Previsioni climatiche nella regione Euro-Mediterranea

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Ricerca d'eccellenza per sistemi agro-alimentari e territoriali competitivi e resilienti

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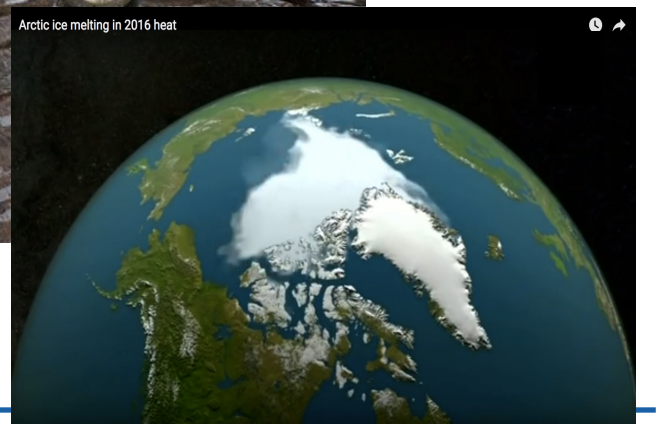
DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRO-ALIMENTARI

Preamble

Climate predictions provide information about the **probability** of anomalous climatic conditions occurring in a relatively **near future (months, seasons, a few years)**, helping to address, manage and mitigate potential severe impacts across a broad spectrum of socio-economic sectors.

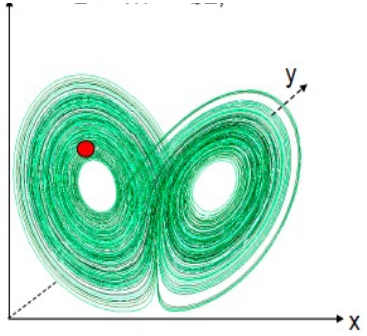
Therefore, climate predictions represent an extremely useful tool for adaptation in a changing climate



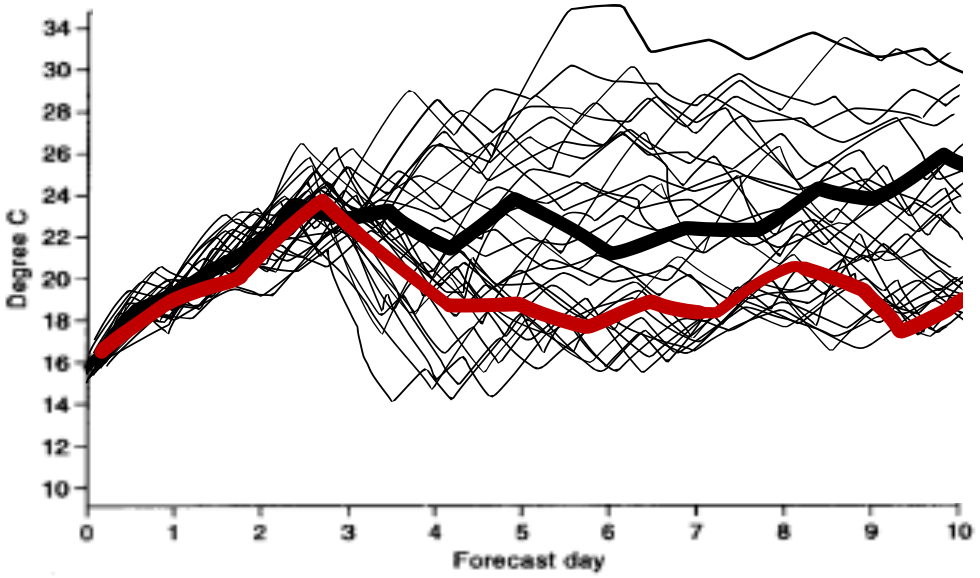
The basis for climate predictions

How is it possible to make climate predictions considered that weather is a chaotic system?

Edward N. Lorenz (1917–2008)



The atmosphere is a **chaotic system**: due to the strong non–linearity of the atmospheric dynamics, simulations (predictions) of the evolution of the atmosphere are very sensitive to (small) changes in their initial conditions.



Limit of deterministic predictability: given by the growth rate of the (inevitable) errors in the initial state → the atmosphere loses memory of its initial conditions after a **few days** (limit of about 10–15 days).

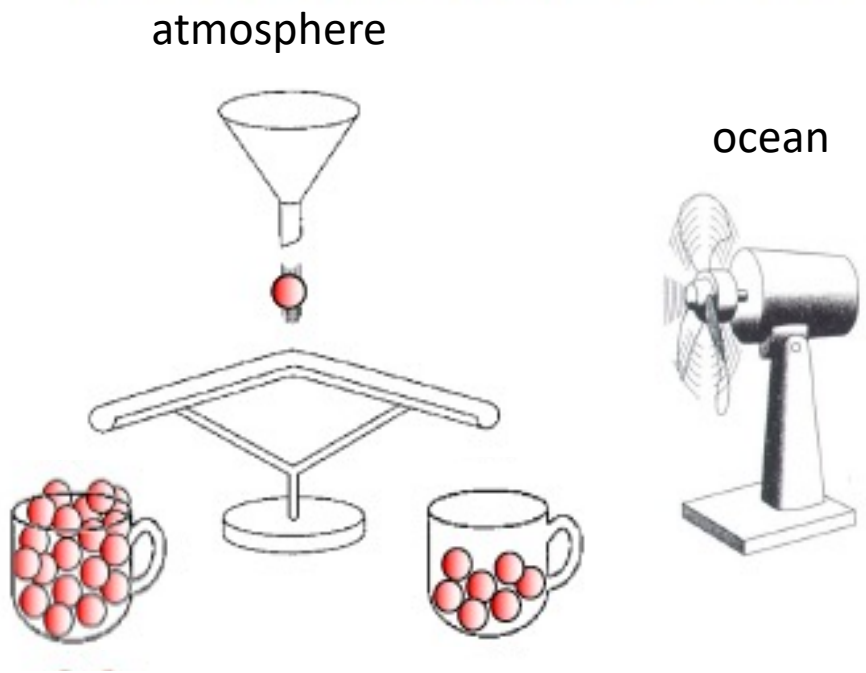
Predictability of the first kind (or initial value problem)

The memory of the **land–surface** (snow, soil moisture, vegetation) to initial conditions can extend **to several months**

The memory of the **ocean** to initial conditions can range **from months to (many) years**.

The basis for climate predictions

Ocean, land surface and sea–ice are characterised by slower dynamical processes, providing a **long–term memory** which leads to **skill in predicting climate evolution.**



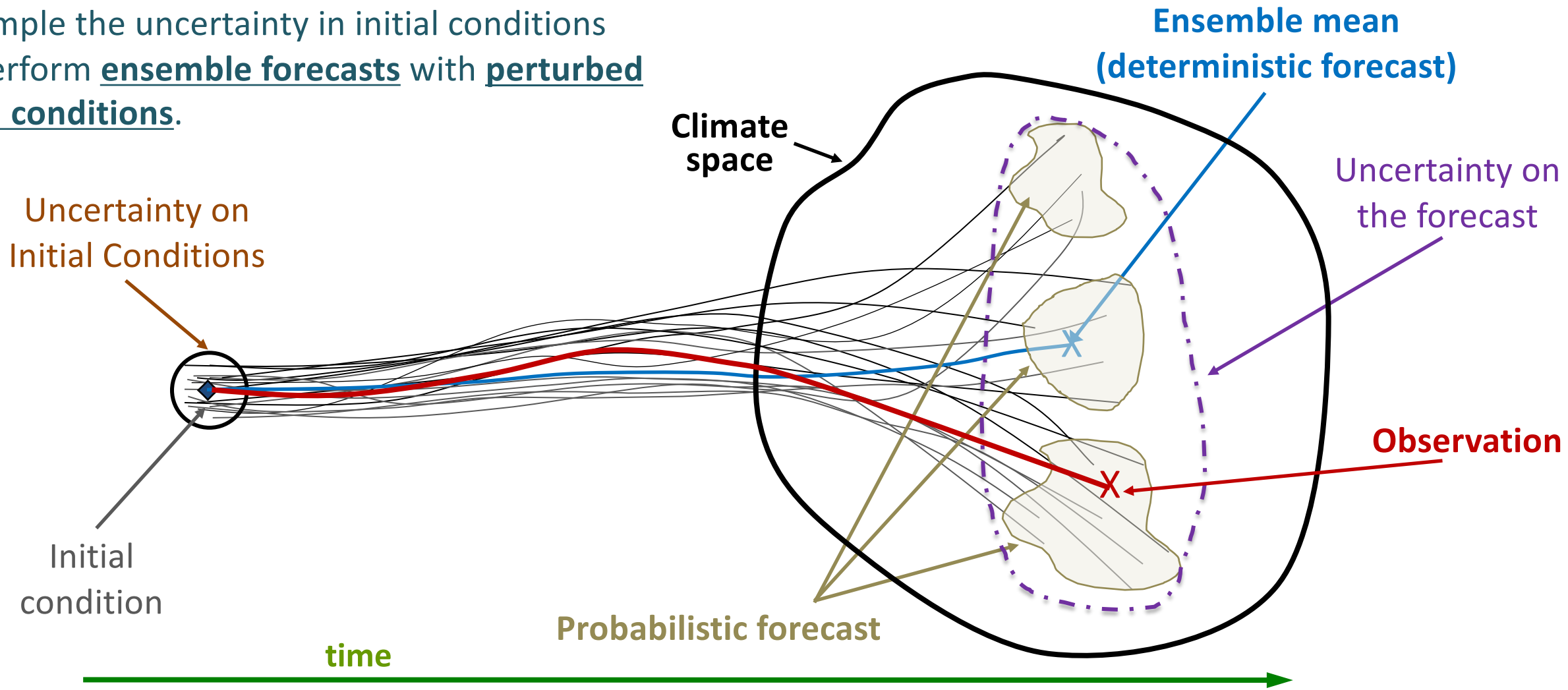
(Palmer, 1998)

Even though **individual weather events** are not predictable beyond 10 days, the ***average weather behaviour*** (climate) may be **influenced by predictable boundary conditions** (e.g. land–surface, ocean, …) for **several months or longer**.

Predictability of the second kind (or boundary conditions problem)

How do we do climate predictions?

To sample the uncertainty in initial conditions we perform **ensemble forecasts** with **perturbed initial conditions**.



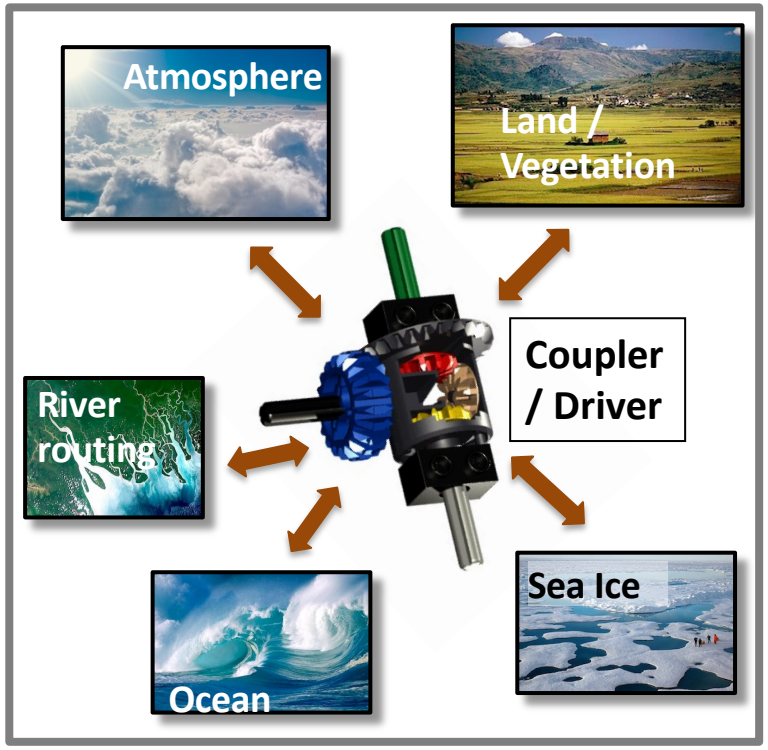
Readapted from Trzaska (http://portal.iri.columbia.edu)

The external forcing (ocean and land–surface anomalies) makes some state more probable than others

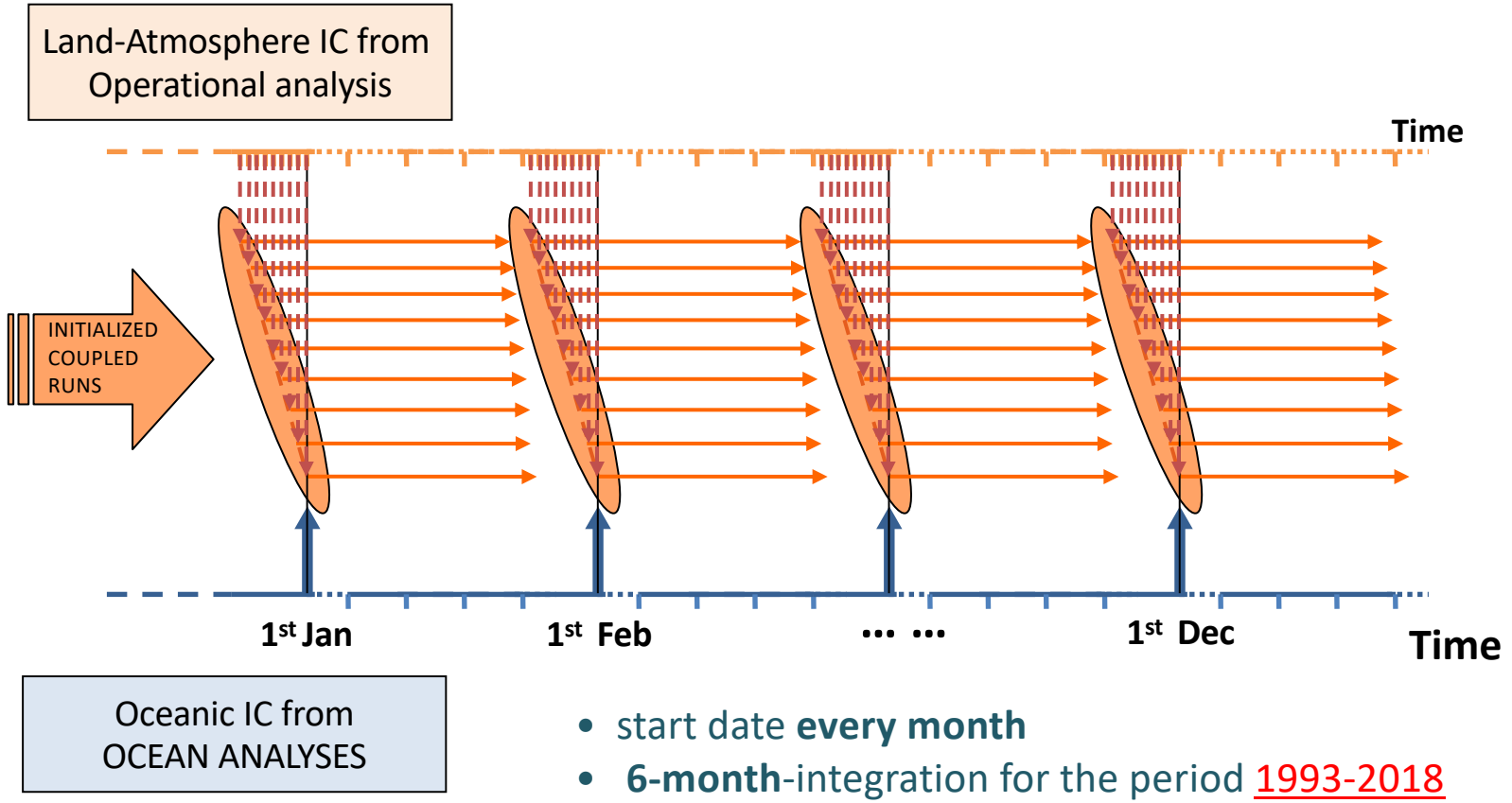
How do we do climate predictions?

The operational setup: forecast and re-forecasts (forecast in the past) for validation) and calibration

Climate Model



Seasonal



- start date **every month**
- **6-month**-integration for the period 1993-2018
- **12 start dates** per year (once a month)
- **50 ensemble members** for each start date

How do we do climate predictions?

Climate Change

C3S multi-system seasonal forecast

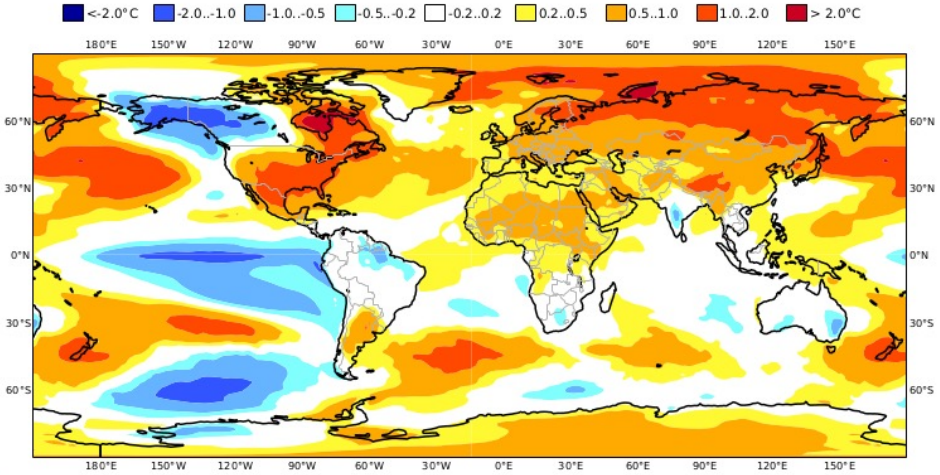
DJF 2021-2022 Prediction – Start date: 2021 November 1st

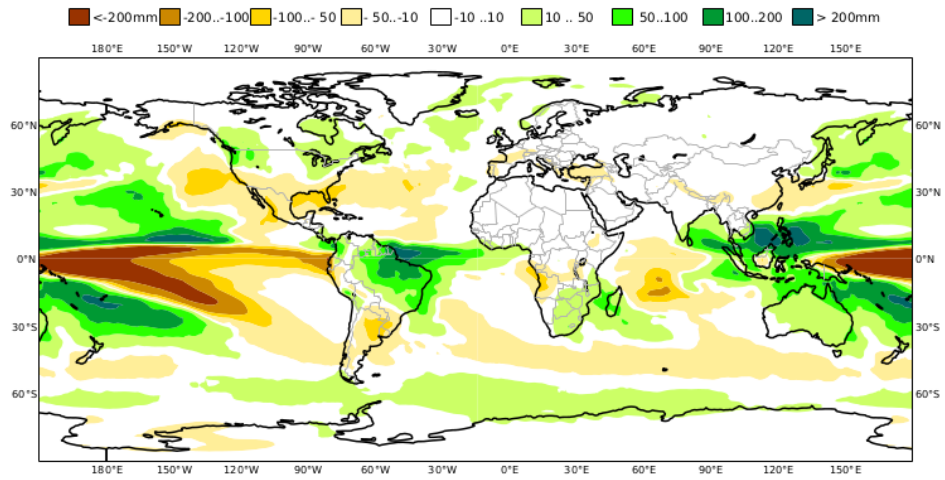
(reference period 1993–2016)

T2m

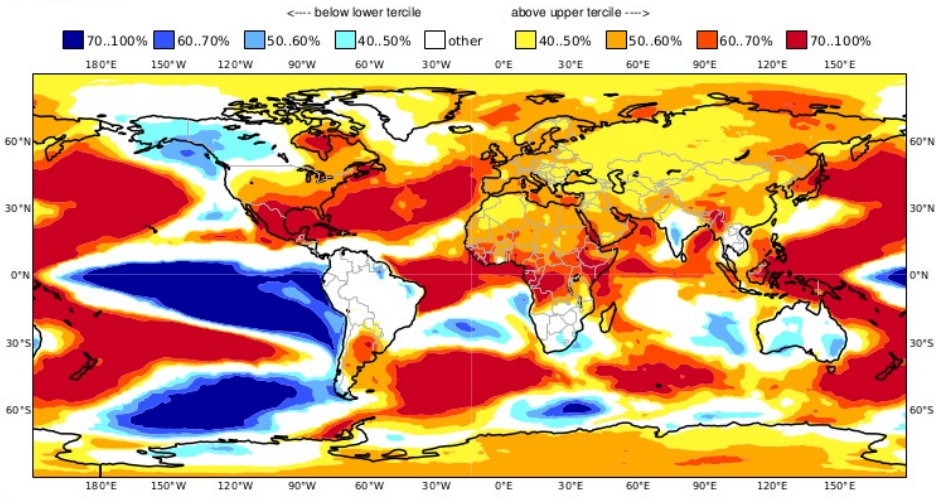
Precipitation

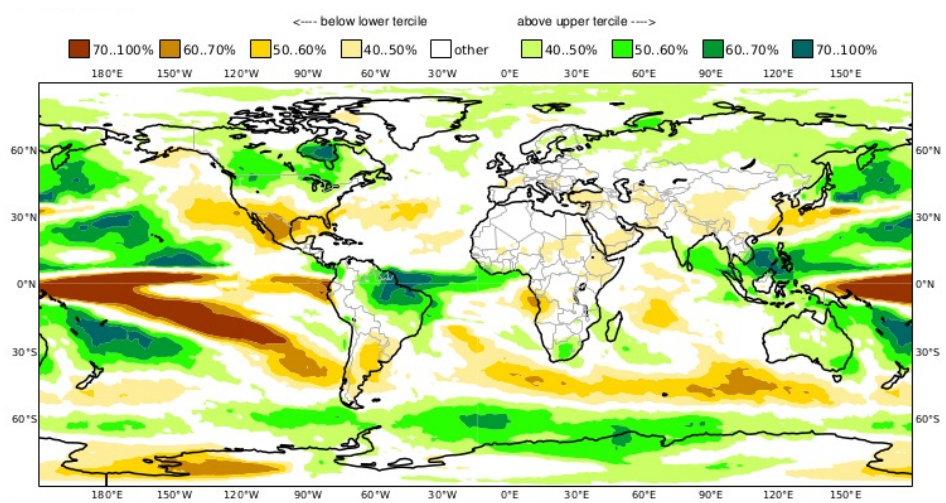
DJF mean anomaly





DJF probabilistic forecast





How good are seasonal predictions?

T2m ACC

(reference period 1993 – 2016)

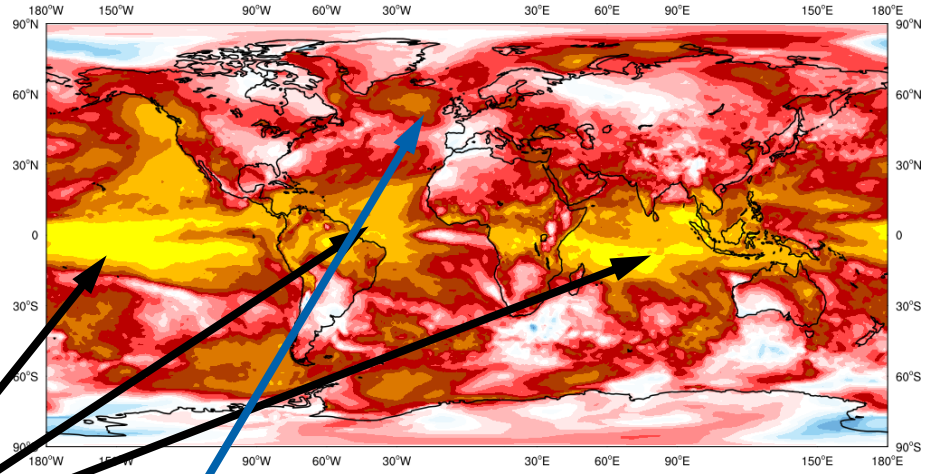
Lead season 1

Lead time 1 refers to the season starting one month after the start date (e.g. Feb lead 1 = MAM)

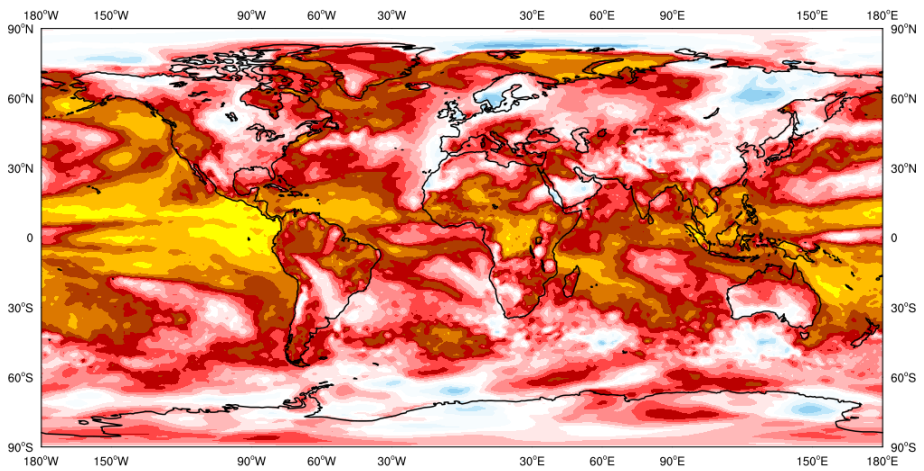
- Skill is higher in the Tropical oceans (ENSO and teleconnections) and extra-trop. Pacific

- Good skill in the northern Atlantic region, particularly in the winter and the spring

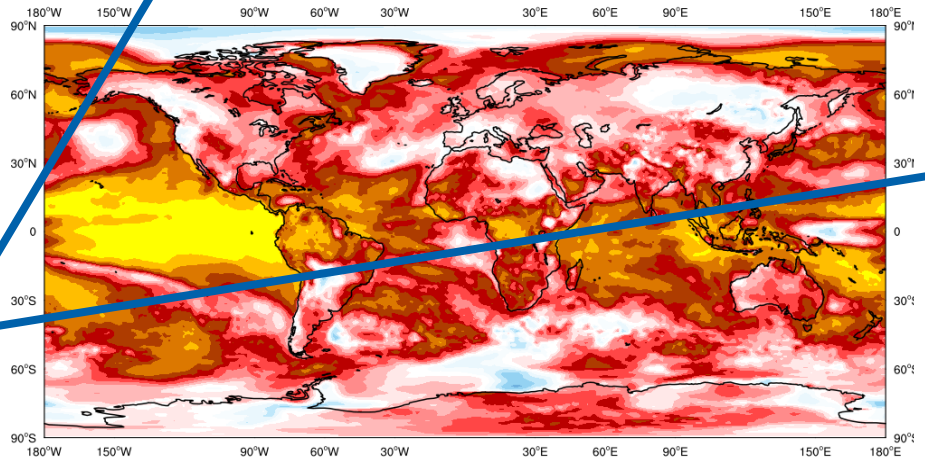
Feb 1st → MAM



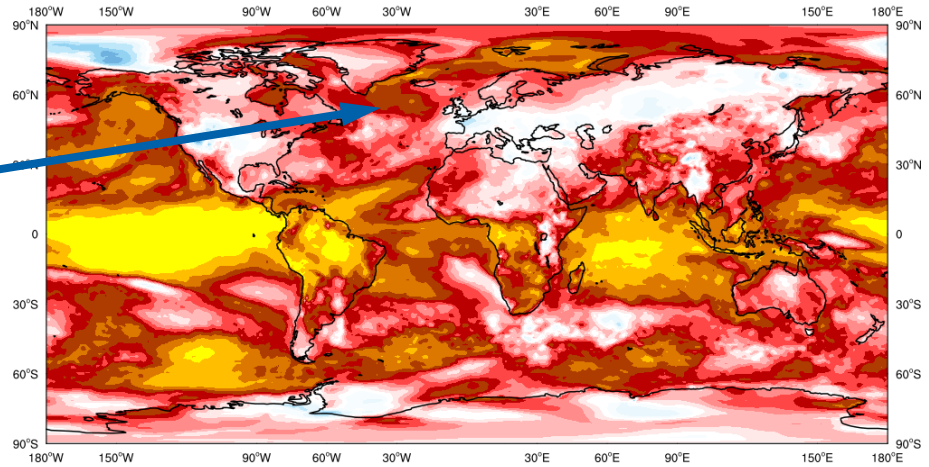
May 1st → JJA

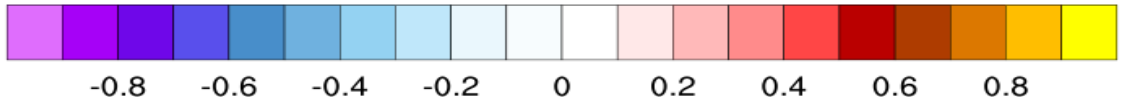


Aug 1st → SON



Nov 1st → DJF





CMCC SPS3.5 (Gualdi et al. 2020)

How good are seasonal predictions in the Mediterranean region

DJF Forecasts **initialised on** **November 1st**

Anomaly Correlation Coefficients

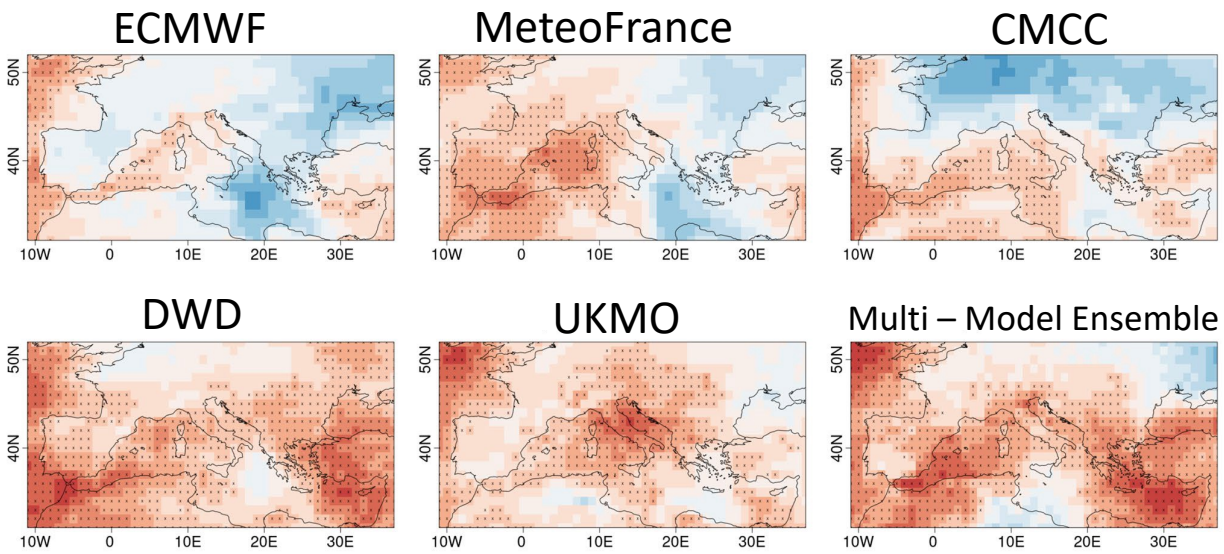
with respect to ERA5, 1993 – 2014

C3S multi–system

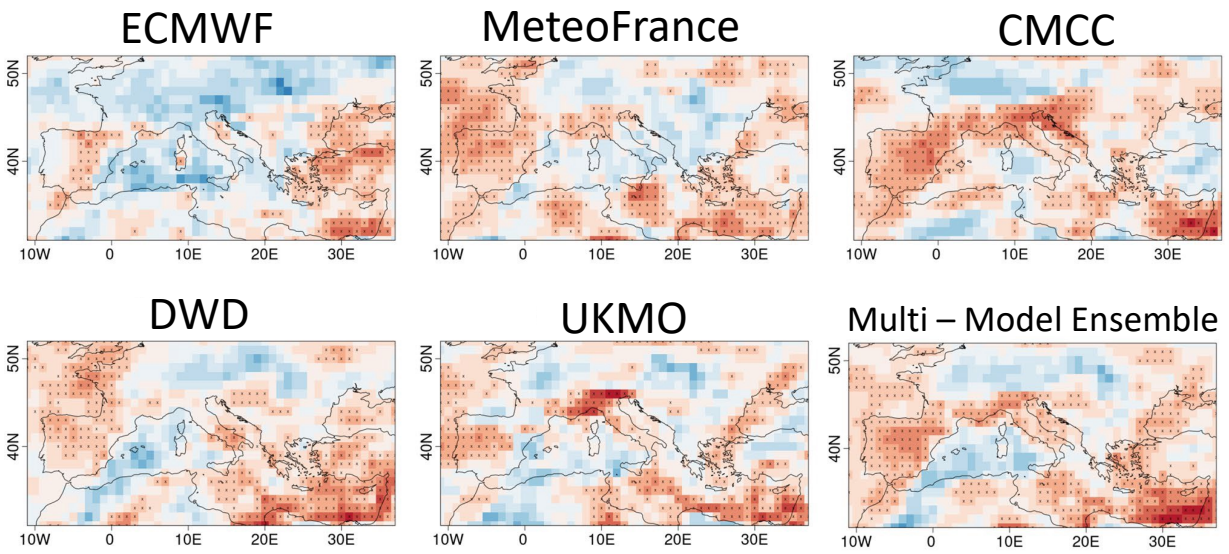
(5 prediction systems)

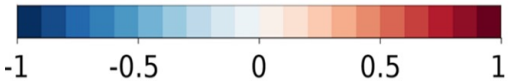
Climate Change

2m-Temperature



Precipitation





Stippling = significant correlations (95% confidence level).

Modified from Calì Quaglia et al. 2021

How good are seasonal predictions in the Mediterranean region

JJA Forecasts **initialised on** **May 1st**

Anomaly **C**orrelation **C**oefficients

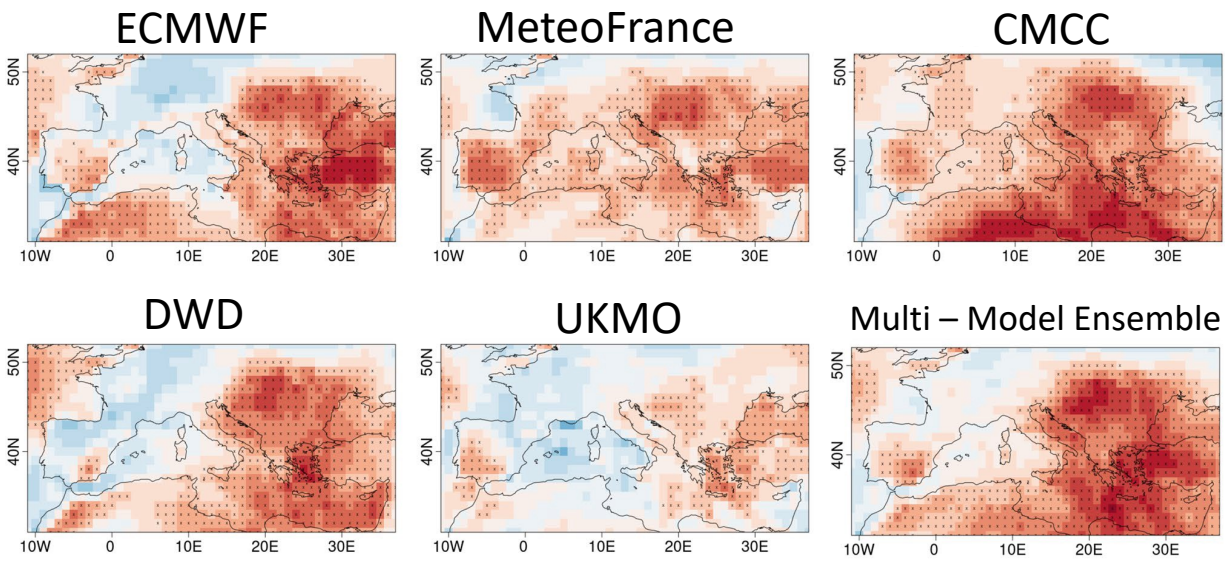
with respect to ERA5, 1993 – 2014

C3S multi–system

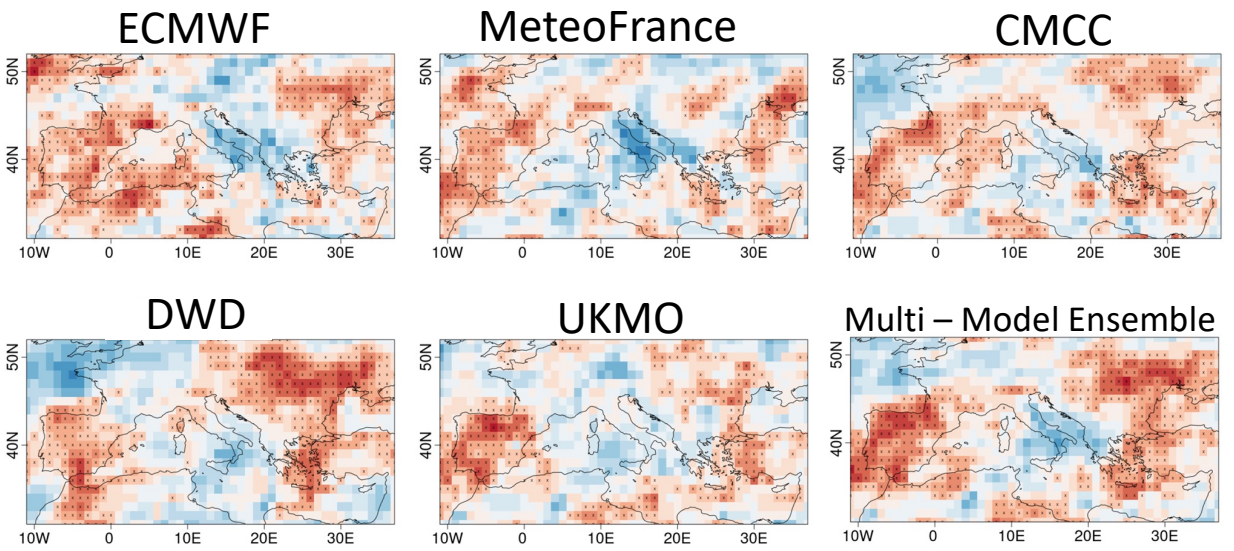
(5 prediction systems)

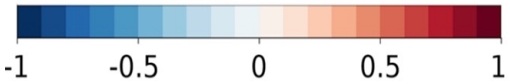
Climate Change

2m-Temperature



Precipitation





Stippling = significant correlations (95% confidence level).

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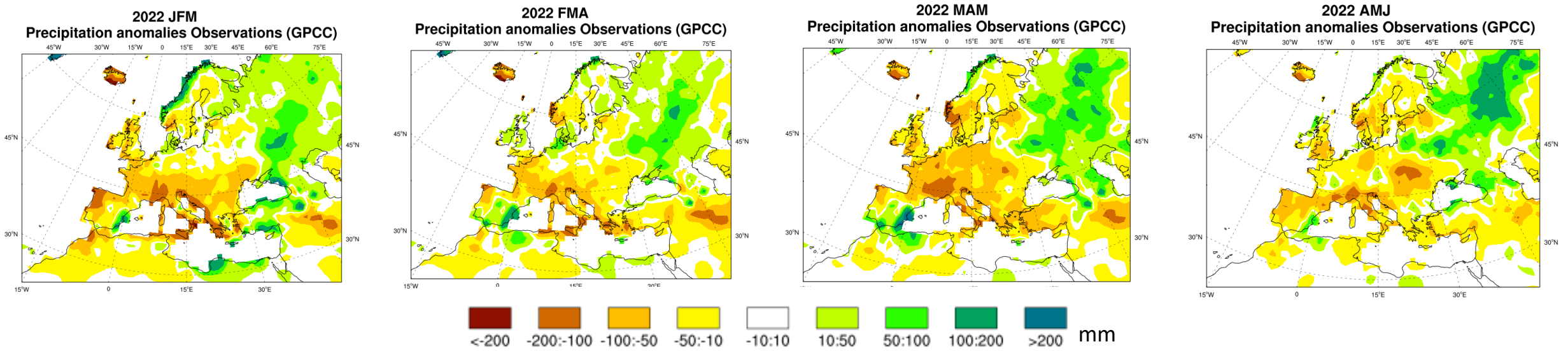
A case study: 2021–2022 drought

Reference period: 1993 - 2016



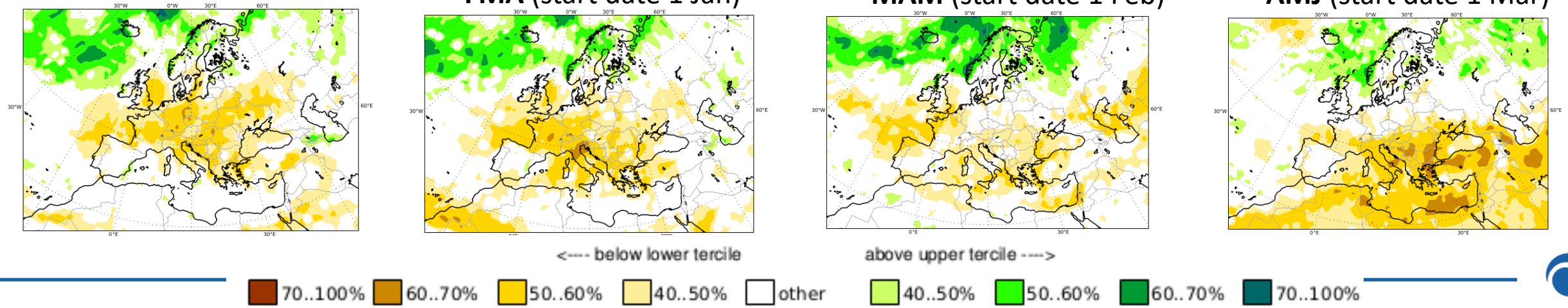
Precipitation forecast: Probability (most likely category of precipitation)

JFM (start date 1 Dec)

FMA (start date 1 Jan)

MAM (start date 1 Feb)

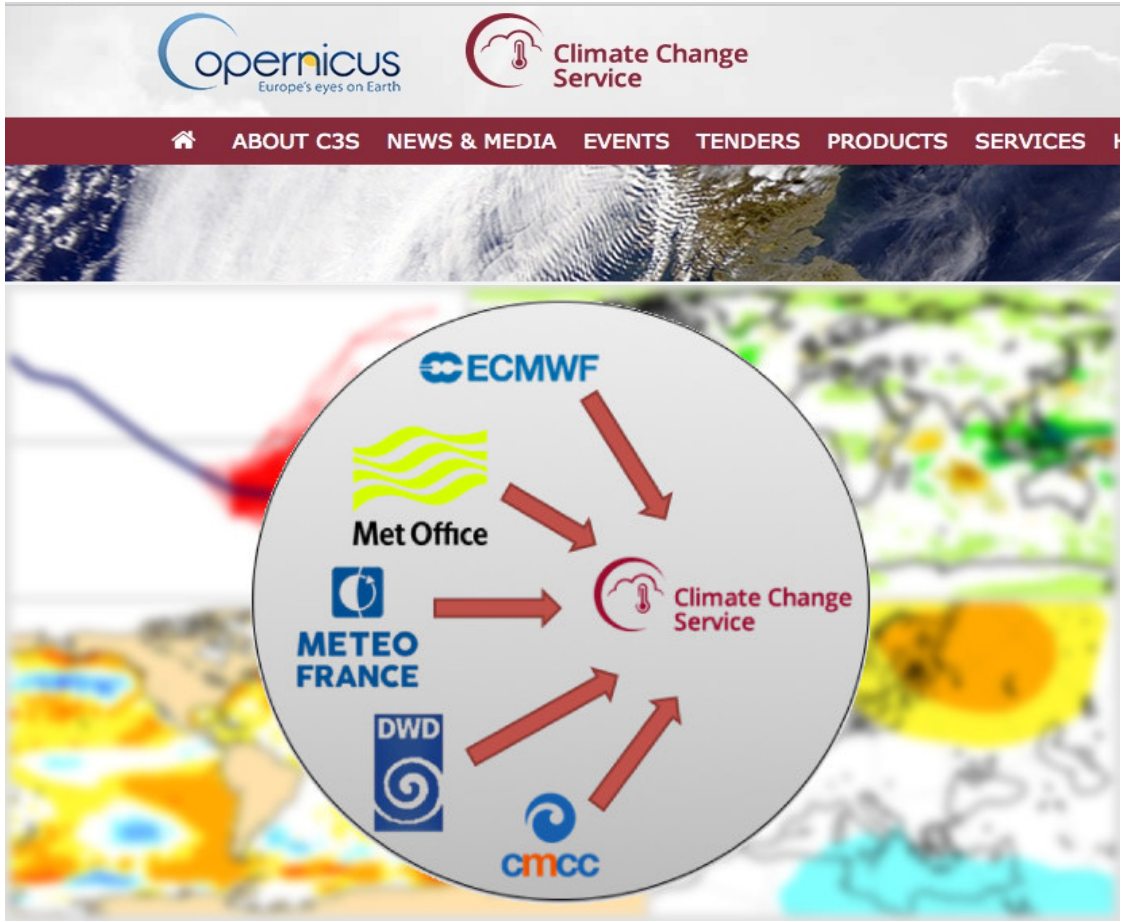
AMJ (start date 1 Mar)



Where is it possible to find information and data?

International Program for Operational Seasonal Predictions

https://www.wmolc.org/

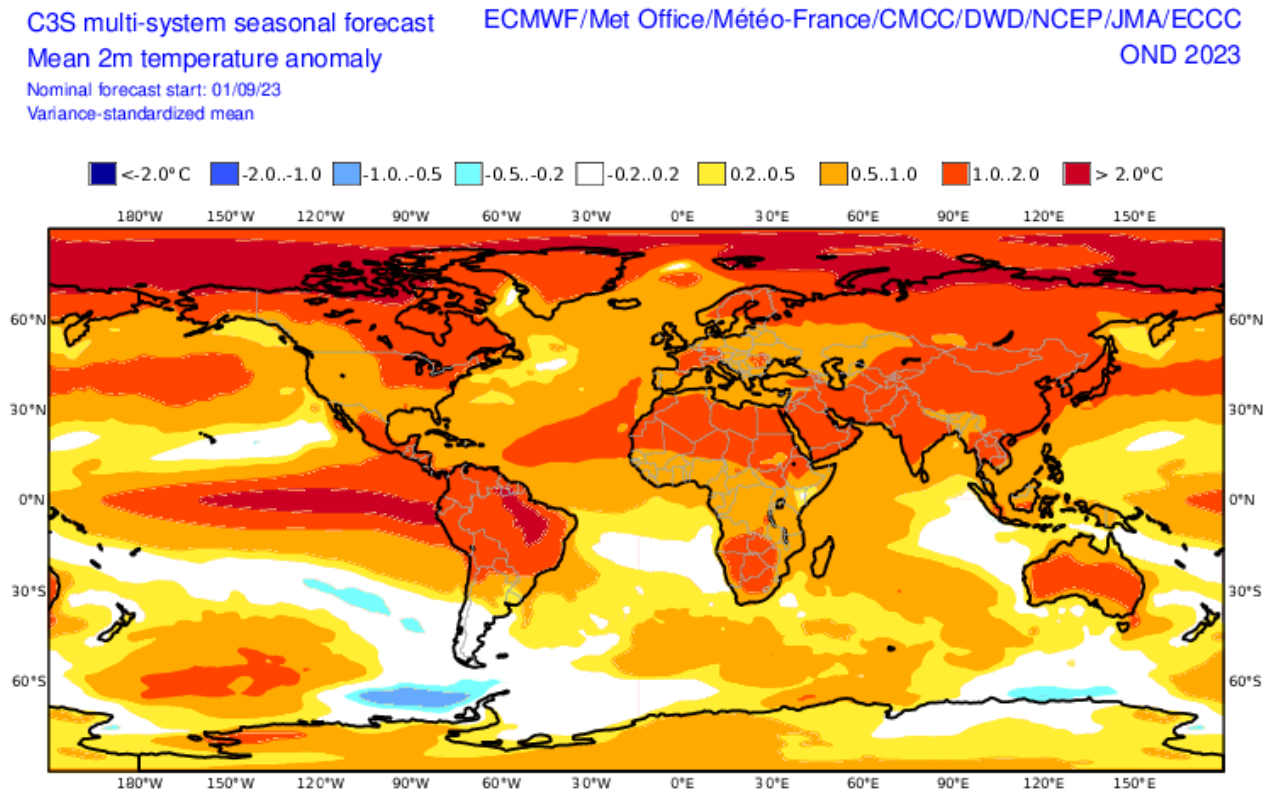


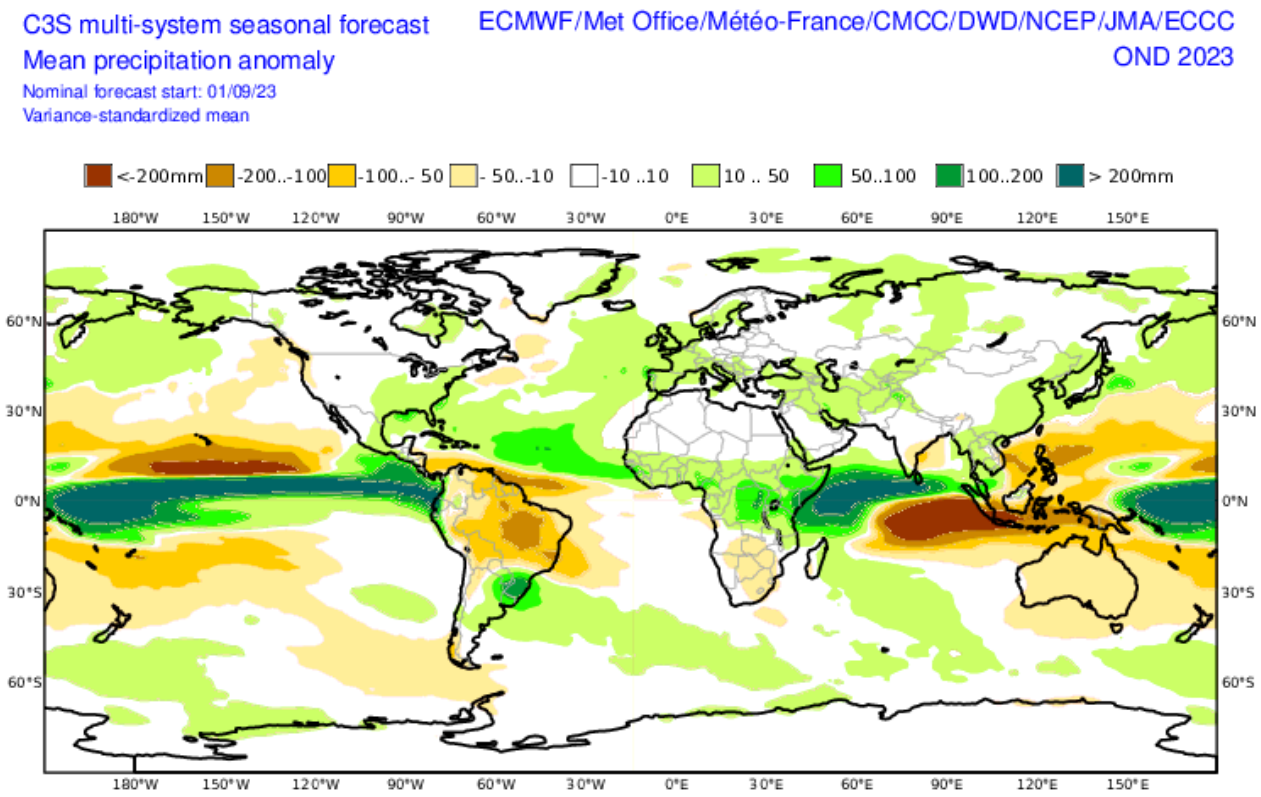
https://climate.copernicus.eu/seasonal-forecasts

Examples of application

Autumn (Oct–Nov–Dec) 2023 Prediction – Start date 1st of September

(anomalies wrt to the reference period 1993 – 2016)





Climate Change Service

Thanks

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