Earth Sciences Department

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Forecast Briefing

March 2026

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Climate Services Team (CST)

Earth System Services (ESS)

Barcelona Supercomputing Center (BSC)

Tuesday 24th March 2026

Outline

I. Recent state of the climate

II. Subseasonal forecasts

III. Seasonal forecasts

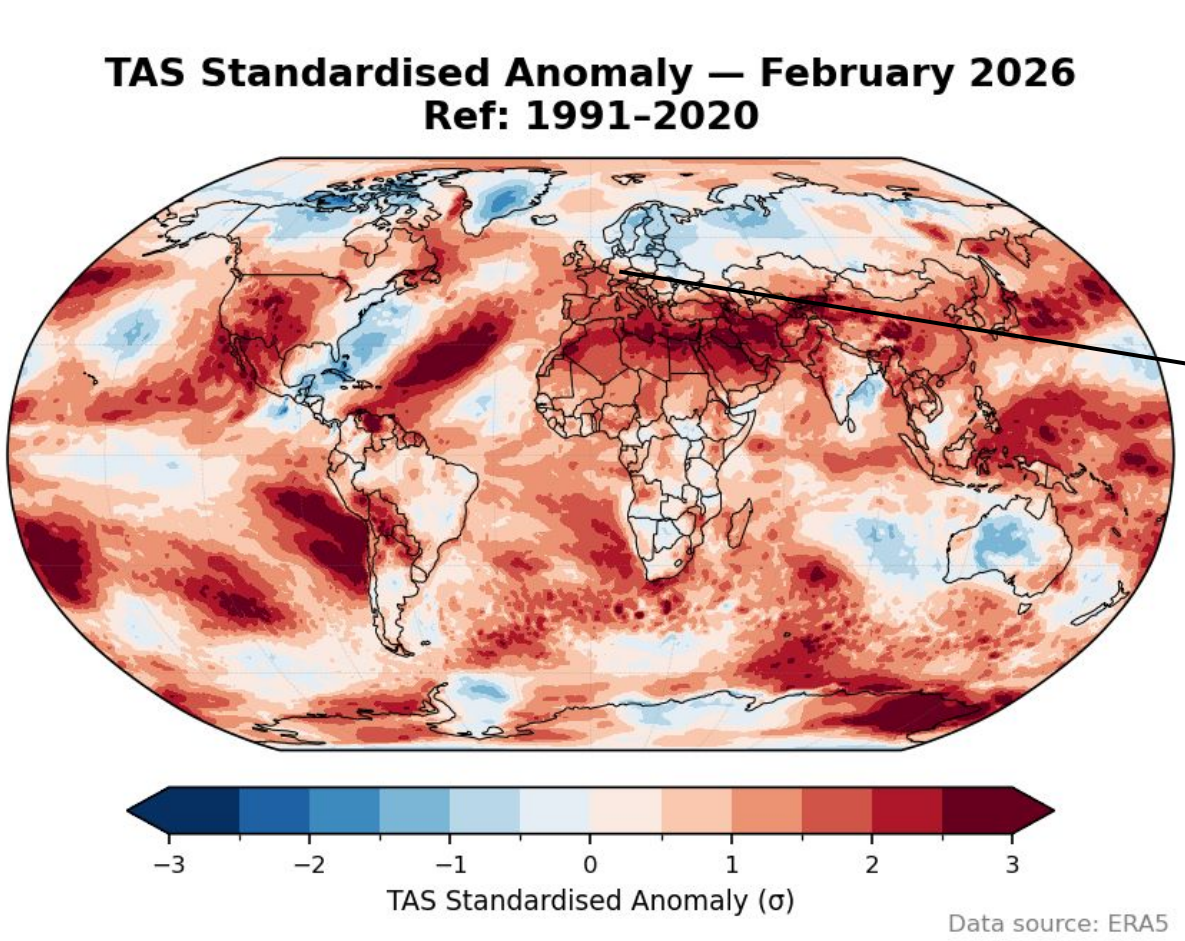
IV. Discussion

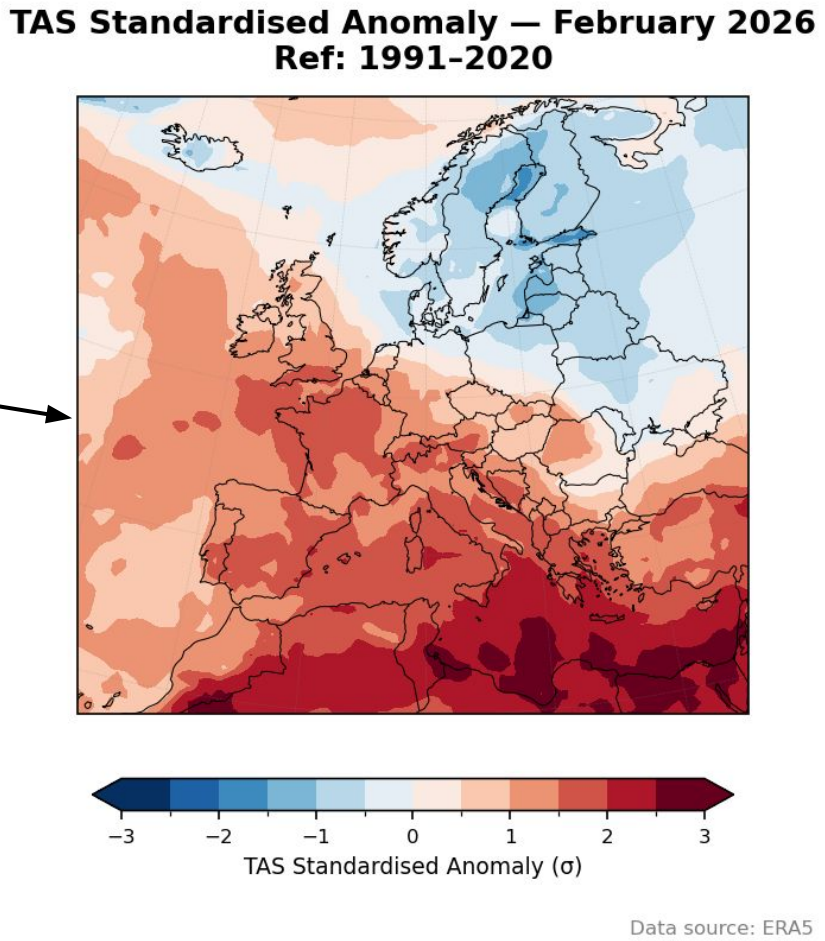
I. Recent state of the climate

I. Recent state of the climate

Temperature

1.49°C above Feb 1850-1900 (ERA5)





- Warm anomalies across the US, NE Canada, Middle East, Cendral Asia and E Antartica. Cold anomalies in Alaska, N Canada, Greenland and N Russia.
- In Europe, strong temperature contrast (SW/NE), one of the three coldest Feb of the last 15 years.

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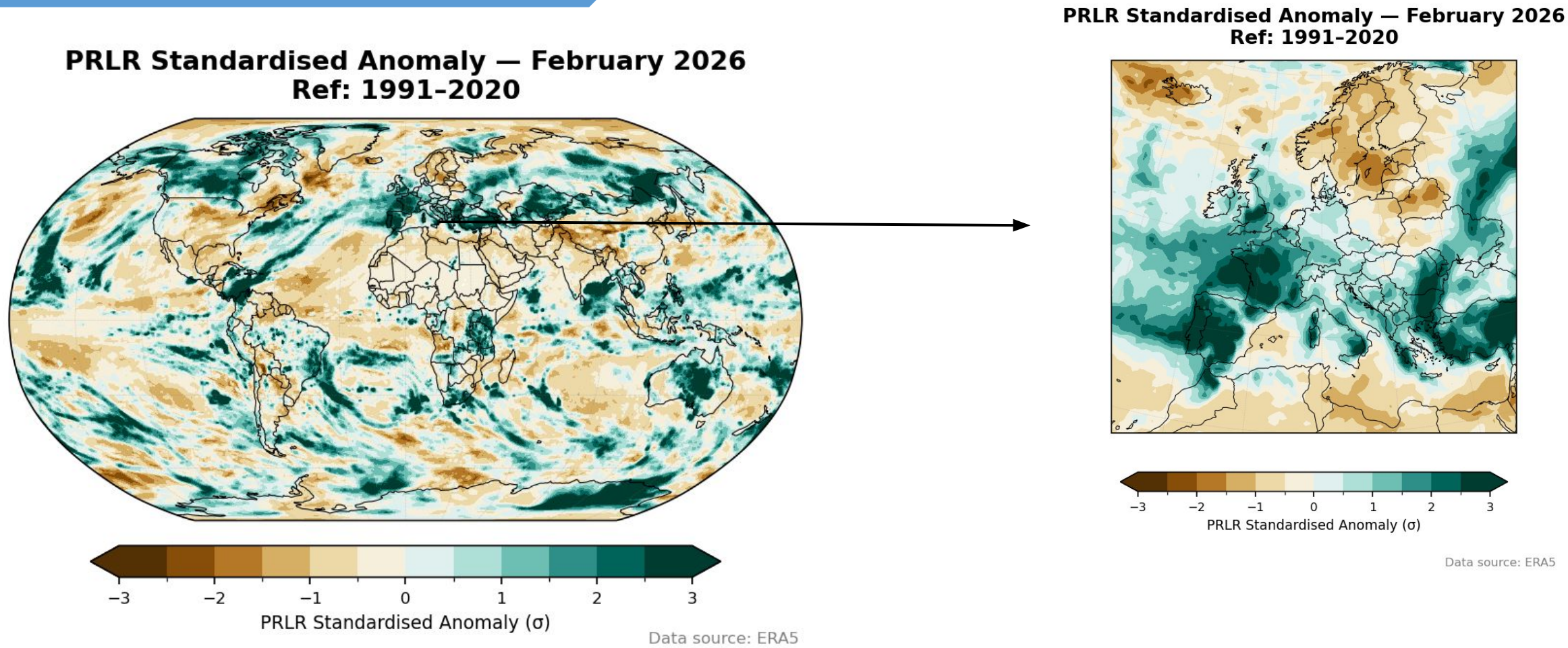
I. Recent state of the climate

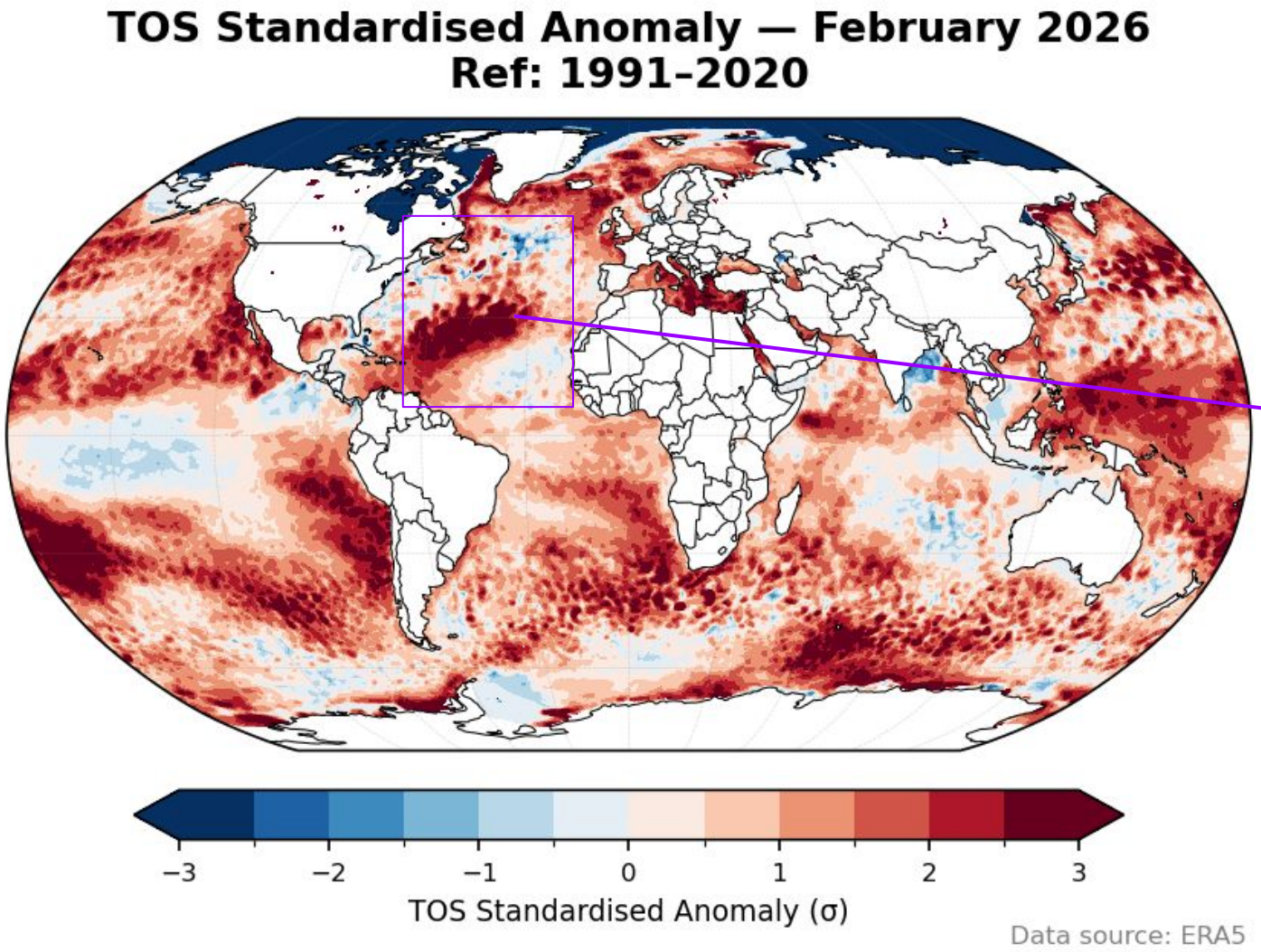
Precipitation



- Very wet conditions in most of Europe (except the North). France saw its wettest February on record.
- Heavy rain after already wet January led to landslides in Spain, Portugal, France, Italy and North Africa.
- SST gradient in the North Atlantic, alongside a series of atmospheric rivers drove this very wet conditions.

I. Recent state of the climate

Sea surface temperature (SST)



- Average SST anomaly (60°N-60°S): 20.88°C, second highest value for the month.
- SST gradient between subtropical and North Atlantic -> favoured the development of storms that reached Europe.
- Cold SST anomalies in the eastern equatorial Pacific (end of La Niña)

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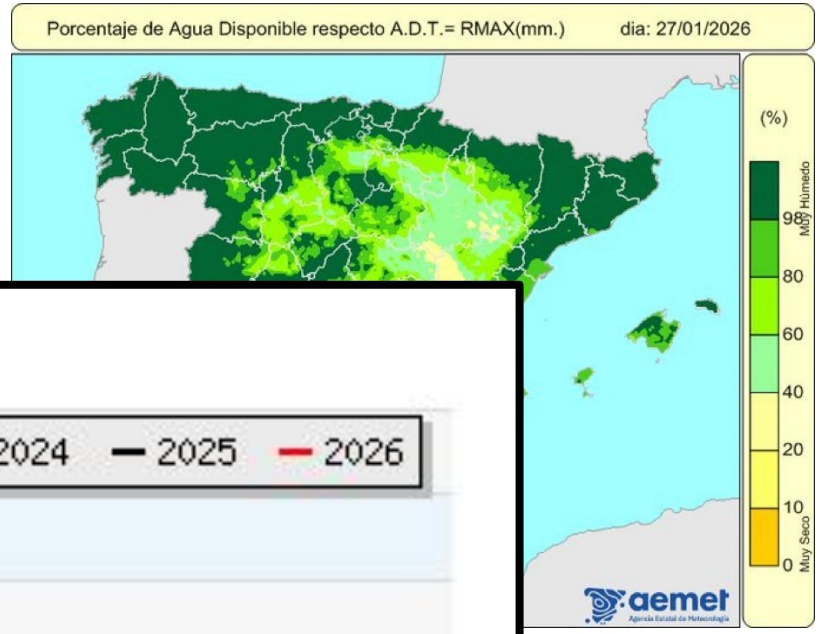
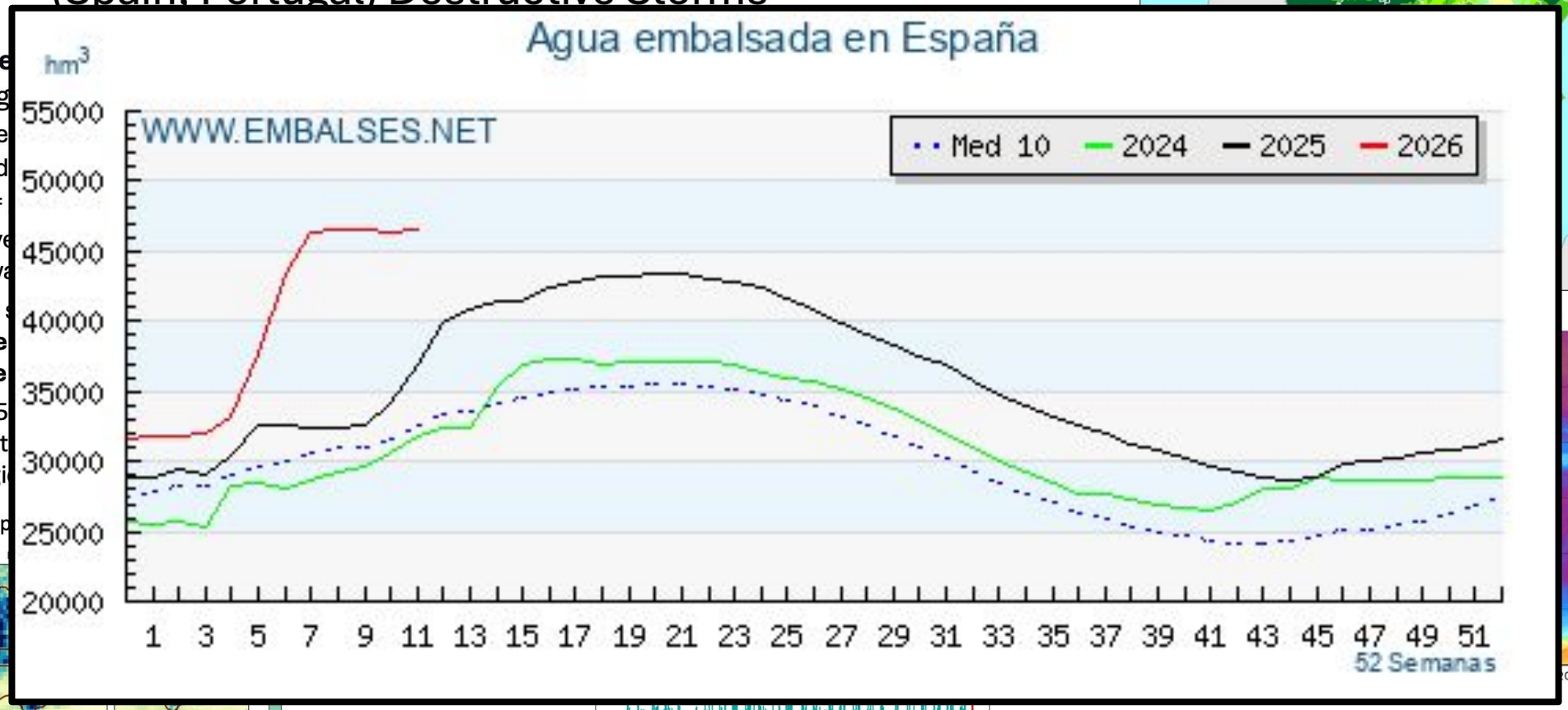
I. Recent state of the climate

Precipitation

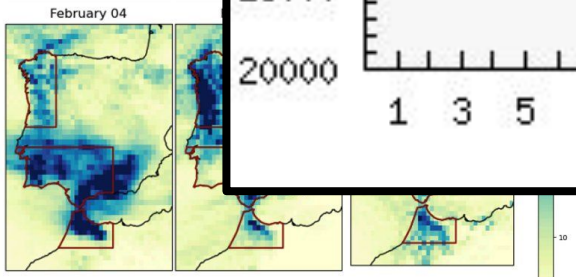
Climate change Supercharged the Iberian Peninsula's (Spain, Portugal) Destructive Storms

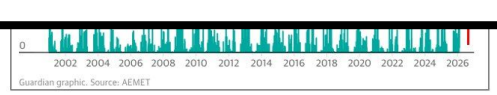


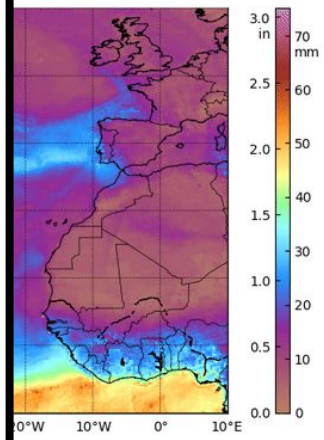


World Weathe
Climate chang
Nine destructive
Record rainfall d
A succession of
passing over a ve
Atlantic on its wa
This increase in
times more like
climate change
Compared to 195
increase of about
the northern regi

Extreme precip







Peter Carter, Climate Emergency Institute

Source: https://bin.ssec.wisc.edu/pub/mtpw2/images/tpw_nrl_colors/natl/202602/

I. Recent state of the climate

Saharan dust

🌍 Why dust matters

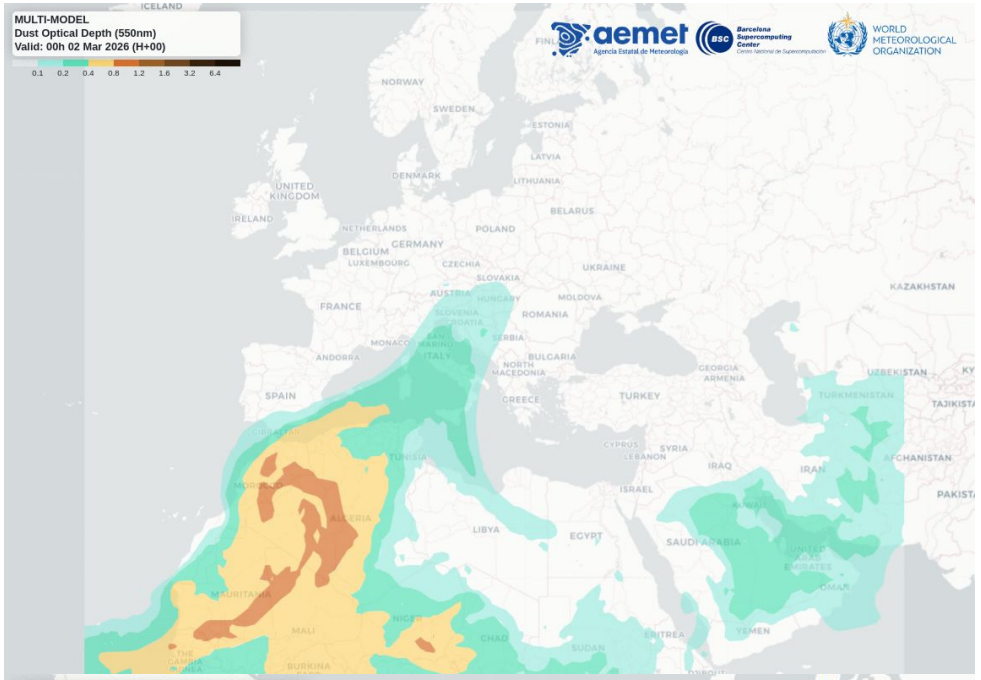
- ➢ Desert dust is the most abundant aerosol in the atmosphere by mass
- ➢ It affects climate, air quality and health
- ➢ It can be transported over long distances, affecting regions far from its source

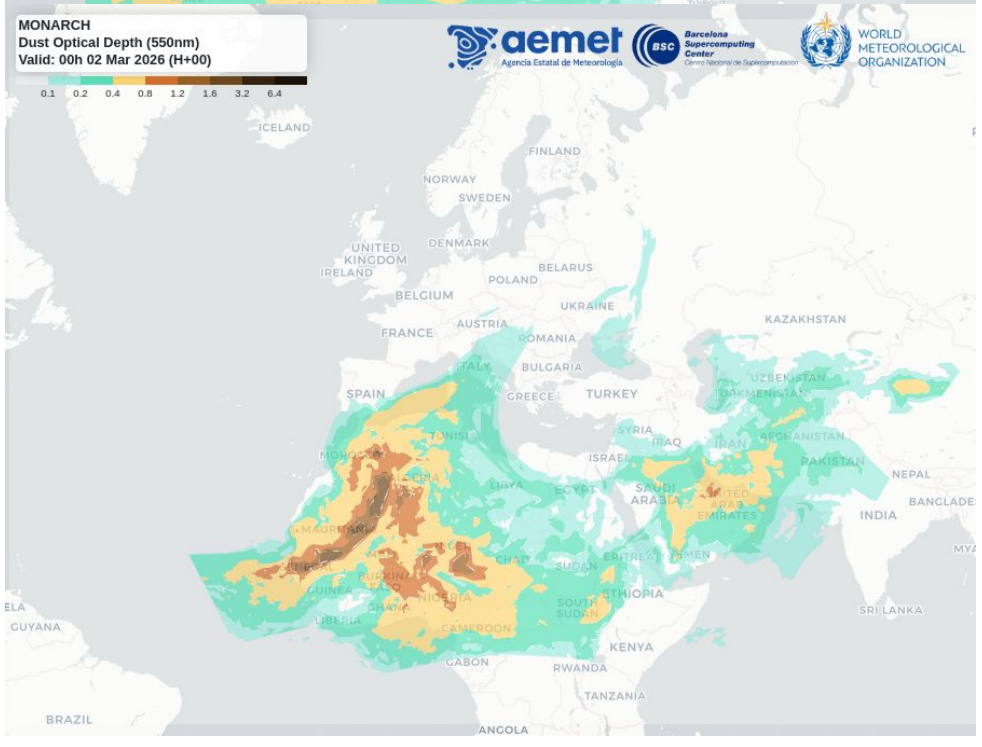
🌧️ Storm Regina (March 2026)

- ➢ Atlantic low-pressure storm affecting Spain
- ➢ It brought rain + strong winds + Saharan dust
- ➢ Result: “mud rain” (dust + precipitation)

🖥️ Forecasting with dust models

- ➢ Simulate dust emissions, transport in the atmosphere, deposition
- ➢ Barcelona Dust Regional Center: https://dust.aemet.es/





Dust optical depth from the March 2026 event as modelled by the SDS-WAS multi-model ensemble (top) and MONARCH (bottom) (image courtesy of the Barcelona Dust Regional Center).

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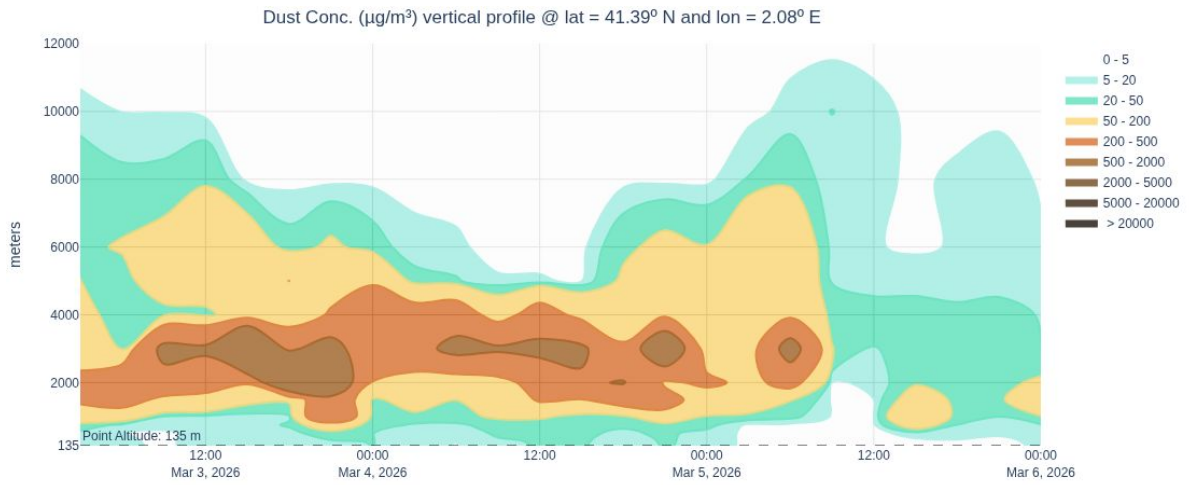
I. Recent state of the climate

Saharan dust



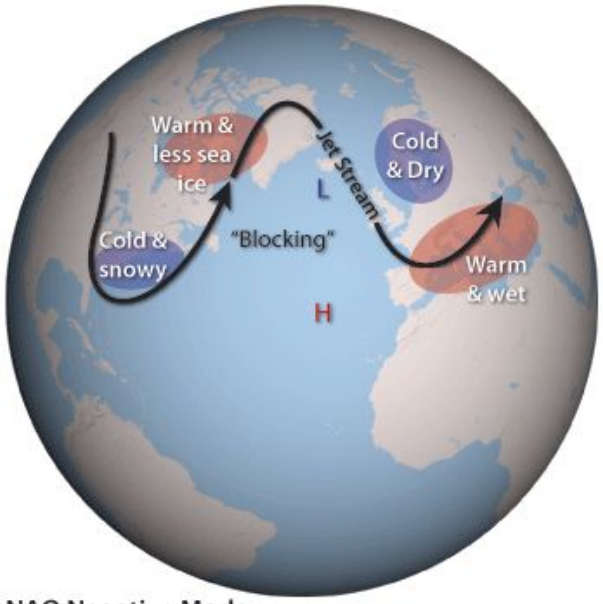
Vertical profile of MONARCH dust concentration over Palau Reial, Barcelona (image courtesy of the Barcelona Dust Regional Center)

Credit: Natalia de la Rubia, Shutterstock (taken on 15/2/2022 in Madrid)

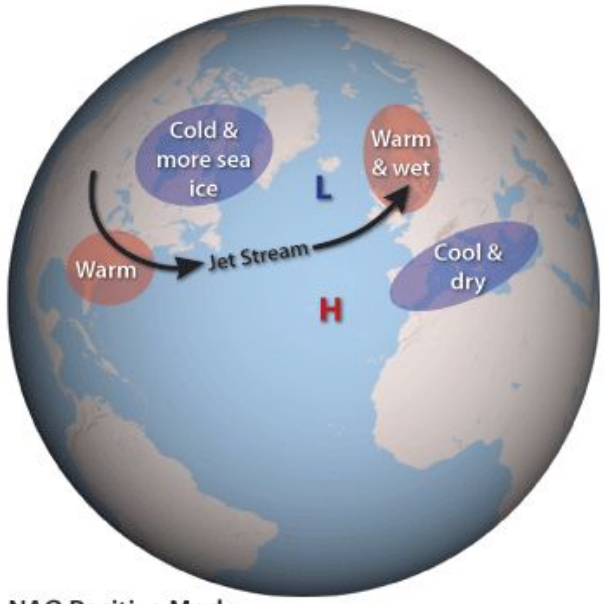
- Dust intrusions cause reduced visibility, health hazards and other phenomena such as “blood rain”.
- Dust intrusions can occur year round, but are more common in spring and summer.

North Atlantic Oscillation (NAO)

➢ The North Atlantic Oscillation (NAO) is the leading mode of large-scale atmospheric variability in the North Atlantic basin.

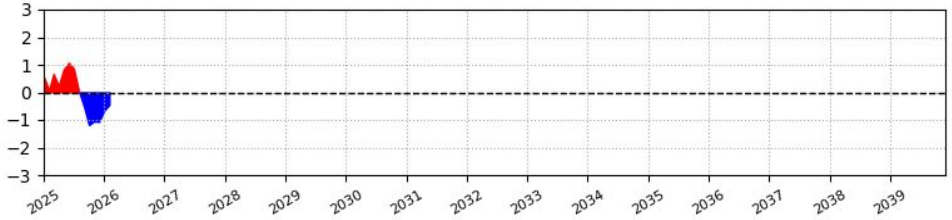


NAO Negative Mode



NAO Positive Mode

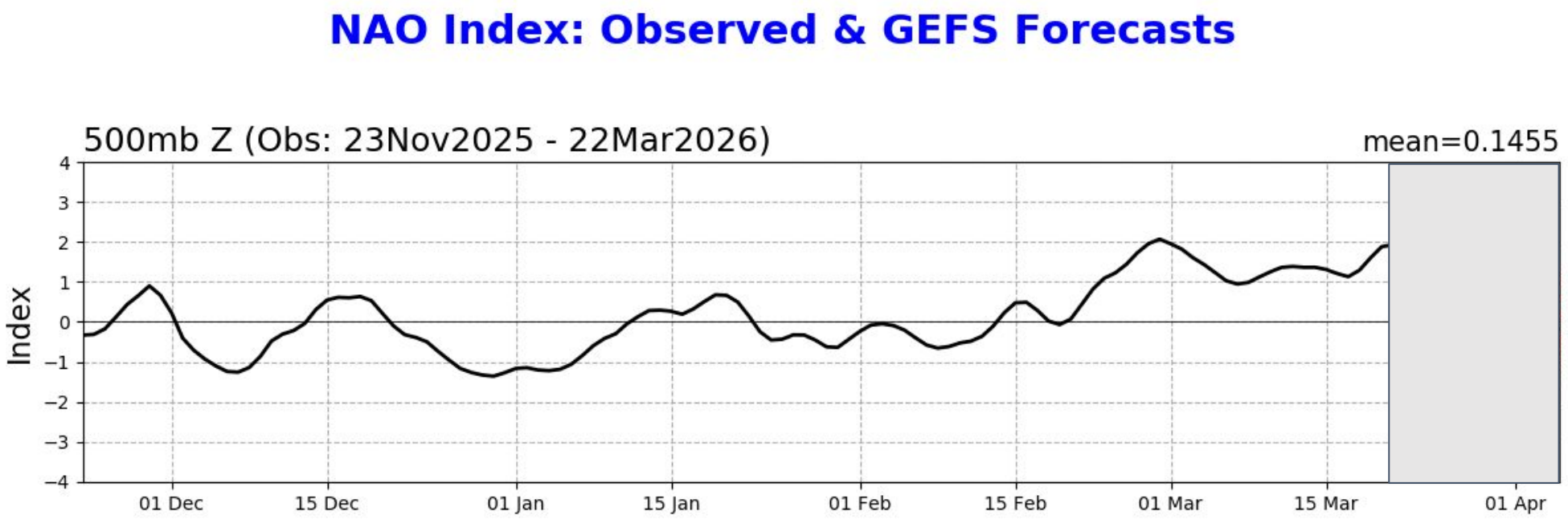
NAO index: Standardized 3-month Running Mean Index



Source: https://www.cpc.ncep.noaa.gov/data/teledoc/nao_ts.shtml

North Atlantic Oscillation (NAO)

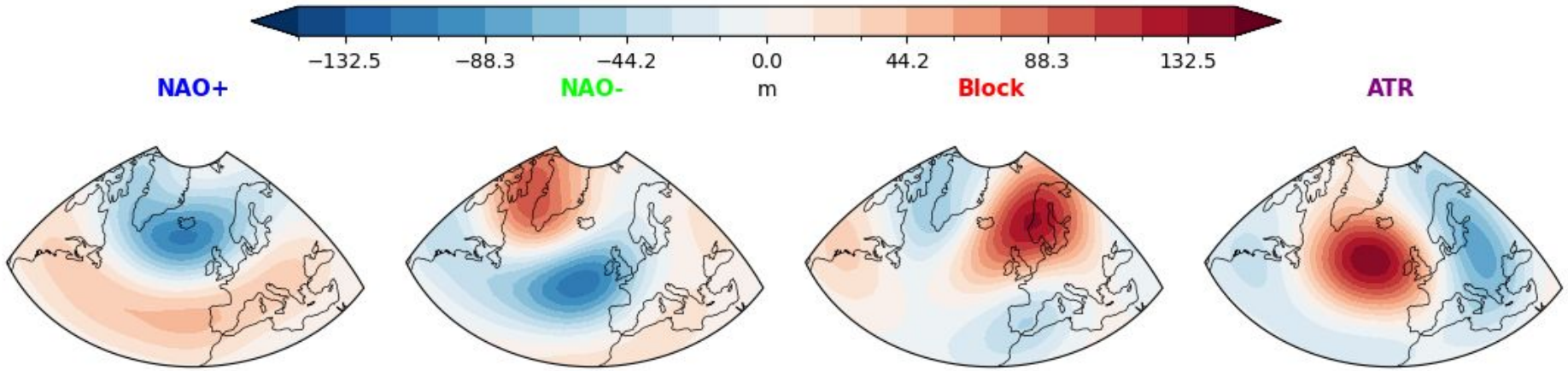
➢ Positive NAO from mid-February and throughout March.



Source: https://www.cpc.ncep.noaa.gov/products/precip/CWlink/pna/nao_index_ensm.shtml

I. Recent state of the climate

European weather regimes

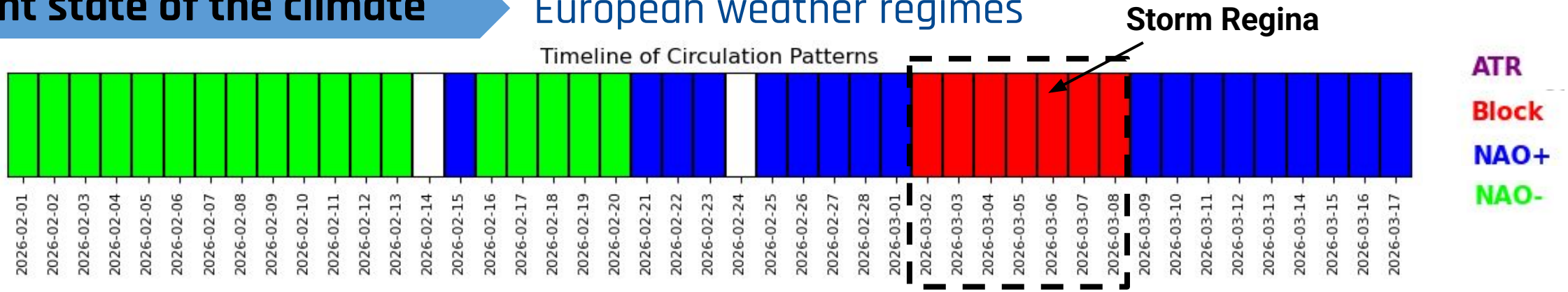


- Geopotential height anomaly composites at 500 hPa.
- 1980 - 2008 ONDJFMA (k-means clustering).

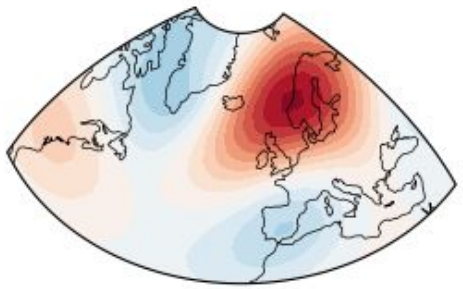
- **Blocking:** Cold and dry anomalies in Northern Europe, wet anomalies in Southwestern Europe. Onset through anticyclonic wave breaking over Europe in the upper troposphere (Michel et al., 2012).
- **NAO+:** Westerly winds predominate bringing mild, wet and stormy winter conditions to northern Europe and eastern USA while southern Europe is more likely to see cold, dry winter conditions.
- **NAO-:** Spells of easterly winds bring cold dry and calm winters with fewer and weaker storms to northern Europe and eastern USA.
- **ATR:** Northern Europe: Drier and slightly milder due to being under the influence of ridging on the upstream side. Southern Europe: Can be wetter (particularly Iberia and Western Mediterranean) due to enhanced storm tracks directed southward. Eastern Mediterranean may be less affected.

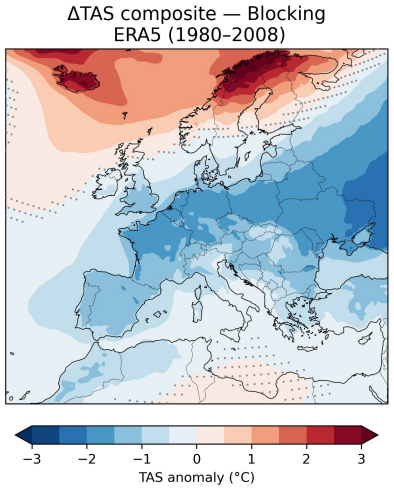
I. Recent state of the climate

European weather regimes

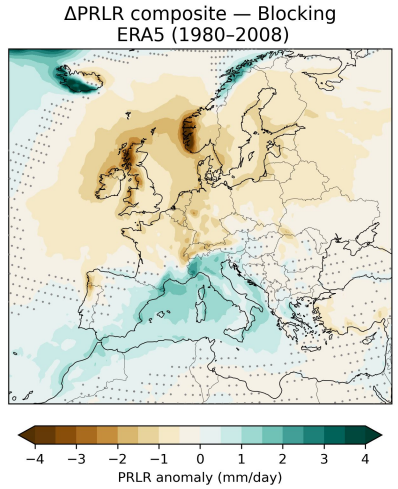


Block

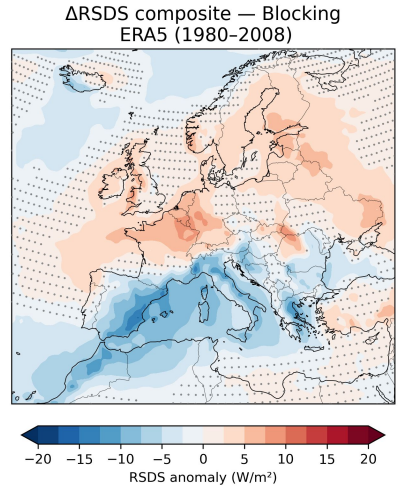




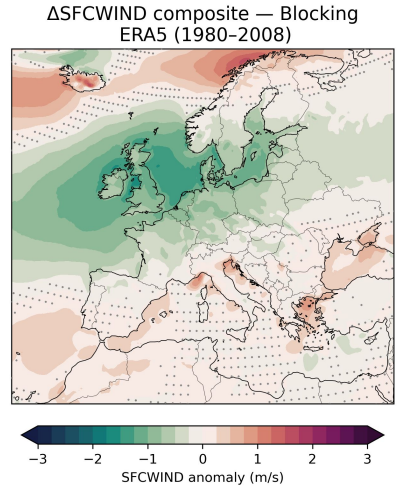
Temperature



Precipitation



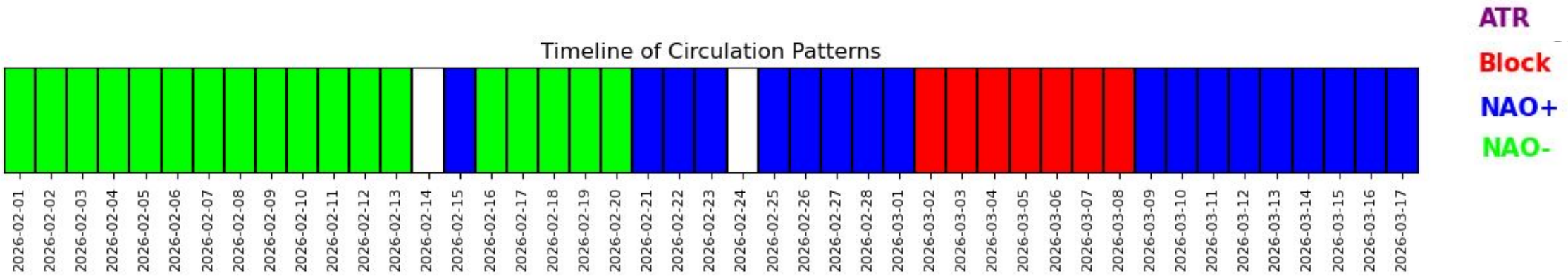
Solar radiation



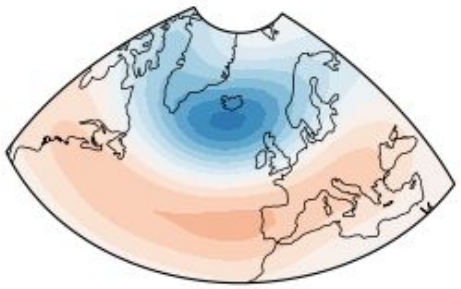
Surface wind

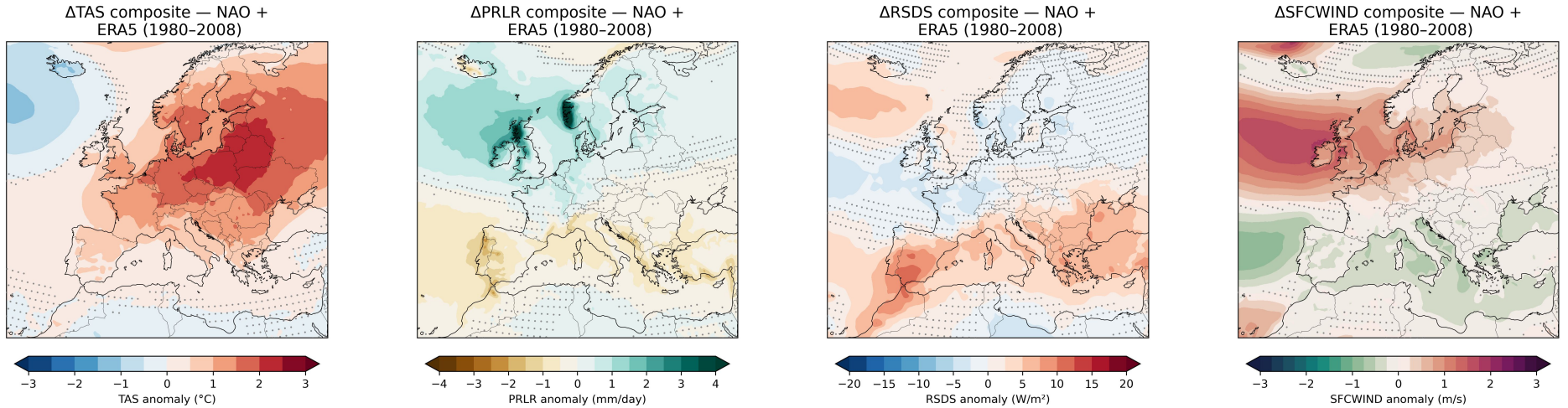
I. Recent state of the climate

European weather regimes



NAO+





Temperature | Precipitation | Solar radiation | Surface wind

➢ A positive NAO is characterised by a northward shift of the jet stream, that brings positive wind and precipitation anomalies to northwestern Europe, alongside milder temperatures and reduced incoming solar radiation.

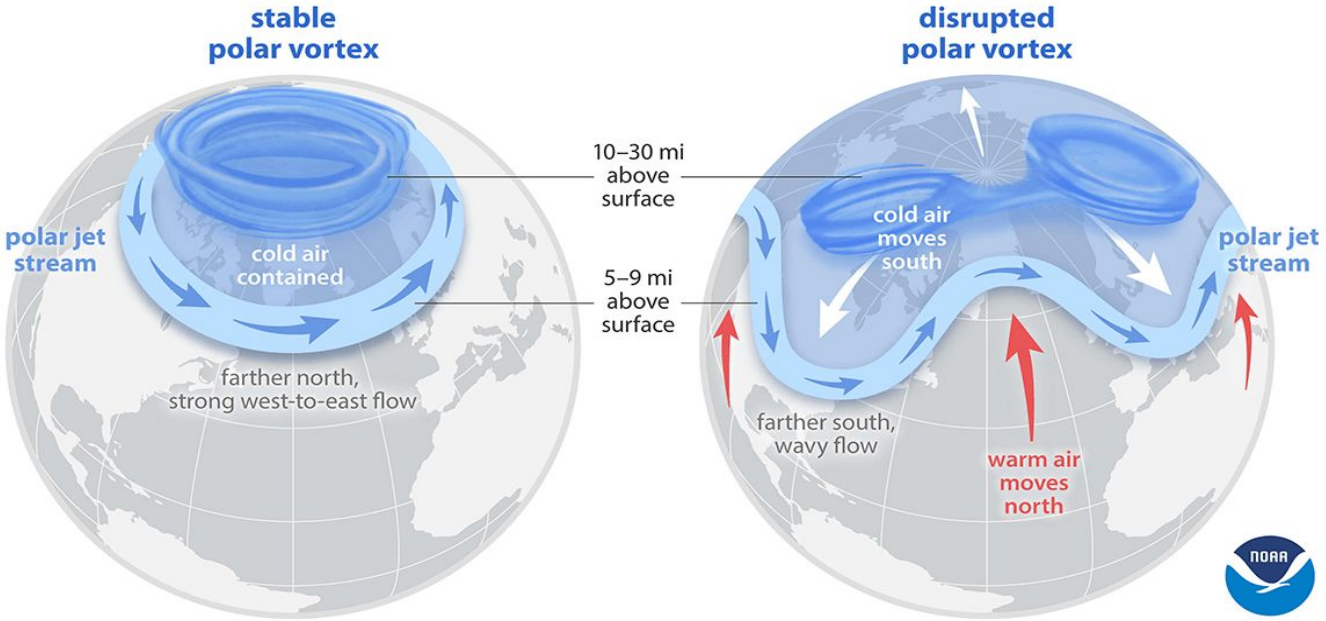
Stratospheric polar vortex (SPV)

Understanding the polar vortex

The Arctic polar vortex is a strong band of winds in the stratosphere, surrounding the North Pole 10–30 miles above the surface.

The polar vortex is far above and typically does not interact with the polar jet stream, the flow of winds in the troposphere 5–9 miles above the surface. But when the polar vortex is especially strong and stable, the jet stream stays farther north and has fewer "kinks." This keeps cold air contained over the Arctic and the mid-latitudes warmer than usual.

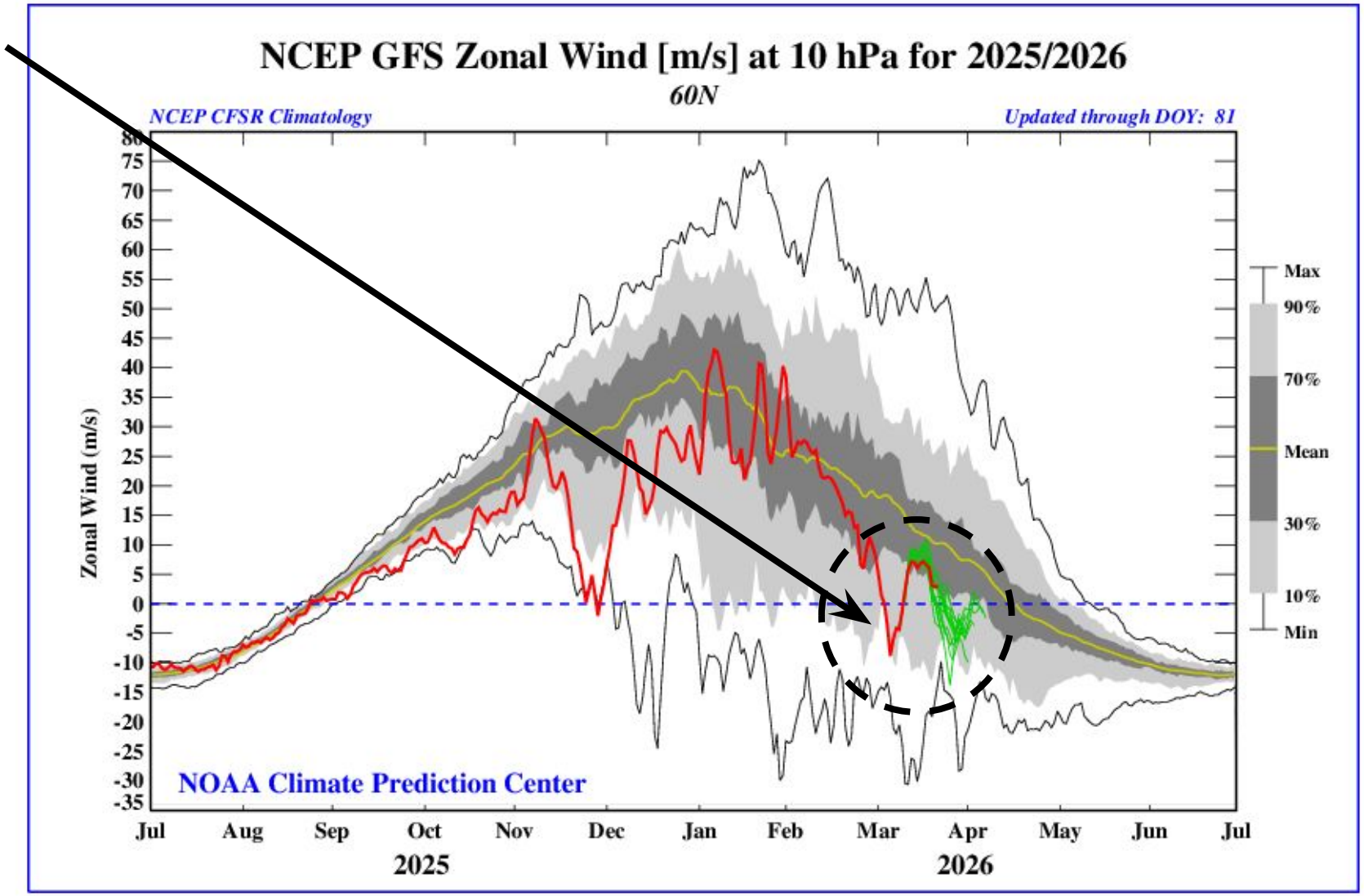
Every other year or so, the Arctic polar vortex dramatically weakens. The vortex can be pushed off the pole or split into two. Sometimes the polar jet stream mirrors this stratospheric upheaval, becoming weaker or wavy. At the surface, cold air is pushed southward to the mid-latitudes, and warm air is drawn up into the Arctic.



NOAA Climate.gov
2021

Stratospheric polar vortex

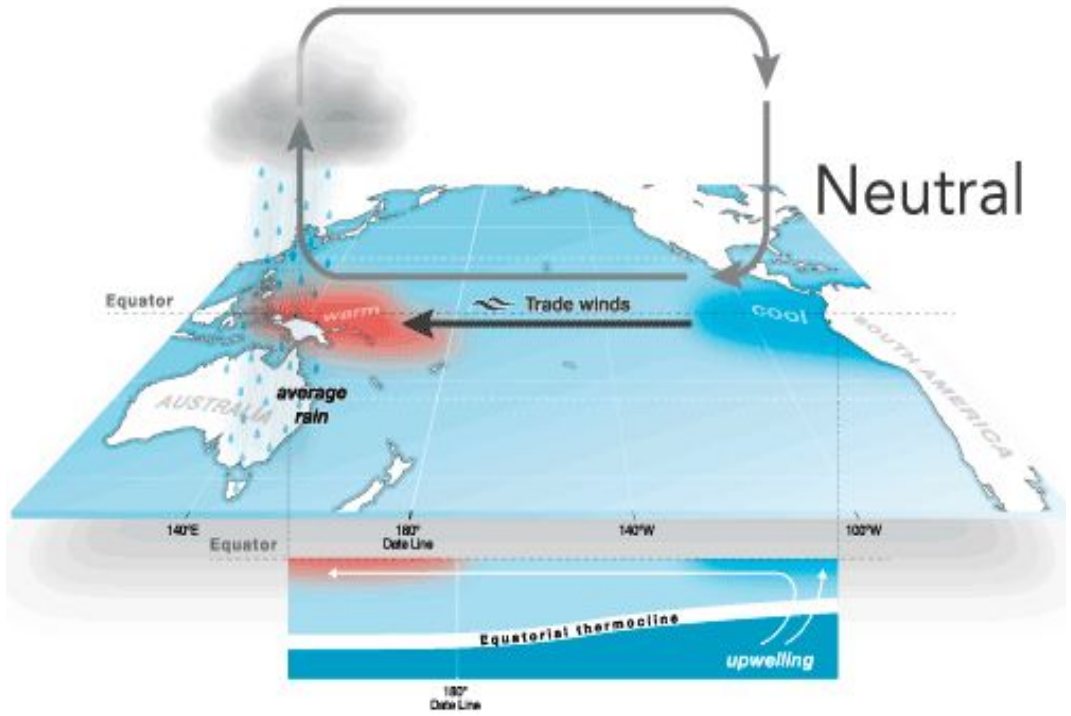
- A SSW occurred in early March, in the form of a polar vortex split (PV split).
- Another split or final warming?
- If both PV splits occur within less than 20 days then they are considered part of the final warming event.

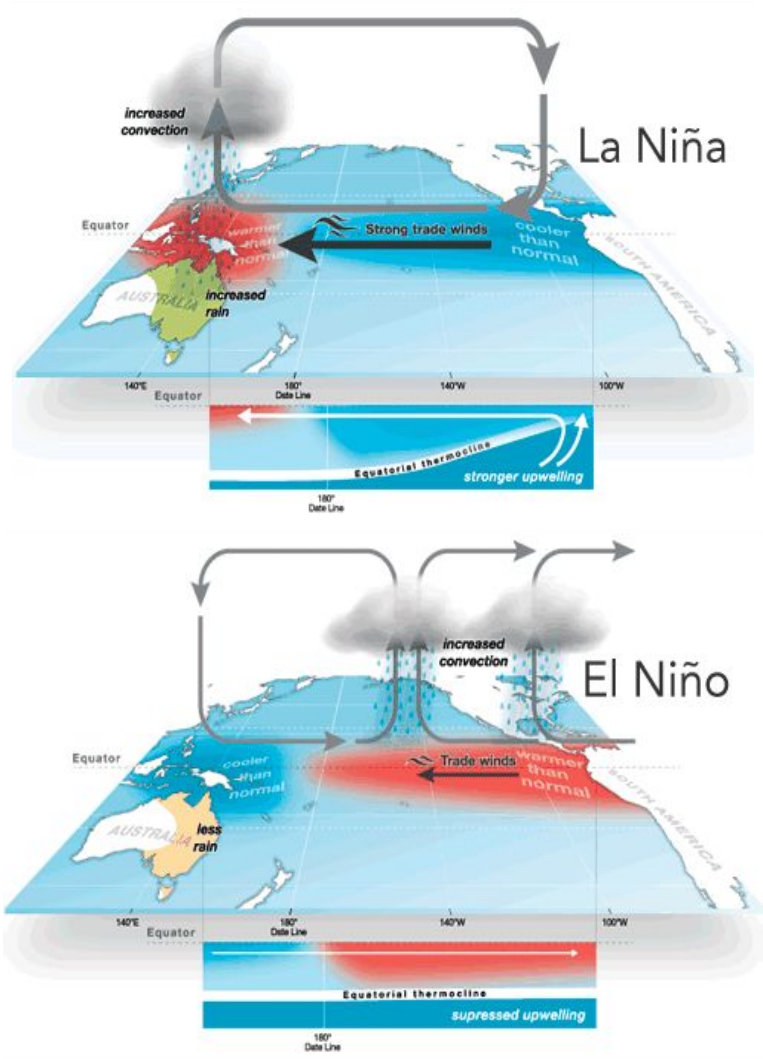


Source: https://www.cpc.ncep.noaa.gov/products/stratosphere/SSW/

El Niño-Southern Oscillation (ENSO)

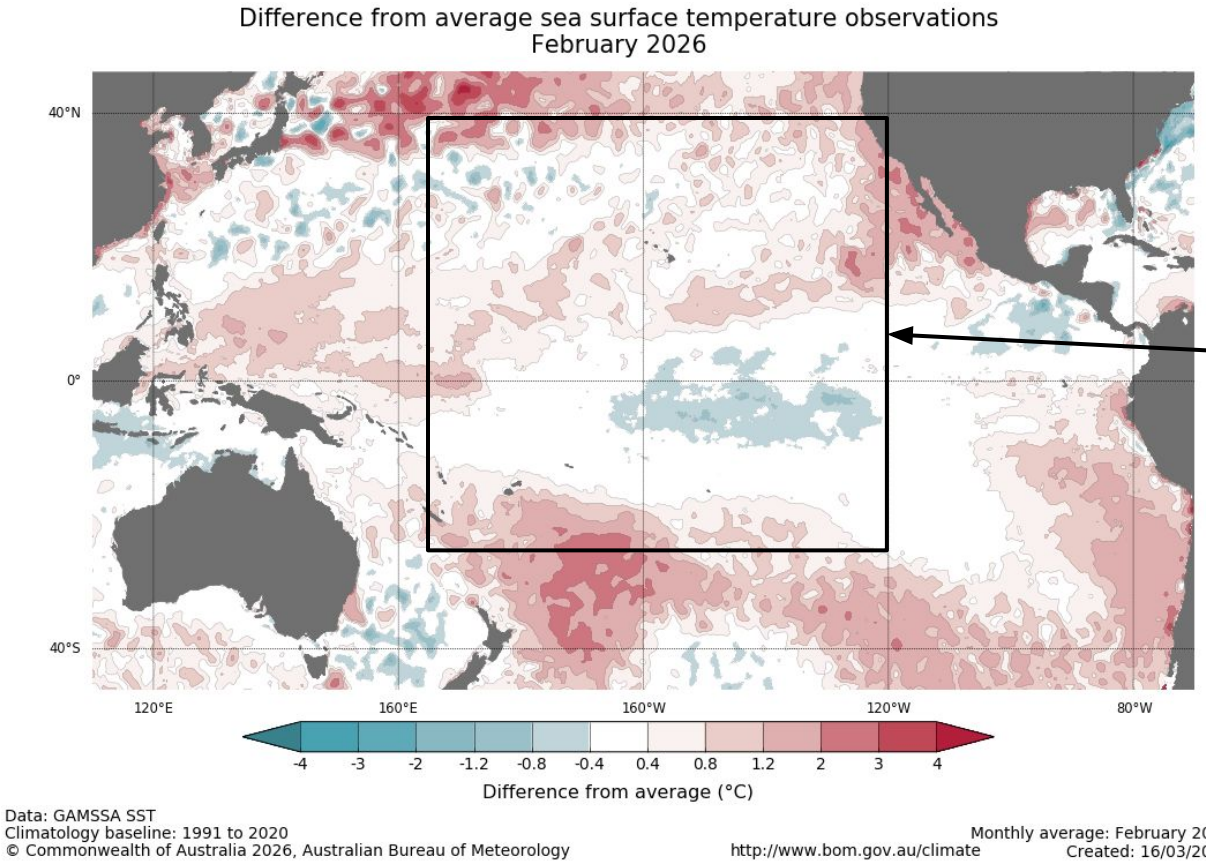
➢ ENSO is the leading mode of natural variability at seasonal to interannual (S2I) time scales and is considered as an internally occurring coupled ocean-atmosphere phenomenon.

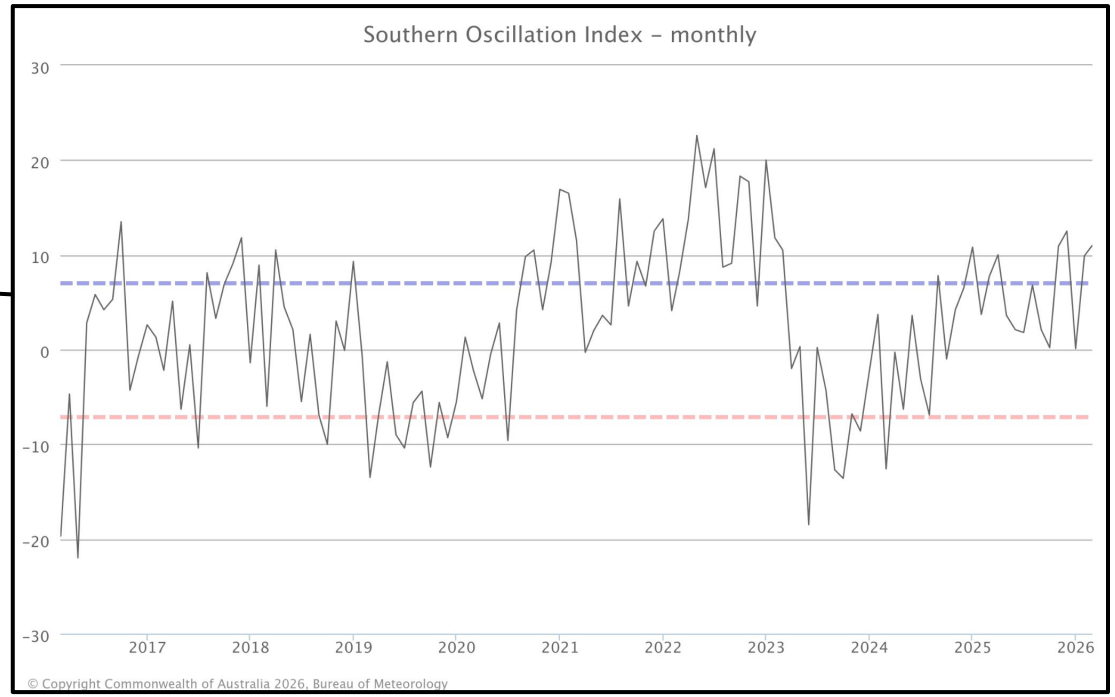




I. Recent state of the climate

El Niño-Southern Oscillation (ENSO)





➢ Negative relative SST anomalies in the Niño 3.4 region, known as the **Relative Oceanic Niño Index** (RONI).

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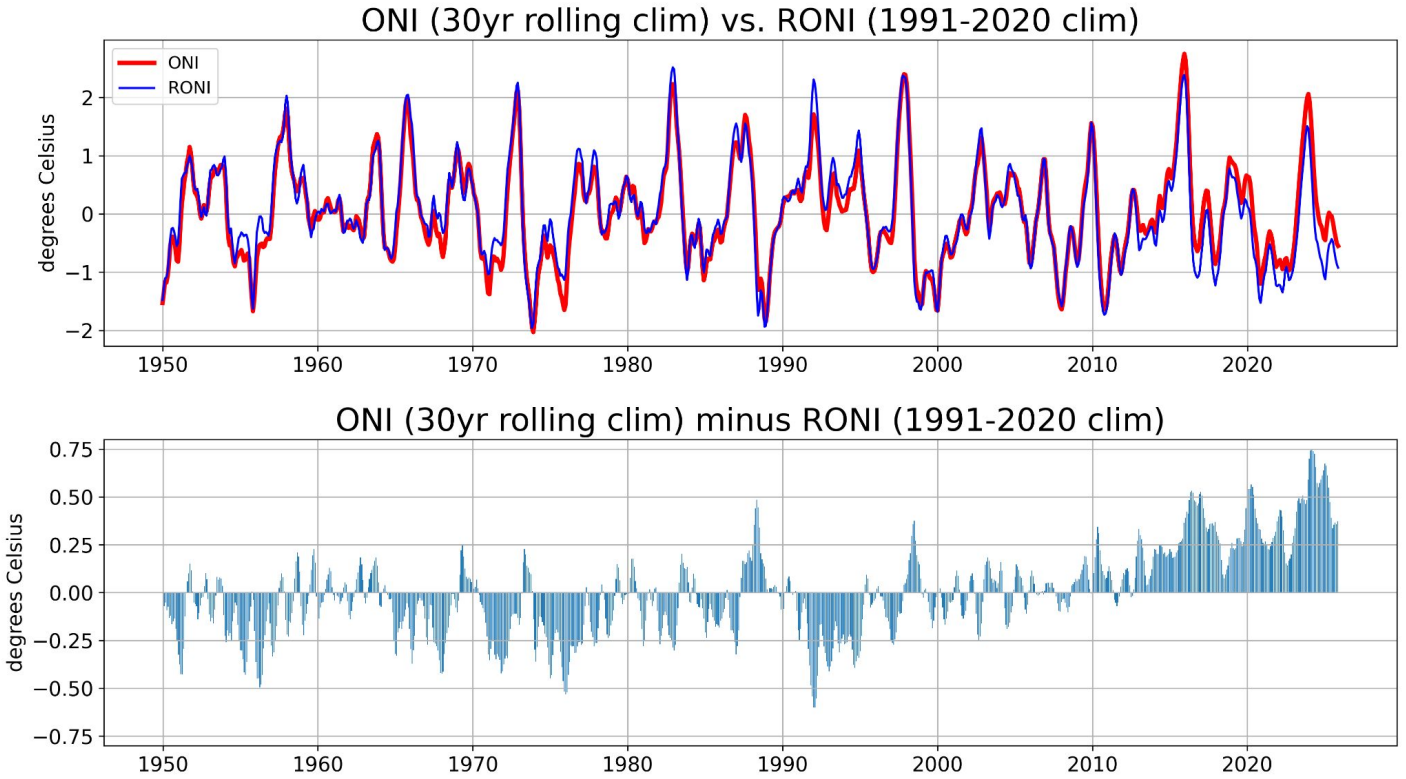
Source: https://www.climate.gov/news-features/blogs/enso / http://www.bom.gov.au/climate/enso/?ninoIndex=nino3.4&index=nino34&period=weekly#tabs=Pacific-Ocean&pacific=SOI / https://www.nnvl.noaa.gov/view/#SSTA

News in ENSO forecasts - Relative Oceanic Niño Index

Helps placing current events in a historical perspective. SSTs in the Niño3.4 region minus tropical mean removed.
El Niño = 5 or more overlapping 3-month running seasons with RONI > 0.5°C.

- RONI is less sensitive to the chosen based climatology period.

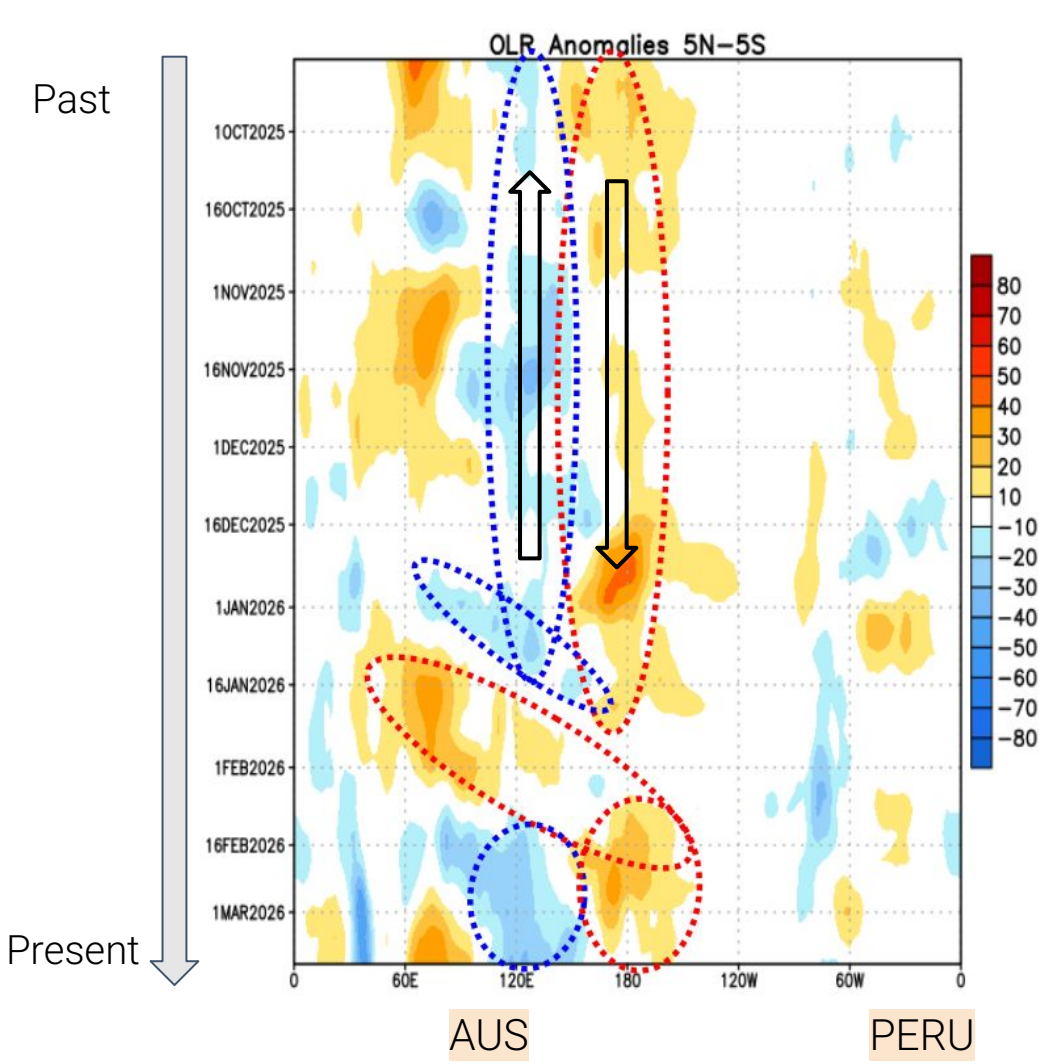
- More related to rainfall in the tropical Pacific than the traditional index (captures better the source of ENSO teleconnections).



Source: https://www.weather.gov/media/notification/pdf_2026/pns26-05_Relative_ONI.pdf

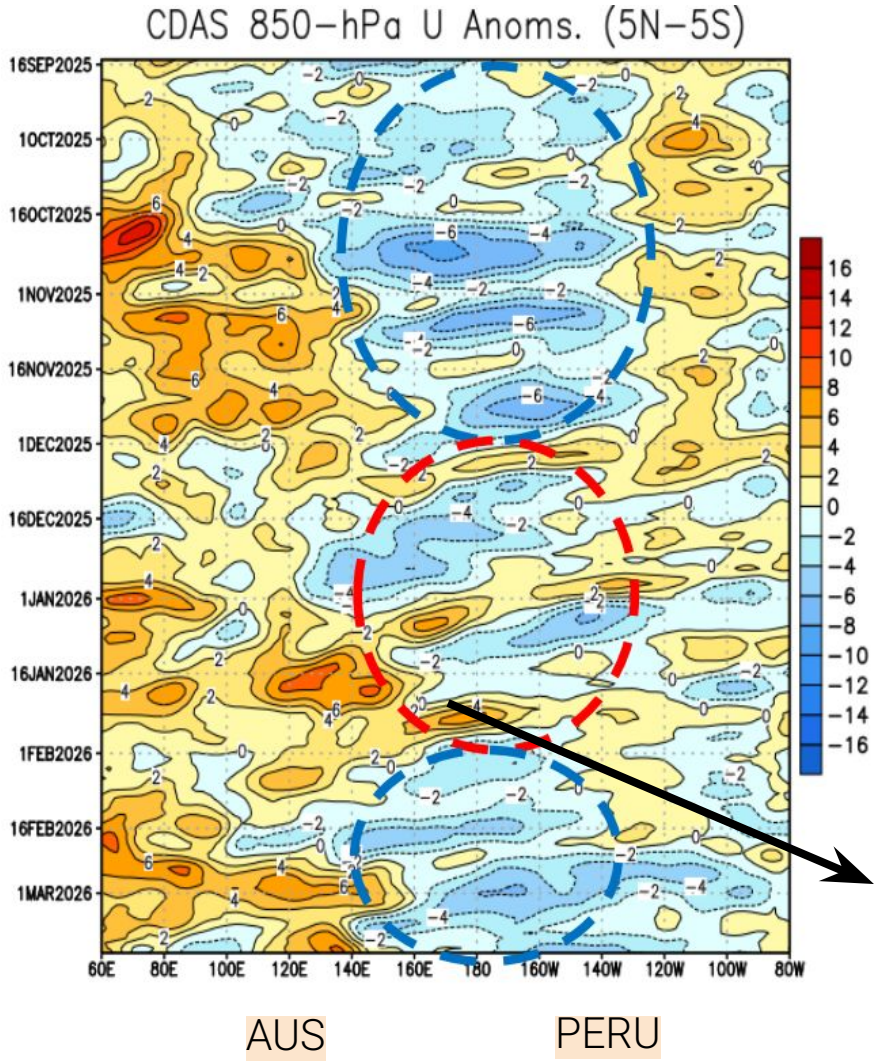
I. Recent state of the climate

El Niño-Southern Oscillation (ENSO) - **The atmosphere**



Blue = easterly wind anomalies

Red = westerly wind anomalies



Blue = negative OLR, enhanced convection/rainfall.

Red = positive OLR anomalies, subsidence, suppressed rainfall

- During February, atmospheric conditions indicate that **La Niña-Like** anomalies are weak but persisting.
- Upward motion over the West Pacific, subsidence in the central Pacific. Easterly winds dominate.
- **Westerly wind burst (WWB)**

Source: https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf / https://www.pmel.noaa.gov/gtmba/assorted-plots

El Niño-Southern Oscillation (ENSO) - **Westerly wind bursts (WWBs)**

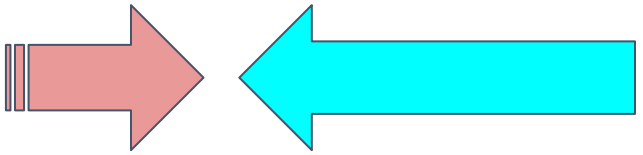
La Niña

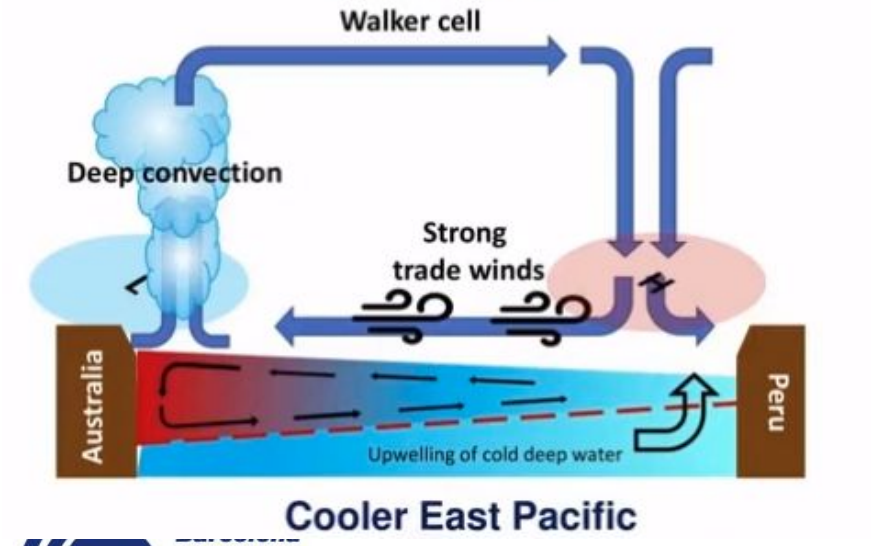
Strong easterlies (westward, from the east)

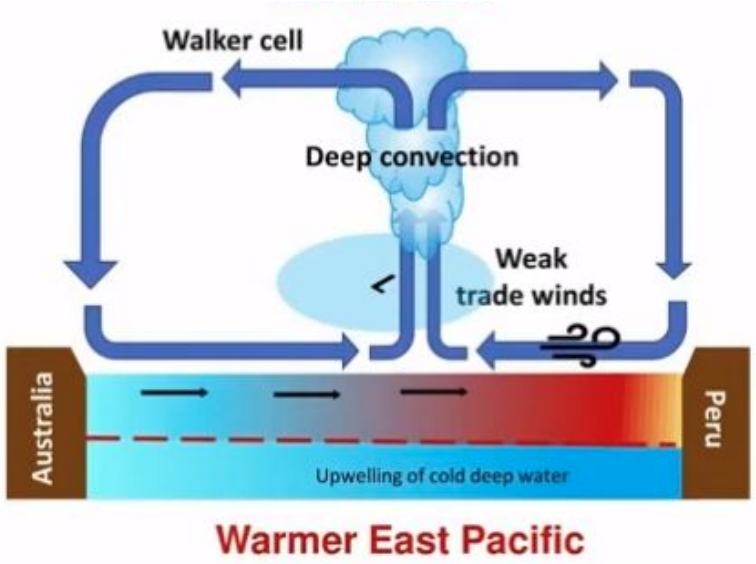
WWBs: Strong "pulses" of westerly (eastward) wind in the western Pacific that can lead to the onset of El Niño

El Niño

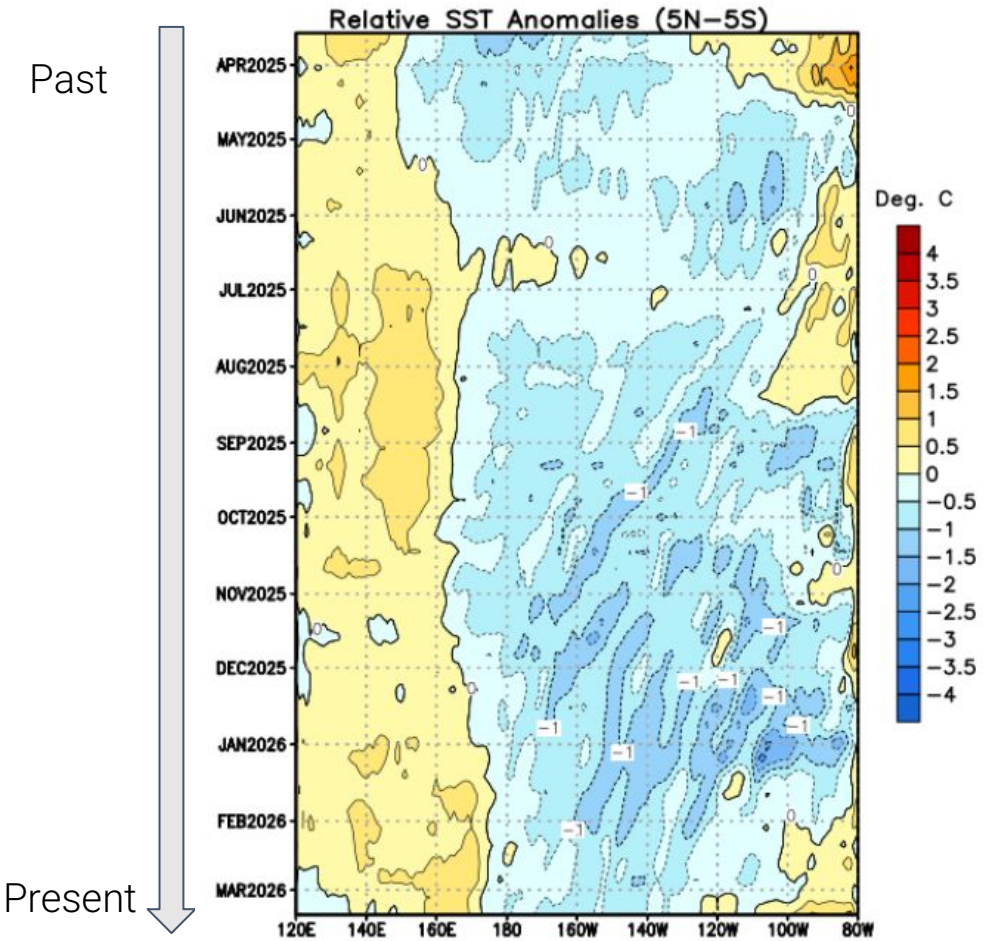
Westerlies (eastward, from the west)

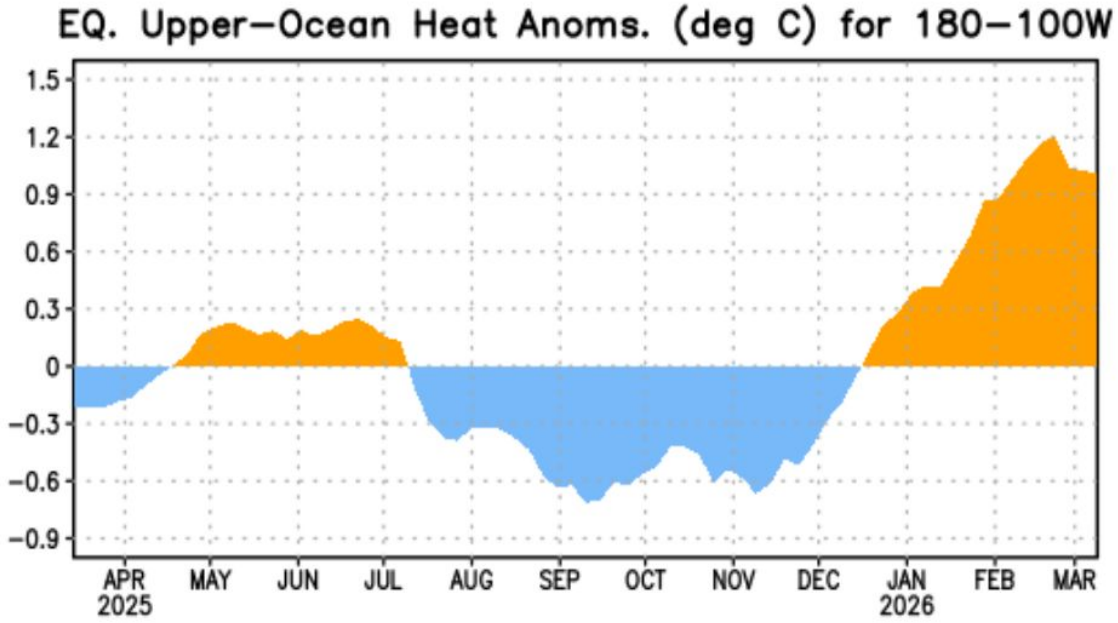






El Niño-Southern Oscillation (ENSO) - **The ocean**





- The Eastern Pacific upper ocean has been warming since mid-December.
- **ENSO precursor** (most of the times).

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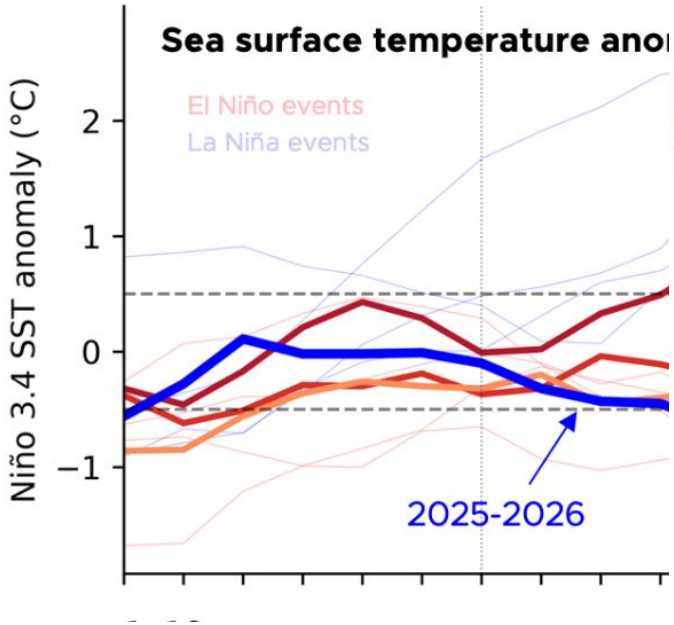
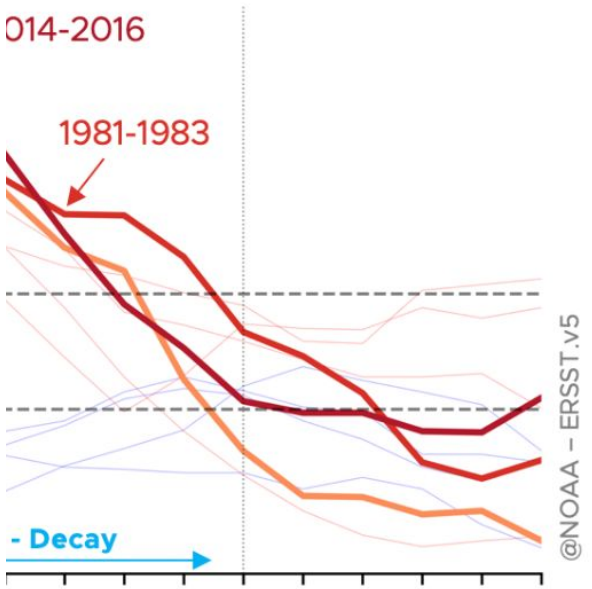
Source: https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf / https://www.pmel.noaa.gov/gtmba/assorted-plots

El Niño-Southern Oscillation (ENSO) - **The ocean**



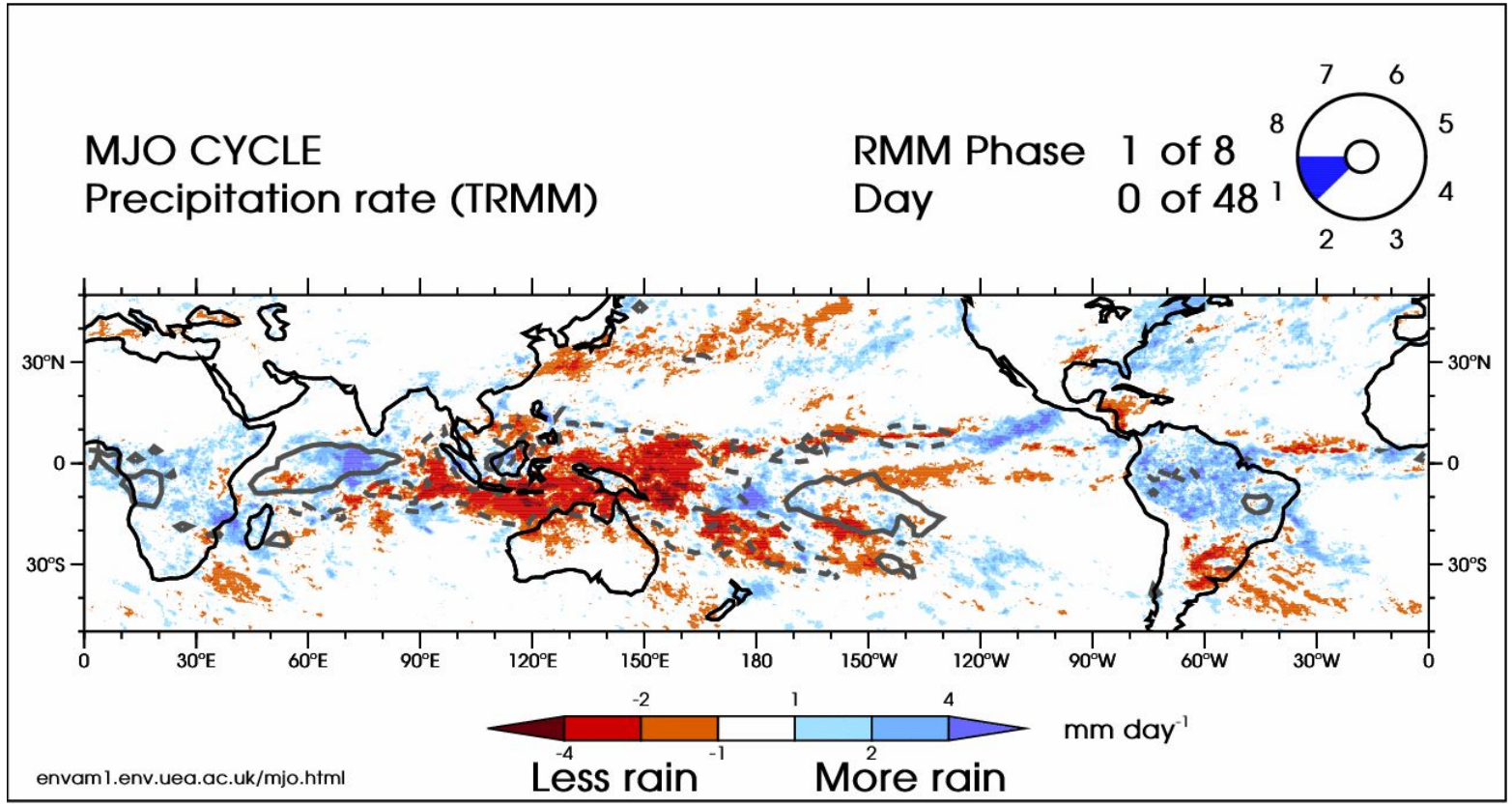


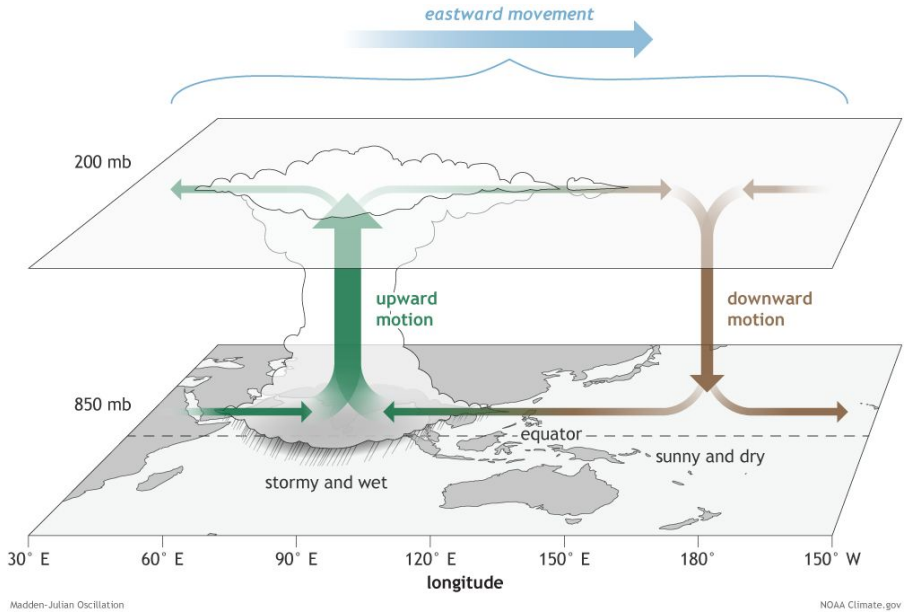
I. Recent state of the climate

II. Subseasonal forecasts

Madden-Julian Oscillation (MJO)

➢ The MJO is the leading mode of tropical subseasonal variability with a 20–90 days time scale. It is an important source of regional climate variability and predictability across the globe at subseasonal time scales.





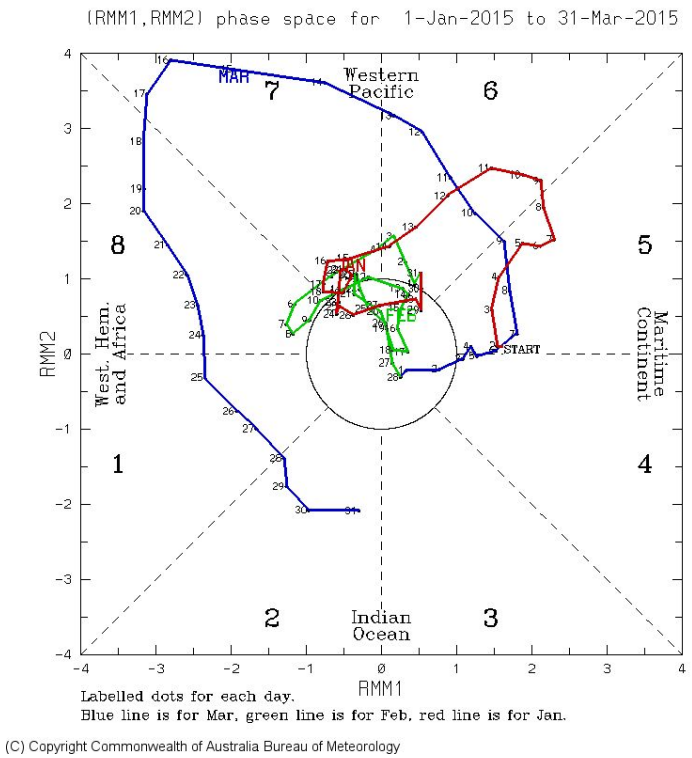
Source: https://www.climate.gov/news-features/blogs/enso/what-mjo-and-why-do-we-care

II. Subseasonal forecasts

Is a Super El Niño coming?

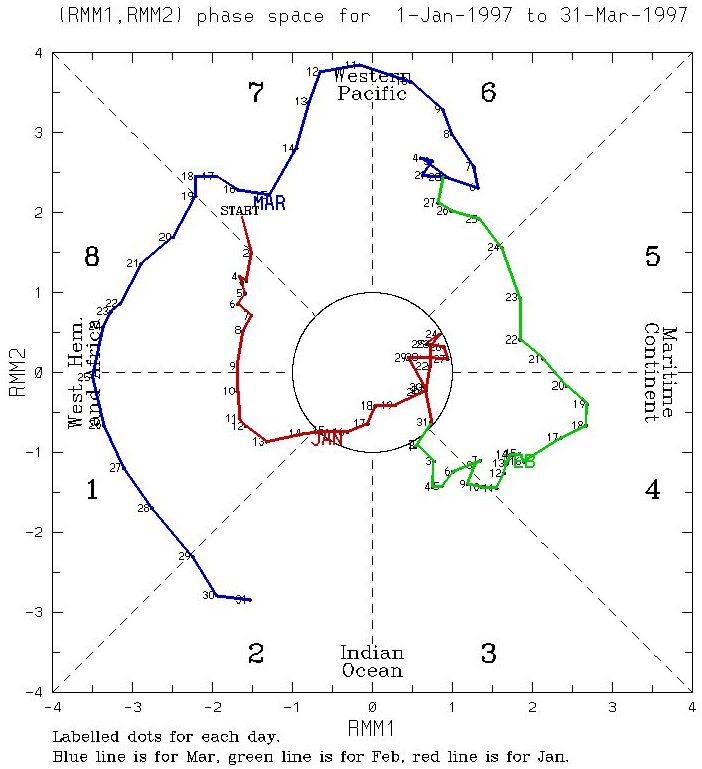
➢ MJO 97/98, 15/16 very strong in phase 7 and 8 in March (prior to the development of El Niño).

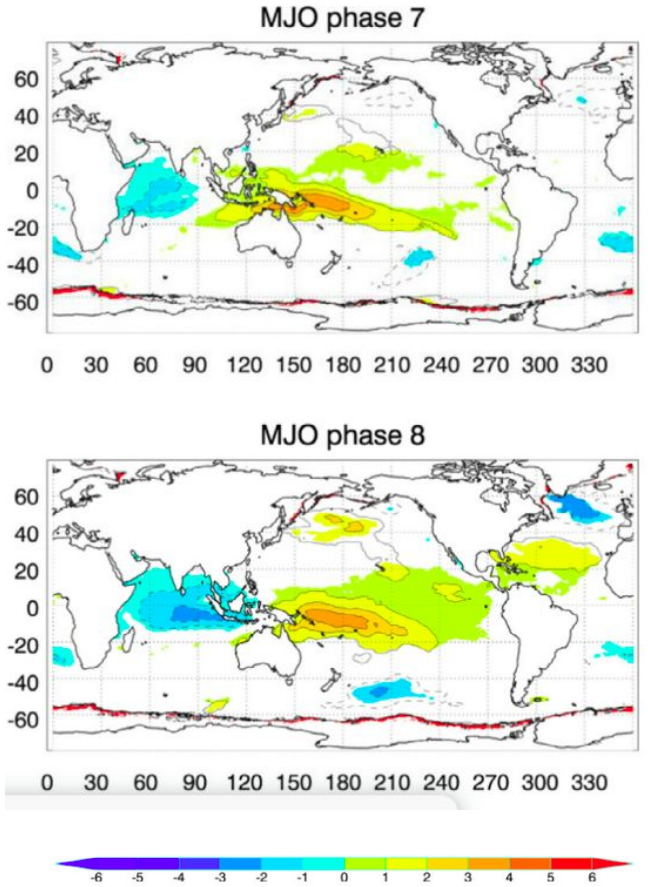
15/16



(C) Copyright Commonwealth of Australia Bureau of Meteorology

97/98



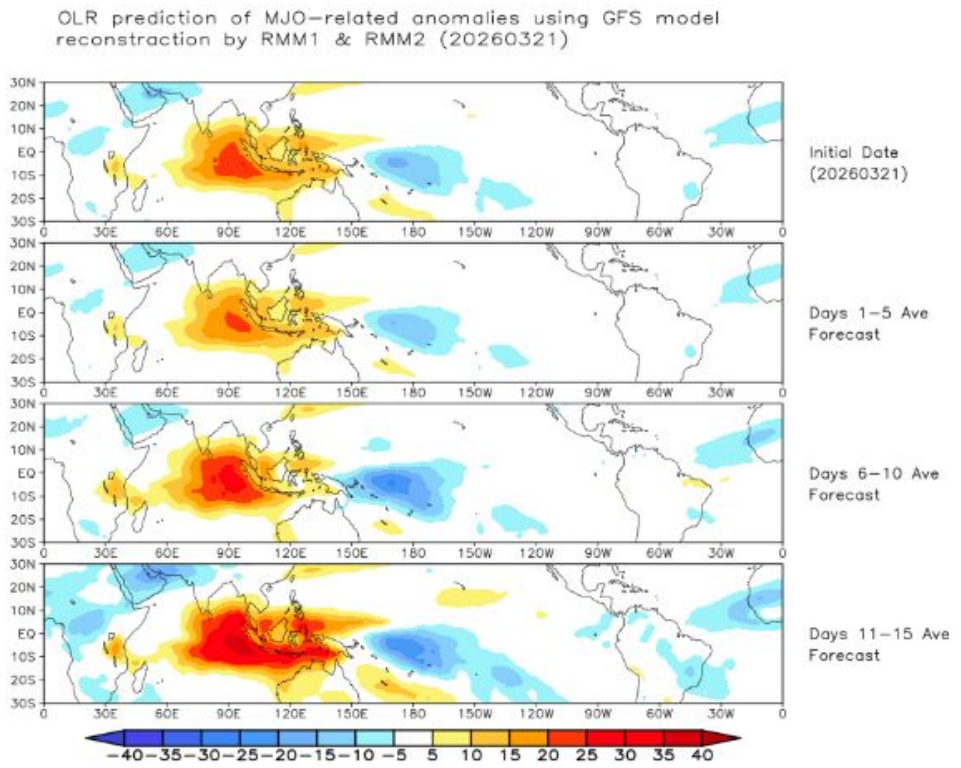


Source: Marshall, Andrew & Hendon, Harry & Hemer, Mark. (2015). Madden Julian Oscillation impacts on global ocean surface waves. Ocean Modelling. 96. 10.1016/j.ocemod.2015.06.002.

II. Subseasonal forecasts

MJO forecasts

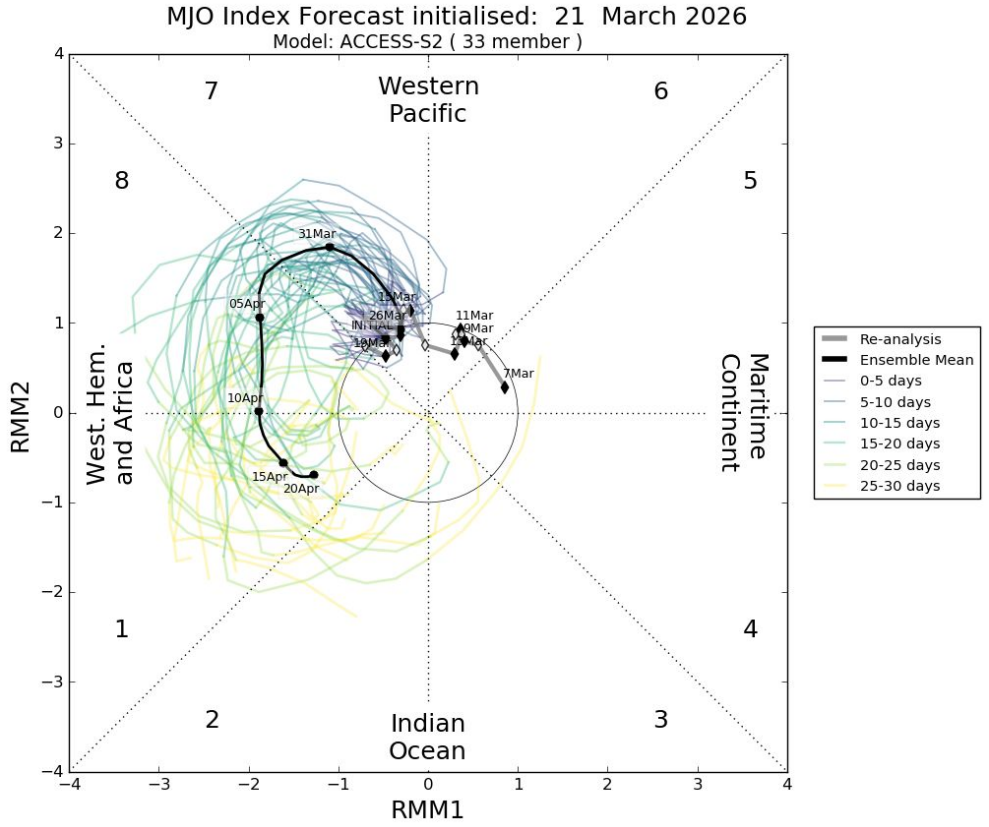
➢ OLR anomalies [W/m2] (ensemble mean GEFS)



Time

Low OLR (enhanced convection) / High OLR (suppressed convection)

➢ Evolution of last days of observations + ensemble forecast



➢ MJO has remained weak during most of March although the forecast points to an intensification by the end of the month, through phases 7, 8 and 1.

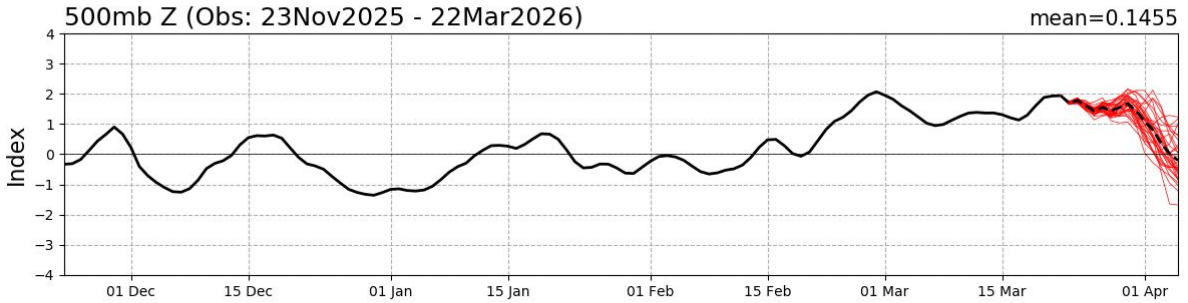
Source: https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/foregfs.shtml / https://www.bom.gov.au/climate/mjo/

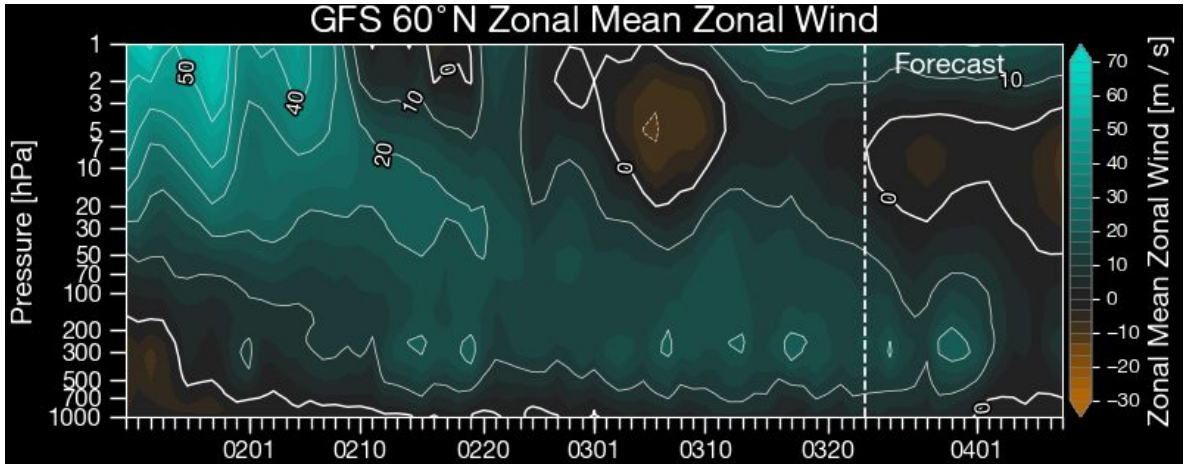
II. Subseasonal forecasts

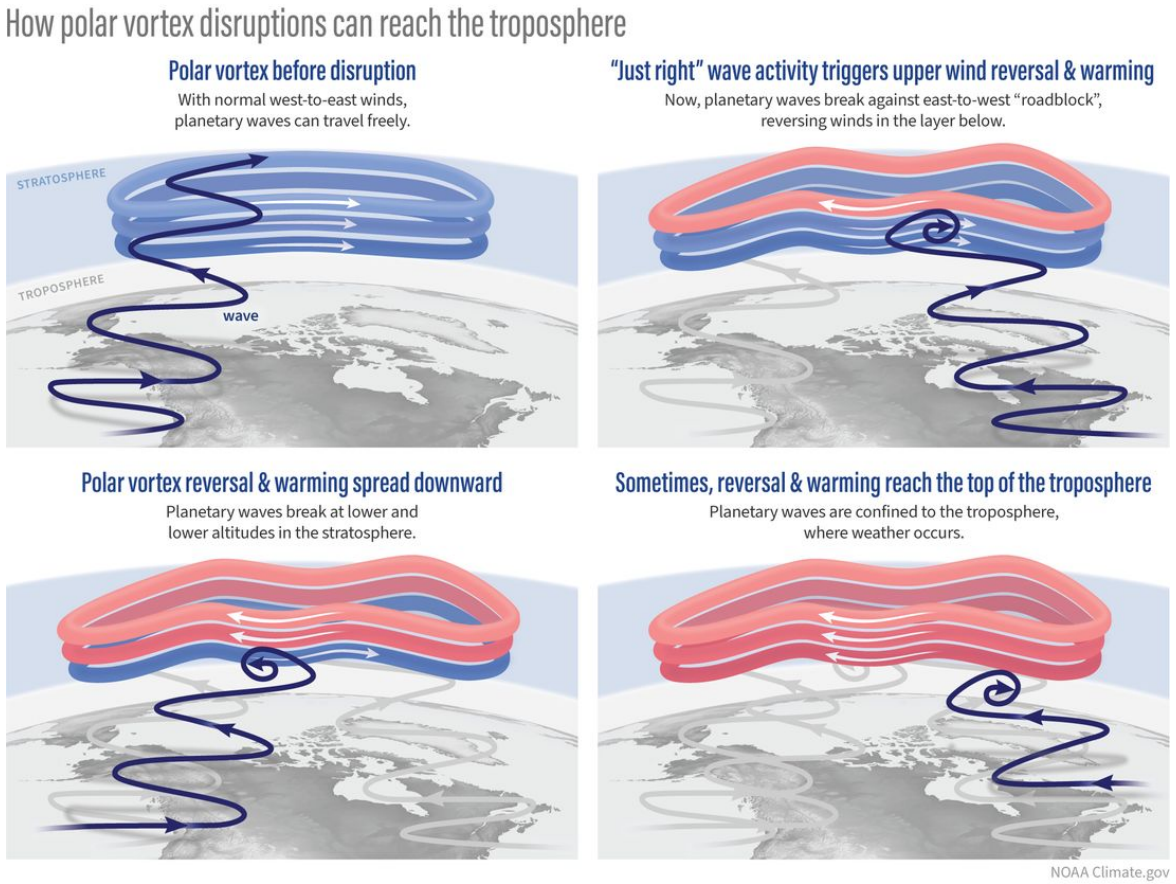
NAO / PV forecast

➢ Transition to negative NAO in early April, possibly associated to blocking situation caused by PV split.

NAO Index: Observed & GEFS Forecasts



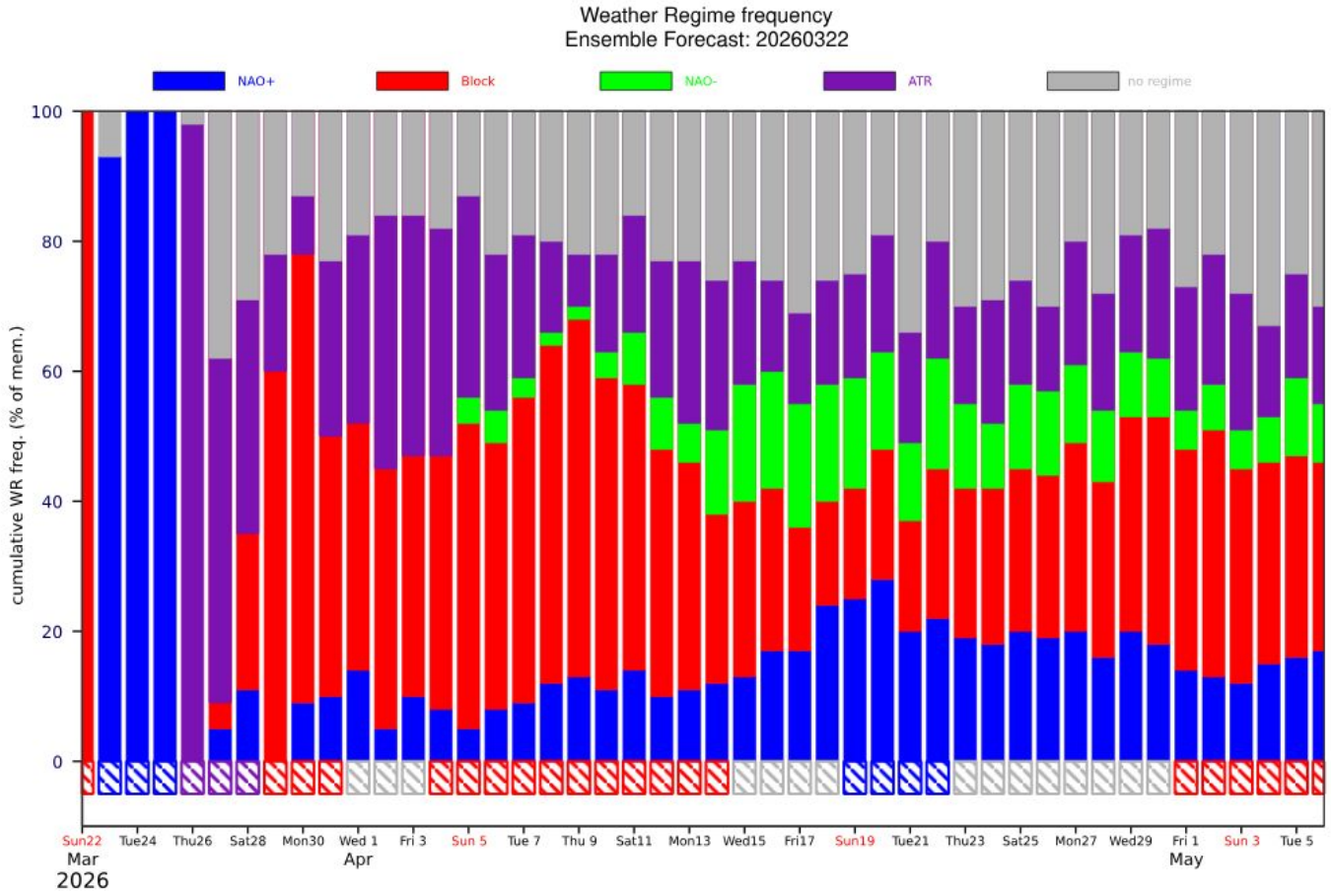


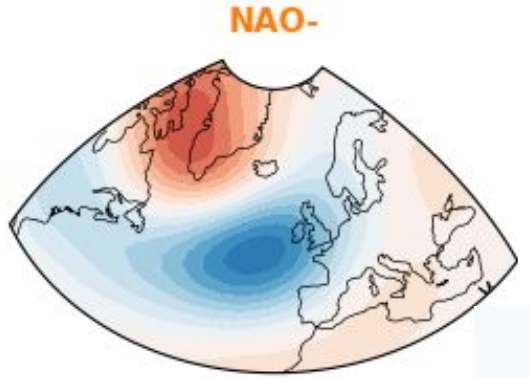


Source: https://www.cpc.ncep.noaa.gov/products/precip/CWlink/pna/nao_index_ensm.shtml

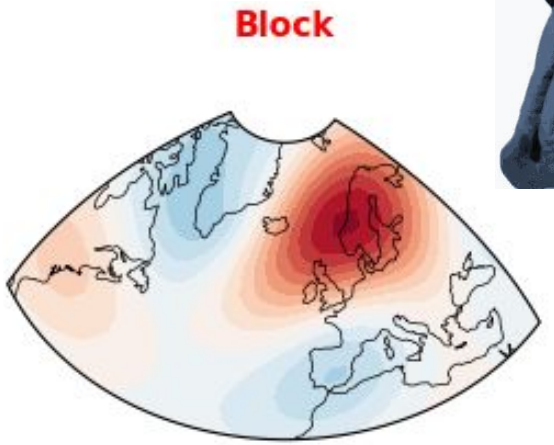
II. Subseasonal forecasts

Weather regimes





or



➢ ECMWF more in favour of Scandinavian Blocking (no warming spread from the stratosphere)

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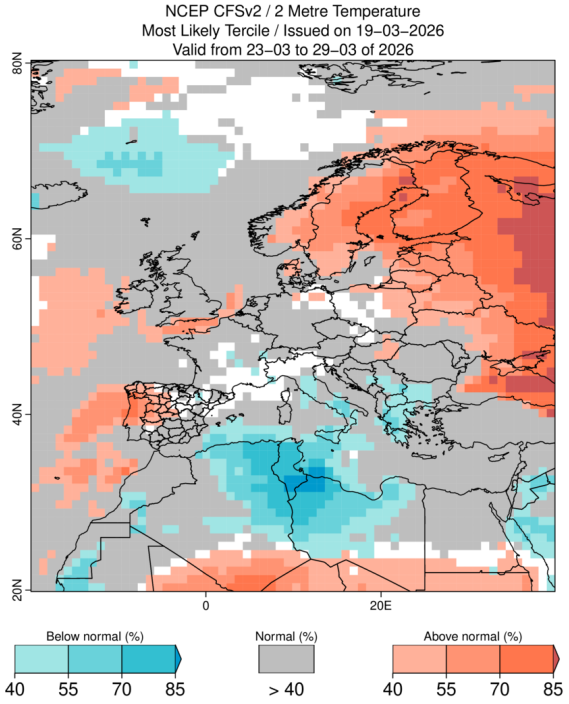
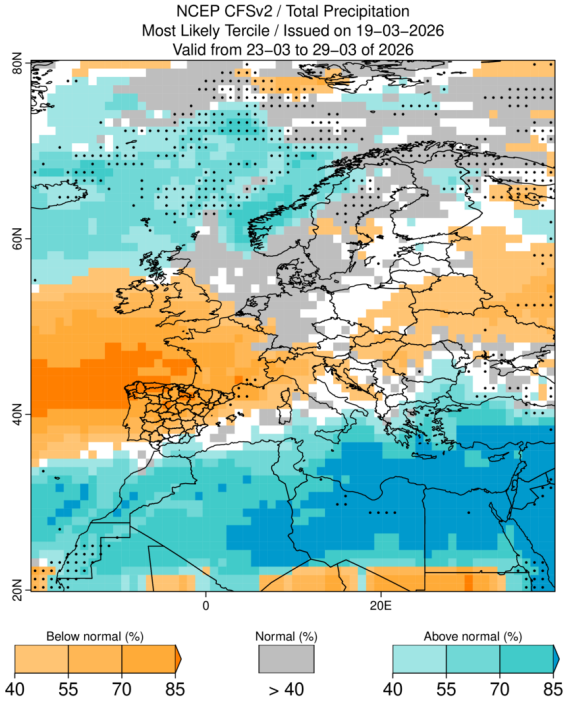
Source: https://charts.ecmwf.int/products/extended-regime-probabilities?forecast_from=latest

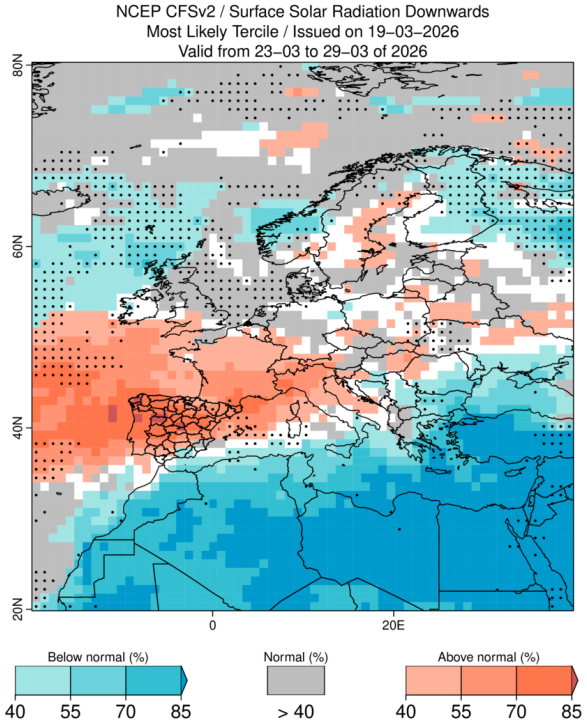
II. Subseasonal forecasts

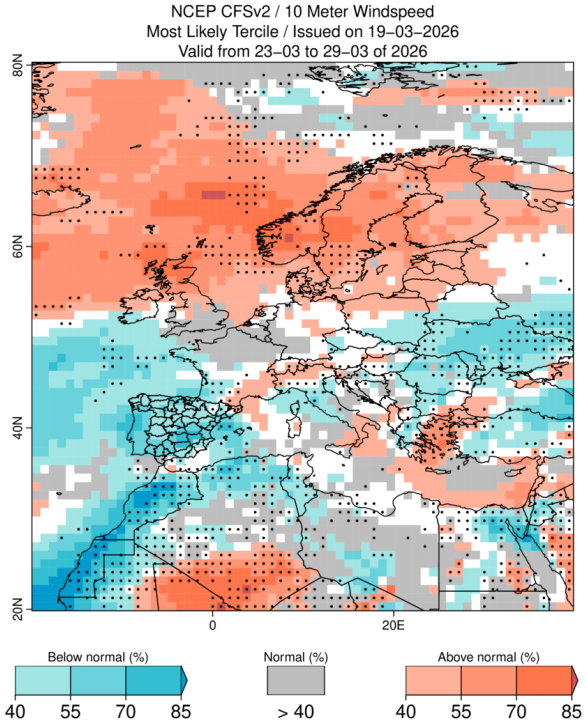
Valid on 23-29 Mar [Init. 19 Mar]

Hindcast period: 1999 - 2016









Temperature

Precipitation

Solar radiation

Surface wind

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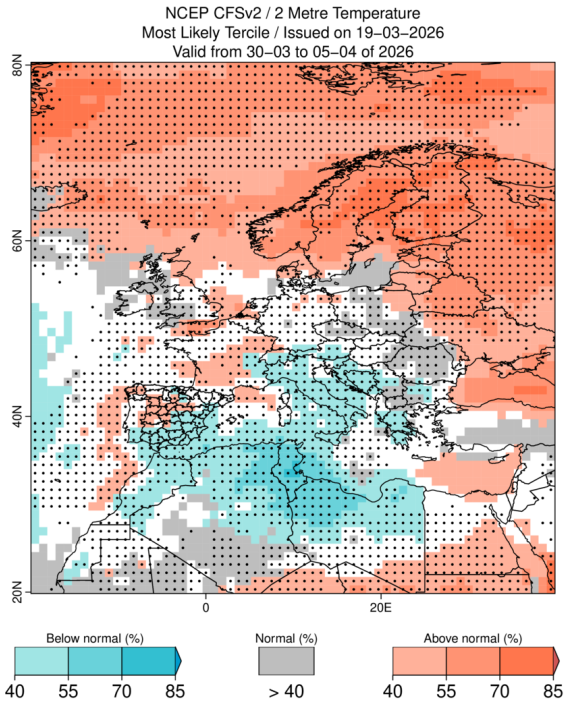
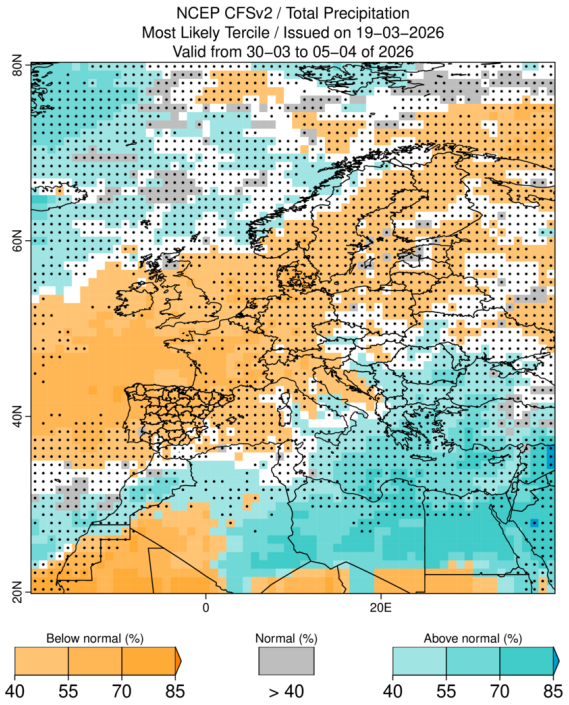
Consistent with NAO+

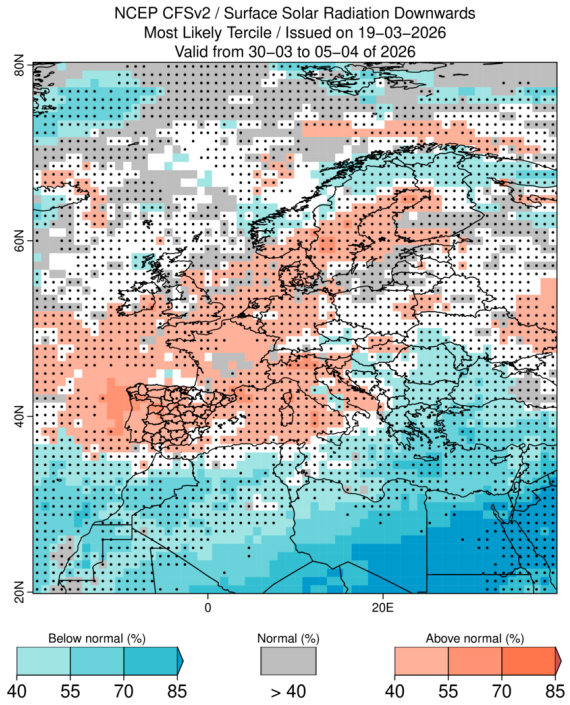
II. Subseasonal forecasts

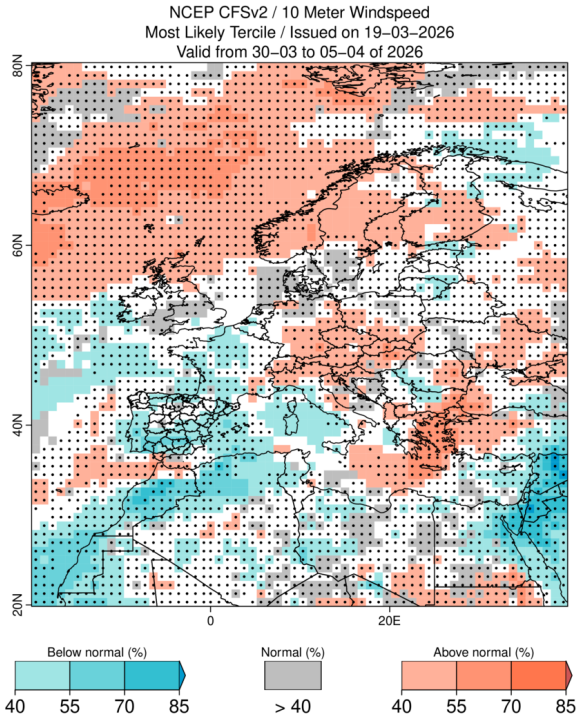
Valid on 30 Mar to 5 Apr [Init. 19 Mar]

Hindcast period: 1999 - 2016









Temperature

Precipitation

Solar radiation

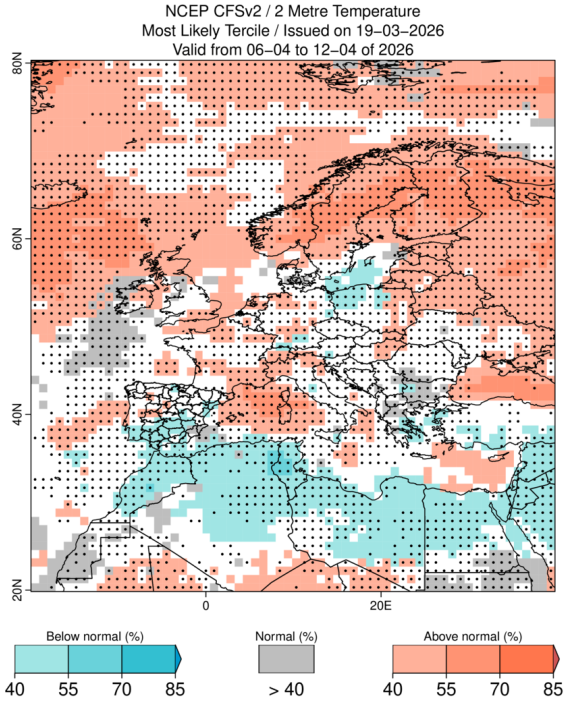
Surface wind

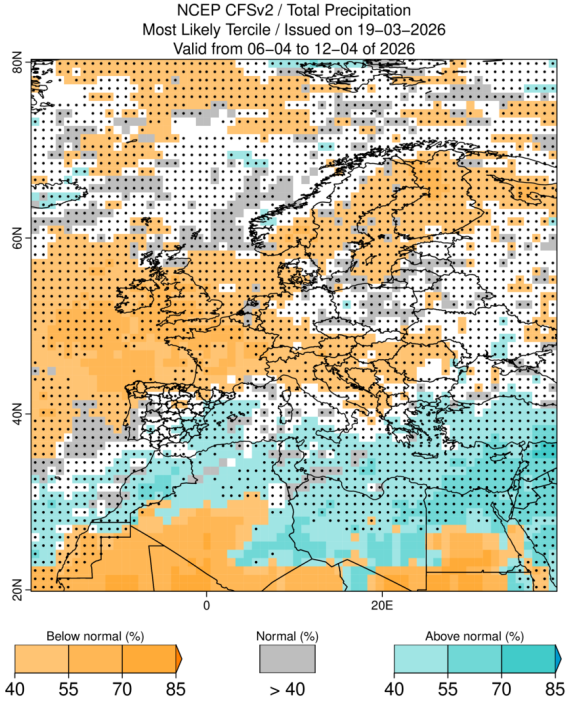
Mixed NAO-/Block signals + trends?

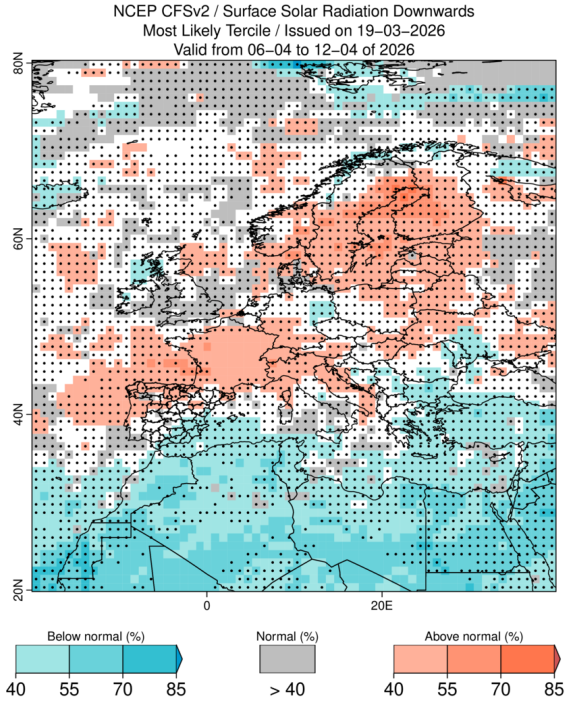
II. Subseasonal forecasts

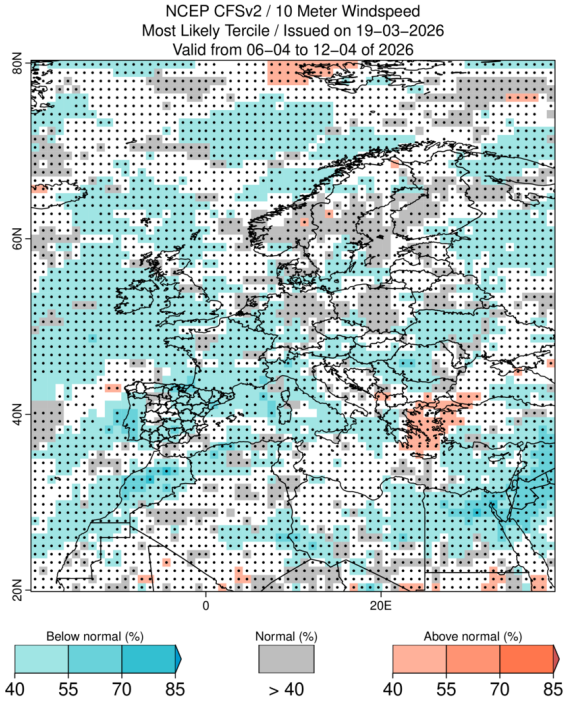
Valid on 6-12 Apr [Init. 19 Mar]

Hindcast period: 1999 - 2016









Temperature

Precipitation

Solar radiation

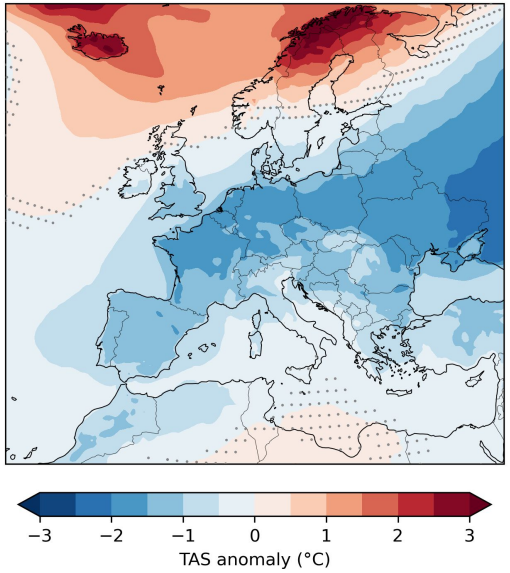
Surface wind

Mixed NAO-/Block signals + trends?

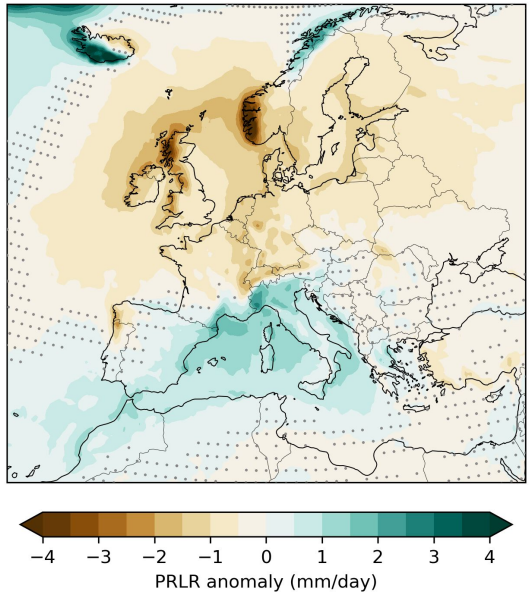
II. Subseasonal forecasts

Composites of Blocking pattern and surface climate

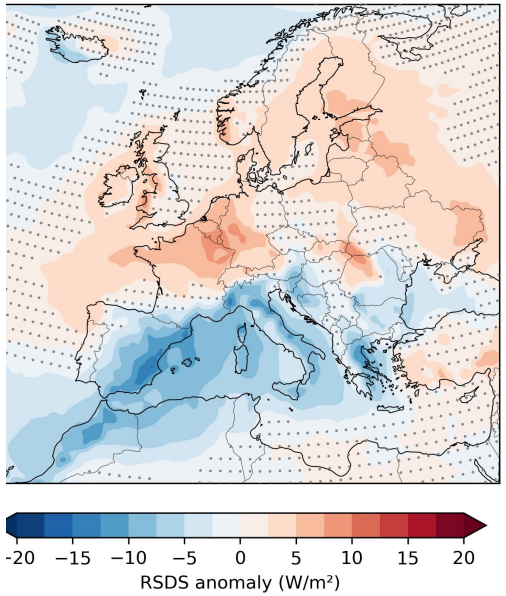
ΔTAS composite — Blocking
ERA5 (1980–2008)



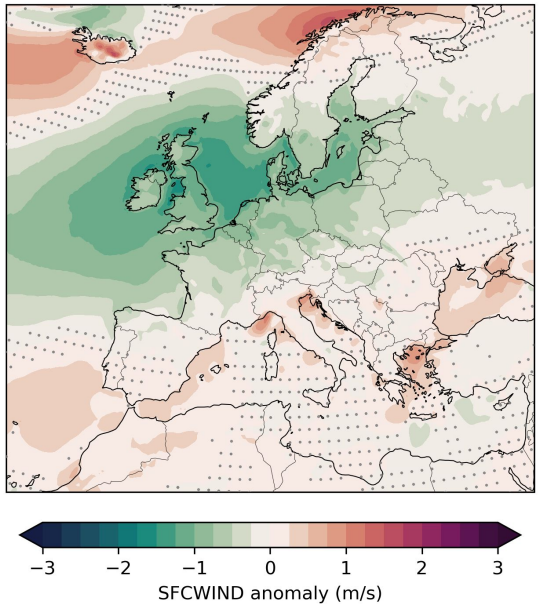
ΔPRLR composite — Blocking
ERA5 (1980–2008)



ΔRSDS composite — Blocking
ERA5 (1980–2008)



ΔSFCWIND composite — Blocking
ERA5 (1980–2008)



Temperature

Precipitation

Solar radiation

Surface wind

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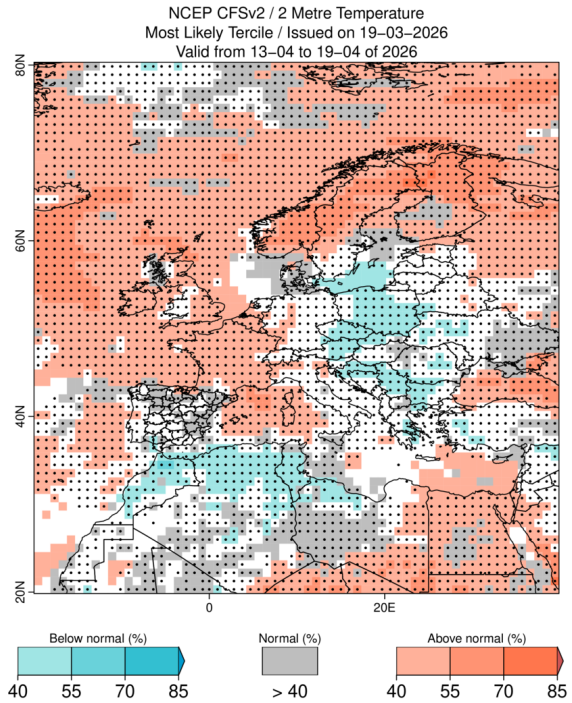
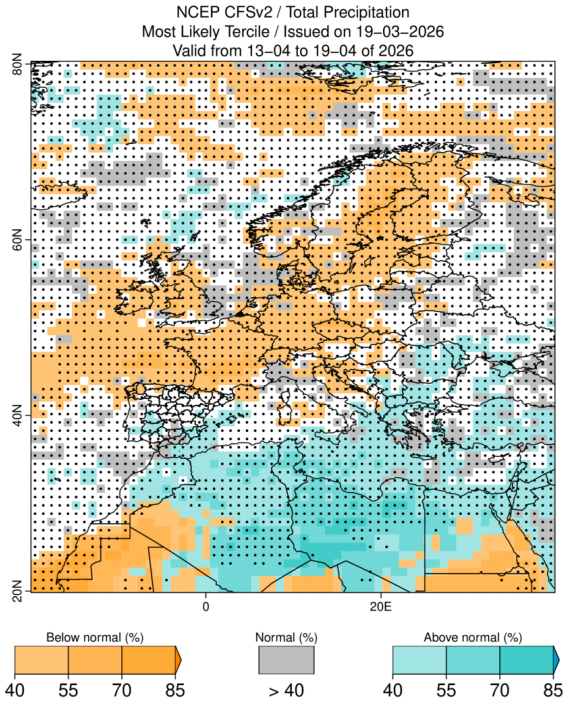
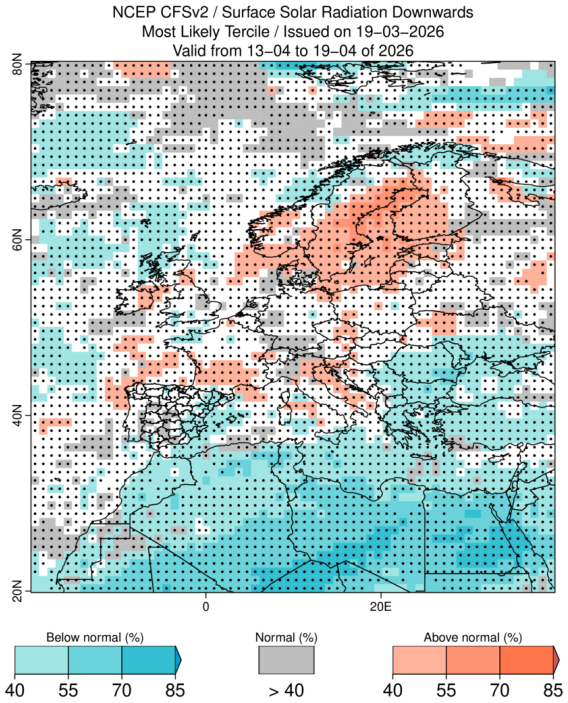
II. Subseasonal forecasts

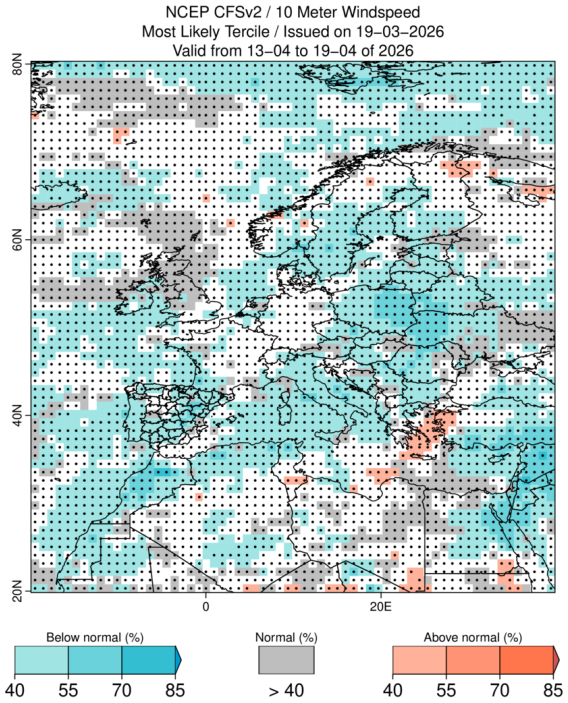
Valid on 13-19 Apr [Init. 19 Mar]

Hindcast period: 1999 - 2016









Temperature

Precipitation

Solar radiation

Surface wind

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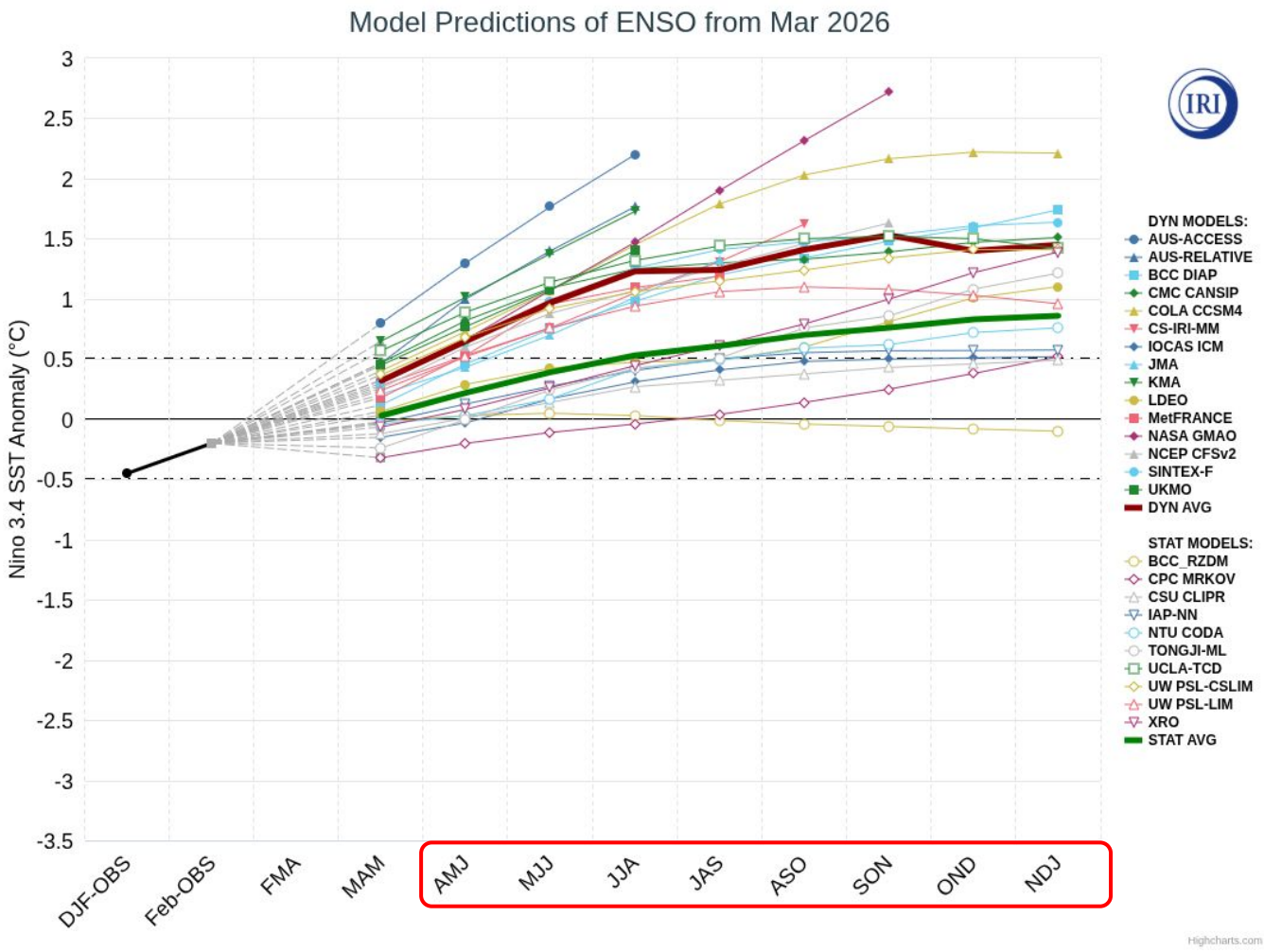
I. Recent state of the climate

II. Subseasonal forecasts

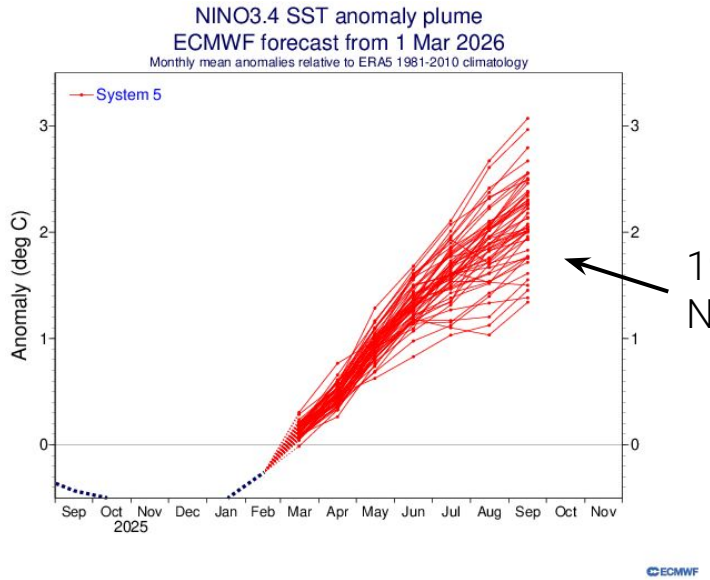
III. Seasonal forecasts

III. Seasonal forecasts

ENSO forecasts



- Transition towards **El Niño** conditions as early as in April-May-June (AMJ).
- The statistical models predict ENSO-neutral conditions until JJA.
- Watch out, the amplitude of ENSO (SST anomalies) is quite sensitive to the reference period. Here IRI's using 1991- 2020.



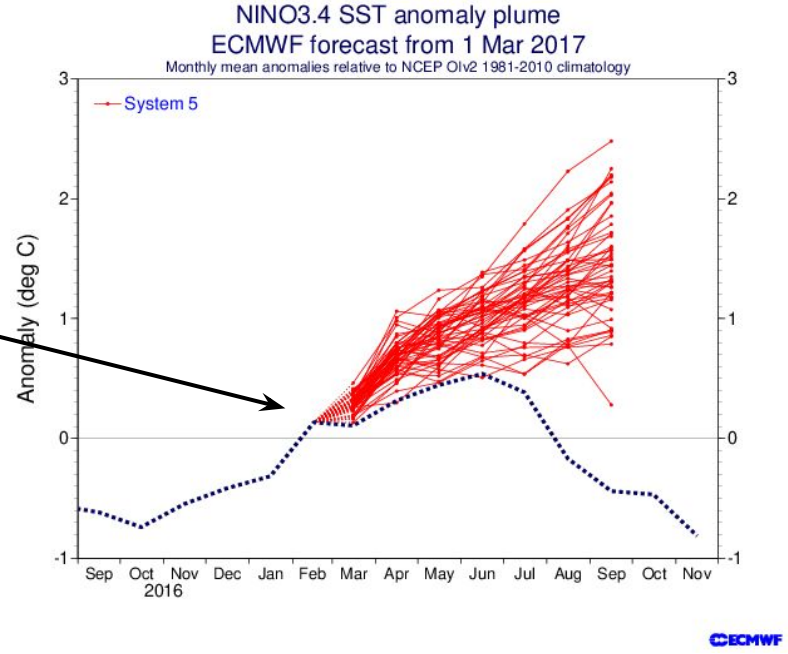
1981 - 2010
No running mean

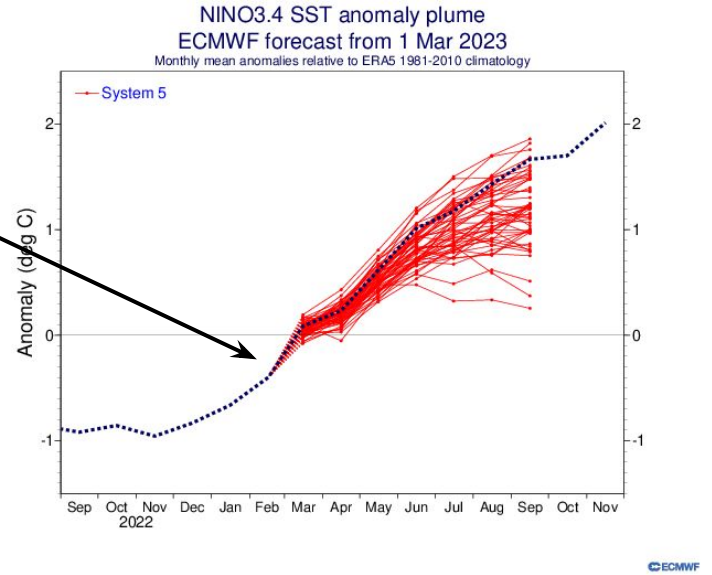
Source: https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table /

III. Seasonal forecasts

ENSO forecasts

- SEAS5 tends to overestimate ENSO amplitude with spring initialisations (e.g., 2017), an issue linked to the springtime predictability barrier.
- Weakened ocean-atmosphere coupling during the period of ENSO decay (i.e., low signal-to-noise ratio) can lead to models having problems in accurately forecasting the correct signal of the following event.
- Although there are also examples of accurate ENSO forecasts in spring (e.g., 2023).
- Some media are saying that a “super El Niño” is coming. Carefully check reference period and if there’s a running mean.



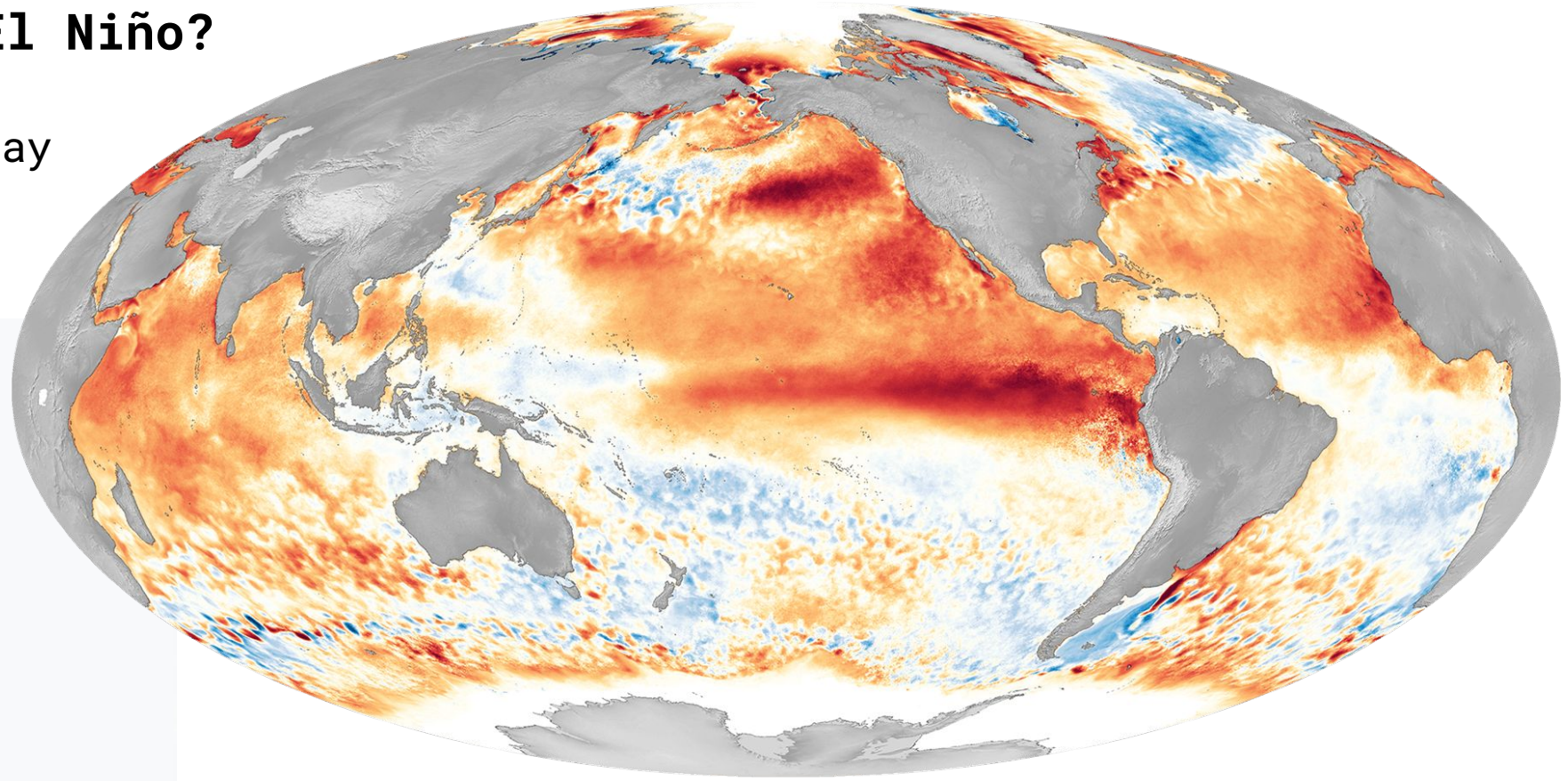


Source: https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table /

III. Seasonal forecasts

Where's the super El Niño?

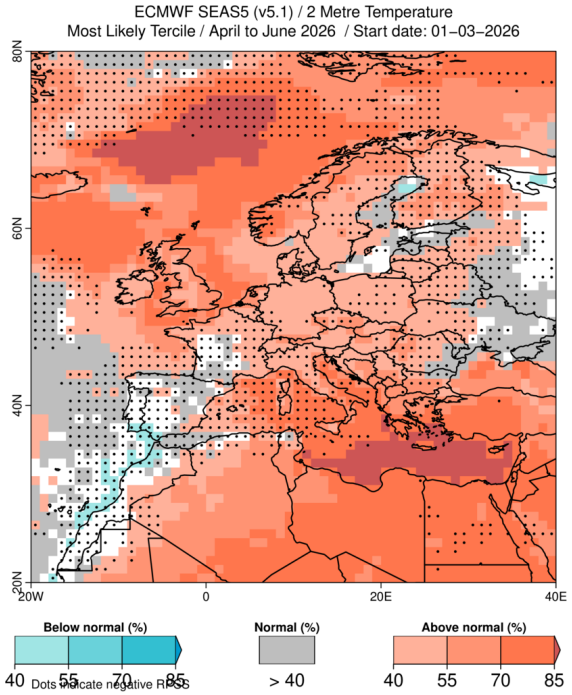
Probably too soon to say

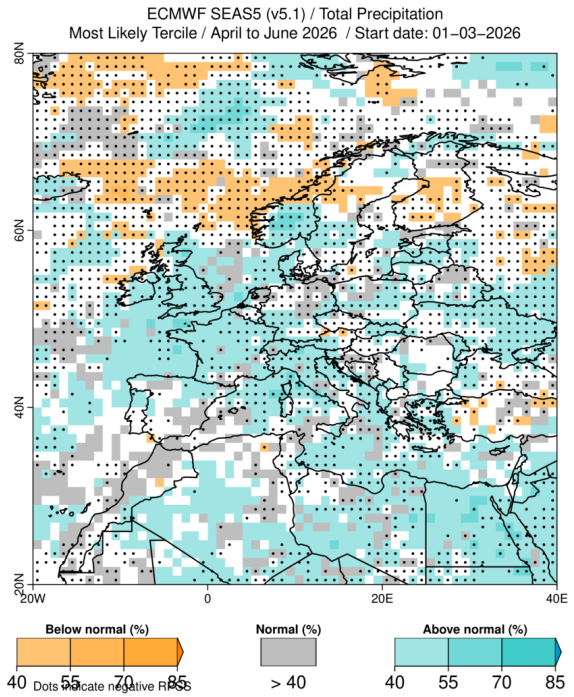


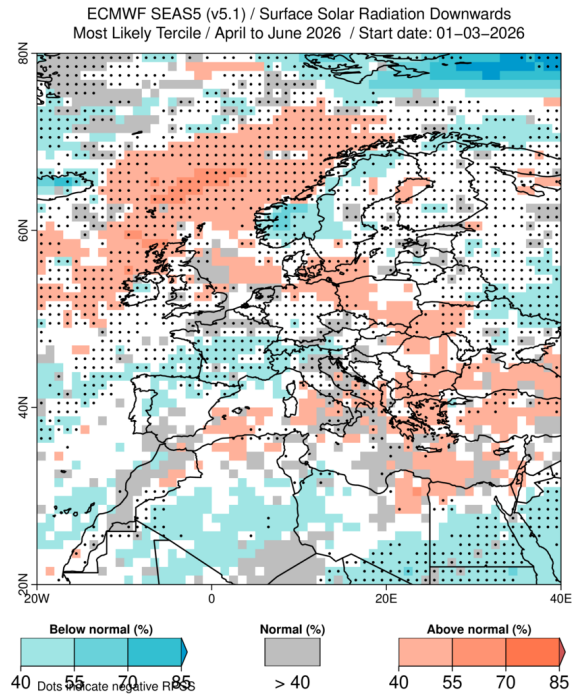
III. Seasonal forecasts

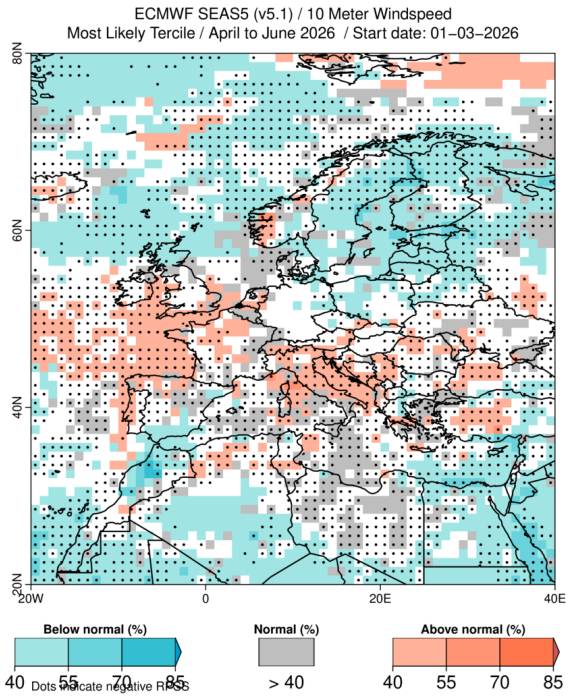
AMJ 2026 (Forecast times 2-4)

Hindcast period: 1993 - 2016









Temperature

Precipitation

Solar radiation

Surface wind

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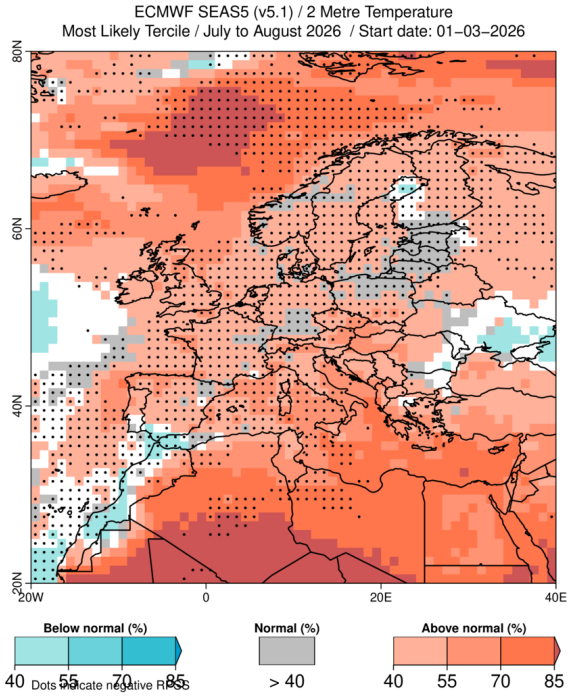
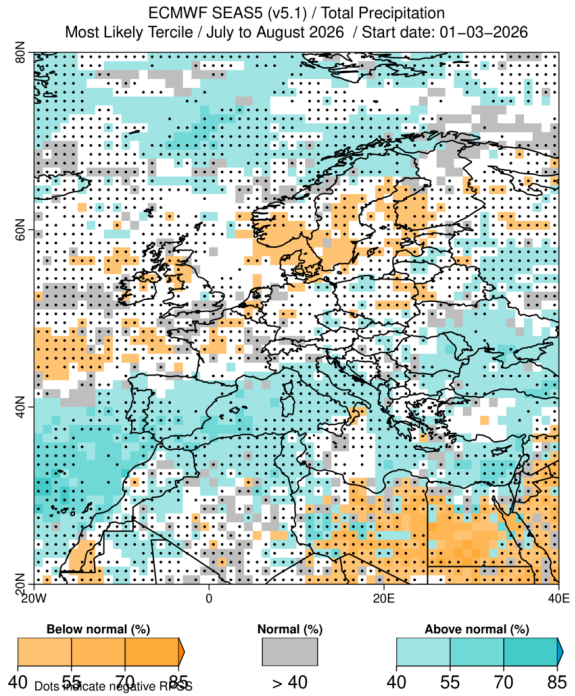
Dots = negative Ranked Probability Skill Score

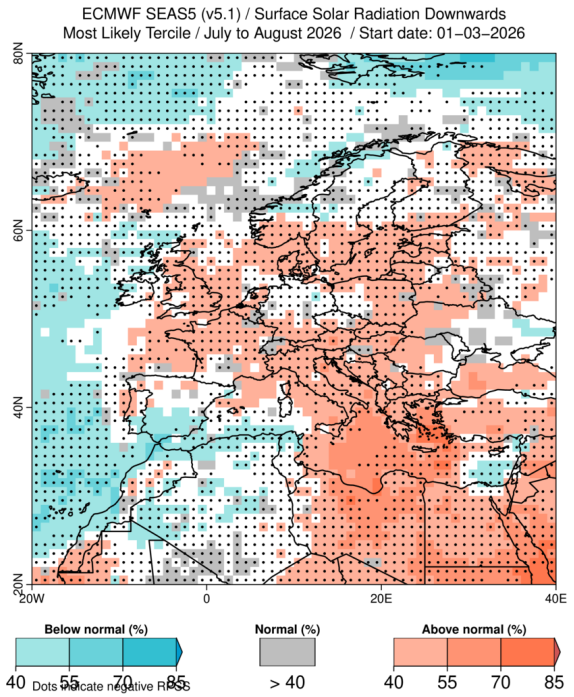
III. Seasonal forecasts

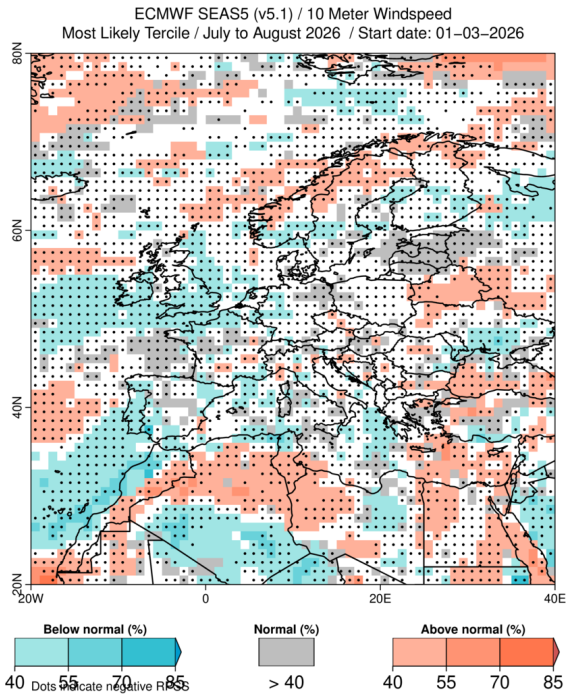
JA 2026 (Forecast times 5-6)

Hindcast period: 1993 - 2016









Temperature

Precipitation

Solar radiation

Surface wind

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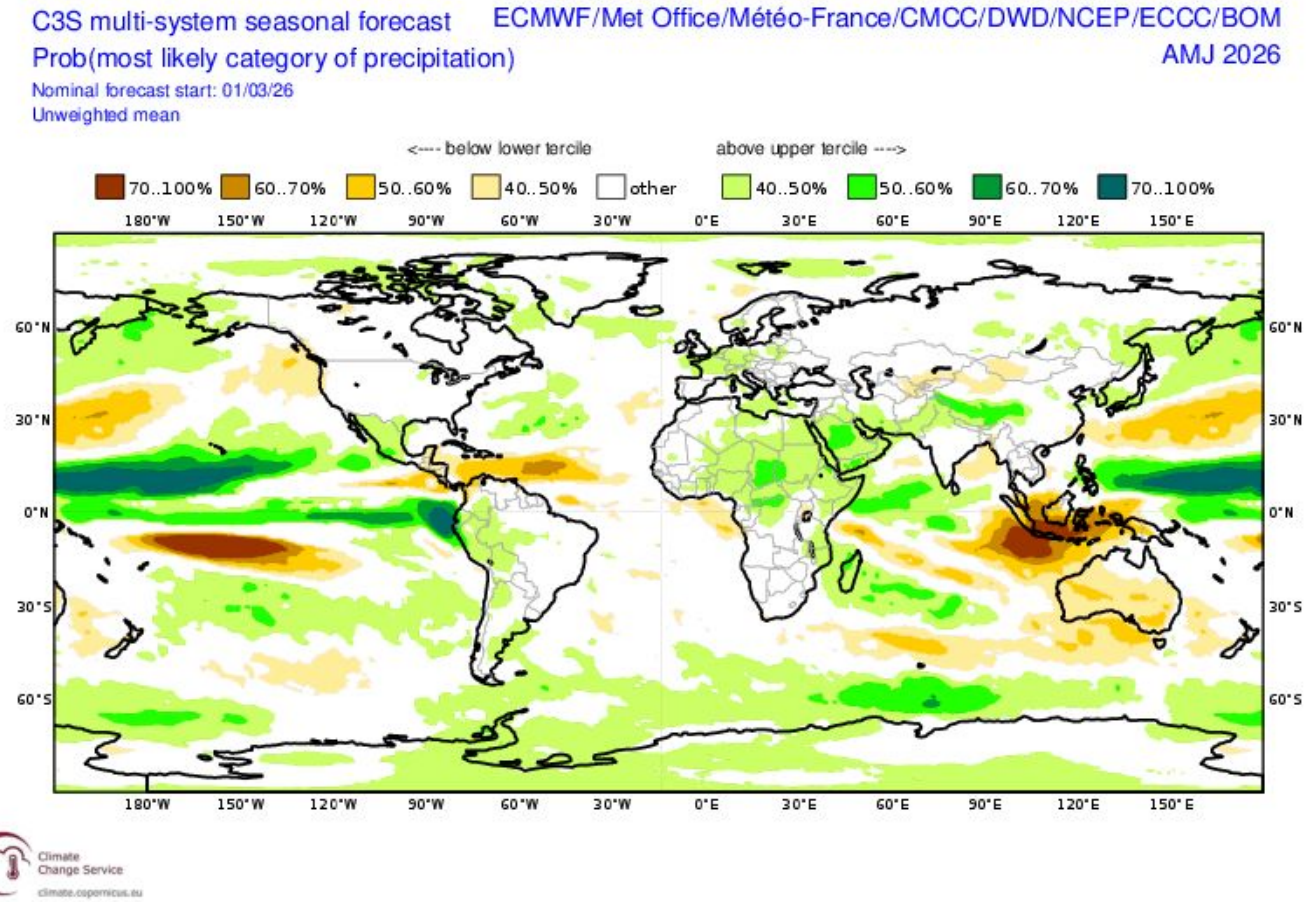
Dots = negative Ranked Probability Skill Score

III. Seasonal forecasts

Precipitation

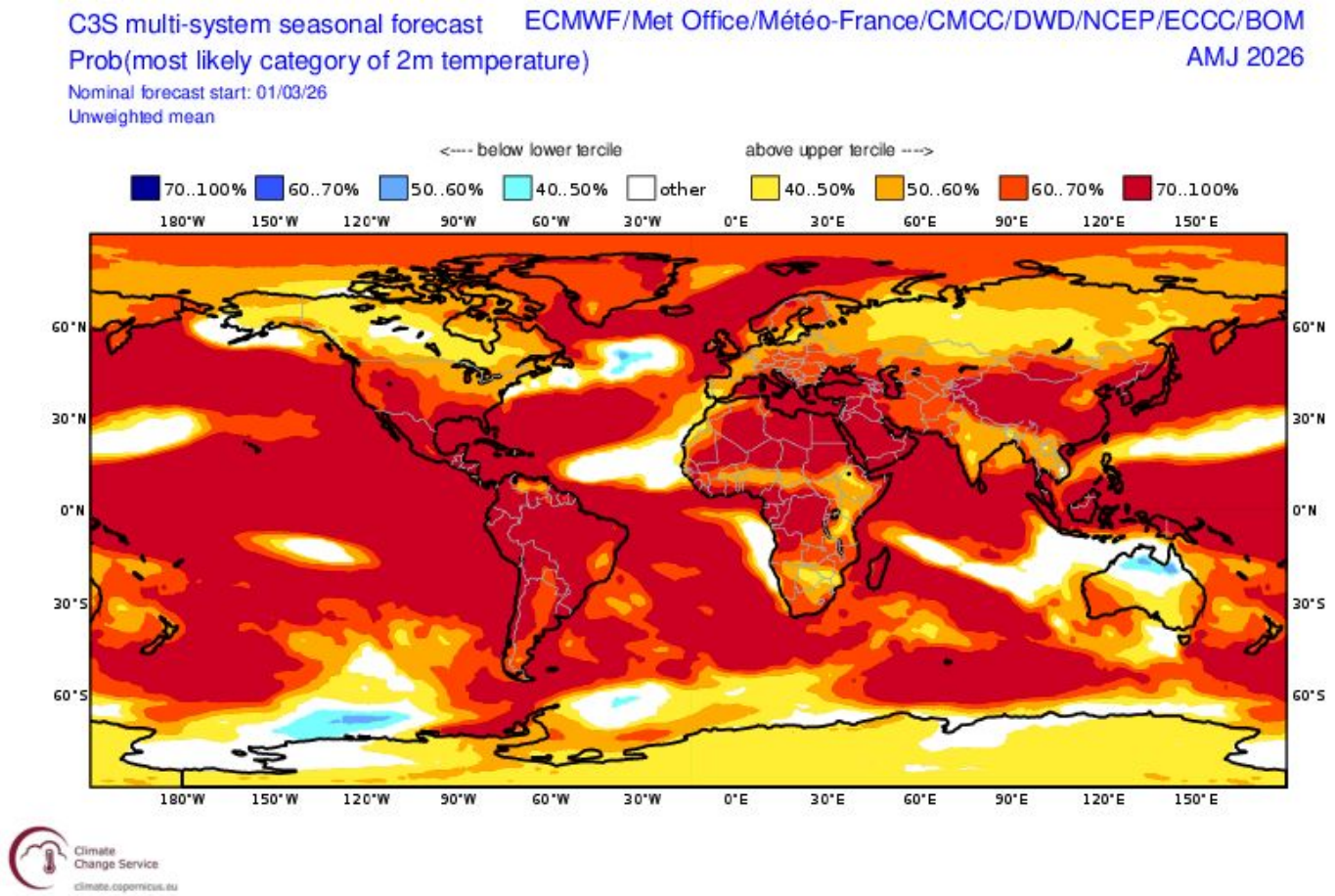


- ➢ Positive Peru, Ecuador, N. Bolivia, Central Europe, N-E/E Africa…
- ➢ Negative Indonesia, Australia, Central America…
- ➢ Overall mixed signals between fading la niña, MJO 7-8 and coastal el niño

Source: https://climate.copernicus.eu/charts/packages/c3s_seasonal/ / https://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/

III. Seasonal forecasts

Temperature



- Typical global warming signal.
- Parts of North Atlantic, Southern Ocean & North Australia with normal/cooler anomalies.

Source: https://climate.copernicus.eu/charts/packages/c3s_seasonal/ / https://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/

Earth Sciences Department

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Forecast Briefing

March 2026

Climate Services Team (CST)

Earth System Services (ESS)

Barcelona Supercomputing Center (BSC)

Tuesday 24th March 2026