WMO RA VI
RCC Network

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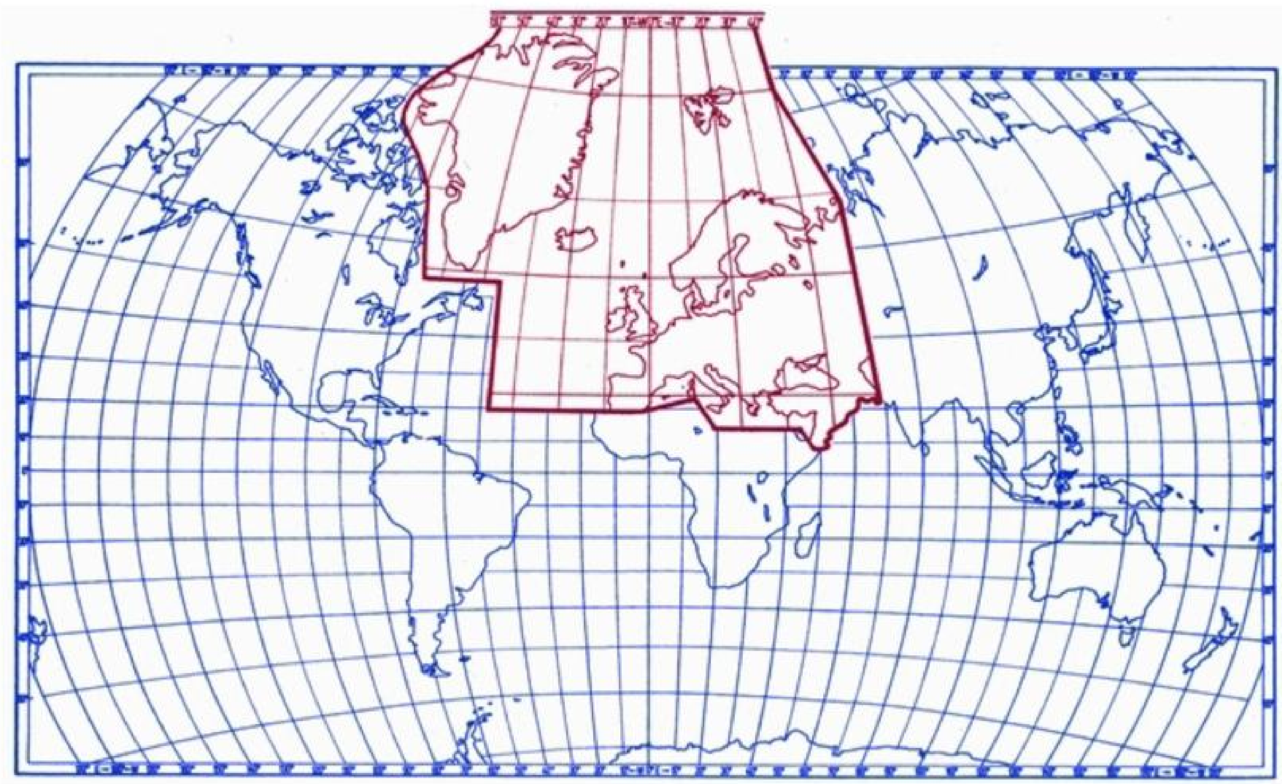
Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2017



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The Bulletin is a summary of contributions
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Belarus
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Luxembourg
The Former Yugoslav Republic of Macedonia
Moldova
Netherlands
Norway
Portugal
Romania
Russia
Serbia
Slovakia
Slovenia
Spain
Sweden
Switzerland
Turkey
Ukraine
United Kingdom

Content

1. Introduction

The Annual Bulletin on the Climate in WMO Region VI (Europe and Middle East with 50 Members) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official Websites. Supported by the European Climate Support Network (ECSN) and WMO´s World Climate Data and Monitoring Programme (WCDMP) the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's Annual Statement on the Status of the Global Climate and the State of the Climate published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ among the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the Webpages of the RA VI RCC Network (http://www.rccra6.org) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

This annual bulletin includes 4 parts: the annual, seasonal and monthly survey of the climate state in 2017 as well as contributions of the NMHSs to the long-term variability of selected parameters up to 2017 (section 5).

Notes:

Maps of the RA VI RCC Network are based on the following data sources:

- Temperature: CLIMAT data and ship observations provided by the Global Collecting Centre (GCC), operated by the Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC), operated by the Deutscher Wetterdienst
- Sunshine: CLIMAT data.
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC Node-CD) via the European Climate Assessment & Dataset project (ECA&D) run by Royal Netherlands Meteorological Institute (KNMI)

Sub-regional monthly maps are provided by the Eastern Mediterranean Climate Centre (EMCC).

The following sub-regions are used in this Bulletin:

Central and western Europe (14 countries): *Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, the Netherlands, Poland, Slovakia, Switzerland, and United Kingdom*

Nordic and Baltic Countries (9 countries): *Denmark, Estonia, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, and Sweden*

Iberia (2 countries): *Portugal, and Spain*

Mediterranean, Italian and Balkan Peninsula (12 countries): *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Slovenia, and Turkey*

Eastern Europe (5 countries): *Belarus, European Russia, Moldova, Romania, and Ukraine*

Middle East (9 countries): *Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, and western Kazakhstan*

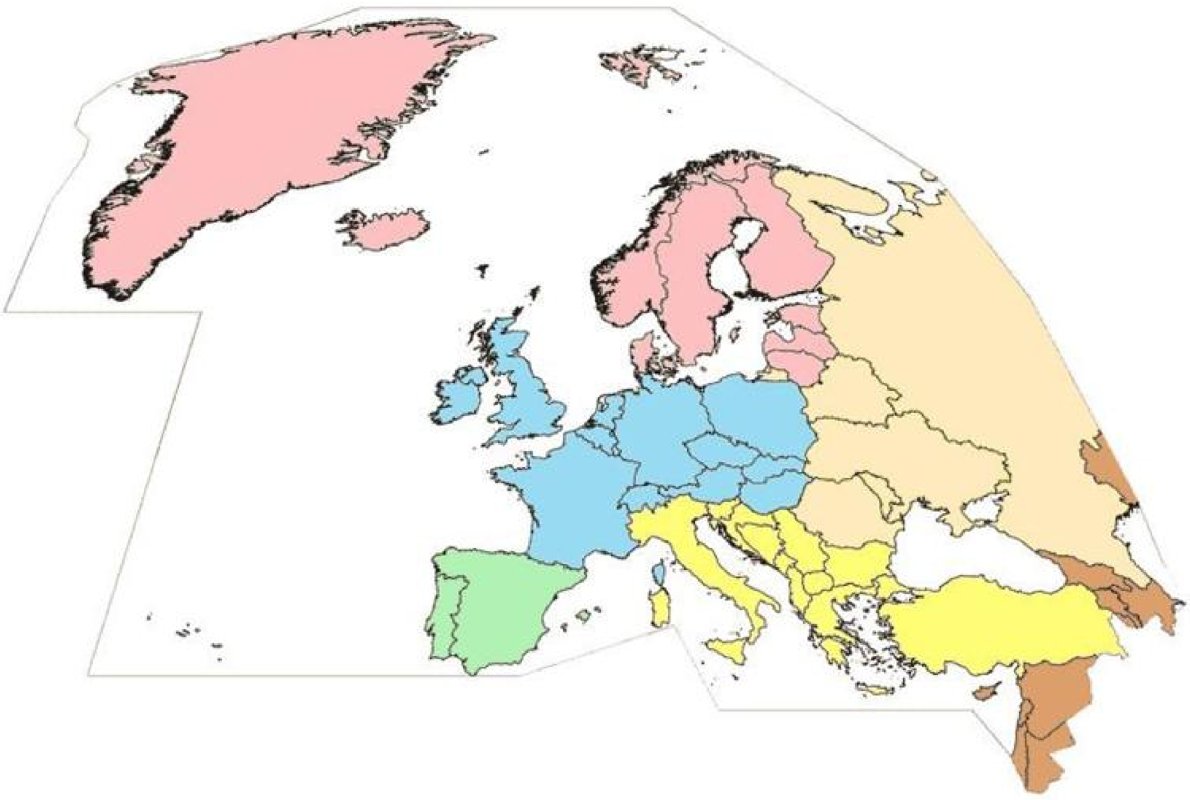


Figure 1.1: Definitions of the 6 sub-regions used in this bulletin.

Box 1

Notable anomalies and events 2017

Anomalies

Temperature

- Record breaking warm year in many European countries (see Table 2.1).
- Cold spell at the end of April 2017 in Central Europe and the Balkans with significant agricultural damage.
- April to December extremely warm and dry period in western and central Mediterranean.
- Several heat waves over central and southern Europe from June to September (The highest temperatures of 46.9°C was recorded at Cordoba airport, southern Spain, on 13th of July).

Precipitation

- Meteorological drought between April and December in Portugal.
- The wettest station in 2017 was Gullfjellet (Bergen, Norway) with 5057 mm.

Sunshine Duration

- Central Europe experienced a very sunny January with more than 200% of normal.

Other Anomalies

- Little snow in winter 2016/17 in the Alps.

Events:

- Several **forest fires** in Portugal in June and October.
- **Medicane** "Numa" in Central Mediterranean in November 2017.
- New Swedish air pressure record was recorded for September with 1044.1 hPa
- In **Slovakia** maximum wind gust of 61.6 m/s (222 km/h) occurred at Lomnický štít (2634 m a.s.l.)
- Ex-Hurricane **Ophelia** crossed Ireland and the United Kingdom with wind speeds of up to 49 m/s

2. Annual survey

The climate of 2017 was characterised by a broad range of spatial and temporal anomalies outlined in Box 1 and Figure 2.5. This section presents an overview of the spatial patterns of mean annual climate conditions in 2017 and anomalies related mainly to the normal period 1961-1990 of the selected climate variables: sea level pressure, surface air temperature, precipitation, sunshine duration and snow. Sub-section 2.1.4 reveals climate extremes for individual countries. Long-term trends in temperature and precipitation indices offers section 2.2.

More detailed insight into the long-term variability of temperature, precipitation and also some other parameters from the individual countries are presented in section 5.

2.1. Annual averages and anomalies of selected essential climate variables

2.1.1. Sea level pressure

Generally, mean annual sea level pressure distribution in 2017 over the WMO Region VI is dominated by a low pressure trough in the polar area with the Icelandic low that extended from southern Greenland to Iceland. The second pressure system, the subtropical high pressure belt, extended from the centre over the Azores (Azores high) across southern and central Europe to European Russia.

In 2017 the mean sea surface pressure differs to some extent from the long-term mean with a reduced pressure especially in a region over Greenland and northern Russia with anomalies of -2 to -4 hPa. Southeastern Europe also shows below normal anomalies. Higher pressure anomalies of more than +2 hPa occurred over southern France and the Bay of Biscay as can be seen from Figure 2.1 (right; normal period 1961-1990) indicating a slightly stronger than normal NAO.

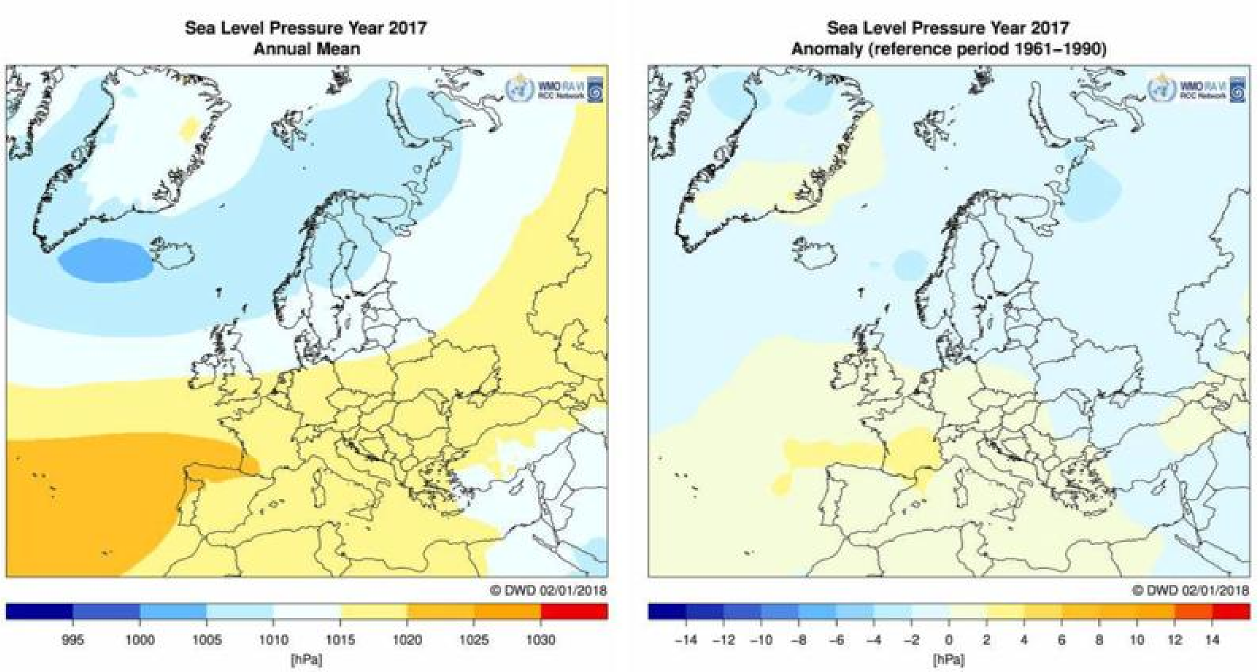


Figure 2.1: Annual mean of sea level pressure (left) and anomalies (right) in hPa for the year 2017 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.2. Temperature

In the entire European region (35°–75°N, 25°W–40°E) the year 2017 was warmer than normal with an anomaly of +0.86°C (base period 1981-2010) according to the E-OBS dataset. Many of the European countries reported new records (Table 2.1).

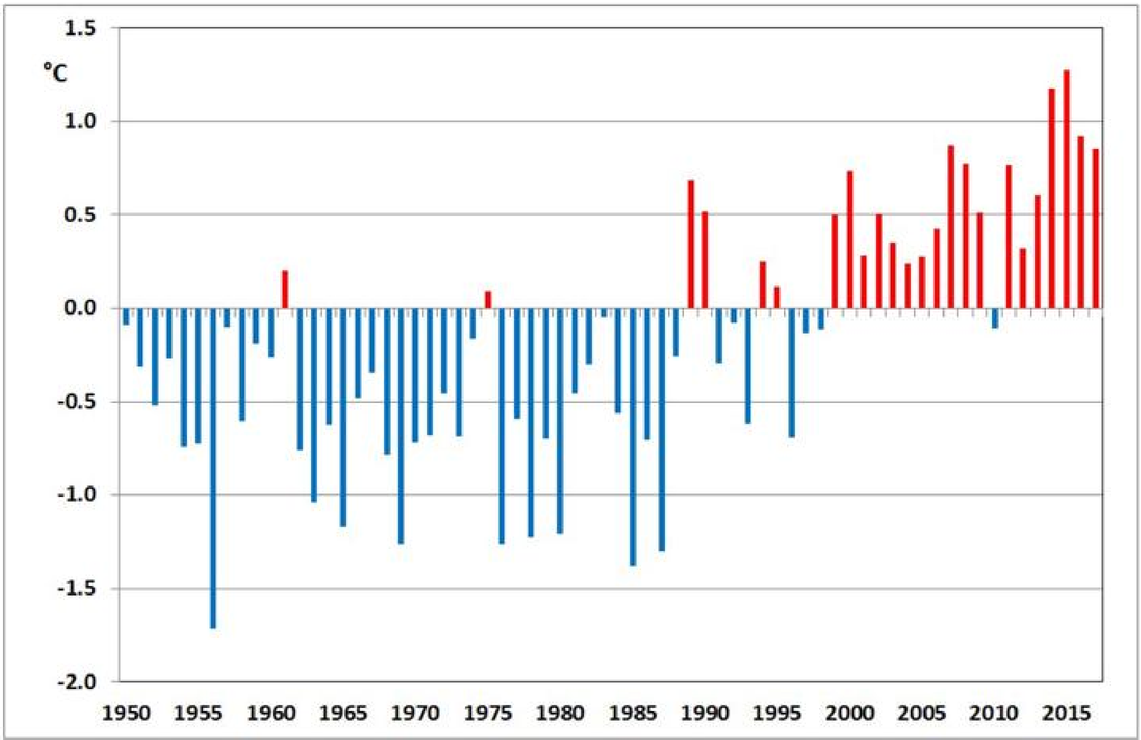


Figure 2.2: Annual temperature anomalies 1950-2017 for Europe (land area; 34°N-71°N and 25°W-40°E, reference period 1981–2010; based on the E-OBS dataset, van der Schrier et al. 2013). (Source: Royal National Meteorological Institute Netherlands, KNMI).

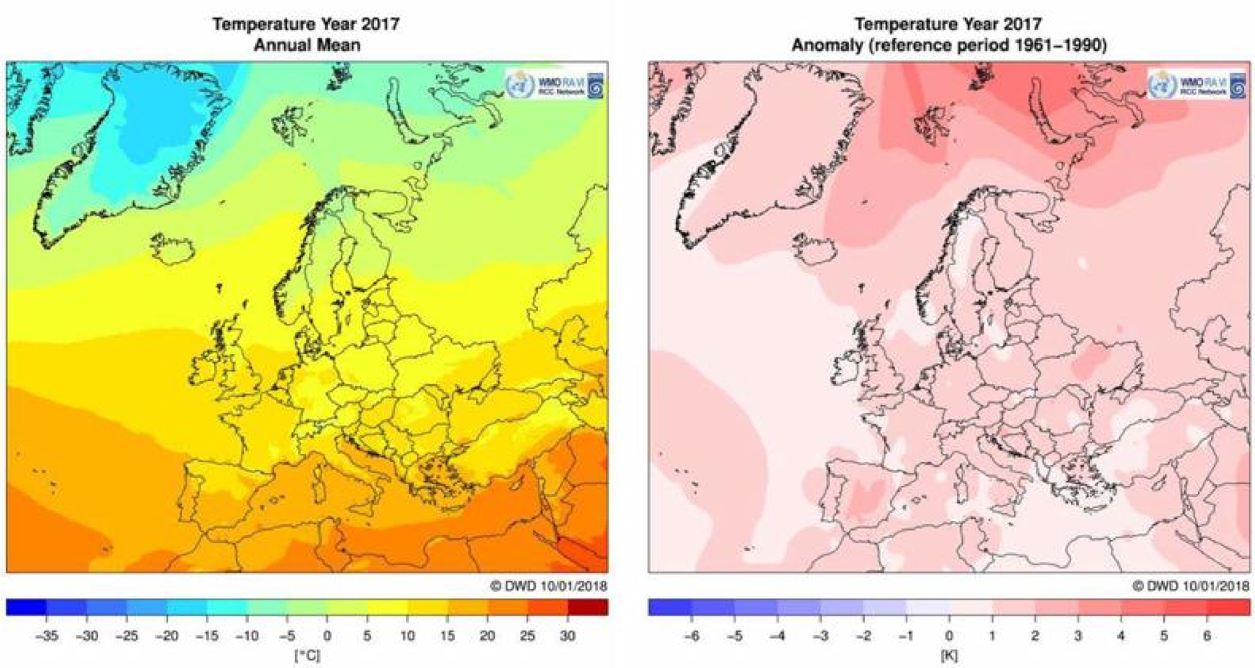


Figure 2.3: Mean annual temperature in °C (left) and anomalies (right) for 2017 (reference period 1961-1990, source: http://www.dwd.de/rcc-cm).

The highest annual anomaly of 1.52°C referred to 1961-1990 was observed in the sub-region Nordic and Baltic countries followed by Iberia (1.49°C), eastern Europe (1.47°C), the

Mediterranean, Italian and Balkan Peninsula (1.44°C) and Middle East (1.42°C). The sub-region Central and Western Europe showed the lowest anomalies of 1.35°C (Table 3.2). Most of the months in 2017 were warmer than normal (1961-1990) with remarkably consistent deviations of more than +4°C especially in northern Europe (cf. section 3.1.2 and 4.2).

The global annual land and ocean surface temperature for 2017 ranked as the second or third highest, depending on the dataset, 0.38° – 0.48°C above the 1981–2010 average (Blunden, Arndt und Hartfield 2018) or 1.1 °C ± 0.1 °C above pre-industrial levels (WMO 2018).

The **Norwegian Arctic** in 2017 was again warmer than usual with an annual mean temperature of -2.2 °C (4.4 °C above normal) in Svalbard airport and -2.2 °C (4.2°C above normal) at Hopen.

This year 9 heat waves were reported from **Portugal**, starting in April and ending in November.

Table 2.1: Rank statistics and anomalies of annual temperature in 2017 from some participant countries as reported by the National Meteorological and Hydrological Services (NMHSs).

Country	Rank of annual temperature in 2017	Anomaly 1961-1990 in °C	Anomaly 1981-2010 in °C	start of time series
Europe (35°–75°N, 25°W–40°E, E-OBS)	15	+0.86	+0.35	1951
Austria	9	+1.6	+0.9	1767
Belarus	9	+1.7		1881
Belgium			+0.8	(Ukkel)
Bosnia and Herzegovina		+0.6 to 2.1		
Bulgaria		+1.2		1980
Croatia	6	+2.1		1862 (Zagreb)
Czech Republic	9 - 10		+0.7	1961
Denmark	17	+1.2	+0.6	1874
Estonia	16-17		+0.5	1961
Finland	23	+1.3		1900
France	5		+0.8	1900
Georgia		+1 to +3°C		
Germany	6-8	+1.4	+0.7	1881
Hungary	11		+0.8	1901
Iceland		+1.4		1871 (Reykjavík)
Ireland			+0.4	1900
Israel	4	+1.3		1951
Latvia	20	+1.2	+0.5	1924
Lithuania	12	+1.3	+0.6	
Luxembourg		+1.9	+0.9	
Moldova	4 (7)		+1.1	1887 (Chisinau)
Netherlands	4		+0.9	1901(de Bilt)
Norway	20	+1.1		1900
Portugal	2	+1.1 (1971-2000)		1931
Romania			+0.7	1901
Russia, European		+1.45		1939
Serbia	12		+0.9	1951
Slovakia	12	+1.3	+0.8	1872
Slovenia			+1.0	1961
Spain	1		+1.1	1965
Sweden	21			1860
Switzerland	6		+0.8	1864
Turkey	9		+0.7	1960
Ukraine	3	+1.8		1881
United Kingdom	5		+0.7	1910

2.1.3. Precipitation

The wettest stations in Norway in 2017 were Gullfjellet (Bergen, Hordaland) with 5057 mm, Kritle (Etne, Hordaland) 4309 mm and Hundseid in Vikedal (Vindafjord, Rogaland) 4238 mm (154 % of the normal).

The 2017/2018 rainfall season in **Israel** had a very dry start with limited rainfall amounts in October, November and December. In most parts of Israel it was the driest start of the rainfall season since 1999. Detailed descriptions can be found in the seasonal (3.1.3) and monthly survey (4.3).

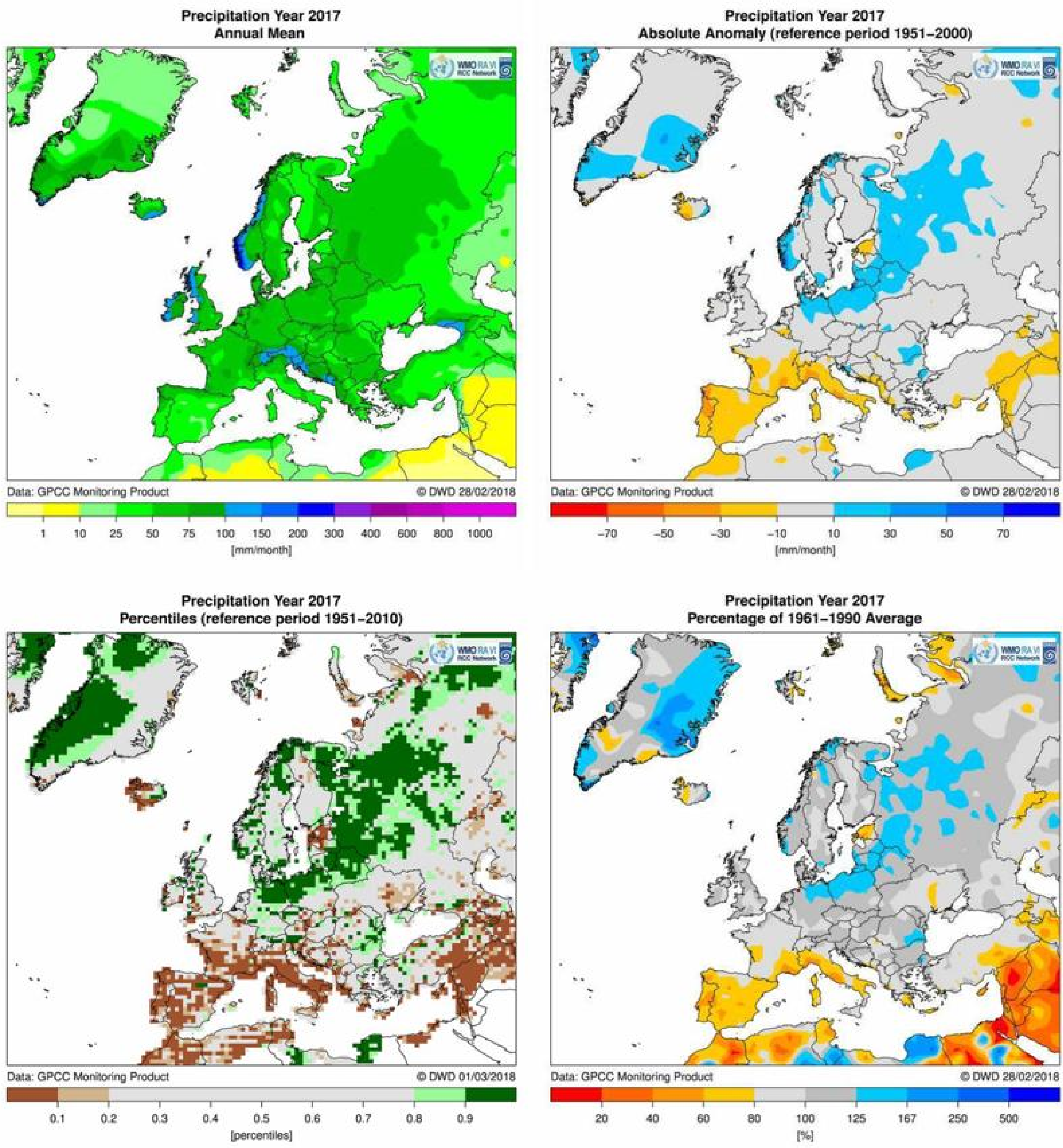


Figure 2.4: Total precipitation (left, top), anomalies (right, top) in mm/month, percentiles (left, bottom) and percentage of precipitation in % (right, bottom, reference period 1951-2010) for 2017 (reference period 1961-1990; source: http://www.dwd.de/rcc-cm).

2.1.4. Annual extreme values of temperature and precipitation

In this section an overview is given for the temperature spread and the extreme precipitation for each country. Absolute annual extreme values for 2017 of temperature (minimum and maximum), maximum of total daily precipitation and maximum of total 5 consecutive days with precipitation for each country in the WMO Region VI are given in Figure 2.5.

The spatial pattern of extreme temperature corresponds roughly to those of the temperature anomalies of 2017. The highest maximum temperatures (above 40°C) occurred primarily in sub-regions Middle East, Mediterranean, Italian, France and Iberian Peninsula, but also from the Balkans. Maximum temperatures higher than 35°C were reported from most of the countries in central and eastern Europe.

The one-day precipitation totals (RX1) of more than 150 mm for individual countries are documented in several sub-regions; the highest value occurred in Italy (359 mm/day). Highest total precipitation on 5 consecutive days (RX5) (above 300 mm) was measured in Slovenia (592 mm), Italy (469.8 mm), Croatia (369.6 mm), Turkey (333 mm) followed by Norway (300 mm).

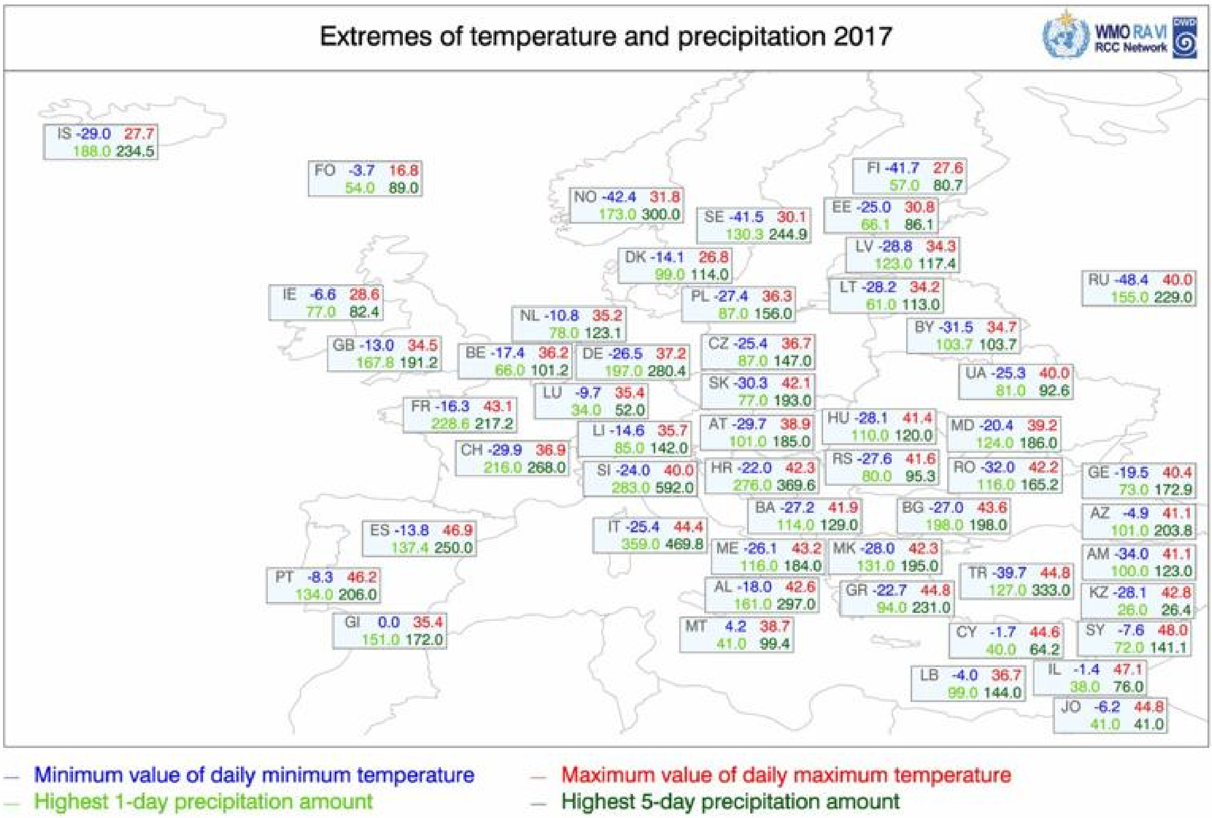


Figure 2.5: Annual extreme values for each country in 2017: first row: Internet country code, lowest daily minimum temperature (in °C, blue) and highest daily maximum temperature (in °C, red); second row: maximum daily precipitation totals (in mm, light green) and maximum 5-daily consecutive precipitation totals (in mm, dark green).

Note: Data (by order or priority) from reports of NMHSs, GPCC, ECA&D or SYNOP; the countries are represented by their Internet country codes. (Source: http://www.dwd.de/rcc-cm)

2.1.5. Sunshine duration

As expected, the annual sum of sunshine duration in 2017 showed from the south to the north generally gradual decreasing values. More than normal sunshine hours have been primarily noted in southern Europe, the western Alpine region, most parts of the Balkans and southern Russia. Finland and northeastern Europe had a sunshine deficit.

North of the Swiss Alps and in southern Ticino the annual total of sunshine duration amounted to 110 % to 120 % of normal values 1981–2010. The other parts of **Switzerland** recorded 100 % to 110 % of normal values. Lugano and Locarno-Monti in Ticino registered the sunniest year, some other regions of Switzerland the third- or fourth-sunniest year in the homogenous measurement series extending over more the 50 years.

The sunshine duration from January to December 2017 in **Austria** was 17 % above the climatological mean.

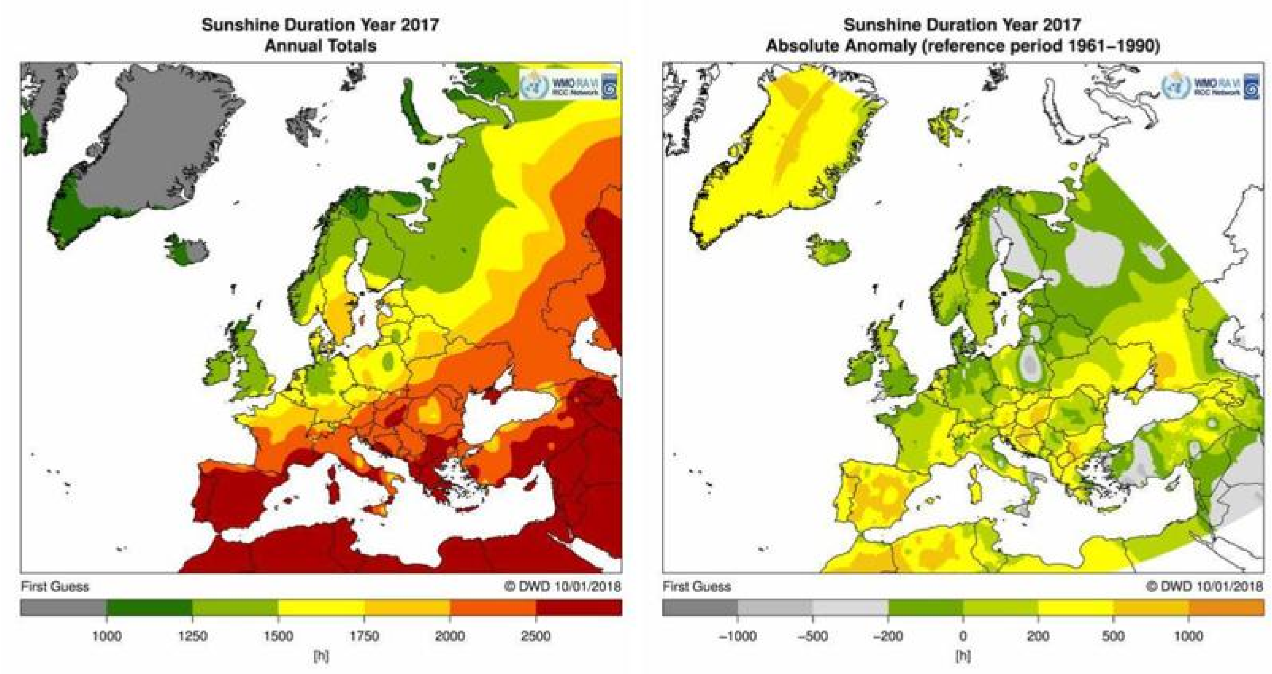


Figure 2.6: Annual sum of sunshine duration (left) and absolute anomalies (right) for the year 2017 in hours with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.6. Drought situation

At the eastern part of the Mediterranean, in **Cyprus**, there was also a drought from February to December 2017. The area average precipitation for February was 14% of normal (1961-90) and therefore the lowest for February since 1901, and Area Average Precipitation for December=33% was among the 10 worst for December also since 1901.

The year 2017 has been very dry in **Spain** as a whole. The annual mean precipitation was about 475 mm, which is around 27% lower than the mean normal value, according to the reference period 1981-2010. This big negative anomaly was mainly due to the rainfall deficit generated along the autumn and the spring quarter. According to the available information, the year 2017 has been the second driest year since the serial beginning in 1965, only below 2005 year with an annual mean precipitation of 468 mm.

Meteorological drought between April and December in Portugal

(Contribution from IPMA, Instituto Português do Mar e da Atmosfera)

The period from April to September 2017 (dry half-year) was extremely warm and extremely dry in mainland Portugal.
In this period, the conjugation of well below normal precipitation values and above normal air temperature values, especially the maximum temperature, resulted in the occurrence of high evapotranspiration values and significant soil moisture deficits. This previous conditions led to the beginning of a drought situation in mainland Portugal.
In the beginning of the new hydrological year (October 2017), the precipitation deficit increased, due to the occurrence of precipitation values well below normal in October and November. The period, from April to November, was the driest since 1931 (precipitation about 30% of normal).
Table 1 shows the percentage of the territory in the different classes of PDSI index between April and December 2017.
This meteorological drought began in April and persisted until the end of the year. This drought situation differs from previous cases since severe classes of the index started later (late June). Due to lack of rain and above normal evapotranspiration the territory percentage affected by severe and extreme drought increased in the beginning of the autumn (by the end of October 100 % of territory was in severe and extreme drought). In previous drought situations autumn precipitation near or above normal led to an effective reduction of drought severity (Figure 2.7).

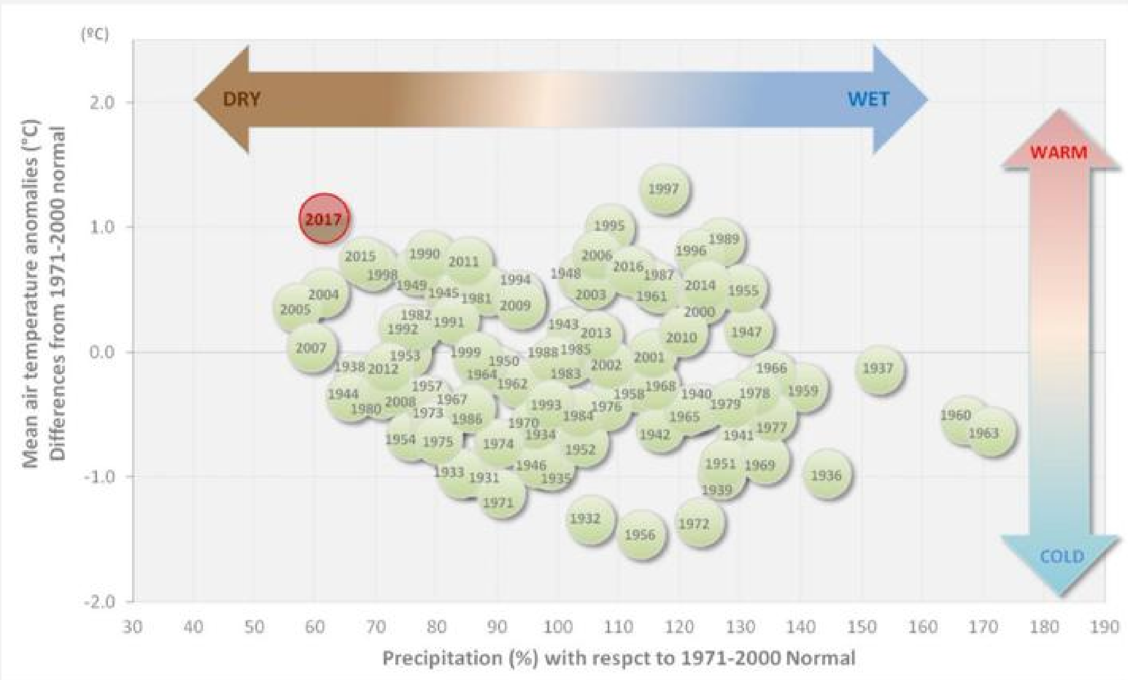


Figure 2.7: Annual mean air temperature and precipitation anomalies (1931 – 2017) (Difference (°C) and percentage (%) from 1971-2000 normal).

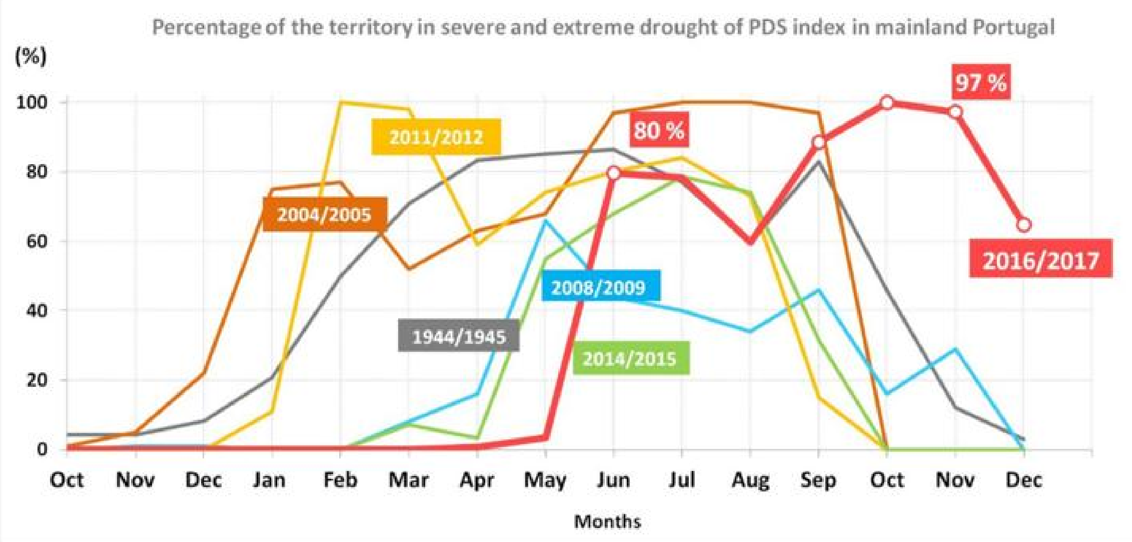


Figure 2.8: Monthly evolution of the percentage of the territory of Portugal in severe and extreme drought, according to the PDSI index, for historical drought situations (1944/45; after 2000: 2004/05, 2008/09, 2011/12, 2014/15 and 2016/17).

In many parts north of the **Swiss** Alps annual precipitation reached 70 to 90 % of the normal values 1981–2010. Alpine areas received mostly 90 to 115%, southern valleys of the Valais, however, only 60% to 80% of normal values. South of the Alps annual precipitation amounted to 80 to 95% of the normal values.

Monthly precipitation amounts between January and June 2017 in **Luxembourg** were all lower than the climate normal (about 34% on average). Most of all, April (5.3 mm) ranked on number two of the driest months at Luxembourg/Findel-Airport since station history in 1947, only exceeded by April 1996 with only 4.9 mm.

Drought also occurred during winter, spring and summer in the most southwestern part of **Slovakia** (1500 km^2) with agricultural losses in crop yields (spring crops, sunflower, maize).

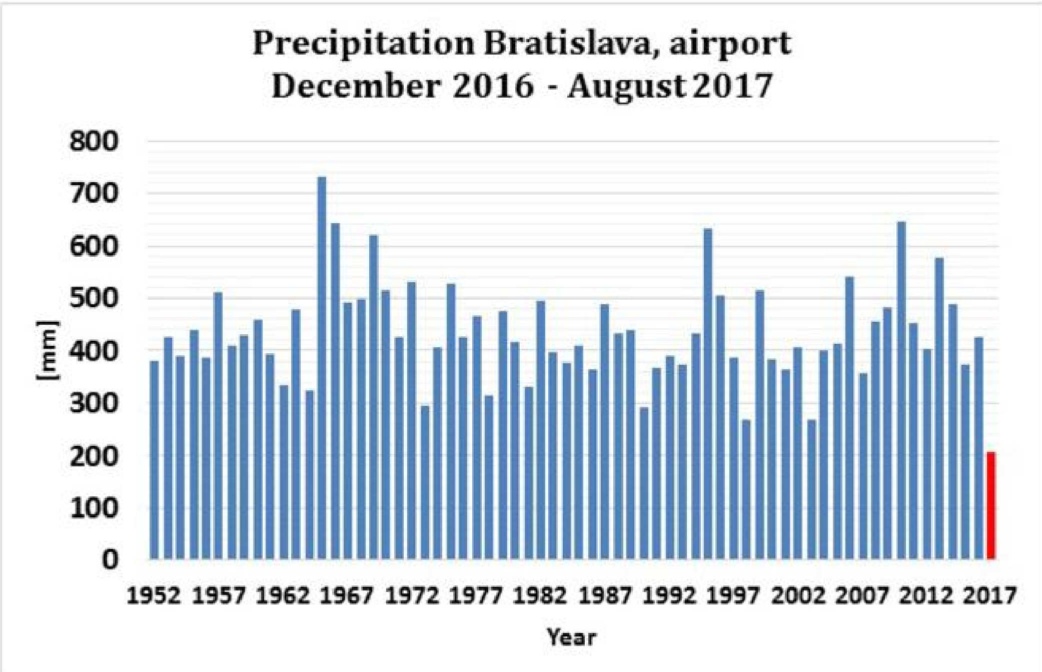


Figure 2.9: Precipitation at Bratislava, airport (Slovakia) for December 2016 - August 2017. (Diagram as provided by the Slovak Hydrometeorological Institute)

In **Italy**, from January to October 2017 below normal precipitation intensified the drought situation with low water levels in rivers and reservoirs and harvest losses.

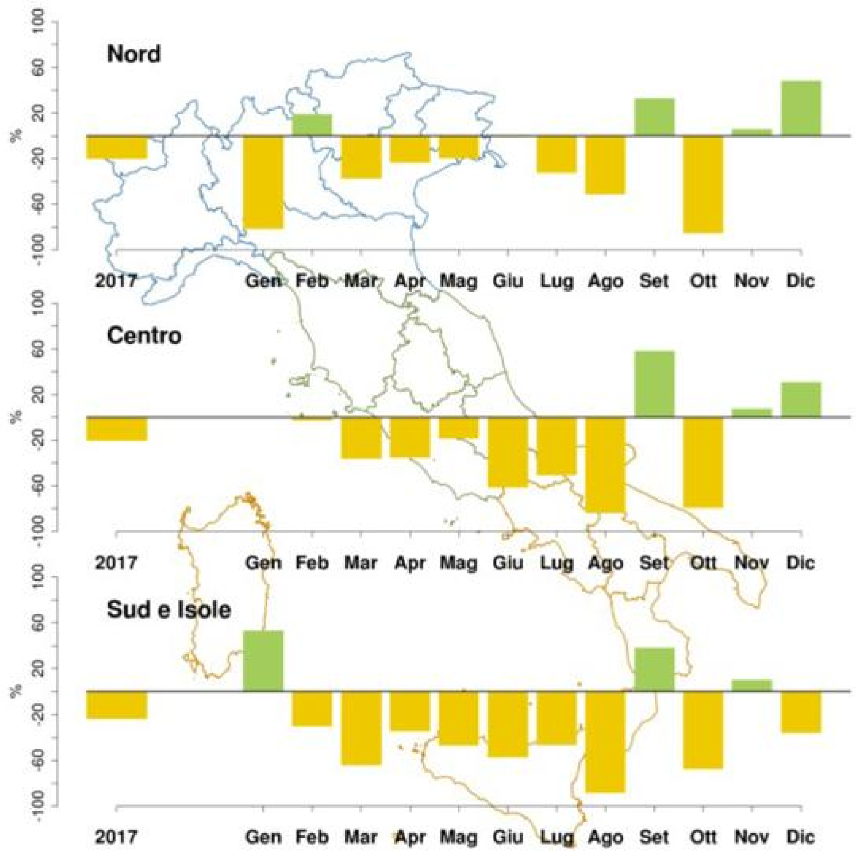


Figure 2.10: Annual and monthly precipitation anomalies for 2017 expressed in percentage of the normal value (1961-1990) for northern, central and southern Italy (including the Islands; diagram as provided by **ISPRA** – Istituto Superiore per la Protezione e la Ricerca Ambientale).

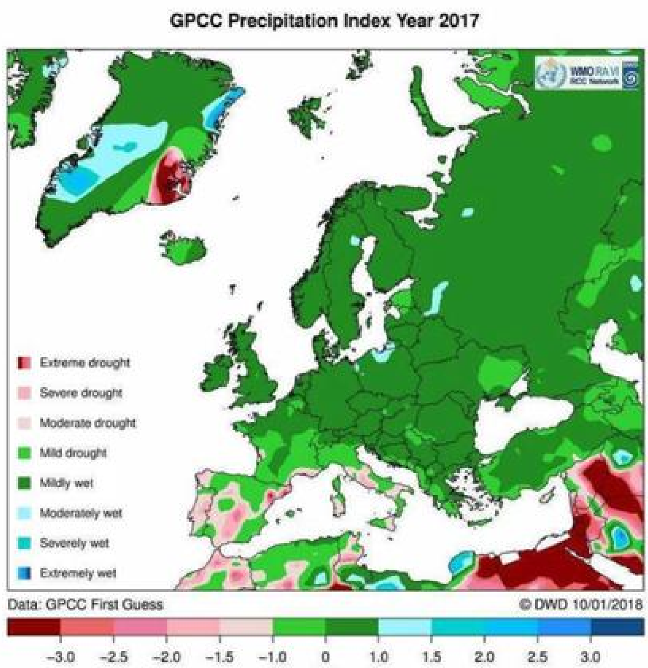


Figure 2.11: Annual modified Standardized Precipitation Index (DWD-SPI) for the year 2017 with respect to the reference period 1961-1990. (Source: http://www.dwd.de/rcc-cm).

2.1.7. Snow cover

The snow-season 2016/2017 (September 2016 – August 2017) was warmer than normal and consequently in many low land areas in western and southern Europe no snow occurred at all. Apart from mountain areas, in central Europe partly occasional snow fall events occurred in November. As expected, towards northern and eastern Europe snow cover duration was longer and ended in April and May. In Switzerland, the thin winter snow cover in 2016/17 was at close to record-breaking levels. In western Switzerland and in the Valais only 30 to 50 % of the normal precipitation (mainly snow) values were recorded.

Last snow in low land areas over central Europe and the Balkans occurred during last decade of April 2017 due to a cold wave in these regions. In April a cold surge led to unusual accumulation of fresh snow in Austria. Especially in the area of the Ybbstaler Alps to the Wienerwald the amount of fresh snow within 24 hours reached from 20 to 125 cm. At the weather station Annaberg (Lower Austria, 911 m) the amount of fresh snow on the 20th of April was 125 cm.

The snow layer in Rumania was present throughout January everywhere in the country, maximum snow depths measured on the platforms of the weather stations, especially on 10 - 11 January reaching up to 175 cm in the mountain area (Făgăraş Mountains), up to 62 cm in Wallachia, up to 41 cm in Transylvania, up to 40 cm in Dobrudja, up to 35 cm in Moldavia, up to 26 cm in Oltenia, up to 22 cm in Maramureş, up to 20 cm in Banat and up to 16 cm in Crişana.

On 20-21 April, when the weather cooled markedly in Rumania and the deviations of the mean daily air temperatures were of the order of -10 ... -15ºC, rainfalls turned into sleet and snow in most part of Moldavia and locally in Transylvania.

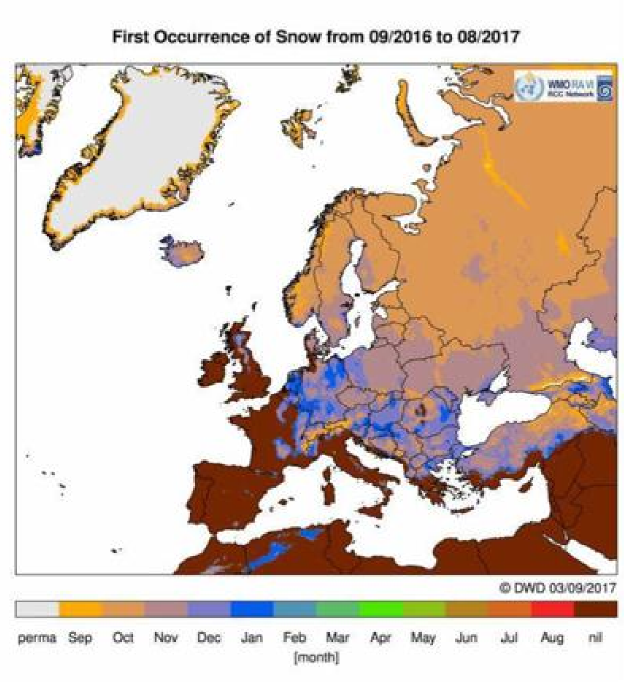


Figure 2.12: First occurrence of snow (left) and last occurrence of snow (right) during the snow-season 2016/2017. (Source: http://www.dwd.de/rcc-cm).

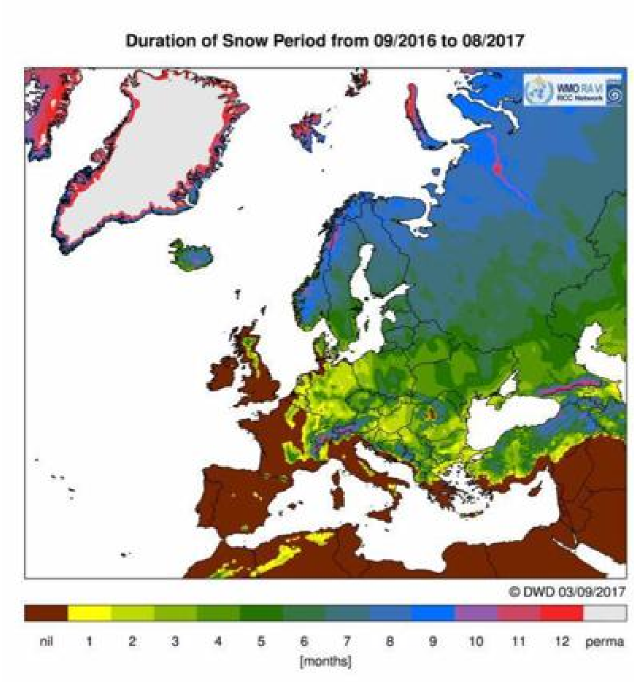


Figure 2.13: Duration of snow cover in the snow-season 2016/2017.
(Source: http://www.dwd.de/rcc-cm).

2.2. Selected climate indices for 2017

This section presents selected temperature and precipitation indices calculated based on the station-based ECA&D (European Climate Assessment & Dataset; http://www.ecad.eu) dataset. Annual climate index maps are shown as well as anomaly and trend maps. The following climate indices are considered:

1. **RR1, Number of wet days**: count of days where RR (precipitation > 1 mm) Precipitation below 1 mm/day has no effect on vegetation because it normally evaporates on the same day and is locally effected.

2. **SU, Number of summer days**: count of days where TX (daily maximum temperature) ≥ 25°C

3. **WW, Number of warm and wet days:** days with TG (daily mean temperature) > 75th percentile and
RR > 75th percentile

4. **TR, Number of tropical nights**: count of days where TN ≥ 20°C

The map with the number of wet days (RR1, uppermost left panel) clearly depicts the dry conditions prevailing in 2017 with less than 60 wet days in most parts of Spain and Portugal, but also along the Côte d'Azur and over Italy. The anomalies of the number of rainy days with respect to the 1961 to 1990 mean show that the area with less than normal wet days extends even further north additionally covering France and large parts in southeastern Europe. The northwestern, Central and northeastern part of Europe (for example Great Britain, Netherlands, Germany, Scandinavia) on the contrary experienced more than normal wet days which also resulted in above-normal precipitation amounts (see section 2.1.3).

Looking at the number warm and wet days (WW) it appears that above-normal numbers of WW were registered in most parts of Europe in 2017, also in the (drier) southern part. Only very locally, the number of wet and warm days was fewer than normal.

The anomaly map for the number of summer days (SU) illustrates the longer-than-normal summer conditions in 2017 over large parts of Europe. There is a North-South dipole structure visible dividing the area in a northern part which experienced less than normal summer days (Scandinavia) and a southern part where more than normal summer days were counted (central and southern parts of Europe). A feature that is also visible in the seasonal temperature anomalies for summer shown later (see Figure 3.3).

The anomalies of tropical nights do not show a clear pattern for 2017: there are positive and negative anomalies without a clear discrimination of regions. This suggests that there are only small deviations from the long-term mean and thus near normal numbers of tropical nights. Only a small band along the Mediterranean coast actually experienced a larger positive anomaly of more than 30 tropical nights more than usual.

Figure 2.15 shows the trend maps for the selected climate indices based on the years 1951 to 2017. In northern, northwestern, central and eastern Europe most stations showed an increase in the annual number of wet days (RR1) for the last 67 years (mostly greater than 3 days per year per decade) while in southern Europe a decreasing trend prevails. The decreasing and increasing trends at neighbouring stations, however, indicate inhomogeneities in the time series. The number of warm and wet days (WW) has increased over almost whole Europe by more than 1.5 days per year per decade. Only the Greek stations show negative WW trends of up to -1.5 days per year per decade. The annual numbers of summer days (SU) have increased in central and southern Europe and partly in eastern Europe, while stations in northwestern and northern Europe do not indicate any significant trend. Annual numbers of tropical nights (TR) show an increasing trend in the southeastern part of Region VI but values are generally small with 0 to 2 days per year per decade. In the northwestern part no significant trends are found.

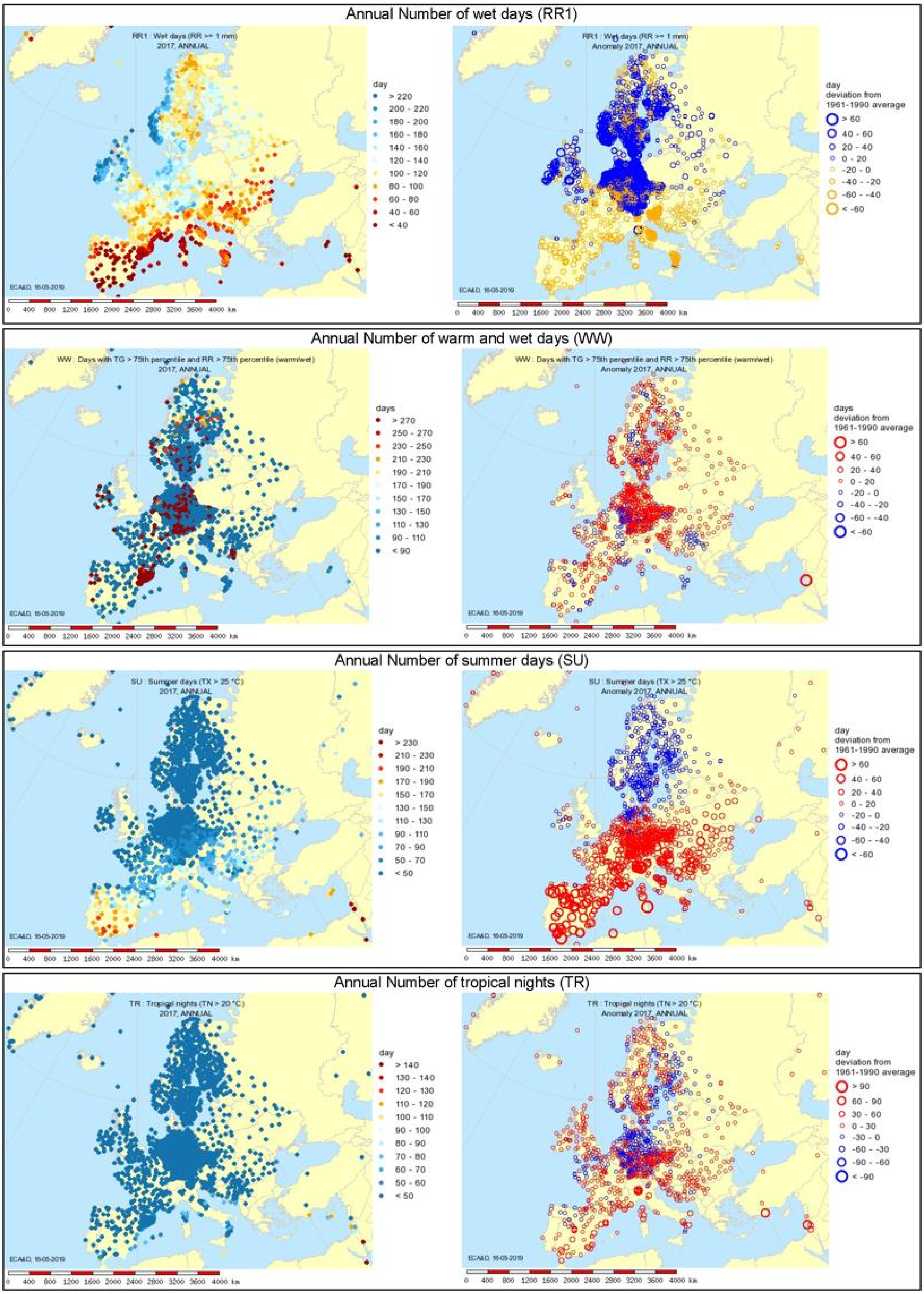


Figure 2.14: Selected Climate Indices for 2017 (left) and their anomalies (right) with respect to the 1961 to 1990 reference period (Source: ECA&D, http://www.ecad.eu).

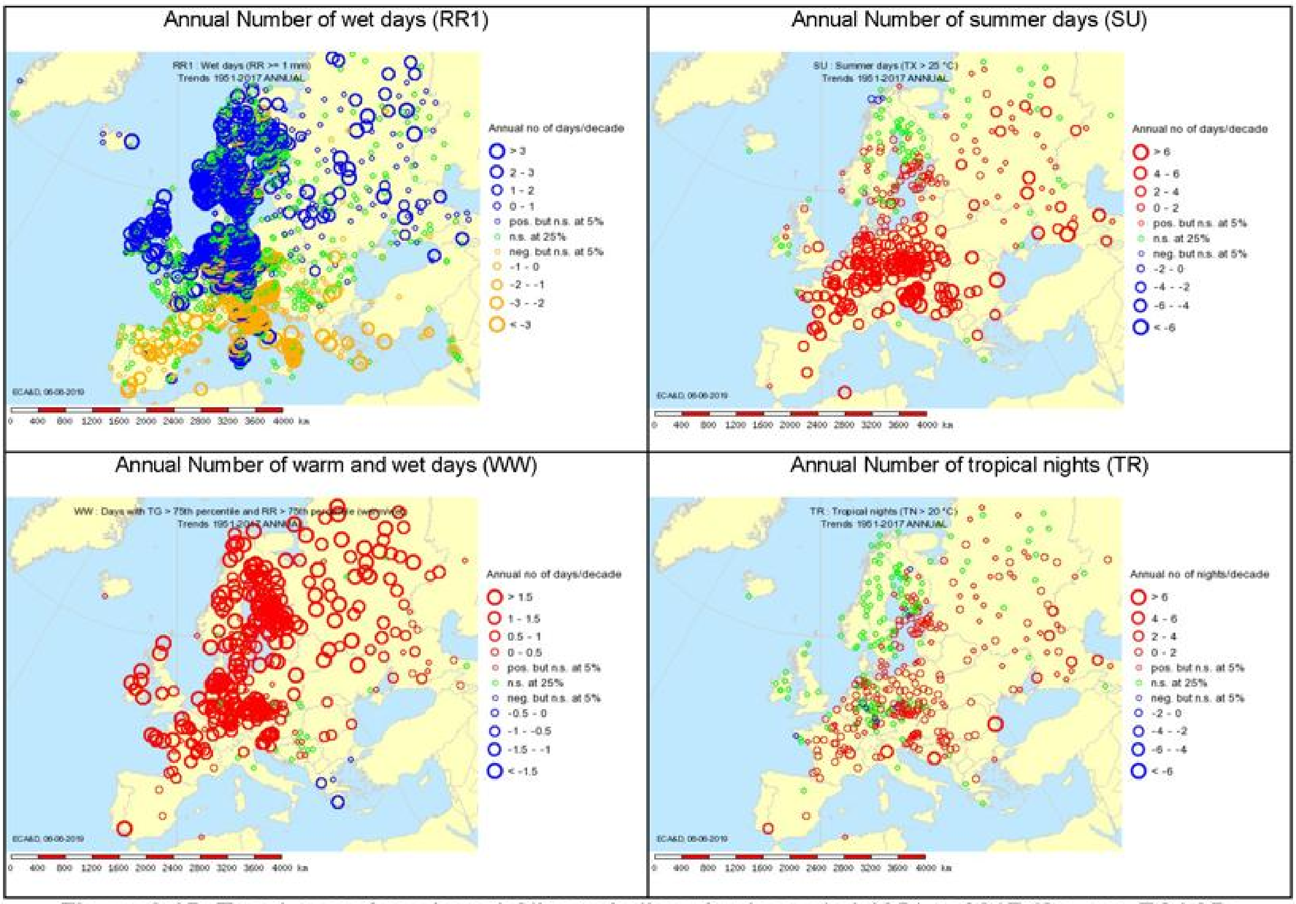


Figure 2.15: Trend maps for selected Climate Indices for the period 1951 to 2017 (Source: ECA&D, http://www.ecad.eu).

2.3. Socio-economic impacts of extreme climate or weather events

From January to October 2017 a severe **drought** occurred in southern Europe (Spain, Italy, and Serbia). MunichRe (2018) estimated the financial loss to 3400 Million €. Dry conditions and heat wave affected most of the agricultural production.

From 15.4. to 9.5.2017 Europe experienced a **cold wave** with frost in central Europe with damages of 3600 Million € (MunichRe 2018). A series of cold spells with low temperatures anomalies (-7°C) and heavy snowfall caused damages at some houses. Severe damages occurred at vineyards, fruit crops, (apples, stone fruits, berries) and vegetables because previous weeks were warm and all the plants were growing and blooming.

Abnormally severe forest fire season in Portugal

(Contribution from IPMA, Instituto Português do Mar e da Atmosfera)

2017 forest fire season was extremely severe and long, with terrific consequences, namely life losses and significant environmental and economic impacts. The accumulated Daily Severity Rating (DSR), obtained from Fire Weather Index (FWI), for 1st of July to 31st of October, was the highest on record (Figure 2.16). Burnt areas exceeded 440 000 ha (ICNF - Portuguese Forest Institute), a new record, even compared to previous extreme 2003 and 2005 fire seasons.

Central regions of mainland Portugal were the most affected by very large fires (> 1000 ha) in several periods namely, 16-21 June (64 casualties and several people were homeless and a financial loss of 180 Million €, after MunichRe, 2018), 16-18 July, 23-26 July, 9-19 August, 23-27 August, 5-9 September and 12-15 October (45 casualties and about 70 wounded and a financial loss of 400 Million €, after MunichRe, 2018). During these periods, the associated meteorological conditions were extremely favourable to fire propagation and very adverse to fire combat, fire weather index (FWI) values were higher than the 90th percentile, in the majority of the regions.

In the particular case of 15th of October, when a burnt area exceeded 200 000 ha, FWI values greater than 99th percentile were recorded due to:

- extremely low soil moisture content;
- a two week period with consecutive hot and dry days following the driest September on record;
- during the day very low humidity values (< 20 %) and wind intensification, with gusts exceeding 50 km/h, in several meteorological stations. The wind intensification was due to the proximity of the hurricane **Ophelia** to the Iberian Peninsula, centred approximately 485 km from Viana do Castelo.

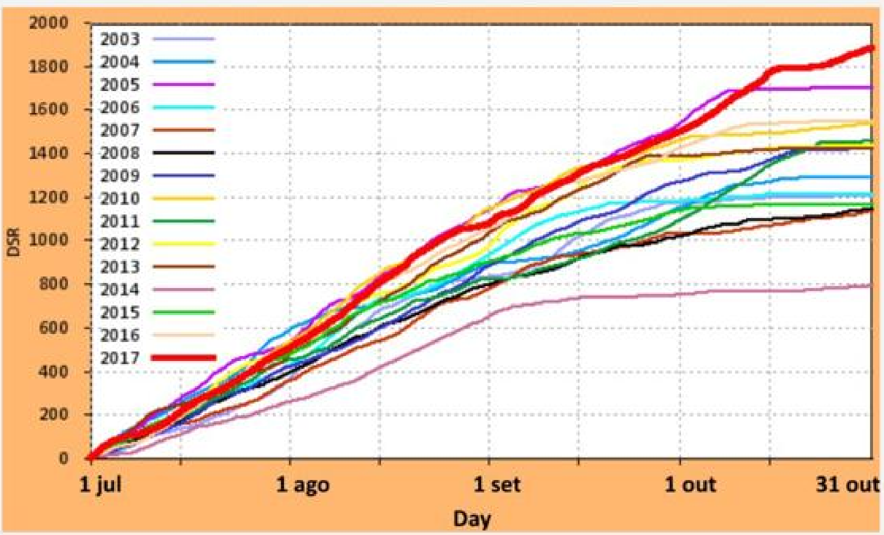


Figure 2.16: Daily severity rate (DSR) average value for mainland Portugal, 1st of July to 31st October from 2003 to 2017 (diagram as provided by IPMA)

Germany was hit by a tornado, severe thunderstorms with hail of up to 8 cm in diameter, heavy rain and wind gusts up to 39 m/s (140 km/h), during 22–23 June. Numerous houses, vehicles, fruits, vegetables, 500 km^2 of crops and vineyards were damaged and two persons were killed. The damage was estimated to 700 Million € (MunichRe 2018).

Extremely vigorous wildfire in Split, 17-19 July 2017

(Contribution from Meteorological and Hydrological Service of the Republic of Croatia)

An intense heatwave hit Croatia in the first half of July. Extremely high temperatures made the already dry plant cover in Dalmatia even drier, resulting in very high risk of wildfire occurring and spreading. There was almost no precipitation in Dalmatia despite the humid and colder air inflow in mid-July. Driven by the rising anticyclonic ridge from Northwest Europe, strong Bura stormwinds on 15 and 16 July continued to dry out the vegetation. Such weather contributed to the extreme behaviour of the wildfire that broke out near Split on 17 July and was localized on 19 July. Approximately 4300 ha of forest, brush, olive groves and vineyards were burned. The fire front was at times 40 km long and it was one of the biggest wildfires in Croatian history.

The fire was put under control by a joint effort of the firefighters and the military on the afternoon of 18 July, localized and finally extinguished. The damage was substantial, but fortunately there were no human casualties. The authorities declared a state of natural disaster in the Split-Dalmatia County.

Remnants of Hurricane **Ophelia** crossed **Ireland** and the **United Kingdom** with wind speeds up to 49 m/s (175 km/h) on the 16th and 17th of October. Several houses, commercial buildings and 40 schools were damaged with a financial loss of about 90 Million € (MunichRe 2018).

Winter storm **Herwart** hit **Central Europe** on 29th of October with wind speeds up to 40 m/s (145 km/h), heavy rain and flash floods. Houses, roads and railways were damaged. 390,000 customers remained without power. The overall financial loss was estimated to 430 Million €, especially in the forestry (MunichRe 2018).

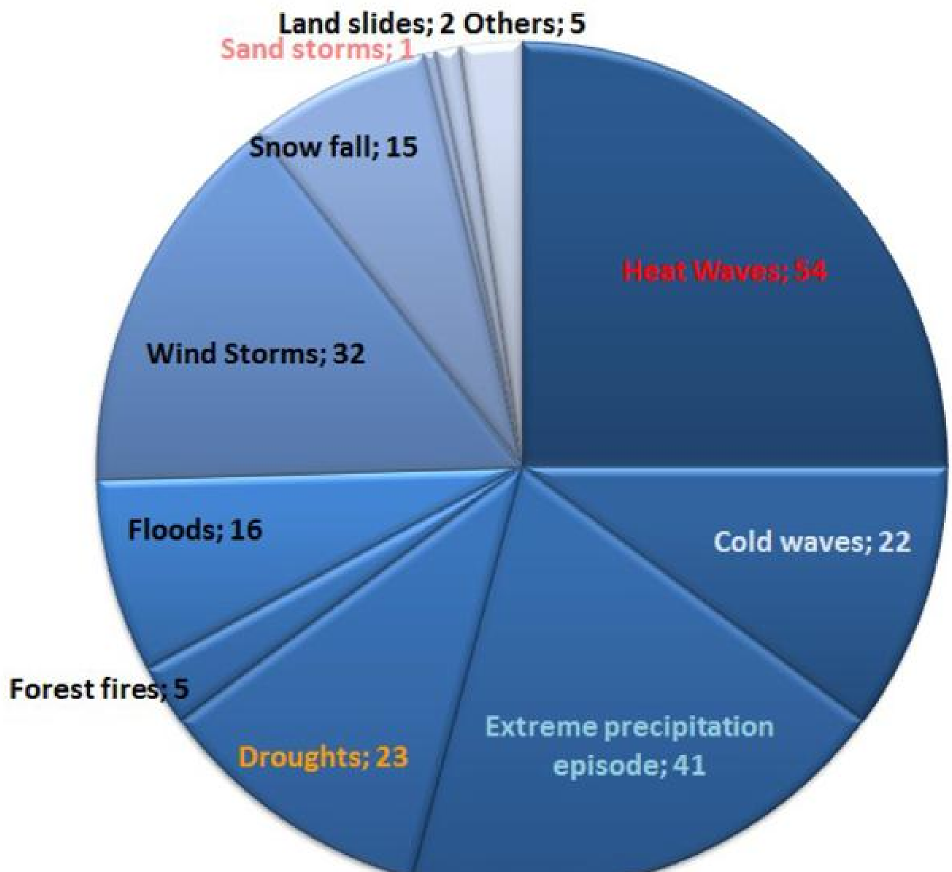


Figure 2.17: Observed extreme weather or climate events in 2017 based on 32 reports from NMHSs (total events reported for 2017: 216).

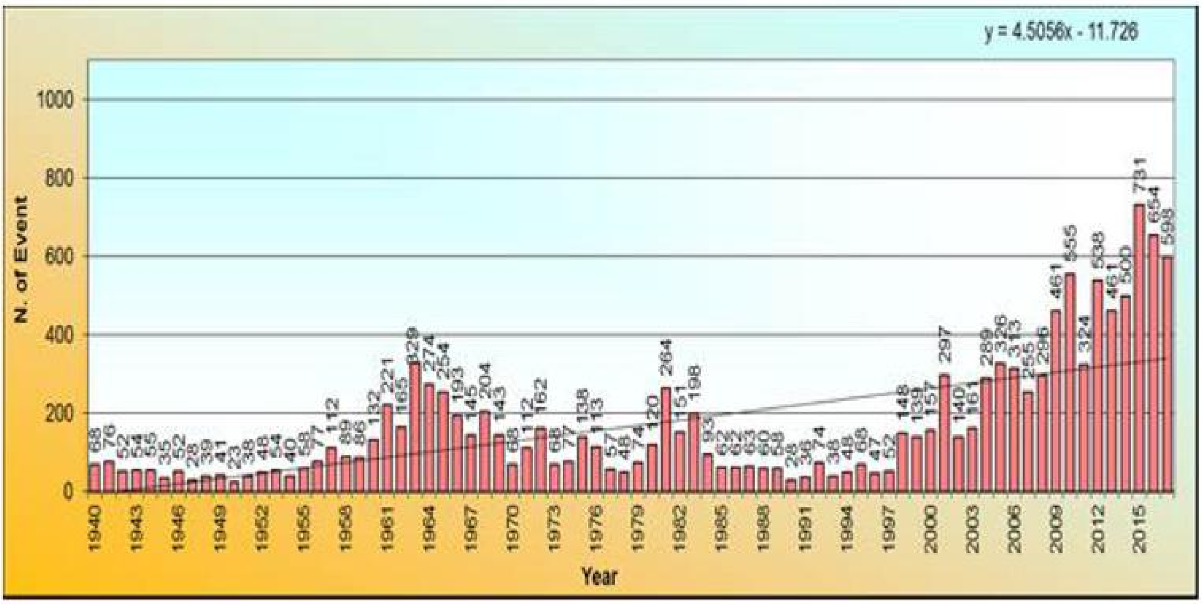


Figure 2.18: Annual count of extreme events per station occurred in Turkey from 1971-2017 (Diagram as provided by the NHMS).

The number of extreme events in 2017 in Turkey reached 598 (Figure 2.18). There is an increasing trend in extreme event occurrences especially during the last two decades (4.0 events/year), possibly partly also due to improved observations and communication means.

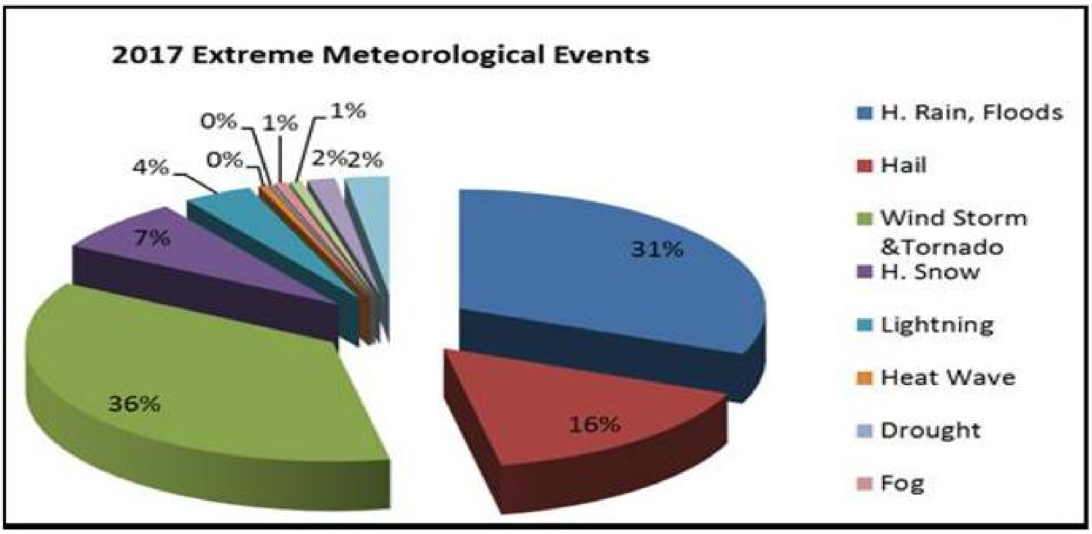


Figure 2.19: Distribution of extreme events occurred in Turkey in 2017 (Diagram as provided by the NHMS).

Most hazardous extreme events recorded in 2017 were wind storms and tornadoes (36%) and heavy rain/floods (31%). The others were hail (16%), heavy snow (7%), lightning (~ 4%), avalanche and frost (~ 1.5%) and heat waves, drought, forest fire and fog (<%1).

3. Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2017 and anomalies related mainly to the normal period 1961-1990 of the following selected climate variables: sea level pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1. Seasonal averages and anomalies of selected climate variables

3.1.1. Sea level pressure and circulation indices

Pressure distribution in **winter 2016/2017** showed a connection between the Azores high and the Russian high. On seasonal average the Icelandic low showed a core pressure below 995 hPa and the Azores high a core pressure above 1025 hPa. The pressure anomalies were above +8 hPa above Central Europe and the zone of below-normal pressure ranged from Greenland and Iceland to the Barents Sea and eastern Europe. This winter the North Atlantic Oscillation (NAO) was not well developed and therefore the East Atlantic/West Russia Pattern (EA/WR) dominated the teleconnections. Several storms affected Europe especially in February 2017. Storm "Urd" crossed Scandinavia during 26-27 December 2016. A mid-Atlantic trough deepened rapidly to a storm (named "Doris" by UK-MetOffice), before crossing Ireland on the 23rd February. This resulted in widespread gales and some disruption.

In **spring 2017** both circulation centres, the Icelandic low and Azores high, were not well distinct. A second low pressure centre was located around the Barents Sea. The Azores and Siberian high were connected with negative anomalies in northern Russia and positive anomalies in central Europe. The northern hemisphere teleconnection indices were small because they had opposite sign in the different months of the season.

Table 3.1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference.

	NAO	EA	EA/WR	SCA	POL	AO
Winter 2016/2017	0.36	0.10	1.10	-0.11	-0.17	1.02
Spring 2017	0.13	0.32	0.39	-0.51	-0.06	0.18
Summer 2017	0.03	1.96	-1.06	-0.99	0.56	0.40
Autumn 2017	0.04	0.77	-1.25	0.23	-1.69	0.04

Note that all values are standardized with the reference 1981 to 2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

Both circulation centres, the Icelandic low and Azores high, were shifted south in **summer 2017**. The anomalies were deepest between Iceland and Great Britain and reaching Scandinavia and northern Russia resulting in a high East Atlantic Pattern (EA) in all three months. This induced colder and wetter conditions in northern Europe. Austria was hit by several thunderstorms with hail and tornadoes during the summer 2017 and two people died; more than 140 persons were injured. The damage was estimated to more than 22 Mio €.

The circulation centres in **autumn 2017** were well pronounced with a core pressure below 1005 hPa around Iceland and above 1020 hPa around the Azores. Above normal pressure anomalies could be detected in south-western and northern Europe while negative anomalies prevailed from Iceland to south-eastern Europe. The dominant circulation patterns were the East Atlantic/West Russia Pattern (EA/WR) and the Polar/Eurasia Pattern (POL). During October and November several low pressure systems crossed western and northern Europe and also Medicane NUMA (a hurricane like cyclone in the Mediterranean) that circulated several days in the Ionian Sea with heavy precipitation, floods and damages in the surrounding countries, not only in Greece (see 4.1).

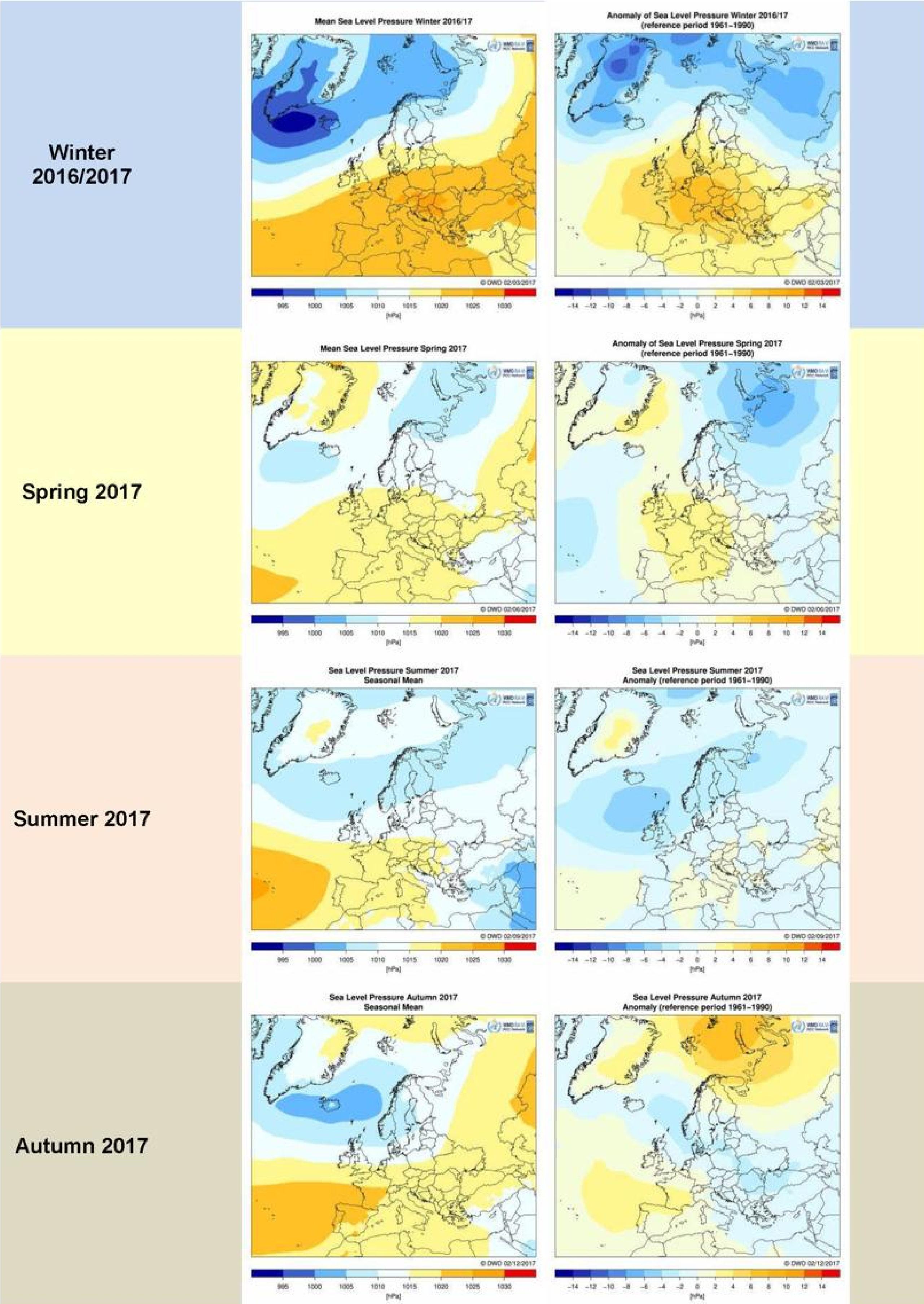


Figure 3.1: Seasonal sea level pressure (left, in hPa) and anomalies (right, in hPa) in 2016/2017, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.2. Temperature

On average for the whole WMO Region VI and sub-regions the temperature in all seasons in 2016/2017 (except in winter in Mediterranean, Italian and Middle East) was warmer than the normal period 1961-1990. In regional view, however, some differences existed (Tab. 3.2). The annual averages of all sub-regions are very similar and ranged between +1.4 and +1.5°C.

Table 3.2: Seasonal and annual average of temperature anomalies over land areas in °C for each sub-region in the year 2017 (reference period: 1961-1990; definitions of the sub-regions see Figure 1.1)

Sub-Region	Winter 2016/2017	Spring 2017	Summer 2017	Autumn 2017	Year 2017
Central and western Europe	0.68	1.99	2.56	0.07	1.35
Nordic and Baltic countries	2.98	0.83	0.65	1.74	1.52
Iberia	0.80	2.51	2.81	0.20	1.49
Mediterranean, Italian and Balkan Peninsula	-0.40	1.74	2.93	0.91	1.44
Eastern Europe	1.66	0.92	0.09	1.74	1.47
Middle East	-0.49	1.19	1.57	2.06	1.42

Temperature anomalies for winter 2016/17 show lower than normal values in south-eastern Europe and eastern Russia as well as in parts of France and Spain. Northern Scandinavia showed higher than normal values of more than +4°C. The highest positive anomalies occurred in the far North. For example Svalbard Lufthavn reported a temperature anomaly for winter of +7.3°C (+9.3°C in February 2017) and Ny Älesund +4.9°C. In Porvoo, Finland, the temperature rose to +8.2°C on 14 February, which also was the month's highest temperature in whole Finland.

Some ranks of warm winters based on web-available bulletins by NMHSs are given below (Most countries have not published a rank statistic since the temperature of this winter (2016/17) were for many countries about normal).

Table 3.3: Seasonal rank statistics for winter mean temperature (2016/2017) as provided by the NMHSs.

Country	Rank	Anomaly in °C	Start of time series
Austria	~20 (14 in the mountains)	0.5 (+1.2)	1767
Germany	21	+1.6 (1961-1990)	1881
Norway	8	+3.7 (1961-1990)	1900

The third-warmest spring 2017 in Switzerland, since measurements started in 1864, was recorded with country wide anomaly of 1.7°C above the normal value 1981–2010. March (the second-warmest since observations began) was 3.3°C, April 0.5°C and May 1.1°C above the normal value. The spring in Spain was extremely warm with an average temperature 1.7 ºC above its normal value. It was the hottest spring since1965, exceeding by 0.1 ºC the highest spring in the series recorded before, the one in 2011. Spring in Spain began with a warm March, with a mean anomaly of +0.9 ºC. April was very warm with an average temperature exceeded by +1.9 ºC its normal value, while May was extremely warm with a mean anomaly of +2.4 ºC.

From Spain, **France** and **Slovenia** 5 heat waves were reported for the summer 2017. During summer in **Spain** there were frequent episodes of temperatures higher than normal, both in the peninsula and in the Balearic and Canary Islands. There were three remarkable heat waves. That from 13th to 21st June, which affected mainly the west, center and northeast of the peninsula; that from 12th to 16th July, when the highest temperatures of the summer were registered and that affected mainly to the south and center of the peninsula; and the one from 2nd to 6th August which affected mainly the south and east of the peninsula and the Balearic Islands. The highest temperatures in principal stations were observed during the first days of the heat wave from 12th to 16th July. In this heat wave it is remarkable the maximum absolute temperature of 46.9 ºC which was observed in Córdoba Airport on 13th. In eight principal stations of the southern half of the peninsula the highest temperature observed exceeded the maximum absolute temperature previously recorded in any summer month. It was the second hottest summer since 1965, only below 2003.

The third-warmest spring in Switzerland was followed by the third-warmest summer since analysis started in 1864. Averaged across the country the summer temperature rose +1.9°C above the normal value 1981–2010. Only the summers of 2015 and the legendary hot summer of 2003 were warmer: the former with +2.3°C, the latter with +3.6°C above the normal value. There were five heat waves in Slovenia during summer, but none of them lasted longer than 8 days.

Summer 2017 in Slovakia, with a country average temperature of 18.5°C, was the 4th warmest summer since 1961 with temperature anomaly +2.7°C compared to 1961-1990 values and +1.7°C compared to 1981-2010 values. Summer temperature at Hurbanovo was the 3rd highest (1901-2017, Figure 3.2).

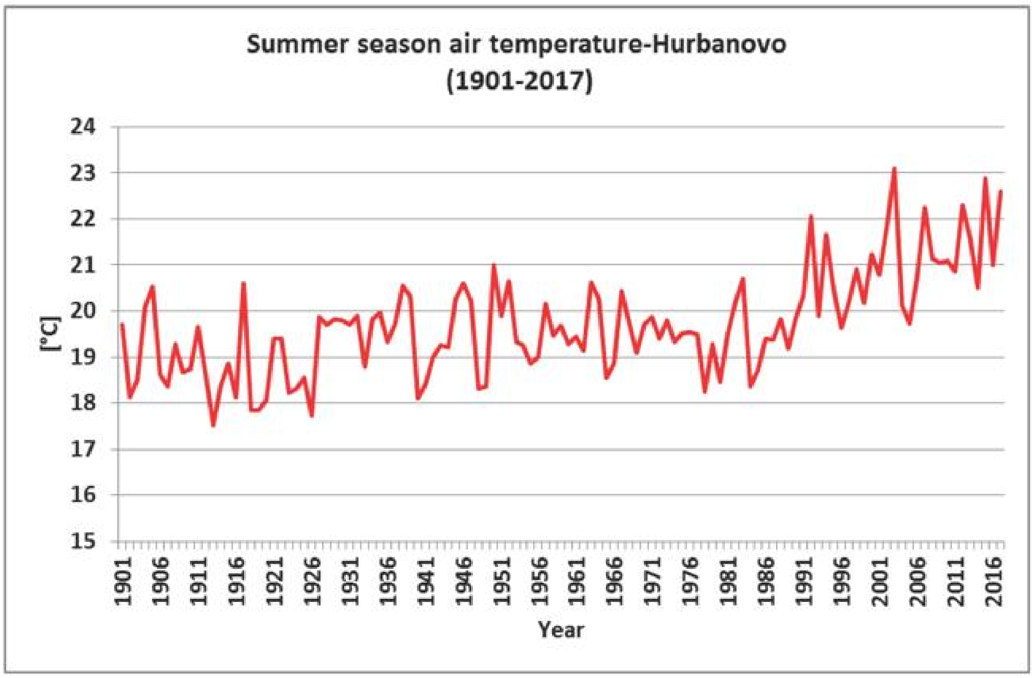


Figure 3.2: Summer temperature at Hurbanovo for 1901-2017

The summer in **Sweden** showed an almost complete absence of really warm spells. The highest temperature in Sweden during the summer was 28.0°C. This is the lowest national maximum temperature for a summer since at least 1922.

Temperatures of **autumn 2017** were normal in most of Europe, around the Mediterranean below normal. In Spain, October was extremely warm, with an average temperature of +2.6 ºC above its normal value. It was the warmest October since the beginning of the analysis in 1965. In Poland the highest autumn temperature occurred at station Rzeszów with 29.1°C on 1.09.2017.

In the Arctic temperatures in autumn were well above normal with anomalies of +5.8°C in Svalbard Lufthavn and 5.7°C in Ny Alesund (Norway).

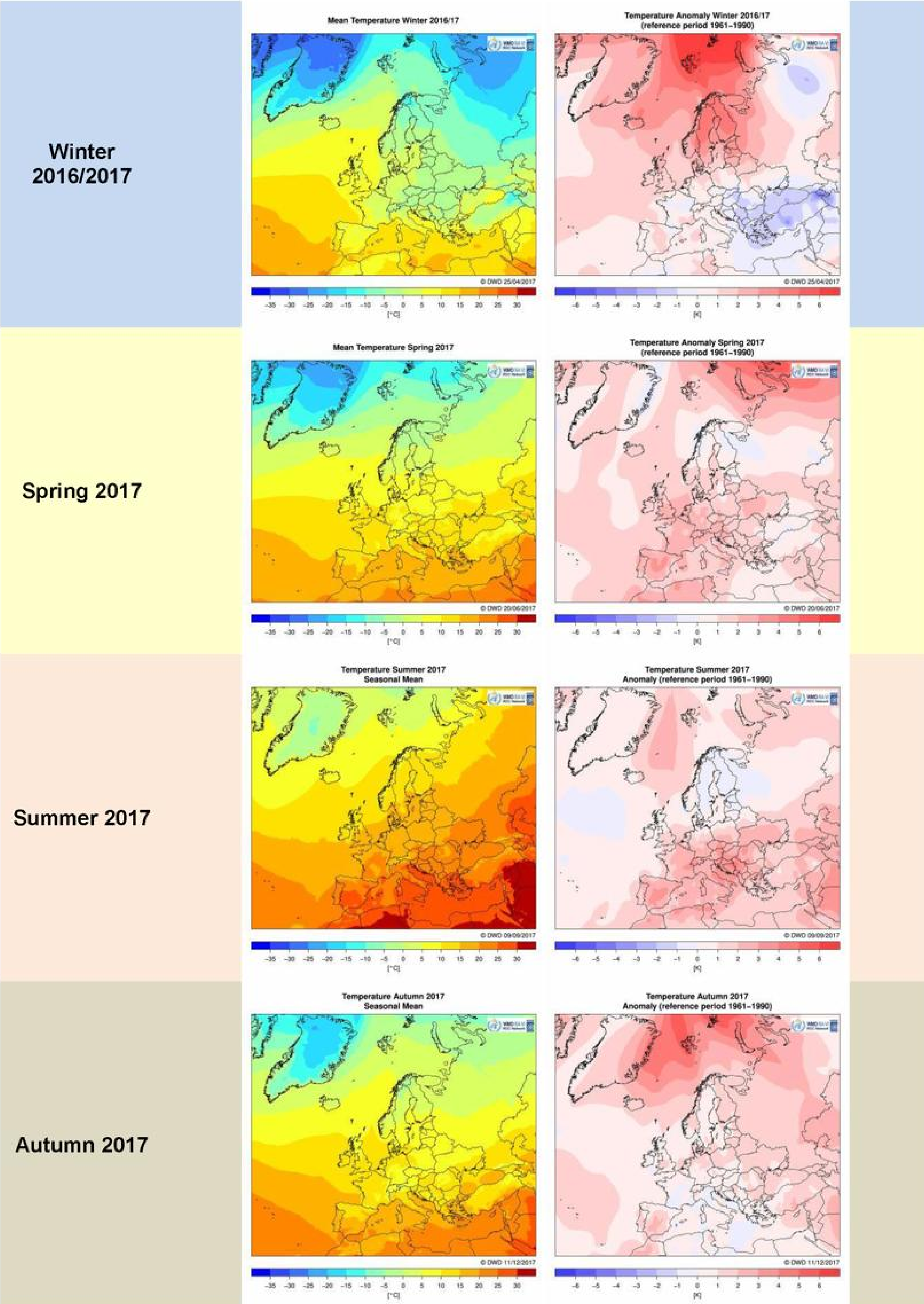


Figure 3.3: Seasonal mean temperature (left, in °C) and anomalies (right, in K) in 2016/2017, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.3. Precipitation

Precipitation anomalies in **winter 2016/17** showed lower-than-normal values in many parts of Europe except in eastern Europe, Norway and south-eastern Spain. Therefore the mean snow depth was also less than normal in many mountains although January was very cold in many parts.

Corsica (France) noted the rainiest and snowiest (several episodes) **winter** (DJF) since 1959 that culminated in a flood from 21-23 January with damages on roads and houses.

In mountain regions of **Switzerland** the thin winter snow cover in 2016/17 was at close to record-breaking levels. Davos for example recorded 27 cm, only 1 to 3 cm more than the winters with the least snow up to now: 2006/07, 1995/96 and 1989/90. Arosa registered – on average from December 2016 to February 2017 - only 31 cm of snow, Segl-Maria even as little as 12 cm. At both stations, only one winter with an even thinner winter snow cover had been observed: in Arosa this was the winter 1989/90 with 28 cm and in Segl-Maria the winter 2001/02 with only 7 cm of average snow cover.

In **spring 2017**, western and southern Europe was drier than normal while eastern Europe and Norway were wetter. **Romania** was affected by several floods in May due to storms and convective phenomena almost everywhere on numerous days during the month. On the 6th, such phenomena led to hail occurrence and flooding in Oltenia, which triggered damage to a number of households. The situation was similar in Arad County, where massive rainfalls disturbed the traffic. Rainfalls continued in the same manner until the 14th in more counties, flooding tens of houses, households, communes and county roads. In the latter half of the month, torrential rainfalls accompanied by hail, thunder and squalls again occurred in several counties and in the Capital city Bucharest, flooding tens of localities. Hundreds of households and agricultural lands were flooded and even completely covered by water, crops were destroyed and more county and national roads were blocked after the water outpoured.

Precipitation anomalies in **summer 2017** were highest in Scandinavia, European Russia, and central Europe with partly more than 150%. Greece and western Turkey were wetter than normal due to convection. Southern France, Italy, the Balkans, eastern Turkey and parts of Iberia showed a precipitation deficit.

The **United Kingdom** received 320 mm of rainfall over the summer (1 June – 30 August), 32.8% more than the 241 mm average. This makes this summer the UK's 11 wettest on record. In Germany the start of the summer saw long periods of dry weather, from the end of June onwards there were frequent thunderstorms and intensive heavy rain events. Berlin Airport measured on 29th of June 197 mm/day (low RASMUND). From 24 to 26 July, low ALFRED moved slowly through central Germany (Harz-region, Lower Saxony and Thuringia) with a precipitation amount of 302 mm/72h inducing floods and damages. Greece was also affected by thunderstorms with highest daily precipitation amount of locally up to 99 mm on 29th of August. Local thunderstorms in Turkey induced local heavy precipitation of 98.4 mm/d in August.

In central and eastern Europe **autumn 2017** was wetter than normal, while western and southern Europe was drier than normal.

In **Latvia**, September with an average precipitation amount of 129.4 mm was the 3rd wettest since 1924, while October with an average of 114.3 mm was 6th wettest on record and 1st wettest in the 21st century. Due to high precipitation amount in September and October, autumn with an average precipitation amount of 313.5 mm was the 2nd wettest in the last 94 years, while in western Latvia in some stations it was the wettest autumn. Monthly precipitation in most parts of **Lithuania** amounted in September and October to about 1.5–2.5 of the norms. Autumn became the most humid season in Lithuania since 1961 (amounting to 345 mm, i.e. more than 1.8 of the norms).

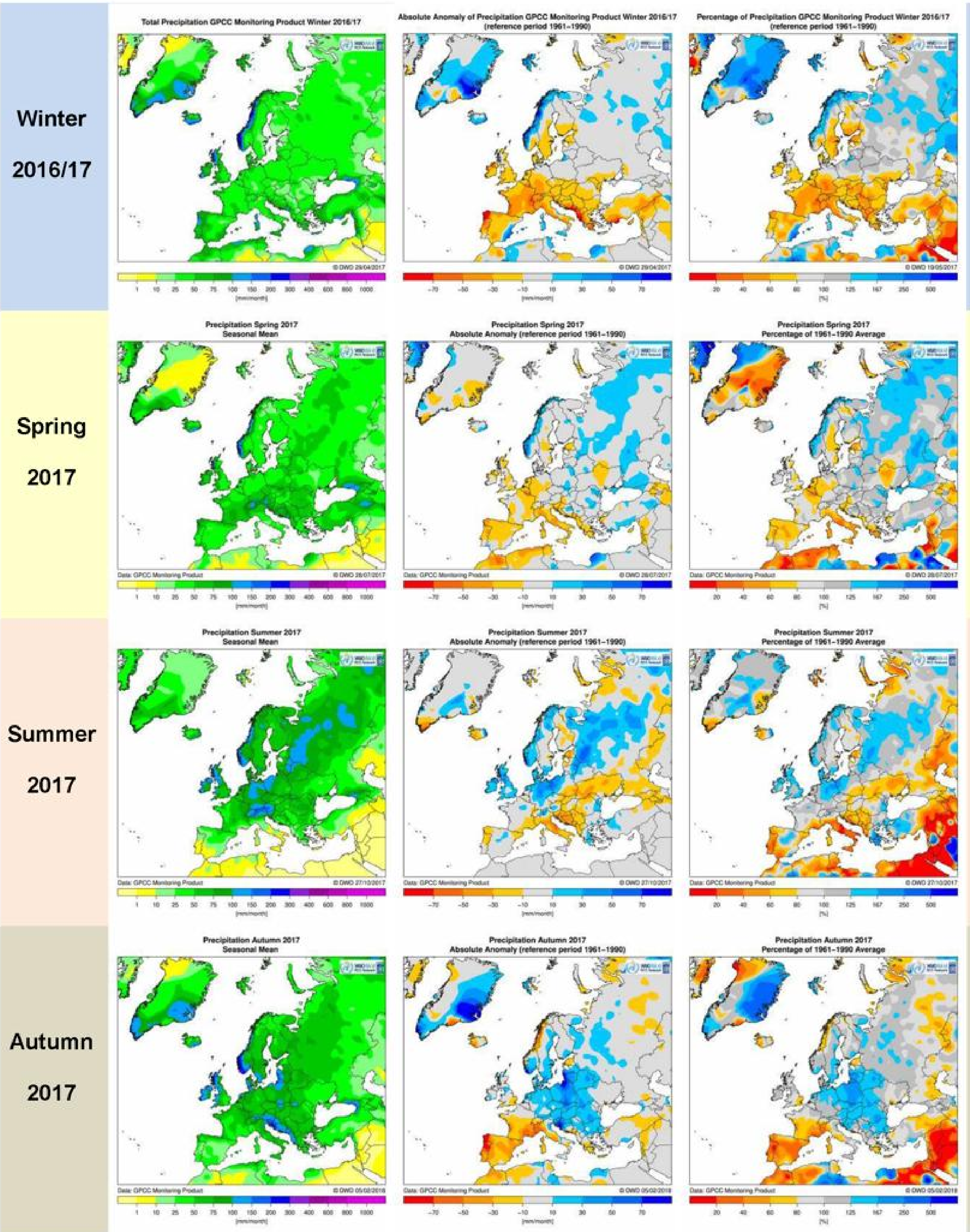


Figure 3.4: Seasonal total precipitation (left, in mm/mon), absolute anomalies (middle, in mm/mon) and relative anomalies (right, in %) in 2016/2017, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.4. Sunshine duration

Many parts of Europe received more than average sunshine in **winter 2016/17**. Only parts of Portugal, the United Kingdom, northern Scandinavia, the Baltic States, Belarus, Ukraine and Russia noted below-normal sunshine. This coincided well with below-normal cloud cover anomalies in most parts Europe. In contrast, the far north showed more clouds and less sunshine than normal in winter 2016/17.

Sunshine duration in winter **Switzerland** amounted to between 110 and 145 percent of normal values 1981–2010 across many parts of the country. In mountain areas the above-average sunny winter of 2016/17 terminated a multi-annual period with mostly below-average sunshine duration. Samedan registered 419 sunshine hours and Davos 409, bringing the winter at these stations up to the second-sunniest since the beginning of homogenous data series in 1959. The sunshine record in December 2016 contributed substantially to this sunshine record. Above-average sunshine was also registered for January 2017. For the winter 2016/17, both meteorological stations registered only a few sunshine hours below the existing record.

In **spring 2017** most of Europe registered above normal sunshine duration. Sunshine deficit was reported for south-eastern and northern Europe.

Southern and Central Europe had positive sunshine duration anomalies in **summer 2017** with up to 125% in the Balkans. Only Scandinavia, the Baltic States, and northern European Russia showed less sunshine and more cloud cover. Due to more radiation several heat waves were observed in southern Europe.

In **autumn 2017** most of Europe registered a sunshine deficit or higher cloud amount which was related to the extreme precipitation. Only south-western and north-western Europe as well as the Caucasus and parts of south-eastern Europe received more sunshine than normal.

In Austria, in this autumn the sun shone 10 % less than on average. Together with the one from 2013 and 2014 this autumn was the dullest in the past 20 years.

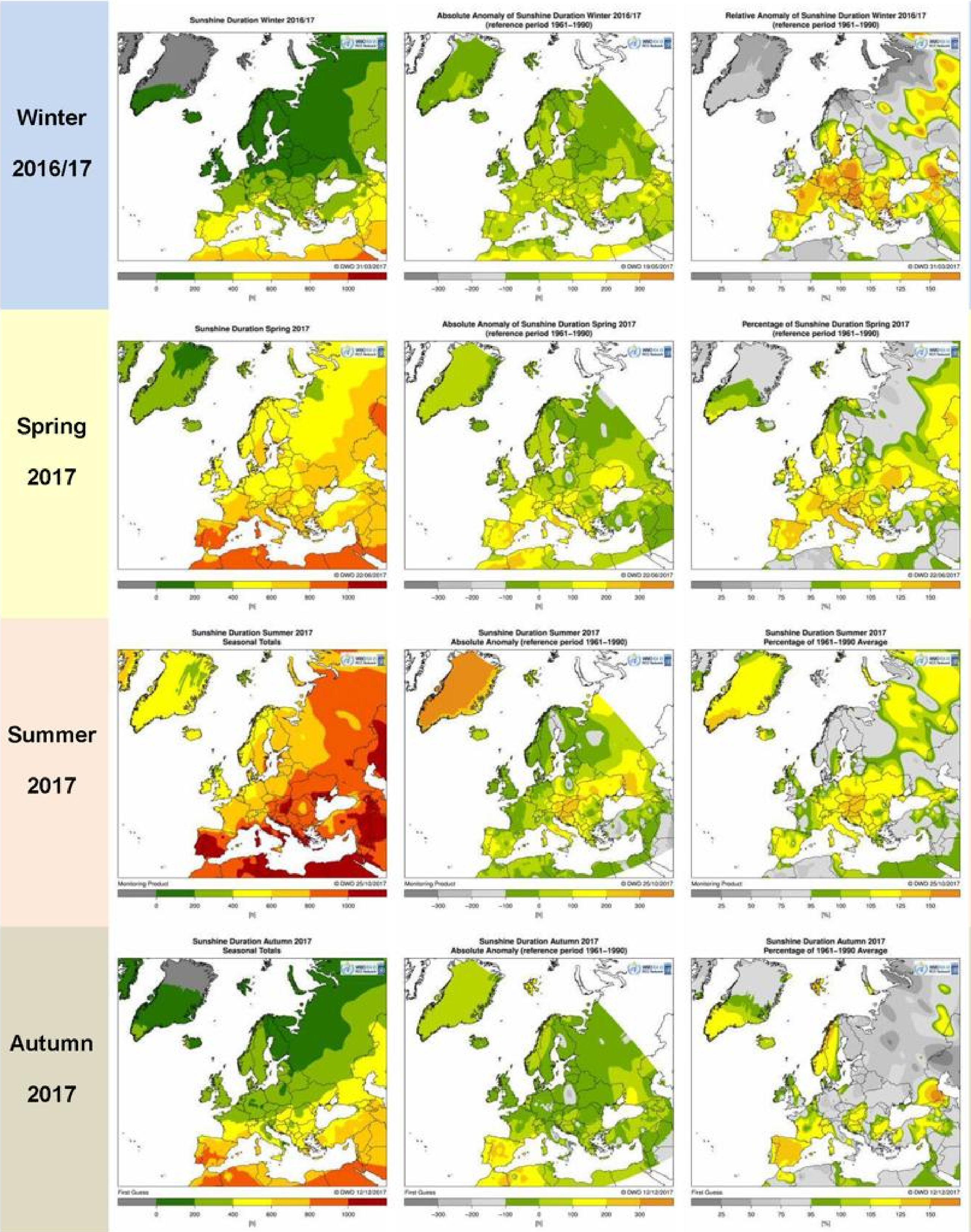


Figure 3.5: Seasonal sunshine duration (left, in hours), absolute anomalies (middle, in hours) and percentage of mean (right, in %) in 2016/17, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

3.1.5. Drought

Winter 2016/17 precipitation in **Switzerland** totals from December 2016 to February 2017 reached only half of the normal values 1981-2010 in the nationwide average. In western Switzerland and in the Valais only 30% to 50% of the normal precipitation values were recorded. Western Switzerland observed – in certain regions - a winter with the least precipitation in 45 to 55 years. A comparable winter drought period in the Valais dates back 40 years. Little precipitation also means little snow. Some places south of the Alps registered the thinnest snow cover since measurements began 55 years ago.

In spring 2017 mild drought occurred in southern, western and northern Europe while eastern Europe was mildly wet. Only central Italy showed severe drought. The monthly amount of precipitation of 5.3 mm recorded at Findel Airport (**Luxembourg**) is the second driest value ever recorded in April since 1947. This event can be referred to as exceptional. Very dry weather was observed in **Lithuania** in May (24% of the norm) and the water level of the rivers reached its minimum due to below normal temperature. **Austria** documented a drought in northern parts from May to 20 July with locally massive harvest losses (especially winter wheat, maize, potatoes) of approximately 40% (in Lower Austria). The drought in the **Czech Republic** last from June until August. In southern Moravia even from January to August 2017 when a precipitation amount of only 284 mm (71 % of normal 1981-2010) was registered which was the 2nd lowest in 1961-2017 (affected area: approx. 8 000 km^2).

In **Belgium**, almost the whole country had a rainfall deficit in 2017. Especially the winter and spring were highly dry. For a limited period of time, pumping water as watering the gardens was prohibited in some areas of Belgium. All this caused a lot of damage on field crops. The spatial distribution of the drought index SPI-3 for April-June 2017 shows that the main part of the country was extremely dry.

Spring and summer atmospheric droughts in the **Ukraine** have gradually evolved since April, intensified and spread in May-June and last until first half of September. Precipitation deficiencies in many areas reached 50-70% of the norm. In June the drought was classified as air-soil one of varying intensity. She has led to essential reduction of the harvest of early grain crops and late crops, namely corn, soybeans, sunflower.

Summer 2017 was extremely dry in many parts of southern Europe. Especially Italy suffers from heat, drought and water scarcity (Figure 3.7). Because of the water crisis in Italy, the government in Rome has declared a state of emergency for Lazio (with the capital Rome) and Umbria. Cooler air from north induced heavy storms with hail in northern Italy (e.g. 9th of August on Lake Garda) and tornadoes (e.g. the 10th August in the seaside resort Cavallino northeast of Venice) and reduced partly the drought.

Very dry autumn 2017 in south-western Europe. Autumn in **Spain** has been the driest in the XXI century. Mean precipitation was only 84 mm, 59% lower than normal. In the Republic of **Moldova** between August 1st and September 20th it was hot with a significant shortage of precipitation, which contributed to the occurrence of a severe, and sometimes very severe, drought and in this period of the year, it is possible on average once every 15 years.

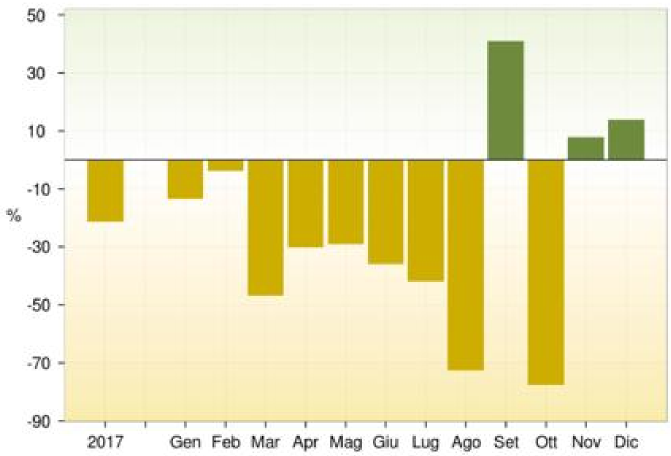


Figure 3.6: Monthly and annual precipitation anomalies for Italy in 2017, expressed as percentage of the normal value 1961-1990 (Diagram as provided by the ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

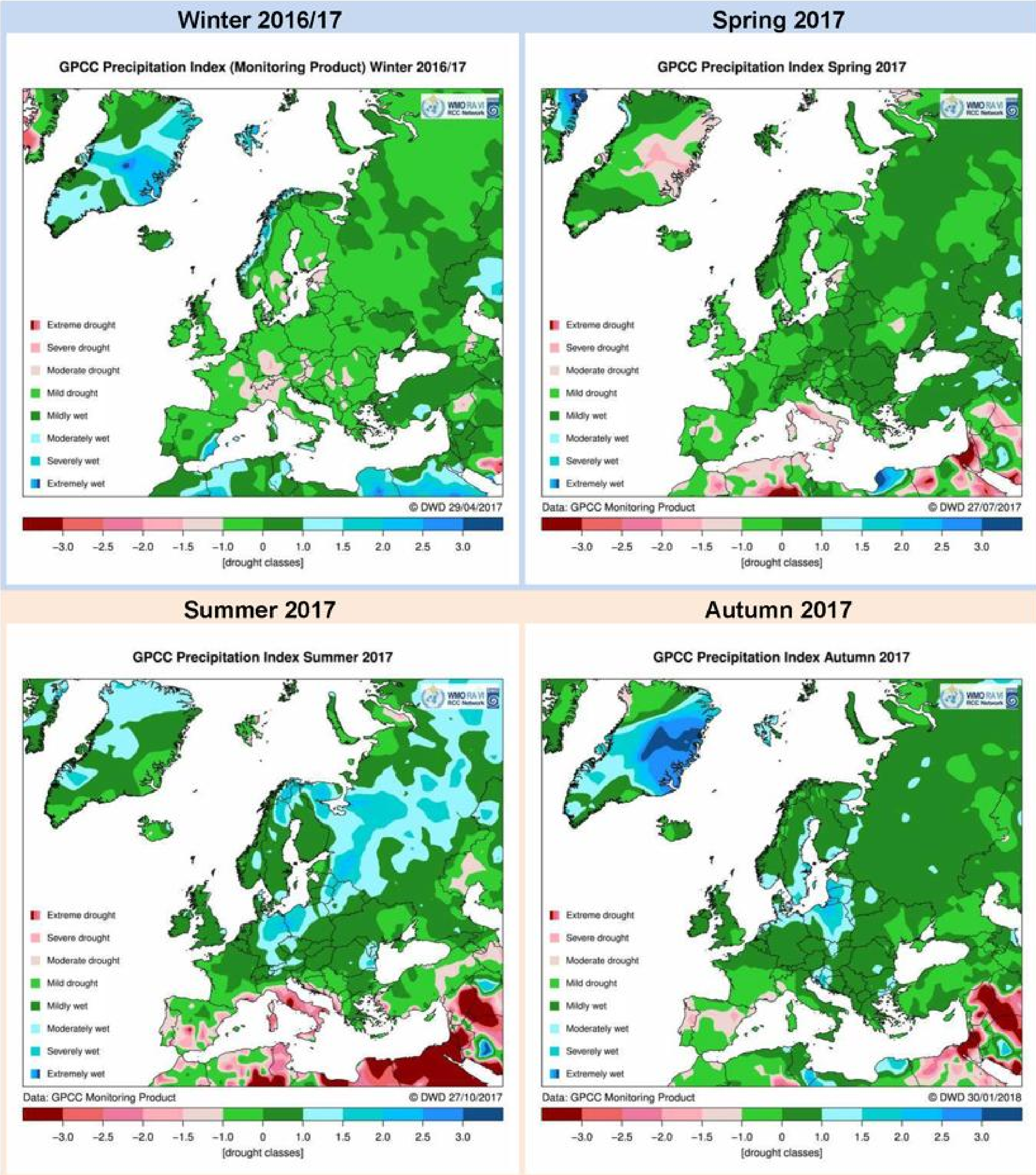


Figure 3.7: Seasonal standardized precipitation index (SPI, in drought classes) in 2016/2017, reference period 1961-1990 (Source: http://www.dwd.de/rcc-cm).

4. Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2017 on the Climate in WMO Region VI - Europe and Middle East (available on http://www.dwd.de/rcc-cm).

It contains highlights, means and anomalies of sea level pressure, temperature, precipitation and sunshine duration for each month as well as monthly overviews of extremes and notable events.

4.1. Sea surface pressure and circulation indices

This chapter about atmospheric circulation provides information on selected northern hemisphere teleconnection indices which are considered to be relevant for WMO RA VI and it discusses influences of circulation patterns upon anomalies and outstanding events. The information is based on the "Monthly Bulletins on the Climate in WMO RA VI" and was completed by reports of the NMHSs. The discussion partly refers to atmospheric circulation patterns in the mid-/upper troposphere not shown here. (See http://www.ncdc.noaa.gov/teleconnections/ and http://www.cpc.ncep.noaa.gov/products/CDB/index.shtml)

Table 4.1: Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference and the Arctic Oscillation, for January to December 2017.

Year	Month	NAO	EA	EA/WR	SCA	POL	AO
2017	1	0.05	-1.15	0.63	0.17	0.96	0.94
2017	2	0.69	0.58	1.14	0.67	-0.38	0.34
2017	3	0.37	1.03	-1.02	-1.02	0.73	1.37
2017	4	1.74	-0.62	0.71	-1.45	-1.37	-0.09
2017	5	-1.72	0.54	1.48	0.95	0.46	-0.73
2017	6	0.35	2.03	0.34	-1.43	-0.11	0.40
2017	7	1.28	1.83	-0.58	0.03	-0.05	0.63
2017	8	-1.53	2.02	-2.93	-1.57	1.83	0.15
2017	9	-0.45	1.58	-2.52	0.46	-1.66	-0.49
2017	10	0.71	0.62	-0.02	0.30	-1.17	0.69
2017	11	-0.14	0.12	-1.21	-0.08	-2.23	-0.08
2017	12	0.73	-0.50	-1.63	-0.48	-1.95	-0.06

Note that all values are standardized with reference to the period1981-2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)
(**Sources**:ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii.table)

The winter storm "Egon" affected from 12–13 **January 2017** mainly **France** and **Germany** with wind gusts of up to 40 m/s (145 km/h) and heavy snowfall. Rail and air traffic were affected. Several houses and a cathedral were damaged and one person died. The financial loss was estimated to about 350 Million Euro (MunichRe 2018).

On the 18 January in **Sweden** the mountain top station Stekenjokk recorded a mean wind speed of 47.8 m/s. This is a new Swedish record, but due to the extreme exposure of the station it might be regarded as a singular event. During the 3th and 5th storm "Axel" (in German), with wind gusts of 36 m/s (130 km/h) caused fallen trees and traffic disruption in **Austria**. The majority of damage, like uprooted trees and damaged roofs, was reported in the eastern part of Austria. On the **German** coasts storm "Axel" caused storm surges with rock slide, flooding, fallen trees and heavy snow fall.

Several storms affected Europe in **February 2017**. From 2nd – 5th in **Portugal** a maximum wind gust of 36 m/s (129.6 km/h) was measured in Guarda. **Spain** reported storms from 1st – 4th of February in many provinces with maximum wind gusts of more than 25 m/s (90 km/h). In **Slovakia** the highest maximum wind speed (gusts: 61.6 m/s or 222 km/h) occurred at Lomnický štít (2634 m a.s.l.) in recorded history (at least from 1951) on 24th of February. In **Ireland** storm "Doris" (named by MetOffice; 23rd Feb) brought the month's highest wind gust of 39 m/s (141 km/h) at Mace Head.

Strong wind in February

(Contribution from Instituto Português do Mar e da Atmosfera, I.P.M.A.)

Between the 1st and 5th of February heavy precipitation and strong wind occurred in the territory of Portugal, especially in the northern and central regions.
Between the 2nd and 5th of February the wind was moderate to strong on the west coast, with wind gusts of 60-80 km/h, and strong to very strong in the highlands with wind gusts of 100-110 km/h. During this period, high and persistent values of wind intensity were recorded in some places in the North and Center regions, with values above 100 km/h (Guarda, Penhas Douradas, Mogadouro, Moimenta da Beira and Vila Real stations).

In the early morning and late afternoon of the 3rd and early morning of the 5th of February there was a persistence of high values of wind intensity at more than 10% of the stations, namely with wind mean values above 40 km/h and gusts above 70 km/h (Figure 4.1). The highest value occurred in Guarda weather station at 04:20 UTC, 129.6 km/h, which exceeded the previous maximum (129.2 km/h on January 23rd, 2009).

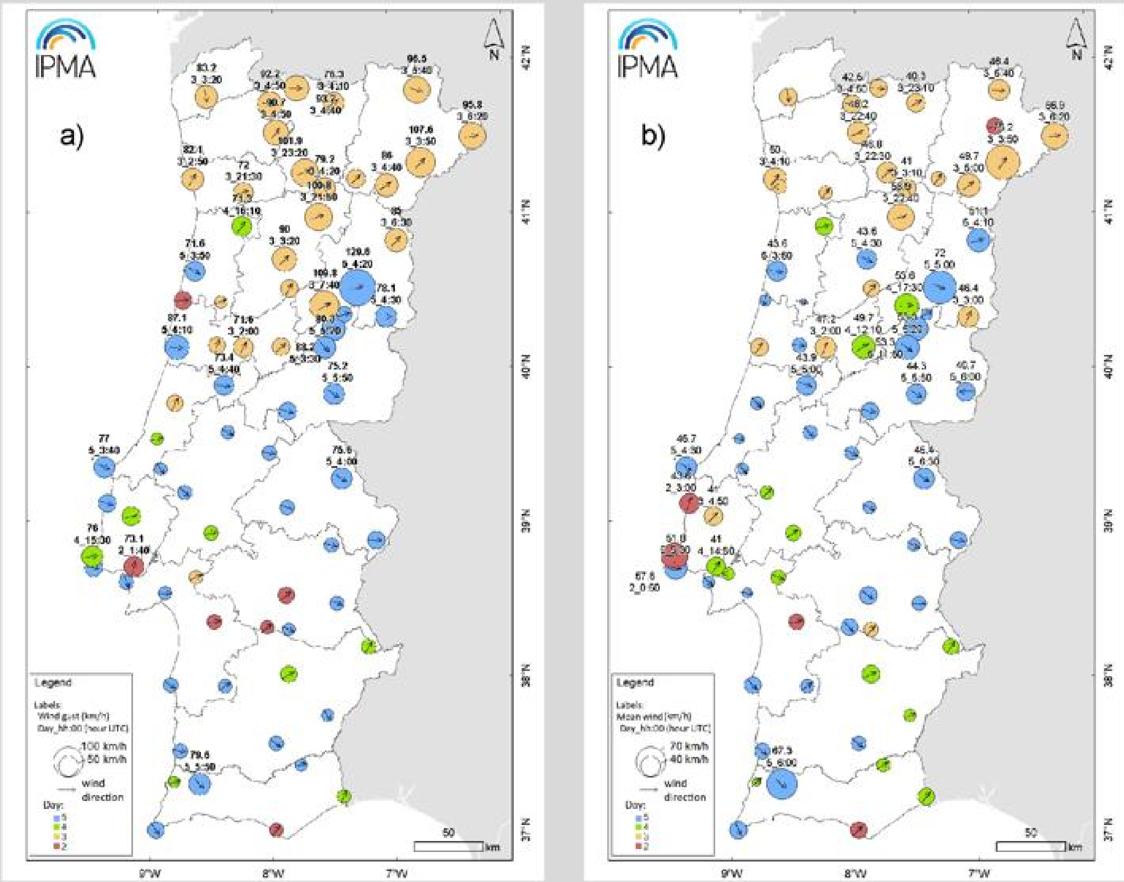


Figure 4.1: Maximum values of instantaneous wind intensity (a) and mean wind (b), respective direction, day and hour of occurrence, in IPMA observation network, 2nd to 5th February, 2017

Europe was affected by several storms in **March 2017**. On March 4, 2017, in **Austria** a heavy Foehn storm on the mountains in Vorarlberg, Tyrol and Salzburg caused numerous storm damages. Numerous trees were uprooted by wind peaks of up to 44 m/s (160 km/h). In Tyrol, railway lines were interrupted by fallen trees. In Salzburg, several ski lifts were closed because of the storm. During the 6th and 7th March storm "**Zeus**" passed **France** with strongest gusts of about 35 m/s in Brittany (tornadoes were also observed and power breakdown). On the coasts, they reached about 40 m/s and even 53 m/s at station Ouessant and 54 m/s at Camaret-sur-Mer, new absolute records. The system moved across the Mediterranean with strongest gusts of about 51 m/s at Saint-Raphaël (near Cannes) and 40 m/s at Calvi (Corsica). Storm "Zeus" was accompanied by heavy precipitation of up to 30 mm/day in south-eastern France, above an elevation of 300 m as snow.

In **April 2017** Europe was still affected by several storms. Especially from 27 to 29.04.2017 low "**Tarek**" affected Europe from southern Spain to Belarus with locally heavy precipitation. In southern **Spain** over 100 mm were accumulated at station Huelva and more than 200 mm in the City of Ceuta (Spanish enclave in Africa). The Alps were also affected by snow and rain. **Switzerland** reported several new records of snow depth for the second half of April. In St. Gallen 35 cm snow were accumulated during 2 days. The maximum precipitation amount in **Germany** also occurred in the Alpine region with 237 mm/month at station Zugspitze. At the end of April the precipitation in south-western **Austria** was also extreme with 256 mm/48hours at station Loiblpass (return period of once in 40 to 50 years) with a monthly total of 340 mm (or 108% of the reference 1981-2010). In **Slovenia**, at station Vogel 626 mm/month and 269 mm/day were registered

On 29 **May 2017**, a hurricane affected Moscow (**Russia**), with wind speed as strong as 29 m/s, caused the greatest number of victims on record: 11 people were killed and 70 were injured. In a few minutes, the wind fell thousands of trees, damaged many cars and roofs of 30 houses, and stopped the operation of above-ground subway and commuter trains.

June 2017 started with some showers in western and Central Europe. Prevailing westerly currents accompanied by thunderstorms, sometimes strong wind gusts and heavy showers reached **France** on the 3rd. The west and the east flank of the Massif Central received a daily rainfall amount of 49.5 mm in Aurillac (Cantal) and 80.2 mm in Coublevie (Isère). During the 3rd the cold front (of low "Heinrich") passed **Germany** with hail and heavy precipitation. An amount of 105.6 mm during several hours at station Ludwigschorgast (Bavaria) causing floods. During the 22nd of June a low pressure trough passed northern **Germany** with showers and thunderstorm. Locally heavy rainfall of 72 mm in Göttingen was measured and 37.8 mm in Potsdam.

Strong thunderstorms from the south-west passed **Switzerland** from the 24th to the 25th of June. At the southern side of the Alps station Lugano measured a rainfall of 81.5 mm within one hour (the last record with 63.8 mm dates back to 12th of September 1994). Until the end of the month several depressions passed the Alps with heavy precipitation. Together with the heavy rainfall at the beginning of the month, the southern side of the Alps and the Engadin received precipitation sums well above the normal 1981-2010. At station Lugano a new June record with a sum of 493.3 mm was registered (measurements started in 1864). At station Crana-Torricella an amount of 33.5 mm was measured during 10 minutes.

In **July 2017** in Austria out of a thunderstorm with heavy rainfall and hail a tornado of the F1 category developed in the vicinity of the airport Vienna-Schwechat with wind peaks up to 50 m/s (180 km/h). Only negligible damage was reported, however, there were some air traffic delays. In addition, hailstones of up to 5.5 cm caused damage to agriculture

In **August 2017** at Osmussaar, (an island) in Northwest Estonia on the 12th a wind gust of 38.2 m/s was measured and in Käravete an F(0) tornado was observed.

At the end of **September 2017**, extremely high air pressure was observed in Sweden. On the 28th, a new Swedish air pressure record was recorded for September with 1044.1 hPa in Lycksele and Åsele in southeast Lapland. Storm „Sebastian" passed Austria in the middle of the month with wind gusts of 31 m/s (110 km/h) causing uprooted trees and unroofed houses.

Ex-Hurricane "**Ophelia**" (named by the US National Hurricane Center) reached on 16th of **October 2017** the British Isles. The strongest winds were around Irish Sea coasts, particularly west Wales, with gusts of 43 m/s (155.6 km/h at Roche's Point, Ireland) with cancelled flights, closed roads and railway lines and disrupted ferry services between Wales and Ireland. On 5th of October 2017, storm "**Xavier**" crossed Germany, with wind gusts up to hurricane force (118 km/h and more) even in the lowlands. In northern Germany heavy rain with locally more than 50 mm/d was noted. In other European countries, such as Netherlands, Poland and the Czech Republic - with the exception of exposed layers - gusts of up to 11 Beaufort (up to 117 km/h) were registered.

During the 29th of October northern Austria was hit by a storm (named "**Herwart**" in Germany and "**Ingolf**" in Scandinavia) with wind gusts of up to 50 m/s (180 km/h) that led to operating delays on some Austrian airports, about 150.000 homes were left without power. The same storm reached also the Czech Republic with wind gusts over 30 m/s in some locations, over 50 m/s in mountain stations (Krkonoše Mountains). The result of "**Herwart**" was a loss of about 20 Million Euro and 3 dead (MunichRe 2018).

Spain reported wind storms from 10-11 **November 2017** in many provinces with maximum wind gust of more than 25 m/s (90 km/h). The cyclone "**Ylva**" (named by Met Norway, "Reinhard" in German) affected northern Norway with very strong winds from 22 to 24 November. The strongest wind was recorded at the station Narvik - Fagernesfjellet (Nordland) with a wind speed of 47.5 m/s.

Medicane "Numa" over the Adriatic Sea

(Contribution from Hellenic National Meteorological Service)

On 11 November a cut-off upper low over Tunisia accompanied by a corresponding low pressure center in the sea level pressure field over the Gulf of Syrtis produced widespread thunderstorms across the central Mediterranean region, mainly over Sicily, Malta and north Ionian Sea. On 12 November, the cut-off low moved east northeast and on 13 November affected at first the west Greece and gradually the eastern areas including Attica, Cyclades, Crete, and Dodecanese islands causing locally strong flash flooding (e.g. Symi Island). Also on 13 November a second deep low over the gulf of Genoa (995 hPa surface pressure for 00UTC) pushed polar air towards southern Italy. From 15 November onwards the low widened and moved to the Central Mediterranean. Over the warm Ionian Sea the cold and humid air mass destabilized, under weak vertical wind shear, causing the formation of a Medicane (Mediterranean tropical-like hurricane).

On 15 November major flash floods hit western Attica, after a night of intense rainfall. In particular, flooding hit the towns of Mandra and Nea Peramos. According to the HNMS's radar recordings the 24 hour accumulated precipitation over the wider area of the Mount Pateras (west Attica) during 14 - 15 November was 80 mm approximately (there is no meteorological station in that region). Also the HNMS's radar recorded the intensity of rainfall over west Attica.

The figure below indicates the appearance of a Medicane on 18 November. A whirl of convective cloud and a distinct quasi cloud-free eye is obvious (Figure 4.2). However by the evening of 18 November the Medicane had dissipated.

Figure 4.2: A well-defined eye structure of Medicane over the north Ionian Sea on November 18, 12:00 UTC (Terra MODIS and Suomi NPP VIIRS true-color RGB, source: http://cimss.ssec.wisc.edu/goes/blog/archives/26136).

Several storms affected Europe in **December 2017**. In western **Norway** on 7 and 8 December storm **Aina** (named by Met Norway, Walter in German) came with a mean wind speed of 33.1 m/s, at Folgefonna Ski Center (Jondal, Hordaland). The station also recorded a wind gust of 40.2 m/s. On 25 December wind speed in Stavropol (**Russia**) reached 30 m/s. As result, trees were fallen, a gas pipeline and cars were damaged, and interruption of power supply was recorded. Storm Dylan on 31st December brought strong winds, and trees downed in the South West of the **United Kingdom** with travel disruption. There were fallen trees also across Northern Ireland. The month's highest gust in **Ireland** was 34 m/s (124 km/h) reported at Malin Head, Co Donegal on the 31st Dec.

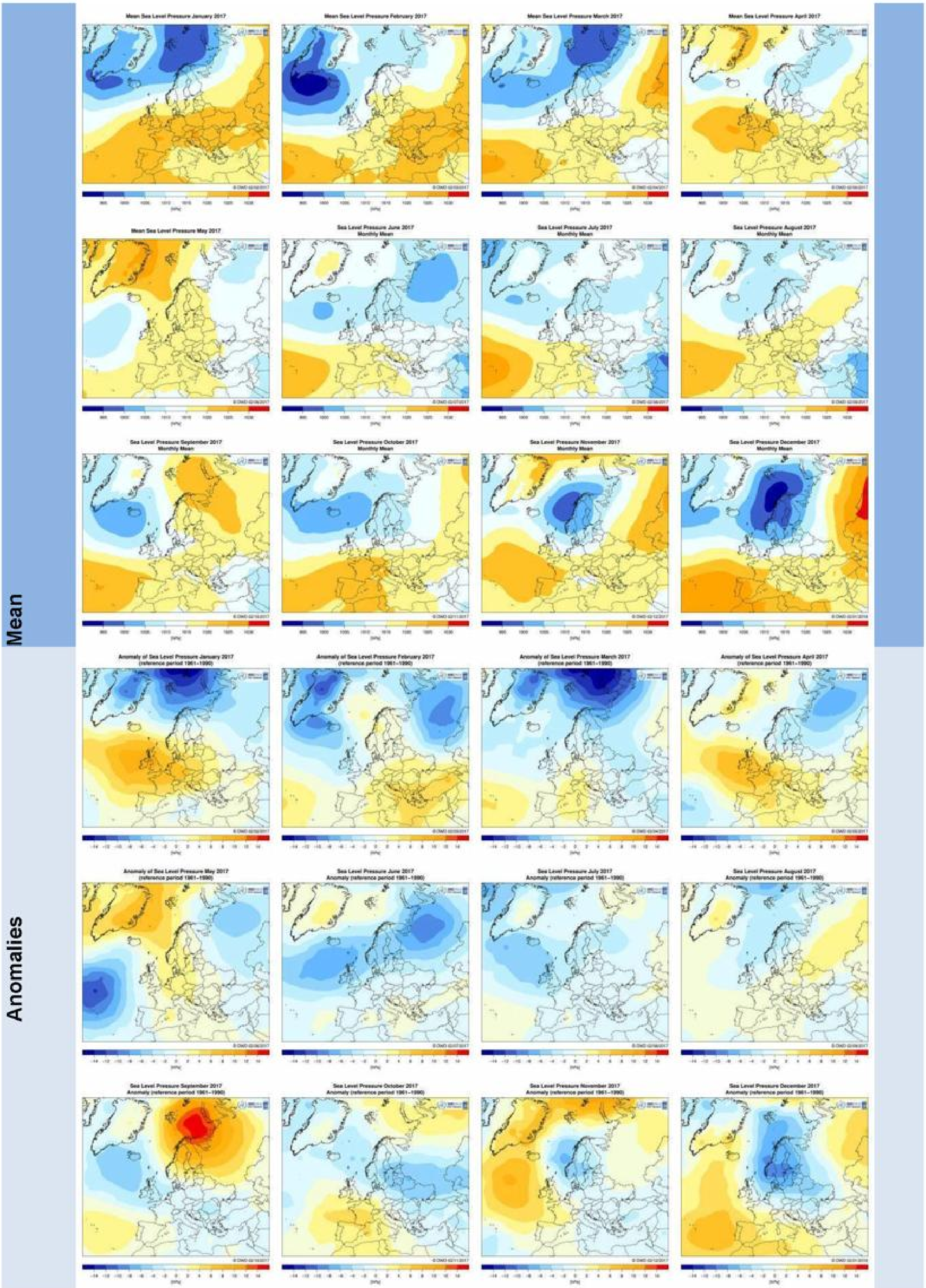


Figure 4.3: Mean and anomalies of sea level pressure in hPa for each month of the year 2017. (First row January, February, March, April; reference period 1961-1990).

4.2. Temperature

In most of the months and sub-regions it was warmer than normal as can be seen from Table 4.2. The Nordic und Baltic Countries had positive anomalies throughout the whole year 2017 and in eastern Europe in March and December anomalies above +4°C occurred.

Table 4.2: Monthly and annual area average temperature anomalies in °C for each sub-region in the year 2017 (reference period: 1961-1990; definitions of the sub-regions see Figure 1.1).

Region	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Central and western Europe	1.35	-1.25	2.26	3.38	0.61	1.99	2.76	2.25	2.68	-0.07	-0.39	0.68	1.34
Nordic and Baltic Countries	1.52	2.30	3.05	2.18	0.14	0.17	0.32	0.60	1.02	1.86	1.35	2.03	3.28
Iberia	1.49	-0.42	1.72	1.79	2.57	3.17	4.08	3.07	1.27	-0.64	0.76	0.49	0.06
Mediterranean	1.44	-2.60	2.03	3.03	0.85	1.34	3.02	3.36	2.42	1.70	0.58	0.45	1.07
Eastern Europe	1.47	2.00	2.54	4.54	-0.26	-1.51	-0.91	-0.17	1.36	3.40	-0.21	2.01	4.80
Middle East	1.42	0.41	-0.15	2.21	0.58	0.77	1.18	1.46	2.07	3.39	1.38	1.40	2.34

In January 2017 a cold wave occurred in central and southern Europe. **Spain** reported a cold wave from 15 provinces with a monthly minimum temperature of -4.0°C and a deviation from normal of -2.5°C. The most significant cold spell of the year occurred from 18th to 20th of January, due to an invasion of a mass continental cold air that affected the Iberian Peninsula and the Balearic Islands, with the lowest temperatures of the year. The coldest temperatures recorded in 2017 at principal stations were observed in Puerto de Navacerrada with -13.8ºC on 18th January, Molina de Aragón with -13.4ºC on the same day, Salamanca Airport on 19th with -10.9ºC and Albacete Air Base with -10.2ºC on 18th.

The first cold wave encompassed **Serbia** from 6 - 12 January 2017. Cold wave first affected Vojvodina and mountain regions on January 6, spreading to the entire country on January 7 and lasting until January 12, 2017. During this cold wave, the departure of the minimum daily air temperature from the mean minimum daily air temperature reached -20.4°C in Leskovac. The second less intensive cold wave was registered from 20 to 24 January 2017 in most of Serbia. The third cold wave was recorded in a period from 27 to 31 January 2017 in Pozega and others.

Greece experienced a cold wave during 7-12 January 2017 with low minimum temperatures (Florina Tmin=-22.7°C on 11th January). Heavy snowfall caused huge problems in transportation; hundreds of vehicles were trapped in highways; public transportation in Thessaloniki collapsed and flights were suspended. Migrants in Greece suffered from very low temperatures and were housed in commercial buildings and ships; one migrant died due to harsh weather conditions.

Minimum temperatures in **Bulgaria** in January 2017 in some parts of western Bulgaria were close to the absolute minimum possible at least once in 50 years (-26°C in Kyustendil and -27°C in Pernik). Seven-day cold spell gripped the most part of Bulgaria in the period 6-13.01.2017 and was caused by the advection of very cold air masses from northern Russia related to the amplification of a ridge over the eastern parts of North Atlantic and a trough downstream which thereafter formed a cut-off low over south-eastern regions of Europe. In the Republic of **Moldova** January 7-9 was extremely cold. The average daily air temperature in these days was -10..-16ºC, which is 8-13ºC below the norm and it is observed in January on average once in 10-20 years.

The mean temperature in **Norway** was +3.9°C above normal, the 12th mildest January month since 1900. A long lasting Foehn wind caused the daily mean temperature at Sunndalsøra to become

13.8 °C, on 25 January. This is equivalent to the daily normal for 4 July, and is probably the highest daily mean temperature ever recorded by a Norwegian weather station in January.

In **February 2017** only in the south-eastern part of the RA VI region negative temperature anomalies occurred. According to the temperature anomaly map all other regions showed positive temperature anomalies with its maximum in the north. This is a drastic picture but the rank statistics show that it was in many countries only the 9th warmest year. An overview of the temperature anomalies is shown in the following table.

Table 4.3: Rank statistics, monthly average temperature and anomalies (in °C) from several countries of the RA VI for February 2017.

Country (station)	Monthly average temperature (°C)	Anomaly (°C)	reference period	rank
Austria		+2.9	1981-2010	15th (since 1768)
Belgium (Uccle)	6.1	+2.4	1981-2010	
Denmark	1.9	+1.9	1961-1990	
France		+2.5	1981-2010	10th (since 1900)
Germany	2.9	+2.5	1961-1990	24th (since 1901)
Iceland (Reykjavík)	2.8	+2.5	1961-1990	
Netherlands	4.9	+1.7	1981-2010	
Norway		+2.7	1961-1990	
Portugal	11.05	+1.07	1971-2000	9th (since 1931)
Spain	10.2	+1.6	1981-2010	8th (since 1965)
Svalbard	-6.9	+9.3	1961-1990	
Switzerland		+2.7	1981-2010	
United Kingdom	5.3	+1.6	1981-2010	9th (since 1910)

In **Denmark** the temperature anomaly was +1.9°C above the reference period of 1961-90 but the record was found in the year 1990 with an anomaly of +5.5°C. In **Switzerland** several stations reported new daily maximum temperature records. In **Norway** 12 stations observed new daily maximum temperature records. Extreme monthly temperature anomalies were registered in the Arctic e.g. at Svalbard Lufthavn with a monthly temperature of -6.9°C (or +9.3°C above the normal period 1961 - 1990).

Several stations in **Norway** measured 20 °C or more on 26 **March 2017**. This is the earliest date with such high temperatures. In Vestfold the record from 26 March 2012 was hit. Together with 2012, March 2017 (8.5 °C) was the warmest March since the beginning of station records in **Luxembourg** in 1947. The March temperature in Germany, with 7.2 °C, was +2.9 °C above the long-term average (reference period 1981-2010). It was therefore the warmest March since the beginning of the analyses in 1881. The month was warmer than normal everywhere - on the coasts locally less than +2 °C (Helgoland +1.6 °C) and isolated in the Alps more than +4 °C (Oberstdorf +4.1 °C).The warmest March of the 251-year observation history in **Austria** was noted with an anomaly of +3.5°C above the long-term average. In second place is March 1994 with a deviation of +3.4°C. In **Switzerland** temperature deviation in March reached +4.1°C and therefore the second rank after March 1994 with +4.3°C. At several stations new records were set since the beginning of measurements.

April 2017 was warm over western and cold over eastern Europe. The first half was warmer than normal in many parts of Europe, the second half much colder except of Iberia and the United Kingdom. At many stations new minimum temperature records were set e.g. in Switzerland, Germany and Austria. In **Austria**, after the warmest March in measurement history and a very mild start of April, the apple blossom started at the beginning of the second week in April. This was the 3rd earliest beginning of the apple blossom since documentation began in 1943. In the midst of April cold air from the north reached **Central Europe** with ground frost that caused widespread frost damage in many fruit cultures. Many farmers tried to protect their fruits by sprinkling water on the trees against the frost. The agricultural damage in Austria summed up to about 45 million Euros. In **Switzerland** it was one of the earliest fruit-tree flowering in the measurement series.

Severe night frosts on 20 and 21 April, however, resulted in a lot of ruin. Substantial damage was caused above all to flowering fruit trees and budding vines. The frost period in **Slovenia** during 21 and 22 April caused considerable damage in agriculture. The fourth cold wave in **Serbia** of 2017 lasted from 18 to 22 April, with the longest duration, of 6 days, between 20-25 April, in Sjenica.

Severe thunderstorms, accompanied by torrential precipitation or hail events, hit many regions in West and Central parts of **Bulgaria** on 15 and 16 April. In some places, a hail precipitation with size about eggs was registered. On 20 April a new snow covers up to 10 cm was observed in non-mountainous parts in North Bulgaria. Low temperatures, snowfall or frost caused considerable damages to the fruit crops.

Spring-like temperatures were recorded during the first half of April in **Finland** with highest temperature (14.4°C) at station Hattula on 10 April. The second half was much colder with snowfall and graupels of 1 to 2 cm in size. In **Estonia** it was the fourth coldest April since 1961 with 3.0°C (together with April 1974 and 1971). In **Russia** in the region around Smolensk minimum temperature falls down to -15°C.

May 2017 was warm in south-western and cold in north-eastern Europe. The highest maximum temperature in **Norway**, 31.8 °C, was recorded on 27 May at Sigdal – Nedre Eggedal (Buskerud). This was a record high temperature for May in Norway and also the highest temperature of the year. In **Sweden** the highest temperature for the year was recorded at Oskarshamn with 30.1°C on 28 May. This is only the third time during the last 100 years that the highest temperature in the nation has been reported in the month of May. From the 9th until 12th of May **Latvia** was affected by a cold wave, when 39 new minimum air temperature records were set. In 8 observation stations new latest snowing records were set (Observations started in 1895) leading to a reduction in harvest of fruits and berries due to late frosts (Figure 4.4).

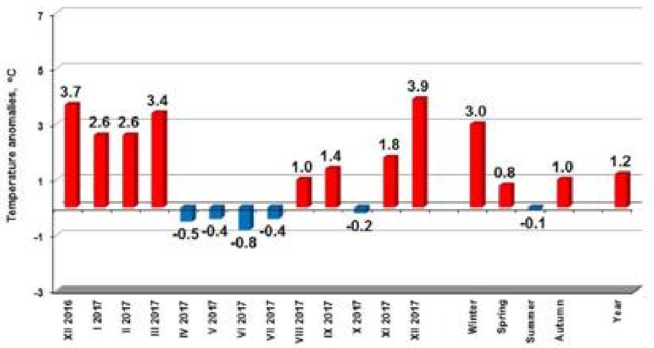


Figure 4.4: Latvian monthly, seasonal and annual mean air temperature for 2017

The weather in **Lithuania** became suddenly cold on May 8: maximum daytime temperature rose merely to 8–13 ºC, and on May 9 at night and in the morning a snowfall was observed in many regions. This extraordinary cooling with winter-related phenomena, such as wet snow-stick, snow cover and even outbreaks of frost, lasted for 6 days. During this period, even the maximum daytime air temperature ranged merely from 5 to 10 ºC, and only on May 13 it jumped locally to above 15 ºC. Mean daily temperature of those six days were typical for the end of March and the beginning of April and did not reach 8 ºC, and on some days even 5 ºC! On May 9–14 many meteorological stations observed morning frost during active plant vegetation. Air temperature dropped to -0.1...-5.5 ºC, and on the soil surface to -1...-6 ºC, on the coldest nights of May 11–12 it fell locally to -7...-8 °C at 2 cm height above the ground. A considerable damage was done to field crops, fruit trees and other plants (Figure 4.5).

Figure 4.5: Unusual snow cover during cold air intrusion on 9-11 of May, 2017 in Lithuania (Photo: from Telsiai meteorological station, provided by the LHMS)

The maximum air temperatures, recorded at **Luxembourg**/Findel-Airport on May 28, 2017 (31.5 °C) and on May 29, 2017 (31.6 °C), exceeded the existing absolute record from May 2009 (30.4°C) on two subsequent days. A heat wave during 12-13 May occurred in the central and southern parts of **Greece**. Many stations over south-eastern mainland recorded temperature records e.g. Argos measured on May 13th, 2017 Tmax = 40.6°C while its monthly average (1981-2017) is 27.0°C.

June 2017 was warm in south-western and cold in north-eastern Europe. From 17 to 21 June **United Kingdom's** temperatures exceeded 28 °C widely across parts of England, with some locations reaching 30 to 32 °C. On 21 June Heathrow (Greater London) recorded 34.5 °C, the UK's highest June temperature since 1976. The heat resulted in some speed restrictions on rail lines to avoid buckling, and there was an increased risk of high air pollution for congested areas such as the East Midlands. The daily maximum air temperature at **Luxembourg**/Findel-Airport of 35.4 °C, recorded on June 22, 2017 is the highest value ever recorded in June since 1947. June 2017 (19.1 °C) is the third-warmest June in station history. With a mean temperature of 21.2°C (2.8°C above normal) June was the 2nd warmest for France with a lot of temperature records being broken.

June was the 3rd warmest for **Serbia**, 2nd warmest for Novi Sad, Zrenjanin and Cuprija. A severe heat wave occurred from 20.06 to 2.07.2017 in **Bulgaria** with maximum temperature up to 42.5°C in Sandanski and 43.6°C in Ruse. The Heat wave in **Greece** persisted between 29 June and 3 July 2017. Most regions of Greece experienced high temperatures; the daily maximum temperatures on June 30, 2017 exceeded 40 °C in many parts especially in July. On 1st July Larissa (airport) reported a maximum daily temperature of 43.2 °C

The heat wave from 12th to 16th **July 2017** in Spain is remarkable as the absolute maximum temperature of 46.9 ºC which was observed in Córdoba Airport on 13th July 2017 turned out the 4th warmest for **Serbia** with two heat waves and record-breaking numbers of tropical nights. **Cyprus** recorded 5 heat waves and July 2017 was the warmest month recorded for at least the last 30 years. Specifically the mean provisional daily maximum temperatures of Athalassa, Prodromos, Pafos Airport, Larnaka Airport and Paralimni are the highest temperatures ever recorded for the last 30 years. From 30 July - 5 August a heat wave was observed in the **Czech Republic** with a maximum temperature 38.3 °C, such an event occurred once per five years, recently more severe heat waves were recorded in 2015, 2013, 2010. The heat wave in the **Greece** mainland last from 11 to 13 July: Maximum daily temperatures were about 40 - 41 °C

July was the warmest July ever recorded in Israel

(Contribution from Israel Meteorological Service IMS)

Alongside with July 2012 (Figure 4) July 2017 was much warmer than normal - The average daily temperature was 2-2.5°C above normal and in most stations it ranks as the warmest on record alongside July 2012 (figure 4). If we compare July 2017 to the months of August in the past then only August 2010 and August 2015 were warmer.

During the month there were three heat waves, two of them prolonged ones. The first heat wave of the month was the shorter one (July 1-4th) with temperatures reaching 40-42°C in the Negev, 42-43°C in the northern Valleys and 44-46°C in the Jordan Valley and the Arava. On July 3rd, 47.1°C were measured in Hazeva (Arava) and 46.9°C in Gilgal (the Jordan Valley). The other two heat waves were prolonged ones (on July 10-17th and on July 21-27th) yet the temperatures were not as extreme as in the first one.

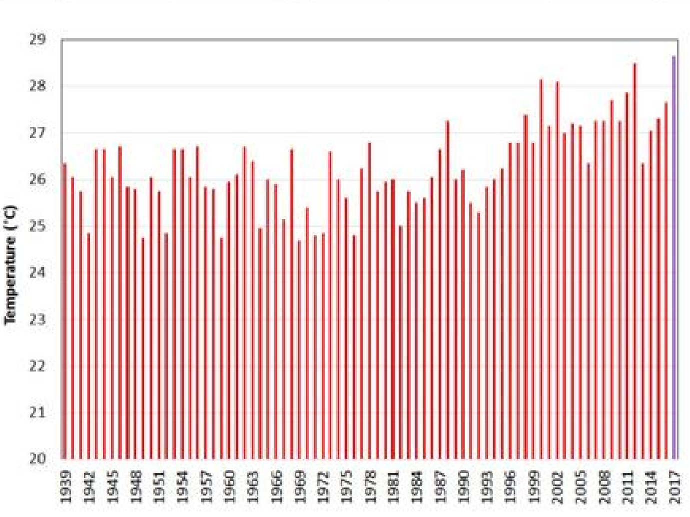


Figure 4.6: Average daily temperature (in °C) in Beit Jimal (Judean Foothills) in July 1939-2017 (Source: Israel Meteorological Service)

The highest temperature in **Finland** in 2017 (27.6 °C in Utsjoki on 28 July) was measured in the northernmost part of the country in Utsjoki and has been this low only twice before since the 1960s (1962 and 1976).

In **Switzerland** in many areas it was one of the ten warmest **August 2017** months since observations started in 1864. The warm temperatures prevailed even at night. Some meteorological stations registered the highest August minimum temperatures since measurements began: In Lugano the temperature on 5 August did not fall below 23.5°C, in Neuchâtel on 4 August not below 23°C. In Geneva on 4 August and in Basel on 3 August the minimum was not below 21.8°C respectively. On 5 August Locarno-Monti registered the second-highest August minimum with 23.9°C. All five measurement series span more than 100 years.

In **Serbia** several temperature records were broken, for example: Banatski Karlovac observed air temperature of 40.1°C thereby breaking the previous record of 39.8°C set on August 22, 2000. On August 6, Zrenjanin observed air temperature of 40.4°C besting the previous record of 39.6°C set on August 24, 2012. Absolute maximum air temperature anomalies in **Croatia** for August 2017 were above the corresponding average (1961 - 1990) at the all stations considered and were within the range from 3.5°C to 8.2°C. The historical comparison reveals that in August 2017 13 out of 27 stations exceeded or was on par with the previous maximum air temperature records of the available data series. The highest maximum temperature with 42.3°C was measured at station Knin. **Bulgaria** observed a heat wave in the south during the period 30.07-13.08.2017 (40.8°C in Sandanski) and in the north from 30.07 to 07.08.2017 (40°C in Vidin).

September 2017 was warm over most of eastern Europe and cold in Central Europe. On September 18, station Serres (**Greece**) reported daily maximum temperature of 39.9 °C while its normal monthly value is about 28.0 °C. Furthermore during 10 consecutive days (11-20 September), the maximum temperatures were above 34.0 °C. Also, station's mean monthly maximum temperature was 31.2 °C, which is the second highest mean monthly value in September since 1961 (previous mean monthly record of maximum temperature was 1994 with a value of 33.3 °C). On September 18, Tithorea station located in central mainland of Greece reported daily maximum temperature of 41.0°C.

It was the warmest **October 2017** of the last 87 years in mainland **Portugal** and also the highest average maximum temperature was recorded with 27.11 °C or +5.88° C above the normal; extreme temperature values (38.5°C at station Alvega during the 6th) for the month of October were exceeded, especially on the 15th (the hottest day of the month). At the same time **Spain** measured a maximum temperature of 35.8 °C at station Badajoz/aeropuerto. The highest temperatures between were registered in Canary Islands (Spain) during the episode of high temperatures in mid of the month, highlighting the 38.7 °C in Fuerteventura/airport and 38.6°C in Tenerife South/airport measured on day 14. In the extreme north temperature anomalies were also extreme. In the Norwegian arctic Jan Mayen was the mildest station with a mean temperature of 4.7 °C (+4.6 °C above the normal). Svalbard airport had a mean temperature of 0.5 °C (+6.0 °C above the normal).

In **November 2017** central and eastern Europe was warmer than normal while the temperature anomalies in southern Europe were normal or below the reference period of 1961-1990. In most parts of **Finland**, November was 1-3 °C warmer than usual. **European Russia** was also warm, particularly in the northeast of the Region, where mean monthly air temperature anomalies exceeded +5°C.

Temperature anomalies in **December 2017** were above normal in eastern Europe and below normal in southern Europe. Throughout December, abnormally warm weather was recorded over **European Russia**. From one ten-day period to the other, both the value of positive ten-day anomalies and the area of the warm source were increasing. Record-breaking maximum temperatures were registered in central European Russia, the Black Earth Zone, northern Caucasia, the Crimea and the Volga Region. On 17 December, the absolute air temperature record for the entire period of observations was registered in Moscow: air temperature in the morning was +8°C.

At the beginning of December Alexandroupolis (**Greece**) recorded during 4 consecutive days daily maximum temperature equal or above 18.0 °C while its monthly normal value (1971-2000) is about 10.0 °C. Furthermore, station's mean monthly maximum temperature was 13.5 °C.

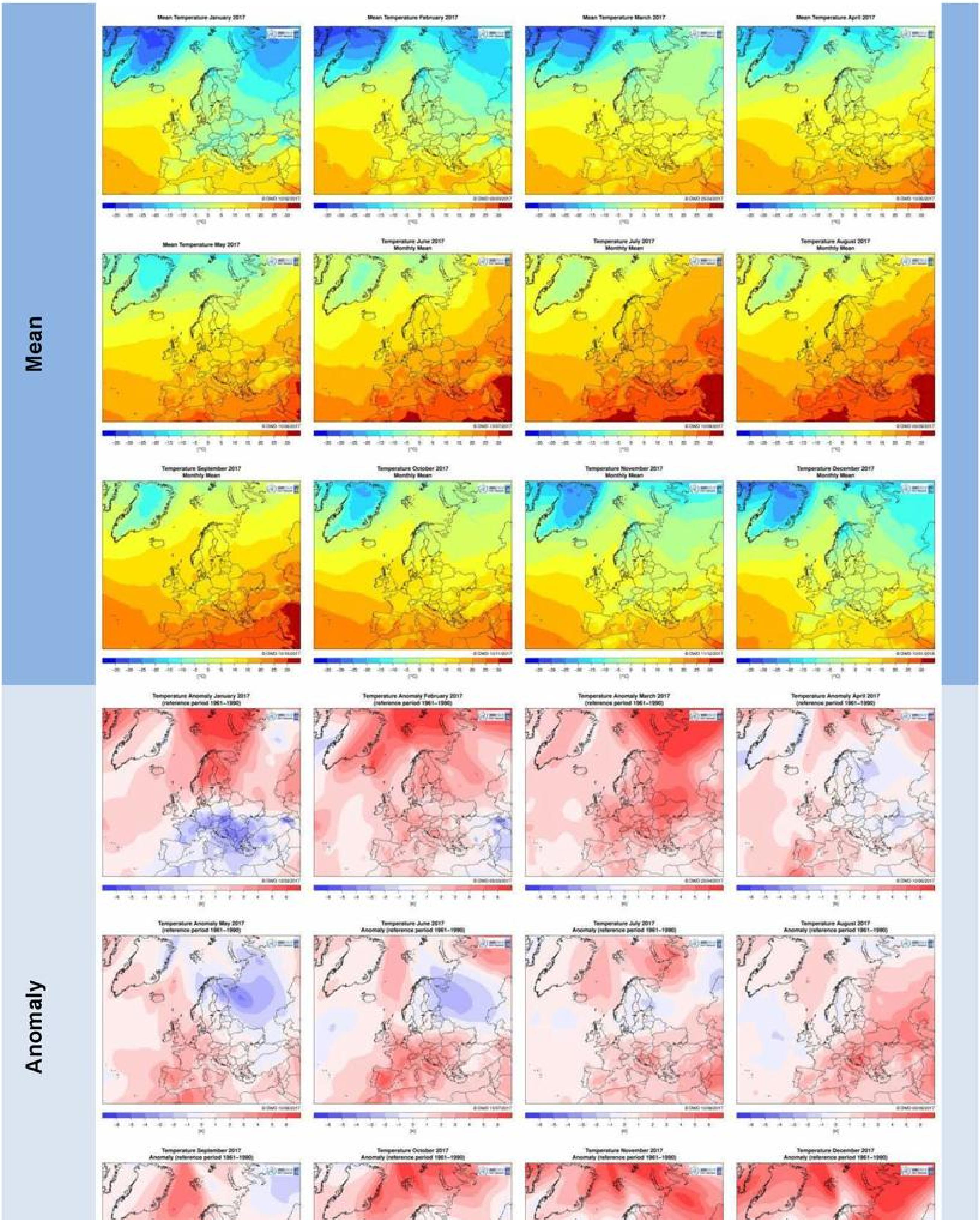


Figure 4.7: Mean and anomalies of temperature (in °C) for each month of the year 2017. (First row January, February, March, April, …; reference period: 1961-1990).

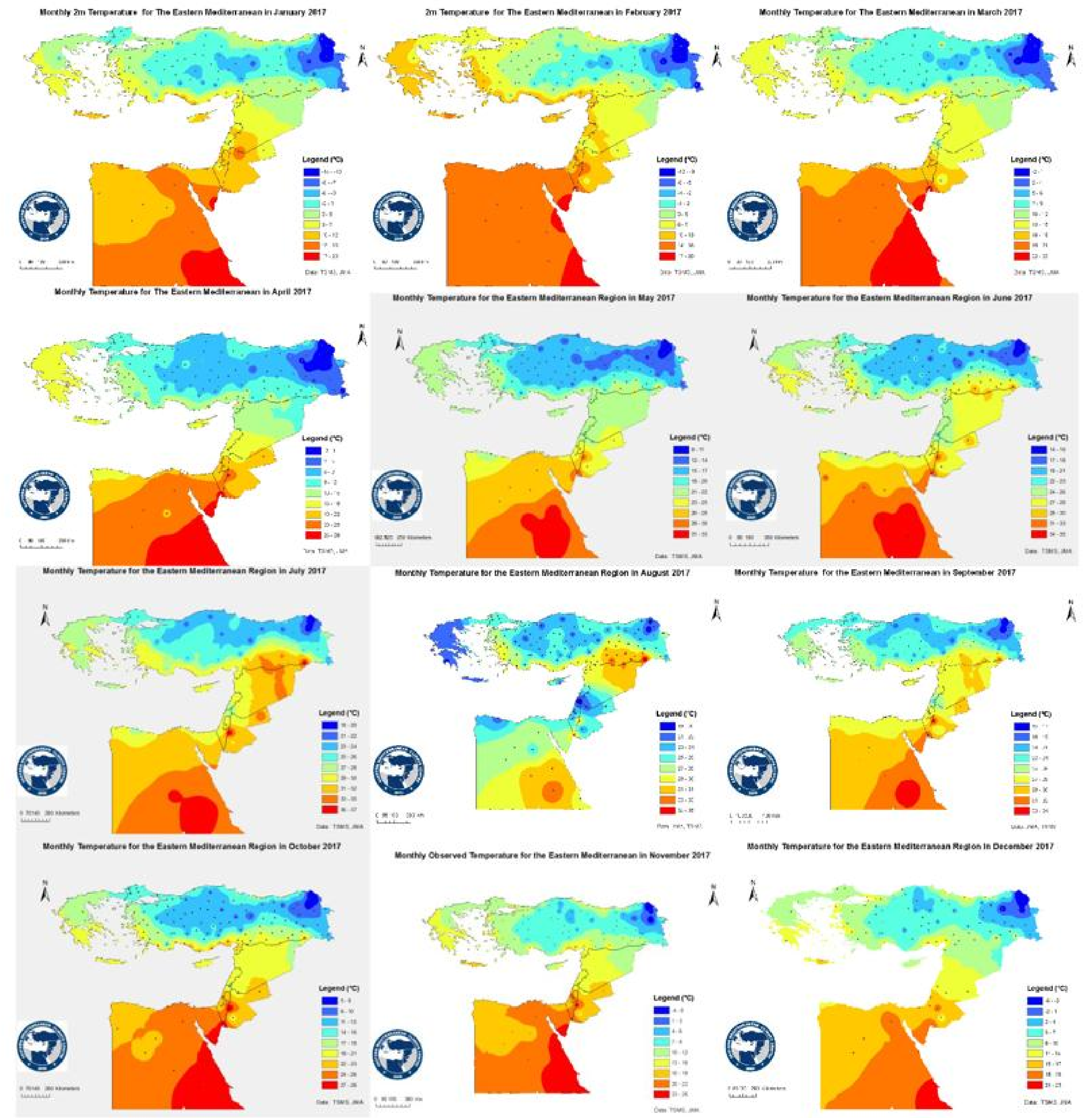


Figure 4.8: Monthly mean temperature (°C) for the eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC http://www.emcc.mgm.gov.tr/prediction.aspx; first row January, February, March, …).

4.3. Precipitation

One of the heaviest rainfalls in **Spain** this year occurred from 18th to 22nd **January 2017** and affected Baleares, Valencia Region, Murcia, Almeria, south and northeast Catalonia, Southeast Aragón and east Castilla-La Mancha, which in many places were snow precipitations. In the far northeast of Alicante and in the north area of Mallorca the accumulated precipitation during this event was more than 250 mm (117 mm/24h recorded in Castellón de la Plana / Almazora on January 19th).

From 27th to 29th January on **Cyprus** snow was observed at mountainous and semi-mountainous areas and reached locally 10 cm and at the highest peak-Olympos 15 cm. Last time of snowfall in Akaki on the 1st January (Nicosia district) was in 1952. January was not only very cold but also a very snowy month in **Bulgaria** with positive precipitation anomalies, especially in East Bulgaria (257% in Omurtag, North-East Bulgaria; 287% in Sredets, South-East Bulgaria). The snow cover reached 1m in Isperih, North-East Bulgaria. Wet conditions dominated in most parts of **Greece** during the second half of January. The precipitation amounts for January were 140 -260 % above climatological normals (1971-2000) for the greatest part of Greece.

From 1th to 6th **February 2017** in **Spain** a heavy precipitation event mainly affected the northern half of the peninsula which accumulated more than 200 mm in some areas of Galicia, and, in the same month, the one from 11th to 13th that affected to the west of the peninsula and were more intensive over the Central System (137 mm/24h recorded in Puerto de Navacerrada on February 12).

Floods on February the 11th in eastern Algarve

(Contribution from Instituto Português do Mar e da Atmosfera, I.P.M.A.)

On February the 11th, strong precipitation occurred in eastern Algarve, especially in the municipality of Vila Real de Santo António. The strong and persistent precipitation and hail caused several floods in this region. The daily precipitation value on this day (00-24UTC) was 98.1 mm, however it was between 14 UTC and 20 UTC that the highest precipitation values occurred and in 1h (18 and 19 UTC) 57.8 mm was observed. Figure 4.9 shows the accumulated precipitation values (mm) in 24 hours, on February 11th, 2017 estimated by a combined method radar/udometer.

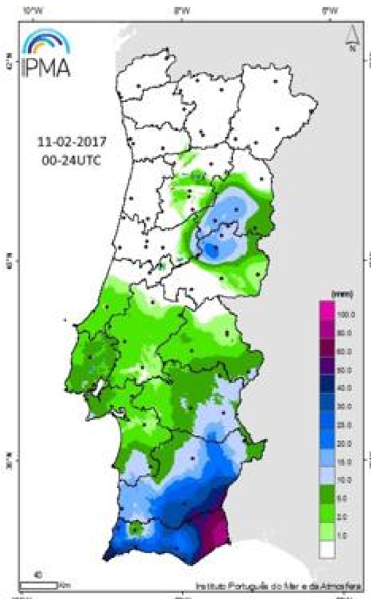


Figure 4.9: Daily precipitation (mm), on 11th of February, 2017, estimated by the combined method radar/udometer.

In **March 2017,** a remarkable precipitation episode in **Spain** from 12th to 13th affected the southeast of the peninsula, with more than 120 mm/month in some areas.

At the beginning of March, in **Lithuania** a 2–13 cm snow cover formed again in many regions, it melted by the middle of the month. The precipitation amount in **Norway** was 130% of the norm. The highest relative amounts could be found in northern Norway, from just over 200 to almost 400% of the normal. Some stations in eastern Norway got less than 50% of normal rainfall. In most countries of the RA VI the precipitation amount in March was around normal without extreme events.

In **April 2017**, the episode from 25 to 29 that affected mostly of **Spain**, with intense rainfall on 27 and 28 in the area of Huelva, Ceuta, southern Cádiz and Málaga with new daily records set in Ceuta on April 28 with 184 mm.

The southern part of Lower **Austria** and Obersteiermark (state of Styria) was affected by heavy snow fall during 19th and 20th of April with more than 750 vehicles caught in traffic jam for hours (even the whole night), temporary more than 25.000 homes were without power.

April was (according to the reference period 1961-1990) exceptionally wet especially in the middle and northeastern part of **Slovakia**. Maximum precipitation amount 425.7 mm that is 432.6% of normal and was measured at Lomnický štít (mountain meteorological station). According to the long time series (historical measurements) since 1901, and individual station precipitation totals in north parts of Slovakia April 2017 was from 1st to 3rd wettest since 1901. The consequence was a flood during 28.4. - 2.5.2017 within the tributaries of the upper Váh and the upper Hron river basins (less than 500 km^2).

In the Republic of **Moldova** very difficult meteorological conditions were observed on most of the territory on April 20-21 in connection with a cyclone - rain, snow, sleet, deposition of wet snow on wires and trees, a strong gusty wind, and frost, which led to disastrous consequences for the country's economy. Amount of precipitations in the form of rain and snow, on 20-21 April, in the central and southern regions reached 35-82 mm (100-230% of the norm for the month), which in some areas in April is observed for the first time for the entire period of observations. For the first time a country wide snow cover in late April was observed. Its maximum height on meteorological sites, on April 21, in northern regions reached 5-14 cm, in the central and southern regions – mostly 20-40 cm. However, in some areas its height reached 47-57 cm, which in the winter season in these places is observed for the first time for the entire period of observations. Similar happened in **Romania** where hundreds of localities were left without electricity; traffic was disturbed along roads and railroads because of the snowfalls and frost damage were registered in many fruit cultures. In most regions of **Lithuania**, April 16 saw a snow cover of 1–5 cm, locally 9–12 cm deep, which thawed during the day.

May 2017 was characterized in **Romania** by storms and convective phenomena almost everywhere on numerous days during the month although on the average, 79 mm of water fell across the country or 19% more than the climatological normal. On the 6th, such phenomena led to hail occurrence and flooding in Oltenia, which triggered damage to a number of houses. Similar happened in different regions of Romania until the end of the month with flooding and damages at houses and crops due to heavy rain and hail. A flash flood reached the capital city of **Hungary**, Budapest on 23rd of May. One hour rainfall exceeded 44 mm and the daily mean precipitation was 55.2 mm. The mean May precipitation is 59.6 mm, thus diurnal rainfall amount almost reached the monthly average. In the afternoon of the 5th May many regions in West **Bulgaria** were hit by severe thunderstorms with strong winds, hail and short heavy precipitation. More than 20 houses were flooded in village Lilyache, Vratsa district. Many roads were blocked by broken trees. Severe convective storm with giant hailstones on 15th of May in the region of Lyubimets and Svilengrad caused significant damages on buildings, vehicles and agricultural crops. Several hailstorm destroyed agricultural crops in **Greece** in May.

In **Sweden** there was an unusually late peak of the snow cover in the northern mountains with a maximum value of 205 cm at Katterjåkk on 2nd May. Snow fall also in **Latvia** from 9th - 11th May, an unprecedented event (historical record): At 8 observation stations new latest snowing records were set (Observations started in 1895).

In **Slovenia**, during the 6th of **June 2017** a new daily precipitation record was set at station Vojsko with 200 mm/24h. Between the 1st and 6th of June a series of severe thunderstorms, accompanied by heavy rainfall and hail were registered in many regions in West and Central **Bulgaria**. In some towns and rural areas, they caused local floods and damages on vegetable and fruit crops.

On June 13th, between 17:30h and 22:30h, southern **France** (Haute-Loire) was struck by exceptionally intense and localized rainstorms. Between 20h and 21h, the accumulations exceeded locally 150 mm and up to 300 mm in 4 hours (after radar images). At station Landos-Charbon 226 mm were measured during the episode, 122.7 mm in 1 hour (between 20 and 21h) and 21.5 mm in 6 minutes.

Severe thunderstorms during the 22nd and 23rd with hail of up to 8 cm in diameter, heavy rain and gusts of up to 39 m/s (140 km/h) in western and northern **Germany** caused damages of about 640 Million Euro and two deaths. Numerous houses and vehicles were damaged and delays in air and rail traffic occurred. The affected agricultural area was 500 km^2 with damages in crops, fruits, vegetables and vineyards (MunichRe 2018). A rain band moved from southern **Germany** to the north during the 29th and converged with thunderstorms coming from Poland leading to heavy and long lasting rainfall. The highest daily totals of 197 mm were measured at the airport Berlin-Tegel (return period of 100 years) and also 73.5 mm in Potsdam. The highest daily total in the history was below 90 mm, measured at a surrounding station near to Berlin. The enormous amounts of water led to flooding and the fire brigades in the capital reported 1830 weather-related missions during this exceptional event.

From 28 - 29 of June an extreme precipitation episode was observed in the **Czech Republic** with more than 100 mm in 2 days, such an event occurred once per five years. In **Austria** thunderstorms with heavy precipitation and hail caused more than 4 Million Euro agricultural damage. In **Lithuania** on 29th of June very severe storm in southeastern regions occurred with very heavy rain (50–65.6 mm/12 hours). From 30 June to 1 July, heavy thundershower (65 mm) accompanied by hail as large as 3-8 mm and strong wind took place in Moscow (**Russia**). Railroad bed in the Moscow Central Circle and motor roads were inundated, 1200 trees were fallen, roofs of nearly 100 houses and nearly 100 cars were damaged. Two people were killed.

High precipitation amounts were measured from Ireland to northern European Russia in **July 2017**. Severe convective storms, associated with hail and strong winds hit northwestern and northcentral parts of **Bulgaria** on 3rd of July. In some meteorological stations more than 4 hail-fall events were registered in the time interval 00:00-05:45 local time (LT). In Mezdra and Levski the giant hail stones with size up to 8 cm were observed. Several locally disastrous rainfalls (>80 mm/12 h) occurred in **Lithuania** on July 1st and 11th. The thunderstorms also affected **Belarus** with 57 mm at Novogrudak on the 13th. During 25th and 26th widespread thunderstorms occurred in **Belarus** with local precipitation amounts of 77.5 mm in Minsk or 103.7 mm (16:00 - 03:00 on 26th) in Samohvalovichi with local floods and damages on houses and infrastructures.

Especially central and eastern **Germany** was affected by continuous rainfall from 24th to 27th with more than 100 mm/day at several stations. The several days lasting rainfall caused flooding and landslides. For example, in Goslar and Wolfenbüttel entire streets were flooded - residents had to be evacuated. Flooded railway lines were blocked and softened dikes secured with sandbags.

On the 27th a severe thunderstorm with wind speeds of up to 28 m/s (100 km/h), hail of up to 9 cm in diameter, heavy rain and flash floods occurred in **Turkey.** More than 90 houses, 150,000 vehicles and 4 planes were damaged. Streets and metro stations were flooded. The overall damage loss was estimated to 500 Million Euro (MunichRe 2018).

On the evening of 1st and in the night to the 2nd **August 2017**, violent thunderstorms erupted in **Switzerland** north of the Alps, accompanied by hail and strong wind gusts. At the northern edge of Switzerland wind gusts attained 25-38 m/s (90 to 135 km/h), locally even up to 53 m/s (190 km/h) brought a new Swiss rain record. At the station of Eschenz a ten-minute total of 36.1 mm fell between 02.40 and 02.50. The previous ten-minute record amounted to 33.6 mm, collected on 29 August 2003 in Locarno-Monti. A comparable ten-minute total of 33.5 mm was registered on 25 June 2017 at the Ticino observation site Crana-Torricella. The previous highest ten-minute total north of the Alps amounted to 32.8 mm, collected on 2nd May 2013 in Schaffhausen.

Heavy thunderstorms in **Austria** caused mudslides with a damage loss of more than 20 million Euro on the road system. Trees were brought down, power outages of 80.000 homes and travel disruption. On the night of 19 August a storms over the northern part of Upper Austria damaged a marquee and killed two people and at least 140 people were seriously injured.

An extreme precipitation episode was observed in southeastern **Estonia** with 84.7 mm (98% of the month's normal) in Räpina and 78.8 mm (94% of the month's normal) in Mehikoorma during 24 hours on the 24th. The heavy precipitation caused floods and washed away roads. This extreme precipitation also affected southeastern part of **Latvia** from 22nd - 24th August causing in the next hours a flash flood in the region that was one of the biggest flash flood events in Latvia on the record. 20 000 ha of agricultural lands were flooded and 17 roads were washed out.

Torrential precipitation in **Bulgaria** with duration of more than 30 hours caused local floods in southeastern parts of Burgas district in **September 2017**. More than 10 villages were flooded. In Gramatikovo the 24-hours precipitation amount of 198 mm was measured on 27th, which was 4 times over the monthly normal. September was (according to the reference period (1961-1990) significantly above-normal in most of **Slovakia**, exceptionally wet in the northern part (Orava, Kysuce region) and locally in south of Slovakia. Minimum percentage of normal value compared to 1961-1990 was 134.8% at Milhostov (southeastern part), maximum 294.6% at Hurbanovo (southern part of west Slovakia) that was the 4th wettest monthly precipitation total since 1901. According to the long time series (historical measurements) since 1901, and individual station precipitation totals in north parts of Slovakia (Tvrdošín, Dolný Kubín, Čadca) September 2017 was the wettest since 1901.

Precipitation amounts in **Croatia** were within the range of 110% - 470% of the average for this month. In September 2017, the maximum daily precipitation amount observed at 7 a.m. (CET) at the main meteorological station Zadar was 213.4 mm (12th), less than the highest daily precipitation amount on record for Zadar (352.2 mm, 11 September 1986). On 11 September 2017, rain shower started at 4:57 a.m. and lasted till noon, and then rain was recorded till 4:52 p.m. The maximum 10-minute precipitation amount for this day was 18.9 mm while the total precipitation amount during the period in question was 283.4 mm. Such amounts caused torrential floods that led to substantial property damage and declaration of state of natural disaster in the wider Zadar area. Roads, cellars, shopping centres and the hospital in Zadar were flooded, and there was a power outage in parts of the city.

Very wet from north-western to southeastern Europe in **October 2017**. The rainiest month in **Bulgaria** was October with average precipitation of about 2.5-3 times more than monthly normal (692% in Karnobat, Burgas district). A 20-hours heavy precipitation led to overflowing dams and rivers, local floods, great damages on infrastructure and 4 victims. In Karnobat the 24-hours precipitation amount of 178 mm was measured on 25th of October (460% of monthly normal). At three weather stations in **Romania**, Bucharest Băneasa, Videle (631%) and Omu Peak (207 mm), the absolute monthly maximum precipitation amounts in a month of October were exceeded. Monthly precipitation in most parts of **Lithuania** amounted to 80–125 mm (1.5–2 norms), and in some southern and most western regions to 130–260 mm (2.3–2.8 norms), locally to 277 mm (even 3 monthly norms!).

Norway was affected by two heavy precipitation events, the one from 30 September - 2 October and only 100 km eastwards the second one from 20 - 22 October 2017. During the three days of the first event 10 stations reported a total precipitation of more than 200 mm/3d and even two of them more than 280 mm/3d. New precipitation records were set for 1, 2 and 3 days at a number of stations. The highest values were observed at Senumstad with 173.1 mm in a 24-hour period (88% of October monthly normals), 236.7 mm in two days, and 281.8 mm in 3 days. For some water courses this was the largest flood ever recorded in southern Norway. In the areas most affected, both observed rainfall and flood levels exceed 100 years of return periods. The rain induced flooding and landslides. Over 40 roads were closed, several houses were destroyed, tens of thousands of people were evacuated 2000 damages have been reported and the overall losses were estimated to several 10th of millions € (hundred millions of Norwegian Kroner, NOK).

On the 20th of October 2017 a front passed southern **Norway** while a low west of Ireland (storm **Brian**) passed during the 21st Ireland and United Kingdom and moved towards Norway with plenty of rain. In southern Norway during the following days the maximum precipitation amount was registered in Bøylefoss with 192 mm/3 days (return period of 50 years) or 103.8 mm/24h at Eikeland (return period of 50 years). The high precipitation amount caused local floods but the damage and the impact was much smaller than of the event 3 weeks ago. Some roads were closed for a shorter or longer period. For this period a Climate Watch Advisory on above-normal precipitation was issued on 13th of October 2017 for Ireland, United Kingdom and Norway and terminated on 29th of October 2017 after precipitation in these countries had normalized.

High precipitation due to cyclone "Numa" in the Central Mediterranean in **November 2017**. The **Greek** station Kerkyra (airport), located in the north Ionian Sea, reported a total monthly precipitation of 439.0 mm, while its monthly normal value (1971-2000) is 182.0 mm. Also, the station reported its second wettest November since 1955 (previous record of monthly total precipitation was 446.0 mm on November 2000). Moreover on 11th November the station recorded daily (24-hour) precipitation of 94.0 mm. Station Elefsis (airport, Greece), located in west Attica, reported total monthly precipitation of 194.0 mm while its monthly normal value (1971-2000) is about 64.0 mm. Moreover, the 4-day total precipitation measured between 14 and 17 November was also high (108.9mm). Heavy rainfall hit Symi island (Greece) on 13th, causing flash floods and major problems in infrastructures, such as power and water supply. Greek authorities declared a state of emergency on the island of Symi. On 15th of November, a sudden flash flood over western Attica (Greece) caused 23 fatalities. The flooding came after a severe overnight storm. Roads were turned into muddy rivers and dozens of people were trapped inside their flooded homes. Cars, trucks, and buses were trapped in an inundated underpass in the highway between Athens and Corinth. A state of emergency has been declared in the west Attica region.

On 10/11 **December 2017** the lowest altitude levels south of the **Swiss** Alps received a snow cover of a few centimetres. Meanwhile, in the low areas of the Central Valais record snow totals were measured. Sion registered an extreme value of 60 cm within one day. This is far above the previous maximum value of 43 cm, collected in November 1971. Even the previous highest 2-day totals only amounted to scarcely above 50 cm in Sion. Shortly after mid-month over 170 % of the normal snow totals were registered in many parts of the Alps. In the entire Alpine region of Switzerland conditions for the seasonal ski tourism were ideal.

Heavy precipitation with snow melting affected **Belarus** on 10th with 35-39 mm in 4 hours.

From 4th to 7th December, a strong western and southwest wind (storm **Aina,** named by Met Norway) brought warm and humid air masses to the southern part of western Norway with a lot of precipitation over several days. The strongest wind associated with Aina was measured at Folgefonna with 33 m/s (10 minutes average), and the most powerful windgust was 44.2 m/s. Most precipitation was observed at Gullfjellet, where the 3 days totals were 284.6 mm. Such amounts resulted in floods, landslides and damages at houses and ships. Storm **Birk** (named by Met Norway, Diethelm in German) affected south-western **Norway** with heavy precipitation from 22nd - 24th of December 2017. The largest daily amount during this event was 127.5 mm on Gullfjellet (Bergen) on 23 December and more than 200 mm in 3 days. This amount of precipitation resulted in floods and landslides.

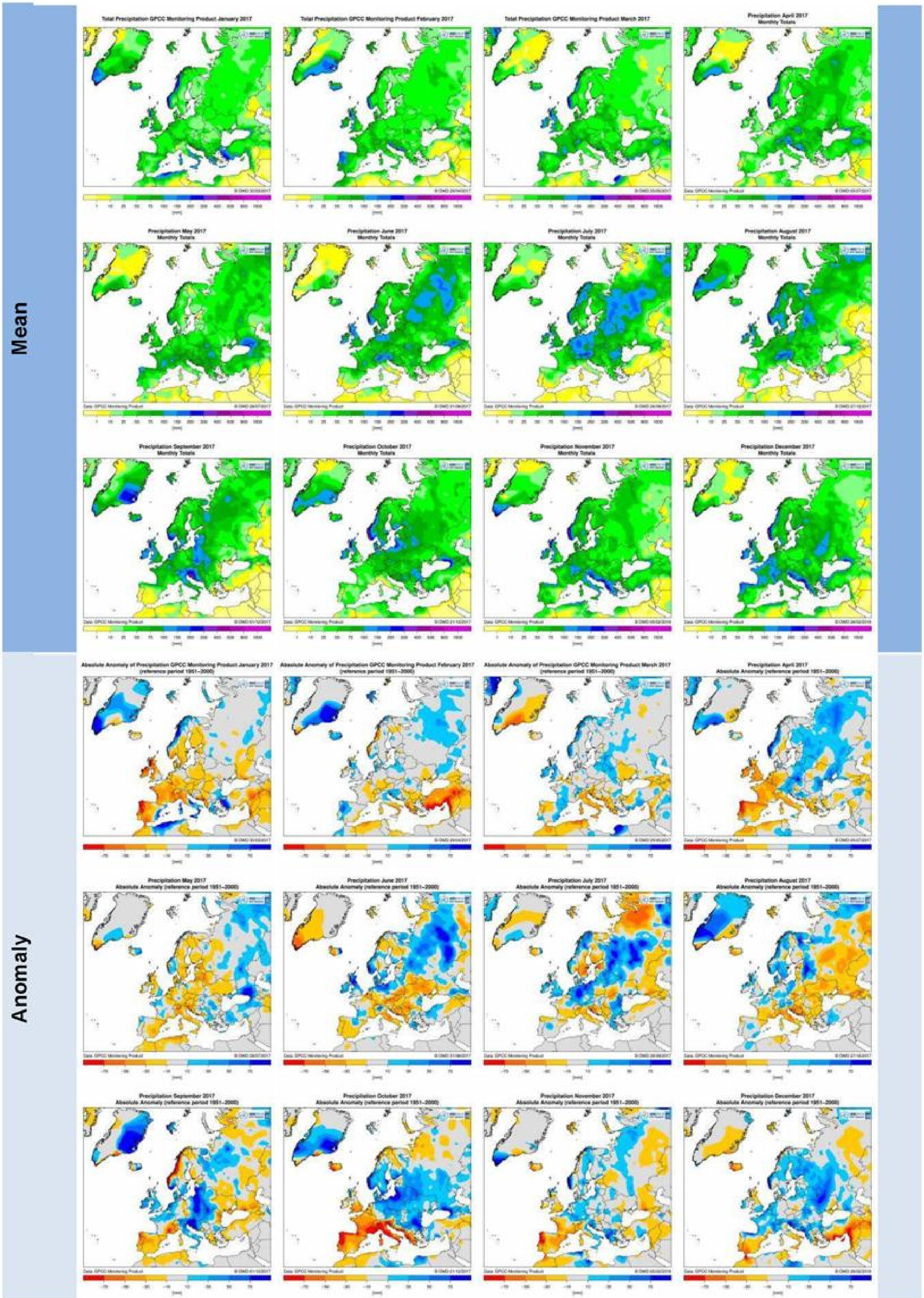


Figure 4.10: Mean and anomalies of precipitation (in mm/month) for each month of the year 2017. (First row January, February, March, April, ... ; reference period 1961-1990).

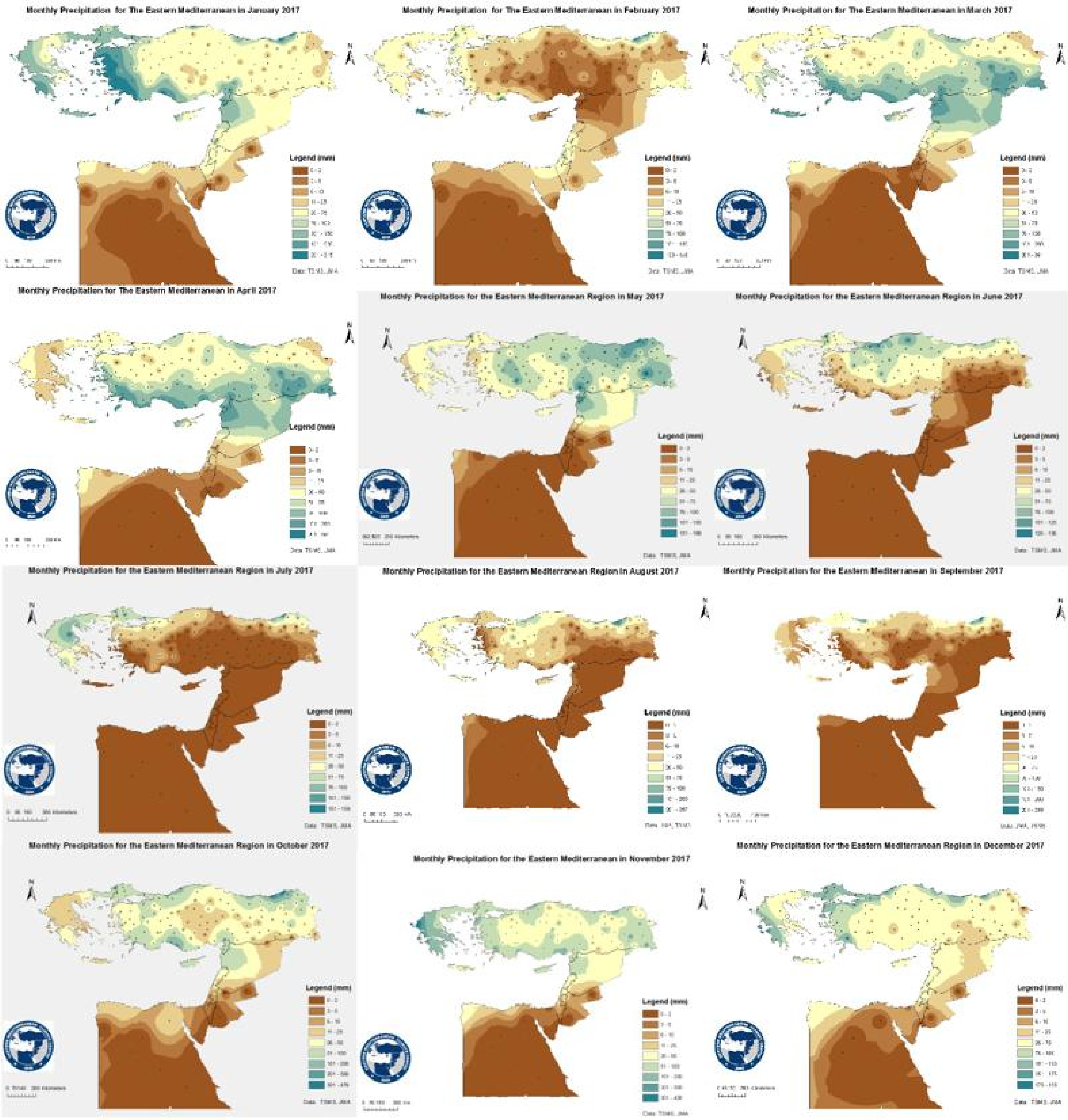


Figure 4.11: Monthly precipitation totals (mm) for the eastern Mediterranean region as provided by the Eastern Mediterranean Climate Center (EMCC http://www.emcc.mgm.gov.tr/prediction.aspx; first row January, February, March, …).

4.4. Sunshine duration

Monthly sunshine duration in **January 2017** in Central Europe was well above normal. In **Slovakia** 6 out of 14 stations measured their highest sunshine duration in this January with more than 200%. In Hurbanovo 119.7 hours or 193% of the normal (1961-1990) was registered (Figure 4.12). In **Germany** most stations reported more sunshine than usual and January became the fourth sunniest since 1951 with 143% from the normal, at some stations even more than 200%.

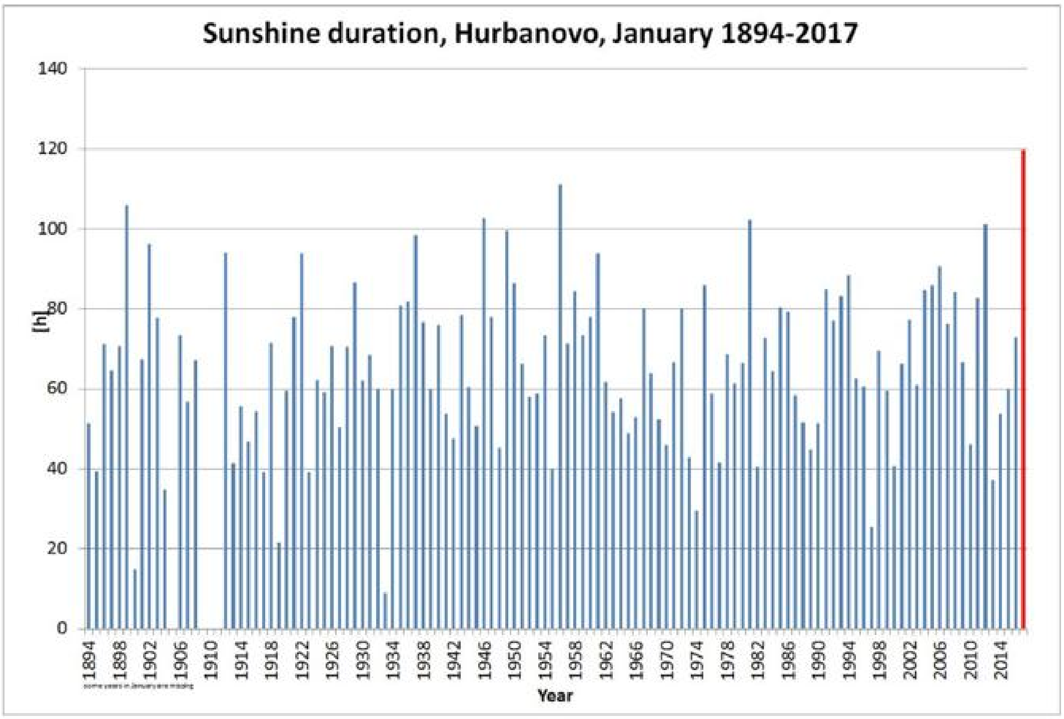


Figure 4.12: Monthly sunshine duration at station Hurbanovo for January 1894-2017 (Source: Slovak Hydrometeorological Institute)

Sunshine duration in **March 2017** in **Serbia** ranged from 115% in Leskovac up to 148% in Pozega relative to the normal for the 1981-2010 base period. The insolation ranged from 157.9 hours at Kopaonik to 197.9 hours in Banatski Karlovac.

Sunshine duration for **April 2017** in **Spain** was higher than normal (reference period 1981-2010) in all Spanish regions. The relative positive anomalies of sun hours exceeded 50% in a large part of the northern third of the peninsula, rising above 70% in the northeast of Galicia. The maximum sunshine value was observed in Izaña with 339 hours, followed by Zaragoza/Airport with 331 hours and Salamanca/Airport with 329 hours.

In **June 2017** sunshine duration was above average in whole **Slovenia**. Most sunshine hours were registered on the coast, in Portorož the sun shone for 323 hours. For the summer months, it is characteristic that in the mountains there is less sunshine than in the lowlands, in Kredarica the sun shone only 225 hours. In Ljubljana, the sun shone 274 hours, which is 15% above the long-term average.

The sunshine deficit in **France** in **July 2017** was generally greater than 10% in the western half of the country as well as in the east and often reached 20 to 30% in the south. The sun shone only 140 hours in Brest (Finistère) and 173 hours in Le Mans (Sarthe).

Most measuring stations in **Slovenia** reported in **August 2017** a surplus of sunshine between 20% and 30% above the long-term average. A smaller surplus, between 10 and 20%, was in Pomurje, on the coast, in Godnje. Most sunshine hours were measured at the airport in Portorož (352 hours).

The sunshine duration in **Germany** for **September 2017** with 121 hours was 18% below the long-term average of 148 hours. Stations on the Baltic Sea exceeded the normal values (Waren 102%).

Sunshine deficit with values below 60% occurred in the mountains (Braunlage 52%). The sun shone from 67 hours on the Kahler Asten to 162 hours in Rostock-Warnemünde.

Around mid-**October 2017** the weather in **Switzerland** was dominated for ten days by high-pressure zones. The autumn sun shone frequently from a cloudless bright blue sky. In the lower areas, daily maximum temperature rose in many parts to between 22 and 25°C. The persistent fair weather brought the Plateau and southern Switzerland the sunniest October, regionally, in the homogenous observation series spanning at least 50 years. At other stations with homogenous observation series of at least 50 years it was the second- or third-sunniest October. In **Spain** sunshine duration was higher than normal (reference period 1981-2010). The relative anomalies of sunshine surpassed 30% in central Spain and were especially significant, above 50% in north-western; reaching over 70% in some points of the provinces of A Coruña and Lugo. The maximum value of insolation was observed in Seville Airport with 289 hours, followed by Huelva Ronda Este with 286 hours and Ciudad Real with 285 hours.

In **November 2017** sunshine duration in **Spain** was more than 10% higher than the normal value (reference period 1981-2010) throughout the Peninsula. The relative anomalies of sunshine exceeded 30% in a large part of the peninsular territory and values higher than 50% were reached in some places in central Spain. The maximum value of sunshine was observed in Castellón Almassora with 246 hours.

December 2017 was dull in the Netherlands. Only 32 hours of sunshine on average over the country instead of 49 hours as in the long-term average. In the west the sun shone the least with only 16 hours. The sunniest station was Terschelling with 47 hours. In De Bilt the sun was shining only 25 hours and on 15 days the sun was not visible.

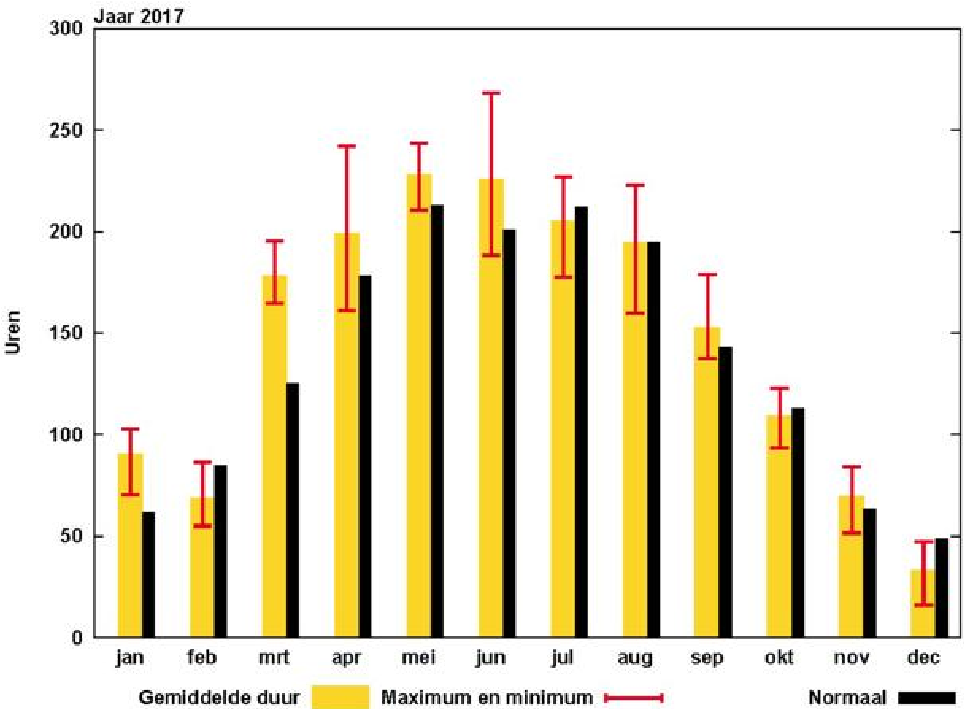


Figure 4.13: Annual cycle of sunshine duration (in hours) for the Netherlands in comparison to the normal values (black bar; source: Koninklijk Nederlands Meteorologisch Instituut, KNMI)

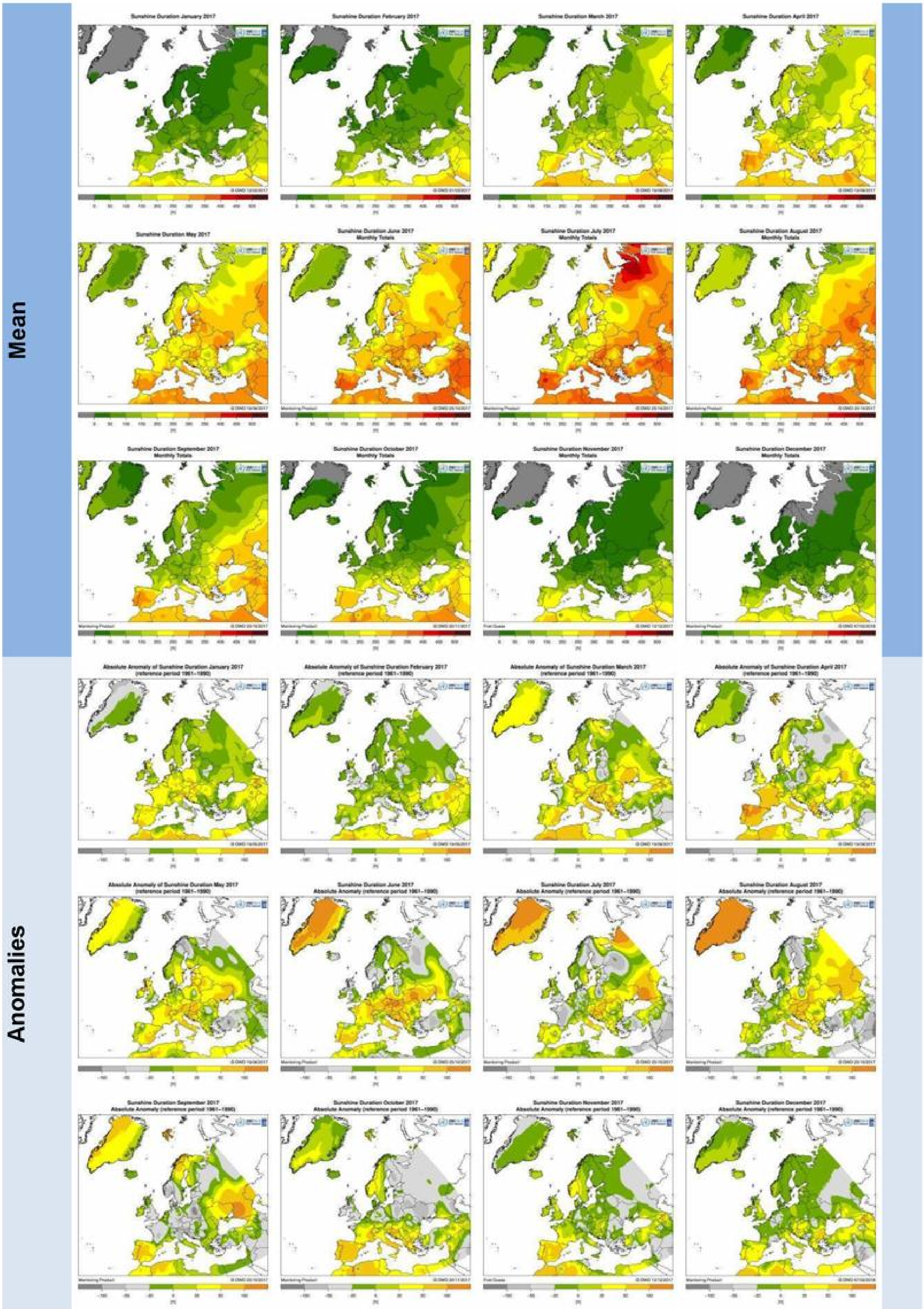


Figure 4.14: Mean of sunshine duration (in hours) and anomalies (in hours) for each month of the year 2017. (First row January, February, March, April, ... ; reference period 1961-1990).

4.5. Maps of monthly climate extremes and events

The following maps are based on different data (as noted in the legends in parentheses), and is meant to summarize weather conditions in each month of the year 2017.

In **January 2017** Scandinavia was down to +5°C warmer than normal and the numbers of warm days were above normal. Central and southern Europe showed more cold days than usual. The areas at the Norwegian and Greenland coasts were affected by strong wind gusts (storm "Axel", "Doris", "Egon") and also the Bretagne, the Gulf of Lions and the coast of the Adriatic Sea. Most of Europe was wetter than usual.

In **February 2017** more warm days than normal could be found in Europe in combination with more precipitation and storms on the coasts of western Europe.

Warmer days in **March 2017** occurred almost everywhere in Europe with strong wind gusts at the Atlantic and Mediterranean coasts. In most parts of Europe the very wet days were abnormally high.

In nearly the whole of Europe **April 2017** had more warmer-than-normal-days in combination with very wet days; only in northern and southeastern Europe cold days were more usual.

In **May 2017** more than usual warm and wet days were registered except in northeastern Europe where some cold days occurred.

June 2017 was wet and warm in many parts except in northeastern Europe where some cold days occurred. It was also drier than normal in southern Iberia.

As several month before **July 2017** became warmer than normal in the southern and western part of Europe while the North had more cold days and East Europe had more wetter days as usual.

Europe had more warm days in **August 2017** with thunderstorms in France and Iberia. Sweden had more wet days and locally some colder days. Eastern and northern Europe had in many parts a precipitation surplus.

In **September 2017** the Mediterranean coasts were affected by wind gusts from thunderstorms and with more cold days. The rest of Europe has above normal wet and warm days.

Central, northern and western Europe showed in **October 2017** more warm days than usual and strong wind gusts because Ex-Hurricane "**Ophelia**" and other storms crossed these areas. Eastern Europe noted a higher number of very wet days. The Gulf of Lions and the Aegean Sea were affected by thunderstorms with strong wind gusts.

During **November 2017** western parts of Europe showed a higher number of warm and wet days. Norway, the UK, Denmark, the Bretagne and in the Gulf of Lions were affected by strong wind gusts in November. Central, northern and eastern Europe showed more wet days than normal

December 2017 showed in the northern part of Europe more warm days than normal, but in the south more cold days. Eastern Europe was wetter than normal. Several cyclones with strong wind gusts passed over Scandinavia, the UK, Central Europe up to Greece.

The Monthly Event Map contains information about the extreme anomalies of temperature, precipitation and wind gusts. Points are calculated from station data and represent the number of very warm or cold days, the locations of strong wind gusts (>=32 m/s) and days with precipitation. If more than one extreme anomaly occurs at the same location, the point is subdivided into several different colours. Coloured areas are based on interpolated gridded data for temperature (land and ocean) and precipitation (only land areas). If more than one extreme anomaly occurs at the same grid, the area is shaded.

Legend of Figure 4.10:

- ● Anomaly of very wet days > 0 (ECAD)
- ● Wind gusts (≥ 32 m/s) (SYNOP)
- ● Anomaly of warm days > 0 (ECAD)
- ● Anomaly of cold days > 0 (ECAD)
- ■ Anomaly of TG ≤ -4K (CLIMAT and ship obs.)
- ■ Anomaly of TG ≥ 4K (CLIMAT and ship obs.)
- ■ Aridity index < -1.5 modified SPI (GPCC)
- ■ RR ≥ 150% of climatology (GPCC)

Based on climatology 1961-1990 (GPCC climatology: 1951-2000)

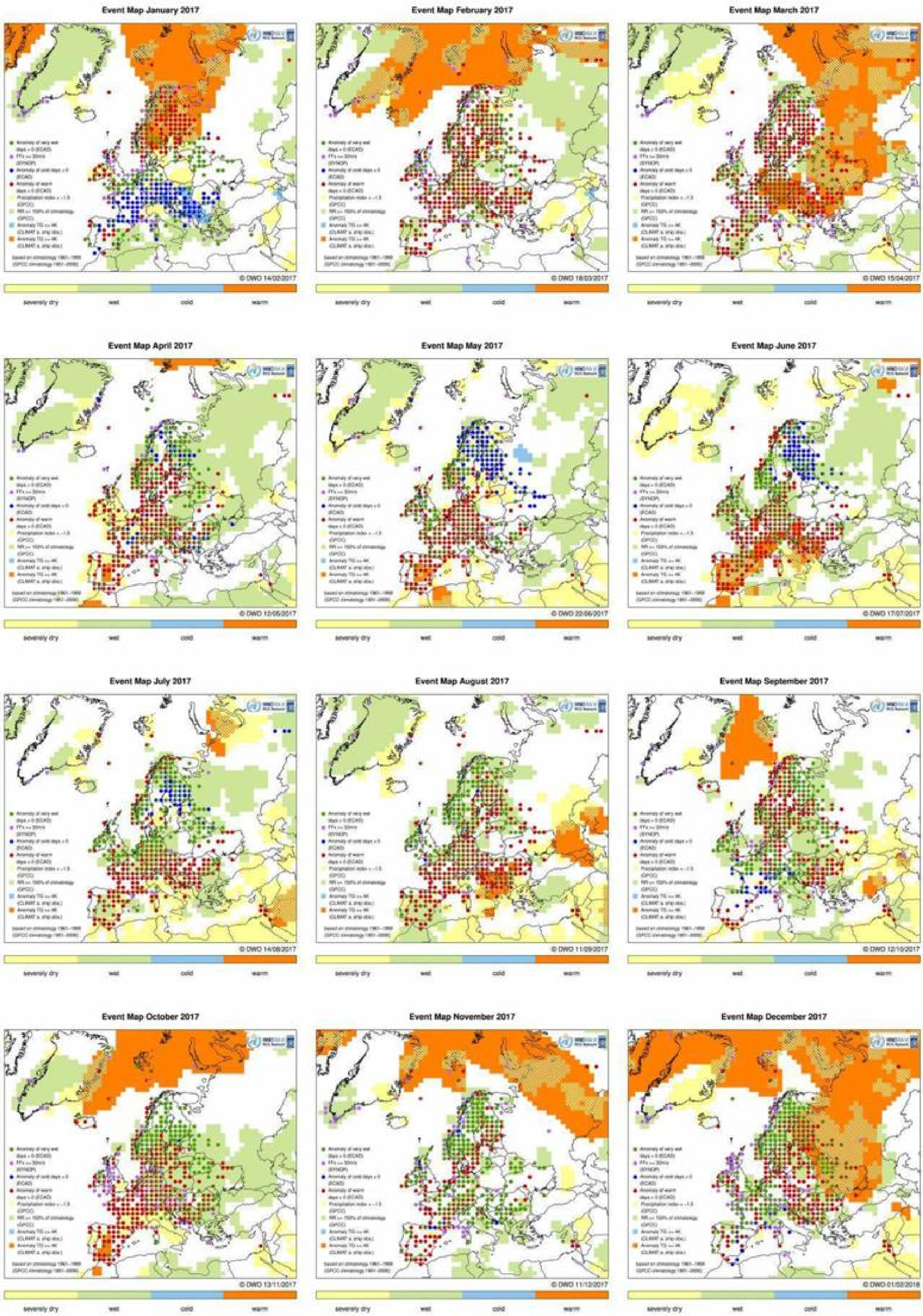


Figure 4.15: Maps of Climate Extremes for each month of the year 2017 (First row January, February, March…).

5. Long-term variability of the selected climate parameters - Regional examples

On the following pages graphs of long time series of temperature, precipitation and sunshine duration as provided by the National Meteorological and Hydrological Services (NMHSs) are presented to give an overview of the temporal development of the basic climate elements. The graphs are grouped with respect to the 6 sub-regions defined above (Figure 1.1**Fehler! Verweisquelle konnte nicht gefunden werden.**). An overview of contributing countries, time series' lengths and area representativeness can be found in Table 5.1**.** Most are temperature time series. Each sub-region is at least represented by one country. Time series of precipitation totals are fewer but each sub-region is represented by at least one time series for precipitation. Diagrams of long-term annual sums of sunshine duration are provided by 4 countries, belonging to different sub-regions.

After this, we present examples of the temporal development of other temperature-related phenomena, such as the sea surface temperature in the North Sea and sea level anomalies at the Polish station Władysławowo.

Table 5.1: Availability of the long-term records (start year) of temperature, precipitation and sunshine duration from some participant countries.

Sub-region	Country	Temperature		Precipitation		Sunshine Duration	
		Spatial Mean	Single Station	Spatial Mean	Single Station	Spatial Mean	Single Station
Central and Western Europe	Austria	1768					
	Belgium		1833		1833		
	France	1900		1959			
	Germany	1881		1881		1951	
	Hungary	1901		1901			
	Luxembourg		1947				
	Netherlands	1906			1906		
	Switzerland	1864		1864		1959	
	United Kingdom	1910		1910		1929	
Nordic and Baltic Countries	Denmark	1873	1768	1874	1821	1920	1876
	Greenland		1784		1890		
	The Faroe Islands		1873		1890		1922
	Estonia		1866		1866		1953
	Finland	1900		1961			
	Iceland		1931				
	Latvia	1924		1924			
	Lithuania	1923	1777			1961	1916
	Norway	1900		1900			
	Sweden	1860		1860			
Iberia	Portugal	1931		1931			
	Spain	1965		1965			
Mediterranean, Italian and Balkan Peninsula	Croatia		1862		1862		
	Italy	1961		1961			
	Slovenia		1961		1961		
	Serbia	1951					
	Turkey	1971		1981			
Eastern Europe	Belarus	1881		1891			
	European Russia	1939		1966		1961	
	Moldova		1887				
	Ukraine		1881		1891		
Middle East	Georgia	1960	1881	1961	1881		
	Israel	1951			1916		

5.1. Temperature

Central and Western Europe – annual temperature series

Austria, Belgium, France, Germany, Hungary, Luxembourg, The Netherlands, Switzerland and United Kingdom

Austria

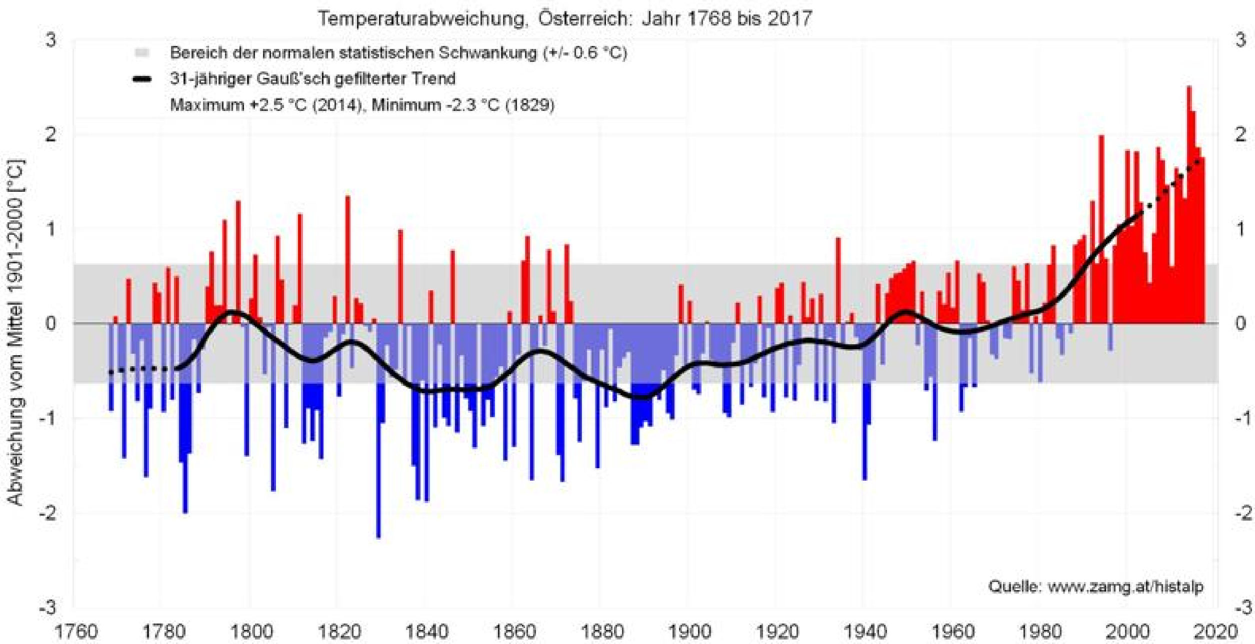


Figure 5.1: Time series of annual temperature anomalies for Austria (reference period 1961-1990, diagram as provided by the NHMS)

Belgium

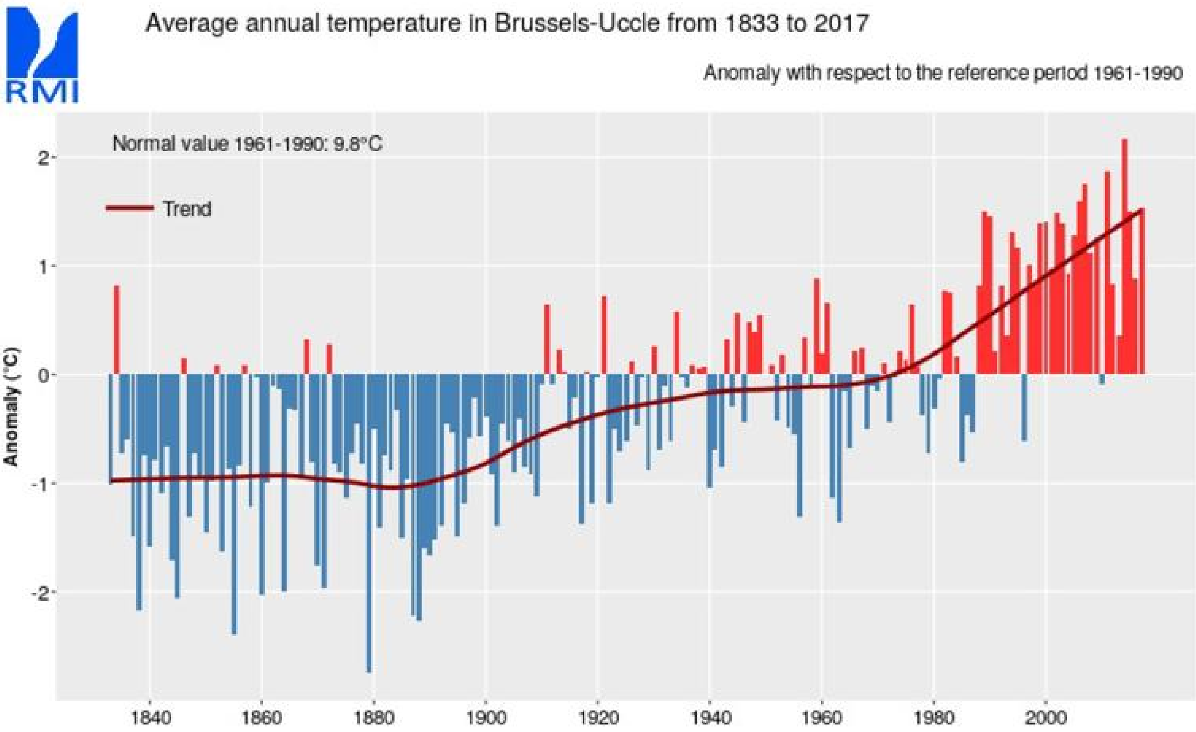


Figure 5.2: Time series of annual mean temperature anomalies for Uccle, Belgium (reference period 1961-1990, diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

France

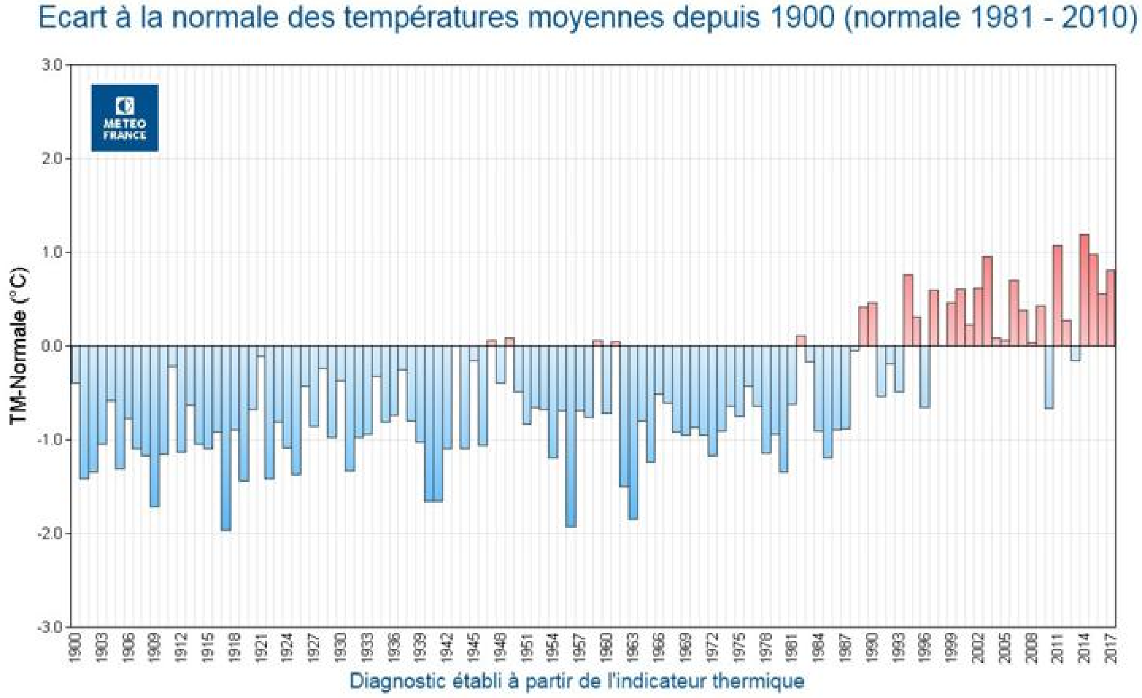


Figure 5.3: Time series of annual temperature anomalies for France for the period 1900-2017 (reference period 1981-2010; diagram as provided by the NHMS)

Germany

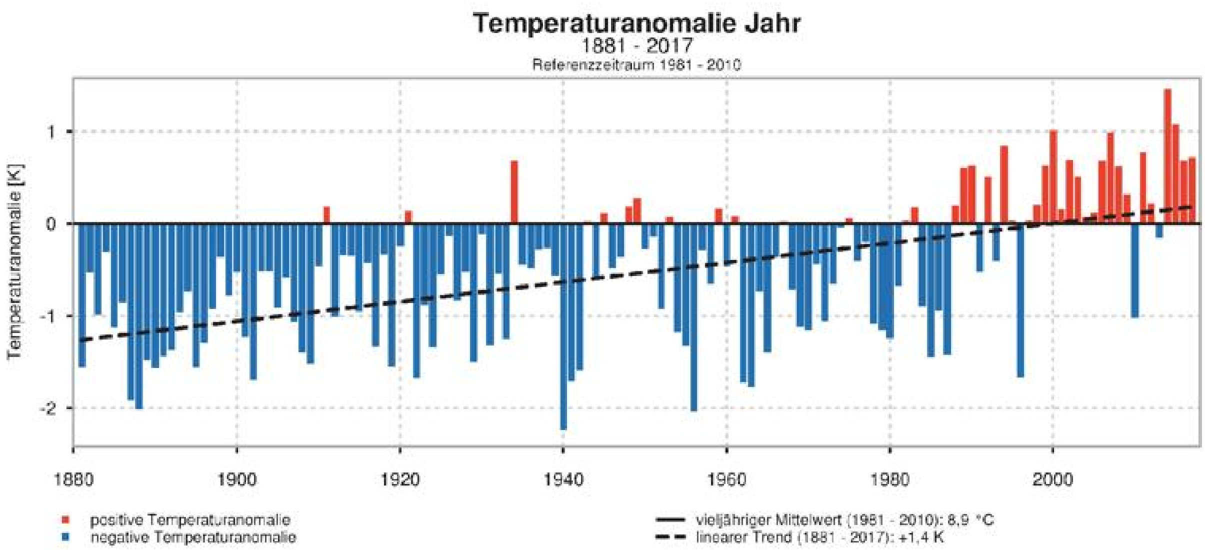


Figure 5.4: Time series of annual temperature anomalies for Germany for the period 1881-2017 (reference period 1981-2010 black line, diagram as provided by the NHMS)

Central and Western Europe – annual temperature series

Hungary

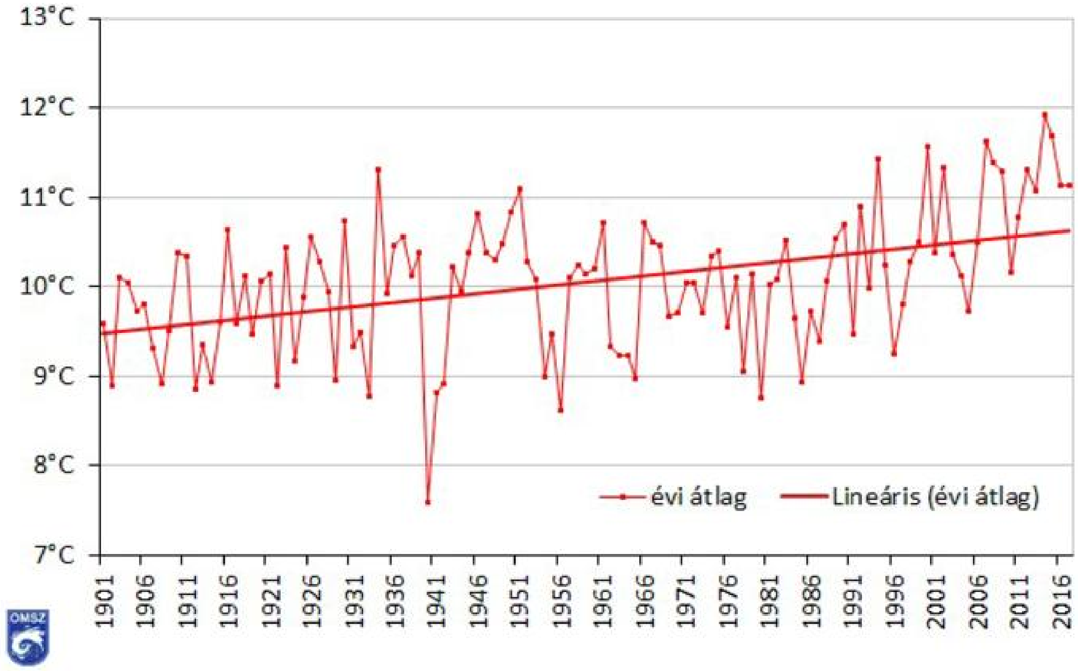


Figure 5.5: Time series of annual average temperature for the period 1901-2017 for Hungary (based on homogenized and interpolated data from 58 stations; Diagram as provided by the NHMS)

Luxembourg

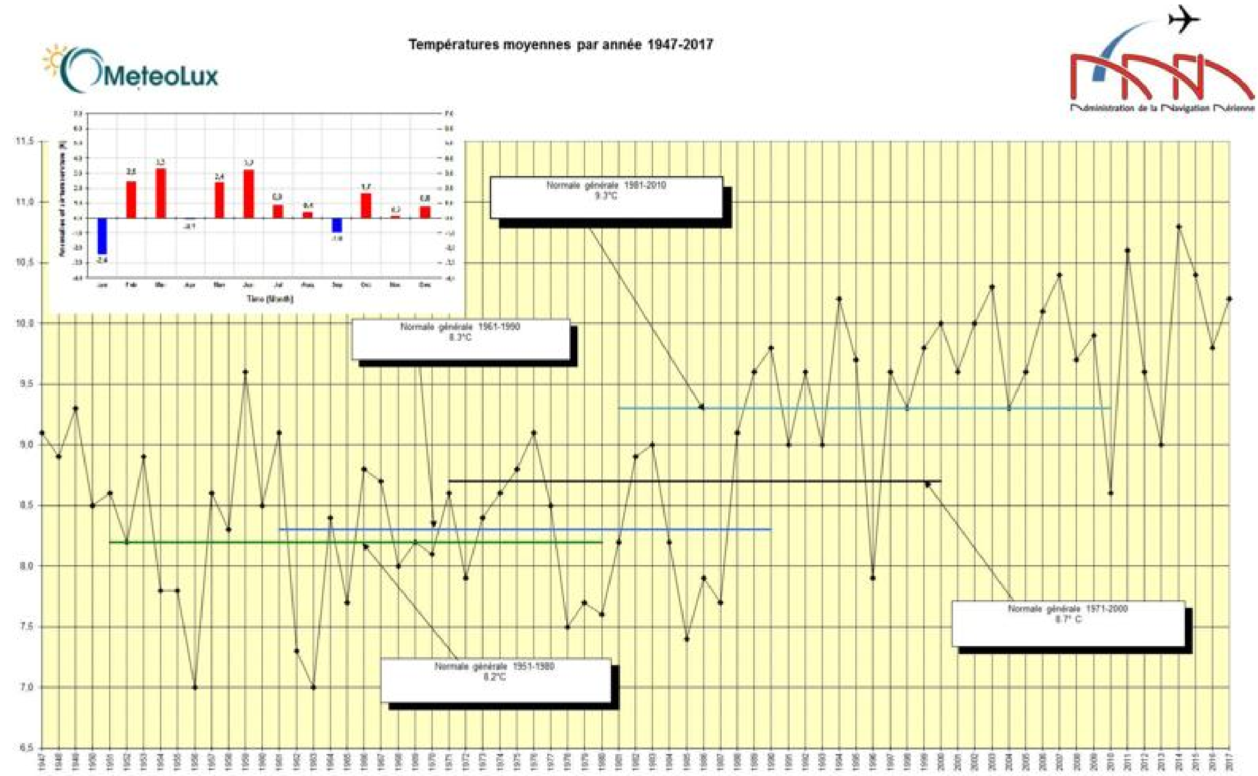


Figure 5.6: Time series of annual average temperature for the period 1947-2017 for station Luxembourg-Findel (Diagram as provided by the MeteoLux)

Central and Western Europe – annual temperature series

The Netherlands

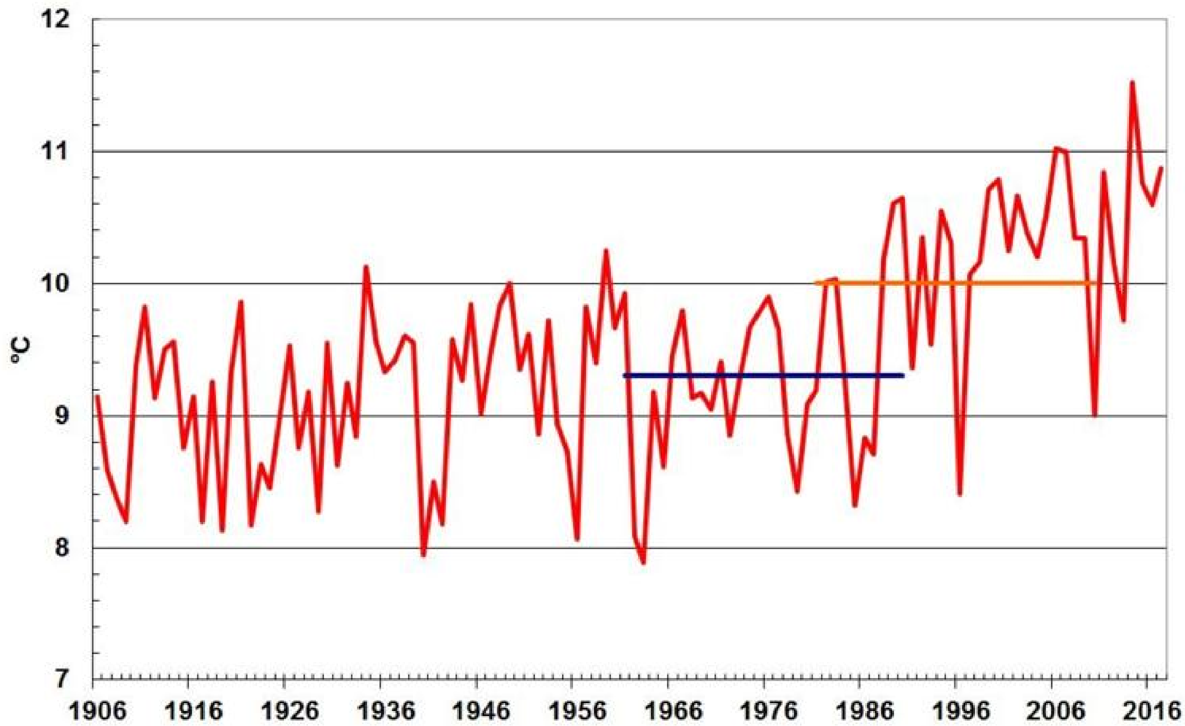


Figure 5.7: Time series of annual average temperature for the period 1906-2017 for the Netherlands (Central Netherlands Temperature v6, mean of 6 stations, blue line: reference period 1961-1990, orange line: 1981-2010; data as provided by the KNMI)

Switzerland

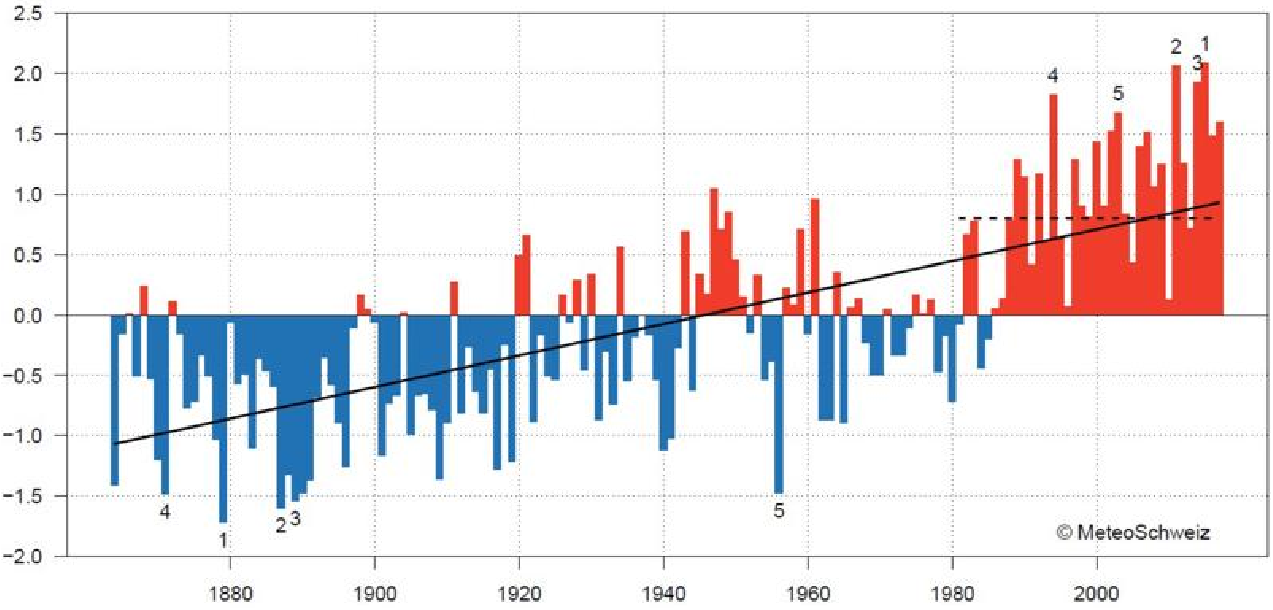


Figure 5.8: Time series of annual temperature anomalies for the period 1864-2017 for Switzerland (reference period 1961-1990, the black line represents the linear significant trend (1.29°C/100y). The black dashed line represents the mean 1981–2010. Source: MeteoSwiss)

Central and Western Europe – annual temperature series

United Kingdom

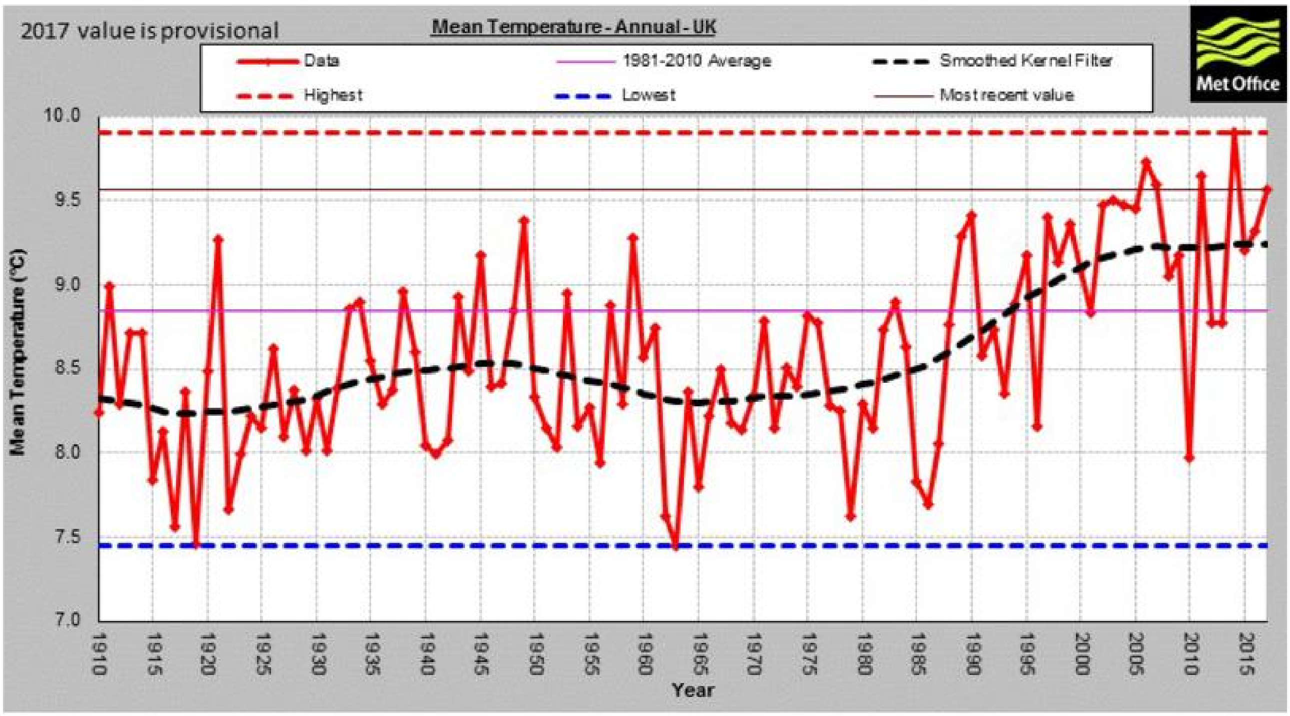


Figure 5.9: Time series of annual temperature for the period 1910-2017 for the United Kingdom (Diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Denmark, Finland, Greenland, Iceland, Latvia, Lithuania, Norway, Sweden

Denmark, Greenland, the Faroe Islands

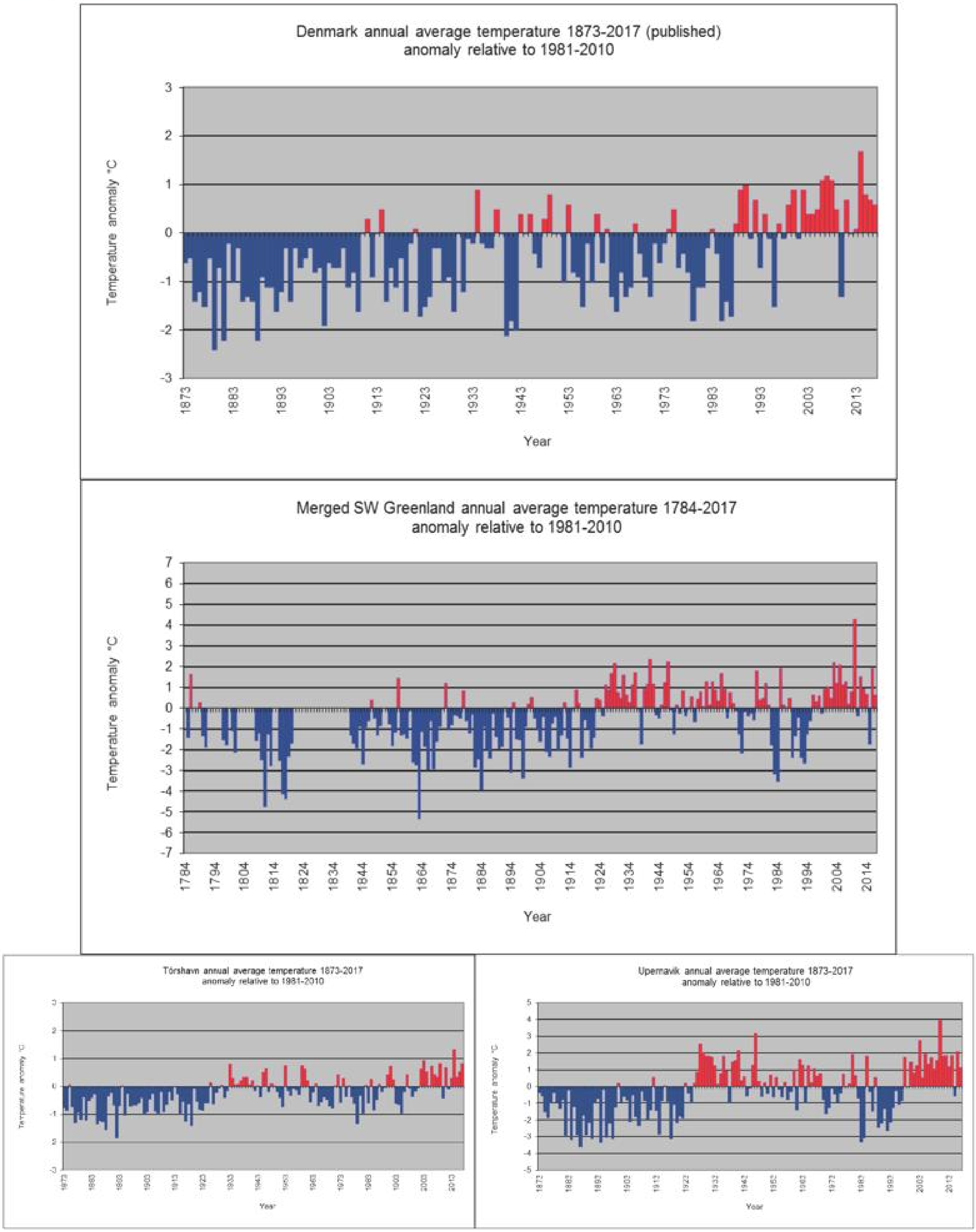


Figure 5.10: Time series of annual temperature anomalies for the period 1873-2017 for Denmark (top), 1784-2017 southwestern Greenland (middle) 1873-2017 the Faroe Islands (bottom left, Tórshavn) and 1873-2017 Greenland (bottom right, Upernavik); diagrams as provided by the NHMS

Nordic and Baltic Countries – annual temperature series

Estonia

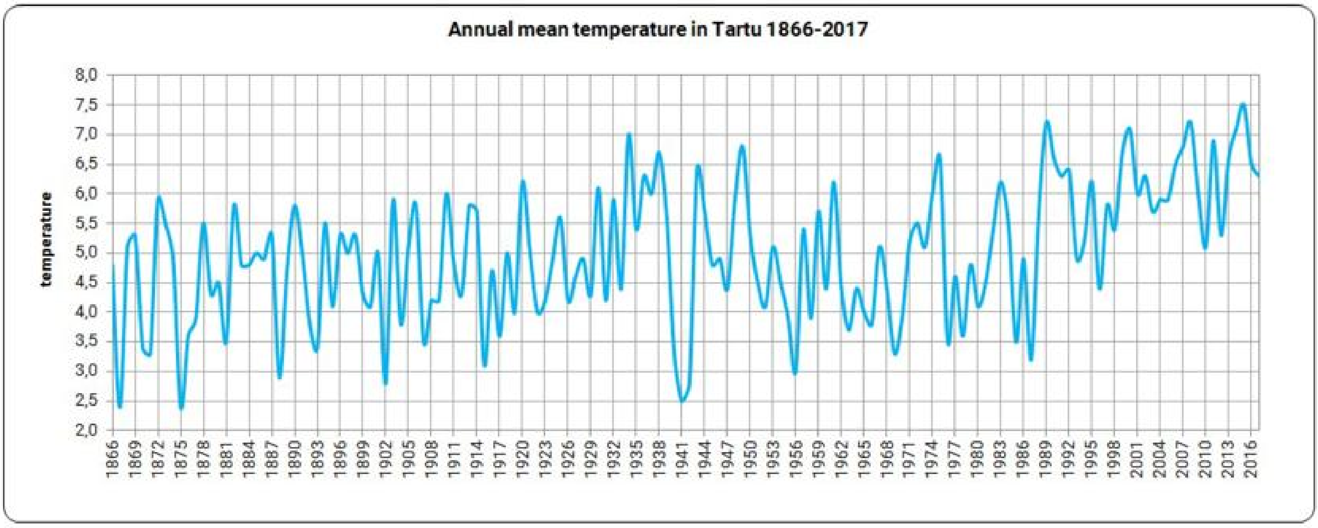


Figure 5.11: Time series of annual temperatures for the period 1866-2017 for station Tartu, Estonia (diagram as provided by the NHMS)

Finland

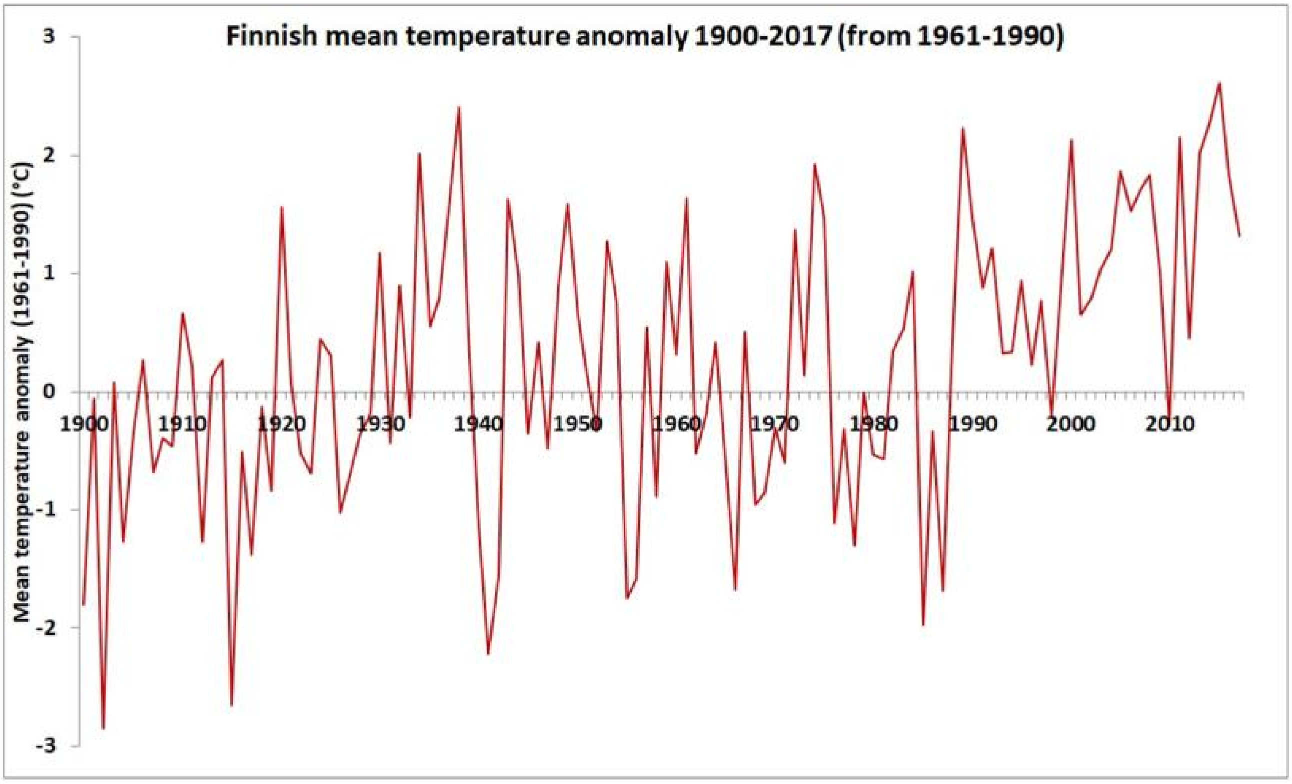


Figure 5.12: Time series of annual temperatures anomalies for Finland (reference period 1961-1990; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Iceland

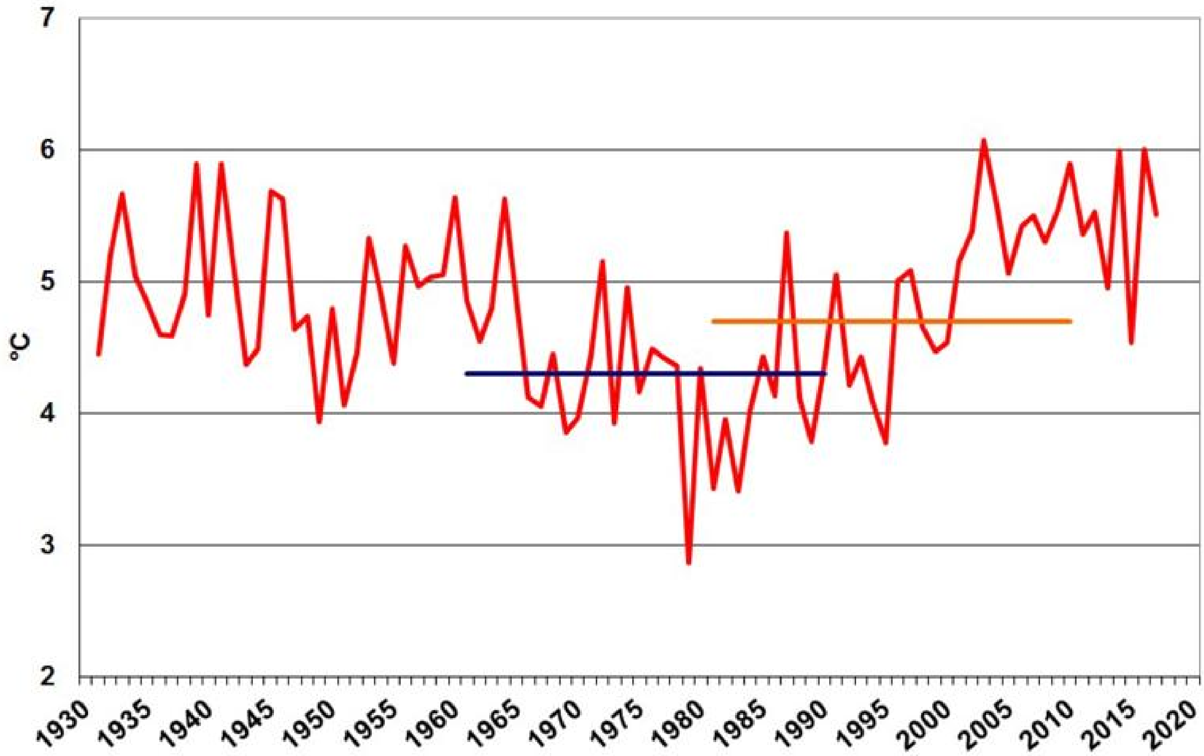


Figure 5.13: Time series of annual average temperature for the period 1931-2017 for station Reykjavík, Iceland (blue line: reference period 1961-1990, orange line: 1981-2010; data as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Latvia

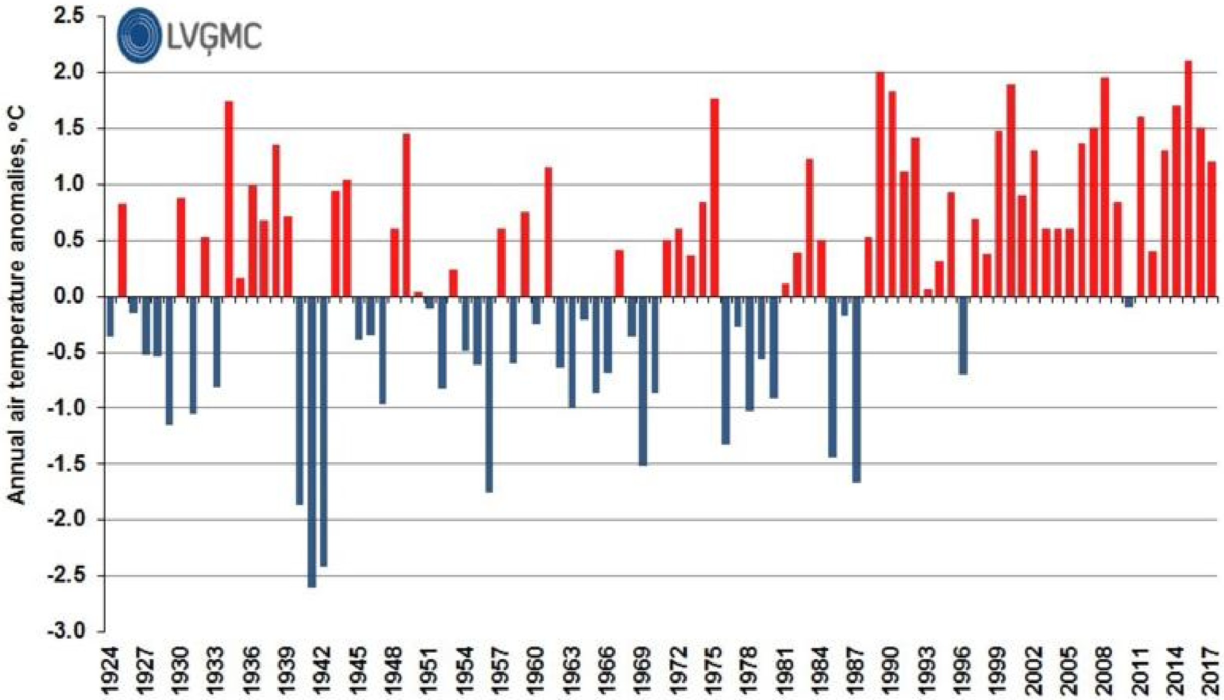


Figure 5.14: Time series of annual temperature anomalies for the period 1924-2017 for Latvia (reference period 1961-1990; diagram as provided by the NHMS)

Lithuania

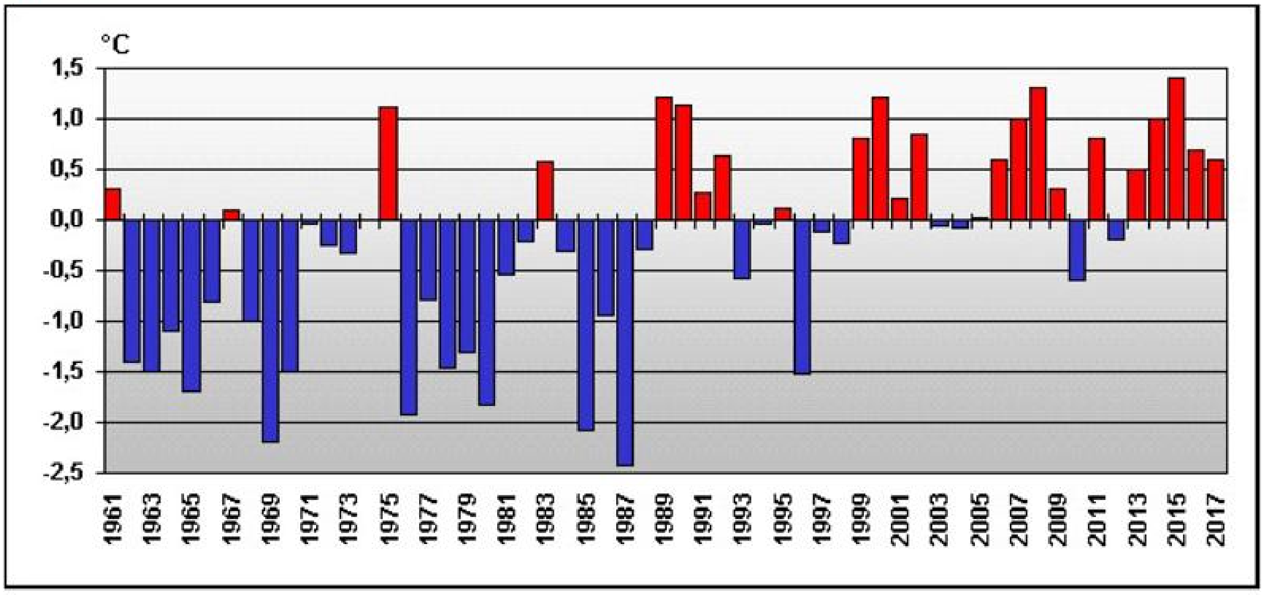


Figure 5.15: Time series of annual temperature anomalies for the period 1961-2017 for Lithuania (reference period 1981–2010; diagram as provided by the NHMS)

Nordic and Baltic Countries – annual temperature series

Norway

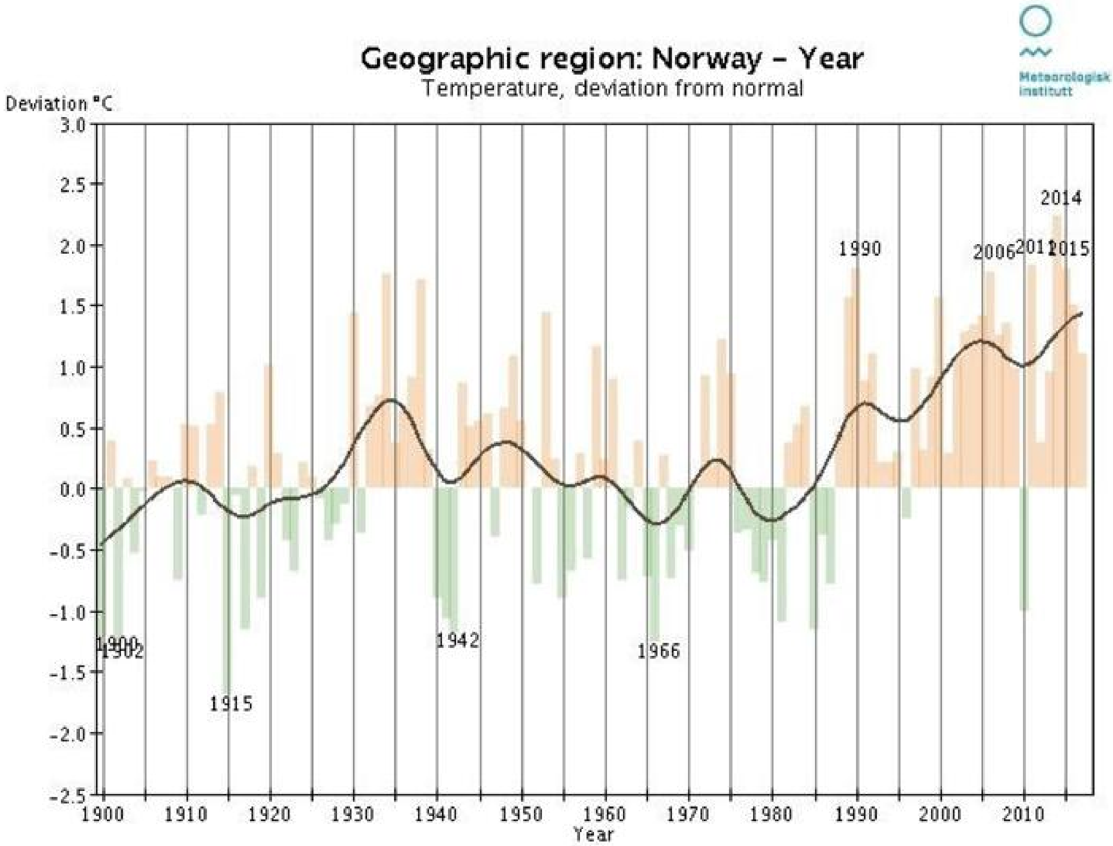


Figure 5.16: Time series of annual temperature anomalies for the period 1900-2017 for Norway (reference period 1961-1990; diagram as provided by the NHMS)

Sweden

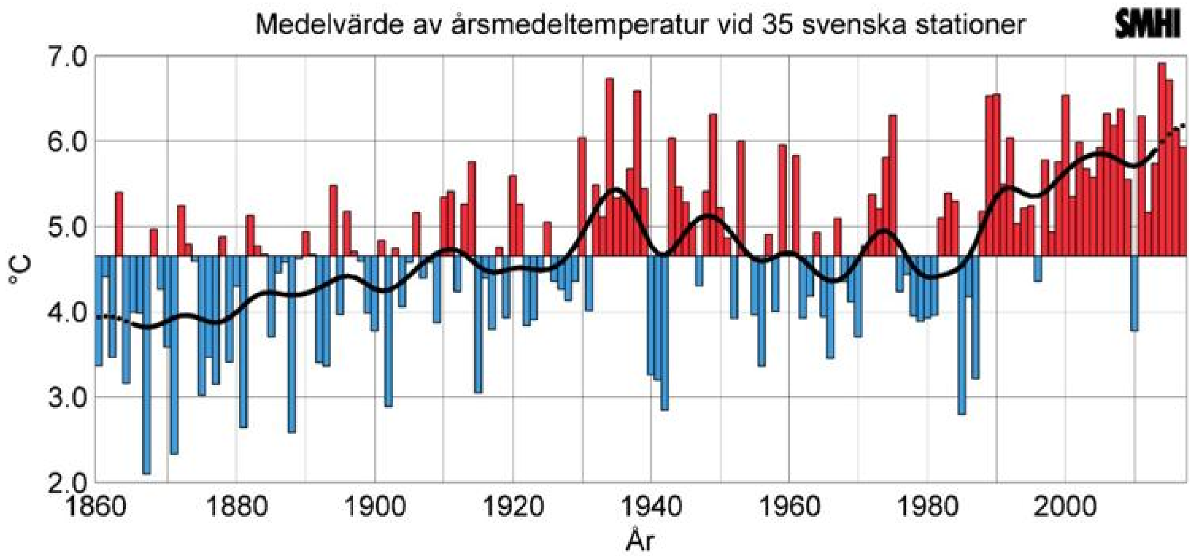


Figure 5.17: Time series of annual average temperature for the period 1860-2017 for Sweden (mean of 35 stations, diagram as provided by the NHMS)

Iberia – annual temperature series

Portugal, Spain

Portugal

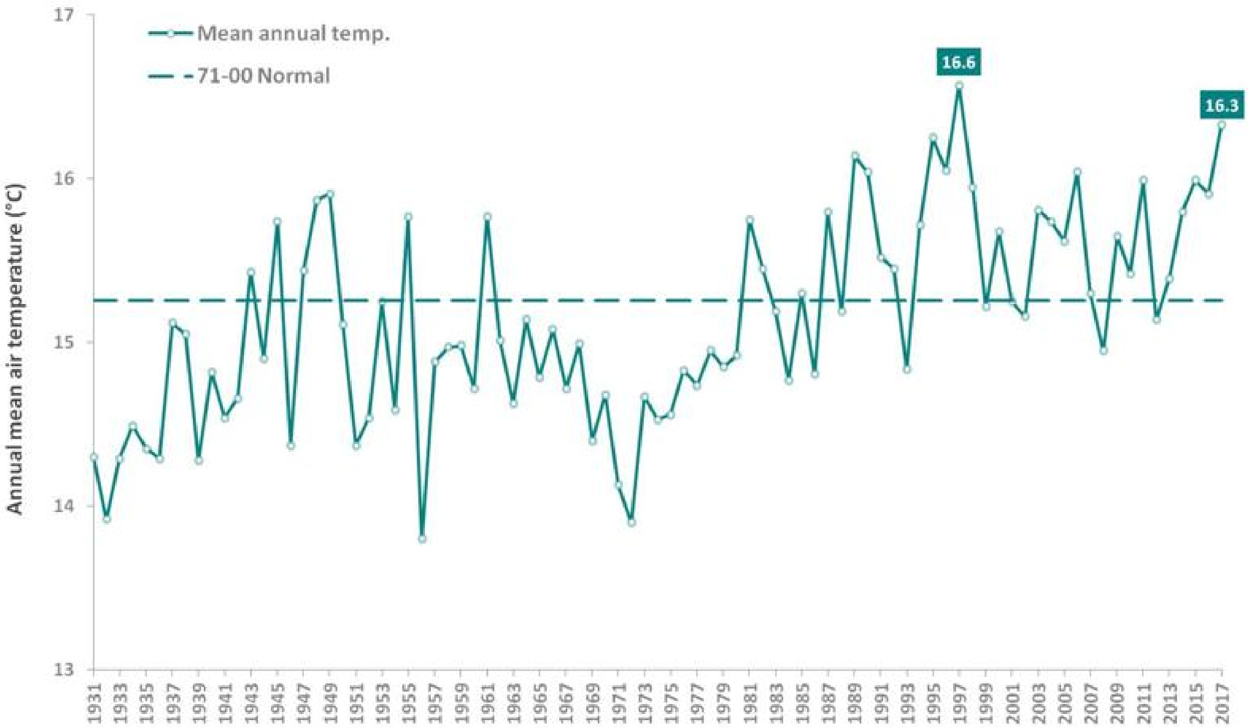


Figure 5.18: Time series of annual average temperature for the period 1931-2017 for Portugal (Dashed line normal 1971-2000, diagram as provided by the NHMS)

Spain

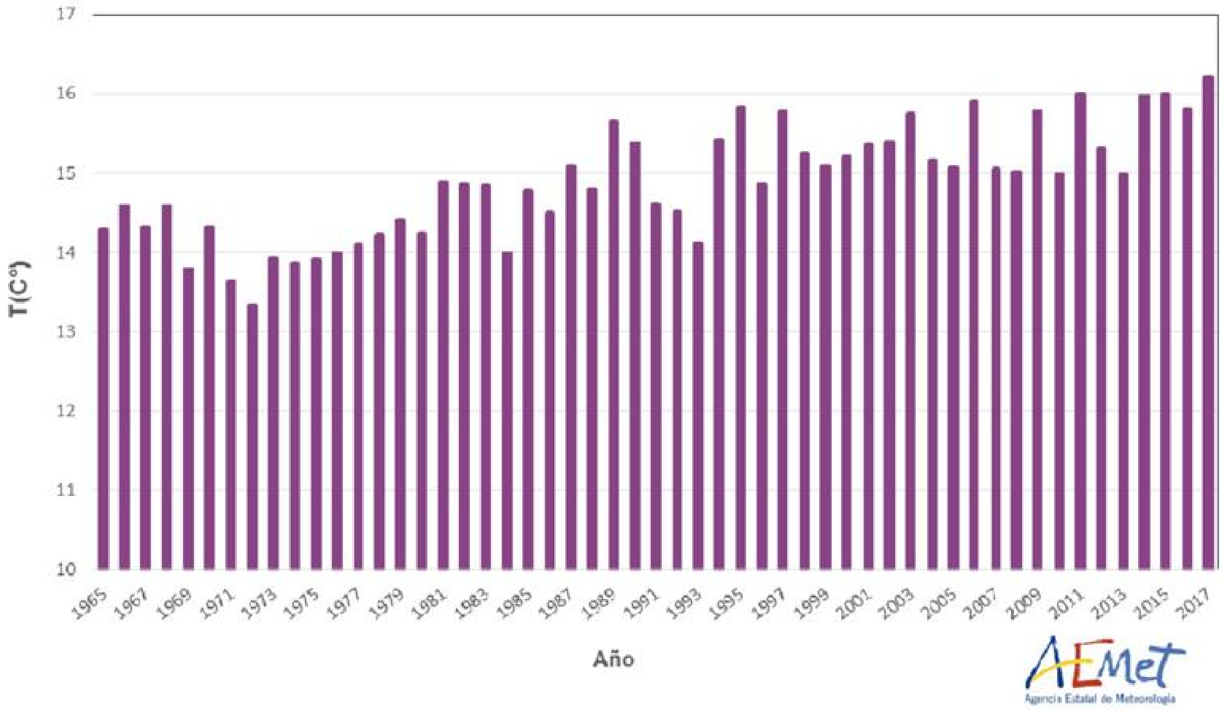


Figure 5.19: Time series of annual average temperature for the period 1965-2017 for Spain (diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Croatia, Italy, Slovenia, Serbia, Turkey

Croatia

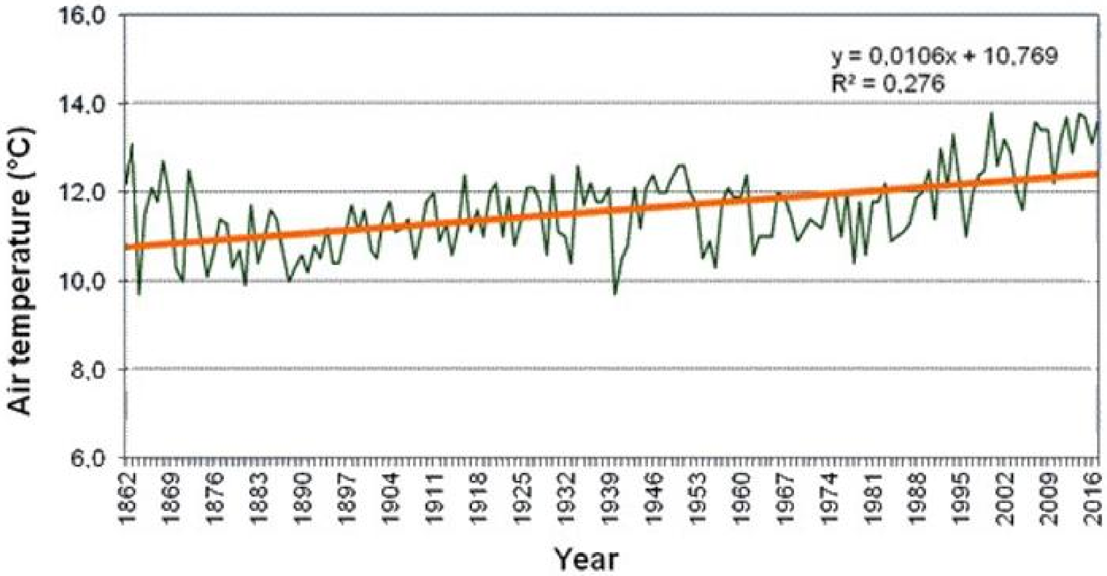


Figure 5.20: Time series of annual average temperature for Zagreb Grič (Croatia) for the period 1862-2017 (diagram as provided by the NHMS)

Italy

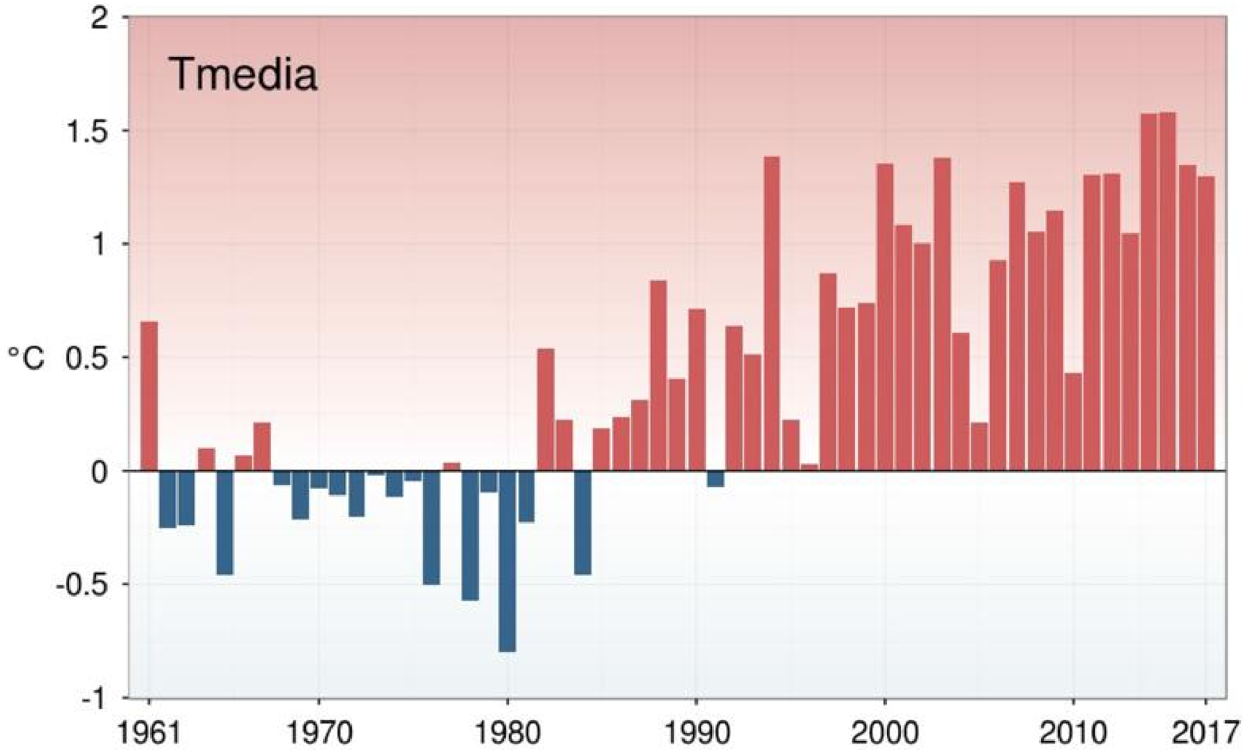


Figure 5.21: Time series of annual temperature anomalies for Italy for the period 1961-2017 (reference period 1961-1990; diagram as provided by ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Slovenia

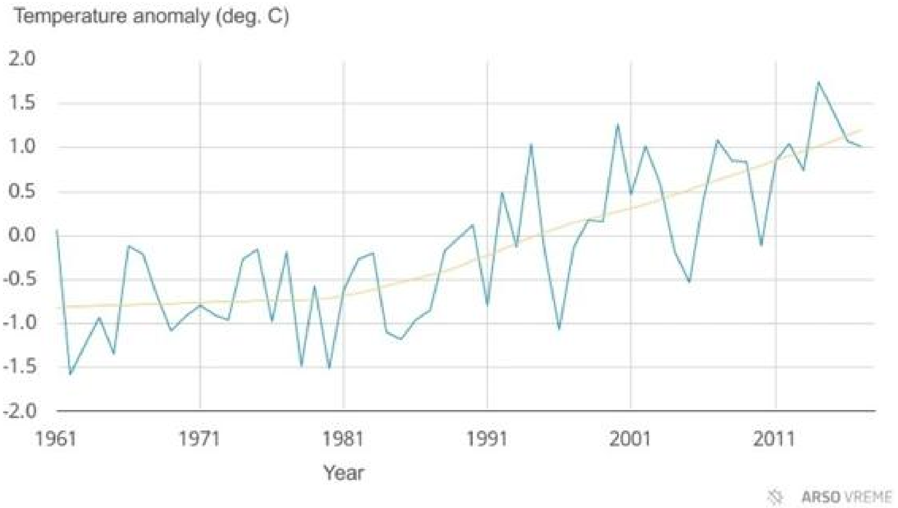
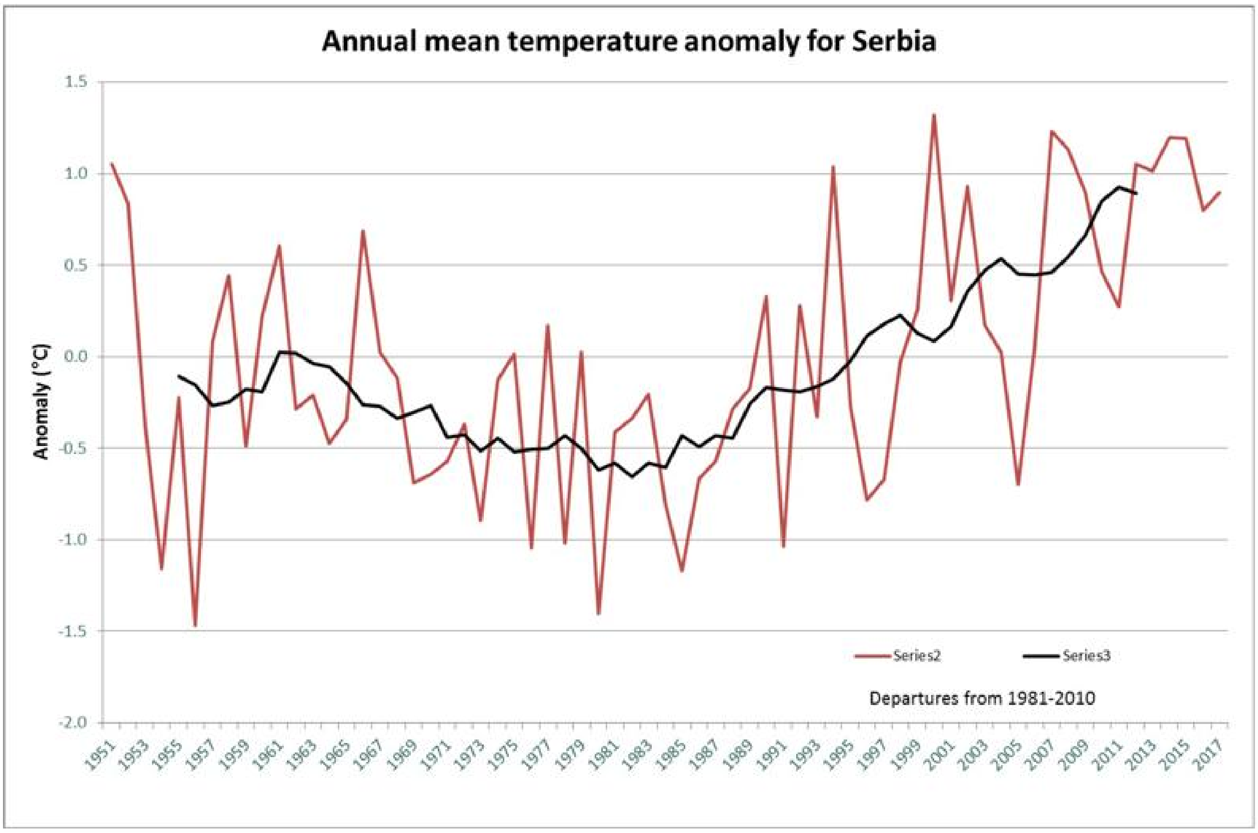


Figure 5.22: Time series of annual temperature anomalies for Slovenia for the period 1961-2017 (reference period 1961-1990; diagram as provided by the NHMS)



Serbia

Figure 5.23: Time series of annual temperature anomalies for Serbia for the period 1951-2017 (reference period 1981-2010; diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula – annual temperature series

Turkey

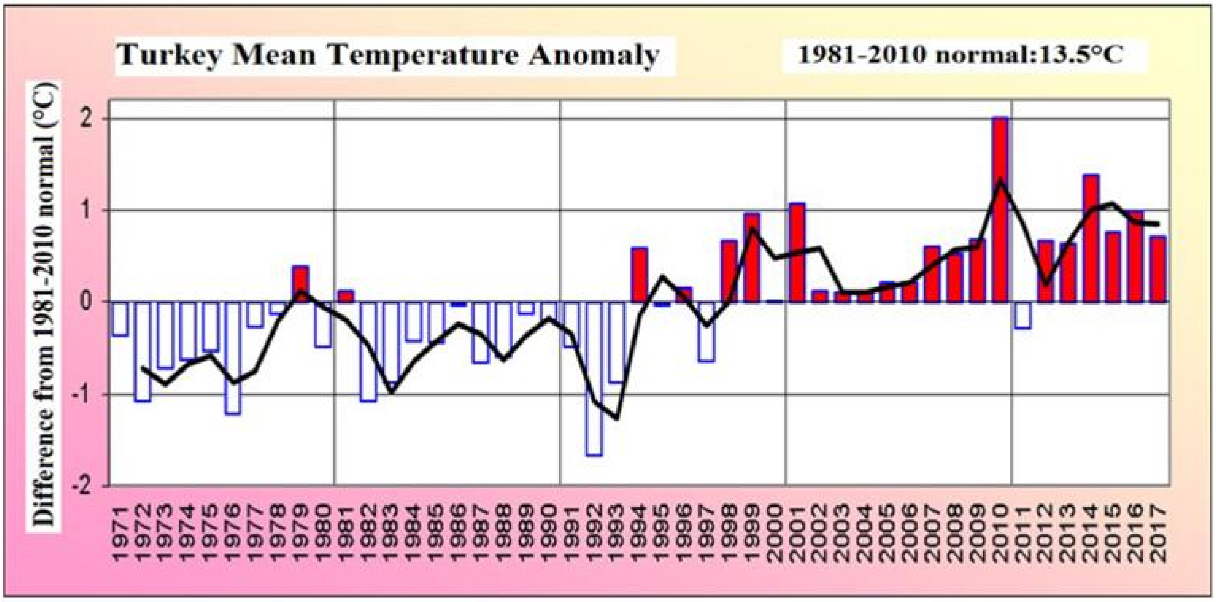


Figure 5.24: Time series of annual temperature anomalies for Turkey for the period 1971-2017 (reference period 1981-2010; diagram as provided by the NHMS)

Eastern Europe – annual temperature series

Belarus, European Russia, Moldova, Ukraine

Belarus

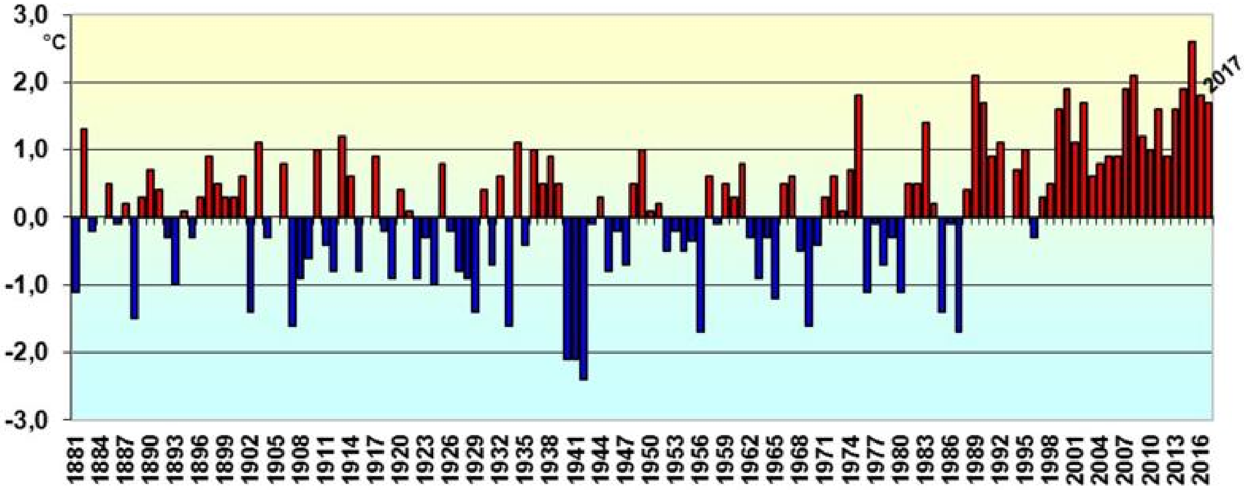


Figure 5.25: Time series of annual temperature anomalies for the Republic of Belarus for the period 1881-2017 (reference period 1961-1990; diagram as provided by the NHMS)

European Russia

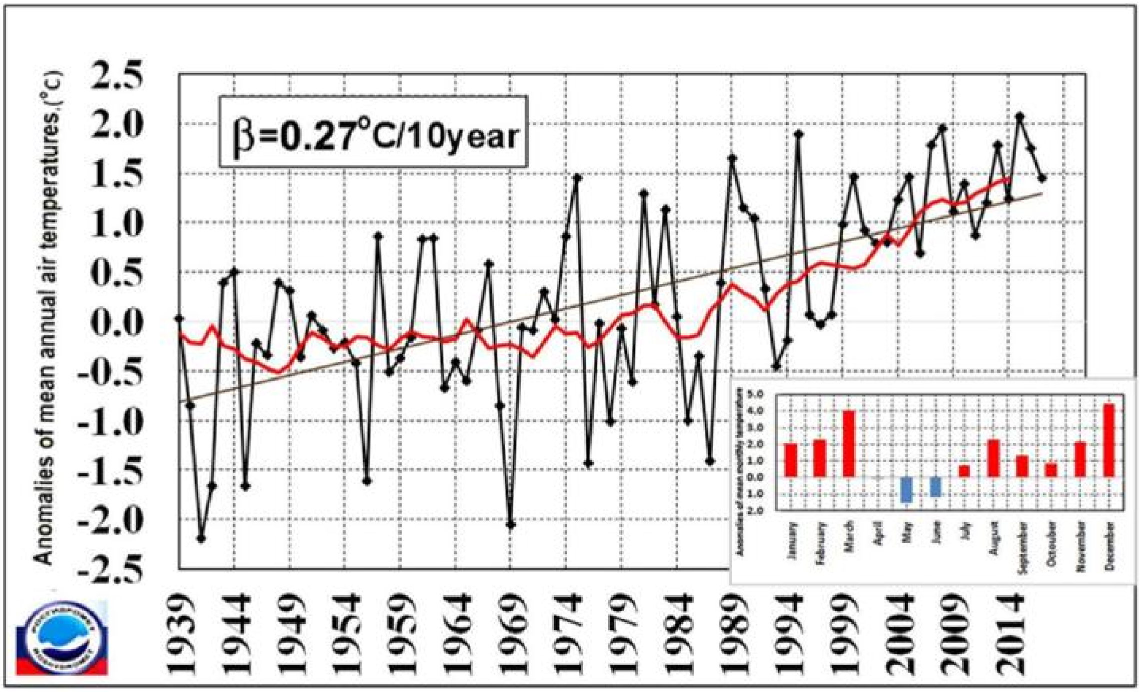


Figure 5.26: Time series of annual temperature anomalies for European Russia for the period 1939-2017 (reference period 1961-1990; diagram as provided by the NHMS)

Eastern Europe – annual temperature series

Moldova

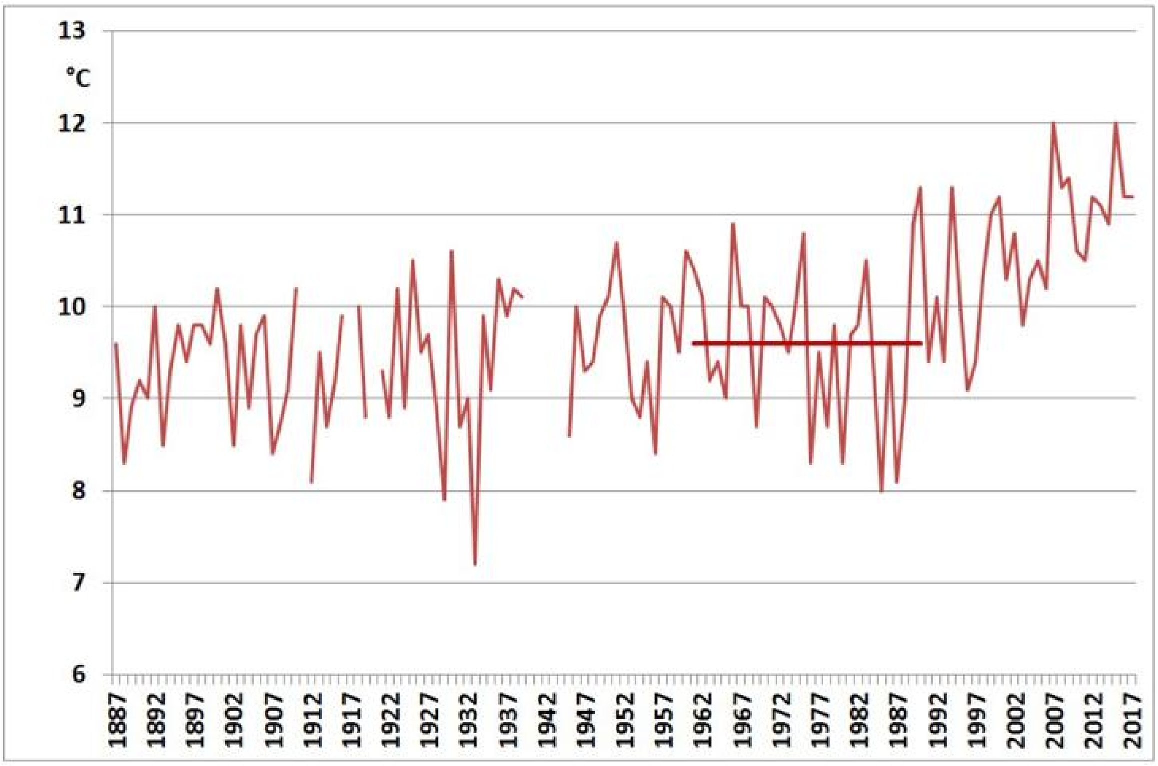


Figure 5.27: Time series of annual temperature for station Chisinau, Moldova for the period 1887-2017 (diagram as provided by the NHMS)

Ukraine

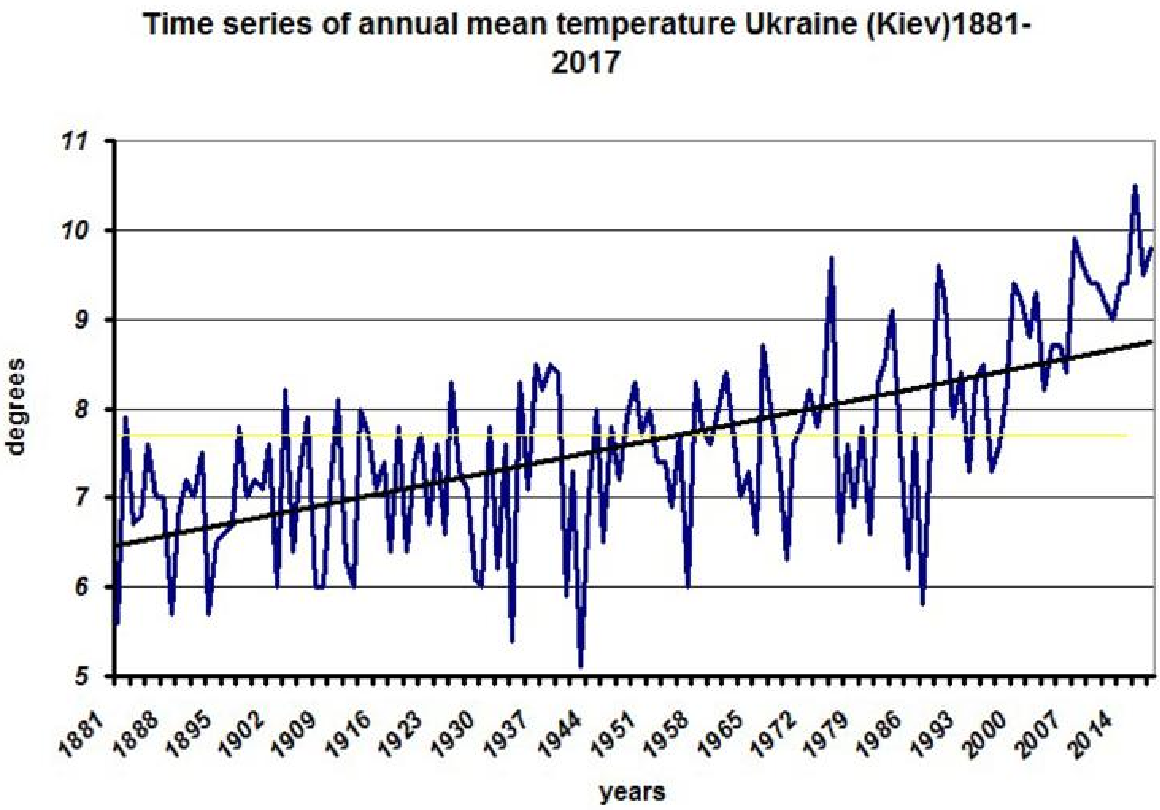


Figure 5.28: Time series of annual temperature for Kiev (Ukraine) for the period 1881-2017 (Diagram as provided by the NHMS)

Middle East – annual temperature series

Georgia, Israel

Georgia

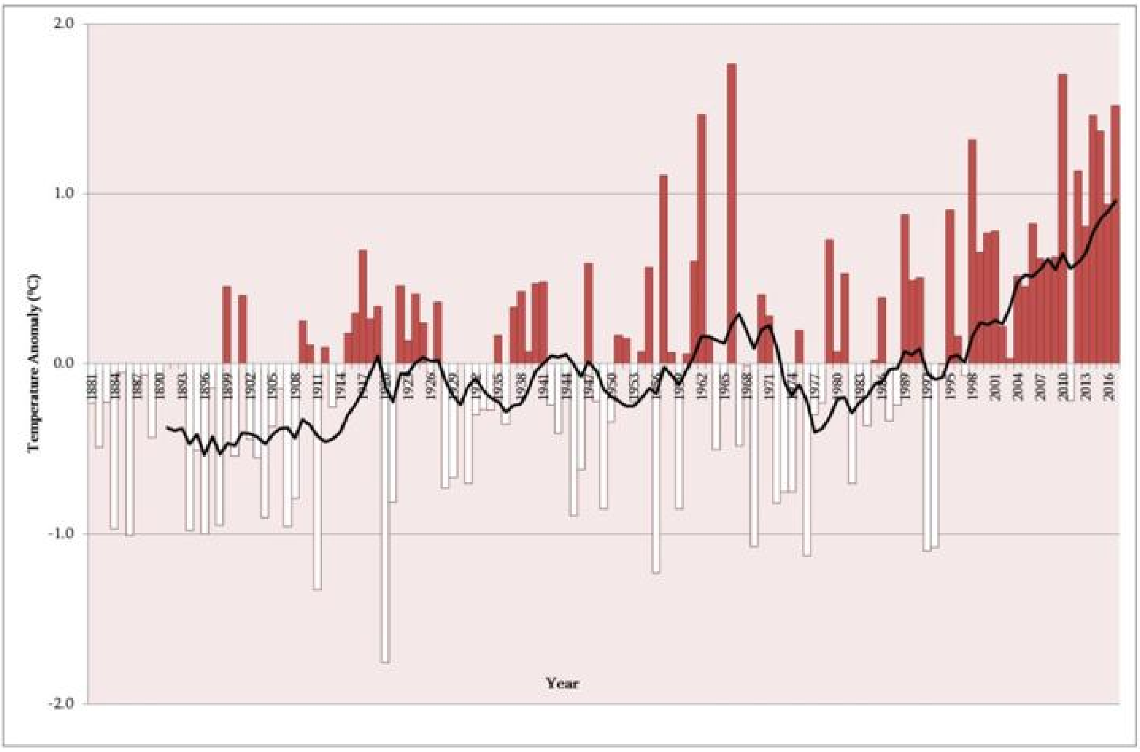


Figure 5.29: Time series of annual temperature anomalies and 11-yr moving averages for Tbilisi (Georgia) for the period 1881-2017(reference period 1961-1990; diagram as provided by the NHMS)

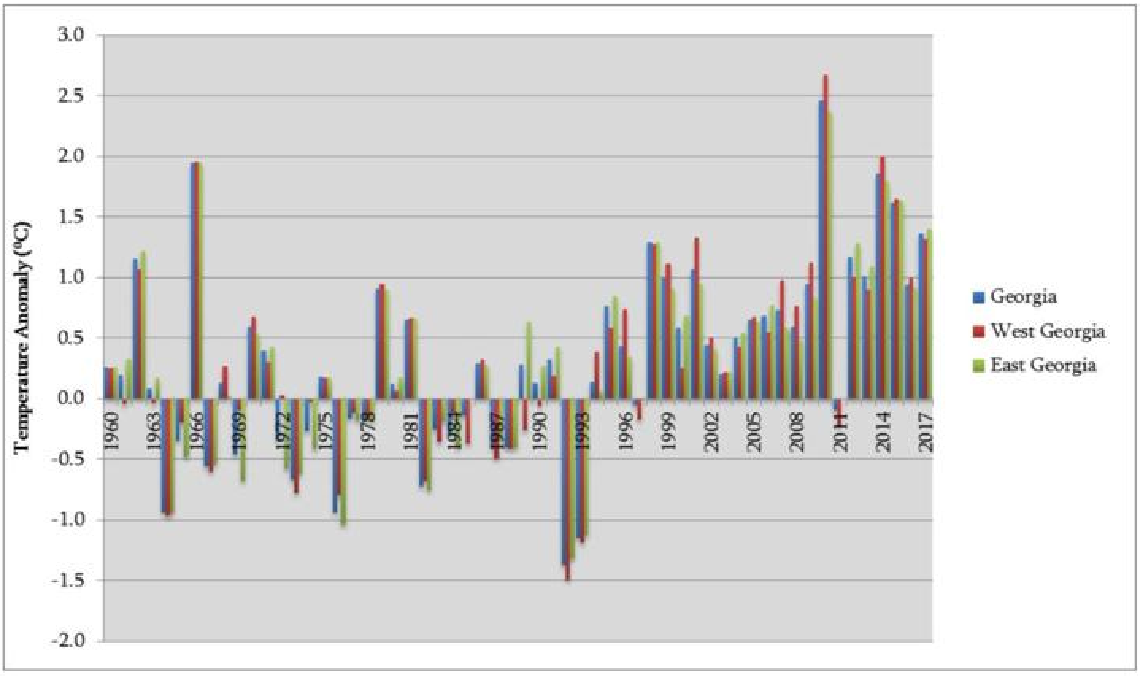


Figure 5.30: Time series of annual temperature anomalies for Georgia for the period 1960-2017 (reference period 1961-1990; diagram as provided by the NHMS)

Middle East – annual temperature series

Israel

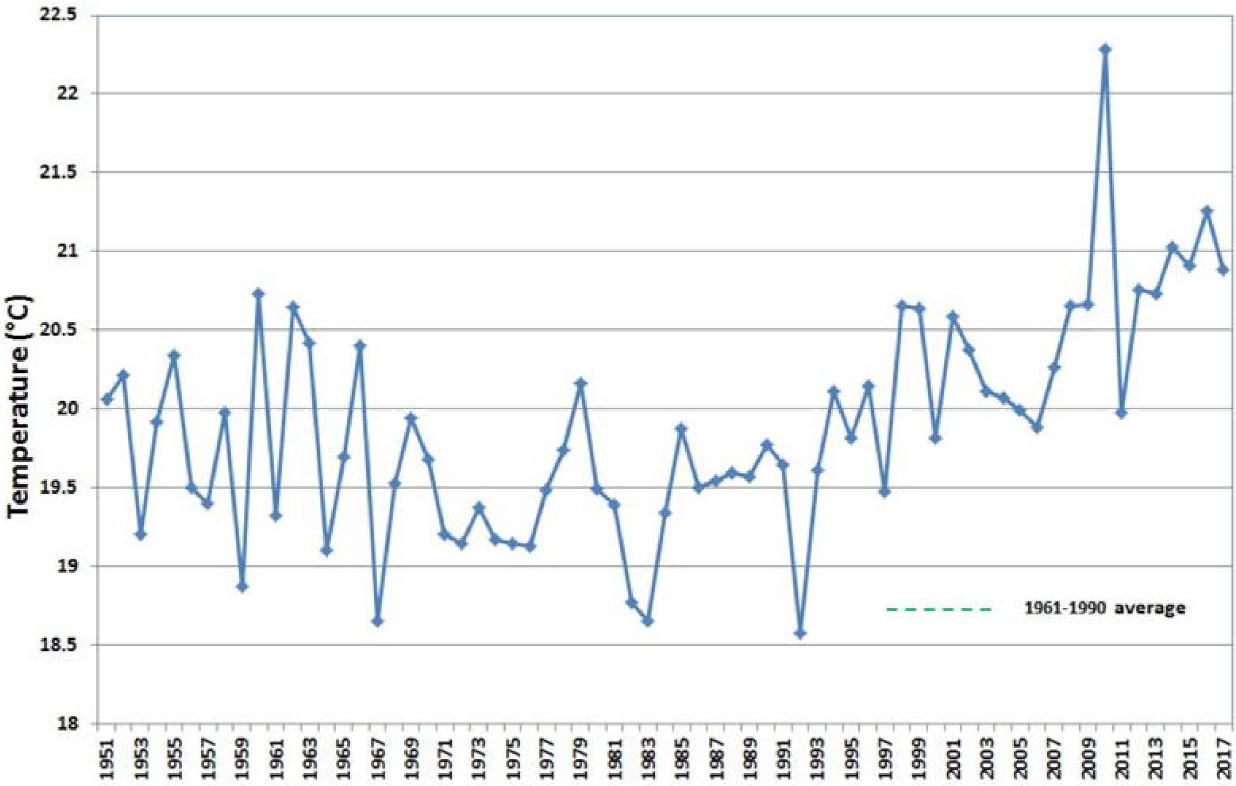


Figure 5.31: Time series of annual temperature for Israel (based on five stations) for the period 1951-2017 (diagram as provided by the NHMS)

5.2. Precipitation

Central and Western Europe - precipitation totals and anomalies

Belgium, France, Germany, Hungary, Netherlands, Switzerland, United Kingdom

Belgium

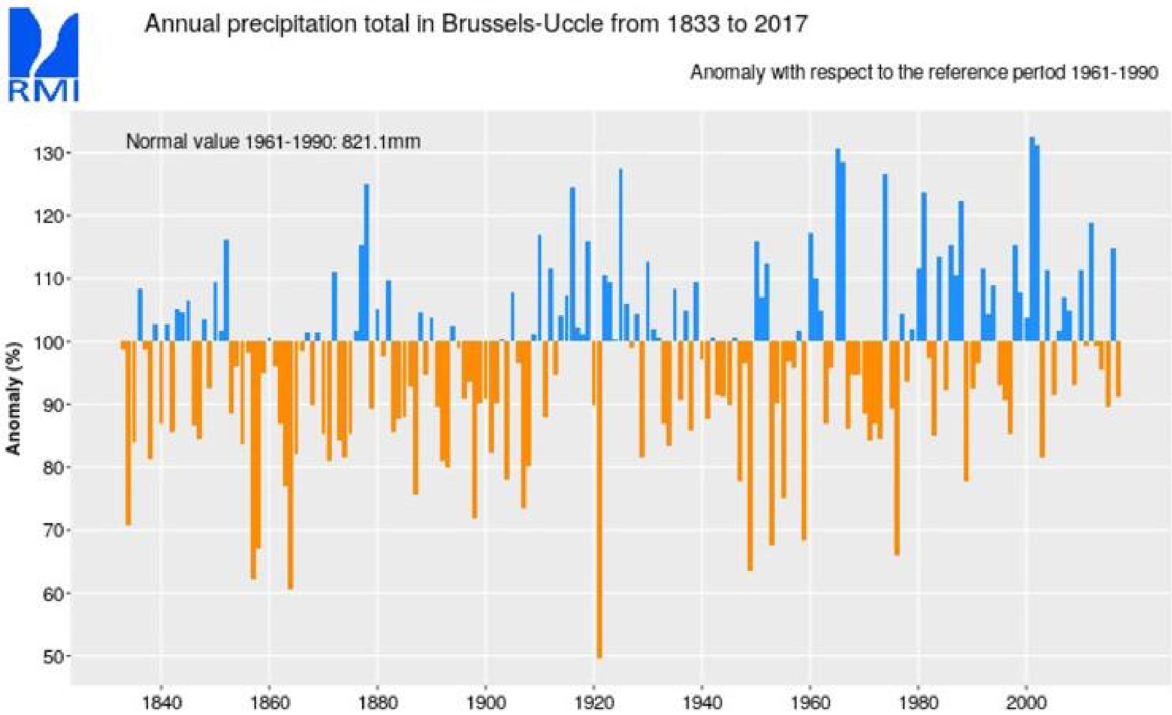


Figure 5.32: Time series of annual precipitation anomalies in relation to the long term mean (1961-1990) for Belgium (station Uccle) for the period 1833-2017 (Diagram as provided by the NHMS)

France

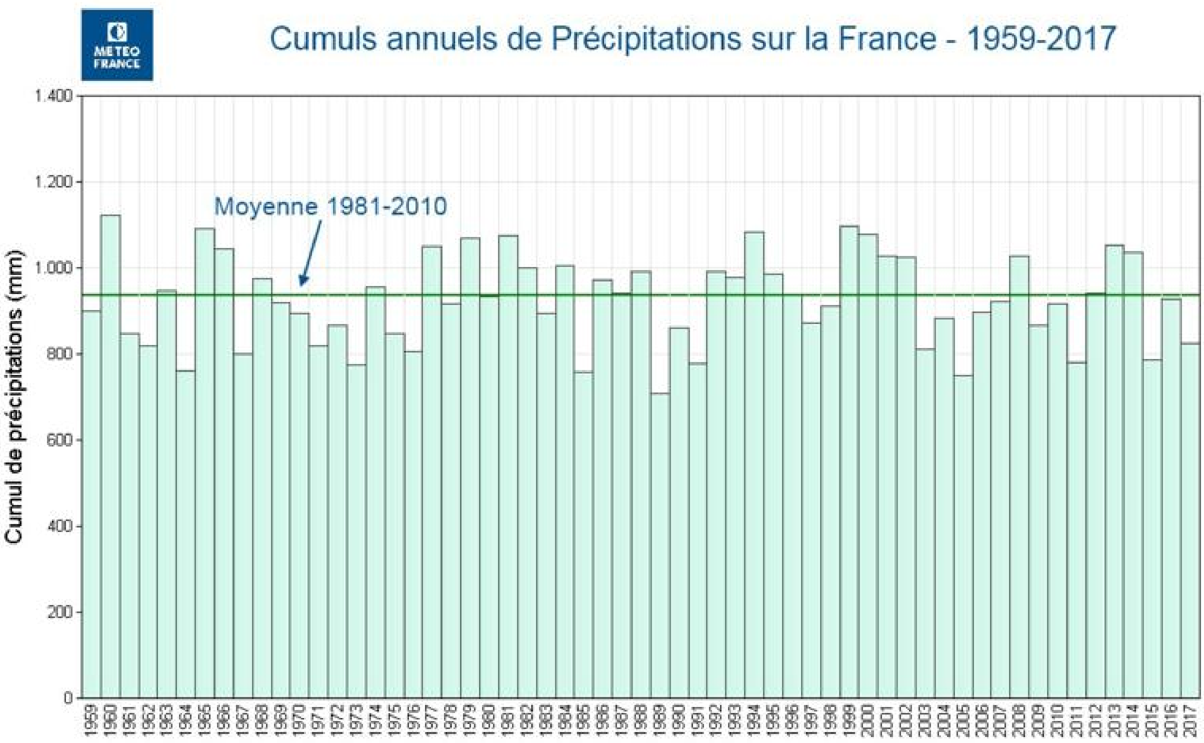


Figure 5.33: Time series of annual precipitation totals in mm/year for France for the period 1959-2017 (green line: long term mean 1981-2010; Diagram as provided by the NHMS)

Germany

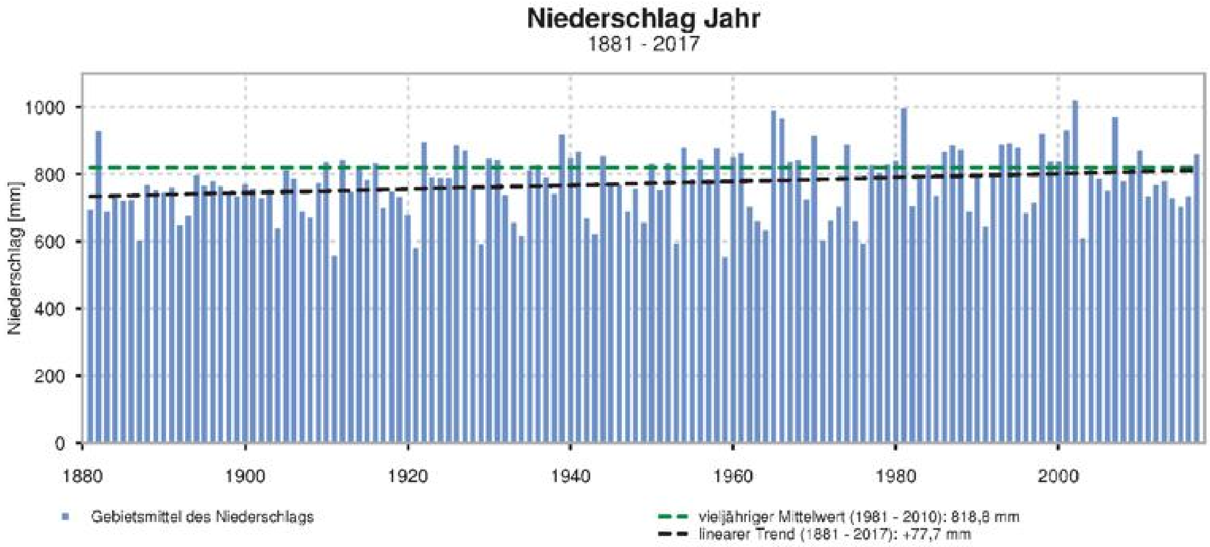


Figure 5.34: Time series of annual precipitation totals in mm/year for Germany for the period 1881-2017 (green line: long term mean; Diagram as provided by the NHMS)

Central and Western Europe - precipitation totals and anomalies

Hungary

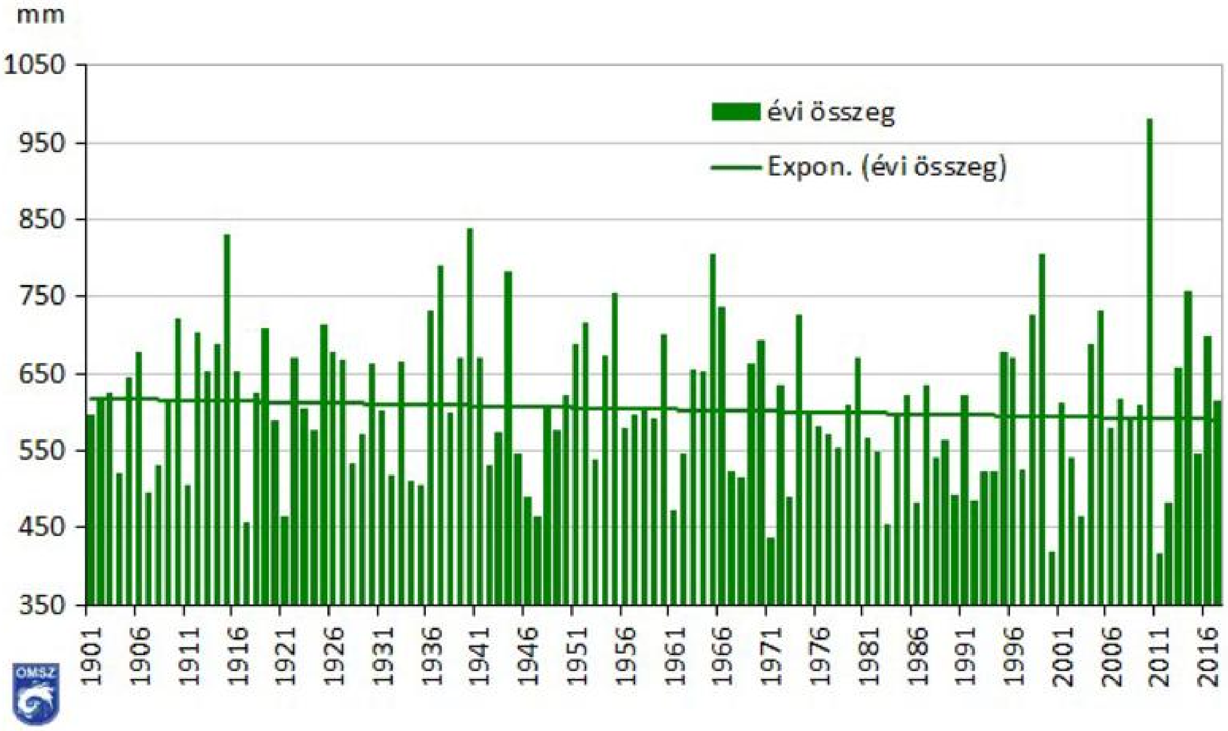


Figure 5.35: Time series of annual precipitation totals in mm/year for Hungary for the period 1901-2017 (Diagram as provided by the NHMS)

The Netherlands

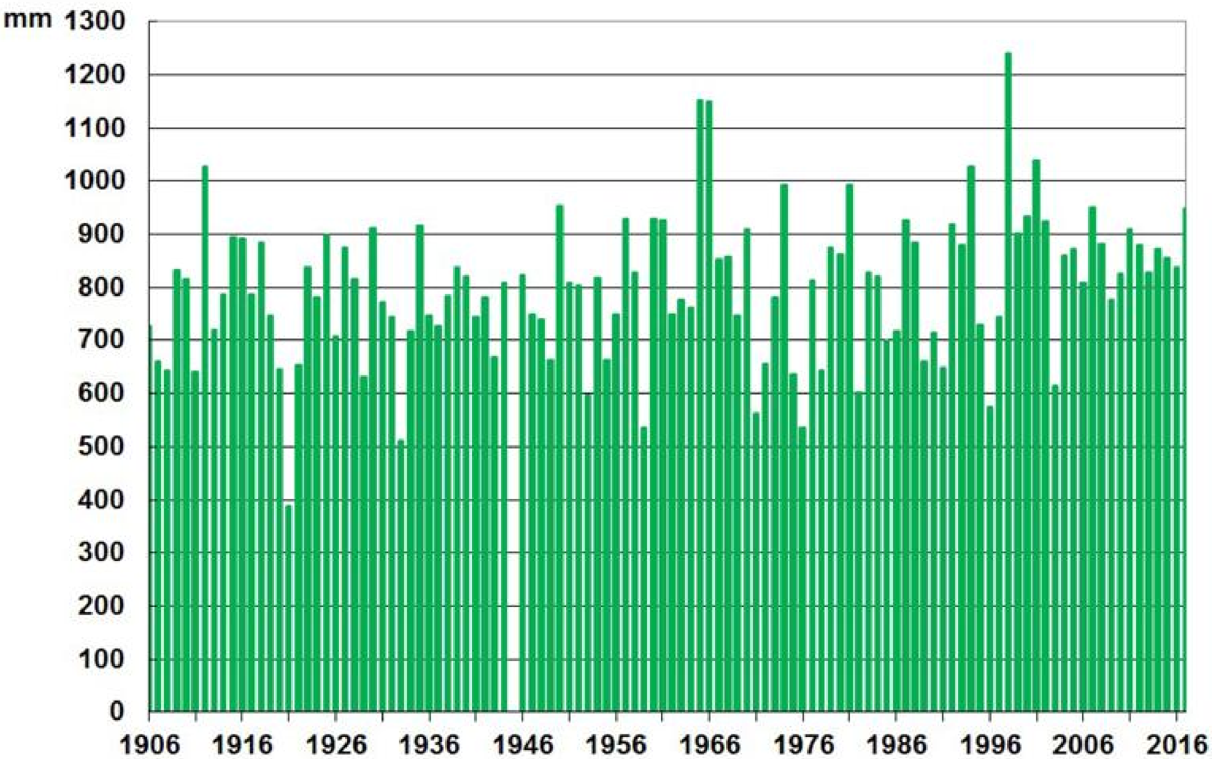


Figure 5.36: Time series of annual precipitation totals in mm/year for the Netherlands (station De Bilt) for the period 1906-2017 (Data as provided by the KNMI)

Central and Western Europe - precipitation totals and anomalies

Switzerland

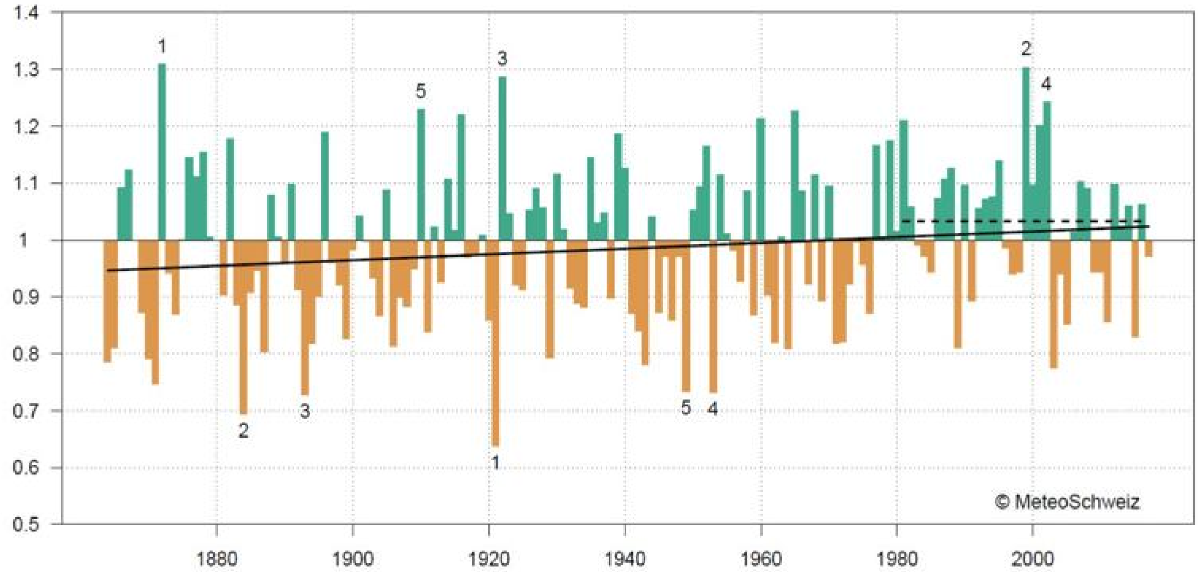


Figure 5.37: Time series of annual precipitation anomalies in relation to the mean of 1961-1990 for Switzerland for the period 1864–2017. Color bars represent anomalies in respect to the long-term mean 1961–1990 and green indicates positive and bronze negative anomalies. The black line represents the linear significant trend (5.0%/100y). The black dashed line represents the mean 1981–2010. (Diagram as provided by the NHMS)

United Kingdom

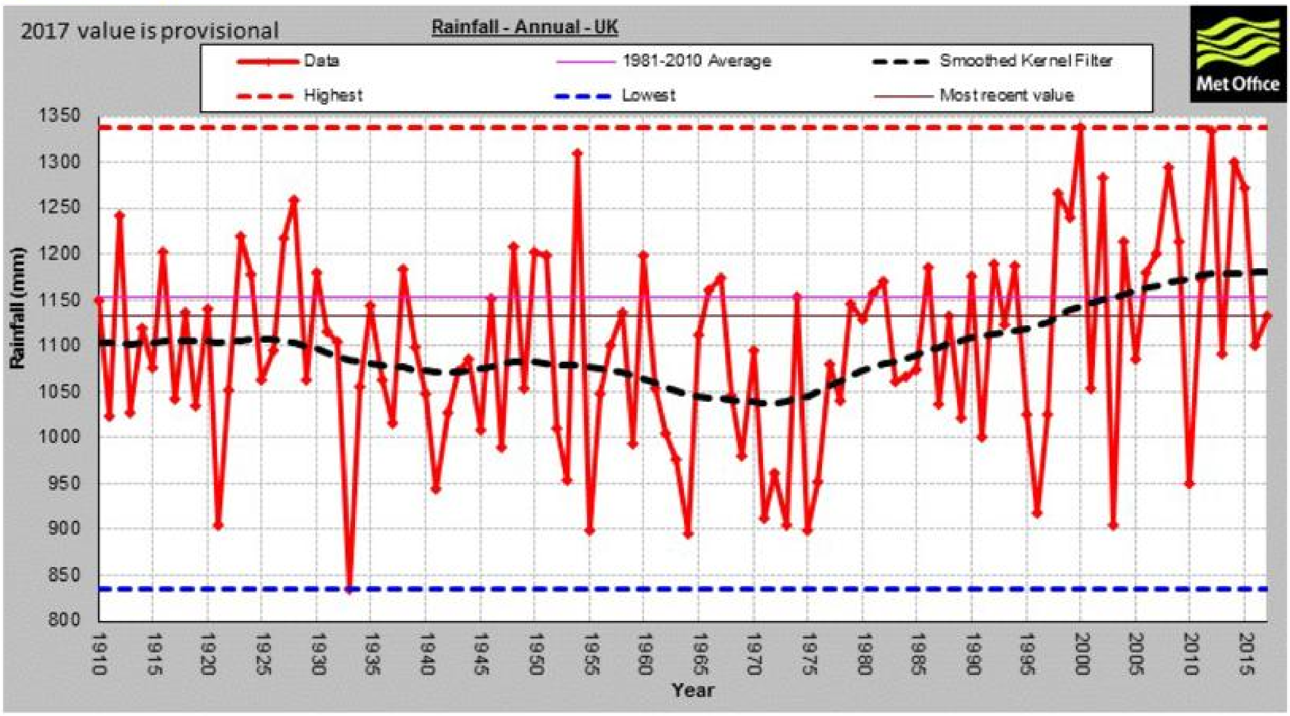


Figure 5.38: Time series of annual precipitation totals in mm/year for the United Kingdom for the period 1910-2017 (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Denmark, Finland, Latvia, Norway, Sweden

Denmark

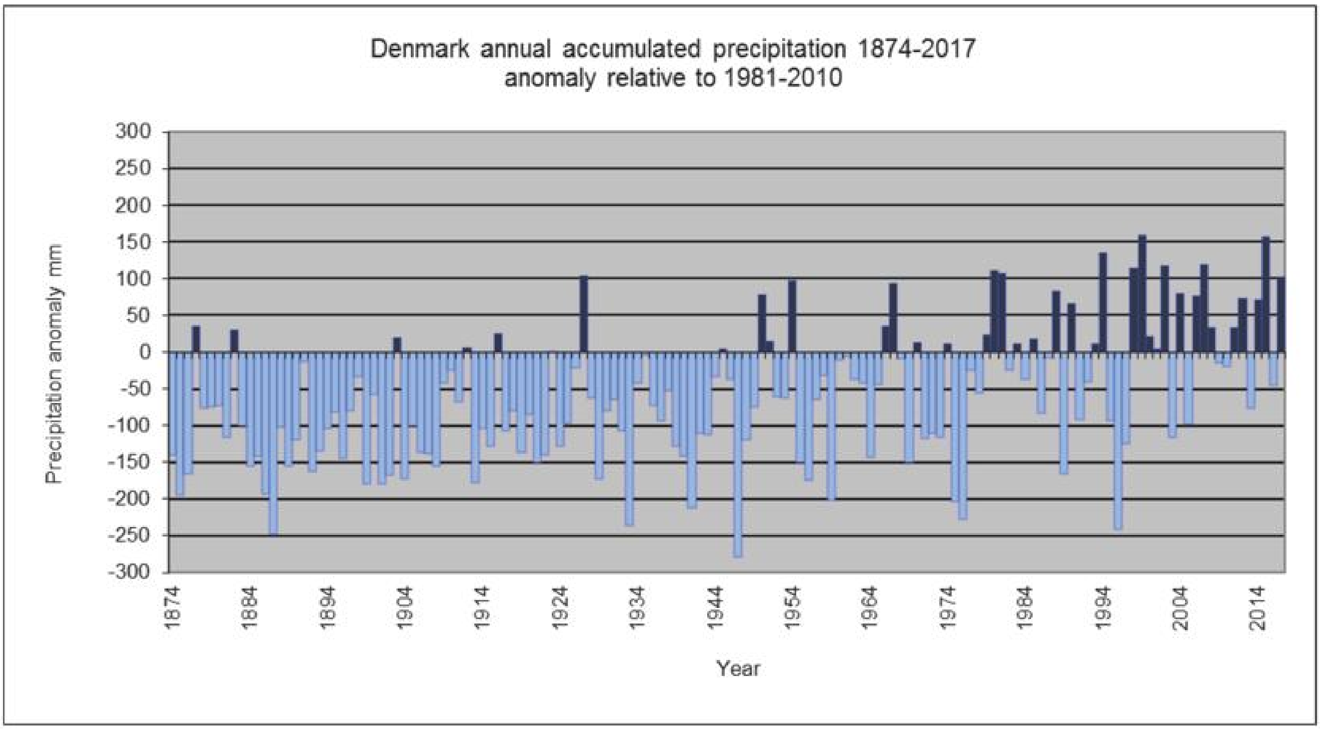


Figure 5.39: Time series of annual precipitation totals in mm/year for Denmark: anomaly relative to 1981-2010 (Diagram as provided by the NHMS)

Estonia

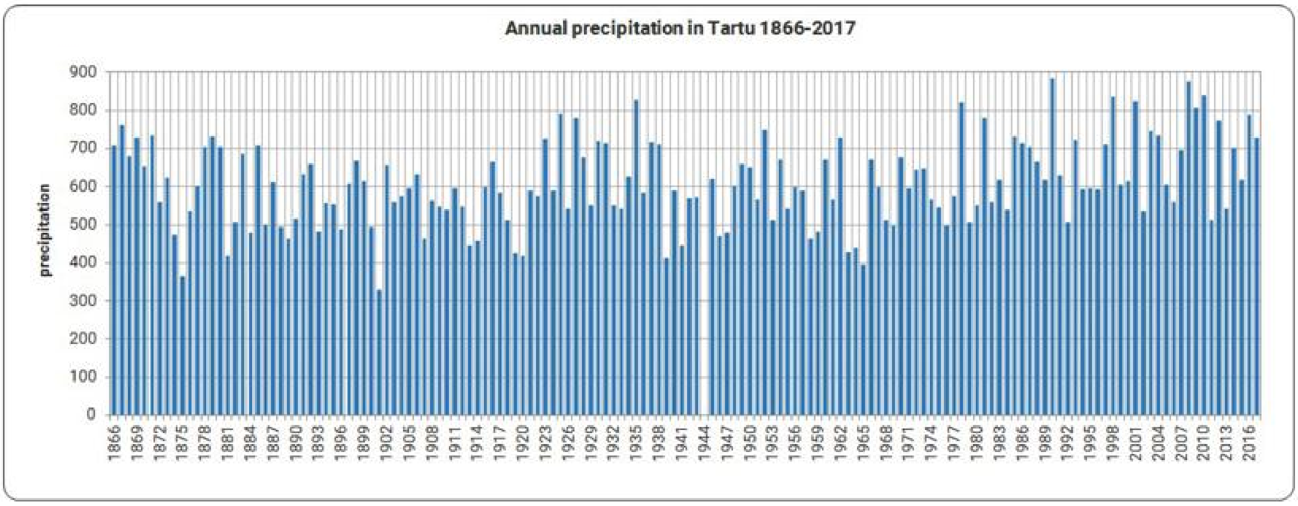


Figure 5.40: Time series of annual precipitation totals in mm/year at station Tartu, Estonia (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Finland

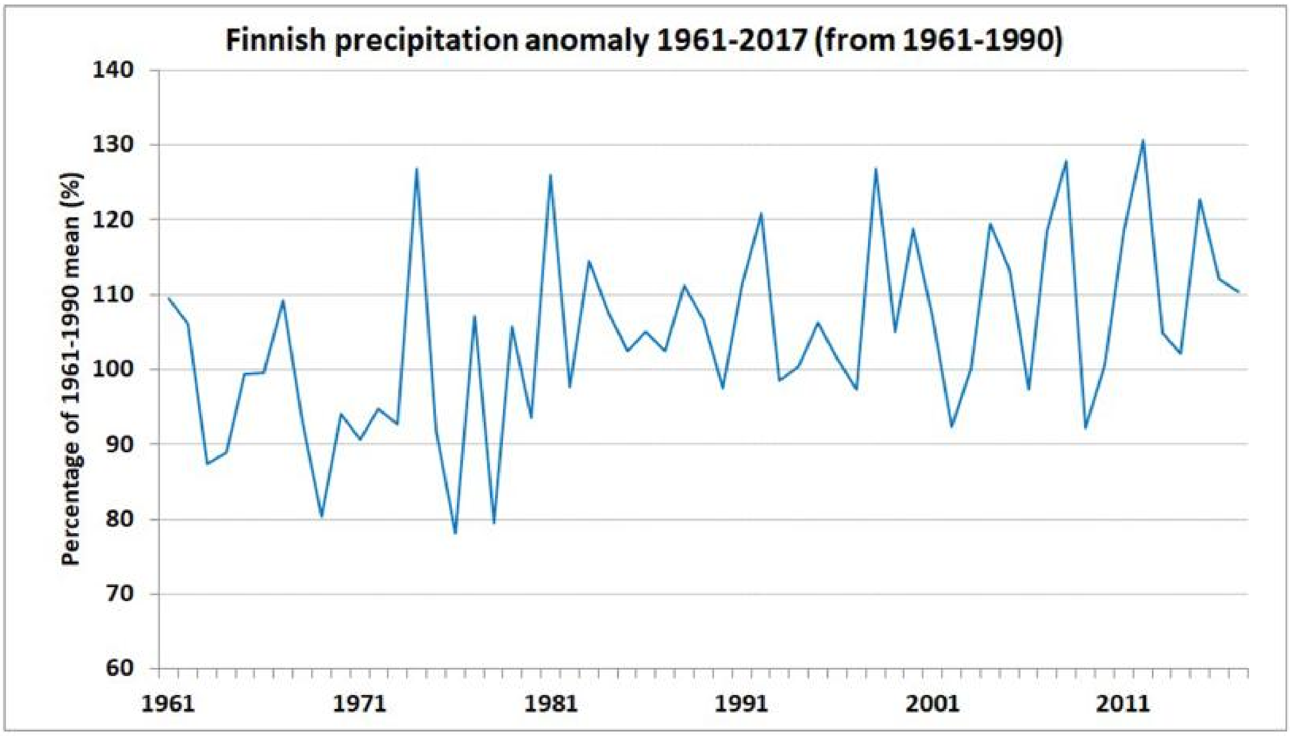


Figure 5.41: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Finland (Diagram as provided by the NHMS)

Latvia

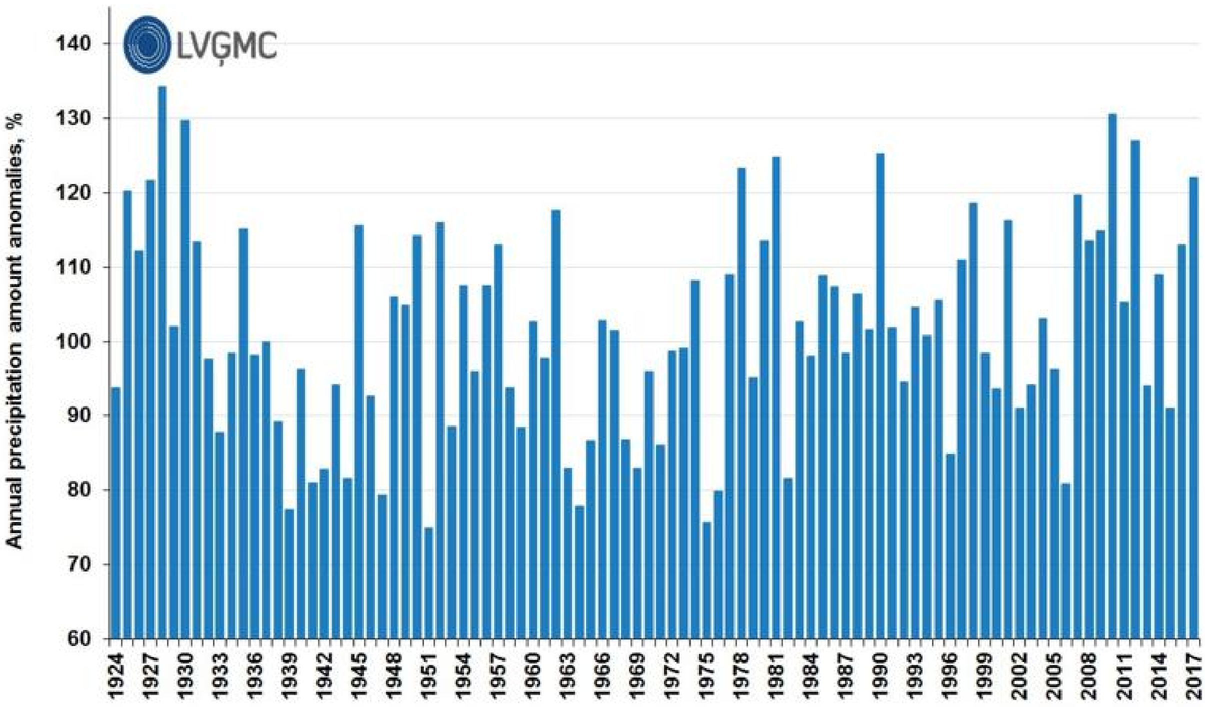


Figure 5.42: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Latvia (Diagram as provided by the NHMS)

Nordic and Baltic Countries - precipitation totals and anomalies

Norway

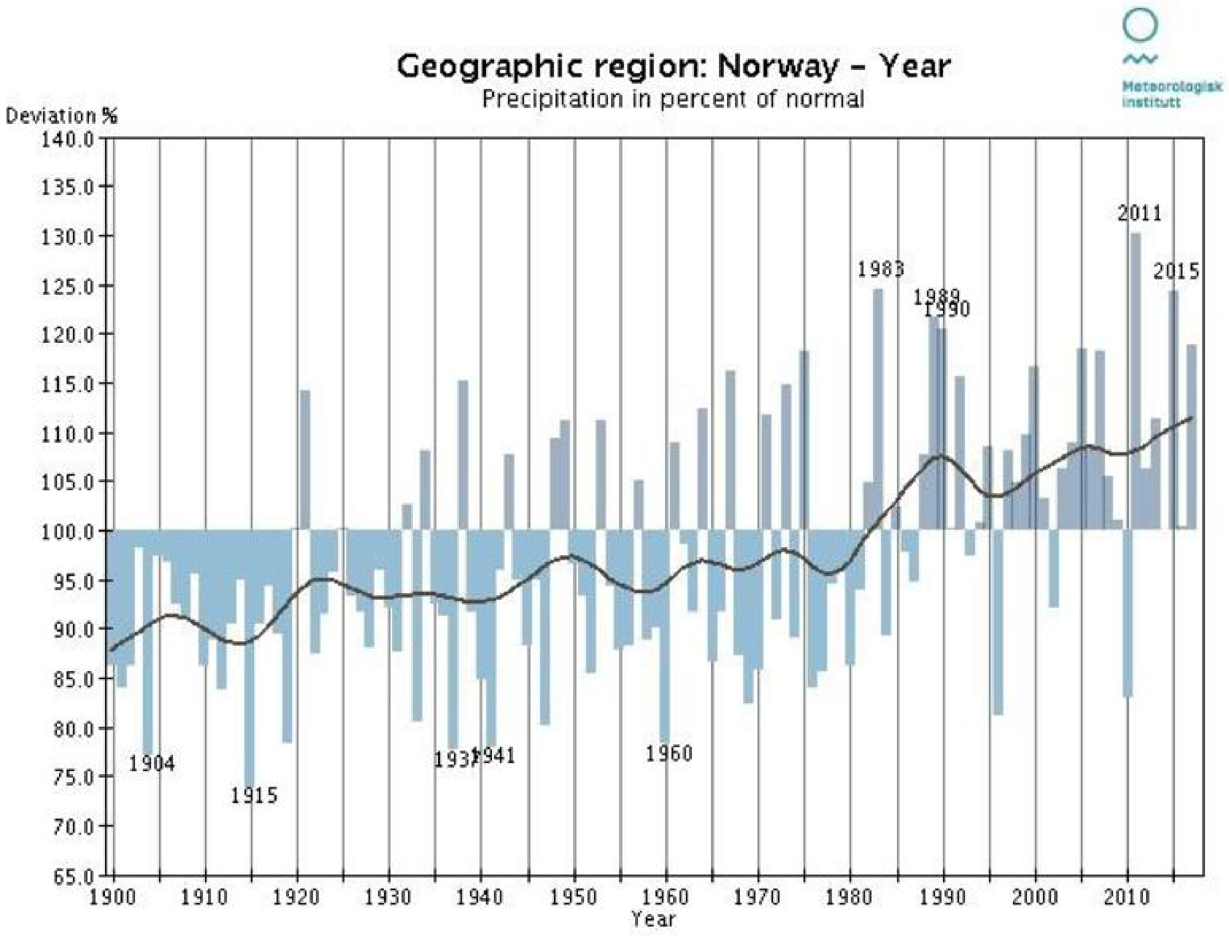


Figure 5.43: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Norway (Diagram as provided by the NHMS)

Sweden

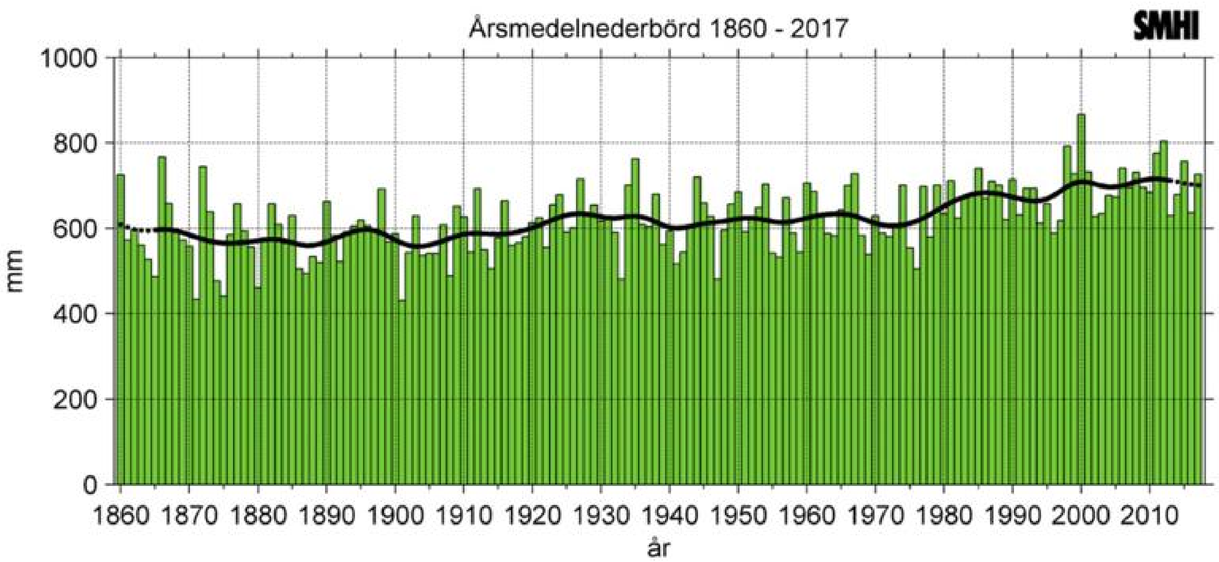


Figure 5.44: Time series of annual precipitation totals in mm/year for Sweden (Diagram as provided by the NHMS)

Iberia - precipitation anomalies

Portugal, Spain

Portugal

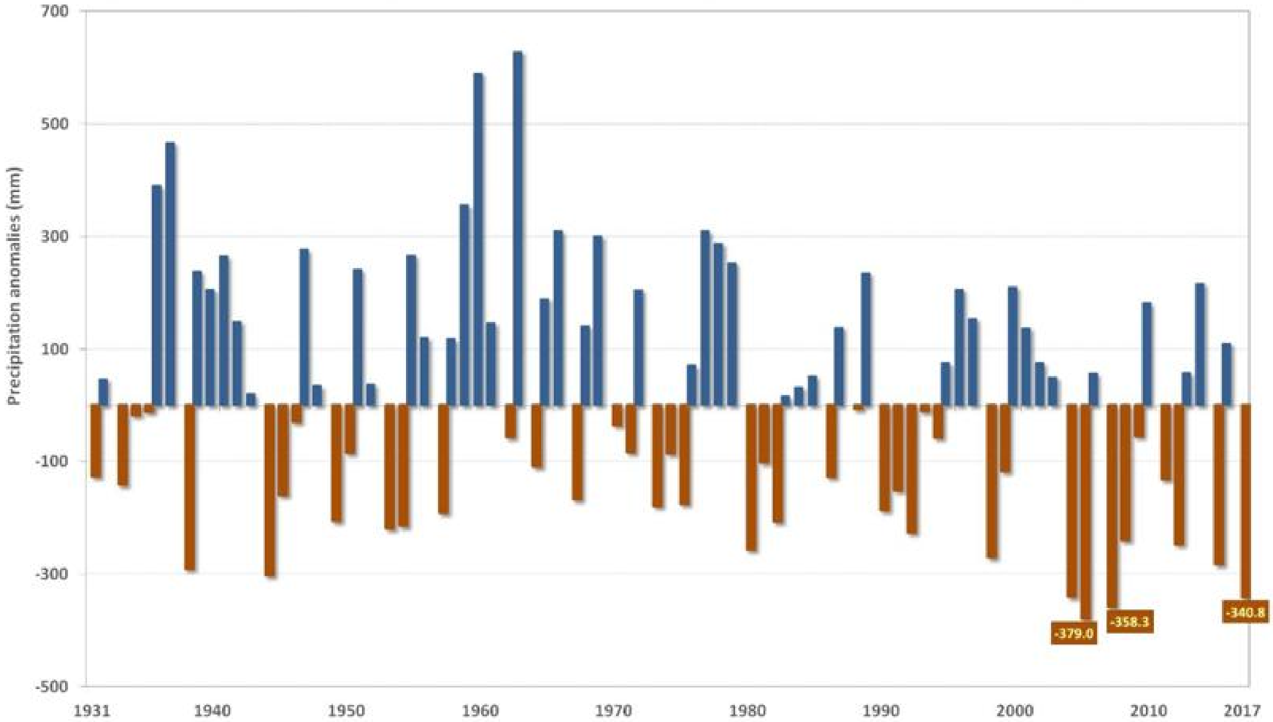


Figure 5.45: Time series of annual precipitation totals in mm/year (deviations from the mean of 1971-2000) for Portugal (Diagram as provided by the NHMS)

Spain

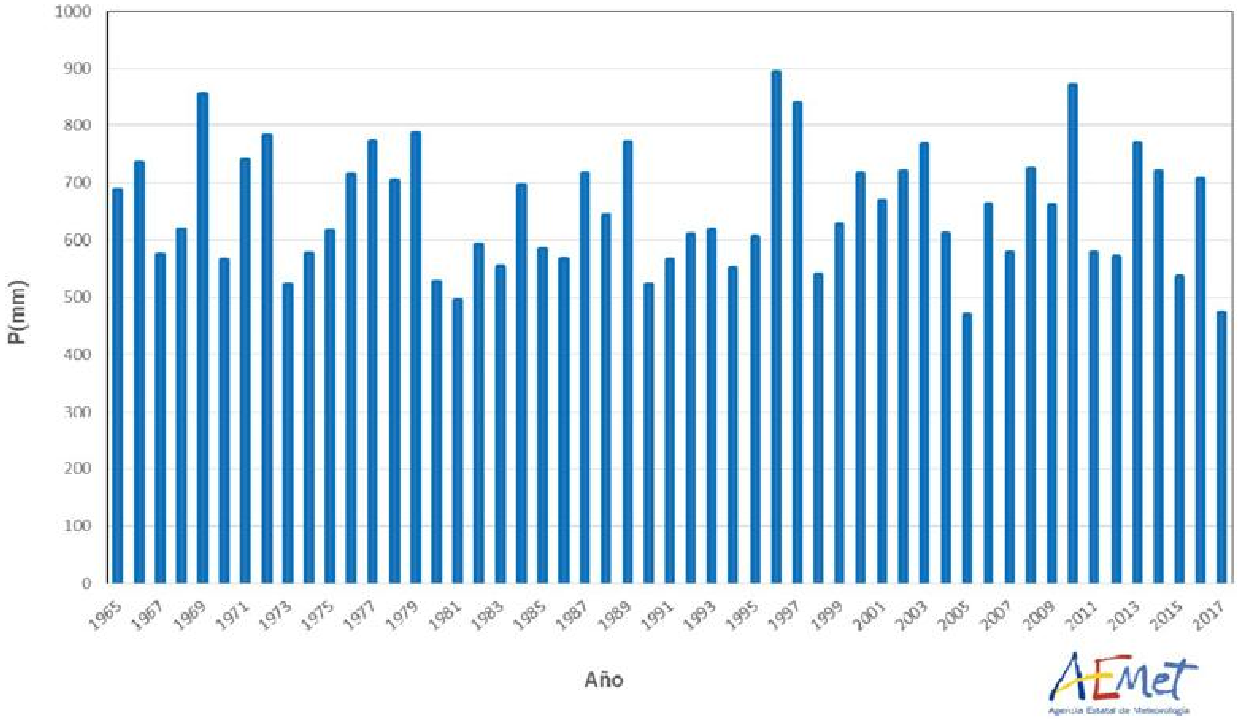


Figure 5.46: Time series of annual precipitation totals in mm/year for Spain (Diagram as provided by the NHMS)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Croatia, Italy, Slovenia, Turkey

Croatia

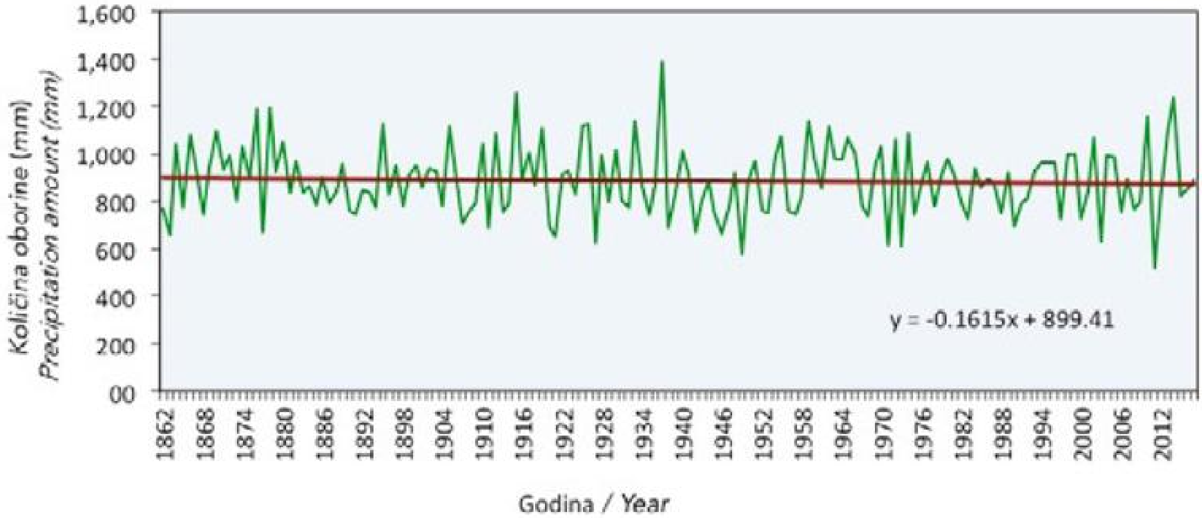


Figure 5.47: Time series of annual precipitation totals in mm/year for Zagreb Grič (Croatia) (Diagram as provided by the NHMS)

Italy

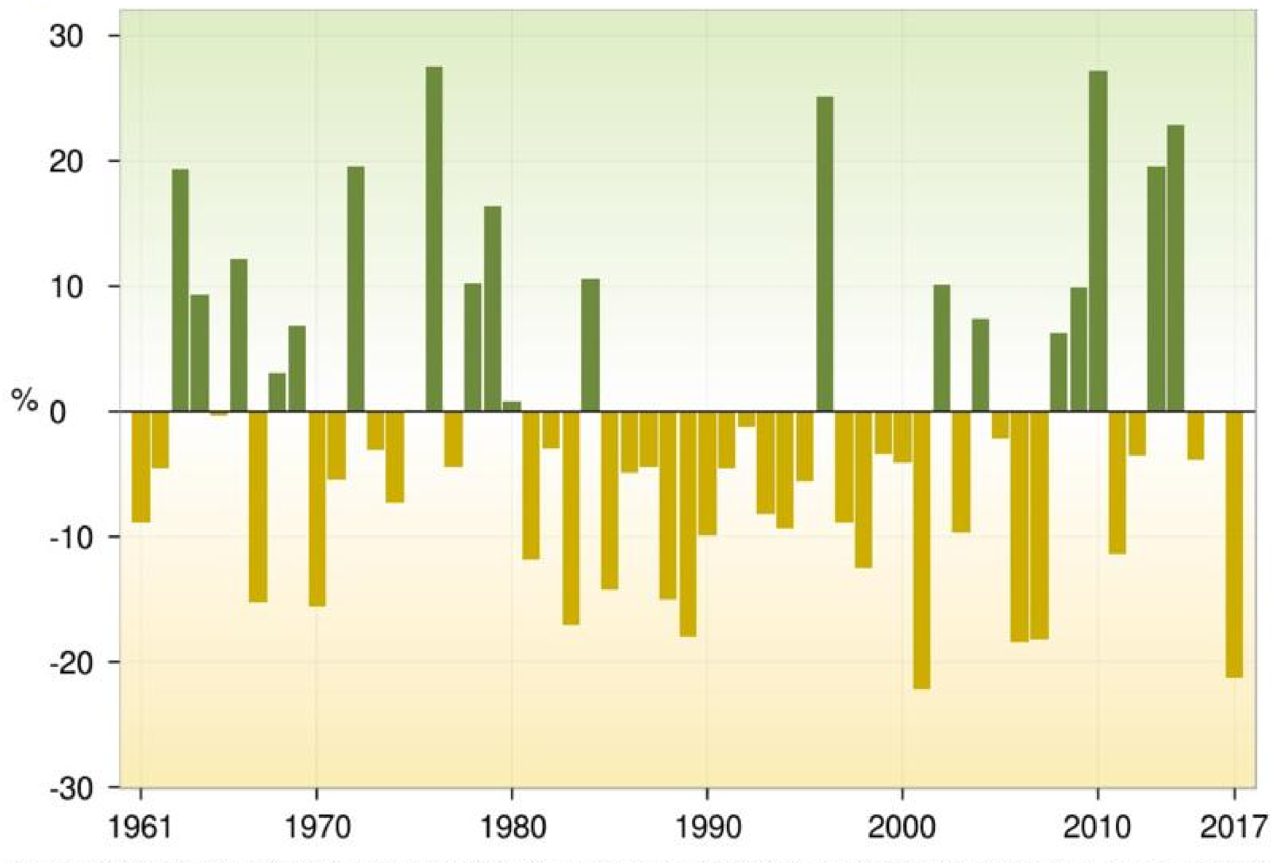


Figure 5.48: Time series of annual precipitation anomalies for 1961 to 2017 in relation to the mean of 1961-90 for Italy (diagram as provided by ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale)

Mediterranean, Italian and Balkan Peninsula - precipitation anomalies

Slovenia

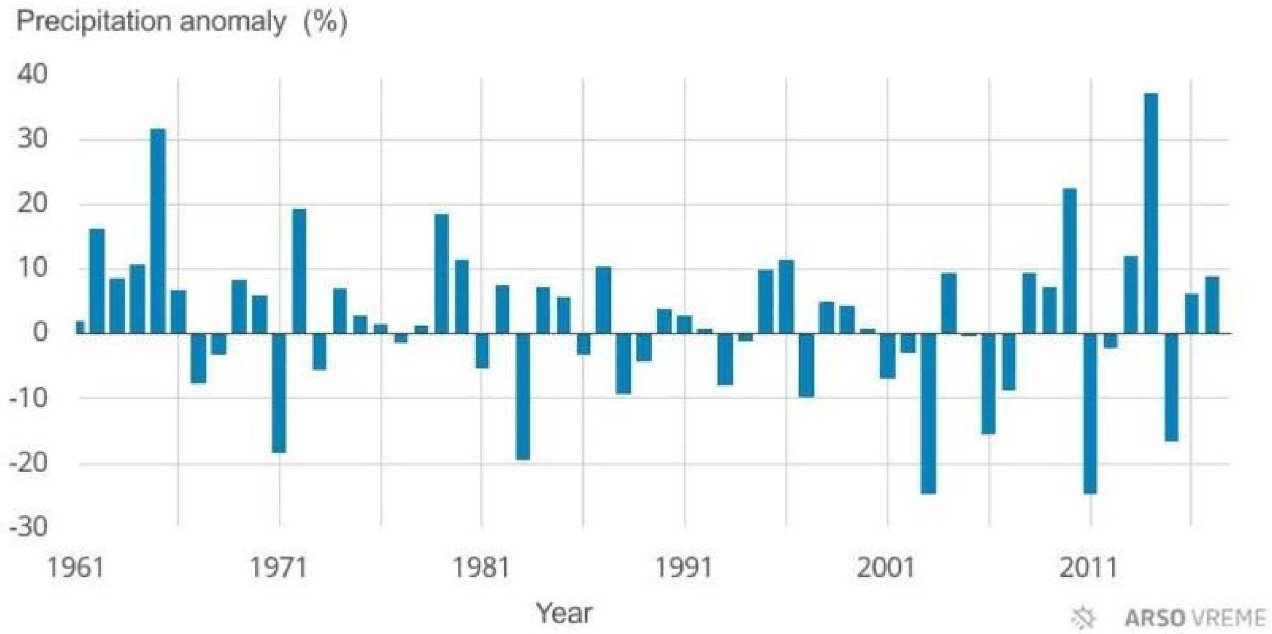


Figure 5.49: Time series of annual precipitation totals in mm/year for Slovenia 1961-2017 (diagram as provided by the NHMS)

Turkey

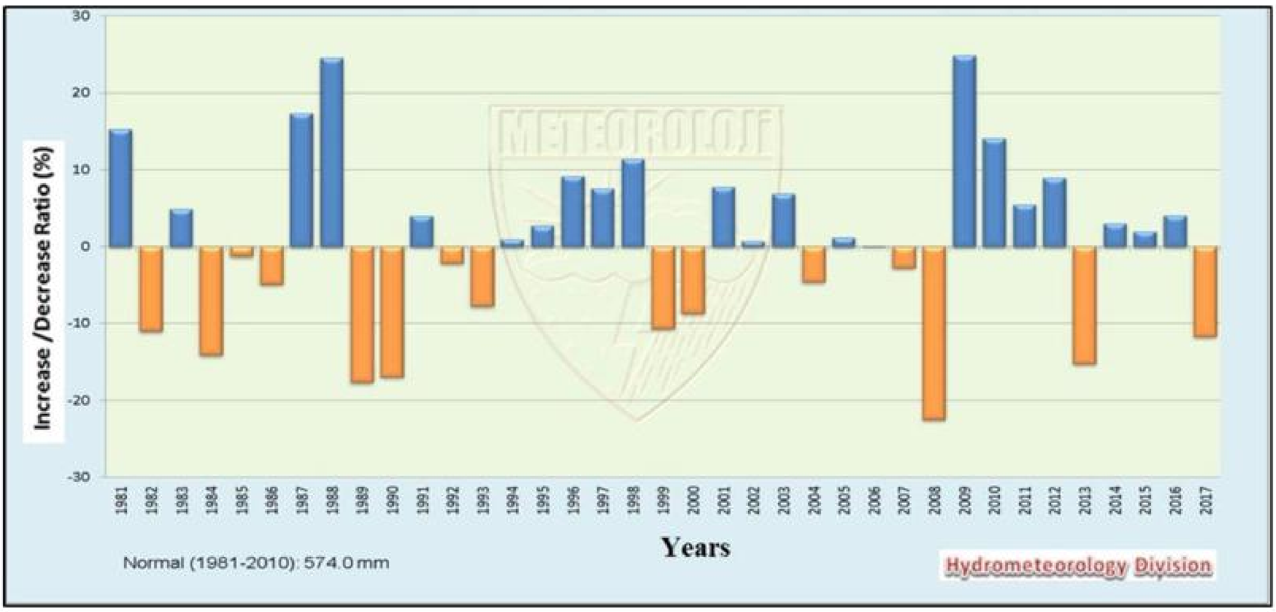


Figure 5.50: Time series of annual precipitation anomalies in relation to the mean of 1981-2010 for Turkey (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Belarus, European Russia, Ukraine

Belarus

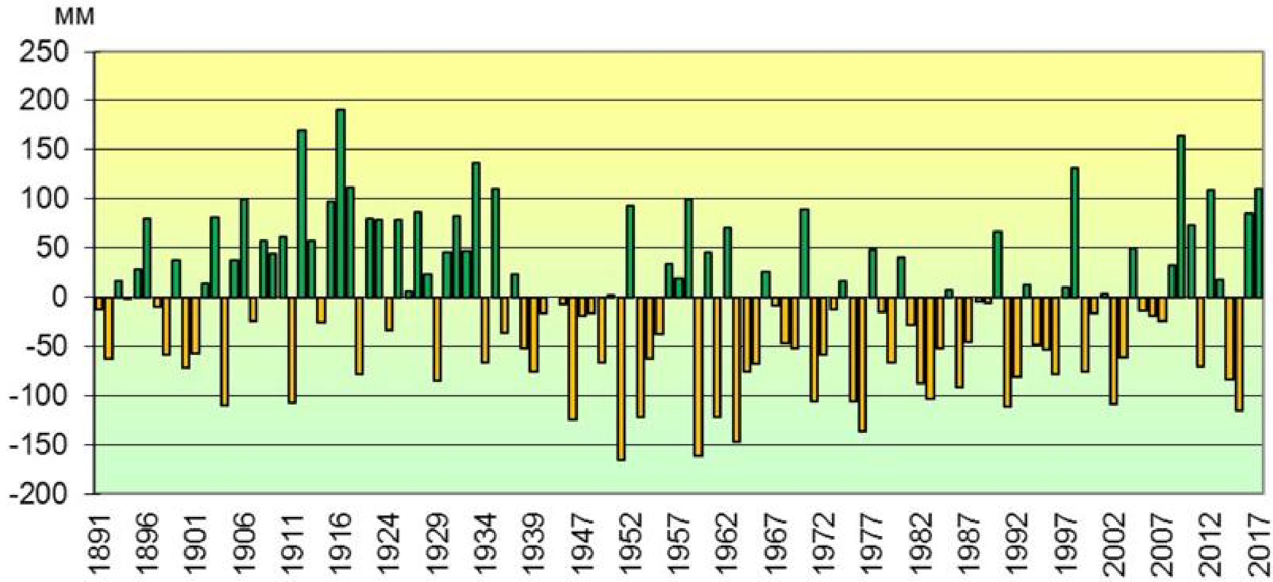


Figure 5.51: Anomalies of annual precipitation totals for Belarus 1891-2017 (base period: 1961-1990; Diagram as provided by the NHMS)

European Russia

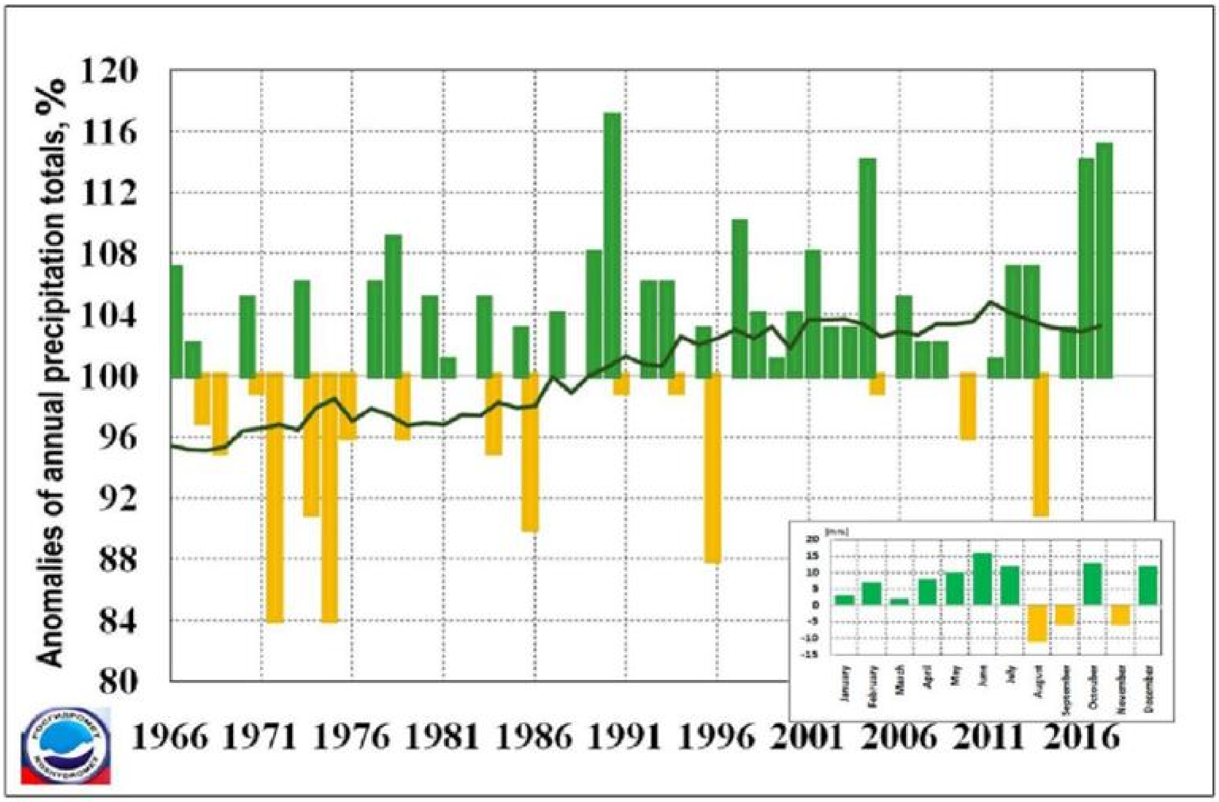


Figure 5.52: Time series of annual precipitation totals in relation to the mean of 1961-1990 for European Russia (Diagram as provided by the NHMS)

Eastern Europe - precipitation anomalies

Ukraine

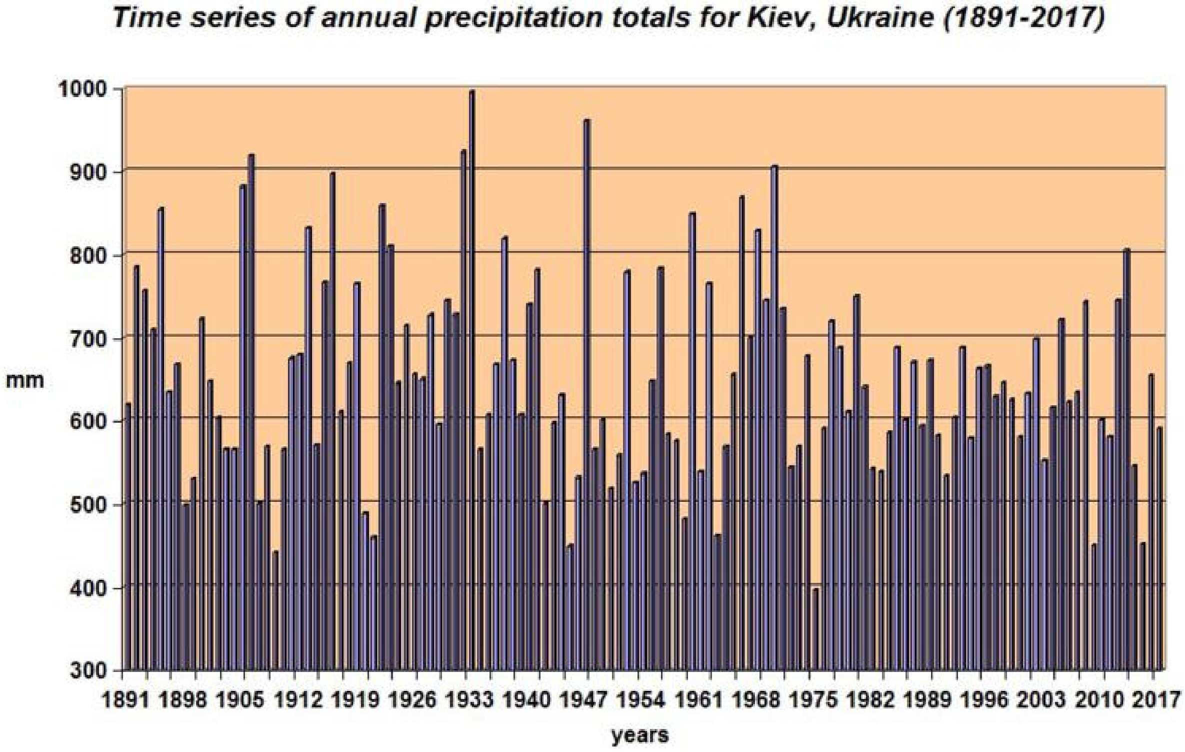


Figure 5.53: Time series of annual precipitation totals for Kiev (Ukraine)
(Diagram as provided by the NHMS)

Middle East - precipitation anomalies

Georgia, Israel

Georgia

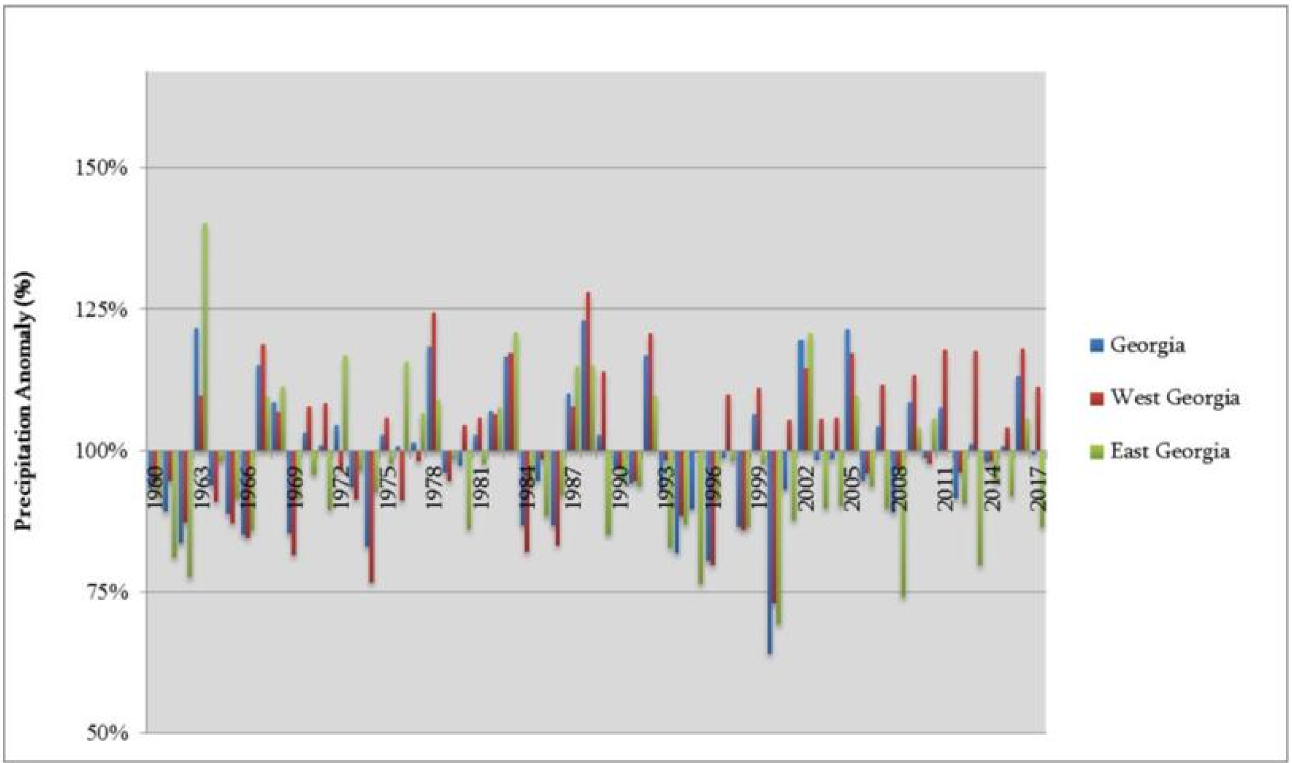


Figure 5.54: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Georgia (Diagram as provided by the NHMS)

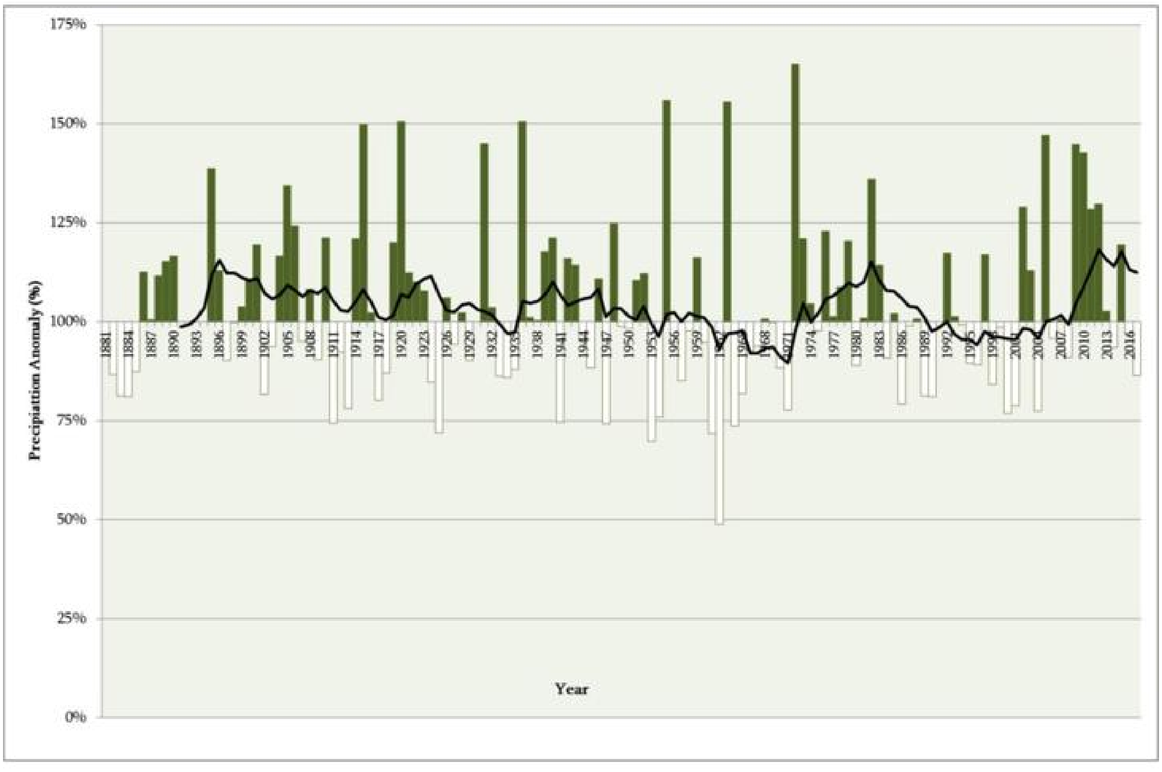


Figure 5.55: Time series of annual precipitation totals in relation to the mean of 1961-1990 for Tbilisi, Georgia (Diagram as provided by the NHMS)

Middle East - precipitation anomalies

Israel

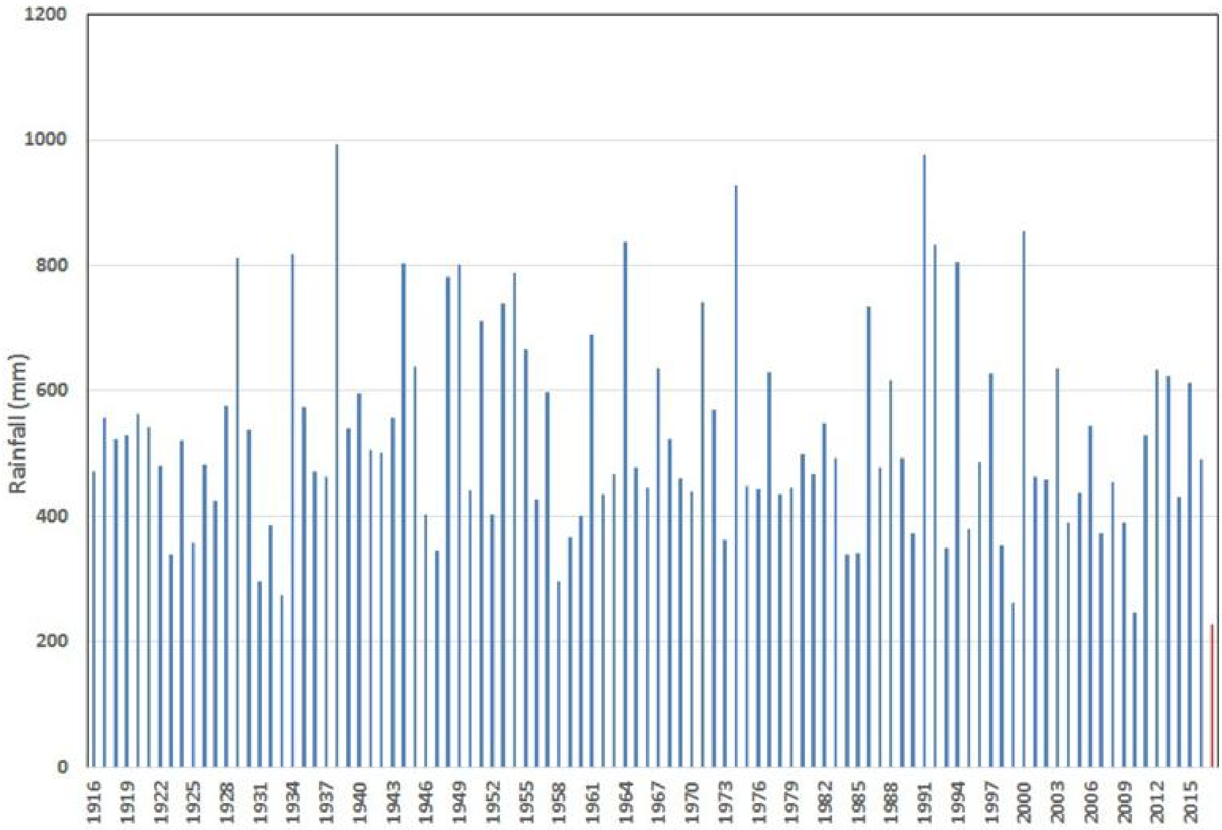


Figure 5.56: Yearly rainfall amounts (mm) in Miqwe Yisrael (Central Coastal Plain) 1916-2017 (diagram as provided by the NHMS)

5.3. Sunshine duration

Central and Western Europe - sunshine duration anomalies

Germany, Switzerland, United Kingdom

Germany

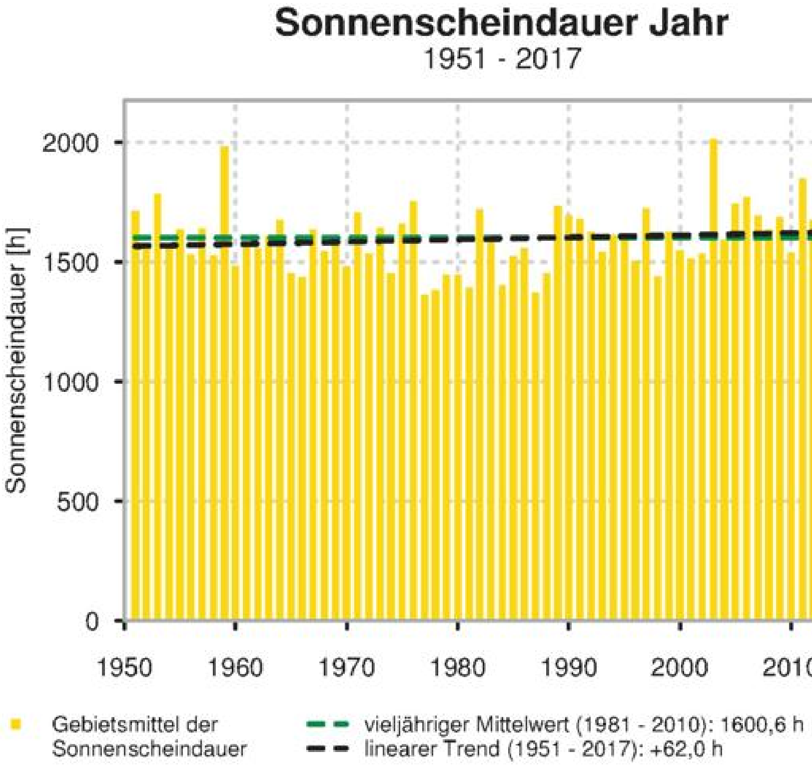


Figure 5.57: Time series of annual sum of the sunshine duration in hours for Germany (green line: long term mean; diagram as provided by the NHMS)

Switzerland

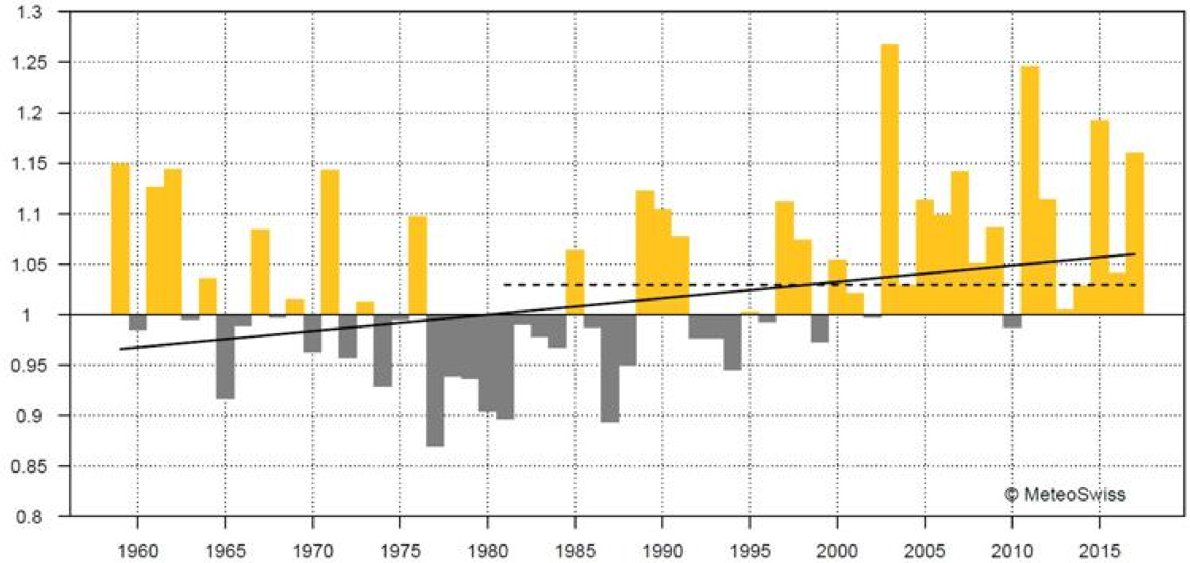


Figure 5.58: Time series of the yearly sunshine duration [ratio] for Switzerland 1959–2017. Color bars represent anomalies in respect to the long-term mean 1961–1990 and yellow indicates positive and grey negative anomalies. The black line represents the linear significant trend (1.48 %/10y). The black dashed line represents the mean 1981–2010 (diagram as provided by MeteoSwiss).

Central and Western Europe - sunshine duration anomalies

United Kingdom

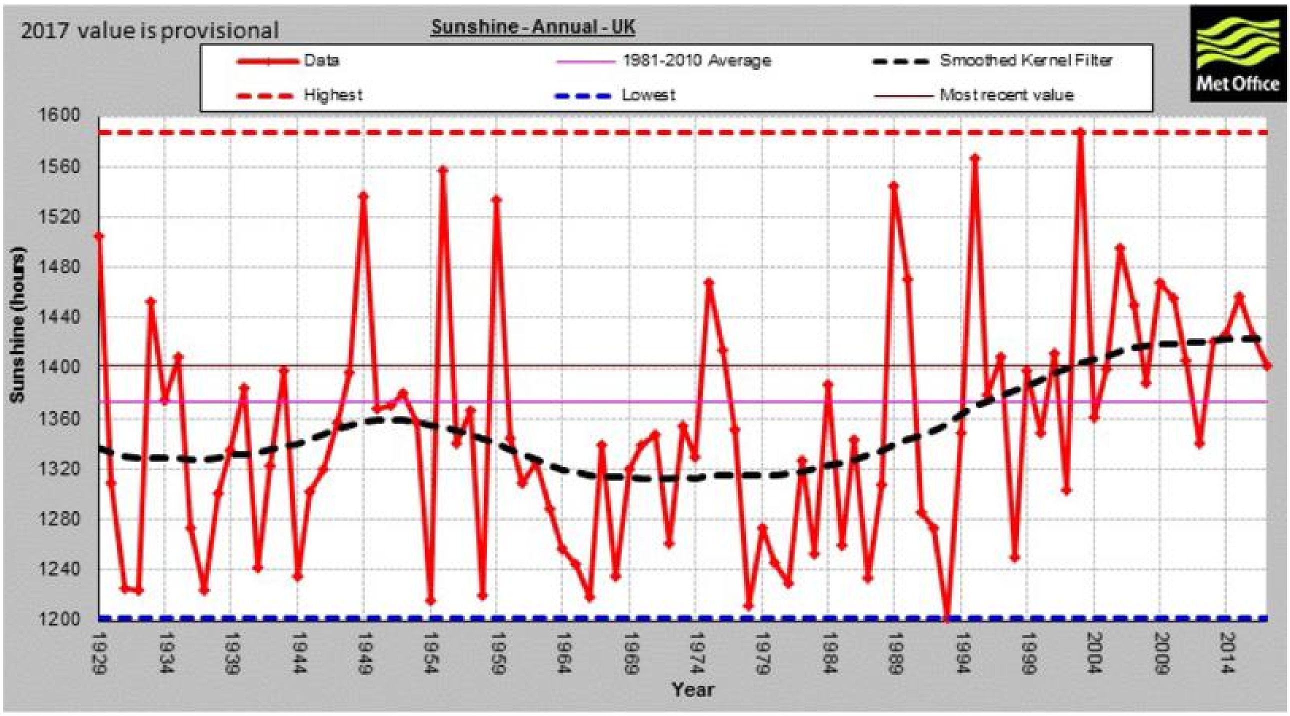


Figure 5.59: Time series of annual sum of the sunshine duration in hours for United Kingdom (Diagram as provided by the NHMS)

Nordic and Baltic Countries - sunshine duration

Denmark

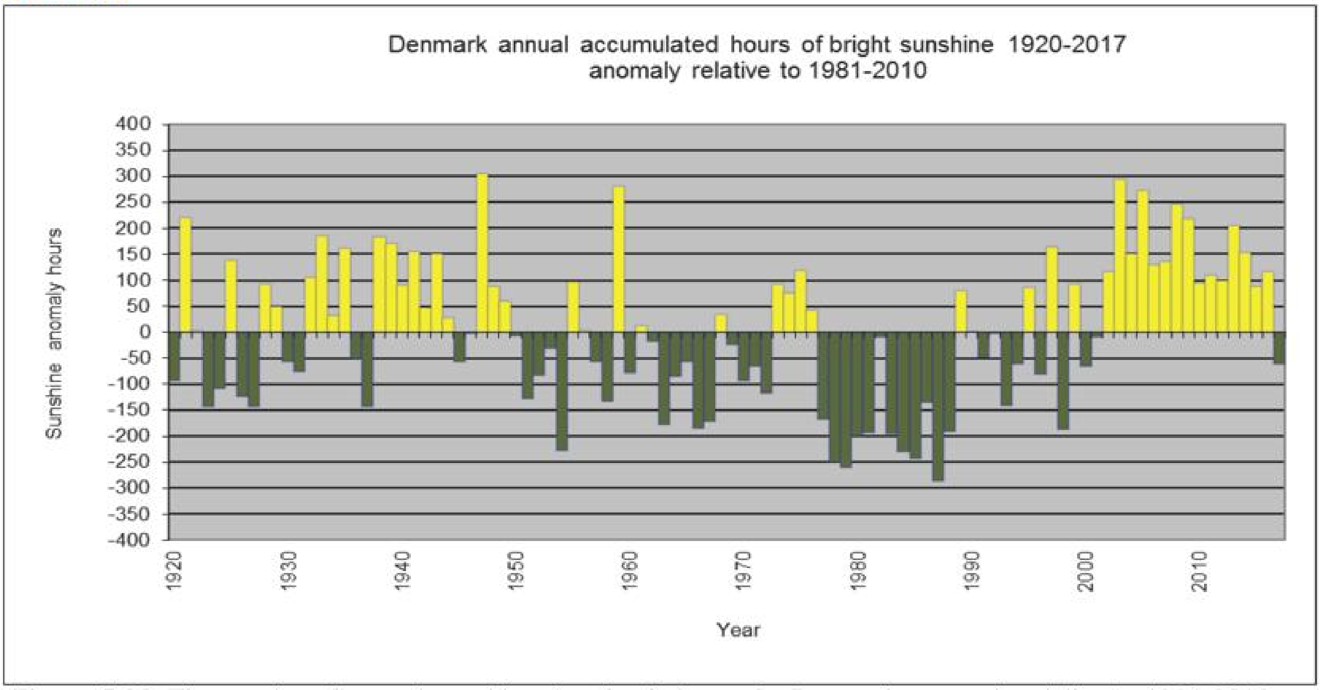


Figure 5.60: Time series of annual sunshine duration in hours for Denmark: anomaly relative to 1981-2010. The values are calculated national average based on a number of selected stations. (Diagram as provided by the NHMS)

Note: *OBS! DMI has since 2002 observed the hours of bright sunshine using measurements of global radiation instead of measurements from a traditional Campbell-Stokes sunshine recorder. For that reason "new" and "old" hours of bright sunshine cannot directly be compared. I should also be noted that all values before 2002 are adjusted ensuring comparability to the new level. For details on that, see DMI Technical 02-25: Ellen Vaarby Laursen, Stig Rosenørn: New hours of bright sunshine normals for Denmark, 1961-1990.*
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2002/tr02-25.pdf
Data up to 2016 are published in DMI report series, No. 17-02 John Cappelen (ed) (2017): Denmark - DMI Historical Climate Data Collection 1768-2016.
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2017/DMIRep17-02.pdf (report)
http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/2017/DMIRep17-02.zip (data)

Estonia

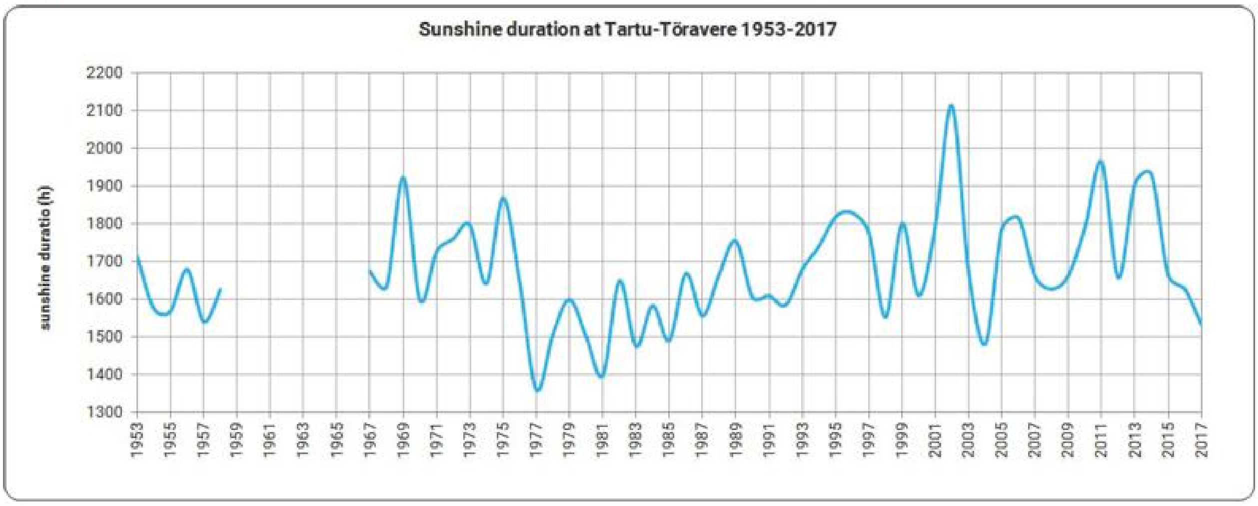


Figure 5.61: Time series of annual sunshine duration in hours for Estonia (station Tartu-Tõravere, diagram as provided by the NHMS)

Eastern Europe - sunshine duration

European Russia

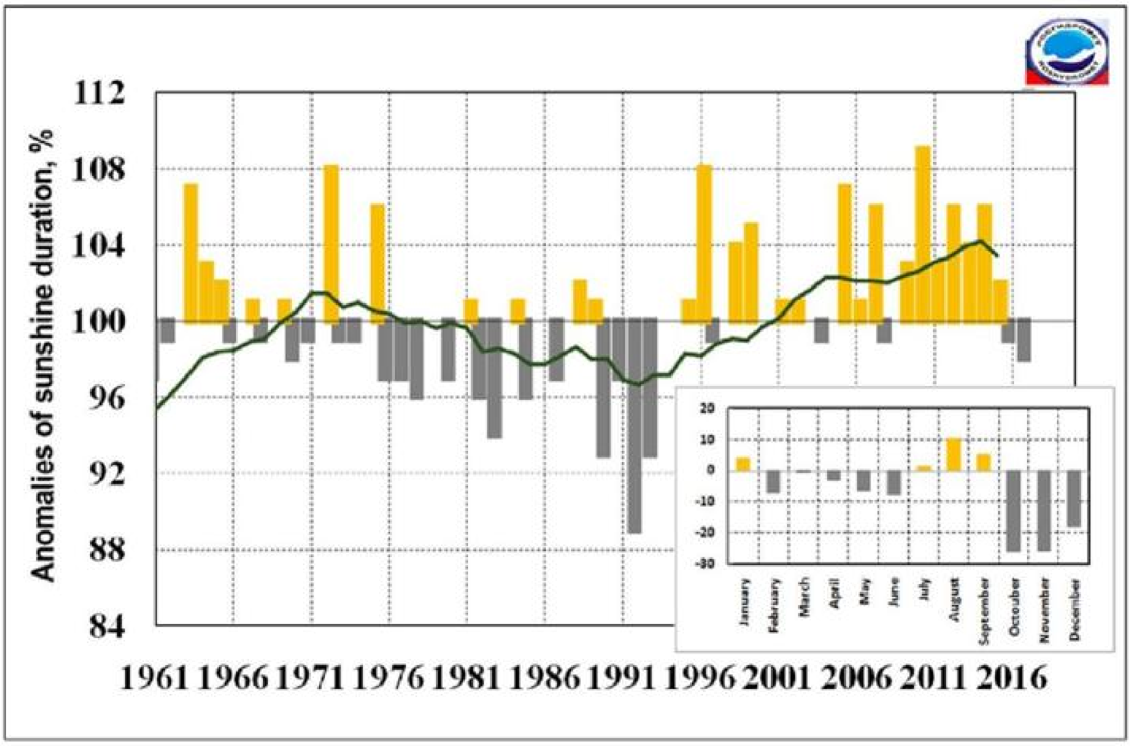


Figure 5.62: Time series of annual sunshine duration in relation to the mean of 1981-2010 for European Russia (Insets show the anomalies of monthly sunshine duration in 2017; Diagram as provided by the NHMS)

6. Annex: Monthly and annual tables

Table 6.1: Statistical values of **annual** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

WMO Nr.	Station name	Country	Temperature (°C)		Precipitation (mm)	
			mean	dev.	total	dev.
1001	Jan Mayen	NOR	1.6	3.0	540	-147
1008	Svalbard	NOR	-2.2	4.2	207	24
1025	Tromsoe	NOR	3.4	0.6	1135	162
1492	Oslo	NOR	6.9	1.2	948	179
2196	Haparanda	SWE	2.3	1.1	603	51
2485	Stockholm	SWE	8.0	1.4	560	21
2836	Sodankylä	FIN	0.3	1.3	446	-54
2974	Helsinki Airp.	FIN	6.1	1.5	818	167
3091	Aberdeen	GBR	9.3	1.3	843	60
3772	London	GBR	12.3	1.7	574	-25
3967	Dublin/Casement	IRL	10.0	0.8	705	-7
4030	Reykjavik	ISL	5.5	1.2	901	103
4320	Danmarkshavn	GRL	-10.4	1.9	160	28
6186	Copenhagen	DNK	9.7	1.1	883	247
6260	De Bilt	NLD	10.9	1.6	948	143
6447	Brussels (Uccle)	BEL	11.3	1.4	750	-68
6590	Luxembourg	LUX	10.2	1.9	725	-150
6660	Zurich	CHE	10.2	1.7	1107	21
6700	Geneva (Genf)	CHE	11.3	1.6	693	-261
7510	Bordeaux	FRA	13.9	1.2	762	-161
7650	Marseille	FRA	16.0	1.2	306	-240
8001	La Coruna	ESP	15.4	1.4	727	-268
8222	Madrid Retiro	ESP	16.7	2.4	256	-200
8314	Menorca	ESP	17.8	1.2	460	-139
8495	Gibraltar	GIB	19.1	0.9	539	-236
8515	Santa Maria/Azores	PRT	18.6	1.1	735	-40
8535	Lisbon	PRT	17.9	1.1	480	-273
10384	Berlin-Tempelhof	DEU	10.6	1.2	797	213
11035	Wien/Hohe Warte	AUT	11.6	1.8	589	-18
11518	Prague	CZE	9.2	1.4	537	11
11903	Sliac	SVK	8.8	0.8	755	69
12160	Elblag	POL	7.7	0.1	1222	532
12375	Warsaw	POL	9.4	1.6	699	180
12843	Budapest	HUN	11.7	1.3	638	120
13274	Beograd	SRB	13.8	1.9	509	-175
14015	Ljubljana	SVN	11.9	2.1	1532	138
14445	Split	HRV	17.0	1.2	560	-265
14654	Sarajevo	BIH	10.8	1.3	937	5
15420	Bucharest	ROU	11.3	0.8	786	191
15614	Sofia	BGR	11.1	1.4	663	100
16158	Pisa	ITA	15.2	1.2	684	-224
16597	Luqa	MLT	19.5	0.9	606	53
16716	Athens	GRC	19.3	0.8	338	-34
16754	Iraklion	GRC	19.2	0.5	373	-129
22113	Murmansk	RUS	0.9	1.0	540	62
26038	Tallinn	EST	6.3	1.2	860	193
26406	Liepaja	LVA	7.9	1.2	922	232
26629	Kaunas	LTU	7.7	1.3	717	111
26730	Vilnius	LTU	7.3	1.3	899	131
26850	Minsk	BLR	7.6	1.8	780	103
27612	Moscow	RUS	6.3	1.3	870	182
33345	Kiev	UKR	9.8	2.1	590	-59
33815	Kisinev	MDA	11.2	1.6	635	88
34300	Kharkiv	UKR	9.5	2.0	421	-98
34880	Astrachan	RUS	11.5	1.6	195	-26
37789	Yerevan	ARM	12.5	1.0	253	-24
17030	Samsun	TUR	15.3	1.0	652	-40
17062	Istanbul-Kartal	TUR	15.9	1.8	697	0
17130	Ankara	TUR	12.9	1.2	378	-29
17170	Van	TUR	9.8	1.2	328	-50
17300	Antalya	TUR	19.2	0.8	625	-442
17609	Larnaka	CYP	20.2	1.2	211	-118
35108	Uralsk	KAZ	6.9	1.5	247	-77
37545	Tbilisi	GEO	14.5	1.5	418	-80
40103	Tripoli	LBN	20.3	1.0	639	-241
40180	Tel Aviv	ISR	21.2	1.7	195	-373
40199	Elat	ISR	26.1	1.6	14	-18
40265	Mafraq	JOR	18.0	1.5	80	-80
60030	Las.Palmas/Gran Can.	ESP	21.8	1.3	58	-59

Table 6.2: Statistical values of **monthly** mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI region.

Station name	Country	January				February				March			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	-3.3	2.4	67	6	-1.2	4.9	32	-21	-4.2	1.9	27	-28
Svalbard	NOR	-10.3	5.1	25	11	-6.9	8.8	45	26	-11.6	3.1	16	-5
Tromsoe	NOR	-1.1	2.9	166	85	-2.8	0.9	93	7	-1.6	0.6	141	77
Oslo	NOR	-1.4	2.9	26	-23	-1.5	2.5	64	28	2.6	2.8	42	-4
Haparanda	SWE	-7.2	4.9	38	-6	-7.5	3.8	27	-5	-4.1	2.7	51	16
Stockholm	SWE	-0.3	2.5	34	-5	0.2	3.2	18	-9	3.3	3.2	30	4
Sodankylä	FIN	-10.2	4.9	24	-7	-10.1	3.5	15	-10	-5.6	2.9	27	2
Helsinki Airp.	FIN	-2.9	4.0	35	-6	-3.2	3.6	32	1	0.6	3.5	35	1
Aberdeen	GBR	4.4	1.7	47	-34	5.6	2.7	83	32	6.8	2.3	57	-1
London	GBR	4.3	0.1	60	8	7.5	3.0	38	3	10.5	4.0	26	-21
Dublin/Casement	IRL	5.8	0.9	26	-43	6.4	1.8	64	13	8.0	2.0	66	12
Reykjavik	ISL	1.4	1.9	83	7	2.8	2.4	126	54	1.8	1.3	52	-30
Danmarkshavn	GRL	-24.6	-1.5	10	-1	-20.5	3.8	11	0	-23.6	-0.2	5	-12
Copenhagen	DNK	1.5	1.0	18	-33	2.5	2.0	52	21	5.5	2.9	50	8
De Bilt	NLD	1.6	-0.6	59	-7	5.1	2.6	78	29	8.6	3.6	62	-1
Brussels (Uccle)	BEL	1.1	-1.5	64	-3	6.1	2.6	41	-12	9.6	4.1	48	-24
Luxembourg	LUX	-1.6	-1.6	25	-46	4.1	3.0	54	-8	8.5	4.5	45	-25
Zurich	CHE	-3.0	-2.5	89	22	3.7	2.8	52	-18	8.5	4.3	63	-6
Geneva (Genf)	CHE	-1.2	-2.0	25	-55	4.8	2.5	52	-29	8.7	3.6	57	-22
Bordeaux	FRA	4.1	-1.7	28	-72	9.1	2.0	75	-11	11.6	2.8	65	-11
Marseille	FRA	5.5	-1.2	30	-17	11.3	3.4	21	-33	13.1	2.9	75	31
La Coruna	ESP	10.3	0.1	50	-81	11.8	1.3	126	22	12.9	1.6	130	44
Madrid Retiro	ESP	6.0	-0.1	22	-24	9.2	1.7	45	1	12.2	2.2	19	-14
Menorca	ESP	10.0	-0.5	167	101	12.3	1.6	20	-37	13.8	2.2	30	-25
Gibraltar	GIB	13.2	-0.2	38	-83	15.0	1.2	112	12	15.6	0.6	57	-18
Santa Maria/Azores	PRT	15.6	1.2	142	42	14.8	0.8	25	-61	15.1	0.5	35	-44
Lisbon	PRT	11.1	-0.3	82	-28	13.2	0.9	88	-23	14.4	0.7	84	15
Berlin-Tempelhof	DEU	-0.8	-0.6	38	-5	2.4	1.6	34	0	8.0	3.8	48	11
Wien/Hohe Warte	AUT	-3.4	-2.4	21	-17	3.1	2.1	29	-13	9.3	4.3	42	1
Prague	CZE	-5.4	-3.0	14	-9	1.7	2.5	16	-7	6.8	3.8	31	3
Sliac	SVK	-10.0	-6.1	26	-18	1.4	2.5	35	-9	6.7	3.7	35	-7
Elblag	POL	-3.1	-0.7	31	-16	-1.5	0.7	44	19	4.1	2.0	61	26
Warsaw	POL	-3.7	-0.4	19	-3	-0.8	1.2	39	18	6.2	4.2	39	11
Budapest	HUN	-5.0	-3.4	26	-6	2.7	1.6	34	2	9.7	4.1	41	12
Beograd	SRB	-3.6	-4.0	23	-26	5.2	2.5	24	-20	11.4	4.2	27	-23
Ljubljana	SVN	-3.2	-2.1	56	-26	4.5	3.1	114	34	10.2	4.8	34	-64
Split	HRV	4.4	-3.0	50	-33	10.4	2.3	69	1	13.5	3.1	68	-7
Sarajevo	BIH	-5.1	-4.2	58	-13	5.0	3.5	69	2	8.5	3.4	44	-26
Bucharest	ROU	-5.4	-3.0	49	9	0.6	0.7	39	3	8.6	3.8	51	13
Sofia	BGR	-5.9	-4.3	39	12	2.7	2.2	38	5	8.7	4.1	62	24
Pisa	ITA	5.8	-0.3	44	-31	9.9	2.8	87	16	11.7	2.2	41	-35
Luqa	MLT	11.5	-0.7	154	65	13.6	1.2	149	88	14.6	1.2	24	-17
Athens	GRC	8.4	-1.8	28	-17	11.4	0.9	6	-42	14.2	1.8	69	25
Iraklion	GRC	10.7	-1.3	118	26	12.9	0.7	8	-69	13.8	0.2	98	41
Murmansk	RUS	-7.9	3.8	49	16	-7.6	3.6	31	9	-3.5	3.3	36	16
Tallinn	EST	-1.8	3.7	24	-21	-2.3	3.4	32	3	1.1	3.3	44	15
Liepaja	LVA	-0.5	2.5	37	-9	-0.9	2.1	32	1	2.7	2.9	37	1
Kaunas	LTU	-3.7	1.5	18	-21	-1.5	2.8	30	-1	3.7	4.1	53	18
Vilnius	LTU	-4.6	1.5	29	-12	-2.3	2.5	36	-2	3.4	4.0	61	22
Minsk	BLR	-5.7	1.2	37	-3	-3.1	2.7	25	-9	4.2	5.6	60	18
Moscow	RUS	-7.8	1.5	44	-1	-4.6	3.1	36	-1	2.4	4.6	57	23
Kiev	UKR	-4.9	0.7	32	-15	-2.8	1.4	36	-10	6.2	5.5	18	-21
Kisinev	MDA	-4.2	-0.9	23	-17	-0.5	1.2	32	-6	7.8	4.9	23	-12
Kharkiv	UKR	-5.8	1.1	35	-9	-4.0	1.7	21	-11	5.0	5.3	23	-4
Astrachan	RUS	-2.9	2.5	6	-7	-4.0	0.9	17	7	4.4	3.1	34	20
Yerevan	ARM	-8.7	-5.5	25	4	-6.1	-5.1	17	-7	6.4	1.3	19	-13
Samsun	TUR	6.1	-0.8	79	18	7.5	0.3	40	-10	9.4	1.4	65	9
Istanbul-Kartal	TUR	4.4	-1.2	131	32	7.6	1.7	38	-29	10.0	2.5	56	-6
Ankara	TUR	-1.4	-1.4	33	-8	3.1	1.4	9	-27	8.1	2.1	51	15
Van	TUR	-3.3	1.1	18	-16	-4.4	-0.6	26	-7	3.3	2.4	44	2
Antalya	TUR	8.3	-1.6	133	-106	10.7	0.4	7	-189	13.5	0.8	117	14
Larnaka	CYP	10.8	-1.0	31	-34	11.9	-0.3	1	-56	14.9	1.4	37	-12
Uralsk	KAZ	-10.8	2.1	8	-17	-10.4	2.1	20	2	-2.7	2.3	21	1
Tbilisi	GEO	2.3	0.6	5	-14	3.5	0.6	10	-16	9.7	2.8	10	-20
Tripoli	LBN	11.3	-1.4	288	94	11.8	-1.4	30	-97	15.4	0.7	80	-36
Tel Aviv	ISR	12.7	0.4	39	-110	12.8	-0.1	62	-36	16.5	1.6	2	-60
Elat	ISR	15.3	0.2	0	-5	16.5	-0.3	13	8	21.3	1.5	0	-4
Mafraq	JOR	7.2	0.0	30	-4	8.0	-0.7	12	-19	12.5	1.0	21	-8
Las Palmas/Gran Can.	ESP	18.3	0.8	2	-15	18.6	1.0	7	-15	18.9	0.5	16	6

Table 6.2: continued

Station name	Country	April				May				June			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	-2.1	1.8	29	-11	1.9	2.6	9	-31	4.8	2.8	14	-21
Svalbard	NOR	-8.3	3.4	6	-6	-3.9	-0.2	5	-1	4.6	2.4	6	-4
Tromsoe	NOR	0.0	-0.7	67	7	3.4	-1.5	76	28	9.5	0.2	30	-23
Oslo	NOR	5.2	0.6	46	4	11.6	0.8	79	27	15.1	-0.1	90	25
Haparanda	SWE	-0.4	0.1	46	17	4.6	-1.5	23	-8	12.0	-0.8	24	-17
Stockholm	SWE	4.9	0.3	23	-7	11.3	0.6	12	-18	15.2	-0.4	75	30
Sodankylä	FIN	-2.5	-0.4	28	4	2.6	-2.4	9	-26	10.3	-1.3	37	-19
Helsinki Airp.	FIN	2.3	-0.6	40	3	10.3	0.4	10	-25	13.8	-1.1	100	56
Aberdeen	GBR	8.0	1.7	52	-1	11.3	2.3	24	-35	13.6	1.5	143	90
London	GBR	10.9	2.0	5	-40	15.1	2.6	65	14	18.9	3.2	46	-5
Dublin/Casement	IRL	8.3	0.8	9	-41	12.4	2.3	67	10	14.4	1.3	92	39
Reykjavik	ISL	3.1	0.2	150	92	8.6	2.3	84	40	9.9	0.9	43	-7
Danmarkshavn	GRL	-19.3	-2.0	7	-3	-8.8	-2.2	2	-2	1.2	0.5	5	0
Kopenhagen	DNK	7.3	0.7	72	30	13.3	1.3	18	-25	16.2	0.1	101	47
De Bilt	NLD	8.6	0.6	24	-28	15.0	2.7	36	-25	18.0	2.8	61	-7
Brüssel	BEL	8.8	0.0	15	-42	15.5	2.6	45	-26	19.2	3.5	51	-28
Luxemburg	LUX	8.6	1.1	5	-56	15.3	3.5	38	-43	19.0	4.1	54	-28
Zürich	CHE	8.8	1.0	117	30	14.8	2.7	75	-28	19.9	4.7	86	-38
Genf	CHE	10.5	1.7	40	-25	15.0	2.0	81	4	20.9	4.4	77	-12
Bordeaux	FRA	12.8	1.5	22	-50	17.9	3.3	64	-13	21.4	3.6	137	81
Marseille	FRA	14.3	1.1	56	8	18.6	1.5	27	-15	24.6	3.7	18	-10
La Coruna	ESP	14.3	2.2	15	-68	17.4	3.3	61	-17	18.7	2.3	28	-21
Madrid Retiro	ESP	16.0	3.8	12	-42	20.1	4.1	27	-14	26.4	5.7	5	-21
Menorca	ESP	14.9	1.6	23	-27	19.6	2.8	<1	-37	24.5	3.7	17	3
Gibraltar	GIB	17.6	1.4	173	113	20.0	1.5	14	-21	23.6	2.5	0	-11
Santa Maria/Azoren	PRT	16.2	1.0	88	33	17.1	0.4	75	45	19.5	0.8	7	-15
Lissabon	PRT	18.3	3.2	5	-59	19.7	2.3	60	21	22.7	2.5	1	-20
Berlin-Tempelhof	DEU	8.6	0.0	26	-15	15.5	1.6	16	-40	18.9	1.5	193	118
Wien	AUT	10.0	0.1	72	21	16.6	2.0	44	-17	22.1	4.2	32	-42
Prag	CZE	7.6	-0.1	55	17	14.2	1.5	33	-44	18.5	2.6	117	44
Sliac	SVK	8.3	-0.2	75	28	15.2	1.5	18	-46	19.8	3.2	111	26
Elbing	POL	5.5	-1.3	65	23	12.1	-0.8	25	-16	15.0	-0.4	96	2
Warschau	POL	7.7	-0.1	48	16	14.6	1.2	49	-10	18.5	1.9	86	14
Budapest	HUN	11.0	-0.1	71	33	17.2	1.2	72	17	22.5	3.4	37	-26
Belgrad	SRB	12.6	0.2	52	-7	18.2	1.0	86	15	24.0	3.9	53	-37
Ljubljana	SVN	12.0	2.1	153	43	16.9	2.3	72	-50	21.7	3.9	150	-5
Split	HRV	14.5	0.6	36	-30	20.1	1.7	41	-15	25.8	3.6	4	-47
Sarajevo	BIH	9.1	-0.3	132	58	15.1	1.0	74	-8	20.3	3.4	55	-36
Bukarest	ROU	10.1	-1.2	90	44	16.2	-0.5	77	7	22.0	1.8	42	-35
Sofia	BGR	10.4	0.5	55	5	15.1	0.8	49	-24	20.7	3.0	63	-9
Pisa	ITA	13.9	1.4	21	-58	18.1	1.8	24	-35	23.0	3.2	33	-11
Luqa	MLT	16.4	0.9	13	-10	20.8	1.7	2	-5	25.3	2.3	7	4
Athen	GRC	17.0	1.0	4	-21	21.7	1.1	35	21	26.1	1.1	45	39
Heraklion	GRC	16.8	0.2	16	-14	21.0	0.7	37	22	25.2	0.9	2	-1
Murmansk	RUS	-2.0	-0.1	30	9	2.0	-1.8	34	2	6.9	-2.5	65	12
Tallinn	EST	2.9	-0.5	45	9	9.2	-0.5	12	-25	13.1	-1.4	85	32
Liepaja	LVA	4.3	-0.3	35	0	10.6	0.3	8	-32	14.6	0.3	66	20
Kaunas	LTU	5.6	-0.2	74	32	12.9	0.5	11	-44	15.4	-0.4	80	11
Vilnius	LTU	5.4	-0.3	69	23	12.7	0.2	8	-54	15.4	-0.4	127	50
Minsk	BLR	6.0	0.0	72	30	13.1	0.2	28	-34	16.4	0.3	53	-30
Moskau	RUS	5.3	-0.5	77	37	10.9	-2.0	83	25	14.4	-2.2	139	63
Kiew	UKR	10.4	1.7	25	-24	15.3	0.2	34	-19	20.0	1.8	27	-46
Kischinau	MDA	9.4	-0.8	127	85	16.4	0.3	58	7	21.3	1.9	73	-2
Charkiw	UKR	8.9	0.0	39	3	14.6	-1.0	37	-10	19.6	0.7	18	-40
Astrachan	RUS	11.5	0.4	1	-17	18.2	-0.1	28	4	22.2	-0.7	47	25
Jerewan	ARM	12.5	0.9	14	-23	17.9	1.6	44	1	23.3	2.7	24	3
Samsun	TUR	10.3	-1.1	78	16	15.3	-0.2	71	22	21.0	1.0	45	0
Istanbul	TUR	13.0	1.0	28	-21	17.9	1.4	36	5	23.3	2.2	49	28
Ankara	TUR	11.1	-0.1	23	-25	15.7	0.1	54	-1	20.4	0.8	56	19
Van	TUR	7.7	0.4	62	8	13.1	0.3	81	31	18.4	0.8	<1	-21
Antalya	TUR	16.7	0.6	40	-6	21.4	1.1	42	14	26.5	1.5	3	-5
Larnaka	CYP	18.1	1.2	23	12	21.7	1.3	28	21	25.6	1.6	2	1
Oral	KAZ	8.0	0.3	32	13	14.9	-1.2	14	-7	18.5	-1.7	50	13
Tiflis	GEO	12.6	-0.2	24	-27	17.7	0.3	91	13	22.4	1.2	96	20
Tripoli	LBN	18.2	0.7	41	-15	21.8	1.9	3	-14	24.9	1.6	0	-1
Tel Aviv	ISR	19.8	1.6	16	-7	23.4	2.3	<1	-3	25.7	1.7	0	0
Eilat	ISR	26.1	1.7	<1	-3	30.0	1.8	0	-1	33.1	2.2	0	0
Mafraq	JOR	17.4	1.6	<1	-10	21.5	1.7	0	-3	24.3	1.6	0	0
L.Palmas/Gran Can.	ESP	21.1	2.4	1	-5	22.1	2.2	2	0	23.6	2.2	0	0
Le Lamentin	MTQ	26.8	0.9	133	37	27.6	0.8	180	57	27.7	0.4	184	14

Table 6.2: continued

Station name	Country	July				August				September			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	6.9	2.7	25	-22	7.1	2.2	56	-5	7.6	4.8	74	-8
Svalbard	NOR	6.9	0.9	20	7	6.1	1.3	18	-7	4.9	4.4	21	-2
Tromsoe	NOR	11.1	-0.6	66	-6	10.7	-0.2	109	27	8.9	2.1	6	-88
Oslo	NOR	16.9	0.5	100	16	15.3	0.1	158	68	12.2	1.4	99	9
Haparanda	SWE	14.8	-0.7	34	-16	13.2	-0.1	46	-17	8.8	0.9	49	-14
Stockholm	SWE	17.4	0.2	15	-57	17.0	0.8	70	4	13.1	1.9	67	12
Sodankylä	FIN	15.1	1.0	84	19	11.9	0.7	58	-5	7.2	1.3	27	-28
Helsinki Airp.	FIN	16.1	-0.5	33	-40	16.0	1.0	72	-8	11.2	1.2	67	-6
Aberdeen	GBR	14.5	0.7	75	15	14.5	0.9	77	2	12.3	0.6	72	4
London	GBR	19.4	1.6	90	44	17.8	0.4	59	8	15.1	0.1	59	8
Dublin/Casement	IRL	15.3	0.1	43	-6	14.7	-0.1	65	1	12.5	-0.1	71	12
Reykjavik	ISL	11.7	1.1	37	-15	10.8	0.5	39	-23	9.7	2.3	89	23
Danmarkshavn	GRL	5.7	2.0	1	-13	3.9	1.5	0	-14	-0.8	3.4	76	65
Copenhagen	DNK	16.8	-0.4	107	38	17.4	0.4	105	42	14.2	0.6	134	72
De Bilt	NLD	17.9	1.1	132	57	17.2	0.5	53	-18	13.7	-0.3	121	54
Brussels (Uccle)	BEL	18.6	1.1	58	-17	18.1	0.8	71	8	14.1	-0.4	78	19
Luxembourg	LUX	19.1	2.2	119	51	18.1	1.7	49	-23	12.9	-0.5	86	16
Zurich	CHE	19.2	1.6	172	55	19.5	2.8	102	-31	13.1	-0.7	107	15
Geneva (Genf)	CHE	21.4	2.3	40	-27	21.2	3.0	62	-17	14.1	-0.8	44	-37
Bordeaux	FRA	21.4	1.2	28	-19	21.3	1.4	30	-24	16.8	-1.1	72	-2
Marseille	FRA	25.9	2.1	0	-14	25.4	2.2	5	-24	19.1	-1.2	7	-40
La Coruna	ESP	19.9	1.5	13	-12	19.8	1.0	29	0	18.2	0.1	43	-19
Madrid Retiro	ESP	26.8	2.4	49	36	26.7	2.8	26	17	21.5	1.0	0	-30
Menorca	ESP	25.7	1.5	26	22	26.3	1.8	12	-14	21.5	-0.7	44	-10
Gibraltar	GIB	23.9	0.2	0	-1	25.0	0.8	2	-4	23.1	0.3	1	-14
Santa Maria/Azores	PRT	21.9	1.1	25	0	23.1	0.9	22	-18	22.7	1.3	23	-34
Lisbon	PRT	22.7	0.3	2	-3	23.2	0.4	5	-1	21.0	-0.7	0	-26
Berlin-Tempelhof	DEU	19.2	0.4	137	85	19.5	1.1	70	10	14.3	-0.3	32	-14
Wien/Hohe Warte	AUT	22.2	2.5	67	4	22.5	3.6	43	-15	14.9	-0.2	94	49
Prague	CZE	19.1	1.6	66	0	19.2	2.2	79	9	12.6	-0.7	24	-16
Sliac	SVK	19.2	1.0	86	27	20.3	3.0	56	-13	13.9	0.5	108	52
Elblag	POL	16.0	-0.8	150	56	17.2	0.5	131	50	12.8	0.1	212	142
Warsaw	POL	19.0	1.1	90	23	19.7	2.4	41	-22	14.0	0.8	127	84
Budapest	HUN	22.6	1.7	57	5	23.6	3.3	57	6	15.9	-0.5	91	51
Beograd	SRB	25.5	3.8	26	-40	26.0	4.7	20	-32	18.6	0.9	46	-5
Ljubljana	SVN	23.2	3.3	73	-49	23.2	4.1	60	-85	14.3	-1.2	344	214
Split	HRV	27.5	2.1	3	-25	28.8	3.6	0	-50	20.8	-0.6	92	31
Sarajevo	BIH	21.5	2.6	66	-14	22.4	3.9	39	-32	15.4	0.3	93	23
Bucharest	ROU	22.7	0.7	128	64	23.0	1.8	47	-11	18.2	1.3	28	-14
Sofia	BGR	22.0	2.0	72	16	22.2	2.8	29	-23	17.6	1.8	44	5
Pisa	ITA	24.1	1.3	3	-20	25.3	2.8	2	-58	19.4	-0.1	194	105
Luqa	MLT	27.7	1.8	0	0	28.4	2.1	2	-5	24.5	0.4	42	2
Athens	GRC	29.5	1.7	4	-2	29.8	2.2	<1	-8	25.1	0.8	0	-10
Iraklion	GRC	27.5	1.4	<1	<1	26.9	1.0	0	-1	24.5	1.0	7	-13
Murmansk	RUS	14.2	1.4	40	-20	11.2	0.2	87	22	7.3	0.6	55	3
Tallinn	EST	15.5	-0.8	22	-57	16.1	0.8	180	96	12.1	1.3	90	8
Liepaja	LVA	16.4	0.0	65	-9	16.9	0.5	54	-26	13.7	0.8	186	108
Kaunas	LTU	16.8	-0.1	80	0	17.4	1.0	55	-23	13.4	1.5	87	31
Vilnius	LTU	16.7	-0.2	120	42	17.4	1.1	130	58	13.4	1.8	76	11
Minsk	BLR	17.6	0.3	150	62	18.8	2.3	83	11	13.7	2.0	80	20
Moscow	RUS	17.9	-0.2	103	11	18.8	2.4	68	-6	13.0	2.1	38	-26
Kiev	UKR	20.9	1.6	62	-26	22.4	3.8	57	-12	16.4	2.5	43	-4
Kisinev	MDA	22.4	1.5	78	9	23.7	3.2	22	-23	18.6	2.4	16	-32
Kharkiv	UKR	21.5	1.2	38	-22	23.5	4.0	11	-39	17.1	3.0	24	-17
Astrachan	RUS	26.8	1.5	3	-20	26.6	3.3	2	-17	20.2	2.9	<1	-26
Yerevan	ARM	27.4	2.8	3	-7	28.2	4.3	8	1	24.5	4.7	1	-9
Samsun	TUR	24.2	1.5	<1	-29	25.4	2.7	14	-19	22.3	2.7	30	-20
Istanbul-Kartal	TUR	25.6	2.4	55	36	25.5	2.5	44	18	23.1	3.4	15	-26
Ankara	TUR	25.5	2.6	12	-2	24.7	2.1	17	5	22.6	4.3	4	-15
Van	TUR	22.1	0.2	3	-1	22.5	1.3	3	-1	18.8	2.0	<1	-10
Antalya	TUR	30.4	2.3	<1	-3	29.0	1.3	2	1	26.1	1.6	2	-9
Larnaka	CYP	29.2	2.6	0	0	28.5	1.9	0	0	26.7	2.1	0	0
Uralsk	KAZ	23.3	0.8	6	-32	24.0	3.6	6	-19	16.3	2.2	3	-24
Tbilisi	GEO	26.4	2.0	24	-21	28.0	4.3	0	-48	23.5	3.9	23	-13
Tripoli	LBN	28.4	3.4	0	0	28.3	2.7	0	-1	27.0	2.2	0	-4
Tel Aviv	ISR	28.9	3.2	0	0	28.6	2.5	0	0	27.1	2.3	0	0
Elat	ISR	35.5	3.1	0	0	34.9	2.6	0	0	32.0	1.6	0	0
Mafraq	JOR	28.4	4.3	0	0	26.0	1.8	0	0	25.1	2.4	0	-1
Las .Palmas/Gran Can.	ESP	24.2	0.9	0	0	25.5	1.4	0	0	24.4	0.6	0	-8

Table 6.2: continued

Station name	Country	October				November				December			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	4.7	4.6	106	24	-0.7	2.6	67	1	-2.3	2.9	34	-31
Svalbard	NOR	0.5	6.0	27	12	-3.6	6.9	3	-10	-4.9	8.4	15	3
Tromsoe	NOR	4.3	1.4	141	16	0.2	1.0	110	6	-1.7	1.3	130	26
Oslo	NOR	7.2	0.8	111	27	1.6	0.9	78	3	-1.5	1.3	55	-1
Haparanda	SWE	2.8	0.3	78	14	-2.2	1.9	120	62	-7.3	2.2	67	25
Stockholm	SWE	8.0	0.5	104	54	3.8	1.2	55	2	1.5	2.5	57	11
Sodankylä	FIN	0.4	0.7	42	-9	-5.5	1.9	55	16	-10.1	3.0	40	9
Helsinki Airp.	FIN	5.0	-0.4	172	99	2.7	2.6	109	37	0.7	4.8	113	55
Aberdeen	GBR	10.7	0.8	58	-19	5.2	0.2	105	30	4.2	0.7	50	-23
London	GBR	13.8	2.1	11	-47	8.0	0.8	34	-21	5.9	0.8	81	24
Dublin/Casement	IRL	11.2	1.1	57	-10	6.2	-0.5	80	13	5.2	-0.4	65	-8
Reykjavik	ISL	6.9	2.5	42	-44	0.2	-0.9	92	20	-0.7	-0.5	64	-15
Danmarkshavn	GRL	-6.9	6.7	22	10	-14.2	5.7	19	9	-16.9	4.9	2	-11
Copenhagen	DNK	11.3	1.4	94	35	6.1	0.6	77	15	4.2	2.0	55	-3
De Bilt	NLD	13.3	2.8	85	13	7.3	1.4	74	-7	4.9	1.7	163	84
Brussels (Uccle)	BEL	13.3	2.4	43	-27	6.6	0.5	106	30	4.4	0.9	130	54
Luxembourg	LUX	11.2	2.1	36	-39	4.9	1.1	96	13	2.6	1.6	118	38
Zurich	CHE	11.3	2.0	40	-29	4.8	0.9	89	7	1.3	0.7	115	42
Geneva (Genf)	CHE	11.8	1.7	18	-59	5.7	0.7	64	-28	2.5	0.7	133	46
Bordeaux	FRA	15.6	1.6	13	-75	8.6	-0.5	65	-29	6.7	0.3	163	64
Marseille	FRA	17.3	1.2	<1	-78	10.4	-0.3	41	-17	6.4	-0.9	25	-31
La Coruna	ESP	17.8	2.1	18	-86	13.0	0.4	65	-51	11.2	0.3	149	21
Madrid Retiro	ESP	18.7	3.9	25	-20	10.2	0.8	9	-55	6.8	0.4	17	-34
Menorca	ESP	19.7	1.2	10	-74	14.1	-0.3	47	-30	11.4	-0.4	63	-11
Gibraltar	GIB	20.9	1.4	31	-33	17.0	0.9	50	-91	14.2	0.1	61	-85
Santa Maria/Azores	PRT	21.2	1.9	81	-3	18.6	1.2	177	75	17.8	2.4	35	-60
Lisbon	PRT	21.3	2.8	36	-44	15.1	0.6	64	-50	12.2	0.4	53	-55
Berlin-Tempelhof	DEU	12.0	2.0	91	55	6.2	1.3	69	20	3.9	2.5	43	-10
Wien/Hohe Warte	AUT	12.1	2.2	62	21	6.1	1.5	40	-10	3.1	2.2	43	0
Prague	CZE	10.5	2.2	52	22	4.5	1.7	28	-4	1.5	2.1	22	-4
Sliac	SVK	8.7	0.4	72	22	3.3	0.3	84	15	-1.7	0.0	49	-8
Elblag	POL	8.9	0.0	172	119	3.9	0.6	116	60	1.4	1.1	119	67
Warsaw	POL	10.0	1.7	83	45	4.9	1.7	45	3	2.5	3.4	33	1
Budapest	HUN	11.7	0.8	70	36	6.0	1.2	45	-7	2.6	2.2	37	-3
Beograd	SRB	13.7	1.3	66	26	8.4	1.4	41	-13	5.0	2.7	45	-13
Ljubljana	SVN	12.0	1.6	54	-61	6.2	1.6	204	69	1.9	1.9	218	117
Split	HRV	17.2	0.3	29	-50	12.1	-0.1	88	-20	8.9	0.2	80	-20
Sarajevo	BIH	10.4	0.1	89	12	5.4	0.1	75	-19	2.1	1.8	143	58
Bucharest	ROU	10.5	-0.3	132	100	6.4	1.2	63	14	2.9	2.7	40	-3
Sofia	BGR	10.9	0.5	77	40	5.8	0.8	50	3	2.6	2.1	85	46
Pisa	ITA	14.9	-0.4	6	-117	9.6	-0.8	133	9	6.8	0.0	96	11
Luqa	MLT	20.6	-0.1	103	13	17.2	0.2	64	-16	13.5	-0.3	46	-66
Athens	GRC	19.7	0.4	4	-44	15.5	0.1	106	55	12.6	0.6	36	-30
Iraklion	GRC	20.2	0.3	11	-58	16.5	-0.1	18	-41	14.5	0.7	57	-20
Murmansk	RUS	1.9	0.9	37	-5	-3.8	1.3	43	3	-8.0	1.3	33	-5
Tallinn	EST	5.7	-0.6	153	83	3.0	1.8	85	17	1.1	4.0	88	33
Liepaja	LVA	8.6	0.1	172	98	5.3	1.6	130	47	3.4	3.7	100	33
Kaunas	LTU	7.6	0.5	111	66	3.9	2.1	45	-8	1.1	3.6	73	26
Vilnius	LTU	6.7	0.1	126	73	3.1	1.9	47	-10	0.5	3.4	70	15
Minsk	BLR	6.7	0.4	78	29	2.8	2.0	45	-7	0.5	4.3	69	16
Moscow	RUS	5.0	0.0	93	35	0.0	1.1	46	-12	0.0	6.1	86	34
Kiev	UKR	8.4	0.3	80	45	3.3	1.2	47	-4	1.6	3.9	129	77
Kisinev	MDA	10.8	0.7	76	49	5.5	1.1	34	-5	3.3	3.6	73	35
Kharkiv	UKR	8.1	0.8	49	14	2.2	0.9	53	9	2.8	6.2	73	28
Astrachan	RUS	10.5	1.4	24	7	4.9	1.6	15	-4	-0.1	1.8	17	2
Yerevan	ARM	13.6	0.8	31	4	8.0	1.4	47	25	2.4	1.9	20	-3
Samsun	TUR	16.3	0.7	35	-50	13.3	0.8	59	-30	12.2	3.0	135	53
Istanbul-Kartal	TUR	16.1	0.8	64	-7	13.2	1.6	68	-21	11.1	3.0	113	-9
Ankara	TUR	12.5	-0.1	32	5	7.2	0.1	41	8	4.7	2.2	46	-3
Van	TUR	11.5	1.4	28	-20	5.8	1.8	40	-4	1.8	2.9	22	-12
Antalya	TUR	20.6	1.0	71	1	14.7	-0.1	102	-32	12.3	0.9	105	-122
Larnaka	CYP	22.5	1.2	13	-6	17.7	0.8	62	18	14.9	1.5	14	-62
Uralsk	KAZ	6.0	0.9	29	-1	1.8	3.9	34	-1	-6.2	2.2	24	-5
Tbilisi	GEO	13.6	0.1	95	57	8.8	0.7	15	-15	5.5	1.7	25	4
Tripoli	LBN	22.9	0.7	45	-26	18.1	-0.2	125	12	15.4	1.3	27	-153
Tel Aviv	ISR	23.4	1.4	8	-18	19.3	1.3	15	-53	16.6	2.8	52	-86
Elat	ISR	27.1	0.5	0	-3	21.9	0.8	0	-4	19.4	3.2	0	-6
Mafraq	JOR	19.5	0.4	0	-7	14.5	1.0	4	-13	12.0	3.2	12	-16
L.Palmas/Gran Can.	ESP	24.3	1.8	4	-6	21.9	1.5	4	-17	18.7	0.4	22	1

7. References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2016 edition of the Bulletin, are listed on page 3 above. Many contributions or additional information may as well be found on the web, see below.

Austria: Zentralanstalt für Meteorologie und Geodynamik (**ZAMG**), Wien, Annual Climate Reports
Belgium: The Royal Meteorological Institute of Belgium (**KMI**), Klimatologisch overzicht
Bosnia and Herzegovina: Federal Meteorological Institute (**METEOBIH**), Analiza-godina.
Croatia: Meteorological and Hydrological Service (**DMHZ**) Annual reports
Denmark: Danish Meteorological Institute (**DMI**), Vejret i Danmark
Denmark: Danish Meteorological Institute (**DMI**), Storms in Denmark since 1891
Estonian Weather Service: Estonian weather events in 2017
Finnish Meteorological Institute (FMI) Press release 2017
France: Météo-France, Toulouse, Bilan climatiques
Germany: Deutscher Wetterdienst (**DWD**), Annual, Seasonal and Monthly Summary
Greece: Hellenic National Meteorological Service, http://www.hnms.gr/emy/en/climatology/climatology_extreme
Greece: National Observatory of Athens, Meteorological bulletin
Hungarian Meteorological Service (**OMSZ**), Climate retrospective
Icelandic Met Office: The weather in Iceland 2017-Climate summary
Ireland: The Irish Meteorological Service (**MET Éireann**), Weather Summary
Israel Meteorological Service (**IMS**): Weather summary in Israel
Italy: Agenzia Regionale per la Protezione Ambientale (**ARPA**) Piemonte, Rapporti annuali
Latvian Environment, Geology and Meteorology Centre Monthly bulletins
Lithuanian hydrometeorological Service (**Lhmt**) http://www.meteo.lt/menesio-apzvalgu-archyvas
Luxembourg: MeteoLux, Bilans climatologiques annuels (http://meteolux.lu/fr/produits-et-services/bilans-climatologiques/bilans-climatologiques-annuels/)
Moldova: State Hydrometeorological Service (**SHS**), Caracterizarea conditiilor meteorologice si agrometeorologice din anul
Montenegro: Institute of Hydrometeorology and Seismology (IHMS) Annual reports
Netherlands: Royal Netherlands Meteorological Institute (**KNMI**), Jaaroverzicht van het weer in Nederland
Netherlands: Royal Netherlands Meteorological Institute (**KNMI**), Zware stormen in Nederland sinds 1910
Norway: Det Norske Meteorologiske institutt (**DNMI**), Klimatologisk månedsoversikt
Portugal: Instituto portuguesa do mar e da atmosfera (**ipma**), Bolletim Climatológico Anual
Romania: Administrația Națională de Meteorologie, Monitorizare climatica
Russia: Hydrometeorological Centre of Russia (**Roshydromet**) Climate features of the northern hemisphere
Serbia: Republic Hydrometeorological Service of Serbia (**RHMZ**) Annual Bulletin for Serbia
Slovak hydrometeorological institute (**SHMU** Slovenský hydrometeorologický ústav) Bulletin Meteorológia a Klimatológia
Slovenian Environment Agency (**ARSO,** Agencija Republike Slovenije za okolje): Mesečni bilten ARSO
Slovenia: Unusual events http://meteo.arso.gov.si/met/sl/climate/natural-hazards/
Spain: Agencia Estatal de Meteorología (**AEMET**), Resumen anual climatologico
Spain: Agencia Estatal de Meteorología (**AEMET**), Olas de calor en España desde 1975
Spain: Agencia Estatal de Meteorología (**AEMET**), Olas de frío en España desde 1975
Swedish Meteorological and Hydrological Institute (**SMHI)**, Året (year)
Swedish Meteorological and Hydrological Institute (**SMHI)**, Stormar i Sverige
Switzerland: Federal Office of Meteorology and Climatology **MeteoSwiss**, Klimabulletin
Turkish State Meteorological Service (**TSMS**), https://www.mgm.gov.tr/FILES/iklim/yillikiklim/2017-iklim-raporu.pdf
United Kingdom: **Met Office** Climate summaries and State of the UK Climate 2017 in RMetS https://www.metoffice.gov.uk/climate/uk/about/state-of-climate

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9. Abbreviations

AO	Arctic Oscillation (circulation indices)
BAMS	Bulletin of the American Meteorological Society
CLIMAT	monthly climatological data provided by the NMHSs via GTS
DWD	Deutscher Wetterdienst (German Meteorological Service)
EA	East Atlantic Pattern (circulation indices)
EA/WR	East Atlantic/West Russia Pattern (circulation indices)
ECA&D	European Climate Assessment & Dataset, located at Royal Netherlands Meteorological Institute (KNMI)
EMCC	Eastern Mediterranean Climate Centre
E-OBS	daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D information
GCC	Global Collection Centre operated by the Deutscher Wetterdienst
GPCC	Global Precipitation Climatology Centre located at the Deutscher Wetterdienst
GTS	Global Telecommunication System
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (Italian National Institute for Environmental Protection and Research)
JRC	Joint Research Centre's of the European Commission
m a.s.l.	Meter above sea level
NAO	North Atlantic Oscillation (circulation indices)
NMHSs	National Hydro-Meteorological Services
POL	Polar/Eurasia Pattern (circulation indices)
PDSI	Palmer Drought Severity Index
RCC-CM	WMO Regional Climate Centre Network (RA VI) Offenbach Node on Climate Monitoring
SCA	Scandinavia Pattern (circulation indices)
SCE	Annual snow cover extent
SYNOP	surface synoptic or weather observations provided by the NMHSs via GTS
WCDMP	World Climate Data and Monitoring Programme
WMO RA VI	WMO Regional Association VI (Europe and Middle East)
WMO	World Meteorological Organization