Karlsruhe Institute of Technology
Deutscher Wetterdienst
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GOETHE UNIVERSITÄT FRANKFURT AM MAIN
University of Cologne
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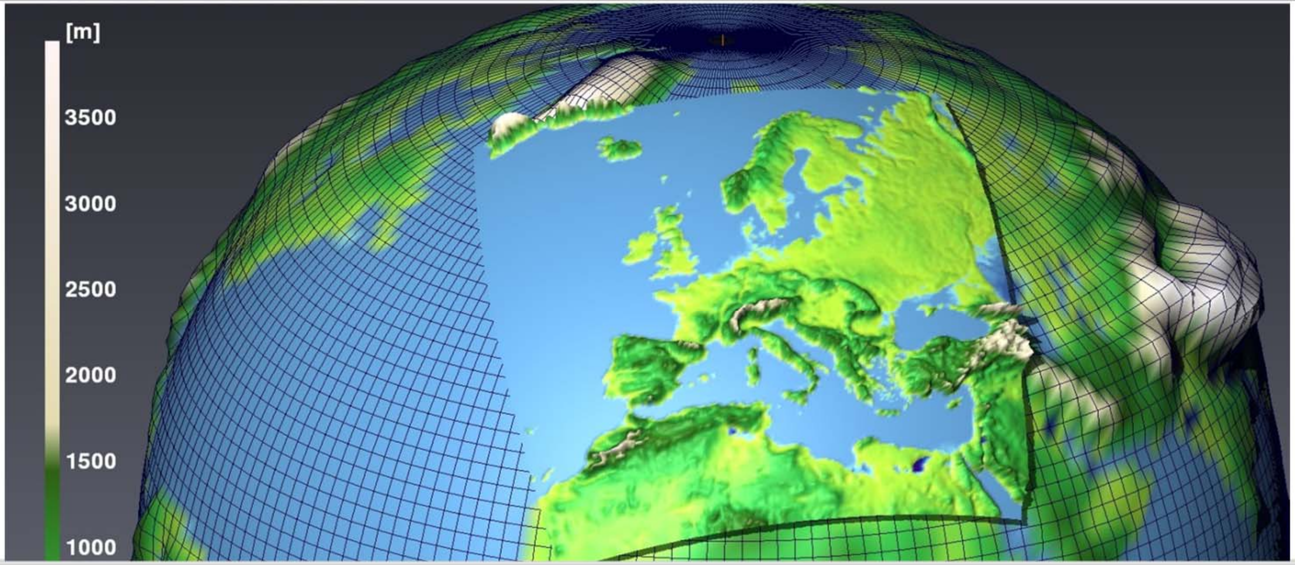
Decadal Predictions for Europe

Hendrik Feldmann and the MiKlip People

COSMO/CLM/ART User Seminar 2016
Offenbach

MiKlip II Module C

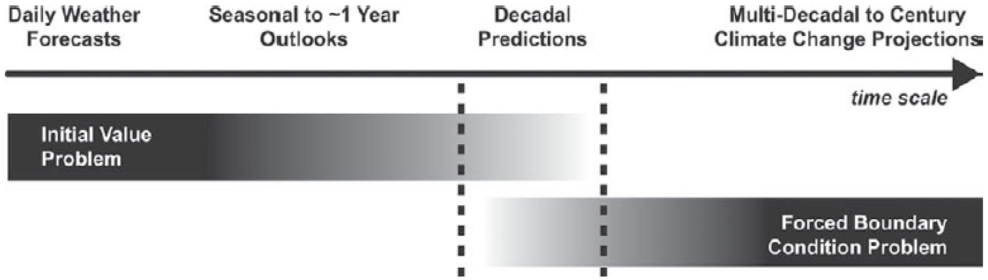


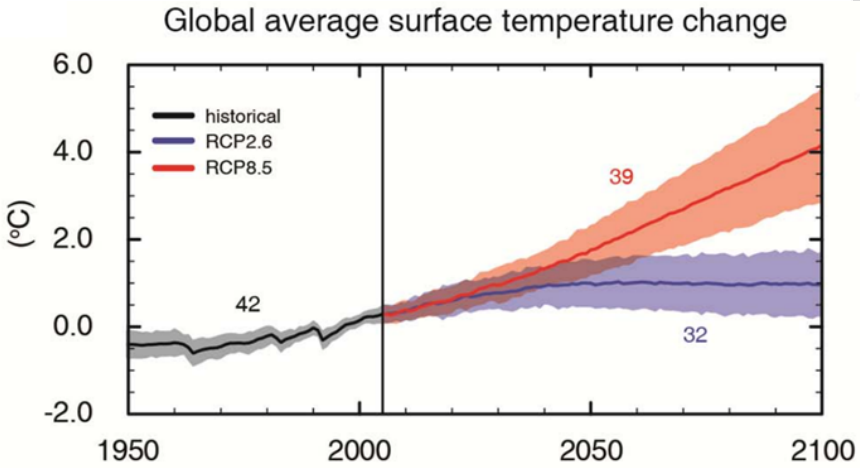
Outline

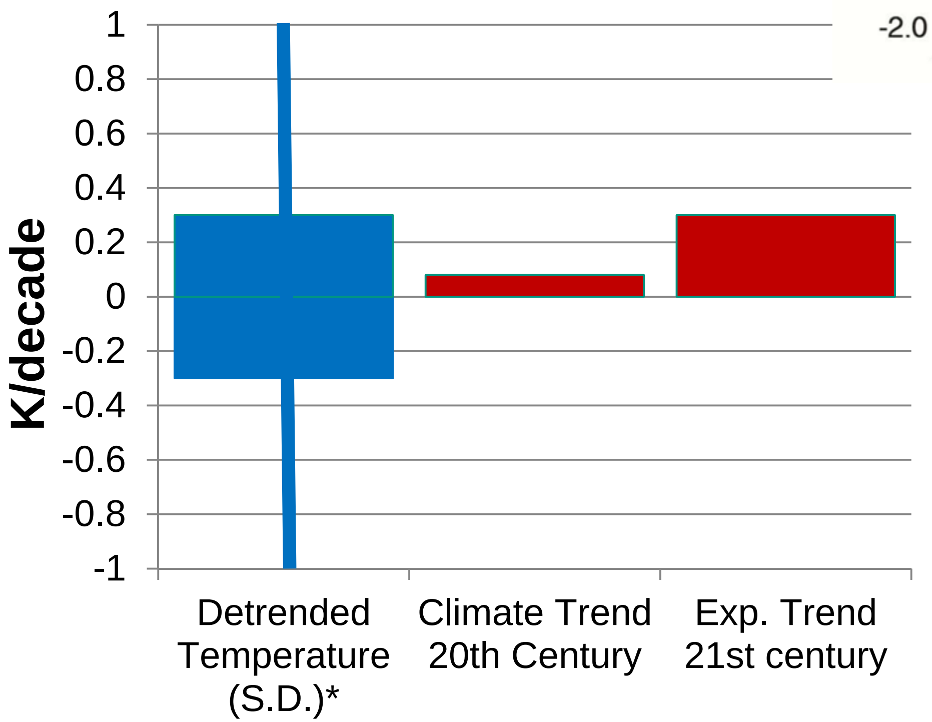
- Predictability for Europe
- The MiKlip Decadal Prediction System
  - Development stages of MiKlip
- What can we expect from regionalized decadal predictions?
  - Examples

Potential Predictability over Europe on Decadal Time-scales

Decadal Change Rates [K/Decade] Europe

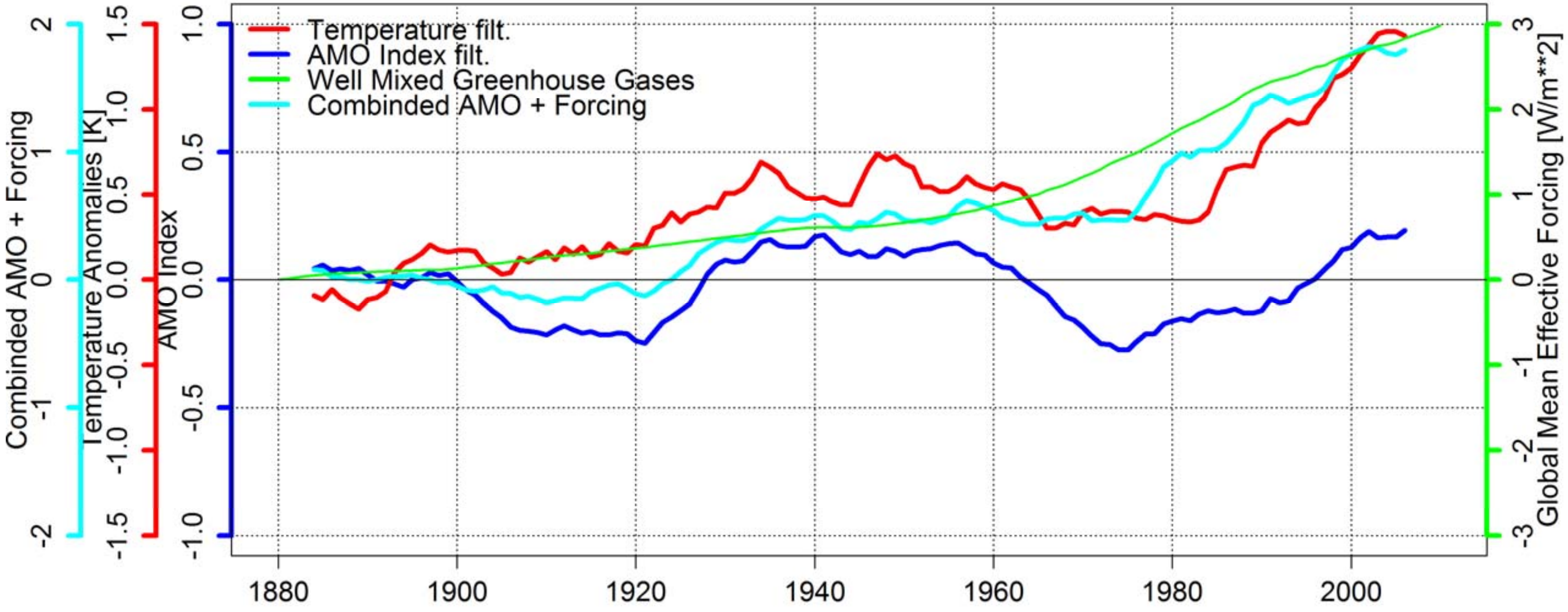






*HadCRUT4 1880-2014 de-trended standard deviation 10yr change rates

Multi-Decadal Variability in Europe Temperature 1880 - 2010



Temperature: HadCRUT4 (9-year mean)
AMO Index: NOAA ESRL (9-year mean)
Forcings: NASA GSFC

Uhlig (2016)

Decadal Prediction Ensembles in MiKlip

MiKlip Ensemble System (Global: MPI-ESM)
Annual Starting Years 1961 – 201x

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Baseline0 b0 (=CMIP5)

- MPI-ESM-LR
  - 3(10) member
- Initialization
  - Ocean: Anomaly T&S from NCEP forced MPIOM
- 1-day time lagged init.

Baseline1 b1

- LR
  - 10 member
- MR
  - 5 member
- Initialization
  - Ocean: Anomaly ORA S4
  - Atmosphere: Full field ERA

Prototype pr

- LR
- 2x15 member
- Initialization
  - Ocean:
    - Full field
      - ORA S4
      - GECCO2
  - Atmosphere:
    - Full field ERA

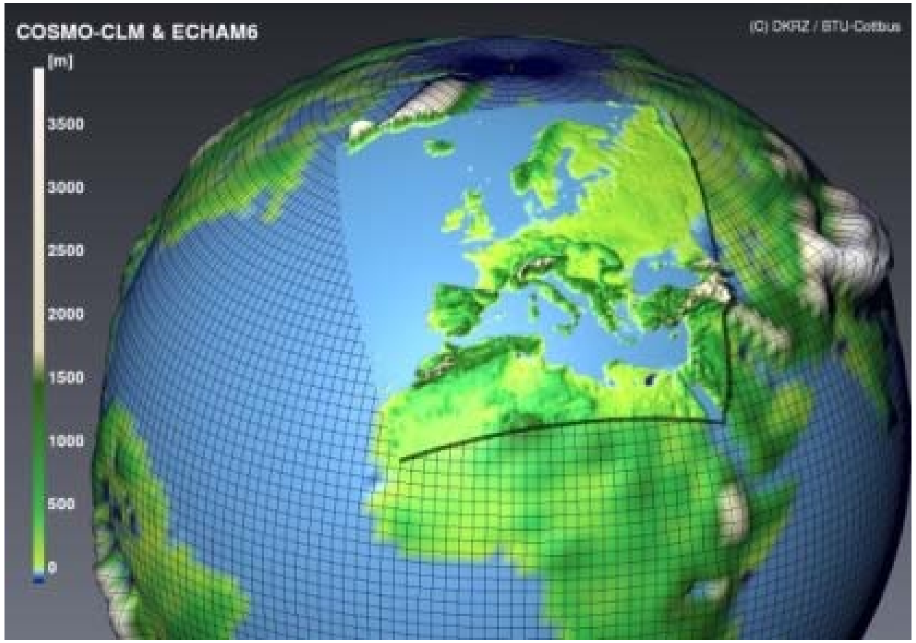
DS4 (planned 2016)

- HR
- 10 member
- Initialization
  - Ocean: Anomaly ORA S5
  - Atmosphere: Full field ERA

MPI-ESM = ECHAM6 + MPI-OM + JSBACH

MPI-ESM-	Atmosphere	Ocean
LR	T63L47	1.5° L40
MR	T63L95	0.4° L40 TP
HR	T127L95	0.4° L40 TP

Regional Downscaling of Initialized Hindcast Ensembles



- Hindcast generations b0, b1
- DS4 Ensemble:
  - CCLM5.0_7
  - CORDEX-EU 0.22°
  - Focus on Europe

- Global forcing: MPI-ESM decadal prediction ensemble
- Annual 10yr hindcasts 1961 – 2012
- Ensemble size up to 10 member
- 2 downscaling methods
  - Dynamical downscaling with 2 RCMs (COSMO-CLM and REMO)
  - Statistical-dynamical downscaling (COSMO-CLM)
- Resolution 0.44°/0.22° (Cordex-EU) and 0.0625° (Central Europe)
- Soil initialization from long-term simulations with ERA forcing
- MiKlip I: Europe, Africa, CANA

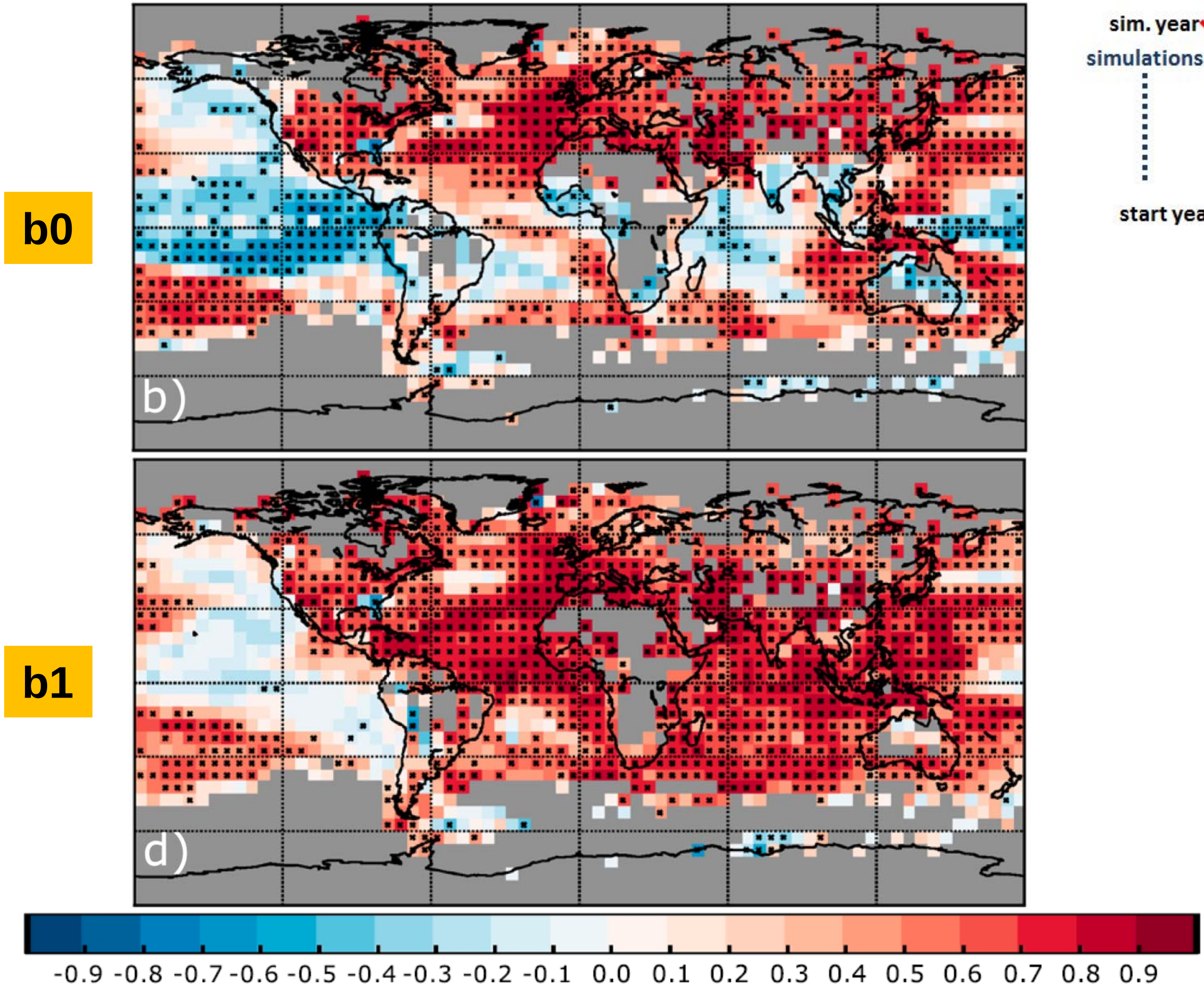
Results:

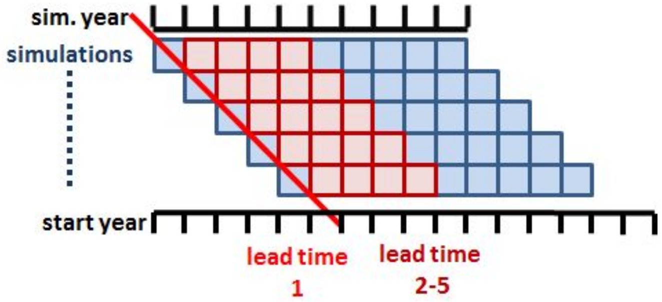
Predictive skill for Europe and added value of downscaling

Hindcast skill of decadal predictions

Annual mean temperature T_{2m} lead years 2-5 (1961-2012)

Anomaly correlation MPI-ESM-LR vs. HadCRUT3v





Pohlmann et al. (2013, GRL)

Hindcast skill of decadal predictions

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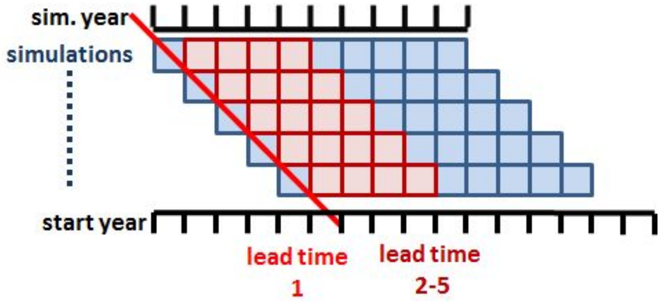
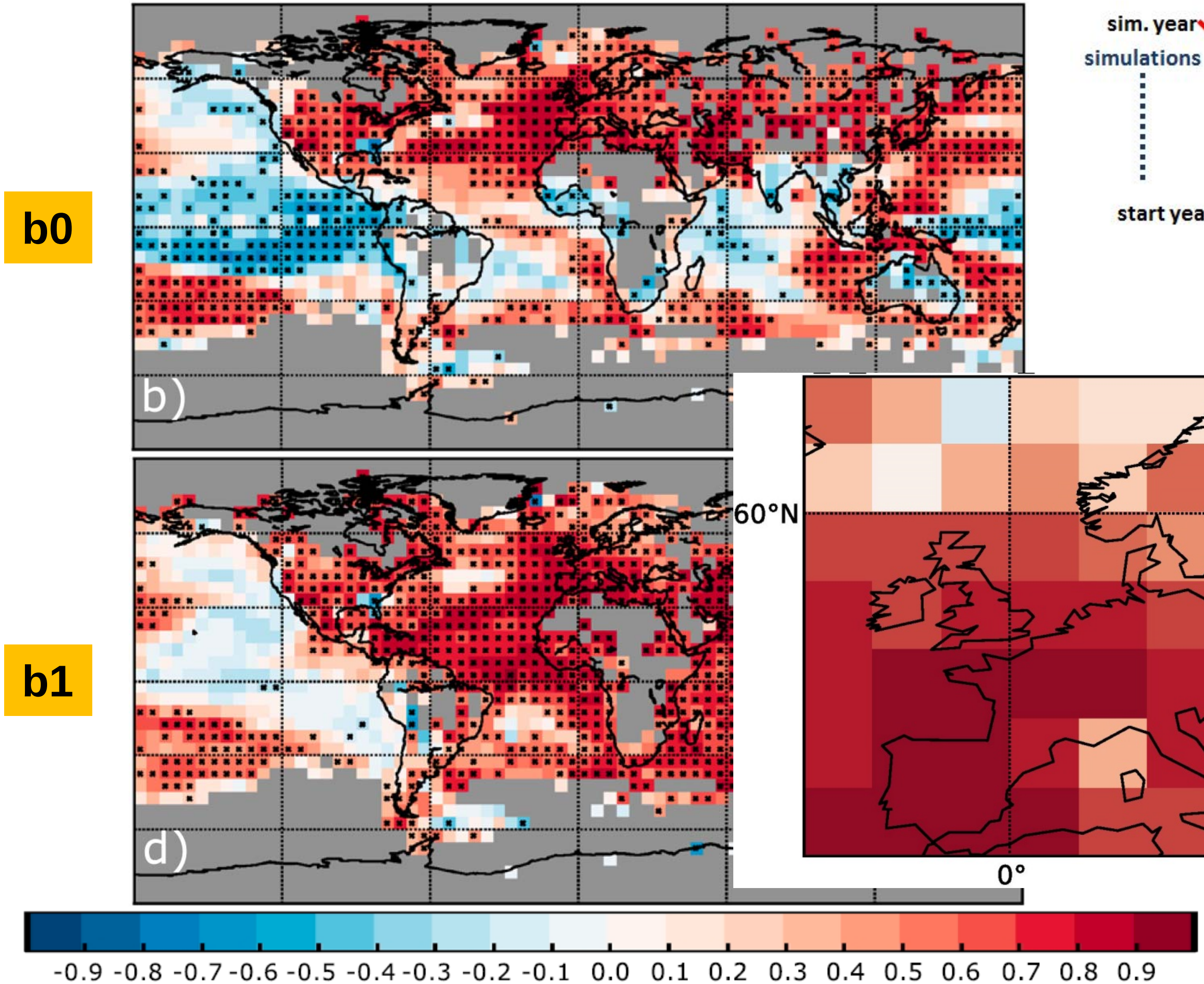
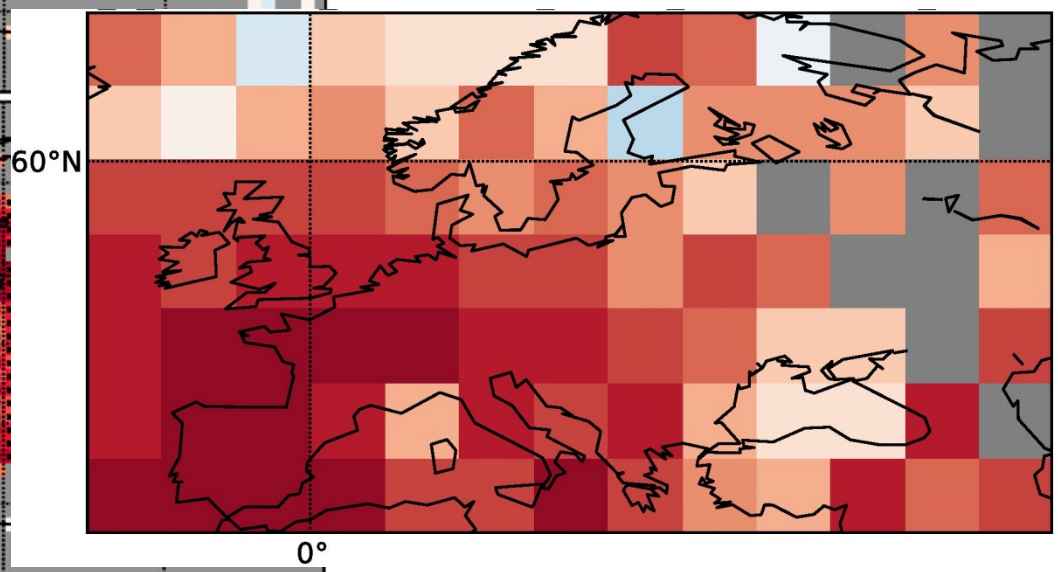


b0

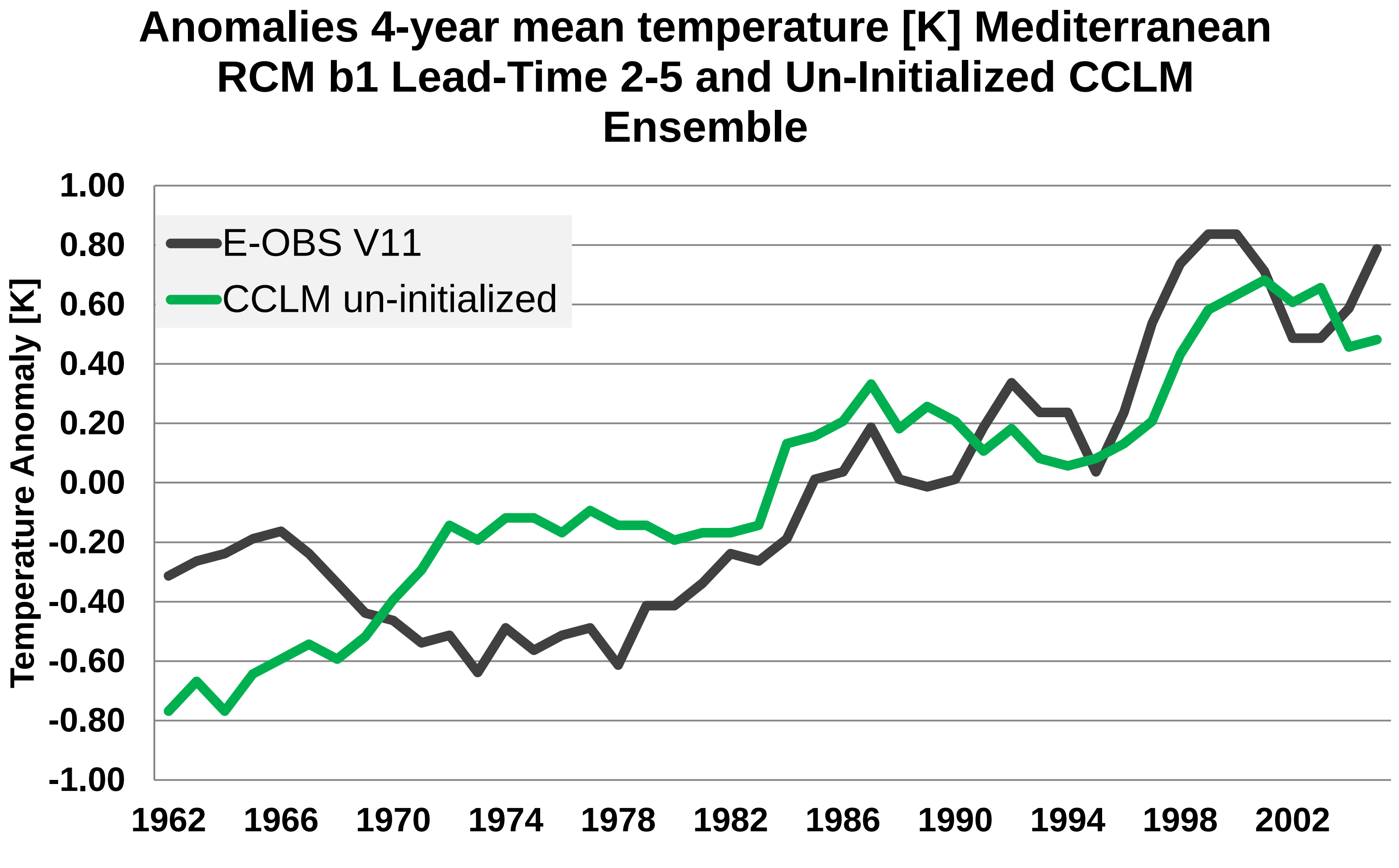
b1





Pohlmann et al. (2013, GRL)

Initialized vs. un-initialized ensembles



CCLM 4.8_17, 0.44°, 7 member, forcing MPI-ESM-LR historical

Initialized vs. un-initialized ensembles

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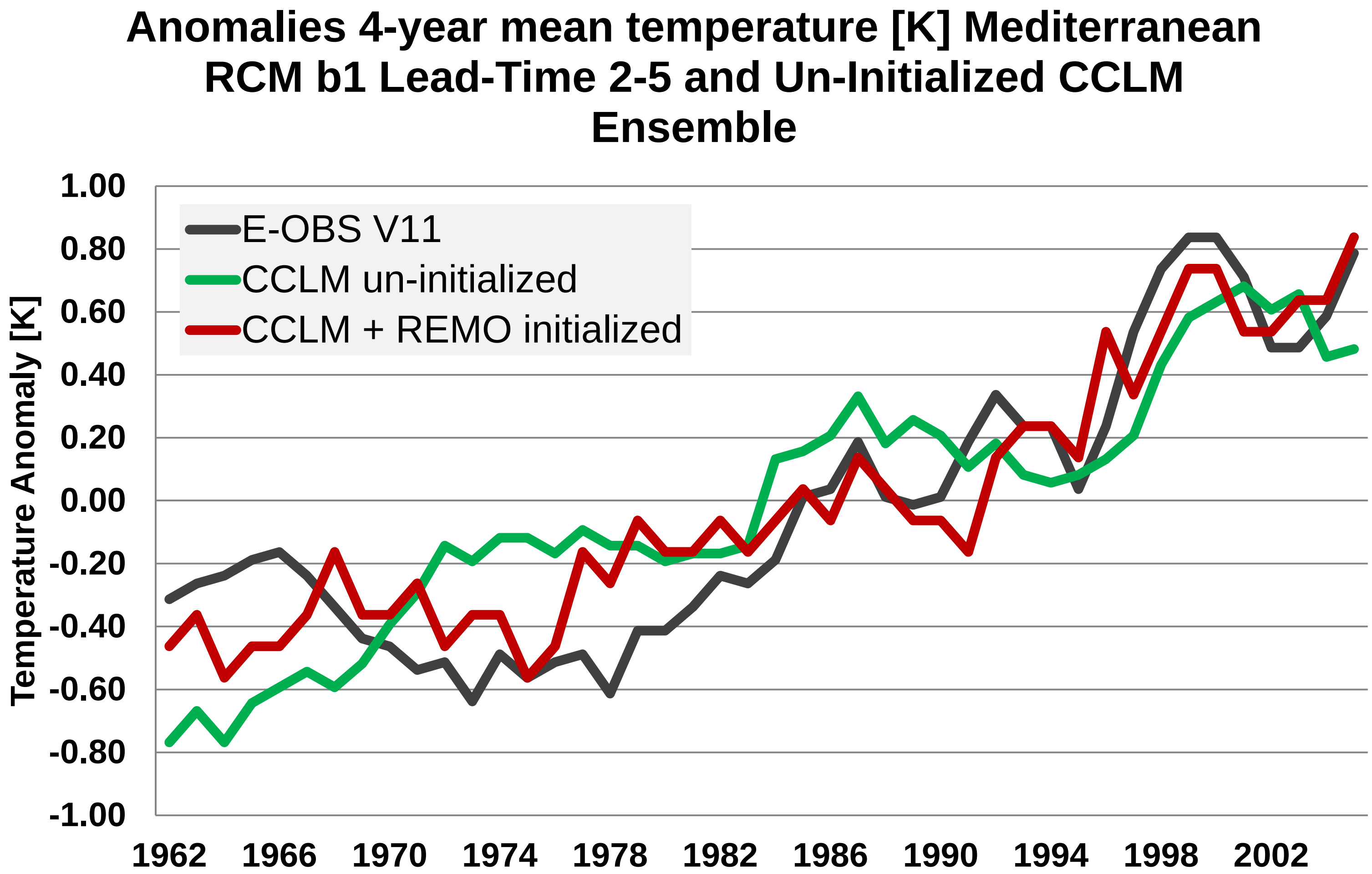
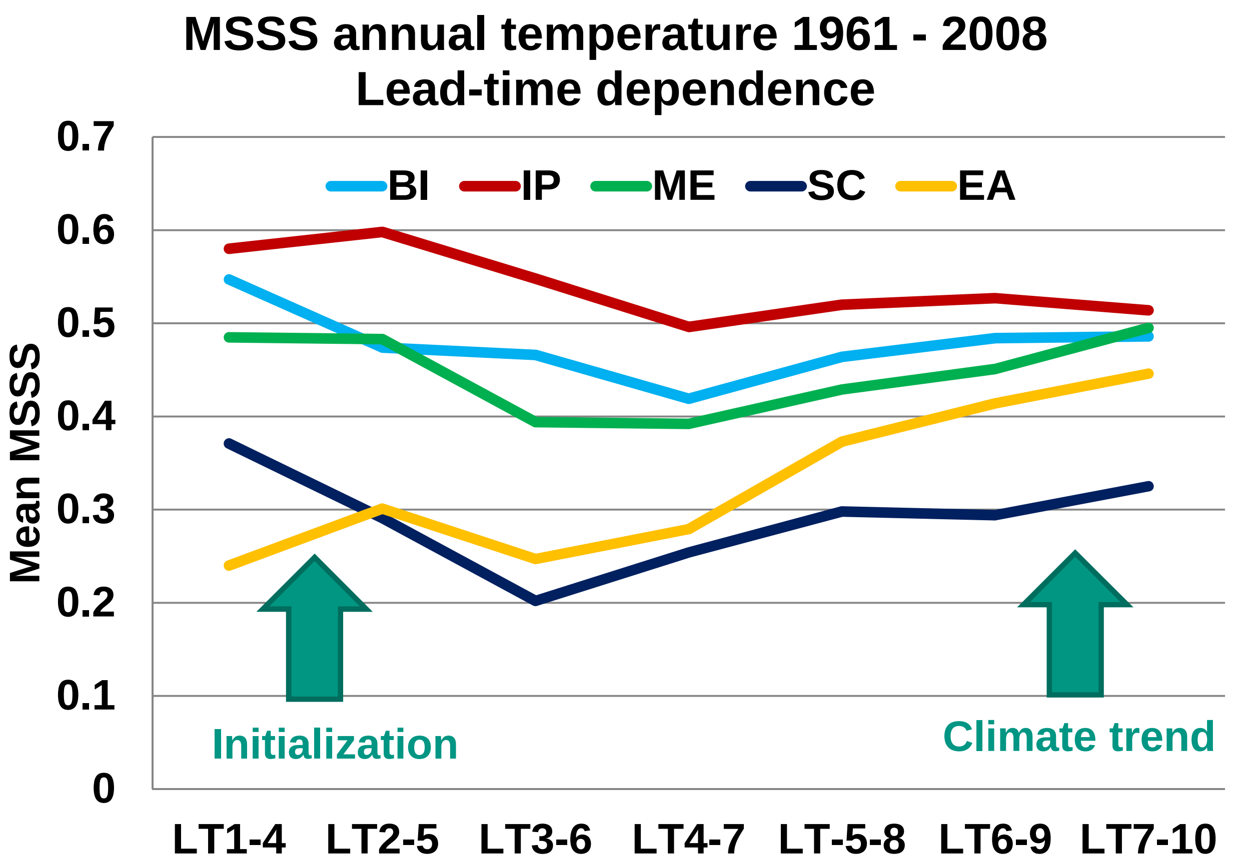


7 member CCLM 4.8_17, 0.44°, forcing MPI-ESM-LR historical

7 member CCLM+REMO, 0.44°, forcing MPI-ESM-LR initialized b1

Regional skill of the RCM ensemble

Example: MSESS annual temperature lead-time 2-5 years
CCLM b1 ensemble; st. yrs 1961 - 2003 vs. E-Obs

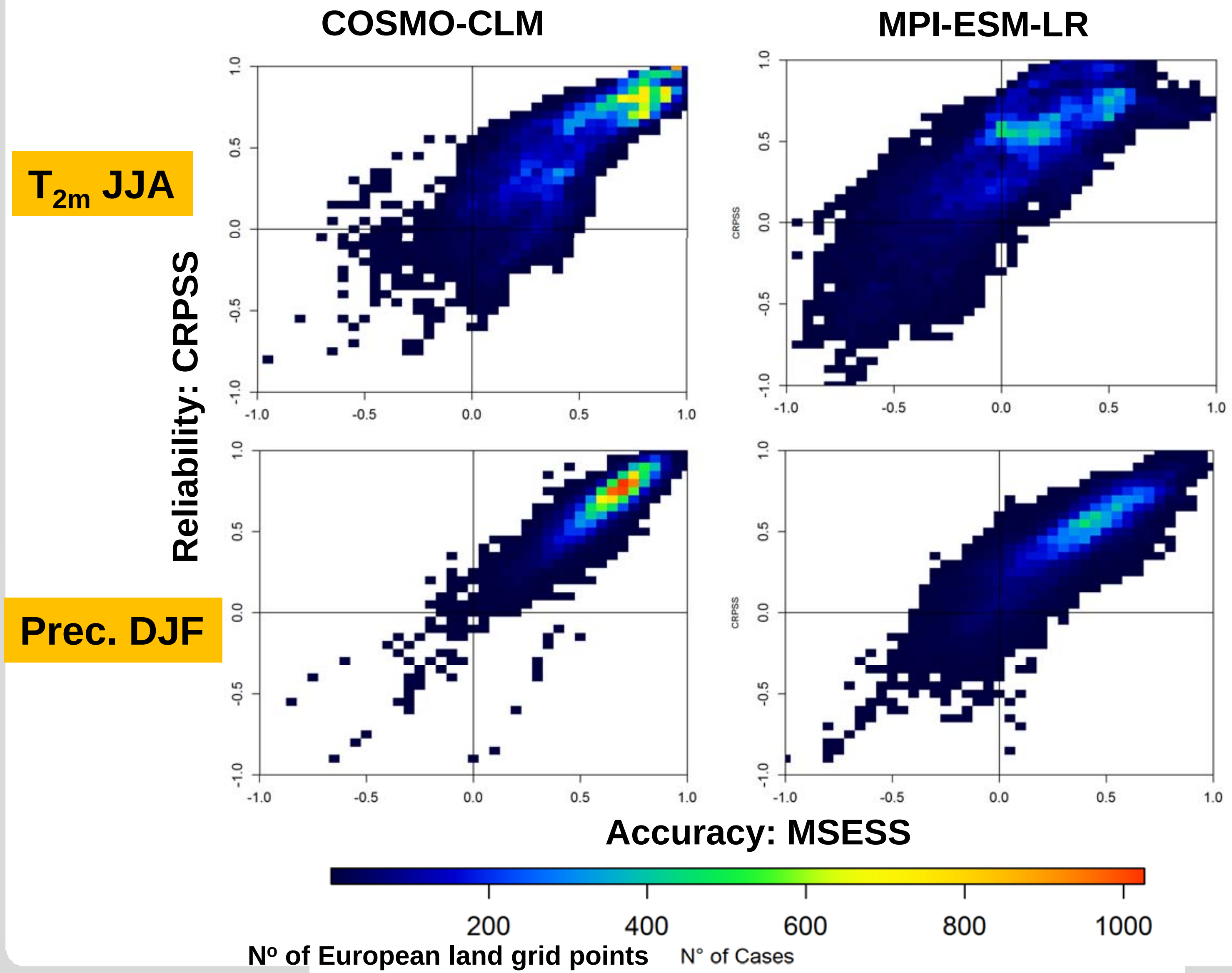


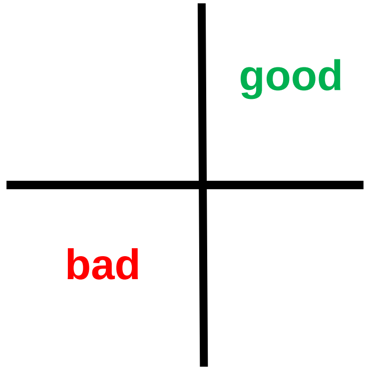
BI	British Isles
IP	Iberian Peninsula
ME	Mid Europe
SC	Scandinavia
EA	Eastern Europe

Regio_Predict, REDCLIP, LACEPS

Added Value of Downscaling

Decadal Hindcasts for Europe 1961 – 2010 (10 member)





Uhlig (2016)

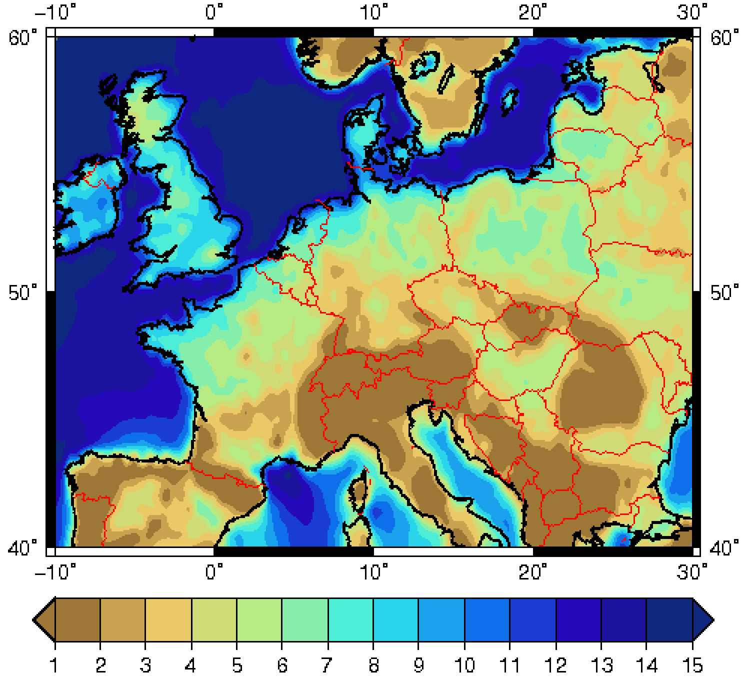
Statistical-Dynamical Downscaling

Example: Wind Energy Potential

PRODEF

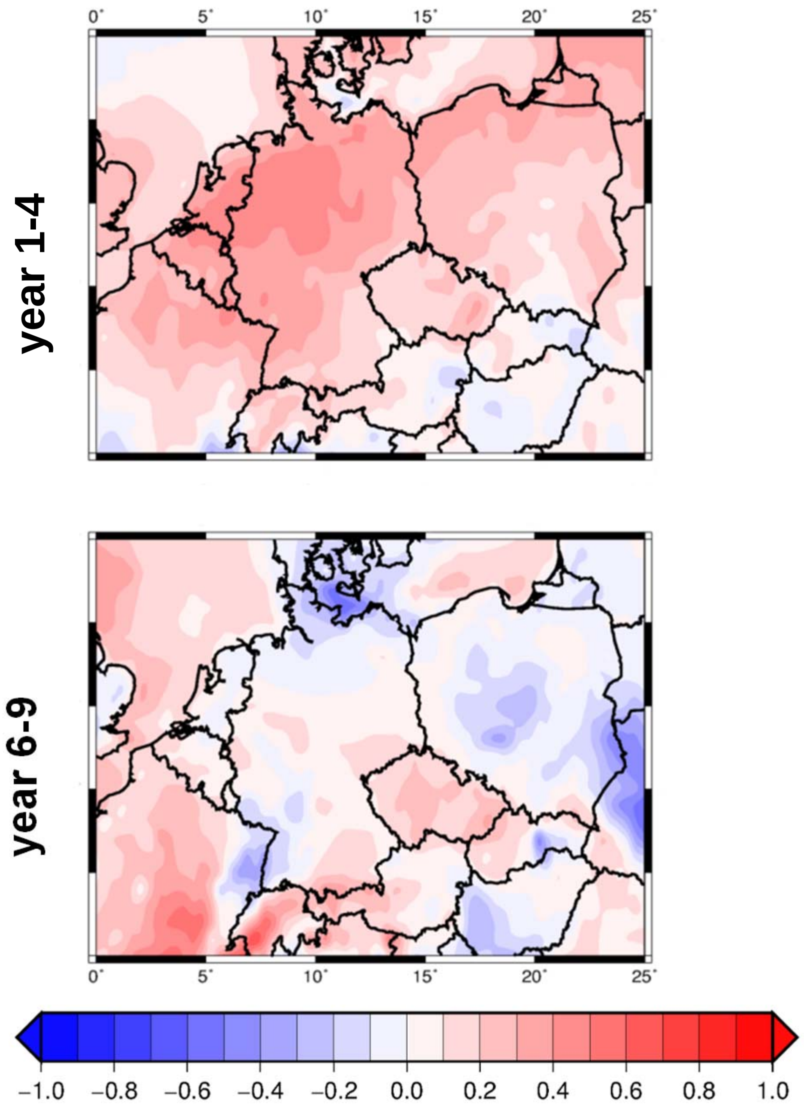
Downscaling all **MPI-ESM** ensemble generations with **CCLM-SDD**

$$E_{out} \sim |v|^3$$



E_{out} [10^3 MWh/year] climatological mean 1979 – 2010
SDD driven with ERAInterim

MSESS Skill Score Period 1979-2005



Reyers et al., Int J Clim, Marotzke et al. (BAMS, 2016)

Conclusions

- Decadal predictions offer an opportunity to test and improve our understanding of (natural) climate variability – important for the detection and attribution of climate change
- It might offer some valuable information several years ahead
- Regional downscaling offers a better link to users of climate information
  - Typically slightly increased accuracy of downscaling compared to the GCM for mean quantities, but often improved reliability
  - For extremes there is a higher potential for added value of regional downscaling (e.g. heavy precipitation, temperature extremes, wind gusts)
  - The downscaling enables additional applications (e.g. wind energy)

Thank you for your attention