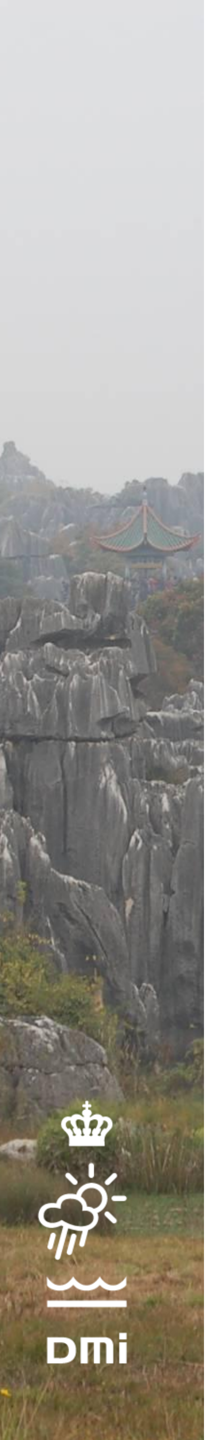

Adding value by regional models revisited: New lessons learned by exploring the ENSEMBLES RCMs

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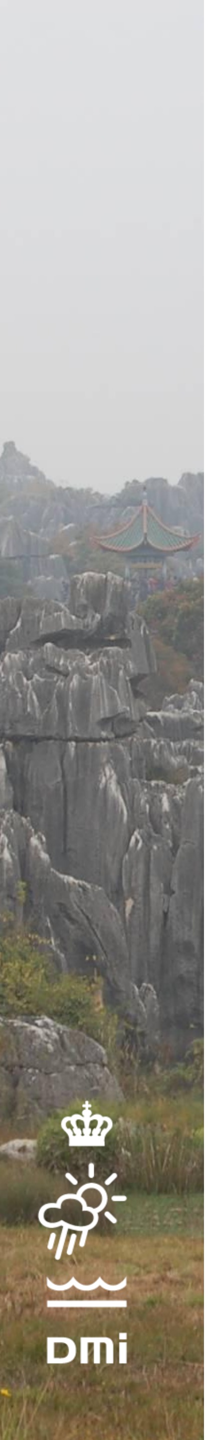
http://www.dmi.dk
http://www.cres-centre.dk

International workshop on downscaling; Jan 19, 2011; Tsukuba, Japan



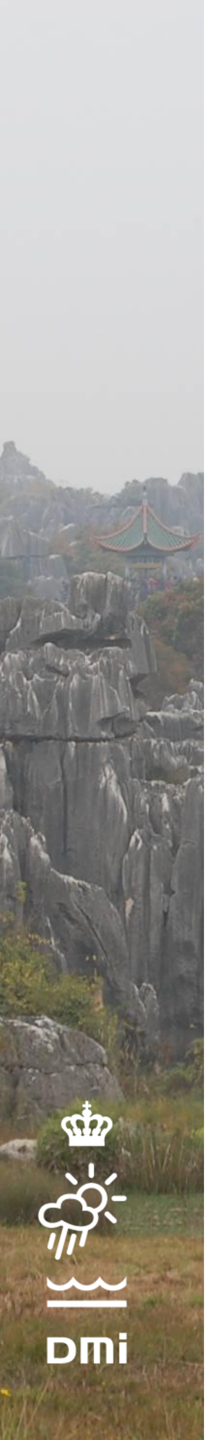
Outline

- Uncertainties related to regional climate change

- ENSEMBLES

- Addressing precipitation extremes (fast flood and drought)

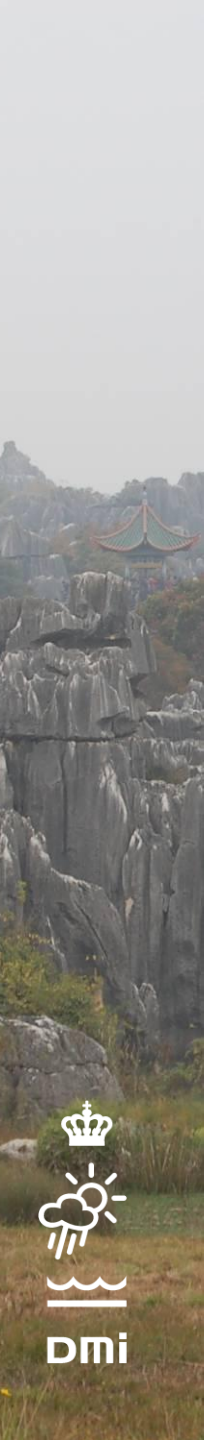
- Exploring ENSEMBLES RCM errors



Climate; the IPCC definition

- in a narrow sense defined as the average weather
- more rigorously, the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years.
- The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization.
  - The relevant quantities are most often surface variables such as temperature, precipitation and wind.

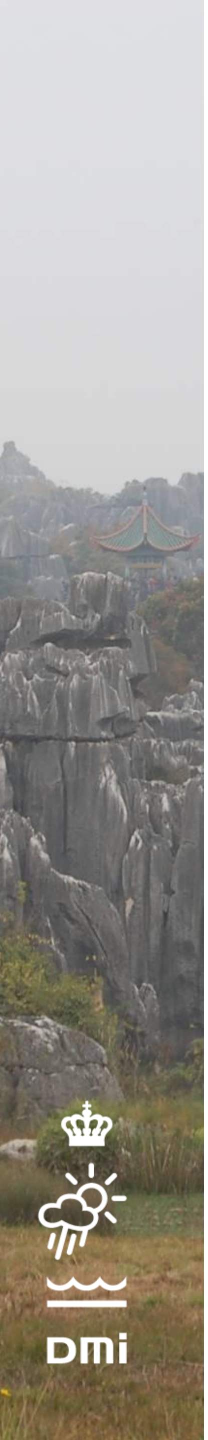
- in a wider sense is the state, including a statistical description, of the *climate system*.



Uncertainty; the IPCC definition

- An expression of the degree to which a value (*e.g.*, the future state of the *climate system*) is unknown.
- It can result from
  - lack of information
  - from disagreement about what is known or even knowable.
- It may have many types of sources,
  - from quantifiable errors in the data
  - to ambiguously defined concepts
  - or terminology,
  - or uncertain *projections* of human behaviour.
- It can therefore be represented
  - by quantitative measures, for example, a range of values calculated by various models,
  - or by qualitative statements, for example, reflecting the judgement of a team of experts

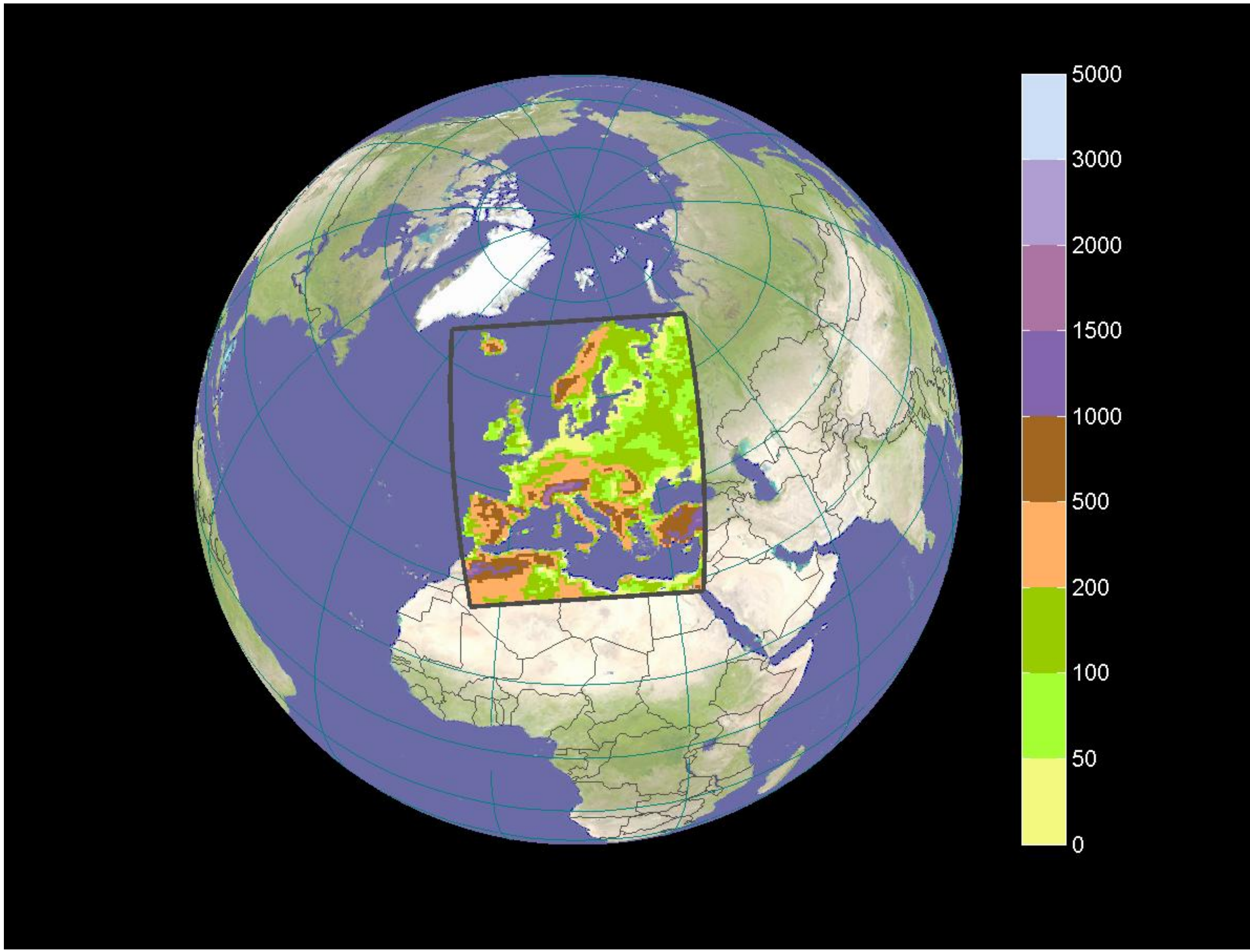
Van der Linden & Mitchell (2009)

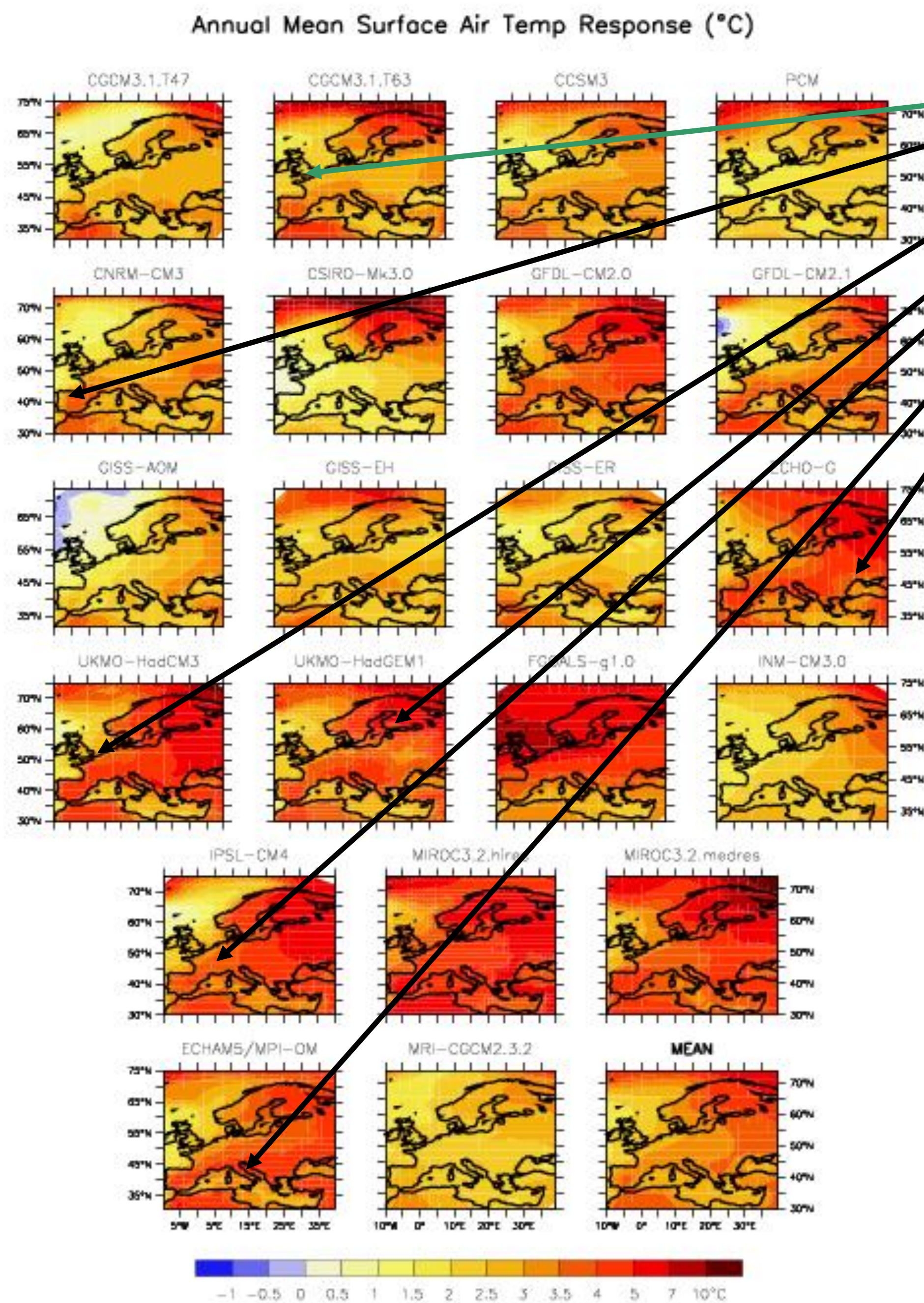


ENSEMBLES
http://www.ensembles-eu.org/

- Development of the Ensembles Prediction Systems
- Formulation of very high resolution Regional Climate Model Ensembles for Europe
- Production of seasonal to decadal hindcasts and climate change scenarios
- Understanding the process governing climate variability and change, climate predictability and the probability of extreme events
- Independent comprehensive evaluation of the ENSEMBLES simulation-prediction system
- Assessments of impacts of climate change
- Scenarios and policy implications

The RCM approach





ENSEMBLES

AR4, WGI, Ch11
Suppl. Mat.

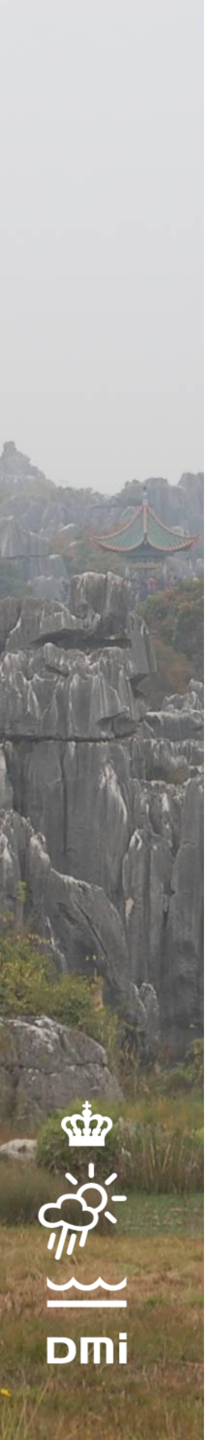
ENSEMBLES GCM-RCM Matrix

Global model Regional inst.	METO-HC Standard	METO-HC Low sens.	METO-HC Hi sens.	MPIMET Standard	MPIMET Ens.m. 1	MPIMET Ens.m. 2	IPSL	CNRM	NERSC	MIROC	CGCM3	Total number
METO-HC	2100	2100*	2100*	2100 (??)								4
MPIMET				2100			2050* (06/2009)					2
CNRM								2100				1
DMI				2100*				2100	2100*			3
ETH	2100											1
KNMI				2100* 2100	2100*	2100*				2100*		1+4
ICTP				2100								1
SMHI		2100*		2100* 2100*					2100			3+1
UCLM	2050											1
C4I			2100*	2050 (A2)*								2
GKSS							2050*					1
METNO	2050*								2050*			1
CHMI								2050* (12/2009)				1
OURANOS**											2050*	1
VMGO**	2050*											1
Total (1951-2050)	5	2	2	7+2	0+1	0+1	2	3	3	0+1	1	25+5

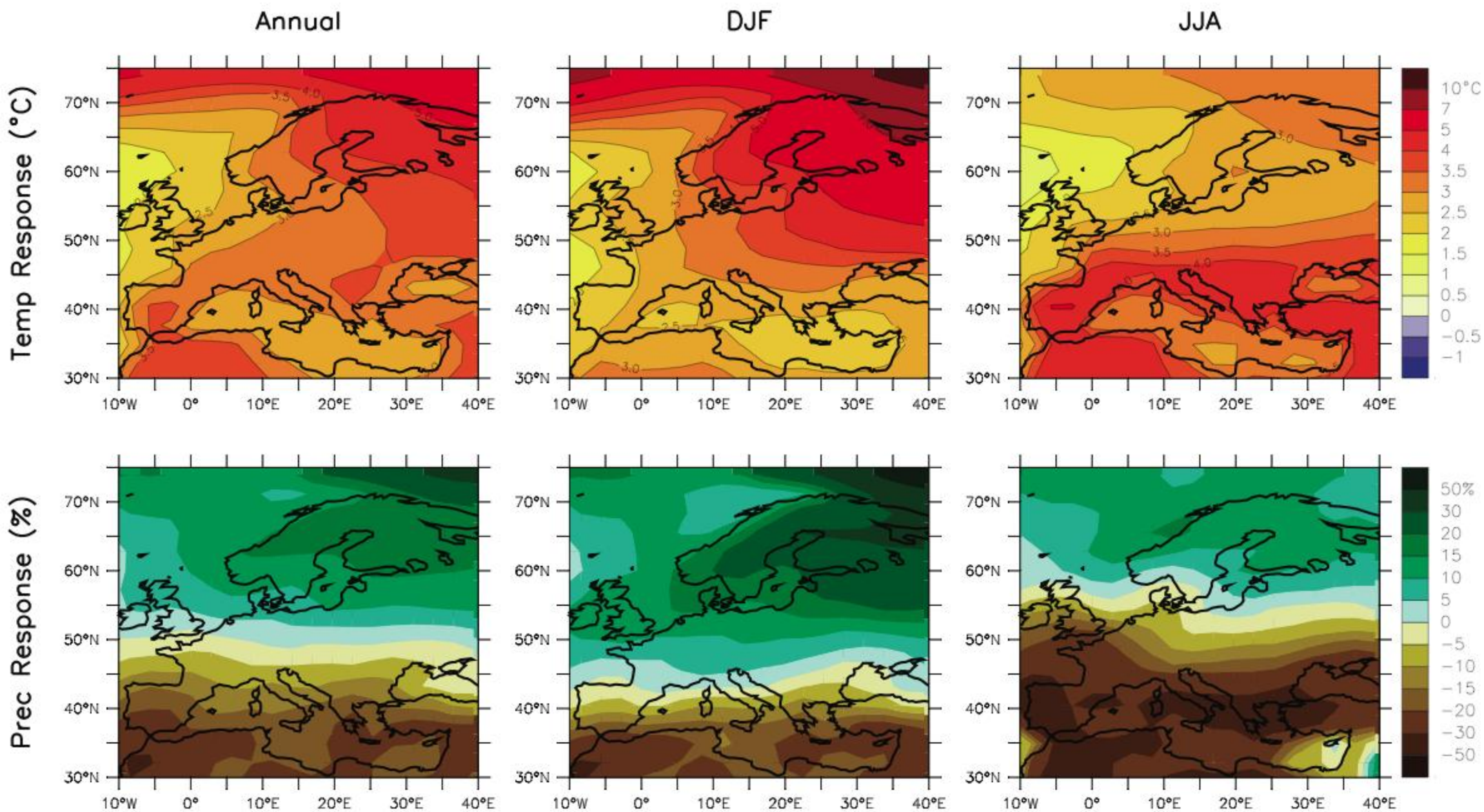
Red: Online now; *: non-contractual runs; **:affiliated partners without obligations; underscore: 50km resolution; (in parantheses): Expected date

ERA40 (1958-2002) experiments exists for all models

DMI

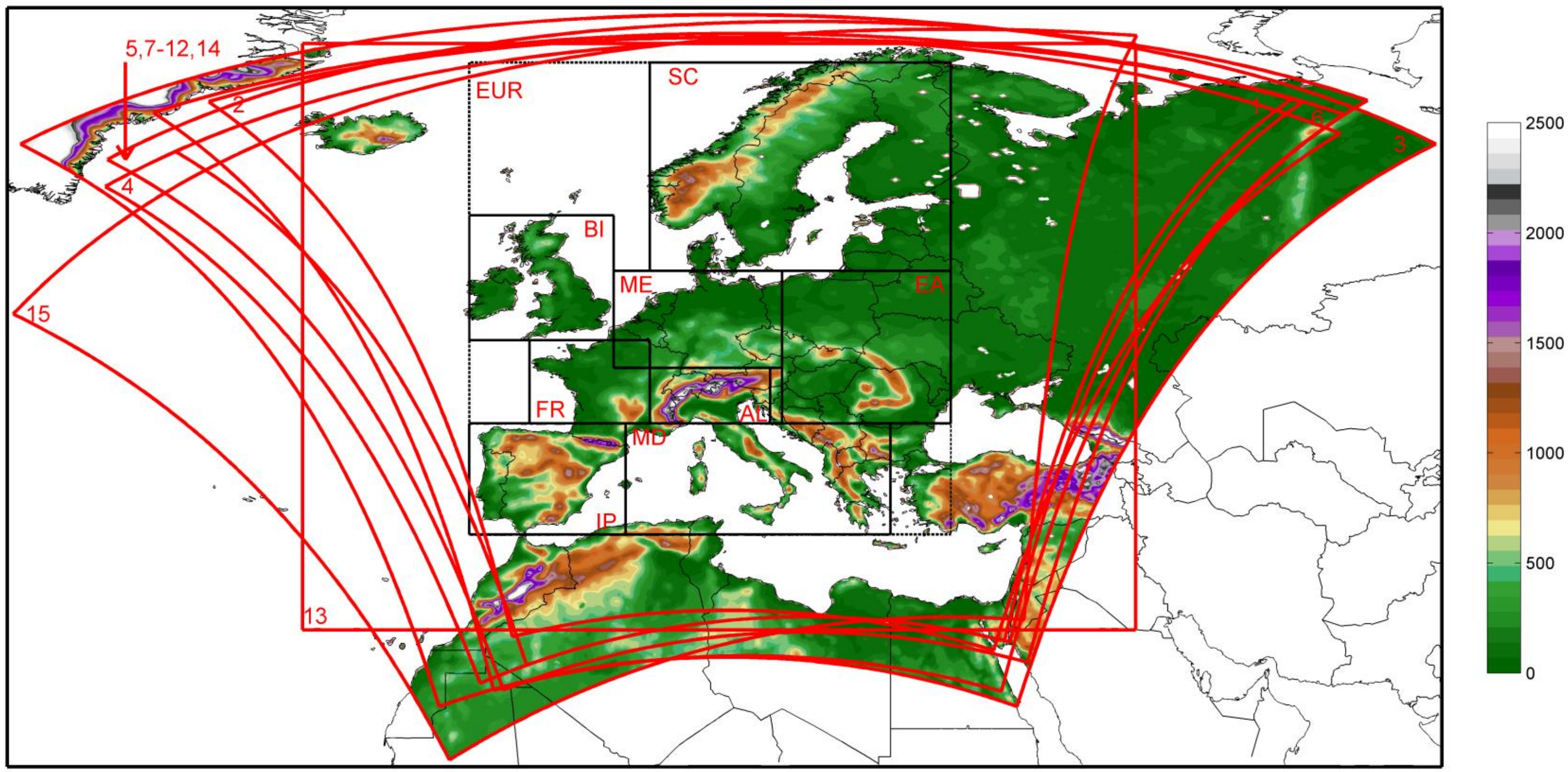


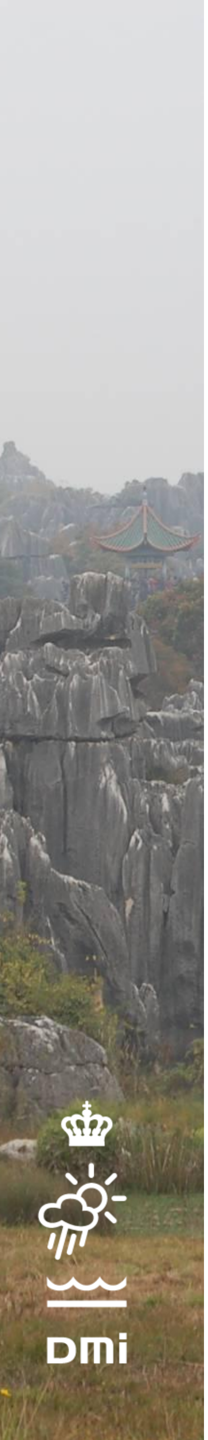
GCM based projections



AR4, WG1

ENSEMBLES set-up



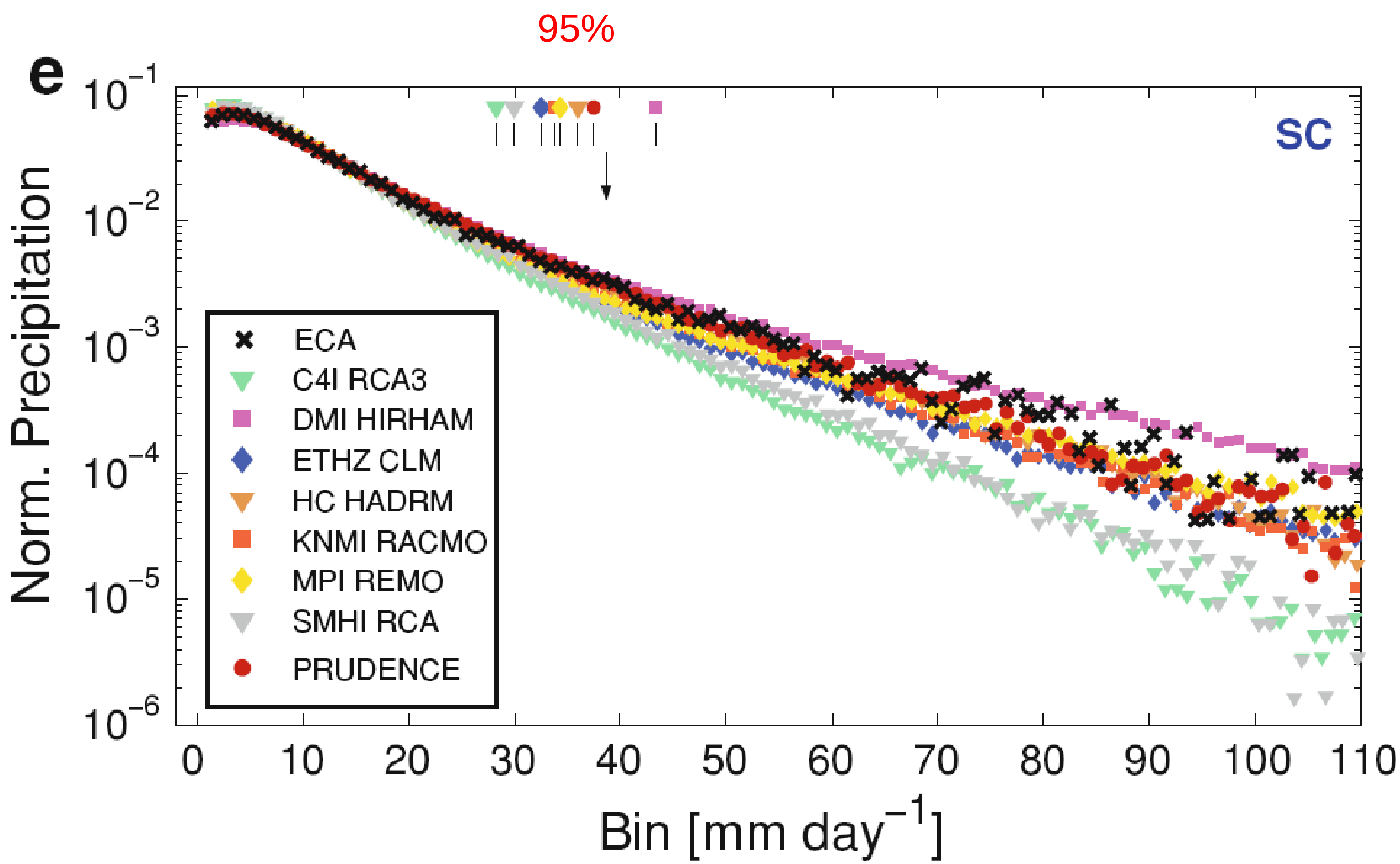


Extremes

- Can we assign confidence to extreme events, knowing they are rare?

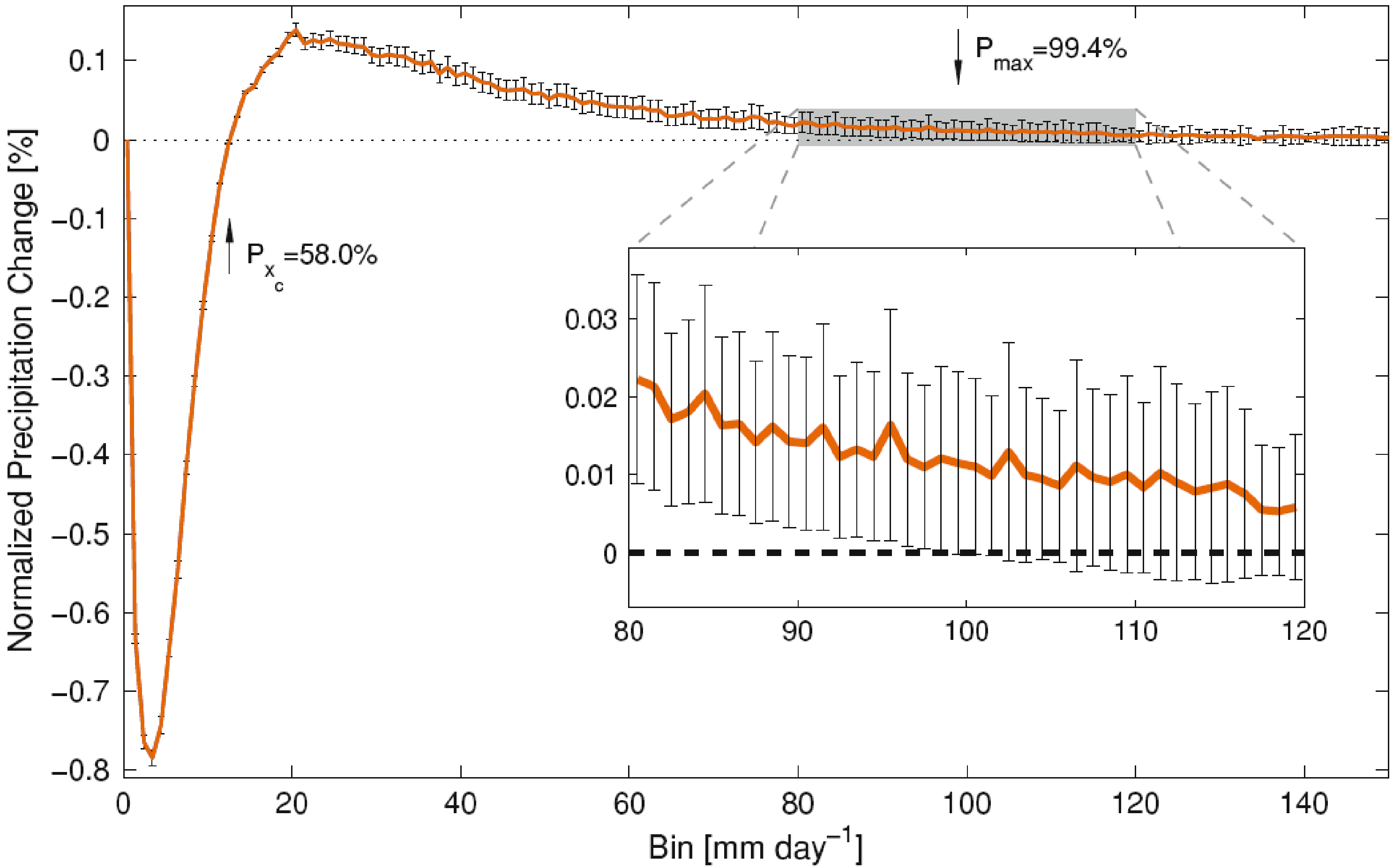
- Two cases in brief
  - Normalized daily precipitation
  - The drought case

Normalized daily precipitation 1961-1990

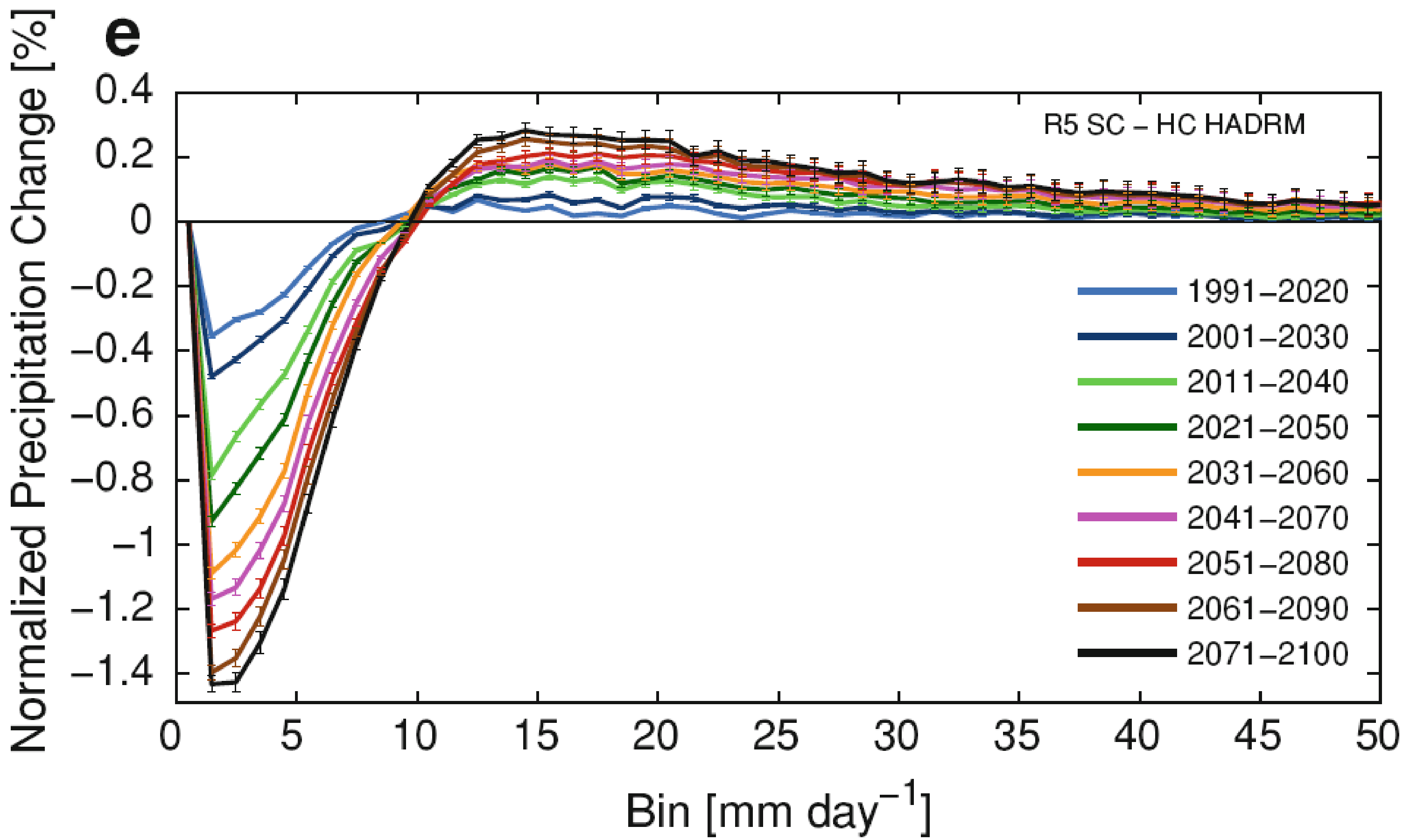


Boberg et al. (2010)

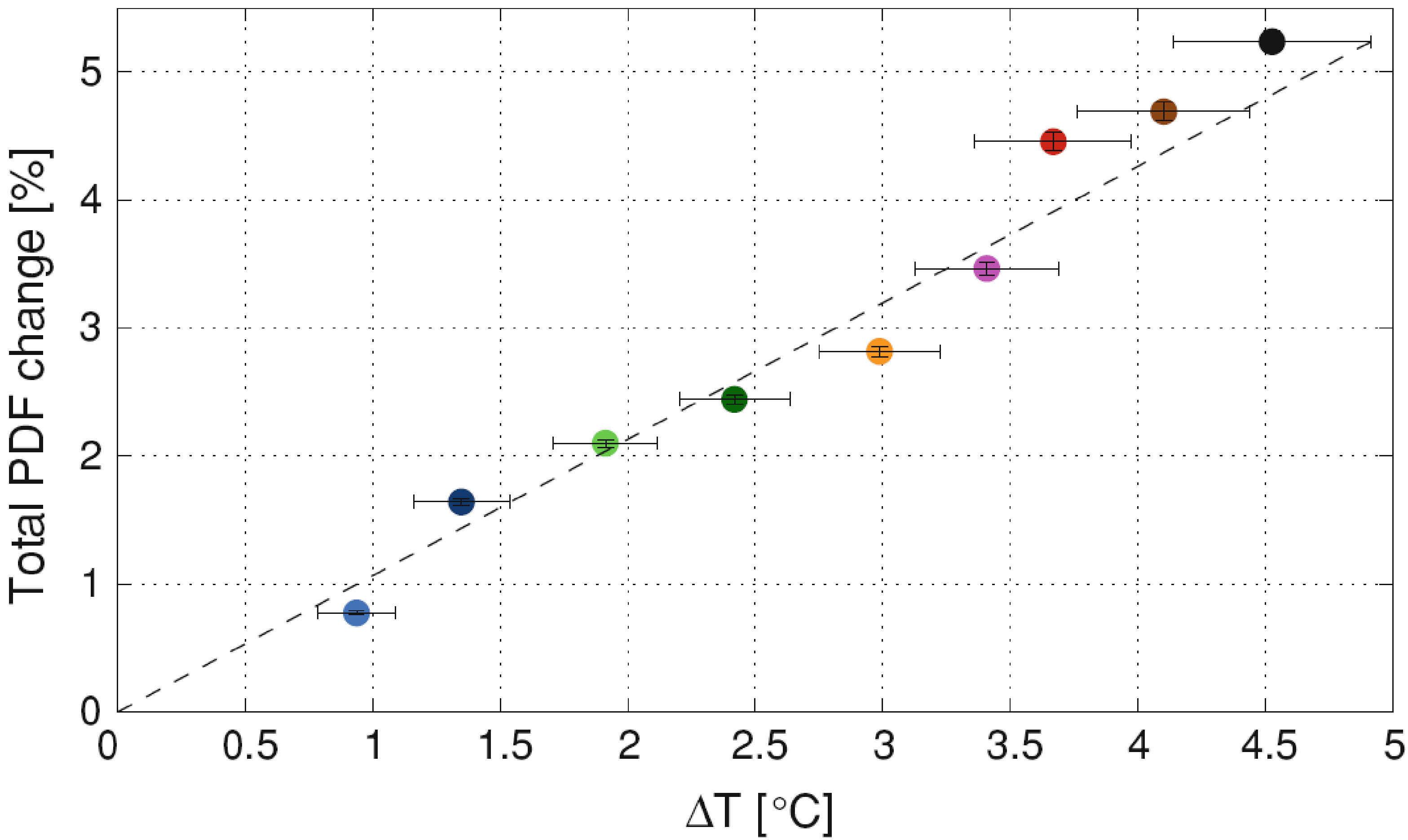
Change
end of century



Boberg et al. (2010)

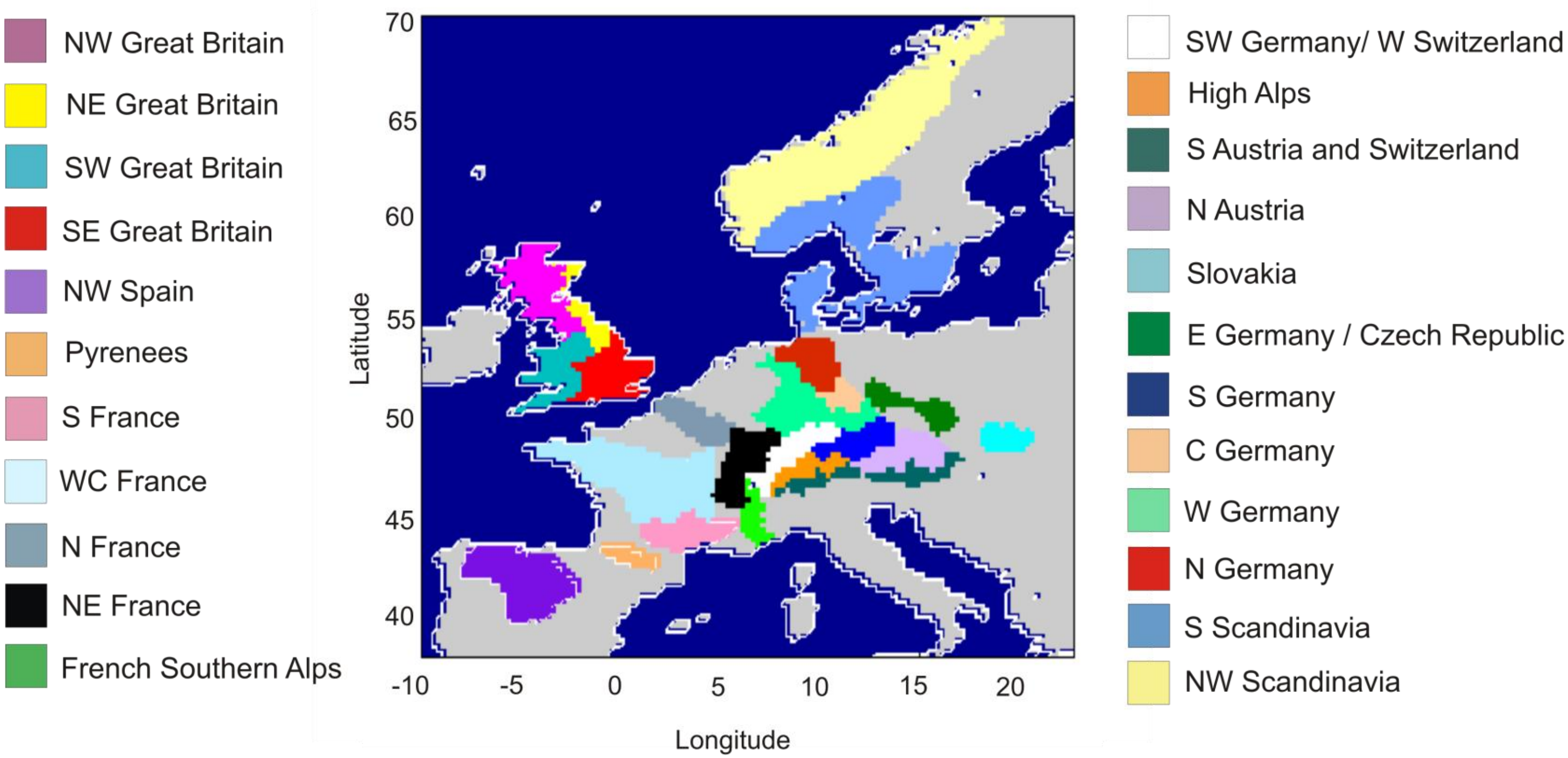


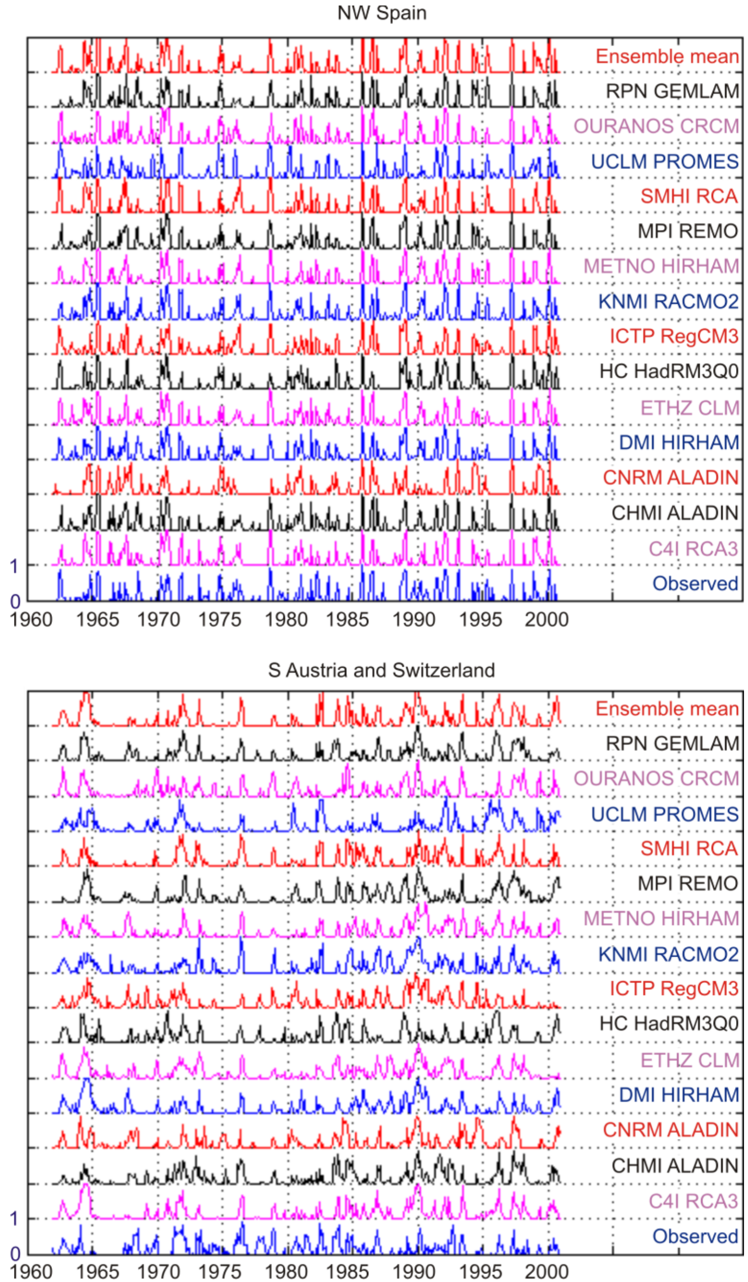
Boberg et al. (2010)



DMI

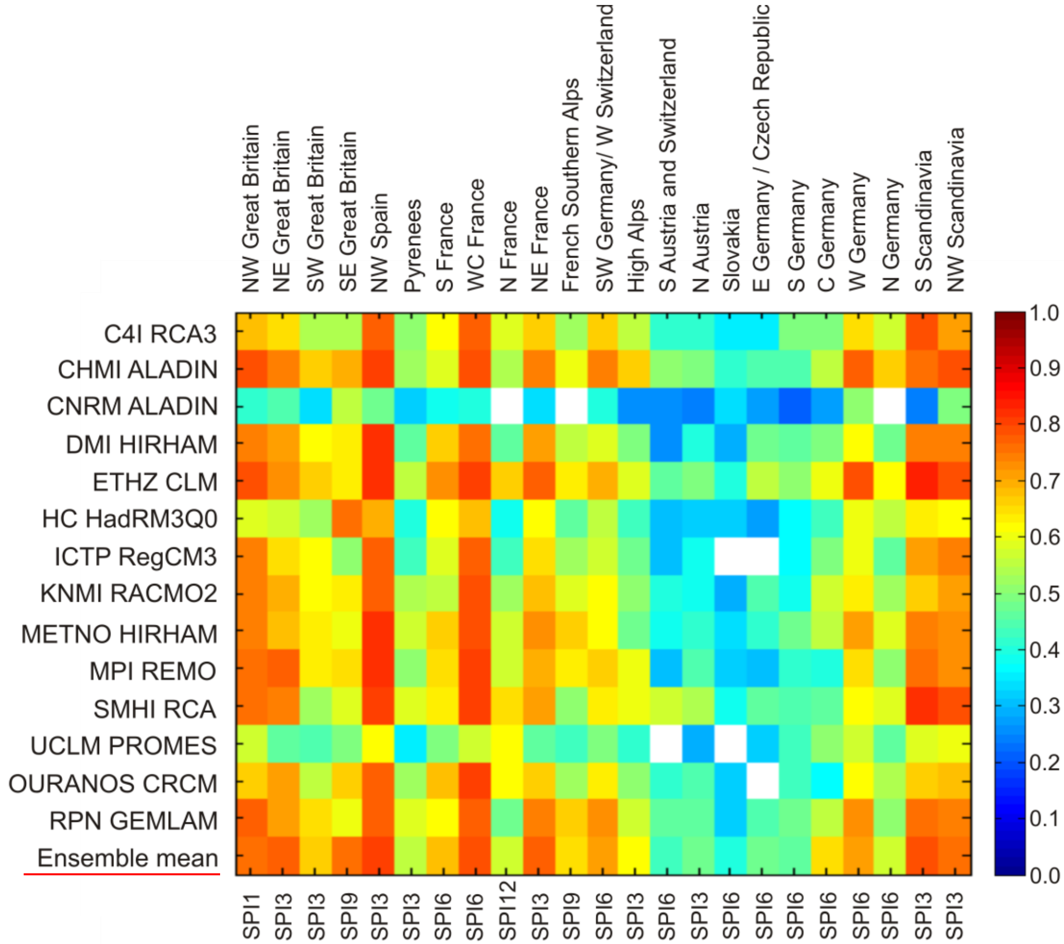
Drought as an example





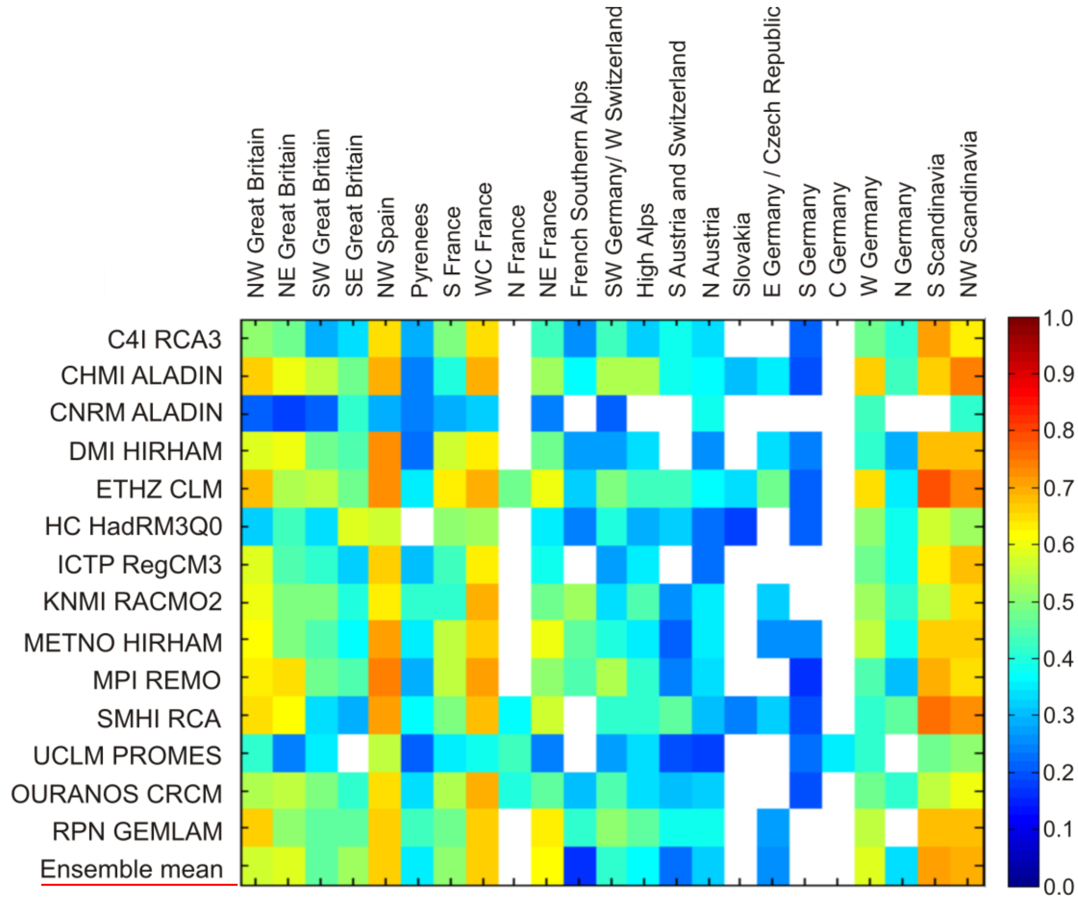
- Time series of RSPI values for the 14 RCMs
  - Good match
  - Less good match

Maule et al. 2011



Maule et al. 2011

Cross correlation coefficients between the RCMs and the Drought Catalogue in each of the 23 regions



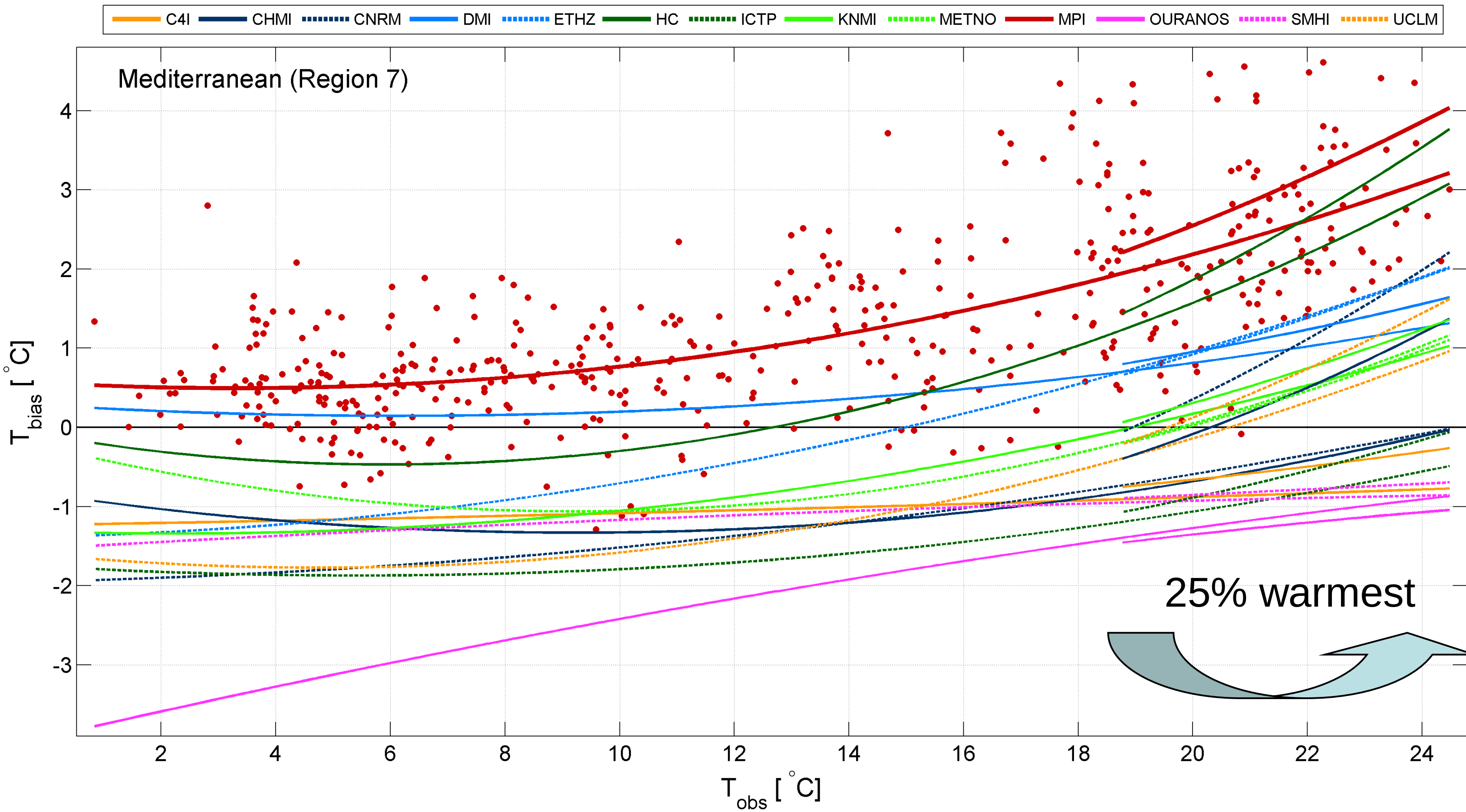
Maule et al. 2011

Cross correlation coefficients between the RCMs and the Drought Catalogue in each of the 23 regions after Zero removal

Relating model spread and uncertainty assignment

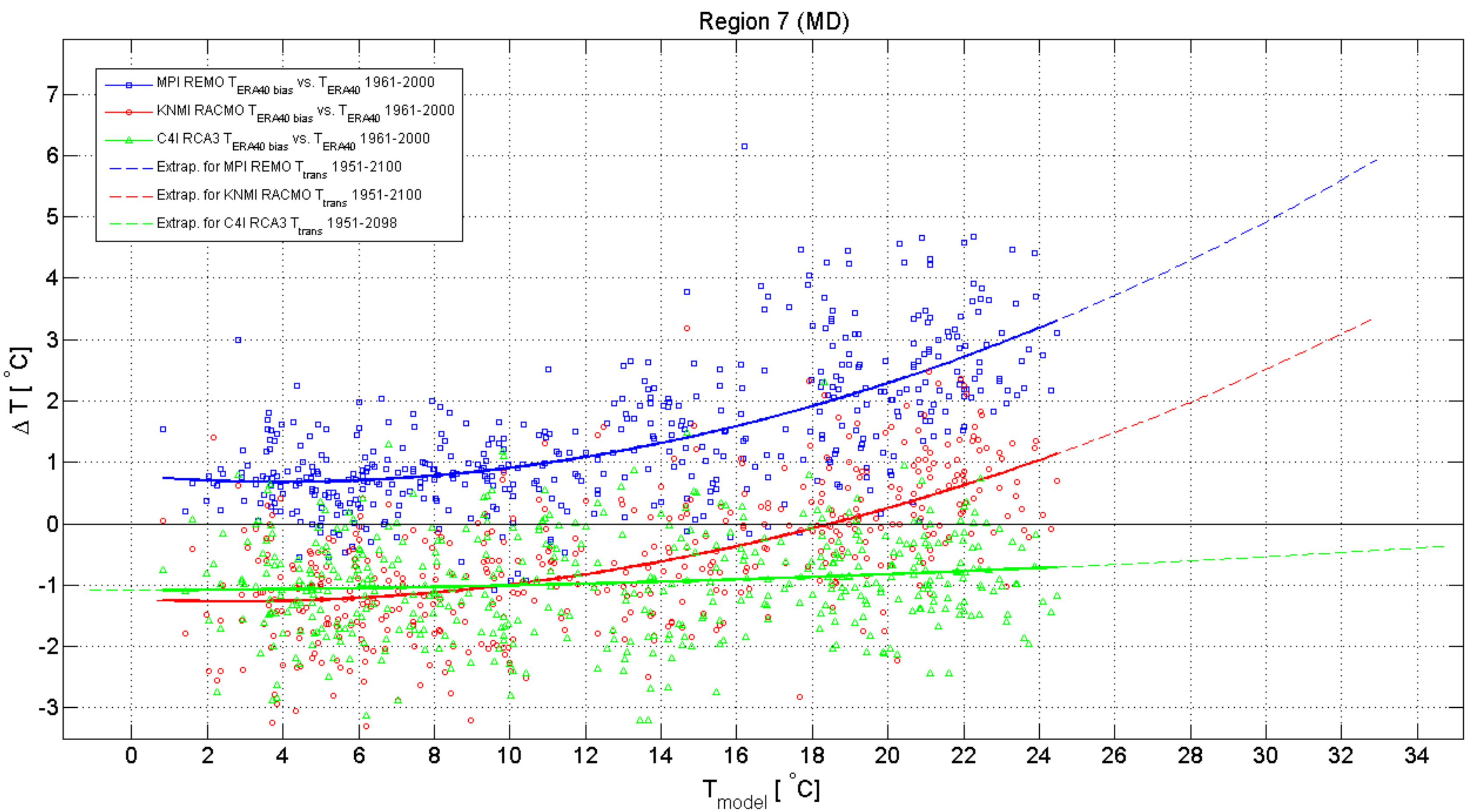
- Delta change and transient change assumes invariance of model bias under climate change
- What if this is not the case?
- What are the implications for the ’predictions’?
- Can this possibly be ameliorated?

Model bias vs. observations

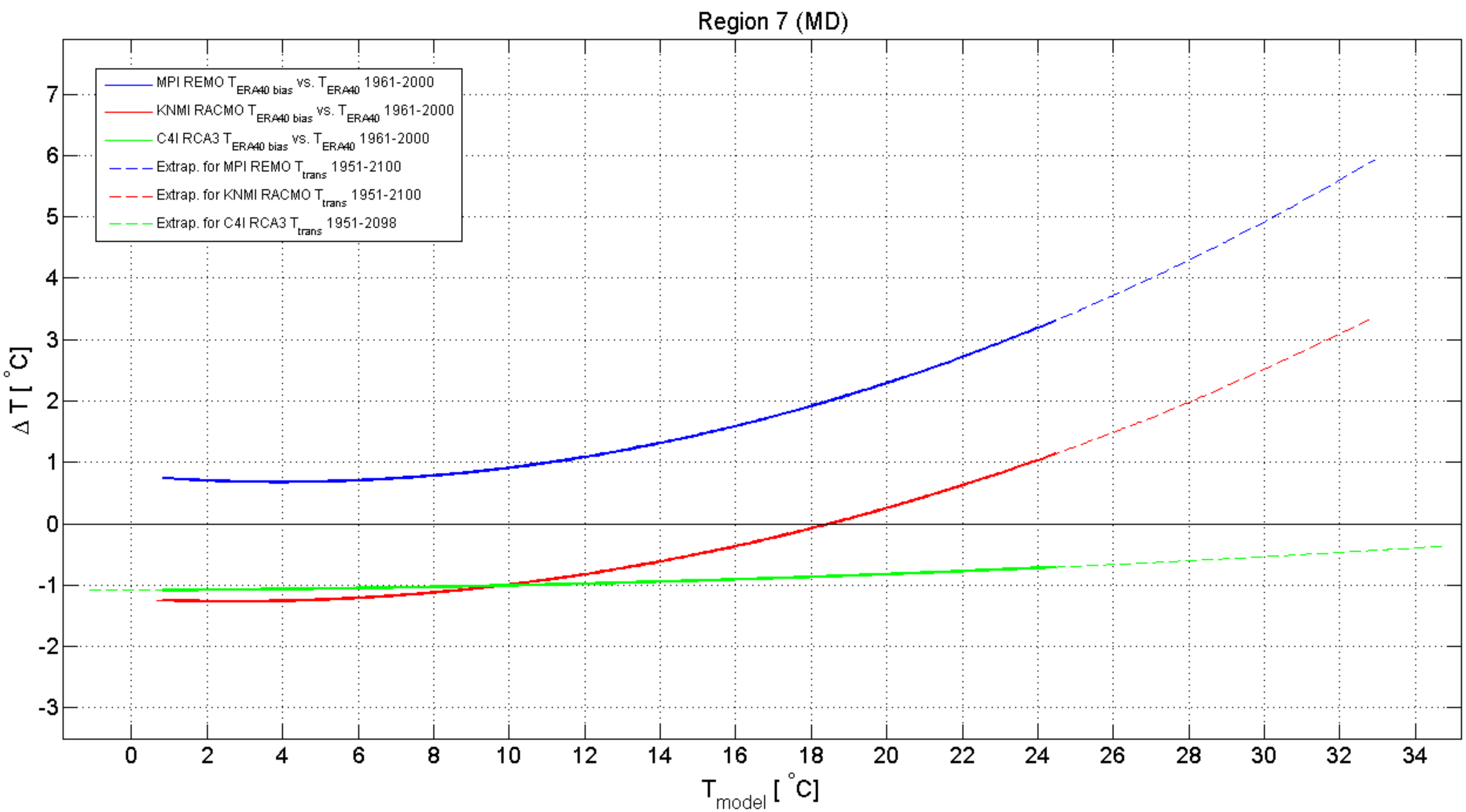


(Christensen *et al.* 2008)

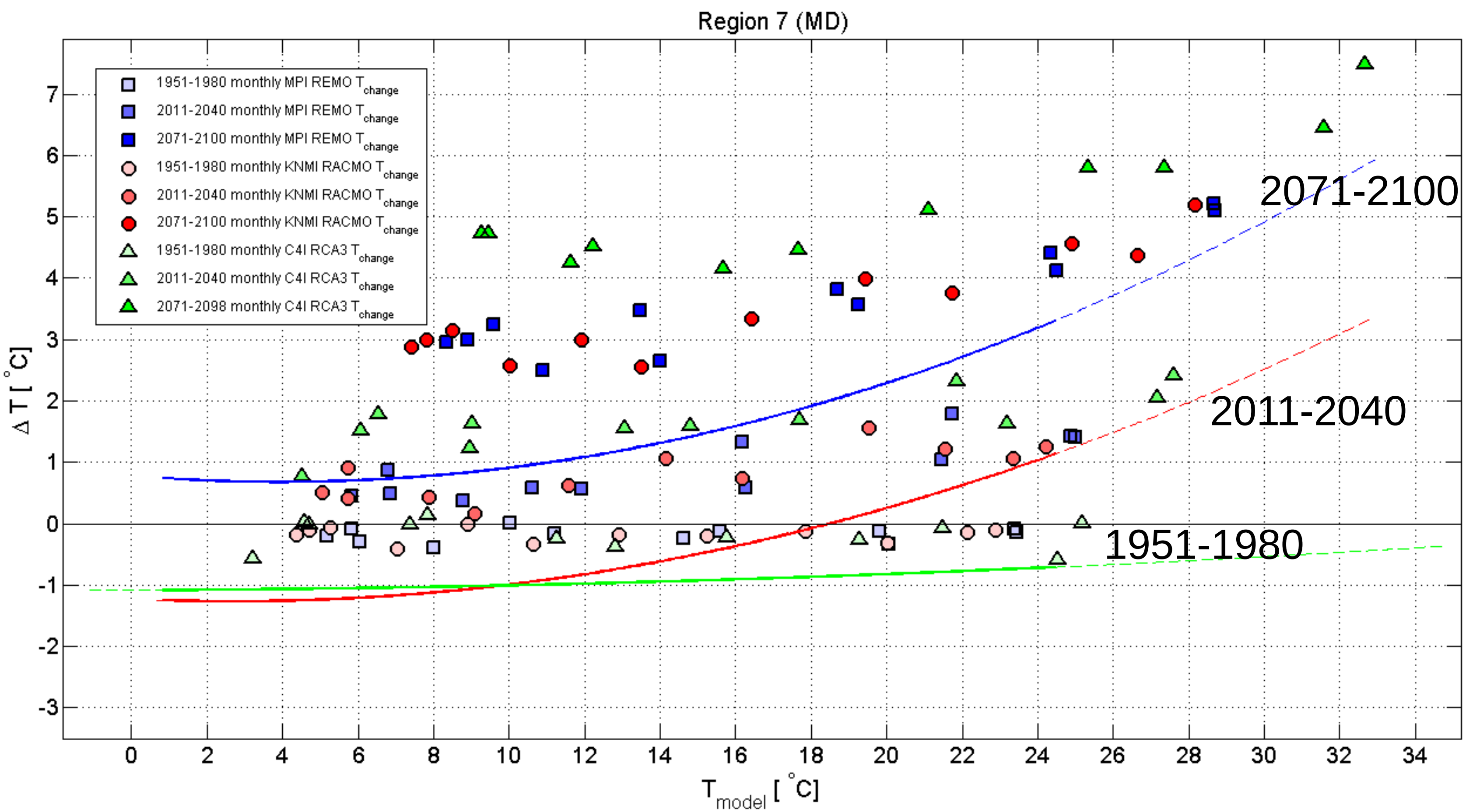
Model bias vs. model values



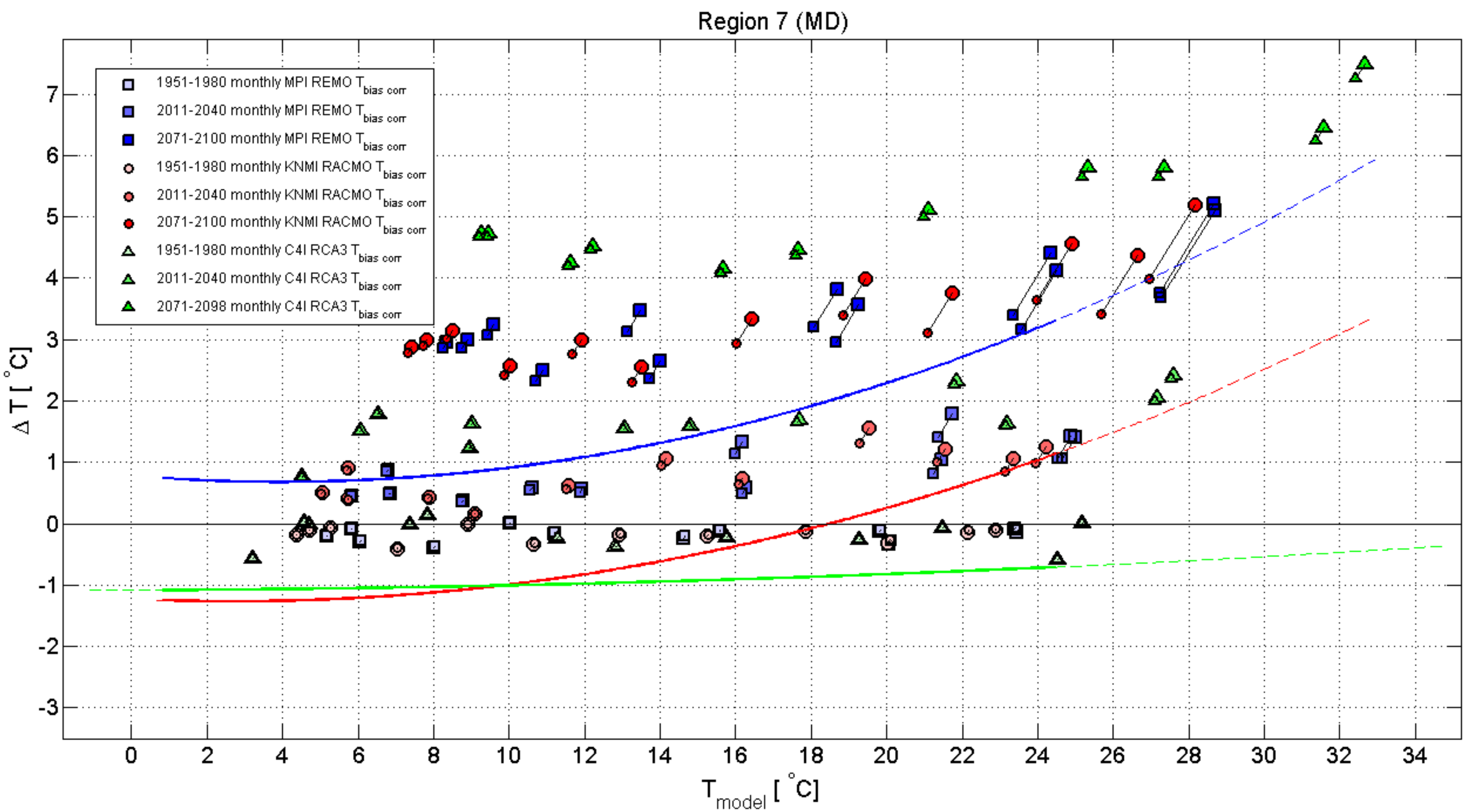
Assessing climate change

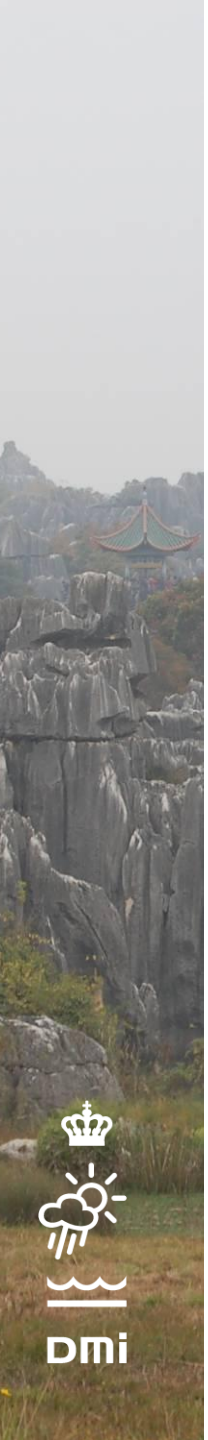


Assessing climate change

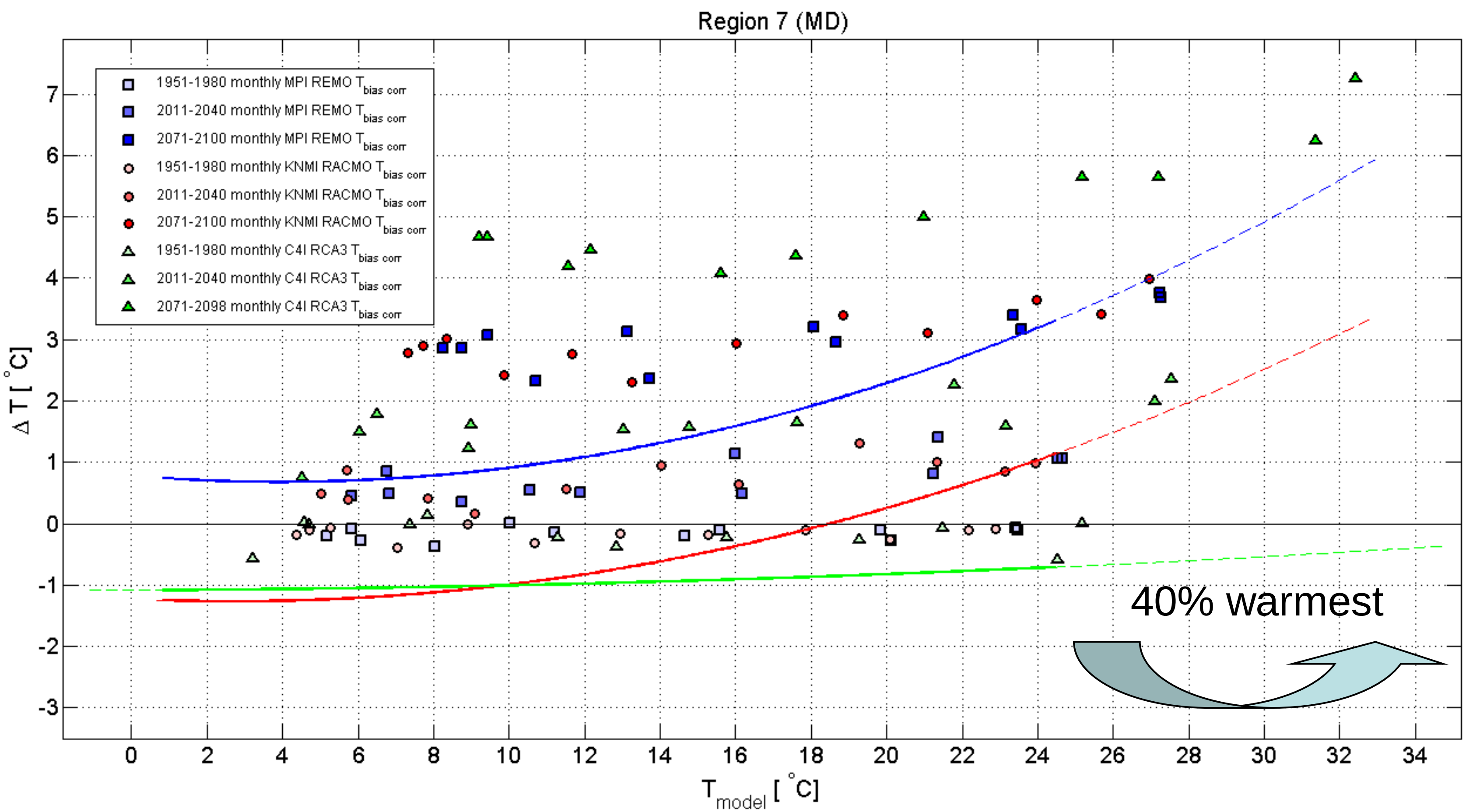


Assessing climate change

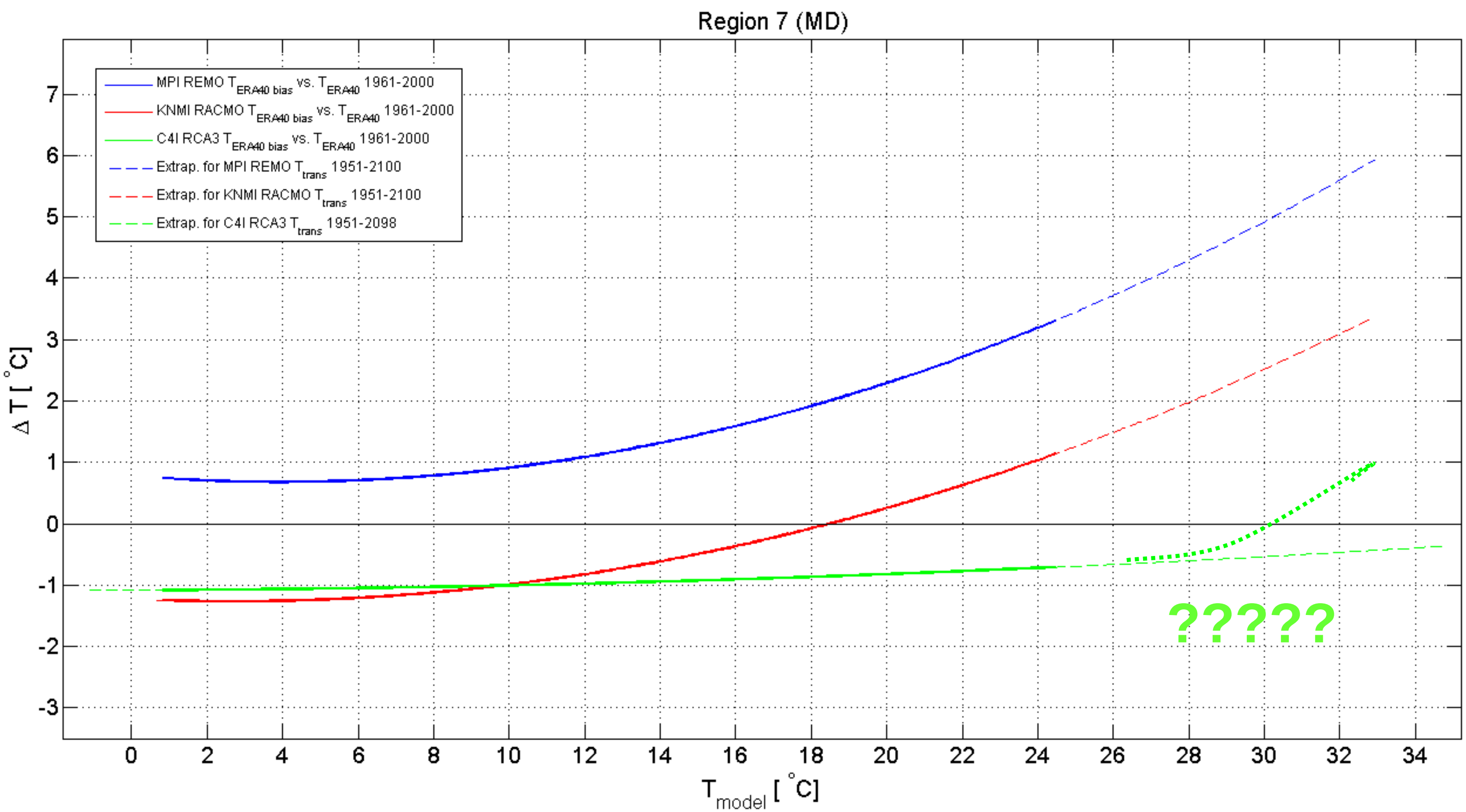




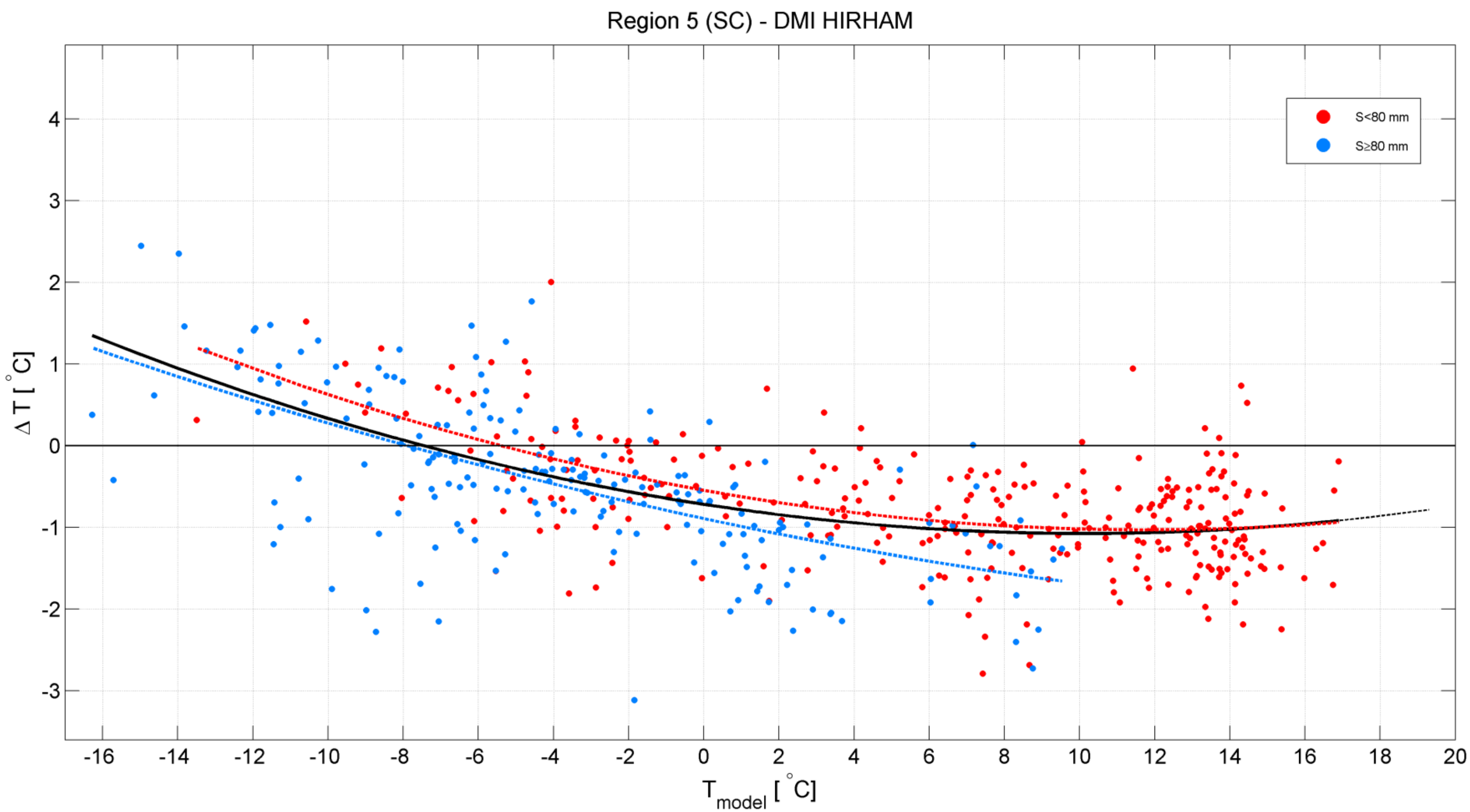
Assessing climate change



Assessing climate change

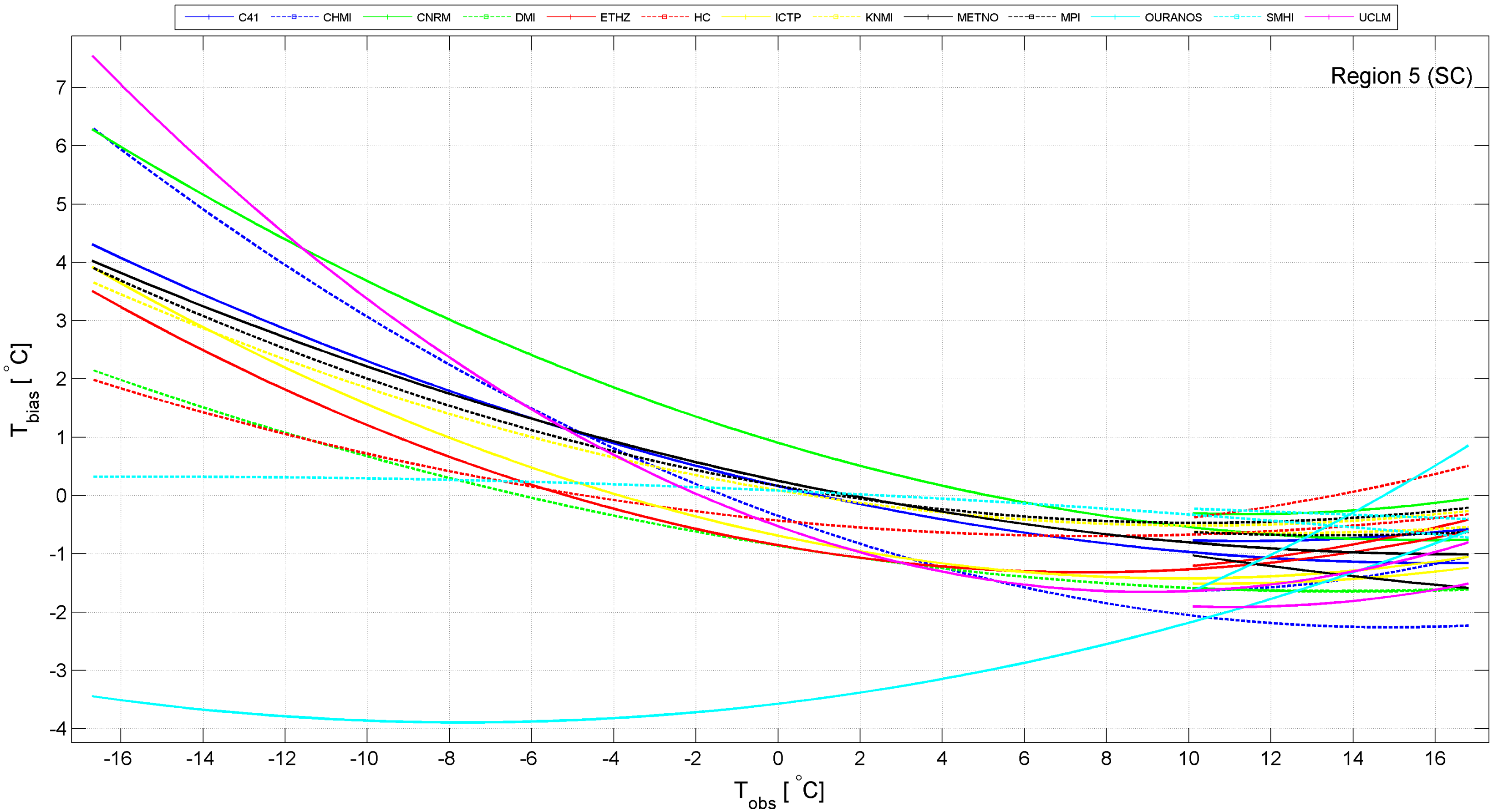


Model bias vs. observations



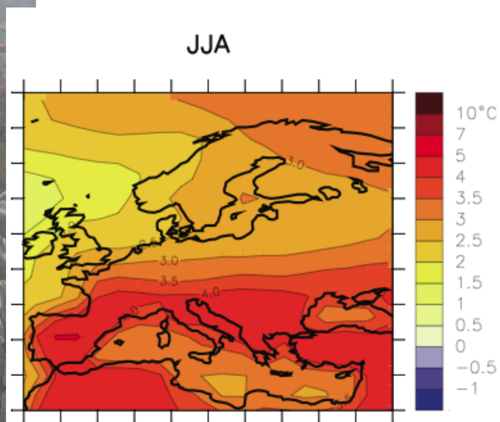
Boberg et al. (2011)

Model bias vs. observations

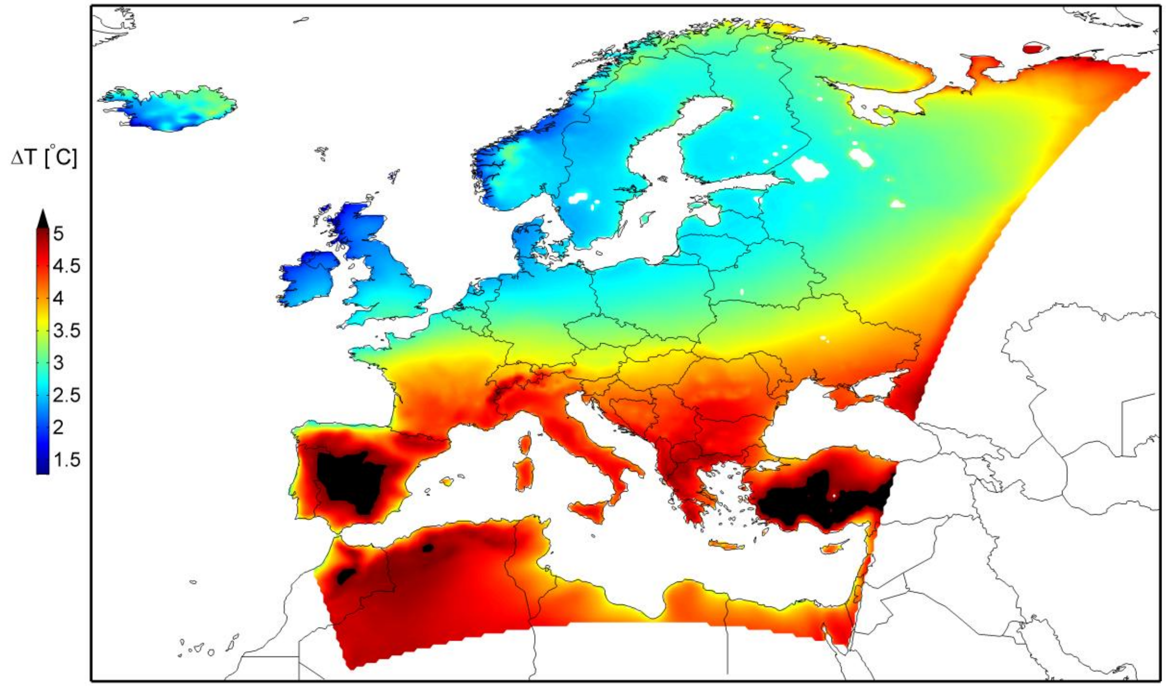


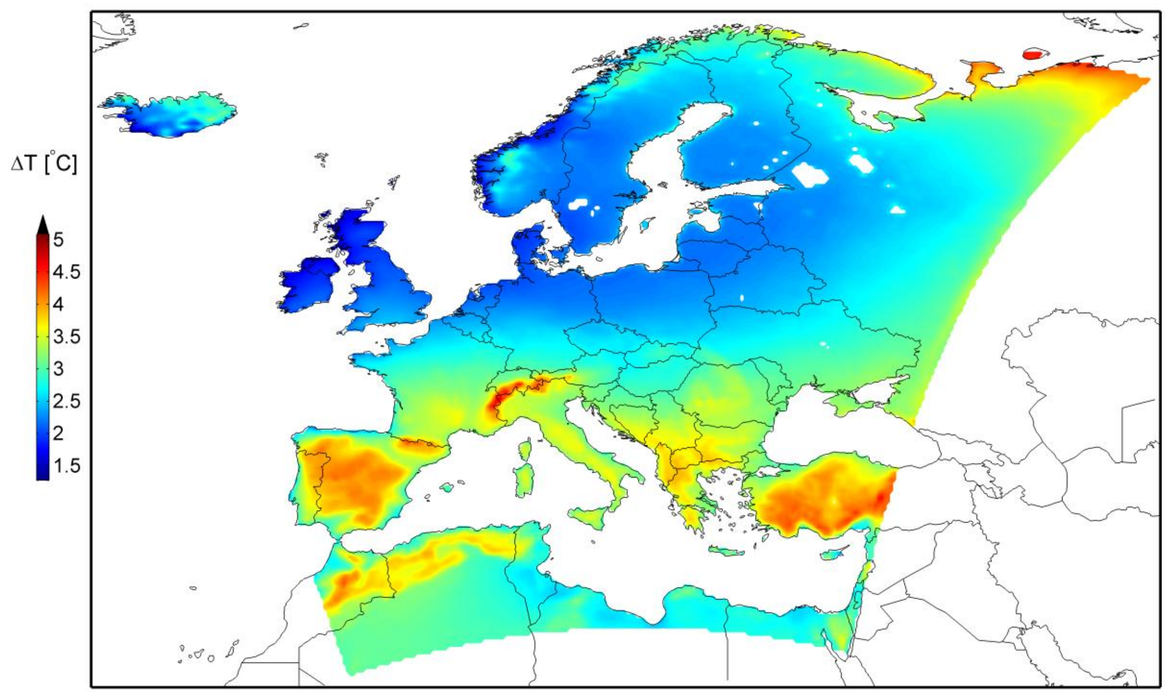
Boberg et al. (2011)

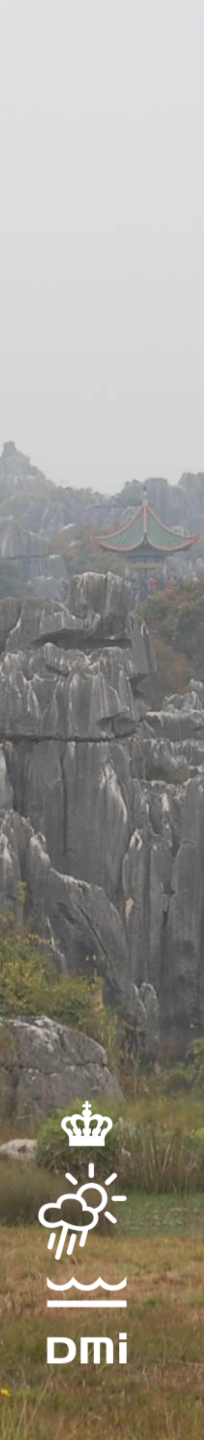
Summer



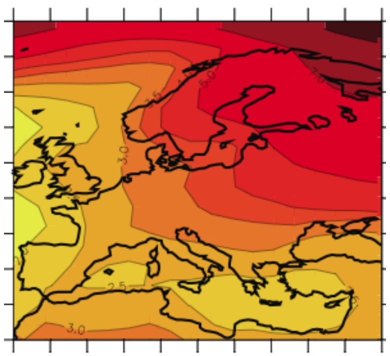
Boberg et al. (2011)



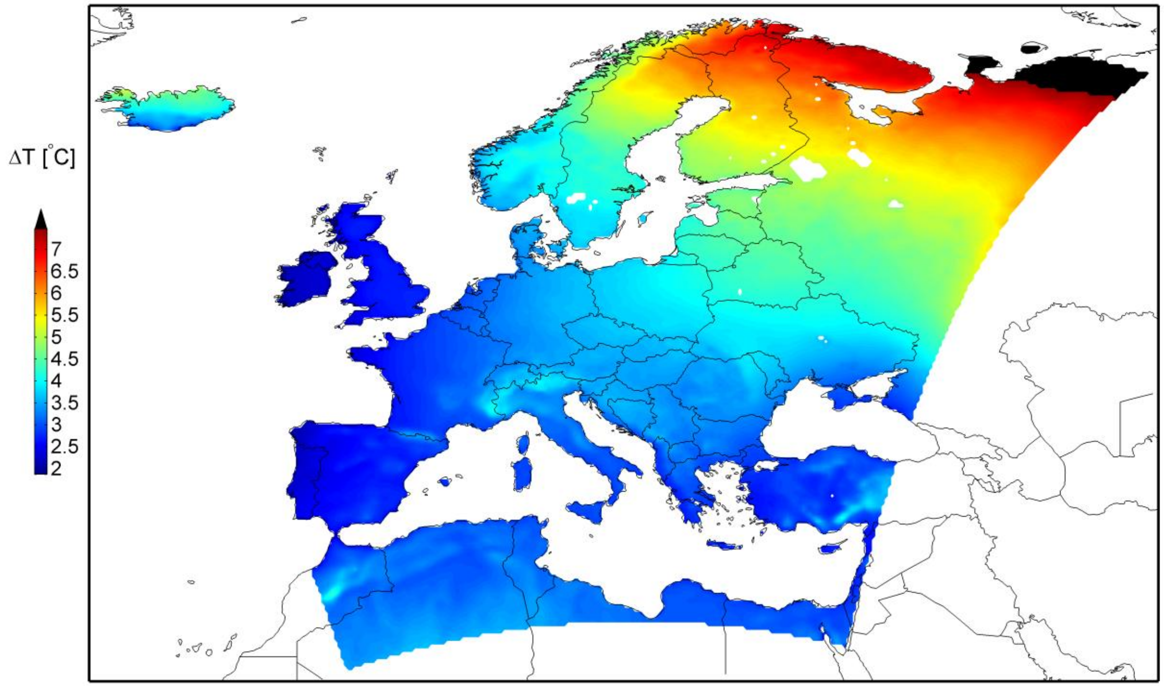


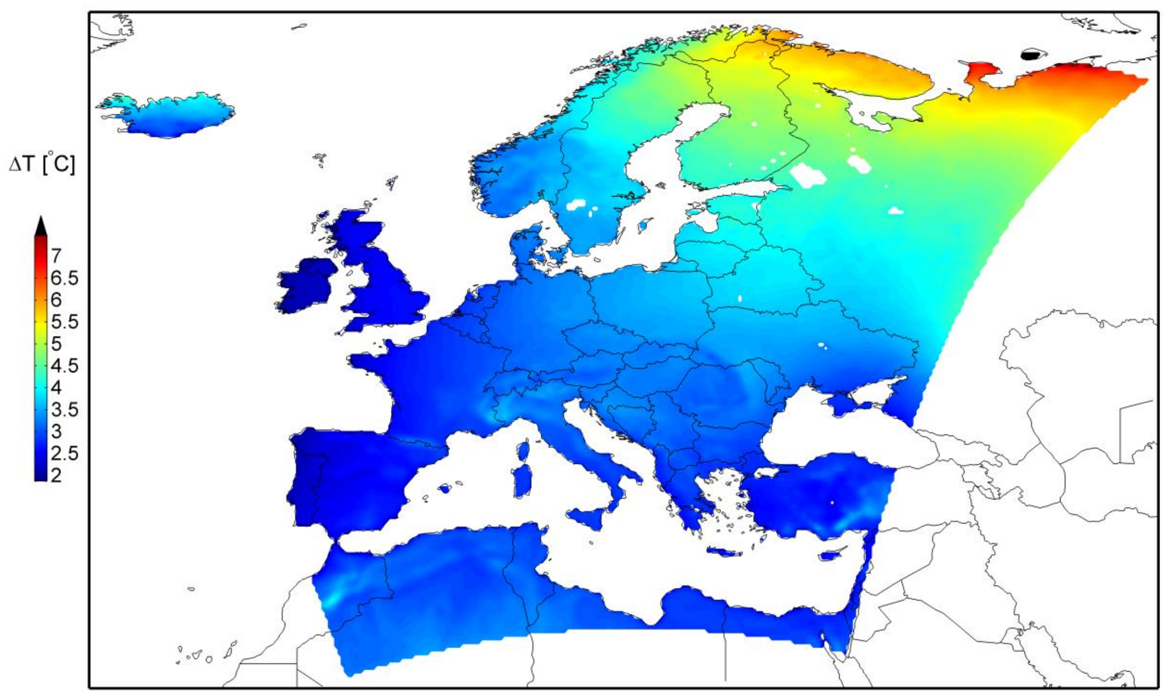


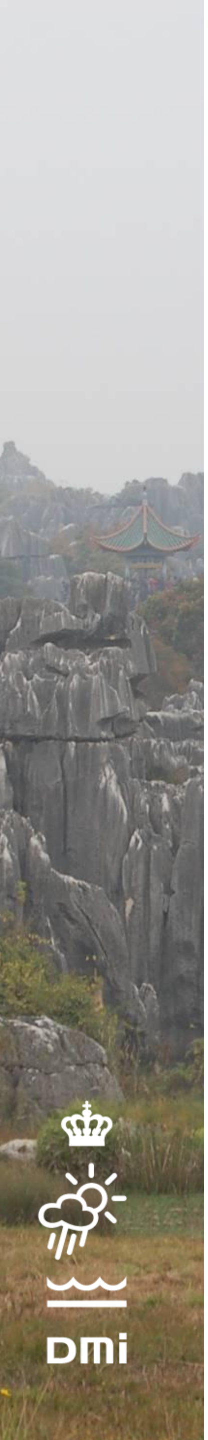
Winter



Boberg et al. (2011)







Conclusions

- Extremes are only known from a few events. Regional climate models handle timing (and extent) of events, but not the strength (of the few events).
  - This is a test that GCMs cannot pass!
  - Utilization of the full spectrum
  - Can we account for this in projection work?

Conclusions

- Models (here RCMs) are suffering from non-linear biases
  - *in casu* temperature
- These impact climate change results, particular when entering non-experienced regimes, but in general where thresholds are present in the land surface/atm. interaction
  - Snow or dry out of soils
- Applying a bias correction tends to reduce model spread and signal, suggesting higher model agreement in projections of change
  - The same physical mechanism is likely to be at play in GCMs!

Thank you for your attention!