is the fewest since 1914.

The summer continued very sunny for Western Europe and Scandinavia which over large parts received more than 100 hours more sunshine than normal in **July**. In Denmark, it was the sunniest July in Danish weather history with 339 hours of sunshine on a national level beating the old record from 2006 of 321 hours. With 348 hours of sunshine recorded, Luxembourg broke all records for the month of July as well, beating the previous record set in July 2006 of 345.5 hours.

August, September and **October** brought more sunshine hours than normal for almost the entire RA VI region with mostly 20 to 50 more sunshine hours than normal and largest surpluses in the range of 50 to 100 hours more than normal. Only in the Mediterranean region smaller surpluses and even deficits up to 20 hours less than normal were recorded.

November was still more sunny than normal in a band from France over Germany towards Russia (mostly 20 to 50 hours more) but brought less than normal sunshine hours to the regions north and south of it.

In **December** most parts of the RA VI region recorded less than normal sunshine hours with deficits up to 50 hours. In Estonia there were very few sunny hours in December. The monthly total of sunshine in Estonia was only 7 hours (34% of normal) – the second place since 1961. The monthly

total of sunshine in Tartu was even only 2 hours (only 8% of normal) – the second place since 1950. Only in the south from Iberia over Italy to the western coast of the Balkan Peninsula, sunshine hours were above the climatological average, generally 20 to 50 hours more than normal, locally even more.

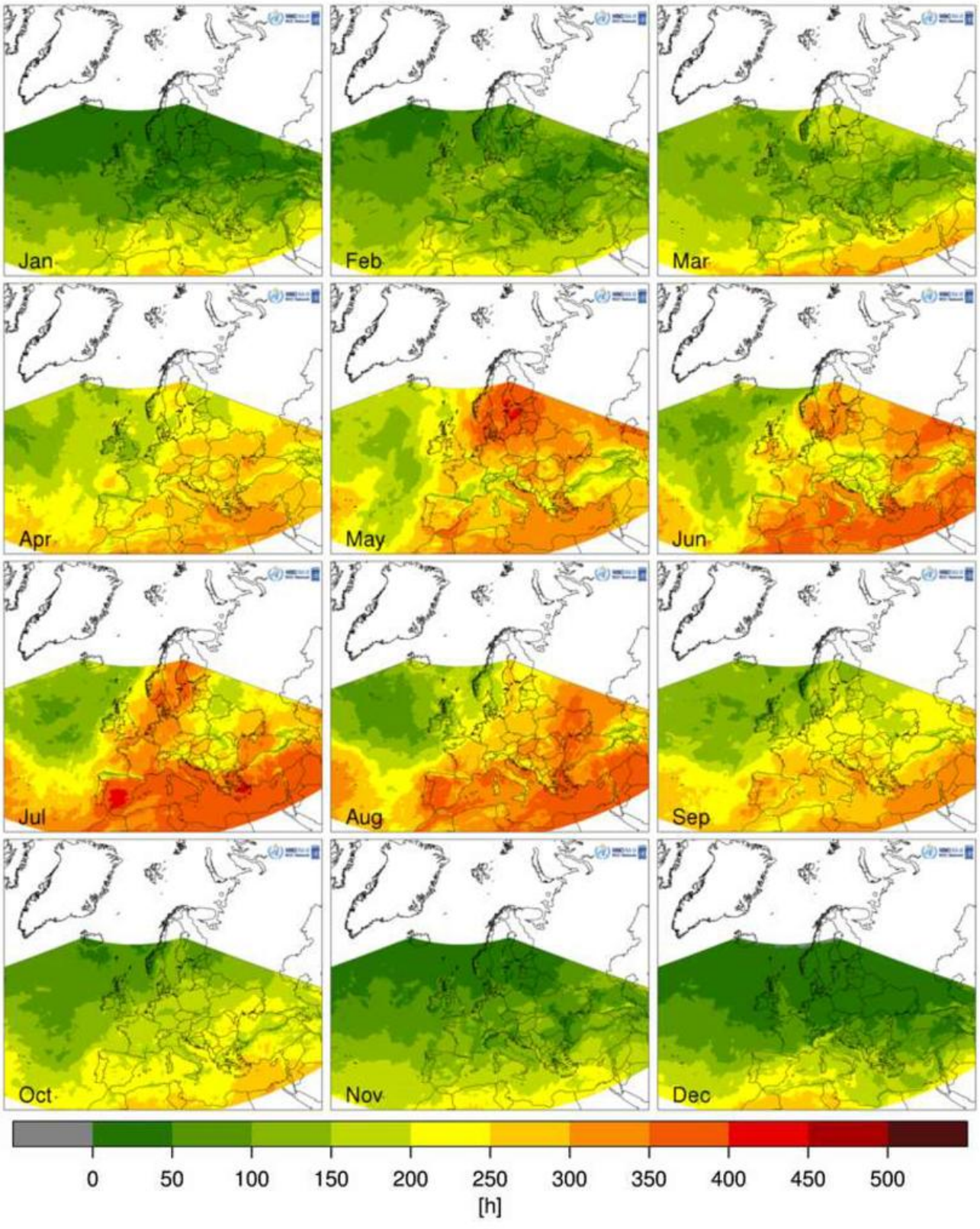


Figure 4-9: Mean of sunshine duration (in hours) for each month of the year 2018.

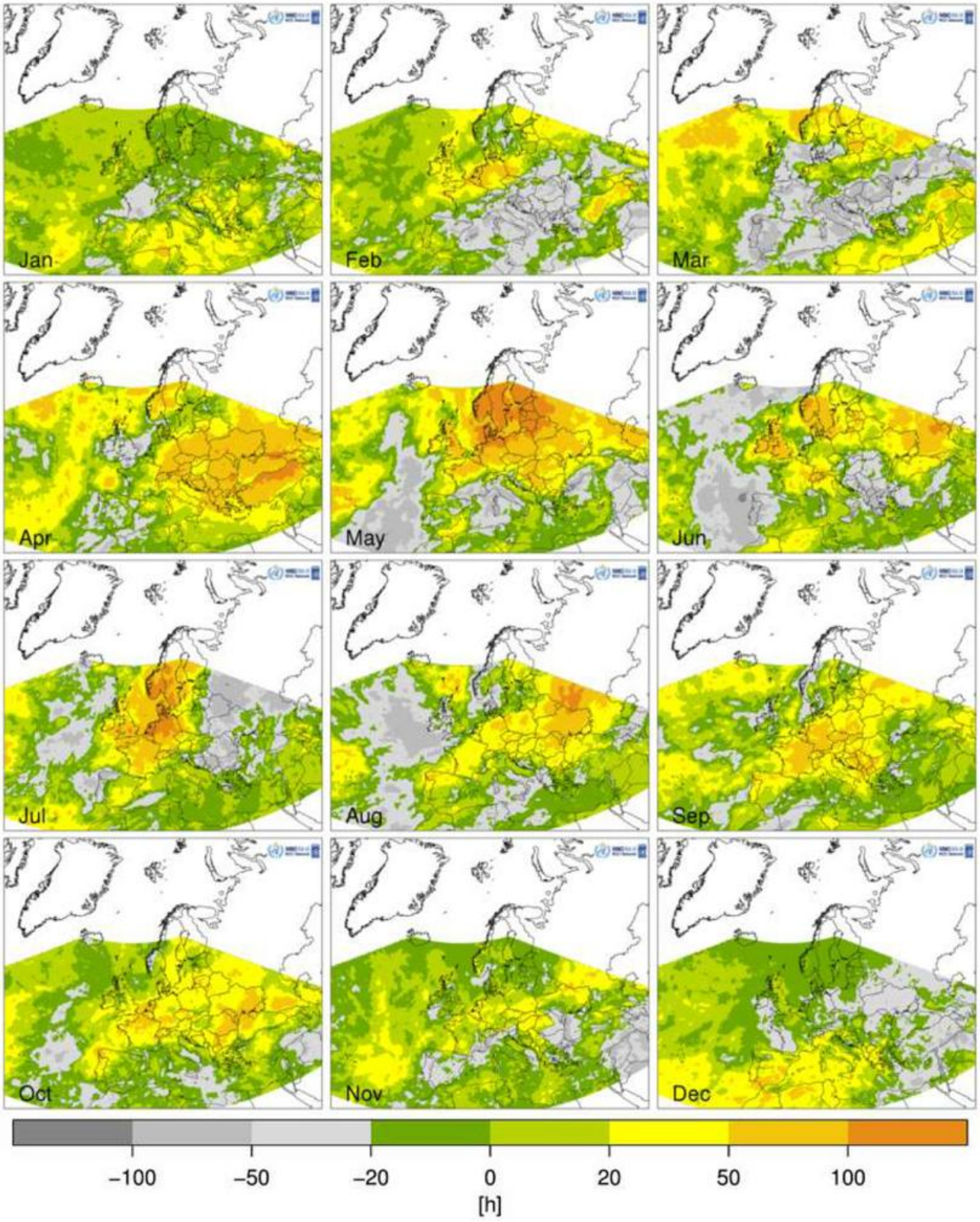


Figure 4-10: Monthly Anomalies of sunshine duration (in hours) for the year 2018 (reference period 1986-2015).

4.5. *Maps of monthly climate extremes and events*

The following maps are based on different data (as noted in the legends in parentheses), and are meant to summarize weather conditions in each month of the year 2018. The Monthly Event Maps contain information about the extreme anomalies of temperature, precipitation and wind gusts. Points are calculated from station data and represent the number of very warm or cold days, the locations of strong wind gusts (>=32 m/s) and days with precipitation. If more than one extreme anomaly occurs at the same location, the point is subdivided into several different colours. Coloured areas are based on interpolated gridded data for temperature (land and ocean) and precipitation (only land areas). If more than one extreme anomaly occurs at the same grid, the area is shaded.

In **January** the coast of Greenland, Norway, France and the UK were affected by strong wind gusts in the context of severe winter storms passing over Western and Central Europe at the beginning and in the middle of the month. First, storm Eleanor passed over Ireland on the 2 January bringing rain and some of the strongest winds of the month. The highest gust was 43 m/s (155.6 km/h) at Knock Airport. When crossing the United Kingdom during the 2 and 3 January, storm Eleanor caused gusts exceeding 33 m/s in England and Wales and even 40 m/s Northern Ireland. The storm moved then over Central Europe and dissipated. The Netherlands registered a wind gust of 34 m/s (122 km/h) at Vlieland. France was affected by Storm Eleanor on the 3rd. Gusts reached 54 m/s (196 km/h) at Cap Corse (new monthly record), up to 50 m/s (180 km/h) on the alpine ridges, 47 m/s (170 km/h) on the Vosges and 31 m/s (111 km/h) at Paris. Storm Friederike (in German, David in French) then moved on 17-20 January over central Europe from the United Kingdom to the Baltic Sea with its cold front reaching the Alps. In the UK wind gusts of 42 m/s were observed at Capel Curig on 18th with wintry showers of rain and snow. At the Netherlands coast, the storm reached a wind speed of Beaufort 11 (more than 32 m/s) but decreased rapidly with the distance from the coast to Beaufort 8 and 9. The storm was among the ten heaviest since 1970 in the Netherlands. Throughout the month of January, several episodes of heavy rain and snow occurred over Western and Central Europe. Especially in France, Germany, the Alps and parts of the UK, extreme amounts of rain fell with sums up to 250 mm as seen from the positive anomaly of very wet days. These occurred also over large parts of Scandinavia. Over most of the area, it was warmer than normal which goes along with the higher-than-normal number of warm days.

February and **March** were for most of the RA VI region the only months with below-normal temperatures due to several cold spells, which resulted in more than normal cold days over Central, Northern and Eastern Europe in both months. Southern Europe was only affected in February. In both months positive temperature anomalies occurred over the southeastern part of the RA VI region, Turkey and the Middle East. During February several storms moved over the Mediterranean with high precipitation amounts e.g. in the Pyrenees of more than 200 mm, at the Balkans 300 to 600 mm and in Greece locally more than 300 mm. For Malta the 9th of February was the second wettest day in February since 1923 with 117 mm of rain measured, causing flooding. In southern France, there were 14 days of significant precipitation in Nice, 18 days in Cape Pertusato (Corse-du-Sud) and up to 20 days in Socoa (Pyrénées-Atlantiques), which is 8 to 11 days more than normal. In France, from February 5th to 7th, a remarkable snow episode in the region around Paris happened with a snow depth of 15 cm at Chartres and 12 cm at Paris on February 7th. During 26th and 27th of February, snowfall of 8-15 cm occurred in the Provence, on the Côte d'Azur and in Corsica.

In **April,** it was extremely warm from Central Europe up to Moldova with temperatures more than +4 K above normal. Many countries (such as Germany, Czech Republic, Luxembourg, Moldova, and Montenegro) registered the warmest April since their weather analysis begun. Large parts of eastern and southeastern Europe experienced much below-average precipitation as indicated by standardized precipitation index values below -1.5.

May was exceptionally warm over Central Europe and the Nordic and Baltic countries, which experienced temperature anomalies above +4 K and more than normal warm days. Several countries reported not only their warmest May for centuries but also new station records. These regions were also affected by a significant deficit in precipitation with values of the GPCC-DI dropping below -1.5. May was characterized by high pressure over northern Europe and lower-than-normal pressure over the southeastern Mediterranean due to several cyclones crossing the Mediterranean Sea from west to east. They were accompanied by thunderstorms and hail with locally heavy precipitation. On the 22nd of May 2018 at the Swiss station Belp 46.6 mm was measured during one hour and 71 mm during 2 hours at station Ehrendingen with hail, local flooding and damages. In France the monthly totals of the number of lightning strikes reached 180,000, which is three times the average of measurements in May since 2000 (start of measurements). At the beginning of May several thunderstorms moved from the Alps to the Pyrenees with hail and heavy precipitation, e.g. on the 7th a daily total of 63.2 mm at station Apt (Vaucluse) of which 60.4 mm fell during one hour.

June was also warmer than normal over most of the RA VI region, similar to the two previous months with above-normal numbers of warm days except for some parts of northern Scandinavia as well as European Russia were more than normal cold days occurred. Mean temperature anomalies, in contrast, were not extreme (below +4 K).

In **July** a blocked weather pattern over Europe with large positive pressure anomalies over Scandinavia and northern Russia caused heat waves in many countries of the RA VI, also visible from the increased number of warm days and exceptionally above-normal temperatures over central and northern Europe. The heat was accompanied by drier than-normal conditions as seen from GPCC-DI values below -1.5. Next to the high pressure over the northern Europe, July was characterized by lower-than-normal pressure anomalies over the Mediterranean leading to several cyclones crossing the Mediterranean Sea from west to east. They were accompanied by thunderstorms and hail with locally heavy precipitation.

In **August** the long drought conditions in Western and Central Europe continued, but in Southern Europe, the Balkans and over Norway more precipitation than usual was reported. Extremely warm temperatures occurred over the southeastern part of Europe (Balkan Peninsula) with temperature anomalies of more than +4°C.

September was again a very warm month, the warmest September on record for Europe according to NOAA and Copernicus data. This resulted in more than normal warm days over most of the RA VI region. Temperature anomalies stayed below +4°C though except for a small region in Western Russia. In the UK and Ireland, Storm Ali and storm Bronagh brought in mid-September very strong winds with wind speeds exceeding 32m/s. The highest gust at Mace Head station on that day was 146 km/h, its highest September gust since the station opened in 2004. Parts of Wales, the Midlands and the east and northeast of England were especially affected by flooding and fallen trees on roads, and a landslip onto a railway line in the Rhondda valley closed the line to Cardiff. In several parts of RA VI region accumulation sums exceeded 150% of climatological mean. In Slovakia for example,

intensive rainfall also occurred in early September in the southwest of Slovakia. For the first three days in September 2018, a precipitation total of more than 100 mm in western Slovakia at some meteorological stations was recorded, which is twice the monthly normal total in this area. The highest precipitation totals were recorded at the meteorological stations: Smolenice 124 mm, Siladice 129 mm, Jaslovské Bohunice 138 mm (here for the first four days of September together up to 176.3 mm precipitation).

In **October** the main part of Europe was dominated by high pressure weather. Average temperatures were therefore above the 1961-1990 average in large parts of the continent, which resulted in a larger-than-normal number of warm days. Ireland was hit by Storm Callum having a minimum pressure of 938 hPa and thus the lowest early season pressure for an extratropical Atlantic storm since at least 1979. Storm Callum moved northwards close to the west of Ireland on the 12th giving the windiest spell of the month and widespread heavy rain on the 12th and 13th. On October 13th and 14th, mainland Portugal, especially Centre region, was strongly affected by the passing of the tropical storm (ex-hurricane) Leslie, which caused very strong winds. Highest value of gust was 176 km/h at the meteorological station of Figueira da Foz (coastal centre region) on 13th; this was the highest gust ever recorded in Portugal (see below). The exceptional drought (GPCC-DI < -1.5) continued over much of Central Europe, particularly over southern Germany, but also in parts of southeastern Europe. Soil moisture and groundwater levels were very low, restrictions of water use came into force, record low water levels in rivers caused restrictions in ship traffic with economic losses. Wetter conditions than normal with monthly precipitation sums greater than 150% of the climatological norm occurred along the Mediterranean coasts of Spain, France and Italy for example. In Italy, on 27th-30th October intense and persistent precipitation occurred over the whole region (as part of a system extended to a great fraction of the national territory). Maximum cumulated precipitation over the event were 340,4 mm recorded at Casoni di S.Maria di Taro (PR, 853 m asl). Over the Taro basin, return periods for precipitation intensities cumulated over 3h were locally greater than 100 years at Bardi (66.2 mm) and Noveglia (75.6 mm), for precipitation intensities over 6h were locally greater than 200 years at Bardi (93.6 mm) and Noveglia (108.8 mm), and greater than 100 years at Valdena (134.8 mm), for precipitation intensities cumulated over 12h and 24h were greater than 50 years at Bardi (105.4 and 132.0 mm) and Noveglia (75.6122.8 and 148.0 mm). Moreover, at the end of October, the low pressure area called Vaia crossed the Alps causing heavy damage especially in southern Switzerland and northern Italy, at some places even whole forests were devastated by hurricane gusts. Vaia took a very unusual trajectory, as Italian lows usually move east or southeast. In the northern Alps there was a foehn storm with hurricane gusts of 200 km/h measured at some mountain peaks. But also in the valleys there were gusts of up to 130 km/h like in Elm in Switzerland.

November had exceptionally warm and dry weather in northern Scandinavia with temperature anomalies exceeding +4°C and GPCC-DI values lower than -1.5. Drought conditions also affected Central and Eastern Europe. Over large parts of Europe, the number of warm days was larger than normal. Storms across Southern Europe brought strong winds and heavy rain to the Mediterranean region, affecting the Iberian Peninsula, southern France, Italy, the Middle East and South Caucasus where precipitation sums exceeding 150% of the climatological mean occurred. In Portugal, for example, on 11th November, there were record high values of precipitation, particularly in the region of Lisbon, causing floods. Heavy rain events also led to flash floods and landslides in southern parts

of France and in Spain where 24h totals of 160mm were recorded in Vauvert (France), 206mm at Barx (Spain). Much of this heavy rain fell just in few hours.

In **December,** heavy precipitation events in the Eastern Mediterranean as well as over Central and Eastern Europe resulted in monthly precipitation sums exceeding 150% of the climatological norm. These were caused by several low-pressure systems developing over the North Atlantic. One of

Box 7 | Contributions by NMHSs – Extreme events October

Tropical storm Leslie (Contribution from the Portuguese Meteorological Service)

On October 13th and 14th the tropical storm Leslie passed in continental Portugal. It was first designated a subtropical storm by the National Hurricane Center of Miami (NHC) on 23 September 2018, when it was located about 2000 km southwest of the Azores. This storm passed on the 12 October north of the archipelago of Madeira, still as a hurricane, and later headed towards the mainland, having already entered the territory (north of Figueira da Foz) as a post-tropical storm on the 13th at 21:40 UTC (22:40 local time), however still maintained winds with a force corresponding to tropical storm.

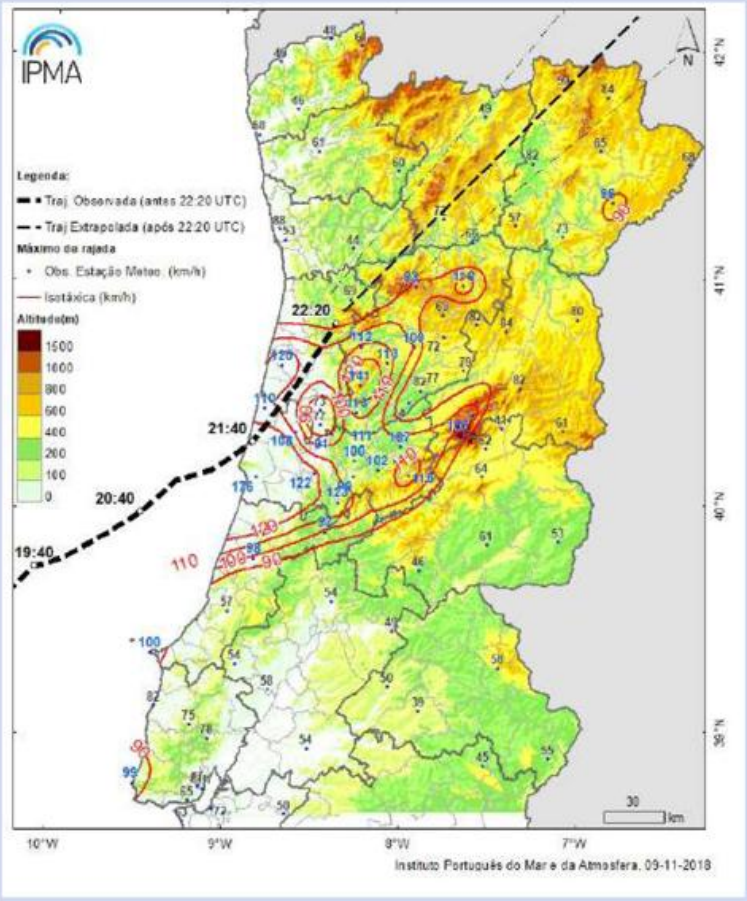


Figure 4 10- Maximum instantaneous wind values (gust), recorded at the passage of the post-tropical storm Leslie, on 13 and 14 October 2018 and the trajectory of the same (dotted line segments delimit territorial range on which the nucleus, or nuclei, of the storm passed after 22:20 UTC)

Storm Leslie caused very strong winds in the districts of Lisbon, Leiria, Coimbra, Aveiro and Viseu. The gusts of 176.4km/h, recorded at the weather station of Figueira da Foz/Vila Verde at 21:40 UTC on the 13th, correspond to the highest value recorded at stations of the national weather network (previous maximum of 169 km / h on October 17, 2015). The second and third highest values were, 141.1 km/h (day 13, 23:10 UTC) in Tondela/Caramulinho and 122.8 km/h (day 13, 21:40 UTC) in Penela/Serra do Espinhal, respectively. Figure 14 shows the highest values of maximum instantaneous wind (gust), recorded at the passage of the Posttropical Storm Leslie, on October 13 and 14, 2018 and its trajectory.

them was a storm named Marielou II with a core pressure of 965 hPa over northwestern Europe. Due to large pressure difference between this low and the Azores High, a storm field was generated which passed Western and Central Europe on 07-09 December and brought gusts up to hurricane-force, e.g.in northwestern France (Caen) at 144km/h, in Germany on the Brocken peak (1100m altitude) at 157 km/h and on peak Zugspitze at 144 km/h. Within the precipitation of the cold front of this low there were some showers and thunderstorms over Western and Central Europe, which is not very typical for the winter season. On 9 December, the storm also affected south-eastern France including Corsica with gusts up to 186km/h at Cap Corse station. Storm Deirdre ("Oswalde" in Central Europe) then formed in the Atlantic by mid of the month, bringing severe weather to the UK on 15 and 16 December 2018, reaching a minimum pressure depth of 980hPa. Strong winds and heavy rain spread to many areas, with severe gales in the southwest, resulting in a wind gust of 79 mph (127km/h) at Aberdaron. Although it was a windy day, the most dangerous impacts were from snow and freezing rain. Heavy snow affected central parts of Scotland and northeast England. Widespread freezing rain also caused impacts in northern England and southern Scotland, giving icy conditions on roads. While the western and central Mediterranean mostly received very little precipitation for this time of year, the eastern basin and adjacent land areas of Turkey and the Middle East suffered from abundant rain, violent thunderstorms and snowfall, more or less throughout the month. Flooding occurred in many places, particularly in the coastal areas of the eastern Mediterranean including Cyprus, together with several fatalities and injured, losses of animals, blocked roads and rails due to landslides near slopes or deep snow particularly in higher elevations, local hail layers of several cm, power outage, cancellation of flight and ship connections, several tornados, buildings and greenhouses damaged. Refugee sites were especially vulnerable to that heavy weather. Monthly totals near the eastern Mediterranean coasts were above 200mm in many places. December rainfall was a record high in the south-eastern Anatolia Region in Turkey; the region received the highest rainfall in the last 37 years since 1981. In Israel, the precipitation event of December 5-8th was the most significant one, obtaining half of the monthly totals. The amounts in the Coastal Plain were more than 200 mm, locally close to 250-280 mm. The intensive rainfall caused widespread flooding in the Coastal Plain.

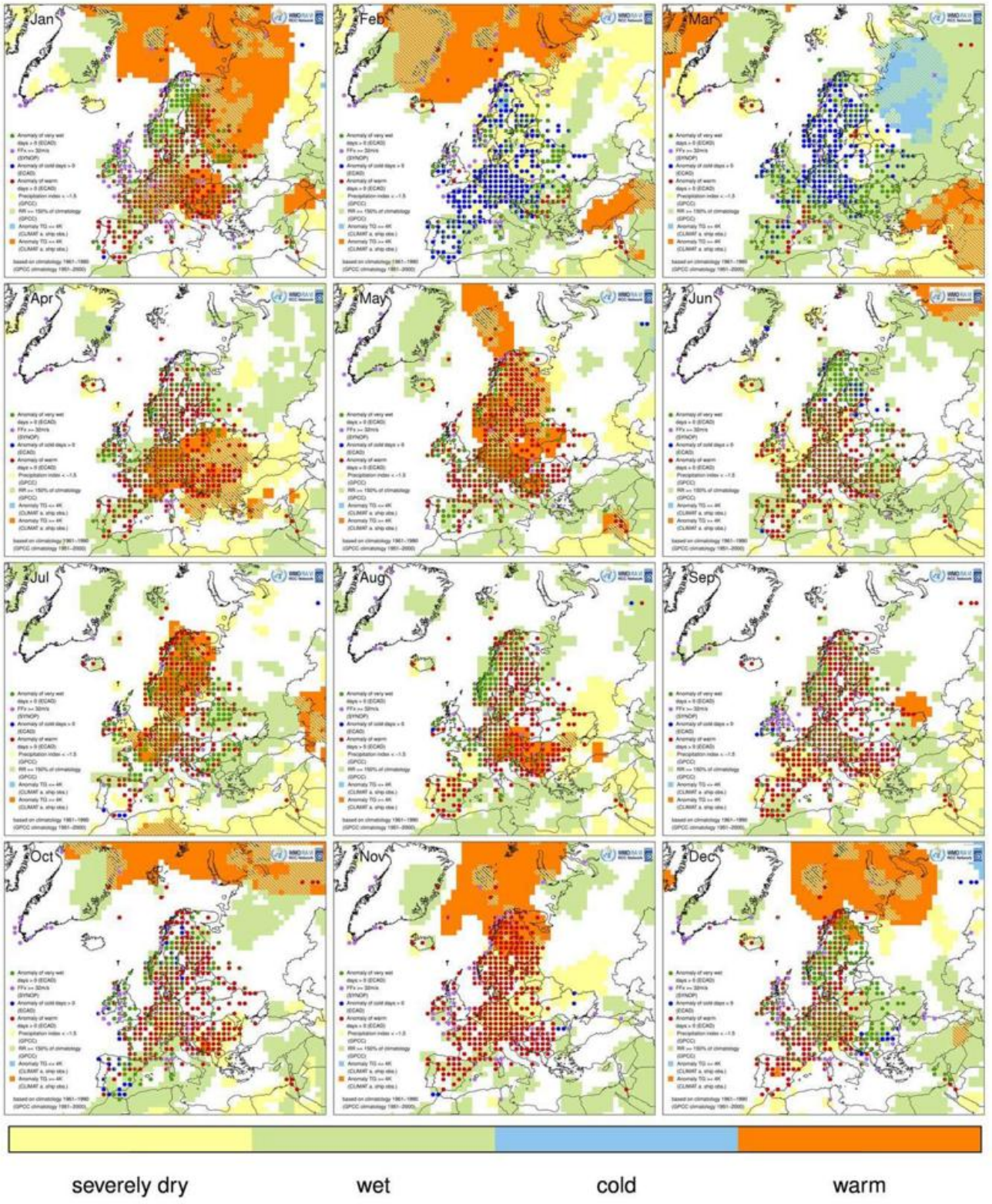


Figure 4-11: Monthly maps of Climate Extremes for the year 2018.

5. Long-term variability of the selected climate parameters - Regional examples

On the following pages graphs of long time series of temperature, precipitation and sunshine duration as provided by the National Meteorological and Hydrological Services (NMHSs) are presented to give an overview of the temporal development of the basic climate elements. The graphs are grouped with respect to the 6 sub-regions defined above (Figure 1-1). An overview of contributing countries, time series' lengths and area representativeness can be found in Table 5-1. Most time series are available for temperature. Each sub-region is at least represented by one country. Time series of precipitation totals are fewer but each sub-region is represented by at least one time series for precipitation. Diagrams of long-term annual sums of sunshine duration are provided by few countries, belonging to different sub-regions.

Table 5-1: Availability of the long-term records (start year) of temperature, precipitation and sunshine duration from some participant countries.

Sub-region	Country	Temperature		Precipitation		Sunshine Duration	
		Spatial Mean	Single Station	Spatial Mean	Single Station	Spatial Mean	Single Station
Central and Western Europe	Austria	1768					
	Belgium		1833		1833		1887
	France	1900		1959			
	Germany	1881		1881		1951	
	Hungary	1901		1901			
	Luxembourg		1947				
	Netherlands	1906			1906		
	Switzerland	1864	1864	1901	1864		1884
	United Kingdom	1910		1910		1929	
Nordic and Baltic Countries	Denmark	1873	1768	1874	1821	1920	1876
	Greenland		1784		1890		
	The Faroe Islands		1873		1890		1922
	Estonia		1866		1866		1953
	Finland	1900		1961			
	Iceland		1931				
	Latvia	1924		1924			
	Lithuania	1961					
	Norway	1900		1900			
	Sweden	1860		1860			
Iberia	Portugal	1931		1931			
	Spain	1965		1965			
Mediterranean, Italian and Balkan Peninsula	Croatia		1862		1862		
	Italy	1961		1961			
	Slovenia		1961		1961		
	Serbia	1951					
	Turkey	1971		1981			
Eastern Europe	Belarus	1881		1891			
	European Russia	1939		1966		1961	
	Moldova		1887				
	Ukraine		1881		1891		
Middle East	Georgia	1956	1881	1956	1881		
	Israel	1951			1916		

5.1. *Temperature*

Central and Western Europe – annual temperature series

Austria, France, Germany, Hungary, Slovakia, Switzerland

Austria

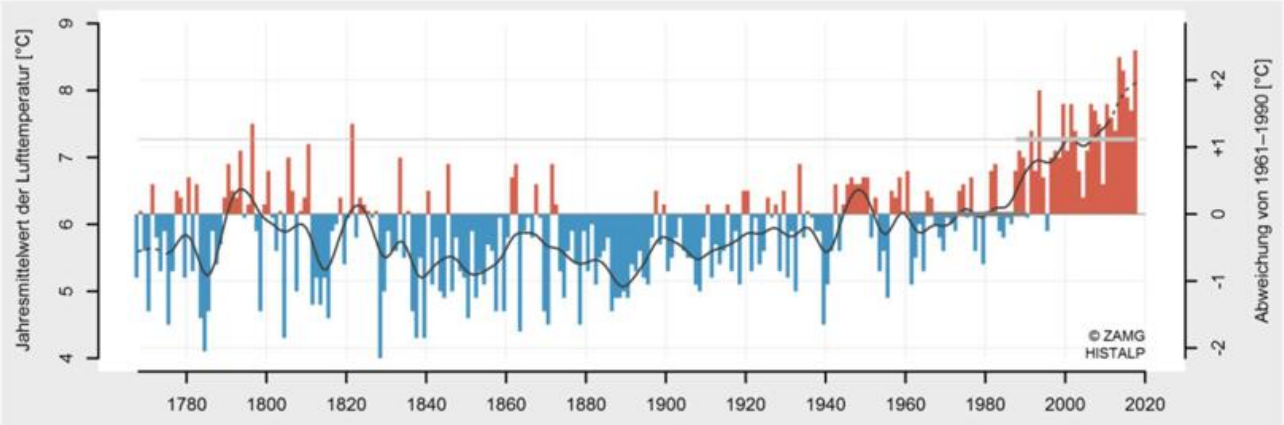


Figure 5-1: Time series of annual temperature anomalies for Austria (reference period 1961-1990, diagram as provided by the NHMS)

France

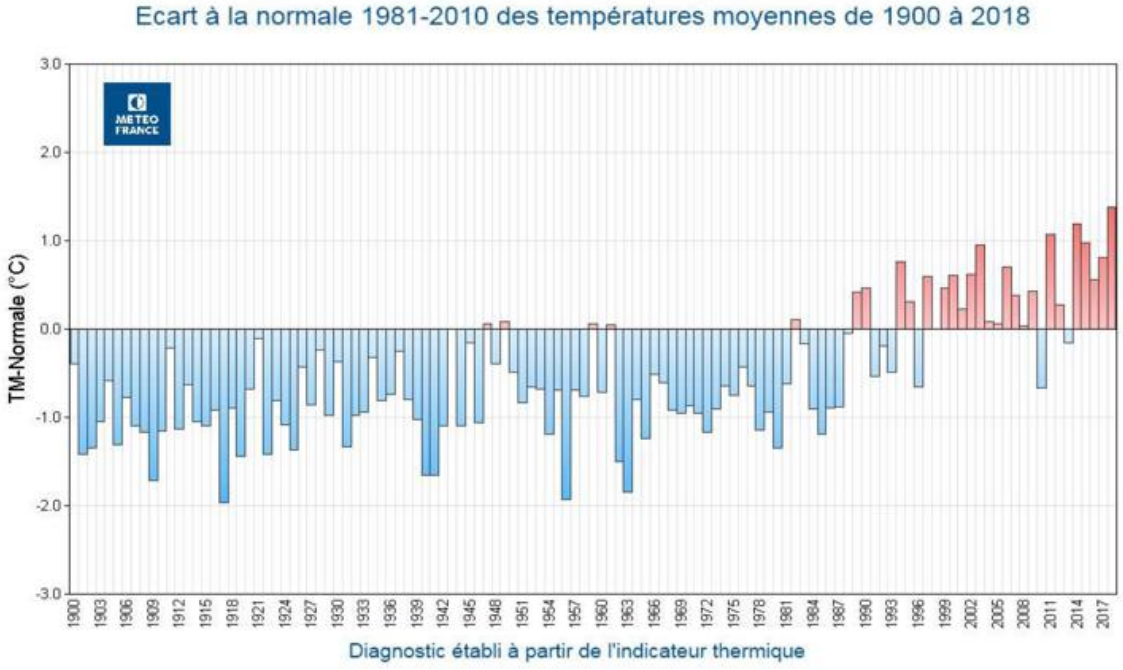


Figure 5-2: Time series of annual temperature anomalies for France for the period 1900-2018 (reference period 1981-2010; diagram as provided by the NHMS)

Germany

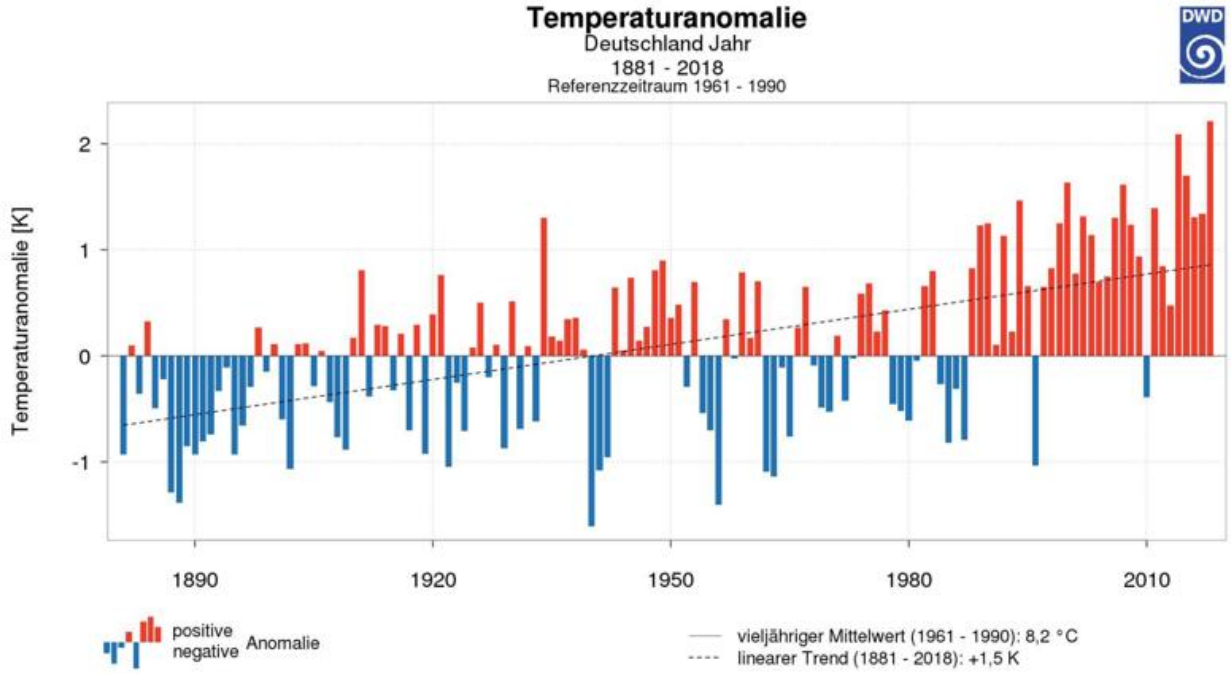


Figure 5-3: Time series of annual temperature anomalies for Germany for the period 1881-2018 with respect to reference period 1961-1990 (dotted line: linear trend, diagram as provided by the NHMS)

Hungary

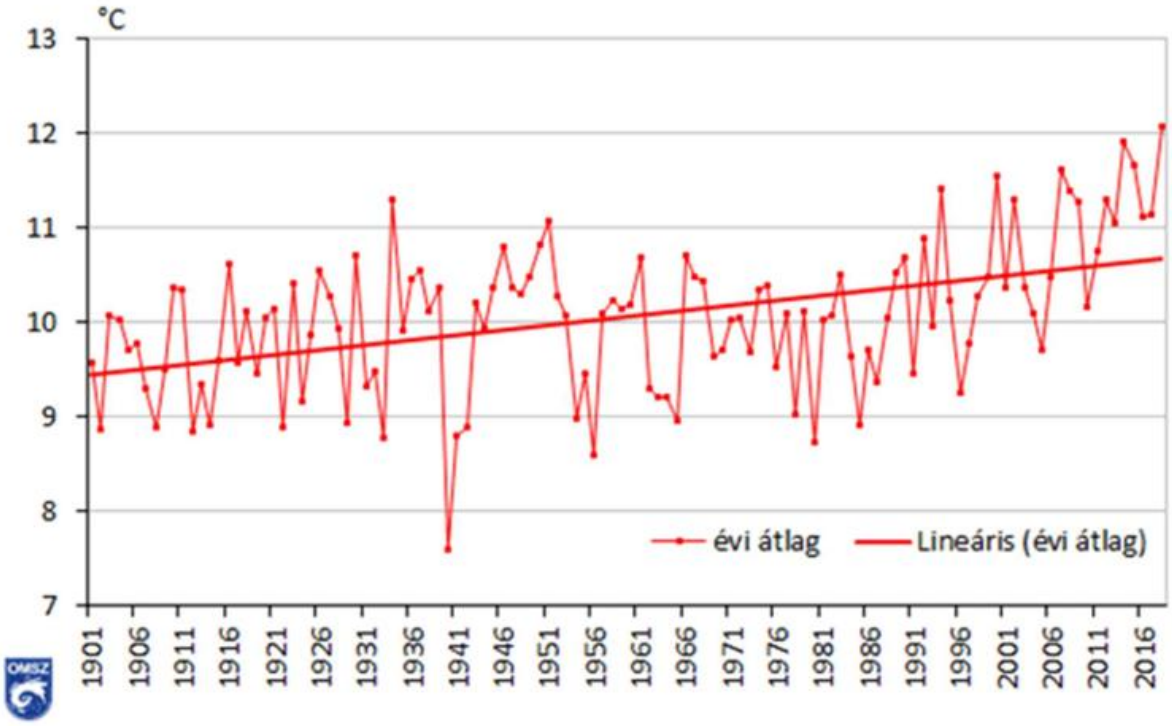


Figure 5-4: Time series of annual average temperature for the period 1901-2018 for Hungary (based on homogenized and interpolated data from 58 stations; Diagram as provided by the NHMS)

Slovakia

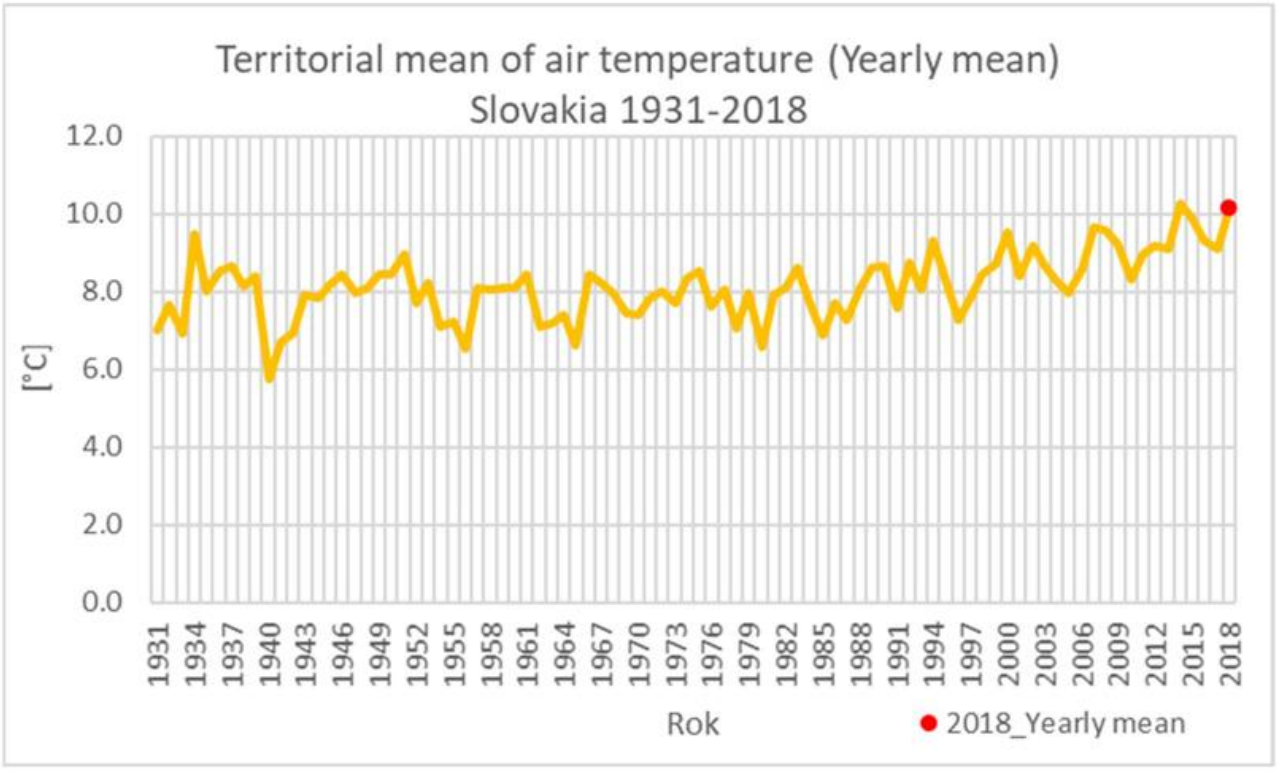


Figure 5-5: Time series of annual average temperature for the period 1931-2018 for Slovakia (graph provided by Slovak hydrometeorological institute)

Switzerland

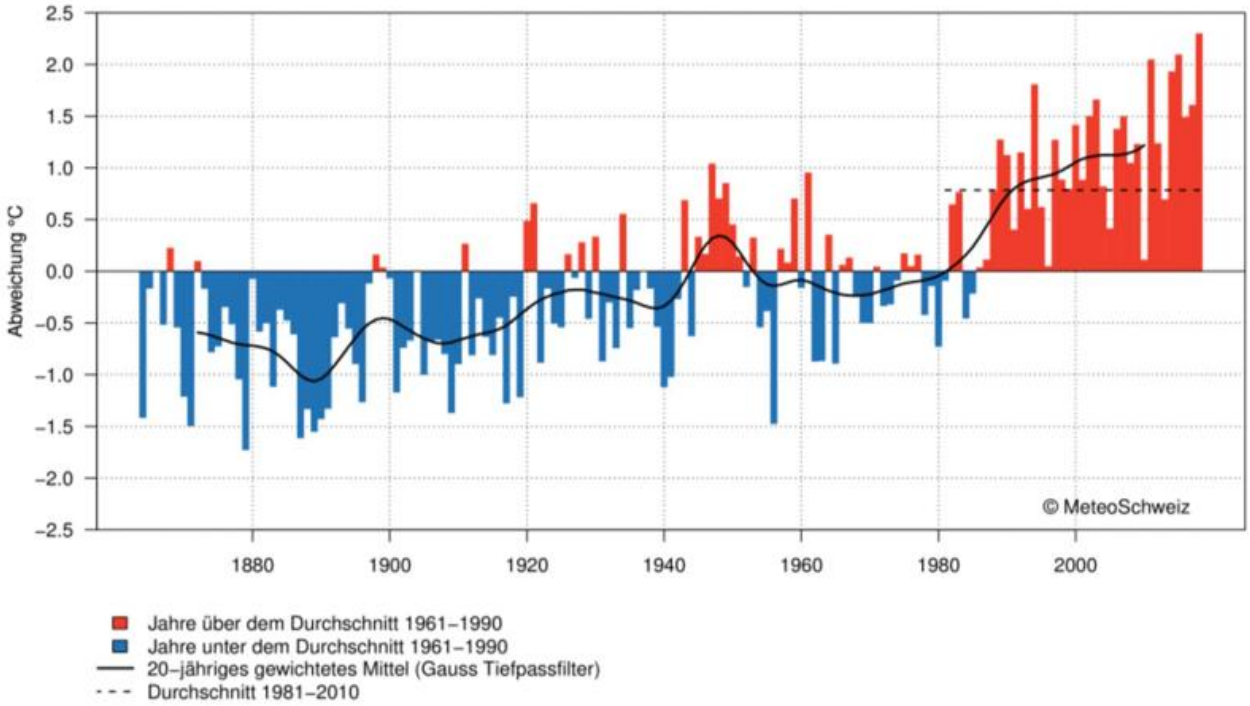


Figure 5-6: Time series of annual temperature anomalies for Switzerland with respect to the reference period 1961-1990. Warmer/colder-than-normal temperatures are displayed in red/blue respectively. The black line represents the 20 year running mean (diagram as provided by the NHMS).

Nordic and Baltic Countries – annual temperature series

Denmark together with Greenland and the Faroe Islands, Estonia, Finland, Latvia, Lithuania, Norway, Sweden

Denmark, Greenland, the Faroe Islands

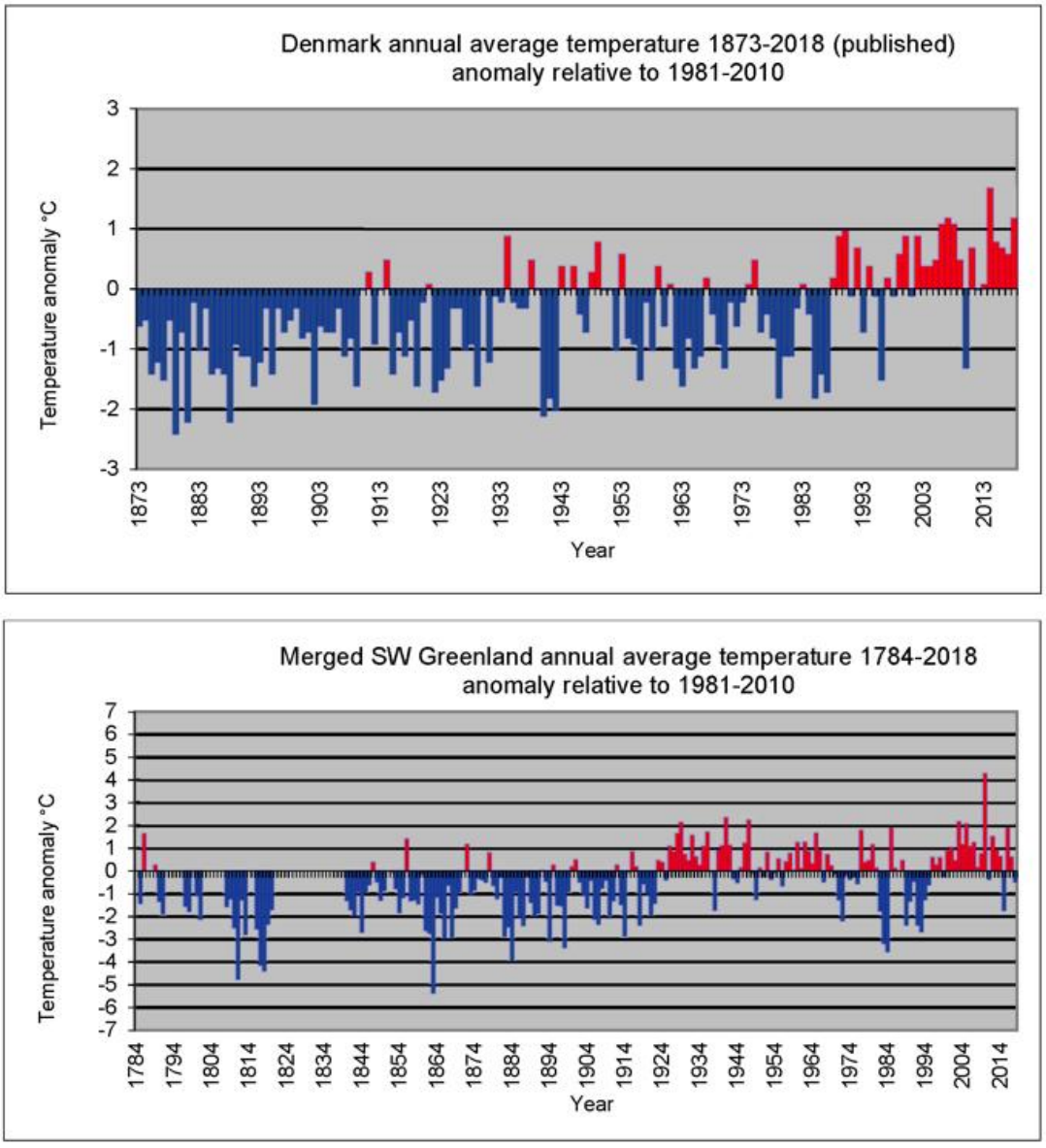


Figure 5-7: Time series of annual temperature anomalies for the period 1873-2018 for Denmark (top), 1784-2018 southwestern Greenland (bottom); diagrams as provided by the NHMS, Data up to 2018 are published in DMI report series, No. 19-02 John Cappelen (ed),(2019): Denmark - DMI Historical Climate Data Collection 1768-2018.

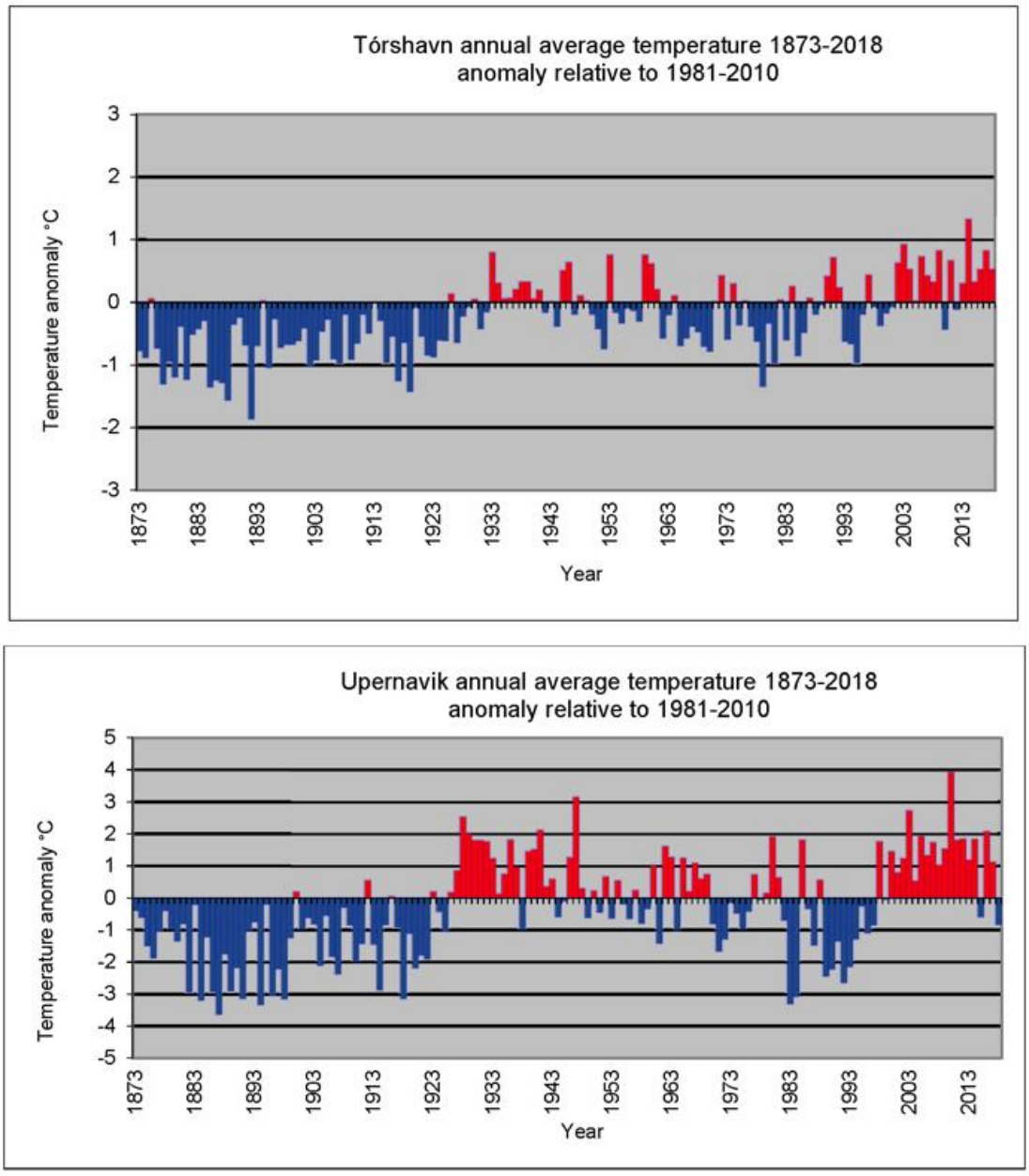


Figure 5-8: Time series of annual temperature anomalies for the period 1873-2018 for the Faroe Islands (Tórshavn, top) and for Greenland (Upernavik, bottom); diagrams as provided by the NHMS, Data up to 2018 are published in DMI report series, No. 19-02 John Cappelen (ed),(2019): Denmark - DMI Historical Climate Data Collection 1768-2018.

Estonia

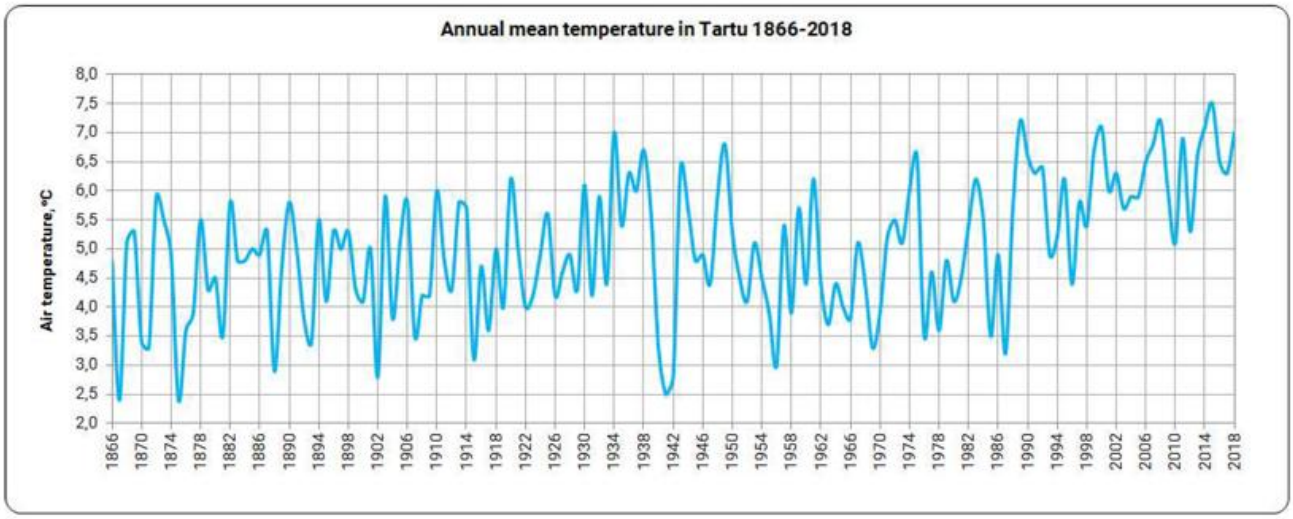


Figure 5-9: Time series of annual temperatures for the period 1866-2018 for station Tartu, Estonia (diagram as provided by the NHMS)

Finland

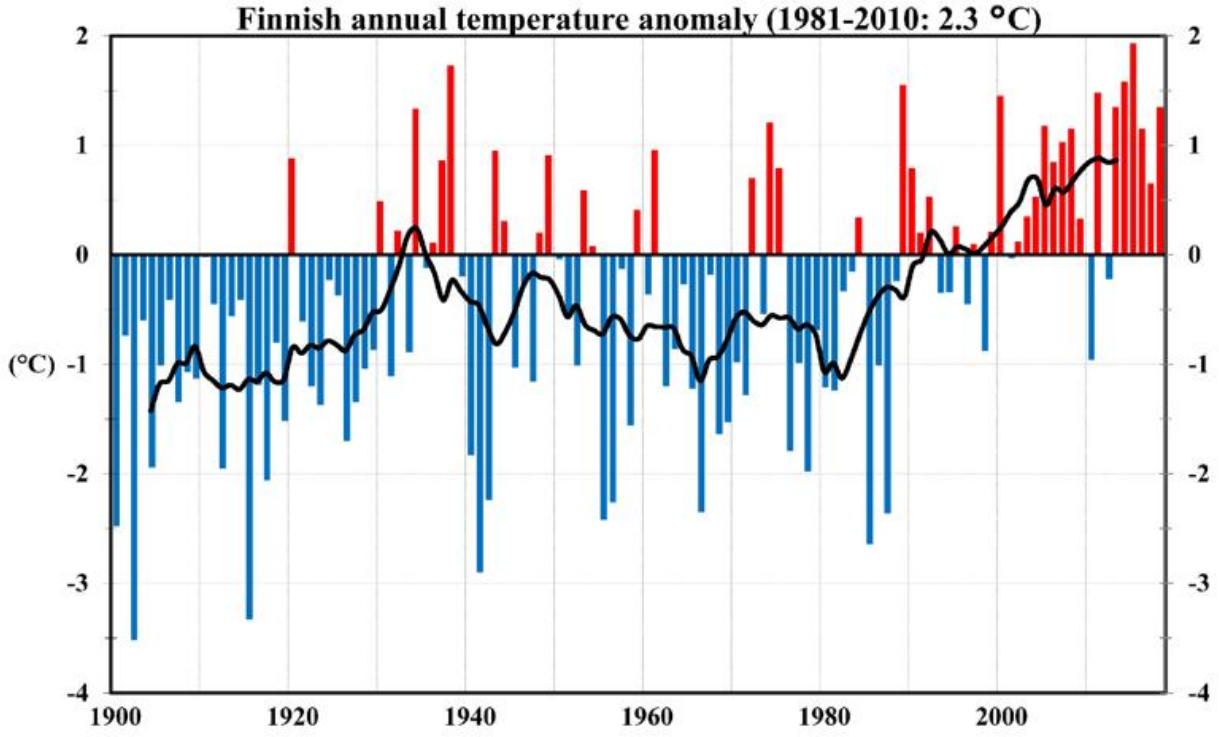


Figure 5-10: Time series of annual temperatures anomalies for Finland (reference period 1981-2010) for the period 1900 to 2018; diagram as provided by the NHMS.

Latvia

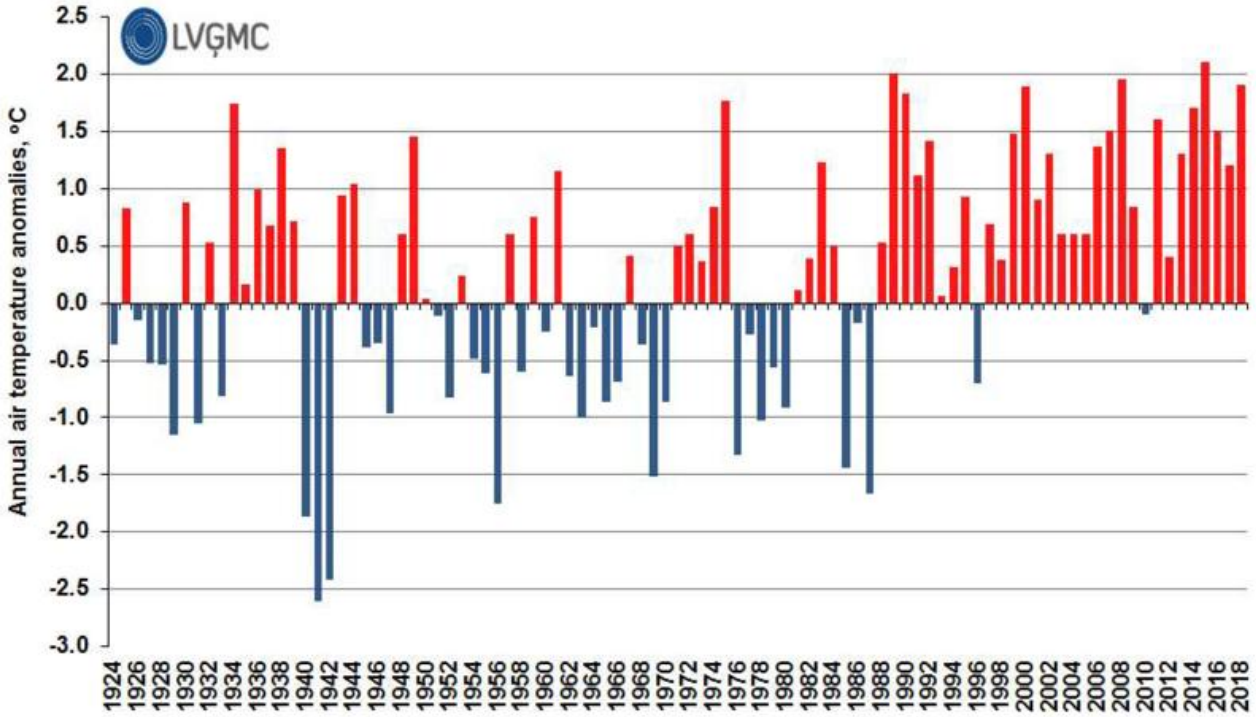


Figure 5-11: Time series of annual temperature anomalies for the period 1924-2018 for Latvia (reference period 1961-1990; diagram as provided by the NHMS)

Lithuania

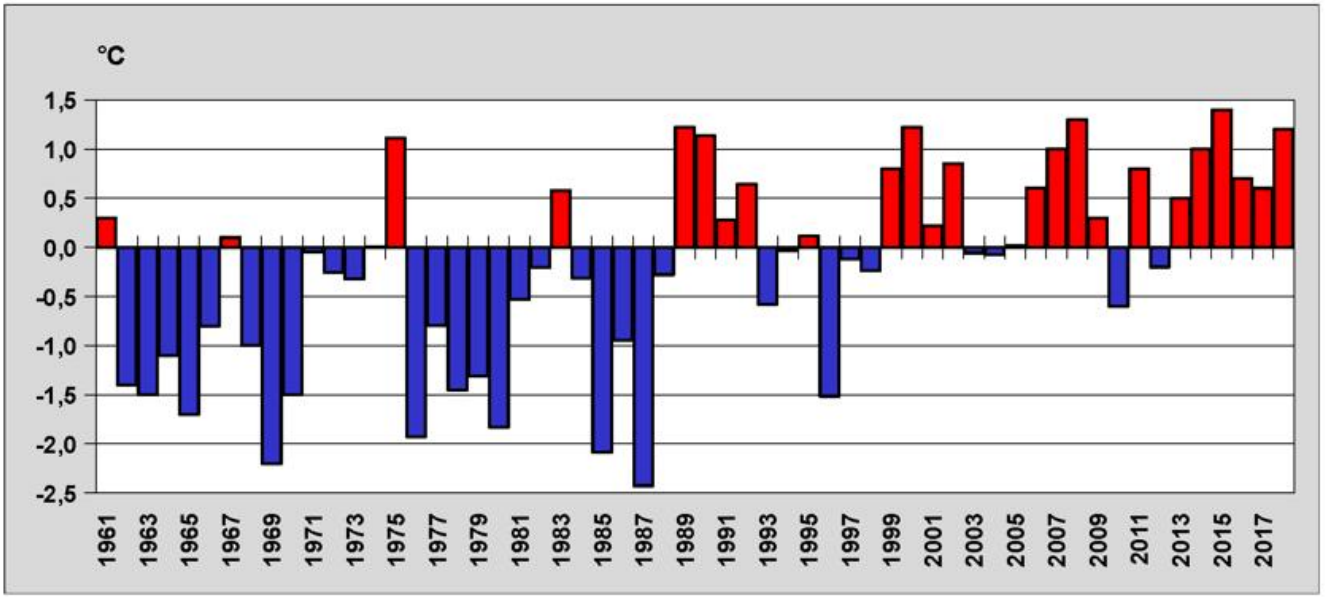


Figure 5-12: Time series of annual temperature anomalies for the period 1961-2018 for Lithuania (reference period 1981–2010; diagram as provided by the NHMS)

Norway

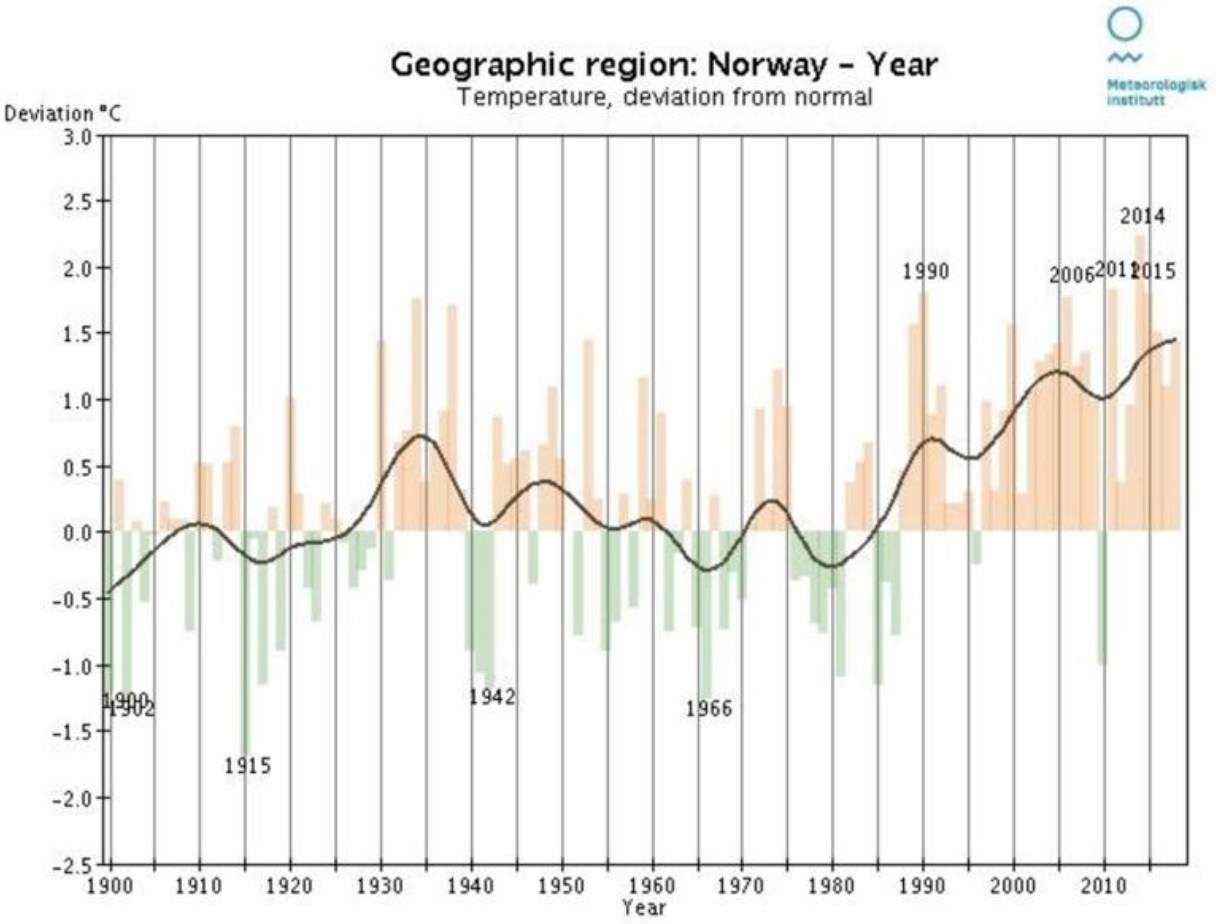


Figure 5-13: Time series of annual temperature anomalies for the period 1900-2018 for Norway (reference period 1961-1990; diagram as provided by the NHMS)

Sweden

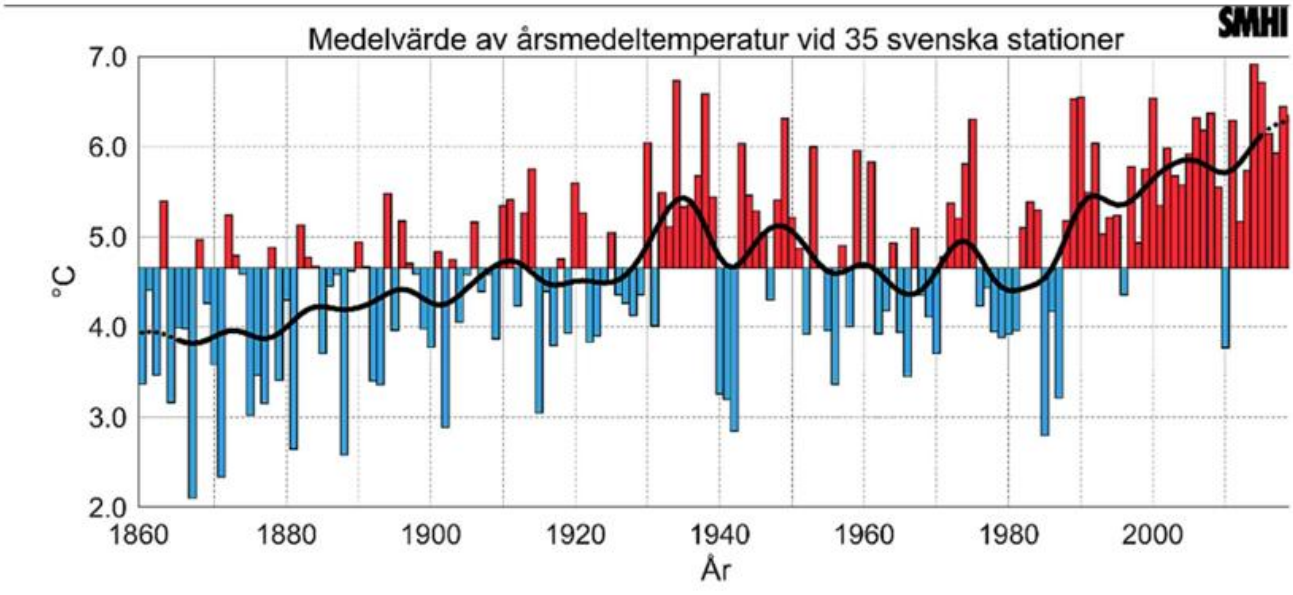


Figure 5-14: Time series of annual temperature anomalies (relative to 1969-2018) for the period 1860-2018 for Sweden (mean of 35 stations, diagram as provided by the NHMS)

Iberia – annual temperature series

Portugal, Spain

Portugal

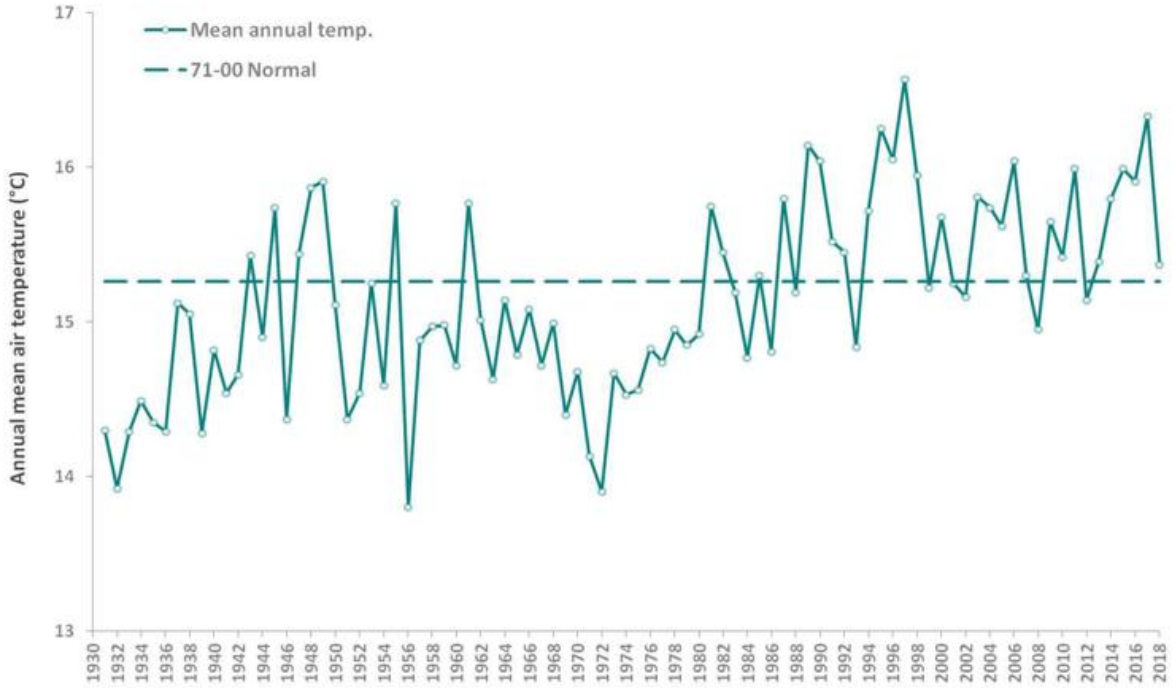


Figure 5-15: Time series of annual average temperature for the period 1931-2018 for Portugal (Dashed line normal 1971-2000, diagram as provided by the NHMS)

Spain

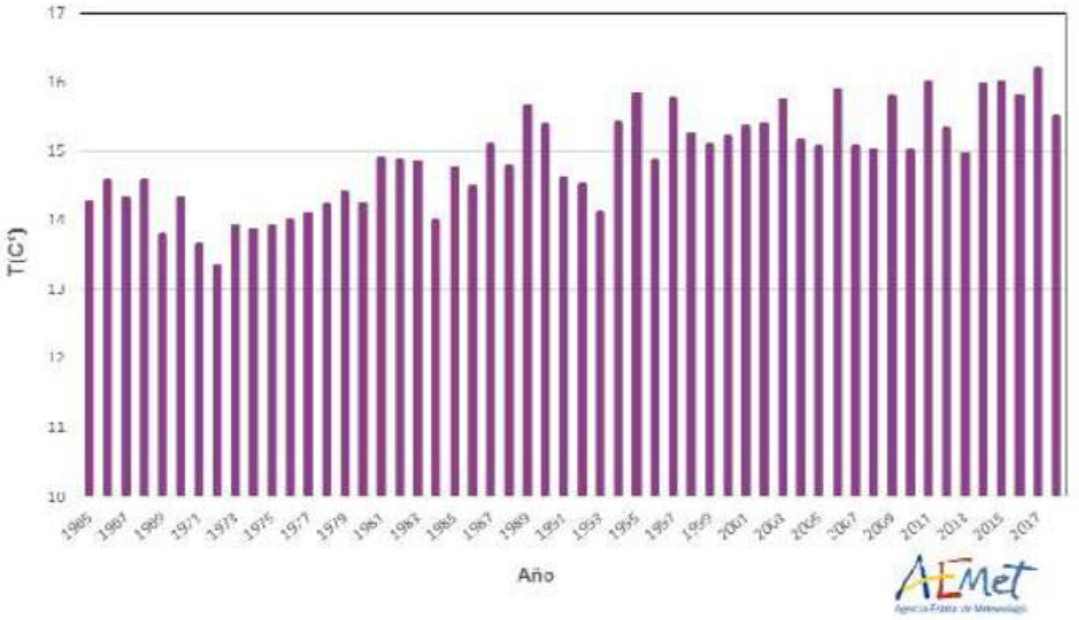


Figure 5-16: Time series of annual average temperature for the period 1965-2018 for Spain (diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Bulgaria, Croatia, Italy, Slovenia, Serbia, Turkey

Bulgaria

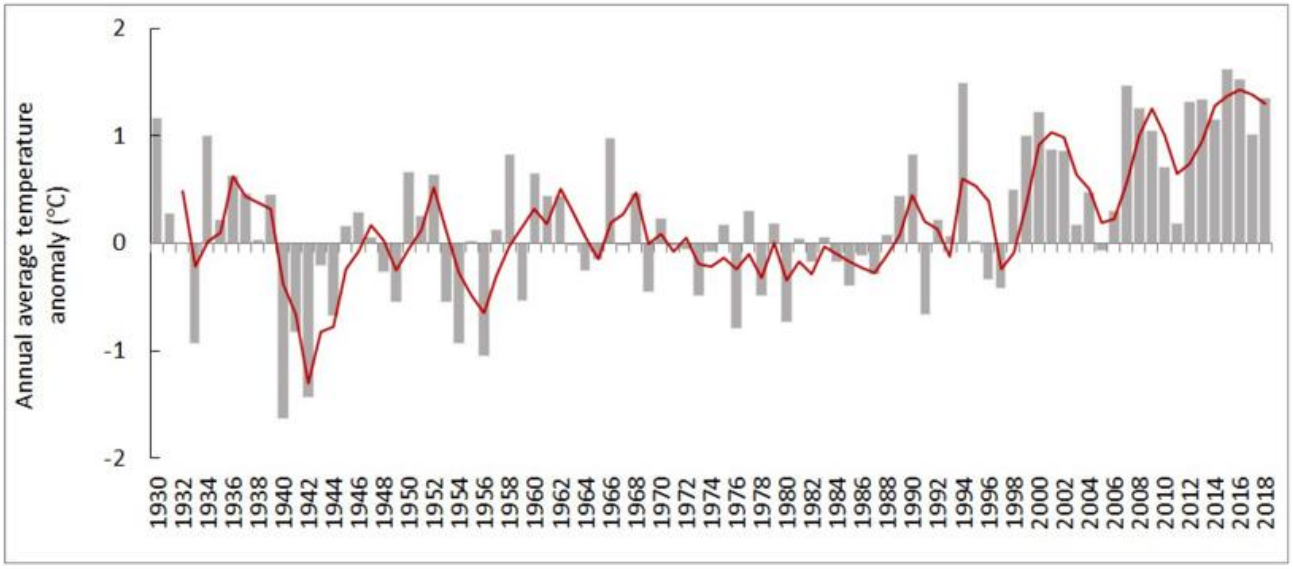


Figure 5-17: Time series of annual temperature anomalies for Bulgaria for the period 1930-2018 (reference period 1981-2010; diagram as provided by NHMS)

Italy

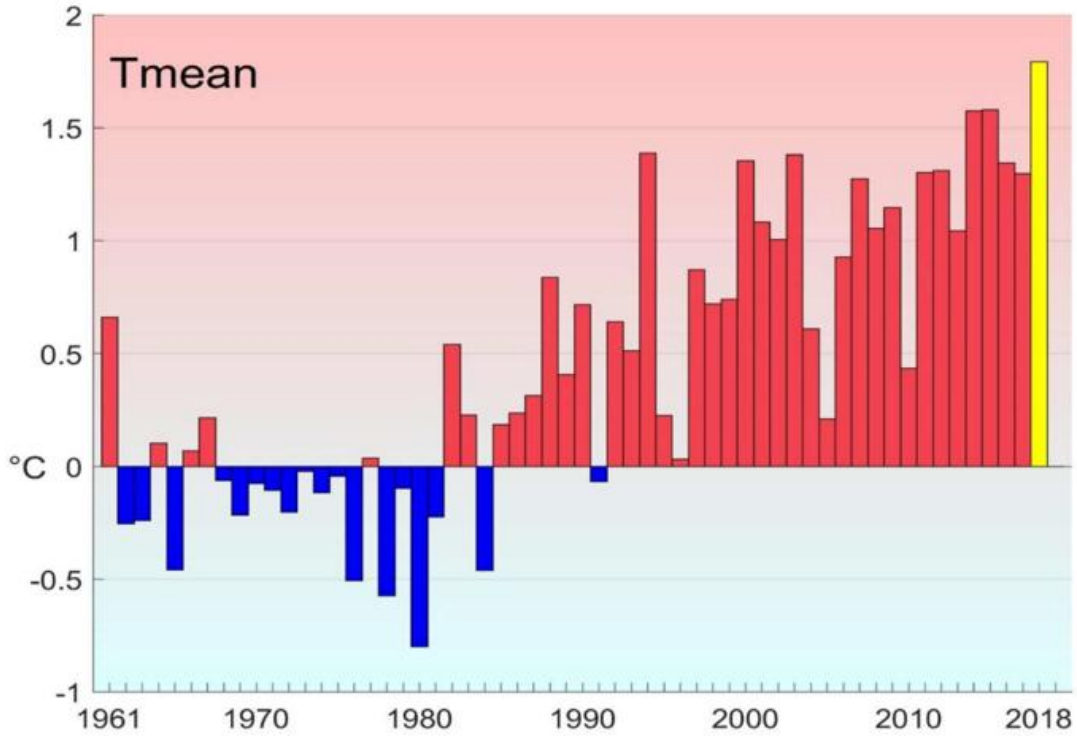


Figure 5-18: Time series of annual temperature anomalies for Italy for the period 1961-2018 (reference period 1961-1990; diagram as provided by ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

Slovenia

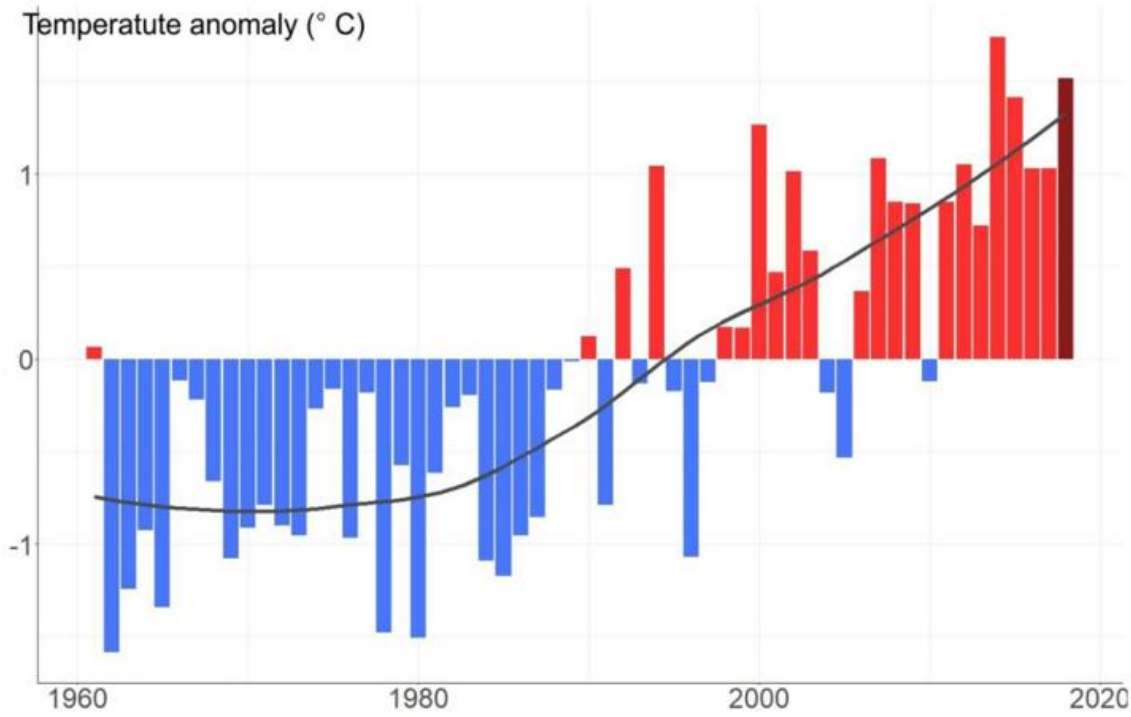


Figure 5-19: Time series of annual temperature anomalies for Slovenia for the period 1961-2018 (reference period 1961-1990; diagram as provided by the NHMS)

Serbia

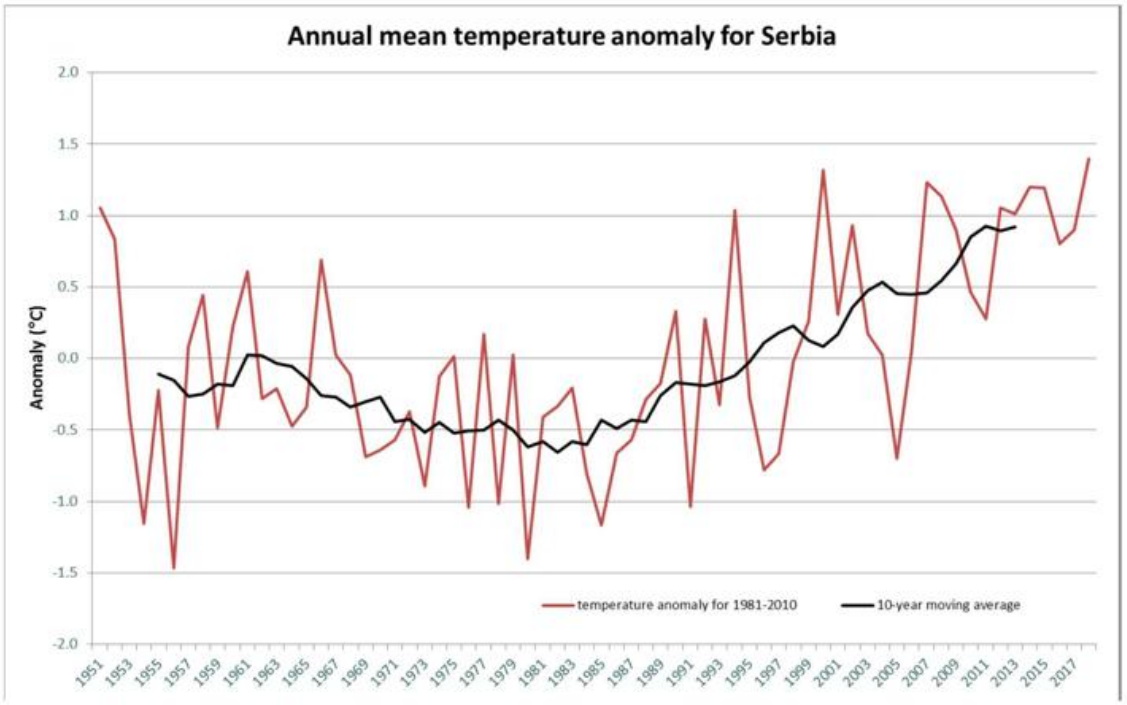


Figure 5-20: Time series of annual temperature anomalies for Serbia for the period 1951-2018 (reference period 1981-2010; diagram as provided by the NHMS)

Turkey

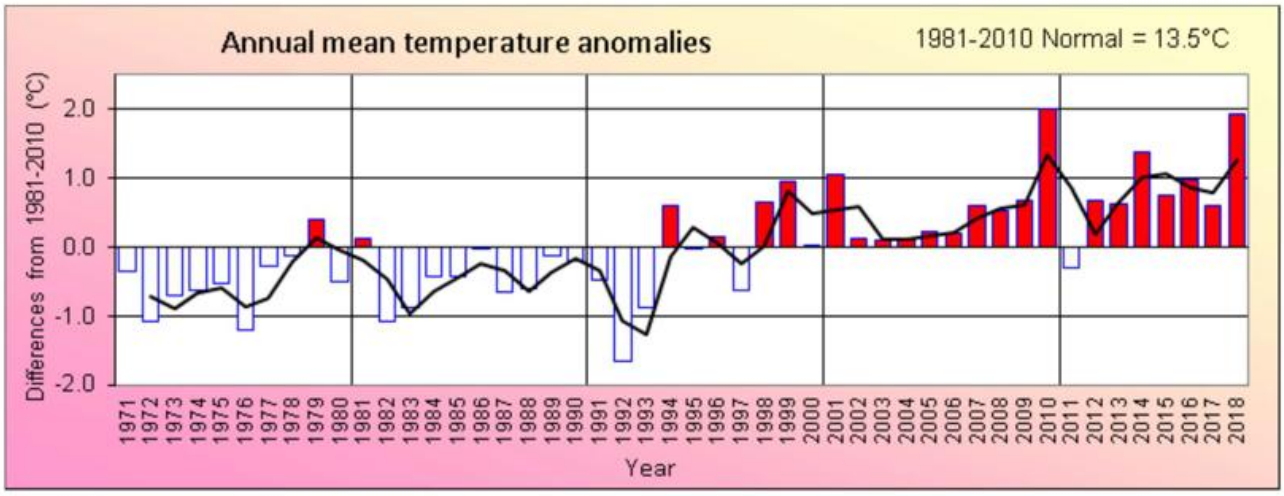


Figure 5-21: Time series of annual temperature anomalies for Turkey for the period 1971-2018 (reference period 1981-2010; diagram as provided by the NHMS)

Eastern Europe – annual temperature series

Belarus, European Russia, Ukraine

Belarus

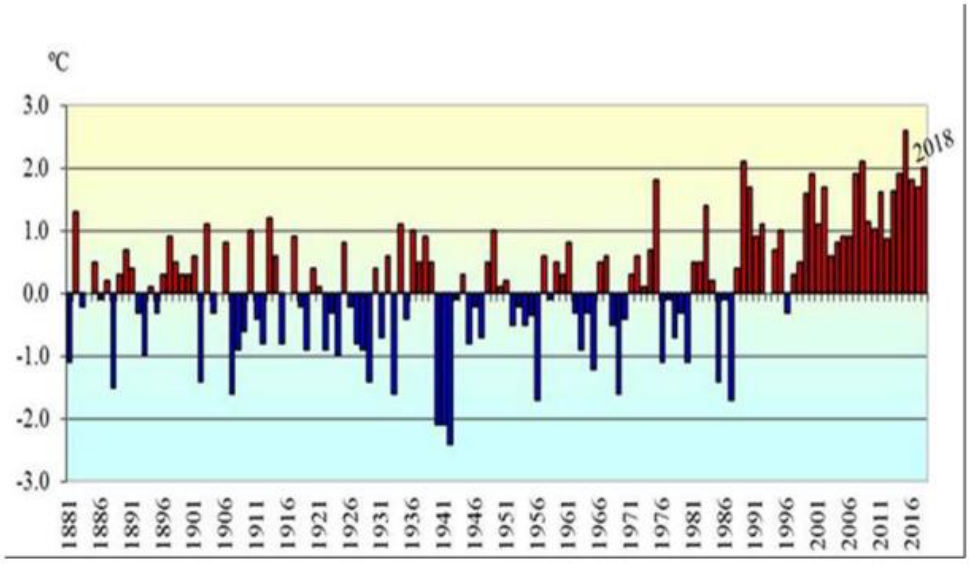


Figure 5-22: Time series of annual temperature anomalies for the Republic of Belarus for the period 1881-2018 (reference period 1961-1990; diagram as provided by the NHMS)

European Russia

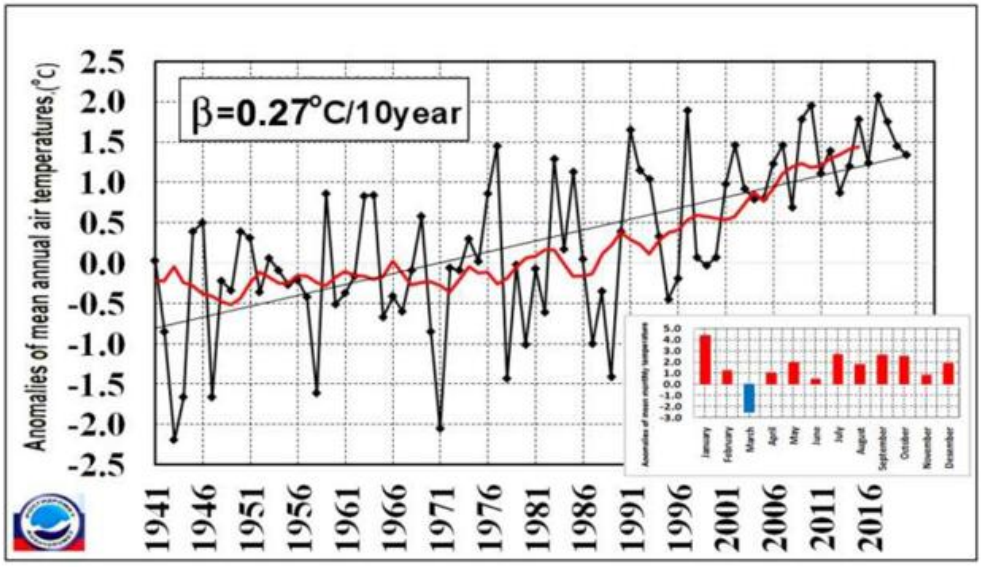


Figure 5-23: Time series of annual temperature anomalies for European Russia for the period 1939-2018 (reference period 1961-1990; diagram as provided by the NHMS)

Ukraine

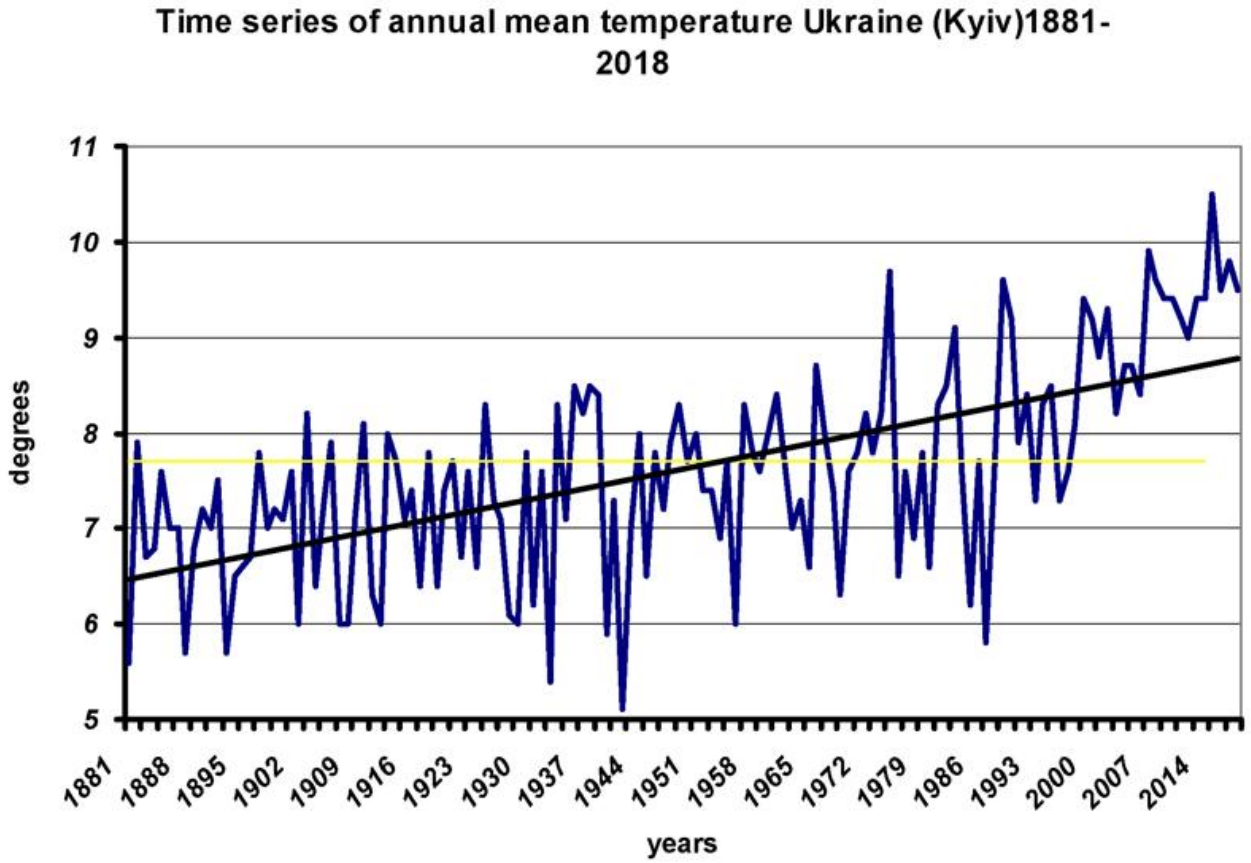


Figure 5-24: Time series of annual temperature for Kiev (Ukraine) for the period 1881-2018 (Diagram as provided by the NHMS)

Middle East – annual temperature series

Georgia, Israel, Kazakhstan

Georgia

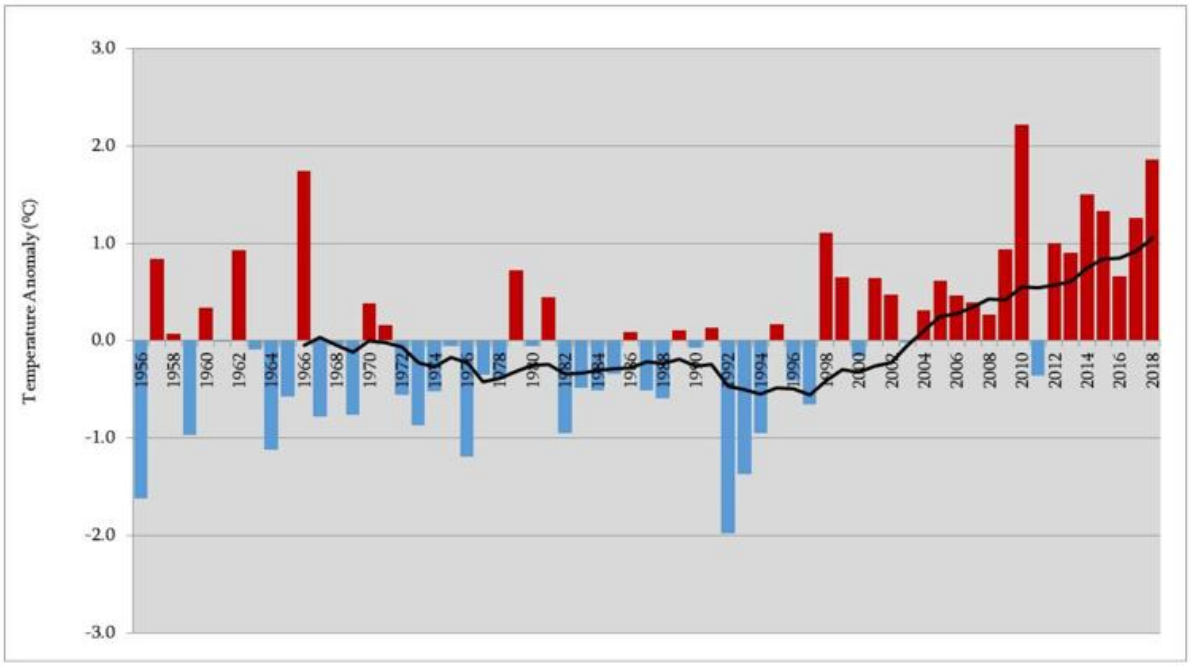


Figure 5-25: Anomalies of the annual mean temperature for Georgia for the period 1956 to 2018 (reference period 1981-2010; diagram as provided by the NHMS).

Israel

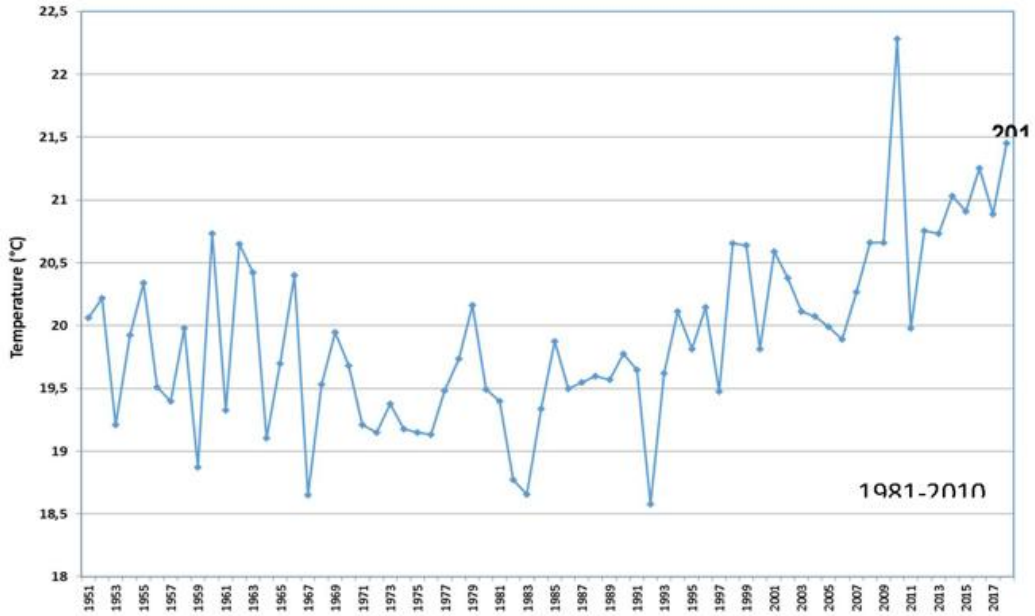


Figure 5-26: Time series of annual temperature for Israel (based on five stations) for the period 1951-2018 (diagram as provided by the NHMS)

Kazakhstan

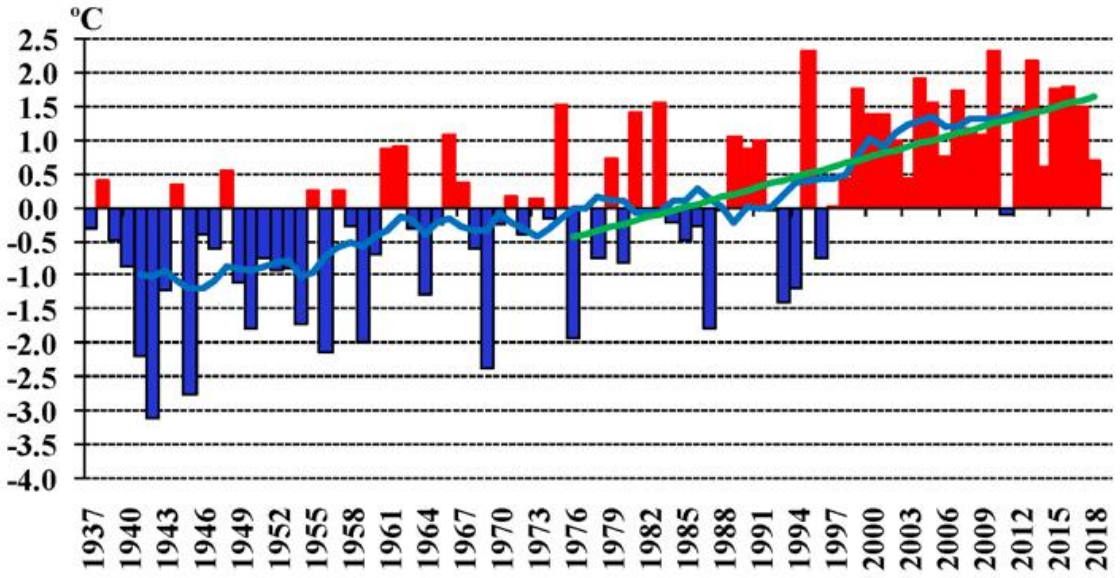


Figure 5-27: Anomalies of the annual mean temperature averaged over the European part of Kazakhstan in the period 1936 2018 with 11-year running mean (reference period 1961-1990, diagram as provided by the NHMS)

5.2. *Precipitation*

Central and Western Europe - precipitation totals and anomalies

Austria,, Germany, Hungary, Switzerland

Austria

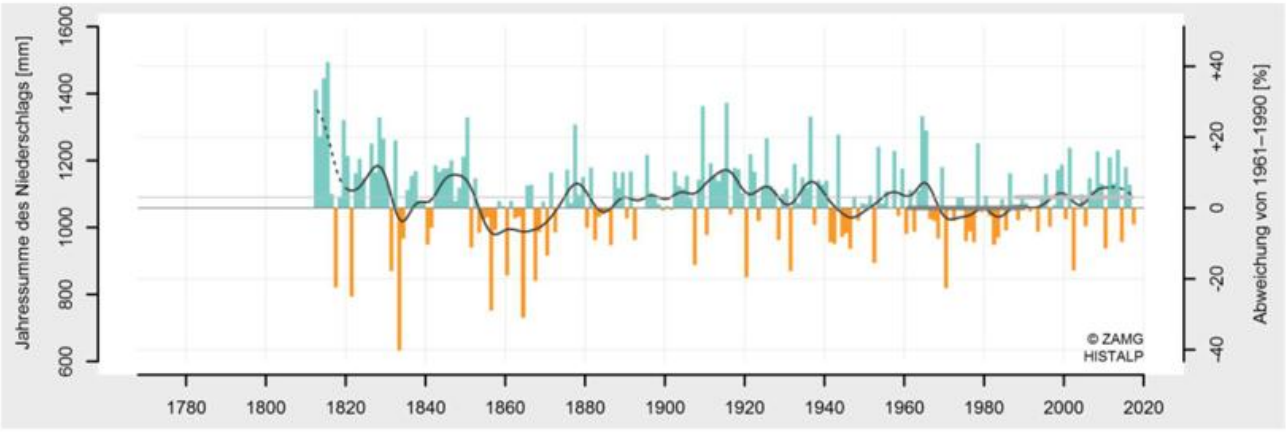


Figure 5-28: Time series of annual precipitation anomalies in relation to the long term mean (1961-1990) for Austria (Diagram as provided by the NHMS)

Germany

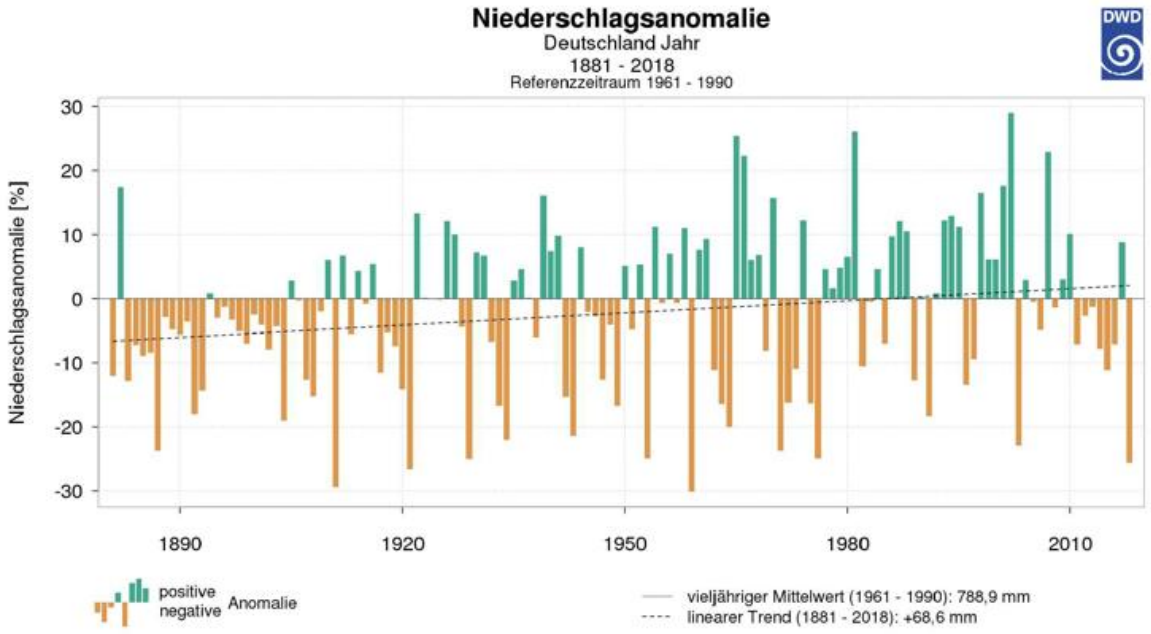


Figure 5-29: Time series of annual precipitation anomalies in % from reference period 1961-1990 for Germany for the period 1881-2018 (green line: long term mean; Diagram as provided by the NHMS)

Hungary

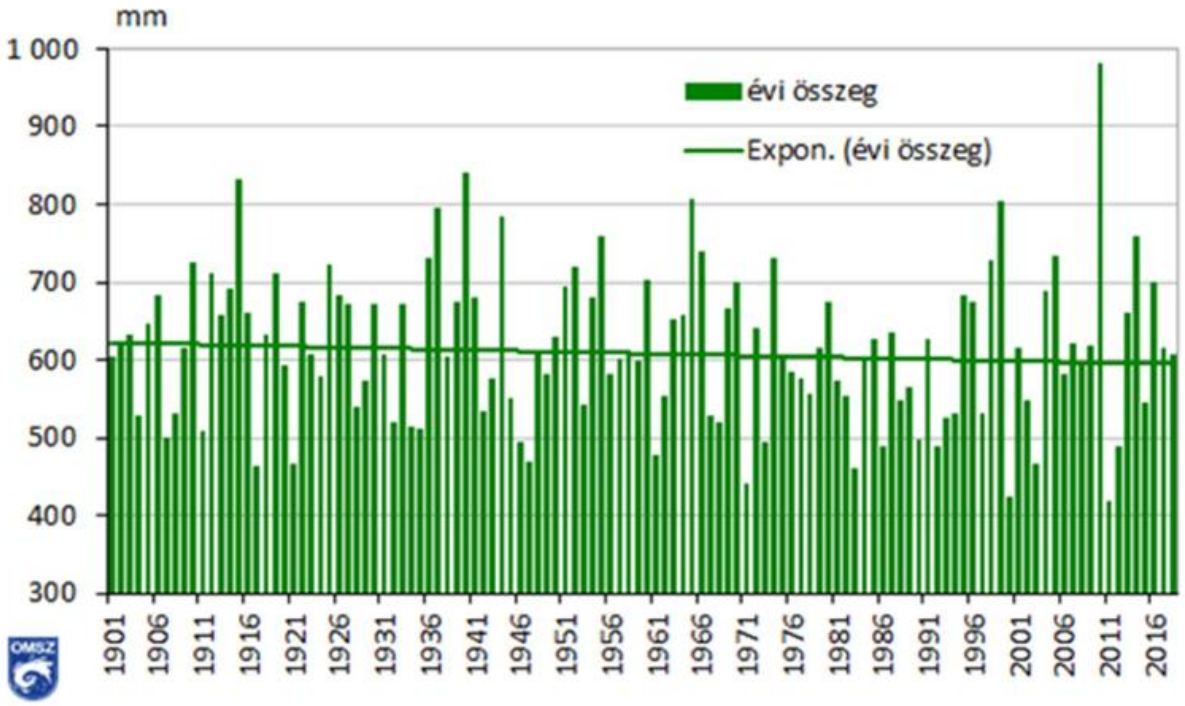


Figure 5-30: Time series of annual precipitation totals in mm/year for Hungary for the period 1901-2018 (Diagram as provided by the NHMS)

Switzerland

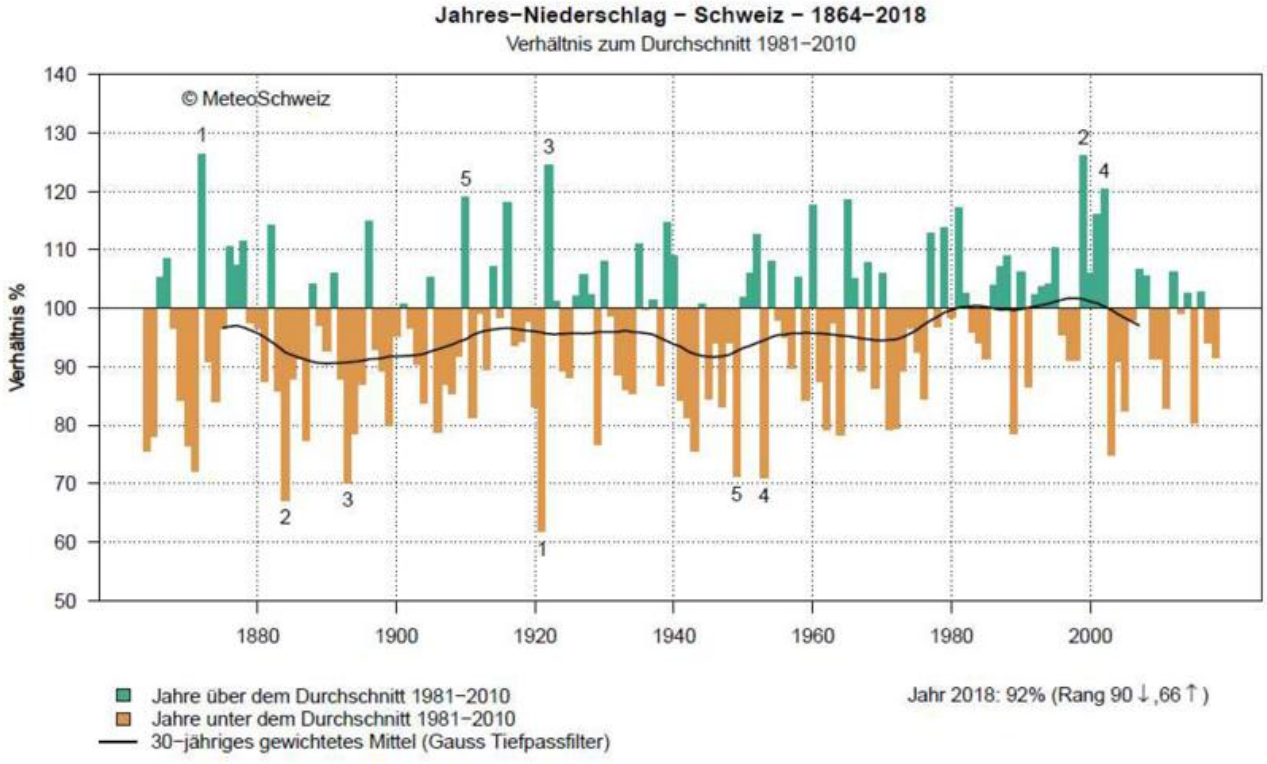


Figure 5-31: Time series of annual precipitation anomalies in % from reference period 1981-2010 for Switzerland for the period 1864-2018 (black line: long term weighted mean; Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Denmark, Estonia,, Latvia, Norway, Sweden

Denmark

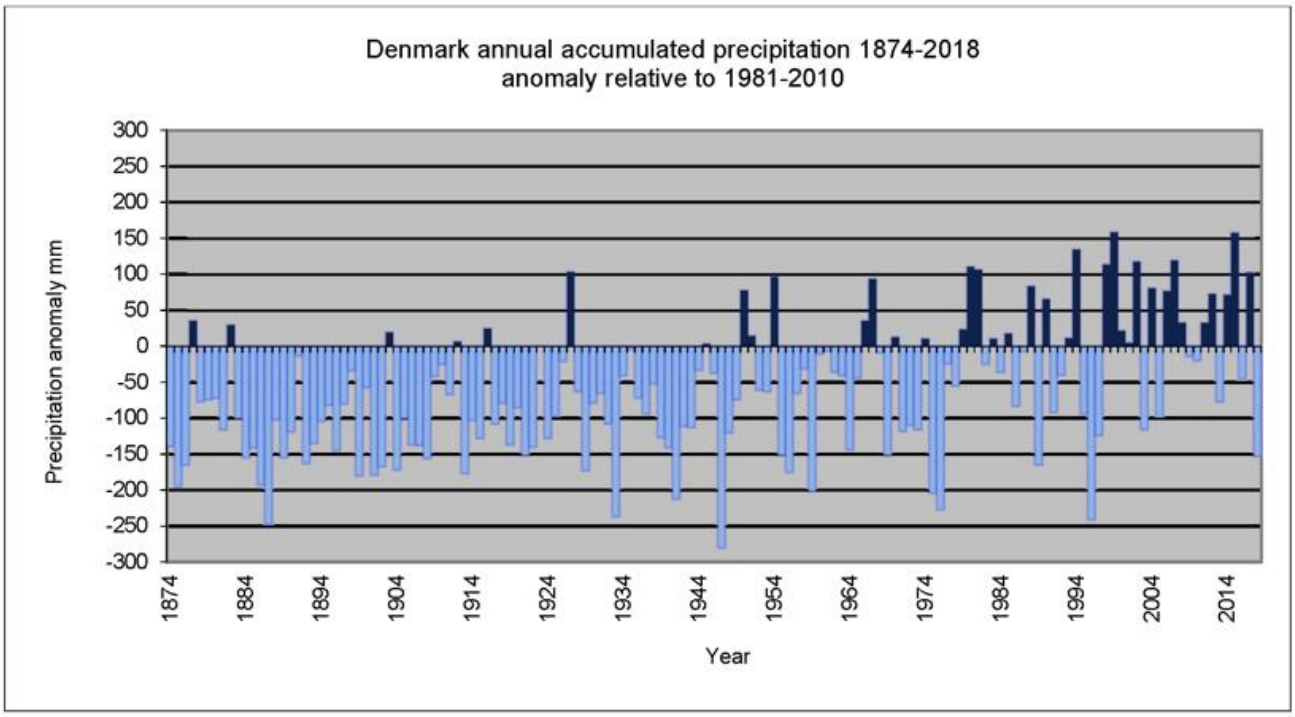


Figure 5-32: Time series of annual precipitation totals in mm/year for Denmark: anomaly relative to 1981-2010 (Diagram as provided by the NHMS)

Estonia

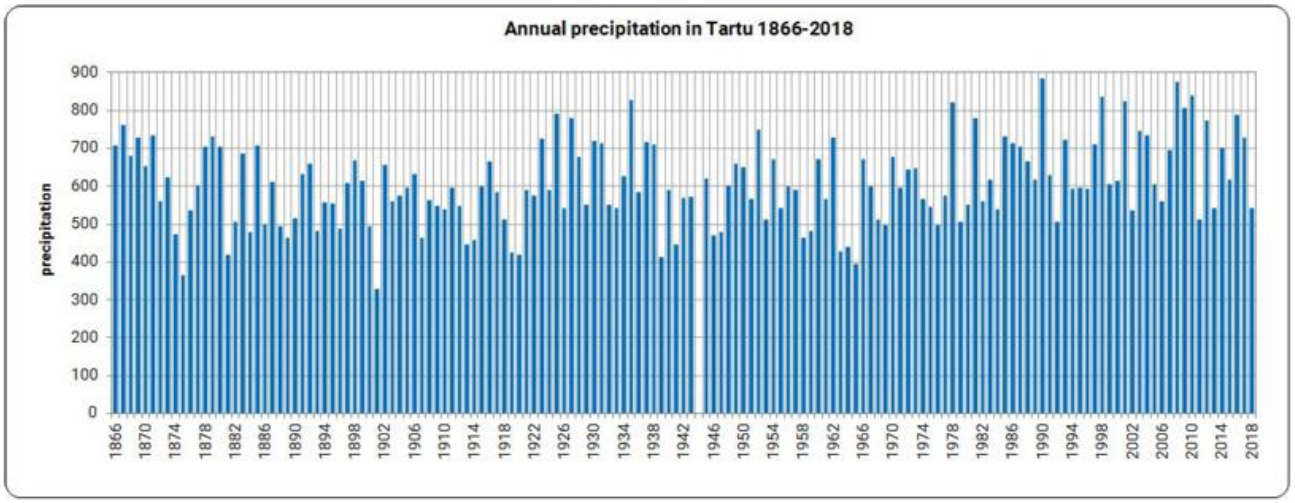


Figure 5-33: Time series of annual precipitation totals in mm/year at station Tartu, Estonia (Diagram as provided by the NHMS)

Latvia

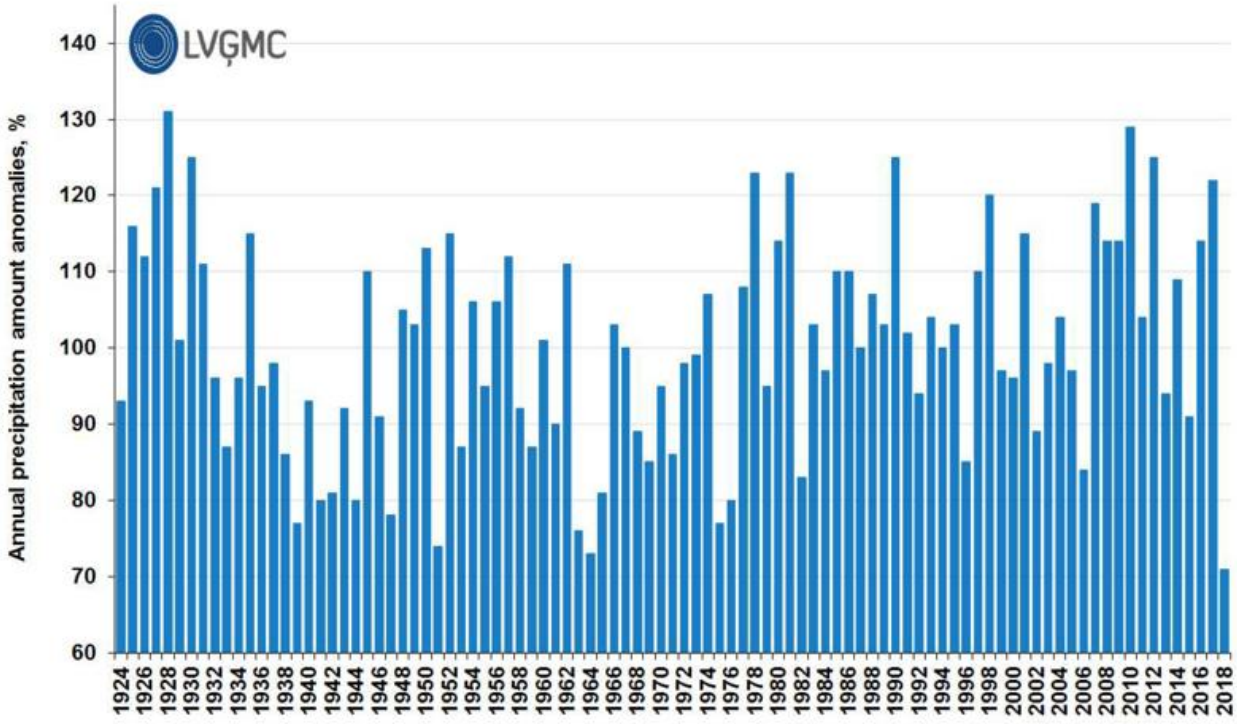


Figure 5-34: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Latvia (Diagram as provided by the NHMS)

Norway

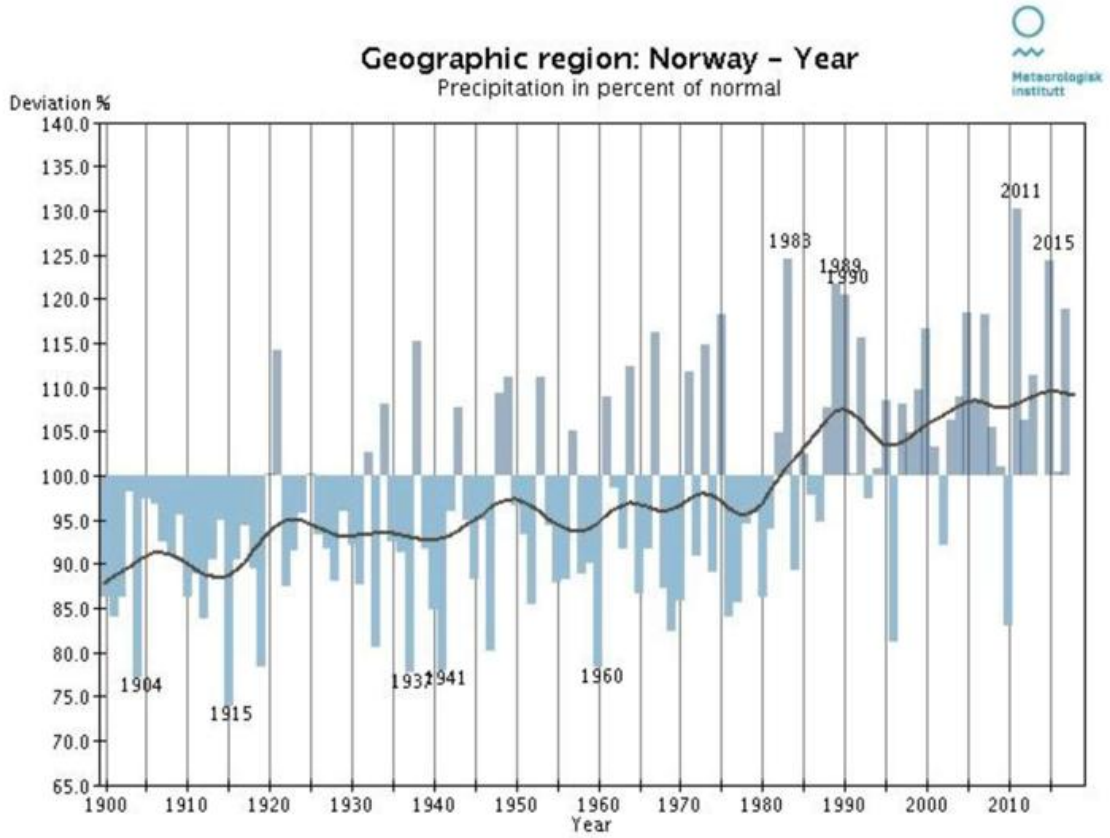


Figure 5-35: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Norway (Diagram as provided by the NHMS)

Sweden

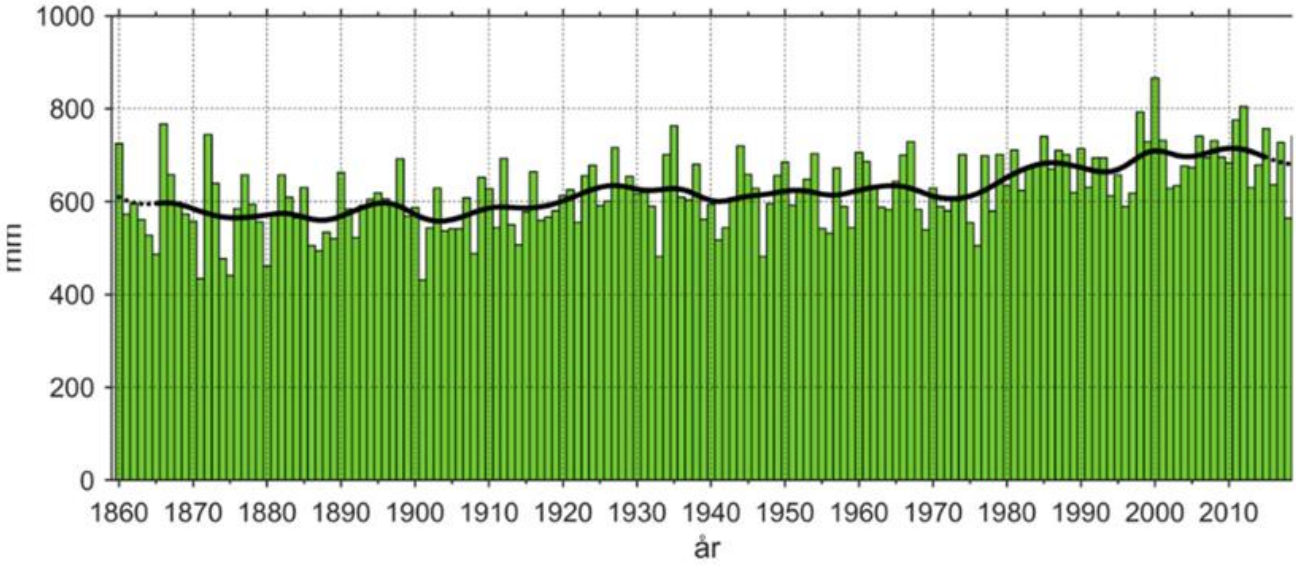


Figure 5-36: Time series of annual precipitation totals in mm/year for Sweden
(Diagram as provided by the NHMS)

Iberia - precipitation anomalies

Portugal, Spain

Portugal

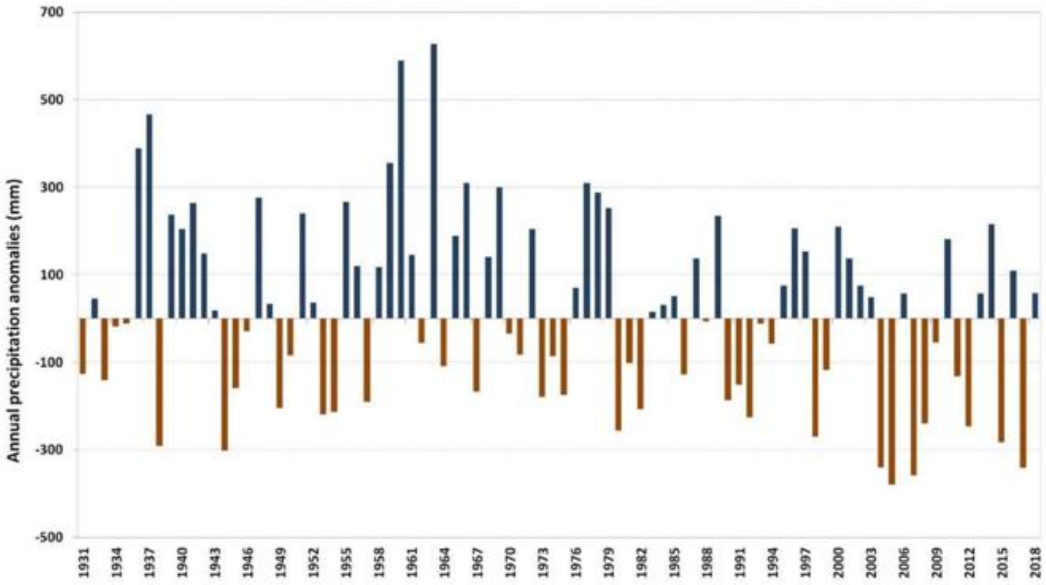


Figure 5-37: Time series of annual precipitation totals in mm/year (deviations from the mean of 1971-2000) for Portugal (Diagram as provided by the NHMS)

Spain

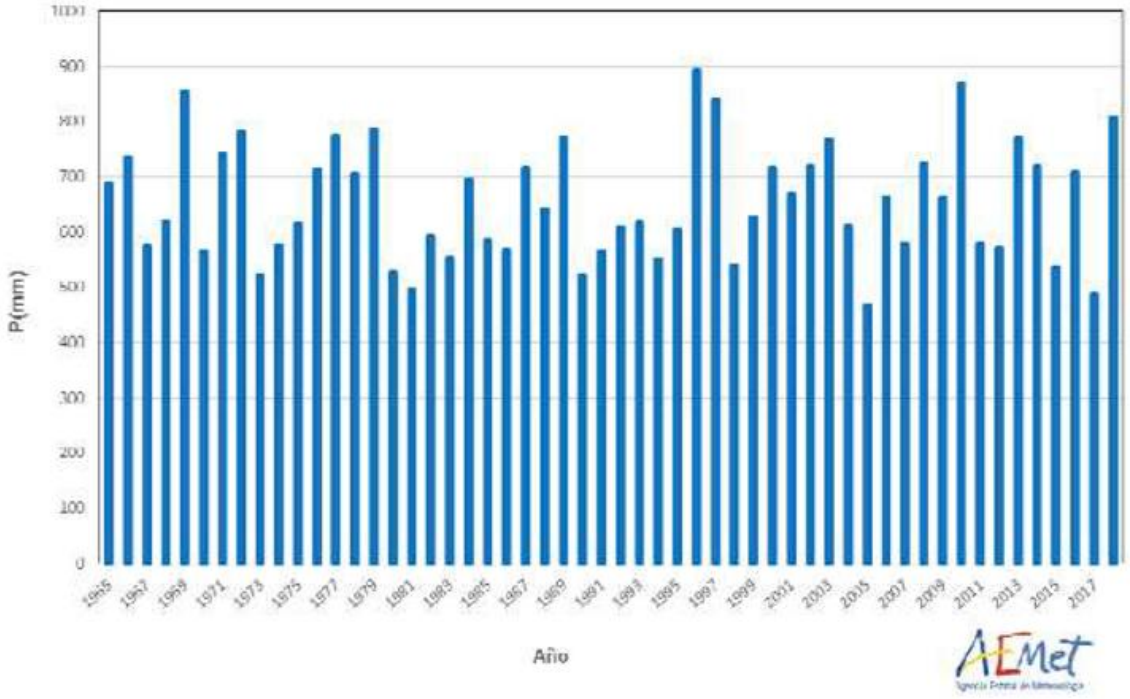


Figure 5-38: Time series of annual precipitation totals in mm/year for Spain (Diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Bulgaria, Italy, Slovenia, Turkey

Bulgaria

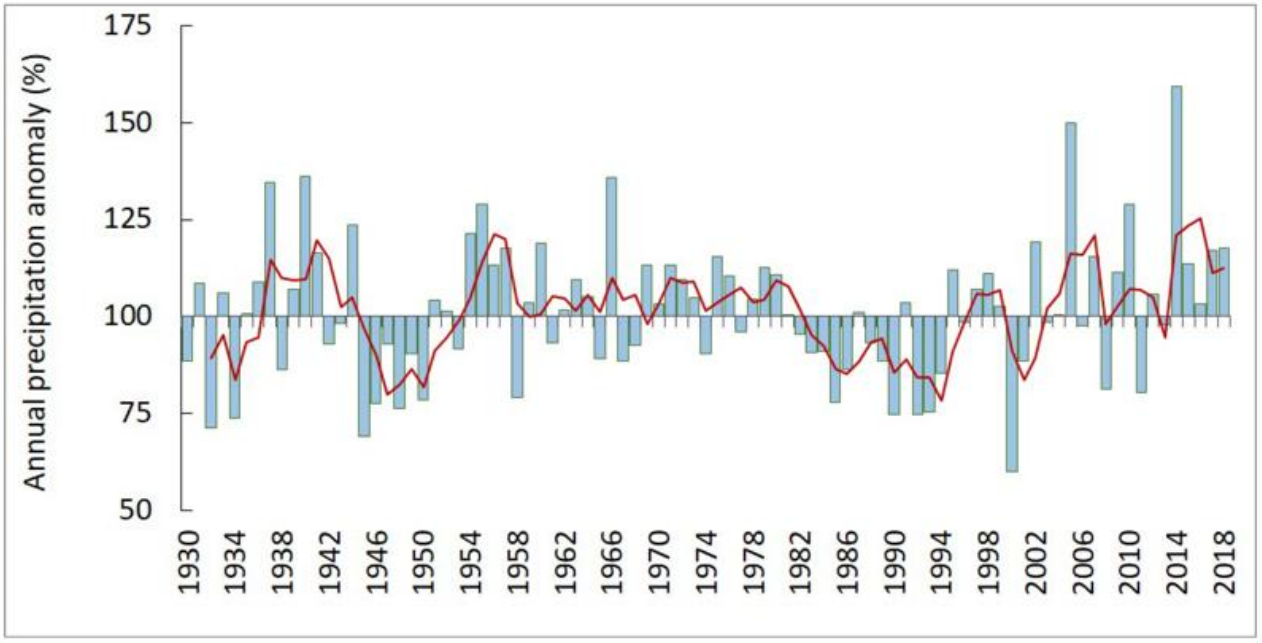


Figure 5-39: Time series of annual precipitation anomalies in relation to the mean of 1981-2010 for the period 1930 to 2018 for Bulgaria (diagram as provided by NHMS)

Italy

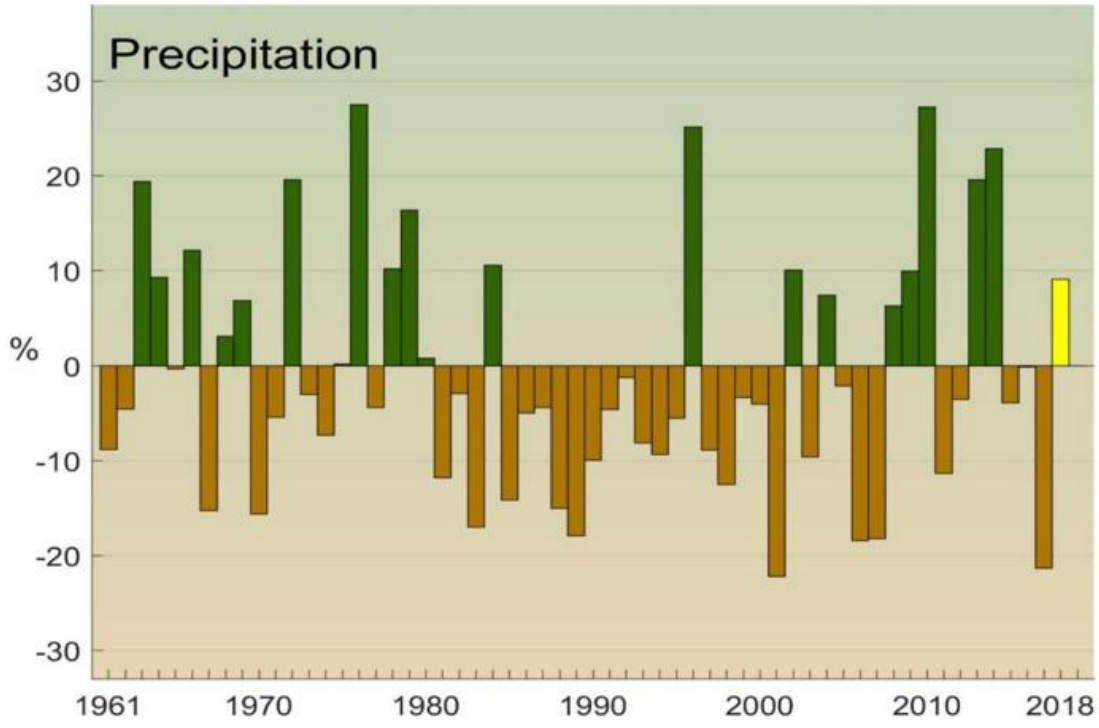


Figure 5-40: Time series of annual precipitation anomalies in relation to the mean of 1961-90 for Italy (diagram as provided by ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Slovenia

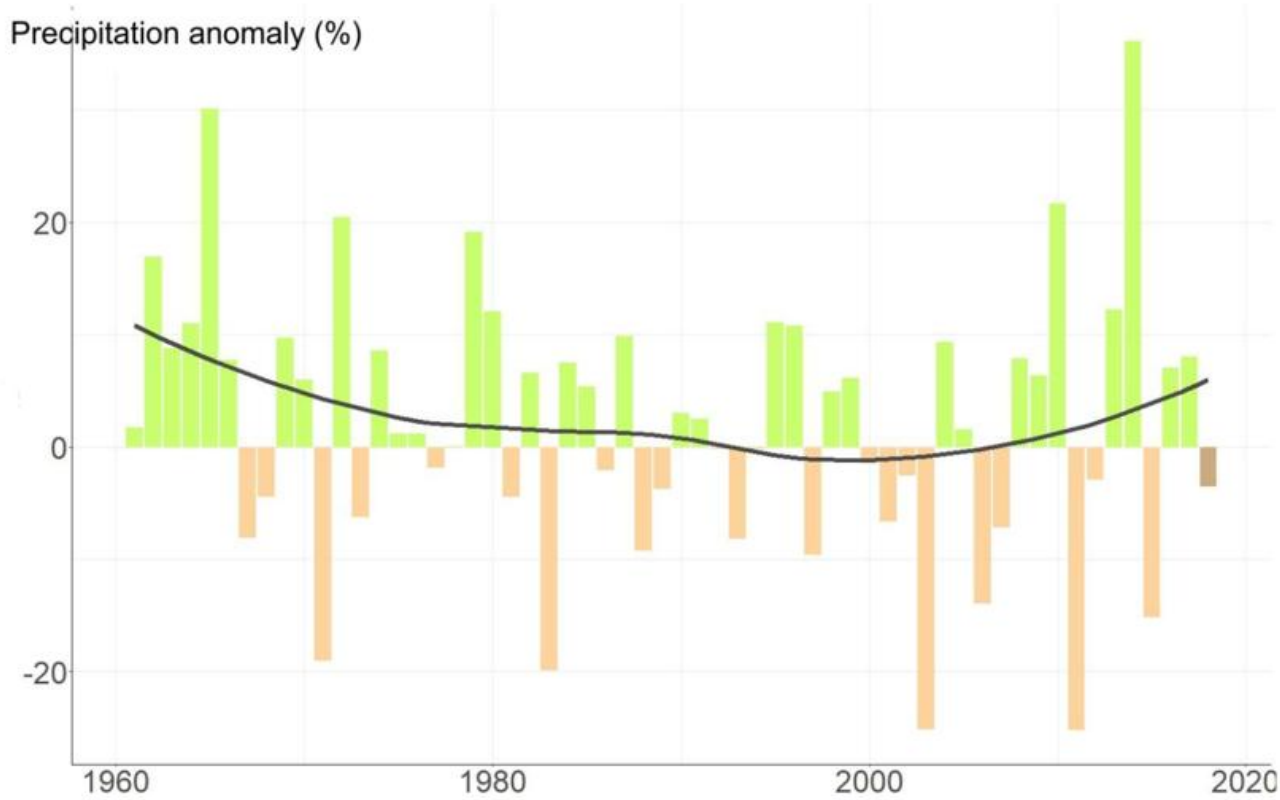


Figure 5-41: Time series of annual precipitation anomalie in % of reference period for Slovenia 1961-2018 (diagram as provided by the NHMS)

Turkey



Figure 5-42: Time series of annual precipitation anomalies in relation to the mean of 1981-2010 for Turkey (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Belarus, European Russia, Ukraine

Belarus

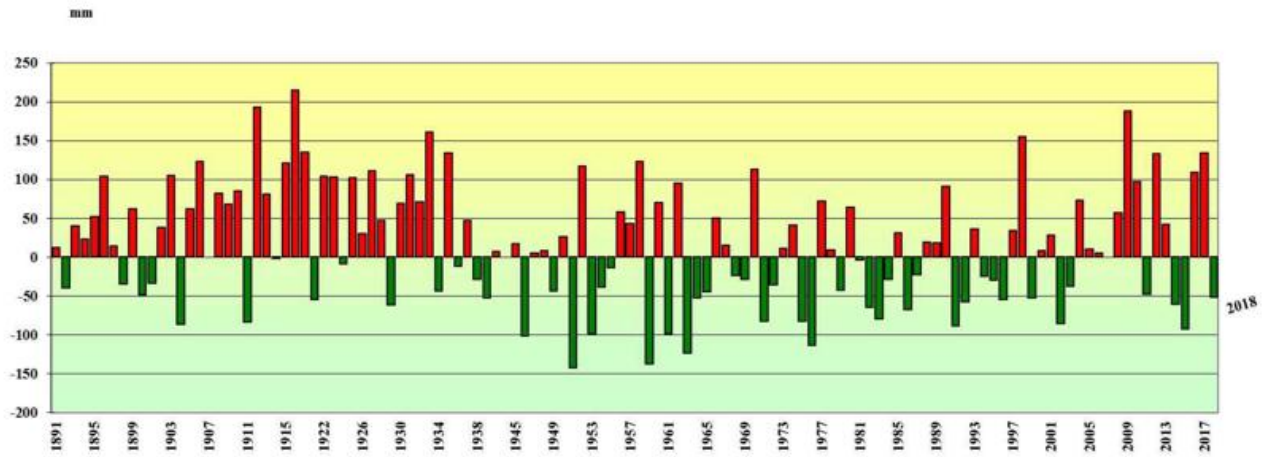


Figure 5-43: Anomalies of annual precipitation totals for Belarus 1891-2018 (base period: 1961-1990; Diagram as provided by the NHMS)

European Russia

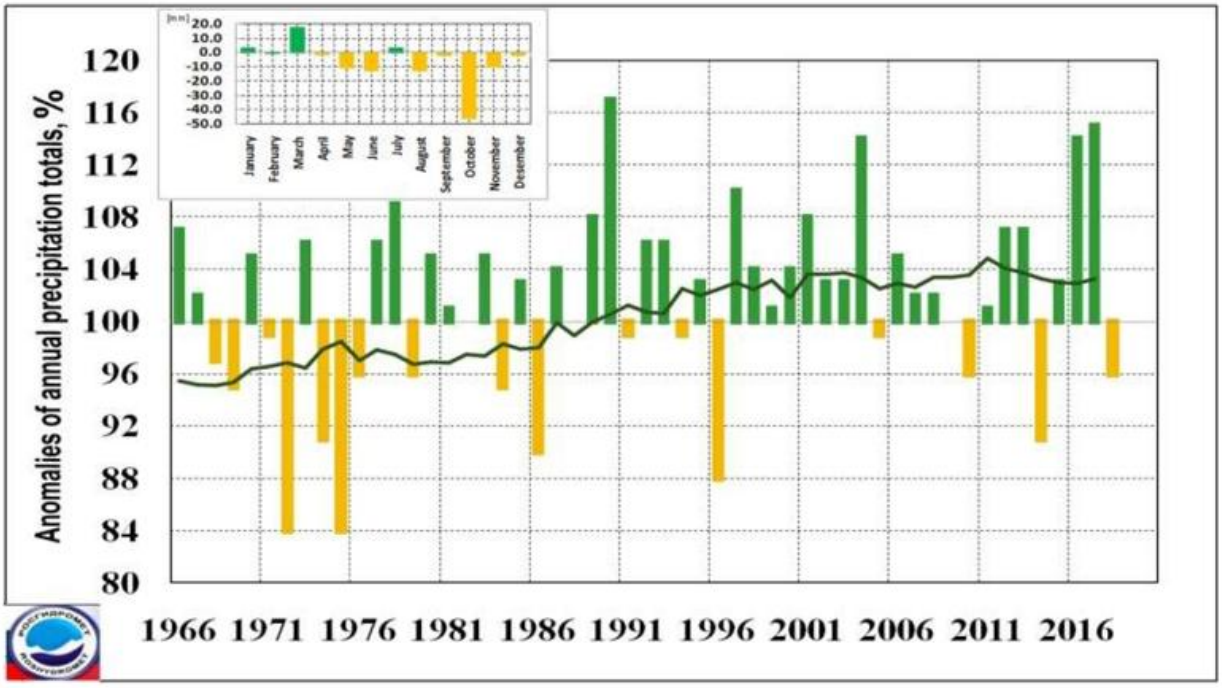


Figure 5-44: Time series of annual precipitation totals in relation to the mean of 1961-1990 for European Russia (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Ukraine

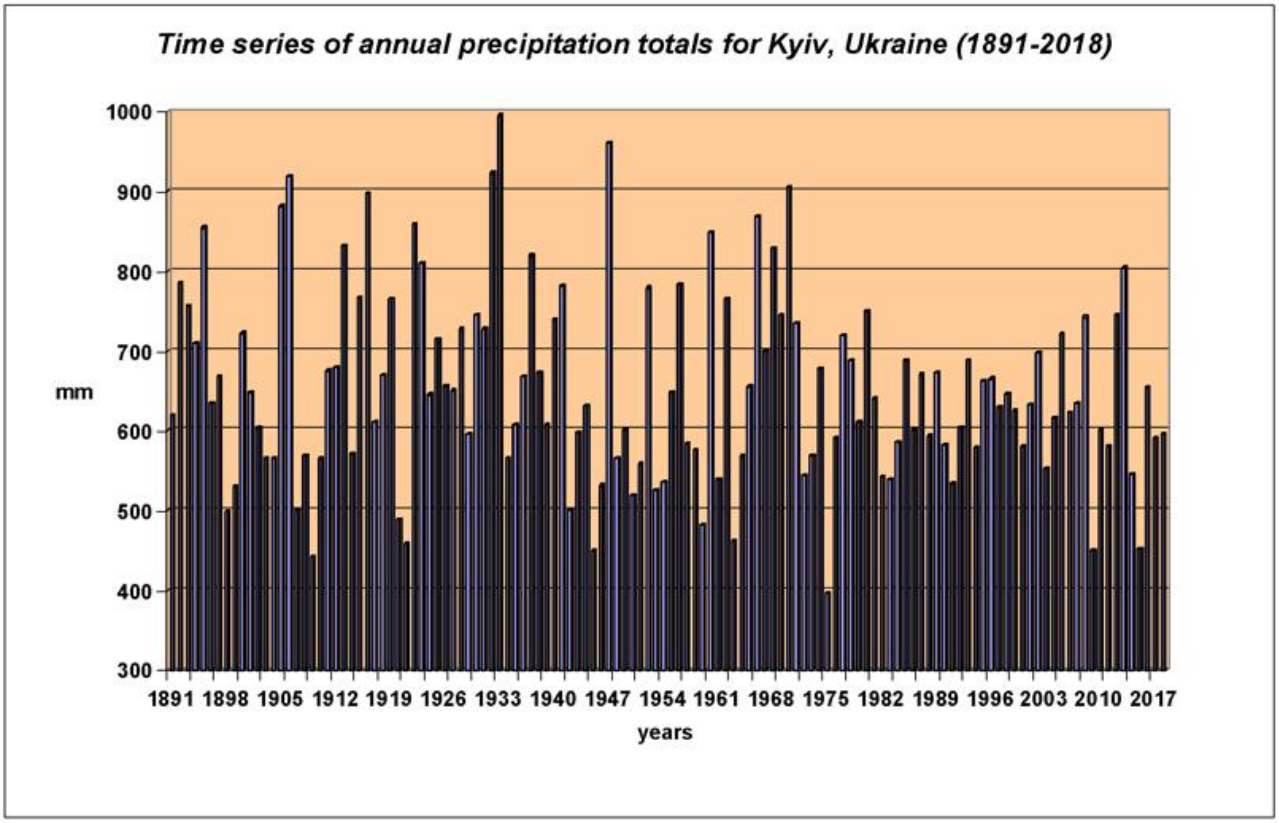


Figure 5-45: Time series of annual precipitation totals in mm/year for Kiev (Ukraine) (Diagram as provided by the NHMS)

Middle East - precipitation anomalies

Georgia, Israel, Kazakhstan

Georgia

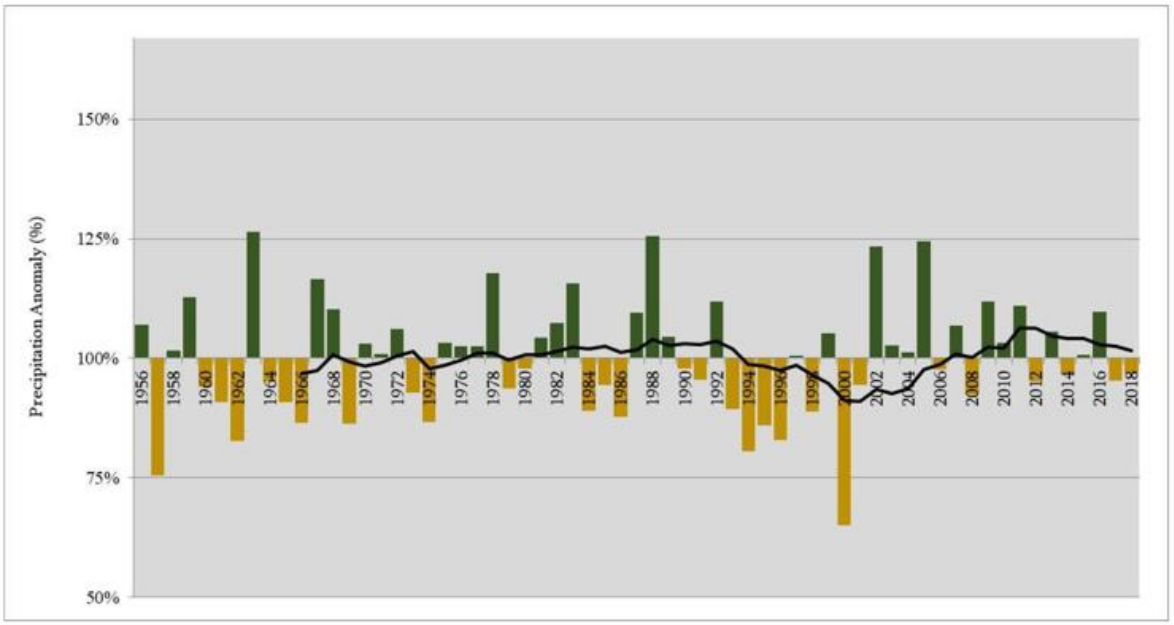


Figure 5-46: Annual precipitation anomalies (relative to 1981–2010) expressed as percentages above or below the long-term average with 11-yr moving average for Georgia for the period 1956– 2018.

Israel

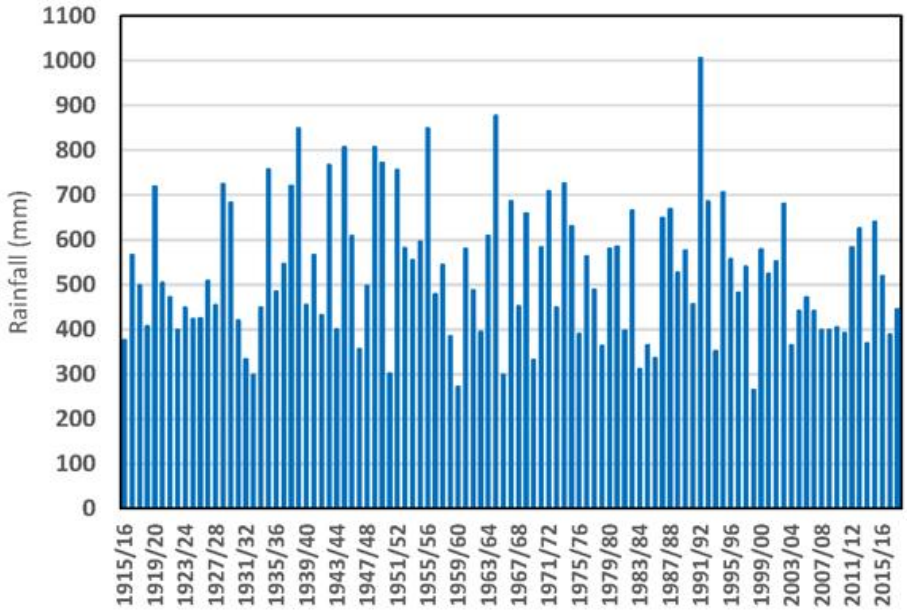


Figure 5-47: Yearly rainfall amounts (mm) in Miqwe Yisrael (Central Coastal Plain) **prepared according to the rainfall seasons** starting **in rainfall season 1915/16 and ending in rainfall season 2017/18**, (diagram as provided by the NHMS)

Kazakhstan

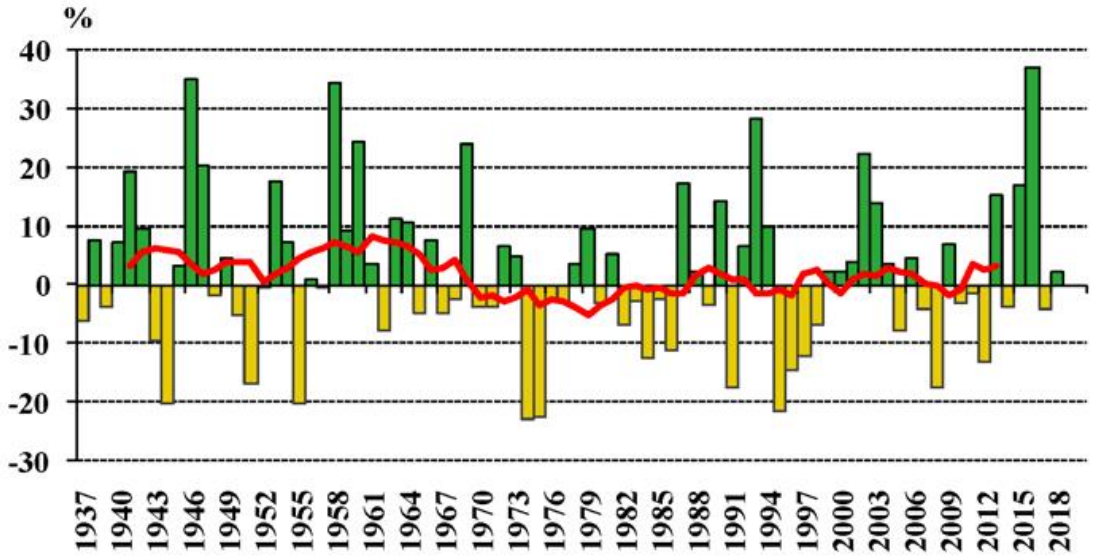


Figure 5-48: Anomalies of annual precipitation totals (in %) averaged over Kazakhstan in the period 1936-2018 (reference period 1961-1990, diagram as provided by the NHMS).

5.3. *Sunshine duration*

Central and Western Europe - sunshine duration anomalies

Germany

Germany

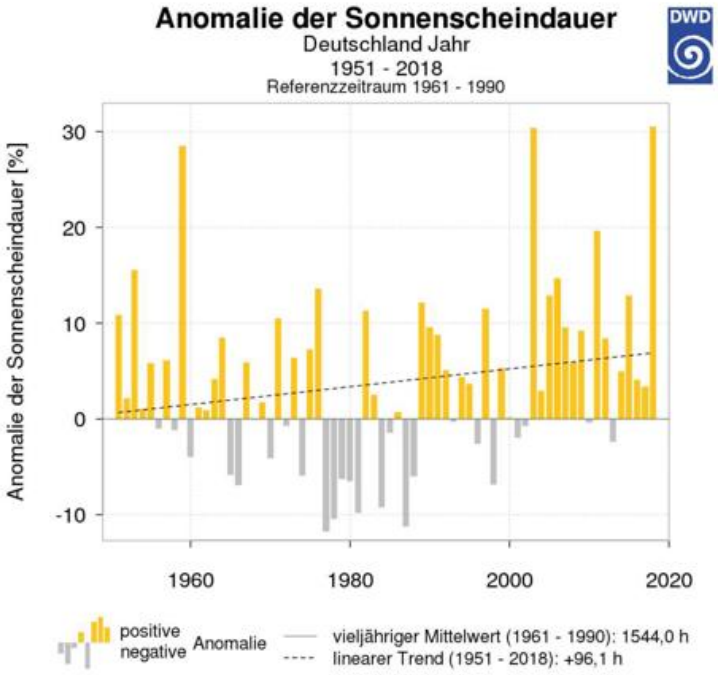


Figure 5-49: Time series of annual anomaly of the sunshine duration [%] for Germany with respect to the long-term mean 1961-1990 (dotted line: linear trend; diagram as provided by the NHMS)

Nordic and Baltic Countries - sunshine duration

Denmark, Estonia

Denmark

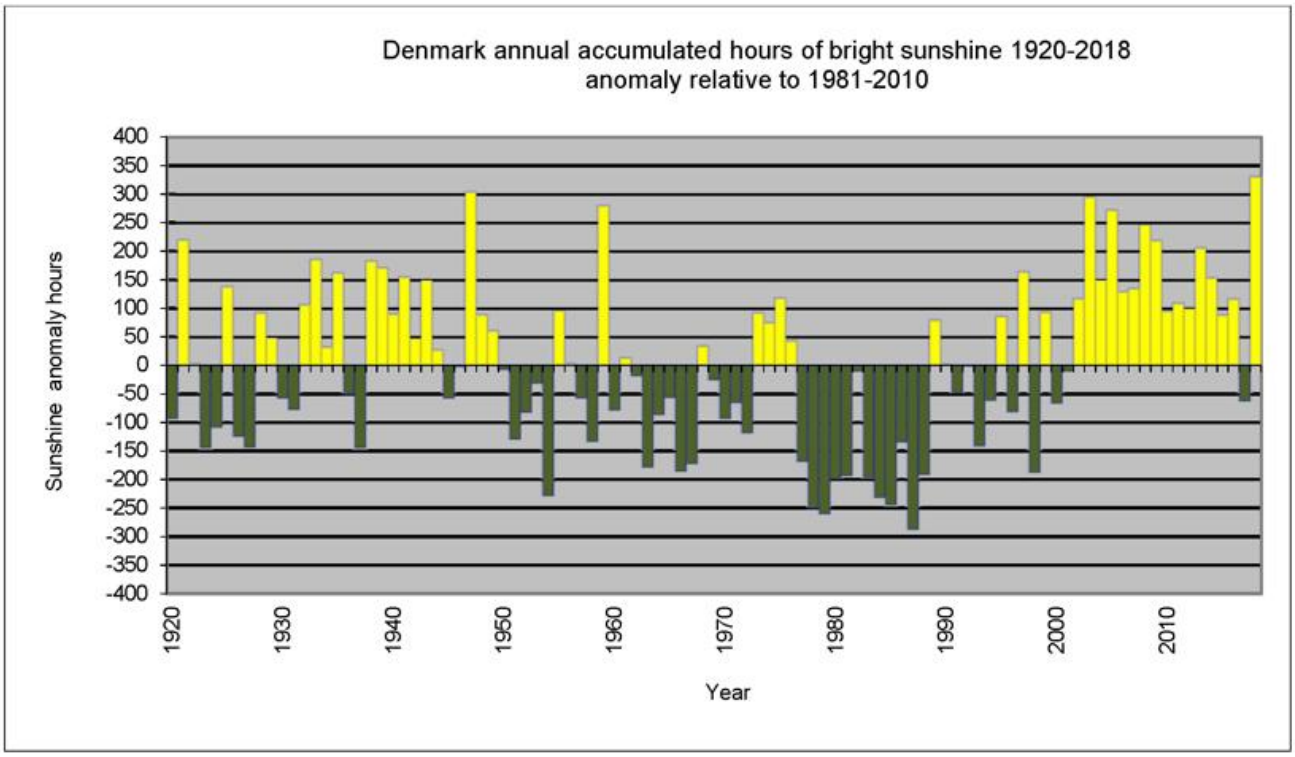


Figure 5-50: Time series of annual sunshine duration in hours for Denmark: anomaly relative to 1981-2010. The values are calculated as national average based on a number of selected stations. (Diagram as provided by the NHMS)

Note: *OBS! DMI has since 2002 observed the hours of bright sunshine using measurements of global radiation instead of measurements from a traditional Campbell-Stokes sunshine recorder. For that reason "new" and "old" hours of bright sunshine cannot directly be compared. It should also be noted that all values before 2002 are adjusted ensuring comparability to the new level. For details on that, see DMI Technical 02-25: Ellen Vaarby Laursen, Stig Rosenørn: New hours of bright sunshine normals for Denmark, 1961-1990.*

http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2002/tr02-25.pdf

Data up to 2016 are published in DMI report series, No. 17-02 John Cappelen (ed)(2017): Denmark - DMI Historical Climate Data Collection 1768-2016.

http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2017/DMIRep17-02.pdf (report)

http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2017/DMIRep17-02.zip (data)

Estonia

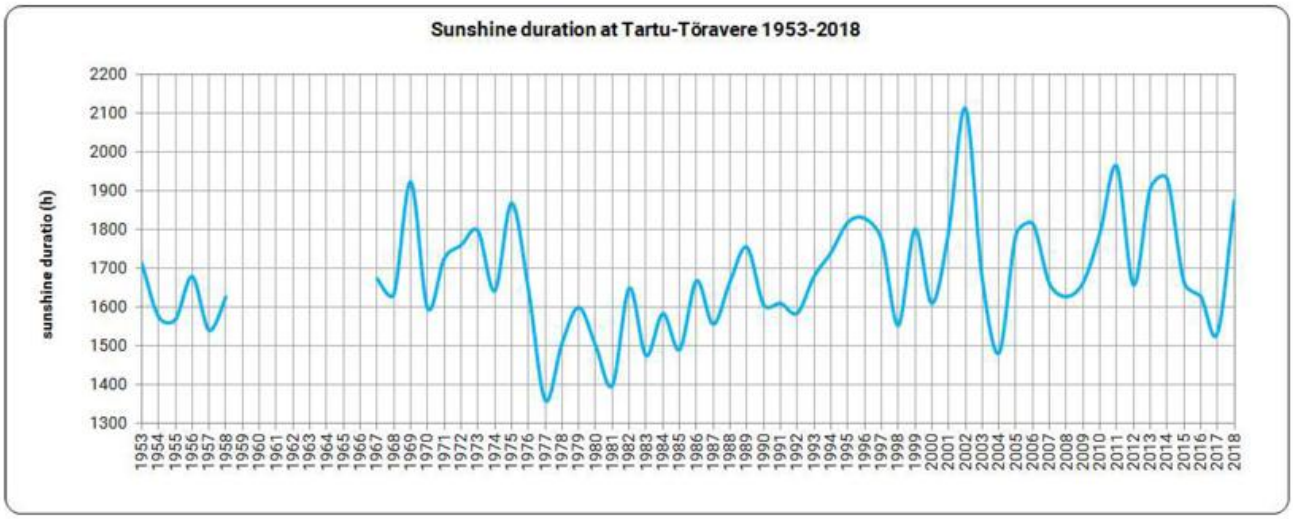


Figure 5-51: Time series of annual sunshine duration in hours for Estonia (station Tartu-Töravere, diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula - sunshine duration anomalies

Slovenia

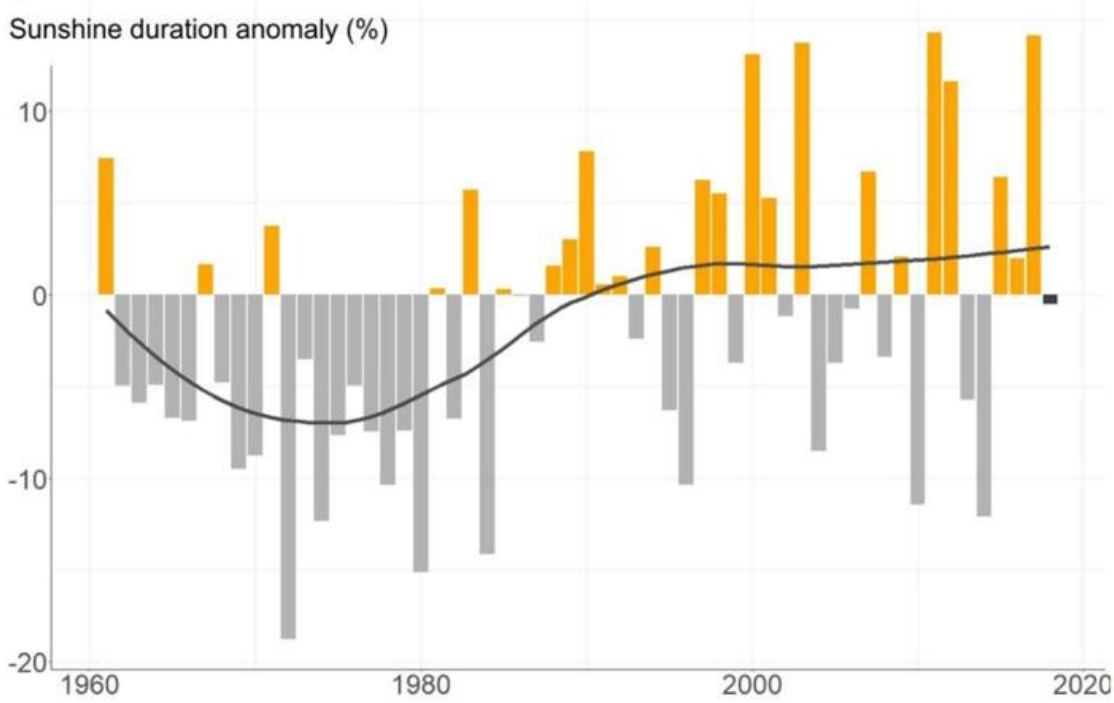
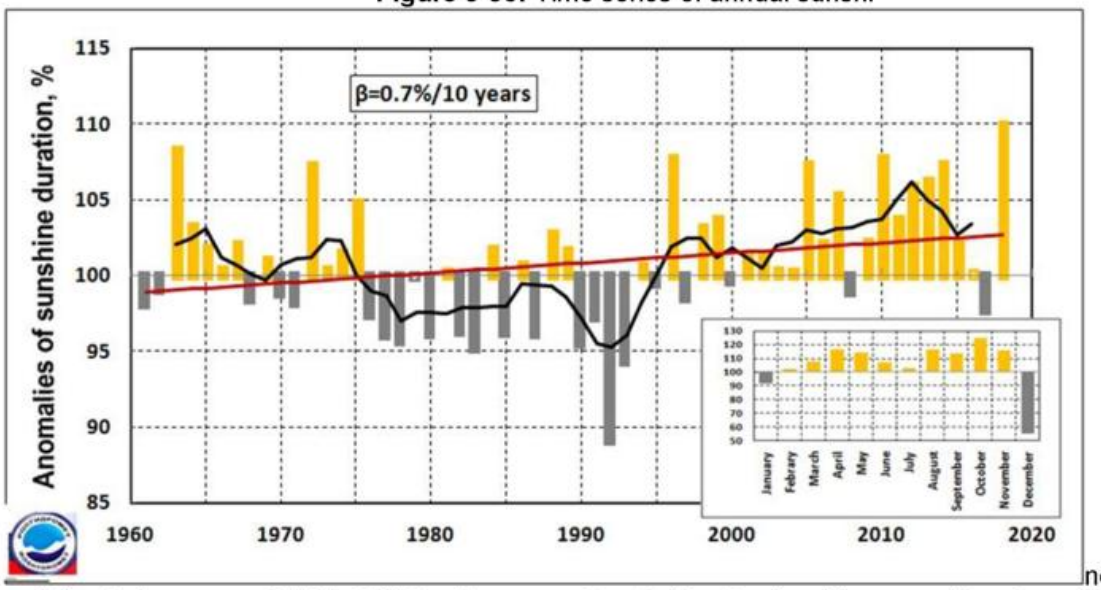


Figure 5-52: Time series of annual sunshine duration in hours for Slovenia: anomaly relative to 1981-2010 (graph as provided by the NHMS).

Eastern Europe - sunshine duration anomalies

European Russia

Figure 5-53: Time series of annual sunshi



ne duration in relation to the mean of 1981-2010 for European Russia (Insets show the anomalies of monthly sunshine duration in 2018; Diagram as provided by the NHMS)

6. Annex: Monthly and annual tables

Table 6-1: Statistical values of **annual** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

station name	country	Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.
Jan Mayen	NOR	2,0	3,4	683	-4
Svalbard	NOR	-1,8	4,6	292	109
Tromsoe	NOR	3,6	0,8	1015	42
Oslo	NOR	7,8	2,0	652	-117
Haparanda	SWE	2,9	1,8	413	-139
Stockholm	SWE	8,8	2,3	348	-191
Sodankylä	FIN	1,4	2,4	472	-28
Helsinki Airp.	FIN	6,7	2,2	498	-153
Leuchars (Dundee)	GBR	9,2	0,9	635	-20
London	GBR	12,5	2,0	580	-20
Dublin/Casement	IRL	9,9	0,7	660	-52
Reykjavik	ISL	5,1	0,8	1054	256
Aasiaat (Egedisminde)	GRL	-4,6	0,3	304	30
Copenhagen	DNK	10,6	1,9	519	-117
De Bilt	NLD	11,3	2,0	583	-222
Brussels	BEL	11,9	2,1	650	-171
Luxemburg	LUX	11,1	2,8	770	-105
Zürich	CHE	11,1	2,6	898	-188
Geneva	CHE	12,3	2,6	865	-89
Bordeaux	FRA	14,5	1,8	796	-127
Marseille	FRA	16,6	1,8	824	279
La Coruna	ESP	14,9	0,8	1166	171
Madrid/Barajas	ESP	15,0	1,0	568	155
Menorca	ESP	17,7	1,1	817	219
Gibraltar	GIB	18,5	0,3	805	30
Santa Maria/Azores	PRT	18,4	0,9	626	-149
Lisbon	PRT	17,0	0,2	726	-27
Berlin-Tempelhof	DEU	11,7	2,3	376	-208
Wien	AUT	12,4	2,7	726	119
Prague	CZE	10,4	2,5	390	-136
Sliac	SVK	10,2	2,3	641	-45
Elbing	POL	8,7	1,1	689	-1
Warschau	POL	10,4	2,7	434	-85
Budapest	HUN	12,7	2,3	561	43
Belgrade	SRB	14,4	2,5	604	-80
Ljubljana	SVN	12,5	2,7	1377	-17
Split	HRV	17,8	2,0	869	44
Sarajevo	BIH	11,4	1,9	1046	114
Bucharest	ROU	11,8	1,2	675	80
Sofia	BGR	11,4	1,7	701	138
Pisa	ITA	15,7	1,6	784	-124
Luqa	MLT	19,8	1,2	619	66
Athens	GRC	19,9	1,5	411	40
Heraklion	GRC	20,1	1,4	388	-114
Murmansk	RUS	2,1	2,2	510	32
Tallinn	EST	7,1	2,0	540	-127
Klaipeda	LTU	8,9	1,8	621	-114
Kaunas	LTU	8,3	2,0	643	13
Vilnius	LTU	8,0	2,0	535	-148
Minsk	BLR	8,0	2,2	647	-30
Moscow	RUS	6,6	1,6	649	-39
Kiev	UKR	9,5	1,8	595	-54
Chisinau	MDA	11,2	1,6	610	63
Charkiw	UKR	9,1	1,6	465	-54
Astrakhan	RUS	11,3	1,3	129	-91
Yerevan	ARM	15,0	3,6	334	57
Samsun	TUR	16,6	2,3	756	65
Istanbul	TUR	16,8	2,7	815	118
Ankara	TUR	14,2	2,6	496	89
Van	TUR	11,5	2,9	410	32
Antalya	TUR	20,3	1,9	884	-182
Larnaca	CYP	21,3	2,3	422	93
Oral	KAZ	6,0	0,6	273	-51
Tiflis	GEO	15,3	2,3	465	-33
Tripoli	LBN	21,2	1,9	947	67
Tel Aviv	ISR	22,0	2,5	624	57
Eilat	ISR	26,8	2,3	44	13
Mafraq	JOR	18,7	2,1	132	-27
Tenerife/Reina Sofia	ESP	21,3	-0,1	131	47
Princess Juliana Airp.	SMA	27,3	0,5	907	-100
Le Lamentin	MTQ	26,6	0,4	1984	-48

Table 6.2: Statistical values of **monthly** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

station name	country	January				February				March			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	-1,8	3,9	47	-14	1,1	7,2	63	10	-2,3	3,8	16	-39
Svalbard	NOR	-5,5	9,9	27	13	-5,4	10,3	36	17	-12,7	2,0	6	-15
Tromsoe	NOR	-4,1	-0,1	73	-8	-5,1	-1,4	4	-82	-5,0	-2,8	83	19
Oslo	NOR	-1,7	2,6	93	44	-4,1	-0,1	41	5	-2,3	-2,1	14	-32
Haparanda	SWE	-9,4	2,7	54	10	-12,5	-1,2	14	-18	-7,6	-0,8	31	-4
Stockholm	SWE	0,2	3,0	48	9	-3,2	-0,2	28	1	-1,6	-1,7	14	-12
Sodankylä	FIN	-11,7	3,4	45	14	-14,9	-1,3	4	-21	-10,4	-1,9	16	-9
Helsinki Airp.	FIN	-2,4	4,5	62	21	-8,5	-1,7	22	-9	-4,8	-1,9	21	-13
Leuchars (Dundee)	GBR	3,4	0,3	66	0	2,8	-0,4	26	-18	3,8	-1,2	97	50
London	GBR	6,9	2,7	58	6	3,8	-0,7	25	-10	6,4	-0,1	85	38
Dublin/Casement	IRL	5,2	0,3	92	23	3,4	-1,2	27	-24	4,5	-1,5	69	15
Reykjavik	ISL	-0,2	0,3	107	31	1,1	0,7	159	87	2,3	1,8	25	-57
Aasiaat (Egedisminde)	GRL	-11,3	2,0	22	7	-18,1	-2,6	30	15	-13,9	2,4	13	-5
Copenhagen	DNK	3,2	2,7	65	14	-0,2	-0,7	10	-21	0,7	-1,9	64	22
De Bilt	NLD	5,6	3,4	85	19	0,7	-1,8	20	-29	4,7	-0,3	60	-3
Brussels	BEL	6,0	3,4	81	14	0,8	-2,7	22	-31	5,4	-0,1	71	-1
Luxemburg	LUX	4,5	4,5	143	72	-1,3	-2,4	16	-46	3,7	-0,3	47	-23
Zürich	CHE	4,8	5,3	132	65	-1,5	-2,4	44	-26	3,8	-0,4	66	-3
Geneva	CHE	6,0	5,2	174	94	1,2	-1,1	29	-52	5,3	0,2	105	26
Bordeaux	FRA	9,2	3,4	122	22	4,7	-2,4	50	-36	9,4	0,6	113	37
Marseille	FRA	10,7	4,0	85	38	5,7	-2,2	23	-31	11,0	0,8	47	3
La Coruna	ESP	11,6	1,4	118	-13	9,4	-1,1	151	47	10,5	-0,8	194	108
Madrid/Barajas	ESP	6,6	1,1	47	5	5,6	-1,4	65	21	9,2	-0,1	139	109
Menorca	ESP	12,3	1,8	83	17	9,3	-1,4	66	9	12,4	0,8	109	54
Gibraltar	GIB	13,4	0,0	50	-71	13,1	-0,7	51	-49	14,9	-0,1	313	238
Santa Maria/Azores	PRT	16,1	1,7	14	-86	14,9	0,9	57	-29	15,6	1,0	85	6
Lisbon	PRT	12,1	0,7	75	-35	11,7	-0,6	44	-67	12,7	-1,0	217	148
Berlin-Tempelhof	DEU	3,7	3,9	73	30	-0,8	-1,6	2	-32	2,0	-2,2	46	9
Wien	AUT	4,1	5,1	47	9	-0,7	-1,7	27	-15	3,5	-1,5	51	10
Prague	CZE	2,9	5,3	21	-2	-2,7	-1,9	5	-18	1,3	-1,7	32	4
Sliac	SVK	0,4	4,3	52	8	-1,8	-0,7	40	-4	1,9	-1,1	52	10
Elbing	POL	-0,6	1,8	73	26	-4,8	-2,6	14	-11	-1,2	-3,3	34	-1
Warschau	POL	0,8	4,1	30	8	-3,2	-1,2	7	-14	0,9	-1,1	19	-9
Budapest	HUN	2,9	4,5	20	-12	0,2	-0,9	68	36	3,8	-1,8	79	50
Belgrade	SRB	5,2	4,8	39	-10	2,2	-0,5	58	14	6,6	-0,6	65	15
Ljubljana	SVN	4,8	5,9	73	-9	-0,1	-1,5	132	52	4,6	-0,8	122	24
Split	HRV	9,8	2,4	76	-7	7,0	-1,1	119	51	10,5	0,1	145	70
Sarajevo	BIH	4,0	4,9	67	-4	0,6	-0,9	77	10	5,3	0,2	110	40
Bucharest	ROU	0,6	3,0	48	8	1,1	1,2	99	63	3,3	-1,5	75	37
Sofia	BGR	1,1	2,7	26	-1	1,7	1,2	65	32	5,7	1,1	78	40
Pisa	ITA	9,9	3,8	34	-41	6,1	-1,0	75	4	9,4	-0,1	180	104
Luqa	MLT	14,2	2,0	30	-59	12,8	0,4	183	122	15,2	1,8	45	4
Athens	GRC	11,3	1,1	36	-9	12,6	2,1	66	18	15,5	3,1	6	-38
Heraklion	GRC	12,5	0,5	46	-46	13,8	1,6	38	-39	16,5	2,9	8	-49
Murmansk	RUS	-9,4	2,3	33	0	-10,6	0,6	22	0	-8,0	-1,2	50	30
Tallinn	EST	-1,7	3,8	42	-3	-6,4	-0,7	27	-2	-3,1	-0,9	23	-6
Klaipeda	LTU	-0,1	2,7	80	30	-4,7	-2,1	29	-2	-1,0	-1,3	19	-20
Kaunas	LTU	-1,6	3,6	57	18	-5,8	-1,5	24	-7	-1,8	-1,4	23	-12
Vilnius	LTU	-2,4	3,7	47	6	-6,1	-1,3	37	-1	-2,1	-1,5	21	-18
Minsk	BLR	-2,8	4,1	37	-3	-6,0	-0,2	29	-5	-2,6	-1,2	46	4
Moscow	RUS	-4,3	5,0	66	21	-9,1	-1,4	64	27	-5,1	-2,9	31	-3
Kiev	UKR	-2,4	3,2	40	-7	-3,8	0,4	40	-6	-1,9	-2,6	81	42
Chisinau	MDA	-0,8	2,5	32	-8	-1,3	0,4	55	17	0,8	-2,1	103	68
Charkiw	UKR	-3,5	3,4	45	1	-4,9	0,8	29	-3	-3,5	-3,2	96	69
Astrakhan	RUS	-5,9	-0,5	11	-2	-2,4	2,5	9	-1	1,0	-0,3	17	3
Yerevan	ARM	2,7	5,9	10	-11	6,4	7,4	17	-7	11,3	6,2	43	11
Samsun	TUR	8,8	1,9	154	93	10,1	2,9	37	-13	11,5	3,5	119	63
Istanbul	TUR	8,1	2,5	64	-35	8,8	2,9	90	23	11,5	4,0	103	41
Ankara	TUR	3,1	3,1	55	14	6,5	4,8	36	0	10,0	4,0	85	49
Van	TUR	0,6	5,0	30	-4	1,9	5,7	21	-12	7,4	6,5	29	-13
Antalya	TUR	10,9	1,0	140	-99	13,1	2,8	154	-42	15,1	2,4	100	-3
Larnaca	CYP	13,1	1,3	96	31	14,5	2,3	41	-16	16,5	3,0	11	-38
Oral	KAZ	-11,2	1,7	5	-20	-10,9	1,6	24	6	-9,2	-4,2	26	6
Tiflis	GEO	4,5	2,8	24	5	6,5	3,6	7	-19	10,2	3,3	22	-8
Tripoli	LBN	13,5	0,8	155	-39	14,9	1,7	152	25	17,5	2,8	4	-112
Tel Aviv	ISR	13,7	1,4	176	27	15,8	2,9	84	-14	18,9	4,0	5	-57
Eilat	ISR	16,7	1,6	3	-2	20,2	3,4	7	2	24,1	4,3	0	-4
Mafraq	JOR	8,8	1,6	39	5	12,0	3,3	29	-2	16,0	4,5	2	-27
Tenerife/Reina Sofia	ESP	19,0	0,6	1	-5	17,7	-0,7	79	70	19,7	0,1	1	-10
Princess Juliana Airp.	SMA	26,5	1,3	70	8	25,2	0,0	76	32	25,9	0,4	22	-22
Le Lamentin	MTQ	25,7	0,8	156	35	25,1	0,3	165	76	25,9	0,7	67	-21

Table 6.2: continued

station name	country	April				May				June			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	0,0	3,9	39	-1	2,8	3,5	71	31	3,4	1,4	35	0
Svalbard	NOR	-8,4	3,3	11	-1	1,8	5,5	23	17	4,0	1,8	4	-6
Tromsoe	NOR	1,4	0,7	52	-8	7,8	2,9	59	11	7,3	-2,0	163	110
Oslo	NOR	6,5	1,9	45	3	16,1	5,3	19	-33	17,9	2,7	39	-26
Haparanda	SWE	0,6	1,1	32	3	9,6	3,5	10	-21	11,6	-1,2	52	11
Stockholm	SWE	7,2	2,6	27	-3	16,1	5,4	4	-26	17,3	1,7	41	-4
Sodankylä	FIN	0,2	2,3	47	23	10,2	5,2	11	-24	11,0	-0,6	42	-14
Helsinki Airp.	FIN	5,0	2,1	40	3	15,3	5,4	11	-24	15,8	0,9	37	-7
Leuchars (Dundee)	GBR	7,4	0,6	48	7	11,5	2,1	25	-29	13,5	1,0	31	-19
London	GBR	11,6	2,7	65	20	15,4	2,9	58	7	18,7	3,0	<1	-51
Dublin/Casement	IRL	8,5	1,0	76	26	12,0	1,9	17	-40	15,5	2,4	19	-34
Reykjavik	ISL	5,0	2,1	58	0	5,7	-0,6	129	85	8,7	-0,3	88	38
Aasiaat (Egedisminde)	GRL	-7,7	1,9	6	-12	-3,2	-1,4	10	-5	2,3	-0,4	10	-9
Copenhagen	DNK	9,6	3,0	34	-8	16,4	4,4	8	-35	18,6	2,5	22	-32
De Bilt	NLD	12,2	4,2	79	27	16,4	4,1	38	-23	17,5	2,3	12	-56
Brussels	BEL	13,0	4,2	66	9	16,3	3,4	14	-57	18,1	2,4	16	-63
Luxemburg	LUX	12,7	5,2	57	-4	16,2	4,4	115	34	18,2	3,3	64	-18
Zürich	CHE	13,5	5,7	13	-74	15,4	3,3	107	4	18,5	3,3	65	-59
Geneva	CHE	13,3	4,5	19	-46	15,5	2,5	98	21	19,7	3,2	93	4
Bordeaux	FRA	14,2	2,9	78	6	16,3	1,7	47	-30	20,9	3,1	46	-10
Marseille	FRA	16,1	2,9	74	26	18,6	1,5	54	12	23,2	2,3	21	-7
La Coruna	ESP	13,2	1,1	80	-3	14,8	0,7	29	-49	17,4	1,0	115	66
Madrid/Barajas	ESP	12,8	1,2	63	18	16,6	1,1	53	14	21,7	1,3	35	9
Menorca	ESP	15,5	2,2	23	-27	17,1	0,3	55	18	22,2	1,4	27	13
Gibraltar	GIB	16,3	0,1	66	6	18,7	0,2	1	-34	21,2	0,1	0	-11
Santa Maria/Azores	PRT	15,9	0,7	24	-31	17,1	0,4	1	-29	21,0	2,3	2	-20
Lisbon	PRT	14,8	-0,3	112	48	17,4	0,0	9	-30	19,9	-0,3	18	-3
Berlin-Tempelhof	DEU	14,0	5,4	43	2	18,0	4,1	14	-42	19,6	2,2	34	-41
Wien	AUT	15,7	5,8	8	-43	18,7	4,1	75	14	21,3	3,4	46	-28
Prague	CZE	13,1	5,4	22	-16	16,5	3,8	30	-47	17,9	2,0	105	32
Sliac	SVK	13,8	5,3	23	-24	17,2	3,5	80	16	19,1	2,5	62	-23
Elbing	POL	10,7	3,9	41	-1	15,8	2,9	34	-7	16,8	1,4	49	-45
Warschau	POL	13,7	5,9	14	-18	18,3	4,9	35	-24	19,7	3,1	22	-50
Budapest	HUN	16,5	5,4	12	-26	20,1	4,1	49	-6	21,5	2,4	87	24
Belgrade	SRB	18,1	5,7	40	-19	21,2	4,0	56	-15	22,1	2,0	122	32
Ljubljana	SVN	15,1	5,2	102	-8	18,0	3,4	131	10	20,9	3,1	84	-71
Split	HRV	18,0	4,1	57	-9	22,3	3,9	65	9	24,6	2,4	51	0
Sarajevo	BIH	14,7	5,3	61	-13	16,4	2,3	178	96	17,9	1,0	132	41
Bucharest	ROU	15,4	4,1	5	-41	19,0	2,3	8	-62	21,8	1,6	164	87
Sofia	BGR	15,0	5,1	28	-22	17,5	3,2	37	-36	18,7	1,0	162	90
Pisa	ITA	15,0	2,5	59	-20	17,6	1,3	94	35	21,4	1,6	12	-32
Luqa	MLT	17,4	1,9	3	-20	20,1	1,0	11	4	23,9	0,9	12	9
Athens	GRC	19,8	3,8	5	-20	23,6	3,0	24	10	26,7	1,7	32	26
Heraklion	GRC	18,7	2,1	<1	-30	22,4	2,1	22	7	25,6	1,3	15	12
Murmansk	RUS	0,2	2,1	21	0	7,6	3,8	52	20	9,3	-0,1	79	26
Tallinn	EST	5,6	2,2	36	0	14,4	4,7	12	-25	14,9	0,4	52	-1
Klaipeda	LTU	8,6	3,6	39	3	15,5	4,9	24	-15	16,2	1,9	19	-37
Kaunas	LTU	10,2	4,4	65	23	17,3	4,9	18	-37	17,5	1,7	58	-11
Vilnius	LTU	10,3	4,6	35	-11	17,0	4,5	17	-45	17,3	1,5	39	-38
Minsk	BLR	10,5	4,5	30	-12	17,4	4,5	53	-9	17,7	1,6	47	-36
Moscow	RUS	7,8	2,0	47	7	16,2	3,3	61	3	17,3	0,7	56	-20
Kiev	UKR	13,1	4,4	8	-41	18,8	3,7	37	-16	20,6	2,4	111	38
Chisinau	MDA	15,1	4,9	4	-38	19,4	3,3	18	-33	21,9	2,5	152	77
Charkiw	UKR	11,5	2,6	14	-22	18,6	3,0	28	-19	20,5	1,6	39	-19
Astrakhan	RUS	11,1	0,0	<1	-18	21,2	2,9	<1	-24	23,8	0,9	4	-18
Yerevan	ARM	13,7	2,1	18	-19	18,1	1,8	80	37	23,0	2,4	34	13
Samsun	TUR	12,7	1,3	7	-55	18,3	2,8	19	-30	22,9	2,9	30	-15
Istanbul	TUR	15,7	3,7	19	-30	19,8	3,3	64	33	23,7	2,6	37	16
Ankara	TUR	15,4	4,2	4	-44	18,0	2,4	94	39	21,4	1,8	45	8
Van	TUR	10,2	2,9	39	-15	13,4	0,6	84	34	18,2	0,6	17	-4
Antalya	TUR	18,9	2,8	1	-45	23,3	3,0	50	22	25,5	0,5	25	17
Larnaca	CYP	19,9	3,0	0	-11	24,1	3,7	26	19	26,1	2,1	0	-1
Oral	KAZ	7,2	-0,5	20	1	17,8	1,7	30	9	19,9	-0,3	7	-30
Tiflis	GEO	13,7	0,9	24	-27	20,3	2,9	50	-28	23,4	2,2	97	21
Tripoli	LBN	19,3	1,8	35	-21	23,5	3,6	37	20	25,8	2,5	3	2
Tel Aviv	ISR	20,1	1,9	15	-8	25,8	4,7	4	1	26,4	2,4	3	3
Eilat	ISR	26,1	1,7	20	17	31,1	2,9	1	0	33,3	2,4	0	0
Mafraq	JOR	17,9	2,1	13	3	23,4	3,6	3	0	23,9	1,2	5	5
Tenerife/Reina Sofia	ESP	19,6	0,4	0	-4	19,6	-0,6	1	-1	21,7	-0,3	0	0
Princess Juliana Airp.	SMA	26,6	0,5	50	-17	27,0	0,0	72	-24	28,1	0,3	13	-50
Le Lamentin	MTQ	26,1	0,2	166	70	26,7	-0,1	204	81	27,4	0,1	170	0

Table 6.2: continued

station name	country	July				August				September			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	6,7	2,5	78	31	7,4	2,5	59	-2	4,9	2,1	51	-31
Svalbard	NOR	7,2	1,2	34	21	6,8	2,0	39	14	1,7	1,2	26	3
Tromsoe	NOR	14,0	2,3	23	-49	11,7	0,8	107	25	8,3	1,5	114	20
Oslo	NOR	22,2	5,8	26	-58	16,3	1,1	47	-43	12,5	1,7	125	35
Haparanda	SWE	20,3	4,8	53	3	15,2	1,9	60	-3	9,9	2,0	29	-34
Stockholm	SWE	22,5	5,3	6	-66	19,3	3,1	44	-22	14,3	3,1	49	-6
Sodankylä	FIN	20,1	6,0	61	-4	13,6	2,4	76	13	7,8	1,9	79	24
Helsinki Airp.	FIN	21,2	4,6	76	3	18,3	3,3	48	-32	13,3	3,3	57	-16
Leuchars (Dundee)	GBR	17,0	2,7	41	-11	15,0	0,9	58	-4	12,5	0,3	37	-24
London	GBR	22,3	4,5	15	-31	19,5	2,1	48	-3	15,9	0,9	29	-22
Dublin/Casement	IRL	16,8	1,6	30	-19	15,6	0,8	43	-21	12,3	-0,3	37	-22
Reykjavik	ISL	10,6	0,0	62	10	10,4	0,1	48	-14	7,1	-0,3	75	9
Aasiaat (Egedisminde)	GRL	4,6	-1,1	43	20	5,8	0,5	52	18	2,4	0,0	17	-17
Copenhagen	DNK	21,5	4,3	13	-56	19,3	2,3	121	58	15,3	1,7	24	-38
De Bilt	NLD	20,7	3,9	5	-70	18,5	1,8	69	-2	14,7	0,7	42	-25
Brussels	BEL	22,0	4,5	50	-25	19,4	2,1	69	6	15,4	0,9	65	6
Luxemburg	LUX	22,1	5,2	15	-53	19,9	3,5	59	-13	15,6	2,2	22	-48
Zürich	CHE	21,2	3,6	63	-54	20,8	4,1	113	-20	16,4	2,6	71	-21
Geneva	CHE	22,3	3,2	49	-18	21,7	3,5	63	-16	17,9	3,0	22	-59
Bordeaux	FRA	23,2	3,0	62	15	22,8	2,9	19	-35	19,9	2,0	3	-71
Marseille	FRA	26,9	3,1	20	6	26,1	2,9	63	34	22,5	2,2	0	-47
La Coruna	ESP	19,6	1,2	23	-2	20,3	1,5	33	4	19,6	1,5	5	-57
Madrid/Barajas	ESP	24,9	0,6	0	-9	26,7	2,9	1	-8	23,4	3,2	5	-23
Menorca	ESP	26,1	1,9	12	8	26,1	1,6	86	60	23,8	1,6	64	10
Gibraltar	GIB	24,0	0,3	0	-1	24,8	0,6	0	-6	23,9	1,1	4	-11
Santa Maria/Azores	PRT	21,3	0,5	8	-17	22,5	0,3	9	-31	22,8	1,4	92	35
Lisbon	PRT	21,2	-1,2	1	-4	24,9	2,1	0	-6	23,7	2,0	0	-26
Berlin-Tempelhof	DEU	22,1	3,3	57	5	22,2	3,8	7	-54	17,1	2,5	20	-26
Wien	AUT	22,6	2,9	130	67	23,6	4,7	49	-9	17,3	2,2	101	56
Prague	CZE	20,8	3,3	16	-50	21,6	4,6	50	-20	15,8	2,5	38	-2
Sliac	SVK	20,1	1,9	114	55	21,5	4,2	50	-19	15,4	2,0	49	-7
Elbing	POL	19,0	2,2	140	46	19,2	2,5	34	-47	14,9	2,2	60	-10
Warschau	POL	21,5	3,6	85	18	21,1	3,8	63	0	16,1	2,9	45	2
Budapest	HUN	22,9	2,0	53	1	24,2	3,9	29	-22	18,1	1,7	69	29
Belgrade	SRB	23,0	1,3	53	-13	25,5	4,2	45	-7	20,3	2,6	11	-40
Ljubljana	SVN	22,3	2,4	138	16	22,8	3,7	223	79	17,5	2,0	126	-4
Split	HRV	27,3	1,9	14	-14	28,2	3,0	11	-39	23,4	2,0	21	-40
Sarajevo	BIH	19,7	0,8	120	40	20,7	2,2	88	17	16,4	1,3	26	-44
Bucharest	ROU	22,0	0,0	90	26	23,3	2,1	9	-49	17,9	1,0	36	-6
Sofia	BGR	20,6	0,6	187	131	21,2	1,8	8	-44	16,8	1,0	22	-17
Pisa	ITA	24,1	1,3	30	7	24,6	2,1	38	-22	21,0	1,5	20	-69
Luqa	MLT	26,9	1,0	<1	<1	27,1	0,8	54	47	25,6	1,5	4	-36
Athens	GRC	28,7	0,9	55	49	29,0	1,4	5	-3	25,0	0,7	75	65
Heraklion	GRC	27,8	1,7	1	0	27,3	1,4	11	10	24,9	1,4	17	-3
Murmansk	RUS	18,1	5,3	24	-36	12,8	1,8	71	6	9,0	2,3	44	-8
Tallinn	EST	20,2	3,9	9	-70	18,2	2,9	67	-17	14,0	3,2	117	35
Klaipeda	LTU	19,3	2,7	58	-16	20,3	3,5	52	-31	16,0	2,7	86	-3
Kaunas	LTU	20,2	3,3	138	58	19,1	2,7	66	-12	14,8	2,9	55	-1
Vilnius	LTU	19,5	2,6	119	41	19,2	2,9	54	-18	14,6	3,0	34	-31
Minsk	BLR	19,6	2,3	169	81	20,1	3,6	59	-13	15,5	3,8	44	-16
Moscow	RUS	20,5	2,4	92	0	19,8	3,4	28	-46	14,6	3,7	77	13
Kiev	UKR	21,4	2,1	86	-2	22,5	3,9	22	-47	17,3	3,4	58	11
Chisinau	MDA	22,2	1,3	121	52	24,6	4,1	1	-44	17,9	1,7	53	5
Charkiw	UKR	22,7	2,4	50	-10	23,2	3,7	0	-50	18,0	3,9	49	8
Astrakhan	RUS	28,7	3,4	13	-10	24,2	0,9	6	-13	19,4	2,1	12	-14
Yerevan	ARM	28,9	4,3	16	6	25,6	1,7	10	3	22,8	3,0	6	-4
Samsun	TUR	25,3	2,6	36	7	25,7	3,0	65	32	21,8	2,2	73	23
Istanbul	TUR	26,3	3,1	55	36	26,9	3,9	2	-24	22,1	2,4	90	49
Ankara	TUR	24,4	1,5	11	-3	25,1	2,5	12	0	20,0	1,7	4	-15
Van	TUR	23,3	1,4	<1	-4	22,1	0,9	<1	-4	18,4	1,6	<1	-10
Antalya	TUR	29,3	1,2	8	5	29,0	1,3	0	-1	27,2	2,7	5	-6
Larnaca	CYP	28,3	1,7	0	0	28,9	2,3	<1	<1	27,2	2,6	<1	<1
Oral	KAZ	25,7	3,2	63	25	21,2	0,8	11	-14	16,8	2,7	12	-15
Tiflis	GEO	27,5	3,1	31	-14	24,7	1,0	75	27	21,8	2,2	15	-21
Tripoli	LBN	27,8	2,8	0	0	28,2	2,6	0	-1	27,1	2,3	2	-2
Tel Aviv	ISR	28,0	2,3	0	0	28,2	2,1	0	0	27,3	2,5	<1	<1
Eilat	ISR	34,2	1,8	0	0	34,1	1,8	0	0	32,4	2,0	0	0
Mafraq	JOR	25,6	1,5	0	0	25,7	1,5	0	0	24,6	1,9	0	-1
Tenerife/Reina Sofia	ESP	23,8	-0,2	0	0	25,1	0,1	0	0	25,0	0,3	0	-2
Princess Juliana Airp.	SMA	28,7	0,7	51	-25	28,6	0,4	81	-18	29,0	0,8	92	-39
Le Lamentin	MTQ	27,7	0,5	112	-92	27,7	0,5	276	24	27,8	0,8	130	-106

Table 6.2: continued

station name	country	October				November				December			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	2,4	2,3	94	12	1,3	4,6	29	-37	-1,6	3,6	101	36
Svalbard	NOR	-1,4	4,1	8	-7	-3,8	6,7	37	24	-5,8	7,5	41	29
Tromsoe	NOR	3,7	0,8	114	-11	3,7	4,5	128	24	-0,4	2,6	95	-9
Oslo	NOR	7,4	1,0	45	-39	3,4	2,7	104	29	-1,2	1,6	54	-2
Haparanda	SWE	2,6	0,1	14	-50	0,7	4,8	12	-46	-5,9	3,6	52	10
Stockholm	SWE	8,7	1,2	22	-28	4,5	1,9	31	-22	0,8	1,8	34	-12
Sodankylä	FIN	-0,4	-0,1	30	-21	-0,8	6,6	17	-22	-8,5	4,6	44	13
Helsinki Airp.	FIN	6,6	1,2	48	-25	2,7	2,6	26	-46	-2,0	2,1	50	-8
Leuchars (Dundee)	GBR	9,9	0,5	49	-13	8,1	2,8	85	28	5,1	1,4	72	13
London	GBR	12,5	0,8	61	3	9,2	2,0	74	19	8,1	3,0	61	4
Dublin/Casement	IRL	9,2	-0,9	56	-11	8,3	1,6	105	38	7,9	2,3	89	16
Reykjavik	ISL	3,9	-0,5	114	28	4,2	3,1	107	35	2,7	2,9	82	3
Aasiaat (Egedisminde)	GRL	-3,7	-1,5	44	18	-5,3	0,6	21	-12	-6,5	3,4	36	12
Copenhagen	DNK	11,0	1,1	48	-11	6,6	1,1	33	-29	4,6	2,4	77	19
De Bilt	NLD	11,9	1,4	37	-35	6,8	0,9	35	-46	6,1	2,9	101	22
Brussels	BEL	12,6	1,7	48	-22	7,4	1,3	55	-21	5,8	2,3	93	17
Luxemburg	LUX	11,8	2,7	16	-59	5,9	2,1	48	-35	3,7	2,7	168	88
Zürich	CHE	11,2	1,9	49	-20	5,4	1,5	17	-65	3,5	2,9	158	85
Geneva	CHE	12,3	2,2	28	-49	6,9	1,9	73	-19	4,9	3,1	112	25
Bordeaux	FRA	14,4	0,4	75	-13	10,1	1,0	88	-6	9,3	2,9	93	-6
Marseille	FRA	17,0	0,9	263	185	13,4	2,7	145	87	8,4	1,1	29	-27
La Coruna	ESP	16,0	0,3	93	-11	13,1	0,5	232	116	13,2	2,3	93	-35
Madrid/Barajas	ESP	15,1	0,6	74	36	10,2	1,3	77	18	6,7	0,8	9	-35
Menorca	ESP	19,4	0,9	146	62	15,3	0,9	128	51	12,6	0,8	18	-56
Gibraltar	GIB	20,1	0,6	175	111	15,9	-0,2	135	-6	15,4	1,3	10	-136
Santa Maria/Azores	PRT	19,6	0,3	174	90	17,2	-0,2	72	-30	16,9	1,5	88	-7
Lisbon	PRT	18,9	0,4	55	-25	14,1	-0,4	173	59	12,9	1,1	22	-86
Berlin-Tempelhof	DEU	11,7	1,7	17	-19	5,7	0,8	19	-30	4,7	3,3	44	-9
Wien	AUT	13,0	3,1	29	-12	6,6	2,0	52	2	3,0	2,1	111	68
Prague	CZE	10,6	2,3	22	-8	4,2	1,4	11	-21	2,5	3,1	38	12
Sliac	SVK	10,7	2,4	33	-17	5,2	2,2	31	-38	-1,1	0,6	55	-2
Elbing	POL	10,1	1,2	90	37	4,0	0,7	29	-27	0,8	0,5	91	39
Warschau	POL	10,4	2,1	52	14	4,4	1,2	11	-31	1,6	2,5	51	19
Budapest	HUN	13,9	3,0	19	-15	7,4	2,6	48	-4	1,3	0,9	28	-12
Belgrade	SRB	16,3	3,9	19	-21	8,9	1,9	35	-19	3,2	0,9	61	3
Ljubljana	SVN	13,2	2,8	125	10	8,2	3,6	109	-26	2,2	2,2	12	-89
Split	HRV	19,2	2,3	97	18	14,4	2,2	121	13	9,0	0,3	92	-8
Sarajevo	BIH	13,1	2,8	48	-29	7,6	2,3	55	-39	0,5	0,2	84	-1
Bucharest	ROU	12,4	1,6	15	-17	4,8	-0,4	66	17	-0,5	-0,7	60	17
Sofia	BGR	12,5	2,1	1	-36	6,0	1,0	63	16	0,1	-0,4	24	-15
Pisa	ITA	18,1	2,8	65	-58	13,0	2,6	112	-12	7,9	1,1	65	-20
Luqa	MLT	21,3	0,6	181	91	18,5	1,5	61	-19	14,4	0,6	34	-78
Athens	GRC	19,8	0,5	10	-38	15,9	0,5	28	-23	10,9	-1,1	69	3
Heraklion	GRC	20,7	0,8	2	-67	17,9	1,3	141	82	13,4	-0,4	86	9
Murmansk	RUS	1,5	0,5	48	6	-0,1	5,0	50	10	-5,4	3,9	16	-22
Tallinn	EST	7,6	1,3	93	23	3,5	2,3	28	-40	-1,5	1,4	34	-21
Klaipeda	LTU	10,6	1,6	122	42	4,4	0,5	21	-69	1,1	1,2	72	4
Kaunas	LTU	8,1	1,0	37	-8	2,8	1,0	26	-27	-0,9	1,6	76	29
Vilnius	LTU	8,1	1,5	41	-12	2,1	0,9	17	-40	-1,5	1,4	74	19
Minsk	BLR	8,2	1,9	46	-3	0,7	-0,1	31	-21	-2,1	1,7	56	3
Moscow	RUS	7,3	2,3	56	-2	-0,6	0,5	18	-40	-5,6	0,5	53	1
Kiev	UKR	10,7	2,6	18	-17	0,3	-1,8	19	-32	-2,2	0,1	75	23
Chisinau	MDA	13,3	3,2	2	-25	2,1	-2,3	47	8	-0,8	-0,5	22	-16
Charkiw	UKR	10,5	3,2	20	-15	-0,6	-1,9	21	-23	-3,2	0,2	74	29
Astrakhan	RUS	12,6	3,5	23	6	2,2	-1,1	7	-12	-0,9	1,0	26	11
Yerevan	ARM	15,9	3,1	32	5	7,9	1,3	26	4	4,1	3,6	42	19
Samsun	TUR	18,5	2,9	72	-13	13,4	0,9	68	-21	9,8	0,6	76	-6
Istanbul	TUR	17,9	2,6	38	-33	13,2	1,6	98	9	8,0	-0,1	155	33
Ankara	TUR	14,8	2,2	55	28	9,0	1,9	25	-8	3,2	0,7	70	21
Van	TUR	12,9	2,8	74	26	6,5	2,5	28	-16	2,8	3,9	86	52
Antalya	TUR	21,6	2,0	16	-54	16,7	1,9	89	-45	12,7	1,3	296	69
Larnaca	CYP	23,5	2,2	23	4	18,6	1,7	58	14	14,9	1,5	166	90
Oral	KAZ	7,8	2,7	21	-9	-3,6	-1,5	24	-11	-9,2	-0,8	30	1
Tiflis	GEO	15,9	2,4	14	-24	9,0	0,9	77	47	5,6	1,8	29	8
Tripoli	LBN	23,6	1,4	104	33	17,8	-0,5	129	16	14,9	0,8	326	146
Tel Aviv	ISR	25,0	3,0	14	-12	19,4	1,4	56	-12	15,6	1,8	266	128
Eilat	ISR	28,5	1,9	7	4	22,9	1,8	2	-2	18,0	1,8	4	-2
Mafraq	JOR	21,4	2,3	5	-2	14,5	1,0	4	-13	10,1	1,3	32	4
Tenerife/Reina Sofia	ESP	23,1	-0,4	38	28	20,5	-1,0	10	-20	20,5	1,0	<1	-10
Princess Juliana Airp.	SMA	27,9	0,1	164	55	27,2	0,3	152	22	27,2	1,4	64	-22
Le Lamentin	MTQ	27,1	0,4	214	-56	26,8	0,5	210	-14	25,7	0,3	114	-45

7. References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2018 edition of the Bulletin, are listed on page 3 above. Many contributions or additional information may as well be found on the web, see below.

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Croatia: Meteorological and Hydrological Service (**DMHZ**) Annual reports

Denmark: Danish Meteorological Institute (**DMI**), Vejret i Danmark

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9. Abbreviations

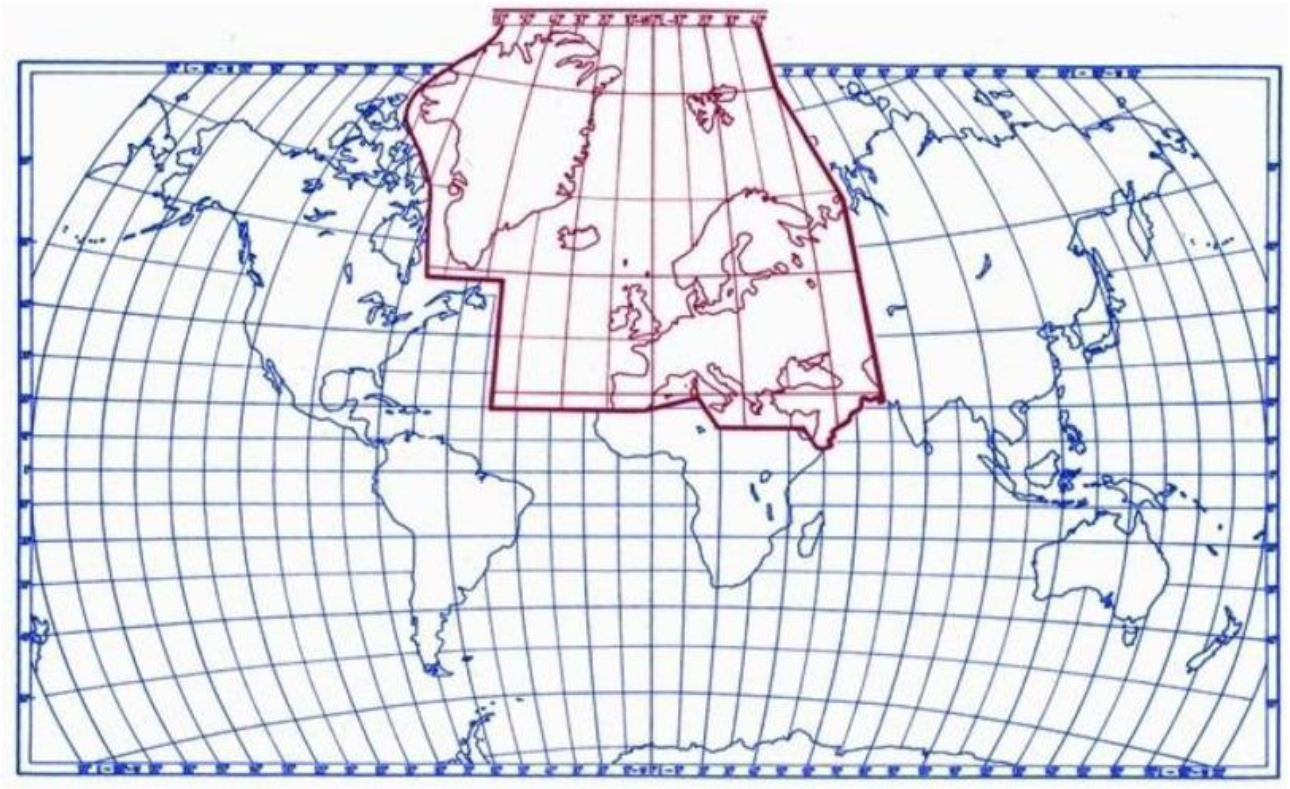
AO	Arctic Oscillation (circulation indices)
BAMS	Bulletin of the American Meteorological Society
CLIMAT	monthly climatological data provided by the NMHSs via GTS
DWD	Deutscher Wetterdienst (German Meteorological Service)
EA	East Atlantic Pattern (circulation indices)
EA/WR	East Atlantic/West Russia Pattern (circulation indices)
ECA&D	European Climate Assessment & Dataset, located at Royal Netherlands Meteorological Institute (KNMI)
EMCC	Eastern Mediterranean Climate Centre
E-OBS	daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D information
GCC	Global Collection Centre operated by the Deutscher Wetterdienst
GPCC	Global Precipitation Climatology Centre located at the Deutscher Wetterdienst
GTS	Global Telecommunication System
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (Italian National Institute for Environmental Protection and Research)
JRC	Joint Research Centre of the European Commission
m a.s.l.	Meter above sea level
NAO	North Atlantic Oscillation (circulation indices)
NMHSs	National Meteorological and Hydrological Services
POL	Polar/Eurasia Pattern (circulation indices)
PDSI	Palmer Drought Severity Index
RCC-CM	WMO Regional Climate Centre Network (RA VI) Offenbach Node on Climate Monitoring
SCA	Scandinavia Pattern (circulation indices)
SCE	Annual snow cover extent
SYNOP	surface synoptic or weather observations provided by the NMHSs via GTS
WCDMP	World Climate Data and Monitoring Programme
WMO RA VI	WMO Regional Association VI (Europe and Middle East)
WMO	World Meteorological Organization

WMO RA VI
RCC Network
DWD

Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2019



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Armenia
Austria
Belarus
Belgium
Bosnia and Herzegovina
Bulgaria
Croatia
Czech Republic
Denmark
Estonia
Finland
Georgia
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Jordan
Latvia
Lithuania
Luxembourg
Moldova
Norway
Portugal
Romania
Russia
Serbia
Slovakia
Slovenia
Spain
Sweden
Switzerland
Turkey
Ukraine
United Kingdom

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1. Introduction

The Annual Bulletin on the Climate in WMO Regional Association VI (RA VI, covering Europe and Middle East with 51 Members) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official websites. Supported by the European Climate Support Network (ECSN) and WMO´s World Climate Data and Monitoring Programme (WCDMP) the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's Annual Statement on the Status of the Global Climate and the State of the Climate published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ among the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the webpages of the RA VI RCC Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

This annual bulletin includes four parts: the annual, seasonal and monthly survey of the climate state in 2019. The long time series of temperature, precipitation and sunshine duration provided by NMHSs in order to illustrate long-term variability up to 2019 (previously presented in section 5) will be made available on the RA VI webpages.

Notes:

Maps of the RA VI RCC Network are based on the following data sources:

- Temperature: CLIMAT data and ship observations provided by the Global Collecting Centre (GCC), operated by the Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC), operated by the Deutscher Wetterdienst
- Sunshine: Meteosat Satellite data (introduced in 2018).
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC Node-CD) via the European Climate Assessment & Dataset project (ECA&D) run by Royal Netherlands Meteorological Institute (KNMI)

1.1 The following sub-regions are used in this bulletin:

Central and western Europe (14 countries):

Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, the Netherlands, Poland, Slovakia, Switzerland, and United Kingdom

Nordic and Baltic Region (9 countries/territories):

Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, and Sweden

Iberia (2 countries):

Portugal, and Spain, Andorra

Mediterranean, Italian and Balkan Peninsula (12 countries):

Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, Montenegro, North Macedonia, Serbia, Slovenia, and Turkey

Eastern Europe (5 countries/territories):

Belarus, European Russia, Moldova, Romania, and Ukraine

Middle East (9 countries):

Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, and Western Kazakhstan

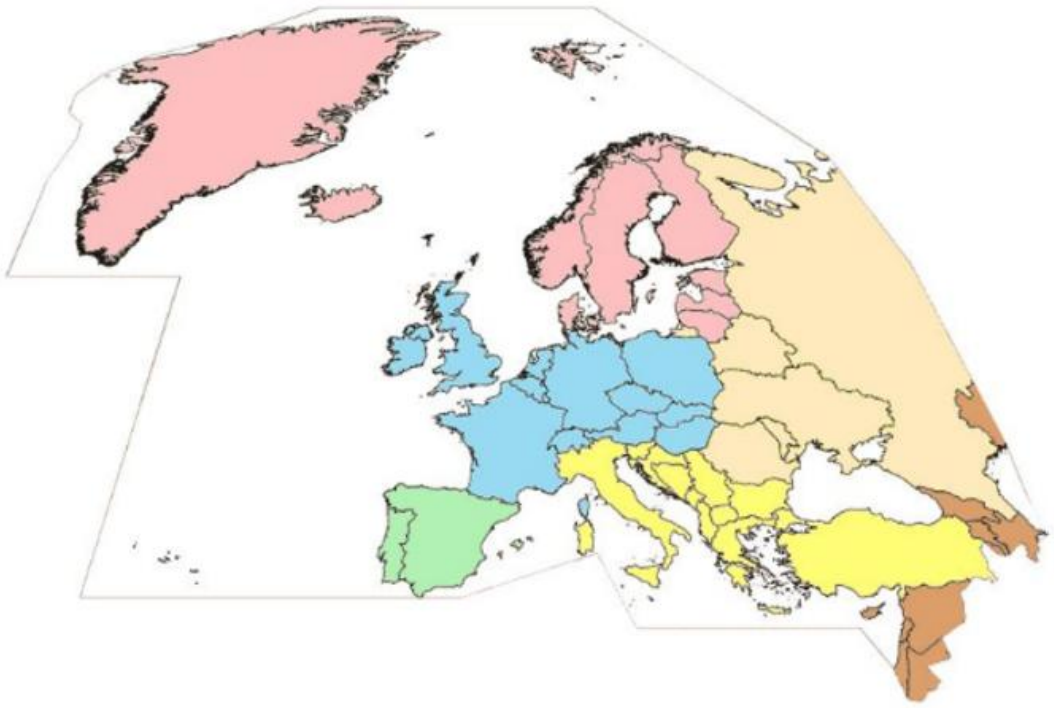

Figure 1-1: Definitions of the six sub-regions used in this bulletin.

1.2 The climate in 2019 - Overview

1.2.1 Anomalies

Temperature

Based on the Global Historical Climate Network (GHCN) v4.0.1 dataset (Menne et al. 2012), Europe (35°–75°N, 10°W–30°E) experienced its second warmest year since at least 1950 with an anomaly of +1.1 °C, very close to 2018. All over the RA VI Region annual temperatures were warmer than normal (1981-2010). Largest anomalies occurred over Greenland and over the eastern part of the RA VI Region, for example over Poland, Ukraine and Belarus where annual temperatures were more than 2 °C above normal.

Precipitation

Annual precipitation totals in 2019 were slightly above average over the RA VI Region. Generally, northern Europe and some parts of western and southern Europe experienced a wetter-than-average year. Precipitation was especially above average in parts of northern Spain and the Alps. In contrast, drier-than-normal conditions occurred across large parts of the Iberian Peninsula, especially in the south, in a band reaching from France through central Europe into Eastern Europe as well as over Iceland.

Sunshine Duration

Most parts of the RA VI Region experienced a sunnier-than-normal year. The widespread positive anomalies of +150 hours to +250 hours caused the average annual sunshine duration over Europe to reach a new record with 2348 hours in 2019 (Bissolli et al. 2020). Largest surpluses in sunshine were recorded in Central and Eastern Europe as well as in Iberia which. These regions saw exceptionally sunny conditions (sunshine duration totals > 90th percentile) with 200 to 500 hours (in relative terms up to 125 %) more sunshine hours than normal.

1.2.2 Events:

- Exceptionally high temperatures occurred throughout Europe during a warm spell end of February, with many areas in central Europe exceeding 20 °C and many local records of maximum temperatures being broken.
- Record June and July heat waves occurred across western and central Europe due to the inflow of warm subtropical air. Numerous temperature records were broken in both months. June ended up the warmest on record for Europe as a whole.
- From October to December, a series of heavy storms brought exceptionally high amounts of precipitation to regions bordering the northern Mediterranean and Atlantic coasts. Some regions recorded precipitation of two to four times the normal amounts and for several countries it was one of the wettest November months on record.

2. Annual survey

The climate of 2019 was characterised by a broad range of spatial and temporal anomalies outlined in section 1.2. This section presents an overview of the spatial patterns of mean annual climate conditions in 2019 and anomalies related mainly to the normal period 1981-2010 considering the following climate variables: sea level pressure, surface air temperature, precipitation, sunshine duration and snow. Sub-section 0 reveals selected climate indices for individual countries. Long-term trends in temperature and precipitation indices are presented in section 2.2. Section 0 and 4. present the seasonal and monthly patterns and statistics for selected climate variables including also reports from individual countries. Annual averages and anomalies of selected essential climate variables

2.1 Annual averages and anomalies of selected essential climate variables

2.1.1 Sea level pressure

Generally, the mean annual sea level pressure distribution in 2019 over RA VI was dominated on one hand by a band of low pressure with the minimum pressure extending from southern Greenland over Iceland until northern Russia. On the other hand, there was a high pressure belt with maximum pressure in the area of the Azores (Azores High) extending further across southern and central Europe into Russia.

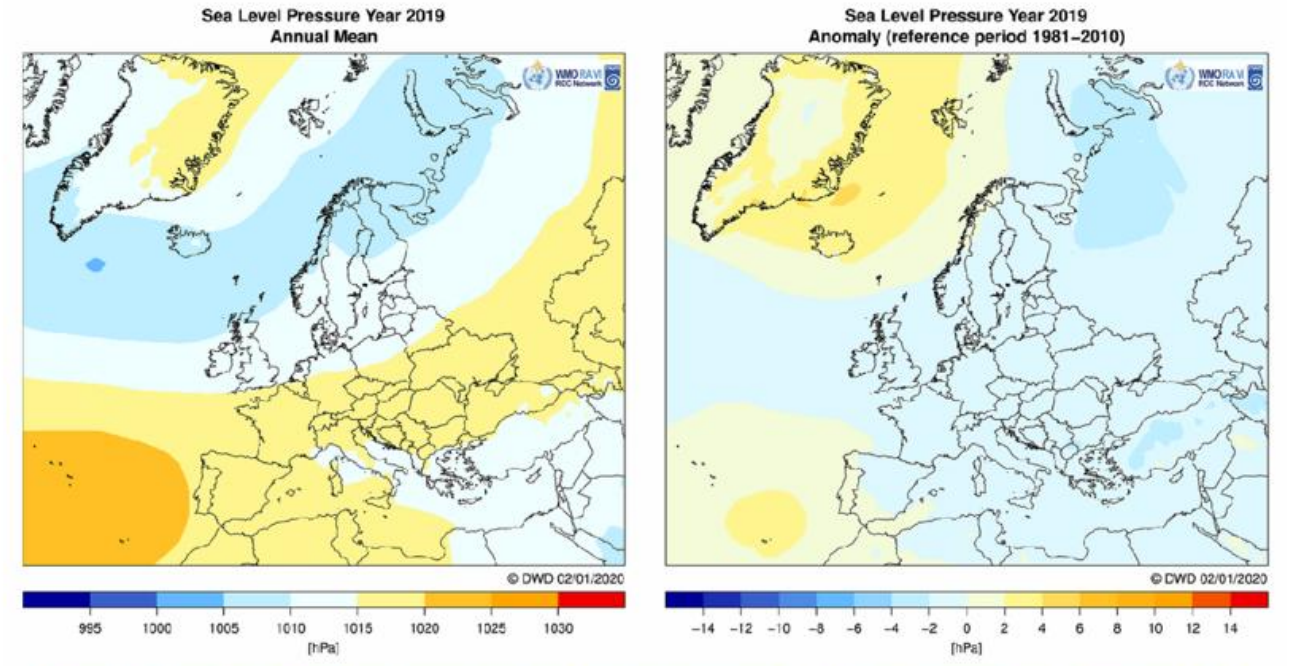

Figure 2-1: Annual mean (left) and anomalies (right) sea level pressure in hPa for the year 2019 with respect to the reference period 1981-2010. (Source: http://www.dwd.de/rcc-cm).

The mean sea surface pressure in 2019 differs to some extent from the long-term mean with reduced pressure over the most parts of the RA VI area with anomalies generally between 0 and -2 hPa as visible in Figure 2-1 (right; normal period 1981-2010). Higher-than-normal pressure occurred especially over Greenland and Iceland with largest anomalies ranging between +2 and +4 hPa and in the area of the Azores High.

2.1.2 Temperature

Overall, the year was exceptionally warm and over the entire RA VI Region temperatures were higher than normal (1981-2010) with anomalies mostly above +1.0 °C – parts of Greenland and of Central and Eastern Europe even experienced annual mean temperatures more than 2 °C warmer than normal. For the European region as a whole, 2019 was the second warmest since at least 1950 considering the Global Historical Climate Network (GHCN) v4.0.1 datasets (Menne et al. 2012; Bissolli et al. 2020) with an overall anomaly (with respect to the base period 1981-2010) of +1.1 °C (Figure 2-3). For many countries the year proved to be the warmest on record: Estonia +1.6 °C (tied with 2015), Serbia +1.7 °C, Belarus +2.0 °C, Latvia +1.8 °C, Lithuania +1.9 °C, Ukraine +2,7 °C (w.r.t. 1961-1990) and Romania +1.9 °C (see also Table 2-1).

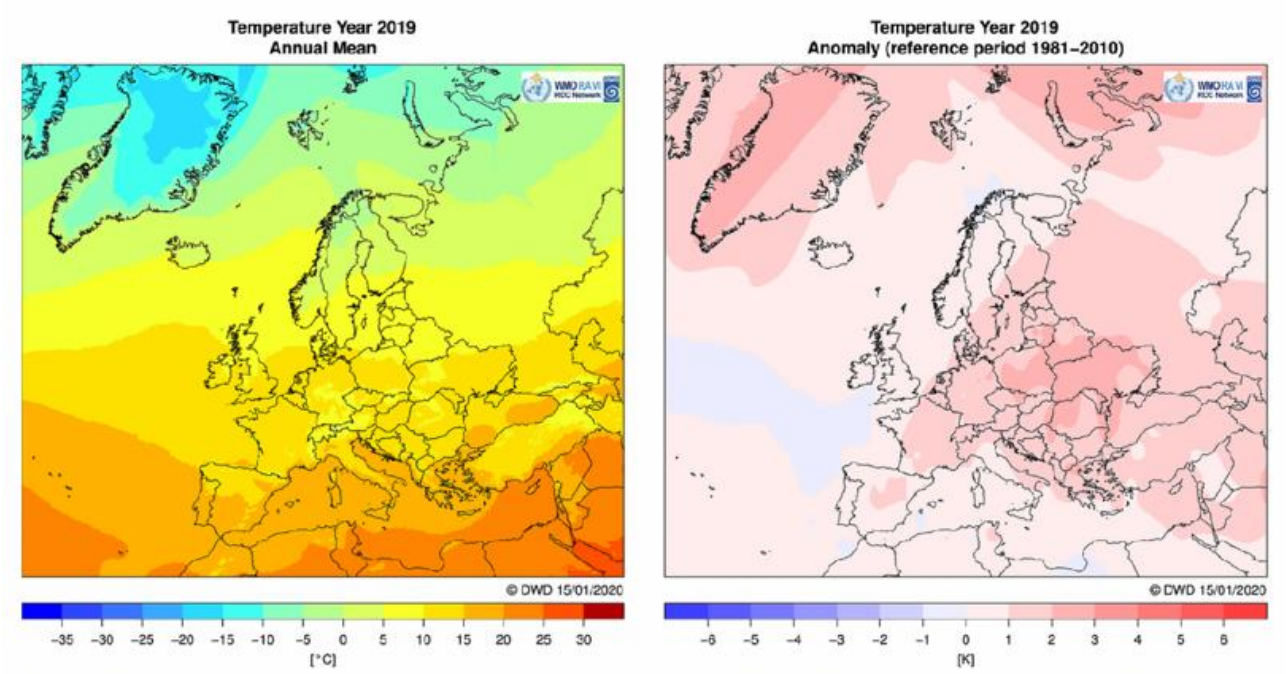

Figure 2-2: Annual mean (left) and anomalies (right) temperature in °C for 2019 (reference period 1981-2010, source: http://www.dwd.de/rcc-cm).

Looking at the specific sub-regions, the year 2019 was characterized by well-above-normal temperatures for **Western Europe** with an anomaly of +1.0 °C and above except for the United Kingdom and Ireland. For all continental countries the year ranked in the top five of the warmest years (third or fourth warmest).

Temperatures for the year were well above normal by +1.0 °C to +2.0 °C in **Central Europe** with 2019 among the five warmest years for all countries of the region. Hungary reported the warmest year on record with an anomaly of +1.9 °C, while for Germany (+1.4 °C), Slovakia (+1.8 °C) and the Czech Republic (+1.6 °C), 2019 was the second warmest.

Concerning the **Nordic and Baltic countries** the year was slightly warmer than normal with anomalies around +0.6 °C (w.r.t.1981-2010) in Norway and +1.2 °C (w.r.t. 1961-1990) in Finland. In the Baltic countries 2019 was even among the 5 warmest years with temperatures more than +1.0 °C above average. In northwestern, southwestern and southern parts of Greenland annual temperatures were much warmer than normal (partly more than 2 °C). At Pituffik/Thule Air Base, at Paamiut, as well as at Narsarsuaq and Qaqertoq, the year2019 finished up as second warmest on record, only second to 2010.

The annual mean temperature over the **Iberian Peninsula** was mostly between +0.0 °C and +1.0 °C above normal. Spain reported a countrywide anomaly of +0.8 °C and the sixth warmest year since 1965. However, anomalies in some parts of Spain exceeded +1.0 °C.

The year was warmer than normal for the **Mediterranean and the Balkan states**. Serbia reported its warmest year on record with +1.7 °C above normal, Slovenia its second highest since 1961 also with +1.7 °C above normal, Italy its third warmest (+1.6 °C, w.r.t. 1961-1990) and Turkey its fourth warmest (+1.2 °C).

Eastern Europe had an overall warm year. The Ukraine (+2.7 °C anomaly w.r.t. 1961-1990), Moldova (+2.1 °C anomaly) and Belarus (+2.0 °C anomaly) reported their warmest year on record.

In the **Middle East**, the year was more than +1.0 °C warmer than normal in most of the region. Temperature anomalies below +1.0 °C were only recorded in Syria and northern parts of Jordan. It was the 7th warmest year in 69 years in Israel, but also the coolest since 2013. It was the 4th warmest year in Georgia since 1960 with an anomaly of around +1.5 °C. In the capital, Tbilisi, it was the 2nd warmest (after 2018) since records began in 1881.

Globally, 2019 was among the three warmest years on record (WMO 2020; Blunden and Arndt 2020) with an average global temperature 0.44°–0.56 °C above the 1981–2010 average according to four independently constructed in-situ analyses (Sánchez-Lugo et al. 2020) and approximately 1.1 ±0.1 °C above pre-industrial levels (WMO 2020). The 2019 Arctic land surface temperature was +1.7 °C above the 1981–2010 average, tying for second highest in the 119-year record, following 2016.

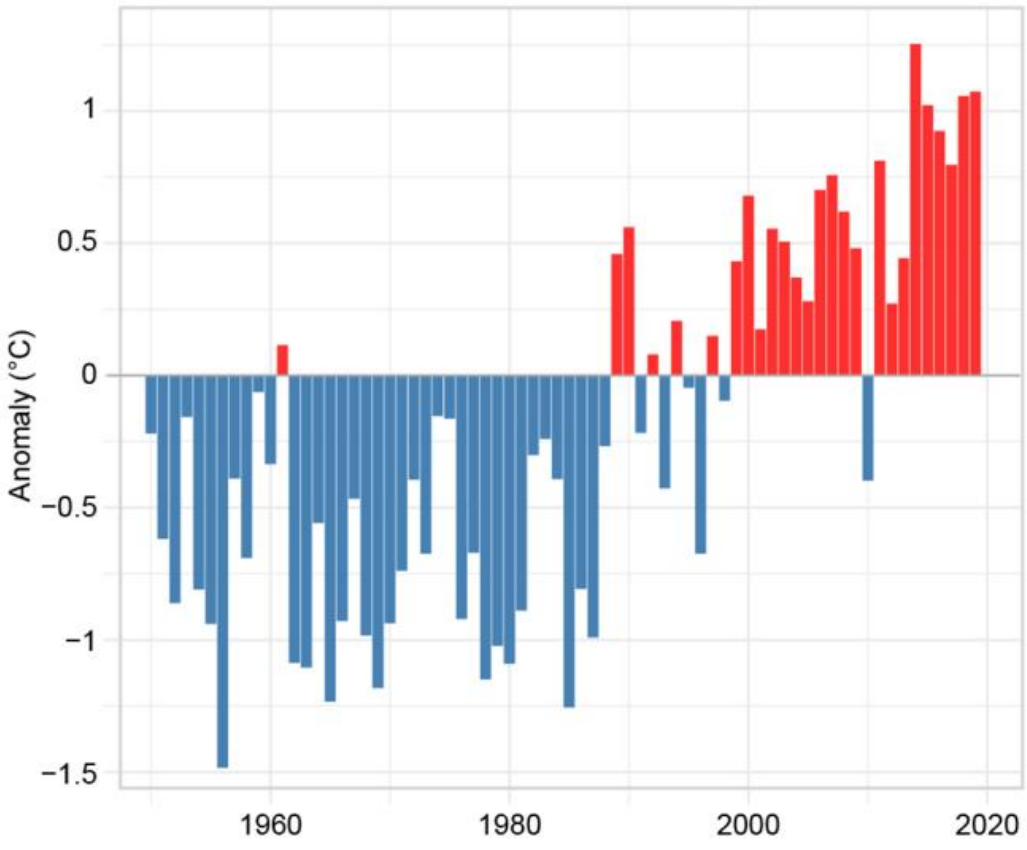

Figure 2-3: Annual average land surface air temperature anomalies for 1950–2019 for Europe (35°–75°N, 10°W–30°E) relative to the 1981–2010 base period. (Source: GHCN version 4.0.1 dataset, Menne et al. 2012.)

Table 2-1: Rank statistics and anomalies of annual temperature in 2019 as reported by the National Meteorological and Hydrological Services (NMHSs). Information about all-time temperature records as provided by the individual NMHSs can be found here: https://rcccm.dwd.de/DWD-RCCCM/EN/products/significant/records/download_tabelle.html?nn=500100?

Country	Rank	Annual Anomaly [°C] (1961-1990)	Annual Anomaly [°C] 1981-2010	start of time series
Europe	ERA5: 1 GHCN: 2	-	+1.2 +1.1	1979 1950
Armenia	6-7	+1.50	-	1935
Austria	3	+2.3	+1.6	1767
Belarus	1 (8.8 °C)[1]	-	+2.0	1881
Belgium (Brussels-Ukkel)	4	+1.7	+0.9	1833
Bulgaria	1 (12.5 °C)[1]	+2.0	-	1930
Czech Republic	2	+1.60	-	1961
Cyprus (station)	3	-	+1.0	2000
Denmark	4	-	+1.1	1873
Estonia	1 - 2	+1.60	-	1961
Finland	19	-	+0.88	1900
France	3 (13.7 °C)[1]	-	+1.1	1900
Germany	2	-	+1.4	1881
Georgia	4	-	+1.5	1960
Hungary	1	-	+1.87	1901
Iceland	15	+1.2°C	+0.7	1931
Ireland	18	+0.92	-	1900
Israel	7	+1.26	+0.86	1951
Italy	3	+1.59	-	1961
Jordan (Amman Airp.)	7	-	+1.0	1981
Latvia	1	-	+1.8	1924
Lithuania	1 (8.8 °C)[1]	-	+1.9	1961
Luxembourg (Findel)	(10.7 °C)[1]	-	+1.4	1947
Moldova (Chisinau)	1	-	+2.1	1886
Norway	20	+1.2	-	1900
Portugal	26 (15.6°C)[1]	-	+0.32 (w.r.t. 1971-2000)	1931
Romania	1 (11.0 °C)[1]	+2.3	+1.9	1961
(European) Russia	4 - 5	+1.88	-	1936
Serbia	1	-	+1.7	1951
Slovakia	2	+2.4	+1.8	1931
Slovenia	2	-	+1.7	1961
Spain	6	+0.8	-	1965
Sweden	10	-	+1.1	1860
Switzerland	5 (6.5°C)[1]	-	+1.10	1864
Turkey	4 (14.7 °C)[1]	-	+1.2	1971
Ukraine	1	+2.70	-	1891
United Kingdom	12	+1.10	+0.55	1884

[1] Annual mean temperature is given in brackets

2.1.3 Precipitation

Annual precipitation totals in 2019 were slightly higher than normal in Region VI, but considerably higher than 2018. Annual totals were above 125 % of normal (and thereby above the 90th percentile) in some places in the north (parts of United Kingdom, Norway, and an extended area in northern European Russia) and in the south around the Mediterranean due to locally heavy rain (Figure 2-4). Dry conditions with less than 80 % of normal precipitation or values below the 10th percentile occurred in other places in the north (southern Greenland, Iceland, Svalbard, Baltic States), but also in the Ukraine and in the southern parts of Iberia. The middle latitudes, too, were generally mostly drier than normal due to a longer drought period in the summer half year, but precipitation was only less than 80 % of normal in limited areas.

The year as a whole was wetter than normal in western parts of **Western Europe**. Precipitation of 100-125 % of normal was reported for Ireland, United Kingdom and western France, while much of the Benelux countries, central and eastern France had below-normal precipitation (80-100 %). Overall, the year had close-to-normal precipitation in most of the **Nordic countries**. Only places in southeastern Norway recorded above 125 % of normal precipitation. Iceland was remarkably dry with locally around 40 % of normal precipitation. The **Baltic states**, too, reported below-normal precipitation, particularly Estonia with 40 % to 60 % of normal. In **Iberia**, Spain reported a close-to-normal year with countrywide precipitation of 97 % of normal. Although precipitation was above 125 % of normal locally in southeastern parts of Spain, most of Iberia had below-normal precipitation, dropping below 60 % of normal in the southwest. Episodes of intense and persistent precipitation occurred often during the year, sometimes causing flooding. Multiple stations reported new local records of daily maximum precipitation. Over the **Mediterranean, Italian and Balkan Peninsula**, annual precipitation was mostly around normal, but locally it was well above average due to some heavy precipitation events, resulting in mostly above-normal country averages. Italy reported 122 mm more than normal precipitation (5th wettest) and Slovenia 109 % of normal. In Serbia, precipitation was around normal. Over **Eastern Europe**, annual precipitation was below normal for all countries of Eastern Europe except for the northern parts of European Russia. Belarus reported 91 % and Ukraine 84 % (fifth driest year) of normal precipitation, Moldova reported a deficit of 146 mm. West Kazakhstan received only 60 % to 80 % of normal precipitation. In the **Middle East**, overall, the year was normal with wetter than normal conditions especially in the northern parts (above 150 % locally) in Syria, Lebanon, Cyprus (wettest since 1902), northern Jordan (5th wettest since 1981 at Amman Airport) and in northern Israel and drier than normal conditions in the southern parts. In the **South Caucasus** region, the year was drier than normal in Georgia (particularly in the east where precipitation was only 50-60 % of normal) while it was close to normal in Armenia and Azerbaijan.

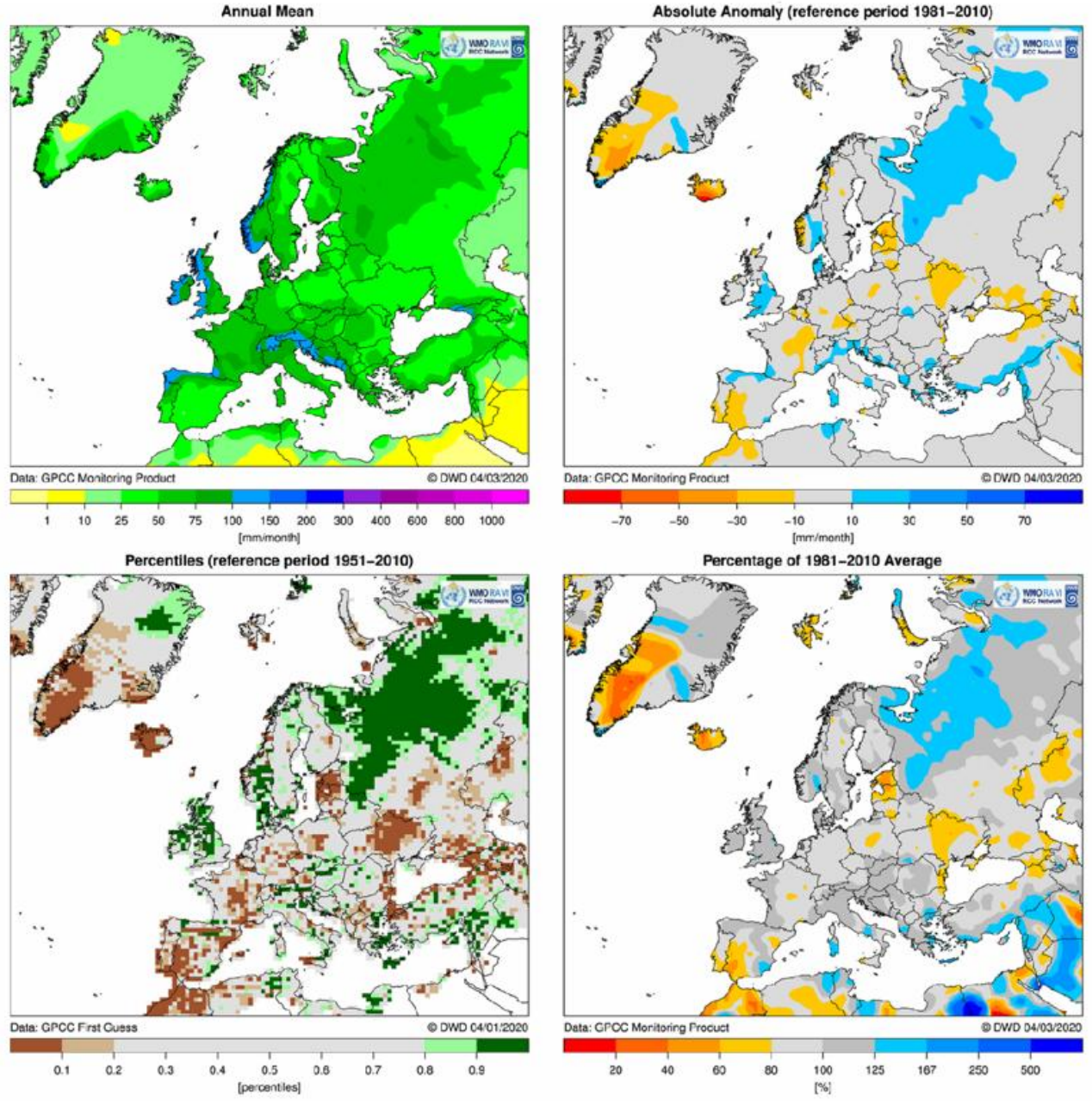

Figure 2-4: Total precipitation (left, top), anomalies (right, top) in mm/month, percentiles (left, bottom) and percentage of precipitation in % (right, bottom), for 2019. Reference period for the anomalies is 1981-2010, for the percentiles the reference period reference period is from 1951-2010); source: http://www.dwd.de/rcc-cm).

Table 2-2: Rank statistics and anomalies of annual precipiation in 2019 as reported by the National Meteorological and Hydrological Services (NMHSs). Information about all-time temperature records as provided by the individual NMHSs can be found here on the RCC RA VI website[2].

Country	Rank	Annual Anomaly (1961-1990)	Annual Anomaly (1981-2010)	start of time series
Armenia	4 (driest)	-143.3 mm	-	1935
Belarus	-	-	91 %	1945
Belgium (Brussels-Ukkel)	98 (driest)	-22.5 mm	-53.8 mm	1833
Bulgaria	25 (driest)	-67 mm	-	1930
Czech Republic	-	-	-52 mm	1961
Cyprus	1 (wettest)	290 mm	-	1902
Denmark	1 (wettest)	-	+159,1 mm	-
Estonia	22 (wettest)	-	-0.6 mm	1961
Finland	16 (wettest)	-	+21.6 mm	1961
Georgia	2 (driest)		-276.5 mm	1960
Hungary	49 (wettest)	-	+30.37 mm	1901
Italy	5 (wettest)	122 mm	-	2010
Jordan (Amman Airp.)	5 (wettest)	-	+117.4 mm	1981
Latvia	62 (wettest)	-	-6.1 mm	1924
Moldova (Chisinau)	14 (driest)	-	-146 mm	1891
Norway	15 (wettest)	115 %	-	1900
(European) Russia	8 (wettest)	55.2 mm	-	1936
Serbia	39 (wettest)	-	-0.6 mm	1951
Slovakia	11 (wettest)	81.6 mm	56,6 mm	1961
Slovenia	-	-	109 %	-
Spain	27 (driest)	-	-20 mm	1965
Switzerland	47 (wettest)	-	+103 %	1864
Ukraine	5 (driest)	-111 mm (84 %)	-	1961
United Kingdom	16 (wettest)	112 %	107 %	1862

[2] https://rcccm.dwd.de/DWD-RCCCM/EN/products/significant/records/download_tabelle.html?nn=500100

2.1.4 Sunshine duration

Most parts of the RA VI Region experienced a surplus of sunshine hours in 2019 (see Figure 2-5). Especially in Central and Eastern Europe and over Iberia, it was exceptionally more sunny than normal (>90th percentile) with 200 to 500 hours (in relative terms up to 125 %) more sunshine hours. Over the Eastern Mediterranean, it was less sunny than normal with deficits in the range of up to 200 hours which corresponds to deficits of only 5 % in relative terms though.

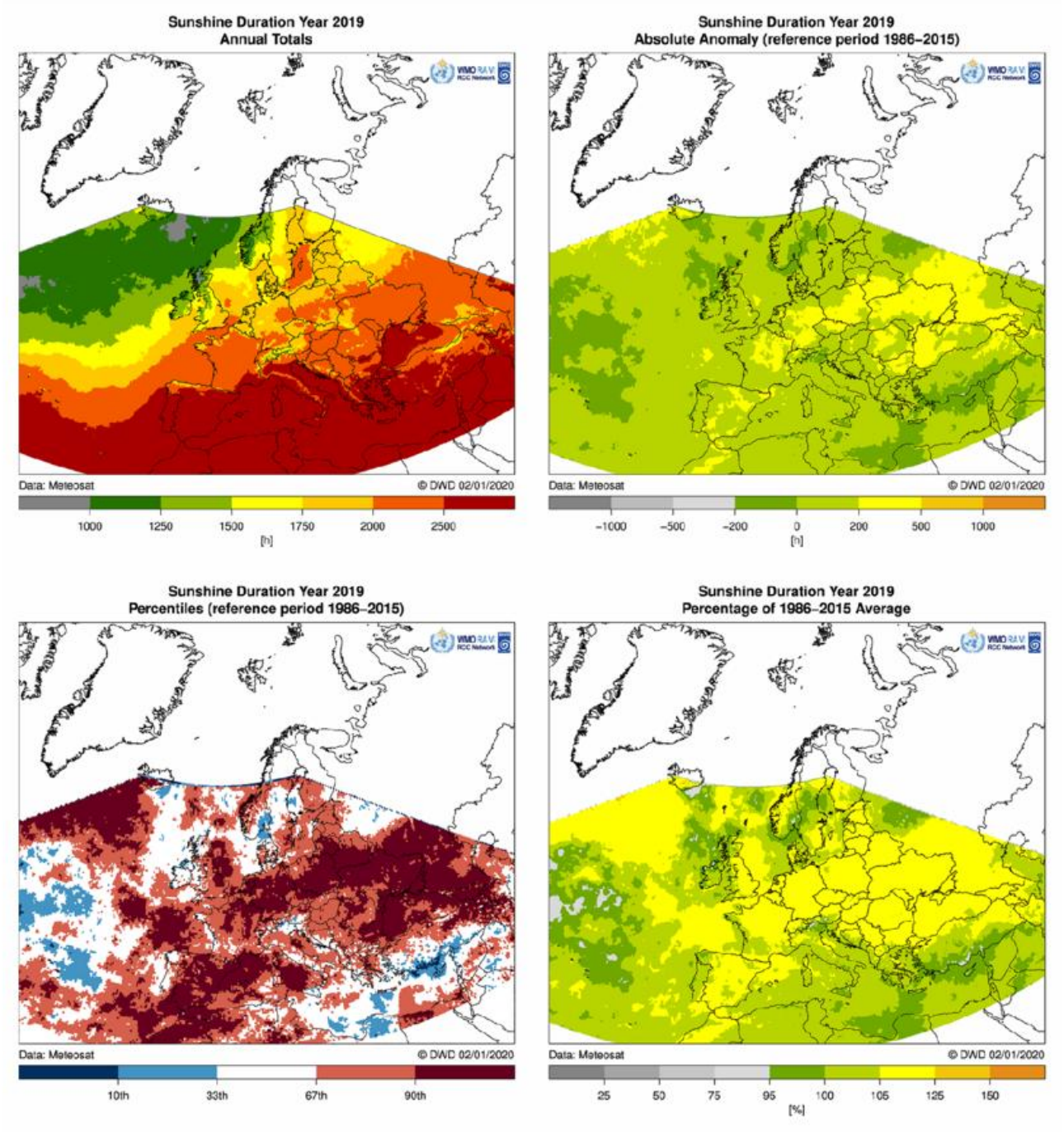

Figure 2-5: Annual sum of sunshine duration (upper left) as well as absolute anomalies (upper right), percentiles (lower left) and percentages of the long-term mean (lower right) with respect to the reference period 1986-2015 for the year 2019. (Source: http://www.dwd.de/rcc-cm).

In Germany overall, the year 2019 brought 1834.2 hours of sunshine on average (Fig. 4), which was above the multi-year mean annual totals. The surplus for the period 1981-2010 was 233.5 hours or 14.6 %. Compared to the climate reference period 1961-1990, there was a surplus of 290.2 hours

or 18.8 %. The year thus ranks as the 5th year with the most sunshine since 1951 in the present climate time series.2019 was also particularly sunny in the southwestern and western part of Iceland. 2019 finished up as third sunniest year on record in Reykjavík.

2.1.5 Drought situation

When looking at the Global Precipitation Climatology Centre Drought Index (GPCC-DI, Ziese et al. 2014) as a metric for characterizing meteorological drought, the values for the year as a whole range mostly between -1 and +1 (see Figure 2-6). Most regions with large precipitation deficits (for example areas neighbouring the Black Sea and the Baltic countries, see also 2.1.3) appear here with values between 0 and -1 indicating mild drought conditions on annual average. Over parts of Spain and the Middle East the drought situation is even classified as moderate drought with values up to -1.5 (Spain) or up to extreme drought (Syria). Several countries reported national or local low records of annual precipitation. For Armenia, for example, 2019 was the 4th driest year since 1935, after 1961, 2000 and 2008. In Spain it was very dry from January to October, especially in the central areas of the peninsula. It was very dry in some areas of Extremadura, Avila, Toledo, western half of Andalusia, Tarragona, Castellón, Ceuta y Melilla. Málaga and Cádiz only received less than 50 % of normal precipitation amounts.

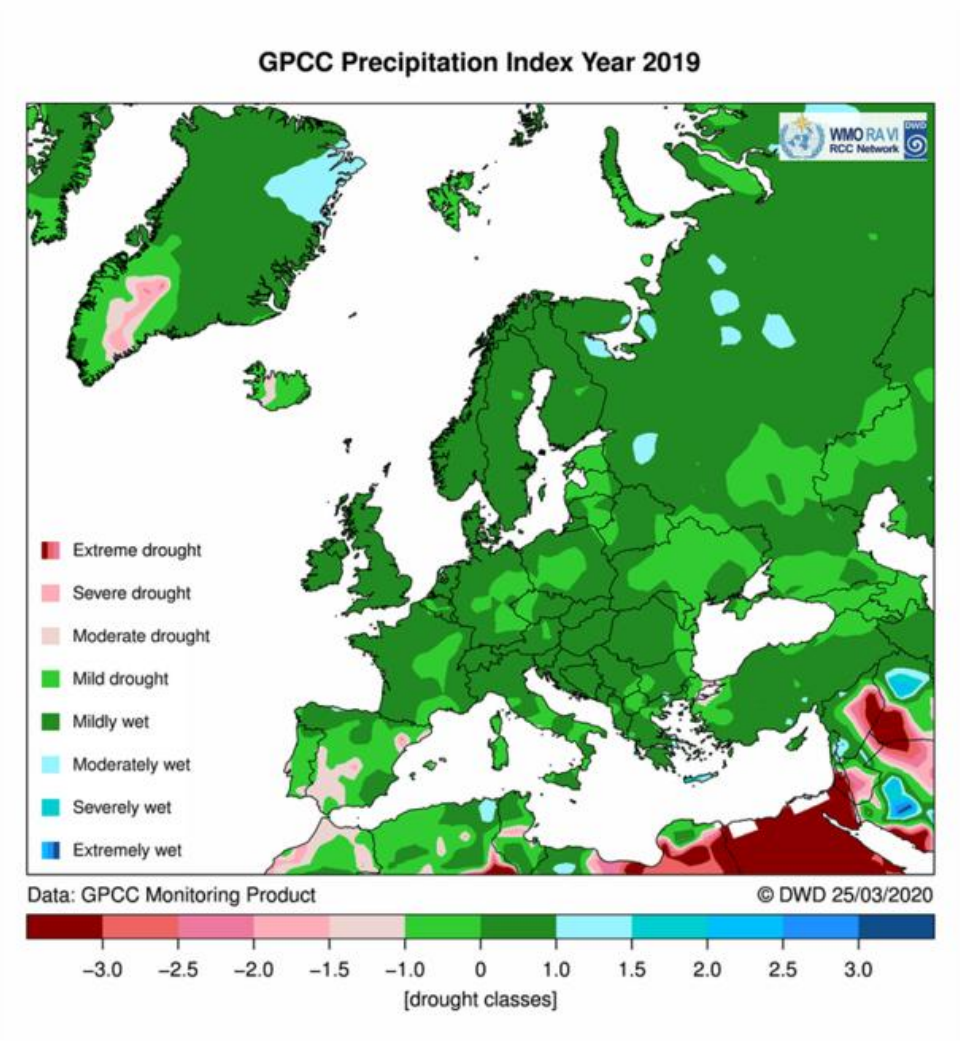

Figure 2-6: Annual GPCC –DI (GPCC-Drought Index) for the year 2019 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.6 Snow cover

In January, there was considerable **snow** in many parts of Iceland. In Sweden, snow came only in parts of the country at the beginning of the month, but on 27-28 January, when an extensive snowy weather entered southern Sweden, almost all of Sweden apart from parts of Skåne became snow covered. The largest snow depth in Sweden was measured in Katterjåkk, where it was 120 cm in the morning on January 13. In Finland, too, the snow depth was exceptionally high in the south (roughly 50 cm, occurring about once in 10 years), whereas Lapland had less snow than normal. Similar depths were measured in European Russia; the resulting snowdrifts blocked railway and motor traffic in certain places. In Moscow, heavy snowfall, which started on January 26 and continued without interruption for 37 hours, had set a new record for total daily precipitation. The deepest snow cover in Latvia (35 cm) was observed on 29 and 30 January in Aluksne, in Belarus it was 39 cm. Also in Lithuania, the thickest layer of snow reaching 28–33 cm was recorded in the last days of the month near Vilnius and Šilalė. The thickness of the ice cover on water surfaces in Belarus was less than average for that month. The monthly number of days with snow cover in Belarus was 5.4 on national average, these were relatively few (1961-90 normal is 12 days). Lots of snow fell in Ukraine; the snow depth reached 39 cm in Kiev (highest maximum in January was 47 cm in 1987). In Moldova, a snow cover existed almost the whole month, only at the end of January the snow melted in isolated places in the south of the country. Maximum snow cover in Moldova was 40 cm in Ribnita.

In Central Europe, heavy snowfalls took place at the beginning of the month in southern Germany and Austria, producing up to 80 cm of snow cover per day. This resulted in some new records, e.g. at station Reutte (850m altitude) in Austria with a maximum depth of 116 cm, the highest since beginning of measurements in 1937. Switzerland received much snow in mid-January, leading to a high risk of avalanches. In the Czech Republic, 37 cm of fresh snow fell on 8 January at Kvilda station; the highest total snow depth was 235 cm at Labská Bouda station on 30 January. In the west of the continent, everybody was readily accustomed to the absence of snow, and the more surprising was the snowfall that hit the western coast of France, England and Scotland in the last days of the month and delivered up to 10 cm of snow per day. In the Netherlands and Belgium, too, snowfall came rather late in the month (22 to 23 January) with only a few cm in the Netherlands, but up to 14 cm in the western part of Belgium (Lissewege). In Luxemburg, snow depth was 16 cm on 31 January at Findel Airport, the same depth in the United Kingdom on 23 January at Malham Tarn in North Yorkshire. In the Pyrenees Mountains, abundant snow fell reaching depths up to above 260 cm in high altitudes.

In Slovenia on the other hand, Kredarica Mountain had a snow depth of only 85 cm on 28 January, the third lowest monthly January maximum since beginning of observations. The number of days with snow cover in Croatia ranged from 17 to 29 days and was 6-16 days above the January average in most of the country. A snow cover was observed even in Albania at 1400m altitude on 30 January. In the south, Athens was hit by a severe snowstorm that required closing the schools, as they were normally not heated and unfit for operation in such conditions. Snowstorms in Lebanon and Israel occurred several times that month. In Jerusalem, snow fell for the first time in the last five years.

Snow cover was persistent as usual in much of Northern and Eastern Europe in February, but for the rest of the Region, snow was mostly rare with only a few snow days (snow cover at least 1 cm) even in Central Europe. Denmark recorded only 2 snow days on spatial average (normal 1961-1990

is 9 days), Belgium 6 days, Luxembourg 3 days (normal 8 days). The United Kingdom, Ireland and the Netherlands saw some snow mainly at the beginning of the month. Even Slovenia and Serbia saw some snow on 1 February in the lowlands in some places, but the snow cover did not persist. In the course of the warming during the month, the snow melted even in southern Sweden. Snow depths of more than 50 cm were recorded in much of Northern and Eastern Europe, while other parts in the lowlands mostly saw only a few cm. The eastern Swiss Alps recorded 50-70 cm fresh snow at the beginning of the month on 1-2 February. During the month, snow depths were around or above average in large parts of the Swiss Alps. Combined with warmth and much sunshine, winter sport conditions in the Alps were excellent, due to previous snowfall in January. In Sweden and Finland, the snow depth was generally around or below normal except in the northern Lapland Mountains with the largest depth of 158 cm in Cattery (Sweden). Heavy snowfall occurred in central regions of Russia including Moscow around the middle of the month. The United Kingdom measured 33 cm in Morayshire Province on 2 February. In Israel, some snowfall occurred in the northern mountains in mid-February and end of February. In **March**, snow cover persisted in continental Scandinavia (except the south) and Russia/ West-Kazakhstan (except the south) during the entire month. In mid-March, snowfall even reached southern parts of European Russia. In central Sweden, some melting occurred only in the last week. In Iceland, snow had much regional variability: 6 snow days were registered in Reykjavik, 22 in Akureyri. In the United Kingdom, from the Midlands northwards, it was occasionally cold enough for sleet and snow to penetrate to low levels. Ireland, too, saw some snow in places. Belgium saw 10 snow days, Luxembourg Airport 1 day (normal 5), Innsbruck in Austria also 1 (normal 6). The Baltic countries, Belarus and northeastern Ukraine also had snow only temporarily, mostly in the first and second decade of the month, other parts of the Region mainly in higher elevations throughout the month, only temporarily partly a thin snow coverage in the lowlands.

In terms of anomalies, snow was more frequent than normal in southern Norway, central Sweden, southern Finland, central European Russia, and eastern Turkey, but less frequent in the other Eastern European countries, Central Europe, the Balkan Peninsula and western Turkey (data after Rutgers University[3]). In the Alps in Austria (above 800m a.s.l), the number of snow days was around the climate mean or above.

Snow depths reached above 100 cm in high mountains, above 50 cm in Lapland and northern European Russia. Katterjakk, often the snowiest station in Sweden, recorded 206 cm on 1 April (there was an interruption of measurements in the second half of March). Finland had between half a meter and one meter of snow in the north from Northern Karelia to Lapland, and mostly 10–50 cm the rest of the country. Areas near the southern and western coastline of Finland were free of snow in many places. At the end of the month, snow depth was lower than usual in large parts of the country. Russia recorded a depth up to 70 cm in the Volga region. Latvia reported up to 31 cm (Aluksne). In the United Kingdom, a snow depth of 6 cm was measured at Middleton (Derbyshire) on the 10th and at Mugdock Park (Stirlingshire) on the 11th.

Western parts of Eastern Europe, Turkey and South Caucasus still recorded some snow, even parts of Central Europe and locally southern Europe. Belgium had 3 cm snow on Mont-Rigi on 11th. Denmark saw only a small snow cover of 0.5 cm on some days in places. Extremely rare was snow

[3] See https://climate.rutgers.edu/snowcover/index.php

in the Southern Alps. The station Bosco-Gurin in southern Switzerland (1486m a.s.l.) measured 4 cm of snow on monthly average, the lowest depth since 1961. In the 1970s, up to above 200 cm were observed at this station. The French Alps and the Pyrenees, too, had a deficit in snow, which was near record. On the Kredarica Mountain in Slovenia, the greatest depth this month was 190 cm, in the lowlands of Slovenia up to 26 cm, in Bosnia-Herzegovina 220 cm in the mountains and up to 21 cm in the lowlands, in Serbia 99 cm in the mountains (Kopaonik), 6 cm in the lowlands, in Montenegro 84 cm (Zabljak), in North Macedonia 26 cm (Mavrovo).

In **April,** areas north of around 60°N had a snow cover during the whole month. Normally snow comes down further south at least on some days in April (to around 55°N) according to data of Rutgers University (https://climate.rutgers.edu/snowcover/index.php). Depths were especially large at the beginning of the month due to previous snowfalls (e.g. up to 206 cm in Sweden), but decreased rapidly due to the warmth during the following days. At the end of the month, there was still up to 50 cm of snow in northern Finland. In the United Kingdom, a snow depth of 13 cm was measured at Warcop Range (Cumbria) on the 3rd. Russia saw some snowfalls in areas, where the snow previously melted in March, e.g. in the Moscow Region and in St. Petersburg (2-4 cm depth). Other parts in the RA VI Region had snow mainly in higher elevations. The Alpine valleys saw record snowfalls at the beginning of the month, e.g. 99 cm in 24 hours in Guttannen (northern Switzerland, 1055m a.s.l.) on 4-5 April, the highest fall since start of measurements in 1877. However, even the lowlands received some snow in Switzerland, e.g. 6 cm in Geneva on 4 April, a new April record, also Tirana in Albania saw a thin snow cover on 11 April. At the end of the month, snow came again down to the Alpine valleys (e.g. 11 cm in Defereggental, east Tyrol, Austria, 1383m a.s.l. on 28 April). The mountain station Lomnicky Stit in Slovakia (2633m a.s.l.) had a depth of 252 cm at the beginning, which decreased to 170 cm at the end of the month, but even in the last days of the month it was snowing. Kredarica in Slovenia (2514m a.s.l.) had its largest depth late in the month (220 cm on 29 April).

In **May,** snow occurred mostly only in Northern Europe and at high elevations. In Norway, snow came down to the south, while even parts of northern Sweden, southern Finland and northern European Russia remained free of snow. On the other hand, Lapland and northern European Russia still recorded local maximum depths of more than 50 cm. The largest depth in Sweden was 144 cm in Katterjåkk on 6 May. However, snow fell also in the lowlands of Central Europe at the beginning of the month, leading to short-living snow depths of a few cm. The Netherlands reported around 2 cm at the beginning of the month, Belgium 8 cm (in Presgaux, Couvin and Stembert, Verviers), Bern in Switzerland 4 cm, the latest fresh snow since 1898. Several snowfall periods occurred in the Alps, especially on northern slopes, compensating the snow deficit of the previous months. Peak Zugspitze in the German Alps reached a depth of 645 cm on 30 May, the largest of the year so far, Kredarica Mountain in Slovenia 320 cm on 31 May (largest of the month). Snow depths in Austrian highlands were close to new records. Hungary, too, had a snow cover of 5-10 cm in the mountains, which did not occur in May in this country for 34 years. Unusual snowfalls for May also occurred in middle elevations (1000-1500m a.s.l.) in Italy, partly with new record depths.

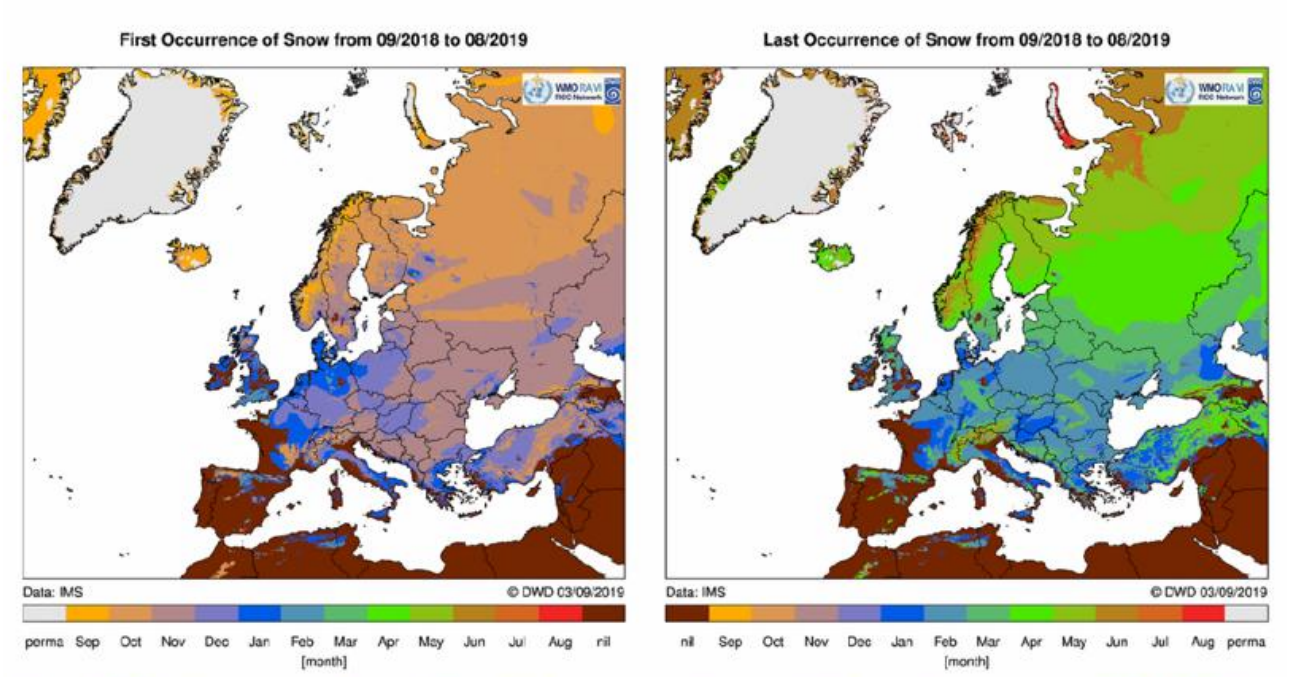

Figure 2-7: First occurrence of snow (left) and last occurrence of snow (right) during the snow season 2018/2019 from 09/2018 to 08/2019. (Source: http://www.dwd.de/rcc-cm).

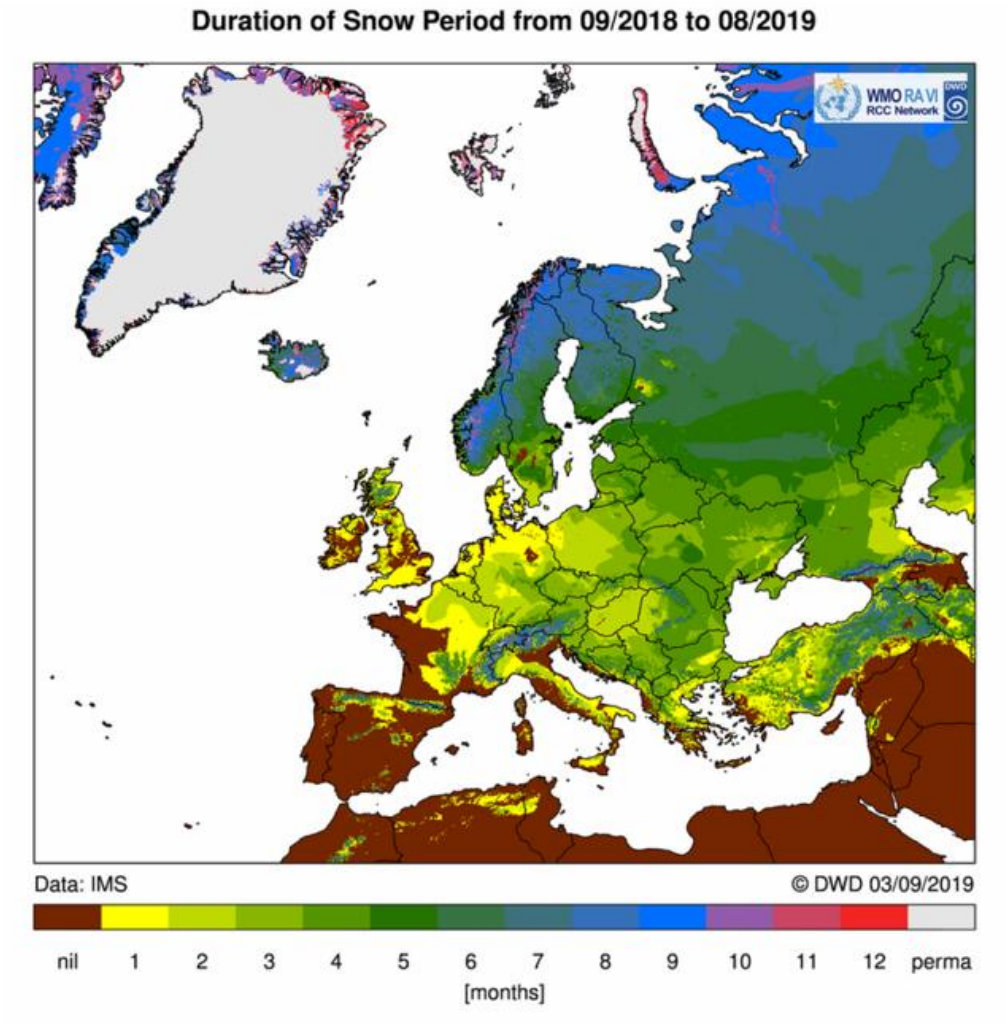

Figure 2-8: *Duration of snow cover in the snow season 2018/2019 (from 09/2018 to 08/2019). (Source: http://www.dwd.de/rcc-cm).*

2.2 Selected climate indices for 2019

This section presents selected temperature and precipitation indices calculated based on the station-based ECA&D (European Climate Assessment & Dataset; http://www.ecad.eu) dataset. Annual climate index maps are shown as well as anomaly maps. The following climate indices are considered:

1. **RR1, Number of wet days**: count of days where RR (precipitation) ≥ 1 mm

Precipitation below 1 mm/day has no effect on vegetation because it normally evaporates on the same day and is locally affected.

2. **SU, Number of summer days**: count of days where TX (daily maximum temperature) ≥ 25 °C

3. **WW, Number of warm and wet days**: days with TG (daily mean temperature) > 75th percentile and RR > 75th percentile

4. **TR, Number of tropical nights**: count of days where TN ≥ 20 °C

The maps showing the number of wet days (RR1, uppermost left panel in Figure 2-9) clearly depict the dry conditions prevailing in 2019. Over parts of Central Europe, in southern and eastern Europe there were less than 110 wet days which correspond to up to 60 less rainy days with respect to the 1961 to 1990 mean in these areas. The northern and northwestern parts of Europe, on the contrary, experienced more than normal wet days, mostly up to 60 days.

Looking at the number of warm and wet days (WW) it appears that above-normal numbers of WW were registered across most parts of Europe in 2019, also in the drier parts. Only very locally, the number of wet and warm days was fewer than normal.

The anomaly map for the number of summer days (SU, second row from the bottom on the right in Figure 2-9) also illustrates well the longer-than-normal summer conditions in 2019 all over the entire RA VI domain. Over Scandinavia, the UK and Ireland up to 10 summer days more than normal were observed, locally even less summer days than normal occurred. The rest of the RA VI domain saw more than 30 summer days more than normal.

There were also more tropical nights (TR) than normal in 2019 over most parts of the RA VI domain. However, the anomaly values for TR are smaller than for SU with mostly up to 20 tropical nights more than normal. Largest anomalies with 40-60 tropical nights more than normal occurred along the Mediterranean coast. Locally, there were also less than normal tropical nights throughout the RA VI Region.

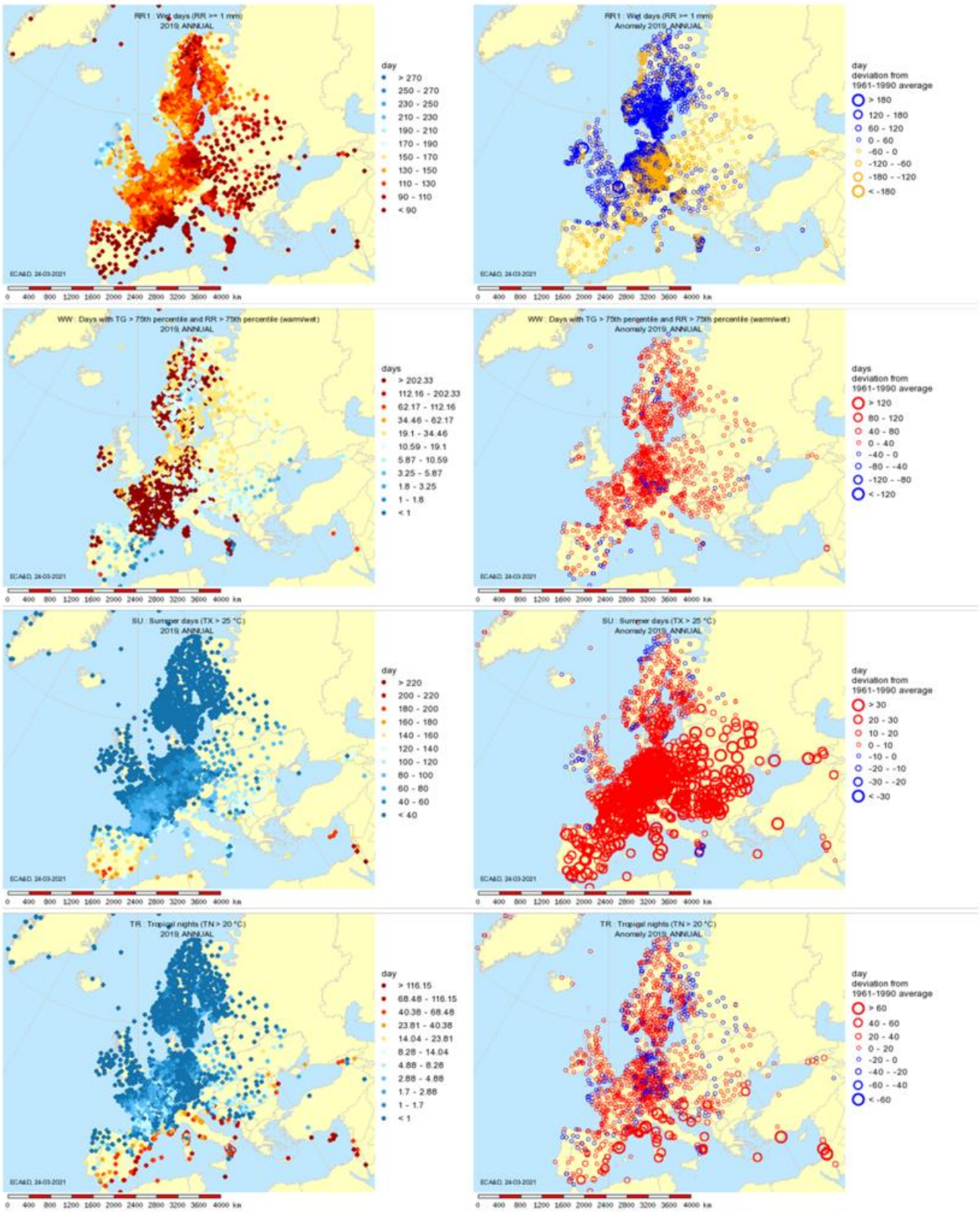

Figure 2-9: Selected Climate Indices for 2019 (left) and their anomalies (right) with respect to the 1961 to 1990 reference period (Source: ECA&D, http://www.ecad.eu).

3. Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2019 with anomalies related mainly to the normal period 1981-2010 for the following selected climate variables: sea level pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1 Seasonal averages and anomalies of selected climate variables

3.1.1 Sea level pressure and circulation indices

Pressure distribution in **winter 2018/2019** shows that both circulation centres, the Icelandic Low and Azores High, were stronger than normal with anomalies of -4 to -6 hPa and up to +6 to +8 hPa respectively. That winter the North Atlantic Oscillation (NAO) was positive, but with 1.08 not very pronounced; the Arctic Oscillation (AO) was in a neutral phase (-0.08). The dominant circulation patterns were the East Atlantic/ West Russia Pattern (EA/WR) and the Polar/ Eurasia Pattern (POL), with values of -1.55 and -1.89 respectively.

In **spring,** pressure was lower than normal over the entire RA VI Region except for Scandinavia. The Icelandic low was shifted south. Largest negative anomalies occurred southwest of Ireland and over Russia.

In **summer** the pressure anomalies were mostly only slightly positive or negative (within -2 to +2 hPa). Larger negative anomalies occurred tough over the Arctic including Iceland.

The circulation centres in **autumn** were well pronounced with a core pressure between 1000 and 1005 hPa around Iceland and between 1020 to 1025 hPa around the Azores. The latter formed part of high pressure belt extending further across southern and central Europe to western Kazakhstan with one maximum around the Azores and the second one over Eastern Europe. Above-normal pressure anomalies occurred over northeastern Europe, with largest anomaly values in the range of +4 to +6 hPa over the Baltic countries. All circulation patterns were in a neutral phase except for the NAO which was positive with a value around 1.

Table 3-1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference. Blue and yellow colors indicate index values lower and greater than zero respectively

season	NAO	EA	EA/WR	SCA	POL	AO
Winter 2018/2019	-0.16	0.18	-0.12	0.25	0.29	0.77
Spring 2019	-0.17	-0.38	-0.22	-0.34	0.35	-0.07
Summer 2019	-0.74	-1.27	1.1	-0.12	-0.98	-0.54
Autumn 2019	-0.63	-0.29	0.98	-0.11	0.36	0.24

Note that all values are standardized with the reference 1981 to 2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**:ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

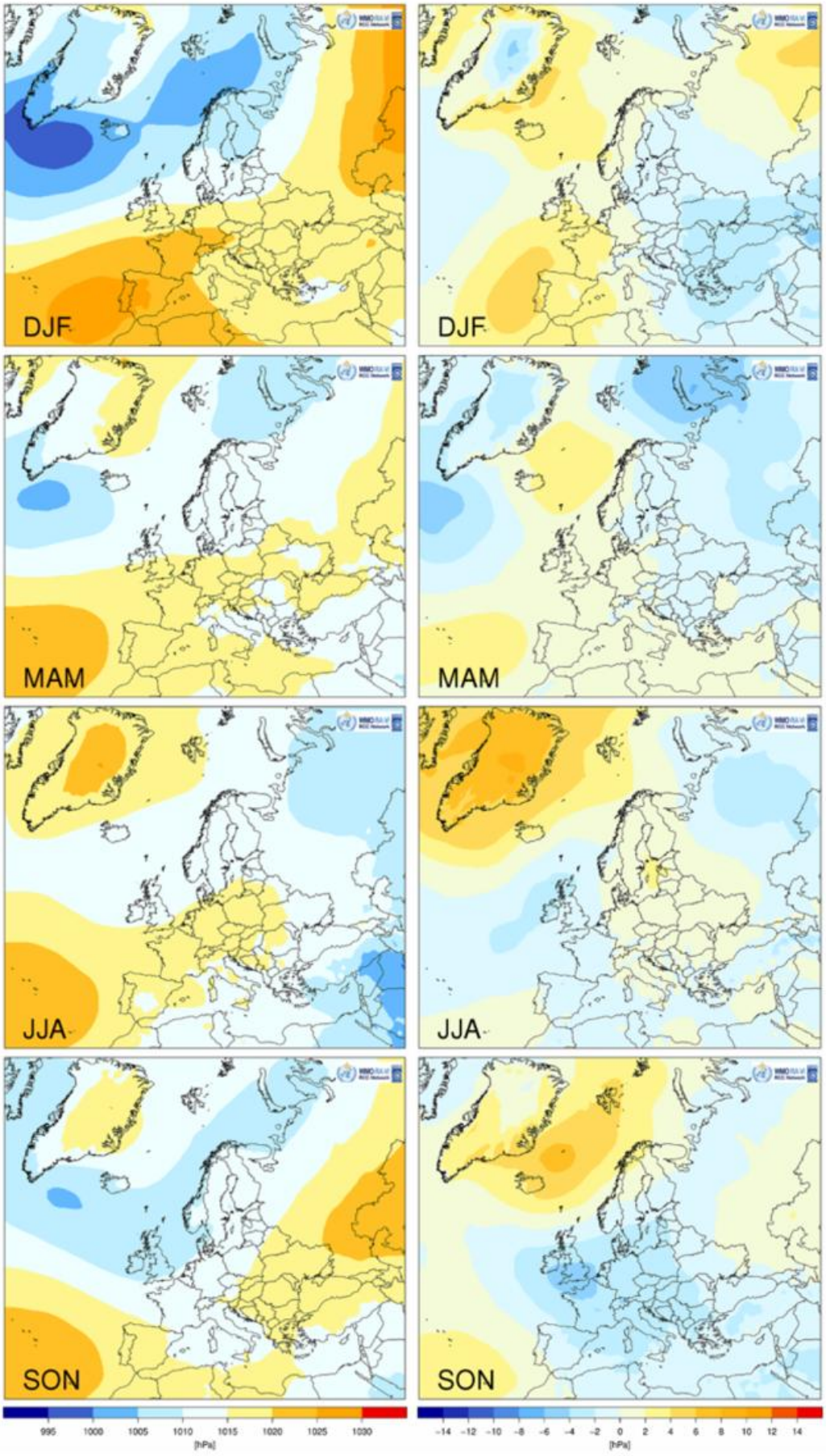

Figure 3-1: *Seasonal sea level pressure (left, in hPa) and anomalies (right, in hPa) in 2018/2019, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).*

3.1.2 Temperature

In 2019, mean annual temperatures were higher than normal (w.r.t. 1981-2010) over the whole RA VI Region which is reflected by positive anomalies in all sub-regions ranging from +0.69 °C over Iberia to +1.51 °C over Eastern Europe (see Table 3-2). Temperatures were not only higher than normal on an annual basis but also in all seasons except for the summer season over Eastern Europe which was normal with an anomaly value very close to zero (0.1).

Table 3-2: Seasonal and annual average of temperature anomalies over land areas in °C for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1)

region	year	winter	spring	summer	autumn
Central and Western Europe	1.33	0.91	0.59	1.94	1.06
Nordic und Baltic Countries	1.46	0.78	1.78	1.28	1.36
Iberia	0.69	0.34	0.56	0.63	0.66
Med. Italian and Balkan Peninsula	1.43	0.38	0.55	1.79	2.26
Eastern Europe	1.51	1.26	1.73	0.09	1.27
Middle East	1.17	0.85	0.79	1.06	1.19

Meteorological **winter 2018/19** (December 2018, January and February 2019) was mild in much of Europe (Fig. 5) with a NAO index of 1.16. Winter 2018/19 in Ireland was the warmest winter on record (since 1900). February was exceptionally warm (anomalies of +2.0 °C to +4.0 °C in Eastern Europe, and even higher in places) due a strong southwesterly airflow of moist and mild air from the East Atlantic.

In **Western Europe**, the winter was very mild (United Kingdom +1.4 °C above normal (eighth warmest), Netherlands +1.8 °C, Luxembourg +1.8 °C, France +1.3 °C, Ireland +1.8 °C above normal (warmest on record)) due to a very warm December 2018 and an exceptionally warm February. The United Kingdom reported the second warmest February on record (+2.4 °C above normal), Luxembourg and Ireland its third warmest (+3.7 °C and +2.4 °C respectively). In France, the countrywide average of maximum temperature was +4.1 °C above normal making it the second warmest February after 1990. Similarly in Ireland it was the warmest winter on record for many stations and more than half of the stations set new monthly maximum temperature records in February on the 25th and 26th. Other countries in Western Europe reported new records as well in late February (see below in section "Notable events"). Winter was mild in **Central Europe** with anomalies between +1.0 °C and +2.0 °C. Germany reported the ninth warmest winter with an anomaly of +1.9 °C. February, with an NAO index of 1.9, was unusually warm with anomalies of +2.0 °C and above (Austria +2.0 °C, Slovakia +2.9 °C, Czech Republic +2.6 °C, Hungary +3.0 °C, Germany +3.1 °C). In **the Nordic and Baltic countries**, the winter had well-above-normal temperatures. Denmark reported the seventh warmest winter on record with an anomaly of +2.9 °C. January, however, was colder than normal in most of the region, especially in Finland where temperatures were -3.0 °C to -4.0 °C below normal in the north. February, in contrast, was very mild with anomalies of +4.0 °C to +5.0 °C in the Baltic countries and Finland, resulting in many new monthly records of maximum temperature. On February 26th, 15.8 °C was measured at Tirstrup in

Djursland (Denmark), tied with the previous record of 24 February 1990 measured in Copenhagen. In Sweden, a new record was measured at Karlshamn with 16.7 °C on the same day. In Latvia, at Kolka, a new record of 13.4 °C was set on 16 February for the highest winter maximum temperature. Estonia reported the seventh warmest February on record with an anomaly of +4.3 °C, Latvia the eighth warmest (+4.5 °C above normal), Lithuania sixth warmest (+4.4 °C above normal). In **Iberia**, winter was generally warmer than normal. Spain reported an anomaly of +0.8 °C and Portugal +0.4 °C. After the year started with colder-than-normal temperatures in January (-0.1 °C anomaly) it continued with a very warm February ending the season with +1.2 °C above normal in Spain. In the north of Portugal, about 30 % of the stations registered new maximum temperature records for February. Concerning the **Mediterranean, Italian and the Balkan peninsula**: except for Greece (anomaly -0.2 °C) the winter season was warmer than normal for the region between +0.6 °C above normal for Italy and Serbia up to +1.3 °C above normal for Slovenia and Turkey. January was colder than normal for some western parts of the region. Serbia and Greece reported January anomalies of -0.9 °C, Italy -0.7 °C. The season ended with a warmer-than-usual February except for Sicily and Malta, the latter reporting its second coldest February on record. Slovenia reported +3.1 °C, Serbia +2.1 °C, Italy +1.4 °C and Greece +0.7 °C above normal. Over **Eastern Europe**, the year started with below-normal temperatures in January for most of Eastern Europe with anomalies of 1.0 °C in Belarus, -0.7 °C in Moldova and -0.5 °C in Ukraine (NAO of -0.36). February was extremely mild with anomalies ranging from +3.2 °C above normal to above +4.0 °C in Russia (+4.1 °C) and Ukraine (+4.4 °C) (NAO of +1.9). The **Middle East** experienced a warmer-than-normal winter, though anomalies in January and February exceeded +1.0 °C only locally. Winter was exceptionally mild in the **South Caucasus**. The whole region experienced anomalies above +2.0 °C and in Armenia even close to +3.0 °C. During all winter months, the anomalies were above +2.0 °C.

Above-normal temperatures continued with the start of **spring,** and only at the end of the season temperatures from Italy to the Nordic countries dropped to below normal by -2.0 °C to -3.0 °C in many regions, making it one of the coldest Mays in a long time for many countries. In **Western Europe,** spring was mild with anomalies ranging from +0.3 °C in France, over +0.7 °C in the Netherlands to +0.8 °C in the United Kingdom. Only May had below-normal temperatures with anomalies below -1.0 °C in the Benelux countries, eastern and southern France. In **Central Europe**, spring was just slightly warmer than normal for Switzerland and Austria (+0.1 °C and +0.2 °C above normal) and between +0.5 °C in Germany and +0.7 °C for the rest of the countries in the region. While March and April brought widespread temperatures up to +3.0 °C above normal, May was far colder than normal due to northwesterly circulation and below average solar radiation with anomalies between -2.2 °C and -2.6 °C ranking among the 10 coldest Mays for most countries. In **the Nordic and Baltic countries**, spring temperatures were above normal by more than +1.0° in most of the region (Norway +0.8 °C, Finland +1.15 °C, Denmark +1.5 °C and Latvia +1.5 °C above normal). April was especially warm with Finland and Norway reporting their second warmest April on record (+2.5 °C above normal) and Latvia the third warmest (+2.1 °C above normal) May was the only month of the season, which was colder than normal in the whole region except for Lithuania and Latvia, where May was slightly warmer than usual. Over **Iberia**, spring started with a warmer-than-usual March and anomalies of around +0.7 °C. While April was close to normal, May proved to be warm again especially in Portugal, which reported its 7th hottest May since 1931, and southern Spain.

Table 3-3: Seasonal rank statistics for temperature (2018/2019) as provided by the NMHSs including countries with rankings among the top 5 (ranks 1–5) since start of the to time series.

Country	Anomaly	Reference period	Rank /Start of time series
		winter	
Ireland	+2.18	1961-1990	1
		spring	
Latvia	+1.6	1981-2010	4
Lithuania	+1.5	1981-2010	5
Moldova	+1.4	1981-2010	5
		summer	
Slovakia	+3.5 +2.4	1961-1990 1981-2010	1
Czech Republic	+2.5	1981-2010	1
Austria	+3.8	1961-1990	2
Italy	+2.92	1961-1990	2
Hungary	+2.19	1981-2010	2
Switzerland	+2.3	1981-2010	3
Belgium	+1.5	1981-2010	4 (warmest since 1833)
Lithuania	+1.5	1981-2010	4
Armenia	+2.1	1961-1990	5
Bulgaria	+2.2	1961-1990	5 (since 1930)
Moldova	+1.9	1981-2010	5
Serbia	+1.8	1981-2010	5
		autumn	
Bulgaria	+3.0	1961-1990	1 (since 1930)
Serbia	+2.9	1981-2010	1
Hungary	+2.38	1981-2010	1
Slovakia	+2.3 +2.1	1961-1990 1981-2010	1
Lithuania	+1.9	1981-2010	3
Moldova	+2.6	1981-2010	3
Austira	+1.9	1961-1990	4
Italy	+1.92	1961-1990	3
Czech Republic	+1.6	1981-2010	5
Jordan	+1.5	1981-2010	5

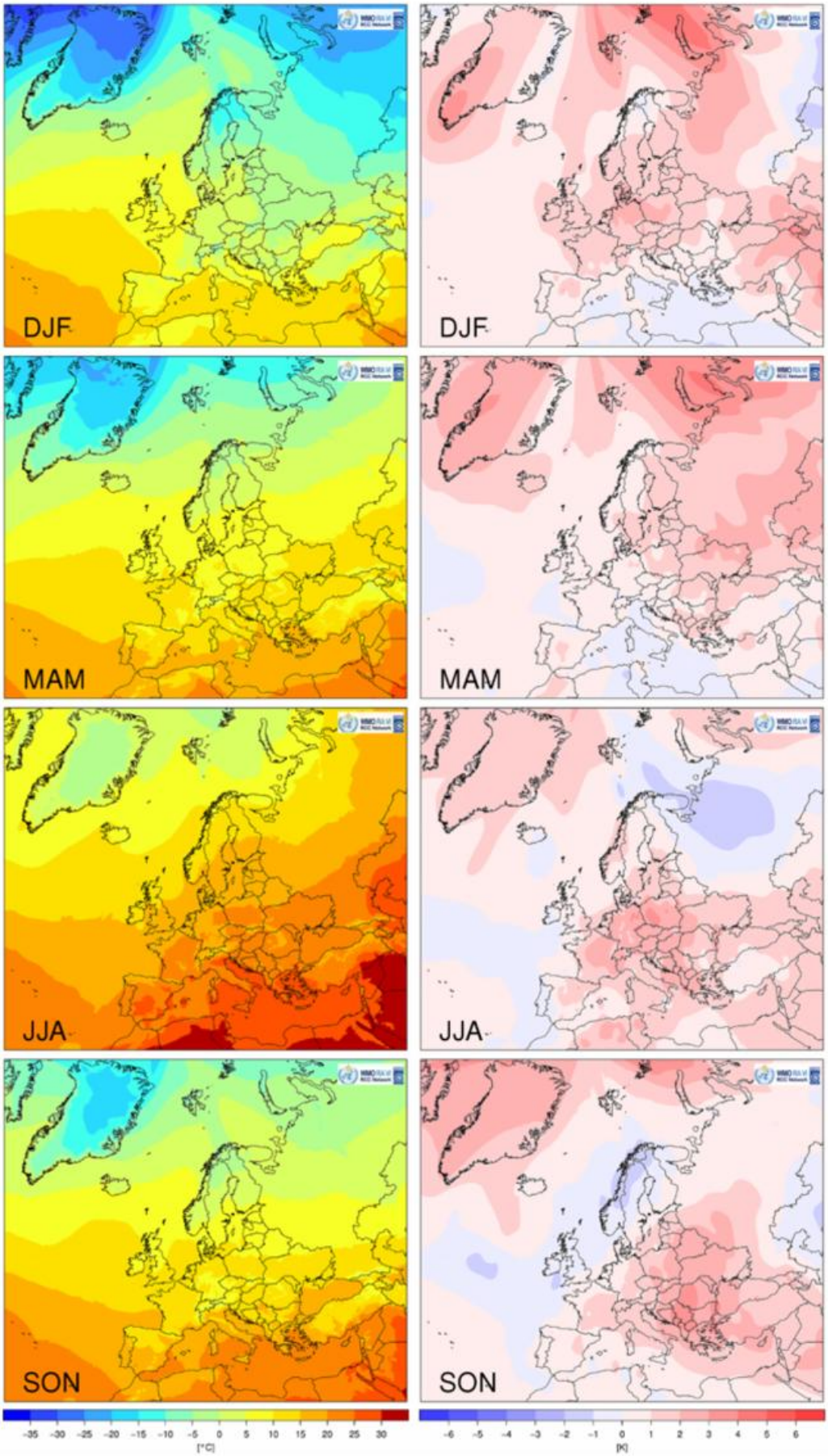

Figure 3-2: *Seasonal mean temperature (left, in °C) and anomalies (right, in K) in 2018/2019, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).*

Concerning the **Mediterranean, Italy and the Balkan states**, overall spring anomalies were +0.5 °C for Spain and +1.03 °C for Portugal. Spring was warmer than normal for almost the entire region. Anomalies mainly ranged from +0.2 °C to +0.7 °C r. The end of the season, due to northwesterly circulation and below-average solar radiation, was unusually cold in Italy and the Balkans. Slovenia reported one of the coldest May's on record (anomaly -2.8 °C), Italy the sixth coldest (anomaly -1.45 °C), Serbia the eighth coldest (anomaly -2.1 °C), and Malta and Greece reported anomalies of -1.5 °C and -0.5 °C respectively. Over **Eastern Europe**, well-above-normal temperatures continued in spring. Russia and Ukraine reported their eighth and seventh warmest spring each with an anomaly of +2.3 °C. Belarus and Moldova reported their fourth and fifth warmest spring (anomalies of +1.7 °C and +1.4 °C). March with an NAO of 2.39 was especially warm with anomalies of +2.9 °C (in Belarus) to +3.9 °C (in Ukraine) and ranked in the top ten of the warmest March months for all countries of the region. In the **Middle East**, after a slightly-colder-than-normal March (anomalies down to -1.0 °C for most of the region) and an April with well-below-normal temperatures (anomalies below -1.0 °C), a warmer-than-normal May followed with anomalies above +2.0 °C in parts of Israel and Jordan. Israel reported its warmest May for at least 50 years. During a prolonged heat spell starting in mid-May, multiple Sharav events (hot and dry winds coming from desert regions) brought very high temperatures, most notably between 22 and 24 of May when maxima of 43 °C to 45 °C were reached in the coastal plain and up to 47 °C in the Dead Sea region. Overall, spring season was closer to normal except for Cyprus where temperatures were +0.7 °C above normal. In the **Middle East**, in spring, above-normal precipitation (>125 % of normal) was received in northern and western Syria and in the Lebanon. Southeastern Syria and eastern Jordan had an early start of the dry season and received less than 10 mm in the whole spring. In May, precipitation was scarce in the whole region. The dry season continued until September. Spring started with a close-to-normal March in the **South Caucasus** followed by a colder-than-normal April with anomalies below -1.0 °C in Armenia. However, due to well-above-normal temperatures in May (anomalies above +2.0 °C in the whole region) the season overall was warmer than normal.

Summer was warmer than normal in much of Europe. June proved to be a month full of records for many countries with widespread anomalies of +2.0 °C to +4.0 °C. Summer in **Western Europe** was close to normal (+0.4 °C) in Ireland and only slightly warmer in the United Kingdom (anomaly of +0.8 °C, twelfth warmest). For Belgium (+1.5 °C), Luxembourg (+2.4 °C) and France (+1.7 °C) it was the third warmest summer on record and in the Netherlands the fourth warmest at De Bilt with an anomaly of +1.4 °C. June was very warm for most of Europe. It was the warmest June in the Netherlands, second warmest in Luxembourg (anomaly +3.6 °C) and fifth warmest in France (anomaly +1.8 °C). Ireland was below normal with anomalies of -0.3 °C. Although it was only the 4th warmest July on record for France (+2.2 °C), many records of daily maximum temperature were broken especially on 25 July (see "notable events" and sidebar for more details). Summer in **Central Europe** was exceptionally warm. Slovakia and the Czech Republic reported their warmest summer on record with anomalies of +2.4 °C and +2.5 °C, Hungary and Austria reported their second warmest (+2.2 °C and +2.7 °C above normal), and Germany and Switzerland their third warmest (+2.1 °C and +2.3 °C). All summer months were warmer than normal in the region but June in particular was the warmest month on record for all countries except for Switzerland where it was second warmest. Anomalies in June were well above +3.0 °C, and close to +5.0 °C in places. Many highest temperature records were broken. In Germany, the previous countrywide record of 40.3 °C, measured at station Kitzingen in summer 2015 was beaten by 14 different stations during the peak

of the heat wave on 25 June. Austria reported new June records at more than half of the 269 stations of ZAMG. In the **Nordic and Baltic countries**, summer was warmer by above +1.0 °C in the northern countries (Estonia +1.6 °C (warmest since 1961 together with 2015), Denmark +1.6 °C, Norway +0.9 °C, Latvia +1.0 °C, Finland +0.29 °C). Some new records were set, for example a new high minimum temperature of 26.1 °C observed at station Sømna – Kvaløyfjellet (Nordland, Norway) on 28. July. Never before a higher minimum temperature had been recorded in Norway. At the Swedish station Markusvinsa a new record of maximum temperature at 34.8° was measured on 26 July. This was the highest temperature ever reported north of the Arctic Circle in Sweden. On June 13, a new seasonal record with a temperature of 33.0 °C was set in Riga. Many other stations broke their monthly maximum temperature record during June. Contrasting to the warm June, July was colder than normal in the Baltic countries and Finland with anomalies slightly below -1.0 °C (Finland -1.1 °C, Latvia -1.2 °C, Lithuania -1.0 °C, Estonia -1.0 °C). In **Iberia**, the summer was warmer than usual by +0.8 °C for Spain, contrary to the situation in Portugal where temperatures were below normal by -0.3 °C. During a heat wave in the last days of June (26 June to 01 July) the highest measured temperatures reached well above 40.0 °C, for example 43.4 °C in Lleida and 43.2 °C at Zaragoza Airport, each on 29 June, and 43 °C at Girona Airport on 28 June. Seven main stations in Spain recorded a new daily maximum temperature record for the season during this heat wave. Concerning the **Mediterranean, Italian and Balkan Peninsula**: during the summer season, especially the Balkan states experienced widespread temperatures of more than +2.0 °C above normal. Slovenia and Italy reported the second warmest summer on record with an anomaly of +2.5 °C and +2.9 °C, respectively, Greece the fourth warmest (+1.3 °C above normal) and Serbia the fifth warmest (+1.8 °C above normal). June and August featured very high temperatures. It was the hottest June on record for Malta (+2.45 °C above normal), the second warmest for Slovenia (+4.2 °C above normal) and Italy (+3.9 °C above normal) and the fourth warmest for Greece (+1.5 °C above normal). August was reported the fourth (+1.7 °C) and fifth (+2.7 °C) warmest on record by Greece and Italy. Over **Eastern Europe**, during summer, the month of June was exceptional. Belarus, Ukraine and Moldova reported their warmest June on record with anomalies of +4.5 °C, +4.7 °C and +3.6 °C above normal, respectively. Records were broken at several stations. In Belarus, temperatures up to 34.7 °C were recorded during daytime while temperatures at night often did not fall under 21.0 °C in the period of 11 to 26 June. Locally, anomalies reached up to +7.0 °C. On 2 July, the 1929 highest maximum temperature record was broken at station Voznesensk in the Ukraine with a temperature of 39.0 °C. In the **Middle East**, summer was warmer than normal by more than +1.0°. In June, anomalies in the Middle East were close to and, in Jordan, even above +2.0 °C, ranking the season amongst the warmest five for all countries in the region. Summer in **South Caucasus** was characterized by a record June (in Georgia the warmest since 1960) with anomalies of +3.0 °C to +5.0 °C for the whole region, while in July the western parts of Georgia were slightly colder than normal and the other parts of South Caucasus had slightly-above-normal temperatures. This reversed in August when anomalies were below normal in Azerbaijan and above normal in Georgia and Armenia.

Autumn also was warmer than normal except for the Nordic countries, Ireland and the United Kingdom. The Balkan states were particularly warm with anomalies well above +2.0 °C.

Western Europe: While autumn brought below-normal temperatures to Ireland (anomaly -0.4 °C) and the United Kingdom (anomaly -0.3 °C) and near-normal temperatures in the Benelux countries (Netherlands +0.2 °C, Belgium +0.3 °C, Luxembourg +0.7 °C above normal), France reported its

sixth warmest autumn since 1900 with an anomaly of +1.0 °C. December 2019 was mild with anomalies of 0.8 °C in Ireland, around +1 °C in the United Kingdom and +2 °C in Benelux and France. **Central Europe** experienced a warmer-than-usual autumn, especially for the southeastern parts of the region. Hungary (+2.4 °C anomaly), Slovakia (+2.1 °C) and the Czech Republic (+1.6 °C) reported their warmest autumns, while for Austria (+1.6 °C) it was the fourth warmest, Switzerland (+1.1 °C) the sixth warmest and Germany, with 1.0 °C above normal, the 10th warmest. December 2019, too, was a mild month with anomalies ranging from about +1 °C in western Germany and +3 °C in eastern Poland. In the **Nordic and Baltic countries**, autumn was colder than normal in Norway (-0.9 °C below normal), Sweden and Finland (-0.16 °C below normal), while the Baltic countries and Denmark reported above-normal temperatures (Latvia +1.6 °C anomaly, eighth warmest together with 1949; Lithuania +1.9 °C, Estonia +1.1 °C, Denmark +0.7 °C). On 14 November, daily maximum temperature records were broken at many stations in Estonia, for example at coastal station Kunda the temperature rose to 12.5 °C (the previous record was recorded on 14 November 1938). December 2019 was generally mild, with anomalies ranging from below +1 °C in Iceland to above +5 °C in easternmost parts of the region. In **Iberia**, with an anomaly of +0.7 °C, Spain had a warm autumn. Only November had close to normal temperatures (anomaly +0.1 °C) while September and October were warmer than usual with anomalies of +0.7 °C and +1.3 °C for Spain. December, too, was a mild month with anomalies above +2 °C in central parts of Spain. For the **Balkan states**, an extremely warm autumn followed. For Croatia (+2.1 °C), Serbia (+2.9 °C) and Greece (+1.9 °C) it was the warmest autumn on record while for Slovenia it was the second warmest with +1.9 °C above normal, and Turkey and Italy reported their third warmest autumn with +1.9 °C above normal. December, too, was very mild with anomalies mostly between +1 °C and +3 °C, highest in northeastern Balkans and eastern Turkey. Over **Eastern Europe**, all three autumn months were warmer than normal for all countries in Eastern Europe except West Kazakhstan, which was repeatedly touched by a northerly inflow of cold air. Belarus reported the second warmest (+2.2 °C), Moldova the third warmest (+2.6 °C) and Ukraine the eighth warmest (+2.4 °C) autumn. It was the warmest October in Belarus since records began (anomaly of +2.87 °C). Abnormally warm weather between 14 and 22 October with anomalies up to +10.0 °C was observed in the whole country. The season ended with a warmer-than-normal November ranking fifth warmest in Belarus (+3.2 °C) and Moldova (+3.8 °C) while for the Ukraine it was only the 12th warmest (+3.1 °C). December, too, was extremely mild with highest monthly anomalies between +8 °C and +10 °C in the Arkhangelsk region in northwestern European Russia and many new daily records of daily maximum temperature especially in the period 18-23 December. It was the second warmest air temperature anomaly in December for the European part of Russia on average (+5.25 °C). In the **Middle East**, the warmth continued in autumn and December with anomalies of well above +1.0 °C in much of the Middle East in all four months September to December. In the **South Caucasus** region, autumn was warmer than usual in Georgia and Armenia while temperatures in Azerbaijan were close to normal. While temperatures were unusually high in October with anomalies above +2.0 °C in the whole South Caucasus region (3rd warmest October since 1960 in Georgia), cold air in the east caused a drop to slightly-below-normal values in November in its eastern parts. Warm air came again in December, and anomalies increased notably to around +3 °C.

3.1.3 Precipitation

Many parts of Western Europe received only 60 % to 80 % of normal precipitation that **winter** (Fig. 6), and only 20-60 % in parts of the Iberian Peninsula, while in the south of Central Europe, Eastern

Europe and parts of the Eastern Mediterranean precipitation was 125 % to 250 % of normal. During the winter season, precipitation was close to normal or below normal for **Western Europe**. The United Kingdom and Ireland reported 77 % and 66 % of normal precipitation, respectively. In the Benelux countries and most parts of France, precipitation was close to normal and only some western, central and southern parts of France recorded below-normal precipitation down to 60 % of normal. In **Central Europe**, the year as a whole was close to normal or drier. Some places in eastern Germany and Poland even received less than 80 % of normal precipitation. In **Central Europe**, the winter season was wetter than normal. Germany, Slovakia and Hungary reported about 110 % and the Czech Republic 148 % (eighth wettest) of normal precipitation. While January was wetter than normal with widespread precipitation between 125 % and 167 % of normal, February was drier than normal especially in Germany with most of the country receiving between 20 % and 60 % of normal precipitation. In the **Nordic and Baltic countries**, winter was wetter than normal in Denmark with 105 % and Norway with 115 % of normal precipitation. Precipitation in Norway, however, was distributed inhomogeneously. While some stations in the east received 200 % to 300 % of normal, several stations in the west received only about 50 % of normal. Finland was close to normal with countrywide precipitation of 102 % of normal. Estonia and Latvia were drier than normal with about 60 % to 80 % of normal precipitation, western Iceland was even drier, while southern Lithuania recorded locally above 125 % due do some low pressure systems coming from Central Europe. In **Iberia**, it was the fifth driest winter in Spain with 49 % of normal rainfall. Portugal had 42 % of normal, the fourth driest winter since 2000. Only in January did northern parts of Spain receive above-normal precipitation. In February, precipitation on the entire Iberian Peninsula was widely 20 % to 60 % of normal. With a countrywide average of 28 % of normal precipitation, Spain recorded the fourth driest February since 1965 and the driest in the 21st century. Concerning the **Mediterranean, Italian and Balkan peninsula**, winter was drier than normal in Italy (63 % of normal), Slovenia (68 % of normal) and Croatia (77 % of normal) while it was wetter for Serbia (120 % of normal), Turkey (146 % of normal), and for Greece it was the fifth wettest winter on record (155 % of normal). January was particularly wet in almost all parts of the region with Greece reporting the wettest January on record with 244 % of normal precipitation. Over **Eastern Europe**, the winter was generally wetter than normal with up to 126 % of normal precipitation in places. January in particular brought a precipitation surplus and was reported the fifth wettest by Russia (132 % of normal) and Moldova (231 % of normal). February, on the other hand, was the fourth driest in Belarus with locally just 20 % of normal precipitation. Ukraine reported 46 % of normal precipitation while Moldova was close to normal (94 %) and Russia reported above-normal precipitation with 132 % of normal, mainly in the north. In the **Middle East**, during January, Cyprus, Lebanon and the western parts of Syria received above-normal precipitation while in Israel and Jordan precipitation was below normal. February was wet again except for some parts in the east of Syria. In the **South Caucasus** region, the winter season was wet in Azerbaijan and Armenia, which received 125 % -250 % of normal precipitation and more than 250 % in places. Georgia received below-normal precipitation, below 80 % of normal in places.

Many parts of France and the Iberian Peninsula were drier than normal in spring with precipitation of 60 % to 80 % while in the rest of Europe it was closer to normal or wetter (125 % to 167 % of normal in Scandinavia and Italy/ northern Balkans). In **Western Europe**, Ireland and the United Kingdom reported slightly above-normal totals for the spring season. March was very wet in both countries. The United Kingdom reported the eighth wettest March since 1910 (136 % of normal). The Benelux countries were slightly drier than normal in spring with around 90 % of normal

precipitation. Parts of France remained dry with deficits as low as 50 % to 80 % of normal. In **Central Europe**, for Germany (98 %), Switzerland (102 %) and the Czech Republic (103 %) spring was close to normal while for Slovakia (121 %) and Hungary (112 %) the season was wetter than normal. For Hungary, March was the 10th driest on record with only 28 % of normal precipitation. During April, the precipitation deficit shifted to Germany, the Czech Republic (60 % of normal and the ninth driest) and northern parts of Poland where precipitation reached only 20 % to 40 % of normal.

Table 3-4: Seasonal and annual average of precipitation anomalies over land areas in % for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1)

region	year	winter	spring	summer	autumn
Central and Western Europe	96	95	94	85	113
Nordic und Baltic Countries	94	103	89	95	89
Iberia	89	57	83	87	101
Med. Italian and Balkan Peninsula	106	97	111	104	102
Eastern Europe	107	120	107	100	100
Middle East	99	130	113	119	63

Table 3-5: *Seasonal rank statistics for precipitation (2018/2019) as provided by the NMHSs including countries with rankings among the top 5 (ranks 1–5) since start of the to time series.*

Country	Anomaly	Reference period	Rank /Start of time series
		winter	
Jordan	86.6mm	1981-2010	4th wettest since 1981
Italy	-93 mm	1961-1990	5th driest since 1961
Spain	-101 mm (50% of normal)	1981-2010	5th driest since 1965
		autumn	
Georgia	-99.4 mm	1981-2010	5th driest since 1960

Spring again was wetter than normal for the **Nordic countries** except Iceland (Norway 122 %, Denmark 130 %, Finland 118 % of normal) while the **Baltic countries** reported below-normal precipitation (Latvia 82 %, Lithuania 76 % of normal). Especially April was extremely dry in the whole region. Latvia reported only 9 % of normal precipitation making it the driest April on record. Finland only received 42.8 % of normal, ranking fourth driest, and Denmark reported only 36 % of normal precipitation. In **Iberia**, spring started with a very dry March when precipitation ranged from 20 % to 80 % of normal in most parts of the Iberian Peninsula. After a very wet April with 148 % of normal precipitation, ranking the fourth wettest for Spain, the season ended with an extremely dry May. Almost the whole Iberian Peninsula received only 20 % to 60 % of normal precipitation, with large parts of Spain below even that, making it the fourth and sixth driest May on record for Spain and Portugal, respectively. Over the **Mediterranean, Italian and Balkan peninsula**, most of the region experienced a wetter-than-normal spring, only Turkey was close to normal and Greece reported slightly-below-normal precipitation of 93 %. May was very wet in many countries of the region with

the exception of Greece and Turkey. Croatia and Slovenia reported 195 % of normal precipitation, the latter even reported the wettest May on record. For Serbia, it was the sixth wettest (192 % of normal) and Italy reported 185 % of normal precipitation. Over **Eastern Europe**, spring was wetter than normal in Russia and Ukraine while Belarus and Moldova received below-normal precipitation. March was rather dry in Romania, Moldova and Ukraine. Moldova even reported the second driest March on record with a countrywide average of only 1 mm, which is 3 % of normal precipitation, and Ukraine on countrywide average received 64 % of normal precipitation. In Belarus, it was only slightly drier than normal (91 % of normal) and the European parts of Russia reported a precipitation surplus of 115 % of normal. April was drier than normal in all countries of the region but driest in Russia, which reported the sixth driest April with 66 % of normal and Belarus even recording the driest April on record with only 18 % of normal precipitation. The season ended wet for the whole region with precipitation of 124 % to 161 % of normal, the latter being reported by Ukraine as the sixth wettest May. In the **South Caucasus** region, during spring, Azerbaijan again recorded above-normal precipitation of 125 % or more while precipitation in Georgia and Armenia was closer to normal.

Except for the eastern Mediterranean, the United Kingdom, Ireland and southern parts of Norway, summer was drier than normal with 60 % to 100 % of normal precipitation. In **Western Europe**, summer was predominantly characterized by low pressure leading to a rather wet season in Ireland and the United Kingdom. The United Kingdom reported its 10th wettest summer with 138 % of normal precipitation as well as some broken records - 425.4 mm in South Yorkshire, which is double the average for the season. In contrast, summer was drier than normal in France and the Benelux countries with only 80 % to 90 % of normal precipitation. In **Central Europe**, the summer was drier than normal for the whole region. Germany reported 73 %, Slovakia 84 %, Czech Republic 76 %, Hungary 91 % and Switzerland 95 % of normal precipitation. June in particular was very dry for Austria, which reported its driest June since the beginning of measurements in 1767 with only 43 % of normal precipitation, and Poland where the southern parts only received 20 % to 40 % of normal precipitation. In the Czech Republic, the precipitation deficit was 67 % of normal and thus it was the eighth driest June on record. Germany and Switzerland received 72 % and 88 % of normal precipitation during June. The summer season was drier than normal for all **Nordic and Baltic countries** except for Denmark (115 % or normal) and Norway (110 % of normal). Finland received only 67 %, Latvia and Lithuania a bit more than 80 % and Estonia 78 % of normal precipitation. Especially July was extremely dry in Finland (48 % of normal, ranking the fifth driest in history), Sweden (52 % of normal), most of Norway (74 % of normal) and Estonia (78 % of normal). Over **Iberia**, the summer started with a dry June, ranking seventh driest for Spain (58 % of normal) and Portugal reporting that 98 % of its territory was under meteorological drought (30 % in severe or extreme drought). While July brought above-normal precipitation of 120 % to Spain (enough to make it the 11th wettest July), the drought situation in Portugal increased with precipitation of only 20 % to 80 % of normal in the south and locally even less. In August, precipitation was distributed heterogeneously in Iberia. Locally there was more than 250 % of normal due to heavy rain. In Portugal, the drought was slightly relieved only in northern and central parts by above-normal precipitation while the south stayed dry. Overall, Portugal ended the season with 77 % of normal and Spain with 86 % of normal precipitation. Concerning the **Mediterranean, Italian and Balkan peninsula**, in summer, it was wetter than normal around the Aegean Sea and in Turkey, while Italy and the Balkans had around-normal precipitation or less. Serbia was only slightly wetter with 102 % of normal, Turkey and Greece reported 136 % and 131 % of normal precipitation, respectively. For

Italy, Slovenia and Croatia, precipitation was between 77 % and 84 % of normal. June in particular was notably dry for these countries with only 34 % of normal in Italy, 50 % of normal in Slovenia, 67 % of normal in Croatia, and Malta reporting no precipitation at all for only the fourth June in the last 70 years. In **Eastern Europe**, over the summer, precipitation was below normal except for the European parts of Russia with 108 % of normal, mainly in the north. It was close to normal in Belarus (97 % of normal). Ukraine and Moldova only reported 68 % and 87 % of normal precipitation. Precipitation was distributed inhomogeneously in the summer months as locally extreme amounts of precipitation were observed. At several stations in southern and central Ukraine (Kherson, Mykolaiv, Kirovohrad) new daily maximum record sums were set on 3-5 June with 76 mm to 104 mm, which is equal to 150 % to 200 % of the monthly normal. In the **Middle East**, in spring, above-normal precipitation (>125 % of normal) was received in northern and western Syria and in the Lebanon. Southeastern Syria and eastern Jordan had an early start of the dry season and received less than 10 mm in the whole spring. In May, precipitation was scarce in the whole region. The dry season continued until September. In the **South Caucasus** region, summer was drier than normal, with the highest deficits in eastern Azerbaijan and totals of only 40 % of normal. The dryness persisted more or less during all three summer months, only Georgia received above-average rain in June and particularly July.

For Eastern Europe, Turkey and southwestern Iberia, autumn was rather dry while Central and Western Europe mostly received above-normal precipitation between 100 % and 167 % of normal.. In **Western Europe**, autumn was wetter than normal in the Netherlands and Luxembourg with precipitation of around 115 % of normal. Belgium reported 95 % of normal. France, with 130 % of normal, had its fifth wettest autumn (since 1959), though France recorded a countrywide average of only 60 % of normal during September. December 2019 was wetter than normal in western Scotland, southern England and France, partly more than 125 % of normal, while the Netherlands received only around 80 % of normal. In **Central Europe**, autumn was close to normal in the Czech Republic (99 % of normal), Germany and Hungary (both 104 % of normal), while for Slovakia (130 %), Switzerland (115 %) and Austria (129 %) it was a wetter-than-normal season. December was drier than normal in Germany, western Poland and western Czech Republic (60-100 %), but wetter in the Alps, and in eastern and southeastern parts of Central Europe, locally exceeding 125 % of normal. Concerning the **Nordic and Baltic countries**, autumn season was rather wet in southern Finland and Sweden, southeastern Norway and Denmark. Denmark even reported autumn as the wettest on record with 153 % of normal precipitation. While some stations in eastern Norway received 150 % to 200 % of normal, several in the western parts reported less than 50 % of normal. Sweden received 141 %, Finland 124 %, Estonia 123 %, Latvia 118 %, and Lithuania slightly below-normal (95 %) precipitation. December was again a wet month for much of the Nordic countries (partly above 125 % of normal, locally above 250 % in northern Finland), but closer to normal or drier in the Baltic countries and scarce of snow. In **Iberia**, in the autumn, Spain reported a countrywide average of 115 % of normal precipitation. Double the normal precipitation was registered in some areas in Spain, for example between Granada and Jaén and Murcia while southwestern parts of Iberia were drier than normal with only around 60 % of normal precipitation. December was mainly wetter than normal, with 150 % of the long-term average falling in places. Other parts were drier, but only southern Spain recorded monthly totals below 80 % of normal. Concerning the **Mediterranean, Italian and Balkan Peninsula**, it was the sixth driest autumn on record for Serbia with 55 % of normal precipitation. Turkey also reported well-below-normal precipitation for autumn (63 % of

normal). All other countries of the region received above-normal precipitation, except for Malta, which was near normal. For Italy and the Balkan states only the last month of the season brought a surplus of precipitation while for Turkey only September was wetter than normal in southwestern and northeastern parts. December had a very heterogeneous distribution of precipitation. It was particularly dry in Sicily, North Macedonia and Bulgaria (40-80 % of normal in parts), but very wet in southern Turkey (above 250 % of normal in places). In **Eastern Europe**, autumn was drier than normal in the southern parts and wetter than normal in northern parts. Belarus reported 79 %, Ukraine 67 % and Moldova only 27 % (sixth driest) of normal precipitation for the season. For Ukraine and Moldova all three autumn months were drier than normal. Especially in Moldova, September (19 % of normal, 11th driest) and November (only 15 % of normal, fifth driest) were outstanding. December had a similar distribution with above-normal precipitation in northern European Russia (up to 250 % of normal), but drier than normal in the south (40-80 % of normal in large parts), although heavy showers were observed at the Black Sea coast on individual days. In the **Middle East,** the autumn season was much drier than normal with parts of Syria and Isreal receiving only 40% or less of normal precipitation. For Israel is was the 7th driest November in the past 80 years. In the **South Caucasus** region, autumn started with a wet September with heavy rain in places, particularly in central Georgia and eastern Armenia. Locally, monthly totals exceeded 125 % of normal, especially in Armenia. October and November, on the other hand, were drier than normal in the whole region with only 20 % to 60 % of normal precipitation, and below 20 % in places. The deficit continued in December, except for some places, particularly in Armenia, which experienced heavy rain. Due to abnormally dry conditions in December, snow cover in Georgia persisted up to 18-20 days only in the high-mountainous zone with recorded maximum snow depth up to 10-15 cm. The average snow depth at winter resorts (Bakuriani, Gudauri) was two to three times lower than in previous years.

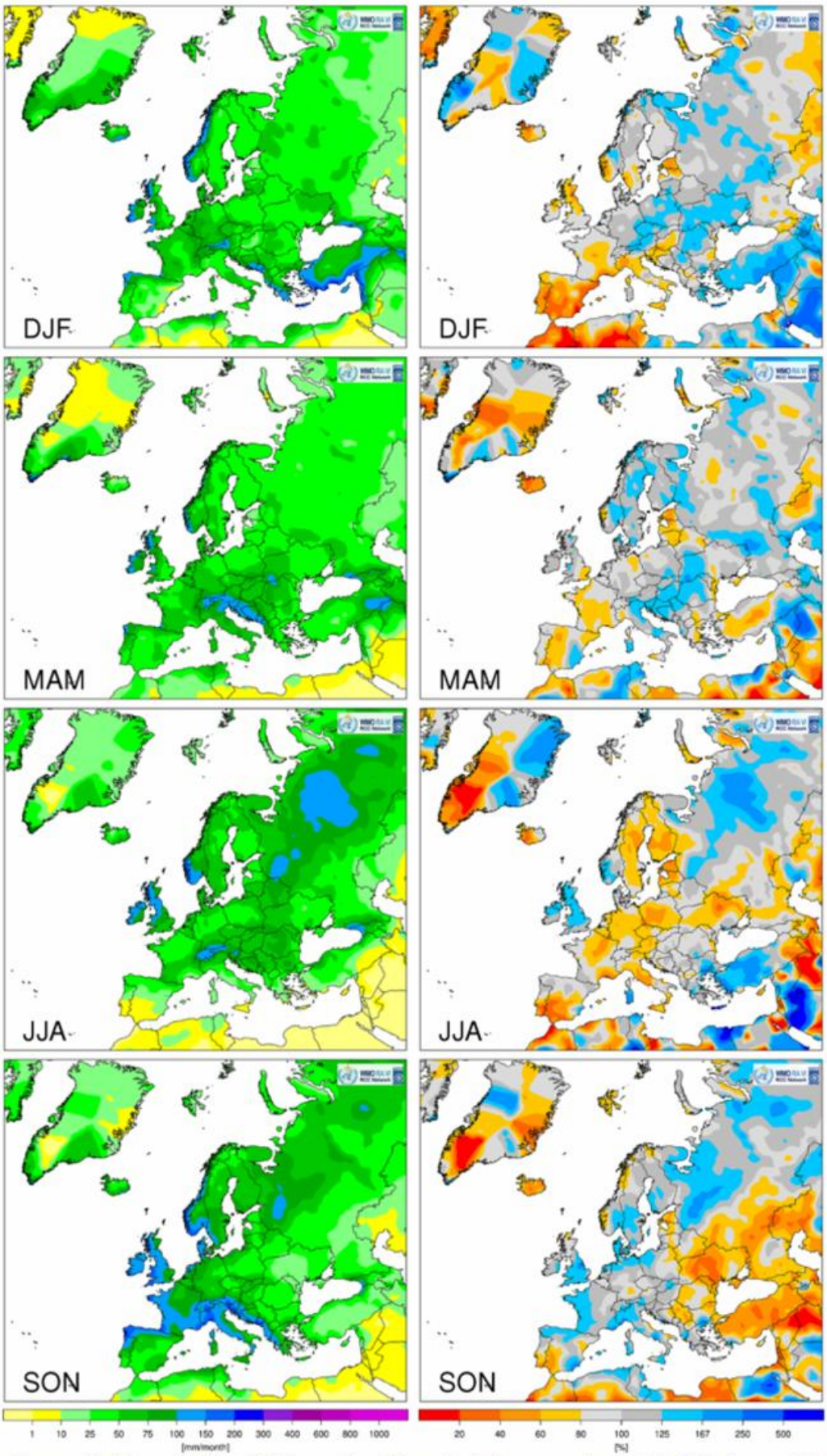

Figure 3-3: *Seasonal total precipitation (left, in mm/month), and relative anomalies (right, in % of normal) in 2018/2019, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).*

3.1.4 Sunshine duration

The year 2019 as a whole was more sunny than normal over most parts of the RA VI Region and even exceptionally sunny with annually accumulated sunshine hours above the 90th percentile over large parts of Central and Eastern Europe as well as over Iberia, which saw 200 to 500 hours (in relative terms up to 125 %) more sunshine hours than normal (see section 2.1.4). This surplus of sunshine hours stems in case of Iberia from seasonal surpluses in winter and spring, which saw over large parts of the area more than 100 sunshine hours more than normal. In case of Central and Eastern Europe the summer and the spring season, respectively, contributed most to the large annual surplus.

During **winter 2018/19** most parts of the RA VI Region recorded above-normal durations of sunshine generally up to 100 hours more than normal, over Iberia even 100 to 200 hours more. Especially northern and eastern parts of the RA VI Region received over large parts less sunshine than normal (up to 100 hours).

Spring brought surplus in sunshine hours to most of the RA VI Region with generally up to 100 hours more sunshine than normal. Over northern parts of Iberia, Belarus and southern Russia the surplus even exceeded 100 hours. Parts of the Italian and Balkan Peninsula, on the contrary, saw a less sunny than normal spring season with a deficit of up to 100 hours.

In **summer**, largest surpluses of sunshine hours were recorded over large parts of Central and Western Europe with more than 100 sunshine hours more than normal.

In **autumn**, the western part of the RA VI Region saw less than normal sunshine hours whereas the eastern part reported a surplus in sunshine duration. Largest surplus in sunshine hours occurred over parts of southern Russia and northern Turkey (between 100 and 200 hours more than normal).

Table 3-6: Seasonal and annual average of sunshine duration anomalies over land areas in hours for each sub-region in the year 2019 (reference period: 1961-1990; definitions of the sub-regions see Figure 1-1)

region	year	winter	spring	summer	autumn
Central and Western Europe	154.2	57.3	18.2	93.3	-9.7
Nordic und Baltic Countries	25.2	21.6	27.2	11.5	-15.7
Iberia	154.7	100.4	86.4	1.0	-14.1
Med. Italian and Balkan Peninsula	97.9	36.6	-1.0	44.9	28.4
Eastern Europe	149.0	24.1	73.3	18.6	46.3
Middle East	110.6	39.7	17.6	0.0	59.4

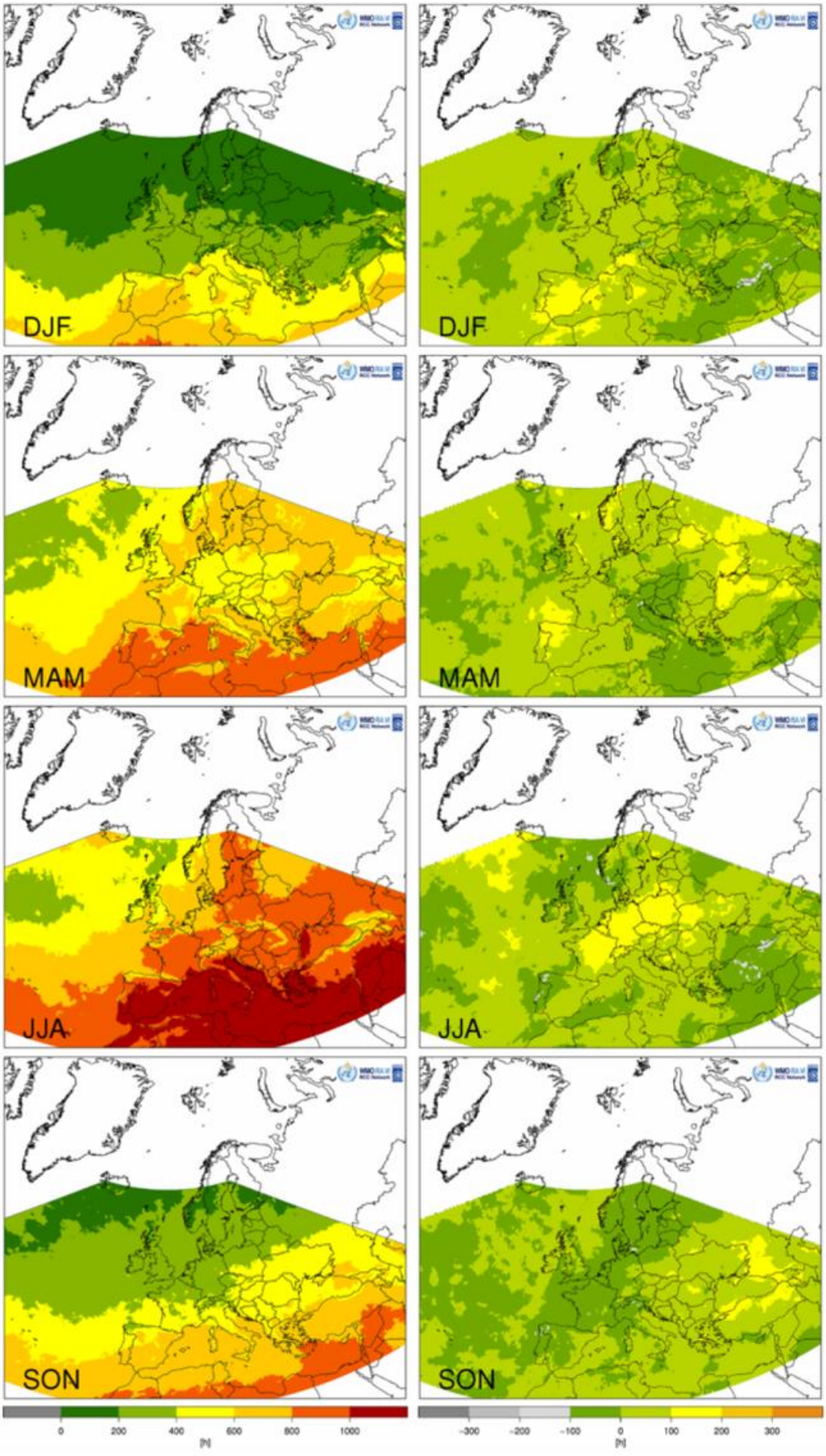

Figure 3-4: *Seasonal sunshine duration (left, in hours), absolute anomalies (middle, in hours) and percentage of mean (right, in %) in 2018/19, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).*

3.1.5 Drought

In **winter 2018/19**, precipitation deficits were most severe in Spain, southern France and northern Italy where partly even less than 40 % of normal precipitation amounts were recorded. These are also the regions for which the GPCC-DI indicates moderate (partly even severe) drought conditions with values lower than -1.5. In Spain February was very dry in the whole of Spain. Its average precipitation was 72 % below normal value, and it represented the driest month in the 21st century and the fourth driest month since 1965. Mild drought conditions (with GPCC-DI values between 0 and -1) occurred over parts of Western, Northern and Eastern Europe, which also received less-than-normal precipitation. The rest of the RA VI Region experienced mildly wet conditions, except for Turkey and the Middle East where GPCC-DI reaches values above 1, partly even above 1.5 indicating moderately wet to severely wet conditions.

In **spring** mild drought conditions continued over Spain and France and smaller parts of Central and eastern Europe. Lowest GPCC-DI values occurred over Iceland (-1 to -1.5) indicating a moderate drought level. Over the rest of the RA VI Region wetter than normal conditions prevailed mostly mildly wet according to the GPCC-DI, only southeastern Turkey saw moderately wet conditions.

In **summer**, most of RA VI Region, experienced mildly wet conditions, only over northern parts of Russia moderately up to extremely wet conditions occurred. But dry conditions continued over Spain and France and extended further towards Italy. In this region mild drought occurred prevailed, locally GPCC-DI values dropped below -1.5 indicating severe drought, partly even up to extreme drought (in Spain). Over Iceland, moderate drought conditions from spring continued in early summer, especially in the South and the West. No precipitation was recorded in Stykkishólmur for 37 consecutive days, from 21 May to 26 June. This is the longest drought on record in Stykkishólmur since 1856.The drought conditions in Western, Central and Northeastern Europe intensified particularly during the first strong heat wave in late June 2019 and continued during the whole month of July. Weeks of dry weather since the heat wave in late June 2019 had left more than 80 of French departments facing water restrictions. Plants and wildlife were stressed. More than 20 departments were in the critical red category that restricts water use to only essential needs. The dry weather also hit parts of Spain, the Netherlands, Germany, Poland, the Czech Republic and Scandinavian countries. Soil moisture in the first week of July in northern and eastern Germany was lowest since at least 1961. Drought Indices (e.g. SPI) indicated extreme drought conditions for these areas. Water levels of major rivers in eastern Central Europe (e.g. Elbe, Odra) fell below mean low water levels, causing restrictions for ship traffic. Also in northern Italy, the Po River recorded low water. This month, Lithuania declared an emergency, with drought expected to cut its harvests by half. Due to too dry soils, there were fires in fields and forests in many parts of Europe and Middle East.

In **autumn**, drought conditions stopped for the southeastern parts, which mostly experienced mildly wet conditions. Over Italy and in the regions along the Atlantic coast of Spain, France and the UK moderately and partly even severely wet conditions occurred. Moderately wet conditions also prevailed in a band stretching from the Benelux countries over northern Germany, Denmark and Sweden into northern Russia. The southeast of the RA VI Region saw mostly drier-than-normal conditions, locally even moderate drought (e.g. Ukraine and southern Russia).

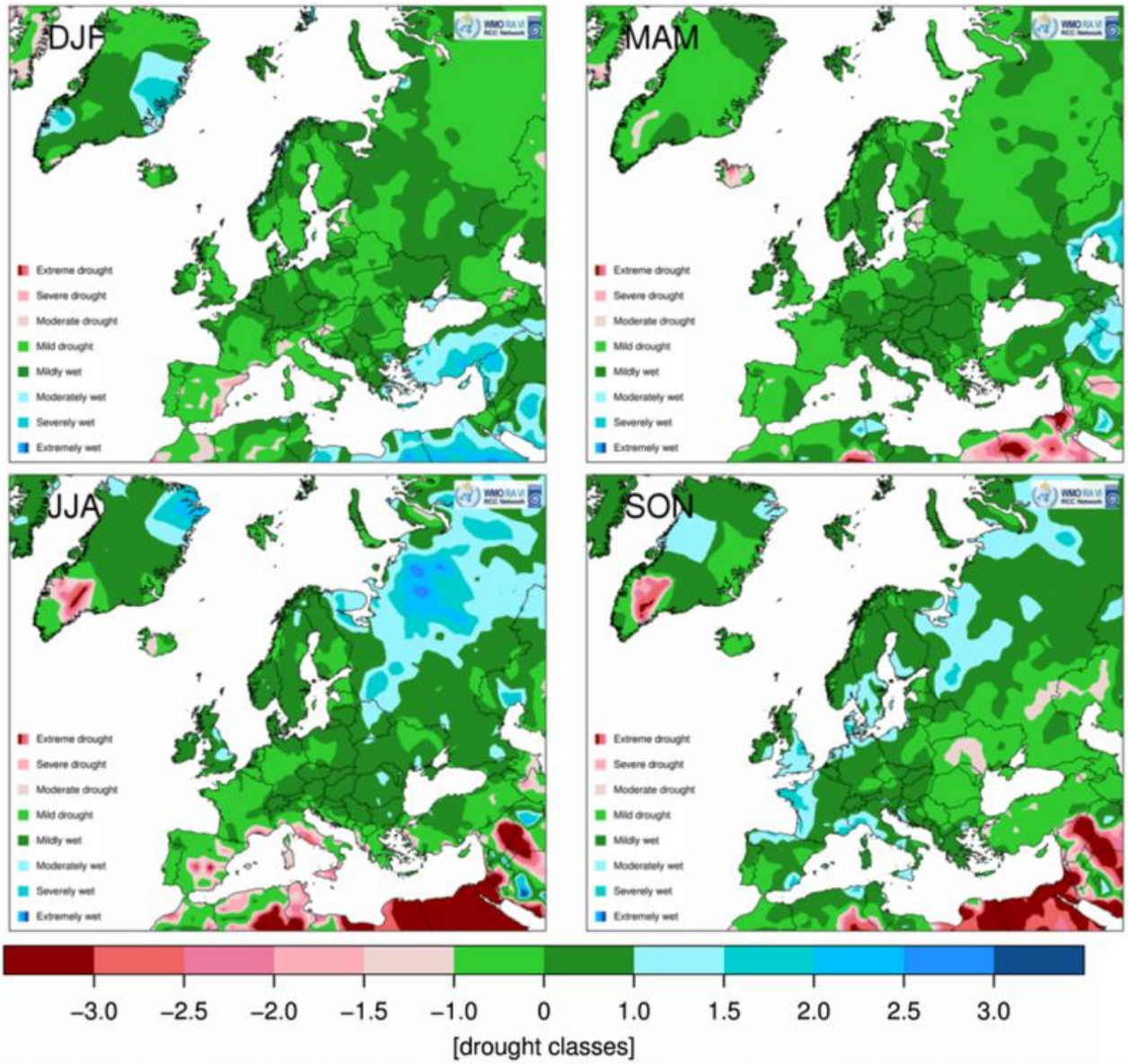

Figure 3-5: *Seasonal GPCC-DI (GPCC-Drought Index, in drought classes, reference period 1961-1990) in 2018/2019 (Source: http://www.dwd.de/rcc-cm).*

4. Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2019 on the Climate in WMO Region VI - Europe and Middle East (available on http://www.dwd.de/rcc-cm). It contains highlights, means and anomalies of sea level pressure, temperature, precipitation and sunshine duration for each month as well as monthly overviews of extremes and notable events.

4.1 Sea surface pressure and circulation indices

This chapter about atmospheric circulation provides information on selected northern hemisphere teleconnection indices relevant for WMO RA VI and discusses influences of circulation patterns upon anomalies and outstanding events. The information is based on the "Monthly Bulletins on the Climate in WMO RA VI" and was completed by reports of the NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/ upper troposphere not shown here. (See http://www.ncdc.noaa.gov/teleconnections/ and http://www.cpc.ncep.noaa.gov/products/CDB/index.shtml)

Table 4-1: Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference including the Arctic Oscillation, for January to December 2019.

year	month	AO	NAO	EA	EA/WR	SCA	POL
2019	1	-0.71	0.18	-1.67	0.72	-0.09	0.08
2019	2	0.11	-0.11	-0.12	0.45	-0.4	0.69
2019	3	0.21	0.89	0.94	-1.15	-0.93	0.93
2019	4	-0.25	0.36	-0.96	0.82	2.09	-0.37
2019	5	-0.12	-2.38	-0.64	-0.7	-0.11	-0.78
2019	6	-0.6	-0.79	1.28	0.3	-0.16	-0.46
2019	7	-0.89	-1.39	0.08	1.02	-0.69	-1.48
2019	8	-0.72	-1.62	1.93	-1.68	-2.09	0.33
2019	9	0.31	-0.01	2.19	0.79	-0.52	-0.07
2019	10	-0.82	-1.03	0.67	-0.52	0.16	-0.2
2019	11	-0.12	0.16	0.07	-0.59	1.45	0.98
2019	12	0.41	1.02	0.81	0.15	0.84	-0.43

North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

In **January**, the Azores High was more intense than normal and extended far to the north, causing mostly drier-than-normal conditions in Western Europe. The Icelandic Low, on the other hand, was weaker than normal. This resulted in a slightly positive NAO phase, which persisted almost the whole month and led mild air to Europe. However, in other parts of the Northern Hemisphere the circulation was less zonal in times as revealed by a below-normal AO index on monthly average. This also included the European continent, where two main low-pressure centers dominated, one over Scandinavia, the other one over the central Mediterranean. The extension of the blocking Russian

High is close to normal. Warm air was advected over Eastern Europe far to the north on average, but the circulation was very variable within the month, with several warm and cold spells and temporary cut-off lows with heavy rain, partly snow in central and eastern parts of RA VI.

In February, the Azores high was more intense than normal and extended very far into the European continent, causing above-normal temperature and low precipitation over large parts of Europe. The Icelandic low also was very intense but shifted to the southwest. The resulting NAO index was slightly positive, but due to the relocation of the pressure centres, it remained weak throughout the month and within the standard deviation. Anyway, a strong southwesterly airflow of moist and mild air from the East Atlantic took place over Northwestern Europe and southern Scandinavia to northern parts of central European Russia, where the temperature anomalies were largest. The Russian high, on the other hand, was less extended to Europe, leading to more cyclonic circulation and high precipitation particularly over northern European Russia. It was also more cyclonic than normal over the Eastern Mediterranean where some heavy rain events occurred. The AO was clearly in a positive phase in the second and last third of the month, which implies relatively low influence of cold Arctic air on the middle latitudes.

In March, both the Icelandic Low and the Azores High were more intense than normal in March 2019. The Azores High was also more extended to the north and to the east. This resulted in an enhanced zonal airflow from the North Atlantic over Ireland and the United Kingdom to Central Europe and even further to Eastern Europe because the Russian High was less extended to Europe than usual. This airflow brought mild and moist air with frequent precipitation to these parts of the Region. In the north, an intense low was located north of Scandinavia and affected Northern Europe with above-normal precipitation. Southern Europe, from Iberia to the Black Sea region, was mainly under high-pressure influence, causing mostly dry and sunny weather with warm days, but partly cold nights, the latter especially in Southwestern Europe. The eastern Mediterranean region including the Middle East, eastern Turkey and sometimes up to Greece, was cyclonic on average with some heavy rain events and partly below-normal temperatures due to missing sunshine.

In April, high-pressure influence extended over Northern Europe and parts of Central Europe, causing high temperatures, very little precipitation and much sunshine there. The high-pressure zone extended even far west and north to Iceland and the Arctic region between Greenland and Svalbard. The Icelandic Low had its normal position for April, but was quite intense and much extended to the southeast. The Azores High, on the other hand, was only slightly more intense than normal, but less extended to the north. Consequently, cool and moist Atlantic air masses mainly affected Iberia and the Mediterranean region, while a warm airflow reached Iceland and the Arctic region. The Middle East and Turkey, too, were under cyclonic influence with cool and partly rainy weather. The NAO showed large fluctuations within the month, implying much air pressure variability over the North Atlantic, occasionally extending to Europe causing changeable weather. The AO had a strong negative phase mainly in the first half of the month, which explains the Arctic warming.

May had mostly a very meridional circulation structure. Much of Europe was under cyclonic influence, while high pressure prevailed over the eastern North Atlantic and Russia. Consequently, cold air flowed over Scandinavia, Central Europe down to the western and central Mediterranean, while warm air from the south came to the eastern Mediterranean and Eastern Europe. High pressure caused much sunshine, prevailing warm and dry weather in western Iberia. The cyclonic area over much of the rest of Europa was characterized by cloudy and rainy weather, including some

heavy rain especially in Central and Southeastern Europe. The NAO index was negative during the whole month following the meridional pattern, most at the beginning but weakening to the end of the month, when a westerly weather type developed over Europe. Similar the AO, causing an arctic air flow to Europe, except the last week of May 2019.

A very pronounced high pressure zone near Greenland was present in June, which blocked the flow of weather systems circulating the Northern Hemisphere. This resulted in weaker zonal winds and more meridional flow instead. A negative NAO is often an indicator of a Greenland block as it is the case this month with negative daily NAO values during the whole month and a monthly NAO value of -1.09. The AO, which often shares the phase with the NAO also stayed negative almost the whole month and finished with a monthly value of -0.601. During the first half of the month low pressure situated over Ireland and UK brought cool and unsettled weather with heavy and thundery showers over the western part of Europe. During the second half an upper-level trough was positioned over the eastern Atlantic, west of France together with a high pressure over the continent and another low pressure system over southeastern Europe formed an omega block which led to a plume of very warm air from North Africa being transported to Europe. It thereby caused a short but severe heat wave to Western and Central Europe with many all-time station and country-wide records being broken. This distribution was due to the main location of the upper trough over low pressure, from the British Isles towards western Iberia, and high pressure over the continent.

In July, both AO and NAO were negative during almost the entire month with just a brief period above zero around 18–20 July and 22–25 July respectively. As a result, NAO and AO monthly mean values for July were both negative with values of -1.43 and -0.89 respectively. The negative phase of both indices was primarily due a very pronounced high pressure zone over Greenland which was already present in June. Together with low pressure systems developing over the North Atlantic and over western Russia and high pressure over the European continent during the second decade of July, this led to hot air masses from North Africa being transported over western Europe up to Scandinavia, causing again (like in June) a short but severe heatwave.

In August, the daily NAO was strongly negative for the first half of the month and then near-neutral for the second half. The daily AO was negative during almost the entire month with just a brief period above zero around August 23–27. The negative phases of both NAO and AO were primarily due to the ridge over Greenland along with the troughs over the Northeast Atlantic (and Northwest Pacific). The primarily negative daily values resulted in negative monthly values of both NAO and AO with respective values of -1.17 and -0.722. NAO and AO thus continue their prolonged negative phase that started back in May.

In September, the general situation was driven by the Azores High, which was stronger and more widespread than usual, and the Icelandic Low, which was deeper than normal. Pressures were higher than normal over much of Europe pushing the westerly flow further north over the northern British Isles and Scandinavia. The daily NAO was weak but positive for the first half of the month and then increasingly negative during the second half resulting in a monthly mean near zero (-0.16). The circulation during the first half of September looked like a classic positive NAO with an enhanced trough over Greenland and enhanced ridging over the northeast Atlantic. These patterns reversed during the second half of the month. The AO was weak but generally positive during most of September, finishing with a monthly value of 0.306.

In **October,** the general situation over Europe was driven by the Icelandic low positioned further south than normal and the Azores high weaker than normal as well as by a persistent high pressure area over Greenland. Pressures over most of the RA VI Region were mostly slightly lower than normal (up to -2 hPa), over Russia up to -6 hPa. The daily NAO was negative for almost the entire month, and moderately negative (-1.4) for the monthly mean. The negative NAO was primarily due to the persistent high pressure over Greenland and the low pressure over the central North Atlantic. The AO was positive for the first half of October and negative for most of the second half, resulting in neutral conditions for the month as a whole with a monthly mean value of -0.082.

In **November,** the general situation over Europe was driven by the Icelandic low positioned much further south than normal and by the Azores high, which was stronger than usual. As a result, pressures were much lower than normal over western and central Europe but higher from Iceland to northern Scandinavia and Russia. The daily NAO was weakly positive for most of the month before turning negative in the final week. The positive values early in the month were largely due to high pressure over the central North Atlantic, but it was likely weakened by the lack of low pressure over Greenland. In the final week of the month, high pressure area shifted northward over Greenland and was replaced by low pressure over the North Atlantic. The AO was negative for almost the entire month, primarily in association with the high pressure over Greenland and low pressure near northwestern Europe.

The meteorological situation in **December** was characterized by a more intense than normal Icelandic low with its core stretching from Greenland towards the north coasts of Scandinavia and a more intense than normal Azores high extending over the entire southern part of the RA VI Region into Kazakhstan. Compared to the climatological mean the monthly mean surface pressure was lower than normal over the entire RA VI Region due to the frequent passing of low-pressure systems. This situation is also reflected in the circulation indices. Due to the low pressure near Greenland, the daily NAO was strongly positive for the first half of the month. For the second half it turned neutral resulting in a monthly value of 1.2. The daily AO was also positive for the first half of December, but then negative for the second half until the final days of December when it returned to positive. Averaged over the month, it was moderately positive.

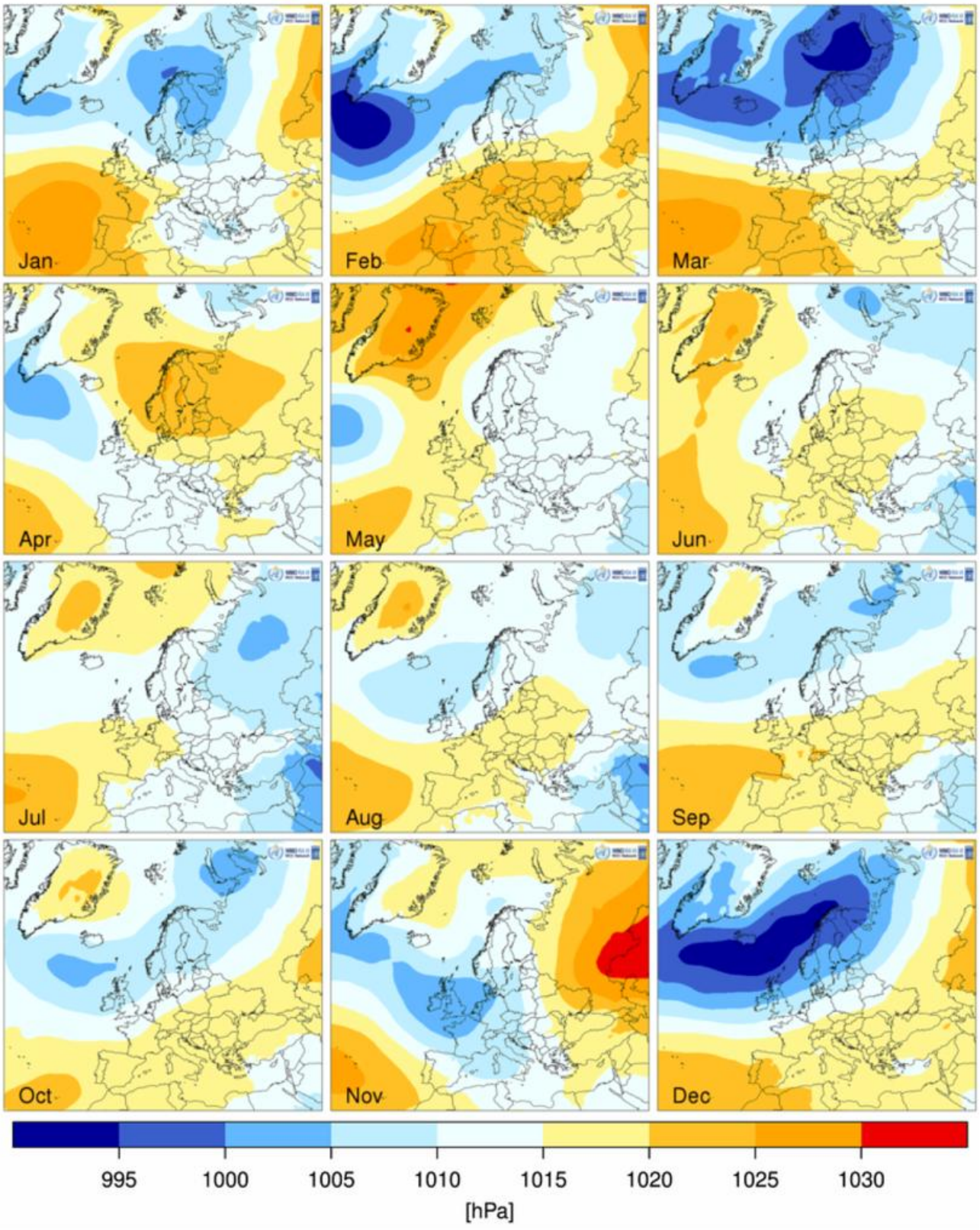

***Figure 4-1**: Monthly mean sea level pressure in hPa for the year 2019 (reference period 1981-2010).*

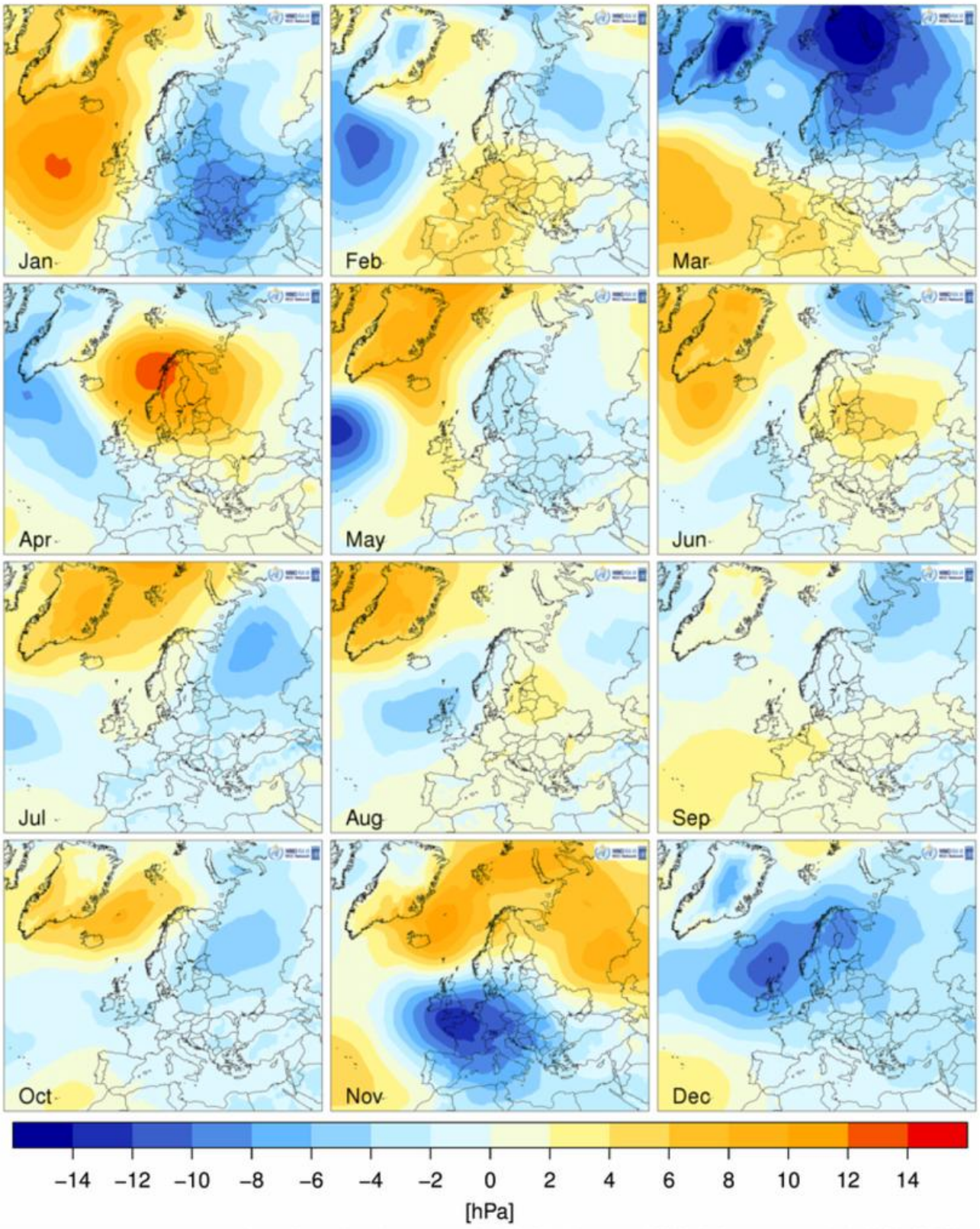

***Figure 4-2**: Monthly anomalies of sea level pressure in hPa for the year 2019 (reference period 1981-2010).*

4.2 Temperature

In most of the months and sub-regions it was warmer than normal as can be seen from Table 4-2, with February and March being the only two months with temperatures below normal in some regions, namely Central and Western Europe, Iberia and Eastern Europe. Largest anomalies with anomaly values exceeding +4 °C occurred in Eastern Europe in January and over Central and Western Europe as well as over the Mediterranean, Italian and Balkan Peninsula in April.

Table 4-2: Monthly and annual area average temperature anomalies in °C for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1).

Region	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Central and western Europe	1.33	0.02	2.70	2.00	1.10	-1.35	3.03	1.28	1.50	0.83	1.31	1.04	2.45
Nordic und Baltic Countries	1.46	-0.11	2.50	0.07	3.70	1.57	2.09	0.74	1.03	1.27	1.29	1.53	1.91
Iberia	0.69	-0.14	1.20	0.69	-0.10	1.13	0.12	1.00	0.76	0.75	1.10	0.13	1.68
Med., Italian and Balkan Peninsula	1.43	-0.48	1.60	2.11	0.80	-1.26	2.65	0.90	1.81	1.52	1.92	3.33	2.29
Eastern Europe	1.51	0.05	3.80	2.30	1.20	1.65	2.42	-1.67	-0.46	0.48	1.45	1.89	5.09
Middle East	1.17	1.13	1.40	0.61	-0.70	2.46	2.70	0.18	0.31	0.76	2.27	0.55	2.32

Most of the RA VI Region had around-normal temperatures (1981-2010 anomalies within +/-1 °C) in January 2019. Anomalies were highest in in the Arctic region (up to +3 °C in southern Greenland) and in the South Caucasus region (+4 °C in Armenia). It was colder than normal in northern Scandinavia (<-3 °C anomaly), locally in Eastern Europe and generally in the Mediterranean region (<-1 °C). On mountain sites of the northern Alps in Switzerland and Austria it was the coldest January for more than 30 years (below 4 °C anomaly in places), while the Southern Alps were very mild. High mountains in Slovenia, too, were noticeable colder than normal (e.g. Kredarica -3.8 °C anomaly). Monthly mean temperature averaged over Europe was close to the 1981-2010 normal, only slightly cooler than normal. Anyway, it was the first colder-than-normal month after nine consecutive warmer-than-normal months since April 2018, also on national average, e.g. in Austria, Italy or Latvia. The warming trend for January since 1910 is +1.25 °C/ 100 years and the January 2019 average corresponds well to the warming trend. However, temperature variability was high during the month. Especially in parts of Northern and Eastern Europe, periods of freezing weather alternated with thaws. In Scandinavia and much of European Russia, mild temperatures characterized the first half of the month, in Iceland even exceptionally high, but the second part of the month was much colder and especially the last few days. Sweden reported 9 days in a row with daily minimum temperatures below -30 °C. On the other hand, Denmark only had 3 ice days (Tx<0 °C) on average (normal is 8.6 days in 1961-1990), the Netherland 2 ice days (normal: 3), Ljubljana in Slovenia 1 ice day, most of Serbia 1-7 ice days. In Central Europe, wintry temperatures dominated the early days of January, while the rest of the month was mostly milder. High-pressure influence in the second half of the month resulted in cold nights even in lowlands. A markedly cold episode occurred between 19 and 25 January in the Czech Republic, at some stations in Slovakia, in Hungary, and even in Slovenia.

During this period, the surface air temperature in the Czech Republic remained below the freezing point throughout the day. In northern Greece and the southern Balkans, temperatures were particularly low in the first decade of the month with daily minima falling down to -20 °C or below. Over the western Mediterranean, the cold spell came down to Malta, minimum temperatures reached 4.1 °C on 5 January.

It was a mild February with above-normal temperatures in almost the entire RA VI Region. The highest anomalies of above +6 °C (1981-2010 reference) had been recorded in northern European Russia. Only a small part of northern Scandinavia (Lapland) and some places in southeastern Spain, southern Italy (Sicily) and Malta had below-normal temperatures. In the Middle East, temperatures were close to average.

According to Copernicus gridded data, the European-average temperature was +2.75 °C higher than normal, making it the seventh warmest February since 1979. Based on the NOAA dataset, February 2019 was the sixth warmest February since 1910. The warmest February on record was by far 1990.

After a cold start of February 2019, the second half the month became very mild, especially in Northern/Northwestern Europe. Svalbard airport in the Arctic region registered again above-normal temperatures, continuously since December 2010. The highest daily maximum at Norwegian Arctic stations that month was 5.0 °C on Jan Mayen Island. On continental Norway, the highest maximum was 18.7 °C in Landvik, a new record for the province Aust-Agder (southern Norway). Sweden even had a new national February record (16.7 °C in Karlshamn). In Denmark, the highest temperature registered in February 2019 (15,8ºC) was record breaking high (together with February 1990). Ireland recorded highest local absolute February maxima at over half of its stations. The United Kingdom recorded its second highest February mean since 1910 behind 1998, which had higher daily minima, but February 2019 had the highest mean maximum temperature on record. The Netherlands and Belgium noted national records above 20 °C (Netherlands: 20.5 °C in Arcen, Belgium: 22.8°C in Houyet on 27 February). This was only the second time since 1901, when a Dutch station measured more than 20 °C in February. France, too, noted maxima above 20 °C with local records on several stations during this month, in the south even above 27 °C. The number of days in February with the temperature exceeding 20° in Paris was also record-breaking. Luxemburg was very close to this threshold with 19.8 °C at Findel Airport, but a local record since 1947. Minima were high in Denmark, where no ice days (daily maximum <0 °C) occurred at all. The Netherlands had only one ice day at a few stations. In contrast, severe frost (< -15 °C) occurred in southeastern Germany on 4-7 February, but maxima also exceeded 20 °C at the end of the month, also with local records.

In the Alps, Switzerland recorded its warmest or second warmest February on record at some mountain sites. It was +5.1 °C warmer than the 1981-2010 average on Jungfraujoch (3580m a.s.l.). A north foehn in the valleys on the southern side of the Alps brought daily maxima around 23 °C in the lowlands on 22 February. Several other Swiss stations had new local records on 26-28 February. Austria had a new national February record at 24.2 °C on 28 February, Slovakia recorded up to 20.6 °C the same day, the Czech Republic up to 18.8 °C. Croatia also had some local monthly February records.

Spain recorded monthly temperature maxima up to 28.3 °C in Murcia, and several other places had above 25 °C at the end of the month, resulting in new local February records. Andorra recorded up

to 26.1 °C, also a new local February record. Monthly mean maxima in Spain, Andorra and Portugal were generally high, while minima were lower than normal due to cold cloudless nights. Thermal inversions occurred frequently.

Malta started the month relatively warm with a maximum of 19.4 °C on 2 February, but late in the month (23-24 February) cold winds from northeast let the temperature drop to a minimum of 3.7 °C, which resulted in a below-normal temperature on monthly average.

At the Black Sea coast of Turkey, the temperature was almost two months ahead in the annual cycle and resulted in too early blossoming of plums, which had never been observed in winter before.

Russia was particularly warm in its European part throughout the month. New records of daily maximum temperature were reached in the south of the Krasnodar region in the first decade. Estonia was especially warm in the second decade of the month, a new record of mean temperature for that decade since 1961. Similarly warm was Latvia, where Kolka station reached a new local record of monthly absolute maximum temperature for February at 13.4 °C on 16 February. Lithuania noted two national daily records of maximum temperature on 16 and 19 February at 10.7 °C and 10.4 °C, respectively. In contrast, Kiev in the Ukraine had its warmest day on 28 February like in Central Europe (11.2 °C daily maximum). Altogether, February 2019 was the warmest winter month in Kiev over the past 139 years.

March 2019 was mostly 1-3 °C warmer than the 1981-2010 normal throughout the Region. Highest anomalies up to above +3 °C (locally above +4 °C) were at the eastern border of RA VI, but also in a secondary maximum over eastern Central Europe, western parts of Eastern Europe and the Balkans. Only a few areas had below-normal temperatures: in the north from eastern Greenland (-3 °C anomaly) to northern Scandinavia, in places in Ireland, Spain and Hungary, in the Middle East, and in small areas over the North Atlantic and the Mediterranean. More than half of the stations in Ireland reported air and ground frost. Denmark reported 5 frost days on average, much below the 1961-1990 normal of 15. De Bilt in the Netherlands had 3 frost days (normal: 8), Uccle in Belgium 1 frost day, Ljubljana in Slovenia 2 frost days (highest number on March record was 26 days in March 1958). In the south, Cyprus recorded 7 frost days in mountainous areas. Soils were frozen in Lithuania and Belarus at the beginning of the month, but thawed until mid-March. Later in the month, there was only a short period of ground frost in these countries. Monthly mean European surface air temperature was +1.7 °C above normal according to Copernicus data. March 2019 was the 7th warmest March since 1979 on European average. According to NOAA data, March 2019 was the 6th warmest since 1910. The warmest March was in 2014. According to a Russian analysis, Europe had the 5th warmest March in history of observations.

In Russia (whole territory), 2019 had the third warmest March, but much of its contribution came from outside of RA VI. The European part of Russia mostly was warmer than normal too, but with weaker anomalies. There were some exceptions: The Russian North was colder than usual in the first decade of the month (with -35 °C frosts on the Kola Peninsula). Cold spells at the end of the month were quite untimely in southern Russia. They reached -3 to -5 °C in the nighttime in the Stavropol and Krasnodar Territories, and -10 °C in the early morning hours in Karachay-Cherkessia (North Caucasus).

April 2019 was particularly warm in the Arctic region with anomalies up to + 5-6 °C in Greenland and Svalbard. Over Iceland, temperatures were also exceptionally warm, making April 2019 the warmest April on record in Reykjavík, Stykkishólmur, Bolungarvík, Grímsey, Akureyri and Hveravellir. Temperature anomalies decreased to the south, but Central Europe and the Balkans were mostly still + 1-2 °C warmer than the 1981-2010 normal. Southern parts of the RA VI, from the Azores over Iberia, the Mediterranean to Turkey, the South Caucasus and the Middle East were mostly slightly colder than normal, in easternmost parts even with anomalies < -1 °C. Especially the first two decades of the month were colder than normal in Greece, but that was overcompensated by a warm third decade. Sea surface temperatures in the Mediterranean were normal or slightly above normal, in the north the Northern, Baltic and Barents Seas were much warmer than normal (up to > +2 °C anomalies). On European average, April 2019 was +1.0 °C warmer than normal and the 7th warmest April since 1979 according to Copernicus data, the 8th warmest since 1910 according to NOAA. The warmest April was in 2018 in both data sets and by far warmer than in 2019. For Germany, Austria and Hungary, April 2019 continued a series of 13 successive warmer-than-normal months (1981-2010 reference), which never occurred before in measurement history. In much of Northern, Western, Central and Eastern Europe, however, the month was characterized by a strongly changing weather picture, with a few cold days with frost in the lowlands down to the middle latitudes and the Balkans, and (wintry) showers alternated by sunny periods with warm summer days. However, the warm periods were prevailing. It was the second warmest April on record in Norway since 1900 (after 2011) and in Iceland (after 1974), the third warmest in Latvia. Some stations noted new local April records in Iceland, Norway, Sweden, Finland, Latvia and Russia (Kaliningrad Region), Latvia reported a new national record of the highest absolute April daily maximum at 28.9 °C. Anomalies in European Russia were mostly lower than in many other parts of Europe because mainly the first decade of the month was warm there, but it became colder in the rest of the month, culminating in night frosts even in Moscow region. In Western and Central Europe and even in Latvia and Lithuania, maxima reached above 25 °C several times locally, in Hungary even 30 °C. Ireland reported its highest monthly April maximum in 44 years at 22.9 °C. Ljubljana in Slovenia recorded 10 summer days that month, the highest number in April since at least 1951. The monthly maximum temperature in Andorra was 23.5 °C and was lower than in February and March there, southern Spain recorded up to slightly above 30 °C, also Serbia in the Balkans.

May 2019 was colder than normal over much of Europe, from Scandinavia over Central Europe down to the western and Central Mediterranean. At many stations in western Norway and northern and eastern Iceland, May 2019 was colder than April 2019, in Hungary only the first 3 weeks of May 2019 were colder. Coldest anomalies were over the Alps, colder than -3 °C, in Austrian highlands -5 °C. In the southern Alps (Dolomites Mountains in Italy), many records of low minimum temperatures were broken. Eastern parts of the RA VI, in contrast, were warmer than normal with local anomalies up to +3 °C. Furthermore, the west of RA VI from Greenland / western Iceland over the eastern North Atlantic to western and southern Iberia also was warmer than normal, up to +4 °C anomaly in northwestern Greenland. Averaged over Europe, the temperature was almost identical to the 1981-2010 average (-0.003 °C anomaly) after Copernicus data. According to NOAA data, May 2019 was the 41st warmest May of the series starting in 1910, which means a little bit more than one third of this series was warmer than May 2019. The warmest May was by far May 2018. To find a month of May, which was colder than in 2019 (and colder than normal), we need to go back to 2004.

In the UK, May 2015 was last colder than 2019, in France and Belgium May 2013, in Germany 2010. In Switzerland, Austria, the Czech Republic, Hungary, Slovenia and even at some stations in Italy (Rome, Pisa, Modena), it was the coldest May since 1991.

Only the middle of the month was relatively warm in Northwestern and Northern Europe, while the beginning and the end of month were rather cold, therefore the monthly mean was very close to normal there (-0.4 °C anomaly in Norway and Sweden, -0.3 °C in the UK, 0.0 °C in Finland). Finland recorded 6 summer days (maximum >=25 °C), 3 more than usual in May. In Southwestern Europe, Portugal and Spain experienced several heat waves with maxima up to above 35 °C at several stations.

France and Spain reported some local records of lowest minima and widespread frost at the beginning of the month. In Central and Southeastern Europe, especially the first half of the month was cold. The cold air and partly frost caused a slowdown of the vegetation development in Central and Southeastern Europe. Most of Austria did not have any summer days at all, the first time for 30 years in a month of May. Other countries, especially on the Balkan Peninsula had higher maxima at the end of the month, partly close to or even exceeding 30 °C (Bosnia-Herzegovina, Albania, North Macedonia, Greece).

Eastern countries were generally warmer than normal this month. May 2019 was the hottest month in Turkey in the last 49 years, many local maximum temperature records were broken. Cyprus had two heat waves at the end of the month with maxima above 40 °C. The highest maximum in Cyprus in May 2019 (42.1 °C) was the highest May maximum since 1983.

Over most of the RA VI Region, the average monthly temperature in June 2019 was above normal (that is the 1981-2010 average), particularly over central and eastern Europe with anomalies around +6 °C. In Eastern and central Europe warm temperatures dominated for the month as a whole, but these regions additionally experienced short but intense heat waves. Around the middle of the month during a first heatwave hit for example in Poland over much of the country, temperatures exceeded 30 °C during several days. At the end of the month the western and central parts of the continent experienced a short but even more intense heatwave, with daily average temperatures up to 10 °C higher than normal and daily maximum temperatures above 40° in France and Spain. In France, the all-time temperature record at Gallargues-le-Montueux, Gard, near the city of Nîmes was even broken on June 28 with a new record of 45.9 °C. For many countries including Austria, the Netherlands, Czech Republic as well as Germany June 2019 finished up as the warmest June on record. Other regions with temperatures substantially above normal include Greenland with anomalies between +2 and +4 °C. Lower-than-normal temperatures in the month of June are only found over western Iberia and parts of the British Isles. This temperature distribution was due to the main location of the upper trough over low pressure, from the British Isles towards western Iberia, and high pressure over the continent. Monthly mean temperature averaged over Europe was 2.34 °C above the 1981-2010 normal according to the Copernicus Climate Change Service (based on ERA5), making it the warmest June on record also for Europe as a whole since 1979,

Over large parts of the RA VI Region the average temperatures in July 2019 were higher than the 1981-2010 average for July, especially over Western, Central and Southern Europe and over Greenland. Compared to June, which was the warmest June on record in several European countries with anomalies around +6 °C, the July anomalies were in general lower in magnitude.

Largest anomalies occurred over France with monthly mean temperatures of +2 to +3 °C above normal. There were also regions with lower-than-normal temperatures in July, namely the southwestern edge of the Iberian Peninsula and northeastern Europe (Finland, Baltic countries, Belarus, western Russia) where monthly mean temperatures of -2° to -4 °C below normal occurred. The monthly mean temperature averaged over Europe was +1.35 °C above the 1910-2000 normal, making it the 13th warmest July for Europe as a whole according to the State of the Climate for July 2019 published by NOAA National Centers for Environmental Information[4].

During a short but severe heatwave occurring over the western part of Europe on 24 and 25 July daily maximum temperatures exceeded 40 °C in many places and many station records were broken. New country-wide records were set in the UK (in Cambridge Botanic Garden: 38,7 °C), the Netherlands (Gilze-Rijen: 40,7 °C), Luxemburg (Steinsel: 40,8 °C) and Belgium (Begijnendijk: 41,8 °C) (see list for RA VI with highest maximum-temperature[5]). In Belgium and the Netherlands temperatures exceeded 40 °C for the first time since the beginning of meteorological recording. Because the area of high pressure extended far to the north, even Scandinavia experienced new temperature records. In Helsinki Kaisaniemi for example temperatures reached 33.2 °C on 28 July exceeding the previous record (31.6 °C) from 1945 by 1.6 °C. In Sweden maximum temperature values exceeded 32 °C, in Norway even 34 °C.

Over largest parts of the RA VI Region averaged temperatures in **August** were above normal temperature, with anomalies mostly up to +2 °C, over eastern/southeastern parts of Europe (Poland down to Greece) even up to +4 °C. Below-normal temperatures occurred over in the northeastern part of Europe, over Western Russia, Portugal and Ireland. In the last third of the month a persistent high pressure zone caused a long warm spell especially in parts of central and southeastern Europe which lasted more than a week. The monthly mean temperature averaged over Europe was 1.9 °C above normal relative to 1910-2000 making it the 3rd warmest August since 1910 for Europe as a whole according to the State of the Climate for August 2019 published by NOAA National Centers for Environmental Information (published online September 2019, retrieved on 08 November, 2019 from https://www.ncdc.noaa.gov/sotc/global-regions/201908).

Over large parts of the RA VI Region the average temperatures in **September** 2019 were higher than the 1981-2010 average for September, especially southeastern Europe and over the South Caucasus region where temperatures were +2 to +3 °C above normal. There were also regions with lower-than-normal temperatures in September, namely European Russia and Kazakhstan in the east as well as Ireland and parts of Scandinavia (Norway and Sweden) in the west. Here monthly mean temperatures of up to 2 °C below normal occurred. The monthly mean temperature averaged over Europe was +1.29 °C above the 1910-2000 normal, making it the 8th warmest September for Europe as a whole according to the State of the Climate for September 2019 published by NOAA National Centers for Environmental Information (retrieved from NOAA website[6]). The European-average temperature for September 2019 was 0.7 °C warmer than the average September from 1981-2010 based on ERA5 (Copernicus Climate Change Service/ECMWF).

[4] published online August 2019, retrieved on October 25, 2019 from https://www.ncdc.noaa.gov/sotc/global-regions/201907

[5] https://rcccm.dwd.de/DWD-RCCCM/EN/products/significant/records/download_tabelle.html?nn=500100

[6] https://www.ncdc.noaa.gov/cag/global/time-series/europe/land/1/9/1880-2019

Table 4-3: Rank statistics, monthly average temperature and anomalies (in °C) from several countries of the RA VI for the individual months 2019 including countries with rankings among the top 5 (ranks 1–5) since start of the to time series.

Country	Rank	Anomaly [°C] (1961-1990)	Anomaly [°C] (1981-2010)	start of time series
		February		
Ireland	3	+2.98	-	1900
Belgium	5	+3.5	+3.3	1833
		March		
Moldova	4	-	+3.70	1886
Hungary	5	-	+3.17	1901
Bulgaria	5	+3.4	-	1930
Serbia	5	-	+2.90	1951
Czech Republic	5	-	+2.70	1961
		April		
Estonia	2	-	+2.20	-
Finland	2	-	+2.51	1900
Iceland	2	+4.0	+3.7	1931
Norway	2	+3.3	+2.5	1900
Latvia	3	-	+2.10	1924
Lithuania	4		+1.9	1961
Cyprus	2 (Coolest)	-	-0.80	2000
		May		
Jordan	1	-	+3.40	1981
Cyprus	4	-	+2.00	2000
Armenia	5	+1.90	-	1935
		June		
Austria	1	+5.7	-	1767
Czech Republic	1	-	+4.90	1961
Georgia	1	-	+3.86	1960
Hungary	1	-	+3.76	1901
Latvia	1	-	+3.80	1924
Lithuania	1	-	+4.70	1961
Moldova	1	-	+3.60	1886
Slovakia	1	+5.30	+4.60	1951
Ukraine	1	+4.70	-	1891
Italy	2	+3.85	-	1961
Switzerland	2	-	+3.40	1864
Estonia	2	-	+3.10	-
Serbia	3	-	+2.60	1951
Jordan	3	-	+2.30	1981
Bulgaria	4	+2.5	-	1930
		July		
Switzerland	5	-	+2.00	1864
		August		
Slovakia	5	+3.20	+2.10	1951
Italy	5	+2.71	-	1961
Czech Republic	5	-	+1.60	1961
		October		
Armenia	1	+3.40	-	1935
Italy	2	+2.26	-	1961
Cyprus	3	-	+1.40	2000
Georgia	3	-	+2.50	1960
Serbia	4	-	+2.10	1951
Lithuania	5	-	+2.10	1961
Switzerland	5	-	+1.90	1864

Country	Rank	Anomaly [°C] (1961-1990)	Anomaly [°C] (1981-2010)	start of time series
November				
Bulgaria	1	+4.5	-	1930
Serbia	1	-	+5.10	1951
Slovakia	1	+4.40	+4.10	1951
Cyprus	2	-	+2.80	2000
Hungary	3	-	+4.08	1901
Czech Republic	4	-	+2.70	1961
Lithuania	4	-	+3.00	1961
Moldova	5	-	+3.80	1886
December				
Italy	1	+2.34	-	1961
Russia	2	+5.25	-	1936
Latvia	2	-	+4.70	1924
Moldova	2	-	+4.10	1886
Estonia	3	-	+4.60	-
Lithuania	3	-	+4.50	1961
Ukraine	3	+4.50	-	1891
Switzerland	3	-	+2.40	1884
Georgia	4	-	+2.72	1960
Spain	4	-	+1.90	1965
Cyprus	5	-	+1.20	2000

Temperatures in October were above normal for most of the RA VI Regions with largest anomalies occurring in the East (Russia and Belarus) where it was 3 to 4 °C warmer than normal. Cooler-than-normal temperatures occurred over the British Isles and Scandinavia where anomalies of up to -1 °C and between -1 and -3 °C were recorded respectively. The monthly mean temperature for Europe as a whole was 1.87 °C above normal relative to 1910-2000 making it the 5th warmest October since 1910 according to the State of the Climate for October 2019 published by NOAA National Centers for Environmental Information (https://www.ncdc.noaa.gov/).

In November, temperatures were above normal over most parts of the RA VI Region. The monthly mean temperature for Europe as a whole was 1.76 °C above normal relative to 1910-2000 period making it the 7th warmest November since 1910 according to the State of the Climate for November 2019 published by NOAA National Centers for Environmental Information (https://www.ncdc.noaa.gov). Largest anomalies occurred over the Balkan Peninsula where is was 3 to 4 °C warmer than normal, locally even more.

Monthly mean air temperature values were higher than the 1981-2010 average for December over the entire RA VI domain. Largest anomalies occurred over Eastern Europe, where temperatures were more than 3 °C above normal, over Russia anomalies exceeded even +6 °C. The temperature in Moscow rose to 6.2 °C on 22 December, a new local record in a series of about 140 years. The monthly mean temperature averaged over Europe was +2.73 °C above the 1910-2000 average, making it the 2nd warmest December for Europe as a whole according to the NOAA National Centers for Environmental Information (https://www.ncdc.noaa.gov). According to the Copernicus Climate Change Service/ECMWF, December over Europe was 3.2 °C warmer than the average for 1981-2010 (based on ERA5), making it, by a narrow margin, the warmest December on record for Europe since 1979.

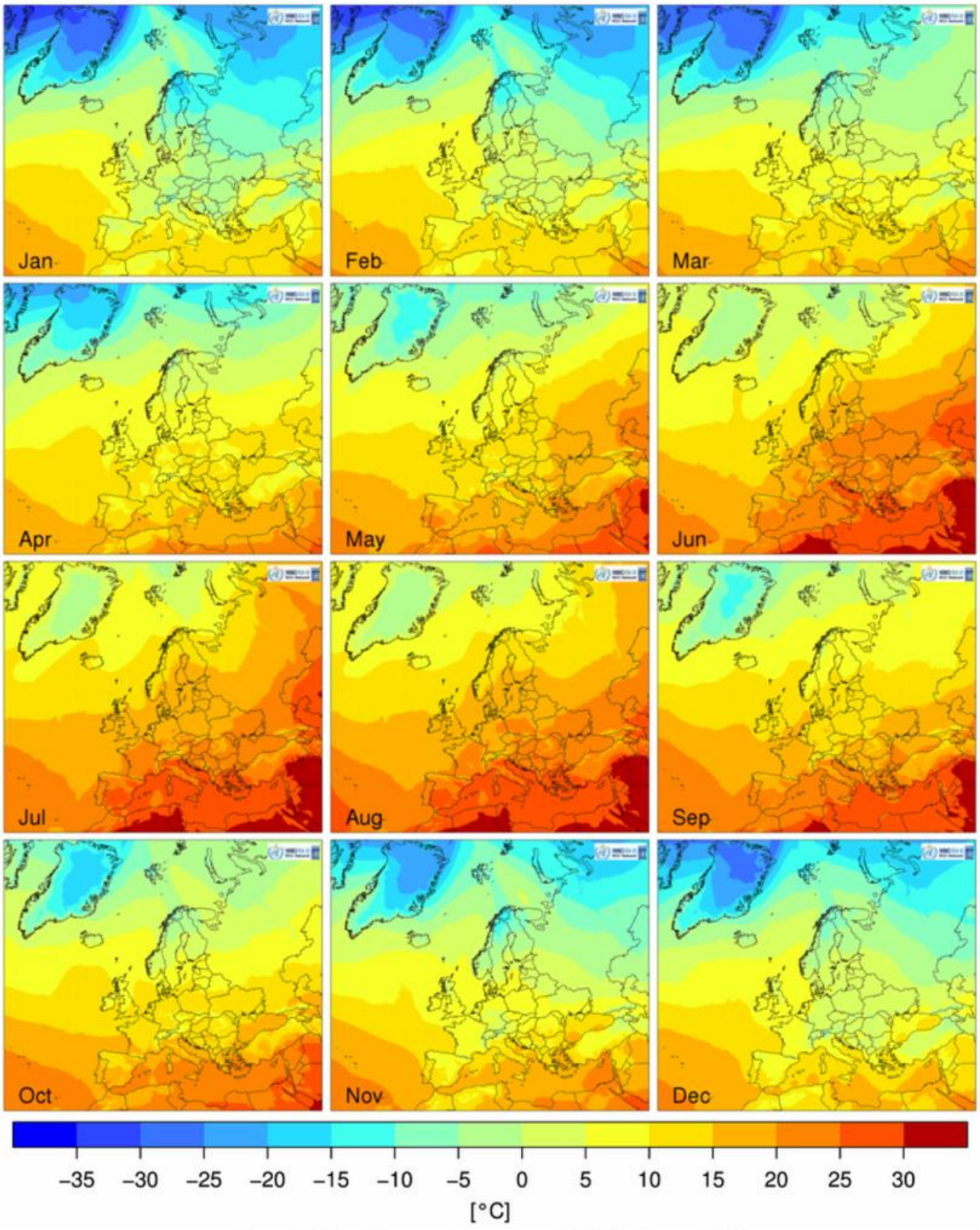

Figure 4-3: Monthly mean temperature (in °C) for the year 2019.

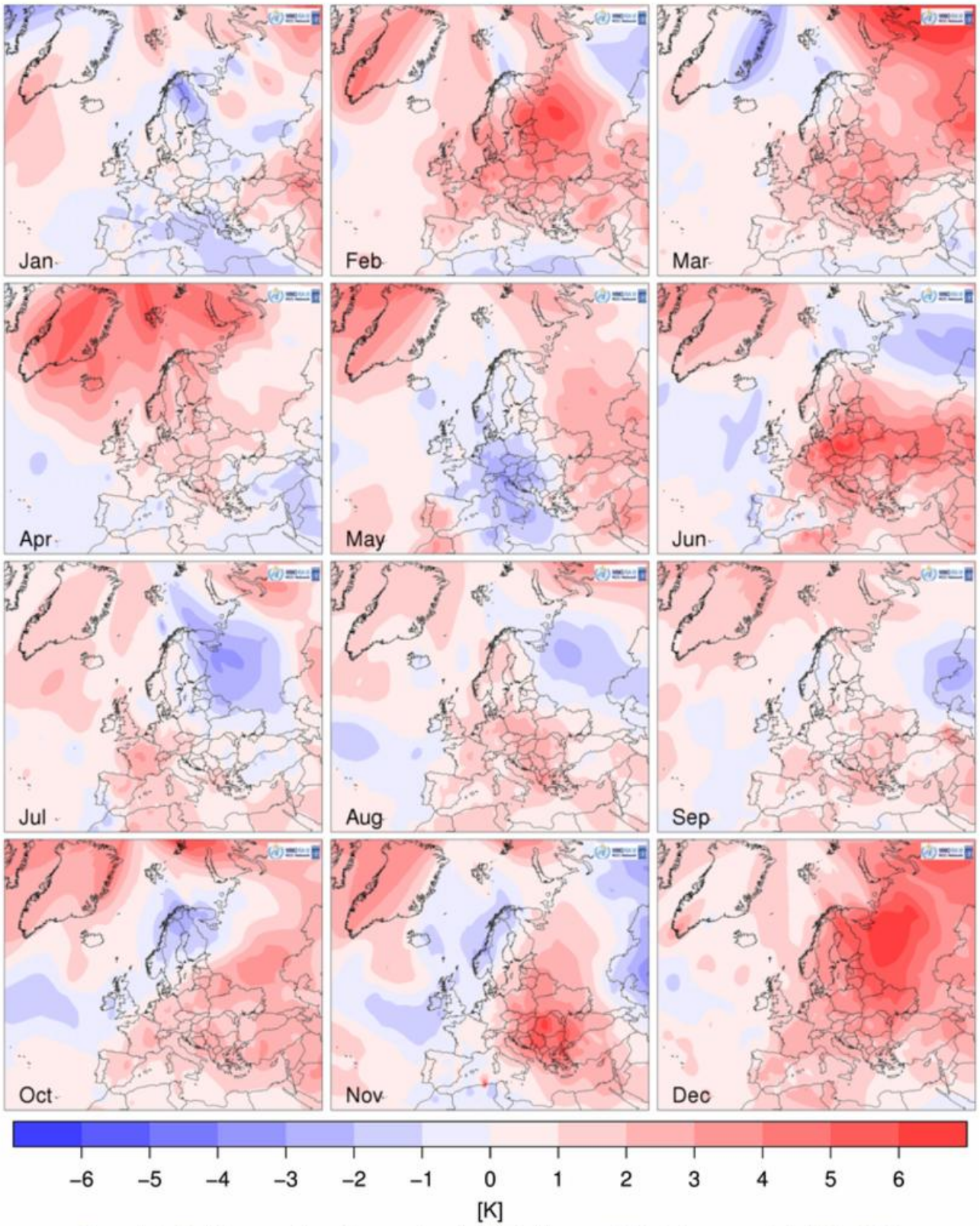

Figure 4-4: *Monthly anomalies of temperature (in °C) for the year 2019 (reference period: 1981-2010).*

4.3 Precipitation

Table 4-4: Monthly and annual area average precipitation anomalies in % for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1).

Region	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Central and western Europe	96	97	69	100	73	109	86	75	93	97	116	126	105
Nordic und Baltic Countries	94	125	85	117	68	83	108	55	123	107	79	80	103
Iberia	89	79	51	60	146	43	52	102	106	103	79	121	130
Med., Italian and Balkan Peninsula	106	149	70	46	123	163	89	148	76	67	64	174	107
Eastern Europe	107	137	119	120	71	129	82	121	97	80	125	95	108
Middle East	99	85	102	146	141	54	123	123	111	77	78	34	112

In January, precipitation anomaly distribution shows a notable west-east dipole. It was drier than normal particularly in Western Europe and parts of Scandinavia, though with locally heavy precipitation e.g. in northern Spain / southwestern France and in Norway. It was the driest January in the United Kingdom since 2006. The southern Alps were dry as well, with less than 10 % of normal in some areas of southern Switzerland, while the northern Alps were very wet with new local records, e.g. 279 mm in Kufstein. Eastern parts of RA VI were mostly wetter than normal as well, particularly around the Black Sea and near the eastern Mediterranean, locally above 250 % of the normal, e.g. in Romania, Moldova, Bulgaria, near the Aegean Sea, in southern Turkey and Cyprus. In Turkey, it was the highest January total in the last 15 years in the Aegean region and the last 37 years at the Mediterranean coast. Especially Greece and Cyprus recorded several heavy rain events with flooding and landslides. Malta, too, was wet, recording the wettest January since 2011, much contributed by 6 thunderstorms (more than 3 are rare in January), partly with hail. In Serbia, the stations Valjevo, Kragujevac and Pozega observed record-breaking numbers of days with precipitation (23-25 days, series since 1925, which means that the above-normal monthly totals came from high frequency of precipitation. In eastern Central Europe (e.g. Czech Republic, Slovakia), most of the precipitation fell in the first half of the month, also in the Middle East (e.g. Israel).

In February, precipitation was below normal in most of the RA VI Region from Western Europe to southern parts of Eastern Europe. Only the first third of the month was stormy and rainy in Western and Central Europe, but turned to anticyclonic conditions with little precipitation afterwards, especially the last third was mostly dry. Some places had severe or even extreme drought, particularly in northeastern Spain, France and Germany. Especially parts of Spain, eastern Ukraine, southern European Russia and west Kazakhstan received less than 10 mm or less than 20 % of the 1981-2010 normal that month. It was the driest month in the 21st century in Spain so far. The Netherlands had 45 mm, but these fell almost all in the first third of the month, similar in Belgium.

It was relatively wet particularly in northern European Russia, above 250 % of normal fell locally. Parts of Scandinavia recorded above-normal precipitation as well (locally above 300 % of normal in Norway). Some stations in Norway (Nordland province) received around 300-350 mm that month and reached new local February records. Places in the Southern Alps had a precipitation excess due to some heavy rain events, much of them within a few days in early February. Near the eastern Mediterranean, too, some heavy rain events took place, e.g. on 25 February in western Crete (Greece), when Chania station recorded 374 mm of daily rainfall, a new record for Crete, and also Cyprus reported several events, resulting in a monthly total of 139 mm or 171 % of normal. Israel, too, had a lot of rain. From 5 February to the end of month, it rained almost every day in any part of the country, including on three heavy precipitation events throughout the month.

In **March**, there was a clear contrast between north and south with respect to precipitation. While the northern half of the RA VI Region was mainly wetter than normal (except Iceland and the Arctic region), much of the southern half was drier than normal. European Russia also was mainly wet, and so was also the southeast of the Region from Azerbaijan to parts of the Middle East and the eastern Mediterranean including the southern Greek island Crete. The difference between north and south was extreme since much of the precipitation in the north was above the 90th percentile and in the south below the 10th percentile with locally less than 20 % of the normal and totals of less than 10 mm or even zero for the whole month. Some stations in Serbia (Palic, Crni Vrh, Sombor) recorded their driest March on record. For Italy, it was the driest month countrywide for at least 15 years. The Turkish Black Sea region received the lowest precipitation since 1995.

A few stations in Norway recorded 3 times the normal precipitation. Sweden even registered local records of monthly precipitation in the southwest with totals up to 179 mm. Finland reported totals occurring less frequently than once every 30 years in places. Some stations in Ireland experienced their wettest March since 2008. For Denmark, it was the wettest March countrywide since 1874 with 106 mm on spatial average. Some parts of European Russia received more than twice the normal monthly precipitation, the same in Israel. Latvia had its third wettest March in the 21st century and its first month since April 2018 with above-normal rainfall; thus, it ended a long drought period. In northern and parts of central Israel, it was the rainiest March since 2003.

March's weather in Northwestern, Western and Central Europe was dominated by westerly and northwesterly winds, mild temperatures and frequent rain belts moving in off the North Atlantic until the 17th-18th. Named storms Freya and Gareth (UK names) brought spells of particularly wet and windy weather. Zurich in Switzerland recorded 6 days of strong wind (gusts >75 km/h), which did not happen before since 1995, also France had more windy days than normal. From the 19th onwards, it was often dry and sunny in Northwestern, Western and Central Europe with cold nights, due to high-pressure influence.

Large areas from Spain to the Ukraine had at least moderate drought conditions, partly severe and locally extreme. Monaco and southern Andorra had just 1 day of rain in the whole month. In Hungary, rainfall exceeded 1 mm only on 3 days on national average

Much of the northern half of Europe was very dry in **April,** especially large parts of Scandinavia, Poland, the Baltic countries, Belarus and adjacent parts of western Russia, which all received less than 10 mm of precipitation in the whole month and thus experienced mostly severe or extreme drought conditions. The totals were mostly below the 10th percentile and less than 20 % of normal

in large parts. Water levels fell considerably in rivers and lakes, e.g. in Lithuania and Belarus. It was the driest April on record in Latvia since 1924 with not more than 2 days with at least 1 mm of daily precipitation anywhere, and the driest in Belarus in the post-war period. Norway saw the second driest April on record (after 1918). Sweden had some local records of low precipitation with below 1 mm over the whole month at several stations. Uppsala station received 1.6 mm; to find a lower value there, we need to go back to 1813. Also in many places in Finnish Lapland, the rainfall in April was the lowest in recorded history. The dryness led to wildfires, especially in southern Finland during the latter half of April and in Belarus during the last five days of the month. In the Russian plain, no similar dryness was observed in April for almost 50 years. Other areas such as parts of the United Kingdom and Central Europe had a moderate, locally also severe drought, most rain in Central Europe came mainly in the last week of the month. Uccle in Belgium recorded only 8 days with precipitation compared to 15 on 1981-2010 average. Highest precipitation this month with totals above 100 mm (locally much more) was mostly in the south, especially in much of Iberia, the southern Alps, Monaco, southern Italy, western Balkans and southeastern Turkey, locally 2-3 times the normal and above the 90th percentile. Monaco recorded its rainiest April on record since 1969 with 212.6 mm (about 300 % of the normal), Spain the second wettest in the 21st century after 2008 with local records.

In May, much of Europe was wetter than normal, from Scandinavia over Eastern / eastern Central Europe to the Balkans and Italy, locally with more than 250 % of the normal, in Norway 300-400 %, Sweden and Finland even had record-wet places with monthly totals above 100 mm. Some places in Austria recorded the second wettest May on record. It was the third rainiest May in Hungary, where also a new record of daily precipitation in May (141.2 mm) was noted. Hungary recorded 18 rainy days, 7 times more than average. Slovenia recorded its wettest May? since start of measurements in 1961 with monthly totals above 400 mm in some places in the Julian Alps. Dubrovnik in Croatia had its highest number of rainy days that month since start of measurements. Serbia reported both local record-breaking monthly precipitation totals (177.9 mm at Zrenjanin station) and number of precipitation days (23 days at Kikinda) for May. Montenegro had a new local monthly precipitation record at 321.4 mm in Herceg Novi. Northern Italy, too, recorded widespread totals above 300 mm, also partly with new records (e.g. Belluno, Modena) and high number of rainy days (16-18 compared to 12-14 normally). Malta recorded 6 thunderstorm that month (normal is 1), the highest number since 1951.

Western Europe (except Scotland) and most parts of western Central Europe were drier than normal and also the eastern Mediterranean region. Places in Ireland saw their driest May since 1991. Especially most of Iberia, but also southern Greece and southern Turkey, and Iceland/ Greenland received less than 40 % of the normal, partly even less than 20 %. It was the second driest May in the 21st century in Spain after 2015 and the third driest since 2000 in Portugal after 2006 and 2003. Turkey was dry especially in the Mediterranean region, the driest May in the last 20 years. Cyprus received only 1.6 mm the whole month (8 % of normal). The Middle East was in the dry season anyway. Over Russia, precipitation had a high spatial variability due to much convective rain.

In June, due to the main influence of high pressure over the continent dry conditions dominated over southwestern, central and also eastern Europe. Large parts only received less than 40 % of the normal precipitation amounts for example parts of Spain, Italy, Poland, the Baltic countries, Finland

and southeastern Russia. In Spain, Italy and Russia precipitation sums did not even reach 20 % of normal. At the same time, both western Europe and southeastern Europe experienced heavy precipitation events due to the eruption of heavy thunderstorms in the first week of June locally resulting in flooding. Turkey experienced a precipitation surplus of 70 %. In France, active disturbances, often stormy, followed one another. Violent thunderstorms locally accompanied by hail and gusts exceeding 100 km/h occurred over the north of the country on the 4th and 5th. The storm "Miguel" swept over a large part of France on the 7th. Then on the 9th, there were numerous thunderstorms over the south-east quarter.

The dry conditions present already in June continued in **July** over large parts of Europe. In Ukkel, Belgium, the dry period that had started on 16 June continued till 11 July, resulting in a total of 26 days in a row without precipitation. Last time Ukkel had seen such a long period without rain was back in 1995. Precipitation sums were exceptionally below normal in western and central Europe as well as over Scandinavia and parts of eastern Europe (< 10th percentile). In France and over Scandinavia the GPCC precipitation index regionally dropped below -1.5 indicating severe drought conditions. In Finland, it was particularly dry in the western parts of Northern Ostrobothnia and in southwestern Lapland where the monthly amount of precipitation was less than 10 millimetres. It rained least in Siikajoki, where the monthly amount of precipitation was only 2.3 millimetres. This is the lowest amount of precipitation recorded for July in the history of the observation station. Wetter conditions occurred in July particularly over southern and eastern Europe with exceptionally above precipitation sums over Russia, the Balkan Peninsula, Turkey but also over the United Kingdom. In southeastern Europe these resulted from severe storms hitting for example Italy, Croatia, Serbia, Bosnia and Herzegovina as well as Greece between 7 and 10 July and producing violent hailstorms. In the United Kingdom, flash floods occurred after torrential rain causing severe damage in northern and central England on 30 and 31 July.

Drought conditions were a very prominent feature again in **August.** There were two main zones of continued dryness: one extending from France over Central Europe to the Baltic countries and Finland and the other one from the Balkans to Ukraine/ Russia. In between the two zones there was a zone with more than average precipitation. Largest monthly deficits with monthly sums lower than the 10th percentiles were recorded over Ukraine, southwestern parts of Russia and parts of Greece as well as over Baltic countries. GPCC precipitation indices regionally dropped below -1.5 for Greece, Ukraine, southern France indicating severe drought conditions (for August). The monthly precipitation deficit was locally above 40 mm so that some places received less than 40 % of the usual August total. Even more serious was the long duration of periods without rain for parts of central and northern Europe and as well as for the Baltic where accumulated summer precipitation amounts stayed exceptionally below the average (< 10th percentile) of the reference period 1951 to 2010. The summer months were exceptionally wet (> 90th percentile considering the reference period 1951 to 2010) over northern UK, Norway, Russia and Turkey. Several heavy precipitation events partly going along with severe storms and floods contributed to these exceptionally wet summer conditions (see also “Selected Significant Events” reported by the National meteorological and hydrological services for this and precious months).

Precipitation sums for **September** were below normal over large parts of the RA VI Region, especially over Eastern Europe, Turkey and France where the monthly totals were partly only 40 % or less of normal. In these regions, the drought index dropped to values below -1.5 for September

indicating severe to extreme drought. In the Ukraine, the south only received 10 mm or less which is 75 % less than normal (w.r.t. 1981-2010). Exceptionally above average precipitation, amounts due to several cyclonic systems were registered over the northwestern part of Europe, for example over the UK, Netherlands, Denmark, but also over southeastern Spain. In Vega Baja del Segura, the area most affected in Spain, the accumulated rainfall in a few hours (from the morning of the 12th to the morning of the 13th) was almost equivalent to the amount normally accumulated over a whole year. Maximum values, accumulated during the period from 10 to 14 September, in the network of AEMET stations were registered at Gaianes with 482.8 mm (more than 350 mm of that fell in the last 24 hours).

In October, the regions receiving more sunshine than normal correspond also to those experiencing below normal precipitation. In parts of Italy and along the western coast of the Balkan peninsula the accumulated amounts were even exceptionally below normal (< 10th percentile). Exceptionally above normal precipitation amounts occurred, on the contrary, over northern Russia and along the Atlantic coast of western Europe affecting France, the UK and the Netherlands. Southern France, the northeast of Spain and the north of Italy were hit by excessive rainfall events during 21 to 24 October caused by a depression over the Mediterranean Sea. They resulted in severe flooding and landslides. The frontal system moved westward from Italy towards Spain between the 22 and 24 October. On the east side of the depression a south to southeasterly wind brought warm and humid air from the Mediterranean Sea causing excessive rainfall and heavy thunderstorms along the Mediterranean coasts. In Italy, most precipitation fell on 22 October. The province of Alessandria in Piedmont was among the worst hit areas. Piedmont Regional Agency for Environmental Protection (ARPA) reported that on 22 October as much as 253 mm of rain fell in 12 hours in Casaleggio Boiro. In France, most precipitation fell on the 22 and 23 October. In southern France, precipitation amounts of 100-200 mm were recorded over a large area, but locally even more than 200 mm. This is the amount of rainfall normally accumulated over three months. The largest rainfall amounts were reported in the Languedoc and the Roussillon regions, for example at the station Puechabon 271.5 mm. The Spanish Meteorological Service of Catalonia (Meteocat) recorded on 23 October at several locations in the northeast of Spain more than 200 mm in 24 hours, among them Prades, Baix Camp, with 287.4 mm. The northern part of Russia also experienced very intense precipitaion with up to 30-50 mm per day and often in the form of snow already. In many regions monthly precipitation normals were exceeded by two or more times.

Monthly accumulated precipitation amounts differed a lot within the RA VI Region in November. The eastern part saw below normal precipitation amounts which were even exceptionally below normal (thus < 10th percentile) over Turkey, Southern Russia, Ukraine and Kazakhstan. In Russia, the monthly precipitation totals in the areas down to the Caucasian Ridge amounted to less than half the normal values, and were altogether zero in some areas of the Trans-Volga Region. A severe drought was observed in the Krasnodar Territory where sizeable rains fell on the last day of November only.

The regions neighbouring the northern Mediterranean as well as the Atlantic coast regions of Spain and France, on the contrary, experienced exceptionally above normal precipitation (>90th percentile). The rainfall amounts accumulated over the whole month are very impressive in these regions. In Italy, monthly precipitation values were in some areas double (for example in the Po basin) or even triple to quadruple (for example in south Tyrol) the normal amounts (that is the average over the reference period). For Italy, November 2019 finished as the rainiest November

ever. In France, rainfall was particularly frequent and abundant in the west and south of the country. France as a whole registered a surplus of precipitation of 90 %, making November 2019 the third wettest November since 1959. Over the western half of France and Corsica there were 15 to 27 days of rain, 5 to 14 days more than normal. Over the South-West as well over the South-East (of France), monthly precipitation totals reached double or even triple to quadrule the normal amounts. Records were broken at several stations including Lanvéoc (Finistère) with 246.4 mm, Ajaccio (Corse-du-Sud) with 284.3 mm, Cambo-les-Bains (Pyrénées-Atlantiques) with 531.5 mm and Saint-Martin-de-Hinx (Landes) with 534 mm. The heavy rainfall generated significant floods in Aquitaine on 16 and 17 November and in the Provence - Alpes - Côte d'Azur region on 22 and 23 November. In Slovenia, precipitation amounts exceeded the long-term averages everywhere. The largest surplus was reported in the northwest of Slovenia, in Gornja Radovna where 327 % of the normal precipitation fell. At lower altitudes, these large amounts of precipitation fell as rain, at higher altitudes as snow. In Kredarica, 29 days with snow cover were reported and the thickness of the snowpack reached 295 cm, which is the thickest snow cover in November ever observed in Kredarica. In Austria, the weather conditions in November brought an extraordinary amount of precipitation in the southern and southwestern parts of the country. In these regions the anomalies of precipitation were 200 to 440 % of normal. Many weather stations in these regions set new monthly precipitation records. In Austria it was the third wettest November (+100 %) since 1858.

These abundant precipitation amounts were due to several Mediterranean Storms occurring between 12 and 24 November. First, Medicane Trudy developed on 12 November from the low pressure area Detlef. Trudy brought heavy rain especially to Italy and the Balkan coasts. In Italy up to 90 mm of rain fell on 12 November, on the Balkan coasts up to 78 mm. In the southern Alps Trudy brought fresh snow quantities of more than 1m as well as strong winds. As soon as Medicane Trudy had left, low Heiner started heading towards Italy and the Alps. This time, largest amounts of precipitation occurred mainly in the south and east of Austria. Almost 140 mm accumulated in 24 hours. At lower altitudes, these fell as rain, at higher altitudes as snow, resulting in floods and enormous amounts of fresh snow. Furthermore, the strong air pressure gradient in Austria caused widespread strong winds and gale force gusts. In the night from 22 to 23 November, Luis II moved across the Bay of Biscay and reached the coast of southwestern France on 23 November. Especially along the Atlantic coast of the Iberian Peninsula, stormy winds and abundant precipitation occurred. Several stations in France and Spain recorded more than 100 mm in 24h. But also parts of Italy experienced again heavy precipitation exceeding 100 mm in 24h at several places (on 24 November).

Monthly precipitation totals were also exceptionally above normal in the northeast, namely over Russia and Finland. In Russia, up to 50 mm of precipitation fell per day in some locations in the Novgorod Region and more than twice the normal monthly amount accumulated in the first decade of November. Such abundance of rains led to a rapid rise of river levels. Water flooded roads, bridges and even in parts the city of Veliky Novgorod. In the Volgograd Region, the situation was similar, while in the Kostroma Region, heavy rains were followed by ample snowfalls. In Finland, in the area extending from Satakunta to Koillismaa, the precipitation was 1.5 to 2 times more than in an average November. In parts, even location-specific precipitation records for November were measured. The month's highest overall amount of precipitation, 134.4 mm, was measured in Niinisalo, Kankaanpää.

At the same time, this was the highest November precipitation in the 80-year history of the observation station.

Monthly precipitation totals for **December** were below normal mainly in the eastern, southeastern and central parts of the RA VI domain with for example less than half the normal precipitation amounts in southern parts of European Russia. Around the Caspian Sea no or only very little precipitation was recorded. More than normal precipitation, on the contrary, was observed among others over northern Europe. In Finland, for example, it rained twice as much as usual in Central Lapland. In Vuotso (Sodankyla), the highest amount of precipitation in the station's measurement history for December was recorded with 98.7 mm. The highest amount of precipitation was recorded in Koivuniemi in Virolathi with 116.8 mm. Wetter than normal conditions also prevailed in western parts of Europe as well as over the eastern Mediterranean region resulting from several winter storms passing over Europe during December. A first storm occurred over Iberia in early December and caused flooding in France and Spain. In southern France (Var region) 187 mm fell in 24 hours on 2 December, the second highest daily total on record behind 3 October 2015. In mid-December another storm caused flash floods in parts of the Murcia region in southern Spain. Gusts of 130-140 km/h were measured in several places in France and Germany (mainly coastal or mountain sites), in Corsica (France) even 173 km/h on 13 December and on the peaks of the Alps up to 158 km/h (Jungfraujoch) on 14 December. In Portugal, 115.8 mm were accumulated in 24 hours on 16 December and in France a gust of 173 km/h was registered on December 13. Between 19 and 22 December several fast-running low-pressure systems reached Western and Central Europe causing stormy winds, mild temperatures and heavy precipitation. Strongest gusts occurred over Iberia and southwestern France with wind speeds up to 150-180 km/h at several stations in Portugal and Spain. In the eastern Mediterranean region, after a very dry autumn, December finally brought above-normal precipitation over almost in the whole region except for southern Israel and southern and eastern Jordan. A weak low-pressure system caused heavy precipitation in Israel (on 25-28 December) and Lebanon. Monthly totals up to above 250 % were recorded particularly in various parts of Syria and Israel.

Table 4-5: Rank statistics, monthly average precipitation (mm) and anomalies (mm or %) from several countries of the RA VI for the individual months in 2019 including countries with rankings among the top 5 (ranks 1–5) since start of the to time series. Ranks refer to monthly values being sorted from wettest to driest if not indicated differently.

Country	Rank	Anomaly [mm] (1961-1990)	Anomaly [mm] 1981-2010	start of time series
January				
Moldova	5	-	+47	1891
(European) Russia	5	+12.1	-	1936
February				
Jordan	5	+61.8	-	1981
Italy	1 (driest)	-26	-	2010
Spain	4 (driest)	-	-38	1965
March				
(Europen) Russia	2	+18.4	-	1936
Estonia	4-5	-	+19.7	-
Italy	2 (driest)	-52	-	2010
Moldova	2 (driest)	-	-34	1891
Bulgaria	4 (driest)	-35	-	1930
April				
Italy	2	+30	-	2010
Spain	4	-	+31.0	1965
Estonia	1 (driest)	-	-26.7	-
Latvia	1 (driest)	-	-31.3	-
Lithuania	1 (driest)	-	-34.0	1961
Finland	4 (driest)	-	-17.1	1961
May				
Italy	1	+63	-	2010
Hungary	3	-	+71.8	1901
Slovakia	3	+63.1	+57.7	1961
Finland	3	-	+25.9	1961
Spain	4 (driest)	-	-37	1965
June				
Italy	1	-40	-	2010
Lithuania	4	-	-41	1961
July				
Italy	2	+23	-	2010
Russia	4	+18.4	-	1936
Finland	5 (driest)	-	-39.1	1961
August				
Italy	4 (driest)	-17	-	2010
September				
Italy	3 (driest)	-9	-	2010
October				
Armenia	2 (driest)	-42.8	-	1965
Georgia	4 (driest)	-	-57.5	1960
Italy	4 (driest)	-12	-	2010
November				
Italy	1	+162	-	2010
Slovakia	2	+58.2	63.0	1961
Moldova	5 (driest)	-	-33	1891
December				
Italy	1	+20	-	2010

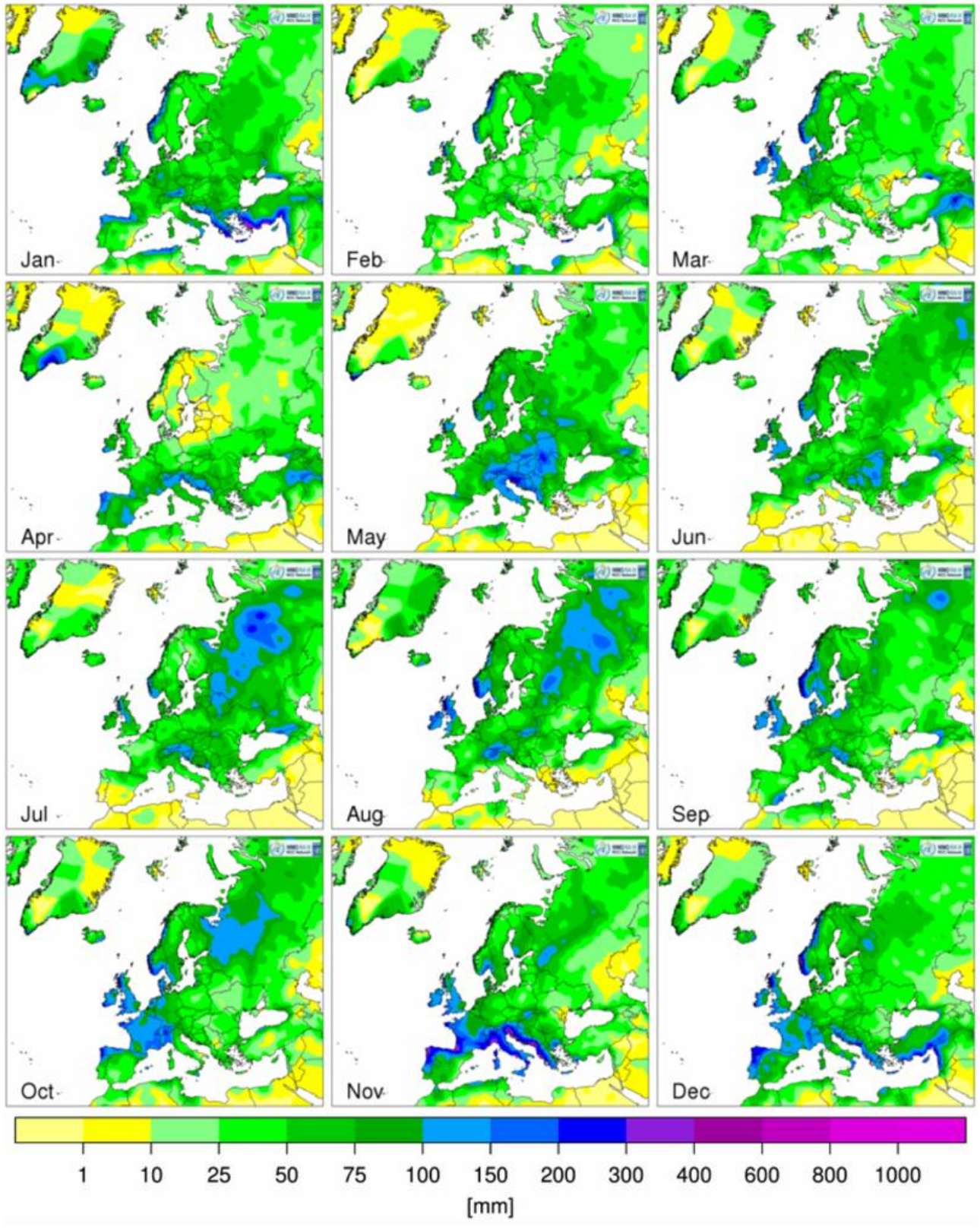

Figure 4-5: Monthly mean precipitation (in mm/month) for the year 2019.

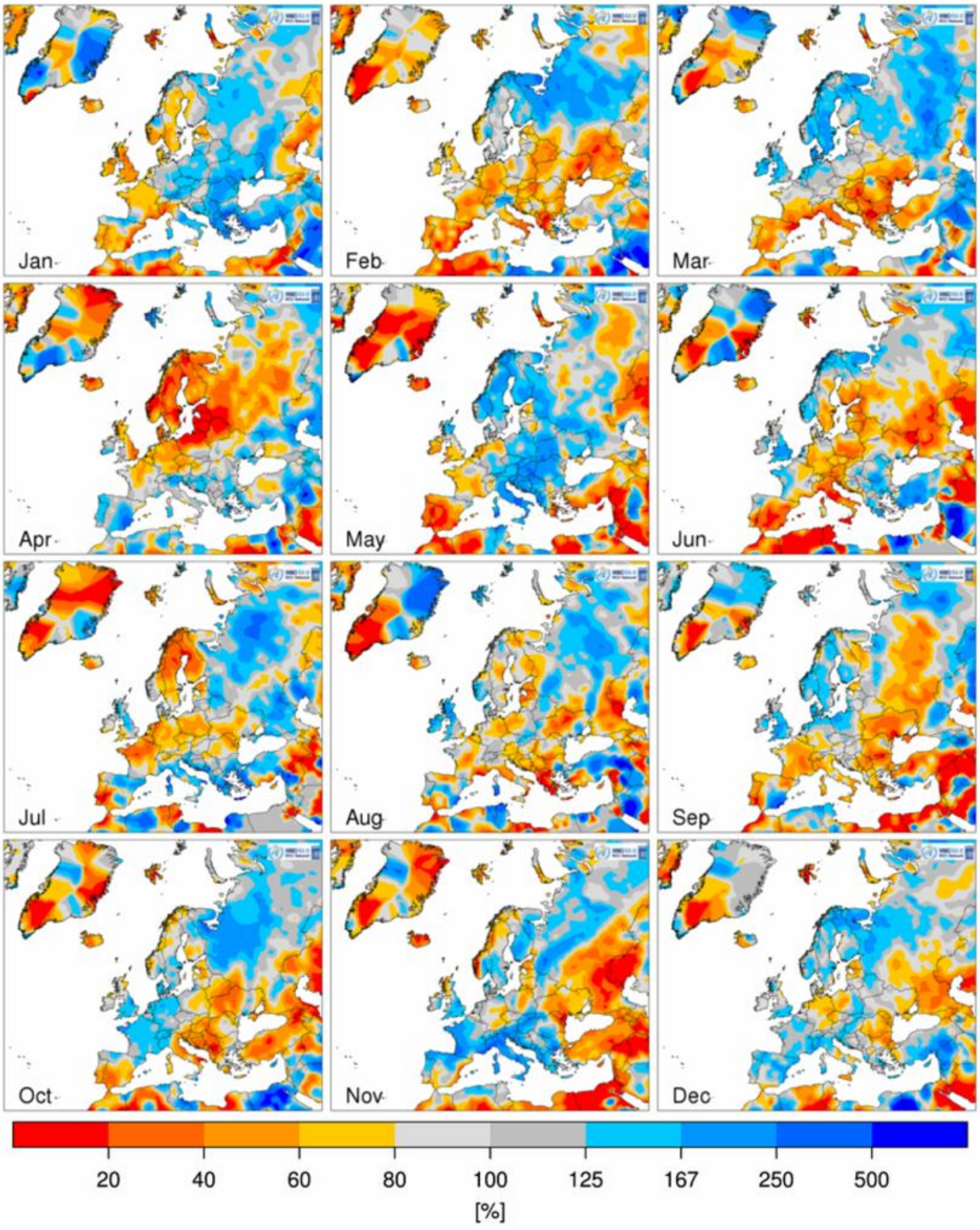

Figure 4-6: Monthly precipitation in % of normal for the year 2019 (reference period 1981-2010).

4.4 Sunshine duration

Table 4-6: Monthly and annual area average sunshine duration anomalies in hours for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1).

Region	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Central and western Europe	154.2	-7.3	46.9	13.1	33.1	-28.1	61.1	18.3	14.0	8.3	-4.2	-13.8	12.8
Nordic und Baltic Countries	25.2	1.6	2.3	-0.5	36.4	-8.7	7.4	5.2	-1.1	-3.4	-7.8	-4.5	-1.7
Iberia	154.7	29.7	53.0	50.3	-16.3	52.5	13.3	-9.9	-2.4	3.3	16.8	-34.2	-1.2
Med., Italian and Balkan Peninsula	97.9	-15.6	32.5	58.1	-4.0	-55.0	32.8	-4.3	16.5	16.7	42.8	-31.1	8.6
Eastern Europe	149.0	2.0	4.4	23.0	48.0	2.3	46.5	-37.2	9.2	14.7	14.4	17.2	4.5
Middle East	110.6	20.9	1.3	-5.2	4.1	18.7	7.3	-9.5	2.2	-2.2	25.7	35.9	11.4

In January, large parts of the RA VI Region were **sunnier** than normal, especially in southwestern Europe and in the Middle East. On the other hand, particularly parts of France, the Alpine region, Southeastern Europe and Turkey were relatively dull. The station Kragujevac in Serbia measured 26.4 hours of sunshine duration, the lowest ever recorded in January there.

Due to prevailing anticyclonic conditions, February was mostly sunny, particularly in Southwestern, Western and Central Europe with over 50 hours more than usual in Spain, France, Germany and parts of eastern Central Europe. It was Germany's sunniest February since 1951 and the UK's second sunniest February in a series from 1929, just behind 2008. De Bilt in the Netherlands recorded the third sunniest February on record. Basel and Geneva, both in Switzerland, registered their sunniest February since start of measurements in 1886 and 1897, respectively, with each 169 hours, more than twice the 1981-2010 normal. Northeastern France, too, had twice as much sunshine compared to the long-term average (1991-2010), and several places in France had new records (including Toulouse in the south with 189 hours, highest since 1948). Similarly, Germany's stations Bad Kissingen and Constance were more than twice as sunny compared to normal. Even southeast Sweden received much sunshine; Karlskrona station registered a new February record at 122 hours since start of measurements in 2009.

For March, there was a contrast between north and south concerning sunshine duration. Some parts of the north, particularly northern Central Europe, but also the Middle East had more than 20 hours sunshine deficit. Conversely, much of the south was sunnier than normal with partly more than 50 additional sunshine hours that month compared to the normal. Some places noted new local records in monthly sunshine duration for March, e.g. Nice in France since 1991 with 283 hours. However, also parts of the north were at least slightly sunnier than normal, e.g. Sweden, Denmark. The United Kingdom was sunny especially in the last week of the month; the monthly total also was higher than normal. In Switzerland, several stations reached the maximum possible sunshine duration on many days in the last third of the month.

In **April**, much sunshine occurred over large parts of Northern Europe within the high-pressure zone, but also most of the middle latitudes of Europe were sunnier than normal. Several stations in Sweden noted new April sunshine records and also the national April record for Sweden was surpassed (Borlänge in Dalarna 335 hours; there, the sun shone at least 10 hours (of a maximum of 14-15 hours) per day from 10 to 30 April). For Denmark, too, it was the sunniest April on record (since 1920). Southern parts of RA VI mostly had around-normal sunshine, partly also duller, especially in the most rainy areas.

In **May**, sunshine duration and global radiation show a very similar distribution like precipitation. The wet areas were also mainly the dullest with deficits down to -100 hours. However, the southern slopes of the Alps often had sunny days due to north foehn. Western and southern Spain had the sunniest places in May 2019 with up to above 400 hours of sunshine, more than 50 hours above normal. Cork Airport in Ireland had its sunniest May since 2007. In contrast, Uccle in Belgium recorded only 182 hours, less than in April 2019. Austria recorded its dullest May since 2010, Slovenia since 1961. Serbia notes some new local records of dullest May.

Due to the strong high-pressure area and corresponding significant subsidence in **June**, there is also a strong positive anomaly (>100 % of normal) of sunshine duration over much of central and eastern Europe. Over an area reaching from western Iberia over England to Norway a zone with negative anomalies in radiation can be clearly distinguished as a result of the frontal systems passing along the western edge of Europe.

In **July** it was generally more sunny than normal (the average calculated from the climatological period 1986 to 2015) over most parts of the RA VI Region with largest anomalies over France and Scandinavia. Over France, we also find the largest surplus of radiation for July whereas negative anomalies in radiation are visible over the southern and the northeastern part Europe as well as over the United Kingdom.

In **August** it was generally more sunny than normal (with respect to the average calculated from the climatological period 1986 to 2015) with anomalies of 5-25 % over most parts of RA VI. The largest radiation surplus in August is found over Eastern Europe (Balkan Peninsula, Ukraine) whereas southern parts of Sweden, Norway, Turkey received below-normal radiation amounts.

In **September** it was generally more sunny than normal (the average calculated from the climatological period 1986 to 2015) over most parts of the RA VI Region with largest anomalies over Eastern Europe, France and Italy with a surplus of 20 to 50 sunshine hours. Over Eastern Europe, we also find the largest surplus of radiation for September (up to 40 W/m² more than normal) whereas negative anomalies in radiation are visible over southern Iberia as well as over the southern Caucasus (up to 30 W/m² less than normal).

In **October** it was more sunny than normal (with respect to the average calculated from the climatological period 1986 to 2015) over the southern and eastern part of the RA VI Region. The largest surplus in sunshine hours is found over Eastern Europe (Balkan Peninsula), over Italy and over the South Caucasus region, which received 50 to 100 hours extra sunshine. Scandinavia and France, on the other hand, experienced fewer than normal sunshine hours (up to 50 hours less) corresponding to a radiation deficit of up to 20 W/m².

Sunshine duration was in November over most parts of the RA VI Region below normal with up to 100 hours less sunshine hours than normal occurring for example over Portugal. Turkey, southern Russia and the Middle East region, on the contrary, experienced above-normal sunshine duration with 50 to 100 hours more sunshine hours than normal corresponding to a surplus of radiation in the range of +20 to +40 W/m².

The month of December was over most parts of the RA VI domain more sunny than normal. Anomalies were mostly small though (only up to +20 sunshine hours). Largest anomalies occurred over the southeastern part, which experienced 50 to 100 more hours of sunshine than normal. This corresponds to a surplus in radiation of 10 to 20 W/m².

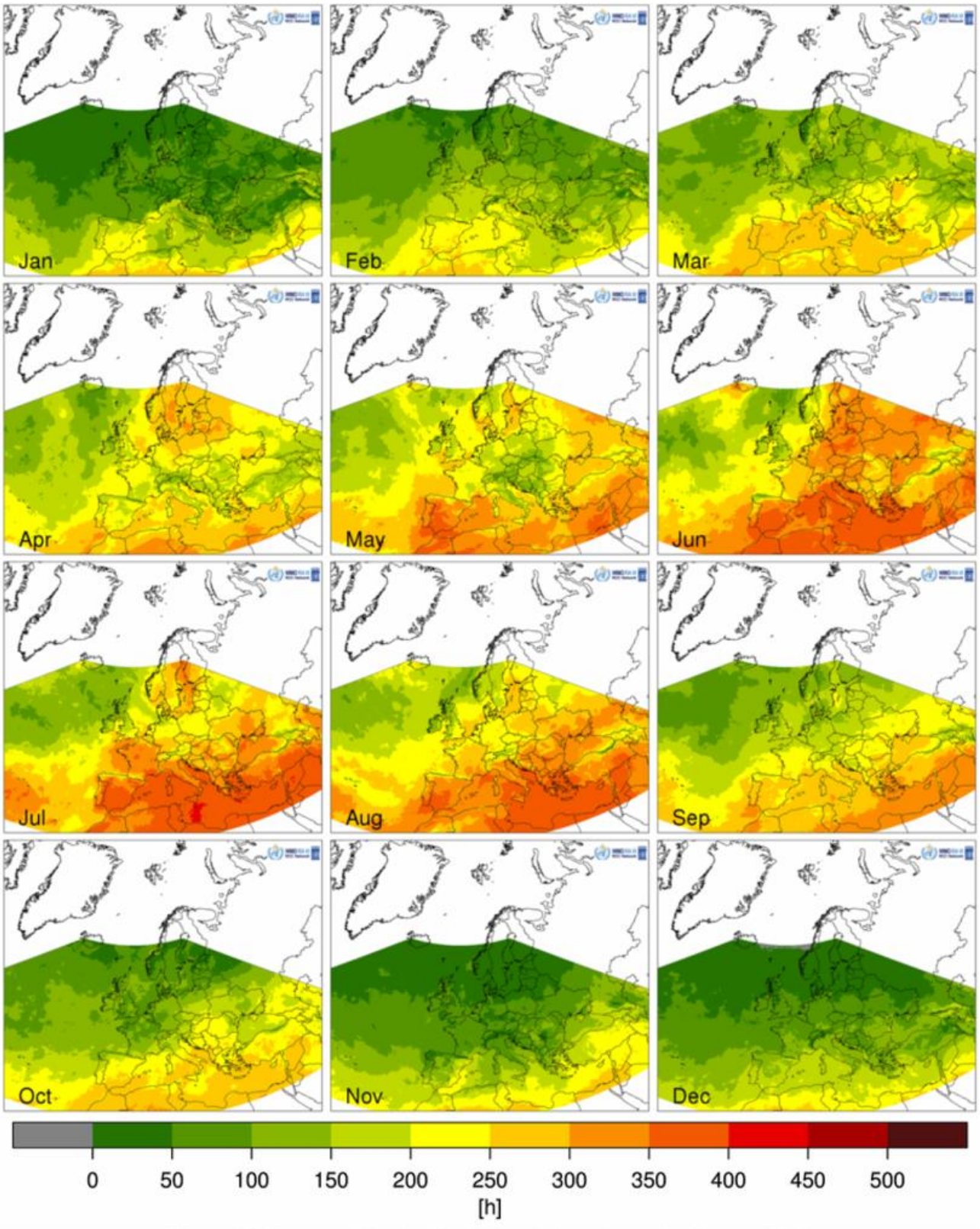

Figure 4-7: *Mean sunshine duration (in hours) for each month of the year 2019.*

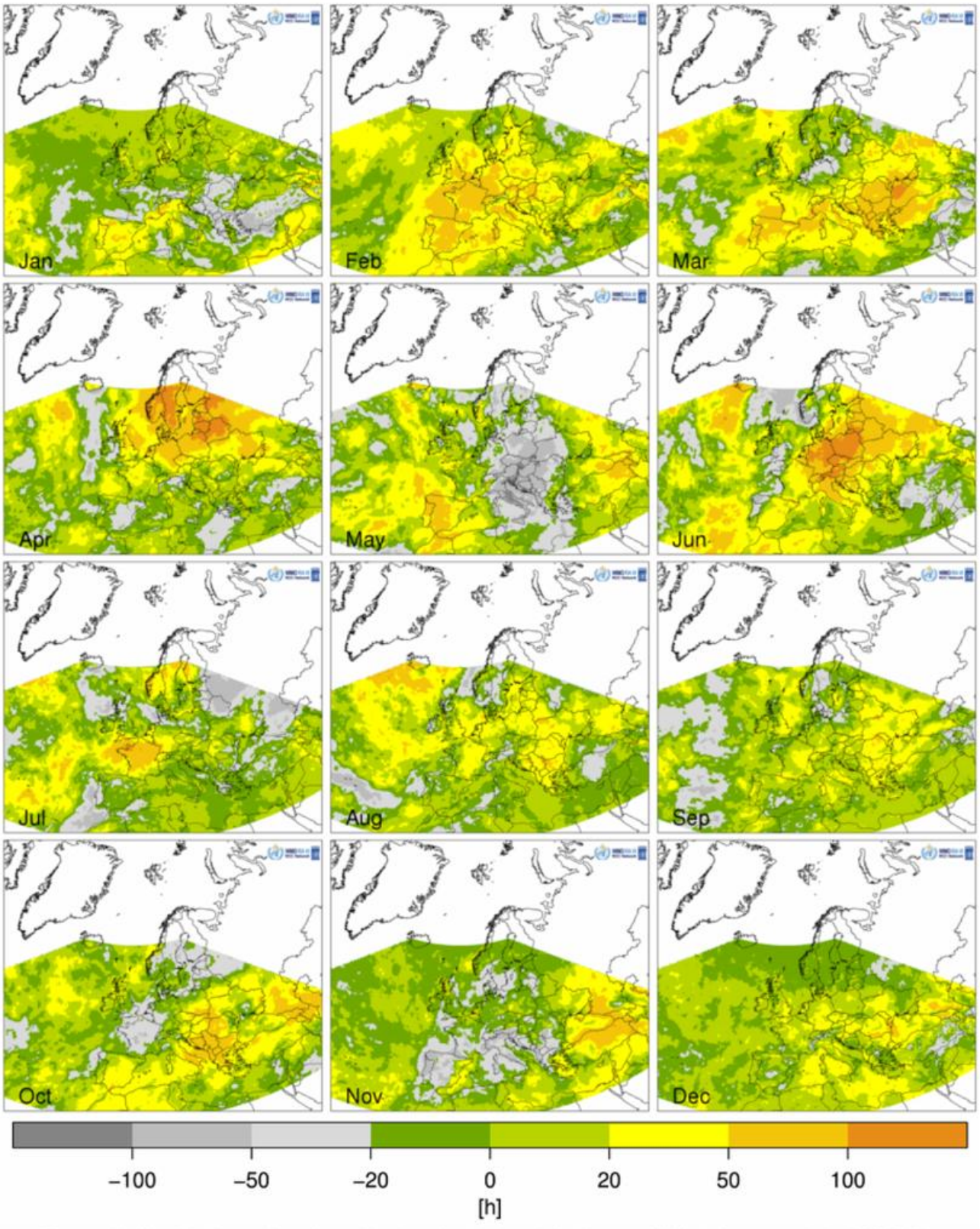

Figure 4-8: *Monthly Anomalies of sunshine duration (in hours) for the year 2019 (reference period 1986-2015).*

4.5 Maps of monthly significant climate anomalies and events

The following maps are based on different data (as noted in the legends in parentheses), and are meant to summarize weather conditions in each month of the year 2019. The Monthly Event Maps contain information about significant anomalies of temperature, precipitation and wind gusts. Dots represent anomalies of climate indices calculated based on station data, for example the number of very warm days and cold days and the locations of strong wind gusts (>=32 m/s). The dot is subdivided into several different colours in case more than one anomaly value needs to be depicted. Coloured areas are based on interpolated gridded data for temperature (land and ocean) and precipitation (only land areas). If more than one extreme anomaly occurs at the same grid, the area is shaded.

January

Monthly mean temperature averaged over Europe was close to the 1981-2010 normal in January, but temperature variability was high during the month. Especially in parts of Northern and Eastern Europe, periods of freezing weather alternated with thaws. In Scandinavia and much of European Russia, mild temperatures characterized the first half of the month, in Iceland even exceptionally high, but the second part of the month was much colder and especially the last few days. Sweden reported 9 days in a row with daily minimum temperatures below -30 °C. On the other hand, Denmark only had 3 ice days (Tx<0 °C) on average (normal is 8.6 days in 1961-1990), the Netherland 2 ice days (normal: 3), Ljubljana in Slovenia 1 ice day, most of Serbia 1-7 ice days.

Eastern parts of RA VI were mostly much wetter than normal in January, particularly around the Black Sea and near the eastern Mediterranean, locally above 250 % of the normal, e.g. in Romania, Moldova, Bulgaria, near the Aegean Sea, in southern Turkey and Cyprus. In Turkey, it was the highest January total in the last 15 years in the Aegean region and the last 37 years at the Mediterranean coast. Especially Greece and Cyprus recorded several heavy rain events with flooding and landslides. Malta, too, was wet, recording the wettest January since 2011, much contributed by 6 thunderstorms (more than 3 are rare in January), partly with hail. In Serbia, the stations Valjevo, Kragujevac and Pozega observed record-breaking numbers of days with precipitation (23-25 days, series since 1925, which means that the above-normal monthly totals came from high frequency of precipitation. In eastern Central Europe (e.g. Czech Republic, Slovakia), most of the precipitation fell in the first half of the month, also in the Middle East (e.g. Israel).

Between 7 and 14 January, the Alps and other mountainous regions in Central Europe experienced extreme snowfall under the influence of north-westerly or northerly flow. Up to 100 mm of precipitation fell in 72 hours in the Ore Mountains (Germany) and northern Alps. On 13 January, Central Europe was within the warm air sector of Low FLORENZ, which made the snow line temporarily rise to 1200 m. Rainfall of up to 109 mm/24h increased the weight of the snow cover dramatically and thus the danger of collapsing buildings or trees. New monthly records of 24h precipitation were registered in Saxony (eastern Germany) on 9 January and new records of snow depth in southern Germany on 11 January. Switzerland recorded up to 160 cm of fresh snow on the northern slopes and wind gusts of up to 180 km/h.

Wintry storms ravaged parts of the north. In Sweden, winds of 111 mph (179 km/h) were recorded as Storm Jan (named "Donald" in Central Europe) ravaged Stekenjokk near the Norwegian border on 11 January. The storm made roads impassable in Sweden and Norway. In Finland, a record 10min average wind speed of 32.5 m/s was measured in the Gulf of Bothnia, and wave heights were close to previous records. The storm was estimated to have caused damage of 10-20 million Euros in forests and due to power outages.

February

At the beginning of February, three storm lows moved over Central Europe and Germany. Low STEFAN launched the storm series on 06/07 February 2019 and brought gusts up to 117 km/h, especially in the UK. THOMAS (named "Erik" in UK and Ireland) followed on 08/09 February, causing storms in Ireland, the UK (with the strongest gust of 138 km/h recorded at Capel Curig in North Wales) and northern Germany. Large waves were observed at exposed coasts and falling trees, causing at least two fatalities when trees fell on cars. Bridges and roads were partially closed. Some flights, ferry and rail services were also affected by the strong winds. In the Republic of Ireland, 2500 people were left without power.

After a cold start of February 2019, the second half of the month became very mild. During a warm spell lasting from 21-27 February, exceptionally mild weather brought record high temperatures with many areas in Central Europe exceeding 20.0 °C. Many local monthly and winter records of maximum temperature were reached or broken even at stations with time series spanning more than 100 years. For Austria, Slovenia, Hungary even countrywide records for February were reported. At Kew Gardens in London, 21.2 °C was reached on the 26th. This was the first time that a temperature above 20 °C had been recorded in winter in the UK. Achnagart (Highland) set a new highest daily minimum temperature record for the UK with temperatures not dropping below 13.9 °C on 23rd. In France, more than half of the 150 measurement stations broke maximum temperature records for February, for example Istres with 23.4 °C on 28 February (previous record 23.3 °C on 27 February 1960) and Cazaux with 26.2 °C on 27 February (previous record 26.0 °C on 23 February 1929). A new record was also set at the station De Bilt in the Netherlands 20.5 °C on the 27th, also breaking the monthly and winter record for all stations. In Belgium, the 26 February was an extremely early first spring day (here defined as daily maximum temperature above 20 °C) in Uccle, making it the first winter with a spring day in history.

March

At the beginning of March, several storm lows swept across Europe in succession. Especially the United Kingdom, Ireland, northern and eastern France, the Benelux countries, Germany and Czech Republic were affected. One of the storms even spread far to the south down to Spain. The storm episode with strong winds, mild temperatures and heavy rain lasted two weeks until 17 March. Storm gusts reached above 200 km/h in exposed places. While the northern half of the RA VI Region was therefore much wetter than normal, much of the southern half was drier than normal and some regions even experienced severe drought conditions.

April

Due to the inflow of moist and warm air from the south, heavy thunderstorms developed along a cold front over Romania. On 30 April a large tornado about 110 km east of Bucharest damaged homes, agricultural fields and vehicles. At least 7 people were injured, most of them after the twister turned over a bus with 39 people inside. Ten houses were left without their roofs. Sahara dust affected Albania in the last few days of April and also Malta during 6 days.

May

In May, much of Europe was wetter than normal, from Scandinavia over Eastern / eastern Central Europe to the Balkans and Italy, locally with more than 250% of the normal (in Norway up to 300-400% of normal), Sweden and Finland even had record-wet places with monthly totals above 100mm. In Italy, the Emilia Romagna region experienced an exceptional wet month. Due to heavy precipitation, severe thunderstorms, hail and snowfalls, total monthly precipitation (average over Emilia Romagna) reached 228 mm, which is 40 % higher than the previous record (164 mm in 1984) and three times the 1961-1990 climatological average of 73 mm. Consequently, flooding and landslides were observed and around one hundred people displaced. In Georgia, heavy rain and hail affected the Kakheti Region, mainly Lagodekhi, Akhmeta, Telavi and Dedoplistskaro municipalities on 4-5 May 2019. The heavy rain of up to 150 mm/24h in Lagodekhi flooded entrances, basements and first floors of many buildings. Furthermore, infrastructure, such as roads and bridges connecting the villages, riverbank protections, as well as agricultural lands, vineyards and fruit trees were destroyed. Supplies of drinking water and electricity were interrupted for a short period. In total 5,088 people were affected by this disaster.

Large parts of the RA VI Region saw more warm days than normal. Especially over the eastern parts and in the southwest monthly temperatures were warmer than normal due to episodes of anomalously hot weather. Across southern and western parts of the Iberian Peninsula, for example, a heat wave occurred mid of May. Alcácer do Sal, Barrosinha (southern Portugal) reached 38.1 °C on 13 May. Daily maxima at many stations in Portugal, western and southern Spain exceeded 30°C. These are extremely high temperatures for this period, being 12-15 °C hotter than average in places. In Israel, a prolonged heat spell occurred from 12 May until the end of the month, most noticeably in the interior parts of the country, during which there were several Sharav events. The most significant one was on 22 to 24 May with temperatures of 43-45 °C in the Coastal Plain, the Negev and the Northern Valleys and 45-47 °C at the Dead Sea and the Arava. Two stations in the area were even warmer – En Gedi (Dead Sea) with 48.0 °C and Hazeva with 47.9 °C. At many stations the maximum temperatures measured during this heat wave are ranked as the 2nd-4th warmest on record since measurements began. In some cases they are the warmest since 1970 or even before. Fires broke out in many areas across Israel on 23 May and continued until the following day. Fortunately there were no casualties, yet dozens of homes were destroyed and thousands of dunams of forests, bush land and open space were burnt. From May 5 to 14, anomalously hot weather was also observed in the eastern regions of European Russia. On average, during this period, the temperature exceeded the climatic norm (1981-2010) by 8-10°C. Many temperature records were broken, both daily highs and absolute for the entire first half of May. The average temperature for the first half of May was 6–7°C above normal (which also corresponds to the highest values in the history of observations).

June

Heatwave conditions affected western, central and northeastern Europe, and particularly in the last week of June with some new national and numerous local records of maximum temperature broken. The heatwave has resulted in at least eight deaths so far. The reason for the heatwave was the shift and spread of the Azores high over Europe and strong warm air advection, which transported the hot air masses of Africa over the Mediterranean to Europe. In the Ukraine the heat wave lasted from 6 June to 10 July and brought record high temperatures making it the hottest June since 1961. The average monthly temperature for June was +4.5 °C to +5.5 °C above normal and the maximum air temperatures exceeded 30 °C in most parts of the country on 30-35 days. For 1-6 days, even 35 °C was exceeded. In Italy, the heat wave lasted from 8 June to 9 July (32 days) and maximum temperatures exceeded 30 °C across wide areas and even 40 °C in some places. At some locations, new records were set for the highest June minimum temperature (e.g. 27.5 °C on 27 June in Milan). In Florence, the maximum temperature exceeded the 90th percentile on 12 consecutive days, the second longest heat wave since 1955. A three-day heat wave in Lithuania starting on 11 June brought an absolute maximum temperature record of 35.7 °C in the city of Kaisiadorys. In Germany, June 2019 was the warmest June since the beginning of observations. The hot air masses from the Sahara and the high solar radiation led to many new June temperature records at DWD stations, highest on 30 June with 39.6 °C. For Germany, June was also the start of an exceptional three-month drought/dry spell affected Western, Central and Eastern Germany. Soil moisture in large areas was below long-term minimum values causing economic losses due to crop failure. On several major rivers low water levels hindered river navigation. It was the second major drought period after that in the year 2018, which was even longer than in 2019. The month of June was also very dry in Estonia. Countrywide only 30 % or less of the monthly normal precipitation was received. The monthly total for Kihnu on Kihnu Island, southwest of Estonia, was only 0.3 mm, which is 1 % of the month's normal and a record low in a series starting in 1932.

Unusually strong storms for this time of year battered parts of Spain, France, United Kingdom, Benelux, Germany, Switzerland, Poland, Hungary during almost the whole month of June. Exceptionally intense hailstorms with hailstones larger than 6.5 cm hit southern Germany on 10-11 June. At least six people were injured; cars, trees and houses were damaged in Munich and Bavaria more widely. Accompanying heavy precipitation led to flooding of homes. In Berlin and surrounding areas, thunderstorms brought daily totals of 60 mm to 70 mm on 11 and 12 June. Roads needed to be closed. Similarly, the northern areas of Poland (including Sopot, Gdynia and Gdańsk) reported heavy winds and precipitation causing flooding, uprooted trees and power outages for thousands of households on 10 June. Record large hailstones of 12 cm were reported in Gorzów Wielkopolski-Ustronie and Wojcieszyce (western Poland). Thunderstorms caused wind damage and flash floods in Hungary starting on 16 June. On that day, a daily total of 144.4 mm of precipitation was measured in Rakamaz, nearly twice the normal monthly mean for June (73.5 mm). On 20 June, a new daily record of 117.8 mm of rain fell in 24 hours, beating the previous record high for this date of 101.3 mm set in Szőlősardó in 1956. On 23 June, the daily total of precipitation was 154.9 mm at Terpes, the highest total in this place / in Hungary? recorded in 2019. Southeastern Europe and Turkey, too, were hit by heavy rain and severe flooding the same time.

July

Short but intense heatwave which set many new temperature records across Western, Central and Northern Europe. Hot air moving from the Sahara region caused temperatures to rise. Like other heat waves, it was caused by a so called Omega weather type with high pressure over Europe and low pressure each over the North Atlantic and west Russia (looking like the Greek letter Omega). In the westerly parts of Germany (Rhine-Main via Lower Rhine to Emsland) maximum temperatures exceeding 40 °C on three consecutive days (24 – 26 July 2019) occurred for the first time since the beginning of meteorological recordings. On 25/07/2019, 25 stations reported maximum temperatures of 40 °C or more. The previous record temperature for Germany (40.3 °C) was exceeded at 14 stations. Four stations recorded temperatures above 41 °C. For Germany, summer 2019 was the third warmest summer season since 1881. In Israel, a daily maximum temperature of 49.9 °C was measured in Sedom (southern Dead Sea region) during an extreme Sharav event on 17 July. This was the highest temperature on record in Israel for more than 70 years (the highest temperature ever measured in Israel was 54 °C in Tirat Tzvi on 21 June 1942).

Severe storms affected southern parts of the RA VI Region (Spain, Italy, Romania, Balkans, Greece, and Turkey) during 5-10 July with strong winds and heavy precipitation events causing floods and landslides over large parts. Northern Greece was hit by very strong winds, tornadoes and violent hailstorms on 10 July 2019. Such severe weather is extremely unusual in Greece for this time of year, which is normally mostly calm and dry. Trees were uprooted and roofs collapsed after a storm with wind gusts up to 100 km/h (62 mph) hit the area, claiming lives of 7 people and injuring more than 100. According to the network of automatic meteorological stations of the National Observatory of Athens / Meteo.gr, the highest wind gusts were recorded in the areas: Klidi Viotia 101 km/h (62.7 mph) and Stratoni Chalkidiki 100 km/h (62 mph). Floods and landslides occurred in north-western Turkey in many districts in Düzce Province on 17-18 July 2019 after heavy rainfall: 84.7 mm of rain fell in Akçakoca district on 17 July, 75 mm in Cumayeri district, 72 mm in Çilimli district and 161.7 mm on Kardüz Plateau.

August

August was exceptionally wet due to heavy rain events (partly associated with storms) especially in UK, Ireland, Italy, Turkey and Spain causing floods and landslides in many places. Flash floods hit Rize Province in the Black Sea Region of Turkey on 04 August 2019 after 120mm of rain had fallen in 4 hours, flooding areas around the city of Rize, inundating roads and buildings. A major tornado occurred on 9 August across northeastern France and south-western Luxembourg. It brought wind speeds between 178 km/h and 217 km/h and caused considerable damage. Almost 500 buildings were damaged in communities of Pétange and Käerjeng, Luxembourg and 30 in the province of Meurthe-et-Moselle, France. Trees were knocked down, roads blocked, cars damaged and 19 people in Luxembourg were reported injured. On 5 August, heavy rain accompanied by a sea storm occurred in Adjara-Guria (south-western part of Georgia) causing infrastructure damage.

September

Record heavy rainfall was observed in southeastern Spain in the first half of September. Due to an almost stationary cut-off low, torrential rainfall and strong winds were observed over the period 10-15 September. The most affected areas included Valencia, Alicante, Murcia, Albacete, Almería and Malaga provinces. Some areas of Valencia region, especially the Vega Baja del Segura plain, got

over 400 mm of rain over 48 hours. The highest total was 521 mm, measured in Orihuela (Alicante province). Six stations reported new records of 24-hour precipitation. At Ontinyent, 296.4 mm of rain was recorded in 24 hours, which equates to about half the yearly average. This is the second highest daily rainfall total on record, behind the 316.0 mm which fell on 04 November 1987. On average for the affected area, the equivalent of a year's rain accumulated on just one day (from the morning of the 12th to the morning of the 13th). The storm was exceptional due to the lack of similar precedents in at least the last 100 years in the Vega Baja del Segura, the area most affected by the rainy season. Consequently, rivers broke their banks in several locations, flash floods damaged several roads and cars were swept away. Flights, railway and ship traffic was disturbed and at least six people died, around 3500 were displaced, including 2000 residents of the town of Santomera.

Northwestern and southeastern parts Europe were hit by several cyclonic systems from mid to end of the month. Upland areas in the western UK recorded more than 200 mm of rain from 21 to 30 September. Western Norway was hit by a series of intense storms mid of September, with trees uprooted, downed power lines, floods, landslides and the closing of several roads. In Bergen, 75 mm of rain was recorded in 24 hours. Albania also experienced severe thunderstorms and heavy rain in September which caused flash flooding in some areas.

October

Very intense precipitation over the northwestern part of the European Russia with up to 30 to 50 mm per day and often in the form of snow already. Normal precipitation amounts were exceeded by two or more times in many regions.

On 3 and 4 October, a low-pressure system passed over Ireland and the United Kingdom as the post-tropical cyclone Ex-Lorenzo, bringing disruptive winds and heavy rain. Lorenzo was still a powerful and very large cyclone. Hurricane-force winds extended outward up to 240 km from the center and tropical-storm-force up to 630 km. On the following days, it moved over Central Europe with rapid weakening, bringing some more rain, but less severe. Finally, LORENZO disappeared after becoming a shallow Low west of the Black Sea on 6 October. Some areas of northwest Ireland saw between 50mm and 100mm of rain.

In mid and late October, deep troughs and a cut off Low over Spain and later the Mediterranean caused heavy rain and thunderstorms. Spain, France and Italy were particularly affected by the torrential rainfall and even several tornadoes. Since warm air was advected from the subtropics and the temperatures of the Mediterranean Sea were still very high, about 23°C at this time, the air masses could absorb a lot of humidity. Due to a ridge over Central and Eastern Europe, the Low and its fronts were almost stationary, resulting in extreme rainfall totals over this area, especially near mountains such as the Pyrenees and the Massif Central.

Starting on 13 October, more than 100 forest fires broke out across central-western (south of Beirut) and northern Lebanon. Over 1,200 hectares of land were burned. At least 72 people were injured. In the districts of Chouf and Nakkar, people were displaced after fires extended to populated areas. Twenty landmines exploded because of the fires. On 15 October, Lebanon requested assistance through the EU Civil Protection Mechanism for aerial forest firefighting capacities.

Northern parts of Northern Europe saw a sudden and outstanding cooling at the end of the month with much snow and low temperatures for that time of year. In Sweden, the temperature dropped

below -20 °C for the first time in 2019. At its lowest, it was -21.1 ° in the well-known cold hole Nikkaluokta in northern Lapland.

November

Above-normal temperatures occurred over most of the RA VI Region in November, especially over the southeastern part. In Israel, for example, November was warm - daytime temperatures in November were 2-3 °C warmer than normal. Night-time temperatures were 1-2 °C warmer than normal. November was one of the warmest in terms of maximum temperatures. The highest temperatures occurred mainly during the first half of the month with temperatures 4-5 °C above normal. In the Coastal Plain, the Northern Negev, and the Northern Valleys maximum temperatures were as high as 28-30 °C, and in the Jordan Valley and the Arava – 30-35 °C. Such a sequence of warm days in November is unusual. In the past 70 years there were similar sequences only in 1962 and 2010. Records of the few stations that operated even further in the past reveal that in 1933 there was a similar warm sequence in the Coastal Plain and the Negev, and in Jerusalem, where measurements date back to the mid-19th century, there were such events in 1878 and 1922.

Several major storms passed over the Mediterranean region during almost the whole month of November 2019, bringing heavy precipitation and devastating impact due to landslides, heavy snow and flooding in various countries, especially at steep coasts and near mountain chains. Already at the beginning of the month on 3 November, a storm affected parts of France, Italy and Spain. In France, gusts up to 163 km/h (Cap Ferret, Gironde) brought down trees and power lines. That gust was only slightly lower than the highest ever measured November gust near the French Atlantic coast (169 km/h in November 1996). Several stations in western France had new local November records of wind gusts since start of data in 1981, including Bordeaux with 120 km/h. Coastal waves up to 15m had been observed. In Italy, local rainfall of 57mm in one hour was recorded (Sestri Levante, Liguria) and waves of over 4 metres were reported along the Ligurian coast. Several families were evacuated, also further south in the Campania Region. Northern parts of Spain also were affected by gusts up to above 150 km/h; Santander airport, too, had a new November record at 130 km/h. Heavy precipitation occurred in Galicia and the Pyrenees.

The Medicane Trudy developed from a cut off low and brought heavy rains to Italy and the Balkan coasts mid of November. In Italy, 90mm came on November 12-13, at the Balkan coasts up to 78mm with heavy thunderstorms. Storm gusts up to 130 km/h occurred in the south of Italy and over the Adriatic Sea. This resulted in a high storm surge and high tide peaks, which led to heavy flooding especially on the Adriatic coasts of Italy and Croatia. Due to high water temperatures of around 23°C, Trudy was able to take up enormous amounts of water vapour and finally developed into a Medicane with a very pronounced eye. The pressure dropped to 990 hPa.

November brought exceptionally wintry conditions to Scandinavia. An exceptional snow depth in Tromsö (northern Norway) had been measured on 6 November. Even the downtown area registered a depth around 70cm. The last time when so much snow was seen in Tromsö so early in the autumn was in 1922. It occurred within a period of the season's first major snowfall, and sub-freezing temperatures affected the whole country including the south and caused many accidents due to slippery roads. The snowfall came along with remarkably low temperatures. In Bardufoss, located 70km south of Tromsö, a daily minimum of -29.8°C was registered on 11 November. The lowest reading at Synop stations in Norway that day, however, was in Kautokeino, also located in the north,

with -34.4°C. A daily minimum temperature of -34.6°C was measured in Nikkaluokta in northern Sweden the same day. There were only three days in the last 75 years before with similar or lower temperatures in Sweden in early November: 4 November 1952 (-39°C in Nikkaluokta), 3 November 1968 (-35.0°C in Vittangi), and 8 November 1971 (-34.1°C in Vittangi).

December

Several storms hit Western, Central and Southern Europe bringing strong winds and heavy rain causing flash floods. A first storm (named Olaf in Central Europe) occurred over Iberia in early December with flooding in France and Spain. In Cannes, southern France, 109mm of rain fell in 3 hours and 187mm in 24 hours which was the second highest daily total on record behind 3 October 2015. In Spaini, the station San Javier recorded more than 120mm of rain in 24 hours on 2-3 December. Waves up to 4 metres and more than 300mm rainfall in 48 hours (2-4 December) were observed in Valencia region. In Mallorca, 123mm of rain fell in 12 hours in Santa Maria del Cami (northwest Mallorca) and gusts of 90 km/h were recorded in Puig de Alfabia (Mallorca highlands, 1067m elevation). Storm Atiyah brought gusts of hurricane force, rough sea and heavy rain across Ireland and the UK on 8 and 9 December and also touched northern France with gusts reaching up to 130 km/h in Brittany (Pointe du Raz, Finistère). End of December a winter storm hit Portugal and Spain with gusts up to 150-180 km/h and heavy precipitation events.

Northern and Eastern Europe were hit by several winter storms as well with gusty winds and record warm temperatures. Parts of Iceland saw heavy snowfall and hurricane-force gales up to nearly 190 km/h on 10-11 December, resulting in snow depths up to 9m near buildings. The Baltic States, too, were affected by this storm. On 18 December, severe storm gusts up to 98 km/h were recorded at the coast of Latvia (Ventspils). Trees fell down, power outages had been reported. The water level of the southern gulf of Riga increased to a dangerous level, warning was issued for the lowlands. The storm also brought warm air, and a new country record for December maximum temperature was reached in Riga at 10.7°C the same day. Temperature in Moscow rose to 6.2°C on 22 December, a new local record in a series of about 140 years. There was no snow that time; trucks with artificial snow were sent. On normal average, Moscow has a snow cover of 16cm at the beginning of the third decade of December.

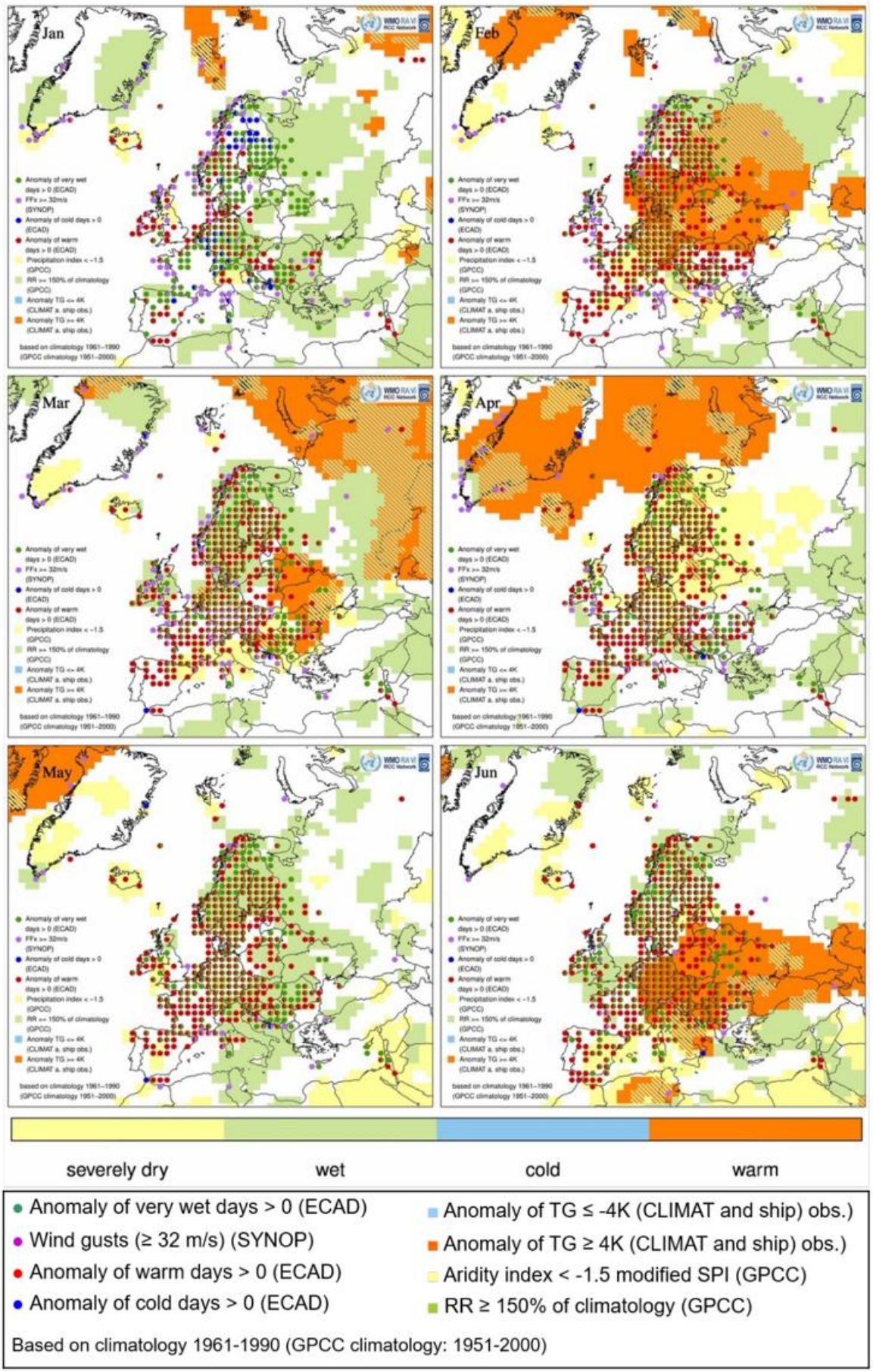

Figure 4-9: Monthly maps of Climate Anomalies for the first half of the year 2019 (January to June).

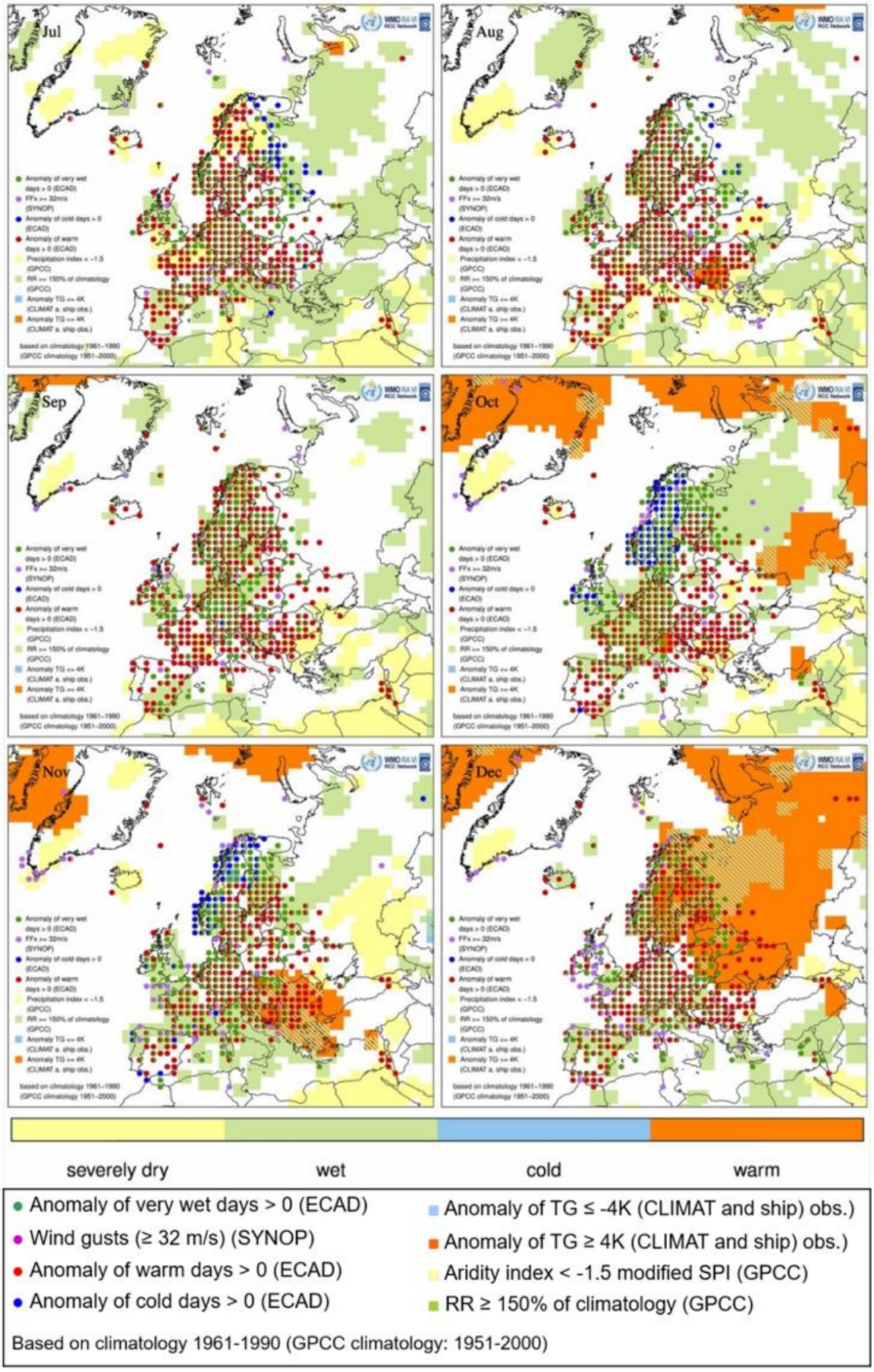

Figure 4-10: Monthly maps of Climate Anomalies for the first half of the year 2019 (July to December).

5. Annex: Monthly and annual tables

Table 5-1: Statistical values of annual mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI Region.

station name	country	Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.
Jan Mayen	NOR	0.8	2.2	622	-65
Svalbard	NOR	-3.4	3.0	171	-12
Tromsoe	NOR	2.8	0.0	1178	205
Oslo	NOR	7.3	1.6	1042	273
Haparanda	SWE	2.3	1.1	685	133
Stockholm	SWE	8.5	1.9	560	21
Visby	SWE	8.7	1.7	652	133
Sodankylä	FIN	0	1.1	527	27
Helsinki Airp.	FIN	6.8	2.3	825	174
Aberdeen	GBR	9.1	1.2	860	77
London	GBR	12.2	1.7	654	55
Dublin/Casement	IRL	9.8	0.6	866	155
Reykjavik	ISL	5.8	1.4	867	69
Danmarkshavn	GRL	-10.8	1.5	198	66
Copenhagen	DNK	10.5	1.9	792	156
De Bilt	NLD	11.2	1.8	934	129
Brussels	BEL	11.5	1.6	816	-2
Luxembourg	LUX	10.7	2.3	781	-94
Zürich	CHE	10.5	2.1	1042	-44
Geneva	CHE	11.8	2.1	841	-113
Bordeaux	FRA	14.5	1.7	999	76
Marseille	FRA	16.2	1.4	647	102
La Coruna	ESP	15.1	1.0	1043	48
Madrid Retiro	ESP	16	1.7	393	-64
Valencia	ESP	18.1	1.2	394	-86
Gibraltar	GIB	18.9	0.7	308	-467
Santa Maria/Azoren	PRT	18.5	0.9	748	-27
Lisbon	PRT	17.4	0.6	512	-241
Berlin-Tempelhof	DEU	11.8	2.4	492	-92
Vienna	AUT	12.4	2.7	685	78
Prague	CZE	10.1	2.2	409	-117
Sliac	SVK	10.1	2.1	741	55
Elbing	POL	8.9	1.3	821	131
Warsaw	POL	10.9	3.1	391	-128
Budapest	HUN	12.9	2.5	687	169
Belgrade	SRB	14.6	2.7	717	33
Ljubljana	SVN	12.5	2.7	1379	-15
Split	HRV	17.6	1.7	888	63
Sarajevo	BIH	11.7	2.1	851	-81
Bukarest	ROU	12.3	1.8	649	54
Sofia	BGR	11.8	2.1	449	-114
Pisa	ITA	15.2	1.2	1063	155
Luqa	MLT	19.7	1.1	545	-9
Athens	GRC	19.6	1.2	588	217
Heraklion	GRC	19.6	0.9	637	136
Murmansk	RUS	0.5	0.6	632	154
Tallinn	EST	7.5	2.4	743	76
Kaunas	LTU	9	2.7	493	-138
Vilnius	LTU	8.8	2.8	537	-147
Minsk	BLR	8.4	2.5	655	-22
Moskow	RUS	7.8	2.9	554	-134
Kiev	UKR	10.6	2.9	521	-128
Kischinau	MDA	12.2	2.6	405	-142
Charkiw	UKR	10.3	2.8	428	-91
Astrachan	RUS	11.9	1.9	168	-53
Jerewan	ARM	13.8	2.3	257	-20
Samsun	TUR	16.1	1.8	677	-14
Istanbul	TUR	16.8	2.7	490	-207
Ankara	TUR	13.7	2.0	417	10
Van	TUR	11	2.3	288	-90
Antalya	TUR	19.9	1.5	1057	-9
Larnaka	CYP	20.9	1.9	636	307
Oral	KAZ	7	1.5	252	-72
Tiflis	GEO	14.7	1.7	384	-114
Tripoli	LBN	20.4	1.1	1110	230
Tel Aviv	ISR	21.4	1.9	441	-126
Eilat	ISR	26.3	1.8	12	-19
Mafraq	JOR	17.9	1.4	171	11
Sta. Cruz de Tenerife	ESP	21.9	0.8	144	-91
Princess Juliana Airp.	SMA	27.6	0.8	918	-89
Le Lamentin	MTQ	26.9	0.6	1692	-340

Table 5.2: Statistical values of monthly mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI Region.

station name	country	January				February				March			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	-3.4	2.3	54	-7	-2.7	3.4	66	13	-4.9	1.2	50	-5
Svalbard	NOR	-10.3	5.1	6	-8	-11.1	4.6	9	-10	-12.6	2.1	5	-16
Tromsoe	NOR	-4.4	-0.4	156	75	-3.3	0.4	148	62	-2.9	-0.7	160	96
Oslo	NOR	-2.8	1.5	38	-11	0.5	4.5	79	43	2.3	2.5	73	27
Haparanda	SWE	-13.2	-1.1	29	-15	-8.5	2.8	39	7	-4	2.8	72	37
Stockholm	SWE	-1.7	1.1	31	-8	1.3	4.3	38	11	2.7	2.6	45	19
Visby	SWE	-0.2	0.6	23	-26	2.3	3.9	28	-2	2.9	2.5	59	25
Sodankylä	FIN	-16.8	-1.7	28	-3	-11.7	1.9	37	12	-7.2	1.3	67	42
Helsinki Airp.	FIN	-6.2	0.7	60	19	-0.5	6.3	61	30	-0.3	2.6	65	31
Aberdeen	GBR	3.4	0.7	47	-34	6	3.1	22	-29	6.9	2.4	63	5
London	GBR	4.9	0.7	33	-19	8	3.5	34	-1	9.6	3.1	50	3
Dublin/Casement	IRL	5.2	0.3	33	-36	7.2	2.6	22	-29	7.1	1.1	86	32
Reykjavik	ISL	0.5	1.0	103	27	1	0.6	73	1	1.2	0.7	92	10
Danmarkshavn	GRL	-23.6	-0.5	51	40	-26.4	-2.1	17	6	-26.1	-2.7	18	1
Copenhagen	DNK	2.2	1.7	58	7	4.9	4.4	42	11	6	3.4	109	67
De Bilt	NLD	3.5	1.3	64	-2	6.1	3.6	68	19	8	3.0	104	41
Brussels	BEL	3	0.4	72	5	7	3.5	73	20	8.5	3.0	82	10
Luxembourg	LUX	0.6	0.6	51	-20	5.3	4.2	43	-19	7.1	3.1	83	13
Zürich	CHE	0.1	0.6	62	-5	3.9	3.0	37	-33	7.2	3.0	68	-1
Geneva	CHE	1.8	1.0	43	-37	3.9	1.6	40	-41	8.2	3.1	57	-22
Bordeaux	FRA	6	0.2	73	-27	9.5	2.4	29	-57	11.3	2.5	31	-45
Marseille	FRA	5.9	-0.8	4	-43	8.7	0.8	11	-43	12	1.8	<1	-44
La Coruna	ESP	10.2	0.0	109	-22	12.8	2.3	48	-56	12.8	1.5	47	-39
Madrid Retiro	ESP	6.5	0.4	19	-27	9.3	1.8	1	-43	12.4	2.4	10	-23
Valencia	ESP	10.2	0.0	<1	-36	11.4	0.2	0	-34	13.8	1.0	39	2
Gibraltar	GIB	14	0.6	36	-85	14.4	0.6	6	-94	16.2	1.2	9	-66
Santa Maria/Azoren	PRT	15.5	1.1	91	-9	15.2	1.2	114	28	15.1	0.5	26	-53
Lisbon	PRT	11.4	0.0	53	-57	13.2	0.9	16	-95	15.5	1.8	49	-20
Berlin-Tempelhof	DEU	1.7	1.9	48	5	5.2	4.4	20	-14	7.4	3.2	63	26
Vienna	AUT	0.8	1.8	73	35	5	4.0	16	-26	8.7	3.7	54	13
Prague	CZE	-0.6	1.8	13	-10	2.5	3.3	12	-11	6.5	3.5	27	-1
Sliac	SVK	-3.5	0.4	54	10	1	2.1	34	-10	6	3.0	47	5
Elbing	POL	-2.1	0.3	76	29	1.7	3.9	41	16	4.1	2.0	55	20
Warsaw	POL	-1.7	1.6	34	12	3.2	5.2	31	10	6.1	4.1	28	0
Budapest	HUN	0	1.6	26	-6	4.5	3.4	7	-25	9.4	3.8	7	-22
Belgrade	SRB	0.8	0.4	82	33	5.4	2.7	34	-10	11.3	4.1	12	-38
Ljubljana	SVN	0.7	1.8	66	-16	4.9	3.5	98	18	9	3.6	48	-50
Split	HRV	6.3	-1.1	123	40	9.9	1.8	10	-58	12.9	2.5	30	-45
Sarajevo	BIH	-1.5	-0.6	80	9	2.7	1.2	57	-10	7.8	2.7	52	-18
Bukarest	ROU	-1.4	1.0	61	21	2.7	2.8	8	-28	8.5	3.7	33	-5
Sofia	BGR	-1	0.6	33	6	2.4	1.9	20	-13	8.3	3.7	8	-30
Pisa	ITA	5.2	-0.9	30	-45	8.4	1.3	39	-32	10.7	1.2	5	-71
Luqa	MLT	11.6	-0.6	99	10	12	-0.4	93	32	14.5	1.1	35	-6
Athens	GRC	9.7	-0.5	121	76	10.3	-0.2	67	19	13.9	1.5	14	-30
Heraklion	GRC	11.5	-0.5	163	71	12.1	-0.1	201	124	14.1	0.5	36	-21
Murmansk	RUS	-12.2	-0.5	59	26	-9.5	1.7	53	31	-5.1	1.7	49	29
Tallinn	EST	-4.1	1.4	83	38	0.3	6.0	50	21	1	3.2	60	31
Kaunas	LTU	-4.4	0.8	59	20	1.4	5.7	32	1	3.5	3.9	41	6
Vilnius	LTU	-4.4	1.7	61	20	0.6	5.4	31	-7	3.1	3.7	49	10
Minsk	BLR	-5.1	1.8	47	7	-0.1	5.7	16	-18	3	4.4	40	-2
Moskow	RUS	-6.6	2.7	67	22	-1.4	6.3	34	-3	0.7	2.9	41	7
Kiev	UKR	-4.5	1.1	45	-2	0.6	4.8	34	-12	5.1	4.4	32	-7
Kischinau	MDA	-2.6	0.7	84	44	2.3	4.0	29	-9	7.4	4.5	1	-34
Charkiw	UKR	-5.2	1.7	58	14	-1.2	4.5	9	-23	3.7	4.0	16	-11
Astrachan	RUS	-2	3.4	3	-10	-1.2	3.7	8	-2	5.1	3.8	11	-3
Jerewan	ARM	1.5	4.7	9	-12	3.1	4.1	42	18	5.8	0.7	40	8
Samsun	TUR	9.2	2.3	64	3	8.4	1.2	38	-12	8.8	0.8	36	-20
Istanbul	TUR	7.5	1.9	71	-28	7.4	1.5	68	1	10.3	2.8	16	-46
Ankara	TUR	2	2.0	48	7	4.8	3.1	38	2	7.2	1.2	40	4
Van	TUR	-0.8	3.6	41	7	-0.6	3.2	25	-8	2.9	2.0	35	-7
Antalya	TUR	10.6	0.7	426	187	11.6	1.3	109	-87	13.8	1.1	97	-6
Larnaka	CYP	12.6	0.8	96	31	13.4	1.2	151	94	14.6	1.1	40	-9
Oral	KAZ	-12.1	0.8	36	11	-9.8	2.7	23	5	-1	4.0	36	16
Tiflis	GEO	4.2	2.5	3	-16	6.1	3.2	12	-14	8.2	1.3	8	-22
Tripoli	LBN	12.6	-0.1	283	89	13.6	0.4	173	46	14.9	0.2	156	40
Tel Aviv	ISR	12.8	0.5	107	-42	14.4	1.5	106	8	15	0.1	74	12
Eilat	ISR	16.5	1.4	0	-5	18.2	1.4	9	4	20.2	0.4	0	-4
Mafraq	JOR	8.5	1.3	26	-8	9.6	0.9	59	28	10.9	-0.6	11	-18
Sta. Cruz de Tenerife	ESP	18.2	0.3	14	-23	19.1	1.1	20	-14	19.1	0.5	5	-19
Princess Juliana Airp.	SMA	25.4	0.2	62	0	25.7	0.5	25	-19	26.1	0.6	13	-31
Le Lamentin	MTQ	24.8	-0.1	71	-50	25.4	0.6	34	-55	25.8	0.6	41	-47

Table 5.2: continued

station name	country	April				May				June			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	0.5	4.4	12	-28	0.3	1.0	21	-19	3.6	1.6	25	-10
Svalbard	NOR	-3.9	7.8	30	18	-2.3	1.4	3	-3	4.8	2.6	1	-9
Tromsoe	NOR	2.6	1.9	82	22	5.2	0.3	44	-4	8.5	-0.8	94	41
Oslo	NOR	8.7	4.1	11	-31	10.4	-0.4	85	33	15.4	0.2	123	58
Haparanda	SWE	2.3	2.8	1	-28	6.9	0.8	81	50	13	0.2	82	41
Stockholm	SWE	7.4	2.8	3	-27	10.9	0.2	49	19	18.4	2.8	22	-23
Visby	SWE	6.4	2.4	<1	-30	10	0.6	60	31	17.6	3.5	36	4
Sodankylä	FIN	1.7	3.8	6	-18	5.4	0.4	53	18	12.5	0.9	71	15
Helsinki Airp.	FIN	6.7	3.8	6	-31	10.6	0.7	66	31	18	3.1	15	-29
Aberdeen	GBR	8.1	1.8	49	-4	9.4	0.4	78	19	12.9	0.8	79	26
London	GBR	10.7	1.8	13	-32	13.5	1.0	36	-15	16.9	1.2	82	31
Dublin/Casement	IRL	8.4	0.9	69	19	10.9	0.8	27	-30	12.9	-0.2	93	40
Reykjavik	ISL	6.5	3.6	81	23	7.7	1.4	34	-10	10.4	1.4	30	-20
Danmarkshavn	GRL	-13.3	4.0	6	-4	-6.2	0.4	0	-4	3.6	2.9	2	-3
Copenhagen	DNK	9.3	2.7	15	-27	11.4	-0.6	53	10	18.6	2.5	54	0
De Bilt	NLD	10.9	2.9	36	-16	11.7	-0.6	41	-20	18.1	2.9	121	53
Brussels	BEL	11	2.2	38	-19	11.9	-1.0	56	-15	18.5	2.8	101	22
Luxembourg	LUX	9.8	2.3	57	-4	11.5	-0.3	61	-20	19.5	4.6	55	-27
Zürich	CHE	9.3	1.5	56	-31	10.6	-1.5	143	40	19.6	4.4	110	-14
Geneva	CHE	10.3	1.5	63	-2	12.4	-0.6	41	-36	19.9	3.4	112	23
Bordeaux	FRA	12.6	1.3	91	19	14.7	0.1	51	-26	19.7	1.9	85	29
Marseille	FRA	14	0.8	57	9	16.8	-0.3	7	-35	23.5	2.6	9	-19
La Coruna	ESP	13	0.9	112	29	15.5	1.4	42	-36	16.6	0.2	62	13
Madrid Retiro	ESP	12.5	0.3	83	29	18.8	2.8	<1	-41	23.7	3.0	2	-24
Valencia	ESP	15.2	0.5	78	37	18.5	0.6	27	-7	22.5	0.8	0	-23
Gibraltar	GIB	16.8	0.6	61	1	20.2	1.7	0	-35	21.4	0.3	0	-11
Santa Maria/Azoren	PRT	15.5	0.3	68	13	18	1.3	43	13	19.2	0.5	43	21
Lisbon	PRT	15.1	0.0	67	3	20.4	3.0	22	-17	19.4	-0.8	12	-9
Berlin-Tempelhof	DEU	11.2	2.6	8	-33	13.2	-0.7	20	-36	22.8	5.4	66	-9
Vienna	AUT	11.9	2.0	27	-24	13.2	-1.4	149	88	23.8	5.9	49	-25
Prague	CZE	9.8	2.1	24	-14	11	-1.7	72	-5	21.3	5.4	37	-36
Sliac	SVK	11.2	2.7	16	-31	12.4	-1.3	112	48	21.5	4.9	91	6
Elbing	POL	8.4	1.6	11	-31	11	-1.9	58	17	19.6	4.2	96	2
Warsaw	POL	10.6	2.8	3	-29	13.6	0.2	79	20	23	6.4	18	-54
Budapest	HUN	13.6	2.5	15	-23	14.3	-1.7	200	145	23.8	4.7	82	19
Belgrade	SRB	14.1	1.7	77	18	15.4	-1.8	142	71	23.9	3.8	139	49
Ljubljana	SVN	11.6	1.7	89	-21	12.9	-1.7	239	118	23.5	5.7	46	-109
Split	HRV	15.6	1.7	96	30	16.3	-2.1	125	69	26.5	4.3	9	-42
Sarajevo	BIH	11.2	1.8	98	24	12.2	-1.9	102	20	21	4.1	97	6
Bukarest	ROU	10.9	-0.4	78	32	16.6	-0.1	154	84	22.7	2.5	73	-4
Sofia	BGR	10.4	0.5	77	27	14.4	0.1	31	-42	20.1	2.4	90	18
Pisa	ITA	12	-0.5	104	25	14.1	-2.2	114	55	22.1	2.3	5	-39
Luqa	MLT	15.9	0.4	15	-8	18.3	-0.8	19	12	26.3	3.3	0	-3
Athens	GRC	16.1	0.1	61	36	20.4	-0.2	3	-11	27	2.0	32	26
Heraklion	GRC	16.7	0.1	35	5	20.7	0.4	1	-14	25.6	1.3	0	-3
Murmansk	RUS	1.9	3.8	11	-10	4.6	0.8	40	8	8.6	-0.8	83	30
Tallinn	EST	6.5	3.1	8	-28	10.2	0.5	58	21	17.7	3.2	34	-19
Kaunas	LTU	9.1	3.3	<1	-42	13.1	0.7	30	-25	20.5	4.7	49	-20
Vilnius	LTU	9	3.3	<1	-46	13.3	0.8	29	-33	21.1	5.3	28	-49
Minsk	BLR	7.7	1.7	4	-38	13.8	0.9	67	5	20.3	4.2	56	-27
Moskow	RUS	8.1	2.3	9	-31	16.3	3.4	57	-1	19.6	3.0	64	-12
Kiev	UKR	10.6	1.9	48	-1	17	1.9	81	28	23.6	5.4	67	-6
Kischinau	MDA	10.5	0.3	33	-9	17	0.9	35	-16	23.5	4.1	83	8
Charkiw	UKR	10.6	1.7	39	3	17.6	2.0	70	23	23.7	4.8	18	-40
Astrachan	RUS	12	0.9	55	37	20.4	2.1	26	2	26.8	3.9	19	-3
Jerewan	ARM	10.8	-0.8	58	21	19.2	2.9	30	-13	25.1	4.5	7	-14
Samsun	TUR	11.8	0.4	66	4	17.1	1.6	67	18	23.7	3.7	80	35
Istanbul	TUR	13.2	1.2	20	-29	20	3.5	48	17	24.9	3.8	20	-1
Ankara	TUR	10.8	-0.4	53	5	18.2	2.6	36	-19	22.4	2.8	43	6
Van	TUR	7.2	-0.1	48	-6	15.4	2.6	18	-32	20.4	2.8	11	-10
Antalya	TUR	16.7	0.6	30	-16	21.5	1.2	9	-19	26	1.0	22	14
Larnaka	CYP	16.9	0.0	39	28	23.2	2.8	<1	-7	26.8	2.8	5	4
Oral	KAZ	9.4	1.7	23	4	18.4	2.3	9	-12	22.2	2.0	40	3
Tiflis	GEO	12.9	0.1	62	11	19.6	2.2	116	38	25	3.8	79	3
Tripoli	LBN	16.9	-0.6	119	63	22	2.1	0	-17	25.7	2.4	4	3
Tel Aviv	ISR	18.3	0.1	10	-13	23.8	2.7	0	-3	26.7	2.7	0	0
Eilat	ISR	24	-0.4	<1	-3	31.2	3.0	0	-1	33.7	2.8	0	0
Mafraq	JOR	14.8	-1.0	12	2	23.4	3.6	0	-3	25.5	2.8	<1	<1
Sta. Cruz de Tenerife	ESP	20	0.8	29	13	21.8	1.3	<1	-4	23.2	1.1	<1	<1
Princess Juliana Airp.	SMA	26.5	0.4	17	-50	27.4	0.4	46	-50	28.5	0.7	37	-26
Le Lamentin	MTQ	26.3	0.4	74	-22	27.3	0.5	95	-28	27.9	0.6	95	-75

Table 5.2: continued

station name	country	July				August				September			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	6.8	2.6	64	17	7.4	2.5	21	-40	4.4	1.6	155	73
Svalbard	NOR	8.4	2.4	9	-4	6.2	1.4	47	22	2.6	2.1	39	16
Tromsoe	NOR	12	0.3	10	-62	11.4	0.5	72	-10	7.4	0.6	106	12
Oslo	NOR	17.9	1.5	58	-26	16.8	1.6	161	71	11.4	0.6	138	48
Haparanda	SWE	15.2	-0.3	8	-42	13.8	0.5	100	37	8.7	0.8	88	25
Stockholm	SWE	17.7	0.5	50	-22	18	1.8	84	18	13.1	1.9	42	-13
Visby	SWE	16	-0.3	103	56	17.8	1.8	25	-24	13.2	0.9	103	43
Sodankylä	FIN	13.5	-0.6	28	-37	12.3	1.1	27	-36	7.3	1.4	36	-19
Helsinki Airp.	FIN	17.5	0.9	67	-6	16.8	1.8	104	24	11.2	1.2	99	26
Aberdeen	GBR	16	2.2	70	10	15.2	1.6	64	-11	12.5	0.8	76	8
London	GBR	20.2	2.4	51	5	19.6	2.2	34	-17	16.5	1.5	63	12
Dublin/Casement	IRL	16.3	1.1	47	-2	15.6	0.8	113	49	13	0.4	109	50
Reykjavik	ISL	13.4	2.8	56	4	10.8	0.5	38	-24	9.6	2.2	138	72
Danmarkshavn	GRL	4.8	1.1	0	-14	4.7	2.3	61	47	-0.8	3.4	19	8
Copenhagen	DNK	18.4	1.2	60	-9	19	2.0	59	-4	14.3	0.7	109	47
De Bilt	NLD	18.8	2.0	53	-22	18.4	1.7	70	-1	14.5	0.5	99	32
Brussels	BEL	19.5	2.0	53	-22	19.2	1.9	50	-13	15.2	0.7	67	8
Luxembourg	LUX	20.1	3.2	17	-51	19.5	3.1	51	-21	14.5	1.1	59	-11
Zürich	CHE	20.7	3.1	97	-20	18.9	2.2	122	-11	15	1.2	90	-2
Geneva	CHE	22.6	3.5	44	-23	20.6	2.4	60	-19	17.2	2.3	25	-56
Bordeaux	FRA	23.6	3.4	42	-5	21.9	2.0	33	-21	19.3	1.4	69	-5
Marseille	FRA	26.7	2.9	6	-8	25.7	2.5	10	-19	21.8	1.5	76	29
La Coruna	ESP	19.3	0.9	11	-14	20.3	1.5	27	-2	19	0.9	19	-43
Madrid Retiro	ESP	27.4	3.0	9	-4	26.1	2.2	58	49	21.2	0.7	33	3
Valencia	ESP	27	2.3	14	-2	26.7	1.8	12	-8	23.6	1.0	123	75
Gibraltar	GIB	23.8	0.1	0	-1	24.9	0.7	0	-6	23.4	0.6	29	14
Santa Maria/Azoren	PRT	21.8	1.0	2	-23	23.1	0.9	69	29	22.1	0.7	41	-16
Lisbon	PRT	21.8	-0.6	2	-3	22.7	-0.1	6	0	22.4	0.7	15	-11
Berlin-Tempelhof	DEU	20.2	1.4	47	-5	21.4	3.0	52	-9	15.5	0.9	50	5
Vienna	AUT	22.4	2.7	63	0	22.6	3.7	53	-5	16.7	1.6	63	18
Prague	CZE	19.8	2.3	34	-32	19.5	2.5	86	16	14.1	0.8	38	-2
Sliac	SVK	19.6	1.4	51	-8	20.7	3.4	59	-10	14	0.6	75	19
Elbing	POL	16.2	-0.6	91	-3	18.4	1.7	64	-17	13	0.3	130	60
Warsaw	POL	19.3	1.4	37	-30	21.2	3.9	34	-29	14.7	1.5	60	17
Budapest	HUN	22.5	1.6	95	43	23.7	3.4	24	-27	17.6	1.2	55	15
Belgrade	SRB	24	2.3	43	-23	25.9	4.6	40	-12	20.1	2.4	26	-25
Ljubljana	SVN	22.9	3.0	142	20	22.6	3.5	112	-33	16.8	1.3	145	15
Split	HRV	27	1.6	70	42	28.2	3.0	12	-38	22.9	1.5	76	15
Sarajevo	BIH	20.9	2.0	68	-12	21.9	3.4	70	-1	16.6	1.5	44	-26
Bukarest	ROU	22.1	0.1	79	15	23	1.8	24	-34	18	1.1	8	-34
Sofia	BGR	21.3	1.3	31	-25	22.9	3.5	45	-7	17.9	2.1	19	-20
Pisa	ITA	24.4	1.6	109	86	24.2	1.7	5	-55	20.9	1.4	63	-26
Luqa	MLT	27.5	1.6	<1	<1	28.2	1.9	0	-7	25.6	1.5	31	-9
Athens	GRC	29	1.2	6	0	30.1	2.5	0	-8	25.5	1.2	4	-6
Heraklion	GRC	27.1	1.0	5	4	27.2	1.3	0	-1	24.5	1.0	0	-20
Murmansk	RUS	10.7	-2.1	67	7	10.7	-0.3	44	-21	8.3	1.6	68	16
Tallinn	EST	16.9	0.6	41	-38	16.6	1.3	84	0	12.3	1.5	80	-2
Kaunas	LTU	17.2	0.3	60	-20	18.1	1.7	68	-10	13	1.1	43	-13
Vilnius	LTU	17	0.1	50	-28	18	1.7	100	28	12.6	1.0	47	-18
Minsk	BLR	16.5	-0.8	120	32	17	0.5	91	19	12.2	0.5	49	-11
Moskow	RUS	16.8	-1.3	69	-23	16.4	0.0	57	-17	12.3	1.4	29	-35
Kiev	UKR	19.8	0.5	73	-15	20.7	2.1	45	-24	15.9	2.0	22	-25
Kischinau	MDA	22.1	1.2	33	-36	23.8	3.3	47	2	18.6	2.4	10	-38
Charkiw	UKR	20.8	0.5	63	3	21.2	1.7	8	-42	16.2	2.1	28	-13
Astrachan	RUS	25.6	0.3	17	-6	23.9	0.6	1	-18	16.6	-0.7	16	-10
Jerewan	ARM	26.5	1.9	1	-9	25.5	1.6	1	-6	20.8	1.0	17	7
Samsun	TUR	23.8	1.1	41	12	24.2	1.5	18	-15	21.3	1.7	27	-23
Istanbul	TUR	24.9	1.7	16	-3	25.3	2.3	92	66	21.9	2.2	20	-21
Ankara	TUR	23.1	0.2	34	20	24.2	1.6	29	17	20.3	2.0	<1	-19
Van	TUR	23	1.1	<1	-4	23.6	2.4	3	-1	18.7	1.9	<1	-10
Antalya	TUR	28.7	0.6	<1	-3	30	2.3	<1	<1	26.7	2.2	4	-7
Larnaka	CYP	28.5	1.9	<1	<1	28.9	2.3	<1	<1	27	2.4	10	10
Oral	KAZ	22.1	-0.4	14	-24	19.8	-0.6	16	-9	12.3	-1.8	20	-7
Tiflis	GEO	25.2	0.8	21	-24	25.4	1.7	23	-25	19.2	-0.4	34	-2
Tripoli	LBN	27.3	2.3	0	0	28.1	2.5	0	-1	26.5	1.7	0	-4
Tel Aviv	ISR	28.1	2.4	0	0	28.6	2.5	0	0	27.1	2.3	0	0
Eilat	ISR	34.7	2.3	0	0	34.2	1.9	0	0	32.1	1.7	0	0
Mafraq	JOR	25.6	1.5	0	0	25.6	1.4	0	0	24.1	1.4	0	-1
Sta. Cruz de Tenerife	ESP	24.8	0.3	<1	<1	26	0.9	0	-1	24.8	0.4	1	-8
Princess Juliana Airp.	SMA	29	1.0	172	96	29.2	1.0	146	47	29.4	1.2	77	-54
Le Lamentin	MTQ	28	0.8	195	-9	28	0.8	214	-38	28	1.0	191	-45

Table 5.2: continued

station name	country	October				November				December			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	1.4	1.3	16	-66	-2.2	1.1	27	-39	-1.7	3.5	111	46
Svalbard	NOR	-4.6	0.9	7	-8	-7.2	3.3	12	-1	-10.8	2.5	3	-9
Tromsoe	NOR	0.6	-2.3	59	-66	-2.4	-1.6	119	15	-0.7	2.3	128	24
Oslo	NOR	5.4	-1.0	107	23	1	0.3	112	37	0.4	3.2	57	1
Haparanda	SWE	0.7	-1.8	56	-8	-4.8	-0.7	54	-4	-2.7	6.8	75	33
Stockholm	SWE	7.2	-0.3	64	14	4	1.4	48	-5	3	4	84	38
Visby	SWE	8.8	0.4	82	32	5.3	1.2	71	14	4	3	61	9
Sodankylä	FIN	-2.5	-2.2	67	16	-8.5	-1.1	38	-1	-5.6	7.5	69	38
Helsinki Airp.	FIN	5.2	-0.2	98	25	1.7	1.6	86	14	1.4	5.5	98	40
Aberdeen	GBR	8.5	-1.4	85	8	5.5	0.5	173	98	4.9	1.4	54	-19
London	GBR	12.2	0.5	93	35	7.5	0.3	75	20	7.2	2.1	90	33
Dublin/Casement	IRL	9.1	-1.0	74	7	6	-0.7	144	77	6.1	0.5	49	-24
Reykjavik	ISL	5.4	1.0	77	-9	2.4	1.3	73	1	0.6	0.8	72	-7
Danmarkshavn	GRL	-8.6	5.0	0	-12	-18.6	1.3	3	-7	-19.4	2.4	21	8
Copenhagen	DNK	10.2	0.3	115	56	6.9	1.4	69	7	5.1	2.9	49	-9
De Bilt	NLD	11.6	1.1	105	33	6.4	0.5	101	20	5.8	2.6	72	-8
Brussels	BEL	12.1	1.2	86	16	6.6	0.5	64	-12	5.9	2.4	74	-2
Luxembourg	LUX	10.9	1.8	129	54	4.9	1.1	88	5	4.3	3.3	87	7
Zürich	CHE	11.6	2.3	132	63	5.5	1.6	63	-19	3.8	3.2	62	-11
Geneva	CHE	13.2	3.1	102	25	6.3	1.3	114	22	4.9	3.1	140	53
Bordeaux	FRA	16	2.0	99	11	9.5	0.4	265	171	9.5	3.1	131	32
Marseille	FRA	18.1	2.0	153	75	11.1	0.4	209	151	10.4	3.1	104	48
La Coruna	ESP	16.8	1.1	142	38	12.9	0.3	232	116	12.1	1.2	192	64
Madrid Retiro	ESP	16.2	1.4	43	-2	9.6	0.2	44	-20	8.8	2.4	90	39
Valencia	ESP	20.1	1.9	22	-65	15.1	1.6	3	-59	13.1	2.6	75	34
Gibraltar	GIB	20.5	1.0	11	-53	16.3	0.2	61	-80	15.3	1.2	95	-51
Santa Maria/Azoren	PRT	20.7	1.4	157	73	18.4	1	19	-83	16.9	1.5	75	-20
Lisbon	PRT	18.6	0.1	44	-36	15	0.5	123	9	13.5	1.7	103	-5
Berlin-Tempelhof	DEU	11.8	1.8	58	22	6.6	1.7	32	-17	4.6	3.2	28	-25
Vienna	AUT	12	2.1	26	-15	7.9	3.3	47	-3	3.6	2.7	65	22
Prague	CZE	9.8	1.5	27	-3	5.3	2.5	30	-2	2.3	2.9	9	-17
Sliac	SVK	9.8	1.5	29	-21	7.4	4.4	125	56	0.7	2.4	48	-9
Elbing	POL	9.6	0.7	76	23	4.7	1.4	51	-5	2.3	2	72	20
Warsaw	POL	11.2	2.9	16	-22	6.3	3.1	13	-29	3.3	4.2	38	6
Budapest	HUN	13.1	2.2	16	-18	8.9	4.1	82	30	3.5	3.1	78	38
Belgrade	SRB	16	3.6	13	-27	12.5	5.5	54	0	5.9	3.6	55	-3
Ljubljana	SVN	13.2	2.8	76	-39	8.7	4.1	188	53	3.6	3.6	130	29
Split	HRV	18.8	1.9	18	-61	15.6	3.4	220	112	10.9	2.2	99	-1
Sarajevo	BIH	13.1	2.8	38	-39	10.7	5.4	80	-14	3.5	3.2	65	-20
Bukarest	ROU	12	1.2	43	11	9.4	4.2	76	27	3.4	3.2	12	-31
Sofia	BGR	13.3	2.9	31	-6	9.7	4.7	44	-3	2.1	1.6	20	-19
Pisa	ITA	17.3	2.0	150	27	13.2	2.8	326	202	10.1	3.3	113	28
Luqa	MLT	22.3	1.6	94	4	18.3	1.3	107	27	15.8	2	51	-61
Athens	GRC	21.9	2.6	22	-26	18.4	3	126	75	12.6	0.6	132	66
Heraklion	GRC	22.1	2.2	14	-55	19.7	3.1	58	-1	14.2	0.4	124	47
Murmansk	RUS	-0.9	-1.9	59	17	-6.4	-1.3	29	-11	-4.5	4.8	70	32
Tallinn	EST	7.1	0.8	142	72	3	1.8	31	-37	2.5	5.4	72	17
Kaunas	LTU	9.2	2.1	47	2	5	3.2	21	-32	2.4	4.9	42	-5
Vilnius	LTU	9	2.4	53	0	4.5	3.3	43	-14	2	4.9	45	-10
Minsk	BLR	9.2	2.9	31	-18	4	3.2	68	16	1.7	5.5	66	13
Moskow	RUS	8.8	3.8	60	2	1.8	2.9	34	-24	0.8	6.9	33	-19
Kiev	UKR	11.1	3.0	13	-22	4.6	2.5	28	-23	2.7	5	33	-19
Kischinau	MDA	12.3	2.2	20	-7	7.9	3.5	6	-33	3.5	3.8	24	-14
Charkiw	UKR	10.7	3.4	72	37	3.4	2.1	19	-25	1.6	5	28	-17
Astrachan	RUS	12.7	3.6	6	-11	2.1	-1.2	<1	-19	0.9	2.8	5	-10
Jerewan	ARM	17	4.2	4	-23	6.4	-0.2	18	-4	3.9	3.4	30	7
Samsun	TUR	18.3	2.7	99	14	15.1	2.6	63	-26	11.2	2	78	-4
Istanbul	TUR	18.7	3.4	30	-41	16.7	5.1	22	-67	10.5	2.4	67	-55
Ankara	TUR	16.4	3.8	8	-19	10.3	3.2	21	-12	4.1	1.6	66	17
Van	TUR	13.4	3.3	26	-22	5.2	1.2	26	-18	3	4.1	54	20
Antalya	TUR	23.2	3.6	15	-55	17.3	2.5	91	-43	12.2	0.8	253	26
Larnaka	CYP	24.1	2.8	47	28	20.3	3.4	7	-37	14.9	1.5	239	163
Oral	KAZ	9.7	4.6	12	-18	-2.5	-0.4	4	-31	-4.9	3.5	19	-10
Tiflis	GEO	17.2	3.7	5	-33	7.6	-0.5	20	-10	6.3	2.5	1	-20
Tripoli	LBN	23.8	1.6	67	-4	19	0.7	40	-73	13.9	-0.2	268	88
Tel Aviv	ISR	24.8	2.8	12	-14	21.1	3.1	4	-64	15.5	1.7	128	-10
Eilat	ISR	29	2.4	2	-1	24	2.9	0	-4	18.1	1.9	<1	-6
Mafraq	JOR	21.7	2.6	4	-3	15.8	2.3	13	-4	9.8	1	45	17
Sta. Cruz de Tenerife	ESP	23.7	0.8	34	16	21.8	1	7	-31	19.9	1.1	32	-20
Princess Juliana Airp.	SMA	28.9	1.1	154	45	28	1.1	35	-95	27.4	1.6	134	48
Le Lamentin	MTQ	27.3	0.6	326	56	26.8	0.5	208	-16	26.7	1.3	148	-11

6. References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2019 edition of the Bulletin, are listed on page 3 above. Many contributions or additional information may as well be found on the web, see below.

Country	Reference
Austria	Zentralanstalt für Meteorologie und Geodynamik (**ZAMG**) Annual Climate Reports
Belgium	The Royal Meteorological Institute of Belgium (**KMI**) Klimatologisch overzicht
Bosnia and Herzegovina	Federal Meteorological Institute (**METEOBIH**) Analiza-godina.
Croatia	Meteorological and Hydrological Service (**DMHZ**) Annual reports
Denmark	Danish Meteorological Institute (**DMI**) Vejret i Danmark Storms in Denmark since 1891
Estonia	Estonian Weather Service Estonian Bulletin
Finland	Finnish Meteorological Institute (**FMI**) Press release archive
France	Météo-France, Toulouse Bilan climatiques
Germany	Deutscher Wetterdienst (**DWD**) Annual, Seasonal and Monthly Summary
Greece	Hellenic National Meteorological Service http://www.hnms.gr/emy/en/climatology/climatology National Observatory of Athens Meteorological bulletin
Hungary	Hungarian Meteorological Service (**OMSZ**) Climate retrospective
Iceland	Icelandic Met Office The weather in Iceland 2021-Climate summary
Ireland	The Irish Meteorological Service (**MET Éireann**) Weather Summary
Israel	Israel Meteorological Service (**IMS**) Weather summary in Israel
Italy	Institute for Environmental Protection and Research (**ISPRA**) System for Climate Data Collection and Dissemination (SCIA) http://www.scia.isprambiente.it/wwwrootscia/Home_new.html http://www.scia.isprambiente.it/ [...] RAPPORTOCLIMA2018.pdf
Latvia	Latvian Environment, Geology and Meteorology Centre Monthly bulletins
Lithuania	Lithuanian Hydrometeorological Service (**Lhmt**) http://www.meteo.lt/menesio-apzvalgu-archyvas
Luxembourg	MeteoLux, Bilans climatologiques annuels http://meteolux.lu/ [...] /bilans-climatologiques-annuels/
Moldova	State Hydrometeorological Service (**SHS**) Caracterizarea conditiilor meteorologice si agrometeorologice din anul

Country	Reference
Montenegro	Institute of Hydrometeorology and Seismology (IHMS) Annual reports
Netherlands	Royal Netherlands Meteorological Institute (**KNMI**) Jaaroverzicht van het weer in Nederland Zware stormen in Nederland sinds 1910
Norway	Det Norske Meteorologiske institutt (**DNMI**) Klimatologisk månedsoversikt
Portugal	Instituto portuguesa do mar e da atmosfera (**ipma**) Bolletim Climatológico Anual
Romania	Administrația Națională de Meteorologie Monitorizare climatica
Russian Federation	Russian Federal Service for Hydrometeorology and Environmental Monitoring (**Roshydromet**) Annual report on climate features on the territory of the Russian Federation
Serbia	Republic Hydrometeorological Service of Serbia (**RHMZ**) Annual Bulletin for Serbia
Slovakia	Slovak Hydrometeorological institute (**SHMU**) Bulletin Meteorológia a Klimatológia
Slovenia	Slovenian Environment Agency (**ARSO**) Mesečni bilten ARSO Unusual events http://meteo.arso.gov.si/met/sl/climate/natural-hazards/
Spain	Agencia Estatal de Meteorologia (**AEMET**) Resumen anual climatologico Olas de calor en España desde 1975 Olas de frío en España desde 1975
Sweden	Swedish Meteorological and Hydrological Institute (**SMHI**) Året (year) Stormar i Sverige
Switzerland	Federal Office of Meteorology and Climatology **MeteoSwiss** Klimabulletin
Turkey	Turkish State Meteorological Service (**TSMS**) Bulletin
United Kingdom	**Met Office** Climate summaries and State of the UK Climate 2017 in RMetS https://www.metoffice.gov.uk/research/ [...] /summaries/index

7. References

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Ziese M. et al., 2014: The GPCC Drought Index – a new, combined and gridded global drought index. Earth Syst. Sci. Data, 6, 285–295, 2014. doi:10.5194/essd-6-285-2014.

8. Abbreviations

Abbreviation	Meaning
AO	Arctic Oscillation (circulation indices)
BAMS	Bulletin of the American Meteorological Society
CLIMAT	monthly climatological data provided by the NMHSs via GTS
DWD	Deutscher Wetterdienst (German Meteorological Service)
EA	East Atlantic Pattern (circulation indices)
EA/WR	East Atlantic/West Russia Pattern (circulation indices)
ECA&D	European Climate Assessment & Dataset, located at Royal Netherlands Meteorological Institute (KNMI)
EMCC	Eastern Mediterranean Climate Centre
E-OBS	daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D information
GCC	Global Collection Centre operated by the Deutscher Wetterdienst
GPCC	Global Precipitation Climatology Centre located at the Deutscher Wetterdienst
GTS	Global Telecommunication System
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (Italian National Institute for Environmental Protection and Research)
JRC	Joint Research Centre of the European Commission
m a.s.l.	Meter above sea level
NAO	North Atlantic Oscillation (circulation indices)
NMHSs	National Meteorological and Hydrological Services
POL	Polar/Eurasia Pattern (circulation indices)
PDSI	Palmer Drought Severity Index
RCC-CM	WMO Regional Climate Centre Network (RA VI) Offenbach Node on Climate Monitoring
SCA	Scandinavia Pattern (circulation indices)
SCE	Annual snow cover extent
SYNOP	surface synoptic or weather observations provided by the NMHSs via GTS
WCDMP	World Climate Data and Monitoring Programme
WMO RA VI	WMO Regional Association VI (Europe and Middle East)
WMO	World Meteorological Organization

WMO RA VI
RCC Network

DWD

Annual Bulletin on the Climate in WMO Region VI

– Europe and Middle East –

2020



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Armenia
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Slovakia
Slovenia
Spain
Sweden
Switzerland
Türkiye
Ukraine
United Kingdom

1. Introduction

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East with 51 Members) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official websites. The Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's annual "State of the Global Climate" and the "State of the Climate" published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ among the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process and are mainly taken from reports, maps and statistics provided by the NMHSs, websites of NMHSs as well as the webpages of the RA VI RCC Network (RCC website) which provide useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the RA VI Region but it might also be interesting for public institutions, research institutes, universities and others.

This annual bulletin includes three parts: the annual, seasonal and monthly survey of the state of the climate in 2020. The long time series of temperature, precipitation and sunshine duration provided by NMHSs in order to illustrate long-term variability up to 2020 (previously presented in section 5) will be made available on the RA VI webpages.

Notes:

Maps of the RA VI RCC Network are based on the following data sources:

- Temperature: CLIMAT data and ship observations provided by the Global Collecting Centre (GCC), operated by the Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC; Schneider et al. 2018), operated by the Deutscher Wetterdienst
- Sunshine: Meteosat satellite data (introduced in 2018).
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC Node-CD) via the European Climate Assessment & Dataset project (ECA&D) run by the Royal Netherlands Meteorological Institute (KNMI)

1.1. Definition of subregions

The following subregions are used in this bulletin:

Central and Western Europe (14 countries):

Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxembourg, Monaco, Netherlands, Poland, Slovakia, Switzerland, and United Kingdom

Nordic and Baltic Region (9 countries/territories):

Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, and Sweden

Iberia (2 countries):

Portugal, and Spain

Mediterranean, Italian and Balkan Peninsula (12 countries):

Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, Montenegro, North Macedonia, Serbia, Slovenia, and Türkiye

Eastern Europe (5 countries):

Belarus, European Russia, Moldova, Romania, and Ukraine

Middle East (9 countries):

Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, and western Kazakhstan

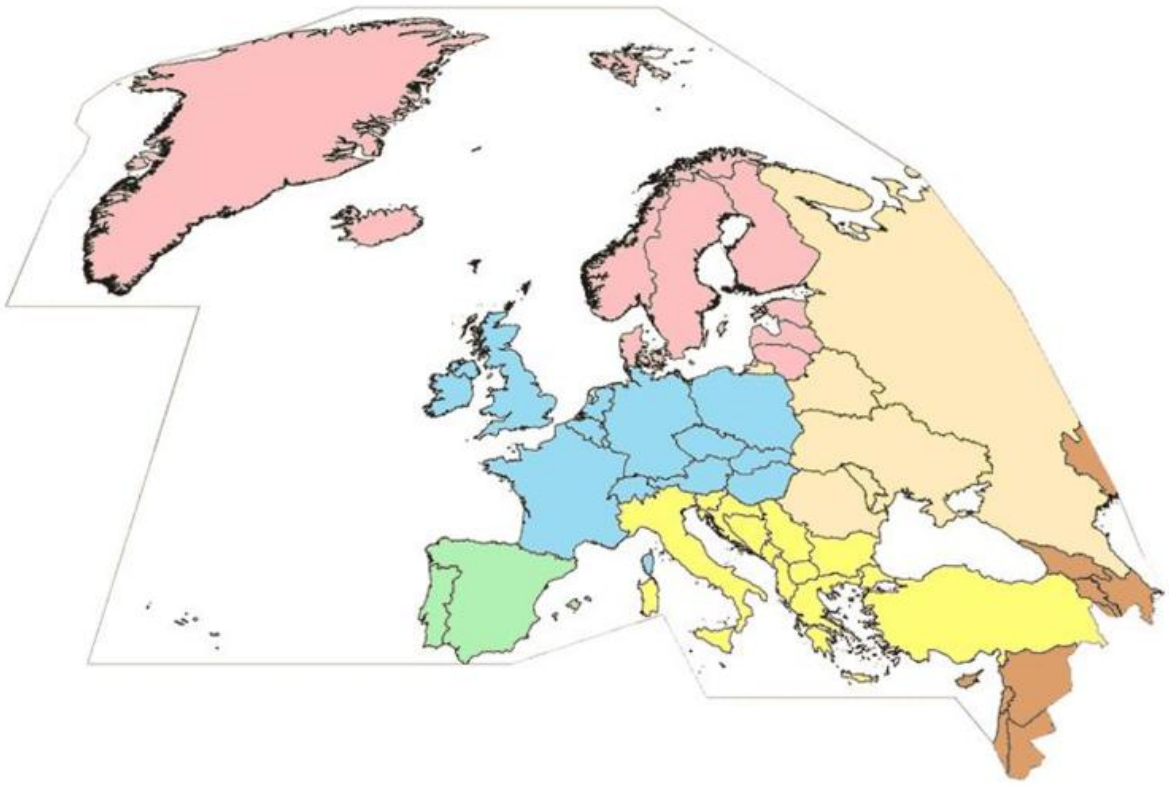


Figure 1-1: *Definitions of the 6 subregions used in this bulletin.*

1.2. The climate in 2020 – Overview

1.2.1. Anomalies

Temperature

Based on both the E-OBS (van der Schrier et al. 2013) and the Global Historical Climate Network (GHCN) v4.0.1 dataset (Menne et al. 2018), 2020 was the warmest year since start of the time series in 1951 and 1900 respectively with annual anomalies of +1.75 °C and +1.6 °C (relative to the 1981–2010 period). For the RA VI Region, temperatures were 1.66 °C above the 1981–2010 average. Largest anomalies occurred in the northeast with anomalies larger than +2 °C (for example Finland, Baltic countries and northern European Russia). All seasons were warmer than normal in all subregions. Especially the winter of 2019/2020 was warm over the RA VI Region with an anomaly of +3.2 °C. Highest seasonal temperature anomaly was +5.31 °C in Eastern Europe during winter.

Precipitation

Precipitation amounts across the RA VI Region were mostly close to normal in 2020. For the RA VI land areas as a whole, the annual precipitation was slightly above normal (w.r.t. 1981–2010). In eastern and southeastern parts of the RA VI Region, the year was characterized by a precipitation deficit which was as low as 40%–60% in wide regions around the Black Sea as well as in west Kazakhstan. Germany and most parts of France and the Iberian Peninsula also received below normal precipitation which reached as low as 60%. The northern parts of Europe on the other hand received above-normal precipitation mostly up to 125% of normal. Similarly, the eastern parts of the Iberian Peninsula as well as many countries east of Germany reported above-normal precipitation. During the year, there was significant variation between seasons. After a mostly wet winter and spring season, autumn and summer 2020 saw mostly drier than normal conditions. The Mediterranean and Balkans for example received only 66% of the normal rainfall during autumn.

Sunshine Duration

Most of the RA VI Region received more sunshine than normal during 2020 (w.r.t. 1986–2015). Central and Western Europe as well as the Mediterranean and the Balkans region recorded the highest surpluses in terms of sunshine duration (about 170 hours). In case of Central and Western Europe this surplus was due to a very sunny spring season with 155 hours more sunshine than normal.

1.2.2. Events

- Stormy start into 2020, February was an extraordinary stormy month
- Warm winter (see above)
- Dry conditions over the RA VI Region during summer and autumn (see above)
- Cold wave in April and May affecting Western, Central Europe, Mediterranean and Balkans
- Period of heat waves between May and September over the RA VI Region especially in the Middle East, Eastern Europe and Türkiye
- Extreme weather events (thunderstorms, flooding, etc.) during summer due to heat waves

2. Annual survey

The climate of 2020 was characterized by a broad range of spatial and temporal anomalies outlined in section 1.2. This section presents an overview of the spatial patterns of mean annual climate conditions in 2020 and anomalies of the selected climate variables: sea level pressure, surface air temperature, precipitation, sunshine duration and snow. Throughout this report, 1981–2010 is the baseline reference period used unless otherwise specified. Long-term trends in temperature and precipitation indices are presented in section 2.2. Section 3 and 4 present the seasonal and monthly patterns and statistics for selected climate variables including also reports from individual countries. The long time series of temperature, precipitation and sunshine duration provided by NMHSs in order to illustrate long-term variability up to 2020 (previously presented in section 5) will be made available on the RA VI webpages.

2.1 Annual averages and anomalies of selected essential climate variables

2.1.1. Sea level pressure

Generally, mean annual sea level pressure distribution in 2020 over the WMO Region VI (RA VI) was dominated on one hand by a band of low pressure with the minimum pressure extending from southern Greenland over Iceland until the Barents Sea. On the other hand, there was a high-pressure belt with maximum pressure in the area of the Azores (Azores High) extending further across Southern and Central Europe into Russia.

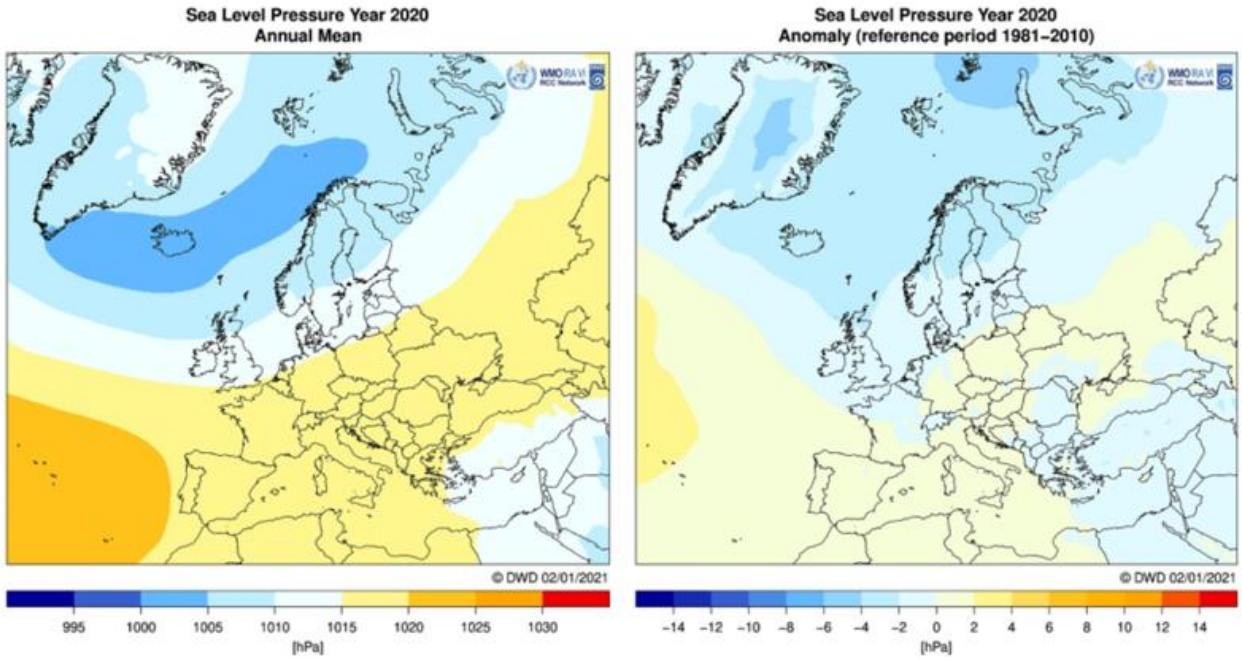


Figure 2-1: *Annual mean sea level pressure in hPa (left) and anomalies in hPa relative to 1981–2010 (right) for the year 2020. Source: RCC-CM website.*

Over most parts of the RA VI Region the mean sea level pressure in 2020 was around normal with anomalies between −2 hPa and +2 hPa. Larger differences only occurred over northern parts of Scandinavia, Iceland and especially Greenland, with negative anomalies as low as −4 hPa to −6 hPa. The Azores High was slightly more intense than normal on annual average.

2.1.2. Temperature

Mean annual temperatures in 2020 were higher than normal (w.r.t. 1981–2010) over almost the whole RA VI Region. Temperature anomalies varied mostly between +1 °C and +3 °C. Largest annual anomalies occurred in Eastern Europe, where temperatures were 2.18 °C above normal, followed by Scandinavia and the Baltic States (+1.55 °C), the Middle East (+1.46 °C), Central and Western Europe (+1.43 °C) and the Mediterranean and Balkan Peninsula (+1.34 °C). The annual average anomaly of +1.01 °C was recorded over the Iberian Peninsula. For the European region as a whole, 2020 was the warmest year since at least 1950 considering the E-OBS data set (van der Schrier et al. 2013) and the Global Historical Climate Network (GHCN) v4.0.1 datasets (Menne et al. 2018; Bissolli et al. 2021) with an overall anomaly (with respect to the base period 1981–2010) of +1.75 °C (**Figure 2-3**) and +1.6 °C respectively. For many countries the year proved to be the warmest on record: Latvia, +2.4 °C; Belgium, +1.6 °C; Belarus, +2.1 °C; Estonia, +2.4 °C; Lithuania, +2.3 °C; Luxembourg, +1.5 °C; Kazakhstan, +1.9 °C; Spain, +1.0 °C; Norway, +1.8 °C; Ukraine, +2.8 °C (w.r.t 1961–1990); (European) Russia, +2.86 °C (w.r.t. 1961–1990); Moldova, +2.6 °C (see also Table 2-1).

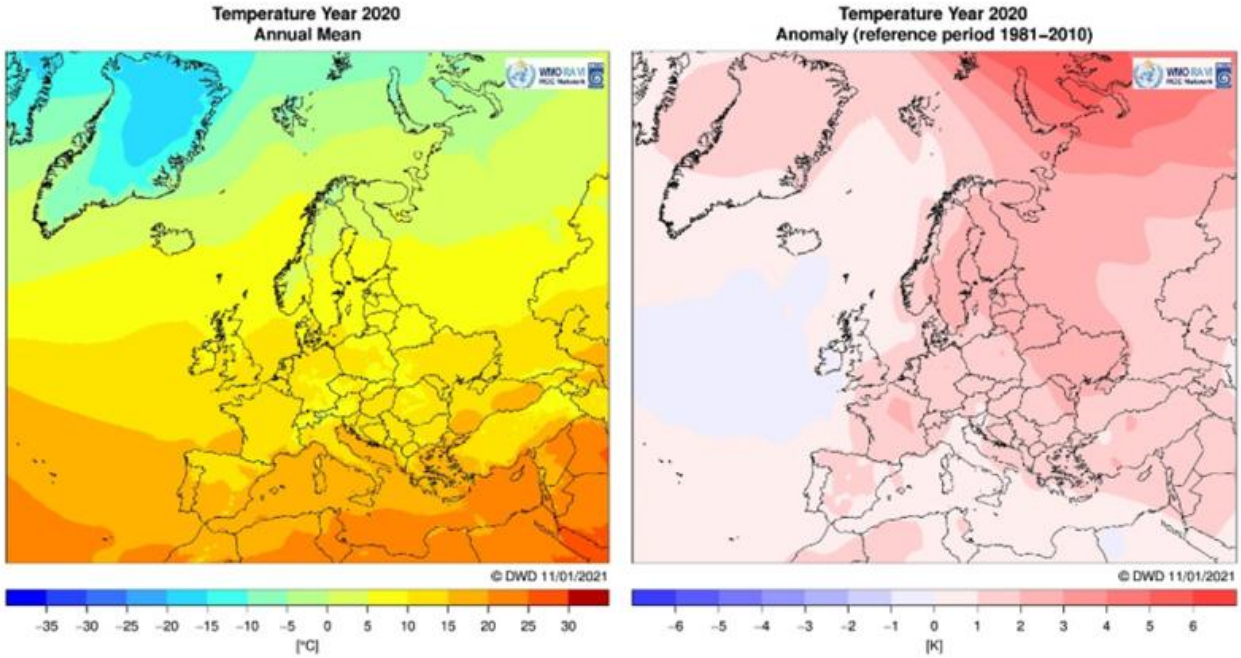


Figure 2-2: *Annual mean temperature in °C (left) and anomalies in °C relative to 1981–2010 (right) for the year 2020. Source: RCC-CM website.*

In 2020, all subregions within the RA VI Region showed positive anomalies ranging from +1.0 °C over the Iberian Peninsula to +2.18 °C over Eastern Europe. The only area with slightly negative annual anomalies was over the central North Atlantic.

The annual mean temperature over **Western and Central Europe** was 10.93 °C and thus 1.43 °C warmer than normal. Some countries showed even higher anomalies and reached new heat records. In Belgium (+1.6 °C) and Luxembourg (+1.5 °C) it was the warmest year since start of the measurements. For Denmark (+1.5 °C), Germany (+2.2 °C) and in Poland (+1.7 °C) 2020 was the second warmest year.

Scandinavia and the Baltic States recorded an anomaly of +1.55 °C. High positive anomalies were measured in Sweden, Finland and the Baltic States. Lithuania reported its warmest year on record with 2.3 °C above normal as well as Estonia with an anomaly of +2.4 °C.

The **Iberian Peninsula** saw the smallest anomalies among the subregions with temperatures being 1.01 °C above normal. However, 2020 was still the warmest year for Spain (+1 °C) since 1961 and the fourth warmest for Portugal (+0.96 °C) since 1931.

The **Mediterranean and the Balkan** countries also recorded warmer than normal temperatures. The anomaly for this subregion was +1.34 °C. The year 2020 was among the top five of the warmest years in Bulgaria (second warmest, +1.9 °C), Cyprus (third warmest, +1.1 °C), Italy (fifth warmest, +1.54 °C), Türkiye (third warmest, +1.5 °C) and Slovenia (fifth warmest, +1.23 °C).

In **Eastern Europe,** 2020 was exceptionally warmer than normal (+2.18 °C). Especially high anomalies were recorded in Russia with 2.86 °C above normal followed by the Ukraine (+2.8 °C) and Moldova (+2.6 °C).

The **Middle East** had an overall warm year as well. It was 1.45 °C warmer than normal. Kazakhstan (+1.9 °C) observed a new annual record with 2020 being its warmest year since 1936.

Globally, 2020 was one of the three warmest years on record (WMO 2021, Dunn et al. 2021). The past six years, including 2020, have been the six warmest years on record. The global mean temperature for 2020 was around 0.6°C above the 1981–2010 average (Dunn et al. 2021) and 1.2 ± 0.1 °C above the 1850–1900 baseline (WMO 2021).

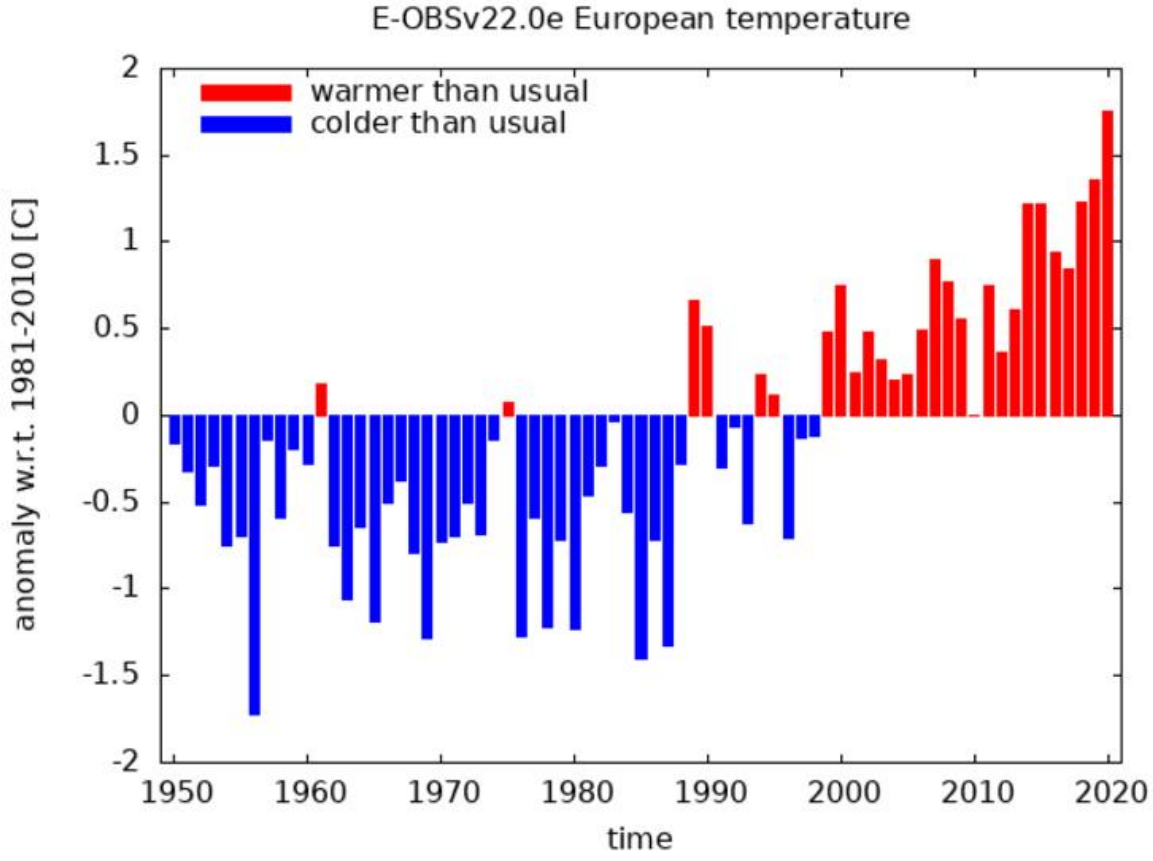


Figure 2-3: *Annual temperature anomalies in° C relative to 1981–2010 for the years 1950–2020 for Europe (land area; 34°N–71°N and 25°W–40°E; based on the E-OBS dataset). Source: Royal Netherlands Meteorological Institute Netherlands, KNMI.*

Table 2-1: *Rank statistics and anomalies of annual temperature in 2020 as reported by the National Meteorological and Hydrological Services (NMHSs). Information about all-time temperature records as provided by the individual NMHSs can be found here: RCC-CM website.*

Country	Rank (warmest)	Annual Anomaly [°C]	Reference period	Start of time series
Europe (35°–75°N, 25°W–40°E, E-OBS) **RA VI Region**	E-OBS: 1 GHCN: 1 RCC-CM: 1	+1.8 +1.6 +1.7	1981–2010	1951 1900 1981
Armenia	8	+1.4	1961–1990	1935
Austria	5	+2.0	1961–1990	1767
Belarus	1	+2.1	1981–2010	1881
Belgium (Uccle)	1	+1.6	1981–2010	1833
Bosnia and Herzegovina	-	+1.2	1981–2010	1950
Bulgaria	2	+1.9	1961–1990	1930
Cyprus	3	+1.1	1981–2010	2000
Czech Republic	5	+1.2	1981–2010	1961
Denmark	2	+1.5	1981–2010	1874
Estonia	1	+2.4	1981–2010	1961
Germany	2	+2.2	1961–1990	1881
Hungary	8	+1.1	1981–2010	1901
Iceland	-	+0.9	1961–1990	-
Ireland	16	+0.4	1981–2010	1900
Italy	5	+1.5	1961–1990	1961
Kazakhstan	1	+1.9	1981–2010	1936
Latvia	1	+2.4	1981–2010	1924
Lithuania	1	+2.3	1981–2010	1961
Luxembourg	1	+1.5	1981–2010	1838
Moldova	1	+2.6	1981–2010	1886
Montenegro	-	+1.3	1981–2010	1951
Netherlands	3	+1.1-	1981–2010	1901
North Macedonia	10	+0.9	1981–2010	1981
Norway	1	+1.8	1981–2010	1900
Poland	2	+1.7	1981–2010	1951
Portugal	4	+1.0	1971–2000	1931
Romania	2	+1.7	1981–2010	1961
Russia	1	+2.9	1961–1990	1936
Serbia	7	+1.2	1981–2010	1951
Slovenia	5	+1.2	1981–2010	1961
Spain	1	+1.0	1981–2010	1961
Sweden	1	+2.3	1981–2010	1860
Switzerland	1	+1,5	1981–2010	1864
Türkiye	3	+1.5	1981–2010	1971
Ukraine	1	+2.8	1961–1990	1891
United Kingdom	3	+0.8	1981–2010	1884

2.1.3. Precipitation

For the RA VI land areas as a whole, precipitation in 2020 was near average (w.r.t. 1981–2010). For large parts of Iberia, France, Germany and especially the Southeast and the Baltic states, the year was characterized by below-normal conditions. Exceptionally dry conditions (< 10th percentile), with deficits as low as 20% to 60% were recorded in wide regions around the Black Sea as well as in parts of the Baltic countries and the Middle East. Conversely, northern parts of Europe, northeastern Spain, some regions of Italy as well as many countries east of Germany received above-normal precipitation, mostly around 125% of normal, some parts even up to 167% of normal.

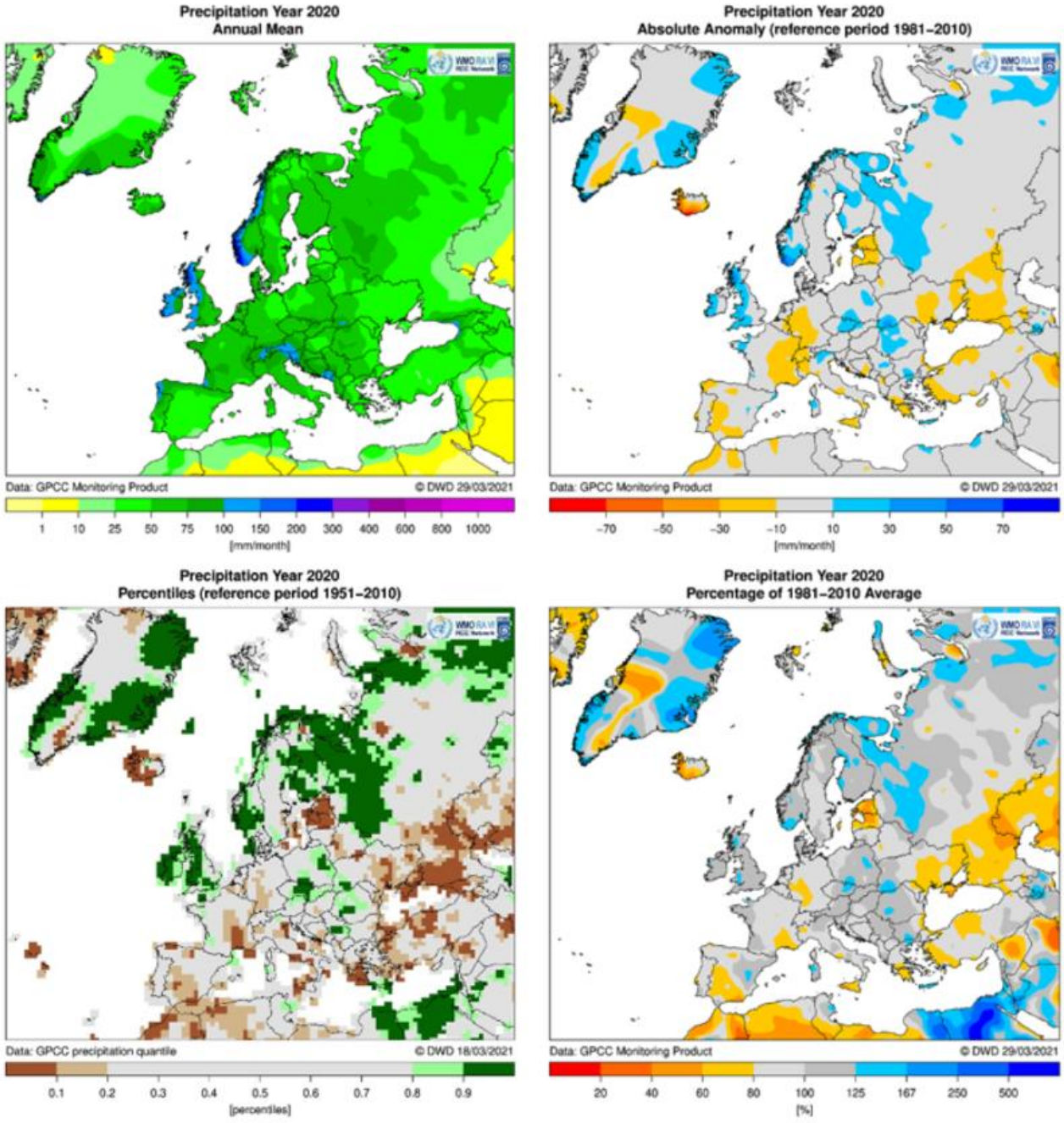


Figure 2-4: *Annual total precipitation (left, top), precipitation anomalies in mm per month relative to 1981–2010 (right, top) and percentiles relative to 1951-2010 (left, bottom) as well as percentage of precipitation in % (right, bottom) relative to1981–2010 for the year 2020. Source: RCC-CM website.*

Across **Central and Western Europe,** precipitation for the year was close to normal (99% of normal precipitation). United Kingdom and Ireland, however, saw much wetter-than-normal conditions with 116% and 121% of normal precipitation respectively, making 2020 United Kingdom's fifth and Ireland's third wettest year on record.

The subregion **Scandinavia and the Baltic States** showed the largest precipitation surplus with 118% of normal precipitation. Norway reported +293 mm more than normal ranking 2020 the second wettest year on record. All Baltic States, however, experienced drier than normal conditions. For Lithuania, 2020 was the seventh driest year with a deficit of 40 mm.[1]

The **Iberian Peninsula** saw slightly lower than normal precipitation (93% of normal). Spain recorded regionally only 60%–80% of normal precipitation but for the country as a whole precipitation amounts were near-normal.

The **Mediterranean and the Balkans** received also slightly lower than normal precipitation amounts. Several countries saw wetter than normal conditions with anomalies mostly up to 125% of normal amounts. Other countries recorded negative precipitation anomalies, for example Bosnia and Herzegovina received 171 mm less precipitation than normal.

In the **Middle East,** there were countries with both drier and wetter than normal conditions as well. Kazakhstan had its seventh driest year since 1936 with 71 mm less rain than normal. Syria also saw drier than normal conditions with regionally less than 60% of normal precipitation. In Israel, Jordan and Lebanon wetter conditions prevailed. For the region as a whole 112% of normal precipitation was recorded.

Eastern Europe as a whole saw close to normal conditions with 97% of normal precipitation. Largest deficits were observed in the areas around the Black Sea and in southern European Russia.

[1] The RCC annual precipitation anomaly map for 2020 shows large negative anomalies for Estonia and slighly negative anomalies for Lithuania. It turned out that these anomalies do not correctly represent the anomalies reported by the respective NMHSs included in Table 2-2. The issue is likely related to incorrect decoded real-time data used for the grid generation. As a result, these grid point values may deviate considerably from actual precipitation totals.

Table 2-2: Rank statistics and anomalies of annual precipitation anomalies in 2020 as reported by the National Meteorological and Hydrological Services (NMHSs).

Country	Rank	Annual Anomaly [mm][2]	Reference period	Start of time series
Europe (35°–75°N, 25°W–40°E, E-OBS)	-	-	-	-
Armenia	4 (wettest)	−54.0	1960–1991	1935
Austria	-	+115.0	1960–1991	1961
Belgium (Uccle)	6 (driest)	−120.5	1981–2010	1833
Bosnia and Herzegovina	-	−171.0	1981–2010	1950
Bulgaria	30 (driest)	−46.0	1961–1990	1930
Cyprus	45 (driest)	−34.0	1961–1990	1902
Czech Republic	10 (wettest)	+78.0	1981–2010	1961
Denmark	26 (wettest)	26.8	1981–2010	1874
Estonia	23 (wettest)	−6.6	1981–2010	1961
Germany	36 (driest)	−84.0	1961–1990	1881
Hungary	60 (wettest)	+14.7	1981–2010	1901
Ireland	3 (wettest)	+255.8	1981–2010	1941
Italy	29 (driest)	−44.0	1961–1990	1961
Kazakhstan	-	−71.0	1981–2010	1936
Latvia	42 (driest)	-50.8	1981–2010	1924
Lithuania	7 (driest)	−39.0	1981–2010	1961
Luxembourg	76 (wettest)	−43.4	1981–2010	1854
Moldova	-	+13.0	1981–2010	1891
Montenegro	-	−139.0	1981–2010	1949
North Macedonia	17 (driest)	−144.0	1981–2010	1981
Norway	2 (wettest)	+293.0	1981–2010	1900
Poland	16	+45.2	1981–2010	1966
Portugal	-	−131.0	1971–2000	1931
Romania	-	+24.4	1981–2010	1961
Russia	42 (wettest)	+3.6	1961–1990	1936
Serbia	18 (wettest)	+64.3	1981–2010	1951
Slovenia	25 (driest)	+24.6	1981–2010	1961
Spain	24 (driest)	−35.0	1981–2010	1961
Sweden	17 (wettest)-	+36.0	1981–2010	1880-
Switzerland	58 (driest)	91% of normal	1981–2010	1864
Türkiye	-	−73.9	1981–2010	1971
Ukraine	39 (driest)	−59.0	1961–1990	1891
United Kingdom	5 (wettest)	116% of normal	1981–2010	1862

[2] By default anomalies are given in mm unless otherwise specified.

2.1.4. Sunshine duration

The year 2020 was sunnier than normal over most parts of the RA VI Region (w.r.t. 1986–2015). Especially Central and Western Europe, Scandinavia and Eastern Europe recorded positive anomalies with between 200 and 500 more hours of sunshine. Deficits of up to 200 hours less sunshine than normal were observed in parts of Portugal, Spain, Russia, Belarus and the Middle East. Some central parts of the North Atlantic saw particularly little sunshine in contrast to the European continent with a duration below the lowest decile. Annual and seasonal average anomalies of sunshine duration are shown in **Table 3-6**.

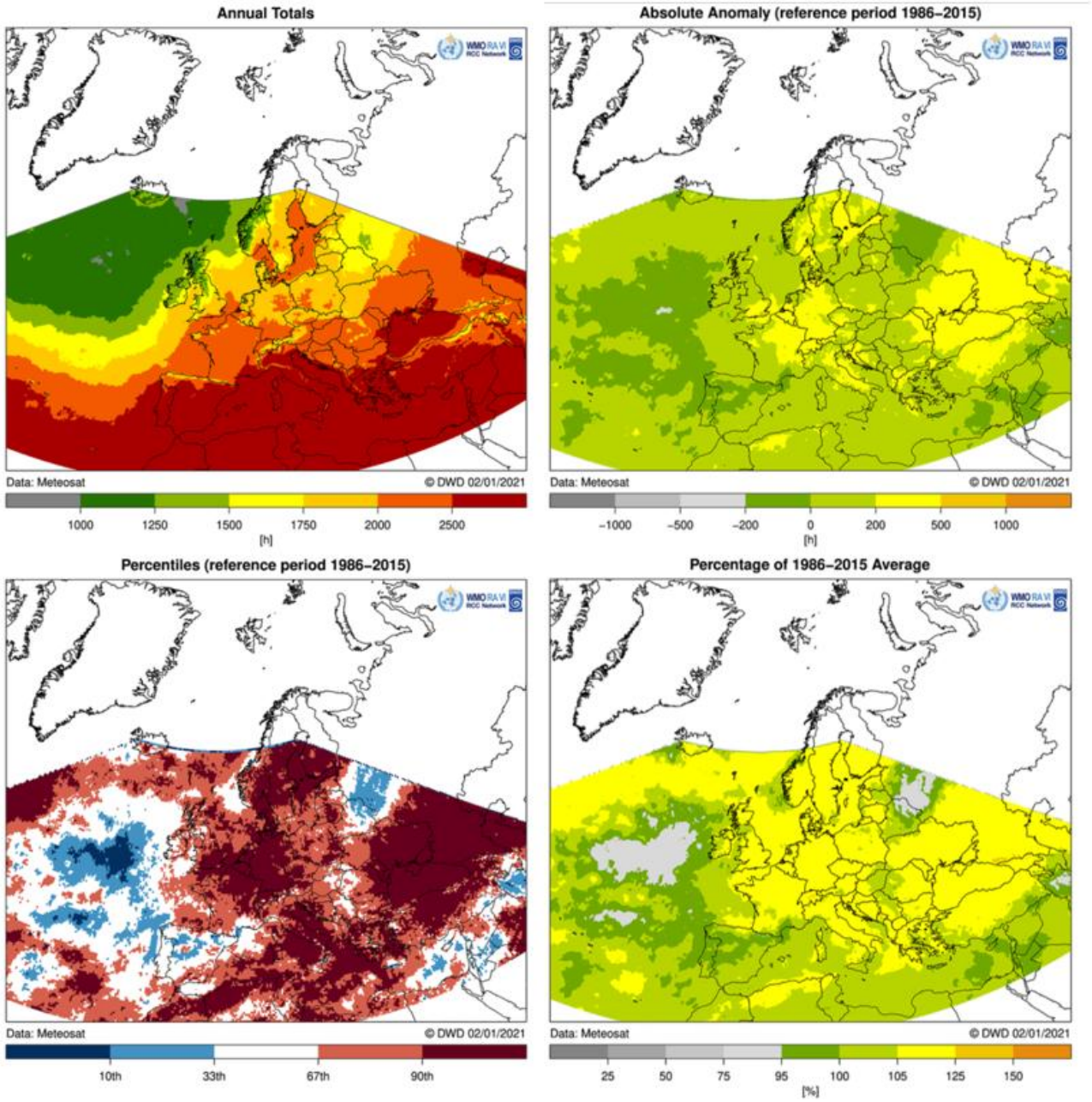


Figure 2-5: *Annual sum of sunshine duration in hours (upper left) as well as absolute anomalies in hours (upper right), percentiles (lower left) and percentages of the long-term mean (lower right) relative to 1986–2015 for the year 2020. Source: RCC-CM website.*

Central and Western Europe received the largest sunshine surplus with 177 hours more sunshine than normal. This was mainly due to a very sunny spring (surplus of 155 sunshine hours).

The **Mediterranean and the Balkans** saw sunnier than normal conditions as well, with around 173 hours more sunshine than normal. Here all seasons, except for the summer, contributed to the overall sunshine surplus. **Eastern Europe** received a surplus of 106 hours of sunshine. All seasons were sunnier than normal with surpluses between 20 and 40 hours of sunshine. Lowest surpluses for sunshine duration were observed over the **Iberian Peninsula** with an average surplus of only 7 sunshine hours. A deficit of 60 hours was observed during summer, the other seasons were slightly sunnier than normal. The **Middle East** received above-normal sunshine hours as well with 78 hours more sunshine than normal. The parts of **Scandinavia and the Baltic States** covered by the maps experienced mostly surpluses of sunshine duration up to 125%. The areal means are not representing the entire subregion but only the parts covered by the product (see **Figure 2-5**).

2.1.5. Drought situation

When looking at the Global Precipitation Climatology Centre Drought Index (GPCC-DI, Ziese et al. 2014) as a metric for characterizing meteorological drought, the values for the year as a whole ranged mostly between −1 and 1 (see **Figure 2-6**). Most regions with large precipitation deficits (for example areas neighbouring the Black Sea and the Baltic countries, see also 2.1.3) appear here with values between 0 and −1 indicating mild drought conditions on annual average. Over parts of Spain and the Middle East the drought situation was even classified as moderate drought with values as low as −1.5 (Spain) or lower (Syria, Israel). For some countries, this year's total precipitation ranked among the top 10 of the driest years.

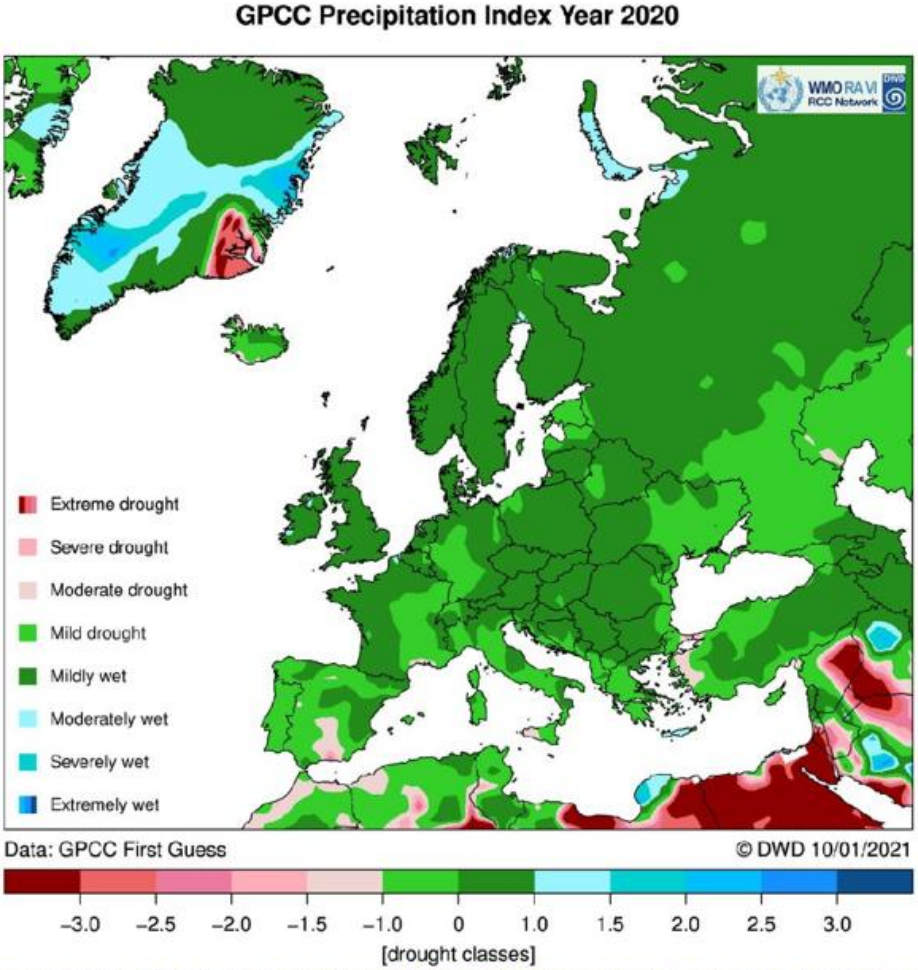


Figure 2-6: *Annual GPCC –DI (GPCC-Drought Index) in drought classes relative to 1961–1990 for the year 2020. Source: RCC-CM website.*

2.1.6. Snow cover

In January, there was considerable snow in Iceland, Scandinavia and Eastern Europe as well as the Alps. These regions were covered by snow for the whole month. Altai is a good example for the high amount of snow in Russia, where snow piles were above human height. In the North Caucasus, the amount of snow reached up to 30 mm per day. In Nur-Sultan, the capital of Kazakhstan, no such abundance of snow has been seen for more than 50 years in January. Due to the high-pressure influence from the Atlantic Ocean and high temperatures, there was no snow in the west, the south and most parts of Central Europe.

In February, there was considerable snow in Iceland, the north of Scandinavia and northeastern Europe as well as the Alps. These regions were covered by snow for almost the entire month. In Finland and Sweden, the country was split into two parts: the southern part experienced exceptionally low (or no) snow coverage, whereas in the northern part, an unusually high snow depth of up to 120 cm was measured. Due to the extended high-pressure influence from the Atlantic Ocean into the European continent and high temperatures, there was no snow in Western, Southern and most parts of Central Europe.

In March, due to warm temperatures and sparse snowfall in the preceding winter there was consequently a less extended snow cover in spring. While snow covered much of Norway and the northern parts of Sweden and Finland during almost the entire month of March, the southern end of each of these countries saw less than 15 days of snow cover, southern Sweden was even completely snow-free.

In April, parts of northern and central Finland received record-breaking amounts of snowfall. At Sodankylä, the Tahtela weather station reported 1.25 m of snow on 14 April, breaking the previous record of 1.19 m set on 6 April 2000. Northern Norway saw extreme snowfall as well. At the official station in Tromsø, 30 cm of snow fell within one day on 5 April. In other parts of the town, a daily accumulation of almost 1.2 m was reported the same day. Over the whole snow season, 6.5 m of snow had fallen, the highest snowfall since the 1999/2000 snow season. The snow depth on 6 April was 160 cm, just 13 cm away from the highest depth on record in 1997. In Ystnes, Finnmark, the snow was 2.8 m high on 1 April, which was the highest snow depth registered in the lowland areas of Troms and Finnmark. In Iceland, up to 1.5 m of snow fell on 4–5 April. Switzerland, on the contrary experienced its mildest winter since observations started and, as a consequence, there was hardly any snow at that time.

In November, the dry high-pressure weather brought Austria one of the ten Novembers with the least precipitation in measurement history. For Austria as a whole, there was 74% less precipitation than normal. This also had an impact on the snow situation. Below 1 000 m above sea level, this November remained almost snow-free. In the high mountains, the snow cover from October remained partly intact, but the total daily amount of new snow was significantly below the average. For example, at the Rudolfshütte weather station, at 2 317 m above sea level in the Hohe Tauern in Salzburg, only 34 cm of snow fell in November 2020. In an average November, 178 cm of new snow fall here.

December brought heavy snow to the Alps. Up to 3 m of snow fell in parts of Austria (particularly eastern Tyrol) and 2 m in Italy (South Tyrol) from 4 to 6 December in elevations above 2 000 m. In Austria, 72-hour totals of fresh snow also had new records in places, e.g. 80 cm in Umhausen (Ötztal

Province, 1 030 m altitude, measurements since 1956). In Switzerland up to more than 140 cm of snow fell in elevations above 1 200–1 500 m in three days on 4–7 December. Total depths were around twice as large the normal at this time of year.

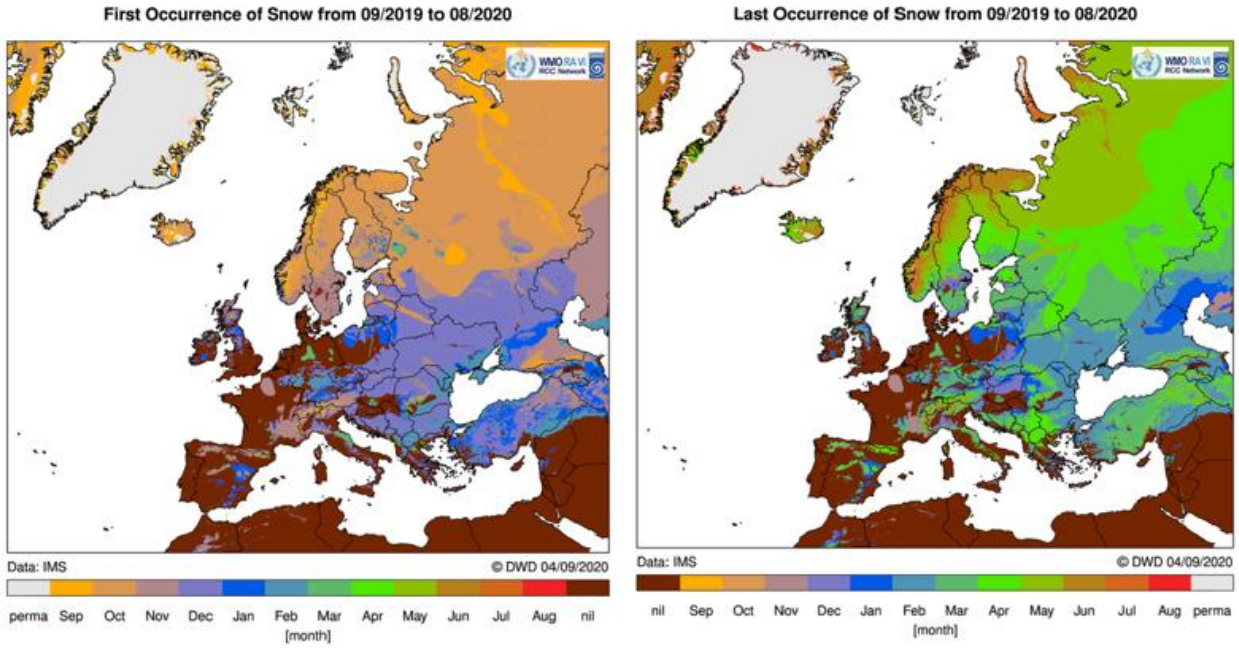


Figure 2-7: First occurrence (left) and last occurrence of snow (right) during the snow season 2019/2020 from /2019 to 08/2020. Source: RCC-CM website.

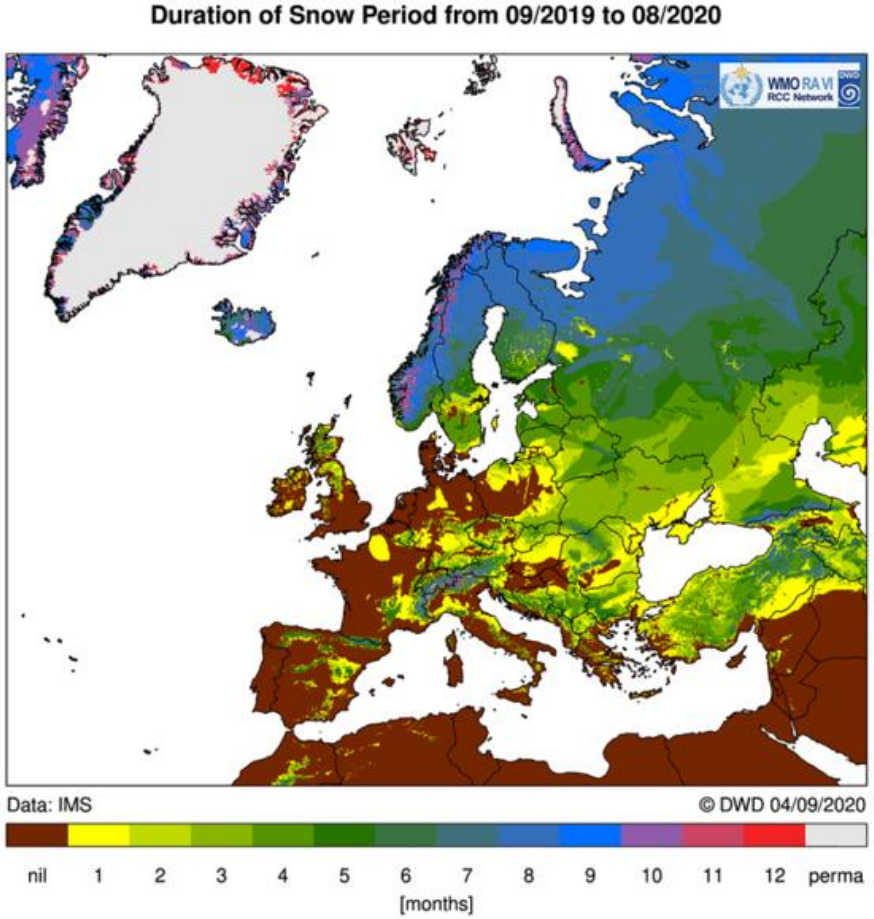


Figure 2-8: Duration of snow cover in the snow season 2019/2020 from 09/2019 to 08/2020. Source: RCC-CM website.

2.2. Selected climate indices for 2020

This section presents selected temperature and precipitation indices calculated using the station-based ECA&D (European Climate Assessment & Dataset; https://www.ecad.eu) dataset. Annual climate index maps are shown as well as anomaly and trend maps. The following climate indices are considered:

1. **RR1, Number of wet days**: count of days where RR (daily total precipitation) ≥ 1 mm; precipitation below 1 mm/day has no effect on vegetation because it normally evaporates on the same day and is locally affected

2. **WW, Number of warm and wet days**: days with TG (daily mean temperature) > 75th percentile and RR > 75th percentile

3. **SU, Number of summer days**: count of days where TX (daily maximum temperature) ≥ 25 °C

4. **TR, Number of tropical nights**: count of days where TN (daily minimum temperature) ≥ 20 °C

The maps showing the number of wet days (RR1, uppermost left panel in Figure 2-9) clearly depict the dry conditions prevailing in 2020 over southern, central and eastern parts of Europe with less rainy days than normal. The northern and northwestern parts of Europe, on the contrary, experienced more than normal wet days, in Northern Europe up to 60 days more.

The maps showing the number of warm and wet days (WW) reveal above-normal numbers of these days across Europe. Most parts show a surplus up to 30 days of warm and wet days. Only a few negative anomalies of 10 days less were recorded for example in Germany.

Another climate index is the number of summer days that are shown in the map below. The entire region received more summer days than normal in reference to 1961–1990. Northern parts saw up to 20, the southern parts more than 30 summer days more than normal. Negative anomalies with up to 10 summer days less than normal only occurred over Ireland and the northern part of Scandinavia.

There were also more tropical nights (TR) than normal in 2020 over most parts of the RA VI domain. The southern part of the RA VI Region experienced up to 60 tropical nights more than normal. Especially over central parts and Scandinavia, there were also less than normal tropical nights reported in many places.

Figure 2-10 shows the trend maps for the selected climate indices based on the years 1951–2020. In Northern, Northwestern, Central and Eastern Europe, most stations showed an increase in the annual number of wet days (RR1) for the last 69 years (mostly greater than 3 days per year per decade) while in Southern Europe a decreasing trend prevails. The decreasing and increasing trends at neighbouring stations, however, indicate inhomogeneities in the time series. The number of warm and wet days (WW) has increased over almost whole Europe by more than 1.5 days per year per decade. The annual numbers of summer days (SU) have increased in Central and Southern Europe and partly in Eastern Europe, while stations in northwestern and northern Europe do not indicate any significant trend. Annual numbers of tropical nights (TR) show an increasing trend in the southeastern part of Region VI but values are mostly small with 0–2 days per year per decade. In the northwestern part no significant trends are found.

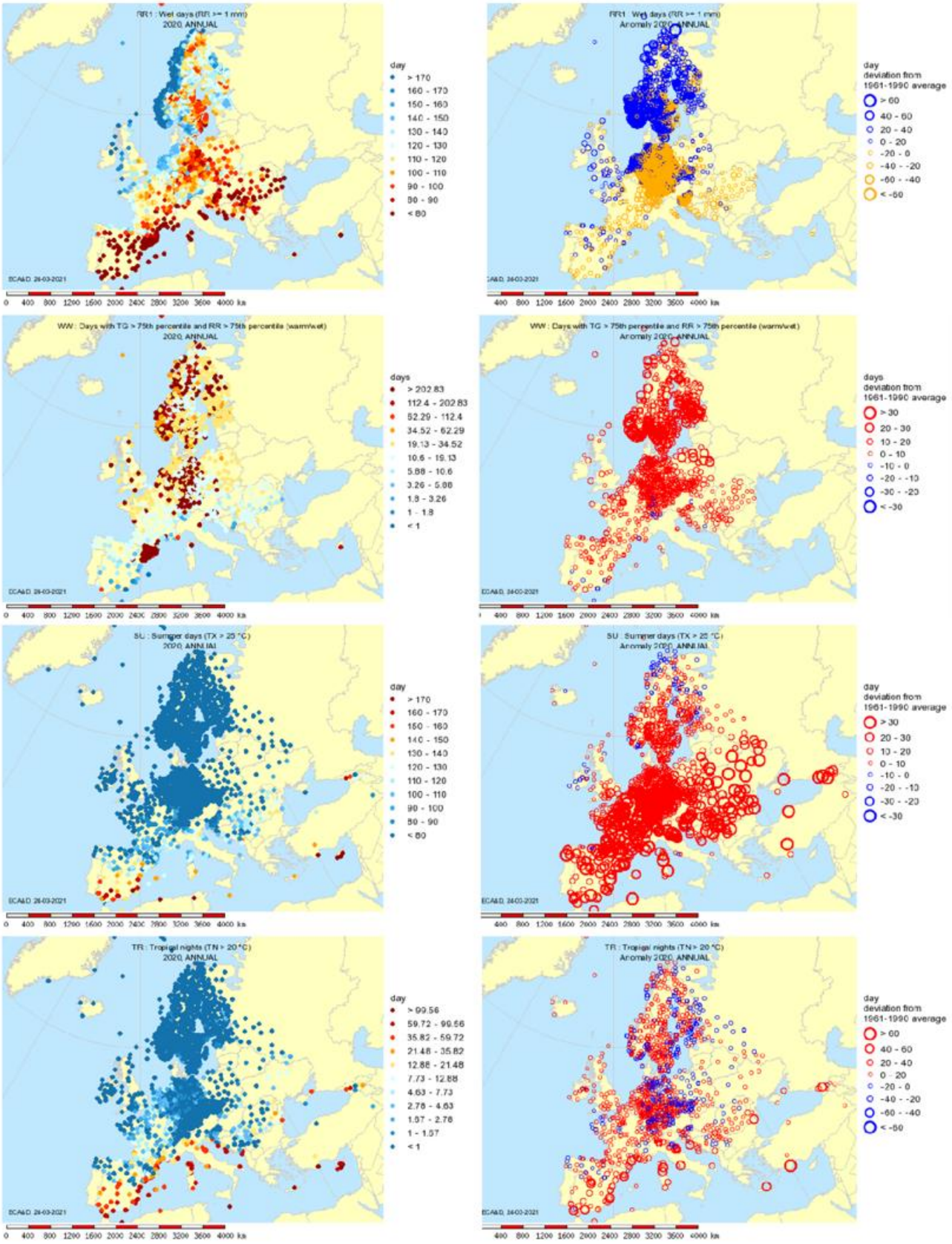


***Figure 2-9**: Selected climate indices (left) and their anomalies (right) relative to 1961–1990 for the year 2020. Source: ECA&D, ECAD website.*

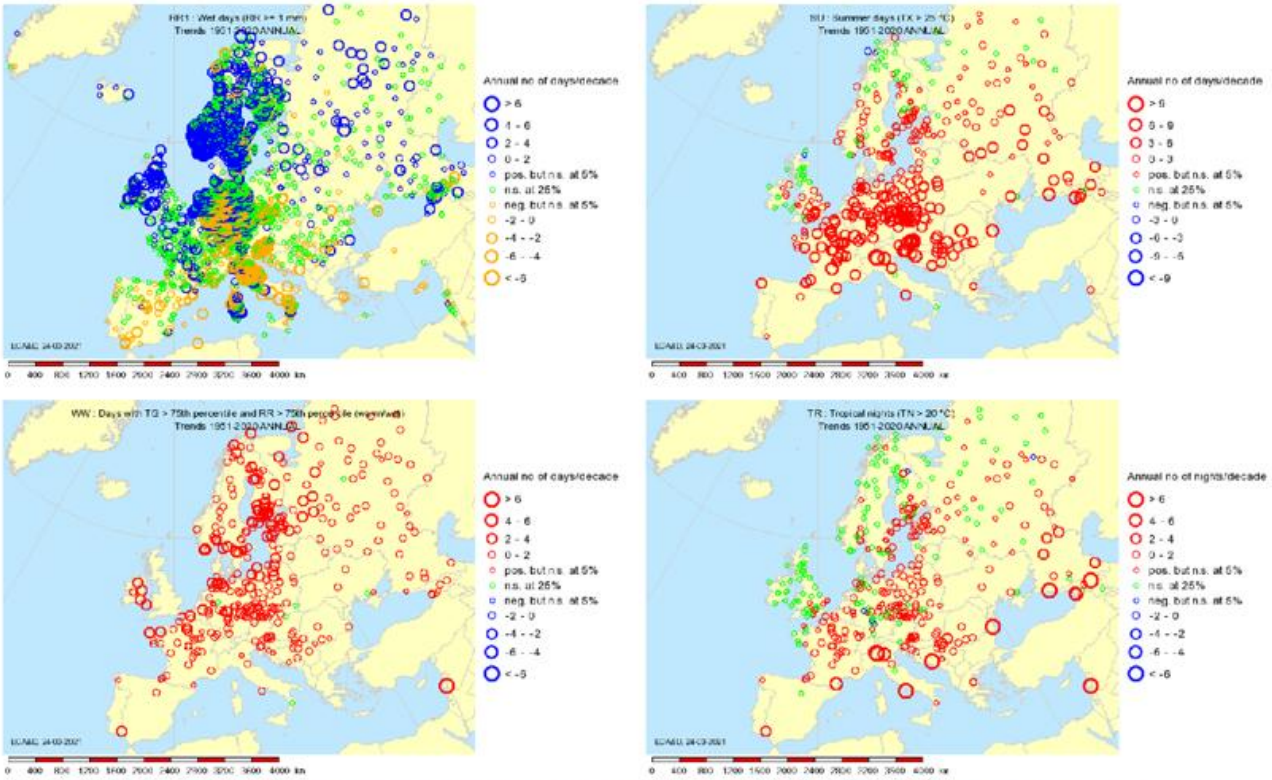


Figure 2-10: *Trends of selected climate indices for the period 1951–2020. Source: ECA&D, ECAD website.*

3. Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2020 and anomalies related mainly to the normal period 1981–2010 of the following selected climate variables: sea level pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1. Seasonal averages and anomalies of selected climate variables

3.1.1. Sea level pressure and circulation indices

The pressure distribution in **winter 2019/2020** shows that both circulation centres, the Icelandic Low and Azores High, were stronger than normal with anomalies up to −14 hPa and between +2 hPa and +6 hPa respectively. As a result, the North Atlantic Oscillation (NAO) and the Arctic Oscillation (AO) were positive with mean values of 1.02 and 2.08. The other dominant circulation pattern next to the positive NAO and AO was the East Atlantic Pattern (EA) with a mean seasonal value of 1.31, indicating that the pressure gradient over the North Atlantic was largest close to Europe.

Table 3-1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981–2010 reference. Blue and yellow colours indicate index values lower than −1 and greater than 1 respectively.

Season	AO	NAO	EA	EA/WR	SCA	POL
Winter 2019/2020	2.08	1.02	1.31	0.25	−0.8	−0.22
Spring 2020	1.18	−0.31	0.18	0.61	−1.59	0.36
Summer 2020	−0.30	−0.33	0.65	−0.68	−1.09	−0.28
Autumn 2020	0.88	1.15	0.59	−0.89	0.29	−0.42

Note that all values are standardized with the reference 1981–2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**: NOAA CPC Indices and NOAA CPC Monthly AO Index)

In **spring**, a high-pressure area extended from the Azores far to the east until southern Russia and Kazakhstan resulting in higher than normal pressure over large parts of the RA VI Region, especially over the northwest (United Kingdom, Ireland). The Icelandic Low was shifted westward. Lowest surface pressures and also largest negative anomalies occurred over the northeast in the Barents Sea. As a result, the Scandinavian Pattern Index (SCA) was strongly negative with −1.59.

In **summer**, the pressure anomalies were mostly slightly negative (within 0 hPa and −2 hPa). Positive anomalies occurred over northern European Russia and Greenland (up to +4 hPa). The negative SCA pattern continued.

The circulation centres in **autumn** were well pronounced with a core pressure between 1 000 hPa and 1 005 hPa around Iceland and between 1 020 hPa and 1 025 hPa around the Azores. The latter formed part of high-pressure belt extending far to the east across Southern and Central Europe till western Kazakhstan with one maximum around the Azores and the second one over southern parts of Russia and Kazakhstan. That is also where the largest positive anomalies (> +4 hPa) occurred. All circulation patterns were in a rather neutral phase or only weakly pronounced except for the NAO which was positive with a value around 1.

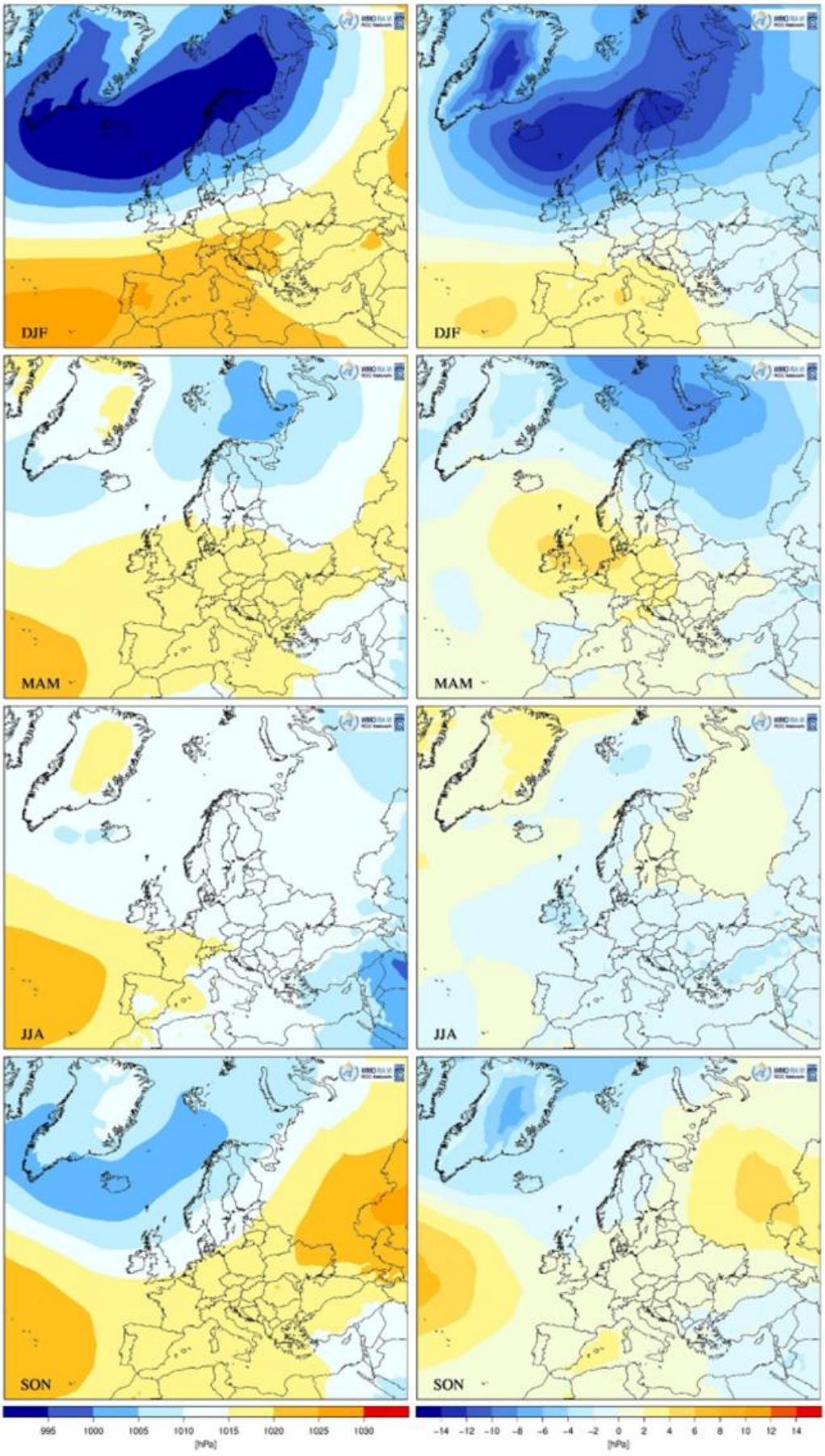


Figure 3-1: *Seasonal sea level pressure in hPa (left) and anomalies in hPa relative to 1961–1990 (right) for winter (DJF), spring (MAM), summer (JJA) and autumn (SON) 2020. Winter values relate to December 2019 – February 2020. Source: RCC-CM website.*

3.1.2. Temperature

In 2020, mean annual temperatures were higher than normal over the whole RA VI Region which is also reflected in the positive anomalies in all subregions ranging from +1.01 °C over the Iberian Peninsula to +2.18 °C in Eastern Europe. All subregions show positive anomalies in all seasons.

Table 3-2: Seasonal and annual average of temperature anomalies over land areas in °C for each subregion in the year 2020 (reference period: 1981–2010; definitions of the subregions see Figure 1-1).

Region	Year	Winter	Spring	Summer	Autumn
Central and Western Europe	+1.43	+2.87	+0.97	+0.98	+1.19
Eastern Europe	+2.18	+5.31	+0.95	+1.06	+2.68
Iberian Peninsula	+1.01	+1.72	+1.45	+0.88	+0.45
Mediterranean and Balkans	+1.34	+1.76	+0.97	+0.69	+1.91
Middle East	+1.46	+1.96	+1.10	+0.96	+2.31
Scandinavia and the Baltic States	+1.55	+2.29	+1.54	+0.86	+1.17

Winter 2019/2020 was remarkably warmer than normal. The entire RA VI Region showed positive anomalies. Mean anomalies of the subregions ranging from +1 °C to +2 °C occurred over Iberia, the Middle East, as well as over the Mediterranean and Balkans region. Larger anomalies were observed in Central and Western Europe (+2.87 °C), Scandinavia and the Baltic States (+2.29 °C). Largest positive temperature anomalies of +5.31 °C occurred in Eastern Europe. Even larger anomalies were recorded on country scale, for example in European Russia (+6.8 °C), Belarus (+5.5 °C) and all Baltic States (from +5.4 °C to +5.8 °C). These and many other countries reported their warmest winter on record (see **Table 3-3**).

Temperature anomalies in spring were also positive, but smaller compared to the winter. The mean anomalies were close to +1 °C in most subregions but higher in southwestern Europe (+1.45 °C in Iberia) and Scandinavia and the Baltic States (+1.54 °C). Locally negative anomalies occurred. Temperature anomalies of up to 1 °C below normal occurred for example in parts of Poland, Belarus and Norway.

Temperature anomalies for summer were again positive in all subregions but stayed below or close to +1 °C. In Ukraine and European Russia, temperatures were locally up to 3 °C above normal. Ireland, the United Kingdom and Italy were the only countries that partially recorded negative anomalies of up to −1 °C.

Autumn also saw above-normal temperatures in all subregions. Largest regional anomalies occurred over Eastern Europe (+2.68 °C) and the Middle East (+2.31 °C). The subregion with the lowest anomalies was the Iberian Peninsula (+0.45 °C). The arctic regions and northern European Russia saw the largest positive anomalies with temperatures being up to 6 °C warmer than normal. Positive anomalies up to +5 °C were also recorded in Türkiye. Several countries reported their warmest autumn on record (see **Table 3-3**).

Table 3-3: *Seasonal rank statistics for temperature (2019/2020) as provided by the NMHSs including countries with rankings among the top 5 (ranks 1–5) since start of the time series.*

Country	Rank	Anomaly [°C]	Reference period
		winter	
Austria	2	+3.4	1961–1990
Belarus	1	+5.5	1981–2010
Belgium	3	+2.7	1981–2010
Bulgaria	3	+2.9	1961–1990
Czech Republic	2	+3.3	1981–2010
Denmark	1	+3.5	1981–2010
Estonia	1	+5.8	1981–2010
Germany	2	+3.9	1961–1990
Hungary	4	+2.7	1981–2010
Italy	2	+2.3	1961–1990
Kazakhstan	1	+5.6	1981–2010
Latvia	1	+5.7	1981–2010
Lithuania	1	+5.4	1981–2010
Moldova	1	+4.2	1981–2010
Norway	1	+3.5	1981–2010
Poland	1	+3.9	1981–2010
Romania	2	+2.9	1981–2010
Russia	1	+6.8	1961–1990
Serbia	5	+2.4	1981–2010
Slovenia	3	+3.1	1981–2010
Spain	1	+2.2	1981–2010
Sweden	1	+4.5	1981–2010
Switzerland	1	+2.9	1981–2010
Ukraine	1	+5.3	1961–1990
		spring	
Luxembourg	4	+1.1	1981–2010
Switzerland	3	+1.8	1981–2010
		summer	
No ranks available.	-	-	-
		autumn	
Armenia	5	+1.9	1961–1990
Belarus	1	+3.1	1981–2010
Belgium	4	+1.4	1981–2010
Bulgaria	4	+1.9	1961–1990
Denmark	5	+1.6	1981–2010
Estonia	1	+3.1	1981–2010
Latvia	1	+3.2	1981–2010
Lithuania	1	+3.0	1981–2010
Moldova	1	+3.1	1981–2010
Norway	4	+2.2	1981–2010
Poland	2	+1.9	1981–2010
Romania	3	+2.0	1981–2010
Russia	2	+2.6	1961–1990
Sweden	1	+2.4	1981–2010
Türkiye	1	+2.5	1981–2010
Ukraine	4	+3.1	1961–1990

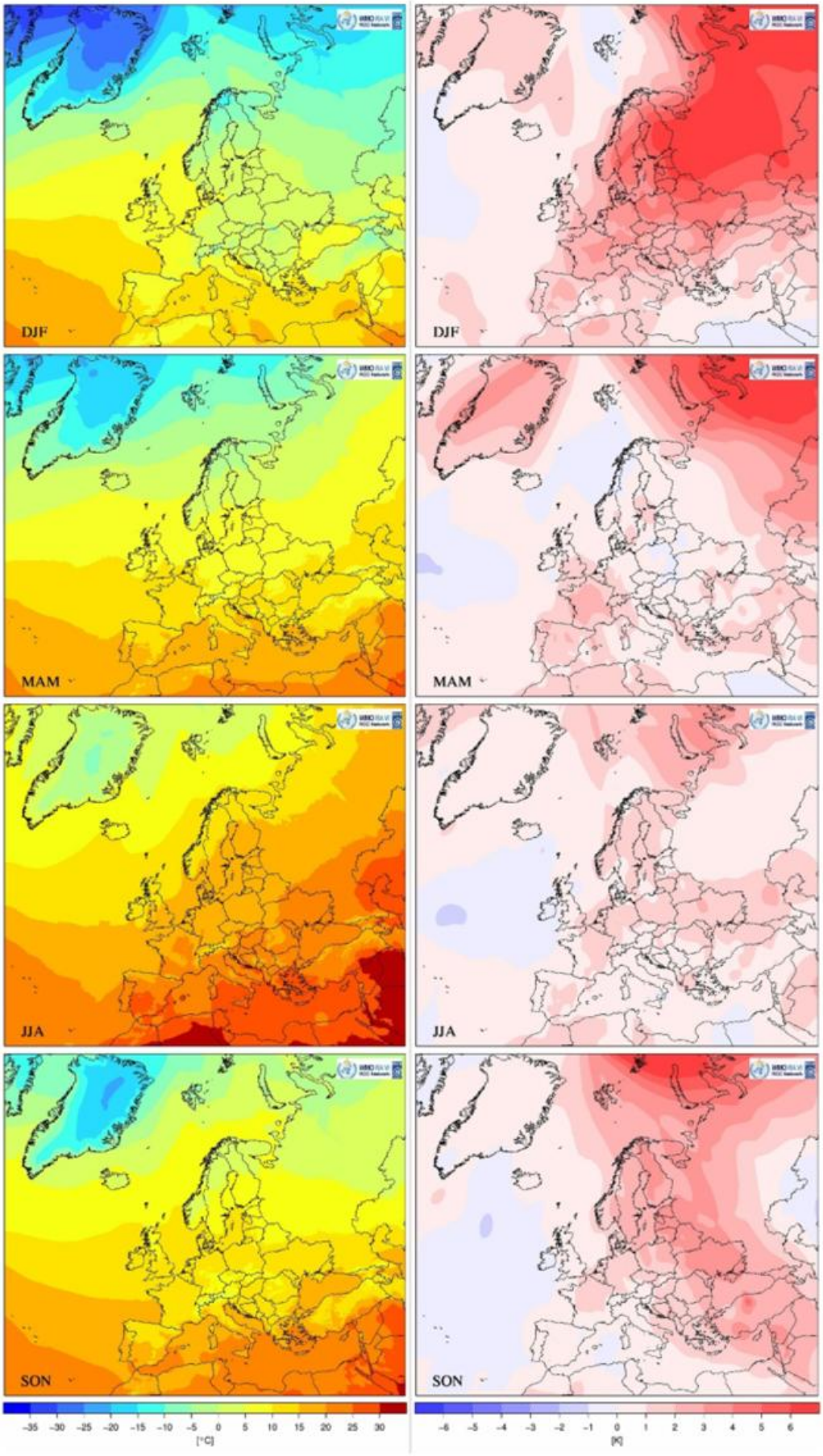


Figure 3-2: *Seasonal mean temperature in °C (left) and anomalies in K relative to 1981–2010 (right) for winter (DJF), spring (MAM), summer (JJA) and autumn (SON) 2020. Winter values relate to December 2019 – February 2020. Source: RCC-CM website.*

3.1.3. Precipitation

In 2020, average precipitation amounts across the RA VI Region were mostly within 80%–125% of normal. Regional averages were close to normal except for the Middle East and Scandinavia and the Baltic States where average precipitation amounts were larger than normal with 112% and 118% respectively.

Winter 2019/2020 saw higher than normal precipitation anomalies in most subregions of the RA VI except for the Iberian Peninsula and the Mediterranean and Balkans region, which registered around normal precipitation. Winter was especially wet in Scandinavia, European Russia, Türkiye, the Middle East, the United Kingdom, Ireland and parts of Greenland and Spain with precipitation totals of 125%–250% of normal amounts. Large parts of Eastern, Central and Western Europe showed around normal values. The Mediterranean and Balkans region, the Baltic States, western Iberia, parts of Greenland and Kazakhstan experienced drier than normal conditions with 20%–40% less precipitation than normal. Even less precipitation was recorded in Sicily (partially 80% less than normal precipitation).

Table 3-4: Seasonal and annual average of precipitation anomalies over land areas in % for each subregion in the year 2020 (reference period: 1981–2010; definitions of the subregions see Figure 1-1)

Region	Year	Winter	Spring	Summer	Autumn
Central and Western Europe	99	115	71	107	98
Eastern Europe	97	113	119	93	83
Iberian Peninsula	93	96	141	76	86
Mediterranean and Balkans	95	99	104	113	66
Middle East	112	124	132	85	59
Scandinavia and the Baltic States	118	117	116	98	132

Spring was wetter than normal for Eastern Europe due to Arctic troughs extending into that area, with many areas receiving precipitation well above 125% of normal, some even more than 167% of normal. Wetter than normal conditions also prevailed over the Iberian Peninsula and the Middle East, with precipitation anomalies of 141% and 132% respectively. Conversely, Central and Western Europe and parts of the Scandinavian and Baltic states and the Balkans were drier than normal, due to more high-pressure influence that contributed to the third spring with a precipitation deficit on a row, after 2018 and 2019. These areas only received 40%–80% of normal precipitation amounts. Northwestern Germany, the Benelux, and southern United Kingdom partially received precipitation as low as 20% of normal.

The distribution of precipitation during the summer months was very inhomogeneous. The central Mediterranean region and the Balkan states, the United Kingdom, and eastern parts of Central Europe received above-normal precipitation with anomalies ranging from 125%–167% of normal precipitation in most parts. Scandinavia and the Baltic states, influenced by higher than normal pressure, as well as the southern parts of the Iberian Peninsula, which were strongly influenced by dry subtropical air from northern Africa, were drier than normal. Largest precipitation deficits occurred over Iberia and the Middle East with average precipitation totals as low as 76% and 85% of normal

precipitation respectively on regional level. For many areas north of the Black Sea, precipitation was well below 60% of normal amounts.

In autumn, the dry conditions over the RA VI Region continued. Over the Eastern Europe and Iberian Peninsula received on regional level only 83% and 86% of normal amounts, respectively. Largest deficits were observed in the Middle East and the Mediterranean and Balkans region which saw only 59% and 66% of normal precipitation amounts, respectively. Over Iceland, Syria, Kazakhstan, Ukraine, Greece and Türkiye partially only 20%–60% of normal precipitation amounts were registered. Ireland, the United Kingdom, the Benelux, and the Scandinavian countries, on the contrary, experienced normal or slightly wetter than normal conditions in autumn.

Table 3-5: Seasonal rank statistics for precipitation (2019/2020) as provided by the NMHSs including countries with rankings among the top 5 (ranks 1–5) since start of the time series.

Country	Rank	Anomaly [mm][3]	Reference period
		winter	
Denmark	2 (wettest)	+100.4	1981–2010
Estonia	5 (wettest)	+37.9	1981–2010
Sweden	1 (wettest)	+63.0	1981–2010
		spring	
Hungary	4 (driest)	−58.0	1981–2010
Lithuania	4 (driest)	−80%	1981–2010
North Macedonia	4 (wettest)	+62.0	1981–2010
		summer	
Armenia	4 (driest)	−14.7	1961–1990
Ireland	4 (wettest)	+133.7	1981–2010
Serbia	2 (wettest)	+11.3	1981–2010
		autumn	
North Macedonia	2 (driest)	−66.2	1981–2010

[3] By default anomalies are given in mm unless otherwise specified.

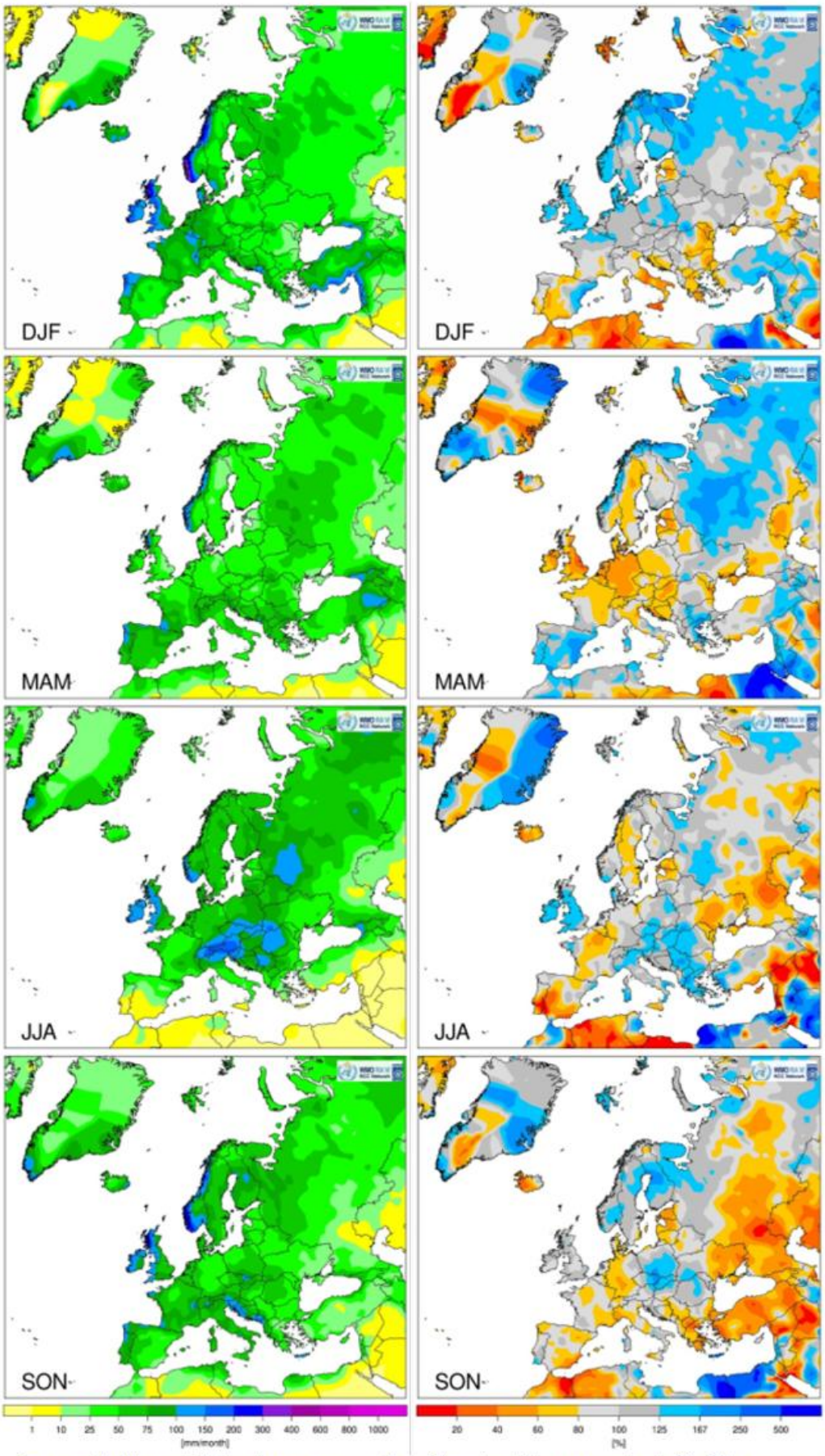


Figure 3-3: *Seasonal total precipitation in mm per month (left), and relative anomalies in % of the average for 1981–2010 (right) for winter (DJF), spring (MAM), summer (JJA) and autumn (SON) 2020. Winter values relate to December 2019 – February 2020. Source: RCC-CM website.*

3.1.4. Sunshine duration

The year 2020 as a whole was sunnier than normal (w.r.t. 1986–2015) over most parts of the RA VI Region with surpluses of up to 500 hours in some parts. On regional scale, largest surpluses were observed in the Mediterranean and the Balkans region as well as in Central and Western Europe with mean anomalies exceeding 170 hours more sunshine than normal.

Table 3-6: Seasonal and annual average of sunshine duration anomalies over land areas in hours for each subregion in the year 2020 (reference period: 1986–2015; definitions of the subregions see Figure 1-1).

Region	Year	Winter	Spring	Summer	Autumn
Central and Western Europe	+177	+40	+155	+3	+5
Eastern Europe[1]	+106	+20	+39	+22	+29
Iberian Peninsula	+7	+32	−61	+11	+30
Mediterranean and Balkans	+173	+57	+58	−2	+65
Middle East	+78	+11	+25	+5	+31
Scandinavia and the Baltic States[4]	+39	+5	+24	+21	−8

In winter 2019/2020, all subregions of the RA VI Region were on average sunnier than normal. With about 57 hours more sunshine than normal, the Mediterranean and Balkans region was the region with the largest surplus. Lowest anomalies occurred in the Middle East with only about 11 hours more sunshine than normal and in Scandinavia and the Baltic States (+5 hours), but due to the low absolute sum in Northern Europe, relative anomalies were large there.

Spring brought a lot of sunshine to Central and Western Europe with a surplus of 155 hours. For Germany, it was the sunniest spring since 1951. In Switzerland, Basel registered the second sunniest spring since the beginning of measurements in 1886 with 718 hours of sunshine. Uccle (Belgium) saw a new spring record for sunshine duration with 741 hours instead of 464 hours (time series started in 1887). Less sunny than normal conditions prevailed over the Iberian Peninsula with around 61 hours less sunshine than normal. Less sunshine was also received in parts of Russia, Belarus and Sicily.

In summer, all subregions registered normal to slightly above-normal sunshine. Eastern Europe (22 hours more sunshine) and Scandinavia and the Baltic countries (21 hours more sunshine) had the largest positive anomalies. Parts of Scandinavia, Russia and Ukraine recorded even surpluses of 100–200 hours sunshine hours compared to normal. Largest deficits occurred over Ireland and the United Kingdom with up to 200 hours less sunshine than normal.

The sunniest subregion in autumn was again the Mediterranean and the Balkans region with an average surplus around 65 sunshine hours. At country level, Russia and Türkiye experienced even larger surpluses with up to 200 hours more sunshine hours than normal. For Russia, it was the sunniest autumn since 1961. Less sunshine hours than normal occurred over northwestern and northern parts and over parts of Central Europe with up to 100 hours less sunshine than normal.

[4] This subregion is not fully covered, therefore the values are not representing the entire region (see maps).

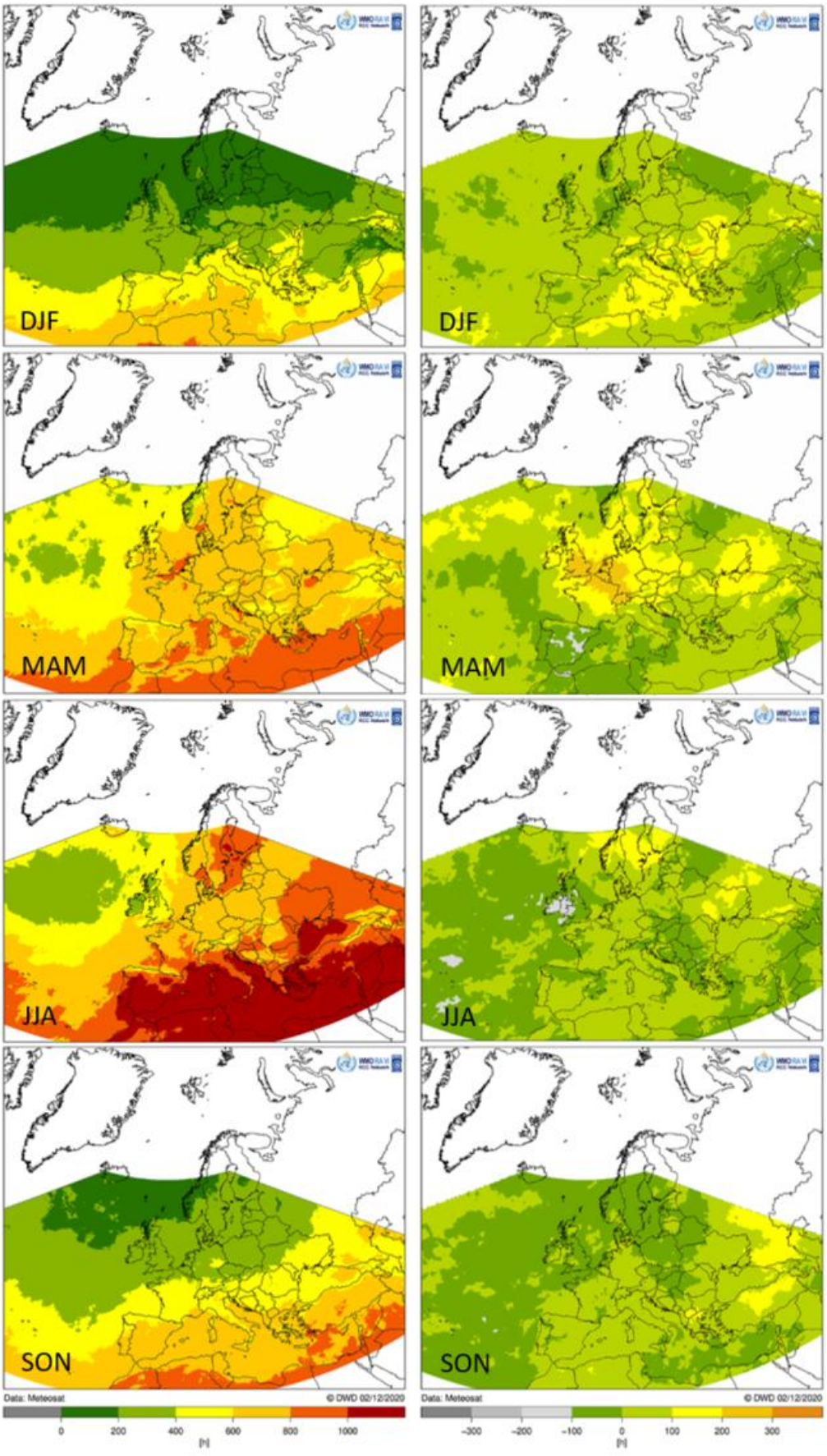


Figure 3-4: *Seasonal sunshine duration in hours (left) and absolute anomalies in hours relative to 1986–2015 (right) for winter (DJF), spring (MAM), summer (JJA) and autumn (SON) 2020. Winter values relate to December 2019 – February 2020. Source: RCC-CM website.*

3.1.5. Drought

In 2020, most regions in the RA VI showed mildly dry to mildly wet conditions on average. Severe to extreme drought signals only appeared in the Middle East, parts of Spain and Greenland. However, some more pronounced drought conditions were observed on seasonal scale.

In **winter 2019/2020**, most parts of the RA VI Region saw mildly dry to mildly wet conditions with GPCC-DI values ranging between −1 and 1. In Romania, the Mediterranean and Balkans, the Iberian Peninsula and Greenland, even drier conditions occurred. For southern regions of Portugal (Baixo, Alentjo, Algarve) January was the start of a prolonged drought situation. Extremely dry conditions in Greece were the determining factor for January 2020 to be one of the top ten driest Januaries on record.

The precipitation deficits occurring in **spring** over Central and Western Europe, Scandinavia and the Baltic countries mostly only led to mildly dry conditions in these areas. In some parts, however, these deficits caused even moderate to severe drought (GPCC-DI values between −1 and −1.5), namely in northern Germany, the Netherlands and parts of the United Kingdom. In the Netherlands, a record high precipitation deficit was observed in the months of April and May, which was 160 mm for De Bilt. In the United Kingdom, spring was the fifth driest on record.

Summer saw wet conditions in most parts of the RA VI Region, especially in the eastern and northeastern parts. Only in the southwest and southeast dry conditions prevailed. The Iberian Peninsula, parts of Türkiye and the Middle East experienced partially even extremely dry conditions (GPCC-DI values up to −3).

Mildly dry to mildly wet conditions prevailed in **autumn** over most of the RA VI Region, except for the Middle East, parts of European Russia and the eastern Mediterranean where locally medium to extremely dry conditions occurred.

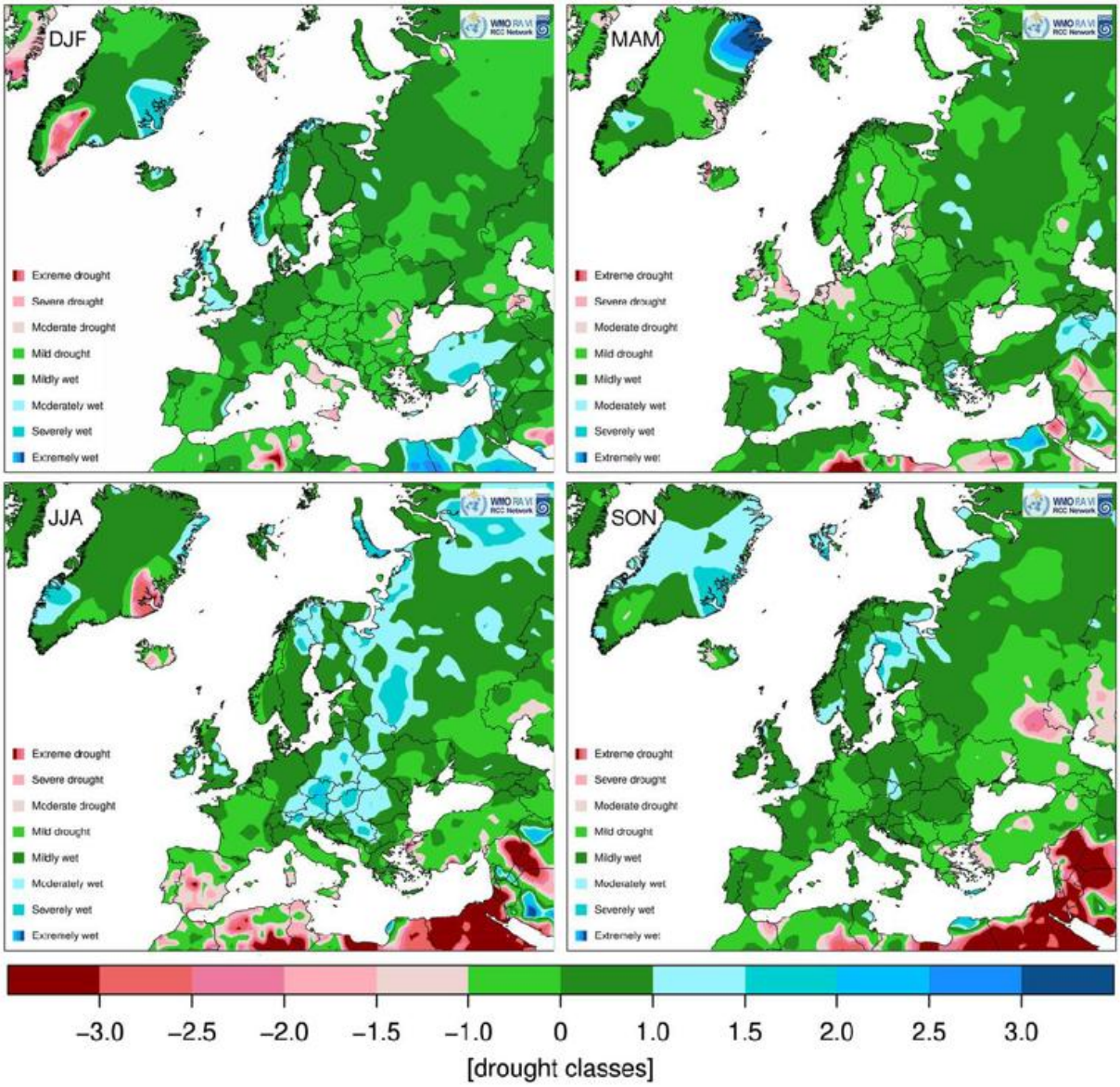


Figure 3-5: *Seasonal GPCC-DI (Drought Index) in drought classes relative to 1961–1990 for winter (DJF), spring (MAM), summer (JJA) and autumn (SON) 2020. Winter values relate to December 2019 – February 2020. Source: RCC-CM website.*

3.1.6. Selected contributions by NMHSs

3.1.6.1. Stormy and very wet conditions during summer in Bulgaria

(Contribution from the National Institute of Meteorology and Hydrology, Bulgaria)

Severe thunderstorms, accompanied by torrential rains, hail and stormy winds, leading to local floods, road damage and broken electricity pools, were registered mainly in western and central parts of the country in May, June, July, and the first half of August.

In May, thunderstorms with hail and heavy rainfall caused significant damage to many settlements, mainly in northwestern Bulgaria. The thunderstorm caused several fires in the Vidin region. In the evening of 20 May, a large hailstorm with hailstomes similar to the size of chestnuts lasted over 10 minutes and caused material damage in the districts of Sofia, Vidin and Montana. Egg-sized hailstones fell in the municipality of Godech on 21 May. It was accompanied by strong wind and rain and caused great material damage, for example broken windows of houses and cars, damaged roofs, and destroyed agricultural areas.

In June, powerful thunderstorm, accompanied by intense rain and hail, led to damages in many parts of the country. More than 30 houses in the village of Kazichene, Sofia District, were flooded. As a result of the heavy rains, dozens of flooded houses and significant damage to the Veliko Tarnovo District's road infrastructure had been reported. Due to the huge amount of water poured into the region, a landslide formed on the road that connects the city with several other neighbouring villages.

In July, a powerful thunderstorm, accompanied by torrential rain, hail, and strong wind, caused serious damage in various regions of Sofia. The disaster lasted about two hours, as the measured amount of rain in some stations in the southwestern part of the capital exceeded 50 mm. Subways, shops, streets, ground floors of administrative and residential buildings were flooded. The Vladayska, Slatinska and Perlovska rivers overflowed. The Evlogi and Hristo Georgievi Boulevard became a canal, as the wave dragged dozens of cars. Strong winds felled nearly 70 trees.

3.1.6.2. Scorching heat in Romania in summer

(Contribution from Meteo Romania)

In order to assess the agrometeorological conditions in the time period with maximum water demands of the crops (June–August), data was processed concerning the intensity and duration of the scorching heat phenomenon. Scorching heat characterized through its intensity (Σ maxT ≥ 32 °C per scorching heat units) and duration (number of days with scorching heat units). **Figure 3-6**, reveals that in time period from 1 June to 31 August, both the sum of the units and the number of days when the scorching heat occurred was small (0–10 scorching heat units per 0–10 days) in Transylvania and Maramureş, most parts of Crişana and Banat, locally in the north, west and east of Moldavia, northern and western Oltenia and in eastern and southeastern Dobrudja. There was moderately intense scorching heat (11–30 scorching heat units in 11–20 days) locally in western and

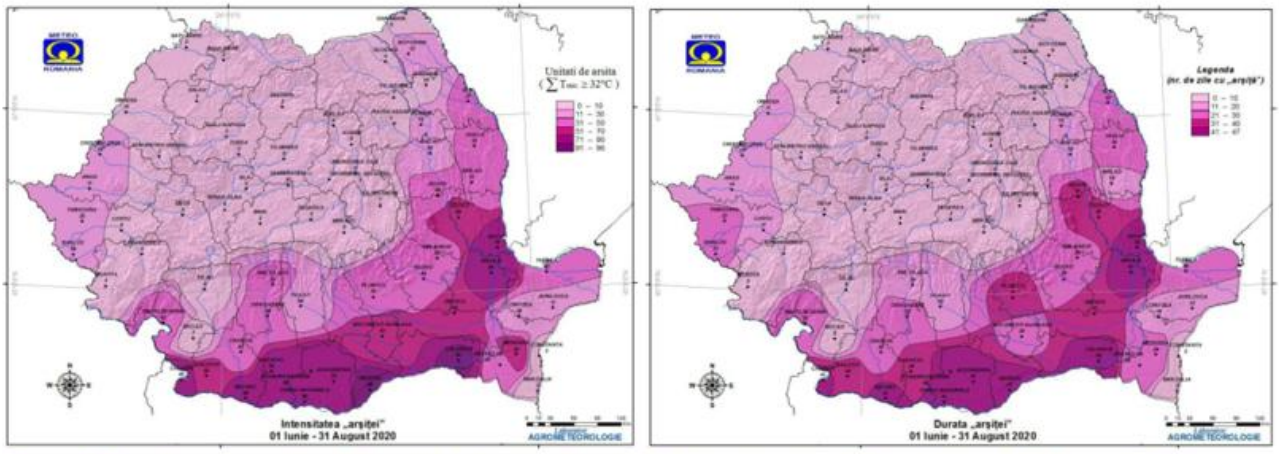


Figure 3-6: *Intensity (on the left) and duration (on the right) of "scorching heat" from 1 June to 31 August 2020. Source: Meteo Romania.*

southern Crișana, northern and western Banat, central and eastern Dobrudja, in central and sparsely in northern Moldavia, also in western Wallachia. Locally, in eastern and southern Moldavia, in northern Wallachia, in eastern, northeastern, central and sparsely in western Oltenia, and in northern and southwestern Dobrudja, the intensity of the scorching heat was high (31–50 scorching heat units in 21–30 days). Locally, in eastern, southern and central Wallachia, in southern Oltenia, in the south and southeast of Moldavia and sparsely in central Dobrudja, 51–96 scorching heat units accumulated per 31–47 days, which made the scorching heat severely intense.

4. Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2020 on the Climate in WMO Region VI - Europe and Middle East (available on RCC-CM website). It contains highlights, means and anomalies of sea level pressure, temperature, precipitation and sunshine duration for each month as well as monthly overviews of extremes and notable events.

4.1. Sea level pressure and circulation indices

This chapter about atmospheric circulation provides information on selected northern hemisphere teleconnection indices relevant for WMO RA VI and discusses influences of circulation patterns upon anomalies and outstanding events. The information is based on the "Monthly Bulletins on the Climate in WMO RA VI" and was completed by reports of the NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/upper troposphere not shown here (see NOAA NCEI Products and NOAA CPC Products).

Table 4-1: *Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981–2010 reference including the Arctic Oscillation, from January to December 2020.*

Year	Month	AO	NAO	EA	EA/WR	SCA	POL
2020	1	2.42	1.05	1.74	0.66	−0.55	0.16
2020	2	3.42	0.98	1.38	−0.06	−2.69	−0.39
2020	3	2.64	0.66	−0.11	0.57	−0.88	1.75
2020	4	0.93	−1.26	0.58	1.82	−1.52	0.45
2020	5	−0.27	−0.33	0.06	−0.55	−2.37	−1.11
2020	6	−0.12	0.16	−0.08	−2.01	0.58	−0.24
2020	7	−0.41	−1.19	0.46	−0.68	−2.29	−0.08
2020	8	−0.38	0.03	1.57	0.64	−1.56	−0.51
2020	9	0.63	1.11	1.95	−0.94	−0.47	0.32
2020	10	−0.72	−0.20	−0.23	−1.82	1.45	−1.01
2020	11	2.09	2.54	0.05	0.08	−0.11	−0.57
2020	12	−1.74	−0.37	−0.80	−1.11	2.33	0.09

North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**: NOAA CPC Indices and NOAA CPC Monthly AO Index)

The daily NAO and AO were strongly positive for almost the whole of January, showing a decreasing tendency. The Azores High was more intense than normal in January 2020 and extended far to the east. The Icelandic Low was also more pronounced than normal, but split into two centres, one over Iceland and another one over northern Russia. This situation resulted in a stronger-than-normal westerly flow over the eastern North Atlantic bringing exceptionally mild air to Europe. Central and Southern Europe were under high-pressure influence the entire month, associated with a lack of precipitation and above-normal sunshine. Around 15 January there was an important change in the European Weather type after Hess/Brezowsky which caused a significant decrease especially of the

AO. Except for the last few days the primarily strong positive daily values resulted in positive monthly values of both NAO and AO with respectively values of 1.05 and 2.42.

The daily NAO and AO were strongly positive for almost the entire month, especially between 7 and 25 February. Around 3–5 February both indices reached their monthly minimum, which is still above normal (1961–1990) for the AO, but below normal for the NAO. On 10 and 21 February the AO reached its maximum value which was 6. The primarily strong positive daily values resulted in positive monthly values of both NAO and AO with respectively values of 0.98 and 3.42. The Azores High was more intense than normal in February 2020 and extended to the east, with its core over Southwestern Europe. The Icelandic Low was more pronounced than normal and extended almost over the whole of Northern Europe from Greenland to eastern Russia. This situation resulted in a stronger-than-normal westerly flow over the eastern North Atlantic bringing exceptionally mild and humid air to Europe.

The daily NAO was neutral at the beginning and end of March and moderately positive in between. The daily AO was strongly positive until the last days of the month when it became neutral. The monthly averages of both indices are positive with values of 0.66 for NAO and 2.64 for AO and thus continue the positive phase of the two previous months. The positive AO/NAO values were due to an anomalous low-pressure area near the North Pole favoured by a strong polar vortex and a well pronounced Azores high. The high-pressure area reached further north than normally and extended over the large parts of the European continent. This positive AO/NAO setup resulted in a strong zonal jet stream which kept much of the frigid air in the Arctic, leaving the mid-latitudes warmer and generally less snowy than normal, but which also brought stormy weather which especially affected northwestern Europe.

The daily NAO was negative at the beginning of April and weakly positive to neutral during the second half of the month. The monthly average was weakly negative (−1.26). The negative NAO was primarily driven by an anomalous trough in the North Atlantic, which was strongest early in the month and high-pressure extending far north and east till south of Iceland and Central Europe. This resulted in higher than normal pressure from Iceland to Southeastern Europe and lower than normal surface pressure over the Azores. The daily AO was mostly positive with two weak negative episodes around 3 and 21 April. The monthly average was positive (0.93). The positive AO was primarily driven by the high-pressure over Western Europe combined with an anomalous trough near the North Pole which extended till northern Russia.

The daily AO was weakly negative for most of the first half of May and then weakly positive later in the month. The monthly average was near zero (−0.27). The daily NAO was also weak but positive for most of the month except for the second week of May when it was strongly negative. With a value of −0.33 it was slightly negative when averaged over the month. Accordingly, the Azores High was weaker than normal in May 2020 but extended far to the northeast until Iceland in the north and Poland in the east, with a second core over the British Isles. The Icelandic low was a bit more intense than normal but split into two cores with the second core situated south of Spitsbergen. This situation resulted in a lower-than-normal westerly flow, with the high-pressure centred over the eastern North Atlantic bringing exceptionally mild and humid air to the northwestern part of Europe.

With a negative NAO index the Azores high and the Icelandic low were weakly pronounced in June. The westerly flow was weak and blocking formed with stable weather conditions. Atmospheric

blocking came up with long-lasting large-scale weather events like the heat wave in the Arctic region. In northern Europe and parts of the Arctic, an area of unusually high-pressure developed, that caused extremely high temperatures. The high-pressure anomaly caused little precipitation in Northern Europe, whereas further south there was more precipitation due to cyclonic influence. The AO was negative most of the month too. The NAO decreased significantly at the end of the month.

The daily NAO and AO indices were mostly negative during the whole month and as a result NAO and AO monthly mean values for July were also both negative with values of −1.19 and −0.41. In July 2020, the Azores High was a little bit more intense than normal and also the Icelandic Low was in its centre more intense, but south of Greenland the sea level pressure was higher than normal. This situation led into north-west flow, which brought cold and wet air to Northern Europe. During the month, the northwesterly flow changed to a southwesterly flow which caused a transport of warm air masses to East Europe. Central and Southern Europe were under high atmospheric pressure influence which led to a lack of precipitation and above-normal sunshine. Due to low atmospheric pressure influence over northern Europe there was above-normal precipitation and lower temperature.

Both NAO and AO were rather weakly pronounced during August resulting in monthly mean values close to zero: 0.03 for NAO and −0.38 for AO. During the first half of August, the daily NAO was moderately positive which was primarily associated with a trough over Greenland early in the month. But then the pattern changed and a blocking pattern built up across Western, Central, Eastern, and Southwestern Europe which is also reflected in the daily NAO values which changed to negative values by mid of the month. This blocking brought an intense heatwave to much of Western Europe. During the second half of the month, the atmospheric situation changed to more cyclonic patterns bringing largely above-normal precipitation to the British Isles, and a band extending from the Alpine region over eastern parts of Central Europe till northwest Russia. On a monthly basis, the pressure was lower than normal over the Atlantic, Western Europe and the Mediterranean, mostly up to 2 hPa below normal, over the North Atlantic even up to 6 hPa below normal. From northern Ukraine to southern Scandinavia, pressures were slightly higher than normal.

The daily NAO was neutral at the beginning of September, then strongly positive during 7 to 21 September and turned strongly negative by the end of the month. The daily AO was positive during most of the month with the strongest values around 10 and 21 September. Monthly averages of both indices were positive, 1.11 and 0.63 for NAO and AO respectively, reflecting the persistent trough near Greenland and the ridge over the North Atlantic throughout the month. The high-pressure extended further to the north than normal and also in the east pressure was larger than normal. The Icelandic Low was also stronger than normal with the lower than normal pressure area reaching even Spitsbergen and Scandinavia. This resulted in a stronger than normal west wind drift shifted towards the north affecting Scandinavia and the British Isles with heavy rain.

Both daily NAO and daily AO were generally negative until around 20 October and positive thereafter. The negative values early in the month were stronger for the NAO than the AO, so the monthly mean NAO for October was negative whereas for AO the monthly mean value was near zero. As visible from the monthly pressure maps, October 2020 was characterized by higher than normal surface pressure around Spitsbergen extending towards the east of the RA VI domain as well as by low pressure in the south of Iceland. The low pressure was more pronounced than usual over Europe, resulting in negative anomalies over practically the whole European continent except

for the Iberian Peninsula and northern Scandinavia. Additionally, a persistent ridge over the North Atlantic favoured stronger than normal westerly winds which dominated especially at the end of the month (positive NAO).

Both daily NAO and AO were strongly positive for nearly the entire month, and the respective **November** means were thus also strongly positive with 2.54 for NAO and 2.09 for AO. The strongly positive signals were associated with a persistent trough near Greenland and a ridge over the North Atlantic. These features were prominent throughout most of November. As a result, November 2020 was characterized by higher than normal mean sea level pressure over most parts of the European continent and lower than normal pressures north of the Arctic Circle. These unusual anticyclonic conditions resulted in very dry, warm and sunny weather conditions over large parts of the RA VI Region.

The daily AO was negative for most of **December** with strongly negative values in mid-December and at the end of the month. The monthly mean was strongly negative (−1.74). The daily NAO was weak but negative during most of December, and the monthly mean NAO was slightly negative (−0.37). The negative values of both indices were associated with a ridge near Greenland. The NAO's amplitude was reduced, however, because that ridge extended southward into the North Atlantic. During a typical negative NAO phase, a trough would have been located to the south of the Greenland ridge. The higher than normal mean sea level pressure extended from Greenland far to the north and east where a pronounced high was located over Russia. Below normal sea level pressure was found over the northwestern parts of Europe which resulted in a pronounced low-pressure area with its core located between Iceland and the British Isles. These patterns led to a southerly flow in between the low-pressure to the west and the high-pressure to the east bringing exceptionally warm conditions even to the Arctic.

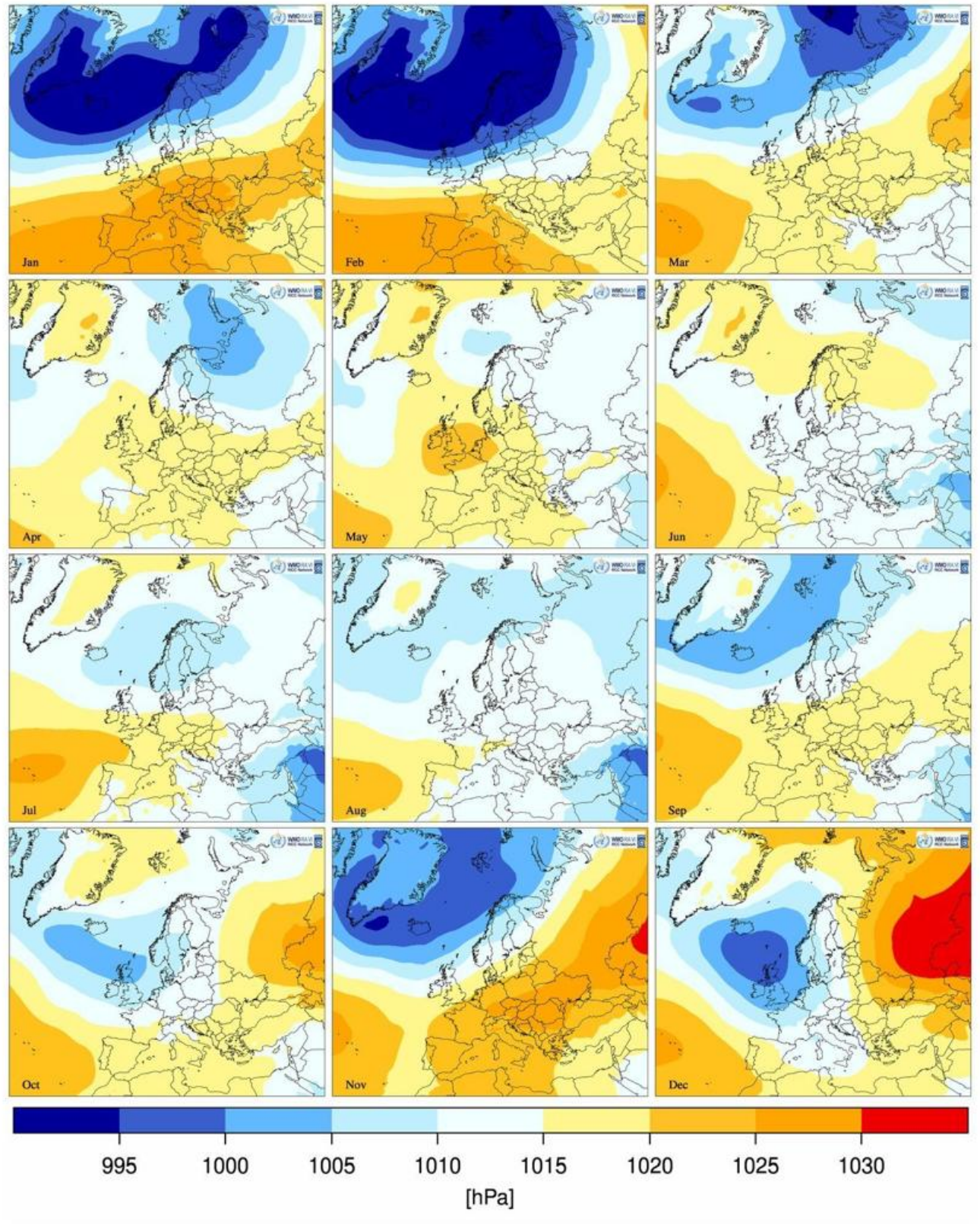


Figure 4-1: *Monthly mean sea level pressure in hPa for each month of the year 2020. Source: RCC-CM website.*

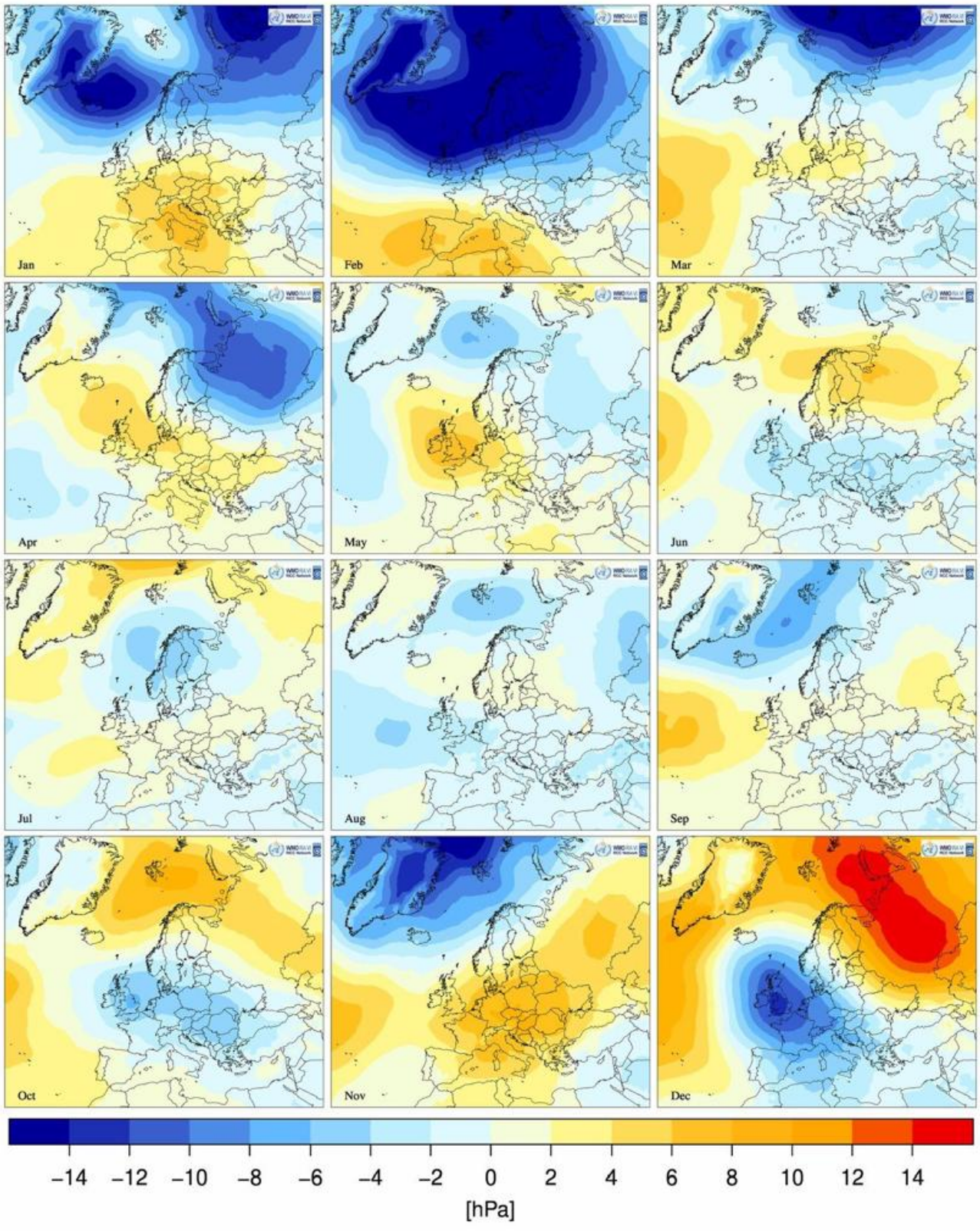


Figure 4-2: *Monthly anomalies of sea level pressure in hPa relative to 1981–2010 for each month of the year 2020. Source: RCC-CM website.*

4.2. Temperature

In most of the months and subregions it was warmer than normal as can be seen from **Table 4-3**, with April, May and October being the only months with below normal temperatures in some regions, namely Iberia and Eastern Europe. Largest anomalies with anomaly values exceeding +4 °C occurred in Eastern Europe from January to March.

Table 4-2: Monthly area average temperature anomalies in °C for each subregion in the year 2020 (reference period: 1981–2010; definitions of the subregions see Figure 1-1).

Region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Central and Western Europe	+2.4	+3.7	+0.9	+2.0	0.0	+0.8	+0.2	+1.9	+1.4	+0.5	+1.7	+1.7
Eastern Europe	+5.3	+5.7	+4.6	−1.0	−1.0	+1.8	+1	+0.4	+2.4	+3.1	+2.5	+1.1
Iberian Peninsula	+0.7	+2.8	+0.4	+1.3	+2.7	0.0	+2.1	+0.7	+0.6	−1.0	+1.7	+0.3
Mediterranean and Balkans	+0.9	+2.3	+1.8	+0.5	+0.6	+0.1	+1.1	+1.0	+2.9	+2.0	+0.8	+2.3
Middle East	+1.7	+2.0	+2.8	0.0	+0.9	+1.1	+2.0	0.0	+3.0	+2.8	+1.2	+0.7
Scandinavia and the Baltic States	+2.7	+2.2	+1.2	+2.7	+0.7	+1.6	+0.1	+0.9	0.0	+1.8	+1.8	+3.0

Table 4-3: Rank statistics, monthly average temperature and anomalies (in °C) from several countries of the RA VI for the individual months 2020 including countries with rankings among the top 5 (ranks 1–5) since start of the time series.

Country	Rank	Value (°C)	Anomaly (°C)	Reference period	Start of time series
		January			
Armenia	2 (warmest)	−5.4	+1.4	1961–1990	1935
Denmark	1 (warmest)	5.5	+4.4	1981–2010	1874
Estonia	1 (warmest)	3.1	+6.6	1981–2010	1961
Kazakhstan	2 (warmest)	−2.0	+5.8	1981–2010	1936
Latvia	1 (warmest)	3.1	+6.3	1981–2010	1924
Lithuania	1 (warmest)	2.8	+6.0	1981–2010	1961
Norway	2 (warmest)	−2.3	+4.7	1981–2010	1900
Poland	5 (warmest)	2.2	+3.7	1981–2010	1951
Russia	1 (warmest)	−4.1	+7.9	1961–1990	1936
Sweden	1 (warmest)	-	-	-	1860
		February			
Armenia	2 (warmest)	−4.0	+1.8	1961–1990	1935
Austria	2 (warmest)	-	+4.4	1961–1990	1767
Belgium	5 (warmest)	7.0	+3.3	1981–2010	1833
Czech Republic	1 (warmest)	3.7	+4.6	1981–2010	1961
Denmark	3 (warmest)	4.7	+3.7	1981–2010	1874
Estonia	2 (warmest)	1.7	+6.2	1981–2010	1961
Hungary	3 (warmest)	5.3	+4.7	1981–2010	1901
Italy	4 (warmest)	7.8	+2.9	1961–1990	1961
Kazakhstan	2 (warmest)	−0.7	+7.1	1981–2010	1936
Latvia	2 (warmest)	2.2	+5.9	1981–2010	1924
Moldova	3 (warmest)	4.4	+5.3	1981–2010	1886
Poland	2 (warmest)	4.0	+4.6	1981–2010	1951
Portugal	1 (warmest)	12.4	+2.5	1971–2000	1931

Country	Rank	Value (°C)	Anomaly (°C)	Reference period	Start of time series
Russia	3 (warmest)	−3.2	+7.3	1961–1990	1936
Slovenia	2 (warmest)	5.0	+4.5	1981–2010	1961
Spain	1 (warmest)	10.2	+3.5	1981–2010	1961
Switzerland	2 (warmest)	1.6	+3.9	1981–2010	1864
March					
Armenia	4 (warmest)	3.1	+4.5	1961–1990	1935
Estonia	5 (warmest)	2.4	+3.5	1981–2010	1961
Kazakhstan	1 warmest)	6.2	+7.1	1981–2010	1936
Moldova	2 (warmest)	8.4	+4.7	1981–2010	1886
Russia	1 (warmest)	1.3	+5.9	1961–1990	1936
Ukraine	3 (warmest)	5.9	+5.1	1961–1990	1891
April					
Armenia	3 (warmest)	3.9	−1.0	1961–1990	1935
Belgium	4 (warmest)	12.6	+2.8	1981–2010	1833
Switzerland	3 (warmest)	7.6	+3.7	1981–2010	1864
May					
Cyprus	5 (warmest)	21.5	+1.6	1981–2010	2000
Portugal	1 (warmest)	19.0	+3.26	1971–2000	1931
Spain	2 (warmest)	17.7	+2.6	1981–2010	1961
June					
Cyprus	3 (coolest)	23.4	−0.6	1981–2010	2000
Estonia	3 (warmest)	17.4	+3.0	1981–2010	1961
Latvia	2 warmest)	18.1	+3.3	1981–2010	1924
Norway	2 (warmest)	12.3	+3.2	1981–2010	1900
July					
Kazakhstan	3 (warmest)	28.3	+3.4	1981–2010	1936
Portugal	1 (warmest)	25.1	+2.91	1971–2000	1931
Spain	3 (warmest)	24.6	+1.7	1981–2010	1961
August					
Belgium	3 (warmest)	20.9	+2.9	1981–2010	1833
Luxembourg	3 (warmest)	20.6	+2.9	1981–2010	1838
Romania	4 (warmest)	21.4	+1.8	1981–2010	1961
September					
Armenia	4 (warmest)	15.7	+2.5	1961–1990	1935
Bulgaria	5 (warmest)	19.6	+3.0	1961–1990	1930
Cyprus	1 (warmest)	27.3	+3.1	1961–1990	2000
Estonia	3 (warmest)	14.0	+2.5	1981–2010	1961
Israel	1 (warmest)	-	-	-	1951
Latvia	3 (warmest)	14.5	+2.8	1981–2010	1924
Lithuania	2 (warmest)	14.8	+2.6	1981–2010	1961
Moldova	1 (warmest)	20.8	+4.5	1981–2010	1886
North Macedonia	5 (warmest)	19.1	+2.0	1981–2010	1981
Romania	3 (warmest)	17.6	+2.8	1981–2010	1961
Türkiye	1 (warmest)	23.9	+3.4	1981–2010	1971
October					
Cyprus	1 (warmest)	23.4	+2.9	1981–2010	2000
Estonia	2 (warmest)	9.5	+2.8	1981–2010	1961
Latvia	2 (warmest)	9.8	+2.9	1981–2010	1924

Country	Rank	Value (°C)	Anomaly (°C)	Reference period	Start of time series
Lithuania	1 (warmest)	10.2	+3.0	1981–2010	1961
Moldova	3 (warmest)	14.6	+4.1	1981–2010	1886
Romania	2 (warmest)	12.0	+2.5	1981–2010	1961
Russia	1 (warmest)	6.9	+3.4	1961–1990	1936
Türkiye	1 (warmest)	18.4	+3.2	1981–2010	1971
Ukraine	4 (warmest)	12.7	+4.6	1961–1990	1891
November					
Armenia	4 (warmest)	2.0	+0.5	1961–1990	1935
Denmark	2 (warmest)	7.7	+2.6	1981–2010	1874
Estonia	1 (warmest)	5.4	+4.0	1981–2010	1961
Latvia	1 (warmest)	5.5	+3.9	1981–2010	1924
Lithuania	3 (warmest)	5.4	+3.5	1981–2010	1961
Norway	1 (warmest)	−1.0	-4.1	1981–2010	1900
Poland	2 (warmest)	5.6	+2.2	1981–2010	1951
Spain	3 (warmest)	11.4	+2.0	1981–2010	1961
Switzerland	5 (warmest)	3.7	+2.5	1981–2010	1864
December					
Armenia	4 (warmest)	−3	+0.9	1961–1990	1935
Bulgaria	3 (warmest)	4.8	+3.2	1961–1990	1930
Cyprus	3 (warmest)	13.7	+1.9	1981–2010	2000
Montenegro	1 (warmest)	9.4	+2.6	1981–2010	1949
North Macedonia	1 (warmest)	5.9	+4.0	1981–2010	1981
Norway	5 (warmest)	−2.2	+4.1	1981–2010	1900
Romania	1 (warmest)	3.0	+3.8	1981–2010	1961
Serbia	2 (warmest)	4.3	+3.4	1981–2010	1951

In January 2020, most of the RA VI Region reached higher temperatures than normal (reference period: 1981–2010) due to steady high-pressure influence. Anomalies were highest in the east of Europe (between +6 °C and +7 °C in the Baltic States, +9.1 °C in Northern European Russia) and in Scandinavia (+9 °C in Norway, +10 °C in Sweden). In Norway, the highest maximum temperature, 19.0 °C, was recorded on 2 January at Sunndalsøra III (Sunndal, Møre and Romsdal). This is a new Norwegian heat record for January. In Trøndelag and Troms and Finnmark, county records were set. In many countries, this month was one of the three warmest in history (see **Table 4-3**). It was colder than normal in the south of Greenland with anomalies around −2 °C. The monthly mean temperature averaged over Europe was +3.27 °C above the 1981–2010 average according to Copernicus data. This anomaly was almost as high as in December 2019. The warming trend for January since 1910 is +1.38 °C per 100 years. January 2020 was the second warmest January since 1910, straight after January 2007 with 3.33 °C above the 1910–2000 average according to NOAA NCEI (National Centers for Environmental Information).

In February 2020, most of the RA VI Region saw higher temperatures than normal (reference period: 1981–2010) due to a powerful and continuous (south-)westerly flow. Most of Central and Southwestern Europe registered anomalies between +2 °C and +4 °C. Anomalies were highest in the east of Europe (for example +7.3 °C in European Russia, +6.2 °C in Estonia and +5.9 °C in Latvia) and in Scandinavia (+6 °C in Norway). In many countries, this month was one of the three warmest on record (see **Table 4-3**). It was colder than normal in the seas around Greenland with anomalies between −1 °C and −3 °C, whereas over land Greenland itself registered mostly negative

anomalies, but temperatures equal to or above the normal level (1981-2010) was also measured (between -6.2 °C and +3.4 °C). Italy recorded not only one of its warmest Februaries since 1800, but also its second warmest winter after 2006/2007 due to positive anomalies in all winter months (December 2019: +1.9 °C, January 2020: +1.9 °C, February 2020: +2.9 °C). The monthly mean temperature averaged over Europe was 3.86 °C above the 1981–2010 average according to Copernicus data. According to NOAA NCEI, for Europe as a whole, February 2020 was the second warmest since 1910, straight after February 1990 with an anomaly of +4.11 °C.

As the polar vortex stayed strong during **March**, it continued to keep much of the frigid air in the Arctic, leaving the mid-latitudes with warmer than normal temperatures. Over the RA VI Region, temperature anomalies for March 2020 (w.r.t. the 1981–2010 average) increased from west to east, with lowest values over Western Europe (up to +2 °C) and largest anomalies over parts of European Russia, where temperatures were more than 5 °C above normal. Over European Russia, the average temperature in each decade of the month exceeded the normal value even by 8 °C to 12 °C or more in various regions. New maxima of air temperature were recorded among others in the northwestern part, Northern Caucasus and Siberia. March 2020 became the warmest in the history of meteorological observations in European Russia and the second warmest in Russia as a whole – outranked by March 2017 only. In Moscow, the monthly-averaged air temperature in March was +3.8 °C, and the anomaly was +6.0 °C. This March was the second warmest in the meteorological chronicle of the capital, only March 2007 being even warmer, by 0.6 °C. The monthly mean temperature averaged over Europe was 2.48 °C above the 1910–2000 normal, making it the sixth warmest March for Europe as a whole according to NOAA NCEI. According to the same reference, the period from January to March as a whole was the warmest on record with an anomaly of +3.19 °C.

For **April**, monthly mean temperatures were warmer than normal over western, central and southern parts and colder than normal in the east of the RA VI Region. Largest positive anomalies occurred over France and Greenland with anomalies greater than +3 °C (w.r.t. 1981-2020). For France, April 2020 ranks as the third warmest April since 1900, behind April 2007 (+3.6 °C) and April 2011 (+3.3 °C). Largest negative anomalies occurred over Russia with temperatures between 1 °C and 2 °C below normal. The European-average temperature for April 2020 was among the 12 warmest on record according to the ERA5 (Copernicus) and the NOAA NCEI data (retrieved from NOAA CAG) with anomalies of +0.6 °C (w.r.t. the 1981–2010 average) and +1.49 °C (relative to 1910–2000) respectively.

The monthly mean temperature in **May** was warmer than normal over western and southern parts of the RA VI domain with largest anomalies occurring over the Iberian Peninsula, where it was, in some places, more than 3 °C warmer than normal. In Spain, the month of May was extremely warm with an average temperature of 19.3 ºC, which is 2.7 ºC above the average for this month (reference period: 1981–2010). This was the warmest May since the beginning of the time series in 1965, having surpassed May 2015 by 0.2 ºC, which was until now the warmest in the series. The largest thermal anomalies, close to +4 ºC, were observed in inland areas of Galicia and the northwest of Castilla y León, as well as in some parts of the Pyrenees of Huesca and Lleida. At 28 stations, the average temperature in May was the highest for a month of May since the beginning of the time series. Colder than normal temperatures, on the contrary, occurred over the central, northern and eastern parts of the RA VI domain with largest negative anomalies over Poland, Belarus and the Ukraine where

temperatures were 2 °C to 3 °C below normal. The monthly mean temperature for May averaged over Europe was 0.47 °C above the 1910–2000 average according to the NOAA NCEI data (retrieved from NOAA CAG) and 0.3 °C below the 1981–2010 average according to the Copernicus Climate Change Service at ECMWF (based on ERA5).

In June, the temperatures in Northern Europe were well above average, but below average or around normal in the south. Overall, this was the second warmest June in Europe on record according to Copernicus data and the third warmest according to NOAA NCEI data (+0.92 °C anomaly, 1910–2000 reference). Due to the influence of high pressure at the beginning of June, Russia and Scandinavia experienced a particularly warm airflow causing high temperatures in the Arctic Cycle. At a station in Russia, located at 66.7° N, 30.3 °C were recorded, which is more than 20 °C warmer than normal. In Russia as a whole, June 2020 was marked as the third warmest in the meteorological chronicle, colder than June 2012 and June 2016 only. The unusually high air pressure over Scandinavia and Russia brought numerous heat anomalies in other places of Northern Europe too. In the middle of the month, new temperature records were reached in Scandinavia: In Sweden, the highest maximum of the month (34 °C) reached the highest ever-measured June temperature in Sweden since 1970. June was hot or very hot in most places and in parts of central Sweden, also record warm. Norway experienced the highest heat anomaly within RA VI this month with 6 °C above normal in Trøndelag. The monthly temperature for the whole country was 3.2 °C above normal, making June the second warmest June since 1900. There were also numerous heat anomalies in Spain (with a maximum temperature of 43 °C), France, Germany, Eastern Europe and the Middle East. Highest monthly mean sea surface temperatures of June were reached in the Mediterranean Sea, in the region of Israel and Lebanon, with temperatures between 24 °C and 26 °C.

In July 2020, the average temperatures were higher than the 1981–2010 average for July in large parts of the RA VI Region due to high pressure influence, particularly over Eastern and Southern Europe with anomalies between +1 °C and +3 °C. Also, along the western coast and southern tip of Greenland, the average temperature was between 1 °C and 2 °C higher than the average for July, for example, in the south of Europe: Portugal experienced the warmest July since 1931 with an anomaly of +2.91 °C and with three periods of heatwaves, which led to severe drought in some regions. France, Cyprus and Spain experienced also several heat waves in July with a maximum daily temperature over 40 °C. In Spain, it was the third warmest July since 1965. In contrast, lower than normal temperatures occurred over Northern Europe, especially in Norway, Finland, Russia, Sweden and Ireland, where the anomalies ranged between −1 °C and −3 °C because of low pressure influence over these regions. In Sweden, the lowest minimum temperature (−3.3 °C) was recorded in Latnivaara, which was the lowest measured temperature in July since 1976. The monthly mean July temperature averaged over Europe was 0.2 °C above the 1981–2010 normal according to Copernicus data. July 2020 was the thirteenth warmest July since 1910, which was just as warm as the year before.

In August, average temperatures were higher than the 1981–2010 average for August over large parts of the RA VI domain, with largest temperature anomalies occurring over France, the Benelux countries, Germany and Poland with values above +2 °C. These large anomalies resulted mainly from an intense heatwave developing during the first half of the month due to a blocking pattern associated with a strong upper ridge expanding across much of the European continent. Peak

daytime temperatures were measured over France, reaching almost 40 °C in the southwestern parts. The heat wave from 6 to 13 August was in terms of cumulative heat – also called severity – very close to the heat waves that France experienced in June and July 2019, but far behind 2003 and 2006, and a little below the episode of the summer of 2018. On 9 August, the maximum temperature reached 39.1 °C in Paris and 40.4 °C in Saint-Maur (Val-de-Marne). Monthly records for maximum temperatures were broken, for example 39.6 °C in Nantes (Loire- Atlantic) on 7 August, 37.1 °C in Lille (North) on 8 August and 39.3 °C in Creil (Oise) on 9 August. In the Netherlands, August was very hot with an average temperature of 20.4 °C in De Bilt compared to a normal of 17.5 °C. This makes August 2020 the second warmest August since the start of observations in 1901 (after August 1997). Large temperature anomalies occurred as well over the Arctic. Svalbard Airport was the warmest station with an average temperature of 7.2 °C (2.5 °C above normal). This is, together with 2013, the third highest mean temperature measured at that station in August (since 1975). For the summer season 2020, the average temperature at Svalbard Airport was 7.2 °C, which is 3.0 °C above normal, and the highest recorded average summer temperature. The old record was 6.7 °C from 2015. The monthly mean temperature averaged over Europe was 2.02 °C above the 1910–2000 average, making it the third warmest August for Europe as a whole according to the NOAA National Centers for Environmental Information (retrieved from NOAA CAG). According to the Copernicus Climate Change Service/ECMWF, August was, over Europe, 1.1 °C warmer than the average for 1981–2010 (based on ERA5), making it the fifth warmest on record for Europe.

September 2020 was warmer than the 1981–2010 average for September over most parts of the RA VI domain especially in countries bordering the Black Sea and in the Middle East with anomalies above +3 °C, in Türkiye locally even +5 °C. New high temperature records were reported for Türkiye, Israel and Jordan. In Eilat, in southern Israel, 48.9 °C were measured on 4 September, which was not only a record for September, but also an all-time record in an over 70-year time series. In Jerusalem, a September record was broken on 3 September with 41.2 °C in a long data series of 118 years. Israel as a whole experienced its warmest September on record, and the intensity and length of the September heatwave in Jordan was exceptional. In European Russia, the air temperatures averaged for the first decade of September exceeded the normal values by 2 °C to 5 °C or more in the southern parts. In the third decade, the whole of European Russia experienced abnormally warm temperatures with decade-averaged temperature anomalies reaching +5 °C and more. New temperature maxima were recorded in the northwest of Russia at that time. The average temperature of September in Moscow was 13.9 °C, implying an anomaly of +2.9 °C. This was the fourth highest temperature for September in the history of meteorological observations in the capital. It was also generally warmer than normal over the Arctic Ocean (except for the Greenland Sea and the Norwegian Sea). Together with the warm spring and early start of snow melting period, this made the Arctic Sea Ice shrink to the second lowest extent (behind September 2012) since modern record-keeping began in the late 1970s. In contrast, it was colder than normal over Greenland and Iceland. The European-average temperature for September 2020 was the highest on record for September according to both ERA5 (Copernicus) with an anomaly of +1.8 °C (w.r.t. the 1981–2010 average) and the NOAA NCEI data with an anomaly of +2.33 °C (relative to 1910–2000).

Monthly mean air temperatures in October were below the long-term means in the western and southwestern parts with anomalies up to −3 °C (w.r.t. 1981–2010) and above normal in the eastern parts of the RA VI domain with largest anomalies occurring over the Ukraine and central parts of

Türkiye with anomalies larger than +3 °C. In Belarus, the average monthly air temperature ranged between 9 °C and 12 °C, which is 3 °C to 5 °C higher than the climatic norm. October 2020 was the warmest on record during the post-war period. Prior to that, the warmest October was in 1967 with the national average temperature of 9.7 °C. In Russia, in the Central Russia District, the average air temperature broke the previous record by 0.5 °C. It was set over a century ago in 1896. In Türkiye, the temperature in October 2020 was 3.2 °C higher than the long-term average (of 1981–2010) making it the warmest October of the last 50 years. The European-average temperature for October 2020 was the highest on record for October according to both ERA5 (Copernicus) with an anomaly of +1.6 °C (w.r.t. the 1981–2010 average) and the NOAA NCEI data (retrieved on 4 December 2020 from NOAA CAG) with an anomaly of +2.17 °C (relative to 1910–2000).

The monthly mean temperature of November was warmer than normal over most parts of the RA VI domain with the largest anomalies occurring in northern Scandinavia and Russia and the Arctic Ocean. In the southern and central parts of Finland, station-specific monthly average temperature records were measured in several places. The deviations from the reference period ranged between +4 °C and +6 °C, with largest anomalies occurring in Lapland. In Sweden, many places in Götaland and southern Svealand experienced their warmest November on record. The cliff in Blekinge had a monthly average temperature of 9.1 °C, which is a new Swedish November record. Previous records were 8.8 °C at Måseskär in 2006 and Falsterbo in 1938. An extremely warm first week in November contributed strongly to the very high monthly average temperature. Especially on 2 and 6 November, new November records were set to a rarely seen extent. One of the most notable ones was 18.4 °C in Gladhammar on 6 November. This is similar to the Swedish heat record for November from Ugerup in Skåne on 2 November 1968. Other station records for November set on 2 November include the old observatory series in Lund (17.1 °C, start year 1753), Stockholm (15.1 °C, start year 1756) and Uppsala (15.7 °C, start year 1739). In Norway, the monthly temperature for the whole country was 4.1 °C above normal, and the month was, together with 2011, the warmest month of November recorded in a series dating back to 1900. Largest anomalies were recorded in Troms and Finnmark, with temperatures between 6 °C and 7 °C above normal. Three stations with measurements dating back to 1867 – namely Torungen lighthouse, Lista lighthouse and Utsira lighthouse – set new records for the warmest November. In Arctic Norway, Bjørnøya was the warmest station with an average temperature of 0.5 °C (3.1 °C above normal). At Hopen, the monthly temperature was −0.5 °C, which is 6.1 °C above normal. Svalbard Airport had −2.9 °C on average for the month, which is 5.3 °C above normal. Jan Mayen had a monthly temperature of −1.0 °C, which is 0.7 °C above normal. Ny-Ålesund got an average temperature of −3.5 °C, which is 4.6 °C above normal. The highest maximum temperature of the month was measured on 12 November on the Reindal Pass with 9.4 °C. This was the highest ever measured temperature on Svalbard in November. The old record was 7.8 °C measured in Ny-Ålesund on 6 November 2011. For Europe as a whole, the temperature for November 2020 was the second highest on record according to both ERA5 (Copernicus) and the NOAA NCEI data (NOAA CAG) with an anomaly of +2.2 °C (w.r.t. the 1981–2010 average) and +2.15 °C (relative to 1910–2000) respectively. When looking at the seasonal average (September–November), it turns out that the average temperature for Europe was even the highest on record with 1.9 °C above the 1981–2010 norm according to the ERA5 data (Copernicus) and 2.24 °C above normal with respect to the 1910–2000 average according to the NOAA NCEI data.

In **December**, monthly mean temperatures were above normal over most of the RA VI domain, with largest anomalies occurring in Scandinavia and Southeastern Europe with temperatures up to 4 °C above normal (w.r.t. 1981–2010). Monthly mean air temperatures below the long-term mean occurred around the Caspian Sea (Kazakhstan, Russia) and over Ireland. In Finland, the largest anomalies occurred in the western part of Finnish Lapland, where temperatures were about 7 °C above normal. In Sweden, December 2020 was warmer than normal with the largest temperature anomalies occurring in the northern half of the country. December 2020 was record-breaking, for example at Luleå Airport. The monthly temperature for Norway was 4.1 °C above normal. The month was the fourth warmest December in a series dating back to 1900. In Innlandet, Viken and Troms and Finnmark, some stations had deviations of 7 to 8 °C above normal. In the Arctic region, Jan Mayen was the warmest station with an average temperature of −1.6 °C (2.0 °C above normal). At Hopen, the monthly temperature was −3.8 °C, which is 6.4 °C above normal. Svalbard Airport had −7.0 °C on average for the month, which is 4.3 °C above normal. Bjørnøya reported a monthly temperature of −1.8 °C, which is 3.5 °C above normal. Ny-Ålesund got an average temperature of −7.5 °C, which is 3.3 °C above normal. Also, Romania saw large deviations of the average air temperature from the median of the standard reference period (1981–2010) in December 2020 which exceeded the value of 3 °C in most regions. The highest value of the positive deviation was 5.4 °C, measured at the Sibiu meteorological station. For Europe as a whole, the temperature for December 2020 was the fifth (NOAA) highest on record according to ERA5 (Copernicus) and the fourth highest according to NOAA NCEI data with anomalies of +2.3 °C (w.r.t. the 1981–2010 average) and +2.43 °C (relative to 1910–2000) respectively.

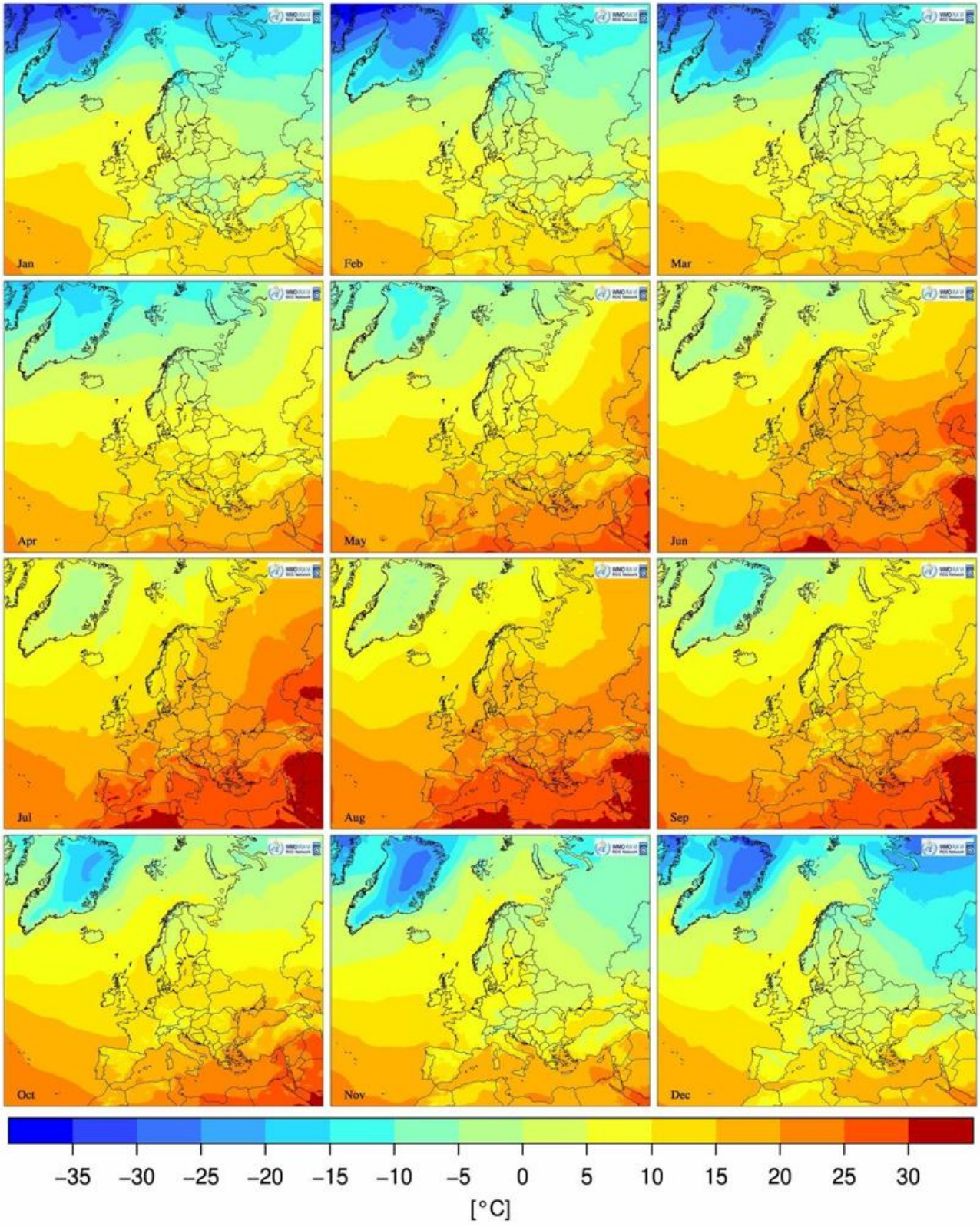


Figure 4-3: *Monthly mean temperature in °C for each month of the year 2020. Source: RCC-CM website.*

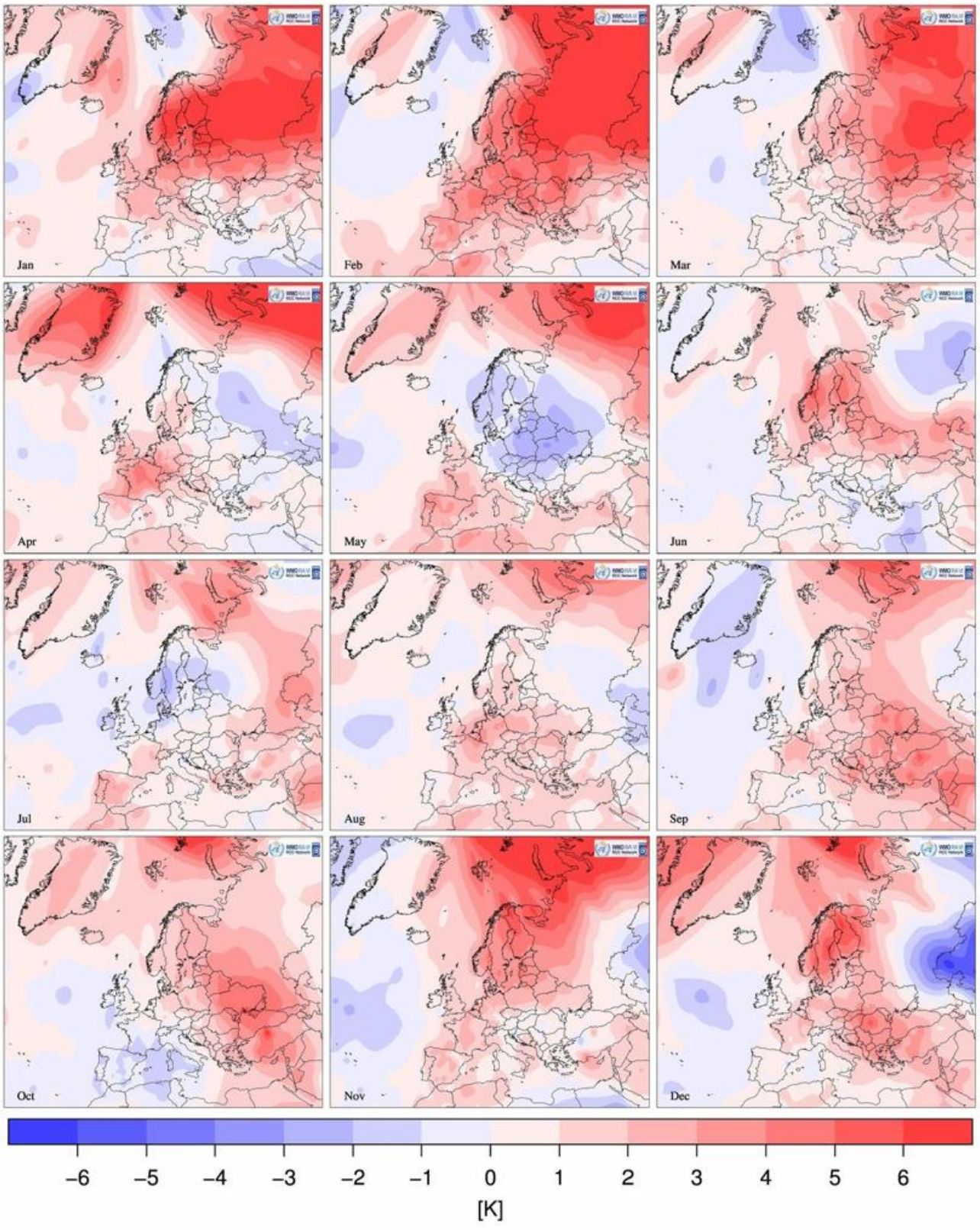


Figure 4-4: *Monthly anomalies of temperature in °C relative to 1981–2010 for each month of the year 2020. Source: RCC-CM website.*

4.3. Precipitation

Annual precipitation in 2020 was near normal over most parts of the RA VI Region. The individual months reveal a lot variability in the course of the year (see **Table 4-4**) that started with mostly wetter than normal conditions in the winter months. These were followed by dry conditions in spring over large parts of the domain. Autumn brought even drier conditions especially to Central and Western Europe and the Mediterranean and Balkans.

Table 4-4: *Monthly area average precipitation anomalies in % for each subregion in the year 2020 (reference period: 1981–2010; definitions of the subregions see Figure 1-1).*

Region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Central and Western Europe	71	180	87	44	75	135	70	113	91	157	47	111
Eastern Europe	98	152	99	90	157	94	102	83	77	94	81	80
Iberian Peninsula	108	19	170	139	91	68	69	92	70	81	92	82
Mediterranean and Balkans	67	99	119	83	107	129	82	113	69	86	48	112
Middle East	131	90	149	93	76	39	111	105	108	26	158	50
Scandinavia and the Baltic States	115	105	120	98	132	114	111	111	101	137	141	134

Table 4-5: *Rank statistics, monthly average precipitation (mm) and anomalies (mm) from several countries of the RA VI for the individual months in 2020, only including countries with rankings among the top 5 (ranks 1–5) since start of the time series.*

Country	Rank	Value [mm]	Anomaly [mm]	Reference period	Start of time series
		January			
Bulgaria	4 (driest)	9.0	−38.0	1961–1990	1930
Italy	3 (driest)	21.0	−63.0	1961–1990	1961
Norway	1 (wettest)	229.0	+96.0	1981–2010	1900
Romania	3 (driest)	9.6	−23.5	1981–2010	1961
		February			
Czech Republic	2 (wettest)	78.0	40.0	1981–2010	1961
Denmark	1 (wettest)	135.8	88.2	1981–2010	1874
Estonia	2 (wettest)	76.1	41.1.0	1981–2010	1961
Germany	2 (wettest)	124.1	+74.7	1961–1990	1881
Italy	2 (driest)	19.0	−61.0	1961–1990	1961
Ireland	1 (wettest)	244.0	+148.0	1981–2010	1941
Latvia	4 (wettest)	60.1	+23.3	1981–2010	1924
Luxembourg	1 (wettest)	157.9	93.5	1981–2010	1854
Poland	1 (wettest)	59.3	29.7	1981–2010	1966
Portugal	5 (driest)	-	-	-	1931
Spain	1 (driest)	8	−44.0	1981–2010	1961
		March			
Armenia	4 (driest)	47.0	−5.0	1961–1990	1935
North Macedonia	3 (wettest)	107.0	33.0	1981–2010	1981
Norway	5 (wettest)	144.0	+50.0	1981–2010	1900
		April			
Czech Republic	2 (driest)	18.0	−24.0	1981–2010	1961
Germany	2 (driest)	16.0	−34.0	1981–2010	1901

Country	Rank	Value [mm]	Anomaly [mm]	Reference period	Start of time series
Hungary	4 (driest)	11.2	−33.2	1981–2010	1901
Moldova	3 (driest)	4.0	−36.0	1981–2010	1891
Poland	2 (driest)	8.3	−28.4	1981–2010	1966
Romania	1 (driest)	12.8	−37.6	1981–2010	1961
Slovenia	2 (driest)	29.8	−76.5	1981–2010	1961
May					
Belgium (Uccle)	2 (driest)	5.4	−61.1	1981–2010	1833
Russia	3 (wettest)	55.1	20.0	1961–1990	1936
Ukraine	2 (wettest)	99.0	42.0	1961–1990	1891
June					
Czech Republic	1 (wettest)	151.0	72.0	1981–2010	1961
Italy	4 (wettest)	91.0	30.0	1961–1990	1961
Poland	2 (wettest)	120.0	48.7	1981–2010	1966
Romania	5 (wettest)	130.3	45.8	1981–2010	1961
Serbia	5 (wettest)	131.6	49.3	1981–2010	1951
July					
Armenia	4 (wettest)	52.9	8.9	1961–1990	1935
France	1 (driest)	20.0	−67.0	1981–2010	1959
August					
Armenia	4 (wettest)	37.5	4.5	1961–1990	1935
Moldova	3 (driest)	5.0	−50.0	1981–2010	1891
North Macedonia	1 (wettest)	114.6	85.0	1981–2010	1981
Romania	3 (driest)	45.6	−19.2	1981–2010	1961
September					
Armenia	4 (wettest)	18.1	−9.9	1961–1990	1935
Cyprus	-	0.4	−4.1	1961–1990	-
October					
Cyprus	3 (driest)	0.3	−32.4	1961–1990	1902
Czech Republic	5 (wettest)	91.0	48.0	1981–2010	1961
Israel	4 (driest)	-	-	-	1962
November					
Armenia	5 (wettest)	26.0	−15.0	1961–1990	1935
Bulgaria	3 (driest)	17.0	−42.0	1961–1990	1930
Czech Republic	3 (driest)	22.0	−27.0	1981–2010	1961
Montenegro	1 (driest)	0.9	−244.7	1981–2010	1949
North Macedonia	1 (driest)	2.5	−71.5	1981–2010	1981
Poland	4 (driest)	19.2	−23.3	1981–2010	1966
Romania	4 (driest)	17.5	−23.5	1981–2010	1961
Serbia	4 (driest)	14.9	−42.5	1981–2010	1951
December					
Austria	1 (wettest)	106.0	38.0	1961–1990	1961
Italy	2 (wettest)	180.0	87.0	1961–1990	1961
Montenegro	1 (wettest)	426.3	194.4	1981–2010	1949
Slovenia	5 (wettest)	221.6	99.9	1981–2010	1961

Monthly accumulated precipitation amounts differed a lot within the RA VI Region in January 2020. The central and southern parts of Europe as well as Northern Greenland saw below normal precipitation amounts, which were even exceptionally below normal over Greece, the southern part

of Italy and Romania. In Greece, only 1 mm of precipitation was recorded in Thessaly, which is 31 mm less than normal. Several Greek stations reported new drought records for January: Kerkyra (second driest since 1901) in the Northern Ionian Sea, Kakmata (fifth driest since 1901) in southern Peloponnese, Andravida in western Peloponnese (second driest since 1959) and Larisa in Thessaly (second driest since 1949). In contrast, regions in the north and east of Europe (especially along the west coast of Norway) as well as in the south of Greenland and the east of Spain experienced exceptionally above-normal precipitation (> 90th percentile). The rainfall amounts accumulated over the whole month were very impressive in these regions: In Norway, the monthly precipitation was 170% of normal, and the month was the wettest in the series going back to 1900. A couple of stations in Norway received more than four times the normal rainfall amounts. In the east of Spain, a major flooding event was caused by both major storm surge (from severe winds) and excessive rainfall amount, triggered by cyclone Gloria from 20 to 22 January. Some areas received more than 300 mm of rain within this 48-hour period.

Monthly precipitation anomalies differed a lot within the RA VI Region in February 2020 as well. The Mediterranean region and Northern Greenland saw below-normal precipitation amounts, which were even exceptionally below normal over Spain and Italy. The south of Italy received less than 20% of normal precipitation and the Maltese Islands only 0.6 mm of rain, making it the driest February on record. Spain also reported its driest February on record with an average precipitation of only 9 mm, which is only 17% of the normal value for the month (w.r.t. 1981–2010). In contrast, regions in northern, eastern and central parts of Europe, especially the United Kingdom, the north of France and regions around the North Sea coast experienced exceptionally above-normal precipitation. In Denmark, the monthly precipitation was 285% of normal (1981–2010), corresponding to an anomaly of +88.2 mm, making it the wettest February in the series going back to the 19th century. In Estonia, about 223% of normal precipitation was recorded. Around Paris and near the river Somme, the amount of rainfall was even more than 3 times higher than usual. In Ireland, February 2020 was the wettest February on record (since 1941).

Precipitation totals for March 2020 were below normal (1981–2010) in a band extending from the British Isles in the west towards western Kazakhstan in the east with largest deficits occurring in regions neighboring the Black Sea with precipitation sums lower than 20% of normal (and < 10th percentile). In Kazakhstan, monthly precipitation totals amounted even to several millimetres only. Over the southern parts of European Russia, the GPCC drought index reached values of −2 and lower, indicating extreme drought conditions. Wetter than normal conditions, on the contrary, prevailed over southern parts of Europe and northern parts of European Russia. The normal precipitation amounts in the Russian North-West Federal District were exceeded by about 1.5 to 2 times, locally even more. The monthly precipitation totals set new records in Karelia and the largest values for the last 25 years were recorded in Saint Petersburg. Heavy rains poured in the north of the central region, bringing up to half the normal monthly amount of precipitation per day in the second decade. Also, Iberia experienced more precipitation than normal, especially the eastern part of Spain. Some Spanish regions experienced 3 times the normal amounts. The largest daily amounts were observed on 31 March with 150 mm in Castellón-Almassora which set a new daily record for March. Additionally, several new monthly records were set as well, among them Castellón-Almassora with 205 mm as well as Logroño/Agoncillo and Teruel, both with 105 mm. Parts of Norway experienced exceptionally above-normal precipitation amounts. Norway as a whole

registered 155% of normal precipitation which resulted in March 2020 being the fourth wettest since 1900. Largest precipitation amounts occurred in Lurøy (Nordland) with 560.9 mm (265% of normal); Takle (Gulen, Vestland) with 444.6 mm (152% of normal) and Hovlandsdal (Fjaler, Vestland) with 432.9 mm (166% of normal).

Large parts of the RA VI Region experienced below normal precipitation in April, especially in western, central and large parts of eastern Europe where the observed precipitation amounts were even exceptionally below normal (< 10th percentile) with locally less than 20% of normal. The precipitation index in these regions reached values below −1.5 indicating severe to extreme drought conditions. Germany experienced its second driest April since 1901, Hungary experienced the third driest since 1901, and the Netherlands experienced the sixth driest since 1906. For France, April 2020 was not exceptional on a national scale, but the province Alsace experienced the second driest April on record behind April 2007. Monthly precipitation totals above the long-term means, on the contrary, were observed over the Iberian Peninsula, western Norway and over Russia. In these regions, precipitation totals were partly even exceptionally above normal (> 90th percentile). In Spain, for example, there was abundant rainfall throughout the month, on many occasions accompanied by storms. It was extremely wet in the interior of Castilla y León and along the Catalan coast. Rainfall exceeded 3 times the normal values on the Mediterranean coast in the provinces of Girona and Barcelona, to the southwest of Cáceres and in some parts of the Balearic Islands. In terms of total precipitation for the month, two observatories also exceeded the previous highest value in their long time series: Barcelona/airport with 264 mm and Valladolid with 114 mm. In addition, several main observatories recorded the highest number of rain and thunderstorm days in the corresponding series for the month of April. In France, rainfall totals often reached 1.5 to 3 times the normal amounts in eastern Corsica and Languedoc-Roussillon and up to 4 times normal locally in the Pyrénées-Orientales with 291.7 mm at Amélie-les-Bains (opened in 1977), a monthly record. As a result, the province Pyrénées-Orientales experienced the fourth wettest April on record behind April 1969.

Monthly precipitation totals in May were below the long-term means in the northwestern and northern part of the RA VI domain, whereas above-normal precipitation amounts were observed in the eastern part, especially over Russia and the Ukraine which saw even exceptionally above-normal precipitation totals (> 90th percentile). Largest precipitation deficits occurred, on the contrary, over southern United Kingdom and the Benelux countries, which saw less than 20% of normal amounts corresponding to drought indices lower than −3 over the United Kingdom indicating extreme drought conditions. Over the United Kingdom as a whole, only 47% of average rainfall was recorded on national level with exceptionally dry conditions over most of England and Wales. In Belgium, the station in Uccle reported only 5.4 mm of precipitation (norm: 66.5 mm) fallen on 6 days (norm: 16.2 days). This low amount is a new record for the current reference period (1981–2010). Looking at the entire period since 1833, only the first May in this series was drier. In May 1833, only 1.4 mm of precipitation fell. In the Netherlands, May was a very dry month as well with a national average of 15 mm compared to the normal 61 mm. In most places, there were at least 24 dry days.

The highest amount of total monthly precipitation within the RA VI Region in June fell in the alpine region between Germany, Austria and Italy (between 200 mm and 300 mm) and in the border region of Poland and the Czech Republic (> 200 mm). Lowest monthly precipitation amounts were recorded in eastern Germany, Scandinavia, Spain, eastern Türkiye, the Middle East and near the Caspian

Sea. Below-average June precipitation fell in Scandinavia, Spain, Portugal, Iceland, parts of Greenland and in large areas of Russia and other eastern parts of RA VI.

The monthly accumulated precipitation differed a lot within the RA VI Region in July. In Central Europe, especially in France and Germany, and in the east of Europe and southern Greenland, the precipitation sums were well below normal (< 10th percentile). In France, Germany, Türkiye and in eastern European Russia the GPCC precipitation index regionally dropped below −1.5, and in some parts below −3, which indicated severe or extreme drought conditions. In France, the national deficit exceeded 70% and with a country average of less than 20 mm precipitation, it was the driest month in the period of 1959–2020. In Germany, it was the sixteenth driest month since 1901. In contrast, due to the main influence of low pressure over the regions in Northern Europe, especially Finland, Sweden, the west of Russia and in northeastern Greenland, the regions experienced exceptionally above-normal precipitation (> 90th percentile) in July. The GPCC precipitation index in Northern Europe increased up to above 2, which indicated severely wet conditions. In some Swedish regions, there was 3 times more precipitation than normal, which led to some local storm surge at the coast of Gothland. In Norway, it was the seventh wettest month since 1900. In Ireland and the United Kingdom, the high precipitation caused some floods in the southwest of Ireland and also in Wales and in Cumbria. Some flooding events were also reported in western Georgia, in Bulgaria (Sofia) and in northeast Türkiye, caused by heavy rain.

Precipitation sums were exceptionally or much above the 1981–2010 average for August over parts of France, Italy, Switzerland, southern Germany, Austria, as well as Spain. Over most parts of Scandinavia, but also over northern Germany, on the contrary, drier than normal conditions prevailed. For several countries in Europe, the hot spell of the first half of the month ended with thunderstorms and torrential downpours, leading to widespread disruption including flooding after the weather situation had turned to a more westerly flow situation. Above-normal precipitation was observed especially in western parts of Europe. At the end of the month, Atlantic low-pressure areas with frontal systems led to widespread above-normal precipitation, especially over Ireland and the United Kingdom and in a band from the Alpine region across eastern Central Europe to northwestern Russia. In the east, on the contrary, August was over large parts drier than normal, especially in the countries neighbouring the Black Sea, where the precipitation sum was exceptionally below normal (< 10th percentile) leading to severe or even extreme drought conditions (for example in the Ukraine and Türkiye).

Precipitation sums were exceptionally below the 1981–2010 average (< 10th percentile) for September in the east and southeast of the RA VI domain. No or almost no precipitation fell in the northwest of the Caspian Sea. Monthly totals above the long-term means were reported in parts of the Mediterranean region, Northeastern and Northern Europe, and locally over the northern Iberian Peninsula. These totals were largely caused by heavy precipitation events. Storm Aila swept for example from the North Atlantic to Scandinavia. It was initially quite weak, but had a strong development, when it came to Finland on 16 and 17 September. Regions in central and southwestern Finland experienced storm gusts up to 125 km h^{-1}, high waves up to 5.8 m in Rauma and heavy rains up to 66 mm in 24 hours in Kajaani, which was equivalent to the area's average rain for the whole September month. The Western Mediterranean, but also the Central and Eastern Mediterranean were affected by intense storms in September as well, mainly due to the warm seawater (temperatures around 27 °C). The most outstanding event in that region was a medicane

over Greece which caused incalculable damage in parts of the Ionian Islands and Thessaly. The medicane made land fall in Kefalonia and wind gusts up to 135 km h^{-1} reaching hurricane strength. Rainfall estimations derived from combined satellite, station and model data resulted in 186 mm over the Ionian Sea and 123 mm over western Greece mainland in 32 hours (17–18 September). In Mouzaki 254 mm of rain was recorded on 18 September and 227 mm in Ithaca for 17–18 September.

Monthly precipitation totals in October were below the long-term means in the east and in the Mediterranean coastal areas of Spain and France as well as over Iceland, and the western slope of the Scandinavian Mountains, while being around or above normal elsewhere. In Türkiye, the deficit in precipitation exceeded 90% in the eastern and southeastern Anatolia Regions, both regions experienced the lowest October precipitation in the last 40 years. In eastern Anatolia, the average rainfall in October was only 4.5 mm which corresponds to a 91% decrease in precipitation compared to normal (which is 50.9 mm). In southeastern Anatolia, the average rainfall of the region in October was 0.3 mm, which is a 99% decrease in precipitation compared to normal (36.8 mm). In the United Kingdom, on the contrary, October was a generally unsettled month with rain crossing the country at frequent intervals and some heavy and persistent falls of rain at times. Storm Alex brought rain and strong winds to much of England and Wales on 2 October, and a very wet day followed for much of the United Kingdom on 3 October. Later on, storm Barbara caused some impacts, with flooding on the Glasgow to Ardrossan/Largs railway line on 19 October. Storm *Alex* also brought exceptionally wet and windy weather to France. Monthly records for the number of days with more wind than 60 km h^{-1} were beaten with 8 days in Lons-le-Saunier (Jura), 9 days in Poitiers (Vienne), 13 days in Saint-Nazaire (Loire-Atlantique) and 16 days in Brest (Finistère). Same for the records of the number of days with higher wind speeds than 100 km h^{-1} which were beaten with 2 days in Aurillac (Cantal) and 3 days at the tip of Socoa (Pyrénées-Atlantiques). The rainfall for France in October was on average 40% higher than normal on national level, but over northern Brittany and the Manche département as well as over the southern Lot aux Landes rainfall was 2 to 3 times the normal: 289.2 mm was recorded at Cavan (Côtes-d'Armor), 307.8 mm at Bricquebec (Manche), 413.5 mm at Saint-Martin-de-Hinx (Landes) and locally more than 580 mm in the Alpes-Maritimes. Conversely, the regions of Roussillon to the south of the Ardèche and Provence, as well as the east of Haute-Corse, experienced a deficit of more than 50%, even 75% on the Rhone delta as well as locally in the Gard and Hérault. Only 14.2 mm were observed at Marsillargues (Hérault), 16.8 mm at Aigues-Mortes (Gard) and 17 mm at Marseille (Bouches-du-Rhône). In Switzerland, storm low *Brigitte* caused wind speeds up to 181 km h^{-1}. In addition, the cyclone caused torrential precipitation, especially along the Alps. In 24 hours, more than 250 mm occurred in some regions of the Alps, especially in Switzerland. In the Czech Republic, October was strongly above normal in terms of precipitation, with a monthly total precipitation of 90 mm, representing 209% of the 1981–2010 normal. Most precipitation (174 mm) fell in the Zlín Region. It also rained more than 100 mm in the Liberec (107 mm), Pardubice (105 mm), Olomouc (129 mm) and Moravian-Silesian (158 mm) regions.

As a result of the unusual anticyclonic conditions dominating in November, monthly precipitation totals were below the long-term means nearly everywhere in the RA VI domain except for Scandinavia, western Russia and some parts of the Mediterranean region. No or almost no precipitation fell in some southern parts of the RA VI domain, for example in Anatolia, the Balkans

and south of the Alps. France reported a precipitation deficit of more than 60%. Records were observed with only 18.1 mm in Biscarrosse (Landes), 15.4 mm in Nevers (Nièvre) or 6.8 mm in Romorantin (Loir-et-Cher). In France, November 2020 ranks among the three driest November months over the period 1959–2020, without reaching the record of November 1978 with a deficit of 80%. In Switzerland, precipitation in November was widely less than 10% of normal from the Valais via the southern side of the Alps to Graubunden and in some areas even less than 5% of the 1981–2010 norm. The other areas of Switzerland mostly received only 20% to 50% of the norm. In Romania, large parts received less than 50% of normal precipitation, most parts less than 20 mm. In Moldova, the monthly precipitation amount over half the territory was equal to 5–25 mm (15%–65% of the norm), in the rest of the territory between 28 mm and 45 mm (75%–115% of the norm). Precipitation during the month fell predominantly in the form of rain, at the end of the month in the form of sleet and snow. In Germany, a deficit of 46.3 mm was observed, corresponding to 69.1% less precipitation than the average for the period 1981–2010. November 2020 was thus the seventh driest November in Germany since 1901 and the eighth driest since 1881, making it one of the very dry November months in terms of precipitation. In Saxony-Anhalt and Thuringia less than 10% of the average precipitation fell locally: Erfurt/Weimar (7%) and Magdeburg (8%) registered the lowest monthly total with 3 mm each. In Austria, the dry high-pressure weather also brought one of the ten Novembers with the least precipitation in history of measurement. For Austria as a whole, there was 74% less precipitation than normal. This also had an impact on the snow situation. In Türkiye, a 49% decrease in precipitation compared to normal was observed in November, in the north and west of the Aegean, Marmara and Central Anatolia, the deficits exceeded even 80% in places. In Greece, the station Aktio only reported 9 mm (only 5.3% of the normal value referring to 1971–2000) precipitation, making it the driest November on record. Both, the northwestern part of Europe and the Mediterranean region, on the contrary, were hit by several heavy rain events along with strong winds. Due to the heavy rains widespread flooding occurred.

December: Monthly precipitation totals were below the long-term means, especially in the eastern parts of the RA VI domain, but also in Western Scandinavia, Central Europe, over the south of the Iberian Peninsula, and the Baltics. No or almost no precipitation fell in some parts around the Caspian Sea and the southern coast of the Iberian Peninsula. Exceptionally dry conditions (< 10th percentile) occurred over Türkiye, Baltic countries and parts of European Russia with less than 40% of normal precipitation. Above-normal precipitation totals, on the contrary, occurred in the central Mediterranean region, Northwestern Europe and parts of Scandinavia with partly even exceptionally above-normal amounts (> 90th percentile), affecting for example the United Kingdom, France, the northern coast of Spain, and Italy. In the United Kingdom, rainfall was 135% of average overall, with parts of eastern Scotland, East Anglia and Gloucestershire seeing more than twice the normal rainfall. In Norway, the monthly precipitation was 115% of normal for the country as a whole, but in Agder, Vestfold and Telemark and Viken there were stations that received between 400% and almost 500% of normal: for example, Senumstad (Birkenes, Agder) 595.1 mm (416% of normal), Bøylefoss (Froland, Agder) 559.8 mm (491% of normal) and Nelaug (Åmli, Agder) 517.7 mm (493% of normal). The highest daily precipitation was 100 mm, and was registered at Godal (Skien, Vestfold and Telemark) on 28 December. In Romania, the deviation of the precipitation amount in December 2020 from the median of the standard reference interval (1981–2010), was positive in most regions of the country. High values, between 100% and 300%, were recorded in the northeast, east, central and west of Muntenia, central and southern Moldova and on the coast. The largest positive deviation,

391.5%, was registered at the Râmnicu Sărat meteorological station. In Croatia, precipitation anomalies for December ranged from 77% of the multi-annual average in Sisak, where 53.6 mm of precipitation fell, to 347% in Makarska (443.1 mm). Very wet and extremely wet conditions occurred in the southernmost part of the country.

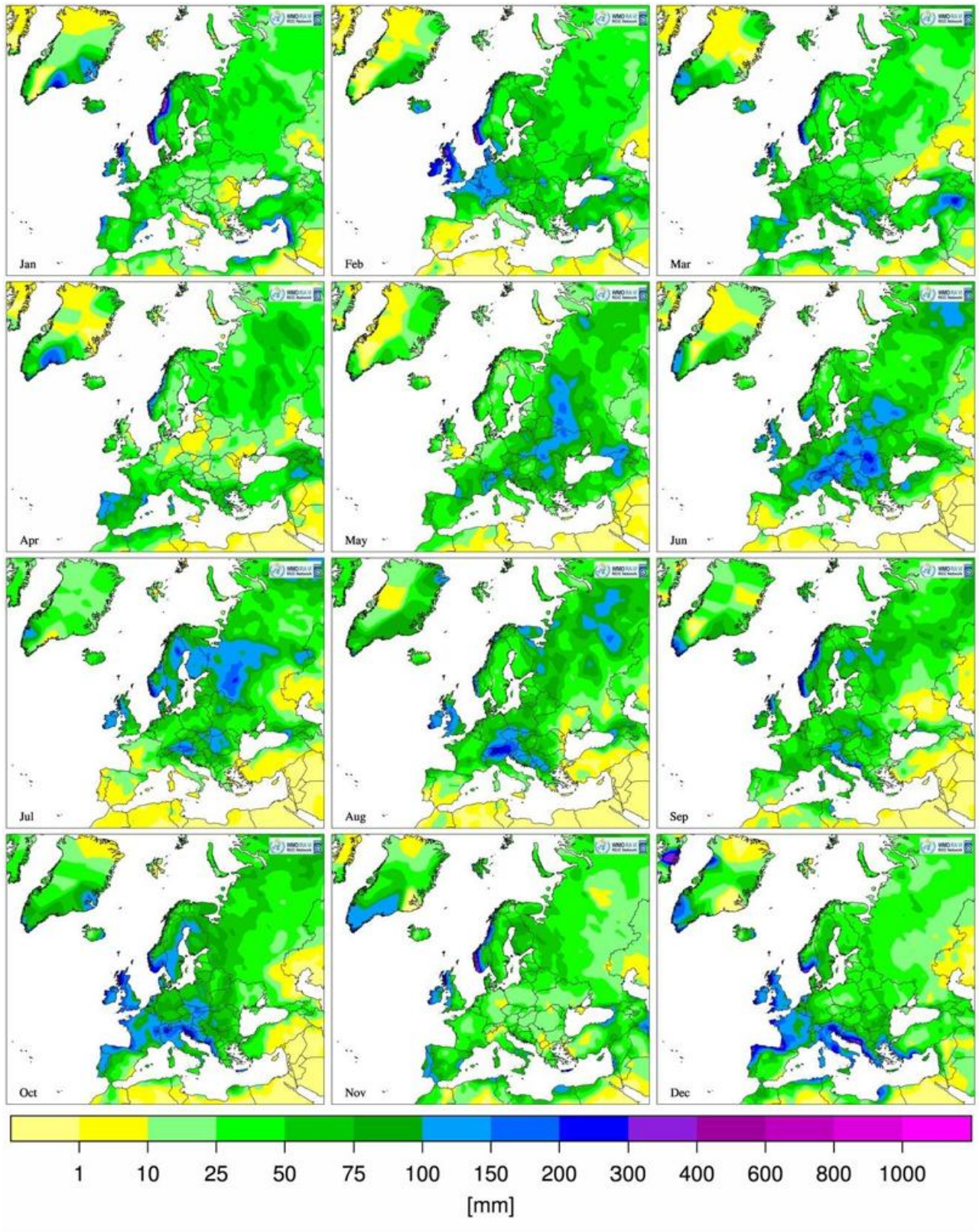


Figure 4-5: *Monthly mean precipitation in mm/month for each month of the year 2020. Source: RCC-CM website.*

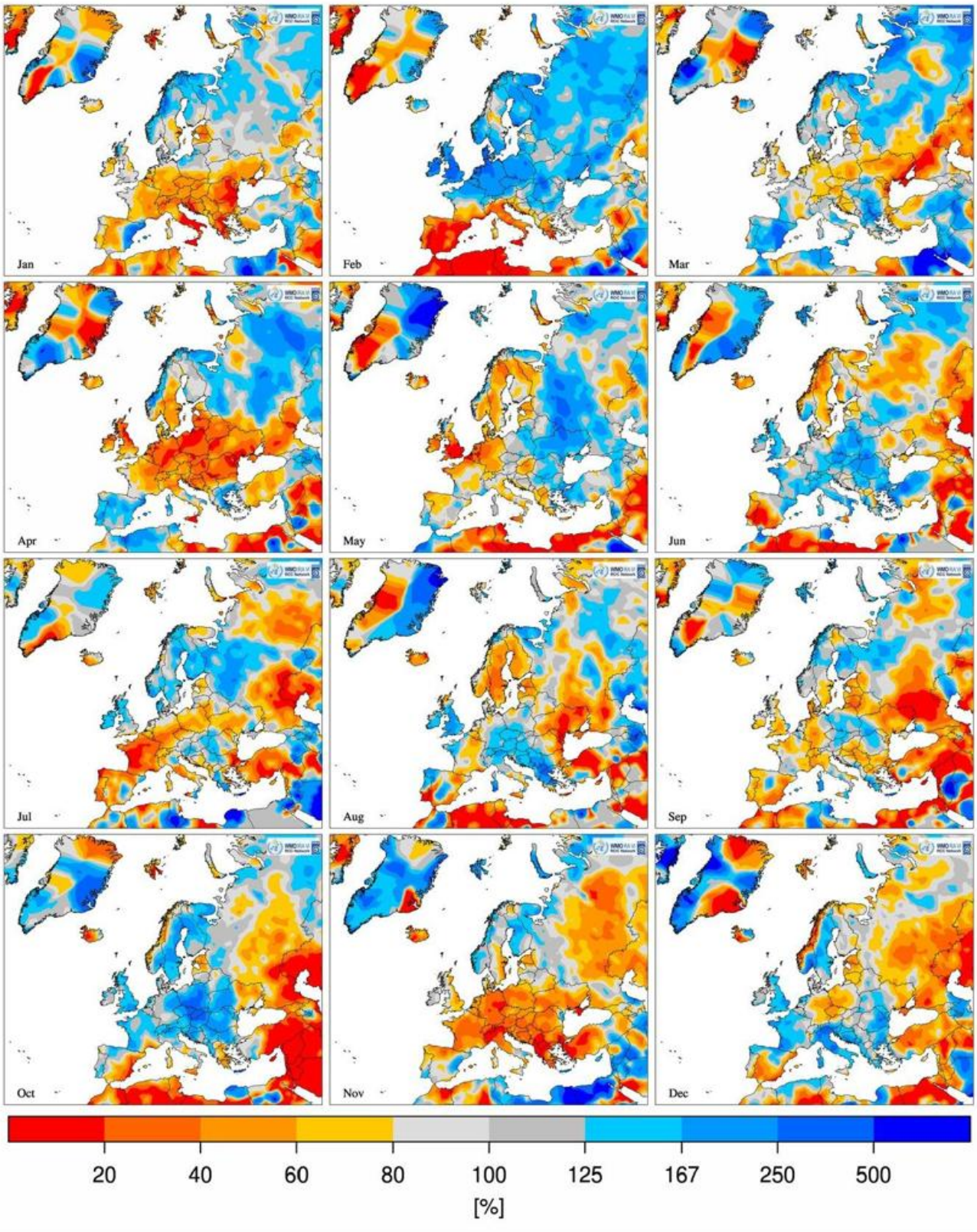


Figure 4-6: *Monthly precipitation anomalies in % of the average for 1981–2010 for each month of the year 2020. Source: RCC-CM website.*[5]

[5] Similar to the RCC annual precipitation anomaly maps shown in 2.1.3, the RCC monthly precipitation anomaly maps for March, April, June and July show deficits for Estonia which turned out to not correctly represent the anomalies reported by NMHS of Estonia (indicating above normal precipitation amounts). The issue is likely related to incorrect decoded real-time data used for the grid generation. As a result, these grid point values may deviate considerably from actual precipitation totals.

4.4. Sunshine duration

Table 4-6: Monthly area average sunshine duration anomalies in hours for each subregion in the year 2020 (reference period: 1981–2010; definitions of the subregions see Figure 1-1).

Region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Central and Western Europe	+14	+11	+37	+80	+38	−16	+16	+3	+30	−44	+18	−11
Eastern Europe	+4	+9	+36	+32	−29	+8	0	+15	+32	0	−3	+3
Iberian Peninsula	−2	+36	−26	−61	+26	−5	+13	+3	+6	+20	+4	−8
Mediterranean and Balkans	+30	+20	+7	+43	+7	−13	+7	+4	+17	+24	+25	+2
Middle East	0	+3	+4	+6	+15	+11	−8	+2	+3	+38	−9	+14
Scandinavia and the Baltic States[6]	+1	+4	+6	+8	+9	+17	−7	+10	−1	−6	−1	−2

In January 2020, sunshine duration was above normal over most parts of the RA VI Region, with a surplus up to 100 hours more than normal occurring over Italy and the Balkans, corresponding to a surplus of radiation in the range of +10 W m^{-2} to +30 W m^{-2}. Spain, the United Kingdom and the northeast of Europe, on the contrary, experienced anomalies of 50 hours less sunshine than normal. As for the whole month of January, the sun shone in Moscow for eleven hours only, 3 times less than normal. Such a deficiency of sunshine was observed for the first time in this century.

In February 2020, sunshine duration was above normal over major parts of the RA VI Region (reference period 1986–2015), with a surplus up to 20–100 hours more than normal occurring over Italy and the Mediterranean Sea, corresponding to a surplus of radiation in the range of 20 to 40 W m^{-2}. The northwest and east of Europe, on the contrary, experienced sunshine anomalies of 20 hours less than normal.

In March, it was sunnier than normal almost everywhere in the RA VI Region, corresponding to a positive anomaly of incoming radiation. Largest surpluses in sunshine hours were recorded over southern parts of European Russia and over eastern Ukraine with more than 100 hours. Parts of Spain experienced less sunshine than normal, locally up to 100 hours less, corresponding to a deficit in radiation of 30 to 40 W m^{-2}.

Western, central and eastern parts of the RA VI Region were not only very dry in April, but they also received much more sunshine than normal. Largest surpluses of sunshine duration occurred over a wide band stretching from the British Isles in the west to southern parts of European Russia in the east. These areas received more than 50 hours more sunshine than normal, partly even 100 hours more. This corresponds with surpluses of 40 W m^{-2} and more. Only Iberia received much less sunshine and radiation with deficits of 50 to 100 hours of sunshine or 30 W m^{-2} respectively. Several countries reported their sunniest April on record, among them the United Kingdom, the Netherlands (since 1901) and Germany, for Austria April 2020 ranked second sunniest on record.

May 2020 was sunnier than normal over the western and northern part of Europe as well as over the southeast with largest anomalies occurring over parts of France, the United Kingdom and Belgium. The latter experienced more than 100 hours more sunshine than normal and radiation

[6] This subregion is not fully covered, therefore the values are not representing the entire region (see maps)

surpluses of more than 50 W m^{-2}. In the United Kingdom, it was the sunniest May in a series from 1929, with 143% of average sunshine. Sunshine was relatively close to average in the north of both, Scotland and Northern Ireland, but it was the sunniest May on record by a wide margin for England and Wales, with numerous sites recording over 300 hours. In Belgium, more than 300 hours of sunshine were recorded in Uccle (normal: 191 h 03 min). Only in 1989 (327 h 41 min) and 1990 (308 h 31 min) did the sun shine even more. This high sunshine duration is also reflected in the very low number of heavily cloudy days: 4 days, as in 2011 (normal: 10.7 days). For the ninth time, there were no days with completely cloudy skies (normal: 2.7 days). The previous time this was the case was in 2015. Also, the Netherlands reported a very sunny month with a national average of 324 sunshine hours, compared to the normal of 213 sunshine hours. The east of the RA VI Region, on the contrary, experienced up to 100 hours less sunshine than normal.

The sunshine duration in Norway, Finland and Sweden was over 100 hours above normal in June. As a result, the radiation was 40–50 W m^{-2} above normal in Scandinavia and 30–40 W m^{-2} in parts of Eastern Europe. The Swedish east coast experienced the highest anomaly of radiation with +50 W m^{-2}.

In July 2020, the sunshine duration was above normal (w.r.t. 1986–2015) over most parts of the RA VI Region with large positive anomalies over Central Europe. Especially France and Germany had a surplus up to 50 hours more than normal, corresponding to a surplus of radiation in the range of 10 W m^{-2} to 30 W m^{-2}. Northern Europe (Scandinavia, the United Kingdom and Ireland), on the contrary, experienced anomalies from −20 to −50 hours.

Over Scandinavia and eastern parts of Europe, August was sunnier than normal with a radiation surplus of 30 W m^{-2} and more. The western part of Europe, on the contrary, experienced mostly less than normal radiation, especially the British Isles.

Over central and eastern parts of Europe, September was sunnier than normal with a radiation surplus of 20 W m^{-2} and more. Largest surpluses occurred over Germany, the Ukraine and southern parts of European Russia. The southwestern part of Europe and Scandinavia, on the contrary, experienced mostly normal or slightly less than normal radiation.

October: Western, central and eastern parts of the RA VI Region received mostly less than normal sunshine hours and radiation, with deficits up to 100 sunshine hours or 30 W m^{-2} respectively. Large parts of Iberia and the southeast, on the contrary, experienced more than normal sunshine hours and radiation with largest anomalies occurring over Türkiye and the South Caucasus region.

Due to the prevailing anticyclonic conditions in November, the sun shone generously over many regions for much of the month. As a result, it was sunnier than normal over Western Europe, Italy and Southeastern Europe (Southwestern Balkans, Greece) and Türkiye with up to 50–100 sunshine hours more than normal and radiation surpluses of up to 20–30 W m^{-2}. For the rest, the number of sunshine hours were closer to normal in absolute terms, but partly also outstanding. In Germany, the area average of sunshine duration was 85.7 hours. This is 32.1 hours or 59.9% more than in the reference period 1981–2010. This makes the month the third sunniest month since 1951 among the very sunny months of November. In France, sunshine was more than 25% above average across most of the country. Numerous monthly sunshine records over the 1991–2020 period have been recorded from the southwest to the northeast with a surplus reaching 1.5 to 2 times of normal, and even locally more than twice from Burgundy to the Great East with 132 hours in Langres (Haute-

Marne) and 144 hours in Nevers (Nièvre). In Switzerland, sunshine duration in November in the Alps and on the southern side of the Alps was between 150% and 180% of the 1981–2010 norm. North of the Alps, the values mostly rose to 120 to 150%, in northwestern Switzerland locally between 170% and 180% of the norm. Austria received 40% more sunshine than the average and had thus one of the five sunniest November in the history of measurements.

December: Most of the RA VI Region experienced normal or less sunshine hours and radiation than normal. Largest deficits occurred over the region experiencing largest precipitation surpluses, for example northern Iberia, northern Italy and parts of the Balkan Peninsula with up to 100 sunshine hours or 20 W m^{-2} less than normal. The east, on the contrary, saw more sunshine than normal with surpluses of up to 100 sunshine hours and 30 W m^{-2} occurring for example over Türkiye.

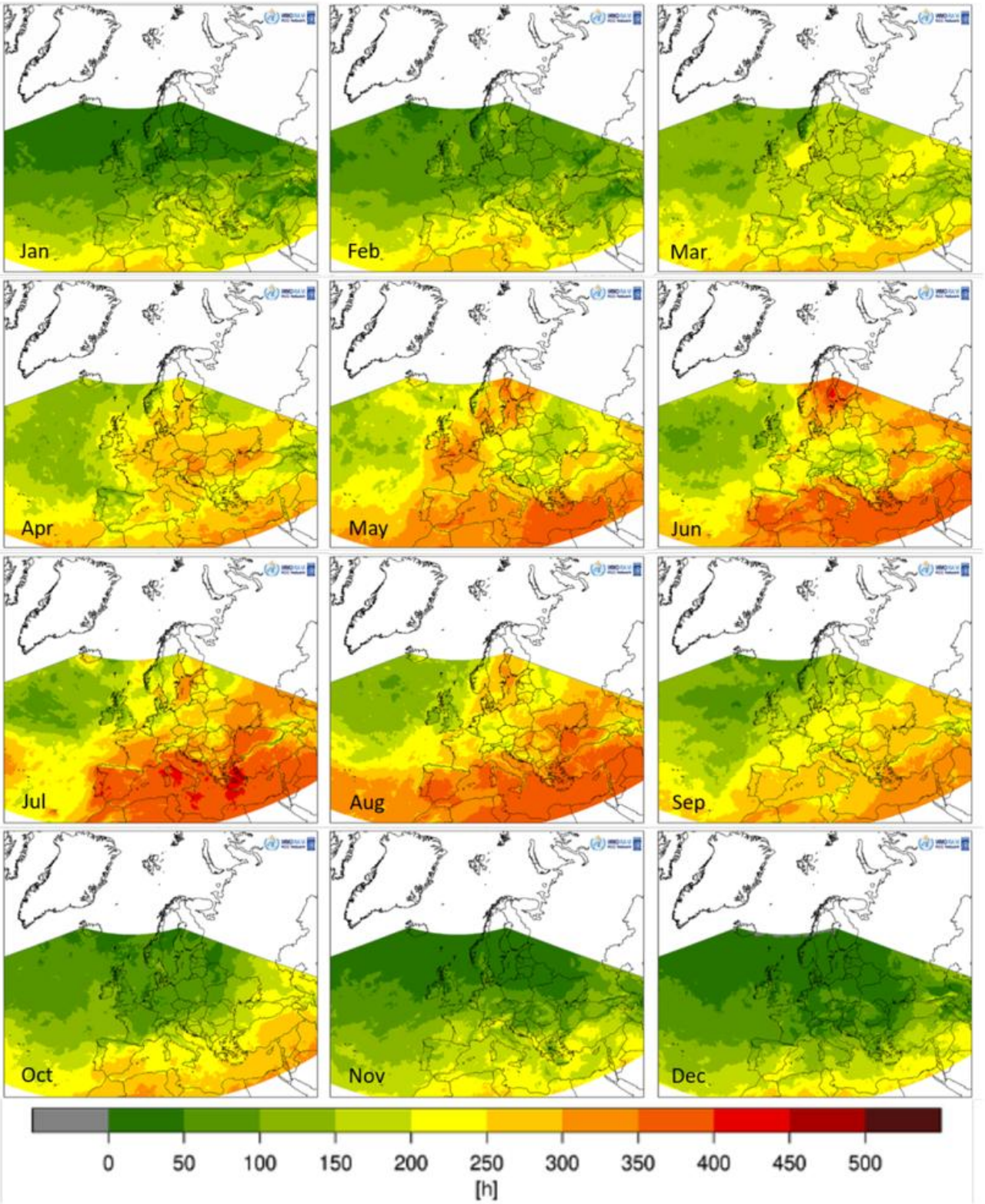


Figure 4-7: *Mean sunshine duration in hours for each month of the year 2020. Source: RCC-CM website.*

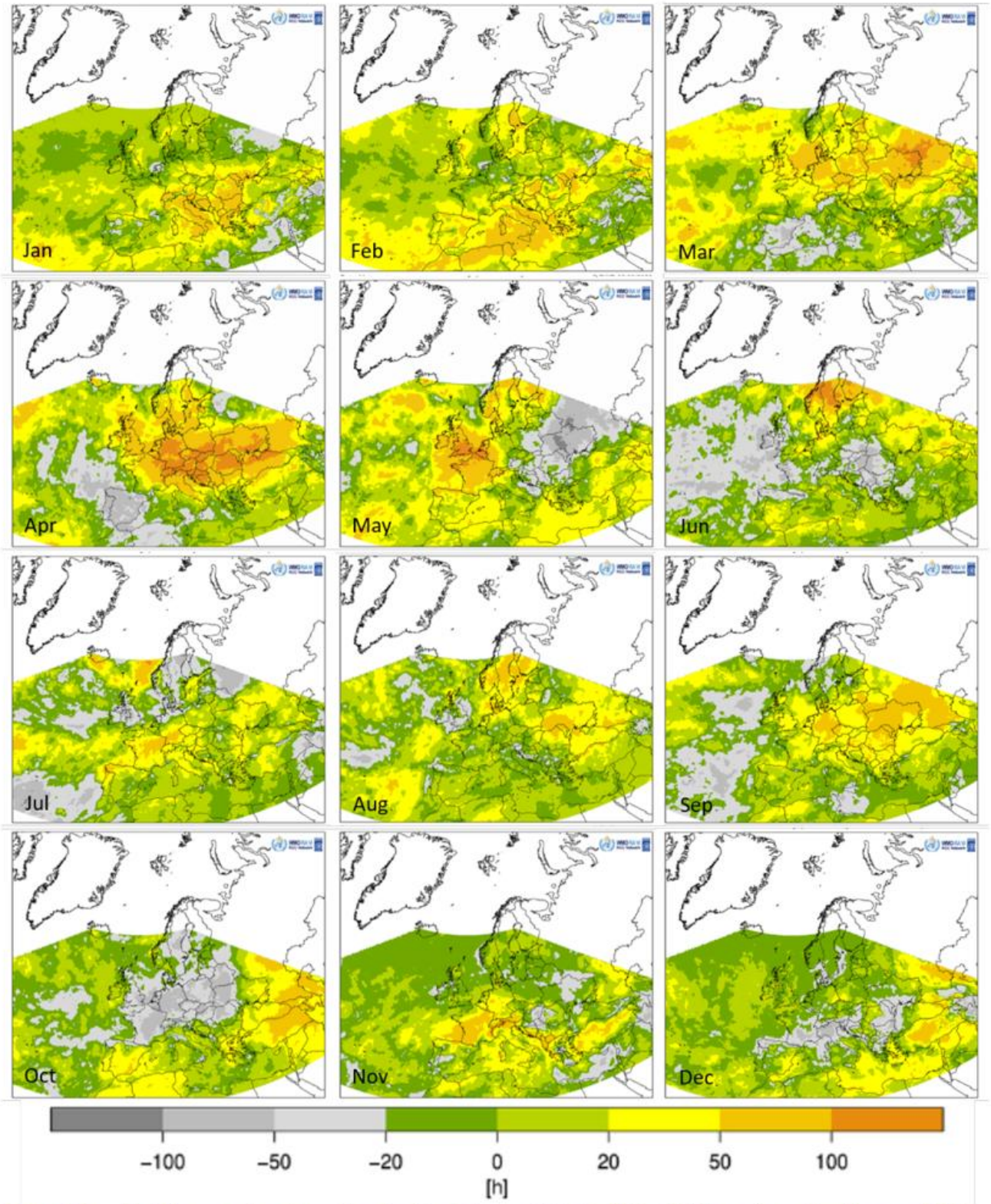


***Figure 4-8**: Monthly anomalies of sunshine duration in hours relative to 1986–2015 for each month of the year 2020. Source: RCC-CM website.*

4.5. Monthly maps of selected significant climate anomalies and events

The following maps are based on different data (as noted in the legends in parentheses), and are meant to summarize weather conditions in each month of the year 2020. The monthly maps contain information about the extreme anomalies of temperature, precipitation and wind gusts. Points are calculated from station data and represent the number of very warm or cold days, the locations of strong wind gusts (≥ 32 m s^{-1}) and days with precipitation. If more than one extreme anomaly occurs at the same location, the point is subdivided into several different colours. Coloured areas are based on interpolated gridded data for temperature (land and ocean) and precipitation (only land areas). If more than one extreme anomaly occurs at the same grid, the area is shaded.

4.5.1. January

In Russia, many stations reported new maximum air temperature records, some of these were also broken for several days running. During a warm spell from 31 January to 4 February in Serbia highest numbers of bright days were registered on Sombor and Zlatibor as well as new records of insolation hours in Kursumlija. January 2020 belongs to one of the 10 driest Januaries in Greece. The stations Kerkyra (sixth driest since 1901) in the northern Ionian Sea, Kakmata (fifth driest since 1901) in southern Peloponnese, Andravida in western Peloponnese (second driest since 1959) and Larisa in Thessaly (second driest since 1949) reported new drought records for January. In Thessaly only 1 mm precipitation occurred, which is 31 mm less than normal.

Exceptional above-normal precipitation of 470 mm was recorded for Israel in January, making it the second rainiest January on record. In Mikve Yisrael, it was a record-breaking wet January. In Tel Aviv highest rain intensities of 79 mm within two hours occurred and caused flooding. Heavy precipitation events of intensities returning only every 10 to 20 years were observed over the Azores (Portugal) causing landslides and flooding. In Spain, extreme rainfall was reported due to the storm *Gloria* along the Mediterranean coast between Catalonia and Alicante, as well as the coast of Málaga and the Balearic Islands from 18 to 25 January.

4.5.2. February

Several new heat records occurred in February. In Türkiye, 201 stations set new maximum temperature records as well as many cities in Russia, for example Petrozavodsk and Kotlas. The capital city, Moscow, even measured the second warmest February since start of the timeseries. Record-breaking daily air temperatures were also observed in Kopaonik (Serbia). Vilsandi and Kuusiku in Estonia measured its second (3.4 °C) and third to fourth (9 °C) warmest monthly mean temperature, respectively. More records were set in Italy, where in Emilia Romagna and Piedmont due to a heat wave the warmest February since 1961 and 1958 was recorded. Piedmont broke the daily temperature record of the month on 3 February. A heatwave from 14 to 25 February occurred in the Inner Centre Region of Portugal.

Sweden reported low temperatures of −36.4 °C at Nikkaluokta on 20 February which was the lowest for the winter 2019/2020.

In February, a few precipitation records were set. Monthly total for Virtsu station in Estonia was 110 mm (307% of normal) – first rank since 1911. The monthly total for Tallinn station was 105 mm (293% of normal) – the first rank since 1883. Exceptionally high rain amounts occurred as well in Luxembourg. At some stations for example Grevenmacher and Koerich new precipitation records

were set. In Russia, after heavy rainfall a flood occurred on the Pshish river on 4 February. The town of Khadyzhensk in the Krasnodar Territory was inundated leading to infrastructural damage.

February 2020 was an extraordinarily stormy month in some places. The month started with cyclone Petra, followed by cyclone Sabine on 10 February and finishing the month with the cyclones Yulia and Bianca. These storms affected main parts of Austria. The wind gusts reached up to 140 km h^{-1} causing damages on infrastructure, cancelled flights as well as power breakdowns in many households. Damages occurred mainly north of the Alps (Vorarlberg, Tyrol, Salzburg, Upper and Lower Austria as well as in Vienna and Burgenland). Poland also was hit by the heavy storm called Sabine on 10 and 11 February. Three casualties where caused through the extratropical cyclone. Storm Yulia also affected Poland at the end of February with wind gusts of 110 km h^{-1}. In Lens (Belgium), a tornado was reported on 10 February. A heavy storm (named Uta in Central Europe) hit the country of Iceland on 14 February, the worst storm for many years. There was considerable damage in the south, southeast and west.

4.5.3. March

In March, a cold wave over Central Europe held on up to 8 days. At the end of March, the cold period started for Austria continuing until April and causing frosty nights and late frost. This cold wave was also the reason for agricultural damage especially in Vorarlberg, Styria and Burgenland, where fruit cultivations were damaged. Hungary too, was affected by the cold wave between 22 and 26 March and between 30 March and 3 April reaching new regional daily minimum temperatures. In Russia, three warm spells were reported. Regional temperature anomalies of +5 °C were observed setting new temperature records.

Intensive rainfall occurred over the Mediterranean and the Balkans, Spain and the Middle East. In Dimitrovgrad (Serbia), record-breaking daily and monthly sums were measured. The storms Karine, Myriam and Noberto hit especially the north of the Iberian Peninsula between 1 and 6 March. Spain recorded new precipitation records on 31 March when heavy rainfall was observed. Castellón-Almassora set a new record of 150 mm as the highest rainfall at this station since 1976. In Russia, an Atlantic cyclone caused warm conditions.

Sweden reached its annual maximum sea ice extent during the first week of March. However, it was the lowest maximum extent for at least 120 years.

4.5.4. April

Cold waves extending from France over the Alps and the Mediterranean and Balkan countries to Türkiye were dominating in April. In Austria, the cold period from March continued to the beginning of April. Cold conditions prevailed up to 26 days over Bulgaria and Rumania starting on 1–5 April with minimum temperatures of −6.7 °C and affecting fruit cultivations in Bulgaria. Cold conditions at the beginning of April were also observed in parts of Serbia like Kikinda and Belgrade as well. Hungary recorded new daily minimum records up to −11.9 °C at Zabar station due to this cold wave. A second frost period occurred from 6 to 10 April in Bulgaria. Slovenia observed a cold period from 30 March to 3 April and between 14 and 16 April over the whole country leading to snow fall and damage of fruit cultivations. Another period with frost was registered between 21 and 25 April, where minimum air temperatures of −3.9 °C were measured in Bulgaria (e.g. Vidin and Dobrich). This cold wave caused damages to orchards as well.

In Belgium, contrary conditions were observed. In Uccle, the daily maximum temperature was at least 20 °C from 5 to 12 April, which was the earliest year series of consecutive spring days in April. In general, April was extremely dry and sunny in Belgium (new record for sunshine duration in Uccle for April and May of 578.9 hours since 1887). Between 9 to 13 April a warm spell was recorded in Banatski Karlovac (Serbia). Beside a record-breaking warm April at Kap Morris Jesup and station Nord in Greenland, another record was set in Denmarkshavn for the second warmest April and May. Poland reported a dry spell over the whole country with total precipitation of 8.3 mm.

Heavy precipitation occurred over Greece, causing floods and infrastructural damage on 4–8 April. Thessaloniki station recorded its wettest April, measuring 111 mm rainfall which is almost 3 times above the normal value.

4.5.5. May

Cold and wet conditions occurred in Eastern Europe, especially in Poland and Russia, during May. In Russia, mainly western and southwestern regions were affected by cold air masses and night frost. Moreover, many records of minimum air temperatures and maximum precipitation were observed between 29 and 31 May.

Especially warm conditions were registered over the Iberian Peninsula and southern France. Several heat waves appeared in the Mediterranean, the Balkan states and the Middle East. In the first half of May drought caused wildfires in Austria which had to be extinguished by large scale operation of firefighters and helicopters. In Portugal, new heat records were set due to a heat wave with particularly high intensities and duration (13–31 May) over the whole territory. Another warm spell was registered in Dimitrovgrad (Serbia) from 13 to 17 May. An especially extreme heat wave was reported in Greece from 15 to 20 May. It was the hottest heat wave in May in the past 50 years. During the same period, an intense heatwave overcame Israel starting one day earlier on 14 May. In several regions of Israel, temperatures of 35–42 °C lasted for a week. In May, many monthly and daily maximum temperature records were observed for example in Armenia, Cyprus and Estonia.

On 20 and 21 May, extreme storms with hail and rainfall including thunderstorms induced damage and fires in Bulgaria. Especially northwestern Bulgaria was affected. Regional egg-sized hailstones fell during the storm destroying houses, agriculture and cars. Heavy rainfall and thunderstorms occurred as well in Austria causing floods in the last third of May. Especially on 23 May, thundery rain showers showed extreme intensities and damaged infrastructure of regions in Austria.

In Lithuania, an impressive temperature drop and a snow cover over the whole country was observed from 12 to 15 May. Big damage to active plant vegetation was caused due to the temperature drop from 16–25 ºC to 9–11 ºC. Arctic airmass let to a sleet and snow cover of 16 cm in the entire country.

4.5.6. June

In June, warm conditions were observed in Eastern Europe, Scandinavia, parts of Spain, France and United Kingdom. This weather situation came along with heat waves, which occurred with high intensities in parts of Eastern Europe. The second half of June recorded a heat wave in Estonia causing temperatures over 30 °C. Russia recorded several new monthly heat records as well as Sweden, where at Skellefteå Airport with 34 °C the highest temperature for June was observed since 1970 .

In the Mediterranean, the Balkan States and Central Europe especially wet conditions and flooding were recorded. June was a very wet month in Austria with precipitation anomalies of +25% of normal. Heavy precipitation events and thunderstorms, especially at the end of June, caused fires, mudflows, flooding and damages of more than eight million euros. In the states Salzburg, Upper Austria, Styria and Lower Carinthia the events were intensive. An amount of 90 mm of rain during two hours was measured in Gleisdorf.

Large parts of Europe observed more precipitation than normal. New records were set in Russia on 3 and 4 June, when the Uzlovaya station recorded a daily precipitation record of 144 mm. Similar records for the month of June were registered in Serbia (in Kragujevac and Nis). Heavy precipitation events caused floods. Between 14 and 15 June, thunderstorms, rain and hail desolated parts of Bulgaria. Even landslides were observed. In Bursa (Türkiye), on 21 June extreme rainfall triggered flooding and damaged agriculture and cars, five people died as well as many farm animals.

In Poland, a tornado destroyed 23 buildings, infrastructure and power grids near Kaniów on 7 June.

4.5.7. July

In July, a few prolonged heat waves occurred. Over parts of the Iberian Peninsula, the Middle East, Eastern Europe, the Mediterranean and Balkans heat waves continued the whole month. The warmest July since 1931 was recorded in Portugal due to the occurrence of a heat period. The station Uccle in Belgium registered the third highest temperature (36.5 °C) on record. Abnormally hot conditions and new heat records were also observed in many regions of Russia. In Rostov-on-Don 40.2 °C were measured, which is the highest absolute temperature for the summer period.

Hot weather conditions were observed, followed by thunderstorms and heavy rainfall. On 6 July, large parts of Sofia (Bulgaria) were flooded as the Perlovska river burst its banks after extreme rainfall. Some stations in the capital measured up to 50 mm. The Vladayska River also inundated the districts of Orlandovtsi and Benkovski. In Lithuania, five heat waves were recorded followed by powerful convection including a tornado on 7–9 June. In Austria, a heavy storm with wind gusts up to 90 km h^{-1} caused infrastructural damages at the end of July. Floods and mudflows occurred. Krusevac in Serbia even measured its third wettest July with a value of 187.5 mm precipitation. Seven million euros of damage were caused by heavy rainfall, hail and storm in Slovenia on 29 July. In Luxembourg, on the other hand, July ranked among the 10 driest July months since 1851 at all stations. In Fouhren and Hosingen it was even the driest July since 1951.

4.5.8. August

August 2020 was dominated by heat waves and stormy extreme events. Many parts of the RA VI Region showed extremely warm conditions, causing wildfires due to drought or flooding due to thunderstorms. Heat periods of July continued during August in most subregions (Mediterranean, Balkan states, the Middle East, the Iberian Peninsula). High temperatures were reported in Central Europe, especially in Poland, Belgium and Luxembourg. In Poland and Belgium, heat waves with temperatures about 30 °C occurred setting new heat records during the first half of August. At Findel Airport in Luxembourg, the second warmest August (monthly mean value 21.2 °C) since 1947 was measured. At the end of August, an intense heat spell prevailed in Israel reaching temperatures up to 46 °C in the eastern valleys. The only country that registered a cold wave was Armenia from 21 to 28 August. During this time period temperatures around 0 °C were measured which were the lowest in August on record.

Heat spells ended in thunderstorms including heavy rain, hail and wind causing floods and mudflows. For example, in some regions in Austria (Dornbirn, Kötschach-Mauthen, Brenner) it rained up to 150 mm accompanied by hailstorms and lightning strikes from 28 to 31 August. Due to heavy precipitation events, Matrei/Brühl was close to reach its 100-year flood mark with 449 cm. The neighbouring country Switzerland measured heavy rainfall up to 224.5 mm on 29 August. Exceptionally wet conditions were also observed over the Balkan Peninsula, the Iberian Peninsula and the United Kingdom. On 8 August, Greece reported on storms causing heavy floods, erosion phenomena and destruction on the island of Evia. The state of emergency was declared, eight people even died. In Demir Kapija (North Macedonia) extremely heavy precipitation with more than 700% of normal were measured. For North Macedonia as a whole, August 2020 was the wettest on record. Several million euros damage on infrastructure was caused by a fast-moving supercell storm in eastern Slovenia on 30 August. Especially wine yards were damaged by a heavy hailstorm.

4.5.9. September

Exceptionally dry conditions during September were observed in the east and southeast due to the occurrence of heat waves. Bulgaria recorded a prolonged heat spell in the entire country during the first half of September. Dry conditions and wind gusts triggered a higher risk of fire. Cyprus measured the highest maximum temperature of 46.2 °C (Athalassa Park) on record. In Israel, an exceptionally strong heat wave between 3 and 20 September occurred. Highest temperatures were measured between 3 and 5 September, setting monthly and annual records for September. However, warmer than normal conditions occurred in barely every subregion. Belgium set a new maximum temperature record in Uccle with 34.3 °C and in Steinsel in Luxembourg the highest monthly temperature on record of 35.2 °C was observed. Luxembourg registered even more new records on 15 and 16 September. This heatwave affected even Poland between 14 and 16 September with temperatures about 30 °C.

Several floods were recorded in the southern part of the RA VI Region, especially in the Mediterranean and the Balkan states. Extremely high precipitation amounts occurred in Hungary during 25 September and 13 October causing river floods. In Austria, heavy precipitation was accompanied with a temperature drop between 24 and 26 September. These weather conditions led to heavy snowfall and flooding in September.

On 18 and 19 September a subtropical storm including thunderstorms and strong gusts up to 90 km h^{-1} occurred in Portugal. In Beja and Palmela, even two tornados were reported. A dust storm affected life in Ankara (Türkiye) on 12 September. Six people were injured.

4.5.10. October

In October, extremely wet conditions occurred in Western Europe, Scandinavia and on the Iberian Peninsula. Flooding occurred in many RA VI subregions. Heat periods continued in Eastern Europe and the Middle East. In Israel high temperatures occurred again due to a Sharav on 8 and 9 October. Temperatures reached up to 42 °C in the Jordan Valley and the Arava. An unusual warm period was also registered in Estonia during October. Several monthly heat records were set. The monthly mean anomaly was +2.8 °C in Tallin – the highest anomaly since 1883.

Stormy weather and thunderstorms were reported in Austria at the beginning of October. In Feuerkogel wind gusts reached up to 160 km h^{-1}. Heavy rain events were especially observed in East Tyrol and Upper Carinthia followed by flooding and mudslides. Historic Mediterranean rainfall

with dramatic floods and more than 20 victims occurred on 3 October (associated to Alex storm): a rainfall record was set with 513 mm in 24 hours (Saint-Martin-Vésubie, Alpes-Maritimes, France)." The Iberian Peninsula was affected by the storm *Barbara* on 19–22 October leading to heavy rainfall especially in the Central System Mountains of Spain. Crete (Greece) also experienced an extremely wet October. Thunderstorms and heavy rainfall caused floods and landslides on the island. October 2020 was the wettest since 1931 at the Heraklio station where 304 mm precipitation was measured which is 6.5 times above normal (1971–2000).

4.5.11. November

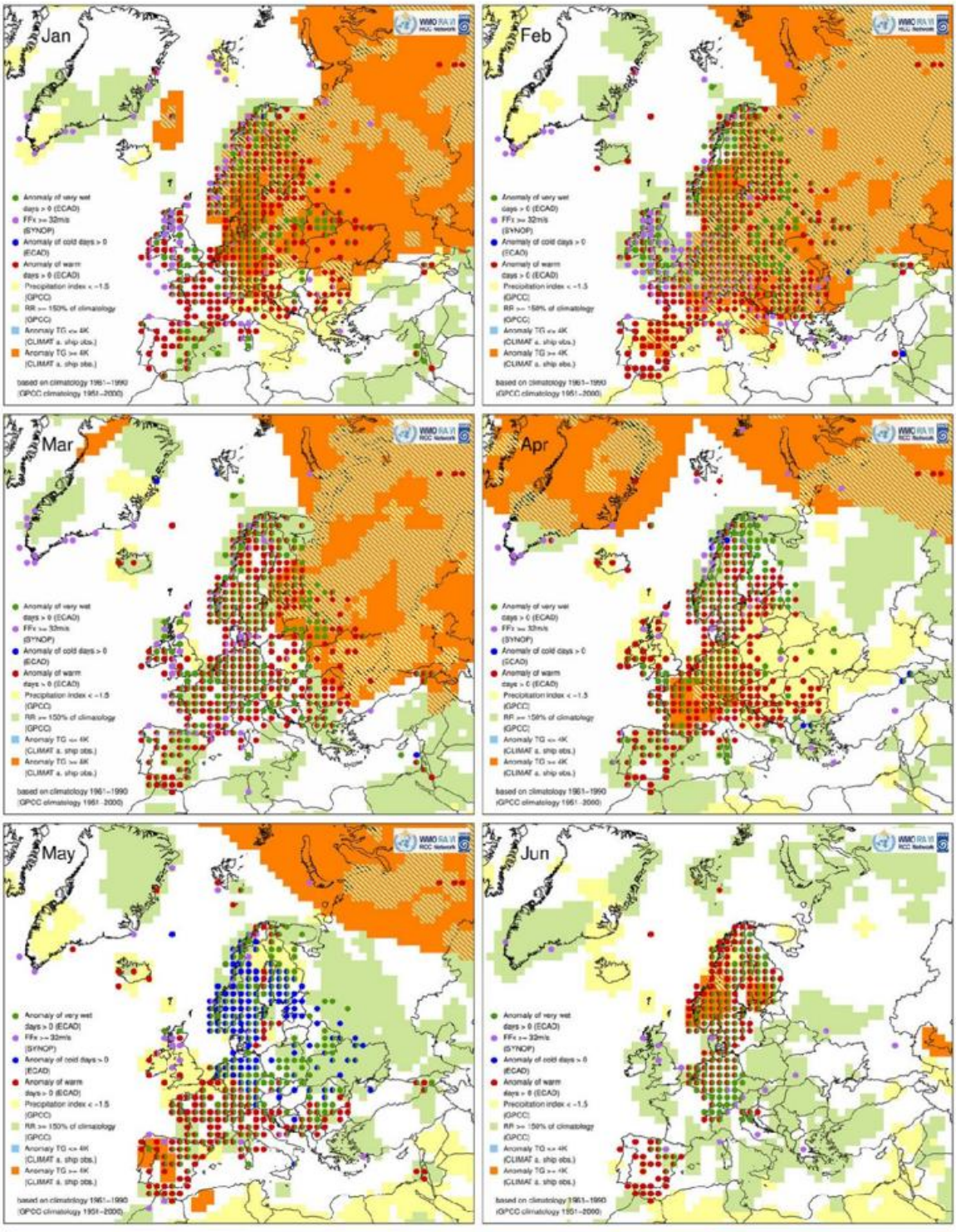
November was especially warm in Scandinavia with a temperature anomaly of +3 °C. In Estonia, the warm spell of the previous month continued. Several new records were set for November. Tallinn experienced an anomaly of +4 °C (monthly mean temperature of 5.3 °C) making it the warmest November since 1883. New maximum air temperature records were also measured in Luxembourg. In Greece dry conditions were observed. The station Aktio only received 5.3% of the normal precipitation (1971–2000). Another dry spell was also registered in Poland: Several stations reported monthly precipitation values only up to 10 mm. Drought and heat waves also occurred across most of Serbia.

In November, several extreme precipitation events occurred in countries bordering the Mediterranean Sea. On 4 and 5 November, the first heavy rainfall occurred in Spain. From 7 to 10 November Greece was hit by a storm causing floods, mudflows and destructions. With a surplus of 471% precipitation it was the wettest November for Kastelli station in Crete. The Azores (Portugal) were affected by heavy rainfall on 9 and10 November. During 24 hours 152 mm rain fell in São Miguel. Precipitation amounts of these intensities are only received every 40 to 50 years. Exceptional precipitation amounts were registered in Israel as well. From 19 to 21 November the Middle East countries received precipitation amounts up to 200 mm. Bet Dagan station measured highest precipitation intensities during 30 minutes since 1962.

4.5.12. December

Floods and storms occurred in many parts of the RA VI Region during December. In Austria, heavy precipitation came down as snow. New records of snow in East Tyrol and Upper Carinthia caused widespread traffic and infrastructural problems. The unstable snow cover triggered a higher risk for avalanches. In lower altitudes like Lenz, rain led to damage due to flooding and mudflows. Exceptional rainfall was measured in Iceland as well. Seyðisfjörður received highest precipitation amounts with 577.5 mm from 14 to 18 December causing landslides. New precipitation records since start of time series were reported in New Yaar and Ramat David (Israel) on 15 December.

Storms *Dora* and *Ernest* caused heavy rainfall in Spain from 4 to 10 December. Foehn wind occurred in Poland. In Kasprowy Wierch wind gusts up to 170 km h^{-1} were measured.



- Anomaly of very wet days > 0 (ECAD)
- Wind gusts (≥ 32 ms^{-1}) (SYNOP)
- Anomaly of warm days > 0 (ECAD)
- Anomaly of cold days > 0 (ECAD)
- Anomaly of TG ≤ −4 K (CLIMAT and ship obs.)
- Anomaly of TG ≥ 4 K (CLIMAT and ship obs.)
- Precipitation index < −1.5 (GPCC)
- RR ≥ 150% of climatology (GPCC)

Based on climatology 1961-1990 (GPCC climatology: 1951-2000)

Figure 4-9: *Monthly maps of climate extremes for the months January to June 2020; RR = daily total precipitation, TG = daily mean temperature. Source: RCC-CM website.*

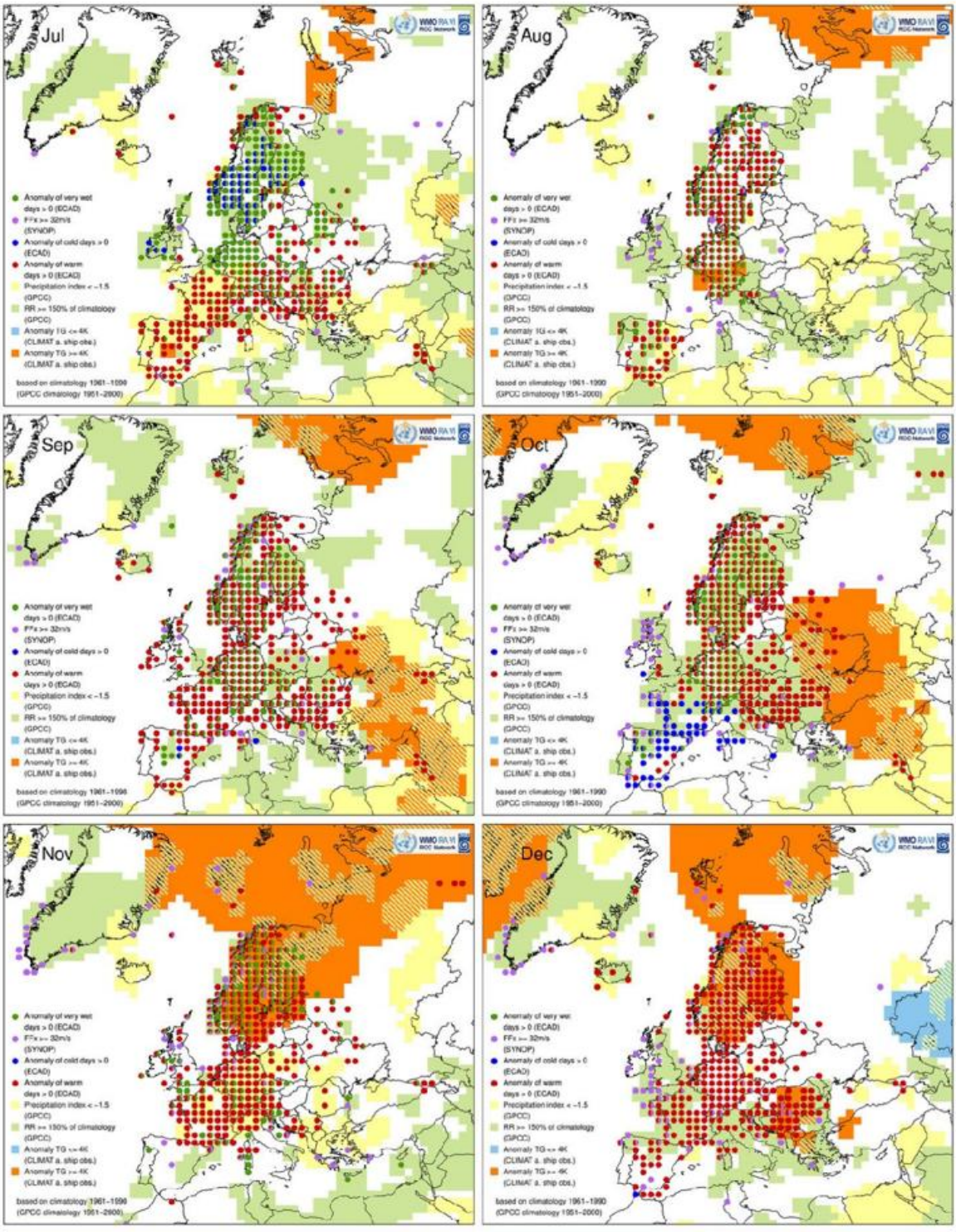


Figure 4-10: Monthly maps of Climate Extremes for the months July to December 2020; RR = daily total precipitation, TG = daily mean temperature. Source: RCC-CM website.

4.6. Selected contributions by NMHSs

4.6.1. Temperature September: Prolonged heat wave in Israel from 3 to 21 September

(Contribution from the Israel Meteorological Service)

A prolonged heat wave prevailed for the first three weeks of the month. The peak of the heat wave was at its beginning, between 3 and 5 September, when extreme values were measured, some of them set new records not only for September, but also for the entire year. The highest temperature with 48.9 °C was measured on 4 September in Eilat (southern Arava). This was an all-time record at this station, where measurements began more than 70 years ago. All-time records were also set in Kefar Blum −47.0 °C, Ayyelet HaShahar −46.6 °C (both in the Hula Valley, northeastern Israel) and in Zefat (Upper Galilee), with 40.6 °C. At some of the stations, new maximum temperature records were set for September. In Jerusalem, the old record from 89 years ago was replaced by a new one on 3 September with 42.3 °C, much higher than the previous 39.4 °C in 1931. It was broken once again on the next day (4 September) with 42.7 °C (**Figure 4-11**).

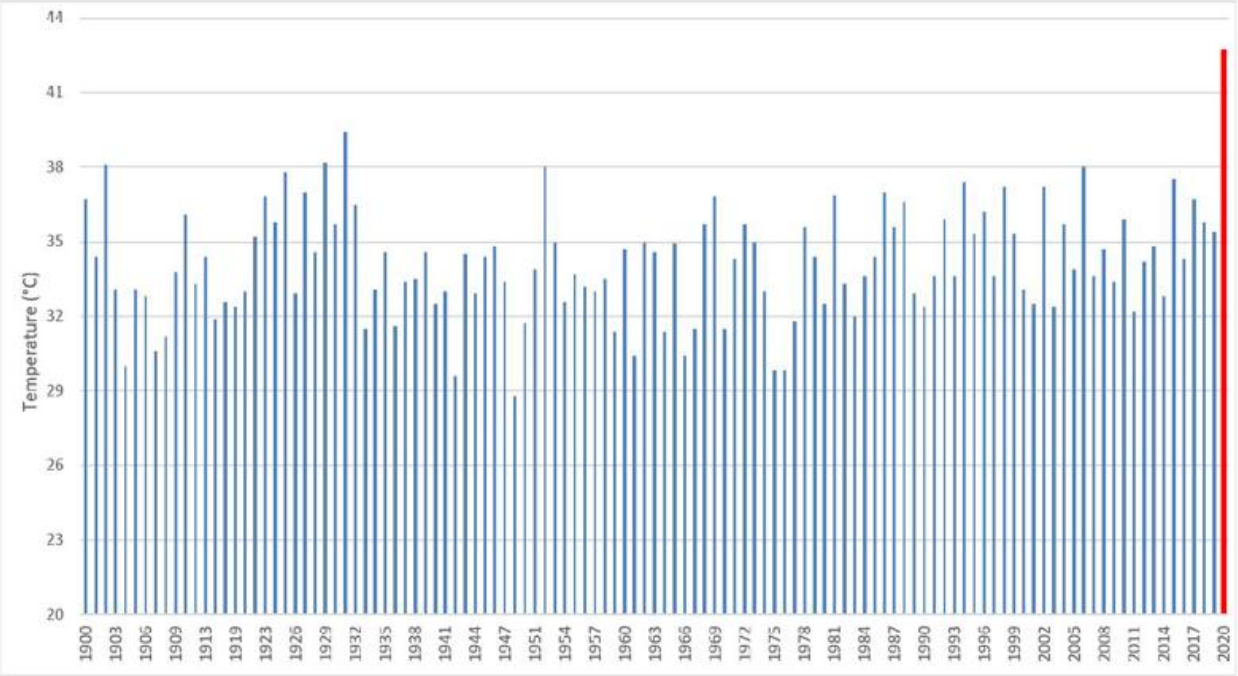


Figure 4-11: *Absolute Maximum temperature in Jerusalem in September 1900-2020. Source: Israel Meteorological Service.*

New historical records were also set with the minimum temperature, most of which occurred during the night of 3–4 September. In Jerusalem, a minimum temperature of 31.6 °C was measured and thereby replaced the previous record of 30.5 °C from June 1942. In Bet Dagan (28.9 °C) as well as in Zefat (30.3 °C), a new record was set for the entire year.

- Jerusalem (Judean Mountains): 24 days with temperatures above 31 °C (28 August to 20 September). No comparable sequences (concentrated in September) have ever been recorded since the beginning of measurements in 1867. In July–August, there were only two similar cases, in 1922 and 1887.
- Beer Sheva (northern Negev): 12 days with more than 36 °C. In the past, similar cases occurred only in September 1931 and August 1922.
- Kefar Blum (Hula Valley, northeastern

Israel): 8 days with more than 40 °C. There were no comparable sequences since the beginning of measurements at this station for more than 65 years, for all months of the year.

- Bet Dagan (central Coastal Plain): 16 days with more than 33 °C. Such a sequence did not occur at this station since the beginning of measurements in 1962.

4.6.2. Extreme events May: Intensive Saharan outbreak in Bulgaria

(Contribution from the National Institute of Meteorology and Hydrology, Bulgaria)

An intensive Saharan Dust outbreak occurred in the period 12–22 May 2020 over the southeast parts of the continent and the Balkans. It took place under a cyclone over the southern part of the Iberian Peninsula and an upper ridge over the central Mediterranean. A very deep and strong low at 500 hPa formed over the Atlantic, extending from the Pyrenees towards Northwest Africa, taking in its circulation an anomalous amount of dust from the Sahara Desert. In the front part of this cyclone, in a strong southwest flow, the dust was transported through the Central Mediterranean over the Balkans.

Figure 4-12: *MSLP (contours 5 hPa) and 200 hPa wind (vectors and shading: speeds > 30 m s^{-1}) on 15.05.2020 at 00 UTC, ECMWF-HRES model, https://www.ecmwf.int.*

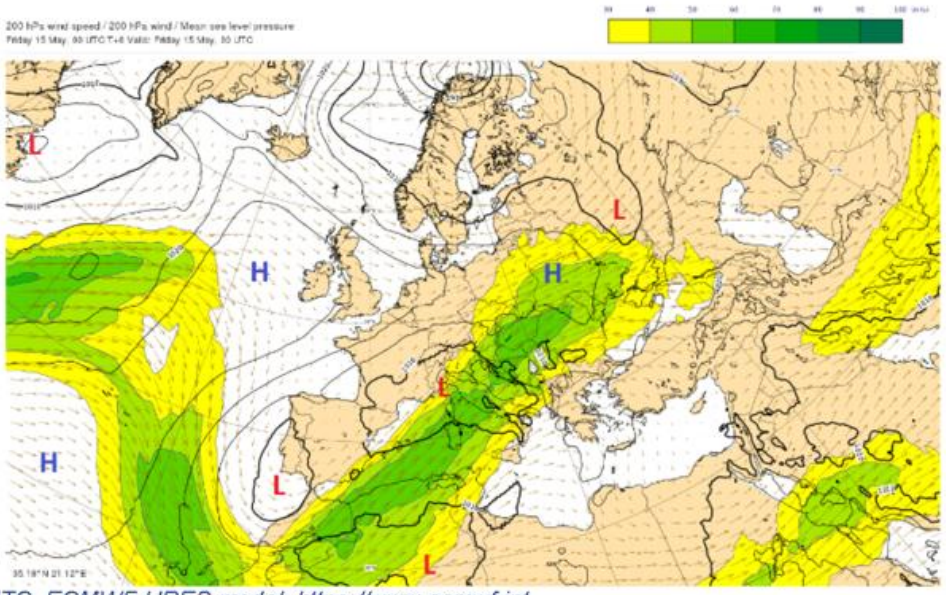


Figure 4-12 shows synoptic charts for this very specific situation in which the jet stream noticed easily on 200 hPa helped for transporting the dust far away from Northwest Africa as seen by satellite pictures. The cyclone remained stationary over the Western and Central Mediterranean and caused a heat wave with a temperature anomaly at 850 hPa of 12 °C–16 °C warmer air than the mean for the period (1979–2010), as estimated by the ECMWF ENS model. Over Bulgaria, the Saharan outbreak lasted for an exceptionally long period: from 12 to 22 May 2020. The peak was on 15 May 2020, when Foehn winds on the northern slopes of the mountains in Bulgaria were observed. In combination with the warm air mass advection, the temperatures in many regions of Bulgaria were above 30 °C, (in Sevlievo, north of the Balkan Mountain, 37.7 °C). An extremely dry situation with dusty atmosphere was observed in the next four days. The visibility at peak Musala (2925 m) was reduced from 40 km on 14 May 2020, 06:00 UTC to 15 km at 18:00 UTC. The particulate matter concentration PM10 at the mountain peak Kopitoto (1345 m) near Sofia increased to a daily mean value of 104.7 μg m^{-3} on 14 May 2020, higher by a factor of 15 compared to the mean of the previous 2 weeks. The chemical analysis of PM10 samples collected at NIMH on 15 May 2020 and

16 May 2020 showed high concentrations of the elements Ca, Mg, Al and Fe. The ratio of Ca to Al was 2.24, the ratio of Fe to Al was 0.52 and the ratio of Mg to Al was 2.42, confirming the origin of the aerosol particles in northwestern Africa (Algeria and Tunisia).

4.6.3. Extreme events September: Medicane over Greece on 17–20 September 2020

(Contribution from the Hellenic National Meteorological Service)

Greece was impacted by a so-called Medicane (MEDIterranean hurriCANE), a cyclonic low-pressure system with tropical characteristics that caused high winds, waves, torrential rain and extensive flooding between 18 and 20 September 2020.

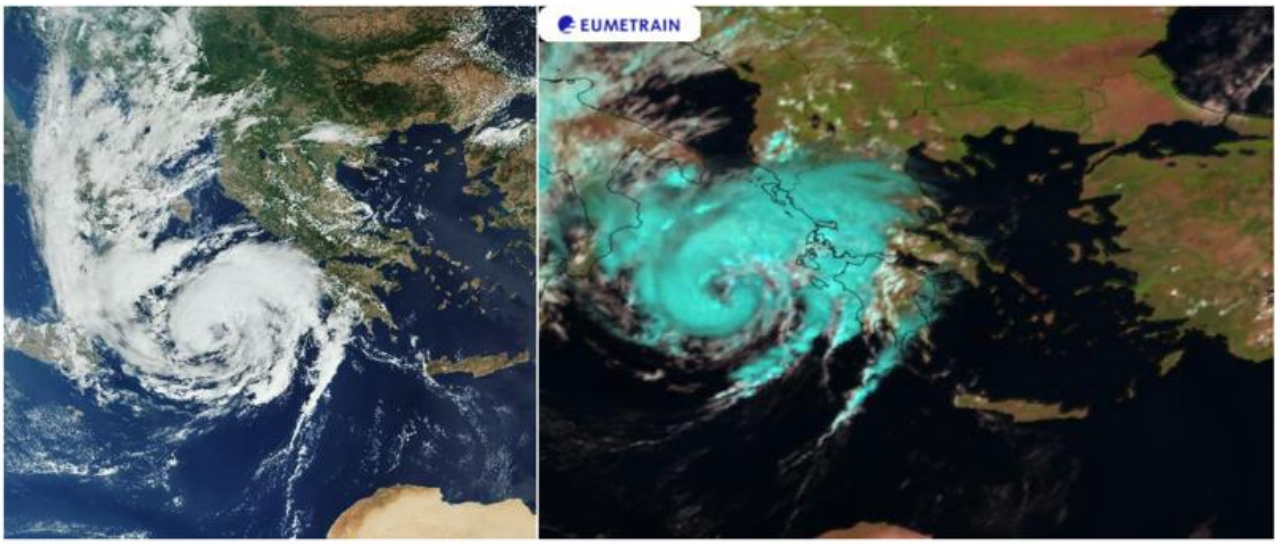


Figure 4-13: *The Copernicus Sentinel-3 mission captured this image of the Medicane, crossing the Ionian Sea and approaching west Greece on 17 September 2020 at 10:48 CEST (lefi); Day natural colors at 12:00 UTC (right).*

On 14 September 2020, a low-pressure system began to develop over the Gulf of Sidra, quickly developing in the coming hours while slowly moving north-northeastwards. The cyclone gradually intensified over the warm waters of the Mediterranean Sea, acquiring an eye-like feature, making landfall over the Greek island of Kefalonia on 17 September 2020 evening, with maximum wind gusts of 120 km h^{-1} (65 knots) and a surface pressure in the vicinity of 993 hPa (Figure 4-13, Figure 4-14). The Hellenic National Meteorological Service had issued top-level Red Alerts to warn people of hazards. Greece was last hit by a strong explosive cyclogenesis in 2018. Due to its long life, its tropical characteristics and its intensity, it can be classified as one of the most powerful Mediterranean Cyclones recorded since 1969, that is, from the beginning of satellite observations.

As the medicane shifted eastwards, strong convergence conditions were established in Thessalia and central Greece, resulted in heavy rains for a prolonged period, mainly in the areas around the cities of Karditsa and Farsala. Although the medicane didn't swept across east mainland since it moved south southeast to the area of Crete, the large-scale circulation brought warm moist air masses in the area of Thessaly. The eastward movement of an upper level trough enhanced the strength of the easterly to north-easterly winds. Also, the impact of orography caused convergence

zones leading to deep convection. By the evening of 19 September, the medicane had reached the island of Crete, bringing heavy rainfall that flooded streets and properties.

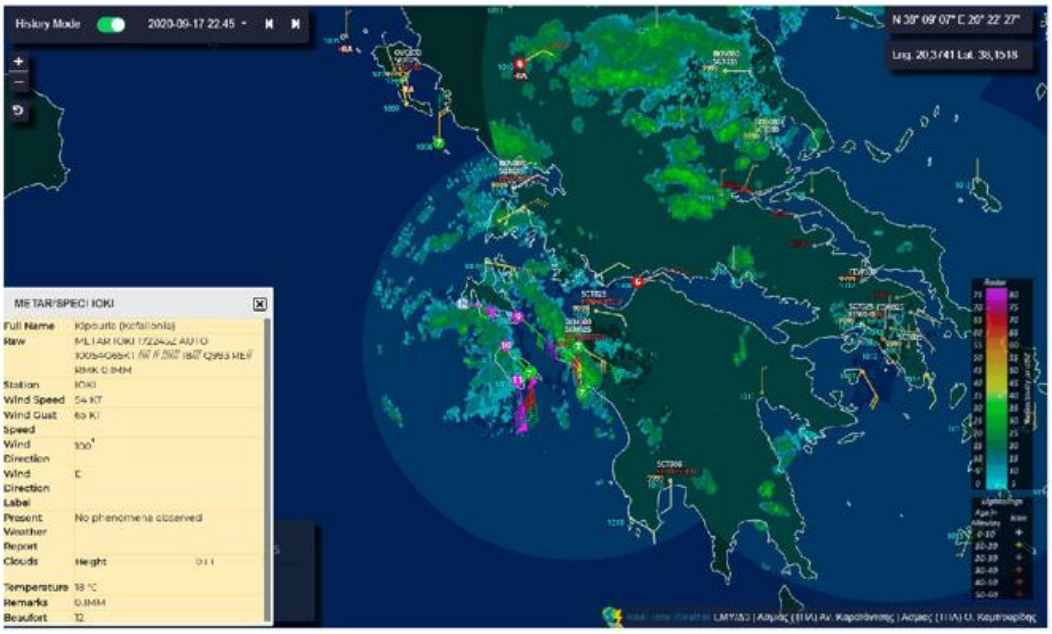


Figure 4-14: Radar image and station observations on 17 September 2020 22.45 UTC. A station located in the westernmost point of Paliki peninsula in Kefalonia island recorded a wind gust of 65 knots (12 Beaufort) and a pressure of 993 hPa.

Impacts

- The Ionian Sea islands of Zakynthos, Kefalonia and Ithaca were badly hit by the cyclone, as winds reaching 120 km h^{-1} damaged buildings, uprooted trees, sank sailboats and left thousands along Greece's western coast without power, while huge waves lashed the beaches.
- Flights and ferry services were cancelled and people were advised to stay indoors.
- The torrential rain caused flash flooding and landslides.
- The tourist village of Assos, in Kefalonia, was buried under mud and stones, while many houses were uninhabitable.
- The areas of Karditsa and Mouzaki in Thesallia were flooded and triggered significant landslides. A bridge collapsed and about 5 000 homes in the area were affected by flooding, while roads were also damaged. A river flooded its banks and damaged roads and a medical centre in the town of Mouzaki.
- Greece's cotton crop was at maturity with harvest set to begin soon, and the storm resulted in significant impacts and crop losses where rain was heaviest, most notably in Thessaly and central Greece.
- Throughout the country, over 1 000 people were rescued by the national firefighting service and four people lost their lives.

5. Annex: Monthly and annual tables

Table 5-1: *Statistical values of annual mean temperature and total precipitation and their deviations from the long term mean (1961–1990, CLIMAT Data) for the year 2020 for several stations of the RA VI Region.*

Station name	Country	Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.
Jan Mayen	NOR	0.4	1.8	855	168
Svalbard	NOR	−3.4	3.0	141	−42
Tromsoe	NOR	4.1	1.3	1376	403
Oslo	NOR	8.7	3.0	1082	313
Haparanda	SWE	4.4	3.2	917	365
Stockholm	SWE	9.8	3.2	504	−35
Sodankylä	FIN	2.2	3.3	553	53
Jokioinen	FIN	7.3	3.4	729	148
Aberdeen	GBR	9	1.1	801	18
London	GBR	12.7	2.1	662	63
Dublin/Casement	IRL	9.8	0.5	820	109
Reykjavik	ISL	5.1	0.7	873	75
Danmarkshavn	GRL	−10.3	1.9	324	192
Copenhagen	DNK	10.8	2.1	684	48
De Bilt	NLD	11.7	2.3	856	51
Brussels	BEL	12.2	2.3	748	−70
Luxembourg	LUX	11.3	3.0	790	−85
Zurich	CHE	10.9	2.4	860	−226
Geneva	CHE	12.2	2.5	795	−159
Bordeaux	FRA	14.9	2.2	1159	236
Marseille	FRA	16.3	1.5	453	−92
La Coruna	ESP	15.7	1.6	955	−40
Madrid Retiro	ESP	16	1.7	476	20
Menorca	ESP	17.8	1.2	415	−183
Gibraltar	GIB	19.2	1.0	439	−336
Santa Maria/Azoren	PRT	18.2	0.7	623	−152
Braganca	PRT	13.3	1.2	797	56
Berlin−Tempelhof	DEU	11.7	2.3	478	−106
Vienna	AUT	11.8	2.1	705	98
Prague	CZE	9.9	2.0	569	43
Sliac	SVK	9.7	1.7	779	93
Elbing	POL	9	1.4	678	−12
Warsaw	POL	10.5	2.7	648	129
Budapest	HUN	12.1	1.7	543	25
Belgrad	SRB	13.8	2.0	655	−29
Ljubljana	SVN	12.1	2.3	1263	−131
Split	HRV	17.5	1.7	727	−98
Sarajevo	BIH	11.3	1.7	792	−140
Bukarest	ROU	12.4	1.9	702	107
Sofia	BGR	11.4	1.7	652	89
Pisa	ITA	15.4	1.4	1008	100
Luqa	MLT	19.8	1.2	387	−166
Athens	GRC	19.7	1.2	311	−60
Heraklion	GRC	19.7	0.9	776	275
Murmansk	RUS	2.5	2.6	654	176
Tallinn	EST	8.2	3.1	855	188
Liepaja	LVA	9.8	3.0	698	8
Kaunas	LTU	9.3	3.0	600	−30
Vilnius	LTU	9	3.0	563	−120
Minsk	BLR	8.6	2.8	616	−61
Moscow	RUS	8	3.1	888	200
Kiew	UKR	10.9	3.2	580	−69
Kischinau	MDA	12.6	3.0	553	6
Charkiw	UKR	10.4	3.0	559	40
Astrachan	RUS	12.2	2.2	131	−89
Jerewan	ARM	13.6	2.1	333	56
Samsun	TUR	16.2	1.9	566	−125
Istanbul	TUR	16.6	2.5	525	−173
Ankara	TUR	14.1	2.5	381	−26
Van	TUR	10.8	2.2	413	35
Antalya	TUR	20.4	2.1	804	−262
Larnaka	CYP	21.1	2.1	366	37
Oral	KAZ	8	2.5	264	−60
Tiflis	GEO	14.6	1.6	400	−98
Eilat	ISR	26.4	1.9	31	0
L.Palmas/Gran Can.	ESP	21.8	1.3	65	−53
Princess Juliana Airp.	SMA	27.9	1.0	1114	107
Le Lamentin	MTQ	27	0.8	1926	−106

Table 5.2: *Statistical values of monthly mean temperature and total precipitation and their deviations from the long term mean (1961–1990, CLIMAT Data) for the year 2020 for several stations of the RA VI Region.*

Station name	Country	January				February				March			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	−0.4	5.3	107	46	−4	2.1	46	−7	−5.1	1.0	38	−17
Svalbard	NOR	−13.4	2.0	3	−11	−15.5	0.2	3	−16	−16.2	−1.5	8	−13
Tromsoe	NOR	−1.4	2.6	158	77	−1.4	2.3	140	54	−1.6	0.6	179	115
Oslo	NOR	2.7	7.0	77	28	1.9	5.9	45	9	3	3.2	32	−14
Haparanda	SWE	−4.2	7.9	83	39	−6	5.3	98	66	−3	3.8	43	8
Stockholm	SWE	4.1	6.9	18	−21	2.9	5.9	26	−1	3.6	3.5	40	14
Sodankylä	FIN	−9.4	5.7	48	17	−8.9	4.7	47	22	−5.6	2.9	36	11
Jokioinen	FIN	1.5	9.0	58	22	−0.3	7.1	109	85	1.1	4.6	50	25
Aberdeen	GBR	5.5	2.8	22	−59	4.3	1.4	72	21	5.6	1.1	19	−39
London	GBR	7.5	3.3	48	−4	8	3.5	100	65	8	1.5	43	−4
Dublin/Casement	IRL	6.1	1.2	49	−20	5.6	1.0	155	104	6.1	0.1	33	−21
Reykjavik	ISL	0.3	0.8	124	48	0.3	−0.1	55	−17	0.4	−0.1	87	5
Danmarkshavn	GRL	−20.1	3.0	157	146	−24.7	−0.4	5	−6	−24.7	−1.3	0	−17
Copenhagen	DNK	5.5	5.0	76	25	5	4.5	92	61	5.3	2.7	16	−26
De Bilt	NLD	6.2	4.0	51	−15	7.2	4.7	157	108	6.8	1.8	67	4
Brussels	BEL	5.9	3.3	69	2	7	3.5	100	47	7.1	1.6	85	13
Luxembourg	LUX	3.6	3.6	47	−24	5.2	4.1	149	87	6.2	2.2	66	−4
Zurich	CHE	2.6	3.1	23	−44	6.2	5.3	119	49	5.9	1.7	40	−29
Geneva	CHE	3.1	2.3	29	−51	7.1	4.8	64	−17	7.4	2.3	78	−1
Bordeaux	FRA	8.6	2.8	67	−33	10.5	3.4	61	−25	10.4	1.6	104	28
Marseille	FRA	9.1	2.4	39	−8	10.6	2.7	6	−48	11.2	1.0	15	−29
La Coruna	ESP	11.5	1.3	119	−12	13.3	2.8	47	−57	12.4	1.1	114	28
Madrid Retiro	ESP	7	0.9	16	−30	10.9	3.4	<1	−44	11.4	1.4	57	24
Menorca	ESP	11.7	1.2	116	50	12.4	1.7	1	−56	13.1	1.5	26	−29
Gibraltar	GIB	13.9	0.5	72	−49	15.7	1.9	1	−99	15.8	0.8	98	23
Santa Maria/Azoren	PRT	16.5	2.1	26	−74	15.8	1.8	26	−60	15.5	0.9	33	−46
Braganca	PRT	5	0.5	65	−36	9.1	3.2	10	−92	9	1.0	91	32
Berlin−Tempelhof	DEU	4.7	4.9	34	−9	6.2	5.4	83	49	5.9	1.7	30	−7
Vienna	AUT	1.4	2.4	20	−18	6.6	5.6	51	9	7.1	2.1	21	−20
Prague	CZE	1.2	3.6	7	−16	4.6	5.4	46	23	4.6	1.6	52	24
Sliac	SVK	−2.2	1.7	12	−32	2.8	3.9	85	41	4.5	1.5	60	18
Elbing	POL	2.2	4.6	78	31	2.7	4.9	55	30	3.6	1.5	50	15
Warsaw	POL	2.5	5.8	29	7	4	6.0	43	22	5	3.0	13	−15
Budapest	HUN	−0.4	1.2	11	−21	6	4.9	25	−7	7.5	1.9	32	3
Belgrad	SRB	1.8	1.4	22	−27	7.6	4.9	56	12	9.1	1.9	48	−2
Ljubljana	SVN	1.9	3.0	14	−68	6.8	5.4	42	−38	7.2	1.8	105	7
Split	HRV	9.5	2.1	3	−80	10.9	2.8	36	−32	11.8	1.4	15	−60
Sarajevo	BIH	−0.7	0.2	25	−46	5.2	3.7	70	3	6.6	1.5	55	−15
Bukarest	ROU	0.3	2.7	3	−37	4.5	4.6	47	11	7.7	2.9	32	−6
Sofia	BGR	0.2	1.8	10	−17	3.8	3.3	52	19	6.2	1.6	91	53
Pisa	ITA	7.7	1.6	61	−14	10.4	3.3	30	−41	10.5	1.0	39	−37
Luqa	MLT	13.2	1.0	15	−74	13.7	1.3	1	−60	14.4	1.0	39	−2
Athens	GRC	9.8	−0.4	26	−19	12	1.5	14	−34	14	1.6	59	15
Heraklion	GRC	11.9	−0.1	92	0	12.8	0.6	44	−33	14.6	1.0	43	−14
Murmansk	RUS	−8.7	3.0	73	40	−5.8	5.4	45	23	−3.8	3.0	42	22
Tallinn	EST	3	8.5	65	20	1.5	7.2	105	76	2.2	4.4	49	20
Liepaja	LVA	4.8	7.8	63	17	3.9	6.9	85	54	3.7	3.9	52	16
Kaunas	LTU	2.5	7.7	53	14	2.2	6.5	55	24	3.6	4.0	29	−6
Vilnius	LTU	1.7	7.8	47	6	1.7	6.5	55	17	3.3	3.9	38	−1
Minsk	BLR	1.2	8.1	45	5	1.5	7.3	49	15	3.1	4.5	22	−20
Moscow	RUS	0.1	9.4	54	9	−0.3	7.4	39	2	3.8	6.0	51	17
Kiew	UKR	0.8	6.4	21	−26	2.5	6.7	46	0	6.5	5.8	15	−24
Kischinau	MDA	1.5	4.8	9	−31	4.4	6.1	23	−15	7.8	4.9	19	−16
Charkiw	UKR	−0.1	6.8	27	−17	0.3	6.0	68	36	6.5	6.8	18	−9
Astrachan	RUS	0	5.4	18	5	1.8	6.7	5	−5	7.6	6.3	15	1
Jerewan	ARM	0.1	3.3	10	−11	1.5	2.5	26	2	10.1	5.0	34	2
Samsun	TUR	8	1.1	118	57	8.8	1.6	61	11	10.6	2.6	46	−10
Istanbul	TUR	7.4	1.8	154	55	9	3.1	60	−7	10.6	3.1	58	−4
Ankara	TUR	1.3	1.3	22	−19	4.2	2.5	70	34	9.3	3.3	23	−13
Van	TUR	−2.5	1.9	62	28	−1.7	2.1	104	71	4.9	4.0	56	14
Antalya	TUR	11.7	1.8	87	−152	11.4	1.1	106	−90	15	2.3	61	−42
Larnaka	CYP	12.1	0.3	100	35	12.9	0.7	53	−4	15.3	1.8	53	4
Oral	KAZ	−3.6	9.3	21	−4	−3	9.5	33	15	4.5	9.5	9	−11
Tiflis	GEO	3.8	2.1	3	−16	5	2.1	0	−26	10.5	3.6	41	11
Eilat	ISR	15.6	0.5	3	−2	17.6	0.8	17	12	21.1	1.3	0	−4
L.Palmas/Gran Can.	ESP	17.8	0.3	2	−15	20.1	2.5	1	−21	18.8	0.4	16	6
Princess Juliana Airp.	SMA	26.2	1.0	136	74	26.2	1.0	64	20	26.3	0.8	72	28
Le Lamentin	MTQ	25.4	0.5	107	−14	25.9	1.1	87	−2	25.7	0.5	44	−44

Table 5.2: continued

Station name	Country	April				May				June			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	−1.6	2.3	41	1	−1	−0.3	41	1	3.4	1.4	40	5
Svalbard	NOR	−8.9	2.8	6	−6	0.1	3.8	8	2	4.5	2.3	19	9
Tromsoe	NOR	−0.1	−0.8	115	55	4.3	−0.6	86	38	10.1	0.8	27	−26
Oslo	NOR	7.3	2.7	39	−3	10.2	−0.6	38	−14	18.8	3.6	120	55
Haparanda	SWE	0.5	1.0	35	6	6.2	0.1	23	−8	16	3.2	76	35
Stockholm	SWE	7.1	2.5	22	−8	10.1	−0.6	27	−3	18.6	3.0	66	21
Sodankylä	FIN	−1.8	0.3	28	4	5	0.0	18	−17	15.4	3.8	64	8
Jokioinen	FIN	3.8	1.4	48	17	8.5	−0.9	32	−3	18.1	3.8	32	−15
Aberdeen	GBR	7.8	1.5	16	−37	10.6	1.6	36	−23	13	0.9	56	3
London	GBR	12.3	3.4	38	−7	15.1	2.6	2	−49	17.5	1.8	54	3
Dublin/Casement	IRL	9.4	1.9	19	−31	12.1	2.0	11	−46	13.5	0.4	87	34
Reykjavik	ISL	4	1.1	75	17	7.1	0.8	58	14	10.2	1.2	50	0
Danmarkshavn	GRL	−9.9	7.4	1	−9	−3.3	3.3	32	28	3	2.3	7	2
Copenhagen	DNK	8.9	2.3	23	−19	11.5	−0.5	35	−8	17.9	1.8	104	50
De Bilt	NLD	11.1	3.1	13	−39	13.1	0.8	12	−49	17.5	2.3	78	10
Brussels	BEL	12.6	3.8	17	−40	14.2	1.3	11	−60	17.5	1.8	84	5
Luxembourg	LUX	12.9	5.4	22	−39	13.7	1.9	34	−47	16.8	1.9	114	32
Zurich	CHE	12.9	5.1	27	−60	13.6	1.5	87	−16	16.3	1.1	145	21
Geneva	CHE	13	4.2	38	−27	15.6	2.6	78	1	17.9	1.4	92	3
Bordeaux	FRA	15.2	3.9	116	44	18.5	3.9	122	45	18.3	0.5	92	36
Marseille	FRA	14.6	1.4	50	2	19.6	2.5	58	16	22	1.1	38	10
La Coruna	ESP	14.4	2.3	73	−10	17.6	3.5	8	−70	17.6	1.2	39	−10
Madrid Retiro	ESP	13.8	1.6	70	16	19.7	3.7	95	54	22.5	1.8	8	−18
Menorca	ESP	15.7	2.4	56	6	19.7	2.9	15	−22	21.9	1.1	8	−6
Gibraltar	GIB	17	0.8	72	12	20.5	2.0	56	21	22.5	1.4	2	−9
Santa Maria/Azoren	PRT	16.2	1.0	162	107	17.7	1.0	34	4	18.7	0.0	88	66
Braganca	PRT	10.8	0.8	141	79	17.4	4.0	33	−20	18.4	0.7	5	−33
Berlin−Tempelhof	DEU	11.2	2.6	23	−18	12.9	−1.0	33	−23	19.5	2.1	36	−39
Vienna	AUT	12.4	2.5	9	−42	14.5	−0.1	87	26	19	1.1	95	21
Prague	CZE	10.1	2.4	12	−26	11.5	−1.2	51	−26	16.8	0.9	72	−1
Sliac	SVK	9.3	0.8	8	−39	12.3	−1.4	45	−19	18.4	1.8	96	11
Elbing	POL	7.1	0.3	4	−38	9.2	−3.7	92	51	16.9	1.5	75	−19
Warsaw	POL	9.5	1.7	8	−24	12	−1.4	67	8	19.1	2.5	166	94
Budapest	HUN	12.8	1.7	13	−25	15	−1.0	14	−41	20.3	1.2	129	66
Belgrad	SRB	14	1.6	9	−50	16.5	−0.7	71	0	20.7	0.6	158	68
Ljubljana	SVN	12.9	3.0	26	−84	15.3	0.7	115	−7	19.6	1.8	147	−8
Split	HRV	15.8	1.9	30	−36	19.7	1.3	45	−11	23	0.8	22	−29
Sarajevo	BIH	11.4	2.0	23	−51	14.3	0.2	96	14	18	1.1	92	1
Bukarest	ROU	11.5	0.2	19	−27	15.9	−0.8	102	32	20.6	0.4	201	124
Sofia	BGR	9.7	−0.2	57	7	15.4	1.1	50	−23	18.4	0.7	44	−28
Pisa	ITA	13.5	1.0	36	−43	18.7	2.4	60	1	20.2	0.4	124	80
Luqa	MLT	16.7	1.2	18	−5	21.2	2.1	28	21	23.4	0.4	0	−3
Athens	GRC	16.3	0.3	20	−5	21.8	1.2	23	9	25.2	0.2	18	12
Heraklion	GRC	16.3	−0.3	15	−15	21.7	1.4	2	−13	24.5	0.2	<1	−3
Murmansk	RUS	−1	0.9	54	33	5	1.2	50	18	10.7	1.3	51	−2
Tallinn	EST	4.6	1.2	39	3	8.8	−0.9	34	−3	16.9	2.4	94	41
Liepaja	LVA	6.2	1.6	3	−32	9.6	−0.7	30	−10	17.8	3.5	125	79
Kaunas	LTU	6.9	1.1	4	−38	10.5	−1.9	94	39	19	3.2	99	30
Vilnius	LTU	6.6	0.9	6	−40	10.3	−2.2	78	16	19.4	3.6	68	−9
Minsk	BLR	6.1	0.1	11	−31	10.4	−2.5	52	−10	19.2	3.1	134	51
Moscow	RUS	4.8	−1.0	28	−12	11.7	−1.2	156	98	18.9	2.3	159	83
Kiew	UKR	9.9	1.2	39	−10	12.4	−2.7	122	69	21.7	3.5	49	−24
Kischinau	MDA	11.8	1.6	4	−38	14.4	−1.7	70	19	21.8	2.4	86	11
Charkiw	UKR	8.7	−0.2	21	−15	13.5	−2.1	138	91	22.1	3.2	68	10
Astrachan	RUS	10.2	−0.9	3	−15	18.9	0.6	31	7	26.4	3.5	5	−17
Jerewan	ARM	10.5	−1.1	98	61	17.8	1.5	84	41	23.5	2.9	5	−16
Samsun	TUR	10.7	−0.7	37	−25	16.3	0.8	43	−6	21.8	1.8	33	−12
Istanbul	TUR	12.3	0.3	21	−28	17.9	1.4	66	35	23.1	2.0	20	−1
Ankara	TUR	11.7	0.5	23	−25	17.1	1.5	69	14	20.8	1.2	109	72
Van	TUR	8.6	1.3	62	8	14.6	1.8	30	−20	19.4	1.8	12	−9
Antalya	TUR	17.4	1.3	21	−25	22.1	1.8	58	30	23.9	−1.1	4	−4
Larnaka	CYP	17.9	1.0	27	16	23.8	3.4	7	0	24.9	0.9	1	0
Oral	KAZ	7.9	0.2	18	−1	17	0.9	15	−6	20.7	0.5	56	19
Tiflis	GEO	11.2	−1.6	64	13	18	0.6	73	−5	24.3	3.1	58	−18
Eilat	ISR	24.8	0.4	0	−3	29.8	1.6	0	−1	32.4	1.5	0	0
L.Palmas/Gran Can.	ESP	20.2	1.5	8	2	21.5	1.6	1	−1	23.3	1.9	1	1
Princess Juliana Airp.	SMA	27.7	1.6	45	−22	28.5	1.5	12	−84	29.1	1.3	26	−37
Le Lamentin	MTQ	27	1.1	25	−71	28	1.2	39	−84	28.2	0.9	118	−52

Table 5.2: continued

Station name	Country	July				August				September			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	4.9	0.7	54	7	5.5	0.6	70	9	3.2	0.4	192	110
Svalbard	NOR	9.8	3.8	17	4	7.2	2.4	16	−9	3.2	2.7	32	9
Tromsoe	NOR	12.7	1.0	76	4	11.2	0.3	165	83	8.3	1.5	177	83
Oslo	NOR	15.1	−1.3	155	71	17.2	2.0	56	−34	12.8	2.0	77	−13
Haparanda	SWE	14.7	−0.8	106	56	14.1	0.8	23	−40	10	2.1	63	0
Stockholm	SWE	17	−0.2	101	29	19.3	3.1	29	−37	14.2	3.0	32	−23
Sodankylä	FIN	15	0.9	77	12	13.1	1.9	32	−31	7.7	1.8	45	−10
Jokioinen	FIN	15	−0.8	135	55	15.7	1.5	30	−53	12.3	2.9	30	−35
Aberdeen	GBR	13.5	−0.3	95	35	14.1	0.5	87	12	12.3	0.6	33	−35
London	GBR	18.6	0.8	35	−11	20.6	3.2	58	7	16.6	1.6	20	−31
Dublin/Casement	IRL	14.6	−0.6	114	65	15.1	0.3	85	21	13	0.4	48	−11
Reykjavik	ISL	10.7	0.1	45	−7	11.2	0.9	93	31	7.4	0.0	105	39
Danmarkshavn	GRL	3.6	−0.1	21	7	4	1.6	41	27	−3.7	0.5	2	−9
Copenhagen	DNK	16.3	−0.9	84	15	19.6	2.6	44	−19	15.2	1.6	45	−17
De Bilt	NLD	17	0.2	51	−24	20.4	3.7	89	18	15.2	1.2	65	−2
Brussels	BEL	17.9	0.4	24	−51	20.9	3.6	53	−10	16.4	1.9	105	46
Luxembourg	LUX	18.7	1.8	11	−57	21.2	4.8	28	−44	16.7	3.3	54	−16
Zurich	CHE	20	2.4	57	−60	19.7	3.0	137	4	16.1	2.3	36	−56
Geneva	CHE	22.2	3.1	17	−50	21.2	3.0	93	14	17.3	2.4	61	−20
Bordeaux	FRA	22.3	2.1	3	−44	22.4	2.5	67	13	19.6	1.7	90	16
Marseille	FRA	25.7	1.9	0	−14	25.5	2.3	3	−26	21.2	0.9	82	35
La Coruna	ESP	19.5	1.1	1	−24	20.2	1.4	108	79	19.5	1.4	39	−23
Madrid Retiro	ESP	28.2	3.8	6	−7	25.4	1.5	29	20	20.9	0.4	54	24
Menorca	ESP	25.3	1.1	3	−1	25.8	1.3	8	−18	22.7	0.5	42	−12
Gibraltar	GIB	24.9	1.2	0	−1	25.4	1.2	2	−4	23.5	0.7	8	−7
Santa Maria/Azoren	PRT	21.4	0.6	18	−7	23.3	1.1	46	6	21.6	0.2	31	−26
Braganca	PRT	24.4	3.3	17	0	21.5	0.7	84	70	19	0.7	50	12
Berlin−Tempelhof	DEU	19.2	0.4	47	−5	22.3	3.9	43	−18	16.4	1.8	53	8
Vienna	AUT	21.5	1.8	77	14	21.9	3.0	100	42	16.9	1.8	75	30
Prague	CZE	18.7	1.2	34	−32	20	3.0	138	68	15.2	1.9	59	19
Sliac	SVK	19.5	1.3	95	36	20.6	3.3	71	2	15.4	2.0	81	25
Elbing	POL	16.5	−0.3	61	−33	19	2.3	53	−28	14.9	2.2	44	−26
Warsaw	POL	19.3	1.4	48	−19	20.7	3.4	95	32	15.7	2.5	64	21
Budapest	HUN	22	1.1	56	4	23.2	2.9	81	30	18.6	2.2	18	−22
Belgrad	SRB	23.4	1.7	38	−28	24.7	3.4	90	38	21.2	3.5	22	−29
Ljubljana	SVN	21.8	1.9	160	38	22.2	3.1	87	−58	17.5	2.0	133	3
Split	HRV	26.4	1.0	4	−24	27.8	2.6	24	−26	23.6	2.2	105	44
Sarajevo	BIH	20.2	1.3	49	−31	21.3	2.8	79	8	17.6	2.5	52	−18
Bukarest	ROU	23.2	1.2	77	13	23.7	2.5	16	−42	19.4	2.5	52	10
Sofia	BGR	21	1.0	109	53	21.4	2.0	84	32	18.9	3.1	26	−13
Pisa	ITA	23.4	0.6	5	−18	24.6	2.1	53	−7	20.7	1.2	58	−31
Luqa	MLT	26.9	1.0	0	0	28.6	2.3	0	−7	25.6	1.5	121	81
Athens	GRC	29.5	1.7	20	14	29.8	2.2	14	6	26.5	2.2	20	10
Heraklion	GRC	26.9	0.8	0	−1	27.5	1.6	0	−1	25.9	2.4	46	26
Murmansk	RUS	15.7	2.9	39	−21	11.7	0.7	112	47	8.6	1.9	67	15
Tallinn	EST	16.1	−0.2	124	45	16.6	1.3	94	10	13.8	3.0	49	−33
Liepaja	LVA	17	0.6	54	−20	18.1	1.7	51	−29	15.6	2.7	72	−6
Kaunas	LTU	17.3	0.4	60	−20	18.6	2.2	93	15	14.9	3.0	13	−43
Vilnius	LTU	17.6	0.7	67	−11	18.4	2.1	78	6	14.7	3.1	14	−51
Minsk	BLR	17.4	0.1	68	−20	17.8	1.3	62	−10	13.9	2.2	31	−29
Moscow	RUS	18.7	0.6	170	78	17.6	1.2	34	−40	13.9	3.0	65	1
Kiew	UKR	21.9	2.6	47	−41	21.4	2.8	31	−38	18.4	4.5	31	−16
Kischinau	MDA	23.7	2.8	85	16	24	3.5	4	−41	20.2	4.0	70	22
Charkiw	UKR	22.8	2.5	105	45	20.9	1.4	7	−43	18.4	4.3	1	−40
Astrachan	RUS	28.3	3.0	2	−21	23.5	0.2	20	1	18.6	1.3	8	−18
Jerewan	ARM	26.1	1.5	15	5	23.6	−0.3	6	−1	23.6	3.8	0	−10
Samsun	TUR	25.2	2.5	1	−28	24.3	1.6	23	−10	23.5	3.9	17	−33
Istanbul	TUR	25.4	2.2	<1	−19	25.6	2.6	2	−24	23.8	4.1	9	−32
Ankara	TUR	26	3.1	5	−9	25.3	2.7	0	−12	23.3	5.0	6	−13
Van	TUR	23.1	1.2	18	14	21.5	0.3	11	7	20.1	3.3	5	−5
Antalya	TUR	29.2	1.1	0	−3	29.6	1.9	<1	<1	28.7	4.2	<1	−11
Larnaka	CYP	28.5	1.9	1	1	29.1	2.5	<1	<1	28.6	4.0	<1	<1
Oral	KAZ	26.1	3.6	6	−32	20.5	0.1	17	−8	13.9	−0.2	39	12
Tiflis	GEO	26.9	2.5	23	−22	24.1	0.4	29	−19	22.8	3.2	21	−15
Eilat	ISR	35.2	2.8	0	0	34.4	2.1	0	0	34.5	4.1	0	0
L.Palmas/Gran Can.	ESP	24.7	1.4	0	0	25.5	1.4	<1	<1	25.4	1.6	2	−6
Princess Juliana Airp.	SMA	29	1.0	129	53	29.3	1.1	97	−2	29.5	1.3	97	−34
Le Lamentin	MTQ	28.2	1.0	239	35	28.6	1.4	253	1	28	1.0	156	−80

Table 5.2: continued

Station name	Country	October				November				December			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	1.9	1.8	17	−65	−1	2.3	93	27	−1.6	3.6	116	51
Svalbard	NOR	−2.2	3.3	5	−10	−2.9	7.6	20	7	−7	6.3	4	−8
Tromsoe	NOR	4.1	1.2	78	−47	3.3	4.1	151	47	−0.1	2.9	24	−80
Oslo	NOR	8.1	1.7	209	125	5.2	4.5	86	11	2.2	5.0	148	92
Haparanda	SWE	4.2	1.7	153	89	1.6	5.7	125	67	−1.7	7.8	89	47
Stockholm	SWE	9.3	1.8	59	9	6.9	4.3	27	−26	4	5.0	57	11
Sodankylä	FIN	2.6	2.9	75	24	−1.1	6.3	43	4	−5.2	7.9	40	9
Jokioinen	FIN	7.4	2.7	72	14	4	4.5	85	30	0.3	5.2	48	6
Aberdeen	GBR	9.2	−0.7	186	109	7.3	2.3	25	−50	4.5	1.0	154	81
London	GBR	12	0.3	142	84	9.7	2.5	50	−5	6.1	1.0	72	15
Dublin/Casement	IRL	9.4	−0.7	82	15	8.2	1.5	59	−8	4.6	−1.0	78	5
Reykjavik	ISL	5.8	1.4	42	−44	1.9	0.8	81	9	1.8	2.0	58	−21
Danmarkshavn	GRL	−12.8	0.8	24	12	−15.4	4.5	20	10	−20.1	1.7	14	1
Copenhagen	DNK	11.2	1.3	72	13	8.2	2.7	24	−38	4.8	2.6	69	11
De Bilt	NLD	11.3	0.8	108	36	8.9	3.0	58	−23	5.5	2.3	107	28
Brussels	BEL	11.4	0.5	75	5	9.2	3.1	48	−28	5.7	2.2	77	1
Luxembourg	LUX	9.9	0.8	113	38	6.7	2.9	34	−49	3.8	2.8	118	38
Zurich	CHE	9.5	0.2	92	23	5.9	2.0	24	−58	2.1	1.5	73	0
Geneva	CHE	10.3	0.2	153	76	6.8	1.8	16	−76	3.9	2.1	76	−11
Bordeaux	FRA	13.5	−0.5	179	91	11.2	2.1	17	−77	8.2	1.8	241	142
Marseille	FRA	15	−1.1	21	−57	12.7	2.0	103	45	8.5	1.2	38	−18
La Coruna	ESP	15.9	0.2	123	19	14.7	2.1	65	−51	11.6	0.7	219	91
Madrid Retiro	ESP	13.7	−1.1	59	14	11.2	1.8	61	−3	7.2	0.8	20	−31
Menorca	ESP	17.8	−0.7	54	−30	15.9	1.5	20	−57	12.1	0.3	66	−8
Gibraltar	GIB	18.6	−0.9	24	−40	17.5	1.4	75	−66	14.7	0.6	29	−117
Santa Maria/Azoren	PRT	19.6	0.3	56	−28	16.4	−1.0	39	−63	15.4	0.0	64	−31
Braganca	PRT	11.4	−1.7	120	50	8.5	0.5	105	16	5.2	0.2	76	−22
Berlin−Tempelhof	DEU	11.5	1.5	58	22	7.3	2.4	16	−33	3.5	2.1	22	−31
Vienna	AUT	11.2	1.3	131	90	6.1	1.5	17	−33	3.3	2.4	22	−21
Prague	CZE	9.6	1.3	76	46	4.2	1.4	8	−24	2.2	2.8	14	−12
Sliac	SVK	10.2	1.9	145	95	2.9	−0.1	20	−49	2.5	4.2	61	4
Elbing	POL	9.8	0.9	54	1	5.5	2.2	39	−17	1	0.7	73	21
Warsaw	POL	10.8	2.5	80	42	5.8	2.6	9	−33	1.9	2.8	26	−6
Budapest	HUN	11.7	0.8	105	71	5.3	0.5	25	−27	3.7	3.3	34	−6
Belgrad	SRB	14.2	1.8	93	53	7.2	0.2	13	−41	5.5	3.2	35	−23
Ljubljana	SVN	11.9	1.5	203	88	5.3	0.7	48	−87	2.9	2.9	183	82
Split	HRV	17	0.1	85	6	13.6	1.4	61	−47	11.2	2.5	297	197
Sarajevo	BIH	11.8	1.5	92	15	5.2	−0.1	16	−78	4.5	4.2	143	58
Bukarest	ROU	13.5	2.7	61	29	5.4	0.2	18	−31	3.4	3.2	74	31
Sofia	BGR	12.3	1.9	60	23	5.2	0.2	11	−36	4.3	3.8	58	19
Pisa	ITA	15.2	−0.1	245	122	12.1	1.7	56	−68	8.1	1.3	241	156
Luqa	MLT	20.8	0.1	25	−65	17.7	0.7	77	−3	15.3	1.5	63	−49
Athens	GRC	21.2	1.9	16	−32	15.4	0.0	2	−49	14.4	2.4	79	13
Heraklion	GRC	22	2.1	304	235	16.9	0.3	177	118	15.2	1.4	52	−25
Murmansk	RUS	3	2.0	61	19	0.2	5.3	34	−6	−5.4	3.9	26	−12
Tallinn	EST	9.3	3.0	84	14	5.3	4.1	75	7	0.2	3.1	43	−12
Liepaja	LVA	10.9	2.4	74	0	7.7	4.0	48	−35	1.7	2.0	41	−26
Kaunas	LTU	10.2	3.1	53	8	5.1	3.3	30	−23	0.6	3.1	17	−30
Vilnius	LTU	10.1	3.5	47	−6	4.2	3.0	42	−15	−0.2	2.7	23	−32
Minsk	BLR	10.5	4.2	42	−7	3.6	2.8	51	−1	−1.2	2.6	49	−4
Moscow	RUS	9.2	4.2	54	−4	2.2	3.3	48	−10	−4.4	1.7	30	−22
Kiew	UKR	12.5	4.4	101	66	3.8	1.7	30	−21	−0.5	1.8	48	−4
Kischinau	MDA	14.6	4.5	81	54	4.8	0.4	28	−11	1.8	2.1	74	36
Charkiw	UKR	12.4	5.1	40	5	2.6	1.3	41	−3	−3.1	0.3	25	−20
Astrachan	RUS	12.8	3.7	<1	−17	3	−0.3	23	4	−4.9	−3.0	<1	−15
Jerewan	ARM	16.4	3.6	0	−27	7.9	1.3	19	−3	1.5	1.0	36	13
Samsun	TUR	19.8	4.2	31	−54	12.6	0.1	129	40	12.3	3.1	27	−55
Istanbul	TUR	19.8	4.5	88	17	12.8	1.2	25	−64	11.8	3.7	21	−101
Ankara	TUR	17.6	5.0	30	3	6.8	−0.3	6	−27	6.1	3.6	18	−31
Van	TUR	13.3	3.2	2	−46	6.6	2.6	16	−28	1.3	2.4	35	1
Antalya	TUR	24	4.4	26	−44	17.7	2.9	39	−95	14.5	3.1	401	174
Larnaka	CYP	25.1	3.8	0	−19	19.1	2.2	27	−17	15.7	2.3	96	20
Oral	KAZ	7.8	2.7	16	−14	−2.4	−0.3	17	−18	−13.8	−5.4	17	−12
Tiflis	GEO	16	2.5	17	−21	9.2	1.1	36	6	3.8	0.0	35	14
Eilat	ISR	29.9	3.3	0	−3	22.5	1.4	4	0	19.4	3.2	7	1
L.Palmas/Gran Can.	ESP	23.4	0.9	4	−6	21.7	1.3	18	−3	19.2	0.9	11	−10
Princess Juliana Airp.	SMA	28.4	0.6	271	162	27.5	0.6	94	−36	26.6	0.8	71	−15
Le Lamentin	MTQ	26.9	0.2	440	170	26.6	0.3	325	101	25.6	0.2	93	−66

6. References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2020 edition of the Bulletin, are listed on page 3 above. Many contributions or additional information may as well be found on the web, see below.

Austria: Zentralanstalt für Meteorologie und Geodynamik (**ZAMG**), Vienna, Annual Climate Reports

Belgium: The Royal Meteorological Institute of Belgium (**KMI**), Klimatologisch overzicht

Bosnia and Herzegovina: Federal Meteorological Institute (**METEOBIH**), Analiza-godina

Croatia: Meteorological and Hydrological Service (**DMHZ**) Annual reports

Denmark: Danish Meteorological Institute (**DMI**), Vejret i Danmark

Denmark: Danish Meteorological Institute (**DMI**), Storms in Denmark since 1891

Estonian Weather Service: Estonian Bulletin

Finnish Meteorological Institute (FMI) Press release archive

France: Météo-France, Toulouse Bilan climatiques

Germany: Deutscher Wetterdienst (**DWD**), Annual, Seasonal and Monthly Summary

Greece: Hellenic National Meteorological Service, Climatology extreme

Greece: National Observatory of Athens, Meteorological bulletin

Hungarian Meteorological Service (**OMSZ**), Climate retrospective

Icelandic Met Office: The weather in Iceland 2020-Climate summary

Ireland: The Irish Meteorological Service (**MET Éireann**), Weather Summary

Israel Meteorological Service (**IMS**): Weather summary in Israel

Italy: Institute for Environmental Protection and Research (**ISPRA**) - System for Climate Data Collection and Dissemination (SCIA), ISPRA SCIA Website; RAPPORTOCLIMA2020

Latvian Environment, Geology and Meteorology Centre Monthly bulletins

Lithuanian Hydrometeorological Service (**Lhmt**) Monthly Reviews

Luxembourg: MeteoLux, Bilans climatologiques annuels (Annual climate assessments)

Moldova: State Hydrometeorological Service (**SHS**), Caracterizarea conditiilor meteorologice si agrometeorologice din anul

Montenegro: Institute of Hydrometeorology and Seismology (IHMS) Annual reports

Netherlands: Royal Netherlands Meteorological Institute (**KNMI**), Jaaroverzicht van het weer in Nederland

Netherlands: Royal Netherlands Meteorological Institute (**KNMI**), Zware stormen in Nederland sinds 1910

Norway: Det Norske Meteorologiske institutt (**DNMI**), Klimatologisk månedsoversikt

Portugal: Instituto portuguesa do mar e da atmosfera (**ipma**), Bolletim Climatológico Anual

Romania: Administrația Națională de Meteorologie, Monitorizare climatica

Russia: Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) Annual report on climate features on the territory of the Russian Federation

Serbia: Republic Hydrometeorological Service of Serbia (**RHMZ**) Annual Bulletin for Serbia

Slovakia: Slovak Hydrometeorological institute (**SHMU** Slovenský hydrometeorologický ústav) Bulletin Meteorológia a Klimatológia

Slovenia: Slovenian Environment Agency (**ARSO,** Agencija Republike Slovenije za okolje): Mesečni bilten ARSO

Slovenia: Unusual events http://meteo.arso.gov.si/met/sl/climate/natural-hazards/

Spain: Agencia Estatal de Meteorología (**AEMET**), Resumen anual climatologico

Spain: Agencia Estatal de Meteorología (**AEMET**), Olas de calor en España desde 1975

Spain: Agencia Estatal de Meteorología (**AEMET**), Olas de frío en España desde 1975

Swedish Meteorological and Hydrological Institute (**SMHI)**, Året (year)

Swedish Meteorological and Hydrological Institute (**SMHI)**, Månadens väder

Switzerland: Federal Office of Meteorology and Climatology **MeteoSwiss**, Klimabulletin

Türkiye: Turkish State Meteorological Service (**TSMS**), Bulletin

United Kingdom: **Met Office** Climate summaries and State of the United Kingdom Climate 2020 in RMetS

7. References

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8. Abbreviations

Abbreviation	Meaning
AO	Arctic Oscillation (circulation indices)
BAMS	Bulletin of the American Meteorological Society
CLIMAT	Monthly climatological data provided by the NMHSs via GTS
DWD	Deutscher Wetterdienst (German Meteorological Service)
EA	East Atlantic Pattern (circulation indices)
EA/WR	East Atlantic/West Russia Pattern (circulation indices)
ECA&D or ECAD	European Climate Assessment & Dataset, located at Royal Netherlands Meteorological Institute (KNMI)
EMCC	Eastern Mediterranean Climate Centre
E-OBS	Dily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D information
GCC	Global Collection Centre operated by the Deutscher Wetterdienst
GHCN	Global Historical Climate Network
GPCC	Global Precipitation Climatology Centre located at the Deutscher Wetterdienst
GTS	Global Telecommunication System
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (Italian National Institute for Environmental Protection and Research)
JRC	Joint Research Centre of the European Commission
KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Netherlands Meteorological Institute)
maxT	Maximum temperature
m a.s.l.	Metre above sea level
NAO	North Atlantic Oscillation (circulation indices)
NMHSs	National Meteorological and Hydrological Services
POL	Polar/Eurasia Pattern (circulation indices)
PDSI	Palmer Drought Severity Index
RCC	Regional Climate Centre
RCC-CM	Regional Climate Centre on Climate Monitoring
RR	daily total precipitation
RR1	count of days where RR ≥ 1 mm
SCA	Scandinavia Pattern (circulation indices)
SCE	Annual snow cover extent
SU	Number of summer days
SYNOP	Surface synoptic or weather observations provided by the NMHSs via GTS
TG	Daily mean temperature
TN	Daily minimum temperature
TX	Daily maximum temperature
United Kingdom	United Kingdom
WCDMP	World Climate Data and Monitoring Programme
WMO RA VI	WMO Regional Association VI (Europe and Middle East)
WMO	World Meteorological Organization
WW	Number of warm and wet days