MEDITERRANEAN CLIMATE OUTLOOK FORUM
MEDCOF-13 Online Forum

ANALYSIS AND VERIFICATION
OF THE MEDCOF-12 CLIMATE OUTLOOK
FOR THE 2019 SUMMER SEASON
FOR THE MEDITERRANEAN REGION (MED)

Final version

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The following MedCOF verification report is based on

- the outcome of the consensus forecast of MedCOF 12,
- climate monitoring results of RA I NA RCC and RA VI RCC networks,
- the analysis and verification report of SEECOF-22 for 2019 summer season for southeast Europe (SEE)
- national verification reports received from NMHSs or posted in RCOF forums of MedCOF, SEECOF or PRESANORD.

1 MedCOF-12 Climate outlook for the 2019 summer season

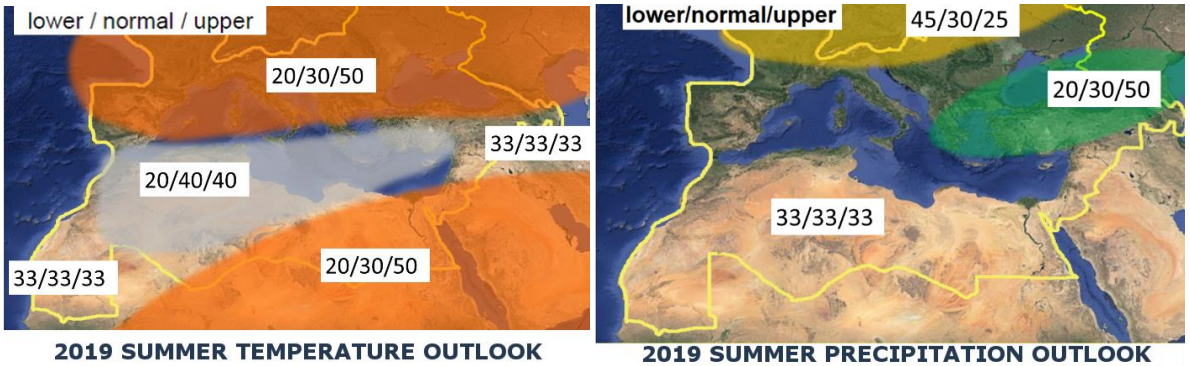


Figure 1: Graphical presentation of the climate outlook for the 2019 summer season for the Mediterranean region (a) Temperature Outlook, (b) Precipitation Outlook

General circulation and sea surface temperature

As stated in the MedCOF12 consensus statement, the sea surface temperatures in the Niño3.4 and Niño 3 regions, both of which are often used to characterize El Niño/Southern Oscillation (ENSO) conditions, were predicted to be approximately 0.7 to 0.9 °C above average during the June-August 2019 season, and hence, were expected to remain at weak El Niño levels. This tendency towards weak El Niño conditions was consistently predicted by a majority of dynamical models. However, the spread between models was rather high, with a considerable number of simulations overpassing the +1°C anomaly.
No extra-tropical connections were visible, and consequently the signal seemed to be trapped in low latitudes. Differences between models were noticeable for the North Atlantic and Europe circulation; however, a blocking pattern and relatively low geopotential over Central Atlantic were foreseen by most of them.

Temperature

Within this general context, temperature should have been warmer than normal for most of the European continent (figure 1a). Over North Africa, a west-east temperature gradient was expected by the majority of models, with consensus for upper tercile over its northeastern part. Southeastern Levantine Sea and Arabian Peninsula showed a consistent warm signal too. A less clear signal appeared over north-western Africa and the rest of the Mediterranean Sea, with similar probabilities for upper and medium tercile, and lower chances for the colder one.

Precipitation

Precipitation showed drier than normal conditions over North-Central Europe affecting the Northern Balkans and wetter than normal over the eastern part of the domain. For the rest of the region no large-scale precipitation signal was present in the forecasts (see figure 1b). The climatological forecast (33, 33, 33) over the southern part of the domain also implied the fact that no meaningful forecast could be provided for these seasonally dry areas.

2 Analysis of the 2019 summer season

Analysis of the summer season temperature and precipitation anomalies and general circulation are based on maps and monthly or seasonal bulletins on the climate in the WMO region I – NA and VI for the summer 2019 (WMO RA I RCC Node on Climate Monitoring: http://www.meteo.tn/htmlen/donnees/climatemonitoring.php; WMO RA VI RCC Offenbach Node on Climate Monitoring: http://www.dwd.de/rcc-cm), contributions from Météo France (http://seasonal.meteo.fr/), Regional Climate Outlook Forums for Southeastern Europe (SEECOF-22, http://www.seevccc.rs) and North Africa (PRESANORD, http://acmad.net/rcc/presanord.php), and national verification reports from MedCOF participants.

2.1. General circulation

2.1.1. Ocean

While the western tropical Pacific still was warmer than normal (1981-2010 reference) in summer 2019 at the ocean surface, sea surface temperatures (SST) in the eastern tropical Pacific mostly were closer to normal on summer average, close to the South American coast even below normal (Fig. 2).

The Niño 1+2 region (close to South America) started with negative SST anomalies in June 2019, which further intensified until August (Tab. 1). Anomalies in Niño 3 region, which is located further in the open ocean, decreased to around zero in July/August 2019. In contrast, Niño 4 region, which is located even further to the west, had persisting positive anomalies from June to August 2019 at around +0.8 to +0.9 K. Hence, the combined Niño 3.4 region still had positive, but rapidly decreasing anomalies, from +0.6 K in June 2019 to +0.2 K in August 2019. In summary, SST was overestimated by predictions taken in MedCOF-12. Instead of ongoing weak El Niño conditions, the situation changed very quickly to neutral conditions in JJA 2019. However, this confirmed the hypothesis, that no extratropical connections due to ENSO were to be expected.

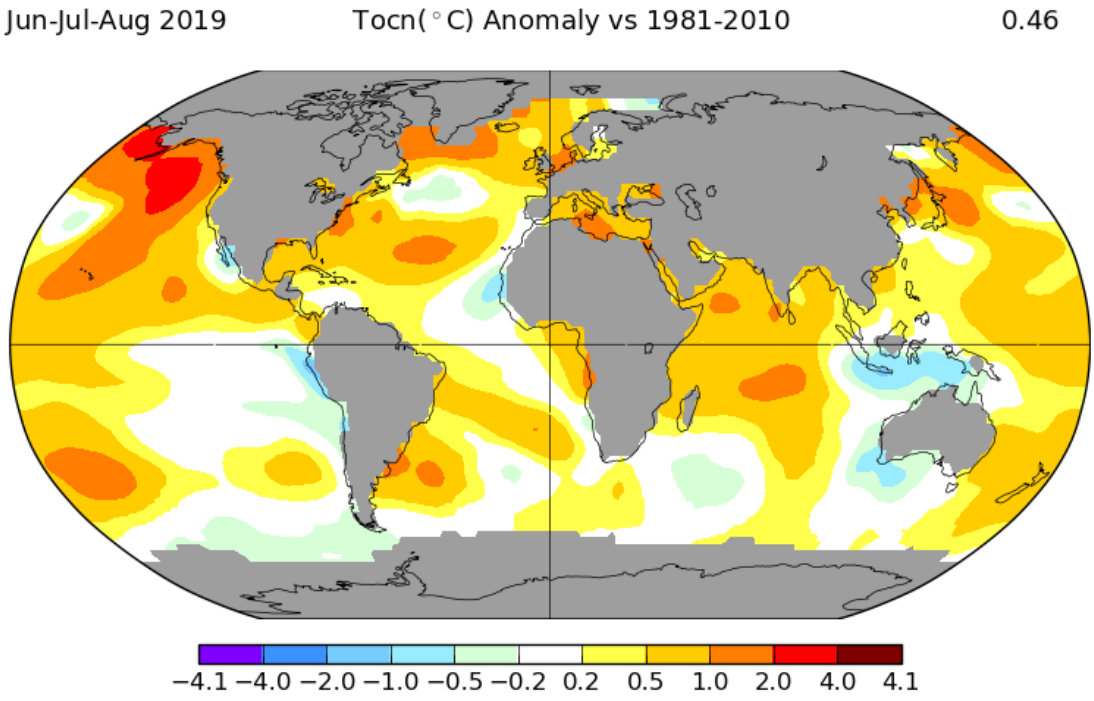


Figure 2: Sea surface temperature anomalies for boreal summer 2019 (June-August), 1981-2010 reference. Data from ERSSTv5 Ocean model analysis with 250km smoothing, source: NASA GISS, https://data.giss.nasa.gov/gistemp/maps/

MONTH	NIÑO 1+2		NIÑO 3		NIÑO 4		NIÑO 3.4	
	TEMP	ANOM	TEMP	ANOM	TEMP	ANOM	TEMP	ANOM
June 2019	22.62°C	-0.26°C	26.81°C	0.38°C	29.62°C	0.78°C	28.24°C	0.59°C
July 2019	21.34°C	-0.28°C	25.68°C	0.06°C	29.73°C	0.92°C	27.63°C	0.41°C
August 2019	20.20°C	-0.44°C	24.89°C	-0.10°C	29.50°C	0.82°C	26.97°C	0.15°C

Table 1: Sea surface temperature and anomalies for various Niño regions in boreal summer months 2019 (June-August), 1971-2000 reference. Data from ERSST.v5 ocean model analysis, source: NOAA, https://www.ncdc.noaa.gov/teleconnections/enso/indicators/sst.php with definitions of Niño regions.

2.1.2. Atmosphere

Seasonal averages of 500 hPa geopotential in summer 2019 show a characteristic trough-ridge pattern over the eastern North Atlantic and Europe, especially for southern parts over the Mediterranean region (Fig. 3). It consists of a trough over the eastern North Atlantic, then a blocking ridge over much of Europe and the western and central Mediterranean, and again a trough over the eastern Mediterranean. This is also reflected by the summer 2019 anomalies of 500 hPa geopotential. It is in line with model predictions taken by MedCOF-12 (see above in chapter 1). The pattern can be seen more or less in all three summer months (Fig. 4), most intense in June.

Geopotential anomalies show a dipole over the eastern North Atlantic with higher-than-normal geopotential over Greenland and lower-than-normal geopotential over the central North Atlantic, implying a NAO- pattern. This pattern also persisted during all summer months (see table 2). In June and in August, but not in July, the low anomaly was located close to Western Europe, which was part of an EA+ pattern. Differences within summer months can also be seen for western Russia extending to the Balkan region: June and August had high-pressure anomalies, July low pressure, which resulted in weak positive anomalies for the seasonal mean in the Balkans and Eastern Europe. Consequently, the EA/WR pattern changed from the positive phase in July to a negative phase in August.

Sea level pressure distribution over the North Atlantic shows a very intense Greenland High and a very weak Icelandic Low, while the Azores High was less intense than normal in its northern part (Fig. 5). Furthermore, there was a slight positive anomaly of extension of the Azores High into Europe. The

extension was largest in June and August, reaching much of Eastern Europe, but was weaker in July (Fig. 6). Over the eastern Mediterranean region and the Middle East, cyclonic influence was active, which was normal for summer, but did not have much impact in the dry season except some parts of Turkey.

Circulation statistics of Météo France (Fig. 7) confirm a domination of NAO- patterns, but also Atlantic Low patterns were more frequent than normal in all summer months. In contrast, there were very few zonal and Scandinavian Blocking patterns in summer 2019.

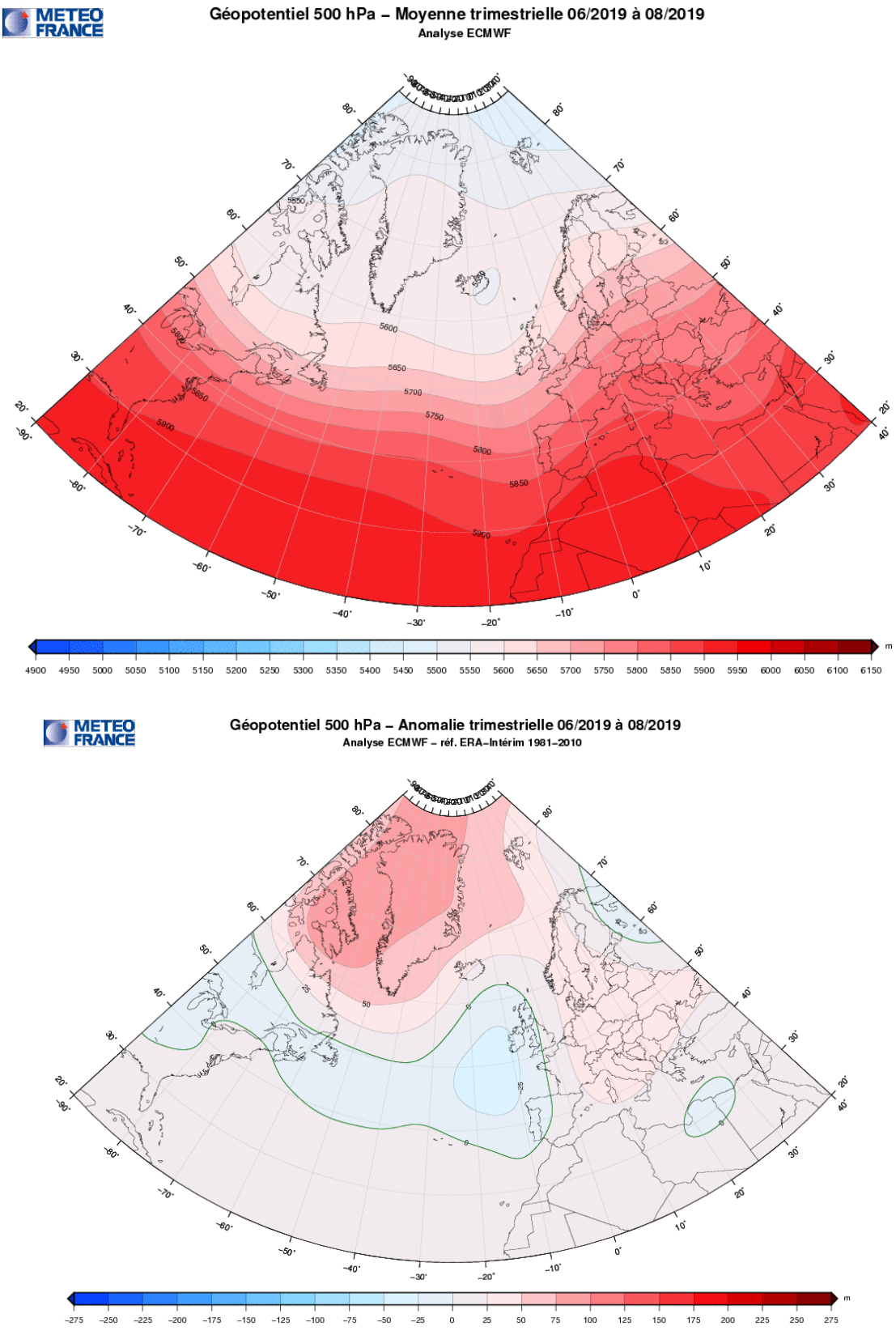
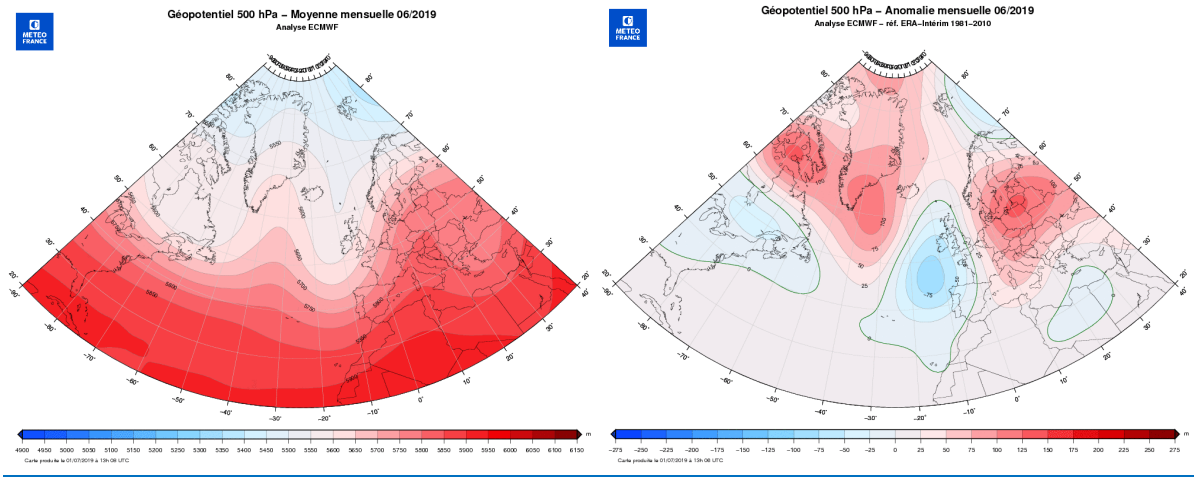
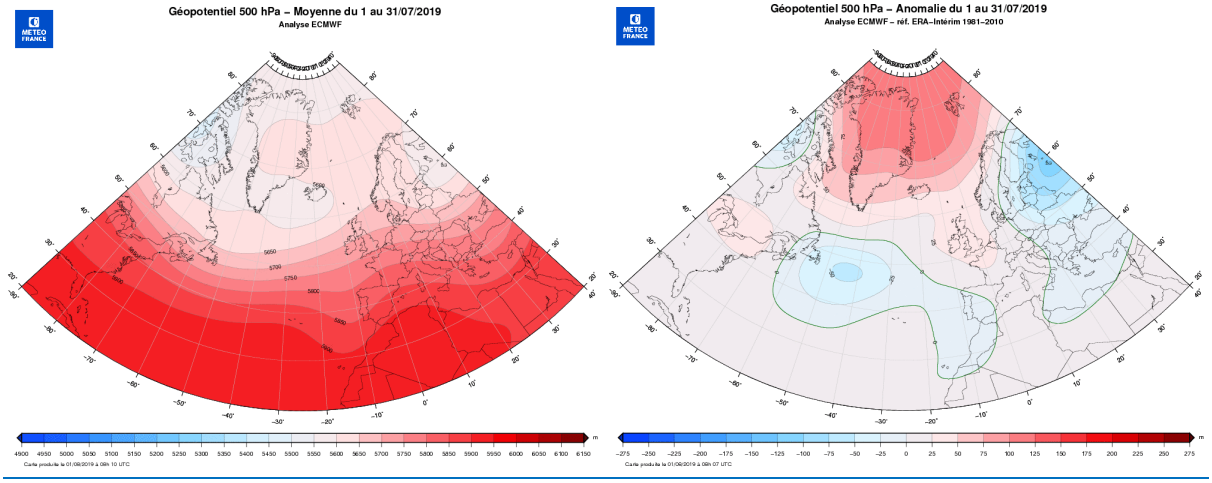


Figure 3: Seasonal mean and anomalies of 500-hPa geopotential for summer 2019 (1981-2010 reference). Source: Météo France, data source: ECMWF ERA Interim reanalysis, http://seasonal.meteo.fr/en/content/suivi-clim-cartes (login required)





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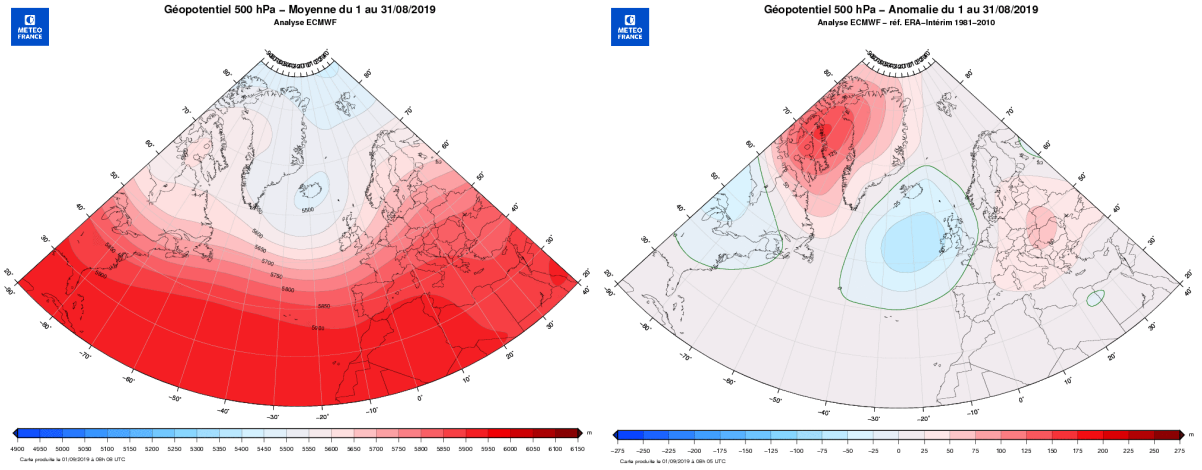
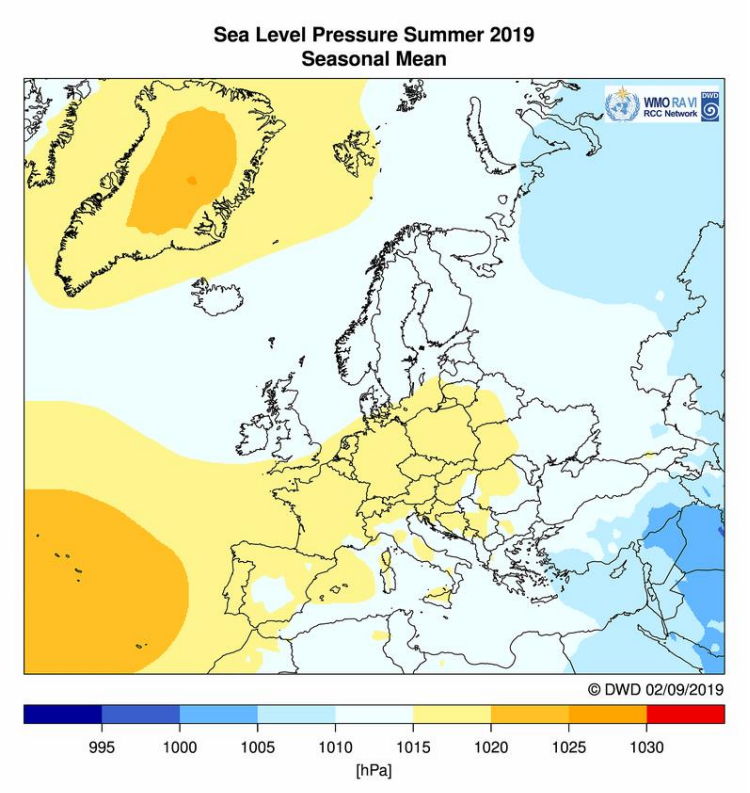


Figure 4: Same as Figure 3, but for the months June, July, August 2019.



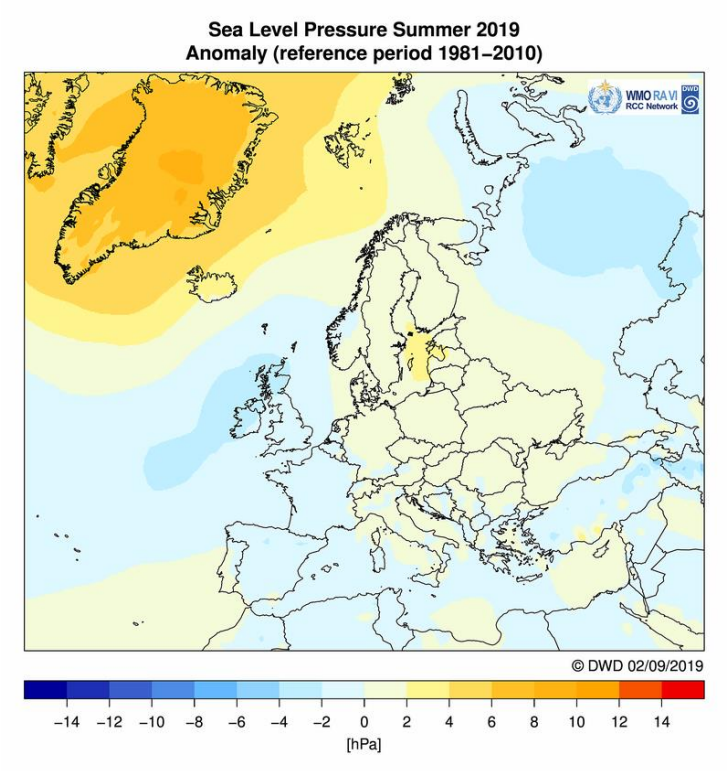


Figure 5: Seasonal mean sea level pressure (upper graph) and its seasonal anomalies (lower graph) for summer 2019 (1981-2010 reference). Source: Deutscher Wetterdienst (DWD), data source: DWD numerical ICON model analysis, http://www.dwd.de/EN/research/weatherforecasting/num_modelling/01_num_weather_prediction_modells/icon_description.html?nn=484268

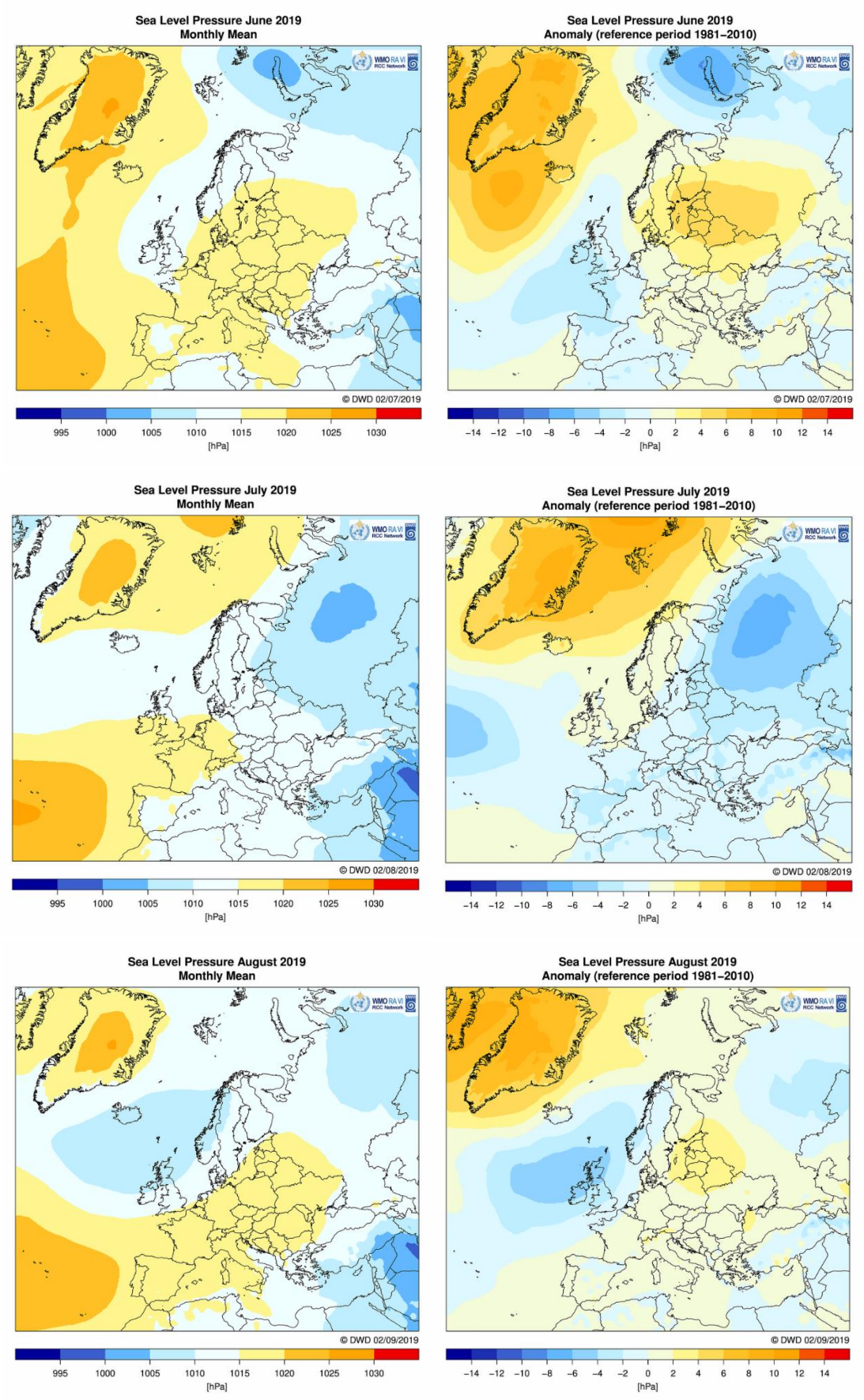


Figure 6: Same as Figure 5, but for the months June-August 2019.

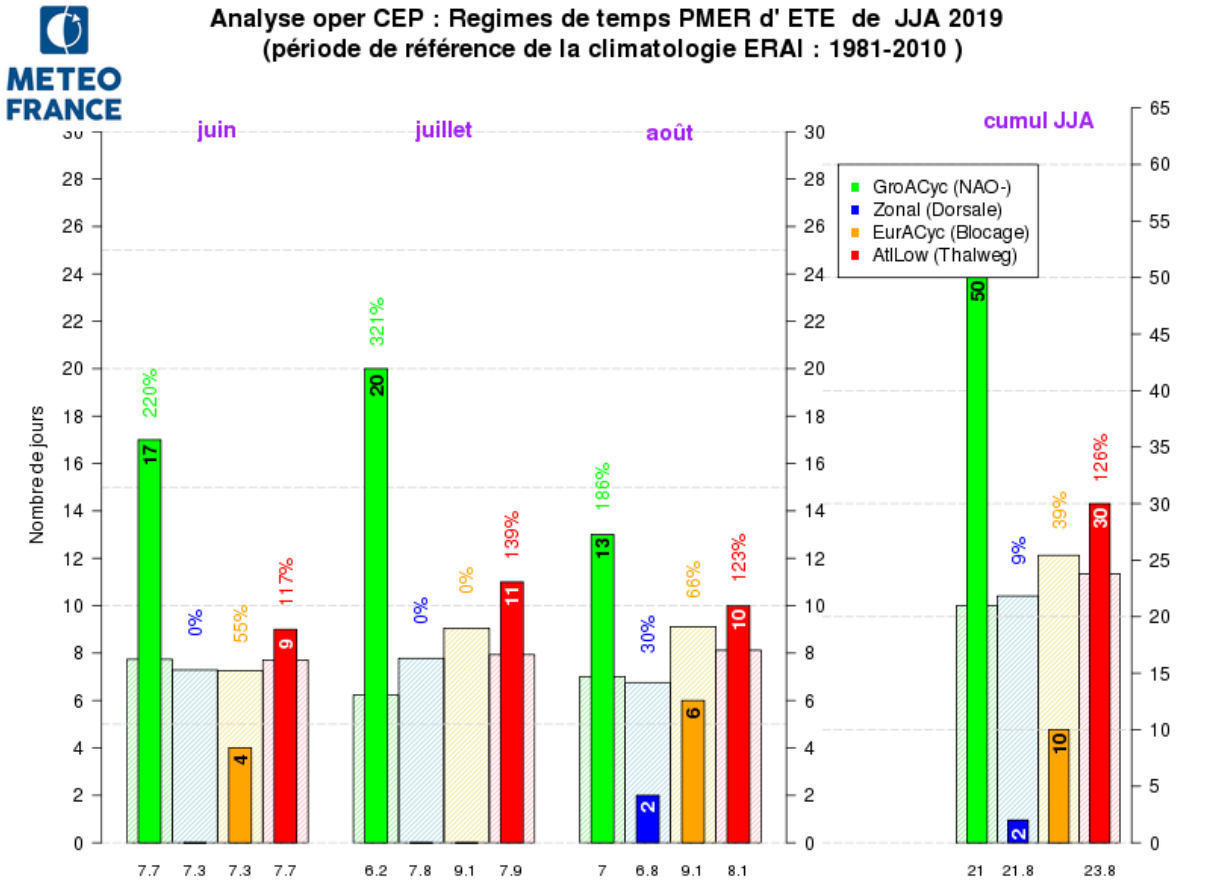


Figure 7: Number of days with circulation types of the Météo France classification for each month of the summer 2019 season and for the whole season (right), and in percent of the climatological frequency distribution 1981-2010. Circulation types are: negative North Atlantic Oscillation phase (NAO-), Atlantic ridge / zonal (Dorsale), Scandinavian Blocking (Blocage) and Atlantic trough/Low (Thalweg). Source: Météo France, http://seasonal.meteo.fr/en/content/suivi-clim-regimes-trim

yyyy	mm	NAO	EA	WP	EP/NP	PNA	EA/WR	SCA	TNH	POL	PT	ExV
2019	6	-0.79	1.28	-1.92	1.74	0.24	0.30	-0.16	-99.90	-0.46	-99.90	44.4
2019	7	-1.39	0.08	-0.27	0.10	0.62	1.02	-0.69	-99.90	-1.48	-99.90	62.2
2019	8	-1.62	1.93	-2.19	-1.18	1.16	-1.68	-2.09	-99.90	0.33	-0.91	51.5

Table 2: Circulation indices of NOAA CPC patterns for the summer months 2019. ExV = explained variance in %. **ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh**

2.2. Temperature

Europe and Middle East (RA VI)

Temperature was higher than the 1981-2010 normal in almost the entire MedCOF RA VI domain (Fig. 8). Highest anomalies (> +2°C) were recorded particularly in northern parts of the domain, which were those with most high-pressure influence, but also in the Balkans, northern Greece and over parts of the Adriatic Sea. Slightly below normal temperatures were recorded in Portugal / western Spain and locally in northwestern Turkey.
Seasonal mean temperatures in the lowlands ranged from around 19°C in northwestern France to around 30°C in southeastern Turkey, Syria, Israel and Jordan, in higher elevations mostly between 15 and 20°C.

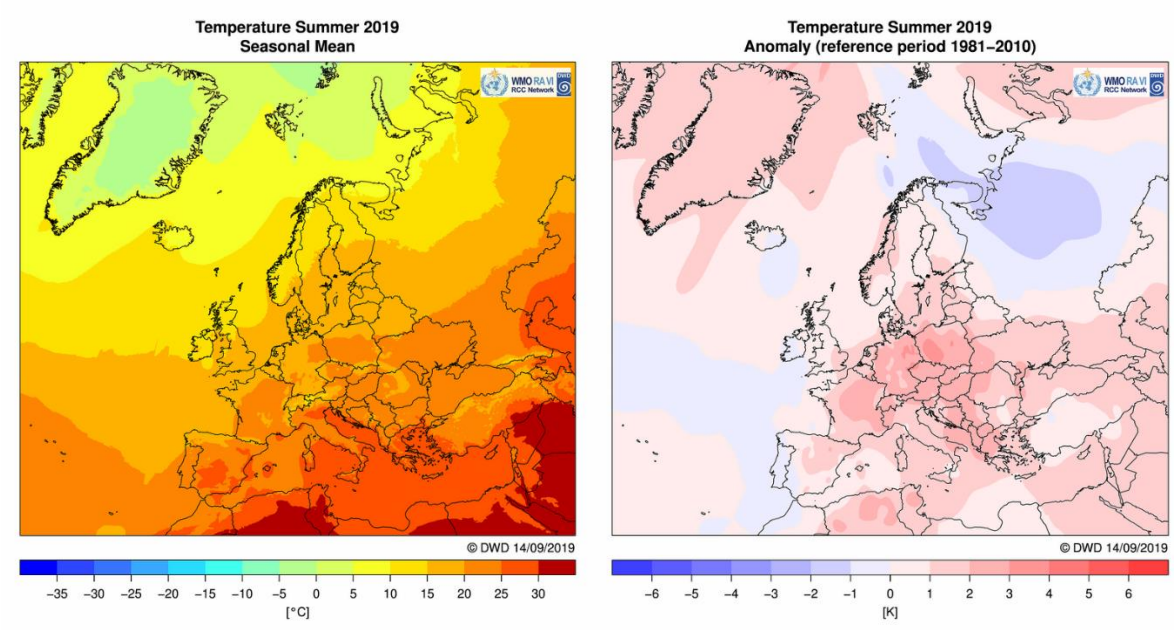


Figure 8: Surface air temperature for summer 2019. Left: seasonal mean, right: anomalies, 1981-2010 reference, source of both maps: WMO RAVI RCC, based on interpolated CLIMAT data, www.dwd.de/rcc-cm

In terms of terciles, most of the domain had summer mean temperatures in the upper tercile, especially in the north (Fig. 9-12). Temperatures in the middle or locally in the lower tercile were recorded in western and southern Iberia and parts of Turkey, and Cyprus. There are also some discrepancies among the different datasets, especially for the eastern Mediterranean region. Particularly for northeastern Greece, ERA5 reanalysis displays the upper tercile, but E-OBS data the middle or lower tercile. However, the national report from Greece shows highly positive anomalies for the northeast and an "extremely warm" classification, based on national stations and SEEVCCC analyses, so this seems to be the most likely version.

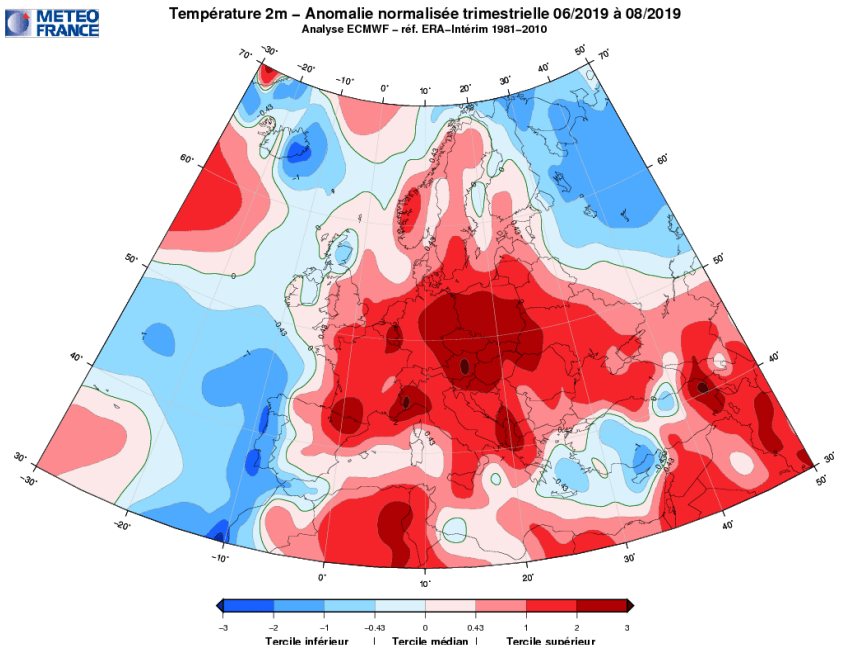


Figure 9: Seasonal normalized temperature anomalies of summer 2019 surface air temperature based on ECMWF / ERA-INTERIM grid data, 1981-2010 reference. The data range between -0.43 and +0.43 represents the middle tercile, below -0.43 the lower tercile and above +0.43 the upper tercile. Source: Météo France, data reference: http://www.ecmwf.int/en/research/climate-reanalysis/era-interim

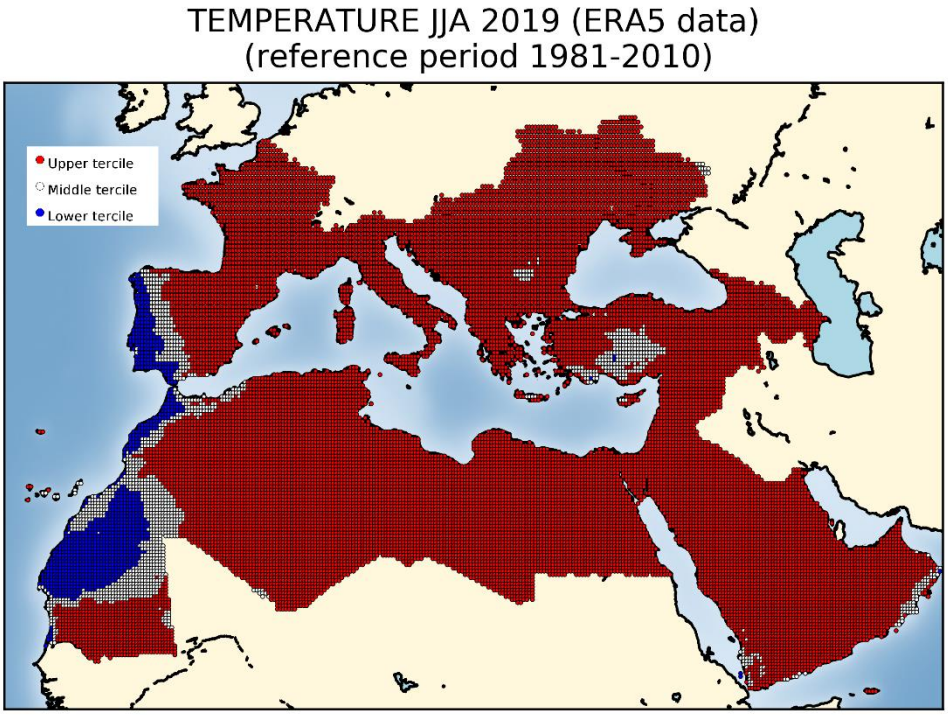
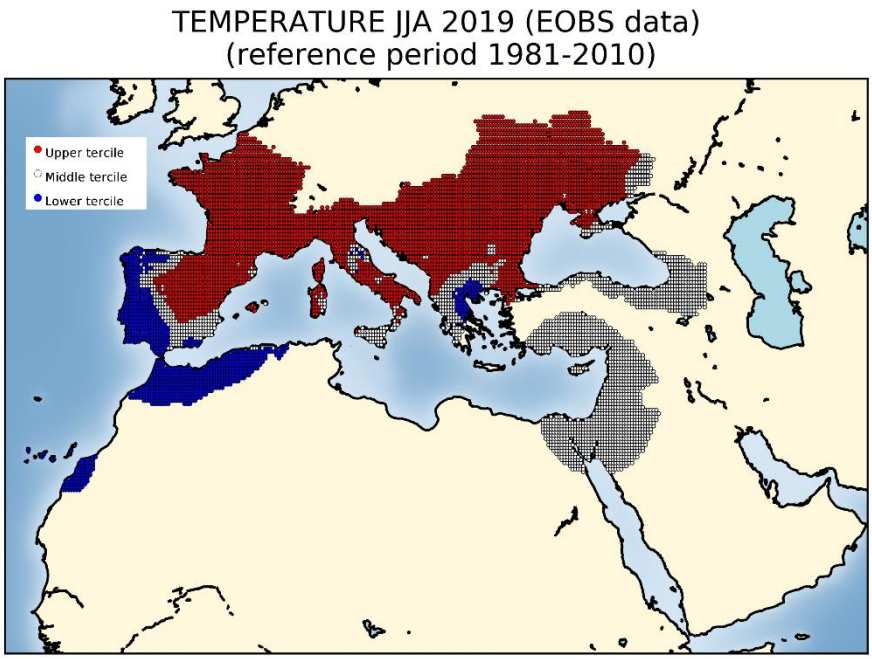


Figure 10: Terciles of summer 2019 surface air temperature based on ERA5 Reanalysis, 1981-2010 reference. Source: AEMET, data source https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5



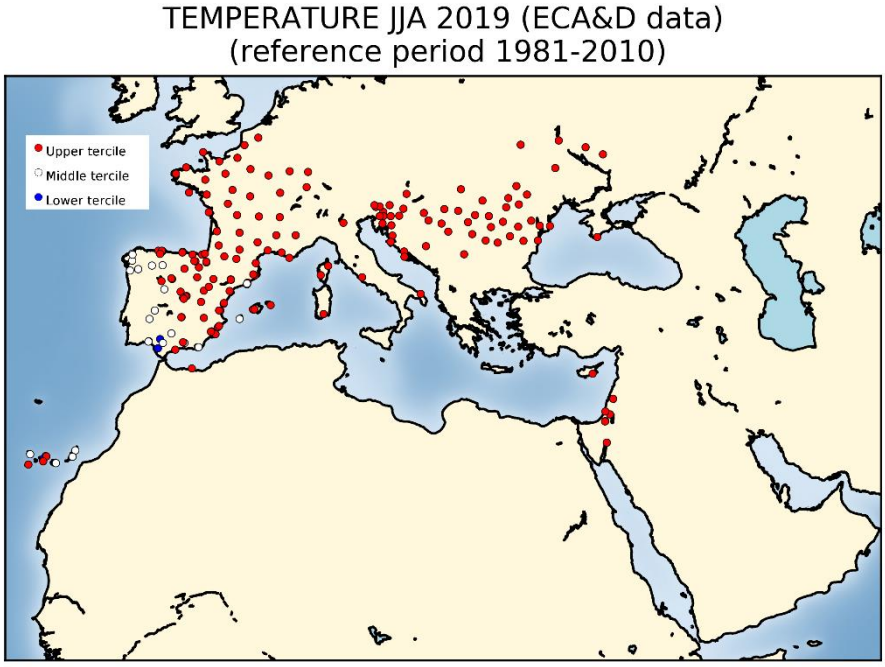


Figure 11: Terciles of summer 2019 surface air temperature based on interpolated E-OBS grid data (upper graph) and individual ECA&D station data (lower graph), 1981-2010 reference. Note: E-OBS uses a higher number of stations than those which are freely available at ECA&D. Source: AEMET, data source: http://www.ecad.eu/

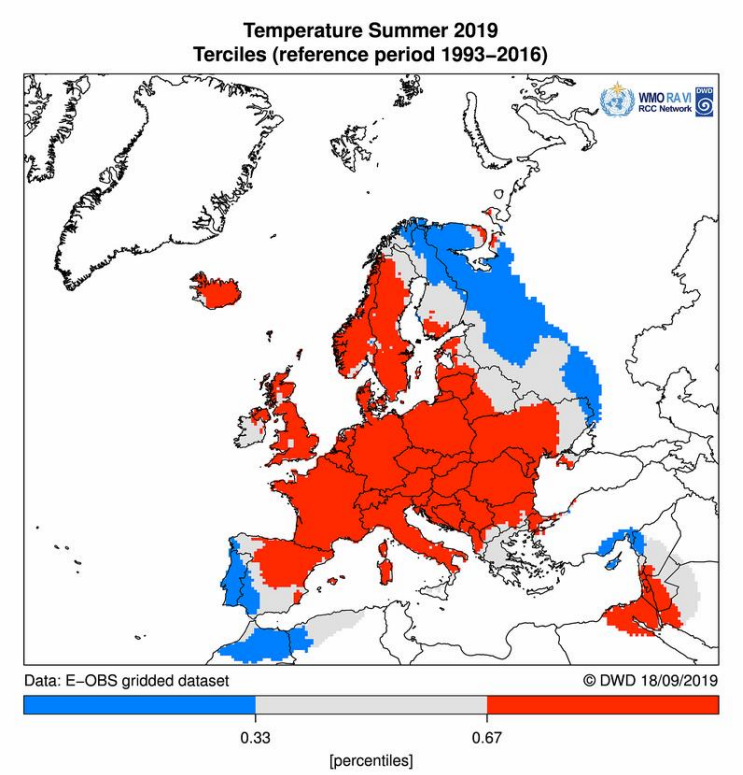


Figure 12: Terciles of summer 2019 surface air temperature based on interpolated E-OBS gridded data, 1993-2016 reference. Source: DWD, data source: http://www.ecad.eu/

North Africa (RA I)

Summer 2019 was above normal in almost all North Africa. Mean temperatures were ranging between 17°C and 46°C. The seasonal mean temperature was at its minimum over north-western regions and the coastal areas of North Africa.

In Morocco, the temperature was near normal to below normal over the western part except Safi (above normal). The remaining stations were characterized by normal to above-normal conditions with exception of Al-Hoceima station.

In Algeria, except the extreme north-western and the extreme south-western zones where the maximum temperatures were normal, all the remaining regions have observed above-normal temperatures. The anomalies (with respect to 1981-2010 normal) reached in some regions +3°C. In July and August, Algeria has recorded six new maximum temperatures records over 6 cities.

In Tunisia, the summer season mean temperature was at its minimum over north-western regions and the coastal area. The lowest value of seasonal mean temperature was 26.3°C measured in Tabarka in the North-West of Tunisia. The west southern parts of Tunisia were mainly the hottest region in 2019 summer season. Highest seasonal mean temperature was registered in Tozeur in the southwest of Tunisia with 34 °C, also the highest value of absolute maximum temperature was registered in the same region

during July 2019, it was reaching 48.8°C. Mean temperature was above normal over all of Tunisia, with anomalies ranging from +1.23°C to +2.23°C.

Above-average temperatures were observed over all of Egypt and Libya.

Most of the domain had temperatures in the upper tercile. Only in western parts, mainly in the west of Morocco, temperatures were in the lower or middle tercile.

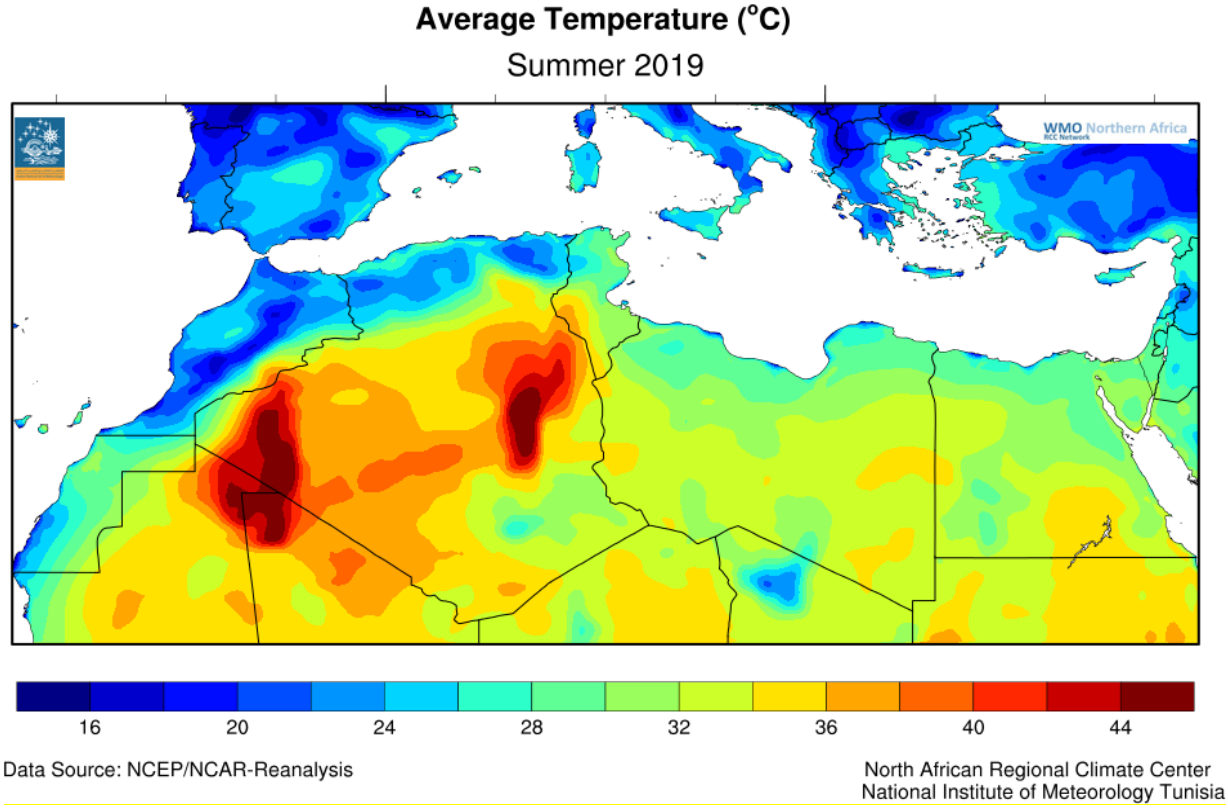


Figure 13: Mean temperature for summer season 2019 in North Africa (in °C). Source: INM, (Data from NCEP/NCAR reanalysis, http://www.esrl.noaa.gov)

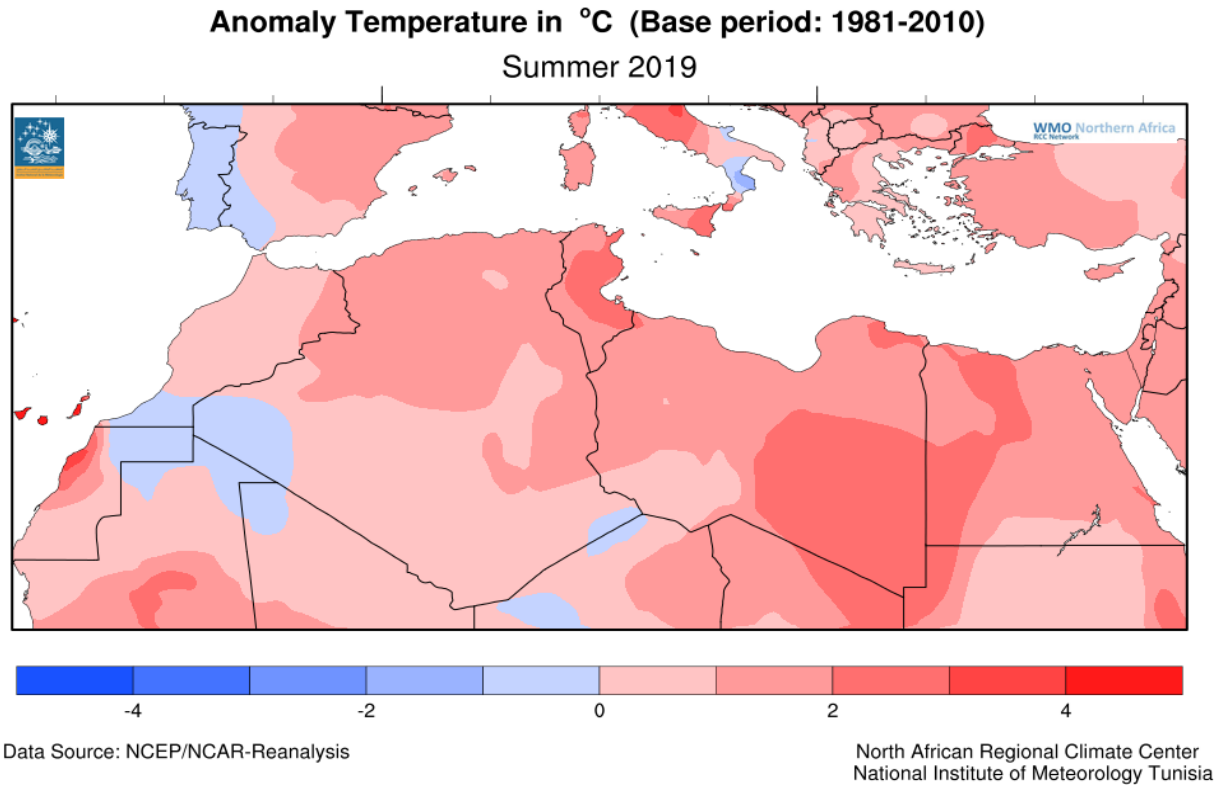


Figure 14: Temperature anomaly for summer season 2019 in North Africa (in °C), reference period 1981-2010.
Source: INM, Data from NCEP/NCAR reanalysis, http://www.esrl.noaa.gov

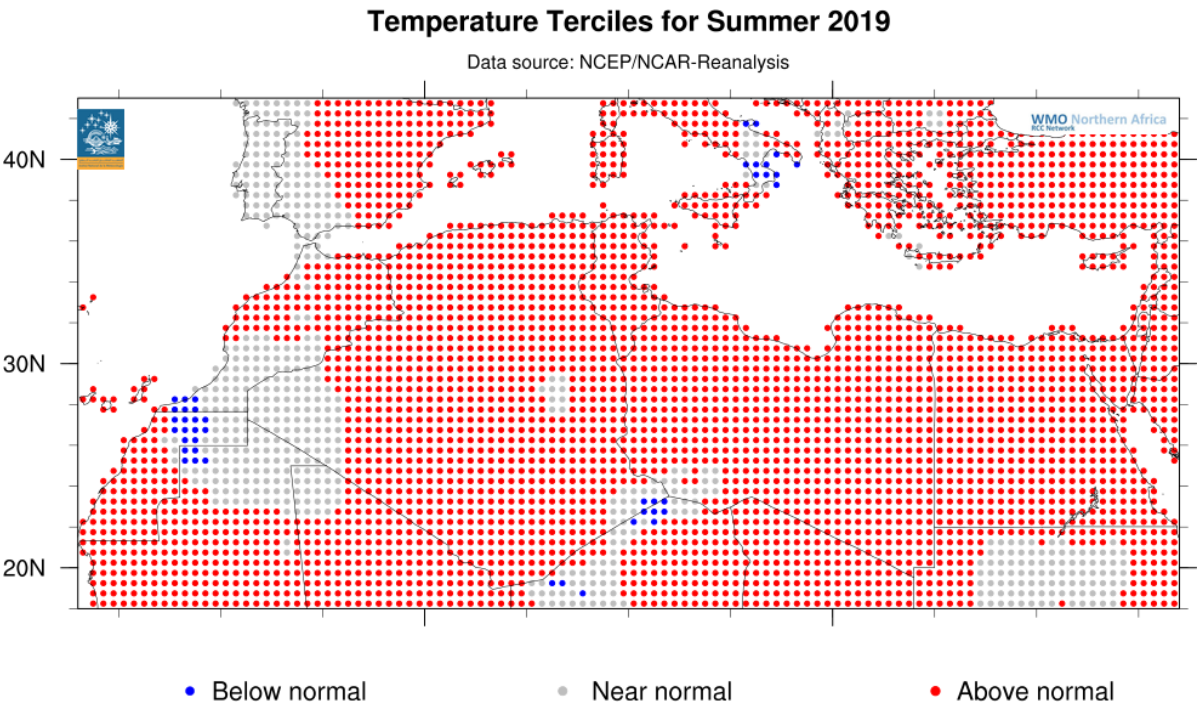


Figure 15: Tercile distribution for temperature of JJA 2019 in North Africa, reference period 1981-2010.
Source: INM, Data from NCEP/NCAR reanalysis, http://www.esrl.noaa.gov

2.3. Precipitation

Europe and Middle East (RA VI)

Precipitation was well below normal in northern parts of the domain from France to Ukraine and in south-western Europe (Fig. 16), again in line with the high-pressure zone. Widespread drought conditions, partly similar to summer 2018, were reported from many of these countries. In southeastern parts close to the Mediterranean Sea, seasonal precipitation mainly was above normal. However, absolute deviations were small in the latter areas due to seasonal aridity, except some places on the southeastern Balkan Peninsula and in Turkey, where deviations exceeded +30mm locally.

Seasonal totals ranged from zero in the Middle East to above 300mm in the Julian Alps, places at the eastern Black Sea coast, and over the Caucasus mountain chain.

In terms of percentiles (Fig. 16-18), parts of Spain, France, Italy, Slovenia, much of the Ukraine, eastern Turkey and the South Caucasus region had precipitation in the lower tercile, others mostly in the middle tercile, locally in the upper tercile. Some areas in Greece, Bulgaria, western and central Turkey recorded precipitation mostly in the upper tercile. Again, some discrepancies among the different data sets can be seen; especially E-OBS data show some differences particularly in the east, which might be due to missing data in that part of the domain. Other parts of Europe show some local differences, which might be explained by different spatial resolutions of the datasets.

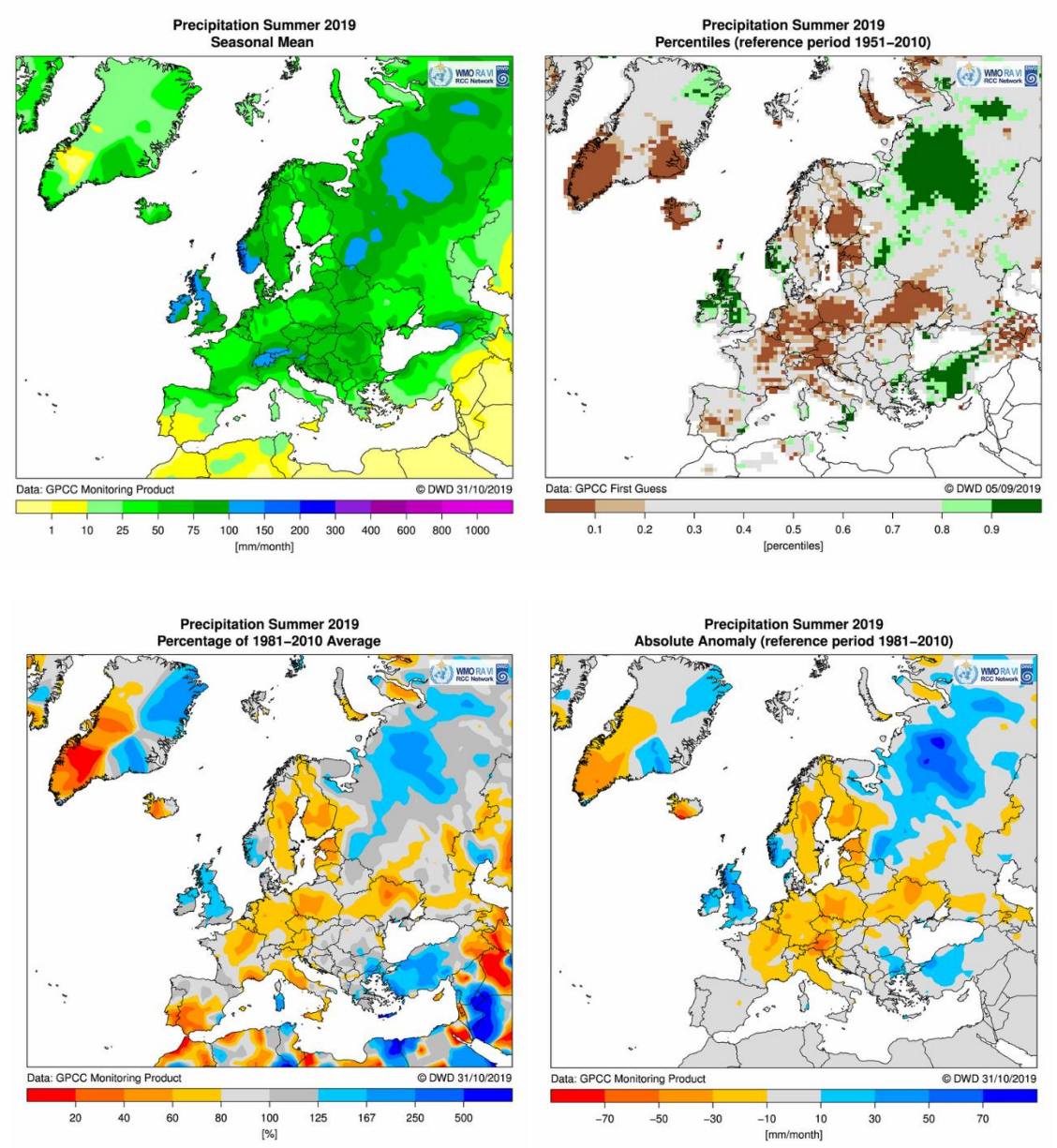
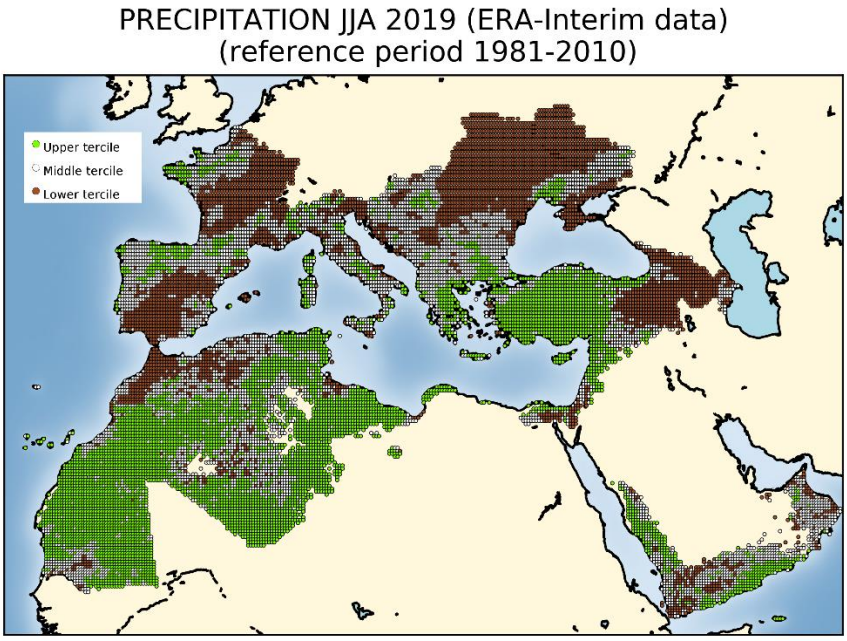


Figure 16: Precipitation for summer 2019 in Europe. Upper maps: seasonal total in mm/month and percentiles, lower maps: percentage of 1981-2010 average and absolute anomalies, source: WMO RAVI RCC, www.dwd.de/rcc-cm , data source: GPCC, http://gpcc.dwd.de



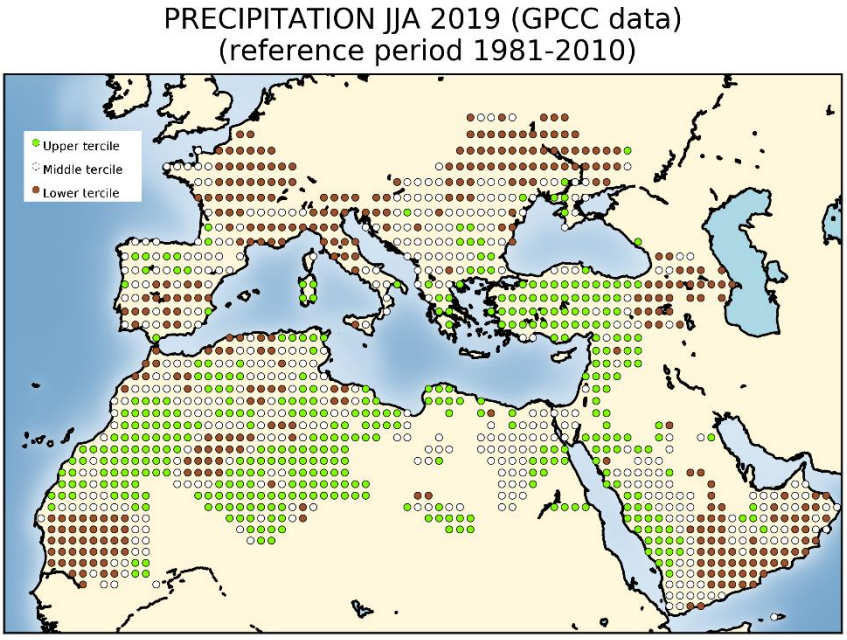


Figure 17: Terciles of summer 2019 precipitation based on ERA-INTERIM Reanalysis (upper graph) and GPCC (lower graph) grid data, 1981-2010 reference. Source: AEMET, data reference: ERA-INTERIM: http://www.ecmwf.int/en/research/climate-reanalysis/era-interim , GPCC: http://gpcc.dwd.de

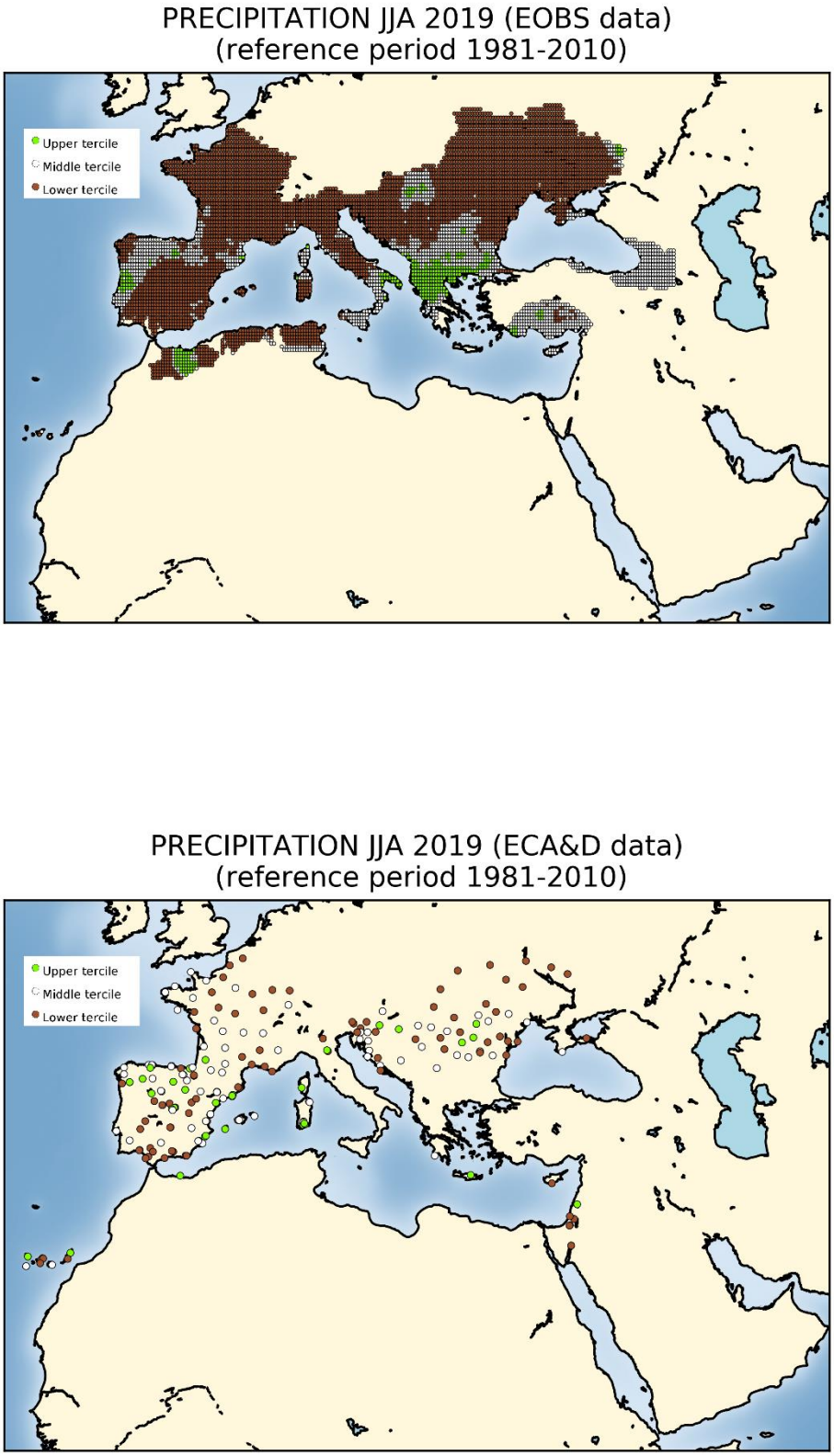


Figure 18: Terciles of summer 2019 precipitation based on interpolated E-OBS grid data (upper graph) and individual ECA&D station data (lower graph), 1981-2010 reference. Source: AEMET, data source: http://www.ecad.eu/

A more detailed analysis for south-eastern Europe, including high impact events, is given in the analysis and verification report of the SEECOF-21 CLIMATE OUTLOOK for the 2019 summer season for southeast Europe (SEE), provided by SEECOF-22 (presently draft version):

http://www.seevccc.rs/SEECOF/SEECOF-22/Pre-COF/Draft-Version-of-Final-assessment-of-SEECOF-21-Climate-outlook-for-summer-season-2019.pdf

North Africa (RA I)

During the summer 2019, the North Africa region was marked by dry summer season. In general, the precipitation was below normal to near normal over most of the North African region.

The accumulated rainfall totals in most parts of Algeria were below normal. The eastern highland zones observed the maximum amount reaching 100mm during the whole 3 months (June-July-August). However, Algeria recorded a high rainfall deficit where the percentages with respect to the normal conditions were varying between -50 % and -100%. Therefore, the summer conditions were drier in a large part of Algeria.

In Morocco, the classification by tercile was characterized by normal to above-normal conditions over northwestern and central regions. Normal to below-normal conditions were observed over the south-east Atlas side, the northeast and the south. These regions have known significant convective rainfall exceeding seasonal normal.

In Tunisia, total precipitation amount was above normal in the northeast region and a few stations distributed in the centre and the southwest.

Over the remaining region, the precipitations were normal to below normal.

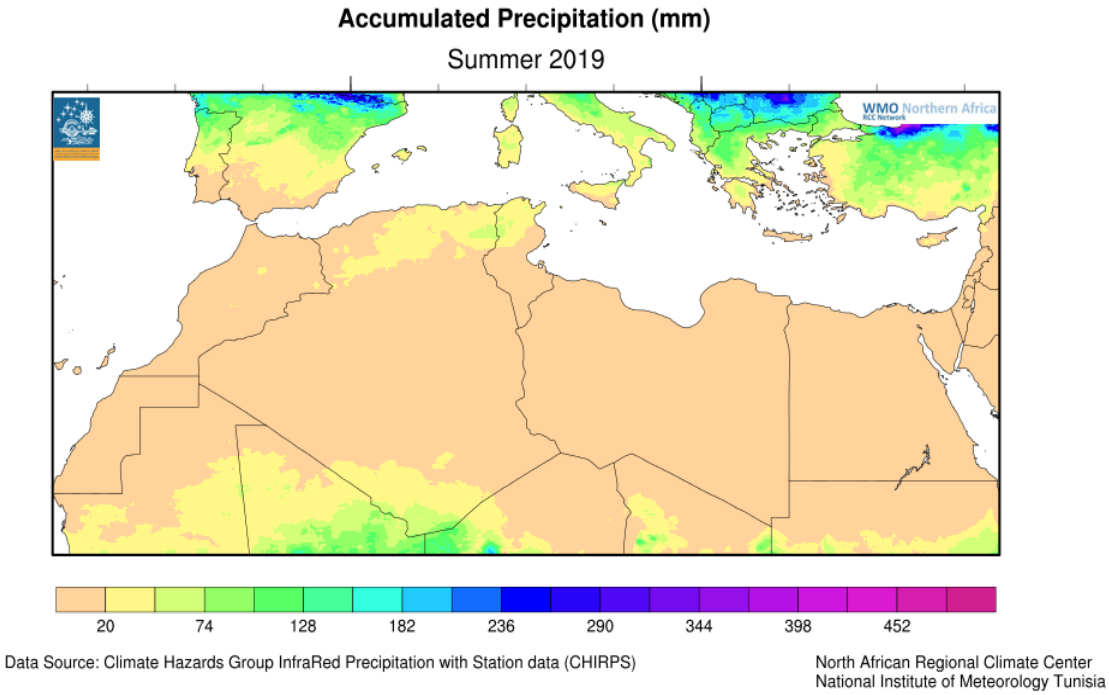


Figure 19: Total precipitation for summer season 2019 in North Africa (in mm). Source: INM, Data from GPCC (First Guess Product), http://gpcc.dwd.de

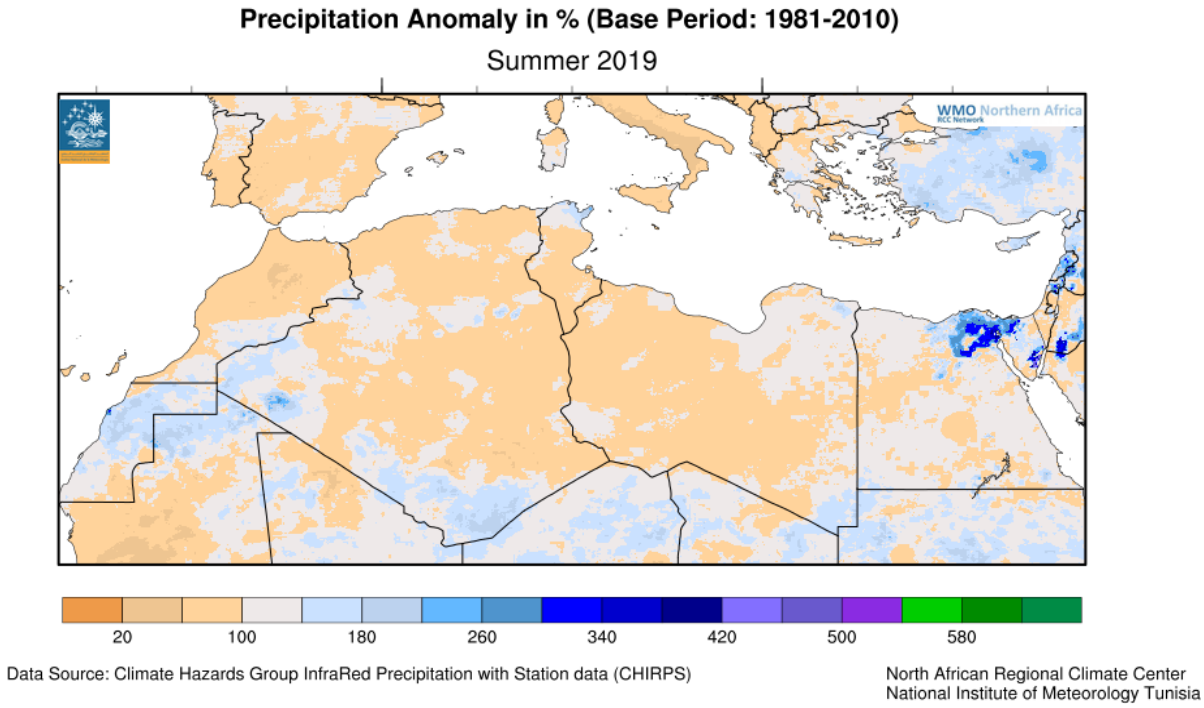


Figure 20: Precipitation anomaly for summer season 2019 in North Africa (in %) (Reference period 1981-2010). Source: INM, data from GPCC, http://gpcc.dwd.de

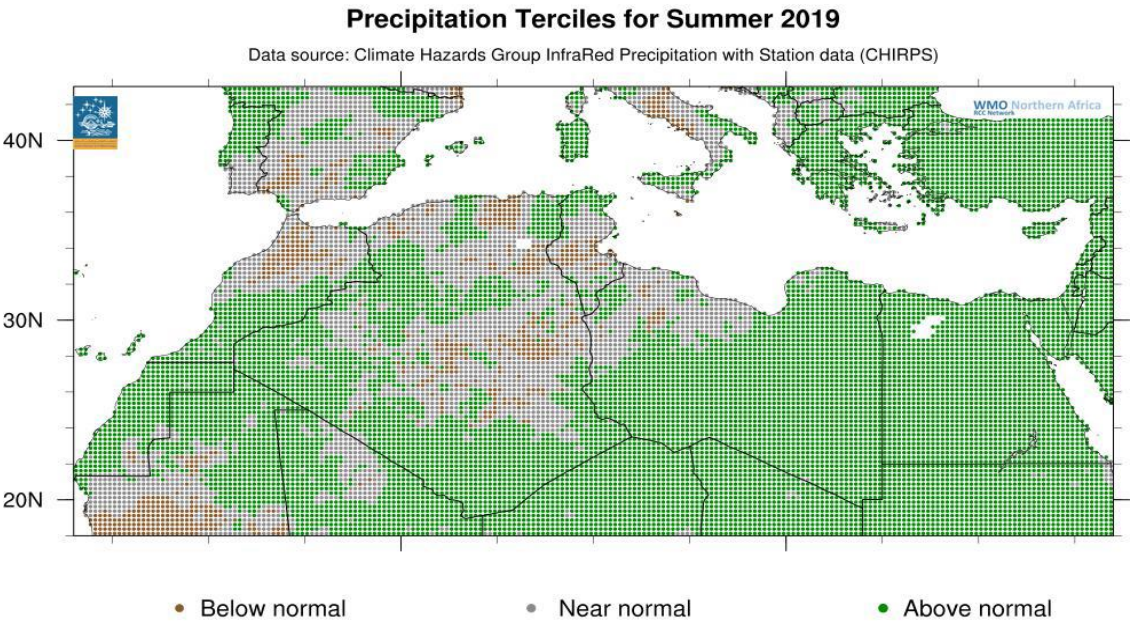


Figure 21: Terciles for precipitation (Reference period 1981-2010). Source: INM, data from GPCC, http://gpcc.dwd.de

3 Verification of the MedCOF-12 climate outlook for the 2019 summer season

3.1. Temperature

Europe/RA VI

The MedCOF-12 outlook favored the upper tercile for all northern parts of the domain from most of Iberia to northern parts of the South Caucasus, and southern parts of the Middle East (Israel and Jordan). For southern parts of Europe/RA VI close to the Mediterranean Sea (southern Iberia, southern Italy, Aegean Sea region, southwestern Turkey), the middle and upper tercile was preferred equally. No preferred scenario was given for southern parts of South Caucasus, southeastern Turkey, Lebanon and Syria.

The warm scenario for the northern parts and southern Middle East was well predicted. Southern parts of the domain close to the Mediterranean Sea mainly had temperatures in the middle or upper tercile as predicted. Southeastern Turkey, southern South Caucasus and northern Middle East temperatures were all in the upper tercile, which was not captured by the outlook. Also not predicted were the lower-tercile temperatures in western Iberia.

In summary, the outlook was good for almost the whole domain.

North Africa (RAI)

The MedCOF-12 climate outlook for the summer 2019 season favored the upper tercile over the northeastern part of North Africa and less clear signal over the northwestern part with similar probabilities for upper and medium tercile. The outlook was correct over most of the region except the cooling over the western part of Morocco, which was not predicted.

3.2. Precipitation

Europe/RA VI

The MedCOF-12 outlook favored a dry scenario (lower tercile) over northern parts of the domain and a wet scenario for eastern parts from the southern Balkan Peninsula to South Caucasus. For the rest of the domain no signal was given, which means climatology was recommended.

The dry scenario for the northern parts was at least partly well predicted, particularly for large parts of France and the Ukraine. In addition, the wet scenario in the east was partly well predicted, particularly for the Aegean region and much of Turkey. Much of the remaining parts of the domain had precipitation in the middle tercile, which corresponds to climatology given by the no signal prediction.

In summary, the outlook was correct for most of the domain. The main large-scale features were captured, but with local differences.

North Africa

No scenario for the North Africa region was favored. In fact, the summer 2019 was drier than normal in most of the North African domain except a small region in the west of Morocco and in the northeast of Tunisia. MedCOF-12 precipitation prediction did not give valuable information.

4. Users' perceptions of the MedCOF-12 outlook

In most of RA VI, feedback was not available. Not all countries provide a national seasonal outlook for external users. In North Africa, no feedback was given by users.

Croatian Meteorological Service provides seasonal forecast to Croatian Civil Protection (Sector for firefighting in summer season), to Croatian Water Management and in different form (adjusted format) to the general public on its web page.

AEMET provides seasonal forecasts to the general public on its webpage and on the MedCOF webpage.

Appendix A: Contributors to verification of MEDCOF-12

- World Meteorological Organization as initiator and supporter of this activity

Europe and Middle East (RA VI)

- Climate Centres:

- WMO RA VI RCC Offenbach Node on Climate Monitoring, Deutscher Wetterdienst, Germany
- South East European Virtual Climate Change Center hosted by Republic Hydrometeorological Service of Serbia, Republic of Serbia

- National Meteorological and Hydrological Services:

- Service of the Hydrometeorology and Active Influence on Atmospheric Phenomena
- Republic Hydrometeorological Service, Republika Srpska, Bosnia and Herzegovina
- Meteorological and Hydrological Service of Croatia, Republic of Croatia
- Météo France, Republic of France
- National Environmental Agency (NEA), Georgia
- Deutscher Wetterdienst, Federal Republic of Germany
- Hellenic National Meteorological Service, Greece
- Israeli Meteorological Service
- State Hydrometeorological Service, Republic of Moldova
- AEMET, Spain
- Turkish State Meteorological Service, Republic of Turkey

- **Further National Meteorological and Hydrological Services via SEECOF-20:** http://www.seevccc.rs/SEECOF/SEECOF-20/Pre-COF/Draft-Version-Final-assessment-of-SEECOF-19-climate-outlook-for-summer-season.pdf

- Federal Hydrometeorological Institute, Federation of Bosnia and Herzegovina
- National Institute of Meteorology and Hydrology, Bulgaria
- Hydrometeorological Institute of Montenegro
- Hydrometeorological Service of Republic of North Macedonia
- Republic Hydrometeorological Service of Serbia, Republic of Serbia
- Slovenian Environment Agency, Slovenia
- Ukrainian Hydrometeorological Center, Ukraine

APPENDIX B: **Analysis and verification of the MedCOF-12 climate outlook for the summer season 2019:**

Verification summary based on the national reports and contributions of the participants of the SEECOF-22 and MedCOF-13.

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	MedCOF-12 climate outlook for temperature	Observed	MedCOF-12 climate outlook for precipitation	
Albania *	Above normal	No signal	Around normal	No signal	No events
Armenia (1)	Above normal	No clear signal	Above normal	Below and near normal	Heat Wave was observed from 22 of July until 20 of August in lowland areas. The maximum air temperature reached 43.0°C in Meghri on July 30, (the highest recorded was 43.7°C in Meghri on July 31, 2011 and in Yerevan on July 12, 2018). Drought was recorded from May up to the end of August in Ararat valley and Syuniq lowlands. Extreme precipitation sums (65mm/25 min) were recorded in Tashir(lori) on 8 Jun and 69mm/12hour in Aparan (Aragatcotn) regions on 6th of July. Severe hailstorms were observed with diameters of hail exceeding 20 mm. Forest fires: Forest fires were recorded in Vayots Dzor and Sjuniq region (July, August). Forest fires were characterized by higher frequency during the summer season of 2019.
Azerbaijan *	Above normal	No signal	Below normal	No signal	No events

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	MedCOF-12 climate outlook for temperature	Observed	MedCOF-12 climate outlook for precipitation	
Federation of Bosnia and Herzegovina (1)	Above normal in almost entire Bosnia and Herzegovina (extremely warm)	Above normal (20, 30, 50)	Below normal in west Bosnia Normal in central Bosnia and Herzegovina, except Bugojno (extremely wet)	No predictive signal	June 1 st warmest (Bihac and Drvar); 2 nd warmest (Bjelasnica, Gradacac, Livno, Sanski Most, Sarajevo, Stolac and Tuzla. 1 st wettest (Bugojno) - Summer 5 th and 6 th warmest summer for Bosnia and Herzegovina; MS Mostar 75 days with T max ≥30°C, 52 days withT min ≥20°C. Extremely wet for MS Neum (coastline) and Bihac (west Bosnia)
Rep. Srpska, Bosnia and Herzegovina (5)	Extremely warm +2.3°C (0.99P r1981-2010)	Above normal (20, 30, 50)	Normal over most areas	No clear signal	Extremely warm weather pattern over the RS caused intense convective Cb instability (hail, thunder, storm wind gust, showers, temperature drop) on 3-June, 5-June, 16-June, 23-June; 4-July,7- July,13-July,18-July;27-July; 13-August, 17-August
Bulgaria (1)	Above normal	Above normal	Near or above normal	Near or above normal	Summer 2019 started with wet weather in June and finished with dry weather in August. It was warm throughout the season except for part of July. The dry weather in August brought risky fire weather illustrated. There were strong convection days with 24-hour precipitation amounts above 100 mm at few stations.

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	MedCOF-12 climate outlook for temperature	Observed	MedCOF-12 climate outlook for precipitation	
Croatia (5)	Above normal	Above normal (20,30,50)	Below normal (wider area of Parg, wider areas of city of Zagreb, Bjelovar and Sisak, and part of the Northern and Middle Adriatic) Above normal (wider area of city of Varaždin)	No predictive signal Drier than normal conditions (45/30/25) – north Croatia	Summer 2019 was very warm and extremely warm. Heat waves were observed during all three months (two in June and July and three in August) – and only in June there were several maximum air temperatures which exceeded the absolute maximum (Dubrovnik, Hvar, Pazin, Poreč, Zadar, Parg, Puntijarka and Zavižan). In all three months convective related severe weather phenomena (thunderstorms, hail, heavy rains, flash floods, waterspouts) were observed mostly all over Croatia.

Cyprus (5)	Normal to Above Normal	Normal to above normal (20/40/40)	June Above Normal July, August Below Normal	No signal	June Both maximum and minimum temperatures were around normal. Extremes were also recorded with great positive departures of 4 to 6°C, like Paphos airport where the absolute maximum of the station was 31.7°C departing 4.1°C from the normal (27.6°C), or over Athalassa station, where the highest daily maximum temperature of 40.8°C was 6.8°C higher than normal of 34.0°C. June ranks as the 6th in terms of highly accumulated precipitation, a record of 27.1mm of accumulated precipitation resulting to 411% of the climatological precipitation (6.6mm). The accumulated precipitation was a result of local thunderstorms in the period from the 1st to the 5th and from the 11th to the 19th of June, which in some cases were accompanied by hail. July Both maximum and minimum temperatures were above normal. The recorded maximum temperature was around 0.5-1.5°C above normal over most areas of Cyprus. Daily maximum temperatures that were above normal (deviating by 4°C or more from normal) were recorded at many stations. Except the highest daily maximum temperature of Prodromos that was 33.7°C (with a normal of 27.9°C), note the highest daily maximum of Larnaca and Achna that was 37.8°C and 38.5°C respectively (with normal of 32.5°C and 33.2°C). Highest daily minimum temperatures were also recorded, with positive departures greater than 4°C, like Polis Chrysochous, where a minimum of 27°C was by 5.9°C above station's normal (21.1°C) and the station of Larnaca, where a minimum of 27.3°C that was by 5.3°C above station's normal (22°C). On 16th, 20th and 24th of July isolated showers resulted in accumulated precipitation of 29% of normal. August Extremes were recorded with positive departures greater than 4°C, like Achna station where the highest daily maximum temperature (38.6°C) was 5.1°C greater than normal (33.5°C) and Prodromos station, where the

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	MedCOF-12 climate outlook for temperature	Observed	MedCOF-12 climate outlook for precipitation	
					highest daily maximum temperature (32.7°C) was 4.7°C greater than normal (28°C). Generally, the highest maximum of the month was recorded on 1st of August over the inland station of Athalassa and it was 41.1°C with the normal being 36.9°C. Daily minimum temperatures were also recorded, like Prodromos, where a minimum of 12.9°C was 5.2°C below station's normal (18.1°C), a negative departure greater than 4°C. On the 2nd, 4th, 5th, 7th, 8th and 21st of August episodes of local showers and isolated thunderstorms resulted in accumulated precipitation of 55% of normal.
France (5)	Above normal	Above normal 20/30/50	On a national scale below normal with strong regional contrasts	Below normal (45/30/25) in the northern part of France No signal in the rest of the country (including Medit. Regions)	Heat Wave 25 to 30/6/2019: very severe, very early for this season. Maximum temperatures exceeded 35°C across wide areas on 3 consecutive days. A new record for France was reached with 46°C. It was less severe than the 2003 heatwave. 500 casualties (estimated excess of mortality). Heat Wave 21 to 26/7/2019: Maximum temperatures often exceeded 40°C in Northern and Central parts of the country from 23th to 25th of July. Many absolute records were broken (either 1947 or 2003) for old stations. For instance, the historical record of Paris (Station Paris-Montsouris) of 40.4°C became 42.6°C. This heatwave was shorter (6 days) but intense like heatwave 2003. 1000 casualties (estimated excess of mortally). Drought: center and northeast of France in the whole season. The drought is unusual but in center and northeast, the soil drought was already present during summer and autumn 2018. In 2019, the event began in March. Important agriculture and rearing losses. Water supply in several regions. Forest fire south of France : 16 500 ha

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	**MedCOF-12 climate outlook for temperature**	**Observed**	**MedCOF-12 climate outlook for precipitation**	
Georgia (1)	Above normal	Above normal (20/30/50)	Near and below normal	Above normal (20/30/50)	No events
Greece (2)	Above normal for most of the country Only few southern parts near to normal	Above normal (20/30/50) for northern parts Near or above normal (20/40/40) for central and southern parts	Above or near to normal for the most of the country and especially for west Crete Below normal in north Ionian, most of the east Aegean islands, NW Peloponnese	Above normal (20/30/50) for most parts No signal for southern and northwestern parts	On June 11th, 2019: Heavy rain caused flooding in Varkiza (suburb of southern Attica) and traffic problems. On June 18th and 19th, 2019: Summer thunderstorms with intense electrical activity accompanied by hail caused flooding in Attica. On July 10-11, 2019: Storm affected central and east Macedonia, mainly the Prefecture of Halkidiki. Seven people died and 120 were injured, roofs collapsed, trees and electrical posts fell, caravans and boats were swept away in the storm that broke out at night. Also, the violent storm led to power outages in most of the Halkidiki region. On July 14-17, 2019: Heavy thunderstorms affected mainly south Ionio, west Greece, west Crete, and Sporades islands and caused flooding and destructions.
Hungary*	Above normal	Above normal (20/30/50)	Mostly around normal	Below normal (45/30/25)	No events
Israel (5)	Above normal	Above normal (20, 30, 50)	No precipitation	Dry season	No events

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	MedCOF-12 climate outlook for temperature	Observed	MedCOF-12 climate outlook for precipitation	
Italy*	Above normal	Above normal (20/30/50) In the south normal to above normal (20/40/40)	Mostly below or around normal, locally above	Below normal in the north (45/30/25) No signal elsewhere	No events
Jordan*	Above normal	Above normal (20/30/50)	No precipitation	Dry season	No events
Lebanon *	Above normal	No signal	Almost no precipitation	Dry season	No events
Moldova (5)	Above normal	Above normal (20/30/50)	70% of the territory near normal 25% of the territory below normal 5% of the territory above normal	Below normal (45/30/25)	During the summer season, meteorological phenomena in form of torrential rains and hail (June, July), as well as strong winds with a maximum speed of up to 27 m/s (July 3rd, MS Ceadâr-Lunga) were reported, which caused the damage of agricultural crops, the deterioration of the objects of the national economy and the disconnection from the sources of electricity.

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	MedCOF-12 climate outlook for temperature	Observed	MedCOF-12 climate outlook for precipitation	
Montenegro (1,5)	Very warm to extremely warm	Above normal (20/30/50)	Normal for the most of the country	No predictive signal	The 4th July: Heavy hail impact in the northern mountainous region; https://www.vijesti.me/vijesti/drustvo/pogledajte-video-kad-grad-uhvati-na-putu-jasenovo-polje-savnik The 28th July: The storm surges hit Montenegrinian coast as meteorologist forecasted. Combination of the storm and surge consequences: https://www.vijesti.me/vijesti/drustvo/video-pogledajte-kako-izgleda-kad-talasi-i-vjetar-udruze-snage
North Macedonia (5)	Above normal	Above normal (20, 30, 50)	Below normal, variable precipitation regime	No predictive signal in the north Above normal in the south (20/30/50)	No events
Portugal *	Below normal	Above normal in the north (20/30/50) Normal or above normal in the south (20/40/40)	Mostly around normal	No signal	No events
Romania *	Above normal	Above normal (20/30/50)	Mostly around normal	Mostly no signal In the southeast above normal (20/30/50)	No events

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	MedCOF-12 climate outlook for temperature	Observed	MedCOF-12 climate outlook for precipitation	
Serbia (1,5)	Above normal in entire Serbia	Above normal (20, 30, 50)	Normal in most of Serbia	Below-normal (45/35/20) in northern Serbia No predictive signal elsewhere	* Summer 2019 The 5th warmest summer for Serbia, the 3rd warmest for Palic (northern Serbia). The 2nd warmest summer for Serbia based on the minimum air temperature. There were 73 days with the "feels like" temperature (THI) above 30 degrees, which is 6 days above the summer of 2017 that ranks as the 2nd warmest in the period from 1951 up to now. A heat wave was registered in the period from August 23rd to September 2nd in most of Serbia. * June The warmest June for Serbia based on the minimum air temperature. The 3rd warmest June for Serbia based on the mean air temperature. The 6th wettest June for Sombor (northern Serbia). Record-breaking precipitation sums for Pozega (southwestern Serbia). A heat wave was registered on Zlatibor (southwestern Serbia), lasting for 5 days.

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	MedCOF-12 climate outlook for temperature	Observed	MedCOF-12 climate outlook for precipitation	
Slovenia (5)	Warmer than normal	Above normal (20/30/50)	Drier than normal in the west and northeast, normal to above normal in the southeast	Drier than normal in the northeast (45/30/25) No clear signal elsewhere	● Second warmest summer since 1961, second only to summer 2003, ● Second warmest June since 1961, second only to June 2003. Two to three heatwaves. June temperature records for Slovenia: Ljubljana 36.5 °C (former record 35.6 °C in 2003), Rateče (35.5 °C), Kredarica (20.8 °C) and many more. ● August among 6 warmest since 1961. ● Summer was dry, among 15 driest since 1961, ● This summer, there was large number of thunderstorms with hail, heavy precipitation and strong wind gusts. Some featured episodes: − 11 June in southeast Slovenia thunderstorms with hail with diameter between 5 and 10 cm (Stari trg ob Kolpi near border with Croatia). Some damage. − 19–23 June thunderstorms with heavy precipitation and hail (20 June Trzin near Ljubljana 120 mm precipitation in one hour). − 7 July, thunderstorms with strong wind gusts over central and northeast Slovenia. Ptuj region wind gusts over 28 m/s, precipitation 49 mm in 25 minutes. Damage: floods, ruined trees, damage on roofs and crops. − 8 July, Supercell storm from south foothills of Julian Alps over Ljubljana region to Kočevje region (southeast Slovenia): strong wind gusts, heavy precipitation and hail. Some damage.

Spain (5)	Overall, summer (1 June 2019- 31 August 2019) was very warm over Spain. Mean temperature was 23.8 °C, 0.8 °C above the seasonal average. This summer is ranking as the 10th warmest since 1965 and the 9th warmest from the beginning of 21st century. Summer exhibited a stark contrast between the western third of the Iberian Peninsula (IP), which was normal or cold and the remaining mainland Spain where it was predominantly	Temperature should be warmer than normal for most of the European continent (20/30/50).	Overall, summer in Spain was dry though close to normal, with an average precipitation of 64 mm (14 % below normal). Summer began with a very dry June, corresponding to 42 % of normal, followed by a very wet July, with precipitation above 20% of normal and a wet August with a precipitation that was equal to normal. Summer 2019 was wet or very wet in some regions, including areas of Asturias, Cantabria, southeast Galicia and west and the northern half of Castilla -León; as well as some little zones of Catalonia, northern Aragón, eastern Extremadura,	no large-scale precipitation signal	Heat wave lasting from 26 June to 1 July affected the IP and the Balearic Islands. Extensive areas of the center and northeast of the IP exceeded 40 ° C, reaching values above 43 ° C at some locations. Other outstanding warm episodes were those of July 20-25 and August 6-10. New summer records of daily maximum temperature were set at seven main stations, of daily minimum temperatures at six main stations. Cold episode between June 5 and 16: some frosts in high areas of the plateaus and mountain areas. During this episode, the lowest summer temperatures were recorded, highlighting among the main stations: the Port of Navacerrada (-1 °C, 7 June), Molina de Aragon (-0.6 °C, 12 June), Teruel (0.7 °C, 12 June) and Burgos airport (0.8 °C, 12 June). Record-breaking of daily minimum temperatures in two main stations, Logroño/Agoncillo and Teruel. Maximum daily precipitation (JJA 2019) registered in a main station: 87 mm in Alicante (20 August 2019), followed by 85 mm in Alicante/Elche Airport (20 August 2019) and 72 mm in Huesca/Pyrenees (19 August 2019). In addition, in Alicante, the accumulated summer precipitation amount was 99 mm, the maximum of the corresponding series. As regards maximum precipitation intensity between main observatories, Barcelona stands out for accumulating more than 30 mm in 10 minutes on July 27 and August 12. First cut off low of the season happened on August 26th, generating some intense storms over IP and Balearic Islands, including a tornado in Campillos (Malaga).

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	MedCOF-12 climate outlook for temperature	Observed	MedCOF-12 climate outlook for precipitation	
	very warm. The Balearic Islands were, overall, very warm.		Alicante province and Ibiza Island. By contrast, it was very dry in extensive areas of inner IP, southern Extremadura, western and southern Andalusia, Girona province and northern Mallorca.		
Syria *	Above normal	No signal	Almost no precipitation	Dry season	No events

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	**MedCOF-12 climate outlook for temperature**	**Observed**	**MedCOF-12 climate outlook for precipitation**	
Turkey (5)	Near and above normal	Near and above normal for the northern part of Turkey (20/40/40) No signal for eastern part of Turkey	Above normal in the inner and western part of Turkey Below normal in eastern part of Turkey	Above normal (20/30/50) No signal for southeastern part of Turkey	• June 2019, was the hottest June in the long-term period (1971-2019). Turkey June mean temperature is 21.3°C, June 2019 mean temperature was 23.4°C. • June and August 2019 mean temperatures were above normal, July 2019 mean temperature was around normal (RF: 1981-2010). • 8 stations reached new maximum temperature record in June 2019. • 15 stations reached new maximum temperature record in August 2019. • In June 2019, 7 casualties due to heavy rain and flood in Trabzon (in Black Seas Region). • In June 2019, 3 casualties due to heavy rain and flood and 1 casualty due to lightning in Agri (Eastern Anatolian Region) province. • In June 2019, heavy hail caused damage in agricultural areas in Ankara. • In June 2019, heavy rain and flood damaged infrastructure. 3 casualties in Ankara. • In July 2019, flood and landslide caused transportation difficulties, damaged livestock and 2 casualties in Duzce. • In August 2018, flood and landslide caused damage in agricultural areas, livestock, transportation and 2 casualties in Samsun (Black Sea Region).

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High Impact Events
	Observed	**MedCOF-12 climate outlook for temperature**	**Observed**	**MedCOF-12 climate outlook for precipitation**	
Ukraine (1,5)	above normal	above normal (20/30/50)	Below normal (67% stations) Normal (21% stations) Above normal (12% stations)	Below normal in the northwest (45/30/25) No signal in central parts Above normal in southern parts (20/30/50)	• In June - heavy rains (30-60 mm precipitation per 2-9 hours, 05/06 in Hivoron 104 mm/7h and in Nova Kahovka 93/5h, 19/06 in Rava-Ruska 83/3h), showers (32-46 mm per hour), squalls (speed 25 m/s), big hail (diameter 23-30 mm). • In July - heavy rains (30-70 mm precipitation per 2-9 hours), squalls (speed 26-30 m/s). • In August - heavy rains (30-76 mm precipitation per 2-12 hours, 04/08 in Hourly 105 mm/8h and in Bilgorod-Dnistrovsky 121 mm/6h, 14/08 in Drohobych 90 mm/10h), big hail (diameter 27 mm), 13/08 in Chernivtsy region was big hail with diameter 60 mm. • Unfavorable weather conditions locally caused power outage, and disturbances in telecommunications, utilities and transport. • Summer was hottest at some places in the western part of Ukraine in the last 58 years. • June was the warmest in the entire period of meteorological observations (ever since the record-keeping began), maximum temperatures were 30…37 °C. • Summer was arid in most of Ukraine, driest conditions since 1961 were recorded in the north and in the center.

Note:

1 – Basic climatological period (1961-1990)

2 – Basic climatological period (1971-2000)

3 – Basic climatological period (1951-2000)

4 – Basic climatological period (1980-2009)

5 – Basic climatological period (1981-2010)

6 – No information about the basic climatological period

*Data base: ERA5 1981-2010 for temperature, GPCC 1981-2010 for precipitation

North Africa (RA I)

Appendix A: Contributors to MEDCOF-13

National Institute of Meteorology, Tunisia
National Meteorological Directorate, Morocco
National office of Meteorology, Algeria

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High impacts events
	Observed	**MedCOF-12 climate outlook for temperature**	**Observed**	**MedCOF-12 climate outlook for precipitation**	
Algeria (1)	Normal to above normal	Normal to above normal	Below normal	Climatology (33/33/33)	- Hot and drier summer season - New maximum temperature records in 6 cities in Algeria

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High impacts events
	Observed	**MedCOF-12 climate outlook for temperature**	**Observed**	**MedCOF-12 climate outlook for precipitation**	
Egypt *	Above normal	Above normal	Below normal to normal in the north Near normal to above normal in the south	Below normal in the north No forecast in the south	No comment
Libya *	Above normal	Above normal	Near normal to above normal in the western parts Below normal to near normal in the eastern parts	Below normal in the north No forecast in the south	No comment

Country	Seasonal temperature (JJA)		Seasonal precipitation (JJA)		High impacts events
	Observed	**MedCOF-12 climate outlook for temperature**	**Observed**	**MedCOF-12 climate outlook for precipitation**	
Morocco (1)	Near normal to below normal over the Western part of Morocco except Safi (above normal) Normal to above normal over the remaining stations except Al-Hoceima.	Normal to above normal over the extreme North-West, Northeast and South-East Atlas side of Morocco (20/40/40). Normal to below normal over the West (NA-RCC). No special scenario is given elsewhere	Normal to below normal conditions with exception for Oujda (NE), Errachidia, Ouarzazate (SE) and Tan-Tan(S).	No clear scenario (33/33/33)	-June: New records of daily maximum temperature for Midelt. -July: 24 July, heavy rainfall due to convective situations (landslide in Alhaouz region) -August: New record of daily maximum temperature for 3 stations (Oujda, Bouarfa et Errachidia). 28 August heavy rainfall due to convective situations (floods in Taroudant region)
Tunisia (1)	Near normal to above normal	Above normal	Above normal in some parts of the south Normal to below normal elsewhere	Below normal	No comment

Note:
(1) Basic climatological period (1981-2010)
* Data source: Temperature: NCEP/NCAR reanalysis data, precipitation: GPCC first guess product

References:

MedCOF 12 Outlook: http://medcof.aemet.es/images/doc_events/medcof12/step3/docStep3/Consensus_Statement_MedCOF-12_final.pdf

SEECOF Online Forum: http://www.seevccc.rs/forum/

PRESANORD: http://nwp.gov.eg/index.php/rcof/presanord

WMO RA I RCC Node on Climate Monitoring Website with monitoring results: http://www.meteo.tn/htmlen/donnees/climatemonitoring.php

WMO RA VI RCC Node on Climate Monitoring Website with monitoring results: http://www.dwd.de/rcc-cm

Météo France climate monitoring products: http://seasonal.meteo.fr (password protected)

ECMWF ERA Interim reanalysis: http://www.ecmwf.int/en/research/climate-reanalysis/era-interim

ECMWF ERA5 reanalysis: https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5

NOAA-NCEP-CPC northern hemisphere teleconnection patterns: http://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml

ECA&D, E-OBS: http://www.ecad.eu

GPCC: http://gpcc.dwd.de