Multi-year prediction of European summer drought conditions for the agricultural sector

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OBJECTIVES

- To assess the forecast quality of decadal climate predictions for two user-relevant drought indices, SPEI (Standardized Potential Evapotranspiration Index) and SPI (Standardized Precipitation Index), at multi-annual timescales during European summer.

- To determine the improvement in the skill due to the initialization of the climate model.

- To evaluate the predictive skill of the components (precipitation and potential evapotranspiration - PET) used to compute both indices in order to assess to what extent the individual components contribute to the overall skill.

DATA AND METHODS

- Observations: Monthly mean 2m temperature and precipitation from GHCN-CAMSv2 and GPCCv7 respectively.
- Model: A large multi-model ensemble forecast was built with six models (CanCM4, EC-Earthv2.3, GFDL-CM2p1, HadCM3, MIROC5, MPI-ESM-LR) that were produced as part of CMIP5 and SPECS. Total members: 44 for **initialized decadal prediction (INIT)** and 46 for **uninitialized climate projection (No-INIT)**. Evaluated forecast period: year 2-5.

Raw data were interpolated into a common 2.5° grid over the European domain for the period of 1961-2010. A simple mean bias correction technique is used to correct the forecast biases of temperature and precipitation. Later, SPI and SPEI are computed. SPI and SPEI are based, respectively, on the standardized precipitation and the climatic water balance (precipitation minus potential evapotranspiration) accumulated over a given number of months (6-month period in our case, which are referred to as SPEI6 and SPI6)

RESULTS

(1) Forecast quality assessment of Potential evapotranspiration and precipitation (April - September)
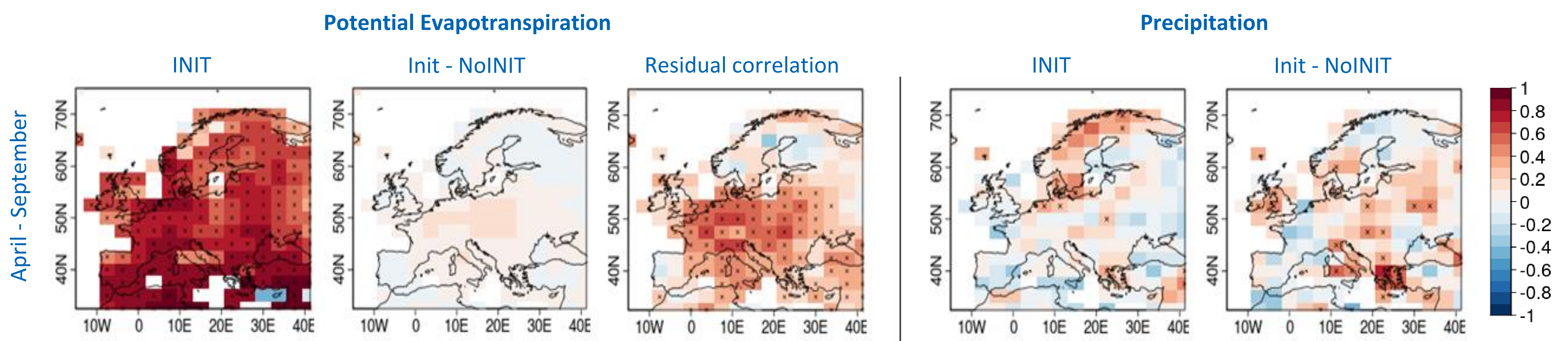

Figure 1: Multi-model ensemble-mean correlation coefficients of the accumulated PET (first two columns) and precipitation (last two columns) averaged over forecast years 2 to 5. The first and fourth column corresponds to the correlation of INIT while the second and fifth column show the difference between INIT-NoINIT. The third column corresponds to the correlation of residual between INIT and observed PET time series obtained by linearly regressing out the No-INIT ensemble mean. Dotted regions - statistically significant at 95% confidence level.

- For INIT, PET averaged from April to September 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 (INIT-NoINIT) is low for PET, whereas the skill for precipitation is improved noticeably over central Europe with INIT.
- The residuals of initialized and observed accumulated PET timeseries are highly correlated after linearly regressing out the uninitialized ensemble mean.

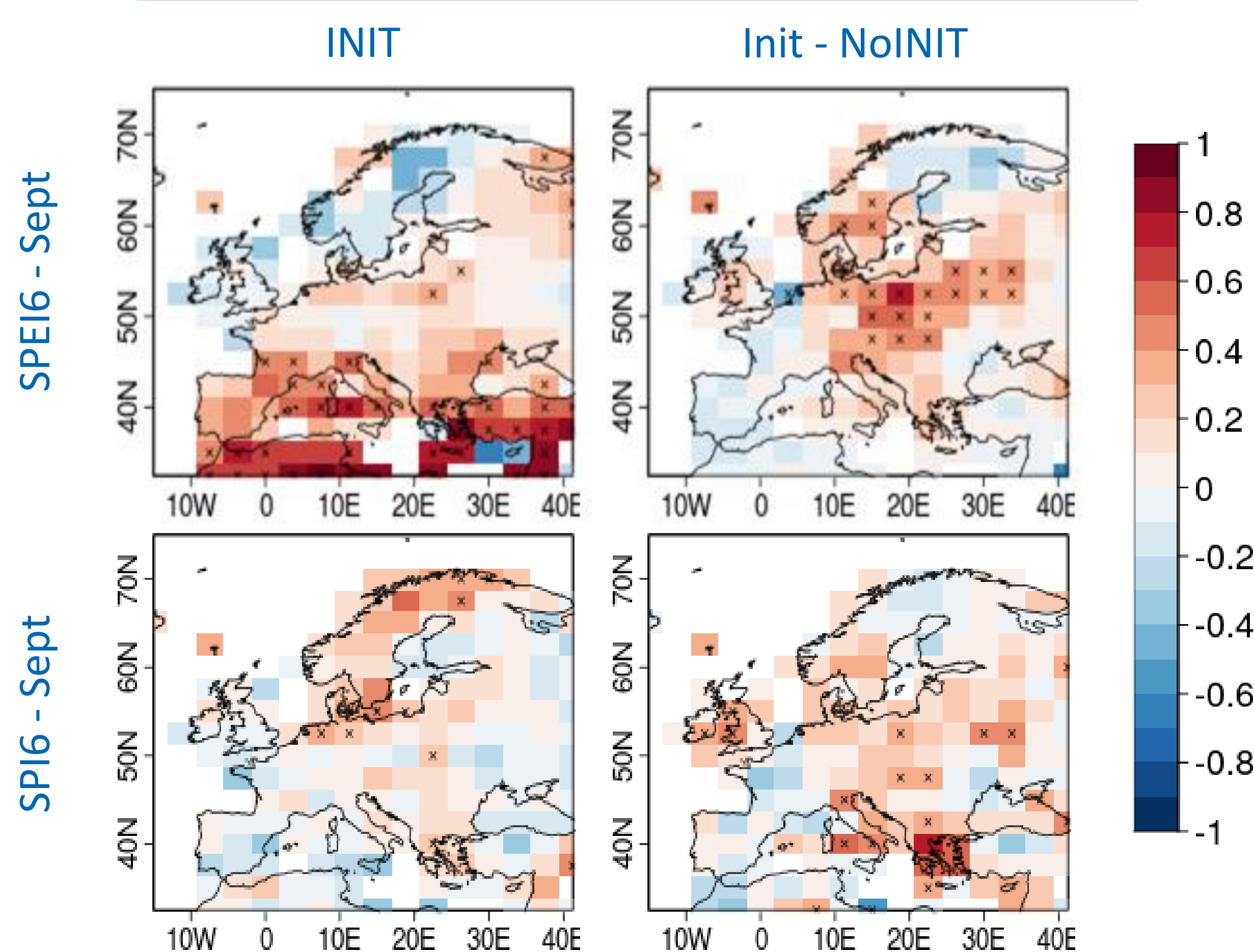### (2) Predictive skill of SPEI6 and SPI6 (September)

Figure 2: Ensemble mean correlation map of SPEI6 (top) and SPI6 (bottom) for the month of September averaged over the forecast years 2 to 5 (left column: INIT, right column: difference between INIT and No-INIT). Dotted regions – statistically significant at 95% confidence level

- Initialized predictions of SPEI6 for September are skilful for Southern Europe whereas SPI6 exhibits positive skill over the Scandinavian region.
- For both the indices, INIT show increase in correlation over central Europe.

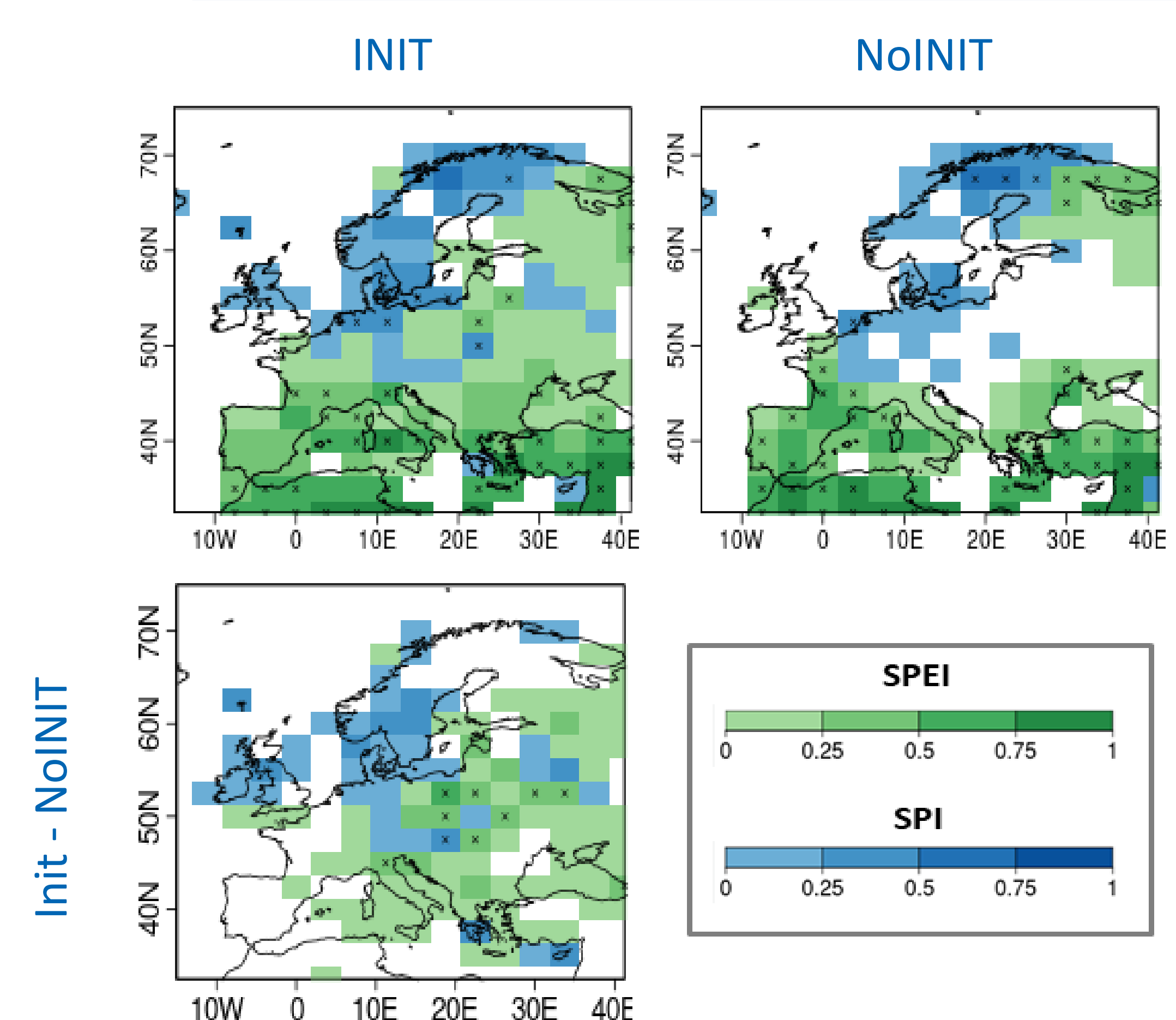### (3) Maximum correlation values (September)

Figure 3: Maximum positive correlation values among the considered drought indices - Top: first column: with INIT; second column: with No-INIT. Bottom: (positive) correlation difference between INIT and No-INIT. Dotted regions – statistically significant at 95% confidence level

- Initialized experiments exhibit maximum positive correlation values over most of Europe for the month of September.
- Enhanced skill due to initialization over Central Europe and Balkan region.

CONCLUSION AND FUTURE WORK

In this study, we found reasonable skill on a multi-annual timescale (year 2-5) over the European region for PET and precipitation and the drought indices SPEI and SPI, demonstrating the potential of those predictions for an agricultural climate service. The enhancement in the skill due to initialization is linked to the improvement in forecasting extended summer precipitation.

Future steps will include probabilistic forecast quality assessment of decadal predictions of drought indices on a global spatial scale. Additionally, the forecast skill of drought at different time scales will be explored.

REFERENCES:

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