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Climate Support  
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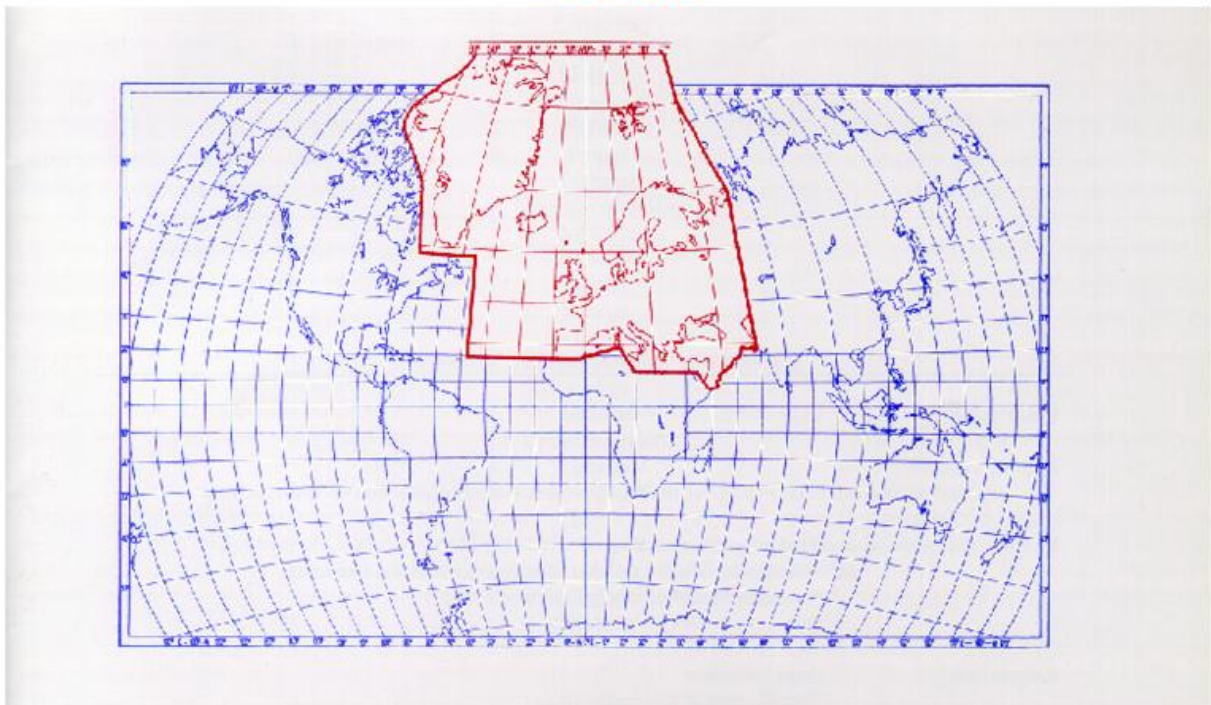
World Meteorological  
Organization  
World Climate Data  
and Monitoring Programme

Deutscher  
Wetterdienst



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

## 2002



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**Annual Bulletin on the Climate in WMO Region VI  
- Europe and Middle East -  
2002**

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

Armenia  
Austria  
Azerbaijan  
Belarus  
Belgium  
Bosnia and Herzegovina  
Bulgaria  
Croatia  
Cyprus  
Czech Republic  
Denmark  
Estonia  
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Ireland  
Israel  
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Jordan  
Latvia  
Lithuania  
Luxembourg  
Netherlands  
Norway  
Poland  
Portugal  
Romania  
Serbia and Montenegro  
Slovakia  
Slovenia  
Spain  
Sweden  
Switzerland  
Turkey  
Ukraine  
United Kingdom

Furthermore, contributions to the WMO Bulletin article on consequences of abnormal weather in 2002  
were referred from the following countries:  
Georgia, Kazakhstan, Russian Federation

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## Foreword

This 9<sup>th</sup> edition of the Annual Bulletin on the Climate in WMO Region VI – Europe and Middle East – for 2002 was enabled by national contributions from the Meteorological and Hydro-Meteorological Services in WMO Region VI.

The Call for Input was answered directly by 80% of the 49 member countries. Additionally, WMO Secretariat provided the editor with all national contributions to the WMO Bulletin article on consequences of abnormal weather in 2002 from the WMO Regional Association VI. Thus, even more information could be used for the compilation of this edition, leading to a percentage of 86 of represented member countries. More than 3 quarters of possible national reports were sent in the most preferred way, which is email including attachments or server addresses.

The bulletin elaborates on a very interesting climatological year. A long lasting period of positive temperature anomaly began in the middle of January and dominated the regime of monthly mean temperatures all over Europe. This period ended between August and October, depending on the specific area. Outside this period, relatively cool and sometimes extremely cold weather conditions

prevailed in most countries with some exceptions.

Another characteristic and dramatic feature of the year was continuously intense rain fall in central eastern Europe for quite some days in August with disastrous consequences to the infrastructure of wide areas, especially in Austria, Czech Republic and eastern Germany. Hundred thousands of people have been directly involved in this natural catastrophe. A special article on this extreme climatic event is included in this Bulletin.

Other special reports in this edition have been contributed by the ECSN Programme Manager and the Meteorological Observatory Hohenpeißenberg.

On this occasion, I want to thank all, who contributed to this paper by reports and practical support. I am especially thankful to the German Meteorological Service for the co-ordination, the editorial review, publishing and distribution of this Bulletin.



Daniel Keuerleber-Burk  
Acting President of WMO Region VI

## **Outstanding Events and Anomalies in 2002**

### **Temperature**

- **A very cold start of the year, followed by a long lasting period of positive anomaly from the middle of January into autumn nearly all over the Region**
- **Extremely mild February in central and eastern Europe**
- **Hottest summer since the beginning of observations in a large area around the Baltic Sea**
- **Extremely cold in eastern Europe at the end of the year**

### **Precipitation**

- **Wet summer in central Europe with record breaking daily rainfall rates in August leading to disastrous flooding in Austria, Czech Republic and eastern Germany**
- **Long lasting drought in the Baltic countries and Belarus in late summer**
- **Extremely wet in the Caucasus at the end of the year**

### **Wind**

- **Strong winds in northern Europe during the last days of January causing lots of life losses and material damage**
- **Stormy weather with lots of damage in many European countries at the end of October**

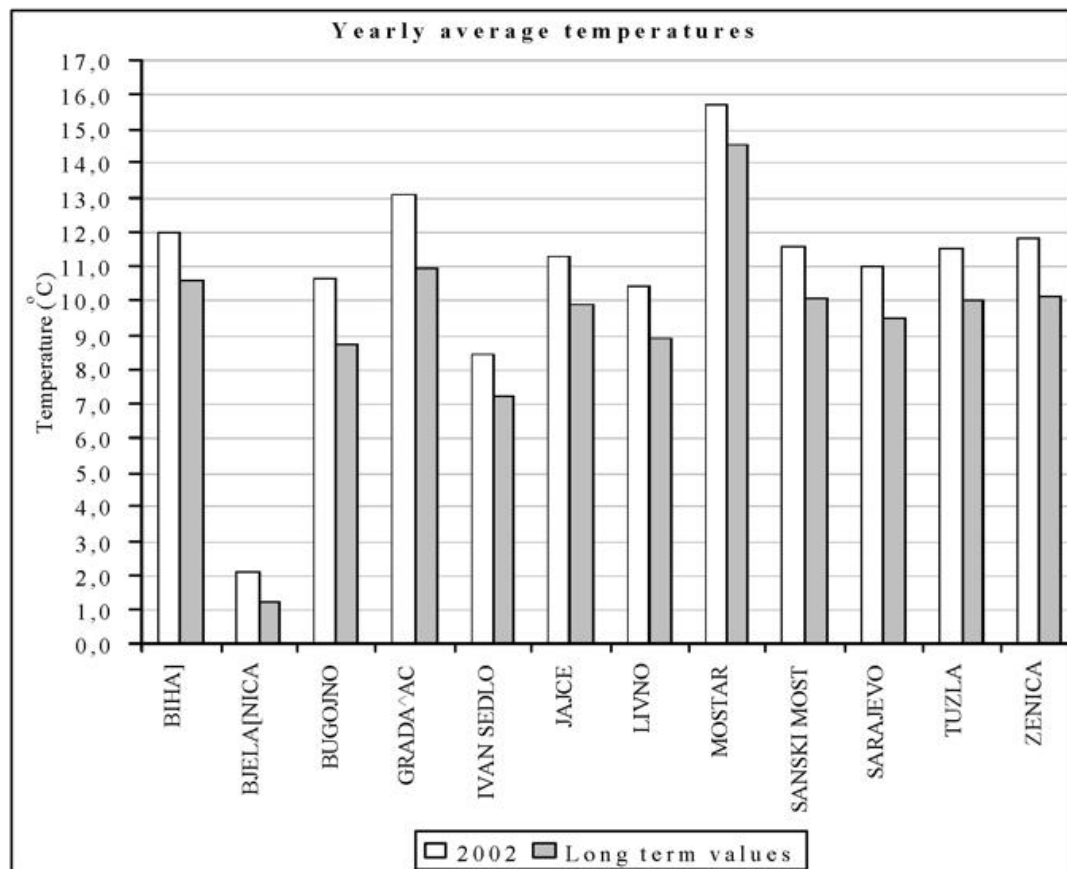
## Annual Survey

**Temperature** deviations from the long term annual average were mainly positive all over the Region up to about +2.5°C except for some places in Turkey and parts of northern Russia with slightly negative anomalies. Typical values of the yearly mean temperature compared to normal are presented for example by fig. 0.1.

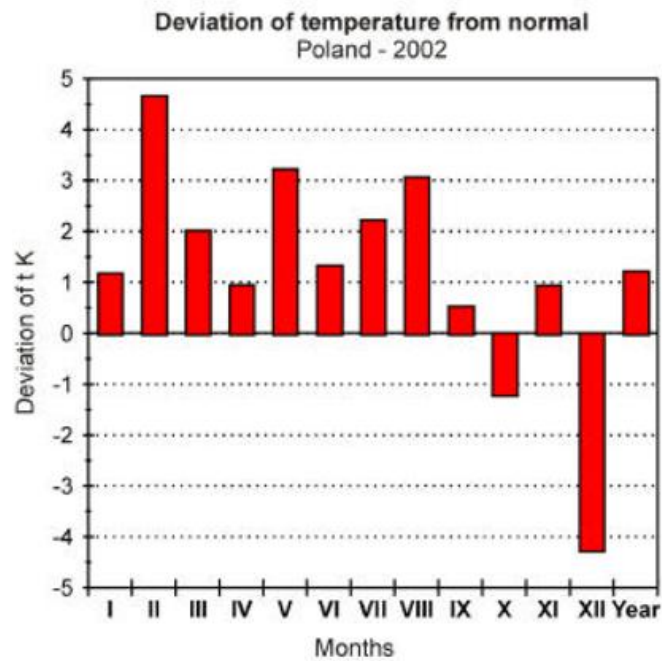
Scandinavia and great parts of central and eastern Europe had a long lasting period, i.e. from the middle of January until September, of continuously positive monthly temperature anomalies (e.g. see fig 0.2 and tab. 7.1).

Additionally, there were some record breaking observations. At Weather Ship "Mike" (66°N, 2°E), operated by Norway, the

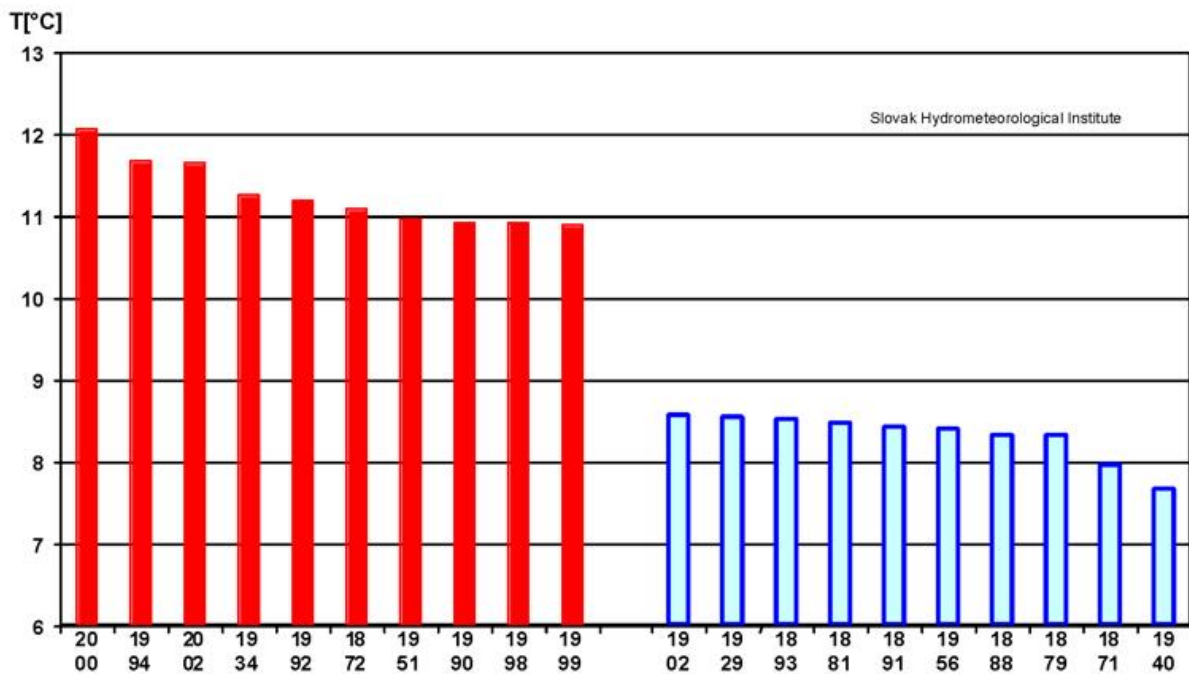
mean air temperature for the months April to July was the highest ever recorded since the start of the series in 1948; with a time delay of one month, the mean sea surface temperatures were also extremely high. The number of days with snow cover in Iceland was reduced to about two thirds of normal. The mountain range of the High Tatras in Slovakia had the warmest year since 1951; as in other European countries, it was one of the warmest in more than 100 years, illustrated by figs. 0.3-0.5. In the Middle East, the positive temperature anomalies prevailed also, as can be seen from the example of extreme temperatures in fig 0.8.



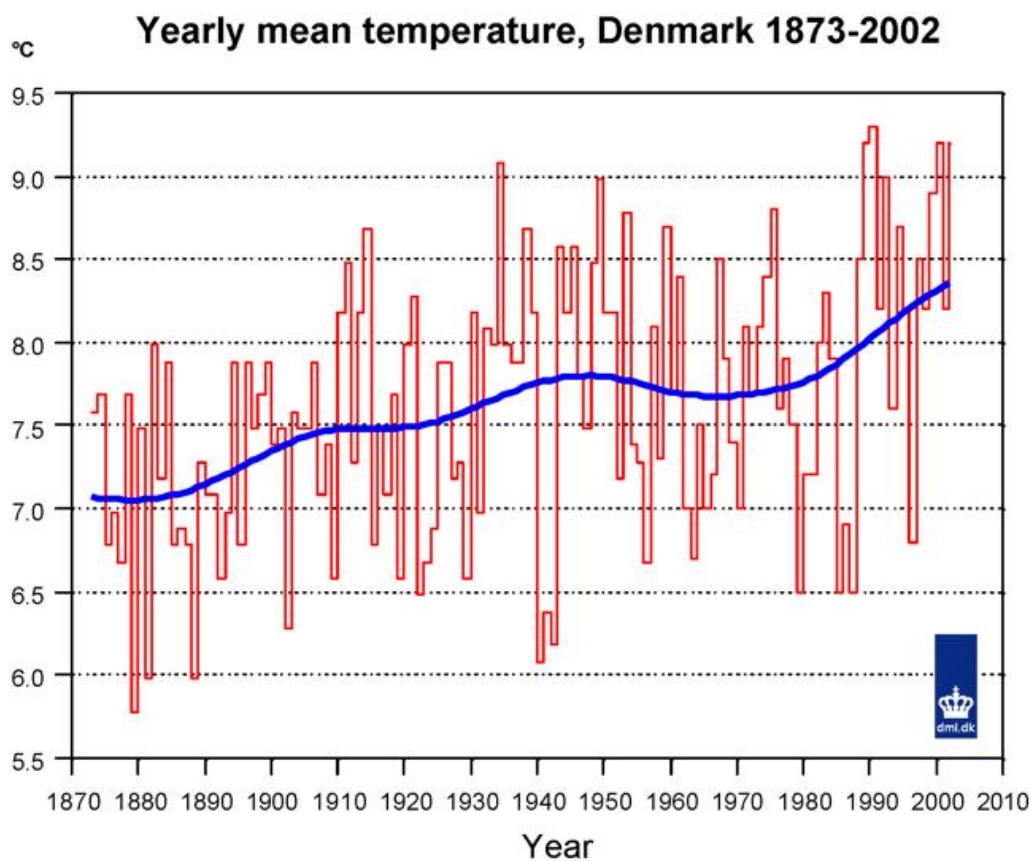
**Fig. 0.1:** Yearly average Temperatures in Bosnia-Herzegovina  
From: Federal Meteorological Institute of Bosnia and Herzegovina



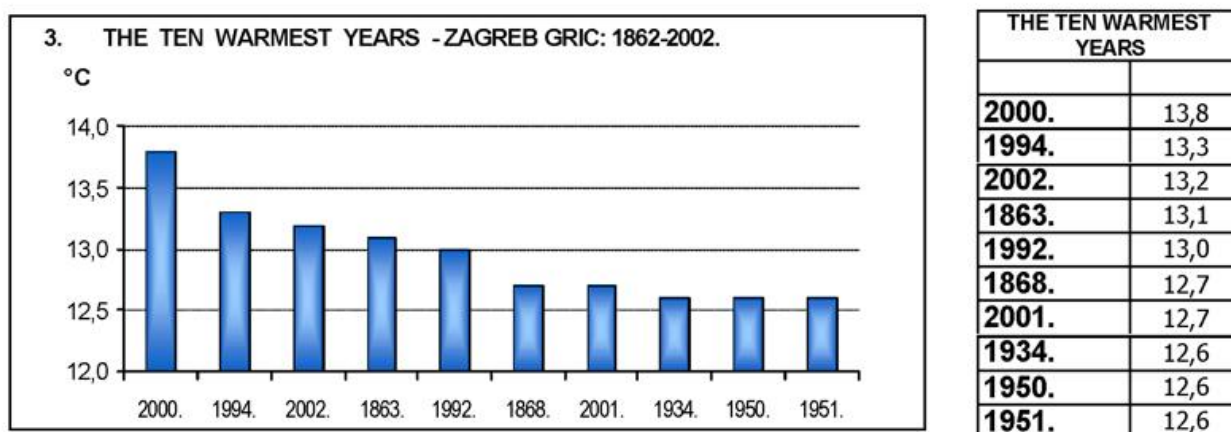
**Fig. 0.2:** Mean anomalies of temperature in Poland in 2002 (averages from 8 stations)  
From: Institute of Meteorology and Water Management, Kraków, Poland



**Fig. 0.3:** Ten warmest and ten coldest years at the Hurbanovo Observatory  
(SW Slovakia, 115m a.s.l.) since 1871  
From: Slovak Hydrometeorological Institute



**Fig. 0.4:** Yearly mean temperature in Denmark since 1874, single values and nonlinear trend  
From: Danish Meteorological Institute



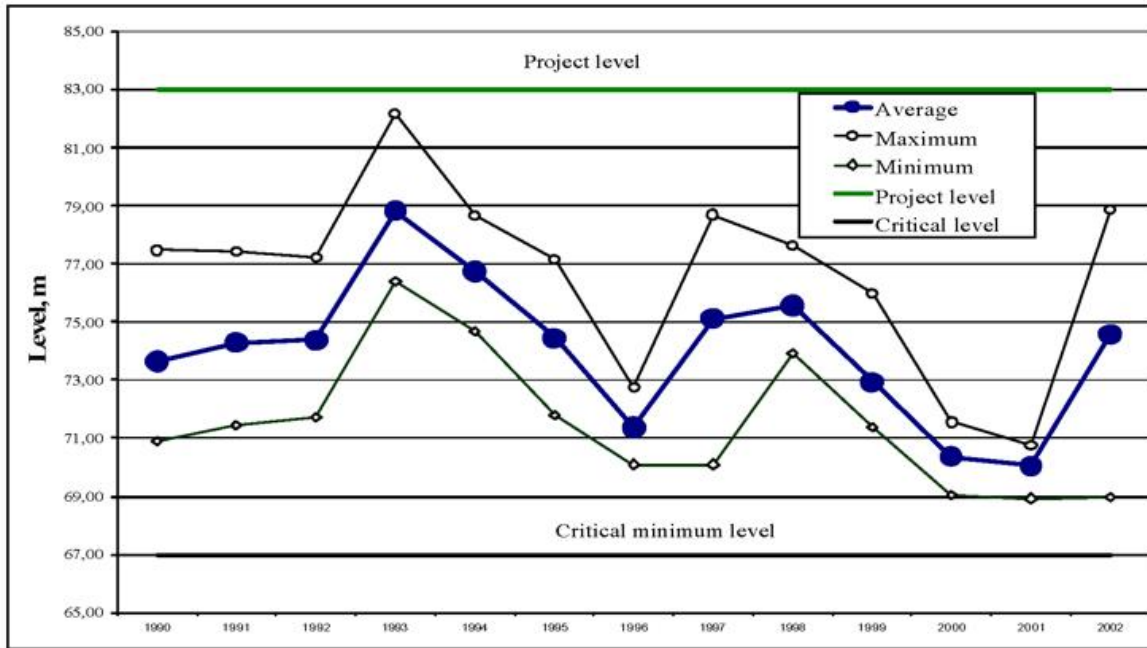
**Fig. 0.5:** The ten warmest years in Zagreb since 1862  
From: Meteorological and Hydrological Service, Croatia

**Precipitation** was above normal in central, north-western and south-eastern Europe except for an area in and around Hungary. Significant deficits to the mean annual accumulated precipitation occurred also near the coastal areas of the Biscay, in the Southeast of Spain, around the middle and northern Baltic Sea as well as in Russia, Turkey and other parts of the Middle East. The surplus precipitation in other parts of the Region as well as the deficits

generally did not miss the normal by more than  $\pm 50\%$ .

Nevertheless, some records of the yearly precipitation sum were broken; e.g. at station Kvisker, Iceland, the annual total exceeded the previous maximum of 4335 mm (1997) by 7%. This is 36% above normal.

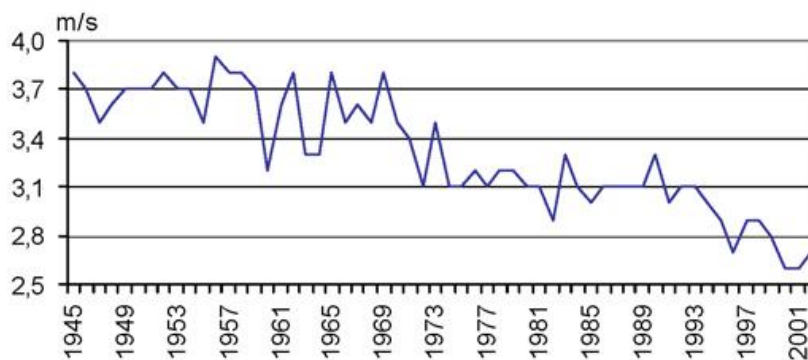
Drought conditions in the Caucasus lasting on from former years, were soothed after the winter months (see figs. 0.6, 4.1, 12.2).



**Fig. 0.6:** Annual average, minimal and maximal levels of Mingechevir Water Reservoir, Azerbaijan  
From: Ministry of Ecology and Natural Resources of Azerbaijan

**Wind** force again caused a lot of damage in the Region, especially at the end of January in northern European countries. But there is also

the phenomenon of a considerable decrease of the annual mean wind speed in Belarus during the last five decades (fig. 0.7).



**Fig. 0.7:** Mean annual wind speed in Belarus since 1945  
From: Hydrometeorological Centre of Republic Belarus

## Seasonal Survey

**Winter 2001/2002** was generally mild in terms of mean temperatures above normal except for areas around the Adriatic and the Black Sea. A zone of high positive temperature anomalies is stretching from the British Isles over central Europe to Belarus and central Russia (see figure page 11 above). A remarkable feature was a period of extremely high temperatures starting around the middle of January and lasting for several weeks (see e.g. figs. 1.1 and

**Spring 2002** was generally warmer than normal. The highest positive temperature anomalies up to +3°C were observed in a coherent area of parts of Sweden, Finland, Poland, the Baltic countries and Belarus (see figure page 12 above). It was the warmest spring in a century in Lithuania. The spatial distribution of the seasonal precipitation totals

**Summer 2002** was warmer than normal nearly all over the Region (see figure page 13 above). In Lithuania, Latvia, Sweden (see fig. 0.9) and in parts of Norway it was the hottest summer since the beginning of observations. Areas of minimum precipitation were the southern Iberian peninsula and central Russia (see figure page 16 above). Other countries like Denmark and Hungary experienced a mixture of intense

**Autumn 2002** had negative temperature anomalies in north-eastern Europe with a centre in Finland. Else there were seasonal mean temperatures mostly above normal with relatively high deviations in England, Iceland and the adjacent seas. Maximum temperature anomalies of about +3°C were observed in the

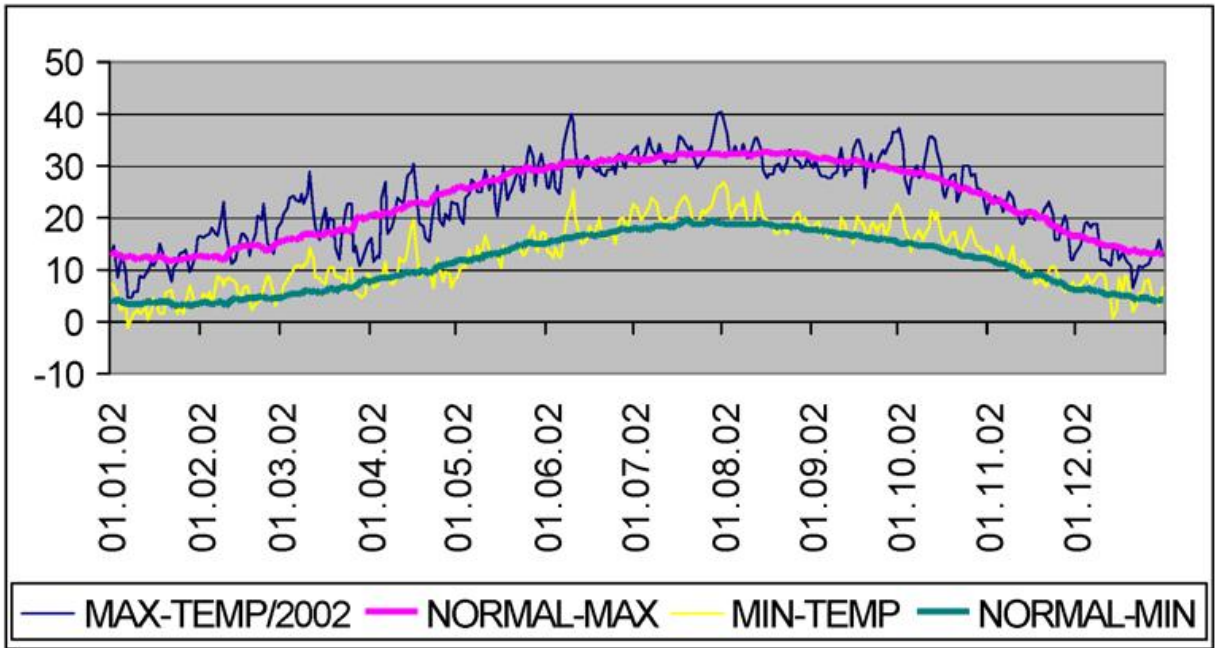
1.2). Northern Scandinavia and especially Svalbard had extremely mild winter season. There were many areas with extremely low precipitation. Most of the Iberian peninsula and southern France received less than 50% of the usual precipitation in the reference period. This situation and partly even worse was given in parts of Italy, south-eastern Austria, some Balkan countries, especially Romania, and the Ukraine (see figure page 15 above).

looks rather patchy all over the Region. There are many centres of relatively high and low precipitation rates against normal (see figure page 15 below). The long lasting drought in southern France ended in May. Despite some local relief in March the drought situation in Romania continued and even worsened till the end of the season.

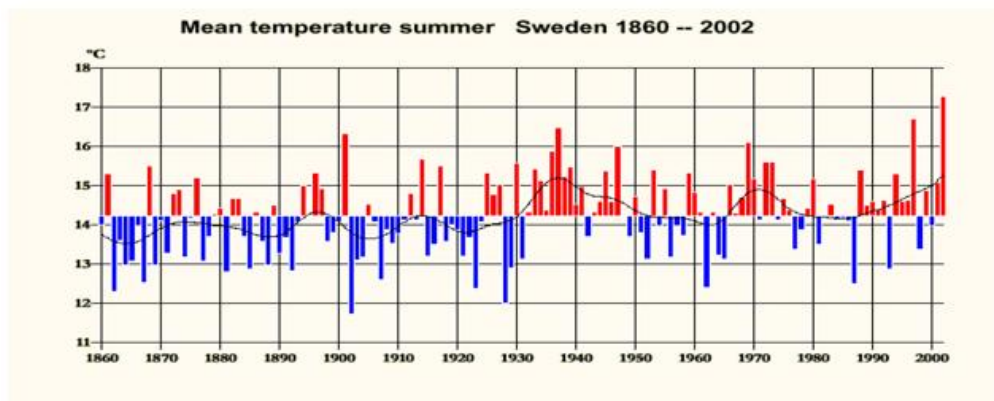
rainfall with flooding as well as drought periods. Intense and continuous rain over central eastern Europe did not only lift the water balance of the whole season, but firstly caused catastrophic damage to the infrastructure and to people in Czech Republic, Austria and eastern Germany in an extent, that was not known before (see special report on pages 55-62).

Caucasus area (see figure 14 above). It was the third wettest fall across England and Wales as a whole since 1766. Additionally, central Europe as well as Portugal, Greece, the Ukraine and southern Russia received much more precipitation compared to the reference period 1961-1990 (figure page 16 below).

*Note: Plus signs in figures on pages 11-14 below indicate anomalies exceeding the 98<sup>th</sup> percentile of a modified 2-parameter gamma distribution fitted to 1961-1990 data (Horton et al. 2001)*



**Fig. 0.8:** Daily extreme temperatures in °C at Amman Airport, Jordan, in 2002 and their long term averages

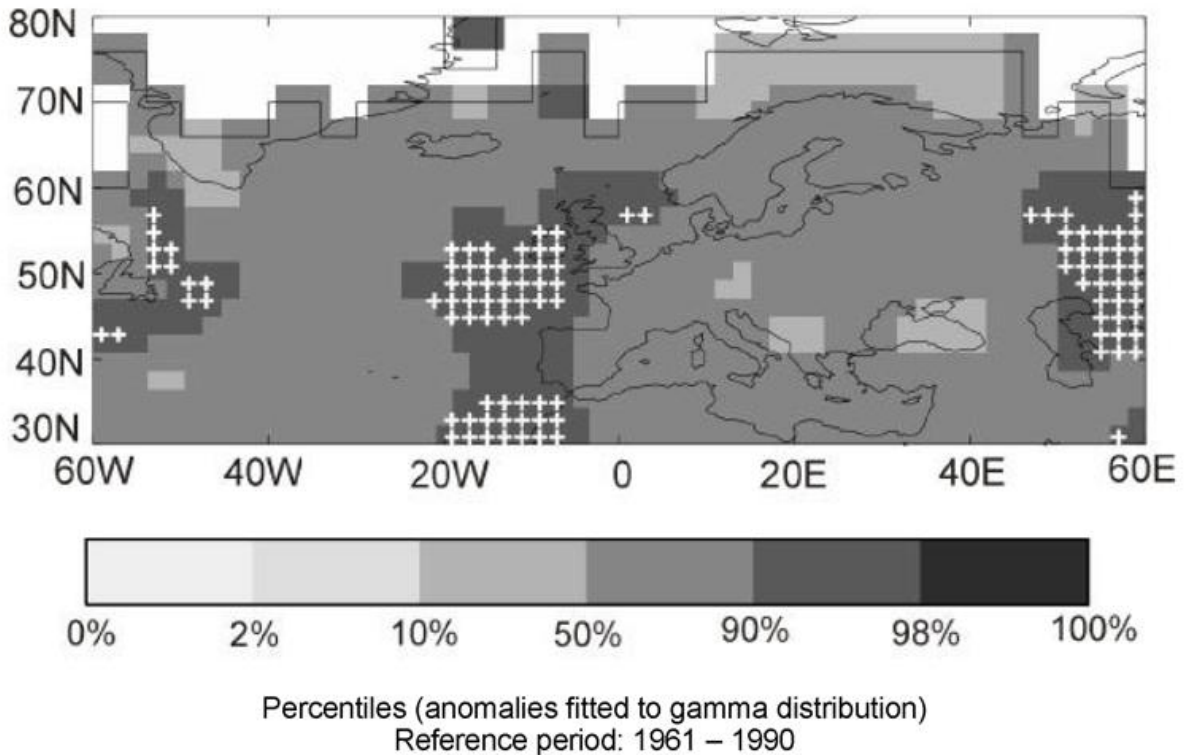
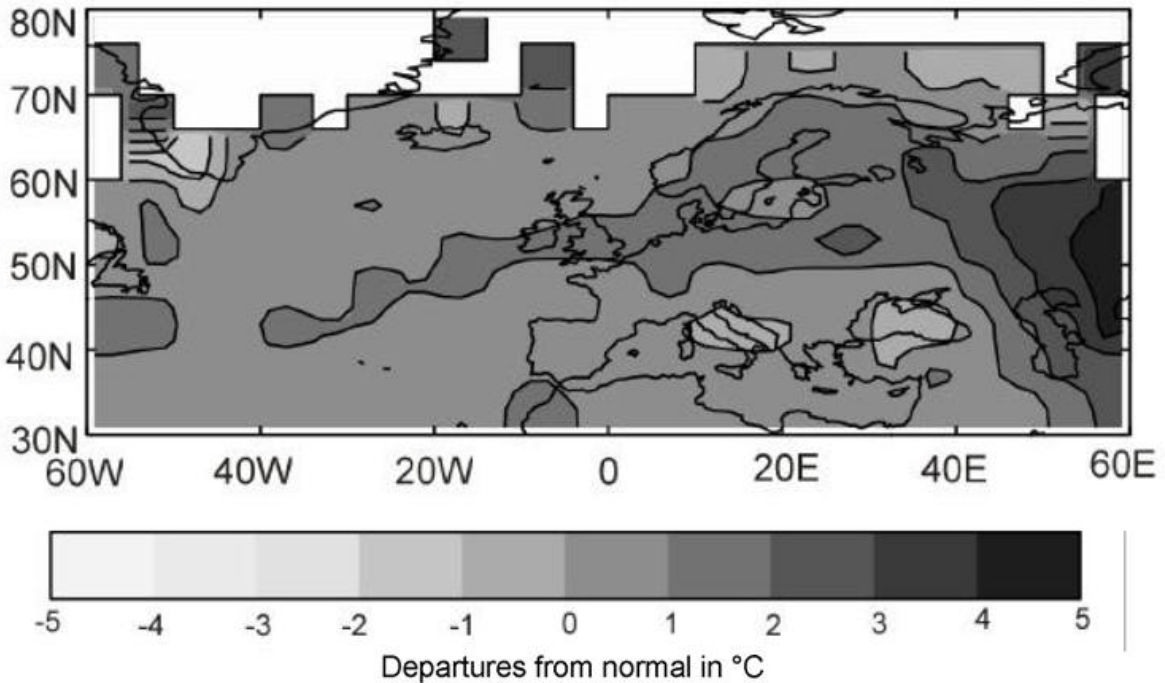


**Fig. 0.9:** Summer temperatures in Sweden since 1860 with running and long term average  
From: Swedish Meteorological and Hydrological Institute

### Seasonal Maps

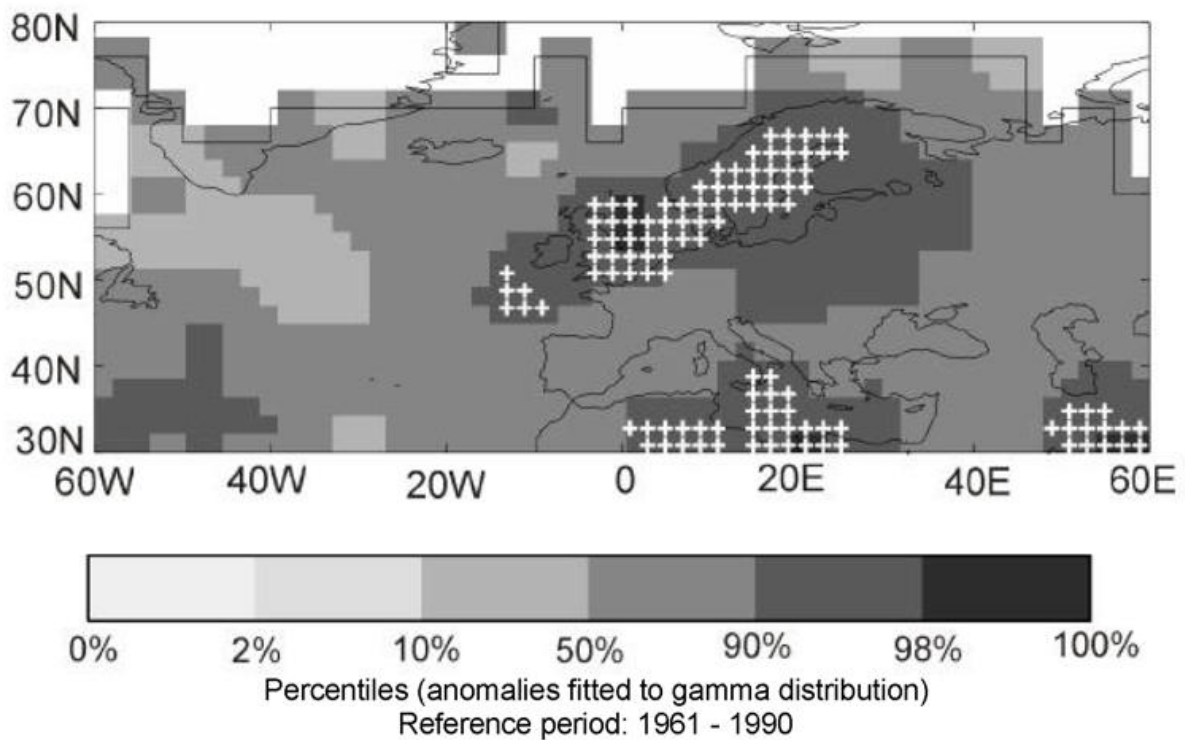
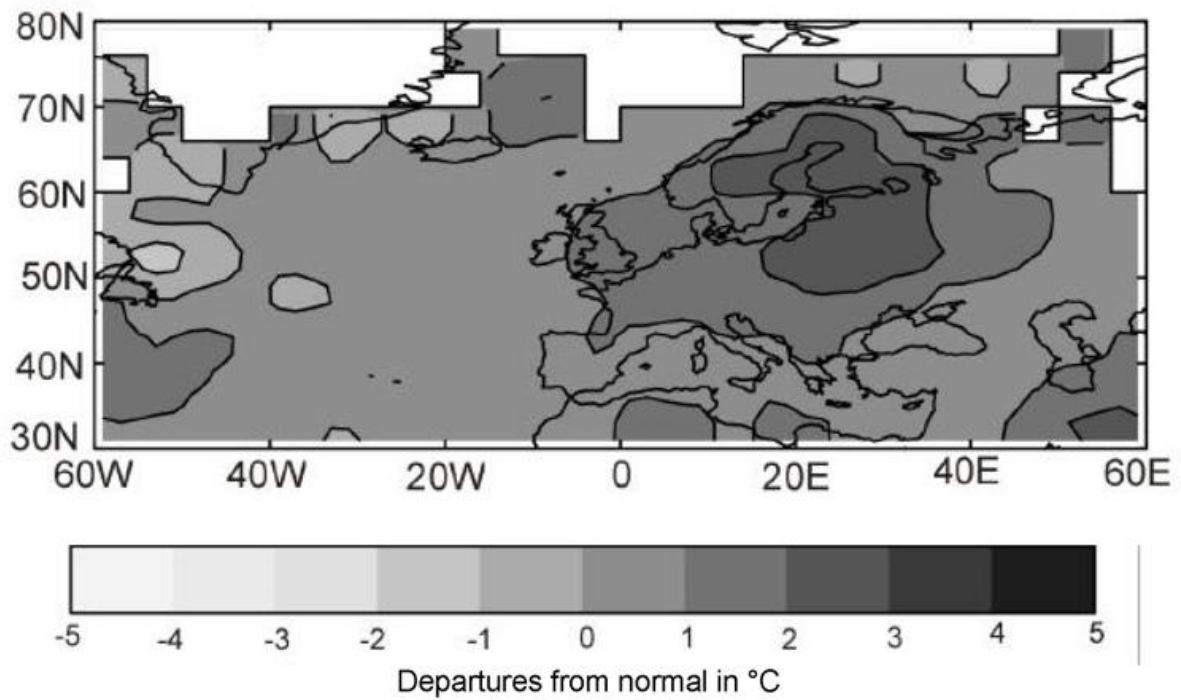
#### Surface temperature anomalies: December 2001 - February 2002

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



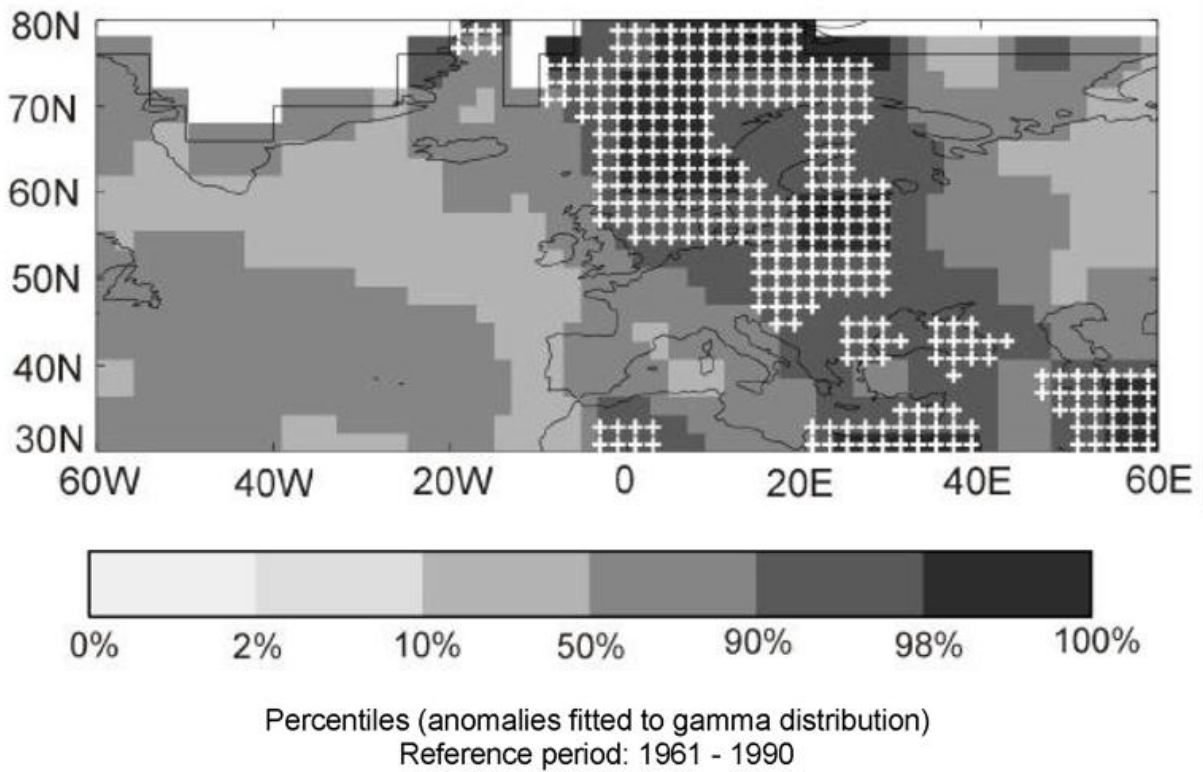
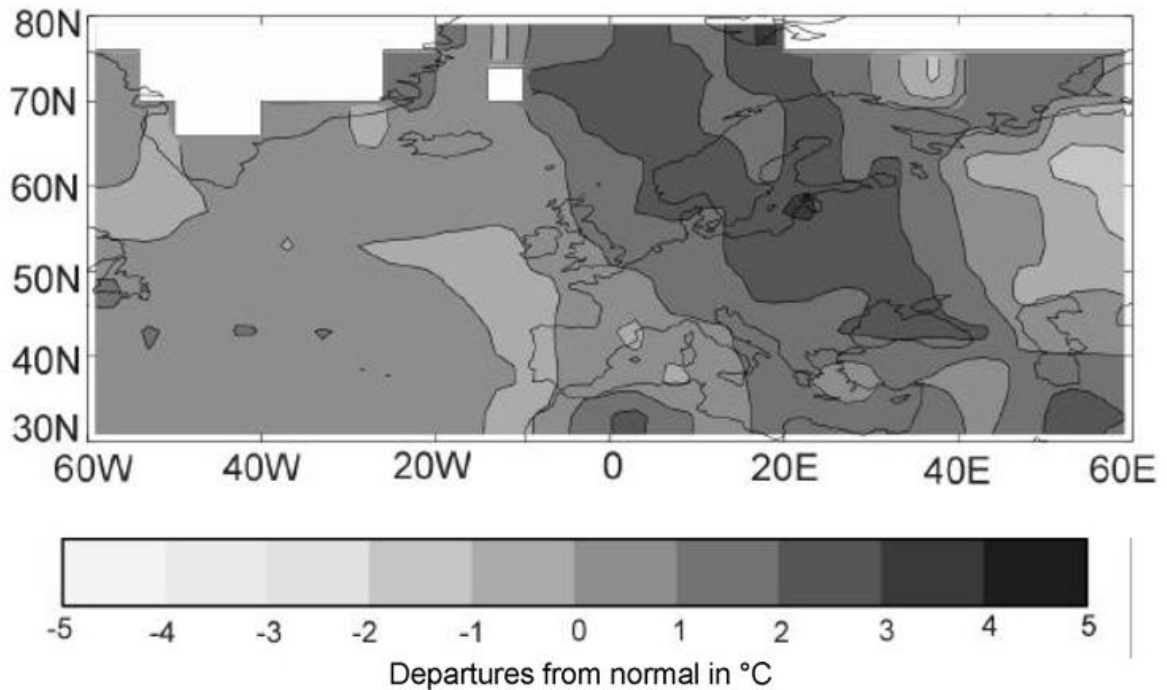
**Surface temperature anomalies: March 2002 - May 2002**

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



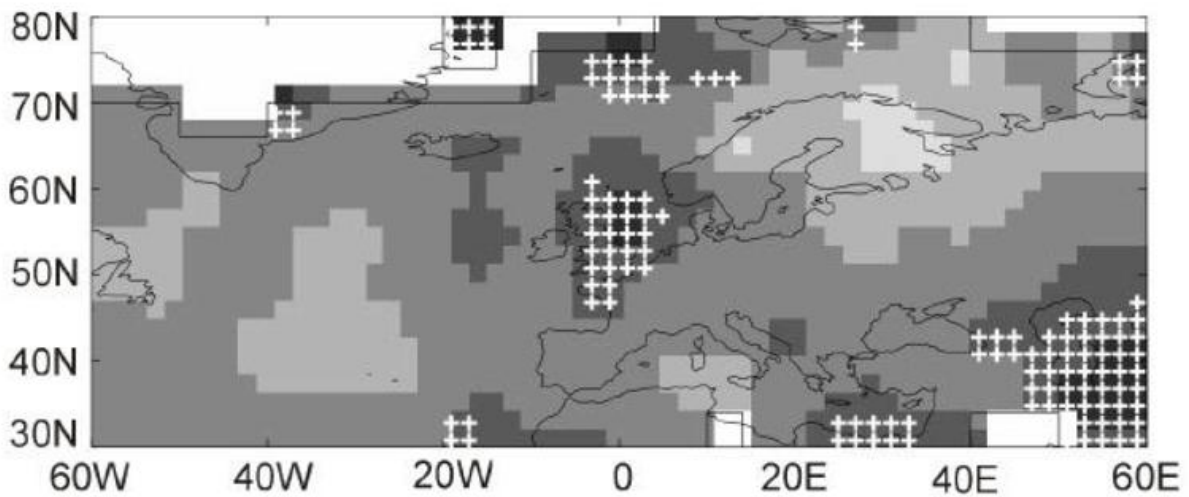
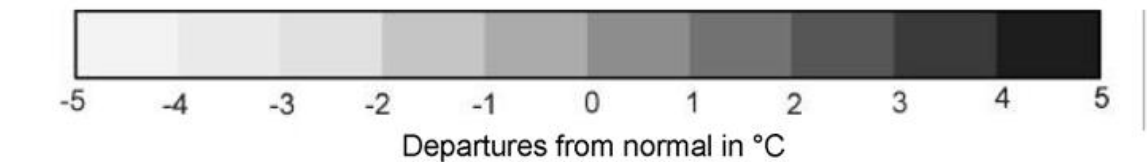
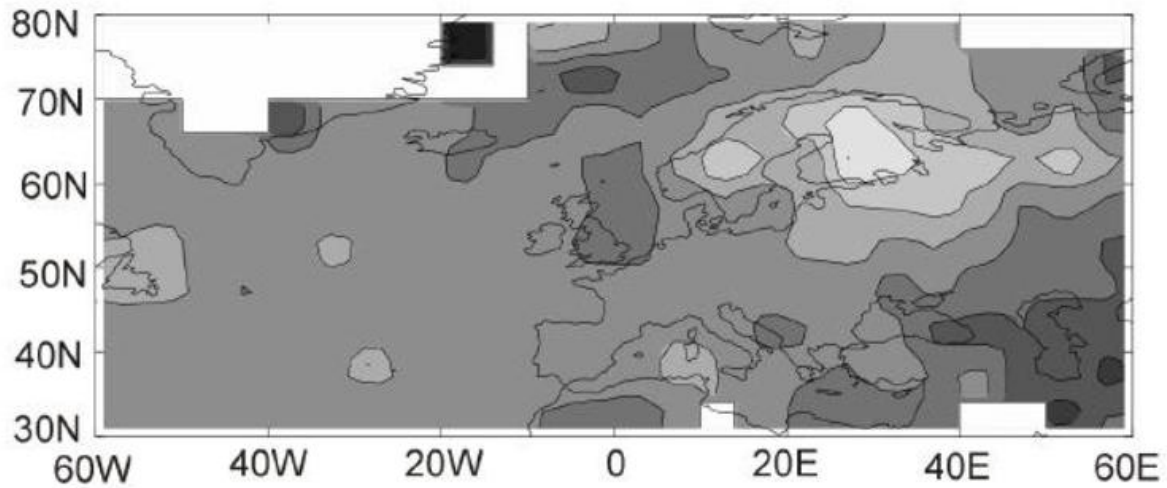
**Surface temperature anomalies: June 2002 - August 2002**

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



**Surface temperature anomalies: September 2002 - November 2002**

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

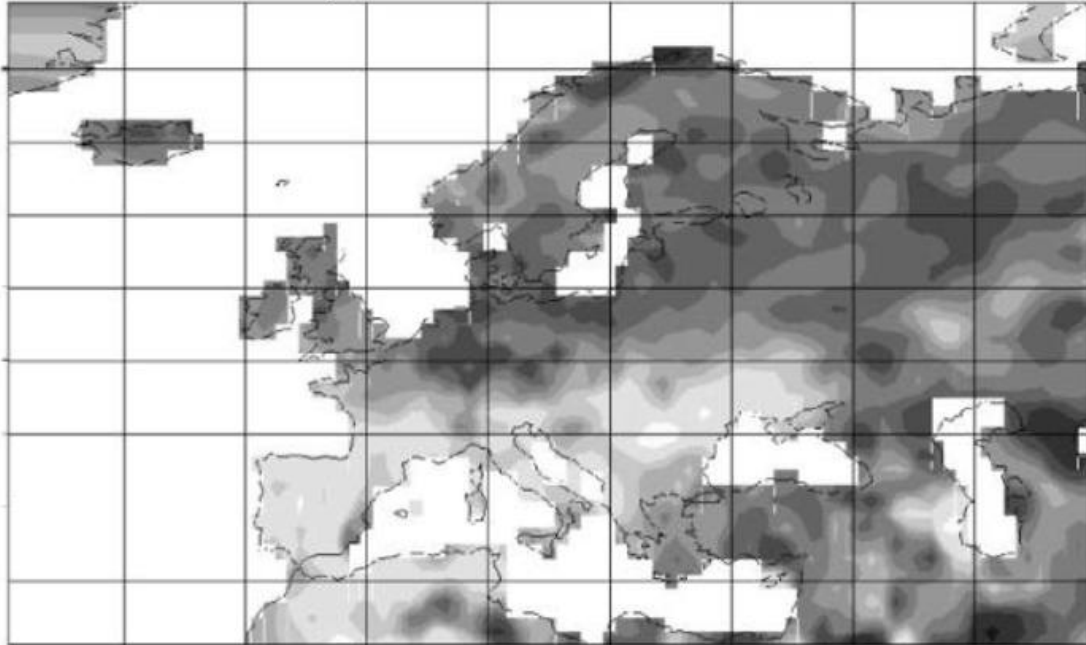
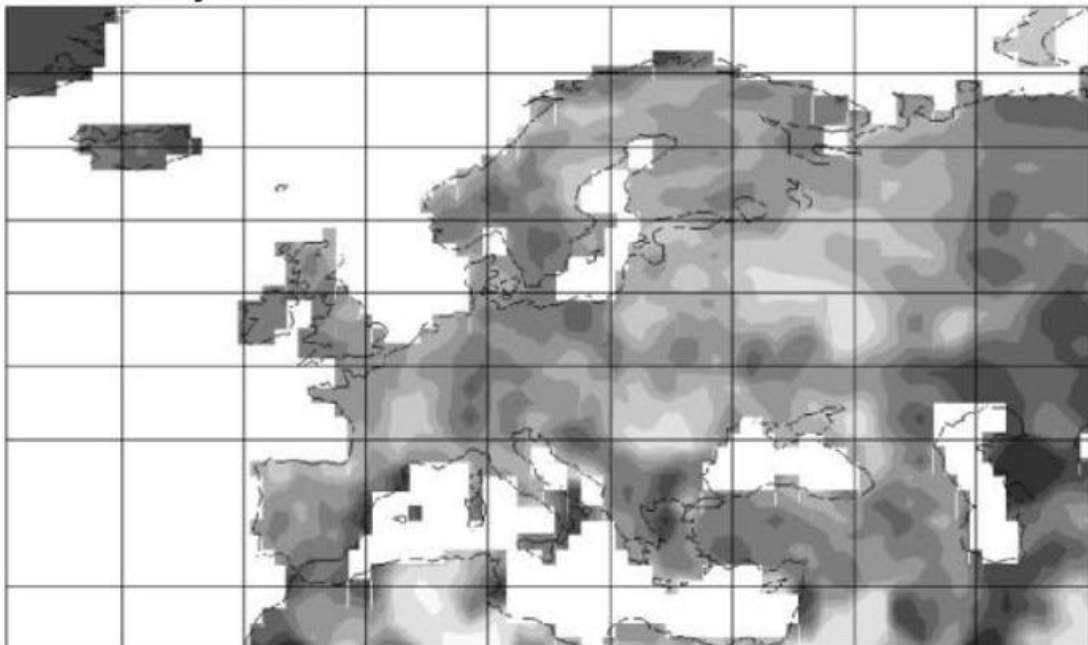


Reference period: 1961 – 1990

**Precipitation in percent of normal**

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

From: GPCC / Deutscher Wetterdienst Germany

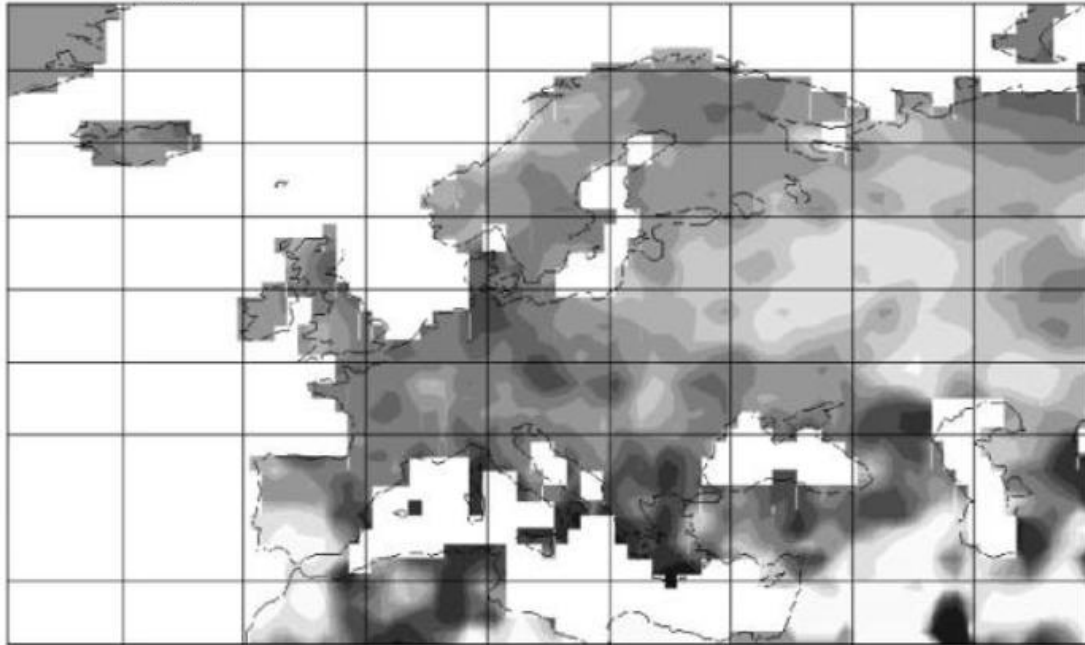
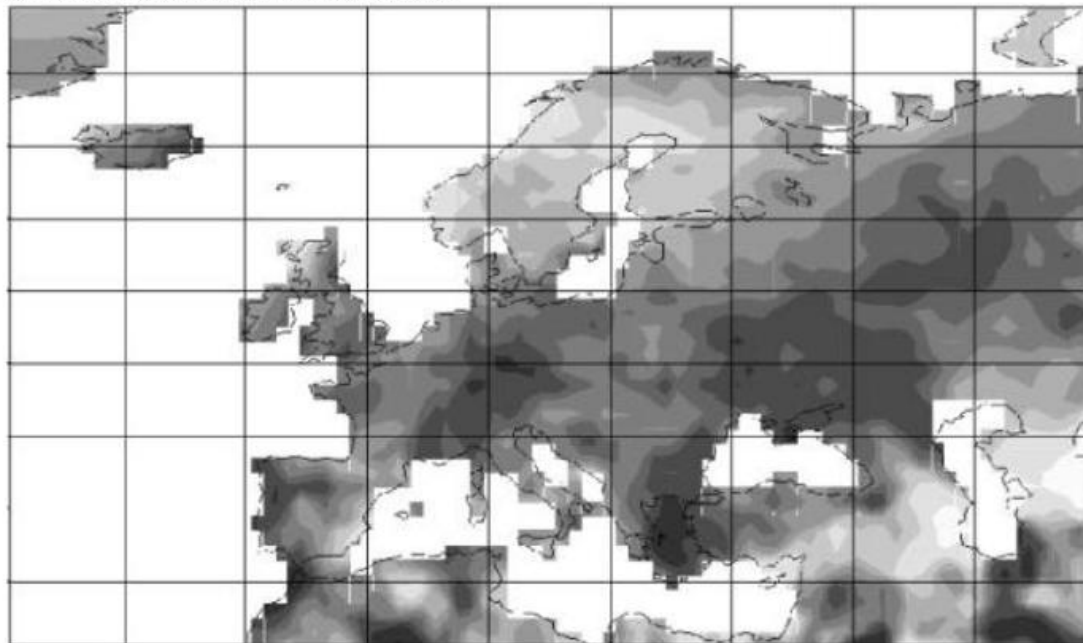
**December 2001 - February 2002****March 2002 - May 2002**

25 50 66 80 100 125 150 200 400

**Precipitation in percent of normal**

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

From: GPCC / Deutscher Wetterdienst Germany

**June 2002 - August 2002****September 2002 - November 2002**

25 50 66 80 100 125 150 200 400

## Monthly and Annual Tables

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

| WMO No. | Station              | January 2002 |           |          |           | February 2002 |           |          |           |
|---------|----------------------|--------------|-----------|----------|-----------|---------------|-----------|----------|-----------|
|         |                      | Temp. mean   | (°C) dep. | Prec sum | (mm) dep. | Temp. mean    | (°C) dep. | Prec Sum | (mm) dep. |
| 01008   | Svalbard             | -12,7        | 2,7       | 21       | 7         | -13,6         | 2,1       | 3        | -16       |
| 01025   | Tromsø               | -2,6         | 1,4       | 165      | 84        | -3,0          | 0,7       | 95       | 9         |
| 01492   | Oslo-Blindern        | -2,8         | 1,5       | 75       | 26        | 0,6           | 4,6       | 58       | 22        |
| 02196   | Haparanda            | -11,1        | 1,0       | 30       | -14       | -6,1          | 5,2       | 68       | 36        |
| 02485   | Stockholm            | -0,3         | 2,5       | 63       | 24        | 2,0           | 5,0       | 42       | 15        |
| 02974   | Helsinki-Vantaa      | -3,6         | 3,3       | 69       | 28        | -0,9          | 5,9       | 52       | 21        |
| 03091   | Aberdeen             | 4,7          | 1,8       | 52       | -28       | 4,5           | 1,4       | 64       | 12        |
| 03772   | London-Heathrow      | 6,9          | 2,7       | 51       | -1        | 8,4           | 3,9       | 64       | 29        |
| 03967   | Dublin (Casement)    | 7,2          | 2,8       | 62       | -4        | 6,6           | 2,2       | 128      | 77        |
| 04030   | Reykjavik            | 1,4          | 1,9       | 117      | 41        | -3,3          | -3,7      | 42       | -29       |
| 04320   | Danmarkshaven        | -21,9        | 1,2       | 17       | 6         | -23,2         | 1,1       | 24       | 13        |
| 04360   | Angmagssalik         | -5,4         | 2,1       | 97       | -15       | -9,0          | -1,3      | 70       | -21       |
| 06186   | København-Landb.     | 2,4          | 1,9       | 57       | 6         | 4,2           | 3,7       | 73       | 42        |
| 06260   | De Bilt              | 4,4          | 2,2       | 78       | 12        | 7,1           | 4,6       | 139      | 90        |
| 06447   | Uccle                | 4,6          | 2,0       | 90       | 23        | 7,1           | 3,6       | 168      | 115       |
| 06590   | Luxembourg           | 0,4          | 0,2       | 49       | -22       | 5,3           | 3,9       | 145      | 85        |
| 06660   | Zürich               | 0,8          | 0,9       | 25       | -45       | 5,7           | 4,8       | 85       | 12        |
| 06700   | Genève               | 1,4          | 0,7       | 44       | -36       | 6,3           | 4,3       | 79       | -2        |
| 07510   | Bordeaux             | 7,8          | 2,0       | 22       | -78       | 9,3           | 2,2       | 54       | -31       |
| 07650   | Marseille            | 6,4          | -0,3      | 23       | -24       | 9,8           | 1,9       | 76       | 22        |
| 08222   | Madrid               | 7,2          | 1,2       | 57       | 11        | 9,0           | 1,6       | 14       | -32       |
| 08314   | Mahon / Menorca      | 11,0         | 0,3       | 32       | -29       | 11,8          | 1,1       | 13       | -40       |
| 08495   | Gibraltar            | 15,0         | 1,6       | 24       | -97       | 15,2          | 1,4       | 112      | 12        |
| 08515   | St. Maria / Acores   | 14,9         | 0,5       | 76       | -24       | 14,7          | 0,7       | 94       | 8         |
| 08535   | Lisboa               | 12,5         | 1,1       | 76       | -34       | 13,4          | 1,1       | 33       | -78       |
| 10384   | Berlin-Tempelhof     | 2,2          | 2,4       | 38       | -5        | 5,5           | 4,7       | 90       | 56        |
| 11035   | Wien-Hohe Warte      | 1,5          | 2,2       | 13       | -25       | 6,2           | 4,9       | 37       | -5        |
| 11518   | Praha-Ruzyne         | -0,1         | 2,3       | 13       | -11       | 4,1           | 4,7       | 45       | 22        |
| 11903   | Slica                | -4,3         | -0,4      | 18       | -26       | 1,8           | 2,9       | 62       | 18        |
| 12160   | Elblag               | 0,2          | 2,6       | 50       | 3         | 3,7           | 5,9       | 45       | 20        |
| 12375   | Warszawa-Okecie      | -0,7         | 2,6       | 38       | 16        | 3,6           | 5,6       | 72       | 51        |
| 12843   | Budapest-Lorinc      | 0,0          | 1,6       | 7        | -25       | 4,9           | 3,8       | 12       | -20       |
| 13274   | Beograd              | 1,2          | 0,8       | 15       | -34       | 8,5           | 5,8       | 14       | -30       |
| 14015   | Ljubljana            | -0,6         | 0,5       | 20       | -62       | 5,0           | 3,6       | 68       | -12       |
| 14445   | Split                | 6,8          | -0,6      | 58       | -25       | 10,5          | 2,4       | 67       | -1        |
| 14654   | Sarajevo             | -1,9         | -1,0      | 41       | -30       | 5,8           | 4,3       | 25       | -42       |
| 15420   | Bucuresti            | -2,8         | -0,4      | 14       | -26       | 4,4           | 4,5       | 17       | -19       |
| 15614   | Sofia                | -2,1         | -0,5      | 10       | -17       | 4,9           | 4,4       | 17       | -16       |
| 16158   | Pisa                 | 4,5          | -1,6      | 29       | -46       | 9,0           | 1,9       | 56       | -17       |
| 16597   | Luqa / Malta         | 11,5         | -0,7      | 22       | -67       | 13,8          | 1,4       | 61       | 0         |
| 16716   | Athens (Hellinikon)  | 8,5          | -1,7      | 33       | -11       | 12,6          | 2,0       | 10       | -33       |
| 16754   | Heraklion / Kreta    | 11,1         | -0,9      | 85       | -5        | 13,5          | 1,4       | 14       | -63       |
| 17040   | Rize                 | 5,3          | -1,0      | 172      | -45       | 7,9           | 1,3       | 118      | -55       |
| 17062   | Istanbul-Goztepe     | 4,9          | -0,7      | 56       | -43       | 8,9           | 3,0       | 35       | -32       |
| 17130   | Ankara / Central     | -3,8         | -3,9      | 30       | -17       | 5,0           | 3,1       | 12       | -24       |
| 17170   | Van                  | -3,3         | 0,9       | 31       | -4        | -0,8          | 2,6       | 8        | -26       |
| 17609   | Larnaca              | 10,4         | -1,1      | 68       | 3         | 13,5          | 1,8       | 27       | -30       |
| 22113   | Murmansk             | -9,6         | 2,1       | 32       | -1        | -9,1          | 2,1       | 22       | 0         |
| 26038   | Tallina              | -1,8         | 3,7       | 58       | 13        | 0,3           | 6,0       | 52       | 23        |
| 26629   | Kaunas               | -1,5         | 3,5       | 62       | 25        | 2,0           | 6,3       | 66       | 39        |
| 26730   | Vilnius              | -2,5         | 3,6       | 56       | 15        | 1,3           | 6,1       | 77       | 39        |
| 26850   | Minsk                | -3,0         | 3,9       | 51       | 11        | 1,4           | 7,2       | 51       | 17        |
| 27199   | Wjatka (Kirov)       | -9,5         | 4,7       | 69       | 31        | -4,2          | 7,6       | 75       | 47        |
| 27612   | Moskva               | -4,8         | 4,5       | 48       | 3         | -0,4          | 7,3       | 49       | 12        |
| 33345   | Kiev                 | -2,6         | 3,0       | 22       | -25       | 3,7           | 7,9       | 38       | -8        |
| 33815   | Chisinau             | -1,7         | 1,6       | 16       | -24       | 4,9           | 6,6       | 2        | -36       |
| 34300   | Charkov (Kharkiv)    | -4,7         | 2,2       | 12       | -32       | 2,0           | 7,7       | 27       | -5        |
| 34880   | Astrahan'            | -3,1         | 2,3       | 10       | -3        | 2,3           | 7,2       | 16       | 6         |
| 35188   | Akmola               | -6,3         | 9,5       | 25       | 8         | -5,6          | 10,3      | 25       | 11        |
| 37789   | Yerevan              | -2,7         | 0,8       | 22       | 1         | 3,5           | 4,5       | 11       | -13       |
| 40080   | Damascus             | 5,4          | -0,8      | 36       | 1         | 9,4           | 1,5       | 19       | -13       |
| 40100   | Beyrouth             | 13,5         | -0,1      | 206      | -16       | 16,6          | 3,1       | 67       | -69       |
| 40180   | Tel Aviv (Airport)   | 11,8         | -0,5      | 200      | 51        | 14,9          | 2,0       | 71       | -27       |
| 40270   | Amman                | 6,5          | -2,6      | 103      | 41        | 10,6          | 0,6       | 14       | -40       |
| 60030   | Las Palmas / Gr. Can | 18,8         | 1,3       | 47       | 30        | 19,0          | 1,4       | 3        | -19       |

| WMO No. | March 2002 |                |          |           | April 2002 |                |          |           | May 2002  |                |          |           |
|---------|------------|----------------|----------|-----------|------------|----------------|----------|-----------|-----------|----------------|----------|-----------|
|         | Temp mean  | Temp (°C) dep. | Prec sum | (mm) Dep. | Temp mean  | Temp (°C) dep. | Prec sum | (mm) dep. | Temp mean | Temp (°C) dep. | Prec Sum | (mm) dep. |
| 01008   | -18,3      | -3,6           | 4        | -17       | -6,1       | 5,6            | 15       | 3         | -3,3      | 0,4            | 4        | -2        |
| 01025   | -1,5       | 0,7            | 98       | 34        | 4,1        | 3,4            | 54       | -6        | 7,7       | 2,8            | 41       | -7        |
| 01492   | 2,1        | 2,3            | 32       | -14       | 6,9        | 2,3            | 40       | -2        | 12,9      | 2,1            | 99       | 47        |
| 02196   | -5,4       | 1,4            | 32       | -3        | 2,5        | 3,0            | 23       | -6        | 8,4       | 2,3            | 30       | -1        |
| 02485   | 2,5        | 2,4            | 27       | 1         | 7,4        | 2,8            | 8        | -22       | 12,6      | 1,9            | 34       | 4         |
| 02974   | 0,3        | 3,2            | 38       | 4         | 5,7        | 2,8            | 8        | -29       | 12,0      | 2,1            | 26       | -9        |
| 03091   | 5,9        | 1,3            | 34       | -27       | 7,6        | 1,2            | 27       | -26       | 10,5      | 1,5            | 54       | -5        |
| 03772   | 8,8        | 2,3            | 38       | -9        | 10,9       | 2,0            | 38       | -7        | 13,4      | 0,9            | 66       | 15        |
| 03967   | 7,4        | 1,4            | 28       | -21       | 8,4        | 0,6            | 77       | 30        | 11,2      | 0,7            | 83       | 25        |
| 04030   | 0,3        | -0,2           | 91       | 8         | 3,9        | 1,0            | 90       | 32        | 7,2       | 0,9            | 23       | -21       |
| 04320   | -23,1      | 0,3            | 7        | -10       | -17,9      | -0,6           | 36       | 26        | -5,8      | 0,8            | 8        | 4         |
| 04360   | -7,2       | 1,0            | 101      | 13        | -2,5       | 1,6            | 61       | -12       | 1,3       | 0,7            | 49       | -8        |
| 06186   | 4,6        | 2,0            | 27       | -15       | 7,4        | 0,8            | 17       | -25       | 13,4      | 1,4            | 53       | 10        |
| 06260   | 7,2        | 2,2            | 33       | -30       | 9,3        | 1,3            | 49       | -3        | 13,4      | 1,1            | 35       | -26       |
| 06447   | 7,8        | 2,3            | 66       | 12        | 9,9        | 1,1            | 42       | -15       | 13,6      | 0,7            | 57       | -14       |
| 06590   | 6,5        | 2,2            | 69       | 1         | 9,0        | 1,2            | 41       | -19       | 12,8      | 0,7            | 63       | -14       |
| 06660   | 7,2        | 2,8            | 58       | -15       | 9,1        | 1,1            | 70       | -24       | 13,0      | 0,9            | 180      | 77        |
| 06700   | 7,8        | 2,8            | 57       | -21       | 10,5       | 1,8            | 23       | -42       | 13,4      | 0,2            | 149      | 83        |
| 07510   | 11,1       | 2,3            | 29       | -47       | 12,7       | 1,4            | 40       | -32       | 15,1      | 0,5            | 93       | 16        |
| 07650   | 12,7       | 2,5            | 46       | 2         | 14,8       | 1,6            | 32       | -16       | 17,3      | 0,2            | 93       | 51        |
| 08222   | 11,3       | 1,3            | 51       | 18        | 13,7       | 1,5            | 47       | -7        | 15,6      | -0,5           | 46       | 5         |
| 08314   | 13,6       | 1,8            | 68       | 19        | 14,9       | 1,2            | 63       | 18        | 17,6      | 0,6            | 54       | 21        |
| 08495   | 15,2       | 0,2            | 94       | 19        | 16,8       | 0,6            | 67       | 7         | 18,7      | 0,2            | 23       | -12       |
| 08515   | 13,7       | -0,9           | 91       | 12        | 15,9       | 0,7            | 4        | -51       | 17,7      | 1,0            | 22       | -8        |
| 08535   | 14,9       | 1,2            | 90       | 21        | 15,5       | 0,4            | 43       | -21       | 16,8      | -0,6           | 17       | -22       |
| 10384   | 5,7        | 1,5            | 44       | 7         | 8,8        | 0,2            | 38       | -3        | 15,8      | 1,9            | 67       | 11        |
| 11035   | 7,2        | 1,9            | 65       | 24        | 10,1       | -0,1           | 57       | 7         | 17,5      | 2,7            | 47       | -14       |
| 11518   | 4,6        | 1,6            | 27       | -1        | 8,0        | 0,3            | 26       | -12       | 15,1      | 2,4            | 59       | -18       |
| 11903   | 5,0        | 2,0            | 26       | -16       | 8,7        | 0,2            | 32       | -15       | 16,6      | 2,9            | 63       | -1        |
| 12160   | 4,4        | 2,3            | 43       | 8         | 8,3        | 1,5            | 16       | -26       | 17,1      | 4,2            | 70       | 29        |
| 12375   | 4,5        | 2,5            | 37       | 9         | 9,0        | 1,2            | 17       | -15       | 17,4      | 4,0            | 44       | -15       |
| 12843   | 7,9        | 2,3            | 25       | -4        | 11,5       | 0,4            | 50       | 12        | 19,1      | 3,1            | 28       | -27       |
| 13274   | 10,3       | 3,1            | 15       | -35       | 12,1       | -0,3           | 54       | -5        | 20,1      | 2,9            | 21       | -50       |
| 14015   | 8,9        | 3,5            | 44       | -54       | 10,1       | 0,2            | 130      | 21        | 17,2      | 2,6            | 91       | -31       |
| 14445   | 13,0       | 2,6            | 12       | -63       | 15,0       | 1,1            | 61       | -5        | 20,0      | 1,6            | 83       | 27        |
| 14654   | 8,3        | 3,2            | 46       | -24       | 9,4        | 0,0            | 114      | 40        | 15,6      | 1,5            | 80       | -2        |
| 15420   | 7,7        | 2,9            | 22       | -16       | 9,5        | -1,8           | 26       | -20       | 17,9      | 1,2            | 10       | -60       |
| 15614   | 7,4        | 2,8            | 63       | 25        | 8,9        | -1,0           | 40       | -10       | 15,8      | 1,5            | 67       | -6        |
| 16158   | 11,4       | 1,9            | 5        | -71       | 13,0       | 0,5            | 64       | -15       | 16,9      | 0,6            | 66       | 7         |
| 16597   | 15,5       | 2,1            | 9        | -31       | 16,9       | 1,4            | 6        | -17       | 19,5      | 0,4            | 9        | 2         |
| 16716   | 13,4       | 0,8            | 47       | 6         | 15,8       | -0,3           | 38       | 13        | 21,9      | 1,3            | 1        | -16       |
| 16754   | 14,7       | 1,3            | 33       | -23       | 16,9       | 0,6            | 18       | -12       | 20,4      | 0,6            | 0        | -16       |
| 17040   | 9,7        | 1,8            | 89       | -58       | 10,5       | -1,1           | 97       | -4        | 16,5      | 0,7            | 24       | -78       |
| 17062   | 9,4        | 1,9            | 61       | -1        | 11,1       | -0,9           | 47       | -2        | 16,9      | 0,4            | 20       | -11       |
| 17130   | 8,6        | 2,5            | 23       | -13       | 10,4       | -0,8           | 101      | 53        | 16,7      | 1,2            | 39       | -16       |
| 17170   | 3,4        | 2,3            | 67       | 24        | 6,9        | -0,4           | 107      | 53        | 12,3      | -0,4           | 55       | 6         |
| 17609   | 15,2       | 1,9            | 39       | -10       | 16,7       | -0,7           | 49       | 38        | 20,6      | -0,3           | 4        | -3        |
| 22113   | -6,6       | 0,2            | 35       | 15        | 1,2        | 3,1            | 12       | -9        | 4,5       | 0,7            | 25       | -7        |
| 26038   | 1,2        | 3,4            | 42       | 13        | 5,5        | 2,1            | 5        | -31       | 12,1      | 2,4            | 11       | -26       |
| 26629   | 3,3        | 3,5            | 40       | 8         | 8,2        | 2,2            | 28       | -15       | 15,7      | 3,0            | 30       | -26       |
| 26730   | 2,6        | 3,2            | 33       | -6        | 8,0        | 2,3            | 31       | -15       | 15,3      | 2,8            | 32       | -30       |
| 26850   | 3,1        | 4,5            | 24       | -18       | 8,4        | 2,4            | 43       | 1         | 15,1      | 2,2            | 59       | -3        |
| 27199   | -1,6       | 3,5            | 71       | 42        | 3,8        | 0,6            | 9        | -27       | 8,0       | -3,1           | 44       | -5        |
| 27612   | 2,2        | 4,4            | 29       | -5        | 7,2        | 1,4            | 14       | -26       | 12,7      | -0,2           | 18       | -40       |
| 33345   | 5,5        | 4,8            | 17       | -22       | 9,9        | 1,2            | 40       | -9        | 16,5      | 1,4            | 65       | 12        |
| 33815   | 7,2        | 4,3            | 59       | 24        | 10,4       | 0,2            | 31       | -11       | 18,0      | 1,9            |          |           |
| 34300   | 4,9        | 5,2            | 26       | -1        | 9,6        | 0,7            | 12       | -24       | 15,5      | -0,1           | 48       | 1         |
| 34880   | 6,9        | 5,6            | 9        | -5        | 9,6        | -1,5           | 18       | 0         | 15,2      | -3,1           | 34       | 10        |
| 35188   | 0,9        | 9,0            | 29       | 15        | 4,2        | -0,7           | 46       | 24        | 12,1      | -1,0           | 45       | 12        |
| 37789   | 7,7        | 1,9            | 24       | -8        | 9,7        | -3,0           | 97       | 60        | 14,6      | -2,9           | 56       | 13        |
| 40080   | 13,2       | 2,0            | 15       | -9        | 16,5       | 0,8            | 6        | -6        | 21,0      | 0,6            | <1       | -5        |
| 40100   | 17,5       | 2,4            | 102      | -18       | 18,7       | 0,9            | 113      | 62        | 21,4      | 1,0            | 4        | -16       |
| 40180   | 17,4       | 2,5            | 44       | -18       | 18,7       | 0,5            | 32       | 9         | 21,3      | 0,2            | 8        | 5         |
| 40270   | 13,9       | 1,0            | 42       | -9        | 15,3       | -2,5           | 20       | 3         | 19,9      | -2,0           | NIL      | NIL       |
| 60030   | 19,6       | 1,2            | 3        | -7        | 20,3       | 1,6            | 11       | 5         | 20,7      | 0,8            | 2        | 0         |

| WMO No. | Station              | June 2002  |           |           |           | July 2002  |           |           |           |
|---------|----------------------|------------|-----------|-----------|-----------|------------|-----------|-----------|-----------|
|         |                      | Temp. mean | (°C) dep. | Prec. sum | (mm) dep. | Temp. mean | (°C) dep. | Prec. Sum | (mm) dep. |
| 01008   | Svalbard             | 3,7        | 1,5       | 6         | -4        | 7,1        | 1,1       | 7         | -6        |
| 01025   | Tromsø               | 10,8       | 1,5       | 30        | -23       | 13,2       | 1,5       | 48        | -24       |
| 01492   | Oslo-Blindern        | 16,6       | 1,4       | 54        | -11       | 17,4       | 1,0       | 133       | 49        |
| 02196   | Haparanda            | 15,7       | 2,9       | 73        | 32        | 17,4       | 1,9       | 82        | 32        |
| 02485   | Stockholm            | 17,5       | 1,9       | 94        | 49        | 19,2       | 2,0       | 108       | 36        |
| 02974   | Helsinki-Vantaa      | 16,4       | 1,5       | 68        | 24        | 19,3       | 2,7       | 57        | -16       |
| 03091   | Aberdeen             | 13,0       | 0,9       | 107       | 54        | 14,0       | 0,2       | 101       | 40        |
| 03772   | London-Heathrow      | 15,8       | 0,1       | 74        | 23        | 17,9       | 0,1       | 67        | 21        |
| 03967   | Dublin (Casement)    | 13,0       | -0,3      | 80        | 32        | 14,5       | -0,4      | 74        | 20        |
| 04030   | Reykjavik            | 10,8       | 1,7       | 34        | -17       | 10,6       | 0,0       | 45        | -6        |
| 04320   | Danmarkshaven        | 3,5        | 2,8       | 6         | 1         | 3,5        | -0,2      | 13        | -1        |
| 04360   | Angmagssalik         | 6,5        | 2,4       | 85        | 33        | 6,8        | 0,4       | 53        | 4         |
| 06186   | København-Landb.     | 16,5       | 0,4       | 49        | -5        | 18,3       | 1,1       | 74        | 5         |
| 06260   | De Bilt              | 16,5       | 1,3       | 85        | 17        | 17,6       | 0,8       | 97        | 22        |
| 06447   | Uccle                | 17,1       | 1,4       | 72        | -7        | 17,8       | 0,3       | 97        | 22        |
| 06590   | Luxembourg           | 17,4       | 2,1       | 33        | -36       | 17,5       | 0,4       | 58        | -9        |
| 06660   | Zürich               | 19,3       | 4,1       | 85        | -39       | 18,2       | 0,5       | 110       | -8        |
| 06700   | Genève               | 20,5       | 3,8       | 64        | -16       | 19,9       | 0,8       | 118       | 53        |
| 07510   | Bordeaux             | 19,1       | 1,3       | 31        | -25       | 19,7       | -0,5      | 29        | -18       |
| 07650   | Marseille            | 22,8       | 1,9       | 71        | 43        | 23,8       | 0,0       | 17        | 3         |
| 08222   | Madrid               | 23,5       | 2,9       | 28        | 1         | 24,8       | 0,4       | 2         | -11       |
| 08314   | Mahon / Menorca      | 22,8       | 1,8       | 23        | 8         | 23,9       | -0,4      | 54        | 49        |
| 08495   | Gibraltar            | 21,3       | 0,2       | 13        | 2         | 24,0       | 0,3       | 0         | -1        |
| 08515   | St. Maria / Acores   | 19,2       | 0,5       | 52        | 30        | 21,1       | 0,3       | 14        | -11       |
| 08535   | Lisboa               | 19,7       | -0,5      | 7         | -14       | 21,8       | -0,6      | <1        | -5        |
| 10384   | Berlin-Tempelhof     | 18,0       | 0,6       | 31        | -44       | 19,6       | 0,8       | 56        | 4         |
| 11035   | Wien-Hohe Warte      | 20,5       | 2,5       | 69        | -5        | 21,7       | 1,8       | 52        | -10       |
| 11518   | Praha-Ruzyně         | 17,5       | 1,6       | 82        | 9         | 18,5       | 1,0       | 100       | 34        |
| 11903   | Slica                | 18,6       | 2,0       | 65        | -20       | 20,8       | 2,6       | 167       | 108       |
| 12160   | Elblag               | 16,4       | 1,0       | 106       | 12        | 19,9       | 3,1       | 47        | -47       |
| 12375   | Warszawa-Okecie      | 17,6       | 1,0       | 55        | -17       | 21,1       | 3,2       | 23        | -44       |
| 12843   | Budapest-Lorinc      | 21,3       | 2,2       | 51        | -12       | 23,6       | 2,7       | 79        | 27        |
| 13274   | Beograd              | 22,9       | 2,8       | 80        | -10       | 24,2       | 2,5       | 61        | -5        |
| 14015   | Ljubljana            | 21,1       | 3,3       | 176       | 21        | 21,3       | 1,4       | 127       | 5         |
| 14445   | Split                | 25,1       | 2,9       | 24        | -27       | 26,6       | 1,2       | 16        | -12       |
| 14654   | Sarajevo             | 19,4       | 2,5       | 51        | -40       | 20,3       | 1,4       | 77        | -2        |
| 15420   | Bucuresti            | 21,8       | 1,6       | 109       | 32        | 23,8       | 1,8       | 92        | 28        |
| 15614   | Sofia                | 20,0       | 2,3       | 38        | -34       | 21,9       | 1,9       | 82        | 26        |
| 16158   | Pisa                 | 22,2       | 2,4       | 60        | 16        | 23,3       | 0,5       | 99        | 76        |
| 16597   | Luqa / Malta         | 24,6       | 1,6       | <1        | -3        | 27,1       | 1,2       | <1        | 1         |
| 16716   | Athens (Hellinikon)  | 27,2       | 2,1       | 1         | -7        | 29,5       | 1,7       | 7         | 2         |
| 16754   | Heraklion / Kreta    | 24,6       | 1,1       | 0         | -3        | 27,9       | 2,2       | 5         | 4         |
| 17040   | Rize                 | 20,8       | 0,9       | 152       | 24        | 25,4       | 3,2       | 203       | 67        |
| 17062   | Istanbul-Goztepe     | 22,7       | 1,6       | 8         | -13       | 26,6       | 3,4       | 4         | -15       |
| 17130   | Ankara / Central     | 20,8       | 1,2       | 28        | -9        | 24,8       | 1,9       | 35        | 21        |
| 17170   | Van                  | 17,9       | 0,3       | 20        | -1        | 22,6       | 0,7       | 3         | -1        |
| 17609   | Larnaca              | 25,5       | 1,2       | <1        | -1        | 28,4       | 1,5       | 0         | 0         |
| 22113   | Murmansk             | 9,1        | -0,3      | 67        | 14        | 14,3       | 1,5       | 73        | 13        |
| 26038   | Tallina              | 15,6       | 1,1       | 82        | 29        | 18,8       | 2,5       | 86        | 7         |
| 26629   | Kaunas               | 16,8       | 0,8       | 93        | 18        | 20,6       | 3,5       | 54        | -14       |
| 26730   | Vilnius              | 16,7       | 0,9       | 70        | -7        | 20,8       | 3,9       | 34        | -44       |
| 26850   | Minsk                | 17,1       | 1,0       | 63        | -20       | 22,0       | 4,7       | 35        | -53       |
| 27199   | Wjatka (Kirov)       | 15,5       | -0,1      | 73        | 9         | 20,8       | 2,6       | 47        | -39       |
| 27612   | Moskva               | 17,4       | 0,8       | 42        | -34       | 22,6       | 4,5       | 24        | -68       |
| 33345   | Kiev                 | 18,4       | 0,2       | 190       | 117       | 23,9       | 4,6       | 13        | -75       |
| 33815   | Chisinau             | 20,1       | 0,7       | 53        | -22       | 24,2       | 3,3       | 134       | 65        |
| 34300   | Charkov (Kharkiv)    | 19,0       | 0,1       | 50        | -8        | 24,9       | 4,6       | 91        | 31        |
| 34880   | Astrahan'            | 20,4       | -2,5      | 24        | 2         | 27,1       | 1,8       | 1         | -22       |
| 35188   | Akmola               | 17,4       | -1,6      | 72        | 37        | 19,4       | -1,9      | 22        | -28       |
| 37789   | Yerevan              | 21,0       | -0,9      | 12        | -9        | 25,2       | -0,8      | 28        | 18        |
| 40080   | Damascus             | 25,2       | 0,6       | 0         | -1        | 28,7       | 2,1       | 0         | 0         |
| 40100   | Beyrouth             | 25,2       | 1,6       | 0         | -1        | 27,9       | 2,4       | 0         | 0         |
| 40180   | Tel Aviv (Airport)   | 25,5       | 1,5       | 0         | 0         | 28,2       | 2,5       | 0         | 0         |
| 40270   | Amman                | 23,6       | -1,4      | 0         | 0         | 27,1       | 0,7       | NIL       | NIL       |
| 60030   | Las Palmas / Gr. Can | 22,2       | 0,8       | 3         | 3         | 22,8       | -0,5      | <1        | 1         |

| WMO No. | August 2002 |           |          |           | September 2002 |           |          |           | October 2002 |           |          |           |
|---------|-------------|-----------|----------|-----------|----------------|-----------|----------|-----------|--------------|-----------|----------|-----------|
|         | Temp mean   | (°C) dep. | Prec sum | (mm) Dep. | Temp mean      | (°C) dep. | Prec sum | (mm) dep. | Temp mean    | (°C) dep. | Prec Sum | (mm) dep. |
| 01008   | 7,5         | 2,7       | 27       | 4         | 0,1            | -0,4      | 16       | -7        | -3,0         | 2,5       | 26       | 11        |
| 01025   | 12,5        | 1,6       | 121      | 42        | 7,4            | 0,6       | 130      | 36        | 0,6          | -2,3      | 65       | -60       |
| 01492   | 20,2        | 5,0       | 35       | -54       | 13,1           | 2,3       | 97       | 7         | 3,4          | -3,0      | 100      | 16        |
| 02196   | 16,4        | 3,1       | 8        | -55       | 7,9            | 0,0       | 33       | -30       | -1,3         | -3,8      | 22       | -42       |
| 02485   | 21,3        | 5,1       | 3        | -63       | 13,6           | 2,4       | 13       | -42       | 4,1          | -3,4      | 45       | -5        |
| 02974   | 19,3        | 4,3       | 18       | -62       | 11,2           | 1,2       | 22       | -51       | 0,6          | -4,8      | 37       | -36       |
| 03091   | 15,0        | 1,4       | 108      | 33        | 12,9           | 1,2       | 16       | -52       | 8,2          | -0,9      | 230      | 152       |
| 03772   | 19,0        | 1,6       | 36       | -15       | 15,9           | 0,9       | 20       | -31       | 11,8         | 0,1       | 62       | 4         |
| 03967   | 15,3        | 0,7       | 65       | -13       | 13,1           | 0,1       | 9        | -60       | 9,7          | -0,6      | 179      | 111       |
| 04030   | 10,2        | -0,1      | 77       | 15        | 9,4            | 2,0       | 124      | 57        | 4,9          | 0,5       | 69       | -17       |
| 04320   | 3,5         | 1,1       | 25       | 11        | -1,0           | 3,2       | 2        | -9        | -6,9         | 6,7       | 5        | -7        |
| 04360   | 5,8         | -0,2      | 66       | 5         | 5,1            | 2,0       | 137      | 69        | 1,0          | 1,8       | 134      | 52        |
| 06186   | 20,5        | 3,5       | 86       | 23        | 15,1           | 1,5       | 8        | -54       | 7,4          | -2,5      | 105      | 46        |
| 06260   | 18,6        | 1,9       | 112      | 41        | 14,6           | 0,6       | 32       | -35       | 9,5          | -1,0      | 91       | 19        |
| 06447   | 18,6        | 1,3       | 172      | 109       | 14,7           | 0,2       | 26       | -33       | 10,5         | -0,4      | 105      | 35        |
| 06590   | 17,9        | 1,2       | 118      | 46        | 13,4           | 0,0       | 49       | -21       | 9,2          | -0,1      | 142      | 68        |
| 06660   | 17,7        | 0,8       | 150      | 16        | 13,0           | -1,1      | 123      | 29        | 10,1         | 0,6       | 128      | 56        |
| 06700   | 18,6        | 0,5       | 90       | 12        | 15,1           | 0,2       | 29       | -51       | 11,6         | 1,6       | 138      | 64        |
| 07510   | 19,5        | -0,4      | 79       | 25        | 17,7           | -0,2      | 64       | -10       | 15,0         | 1,0       | 74       | -14       |
| 07650   | 23,1        | -0,1      | 64       | 35        | 19,3           | -1,0      | 168      | 121       | 16,4         | 0,3       | 51       | -27       |
| 08222   | 23,7        | -0,2      | 7        | -2        | 19,7           | -0,8      | 28       | -2        | 14,8         | 0,0       | 68       | 23        |
| 08314   | 24,2        | -0,3      | 55       | 29        | 22,1           | -0,1      | 52       | -3        | 19,4         | 0,9       | 97       | 13        |
| 08495   | 24,1        | -0,1      | 0        | -6        | 21,1           | -1,7      | 22       | 7         | 19,9         | 0,4       | 204      | 140       |
| 08515   | 22,6        | 0,4       | 28       | -12       | 21,5           | 0,1       | 34       | -23       | 18,9         | -0,4      | 100      | 16        |
| 08535   | 22,1        | -0,7      | <1       | -6        | 20,1           | -1,6      | 82       | 56        | 19,0         | 0,5       | 104      | 24        |
| 10384   | 21,2        | 2,8       | 156      | 95        | 15,2           | 0,6       | 50       | 5         | 8,4          | -1,6      | 107      | 71        |
| 11035   | 20,4        | 1,2       | 210      | 145       | 14,5           | -1,0      | 44       | -1        | 9,1          | -1,0      | 92       | 51        |
| 11518   | 19,1        | 2,1       | 121      | 51        | 12,7           | -0,6      | 43       | 3         | 7,8          | -0,5      | 38       | 8         |
| 11903   | 19,1        | 1,8       | 107      | 38        | 13,1           | -0,3      | 60       | 4         | 7,4          | -0,9      | 89       | 39        |
| 12160   | 21,5        | 4,8       | 34       | -47       | 13,6           | 0,9       | 43       | -27       | 6,9          | -2,0      | 138      | 85        |
| 12375   | 20,7        | 3,4       | 141      | 78        | 13,7           | 0,5       | 31       | -12       | 7,2          | -1,1      | 64       | 26        |
| 12843   | 21,5        | 1,2       | 96       | 45        | 16,0           | -0,4      | 45       | 5         | 10,1         | -0,8      | 49       | 15        |
| 13274   | 22,2        | 0,9       | 107      | 55        | 17,4           | -0,3      | 52       | 1         | 13,2         | 0,8       | 88       | 48        |
| 14015   | 20,1        | 1,0       | 187      | 43        | 15,0           | -0,5      | 88       | -42       | 11,5         | 1,1       | 188      | 73        |
| 14445   | 24,5        | -0,7      | 170      | 120       | 20,2           | -1,2      | 189      | 128       | 17,1         | 0,2       | 72       | -7        |
| 14654   | 18,8        | 0,3       | 91       | 20        | 13,4           | -1,7      | 197      | 127       | 11,2         | 0,8       | 122      | 34        |
| 15420   | 20,8        | -0,4      | 35       | -23       | 15,8           | -1,1      | 58       | 16        | 9,9          | -0,9      | 85       | 53        |
| 15614   | 19,2        | -0,2      | 90       | 38        | 14,9           | -0,9      | 106      | 67        | 10,7         | 0,3       | 78       | 41        |
| 16158   | 22,5        | 0,0       | 158      | 101       | 18,8           | -0,7      | 189      | 100       | 15,8         | 0,5       | 110      | -10       |
| 16597   | 26,4        | 0,1       | 17       | 10        | 24,0           | -0,1      | 21       | -19       | 21,3         | 0,6       | 22       | -68       |
| 16716   | 27,5        | -0,1      | 22       | 17        | 24,0           | -0,2      | 62       | 52        | 19,9         | 0,6       | 41       | -11       |
| 16754   | 27,4        | 1,8       | 25       | 24        | 24,5           | 1,4       | 74       | 56        | 20,6         | 0,9       | 61       | -15       |
| 17040   | 24,3        | 2,1       | 125      | -58       | 21,9           | 2,5       | 249      | 28        | 17,9         | 2,5       | 346      | 74        |
| 17062   | 24,6        | 1,6       | 137      | 111       | 20,4           | 0,7       | 70       | 29        | 16,2         | 0,9       | 56       | -15       |
| 17130   | 22,5        | -0,1      | 7        | -5        | 18,3           | 0,0       | 55       | 36        | 13,3         | 0,7       | 23       | -4        |
| 17170   | 22,2        | 1,0       | 0        | -7        | 18,1           | 1,3       | 6        | -8        | 12,8         | 2,7       | 59       | 11        |
| 17609   | 28,5        | 1,4       | <1       | 1         | 26,0           | 0,9       | 44       | 44        | 23,1         | 1,8       | 4        | -15       |
| 22113   | 10,1        | -0,9      | 49       | -16       | 5,5            | -1,2      | 54       | 2         | -0,7         | -1,7      | 58       | 16        |
| 26038   | 18,5        | 3,2       | 22       | -62       | 11,7           | 0,9       | 35       | -47       | 1,9          | -4,4      | 32       | -38       |
| 26629   | 20,4        | 4,1       | 14       | -49       | 12,8           | 0,7       | 42       | -17       | 4,8          | -2,1      | 167      | 116       |
| 26730   | 19,9        | 3,6       | 32       | -40       | 12,3           | 0,7       | 59       | -6        | 4,4          | -2,2      | 150      | 97        |
| 26850   | 19,7        | 3,2       | 44       | -28       | 12,1           | 0,4       | 41       | -19       | 4,4          | -1,9      | 142      | 93        |
| 27199   | 12,4        | -3,1      | 39       | -26       | 9,6            | 0,4       | 66       | -5        | 0,9          | -0,8      | 98       | 36        |
| 27612   | 17,0        | 0,6       | 21       | -53       | 12,0           | 1,1       | 80       | 16        | 2,5          | -2,5      | 131      | 73        |
| 33345   | 20,1        | 1,7       | 101      | 32        | 13,9           | 0,0       | 76       | 29        | 7,0          | -1,1      | 74       | 39        |
| 33815   | 21,3        | 0,8       | 81       | 36        | 16,6           | 0,4       | 47       | -1        | 9,3          | -0,8      | 29       | 2         |
| 34300   | 20,3        | 0,8       | 20       | -30       | 15,5           | 1,4       | 104      | 63        | 6,6          | -0,7      | 57       | 22        |
| 34880   | 22,9        | -0,4      | 14       | -5        | 20,0           | 2,7       | 36       | 10        | 11,1         | 2,0       | 18       | 1         |
| 35188   | 19,0        | 1,3       | 20       | -20       | 14,3           | 2,3       | 6        | -18       | 4,6          | 1,8       | 17       | -13       |
| 37789   | 24,8        | -0,4      | 13       | 6         | 22,6           | 1,9       | 4        | -6        | 15,5         | 2,3       | 42       | 15        |
| 40080   | 27,2        | 1,0       | 0        | 0         | 24,6           | 1,3       | 0        | 0         | 21,3         | 2,7       | 4        | -8        |
| 40100   | 28,4        | 2,0       | 0        | -1        | 27,3           | 2,1       | 9        | 4         | 24,8         | 2,2       | 20       | -34       |
| 40180   | 28,2        | 2,1       | 0        | 0         | 26,9           | 2,1       | 0        | 0         | 24,1         | 2,1       | 19       | -7        |
| 40270   | 25,4        | -1,0      | 0        | 0         | 24,1           | -1,1      | 0        | 0         | 22,0         | 0,2       | 3        | -6        |
| 60030   | 23,6        | -0,5      | 0        | 0         | 23,9           | 0,1       | <1       | -8        | 24,9         | 2,4       | 2        | -8        |

| WMO<br>No. | Station              | November 2002 |              |             |              | December 2002 |              |              |              |
|------------|----------------------|---------------|--------------|-------------|--------------|---------------|--------------|--------------|--------------|
|            |                      | Temp.<br>mean | (°C)<br>dep. | Prec<br>sum | (mm)<br>dep. | Temp.<br>mean | (°C)<br>dep. | Prec.<br>Sum | (mm)<br>dep. |
| 01008      | Svalbard             | -5,6          | 4,9          | 46          | 33           | -7,5          | 5,8          | 17           | 5            |
| 01025      | Tromsø               | -3,0          | -2,2         | 50          | -54          | -3,9          | -0,9         | 79           | -25          |
| 01492      | Oslo-Blindern        | -1,2          | -1,9         | 78          | 3            | -5,9          | -3,1         | 28           | -28          |
| 02196      | Haparanda            | -8,8          | -4,7         | 17          | -41          | -12,5         | -3,0         | 24           | -18          |
| 02485      | Stockholm            | 1,1           | -1,5         | 31          | -22          | -3,2          | -2,2         | 9            | -37          |
| 02974      | Helsinki-Vantaa      | -2,8          | -2,9         | 43          | -29          | -8,1          | -4,0         | 11           | -47          |
| 03091      | Aberdeen             | 7,5           | 2,3          | 185         | 110          | 5,5           | 1,8          | 111          | 38           |
| 03772      | London-Heathrow      | 9,8           | 2,6          | 151         | 96           | 7,2           | 2,1          | 119          | 62           |
| 03967      | Dublin (Casement)    | 8,9           | 2,2          | 154         | 84           | 6,4           | 1,1          | 75           | -2           |
| 04030      | Reykjavik            | 4,7           | 3,5          | 85          | 12           | 4,5           | 4,7          | 119          | 41           |
| 04320      | Danmarkshaven        | -17,5         | 2,4          | 2           | -8           | -16,3         | 5,5          | 38           | 25           |
| 04360      | Angmagssalik         | 1,0           | 5,7          | 109         | 13           | -1,2          | 6,0          | 128          | 25           |
| 06186      | København-Landb.     | 4,6           | -0,9         | 61          | -1           | 0,2           | -2,0         | 22           | -36          |
| 06260      | De Bilt              | 7,9           | 2,0          | 83          | 2            | 2,9           | -0,3         | 89           | 6            |
| 06447      | Uccle                | 8,6           | 2,5          | 92          | 16           | 4,4           | 0,9          | 109          | 33           |
| 06590      | Luxembourg           | 6,9           | 2,9          | 114         | 36           | 3,1           | 1,3          | 88           | 3            |
| 06660      | Zürich               | 6,7           | 2,6          | 182         | 97           | 3,9           | 3,3          | 80           | 7            |
| 06700      | Genève               | 7,8           | 2,8          | 295         | 207          | 5,6           | 3,6          | 81           | 6            |
| 07510      | Bordeaux             | 10,9          | 1,8          | 117         | 23           | 9,7           | 3,3          | 91           | -8           |
| 07650      | Marseille            | 13,2          | 2,5          | 139         | 81           | 9,1           | 1,8          | 34           | -22          |
| 08222      | Madrid               | 9,9           | 0,5          | 91          | 27           | 8,7           | 2,3          | 63           | 14           |
| 08314      | Mahon / Menorca      | 16,0          | 1,6          | 112         | 35           | 13,3          | 1,5          | 78           | -2           |
| 08495      | Gibraltar            | 16,6          | 0,5          | 260         | 119          | 15,1          | 1,0          | 133          | -13          |
| 08515      | St. Maria / Acores   | 17,4          | 0,0          | 36          | -66          | 15,6          | 0,2          | 147          | 52           |
| 08535      | Lisboa               | 14,9          | 0,4          | 196         | 82           | 13,7          | 1,9          | 162          | 54           |
| 10384      | Berlin-Tempelhof     | 4,4           | -0,5         | 50          | 1            | -2,0          | -3,4         | 13           | -40          |
| 11035      | Wien-Hohe Warte      | 7,5           | 2,7          | 67          | 17           | -0,4          | -1,4         | 66           | 22           |
| 11518      | Praha-Ruzyně         | 4,3           | 1,5          | 81          | 49           | -2,1          | -1,5         | 44           | 18           |
| 11903      | Slica                | 4,8           | 1,8          | 50          | -19          | -3,5          | -1,8         | 66           | 9            |
| 12160      | Elblag               | 3,5           | 0,2          | 34          | -22          | -5,3          | -5,6         | 19           | -33          |
| 12375      | Warszawa-Okecie      | 4,1           | 0,9          | 29          | -13          | -6,6          | -5,7         | 3            | -29          |
| 12843      | Budapest-Lorinc      | 7,4           | 2,6          | 33          | -19          | -1,1          | -1,5         | 38           | -2           |
| 13274      | Beograd              | 10,6          | 3,6          | 36          | -18          | 1,3           | -1,0         | 53           | -5           |
| 14015      | Ljubljana            | 9,3           | 4,7          | 119         | -16          | 2,6           | 2,6          | 51           | -50          |
| 14445      | Split                | 14,5          | 2,3          | 64          | -44          | 9,8           | 1,1          | 99           | -1           |
| 14654      | Sarajevo             | 9,8           | 5,0          | 50          | -41          | 2,4           | 2,6          | 71           | 7            |
| 15420      | Bucuresti            | 6,6           | 1,4          | 69          | 20           | -5,2          | -5,4         | 70           | 27           |
| 15614      | Sofia                | 6,3           | 1,3          | 31          | -16          | -0,3          | -0,8         | 31           | -8           |
| 16158      | Pisa                 | 14,3          | 3,9          | 138         | 14           | 9,3           | 2,5          | 143          | 58           |
| 16597      | Luqa / Malta         | 18,3          | 1,3          | 180         | 100          | 14,2          | 0,4          | 107          | -5           |
| 16716      | Athens (Hellinikon)  | 16,0          | 0,5          | 119         | 69           | 10,9          | -1,3         | 163          | 92           |
| 16754      | Heraklion / Kreta    | 17,0          | 0,4          | 93          | 34           | 13,4          | -0,4         | 108          | 34           |
| 17040      | Rize                 | 13,2          | 1,6          | 143         | -107         | 5,9           | -2,4         | 354          | 111          |
| 17062      | Istanbul-Goztepe     | 12,7          | 1,1          | 71          | -18          | 6,2           | -1,9         | 58           | -64          |
| 17130      | Ankara / Central     | 8,0           | 0,9          | 19          | -14          | -0,8          | -3,4         | 16           | -33          |
| 17170      | Van                  | 5,3           | 1,3          | 50          | 8            | -2,6          | -1,7         | 73           | 39           |
| 17609      | Larnaca              | 18,8          | 2,4          | 14          | -30          | 13,3          | 0,1          | 128          | 52           |
| 22113      | Murmansk             | -8,9          | -3,8         | 44          | 4            | -11,4         | -2,1         | 21           | -17          |
| 26038      | Tallina              | -1,0          | -2,2         | 97          | 29           | -6,9          | -4,0         | 15           | -40          |
| 26629      | Kaunas               | 1,9           | -0,2         | 27          | -26          | -8,1          | -5,7         | 22           | -22          |
| 26730      | Vilnius              | 1,4           | 0,2          | 22          | -35          | -8,8          | -5,9         | 19           | -36          |
| 26850      | Minsk                | 1,1           | 0,3          | 27          | -25          | -9,1          | -5,3         | 14           | -39          |
| 27199      | Wjatka (Kirov)       | -4,7          | 0,0          | 118         | 66           | -18,8         | -8,5         | 40           | -5           |
| 27612      | Moskva               | -1,5          | -0,4         | 41          | -17          | -12,6         | -6,5         | 37           | -15          |
| 33345      | Kiev                 | 3,9           | 1,8          | 50          | -1           | -8,4          | -6,1         | 11           | -41          |
| 33815      | Chisinau             | 6,5           | 2,1          | 76          | 37           | -6,6          | -6,3         | 5            | -33          |
| 34300      | Charkov (Kharkiv)    | 2,6           | 1,3          | 36          | -8           | -9,6          | -6,2         | 8            | -37          |
| 34880      | Astrahan'            | 5,0           | 1,7          | 12          | -7           | -9,7          | -7,8         | 8            | -7           |
| 35188      | Akmola               | -2,5          | 3,4          | 42          | 20           | -17,8         | -5,2         | 28           | 11           |
| 37789      | Yerevan              | 7,8           | 1,3          | 6           | -16          | -5,7          | -5,9         | 42           | 19           |
| 40080      | Damascus             | 12,5          | 0,2          | 29          | 2            | 8,2           | 0,6          | 30           | -16          |
| 40100      | Beyrouth             | 20,8          | 2,1          | 123         | 19           | 15,7          | 0,9          | 225          | 51           |
| 40180      | Tel Aviv (Airport)   | 20,5          | 2,5          | 30          | -38          | 15,4          | 1,6          | 223          | 85           |
| 40270      | Amman                | 14,9          | -0,8         | 16          | -9           | 9,4           | -1,3         | 81           | 31           |
| 60030      | Las Palmas / Gr. Can | 22,0          | 1,6          | 11          | -10          | 20,3          | 2,0          | 102          | 81           |

## Year 2002

| WMO No. | Station              | Temp. mean | (°C) dep. | Prec sum | (mm) dep. |
|---------|----------------------|------------|-----------|----------|-----------|
| 01008   | Svalbard             | -4,3       | 2,5       | 192      | 11        |
| 01025   | Tromsø               | 3,5        | 1,6       | 976      | 6         |
| 01492   | Oslo-Blindern        | 6,9        | 2,5       | 829      | 61        |
| 02196   | Haparanda            | 0,6        | 0,5       | 442      | -110      |
| 02485   | Stockholm            | 6,4        | 1,1       | 477      | -62       |
| 02974   | Helsinki-Vantaa      | 4,2        | 0,9       | 449      | -202      |
| 03091   | Aberdeen             | 7,9        | 1,1       | 1089     | 301       |
| 03772   | London-Heathrow      | 10,6       | 1,5       | 786      | 187       |
| 03967   | Dublin (Casement)    | 8,9        | 0,8       | 1014     | 279       |
| 04030   | Reykjavik            | 4,5        | 1,0       | 916      | 116       |
| 04320   | Danmarkshaven        | -10,6      | 1,9       | 183      | 51        |
| 04360   | Angmagssalik         | -0,3       | 1,9       | 1090     | 158       |
| 06186   | København-Landb.     | 7,8        | 0,6       | 632      | -4        |
| 06260   | De Bilt              | 9,2        | 1,2       | 923      | 115       |
| 06447   | Uccle                | 9,7        | 1,2       | 1096     | 296       |
| 06590   | Luxembourg           | 10,0       | 2,7       | 969      | 118       |
| 06660   | Zürich               | 8,9        | 1,7       | 1276     | 163       |
| 06700   | Genève               | 10,0       | 1,9       | 1167     | 257       |
| 07510   | Bordeaux             | 12,3       | 1,3       | 723      | -200      |
| 07650   | Marseille            | 13,8       | 1,0       | 814      | 269       |
| 08222   | Madrid               | 13,2       | 0,9       | 502      | 45        |
| 08314   | Mahon / Menorca      | 15,5       | 0,9       | 701      | 118       |
| 08495   | Gibraltar            | 16,6       | 0,4       | 952      | 177       |
| 08515   | St. Maria / Acores   | 15,9       | 0,2       | 698      | -77       |
| 08535   | Lisboa               | 15,2       | 0,3       | 810      | 115       |
| 10384   | Berlin-Tempelhof     | 8,5        | 0,6       | 740      | 157       |
| 11035   | Wien-Hohe Warte      | 9,6        | 1,3       | 819      | 206       |
| 11518   | Praha-Ruzyně         | 7,5        | 1,0       | 679      | 152       |
| 11903   | Slica                | 7,4        | 0,9       | 805      | 119       |
| 12160   | Elblag               | 7,4        | 1,2       | 645      | -45       |
| 12375   | Warszawa-Okecie      | 7,6        | 1,2       | 554      | 35        |
| 12843   | Budapest-Lorinc      | 10,1       | 1,3       | 513      | -5        |
| 13274   | Beograd              | 11,8       | 1,7       | 596      | -88       |
| 14015   | Ljubljana            | 10,1       | 1,9       | 1289     | -104      |
| 14445   | Split                | 14,9       | 1,1       | 915      | 90        |
| 14654   | Sarajevo             | 9,5        | 1,6       | 965      | 47        |
| 15420   | Bucuresti            | 9,1        | 0,3       | 607      | 12        |
| 15614   | Sofia                | 9,0        | 0,9       | 653      | 90        |
| 16158   | Pisa                 | 13,2       | 1,0       | 1117     | 213       |
| 16597   | Luqa / Malta         | 17,2       | 0,8       | 454      | -98       |
| 16716   | Athens (Hellinikon)  | 16,6       | 0,5       | 544      | 175       |
| 16754   | Heraklion / Kreta    | 17,1       | 0,7       | 516      | 15        |
| 17040   | Rize                 | 12,9       | 0,8       | 2072     | -101      |
| 17062   | Istanbul-Goztepe     | 13,0       | 0,8       | 623      | -74       |
| 17130   | Ankara / Central     | 10,1       | 0,3       | 388      | -25       |
| 17170   | Van                  | 7,7        | 0,8       | 479      | 94        |
| 17609   | Larnaca              | 17,6       | 0,8       | 377      | 48        |
| 22113   | Murmansk             | -1,0       | 0,0       | 492      | 14        |
| 26038   | Tallina              | 4,8        | 1,0       | 537      | -130      |
| 26629   | Kaunas               | 6,4        | 1,3       | 645      | 37        |
| 26730   | Vilnius              | 6,0        | 1,3       | 615      | -68       |
| 26850   | Minsk                | 6,1        | 1,6       | 594      | -83       |
| 27199   | Wjatka (Kirov)       | 1,7        | 0,6       | 749      | 124       |
| 27612   | Moskva               | 4,8        | 1,2       | 534      | -154      |
| 33345   | Kiev                 | 7,6        | 1,5       | 697      | 58        |
| 33815   | Chisinau             | 9,1        | 1,2       | 533      | 37        |
| 34300   | Charkov (Kharkiv)    | 7,2        | 1,4       | 491      | -28       |
| 34880   | Astrahan'            | 8,7        | 0,7       | 200      | -20       |
| 35188   | Akmola               | 3,4        | 2,1       | 377      | 59        |
| 37789   | Yerevan              | 12,0       | -0,1      | 357      | 80        |
| 40080   | Damascus             | 15,5       | 1,0       | 139      | -55       |
| 40100   | Beyrouth             | 19,1       | 1,5       | 869      | -19       |
| 40180   | Tel Aviv (Airport)   | 18,7       | 1,4       | 627      | 60        |
| 40270   | Amman                | 15,6       | -0,8      | NIL      | NIL       |
| 60030   | Las Palmas / Gr. Can | 19,5       | 1,1       | 184      | 68        |

## Monthly Surveys

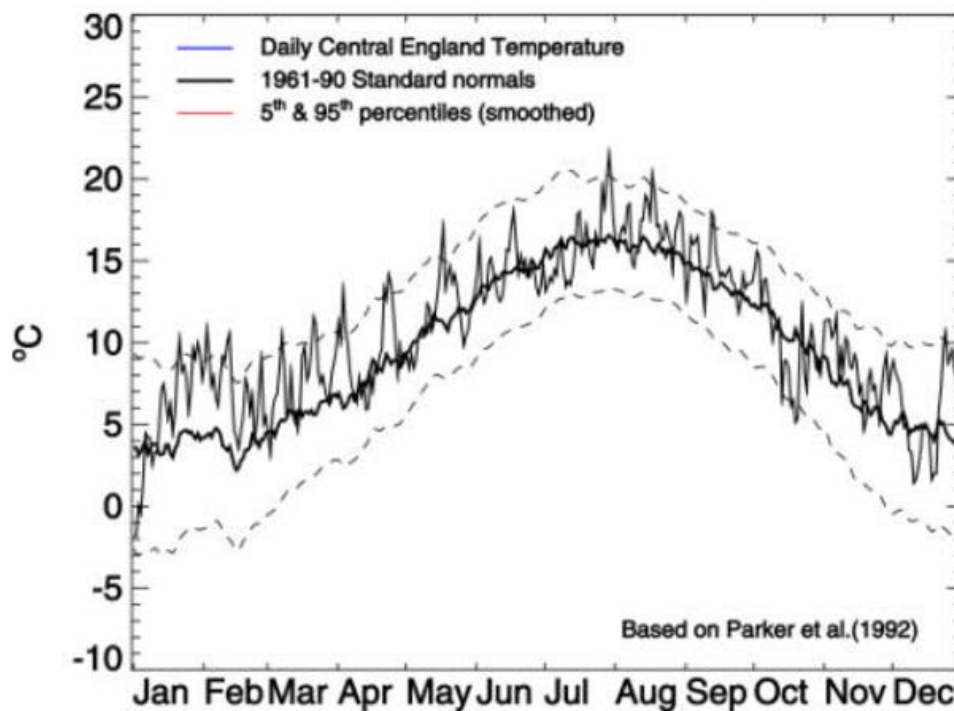
### January 2002

- After a cold start in the very first days of the year, generally warmer than normal in the northern and south-western Region, extremely mild in central Russia
- Cold in the south-east with a centre of negative temperature deviations from normal in Turkey
- Extremely dry in a zonal belt from the Biscay over the Alps and the Carpathians to the Ukraine as well as in the southern parts of Italy and Spain
- Severe storms in northern Europe during the last days of the month

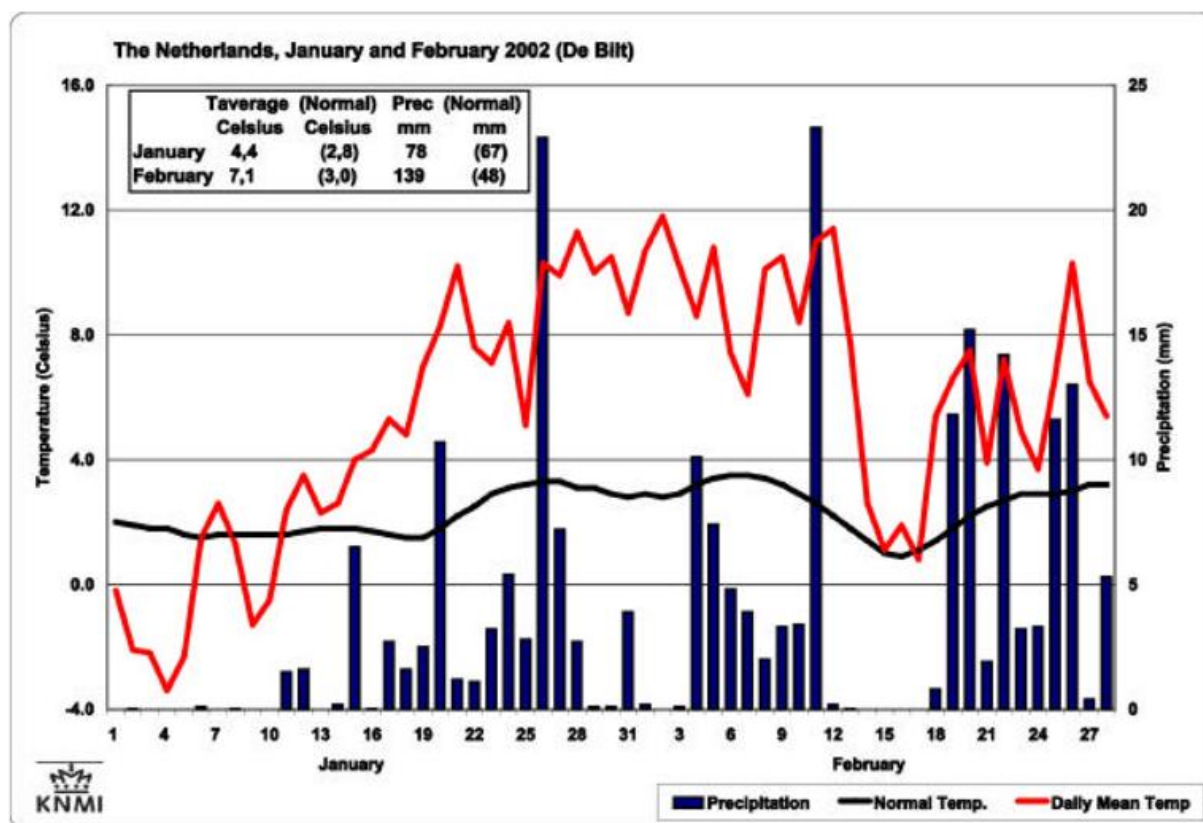
In Iceland, some meteorological records were broken. The absolute maximum temperature in Reykjavik was  $+10.6^{\circ}\text{C}$  and thus the highest temperature ever measured there in January. A relatively warm period during the first three weeks of the month was the reason for the absence of a snow cover in the southern and western lowlands of the island, which is a highly unusual situation. A new national record of 24 hr precipitation was set on January 10, when 293.3 mm were measured at Kvisker. This record exceeds the previous one

by 50 mm, measured in 1979 at the same station.

In the U.K., a 31 day period of extremely mild weather started on the 13<sup>th</sup> of the month, which never before was observed in the Central England Temperature series (fig. 1.1). In the Netherlands, the lowest temperature of the year,  $-11.9^{\circ}\text{C}$ , was observed at station Hupsel on January 4. One week later, a period of positive temperature anomaly up to  $+9^{\circ}\text{C}$  began and lasted for 5 weeks (fig. 1.2), similar to the situation in the U.K..



**Fig 1.1:** *Central England temperature, daily values 2002*  
 From: U. K. Met Office, Hadley Centre for Climate Prediction and Research



**Fig. 1.2:** Daily precipitation and daily mean temperature at Station De Bilt, The Netherlands  
From: The Dutch Royal Meteorological Institute, KNMI

During the last decade of the month, some national records of maximum temperature were broken, especially on January 29 in Austria (+20.5°C, Eisenstadt), Hungary (+20.0°C, Máza), Slovakia (+20.3°C, Bratislava) and on January 30 in Germany (+21.0°C, Altenstadt). Also in La Coruña, Spain, a new record of  $T_{max}$  was set in a series of more than 100 years.

Strong winds up to Hurricane force affected N-Europe in a belt from the British Isles over northern Germany and Poland to the Baltic States within the last week of the month.

England and Scotland suffered from heavy damage to traffic and power lines, caused by strong winds, which were up to 190 km/h in the Scottish Highlands. In Husum, Germany, a wind energy converter crashed on January 29, while maximum wind speeds of more than 150 km/h were observed.

The lowest temperatures of the year in Ireland were measured on January 1, namely -8.0°C air temperature at Mullingar and -12.5°C grass minimum temperature at Kilkenny. Strong winds were observed during the last days of the month; Malin Head

measured the highest gust of the year, 159 km/h on January 28.

Considerable damage occurred during stormy weather in the centre and the north of Belgium, accompanied by floods in the provinces of Brabant and Luxembourg on January 26-28.

The year started extremely cold in France, whereas the end of January was particularly mild.

Like in many other countries, in Germany very cold weather at the beginning of the year turned into extremely mild conditions at the end of the month. From January 6-7 freezing rain in many parts of the country caused thousands of accidents on roads with 120 people injured and 3 deaths. A period of very strong winds from January 26-29, especially in the northern parts of the country with maximum gusts up to 169 km/h (Brocken), caused floods in coastal areas, disruption of traffic and power lines, and lots of damage to houses and forests.

Stormy weather was also reported from Denmark on January 28-29.

In Norway the month was generally warmer than normal and precipitation was above normal for most of the country. The lowest temperature of the year was  $-40.6^{\circ}\text{C}$ , measured in Kautokeino in Finnmark County on January 24. The station Glomfjord in Nordland County received a precipitation amount of 134.6 mm on January 11, which is the highest diurnal value of all weather stations in Norway for 2002.

A new national record of daily precipitation was set in Sweden, when Katterjäck got 104 mm. This precipitation came down as rain at a station where the normal temperature for January is  $-12^{\circ}\text{C}$ .

Precipitation in Finland was generally well above normal.

In Lithuania the year started with cold frosty weather combined with heavy snowfalls and blizzards. Minimum temperatures in most regions fell down to minus  $22 - 27^{\circ}\text{C}$ . After the first 5 days, frost conditions weakened and the mean daily temperatures became unusually mild, so that the monthly mean temperature resulted to  $+3.8^{\circ}\text{C}$  above normal. Precipitation in January was in excess of normal and amounted to 68 mm, which is 162% of normal. In the first five-day and the third ten-day periods, the weather was very windy. The strongest wind was observed in western Lithuania with gusts above 120 km/h on January 29. The wind broke many trees, disrupted power lines, and damaged two ships in the port of Klaipeda.

Very cold weather dominated the first days of the month also in Poland with temperatures below  $-30^{\circ}\text{C}$  in the Carpathian Mountains on January 4. In the second half of the month, the wintry conditions turned into very mild weather, which made the snow cover completely disappear. Cracow had a maximum temperature of  $+13.1^{\circ}\text{C}$  on January 29 and the countrywide monthly mean temperature rose to  $+1.2^{\circ}\text{C}$ . The national precipitation rate was 121% of normal with considerable spatial variation. For example, station Wroclaw received only 70% of normal. The economically most unfavourable weather was observed at the end of the month, according to an exceptionally active westerly circulation. From January 25-31 violent storms and thunderstorms caused a lot of material damage all over the country and the loss of 6 lives.

In Belarus the year started with very mild weather and a monthly mean temperature anomaly of  $+4^{\circ}\text{C}$ .

Slovakia had very dry conditions. The precipitation total was 61% of normal; which was the lowest monthly mean of the year.

Also in Slovenia, the month was exceptionally dry. The mean precipitation rate was less than 50% of the long term average. In some places in the north of the country, precipitation rates were even below 10% of normal. Accordingly, the sunshine duration was well above normal. Some areas, like Ljubljana's and Celje's basin, received more than twice the usual sunshine duration. As in many other countries, the month had a cold start and ended with significantly mild weather.

The same conditions were valid for Hungary; where in some places the maximum temperatures exceeded  $+18.0^{\circ}\text{C}$  at the end of the month.

In Serbia and Montenegro January air temperatures were within the normal limits, and precipitation was scarce.

The first three days of the year were very cold in Bulgaria with temperatures down to  $-22.2^{\circ}\text{C}$  in Sandanski. Due to heavy snowfall and frost more than 200 accidents occurred in the northeast of the country, 3 people froze to death.

In Portugal the monthly average temperatures exceeded their means for the period 1961-90, while the monthly precipitation totals were below normal.

The NW of Spain as well as in the Canary Islands experienced extremely mild weather conditions.

In Turkey two significant weather events occurred at the beginning of the month. Strong winds caused damage to houses, forests and power lines in Kayseri on January 4. Two days later, heavy snowfall cut traffic lines in the area of Yozgat.

January in Armenia was dry and mild.

A tornado affected the west coast of Cyprus on January 4. Another unusual event was snowfall in the western coastal area of the island on January 7. Heavy snowfall continued in the Troodos range on January 9 and disrupted traffic lines to many mountain villages.

The weather in Israel was cool and rainy. In some parts of the country rainfall was twice normal. The most significant rainfall event occurred on January 6-9 with 100-180 mm measured in the northern and central parts of the country. This event included snowfall on the mountains, mostly on January 7, when 30 - 35 cm of snow were measured at Har Kenaan.

Snowfall occurred also at areas with an altitude of only 300-400 m above sea level, an unusual

event in Israel. Areas at a higher altitude reported more than 1 m of snow.

## February 2002

- **Positive temperature anomalies all over the Region except for Iceland and Greenland**
- **Extremely mild in eastern Europe**
- **Extremely wet in central and north-eastern Europe, very dry in southern Europe and the Middle East**

Iceland experienced the coldest February in Reykjavik since 1935 and in Akureyri since 1973. Except for a damaging northerly storm on February 2-3, the weather conditions were favourable during the month.

In Norway the monthly mean temperatures and precipitation totals were well above normal for almost the whole country.

Finland had a wet February, as well as Denmark, where a precipitation rate of more than 200% from normal was recorded.

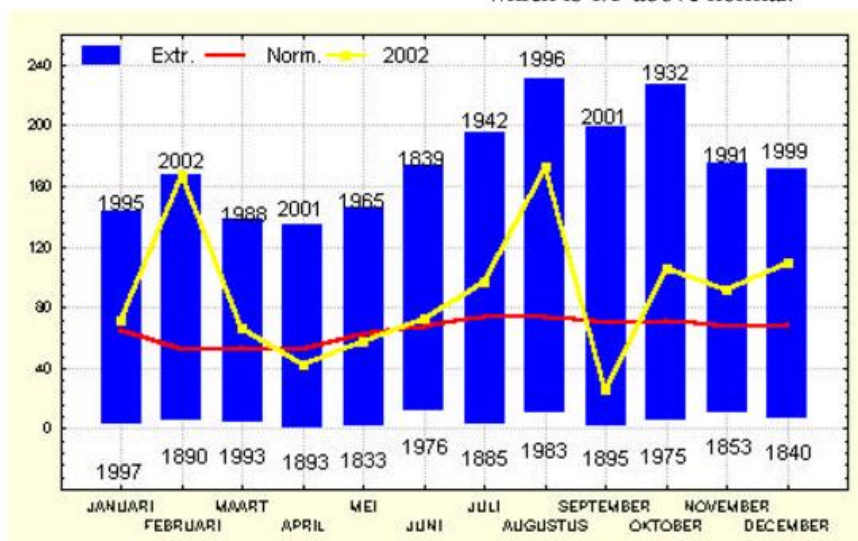
In Ireland, it was one of the wettest months of the year relative to normal. In addition, a combination of heavy rainfall, strong winds and in particular an exceptionally high tide brought significant coastal flooding on February 1st. Monthly mean temperatures were over two degrees higher than normal in places.

It was a particularly wet month in the U.K. too. North-western England and northern

Wales had its highest rainfall, 155 mm, in the 130 year record of the month.

In France, the weather was extraordinarily mild. The long term temperature averages were exceeded all over the country with maximum anomalies of more than +4°C reported from the northern areas. The maximum wind gusts of the year, 144 km/h, were recorded on February 4 at Cap-de-la-Hève and also on February 21 at Cap-Béar.

At station Uccle, Belgium, the monthly mean temperature was significantly above normal. At the same station, the monthly precipitation total was extraordinarily high (see fig. 2.1): 168 mm are equal to 317% of normal and the highest amount since observations started in 1833. Consequently, serious damage was caused by floods in many parts of the country on February 13 and during February 25-28. The mean monthly wind speed was relatively high; 5.3 m/s were measured at Uccle, which is 1/3 above normal.



**Fig 2.1:** Monthly precipitation totals in mm station Uccle, Belgium. Normal and extreme values since 1833  
From: Royal Meteorological Institute, Belgium

The month was the second warmest February since 1901 in the Netherlands. The countrywide monthly mean temperature was 7.1°C and thus +4.1°C above normal. On February 2 a maximum of 15.5°C was measured, the highest temperature ever recorded so early in the year. The month was also extraordinarily wet. The precipitation total averaged over the country was 147 mm, which is 313% of normal. In De Bilt, the second highest monthly precipitation total was observed since 1901. However, the monthly sum of sunshine duration ended up within the top 10 since 1901. Hourly average wind speeds of 88 km/h and more were reported on February 26.

The weather in Germany was extremely mild and wet. In the series of spatial monthly means it was the second warmest and third wettest February since 1901. Intense precipitation led to high waters in rivers of western Germany with flooding on February 12-14 and 25. Heavy snowfall and freezing rain caused hundreds of accidents on slippery roads all over the country during February 19-24. Motorways around Berlin were blocked by overturned trucks on February 19-20. On February 22 stormy winds up to 115 km/h caused snowdrift on Heligoland. A whirlwind damaged more than 100 houses near Münster on February 23. Winds of hurricane force with gusts up to 180 km/h paralysed public life in Schleswig-Holstein on February 26-27.

The monthly mean temperature of Vienna, Austria, was +5°C above normal and is the second highest value in the time series since 1775.

It was the month with the highest temperature anomaly of the year in Poland. Averaged over 8 stations, the deviation from normal was +4.7°C. The spatial distribution of deviations showed a remarkable positive gradient from the western to the eastern parts of the country. A snow cover in the lowlands, which often existed in former years, was absent throughout the month. On February 2 the maximum temperature in Wrocław came up to 15.8°C. February was also the wettest month of the year with a countrywide precipitation rate of 220% compared to normal. Locally, precipitation rates up to 400% were observed, e.g. in Plock. On February 12 thunderstorms combined with hail and intense rainfall caused severe damage to houses and power lines of more than 60 villages in NE Poland. On February 27 thunderstorms and

winds of hurricane force affected the city of Cracow.

In Lithuania the mean monthly air temperature was +1.8°C, which is +6.4°C above normal. Over the past century, February had been warmer only in 1925, 1989 and 1990. Precipitation was in excess of normal and amounted to 74 mm, which is 247 % of the long term average.

In Belarus, a sequence of daily mean temperatures =0°C continued throughout the month, which normally starts to happen 6 weeks later.

The monthly mean temperature in Slovakia was well above normal and exceeded the long term average up to +5°C in the north-eastern part of the country. Precipitation totals were exceptionally low.

Temperature anomalies in Slovenia were above +1.6°C everywhere and up to +4°C in the eastern parts of the country. The month was unusually cloudy at the coast, in the Karst and some other places, where the sunshine duration merely reached half the normal. Snow depths in the mountains were relatively small. On Kredarica, the snow depth was up to 75 cm, which is lower than any February record of former years.

In Serbia and Montenegro, the extreme positive deviations of the monthly mean temperatures from normal were up to >+6°C similar to those of other east European countries. Even higher deviations from normal were recorded for the mean daily maximum temperatures (see fig. 2.2). At the same time, considerably lower precipitation amounts than normal were registered. In the eastern parts of the country the deficit was over 90%.

The month was extraordinarily mild in Romania. Temperature anomalies were positive all over the country and up +8°C (see fig. 2.3).

In Bulgaria, the month was very mild with mean temperatures of +3...+7°C above normal and dry with precipitation rates from 3...54% of normal. Nevertheless, on February 24-25 stormy winds and wet snow fall caused damage of power lines and interrupted transportation to and in the mountain areas.

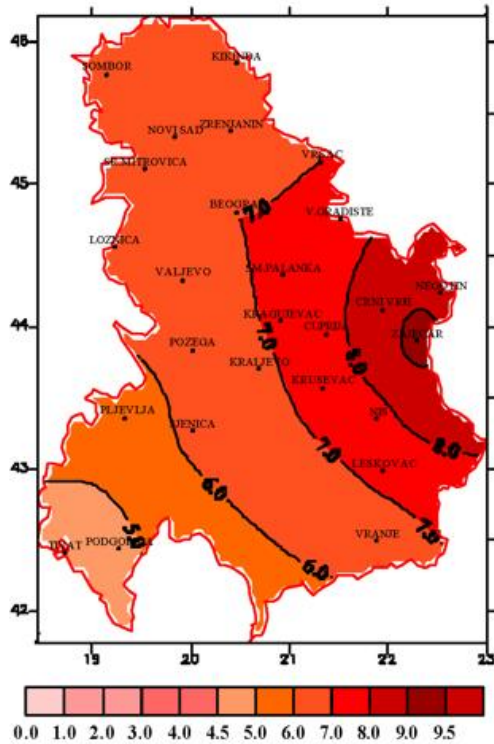
The weather in Portugal was rather mild and dry. The monthly precipitation totals were below 50% of normal.

Rather mild and relatively dry weather prevailed also in Cyprus and in Israel, where it was the warmest February since 1977.

Armenia had a temperature anomaly of more than +4°C.

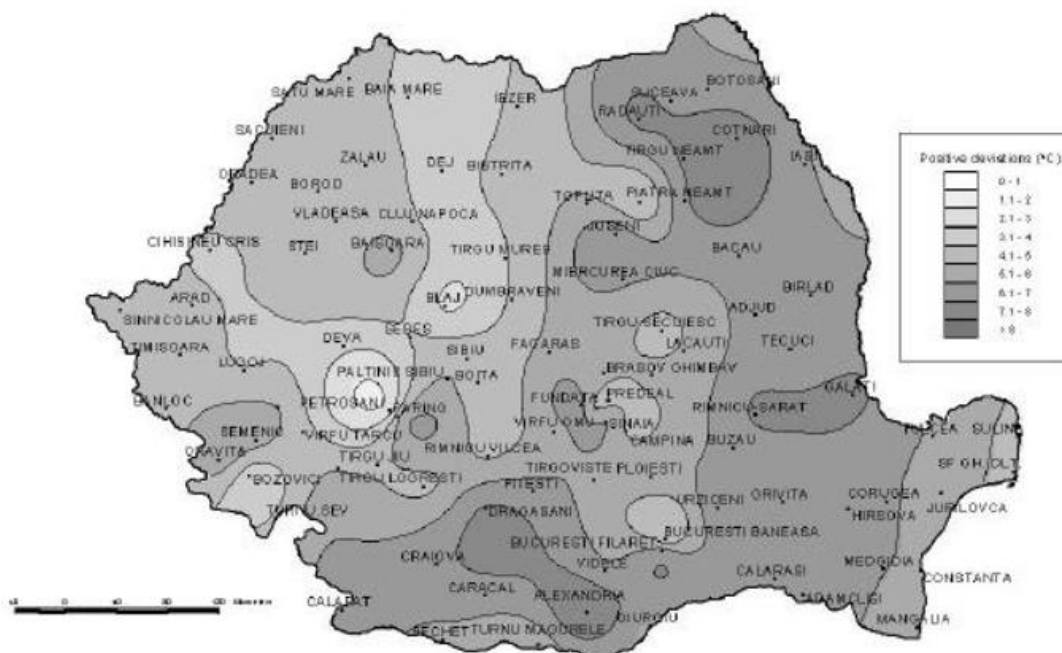
The monthly mean temperature in Azerbaijan, calculated from 15 stations, was

4.6°C above normal, which statistically occurs every 35 years.



**Fig 2.2:**

*Maximum air temperature anomaly (°C) distribution in February 2002 in FRY (now Serbia & Montenegro)  
From: Federal Hydrometeorological Institute of Yugoslavia*



**Fig 2.3:** *Deviation of mean temperatures against the climatological norm in February 2002, in Romania  
From: National Institute of Meteorology and Hydrology, Romania*

## March 2002

- **Warmer than normal everywhere except for Iceland, Svalbard and Acores; extremely warm in eastern Europe**
- **Extremely dry in coastal areas of the Greenland Sea, the North Sea, the Biscay, the Tyrrhenian Sea, the Adriatic Sea, in central Ukraine and parts of Russia**

The monthly mean temperature in Sweden was well above normal, especially in the south-eastern parts of the country. The maximum temperature was 21.4°C at station Oskarshamm, which means the 2<sup>nd</sup> highest national record of the month ever made before.

In the Netherlands March was very sunny and ended in the top 10 since 1901. Hourly average wind speeds of 10 Beaufort (24.5 m/s or higher) were reported on March 9.

In Belgium, the monthly mean temperature was well above normal. A tomado like whirlwind affected the area of Eupen. on March 18.

In Germany the monthly mean temperature was +2°C above normal and the precipitation rate 10% higher than the long term average. However, during the period of March 19-23, intense rainfall together with snow melt in the mountains led to high waters in the rivers of southern Germany together with flooding of cities, e.g. Heidelberg and Passau.

The countrywide temperature anomaly in Poland was +2°C, while the overall precipitation total was near normal. On March 7 intense advection of polar-maritime air lead to strong winds up to 97 km/h in Krakow causing lots of damage.

The month was very dry in Slovakia. The countrywide precipitation totals were only 2 thirds of normal.

The anomaly of the monthly mean air temperature in Slovenia was statistically significant with +3°C above normal. Precipitation totals did not reach the normal rate at any station. Sunshine duration was well above normal everywhere in the country, large basins in the central part of Slovenia got about 60 % more sunny weather than in the long term average.

In Romania monthly temperature anomalies were up to +4°C. At the end of the first decade of the month, the most serious event occurred along the track of gradually intensifying winds up to 145 km/h, when thousands of trees were uprooted and forest fires

broke out, especially in the eastern parts of the country.

In Bulgaria, the month was mild and very wet. The deviation of the monthly mean temperature from normal varied between +2°C and +4°C. The monthly precipitation totals were from 250% up to 444% of normal. During the period of March 23-26, strong winds combined with intense rain and snowfall caused the interruption of traffic and power lines, especially in the mountain areas. Landslides were triggered. A bus with passengers was overturned on the road to Varna by wind force on March 25. The ports of Burgas and Balchik were closed for some time.

The monthly mean temperature in the mainland of Portugal was +1.2°C above normal, while precipitation totals reached 130% of the long term average amount.

On March 14 a tomado with gusts up to 149 km/h affected the area of Extremadura, Spain. Intense rain over Santa Cruz de Tenerife, Canary Islands, caused several mortal casualties and heavy material losses; the precipitation total in 24 hours was 232.6 mm with the maximum intensity of 27.1 mm in 10 minutes.

In the area of Konya, Turkey, frost and storm damaged crops and houses as well as telecommunication and power lines on March 22-23.

Monthly temperatures in Cyprus were well above normal. On March 20 a severe hailstorm in the south-eastern part of the island and a thunderstorm in the western part of the central plain on March 28 caused fatal some accidents.

The month started extremely warm and dry in Israel with temperatures of +6...+9°C above normal. The heat-wave reached its peak on March 11 with temperatures of more than 35°C in the coastal plain. In Tel Aviv 36.4°C were reported, and this was the highest temperature in March since the beginning of measurements at this station in 1950. The second part of the month was cool and rainy, but only the northern parts of the country received rainfall amounts larger than normal with a surplus between 20% and 60%. Other

parts of the country received only 50% to 80% of the long term average rainfall.

The mean monthly temperatures in Armenia were up to +4°C above normal.

Relatively low snow depths compared to previous years were recorded from the mountain areas in Azerbaijan. These

circumstances caused a dramatic decrease of water resources and endangered the ecosystem of river Kura, which is the main waterway of the country. The monthly mean temperature was countrywide +4.5°C above normal. The statistical recurrence period of such an event is more than 100 years.

## April 2002

- **Slightly to moderately warmer than normal except in south-eastern Europe and most parts of the Middle East, extremely mild in Svalbard.**
- **Seriously dry in central France and north-eastern Europe, extremely wet in north-eastern Greenland and around the furthestmost eastern Mediterranean compared to normal.**

Iceland had relatively mild weather except for a bad snowstorm in the north and northeast during the last week of April.

In Norway, the month was a lot warmer than normal for the whole country and precipitation below normal for a greater part of the country. On the island of Svalbard the monthly mean temperature exceeded normal by more than +5°C.

Sweden had fairly dry weather conditions. It was still drier in Finland with a precipitation deficit of more than half of the normal rate.

The weather in Belgium was dominated by two different circulation types importing cool and dry continental as well as mild and humid maritime air. These conditions resulted in monthly mean values of the air temperature and precipitation totals near normal. However, sunshine duration at station Uccle was 35 h higher and thereby 22% above the long term average.

In France it was very dry with monthly precipitation rates below 50% of normal in the central part of the country. The monthly mean temperatures were up to +2°C above the long term averages.

Portugal had a precipitation deficit of about 50%, while the monthly mean temperatures stayed slightly above normal.

In Germany, the monthly mean temperature was slightly above the long term average, while the overall precipitation nearly reached normal. Stormy winds with gusts of hurricane force damaged houses, trees and cars in Düsseldorf on April 29.

The mild winter and favourable conditions at the beginning of spring caused a very early start of vegetation in Poland. For example in Cracow the blossoming of bird cherry (*prunus padus*) was observed very early on April 12; the first blossoms of lilac (*syringa vulgaris*) appeared on April 28. The monthly mean temperature was slightly above and the precipitation total near to normal.

Weather conditions in Lithuania were rather dry. The mean precipitation amounted to 24 mm only, which is 57 % of normal.

The mean air temperature in Slovenia was very close to the long term average. The anomaly was within the normal variability. The countrywide precipitation total exceeded normal, some places received more than twice the average precipitation amount of the reference period.

On April 7-8, a cold front passed over Serbia and Montenegro and brought an intensive drop of temperatures. At that time morning frost brought great damage, especially to agricultural areas in the north-east of the country. However, the overall temperature anomaly was slightly positive.

In Bulgaria the monthly mean temperature deviation was down to -2°C from normal. There was a 14 day period of hoar-frost, while thunderstorms occurred on 12 days including 7 days with hailstorms.

The monthly mean temperatures in Cyprus were below normal. Precipitation totals exceeded normal significantly. In the south-eastern part of the island, a severe hailstorm damaged potato plantations on April 1. A tor-

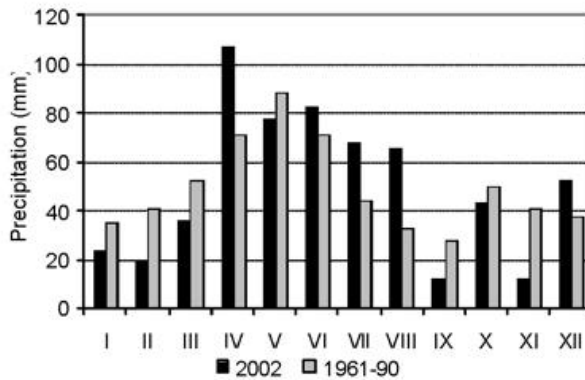
nado crossed the western part of the island on April 19.

The month was cooler than normal in Israel with rainfall amounts reaching 150%-250% of normal and a small number of sharav (local term for Sirocco) events.

In Armenia the monthly mean temperature was moderately below normal, while the precipitation total exceeded the long term average by more than 50% (see fig. 4.1).

Frequent rains and hailstones caused severe damage to agriculture and hindered the work in the fields.

The monthly mean temperature in Azerbaijan was slightly below normal and only 1°C higher than in the month before; normally, this difference is +5.5°C. The precipitation total was 65% above the long term average (see fig. 12.2).



**Fig. 4.1:**

*Monthly precipitation totals in Armenia compared with 1961 - 1990 means*

*From: Department of Hydrometeorology of the Republic Armenia*

**May 2002**

- **Significantly warmer than normal in Scandinavia and eastern Europe**
- **Very wet in the coastal areas of the north-western Mediterranean, extremely dry in the eastern Balkans and around the Aegean Sea**
- **Lots of damage to local infrastructure in many countries as a consequence of strong winds, intense rainfall and thunderstorms**

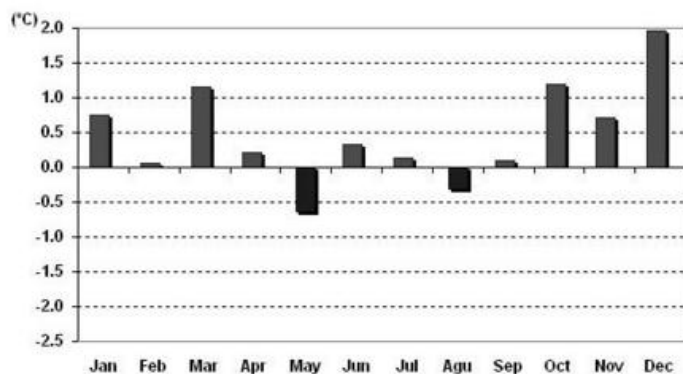
In Iceland, the month was sunny and mild in the south and west, but damp and cool in the north-east. In Ireland it was very wet and dull except in the north.

The month was warmer than normal for the whole of Norway and substantially warmer for a greater part of the country. Precipitation amounts were below normal for most of the country. The southern and southeastern part, however, received a lot more precipitation than normal.

The monthly mean temperature at Uccle, Belgium, was +0.7°C above the norm and the precipitation rate 80% of normal. A violent storm in the eastern provinces occurred on May 9.

In France a very hot period happened in the middle of the month, and highest temperatures established new maximum records for the month, e.g. 34.2 °C in Biscarosse on May 16; the previous record was 33.1°C. Three days before, an intense squall line, locally called “Galerne”, had crossed the south-west of France from the Basque country over Landes to north of Bordeaux with gusts up to 133 km/h.

The mainland of Portugal had a negative temperature anomaly of -0.7°C. The same deviation from normal was observed for the monthly mean minimum temperature, which was positive for nearly all other months of the year (see fig. 5.1). Very dry weather conditions caused a countrywide mean precipitation rate of about 50% from normal.

**Fig. 5.1:**

*Mean monthly minimum temperature anomalies, differences from 1961-90*

*From: Instituto de Meteorologia, Portugal*

In Germany the monthly mean temperature was  $+1.7^{\circ}\text{C}$  above normal and the precipitation total only slightly above normal. During the course of an extensive thunderstorm along the Elbe river, 67000 lightnings per hour were registered and numerous houses were set on fire in the night of May 11-12. Another extreme weather event happened during May 18-19 in Bavaria, when widespread thunderstorms caused the interruption of traffic and power lines, burning down of farmhouses, flooding, mudflow and landslides. Similar damage occurred to an area in and around Berlin on May 23-24, again as consequence of thunderstorms.

A severe cold spell occurred in Lithuania on May 19-21 with morning frosts down to  $-6^{\circ}\text{C}$ , damaging lots of early vegetables. The precipitation total was merely 32 mm, which is 62 % of normal. In some places, e.g. Vilnius, the month was the beginning of a drought episode with a relative humidity of the air below 30% for 31 consecutive days. Additionally, the monthly sunshine duration was 341 h, which is 82 h above normal.

In Poland the whole month was frost-free. On May 4 the maximum temperature came up to  $30.2^{\circ}\text{C}$  in Krakow. The mean temperature anomaly in Poland was  $+3.2^{\circ}\text{C}$  with a spatial variation from  $+2.0^{\circ}\text{C}$  to  $+3.8^{\circ}\text{C}$ . This large positive anomaly of temperature was caused by a very active southern circulation. The overall precipitation rate was 105% with great spatial differences. Monthly totals in deficit were observed in Lower Silesia with less than half of the normal rate, while in mountain areas precipitation amounts exceeded 250% of normal. During a thunderstorm on May 5, an petrol depot caught fire near Katowice. At the occasion of another thunderstorm near Krakow on May 27, intense

precipitation of 133 mm in one hour occurred including hailstones of hen's eggs size. A bridge near Kielce was destroyed by flooding of the river Kamienna after intense rainfall on May 28-29.

The month was very warm in Slovakia. Temperature anomalies were generally above  $+2^{\circ}\text{C}$  and exceeded  $+3^{\circ}\text{C}$  in some parts of the country.

Slovenia experienced also positive temperature anomalies up to around  $+3^{\circ}\text{C}$ , which were statistically significant at most stations. The precipitation was below normal over most of the country combined with a 20% surplus of sunshine duration over the long term average.

In Bulgaria, the temperatures were about and above the norm. In many regions precipitation was below the norms. Hailstorms occurred on 11 days and 17 days with thunderstorms. Heavy rainfall (145 mm in 24 hours) caused floods in the historical capital Veliko Turnovo on May 30.

Although the countrywide mean monthly precipitation total was well below normal, two serious flooding events occurred in Turkey causing lots of damage to agriculture and urban areas: one in Elazig on May 15 and the other one in Istanbul on May 26.

The average temperature was around normal in Cyprus. Severe hailstorms in the area south of Nicosia caused damage to agriculture on May 2. Heavy thundery showers in the afternoon of the 14th caused flooding in the western parts of the town of Nicosia.

In Israel it was the coolest May of the last 10 years. In Azerbaijan the temperatures were slightly below normal ( $-0.3^{\circ}\text{C}$ ) and the precipitation total ended up in 183% of the long term average.

## June 2002

- **Very warm in southern Europe, Greenland and Scandinavia**
- **Very wet in the British Isles, around the north-western Mediterranean and the northern Baltic Sea**
- **Dry in Portugal and south-eastern Europe**
- **Many thunderstorm events, squalls and tornadoes with lots of damage**

Föhn situations produced very high and record-breaking temperatures at several locations in Greenland.

A 'heat wave' in south-western Iceland lasted during the period from June 3-16. The temperature in Reykjavik reached 22.4°C on June 11, exceeding +20°C for the first time in any month at that location since 1995. In Reykjavik, June was the warmest month of the year, which is highly unusual; last time it happened before was in 1898. It was the warmest June in Reykjavik since 1941. The warm period ended abruptly on the 17th of June, when an unseasonably fierce northerly storm hit the country, with heavy precipitation in the north and east and snowcover down to sea level in the northeast.

The highest daily sunshine duration of the year in Ireland was measured at Valentia Observatory on June 6. It was the highest daily value since 1989. The monthly mean temperature was slightly below and the overall precipitation rate well above normal.

In Norway the month was much warmer than normal for most of the country. The highest air temperature of the year was 32.5°C measured at station Høylandet-Drageidet on June 9. The mean air temperature at Weather Ship 'Mike' was 11.4°C, which means a new record since the beginning of observations in 1948; the mean sea surface temperature was 11.8°C and record breaking as well. For a greater part of the country, the precipitation was less than normal, but the western and southern part of Norway received more precipitation than in the long term average.

Due to a rainy latter part of the month, the precipitation totals in Finland were well above normal in most parts of the country. In Denmark several tornado-like waterspouts caused considerable damage.

The month started cool in France and ended record breaking warm. In Luxembourg,

the weather was very warm and dry. The monthly mean temperature was more than 2°C above and the precipitation rate less than half of normal.

In Belgium, the monthly mean temperature was well above normal. The absolute extreme temperatures of the month (minimum as well as maximum) at station Uccle had significant positive deviations of more than +3°C against the long term averages. A tornado affected the country on June 4. Two more events of stormy weather with flooding occurred on June 14 in the central and on June 20 in the eastern provinces.

The monthly mean temperature in Germany was +2°C above normal and the countrywide precipitation rate 80% of the long term average. From June 17-19 several places had 'Tropical Nights' with minimum temperatures above 20°C up to 24°C. New local records were set in some cities with maximum temperatures up to 39°C. There were 3 episodes of widespread thunderstorms with disastrous consequences to the local infrastructure: in the south of the country from June 5-7 and June 19-24 and also in the north-west from June 15-18. Additionally, several whirlwinds affected different areas, e.g. the city of Wittenberg on June 12 (see fig.6.1.).

In Poland, the monthly mean temperature was 1.3°C above normal. In Wroclaw the maximum temperature reached 33.3°C on June 19. The monthly mean precipitation amounted generally to 84% of normal and was even less than 60% in western parts of the country. However, some heavy local rainfall occurred in the second week of the month. The worst event among thunderstorms and heavy downpours was connected to a local tornado on June 13, that destroyed 50 buildings in villages near Czestochowa.



**Fig. 6.1:** Consequences of a local tornado in Wittenberg on June 12, 2002  
 From: Photo Quelle: <http://www.wittenberg.de>

Frequent showers ended a drought period in Lithuania and raised the monthly amount of precipitation close to normal and in excess of it at some places. The sunshine duration was 299 h, which is 20 h above normal.

The monthly mean temperature of Vienna, Austria, came up to 20.6°C, which is the highest since 1811, when it was 22.0°C. On June 6-7, intense rainfall of about 200 mm per day caused disastrous floods in Lower Austria. Thunderstorms with heavy rain caused floods in Carinthia on June 17. Heavy thunderstorms with hail were the reason for widespread damage in and around Klagenfurt on June 23-24.

In Hungary a hot spell started in the middle of the month and lasted for about 10 consecutive days. Thus, drought conditions were triggered for most parts of the country. The maximum temperature was higher than 35°C in southern places on 3 days. The annual absolute maximum of 38.4°C was measured in Békéscsaba on June 24.

The temperature anomalies in Slovenia were between +1.9 and +3.6°C and statistically significant everywhere. In the course of a heat wave the highest temperatures of the year were recorded at many stations and the monthly mean temperatures were the highest of the last fifty years in many places. Precipitation was distributed unevenly in time and space, as it is usually the case in summer; the overall monthly average was near to normal.

The month was significantly warmer than normal in Romania with deviations of more than +2°C above the long term averages. The countrywide precipitation rate stayed in deficit.

The monthly mean temperatures in Bulgaria were above normal from +1°C to +3°C. There were thunderstorms on 22 days of the month, including 6 days with severe hailstorms. The diameter of hailstones were up to 5 cm (see figs. 6.2, 6.3), hitting more than 1000 cars in the capital of Sofia. The estimated damage of about 1.5 million € was also caused by flooding of some cities.



**Fig. 6.2:**  
 Large hail stones from  
 the severe hailstorm  
 over Sofia city,  
 Bulgaria, on June 25  
 From:  
 (Photo: I.Donov and V.  
 Borisher, Newspaper  
 "Trud", Bulgaria)



**Fig. 6.3:**  
 Large hail stones from the severe  
 hailstorm over Banite village, in Rodpy  
 mountain, Bulgaria, on June 29  
 From:  
 (Photo: Press Photo BTA Bulgaria)

Squalls and tornadoes with gusts of more than 100 km/h were observed in western and central parts of the Ukraine on June 24. The agriculture and national economy suffered considerably, there were a number of victims.

In Portugal the temperature was again fairly above the long term average, especially the mean maximum temperature exceeded the normal value by +1.7°C. Precipitation totals continued to stay below normal.

The month was very hot in Spain. New records for monthly mean temperature were set at Madrid and in the Balearic Islands within series of more than 100 years.

Although the monthly mean temperature was just +1.0°C above normal, Cyprus experienced severe heat wave conditions.

In the province of Giresun, Turkey, heavy rainfall triggered flooding of several locations on June 20.

During most days of the month temperatures were lower than normal in Israel. However an extreme sharav event occurred on June 7-9. Temperatures reached 43°C to 45°C in the coastal plain.

In Azerbaijan, the monthly precipitation total, averaged over all stations, was 152% of the normal rate. A thunderstorm with hailstones having a diameter of more than 2 cm. occurred on June 16.

## July 2002

- **Temperature anomalies generally increasing from west to east**
- **Very dry on the Iberian peninsula, mixed precipitation pattern else**
- **Lots of extreme weather events in central Europe**

In Iceland and Ireland the month was rather dull, but in other respects close to average.

The monthly mean precipitation rate in England and Wales was 150% of normal. It was

the summer month with the highest rainfall amount in that area and the only one with precipitation above normal (see table 7.1).

| Month     | CET<br>1961-1990 | CET<br>2002 | EWP<br>1961-1990 | EWP<br>2002 |
|-----------|------------------|-------------|------------------|-------------|
| January   | 3.8              | 5.5         | 91               | 87          |
| February  | 3.8              | 7.0         | 65               | 115         |
| March     | 5.7              | 7.6         | 74               | 53          |
| April     | 7.9              | 9.3         | 62               | 48          |
| May       | 11.2             | 11.8        | 65               | 81          |
| June      | 14.2             | 14.4        | 65               | 57          |
| July      | 16.1             | 16.0        | 62               | 93          |
| August    | 15.8             | 17.0        | 77               | 76          |
| September | 13.6             | 14.4        | 78               | 41          |
| October   | 10.6             | 10.1        | 87               | 144         |
| November  | 6.5              | 8.5         | 92               | 176         |
| December  | 4.7              | 5.8         | 96               | 148         |
| Year      | 9.5              | 10.6        | 914              | 1118        |

*Tab. 7.1: Monthly Mean Central England Temperature and England and Wales Precipitation data for 2002*

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

In the Netherlands, the highest temperature of the year was 34,9 °C, reported from station Westdorpe, located in the south-western part of the country.

The monthly mean values of temperature and precipitation were slightly above normal in Belgium. However, there were some extreme weather events: a violent thunderstorm in the centre of the country caused local flooding with severe damage at many places on July 20; an even more spectacular event occurred on July 30, when locally more than 100 mm rain fell during the course of widespread thunderstorms in central and north-eastern parts of the country.

In France it was mostly cool. However, a hot spell prevailed at the end of month. There were several severe thunderstorm events with heavy rain and hail on July 15 (evacuation of campers and damage to vineyards in the department Var), on July 17 (land- and mudslides in Savoie), on July 22 (people wounded by hailstones with diameters up to 2 cm in Isère), on July 29 (heavy damage caused

by hailstones in Ariège), and on July 30 (railways closed and damage to houses in the north-east).

The monthly mean temperature in Germany was moderately above normal, while the overall precipitation total reached 140% of the long term average. From July 9 until the end of the month, a lot of extreme weather events like thunderstorms with hail, heavy downpours and whirlwinds occurred in many parts of the country; e.g. strong winds up to 152 km/h caused the death of 7 people in and around Berlin on July 10-11.

Vehement and intensive showers released considerable landslides in the area of Salzburg, Austria, on July 9. A lot of buildings in Upper Austria were heavily damaged by landslides and hail on July 13. The showers during the night to July 17 lead to catastrophic situations in Carinthia. Simultaneous showers caused floods in Lower Austria and lead to devastation in the vineyards of the Wachau area as well.

Temperature anomalies in Poland varied from +1.1°C to +3.2°C, while the countrywide precipitation rate was 79% of normal and locally down to 31%, e.g. in Warsaw with a monthly total of 22 mm. However, a lot of extreme weather events occurred in different parts of the country during the month, namely on July 1, 3-4, 7, 10, 14-18 and 21, marked by thunderstorms, downpours, hail, flooding and strong winds up to hurricane force. The worst case was reported from July 4, when a tornado like wind damaged a forest area of about 12 000 ha near Pisz.

Everywhere in Norway, the month was much warmer than in the long term average. Precipitation totals were above normal except for the middle part of the country.

The month was generally very warm in Sweden with numerous and partly heavy thunderstorms.

Two violent local thunderstorm events occurred in southern and central parts of Finland on July 4 and 5. Accompanying downbursts cut trees and caused considerable economic losses to forest owners.

The month was very warm in Latvia with mean temperatures of about +3°C above normal. Connected to the passage of a cold front, a whirlwind with gusts up to hurricane force affected the capital of Riga as well as southern and central parts of the country on July 4; a lot of trees were downed and uprooted, causing the interruption of traffic and power lines.

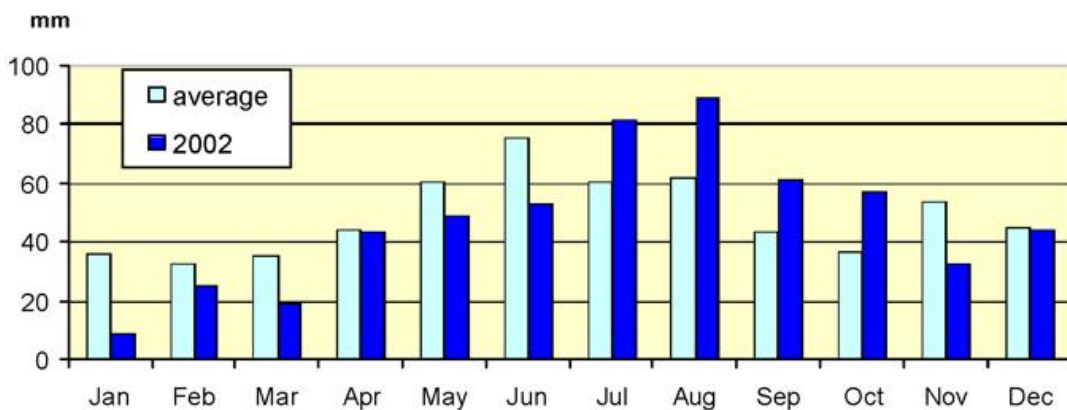
In Lithuania the countrywide mean monthly air temperature was +3.2°C above the long term average and the precipitation rate 91% of normal. The highest temperatures were

recorded on July 30-31 and reached 30-35°C. On the days of July 4, 19, 20, and 31, squall events with maximum wind speeds of 115 km/h, combined with thunderstorms and local-scale showers, caused a considerable number of injuries to persons and a lot of material damage.

The month was very warm in Slovakia with temperature anomalies from +2.2°C to +3.5°C. The countrywide precipitation total was 139% of normal. Significantly high daily precipitation amounts were reported from July 13, when in the western and central parts of the country more than 50 mm rain fell at 17% of the stations. Landslides were observed locally in the Hron river basin as a consequence of repeated heavy precipitation; stations Jarabá and Pohronská Polhora received monthly precipitation totals of 331 mm and 284 mm respectively.

In Slovenia the monthly mean temperature varied from close to normal on the coast up to more than +2°C above the long term average in the north-eastern parts of the country. Precipitation was distributed unevenly in time and space; the monthly totals were in the range from less than 75% up to more than 150% of normal. The number of days with thunderstorm was above normal all over the country, especially in the second half of the month.

The monthly mean temperature in Hungary was +2.5°C above normal. In the capital and in the south of the country, the maximum temperature was often higher than 30°C. From the middle of the month a rainy period started and lasted until October (see fig. 7.1). At station Mátraszentlászló, the second highest monthly precipitation total of 328 mm was measured since 1951.



**Fig 7.1** Monthly precipitation sum (mm) in 2002 and between 1961 and 1990 in Hungary  
From: Hungarian Meteorological Service

In Romania, temperature and precipitation anomalies were significantly above normal.

In Bulgaria it was relatively warm with monthly temperature anomalies of +1.2°C to +3.4°C. There was a period of intense rainfall during the last week of the month, that raised the precipitation total to more than twice normal. The number of days with thunderstorm came up to 25. A whirlwind caused damage of about half a million Euro in some villages near Plovdiv on July 17.

The month was unusually wet on the Balearic Islands, Spain. The station Palma de Mallorca received a record breaking monthly total of 57.5 mm rain.

The north-western parts of Italy were affected by heavy showers during July 13-15, when 67 mm rain fell at station Turin and 73 mm in Rome. Four people lost their lives in the floods.

Cyprus had a monthly temperature anomaly of +1.3°C and suffered temporarily from heat wave conditions.

Heavy rainfall followed by flooding caused the death of 27 people in Rize, Turkey, on July 23, and total material losses of about 17 million Euro in the county of Cayeli. Not far away, at Oltu, another extreme rainfall event combined with flooding occurred on July 31 and caused considerable damage of houses and crops.

The month was very hot in Israel. The most extreme temperatures were recorded on the last 2-3 days of the month, e.g. 47.4°C in Eilat on July 31. In Bet Dagan it was the hottest July since 40 years (fig. 7.2).

Azerbaijan had a relatively hot month with an average temperature of +2.1°C above normal. Maximum temperatures were up to 42°C and caused human health problems in some areas.

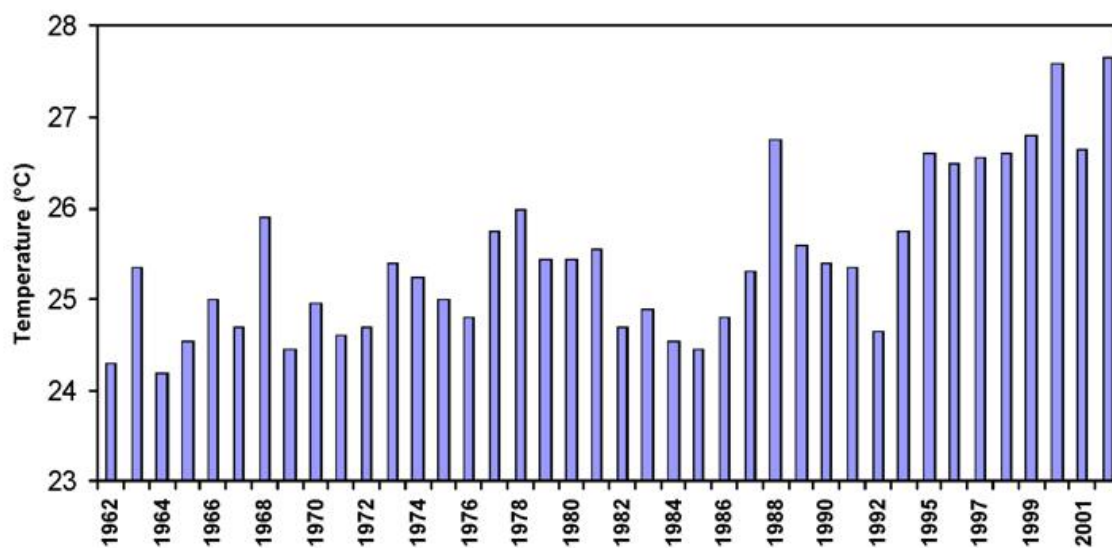


Fig. 7.2

*Mean Daily Temperature in July Bet Dagan (Central Coastal Plain) 1962-2002*  
 From: Israel Meteorological Service

**August 2002**

- **Catastrophic flooding in many parts of eastern central Europe because of long lasting intense rainfall**
- **Extremely hot in Scandinavia and the Baltic countries, very cool in northern Russia**
- **Extremely dry around the Baltic Sea and in the southern Iberian Peninsula, unusually wet in south-eastern Europe**

In Iceland, the month was rather dull and damp, but in other respects close to average.

The highest temperature of the year in Ireland was 25.6°C, measured at Clones on August 5. Precipitation totals were well below normal throughout the country.

On August 1, the north-eastern part of England experienced its highest daily rainfall total since records began in 1931 with 61mm, the highest daily regional mean value on record for any month in any England and Wales area. This was a convective rainfall event and some places within the region received much more than this.

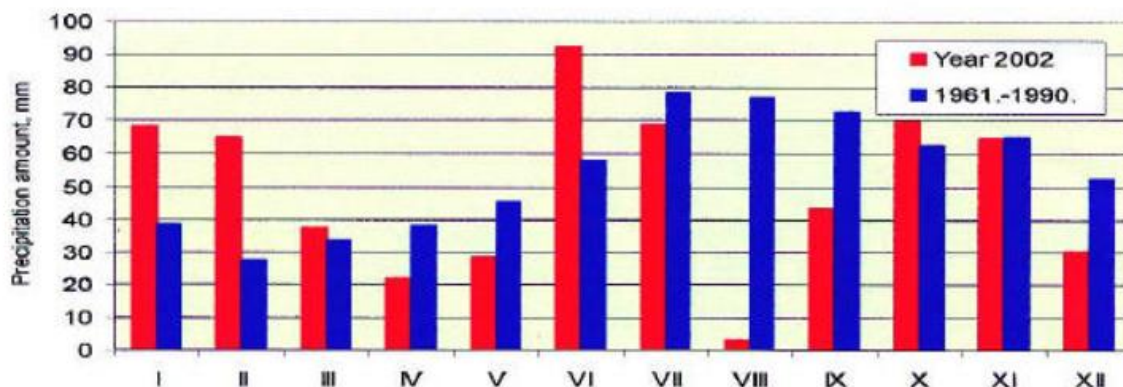
The first week of the month in Denmark was dominated by some intense thunderstorms, causing flooding and lightning. The number of lightning strokes was 2-3 times higher than normal. After this episode, a dry period started and lasted on for several weeks with the main focus on the eastern parts of the country.

In Norway, the precipitation total was well below normal except for Troms County in

the northern part of the country and some coastal areas. The month was also much warmer than normal for the whole country.

The month was generally very warm in Sweden with numerous and partly heavy thunderstorms. The most exceptional thunderstorm caused flash floods on the island of Orust along the west-coast during the night of August 1-2; private measurements showed that 180-200 mm had fallen on western parts of the island during around 10 hours with horrifying thunder. All roads in the area were disrupted and many houses damaged by water, erosion and lightning

A drought period started on August 3 in Latvia and lasted on over the end of the month. It was the second warmest and the absolute driest August ever recorded. The countrywide precipitation rate was only 4% of normal (fig. 8.1). The heat and drought engendered many forest fires.



**Fig. 8.1:** Monthly precipitation Latvia, actually and for the reference period 1961-1990  
 From: Latvian Hydrometeorological Agency

The month was very hot and dry in Lithuania with a mean temperature anomaly of +3.7°C and an overall precipitation total of only 11 mm, which is 14 % of normal. Some stations did not receive any rain during the month. The mean relative humidity was 65% and thus 13 percentage points below normal. The sunshine duration summed up to 351 h; this is 107 h above normal. The soil surface temperature was up to 55°C, and the soil temperature at 20 cm depth reached 22 °C. During the whole month, a disastrous drought affected the country, especially in its eastern parts. It was the longest and most severe drought since 1992. On August 4, the forest fire index reached its highest level in eastern Lithuania and gradually spread over most parts of the country.

It was the warmest summer month in Poland with a temperature anomaly of +3.1°C, calculated from 8 stations. The mean precipitation total was 119% of the normal rate with a large spatial variability. There was a general increase of precipitation totals from north to south, e.g. 7mm (11% of normal) on Hel, 141mm (240%) in Warsaw, and 275% of normal at station Jelenia Gora in the south-west. A lot of heavy rainfall events were connected to thunderstorms, mainly in central and southern parts of the country. Warsaw experienced catastrophic downpours on August 5. Great damage occurred also at the slopes of the Sudety Mountains, especially in Walbrzych, where the daily precipitation total amounted to 179 mm on August 31.

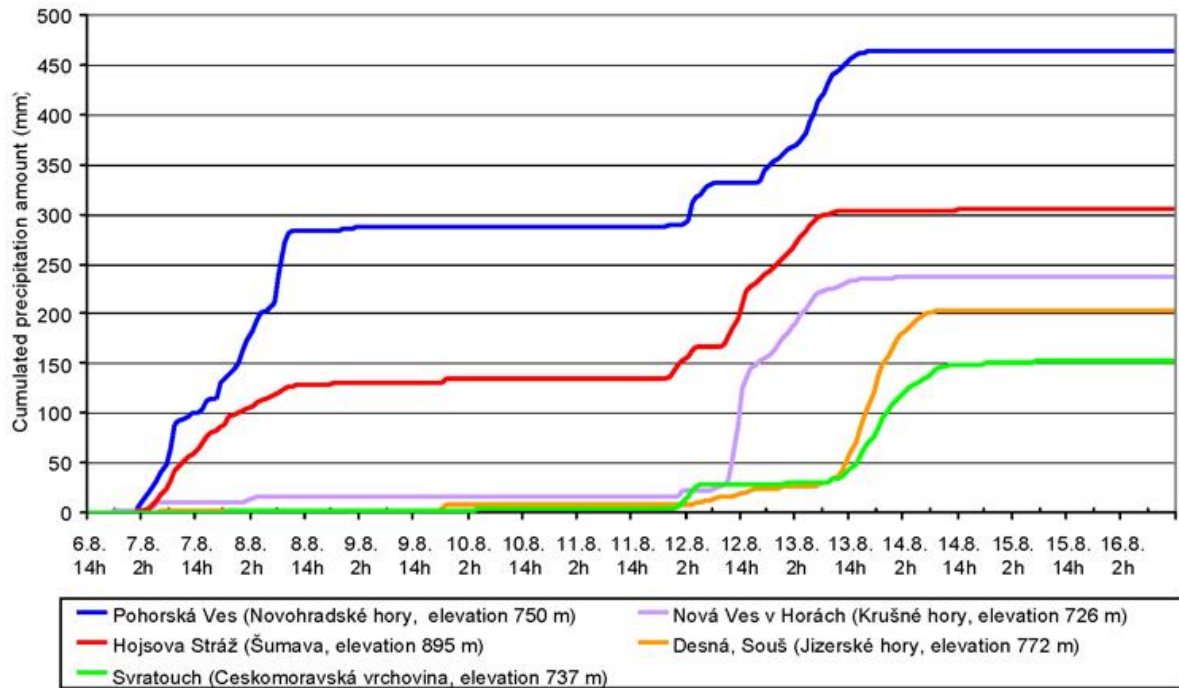
In the Netherlands, some locations were hit by heavy showers at several times and thus received 3 to 4 times the normal amount of monthly precipitation. In a substantial part of the country, 50 mm or more rain fell on August 24. Station Weesp near Amsterdam recorded 101 mm. At station Eext in the northern part of the country, a new national record of 295 mm for the month was measured; the old one (292 mm) dates back to 1942 at station Voorthuizen.

The monthly mean temperature in Belgium was well above normal, although precipitation rates were generally high and reached 273% of normal at station Uccle. At the same station, the monthly mean wind speed was only 2.3 m/s and thus the lowest monthly mean of the year and 26% less than the long term average of 1878-1986. However, quite a lot of violent storm events were recorded during the month; the most remarkable ones on August 24

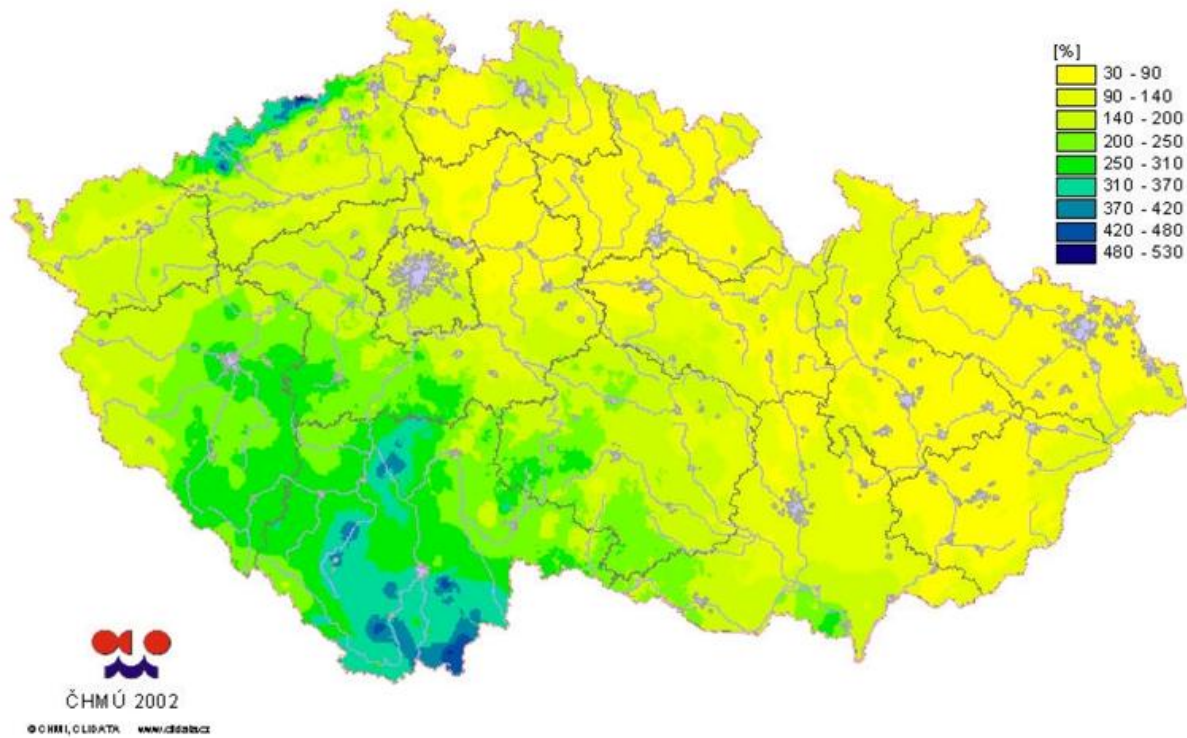
and 27 were combined with daily precipitation sums of 100 mm and more in the south-western parts of the country.

The monthly mean temperature in Germany was +2.3°C above normal and the overall precipitation total reached 155% of the long term average. A lot of extreme events occurred during the month. Thunderstorms with intense rainfall and hail caused severe damage in nearly all parts of the country on August 1-2, e.g. the streets of Dresden were covered with a 5 cm layer of hailstones, 65 mm of rain fell in Hamburg within 45 minutes flooding streets and buildings, a whirlwind near Lüneburg removed the roofs of several houses and turned over some cars within a minute. Another period of heavy rains with flooding, especially in northern and southern areas, lasted from August 5 to 8. The most severe event was the period of intense rain on August 10-13 with catastrophic consequences to the south-eastern part of the country. A new record of 312 mm precipitation in one day was set at station Zinnwald. The flooding of the Elbe river and its tributaries caused damage to urban and rural areas at an extent not known there before for natural reasons. 20 people died and the material losses were estimated to thousands of million Euros (see special report on pages 55-62). Again, on August 20, 25 and 27-29 thunderstorms with heavy rains and hail caused a lot of damage to people and infrastructure by flooding, lightning and wind force at many places throughout the country.

Extremely high precipitation hit the Czech Republic in the periods of August 6-8 and 11-13 (figs. 8.2, 8.3). The passage of two distinct depressions and their frontal systems over central Europe caused disastrous floods, one following the other in a very short time. Both depressions hit the country with their rainiest sectors, the area to the WNW from the centre of the depression. Moreover, both of them moved very slowly, which extended the period of continuous rainfall. The precipitation was markedly intensified by the windward effect of the mountains. In the Novohradské hory Mts. and the Český Krumlov area 130-250 mm of rain fell within the two days between August 6 and 8, which is 150-200 % of August's normal. The highest precipitation totals for the two days were measured at station Staré Hute, 254.3 mm, and Podhorská Ves, 277.7 mm.



**Fig. 8.2:** Cumulative hourly precipitation amounts on selected stations of the Czech Republic  
From: Czech Hydrometeorological Institute



**Fig. 8.3:** Anomaly of the precipitation amount on August 6 to 15, 2002 in the Czech Republic (% of August's normal 1961-1990)  
From: Czech Hydrometeorological Institute

On August 12-13 meteorological stations in Krušné hory Mts. and Jizerské hory Mts. recorded daily precipitation amounts of more than 200 mm and two-days' amounts greater than 300 mm. Most was measured at Cínovec, 312 mm in one day, which is the second highest value in history. The 2-days' total on Cínovec, 380 mm, is the highest one ever observed. The whole amounts of water, which fell in the Labe catchment (area of 49 033 km<sup>2</sup>) was 6.948 km<sup>3</sup>. The first rain period caused the big flood in southern and south-western Bohemia. The second one resulted in terrible floods in the whole Vltava and Ohře catchments. The Vltava river culminated in Prague on August 14 at noon at a level of 782 cm and a discharge of 5200 m<sup>3</sup>/s. This is the highest ever evaluated discharge in the Vltava in Prague in the history of routine observations, which matches a recurrence time of 500 years. On Vltava's left bank near the Charles Bridge the water level was 140 cm above the mark made in 1890 and even 55 cm above the mark of 1784. During the floods 18 people were killed, many houses destroyed, traffic and communication lines damaged as well as bridges, factories and field crops, a lot of animals died. The economical losses were estimated to billions of Euros, the highest damage to this region in written history.

The month was characterized by unusual high precipitation amounts in Austria. More than 300 percent and up to 400 percent of the average monthly total were recorded from many places. There were mighty showers during the periods of August 6-7 and August 11-13 leading to disastrous high water-situations. Station Freistadt received a monthly precipitation amount of 405 mm and on August 7 a daily amount of 172 mm. At Linz-Hörsching a new extreme monthly total of 351 mm was recorded. Particularly villages and towns along the rivers Inn, Enns and Danube were affected by the floods. The province of Salzburg was declared as disaster area. The total losses were estimated to 1 Billion Euro.

In France, the month was relatively cool; the precipitation regime included heavy rainstorms and came up with an overall total well above normal. Additionally, low sunshine duration was reported.

On the mainland of Portugal, the mean monthly temperature as well as the precipitation total were moderately below normal.

On the mainland of Spain, the monthly precipitation rate varied from about 200% of normal in the north-east to zero in the south-west. The monthly precipitation total at Palma de Mallorca in the Balearic Islands reached record-breaking 119.3 mm.

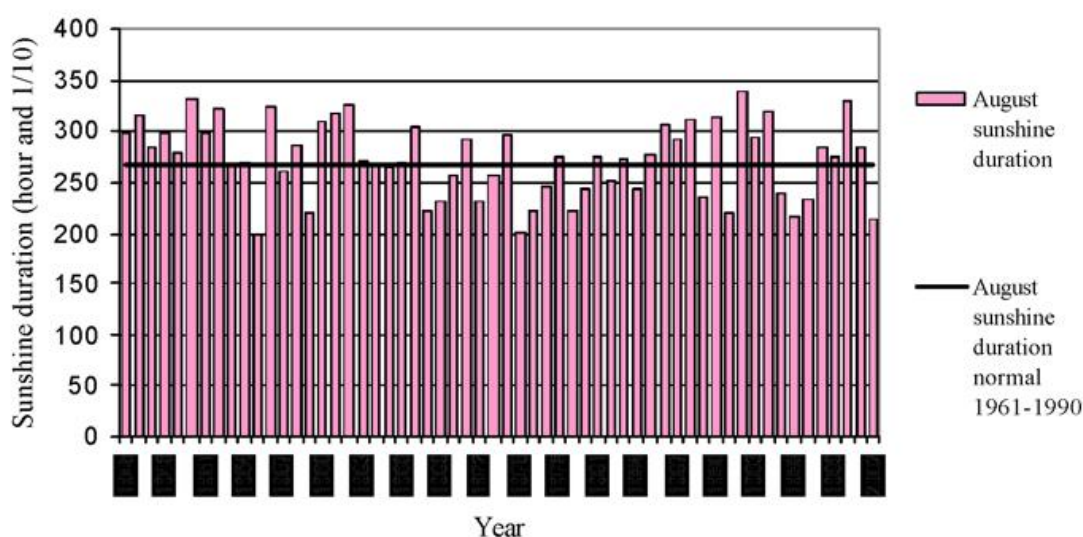
Northern and central Italy was affected by strong winds and flooding. A peak of 106 km/h was registered at Verona. In the period from August 26 to 29 some violent thunderstorms occurred at Turin with a precipitation total of 138 mm, Brescia (166 mm) and Rome (54 mm). The estimated economic losses were about 200 million Euro, due to damage to agriculture, mostly to viticulture.

In Slovakia, it was the wettest month of the year with a precipitation total of 159% of the normal rate. The combination of long-lasting and heavy precipitation caused numerous flood situations. The sum of material losses was estimated to 41 million Euro.

The heavy rainfalls of August 6-7 over Bavaria and Austria caused extreme flooding of the Danube in Hungary during the following days. The same cyclone carried an extreme rainstorm to the reservoir of the rivers Sajó and Hernád with the consequence of floods in that area.

In Slovenia, the monthly mean temperatures were generally above normal up to about +1.5°C. Precipitation was distributed unevenly in time and space. At the beginning of the month, abundant rainfall in the area of Goriška contributed substantially to the excess of the monthly precipitation total of about 40 % above normal. In Vipava valley the monthly precipitation accumulated to more than 200 % of the normal rate. In the Julian Alps cloudiness was above normal, and consequently the sunshine duration reached only ¾ of the long term average.

The beginning of the month in Serbia and Montenegro was characterised by very intensive rainfall, when in several days the precipitation amount was higher than the long term average total for the whole month in some areas. There was a remarkable increase of the monthly precipitation rate from west to east ranging from a little less than 100% up to more than 300% in south-eastern part of the country. Simultaneously, sunshine duration was below normal everywhere in the country and down to 44% of normal at station Pozega. In Belgrade the monthly sum of sunny hours was the lowest since 1975 (see fig.8.4).



**Fig. 8.4:** *Sunshine duration in August in Belgrade between 1945 and 2002 and the August mean of 1961-1990.*  
*From: Federal Hydrometeorological Institute of Yugoslavia*

Precipitation totals in Romania were in excess to normal due to torrential rainfalls, frequently accompanied by hail. A whirlwind behind a passing cold front caused severe damage to the town of Facaieni in the south-eastern plain during the night of August 11-12; three people died, houses and crops were destroyed and a lot of trees were uprooted.

In Bulgaria, the month was less warm than normal. The precipitation amounts varied in most areas between 120% and 250% and were up to 355% of the normal rainfall rate in the north-eastern part of the country. There was a great number of thunderstorms, 2 people and a sheep herd were struck by lightning. Rural and urban areas suffered from significant damage to power and traffic lines as well as to houses, especially in and around Sofia on August 7-8 and in Plovdiv on August 12.

Unusually heavy seasonal rains and thunderstorms occurred on August 25-30 in Greece, resulting in floods over the Ionian Mainland, Athens-Attiki and islands of the North Aegean.

In Turkey, heavy rainfall, partly with hail, caused flooding with severe damage to private and public property including buildings, crop fields, transportation facilities and power lines in the provinces of Kocaeli on August 4 and Erzurum on August 27.

The monthly means of temperature and the precipitation total were slightly above

normal in the Ukraine. During a period of intense rainfall in Crimea on August 7-9, heavy downpours summed up to more than 100 mm at some places and caused the flooding of houses and railways and the damage of power lines.

In Russia, the Black Sea coastal area was heavily affected by rainfall on August 5-8. Torrential rains totalled 35 mm of precipitation in Novorossisk on August 5 in 30 minutes and 57 mm in Anapa on August 6 in one hour. Thousands of homes were flooded and many of them destroyed. Traffic and power lines were damaged causing the interruption of public transport and energy supply.

In Armenia, rains with thunderstorms and hailstones were frequently observed, causing significant damage to agriculture. Precipitation totals were generally rather high and exceeded 400% of normal in the north-east of the country.

The month was very wet in Azerbaijan with an overall precipitation total of nearly 200% of normal. On August 19 and 27-28 local torrents and floods were observed in rivers of the northwestern part of the Major Caucasus leading to a lot of damage to crops and farms.

Cyprus suffered from some heat waves, although the monthly mean temperature of the island was only moderately above normal.

In Israel, the month was fairly warmer than usual, but not as extreme as the month before.

## September 2002

- **Much warmer than normal from the north-western to the south-eastern edge of the Region**
- **Cooler than normal from central to southern Europe and in north-eastern parts of the Region**
- **Extremely wet in the western part of the Iberian Peninsula and in a belt from the western Alps over the Balkans into Turkey**
- **Very dry from the western Mediterranean over western France, the British Isles and southern Scandinavia to the Baltic countries and Belarus**

In Greenland föhn situations gave very high and record-breaking temperatures at several locations.

In Ireland, the month was drier than normal everywhere and very sunny.

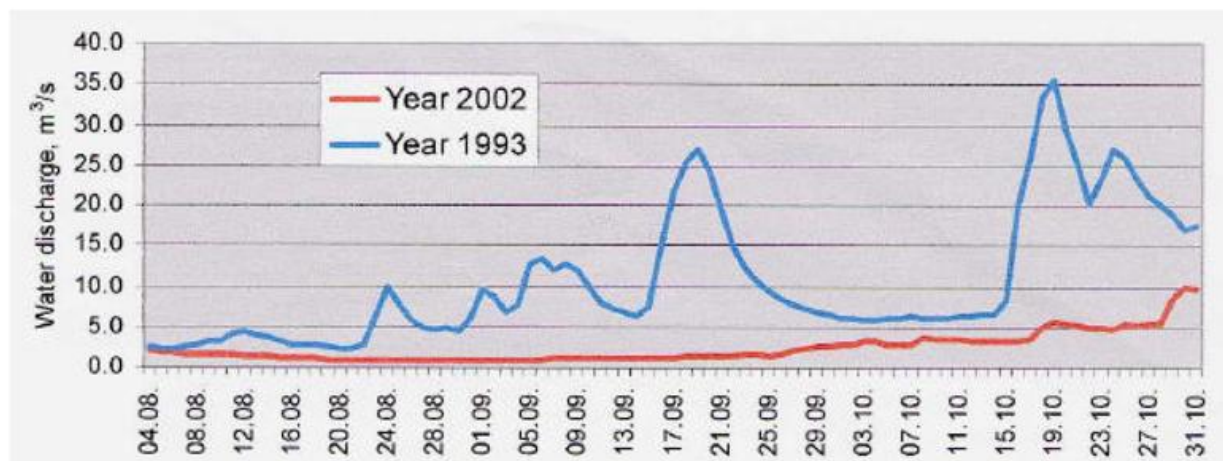
Denmark experienced an ongoing drought nearly throughout the whole month, especially in the eastern parts of the country.

The month was warmer than normal for most of Norway. From the Lofoten area and northwards, the monthly mean was below normal. The precipitation was approximately

50% of the normal rate in the southern part of the country, in the mid part near to normal and in the northern part up to 150 % of the long term average.

The period of temperatures warmer than normal lasted on in southern and central Finland, whereas the rest of the country was colder than normal.

The drought period in Latvia, ending in the middle of the month, resulted in minimum water levels in rivers, close to the lowest in 1993 over a long term observation period (see fig.9.1).



**Fig. 9.1:** Water discharge of the Barta river during low flow period of 2002 (lower curve) compared to 1993 of average runoff (upper curve)  
From: Latvian Hydrometeorological Agency

The drought in Lithuania ended with rainfall and inflow of cool air by September 9 – 22. It was the longest and most severe drought since 1992 and lasted for more than 60 days in some areas. The countrywide monthly precipitation total was 41 mm, which is 60 % of the normal rate.

The continual precipitation deficit since March intensified the drought situation in Belarus. Consequences were obstructions to river traffic, damage to agriculture and an increasing risk of forest fires.

The monthly precipitation total in Belgium was below 50% of the long term

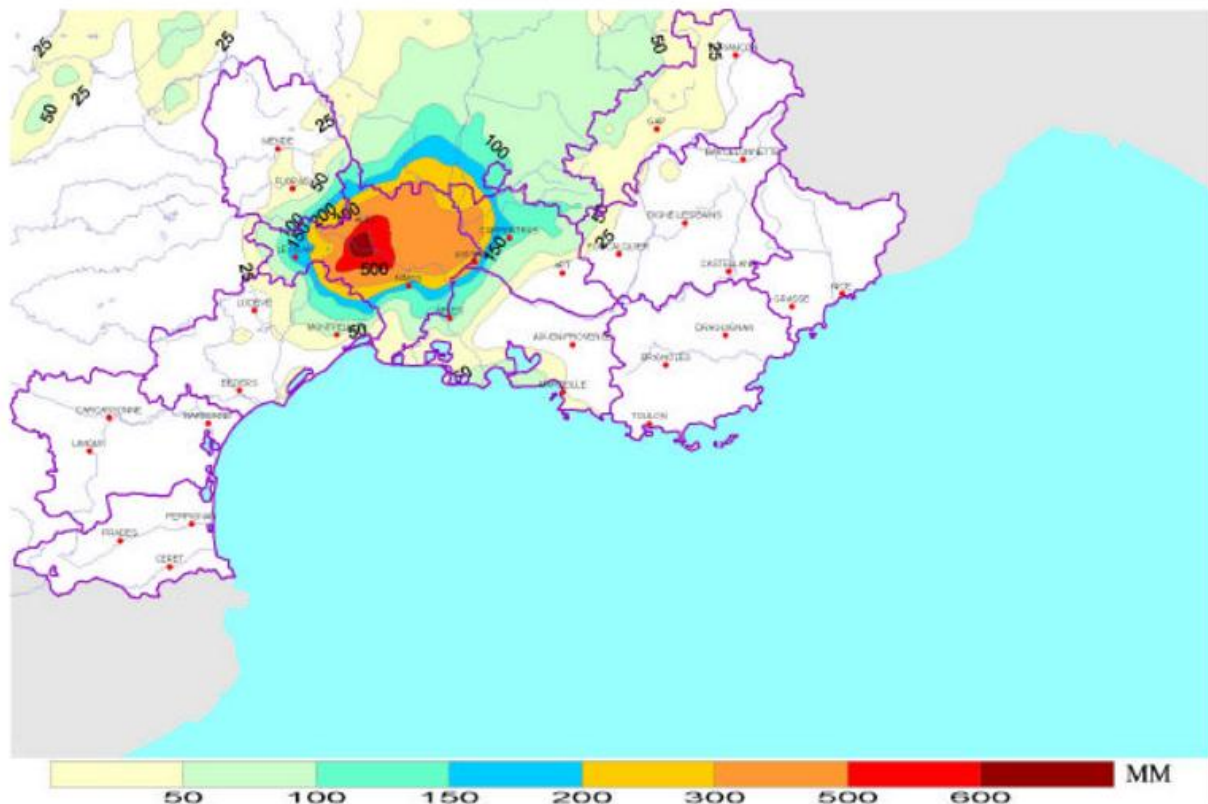
average (fig. 2.1), while the temperature was close to normal. The mean wind speed was about 85% and sunshine duration near to 90% of normal.

In Luxembourg the month was very sunny with 62 hours more sunshine than normal.

In Germany the monthly mean temperature as well as the precipitation total were nearly identical to the averages of the reference period 1961-1990. But there was a remarkable meridional trend from relatively warm and dry weather in the north to cool and wet conditions in the south of the country. Thunderstorms with heavy rains of up to 70 mm in less than 1 hour caused flooding of cities in southern Hesse, northern Bavaria and in Saxony on September 9-10. Snowfall occurred in places down to 400 m above sea level on September 24-25 in southern parts of the country leading to many accidents on roads and fallen trees; a closed snow cover appeared in Munich for the first time in this month since 1931.

The monthly mean temperature in Poland was moderately above normal by +0.5°C; negative deviations were observed in the southern and positive ones in the northern parts of the country. The first frost of the season occurred in Suwalki with a minimum temperature of -1.7°C on September 24. Precipitation totals were generally 90% of normal with a great local variety, e.g. Szczecin received 140% of the normal rate whereas the total precipitation amount in Suwalki was only 20 mm, which equals 39% of the long term average. Strong mist was observed in central and eastern areas on September 5.

Catastrophic floods occurred in south-eastern France on September 8-9. Exceptional rainfall affected the Languedoc area. In the department Gard daily precipitation amounts exceeded 500 mm during this event. The highest values recorded during this spell were 687 mm in Anduze and 514 mm in Alès (s. fig. 9.2). 23 people died and one was reported missing.



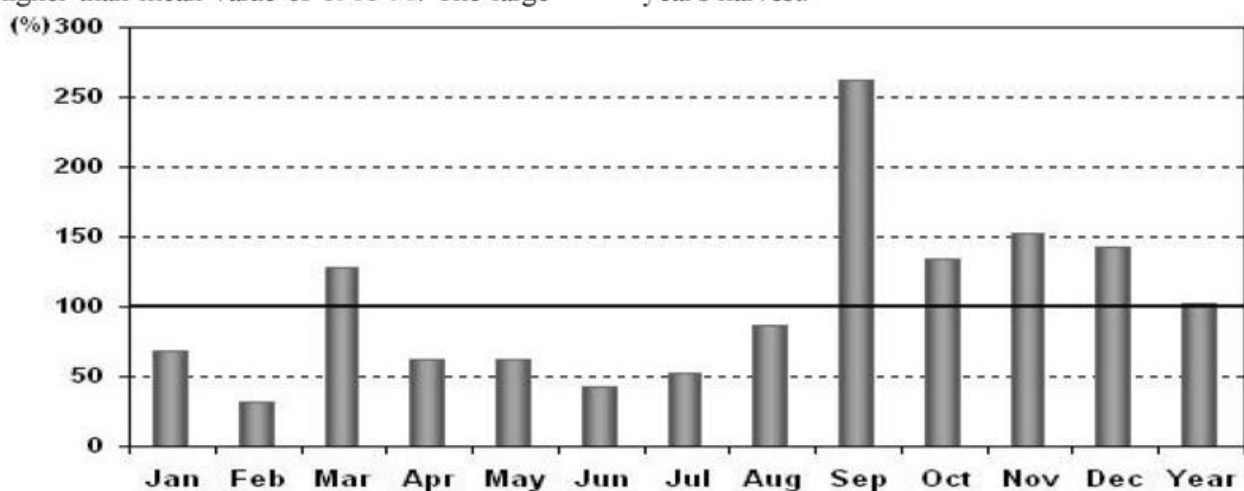
**Fig. 9.2:** *Precipitation totals from 8<sup>th</sup> to 9<sup>th</sup> of September 2002*  
 From: Météo France

In Portugal the month was cool and rainy. The monthly mean temperature

deviation in mainland Portugal was -1.0°C from normal; and the deviation of the monthly

mean maximum temperature even  $-2.0^{\circ}\text{C}$ . The monthly precipitation total on the mainland was about 260% (s. fig. 9.3). In southern areas the monthly precipitation amount was 7 times higher than mean value of 1961-90. The large

precipitation amounts that occurred during this month caused significant damage in agricultural activities, e.g. tomato production was reduced to about 20% of the previous year's harvest.



**Fig. 9.3:** Monthly precipitations totals in percent of normal (1961-1990) in Mainland Portugal in 2002

*From: Instituto de Meteorologia, Portugal*

The monthly mean temperature in Slovakia was slightly below and the precipitation total near to normal.

In Hungary, the monthly mean temperature was  $0.4^{\circ}\text{C}$  below normal and the monthly precipitation total 135% of the long term average. The maximum of the daily precipitation total, 141 mm, was measured in Gagybátor on September 9.

The month started relatively warm in Slovenia, but became cooler after the first ten days with the result of a monthly mean temperature moderately below normal. Precipitation was distributed unevenly in time and space. The normal monthly total was exceeded on the coast and almost everywhere in the southern part of the country, elsewhere precipitation was below normal and down to less than 70% of the long term rate in some places.

In Serbia and Montenegro, the deviation of the mean monthly temperature was negative and the precipitation total was above normal in the whole country

In Bulgaria, the month was cool and extremely wet. The monthly precipitation rate varied from about 200% of normal up to 788% at station Krumovgrad. A severe hailstorm and heavy rainfall on September 25-26 caused great damage to agriculture, communication

and power lines as well as to transport facilities.

In Greece, it was the wettest month since 50 years in some areas. The monthly precipitation totals were generally around 200 % and up to more than 500% of normal at some places. E.g. station Lamia received 88,0 mm of rain, which is equivalent to 506% of the normal monthly precipitation sum. Other stations recorded even higher amounts, but with a lesser percentage of normal.

Heavy rainfall and storm affected the area of Trabzon, Turkey, on September 17. Buildings and streets were flooded, roofs torn off, trees broken and road traffic interrupted.

Very heavy rains were observed in the Crimea, Ukraine, on September 16 with precipitation amounts of 31-85 mm in 4-9 hours, and at some places of 120-150 mm in 12 hours. The Crimean economy suffered considerable damage.

Heavy rainfall caused flooding of the tributaries to the Samur river at the northern Caucasian ridge in the Russian Federation on September 19-20; in consequence mudflow damaged roads, bridges and power lines. In North Osetiya, the Kolka Glacier collapsed on September 20 and triggered an avalanche of ice and debris that buried small villages including 6 holiday complexes, killing dozens of people.

Although the monthly precipitation total was only 52% of normal in Azerbaijan, there were torrential downpours of short duration flooding the rivers in the area of Quba/Khachmaz on September 14 and of Balaken/Sheki on September 19.

The month was warmer than normal in Israel. A significant sharav event occurred on September 29-30 with temperatures reaching 37-38°C in the coastal plain and in the northern Negev.

## October 2002

- **Very cold in Scandinavia, extremely dry in its central part**
- **Wet in a broad belt from the British Isles over central to eastern Europe**
- **Violent storms in many parts of Europe at the end of month**

The month was very warm in Iceland except for the last week which was unusually cold, as the new absolute temperature minimum testifies. The new national minimum temperature record for the month was reached, when -22.3°C was measured at lake Myvatn in the north-eastern inland on October 28. The previous record was set in 1957 by -21.6°C. It was also one of the two sunniest months of the year relative to normal.

In Ireland, it was one of the wettest months of the year relative to normal and a little cooler than normal over most of the country. The highest daily rainfall on record, 80.0 mm, was measured at Rosslare on October 24. The strongest winds of the year were measured during late October.

The period beginning on October 20 saw the highest 7-day running precipitation total in Northern Ireland, U.K., since records began, 114mm falling over this time.

The month was very cool and rainy in Denmark. Stormy weather on October 27-28 caused the loss of one person.

In Norway, the monthly mean temperature was well below normal for the whole country. At some places the anomaly was down to -4°C. The monthly precipitation was below normal for most of the country but parts of the southernmost region received up to 205% of normal.

An exceptionally early snowstorm hit southern Sweden on October 18-19, and a new record snow depth for this month in southern Sweden was noted close to Ulricehamn with

48 cm. More than 20 000 households were without electric supply, as wet snow broke down birches that still had leaves.

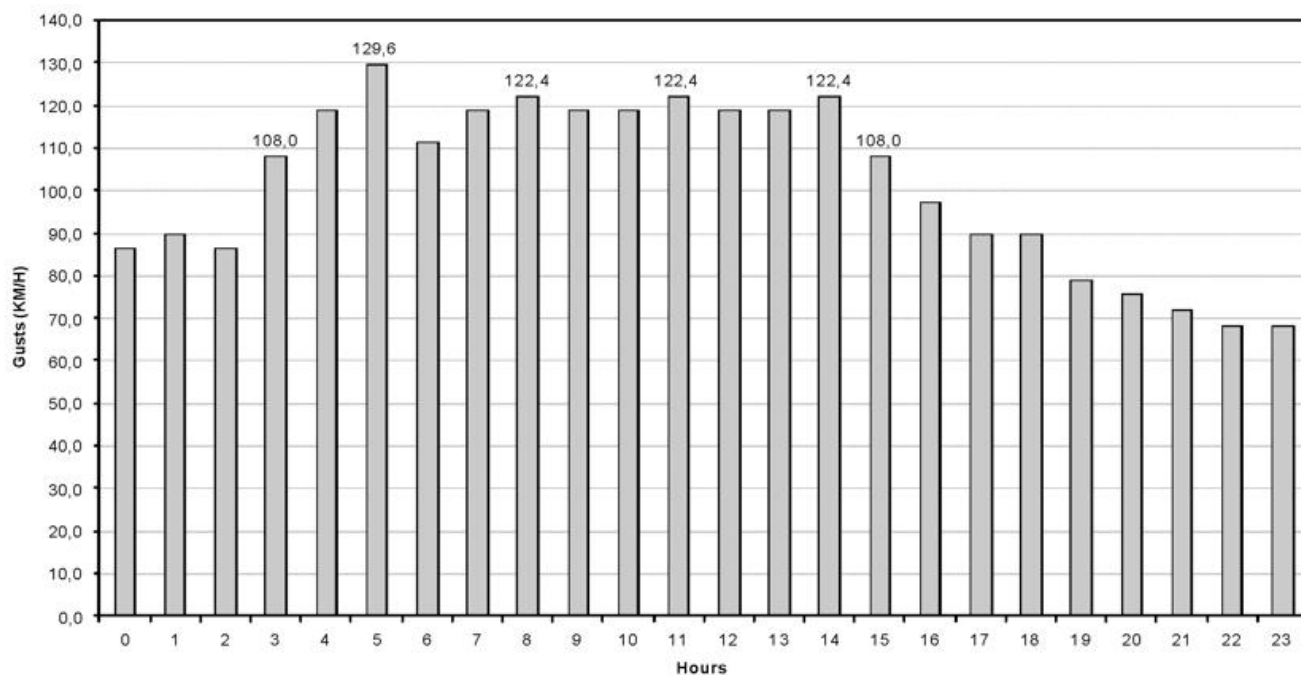
In Finland, the month was very cool and dry with temperature deviations of more than -4°C from normal and precipitation totals below 50% of normal.

A violent storm struck the Netherlands on October 27. The storm was the most severe in 12 years. Highest gusts up to 148 km/h were measured in the south-west of the country. The maximum hourly wind speed reached 101 km/h in the western coastal zone. Public life was disordered and material damage was substantial, 4 people were killed. Another extreme event was a downburst causing extensive damage in the province of Limburg on October 16.

In Belgium, the monthly mean temperature was near to normal and the precipitation total about 50% above the long term average. Stormy weather conditions with thunderstorm and hail prevailed on October 25-27 and caused lots of damage including the death of 4 people in different parts of the country.

During stormy weather in Luxembourg a maximum wind gust of 116 km/h was measured on October 27.

An intense storm hit northern France also on October 27: The wind speed exceeded 100 km/h and highest gusts of 130 km/h and more were recorded on exposed coasts (see for example fig. 10.1) with the consequence of several casualties.

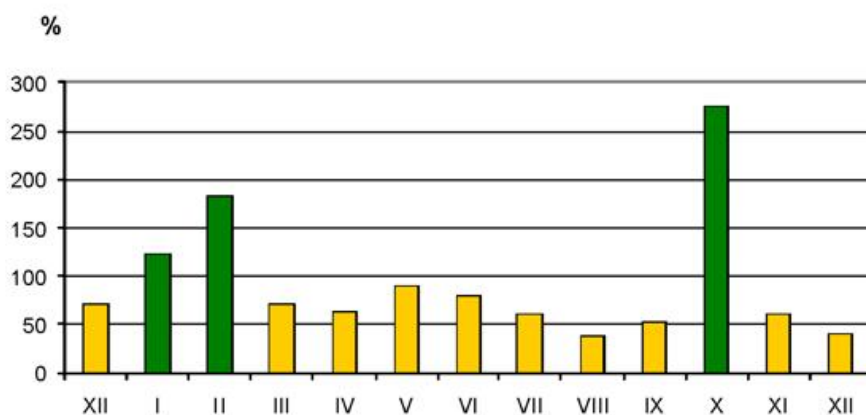


**Fig. 10.1:** Hourly maximum wind gusts on 27-10-02 in Cap de la Hague (Manche)  
From: Météo-France

It was the first month of the year with a countrywide negative temperature anomaly in Germany,  $-0.8^{\circ}\text{C}$ . A local record for the coldest October 13<sup>th</sup> since more than 100 years,  $4.0^{\circ}\text{C}$ , was set in Hamburg. The overall precipitation total was 106.4 mm and thus exceeded the normal value by 91%. It was the 10<sup>th</sup> wettest October since 1901. Three major storm events affected the country on October 22-23, 25-26 and 27-28, especially in the low mountain ranges with winds of hurricane force. During the

latter event highest gusts were observed at the mountain stations Fichtelberg (183 km/h) and Brocken (176 km/h) and in Gütersloh (148 km/h). Severe damage occurred to all kinds of transportation facilities, to houses and church towers, wind generators and power lines. Twelve people were killed and 50 injured.

In Belarus, the monthly precipitation total was about 280 % of the average rate of 1961-1990 (fig. 10.2).



**Fig. 10.2:** Monthly precipitation total in % with reference to the period 1961-1999  
From: Ministry of Natural Resources and Environment Protection, Belarus

Strong winds affected Austria north of the main Alpine ridge on October 26-28. In Upper Austria numerous trees were uprooted on October 27 and several streets were blocked. One day later in Tyrol gusts up to 140 km/h caused traffic obstructions, the destruction of power-lines and the damage of houses and cars.

The countrywide monthly mean temperature anomaly in Poland was  $-1.2^{\circ}\text{C}$  and the overall precipitation total 208% of normal. It was the wettest month of the year except for February. Station Chojnice received even 300% of the long term average precipitation. Strong winds with gusts up to 101 km/h were observed on October 27-28.

The mean monthly temperature in Lithuania was  $4.5^{\circ}\text{C}$  and thus  $2.7^{\circ}\text{C}$  below normal. The monthly amount of precipitation was abundant with 123 mm, which means 203% of normal. The rains were very welcome for the national agronomy.

In Latvia the monthly temperature anomaly was nearly down to  $-4^{\circ}\text{C}$  and the precipitation total about 110% of normal.

In the mainland of Portugal the monthly mean temperature anomaly was  $+0.4^{\circ}\text{C}$  and the precipitation total about 130% of normal. Heavy rain caused floods in Lisbon on October 8. Thunderstorms with heavy rain, strong winds and hail caused the flooding of roads and the damage of houses, forests and power lines in central parts of the country on October 29.

A tornado was registered at Lladux, Spain, on October 21.

In the Ukraine the monthly mean temperature was close to normal, while the precipitation amount summed up to 200% of the long term average.

In Romania, it was moderately cooler than normal and very wet. The countrywide precipitation total was about 200% of the long term average.

The month was very rainy in Bulgaria with precipitation rates of generally around 200% of normal and particularly of 400%-500% in the north-east of the country.

Cyprus had only 29% of normally 33 mm precipitation. The monthly mean temperature was  $+1.2^{\circ}\text{C}$  above normal. A water-spout turned into a tornado over land in the western part of the island on October 8 and caused injuries of people while damaging touristic installations. Heavy thundery showers in the area of Nicosia on October 14 caused flooding and fire from lightning.

The most significant weather event in Israel occurred on October 15 and it included severe hail, intense thunderstorms, heavy rain and strong winds in the central coastal plain. Very large hailstones caused severe damage to homes, cars and trees. In some places the size of the hailstones was 4-5 cm and even more. On October 30-31 heavy rains, 40-50 mm, fell in the Negev Desert causing floods in the area.

## November 2002

- **Very cold and dry in northern Scandinavia**
- **Very mild from Svalbard, Greenland, and Iceland over the British Isles and France to the Alps and the northern Balkans**
- **Very wet over the British Isles, the western Alps and southern parts of Italy and Greece**
- **Intense Alpine foehn event in the middle of the month**

In Iceland it was very mild with monthly mean temperatures of  $+3^{\circ}\text{C}$  and more above normal. The snow cover was far below normal in most parts of the country. The eastern parts of the country received exceptional precipitation. A new absolute monthly total record was established, as the accumulation approached

1000 mm at two stations in the east. This case is exceptional, as the stations involved have average annual totals of less than 1500 mm. Although a few roads were blocked by local flooding and debris flows and a house was hit by a landslide, the total damage was relatively small considering the circumstances.

Relative to normal it was one of the wettest months in Ireland with serious flooding in both rural and urban areas. The monthly mean temperatures were over two degrees higher than normal in places.

In Norway the month was colder than normal for the whole country. In the northern and southern mountainous terrain the anomaly was about  $-4.0^{\circ}\text{C}$ . In the eastern part of the country the precipitation was above normal but well below else.

Sleet and icing events accumulated heavy loads on trees in some areas of southern and south-eastern Finland. Consequently many of these trees were cut and caused considerable economic losses to forestry.

The month was relatively mild and wet in Belgium. There was one major event of heavy precipitation with flooding in the south-eastern part of the country on November 10-11.

In Luxembourg, the monthly mean temperature was  $+2.3^{\circ}\text{C}$  above normal.

The monthly mean temperature in Germany was  $5.5^{\circ}\text{C}$  and thus  $+1.5^{\circ}\text{C}$  above normal. The precipitation total amounted to 111 mm, which is 168% of normal and the third wettest November since 1901. Heavy snowfall up to 10 cm caused a lot of accidents on roads in the eastern parts of the country on November 4. Intensive rain on November 11 triggered flooding of the river Rhine and some of its tributaries. Three foehn events with gusts up to 250 km/h at the mountain station Zugspitze caused severe damage to the infrastructure in the foothills of the Alps on November 14-16, 21 and 25.

Temperature anomalies in Poland varied from  $-0.6^{\circ}\text{C}$  in Szczecin up to  $+3.2^{\circ}\text{C}$  in Lesko with a clear gradient from north to south. In Krakow a maximum temperature of  $20.3^{\circ}\text{C}$  was measured on November 16. The countrywide monthly mean temperature came up to  $+0.9^{\circ}\text{C}$  above the long term average. The overall precipitation total was 87% of normal with a spatial variation of values below 60% in the eastern and above 200% in the western parts of the country. Strong foehn winds caused a lot of damage to the forests of the Tatra National Park on November 15. Maximum gusts were up to 108 km/h in Zakopane and 130 km/h at the mountain station Kasprowy Wierch.

The month started very cold in Lithuania and became much warmer in its second half

resulting in a monthly temperature anomaly of  $-0.3^{\circ}\text{C}$ . Precipitation amounted to 34 mm only, which is 52 % of normal.

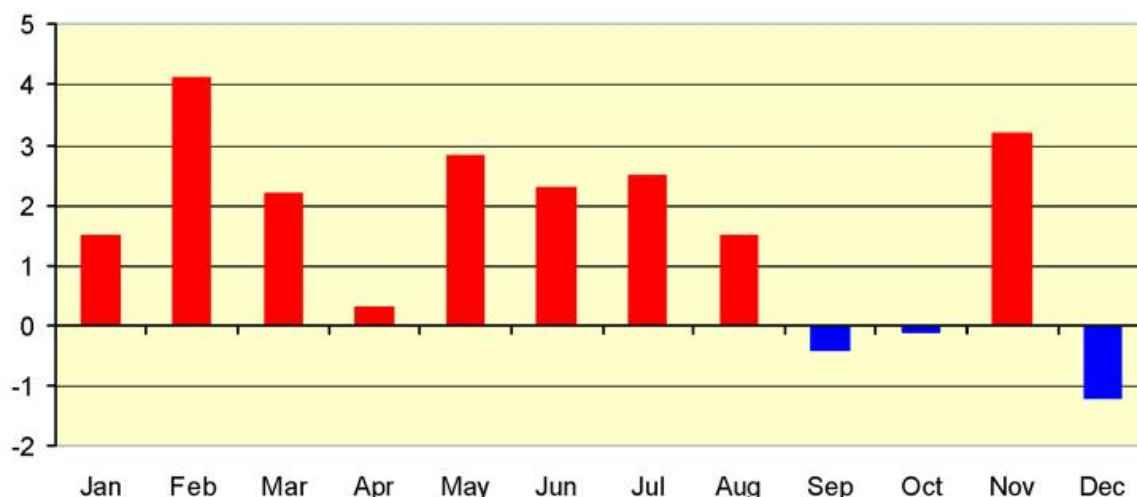
Belarus had a temperature anomaly of  $+0.5^{\circ}\text{C}$  and a precipitation deficit of 40%.

The month was very mild in France with temperature anomalies between  $+3^{\circ}\text{C}$  and  $+3.5^{\circ}\text{C}$ . Exceptional rainfall affected the southern and central eastern parts of the country on November 13-17; cumulated precipitation exceeded record values for November. Thunderstorms with intense rain caused floods in eastern areas on November 23-24, people were evacuated in the departments Var, Vaucluse, Drôme and Ardèche. At Cap-Béar close to the Mediterranean sea shore the maximum wind gust of the year, 144 km/h, was recorded on November 7.

During a powerful foehn situation in Austria on November 14-16 new records of absolute maximum temperature for the month were registered, i.e.  $21.5^{\circ}\text{C}$  in Klagenfurt and  $22.8^{\circ}\text{C}$  in Graz. The previous records were  $18.6^{\circ}\text{C}$  and  $19.7^{\circ}\text{C}$  respectively and date back to 1963. This foehn episode was accompanied also by strong winds with gusts of about 150 km/h. Severe damage occurred to the infrastructure and forestry in the area of Salzburg. The material losses were estimated to 95 million Euro.

The first third of the month in Slovenia was slightly colder than normal, but then it became exceptionally mild. The monthly temperature anomalies in the lowland resulted in values between  $+3^{\circ}\text{C}$  and  $+5^{\circ}\text{C}$ ; during the last 52 years the monthly mean air temperature was higher only in 1963. A stormy southerly wind blowing between November 14 and 16 caused severe damage to houses and forests.

The weather in Hungary was mixed between the first snowfall on November 4 and a succeeding late Indian summer with daily maximum temperatures above  $15^{\circ}\text{C}$  everywhere in the country. Local records of the maximum temperature were set at stations Keszthely,  $23.9^{\circ}\text{C}$ , and Fonyód,  $24.0^{\circ}\text{C}$  on November 15. The daily mean temperature in Budapest was above  $18^{\circ}\text{C}$  for 5 consecutive days, which is without precedence in the last 50 years. The countrywide monthly mean temperature came up to be  $+3.2^{\circ}\text{C}$  above the average of the reference period 1961-1990 (see fig. 11.1).



**Fig. 11.1:** *Monthly temperature anomalies in Hungary in 2002 (reference period 1961-90).  
From: Hungarian Meteorological Service*

Extremely high mean monthly temperatures and very low precipitation amounts characterised the weather in Serbia and Montenegro.

In Romania the month was very mild with significant positive temperature anomalies.

Italy was hit by some intense weather events with flooding. During a violent thunderstorm in Tuscany on November 1, a precipitation amount of 104 mm was measured at Grosseto. In the period of November 22-30, intense precipitation occurred in the north-western part of the country. The largest precipitation amount of 300 mm in this episode fell at the Pass of Giovi near Genoa at 475 m above sea level. The damage to agriculture has been estimated to about 350 million Euro. In the same period, fifteen houses were destroyed by landslides following the flood and one person died.

In Cyprus, the month was very warm and extremely dry.

On the occasion of a hailstorm in the area of Antalya, Turkey, greenhouses and plantations of citrus fruits were heavily damaged on November 22.

The month was warm and dry in Israel. In most areas rainfall amounts were only 50% of normal. There were long periods of hot and dry weather with temperatures reaching more than 30°C.

The month was very dry in Armenia with a general precipitation rate of only 30 % of normal.

In Azerbaijan, the month was significantly warmer and drier than usual. The temperature anomaly was +2.8°C and the precipitation totals varied from 25% to 49% of normal.

## December 2002

- **Extremely mild in Greenland, Iceland and Svalbard, very mild also in south-western Europe**
- **Very cold in eastern Europe and parts of the Middle East, extremely cold and wet in the Caucasus**
- **Extremely dry from Scandinavia over Poland to the Ukraine and central Russia**

Some foehn situations in Greenland yielded very high and record-breaking temperatures at several locations.

In Iceland it was one of the warmest December months on record in most parts of the country. At a few stations the previous record holder, December 1933, was surpassed. The absolute maximum temperature in Reykjavik in December was 12.0°C, the same as the previous record. The snowcover in the north of the island was the lowest on record for this month.

The monthly average temperature in Norway was below normal for the whole country except for some coastal areas in Finnmark County. In southern parts of the country the anomaly was -3°C to -4°C. The monthly precipitation amount varied from near normal to well below normal. Coastal areas in the southern part and the north-eastern part received nearly 100% while coastal areas in the western part received only 25%. Due to a blocking situation in northern Europe in the end of the year, the station Finsevatn recorded the highest air pressure, 1058.7 hPa, ever measured in this month in Norway, on December 8. Extremely high temperatures were observed in the Svalbard area during December 3-8. All regular weather stations recorded temperatures higher or equal to the previous December records. The maximum temperature of 7.9 °C at Svea Gruber on December 7 is the highest December temperature ever measured in Spitsbergen.

The month in Denmark was mild in the beginning, but then the weather became cool and dry with easterly winds and without any snow.

The unusually cold weather in Sweden culminated with -41°C close to Jokkmokk in Lapland on December 24.

In Finland the month was clearly colder than normal in the whole country.

Many areas in the U.K. experienced flooding at the end of the month following heavy rainfall that started on December 26 and lasted into the next year.

The monthly mean temperature in Belgium was moderately above normal, while the precipitation total clearly exceeded the long term average. Intense precipitation with flooding occurred on the occasion of two major events: in west Flandres on December 5 and in the south-eastern part of the country on December 29-31.

In Germany as a whole the temperature anomaly was slightly negative and the precipitation total nearly reached the normal amount. But there were considerable differences between the very cold and dry northern and the mild and wet southern parts of the country. A cold spell on December 9-11 made some lake surfaces freeze and enabled the harvest of frozen grapes for the making of sweet wine; three people froze to death. Freezing rain and snowfall caused chaos with many accidents on roads and motorways during two other weather events in the north and the east of the country, namely on December 13-18 and 23-26.

In Poland it was a typical cold winter month with a temperature anomaly of -4.1°C. According to a rather low precipitation rate of 51% of normal the snow cover was rather poor. Deep frost of nearly -30°C was observed in the valleys of the Carpathian Mountains on December 26. Icing made a lot of problems on the roads on December 29.

The weather in Lithuania was determined by anticyclones in northern latitudes. This circulation pattern led to very low temperatures, 5.5°C below normal, and scarce precipitation, less than 50% of the normal rate.

The weather conditions in Latvia were very cold with a temperature anomaly of -5°C and dry with a precipitation rate below 60% of normal.

The monthly mean temperature anomaly in Belarus was down to nearly  $-6^{\circ}\text{C}$ , while the precipitation total was below 50% of normal.

The month was extraordinarily warm in all parts of France, especially at its end. New records were reported like a daily maximum temperature of  $24.7^{\circ}\text{C}$  in Herrère on December 23 and a daily minimum temperature of  $11.9^{\circ}\text{C}$  in Saint-Yan on December 27. The month was characterised also by a large deficit of sunshine duration: in Dijon with only 3.05 hours between December 1 and 15, it was the lowest sunshine duration for this period since 1947.

The month was unusually warm in the west and south of Austria. The monthly mean temperature in Bregenz reached  $4.4^{\circ}\text{C}$ , which is the highest observed value since 1880, when it was  $5.1^{\circ}\text{C}$ .

The month was very cold in Slovakia with temperature deviations down to  $-3^{\circ}\text{C}$  below normal at some stations in the central and eastern part of the country.

In Hungary the monthly temperature anomaly was  $-1.2^{\circ}\text{C}$ , while the precipitation total nearly reached the normal amount. The lowest temperature of the year,  $-28.3^{\circ}\text{C}$ , was measured in Zabar on December 26.

The monthly mean temperature in Slovenia was clearly above normal with highest anomalies up to  $+3^{\circ}\text{C}$  near the coast. Precipitation was abundant at some mountain stations, but scarce at other places like Potorož at the coast with less than 40% of normal.

In Serbia and Montenegro it was a typical winter month with clearly negative temperature anomalies. A snow cover was formed in the second part of the month

The month was very cold in Romania with a temperature anomaly of  $-2.6^{\circ}\text{C}$ .

The month started mild and rainy in Bulgaria. After the first week temperatures dropped down to  $-18^{\circ}\text{C}$  and snowstorms with gusts up to 86 km/h caused significant damage in the eastern part of the country. Electric power supply was interrupted, hundreds of car accidents occurred on slippery roads, 10 people died.

The monthly average temperature in Portugal was well above normal essentially due to the positive anomaly of about  $+2.0^{\circ}\text{C}$  of the minimum temperature. The precipitation rate was about 140% of normal. Heavy rain and strong winds occurred, mainly in the northern parts of the country on December 25-27. Water levels rose about 7 meters higher than normal in Douro River and 5 meters in Tâmega River. The

swell of the river basins caused several floods that submerged roads, dislodged people and led to the interruption of railway traffic. The sea weather conditions forced the closure of several harbours in northern and central coastal zones.

The month was cool and rainy in Israel. Rainfall amounts were 150%-200% of normal and there was a large number of rain days. In the northern and central parts of the country there were 12 successive days of rain from December 15-26, which is a unique event in Israel.

Unstable weather conditions including thunderstorms with hail prevailed in Cyprus. The monthly precipitation was well above normal, while the monthly mean temperature was near to normal. A tornado caused damage to homes and greenhouses in the western coastal area on December 6. Another tornado in the western part of the central plain again caused damage to farms on December 8. On the same day a very severe hailstorm in the southeastern part of the island caused extensive damage to buildings, cars and farm land. Flooding occurred in the towns of Nicosia, Lamaka and Limassol and land slides in mountain areas.

In Turkey it was very cold, especially at the end of the month. At 75% of 110 stations the long term record of minimum temperature was broken within the last ten days of the month.

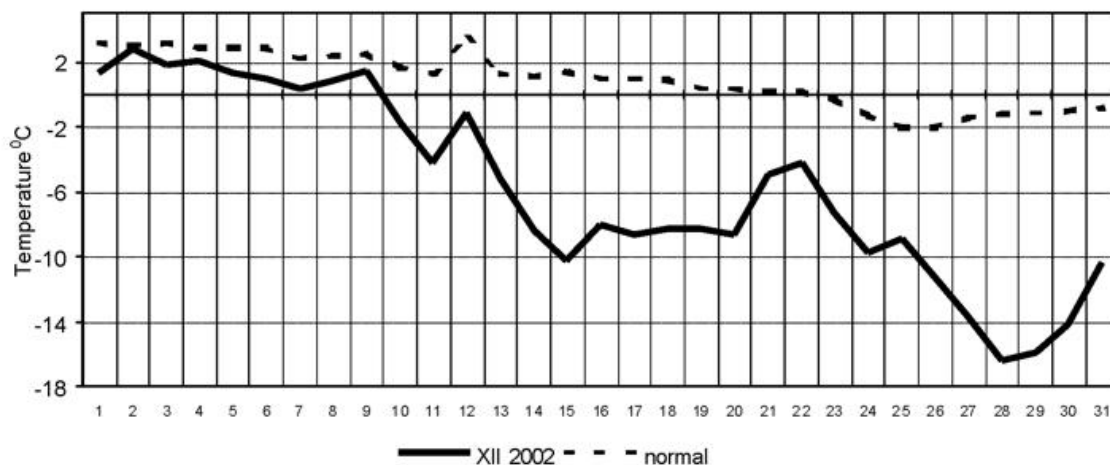
The month was extremely cold and dry in the Ukraine. The temperature anomaly was down to about  $-7.5^{\circ}\text{C}$  and the precipitation rate was only 40% of normal.

The monthly mean temperatures in Russia were very much below normal, especially the southern areas experienced anomalies down to  $-8^{\circ}\text{C}$ . Strong winds with gusts up to 137 km/h in combination with low temperatures caused severe damage to the city of Novorossisk at the Black Sea. One vessel sank and another one stranded because of ice formation. Throughout the month the danger of avalanches continued in the northern Caucasus area. The situation culminated to the end of the month, when seven people died and several villages were cut off in a series of avalanches.

In Armenia the month was very cold and snowy. The monthly temperature anomalies were generally about  $-4^{\circ}\text{C}$ , in Ararat and Sunick valleys down to  $-8^{\circ}\text{C}$ . In Yerevan the absolute minimum temperature reached  $-28^{\circ}\text{C}$  and  $-32^{\circ}\text{C}$  in Ararat town. It was the coldest December since the beginning of observations in 1954. Temperatures dropped down

especially in the second half of the month (e.g. see fig. 12.1). The period with temperatures below  $-14^{\circ}\text{C}$  lasted for about 150 hours in Ararat valley and caused significant damage to vineyards and orchards. Material losses are

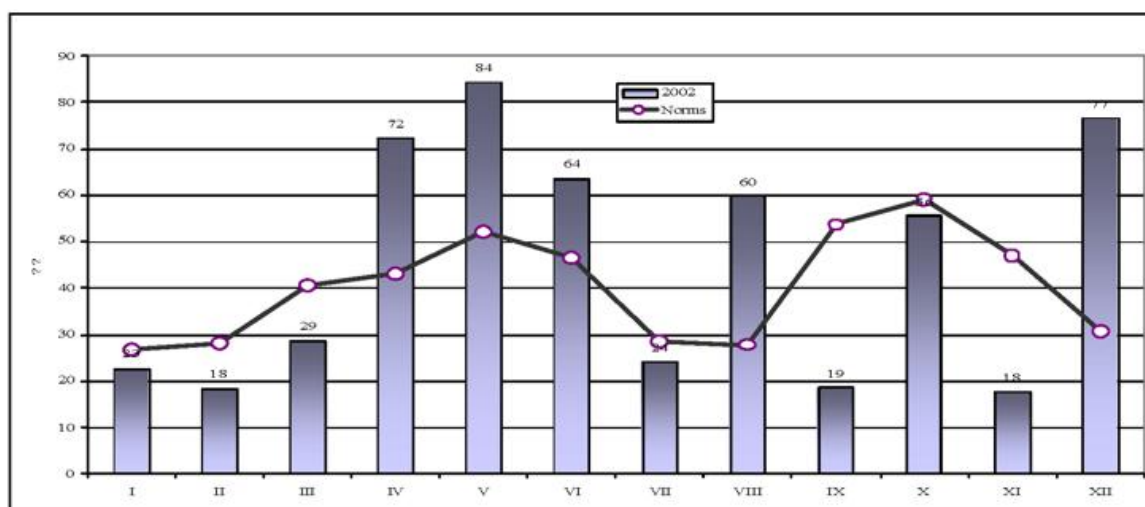
estimated to 30 million Euro. The precipitation totals were about 200% of normal, in Ararat valley even up to 300%. A snow cover was established everywhere with a depth varying from 20 cm up to 50 cm in mountain areas.



**Fig. 12.1:** Daily mean temperature in December 2002 and normal values in Yerevan  
From: Department of Hydrometeorology of the Republic of Armenia

Abnormal cold and wet weather conditions prevailed in Azerbaijan. The monthly mean temperature deviation from normal was  $-4.3^{\circ}\text{C}$ , which statistically occurs once in 86 years. Frost periods were accompanied by strong northerly winds and the daily mean temperature dropped down to  $9^{\circ}\text{C}$  below normal on some days. The lowest daily mean temperature in Baku was  $-2.9^{\circ}\text{C}$  on December 25. The absolute minimum temperature was measured in Nakchivan on

December 28,  $-30^{\circ}\text{C}$ . This is  $5^{\circ}\text{C}$  lower than the absolute minimum temperature within the last 100 years. A stable snow cover appeared all over the country. The cold weather conditions caused difficulties in energy supply, 11 people died. The monthly precipitation total as a mean value of all stations was 253% of normal (see fig. 12.1). The precipitation in Baku amounted to 183.9 mm, which is 5.7 times the monthly and 74% of the annual long term average at this station.



**Fig. 12.2:** Monthly average precipitation in 2002 and normal precipitation in Azerbaijan  
From: Ministry of Ecology and Natural Resources, Azerbaijan

## **Activities and Results of European Climate Centres**

### **The Century Flood of the River Elbe in August 2002: Meteorological Conditions and Climatological Aspects**

**By:** Bruno Rudolf and Joerg Rapp, Global Precipitation Climatology Centre (GPCC)  
German Meteorological Service, Offenbach/Main, Germany

#### **1 The Flood**

The meteorological cause of the catastrophic floods along the Danube and - in particular – the Elbe rivers in August 2002 was an extraordinary weather situation with various meteorological factors leading to such extreme precipitation as has never been recorded before in Germany. In parts of the Erzgebirge (mountain range between Germany/Saxony and Czech Republic) more than 300 mm fell in one day, and even in the region north of the low mountains more than 150 mm fell over a widespread area in 24 hours, and in the Berlin area approximately 100 mm were recorded.

The extreme precipitation was followed by a very quick rise in the water levels of the Elbe tributaries, in particular the rivers which drain the Erzgebirge to the north. The water level of the Elbe subsequently reached a maximum mark, which had not been recorded for centuries. The total economic damage resulting from the August flood (the Czech Republic: € 3 billion, Austria: € 3 billion; Germany: € 9.2 billion) represent a new European record for flood damage.

Floods never have merely one single cause, therefore it is important from the point of view of climatological research to examine more closely the individual meteorological factors leading to the flood. Only in comparison with the climatic temporal-spatial precipitation distribution it can be assessed how extraordinary and extreme the meteorological conditions for this event really were.

#### **2 Synoptic description of the weather situation**

An essential cause of the catastrophe was the transport of cold maritime air from the Icelandic-Greenland area to the western Mediterranean Sea days before, where on 10 August a well-defined upper-air trough was formed. Dynamic lifting processes led to a rapid fall in air pressure in front of this low over Upper Italy, so that in the night of 11 August over the northern Adriatic Sea a so-called Vb-low was formed. The low included extremely moist and warm Mediterranean air into its circulation, a process that was decisive for the precipitation potential that later existed over Central Europe.

The low subsequently moved on "a Vb-track" north-eastwards (Figure 1), whereby its cloud structure was increasingly transformed into a vortex. At this time high-reaching frontal cloud bands with heavy rainfall, which also included thunderstorm cells, were already lying over the southern side of the Alps and over the Alps themselves. By 12 August the low had moved towards the Czech Republic, strengthening all the time, and later reaching Saxony. On the northern and western side of the low an expanded and strong lifting was connected to a divergent upper current, whereby persisting and abundant large-scale precipitation was initiated. Due to stable high pressure areas over eastern and western Europe the low finally became almost stationary and pivoted itself to a certain extent exactly over the eastern part of Germany. The atmosphere here was supplied again and again with warm and very moist, unstably layered Mediterranean air, which experienced a large-scale lifting, condensation and immediate raining out.

**Fig. 1:**

*Track of the "Vb-low" with indication of the core pressure.*



The situation was intensified by the fact that on 12.08.2002, in the region of the Erzgebirge, due to the fall in pressure in the east and the increase in pressure in the west a strong pressure gradient developed, which resulted in a freshening, stormy north-west wind in this mountainous area. As a consequence, the air mass saturated by water vapour was orographically lifted in the Erzgebirge area, which led to extraordinary heavy precipitation.

The impact of at least five meteorological factors upon one another led to the catastrophic flood:

The (1) large-scale, strong and quasi-stationary lifting area was connected with the development of the Vb-low, and is to be classified as an essential synoptic precondition of the heavy precipitation. The large-scale constellation of pressure and airflow over Central Europe changed only very slowly. Warm and very moist air was guided from the Mediterranean and Black Sea via the typical Vb-track, water vapour saturated and with an extended (2) very high liquid water content, a necessary condition for record precipitation, which is naturally fulfilled much better in summer than in winter. (3) Convective precipitation processes in the moist-unstable air mass further east constituted a considerable additional effect locally. Essentially more significant, however, was the (4) additional orographic lifting windward of the Erzgebirge due to a reinforcement of the pressure gradient in the rear of the low. Finally the (5) already deeply water saturated ground and the relatively high water level of many rivers due to the heavy rainfall in the weeks before was responsible for the explosive nature of the Elbe flood, particularly since this river drains - contrary to most of the other rivers - the whole mountain range and not only one side.

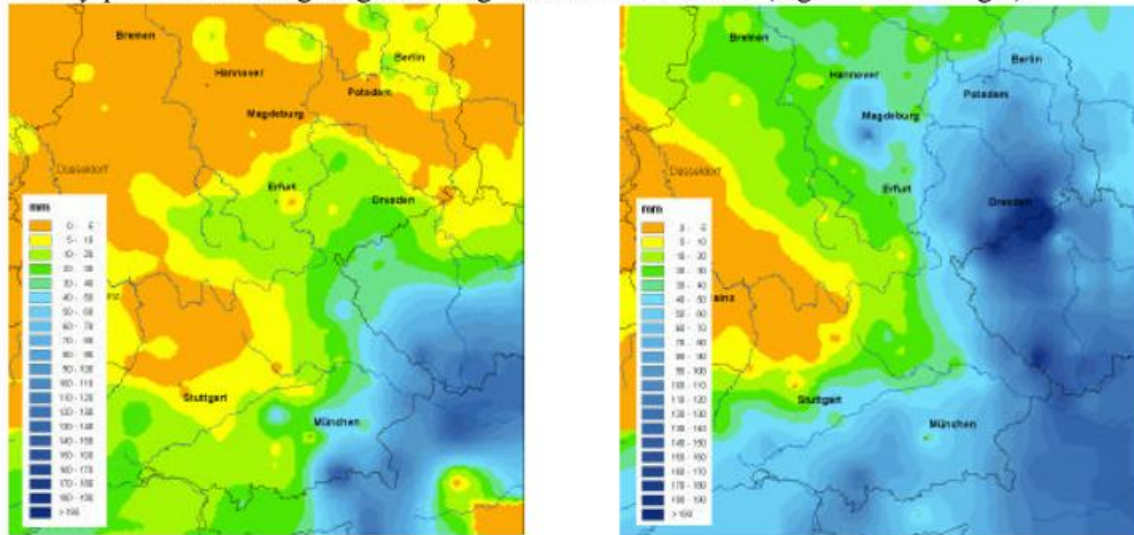
On the basis of a synopsis and an interpretation of the observation material available (total precipitation measured at stations, other weather observations, radar and satellite images, lightning echoes etc.), the following estimation of the causal proportions of the various precipitation mechanisms can be made:

- |   |                        |
|---|------------------------|
| • Stratiform (scaled) precipitation                 | 2 thirds               |
| • Convective precipitation (showers, thunderstorms) | 1 third                |
| • Orographic intensification along the mountains    | doubling of the totals |

The extremely high diurnal precipitation and the devastating flash floods caused by it, which affected the places in and close to the Erzgebirge, resulted thus above all from the lifting at the northern edge of the mountains. Over all, the precarious flood situation along the Elbe and its larger tributaries with flooding in many places and towns was due to the combination of the five causes described above.

### 3 Observed precipitation data

The extreme dimension of the flood disaster was thus based also on the soil moisture saturation resulting from the rainy weather before. Figure 2 shows on the left the precipitation totals for the period 6 - 8 August. The rainfall first centred on Upper Austria with amounts of more than 100 mm which led to heavy flooding along the Danube, but it also rained considerably (20 to 30 mm) in the Erzgebirge. Some days later the heavy rainfall expanded northwards to include the Czech Republic, Saxony and Brandenburg. In the period 10 -13 August, 100 mm were exceeded over widespread areas, with many places in the Erzgebirge reaching the 200 mm threshold (Figure 2 on the right).

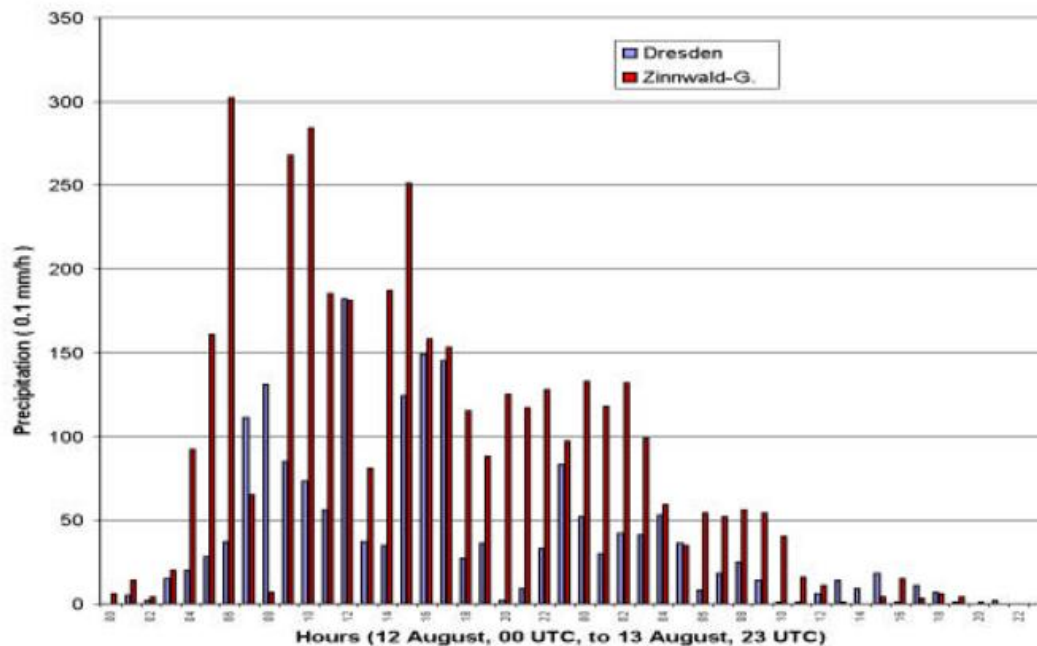


**Fig. 2:** Precipitation totals of the periods 6 - 8 August (left) and 10 - 13 August, 2002 (right).

Zinnwald-Georgenfeld even reported 380 mm of rain. 312 mm fell on one day alone (06 to 06 UTC the following day), or even 353 mm if the reference interval is shifted by three hours (03 to 03 UTC). Radar-based precipitation estimates showed even a maximum of 400 mm/24h. Table 1 shows further impressive individual values of the total precipitation measured. For example, in Dresden, 158 mm fell in 24 hours. The record precipitation also led to unusually high monthly values, which in the areas concerned varied mostly between 150 and 300 mm, which constitutes 200 to 350% of the rain which normally falls in the month of August (reference period 1961-1990).

**Tab. 1:** Measured precipitation totals for various periods in August 2002 and August normals.

| Station name         | Station height ab. msl (m) | Geogr. latitude (deg:min) | 1 day totals 12 August 2002 | 3d-totals 10.-12. August 2002 | August totals 2002 | August normals average 1961-90 | relation of August 2002 to 1961-90 |
|----------------------|----------------------------|---------------------------|-----------------------------|-------------------------------|--------------------|--------------------------------|------------------------------------|
| Berlin-Tempelhof     | 49                         | 52:28                     | 65.1                        | 69.0                          | 156.3              | 61                             | 256%                               |
| Potsdam              | 99                         | 52:23                     | 84.1                        | 90.9                          | 183.3              | 60                             | 306%                               |
| Cottbus              | 69                         | 51:46                     | 49.9                        | 60.0                          | 136.9              | 69                             | 198%                               |
| Doberlug-Kirchhain   | 97                         | 51:39                     | 93.8                        | 102.2                         | 165.4              | 64                             | 258%                               |
| Oschatz              | 150                        | 51:18                     | 108.5                       | 119.0                         | 181.7              | 61                             | 298%                               |
| Dresden-Klotzsche    | 222                        | 51:08                     | 158.0                       | 168.9                         | 233.1              | 76                             | 307%                               |
| Aue                  | 391                        | 50:36                     | 79.9                        | 145.8                         | 230.5              | 83                             | 278%                               |
| Chemnitz             | 418                        | 50:48                     | 78.0                        | 109.2                         | 196.5              | 78                             | 252%                               |
| Marienberg           | 639                        | 59:39                     | 166.5                       | 188.3                         | 308.2              | 89                             | 346%                               |
| Zinnwald-Georgenfeld | 877                        | 50:44                     | 312.0                       | 379.9                         | 469.6              | 103                            | 456%                               |
| Fichtelberg          | 1213                       | 50:26                     | 137.8                       | 199.7                         | 299.1              | 106                            | 282%                               |
| Grosser Arber        | 1446                       | 49:07                     | 88.5                        | 121.1                         | 261.6              | 131                            | 200%                               |



**Fig. 3:** Hourly precipitation totals from 12 August, 00 UTC, to 13 August, 24 UTC.

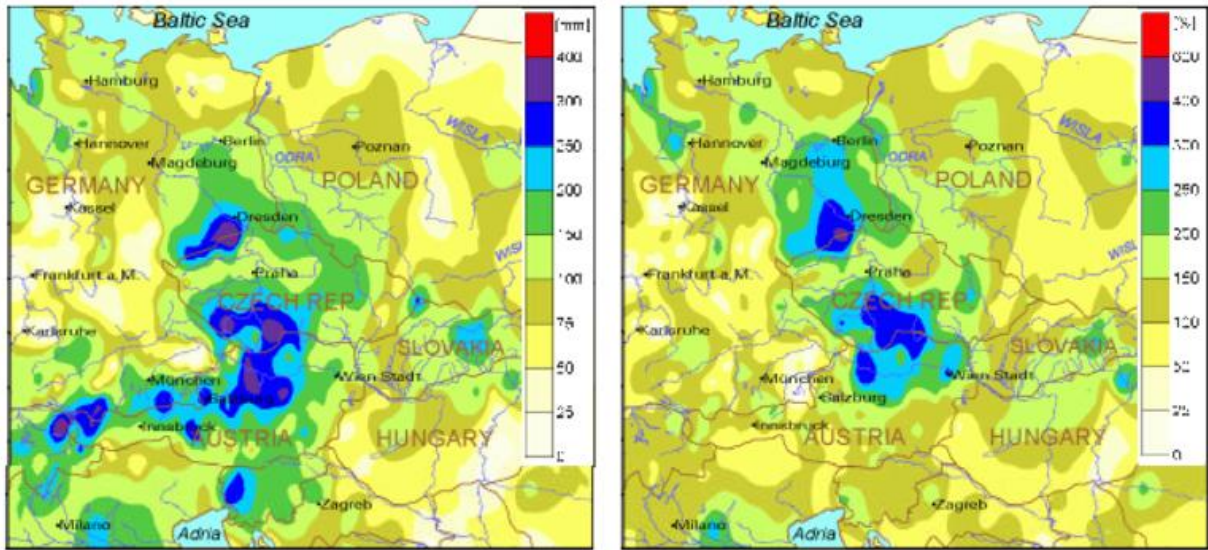
The exact temporal course of events on 12 and 13 August is shown in Figure 3. The severe rainfall began in the early hours of 12 August and persisted, but with high fluctuations, until the late morning of the following day. On the first day extreme hourly precipitation totals of up to 30 mm were measured in the Erzgebirge (Zinnwald-Georgenfeld), and even in the northerly foreland (Dresden) 15 mm or more fell repeatedly. By 13 August the rain intensity had decreased.

#### 4 Climatological assessment

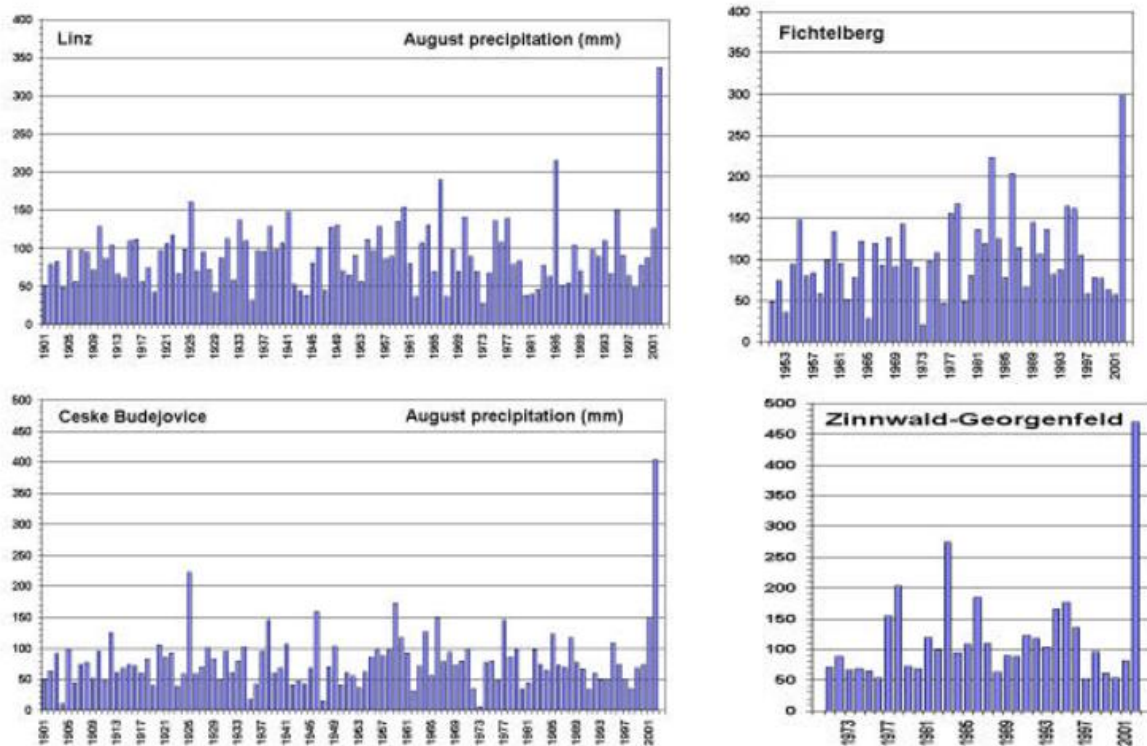
200 per cent of the normal August precipitation had already fallen in the first half of August 2002 in a belt reaching from Berlin and Brandenburg via Saxony to the Czech Republic. In the Erzgebirge and in the southern Czech Republic even three times the mean monthly precipitation total occurred in this time. With a maximum monthly precipitation total of 470 mm for August 2002 in Zinnwald-Georgenfeld, more than four times the normal August precipitation was measured.

The maximum of both, the regional precipitation total as well as the anomaly, cover the Erzgebirge, located in the Elbe catchment area. The belt of the unusually high monthly precipitation follows to a large extent the course of the Elbe river (Figure 4). The measurements from many stations in the area extending from Austria via Saxony to Berlin/Brandenburg resulted in the highest monthly precipitation totals ever measured in August since records began. Figure 5 shows the time series of the August precipitation for selected stations.

On 12 August 312 mm was recorded at the DWD station Zinnwald-Georgenfeld, the highest daily precipitation total ever measured in Germany. Up to then 260 mm was considered as record daily precipitation total, observed on 6 July 1906 in Zeithain, district of Riesa. The three-day (406 mm) and monthly (470 mm) precipitation totals measured in Zinnwald-Georgenfeld had, however, already been clearly exceeded in Stein, district of Rosenheim, in July 1954 with 458 mm in three days and 777 mm for the month (see Table 2).



**Fig. 4:** Monthly precipitation total in mm/mon for August 2002 (left) and the amount of precipitation in per cent in relation to the period 1961-1990 (right). Data base: Observations of 614 stations (left) and 415 stations (right).



**Fig. 5:** Time series of monthly August precipitation totals at the stations Linz (Danube), Ceske Budejovice (Czech Republic), Fichtelberg and Zinnwald-Georgenfeld.

**Tab. 2:** *The extreme precipitation totals observed in Germany for various observation time intervals (one observational day = 06 UTC to 06 UTC subsequent day).*

| interval  | Precipitation depth(mm) | Station name (district / province)      | Date                          |
|-----------|-------------------------|---|-------------------------------|
| 8 min     | 126                     | Fuessen (Ostallgaeu)                    | 25 May 1920                   |
| 1 h       | 200                     | Miltzow (Nordvorpommern)                | 15 September 1968             |
| 2 h       | 239                     | Daudenzell (Baden-Wuerttemberg)         | 27 June 1994                  |
| 1 day     | 260                     | Zeithain (Riesa / Sachsen)              | 6-7 July 1906 (6 – 6 UTC)     |
| 1 day     | 312                     | Zinnwald-Georgenfeld (Sachsen)          | 12-13 August 2002 (6 – 6 UTC) |
| 24h       | 353                     | Zinnwald-Georgenfeld (Sachsen)          | 12-13 August 2002 (3 - 3 UTC) |
| 2 days    | 377                     | Seehaus bei Ruhpolding (Traunstein)     | 7-9 July 1954                 |
| 3 days    | 406                     | Zinnwald-Georgenfeld (Sachsen)          | 11-14 August 2002 (6 – 6 UTC) |
| 3 days    | 458                     | Stein (Rosenheim)                       | 7-10 July 1954                |
| 7 days    | 515                     | Schneizdreuth-Weissbach (Berchtesgaden) | 7-14 September 1899           |
| 10 days   | 652                     | Stein (Rosenheim)                       | 1-11 July 1954                |
| 1 month   | 470                     | Zinnwald-Georgenfeld (Sachsen)          | August 2002                   |
| 1 month   | 777                     | Stein (Rosenheim)                       | July 1954                     |
| 12 months | 3,661                   | Purtschellerhaus (Berchtesgaden)        | Dec. 1943 - Nov. 1944         |

But even higher possible precipitation than observed has been calculated for our climate: The study "Maximierte Gebietsniederschlagshöhen in Deutschland" (Maximised Areal Precipitation Totals in Germany), carried out by the DWD (DVWK 1997), provided "a regionally adjusted maximised grid point precipitation total" of 375 mm/24h and 445 mm/72h for the eastern part of Land Brandenburg and 800 mm/24h and 1340 mm/72h for the eastern part of the Bavarian Alps. Corresponding values for the Erzgebirge area were not published. These values were estimated on the basis of the extreme values observed in the region, the regional land form (orography) as well as the most unfavourable values for humidity and wind speed. The authors of the study vote that the results represent "an approximation to the possible physical/climatological maximum" and that the calculated values will not be reached "according to human estimation", however, they also state that these values could apply to the current climate conditions only.

This restriction applies in particular to the recurrence times of heavy precipitation totals, used in applied hydrology, in particular in hydraulic engineering, which are based on observed precipitation data from the 30-year period from 1951 to 1980 (Bartels et al. 1997). The counting of the measured values (classified according to duration and total amount of precipitation) and application of a statistical extreme value distribution resulted in recurrence times for periods of up to 100 years depending on station. According to these statistics the maximum 24- and 72-hour precipitation totals observed in August 2002 at the stations Zinnwald-Georgenfeld, Fichtelberg, Marienberg and Dresden-Klotzsche are expected to occur less than once in 100 years. The DWD plans to update the atlas of recurrence times for the total period 1951 to 2000. A comparison of the results for two subperiods could then supply information on changes in extreme value behaviour, particularly recurrence times, as a result of the climate change during the second half of the 20th century. The first results of another study, independent of this project, with the few available long data series (Grieser and Beck 2003) already show that a change in the extreme value behaviour of daily precipitation totals in Germany can be proved to be significant.

In the previous considerations it had not been stressed that precipitation is not only a basic quantity in relation to time (there is no exact instantaneous recording, but only - although short - time intervals can be observed), but is also in principle an area-related quantity. Even the observation "point", i.e. the funnel of the precipitation gauge is, strictly speaking, an area. According to general technical opinion, the conventional local gauge measurements represent, in case of a suitable installation of the instrument, daily precipitation or of longer time intervals within a radius of approximately 3 km or for an area of 25 km<sup>2</sup>.

In order to quantitatively assess the precipitation, which led to river floodings, it is thus necessary to determine the spatial distribution and area mean of the precipitation from the point data of the measuring networks, whereby radar images and numerical models can provide additional information. In the already above-mentioned DVWK-Study empirically computed maximised area precipitation of different duration (1, 12, 24 and 72 hours) and area sizes (25, 100, 500 and 1000 km<sup>2</sup>) separated for summer and winter conditions for Germany were mapped. With an area of 1000 km<sup>2</sup> the northern Erzgebirge falls within the classes 300 mm/24h to 400 mm/24h and/or 450 mm/72h to 550 mm/72h. The precipitation totals observed there in August 2002 show that the results of this study are by no means unrealistic.

Based on the generation mechanisms of precipitation a relationship exists between the maximum precipitation total, its duration and the spatial expansion of the affected area. To put it simply, it can be presupposed that, the longer extreme precipitation persists, the larger the affected area is. In this connection, however, different factors play a large role, firstly the regional orographic and climatic conditions in general and then, in individual cases, the weather situation.

Heavy precipitation, which leads to regional flash floods, is not at all unusual in the Erzgebirge (Marx 1966, 1966a and 1967). In the evening of 8 July 1927, for example, two unusual cloudbursts occurred over the watershed between the Mueglitz and the Gottleuba (Alt and Fickert 1936), which in the shortest time produced precipitation totals of up to 200 mm. These resulted in devastating flash floods of the rivers concerned, which were regionally limited to a small area. The precipitation responsible for the Elbe floods of August 2002 was, however, not only more intensive, it lasted considerably longer and covered - together with the Vb-cyclone moving northwards - a significantly larger area.

With respect to the overlapping of the different meteorological processes and the absolute maximum values of precipitation and river levels, the 2002 Elbe flood can be ranked to be an extraordinary event, which occurred for the first time since the 17th century, the beginning of flood registration at Dresden. Global warming and the observed increase of extreme precipitation days during the last century may indicate a higher risk for such events in future.

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## Report on ECSN activities

by: Walter Kirchhofer, MeteoSwiss

- **General remarks**

At the Meeting of the WMO Regional Association VI in Geneva, 3 May 2002, the ECSN activity was presented as one of the successful EUMETNET programme.

The 7th ECSN Advisory Committee (EAC) Meeting took place at Hohenpeissenberg, Germany, 3-5 June 2002.

After the successful termination of the two projects “European Climate Assessment” (ECA) and “ECSN Climate Dataset” (ECD), a follow-up project was prepared in order to continue the ECSN activities in these fields. The project proposal “European Climate Assessment & Dataset” (ECA & D), promoted by KNMI and the ECSN Advisory Committee, was approved by the EUMETNET Council in its September meeting.

MeteoSwiss has generated a new ECSN web-site. The web-site is placed on the EUMETNET Internet server.

The second workshop of the project “Generate Climate Monitoring Products” (GCMP), hosted by DWD, took place in Hamburg, 25-27 September 2002. This GCMP workshop was an important milestone in the project development.

The Fourth European Conference on Applied Climatology, ECAC-2002, took place in Brussels, 12-15 November 2002, with the focus on “Climate related Risk Analysis and Sustainable Development in the 21st Century”. The Royal Meteorological Institute of Belgium organized and hosted this successful ECAC-2002.

At the EUMETNET Council Meeting, 4 December 2002, it was decided that in the future the European Meteorological Society (EMS), in partnership with EUMETNET-ECSN, will organize the European Conference on Applied Climatology (ECAC). The next ECAC will be a combined conference “ECAC-2004 / EMS Annual Meeting 2004” in Nice in September 2004.

UNIDART (Uniform Data Request Interface) is a project to develop an infrastructure for a border-crossing exchange of climate data. ECSN is collaborating very closely with UNIDART and has prepared a list of requirements for the realisation of the pilot phase and further steps of UNIDART.

- **European Climate Assessment (KNMI)**

In the “European Climate Assessment” (ECA) project the temperature and the precipitation climate was analysed for WMO Region VI, putting particular emphasis on changes in daily extremes. The ECA project focusses on the twentieth century from 1901 to 2000. Respecting the data policies of the participating countries, a selection of the daily series in the ECA dataset is made available to the public on a CD-ROM and through the Internet (<http://www.knmi.nl/samenw/eca>). With the Final Report “Climate of Europe: Assessment of observed daily temperature and precipitation extremes” the ECA project was terminated.

- **Generate Climate Monitoring Products (DWD)**

The work on the development of the web-site “Generate Climate Monitoring Products” (GCMP) continued. In order to further improve the Internet platform, external software experts elaborated concept proposals.

An important milestone in the project development was the GCMP workshop, 25 - 27 September 2002, hosted by DWD in Hamburg.

Although cooperation within the project has intensified, especially due to the GCMP workshop in September, it is nevertheless indispensable to increase the number of actively participating European NMHSs to achieve sufficient regional coverage, especially concerning the national climate monitoring products.

Implementation of the workshop results will continue. The GCMP Website will be adapted accordingly. GCMP Web manager and project partners will coordinate the filenaming and directory structure as well as information on the links of the contributions on the respective servers.

- **Climate Atlas of Europe (Meteo-France)**

The Atlas will contain monthly normals for precipitation, temperature, wind and sunshine duration and additional statistical information for these parameters and for the occurrence of phenomena such as fog, thunderstorm, hail and snow. The computation period will be 1971-2000, and the target spatial density will be about one station per 5000 square kilometres. In a first step the contents of the Atlas project will be made available without maps.

Metadata from all the participating countries (24) representing about 685 stations have been received, checked, harmonized and put into a single file. Among the non ECSN countries contributions have been made by Albania, Bulgaria, Czech Republic, Slovakia and Slovenia.

Quality tests applied to the whole dataset have been engaged, revealing the detection of a large number of errors. Considering the large size of the dataset, graphical tools are necessary to assess the quality of some parameters.

- **Drought investigations (Meteo HU, PT)**

The objectives are the following ones:

- Evaluation and use of different drought indices;
- Analysis of long drought index series;
- Study of thresholds of drought indices;
- Calculation of the spatial distribution of drought indices on different time scales;
- Recommendation of drought indices.

The project could not be cared permanently by a scientist. Nevertheless the project has been completed with a Final Report.

- **ECSN climate Dataset (KNMI and DNMI)**

The “ECSN Climate Dataset” (ECD) project is closely related to the project “European Climate Assessment” (ECA). The main objective of the ECD project was the preparation and the distribution of climate datasets on daily amount of precipitation and daily temperature (minimum, mean, maximum) for the period 1901-2000 via CD-ROM and Internet. The project was formally finished with the Final Report prepared on Internet. The server is operational in the network environment of KNMI since November 2002.

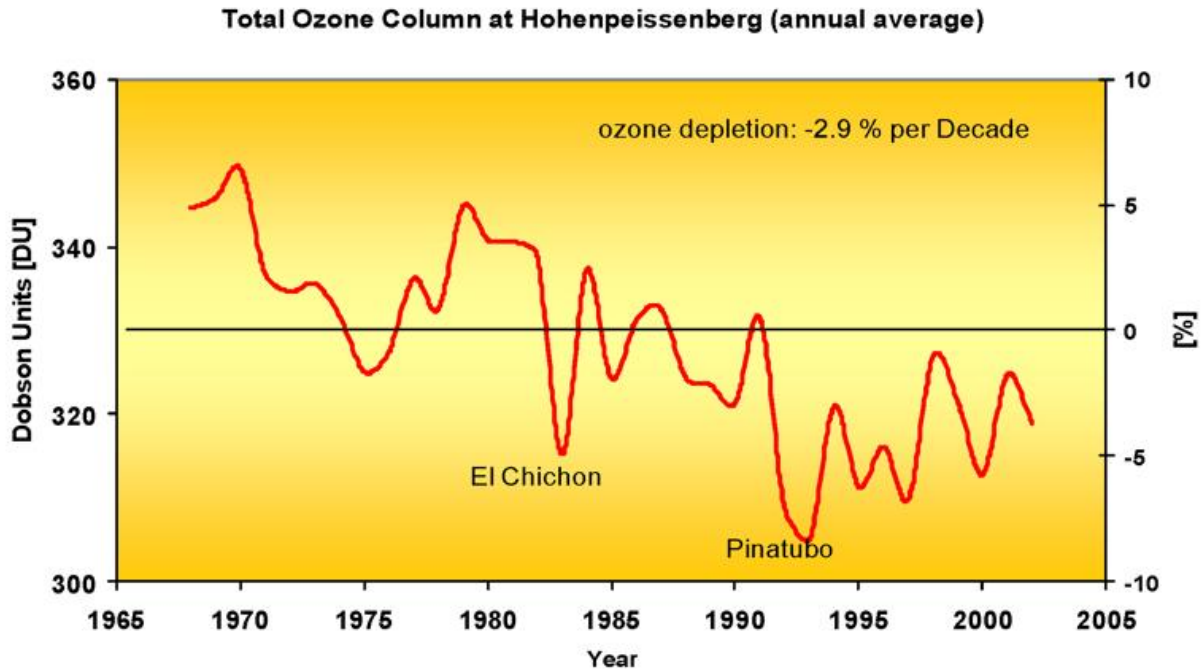
## **Ozone Layer over Central Europe in 2002**

by: Ulf Köhler, Hans Claude and Wolfgang Steinbrecht, Deutscher Wetterdienst

The total ozone column is affected by numerous processes in the atmosphere such as circulation patterns, radiative variations (e.g. 11-year solar cycle) or special events like major volcanic eruptions. Thus even annual averages are subject to large variations. In 2002 the ozone layer above Germany and also above Europe was a little bit thinner compared to the previous year. The total ozone column as a measure of ozone layer thickness was approx. 319 D.U., which is about 3% below the long term average. This deviation is not an extreme value compared with the post Pinatubo years 1992/93. **Fig. 1** clearly shows a quasi biennial oscillation in the annual means, which is superimposed onto the long term decline mainly attributed to the chemical ozone depletion by the CFCs (Chlorofluorocarbons). This oscillation is in opposite phase to the so-called QBO (**Q**uasi **B**iennial **O**scillation) of the stratospheric winds at 30 hPa in the equatorial region. Westerly winds like in 2002 cause lower ozone values at northern midlatitudes with an amplitude between westerly and easterly phase of the equatorial winds of 10 - 20 D.U..

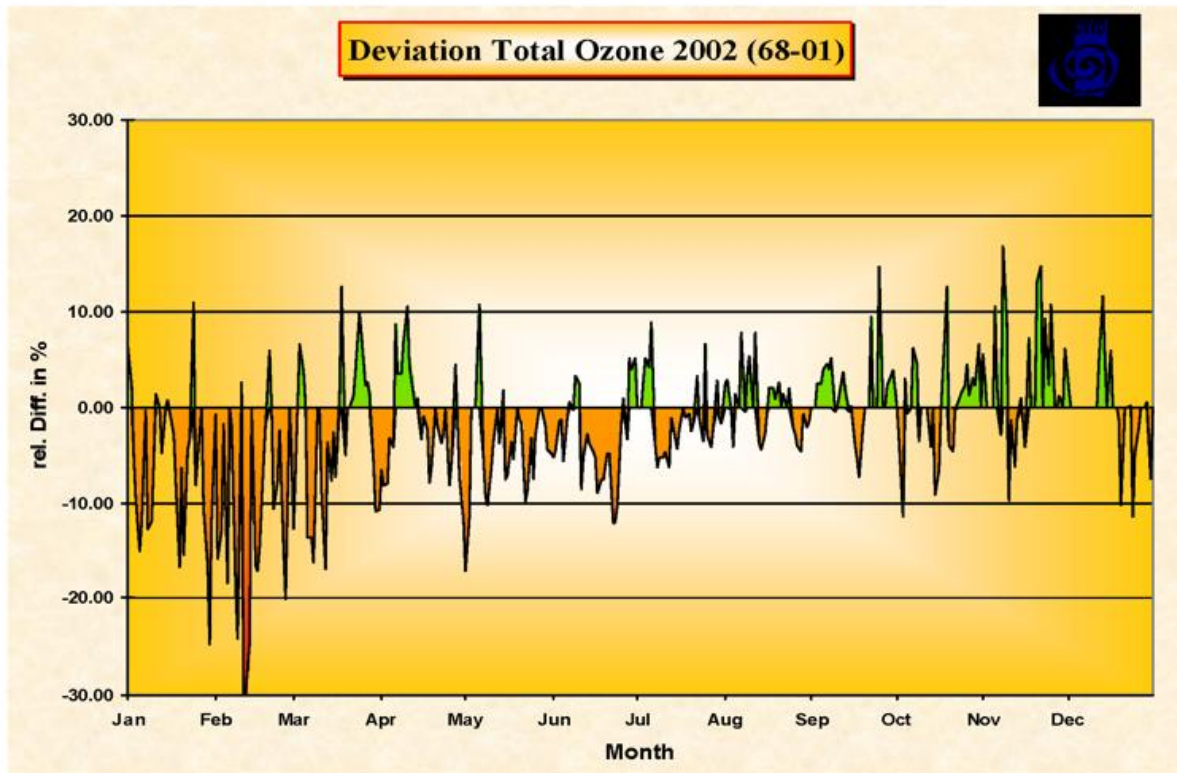
Statistical analysis further indicates a superimposed 11-year oscillation caused by the solar cycle with minimum solar activity around the mid of each of the three decades combined with relative ozone minima. The last years around 2000 are marked by higher ozone (~ 10 D.U.) values compared to the mid nineties due to the recent solar maximum.

Since the very low values after the volcanic eruption of Pinatubo in 1991 there is obviously no recovery of the ozone layer back to the pre-Pinatubo values. Starting from the present low level another severe volcanic eruption of a similar magnitude like Pinatubo (1991) or El Chichon (1982) would probably cause an ozone depletion with annual averages below 300 D.U.. Even without such natural impacts very low values have to be expected, when both solar cycle and QBO are in their negative phase.



**Fig. 1:** Time series of annual means of the total ozone column above Hohenpeissenberg 1967 - 2002. The relative trend of -2.9 % per decade is based on linear regression analysis.

A detailed look at the annual course of the deviation of daily total ozone in 2002 (**Fig. 2**) draws the attention to the first part of the year. Very low values are seen, especially in February, with maximum deficits down to -30% from the long term mean. This low ozone is closely connected with special weather situations (high pressure, warm troposphere / high tropopause and cold stratosphere). In general February shows not only the largest trend with -5.2% per decade, it is additionally the only month with significantly increasing variability of the daily values. Variance has increased by 8% since 1968, whereas all other months either did not show any increasing variance or even an obvious decrease (April, May, June). The main reason appears to be the more frequent occurrence of very deep ozone minima (so-called "mini-holes") with more and more low values. High ozone values do not exhibit such a significant decrease.



**Fig. 2:** *Relative deviation (in %) of the daily total ozone amount over the year 2002 compared to the baseline defined by the period 1968 - 2001 for Hohenpeissenberg (Southern Bavaria).*

Analyses of the atmospheric circulation, described by specific oscillation patterns (e.g. Arctic Oscillation AO, North-Atlantic-Oscillation NAO etc.) indicate that climate change is connected to a modified atmospheric circulation. This has substantially contributed to the more frequent low ozone values in late winter. AO and NAO, especially in February, show significant changes resulting in a prominent warming of the free troposphere over Central Europe by 3 K combined with a lift of the tropopause by 450 m and ozone decrease of about 10 D.U. since the end of the sixties.

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