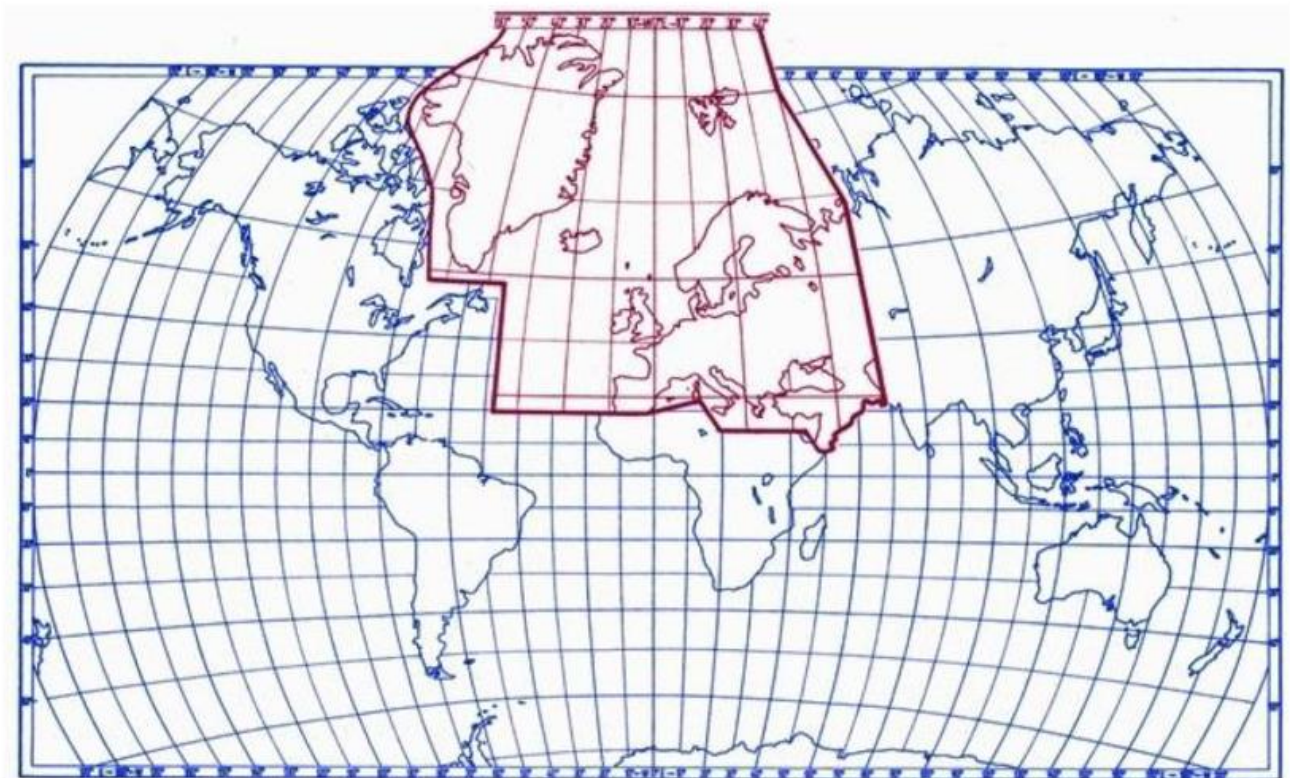




Annual Bulletin on the Climate in WMO Region VI

- Europe and Middle East -

2019



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Armenia
Austria
Belarus
Belgium
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Bulgaria
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Czech Republic
Denmark
Estonia
Finland
Georgia
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Jordan
Latvia
Lithuania
Luxembourg
Moldova
Norway
Portugal
Romania
Russia
Serbia
Slovakia
Slovenia
Spain
Sweden
Switzerland
Turkey
Ukraine
United Kingdom

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1. Introduction

The Annual Bulletin on the Climate in WMO Regional Association VI (RA VI, covering Europe and Middle East with 51 Members) provides an overview of climate characteristics and phenomena in Europe and the Middle East for the preceding year. It is mainly based on dedicated national reports from RA VI National Meteorological and Hydrological Services (NMHSs) as well as general climate monitoring information from their official websites. Supported by the European Climate Support Network (ECSN) and WMO's World Climate Data and Monitoring Programme (WCDMP) the Bulletin provides an excellent example of international collaboration across cultural and political borders since its first publication in 1994. The Bulletin is seen as a regional contribution to WMO's climate system monitoring, complementing and detailing well-known regular global assessments, such as WMO's Annual Statement on the Status of the Global Climate and the State of the Climate published in the Bulletin of the American Meteorological Society (BAMS). The evolution of the RA VI Regional Climate Centre Network (RCC Network) allowed adding a couple of RA VI-wide maps in order to provide a certain degree of consistency across the information and the national borders. Otherwise, basic methodologies for, and operations of, climate monitoring activities still differ among the various RA VI NMHSs. Maps and information compiled in this Bulletin are the result of a selection process. Websites of NMHSs as well as the webpages of the RA VI RCC Network (<http://www.rccra6.org>) offer useful additional information and regularly produced maps etc. The Bulletin is intended to serve primarily NMHSs in the Region but it might also be interesting for public institutions, research institutes, universities and others.

This annual bulletin includes four parts: the annual, seasonal and monthly survey of the climate state in 2019. The long time series of temperature, precipitation and sunshine duration provided by NMHSs in order to illustrate long-term variability up to 2019 (previously presented in section 5) will be made available on the RA VI webpages.

Notes:

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

- Temperature: CLIMAT data and ship observations provided by the Global Collecting Centre (GCC), operated by the Deutscher Wetterdienst
- Precipitation: Global Precipitation Climatology Centre (GPCC), operated by the Deutscher Wetterdienst
- Sunshine: Meteosat Satellite data (introduced in 2018).
- Anomaly maps of climate indices are provided by the RCC De Bilt Node on Climate Data Services (RCC Node-CD) via the European Climate Assessment & Dataset project (ECA&D) run by Royal Netherlands Meteorological Institute (KNMI)

1.1 The following sub-regions are used in this bulletin:

Central and western Europe (14 countries):

Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Luxemburg, Monaco, the Netherlands, Poland, Slovakia, Switzerland, and United Kingdom

Nordic and Baltic Region (9 countries/territories):

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

Iberia (2 countries):

Portugal, and Spain, Andorra

Mediterranean, Italian and Balkan Peninsula (12 countries):

Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, Montenegro, North Macedonia, Serbia, Slovenia, and Turkey

Eastern Europe (5 countries/territories):

Belarus, European Russia, Moldova, Romania, and Ukraine

Middle East (9 countries):

Armenia, Azerbaijan, Cyprus, Georgia, Israel, Jordan, Lebanon, Syria, and Western Kazakhstan

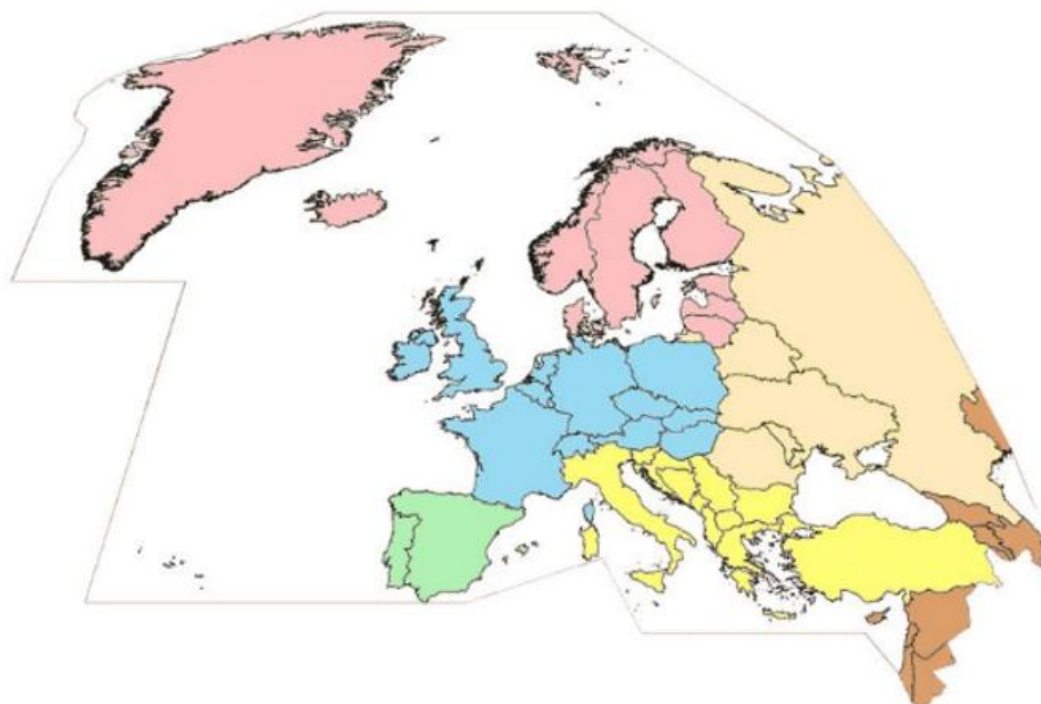


Figure 1-1: Definitions of the six sub-regions used in this bulletin.

1.2 The climate in 2019 - Overview

1.2.1 Anomalies

Temperature

Based on the Global Historical Climate Network (GHCN) v4.0.1 dataset (Menne et al. 2012), Europe (35°–75°N, 10°W–30°E) experienced its second warmest year since at least 1950 with an anomaly of +1.1 °C, very close to 2018. All over the RA VI Region annual temperatures were warmer than normal (1981-2010). Largest anomalies occurred over Greenland and over the eastern part of the RA VI Region, for example over Poland, Ukraine and Belarus where annual temperatures were more than 2 °C above normal.

Precipitation

Annual precipitation totals in 2019 were slightly above average over the RA VI Region. Generally, northern Europe and some parts of western and southern Europe experienced a wetter-than-average year. Precipitation was especially above average in parts of northern Spain and the Alps. In contrast, drier-than-normal conditions occurred across large parts of the Iberian Peninsula, especially in the south, in a band reaching from France through central Europe into Eastern Europe as well as over Iceland.

Sunshine Duration

Most parts of the RA VI Region experienced a sunnier-than-normal year. The widespread positive anomalies of +150 hours to +250 hours caused the average annual sunshine duration over Europe to reach a new record with 2348 hours in 2019 (Bissolli et al. 2020). Largest surpluses in sunshine were recorded in Central and Eastern Europe as well as in Iberia which. These regions saw exceptionally sunny conditions (sunshine duration totals > 90th percentile) with 200 to 500 hours (in relative terms up to 125 %) more sunshine hours than normal.

1.2.2 Events:

- Exceptionally high temperatures occurred throughout Europe during a warm spell end of February, with many areas in central Europe exceeding 20 °C and many local records of maximum temperatures being broken.
- Record June and July heat waves occurred across western and central Europe due to the inflow of warm subtropical air. Numerous temperature records were broken in both months. June ended up the warmest on record for Europe as a whole.
- From October to December, a series of heavy storms brought exceptionally high amounts of precipitation to regions bordering the northern Mediterranean and Atlantic coasts. Some regions recorded precipitation of two to four times the normal amounts and for several countries it was one of the wettest November months on record.

2. Annual survey

The climate of 2019 was characterised by a broad range of spatial and temporal anomalies outlined in section 1.2. This section presents an overview of the spatial patterns of mean annual climate conditions in 2019 and anomalies related mainly to the normal period 1981-2010 considering the following climate variables: sea level pressure, surface air temperature, precipitation, sunshine duration and snow. Sub-section 0 reveals selected climate indices for individual countries. Long-term trends in temperature and precipitation indices are presented in section 2.2. Section 0 and 4. present the seasonal and monthly patterns and statistics for selected climate variables including also reports from individual countries. Annual averages and anomalies of selected essential climate variables

2.1 Annual averages and anomalies of selected essential climate variables

2.1.1 Sea level pressure

Generally, the mean annual sea level pressure distribution in 2019 over RA VI was dominated on one hand by a band of low pressure with the minimum pressure extending from southern Greenland over Iceland until northern Russia. On the other hand, there was a high pressure belt with maximum pressure in the area of the Azores (Azores High) extending further across southern and central Europe into Russia.

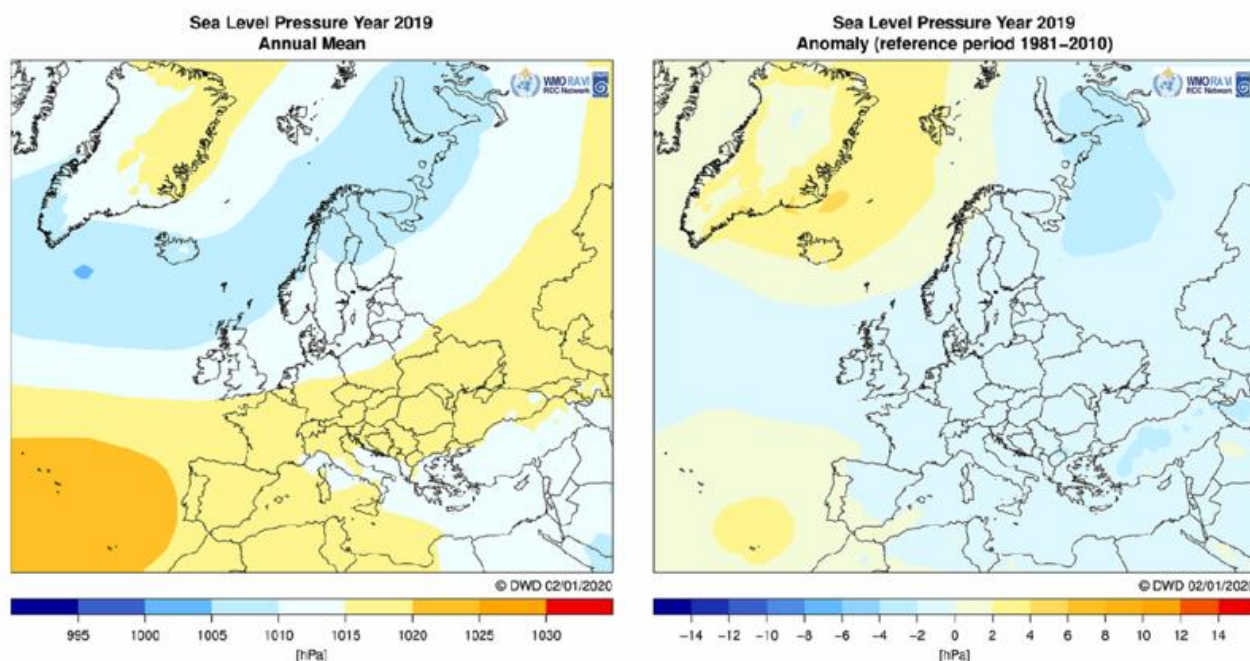


Figure 2-1: Annual mean (left) and anomalies (right) sea level pressure in hPa for the year 2019 with respect to the reference period 1981-2010. (Source: <http://www.dwd.de/rcc-cm>).

The mean sea surface pressure in 2019 differs to some extent from the long-term mean with reduced pressure over the most parts of the RA VI area with anomalies generally between 0 and -2 hPa as visible in Figure 2-1 (right; normal period 1981-2010). Higher-than-normal pressure occurred especially over Greenland and Iceland with largest anomalies ranging between +2 and +4 hPa and in the area of the Azores High.

2.1.2 Temperature

Overall, the year was exceptionally warm and over the entire RA VI Region temperatures were higher than normal (1981-2010) with anomalies mostly above $+1.0\text{ }^{\circ}\text{C}$ – parts of Greenland and of Central and Eastern Europe even experienced annual mean temperatures more than $2\text{ }^{\circ}\text{C}$ warmer than normal. For the European region as a whole, 2019 was the second warmest since at least 1950 considering the Global Historical Climate Network (GHCN) v4.0.1 datasets (Menne et al. 2012; Bissolli et al. 2020) with an overall anomaly (with respect to the base period 1981-2010) of $+1.1\text{ }^{\circ}\text{C}$ (Figure 2-3). For many countries the year proved to be the warmest on record: Estonia $+1.6\text{ }^{\circ}\text{C}$ (tied with 2015), Serbia $+1.7\text{ }^{\circ}\text{C}$, Belarus $+2.0\text{ }^{\circ}\text{C}$, Latvia $+1.8\text{ }^{\circ}\text{C}$, Lithuania $+1.9\text{ }^{\circ}\text{C}$, Ukraine $+2.7\text{ }^{\circ}\text{C}$ (w.r.t. 1961-1990) and Romania $+1.9\text{ }^{\circ}\text{C}$ (see also Table 2-1).

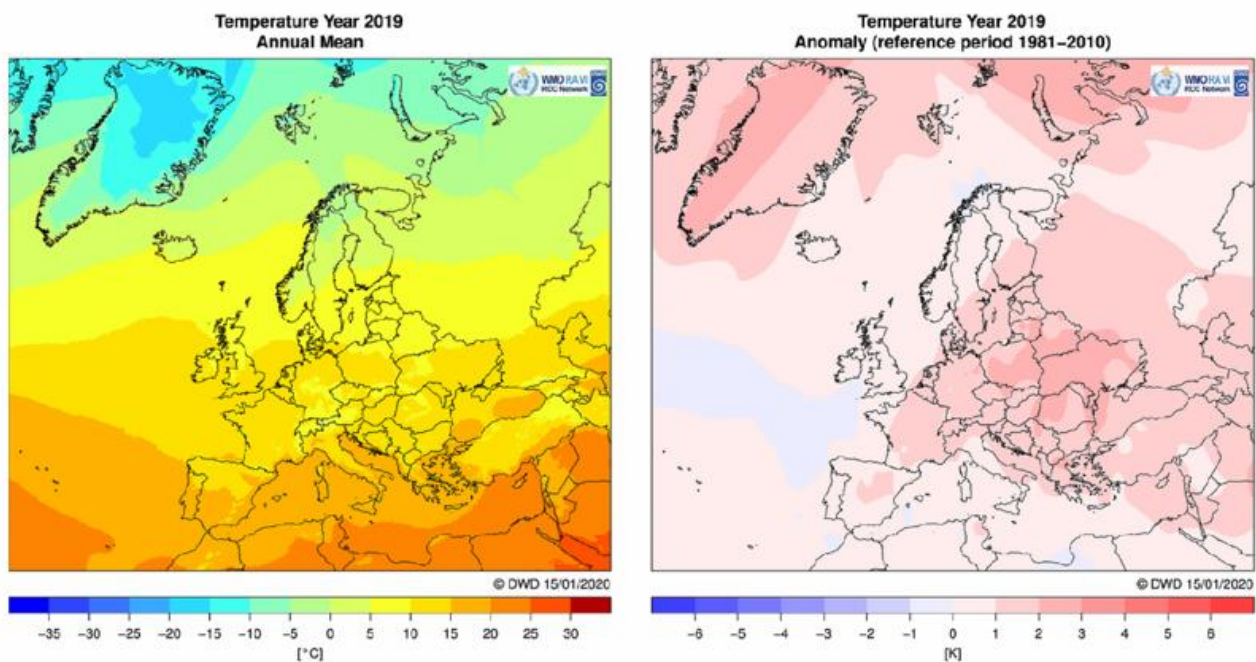


Figure 2-2: Annual mean (left) and anomalies (right) temperature in $^{\circ}\text{C}$ for 2019 (reference period 1981-2010, source: <http://www.dwd.de/rcc-cm>).

Looking at the specific sub-regions, the year 2019 was characterized by well-above-normal temperatures for **Western Europe** with an anomaly of $+1.0\text{ }^{\circ}\text{C}$ and above except for the United Kingdom and Ireland. For all continental countries the year ranked in the top five of the warmest years (third or fourth warmest).

Temperatures for the year were well above normal by $+1.0\text{ }^{\circ}\text{C}$ to $+2.0\text{ }^{\circ}\text{C}$ in **Central Europe** with 2019 among the five warmest years for all countries of the region. Hungary reported the warmest year on record with an anomaly of $+1.9\text{ }^{\circ}\text{C}$, while for Germany ($+1.4\text{ }^{\circ}\text{C}$), Slovakia ($+1.8\text{ }^{\circ}\text{C}$) and the Czech Republic ($+1.6\text{ }^{\circ}\text{C}$), 2019 was the second warmest.

Concerning the **Nordic and Baltic countries** the year was slightly warmer than normal with anomalies around $+0.6\text{ }^{\circ}\text{C}$ (w.r.t.1981-2010) in Norway and $+1.2\text{ }^{\circ}\text{C}$ (w.r.t. 1961-1990) in Finland. In the Baltic countries 2019 was even among the 5 warmest years with temperatures more than $+1.0\text{ }^{\circ}\text{C}$ above average. In northwestern, southwestern and southern parts of Greenland annual temperatures were much warmer than normal (partly more than $2\text{ }^{\circ}\text{C}$). At Pituffik/Thule Air Base, at Paamiut, as well as at Narsarsuaq and Qaqertoq, the year2019 finished up as second warmest on record, only second to 2010.

The annual mean temperature over the **Iberian Peninsula** was mostly between +0.0 °C and +1.0 °C above normal. Spain reported a countrywide anomaly of +0.8 °C and the sixth warmest year since 1965. However, anomalies in some parts of Spain exceeded +1.0 °C.

The year was warmer than normal for the **Mediterranean and the Balkan states**. Serbia reported its warmest year on record with +1.7 °C above normal, Slovenia its second highest since 1961 also with +1.7 °C above normal, Italy its third warmest (+1.6 °C, w.r.t. 1961-1990) and Turkey its fourth warmest (+1.2 °C).

Eastern Europe had an overall warm year. The Ukraine (+2.7 °C anomaly w.r.t. 1961-1990), Moldova (+2.1 °C anomaly) and Belarus (+2.0 °C anomaly) reported their warmest year on record.

In the **Middle East**, the year was more than +1.0 °C warmer than normal in most of the region. Temperature anomalies below +1.0 °C were only recorded in Syria and northern parts of Jordan. It was the 7th warmest year in 69 years in Israel, but also the coolest since 2013. It was the 4th warmest year in Georgia since 1960 with an anomaly of around +1.5 °C. In the capital, Tbilisi, it was the 2nd warmest (after 2018) since records began in 1881.

Globally, 2019 was among the three warmest years on record (WMO 2020; Blunden and Arndt 2020) with an average global temperature 0.44°–0.56 °C above the 1981–2010 average according to four independently constructed in-situ analyses (Sánchez-Lugo et al. 2020) and approximately 1.1 ±0.1 °C above pre-industrial levels (WMO 2020). The 2019 Arctic land surface temperature was +1.7 °C above the 1981–2010 average, tying for second highest in the 119-year record, following 2016.

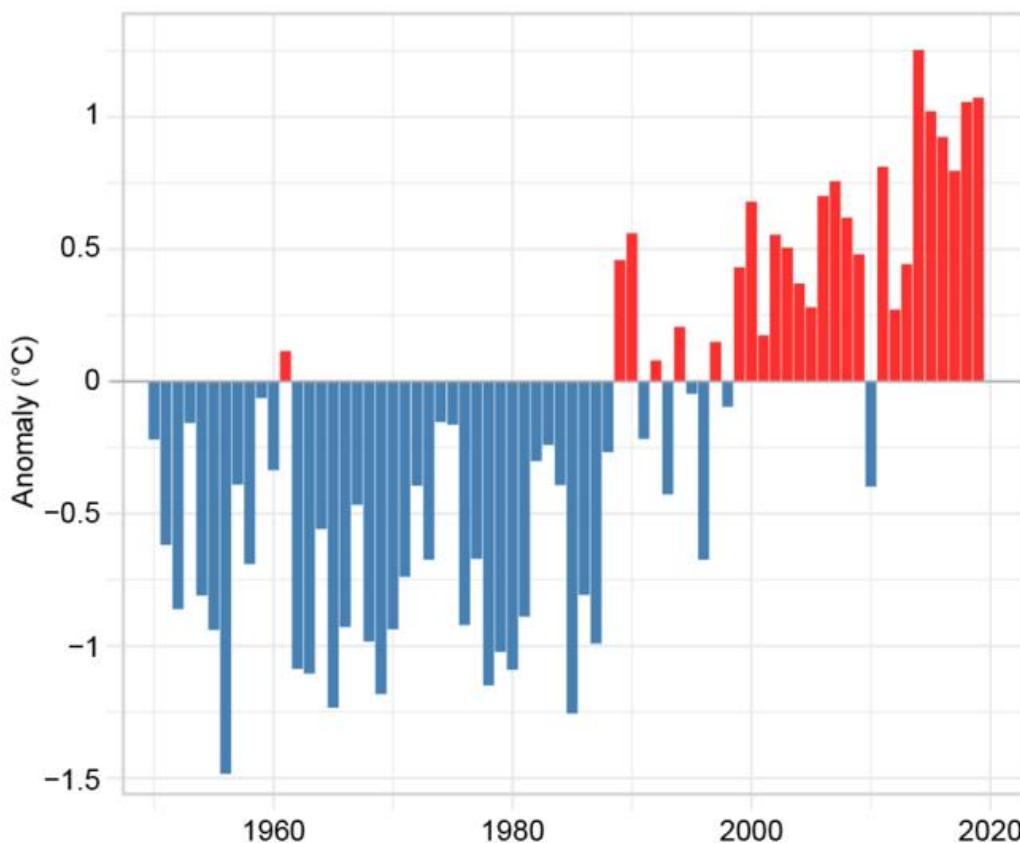


Figure 2-3: Annual average land surface air temperature anomalies for 1950–2019 for Europe (35°–75°N, 10°W–30°E) relative to the 1981–2010 base period. (Source: GHCN version 4.0.1 dataset, Menne et al. 2012.)

Table 2-1: Rank statistics and anomalies of annual temperature in 2019 as reported by the National Meteorological and Hydrological Services (NMHSs). Information about all-time temperature records as provided by the individual NMHSs can be found here: https://rcccm.dwd.de/DWD-RCCCM/EN/products/significant/records/download_tabelle.html?nn=500100?

Country	Rank	Annual Anomaly [°C] (1961-1990)	Annual Anomaly [°C] 1981-2010	start of time series
Europe	ERA5: 1 GHCN: 2	-	+1.2 +1.1	1979 1950
Armenia	6-7	+1.50	-	1935
Austria	3	+2.3	+1.6	1767
Belarus	1 (8.8 °C) ¹	-	+2.0	1881
Belgium (Brussels-Ukkel)	4	+1.7	+0.9	1833
Bulgaria	1 (12.5 °C) ¹	+2.0	-	1930
Czech Republic	2	+1.60	-	1961
Cyprus (station)	3	-	+1.0	2000
Denmark	4	-	+1.1	1873
Estonia	1 - 2	+1.60	-	1961
Finland	19	-	+0.88	1900
France	3 (13.7 °C) ¹	-	+1.1	1900
Germany	2	-	+1.4	1881
Georgia	4	-	+1.5	1960
Hungary	1	-	+1.87	1901
Iceland	15	+1.2°C	+0.7	1931
Ireland	18	+0.92	-	1900
Israel	7	+1.26	+0.86	1951
Italy	3	+1.59	-	1961
Jordan (Amman Airp.)	7	-	+1.0	1981
Latvia	1	-	+1.8	1924
Lithuania	1 (8.8 °C) ¹	-	+1.9	1961
Luxembourg (Findel)	(10.7 °C) ¹	-	+1.4	1947
Moldova (Chisinau)	1	-	+2.1	1886
Norway	20	+1.2	-	1900
Portugal	26 (15.6°C) ¹	-	+0.32 (w.r.t. 1971-2000)	1931
Romania	1 (11.0 °C) ¹	+2.3	+1.9	1961
(European) Russia	4 - 5	+1.88	-	1936
Serbia	1	-	+1.7	1951
Slovakia	2	+2.4	+1.8	1931
Slovenia	2	-	+1.7	1961
Spain	6	+0.8	-	1965
Sweden	10	-	+1.1	1860
Switzerland	5 (6.5°C) ¹	-	+1.10	1864
Turkey	4 (14.7 °C) ¹	-	+1.2	1971
Ukraine	1	+2.70	-	1891
United Kingdom	12	+1.10	+0.55	1884

¹ Annual mean temperature is given in brackets

2.1.3 Precipitation

Annual precipitation totals in 2019 were slightly higher than normal in Region VI, but considerably higher than 2018. Annual totals were above 125 % of normal (and thereby above the 90th percentile) in some places in the north (parts of United Kingdom, Norway, and an extended area in northern European Russia) and in the south around the Mediterranean due to locally heavy rain (Figure 2-4). Dry conditions with less than 80 % of normal precipitation or values below the 10th percentile occurred in other places in the north (southern Greenland, Iceland, Svalbard, Baltic States), but also in the Ukraine and in the southern parts of Iberia. The middle latitudes, too, were generally mostly drier than normal due to a longer drought period in the summer half year, but precipitation was only less than 80 % of normal in limited areas.

The year as a whole was wetter than normal in western parts of **Western Europe**. Precipitation of 100-125 % of normal was reported for Ireland, United Kingdom and western France, while much of the Benelux countries, central and eastern France had below-normal precipitation (80-100 %). Overall, the year had close-to-normal precipitation in most of the **Nordic countries**. Only places in southeastern Norway recorded above 125 % of normal precipitation. Iceland was remarkably dry with locally around 40 % of normal precipitation. The **Baltic states**, too, reported below-normal precipitation, particularly Estonia with 40 % to 60 % of normal. In **Iberia**, Spain reported a close-to-normal year with countrywide precipitation of 97 % of normal. Although precipitation was above 125 % of normal locally in southeastern parts of Spain, most of Iberia had below-normal precipitation, dropping below 60 % of normal in the southwest. Episodes of intense and persistent precipitation occurred often during the year, sometimes causing flooding. Multiple stations reported new local records of daily maximum precipitation. Over the **Mediterranean, Italian and Balkan Peninsula**, annual precipitation was mostly around normal, but locally it was well above average due to some heavy precipitation events, resulting in mostly above-normal country averages. Italy reported 122 mm more than normal precipitation (5th wettest) and Slovenia 109 % of normal. In Serbia, precipitation was around normal. Over **Eastern Europe**, annual precipitation was below normal for all countries of Eastern Europe except for the northern parts of European Russia. Belarus reported 91 % and Ukraine 84 % (fifth driest year) of normal precipitation, Moldova reported a deficit of 146 mm. West Kazakhstan received only 60 % to 80 % of normal precipitation. In the **Middle East**, overall, the year was normal with wetter than normal conditions especially in the northern parts (above 150 % locally) in Syria, Lebanon, Cyprus (wettest since 1902), northern Jordan (5th wettest since 1981 at Amman Airport) and in northern Israel and drier than normal conditions in the southern parts. In the **South Caucasus** region, the year was drier than normal in Georgia (particularly in the east where precipitation was only 50-60 % of normal) while it was close to normal in Armenia and Azerbaijan.

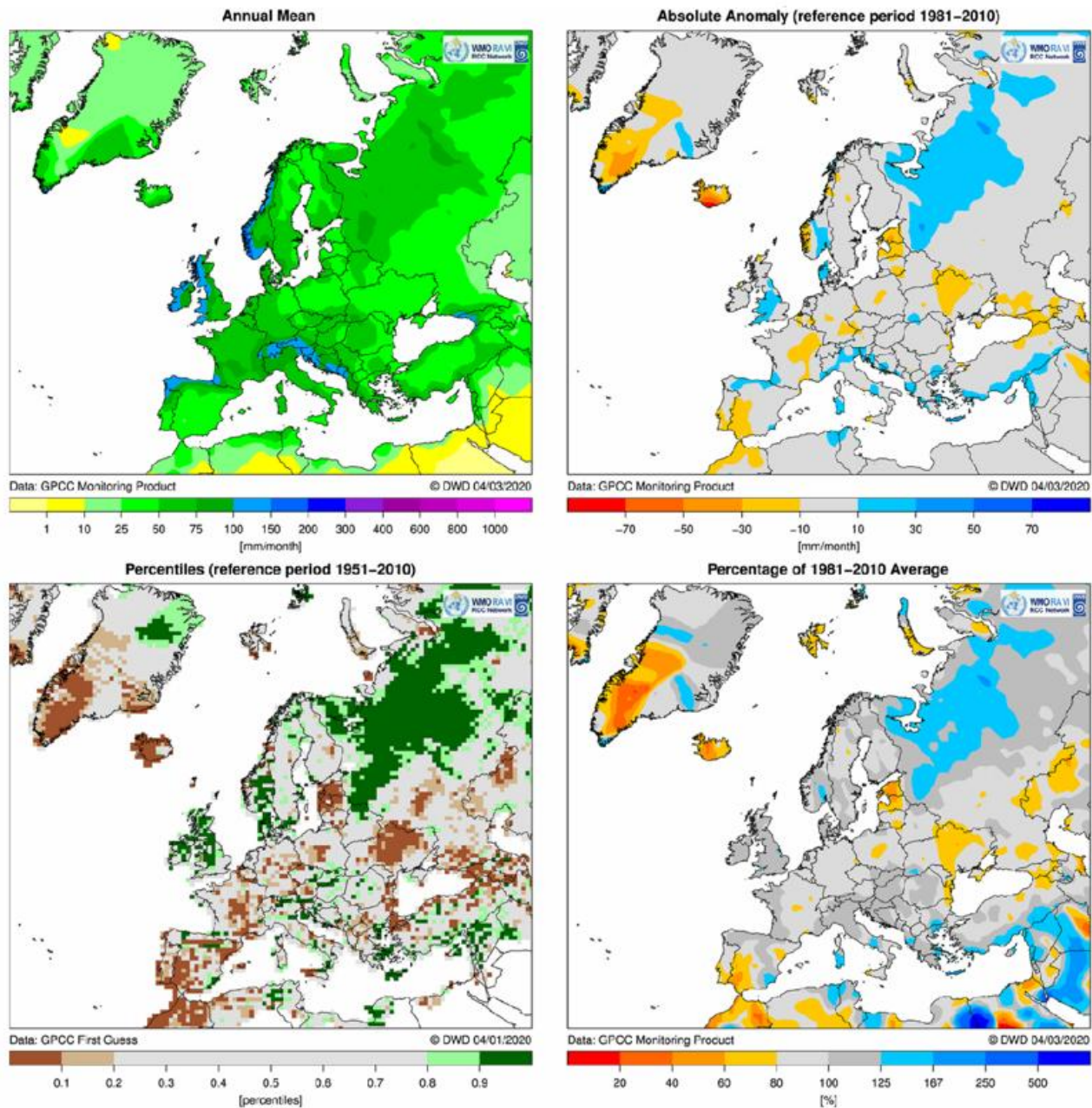


Figure 2-4: Total precipitation (left, top), anomalies (right, top) in mm/month, percentiles (left, bottom) and percentage of precipitation in % (right, bottom), for 2019. Reference period for the anomalies is 1981-2010, for the percentiles the reference period reference period is from 1951-2010); source: <http://www.dwd.de/rcc-cm>.

Table 2-2: Rank statistics and anomalies of annual precipitation in 2019 as reported by the National Meteorological and Hydrological Services (NMHSs). Information about all-time temperature records as provided by the individual NMHSs can be found here on the RCC RA VI website².

Country	Rank	Annual Anomaly (1961-1990)	Annual Anomaly (1981-2010)	start of time series
Armenia	4 (driest)	-143.3 mm	-	1935
Belarus	-	-	91 %	1945
Belgium (Brussels-Ukkel)	98 (driest)	-22.5 mm	-53.8 mm	1833
Bulgaria	25 (driest)	-67 mm	-	1930
Czech Republic	-	-	-52 mm	1961
Cyprus	1 (wettest)	290 mm	-	1902
Denmark	1 (wettest)	-	+159,1 mm	-
Estonia	22 (wettest)	-	-0.6 mm	1961
Finland	16 (wettest)	-	+21.6 mm	1961
Georgia	2 (driest)	-	-276.5 mm	1960
Hungary	49 (wettest)	-	+30.37 mm	1901
Italy	5 (wettest)	122 mm	-	2010
Jordan (Amman Airp.)	5 (wettest)	-	+117.4 mm	1981
Latvia	62 (wettest)	-	-6.1 mm	1924
Moldova (Chisinau)	14 (driest)	-	-146 mm	1891
Norway	15 (wettest)	115 %	-	1900
(European) Russia	8 (wettest)	55.2 mm	-	1936
Serbia	39 (wettest)	-	-0.6 mm	1951
Slovakia	11 (wettest)	81.6 mm	56,6 mm	1961
Slovenia	-	-	109 %	-
Spain	27 (driest)	-	-20 mm	1965
Switzerland	47 (wettest)	-	+103 %	1864
Ukraine	5 (driest)	-111 mm (84 %)	-	1961
United Kingdom	16 (wettest)	112 %	107 %	1862

² https://rcccm.dwd.de/DWD-RCCCM/EN/products/significant/records/download_tabelle.html?nn=500100

2.1.4 Sunshine duration

Most parts of the RA VI Region experienced a surplus of sunshine hours in 2019 (see Figure 2-5). Especially in Central and Eastern Europe and over Iberia, it was exceptionally more sunny than normal (>90th percentile) with 200 to 500 hours (in relative terms up to 125 %) more sunshine hours. Over the Eastern Mediterranean, it was less sunny than normal with deficits in the range of up to 200 hours which corresponds to deficits of only 5 % in relative terms though.

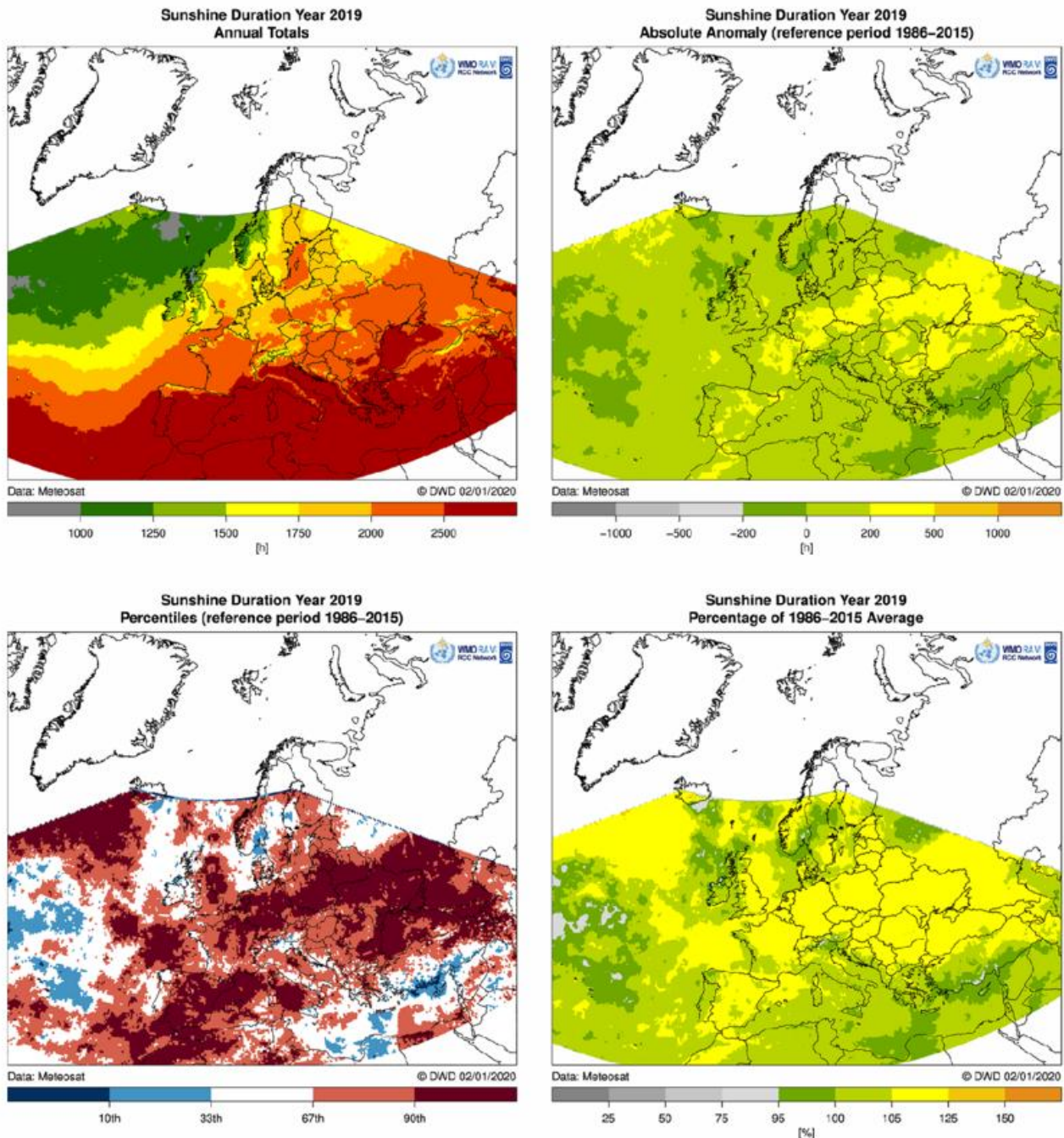


Figure 2-5: Annual sum of sunshine duration (upper left) as well as absolute anomalies (upper right), percentiles (lower left) and percentages of the long-term mean (lower right) with respect to the reference period 1986-2015 for the year 2019. (Source: <http://www.dwd.de/rcc-cm>).

In Germany overall, the year 2019 brought 1834.2 hours of sunshine on average (Fig. 4), which was above the multi-year mean annual totals. The surplus for the period 1981-2010 was 233.5 hours or 14.6 %. Compared to the climate reference period 1961-1990, there was a surplus of 290.2 hours

or 18.8 %. The year thus ranks as the 5th year with the most sunshine since 1951 in the present climate time series. 2019 was also particularly sunny in the southwestern and western part of Iceland. 2019 finished up as third sunniest year on record in Reykjavík.

2.1.5 Drought situation

When looking at the Global Precipitation Climatology Centre Drought Index (GPCC-DI, Ziese et al. 2014) as a metric for characterizing meteorological drought, the values for the year as a whole range mostly between -1 and +1 (see Figure 2-6). Most regions with large precipitation deficits (for example areas neighbouring the Black Sea and the Baltic countries, see also 2.1.3) appear here with values between 0 and -1 indicating mild drought conditions on annual average. Over parts of Spain and the Middle East the drought situation is even classified as moderate drought with values up to -1.5 (Spain) or up to extreme drought (Syria). Several countries reported national or local low records of annual precipitation. For Armenia, for example, 2019 was the 4th driest year since 1935, after 1961, 2000 and 2008. In Spain it was very dry from January to October, especially in the central areas of the peninsula. It was very dry in some areas of Extremadura, Avila, Toledo, western half of Andalusia, Tarragona, Castellón, Ceuta y Melilla. Málaga and Cádiz only received less than 50 % of normal precipitation amounts.

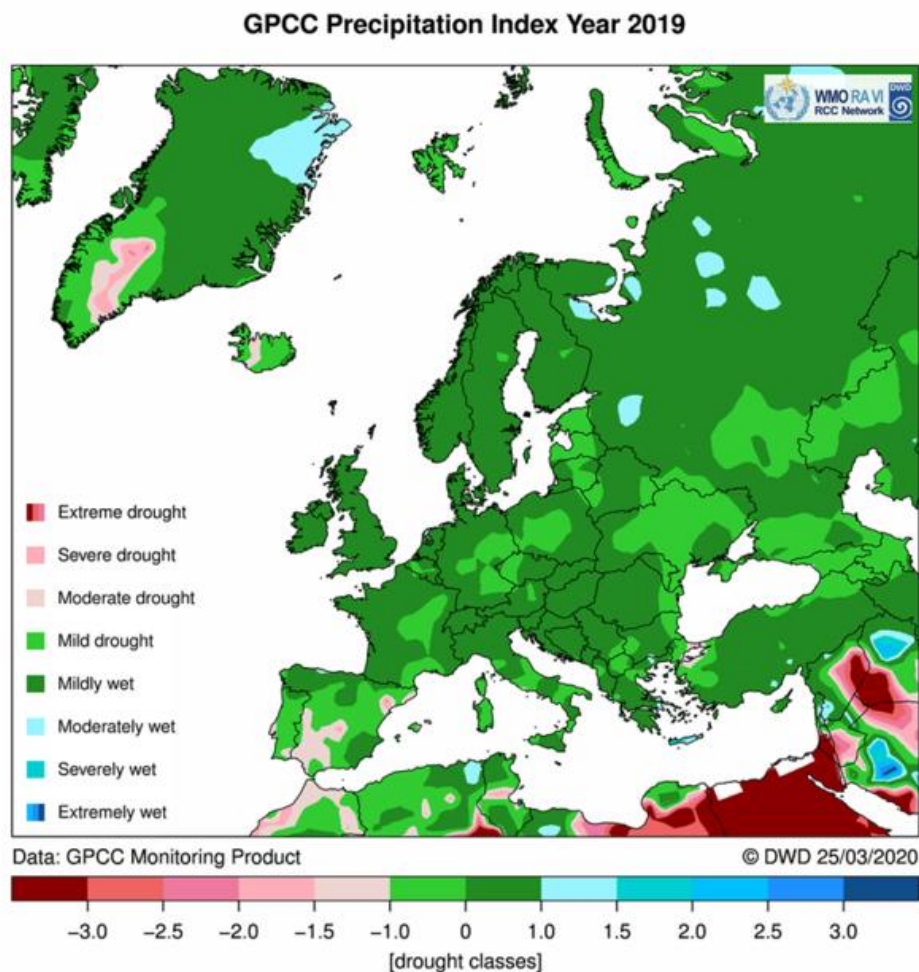


Figure 2-6: Annual GPCC -DI (GPCC-Drought Index) for the year 2019 with respect to the reference period 1961-1990. (Source: <http://www.dwd.de/rcc-cm>).

2.1.6 Snow cover

In **January**, there was considerable snow in many parts of Iceland. In Sweden, snow came only in parts of the country at the beginning of the month, but on 27-28 January, when an extensive snowy weather entered southern Sweden, almost all of Sweden apart from parts of Skåne became snow covered. The largest snow depth in Sweden was measured in Katterjåkk, where it was 120 cm in the morning on January 13. In Finland, too, the snow depth was exceptionally high in the south (roughly 50 cm, occurring about once in 10 years), whereas Lapland had less snow than normal. Similar depths were measured in European Russia; the resulting snowdrifts blocked railway and motor traffic in certain places. In Moscow, heavy snowfall, which started on January 26 and continued without interruption for 37 hours, had set a new record for total daily precipitation. The deepest snow cover in Latvia (35 cm) was observed on 29 and 30 January in Aluksne, in Belarus it was 39 cm. Also in Lithuania, the thickest layer of snow reaching 28–33 cm was recorded in the last days of the month near Vilnius and Šilalė. The thickness of the ice cover on water surfaces in Belarus was less than average for that month. The monthly number of days with snow cover in Belarus was 5.4 on national average, these were relatively few (1961-90 normal is 12 days). Lots of snow fell in Ukraine; the snow depth reached 39 cm in Kiev (highest maximum in January was 47 cm in 1987). In Moldova, a snow cover existed almost the whole month, only at the end of January the snow melted in isolated places in the south of the country. Maximum snow cover in Moldova was 40 cm in Ribnita.

In Central Europe, heavy snowfalls took place at the beginning of the month in southern Germany and Austria, producing up to 80 cm of snow cover per day. This resulted in some new records, e.g. at station Reutte (850m altitude) in Austria with a maximum depth of 116 cm, the highest since beginning of measurements in 1937. Switzerland received much snow in mid-January, leading to a high risk of avalanches. In the Czech Republic, 37 cm of fresh snow fell on 8 January at Kvilda station; the highest total snow depth was 235 cm at Labská Bouda station on 30 January. In the west of the continent, everybody was readily accustomed to the absence of snow, and the more surprising was the snowfall that hit the western coast of France, England and Scotland in the last days of the month and delivered up to 10 cm of snow per day. In the Netherlands and Belgium, too, snowfall came rather late in the month (22 to 23 January) with only a few cm in the Netherlands, but up to 14 cm in the western part of Belgium (Lissewege). In Luxemburg, snow depth was 16 cm on 31 January at Findel Airport, the same depth in the United Kingdom on 23 January at Malham Tarn in North Yorkshire. In the Pyrenees Mountains, abundant snow fell reaching depths up to above 260 cm in high altitudes.

In Slovenia on the other hand, Kredarica Mountain had a snow depth of only 85 cm on 28 January, the third lowest monthly January maximum since beginning of observations. The number of days with snow cover in Croatia ranged from 17 to 29 days and was 6-16 days above the January average in most of the country. A snow cover was observed even in Albania at 1400m altitude on 30 January. In the south, Athens was hit by a severe snowstorm that required closing the schools, as they were normally not heated and unfit for operation in such conditions. Snowstorms in Lebanon and Israel occurred several times that month. In Jerusalem, snow fell for the first time in the last five years.

Snow cover was persistent as usual in much of Northern and Eastern Europe in **February**, but for the rest of the Region, snow was mostly rare with only a few snow days (snow cover at least 1 cm) even in Central Europe. Denmark recorded only 2 snow days on spatial average (normal 1961-1990

is 9 days), Belgium 6 days, Luxembourg 3 days (normal 8 days). The United Kingdom, Ireland and the Netherlands saw some snow mainly at the beginning of the month. Even Slovenia and Serbia saw some snow on 1 February in the lowlands in some places, but the snow cover did not persist. In the course of the warming during the month, the snow melted even in southern Sweden. Snow depths of more than 50 cm were recorded in much of Northern and Eastern Europe, while other parts in the lowlands mostly saw only a few cm. The eastern Swiss Alps recorded 50-70 cm fresh snow at the beginning of the month on 1-2 February. During the month, snow depths were around or above average in large parts of the Swiss Alps. Combined with warmth and much sunshine, winter sport conditions in the Alps were excellent, due to previous snowfall in January. In Sweden and Finland, the snow depth was generally around or below normal except in the northern Lapland Mountains with the largest depth of 158 cm in Cattery (Sweden). Heavy snowfall occurred in central regions of Russia including Moscow around the middle of the month. The United Kingdom measured 33 cm in Morayshire Province on 2 February. In Israel, some snowfall occurred in the northern mountains in mid-February and end of February. In **March**, snow cover persisted in continental Scandinavia (except the south) and Russia/ West-Kazakhstan (except the south) during the entire month. In mid-March, snowfall even reached southern parts of European Russia. In central Sweden, some melting occurred only in the last week. In Iceland, snow had much regional variability: 6 snow days were registered in Reykjavik, 22 in Akureyri. In the United Kingdom, from the Midlands northwards, it was occasionally cold enough for sleet and snow to penetrate to low levels. Ireland, too, saw some snow in places. Belgium saw 10 snow days, Luxembourg Airport 1 day (normal 5), Innsbruck in Austria also 1 (normal 6). The Baltic countries, Belarus and northeastern Ukraine also had snow only temporarily, mostly in the first and second decade of the month, other parts of the Region mainly in higher elevations throughout the month, only temporarily partly a thin snow coverage in the lowlands.

In terms of anomalies, snow was more frequent than normal in southern Norway, central Sweden, southern Finland, central European Russia, and eastern Turkey, but less frequent in the other Eastern European countries, Central Europe, the Balkan Peninsula and western Turkey (data after Rutgers University³). In the Alps in Austria (above 800m a.s.l), the number of snow days was around the climate mean or above.

Snow depths reached above 100 cm in high mountains, above 50 cm in Lapland and northern European Russia. Katterjakk, often the snowiest station in Sweden, recorded 206 cm on 1 April (there was an interruption of measurements in the second half of March). Finland had between half a meter and one meter of snow in the north from Northern Karelia to Lapland, and mostly 10–50 cm the rest of the country. Areas near the southern and western coastline of Finland were free of snow in many places. At the end of the month, snow depth was lower than usual in large parts of the country. Russia recorded a depth up to 70 cm in the Volga region. Latvia reported up to 31 cm (Aluksne). In the United Kingdom, a snow depth of 6 cm was measured at Middleton (Derbyshire) on the 10th and at Mugdock Park (Stirlingshire) on the 11th.

Western parts of Eastern Europe, Turkey and South Caucasus still recorded some snow, even parts of Central Europe and locally southern Europe. Belgium had 3 cm snow on Mont-Rigi on 11th. Denmark saw only a small snow cover of 0.5 cm on some days in places. Extremely rare was snow

³ See <https://climate.rutgers.edu/snowcover/index.php>

in the Southern Alps. The station Bosco-Gurin in southern Switzerland (1486m a.s.l.) measured 4 cm of snow on monthly average, the lowest depth since 1961. In the 1970s, up to above 200 cm were observed at this station. The French Alps and the Pyrenees, too, had a deficit in snow, which was near record. On the Kredarica Mountain in Slovenia, the greatest depth this month was 190 cm, in the lowlands of Slovenia up to 26 cm, in Bosnia-Herzegovina 220 cm in the mountains and up to 21 cm in the lowlands, in Serbia 99 cm in the mountains (Kopaonik), 6 cm in the lowlands, in Montenegro 84 cm (Zabljak), in North Macedonia 26 cm (Mavrovo).

In **April**, areas north of around 60°N had a snow cover during the whole month. Normally snow comes down further south at least on some days in April (to around 55°N) according to data of Rutgers University (<https://climate.rutgers.edu/snowcover/index.php>). Depths were especially large at the beginning of the month due to previous snowfalls (e.g. up to 206 cm in Sweden), but decreased rapidly due to the warmth during the following days. At the end of the month, there was still up to 50 cm of snow in northern Finland. In the United Kingdom, a snow depth of 13 cm was measured at Warcop Range (Cumbria) on the 3rd. Russia saw some snowfalls in areas, where the snow previously melted in March, e.g. in the Moscow Region and in St. Petersburg (2-4 cm depth). Other parts in the RA VI Region had snow mainly in higher elevations. The Alpine valleys saw record snowfalls at the beginning of the month, e.g. 99 cm in 24 hours in Guttannen (northern Switzerland, 1055m a.s.l.) on 4-5 April, the highest fall since start of measurements in 1877. However, even the lowlands received some snow in Switzerland, e.g. 6 cm in Geneva on 4 April, a new April record, also Tirana in Albania saw a thin snow cover on 11 April. At the end of the month, snow came again down to the Alpine valleys (e.g. 11 cm in Defereggental, east Tyrol, Austria, 1383m a.s.l. on 28 April). The mountain station Lomnický štít in Slovakia (2633m a.s.l.) had a depth of 252 cm at the beginning, which decreased to 170 cm at the end of the month, but even in the last days of the month it was snowing. Kredarica in Slovenia (2514m a.s.l.) had its largest depth late in the month (220 cm on 29 April).

In **May**, snow occurred mostly only in Northern Europe and at high elevations. In Norway, snow came down to the south, while even parts of northern Sweden, southern Finland and northern European Russia remained free of snow. On the other hand, Lapland and northern European Russia still recorded local maximum depths of more than 50 cm. The largest depth in Sweden was 144 cm in Katterjåkk on 6 May. However, snow fell also in the lowlands of Central Europe at the beginning of the month, leading to short-living snow depths of a few cm. The Netherlands reported around 2 cm at the beginning of the month, Belgium 8 cm (in Presgaux, Couvin and Stembert, Verviers), Bern in Switzerland 4 cm, the latest fresh snow since 1898. Several snowfall periods occurred in the Alps, especially on northern slopes, compensating the snow deficit of the previous months. Peak Zugspitze in the German Alps reached a depth of 645 cm on 30 May, the largest of the year so far, Kredarica Mountain in Slovenia 320 cm on 31 May (largest of the month). Snow depths in Austrian highlands were close to new records. Hungary, too, had a snow cover of 5-10 cm in the mountains, which did not occur in May in this country for 34 years. Unusual snowfalls for May also occurred in middle elevations (1000-1500m a.s.l.) in Italy, partly with new record depths.

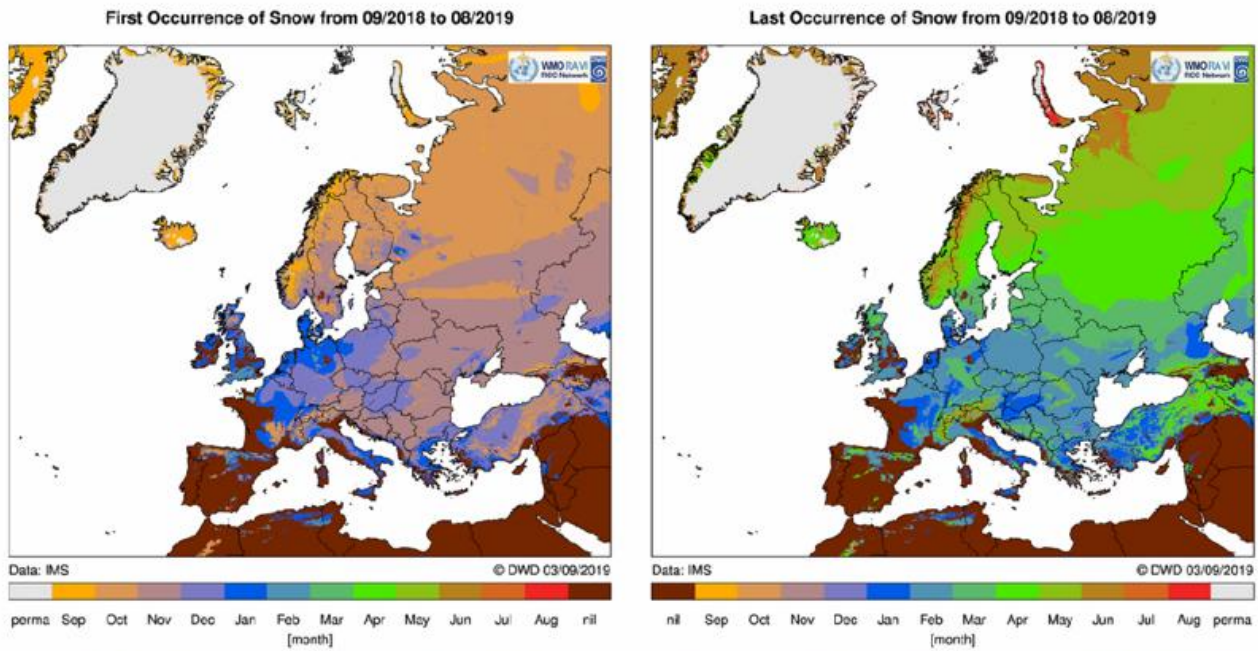


Figure 2-7: First occurrence of snow (left) and last occurrence of snow (right) during the snow season 2018/2019 from 09/2018 to 08/2019. (Source: <http://www.dwd.de/rcc-cm>).

Duration of Snow Period from 09/2018 to 08/2019

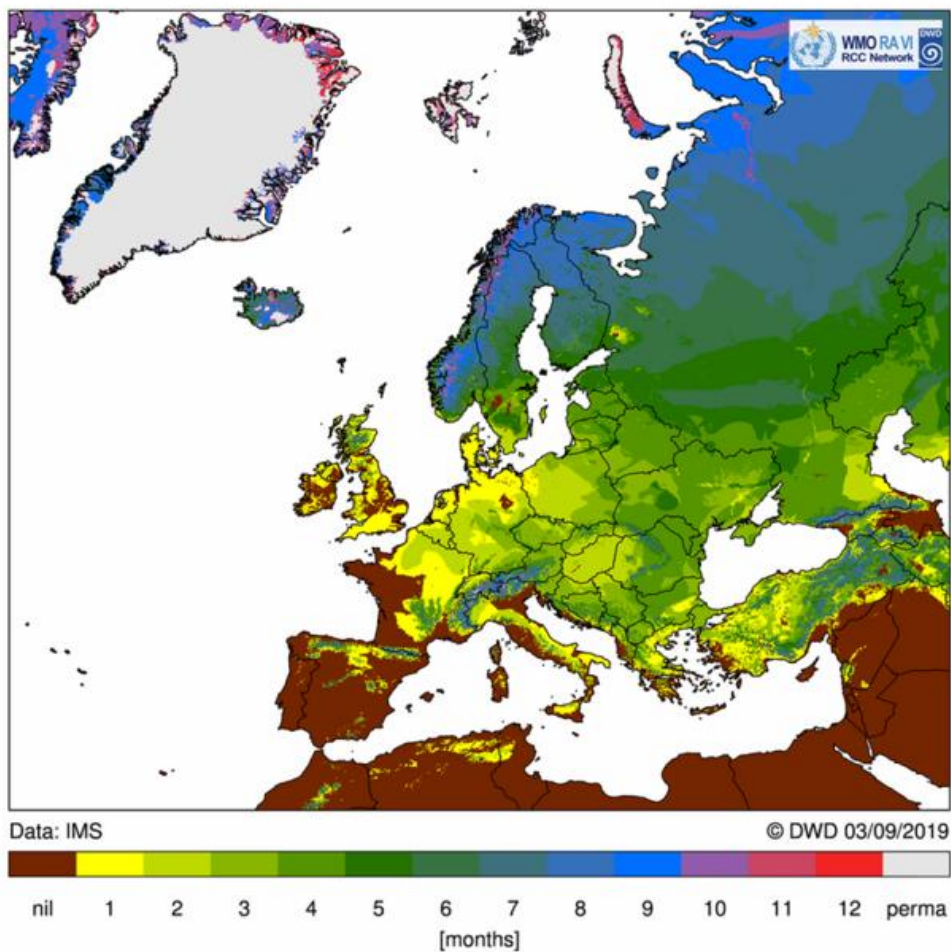


Figure 2-8: Duration of snow cover in the snow season 2018/2019 (from 09/2018 to 08/2019). (Source: <http://www.dwd.de/rcc-cm>).

2.2 Selected climate indices for 2019

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

1. **RR1, Number of wet days:** count of days where RR (precipitation) ≥ 1 mm

Precipitation below 1 mm/day has no effect on vegetation because it normally evaporates on the same day and is locally affected.

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

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

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

The maps showing the number of wet days (RR1, uppermost left panel in Figure 2-9) clearly depict the dry conditions prevailing in 2019. Over parts of Central Europe, in southern and eastern Europe there were less than 110 wet days which correspond to up to 60 less rainy days with respect to the 1961 to 1990 mean in these areas. The northern and northwestern parts of Europe, on the contrary, experienced more than normal wet days, mostly up to 60 days.

Looking at the number of warm and wet days (WW) it appears that above-normal numbers of WW were registered across most parts of Europe in 2019, also in the drier parts. Only very locally, the number of wet and warm days was fewer than normal.

The anomaly map for the number of summer days (SU, second row from the bottom on the right in Figure 2-9) also illustrates well the longer-than-normal summer conditions in 2019 all over the entire RA VI domain. Over Scandinavia, the UK and Ireland up to 10 summer days more than normal were observed, locally even less summer days than normal occurred. The rest of the RA VI domain saw more than 30 summer days more than normal.

There were also more tropical nights (TR) than normal in 2019 over most parts of the RA VI domain. However, the anomaly values for TR are smaller than for SU with mostly up to 20 tropical nights more than normal. Largest anomalies with 40-60 tropical nights more than normal occurred along the Mediterranean coast. Locally, there were also less than normal tropical nights throughout the RA VI Region.

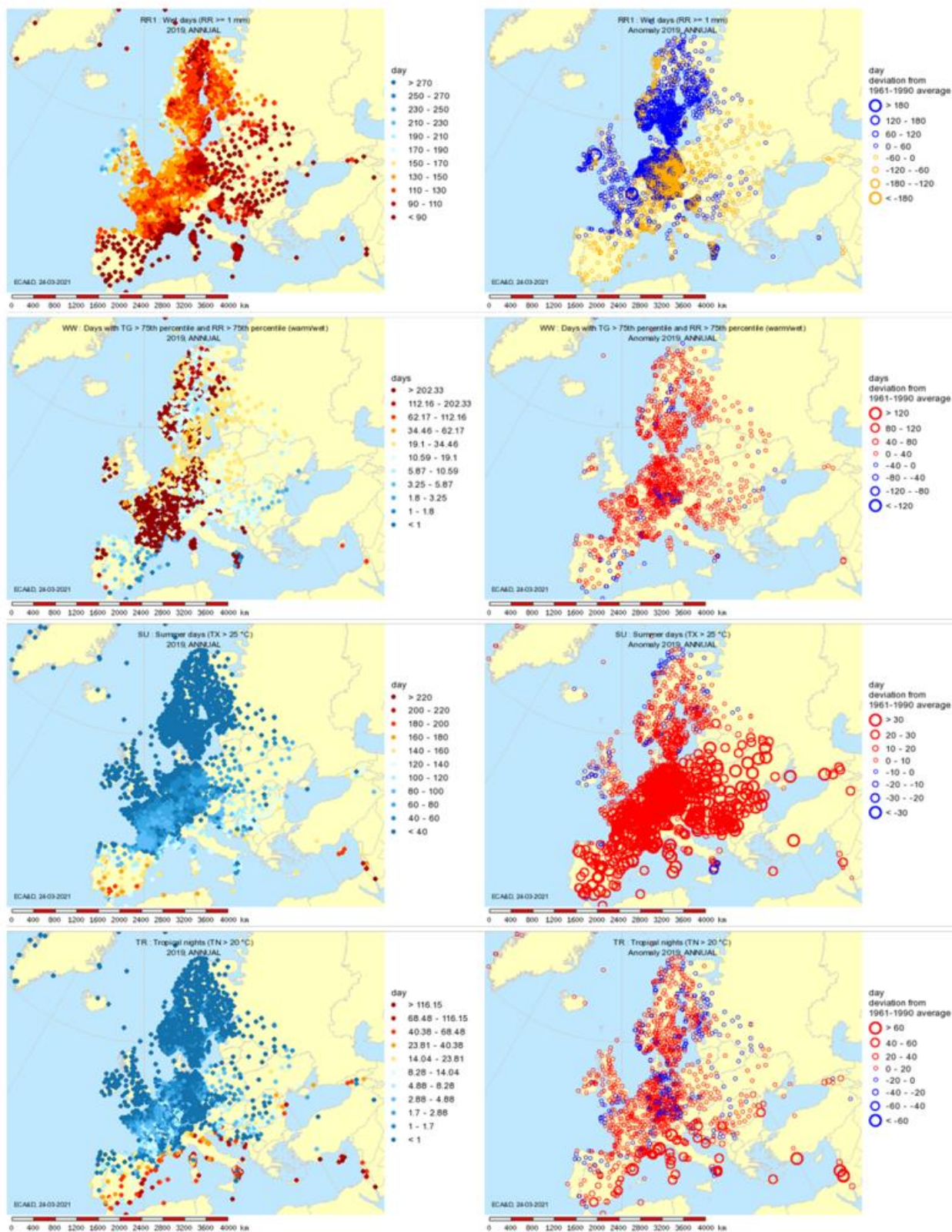


Figure 2-9: Selected Climate Indices for 2019 (left) and their anomalies (right) with respect to the 1961 to 1990 reference period (Source: ECA&D, <http://www.ecad.eu>).

3. Seasonal survey

This section presents an overview of the spatial patterns of seasonal mean climate conditions in 2019 with anomalies related mainly to the normal period 1981-2010 for the following selected climate variables: sea level pressure, circulation indices, surface temperature, precipitation and sunshine duration.

3.1 Seasonal averages and anomalies of selected climate variables

3.1.1 Sea level pressure and circulation indices

Pressure distribution in **winter 2018/2019** shows that both circulation centres, the Icelandic Low and Azores High, were stronger than normal with anomalies of -4 to -6 hPa and up to +6 to +8 hPa respectively. That winter the North Atlantic Oscillation (NAO) was positive, but with 1.08 not very pronounced; the Arctic Oscillation (AO) was in a neutral phase (-0.08). The dominant circulation patterns were the East Atlantic/ West Russia Pattern (EA/WR) and the Polar/ Eurasia Pattern (POL), with values of -1.55 and -1.89 respectively.

In **spring**, pressure was lower than normal over the entire RA VI Region except for Scandinavia. The Icelandic low was shifted south. Largest negative anomalies occurred southwest of Ireland and over Russia.

In **summer** the pressure anomalies were mostly only slightly positive or negative (within -2 to +2 hPa). Larger negative anomalies occurred though over the Arctic including Iceland.

The circulation centres in **autumn** were well pronounced with a core pressure between 1000 and 1005 hPa around Iceland and between 1020 to 1025 hPa around the Azores. The latter formed part of high pressure belt extending further across southern and central Europe to western Kazakhstan with one maximum around the Azores and the second one over Eastern Europe. Above-normal pressure anomalies occurred over northeastern Europe, with largest anomaly values in the range of +4 to +6 hPa over the Baltic countries. All circulation patterns were in a neutral phase except for the NAO which was positive with a value around 1.

Table 3-1: Seasonal mean values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference. Blue and yellow colors indicate index values lower and greater than zero respectively

season	NAO	EA	EA/WR	SCA	POL	AO
Winter 2018/2019	-0.16	0.18	-0.12	0.25	0.29	0.77
Spring 2019	-0.17	-0.38	-0.22	-0.34	0.35	-0.07
Summer 2019	-0.74	-1.27	1.1	-0.12	-0.98	-0.54
Autumn 2019	-0.63	-0.29	0.98	-0.11	0.36	0.24

Note that all values are standardized with the reference 1981 to 2010. North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EA/WR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)

(Sources: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly_ao_index_b50_current_ascii.table)

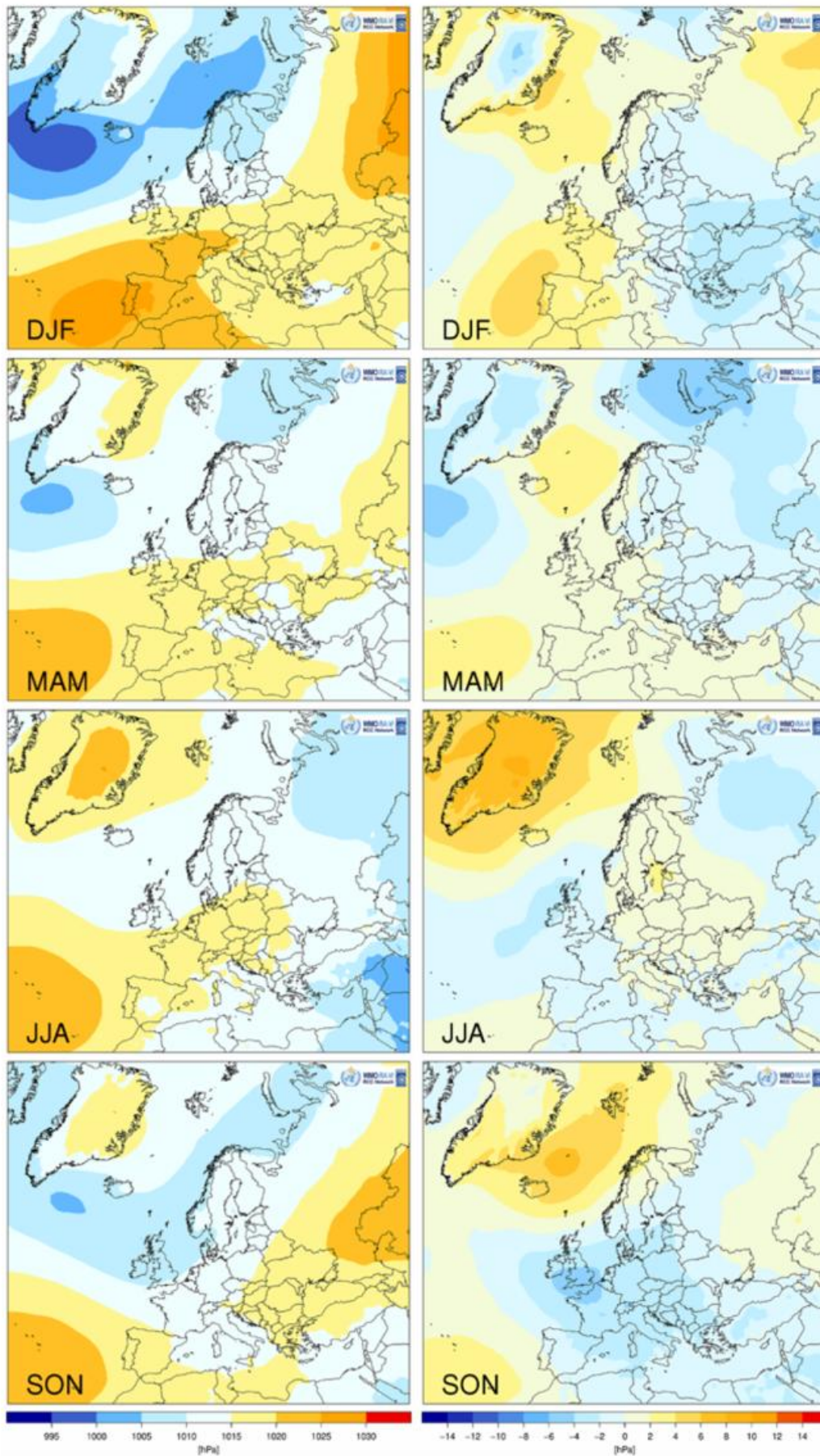


Figure 3-1: Seasonal sea level pressure (left, in hPa) and anomalies (right, in hPa) in 2018/2019, reference period 1961-1990 (Source: <http://www.dwd.de/rcc-cm>).

3.1.2 Temperature

In 2019, mean annual temperatures were higher than normal (w.r.t. 1981-2010) over the whole RA VI Region which is reflected by positive anomalies in all sub-regions ranging from +0.69 °C over Iberia to +1.51 °C over Eastern Europe (see Table 3-2). Temperatures were not only higher than normal on an annual basis but also in all seasons except for the summer season over Eastern Europe which was normal with an anomaly value very close to zero (0.1).

Table 3-2: Seasonal and annual average of temperature anomalies over land areas in °C for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1)

region	year	winter	spring	summer	autumn
Central and Western Europe	1.33	0.91	0.59	1.94	1.06
Nordic und Baltic Countries	1.46	0.78	1.78	1.28	1.36
Iberia	0.69	0.34	0.56	0.63	0.66
Med. Italian and Balkan Peninsula	1.43	0.38	0.55	1.79	2.26
Eastern Europe	1.51	1.26	1.73	0.09	1.27
Middle East	1.17	0.85	0.79	1.06	1.19

Meteorological **winter 2018/19** (December 2018, January and February 2019) was mild in much of Europe (Fig. 5) with a NAO index of 1.16. Winter 2018/19 in Ireland was the warmest winter on record (since 1900). February was exceptionally warm (anomalies of +2.0 °C to +4.0 °C in Eastern Europe, and even higher in places) due a strong southwesterly airflow of moist and mild air from the East Atlantic.

In **Western Europe**, the winter was very mild (United Kingdom +1.4 °C above normal (eighth warmest), Netherlands +1.8 °C, Luxembourg +1.8 °C, France +1.3 °C, Ireland +1.8 °C above normal (warmest on record)) due to a very warm December 2018 and an exceptionally warm February. The United Kingdom reported the second warmest February on record (+2.4 °C above normal), Luxembourg and Ireland its third warmest (+3.7 °C and +2.4 °C respectively). In France, the countrywide average of maximum temperature was +4.1 °C above normal making it the second warmest February after 1990. Similarly in Ireland it was the warmest winter on record for many stations and more than half of the stations set new monthly maximum temperature records in February on the 25th and 26th. Other countries in Western Europe reported new records as well in late February (see below in section "Notable events"). Winter was mild in **Central Europe** with anomalies between +1.0 °C and +2.0 °C. Germany reported the ninth warmest winter with an anomaly of +1.9 °C. February, with an NAO index of 1.9, was unusually warm with anomalies of +2.0 °C and above (Austria +2.0 °C, Slovakia +2.9 °C, Czech Republic +2.6 °C, Hungary +3.0 °C, Germany +3.1 °C). In the **Nordic and Baltic countries**, the winter had well-above-normal temperatures. Denmark reported the seventh warmest winter on record with an anomaly of +2.9 °C. January, however, was colder than normal in most of the region, especially in Finland where temperatures were -3.0 °C to -4.0 °C below normal in the north. February, in contrast, was very mild with anomalies of +4.0 °C to +5.0 °C in the Baltic countries and Finland, resulting in many new monthly records of maximum temperature. On February 26th, 15.8 °C was measured at Tirstrup in

Djursland (Denmark), tied with the previous record of 24 February 1990 measured in Copenhagen. In Sweden, a new record was measured at Karlshamn with 16.7 °C on the same day. In Latvia, at Kolka, a new record of 13.4 °C was set on 16 February for the highest winter maximum temperature. Estonia reported the seventh warmest February on record with an anomaly of +4.3 °C, Latvia the eighth warmest (+4.5 °C above normal), Lithuania sixth warmest (+4.4 °C above normal). In Iberia, winter was generally warmer than normal. Spain reported an anomaly of +0.8 °C and Portugal +0.4 °C. After the year started with colder-than-normal temperatures in January (-0.1 °C anomaly) it continued with a very warm February ending the season with +1.2 °C above normal in Spain. In the north of Portugal, about 30 % of the stations registered new maximum temperature records for February. Concerning the **Mediterranean, Italian and the Balkan peninsula**: except for Greece (anomaly -0.2 °C) the winter season was warmer than normal for the region between +0.6 °C above normal for Italy and Serbia up to +1.3 °C above normal for Slovenia and Turkey. January was colder than normal for some western parts of the region. Serbia and Greece reported January anomalies of -0.9 °C, Italy -0.7 °C. The season ended with a warmer-than-usual February except for Sicily and Malta, the latter reporting its second coldest February on record. Slovenia reported +3.1 °C, Serbia +2.1 °C, Italy +1.4 °C and Greece +0.7 °C above normal. Over **Eastern Europe**, the year started with below-normal temperatures in January for most of Eastern Europe with anomalies of 1.0 °C in Belarus, -0.7 °C in Moldova and -0.5 °C in Ukraine (NAO of -0.36). February was extremely mild with anomalies ranging from +3.2 °C above normal to above +4.0 °C in Russia (+4.1 °C) and Ukraine (+4.4 °C) (NAO of +1.9). The **Middle East** experienced a warmer-than-normal winter, though anomalies in January and February exceeded +1.0 °C only locally. Winter was exceptionally mild in the **South Caucasus**. The whole region experienced anomalies above +2.0 °C and in Armenia even close to +3.0 °C. During all winter months, the anomalies were above +2.0 °C.

Above-normal temperatures continued with the start of **spring**, and only at the end of the season temperatures from Italy to the Nordic countries dropped to below normal by -2.0 °C to -3.0 °C in many regions, making it one of the coldest Mays in a long time for many countries. In **Western Europe**, spring was mild with anomalies ranging from +0.3 °C in France, over +0.7 °C in the Netherlands to +0.8 °C in the United Kingdom. Only May had below-normal temperatures with anomalies below -1.0 °C in the Benelux countries, eastern and southern France. In **Central Europe**, spring was just slightly warmer than normal for Switzerland and Austria (+0.1 °C and +0.2 °C above normal) and between +0.5 °C in Germany and +0.7 °C for the rest of the countries in the region. While March and April brought widespread temperatures up to +3.0 °C above normal, May was far colder than normal due to northwesterly circulation and below average solar radiation with anomalies between -2.2 °C and -2.6 °C ranking among the 10 coldest Mays for most countries. In the **Nordic and Baltic countries**, spring temperatures were above normal by more than +1.0° in most of the region (Norway +0.8 °C, Finland +1.15 °C, Denmark +1.5 °C and Latvia +1.5 °C above normal). April was especially warm with Finland and Norway reporting their second warmest April on record (+2.5 °C above normal) and Latvia the third warmest (+2.1 °C above normal) May was the only month of the season, which was colder than normal in the whole region except for Lithuania and Latvia, where May was slightly warmer than usual. Over Iberia, spring started with a warmer-than-usual March and anomalies of around +0.7 °C. While April was close to normal, May proved to be warm again especially in Portugal, which reported its 7th hottest May since 1931, and southern Spain.

Table 3-3: Seasonal rank statistics for temperature (2018/2019) as provided by the NMHSs including countries with rankings among the top 5 (ranks 1–5) since start of the to time series.

Country	Anomaly	Reference period	Rank /Start of time series
winter			
Ireland	+2.18	1961-1990	1
spring			
Latvia	+1.6	1981-2010	4
Lithuania	+1.5	1981-2010	5
Moldova	+1.4	1981-2010	5
summer			
Slovakia	+3.5	1961-1990	1
	+2.4	1981-2010	
Czech Republic	+2.5	1981-2010	1
Austria	+3.8	1961-1990	2
Italy	+2.92	1961-1990	2
Hungary	+2.19	1981-2010	2
Switzerland	+2.3	1981-2010	3
Belgium	+1.5	1981-2010	4 (warmest since 1833)
Lithuania	+1.5	1981-2010	4
Armenia	+2.1	1961-1990	5
Bulgaria	+2.2	1961-1990	5 (since 1930)
Moldova	+1.9	1981-2010	5
Serbia	+1.8	1981-2010	5
autumn			
Bulgaria	+3.0	1961-1990	1 (since 1930)
Serbia	+2.9	1981-2010	1
Hungary	+2.38	1981-2010	1
Slovakia	+2.3	1961-1990	1
	+2.1	1981-2010	
Lithuania	+1.9	1981-2010	3
Moldova	+2.6	1981-2010	3
Austria	+1.9	1961-1990	4
Italy	+1.92	1961-1990	3
Czech Republic	+1.6	1981-2010	5
Jordan	+1.5	1981-2010	5

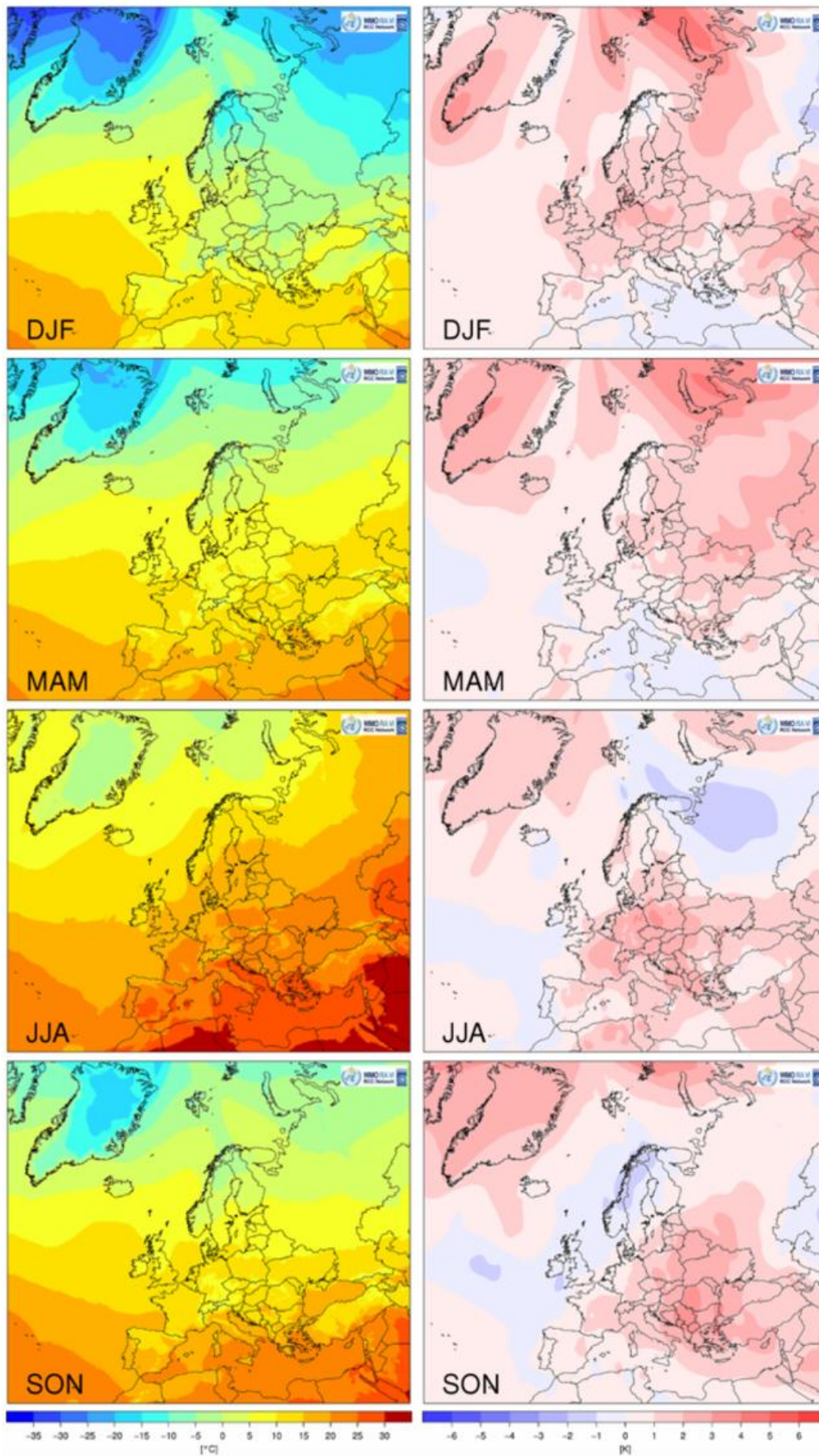


Figure 3-2: Seasonal mean temperature (left, in °C) and anomalies (right, in K) in 2018/2019, reference period 1961-1990 (Source: <http://www.dwd.de/rcc-cm>).

Concerning the **Mediterranean, Italy and the Balkan states**, overall spring anomalies were +0.5 °C for Spain and +1.03 °C for Portugal. Spring was warmer than normal for almost the entire region. Anomalies mainly ranged from +0.2 °C to +0.7 °C. The end of the season, due to northwesterly circulation and below-average solar radiation, was unusually cold in Italy and the Balkans. Slovenia reported one of the coldest May's on record (anomaly -2.8 °C), Italy the sixth coldest (anomaly -1.45 °C), Serbia the eighth coldest (anomaly -2.1 °C), and Malta and Greece reported anomalies of -1.5 °C and -0.5 °C respectively. Over **Eastern Europe**, well-above-normal temperatures continued in spring. Russia and Ukraine reported their eighth and seventh warmest spring each with an anomaly of +2.3 °C. Belarus and Moldova reported their fourth and fifth warmest spring (anomalies of +1.7 °C and +1.4 °C). March with an NAO of 2.39 was especially warm with anomalies of +2.9 °C (in Belarus) to +3.9 °C (in Ukraine) and ranked in the top ten of the warmest March months for all countries of the region. In the **Middle East**, after a slightly-colder-than-normal March (anomalies down to -1.0 °C for most of the region) and an April with well-below-normal temperatures (anomalies below -1.0 °C), a warmer-than-normal May followed with anomalies above +2.0 °C in parts of Israel and Jordan. Israel reported its warmest May for at least 50 years. During a prolonged heat spell starting in mid-May, multiple Sharav events (hot and dry winds coming from desert regions) brought very high temperatures, most notably between 22 and 24 of May when maxima of 43 °C to 45 °C were reached in the coastal plain and up to 47 °C in the Dead Sea region. Overall, spring season was closer to normal except for Cyprus where temperatures were +0.7 °C above normal. In the **Middle East**, in spring, above-normal precipitation (>125 % of normal) was received in northern and western Syria and in the Lebanon. Southeastern Syria and eastern Jordan had an early start of the dry season and received less than 10 mm in the whole spring. In May, precipitation was scarce in the whole region. The dry season continued until September. Spring started with a close-to-normal March in the **South Caucasus** followed by a colder-than-normal April with anomalies below -1.0 °C in Armenia. However, due to well-above-normal temperatures in May (anomalies above +2.0 °C in the whole region) the season overall was warmer than normal.

Summer was warmer than normal in much of Europe. June proved to be a month full of records for many countries with widespread anomalies of +2.0 °C to +4.0 °C. Summer in **Western Europe** was close to normal (+0.4 °C) in Ireland and only slightly warmer in the United Kingdom (anomaly of +0.8 °C, twelfth warmest). For Belgium (+1.5 °C), Luxembourg (+2.4 °C) and France (+1.7 °C) it was the third warmest summer on record and in the Netherlands the fourth warmest at De Bilt with an anomaly of +1.4 °C. June was very warm for most of Europe. It was the warmest June in the Netherlands, second warmest in Luxembourg (anomaly +3.6 °C) and fifth warmest in France (anomaly +1.8 °C). Ireland was below normal with anomalies of -0.3 °C. Although it was only the 4th warmest July on record for France (+2.2 °C), many records of daily maximum temperature were broken especially on 25 July (see "notable events" and sidebar for more details). Summer in **Central Europe** was exceptionally warm. Slovakia and the Czech Republic reported their warmest summer on record with anomalies of +2.4 °C and +2.5 °C, Hungary and Austria reported their second warmest (+2.2 °C and +2.7 °C above normal), and Germany and Switzerland their third warmest (+2.1 °C and +2.3 °C). All summer months were warmer than normal in the region but June in particular was the warmest month on record for all countries except for Switzerland where it was second warmest. Anomalies in June were well above +3.0 °C, and close to +5.0 °C in places. Many highest temperature records were broken. In Germany, the previous countrywide record of 40.3 °C, measured at station Kitzingen in summer 2015 was beaten by 14 different stations during the peak

of the heat wave on 25 June. Austria reported new June records at more than half of the 269 stations of ZAMG. In the **Nordic and Baltic countries**, summer was warmer by above +1.0 °C in the northern countries (Estonia +1.6 °C (warmest since 1961 together with 2015), Denmark +1.6 °C, Norway +0.9 °C, Latvia +1.0 °C, Finland +0.29 °C). Some new records were set, for example a new high minimum temperature of 26.1 °C observed at station Sømna – Kvaløyfjellet (Nordland, Norway) on 28. July. Never before a higher minimum temperature had been recorded in Norway. At the Swedish station Markusvinsa a new record of maximum temperature at 34.8° was measured on 26 July. This was the highest temperature ever reported north of the Arctic Circle in Sweden. On June 13, a new seasonal record with a temperature of 33.0 °C was set in Riga. Many other stations broke their monthly maximum temperature record during June. Contrasting to the warm June, July was colder than normal in the Baltic countries and Finland with anomalies slightly below -1.0 °C (Finland -1.1 °C, Latvia -1.2 °C, Lithuania -1.0 °C, Estonia -1.0 °C). In **Iberia**, the summer was warmer than usual by +0.8 °C for Spain, contrary to the situation in Portugal where temperatures were below normal by -0.3 °C. During a heat wave in the last days of June (26 June to 01 July) the highest measured temperatures reached well above 40.0 °C, for example 43.4 °C in Lleida and 43.2 °C at Zaragoza Airport, each on 29 June, and 43 °C at Girona Airport on 28 June. Seven main stations in Spain recorded a new daily maximum temperature record for the season during this heat wave. Concerning the **Mediterranean, Italian and Balkan Peninsula**: during the summer season, especially the Balkan states experienced widespread temperatures of more than +2.0 °C above normal. Slovenia and Italy reported the second warmest summer on record with an anomaly of +2.5 °C and +2.9 °C, respectively, Greece the fourth warmest (+1.3 °C above normal) and Serbia the fifth warmest (+1.8 °C above normal). June and August featured very high temperatures. It was the hottest June on record for Malta (+2.45 °C above normal), the second warmest for Slovenia (+4.2 °C above normal) and Italy (+3.9 °C above normal) and the fourth warmest for Greece (+1.5 °C above normal). August was reported the fourth (+1.7 °C) and fifth (+2.7 °C) warmest on record by Greece and Italy. Over **Eastern Europe**, during summer, the month of June was exceptional. Belarus, Ukraine and Moldova reported their warmest June on record with anomalies of +4.5 °C, +4.7 °C and +3.6 °C above normal, respectively. Records were broken at several stations. In Belarus, temperatures up to 34.7 °C were recorded during daytime while temperatures at night often did not fall under 21.0 °C in the period of 11 to 26 June. Locally, anomalies reached up to +7.0 °C. On 2 July, the 1929 highest maximum temperature record was broken at station Voznesensk in the Ukraine with a temperature of 39.0 °C. In the **Middle East**, summer was warmer than normal by more than +1.0°. In June, anomalies in the Middle East were close to and, in Jordan, even above +2.0 °C, ranking the season amongst the warmest five for all countries in the region. Summer in **South Caucasus** was characterized by a record June (in Georgia the warmest since 1960) with anomalies of +3.0 °C to +5.0 °C for the whole region, while in July the western parts of Georgia were slightly colder than normal and the other parts of South Caucasus had slightly-above-normal temperatures. This reversed in August when anomalies were below normal in Azerbaijan and above normal in Georgia and Armenia.

Autumn also was warmer than normal except for the Nordic countries, Ireland and the United Kingdom. The Balkan states were particularly warm with anomalies well above +2.0 °C.

Western Europe: While autumn brought below-normal temperatures to Ireland (anomaly -0.4 °C) and the United Kingdom (anomaly -0.3 °C) and near-normal temperatures in the Benelux countries (Netherlands +0.2 °C, Belgium +0.3 °C, Luxembourg +0.7 °C above normal), France reported its

sixth warmest autumn since 1900 with an anomaly of +1.0 °C. December 2019 was mild with anomalies of 0.8 °C in Ireland, around +1 °C in the United Kingdom and +2 °C in Benelux and France. **Central Europe** experienced a warmer-than-usual autumn, especially for the southeastern parts of the region. Hungary (+2.4 °C anomaly), Slovakia (+2.1 °C) and the Czech Republic (+1.6 °C) reported their warmest autumns, while for Austria (+1.6 °C) it was the fourth warmest, Switzerland (+1.1 °C) the sixth warmest and Germany, with 1.0 °C above normal, the 10th warmest. December 2019, too, was a mild month with anomalies ranging from about +1 °C in western Germany and +3 °C in eastern Poland. In the **Nordic and Baltic countries**, autumn was colder than normal in Norway (-0.9 °C below normal), Sweden and Finland (-0.16 °C below normal), while the Baltic countries and Denmark reported above-normal temperatures (Latvia +1.6 °C anomaly, eighth warmest together with 1949; Lithuania +1.9 °C, Estonia +1.1 °C, Denmark +0.7 °C). On 14 November, daily maximum temperature records were broken at many stations in Estonia, for example at coastal station Kunda the temperature rose to 12.5 °C (the previous record was recorded on 14 November 1938). December 2019 was generally mild, with anomalies ranging from below +1 °C in Iceland to above +5 °C in easternmost parts of the region. In **Iberia**, with an anomaly of +0.7 °C, Spain had a warm autumn. Only November had close to normal temperatures (anomaly +0.1 °C) while September and October were warmer than usual with anomalies of +0.7 °C and +1.3 °C for Spain. December, too, was a mild month with anomalies above +2 °C in central parts of Spain. For the **Balkan states**, an extremely warm autumn followed. For Croatia (+2.1 °C), Serbia (+2.9 °C) and Greece (+1.9 °C) it was the warmest autumn on record while for Slovenia it was the second warmest with +1.9 °C above normal, and Turkey and Italy reported their third warmest autumn with +1.9 °C above normal. December, too, was very mild with anomalies mostly between +1 °C and +3 °C, highest in northeastern Balkans and eastern Turkey. Over **Eastern Europe**, all three autumn months were warmer than normal for all countries in Eastern Europe except West Kazakhstan, which was repeatedly touched by a northerly inflow of cold air. Belarus reported the second warmest (+2.2 °C), Moldova the third warmest (+2.6 °C) and Ukraine the eighth warmest (+2.4 °C) autumn. It was the warmest October in Belarus since records began (anomaly of +2.87 °C). Abnormally warm weather between 14 and 22 October with anomalies up to +10.0 °C was observed in the whole country. The season ended with a warmer-than-normal November ranking fifth warmest in Belarus (+3.2 °C) and Moldova (+3.8 °C) while for the Ukraine it was only the 12th warmest (+3.1 °C). December, too, was extremely mild with highest monthly anomalies between +8 °C and +10 °C in the Arkhangelsk region in northwestern European Russia and many new daily records of daily maximum temperature especially in the period 18-23 December. It was the second warmest air temperature anomaly in December for the European part of Russia on average (+5.25 °C). In the **Middle East**, the warmth continued in autumn and December with anomalies of well above +1.0 °C in much of the Middle East in all four months September to December. In the **South Caucasus** region, autumn was warmer than usual in Georgia and Armenia while temperatures in Azerbaijan were close to normal. While temperatures were unusually high in October with anomalies above +2.0 °C in the whole South Caucasus region (3rd warmest October since 1960 in Georgia), cold air in the east caused a drop to slightly-below-normal values in November in its eastern parts. Warm air came again in December, and anomalies increased notably to around +3 °C.

3.1.3 Precipitation

Many parts of Western Europe received only 60 % to 80 % of normal precipitation that **winter** (Fig. 6), and only 20-60 % in parts of the Iberian Peninsula, while in the south of Central Europe, Eastern

Europe and parts of the Eastern Mediterranean precipitation was 125 % to 250 % of normal. During the winter season, precipitation was close to normal or below normal for **Western Europe**. The United Kingdom and Ireland reported 77 % and 66 % of normal precipitation, respectively. In the Benelux countries and most parts of France, precipitation was close to normal and only some western, central and southern parts of France recorded below-normal precipitation down to 60 % of normal. In **Central Europe**, the year as a whole was close to normal or drier. Some places in eastern Germany and Poland even received less than 80 % of normal precipitation. In **Central Europe**, the winter season was wetter than normal. Germany, Slovakia and Hungary reported about 110 % and the Czech Republic 148 % (eighth wettest) of normal precipitation. While January was wetter than normal with widespread precipitation between 125 % and 167 % of normal, February was drier than normal especially in Germany with most of the country receiving between 20 % and 60 % of normal precipitation. In the **Nordic and Baltic countries**, winter was wetter than normal in Denmark with 105 % and Norway with 115 % of normal precipitation. Precipitation in Norway, however, was distributed inhomogeneously. While some stations in the east received 200 % to 300 % of normal, several stations in the west received only about 50 % of normal. Finland was close to normal with countrywide precipitation of 102 % of normal. Estonia and Latvia were drier than normal with about 60 % to 80 % of normal precipitation, western Iceland was even drier, while southern Lithuania recorded locally above 125 % due do some low pressure systems coming from Central Europe. In **Iberia**, it was the fifth driest winter in Spain with 49 % of normal rainfall. Portugal had 42 % of normal, the fourth driest winter since 2000. Only in January did northern parts of Spain receive above-normal precipitation. In February, precipitation on the entire Iberian Peninsula was widely 20 % to 60 % of normal. With a countrywide average of 28 % of normal precipitation, Spain recorded the fourth driest February since 1965 and the driest in the 21st century. Concerning the **Mediterranean, Italian and Balkan peninsula**, winter was drier than normal in Italy (63 % of normal), Slovenia (68 % of normal) and Croatia (77 % of normal) while it was wetter for Serbia (120 % of normal), Turkey (146 % of normal), and for Greece it was the fifth wettest winter on record (155 % of normal). January was particularly wet in almost all parts of the region with Greece reporting the wettest January on record with 244 % of normal precipitation. Over **Eastern Europe**, the winter was generally wetter than normal with up to 126 % of normal precipitation in places. January in particular brought a precipitation surplus and was reported the fifth wettest by Russia (132 % of normal) and Moldova (231 % of normal). February, on the other hand, was the fourth driest in Belarus with locally just 20 % of normal precipitation. Ukraine reported 46 % of normal precipitation while Moldova was close to normal (94 %) and Russia reported above-normal precipitation with 132 % of normal, mainly in the north. In the **Middle East**, during January, Cyprus, Lebanon and the western parts of Syria received above-normal precipitation while in Israel and Jordan precipitation was below normal. February was wet again except for some parts in the east of Syria. In the **South Caucasus** region, the winter season was wet in Azerbaijan and Armenia, which received 125 % -250 % of normal precipitation and more than 250 % in places. Georgia received below-normal precipitation, below 80 % of normal in places.

Many parts of France and the Iberian Peninsula were drier than normal in spring with precipitation of 60 % to 80 % while in the rest of Europe it was closer to normal or wetter (125 % to 167 % of normal in Scandinavia and Italy/ northern Balkans). In **Western Europe**, Ireland and the United Kingdom reported slightly above-normal totals for the spring season. March was very wet in both countries. The United Kingdom reported the eighth wettest March since 1910 (136 % of normal). The Benelux countries were slightly drier than normal in spring with around 90 % of normal

precipitation. Parts of France remained dry with deficits as low as 50 % to 80 % of normal. In **Central Europe**, for Germany (98 %), Switzerland (102 %) and the Czech Republic (103 %) spring was close to normal while for Slovakia (121 %) and Hungary (112 %) the season was wetter than normal. For Hungary, March was the 10th driest on record with only 28 % of normal precipitation. During April, the precipitation deficit shifted to Germany, the Czech Republic (60 % of normal and the ninth driest) and northern parts of Poland where precipitation reached only 20 % to 40 % of normal.

Table 3-4: Seasonal and annual average of precipitation anomalies over land areas in % for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1)

region	year	winter	spring	summer	autumn
Central and Western Europe	96	95	94	85	113
Nordic und Baltic Countries	94	103	89	95	89
Iberia	89	57	83	87	101
Med. Italian and Balkan Peninsula	106	97	111	104	102
Eastern Europe	107	120	107	100	100
Middle East	99	130	113	119	63

Table 3-5: Seasonal rank statistics for precipitation (2018/2019) as provided by the NMHSs including countries with rankings among the top 5 (ranks 1–5) since start of the time series.

Country	Anomaly	Reference period	Rank /Start of time series
winter			
Jordan	86.6mm	1981-2010	4 th wettest since 1981
Italy	-93 mm	1961-1990	5 th driest since 1961
Spain	-101 mm (50% of normal)	1981-2010	5 th driest since 1965
autumn			
Georgia	-99.4 mm	1981-2010	5 th driest since 1960

Spring again was wetter than normal for the **Nordic countries** except Iceland (Norway 122 %, Denmark 130 %, Finland 118 % of normal) while the **Baltic countries** reported below-normal precipitation (Latvia 82 %, Lithuania 76 % of normal). Especially April was extremely dry in the whole region. Latvia reported only 9 % of normal precipitation making it the driest April on record. Finland only received 42.8 % of normal, ranking fourth driest, and Denmark reported only 36 % of normal precipitation. In **Iberia**, spring started with a very dry March when precipitation ranged from 20 % to 80 % of normal in most parts of the Iberian Peninsula. After a very wet April with 148 % of normal precipitation, ranking the fourth wettest for Spain, the season ended with an extremely dry May. Almost the whole Iberian Peninsula received only 20 % to 60 % of normal precipitation, with large parts of Spain below even that, making it the fourth and sixth driest May on record for Spain and Portugal, respectively. Over the **Mediterranean, Italian and Balkan peninsula**, most of the region experienced a wetter-than-normal spring, only Turkey was close to normal and Greece reported slightly-below-normal precipitation of 93 %. May was very wet in many countries of the region with

the exception of Greece and Turkey. Croatia and Slovenia reported 195 % of normal precipitation, the latter even reported the wettest May on record. For Serbia, it was the sixth wettest (192 % of normal) and Italy reported 185 % of normal precipitation. Over **Eastern Europe**, spring was wetter than normal in Russia and Ukraine while Belarus and Moldova received below-normal precipitation. March was rather dry in Romania, Moldova and Ukraine. Moldova even reported the second driest March on record with a countrywide average of only 1 mm, which is 3 % of normal precipitation, and Ukraine on countrywide average received 64 % of normal precipitation. In Belarus, it was only slightly drier than normal (91 % of normal) and the European parts of Russia reported a precipitation surplus of 115 % of normal. April was drier than normal in all countries of the region but driest in Russia, which reported the sixth driest April with 66 % of normal and Belarus even recording the driest April on record with only 18 % of normal precipitation. The season ended wet for the whole region with precipitation of 124 % to 161 % of normal, the latter being reported by Ukraine as the sixth wettest May. In the **South Caucasus** region, during spring, Azerbaijan again recorded above-normal precipitation of 125 % or more while precipitation in Georgia and Armenia was closer to normal.

Except for the eastern Mediterranean, the United Kingdom, Ireland and southern parts of Norway, **summer** was drier than normal with 60 % to 100 % of normal precipitation. In **Western Europe**, summer was predominantly characterized by low pressure leading to a rather wet season in Ireland and the United Kingdom. The United Kingdom reported its 10th wettest summer with 138 % of normal precipitation as well as some broken records - 425.4 mm in South Yorkshire, which is double the average for the season. In contrast, summer was drier than normal in France and the Benelux countries with only 80 % to 90 % of normal precipitation. In **Central Europe**, the summer was drier than normal for the whole region. Germany reported 73 %, Slovakia 84 %, Czech Republic 76 %, Hungary 91 % and Switzerland 95 % of normal precipitation. June in particular was very dry for Austria, which reported its driest June since the beginning of measurements in 1767 with only 43 % of normal precipitation, and Poland where the southern parts only received 20 % to 40 % of normal precipitation. In the Czech Republic, the precipitation deficit was 67 % of normal and thus it was the eighth driest June on record. Germany and Switzerland received 72 % and 88 % of normal precipitation during June. The summer season was drier than normal for all **Nordic and Baltic countries** except for Denmark (115 % of normal) and Norway (110 % of normal). Finland received only 67 %, Latvia and Lithuania a bit more than 80 % and Estonia 78 % of normal precipitation. Especially July was extremely dry in Finland (48 % of normal, ranking the fifth driest in history), Sweden (52 % of normal), most of Norway (74 % of normal) and Estonia (78 % of normal). Over **Iberia**, the summer started with a dry June, ranking seventh driest for Spain (58 % of normal) and Portugal reporting that 98 % of its territory was under meteorological drought (30 % in severe or extreme drought). While July brought above-normal precipitation of 120 % to Spain (enough to make it the 11th wettest July), the drought situation in Portugal increased with precipitation of only 20 % to 80 % of normal in the south and locally even less. In August, precipitation was distributed heterogeneously in Iberia. Locally there was more than 250 % of normal due to heavy rain. In Portugal, the drought was slightly relieved only in northern and central parts by above-normal precipitation while the south stayed dry. Overall, Portugal ended the season with 77 % of normal and Spain with 86 % of normal precipitation. Concerning the **Mediterranean, Italian and Balkan peninsula**, in summer, it was wetter than normal around the Aegean Sea and in Turkey, while Italy and the Balkans had around-normal precipitation or less. Serbia was only slightly wetter with 102 % of normal, Turkey and Greece reported 136 % and 131 % of normal precipitation, respectively. For

Italy, Slovenia and Croatia, precipitation was between 77 % and 84 % of normal. June in particular was notably dry for these countries with only 34 % of normal in Italy, 50 % of normal in Slovenia, 67 % of normal in Croatia, and Malta reporting no precipitation at all for only the fourth June in the last 70 years. In **Eastern Europe**, over the summer, precipitation was below normal except for the European parts of Russia with 108 % of normal, mainly in the north. It was close to normal in Belarus (97 % of normal). Ukraine and Moldova only reported 68 % and 87 % of normal precipitation. Precipitation was distributed inhomogeneously in the summer months as locally extreme amounts of precipitation were observed. At several stations in southern and central Ukraine (Kherson, Mykolaiv, Kirovohrad) new daily maximum record sums were set on 3-5 June with 76 mm to 104 mm, which is equal to 150 % to 200 % of the monthly normal. In the **Middle East**, in spring, above-normal precipitation (>125 % of normal) was received in northern and western Syria and in the Lebanon. Southeastern Syria and eastern Jordan had an early start of the dry season and received less than 10 mm in the whole spring. In May, precipitation was scarce in the whole region. The dry season continued until September. In the **South Caucasus** region, summer was drier than normal, with the highest deficits in eastern Azerbaijan and totals of only 40 % of normal. The dryness persisted more or less during all three summer months, only Georgia received above-average rain in June and particularly July.

For Eastern Europe, Turkey and southwestern Iberia, **autumn** was rather dry while Central and Western Europe mostly received above-normal precipitation between 100 % and 167 % of normal.. In **Western Europe**, autumn was wetter than normal in the Netherlands and Luxembourg with precipitation of around 115 % of normal. Belgium reported 95 % of normal. France, with 130 % of normal, had its fifth wettest autumn (since 1959), though France recorded a countrywide average of only 60 % of normal during September. December 2019 was wetter than normal in western Scotland, southern England and France, partly more than 125 % of normal, while the Netherlands received only around 80 % of normal. In **Central Europe**, autumn was close to normal in the Czech Republic (99 % of normal), Germany and Hungary (both 104 % of normal), while for Slovakia (130 %), Switzerland (115 %) and Austria (129 %) it was a wetter-than-normal season. December was drier than normal in Germany, western Poland and western Czech Republic (60-100 %), but wetter in the Alps, and in eastern and southeastern parts of Central Europe, locally exceeding 125 % of normal. Concerning the **Nordic and Baltic countries**, autumn season was rather wet in southern Finland and Sweden, southeastern Norway and Denmark. Denmark even reported autumn as the wettest on record with 153 % of normal precipitation. While some stations in eastern Norway received 150 % to 200 % of normal, several in the western parts reported less than 50 % of normal. Sweden received 141 %, Finland 124 %, Estonia 123 %, Latvia 118 %, and Lithuania slightly below-normal (95 %) precipitation. December was again a wet month for much of the Nordic countries (partly above 125 % of normal, locally above 250 % in northern Finland), but closer to normal or drier in the Baltic countries and scarce of snow. In **Iberia**, in the autumn, Spain reported a countrywide average of 115 % of normal precipitation. Double the normal precipitation was registered in some areas in Spain, for example between Granada and Jaén and Murcia while southwestern parts of Iberia were drier than normal with only around 60 % of normal precipitation. December was mainly wetter than normal, with 150 % of the long-term average falling in places. Other parts were drier, but only southern Spain recorded monthly totals below 80 % of normal. Concerning the **Mediterranean, Italian and Balkan Peninsula**, it was the sixth driest autumn on record for Serbia with 55 % of normal precipitation. Turkey also reported well-below-normal precipitation for autumn (63 % of

normal). All other countries of the region received above-normal precipitation, except for Malta, which was near normal. For Italy and the Balkan states only the last month of the season brought a surplus of precipitation while for Turkey only September was wetter than normal in southwestern and northeastern parts. December had a very heterogeneous distribution of precipitation. It was particularly dry in Sicily, North Macedonia and Bulgaria (40-80 % of normal in parts), but very wet in southern Turkey (above 250 % of normal in places). In **Eastern Europe**, autumn was drier than normal in the southern parts and wetter than normal in northern parts. Belarus reported 79 %, Ukraine 67 % and Moldova only 27 % (sixth driest) of normal precipitation for the season. For Ukraine and Moldova all three autumn months were drier than normal. Especially in Moldova, September (19 % of normal, 11th driest) and November (only 15 % of normal, fifth driest) were outstanding. December had a similar distribution with above-normal precipitation in northern European Russia (up to 250 % of normal), but drier than normal in the south (40-80 % of normal in large parts), although heavy showers were observed at the Black Sea coast on individual days. In the **Middle East**, the autumn season was much drier than normal with parts of Syria and Israel receiving only 40% or less of normal precipitation. For Israel it was the 7th driest November in the past 80 years. In the **South Caucasus** region, autumn started with a wet September with heavy rain in places, particularly in central Georgia and eastern Armenia. Locally, monthly totals exceeded 125 % of normal, especially in Armenia. October and November, on the other hand, were drier than normal in the whole region with only 20 % to 60 % of normal precipitation, and below 20 % in places. The deficit continued in December, except for some places, particularly in Armenia, which experienced heavy rain. Due to abnormally dry conditions in December, snow cover in Georgia persisted up to 18-20 days only in the high-mountainous zone with recorded maximum snow depth up to 10-15 cm. The average snow depth at winter resorts (Bakuriani, Gudauri) was two to three times lower than in previous years.

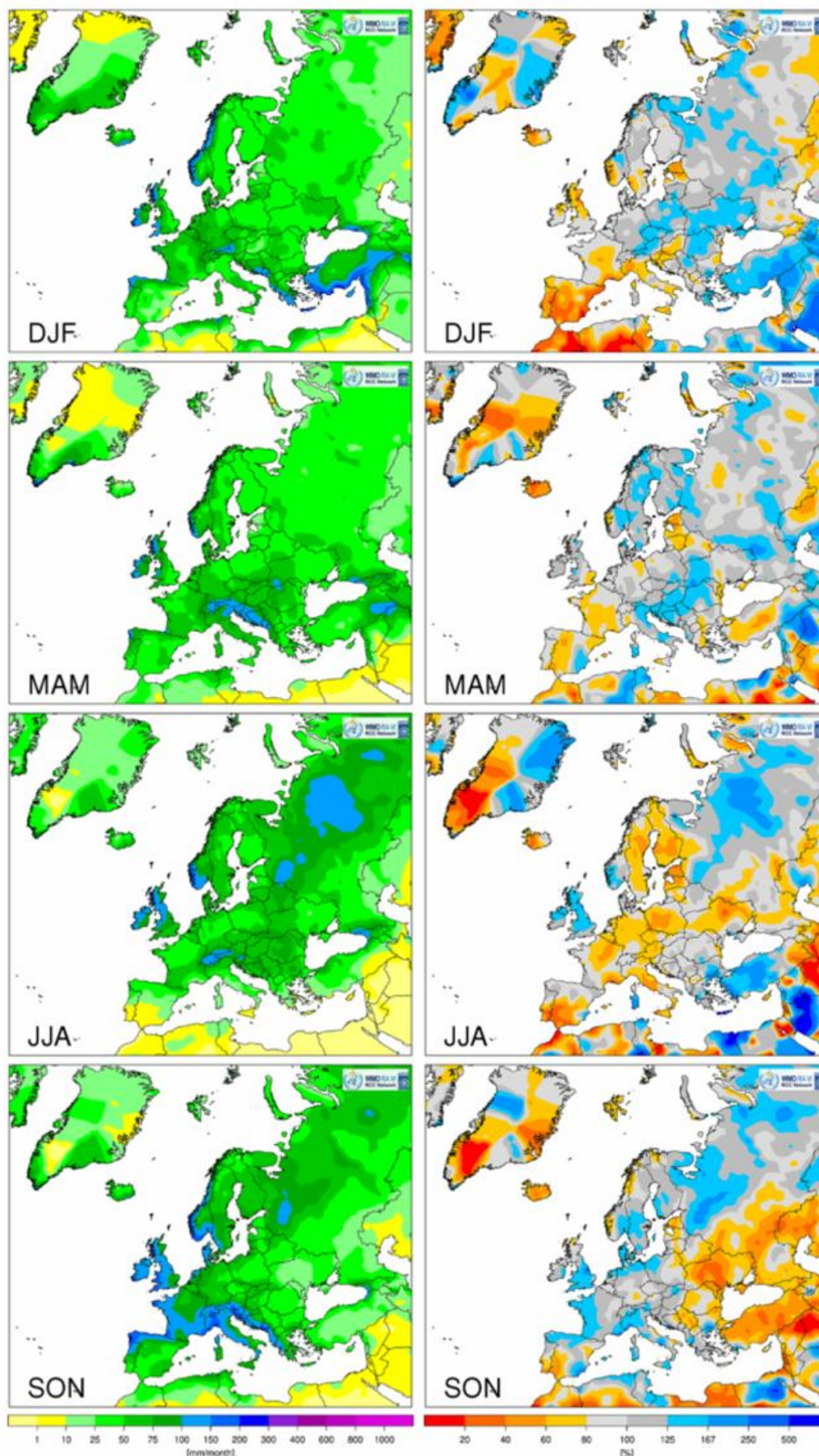


Figure 3-3: Seasonal total precipitation (left, in mm/month), and relative anomalies (right, in % of normal) in 2018/2019, reference period 1961-1990 (Source: <http://www.dwd.de/rcc-cm>).

3.1.4 Sunshine duration

The year 2019 as a whole was more sunny than normal over most parts of the RA VI Region and even exceptionally sunny with annually accumulated sunshine hours above the 90th percentile over large parts of Central and Eastern Europe as well as over Iberia, which saw 200 to 500 hours (in relative terms up to 125 %) more sunshine hours than normal (see section 2.1.4). This surplus of sunshine hours stems in case of Iberia from seasonal surpluses in winter and spring, which saw over large parts of the area more than 100 sunshine hours more than normal. In case of Central and Eastern Europe the summer and the spring season, respectively, contributed most to the large annual surplus.

During **winter 2018/19** most parts of the RA VI Region recorded above-normal durations of sunshine generally up to 100 hours more than normal, over Iberia even 100 to 200 hours more. Especially northern and eastern parts of the RA VI Region received over large parts less sunshine than normal (up to 100 hours).

Spring brought surplus in sunshine hours to most of the RA VI Region with generally up to 100 hours more sunshine than normal. Over northern parts of Iberia, Belarus and southern Russia the surplus even exceeded 100 hours. Parts of the Italian and Balkan Peninsula, on the contrary, saw a less sunny than normal spring season with a deficit of up to 100 hours.

In **summer**, largest surpluses of sunshine hours were recorded over large parts of Central and Western Europe with more than 100 sunshine hours more than normal.

In **autumn**, the western part of the RA VI Region saw less than normal sunshine hours whereas the eastern part reported a surplus in sunshine duration. Largest surplus in sunshine hours occurred over parts of southern Russia and northern Turkey (between 100 and 200 hours more than normal).

Table 3-6: Seasonal and annual average of sunshine duration anomalies over land areas in hours for each sub-region in the year 2019 (reference period: 1961-1990; definitions of the sub-regions see Figure 1-1)

region	year	winter	spring	summer	autumn
Central and Western Europe	154.2	57.3	18.2	93.3	-9.7
Nordic und Baltic Countries	25.2	21.6	27.2	11.5	-15.7
Iberia	154.7	100.4	86.4	1.0	-14.1
Med. Italian and Balkan Peninsula	97.9	36.6	-1.0	44.9	28.4
Eastern Europe	149.0	24.1	73.3	18.6	46.3
Middle East	110.6	39.7	17.6	0.0	59.4

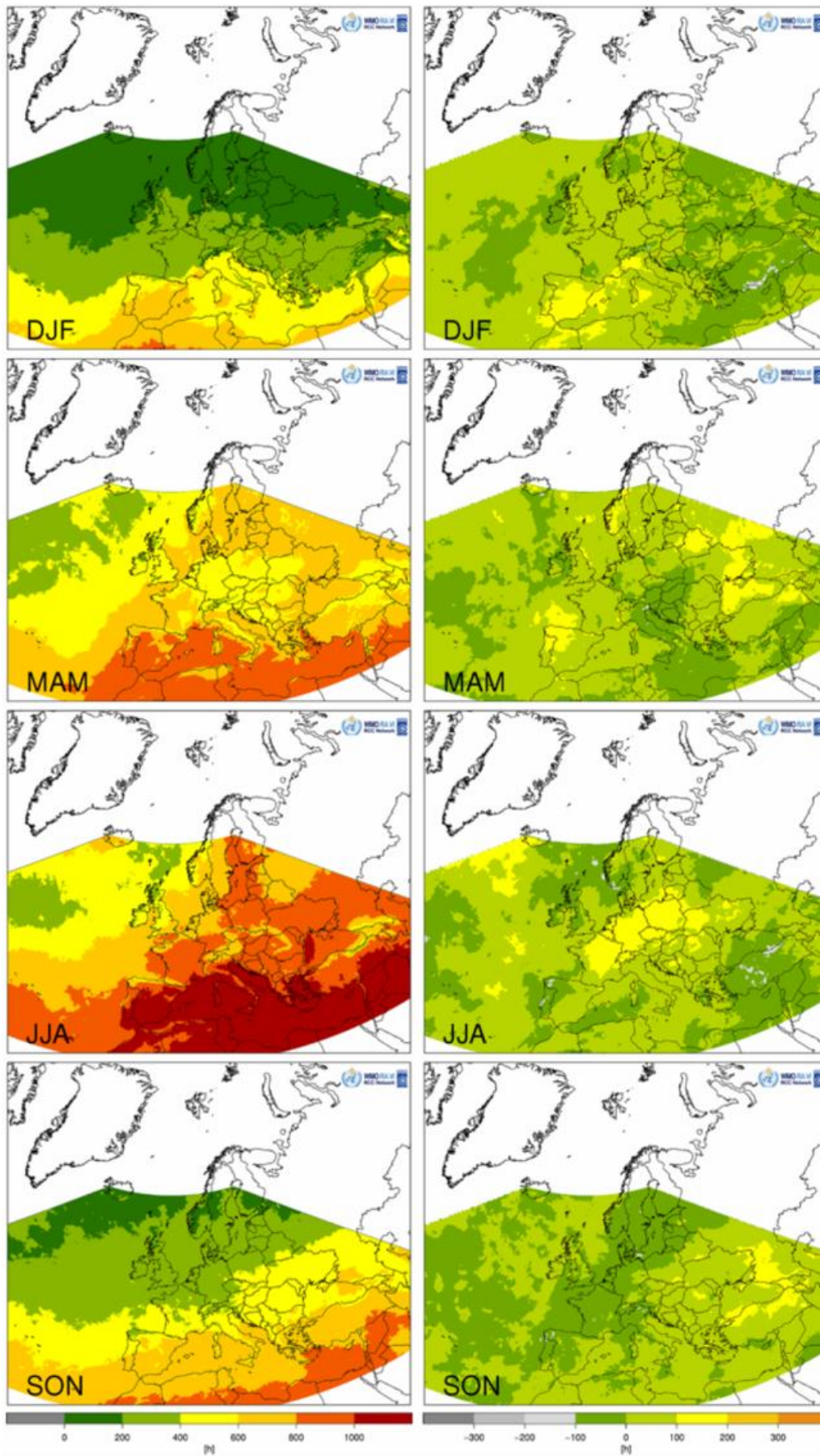


Figure 3-4: Seasonal sunshine duration (left, in hours), absolute anomalies (middle, in hours) and percentage of mean (right, in %) in 2018/19, reference period 1961-1990 (Source: <http://www.dwd.de/rcc-cm>).

3.1.5 Drought

In **winter 2018/19**, precipitation deficits were most severe in Spain, southern France and northern Italy where partly even less than 40 % of normal precipitation amounts were recorded. These are also the regions for which the GPCC-DI indicates moderate (partly even severe) drought conditions with values lower than -1.5. In Spain February was very dry in the whole of Spain. Its average precipitation was 72 % below normal value, and it represented the driest month in the 21st century and the fourth driest month since 1965. Mild drought conditions (with GPCC-DI values between 0 and -1) occurred over parts of Western, Northern and Eastern Europe, which also received less-than-normal precipitation. The rest of the RA VI Region experienced mildly wet conditions, except for Turkey and the Middle East where GPCC-DI reaches values above 1, partly even above 1.5 indicating moderately wet to severely wet conditions.

In **spring** mild drought conditions continued over Spain and France and smaller parts of Central and eastern Europe. Lowest GPCC-DI values occurred over Iceland (-1 to -1.5) indicating a moderate drought level. Over the rest of the RA VI Region wetter than normal conditions prevailed mostly mildly wet according to the GPCC-DI, only southeastern Turkey saw moderately wet conditions.

In **summer**, most of RA VI Region, experienced mildly wet conditions, only over northern parts of Russia moderately up to extremely wet conditions occurred. But dry conditions continued over Spain and France and extended further towards Italy. In this region mild drought occurred prevailed, locally GPCC-DI values dropped below -1.5 indicating severe drought, partly even up to extreme drought (in Spain). Over Iceland, moderate drought conditions from spring continued in early summer, especially in the South and the West. No precipitation was recorded in Stykkishólmur for 37 consecutive days, from 21 May to 26 June. This is the longest drought on record in Stykkishólmur since 1856. The drought conditions in Western, Central and Northeastern Europe intensified particularly during the first strong heat wave in late June 2019 and continued during the whole month of July. Weeks of dry weather since the heat wave in late June 2019 had left more than 80 of French departments facing water restrictions. Plants and wildlife were stressed. More than 20 departments were in the critical red category that restricts water use to only essential needs. The dry weather also hit parts of Spain, the Netherlands, Germany, Poland, the Czech Republic and Scandinavian countries. Soil moisture in the first week of July in northern and eastern Germany was lowest since at least 1961. Drought Indices (e.g. SPI) indicated extreme drought conditions for these areas. Water levels of major rivers in eastern Central Europe (e.g. Elbe, Odra) fell below mean low water levels, causing restrictions for ship traffic. Also in northern Italy, the Po River recorded low water. This month, Lithuania declared an emergency, with drought expected to cut its harvests by half. Due to too dry soils, there were fires in fields and forests in many parts of Europe and Middle East.

In **autumn**, drought conditions stopped for the southeastern parts, which mostly experienced mildly wet conditions. Over Italy and in the regions along the Atlantic coast of Spain, France and the UK moderately and partly even severely wet conditions occurred. Moderately wet conditions also prevailed in a band stretching from the Benelux countries over northern Germany, Denmark and Sweden into northern Russia. The southeast of the RA VI Region saw mostly drier-than-normal conditions, locally even moderate drought (e.g. Ukraine and southern Russia).

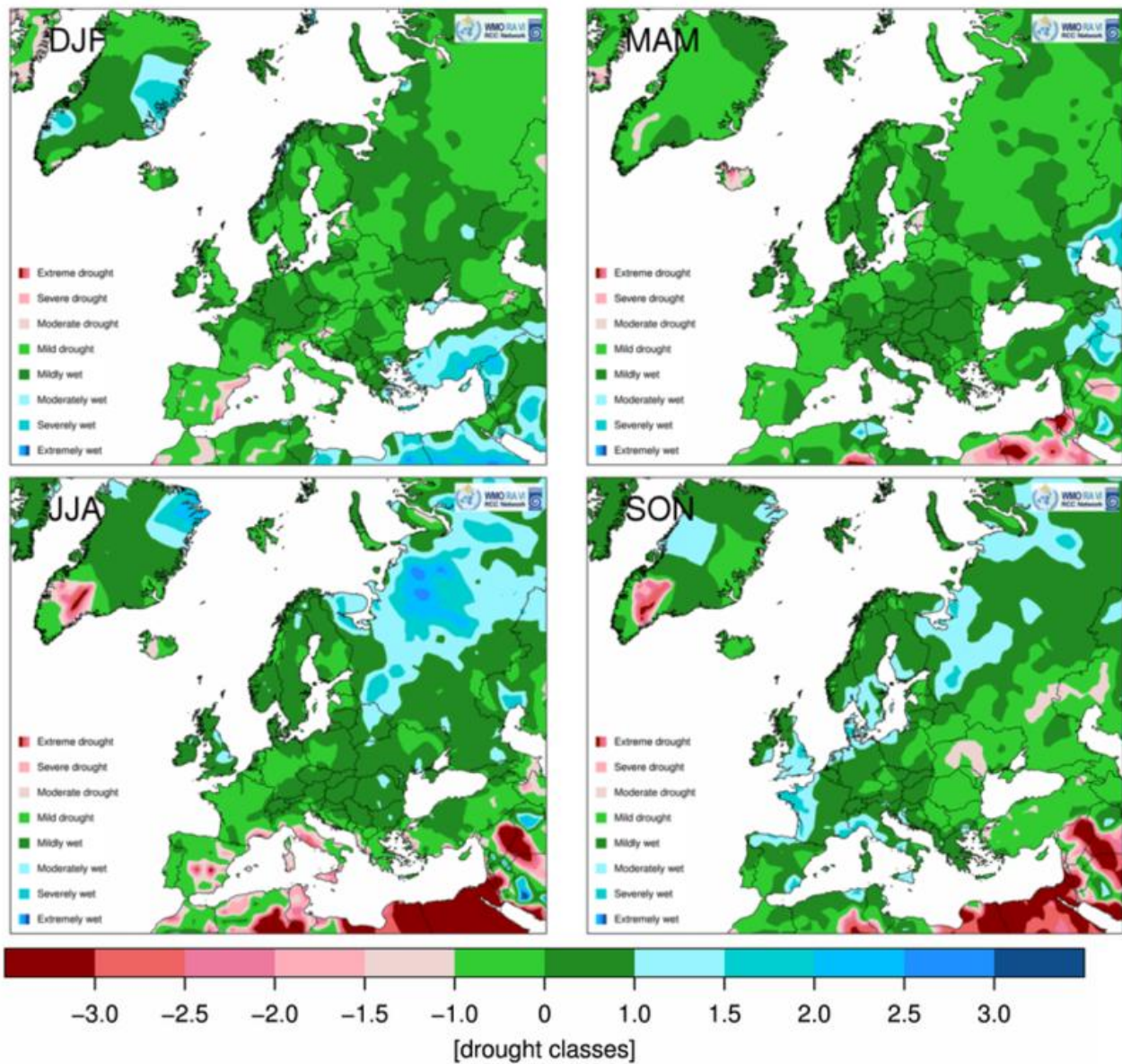


Figure 3-5: Seasonal GPCC-DI (GPCC-Drought Index, in drought classes, reference period 1961-1990) in 2018/2019 (Source: <http://www.dwd.de/rcc-cm>).

4. Monthly survey

The following monthly survey integrates relevant information from the Monthly Bulletins 2019 on the Climate in WMO Region VI - Europe and Middle East (available on <http://www.dwd.de/rcc-cm>). It contains highlights, means and anomalies of sea level pressure, temperature, precipitation and sunshine duration for each month as well as monthly overviews of extremes and notable events.

4.1 Sea surface pressure and circulation indices

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

Table 4-1: Monthly values of selected northern hemisphere teleconnection indices standardized to the 1981-2010 reference including the Arctic Oscillation, for January to December 2019.

year	month	AO	NAO	EA	EAWR	SCA	POL
2019	1	-0.71	0.18	-1.67	0.72	-0.09	0.08
2019	2	0.11	-0.11	-0.12	0.45	-0.4	0.69
2019	3	0.21	0.89	0.94	-1.15	-0.93	0.93
2019	4	-0.25	0.36	-0.96	0.82	2.09	-0.37
2019	5	-0.12	-2.38	-0.64	-0.7	-0.11	-0.78
2019	6	-0.6	-0.79	1.28	0.3	-0.16	-0.46
2019	7	-0.89	-1.39	0.08	1.02	-0.69	-1.48
2019	8	-0.72	-1.62	1.93	-1.68	-2.09	0.33
2019	9	0.31	-0.01	2.19	0.79	-0.52	-0.07
2019	10	-0.82	-1.03	0.67	-0.52	0.16	-0.2
2019	11	-0.12	0.16	0.07	-0.59	1.45	0.98
2019	12	0.41	1.02	0.81	0.15	0.84	-0.43

North Atlantic Oscillation (NAO); East Atlantic Pattern (EA); East Atlantic/West Russia Pattern (EAWR); Scandinavia Pattern (SCA); Polar/Eurasia Pattern (POL); Arctic Oscillation (AO)

(Sources: ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh and http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly_ao_index.b50.current.ascii.table)

In **January**, the Azores High was more intense than normal and extended far to the north, causing mostly drier-than-normal conditions in Western Europe. The Icelandic Low, on the other hand, was weaker than normal. This resulted in a slightly positive NAO phase, which persisted almost the whole month and led mild air to Europe. However, in other parts of the Northern Hemisphere the circulation was less zonal in times as revealed by a below-normal AO index on monthly average. This also included the European continent, where two main low-pressure centers dominated, one over Scandinavia, the other one over the central Mediterranean. The extension of the blocking Russian

High is close to normal. Warm air was advected over Eastern Europe far to the north on average, but the circulation was very variable within the month, with several warm and cold spells and temporary cut-off lows with heavy rain, partly snow in central and eastern parts of RA VI.

In **February**, the Azores high was more intense than normal and extended very far into the European continent, causing above-normal temperature and low precipitation over large parts of Europe. The Icelandic low also was very intense but shifted to the southwest. The resulting NAO index was slightly positive, but due to the relocation of the pressure centres, it remained weak throughout the month and within the standard deviation. Anyway, a strong southwesterly airflow of moist and mild air from the East Atlantic took place over Northwestern Europe and southern Scandinavia to northern parts of central European Russia, where the temperature anomalies were largest. The Russian high, on the other hand, was less extended to Europe, leading to more cyclonic circulation and high precipitation particularly over northern European Russia. It was also more cyclonic than normal over the Eastern Mediterranean where some heavy rain events occurred. The AO was clearly in a positive phase in the second and last third of the month, which implies relatively low influence of cold Arctic air on the middle latitudes.

In **March**, both the Icelandic Low and the Azores High were more intense than normal in March 2019. The Azores High was also more extended to the north and to the east. This resulted in an enhanced zonal airflow from the North Atlantic over Ireland and the United Kingdom to Central Europe and even further to Eastern Europe because the Russian High was less extended to Europe than usual. This airflow brought mild and moist air with frequent precipitation to these parts of the Region. In the north, an intense low was located north of Scandinavia and affected Northern Europe with above-normal precipitation. Southern Europe, from Iberia to the Black Sea region, was mainly under high-pressure influence, causing mostly dry and sunny weather with warm days, but partly cold nights, the latter especially in Southwestern Europe. The eastern Mediterranean region including the Middle East, eastern Turkey and sometimes up to Greece, was cyclonic on average with some heavy rain events and partly below-normal temperatures due to missing sunshine.

In **April**, high-pressure influence extended over Northern Europe and parts of Central Europe, causing high temperatures, very little precipitation and much sunshine there. The high-pressure zone extended even far west and north to Iceland and the Arctic region between Greenland and Svalbard. The Icelandic Low had its normal position for April, but was quite intense and much extended to the southeast. The Azores High, on the other hand, was only slightly more intense than normal, but less extended to the north. Consequently, cool and moist Atlantic air masses mainly affected Iberia and the Mediterranean region, while a warm airflow reached Iceland and the Arctic region. The Middle East and Turkey, too, were under cyclonic influence with cool and partly rainy weather. The NAO showed large fluctuations within the month, implying much air pressure variability over the North Atlantic, occasionally extending to Europe causing changeable weather. The AO had a strong negative phase mainly in the first half of the month, which explains the Arctic warming.

May had mostly a very meridional circulation structure. Much of Europe was under cyclonic influence, while high pressure prevailed over the eastern North Atlantic and Russia. Consequently, cold air flowed over Scandinavia, Central Europe down to the western and central Mediterranean, while warm air from the south came to the eastern Mediterranean and Eastern Europe. High pressure caused much sunshine, prevailing warm and dry weather in western Iberia. The cyclonic area over much of the rest of Europa was characterized by cloudy and rainy weather, including some

heavy rain especially in Central and Southeastern Europe. The NAO index was negative during the whole month following the meridional pattern, most at the beginning but weakening to the end of the month, when a westerly weather type developed over Europe. Similar the AO, causing an arctic air flow to Europe, except the last week of May 2019.

A very pronounced high pressure zone near Greenland was present in **June**, which blocked the flow of weather systems circulating the Northern Hemisphere. This resulted in weaker zonal winds and more meridional flow instead. A negative NAO is often an indicator of a Greenland block as it is the case this month with negative daily NAO values during the whole month and a monthly NAO value of -1.09. The AO, which often shares the phase with the NAO also stayed negative almost the whole month and finished with a monthly value of -0.601. During the first half of the month low pressure situated over Ireland and UK brought cool and unsettled weather with heavy and thundery showers over the western part of Europe. During the second half an upper-level trough was positioned over the eastern Atlantic, west of France together with a high pressure over the continent and another low pressure system over southeastern Europe formed an omega block which led to a plume of very warm air from North Africa being transported to Europe. It thereby caused a short but severe heat wave to Western and Central Europe with many all-time station and country-wide records being broken. This distribution was due to the main location of the upper trough over low pressure, from the British Isles towards western Iberia, and high pressure over the continent.

In **July**, both AO and NAO were negative during almost the entire month with just a brief period above zero around 18–20 July and 22–25 July respectively. As a result, NAO and AO monthly mean values for July were both negative with values of -1.43 and -0.89 respectively. The negative phase of both indices was primarily due a very pronounced high pressure zone over Greenland which was already present in June. Together with low pressure systems developing over the North Atlantic and over western Russia and high pressure over the European continent during the second decade of July, this led to hot air masses from North Africa being transported over western Europe up to Scandinavia, causing again (like in June) a short but severe heatwave.

In **August**, the daily NAO was strongly negative for the first half of the month and then near-neutral for the second half. The daily AO was negative during almost the entire month with just a brief period above zero around August 23–27. The negative phases of both NAO and AO were primarily due to the ridge over Greenland along with the troughs over the Northeast Atlantic (and Northwest Pacific). The primarily negative daily values resulted in negative monthly values of both NAO and AO with respective values of -1.17 and -0.722. NAO and AO thus continue their prolonged negative phase that started back in May.

In **September**, the general situation was driven by the Azores High, which was stronger and more widespread than usual, and the Icelandic Low, which was deeper than normal. Pressures were higher than normal over much of Europe pushing the westerly flow further north over the northern British Isles and Scandinavia. The daily NAO was weak but positive for the first half of the month and then increasingly negative during the second half resulting in a monthly mean near zero (-0.16). The circulation during the first half of September looked like a classic positive NAO with an enhanced trough over Greenland and enhanced ridging over the northeast Atlantic. These patterns reversed during the second half of the month. The AO was weak but generally positive during most of September, finishing with a monthly value of 0.306.

In **October**, the general situation over Europe was driven by the Icelandic low positioned further south than normal and the Azores high weaker than normal as well as by a persistent high pressure area over Greenland. Pressures over most of the RA VI Region were mostly slightly lower than normal (up to -2 hPa), over Russia up to -6 hPa. The daily NAO was negative for almost the entire month, and moderately negative (-1.4) for the monthly mean. The negative NAO was primarily due to the persistent high pressure over Greenland and the low pressure over the central North Atlantic. The AO was positive for the first half of October and negative for most of the second half, resulting in neutral conditions for the month as a whole with a monthly mean value of -0.082.

In **November**, the general situation over Europe was driven by the Icelandic low positioned much further south than normal and by the Azores high, which was stronger than usual. As a result, pressures were much lower than normal over western and central Europe but higher from Iceland to northern Scandinavia and Russia. The daily NAO was weakly positive for most of the month before turning negative in the final week. The positive values early in the month were largely due to high pressure over the central North Atlantic, but it was likely weakened by the lack of low pressure over Greenland. In the final week of the month, high pressure area shifted northward over Greenland and was replaced by low pressure over the North Atlantic. The AO was negative for almost the entire month, primarily in association with the high pressure over Greenland and low pressure near northwestern Europe.

The meteorological situation in **December** was characterized by a more intense than normal Icelandic low with its core stretching from Greenland towards the north coasts of Scandinavia and a more intense than normal Azores high extending over the entire southern part of the RA VI Region into Kazakhstan. Compared to the climatological mean the monthly mean surface pressure was lower than normal over the entire RA VI Region due to the frequent passing of low-pressure systems. This situation is also reflected in the circulation indices. Due to the low pressure near Greenland, the daily NAO was strongly positive for the first half of the month. For the second half it turned neutral resulting in a monthly value of 1.2. The daily AO was also positive for the first half of December, but then negative for the second half until the final days of December when it returned to positive. Averaged over the month, it was moderately positive.

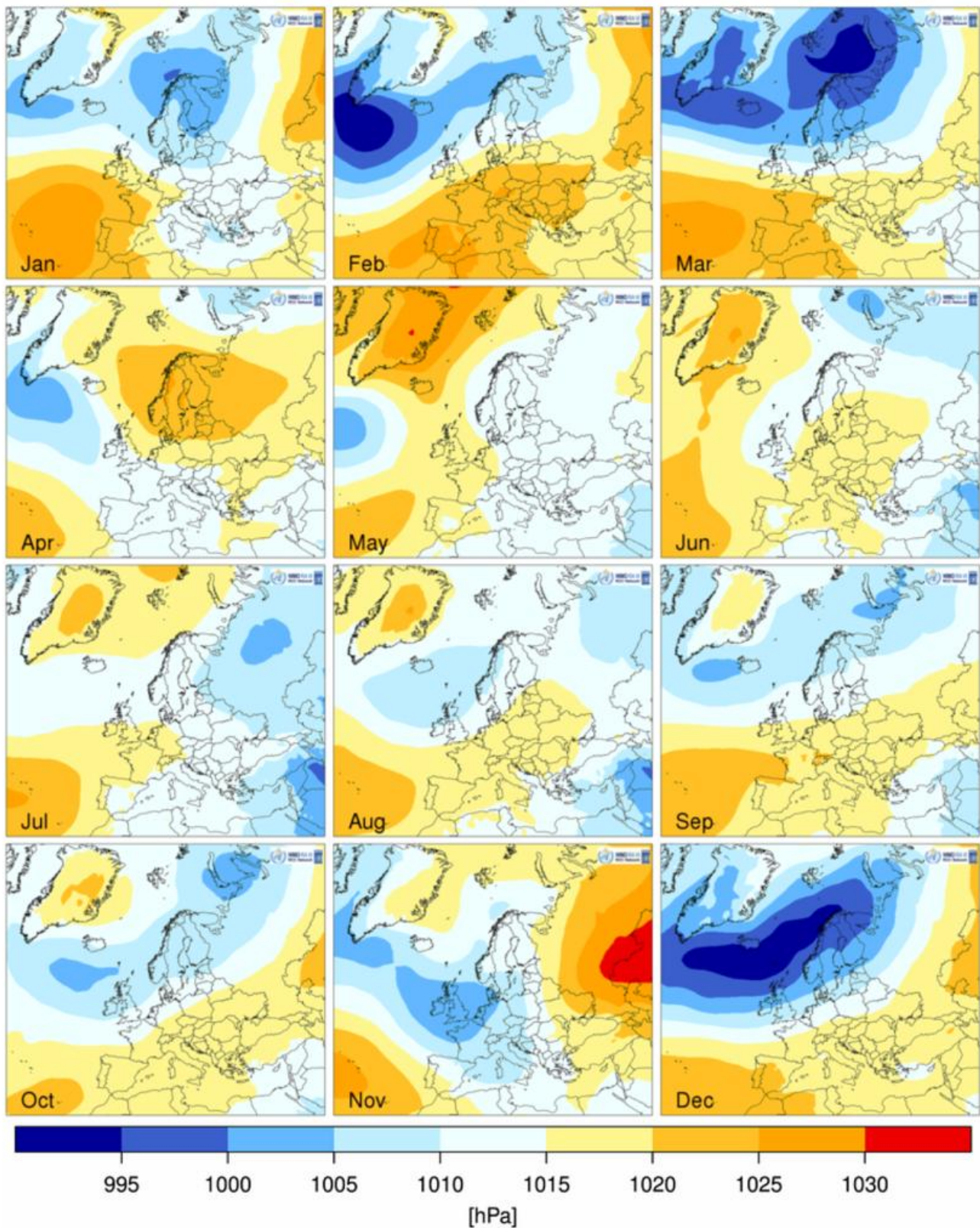


Figure 4-1: Monthly mean sea level pressure in hPa for the year 2019 (reference period 1981-2010).

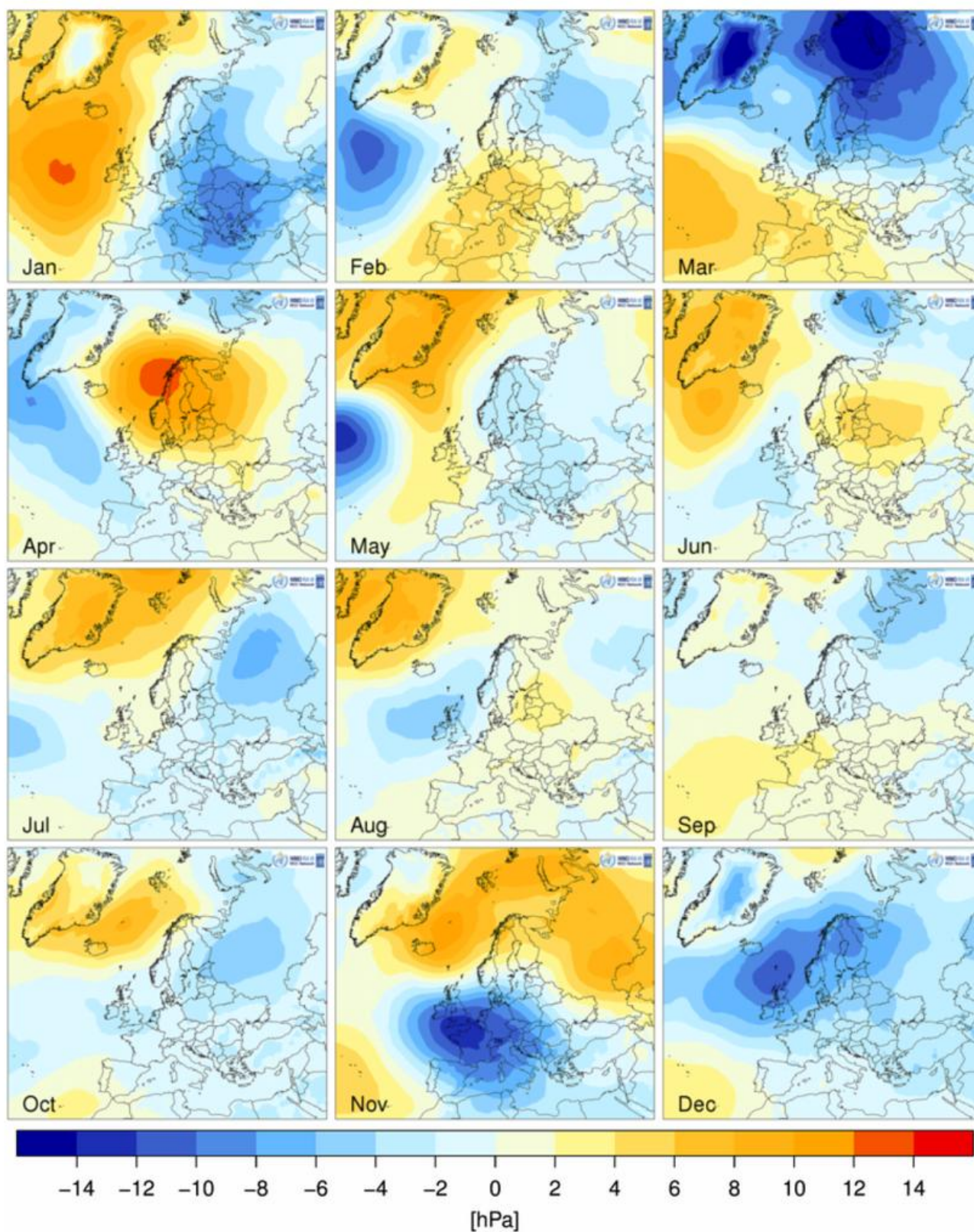


Figure 4-2: Monthly anomalies of sea level pressure in hPa for the year 2019 (reference period 1981-2010).

4.2 Temperature

In most of the months and sub-regions it was warmer than normal as can be seen from Table 4-2, with February and March being the only two months with temperatures below normal in some regions, namely Central and Western Europe, Iberia and Eastern Europe. Largest anomalies with anomaly values exceeding +4 °C occurred in Eastern Europe in January and over Central and Western Europe as well as over the Mediterranean, Italian and Balkan Peninsula in April.

Table 4-2: Monthly and annual area average temperature anomalies in °C for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1).

Region	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Central and western Europe	1.33	0.02	2.70	2.00	1.10	-1.35	3.03	1.28	1.50	0.83	1.31	1.04	2.45
Nordic und Baltic Countries	1.46	-0.11	2.50	0.07	3.70	1.57	2.09	0.74	1.03	1.27	1.29	1.53	1.91
Iberia	0.69	-0.14	1.20	0.69	-0.10	1.13	0.12	1.00	0.76	0.75	1.10	0.13	1.68
Med., Italian and Balkan Peninsula	1.43	-0.48	1.60	2.11	0.80	-1.26	2.65	0.90	1.81	1.52	1.92	3.33	2.29
Eastern Europe	1.51	0.05	3.80	2.30	1.20	1.65	2.42	-1.67	-0.46	0.48	1.45	1.89	5.09
Middle East	1.17	1.13	1.40	0.61	-0.70	2.46	2.70	0.18	0.31	0.76	2.27	0.55	2.32

Most of the RA VI Region had around-normal temperatures (1981-2010 anomalies within +/-1 °C) in **January** 2019. Anomalies were highest in in the Arctic region (up to +3 °C in southern Greenland) and in the South Caucasus region (+4 °C in Armenia). It was colder than normal in northern Scandinavia (<-3 °C anomaly), locally in Eastern Europe and generally in the Mediterranean region (<-1 °C). On mountain sites of the northern Alps in Switzerland and Austria it was the coldest January for more than 30 years (below 4 °C anomaly in places), while the Southern Alps were very mild. High mountains in Slovenia, too, were noticeable colder than normal (e.g. Kredarica -3.8 °C anomaly). Monthly mean temperature averaged over Europe was close to the 1981-2010 normal, only slightly cooler than normal. Anyway, it was the first colder-than-normal month after nine consecutive warmer-than-normal months since April 2018, also on national average, e.g. in Austria, Italy or Latvia. The warming trend for January since 1910 is +1.25 °C/ 100 years and the January 2019 average corresponds well to the warming trend. However, temperature variability was high during the month. Especially in parts of Northern and Eastern Europe, periods of freezing weather alternated with thaws. In Scandinavia and much of European Russia, mild temperatures characterized the first half of the month, in Iceland even exceptionally high, but the second part of the month was much colder and especially the last few days. Sweden reported 9 days in a row with daily minimum temperatures below -30 °C. On the other hand, Denmark only had 3 ice days (Tx<0 °C) on average (normal is 8.6 days in 1961-1990), the Netherland 2 ice days (normal: 3), Ljubljana in Slovenia 1 ice day, most of Serbia 1-7 ice days. In Central Europe, wintry temperatures dominated the early days of January, while the rest of the month was mostly milder. High-pressure influence in the second half of the month resulted in cold nights even in lowlands. A markedly cold episode occurred between 19 and 25 January in the Czech Republic, at some stations in Slovakia, in Hungary, and even in Slovenia.

During this period, the surface air temperature in the Czech Republic remained below the freezing point throughout the day. In northern Greece and the southern Balkans, temperatures were particularly low in the first decade of the month with daily minima falling down to -20°C or below. Over the western Mediterranean, the cold spell came down to Malta, minimum temperatures reached 4.1°C on 5 January.

It was a mild **February** with above-normal temperatures in almost the entire RA VI Region. The highest anomalies of above $+6^{\circ}\text{C}$ (1981-2010 reference) had been recorded in northern European Russia. Only a small part of northern Scandinavia (Lapland) and some places in southeastern Spain, southern Italy (Sicily) and Malta had below-normal temperatures. In the Middle East, temperatures were close to average.

According to Copernicus gridded data, the European-average temperature was $+2.75^{\circ}\text{C}$ higher than normal, making it the seventh warmest February since 1979. Based on the NOAA dataset, February 2019 was the sixth warmest February since 1910. The warmest February on record was by far 1990.

After a cold start of February 2019, the second half the month became very mild, especially in Northern/Northwestern Europe. Svalbard airport in the Arctic region registered again above-normal temperatures, continuously since December 2010. The highest daily maximum at Norwegian Arctic stations that month was 5.0°C on Jan Mayen Island. On continental Norway, the highest maximum was 18.7°C in Landvik, a new record for the province Aust-Agder (southern Norway). Sweden even had a new national February record (16.7°C in Karlshamn). In Denmark, the highest temperature registered in February 2019 (15.8°C) was record breaking high (together with February 1990). Ireland recorded highest local absolute February maxima at over half of its stations. The United Kingdom recorded its second highest February mean since 1910 behind 1998, which had higher daily minima, but February 2019 had the highest mean maximum temperature on record. The Netherlands and Belgium noted national records above 20°C (Netherlands: 20.5°C in Arcen, Belgium: 22.8°C in Houyet on 27 February). This was only the second time since 1901, when a Dutch station measured more than 20°C in February. France, too, noted maxima above 20°C with local records on several stations during this month, in the south even above 27°C . The number of days in February with the temperature exceeding 20° in Paris was also record-breaking. Luxemburg was very close to this threshold with 19.8°C at Findel Airport, but a local record since 1947. Minima were high in Denmark, where no ice days (daily maximum $< 0^{\circ}\text{C}$) occurred at all. The Netherlands had only one ice day at a few stations. In contrast, severe frost ($< -15^{\circ}\text{C}$) occurred in southeastern Germany on 4-7 February, but maxima also exceeded 20°C at the end of the month, also with local records.

In the Alps, Switzerland recorded its warmest or second warmest February on record at some mountain sites. It was $+5.1^{\circ}\text{C}$ warmer than the 1981-2010 average on Jungfrauoch (3580m a.s.l.). A north foehn in the valleys on the southern side of the Alps brought daily maxima around 23°C in the lowlands on 22 February. Several other Swiss stations had new local records on 26-28 February. Austria had a new national February record at 24.2°C on 28 February, Slovakia recorded up to 20.6°C the same day, the Czech Republic up to 18.8°C . Croatia also had some local monthly February records.

Spain recorded monthly temperature maxima up to 28.3°C in Murcia, and several other places had above 25°C at the end of the month, resulting in new local February records. Andorra recorded up

to 26.1 °C, also a new local February record. Monthly mean maxima in Spain, Andorra and Portugal were generally high, while minima were lower than normal due to cold cloudless nights. Thermal inversions occurred frequently.

Malta started the month relatively warm with a maximum of 19.4 °C on 2 February, but late in the month (23-24 February) cold winds from northeast let the temperature drop to a minimum of 3.7 °C, which resulted in a below-normal temperature on monthly average.

At the Black Sea coast of Turkey, the temperature was almost two months ahead in the annual cycle and resulted in too early blossoming of plums, which had never been observed in winter before.

Russia was particularly warm in its European part throughout the month. New records of daily maximum temperature were reached in the south of the Krasnodar region in the first decade. Estonia was especially warm in the second decade of the month, a new record of mean temperature for that decade since 1961. Similarly warm was Latvia, where Kolka station reached a new local record of monthly absolute maximum temperature for February at 13.4 °C on 16 February. Lithuania noted two national daily records of maximum temperature on 16 and 19 February at 10.7 °C and 10.4 °C, respectively. In contrast, Kiev in the Ukraine had its warmest day on 28 February like in Central Europe (11.2 °C daily maximum). Altogether, February 2019 was the warmest winter month in Kiev over the past 139 years.

March 2019 was mostly 1-3 °C warmer than the 1981-2010 normal throughout the Region. Highest anomalies up to above +3 °C (locally above +4 °C) were at the eastern border of RA VI, but also in a secondary maximum over eastern Central Europe, western parts of Eastern Europe and the Balkans. Only a few areas had below-normal temperatures: in the north from eastern Greenland (-3 °C anomaly) to northern Scandinavia, in places in Ireland, Spain and Hungary, in the Middle East, and in small areas over the North Atlantic and the Mediterranean. More than half of the stations in Ireland reported air and ground frost. Denmark reported 5 frost days on average, much below the 1961-1990 normal of 15. De Bilt in the Netherlands had 3 frost days (normal: 8), Uccle in Belgium 1 frost day, Ljubljana in Slovenia 2 frost days (highest number on March record was 26 days in March 1958). In the south, Cyprus recorded 7 frost days in mountainous areas. Soils were frozen in Lithuania and Belarus at the beginning of the month, but thawed until mid-March. Later in the month, there was only a short period of ground frost in these countries. Monthly mean European surface air temperature was +1.7 °C above normal according to Copernicus data. March 2019 was the 7th warmest March since 1979 on European average. According to NOAA data, March 2019 was the 6th warmest since 1910. The warmest March was in 2014. According to a Russian analysis, Europe had the 5th warmest March in history of observations.

In Russia (whole territory), 2019 had the third warmest March, but much of its contribution came from outside of RA VI. The European part of Russia mostly was warmer than normal too, but with weaker anomalies. There were some exceptions: The Russian North was colder than usual in the first decade of the month (with -35 °C frosts on the Kola Peninsula). Cold spells at the end of the month were quite untimely in southern Russia. They reached -3 to -5 °C in the nighttime in the Stavropol and Krasnodar Territories, and -10 °C in the early morning hours in Karachay-Cherkessia (North Caucasus).

April 2019 was particularly warm in the Arctic region with anomalies up to + 5-6 °C in Greenland and Svalbard. Over Iceland, temperatures were also exceptionally warm, making April 2019 the warmest April on record in Reykjavík, Stykkishólmur, Bolungarvík, Grimsey, Akureyri and Hveravellir. Temperature anomalies decreased to the south, but Central Europe and the Balkans were mostly still + 1-2 °C warmer than the 1981-2010 normal. Southern parts of the RA VI, from the Azores over Iberia, the Mediterranean to Turkey, the South Caucasus and the Middle East were mostly slightly colder than normal, in easternmost parts even with anomalies < -1 °C. Especially the first two decades of the month were colder than normal in Greece, but that was overcompensated by a warm third decade. Sea surface temperatures in the Mediterranean were normal or slightly above normal, in the north the Northern, Baltic and Barents Seas were much warmer than normal (up to > +2 °C anomalies). On European average, April 2019 was +1.0 °C warmer than normal and the 7th warmest April since 1979 according to Copernicus data, the 8th warmest since 1910 according to NOAA. The warmest April was in 2018 in both data sets and by far warmer than in 2019. For Germany, Austria and Hungary, April 2019 continued a series of 13 successive warmer-than-normal months (1981-2010 reference), which never occurred before in measurement history. In much of Northern, Western, Central and Eastern Europe, however, the month was characterized by a strongly changing weather picture, with a few cold days with frost in the lowlands down to the middle latitudes and the Balkans, and (wintry) showers alternated by sunny periods with warm summer days. However, the warm periods were prevailing. It was the second warmest April on record in Norway since 1900 (after 2011) and in Iceland (after 1974), the third warmest in Latvia. Some stations noted new local April records in Iceland, Norway, Sweden, Finland, Latvia and Russia (Kaliningrad Region), Latvia reported a new national record of the highest absolute April daily maximum at 28.9 °C. Anomalies in European Russia were mostly lower than in many other parts of Europe because mainly the first decade of the month was warm there, but it became colder in the rest of the month, culminating in night frosts even in Moscow region. In Western and Central Europe and even in Latvia and Lithuania, maxima reached above 25 °C several times locally, in Hungary even 30 °C. Ireland reported its highest monthly April maximum in 44 years at 22.9 °C. Ljubljana in Slovenia recorded 10 summer days that month, the highest number in April since at least 1951. The monthly maximum temperature in Andorra was 23.5 °C and was lower than in February and March there, southern Spain recorded up to slightly above 30 °C, also Serbia in the Balkans.

May 2019 was colder than normal over much of Europe, from Scandinavia over Central Europe down to the western and Central Mediterranean. At many stations in western Norway and northern and eastern Iceland, May 2019 was colder than April 2019, in Hungary only the first 3 weeks of May 2019 were colder. Coldest anomalies were over the Alps, colder than -3 °C, in Austrian highlands - 5 °C. In the southern Alps (Dolomites Mountains in Italy), many records of low minimum temperatures were broken. Eastern parts of the RA VI, in contrast, were warmer than normal with local anomalies up to +3 °C. Furthermore, the west of RA VI from Greenland / western Iceland over the eastern North Atlantic to western and southern Iberia also was warmer than normal, up to +4 °C anomaly in northwestern Greenland. Averaged over Europe, the temperature was almost identical to the 1981-2010 average (-0.003 °C anomaly) after Copernicus data. According to NOAA data, May 2019 was the 41st warmest May of the series starting in 1910, which means a little bit more than one third of this series was warmer than May 2019. The warmest May was by far May 2018. To find a month of May, which was colder than in 2019 (and colder than normal), we need to go back to 2004.

In the UK, May 2015 was last colder than 2019, in France and Belgium May 2013, in Germany 2010. In Switzerland, Austria, the Czech Republic, Hungary, Slovenia and even at some stations in Italy (Rome, Pisa, Modena), it was the coldest May since 1991.

Only the middle of the month was relatively warm in Northwestern and Northern Europe, while the beginning and the end of month were rather cold, therefore the monthly mean was very close to normal there (-0.4 °C anomaly in Norway and Sweden, -0.3 °C in the UK, 0.0 °C in Finland). Finland recorded 6 summer days (maximum ≥ 25 °C), 3 more than usual in May. In Southwestern Europe, Portugal and Spain experienced several heat waves with maxima up to above 35 °C at several stations.

France and Spain reported some local records of lowest minima and widespread frost at the beginning of the month. In Central and Southeastern Europe, especially the first half of the month was cold. The cold air and partly frost caused a slowdown of the vegetation development in Central and Southeastern Europe. Most of Austria did not have any summer days at all, the first time for 30 years in a month of May. Other countries, especially on the Balkan Peninsula had higher maxima at the end of the month, partly close to or even exceeding 30 °C (Bosnia-Herzegovina, Albania, North Macedonia, Greece).

Eastern countries were generally warmer than normal this month. May 2019 was the hottest month in Turkey in the last 49 years, many local maximum temperature records were broken. Cyprus had two heat waves at the end of the month with maxima above 40 °C. The highest maximum in Cyprus in May 2019 (42.1 °C) was the highest May maximum since 1983.

Over most of the RA VI Region, the average monthly temperature in **June** 2019 was above normal (that is the 1981-2010 average), particularly over central and eastern Europe with anomalies around +6 °C. In Eastern and central Europe warm temperatures dominated for the month as a whole, but these regions additionally experienced short but intense heat waves. Around the middle of the month during a first heatwave hit for example in Poland over much of the country, temperatures exceeded 30 °C during several days. At the end of the month the western and central parts of the continent experienced a short but even more intense heatwave, with daily average temperatures up to 10 °C higher than normal and daily maximum temperatures above 40° in France and Spain. In France, the all-time temperature record at Gallargues-le-Montueux, Gard, near the city of Nîmes was even broken on June 28 with a new record of 45.9 °C. For many countries including Austria, the Netherlands, Czech Republic as well as Germany June 2019 finished up as the warmest June on record. Other regions with temperatures substantially above normal include Greenland with anomalies between +2 and +4 °C. Lower-than-normal temperatures in the month of June are only found over western Iberia and parts of the British Isles. This temperature distribution was due to the main location of the upper trough over low pressure, from the British Isles towards western Iberia, and high pressure over the continent. Monthly mean temperature averaged over Europe was 2.34 °C above the 1981-2010 normal according to the Copernicus Climate Change Service (based on ERA5), making it the warmest June on record also for Europe as a whole since 1979,

Over large parts of the RA VI Region the average temperatures in **July** 2019 were higher than the 1981-2010 average for July, especially over Western, Central and Southern Europe and over Greenland. Compared to June, which was the warmest June on record in several European countries with anomalies around +6 °C, the July anomalies were in general lower in magnitude.

Largest anomalies occurred over France with monthly mean temperatures of +2 to +3 °C above normal. There were also regions with lower-than-normal temperatures in July, namely the southwestern edge of the Iberian Peninsula and northeastern Europe (Finland, Baltic countries, Belarus, western Russia) where monthly mean temperatures of -2° to -4 °C below normal occurred. The monthly mean temperature averaged over Europe was +1.35 °C above the 1910-2000 normal, making it the 13th warmest July for Europe as a whole according to the State of the Climate for July 2019 published by NOAA National Centers for Environmental Information⁴.

During a short but severe heatwave occurring over the western part of Europe on 24 and 25 July daily maximum temperatures exceeded 40 °C in many places and many station records were broken. New country-wide records were set in the UK (in Cambridge Botanic Garden: 38,7 °C), the Netherlands (Gilze-Rijen: 40,7 °C), Luxemburg (Steinsel: 40,8 °C) and Belgium (Begijnendijk: 41,8 °C) (see list for RA VI with highest maximum-temperature⁵). In Belgium and the Netherlands temperatures exceeded 40 °C for the first time since the beginning of meteorological recording. Because the area of high pressure extended far to the north, even Scandinavia experienced new temperature records. In Helsinki Kaisaniemi for example temperatures reached 33.2 °C on 28 July exceeding the previous record (31.6 °C) from 1945 by 1.6 °C. In Sweden maximum temperature values exceeded 32 °C, in Norway even 34 °C.

Over largest parts of the RA VI Region averaged temperatures in **August** were above normal temperature, with anomalies mostly up to +2 °C, over eastern/southeastern parts of Europe (Poland down to Greece) even up to +4 °C. Below-normal temperatures occurred over in the northeastern part of Europe, over Western Russia, Portugal and Ireland. In the last third of the month a persistent high pressure zone caused a long warm spell especially in parts of central and southeastern Europe which lasted more than a week. The monthly mean temperature averaged over Europe was 1.9 °C above normal relative to 1910-2000 making it the 3rd warmest August since 1910 for Europe as a whole according to the State of the Climate for August 2019 published by NOAA National Centers for Environmental Information (published online September 2019, retrieved on 08 November, 2019 from <https://www.ncdc.noaa.gov/sotc/global-regions/201908>).

Over large parts of the RA VI Region the average temperatures in **September** 2019 were higher than the 1981-2010 average for September, especially southeastern Europe and over the South Caucasus region where temperatures were +2 to +3 °C above normal. There were also regions with lower-than-normal temperatures in September, namely European Russia and Kazakhstan in the east as well as Ireland and parts of Scandinavia (Norway and Sweden) in the west. Here monthly mean temperatures of up to 2 °C below normal occurred. The monthly mean temperature averaged over Europe was +1.29 °C above the 1910-2000 normal, making it the 8th warmest September for Europe as a whole according to the State of the Climate for September 2019 published by NOAA National Centers for Environmental Information (retrieved from NOAA website⁶). The European-average temperature for September 2019 was 0.7 °C warmer than the average September from 1981-2010 based on ERA5 (Copernicus Climate Change Service/ECMWF).

⁴ published online August 2019, retrieved on October 25, 2019 from <https://www.ncdc.noaa.gov/sotc/global-regions/201907>

⁵ https://rcccm.dwd.de/DWD-RCCCM/EN/products/significant/records/download_tabelle.html?nn=500100

⁶ <https://www.ncdc.noaa.gov/cag/global/time-series/europe/land/1/9/1880-2019>

Table 4-3: Rank statistics, monthly average temperature and anomalies (in °C) from several countries of the RA VI for the individual months 2019 including countries with rankings among the top 5 (ranks 1–5) since start of the to time series.

Country	Rank	Anomaly [°C] (1961-1990)	Anomaly [°C] (1981-2010)	start of time series
February				
Ireland	3	+2.98	-	1900
Belgium	5	+3.5	+3.3	1833
March				
Moldova	4	-	+3.70	1886
Hungary	5	-	+3.17	1901
Bulgaria	5	+3.4	-	1930
Serbia	5	-	+2.90	1951
Czech Republic	5	-	+2.70	1961
April				
Estonia	2	-	+2.20	-
Finland	2	-	+2.51	1900
Iceland	2	+4.0	+3.7	1931
Norway	2	+3.3	+2.5	1900
Latvia	3	-	+2.10	1924
Lithuania	4	-	+1.9	1961
Cyprus	2 (Coolest)	-	-0.80	2000
May				
Jordan	1	-	+3.40	1981
Cyprus	4	-	+2.00	2000
Armenia	5	+1.90	-	1935
June				
Austria	1	+5.7	-	1767
Czech Republic	1	-	+4.90	1961
Georgia	1	-	+3.86	1960
Hungary	1	-	+3.76	1901
Latvia	1	-	+3.80	1924
Lithuania	1	-	+4.70	1961
Moldova	1	-	+3.60	1886
Slovakia	1	+5.30	+4.60	1951
Ukraine	1	+4.70	-	1891
Italy	2	+3.85	-	1961
Switzerland	2	-	+3.40	1864
Estonia	2	-	+3.10	-
Serbia	3	-	+2.60	1951
Jordan	3	-	+2.30	1981
Bulgaria	4	+2.5	-	1930
July				
Switzerland	5	-	+2.00	1864
August				
Slovakia	5	+3.20	+2.10	1951
Italy	5	+2.71	-	1961
Czech Republic	5	-	+1.60	1961
October				
Armenia	1	+3.40	-	1935
Italy	2	+2.26	-	1961
Cyprus	3	-	+1.40	2000
Georgia	3	-	+2.50	1960
Serbia	4	-	+2.10	1951
Lithuania	5	-	+2.10	1961
Switzerland	5	-	+1.90	1864

Country	Rank	Anomaly [°C] (1961-1990)	Anomaly [°C] (1981-2010)	start of time series
November				
Bulgaria	1	+4.5	-	1930
Serbia	1	-	+5.10	1951
Slovakia	1	+4.40	+4.10	1951
Cyprus	2	-	+2.80	2000
Hungary	3	-	+4.08	1901
Czech Republic	4	-	+2.70	1961
Lithuania	4	-	+3.00	1961
Moldova	5	-	+3.80	1886
December				
Italy	1	+2.34	-	1961
Russia	2	+5.25	-	1936
Latvia	2	-	+4.70	1924
Moldova	2	-	+4.10	1886
Estonia	3	-	+4.60	-
Lithuania	3	-	+4.50	1961
Ukraine	3	+4.50	-	1891
Switzerland	3	-	+2.40	1884
Georgia	4	-	+2.72	1960
Spain	4	-	+1.90	1965
Cyprus	5	-	+1.20	2000

Temperatures in **October** were above normal for most of the RA VI Regions with largest anomalies occurring in the East (Russia and Belarus) where it was 3 to 4 °C warmer than normal. Cooler-than-normal temperatures occurred over the British Isles and Scandinavia where anomalies of up to -1 °C and between -1 and -3 °C were recorded respectively. The monthly mean temperature for Europe as a whole was 1.87 °C above normal relative to 1910-2000 making it the 5th warmest October since 1910 according to the State of the Climate for October 2019 published by NOAA National Centers for Environmental Information (<https://www.ncdc.noaa.gov/>).

In **November**, temperatures were above normal over most parts of the RA VI Region. The monthly mean temperature for Europe as a whole was 1.76 °C above normal relative to 1910-2000 period making it the 7th warmest November since 1910 according to the State of the Climate for November 2019 published by NOAA National Centers for Environmental Information (<https://www.ncdc.noaa.gov/>). Largest anomalies occurred over the Balkan Peninsula where it was 3 to 4 °C warmer than normal, locally even more.

Monthly mean air temperature values were higher than the 1981-2010 average for **December** over the entire RA VI domain. Largest anomalies occurred over Eastern Europe, where temperatures were more than 3 °C above normal, over Russia anomalies exceeded even +6 °C. The temperature in Moscow rose to 6.2 °C on 22 December, a new local record in a series of about 140 years. The monthly mean temperature averaged over Europe was +2.73 °C above the 1910-2000 average, making it the 2nd warmest December for Europe as a whole according to the NOAA National Centers for Environmental Information (<https://www.ncdc.noaa.gov/>). According to the Copernicus Climate Change Service/ECMWF, December over Europe was 3.2 °C warmer than the average for 1981-2010 (based on ERA5), making it, by a narrow margin, the warmest December on record for Europe since 1979.

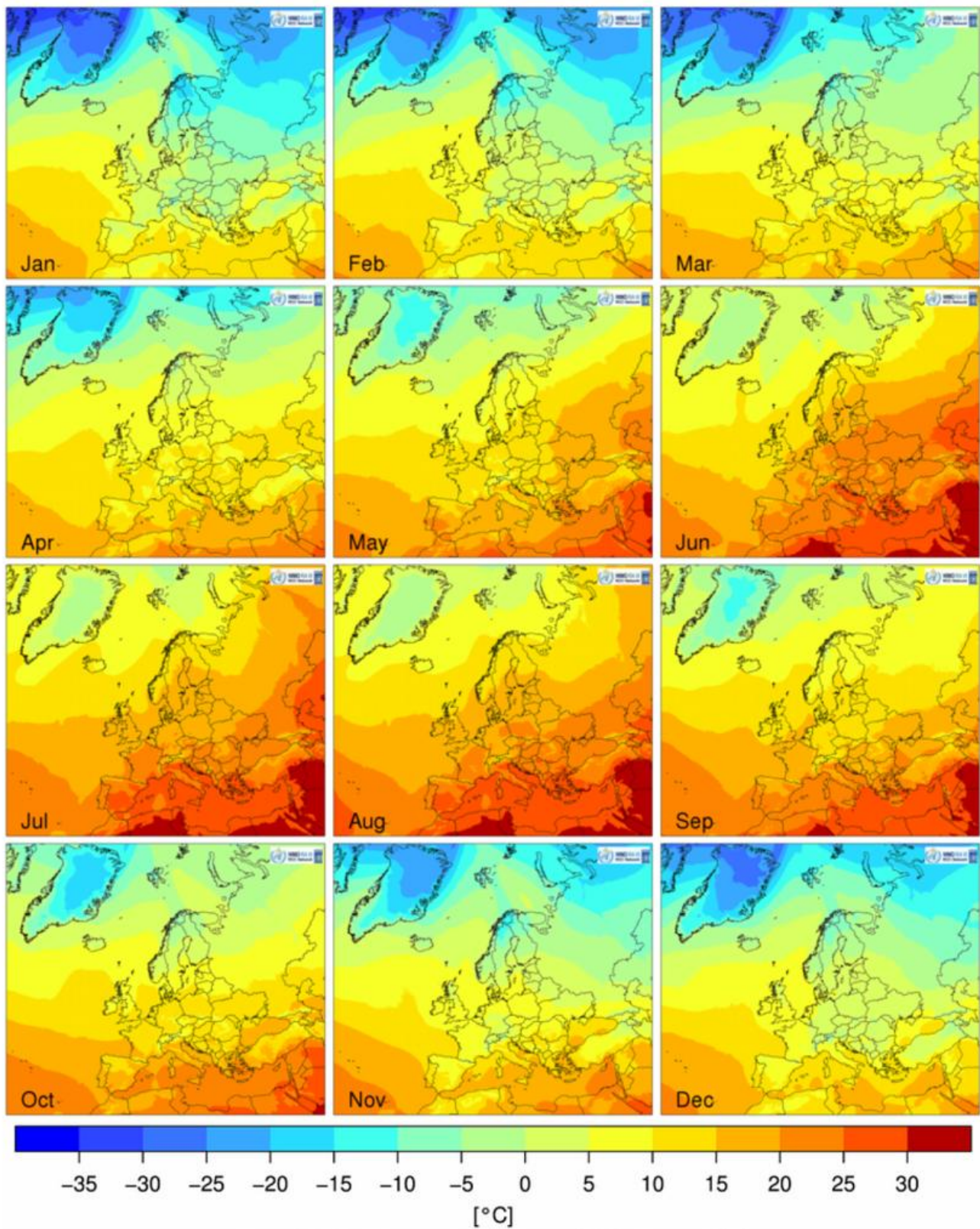


Figure 4-3: Monthly mean temperature (in °C) for the year 2019.

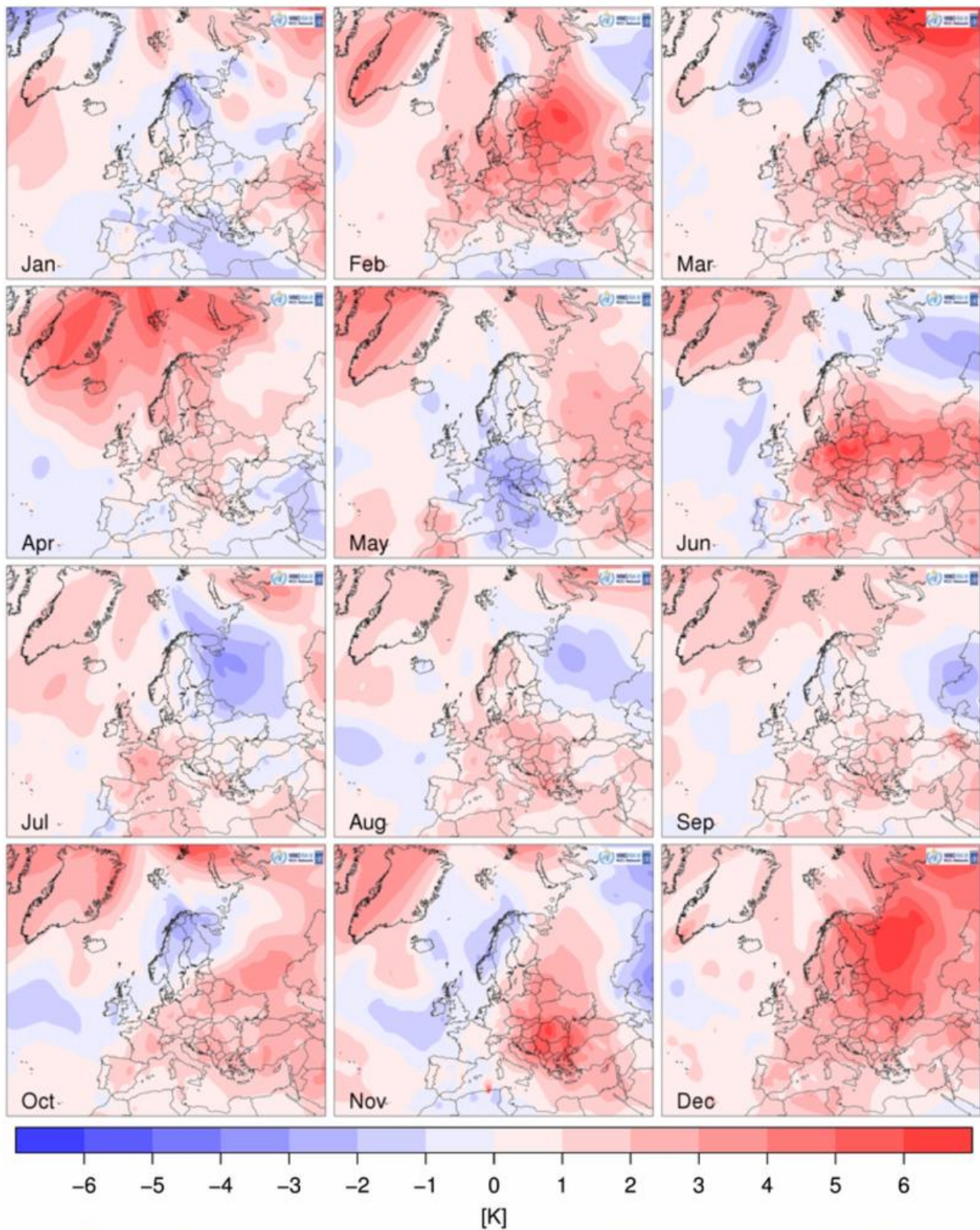


Figure 4-4: Monthly anomalies of temperature (in °C) for the year 2019 (reference period: 1981-2010).

4.3 Precipitation

Table 4-4: Monthly and annual area average precipitation anomalies in % for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1).

Region	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Central and western Europe	96	97	69	100	73	109	86	75	93	97	116	126	105
Nordic und Baltic Countries	94	125	85	117	68	83	108	55	123	107	79	80	103
Iberia	89	79	51	60	146	43	52	102	106	103	79	121	130
Med., Italian and Balkan Peninsula	106	149	70	46	123	163	89	148	76	67	64	174	107
Eastern Europe	107	137	119	120	71	129	82	121	97	80	125	95	108
Middle East	99	85	102	146	141	54	123	123	111	77	78	34	112

In **January**, precipitation anomaly distribution shows a notable west-east dipole. It was drier than normal particularly in Western Europe and parts of Scandinavia, though with locally heavy precipitation e.g. in northern Spain / southwestern France and in Norway. It was the driest January in the United Kingdom since 2006. The southern Alps were dry as well, with less than 10 % of normal in some areas of southern Switzerland, while the northern Alps were very wet with new local records, e.g. 279 mm in Kufstein. Eastern parts of RA VI were mostly wetter than normal as well, particularly around the Black Sea and near the eastern Mediterranean, locally above 250 % of the normal, e.g. in Romania, Moldova, Bulgaria, near the Aegean Sea, in southern Turkey and Cyprus. In Turkey, it was the highest January total in the last 15 years in the Aegean region and the last 37 years at the Mediterranean coast. Especially Greece and Cyprus recorded several heavy rain events with flooding and landslides. Malta, too, was wet, recording the wettest January since 2011, much contributed by 6 thunderstorms (more than 3 are rare in January), partly with hail. In Serbia, the stations Valjevo, Kragujevac and Pozega observed record-breaking numbers of days with precipitation (23-25 days, series since 1925, which means that the above-normal monthly totals came from high frequency of precipitation. In eastern Central Europe (e.g. Czech Republic, Slovakia), most of the precipitation fell in the first half of the month, also in the Middle East (e.g. Israel).

In **February**, precipitation was below normal in most of the RA VI Region from Western Europe to southern parts of Eastern Europe. Only the first third of the month was stormy and rainy in Western and Central Europe, but turned to anticyclonic conditions with little precipitation afterwards, especially the last third was mostly dry. Some places had severe or even extreme drought, particularly in northeastern Spain, France and Germany. Especially parts of Spain, eastern Ukraine, southern European Russia and west Kazakhstan received less than 10 mm or less than 20 % of the 1981-2010 normal that month. It was the driest month in the 21st century in Spain so far. The Netherlands had 45 mm, but these fell almost all in the first third of the month, similar in Belgium.

It was relatively wet particularly in northern European Russia, above 250 % of normal fell locally. Parts of Scandinavia recorded above-normal precipitation as well (locally above 300 % of normal in Norway). Some stations in Norway (Nordland province) received around 300-350 mm that month and reached new local February records. Places in the Southern Alps had a precipitation excess due to some heavy rain events, much of them within a few days in early February. Near the eastern Mediterranean, too, some heavy rain events took place, e.g. on 25 February in western Crete (Greece), when Chania station recorded 374 mm of daily rainfall, a new record for Crete, and also Cyprus reported several events, resulting in a monthly total of 139 mm or 171 % of normal. Israel, too, had a lot of rain. From 5 February to the end of month, it rained almost every day in any part of the country, including on three heavy precipitation events throughout the month.

In **March**, there was a clear contrast between north and south with respect to precipitation. While the northern half of the RA VI Region was mainly wetter than normal (except Iceland and the Arctic region), much of the southern half was drier than normal. European Russia also was mainly wet, and so was also the southeast of the Region from Azerbaijan to parts of the Middle East and the eastern Mediterranean including the southern Greek island Crete. The difference between north and south was extreme since much of the precipitation in the north was above the 90th percentile and in the south below the 10th percentile with locally less than 20 % of the normal and totals of less than 10 mm or even zero for the whole month. Some stations in Serbia (Palic, Crni Vrh, Sombor) recorded their driest March on record. For Italy, it was the driest month countrywide for at least 15 years. The Turkish Black Sea region received the lowest precipitation since 1995.

A few stations in Norway recorded 3 times the normal precipitation. Sweden even registered local records of monthly precipitation in the southwest with totals up to 179 mm. Finland reported totals occurring less frequently than once every 30 years in places. Some stations in Ireland experienced their wettest March since 2008. For Denmark, it was the wettest March countrywide since 1874 with 106 mm on spatial average. Some parts of European Russia received more than twice the normal monthly precipitation, the same in Israel. Latvia had its third wettest March in the 21st century and its first month since April 2018 with above-normal rainfall; thus, it ended a long drought period. In northern and parts of central Israel, it was the rainiest March since 2003.

March's weather in Northwestern, Western and Central Europe was dominated by westerly and northwesterly winds, mild temperatures and frequent rain belts moving in off the North Atlantic until the 17th-18th. Named storms Freya and Gareth (UK names) brought spells of particularly wet and windy weather. Zurich in Switzerland recorded 6 days of strong wind (gusts >75 km/h), which did not happen before since 1995, also France had more windy days than normal. From the 19th onwards, it was often dry and sunny in Northwestern, Western and Central Europe with cold nights, due to high-pressure influence.

Large areas from Spain to the Ukraine had at least moderate drought conditions, partly severe and locally extreme. Monaco and southern Andorra had just 1 day of rain in the whole month. In Hungary, rainfall exceeded 1 mm only on 3 days on national average

Much of the northern half of Europe was very dry in **April**, especially large parts of Scandinavia, Poland, the Baltic countries, Belarus and adjacent parts of western Russia, which all received less than 10 mm of precipitation in the whole month and thus experienced mostly severe or extreme drought conditions. The totals were mostly below the 10th percentile and less than 20 % of normal

in large parts. Water levels fell considerably in rivers and lakes, e.g. in Lithuania and Belarus. It was the driest April on record in Latvia since 1924 with not more than 2 days with at least 1 mm of daily precipitation anywhere, and the driest in Belarus in the post-war period. Norway saw the second driest April on record (after 1918). Sweden had some local records of low precipitation with below 1 mm over the whole month at several stations. Uppsala station received 1.6 mm; to find a lower value there, we need to go back to 1813. Also in many places in Finnish Lapland, the rainfall in April was the lowest in recorded history. The dryness led to wildfires, especially in southern Finland during the latter half of April and in Belarus during the last five days of the month. In the Russian plain, no similar dryness was observed in April for almost 50 years. Other areas such as parts of the United Kingdom and Central Europe had a moderate, locally also severe drought, most rain in Central Europe came mainly in the last week of the month. Uccle in Belgium recorded only 8 days with precipitation compared to 15 on 1981-2010 average. Highest precipitation this month with totals above 100 mm (locally much more) was mostly in the south, especially in much of Iberia, the southern Alps, Monaco, southern Italy, western Balkans and southeastern Turkey, locally 2-3 times the normal and above the 90th percentile. Monaco recorded its rainiest April on record since 1969 with 212.6 mm (about 300 % of the normal), Spain the second wettest in the 21st century after 2008 with local records.

In **May**, much of Europe was wetter than normal, from Scandinavia over Eastern / eastern Central Europe to the Balkans and Italy, locally with more than 250 % of the normal, in Norway 300-400 %, Sweden and Finland even had record-wet places with monthly totals above 100 mm. Some places in Austria recorded the second wettest May on record. It was the third rainiest May in Hungary, where also a new record of daily precipitation in May (141.2 mm) was noted. Hungary recorded 18 rainy days, 7 times more than average. Slovenia recorded its wettest May? since start of measurements in 1961 with monthly totals above 400 mm in some places in the Julian Alps. Dubrovnik in Croatia had its highest number of rainy days that month since start of measurements. Serbia reported both local record-breaking monthly precipitation totals (177.9 mm at Zrenjanin station) and number of precipitation days (23 days at Kikinda) for May. Montenegro had a new local monthly precipitation record at 321.4 mm in Herceg Novi. Northern Italy, too, recorded widespread totals above 300 mm, also partly with new records (e.g. Belluno, Modena) and high number of rainy days (16-18 compared to 12-14 normally). Malta recorded 6 thunderstorm that month (normal is 1), the highest number since 1951.

Western Europe (except Scotland) and most parts of western Central Europe were drier than normal and also the eastern Mediterranean region. Places in Ireland saw their driest May since 1991. Especially most of Iberia, but also southern Greece and southern Turkey, and Iceland/ Greenland received less than 40 % of the normal, partly even less than 20 %. It was the second driest May in the 21st century in Spain after 2015 and the third driest since 2000 in Portugal after 2006 and 2003. Turkey was dry especially in the Mediterranean region, the driest May in the last 20 years. Cyprus received only 1.6 mm the whole month (8 % of normal). The Middle East was in the dry season anyway. Over Russia, precipitation had a high spatial variability due to much convective rain.

In **June**, due to the main influence of high pressure over the continent dry conditions dominated over southwestern, central and also eastern Europe. Large parts only received less than 40 % of the normal precipitation amounts for example parts of Spain, Italy, Poland, the Baltic countries, Finland

and southeastern Russia. In Spain, Italy and Russia precipitation sums did not even reach 20 % of normal. At the same time, both western Europe and southeastern Europe experienced heavy precipitation events due to the eruption of heavy thunderstorms in the first week of June locally resulting in flooding. Turkey experienced a precipitation surplus of 70 %. In France, active disturbances, often stormy, followed one another. Violent thunderstorms locally accompanied by hail and gusts exceeding 100 km/h occurred over the north of the country on the 4th and 5th. The storm "Miguel" swept over a large part of France on the 7th. Then on the 9th, there were numerous thunderstorms over the south-east quarter.

The dry conditions present already in June continued in **July** over large parts of Europe. In Ukkel, Belgium, the dry period that had started on 16 June continued till 11 July, resulting in a total of 26 days in a row without precipitation. Last time Ukkel had seen such a long period without rain was back in 1995. Precipitation sums were exceptionally below normal in western and central Europe as well as over Scandinavia and parts of eastern Europe (< 10th percentile). In France and over Scandinavia the GPCC precipitation index regionally dropped below -1.5 indicating severe drought conditions. In Finland, it was particularly dry in the western parts of Northern Ostrobothnia and in southwestern Lapland where the monthly amount of precipitation was less than 10 millimetres. It rained least in Siikajoki, where the monthly amount of precipitation was only 2.3 millimetres. This is the lowest amount of precipitation recorded for July in the history of the observation station. Wetter conditions occurred in July particularly over southern and eastern Europe with exceptionally above precipitation sums over Russia, the Balkan Peninsula, Turkey but also over the United Kingdom. In southeastern Europe these resulted from severe storms hitting for example Italy, Croatia, Serbia, Bosnia and Herzegovina as well as Greece between 7 and 10 July and producing violent hailstorms. In the United Kingdom, flash floods occurred after torrential rain causing severe damage in northern and central England on 30 and 31 July.

Drought conditions were a very prominent feature again in **August**. There were two main zones of continued dryness: one extending from France over Central Europe to the Baltic countries and Finland and the other one from the Balkans to Ukraine/ Russia. In between the two zones there was a zone with more than average precipitation. Largest monthly deficits with monthly sums lower than the 10th percentiles were recorded over Ukraine, southwestern parts of Russia and parts of Greece as well as over Baltic countries. GPCC precipitation indices regionally dropped below -1.5 for Greece, Ukraine, southern France indicating severe drought conditions (for August). The monthly precipitation deficit was locally above 40 mm so that some places received less than 40 % of the usual August total. Even more serious was the long duration of periods without rain for parts of central and northern Europe and as well as for the Baltic where accumulated summer precipitation amounts stayed exceptionally below the average (< 10th percentile) of the reference period 1951 to 2010. The summer months were exceptionally wet (> 90th percentile considering the reference period 1951 to 2010) over northern UK, Norway, Russia and Turkey. Several heavy precipitation events partly going along with severe storms and floods contributed to these exceptionally wet summer conditions (see also "Selected Significant Events" reported by the National meteorological and hydrological services for this and previous months).

Precipitation sums for **September** were below normal over large parts of the RA VI Region, especially over Eastern Europe, Turkey and France where the monthly totals were partly only 40 % or less of normal. In these regions, the drought index dropped to values below -1.5 for September

indicating severe to extreme drought. In the Ukraine, the south only received 10 mm or less which is 75 % less than normal (w.r.t. 1981-2010). Exceptionally above average precipitation, amounts due to several cyclonic systems were registered over the northwestern part of Europe, for example over the UK, Netherlands, Denmark, but also over southeastern Spain. In Vega Baja del Segura, the area most affected in Spain, the accumulated rainfall in a few hours (from the morning of the 12th to the morning of the 13th) was almost equivalent to the amount normally accumulated over a whole year. Maximum values, accumulated during the period from 10 to 14 September, in the network of AEMET stations were registered at Gaianes with 482.8 mm (more than 350 mm of that fell in the last 24 hours).

In **October**, the regions receiving more sunshine than normal correspond also to those experiencing below normal precipitation. In parts of Italy and along the western coast of the Balkan peninsula the accumulated amounts were even exceptionally below normal (< 10th percentile). Exceptionally above normal precipitation amounts occurred, on the contrary, over northern Russia and along the Atlantic coast of western Europe affecting France, the UK and the Netherlands. Southern France, the northeast of Spain and the north of Italy were hit by excessive rainfall events during 21 to 24 October caused by a depression over the Mediterranean Sea. They resulted in severe flooding and landslides. The frontal system moved westward from Italy towards Spain between the 22 and 24 October. On the east side of the depression a south to southeasterly wind brought warm and humid air from the Mediterranean Sea causing excessive rainfall and heavy thunderstorms along the Mediterranean coasts. In Italy, most precipitation fell on 22 October. The province of Alessandria in Piedmont was among the worst hit areas. Piedmont Regional Agency for Environmental Protection (ARPA) reported that on 22 October as much as 253 mm of rain fell in 12 hours in Casaleggio Boiro. In France, most precipitation fell on the 22 and 23 October. In southern France, precipitation amounts of 100-200 mm were recorded over a large area, but locally even more than 200 mm. This is the amount of rainfall normally accumulated over three months. The largest rainfall amounts were reported in the Languedoc and the Roussillon regions, for example at the station Puechabon 271.5 mm. The Spanish Meteorological Service of Catalonia (Meteocat) recorded on 23 October at several locations in the northeast of Spain more than 200 mm in 24 hours, among them Prades, Baix Camp, with 287.4 mm. The northern part of Russia also experienced very intense precipitation with up to 30-50 mm per day and often in the form of snow already. In many regions monthly precipitation normals were exceeded by two or more times.

Monthly accumulated precipitation amounts differed a lot within the RA VI Region in **November**. The eastern part saw below normal precipitation amounts which were even exceptionally below normal (thus < 10th percentile) over Turkey, Southern Russia, Ukraine and Kazakhstan. In Russia, the monthly precipitation totals in the areas down to the Caucasian Ridge amounted to less than half the normal values, and were altogether zero in some areas of the Trans-Volga Region. A severe drought was observed in the Krasnodar Territory where sizeable rains fell on the last day of November only.

The regions neighbouring the northern Mediterranean as well as the Atlantic coast regions of Spain and France, on the contrary, experienced exceptionally above normal precipitation (>90th percentile). The rainfall amounts accumulated over the whole month are very impressive in these regions. In Italy, monthly precipitation values were in some areas double (for example in the Po basin) or even triple to quadruple (for example in south Tyrol) the normal amounts (that is the average over the reference period). For Italy, November 2019 finished as the rainiest November

ever. In France, rainfall was particularly frequent and abundant in the west and south of the country. France as a whole registered a surplus of precipitation of 90 %, making November 2019 the third wettest November since 1959. Over the western half of France and Corsica there were 15 to 27 days of rain, 5 to 14 days more than normal. Over the South-West as well over the South-East (of France), monthly precipitation totals reached double or even triple to quadruple the normal amounts. Records were broken at several stations including Lanvéoc (Finistère) with 246.4 mm, Ajaccio (Corse-du-Sud) with 284.3 mm, Cambo-les-Bains (Pyrénées-Atlantiques) with 531.5 mm and Saint-Martin-de-Hinx (Landes) with 534 mm. The heavy rainfall generated significant floods in Aquitaine on 16 and 17 November and in the Provence - Alpes - Côte d'Azur region on 22 and 23 November. In Slovenia, precipitation amounts exceeded the long-term averages everywhere. The largest surplus was reported in the northwest of Slovenia, in Gornja Radovna where 327 % of the normal precipitation fell. At lower altitudes, these large amounts of precipitation fell as rain, at higher altitudes as snow. In Kredarica, 29 days with snow cover were reported and the thickness of the snowpack reached 295 cm, which is the thickest snow cover in November ever observed in Kredarica. In Austria, the weather conditions in November brought an extraordinary amount of precipitation in the southern and southwestern parts of the country. In these regions the anomalies of precipitation were 200 to 440 % of normal. Many weather stations in these regions set new monthly precipitation records. In Austria it was the third wettest November (+100 %) since 1858.

These abundant precipitation amounts were due to several Mediterranean Storms occurring between 12 and 24 November. First, Mediane Trudy developed on 12 November from the low pressure area Detlef. Trudy brought heavy rain especially to Italy and the Balkan coasts. In Italy up to 90 mm of rain fell on 12 November, on the Balkan coasts up to 78 mm. In the southern Alps Trudy brought fresh snow quantities of more than 1m as well as strong winds. As soon as Mediane Trudy had left, low Heiner started heading towards Italy and the Alps. This time, largest amounts of precipitation occurred mainly in the south and east of Austria. Almost 140 mm accumulated in 24 hours. At lower altitudes, these fell as rain, at higher altitudes as snow, resulting in floods and enormous amounts of fresh snow. Furthermore, the strong air pressure gradient in Austria caused widespread strong winds and gale force gusts. In the night from 22 to 23 November, Luis II moved across the Bay of Biscay and reached the coast of southwestern France on 23 November. Especially along the Atlantic coast of the Iberian Peninsula, stormy winds and abundant precipitation occurred. Several stations in France and Spain recorded more than 100 mm in 24h. But also parts of Italy experienced again heavy precipitation exceeding 100 mm in 24h at several places (on 24 November).

Monthly precipitation totals were also exceptionally above normal in the northeast, namely over Russia and Finland. In Russia, up to 50 mm of precipitation fell per day in some locations in the Novgorod Region and more than twice the normal monthly amount accumulated in the first decade of November. Such abundance of rains led to a rapid rise of river levels. Water flooded roads, bridges and even in parts the city of Veliky Novgorod. In the Volgograd Region, the situation was similar, while in the Kostroma Region, heavy rains were followed by ample snowfalls. In Finland, in the area extending from Satakunta to Koillismaa, the precipitation was 1.5 to 2 times more than in an average November. In parts, even location-specific precipitation records for November were measured. The month's highest overall amount of precipitation, 134.4 mm, was measured in Niinisalo, Kankaanpää.

At the same time, this was the highest November precipitation in the 80-year history of the observation station.

Monthly precipitation totals for **December** were below normal mainly in the eastern, southeastern and central parts of the RA VI domain with for example less than half the normal precipitation amounts in southern parts of European Russia. Around the Caspian Sea no or only very little precipitation was recorded. More than normal precipitation, on the contrary, was observed among others over northern Europe. In Finland, for example, it rained twice as much as usual in Central Lapland. In Vuotso (Sodankyla), the highest amount of precipitation in the station's measurement history for December was recorded with 98.7 mm. The highest amount of precipitation was recorded in Koivuniemi in Virolathi with 116.8 mm. Wetter than normal conditions also prevailed in western parts of Europe as well as over the eastern Mediterranean region resulting from several winter storms passing over Europe during December. A first storm occurred over Iberia in early December and caused flooding in France and Spain. In southern France (Var region) 187 mm fell in 24 hours on 2 December, the second highest daily total on record behind 3 October 2015. In mid-December another storm caused flash floods in parts of the Murcia region in southern Spain. Gusts of 130-140 km/h were measured in several places in France and Germany (mainly coastal or mountain sites), in Corsica (France) even 173 km/h on 13 December and on the peaks of the Alps up to 158 km/h (Jungfrauoch) on 14 December. In Portugal, 115.8 mm were accumulated in 24 hours on 16 December and in France a gust of 173 km/h was registered on December 13. Between 19 and 22 December several fast-running low-pressure systems reached Western and Central Europe causing stormy winds, mild temperatures and heavy precipitation. Strongest gusts occurred over Iberia and southwestern France with wind speeds up to 150-180 km/h at several stations in Portugal and Spain. In the eastern Mediterranean region, after a very dry autumn, December finally brought above-normal precipitation over almost in the whole region except for southern Israel and southern and eastern Jordan. A weak low-pressure system caused heavy precipitation in Israel (on 25-28 December) and Lebanon. Monthly totals up to above 250 % were recorded particularly in various parts of Syria and Israel.

Table 4-5: Rank statistics, monthly average precipitation (mm) and anomalies (mm or %) from several countries of the RA VI for the individual months in 2019 including countries with rankings among the top 5 (ranks 1–5) since start of the time series. Ranks refer to monthly values being sorted from wettest to driest if not indicated differently.

Country	Rank	Anomaly [mm] (1961-1990)	Anomaly [mm] 1981-2010	start of time series
January				
Moldova	5	-	+47	1891
(European) Russia	5	+12.1	-	1936
February				
Jordan	5	+61.8	-	1981
Italy	1 (driest)	-26	-	2010
Spain	4 (driest)	-	-38	1965
March				
(European) Russia	2	+18.4	-	1936
Estonia	4-5	-	+19.7	-
Italy	2 (driest)	-52	-	2010
Moldova	2 (driest)	-	-34	1891
Bulgaria	4 (driest)	-35	-	1930
April				
Italy	2	+30	-	2010
Spain	4	-	+31.0	1965
Estonia	1 (driest)	-	-26.7	-
Latvia	1 (driest)	-	-31.3	-
Lithuania	1 (driest)	-	-34.0	1961
Finland	4 (driest)	-	-17.1	1961
May				
Italy	1	+63	-	2010
Hungary	3	-	+71.8	1901
Slovakia	3	+63.1	+57.7	1961
Finland	3	-	+25.9	1961
Spain	4 (driest)	-	-37	1965
June				
Italy	1	-40	-	2010
Lithuania	4	-	-41	1961
July				
Italy	2	+23	-	2010
Russia	4	+18.4	-	1936
Finland	5 (driest)	-	-39.1	1961
August				
Italy	4 (driest)	-17	-	2010
September				
Italy	3 (driest)	-9	-	2010
October				
Armenia	2 (driest)	-42.8	-	1965
Georgia	4 (driest)	-	-57.5	1960
Italy	4 (driest)	-12	-	2010
November				
Italy	1	+162	-	2010
Slovakia	2	+58.2	63.0	1961
Moldova	5 (driest)	-	-33	1891
December				
Italy	1	+20	-	2010

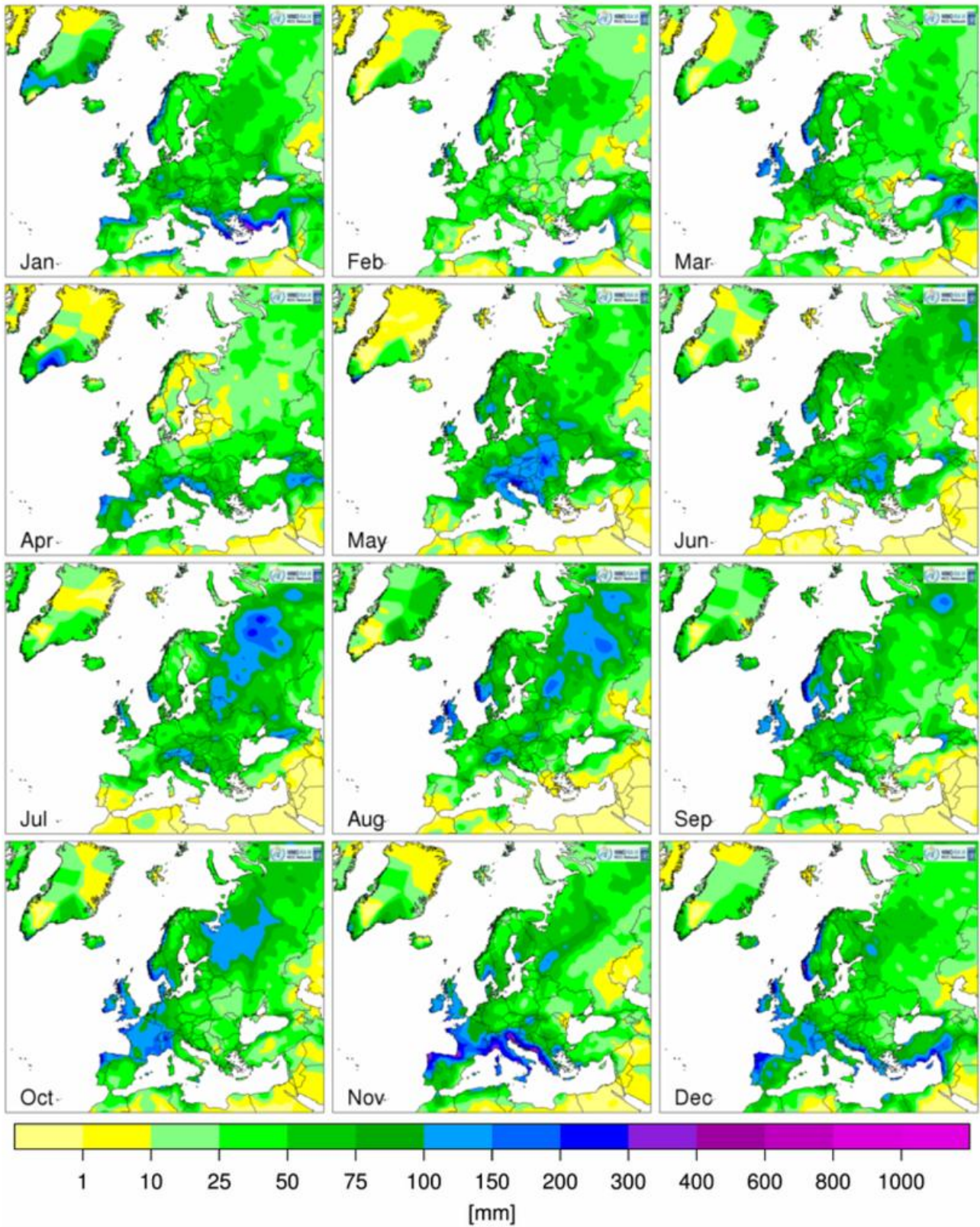


Figure 4-5: Monthly mean precipitation (in mm/month) for the year 2019.

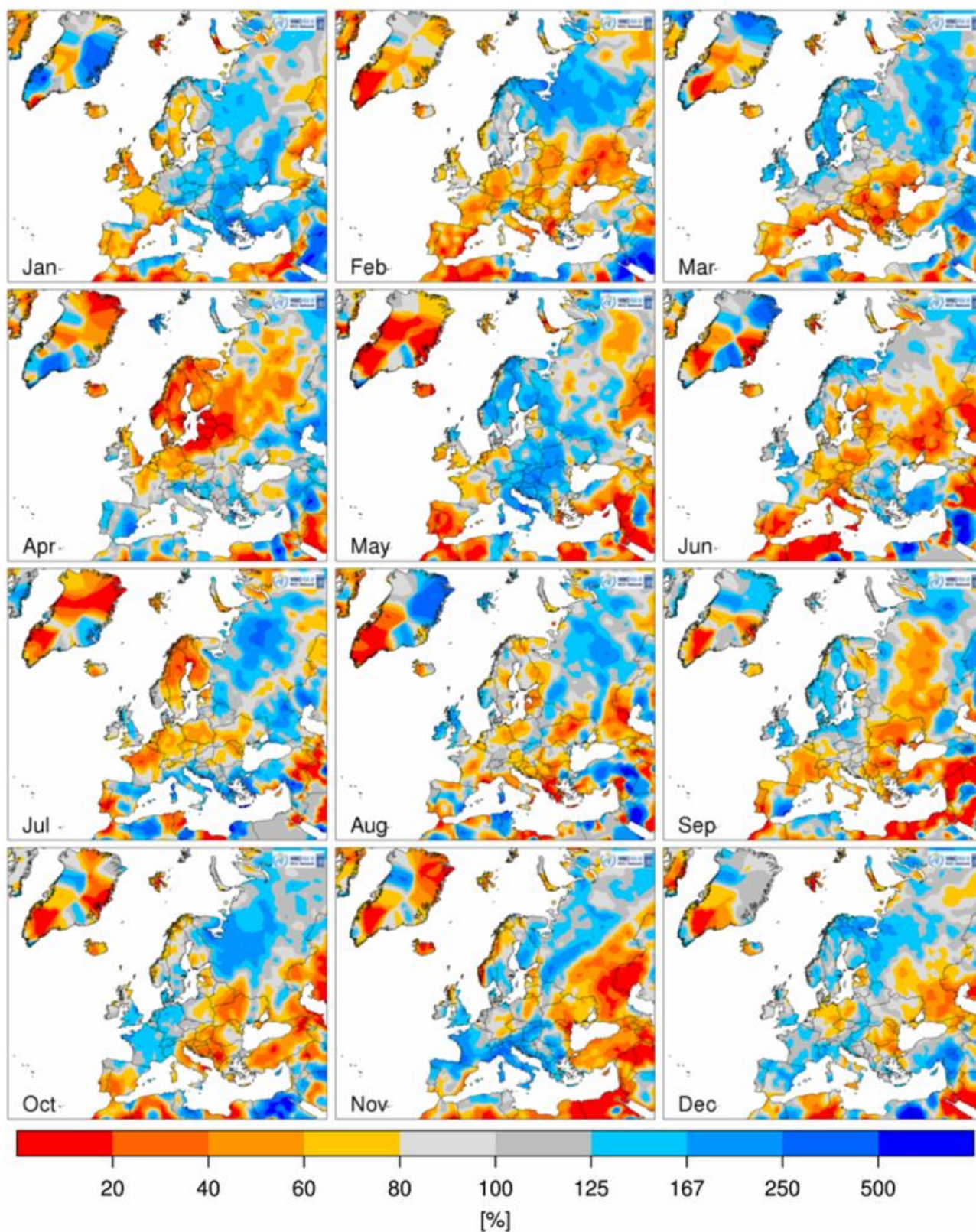


Figure 4-6: Monthly precipitation in % of normal for the year 2019 (reference period 1981-2010).

4.4 Sunshine duration

Table 4-6: Monthly and annual area average sunshine duration anomalies in hours for each sub-region in the year 2019 (reference period: 1981-2010; definitions of the sub-regions see Figure 1-1).

Region	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Central and western Europe	154.2	-7.3	46.9	13.1	33.1	-28.1	61.1	18.3	14.0	8.3	-4.2	-13.8	12.8
Nordic und Baltic Countries	25.2	1.6	2.3	-0.5	36.4	-8.7	7.4	5.2	-1.1	-3.4	-7.8	-4.5	-1.7
Iberia	154.7	29.7	53.0	50.3	-16.3	52.5	13.3	-9.9	-2.4	3.3	16.8	-34.2	-1.2
Med., Italian and Balkan Peninsula	97.9	-15.6	32.5	58.1	-4.0	-55.0	32.8	-4.3	16.5	16.7	42.8	-31.1	8.6
Eastern Europe	149.0	2.0	4.4	23.0	48.0	2.3	46.5	-37.2	9.2	14.7	14.4	17.2	4.5
Middle East	110.6	20.9	1.3	-5.2	4.1	18.7	7.3	-9.5	2.2	-2.2	25.7	35.9	11.4

In **January**, large parts of the RA VI Region were **sunnier** than normal, especially in southwestern Europe and in the Middle East. On the other hand, particularly parts of France, the Alpine region, Southeastern Europe and Turkey were relatively dull. The station Kragujevac in Serbia measured 26.4 hours of sunshine duration, the lowest ever recorded in January there.

Due to prevailing anticyclonic conditions, **February** was mostly sunny, particularly in Southwestern, Western and Central Europe with over 50 hours more than usual in Spain, France, Germany and parts of eastern Central Europe. It was Germany's sunniest February since 1951 and the UK's second sunniest February in a series from 1929, just behind 2008. De Bilt in the Netherlands recorded the third sunniest February on record. Basel and Geneva, both in Switzerland, registered their sunniest February since start of measurements in 1886 and 1897, respectively, with each 169 hours, more than twice the 1981-2010 normal. Northeastern France, too, had twice as much sunshine compared to the long-term average (1991-2010), and several places in France had new records (including Toulouse in the south with 189 hours, highest since 1948). Similarly, Germany's stations Bad Kissingen and Constance were more than twice as sunny compared to normal. Even southeast Sweden received much sunshine; Karlskrona station registered a new February record at 122 hours since start of measurements in 2009.

For **March**, there was a contrast between north and south concerning sunshine duration. Some parts of the north, particularly northern Central Europe, but also the Middle East had more than 20 hours sunshine deficit. Conversely, much of the south was sunnier than normal with partly more than 50 additional sunshine hours that month compared to the normal. Some places noted new local records in monthly sunshine duration for March, e.g. Nice in France since 1991 with 283 hours. However, also parts of the north were at least slightly sunnier than normal, e.g. Sweden, Denmark. The United Kingdom was sunny especially in the last week of the month; the monthly total also was higher than normal. In Switzerland, several stations reached the maximum possible sunshine duration on many days in the last third of the month.

In **April**, much sunshine occurred over large parts of Northern Europe within the high-pressure zone, but also most of the middle latitudes of Europe were sunnier than normal. Several stations in Sweden noted new April sunshine records and also the national April record for Sweden was surpassed (Borlänge in Dalarna 335 hours; there, the sun shone at least 10 hours (of a maximum of 14-15 hours) per day from 10 to 30 April). For Denmark, too, it was the sunniest April on record (since 1920). Southern parts of RA VI mostly had around-normal sunshine, partly also duller, especially in the most rainy areas.

In **May**, sunshine duration and global radiation show a very similar distribution like precipitation. The wet areas were also mainly the duller with deficits down to -100 hours. However, the southern slopes of the Alps often had sunny days due to north foehn. Western and southern Spain had the sunniest places in May 2019 with up to above 400 hours of sunshine, more than 50 hours above normal. Cork Airport in Ireland had its sunniest May since 2007. In contrast, Uccle in Belgium recorded only 182 hours, less than in April 2019. Austria recorded its duller May since 2010, Slovenia since 1961. Serbia notes some new local records of duller May.

Due to the strong high-pressure area and corresponding significant subsidence in **June**, there is also a strong positive anomaly (>100 % of normal) of sunshine duration over much of central and eastern Europe. Over an area reaching from western Iberia over England to Norway a zone with negative anomalies in radiation can be clearly distinguished as a result of the frontal systems passing along the western edge of Europe.

In **July** it was generally more sunny than normal (the average calculated from the climatological period 1986 to 2015) over most parts of the RA VI Region with largest anomalies over France and Scandinavia. Over France, we also find the largest surplus of radiation for July whereas negative anomalies in radiation are visible over the southern and the northeastern part Europe as well as over the United Kingdom.

In **August** it was generally more sunny than normal (with respect to the average calculated from the climatological period 1986 to 2015) with anomalies of 5-25 % over most parts of RA VI. The largest radiation surplus in August is found over Eastern Europe (Balkan Peninsula, Ukraine) whereas southern parts of Sweden, Norway, Turkey received below-normal radiation amounts.

In **September** it was generally more sunny than normal (the average calculated from the climatological period 1986 to 2015) over most parts of the RA VI Region with largest anomalies over Eastern Europe, France and Italy with a surplus of 20 to 50 sunshine hours. Over Eastern Europe, we also find the largest surplus of radiation for September (up to 40 W/m² more than normal) whereas negative anomalies in radiation are visible over southern Iberia as well as over the southern Caucasus (up to 30 W/m² less than normal).

In **October** it was more sunny than normal (with respect to the average calculated from the climatological period 1986 to 2015) over the southern and eastern part of the RA VI Region. The largest surplus in sunshine hours is found over Eastern Europe (Balkan Peninsula), over Italy and over the South Caucasus region, which received 50 to 100 hours extra sunshine. Scandinavia and France, on the other hand, experienced fewer than normal sunshine hours (up to 50 hours less) corresponding to a radiation deficit of up to 20 W/m².

Sunshine duration was in **November** over most parts of the RA VI Region below normal with up to 100 hours less sunshine hours than normal occurring for example over Portugal. Turkey, southern Russia and the Middle East region, on the contrary, experienced above-normal sunshine duration with 50 to 100 hours more sunshine hours than normal corresponding to a surplus of radiation in the range of +20 to +40 W/m².

The month of **December** was over most parts of the RA VI domain more sunny than normal. Anomalies were mostly small though (only up to +20 sunshine hours). Largest anomalies occurred over the southeastern part, which experienced 50 to 100 more hours of sunshine than normal. This corresponds to a surplus in radiation of 10 to 20 W/m².

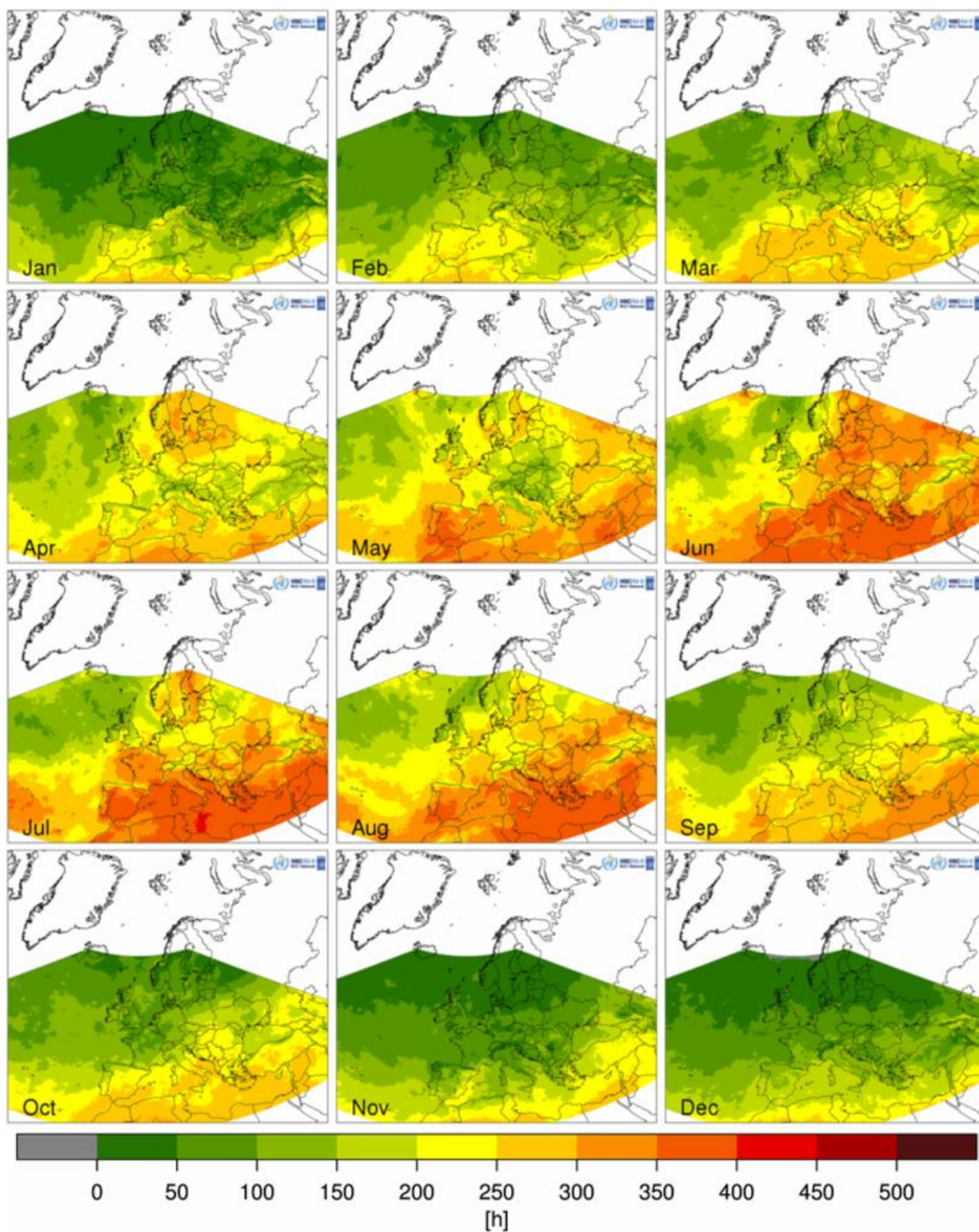


Figure 4-7: Mean sunshine duration (in hours) for each month of the year 2019.

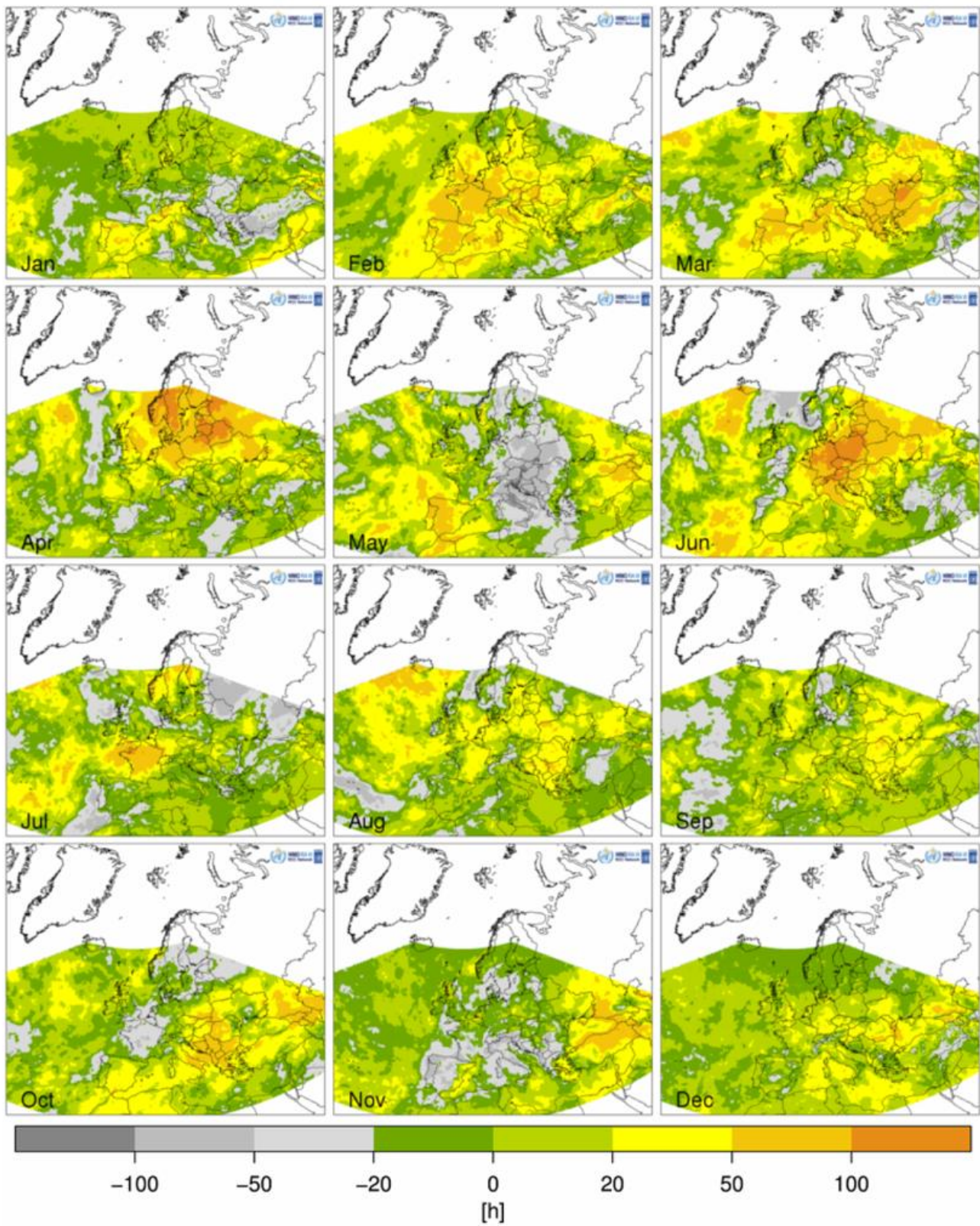


Figure 4-8: Monthly Anomalies of sunshine duration (in hours) for the year 2019 (reference period 1986-2015).

4.5 Maps of monthly significant climate anomalies and events

The following maps are based on different data (as noted in the legends in parentheses), and are meant to summarize weather conditions in each month of the year 2019. The Monthly Event Maps contain information about significant anomalies of temperature, precipitation and wind gusts. Dots represent anomalies of climate indices calculated based on station data, for example the number of very warm days and cold days and the locations of strong wind gusts (≥ 32 m/s). The dot is subdivided into several different colours in case more than one anomaly value needs to be depicted. Coloured areas are based on interpolated gridded data for temperature (land and ocean) and precipitation (only land areas). If more than one extreme anomaly occurs at the same grid, the area is shaded.

January

Monthly mean temperature averaged over Europe was close to the 1981-2010 normal in January, but temperature variability was high during the month. Especially in parts of Northern and Eastern Europe, periods of freezing weather alternated with thaws. In Scandinavia and much of European Russia, mild temperatures characterized the first half of the month, in Iceland even exceptionally high, but the second part of the month was much colder and especially the last few days. Sweden reported 9 days in a row with daily minimum temperatures below -30 °C. On the other hand, Denmark only had 3 ice days ($T_x < 0$ °C) on average (normal is 8.6 days in 1961-1990), the Netherland 2 ice days (normal: 3), Ljubljana in Slovenia 1 ice day, most of Serbia 1-7 ice days.

Eastern parts of RA VI were mostly much wetter than normal in January, particularly around the Black Sea and near the eastern Mediterranean, locally above 250 % of the normal, e.g. in Romania, Moldova, Bulgaria, near the Aegean Sea, in southern Turkey and Cyprus. In Turkey, it was the highest January total in the last 15 years in the Aegean region and the last 37 years at the Mediterranean coast. Especially Greece and Cyprus recorded several heavy rain events with flooding and landslides. Malta, too, was wet, recording the wettest January since 2011, much contributed by 6 thunderstorms (more than 3 are rare in January), partly with hail. In Serbia, the stations Valjevo, Kragujevac and Pozega observed record-breaking numbers of days with precipitation (23-25 days, series since 1925, which means that the above-normal monthly totals came from high frequency of precipitation. In eastern Central Europe (e.g. Czech Republic, Slovakia), most of the precipitation fell in the first half of the month, also in the Middle East (e.g. Israel).

Between 7 and 14 January, the Alps and other mountainous regions in Central Europe experienced extreme snowfall under the influence of north-westerly or northerly flow. Up to 100 mm of precipitation fell in 72 hours in the Ore Mountains (Germany) and northern Alps. On 13 January, Central Europe was within the warm air sector of Low FLORENZ, which made the snow line temporarily rise to 1200 m. Rainfall of up to 109 mm/24h increased the weight of the snow cover dramatically and thus the danger of collapsing buildings or trees. New monthly records of 24h precipitation were registered in Saxony (eastern Germany) on 9 January and new records of snow depth in southern Germany on 11 January. Switzerland recorded up to 160 cm of fresh snow on the northern slopes and wind gusts of up to 180 km/h.

Wintry storms ravaged parts of the north. In Sweden, winds of 111 mph (179 km/h) were recorded as Storm Jan (named "Donald" in Central Europe) ravaged Stekenjokk near the Norwegian border on 11 January. The storm made roads impassable in Sweden and Norway. In Finland, a record 10min average wind speed of 32.5 m/s was measured in the Gulf of Bothnia, and wave heights were close to previous records. The storm was estimated to have caused damage of 10-20 million Euros in forests and due to power outages.

February

At the beginning of February, three storm lows moved over Central Europe and Germany. Low STEFAN launched the storm series on 06/07 February 2019 and brought gusts up to 117 km/h, especially in the UK. THOMAS (named "Erik" in UK and Ireland) followed on 08/09 February, causing storms in Ireland, the UK (with the strongest gust of 138 km/h recorded at Capel Curig in North Wales) and northern Germany. Large waves were observed at exposed coasts and falling trees, causing at least two fatalities when trees fell on cars. Bridges and roads were partially closed. Some flights, ferry and rail services were also affected by the strong winds. In the Republic of Ireland, 2500 people were left without power.

After a cold start of February 2019, the second half of the month became very mild. During a warm spell lasting from 21-27 February, exceptionally mild weather brought record high temperatures with many areas in Central Europe exceeding 20.0 °C. Many local monthly and winter records of maximum temperature were reached or broken even at stations with time series spanning more than 100 years. For Austria, Slovenia, Hungary even countrywide records for February were reported. At Kew Gardens in London, 21.2 °C was reached on the 26th. This was the first time that a temperature above 20 °C had been recorded in winter in the UK. Achnagart (Highland) set a new highest daily minimum temperature record for the UK with temperatures not dropping below 13.9 °C on 23rd. In France, more than half of the 150 measurement stations broke maximum temperature records for February, for example Istres with 23.4 °C on 28 February (previous record 23.3 °C on 27 February 1960) and Cazaux with 26.2 °C on 27 February (previous record 26.0 °C on 23 February 1929). A new record was also set at the station De Bilt in the Netherlands 20.5 °C on the 27th, also breaking the monthly and winter record for all stations. In Belgium, the 26 February was an extremely early first spring day (here defined as daily maximum temperature above 20 °C) in Uccle, making it the first winter with a spring day in history.

March

At the beginning of March, several storm lows swept across Europe in succession. Especially the United Kingdom, Ireland, northern and eastern France, the Benelux countries, Germany and Czech Republic were affected. One of the storms even spread far to the south down to Spain. The storm episode with strong winds, mild temperatures and heavy rain lasted two weeks until 17 March. Storm gusts reached above 200 km/h in exposed places. While the northern half of the RA VI Region was therefore much wetter than normal, much of the southern half was drier than normal and some regions even experienced severe drought conditions.

April

Due to the inflow of moist and warm air from the south, heavy thunderstorms developed along a cold front over Romania. On 30 April a large tornado about 110 km east of Bucharest damaged homes, agricultural fields and vehicles. At least 7 people were injured, most of them after the twister turned over a bus with 39 people inside. Ten houses were left without their roofs. Sahara dust affected Albania in the last few days of April and also Malta during 6 days.

May

In May, much of Europe was wetter than normal, from Scandinavia over Eastern / eastern Central Europe to the Balkans and Italy, locally with more than 250% of the normal (in Norway up to 300-400% of normal), Sweden and Finland even had record-wet places with monthly totals above 100mm. In Italy, the Emilia Romagna region experienced an exceptional wet month. Due to heavy precipitation, severe thunderstorms, hail and snowfalls, total monthly precipitation (average over Emilia Romagna) reached 228 mm, which is 40 % higher than the previous record (164 mm in 1984) and three times the 1961-1990 climatological average of 73 mm. Consequently, flooding and landslides were observed and around one hundred people displaced. In Georgia, heavy rain and hail affected the Kakheti Region, mainly Lagodekhi, Akhmeta, Telavi and Dedoplistskaro municipalities on 4-5 May 2019. The heavy rain of up to 150 mm/24h in Lagodekhi flooded entrances, basements and first floors of many buildings. Furthermore, infrastructure, such as roads and bridges connecting the villages, riverbank protections, as well as agricultural lands, vineyards and fruit trees were destroyed. Supplies of drinking water and electricity were interrupted for a short period. In total 5,088 people were affected by this disaster.

Large parts of the RA VI Region saw more warm days than normal. Especially over the eastern parts and in the southwest monthly temperatures were warmer than normal due to episodes of anomalously hot weather. Across southern and western parts of the Iberian Peninsula, for example, a heat wave occurred mid of May. Alcácer do Sal, Barrosinha (southern Portugal) reached 38.1 °C on 13 May. Daily maxima at many stations in Portugal, western and southern Spain exceeded 30°C. These are extremely high temperatures for this period, being 12-15 °C hotter than average in places. In Israel, a prolonged heat spell occurred from 12 May until the end of the month, most noticeably in the interior parts of the country, during which there were several Sharav events. The most significant one was on 22 to 24 May with temperatures of 43-45 °C in the Coastal Plain, the Negev and the Northern Valleys and 45-47 °C at the Dead Sea and the Arava. Two stations in the area were even warmer – En Gedi (Dead Sea) with 48.0 °C and Hazeva with 47.9 °C. At many stations the maximum temperatures measured during this heat wave are ranked as the 2nd-4th warmest on record since measurements began. In some cases they are the warmest since 1970 or even before. Fires broke out in many areas across Israel on 23 May and continued until the following day. Fortunately there were no casualties, yet dozens of homes were destroyed and thousands of dunams of forests, bush land and open space were burnt. From May 5 to 14, anomalously hot weather was also observed in the eastern regions of European Russia. On average, during this period, the temperature exceeded the climatic norm (1981-2010) by 8-10°C. Many temperature records were broken, both daily highs and absolute for the entire first half of May. The average temperature for the first half of May was 6–7°C above normal (which also corresponds to the highest values in the history of observations).

June

Heatwave conditions affected western, central and northeastern Europe, and particularly in the last week of June with some new national and numerous local records of maximum temperature broken. The heatwave has resulted in at least eight deaths so far. The reason for the heatwave was the shift and spread of the Azores high over Europe and strong warm air advection, which transported the hot air masses of Africa over the Mediterranean to Europe. In the Ukraine the heat wave lasted from 6 June to 10 July and brought record high temperatures making it the hottest June since 1961. The average monthly temperature for June was +4.5 °C to +5.5 °C above normal and the maximum air temperatures exceeded 30 °C in most parts of the country on 30-35 days. For 1-6 days, even 35 °C was exceeded. In Italy, the heat wave lasted from 8 June to 9 July (32 days) and maximum temperatures exceeded 30 °C across wide areas and even 40 °C in some places. At some locations, new records were set for the highest June minimum temperature (e.g. 27.5 °C on 27 June in Milan). In Florence, the maximum temperature exceeded the 90th percentile on 12 consecutive days, the second longest heat wave since 1955. A three-day heat wave in Lithuania starting on 11 June brought an absolute maximum temperature record of 35.7 °C in the city of Kasiadorys. In Germany, June 2019 was the warmest June since the beginning of observations. The hot air masses from the Sahara and the high solar radiation led to many new June temperature records at DWD stations, highest on 30 June with 39.6 °C. For Germany, June was also the start of an exceptional three-month drought/dry spell affected Western, Central and Eastern Germany. Soil moisture in large areas was below long-term minimum values causing economic losses due to crop failure. On several major rivers low water levels hindered river navigation. It was the second major drought period after that in the year 2018, which was even longer than in 2019. The month of June was also very dry in Estonia. Countrywide only 30 % or less of the monthly normal precipitation was received. The monthly total for Kihnu on Kihnu Island, southwest of Estonia, was only 0.3 mm, which is 1 % of the month's normal and a record low in a series starting in 1932.

Unusually strong storms for this time of year battered parts of Spain, France, United Kingdom, Benelux, Germany, Switzerland, Poland, Hungary during almost the whole month of June. Exceptionally intense hailstorms with hailstones larger than 6.5 cm hit southern Germany on 10-11 June. At least six people were injured; cars, trees and houses were damaged in Munich and Bavaria more widely. Accompanying heavy precipitation led to flooding of homes. In Berlin and surrounding areas, thunderstorms brought daily totals of 60 mm to 70 mm on 11 and 12 June. Roads needed to be closed. Similarly, the northern areas of Poland (including Sopot, Gdynia and Gdańsk) reported heavy winds and precipitation causing flooding, uprooted trees and power outages for thousands of households on 10 June. Record large hailstones of 12 cm were reported in Gorzów Wielkopolski-Ustronie and Wojcieszycze (western Poland). Thunderstorms caused wind damage and flash floods in Hungary starting on 16 June. On that day, a daily total of 144.4 mm of precipitation was measured in Rakamaz, nearly twice the normal monthly mean for June (73.5 mm). On 20 June, a new daily record of 117.8 mm of rain fell in 24 hours, beating the previous record high for this date of 101.3 mm set in Szőlősardó in 1956. On 23 June, the daily total of precipitation was 154.9 mm at Terpes, the highest total in this place / in Hungary? recorded in 2019. Southeastern Europe and Turkey, too, were hit by heavy rain and severe flooding the same time.

July

Short but intense heatwave which set many new temperature records across Western, Central and Northern Europe. Hot air moving from the Sahara region caused temperatures to rise. Like other heat waves, it was caused by a so called Omega weather type with high pressure over Europe and low pressure each over the North Atlantic and west Russia (looking like the Greek letter Omega). In the westerly parts of Germany (Rhine-Main via Lower Rhine to Emsland) maximum temperatures exceeding 40 °C on three consecutive days (24 – 26 July 2019) occurred for the first time since the beginning of meteorological recordings. On 25/07/2019, 25 stations reported maximum temperatures of 40 °C or more. The previous record temperature for Germany (40.3 °C) was exceeded at 14 stations. Four stations recorded temperatures above 41 °C. For Germany, summer 2019 was the third warmest summer season since 1881. In Israel, a daily maximum temperature of 49.9 °C was measured in Sedom (southern Dead Sea region) during an extreme Sharav event on 17 July. This was the highest temperature on record in Israel for more than 70 years (the highest temperature ever measured in Israel was 54 °C in Tirat Tzvi on 21 June 1942).

Severe storms affected southern parts of the RA VI Region (Spain, Italy, Romania, Balkans, Greece, and Turkey) during 5-10 July with strong winds and heavy precipitation events causing floods and landslides over large parts. Northern Greece was hit by very strong winds, tornadoes and violent hailstorms on 10 July 2019. Such severe weather is extremely unusual in Greece for this time of year, which is normally mostly calm and dry. Trees were uprooted and roofs collapsed after a storm with wind gusts up to 100 km/h (62 mph) hit the area, claiming lives of 7 people and injuring more than 100. According to the network of automatic meteorological stations of the National Observatory of Athens / Meteo.gr, the highest wind gusts were recorded in the areas: Klidi Viotia 101 km/h (62.7 mph) and Stratoni Chalkidiki 100 km/h (62 mph). Floods and landslides occurred in north-western Turkey in many districts in Düzce Province on 17-18 July 2019 after heavy rainfall: 84.7 mm of rain fell in Akçakoca district on 17 July, 75 mm in Cumayeri district, 72 mm in Çilimli district and 161.7 mm on Kardüz Plateau.

August

August was exceptionally wet due to heavy rain events (partly associated with storms) especially in UK, Ireland, Italy, Turkey and Spain causing floods and landslides in many places. Flash floods hit Rize Province in the Black Sea Region of Turkey on 04 August 2019 after 120mm of rain had fallen in 4 hours, flooding areas around the city of Rize, inundating roads and buildings. A major tornado occurred on 9 August across northeastern France and south-western Luxembourg. It brought wind speeds between 178 km/h and 217 km/h and caused considerable damage. Almost 500 buildings were damaged in communities of Pétange and Käerjeng, Luxembourg and 30 in the province of Meurthe-et-Moselle, France. Trees were knocked down, roads blocked, cars damaged and 19 people in Luxembourg were reported injured. On 5 August, heavy rain accompanied by a sea storm occurred in Adjara-Guria (south-western part of Georgia) causing infrastructure damage.

September

Record heavy rainfall was observed in southeastern Spain in the first half of September. Due to an almost stationary cut-off low, torrential rainfall and strong winds were observed over the period 10-15 September. The most affected areas included Valencia, Alicante, Murcia, Albacete, Almería and Malaga provinces. Some areas of Valencia region, especially the Vega Baja del Segura plain, got

over 400 mm of rain over 48 hours. The highest total was 521 mm, measured in Orihuela (Alicante province). Six stations reported new records of 24-hour precipitation. At Ontinyent, 296.4 mm of rain was recorded in 24 hours, which equates to about half the yearly average. This is the second highest daily rainfall total on record, behind the 316.0 mm which fell on 04 November 1987. On average for the affected area, the equivalent of a year's rain accumulated on just one day (from the morning of the 12th to the morning of the 13th). The storm was exceptional due to the lack of similar precedents in at least the last 100 years in the Vega Baja del Segura, the area most affected by the rainy season. Consequently, rivers broke their banks in several locations, flash floods damaged several roads and cars were swept away. Flights, railway and ship traffic was disturbed and at least six people died, around 3500 were displaced, including 2000 residents of the town of Santomera.

Northwestern and southeastern parts Europe were hit by several cyclonic systems from mid to end of the month. Upland areas in the western UK recorded more than 200 mm of rain from 21 to 30 September. Western Norway was hit by a series of intense storms mid of September, with trees uprooted, downed power lines, floods, landslides and the closing of several roads. In Bergen, 75 mm of rain was recorded in 24 hours. Albania also experienced severe thunderstorms and heavy rain in September which caused flash flooding in some areas.

October

Very intense precipitation over the northwestern part of the European Russia with up to 30 to 50 mm per day and often in the form of snow already. Normal precipitation amounts were exceeded by two or more times in many regions.

On 3 and 4 October, a low-pressure system passed over Ireland and the United Kingdom as the post-tropical cyclone Ex-Lorenzo, bringing disruptive winds and heavy rain. Lorenzo was still a powerful and very large cyclone. Hurricane-force winds extended outward up to 240 km from the center and tropical-storm-force up to 630 km. On the following days, it moved over Central Europe with rapid weakening, bringing some more rain, but less severe. Finally, LORENZO disappeared after becoming a shallow Low west of the Black Sea on 6 October. Some areas of northwest Ireland saw between 50mm and 100mm of rain.

In mid and late October, deep troughs and a cut off Low over Spain and later the Mediterranean caused heavy rain and thunderstorms. Spain, France and Italy were particularly affected by the torrential rainfall and even several tornadoes. Since warm air was advected from the subtropics and the temperatures of the Mediterranean Sea were still very high, about 23°C at this time, the air masses could absorb a lot of humidity. Due to a ridge over Central and Eastern Europe, the Low and its fronts were almost stationary, resulting in extreme rainfall totals over this area, especially near mountains such as the Pyrenees and the Massif Central.

Starting on 13 October, more than 100 forest fires broke out across central-western (south of Beirut) and northern Lebanon. Over 1,200 hectares of land were burned. At least 72 people were injured. In the districts of Chouf and Nakkar, people were displaced after fires extended to populated areas. Twenty landmines exploded because of the fires. On 15 October, Lebanon requested assistance through the EU Civil Protection Mechanism for aerial forest firefighting capacities.

Northern parts of Northern Europe saw a sudden and outstanding cooling at the end of the month with much snow and low temperatures for that time of year. In Sweden, the temperature dropped

below -20 °C for the first time in 2019. At its lowest, it was -21.1 ° in the well-known cold hole Nikkaluokta in northern Lapland.

November

Above-normal temperatures occurred over most of the RA VI Region in November, especially over the southeastern part. In Israel, for example, November was warm - daytime temperatures in November were 2-3 °C warmer than normal. Night-time temperatures were 1-2 °C warmer than normal. November was one of the warmest in terms of maximum temperatures. The highest temperatures occurred mainly during the first half of the month with temperatures 4-5 °C above normal. In the Coastal Plain, the Northern Negev, and the Northern Valleys maximum temperatures were as high as 28-30 °C, and in the Jordan Valley and the Arava – 30-35 °C. Such a sequence of warm days in November is unusual. In the past 70 years there were similar sequences only in 1962 and 2010. Records of the few stations that operated even further in the past reveal that in 1933 there was a similar warm sequence in the Coastal Plain and the Negev, and in Jerusalem, where measurements date back to the mid-19th century, there were such events in 1878 and 1922.

Several major storms passed over the Mediterranean region during almost the whole month of November 2019, bringing heavy precipitation and devastating impact due to landslides, heavy snow and flooding in various countries, especially at steep coasts and near mountain chains. Already at the beginning of the month on 3 November, a storm affected parts of France, Italy and Spain. In France, gusts up to 163 km/h (Cap Ferret, Gironde) brought down trees and power lines. That gust was only slightly lower than the highest ever measured November gust near the French Atlantic coast (169 km/h in November 1996). Several stations in western France had new local November records of wind gusts since start of data in 1981, including Bordeaux with 120 km/h. Coastal waves up to 15m had been observed. In Italy, local rainfall of 57mm in one hour was recorded (Sestri Levante, Liguria) and waves of over 4 metres were reported along the Ligurian coast. Several families were evacuated, also further south in the Campania Region. Northern parts of Spain also were affected by gusts up to above 150 km/h; Santander airport, too, had a new November record at 130 km/h. Heavy precipitation occurred in Galicia and the Pyrenees.

The Medicane Trudy developed from a cut off low and brought heavy rains to Italy and the Balkan coasts mid of November. In Italy, 90mm came on November 12-13, at the Balkan coasts up to 78mm with heavy thunderstorms. Storm gusts up to 130 km/h occurred in the south of Italy and over the Adriatic Sea. This resulted in a high storm surge and high tide peaks, which led to heavy flooding especially on the Adriatic coasts of Italy and Croatia. Due to high water temperatures of around 23°C, Trudy was able to take up enormous amounts of water vapour and finally developed into a Medicane with a very pronounced eye. The pressure dropped to 990 hPa.

November brought exceptionally wintry conditions to Scandinavia. An exceptional snow depth in Tromsø (northern Norway) had been measured on 6 November. Even the downtown area registered a depth around 70cm. The last time when so much snow was seen in Tromsø so early in the autumn was in 1922. It occurred within a period of the season's first major snowfall, and sub-freezing temperatures affected the whole country including the south and caused many accidents due to slippery roads. The snowfall came along with remarkably low temperatures. In Bardufoss, located 70km south of Tromsø, a daily minimum of -29.8°C was registered on 11 November. The lowest reading at Synop stations in Norway that day, however, was in Kautokeino, also located in the north,

with -34.4°C . A daily minimum temperature of -34.6°C was measured in Nikkaluokta in northern Sweden the same day. There were only three days in the last 75 years before with similar or lower temperatures in Sweden in early November: 4 November 1952 (-39°C in Nikkaluokta), 3 November 1968 (-35.0°C in Vittangi), and 8 November 1971 (-34.1°C in Vittangi).

December

Several storms hit Western, Central and Southern Europe bringing strong winds and heavy rain causing flash floods. A first storm (named Olaf in Central Europe) occurred over Iberia in early December with flooding in France and Spain. In Cannes, southern France, 109mm of rain fell in 3 hours and 187mm in 24 hours which was the second highest daily total on record behind 3 October 2015. In Spain, the station San Javier recorded more than 120mm of rain in 24 hours on 2-3 December. Waves up to 4 metres and more than 300mm rainfall in 48 hours (2-4 December) were observed in Valencia region. In Mallorca, 123mm of rain fell in 12 hours in Santa Maria del Cami (northwest Mallorca) and gusts of 90 km/h were recorded in Puig de Alfabia (Mallorca highlands, 1067m elevation). Storm Atiyah brought gusts of hurricane force, rough sea and heavy rain across Ireland and the UK on 8 and 9 December and also touched northern France with gusts reaching up to 130 km/h in Brittany (Pointe du Raz, Finistère). End of December a winter storm hit Portugal and Spain with gusts up to 150-180 km/h and heavy precipitation events.

Northern and Eastern Europe were hit by several winter storms as well with gusty winds and record warm temperatures. Parts of Iceland saw heavy snowfall and hurricane-force gales up to nearly 190 km/h on 10-11 December, resulting in snow depths up to 9m near buildings. The Baltic States, too, were affected by this storm. On 18 December, severe storm gusts up to 98 km/h were recorded at the coast of Latvia (Ventspils). Trees fell down, power outages had been reported. The water level of the southern gulf of Riga increased to a dangerous level, warning was issued for the lowlands. The storm also brought warm air, and a new country record for December maximum temperature was reached in Riga at 10.7°C the same day. Temperature in Moscow rose to 6.2°C on 22 December, a new local record in a series of about 140 years. There was no snow that time; trucks with artificial snow were sent. On normal average, Moscow has a snow cover of 16cm at the beginning of the third decade of December.

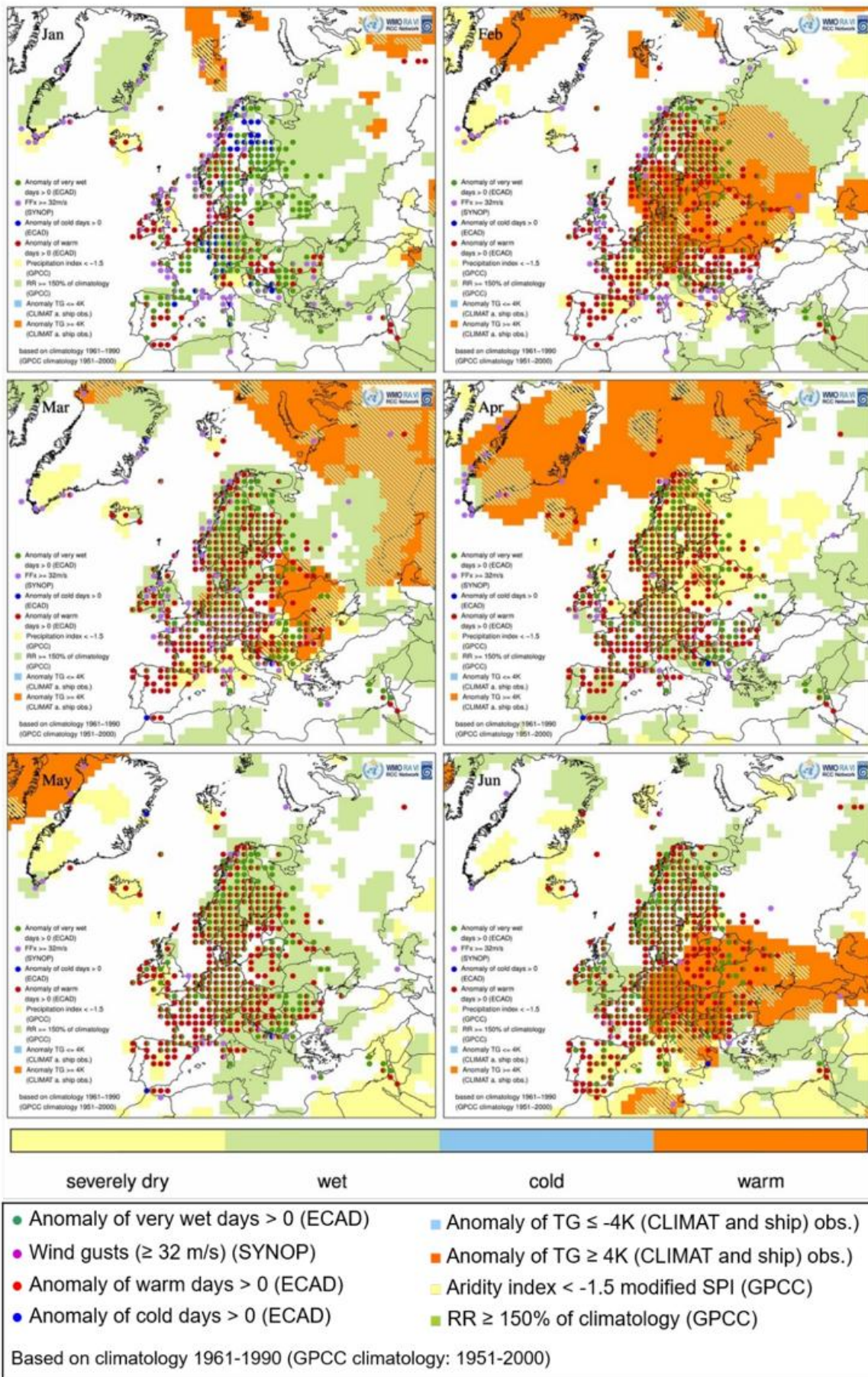


Figure 4-9: Monthly maps of Climate Anomalies for the first half of the year 2019 (January to June).

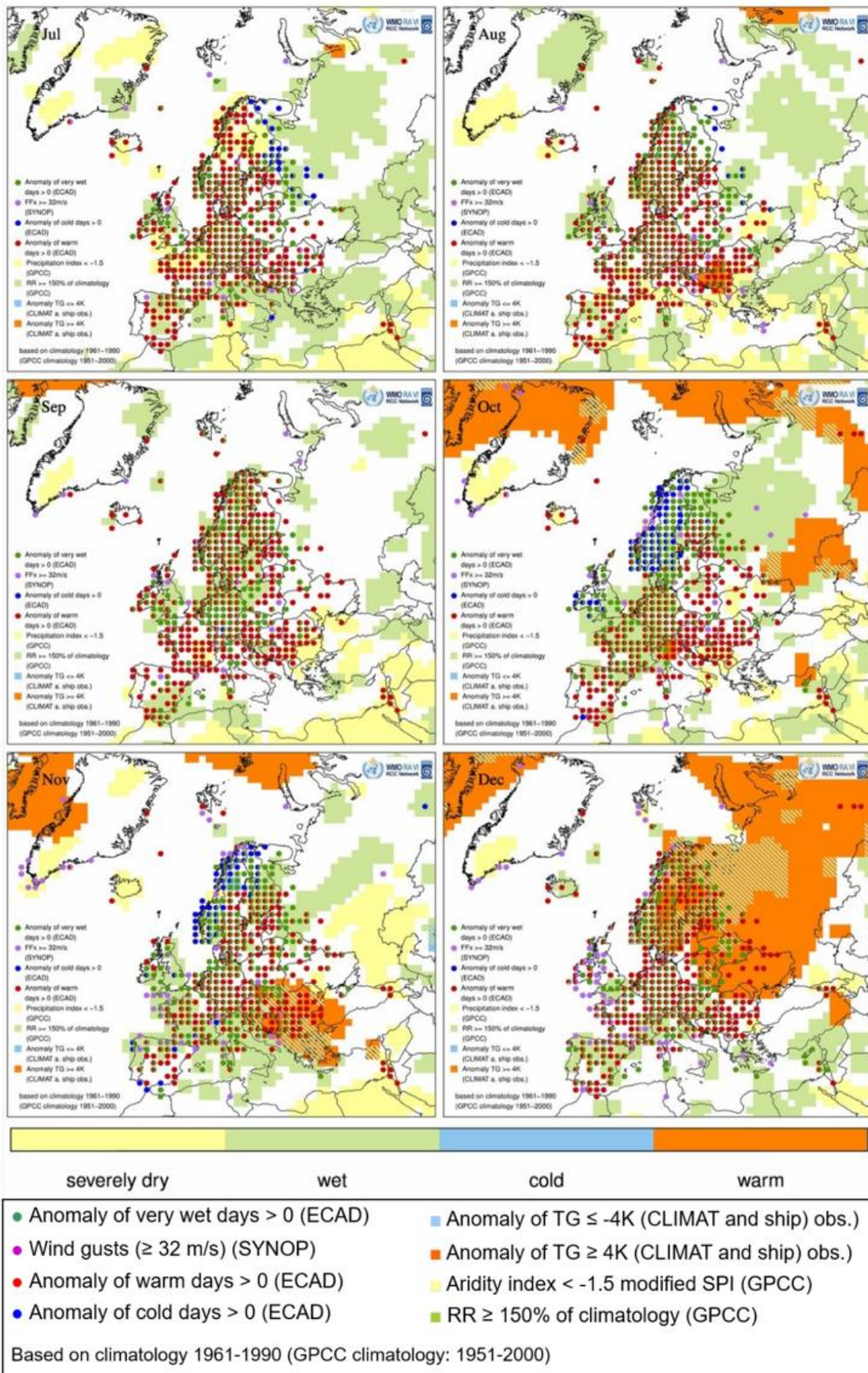


Figure 4-10: Monthly maps of Climate Anomalies for the first half of the year 2019 (July to December).

5. Annex: Monthly and annual tables

Table 5-1: Statistical values of annual mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI Region.

station name	country	Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.
Jan Mayen	NOR	0.8	2.2	622	-65
Svalbard	NOR	-3.4	3.0	171	-12
Tromsøe	NOR	2.8	0.0	1178	205
Oslo	NOR	7.3	1.6	1042	273
Haparanda	SWE	2.3	1.1	685	133
Stockholm	SWE	8.5	1.9	560	21
Visby	SWE	8.7	1.7	652	133
Sodankylä	FIN	0	1.1	527	27
Helsinki Airp.	FIN	6.8	2.3	825	174
Aberdeen	GBR	9.1	1.2	860	77
London	GBR	12.2	1.7	654	55
Dublin/Casement	IRL	9.8	0.6	866	155
Reykjavik	ISL	5.8	1.4	867	69
Danmarkshavn	GRL	-10.8	1.5	198	66
Copenhagen	DNK	10.5	1.9	792	156
De Bilt	NLD	11.2	1.8	934	129
Brussels	BEL	11.5	1.6	816	-2
Luxembourg	LUX	10.7	2.3	781	-94
Zürich	CHE	10.5	2.1	1042	-44
Geneva	CHE	11.8	2.1	841	-113
Bordeaux	FRA	14.5	1.7	999	76
Marseille	FRA	16.2	1.4	647	102
La Coruna	ESP	15.1	1.0	1043	48
Madrid Retiro	ESP	16	1.7	393	-64
Valencia	ESP	18.1	1.2	394	-86
Gibraltar	GIB	18.9	0.7	308	-467
Santa Maria/Azoren	PRT	18.5	0.9	748	-27
Lisbon	PRT	17.4	0.6	512	-241
Berlin-Tempelhof	DEU	11.8	2.4	492	-92
Vienna	AUT	12.4	2.7	685	78
Prague	CZE	10.1	2.2	409	-117
Sliac	SVK	10.1	2.1	741	55
Elbing	POL	8.9	1.3	821	131
Warsaw	POL	10.9	3.1	391	-128
Budapest	HUN	12.9	2.5	687	169
Belgrade	SRB	14.6	2.7	717	33
Ljubljana	SVN	12.5	2.7	1379	-15
Split	HRV	17.6	1.7	888	63
Sarajevo	BIH	11.7	2.1	851	-81
Bukarest	ROU	12.3	1.8	649	54
Sofia	BGR	11.8	2.1	449	-114
Pisa	ITA	15.2	1.2	1063	155
Luqa	MLT	19.7	1.1	545	-9
Athens	GRC	19.6	1.2	588	217
Heraklion	GRC	19.6	0.9	637	136
Murmansk	RUS	0.5	0.6	632	154
Tallinn	EST	7.5	2.4	743	76
Kaunas	LTU	9	2.7	493	-138
Vilnius	LTU	8.8	2.8	537	-147
Minsk	BLR	8.4	2.5	655	-22
Moskow	RUS	7.8	2.9	554	-134
Kiev	UKR	10.6	2.9	521	-128
Kischinau	MDA	12.2	2.6	405	-142
Charkiw	UKR	10.3	2.8	428	-91
Astrachan	RUS	11.9	1.9	168	-53
Jerewan	ARM	13.8	2.3	257	-20
Samsun	TUR	16.1	1.8	677	-14
Istanbul	TUR	16.8	2.7	490	-207
Ankara	TUR	13.7	2.0	417	10
Van	TUR	11	2.3	288	-90
Antalya	TUR	19.9	1.5	1057	-9
Larnaka	CYP	20.9	1.9	636	307
Oral	KAZ	7	1.5	252	-72
Tiflis	GEO	14.7	1.7	384	-114
Tripoli	LBN	20.4	1.1	1110	230
Tel Aviv	ISR	21.4	1.9	441	-126
Eilat	ISR	26.3	1.8	12	-19
Mafraq	JOR	17.9	1.4	171	11
Sta. Cruz de Tenerife	ESP	21.9	0.8	144	-91
Princess Juliana Airp.	SMA	27.6	0.8	918	-89
Le Lamentin	MTQ	26.9	0.6	1692	-340

Table 5.2: Statistical values of monthly mean temperature and total precipitation and their deviations from the long term mean (1961-1990, CLIMAT Data) for several stations of the RA VI Region.

station name	country	January				February				March			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	-3.4	2.3	54	-7	-2.7	3.4	66	13	-4.9	1.2	50	-5
Svalbard	NOR	-10.3	5.1	6	-8	-11.1	4.6	9	-10	-12.6	2.1	5	-16
Tromsø	NOR	-4.4	-0.4	156	75	-3.3	0.4	148	62	-2.9	-0.7	160	96
Oslo	NOR	-2.8	1.5	38	-11	0.5	4.5	79	43	2.3	2.5	73	27
Haparanda	SWE	-13.2	-1.1	29	-15	-8.5	2.8	39	7	-4	2.8	72	37
Stockholm	SWE	-1.7	1.1	31	-8	1.3	4.3	38	11	2.7	2.6	45	19
Visby	SWE	-0.2	0.6	23	-26	2.3	3.9	28	-2	2.9	2.5	59	25
Sodankylä	FIN	-16.8	-1.7	28	-3	-11.7	1.9	37	12	-7.2	1.3	67	42
Helsinki Airp.	FIN	-6.2	0.7	60	19	-0.5	6.3	61	30	-0.3	2.6	65	31
Aberdeen	GBR	3.4	0.7	47	-34	6	3.1	22	-29	6.9	2.4	63	5
London	GBR	4.9	0.7	33	-19	8	3.5	34	-1	9.6	3.1	50	3
Dublin/Casement	IRL	5.2	0.3	33	-36	7.2	2.6	22	-29	7.1	1.1	86	32
Reykjavik	ISL	0.5	1.0	103	27	1	0.6	73	1	1.2	0.7	92	10
Danmarkshavn	GRL	-23.6	-0.5	51	40	-26.4	-2.1	17	6	-26.1	-2.7	18	1
Copenhagen	DNK	2.2	1.7	58	7	4.9	4.4	42	11	6	3.4	109	67
De Bilt	NLD	3.5	1.3	64	-2	6.1	3.6	68	19	8	3.0	104	41
Brussels	BEL	3	0.4	72	5	7	3.5	73	20	8.5	3.0	82	10
Luxembourg	LUX	0.6	0.6	51	-20	5.3	4.2	43	-19	7.1	3.1	83	13
Zürich	CHE	0.1	0.6	62	-5	3.9	3.0	37	-33	7.2	3.0	68	-1
Geneva	CHE	1.8	1.0	43	-37	3.9	1.6	40	-41	8.2	3.1	57	-22
Bordeaux	FRA	6	0.2	73	-27	9.5	2.4	29	-57	11.3	2.5	31	-45
Marseille	FRA	5.9	-0.8	4	-43	8.7	0.8	11	-43	12	1.8	<1	-44
La Coruna	ESP	10.2	0.0	109	-22	12.8	2.3	48	-56	12.8	1.5	47	-39
Madrid Retiro	ESP	6.5	0.4	19	-27	9.3	1.8	1	-43	12.4	2.4	10	-23
Valencia	ESP	10.2	0.0	<1	-36	11.4	0.2	0	-34	13.8	1.0	39	2
Gibraltar	GIB	14	0.6	36	-85	14.4	0.6	6	-94	16.2	1.2	9	-66
Santa Maria/Azoren	PRT	15.5	1.1	91	-9	15.2	1.2	114	28	15.1	0.5	26	-53
Lisbon	PRT	11.4	0.0	53	-57	13.2	0.9	16	-95	15.5	1.8	49	-20
Berlin-Tempelhof	DEU	1.7	1.9	48	5	5.2	4.4	20	-14	7.4	3.2	63	26
Vienna	AUT	0.8	1.8	73	35	5	4.0	16	-26	8.7	3.7	54	13
Prague	CZE	-0.6	1.8	13	-10	2.5	3.3	12	-11	6.5	3.5	27	-1
Sliac	SVK	-3.5	0.4	54	10	1	2.1	34	-10	6	3.0	47	5
Elbing	POL	-2.1	0.3	76	29	1.7	3.9	41	16	4.1	2.0	55	20
Warsaw	POL	-1.7	1.6	34	12	3.2	5.2	31	10	6.1	4.1	28	0
Budapest	HUN	0	1.6	26	-6	4.5	3.4	7	-25	9.4	3.8	7	-22
Belgrade	SRB	0.8	0.4	82	33	5.4	2.7	34	-10	11.3	4.1	12	-38
Ljubljana	SVN	0.7	1.8	66	-16	4.9	3.5	98	18	9	3.6	48	-50
Split	HRV	6.3	-1.1	123	40	9.9	1.8	10	-58	12.9	2.5	30	-45
Sarajevo	BIH	-1.5	-0.6	80	9	2.7	1.2	57	-10	7.8	2.7	52	-18
Bukarest	ROU	-1.4	1.0	61	21	2.7	2.8	8	-28	8.5	3.7	33	-5
Sofia	BGR	-1	0.6	33	6	2.4	1.9	20	-13	8.3	3.7	8	-30
Pisa	ITA	5.2	-0.9	30	-45	8.4	1.3	39	-32	10.7	1.2	5	-71
Luqa	MLT	11.6	-0.6	99	10	12	-0.4	93	32	14.5	1.1	35	-6
Athens	GRC	9.7	-0.5	121	76	10.3	-0.2	67	19	13.9	1.5	14	-30
Heraklion	GRC	11.5	-0.5	163	71	12.1	-0.1	201	124	14.1	0.5	36	-21
Murmansk	RUS	-12.2	-0.5	59	26	-9.5	1.7	53	31	-5.1	1.7	49	29
Tallinn	EST	-4.1	1.4	83	38	0.3	6.0	50	21	1	3.2	60	31
Kaunas	LTU	-4.4	0.8	59	20	1.4	5.7	32	1	3.5	3.9	41	6
Vilnius	LTU	-4.4	1.7	61	20	0.6	5.4	31	-7	3.1	3.7	49	10
Minsk	BLR	-5.1	1.8	47	7	-0.1	5.7	16	-18	3	4.4	40	-2
Moskow	RUS	-6.6	2.7	67	22	-1.4	6.3	34	-3	0.7	2.9	41	7
Kiev	UKR	-4.5	1.1	45	-2	0.6	4.8	34	-12	5.1	4.4	32	-7
Kischnau	MDA	-2.6	0.7	84	44	2.3	4.0	29	-9	7.4	4.5	1	-34
Charkiw	UKR	-5.2	1.7	58	14	-1.2	4.5	9	-23	3.7	4.0	16	-11
Astrachan	RUS	-2	3.4	3	-10	-1.2	3.7	8	-2	5.1	3.8	11	-3
Jerewan	ARM	1.5	4.7	9	-12	3.1	4.1	42	18	5.8	0.7	40	8
Samsun	TUR	9.2	2.3	64	3	8.4	1.2	38	-12	8.8	0.8	36	-20
Istanbul	TUR	7.5	1.9	71	-28	7.4	1.5	68	1	10.3	2.8	16	-46
Ankara	TUR	2	2.0	48	7	4.8	3.1	38	2	7.2	1.2	40	4
Van	TUR	-0.8	3.6	41	7	-0.6	3.2	25	-8	2.9	2.0	35	-7
Antalya	TUR	10.6	0.7	426	187	11.6	1.3	109	-87	13.8	1.1	97	-6
Larnaka	CYP	12.6	0.8	96	31	13.4	1.2	151	94	14.6	1.1	40	-9
Oral	KAZ	-12.1	0.8	36	11	-9.8	2.7	23	5	-1	4.0	36	16
Tiflis	GEO	4.2	2.5	3	-16	6.1	3.2	12	-14	8.2	1.3	8	-22
Tripoli	LBN	12.6	-0.1	283	89	13.6	0.4	173	46	14.9	0.2	156	40
Tel Aviv	ISR	12.8	0.5	107	-42	14.4	1.5	106	8	15	0.1	74	12
Eilat	ISR	16.5	1.4	0	-5	18.2	1.4	9	4	20.2	0.4	0	-4
Mafrq	JOR	8.5	1.3	26	-8	9.6	0.9	59	28	10.9	-0.6	11	-18
Sta. Cruz de Tenerife	ESP	18.2	0.3	14	-23	19.1	1.1	20	-14	19.1	0.5	5	-19
Princess Juliana Airp.	SMA	25.4	0.2	62	0	25.7	0.5	25	-19	26.1	0.6	13	-31
Le Lamentin	MTQ	24.8	-0.1	71	-50	25.4	0.6	34	-55	25.8	0.6	41	-47

Table 5.2: continued

station name	country	April				May				June			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	0.5	4.4	12	-28	0.3	1.0	21	-19	3.6	1.6	25	-10
Svalbard	NOR	-3.9	7.8	30	18	-2.3	1.4	3	-3	4.8	2.6	1	-9
Tromsø	NOR	2.6	1.9	82	22	5.2	0.3	44	-4	8.5	-0.8	94	41
Oslo	NOR	8.7	4.1	11	-31	10.4	-0.4	85	33	15.4	0.2	123	58
Haparanda	SWE	2.3	2.8	1	-28	6.9	0.8	81	50	13	0.2	82	41
Stockholm	SWE	7.4	2.8	3	-27	10.9	0.2	49	19	18.4	2.8	22	-23
Visby	SWE	6.4	2.4	<1	-30	10	0.6	60	31	17.6	3.5	36	4
Sodankylä	FIN	1.7	3.8	6	-18	5.4	0.4	53	18	12.5	0.9	71	15
Helsinki Airp.	FIN	6.7	3.8	6	-31	10.6	0.7	66	31	18	3.1	15	-29
Aberdeen	GBR	8.1	1.8	49	-4	9.4	0.4	78	19	12.9	0.8	79	26
London	GBR	10.7	1.8	13	-32	13.5	1.0	36	-15	16.9	1.2	82	31
Dublin/Casement	IRL	8.4	0.9	69	19	10.9	0.8	27	-30	12.9	-0.2	93	40
Reykjavik	ISL	6.5	3.6	81	23	7.7	1.4	34	-10	10.4	1.4	30	-20
Danmarkshavn	GRL	-13.3	4.0	6	-4	-6.2	0.4	0	-4	3.6	2.9	2	-3
Copenhagen	DNK	9.3	2.7	15	-27	11.4	-0.6	53	10	18.6	2.5	54	0
De Bilt	NLD	10.9	2.9	36	-16	11.7	-0.6	41	-20	18.1	2.9	121	53
Brussels	BEL	11	2.2	38	-19	11.9	-1.0	56	-15	18.5	2.8	101	22
Luxembourg	LUX	9.8	2.3	57	-4	11.5	-0.3	61	-20	19.5	4.6	55	-27
Zürich	CHE	9.3	1.5	56	-31	10.6	-1.5	143	40	19.6	4.4	110	-14
Geneva	CHE	10.3	1.5	63	-2	12.4	-0.6	41	-36	19.9	3.4	112	23
Bordeaux	FRA	12.6	1.3	91	19	14.7	0.1	51	-26	19.7	1.9	85	29
Marseille	FRA	14	0.8	57	9	16.8	-0.3	7	-35	23.5	2.6	9	-19
La Coruna	ESP	13	0.9	112	29	15.5	1.4	42	-36	16.6	0.2	62	13
Madrid Retiro	ESP	12.5	0.3	83	29	18.8	2.8	<1	-41	23.7	3.0	2	-24
Valencia	ESP	15.2	0.5	78	37	18.5	0.6	27	-7	22.5	0.8	0	-23
Gibraltar	GIB	16.8	0.6	61	1	20.2	1.7	0	-35	21.4	0.3	0	-11
Santa Maria/Azoren	PRT	15.5	0.3	68	13	18	1.3	43	13	19.2	0.5	43	21
Lisbon	PRT	15.1	0.0	67	3	20.4	3.0	22	-17	19.4	-0.8	12	-9
Berlin-Tempelhof	DEU	11.2	2.6	8	-33	13.2	-0.7	20	-36	22.8	5.4	66	-9
Vienna	AUT	11.9	2.0	27	-24	13.2	-1.4	149	88	23.8	5.9	49	-25
Prague	CZE	9.8	2.1	24	-14	11	-1.7	72	-5	21.3	5.4	37	-36
Sliac	SVK	11.2	2.7	16	-31	12.4	-1.3	112	48	21.5	4.9	91	6
Elbing	POL	8.4	1.6	11	-31	11	-1.9	58	17	19.6	4.2	96	2
Warsaw	POL	10.6	2.8	3	-29	13.6	0.2	79	20	23	6.4	18	-54
Budapest	HUN	13.6	2.5	15	-23	14.3	-1.7	200	145	23.8	4.7	82	19
Belgrade	SRB	14.1	1.7	77	18	15.4	-1.8	142	71	23.9	3.8	139	49
Ljubljana	SVN	11.6	1.7	89	-21	12.9	-1.7	239	118	23.5	5.7	46	-109
Split	HRV	15.6	1.7	96	30	16.3	-2.1	125	69	26.5	4.3	9	-42
Sarajevo	BIH	11.2	1.8	98	24	12.2	-1.9	102	20	21	4.1	97	6
Bukarest	ROU	10.9	-0.4	78	32	16.6	-0.1	154	84	22.7	2.5	73	-4
Sofia	BGR	10.4	0.5	77	27	14.4	0.1	31	-42	20.1	2.4	90	18
Pisa	ITA	12	-0.5	104	25	14.1	-2.2	114	55	22.1	2.3	5	-39
Luqa	MLT	15.9	0.4	15	-8	18.3	-0.8	19	12	26.3	3.3	0	-3
Athens	GRC	16.1	0.1	61	36	20.4	-0.2	3	-11	27	2.0	32	26
Heraklion	GRC	16.7	0.1	35	5	20.7	0.4	1	-14	25.6	1.3	0	-3
Murmansk	RUS	1.9	3.8	11	-10	4.6	0.8	40	8	8.6	-0.8	83	30
Tallinn	EST	6.5	3.1	8	-28	10.2	0.5	58	21	17.7	3.2	34	-19
Kaunas	LTU	9.1	3.3	<1	-42	13.1	0.7	30	-25	20.5	4.7	49	-20
Vilnius	LTU	9	3.3	<1	-46	13.3	0.8	29	-33	21.1	5.3	28	-49
Minsk	BLR	7.7	1.7	4	-38	13.8	0.9	67	5	20.3	4.2	56	-27
Moscow	RUS	8.1	2.3	9	-31	16.3	3.4	57	-1	19.6	3.0	64	-12
Kiev	UKR	10.6	1.9	48	-1	17	1.9	81	28	23.6	5.4	67	-6
Kischnau	MDA	10.5	0.3	33	-9	17	0.9	35	-16	23.5	4.1	83	8
Charkiw	UKR	10.6	1.7	39	3	17.6	2.0	70	23	23.7	4.8	18	-40
Astrachan	RUS	12	0.9	55	37	20.4	2.1	26	2	26.8	3.9	19	-3
Jerewan	ARM	10.8	-0.8	58	21	19.2	2.9	30	-13	25.1	4.5	7	-14
Samsun	TUR	11.8	0.4	66	4	17.1	1.6	67	18	23.7	3.7	80	35
Istanbul	TUR	13.2	1.2	20	-29	20	3.5	48	17	24.9	3.8	20	-1
Ankara	TUR	10.8	-0.4	53	5	18.2	2.6	36	-19	22.4	2.8	43	6
Van	TUR	7.2	-0.1	48	-6	15.4	2.6	18	-32	20.4	2.8	11	-10
Antalya	TUR	16.7	0.6	30	-16	21.5	1.2	9	-19	26	1.0	22	14
Larnaka	CYP	16.9	0.0	39	28	23.2	2.8	<1	-7	26.8	2.8	5	4
Oral	KAZ	9.4	1.7	23	4	18.4	2.3	9	-12	22.2	2.0	40	3
Tiflis	GEO	12.9	0.1	62	11	19.6	2.2	116	38	25	3.8	79	3
Tripoli	LBN	16.9	-0.6	119	63	22	2.1	0	-17	25.7	2.4	4	3
Tel Aviv	ISR	18.3	0.1	10	-13	23.8	2.7	0	-3	26.7	2.7	0	0
Eilat	ISR	24	-0.4	<1	-3	31.2	3.0	0	-1	33.7	2.8	0	0
Mafrq	JOR	14.8	-1.0	12	2	23.4	3.6	0	-3	25.5	2.8	<1	<1
Sta. Cruz de Tenerife	ESP	20	0.8	29	13	21.8	1.3	<1	-4	23.2	1.1	<1	<1
Princess Juliana Airp.	SMA	26.5	0.4	17	-50	27.4	0.4	46	-50	28.5	0.7	37	-26
Le Lamentin	MTQ	26.3	0.4	74	-22	27.3	0.5	95	-28	27.9	0.6	95	-75

Table 5.2: continued

station name	country	July				August				September			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	6.8	2.6	64	17	7.4	2.5	21	-40	4.4	1.6	155	73
Svalbard	NOR	8.4	2.4	9	-4	6.2	1.4	47	22	2.6	2.1	39	16
Tromsø	NOR	12	0.3	10	-62	11.4	0.5	72	-10	7.4	0.6	106	12
Oslo	NOR	17.9	1.5	58	-26	16.8	1.6	161	71	11.4	0.6	138	48
Haparanda	SWE	15.2	-0.3	8	-42	13.8	0.5	100	37	8.7	0.8	88	25
Stockholm	SWE	17.7	0.5	50	-22	18	1.8	84	18	13.1	1.9	42	-13
Visby	SWE	16	-0.3	103	56	17.8	1.8	25	-24	13.2	0.9	103	43
Sodankylä	FIN	13.5	-0.6	28	-37	12.3	1.1	27	-36	7.3	1.4	36	-19
Helsinki Airp.	FIN	17.5	0.9	67	-6	16.8	1.8	104	24	11.2	1.2	99	26
Aberdeen	GBR	16	2.2	70	10	15.2	1.6	64	-11	12.5	0.8	76	8
London	GBR	20.2	2.4	51	5	19.6	2.2	34	-17	16.5	1.5	63	12
Dublin/Casement	IRL	16.3	1.1	47	-2	15.6	0.8	113	49	13	0.4	109	50
Reykjavik	ISL	13.4	2.8	56	4	10.8	0.5	38	-24	9.6	2.2	138	72
Danmarkshavn	GRL	4.8	1.1	0	-14	4.7	2.3	61	47	-0.8	3.4	19	8
Copenhagen	DNK	18.4	1.2	60	-9	19	2.0	59	-4	14.3	0.7	109	47
De Bilt	NLD	18.8	2.0	53	-22	18.4	1.7	70	-1	14.5	0.5	99	32
Brussels	BEL	19.5	2.0	53	-22	19.2	1.9	50	-13	15.2	0.7	67	8
Luxembourg	LUX	20.1	3.2	17	-51	19.5	3.1	51	-21	14.5	1.1	59	-11
Zürich	CHE	20.7	3.1	97	-20	18.9	2.2	122	-11	15	1.2	90	-2
Geneva	CHE	22.6	3.5	44	-23	20.6	2.4	60	-19	17.2	2.3	25	-56
Bordeaux	FRA	23.6	3.4	42	-5	21.9	2.0	33	-21	19.3	1.4	69	-5
Marseille	FRA	26.7	2.9	6	-8	25.7	2.5	10	-19	21.8	1.5	76	29
La Coruna	ESP	19.3	0.9	11	-14	20.3	1.5	27	-2	19	0.9	19	-43
Madrid Retiro	ESP	27.4	3.0	9	-4	26.1	2.2	58	49	21.2	0.7	33	3
Valencia	ESP	27	2.3	14	-2	26.7	1.8	12	-8	23.6	1.0	123	75
Gibraltar	GIB	23.8	0.1	0	-1	24.9	0.7	0	-6	23.4	0.6	29	14
Santa Maria/Azoren	PRT	21.8	1.0	2	-23	23.1	0.9	69	29	22.1	0.7	41	-16
Lisbon	PRT	21.8	-0.6	2	-3	22.7	-0.1	6	0	22.4	0.7	15	-11
Berlin-Tempelhof	DEU	20.2	1.4	47	-5	21.4	3.0	52	-9	15.5	0.9	50	5
Vienna	AUT	22.4	2.7	63	0	22.6	3.7	53	-5	16.7	1.6	63	18
Prague	CZE	19.8	2.3	34	-32	19.5	2.5	86	16	14.1	0.8	38	-2
Sliac	SVK	19.6	1.4	51	-8	20.7	3.4	59	-10	14	0.6	75	19
Elbing	POL	16.2	-0.6	91	-3	18.4	1.7	64	-17	13	0.3	130	60
Warsaw	POL	19.3	1.4	37	-30	21.2	3.9	34	-29	14.7	1.5	60	17
Budapest	HUN	22.5	1.6	95	43	23.7	3.4	24	-27	17.6	1.2	55	15
Belgrade	SRB	24	2.3	43	-23	25.9	4.6	40	-12	20.1	2.4	26	-25
Ljubljana	SVN	22.9	3.0	142	20	22.6	3.5	112	-33	16.8	1.3	145	15
Split	HRV	27	1.6	70	42	28.2	3.0	12	-38	22.9	1.5	76	15
Sarajevo	BIH	20.9	2.0	68	-12	21.9	3.4	70	-1	16.6	1.5	44	-26
Bukarest	ROU	22.1	0.1	79	15	23	1.8	24	-34	18	1.1	8	-34
Sofia	BGR	21.3	1.3	31	-25	22.9	3.5	45	-7	17.9	2.1	19	-20
Pisa	ITA	24.4	1.6	109	86	24.2	1.7	5	-55	20.9	1.4	63	-26
Luqa	MLT	27.5	1.6	<1	<1	28.2	1.9	0	-7	25.6	1.5	31	-9
Athens	GRC	29	1.2	6	0	30.1	2.5	0	-8	25.5	1.2	4	-6
Heraklion	GRC	27.1	1.0	5	4	27.2	1.3	0	-1	24.5	1.0	0	-20
Murmansk	RUS	10.7	-2.1	67	7	10.7	-0.3	44	-21	8.3	1.6	68	16
Tallinn	EST	16.9	0.6	41	-38	16.6	1.3	84	0	12.3	1.5	80	-2
Kaunas	LTU	17.2	0.3	60	-20	18.1	1.7	68	-10	13	1.1	43	-13
Vilnius	LTU	17	0.1	50	-28	18	1.7	100	28	12.6	1.0	47	-18
Minsk	BLR	16.5	-0.8	120	32	17	0.5	91	19	12.2	0.5	49	-11
Moscow	RUS	16.8	-1.3	69	-23	16.4	0.0	57	-17	12.3	1.4	29	-35
Kiev	UKR	19.8	0.5	73	-15	20.7	2.1	45	-24	15.9	2.0	22	-25
Kischnau	MDA	22.1	1.2	33	-36	23.8	3.3	47	2	18.6	2.4	10	-38
Charkiw	UKR	20.8	0.5	63	3	21.2	1.7	8	-42	16.2	2.1	28	-13
Astrachan	RUS	25.6	0.3	17	-6	23.9	0.6	1	-18	16.6	-0.7	16	-10
Jerewan	ARM	26.5	1.9	1	-9	25.5	1.6	1	-6	20.8	1.0	17	7
Samsun	TUR	23.8	1.1	41	12	24.2	1.5	18	-15	21.3	1.7	27	-23
Istanbul	TUR	24.9	1.7	16	-3	25.3	2.3	92	66	21.9	2.2	20	-21
Ankara	TUR	23.1	0.2	34	20	24.2	1.6	29	17	20.3	2.0	<1	-19
Van	TUR	23	1.1	<1	-4	23.6	2.4	3	-1	18.7	1.9	<1	-10
Antalya	TUR	28.7	0.6	<1	-3	30	2.3	<1	<1	26.7	2.2	4	-7
Larnaka	CYP	28.5	1.9	<1	<1	28.9	2.3	<1	<1	27	2.4	10	10
Oral	KAZ	22.1	-0.4	14	-24	19.8	-0.6	16	-9	12.3	-1.8	20	-7
Tiflis	GEO	25.2	0.8	21	-24	25.4	1.7	23	-25	19.2	-0.4	34	-2
Tripoli	LBN	27.3	2.3	0	0	28.1	2.5	0	-1	26.5	1.7	0	-4
Tel Aviv	ISR	28.1	2.4	0	0	28.6	2.5	0	0	27.1	2.3	0	0
Eilat	ISR	34.7	2.3	0	0	34.2	1.9	0	0	32.1	1.7	0	0
Mafrq	JOR	25.6	1.5	0	0	25.6	1.4	0	0	24.1	1.4	0	-1
Sta. Cruz de Tenerife	ESP	24.8	0.3	<1	<1	26	0.9	0	-1	24.8	0.4	1	-8
Princess Juliana Airp.	SMA	29	1.0	172	96	29.2	1.0	146	47	29.4	1.2	77	-54
Le Lamentin	MTQ	28	0.8	195	-9	28	0.8	214	-38	28	1.0	191	-45

Table 5.2: continued

station name	country	October				November				December			
		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)		Temp. (°C)		Precip. (mm)	
		mean	dev.	total	dev.	mean	dev.	total	dev.	mean	dev.	total	dev.
Jan Mayen	NOR	1.4	1.3	16	-66	-2.2	1.1	27	-39	-1.7	3.5	111	46
Svalbard	NOR	-4.6	0.9	7	-8	-7.2	3.3	12	-1	-10.8	2.5	3	-9
Tromsø	NOR	0.6	-2.3	59	-66	-2.4	-1.6	119	15	-0.7	2.3	128	24
Oslo	NOR	5.4	-1.0	107	23	1	0.3	112	37	0.4	3.2	57	1
Haparanda	SWE	0.7	-1.8	56	-8	-4.8	-0.7	54	-4	-2.7	6.8	75	33
Stockholm	SWE	7.2	-0.3	64	14	4	1.4	48	-5	3	4	84	38
Visby	SWE	8.8	0.4	82	32	5.3	1.2	71	14	4	3	61	9
Sodankylä	FIN	-2.5	-2.2	67	16	-8.5	-1.1	38	-1	-5.6	7.5	69	38
Helsinki Airp.	FIN	5.2	-0.2	98	25	1.7	1.6	86	14	1.4	5.5	98	40
Aberdeen	GBR	8.5	-1.4	85	8	5.5	0.5	173	98	4.9	1.4	54	-19
London	GBR	12.2	0.5	93	35	7.5	0.3	75	20	7.2	2.1	90	33
Dublin/Casement	IRL	9.1	-1.0	74	7	6	-0.7	144	77	6.1	0.5	49	-24
Reykjavik	ISL	5.4	1.0	77	-9	2.4	1.3	73	1	0.6	0.8	72	-7
Danmarkshavn	GRL	-8.6	5.0	0	-12	-18.6	1.3	3	-7	-19.4	2.4	21	8
Copenhagen	DNK	10.2	0.3	115	56	6.9	1.4	69	7	5.1	2.9	49	-9
De Bilt	NLD	11.6	1.1	105	33	6.4	0.5	101	20	5.8	2.6	72	-8
Brussels	BEL	12.1	1.2	86	16	6.6	0.5	64	-12	5.9	2.4	74	-2
Luxembourg	LUX	10.9	1.8	129	54	4.9	1.1	88	5	4.3	3.3	87	7
Zürich	CHE	11.6	2.3	132	63	5.5	1.6	63	-19	3.8	3.2	62	-11
Geneva	CHE	13.2	3.1	102	25	6.3	1.3	114	22	4.9	3.1	140	53
Bordeaux	FRA	16	2.0	99	11	9.5	0.4	265	171	9.5	3.1	131	32
Marseille	FRA	18.1	2.0	153	75	11.1	0.4	209	151	10.4	3.1	104	48
La Coruna	ESP	16.8	1.1	142	38	12.9	0.3	232	116	12.1	1.2	192	64
Madrid Retiro	ESP	16.2	1.4	43	-2	9.6	0.2	44	-20	8.8	2.4	90	39
Valencia	ESP	20.1	1.9	22	-65	15.1	1.6	3	-59	13.1	2.6	75	34
Gibraltar	GIB	20.5	1.0	11	-53	16.3	0.2	61	-80	15.3	1.2	95	-51
Santa Maria/Azoren	PRT	20.7	1.4	157	73	18.4	1	19	-83	16.9	1.5	75	-20
Lisbon	PRT	18.6	0.1	44	-36	15	0.5	123	9	13.5	1.7	103	-5
Berlin-Tempelhof	DEU	11.8	1.8	58	22	6.6	1.7	32	-17	4.6	3.2	28	-25
Vienna	AUT	12	2.1	26	-15	7.9	3.3	47	-3	3.6	2.7	65	22
Prague	CZE	9.8	1.5	27	-3	5.3	2.5	30	-2	2.3	2.9	9	-17
Sliac	SVK	9.8	1.5	29	-21	7.4	4.4	125	56	0.7	2.4	48	-9
Elbing	POL	9.6	0.7	76	23	4.7	1.4	51	-5	2.3	2	72	20
Warsaw	POL	11.2	2.9	16	-22	6.3	3.1	13	-29	3.3	4.2	38	6
Budapest	HUN	13.1	2.2	16	-18	8.9	4.1	82	30	3.5	3.1	78	38
Belgrade	SRB	16	3.6	13	-27	12.5	5.5	54	0	5.9	3.6	55	-3
Ljubljana	SVN	13.2	2.8	76	-39	8.7	4.1	188	53	3.6	3.6	130	29
Split	HRV	18.8	1.9	18	-61	15.6	3.4	220	112	10.9	2.2	99	-1
Sarajevo	BIH	13.1	2.8	38	-39	10.7	5.4	80	-14	3.5	3.2	65	-20
Bukarest	ROU	12	1.2	43	11	9.4	4.2	76	27	3.4	3.2	12	-31
Sofia	BGR	13.3	2.9	31	-6	9.7	4.7	44	-3	2.1	1.6	20	-19
Pisa	ITA	17.3	2.0	150	27	13.2	2.8	326	202	10.1	3.3	113	28
Luqa	MLT	22.3	1.6	94	4	18.3	1.3	107	27	15.8	2	51	-61
Athens	GRC	21.9	2.6	22	-26	18.4	3	126	75	12.6	0.6	132	66
Heraklion	GRC	22.1	2.2	14	-55	19.7	3.1	58	-1	14.2	0.4	124	47
Murmansk	RUS	-0.9	-1.9	59	17	-6.4	-1.3	29	-11	-4.5	4.8	70	32
Tallinn	EST	7.1	0.8	142	72	3	1.8	31	-37	2.5	5.4	72	17
Kaunas	LTU	9.2	2.1	47	2	5	3.2	21	-32	2.4	4.9	42	-5
Vilnius	LTU	9	2.4	53	0	4.5	3.3	43	-14	2	4.9	45	-10
Minsk	BLR	9.2	2.9	31	-18	4	3.2	68	16	1.7	5.5	66	13
Moscow	RUS	8.8	3.8	60	2	1.8	2.9	34	-24	0.8	6.9	33	-19
Kiev	UKR	11.1	3.0	13	-22	4.6	2.5	28	-23	2.7	5	33	-19
Kischinau	MDA	12.3	2.2	20	-7	7.9	3.5	6	-33	3.5	3.8	24	-14
Charkiw	UKR	10.7	3.4	72	37	3.4	2.1	19	-25	1.6	5	28	-17
Astrachan	RUS	12.7	3.6	6	-11	2.1	-1.2	<1	-19	0.9	2.8	5	-10
Jerewan	ARM	17	4.2	4	-23	6.4	-0.2	18	-4	3.9	3.4	30	7
Samsun	TUR	18.3	2.7	99	14	15.1	2.6	63	-26	11.2	2	78	-4
Istanbul	TUR	18.7	3.4	30	-41	16.7	5.1	22	-67	10.5	2.4	67	-55
Ankara	TUR	16.4	3.8	8	-19	10.3	3.2	21	-12	4.1	1.6	66	17
Van	TUR	13.4	3.3	26	-22	5.2	1.2	26	-18	3	4.1	54	20
Antalya	TUR	23.2	3.6	15	-55	17.3	2.5	91	-43	12.2	0.8	253	26
Larnaka	CYP	24.1	2.8	47	28	20.3	3.4	7	-37	14.9	1.5	239	163
Oral	KAZ	9.7	4.6	12	-18	-2.5	-0.4	4	-31	-4.9	3.5	19	-10
Tiflis	GEO	17.2	3.7	5	-33	7.6	-0.5	20	-10	6.3	2.5	1	-20
Tripoli	LBN	23.8	1.6	67	-4	19	0.7	40	-73	13.9	-0.2	268	88
Tel Aviv	ISR	24.8	2.8	12	-14	21.1	3.1	4	-64	15.5	1.7	128	-10
Eilat	ISR	29	2.4	2	-1	24	2.9	0	-4	18.1	1.9	<1	-6
Mafraq	JOR	21.7	2.6	4	-3	15.8	2.3	13	-4	9.8	1	45	17
Sta. Cruz de Tenerife	ESP	23.7	0.8	34	16	21.8	1	7	-31	19.9	1.1	32	-20
Princess Juliana Airp.	SMA	28.9	1.1	154	45	28	1.1	35	-95	27.4	1.6	134	48
Le Lamentin	MTQ	27.3	0.6	326	56	26.8	0.5	208	-16	26.7	1.3	148	-11

6. References to national reports

Note: Primary information sources are the annual reports of RA VI Members, which are kindly provided by RA VI NMHSs. The names of Members, which contributed to the 2019 edition of the Bulletin, are listed on page 3 above. Many contributions or additional information may as well be found on the web, see below.

Country	Reference
Austria	Zentralanstalt für Meteorologie und Geodynamik (ZAMG) Annual Climate Reports
Belgium	The Royal Meteorological Institute of Belgium (KMI) Klimatologisch overzicht
Bosnia and Herzegovina	Federal Meteorological Institute (METEOBIH) Analiza-godina
Croatia	Meteorological and Hydrological Service (DMHZ) Annual reports
Denmark	Danish Meteorological Institute (DMI) Vejret i Danmark Storms in Denmark since 1891
Estonia	Estonian Weather Service Estonian Bulletin
Finland	Finnish Meteorological Institute (FMI) Press release archive
France	Météo-France, Toulouse Bilan climatiques
Germany	Deutscher Wetterdienst (DWD) Annual, Seasonal and Monthly Summary
Greece	Hellenic National Meteorological Service http://www.hnms.gr/emv/en/climatology/climatology National Observatory of Athens Meteorological bulletin
Hungary	Hungarian Meteorological Service (OMSZ) Climate retrospective
Iceland	Icelandic Met Office The weather in Iceland 2021-Climate summary
Ireland	The Irish Meteorological Service (MET Éireann) Weather Summary
Israel	Israel Meteorological Service (IMS) Weather summary in Israel
Italy	Institute for Environmental Protection and Research (ISPRA) System for Climate Data Collection and Dissemination (SCIA) http://www.scia.isprambiente.it/wwwrootscia/Home_new.html http://www.scia.isprambiente.it/ [...] RAPPORTOCLIMA2018.pdf
Latvia	Latvian Environment, Geology and Meteorology Centre Monthly bulletins
Lithuania	Lithuanian Hydrometeorological Service (Lhmt) http://www.meteo.lt/menesio-apzvalgu-archyvas
Luxembourg	MeteoLux, Bilans climatologiques annuels http://meteolux.lu/ [...] /bilans-climatologiques-annuels/
Moldova	State Hydrometeorological Service (SHS) Caracterizarea conditiilor meteorologice si agrometeorologice din anul

Country	Reference
Montenegro	Institute of Hydrometeorology and Seismology (IHMS) Annual reports
Netherlands	Royal Netherlands Meteorological Institute (KNMI) Jaaroverzicht van het weer in Nederland Zware stormen in Nederland sinds 1910
Norway	Det Norske Meteorologiske institutt (DNMI) Klimatologisk månedsoversikt
Portugal	Instituto portuguesa do mar e da atmosfera (ipma) Bolletim Climatológico Anual
Romania	Administrația Națională de Meteorologie Monitorizare climatica
Russian Federation	Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) Annual report on climate features on the territory of the Russian Federation
Serbia	Republic Hydrometeorological Service of Serbia (RHMZ) Annual Bulletin for Serbia
Slovakia	Slovak Hydrometeorological institute (SHMU) Bulletin Meteorológia a Klimatológia
Slovenia	Slovenian Environment Agency (ARSO) Mesečni bilten ARSO Unusual events http://meteo.arso.gov.si/met/sl/climate/natural-hazards/
Spain	Agencia Estatal de Meteorología (AEMET) Resumen anual climatológico Olas de calor en España desde 1975 Olas de frío en España desde 1975
Sweden	Swedish Meteorological and Hydrological Institute (SMHI) Året (year) Stormar i Sverige
Switzerland	Federal Office of Meteorology and Climatology MeteoSwiss Klimabulletin
Turkey	Turkish State Meteorological Service (TSMS) Bulletin
United Kingdom	Met Office Climate summaries and State of the UK Climate 2017 in RMetS https://www.metoffice.gov.uk/research/[...]/summaries/index

7. References

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8. Abbreviations

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