Is there an added value of near-term decadal climate change information for decision making in agricultural sector?

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1. INTRODUCTION AND THE AIM:

Decadal predictions (Figure 1) offer the potential to narrow the uncertainty range with respect to non-initialised climate projections[1], supporting climate-related decisions on the inter-annual to decadal time horizons in key societal sectors such as agriculture.

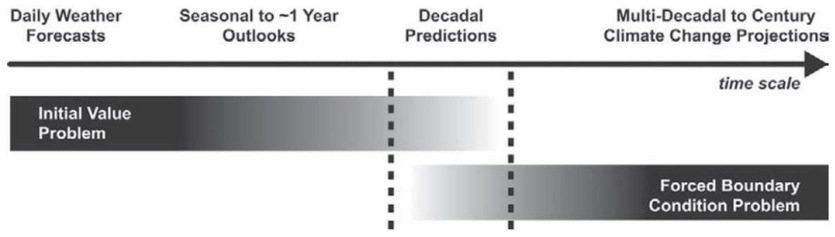

Figure 1: Initialized decadal prediction takes into account both initial conditions as well as the evolution of long-term external forcings of the climate system (from Meehl et al., 2009)

This study aims to illustrate the added value of using decadal predictions for building a climate service for agricultural needs. In particular, we assess the forecast quality of temperature, precipitation and the SPEI (Standardized Potential Evapotranspiration Index), which is a proxy for soil moisture anomalies.

2. DATA AND METHODS:

Data

- Observations: Monthly mean two-meter temperature and precipitation from GHCN-CAMSv2 and GPCCv7 respectively.
- Model: GFDL-CM2.1p1 - Experiments: Initialized decadal prediction 'INIT' and Non-initialized historical simulation 'No-INIT' (members: 10; chosen forecast time: 2-5).

Data for the boreal summer (from March to August) were interpolated into a common 2.5° grid over the European domain (33°N-75°N, 15°W-44°E) for the period of 1961-2017. In order to correct the typical forecast biases of temperature and precipitation present in the global prediction systems, a simple mean bias correction technique[2] is used.

Computation of SPEI6 index

SPEI is a multiscalar drought index. We calculate the SPEI for 6-months period from March to August (**SPEI6 - Aug**), as the heat and associated evaporation during this period is identified to have shaped drought events with pronounced negative impacts on the crop production over Europe [3,4].

- The monthly difference between precipitation (P) and potential evapotranspiration (PET) are used as the input data. (Figure 2a).
- This input values for a 6 months period (Mar-Aug) are accumulated and standardized to obtain SPEI6-Aug. Figure 2b presents an example of computed SPEI6-Aug using the observation data for the year 2003, which was an extremely dry year in Europe.

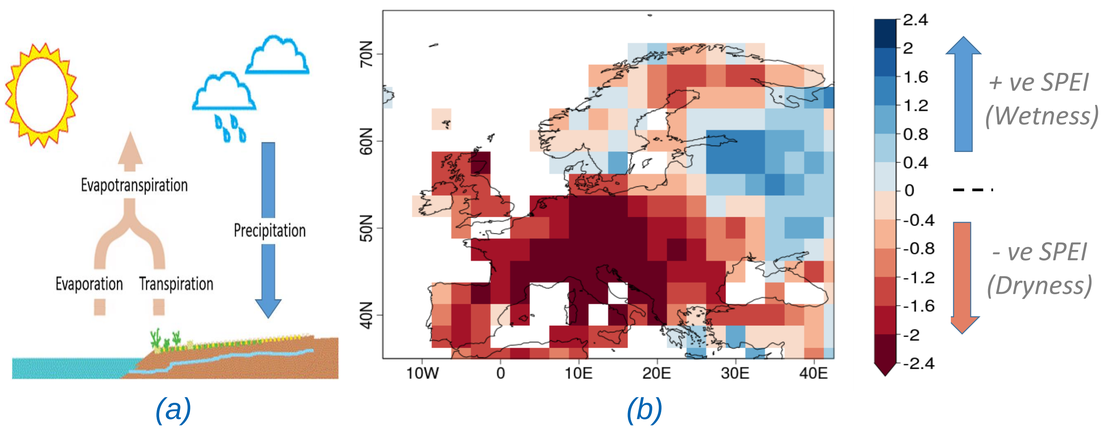

Figure 2: (a) Schematic diagram of a simple climatic water balance (b) Observed 6 month SPEI for August, 2003 (extreme drought event)

Forecast Quality Assessment

Ensemble mean correlation coefficient (deterministic skill measure) was used to quantify the skill. It measures the linear relationship between the ensemble mean of the forecast and the observation over the same period. Significance level is assessed using t-test, after a Fisher-Z transformation.

3. RESULTS AND MAIN FINDINGS:

(1) Forecast quality assessment of 2m air temperature and precipitation:

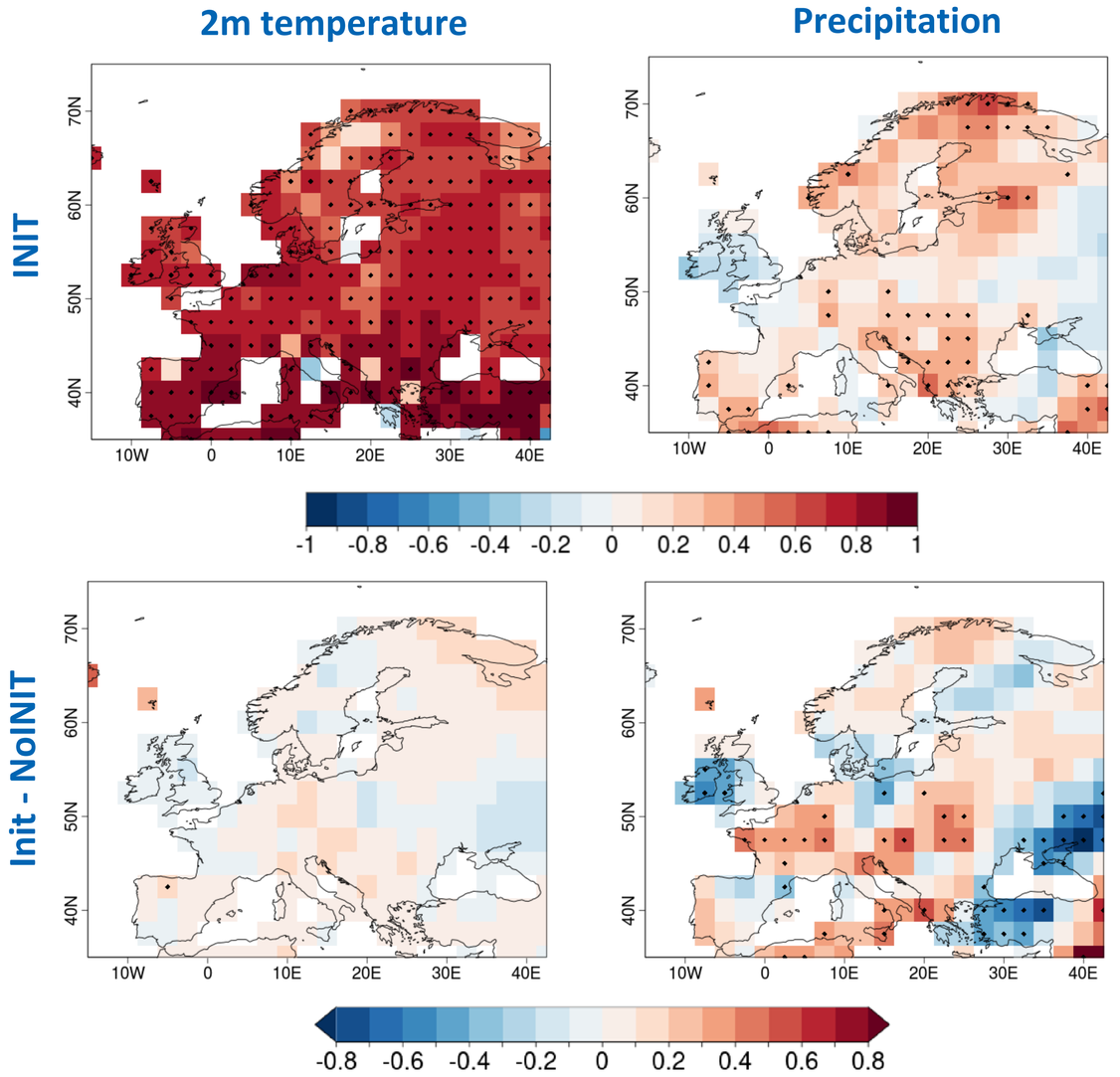

Figure 4: Ensemble mean correlation map for 2m air temperature (left) and precipitation (right), averaged over the months March-August and the forecast years 2 to 5 (top: Initialized predictions; bottom: difference between INIT and No-INIT simulations). The dotted grids represent values of correlation statistically significant at 95% (90%) confidence level for temperature (precipitation).

- Near-surface temperature averaged from March to August, has significant correlation values for forecast year 2 to 5 across Europe. The skill for precipitation is much lower, with significant skill limited to the Balkan and Scandinavian regions.
- The difference in correlation coefficient between INIT and No-INIT is much lower for temperature compared to precipitation.
- The skill for precipitation is improved noticeably over central Europe with INIT.

(2) Forecast quality assessment of drought index (SPEI6 - Aug):

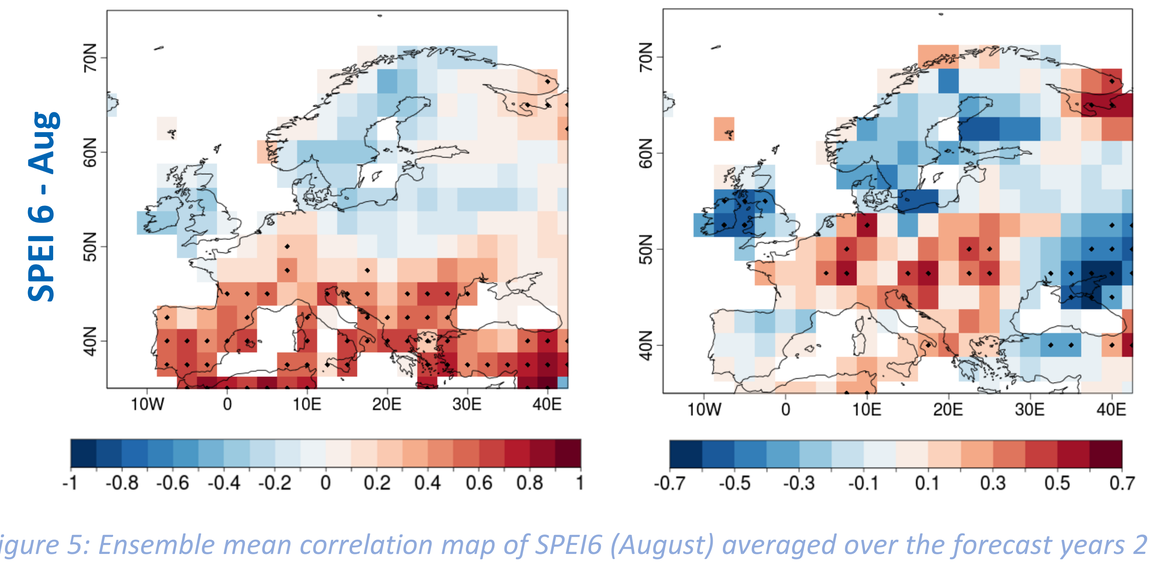

Figure 5: Ensemble mean correlation map of SPEI6 (August) averaged over the forecast years 2 to 5 (left column: initialized prediction, right column: difference between INIT and No-INIT simulation). Dotted region – statistically significant at 95% confidence level

- Initialized predictions of SPEI6 for August are skilful for Southern Europe
- Initialized prediction show increase in correlation over central Europe.

5. CONCLUSION AND FUTURE WORK:

In this study, we found reasonable skill on a multi-annual timescale (year 2-5) over the European region for temperature and precipitation and the index SPEI6-Aug, demonstrating the potential of those predictions for an agricultural climate service.

Future steps will include probabilistic forecast quality assessment of decadal predictions of SPEI6 together with the assessment of a multi-model approach. Additionally, the forecast skill of drought at different time scales will be explored.

REFERENCES:

[1]Doblas-Reyes et al., 2013;
[2]Torralba et al., 2016;
[3]Ceglar et al., 2017;
[4]Turco et al., 2017;
[5]Meehl et al., 2009

The research leading to these results has received funding from the European Commission Service contract no. 720829 (project: JRC-Decadal), the European Commission through EU H2020 Framework Programme under grant no. 776613 (EUCP) and 776467 (MED-GOLD), and the Spanish Ministerio of Economía y Competitividad under projects HIATUS (CGL2015-70353-R) and CLINSA (CGL2017-85791-R). Balakrishnan would also like to acknowledge financial support from the Marie Skłodowska-Curie fellowship (grant no. 713673) and from "La Caixa Banking Foundation". LPC's contract is co-financed by the MINECO under Juan de la Cierva Incorporación postdoctoral fellowship number IJCI-2015-23367.