European
Climate Support
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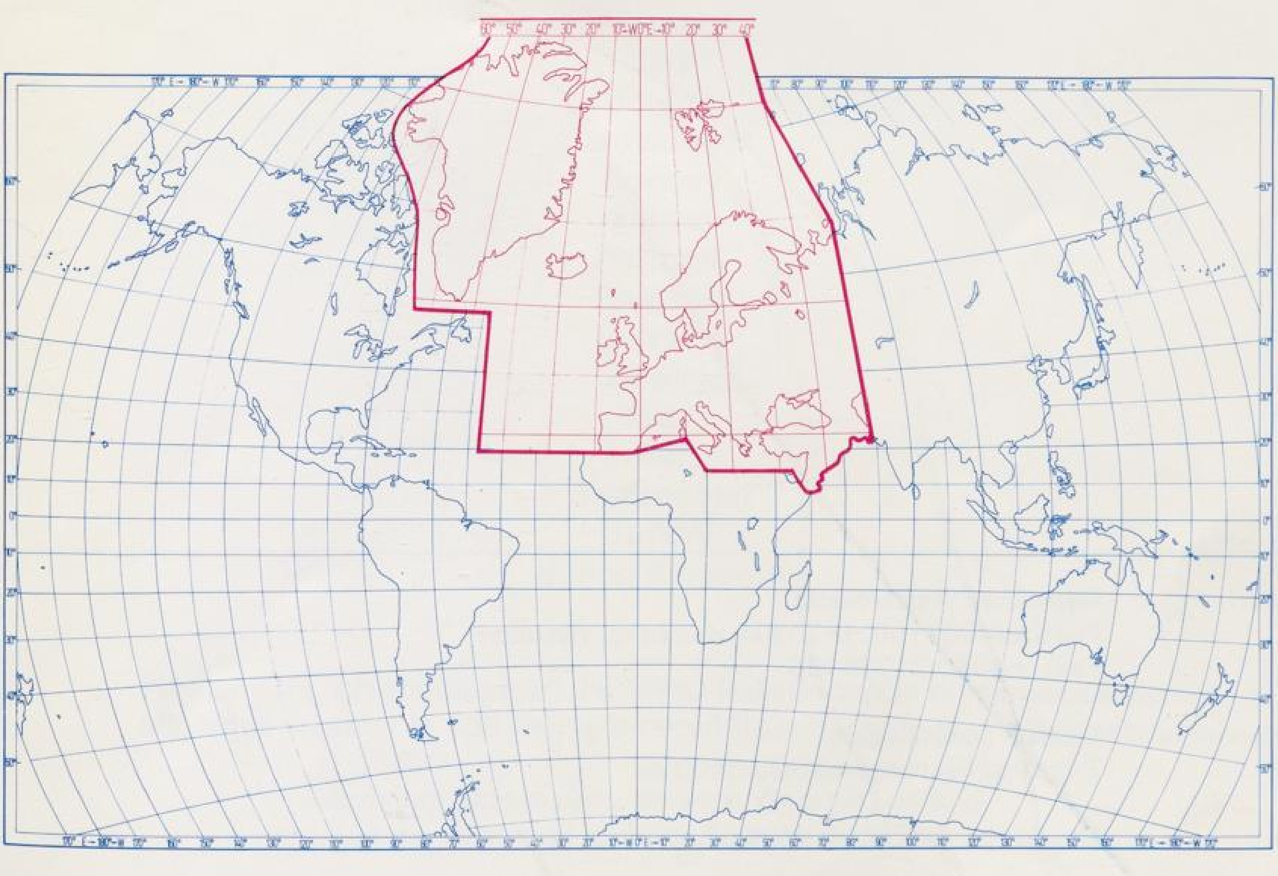
World Meteorological
Organization
World Climate Data
and Monitoring Programme

Deutscher
Wetterdienst

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

1997



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Annual Bulletin on the Climate in WMO Region VI -Europe and Middle East- 1997

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

Austria
Belgium
Bulgaria
Croatia
Cyprus
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Iceland
Israel
Italy
Jordan
Netherlands
Norway
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden
Switzerland
Turkey
United Kingdom

Furthermore, contributions to the WMO Bulletin article on consequences of abnormal weather in 1997 were referred from the following countries:

Armenia, Azerbaijan, Belarus, Georgia, Ireland,
Latvia, Lithuania and the Russian Federation.

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Foreword

I was elected President of Regional Association VI at its twelfth session held in Tel Aviv, Israel from 18 to 27 May 1998. At the session, the Association noted the continued annual publication of the Region VI Climate Bulletin since issueing the first edition covering the year 1994, and expressed the appreciation to Germany and the European Climate Support Network for their support. This regional climate bulletin was also recognized by the WMO Commission for Climatology at its twelfth session, which was held at Geneva in August 1997. The Commission noted that it was the only such publication in any of the six WMO Regions and it encouraged other Regions to follow this example of Region VI.

In June 1997, the need for strengthening the climate observation and monitoring systems was recognized by the United Nations Special General Assembly and was further supported by the Third Conference of the Parties to the UN Framework Convention on Climate Change in Kyoto, Japan, in December. The parties have recognized the important role of continued research and systematic observations to guide their future policies. "Article 5 of the Convention specifically calls upon the Parties to strengthen systematic observations and national scientific and technical research capacities and capabilities." This annual bulletin serves to demonstrate the effectiveness and the value of the observational systems in monitoring climatic anomalies and related impacts in Region VI. Furthermore, the activities section at the end of the bulletin gives some insight into the related research activities in the Region.

The WMO Secretariat has again expressed its pleasure in being able to co-sponsor this publication, which it feels is a significant contribution to the Climate System Monitoring Project of the World Climate Data and Monitoring Programme. The contributions of material from 36 WMO Member countries in the Region and the coordination and preparation of the document by the German Meteorological Service were greatly appreciated.

General Carlo Finizio
President RA VI

Summary

The Bulletin describes, using maps, tables and text, the most important climatological events and anomalies during 1997 in WMO Region VI, which includes the whole of Europe and the Middle East. Where possible, the events are set into an historical context.

It was another warm year in most countries. For the Iberian Peninusula, it was even the warmest on record. Due to the prevailingly dry and sunny weather, it will be remembered as a "good" year in many regions. However, heavy rainfall induced devastating floods in June and July. The most notable being the flooding of river Oder, which affected, primarily, the Czech Republic, Poland and eastern Germany. On the other hand, severe precipitation deficits developed in parts of France, the UK, Denmark and Cyprus.

The climatological review of 1997 is followed by a number of contributions of research institutes, describing activites, project results and initiatives in the field of climatology, as well as results of international conferences on climate during the year.

Annual survey

While 1996 had interrupted the series of warm years, especially in western Europe, 1997 was one of the warmest years of the century in many places (see fig. 3 and 4, page 8). In the southwest, it was even the warmest year on record, warmer than previous warm years, 1990, 1995 and 1989 (see fig. 1, 2 and Table 1). In Portugal, except for June, all months of the year ended with positive temperature anomalies and a record hot spell occurred from February to April. The 1997 mean annual Central England Temperature (CET), starting in 1659, was the 3rd warmest on record, at 10.53 °C, after 1990 and 1949. In south-western and south-eastern France, it was the warmest year since 1949. Only, in the far north- and southeast, 1997 turned out cooler than normal.

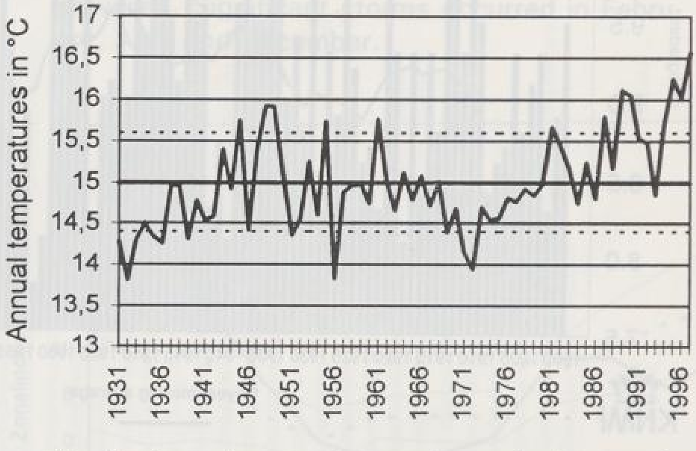


Fig. 1: Annual mean temperatures for Portugal, with long-term mean 1931-1997 (bold line) and standard deviations (dashed lines)
(Source: Instituto de Meteorologia Portugal)

Table 1: Annual temperatures means 1997 and 1961-1990 and standardized anomalies in Spain

(Source: Instituto Nacional de Meteorología, Spain)

Station	T (1997) in °C	T (1961-1990) in °C	T(1997) -T(1961-1990) in standard deviations (σ)
La Coruña	15.8	14.1	3.4 σ
S. Sebastian	14.6	13.0	3.2 σ
Sevilla	19.9	18.2	2.8 σ
P. Mallorca	17.2	15.8	2.3 σ
Madrid	15.6	14.3	2.2 σ

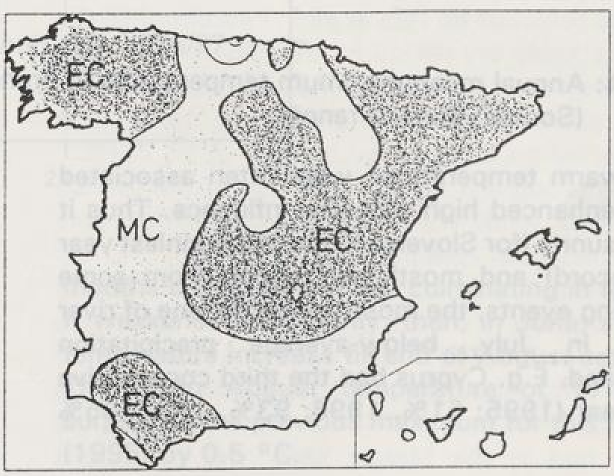


Fig. 2: Annual temperature deciles in Spain for 1997:
EC:extremely warm(9-10),
MC:very warm(8-9)
(Source: Instituto Nacional de Meteorología)

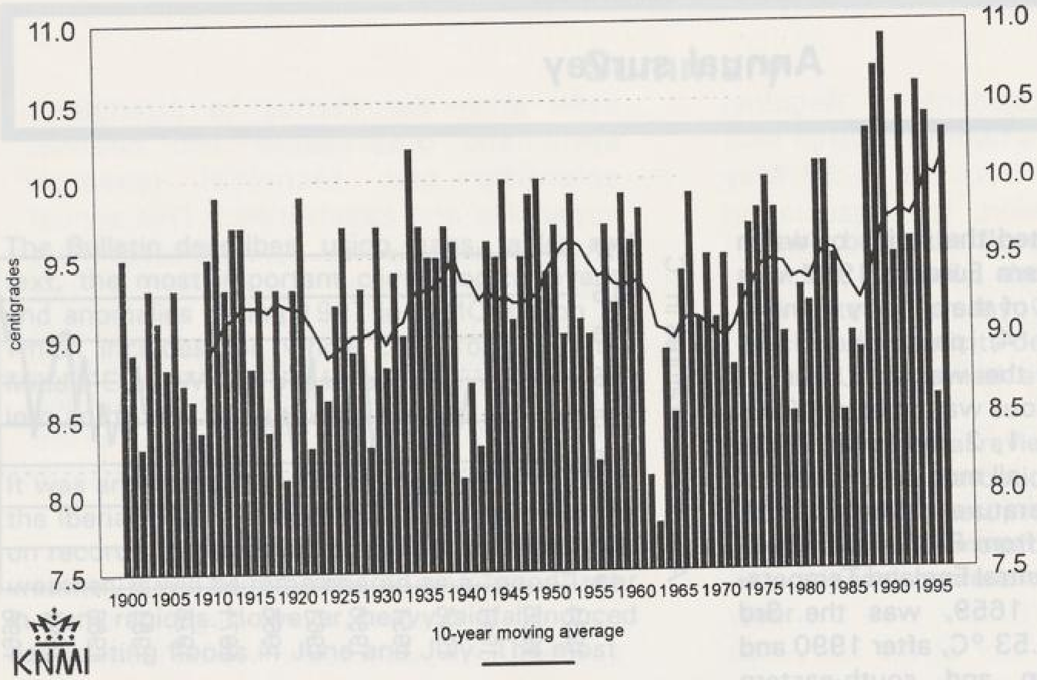


Fig. 3: Annual mean temperatures in De Bilt between 1900 and 1997
(Source: Koninklijk Nederlands Meteorologisch Instituut)

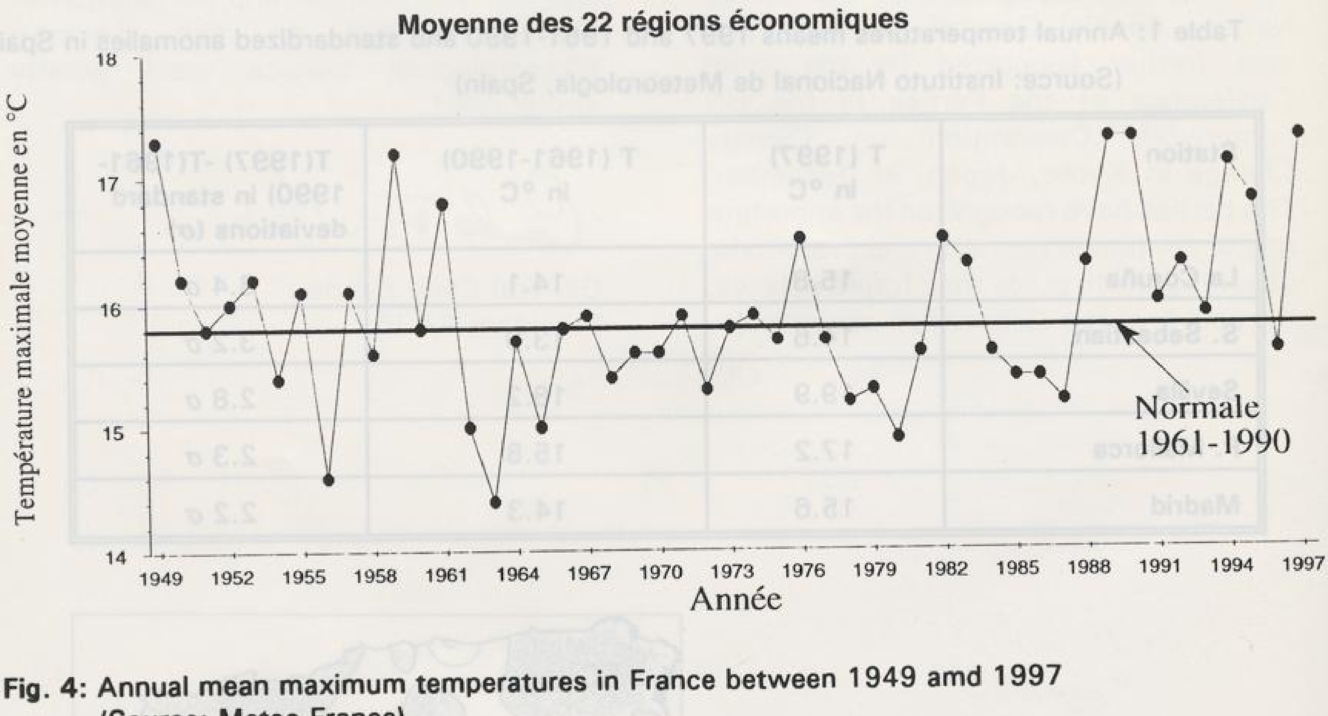


Fig. 4: Annual mean maximum temperatures in France between 1949 amd 1997
(Source: Meteo France)

The warm temperatures were often associated with enhanced high pressure influence. Thus it was sunny (for Slovenia it was the sunniest year on record) and mostly dry. Apart from some flooding events, the most severe the one of river Oder in July, below-average precipitation prevailed. E.g. Cyprus had the third consecutive dry year (1995: 51%, 1996: 93%, 1997: 85% of normal). The worst drought conditions of recent decades seriously affected the water resources of the island. South-western France received only 60% of normal. In Denmark, it was the second consecutive dry year and in February 1998, there was still a deficit of 2-300 mm, which is 30-40% of the normal annual precipitation total. In England and Wales, although February and June were wet, January, March, April, and September were dry so that the 30-month precipitation totals up to September were the lowest on record, with estimated return periods exceeding 200 years in many districts. The Iberian Peninsula again received copious quantities of rain (see fig. 5). Above-normal annual precipitation totals were also recorded from the Black Sea region and northern Norway.

Zonality was lower than normal (see fig. 6). The Atlantic-European zonal index for the latitude belt 35°N to 65°N for the 20°W to 40 °E region, as a measure of the intensity of the circulation was slightly increased, due to extreme conditions in February. Accordingly, storminess was less than usual. In summer, meridional circulation patterns prevailed. Significant storms occurred in February, April and December.

Fig. 5: Precipitation deciles in Spain for 1997, EH:extremely wet(9-10), MH:very wet(8-9), W:wet(7-8), N:normal (4-6), S:dry(2-3), (Source: Instituto Nacional de Meteorología, Spain)

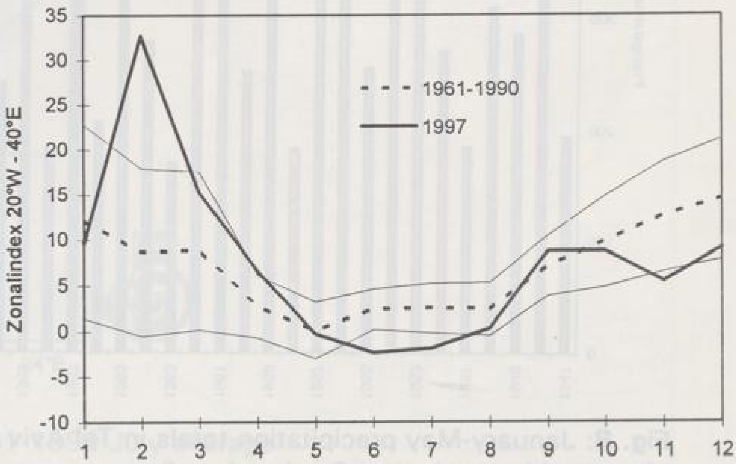


Fig. 6: Mean monthly zonal index for the Atlantic-European region, latitude belt 35°N to 65°N between 20°W and 40°E (Source: Deutscher Wetterdienst)

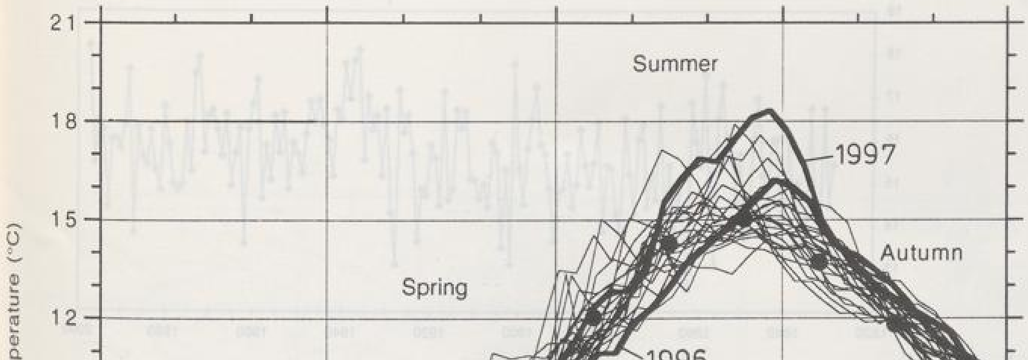


Fig. 7: Seasonal cycle of the areal mean sea surface temperature of the North Sea from Dec. 1996 to Nov. 1997, superimposed on the ensemble of corresponding cycles between 1971 and 1996 (Source: Bundesamt für Seeschiffahrt und Hydrographie, Germany)

An indication of the annual course of temperature in north-western and central Europe can be seen very well in fig. 7, which describes the areal mean sea surface temperatures of the North Sea between 1971 and 1997. In 1997, after a cold start, seasonal warming set in one to two months earlier than usual, culminating in March. It weakened temporarily, then, in June, a rapid temperature increase till end of August set in. The mean August temperature of 17.6 °C surpassed the previous maximum for this month (1995) by 0.5 °C.

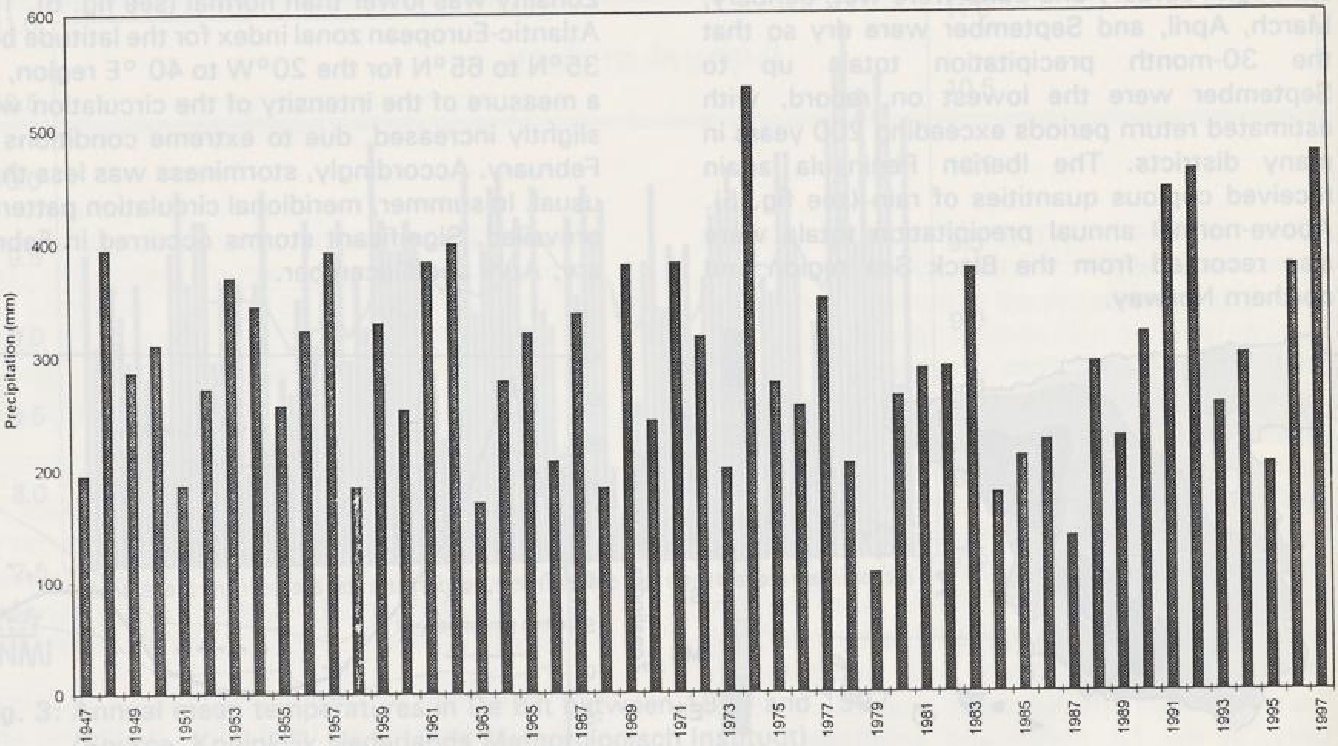


Fig. 8: January-May precipitation totals in Tel Aviv between 1947 and 1997 (Source: Meteorological Service, Israel)

The mild westerly winds during winter and early spring, brought record high snow depths to northern Fennoscandia. January to May were extraordinarily rainy in Israel. In the centre of the country, precipitation totals accumulated to almost 200% of normal. During the last 50 years in Tel Aviv, only one year recorded more rainfall (see fig. 8). In contrast to it, drought prevailed in the southwest of the region.

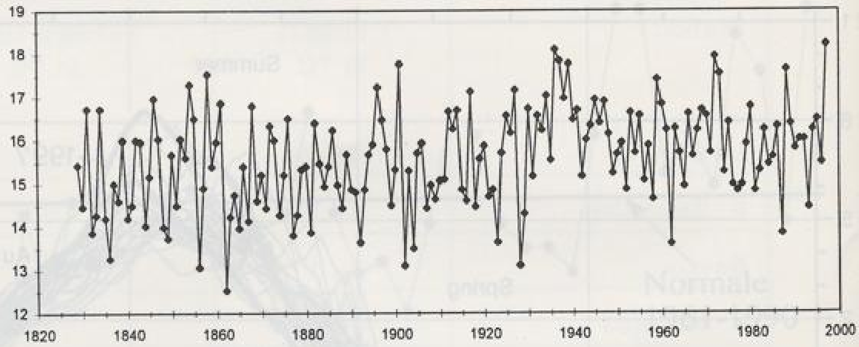


Fig. 9: Mean summer temperature in Helsinki between 1829 and 1997 (Source: Finnish Meteorological Institute)

Madrid received no rain at all in February/March. A remarkably dry period for this time of the year, which never happened before in this century. Also, parts of Switzerland reported the longest dry period on record (1st January to 26 April).
Spring brought a record hot spell to the Iberian peninsula, while weather in the Middle East was extremely cold (see map page 15).
In Fennoscandia, tourists were not the only ones to enjoy the warmest summer ever (see map page 16 and fig. 9). In Norway, due to the sunny and warm weather, the agricultural yield was 11% above normal. While summer was dry in the north and in the Middle East, wet conditions prevailed in the west, in the southern parts of central Europe and around the Black Sea region in July. Summer rainfall for England and Wales exceeded that for the previous winter, an unusual event in relation to the last ten years. Hail and thunderstorms caused high damage in many places during June/July. Heavy rainfall over the south of Poland, Austria, the Czech Republic, Slovakia and eastern Germany (see fig. 10, page 9) engendered the flood of the century of the Oder River with high losses.

Autumn was mostly mild and sunny in the West. Israel reported a good start of the rainy season.

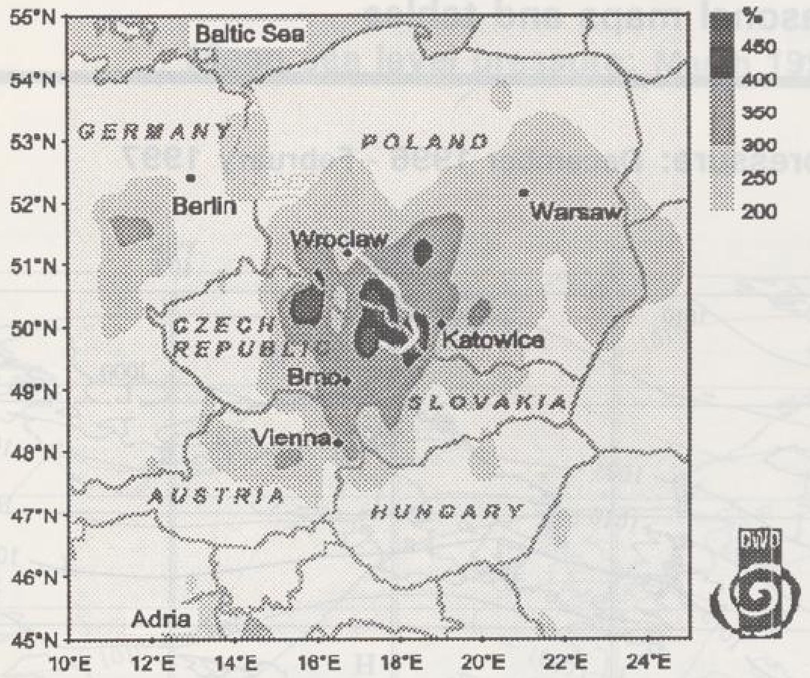
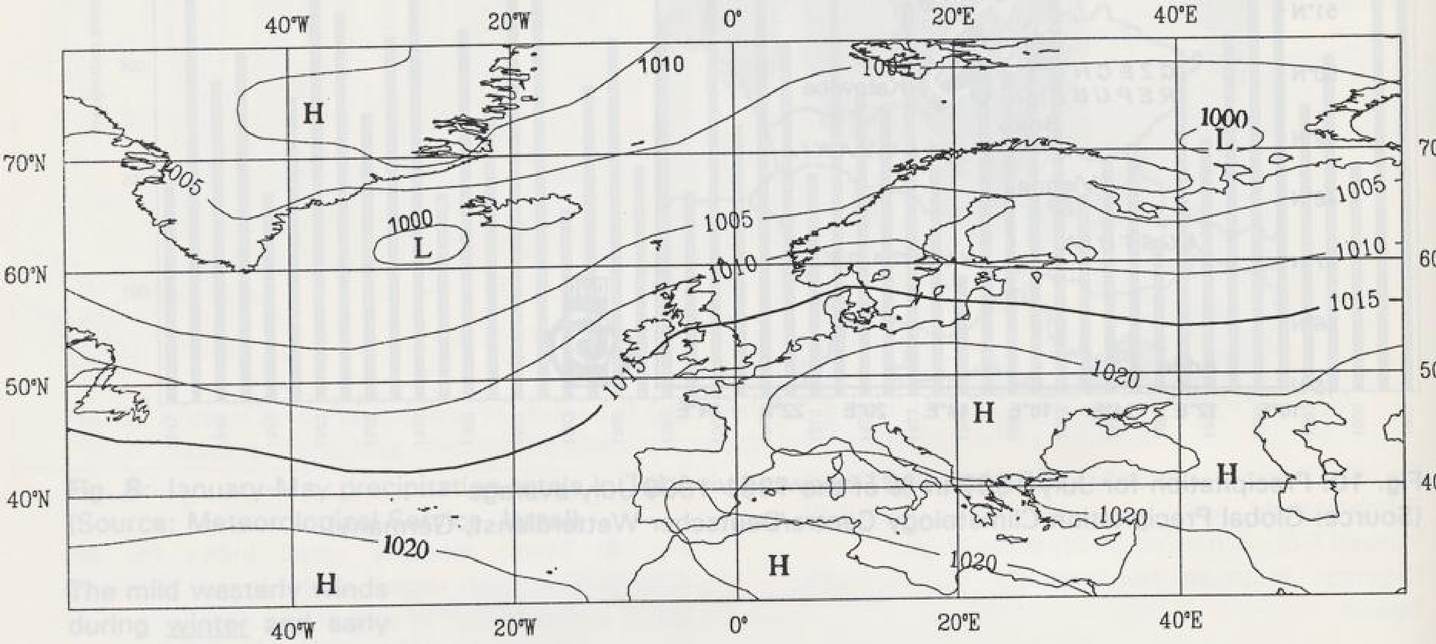


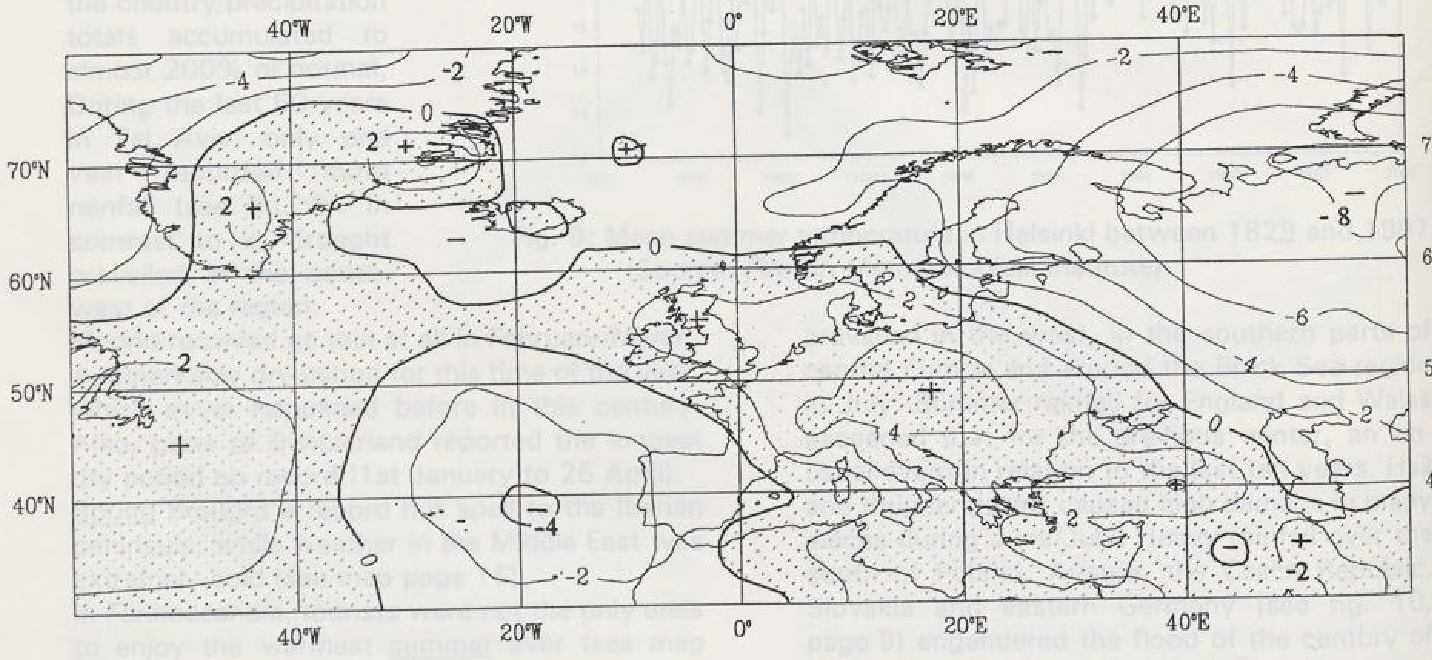
Fig. 10: Precipitation for July 1997 in % of the 1961-1990 July average
(Source: Global Precipitation Climatology Centre/Deutscher Wetterdienst, Germany)

Seasonal maps and tables

Mean sea level pressure: December 1996 - February 1997



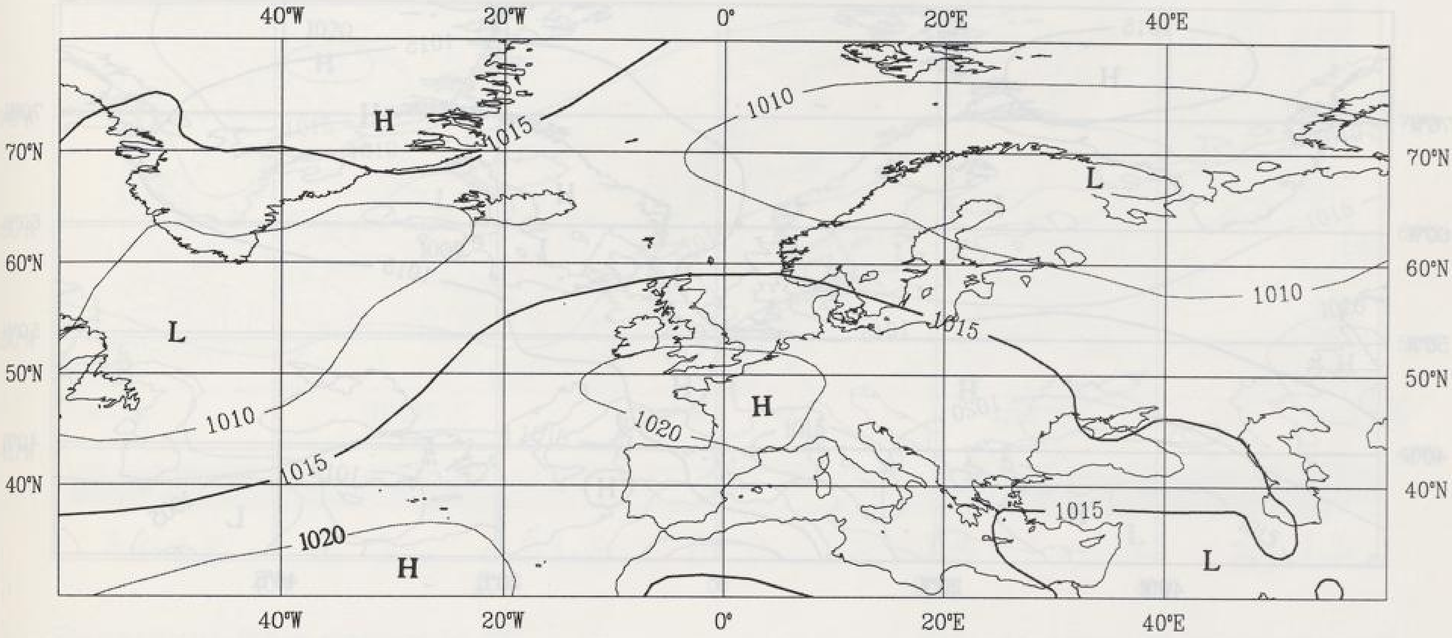
Seasonal averages in hPa



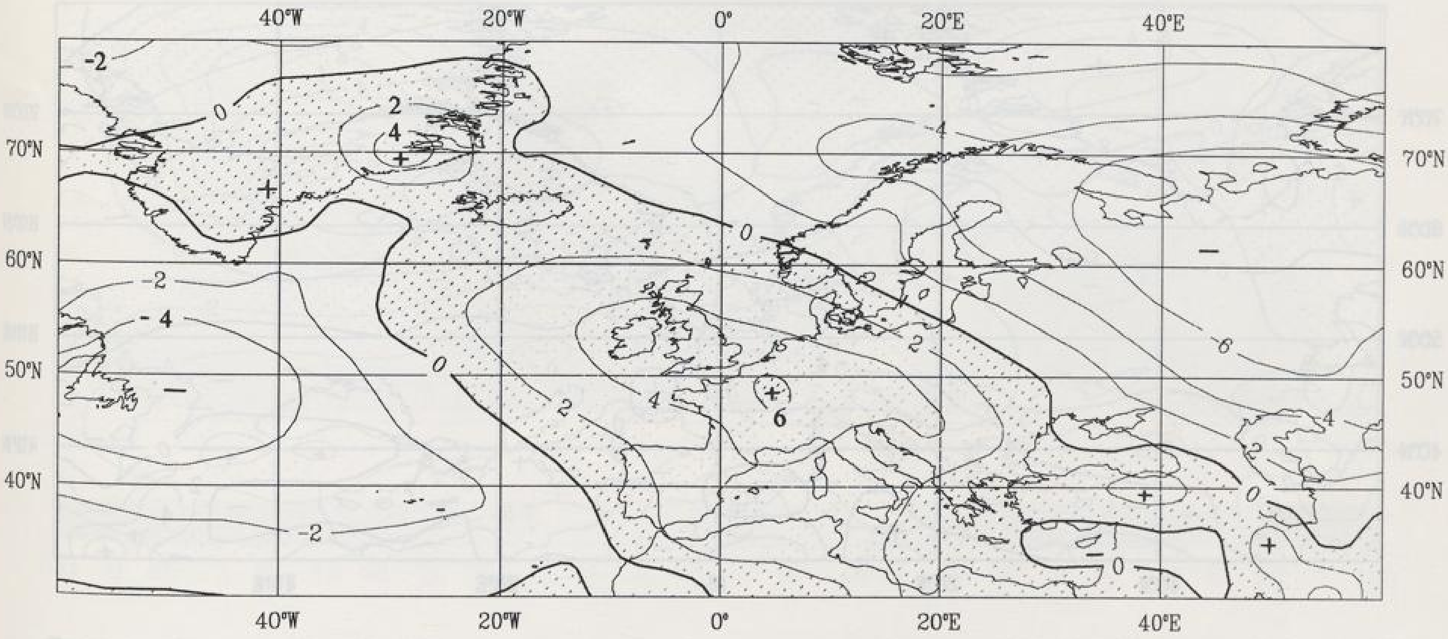
Seasonal anomalies in hPa
Reference Period: 1961-1990

(Source: Deutscher Wetterdienst, Germany)

Mean sea level pressure: March 1997 - May 1997



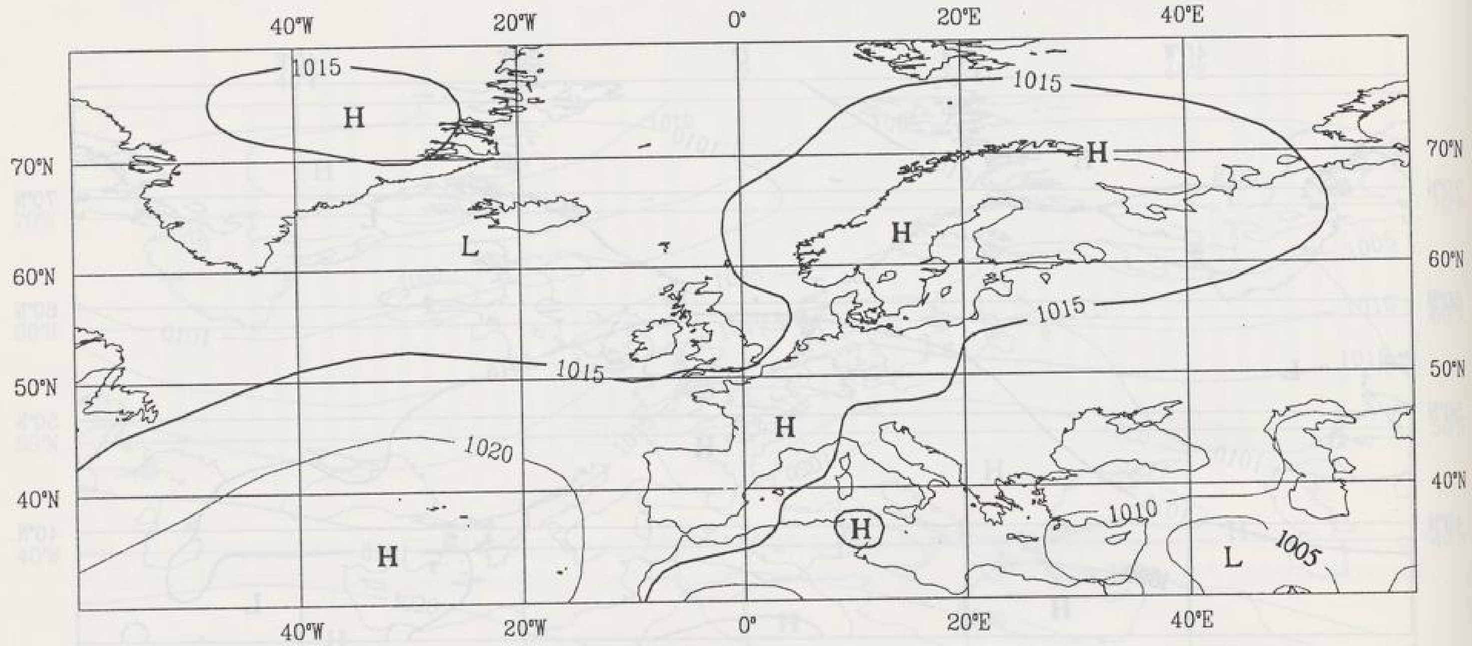
Seasonal averages in hPa



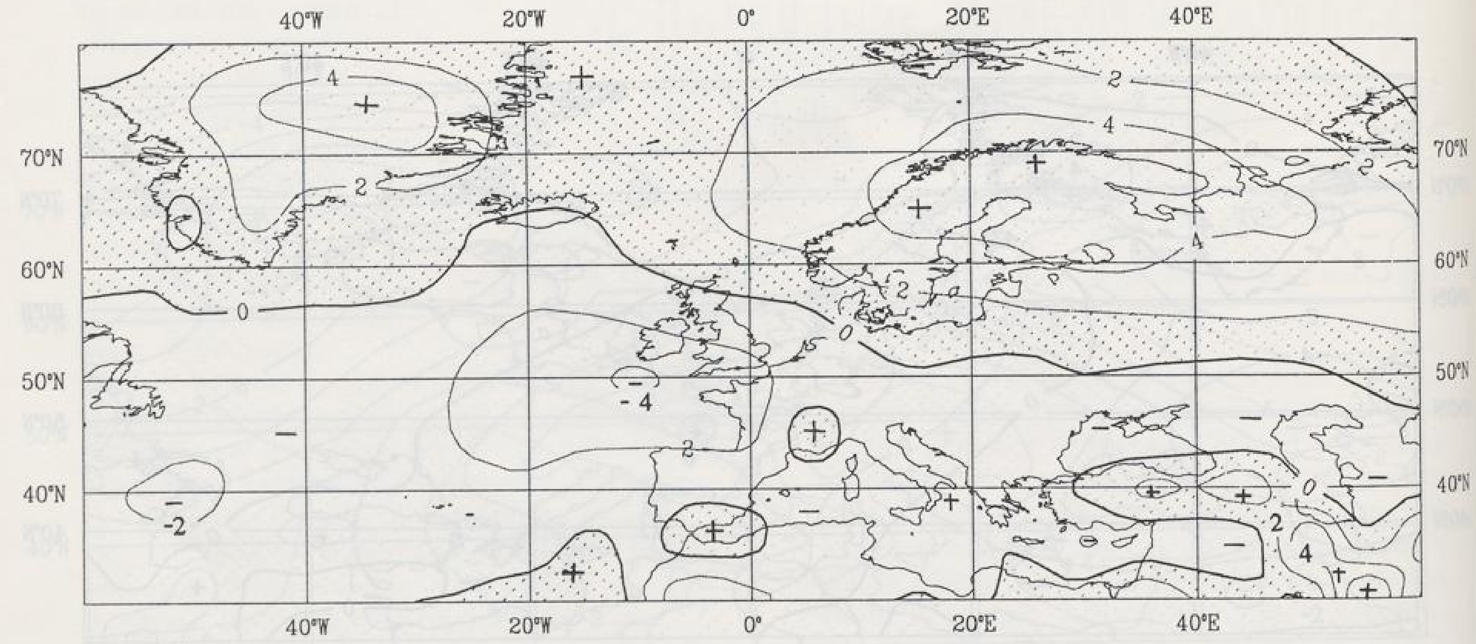
Seasonal anomalies in hPa
Reference period: 1961-1990

(Source: Deutscher Wetterdienst, Germany)

Mean sea level pressure: June 1997 - August 1997



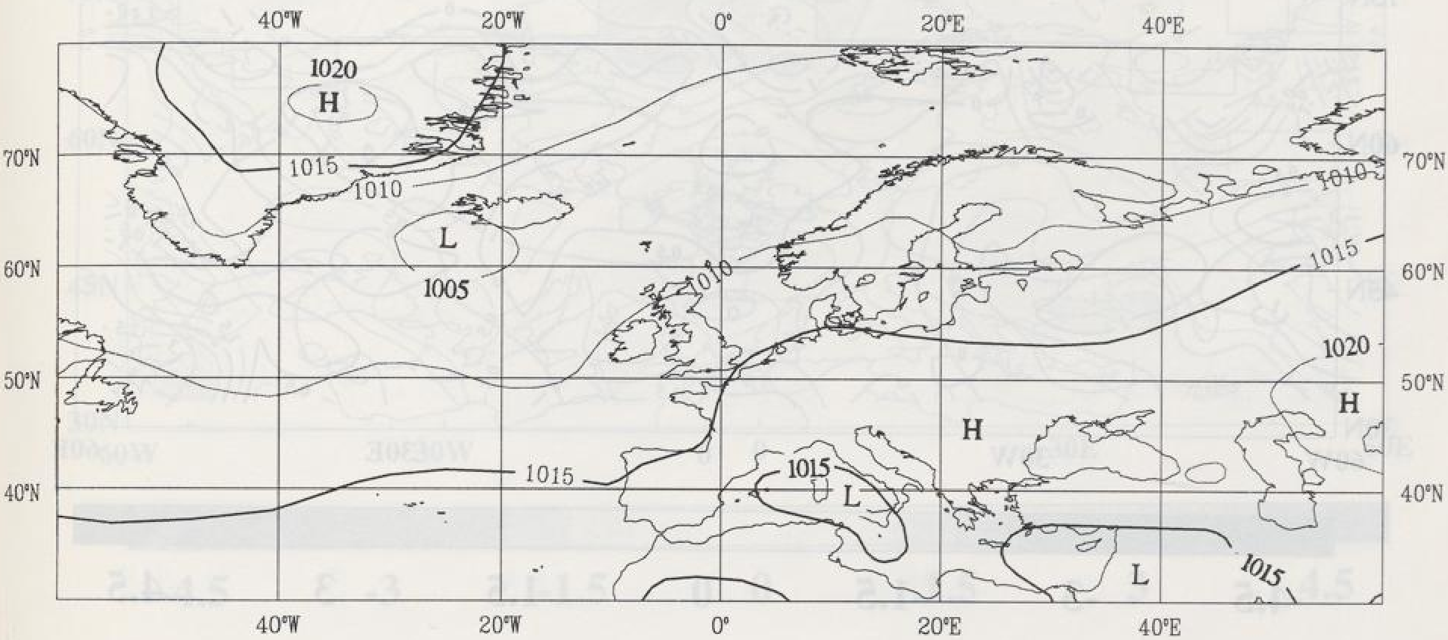
Seasonal averages in hPa



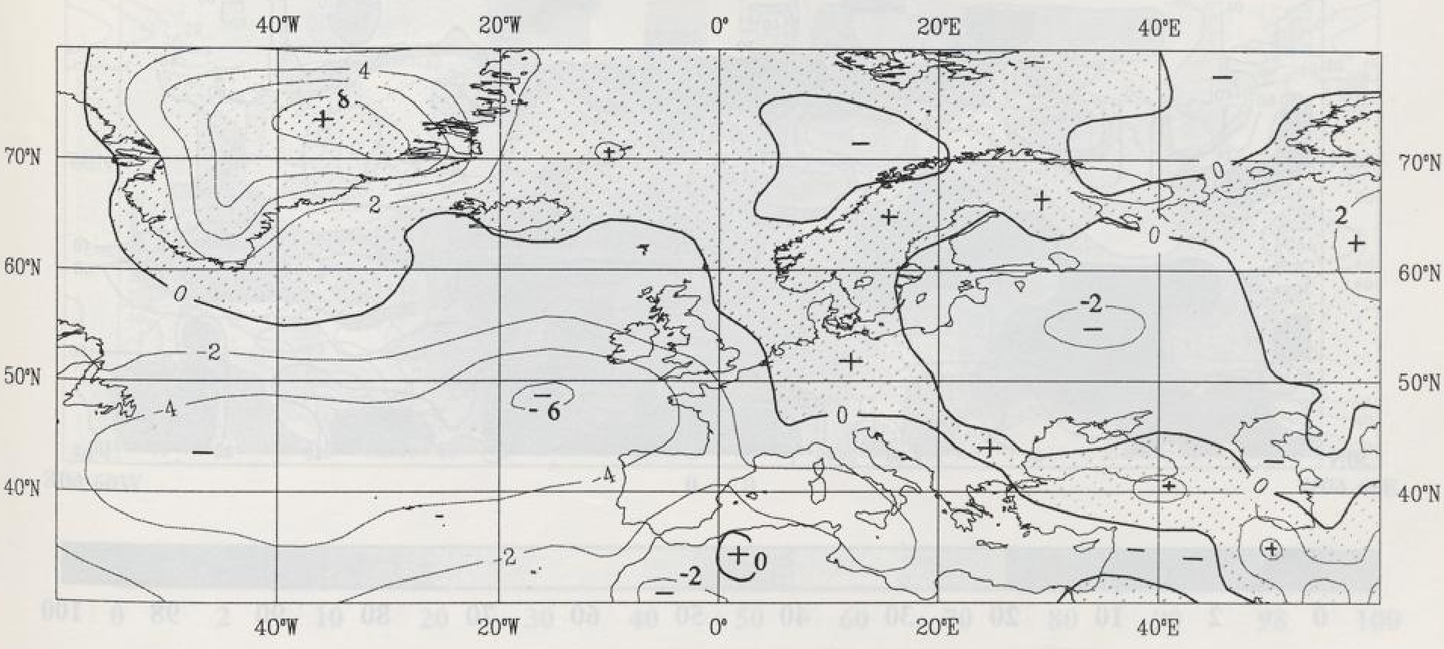
Seasonal anomalies in hPa
Reference period: 1961-1990

(Source: Deutscher Wetterdienst, Germany)

Mean sea level pressure: September 1997 - November 1997



Seasonal averages in hPa

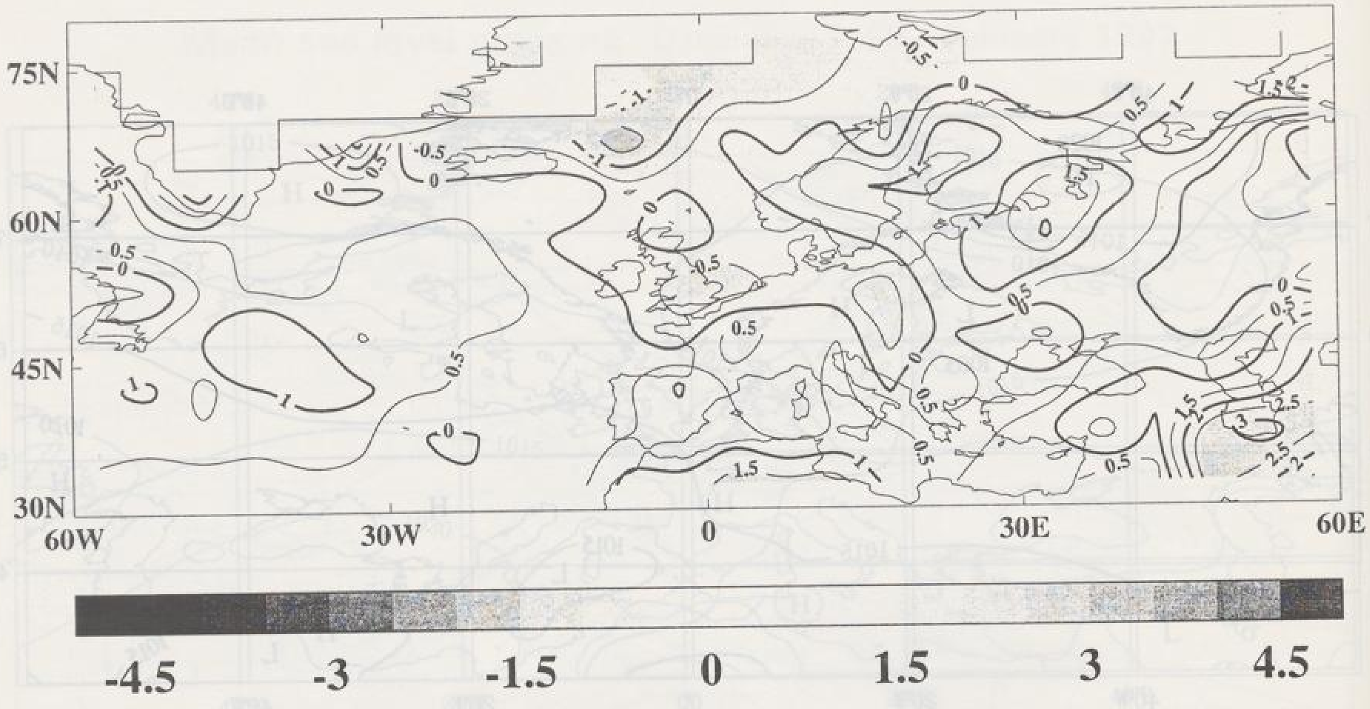


Seasonal anomalies in hPa
Reference period 1961-1990

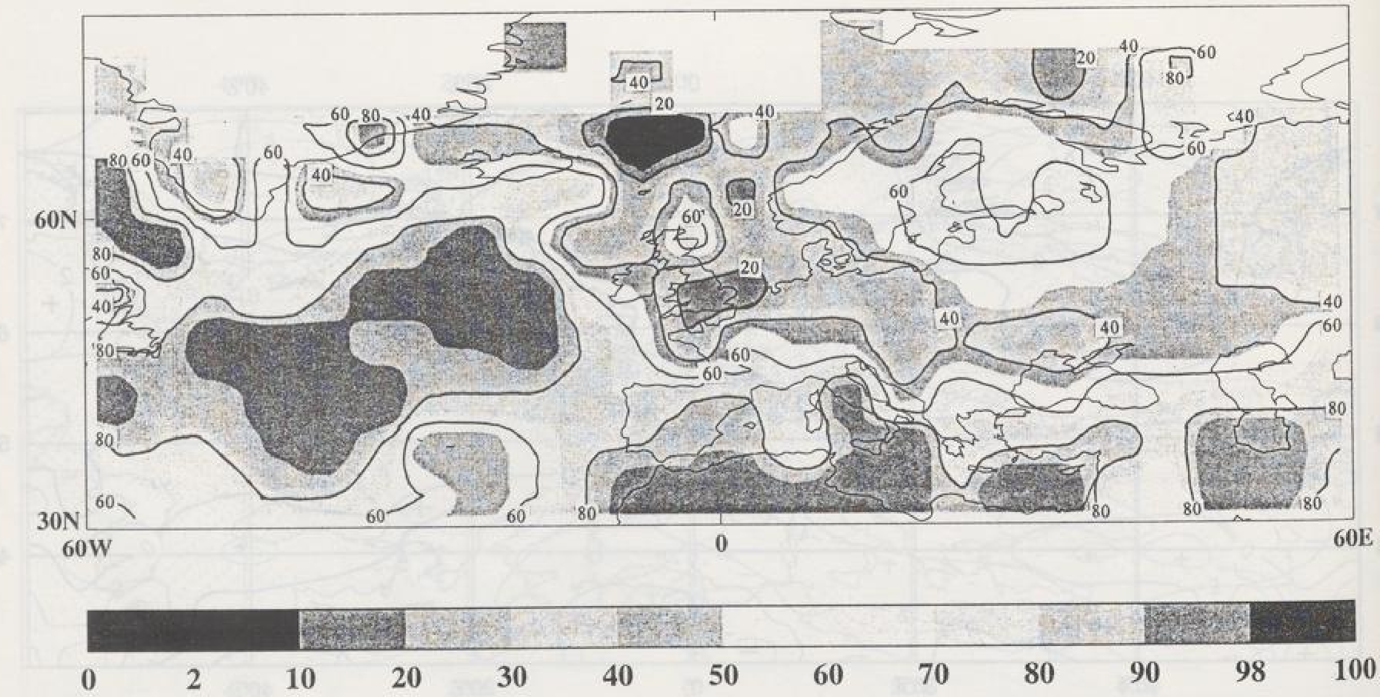
(Source: Deutscher Wetterdienst, Germany)

Surface temperature anomalies: December 1996 - February 1997

Reference period: 1961 - 1990



Departures from normal in °C

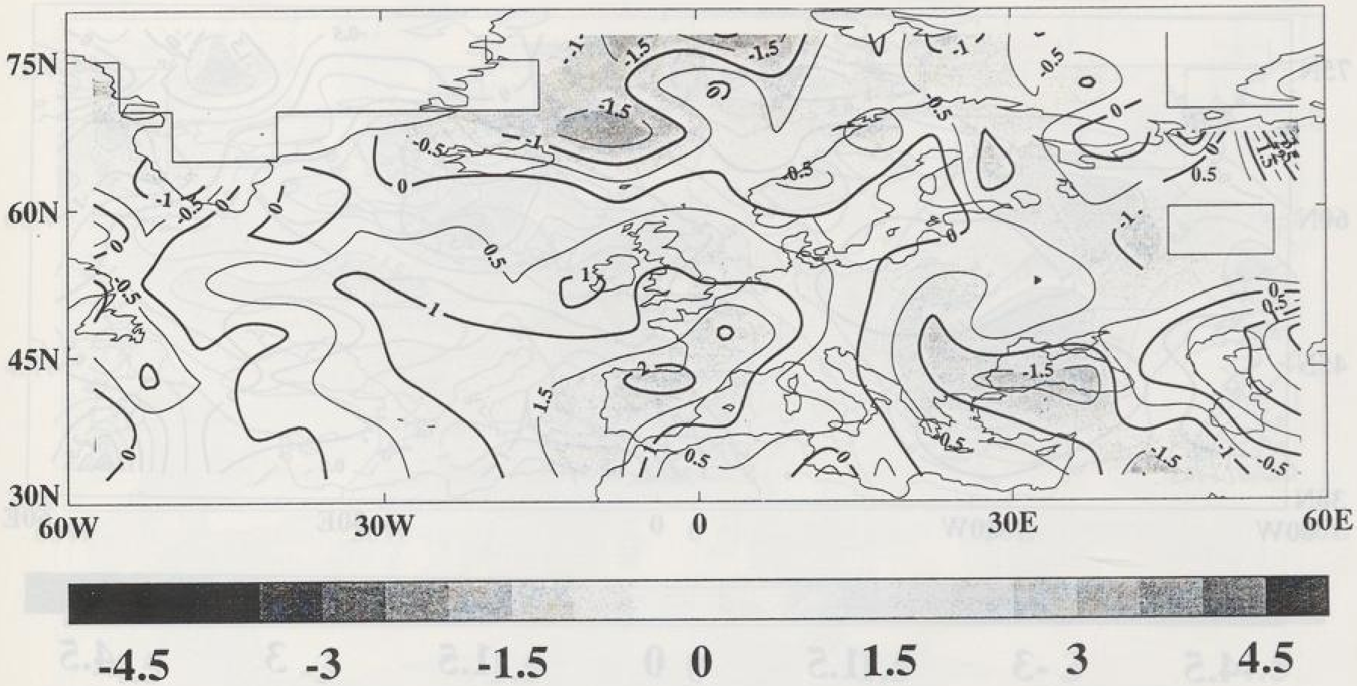


Percentiles (anomalies fitted to gamma distribution)

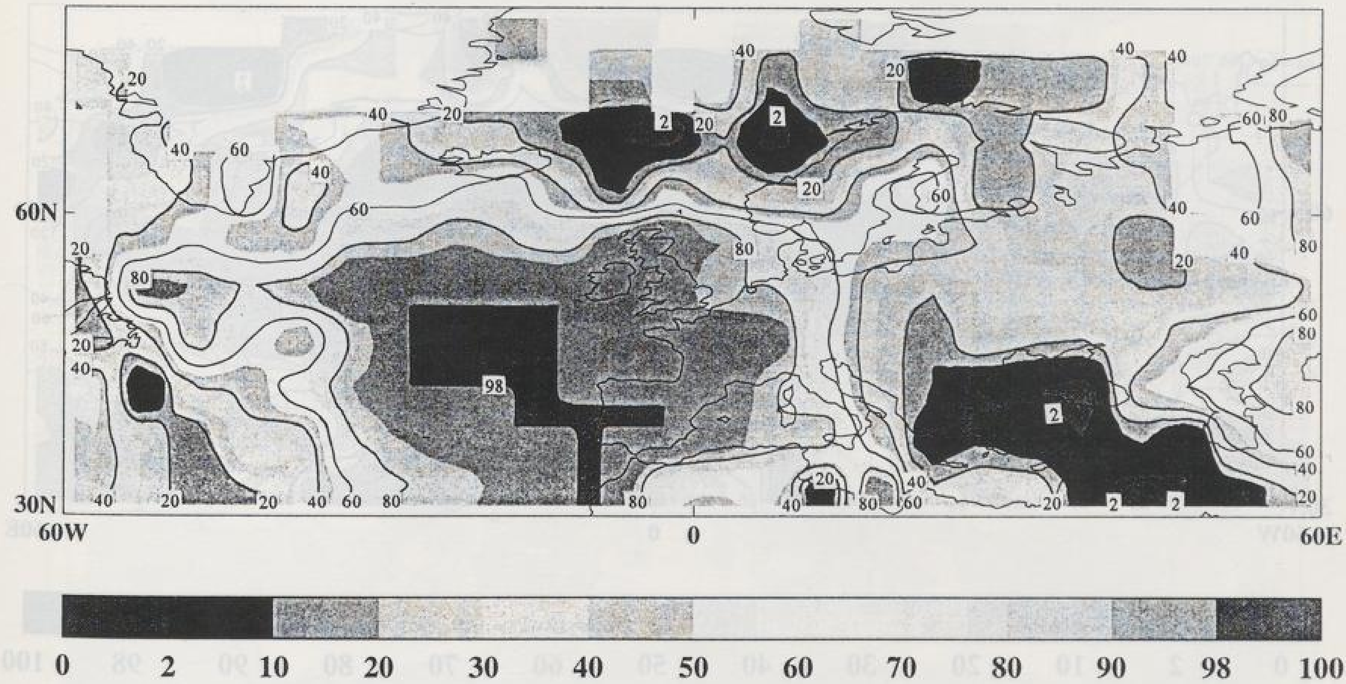
(Source: Hadley Centre, land data provided by the University of East Anglia)

Surface temperature anomalies: March 1997 - May 1997

Reference period: 1961 - 1990



Departures from normal in °C

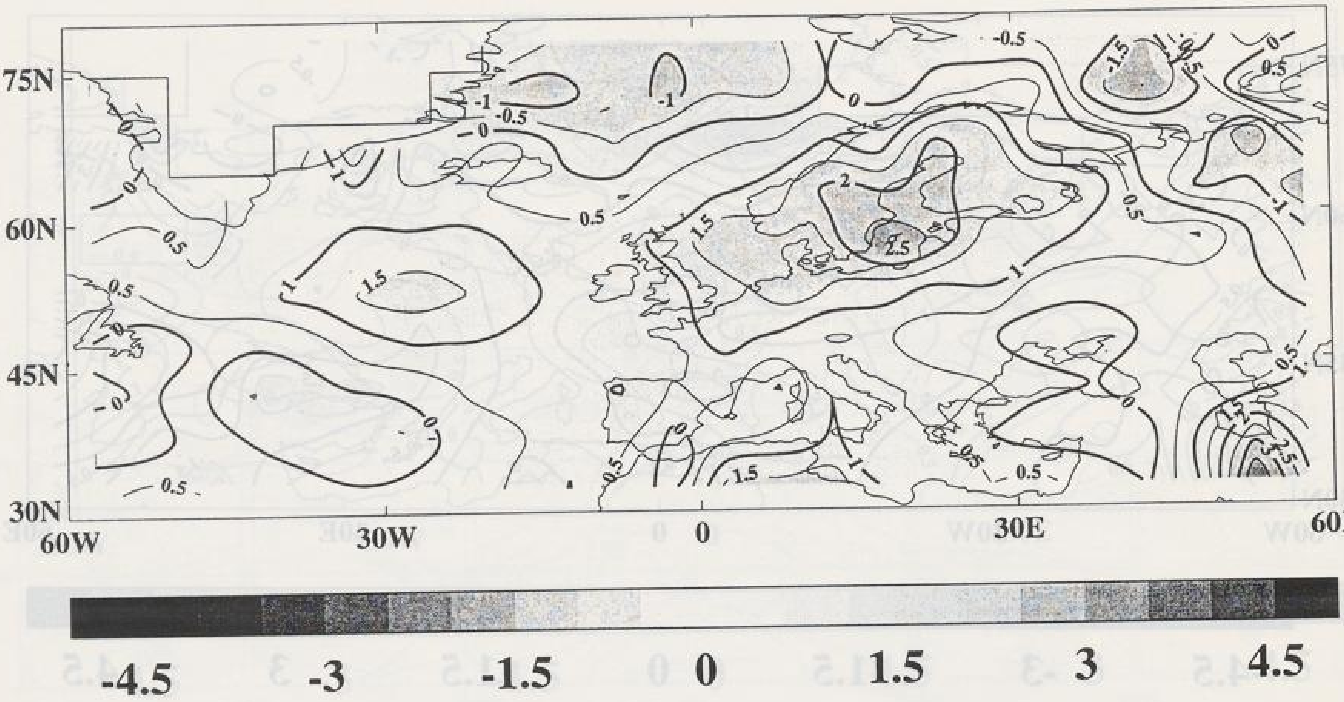


Percentiles (anomalies fitted to gamma distribution)

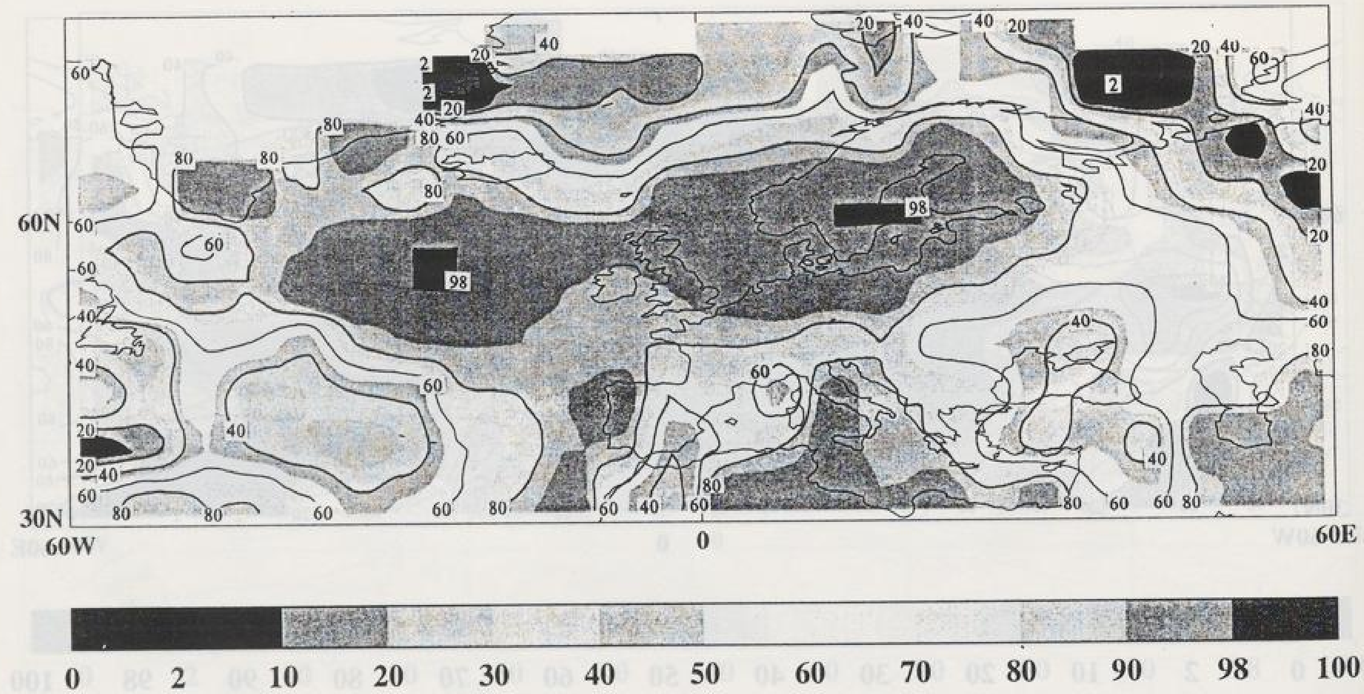
(Source: Hadley Centre, land data provided by the University of East Anglia)

Surface temperature anomalies: June 1997 - August 1997

Reference period: 1961 - 1990



Departures from normal in °C

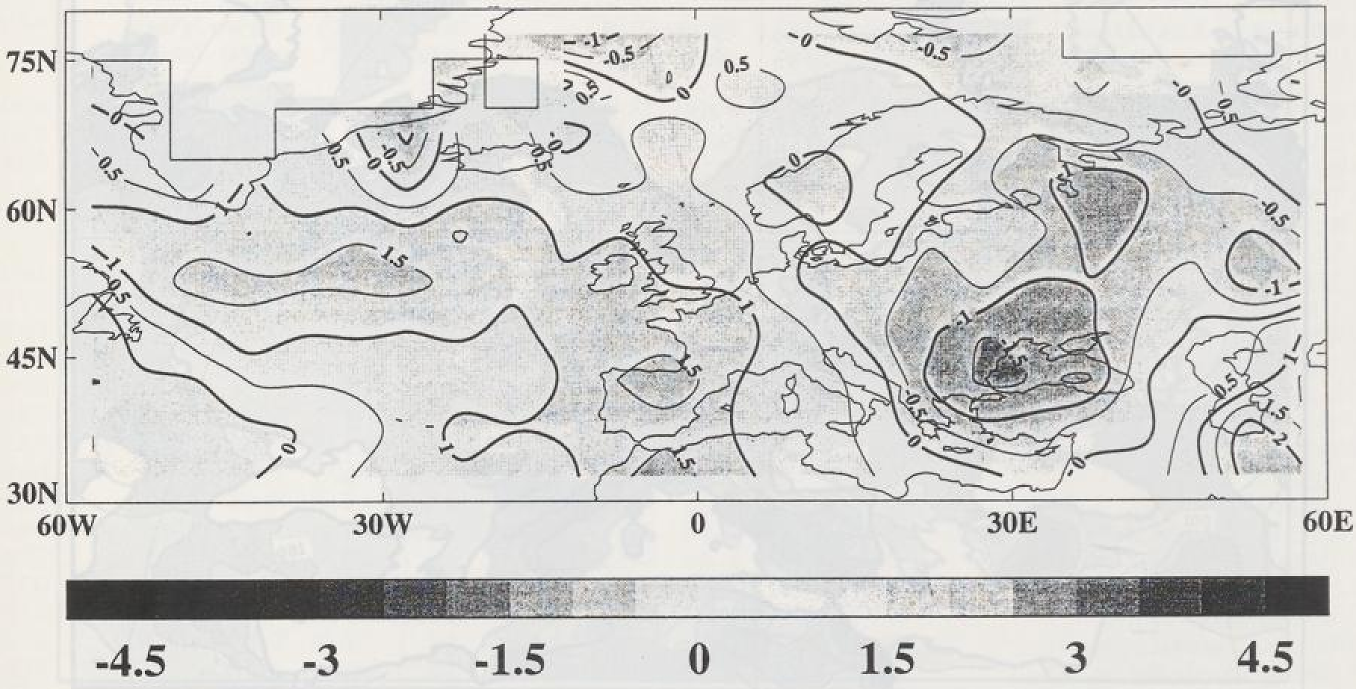


Percentiles (anomalies fitted to gamma distribution)

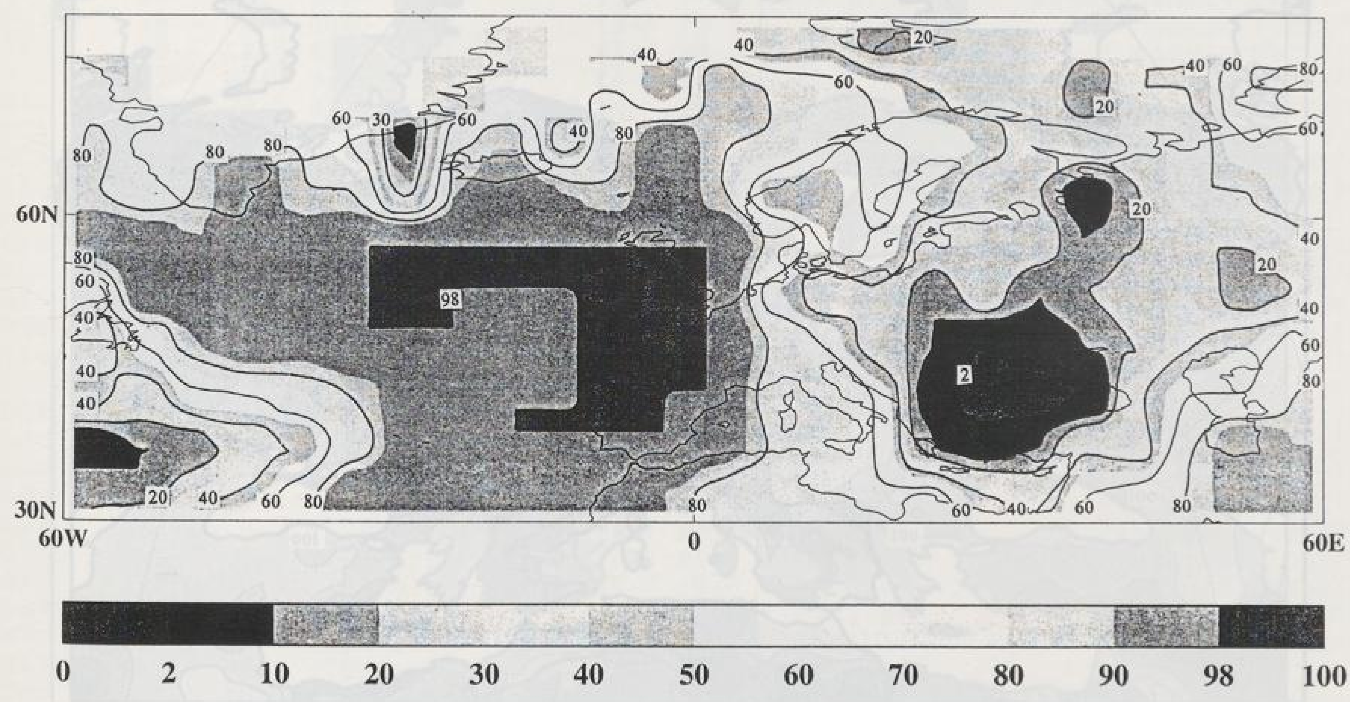
(Source: Hadley Centre, land data provided by the University of East Anglia)

Surface temperature anomalies: September 1997 - November 1997

Reference period: 1961 - 1990



Departures from normal in °C

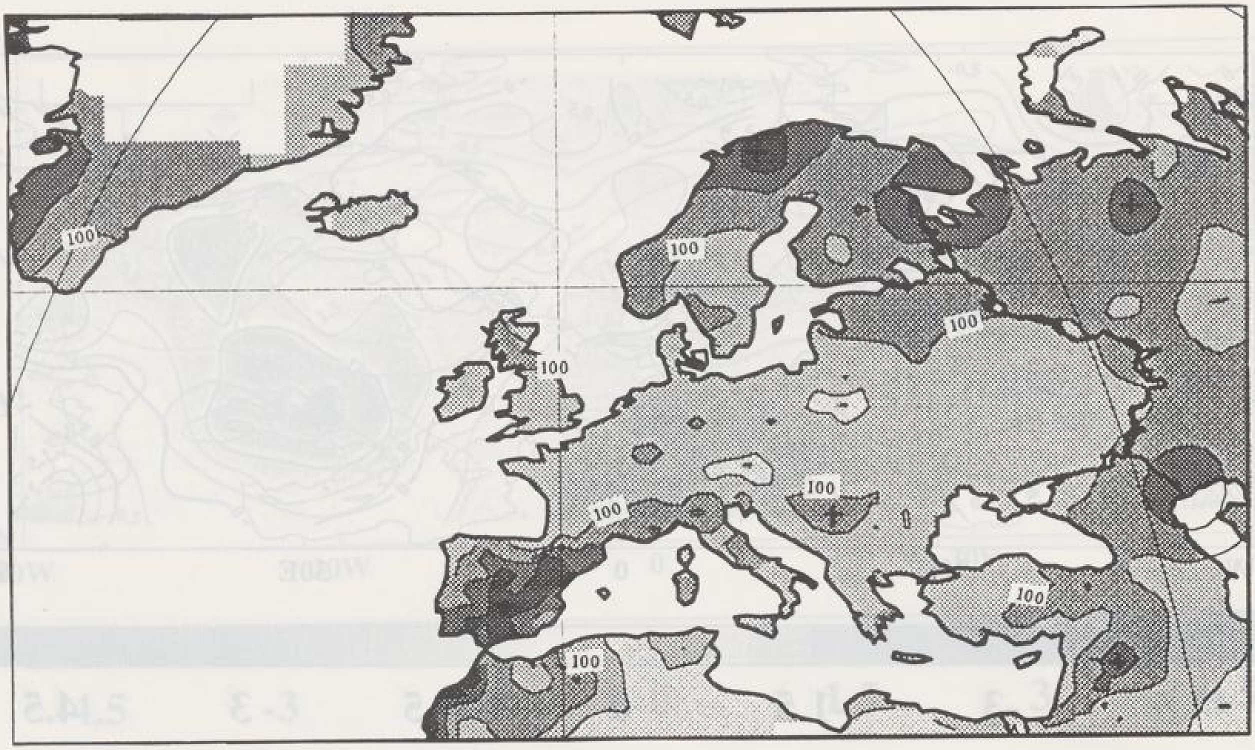


Percentiles (anomalies fitted to gamma distribution)

(Source: Hadley Centre, land data provided by the University of East Anglia)

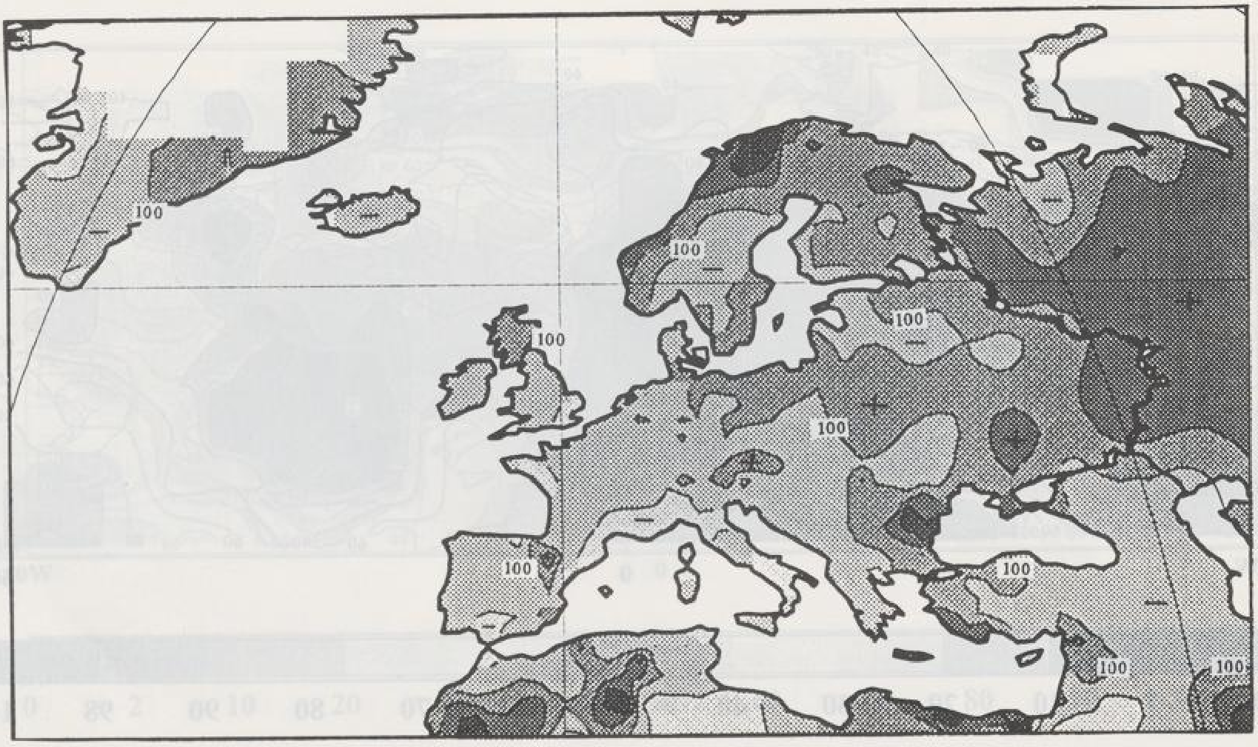
Precipitation in percentage of normal

Reference period: 1961 - 1990



December 1996 - February 1997

Isoline spacing: < 50 %
50 - 100 %
100 -150 %
>200 %

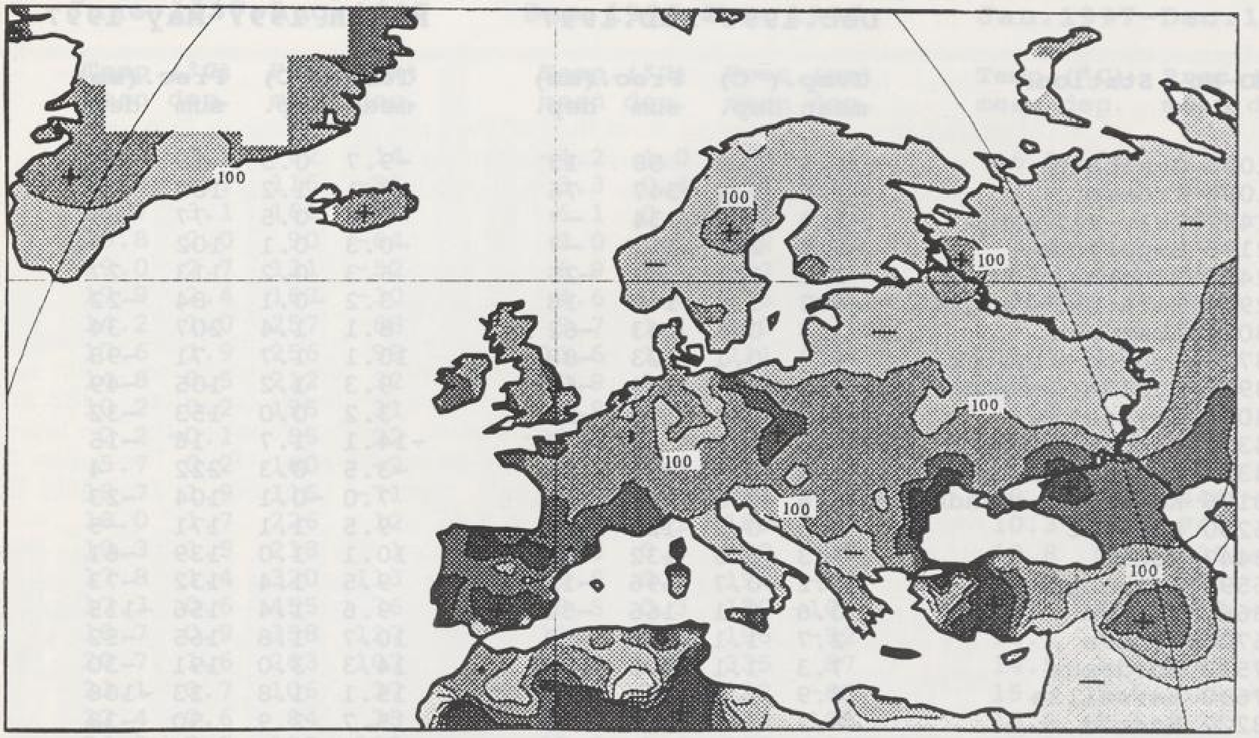


March 1997 - May 1997

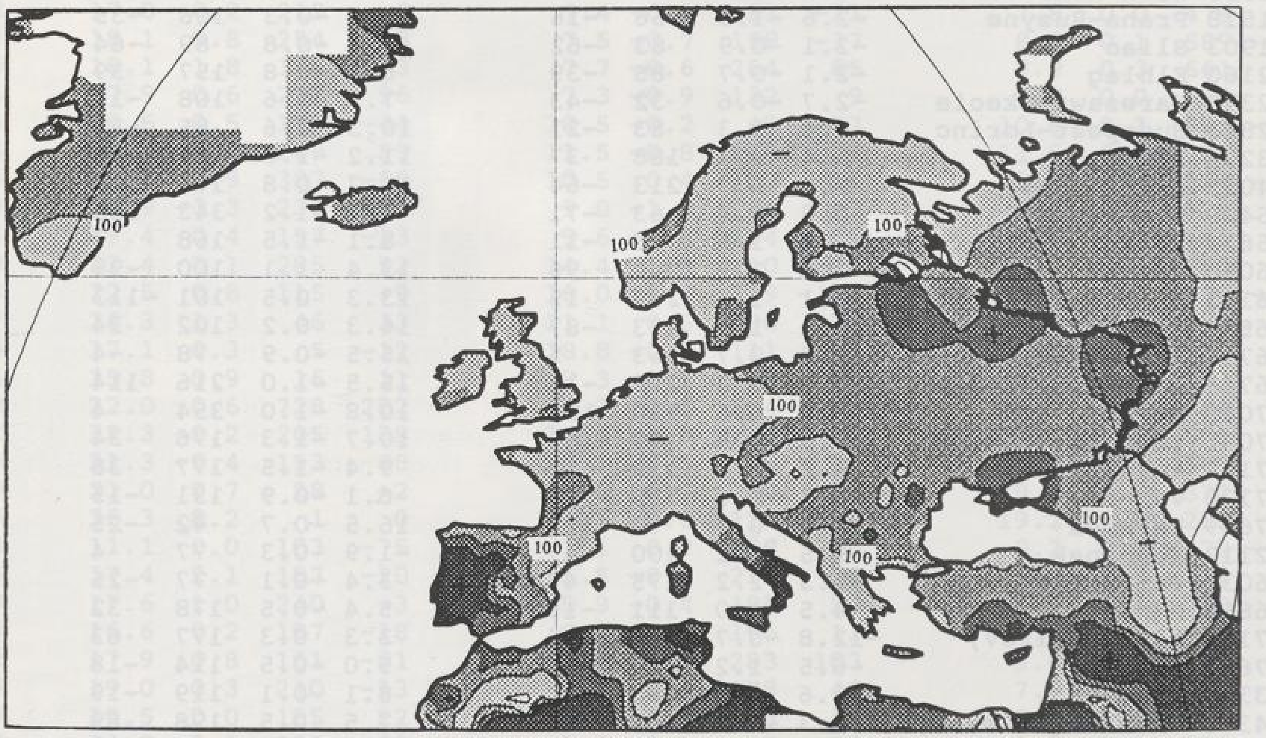
(Source: Global Precipitation Climatology Centre/Deutscher Wetterdienst, Germany)

Precipitation in percentage of normal

Reference period: 1961 - 1990



June 1997 - August 1997



September 1997 - November 1997

(Source: Global Precipitation Climatology Centre/Deutscher Wetterdienst, Germany)

Seasonal and annual temperature means and precipitation sums and their anomalies* for selected stations

WMO-No.	Station	Dec.1996-Feb.1997 Temp.(°C) mean	dep.	Prec.(mm) sum	dep.	March 1997-May 1997 Temp.(°C) mean	dep.	Prec.(mm) sum	dep.
01008	Svalbard	-16.6	-1.8	58	13	-9.7	0.3	16	-23
01025	Tromsø	-4.0	-0.4	347	76	-0.1	-1.2	180	8
01492	Oslo-Blindern	-2.9	0.8	134	-7	5.5	0.5	77	-63
02196	Haparanda	-8.9	2.1	111	-7	-0.3	0.1	102	7
02485	Stockholm-Stadt	-1.2	1.1	87	-25	5.3	0.2	113	27
02974	Helsinki-Vantaa	-4.2	1.8	148	18	3.2	-0.1	84	-22
03091	Aberdeen	3.8	0.6	143	-62	8.1	1.4	207	34
03776	London-Gatwick	4.3	0.1	123	-88	10.1	1.7	71	-98
03967	Dublin(Casement)	5.1	0.4	134	-60	9.3	1.2	105	-49
04030	Reykjavik	0.1	0.2	198	-27	3.2	0.0	153	-32
04320	Danmarkshavn	-24.6	-1.5	42	7	-14.1	1.7	16	-15
04360	Angmagssalik	-7.0	0.4	386	80	-3.5	0.3	222	4
06186	København-Landb.	0.6	-0.5	49	-91	7.0	-0.1	104	-23
06260	De Bilt	1.9	-0.8	125	-70	9.5	1.1	171	-5
06447	Uccle	2.3	-0.8	132	-65	10.1	1.0	139	-61
06590	Luxembourg	0.2	-0.7	196	-13	9.5	1.4	132	-73
06660	Zürich	0.6	0.1	166	-54	9.6	1.4	156	-115
06700	Genève	2.7	1.1	238	-10	10.7	1.8	165	-52
07510	Bordeaux	7.3	1.1	175	-105	14.3	3.0	191	-30
07650	Marseille	8.9	1.9	154	2	15.1	1.8	23	-108
08222	Madrid	8.2	1.6	224	83	15.7	2.9	90	-38
08314	Mahon/Menorca	12.4	1.3	146	-48	15.8	1.6	52	-75
08495	Gibraltar	14.7	0.9	865	498	18.6	2.0	67	-103
08515	St.Maria/Acores	14.6	0.0	308	27	16.2	0.7	170	6
08535	Lisboa	11.6	-0.2	443	114	17.7	2.3	159	-13
10384	Berlin-Tempelhof	0.1	-0.6	83	47	9.0	0.1	155	21
11035	Wien-Hohe Warte	-0.3	-0.8	60	-64	9.8	-0.3	225	73
11518	Praha-Ruzyne	-2.6	-1.3	56	-16	7.5	-0.3	108	-35
11903	Sliac	-3.1	-0.9	83	-62	7.6	-0.8	89	-64
12160	Elblag	-2.1	-0.7	85	-39	6.4	-0.8	157	39
12375	Warszawa-Okecie	-2.7	-0.6	32	-43	7.1	-0.6	108	-11
12843	Budapest-Lorinc	-0.4	-0.3	83	-21	10.3	-0.6	85	-37
13274	Beograd	2.4	0.7	188	37	11.2	-1.0	151	-29
14015	Ljubljana	0.9	0.7	213	-64	10.7	0.8	176	-114
15420	Bucuresti	-0.8	-0.4	63	-71	9.7	-1.2	343	189
15614	Sofia	1.4	1.6	88	-11	8.1	-1.5	168	7
16090	Verona	4.2	1.7	242	96	13.4	1.1	100	-99
16158	Pisa	8.1	1.5	249	15	13.3	0.5	101	-113
16597	Luqa/Malta	14.1	1.2	173	-87	16.3	0.2	102	34
16716	Athens(Hellinikon)	11.7	0.7	163	5	15.5	-0.9	78	-4
16754	Heraklion/Kreta	12.9	0.3	228	-13	15.5	-1.0	216	114
17040	Rize	7.6	0.6	830	198	10.8	-1.0	354	4
17062	Istanbul-Goztepe	7.5	0.9	179	-109	10.7	-1.3	176	34
17130	Ankara/Central	3.2	1.7	119	-13	9.4	-1.5	177	38
17170	Van	-0.3	2.6	112	9	6.1	-0.9	131	-15
17609	Larnaca	12.8	0.7	79	-119	16.5	-0.7	42	-25
22113	Murmansk	-9.5	1.2	100	7	-1.9	-0.3	77	4
26038	Tallina	-2.3	2.2	175	49	3.4	-0.1	77	-25
26850	Minsk	-4.5	1.0	111	-16	5.4	-0.5	178	32
27199	Wjatka(Kirov)	-12.8	-0.7	106	-5	3.3	0.3	177	63
27612	Moskva	-6.5	1.2	107	-27	5.0	-0.5	114	-18
33345	Kiev	-3.6	0.3	82	-57	8.1	-0.1	119	-19
34300	Charkov(Kharkiv)	-5.3	-0.2	87	-39	7.5	-0.5	198	89
34880	Astrahan'	-4.4	-0.3	74	36	10.7	0.5	48	-8
40080	Damascus	7.0	-0.2	108	-5	14.7	-1.1	77	36
40100	Beyrouth	15.0	1.0	345	-187	17.8	0.0	169	-22
40180	Tel Aviv(Airport)	13.7	0.7	371	-14	17.9	-0.2	163	75
40270	Amman	9.2	0.5	176	18	15.4	-0.4	60	-13
60030	Las Palmas/Gr.Can	19.5	1.7	45	-29	21.0	2.0	43	24

* reference period: 1961-1990

WMO-No.	June 1997-Aug.1997 Temp.(°C) mean	dep.	Prec.(mm) mean	dep.	Sep.1997-Nov.1997 Temp.(°C) mean	dep.	Prec.(mm) mean	dep.	Jan.1997-Dec.1997 Temp.(°C) mean	dep.	Prec.(mm) mean	dep.
01008	4.1	-0.2	62	14	-4.2	1.0	55	4	-6.1	0.4	218	35
01025	11.5	0.9	116	-91	3.3	0.4	313	-10	3.0	0.2	923	-50
01492	18.7	3.1	161	-78	6.1	0.1	211	-38	7.1	1.4	581	-188
02196	15.8	2.0	90	-64	2.0	-0.1	202	17	2.4	1.2	500	-52
02485	19.0	2.7	131	-52	6.9	-0.2	157	-1	7.7	1.2	495	-44
02974	17.9	2.4	167	-30	4.6	-0.6	176	-42	5.5	1.0	564	-87
03091	14.2	1.0	257	68	9.7	1.1	308	87	9.2	1.2	946	158
03776	17.6	1.9	256	99	11.6	1.2	231	14	11.1	1.5	761	7
03967	14.8	0.5	212	32	10.9	0.9	158	-49	10.2	0.9	649	-86
04030	10.2	0.2	195	31	5.8	1.5	229	3	5.0	0.6	835	35
04320	2.2	-0.1	55	22	-12.6	-0.3	52	19	-11.9	0.4	194	62
04360	5.7	0.2	160	-2	0.1	0.9	299	53	-1.1	0.6	1039	107
06186	18.7	1.9	115	-71	9.1	-0.6	157	-26	9.1	0.4	444	-192
06260	18.0	1.7	226	12	10.2	0.1	180	-40	10.3	0.9	744	-61
06447	18.3	1.5	218	1	10.8	0.3	170	-35	10.8	0.8	701	-117
06590	17.8	1.4	320	113	9.6	0.6	192	-28	9.6	1.0	893	52
06660	17.3	0.6	455	76	9.5	0.3	150	-101	9.5	0.9	986	-135
06700	18.7	0.9	358	127	11.2	1.3	196	-52	10.9	1.4	931	-13
07510	20.7	1.6	263	107	15.2	1.9	335	87	14.5	2.0	1105	200
07650	23.1	0.7	106	37	17.0	1.6	122	-60	15.9	1.4	389	-145
08222	22.4	-0.6	84	35	16.3	1.4	244	105	15.6	1.3	573	116
08314	24.1	0.8	175	129	19.8	1.4	283	67	18.0	1.3	595	12
08495	23.0	0.0	8	-10	20.9	1.4	330	110	19.3	1.1	799	24
08515	20.4	-0.2	135	48	20.3	0.9	345	102	18.0	0.5	937	162
08535	20.9	-0.9	84	52	19.0	0.7	581	361	17.4	0.6	1141	388
10384	20.0	1.8	166	-22	9.3	-0.6	67	-64	10.0	0.6	528	-56
11035	19.3	0.3	323	122	9.6	-0.5	120	-16	10.0	0.1	753	140
11518	17.0	0.2	212	3	7.4	-0.8	81	-21	7.8	0.0	479	-47
11903	18.1	0.8	254	38	7.5	-0.7	158	-17	8.0	0.1	589	-100
12160	18.1	1.8	136	-133	7.7	-0.6	264	85	7.9	0.3	661	-29
12375	17.9	0.6	298	96	7.3	-0.9	132	9	7.8	0.0	592	73
12843	20.6	0.5	122	-44	10.5	-0.2	49	-77	10.6	0.2	306	-212
13274	21.3	0.3	269	59	11.5	-0.8	168	19	11.8	0.0	750	60
14015	19.8	0.9	387	-66	10.5	0.4	353	-25	10.8	1.0	1224	-174
15420	20.9	-0.3	235	36	9.0	-1.9	164	41	9.7	-0.9	825	230
15614	19.4	0.4	157	-23	9.6	-0.8	204	81	9.5	-0.2	640	77
16090	22.4	0.1	285	52	14.4	1.4	110	-105	13.7	1.2	723	-70
16158	22.5	0.8	115	-9	16.0	0.9	229	-108	15.0	1.0	675	-234
16597	26.3	1.3	46	33	21.1	0.5	550	337	19.4	0.8	897	343
16716	27.1	0.3	5	-12	18.8	-0.9	111	-1	18.2	-0.3	388	19
16754	25.8	0.9	16	11	19.3	-0.5	118	-35	18.3	-0.1	531	30
17040	22.0	0.6	728	282	15.7	0.2	684	-60	13.9	-0.1	2600	421
17062	22.3	-0.2	205	138	14.5	-1.0	283	82	13.6	-0.5	905	208
17130	21.3	-0.4	153	88	12.1	-0.6	98	18	11.3	-0.4	547	133
17170	21.0	0.7	28	-2	11.0	0.7	67	-37	9.1	0.4	372	-11
17609	26.3	0.2	1	0	21.5	0.5	111	48	19.2	0.1	255	-74
22113	11.1	0.0	103	-75	1.1	0.2	108	-26	0.2	0.3	372	-106
26038	17.4	2.1	187	-20	5.5	-0.6	231	12	6.0	0.9	624	-30
26850	17.6	1.0	240	-3	5.9	-0.4	188	27	6.2	0.4	700	23
27199	16.6	0.2	197	-18	2.0	0.0	196	11	2.2	-0.1	708	83
27612	17.9	0.8	161	-81	3.8	-1.1	283	103	5.0	0.1	679	-9
33345	19.0	0.3	210	-13	7.1	-0.9	178	46	7.6	-0.1	624	-8
34300	19.5	0.0	185	22	6.6	-1.3	153	31	6.9	-0.6	652	132
34880	24.0	0.1	127	63	9.8	-0.1	38	-24	9.9	-0.1	258	38
40080	25.6	-0.2	0	-1	18.1	0.0	28	-11	16.3	-0.4	220	26
40100	26.4	1.2	0	-2	23.2	1.0	171	8	20.5	0.7	730	-158
40180	26.2	1.0	0.5	0.5	22.3	0.7	89	-5	19.9	0.5	682	115
40270	24.7	0.1	0	0	19.9	0.6	29	-5	17.2	0.1	288	23
60030	24.1	1.2	1	1	23.9	1.6	43	-2	22.2	1.7	103	-35

Monthly surveys

January:
- **Driest January of the century from the UK over central Europe to Cyprus**
- **Cold from the North Sea to southwestern Russia**
- **Mild and wet in the Mediterranean and in northern Scandinavia**

The cold snap which had gripped central Europe in December 1996, continued into 1997. The death toll due to cold across Europe was set at over 200. Wintry conditions hindered the traffic. The Danube river remained closed to shipping all the way from Germany through Austria to Slovakia and barge traffic was halted throughout Benelux and Germany. A rarely held, 200 km skating marathon in the Netherlands took place and ten thousands of people enjoyed festivals on the frozen river Alster in Hamburg, Germany. High damage to forests and to the electric infrastructure by sheet and black ice was reported in western and central Slovenia. New record lengths of frost periods (e.g. München 26 days) were reported. In many parts of central and northwestern Europe, it was the coldest January of the century. Whereas in the lower altitudes, below 800 m msl, negative monthly temperature anomalies up to 4 to 5 °C occurred, there were positive deviations above 900 m msl (see fig. 11), due to a well pronounced temperature inversion, which was established under strong high pressure influence. Zugspitze, 2963 m and Wendelstein, 1837 m reported the 2nd warmest January on record after 1989. The Julian Alps, Slovenia, reported temperature anomalies up to plus 4.2 °C.

Extensive parts of central and eastern Europe were covered with snow. In Latvia, snow depths measured 25-40 cm in fields, compared to 8-21 cm which is usual for this time of the year. However in the middle of the month, an abrupt, intense thawing started.

Under the inversion, it was extremely dull much of the time, e.g. as in northern Switzerland. In west Slovenia, only 40 % of the normal bright sunshine duration was measured (fig. 12).

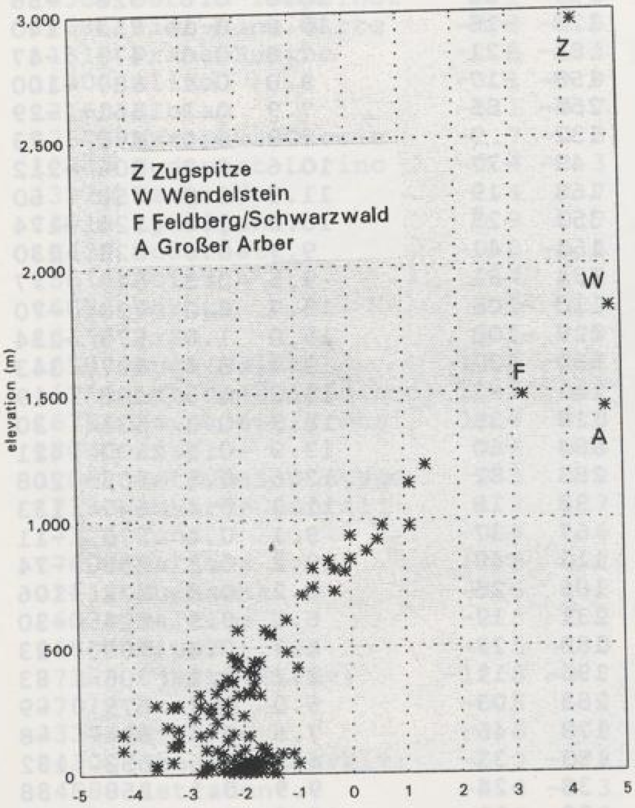


Fig. 11: Deviations of monthly mean temperatures in °C from normal (1961-1990) with respect to elevation for January 1997 (Source: Deutscher Wetterdienst, Germany)

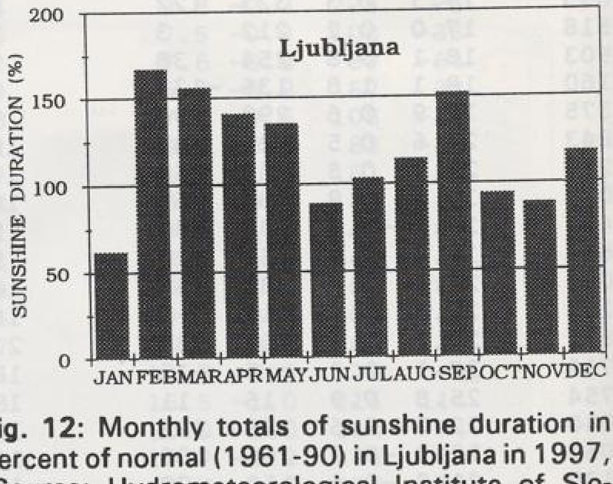


Fig. 12: Monthly totals of sunshine duration in percent of normal (1961-90) in Ljubljana in 1997, (Source: Hydrometeorological Institute of Slovenia)

The persistent anticyclone over central Europe led, above all, to an extreme precipitation deficit and January 1997 turned out to be the driest January of the century in many areas. Extremely dry conditions prevailed in the UK, though it was not as dry as 1766. For Denmark, together with January 1996, with only 6 mm precipitation for the country as a whole, it was the driest ever recorded. In France, the northeast of Switzerland, the Netherlands and in the northeast and south of Germany, new records of dryness were set. Bruxelles-Uccle reported only 2.6 mm, fallen on 4 days, both values representing the lowest monthly values since measurements started in 1833 (see fig. 13). Also for Cyprus, with an areal average precipitation of only 12% of normal, it was the driest January of the century (see fig. 14).

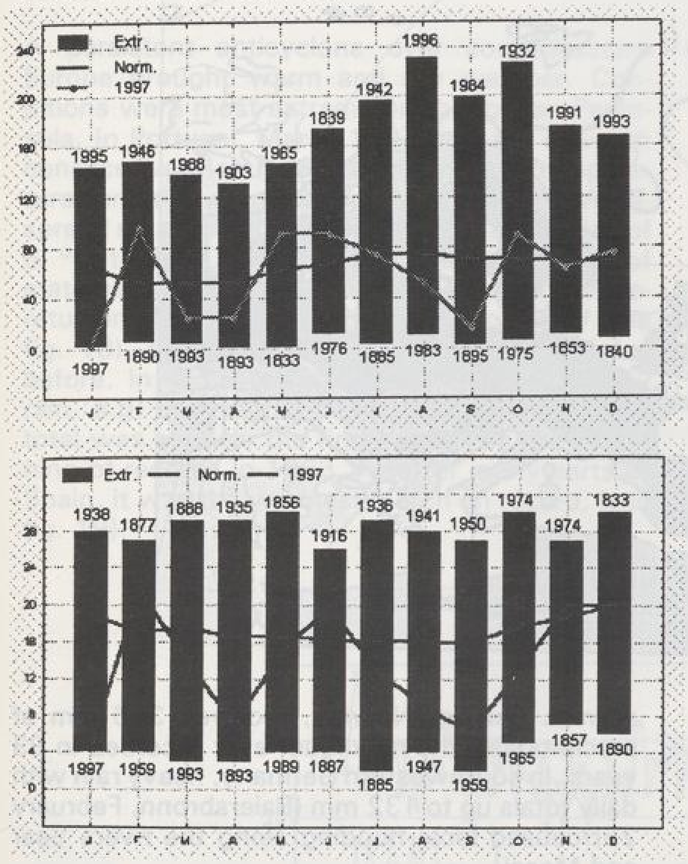


Fig. 13: Mean and extreme monthly precipitation totals in mm (above) and monthly number of precipitation days (below) in Uccle, Belgium, between 1833 and 1997. (Source: Institut Royal de Météorologie de Belgique)

Fig. 14: Monthly areal average precipitation (in mm) in Cyprus in 1997
(Source: Meteorological Service, Cyprus)

Whereas dry and cold conditions prevailed in western and central Europe, mild and wet weather with frequent storms were reported on the western coasts of northern Scandinavia. Temperature anomalies reached more than + 5 °C, at places. Exceptionally heavy snowfall in Lapland brought some reindeer herds to the brink of starvation. In Sweden, a maximum wind gust of 69 m/s was recorded on January 14 at the glaciological station, Tarfala.

Warm conditions prevailed in the southeast of the region. In Armenia, the mean monthly temperature surpassed the long-term average by 2 - 4 °C, and in Ararat valley by 5 - 6 °C. In Israel, the first half of the month was extremely warm and dry on the coast, with maximum temperatures up to 28 - 30 °C on January 12, which is 10 - 13 °C above normal. The second half of the month was cool and rainy instead. In the centre of the coastal plain, on January 22, up to 94 mm of rain within 6 hours engendered floods in several towns. Five people were killed when a landslide caused by two days of torrential rain swept cars off a coastal road near Sorrento, southern Italy on January 10. Heavy rainfall was reported from Greece in the period January 11 to 13. Particularly in the area of Corinth, extreme rainfall totals of 300 mm within 24 hours and 344 mm within 36 hours were recorded. Floods destroyed buildings, railways, roads and interrupted the power and water supply. Six people lost their lives. In Turkey, rain showers caused destructive floods in the Izmir area on January 8 and at the end of the month, after a heavy snowfall, roads in the Kastamonu area were blocked.

On the Iberian Peninsula, which had received abundant rain in December 1996, January was very wet, as well (see fig. 15).

Fig. 15: Precipitation deciles in Spain in January 1997, EH:extremely wet(9-10), MH:very wet(8-9), W:wet(7-8), N:normal (4-6), S:dry(2-3), (Source: Instituto Nacional de Meteorología, Spain)

At many places, monthly precipitation totals surpassed their all-time records, e.g. at the observatory of Ebro, Tortosa, with 140.0 mm, previous record 132.2 mm (1903).

Hungary reported a special national record: On January 27, due to dry foehn winds, the relative humidity fell to 3 % at Kékestető. Such a low humidity had never occurred since the beginning of observations 125 years ago.

February:
- **Cold in the Middle East, elsewhere mostly very mild**
- **Wet in central and northern Europe, extremely dry in the western Mediterranean**
- **Heavy winter storms batter northwestern Europe**

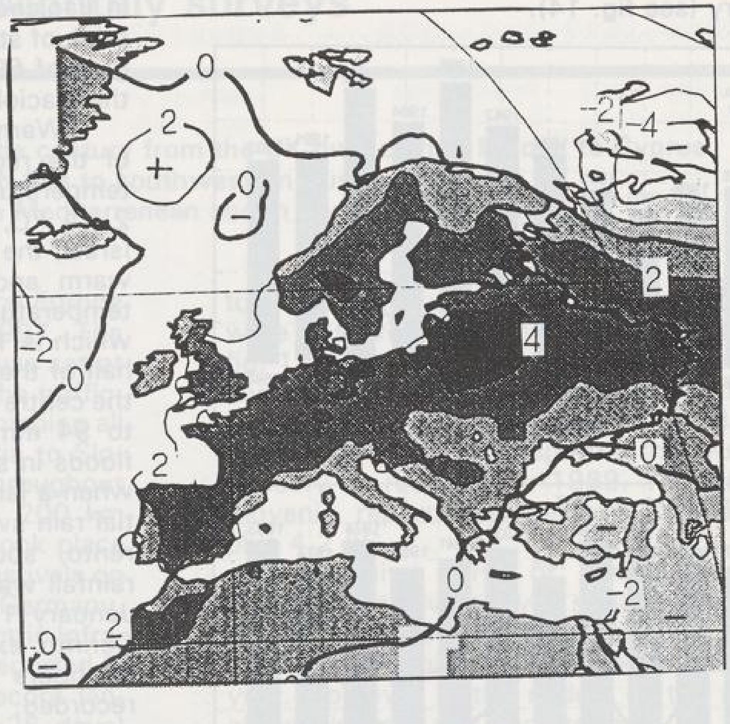


Fig. 16: Temperature anomalies in February 1997
Reference period: 1961-1990
(Source: Deutscher Wetterdienst, Germany)

High pressure influence brought mild and dry weather to southwestern Europe. In Portugal, it was the second warmest February of the 1931 to 1997 period and the monthly precipitation totals did not even reach 10% of normal. Also in the Balkan states, it was extremely dry, mild and sunny (see fig. 12, page 22). The coastal regions of Slovenia received 4 mm of rain only and in Hungary, in many places, monthly rainfall totals did not even reach 10 mm, what is less than 25 % of normal.

In opposition to it, it was cold and wet in the southeast of the Region. Severe frost caused heavy damage to the agricultural industry of Cyprus, in early February. The island experienced a blanket of snow, that happened last in 1983. Snow blocked the roads and wrecked power lines in the Diyarbakir area of southeastern Turkey. In Armenia, temperatures dropped to minus 25 °C in the mountain regions and 14% of the crops were affected. The northern Caucasus republics and the Krasnodar region reported a number of avalanches. A very cold spell occurred in Israel between February 6 and 12: Minimum temperatures were below 0 °C for 7 consecutive days in several places, a phenomenon which occurred only twice in the last 35 years. On February 21 - 22, torrential rain fell on the northern coastal plain and in western Samaria (180 - 200 mm within less than 48 hours). Eleven people died when their vehicles were swamped by floods.

Atlantic depressions brought storms, rain and mild air to northern Europe. Temperature anomalies were high, with widespread anomalies of more than + 4 °C in eastern Europe. At many places, precipitation totals surpassed 200 % of normal. Bergen, Norway, received 366 mm of precipitation, the maximum ever recorded in 93 years. In southwestern Germany, heavy rain with daily totals up to 132 mm (Baiersbronn, February 25) caused local flooding along the rivers Saar and Mosel.

Sunshine totals were often low at the same time (see fig. 17).

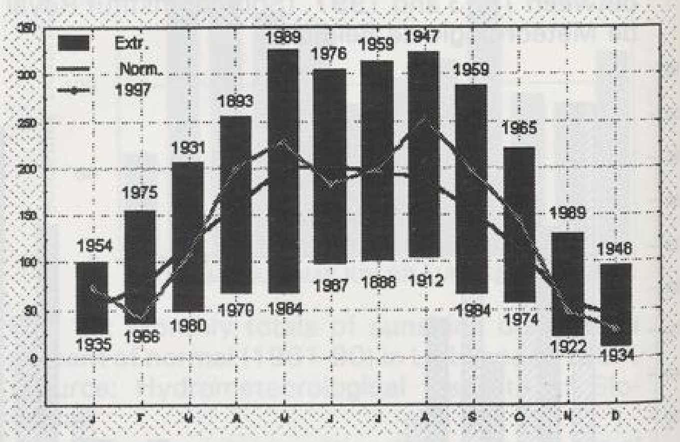


Fig. 17: Mean and extreme monthly totals of sunshine duration in Uccle, Belgium between 1887 and 1997
(Source: Institut Royal de Météorologie de Belgique)

During the period from February 10 to 25, there occurred one of the most sustained periods of strong winds since 1990 in the UK. Gusts frequently exceeded 130 km/h, at least 11 people lost their lives. Also, the Netherlands and northern Germany were battered by heavy winter storms causing considerable damage.

March:

- **Again extremely warm and dry on the Iberian Peninsula**
- **Cold in the southeast**
- **Several regions plagued by severe drought**

A persistent anticyclone over south-western Europe brought warm and dry weather. Conditions were most extreme on the Iberian Peninsula. In Portugal, March 1997 was the eleventh consecutive March with above normal temperatures and the warmest March since 1931. Widespread mean maximum temperature anomalies of 6 °C to 8 °C occurred and, at a number of stations, the monthly mean maximum temperature in 1997 exceeded those of June 1997 (see fig. 18), an event that had not been recorded before. In some regions, there was hardly any rain, e.g. in Porto/S. Pilar, the monthly rainfall total was zero for the first time since the beginning of records in 1863. Also for many parts of Spain, it was the warmest March on record, (see fig. 19).

Fig. 19: Temperature deciles in Spain in March 1997, EC:extremely warm(9-10), MC:very warm(8-9), C:warm(7-8), N:normal (4-6), (Source: Instituto Nacional de Meteorología, Spain)

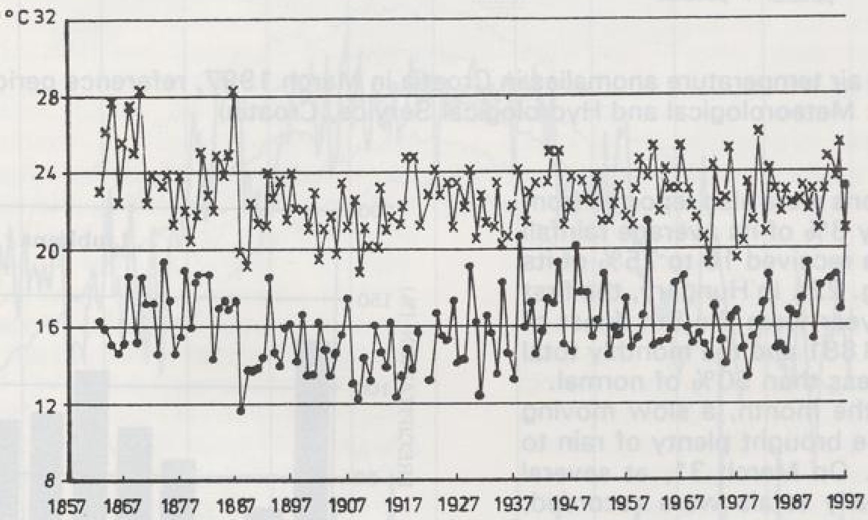


Fig. 18: Mean monthly maximum temperatures in March and June in Porto/S. Pilar, Portugal between 1863 and 1997.
(Source: Instituto Meteorologia, Portugal)

An extraordinary warm spell occurred in the first half of the month in central Europe and March turned out to be very mild (see fig. 20). For the Netherlands, the first decade of the month was the second mildest of the century. In Italy, the mean temperature of the second decade surpassed its normal by 10 °C. Winter returned to central Europe at the end of the second decade. Severe frost caused high damage to the almond and apricot trees in Hungary. Strong cold and snow reigned in Latvia on the calendar onset of spring. Night-time temperatures dropped to minus 18 °C and new ice started to form on the rivers.

Regionally, it was also very sunny (see fig. 12, page 22) and dry at the same time. The precipitation average over the Netherlands, was only 27 mm, compared to 61 mm normally. The farms of the Po Valley, Italy, suffered severe losses of crops, because of the drought.

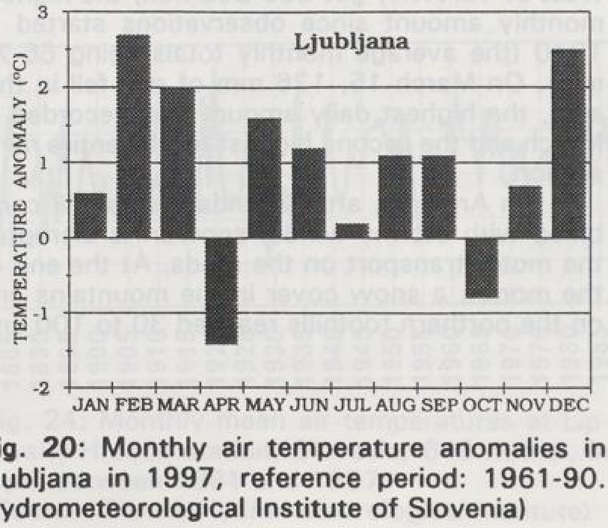


Fig. 20: Monthly air temperature anomalies in Ljubljana in 1997, reference period: 1961-90. Hydrometeorological Institute of Slovenia)

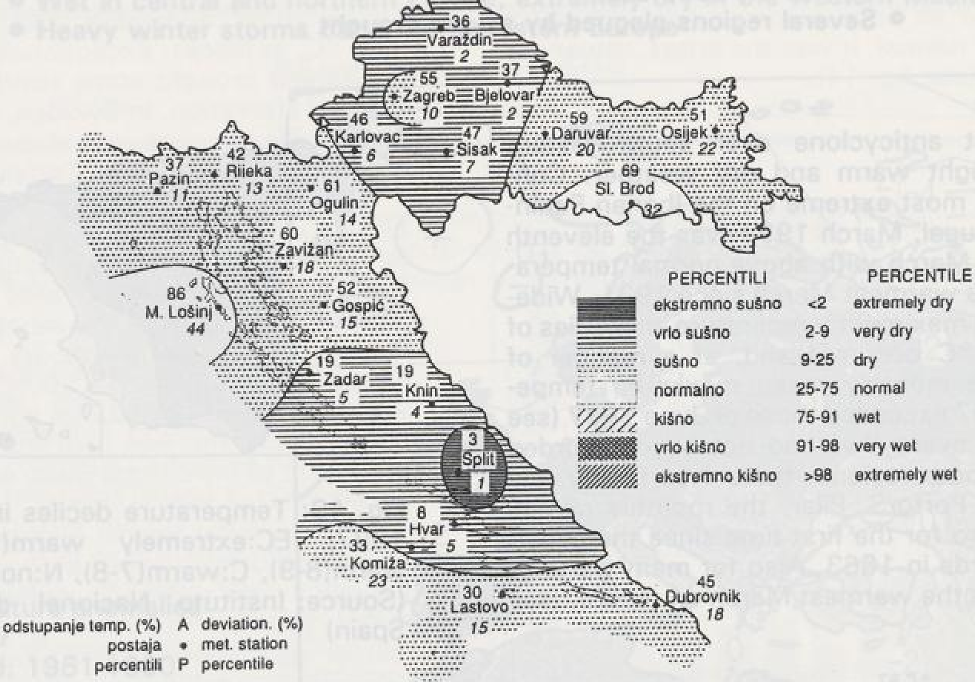


Fig. 21: Monthly air temperature anomalies in Croatia in March 1997, reference period: 1961 - 1990 (Source: Meteorological and Hydrological Service, Croatia)

Extremely dry conditions were also reported from Croatia. Split had only 3% of its average rainfall (see fig. 21). Slovenia received 10 to 75% of its normal rainfall (see fig. 22). In Hungary, the first three months of the year were the 5th driest of the series starting in 1881 and the monthly total of March 1997 was less than 50% of normal.

At the end of the month, a slow moving Mediterranean cyclone brought plenty of rain to the Balkan Peninsula. On March 31, at several places in Bulgaria, daily totals were recorded, surpassing the monthly means (e.g. Belogradchic 63 mm/24h, monthly mean 53 mm; Gramada 55 mm/24h, monthly mean 46 mm). Also Romania reported high daily totals of 40 to 70 mm.

In Israel it was cool and very rainy (150% to 200% of normal). The Sharon region, northwest of Tel Aviv, got 250-265 mm, the highest monthly amount since observations started in 1940 (the average monthly totals being 65-70 mm). On March 15, 126 mm of rain fell in this area, the highest daily amount ever recorded in March and the second highest for the entire rainy season.

In Armenia, after abundant snowfall combined with stormy winds, snowdrifts disrupted the motor transport on the roads. At the end of the month, a snow cover in the mountains and on the northern foothills reached 30 to 100 cm.

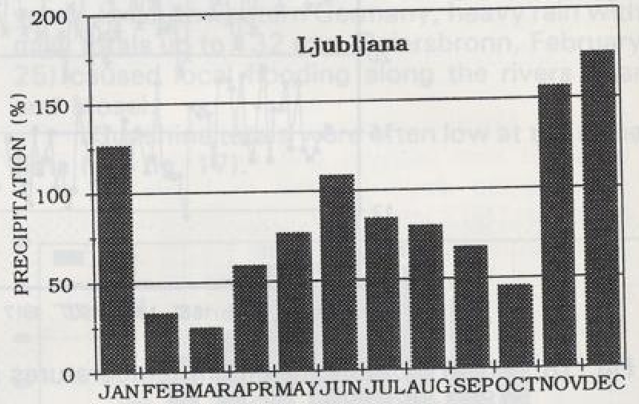


Fig. 22: Precipitation in percent of normal in Ljubljana in 1997, reference period: 1961-90. (Source: Hydrometeorological Institute of Slovenia)

A strong winter storm over Germany and Poland caused deaths, and damaged buildings, powerlines and trees with high losses. Wind exceeding 110 km/h were wide-spread. On the Brocken, the highest mountain of northern Germany, gusts up to 189 km/h were recorded.

In southern England, the hazard of fog was vividly demonstrated when, on the morning of March 10, two multiple rear-end motorway accidents involved 90 vehicles.

April:
- **Severe drought conditions in England, France and Portugal**
- **Extremely warm in the southwest and cold in the east**
- **Wet from northern Norway across western Russia to Turkey and Greece**

April was dry again over the United Kingdom, and, for England and Wales, the April 1995-April 1997 period established a new 25-month minimum for the 231-year national rainfall series. In France, drought conditions were worse in the Seine-et-Marne region, where between March 29 to April 24 no rain fell at all and in Brétigny-sur-Orge, a record sunshine duration of 264 hours within 27 days was measured. Extremely dry weather was also reported from the Netherlands and Belgium. In southern Switzerland, April 1997 was locally the most sunny and the January 21-April 26-period was one of the longest dry periods of this century. 1500 hectares of forest and pastures were destroyed by fires.

In Portugal, prevailingly dry and warm weather continued. In Lisbon, on April 30, 32.2°C was recorded, the highest ever April temperature (since 1871). While the warm weather was locally accompanied by heavy showers, a number of stations reported record numbers of consecutive days without precipitation (e.g. in Béja, where observations started in 1941, had 49 days (16/2 to 5/4), breaking the previous record of 34 days in 1992). In Mecklenburg-Vorpommern, Germany, the dryness caused an unusual sandstorm event, when on April 11, a storm blew the dry crumbs of soil from freshly tilled fields to meter-high sand dunes on roads and at obstacles.

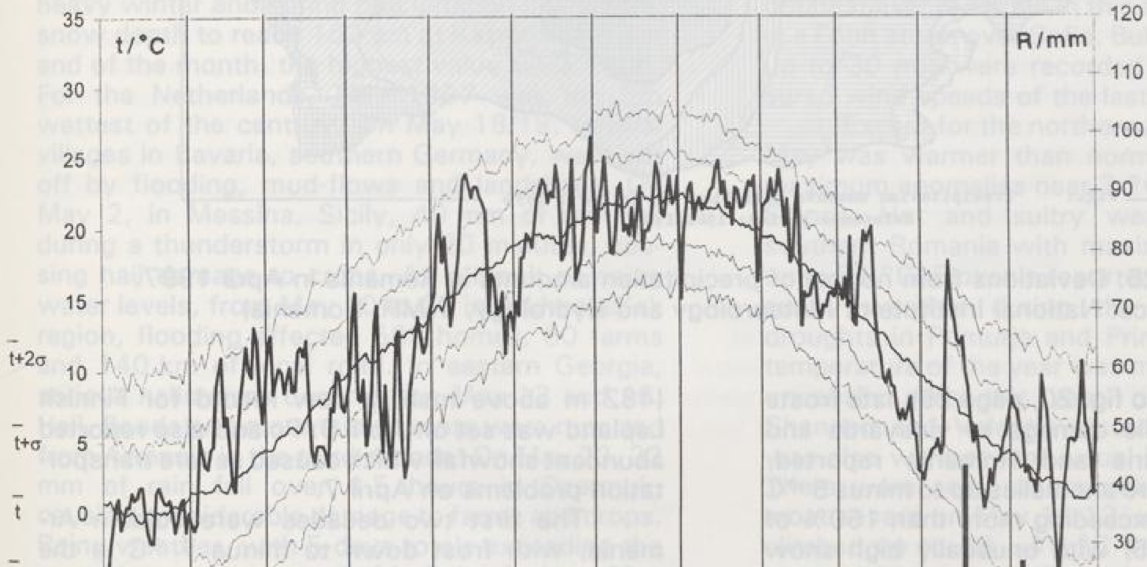


Fig. 23: Mean daily air temperatures in Zagreb-Grič in 1997 compared to long-term means and stan-dard deviation (1862-1990). The columns indicate the daily precipitation amounts. (Source: Meteorological and Hydrological Service of Croatia)

In the central and eastern parts of the region, April was unusually cold, and for a number of stations, e.g. in southern Germany and Austria, the monthly means were lower than those of the preceding March, a rare event, which has become more and more common in the recent decade. The Balkan peninsula had a prolonged winter. Unusually cold conditions were reported from Croatia (see fig. 23) and, for Hvar with a monthly mean of 11.2 °C, it was the coldest April since the beginning of records in 1894. Frost not only appeared in the continental parts of the country, but also at the seaside and on the islands, where the minimum temperature dropped to minus 5 °C, damaging olive trees, vine-yards and early vegetables. For Slovakia and Hungary, after 5 relatively mild years, it was regionally the second coldest April since records began in 1881 (see fig. 24).

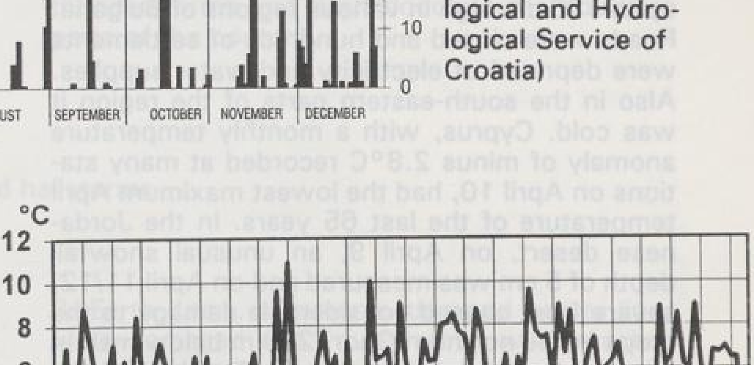


Fig. 24: Monthly mean air temperatures at Liptovsky Hradok station, Slovakia, 640 m msl, in April between 1881 and 1997. (Source: Slovak Hydrometeorological Institute)

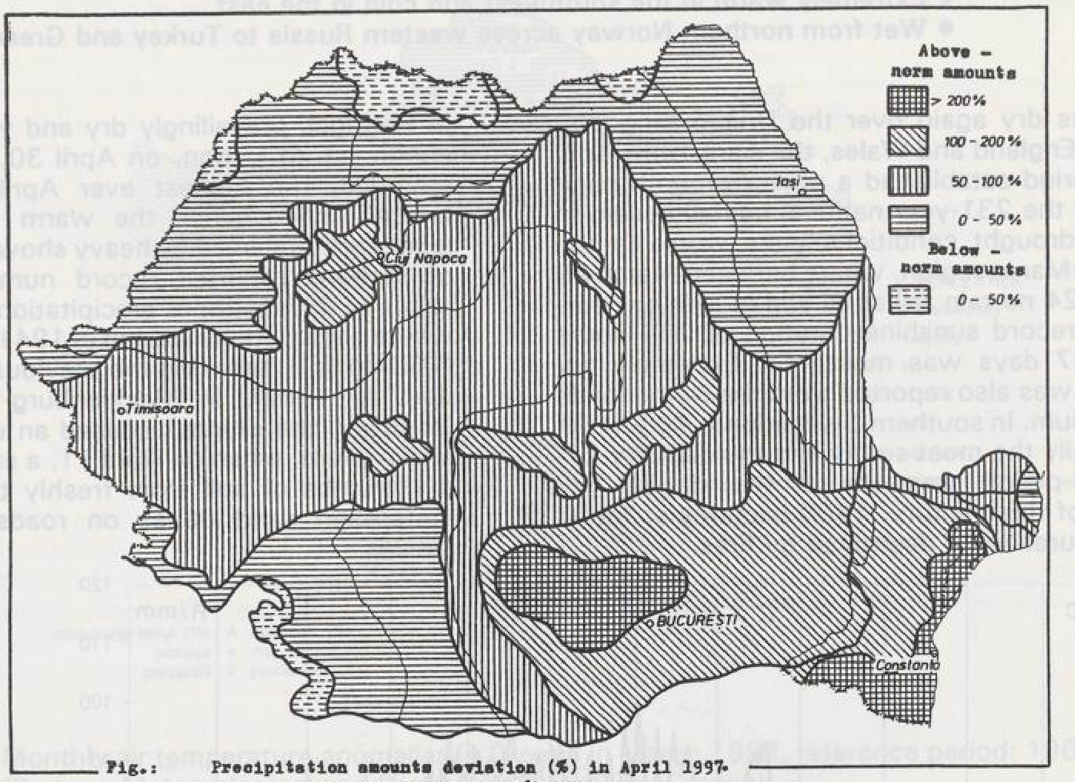


Fig.: Precipitation amounts deviation (%) in April 1997
Reference period: 1961-1990

Fig. 25: Deviations from normal of precipitation amounts in Romania in April 1997. (Source: National Institute of Meteorology and Hydrology, INMH, Romania)

In Slovenia (see also fig. 20, page 25), late frosts caused considerable damage to vineyards and fruit trees. Bulgaria and Romania reported, monthly temperature anomalies up to minus 5 °C and precipitation exceeding more than 150% of normal (see fig. 25) with unusually high snow depths in mountain areas. Between April 13 and 18, strong winds and snowfall caused snowdrifts up to 180 cm high in various regions of Bulgaria. Roads were closed and hundreds of settlements were deprived of electricity and water supplies. Also in the south-eastern parts of the region it was cold. Cyprus, with a monthly temperature anomaly of minus 2.8°C recorded at many stations on April 10, had the lowest maximum April temperature of the last 65 years. In the Jordanese desert, on April 9, an unusual snowfall depth of 5 cm was measured and on April 11/12, severe frost caused considerable damage to the crops in the northern Ghor, 200 m below msl. In Israel, where it was cold in the first half of the month, an extreme sharav event with hot dry winds from the south occurred on April 29, when temperatures climbed up to 40°C.

April was extremely wet in northern Scandinavia. In Norway, some stations recorded 600% of their normal precipitation amounts. New snow depth records were established: in Tromsø, northern Norway, with observations since 1920, the highest ever snow depth of 240 cm was measured on April 29. With a snow depth of 190 cm, at the Enontekiv Kilipisjarvi-station (482 m above msl), a new record for Finnish Lapland was set on April 9. Poland also reported abundant snowfall which caused severe transportation problems on April 7.

The first two decades were cold in Armenia, with frost down to minus 7 °C in the Ararat Valley on April 11, then a hot spell from April 23 to 26 pushed temperatures up to 25-29 °C at night and 31-33 °C during the day. The sudden temperature rise and plenty of rain speeded up the snow melt around the upper reaches of the rivers in Georgia, triggering dangerous floods. On the outskirts of Tbilisi, the river overflowed its banks causing significant damage to the city.

A stormy period occurred in eastern Europe on April 11/12. A severe storm flood threatened the estuary of river Odra, Poland. The Krasnodar territory and Rostov region, Russia, were badly hit by a storm with gusts up to 175 km/h. Four boats in Novorossiysk harbour went aground. At the mouth of river Don and the Gulf of Taganrog, surges up to 804 cm were measured, the highest since observations began in 1881. Thirty-six villages were flooded, four bridges, two dams, roads, power and communi-cation lines were damaged. In Älvdalen, southern Sweden, on April 14, a gust of 42 m/s occurred, an extreme high peak value for the interior parts of Sweden. Strong winds up to 47.2 m/s were registered at the Slovenian mountain station Kredarica.

May: • **Cold in the north, elsewhere mostly warm**
• **Wet from Portugal across the UK to southern Sweden**

In comparison with the recent months, there were remarkable changes in the circulation pattern. The enhanced, persistent anticylonic influence over south-western Europe vanished, bringing above-normal precipitation to relief the drought that had plagued the north-western Iberian Peninsula and UK. In the beginning of May, the provinces of Värmland and Dalarna, Sweden, were hit by rain with amounts never before seen so early in the warm season. Tåson received 182 mm from May 4 to 12, and ended up with a monthly total of 209 mm, the highest May value ever recorded in Sweden. The water cut off almost every road in the area. In Trosa, 8 houses were destroyed and another 21 had to be permanently evacuated after a landslide. The heavy winter and spring precipitation caused the snow depth to reach 162 cm at Katterjåkk at the end of the month, the highest value since 1906. For the Netherlands, May 1997 was the 5th wettest of the century. On May 18/19, several villages in Bavaria, southern Germany, were cut off by flooding, mud-flows and landslides. On May 2, in Messina, Sicily, 40 mm of rain fell during a thunderstorm in only 20 minutes, causing hail damage to crops. As a result of rising water levels, from May 10 to 23 in Arkhangel'sk region, flooding affected 568 homes, 60 farms and 140 km of local road. In eastern Georgia, serious hailstorms occurred on May 13 and 16. Hail, floods and mountain torrents were reported from Armenia in the third decade. On May 23, 32 mm of rain fell over 4.5 hours in Dzermuk, causing considerable damage to farms and crops. Rainy weather, with 5-days totals exceeding the monthly average prevailed in Bulgaria from May 26 to 30.

May started out cold over much of the region causing considerable losses due to late frost, especially on May 7/8. London witnessed the first May snow since 1979 while heavy rain blocked the roads in the Scottish Highlands. Between May 8 and 17 violent thunderstorms were common over southern Britain and, on May 17, hail was reported from Aylesbury, Buckinghamshire, damaging many greenhouses and a tornado hit Hampshire. For Latvia, snowfall on May 5 was the latest since 1990. A remarkable temperature drop was recorded in Munich, southern Germany, on May 7. In the easterly edge of a trough of low pressure, a strong Föhn was set up. The temperature climbed up to 24.5 °C by 2 p.m. With the passage of the cold front, temperatures dropped rapidly to around 12 °C by 4 p.m. to 5.3 °C after 8 p.m.. The temperature fall of 19.2 °C within 6 hours was one of the greatest ever recorded in this area. One day later, in a Föhn storm over Sofia, Bulgaria, wind speeds up to 30 m/s were recorded, the highest measured wind speeds of the last 10 years.

Except for the northern parts of the region, May was warmer than normal, all in all, with maximum anomalies near 3 °C in south-western France. Hot and sultry weather prevailed in southern Romania with maximum temperatures up to 36 °C. Slovenia reported unusually hot and sunny weather during the 2nd decade with droughts in Pomurje and Primorje. The highest temperature of the year was measured in Ireland, unusually early this year, on May 31, when Shannon and Valentia recorded 27.2 °C. May was also warmer than usual in the Middle East. There were some sharav events in Israel, the most severe on May 12/13, when temperatures climbed up to 40 - 41 °C in several areas. An unusual heat wave affected Jordan on May 17 (Amman Airport 37 °C) accompanied by heavy thunderstorms and flash floods in the southern parts of the country.

June: • **Widespread notable thunder- and hailstorms**
• **Wet and cold in the West**

There was an unusually high number of thunder- and hailstorms. Though June 1997, was the wettest for over 100 years over England and Wales, groundwater levels were still the lowest on record in many areas. Downpours of rain disrupted major sports events, such as the Ascot Races and the Wimbledon Tennis Championships. On June 16, flash floods occurred in London. On June 1, heavy rainfall led to communication, electricity and road outages in the Basque area of Spain. On June 2, a large series of thunderstorms caused heavy damage in central Italy. In Penza region, Russia, there was heavy rain and wind with speeds up to 24 m/s on June 2/3 and 8. Earth dams, communication and power lines were damaged and young crops were washed out of an area covering 500 hectares. In the afternoon of June 7, a squall line with severe thunderstorms moved across the Netherlands. Strong gusts caused considerable damage especially in the south-western part of the country . Several people were killed and numerous wounded. During the June 7 to 11 period and on June 30, torrential rain and hail caused high losses fell in Armenia. Precipitation intensities up to 82 mm in one hour (Goris) were registered. In western France, on June 11, hail bigger than cherrystones (up to 8 cm thick) fell in some areas near

Nantes, triggering flooding and damaging up to 60% of the vineyards. Between June 11 and 17, severe thunderstorms, rain showers and floods occurred in Turkey (Rize, Giresun) causing high losses - 7 people were killed. A fierce summer storm hit Poland, Ukraine and Belarus on June 14. 12 people were killed. Torrential rain was also reported from north-west Slovenia. At some stations, the 24-hour precipitation amounts reached 100 mm and the monthly totals surpassed 400% of normal. Romania recorded 13 days with torrential rainfall or hail, causing considerable damage and even life losses. On June 18, a disastrous quick moving cyclone crossed Romania - hailstones with weights up to 800 g were observed. Only 2 days later, a hailstorm along with whirlwind of a velocity up to 20 m/s caused damage in 25 villages - 350 houses were deprived of roofs, 7 persons were killed. On the same day, storms with strong gusts and hail (up to 5 cm in diameters) occurred in Croatia, where in Virovitica area, 70% of all crops were destroyed. On June 23, within only two hours, a severe hailstorm with gusts up to 32 m/s, hailstones with diameters exceeding 2 cm and heavy rain struck western Belarus. 7200 houses were damaged, over 200 towns had power cuts and thousands of hectares of grain crops were flattened. Catastrophic rainfalls were reported from Azerbaijan between June 3 and 24. On June 28, heavy rain triggered a landslide in Lombardy and Apulia, Italy - 6 people died. In Tbilisi, Georgia, on June 29, 117 mm rain poured down within only 3.5 hours (mean monthly total 78 mm). At the end of June/early July, heavy rain and thunderstorms hit southern Norway. Several locations had a rain intensity of about 2 mm per minute during a period of 10-20 minutes. In Lillehammer, an extreme lightning intensity was observed, hitting the ground more than 1000 times within 24 hours.

June was cool at many places, especially in the west and southwest (see fig. 18 page 25) of the region. On June 1, there was frost in many places in Hungary, a rare phenomenon which happens, statistically only once every 30 years in June. Unusually late frosts were recorded in Latvia until June 5. On June 9, snow disappeared in Tromsø, Norway; the second latest date on record for snowcover to disappear at this station. The second decade started out cold in western Austria with an unseasonable blanket of snow down as low as 1500 m, triggering landslides and floods. For the first time in three decades, there was snow down to 1400 m in the Pyrenees in late June.

July:
- **Devastating flood of river Oder**
- **Cool in south-western and central Europe**
- **Warm and mostly dry in Fennoscandia**

The worst flood of this century in the basin of river Oder hit south-western Poland and the Czech Republic (see fig. 26). Also large parts of the neighbouring countries were affected. In Slovakia, after a relatively dry period from October 1996 to June 1997, the aereal precipitation total calculated from 203 stations by the double weighted averages method was the second highest since 1881 (see fig. 27).

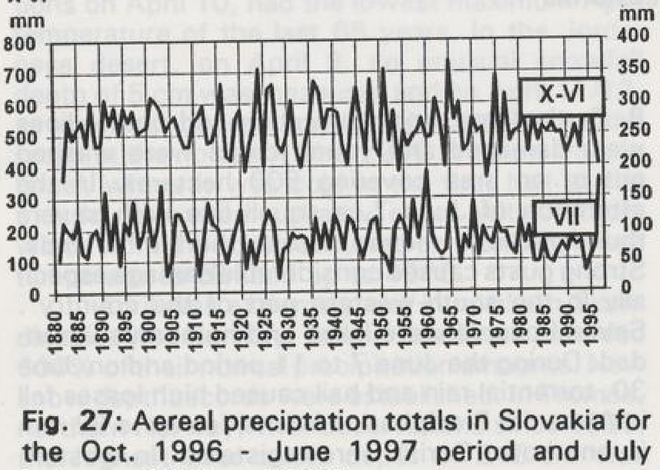


Fig. 27: Aereal preciptation totals in Slovakia for the Oct. 1996 - June 1997 period and July between 1881 and 1997
(Source: Slovak Hydrometeorological Institute)

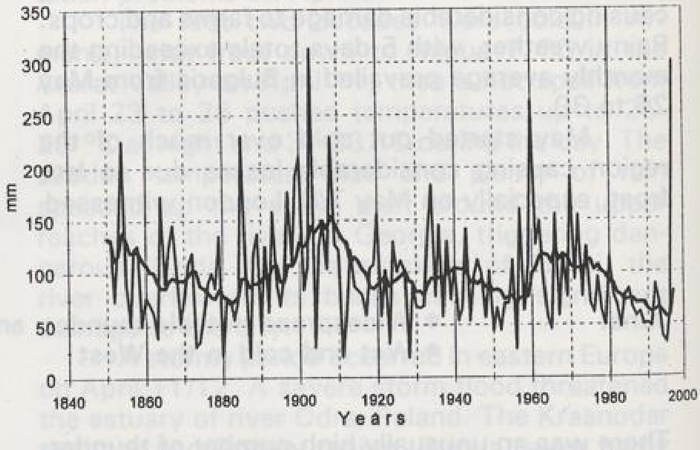


Fig. 26: Monthly precipitation totals in Krakow in July between 1850 and 1997. (Source: Institute of Meteorology and Water Management, Poland)

The situation was caused by the heavy rainfalls of two separate weather phases. The first phase lasted from July 4 to 9. From middle Poland (see fig. 28) across the Czech Republic (see fig. 29) to Lower Austria more than 100% of the monthly mean precipitation fell within only 4 days; in the mountains and in Vienna area 200%. Six stations

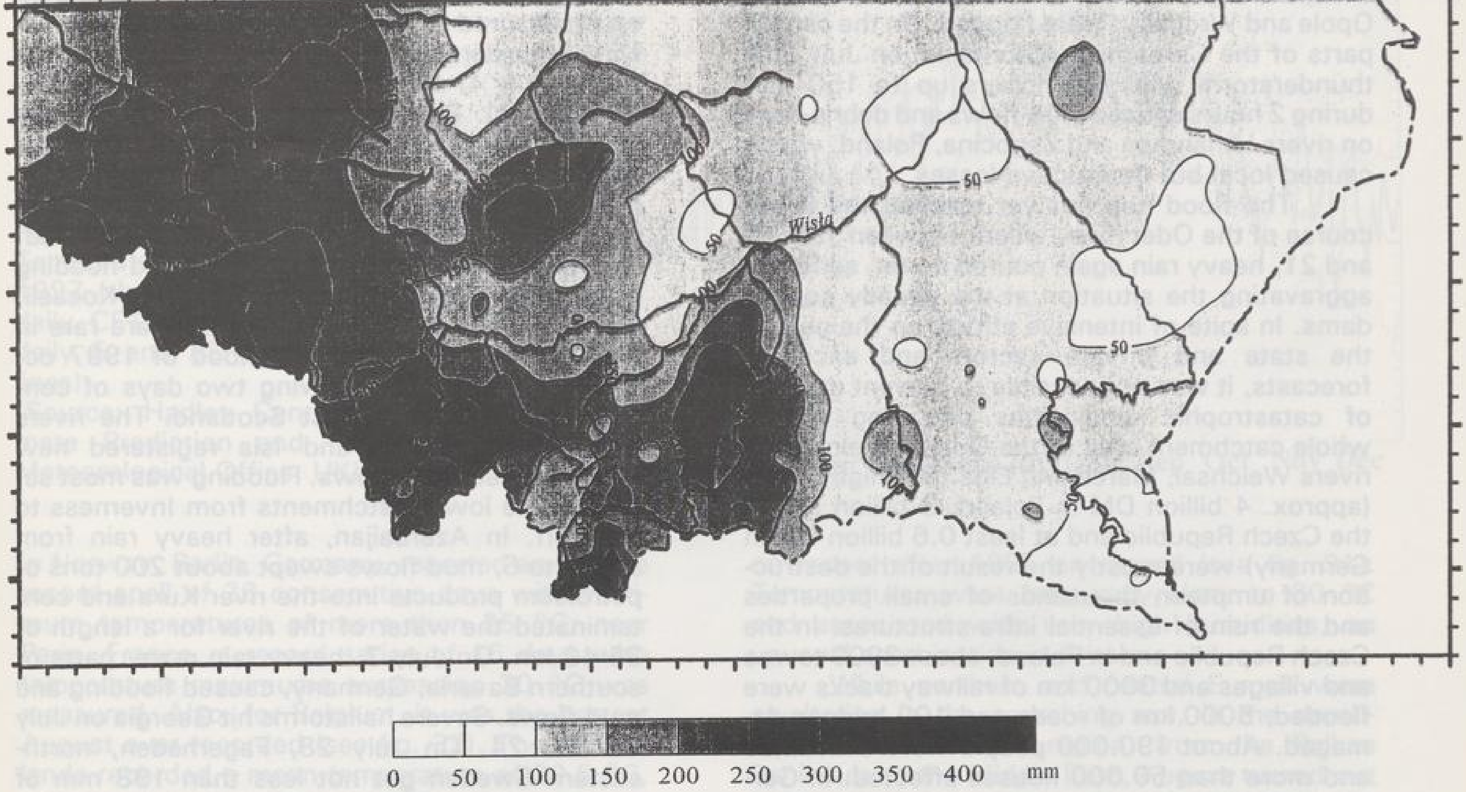


Fig. 28: Precipitation totals in southern Poland between July 4 and 9, 1998
(Source: Institute of Meteorology and Water Management, Poland)

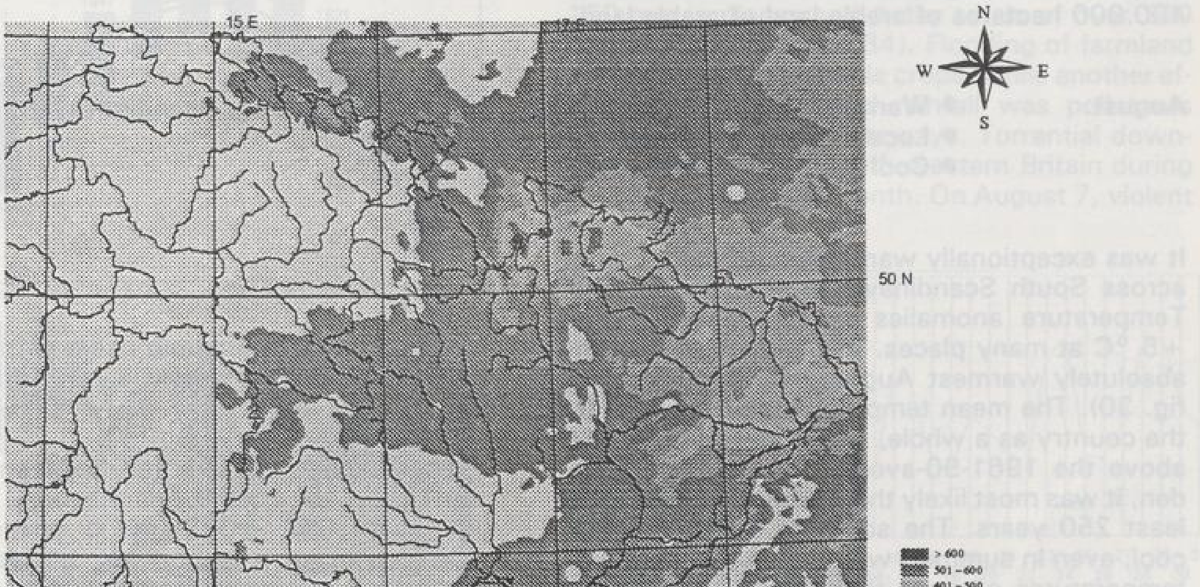


Fig. 29: Precipitation totals in the Czech Republic between July 4 and 8, 1998
(Source: Czech Hydrometorological Institute)

in the Jeseník and northern Beskydy Mountains, Czech Republic, received even more than 500mm within 5 days (e.g. Šance 617 mm, Lysa Hora 596 mm and Jeseník 512 mm). Damage was exceptionally high as two large Polish cities, Opole and Wroclaw, were flooded. On the central parts of the Carpathian Mountains, on July 9, a thunderstorm with downpours up to 150 mm during 2 hours caused mud-flows and debris-flow on rivers Limanowa and Zegocina, Poland, which caused local but destructive losses.

The flood had not yet reached the lower course of the Oder river, when, between July 18 and 21, heavy rain again poured down, seriously aggravating the situation at the already soaked dams. In spite of intensive efforts on the part of the state and private sectors and excellent forecasts, it was not possible to prevent damage of catastrophic dimensions occurring in the whole catchment area of the Oder and along the rivers Weichsal, March and Elbe. The high losses (approx. 4 billion DM in Poland, 3 billion DM in the Czech Republic and at least 0.6 billion DM in Germany) were mostly the result of the destruction of umpteen thousands of small properties and the ruin of essential infra-structures. In the Czech Republic and in Poland, about 3000 towns and villages and 3000 km of railway tracks were flooded, 5000 km of roads and 100 bridges damaged. About 190.000 people were evacuated and more than 50.000 houses affected. In Germany, damage remained comparatively low. This was largely due to the defensive action taken to prevent the catastrophe; approx. 45.000 helpers were in action and close to 9 million sandbags were used. In all, the floods cost more than 100 lives in the countries concerned, and in Poland, one million heads of poultry, close to 2000 cattle and over 5000 pigs perished. It also affected 400.000 hectares of arable land of arable land which 160.000 hectares were so badly damaged that recultivation was necessary.

Devastating rain and hail were also reported from many other parts of the region. On July 1, 45 mm of rain and hail within 70 minutes was measured in Tashir, Armenia. Torrential rain with considerable damage was reported from Gavar (July 4) and Ashotsk (July 23, 40 mm in 10 minutes). Rain and gusts up to 25 m/s damaged the agricultural industry around Orenburg, Russia, on July 2. High water and mud-flows disrupted bridges and homes in Dagestan Republic on July 15/16 - three people were killed. Two severe incidences of landslide and flooding occurred in Turkey (Giresun, July 3/4; Kocaeli, July 27). Though floods during July are rare in the UK, the most damaging flood of 1997 occurred on July 1/2 following two days of continuous rain in north-east Scotland. The rivers Nairn, Divie, Lossie and Isla registered new maximum recorded flows. Flooding was most severe in the lower catchments from Inverness to Macduff. In Azerbaijan, after heavy rain from July 4 to 6, mud-flows swept about 200 tons of petroleum products into the river Kura and contaminated the water of the river for a length of 35-40 km. On July 7, heavy rain many parts of southern Bavaria, Germany, caused flooding and mud-flows. Severe hailstorms hit Georgia on July 10 and 24. On July 28, Fagerheden, north-eastern Sweden got not less than 198 mm of rain, the highest 1-day precipitation amount ever recorded at an official measuring station in Sweden. The total amount of July 27/28 was 256 mm; most roads in the area were cut off.

On the contrary, at the eastern Adriatic coasts, Croatia, warm weather engendered over 1500 bush fires.

August:
- **Warmest August for more than 200 years in southern Scandinavia and Benelux**
- **Local devastating floods**
- **Cool and wet in southeast**

It was exceptionally warm from northern France across South Scandinavia to southern Finland. Temperature anomalies surpassed +4 °C to +5 °C at many places. In Denmark, it was the absolutely warmest August ever recorded (see fig. 30). The mean temperatures of 20.4 °C for the country as a whole, turned out to be 4.7 °C above the 1961-90-average. In southern Sweden, it was most likely the warmest August for at least 250 years. The southern Baltic, normally cool, even in summer, warmed up to record high temperatures of more than 24 °C. Fæderfyr, a lighthouse in the Oslofjord, had the record high mean sea temperature for the entire month of 21.5 °C. And Oslo Airport Fornebu reported a monthly mean of 21 °C the highest monthly mean temperature ever recorded in

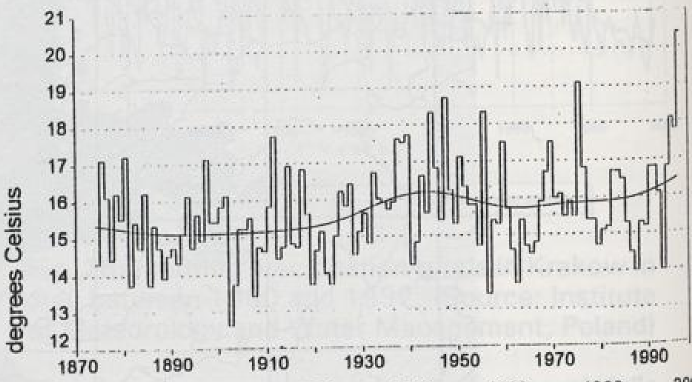


Fig. 30: August mean temperature for Denmark between 1874 and 1997
(Source: Danish Meteorological Institute)

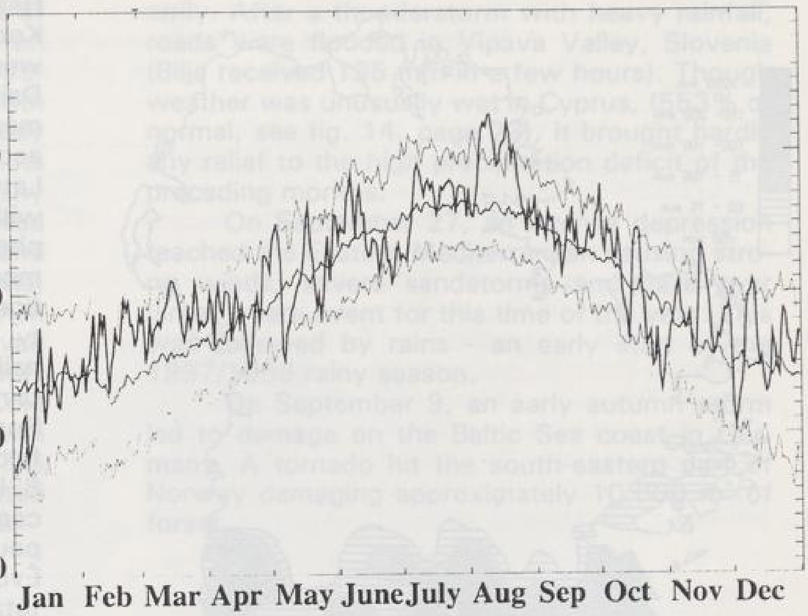


Fig. 31: Daily Central England Temperatures (CET): 1997 (thick line), 1961 to 1990 daily CET normals (central line), daily 5 and 95 percentiles (thin lines) (Source: Hadley Centre for Climate Prediction and Research, Meteorological Office, UK)

in Norway. Berlin, Germany, reported an all-time record spell of 26 consecutive days with maximum temperatures of more than 25 °C; near Paris, France, a record series of 15 days with temperature maximums surpassing 30 °C was measured. Also, for Belgium, it was the hottest August ever recorded (see fig. 32). The Netherlands recorded a mean temperature of 20.5 °C, compared to 16.8 °C normally, which was the warmest August since regular temperature measurements were started in 1706!

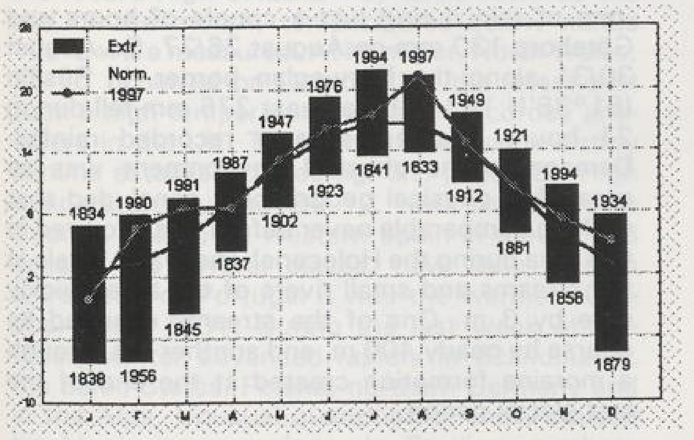


Fig. 32: Monthly mean temperatures in Uccle, (Source: Institut Royal Météorologique de Belgique)

Hot, sunny and mostly dry weather predominated over Latvia, Lithuania and Poland, as well. The sun was shining during 350 - 380 hours in Latvia, surpassing the long-term mean by 150 hours. Some locations received no rain at all. The dryness engendered forest fires. There were also some heavy showers. In Lithuania, Kaišiadorys station recorded 52.4 mm of rain during 4 hours on August 6 and on August 17, at Laukuvu station, 85 mm within 3 h 22 min poured down. For the UK, it was the second warmest August on record after 1995 on record (see fig. 31). Temperatures were frequently close to 30 °C and associated with very high humidities, an unusual combination in Britain.

While northern and central Europe were sweltering in the scorching sun, in the south-eastern parts of the region, from the Balkan Peninsula to the Middle East, August turned out to be unusually cool (see fig. 32). For Nikosia, Cyprus, the mean monthly maximum temperature was the second lowest for August since 1918.

The hot and moist air caused flashfloods and hailstorms at places. The period August 3 to 7, saw some of the wettest weather ever recorded over the counties Limerick and Wexford, southern Ireland, with daily rainfalls of up to 150 mm in places and 4-day totals of over 200 mm (see fig. 33, page 34). Flooding of farmland seriously damaged arable crops, while another effect of the exceptional rainfall was pollutants being washed into waterways. Torrential downpours also deluged south-western Britain during the first week of the month. On August 7, violent

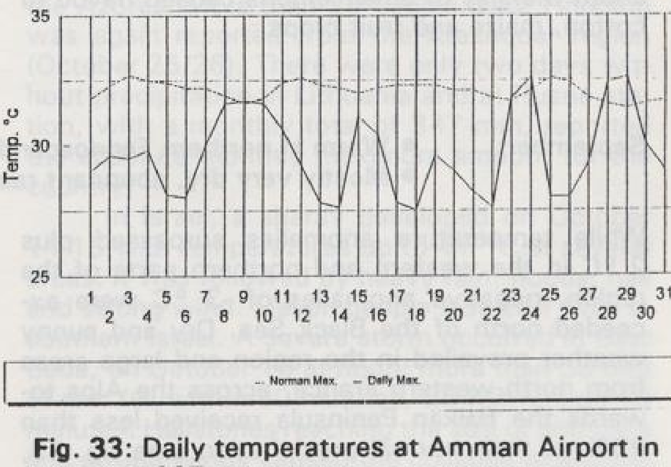


Fig. 33: Daily temperatures at Amman Airport in August 1997 (Source: Meteorological Department, Jordan)

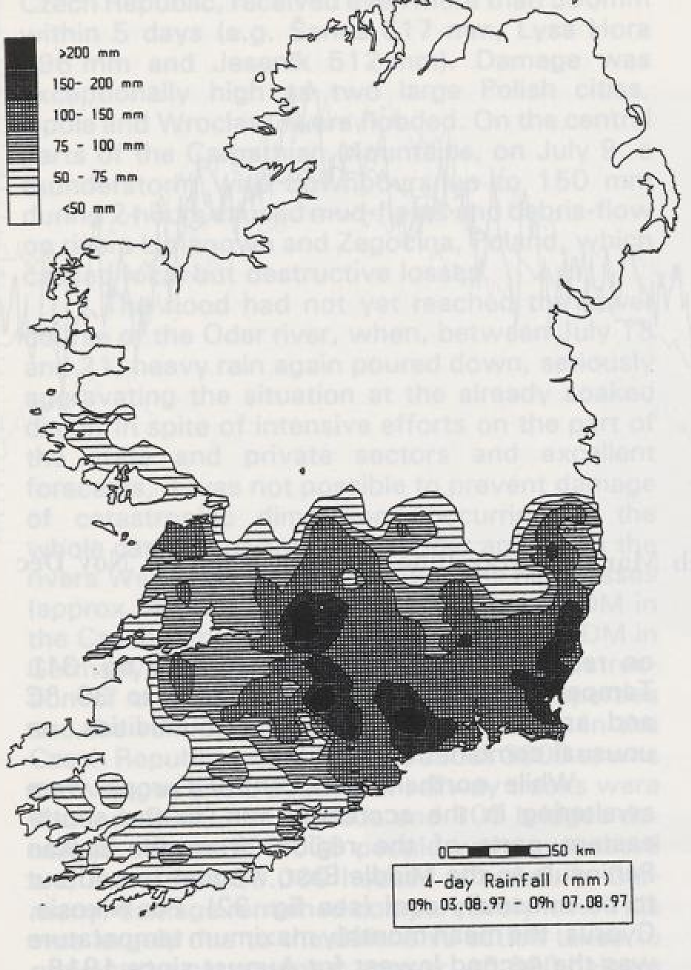


Fig. 34: 4-day rainfall totals in Ireland between August 3 and 7, 1997
(Source: The Irish Meteorological Service)

thunderstorms dumped nearly 75 mm of rain in 45 minutes in east Devon, and on August 13, heavy storms brought chaos across London and the south-east with lightning igniting dozens of roof fires. On August 4/5, thunderstorms with torrential rain were reported from Ile-de-France (up to 125 mm in 90 minutes in Magny-en Vexin). On August 9, an extreme hailstorm was reported in central Greece. Hailstones, some about the size of small lemons caused havoc to cotton, maize and fruit crops.

Heavy rain triggered devastating flooding in Kocaeli, Istanbul and the Bolu region, of north-western Turkey, between August 10 and 13. Daily precipitation totals up to 217 mm were measured. At midday on August 13, a tornado accompanied a thunderstorm in the north-east of Latvia, damaging trees, haystacks and sheds within a 100 m - wide area, a very untypical phenomenon for this region. In Bulgaria, the month was cold and wet. The monthly precipitation total measured at Lyuliakovo , Burgas county, was 199 mm (39 mm on average). Damaging hail was recorded on August 2. Local excessive rainfalls and flash floods were also reported in Romania and Slovenia. Rain with hail caused flooding in Stavropol territory, Russia, on August 8; In Krasnodar region, rivers along the Black Sea coast overflowed their banks after heavy downpours. In Portugal, it was extremely wet in the Évora and Beja region with record high monthly totals (since 1899). On August 25, a thunderstorm with 36 mm of rain within one hour caused substantial damage in Évora.

On August 15, a thunderstorm complex moved along the north slope of the Swiss Alps eastward. The strongest precipitation fell when crossing the Canton of Oberwalden. The precipitation intensity derived from radar echoes amounted to more than 100 mm per hour. Many creeks and rivers swelled. The whole village of Sachseln was devastated by mud and boulders and the damage ran up to 120 million Swiss Franks.

Local heavy rainfall was also reported from Sweden. On August 17, Uppsala received 104-mm of rain during just a couple of hours and Göteborg 130 mm on August 26/27. On August 30/31 along the Norwegian border, in Rösjön (61°38'N;12°41'E), at least 276 mm fell during 24 hours, the largest ever recorded rainfall. Damage to the physical environment was so great that physical geographers concluded that nothing comparable never before had occurred in this area during the Holocene! The water levels in the streams and small rivers of the area quickly rose by 3 m. One of the streams changed its course by nearly 400 m, and another cut through a moraine formation created at the end of the last glacial period.

September:
- **Warm in northern Fennoscandia, cold in the southeast**
- **Mostly very dry, abundant rain in southern Spain and in the Middle East**

While temperature anomalies surpassed plus 2 °C in the western and northern parts of the region, negative anomalies of -3 °C were exceeded north of the Black Sea. Dry and sunny weather prevailed in the region and large areas from north-western France, across the Alps towards the Balkan Peninsula received less than 25% of their normal precipitation (see fig. 13, page 23). Many parts of Britain remained drought stricken. In France, it was the driest September since 1926. Warm and dry conditions favoured forest fires in Lithuania and Armenia. After an unusual cool start in Armenia, an extreme hot spell with temperatures up to 35 °C in Ararat occurred on September 20-22. New records of sunshine duration were set in the eastern parts of Switzerland and in Slovenia (see fig. 12, page 22).

Abundant rain fell in southern Spain and in the southeast. Heavy rain caused serious flooding in south-western Spain towards the end of the month. Huelva received 160 mm of rain on September 26, the highest daily total of the 95-year long time series and, in Alicante, with 270.3 mm, September 30 was the wettest day ever recorded (since 1884). Several districts were cut-off by flooding. On September 1, many rivers in Krasnodar territory, Russia, overflowed their banks and inundated several villages and 320 hectares of farmland. In northern Latvia, lilacs started to bloom for the second time, when after the long dry period, some places received the 200% of the monthly normal rain within only one week in the last decade of the month. Cold and rainy weather prevailed in Azerbaijan with monthly totals 2-5 times above normal. The rivers in the Lenkoran - Astarinsky area inundated two towns which had to be evacuated temporarily. After a thunderstorm with heavy rainfall, roads were flooded in Vipava Valley, Slovenia (Bilje received 195 mm in a few hours). Though weather was unusually wet in Cyprus, (553% of normal, see fig. 14, page 23), it brought hardly any relief to the high precipitation deficit of the preceding months.

On September 27, an intense depression reached the Eastern Mediterranean causing strong winds, severe sandstorms and haze over Israel, a rare event for this time of the year. This was followed by rains - an early start of the 1997/1998 rainy season.

On September 9, an early autumn storm led to damage on the Baltic Sea coast in Germany. A tornado hit the south-eastern part of Norway damaging approximately 10.000 m³ of forest.

October:
- **Very warm on the Iberian Peninsula, cold in the east**
- **Early snowfalls in Scandinavia and around the Baltic Sea**

Though October started out unusually warm in central Europe (the first decade was the second warmest of the century in the Netherlands), the subsequent penetration of cold polar air resulted in the month being colder than normal. With temperature anomalies below minus 4 °C, it was extremely cold in Romania. In Kistelek, Hungary, on October 10, the temperature climbed up to the record high of 28.2 °C, while towards the end of the month, temperatures below minus 10 °C were measured. At Nantmor, North Wales, 26 °C occurred on October 18, the latest that such a high temperature has been recorded anywhere in the UK. There were also new monthly minima established (see fig. 31, page 33). High temperatures up to 34 °C were measured in Georgia and south-western Spain in the second decade. At several places, new daily records were set. For Portugal it was the warmest October since 1931. During the last week of October, winter advanced rapidly in Scandinavia, the Baltic States, Poland, northern Germany and in the Alps. Unusual quantities of snow caused trouble in many regions. In Storlien, northern Sweden, the snow depth grew to the new record value of 60 cm. Record minimum temperatures were measured in western Norway, with Bergen having a minimum temperature of minus 5.5°C, the coldest since 1880. In the north-western parts of the country, the highest snow depth ever recorded in Norway (2m) in October was measured. At the end of the month, snow depth in Elblag, northern Poland, reached 37 cm! Record high snow depths were also reported from the Baltic States; Riga measured 32-35 cm, and in Kuršių Nerija, Lithuania, up to 60 cm were recorded at places, snow depths which have not been measured before in this century in October. Trees and power lines broke down under the heavy burden of snow.

Dry weather prevailed from western Spain across southern France and the Alps eastward. In Hungary, where the period between August and October had been unusually dry, bush fires occurred, causing considerable damage in many parts of the country.

Storms and rain hit England, the Benelux states and northern Germany between October 9 and 11 causing floods in parts. In western Norway, a very old oak forest was damaged by storm. Flooding after heavy rain caused considerable damage in the Istanbul area between October 13 and 15. On October 18, a severe storm hit the Lisbon region, Portugal. Extremely high rainfall intensities were recorded, e.g. 46 mm in one hour. On October 26, a deluge occurred in Mochique, south-western Portugal (273.0 mm of rain within 7 hours and 93.4 mm within 2 hours). On October 30/31, downpours produced floods and land sliding causing high economic losses on the Azores. More than 20 people died. Flooding was again reported from the Krasnodar region (October 25/26). There were only two days without precipitation in Lithuania and at Rusnė station, with a monthly total of 347 mm, reported the absolute monthly maximum amount for the country.

In Israel, a sharav developed on October 14-16 with temperatures up to 41 °C in several areas. It was followed by heavy rain, floods, hail and strong wind. Eleven people lost their lives in southern Israel. A severe storm occurred in Beer Seba, on October 18 at noon; more than 30 mm of rain fell within 30 minutes, 20 mm within 10 minutes. Hailstones reaching the size of golf balls and strong winds caused the collapse of electric power lines and trees, damaged buildings and cars, and flooded the town.

November: • **Wet in the west, dry in the east**
• **Mild in the west, cold in the northeast**

November was very mild and unsettled over western Europe. The temperature in Aultbea in the Scottish Highlands reached 18.8 °C on 16th, breaking a 102-year old record for the second half of November anywhere in the UK. The south of Ireland, was put on flood alert after rivers burst their banks and a train was derailed by a landslide following more than 24 hours of rain. Torrential rainfalls occurred in the south of the region. The rains between November 2 to 5, were the heaviest in memory to hit the south-west corner of the Iberian peninsula. In Badajoz region, Spain, 24 people were killed. A violent storm hit the Alentejo region, Portugal, on November 5 and 6. Torrential rain and wind speeds up to 76 km/h and gusts from 101 to 123 km/h caused considerable damage and high economic losses. Ten people died and 44 were wounded. The following extreme daily precipitation totals were recorded:

Spain:	Cordoba	154 mm
	Caceres	129 mm
	Badajoz	119 mm
Portugal:	Beja	111 mm

At some places, it was the wettest month on record (see table 2).

Table 2: Record high rainfall totals in Portugal and Spain in November 1997

Station	New record	Old record	First observation
Porto/S.Pilar	484 mm	432 mm (1870)	1863
Lisboa/Geofisico	375 mm	344 mm (1983)	1871
Beja	283 mm	180 mm (1983)	1899
Caceres	189 mm	139 mm (1923)	1866
Avila	232 mm	159 mm (1989)	1911
Badajoz	270 mm	222 mm (1951)	1894

In Italy, on November 22, a series of thunderstorms caused the crash of a tourist-aircraft in the Abbruzzi region, of an ambulance-helicopter in Campania and more than 100 road accidents - 17 people died. Flashfloods threw the Greece capital Athens as well as the Corinth region into chaos. Abundant precipitation with flooding of some rivers were reported from Slovenia.

Around the southern Baltic and in the regions west of the Caspian Sea, November turned out to be extremely dry. Monthly precipitation totals were less than 50%, and in some areas, even less than 25% of the normal values.

On November 7/8, an extraordinary hot spell with record high temperatures up to 25 °C (Körösszakál) caused a rare phenomenon in Hungary: a tornado developed in the centre of the Hungarian Plain. It moved along the path Öcsod-Kunszentmárton-Mezötúr and caused considerable damage. A strong Bora occurred in Vipava Valley, Slovenia, with wind speeds up to 130 km/h.

December:
- **Severe cold spells**
- **Wet from the Iberian Peninsula across the Alps to the Ukraine**
- **Violent gales over the British Isles and in the Black Sea region**

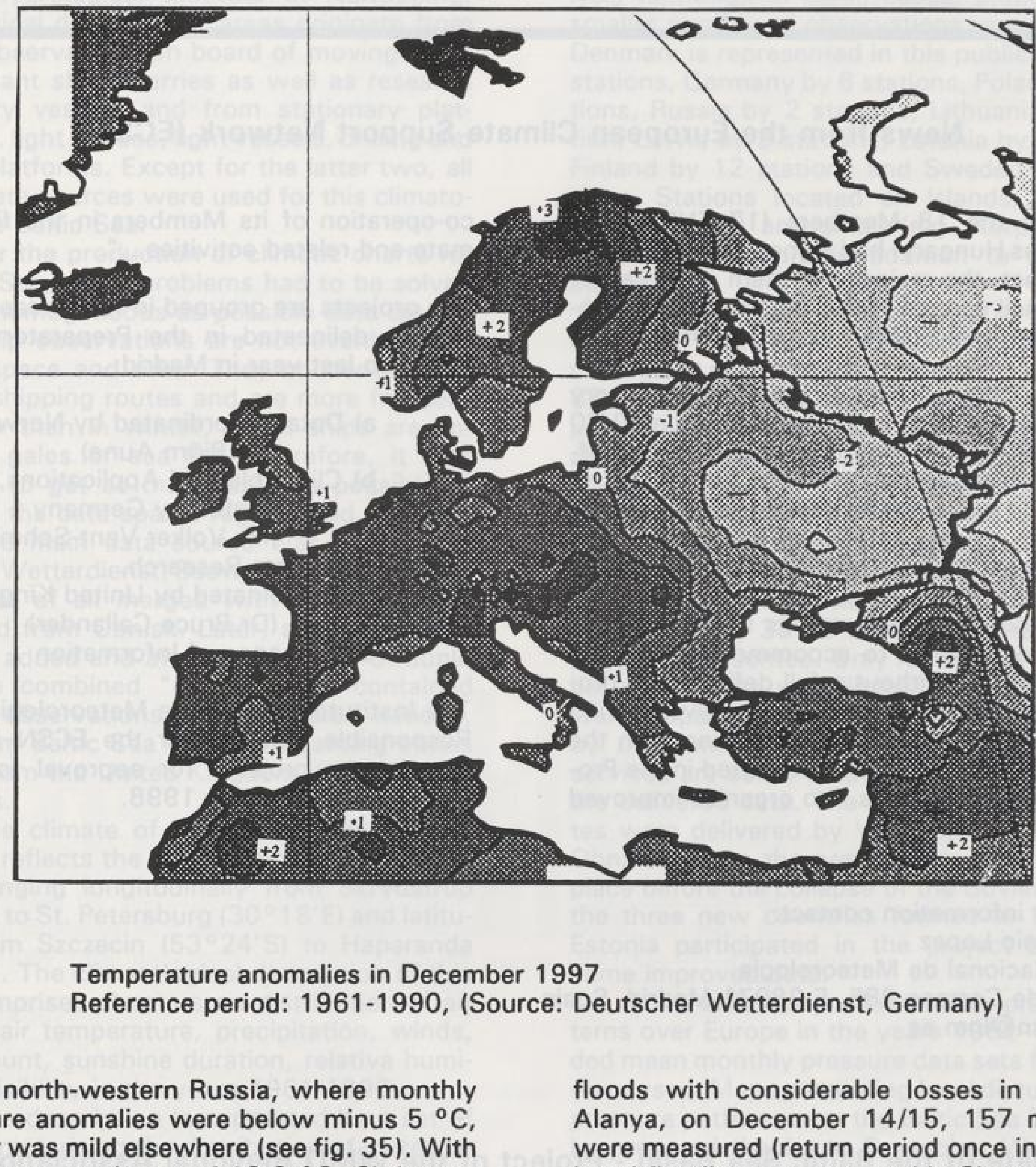


Fig. 35: Temperature anomalies in December 1997
Reference period: 1961-1990, (Source: Deutscher Wetterdienst, Germany)

Except in north-western Russia, where monthly temperature anomalies were below minus 5 °C, December was mild elsewhere (see fig 35). With a temperature maximum of 12.8 °C, Christmas Day was the warmest ever recorded in De Bilt, Netherlands. However, cold snaps gripped western Europe at the beginning and the middle of December. Traffic chaos caused by snow and ice was even spread in Spain. In Sweden, north of Lake Vänern, up to half a meter of new-fallen snow paralysed the traffic and interrupted the electrical energy for several days. In the second decade, cold, heavy snowfall and strong winds caused havoc with power outages, failed heating systems and closed roads in Russia (esp. in the northern Caucasus), Ukraine, Poland and Romania. Temperatures dropped below minus 25 °C at night; dozens of peple, mostly homeless, froze to death.

Above-average precipitation prevailed from the Iberian Peninsula across the Alps and the Balkans to Ukraine and Turkey. The first half of the month brought repeatedly heavy rain and floods with considerable losses in Turkey. In Alanya, on December 14/15, 157 mm of rain were measured (return period once in 14 years). Local flooding was reported in Slovenia (see fig. 22, page 26). On Hios Island, Greece, 113 mm of rain poured down within 12 hours, causing considerable damage. Twenty-four-hour precipitation totals up to 60 mm were recorded in southern Bulgaria on December 16.

A severe storm hit the Black Sea region on December 16/17. Krasnodar, Russia, recorded gusts up to 52 m/s; around Novorossiysk, there were wide-spread power outages. The ports of Varna and Burgas, Bulgaria, had to be closed because of winds up to Beaufort 9 and rough sea. Shipping was severely affected at Tekirdağ, Turkey. For the British Isles, the most notable event of the month was the occurrence of severe gales over Christmas. At least 10 people were killed in the storms, with gusts up to 163 km/h (Valentia, Ireland), and thousands of homes left without electricity. The worst affected areas were Ireland, North Wales and Cheshire.

Activities of European Climatological Centres

News from the European Climate Support Network (ECSN)

After all of the 18 Members (17 EUMETNET NMHS's plus Hungary) had signed the corresponding Contract, the majority of them on occasion of the Council in April 1997, the EUMETNET Optional Programme ECSN has begun officially in 1998.

The first meeting of the ECSN Advisory Committee took place in Madrid during on 19/20 February 1998, with the main objective of drafting project proposals to start the new ECSN. It will focus on a few well-defined projects, trying to deliver in them, rather than embarking on a greater number of more ambitious but less viable tasks. On the other hand, it also became clear that the concept of projects has to be extended or relaxed somewhat to accommodate also activities that start without a full defined end product or objective to be attained in a given period of time. These activities will be in line with the main objective of the ECSN, as stated in the Programme Decision, that is, "to organise improved co-operation of its Members in the field of climate and related activities...".

The projects are grouped in four areas that were already delineated in the Preparatory meeting held also last year in Madrid:

a) Data, co-ordinated by Norway (Mr.Björn Aune)
b) Climatological Applications, coordinated by Germany (Mr.Volker Vent-Schmidt)
c) Climate Research, coordinated by United Kingdom (Dr.Bruce Callander)
d) Exchange of Information

The Instituto Nacional de Meteorologia, INM, as Responsible Member for the ECSN intends to present the projects for approval to the next Council in September 1998.

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Climate of the Baltic Sea Basin - Project of the WMO Regional Association VI

by Dr Miroslaw Mietus, Gdynia

The increasing demand for the exploration of climatic conditions in relatively small sea-basin areas due to the expansion of industry, the intensification of shipping and off-shore activities were the impetus for representatives of several countries from the Baltic Sea Basin to carry out a joint study on the climate of that region. During the eighth session of RA VI held on 5-15 October 1982 in Rome, the main purposes of the project were defined.

In order to properly characterize the climate of the Baltic Sea region, data from the coast as well as from the sea had to be analysed. National Services from the countries involved in the project were requested to offer climatological tables from selected coastal stations, prepared by the use of uniform criteria, for the last WMO normal climatological period 1961-1990. The data from sea areas originated from weather observations made on board of ships and stationary platforms during the same period. On the basis of these data, a climatological analysis of the Baltic Sea and adjacent coasts was carried out. Political changes in the early 90s, i.e. the unification of Germany and the collapse of the Soviet Union, affected some of the countries involved in the project. As a result, the following national services participated in the final stage of the project: the Danish Meteorological Institute in Copenhagen, the Deutscher Wetterdienst, Seewetteramt in Hamburg, the Institute of Meteorology and Water Management, Maritime Branch in

Gdynia, the World Data Center B1 in Obninsk, the Estonian Meteorological and Hydrological Institute in Tallinn, the Finnish Meteorological Institute in Helsinki and the Swedish Meteorological and Hydrological Institute in Norrköping. Climatological data for sea areas originate from weather observations on board of moving ships like merchant ships, ferries as well as research and fishery vessels and from stationary platforms, e.g. light houses, light vessels, drilling and research platforms. Except for the latter two, all kinds of data sources were used for this climatology of the Baltic Sea.

For the production of climatic charts for the Baltic Sea, some problems had to be solved to get an homogeneous as possible data set.

Ship observations are not evenly distributed in space and time: They concentrate on the main shipping routes and are more frequent in summer than in winter, when ships are impeded by gales or sea ice. Therefore, it was necessary to get as many data as possible to cover also the data sparse regions and months.

The main data source was the one of Deutscher Wetterdienst, Seewetteramt Hamburg. It was first of all merged with the data from Poland and from Obnisk. Later, additional datasets were added and after the deletion of duplicates, the combined "BALTIC" set contained 359.881 observations from several nations, mainly from Baltic Sea adjacent/boarding states but also from the United Kingdom, USA, France and others.

The climate of the coastal area of the Baltic Sea reflects the geographical extent of the region, ranging longitudinally from Skrydstrup (09°16'E) to St. Petersburg (30°18'E) and latitudinally from Szczecin (53°24'S) to Haparanda (65°50'S). The climatological description of this region comprises chapters on distribution of air pressure, air temperature, precipitation, winds, cloud amount, sunshine duration, relative humidity and visibility in the years 1961-1990.

The description is supported by a set of tables characterising the distribution of meteorological elements during this period.
Meteorological services from the countries involved in the project delivered about one thousand climatological tables of coastal data. Finally, 69 stations carrying out 8 observations per day and located no further than 30 km from the coast, were accepted for the climatological analysis (although in some cases, stations with a smaller number of observations were analysed). Denmark is represented in this publication by 10 stations, Germany by 6 stations, Poland by 8 stations, Russia by 2 stations, Lithuania by 1 station, Latvia by 3 stations, Estonia by 4 stations, Finland by 12 stations and Sweden by 28 stations. Stations located on islands, both large (e.g. Gotland) and small (e.g. Korppoo), were taken into account in addition to the coastal stations.

The set of tables consists of 4 main parts: tables 1-22 present mean annual distributions of different meteorological elements, tables 23-188 contain monthly frequency distributions of air pressure, air temperature, relative humidity, cloud amount and visibility, tables 189-224 and 225-259 present two-dimensional tables of frequency distributions of wind speed & wind direction and air temperature & wind direction, respectively. When possible, values in the tables 1-22 are given for all 69 stations. In the remaining tables, the data from 33-36 stations located near the coast are presented. Only for visibility, the number of stations was limited to 30. The tables were prepared according to the format proposed by the panel of the experts and the national services are solely responsible for the quality of the delivered data. The tables for the Baltic states were delivered by World Data Center B1 in Obninsk, since the preparation of the data took place before the collapse of the Soviet Union. Of the three new countries formed in 1991, only Estonia participated in the project by sending some improved data.

In order to produce mean pressure patterns over Europe in the years 1961-1990, gridded mean monthly pressure data sets from NCAR were used. Maps presenting local disturbances of pressure patterns over the Baltic Sea Basin could be prepared thanks to Deutscher Wetterdienst, Seewetteramt in Hamburg, which kindly delivered mean monthly pressure values for about 60 European stations.

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North European Group of Historical Climatology

In honour of Knud Frydendahl and Erik Wishman, the North European Group of Historical Climatology met in Reykjavik, on August 4 and 5, 1997. 42 scientists from 11 countries joined the symposium, which was supported in part by the U.S. National Science Foundation (NSF). Twenty papers were presented on the climatic and environmental history of Northern Europe and the North Atlantic region over the past 1000 years. Documentary sources, various proxy indices and early instrumental observation methods used for the reconstruction of the climate and above all the temperature conditions were presented. Most of them focused on the 'Little Ice Age' around the North Atlantic in the seventeenth century.

REWARD - A Nordic project on climatic extremes

Changes in the frequency or intensity of extreme events have extensive impacts on society and the environment. In the *REWARD-project (Relating Extreme Weather to Atmospheric circulation using a Regionalised Dataset)*, special focus was placed determining whether the observed global warming has caused any changes in climatic extremes in the Nordic countries, i.e. Denmark, Finland, Iceland, Norway and Sweden. The REWARD-project is a Nordic continuation of the North Atlantic Climatological Dataset (NACD) project, and is partly financed by the Nordic Council of Ministers, and partly by the national meteorological institutes in the Nordic countries.

Within the framework of REWARD, 67 long-term series of monthly absolute and mean values of maximum and minimum temperature, and 85 monthly series of maximum 1-day precipitation were digitised, quality controlled and compiled in a consistent dataset. The majority of the series covers the period 1895-1996. The data set comprises series for all parts of the Nordic region, including the Faeroes, Greenland and the Norwegian Arctic stations.

For Fennoscandia (Denmark, Finland, Norway and Sweden), the smoothed, area-weighted series indicated high mean summer maximum temperatures in the 1930s. Similarly, the mean minimum temperatures in summer, autumn and winter were also high during the 1930's. Both maximum and minimum temperatures have increased during winter and spring during the last two decades. The recent warm winters (since 1988) seem to surpass even the warm 1930's. Since 1950, there have been negative trends in the daily temperature range (DTR) in all parts of the Nordic region as well as for the Northern Hemisphere (fig. 36). The decrease is largest in Western Greenland. The decrease in spring DTR is significant in all parts of the Nordic region. In Fennoscandia, the narrowing of DTR is mainly due to increase in cloud cover but also atmospheric circulation changes have contributed to the decrease.

Analysis of the long-term series of maximum 1-day precipitation (Rx) showed no distinct large scale trend pattern in the Nordic region, although there is a tendency to higher values in the 1930s and increasing values during the last two decades. For most parts of the Nordic region, the highest frequencies of «extraordinary» precipitation (i.e. Rx events with a return period exceeding 5 years) occurred in the 1930's and in the two last decades (Figure 2), i.e. in decades with high regional summer temperatures. For Western Norway however, there was no local maximum in the 1930's. The two last decades have evidently had the highest number of extraordinary precipitation events. During this period, Western Norway has experienced a substantial increase in orographic precipitation.

One of the objectives of REWARD was to study whether the variation in climatological extremes could be explained by variations in the atmospheric circulation. A multiple linear regression model based on geostrophic winds was developed. Both for Rx and Tn the model gave reasonably high correlation by using geostrophic winds, sea level pressure and monthly mean temperature as predictors.

The large geographical variation of climatic extremes in the Nordic region are mapped in a first REWARD-edition of a «*Nordic Atlas of climatic extremes*». The range of climatic extremes in the Nordic region is large: In Fennoscandia, the highest recorded maximum temperature ranges from 26°C at western, coastal stations in Norway to 38°C in Central Sweden;- the lowest minimum temperatures from -13°C at western, coastal stations in Norway to -53°C at northern interior stations in Norway and Sweden. In Iceland, the absolute temperature range is from -38.0°C to +30.5°C. The highest measured maximum 1-day precipitation varies from 40 mm at stations leeward of the mountains in Southern Norway to around 240 mm at singular stations in Iceland, Norway and Sweden.

For further information contact the co-ordinator of REWARD :

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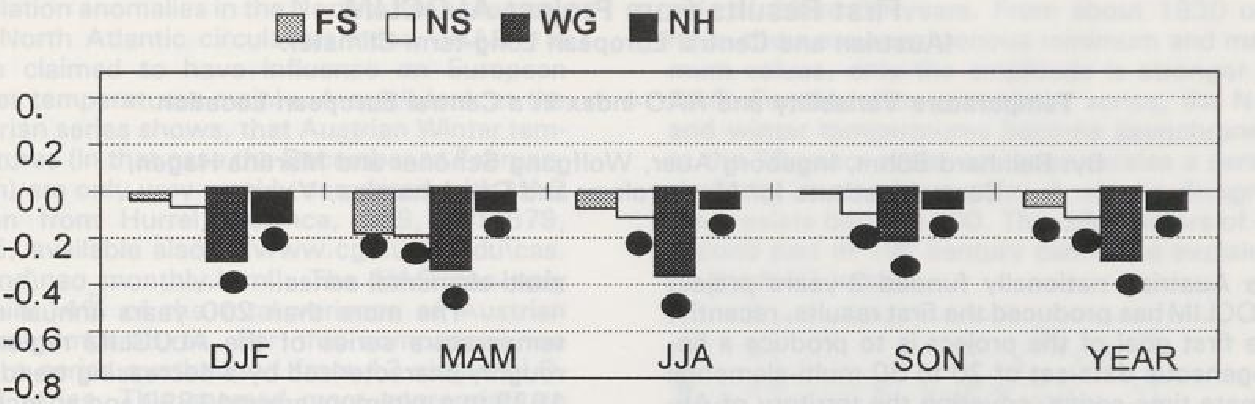

Fig. 36: Linear trends (1950-1995) of diurnal temperature range (DTR) (°C/10 years) for Fennoscandia (FS), Nordic Seas (NS), West-Greenland (WG) and Northern Hemisphere non-urban stations (NH). Statistically significant trends at the 5% level are marked with black dots (The DTR for NH is taken from Easterling et al., 1997, Science, 277, 364-366.)

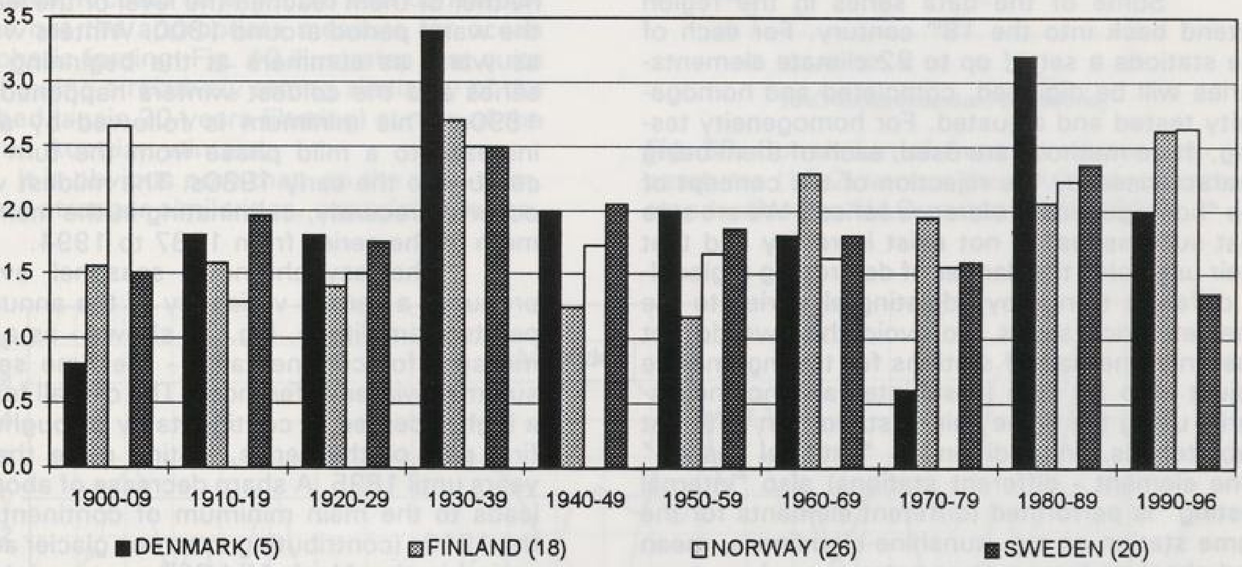

Fig. 37: Number of «extraordinary» 1-day precipitation events per station and decade in Fennoscandia (In brackets: Number of stations analysed)

First Results from Project ALOCLIM
(Austrian and Central European Long-term Climate):

Temperature Variability and NAO-index in a Central European Location

By: Reinhard Böhm, Ingeborg Auer, Wolfgang Schöner and Martina Hagen,
Central Institute for Meteorology and Geodynamics, Vienna

The Austrian nationally funded 2-years project ALOCLIM has produced the first results, recently. The first goal of the project is to produce a homogeneous data-set of 20 to 30 multi-elemental climate time-series, covering the territory of Austria and its border-near neighbourhood. For the non-Austrian regions a productive collaboration with our neighbour-Met-services could be established. The project is funded by the Austrian Ministry of Science and Transport and the Ministry for Environment, Youth and Family Affairs (Gz.308.938/3-IV/B/3/96).

Some of the data series in the region extend back into the 18th century. For each of the stations a set of up to 22 climate elements-series will be digitised, completed and homogeneity tested and adjusted. For homogeneity testing, three methods are used, each of them being characterised by the rejection of the concept of the "homogeneous reference series". We are sure that such series do not exist in reality and that their use holds the danger of destroying regionally different trends by adjusting all series to the one reference series. To avoid this, we do not use only one pair of stations for testing and we adjust step by step in subintervals, not necessarily using the same pair of stations in different subintervals. In addition to "external testing" (one element - different stations) also "internal testing" is performed (different elements for the same station as e.g. sunshine-cloudiness, mean and absolute temperature extremes,...).

The first (homogenising) part of ALOCLIM is still in progress, but some preliminary results can already be shown, which illustrate the benefits of establishing homogeneous time series and multi-elemental series.

The more than 200 years annual mean temperature series of the ALOCLIM region are roughly characterised by a decreasing trend until 1829 to a minimum around 1890 and an increase since then to the first 20th century maximum around 1950 and a second maximum culminating in the early 1990s. Summer temperatures show a higher initial temperature level around 1800 and a longer period of decreasing trend lasting until 1910. In the 20th century there are again two maximums similar to the annual means, but neither of them reached the level or the length of the warm period around 1800. Winters were not as warm as summers at the beginning of the series and the coldest winters happened in the 1890s. This minimum is followed by a sharp increase to a mild phase from the turn of the century to the early 1930s. The mildest winters occurred recently, culminating in the main maximum of the series from 1987 to 1994.

The asynchronous seasonal evolution produces a certain variability of the annual temperature amplitude. Fig. 37 shows - as a simple measure for continentality - the time series of summer-winter differences. The overall feature is a higher degree of continentality throughout the first part of the series, lasting more than 100 years until 1895. A sharp decrease of about 2 °K leads to the main minimum of continentality in the 1910s (contributing to strong glacier advance period in the Alps). Mid 20th century is characterised by higher continentality and after the 1940s it decreased again.

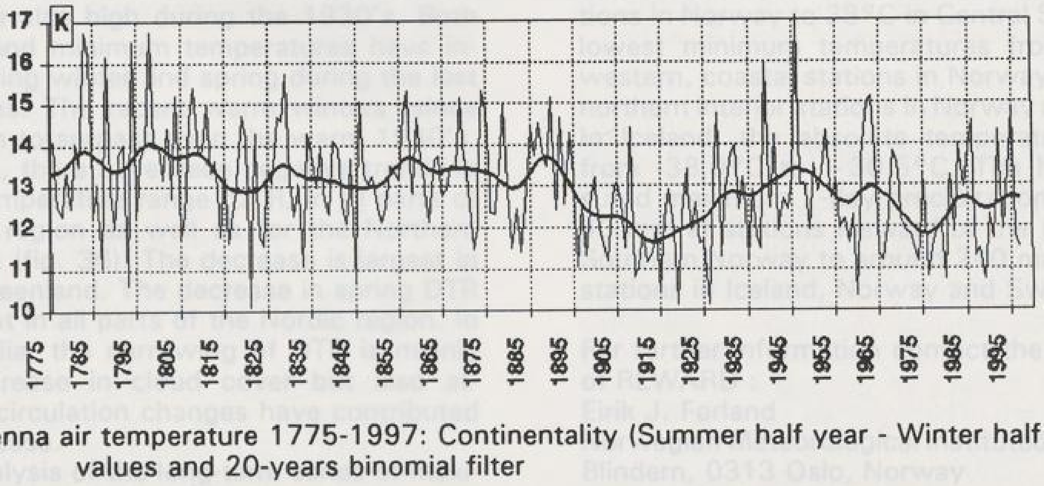

Fig. 38: Vienna air temperature 1775-1997: Continentality (Summer half year - Winter half year), single values and 20-years binomial filter

The recent high temperature level is often mentioned in context of climate change, mainly as an argument for an already existing anthropogenic effect, but also in connection with strong circulation anomalies in the North Atlantic region. The North Atlantic circulation index - NAO - is often claimed to have influence on European winter temperatures mainly. A quick look at the Austrian series shows, that Austrian Winter temperatures (in that case the December to February mean) are only very weakly correlated with NAO (taken from Hurrel, Science, 269, 676-679, 1995, available also at www.cgd.ucar.edu\cas. climind\nao_monthly.html). The NAO can only explain 14% of the total variance of Austrian winter temperatures. For this comparison we used a series synthesised from 12 single ALOCLIM series. This seemed more appropriate to deal with larger scale circulation patterns than using one single series. Fig. 39 shows the correlogram -only a very weak similarity can be seen. But correlation is a measure for single values mainly. Poor correlation does not necessarily mean a weak similarity on the long term. As ocean behaviour is characterised by longer time scales, it could be expected that correlation alone is not the appropriate measure for ocean atmospheric forcing. Fig. 40 illustrates that quite well, showing a relatively strong similarity of the smoothed (again 20-years filtering) curves of the NAO and Austrian winters.

It is obvious now that, on the long-term, there are stronger similarities, especially on the side of 20 to 30 years. From about 1930 until now, there are synchronous minimum and maximum values, only the amplitude is stronger for NAO. For the older part of the series, the NAO and winter temperatures become asynchronous at the 20-years scale, on longer scales a certain similarity seems to remain. A strong disagreement exists before 1900. The cold winters of the second part of 19th century cannot be explained bv the NAO index.

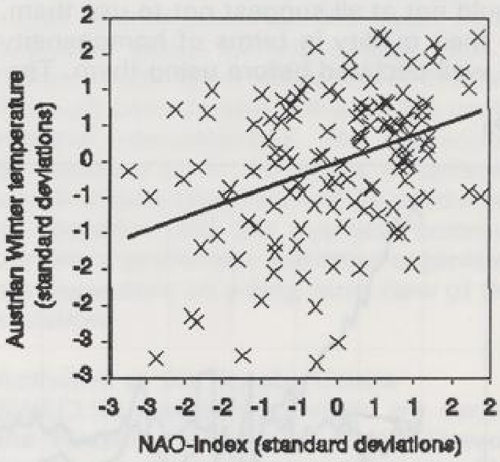

Fig. 39: Correlation of Austrian winter-temperatures (12-2) versus the NAO index (both standardised to NAO-period 1866-1994)

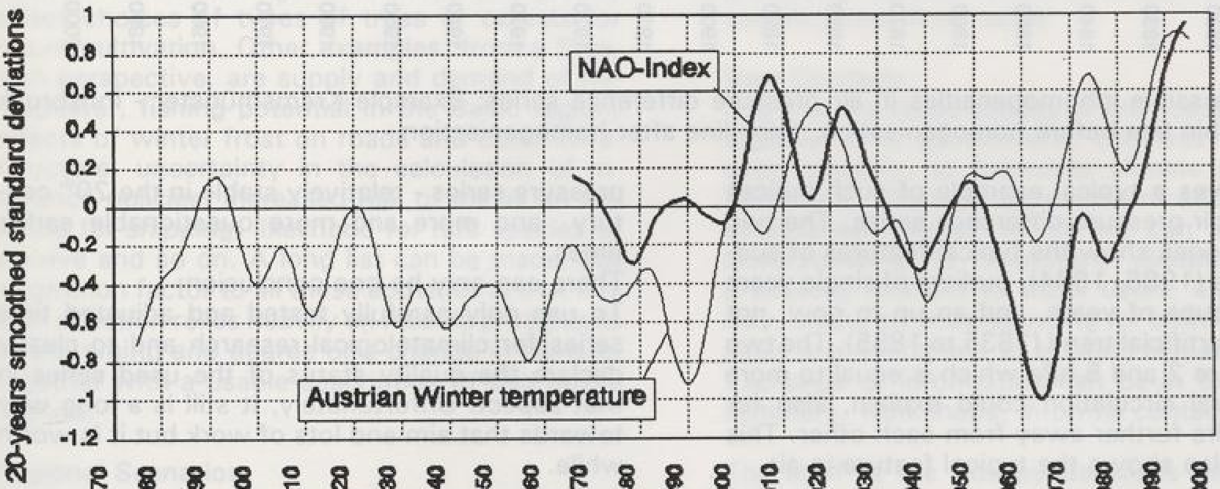

Fig. 40: NAO-index and Austrian Winter temperatures (20-years smoothed, both standardised to 1866-1994)

From the point of view of the underlying physics, a long-term forcing of winter climate by slowly oscillating circulation patterns (forced by the ocean) makes sense. We should look for explanations for the existing similarities, but also for the disagreement of the curves in some aspects.

Taking both curves seriously in terms of homogeneity, we find a stronger overall centennial increase of temperature compared with the circulation index. This could be used as an argument for a forcing not due to circulation changes, but by anthropogenic greenhouse forcing perhaps. A second closer look at the more recent evolution shows, on the other hand, that since 1960 - when the greenhouse gas increase was strongest - the NAO increased greater than temperatures. This suggests that circulation could explain most of (or even more than) the warming of the last 30 years.

The increasing disagreement in the earlier part of the series suggests another more likely factor, the question of homogeneity. We know much about the quality of the historical temperature series and we know much about the strong sensitivity of air pressure series for inhomogeneities. As the historical NAO index is a difference between two single pressure series (Stykkisholmur and Punta Delgado), we must be aware of the many possibilities for breaks in such series, possibly leading to serious biases of the difference series. Variations of such difference series usually are smaller than the typical inhomogeneities.

Our doubts about the homogeneity of long-term circulation indexes based on pressure series should not at all suggest not to use them. However, their quality in terms of homogeneity should be well declared before using them. The experience from the homogenisation of ALOCLIM pressure series clearly underlines two facts:

Original pressure series are never homogeneous. They have many breaks which can totally disturb the true climate signal. But pressure has been treated very carefully by meteorologists at all times and therefore there is a good metadata documentation of this climate element available at the National Met. Services. In addition to that, pressure series are strongly correlated over large distances. This makes homogeneity testing and adjusting very easy and possible on a high quality level.

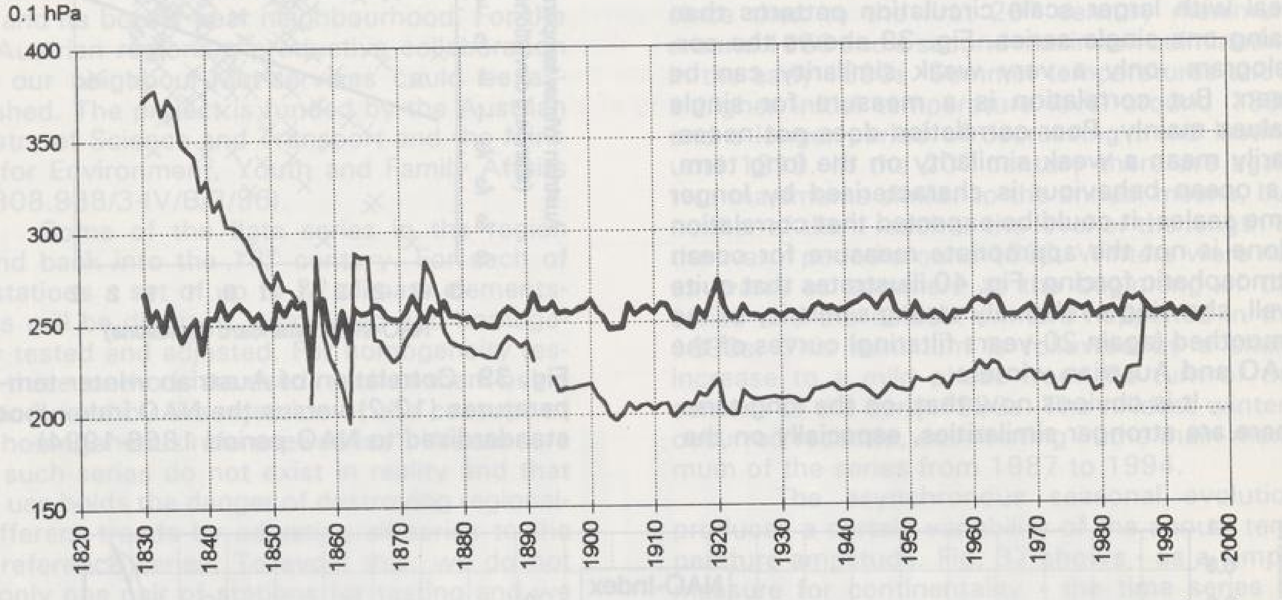

Fig. 41: Possible inhomogeneities in air pressure difference series: Example Kremsmünster - Innsbruck (Austria) thin line before homogenisation, thick line after homogenisation

Fig. 41 gives a typical example of such indices based on air pressure difference series. The two Austrian series show the typical features of sudden breaks (1986, 1894), outliers of single years and of groups of years, and an up to now, not explained artificial trend (1835 to 1855). The two breaks were 2 and 5 hPa which is equal to more than natural circulation could explain, also for station pairs further away from each other. This example also shows the typical feature in air pressure series - relatively stable in the 20th century and more and more questionable earlier times.

There can only be one conclusion:
To use only carefully tested and adjusted time series for climatological research and to clearly declare the quality status of the used series in that aspect. Unfortunately, it still is a long way towards that aim and lots of work but it is worth while.

The Rossby Centre of the Swedish Meteorological and Hydrological Institute SMHI

The Rossby Centre is a new research unit within SMHI whose prime directive is to undertake the goals of the Swedish climate research programme, SWECLIM. One of the main objectives of this programme is to provide society with reliable future scenarios tailored to meet the needs of different interest groups.

The SWECLIM Programme
The Swedish Regional Climate Modelling Programme, financed jointly by MISTRA (Foundation for Strategic Environmental Research) and SMHI (Swedish Meteorological and Hydrological Institute), aims to increase our knowledge of the effects of climate change in Sweden and the other Nordic countries. These effects, with respect to variables such as temperature and precipitation, are central issues under the increasing threat of global climate change. Previous studies show close ties between the present-day natural environment and the existing climate, and it is highly probable that changes in climate will have far-reaching ecological, economic and social consequences.

Widespread Impacts
An example is conditions for forestry and farming in Sweden. Almost all cultivatable cereals and trees today have northerly limits of growth in Scandinavia. A change of climate can greatly affect choices of types of trees or cereals for future cultivation. Other examples, from a Swedish perspective, are supply and demand of hydropower, fishing potential in the Baltic region, effects of winter frost on roads and other infrastructure, uncertainty in the calculation of insurance policies, increased risk of ice as an obstacle for shipping, likelihood for rare species to survive and so on. A long list can be made, but a common factor to all these activities is that any plan of action relies heavily on reliable predictions of the timing and degree of a change in climate, together with a usable description of this future climate.

Regional Scenarios
What is common to all existing climate scenarios on a global level is that they are difficult to put to practical use on a regional level. The aim of SWECLIM is to develop regional climate models which can be used to project climate scenarios for Sweden and the Nordic countries over a time period of 20-100 years in the future. These scenarios will be based on the latest model simulations of global climate change, but they will have a much higher resolution in time and space. This will considerably enhance the usefulness of regional interpretations. The scenarios will also be modified to fit the needs of different users, which means that they will be produced in close co-operation with the business community, government authorities and other organisations that are dependent on a long term view of the climate situation.

Activities at the Rossby Centre
SWECLIM research activities are carried out at the Rossby Centre and at the Universities of Stockholm, Gothenburg and Uppsala. The Rossby Centre functions as the hub of SWECLIM, with the tasks of developing and maintaining regional climate models, identifying needs for and formulation of climate scenarios, and subsequently producing regional scenarios in accordance with specifications from users.

User Contacts
It is thus the responsibility of the Rossby Centre, together with government, business and other user interests, to formulate climate scenarios. Therefore, channels of communication will be established through which we can acquire an understanding of important climate-sensitive processes relevant to these users, and conversely, create an understanding for both the capabilities and limitations of existing climate models. Exchange of information can be in the form of seminars, workshops, informal contacts, etc.

The staff at the Rossby Centre is made up of research scientists in the fields of meteorology, hydrology and oceanography, together with systems analysts, computer programmers and administrative personnel. A total of 14 people will work at the Rossby Centre.

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NOTE:
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