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Barcelona Supercomputing Center
Centro Nacional de Supercomputación

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Climate predictions for vineyard management

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Outline

1. **Introduction to climate predictions** and their application in key sectors of society.

2. **Predictability** of seasonal forecast simulations.

3. **On-going development** at BSC exploring the applicability of seasonal predictions to agriculture and viticulture.

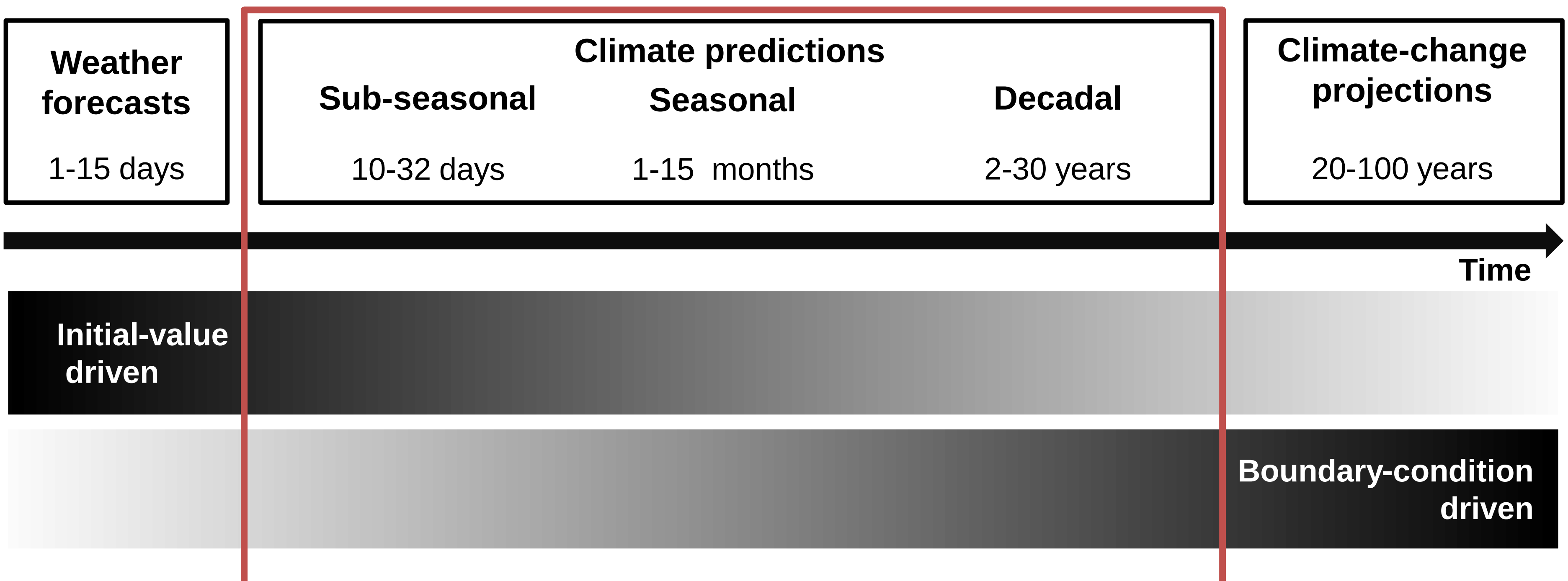
4. **Potential applications** of climate predictions for vineyard management.

5. **Preliminary results.**

6. **Conclusions**

Introduction to climate predictions

- Weather forecasting: Initial-value problems
- Climate projections: forced boundary condition problem.
- **Climate predictions** (sub-seasonal, seasonal and decadal) in the middle.



Adapted from: Meehl et al. (2009)

- Viticulture sector routinely uses weather forecast up to 15 days. Beyond this time horizon, climatological data are used.
- In other sectors, climate information on seasonal-to-interannual time scales have already been illustrated for management decisions.

How can we predict climate for the coming season if we cannot predict the weather next week?

Weather forecasts

The forecasts are based in the initial conditions of the **atmosphere**, which is highly variable and develops a chaotic behaviour after a few days

Climate predictions

The predictions are based in the initial conditions of the **sea surface temperature**, **snow cover** or **sea ice**, which have a slow evolution that can range from few months to years.

Sources of seasonal predictability

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ENSO is the most important source of predictability at seasonal timescales (see e.g. Doblas-Reyes et al. 2013)

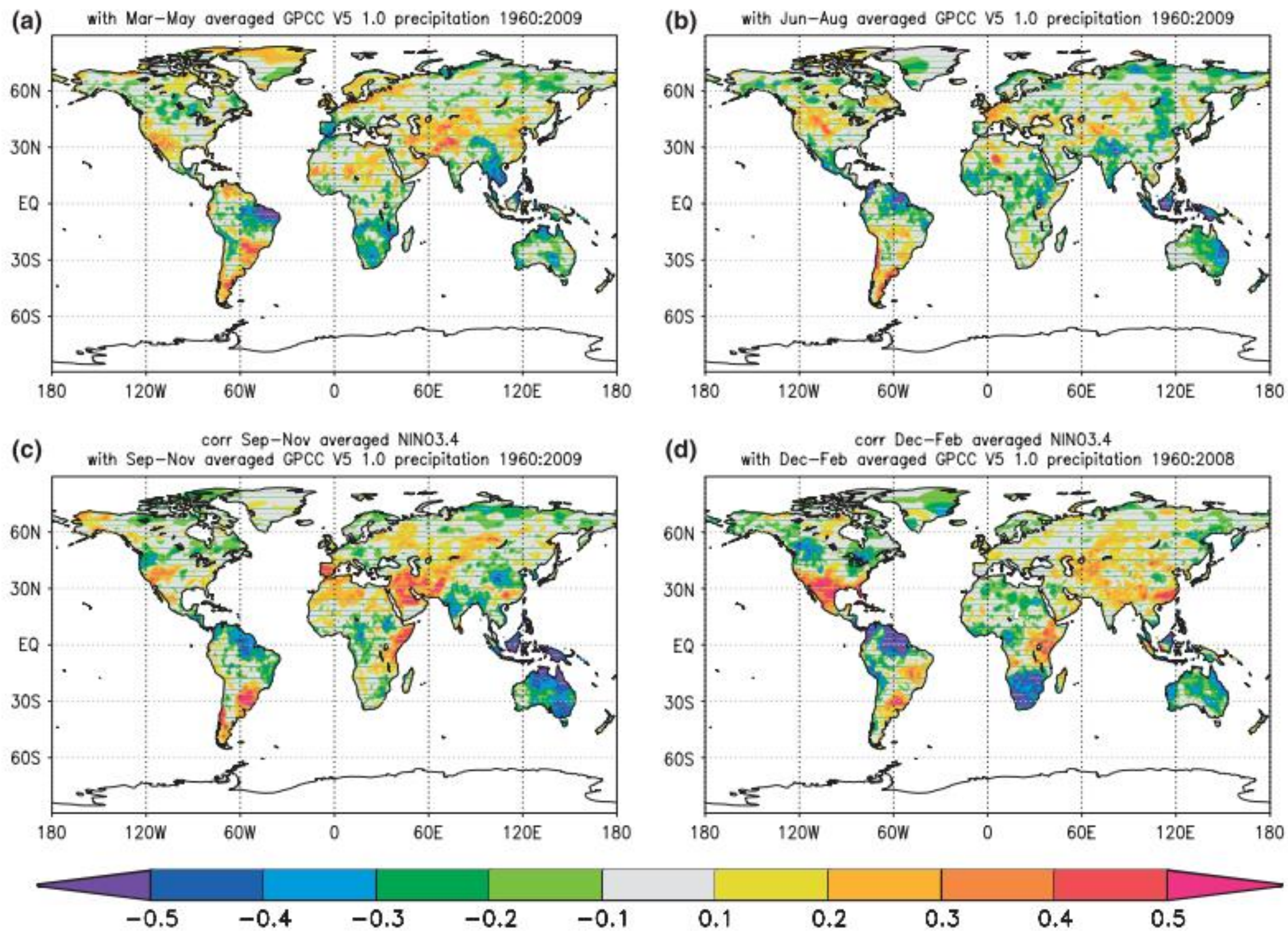
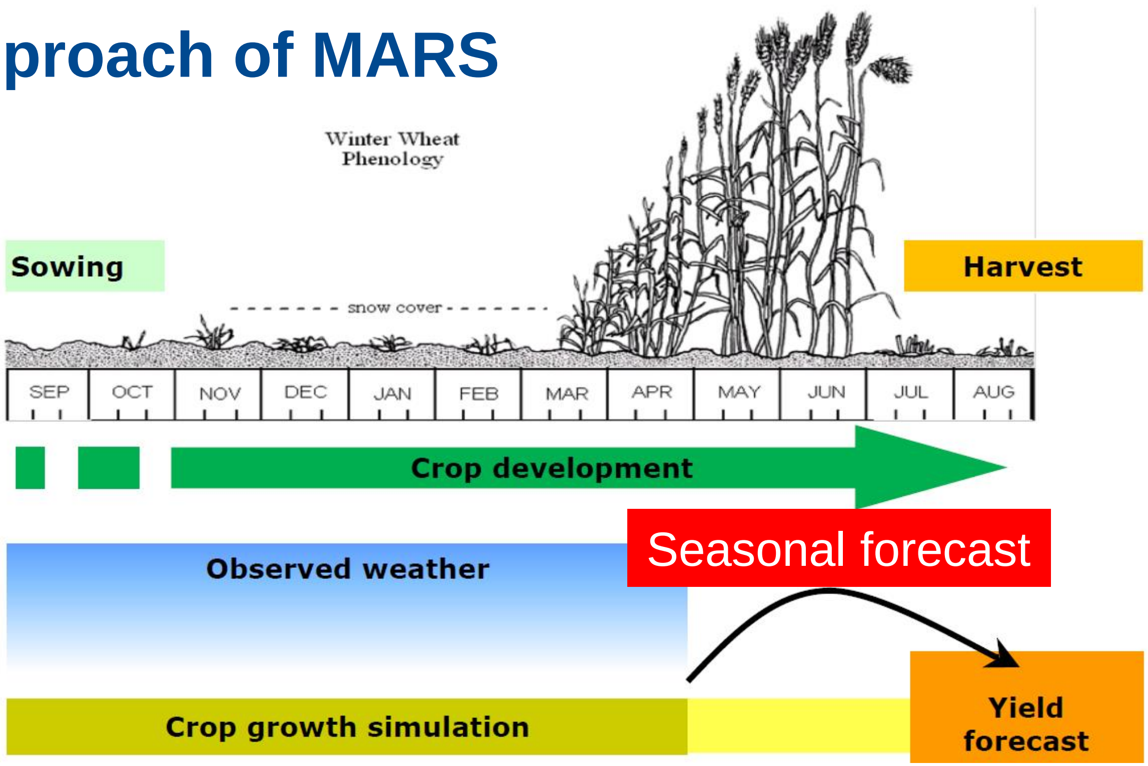


FIGURE 1 | Correlation between the ERSST[38] SST Niño 3.4 index (average temperature over 5°N–5°S, 170°–120°W) and the GPCCv5[39] gridded precipitation over the period 1960–2009. (a) March to May, (b) June to August, (c) September to November, and (d) December to February.

Seasonal forecast for agriculture: on-going developments

Testing seasonal forecast for MARS: BSC and JRC are exploring how the MARS Crop Yield Forecasting System (MCYFS) could ingest the seasonal forecast for a future operational use.

Current approach of MARS



Source: Toreti, 2015. EUPORIAS

Seasonal forecast for viticulture: on-going activities

SECTEUR PROJECT (negotiation process).

HIATUS (accepted).

Objective: develop a climate service for the wine sector to bridge this communications gap and to ensure that research reaches the industry and society in a timely and usable manner.

Seasonal forecast applications for vineyard management

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SOGRAPE VINHOS

PROCESS	days (1 - 30) Short-term	months (1 - 12) Medium-term	years (1 - 50) Long-term
PLANTING VINEYARD			
Siting			
Choice of scion variety			
Choice of rootstock			
Assessment of water needs			
Choice of trellis			
GROWING GRAPES			
Growth cycle duration			
Pathogen pressure			
Abiotic stresses			
Productivity			
Quality			
Identity			
MAKING WINE			
Wine style			
Harvest date and duration			
Building design			
Energy consumption			
Emissions			
LOGISTICS			
Destination constraints			
Choice of itinerary and transportation			
Fuel and energy consumption			
Emissions			
DRINKING WINE			
Style suitability			
Trends and fads			
Seasonality			

Source: Antonio Graça, SOGRAPE VINHOS SA, 2014

Seasonal forecast applications for vineyard management: model chain

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Seasonal forecast

Tmax, Tmin, precipitation, humidity, radiation, wind speed

End-users empirical models

Phenological and irrigation models

Outcomes:

- Critical phenological events

(Bloom, Berry et, veraison and harvest)

- Wine alcoholic category
- Water demand
- Extreme events

Integrated assessment

Preliminary results: Weather regimes. Winter

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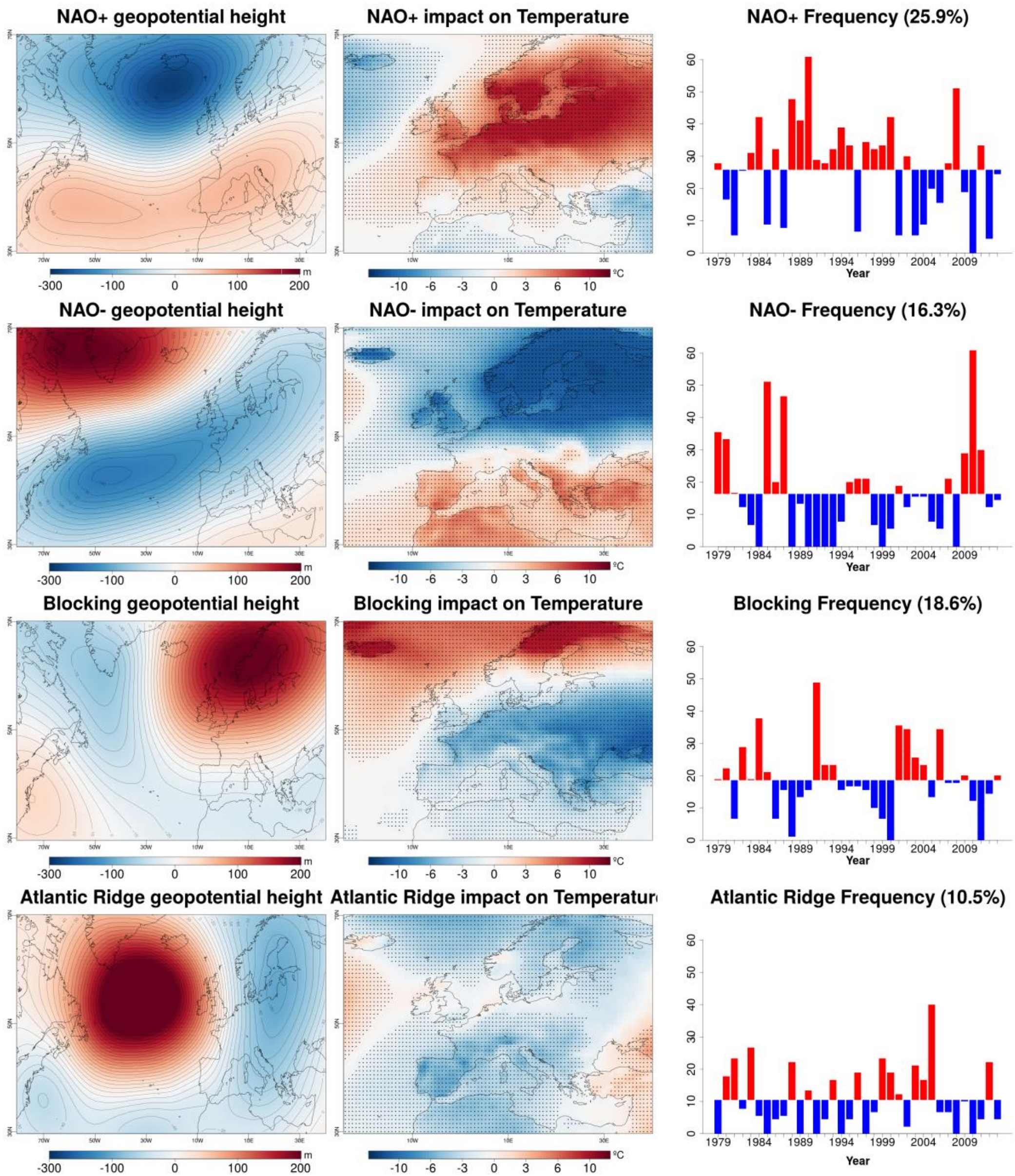
Weather Regimes for Winter season (1979-2013). Source: ERA-Interim



Preliminary results:
Weather regimes. Summer

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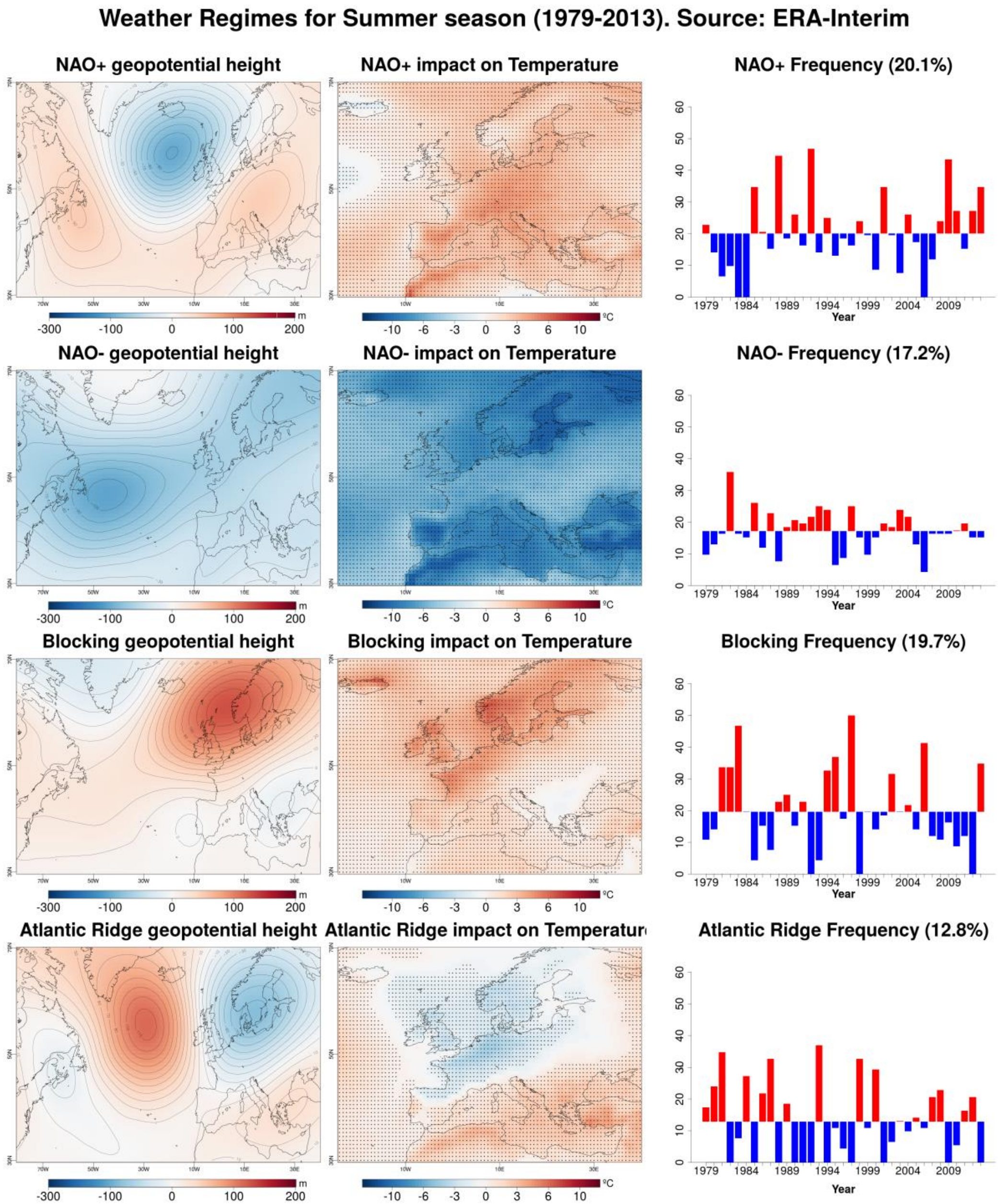
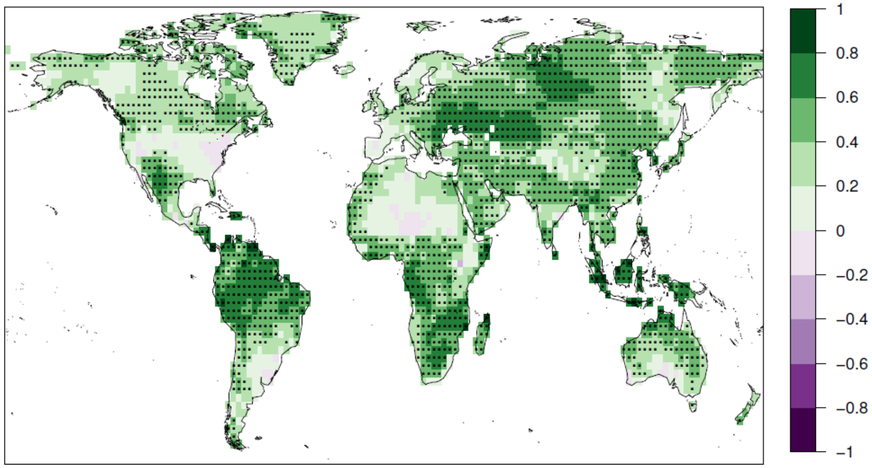
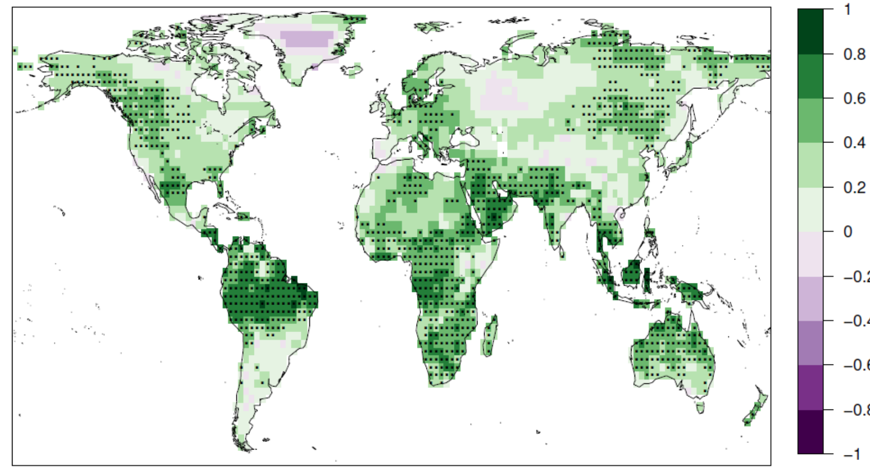


Preliminary results:
Skill of seasonal temperature forecasts

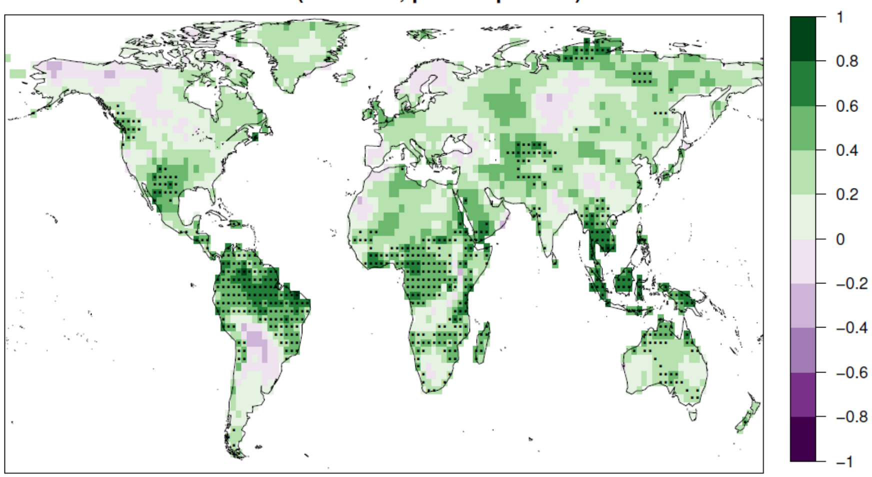
Spearman correlation for T2M ECMWF–System4 against ERA–Interim
Start date: February – Lead time: 1 – Period: 1982/2014
(raw data; points: $p<0.05$)



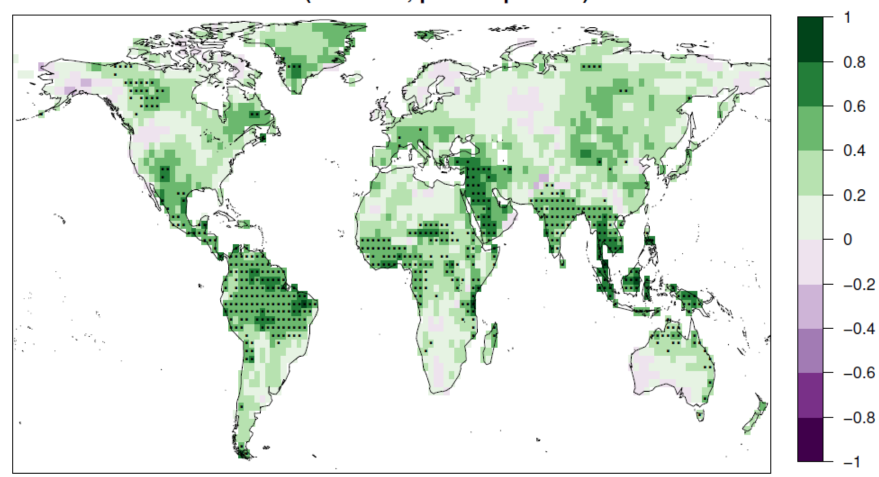
Spearman correlation for T2M ECMWF–System4 against ERA–Interim
Start date: February – Lead time: 2 – Period: 1982/2014
(raw data; points: $p<0.05$)



Spearman correlation for T2M ECMWF–System4 against ERA–Interim
Start date: February – Lead time: 3 – Period: 1982/2014
(raw data; points: $p<0.05$)



Spearman correlation for T2M ECMWF–System4 against ERA–Interim
Start date: February – Lead time: 4 – Period: 1982/2014
(raw data; points: $p<0.05$)



Evaluation of surface air temperature CFSv2 forecasts over land grids issued in February for 4 lead times from month-1 to month-5. Spearman correlation considering raw data

Conclusions

- Climate predictions have nonetheless some skill in predicting anomalies in the seasonal average of the weather i.e., anomalies of the climate.
- This skill is present regardless of the daily timing of the major weather events within the period.
- This level of skill for seasonal averages or totals may be useful for sectors impacted by climate variability, such as viticulture.
- Now is the time to develop climate services for agriculture based on seasonal forecast predictions. Bridging the gap to ensure that research reaches the industry and society in a timely and usable manner.

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Thank you!

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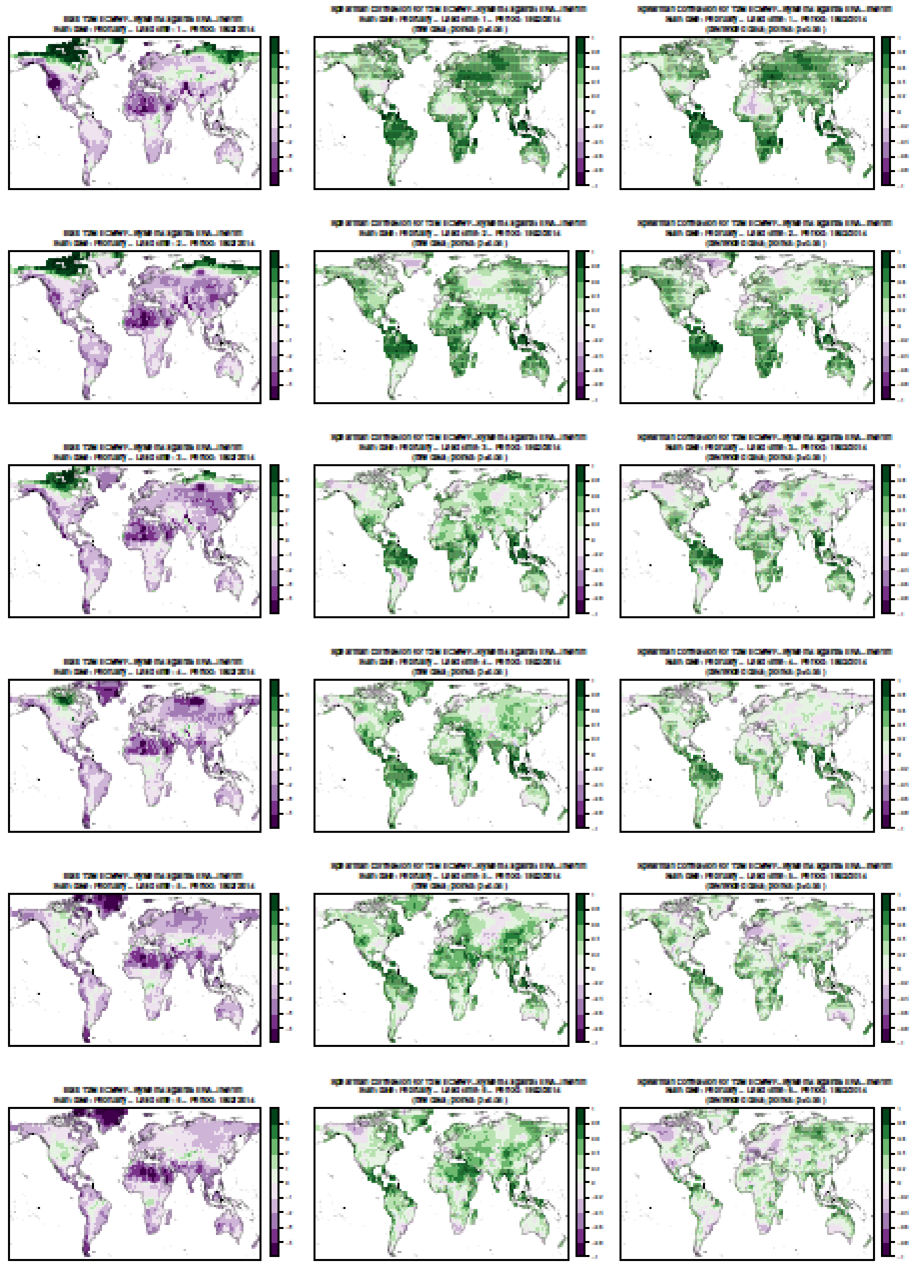
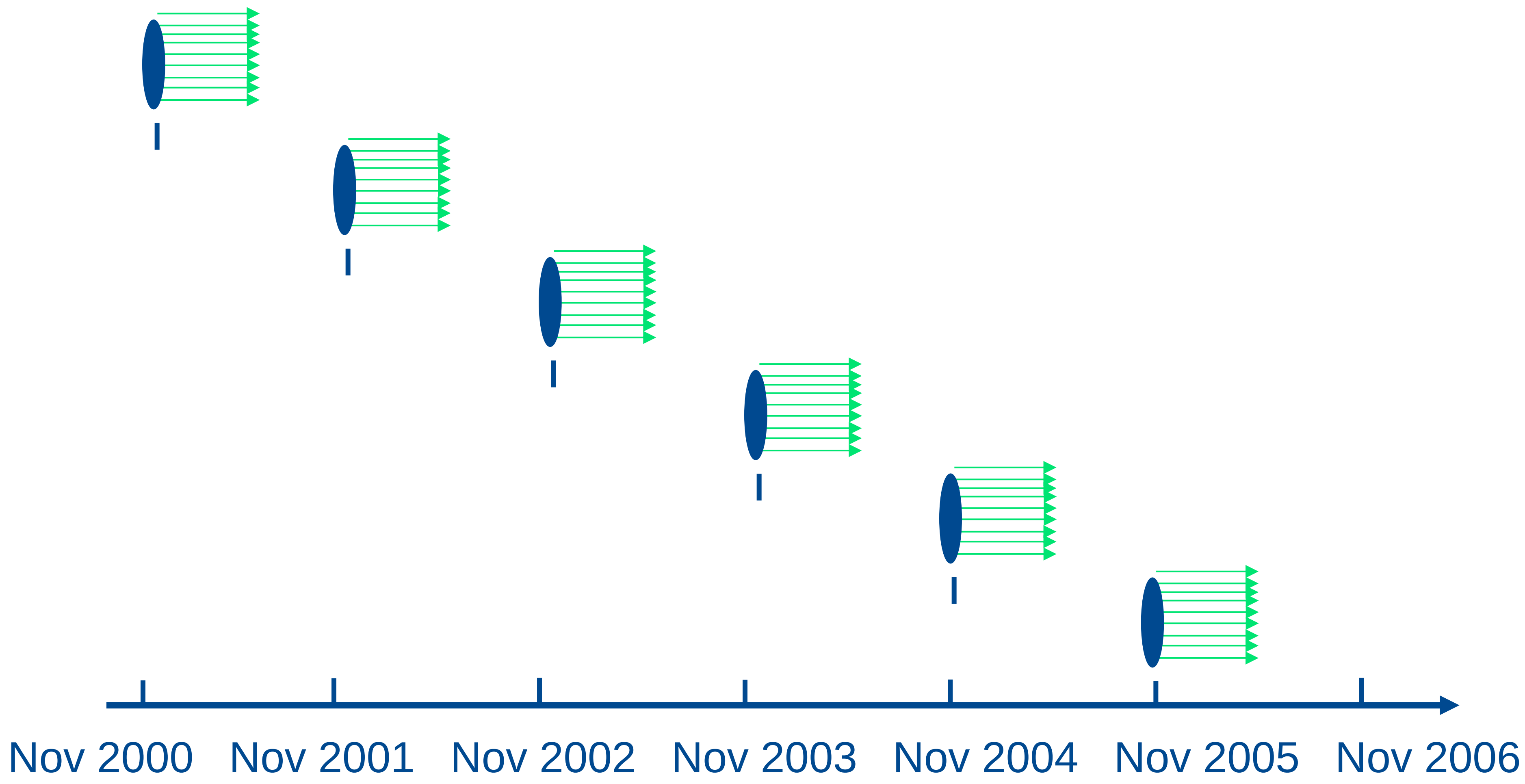
Temperature skill



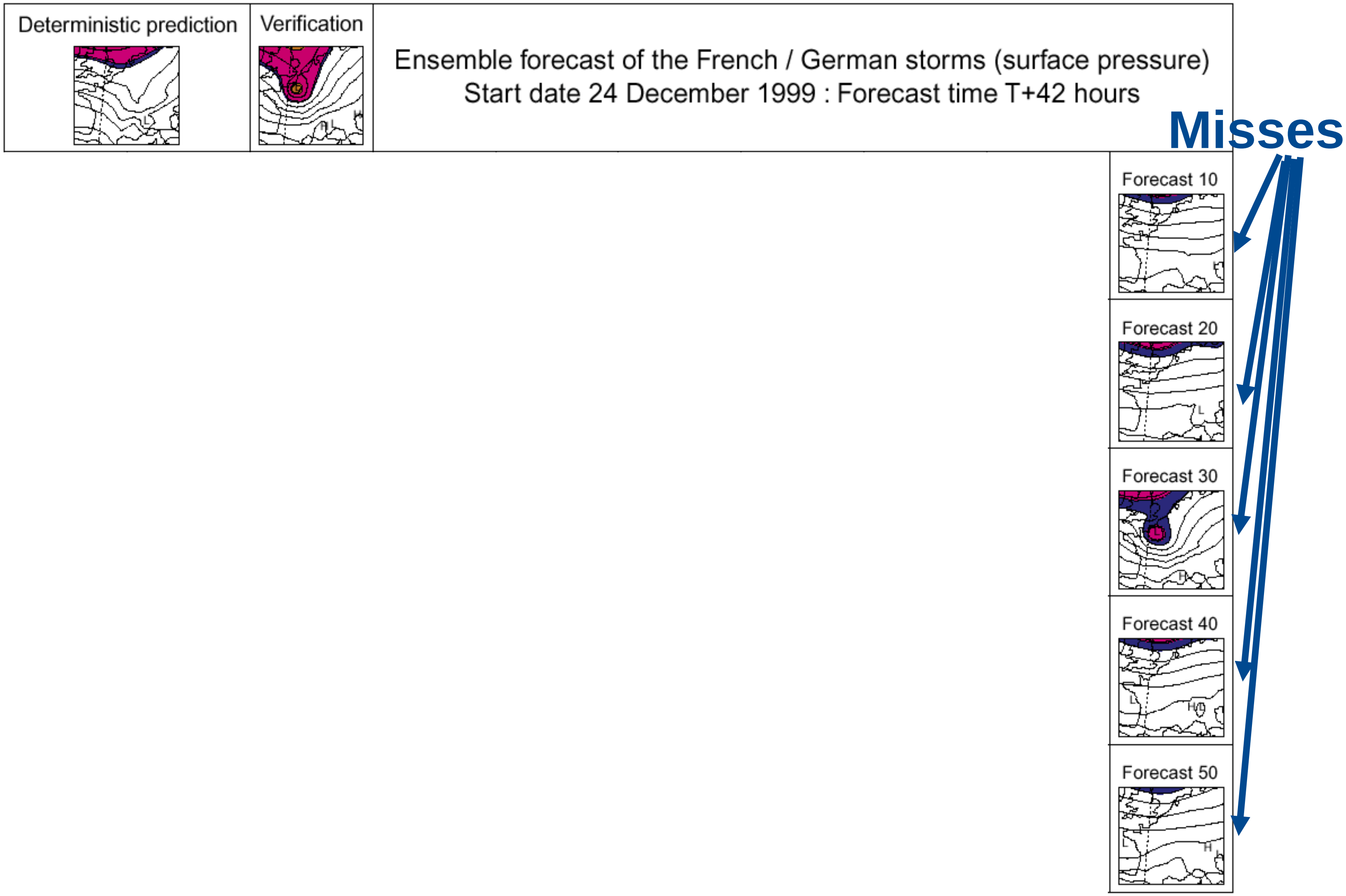
Ensemble predictions

Ensemble forecast system



How many members: ensemble size

ECMWF forecasts (D+42) for the storm Lothar



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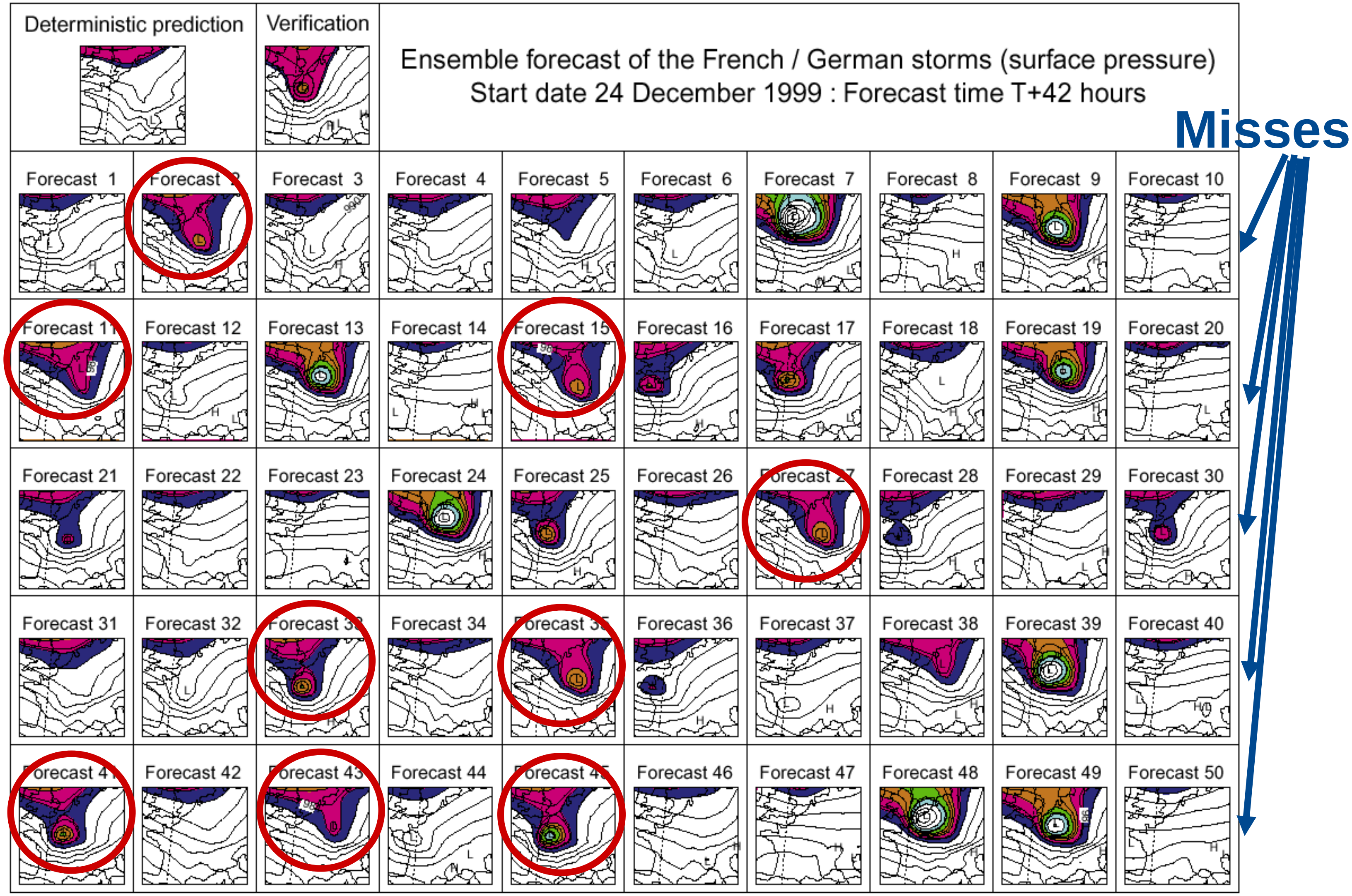

How many members: ensemble size

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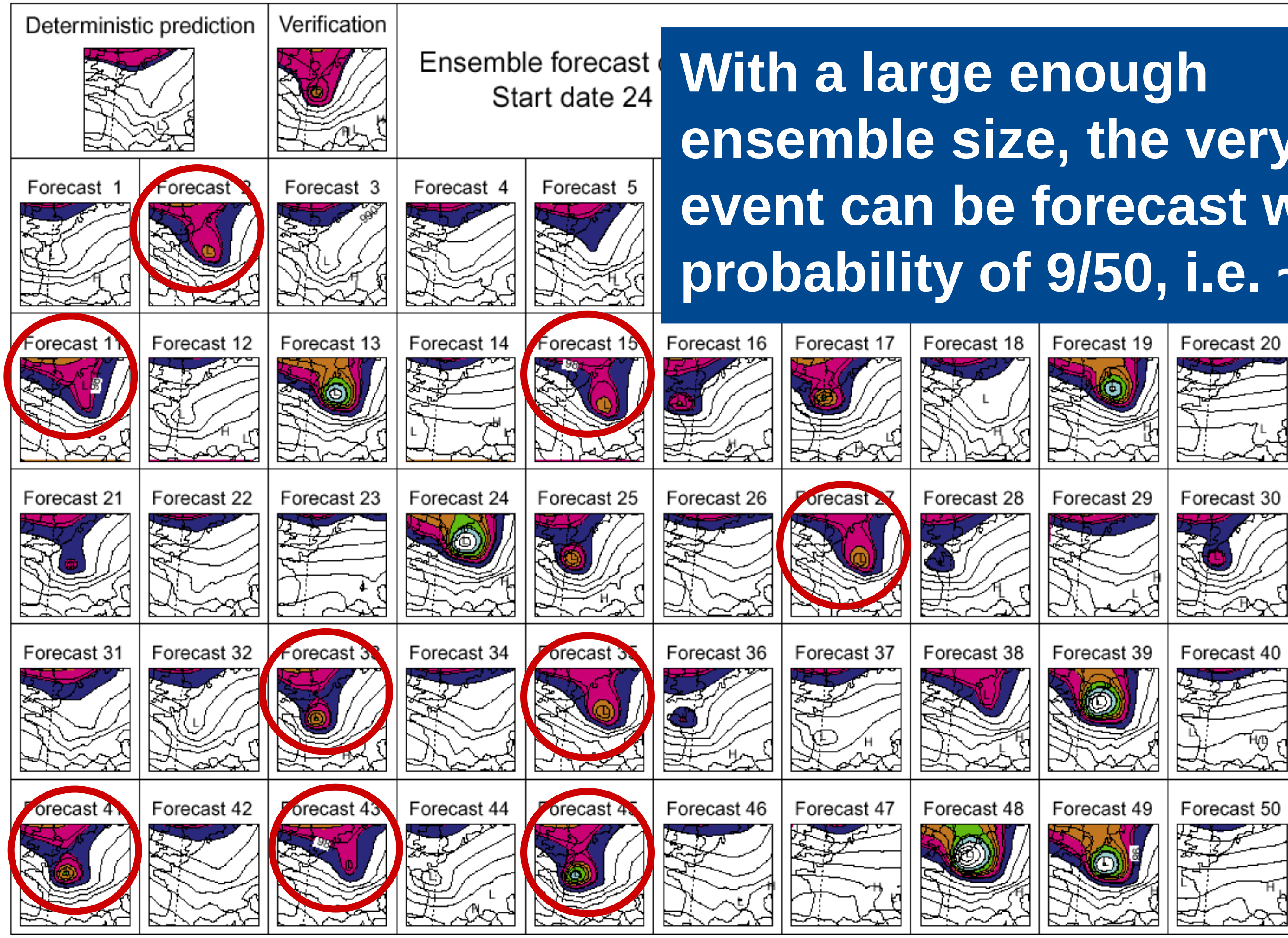
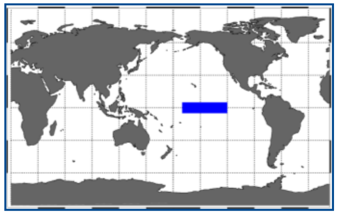
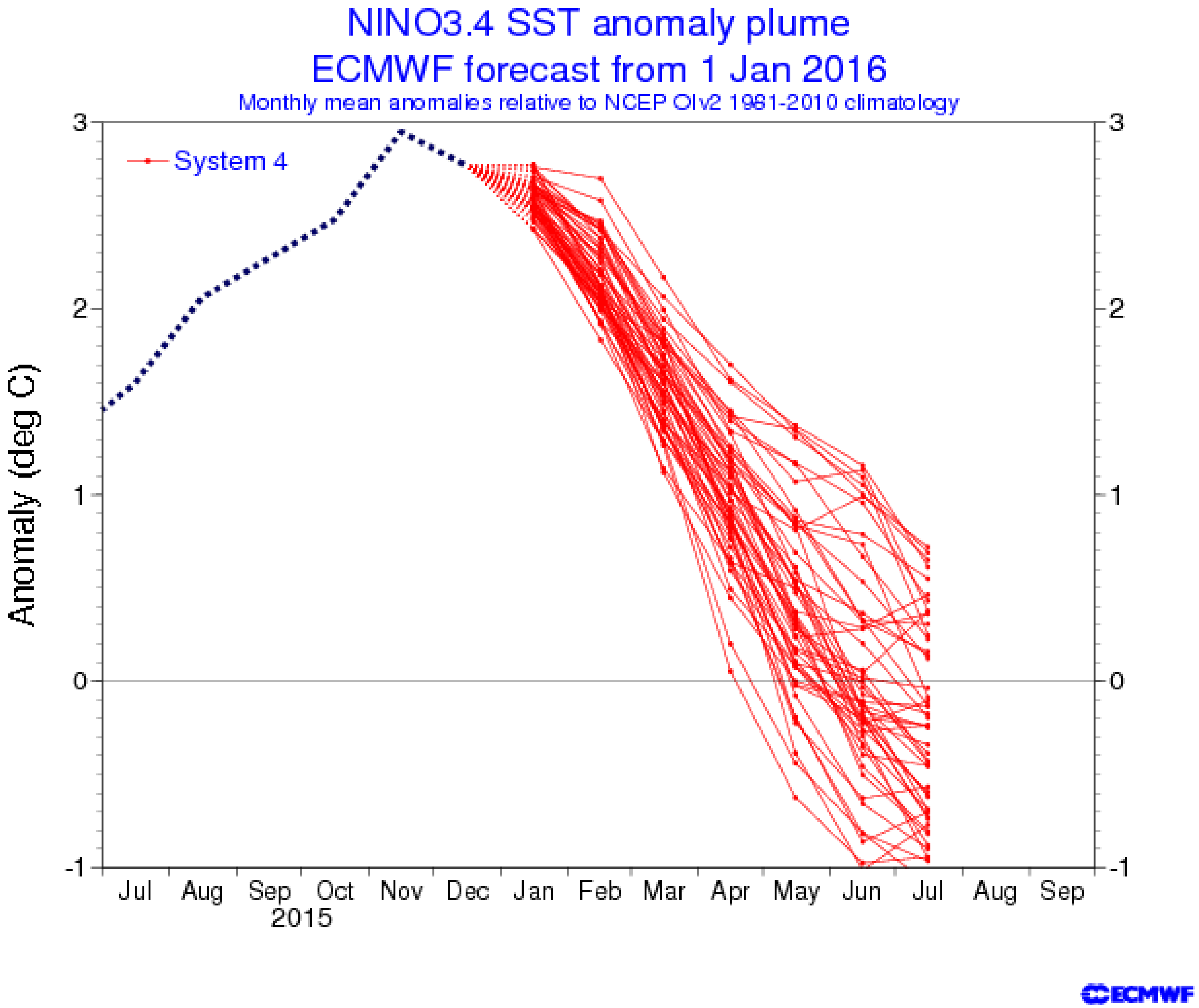


With a large enough ensemble size, the very rare event can be forecast with a probability of 9/50, i.e. ~20%

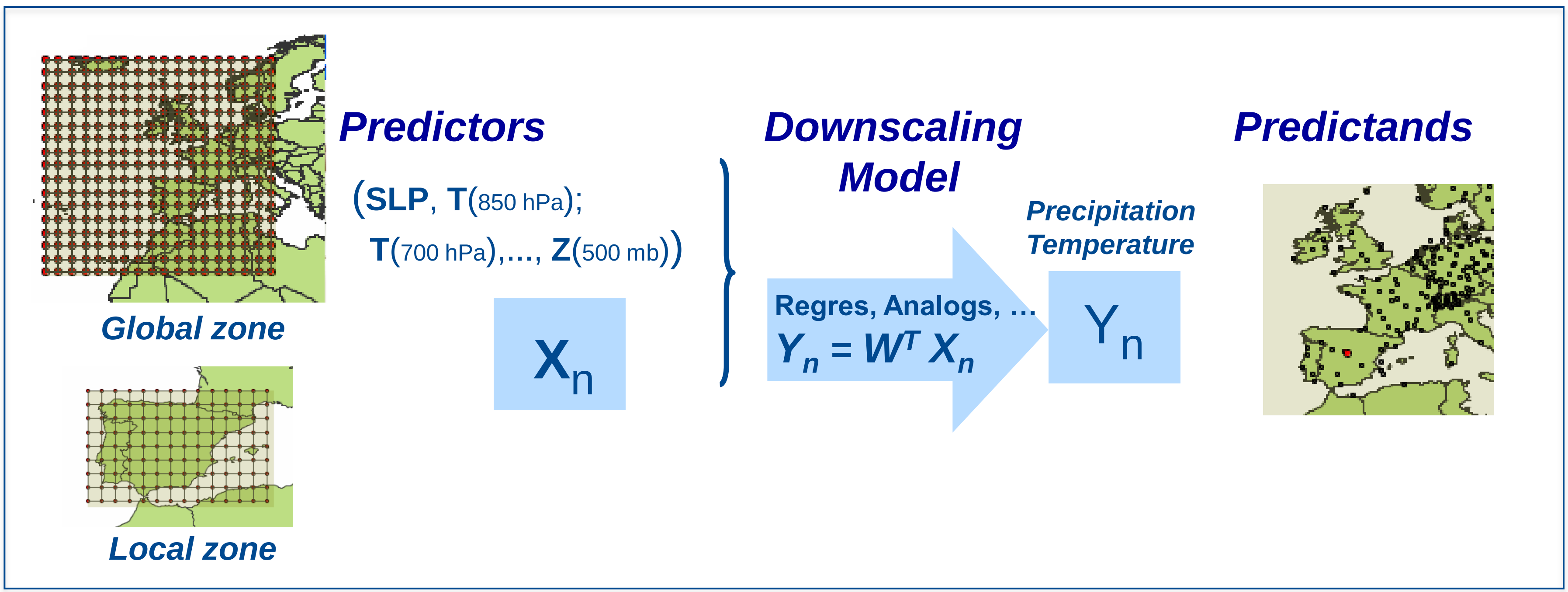
ENSO ensemble predictions





Perfect prognosis approach:

- In the training phase the statistical model is calibrated using observational data for both the predictands and predictors (e.g. reanalysis data)
- Typical techniques: transfer functions, analogs, weather typing, weather generators, etc. (Maraun et al. 2010)



Source: José M. Gutiérrez, University of Cantabria