Tropical sources of predictability for summer precipitation over Nordic European countries

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Motivation

In recent years, potential sources of predictability for summer precipitation over Europe have been identified.

- Different modes of atmospheric variability that cause dry or wet summers have been characterized (e.g. Saeed et al., 2014; O'Reilly et al. 2017, Wulff et al., 2017),

- Possible influences of soil moisture anomalies (Schär et al.,1999; Seneviratne et al.,2006)

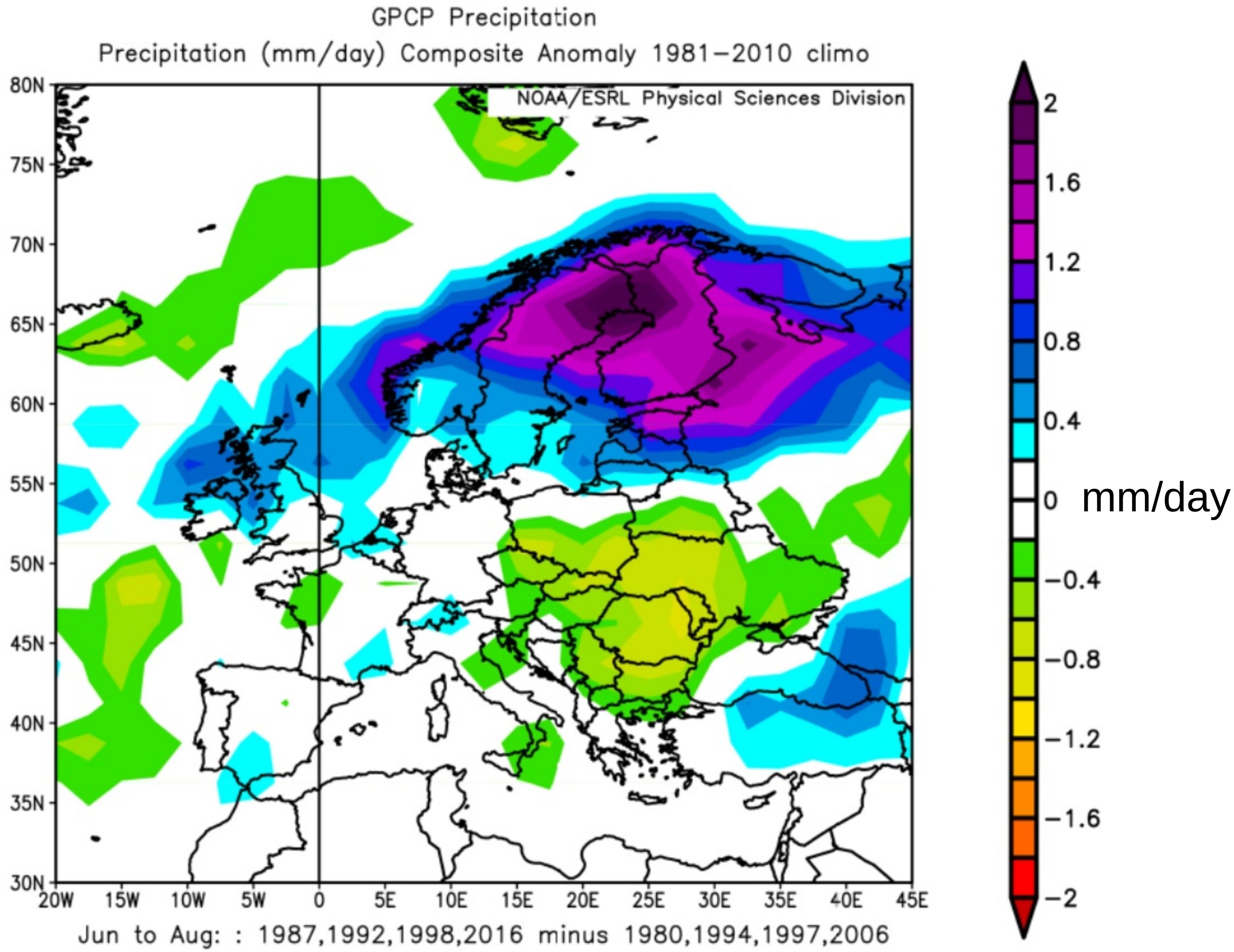
- and linkages to changes in sources of moisture availability due to Sea Surface Temperature (SST) anomalies (Årthun et al., 2017), especially at multi-annual frequencies.

Motivation and aims

However, up to now it is still a challenge to understand which processes influence the variability of summer precipitation over Europe, as well as the inherent predictability, and the skill of current seasonal prediction systems to represent and predict these processes.

We show evidence that atmospheric anomalies over the North Atlantic and Europe, causing wet and dry summers over Northern Europe, have their origin in the tropical and subtropical Pacific in early spring.

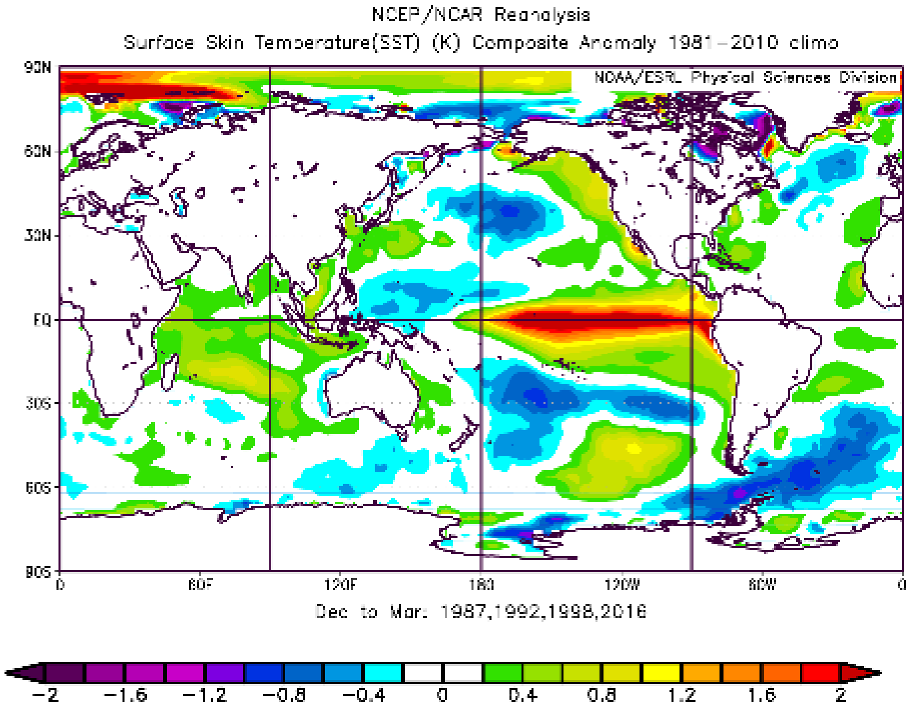
Wettest minus driest summers in Sweden



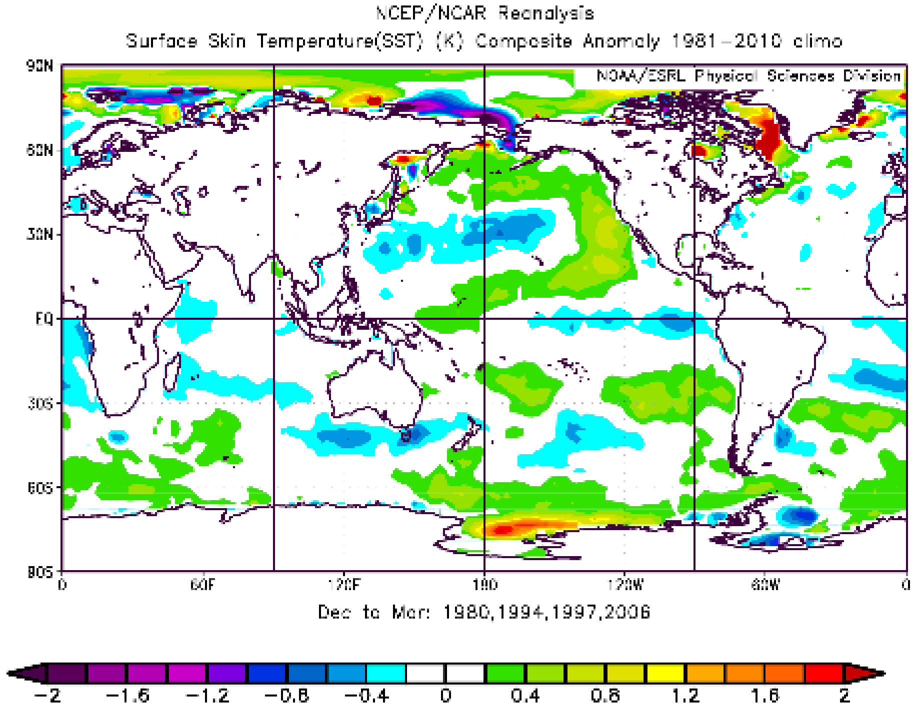
We identify states of the climatic system preceding wet and dry summer conditions over Scandinavia and all Nordic European countries (NEC)

DJFM SST anomalies

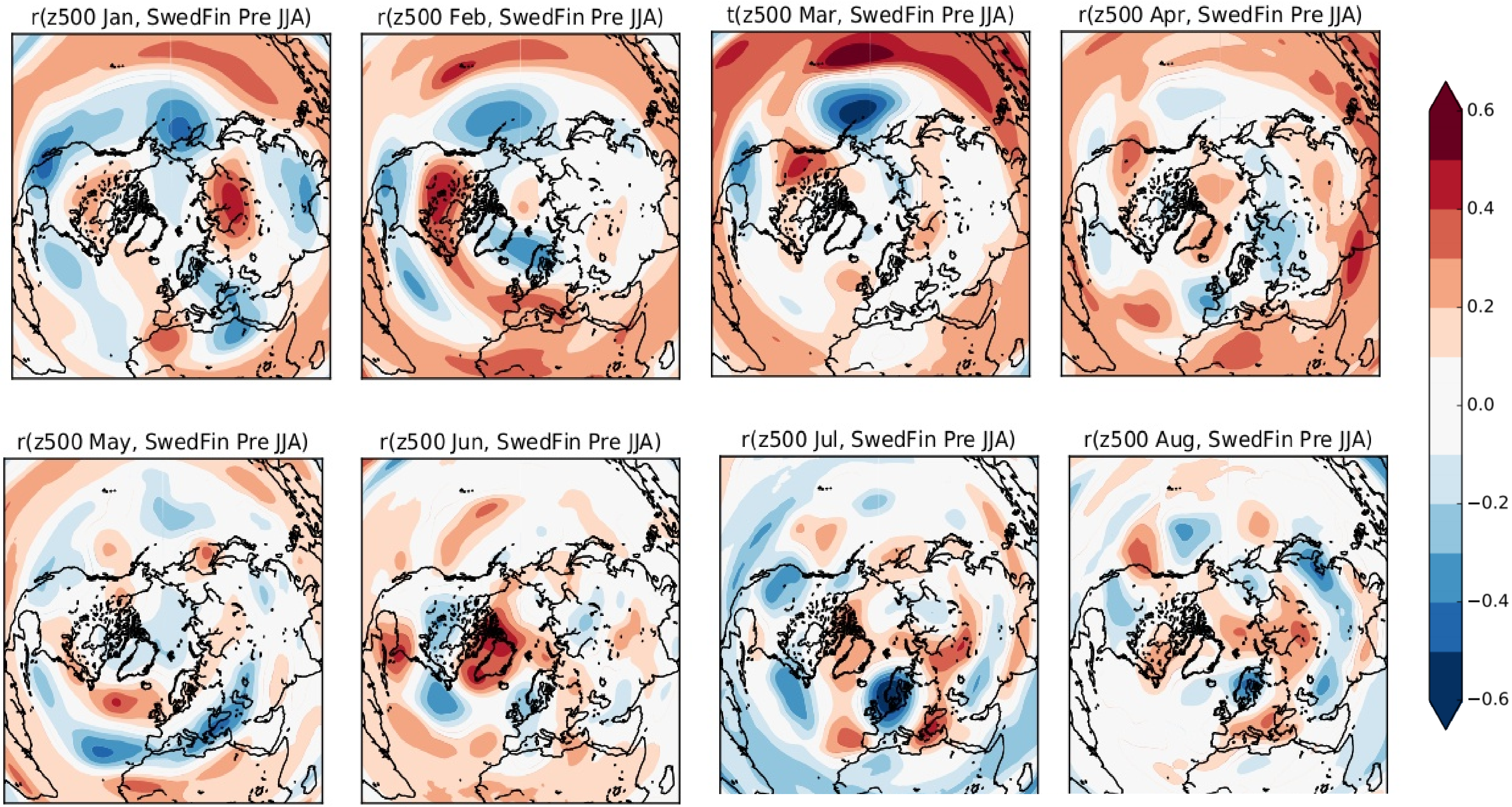
Wet summers



Dry summers



Correlation coefficients of summer precipitation over SwedFin region and of geopotential height at 500 hPa (Z500) in different preceding months.



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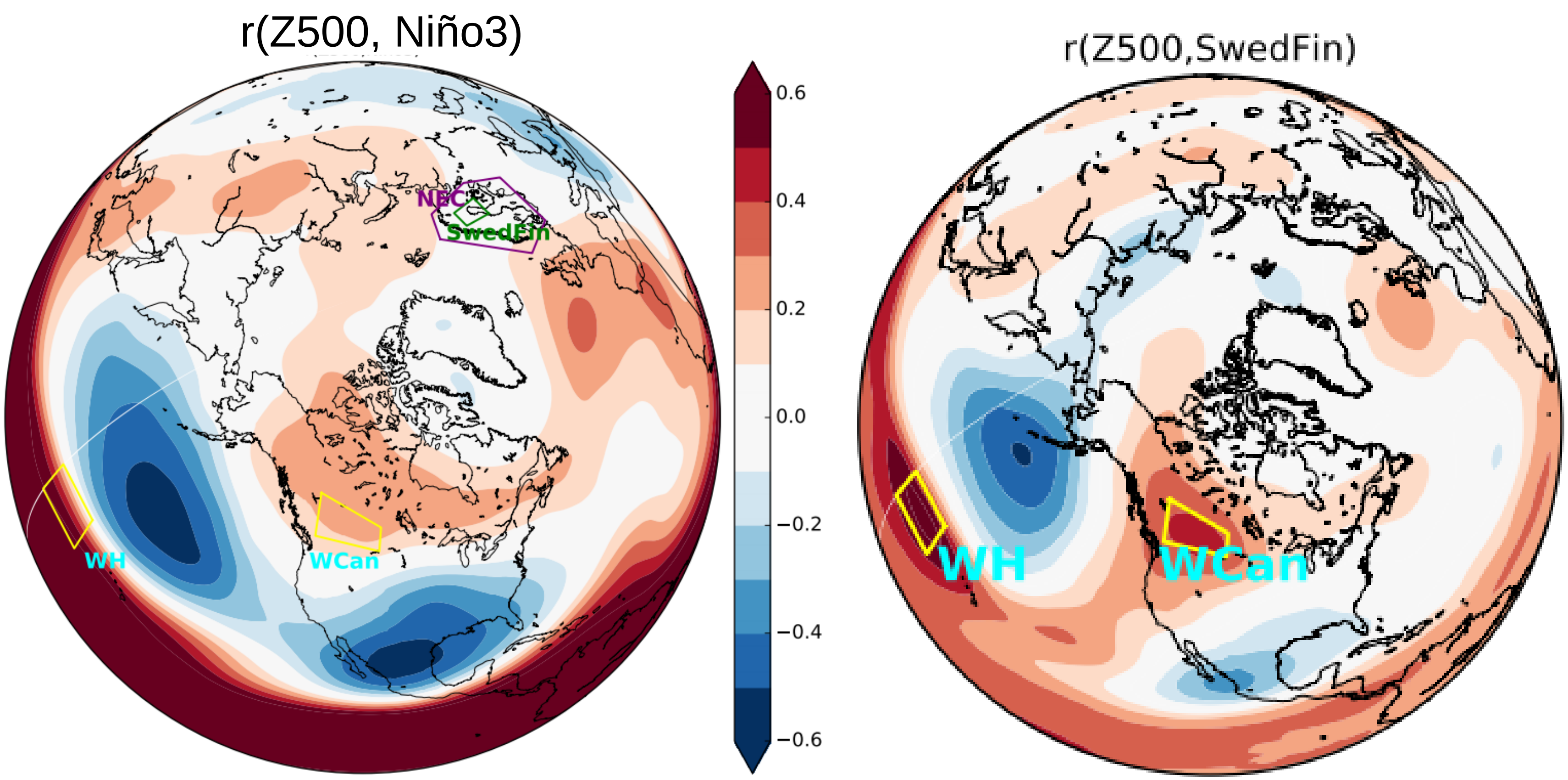
Correlation coefficients of geopotential height at 500 hPa (Z500) with Niño3 index (left) and with summer precipitation over SwedFin region (right).



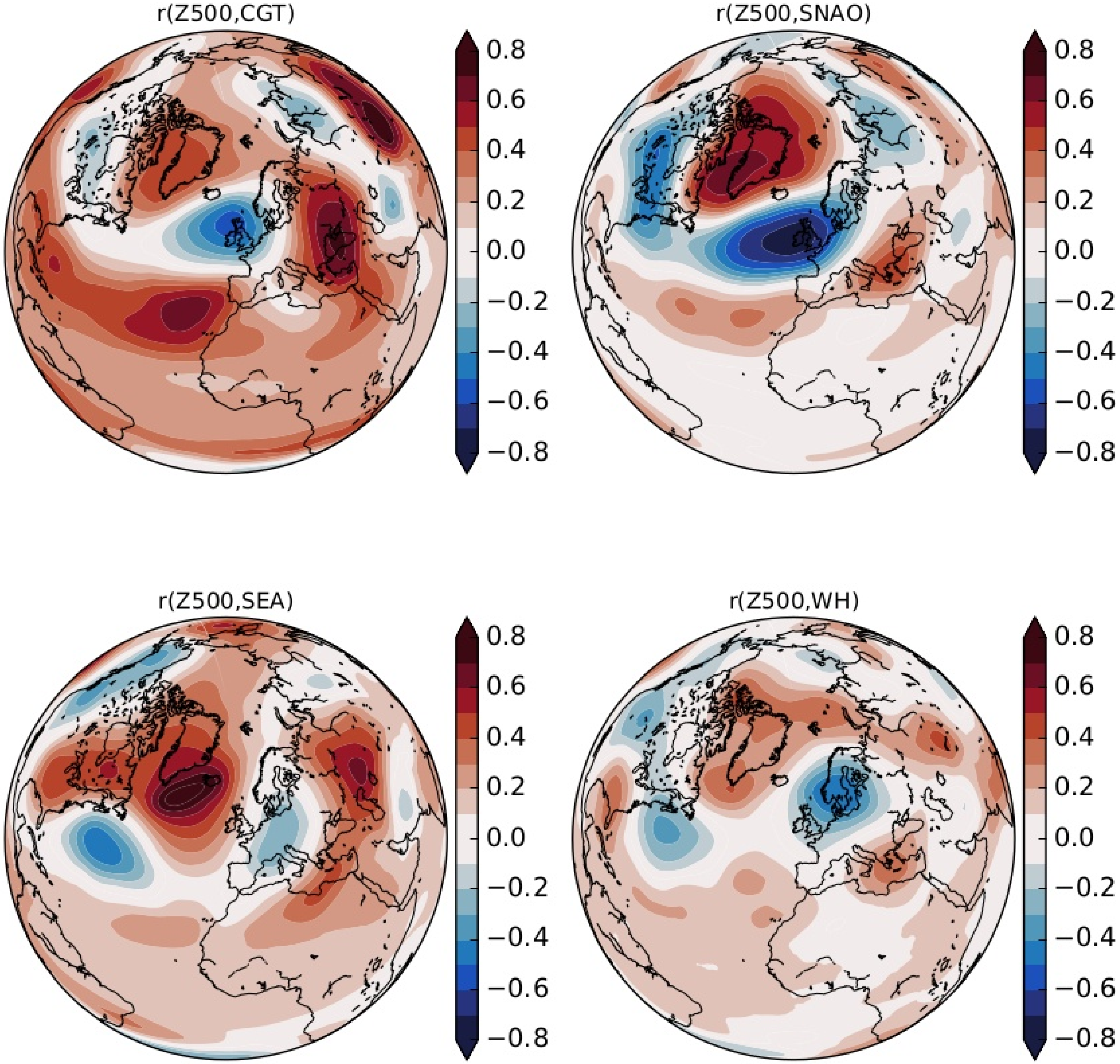
Enclosed are shown the WH and WCan regions used as z500-based predictors. NEC and SwedFin regions for summer precipitation are also shown

Comparison of spatial patterns of different modes of atmospheric variability during summer impacting the NEC climate variability

CGT: Circumglobal teleconnection pattern. Barnstator (2002).

SNAO: Summer North Atlantic Oscillation

SEA: Summer East Atlantic mode. Wulff et al. 2017



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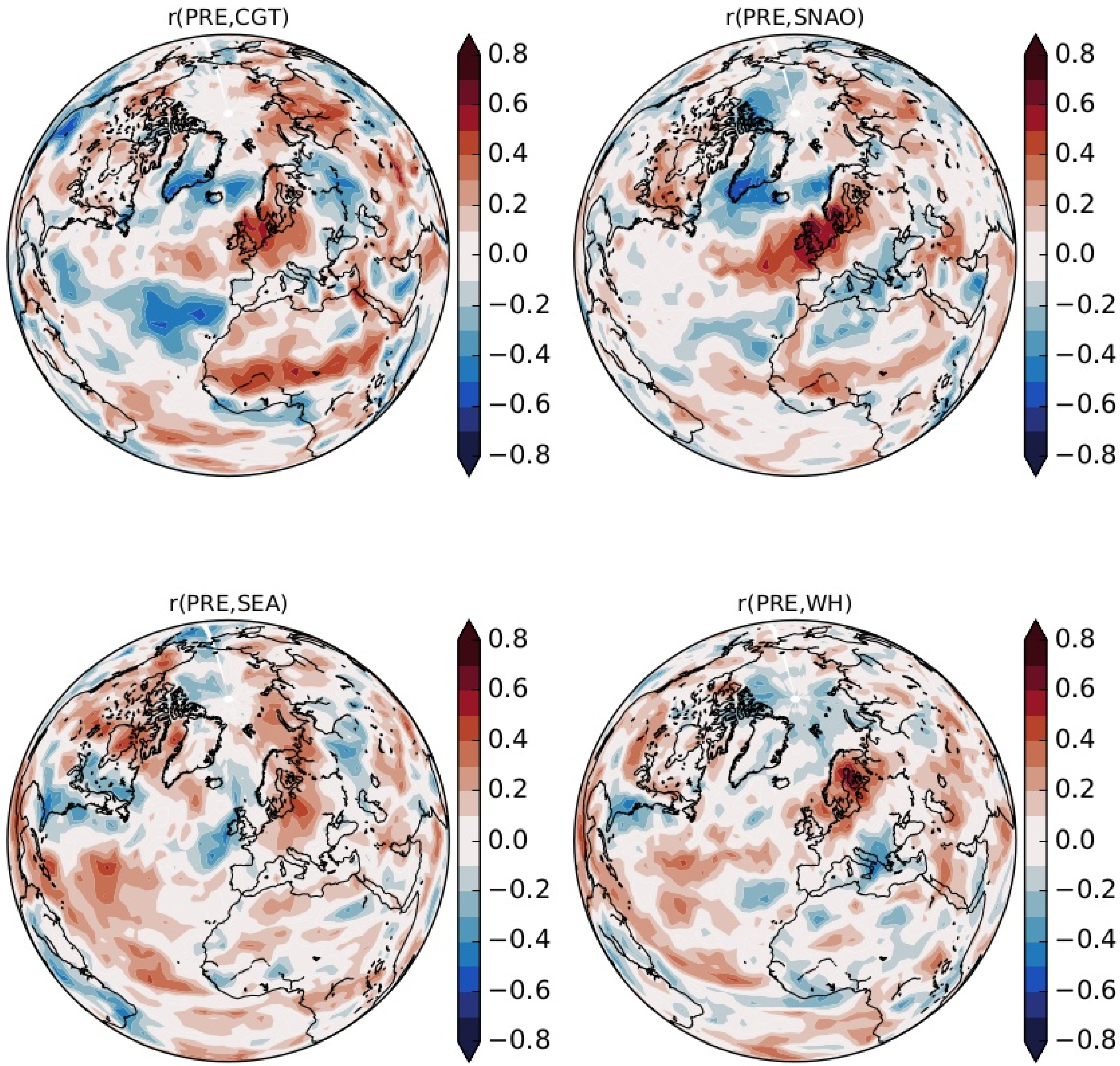
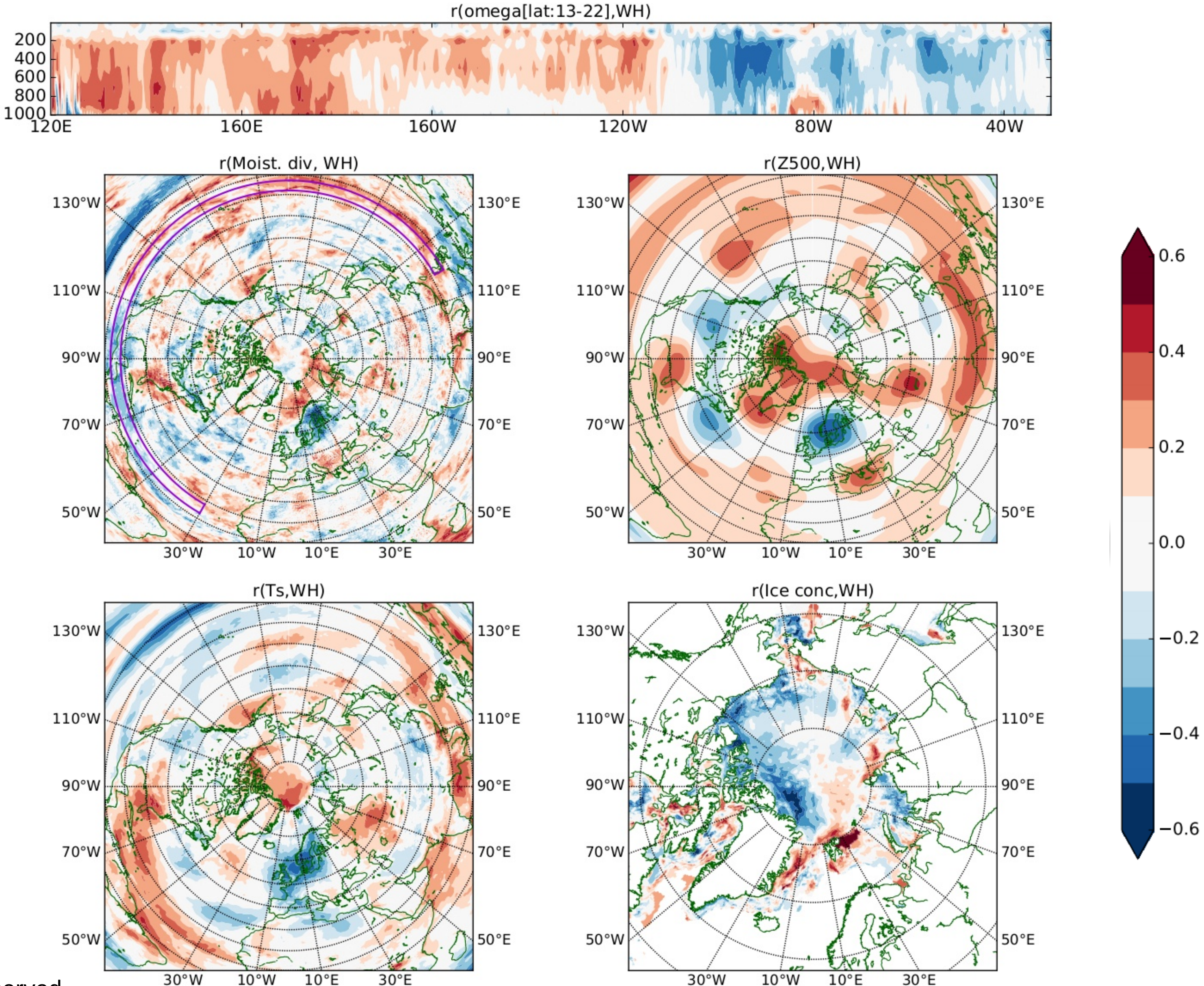


The behavior expressed by WH z500-based predictor shows systematic correlation with other variables during summer



Empirical model for summer precipitation based on z500 anomalies during March

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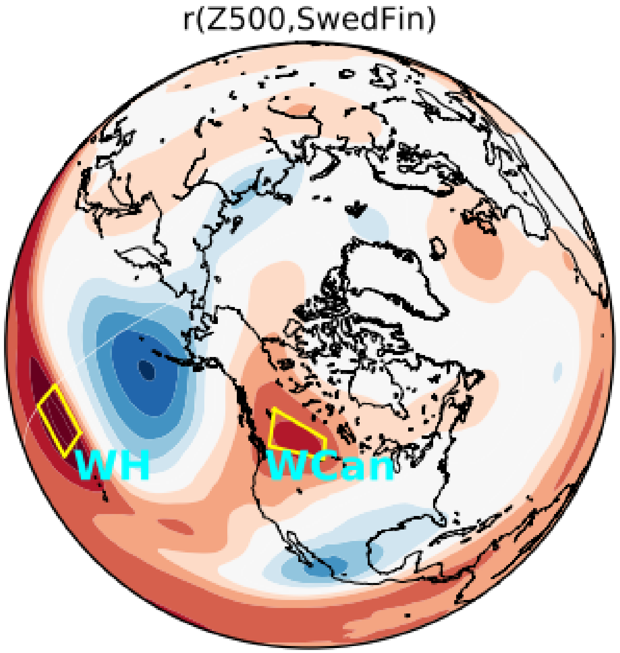
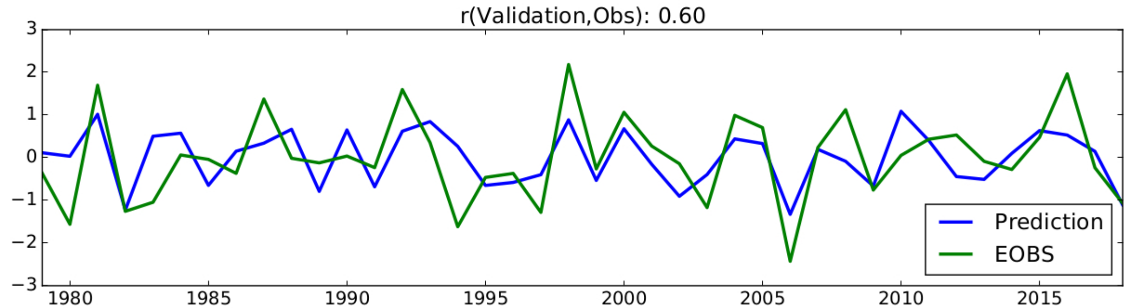
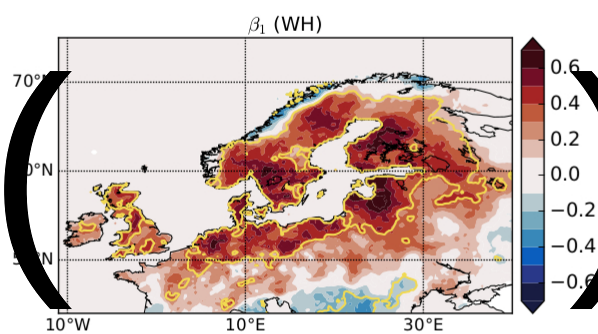


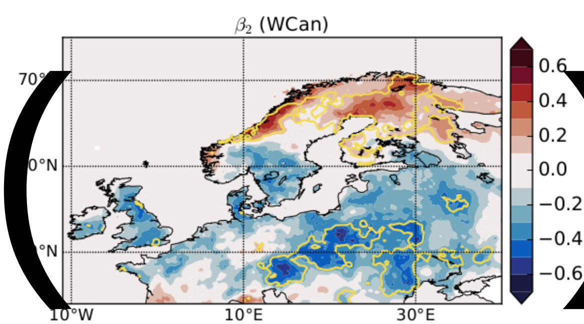
$$P = 0.56\ WH\ + 0.18\ WCan + \varepsilon$$



P=(



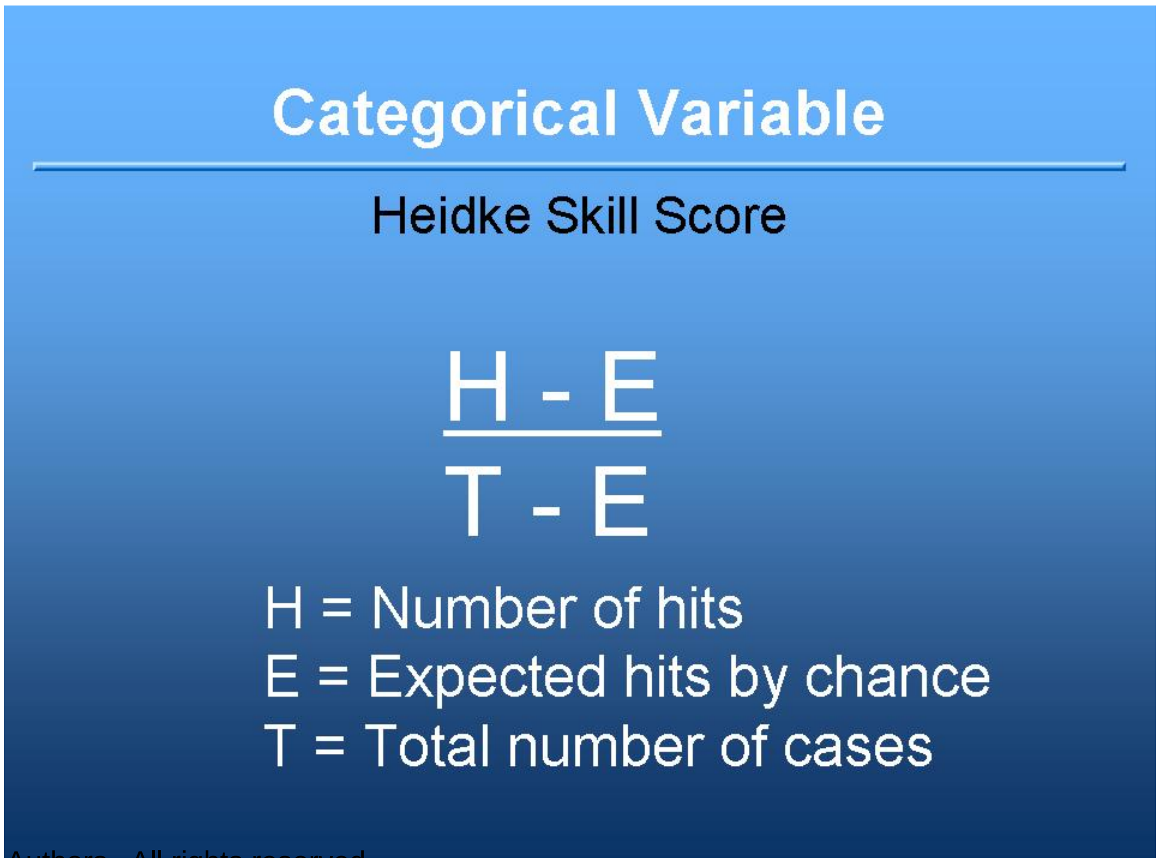
)WH+(



)WCan

How much better is our prediction compared to a random prediction?

To answer this question we calculated the Heidke skill score, that is a measure of the number of hits subtracting the expected skill of a random prediction

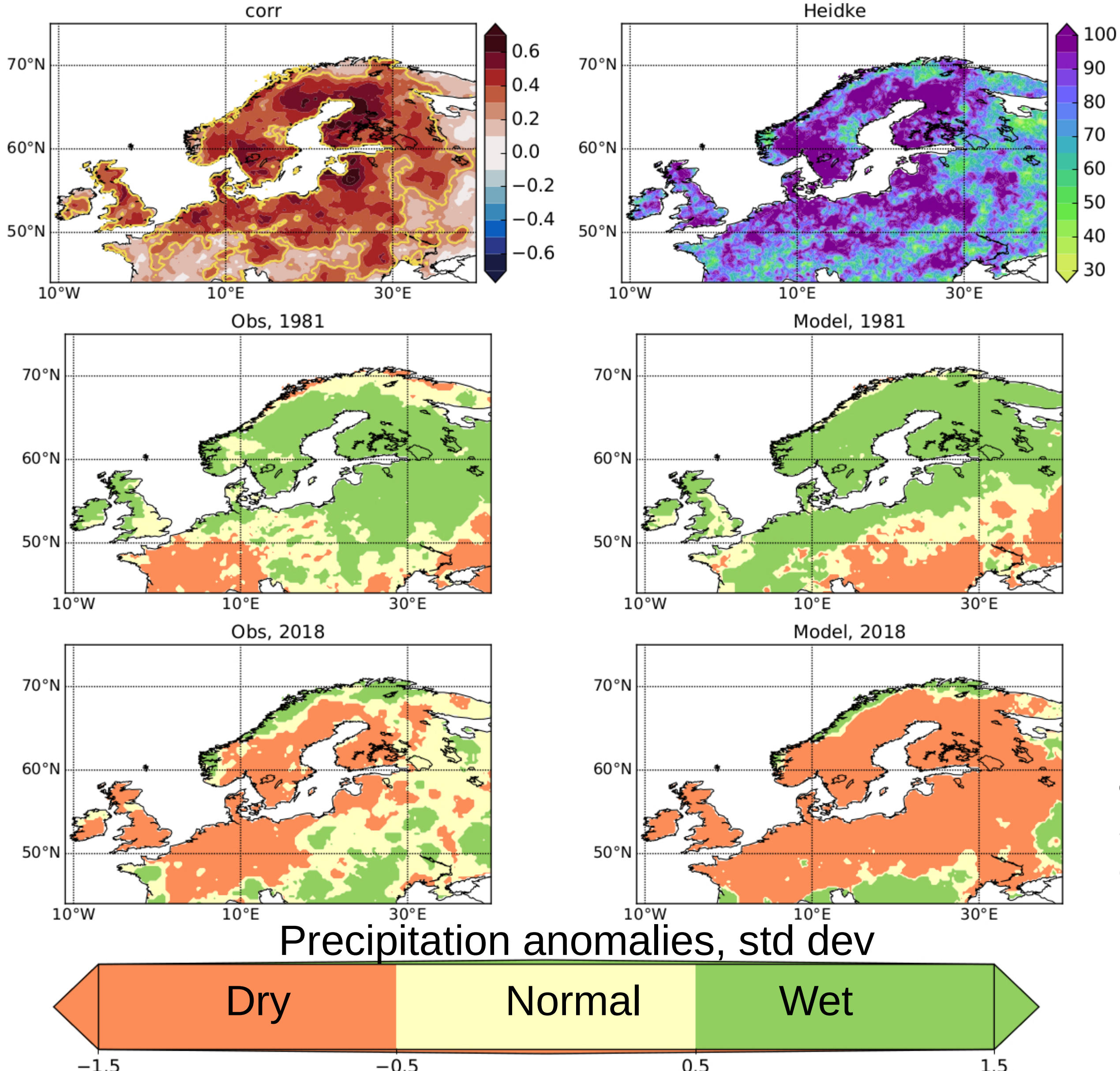


In 100 summers, if we divide them in wet, normal and dry, we get a 33 chance that a random forecast will be correct.

So E = 33% of the total amount of summers we predict.

If Heidke>33 it means that our prediction is better than the random forecast.

Validation

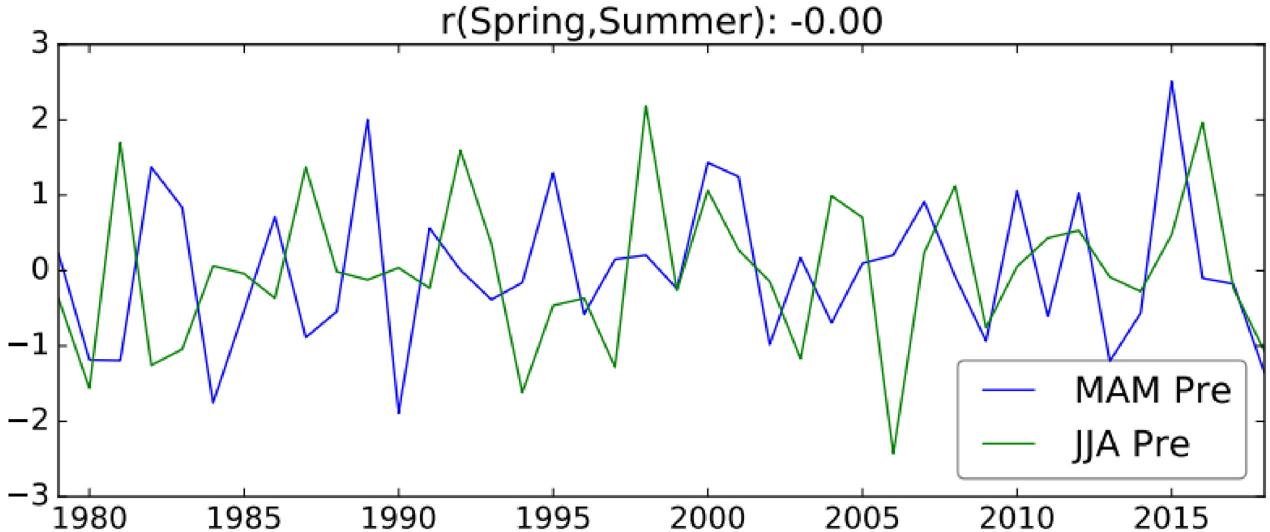


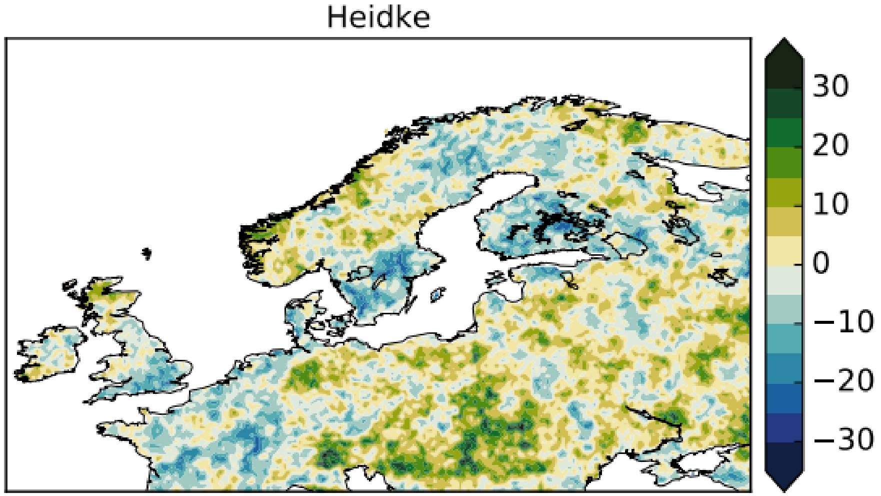
Heidke<33 means that a random forecast is better.

Fuentes-Franco and Koenigk. Submitted to Geophysical Research Letters (2019)

Test of precipitation anomaly persistence

Are wet springs followed by wet summers? Or is there a preferred behaviour of summer precipitation anomalies after observed anomalies during spring?





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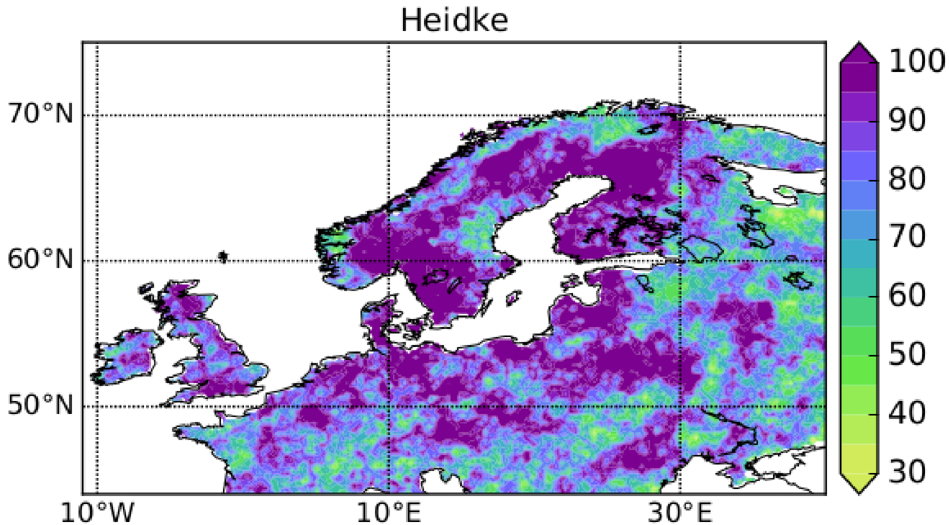
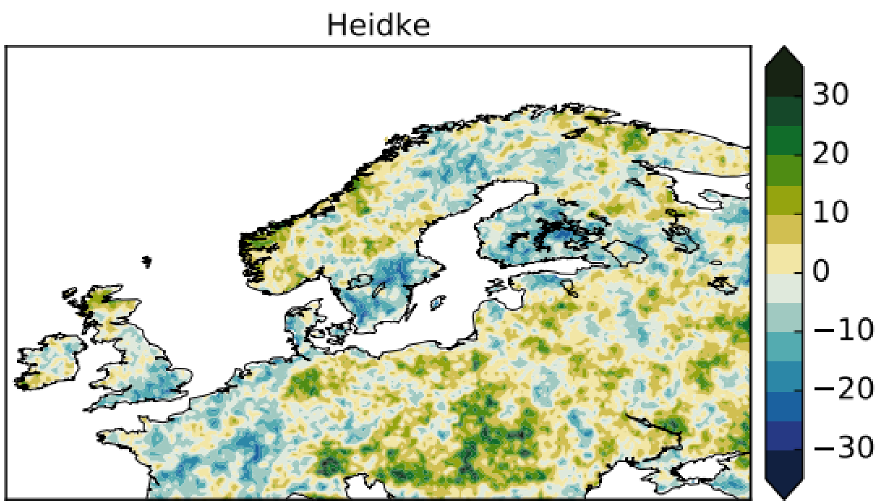
Heidke skills comparison





Our method (upper figure) shows much more skill than the random forecast with all of Europe (especially the northern part) showng Heidke>33%, while the persistence (lower forecast) forecast shows even worse results than the random forecast, showing even negative Heidke skill score.

Summary

We have shown that the Pacific-Northern European climate connection is detectable from early spring and that by choosing z500 predictors during March over the Pacific we get substantial skill for seasonal summer precipitation forecasts over NEC.

Besides broadening the understanding of the teleconnection processes that affect northern European climate, our findings are relevant because our method allow a simple but skilful estimate of the climate conditions several months in advance. This allows decision makers to make efforts to reduce environmental and socio-economic impacts through short-term adaptation and response to climate variability.

Thank you!

Fuentes-Franco and Koenigk (2020)
Tellus A. In Press
https://doi.org/10.1080/16000870.2020.1764303