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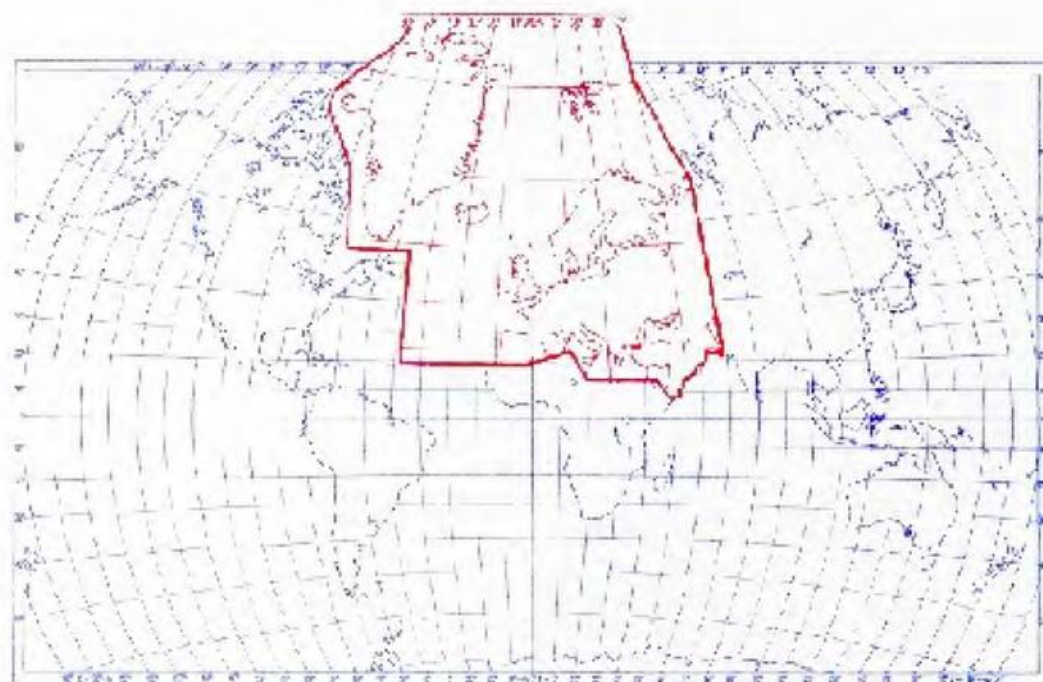
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**Annual Bulletin on the Climate in WMO Region VI
- Europe and Middle East -
2003**

The Bulletin is a summary of contributions
of the following National Meteorological Hydrological Services
and was co-ordinated by Deutscher Wetterdienst, Germany

Albania
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Germany
Greece
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Iceland
Ireland
Israel
Italy
Jordan
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Luxembourg
The former Yugoslav Republic of Macedonia
Moldova
Netherlands
Norway
Poland
Portugal
Romania
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Turkey
Ukraine
United Kingdom

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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 $+1^{\circ}\text{C}$ were registered mainly in central Europe and Scandinavia. Greenland experienced the warmest year since 1941 (fig. 0.1) with deviations from normal up to $+2^{\circ}\text{C}$ 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.

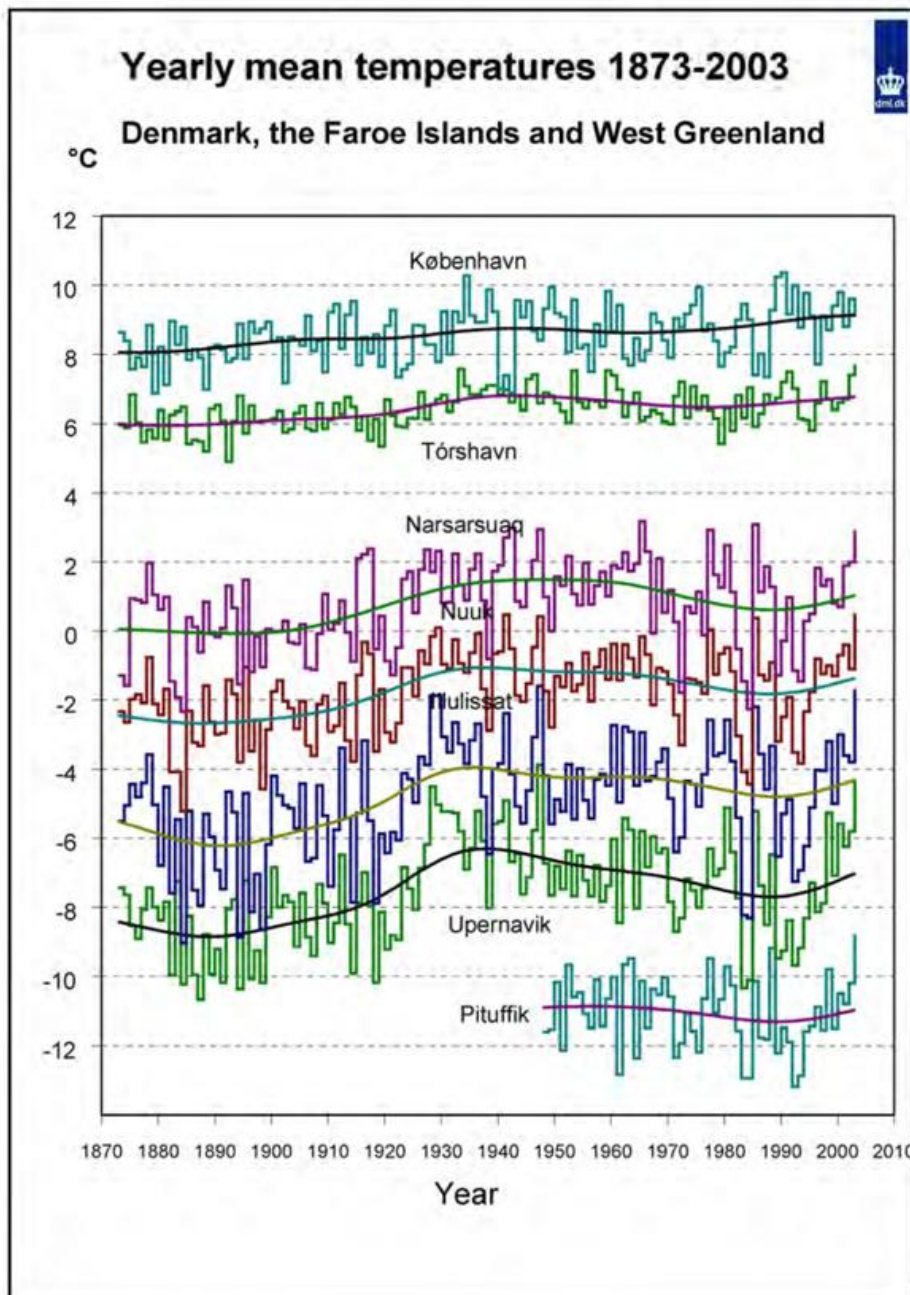


Fig. 0.1: Yearly mean temperatures at stations in Denmark, Faroe Islands and Greenland
From: Danish Meteorological Institute, Copenhagen

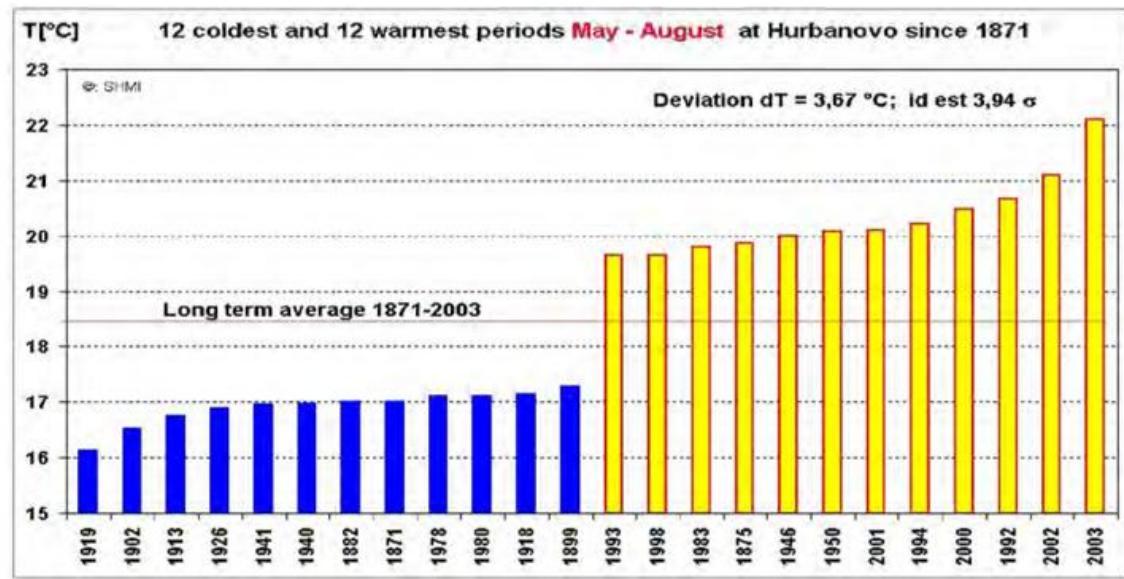


Fig. 0.2: 12 coldest and 12 warmest periods May - August since 1871 at station Hurbanovo, Slovakia
From: Slovak Hydrometeorological Institute, Bratislava

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.

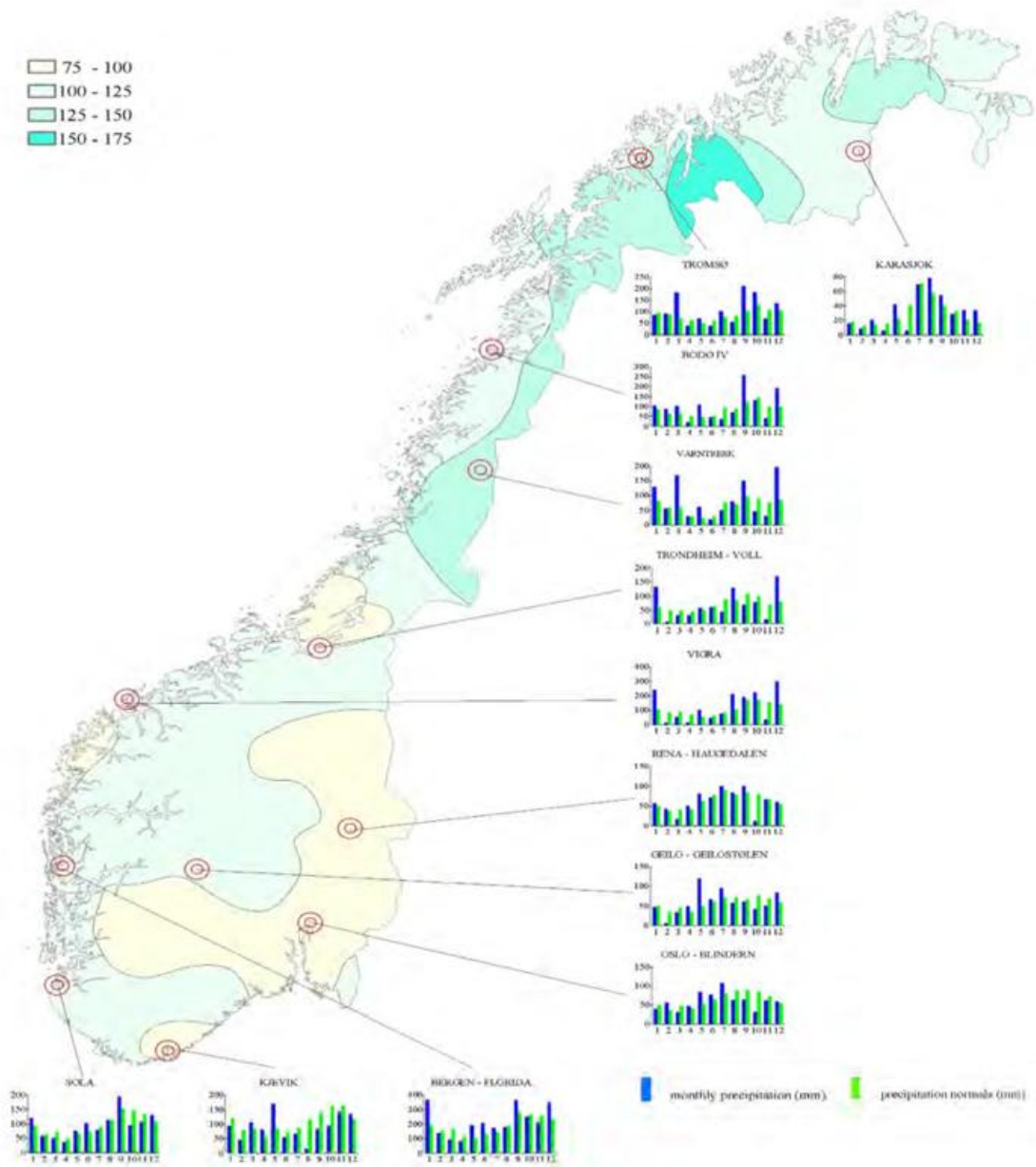


Fig. 0.3: *Precipitation as percentage of normal*
 From: Norwegian Meteorological Institute

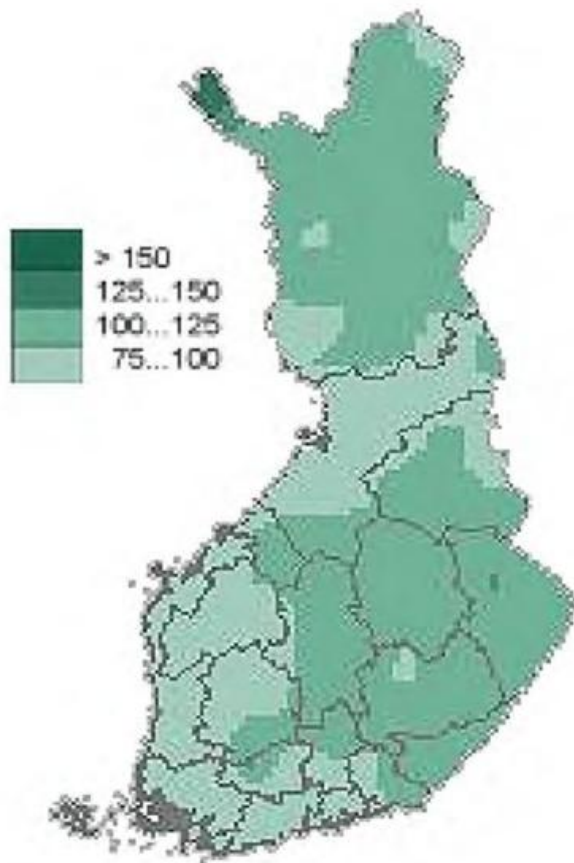


Fig. 0.4

Spatial distribution of the annual precipitation total in % of normal (1971-2000)

From: Finnish Meteorological Institute

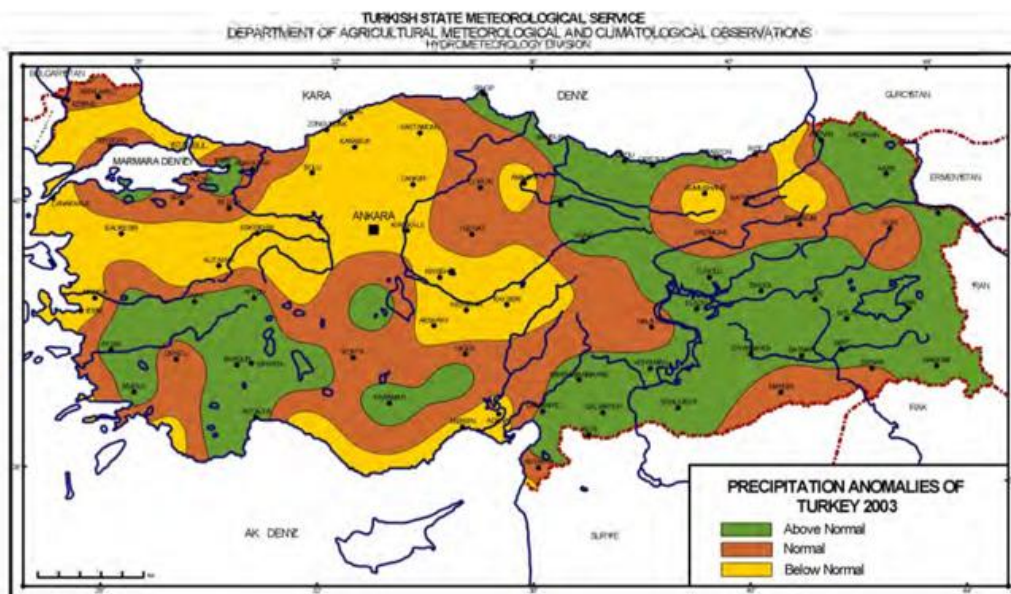


Fig. 0.5: *Spatial distribution of the annual precipitation total compared to normal*
From: Turkish Meteorological Service

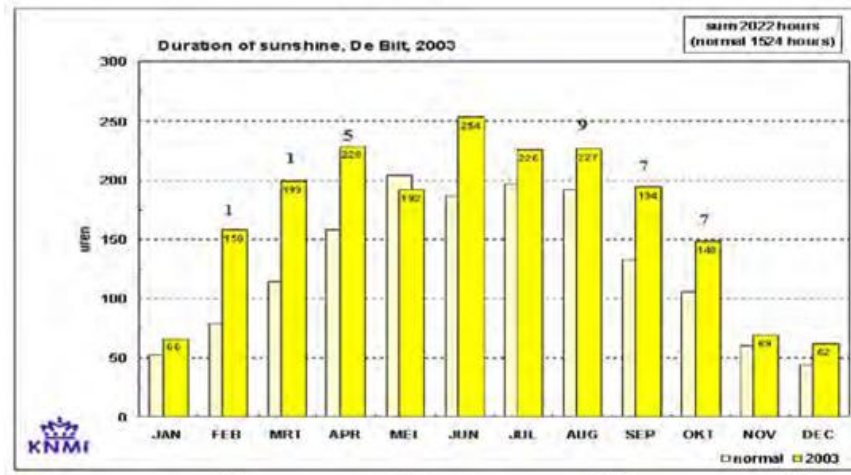


Fig. 0.6: Monthly sunshine duration 2003 and in the reference period 1971-2000 at station De Bilt, Netherlands, with ranking No in the series since 1901
From: Royal Netherlands Meteorological Institute

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).

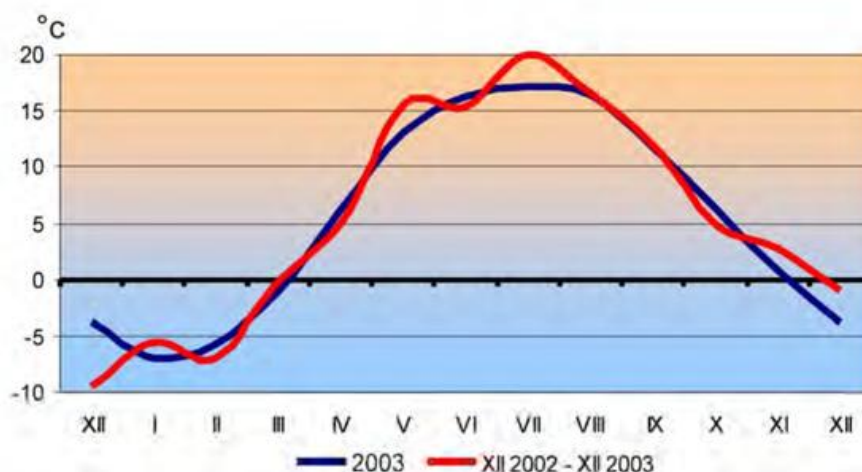


Fig. 0.7: Monthly mean air temperatures from December 2002 until December 2003 and for the reference period 1961-1990 in Belarus
From: Hydrometeorological Centre of the Republic of Belarus

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).

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).

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).

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.

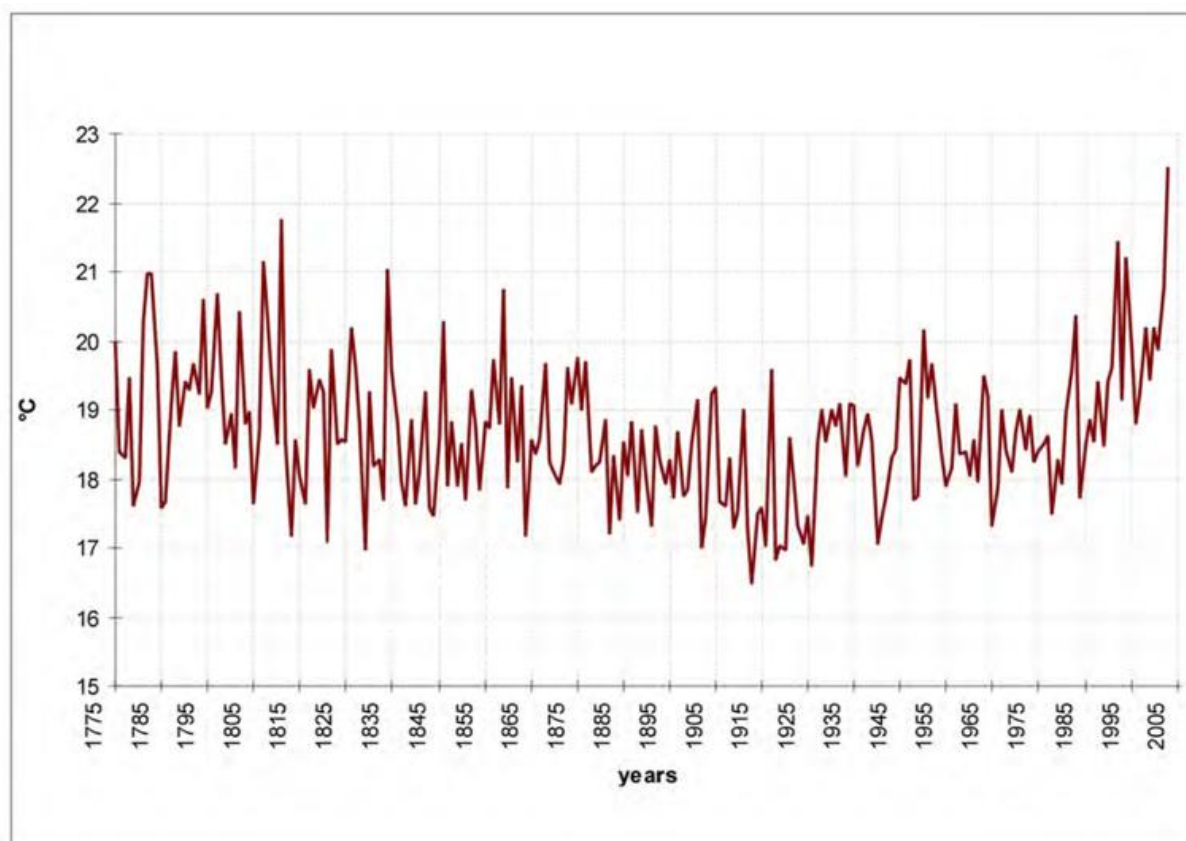


Fig. 0.8: Average summer temperatures of Vienna 1775-2003
From: Zentralanstalt für Meteorologie und Geodynamik, Austria

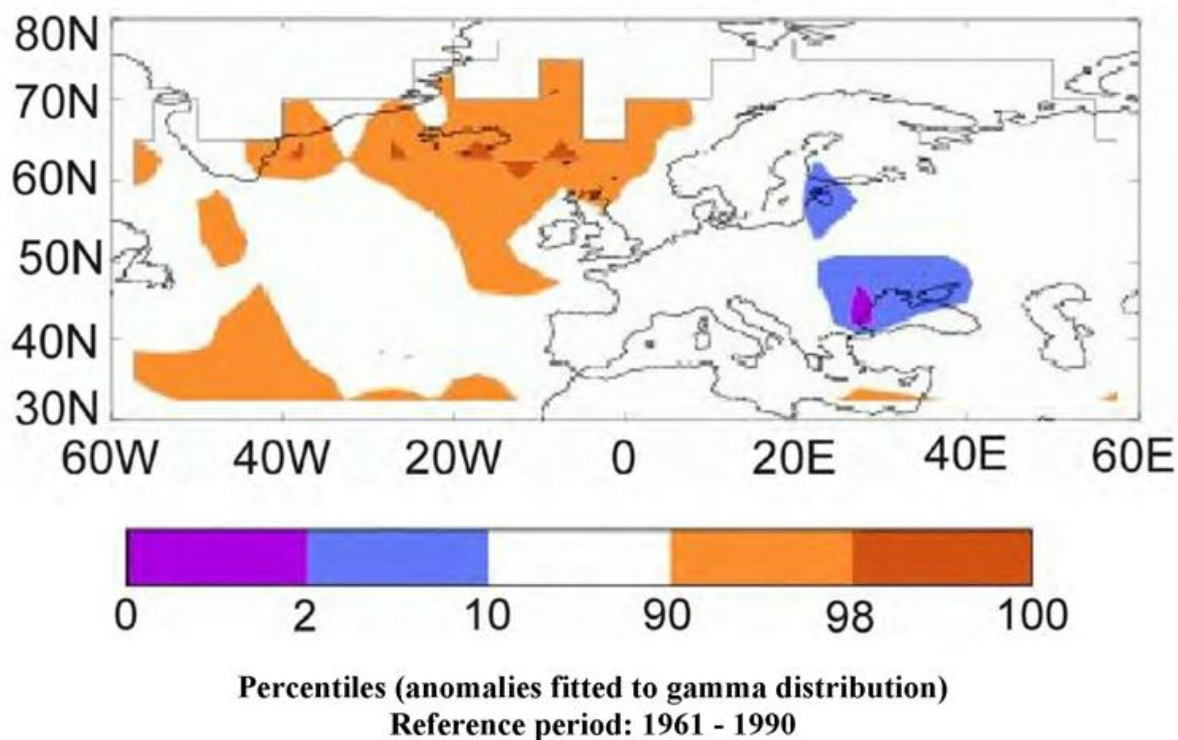
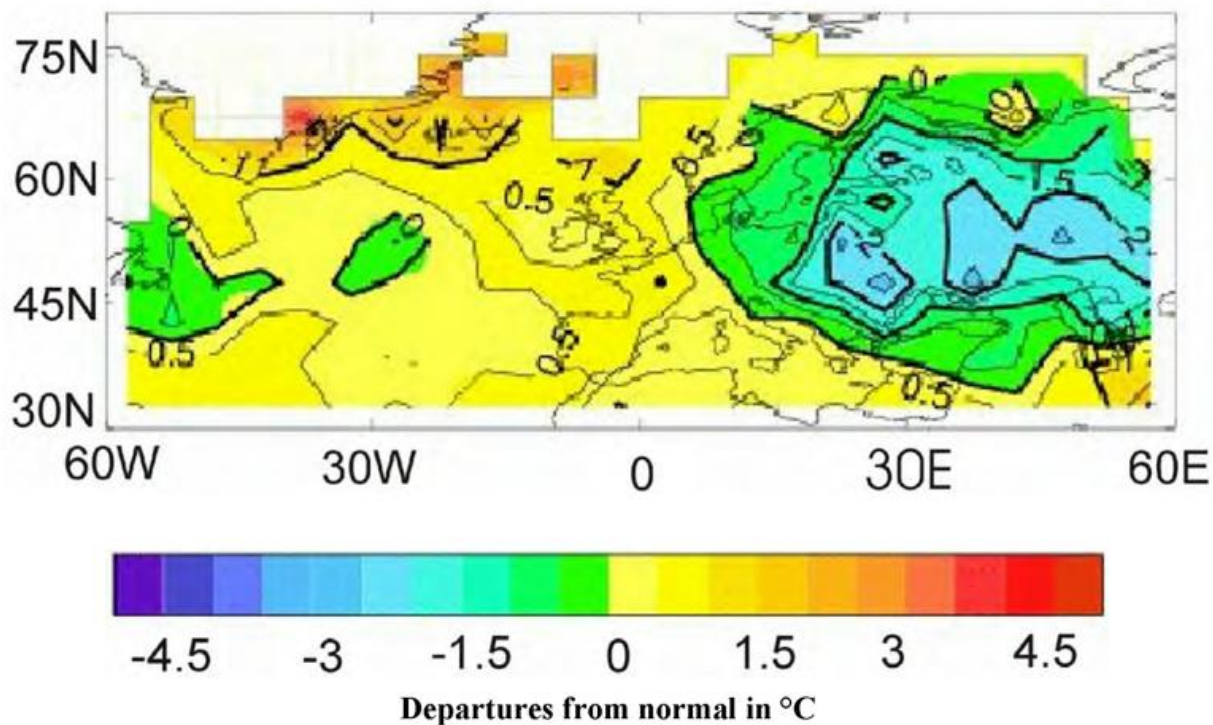
Autumn 2003 was milder than normal all over the Region except for the Alps and the Carpathians. Statistically significant positive deviations were observed mainly in the U.K. (see figs. on page 15). North-western Europe and most of Scandinavia had a precipitation deficit as well as some parts of central 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

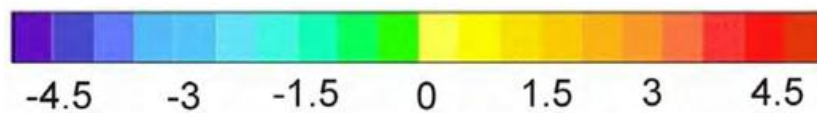
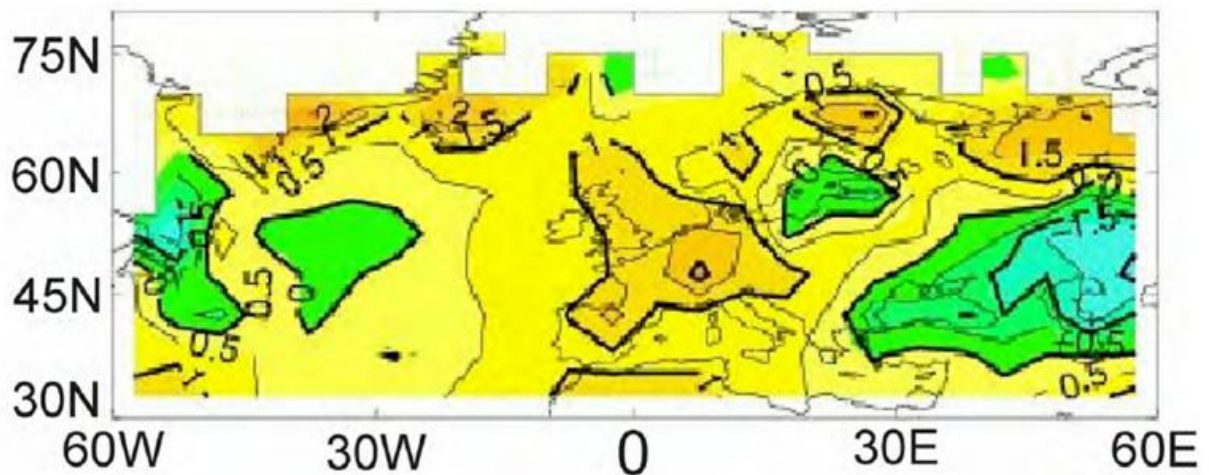
Surface temperature anomalies: December 2002 - February 2003

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

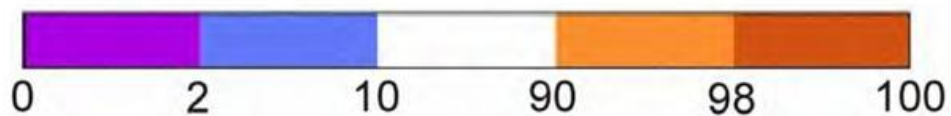
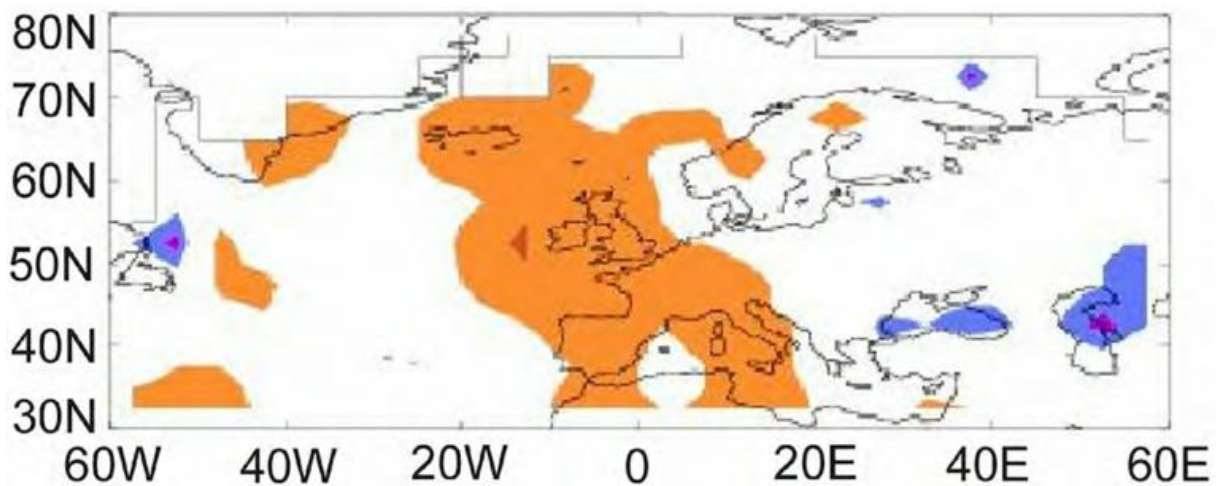


Surface temperature anomalies: March 2003 - May 2003

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



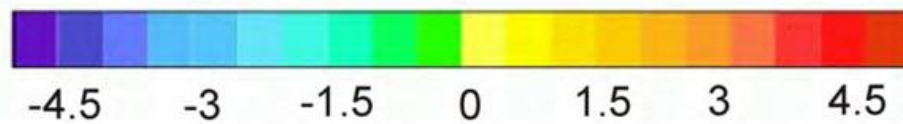
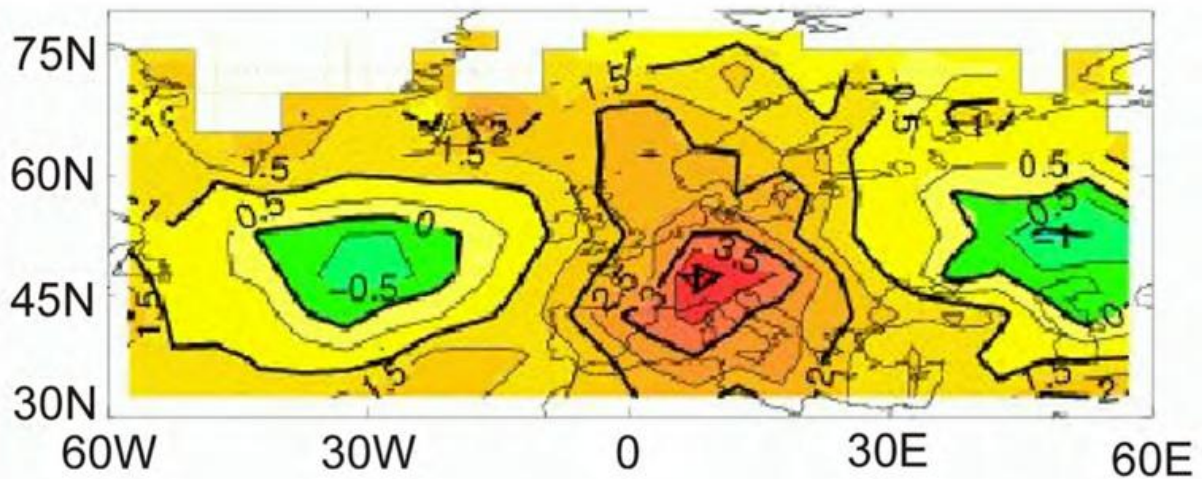
Departures from normal in °C



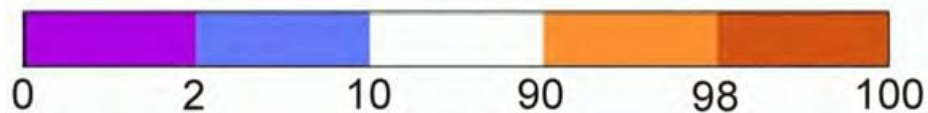
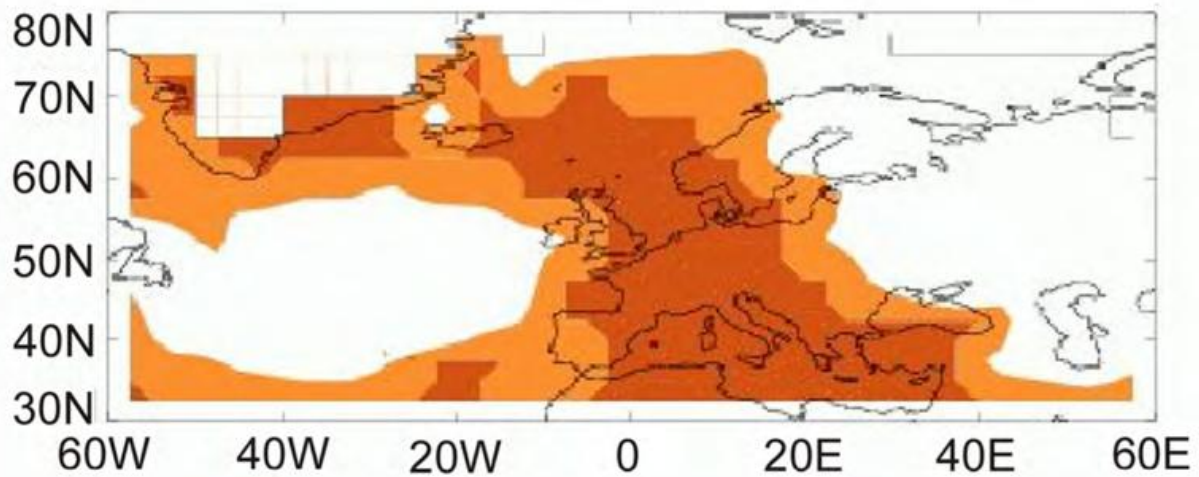
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 - 1990

Surface temperature anomalies: June 2003 - August 2003

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



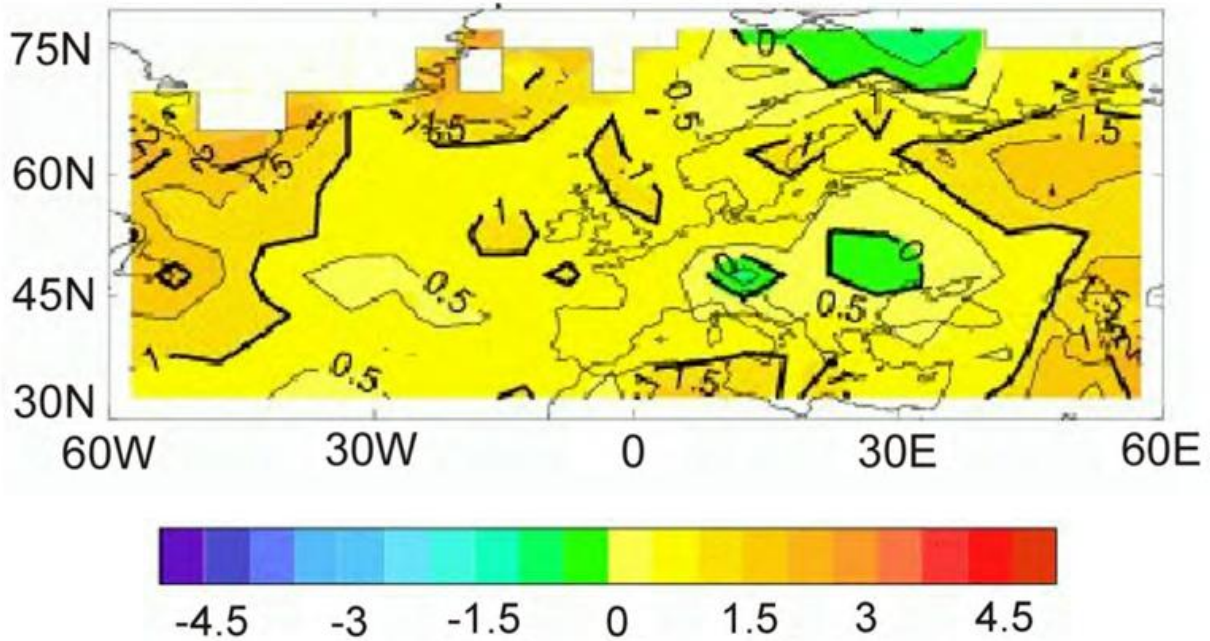
Departures from normal in °C



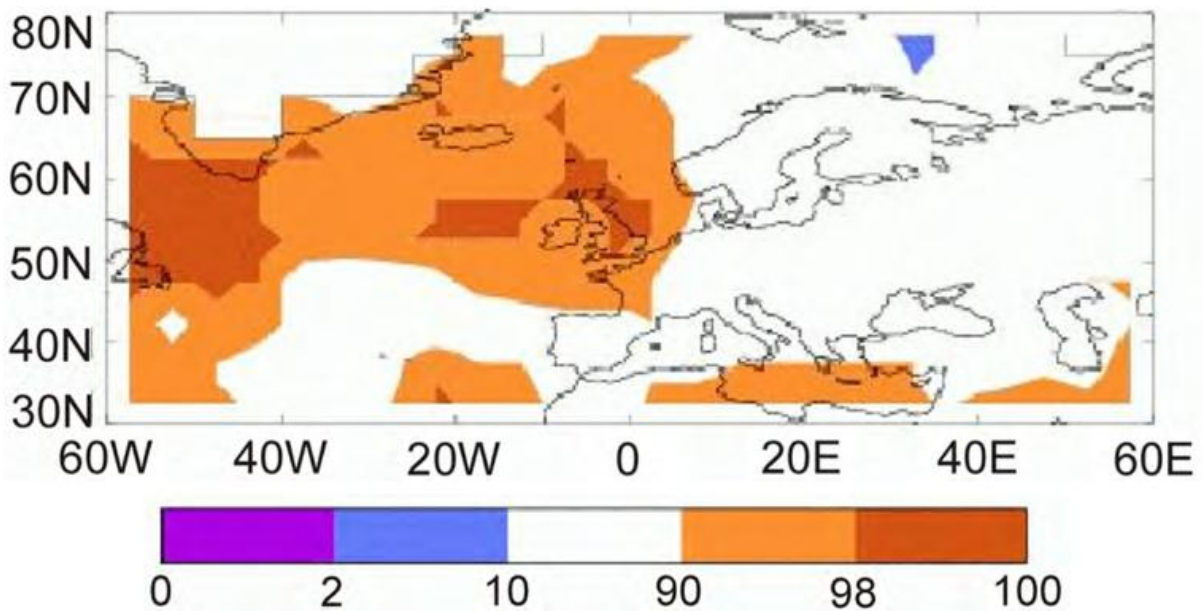
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 - 1990

Surface temperature anomalies: September 2003 - November 2003

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



Departures from normal in °C



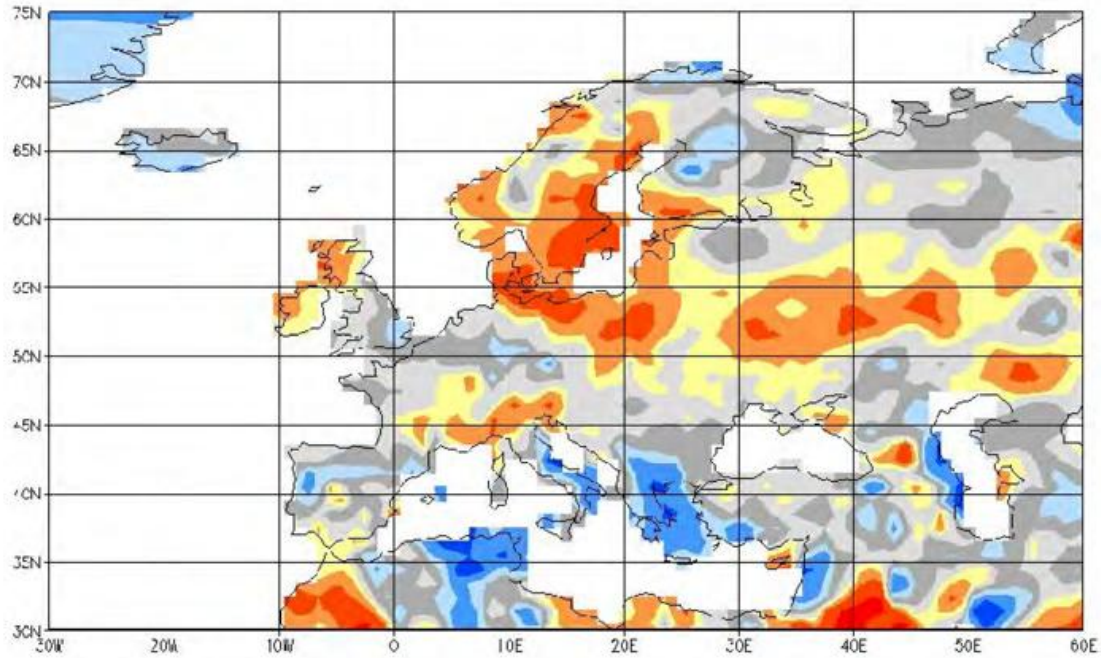
Percentiles (anomalies fitted to gamma distribution)
Reference period: 1961 - 1990

Precipitation in percent of normal

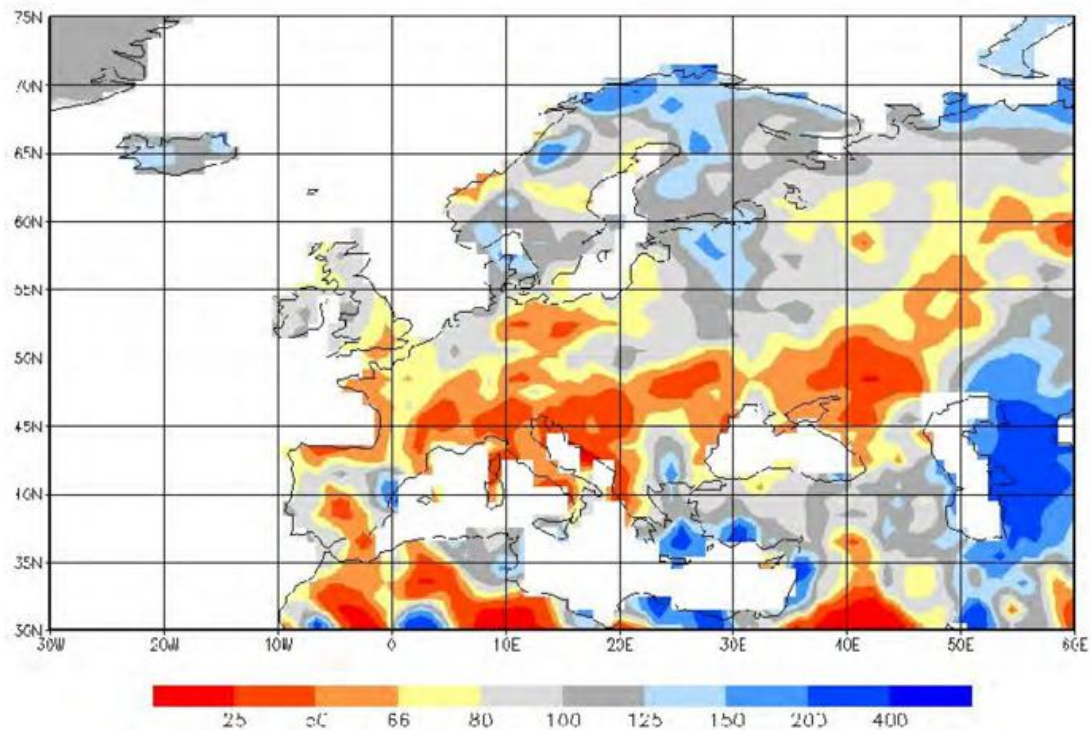
Gauge-Based Analysis 1.0 degree, reference period: 1960 - 1990

From: GPCC / Deutscher Wetterdienst, Germany

December 2002 - February 2003



March 2003 - May 2003

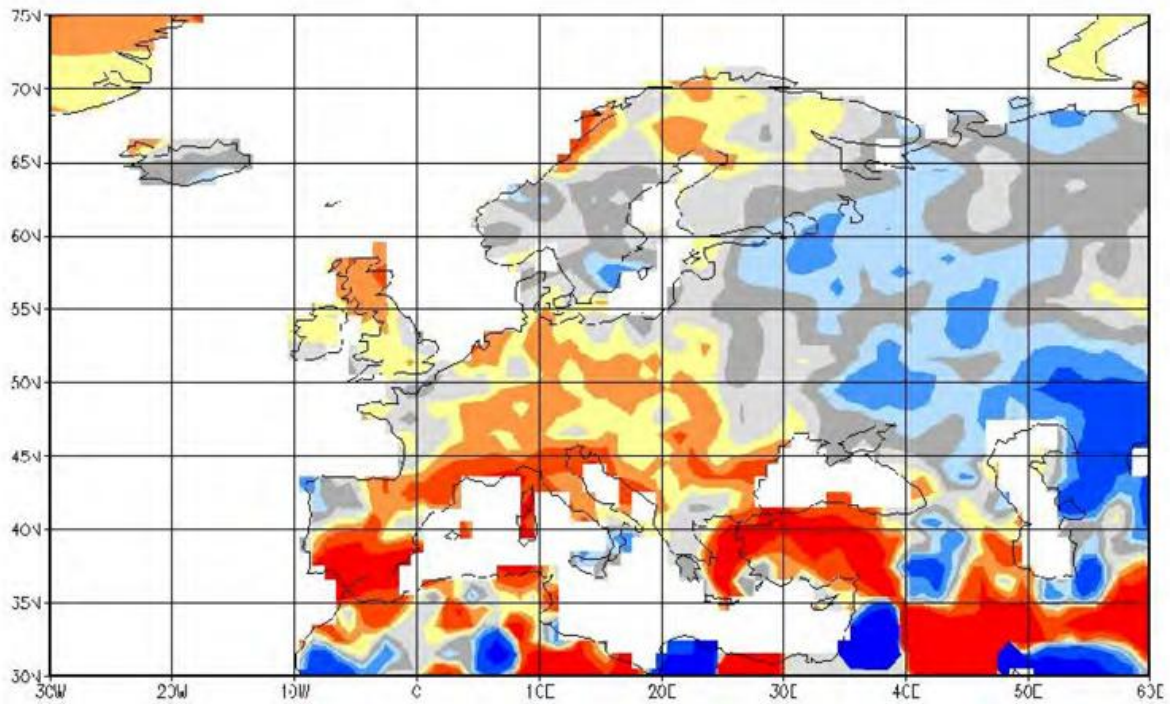


Precipitation in percent of normal

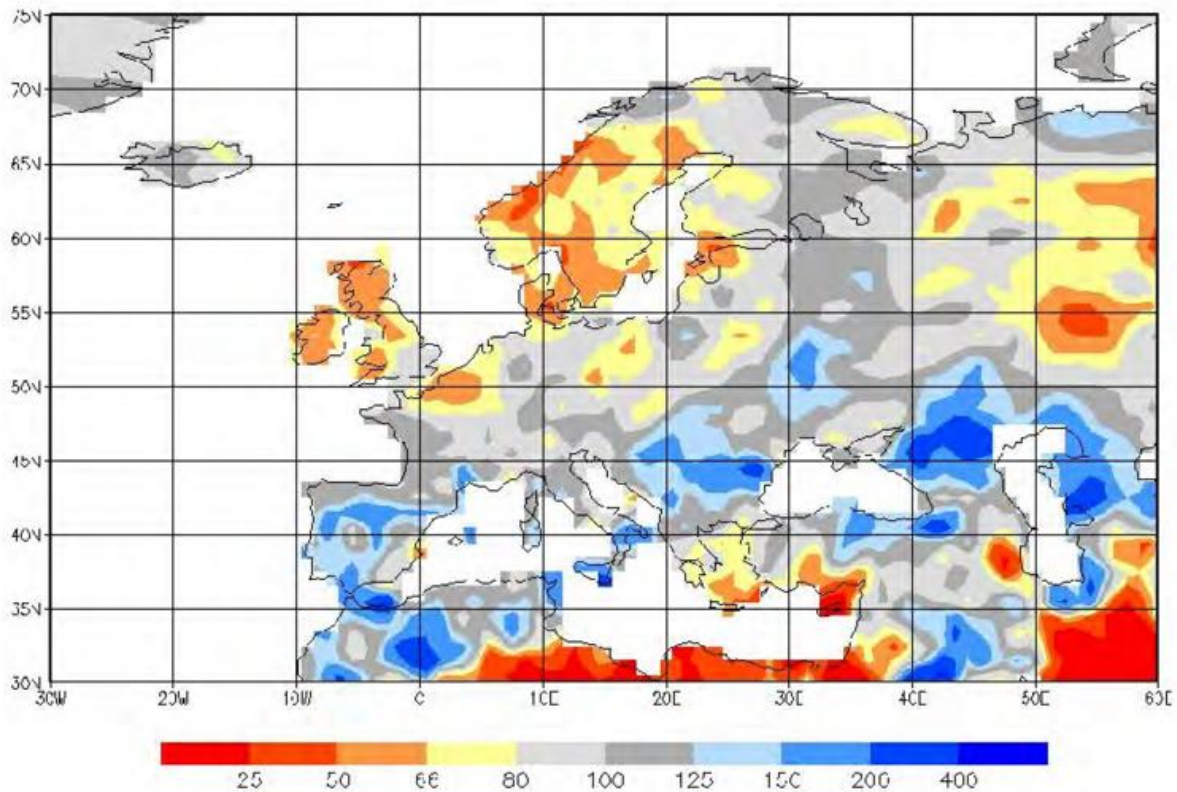
Gauge-Based Analysis 1.0 degree, reference period: 1960 - 1990

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				February 2003			
		Temp. mean	Temp. (°C) dep.	Prec. sum	(mm) dep.	Temp. mean	Temp. (°C) dep.	Prec. sum	(mm) dep.
01008	Svalbard	-18,6	-3,2	4	-10	-12,3	3,4	22	3
01025	Tromso	-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	Kobenhavn-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	Luxembourg	-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-Ruzyně	-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-Okęcie	-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				April 2003				Mai 2003			
	Temp. mean	Temp. (°C) dep.	Prec. sum	(mm) dep.	Temp. mean	Temp. (°C) dep.	Prec. sum	(mm) dep.	Temp. mean	Temp. (°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	Temp. mean	June 2003			Temp. mean	July 2003		
			(°C) dep.	Prec. sum	(mm) dep.		(°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	Luxembourg	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-Ruzyně	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-Okęcie	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				September 2003				October 2003			
	Temp. mean	Temp. (°C) dep.	Prec. sum	(mm) dep.	Temp. mean	Temp. (°C) dep.	Prec. sum	(mm) dep.	Temp. mean	Temp. (°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				December 2003			
		Temp. mean	(°C) dep.	Prec. sum	(mm) dep.	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	Luxembourg	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-Ruzyně	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-Okęcie	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	Luxembourg	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-Ruzyně	8,8	1,0	293	-245
11903	Slica	8,5	0,5	548	-147
12160	Elblag	8,2	0,6	658	-10
12375	Warszawa-Okęcie	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 Republic 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 $20^{\circ}\text{C} / 24\text{h}$ 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 $\pm 1^{\circ}\text{C}$. 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.

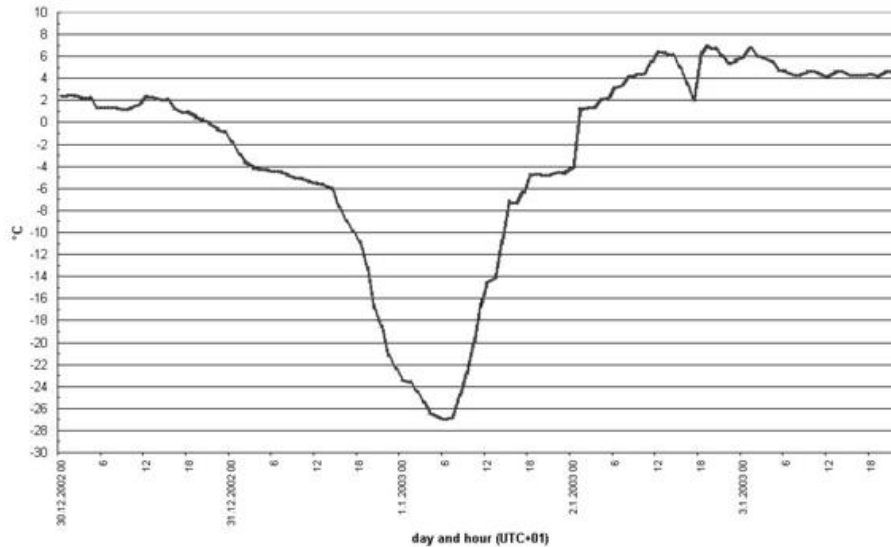


Fig 1.1: *Temperature course at Broumov station (NE Bohemia) around the beginning of the year 2003*
From: Czech Hydrometeorological Institute

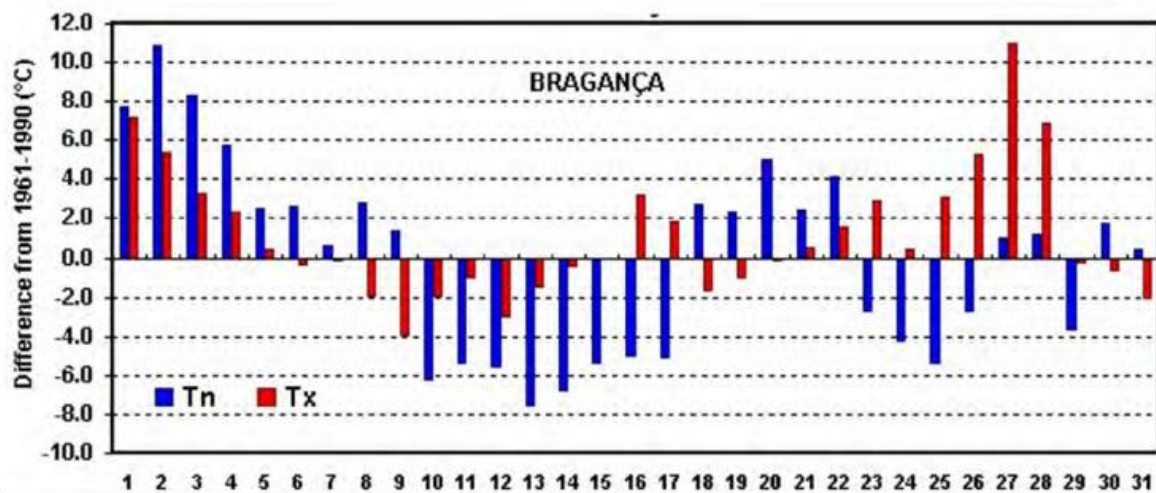


Fig 1.2: *Daily air temperature - anomalies in Bragança (January 2003)*
From: Instituto de Meteorologia, Portugal

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).

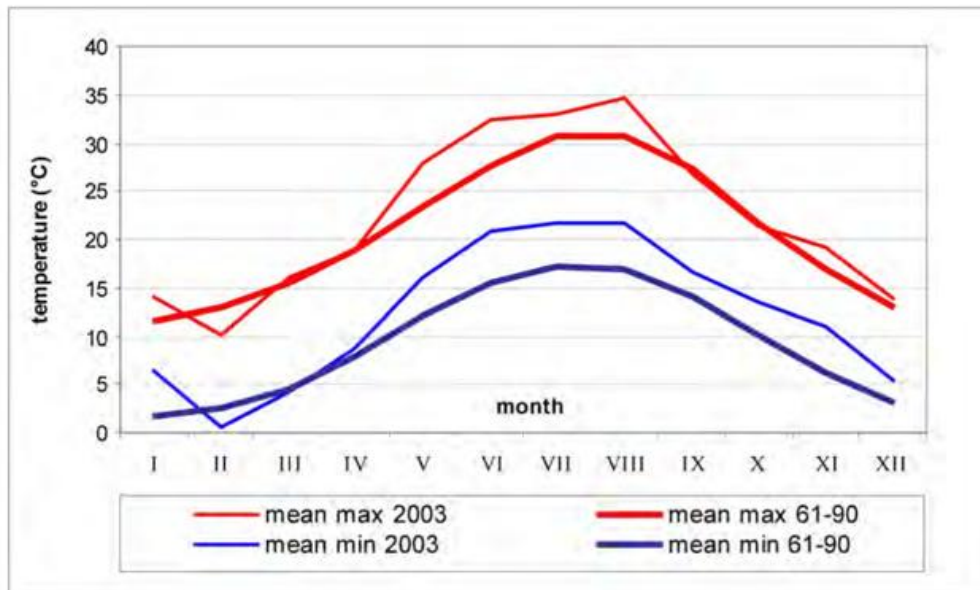


Fig 1.3: Monthly mean of daily temperature extremes in Tirana
From: Hydrometeorological Institute of Albania

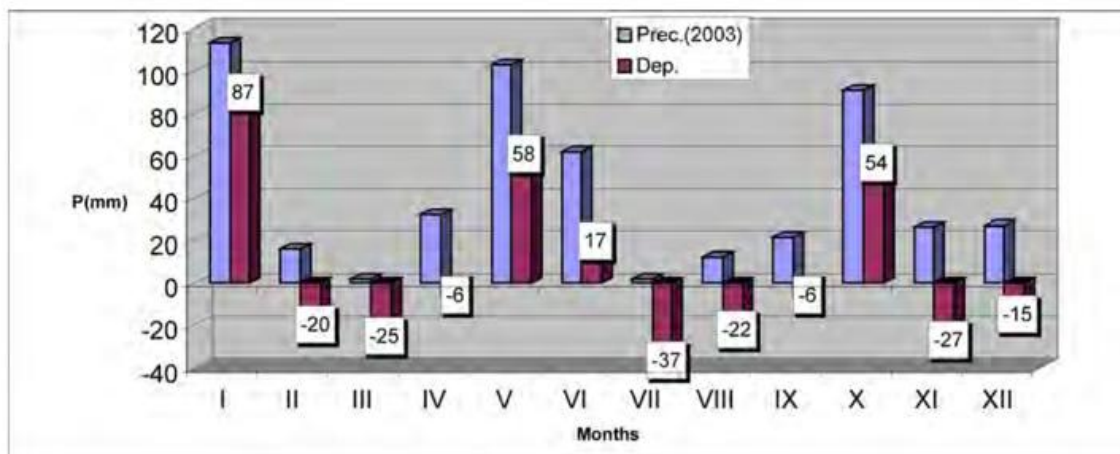


Fig 1.4: Monthly precipitation totals and departures in SkopjeZajcev Rid, in 2003
Reference periode: 1961 - 1990
From: Hydrometeorological Service of Republic Macedonia

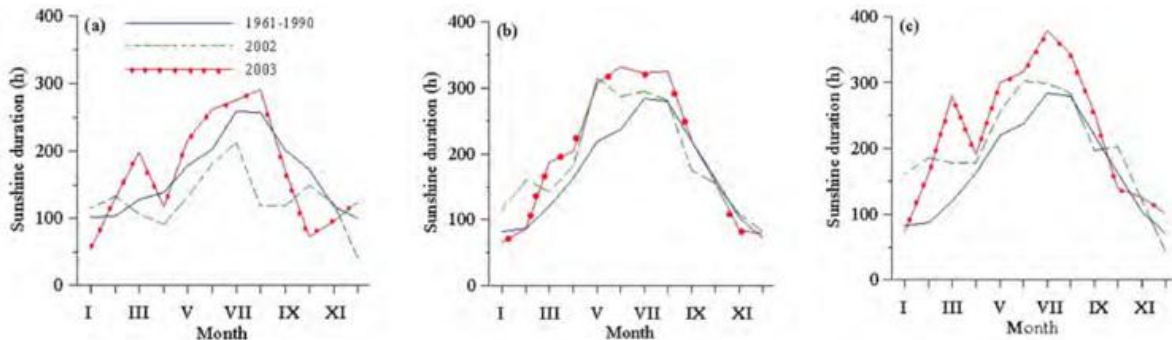


Fig 1.5: Monthly values of sunshine duration at Cherni vrah (a), Varna (b) and Sandanski (c) in 2003, 2002 and normal (1961 - 1990)
From: National Institute of Meteorology and Hydrology Bulgaria

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 Republic Of Macedonia the monthly precipitation rate was about 200% of normal. Fig. 1.4 shows the example of station Skopje. The monthly mean temperatures 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.

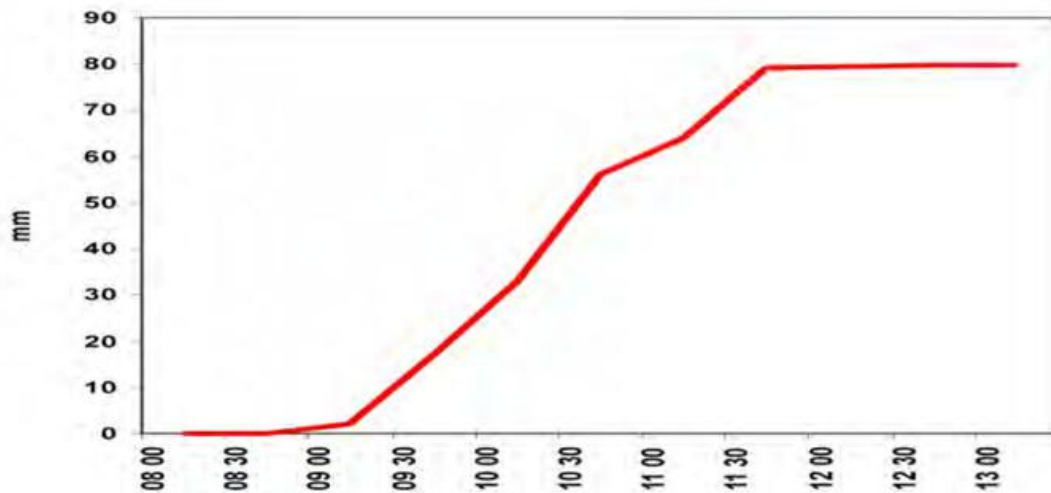


Fig 1.6: Accumulated Rainfall in Tel Aviv on January 21 2003
From: Israel Meteorological Service

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 6°C, 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.

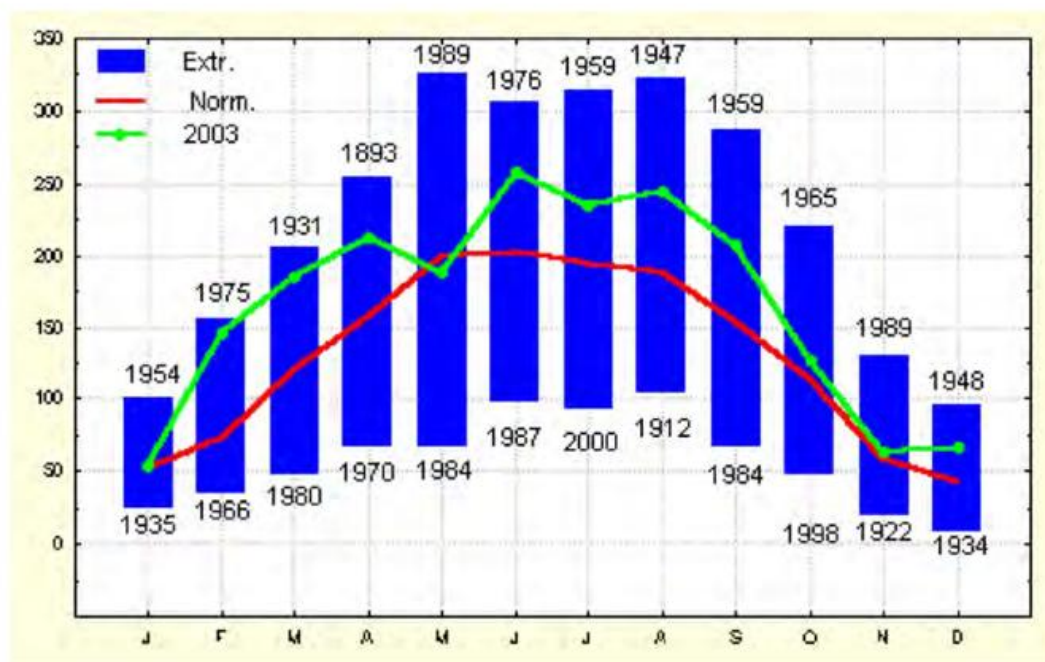


Fig 2.1: Sunshine duration at station Uccle monthly sums of the year 2003, the reference period 1887 - 1988 and extreme values since 1887
From: Institut Royal Météorologique de Belgique

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 .

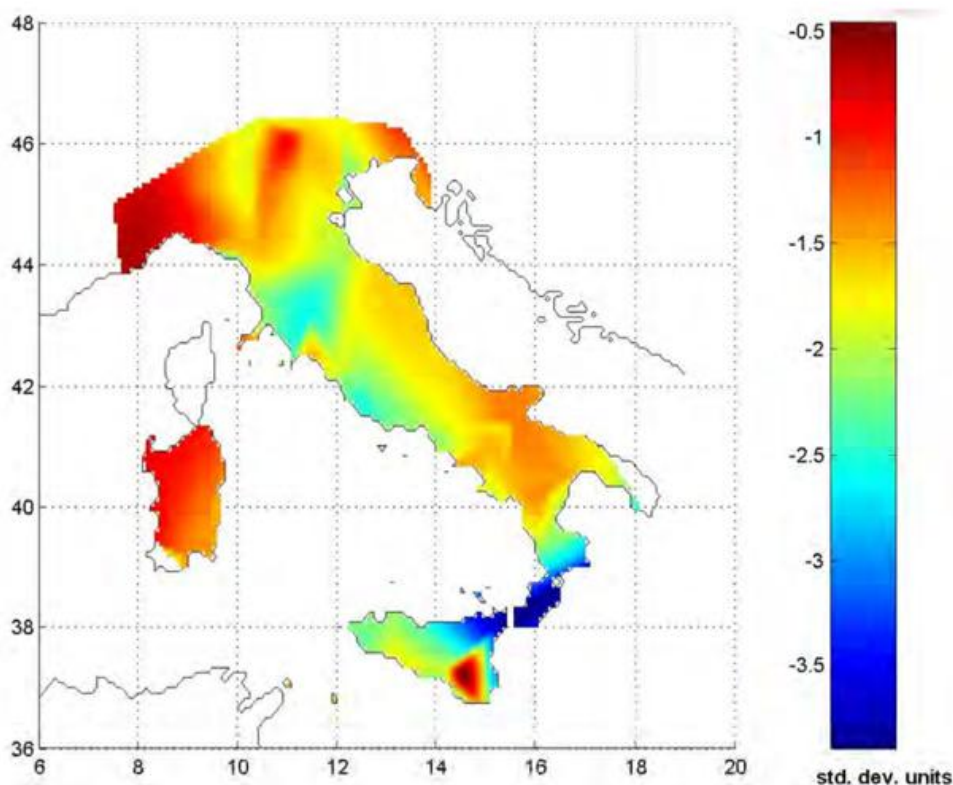


Fig 2.2: *Anomalies of the daily minimum temperature in standard deviation units*
From: Ufficio Generale per la Meteorologia, Italy

The month was extremely cold and very dry in The Former Yugoslav Republic 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

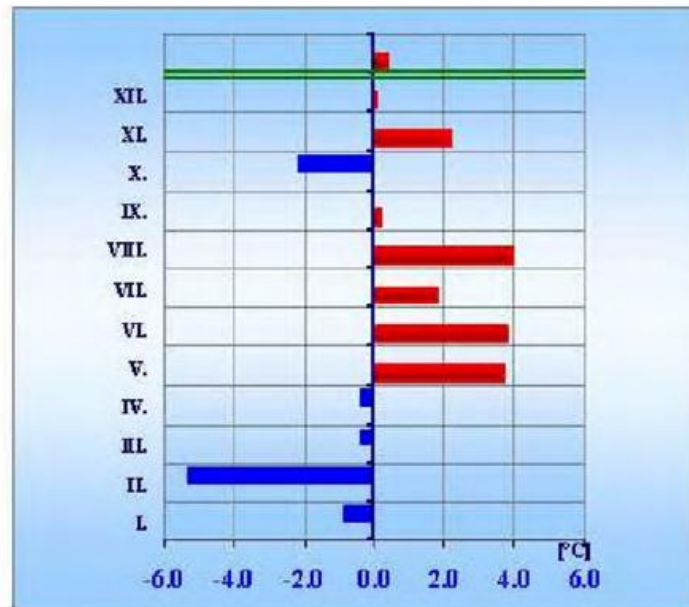


Fig 2.3: Anomaly of the countrywide monthly mean temperatures 2003 (°C) in Hungary
From: Hungarian Meteorological Institute

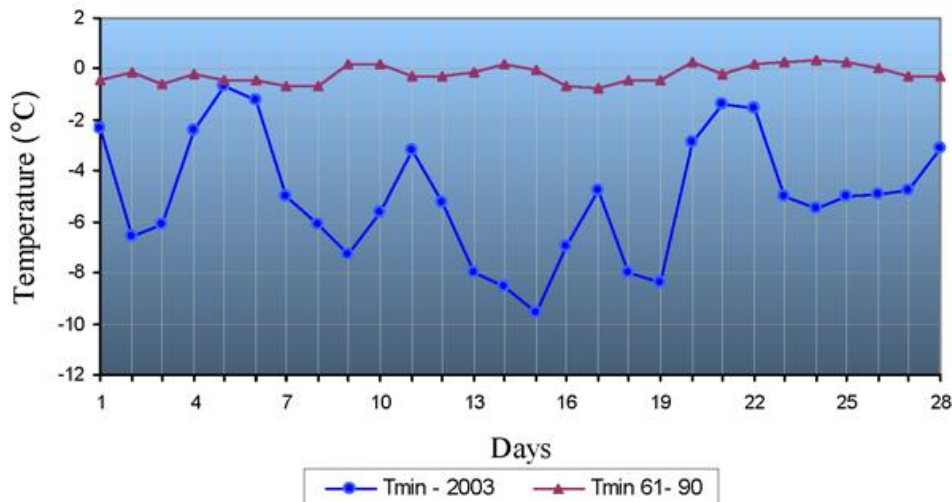


Fig 2.4: Daily minimum temperature in February 2003 and 1961 - 1990 means in Belgrade
From: Republic Hydrometeorological Service of Serbia and Montenegro

part of the country caused a lot of damage on February 5; the seaways into the Bosphorus 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.

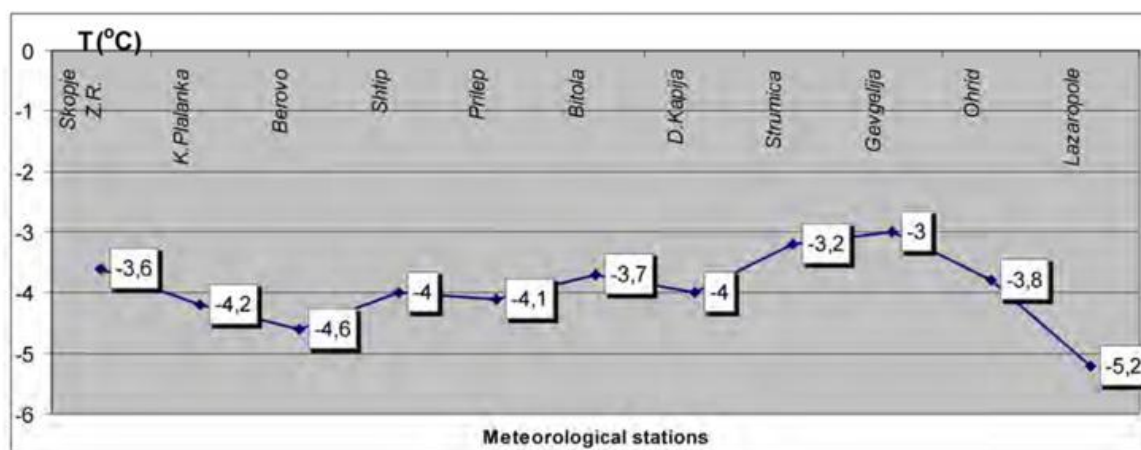


Fig 2.5: Anomalies of the air temperature in February 2003, Macedonia
Reference period is February 1961 - 1990
From: Hydrometeorological Service of Republic Macedonia

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 $> 3^{\circ}\text{C}$ and the precipitation deficit was $\frac{1}{3}$ of the normal amount.

The month was rather mild, dry and very sunny in Germany. The overall monthly mean temperature anomaly was $+1.8^{\circ}\text{C}$ 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 $>20^{\circ}\text{C}$ 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 $+1^{\circ}\text{C}$ 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 $>3^{\circ}\text{C}$ and precipitation rates below 50% of normal in most parts of the country.

In Switzerland the month was very mild with temperature anomalies between

$+2.5^{\circ}\text{C}$ and $+3.5^{\circ}\text{C}$. 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 $+2.5^{\circ}\text{C}$. 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 $+5^{\circ}\text{C}$ and $+6^{\circ}\text{C}$. The anomalies of daily maximum air temperature, especially in the northern and central regions were from $+8^{\circ}$ to $+10^{\circ}\text{C}$. The monthly precipitation amounts were close to normal almost all over the country.

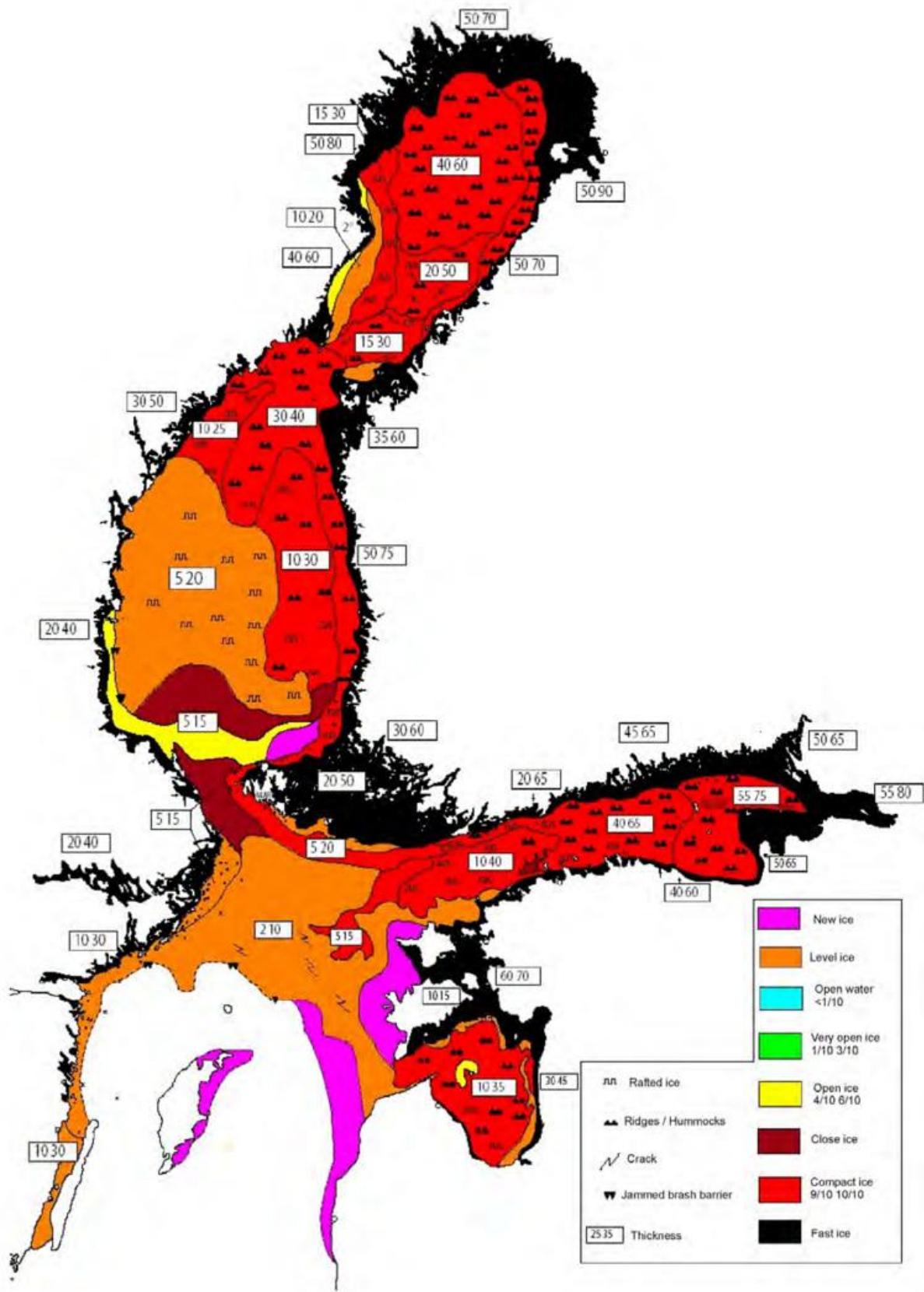


Fig 3.1: The area of ice coverage of the Baltic Sea at its maximum, year 2003
 From: Latvian Environmental, Geological and Meteorological Agency

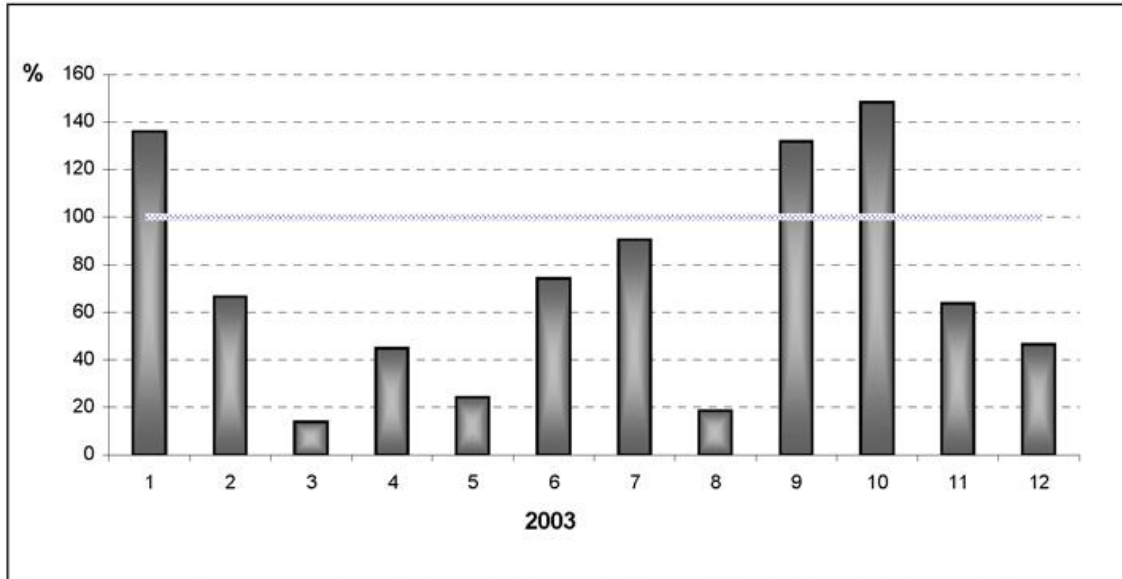


Fig 3.2: Monthly precipitation totals in % of normal (1961 - 1990) in Zagreb Gric, in 2003
From: Meteorological and Hydrological Service, Croatia

Temperature anomalies in Spain were generally positive and centered in the north-west with maxima of $>2.5^{\circ}\text{C}$. 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 Republic 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.

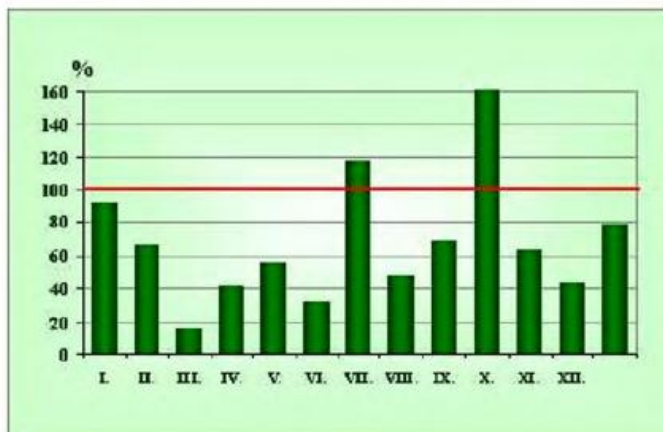


Fig 3.3:

Monthly precipitation average (%) in 2003 (green boxes) compared to the reference period (red line) in Hungary
From: Hungarian Meteorological Institute

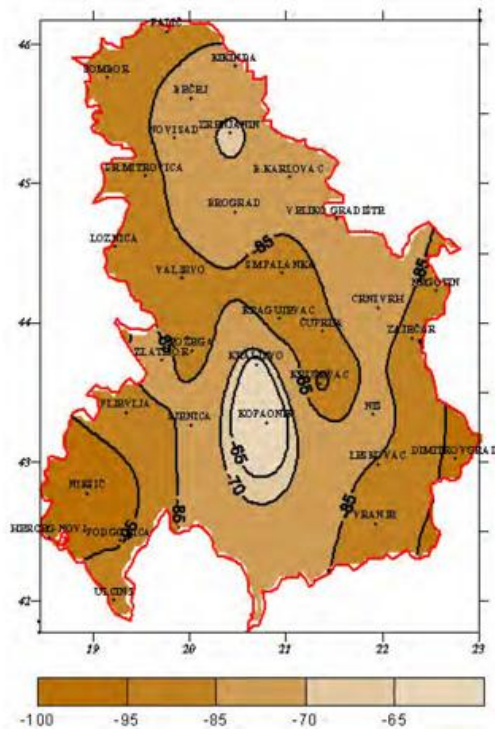


Fig 3.4:

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 lightning activity occurred on March 24-25 causing some power failures.

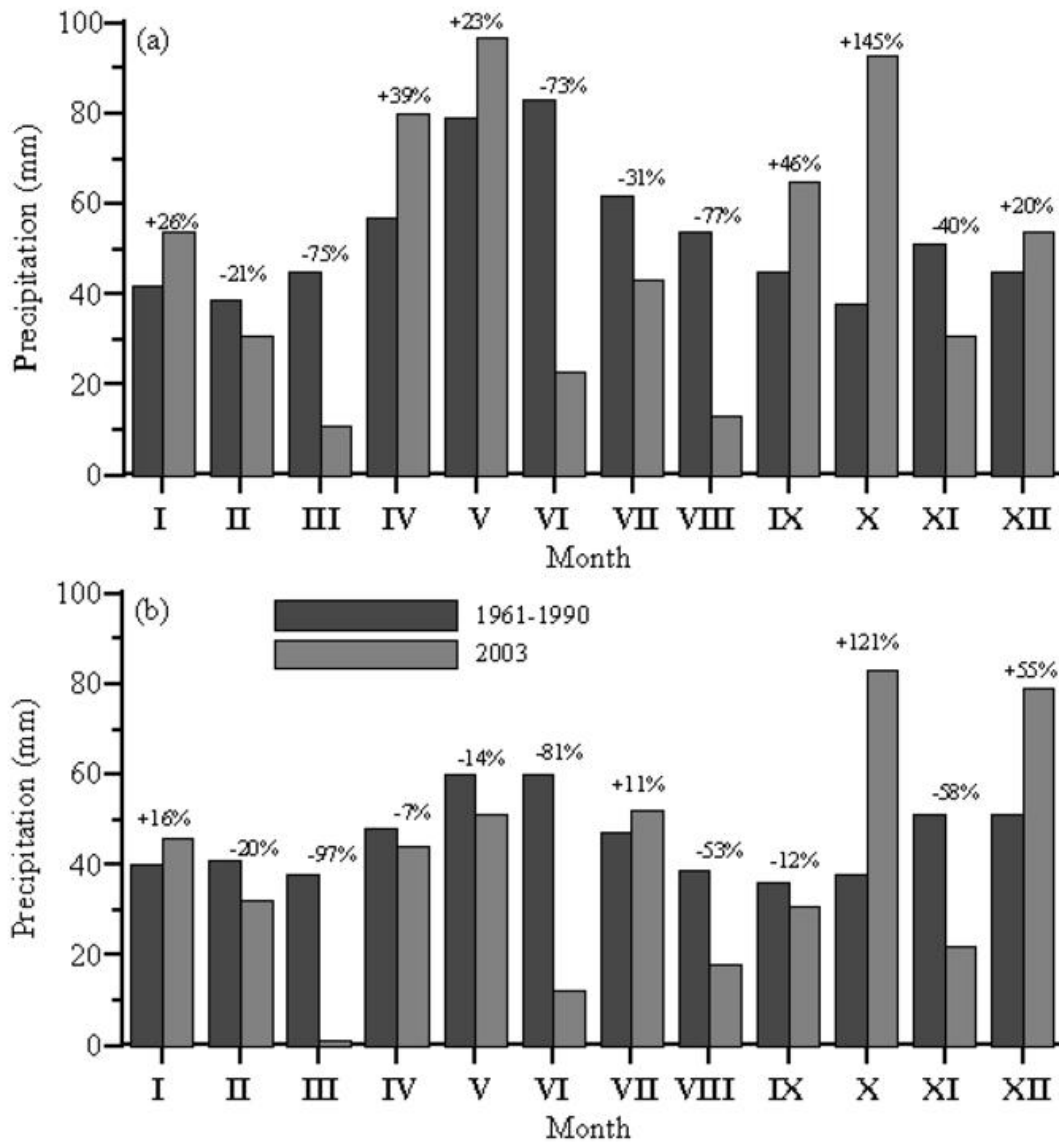


Fig 3.5: Monthly precipitation in north Bulgaria (a) and south Bulgaria (b) in 2003 and departures (in %) relative to normal (1961 - 1990)
From: National Institute of Meteorology and Hydrology, Bulgaria

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.

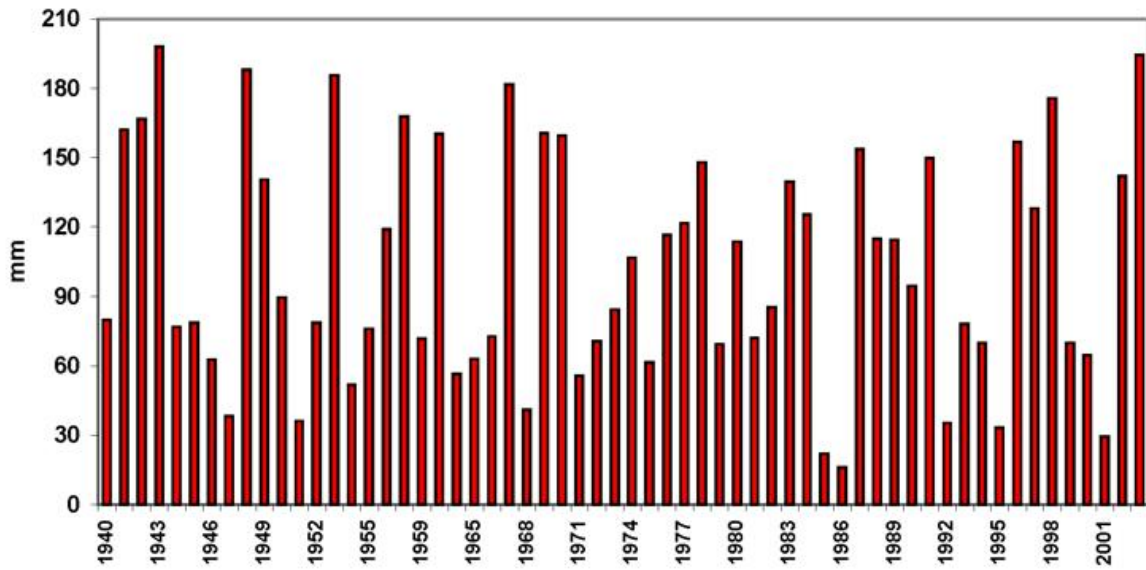


Fig 3.6: Rainfall amounts in Har Kenaan in March 1940 - 2003
From: Meteorological Service Israel

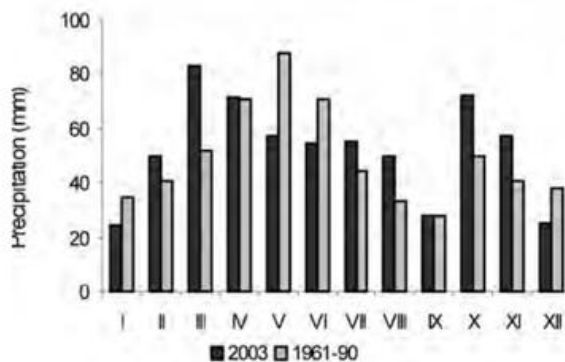


Fig 3.7:

Monthly precipitation totals in 2003 compared with 1961 - 1990
From: Hydrometeorological Institute, 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 Bosphorus

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.

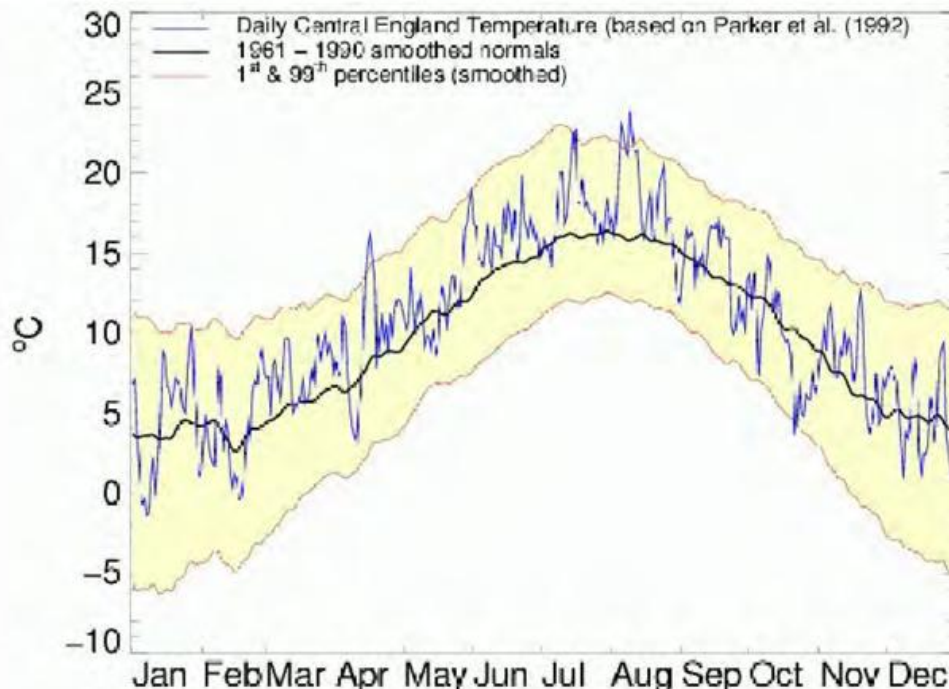


Fig 4.1: Daily Central England temperature (°C) for 2003, normal 1961-1990 and 1st and 99th percentiles for each day of the year
From: Met Office, U.K.

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 $\frac{2}{3}$ 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 $38-40^{\circ}\text{C}$ in the coastal plain and $40-41^{\circ}\text{C}$ 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 Reykjavik 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. Oksey 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.

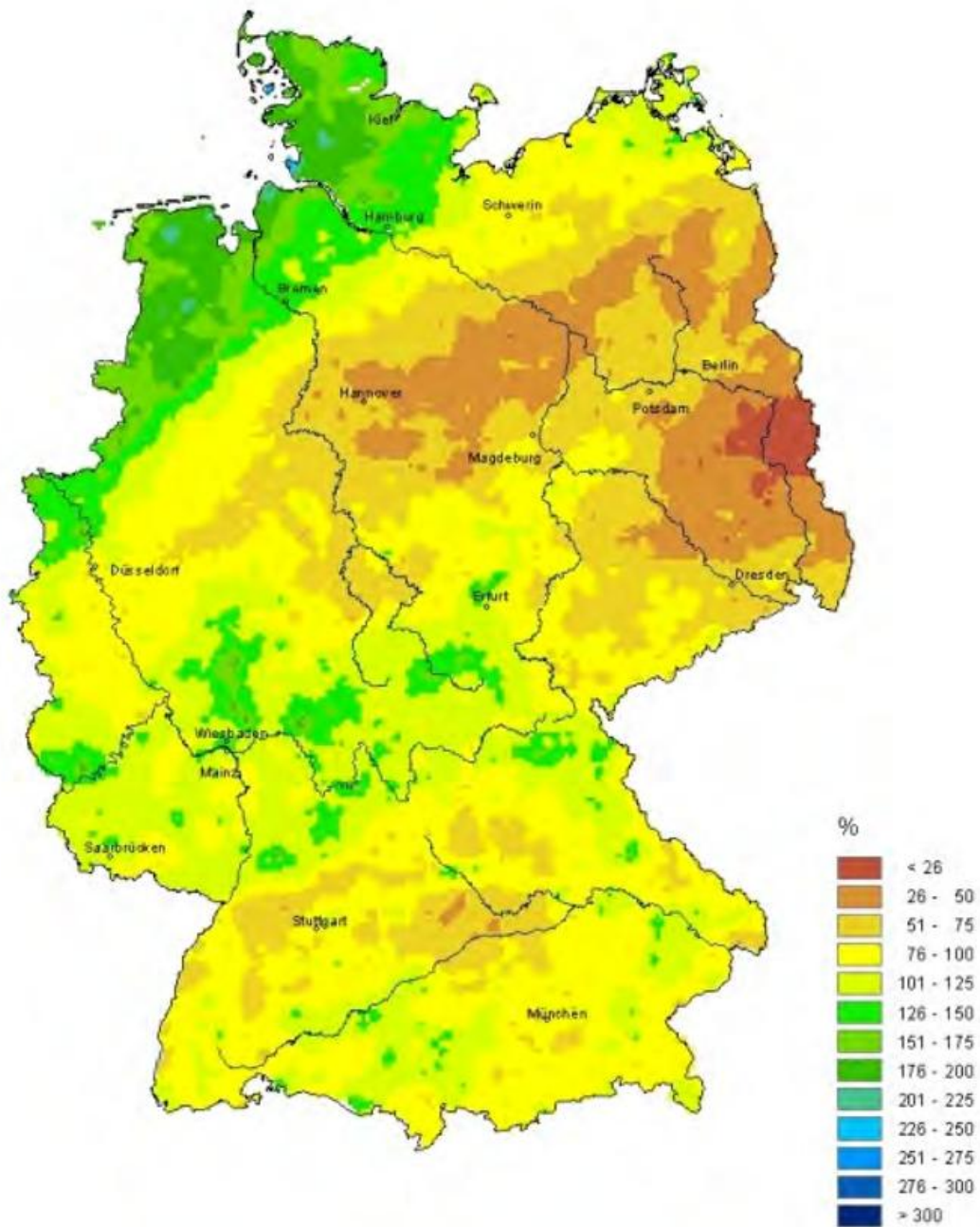


Fig. 5.1: *Precipitation distribution for Germany in % of normal (reference period 1961-1990), May 2003*
From: Deutscher Wetterdienst, Offenbach

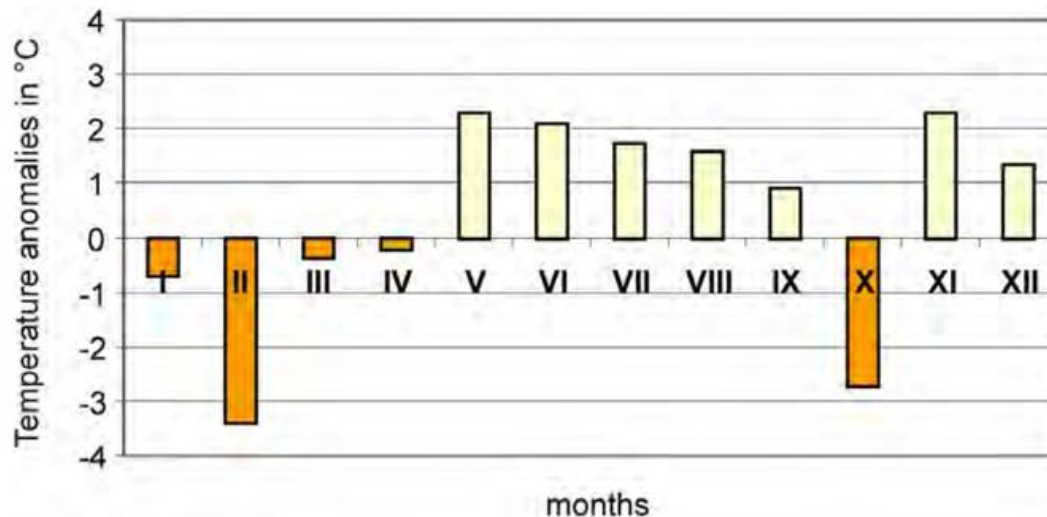


Fig. 5.2: Monthly mean temperature anomalies in Poland in 2003 (average for 14 stations, reference period 1971-2000)
From: Institute of Meteorology and Water Management, Poland

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.

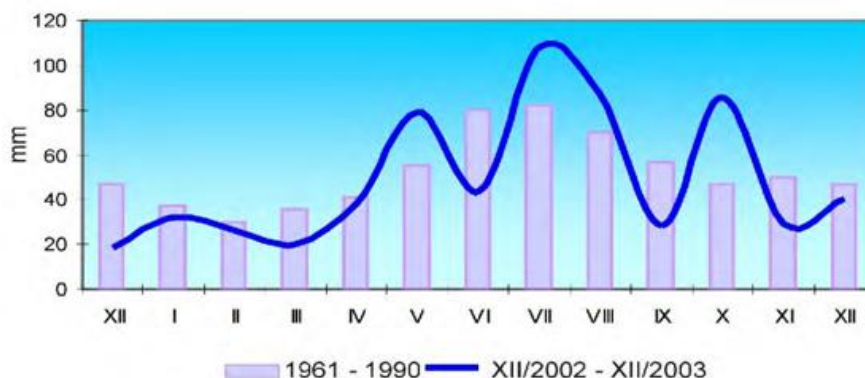


Fig. 5.3: *The monthly precipitation for 2003 and the average long-term precipitation (1961-1990) of Belarus*
From: Hydrometeorological Centre of the Republic of Belarus

In Ukraine the month was very hot and dry. Temperature deviations from normal ranged between $+3.5^{\circ}\text{C}$ and $+4.7^{\circ}\text{C}$. 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 $+7^{\circ}\text{C}$ was registered in the mountain zones.

The month was very warm in Bulgaria with temperature anomalies ranging from $+2.2^{\circ}\text{C}$ in the south to $+3.0^{\circ}\text{C}$ in the north of the country. In 20-25 days the maximum air temperatures were higher than $+25^{\circ}\text{C}$. 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 southwestern 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 $+3.1^{\circ}\text{C}$. The total precipitation was only $\frac{1}{3}$ 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.

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.

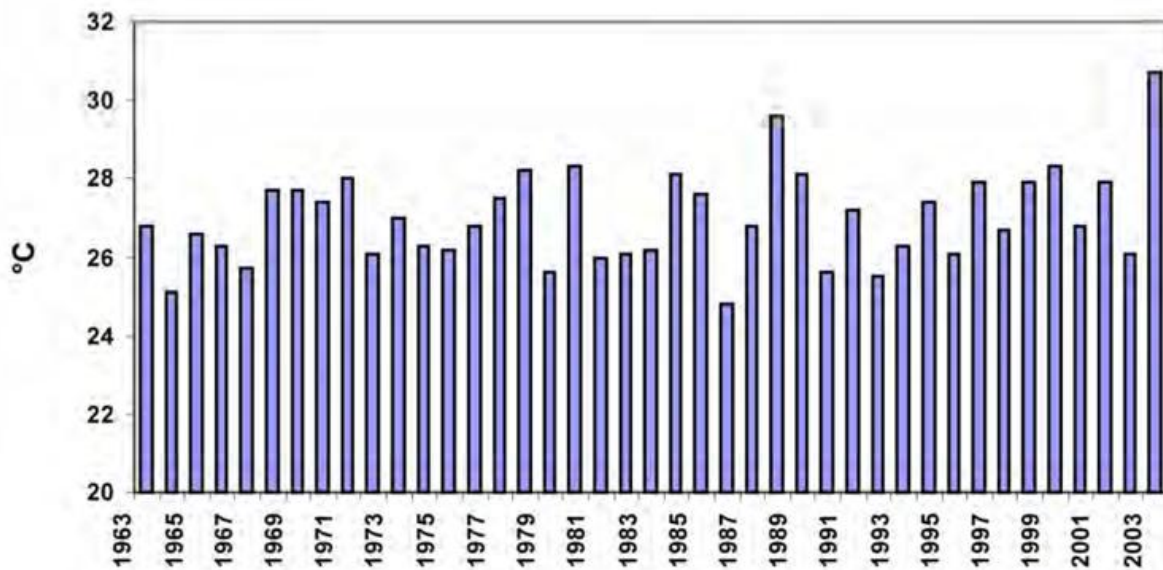


Fig. 5.6: Mean daily temperature in May; Bet Dagan (Central Coastal Plain) 1963-2003
From: Israel Meteorological Service

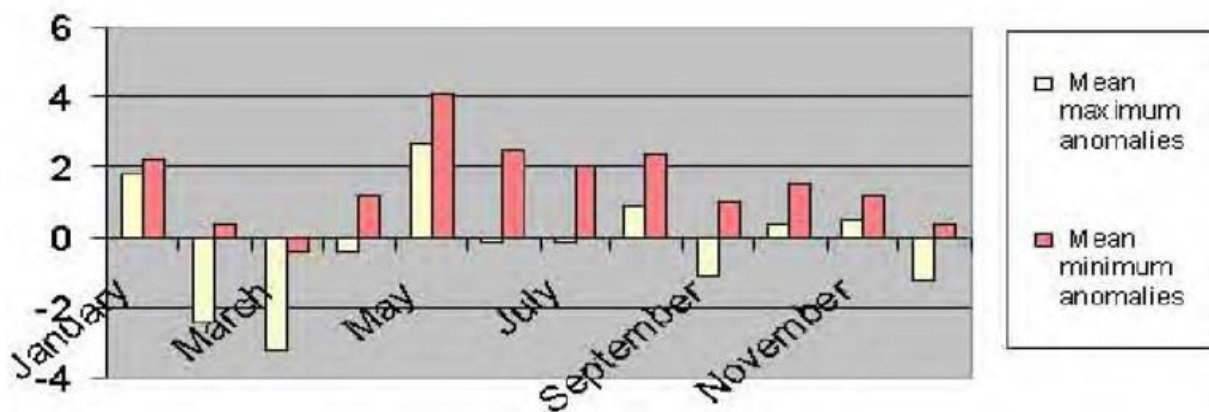


Fig. 5.7: Mean maximum and minimum anomalies for the year 2003; Amman Airport
From: Jordanian Meteorological Department

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 anticyclonic 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 40°C. The monthly mean of Tx was 28.5°C with an anomaly of about +3°C, corresponding

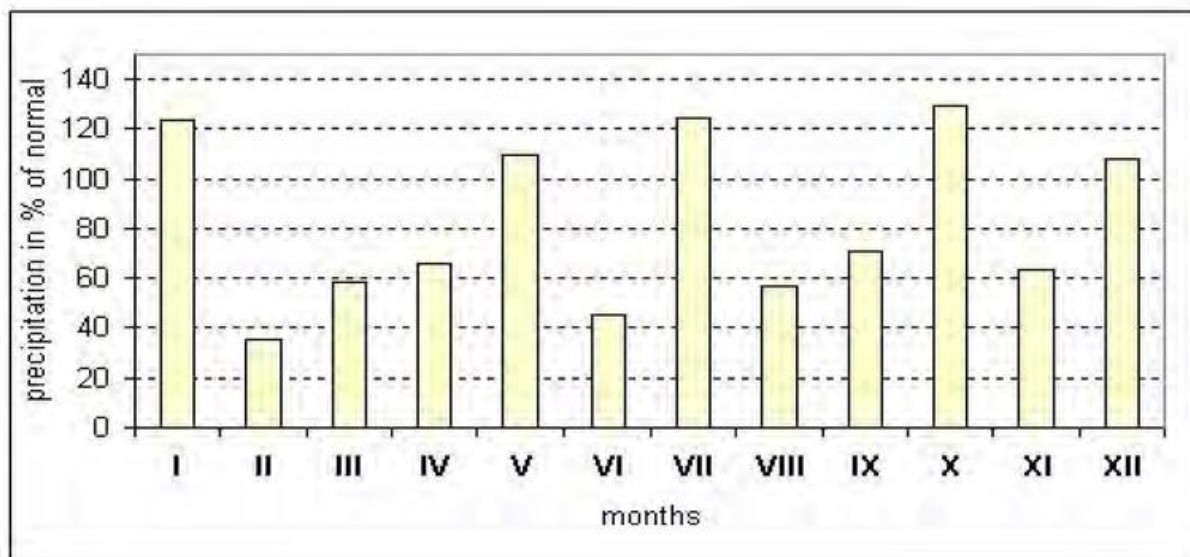


Fig. 6.1: Monthly precipitation totals in Poland in 2003 in percent of 1971-2000 mean (average for 14 stations)

From: Institute of Meteorology and Water Management, Poland

to the 3rd highest value since 1931 (higher values: 29.0°C in 1976 and 28.8°C in 1996). The mean minimum air temperature was 15.0°C, 1.6°C above normal, corre-

sponding to the 3rd highest value of the series (higher values: 15.1°C in 1996 and 1981). Tab. 6.1 shows the number of days with a minimum air temperature of $\geq 20^{\circ}\text{C}$

(tropical nights), and maximum air temperature equal or above 25°C (summer days) and 30°C (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 2°C 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 Kremsmünster with series since the eighteenth century, the warmest June before had been in 1811. In 2003 the

Stations	Minimum T \geq 20°C		Maximum T \geq 25°C		Maximum T \geq 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*

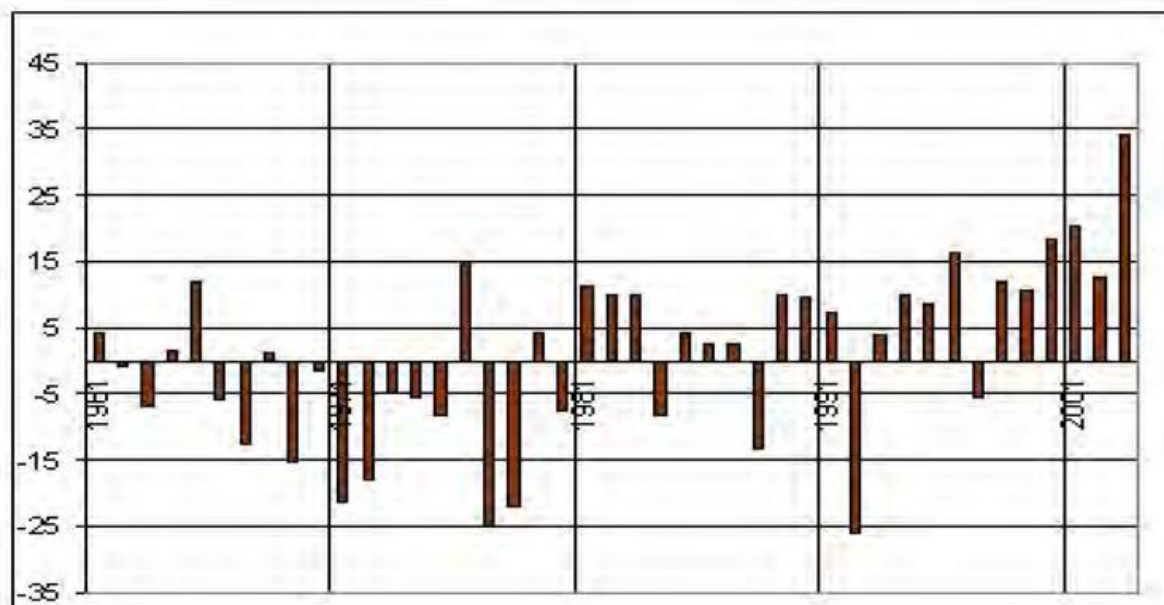


Fig. 6.2: Deviation of average temperature (in tenths of °C) over the Spanish peninsular territory in June (reference 1971-2000)

From: Instituto Nacional de Meteorología, Spain

monthly average in Vienna was +22.4°C (+22.0 in 1811) and +21.2°C in Kremsmünster (+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 $\geq +3.8^\circ\text{C}$ 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 $\frac{1}{3}$ of the monthly normal precipitation.

Drought conditions in Moldova continued (see fig. 5.5).

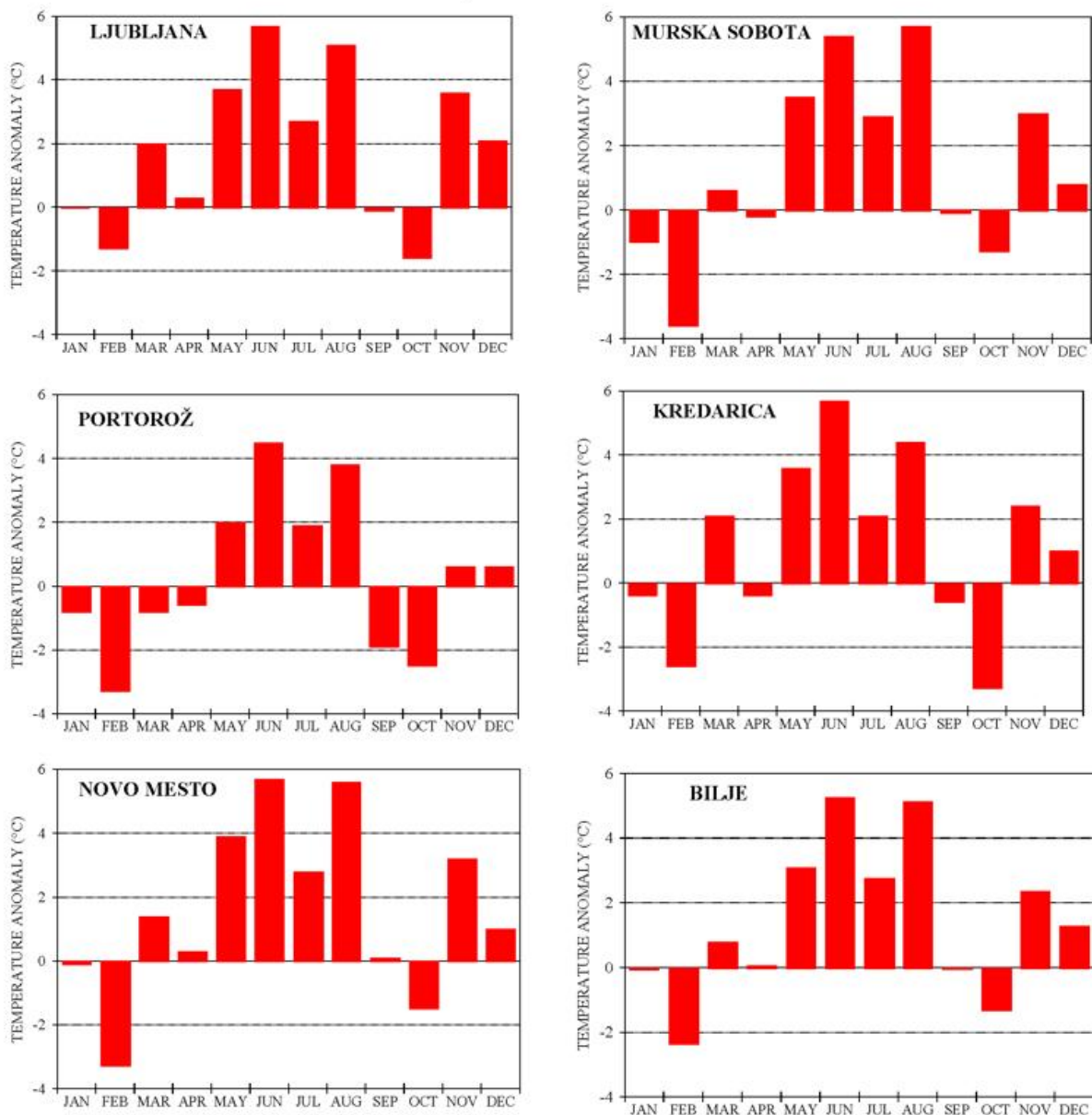


Fig. 6.3: Mean monthly temperature anomaly in the year 2003
From: Environmental Agency of the Republic of Slovenia

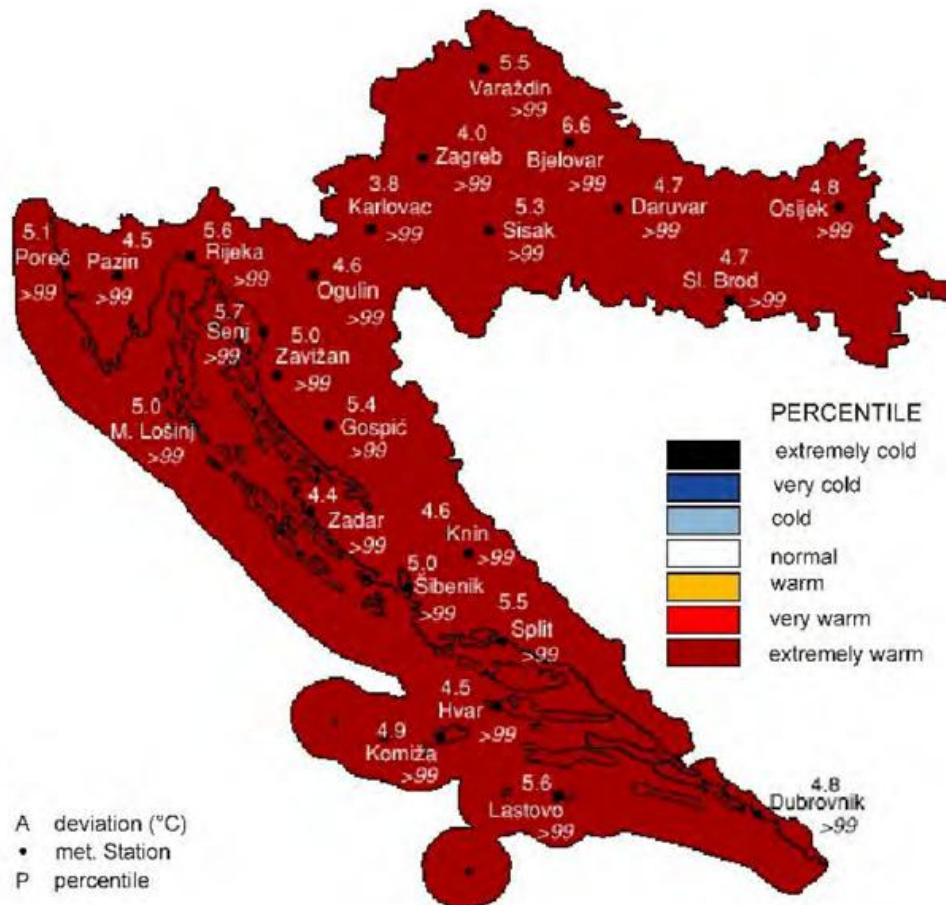


Fig. 6.4: Monthly air temperature anomalies in Croatia in June 2003, from normals 1961-1990
From: Meteorological and Hydrological Service Croatia

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.

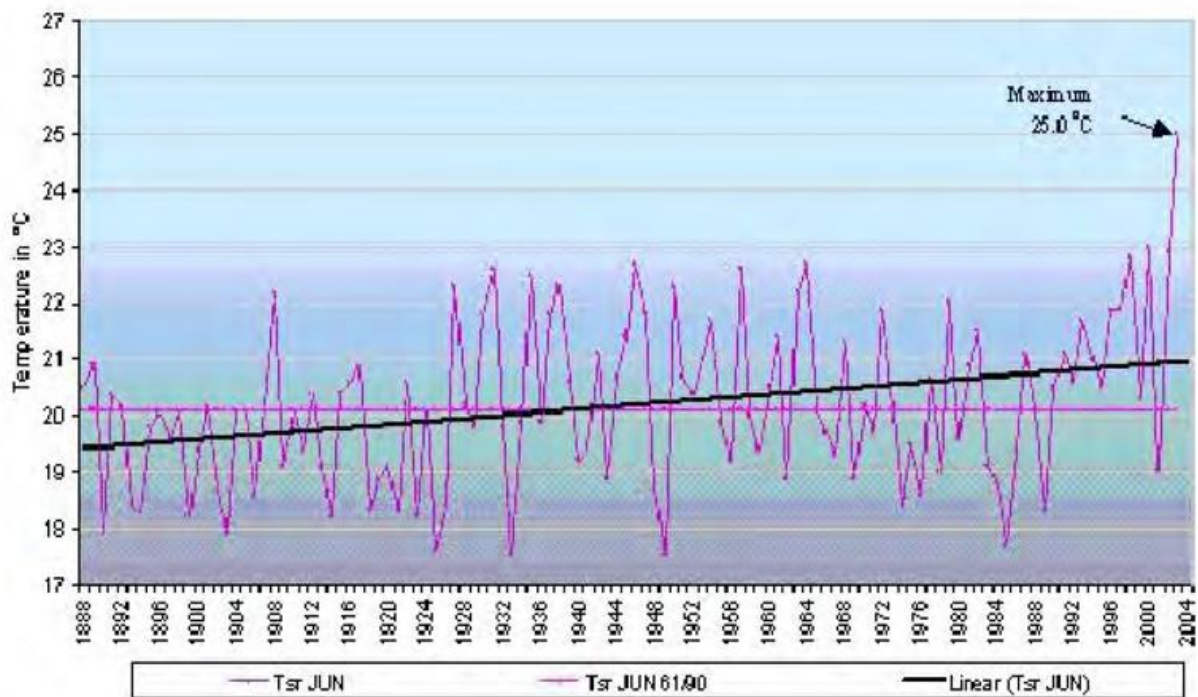


Fig. 6.5: Mean Daily Temperature in June in Belgrade between 1888 and 2003 and 1961 – 1990 June mean
From: Republic Hydrometeorological Service of Serbia and Montenegro

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 $\frac{1}{3}$ 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 $\frac{3}{4}$ 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 $\geq 1^\circ\text{C}$ in the south and $>3^\circ\text{C}$ 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,

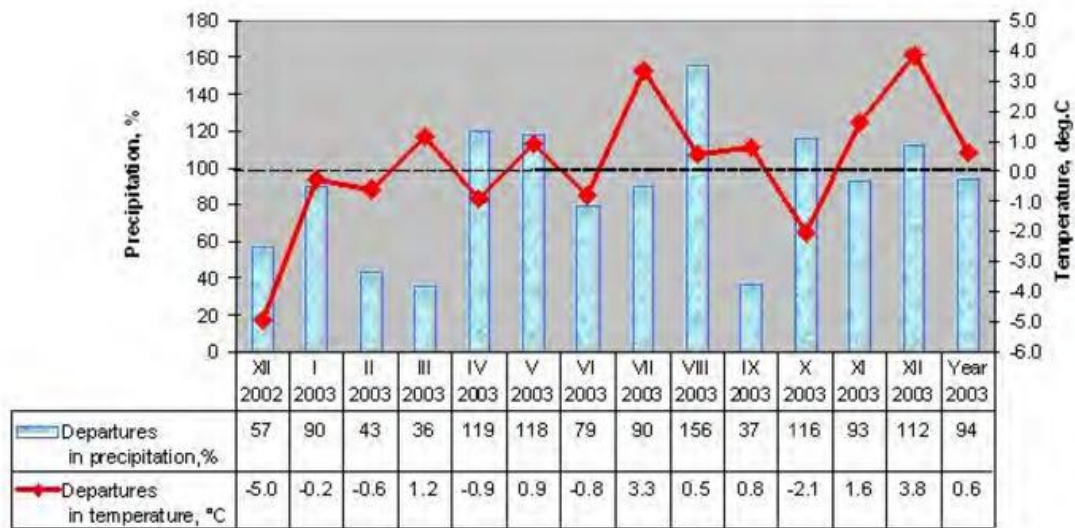


Fig. 7.1: Monthly temperature anomalies and precipitation rates in Latvia 2003
From: Latvian Environmental, Geological and Meteorological Agency

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 $\geq 40^{\circ}\text{C}$.

In The Former Yugoslav Republic Of Macedonia the month was clearly warmer than normal with temperature deviations between $+1^{\circ}\text{C}$ and $+2^{\circ}\text{C}$. 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 $+0.7^{\circ}\text{C}$ 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 $500\,000\text{m}^3$ 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 $\geq 2^{\circ}\text{C}$. 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 $\frac{2}{3}$ 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 $+3.6^{\circ}\text{C}$. 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 $+1^{\circ}\text{C}$ up to $+2.5^{\circ}\text{C}$. 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 $+0.8^{\circ}\text{C}$. 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 $27\text{--}33^{\circ}\text{C}$. 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 $+6^{\circ}\text{C}$ 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 $1\text{--}2^{\circ}\text{C}$. 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

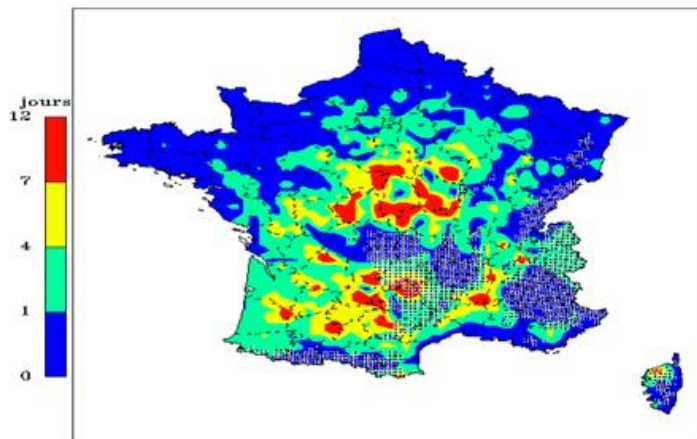


Fig. 8.1:

Number of days with $T_x > 40^\circ\text{C}$ over the period August 1 to 18, 2003. Red areas indicate a range from 7 to 12 days
From: Météo-France

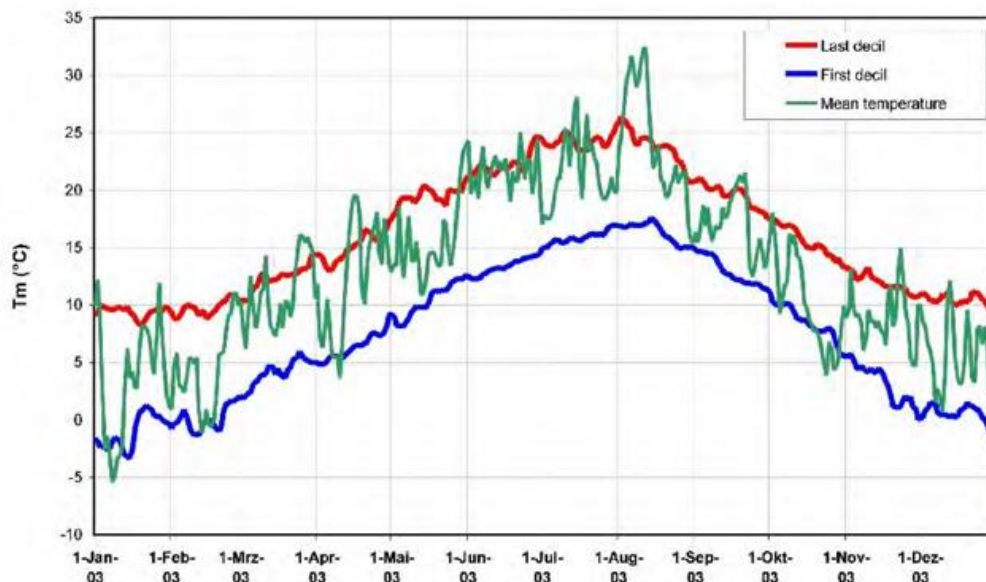


Fig. 8.2: Daily Paris average temperature time series (green) compared with the upper (top/red curve) and lower (blue curve) deciles
From: Météo-France

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.

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 4°C 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 $\geq 30^{\circ}\text{C}$ 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 $>3^{\circ}\text{C}$ and dry with a country-wide precipitation total less than $\frac{1}{3}$ 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

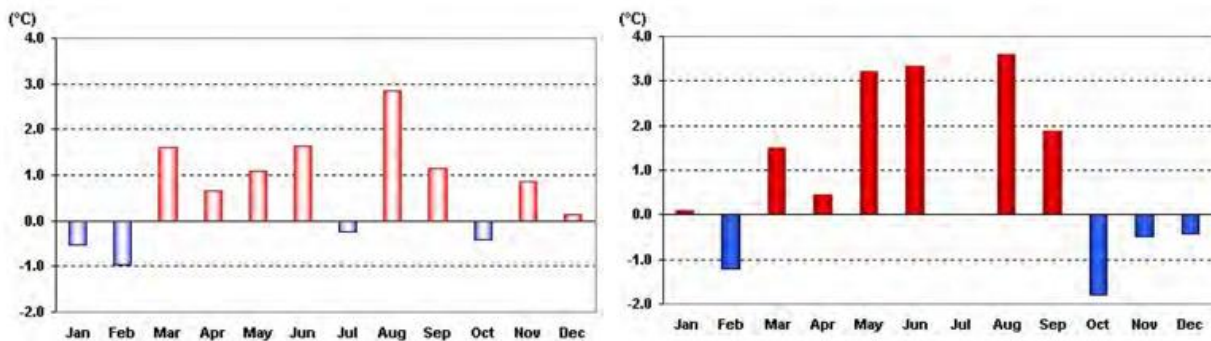


Fig. 8.3: *Anomalies of the monthly means of daily extreme temperatures in the mainland of Portugal, 2003*
From: Instituto de Meteorologia, Portugal

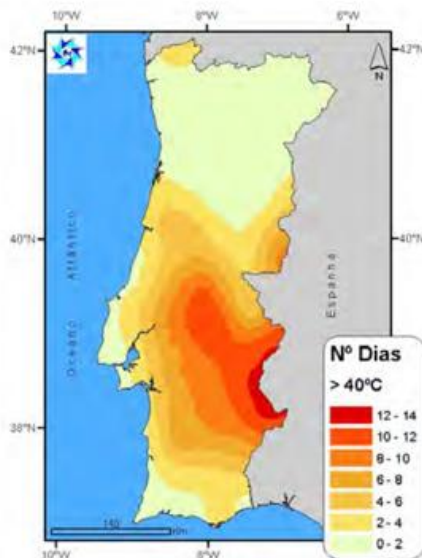


Fig. 8.4:

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).

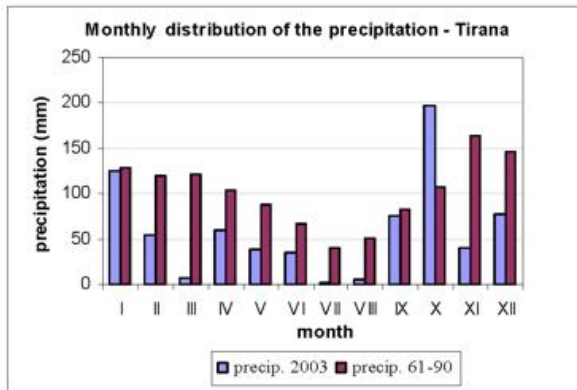


Fig. 8.5:

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

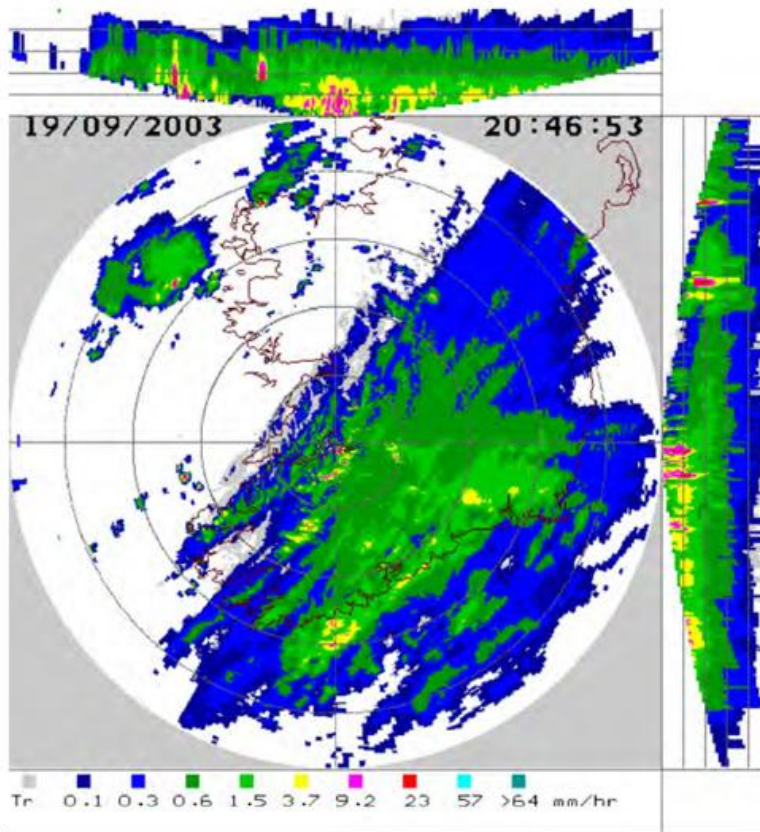


Fig. 9.1:

Shannon radar image illustrating the rainfall intensity in the vicinity 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 $\geq +2^{\circ}\text{C}$ 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 $+2^{\circ}\text{C}$ 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 $+1^{\circ}\text{C}$ 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 $+1^{\circ}\text{C}$ 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 $+0.9^{\circ}\text{C}$. 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 Republic 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 $\pm 1^{\circ}\text{C}$. 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 $\geq 40\text{mm}$. 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 $+4.9^{\circ}\text{C}$ 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 $+1^{\circ}\text{C}$ 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 $\geq 30^{\circ}\text{C}$ 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 5.1°C, which is 3.5°C above normal and the highest November temperature since the measurements started here in 1933. Tromsø with measurements since 1920 noted 2.4°C, which is the same as the record from 1999 with 3.5°C above normal. In southern parts of the country the monthly mean was 4°C to 5°C above normal. A special Foehn situation occurred on November 6 with extraordinary air temperatures for the month. At station Taffjord 21.8°C 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 $\geq 2^\circ\text{C}$ 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 $\geq +2^\circ\text{C}$ 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 $\frac{2}{3}$ 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 snowfall 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 $\geq 1^{\circ}\text{C}$ mainly in the western and $< 1^{\circ}\text{C}$ 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 ($+0.4^{\circ}\text{C}$) 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 $\geq 100\text{mm}$ 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 on 1 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 CCI/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

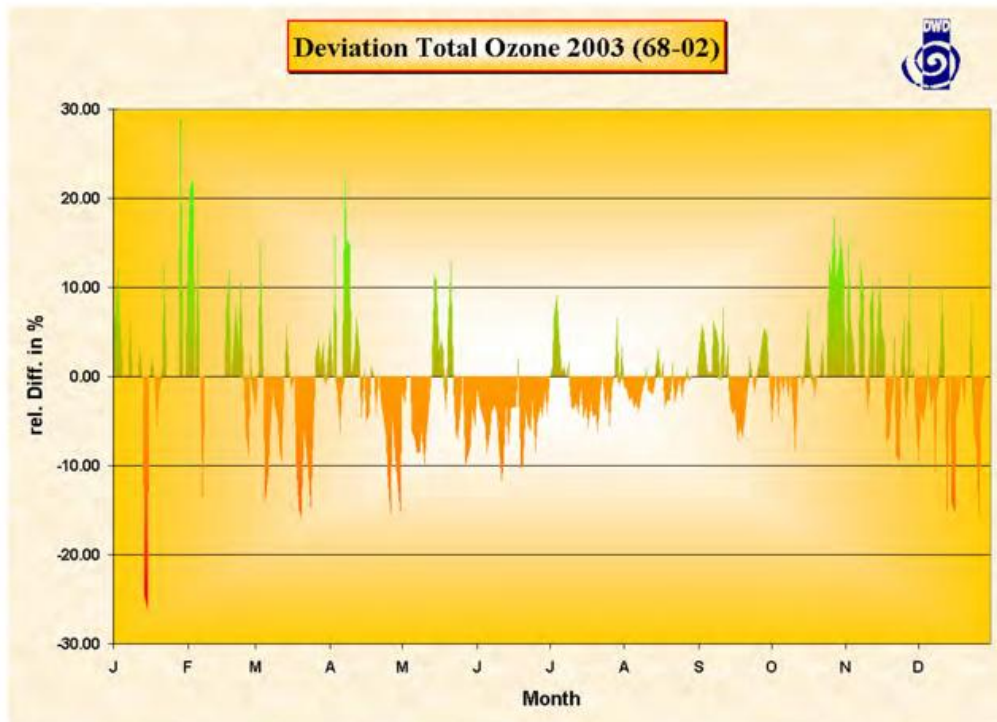


Figure 1: Relative deviation of total ozone daily means from the climatological long-term mean. Measurements are from the year 2003 at Hohenpeissenberg (47.8°N, 11.0°E).

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.

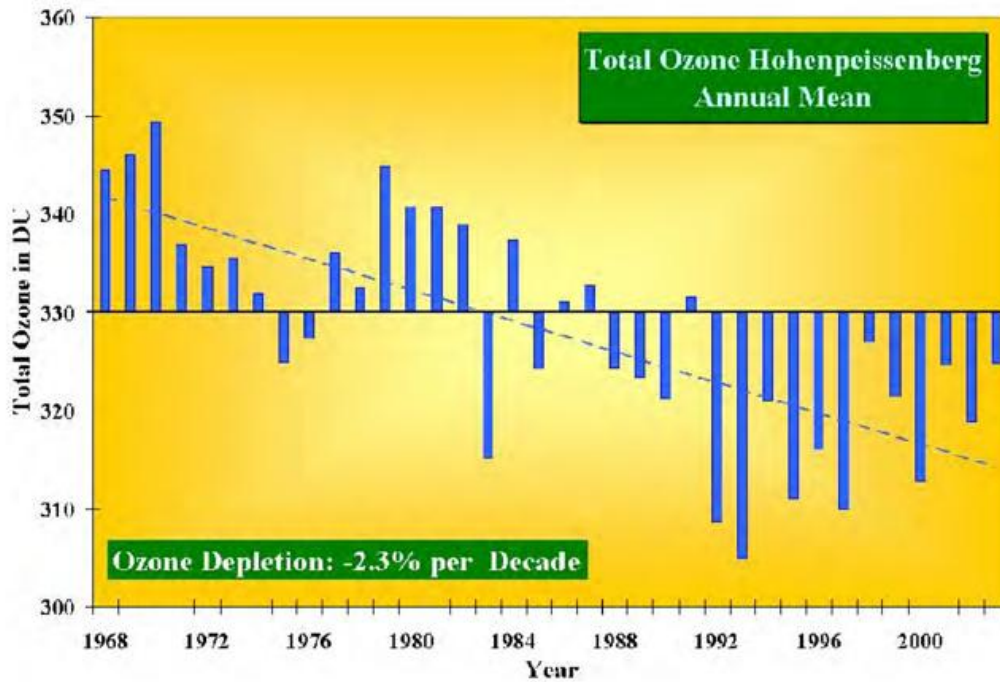


Figure 2: Annual means of total column ozone above Hohenpeissenberg since 1968.

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.

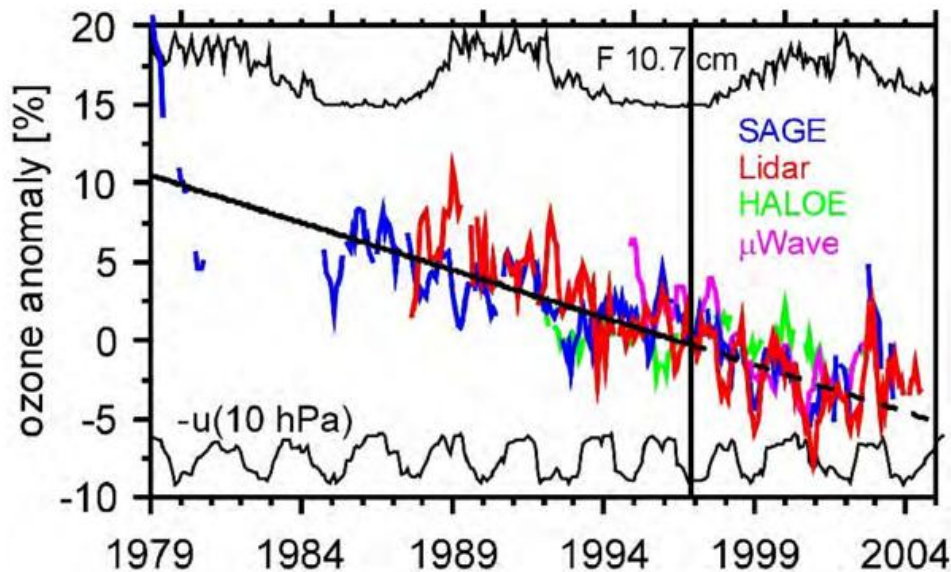


Figure 3: Anomalies of upper stratospheric ozone between 35 and 45 km altitude, based on measurements by Lidar at Hohenpeissenberg (Germany), microwave radiometer at Berne (Switzerland), and zonal mean data from the SAGE and HALOE satellite instruments. Effects of the 11-year solar cycle (thin black 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.

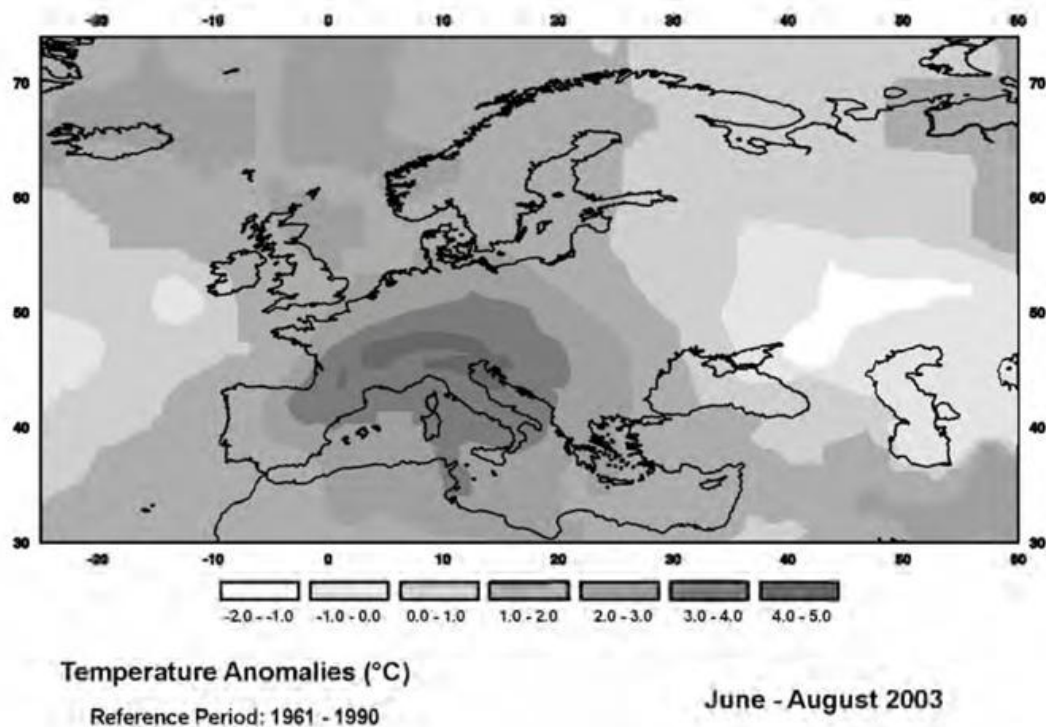


Figure 1: Seasonal anomaly of air temperature (°C, June - August 2003)

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.

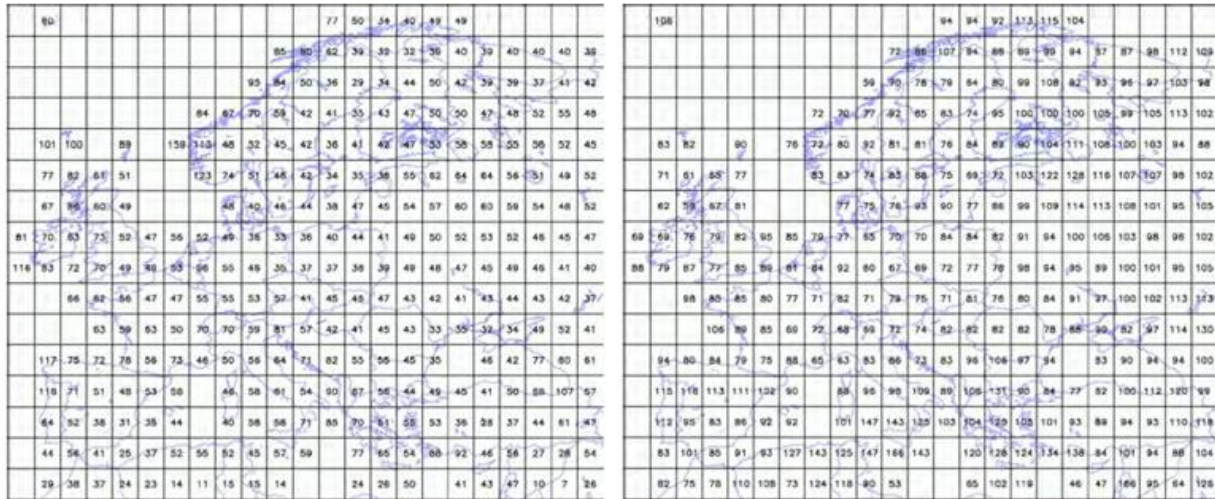


Figure 2: Annual precipitation totals (mm/month, left) and percentage (% , right) for the period Dec. 2002 - Nov. 2003 (percentage related to normal 1961-1990, based on GPCP's monthly monitoring analyses).

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.

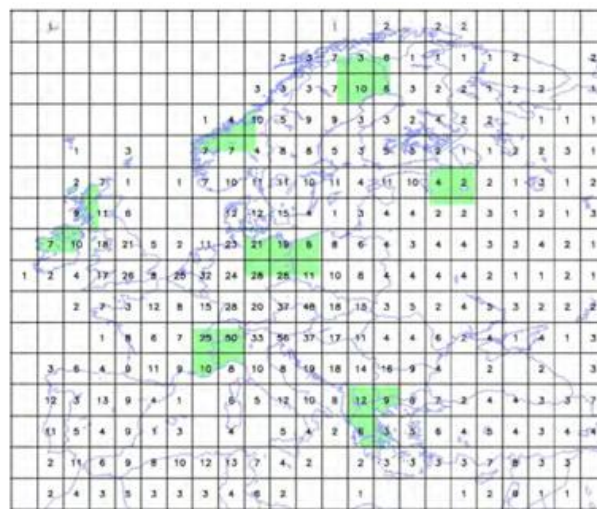


Figure 3: Regions selected for analysis of time-series shown in Figure 4. Numbers indicate the number of stations for each grid box.

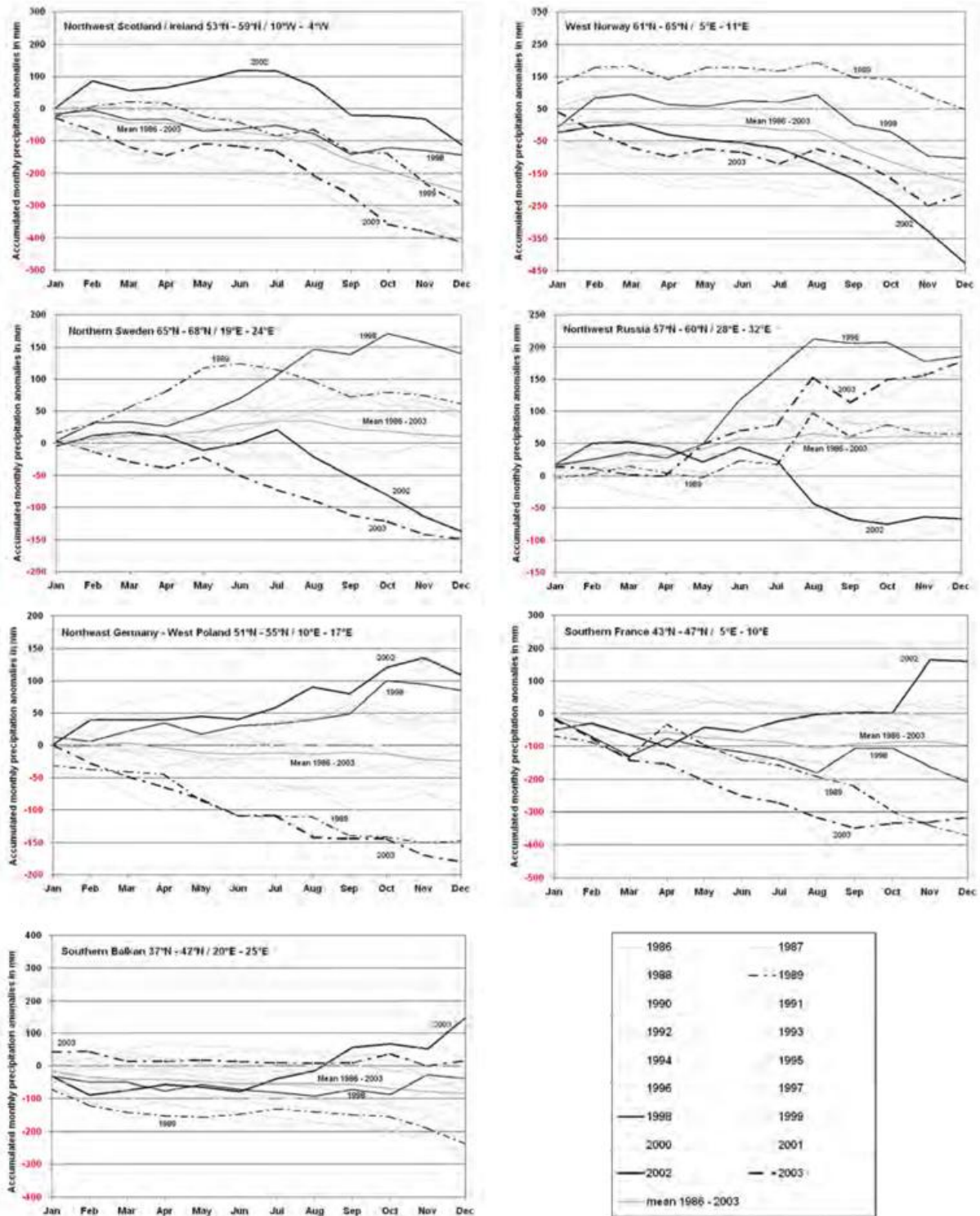


Figure 4: Annual accumulation of monthly precipitation anomalies (mm) related to the period 1961–1990 for selected regions being marked in Figure 3.

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.

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REFERENCES:

- Rudolf, B. (2005): *Global Precipitation Analysis Products of the GPCC. Klimastatusbericht 2004, Deutscher Wetterdienst.*
- Rudolf, B. (2004): *Hydroklimatologische Einordnung der in Europa extremen Jahre 2002 und 2003. Klimastatusbericht 2003, Deutscher Wetterdienst, ISBN 3-88148-394-2, S. 133-151*
- Rudolf, B. (2004): *Zeitlich-räumliche Verteilung der Gebietsniederschläge in Europa: Klimastatusbericht 2003, Deutscher Wetterdienst, S. 115-122*
- Luterbacher, J., D. Dietrich, E. Xoplaki, M. Grosjean, H. Wanner (2004): *European Seasonal and Annual Temperature Variability, Trends, and Extremes Since 1500. Science, 303, S. 1499-1503.*
- Schär, Ch., P. L. Vidale, D. Lüthi, Ch. Frei, Ch. Häberli, M. A. Liniger & Ch. Appenzeller (2004): *The role of increasing temperature variability in European summer heatwaves. Nature, Vol. 427, Jan. 2004, S. 332-336.*
- Grieser, J., und C. Beck (2003): *Extremniederschläge in Deutschland - Zufall oder Zeichen? DWD Klimastatusbericht 2002, im Selbstverlag des Deutscher Wetterdienstes, Offenbach am Main 2003.*
- Grieser, J., Staeger, T., Schönwiese, C.-D. (2000): *Statistische Analysen zur Früherkennung globaler und regionaler Klimaänderungen aufgrund des anthropogenen Treibhauseffektes. Bericht 103, Inst. Meteorol. Geophys. Univ. Frankfurt a.M., 228 S.*