CORDEX in the IPCC WGI perspective

Are regional patterns of chance robust?

Jens H. Christensen, Fredrik Boberg,
Philippe Lucas-Picher* and Ole B. Christensen
Kanikicharla Krishna Kumar**

Danish Meteorological Institute
*now Meteo France
** Indian Institute of Tropical Meteorology

Outline

- Room for CORDEX?
  - One IPCC WG-I view
- Aspects of RCM model bias
  - Model bias as the modelers challenge
  - Learning from organized ensembles modeling
  - Exploring the consequence of systematic errors
  - Increasing confidence in projections

2010	
Nov	WGI AR5 First Lead Author Meeting (LA1) **8-11 November 2010**, Kunming, China
2011	
Mar	WGI AR5 Zero Order Draft (ZOD) Due to TSU **18 March 2011**
Apr	WGI AR5 ZOD Review **15 April – 10 June 2011**
Jul	WGI AR5 Second Lead Author Meeting (LA2) **18-22 July 2011**, TBC, France (includes an extra day for optional individual chapter meetings on the 18th)
Nov	WGI AR5 First Order Draft (FOD) Due to TSU **18 November 2011**
Dec	WGI AR5 FOD Review **16 December** – 10 February 2012
2012	
Feb	WGI AR5 FOD Review 16 December – **10 February 2012**
Apr	WGI AR5 Third Lead Author Meeting (LA3) **16-20 April 2012**, Marrakech, Morocco [TBC] (includes an extra day for optional individual chapter team meetings on the 16th and a one-day meeting of the Technical Summary (TS)/Summary for Policymakers (SPM) writing team on the 20th)
Jun	WGI AR5 FOD Review Comment Responses Due to TSU **1 June 2012**
Jul	WGI AR5 cut-off for "submitted" papers **31 July 2012**
Aug	WGI AR5 Second Order Draft (SOD) Due to TSU **10 August 2012**
Oct-Nov	WGI AR5 SOD Review **5 October – 30 November 2012**
2013	
Jan	WGI AR5 Fourth Lead Author Meeting (LA4) **14-19 January 2013**, [TBD] (includes an extra day for optional individual chapter team meetings on the 14th and a two-day meeting of the TS/SPM writing team on the 18th &19th)
Mar	WGI AR5 SOD Comment Responses Due to TSU **1 March 2013**
Mar	WGI AR5 cut-off for "accepted" papers **15 March 2013**
Apr-May	WGI AR5 Final Draft Due to TSU **13 May 2013**
Jun-Aug	Final Review of WGI AR5 SPM **7 June – 2 August 2013**
Sep	Preparatory Meeting of WGI AR5 SPM Drafting Authors & CLAs **20-21 September 2013**, Stockholm, Sweden
Sep	WGI AR5 Plenary (WGI-12) **23-26 September 2013**, Stockholm, Sweden

AR5 WG-I outline

- Chapter 1: Introduction
- Chapter 2: Observations: Atmosphere and Surface
- Chapter 3: Observations: Ocean
- Chapter 4: Observations: Cryosphere
- Chapter 5: Information from Paleoclimate Archives
- Chapter 6: Carbon and Other Biogeochemical Cycles
- Chapter 7: Clouds and Aerosols
- Chapter 8: Anthropogenic and Natural Radiative Forcing

AR5 WG-I outline

- Chapter 9: Evaluation of Climate Models
- Chapter 10: Detection and Attribution of Climate Change: from Global to Regional
- Chapter 11: Near-term Climate Change: Projections and Predictability
- Chapter 12: Long-term Climate Change: Projections, Commitments and Irreversibility
- Chapter 13: Sea Level Change
- Chapter 14: Climate Phenomena and their Relevance for Future Regional Climate Change
- Annex I: Atlas of Global and Regional Climate Projections

DMI

9. **Evaluation of Climate Models**

- The hierarchy of climate models: from global to regional
- Downscaling methods
- Assessing model performance, including quantitative measures and their use
- New model components and couplings
- Representation of processes and feedbacks in climate models
- Simulation of recent and longer term records
- Simulation of regional patterns, variability and extremes

Chapter 9

Coordinating Lead Authors

Gregory FLATO	CANADA
Jochem MAROTZKE	GERMANY

Lead Authors

Babatunde ABIODUN	SOUTH AFRICA
Pascale BRACONNOT	FRANCE
Sin Chan CHOU	BRAZIL
William COLLINS	USA
Peter COX	UNITED KINGDOM
Fatima DRIOUECH	MOROCCO
Seita EMORI	JAPAN
Veronika EYRING	GERMANY
Chris FOREST	USA
Peter GLECKLER	USA
Eric GUILYARDI	FRANCE
Christian JAKOB	AUSTRALIA
Vladimir KATTSOV	RUSSIA
Chris REASON	SOUTH AFRICA
Markku RUMMUKAINEN	SWEDEN

12. **Long-term Climate Change: Projections, Commitments and Irreversibility**

- Scenario description
- Projections for the 21st century
  RCP experiments
- Projections beyond the 21st century
- Regional climate change, variability and extremes
- Forcing, response and climate sensitivity
- Climate change commitment and inertia
- Potential for abrupt change and irreversibility in the climate system
- Quantification of the range of climate change projections

Chapter 12

Coordinating Lead Authors

Matthew COLLINS	UNITED KINGDOM
Reto KNUTTI	SWITZERLAND

Lead Authors

Julie ARBLASTER	AUSTRALIA
Ken CALDEIRA	USA
Jean-Louis DUFRESNE	FRANCE
Thierry FICHEFET	BELGIUM
Pierre FRIEDLINGSTEIN	UNITED KINGDOM
Xuejie GAO	CHINA
William GUTOWSKI	USA
Tim JOHNS	UNITED KINGDOM
Gerhard KRINNER	FRANCE
Mxolisi SHONGWE	SWAZILAND
Claudia TEBALDI	USA
Andrew WEAVER	CANADA
Michael WEHNER	USA

Chapter 14

- Changes in Local Ambient Conditions
- Climate modes of variability
  - Tropical modes
  - Northern Hemisphere climate modes
  - Southern Hemisphere modes

Chapter 14

- Regional Changes
  - Asia
    - Indian Monsoon
    - East-Asian Monsoon
    - Indo-Australian Monsoon including Maritime Continent
    - Western and North Pacific Monsoon
    - Northern Asia
  - Australia and New Zealand
  - Africa
  - Europe and Mediterranean
  - Americas
  - Polar
  - Small Islands

Chapter 14: Climate Phenomena and their Relevance for Future Regional Climate Change

Length: 30 printed pages excl. refs and figures and FAQ

CLAs: J.H. Christensen and K. Krishna Kumar

LAs:E. Aldrian, S.-I. An, I.F.A. Cavalcanti, M. de Castro, V. Dong, P. Goswami, A. Hall, J. Kanyanga, A. Kitoh, J. Kossin, N.-C. Lau, J. Renwich, D. Stephenson, S.-P. Xie, T. Zhou

DMI

Annex I

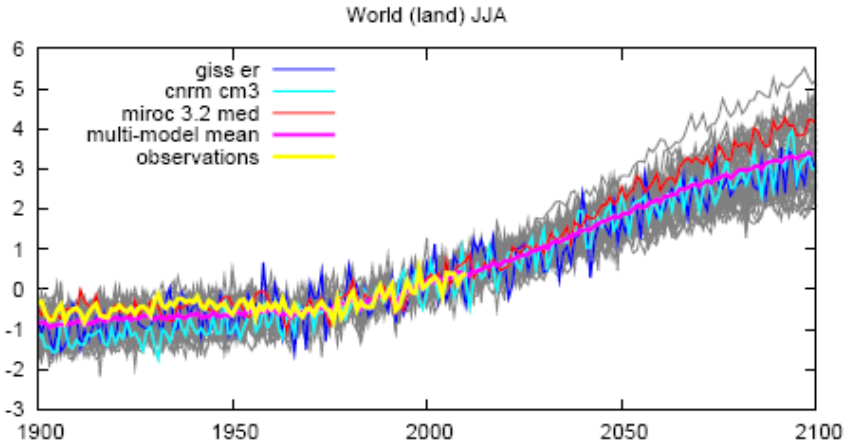
- Annex I: Atlas of Global and Regional Climate Projections will provide comprehensive information on a selected range of variables (e.g., temperature and precipitation) for a few selected time horizons (e.g., 2020, 2050, and 2100) for all regions and, to the extent possible, for the four basic RCP scenarios. Numerical fields corresponding to the figures together with the specification of the data sources and the description of how the figures were constructed will also be included.

Annex I

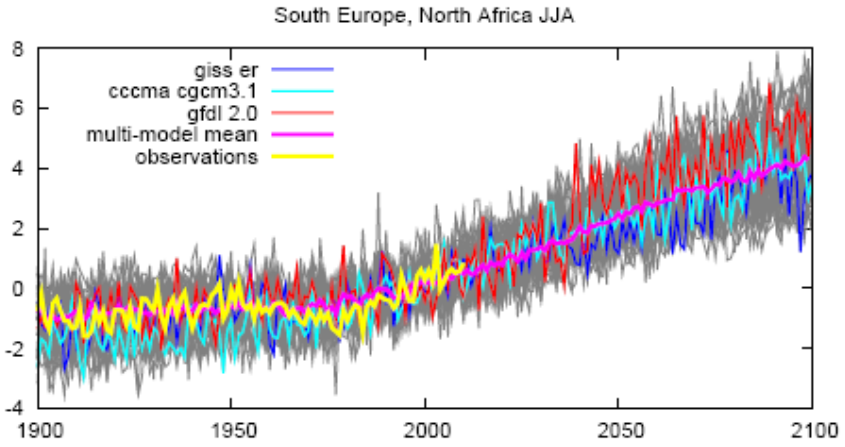
- The information used in Annex I will be based on material assessed in WGI Chapters 11, 12 or 14. Each Figure caption will include a reference to the location in the assessment report where the underlying information is assessed and vice versa. Each figure included in the Atlas will be assessed and reviewed as part of the underlying chapter in which it originates.

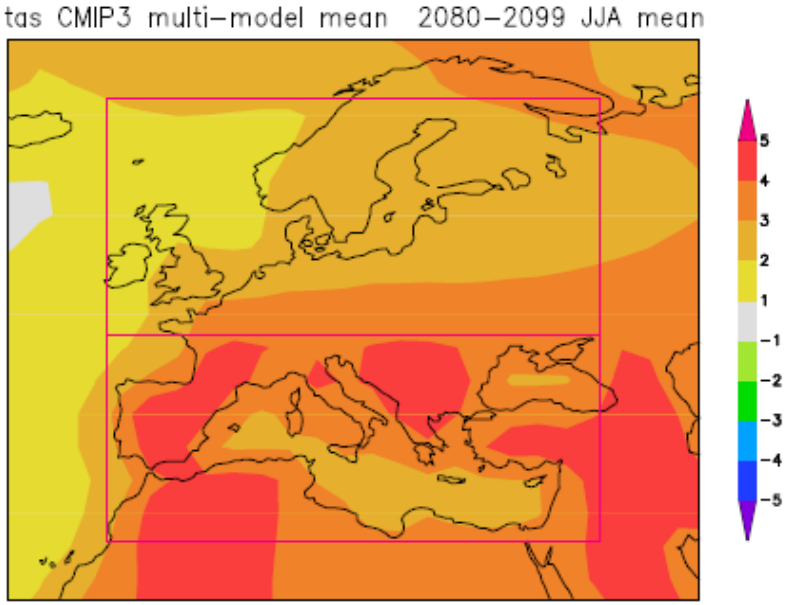
Annex I

- **Editorial Team:** Mat Collins (Ch12 CLA, Chair of Editorial Team), Julie Arblaster (Ch12 LA), Jens Hesselbjerg Christensen (Ch14 CLA), Geert Jan van Oldenborgh (Ch11 LA), Scott Power (Ch11 LA), Tianjun Zhou (Ch14 LA)
- **Advisory Board:** David Wratt (WGI Vice-Chair), Frances Zwiers (WGI Vice-Chair), Bruce Hewitson (WGII CLA)



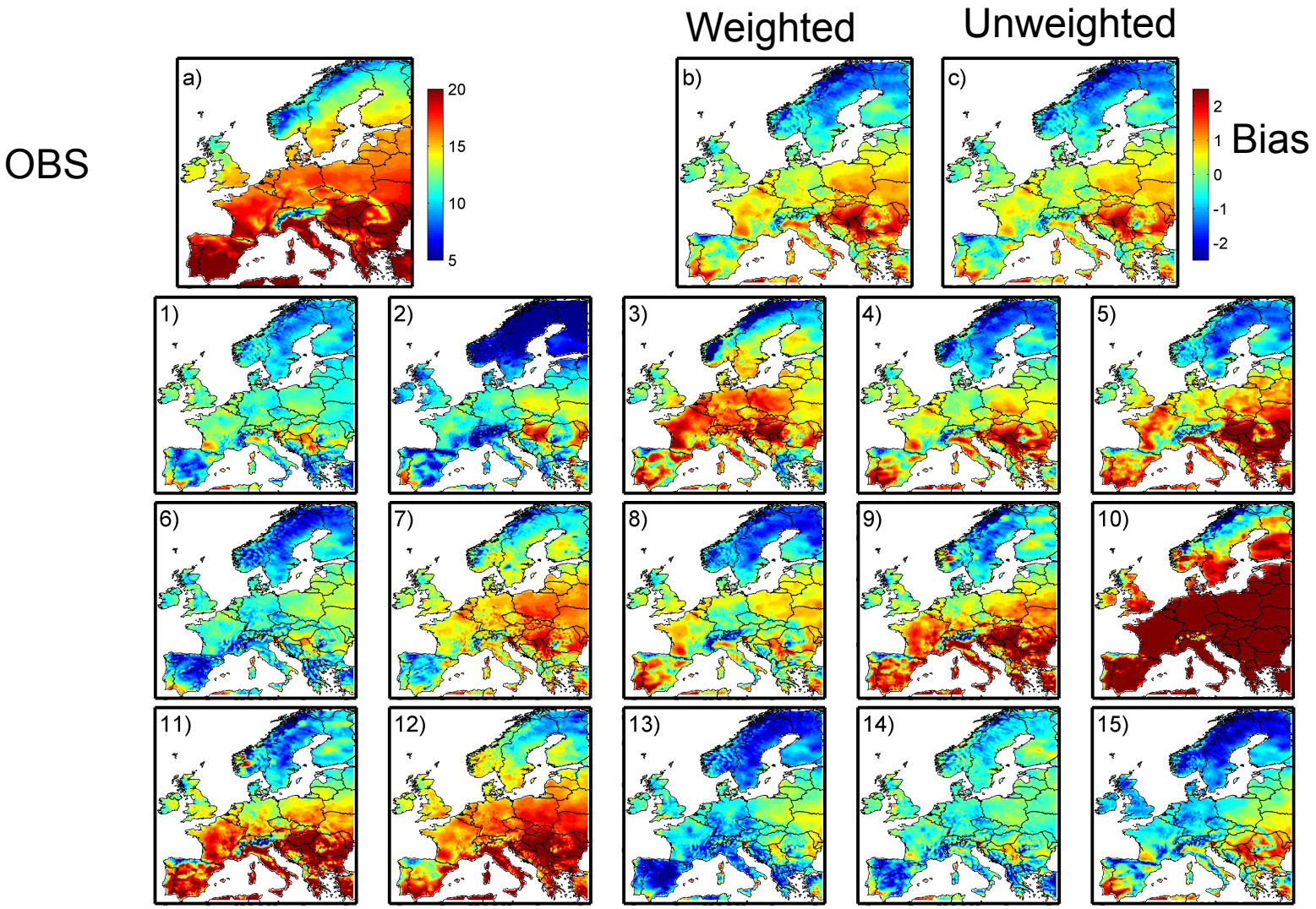
A1B scenario





Curtsey van Oldenborgh (AR5, Atlas)

ENSEMBLES Summer temperature model bias



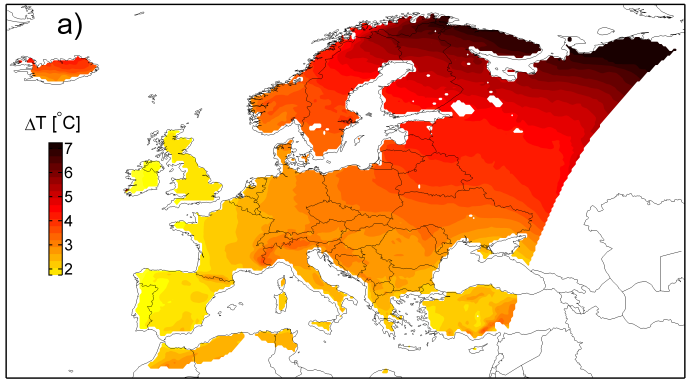
Christensen et al. 2010

Relating model spread and uncertainty assignment

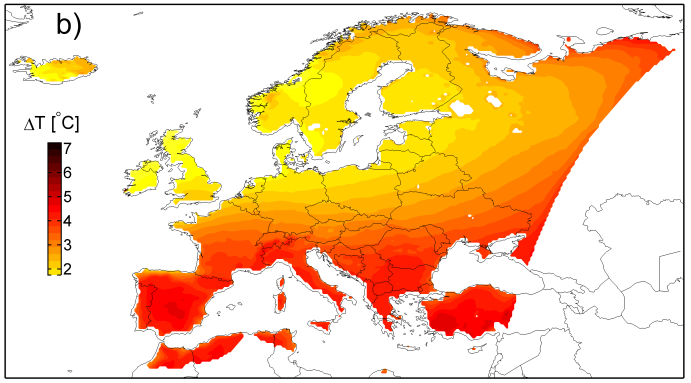
- Delta change and transient change assumes invariance of model bias under climate change
- What if this is not the case?
- What are the implications for the ’predictions’?
- Can this possibly be ameliorated?

$$\langle T_{change} \rangle = \langle T_{2071\text{-}2100} - T_{1961\text{-}1990} \rangle$$

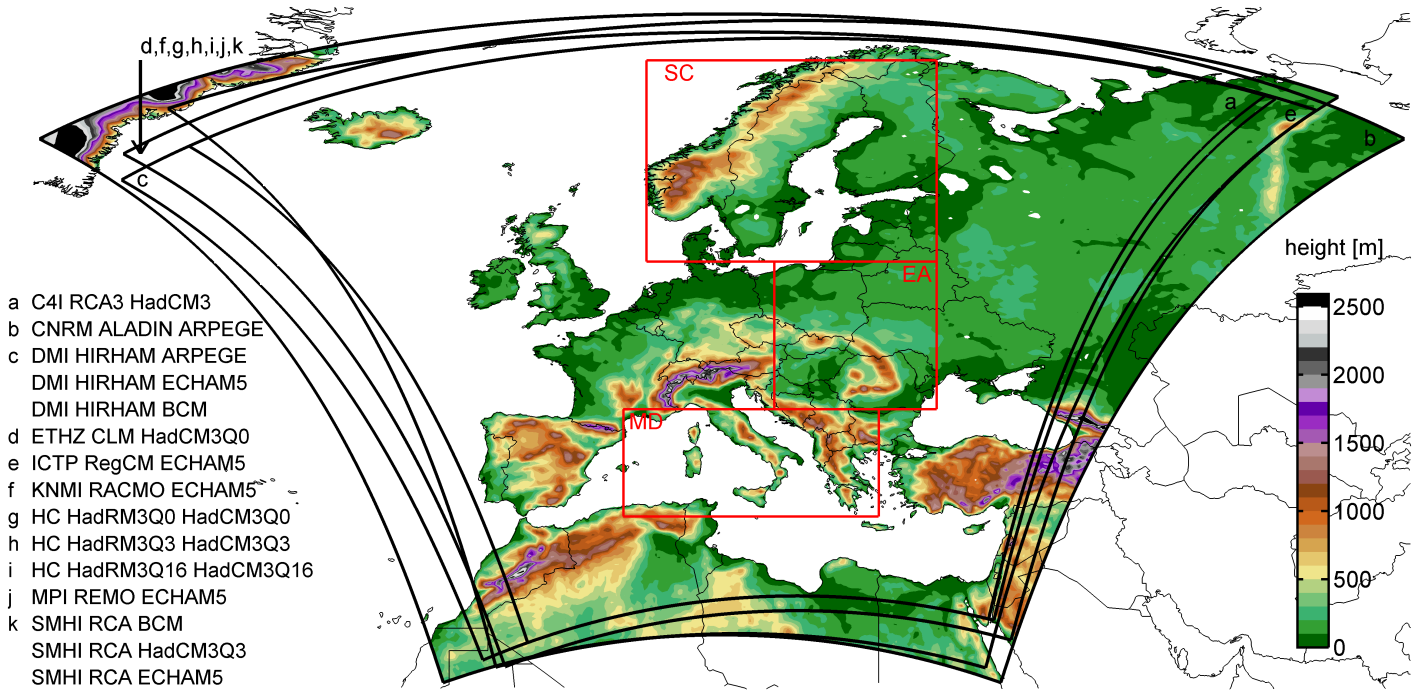
DJF



JJA

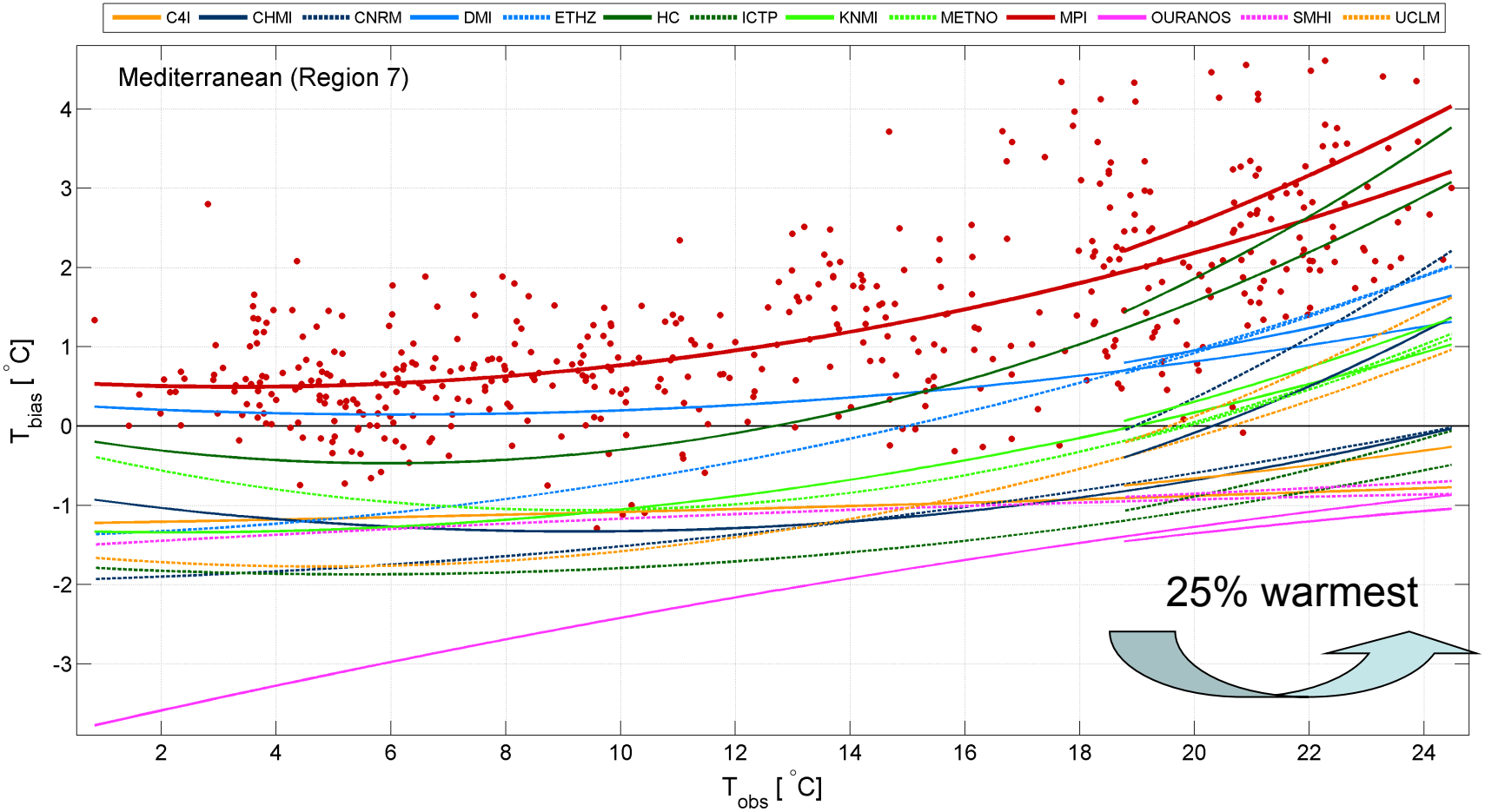


Models and regions



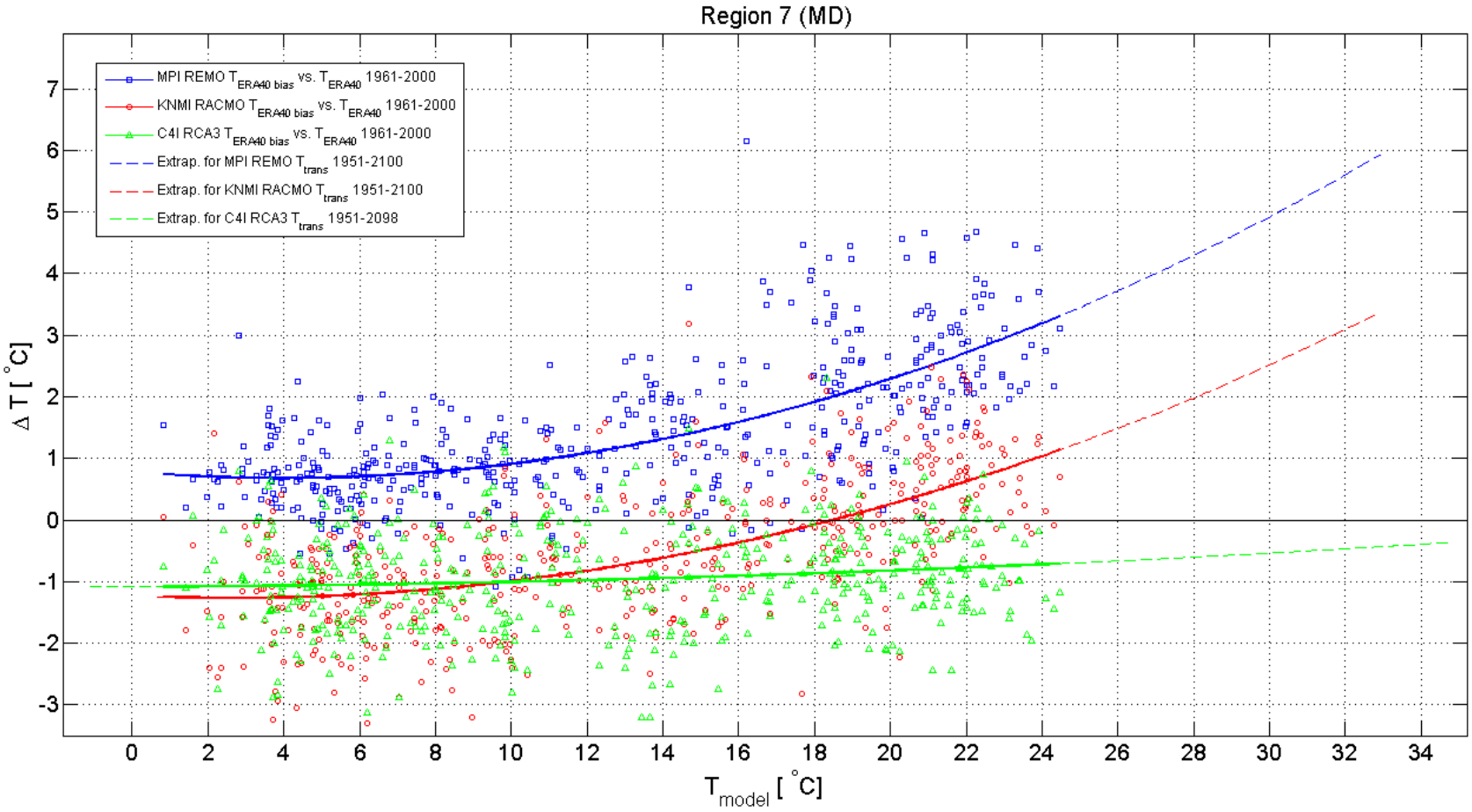
+ gridded E-OBS dataset 1961-2000
+ 64 GCM runs from CMIP3

Model bias vs. observations

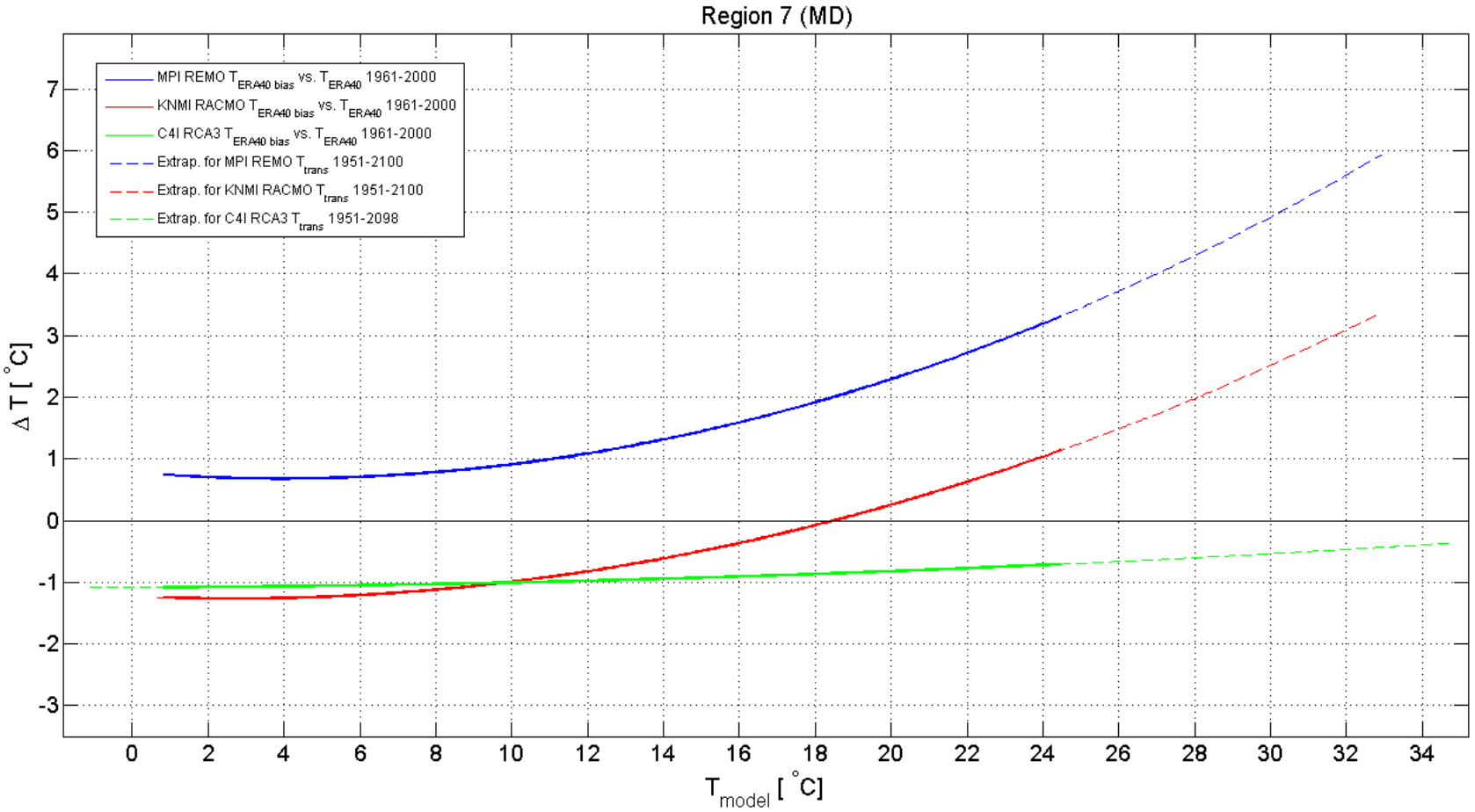


(Christensen *et al.* 2008)

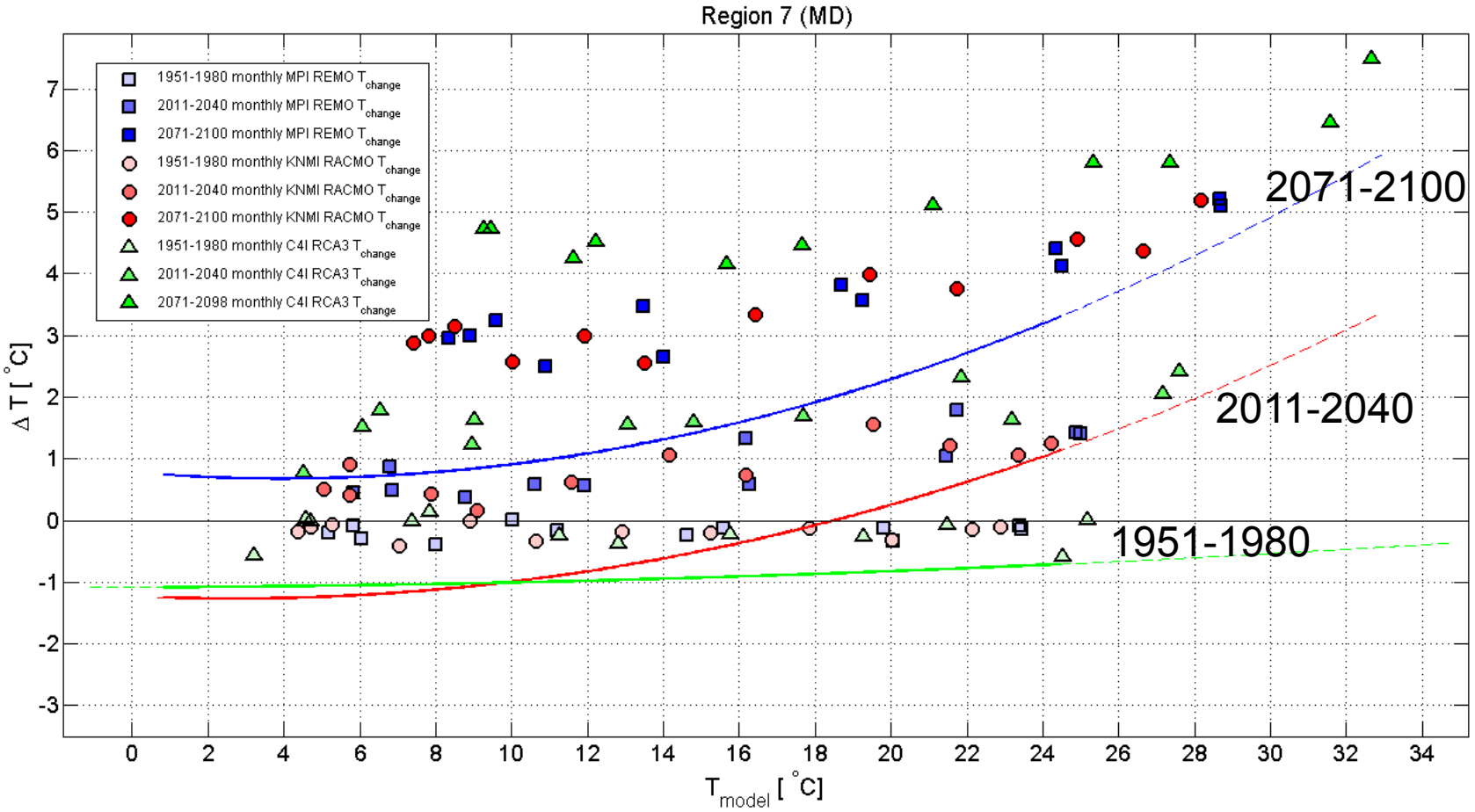
Model bias vs. model values



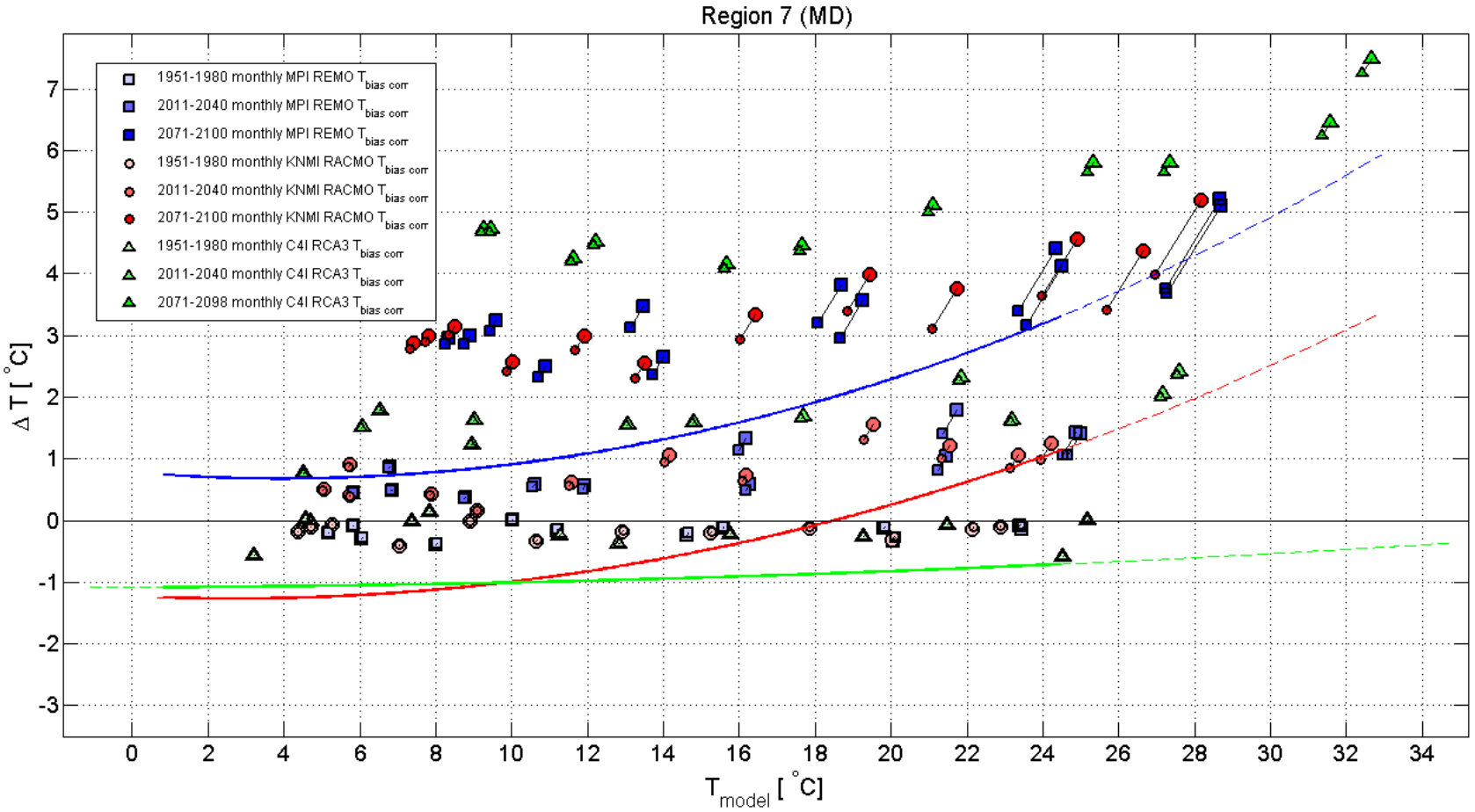
Assessing climate change



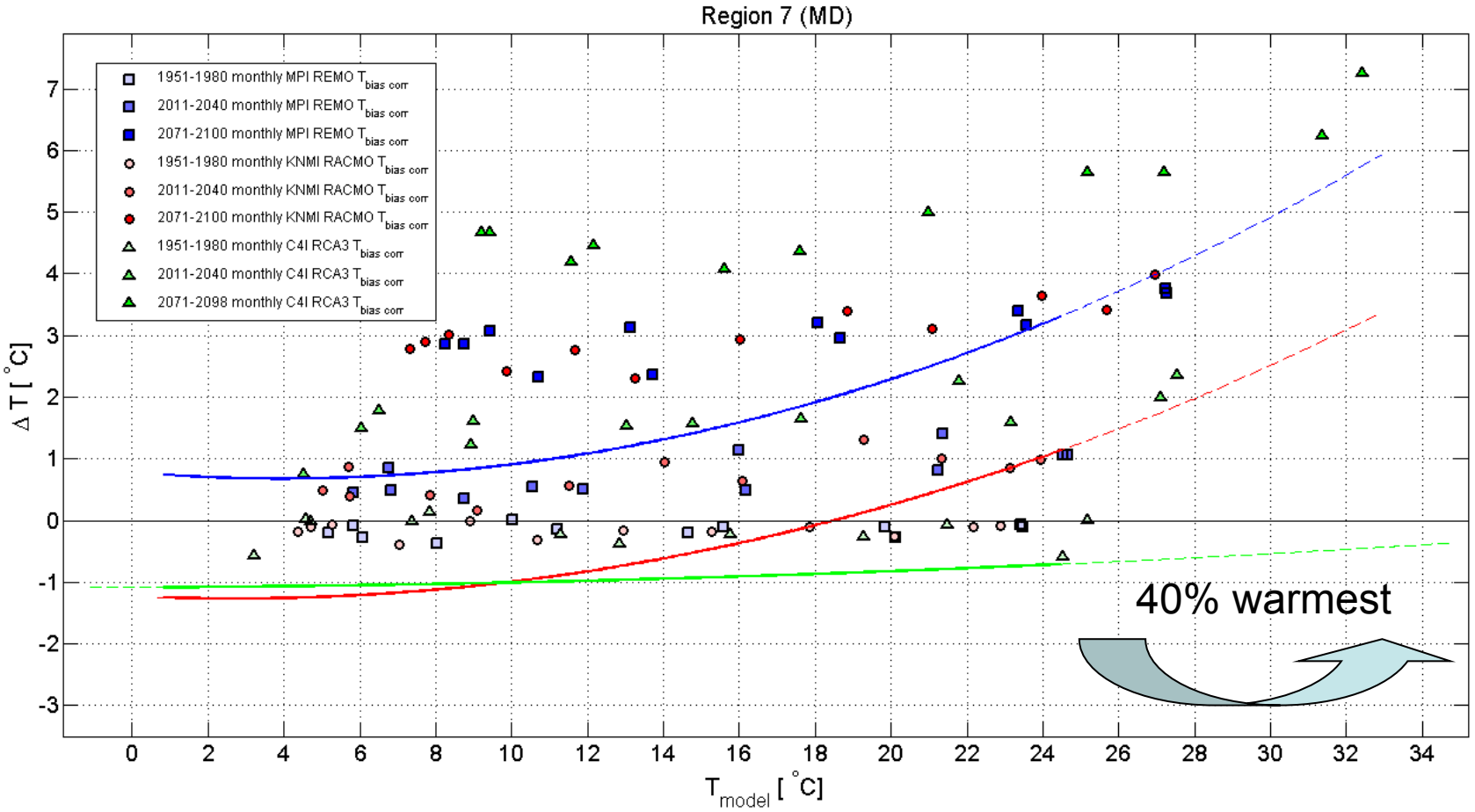
Assessing climate change



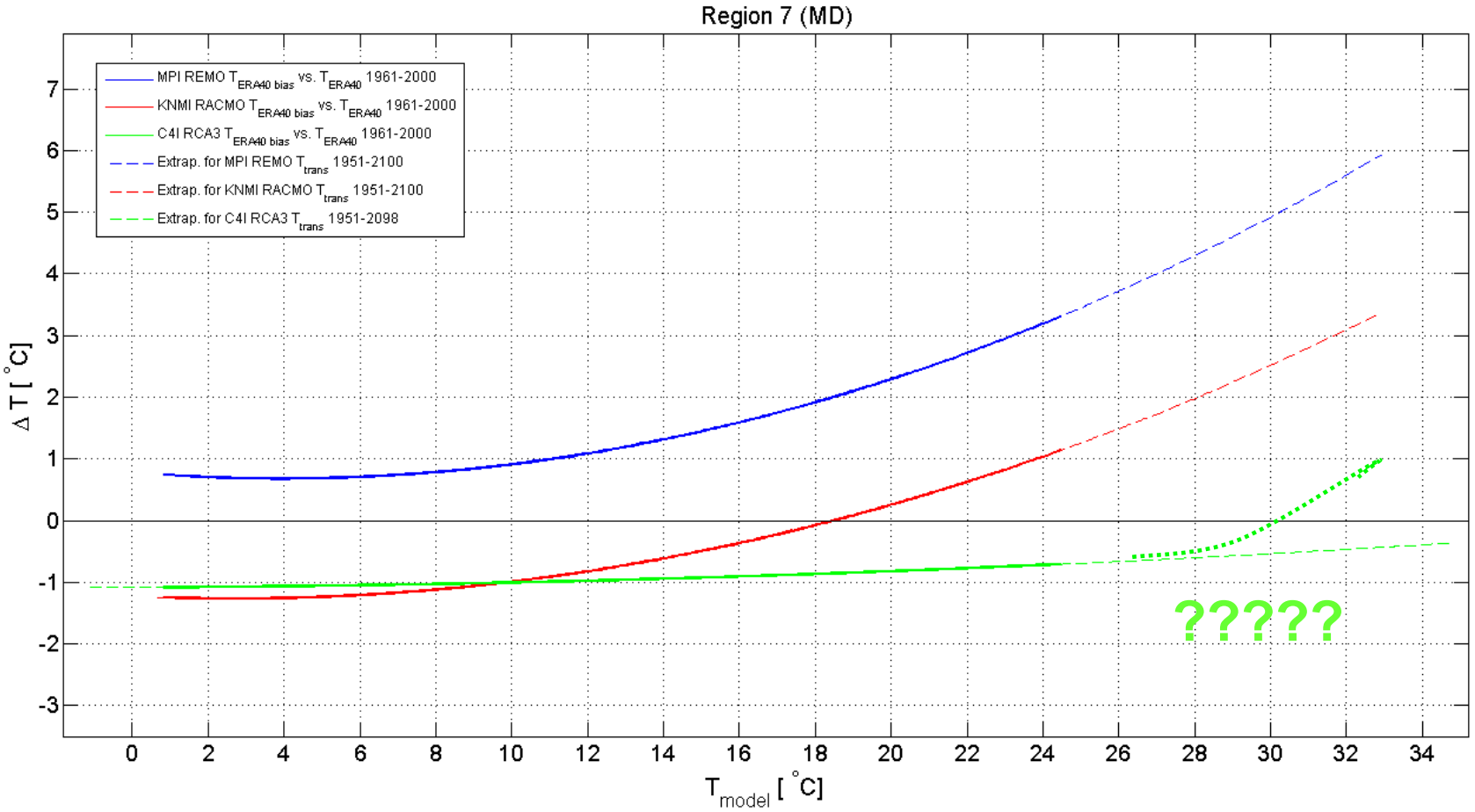
Assessing climate change



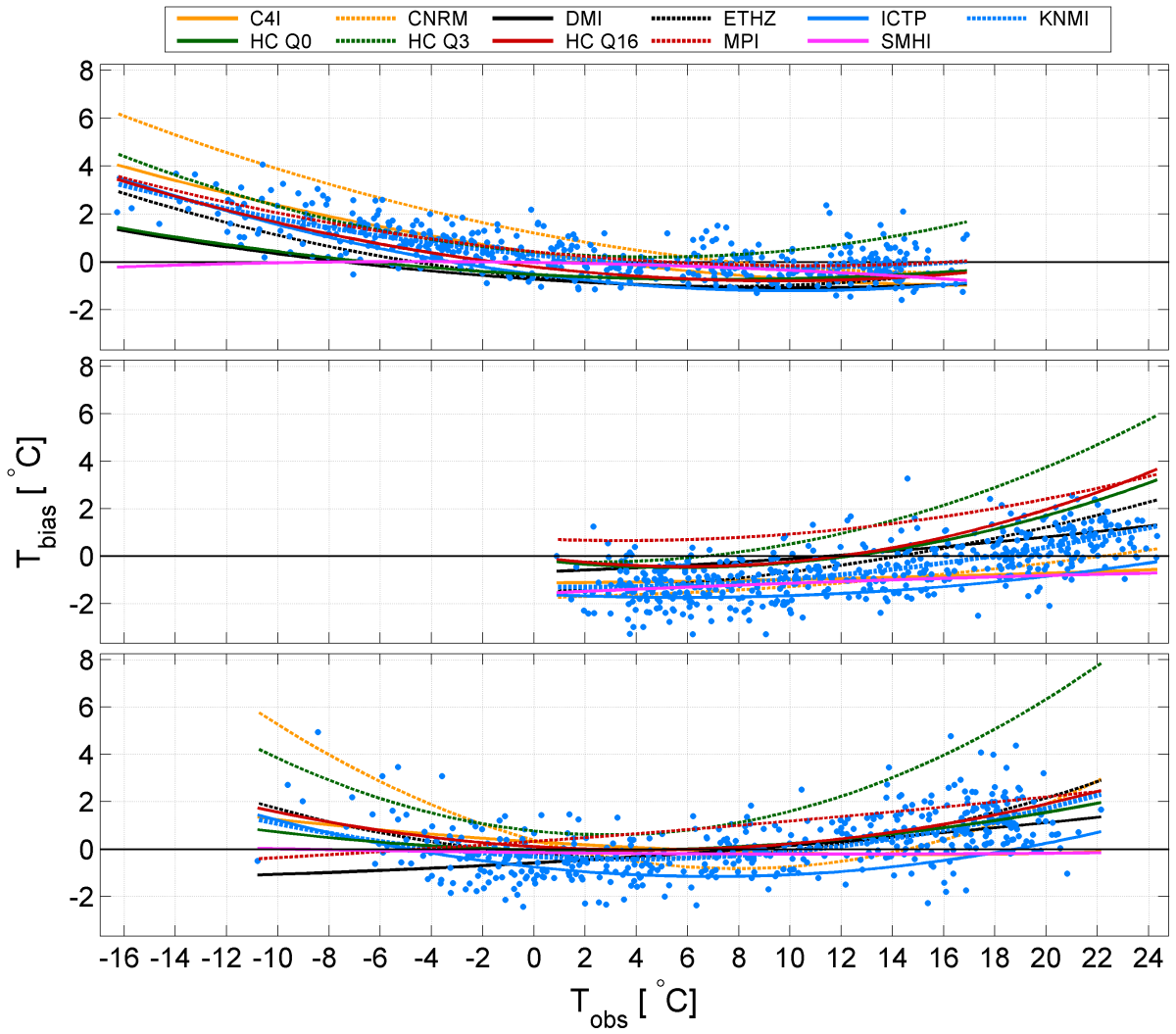
Assessing climate change



Assessing climate change



T_{bias} for ERA40



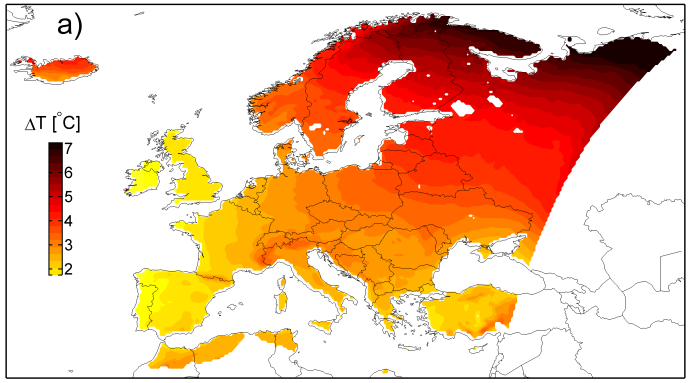
Scandinavia
(cold climate)

Mediterranean
(warm and dry)

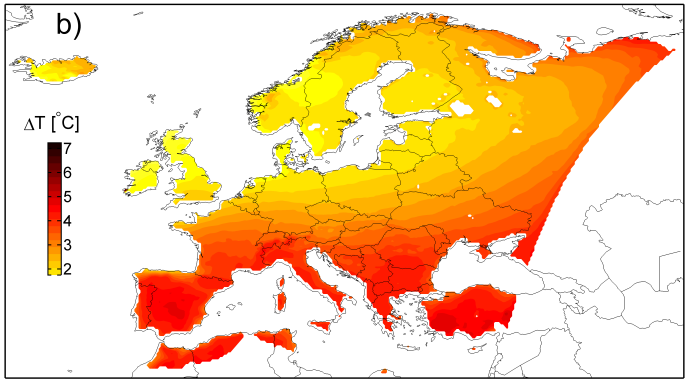
Eastern Europe
(mixed climate)

$$\langle T_{change} \rangle = \langle T_{2071\text{-}2100} - T_{1961\text{-}1990} \rangle$$

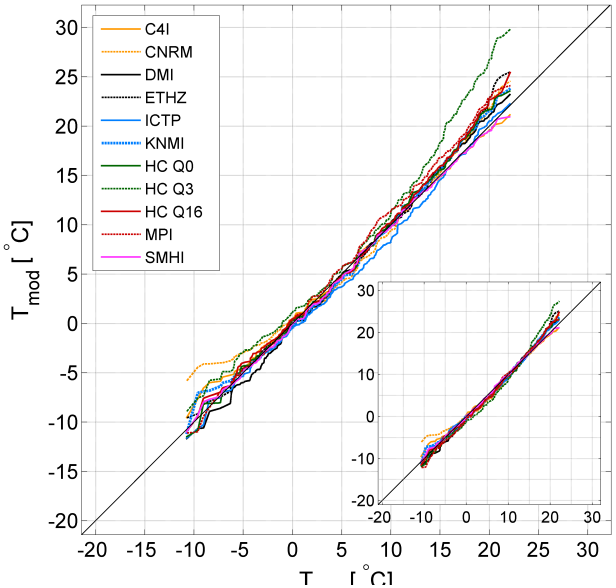
DJF



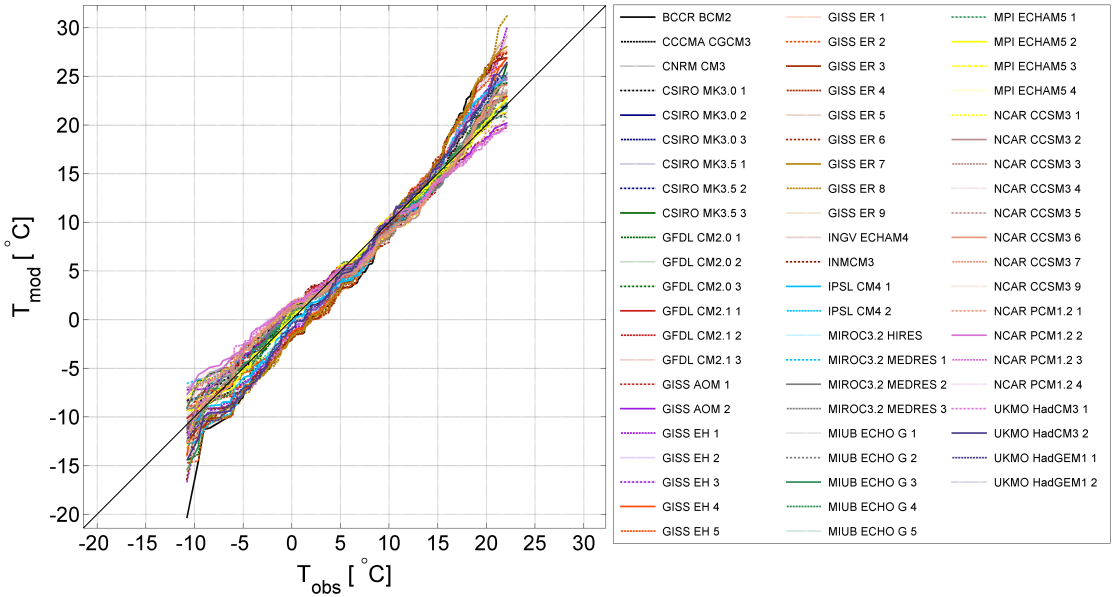
JJA



Ranked T_{mod} for RCMs/GCMs (Eastern Europe)



11 RCMs

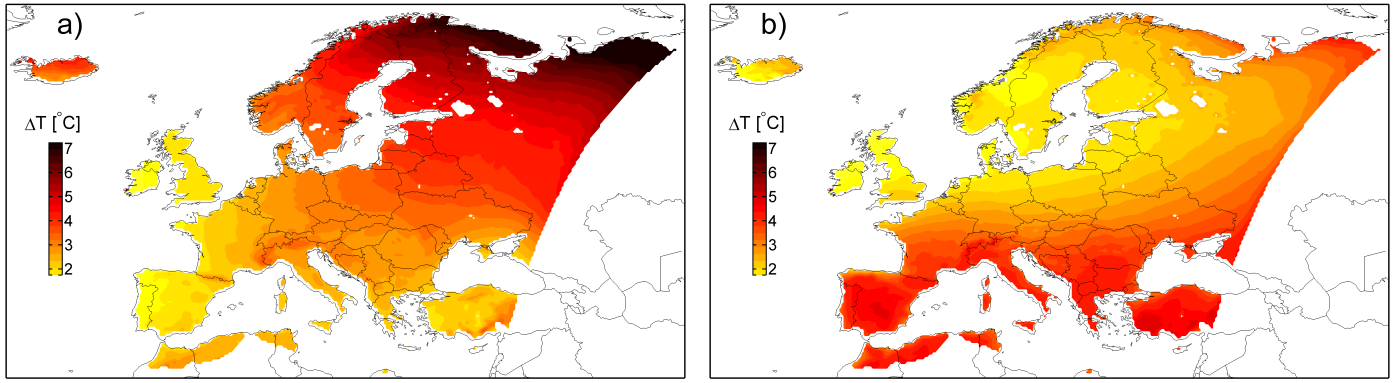


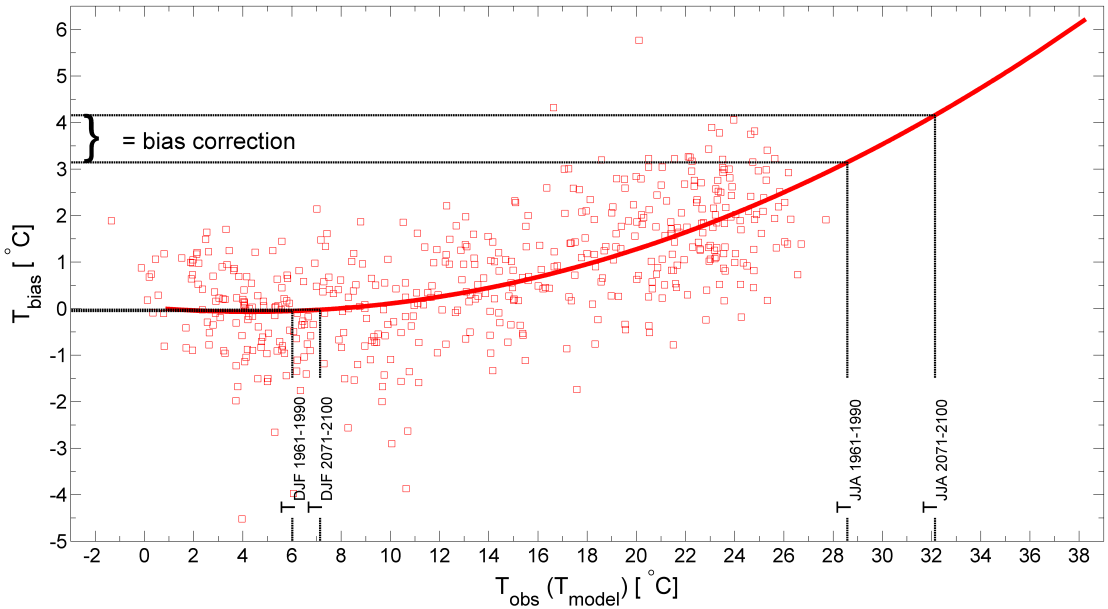
64 GCMs

$\langle T_{change} \rangle = \langle T_{2071\text{-}2100} - T_{1961\text{-}1990} \rangle$

DJF

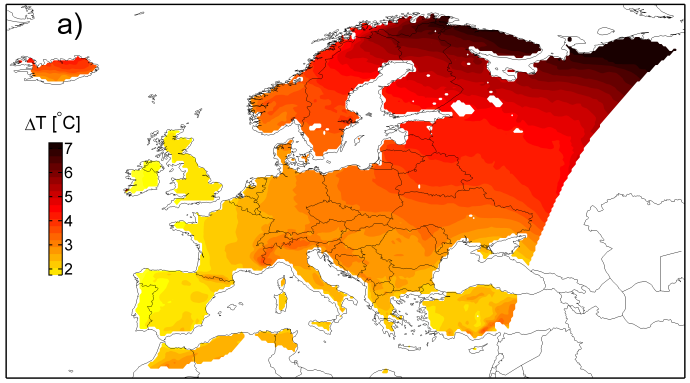
JJA



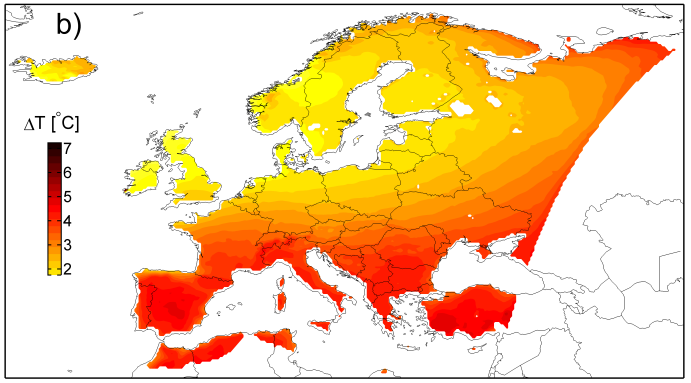


$$\langle T_{change} \rangle = \langle T_{2071\text{-}2100} - T_{1961\text{-}1990} \rangle$$

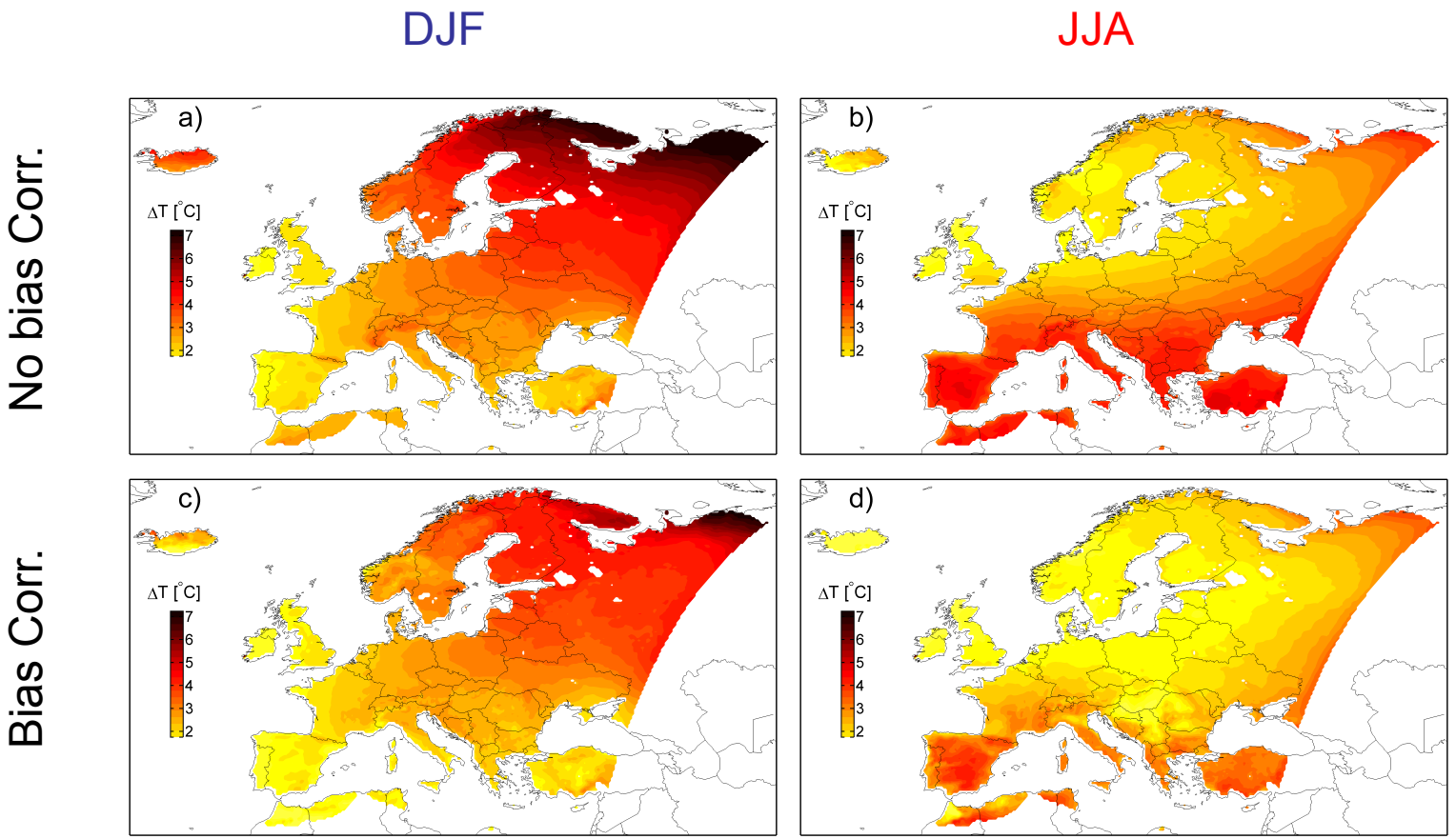
DJF

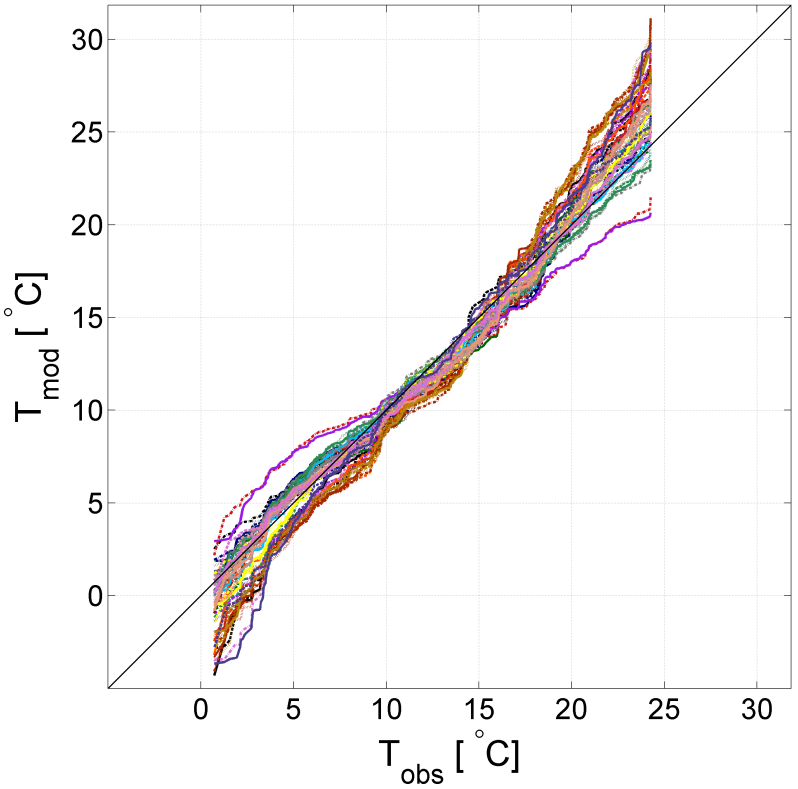


JJA



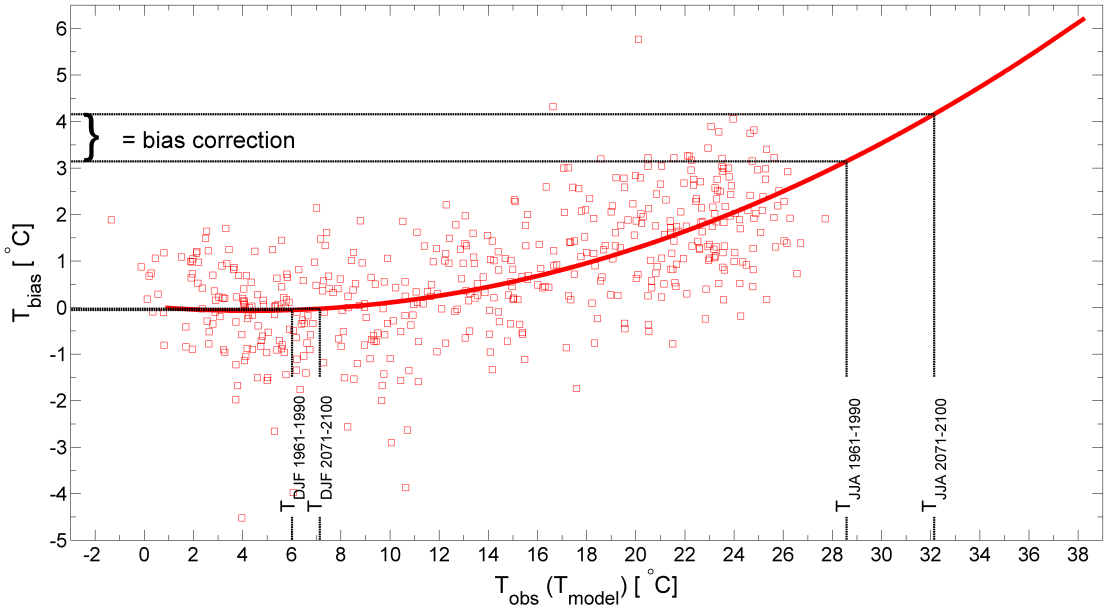
$$\langle T_{change} \rangle = \langle T_{2071\text{-}2100} - T_{1961\text{-}1990} \rangle - \langle BC \rangle$$

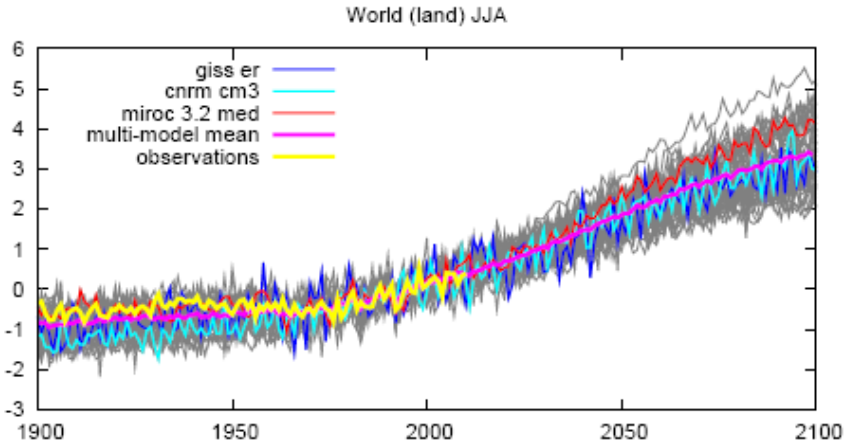




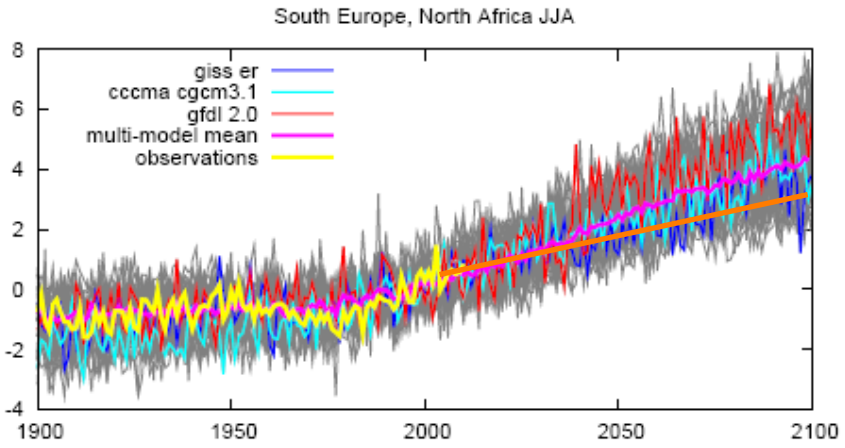
BCCR BCM2
CCCMA CGCM3
CNRM CM3
CSIRO MK3.0 1
CSIRO MK3.0 2
CSIRO MK3.0 3
CSIRO MK3.5 1
CSIRO MK3.5 2
CSIRO MK3.5 3
GFDL CM2.0 1
GFDL CM2.0 2
GFDL CM2.0 3
GFDL CM2.1 1
GFDL CM2.1 2
GFDL CM2.1 3
GISS AOM 1
GISS AOM 2
GISS EH 1
GISS EH 2
GISS EH 3
GISS EH 4
GISS EH 5
GISS ER 1
GISS ER 2
GISS ER 3
GISS ER 4
GISS ER 5
GISS ER 6
GISS ER 7
GISS ER 8
GISS ER 9
INGV ECHAM4
INMCM3
IPSL CM4 1
IPSL CM4 2
MIROC3.2 HIRES
MIROC3.2 MEDRES 1
MIROC3.2 MEDRES 2
MIROC3.2 MEDRES 3
MIUB ECHO G 1
MIUB ECHO G 2
MIUB ECHO G 3
MIUB ECHO G 4
MIUB ECHO G 5
MPI ECHAM5 1
MPI ECHAM5 2
MPI ECHAM5 3
MPI ECHAM5 4
NCAR CCSM3 1
NCAR CCSM3 2
NCAR CCSM3 3
NCAR CCSM3 4
NCAR CCSM3 5
NCAR CCSM3 6
NCAR CCSM3 7
NCAR CCSM3 9
NCAR PCM1.2 1
NCAR PCM1.2 2
NCAR PCM1.2 3
NCAR PCM1.2 4
UKMO HadCM3 1
UKMO HadCM3 2
UKMO HadGEM1 1
UKMO HadGEM1 2

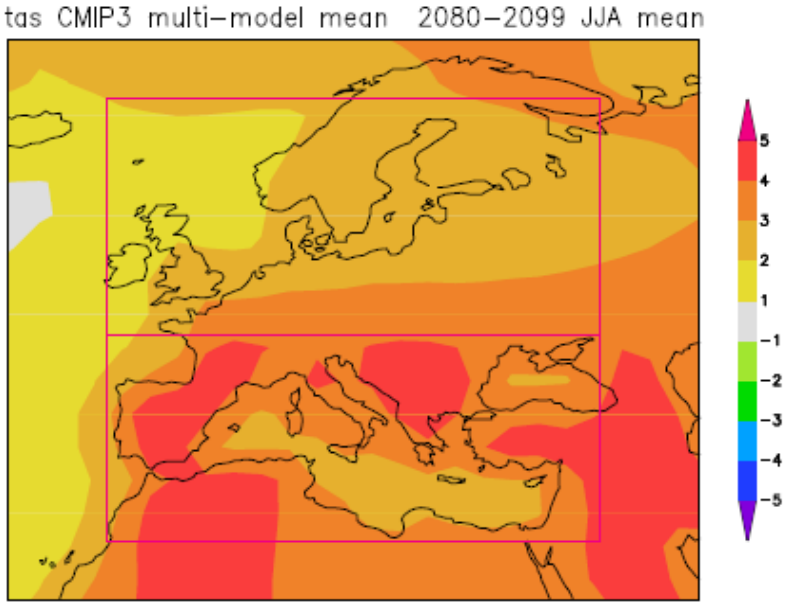
Mediterranean





A1B scenario





Curtsey van Oldenborgh (AR5, Atlas)

Conclusions

- RCMs are suffering from non-linear biases
  - *in casu* temperature
- These impact climate change results, particular when entering non-experienced regimes
- Applying a bias correction reduce what seems to be well established geographical warming patterns. Model spread is reduced
- Implications for extremes are not easy to assess, but could be substantial
- The same physical mechanism appears to be at play in GCMs!


Thank you for your attention
DMI