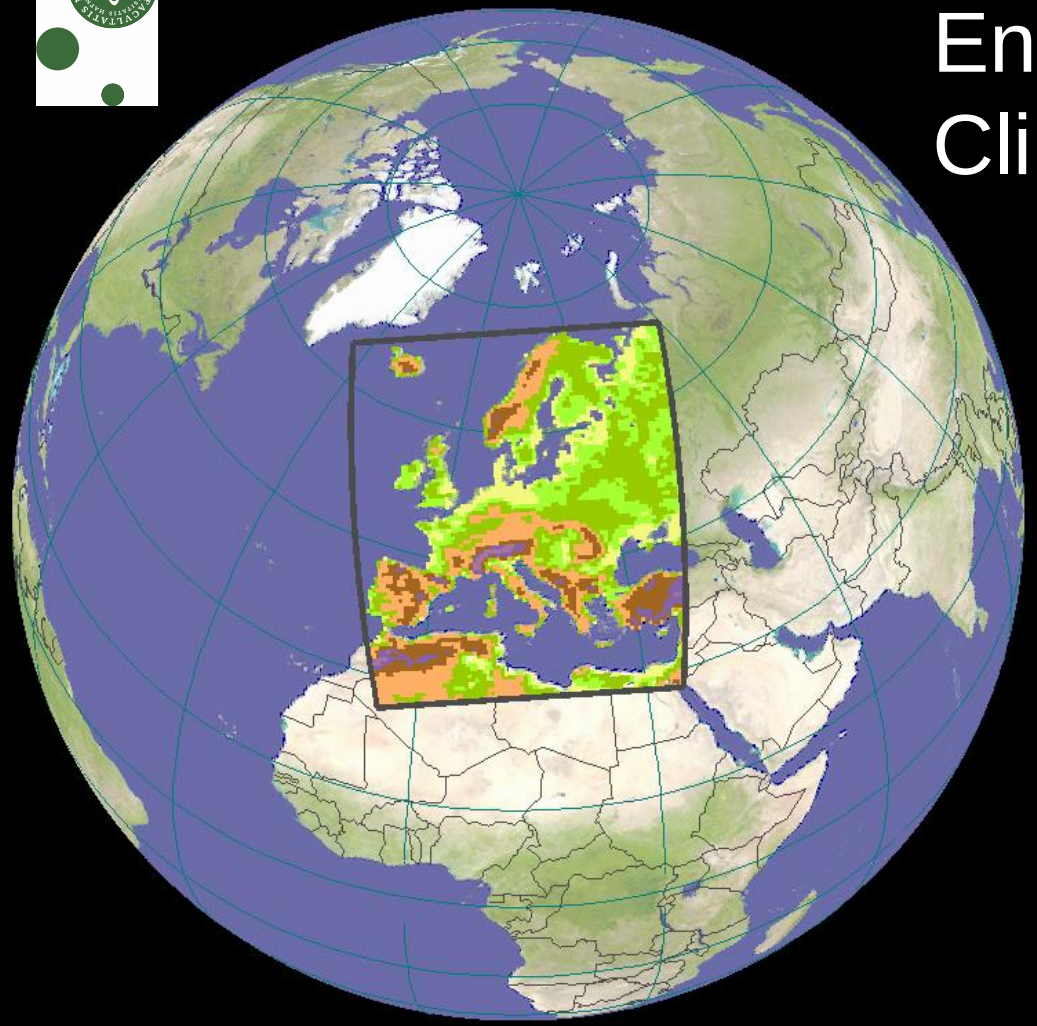


Enhanced Confidence in Regional Climate Projections from Dynamical Down Scaling

Jens H. Christensen & Dominic Matte
Niels Bohr Institute, Uni. of Copenhagen, Denmark
JHC also Danish Meteorological Institute
NORCE Climate, Bergen, Norway

Morten A. D. Larsen & Martin Drews
Technical University of Denmark

Ole B. Christensen & Martin Stendel
Danish Meteorological Institute

5th Nordic Conference on Climate Change Adaptation – Norrköping, Sweden

Enhanced Confidence in Regional Climate Projections from Dynamical Down Scaling

Acknowledging:
ERC
CMIP modellers
RCM modellers
EU FP projects
Co-authors

Jens H. Christensen & Dominic Matte
Niels Bohr Institute, Uni. of Copenhagen, Denmark
JHC also Danish Meteorological Institute
NORCE Climate, Bergen, Norway

Morten A. D. Larsen & Martin Drews
Technical University of Denmark

Ole B. Christensen & Martin Stendel
Danish Meteorological Institute

5th Nordic Conference on Climate Change Adaptation – Norrköping, Sweden

Framing thoughts

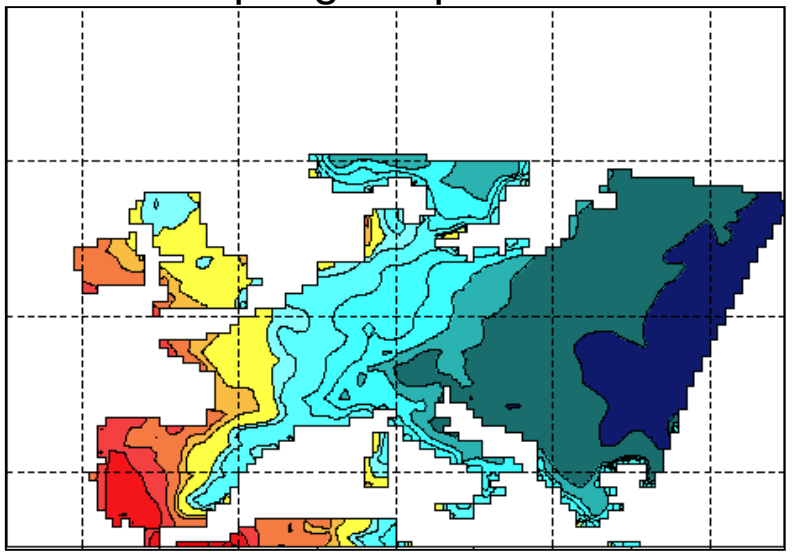
- Looking back
  - Have we changed our minds about future climate?
  - Do we agree more on what to expect?
  - Can we better assess signal-to-noise?
  - Can se see added value in climate change signals due to increased model resolution?
- Looking ahead
  - May we be using ensembles in a wiser way?
  - Distilling information from the GCM/RCM/RCP matrix better

Regional climate simulations 25 years ago

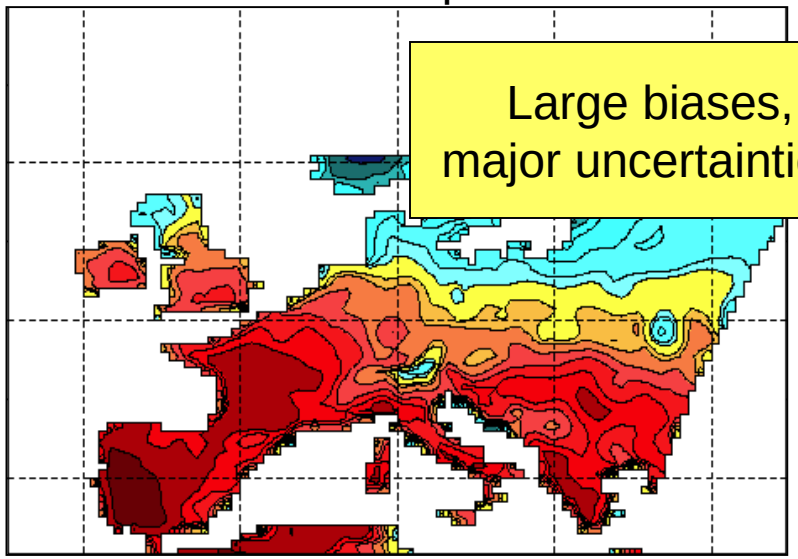
ECHAM4 (T42, 250 km) => RegCM2 (70 km)

Bias of control run (CTRL-CRU), 5 years

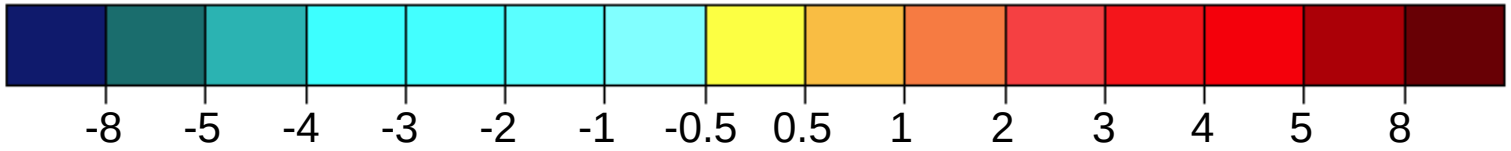
Spring temperature



Summer temperature



Large biases,
major uncertainties!



With thanks to
Christoph Schär

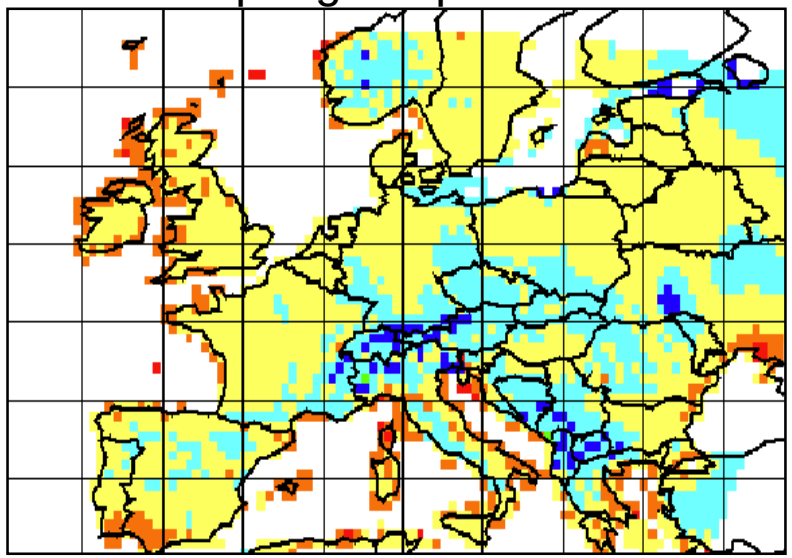
EU Projects REGIONAL and RACCS (1992-1996); Machenhauer et al. (1998, MPI-Report 275)

Climate simulations 15 years ago

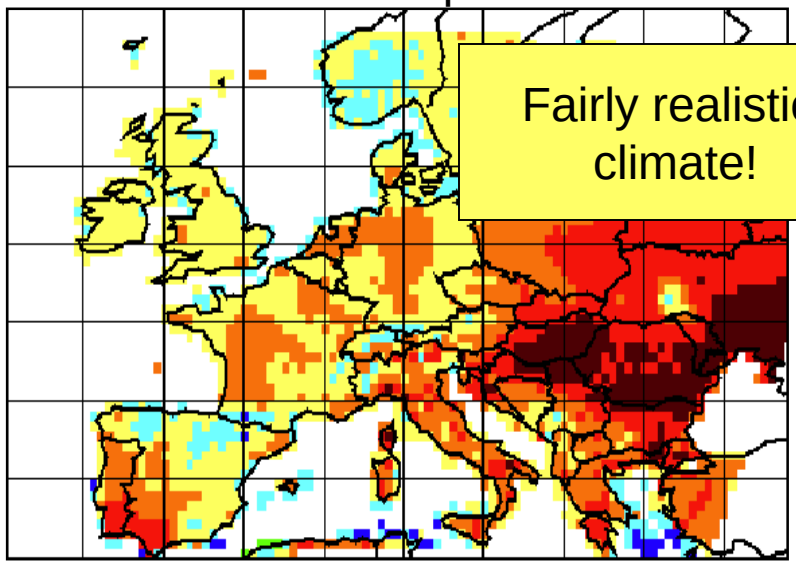
HadAM3 (120 km) => PRUDENCE Regional Models (50 km)

Bias of control run (CTRL-CRU), 30 years

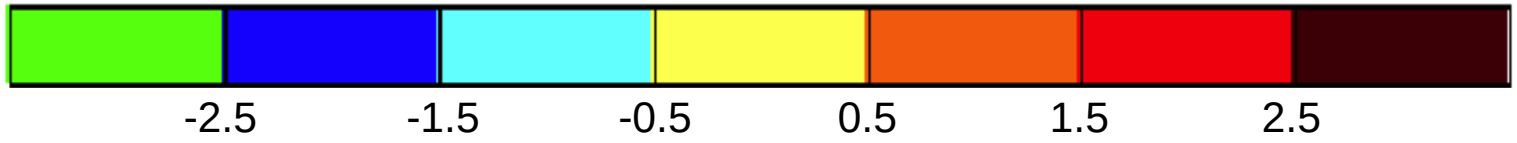
Spring temperature



Summer temperature



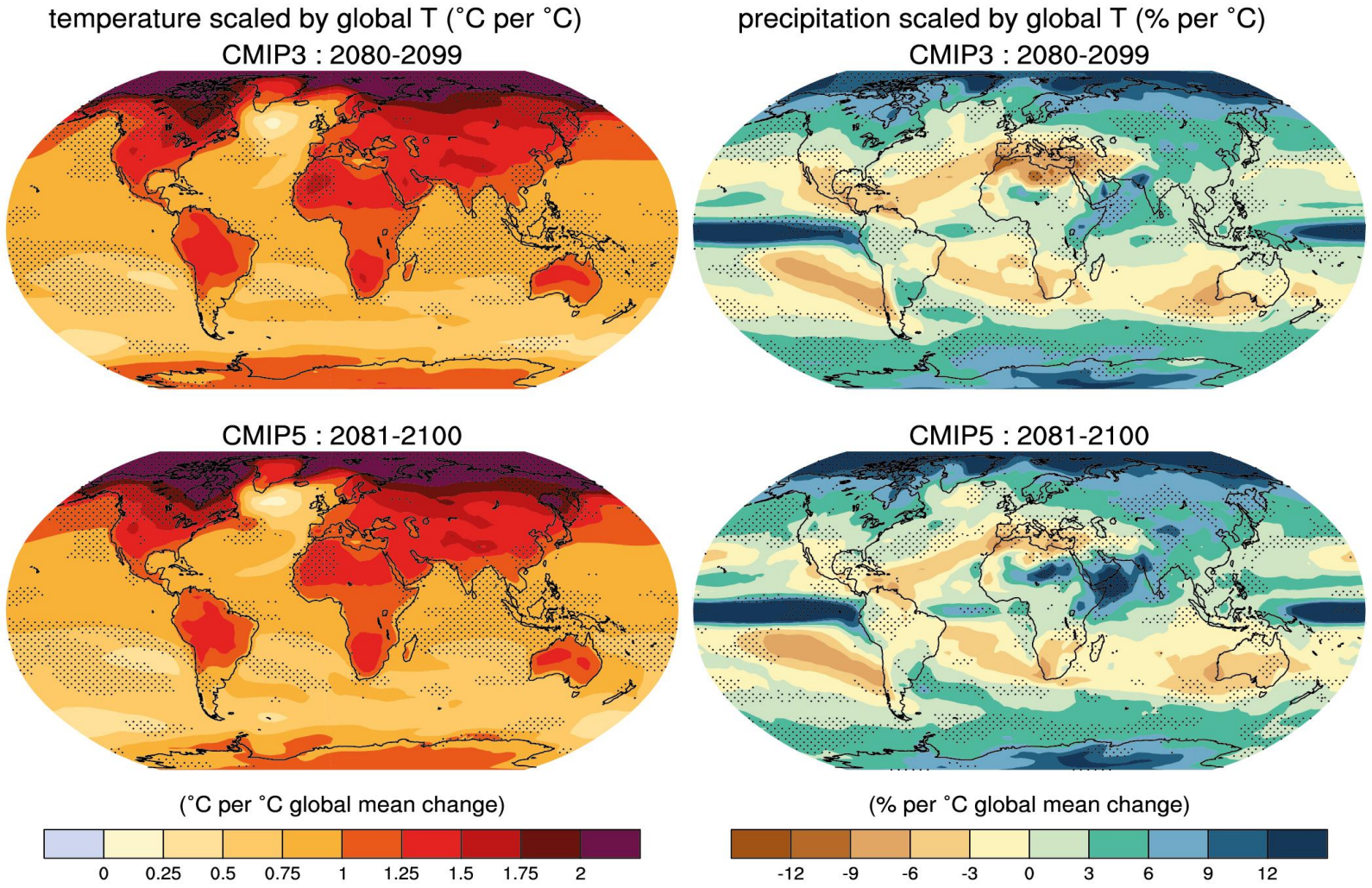
Fairly realistic climate!



How to compare PRUDENCE-ENSEMBLES-CORDEX?

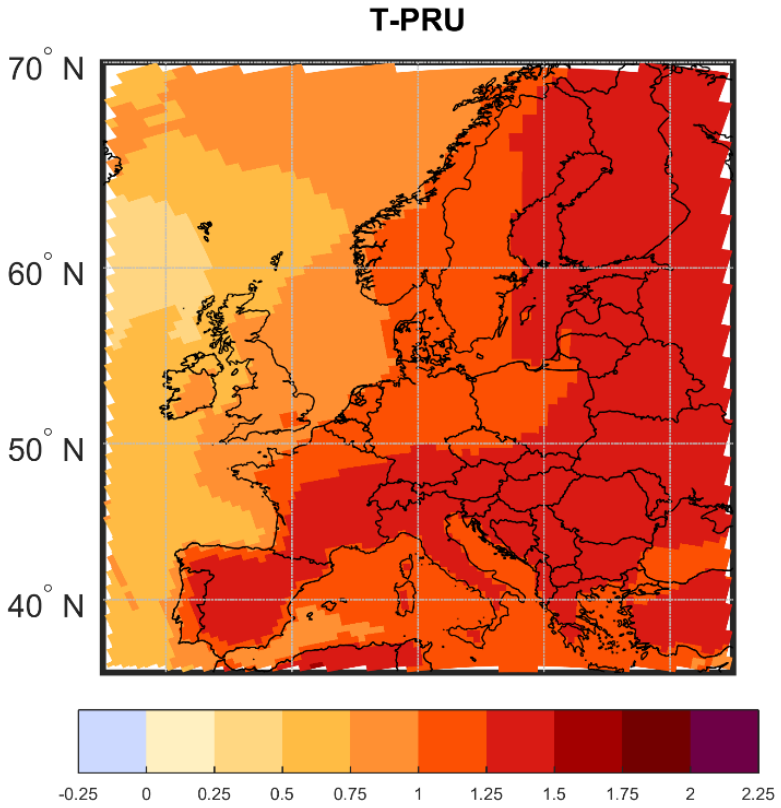
- PRUDENCE (2001-2004):
  - 30 year time slices
  - 50 km grid size
  - SRES A2 and B2
  - 2 GCMs (HadAM3H and ECHAM4/OPYC); 6(7) RCMs
- ENSEMBLES (2004-2009):
  - Transient 1960-2100 (some only 2050)
  - 25 km grid size
  - SRES A1B
  - 8 GCMs; 16 RCMs; sparsely filled RCM/GCM matrix
- (Euro)CORDEX (2009-ongoing) + (PRINCIPLES and CORDEX4CDS):
  - Transient
  - 12km – 50km
  - (RCP2.6), RCP4.5, RCP8.5
  - Multiple GCMs and RCMs – many runs available and still counting

Climate change in AR5: CMIP5 vs. CMIP3



Climate change in PRUDENCE-ENSEMBLES-CORDEX

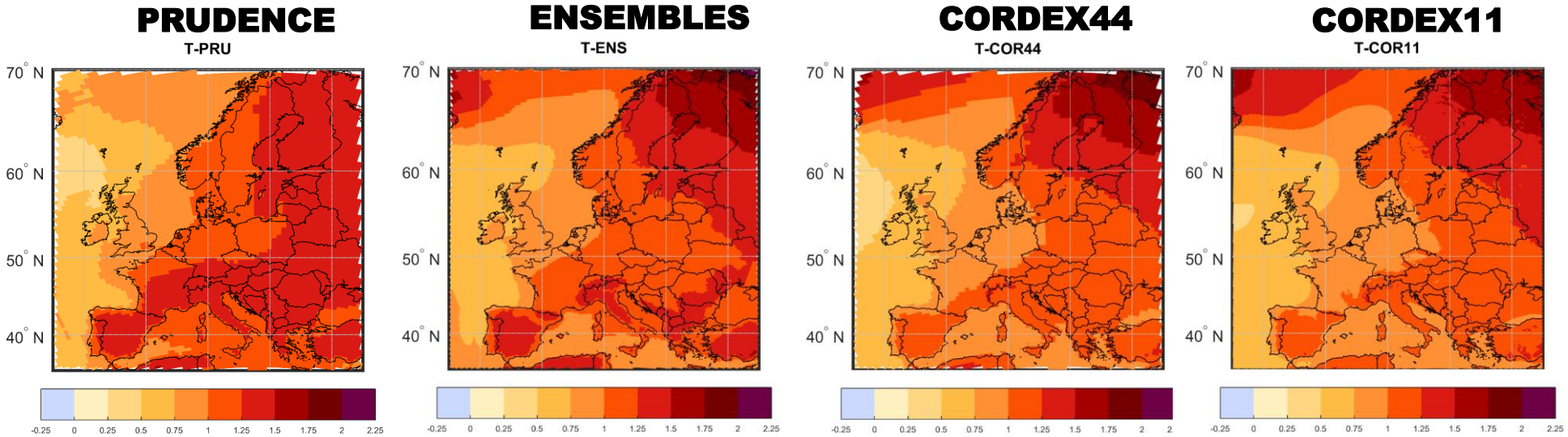
PRUDENCE



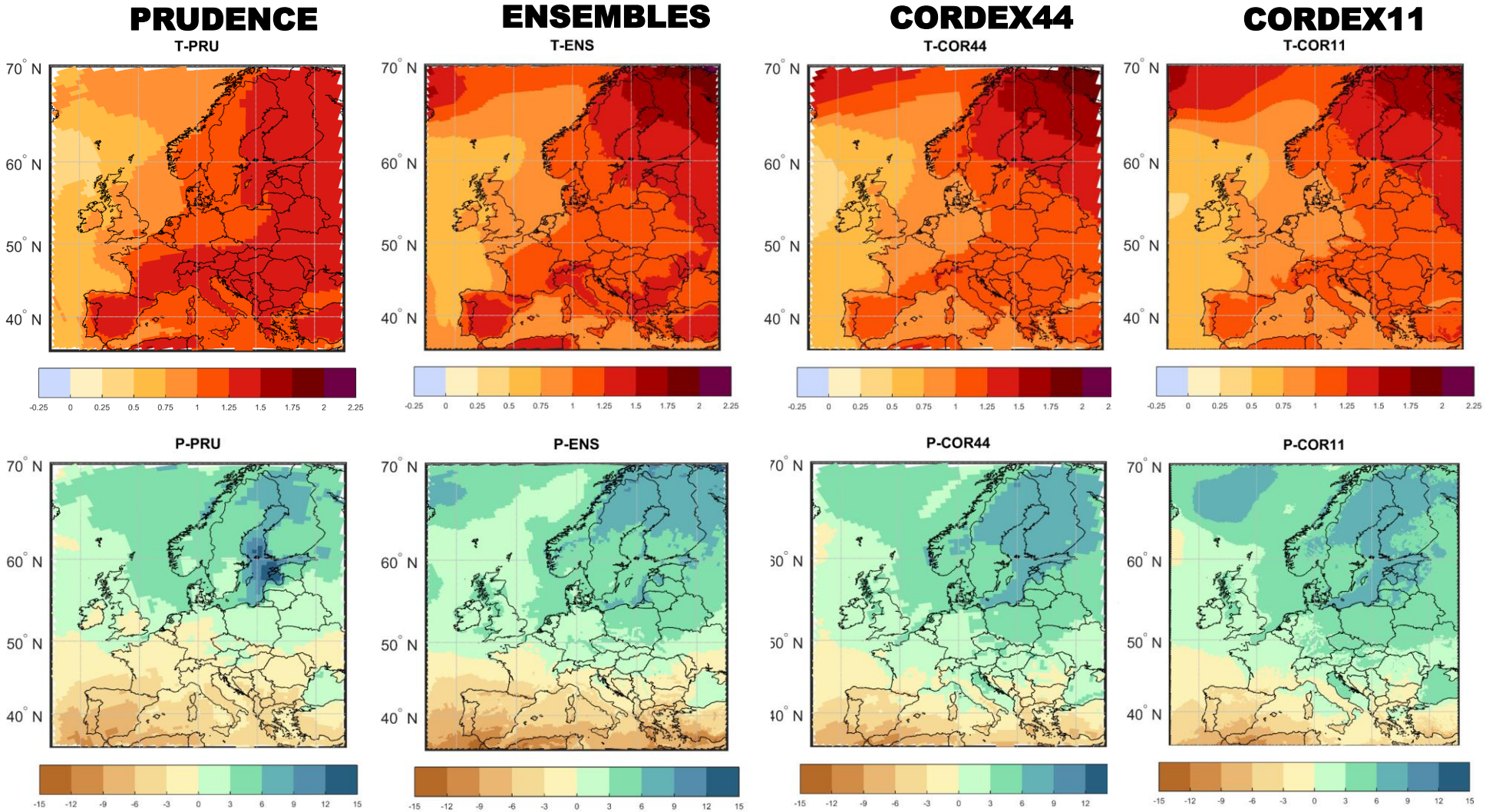
- Scaling per degree global mean temperature
  - <T-global(2071-2100)> - <T-global(1961-1990)>
  - Individual models
    <T(2071-2100)> - <T(1961-1990)>
  - Scale each map with global mean change
  - Combine and take mean value
  - Define Signal-to-Noise S/N as 1 st.dev. of model spread
  - Robust signal if S/N/>1

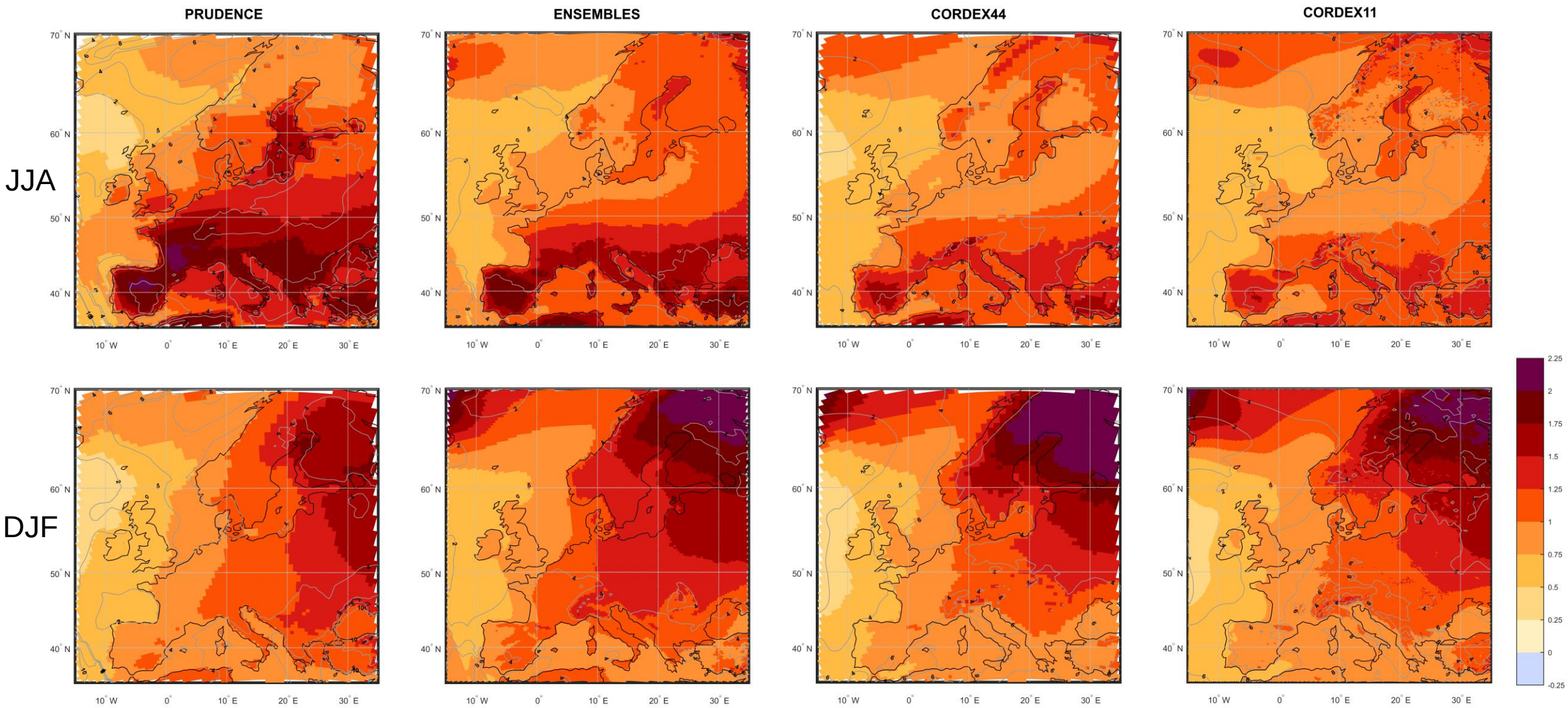
- Precipitation same procedure

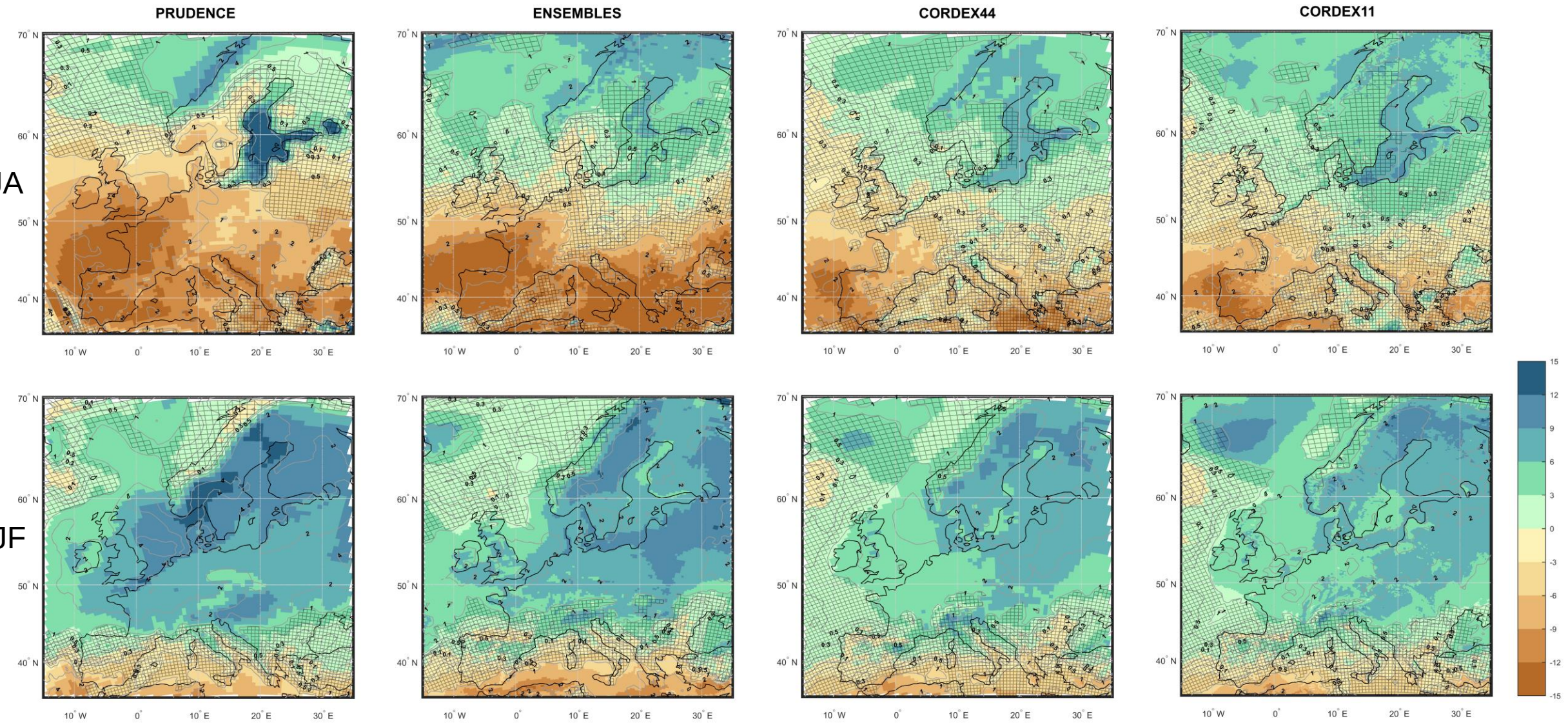
Climate change in PRUDENCE-ENSEMBLES-CORDEX



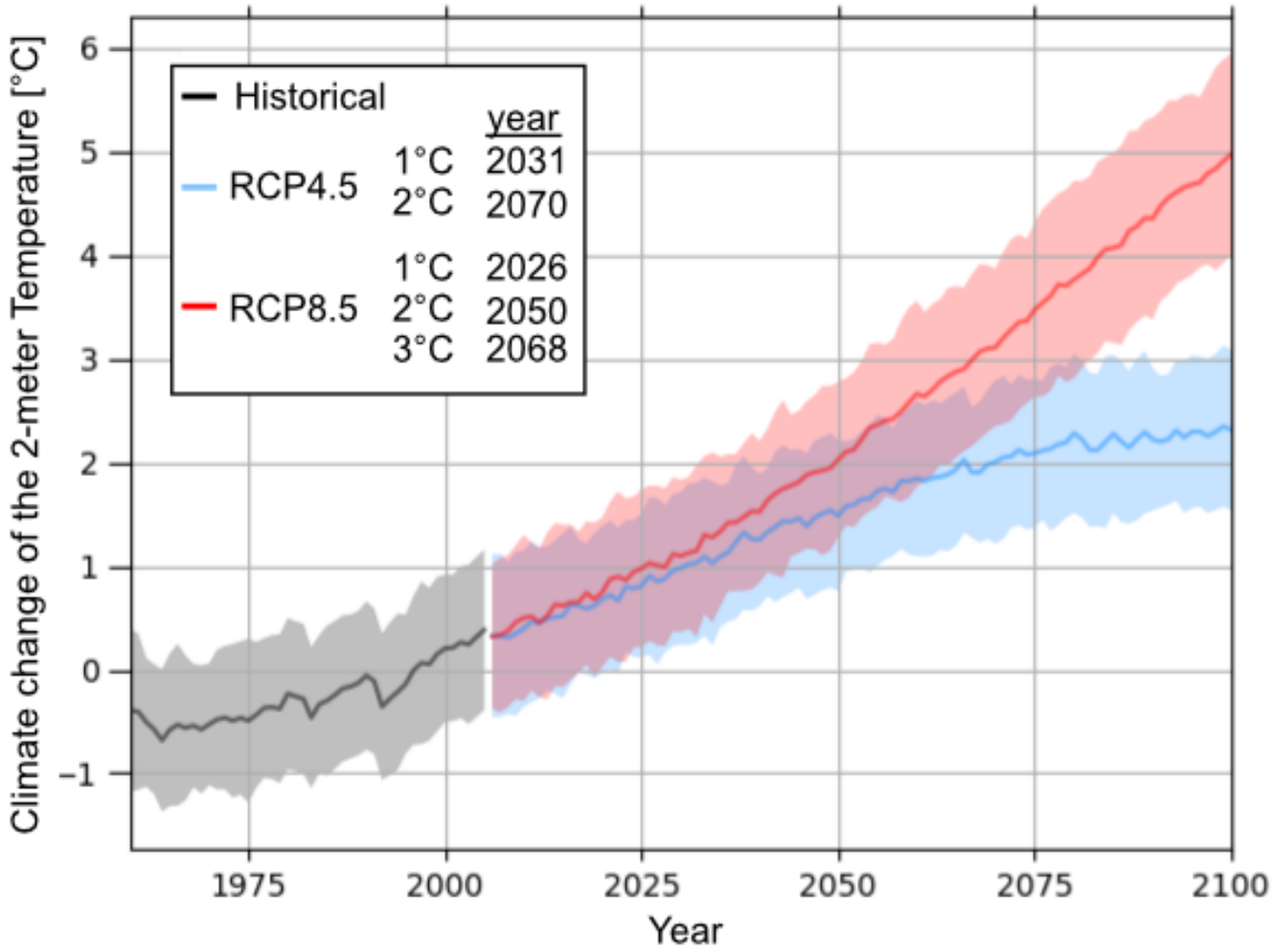
Climate change in PRUDENCE-ENSEMBLES-CORDEX




PRUDENCE
ENSEMBLES
CORDEX44
CORDEX11
JJA
DJF
70° N
60° N
50° N
40° N
10° W
0°
10° E
20° E
30° E
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
-0.25


PRUDENCE
ENSEMBLES
CORDEX44
CORDEX11
JJA
DJF
70° N
60° N
50° N
40° N
10° W
0°
10° E
20° E
30° E
15
12
9
6
3
0
-3
-6
-9
-12
-15

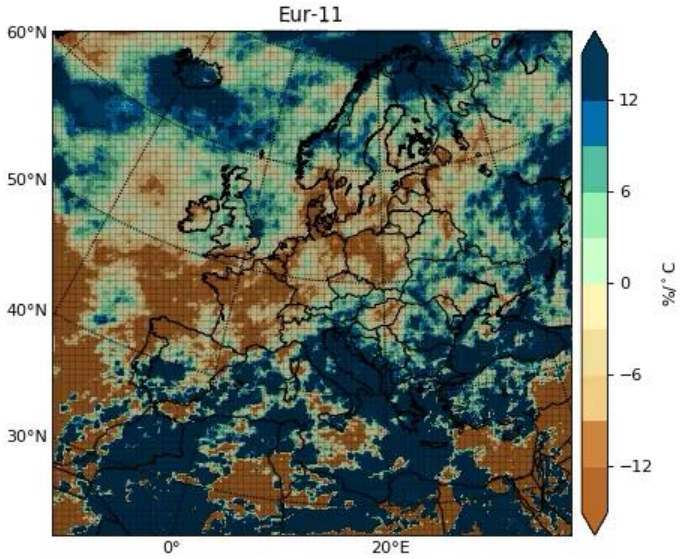
What if Global mean temperature reach 1, 2 or 3 degree?

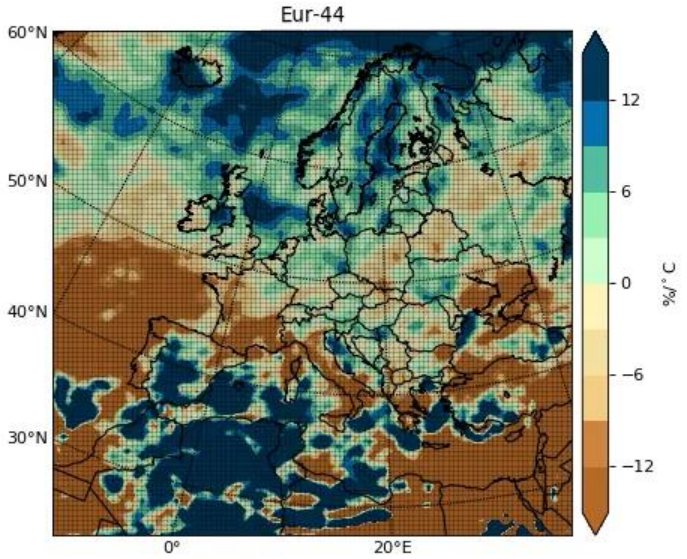


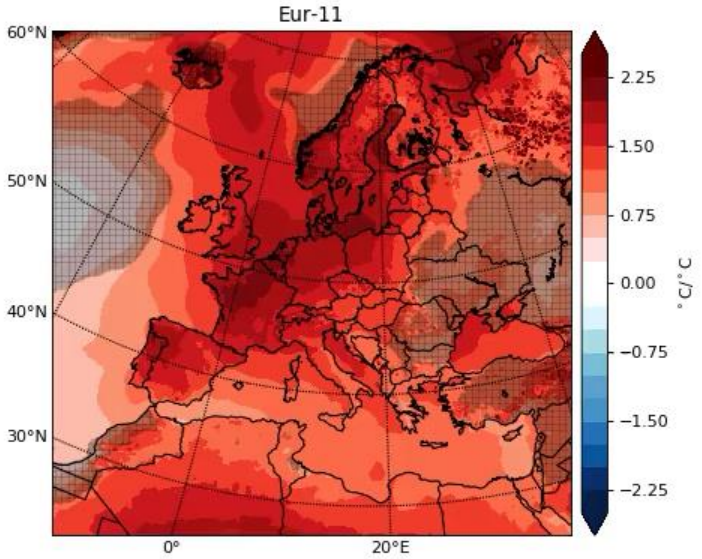
Emerging signals

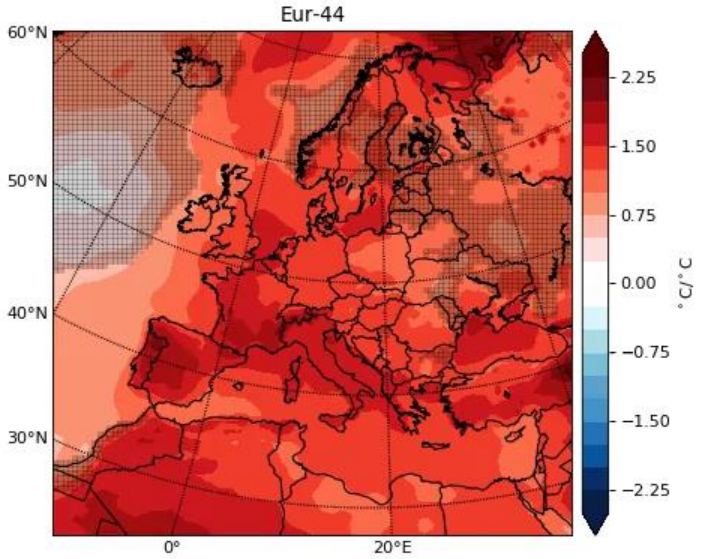
1980

JJA





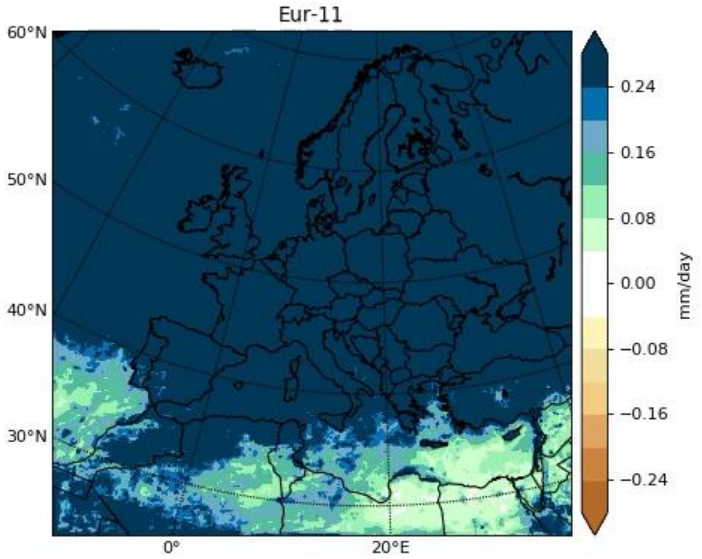


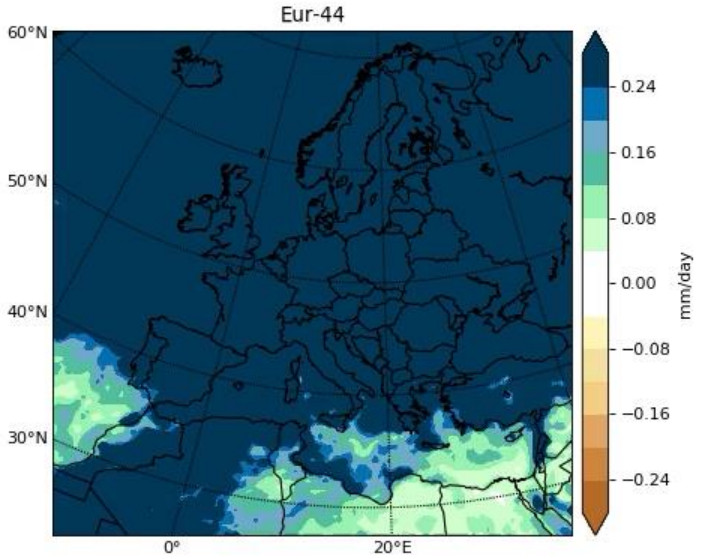


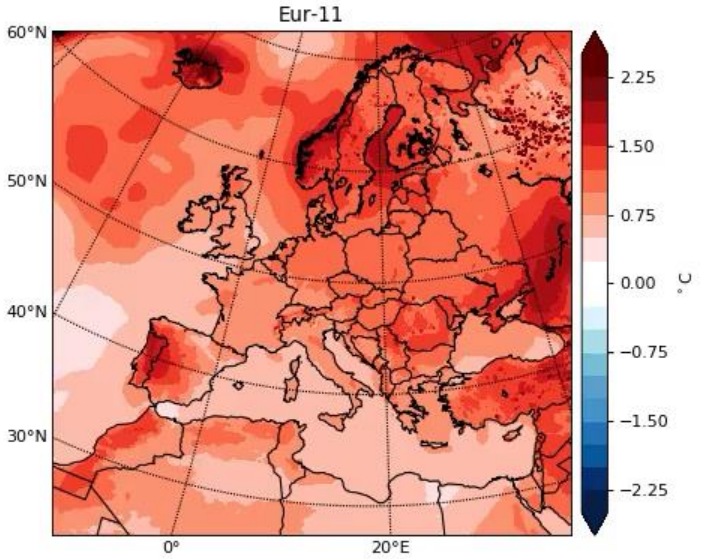
Noise

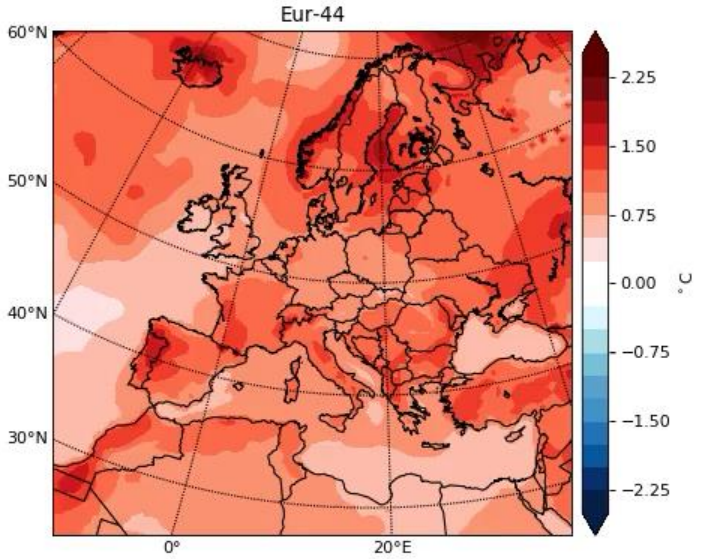
1971

JJA

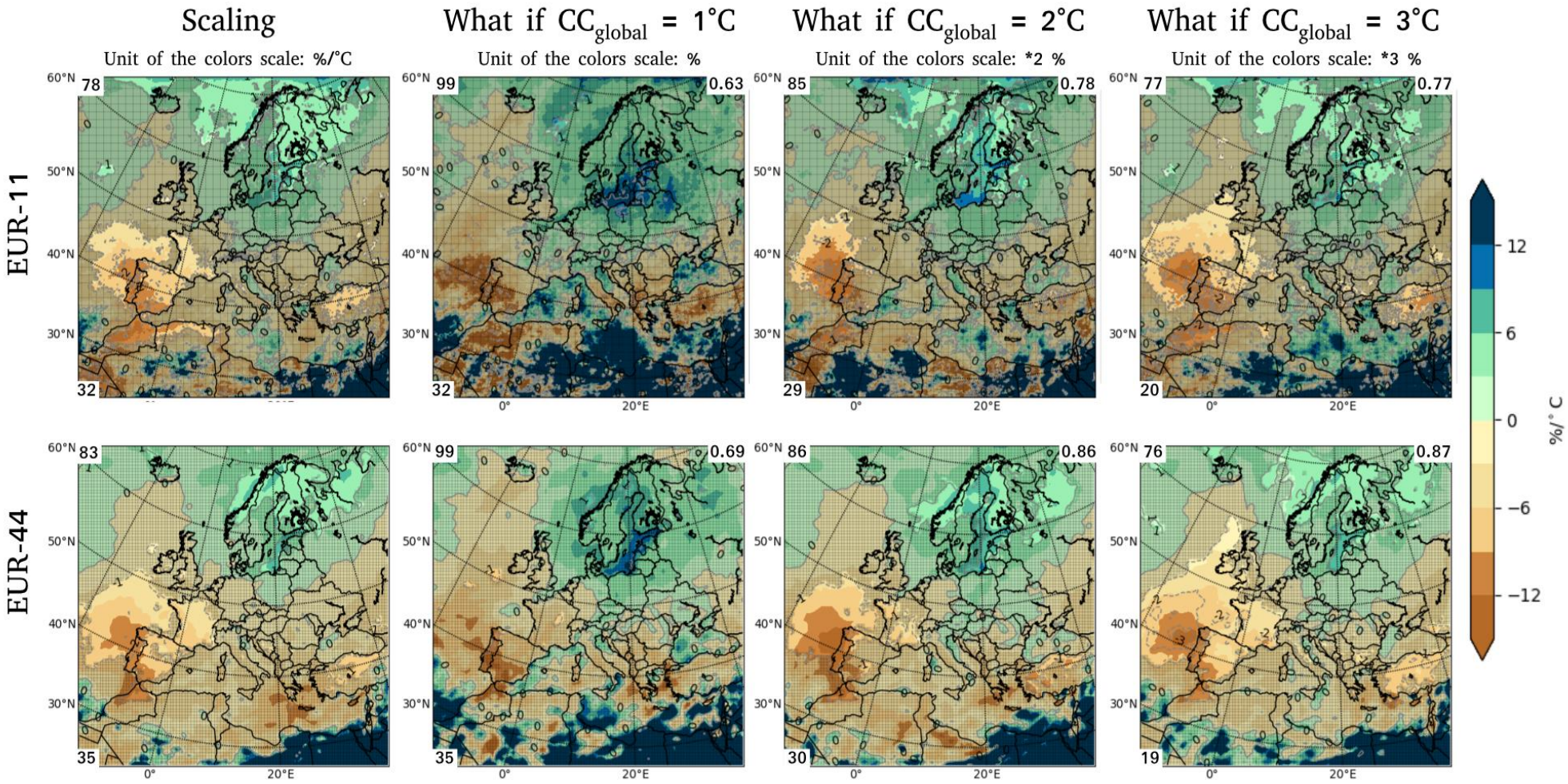






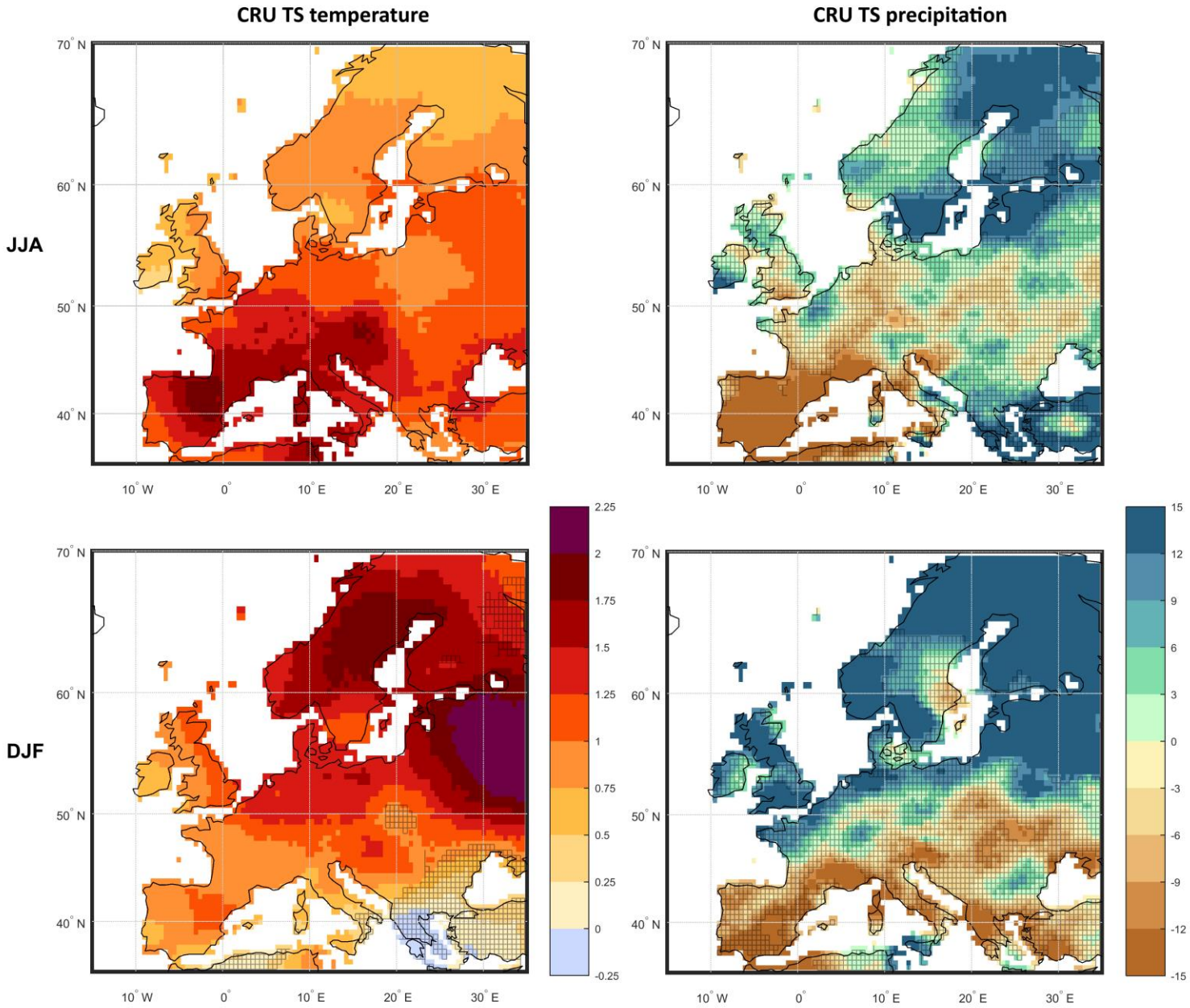


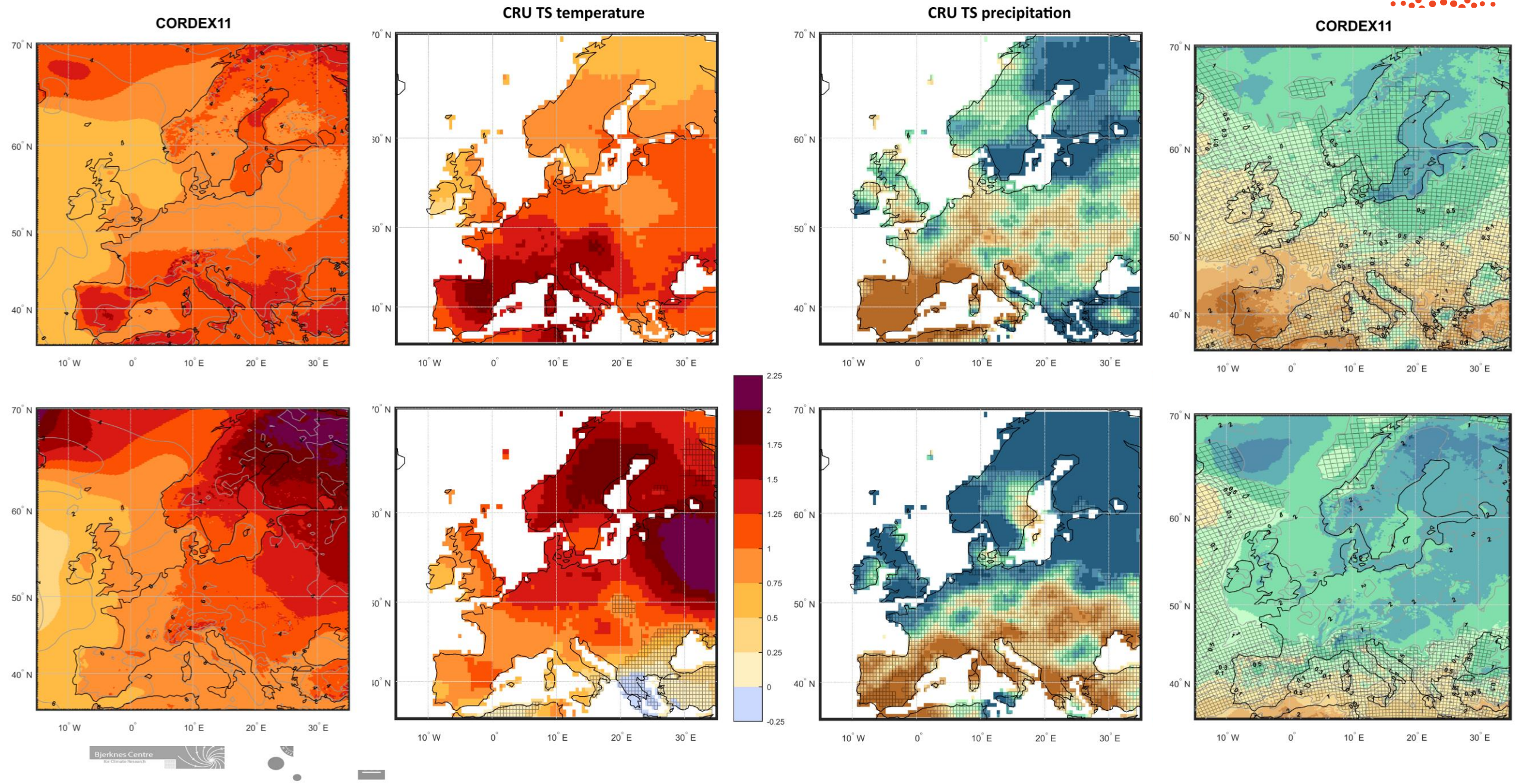
Comparing methods



The last decades of change 1950 - 2016

› Upscaling observed trends to express changes per degree


CRU TS temperature
CRU TS precipitation
JJA
DJF
70° N
60° N
50° N
40° N
10° W
0°
10° E
20° E
30° E
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
-0.25
15
12
9
6
3
0
-3
-6
-9
-12
-15


CORDEX11
CRU TS temperature
CRU TS precipitation
CORDEX11
70° N
60° N
50° N
40° N
10° W
0°
10° E
20° E
30° E
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
-0.25

Conclusions

- Temperature and precipitation patterns of change are quite robust at the European scale across PRUDENCE – ENSEMBLES – CORDEX
  - At annual and seasonal scale
  - Across model development (GCMs as well as RCMs)
  - Across scenarios
  - Across resolution (details may differ at more local scales)

- Model spread is mostly reduced in the project sequence and with increasing signal
  - Precipitation signal is weakened and therefore widely consistent with no change

- The projected changes are similar to current observational trends

Extra slides

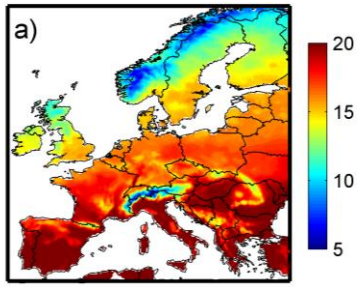
Climate simulations 10 years ago

ECMWF re-analysis => ENSEMBLES Regional Models (25 km)

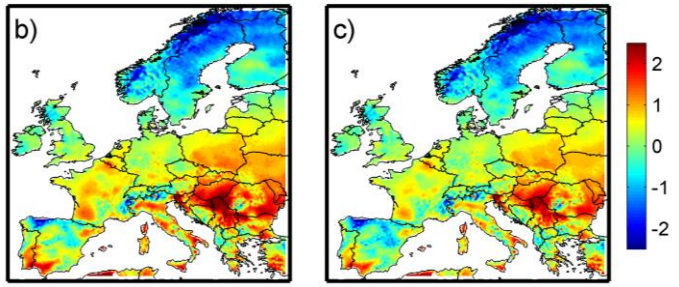
Bias of perfect boundary run, 30 years compared with CRU

ENSEMBLES JJA temperatures - ERA40 driven

OBS



Ens Mean Bias



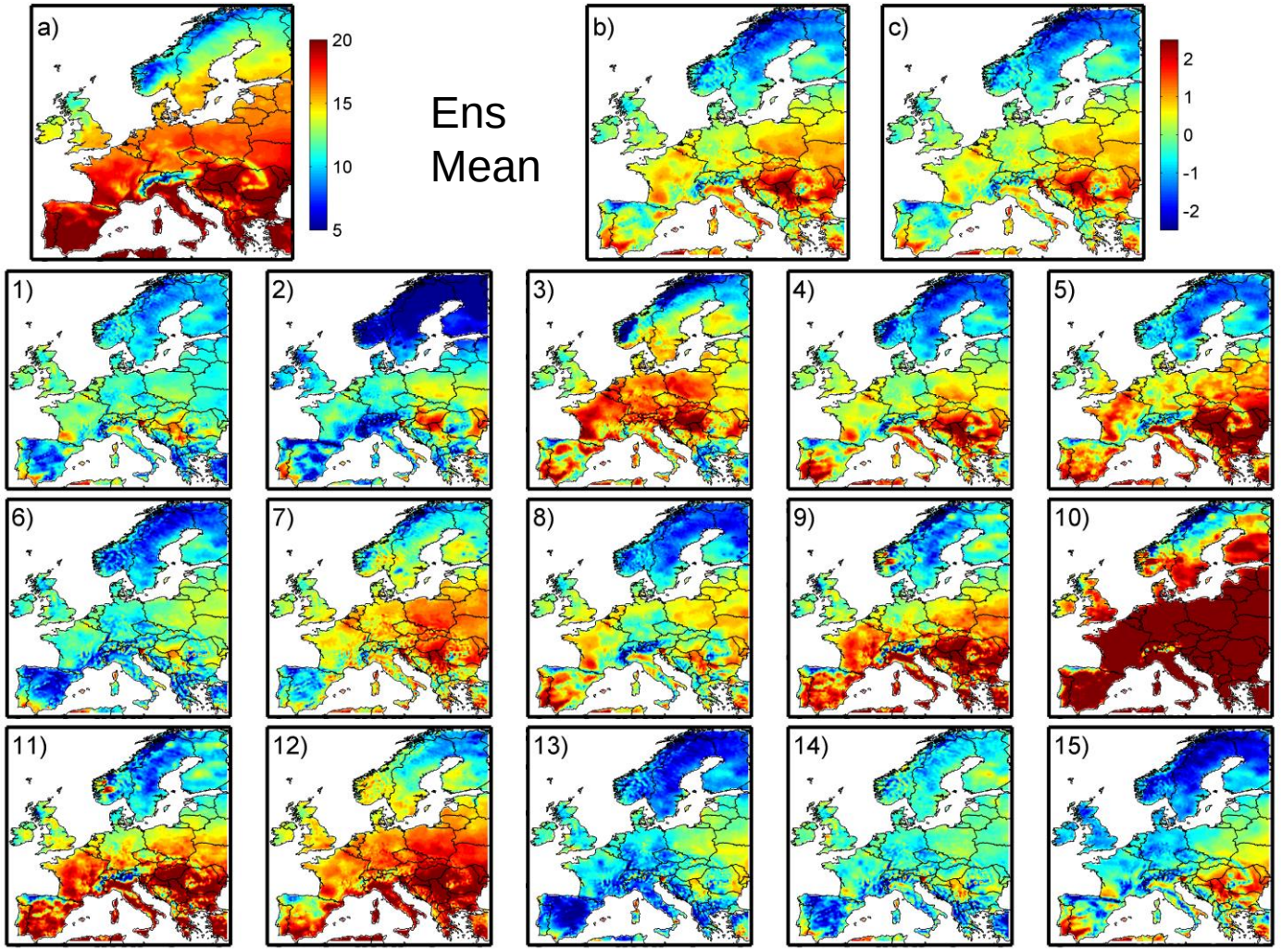
Fairly realistic climate!

ENSEMBLES JJA temperatures - ERA40 driven

OBS

Ens Mean

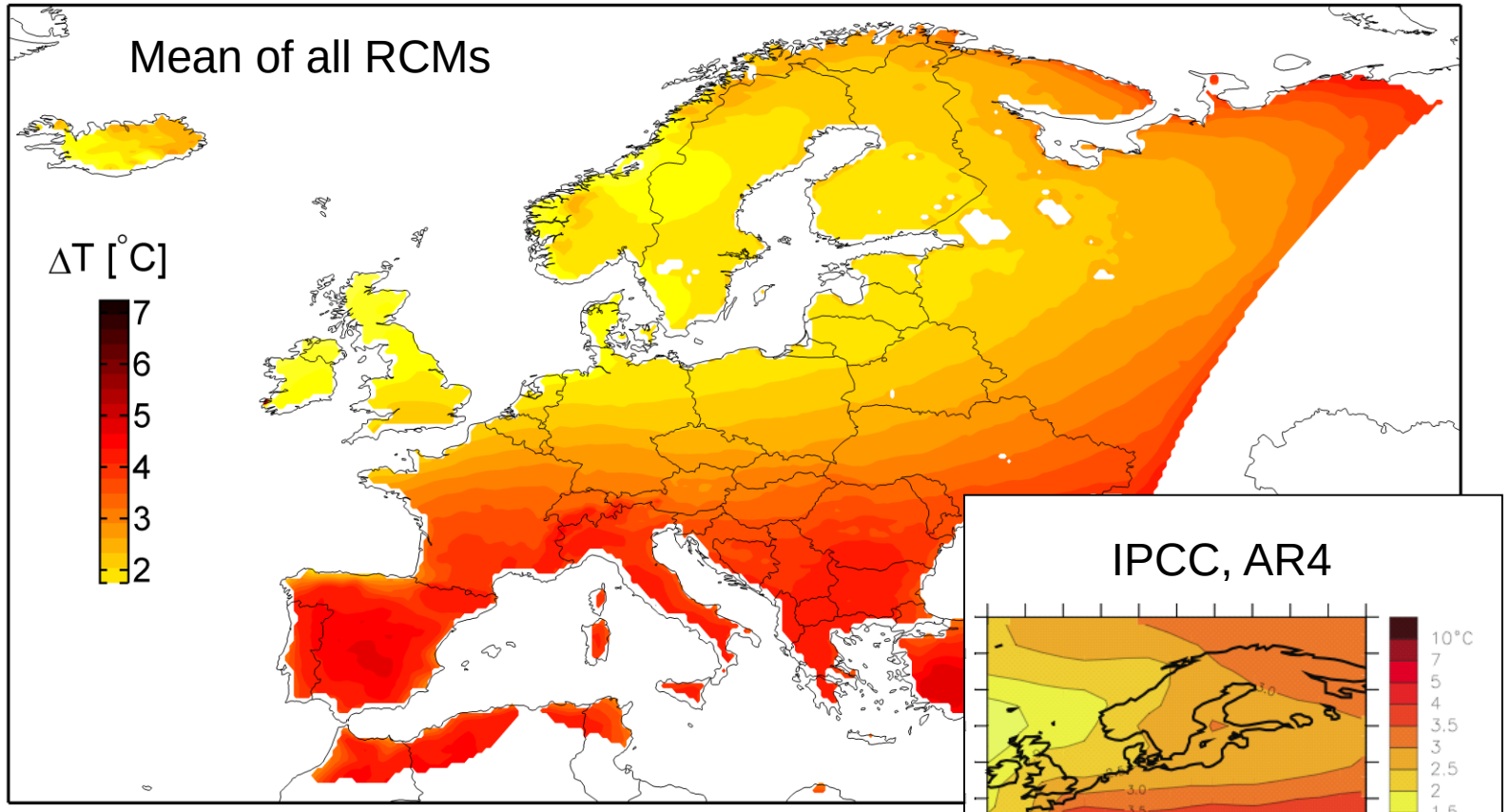
Bias



Fairly realistic climate BUT!

Christensen et al. (2010)

Climate change in ENSEMBLES; JJA temperature



A1B scenario
2071-2100 vs.
1961-1990

Boberg & Christensen (2012)