

Predicability and Skill of Decadal Predictions for Europe

Hendrik Feldmann, Marianne Uhlig and Christoph Kottmeier

Objectives:

Ensemble Generation and Effects of its Composition

- An extended ensemble of regional decadal predictions has been generated using the forcing from MPI-ESM-LR baseline1
- Several options have been tested
 - The use of 2 RCMs CCLM and REMO
 - Different Resolutions 0.22° and 0.44°
- Several references are available:
 - Re-analysis driven RCM simulation
 - Un-initialized simulation using the MPI-ESM-LR historical

Predictability and Predictive Skill for potentially user relevant variables

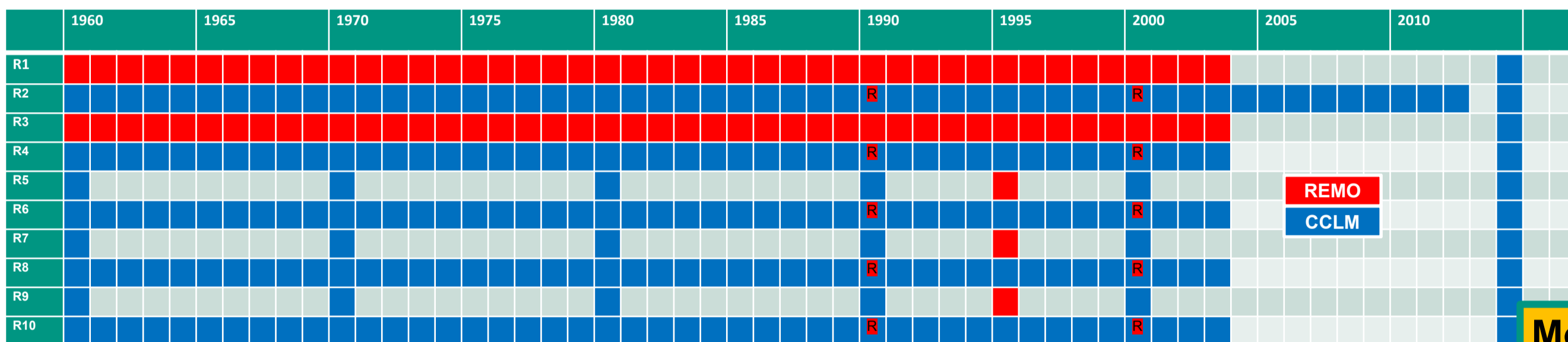
- Going further: Predictions beyond Temperature & Precipitation
- Assessing the prediction potential for relevant variables as well as the benefit for users, utilizing observations
- Finding Possible mechanism behind the Variability: Teleconnections

The Regional DS2 (baseline1) ensemble

Regional DS2 Ensemble Matrix (Europe)

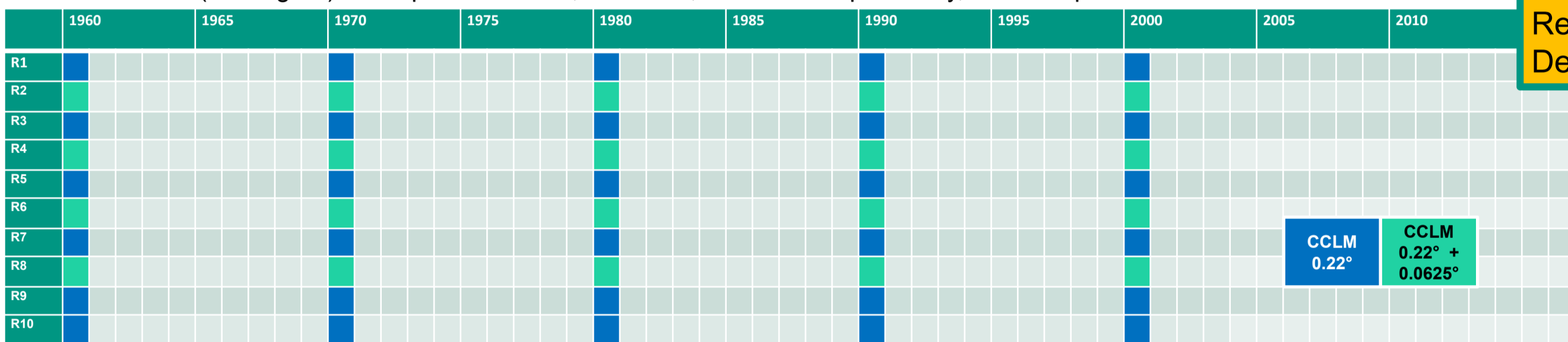
0.44° resolution - annual starting dates, lead time dependency, towards robust skill estimates

Starting years of decadal simulations



Module-C Europe
with contributions from
Regio_Predict, REDCLIP, LACEPS,
DecReg and PRODEF

0.22° resolution (and higher) - comparison DS1/2, extremes, resolution dependency, ens. comp.



Potential Decadal Predictability

Potential for user relevant predictions

- Decadal predictability in Europe originates from low frequency climate variations, especially in the North Atlantic
- Before attempting to forecast: quantify a variable's predictive potential

Several Methods:

- Frequency Analysis (First and second maxima)
- Relative Entropy (Gain of information by using 10-year predictions as opposed to climatology)
- Coherence (Comparison to potential teleconnections)

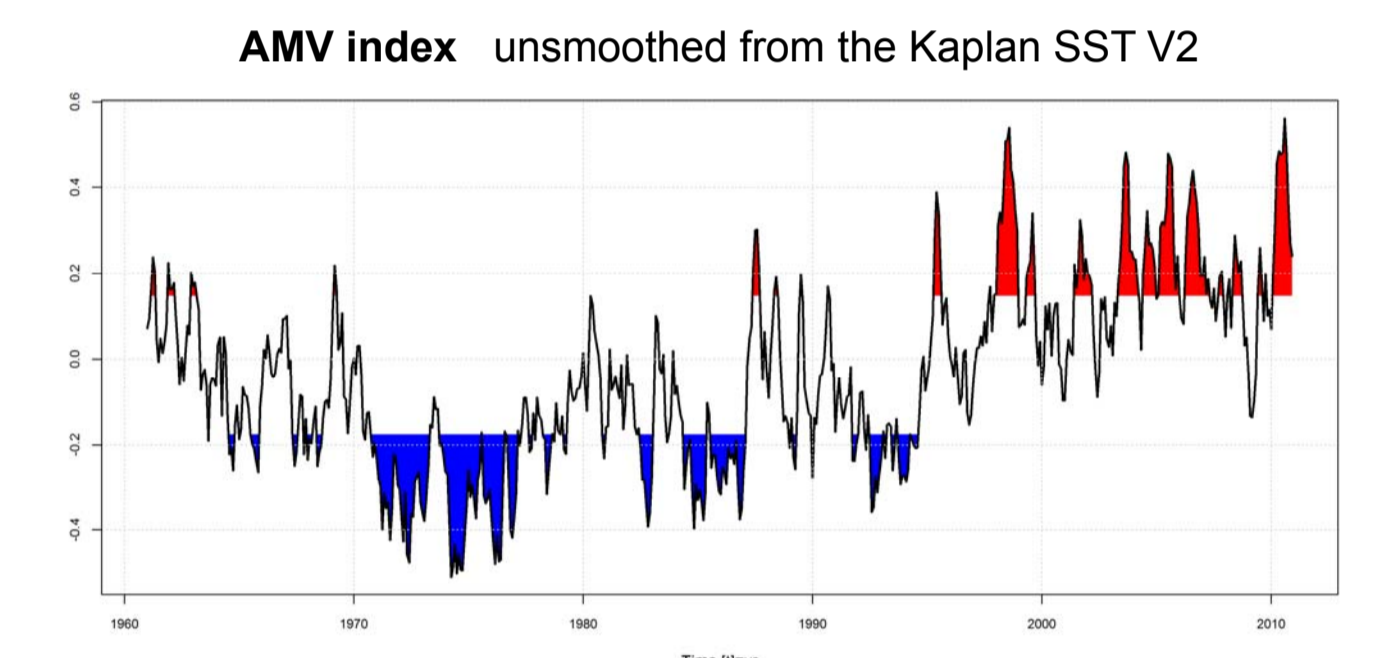
Analysis of Extreme Indices

- Moderate Extremes (about 90th percentile)
- Temperature based or combined Extremes
- Summer Days, Frost Days, Growing Season, 90th Percentile of Precipitation

Teleconnections for Europe and their predictability

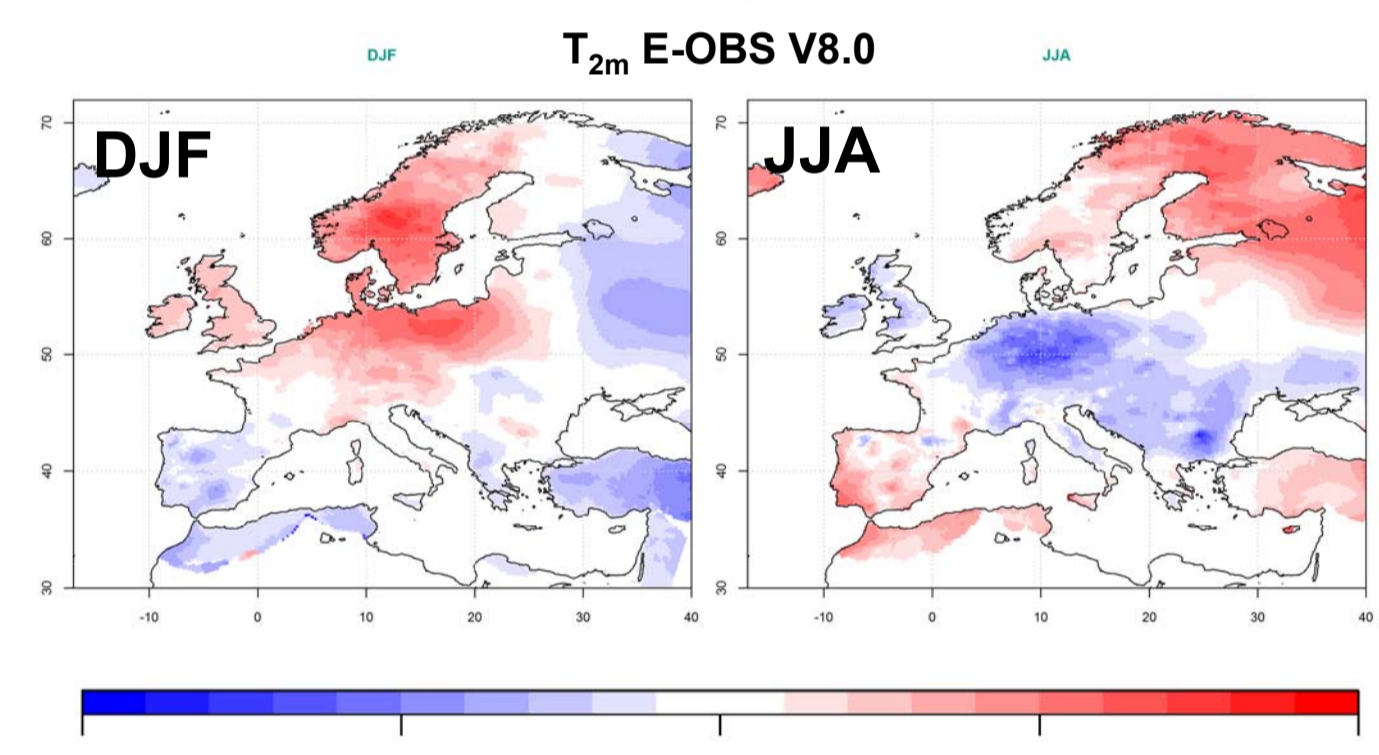
Climate variations on long time scales:

Observed
Atlantic Multidecadal Variability (AMV)
Atlantic SST Index
Shaded: Upper and Lower Quantiles



Influence on atmospheric variables over land:

Observed near surface temperature
Composite differences AMV+/AMV-
E-Obs
Left: DJF, right: JJA



Predictive Skill ...

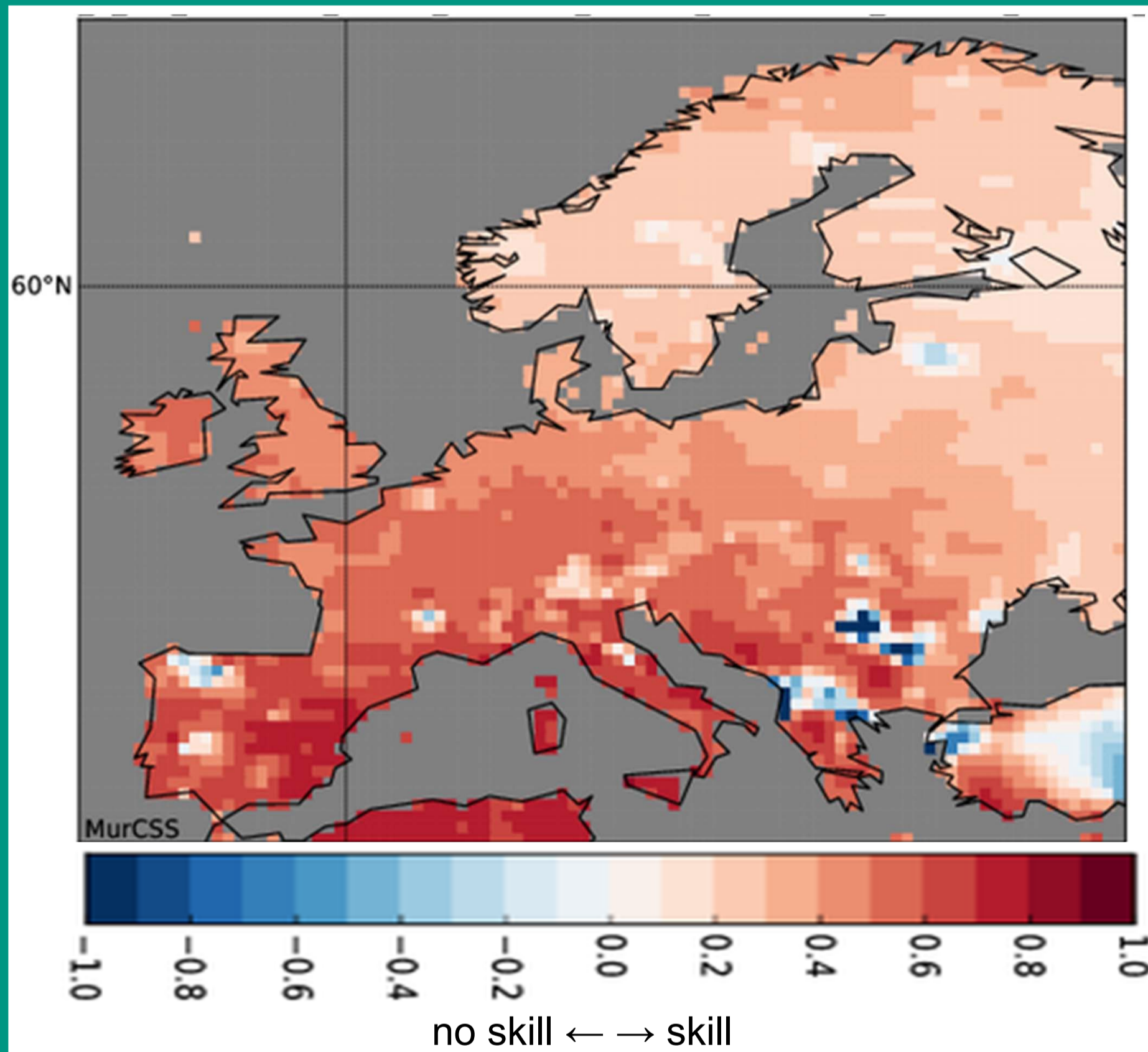
Skill of the RCM ensemble MSESS annual temperature lead-time 2-5 years

CCLM DS2 (baseline1) vs. E-Obs
St.years.:1961 - 2003

Ensemble Verification:

- Accuracy: General agreement with observation
- Anomaly Correlation
- Mean Square Skill Score (MSSS)
- Perfect skill = 1; no skill < 0

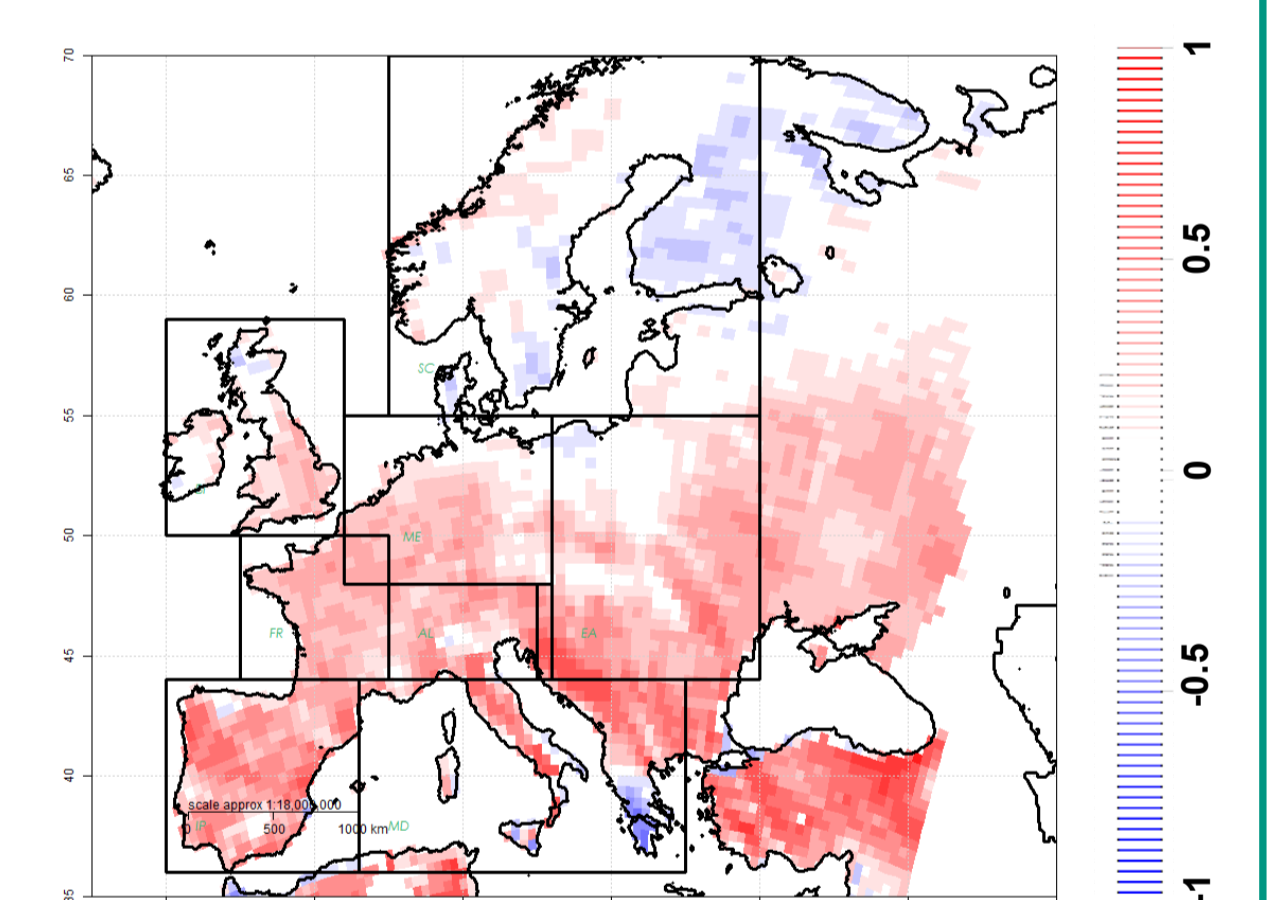
$$MSSS = 1 - \frac{MSE_{est}}{MSE_{ref}}$$



Prediction of (moderate) extremes

Example 1

96th pct. of daily maximum temperature
(hottest two weeks)
Correlation CCLM ensemble
with E-OBS,
Target years 1961-2010



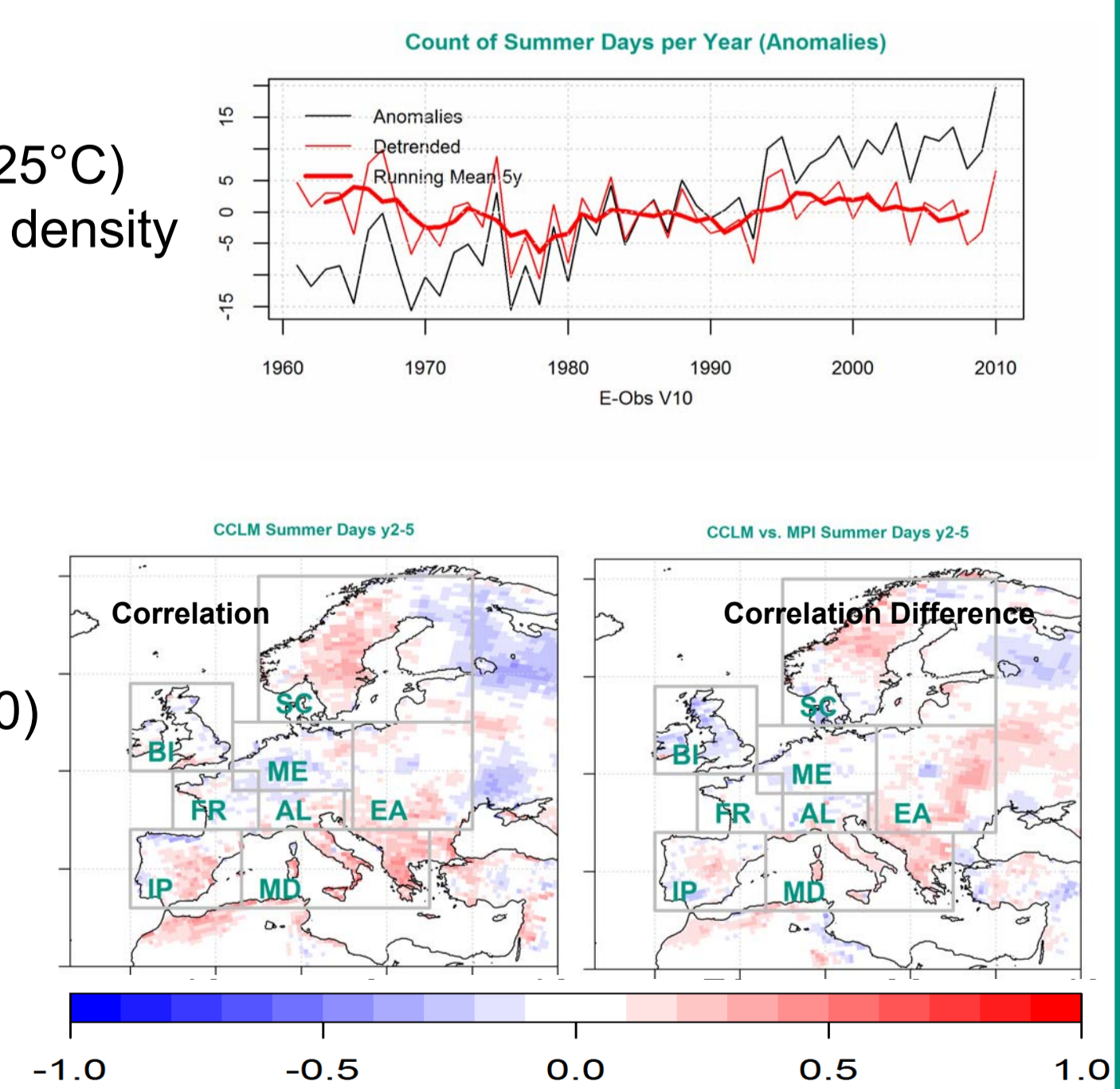
Example 2

E-OBS
Summer Days (SU, T_{max}>25°C)
First 2 maxima of spectral density
at: 2 and 23 years.

$$r(SU(E-Obs), AMO) = 0.64$$

CCLM DS2 EUR-44
(3 Realizations, 1960-2000)

Prediction Skill for Annual
count of Summer Days &
Added Value of
Regionalization

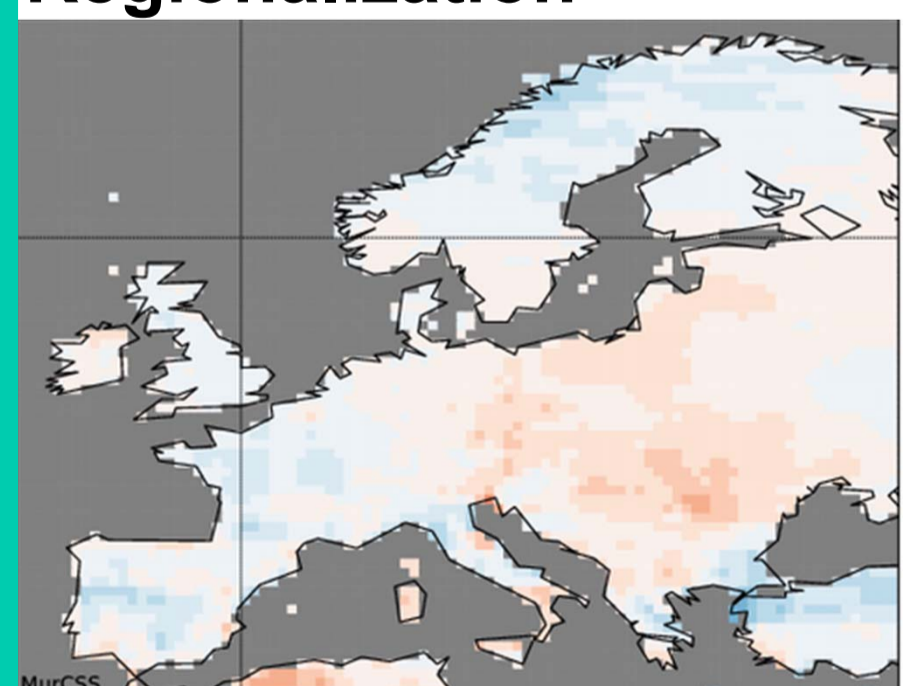


...and Added Value

Annual temperature lead-time 2-5 years

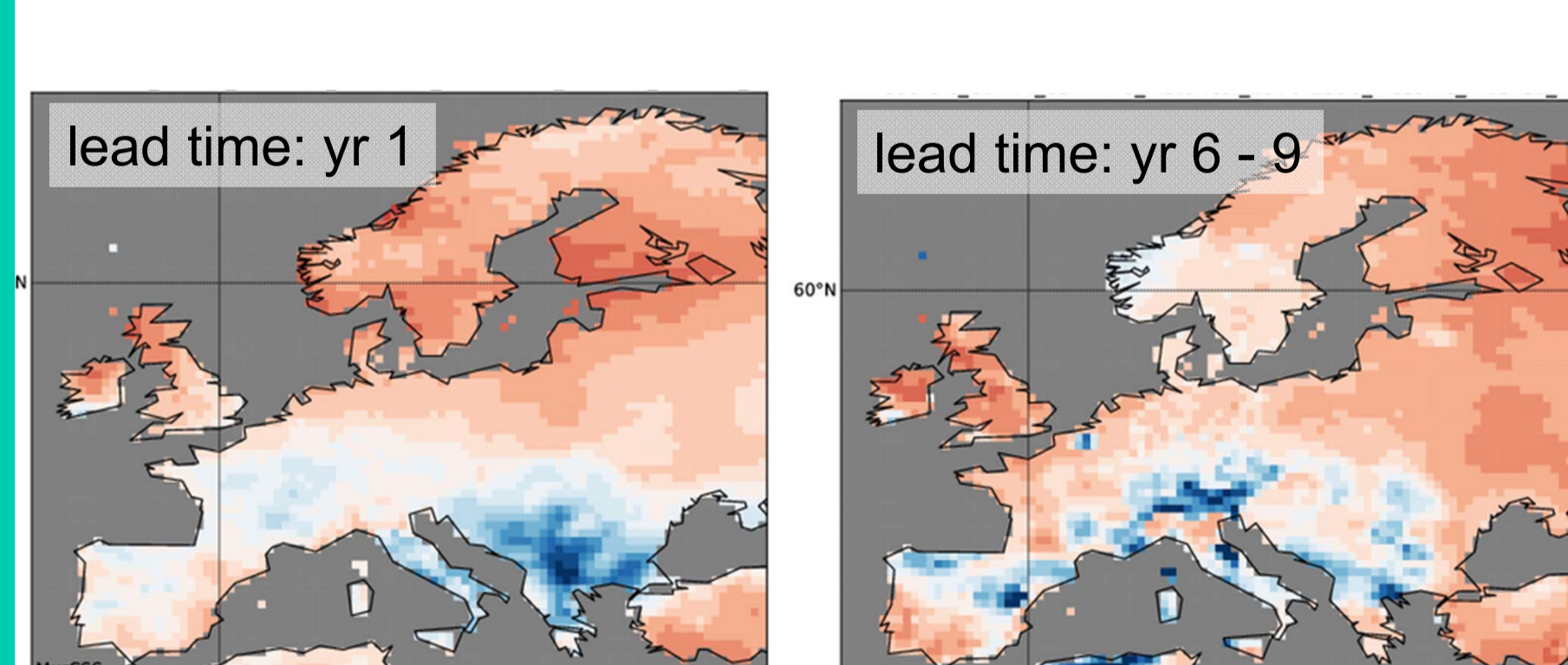
CCLM DS2 (baseline1) vs. E-Obs; 1961 - 2003

Added Value of Regionalization



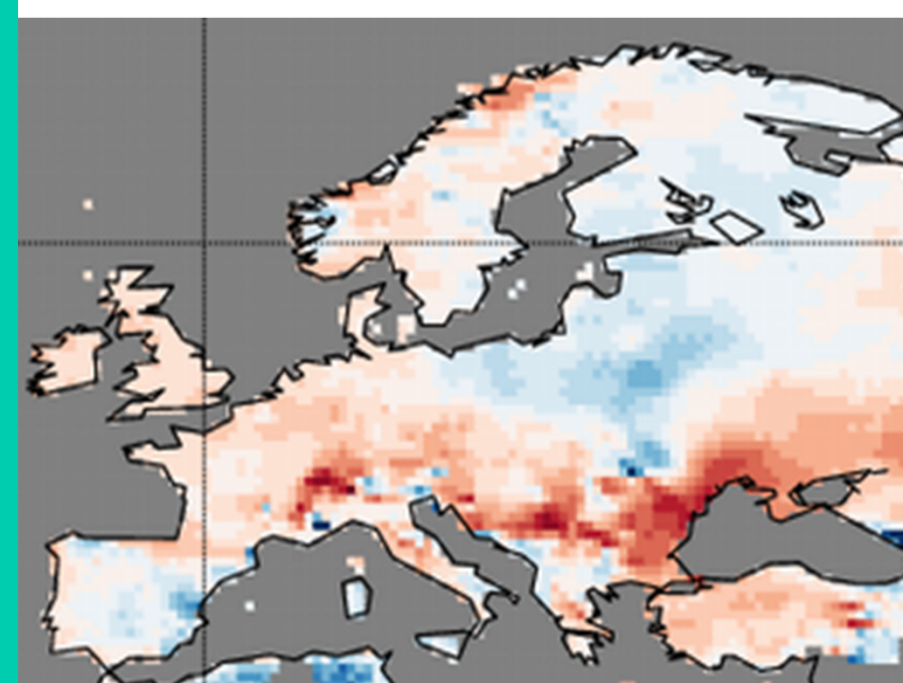
Added value MSSS CCLM DS2 vs MPI-ESM-LR B1

Added Value of Initialization



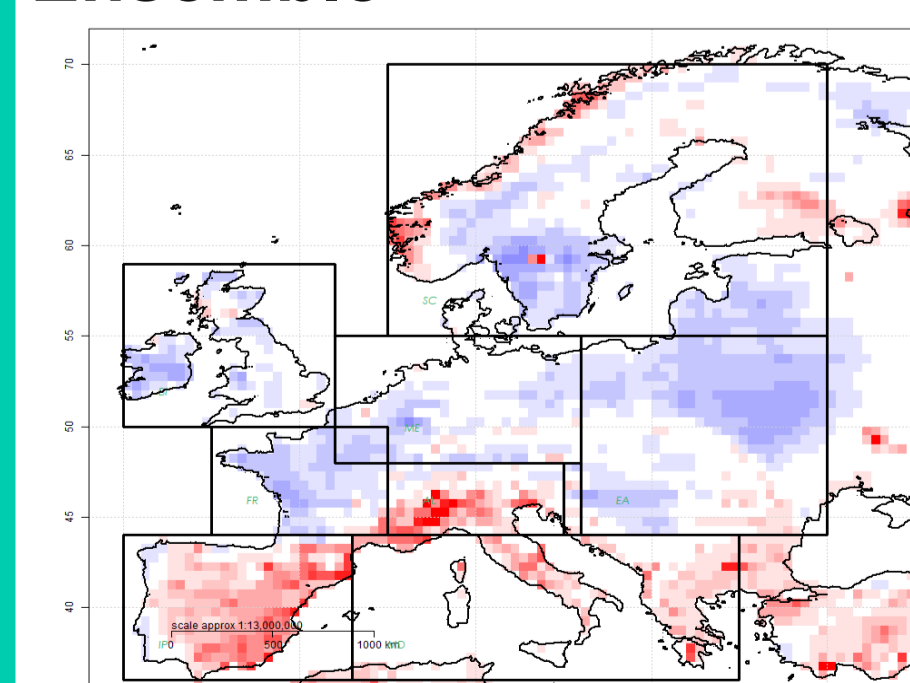
Added value Correlation CCLM DS2 vs CCLM historical 1976 - 1997

Added Value of Increased Resolution



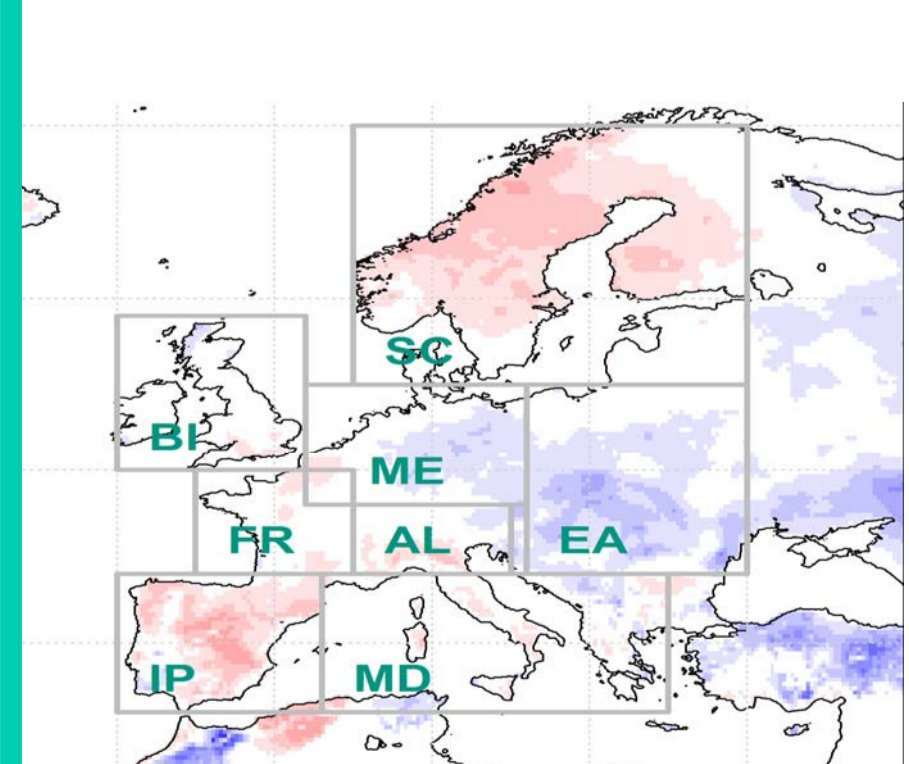
Added value MSSS CCLM DS2 EUR-22 vs CCLM DS2 EUR-44

Added Value of 2-RCM Ensemble

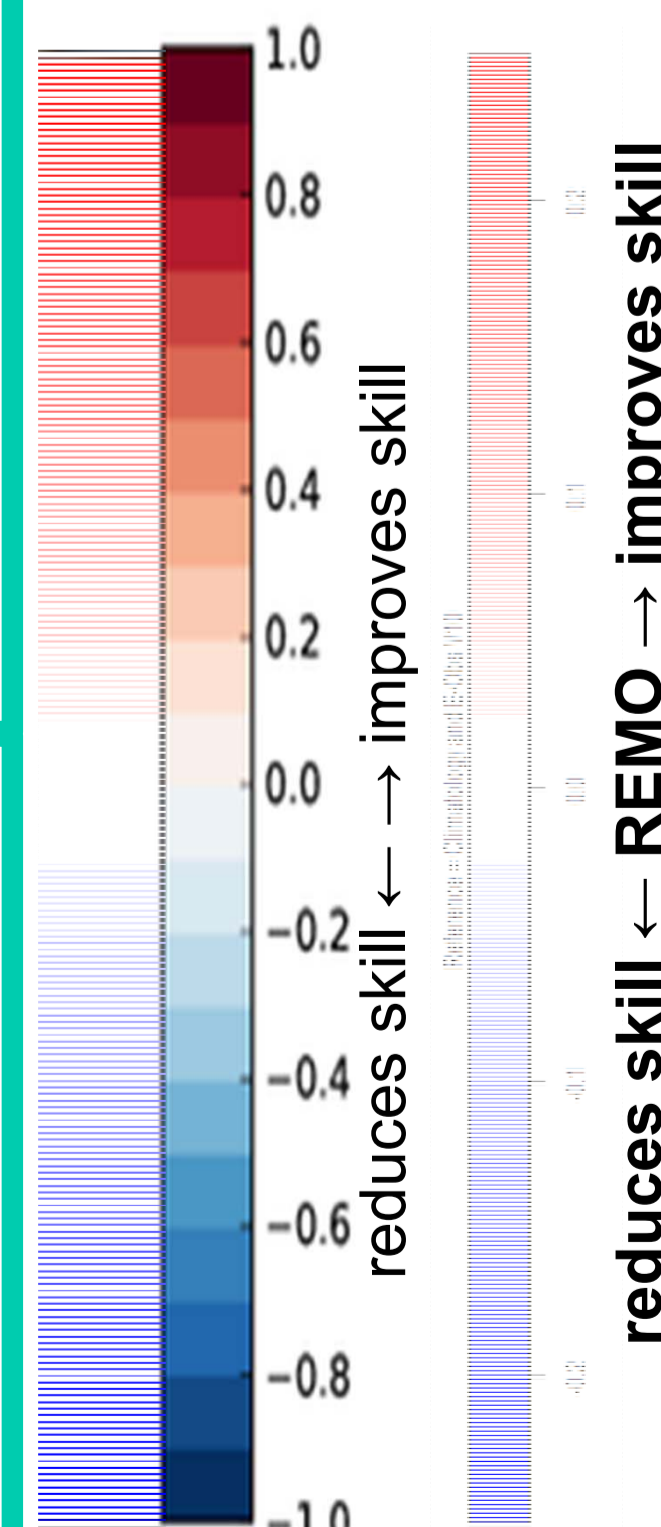


Added value correlation REMO+RCM DS2 vs CCLM

Added Value of DS2



Added value MSSS CCLM DS2 EUR-22 vs CCLM DS1 EUR-22 yr1-5



Publication:

- Khodayar S., A. Sehlinger, H. Feldmann and Ch. Kottmeier, 2014: Sensitivity of soil moisture initialization for decadal predictions under different regional climatic conditions in Europe, Int. J. Climatol., Early Online View, doi:10.1002/joc.4096
- Mieruch, S., H. Feldmann, G. Schädler, C.-J. Lenz, S. Kothe, and C. Kottmeier, 2013: The regional MiKlip decadal forecast ensemble for Europe. Geosci. Model Dev. Discuss., 6, 5711-5745, doi:10.5194/gmdd-6-5711-2013