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Joint Research Centre

EC capabilities in drought monitoring, forecasting and prediction

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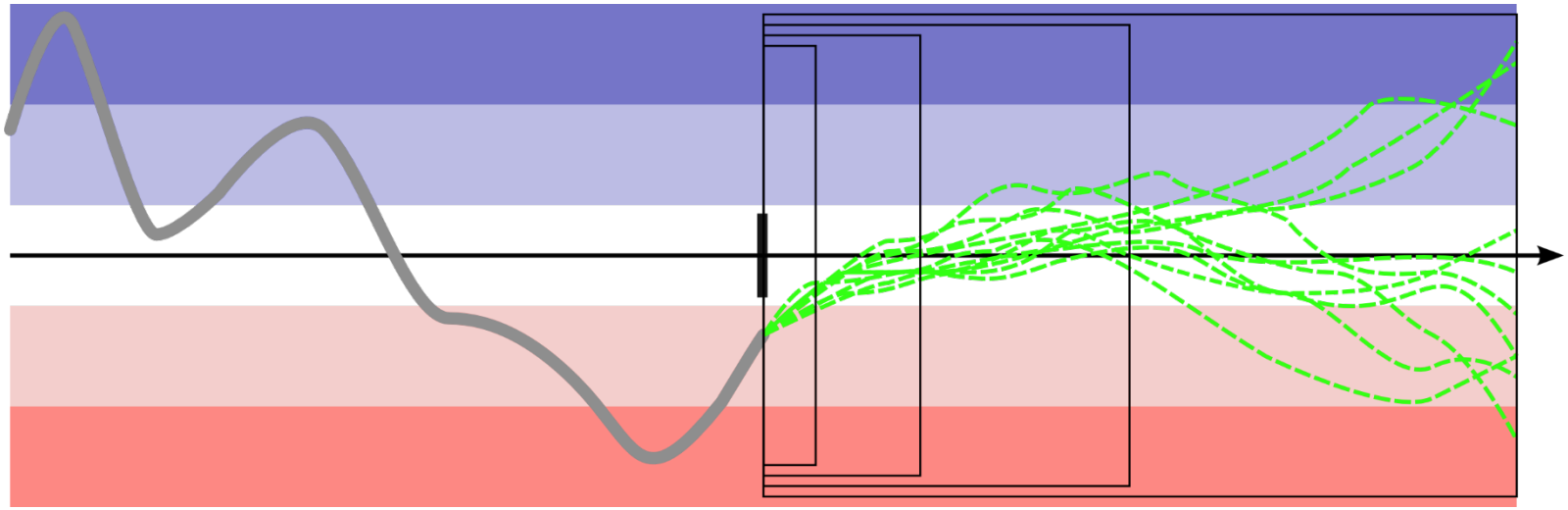
Joint Research Centre

Motivation

Strong expertise on drought monitoring at the JRC:

- different datasets: ground observation, satellite images ...
- Combined Drought Index



➢ To complete this product, need to provide drought forecasting that should be

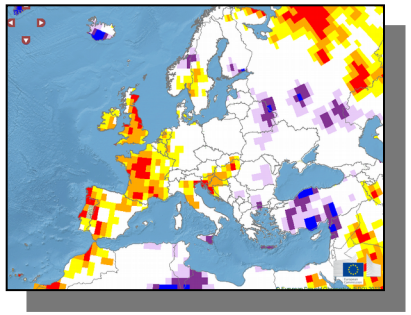
- **Adapted to regions/needs**
- **Adjusted to the forecast abilities**
- **Seamless (Ready/Set/Go)**
- **Based on simple, comprehensible, reliable indices**

Different lead times, cumulative periods, intensities

Monitoring droughts

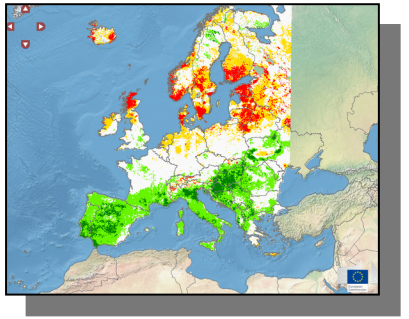
Precipitation (SYNOP, GPCC)

- ✓ SPI (1, 3, 6, 9, 12, 24, 48 months)
- ✓ Standardized Snow Pack, SSPI (10 & 30 days)
- ✓ SPI since 1973, SSPI since 2013
- ✓ Resolution: 0.25 to 1.0 degree



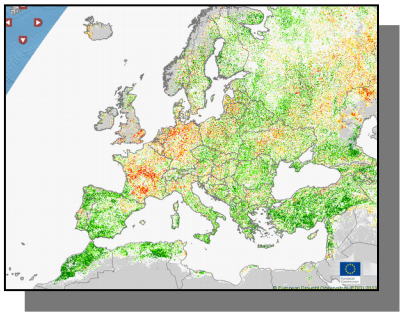
Soil Moisture (modelled, LISFLOOD)

- ✓ Daily & 10-day soil moisture
- ✓ Daily & 10-day soil moisture anomaly
- ✓ 7-day forecasted soil moisture anomaly
- ✓ Since 1990
- ✓ Resolution 5 km



Vegetation Status (MODIS)

- ✓ fAPAR 10-day composites.
- ✓ fAPAR anomalies
- ✓ Since 2002
- ✓ Resolution 1.2 km



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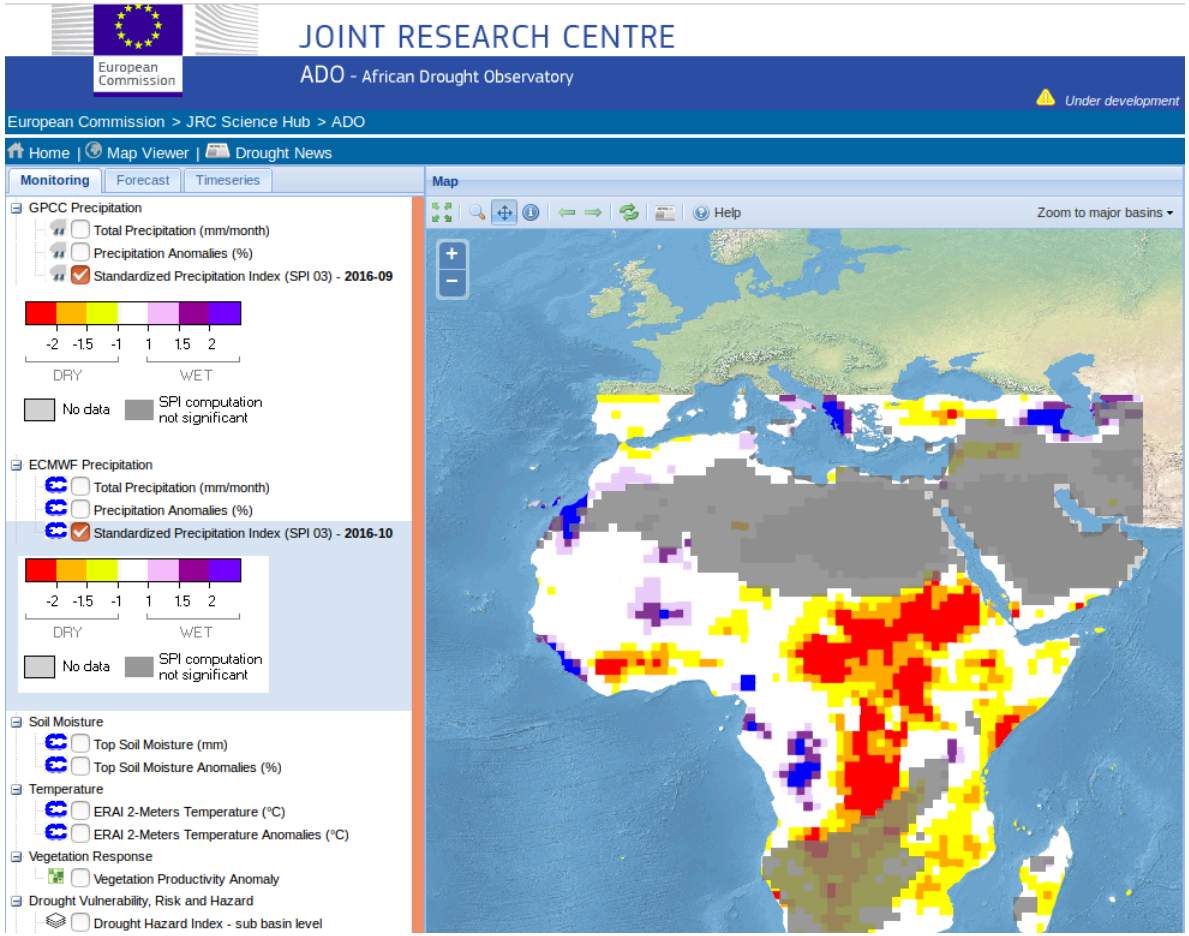
Forecasting droughts

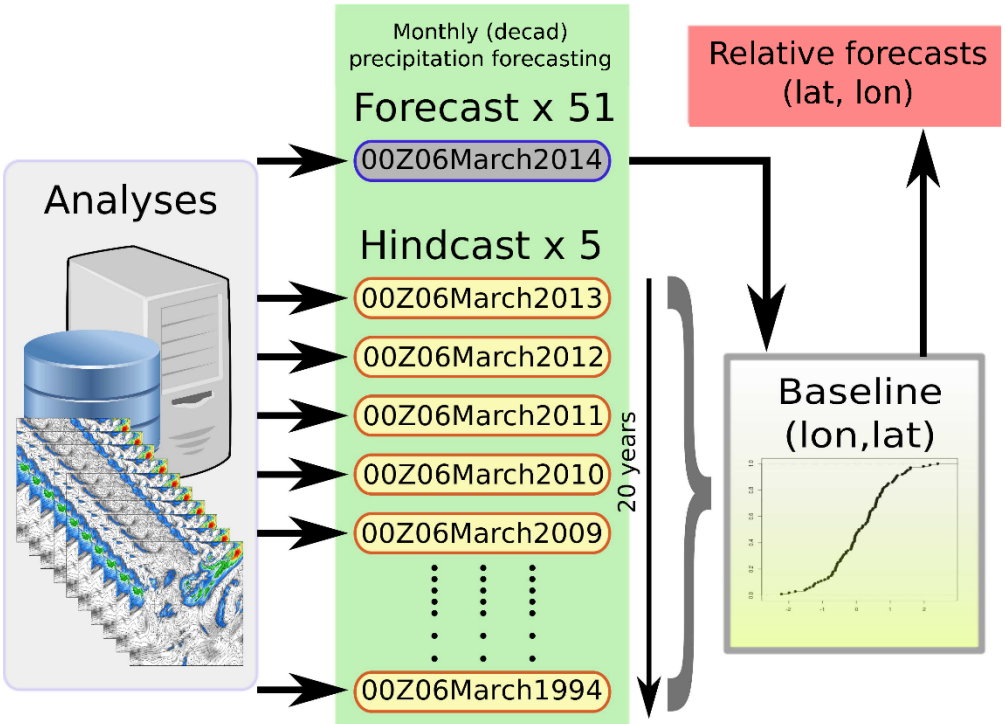


Forecasting droughts

Datasets:

- *Observations from ECAD/EOBS*
- Uncertainties of the deterministic forecast **-> ensemble/probabilistic forecasts**
  Coll. with ECMWF

Model	ENS	SEAS
Forecast	50+1 memb.	50+1 memb.
Hindcast	10+1 memb.	14+1 memb.
Hind per	20 years	Cont sinc 1981
Lead time	45d (2/week)	13months (1/month)
Version	"up to date"	2011
Resolution	16/32km	0.7deg
Coupling	Yes	Yes
Reference	Vitart, 2004	Molteni et al. 2011



Forecast flash droughts (dry spells, 10d)

Relevant for :

- Extreme short term droughts (specific steps of crops)
- Region with rainfed agriculture
- Assessing the predictability of precipitation deficiencies

Method :

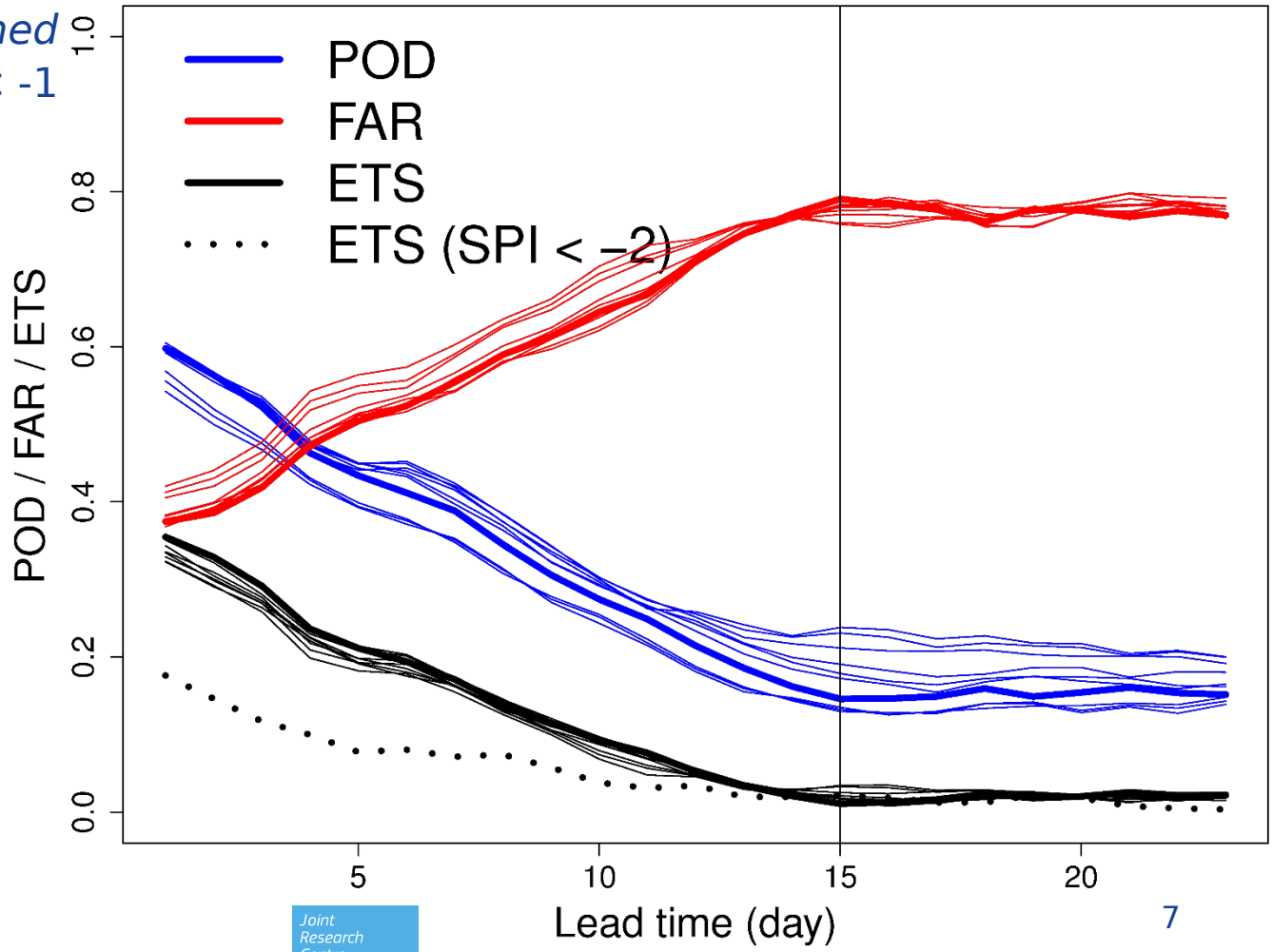
- SP1-10d
- Coarse resolution (3 or 5 square degrees)
- To measure the predictability, 23 x 10-day moving windows
- Dichotomous solution based on the 30% of members (discussed in the following slides)

Forecast flash droughts (dry spells, 10d)

For droughts defined as SPI < -1

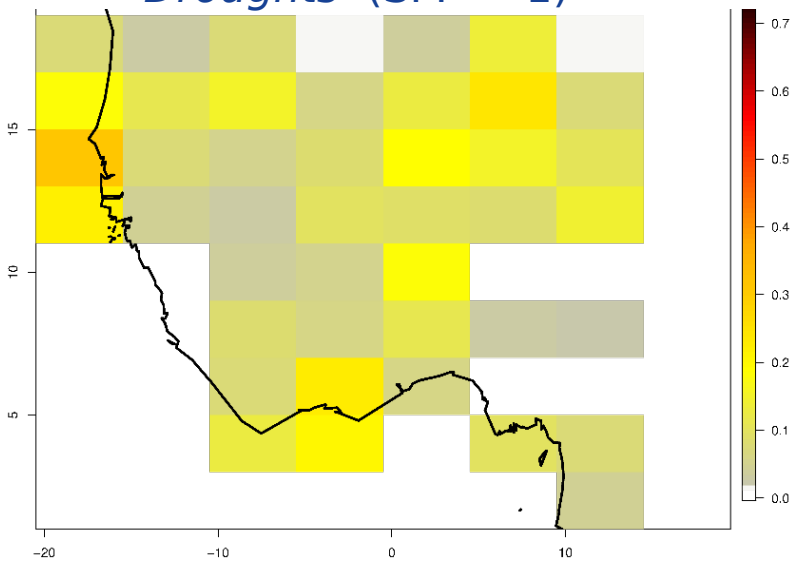
Predictability in Europe:

- More than 60% of droughts detected at t - t+10
- No skill after t+15 - t+25

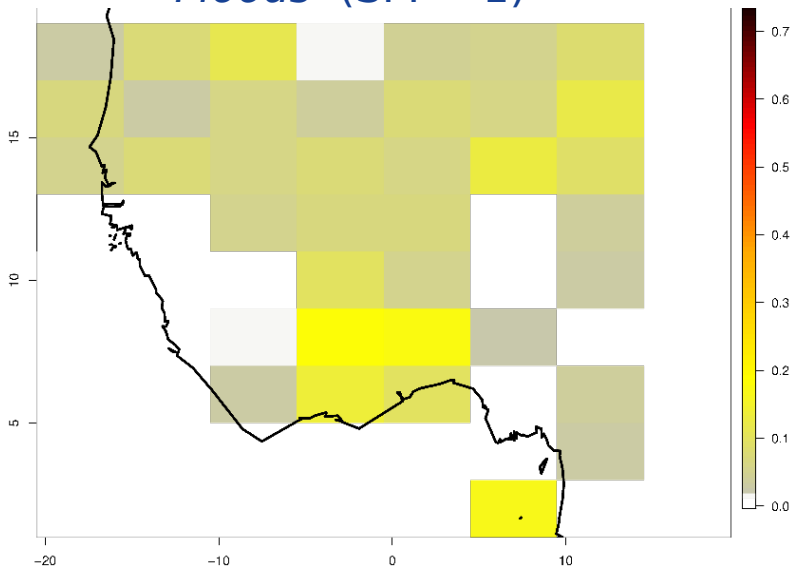


Forecast flash droughts (dry spells, 10d)

‘*Droughts*’ (SPI < -1)



‘*Floods*’ (SPI > 1)



ETS (GSS) in Africa :

- Better for deficit than exceed of SPI
- 2x lower than in Europe

Really need to improve the forecasts:

- Need to better understand the mechanisms
- focus on the onset of rainfall

Lavaysse et al. in preparation

Forecast droughts (1month)

Relevant for:

- Relative short term drought (specific steps of growing crops)
- Onset, extension, end of a long term drought (combination with monitoring)

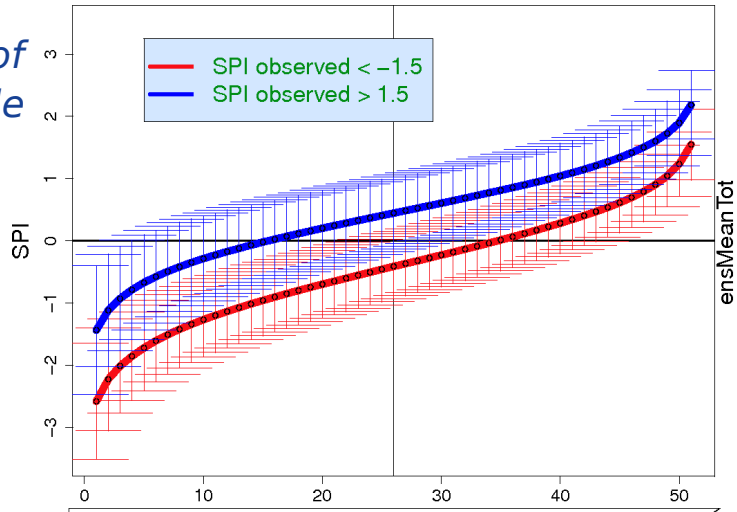
Method :

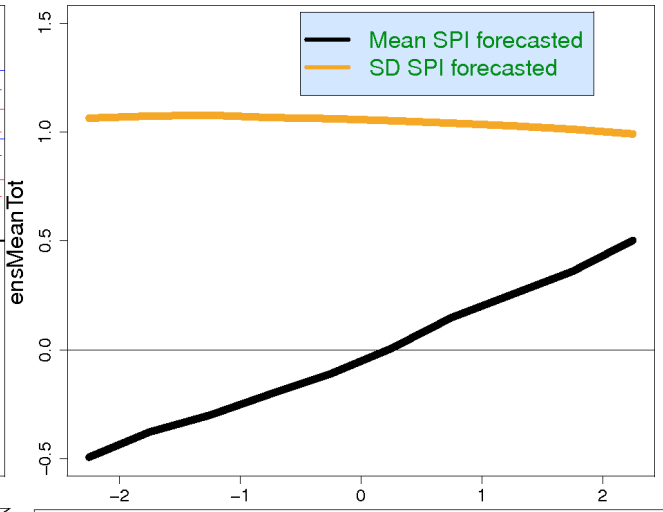
- SP1-1
- Horizontal resolution (1 to 5 square degrees) -> to analyze the spatial uncertainties
- Different methods defined :
  - **Direct**
  - **Predictors (WR occurrences)**

Forecast droughts (1month)

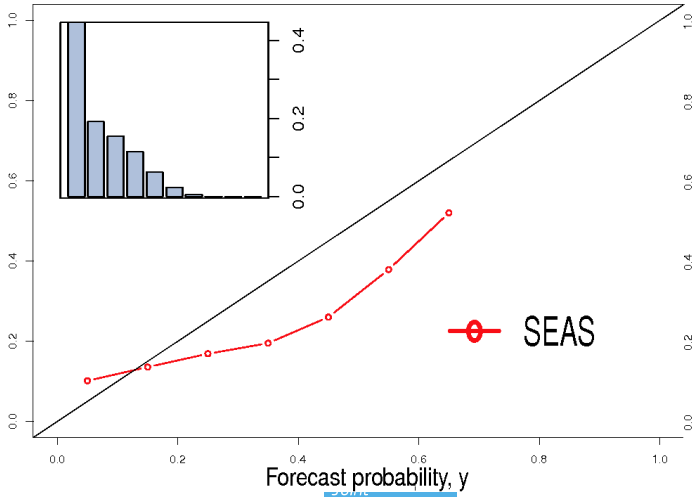
Resolution – Sharpness of the ensemble

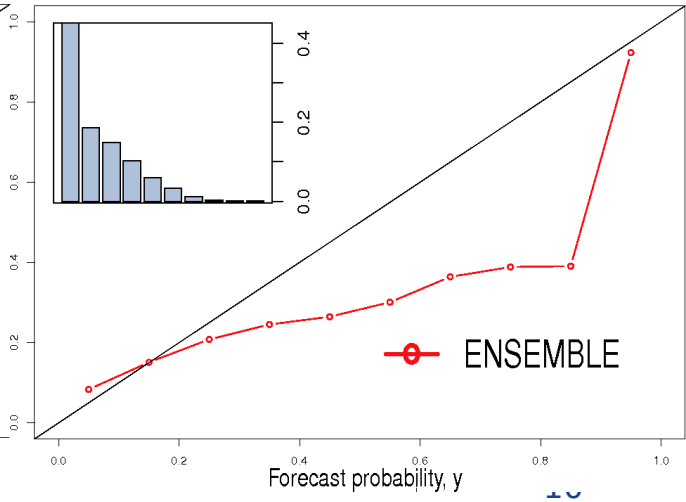
- ENS partially reliable
- SD still larger than the difference
- ENS underdispersive





Reliability diagrams for SPI < -1





Forecast droughts (1month)

Extracting robust and comprehensible informations from the outputs of the ensemble model by:

- Providing a dichotomous solution: YES/NO
- Assessing the forecasts uncertainties

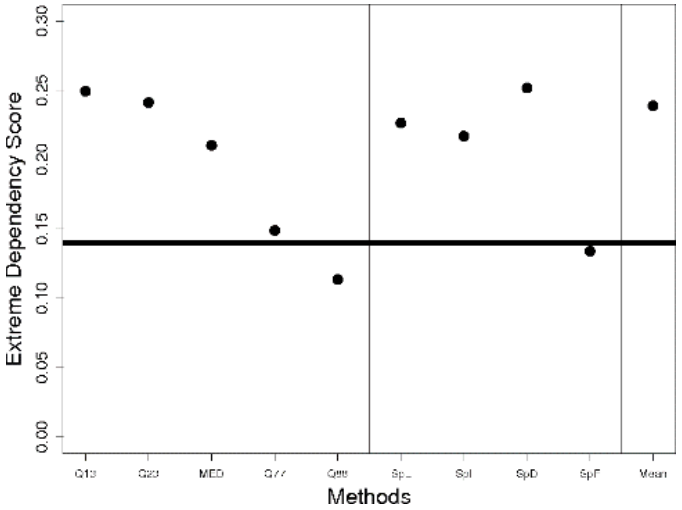
Different indices tested:

- Integrative (mean)
- Partially integrative (median, quantiles)
- Consistency (deviations, ensemble spread)
- Probabilistic

For each index, threshold defined to measure the same number of cases.

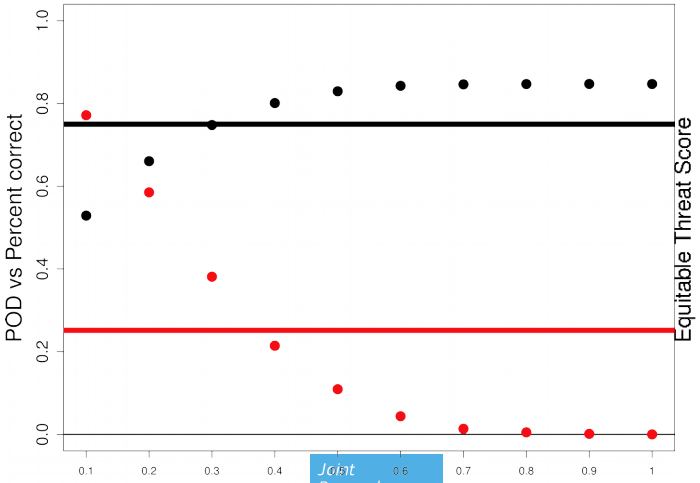
Forecast droughts (1month)

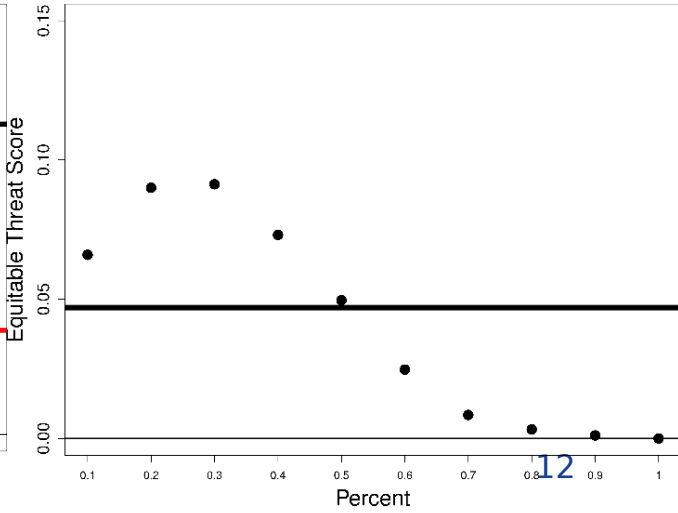
Scores (EDS) for each method



- large variability of the scores depending the method
- best index : 30% of members with SPI-1 under the threshold
- 40% of droughts forecasted one month in advance

Scores (POD, PC, GSS) for each percentage (only ENS)





Forecast droughts (1month)

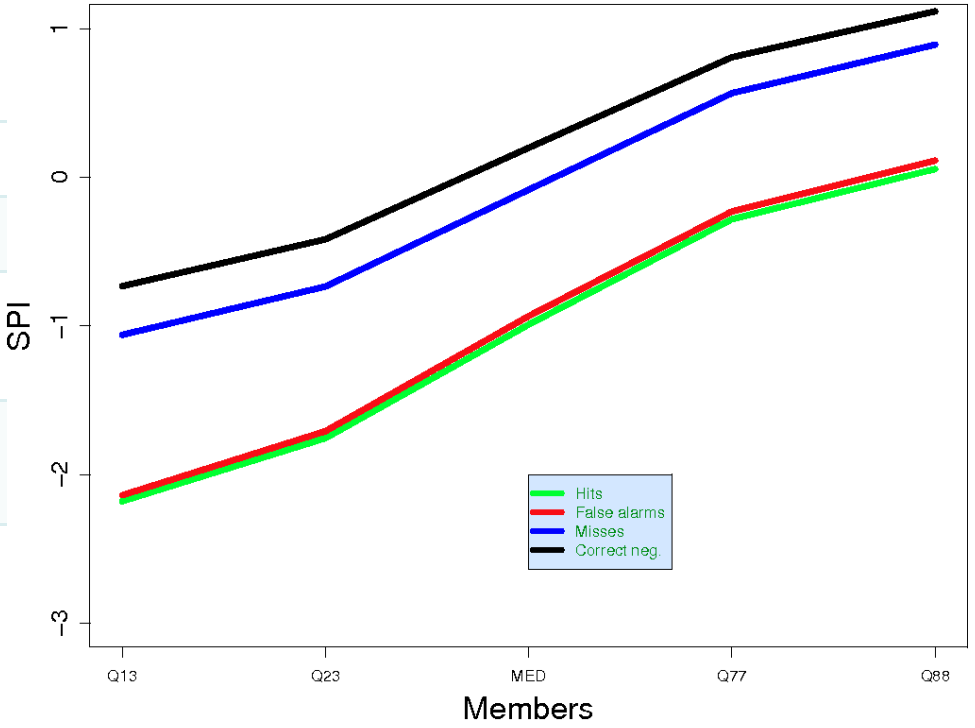
How to assess the uncertainties?

Ensemble spread in the contingency table:

		Drought observed	
		Yes	No
Drought forecasted	Yes	2.31±0.4	2.37±0.4
	No	1.99±0.4	1.88±0.3

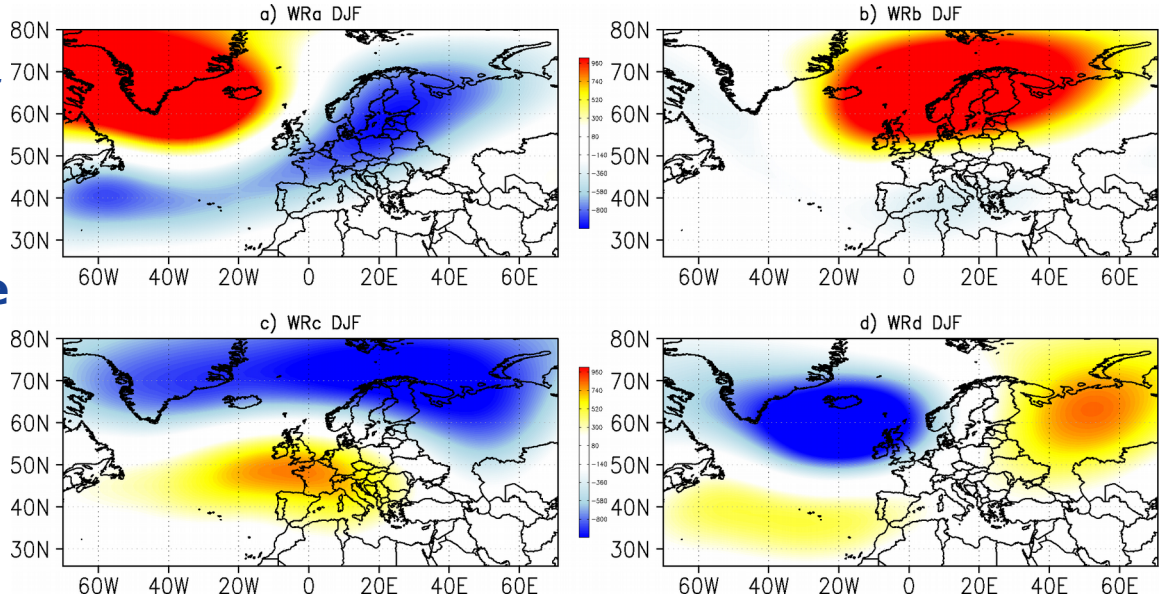
Lavaysse et al. 2015

Distribution of the mean SPI for the ranked members following the contingency table



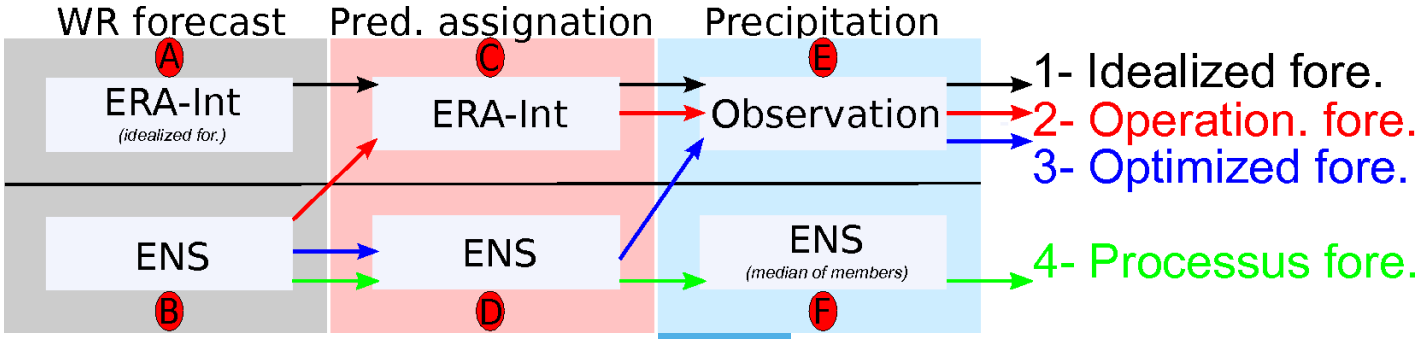
Forecast droughts (1month)

Patterns of the 500hPa geop. anomalies associated with WRs in winter



On the use of Weather regime occurrences to predict meteorological droughts:

Schema of the procedures tested

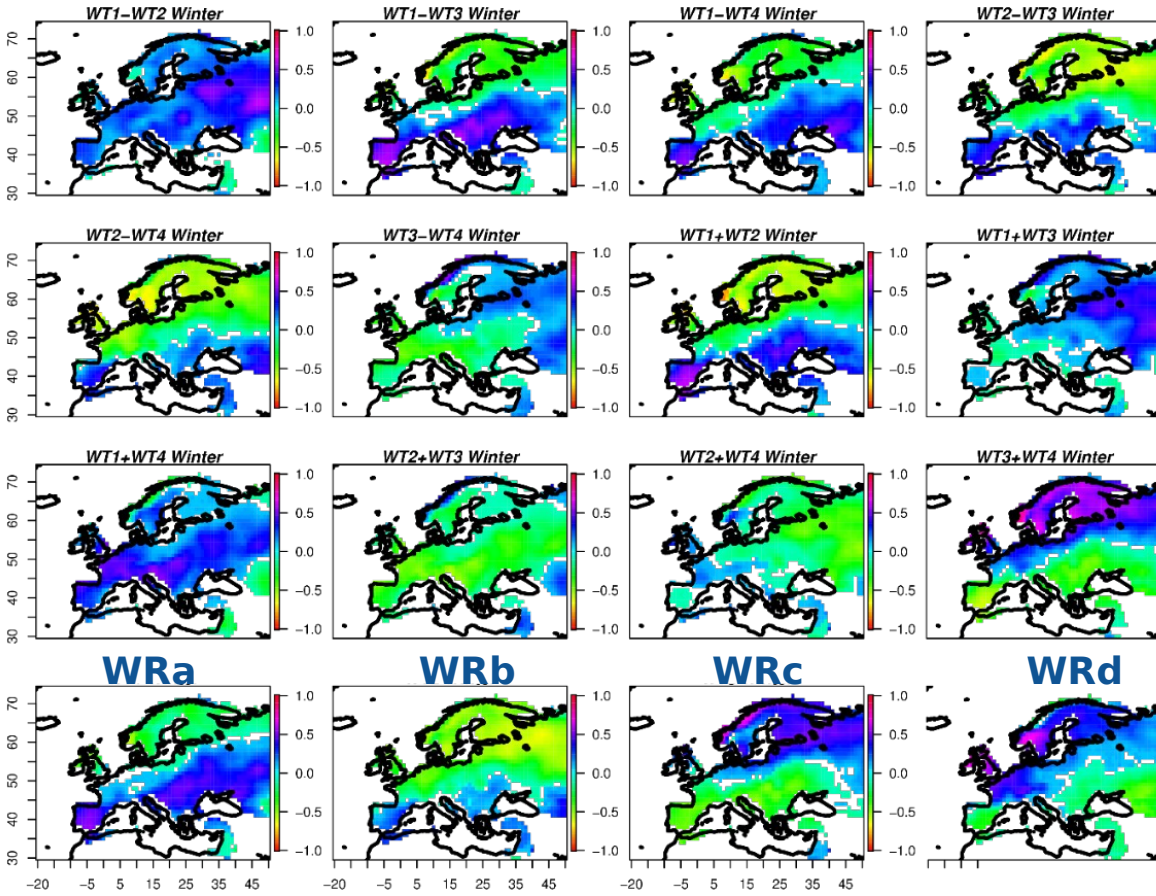


Forecast droughts (1month)

ACC between WR occurrences and SPI in Winter

Attribution of predictors for each grid point independently:

- Best ACC (+ preferred)
- MDA (- not adapted)



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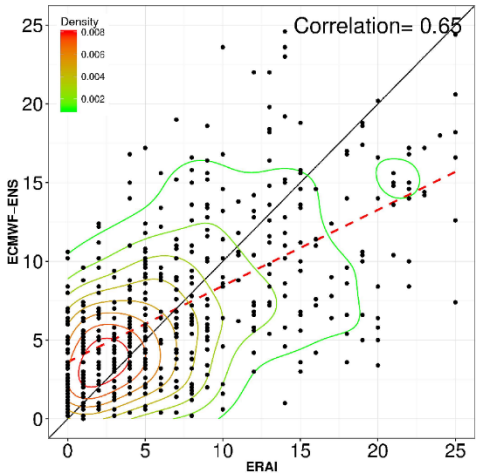
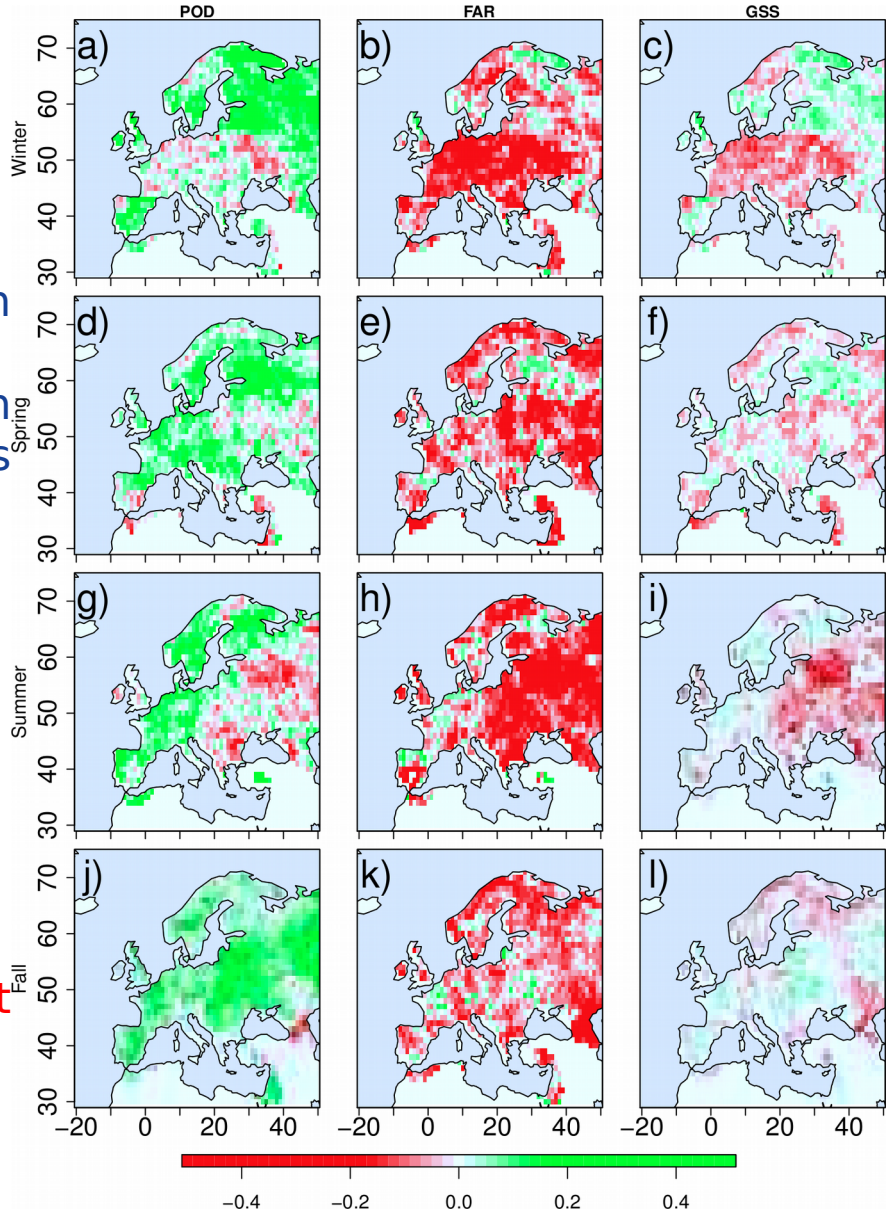
Forecast droughts

Real score of forecasts:

- Potential strong benefits with ERAI
- Benefits decreased but still significant in several regions
- Explained by both the relation predictor/predictant and the errors of WRs forecasted





-> Provide a 'combine product' using the most accurate forecast system for each grid point

Lavaysse et al. in revision in QJRMS

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Conclusions, perspectives

Short term droughts (SPI-10d)

- ✓ Significant predictability up to 15 days (t+15,t+25)
- ➢ Better deal with 0 and low precipitation amounts in West Africa

Medium term droughts (SPI-1)

- ✓ Definition of the best method to predict droughts
- ✓ Potential benefit of using atmospheric predictors such as WR occurrences
- ➢ Improvement of scores by using multi-model ensemble (S2S project)?

Long term droughts (seasonal) perspective work

- ➢ Too limited predictability of the precipitation in the models, need to use MME + post-processing approaches
- ➢ Need to identify/develop predictors (oceanic, upper level circulation, global oscillations)

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