MEDITERRANEAN CLIMATE OUTLOOK FORUM
MEDCOF-21 Online Forum

MONITORING SUMMARY MEDCOF-21

for October 2023

Final version

Last update: 29 November 2023

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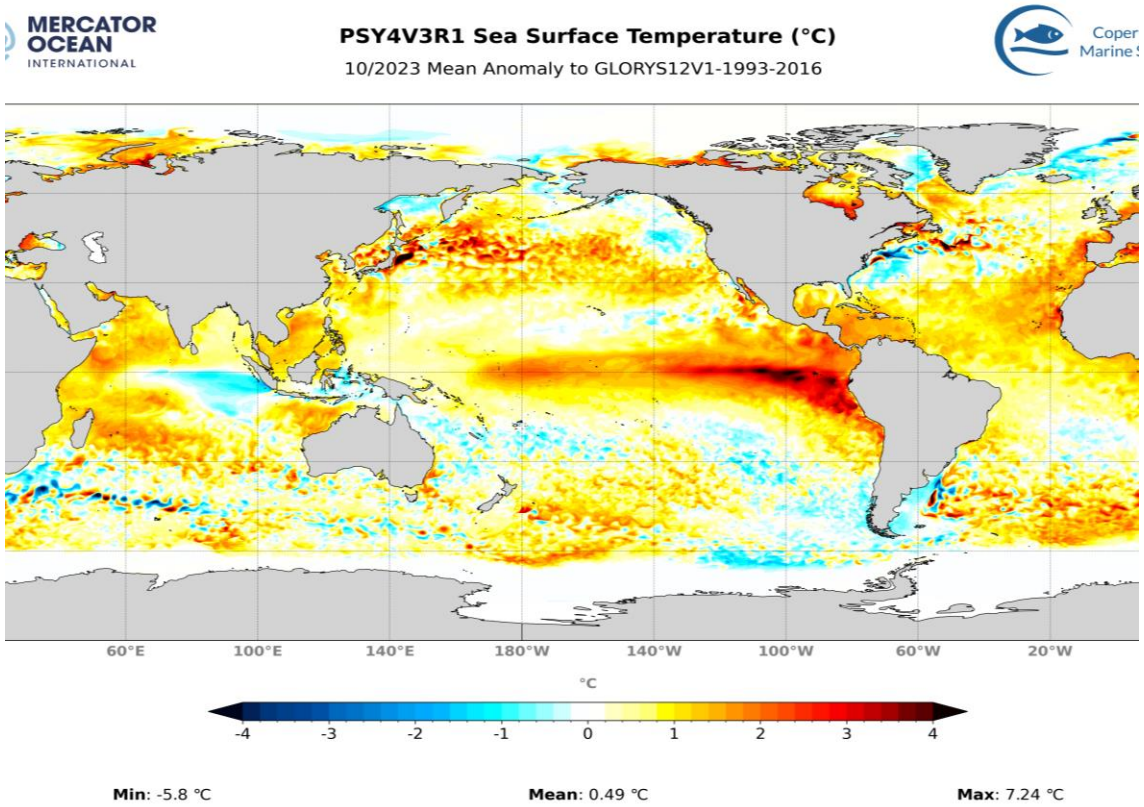
The following MedCOF monitoring summary is based on

- climate monitoring results from RA VI RCC Node-CM at DWD,
- Seasonal forecast bulletins and verification bulletins from RA VI RCC Node-LRF at Météo France,
- SEECOF monitoring report
- Assessments from NOAA CPC and BOM Australia

1 Oceanic Analysis

1.1 Sea Surface Temperature (SST) anomalies

- **Equatorial Pacific**: El Niño has developed over the summer and has strengthened to reach moderate to strong intensity level. Large positive SST anomalies can be seen over the eastern equatorial Pacific, but recently, they became also larger over the central equatorial Pacific. The SST anomaly for the Nino3.4 region has increased continuously this year from negative values last winter to +1.5 °C for the 3-month period August-October 2023, see https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php. Nino3.4 monthly index issued from Mercator Ocean analysis: +1,6 °C. The western equatorial Pacific had around-normal temperatures.
- The **northern Pacific** was mostly some northern coastal areas. The PDO remains continuously in a negative phase since 2020: https://www.ncei.noaa.gov/access/monitoring/pdo/ and was especially intense in recent months.
- **Atlantic**: Warm anomaly over all of the tropical North Atlantic, more pronounced off the African coast and Caribbean. In the central North Atlantic, SST was mostly close to normal, but clearly higher close to the European coasts. In the western Arctic region, SST was mostly negative due to some outbreaks of colder air.
- **Indian Ocean:** A east-west gradient can be clearly detected south of the equator. Positive value of DMI (positive phase of IOD).
- The **western Mediterranean Sea** was much warmer than normal and has further warmed since September 2023. On the other hand, the **eastern Mediterranean** shows a cooling trend since last month; October temperatures were closer to normal.
- The was warmer than normal in the west, but colder in the east.



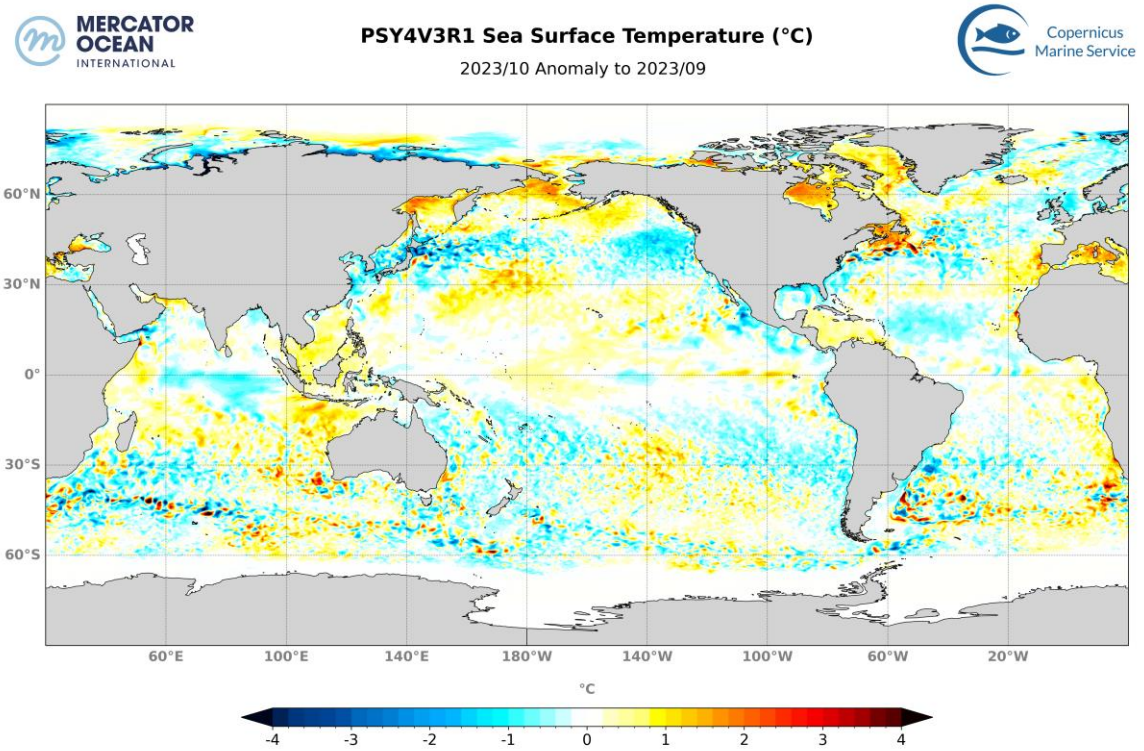


Figure 1.1: Upper map: sea surface temperature anomalies for October 2023. Lower map: anomaly differences October minus September 2023 (anomaly trend). Source: Météo France, Mercator Ocean data.

1.2 ENSO analysis of recent months and years:

The present El Niño has developed since this boreal spring 2023. Before, there were three successive La Niña seasons. The development of El Niño was quick and strong in the eastern Pacific (Niño 1+2 region), but came much later and weaker in the central Pacific (Niño 4 region).

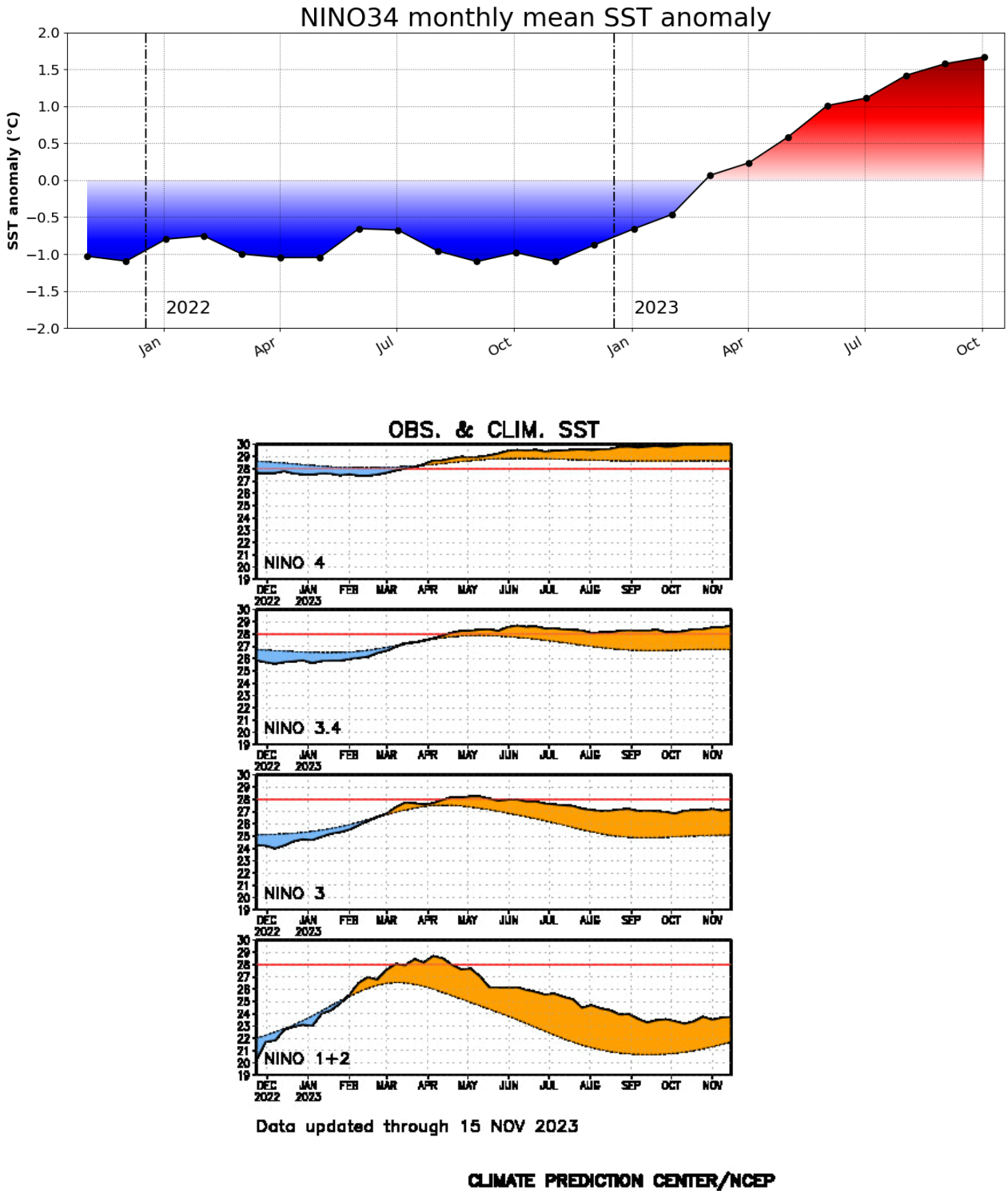


Figure 1.2: Evolution of sea surface temperature anomalies in several Niño boxes. Source: Upper map: Météo France, Mercator Ocean data. Lower map: NOAA CPC, https://origin.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml#history

1.3 ENSO Forecasts

Recent multi-model forecasts of Niño3.4 SST show that El Niño will likely persist during the coming boreal winter (DJF) 2023/24, reaching its peak in December 2023 or January 2024 and weakening afterwards. Neutral conditions are not to be expected before boreal spring 2024, likely around May 2024.

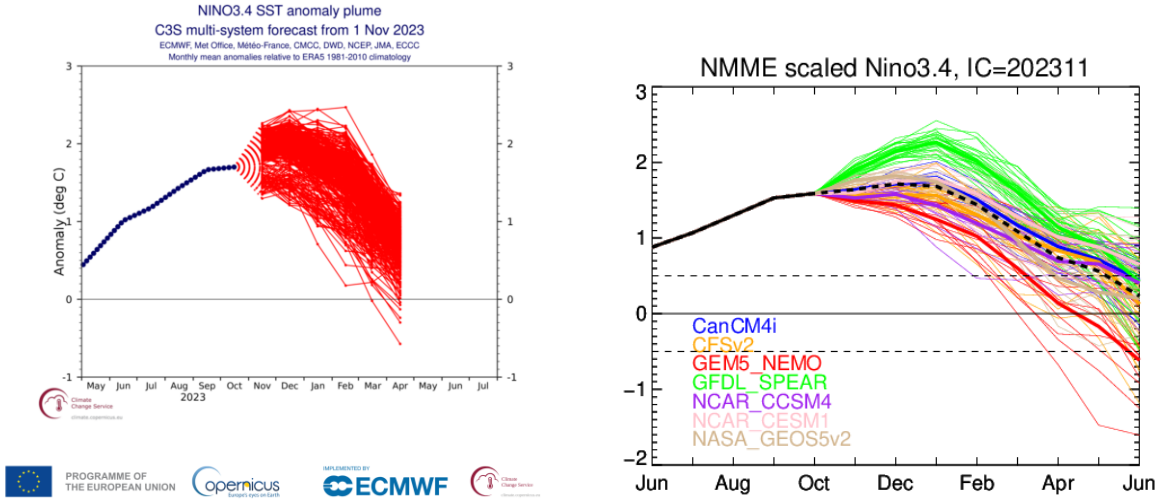


Figure 1.3: Evolution of El Niño3.4 expected temperature from C3S (left) and NMME (right) until April-June 2023. Source: C3S: https://climate.copernicus.eu/charts/c3s_seasonal/c3s_seasonal_plume_mm ; NMME: https://www.cpc.ncep.noaa.gov/products/NMME/current/plume.html

1.4 Pacific Decadal Oscillation (PDO) analysis:

Since January 2020, PDO was negative without interruption and became more intense over the year. October 2023 value of PDO Index after NOAA NCEI was -2.36, https://www.ncei.noaa.gov/access/monitoring/pdo/).

PDO- means warm SST anomalies in the interior North Pacific and cool SST anomalies along the North American coast or above average sea level pressures over the North Pacific, see https://www.ncei.noaa.gov/access/monitoring/pdo/ . A negative PDO has a tendency to intensify La Niña, but to weaken El Niño events.

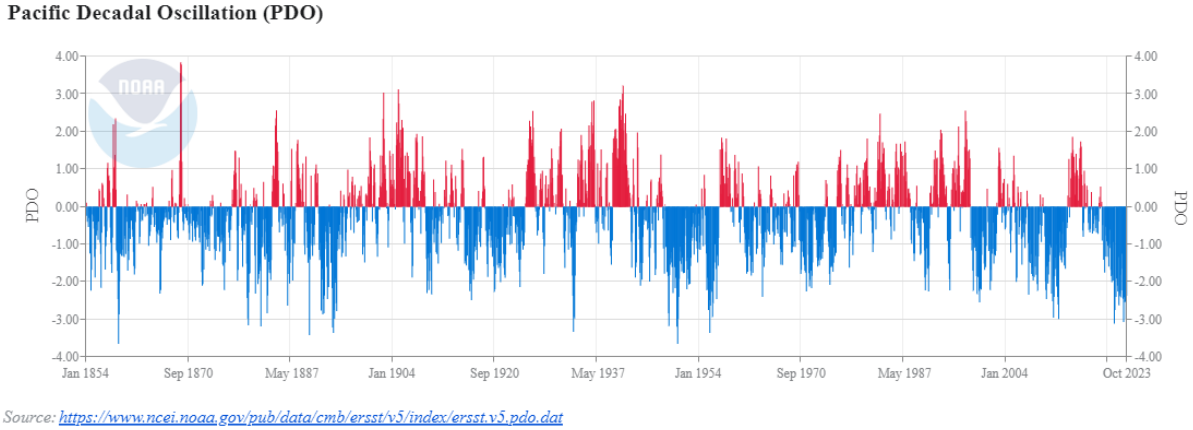
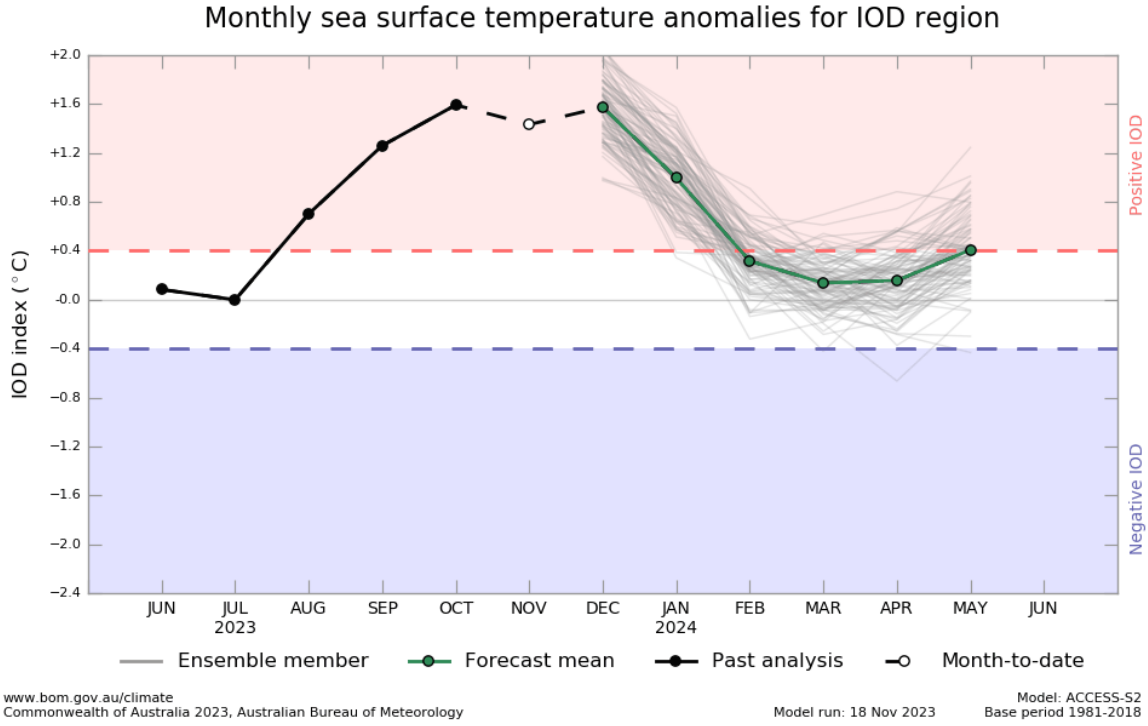


Figure 1.4: Evolution of PDO index, source: https://www.ncdc.noaa.gov/teleconnections/pdo/

1.5 Indian Ocean Dipole (IOD):

A significant positive IOD (east-west gradient of SST anomalies) persists since August 2023 and intensified to a strong event until October 2023. Forecasts show a continuation with same intensity until December 2023, then weakening to neutral conditions until end of boreal winter 2023/24.

IOD events typically break down in November or December with the arrival of the Asian monsoon, but given the strength of this event, it is likely that the breakdown will occur later than usual. Additionally, during El Niño, the onset of the North Australian Monsoon tends to be delayed. DMI (Dipole mode index) from Mercator Ocean analysis was +1.5 °C for October 2022.



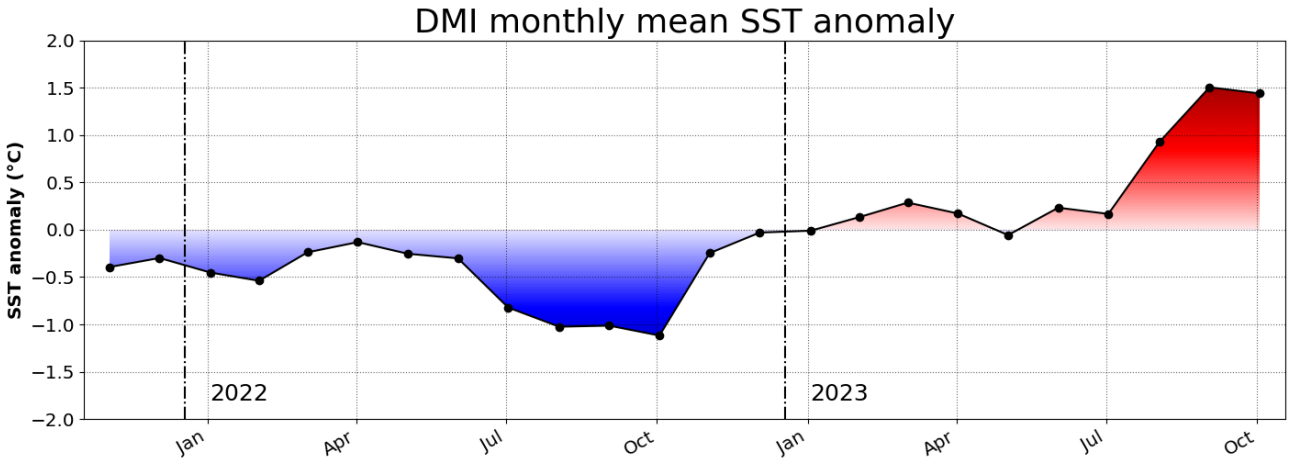


Figure 1.6 Observed and expected evolution of Indian Ocean Dipole. Source: upper map: BOM, http://www.bom.gov.au/climate/enso/index.shtml#tabs=Indian-Ocean), lower map: Météo France, Mercator Ocean data

2 Atmospheric Circulation Analysis

2.1 Velocity potential and stream function anomalies in the high troposphere

Velocity Potential 200 hPa: Upward anomaly motion around the equatorial Pacific (linked to El Niño) and over the northern tropical Atlantic (warm anomalies of sea surface). Dipole with downward anomaly over the eastern Indian Ocean and upward anomaly motion over the extreme west of the Indian Ocean and over Africa (positive IOD).

Stream function at 200 hPa: neither a dipole around the equator nor a clear teleconnection towards mid-latitudes are observed.

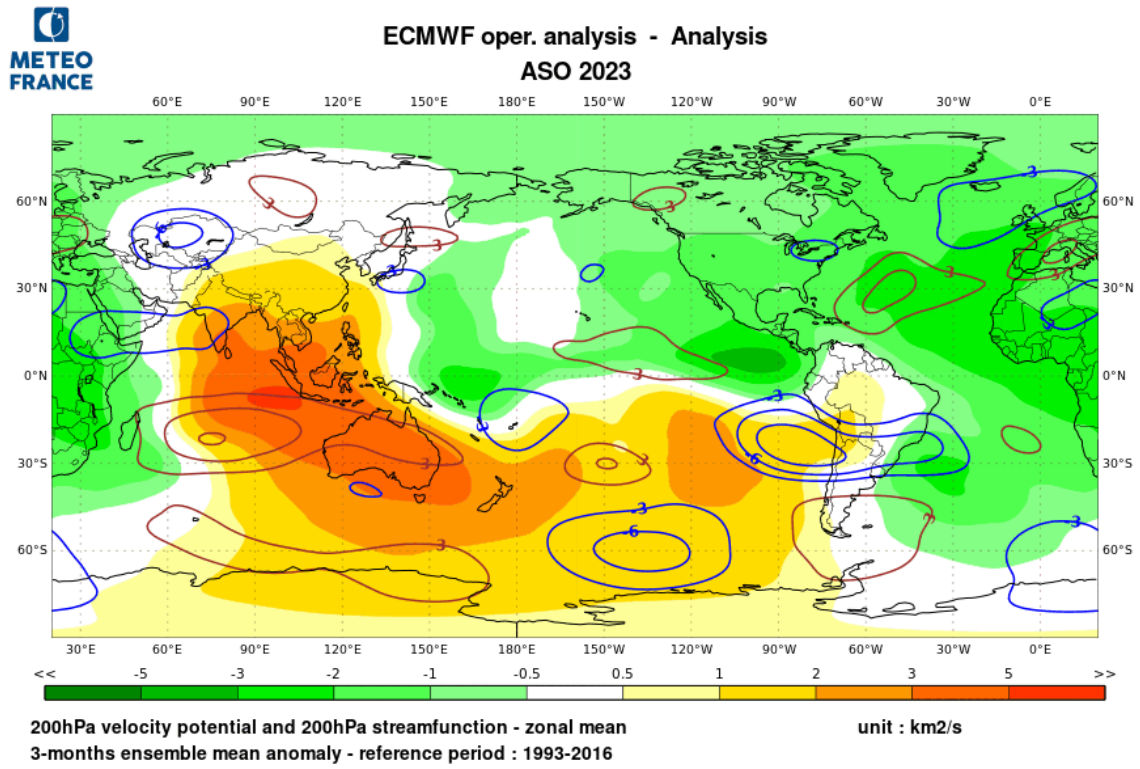


Figure 2.1: Averaged anomalies of stream function (contours) and velocity potential (shaded) average during August-October 2023. Positive shaded values (yellow/orange): convergence (downward motions). Negative ones (green): divergence (upward motions). Positive contours (red): anticyclonic circulation in the northern hemisphere, negative contours (blue): cyclonic circulation in the northern hemisphere.

Source: Météo France, http://seasonal.meteo.fr/content/suivi-clim-cartes-ref93-16 .

2.2 SOI index:

SOI index is negative (El Niño) since July 2023, in line with SST anomalies. However, the peak value up to now was in September 2023 (−1.3); afterwards in October, SOI weakened to −0.5. This would mean that the atmospheric response ran out of phase from the oceanic component in October. Nevertheless, variability can be large from month to month.

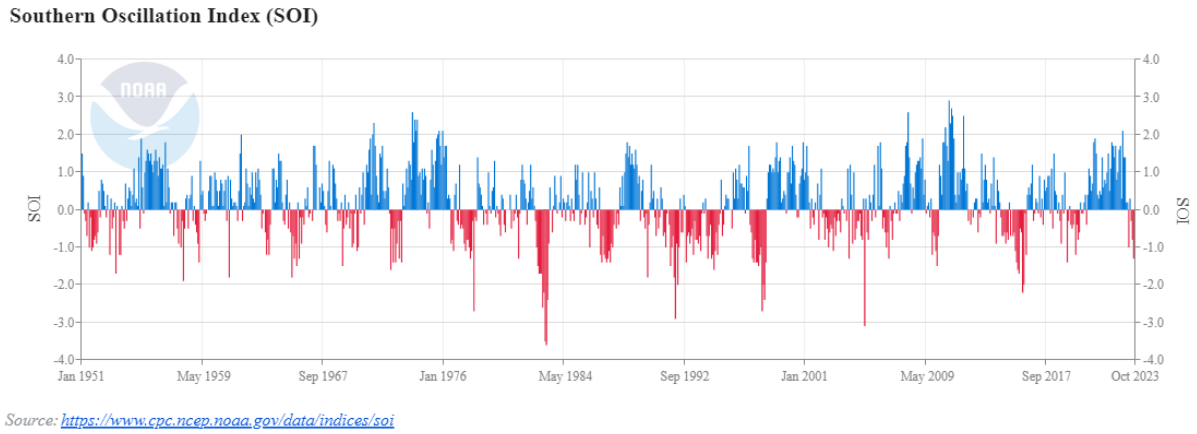


Figure 2.2: Southern Oscillation Index (SOI). Positive values mean La Niña response, negative values El Niño response. Source: https://www.ncdc.noaa.gov/teleconnections/enso/indicators/soi/

2.3 Geopotential height at 500 hPa:

In October 2023, there was an extension of the polar vortex in the direction to Europe. This resulted in negative geopotential anomalies in Northern Europe combined with Arctic air outbreaks. Over the North Atlantic, high geopotential in the north expanded to eastern Greenland and Iceland, leading to a NAO-situation. The Mediterranean region including North Africa, on the other hand, was dominated by anticyclonic conditions and subtropical air, in the west from the subtropical Atlantic, in the east from the Arabic Peninsula.

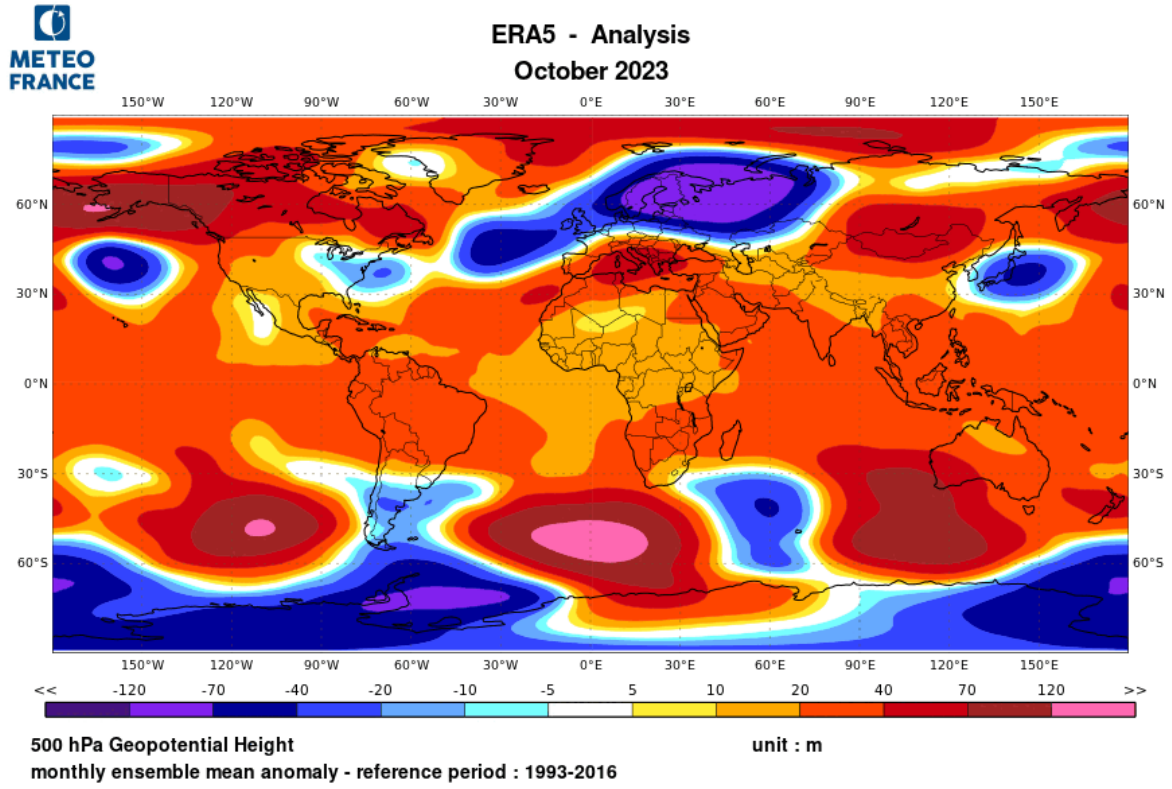


Figure 2.3: Anomalies of Geopotential height at 500hPa (Source: Météo-France, http://seasonal.meteo.fr/content/suivi-clim-cartes-ref93-16 , data from ECMWF)

2.4 Sea level pressure (SLP)

Near surface, the Greenland High expanded far into the Arctic Sea, whereas a low-pressure zone extended from the North Atlantic over the northern and middle latitudes to Russia. A cold airflow between the Greenland High and northern Russia influenced mainly Northern Europe, but very little areas further south. Much of the MedCOF domain remained mostly under anticyclonic conditions, though not above normal.

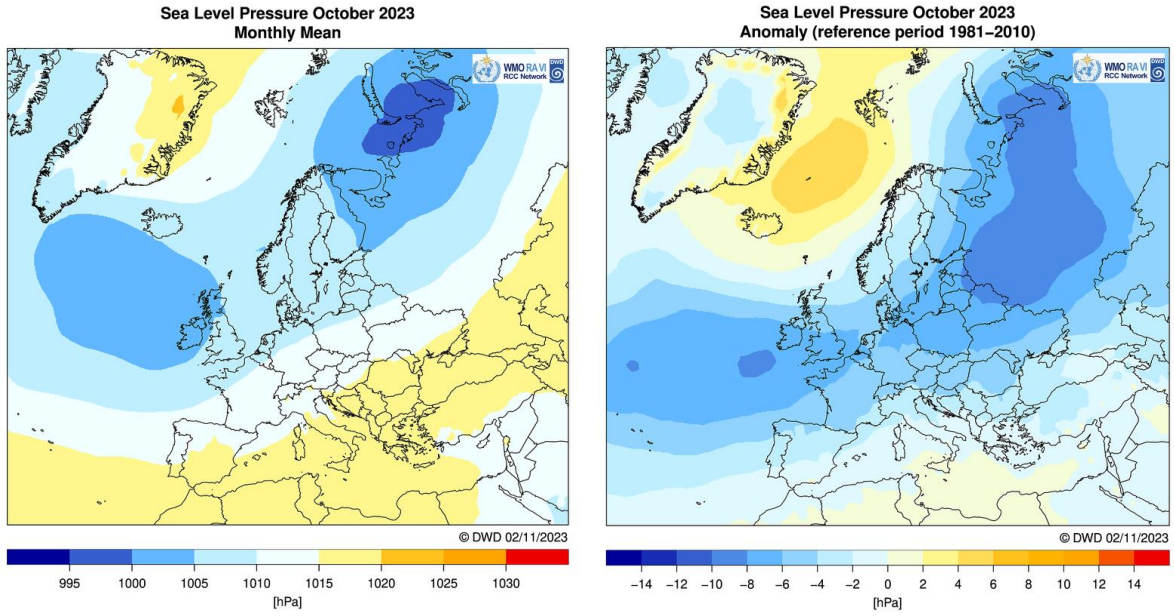


Figure 2.4: Mean sea level pressure and anomalies (1981-2010 reference) over the North Atlantic, Europe and North Africa for October 2023. Source: DWD, https://www.dwd.de/DE/leistungen/rcccm/int/rcccm_int_ppp.html?nn=490674

2.5 Circulation patterns

The most dominating circulation patterns relevant for Europe and the MedCOF region were NAO- and a positive East Atlantic pattern (EA+). NAO- refers to the Greenland High in combination with the low-pressure zone extending over the whole central North Atlantic. EA+ refers to the geopotential gradient between the central North Atlantic and the Azores High, which occurred further south and mainly over the East Atlantic. Therefore EA+ had impact on the MedCOF domain by a westerly or southwesterly flow from the North Atlantic to northern parts of the domain.

Table of Teleconnection Indices

OCTOBER 2023

MONTH	NAO	EA	WP	EP-NP	PNA	TNH	EATL/WRUS	SCAND	POLEUR
OCT 23	-1.7	1.2	-0.8	0.3	1.5	---	0.6	-0.6	-0.1
SEP 23	-0.3	2.7	1.3	-2.6	0.8	---	-2.1	-0.3	0.8
AUG 23	-1.6	2.1	-0.4	-1.2	0.4	---	-2.4	-1.1	-1.1
JUL 23	-2.1	1.8	1.3	0.8	0.7	---	-1.8	-0.6	0.0
JUN 23	-0.3	-1.1	0.3	-1.9	0.8	---	0.4	0.8	0.2
MAY 23	0.4	-0.1	1.0	-0.8	-0.7	---	-2.2	-1.1	1.9
APR 23	-0.8	-0.2	-0.2	-0.7	-0.7	---	-0.2	1.3	-0.7
MAR 23	-1.6	0.5	0.6	0.4	-1.9	---	2.0	-2.1	0.9
FEB 23	0.6	-0.8	2.5	-0.5	-1.2	1.7	1.5	-0.7	-0.9
JAN 23	0.9	-1.0	2.0	1.4	-0.4	-0.4	-0.6	0.7	-1.1
DEC 22	-0.2	0.0	0.0	---	-1.0	-0.7	-1.2	0.9	-1.2
NOV 22	0.6	1.2	0.3	0.4	-0.7	---	0.8	1.6	-0.3
OCT 22	-0.3	0.2	1.0	-0.1	0.3	---	-0.7	-0.2	1.1

Table 2.1: Evolution of the main atmospheric indices for the Northern Hemisphere for the last months: http://www.cpc.ncep.noaa.gov/products/CDB/Extratropics/table3.shtml

2.6 North Atlantic Oscillation (NAO) and Arctic Oscillation (AO)

The NAO- phase persisted a long time from mid-September to mid-November 2023. In recent days, NAO has turned to NAO+, but GEFS forecasts suggest that this is only a short interruption, and a new NAO- phase will likely come back soon and will continue into December.

The AO also had a quite long negative period from early October to early November. This explains the Arctic cold air outbreaks in Northern Europe in October. In November, presently an AO+ phase is ongoing, but forecasts suggest again an AO- period likely going into December, in line with NAO. This would likely mean that further cold Arctic air might come to Europe.

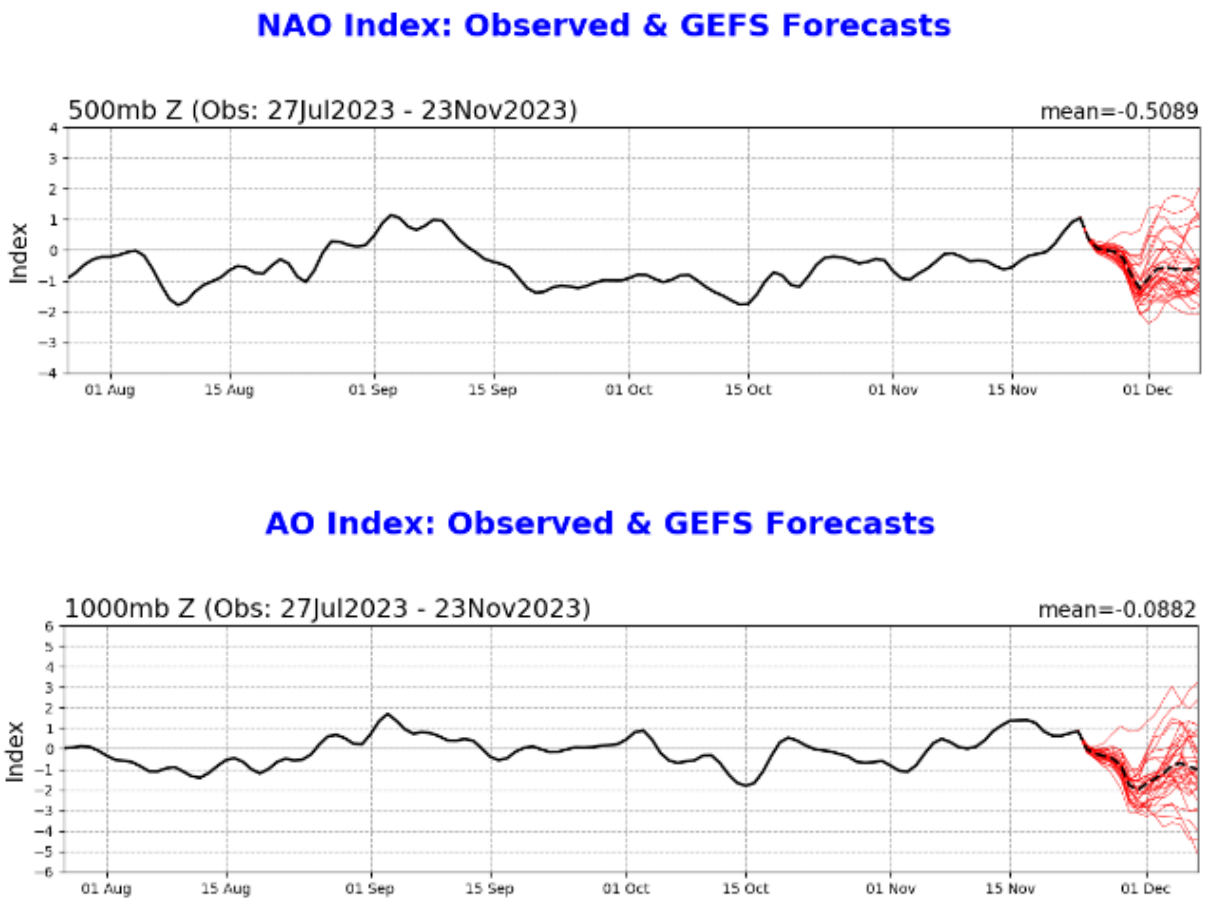


Figure 2.6: North Atlantic Oscillation (NAO) and Arctic Oscillation (AO) indices. Source: NOAA CPC, https://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/ao.shtml

2.7 Weather regimes

Over North Atlantic and Europe, weather regime frequencies showed intra-seasonal variability during the ASO season. Nevertheless, the Atlantic Low regime has been dominant each of the three months. Over the quarter, Atlantic Low and Greenland Anticyclone were observed at a higher frequency than normal.

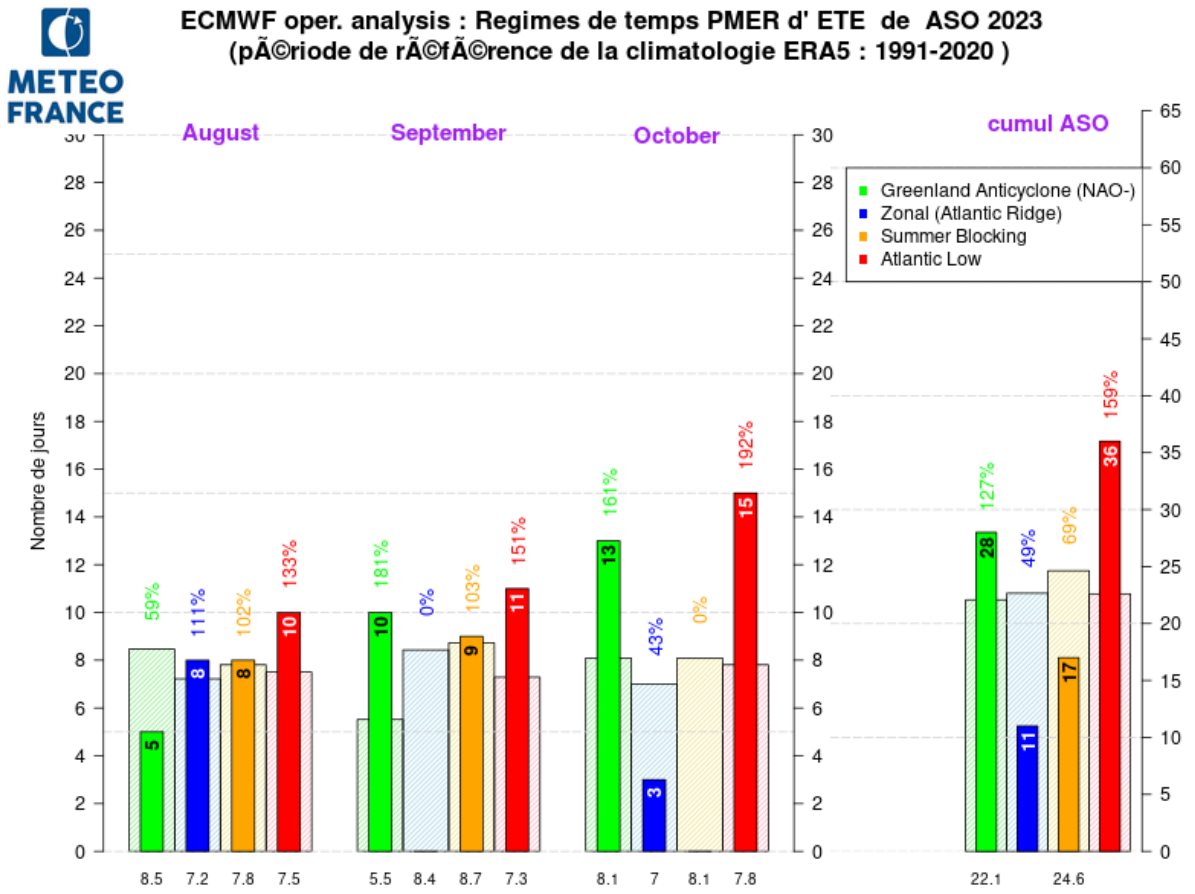


Figure 2.7: Weather regimes frequencies during ASO 2023 compared to 1991-2020 climatology and aggregation over the entire quarter, source: Météo France, data from ERA5.

2.8 Madden-Julian Oscillation (MJO)

In September 2023, MJO was active over the eastern Indian Ocean and the Maritime Continent, favoring the NAO+ regime. However, in October, MJO was mainly inactive with little impact. In November, MJO became active again, this time over the Pacific and Africa.

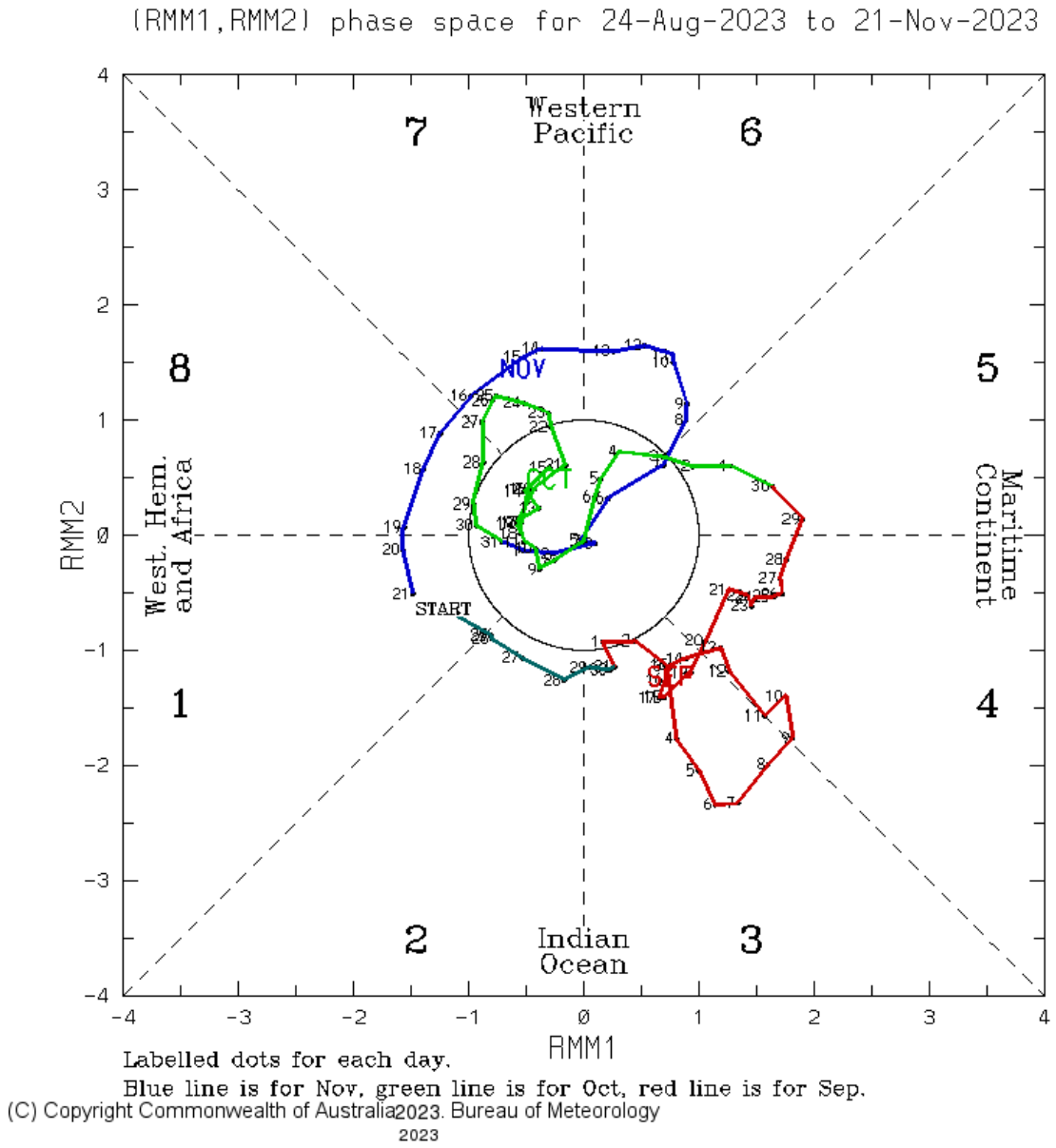


Fig. 2.8: MJO phase diagram August-November 2023. Source: http://www.bom.gov.au/climate/mjo/

3 Drivers

El Niño ==> Statistical effect on the Atlantic/Europe sector is different between the beginning and the end of winter

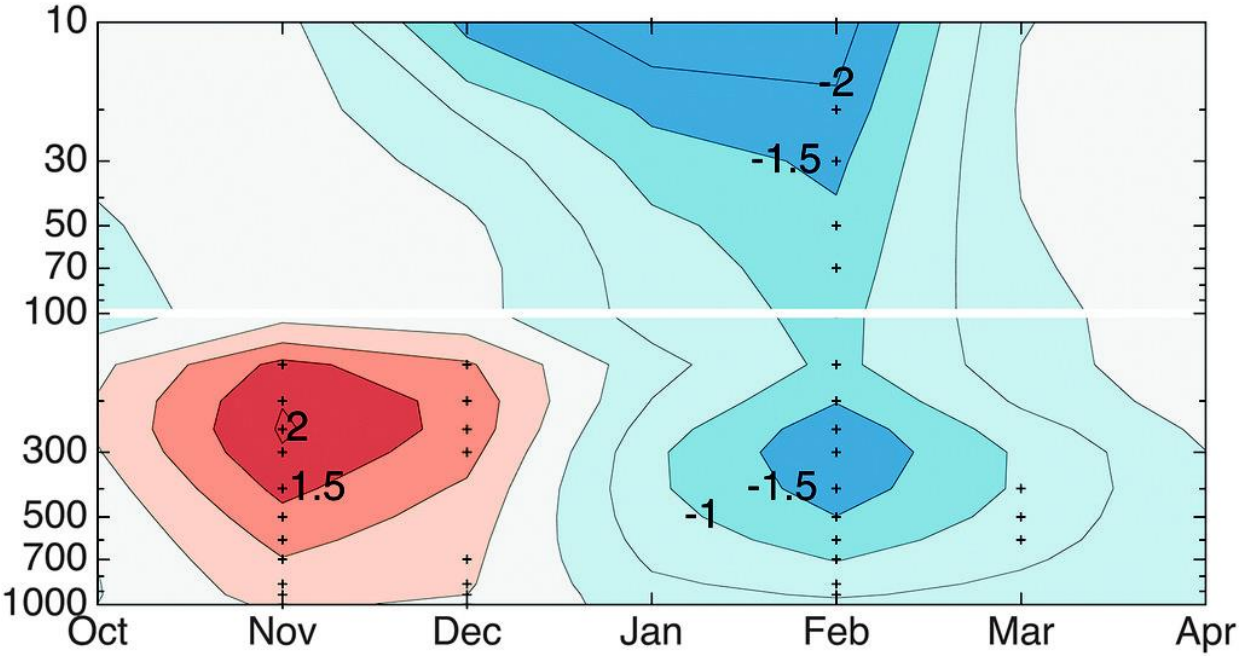


Fig 3.1: Regression of zonal wind (m s−1) on the Niño-3.4 index on a pressure level–month plane. The zonal wind time series is defined as the area average of the zonal wind in the area 40°–50°N, 90°W–0° for levels below 100 hPa, and the zonal mean is in the latitude band 50°–60°N for levels at and above 100 hPa (Citation: Martin P. King et all, Bulletin of the American Meteorological Society 99, 7; 10.1175/BAMS-D-17-0020.1)

At the end of autumn and beginning of winter, the westerly flow is reinforced, while at the end of winter and beginning of spring it is attenuated (following an increased frequency of SSW).

IOD ==> In the case of a strong positive phase of the IOD, it is an NAO+ type circulation which is favored during winter

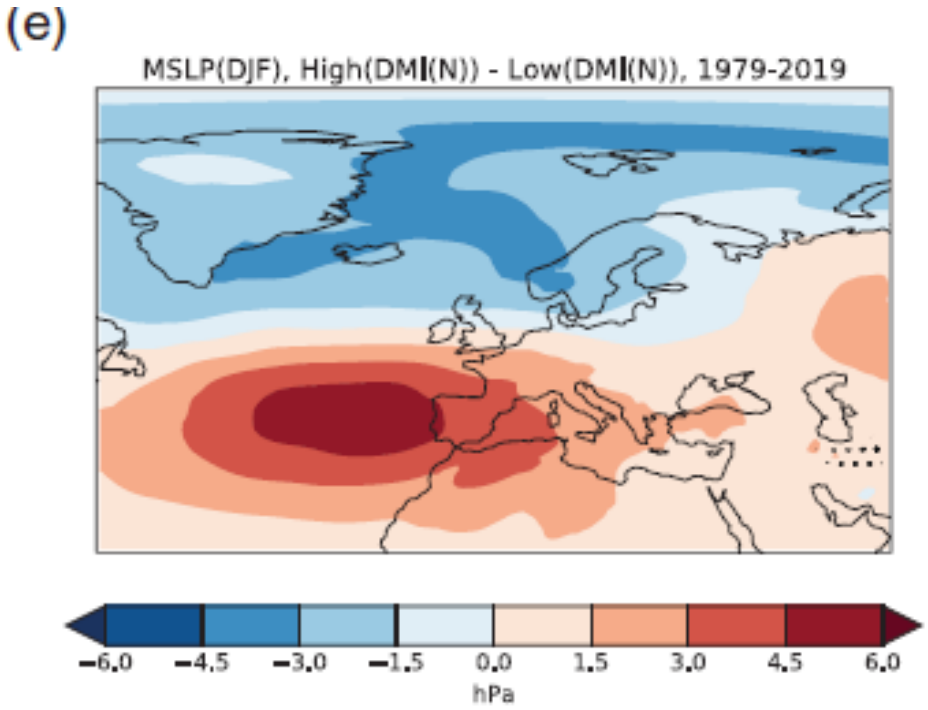


Fig 3.1: MSLP (hPa) with ENSO signal removed and stippling denoting statistical significance at the 90% level (source : Hardiman et al. Predictability of European winter 2019/20: Indian Ocean dipole impacts on the NAO. Atmospheric Science Letters, 21(12), e1005)

4 Temperature

Europe/RA VI domain

According to Copernicus data, October 2023 was 1.30 ºC warmer than the 1991-2020 average in Europe and the fourth warmest October on record. The warming trend rate was about 0.4 °C per decade. Temperatures were well above normal in much of Europe/RA VI including the Mediterranean region, only Northern Europe was colder than normal.

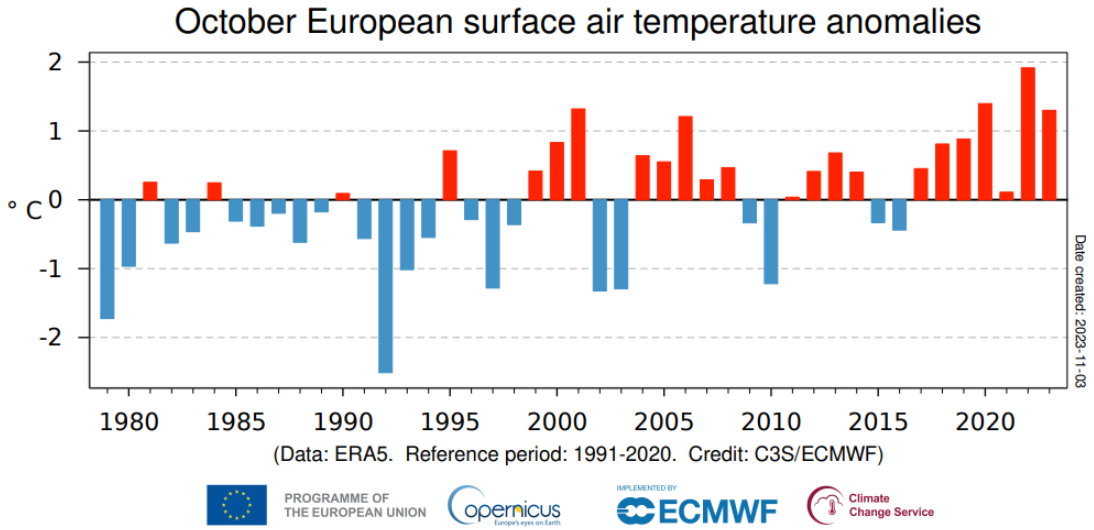


Fig. 4.1: Monthly European-mean surface air temperature anomalies relative to 1991-2020 for October months, from 1979 to 2023. Data source: ERA5. Credit: Copernicus Climate Change Service/ECMWF, https://climate.copernicus.eu/surface-air-temperature-maps

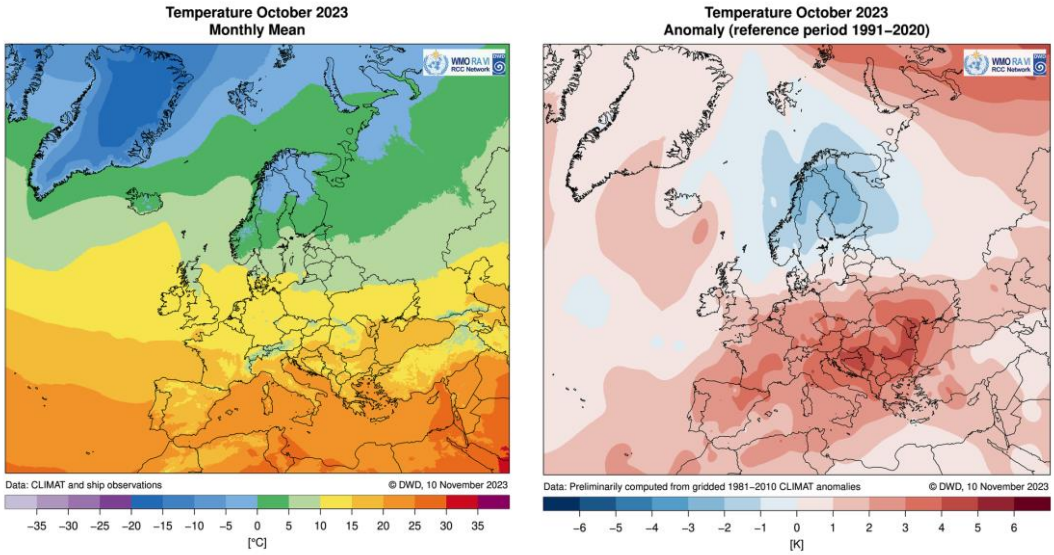


Fig. 4.2: Mean temperature (left) and anomalies (1991-2020 reference, right) in °C in the RA VI Region (Europe) interpolated from CLIMAT station data, for October 2023. Source: DWD, https://www.dwd.de/EN/ourservices/rcccm/int/rcccm_month_ttt.html

Within the RAVI MedCOF domain, October 2023 was everywhere warmer than on 1991-2020 average. Anomalies were mainly between +1 °C and +4 °C, highest on the northern and eastern Balkan Peninsula, lowest in eastern Türkiye, eastern Syria, Armenia, and Azerbaijan.

In terms of terciles, the whole domain had temperatures above the upper tercile (1993-2016 reference), without any exceptions.

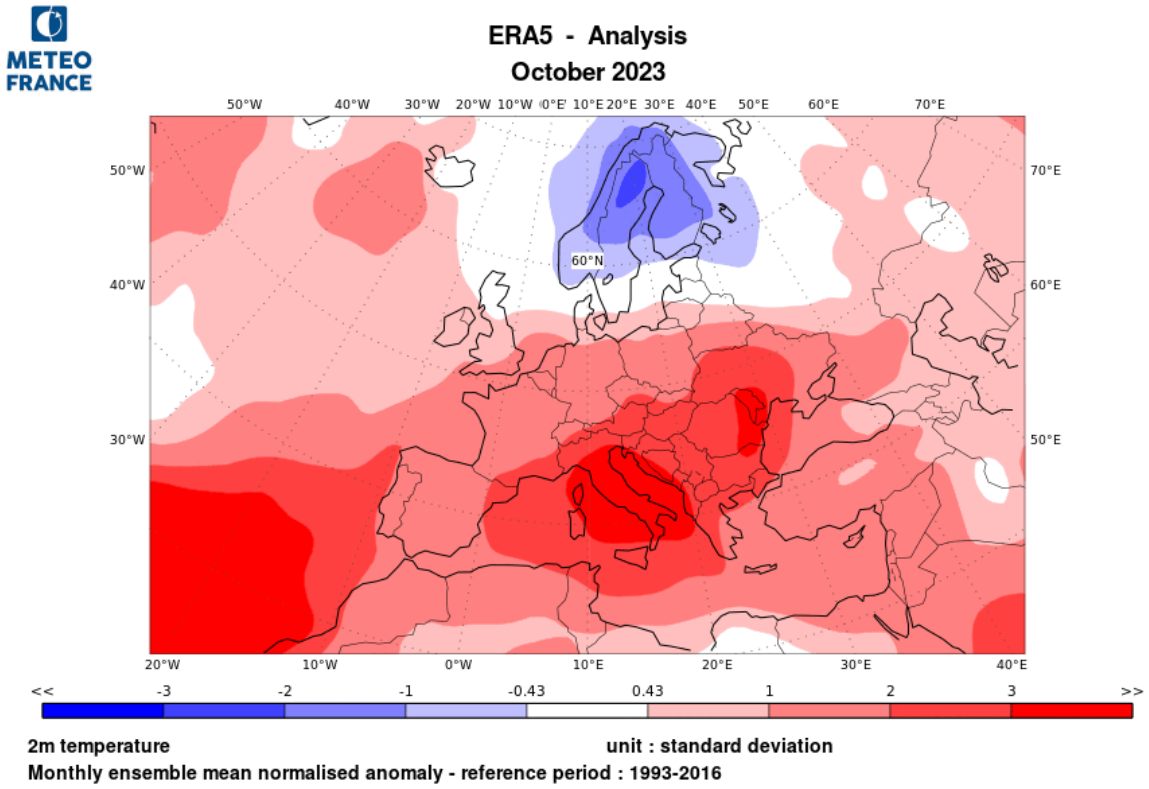


Fig. 4.3: Mean standardized temperature anomalies with terciles for October 2023. Source : Météo France, http://seasonal.meteo.fr/content/suivi-clim-cartes-ref93-16, data source : ERA5 reanalysis

Temperature in North Africa

Fig. 4.4 shows the monthly trend of air temperature anomaly in degrees Celsius of October from 1979 until 2023. For each year, the positive anomaly is indicated by the red vertical bars and the negative anomaly is indicated by the blue vertical bars. The black line tracks the changes in the trend over time.

For October 2023, mean temperature of North Africa region was above the 1991-2020 normal by +0.3 °C. The warming trend rate was about 0.4°C per decade.

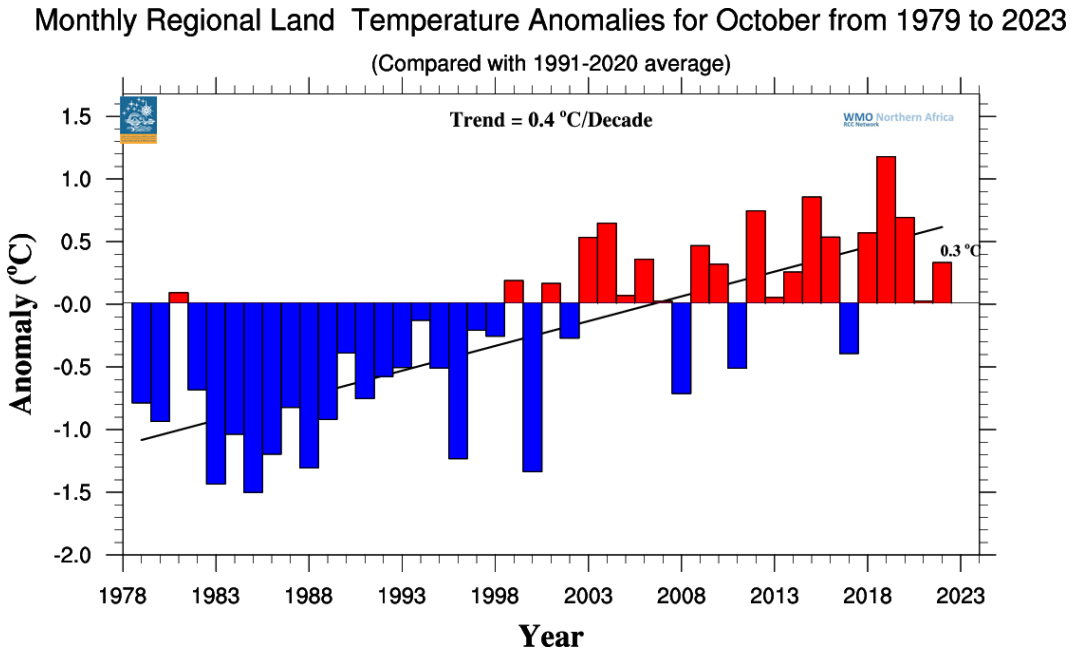


Figure 4.4: October mean temperature anomaly (until October 2023) time series plot with trend line

5 Precipitation

Europe/RA VI domain

Western and northern parts, which were located in the low-pressure zone, had well above-normal precipitation, partly heavy rain. This concerned Portugal, western Spain, France except for the south, northern Italy, Slovenia, and northern Ukraine. The other parts around the Mediterranean Sea, the Balkan Peninsula, and western Türkiye had mostly below-normal precipitation.

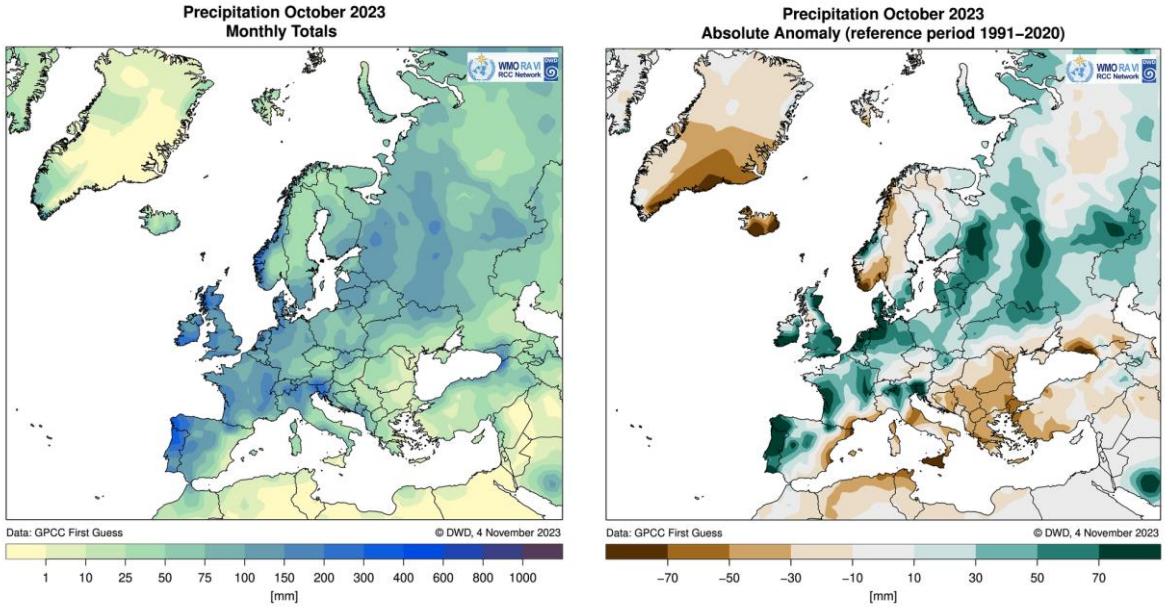


Fig. 5.1: Monthly precipitation totals (left) and percentage of 1991-2020 normal (right) for October 2023 in Europe/RAVI. Data from GPCC (First Guess version). Source: DWD, https://www.dwd.de/EN/ourservices/rcccm/int/rcccm_month_rrr.html

In terms of terciles, the above-mentioned areas with above-normal precipitation had totals above the upper tercile. The other areas received precipitation totals mostly in the lower or middle third.

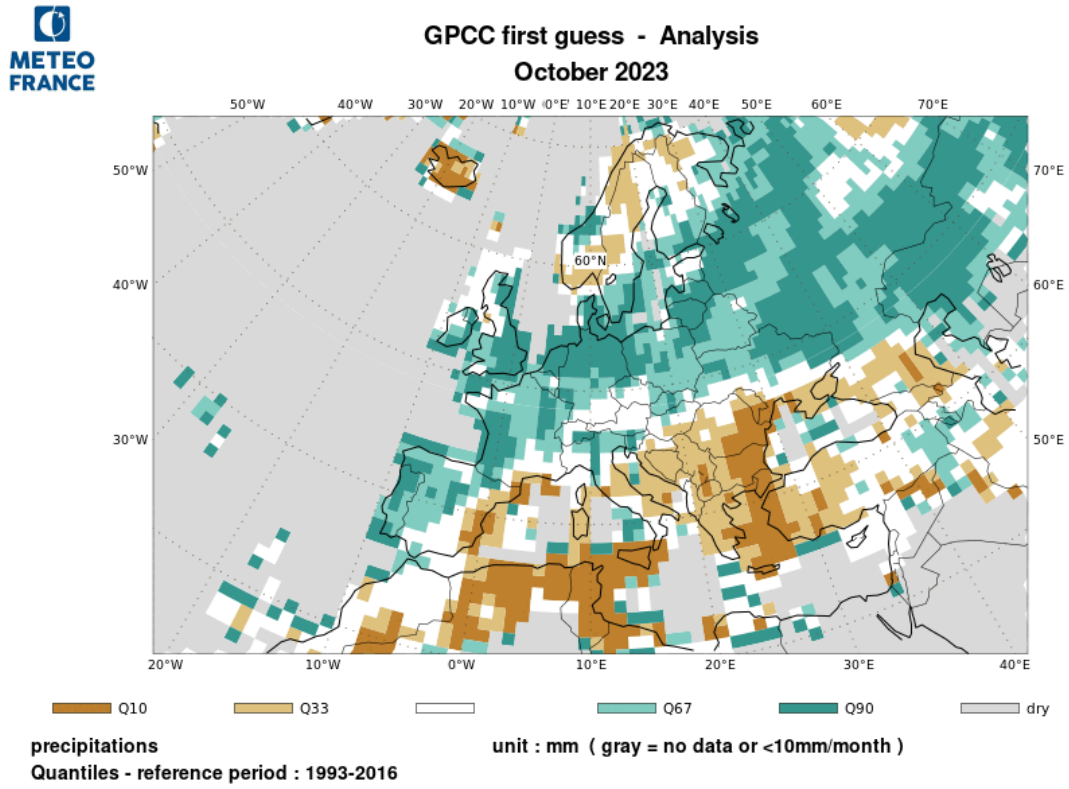


Fig. 5.2: Quantiles of monthly precipitation totals for October 2023. Source : Météo France, http://seasonal.meteo.fr/content/suivi-clim-cartes-ref93-16, data source : GPCC

Precipitation in North Africa

October 2023 was mainly drier than normal in the RAI North Africa domain. Large parts in the domain have received only less than 60% of the normal precipitation (1991-2020 reference period), particularly Tunisia, North Algeria and Morocco. It was slightly wetter than normal over the eastern part of the domain including east of Libya and Egypt (but total precipitation was less than 20 mm over these regions).

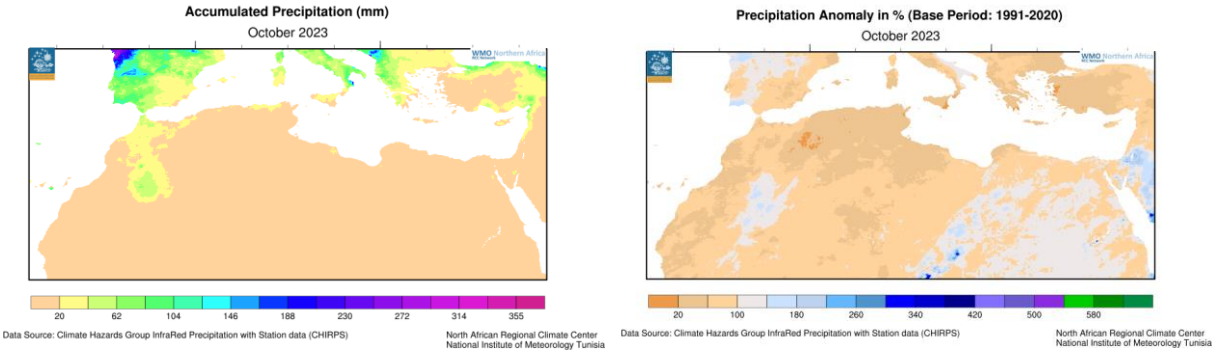


Figure 5.3: Left: Total precipitation; Right: Percentages of normal in the RAI-NA Region (North Africa)
Data from NCDC (National Climate Data Centre NOAA – reference 1991-2020)
https://www.meteo.tn/en/climate-monitoring-watch

3. Soil moisture

Europe/RA VI domain

Soil moisture was below normal in October 2023 especially in eastern Italy and on the eastern Balkan Peninsula.

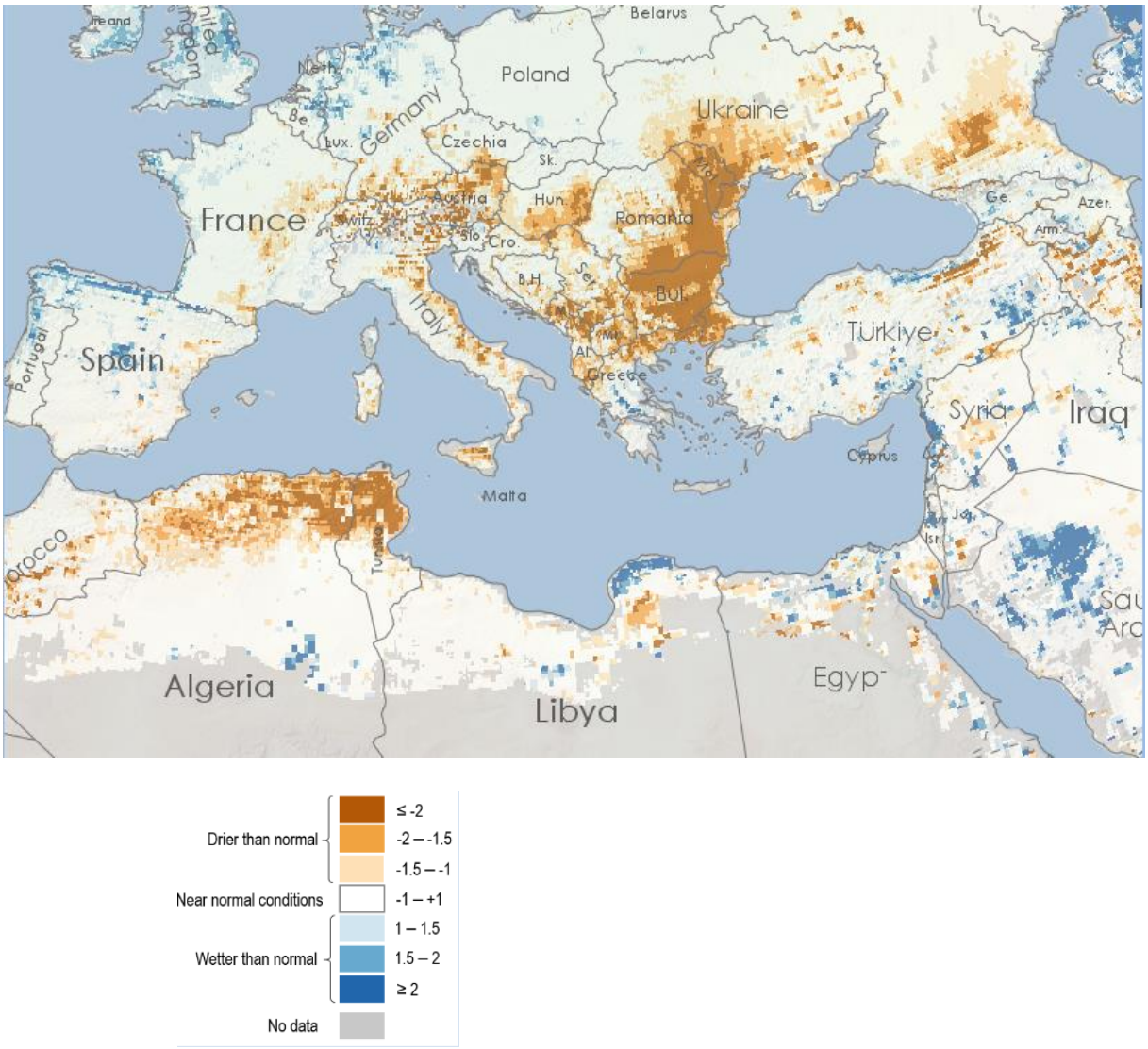


Figure 6.1: Monthly anomalies of soil moisture index (SMI) in October 2023, reference period: 1995-2022. Source: European Drought Observatory (EDO), https://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1111

North Africa/RA I domain

In October 2023, soil moisture anomalies were slightly above normal over the extreme north and the east of Libya, and over the center of Morocco. The north and center of Tunisia, north of Algeria and north of Morocco had below normal soil moisture. Elsewhere anomalies were close to normal.

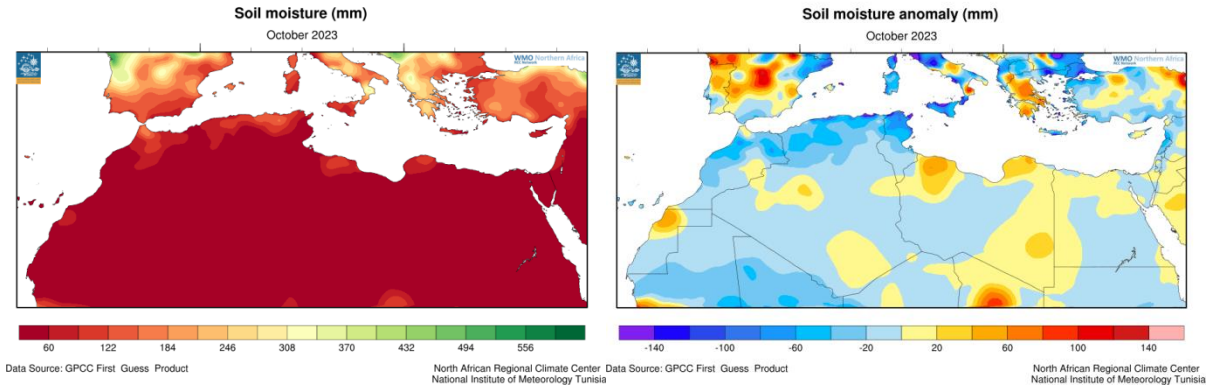


Figure 6.2: October 2023 soil moisture, left: monthly total, right: monthly anomalies with reference period: 1981-2010.

References:

Météo France monthly and seasonal climate monitoring maps: http://seasonal.meteo.fr

WMO RA I RCC Node on Climate Monitoring Website with monitoring results: https://www.meteo.tn/en/climate-monitoring-watch

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

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Copernicus Climate Change Service: https://climate.copernicus.eu

NOAA National Centers of Environmental Information (NCEI): https://www.ncei.noaa.gov/

NOAA National Centers of Environmental Prediction (NCEP): https://www.ncep.noaa.gov/

Deutscher Wetterdienst (DWD), Germany: https://www.dwd.de

EU Joint Research Centre: http://edo.jrc.ec.europa.eu

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