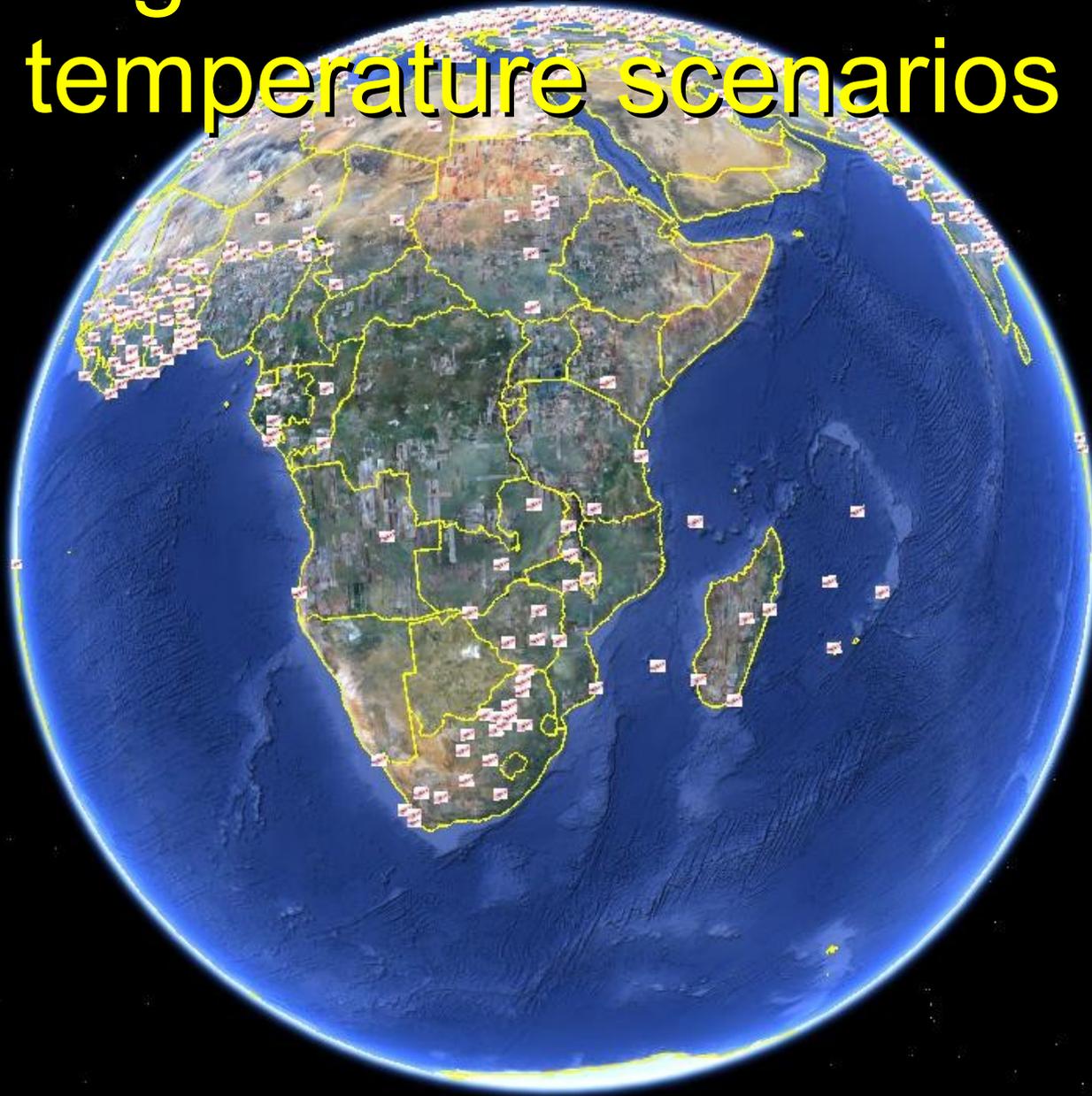


# A new global set of downscaled temperature scenarios



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CORDEX Workshop, Trieste, March 21-24

# Is downscaling even possible?

## Adaptation to Global Warming: Do Climate Models Tell Us What We Need to Know?

N. Oreskes, D.A. Stainforth, & L.A. Smith  
Philosophy of Science, 77 (December 2010):

“Do climate models give us the information we would need to accurately estimate the costs of adaptation and effectively prepare for the consequences of climate change? ... we argue that they do not.”

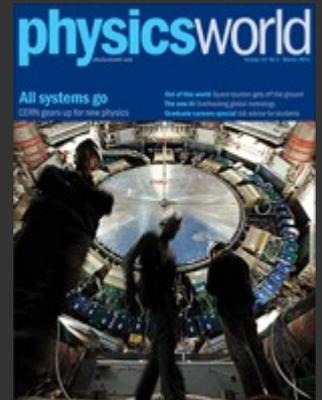
“... attempts to “downscale” climate models are still in the early stages of development.”

# Climate modelling not yet there...

Tim Palmer 'A CERN for climate change', *Physics World*, March 2011, p. 14-15

“We do not have sufficient computing power to solve the equations of climate science with sufficient accuracy”

“requires a rather fine grid-point spacing of about a few tens of kilometres or less. The IPCC models, however,...”

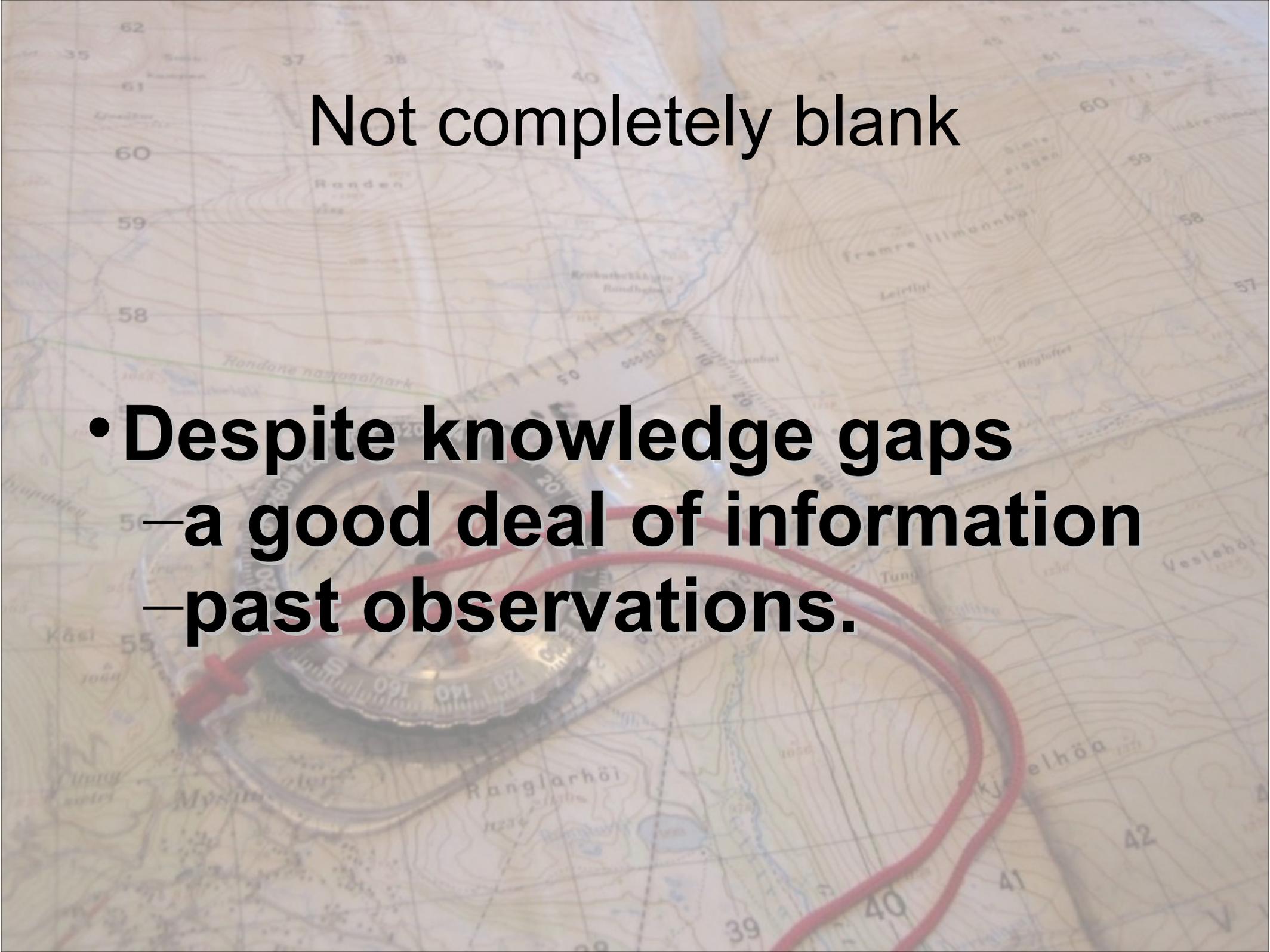


# The Challenge



Should we just go home, then? Or, can we do better?

Account for uncertainties. Risk analysis still possible without complete knowledge.

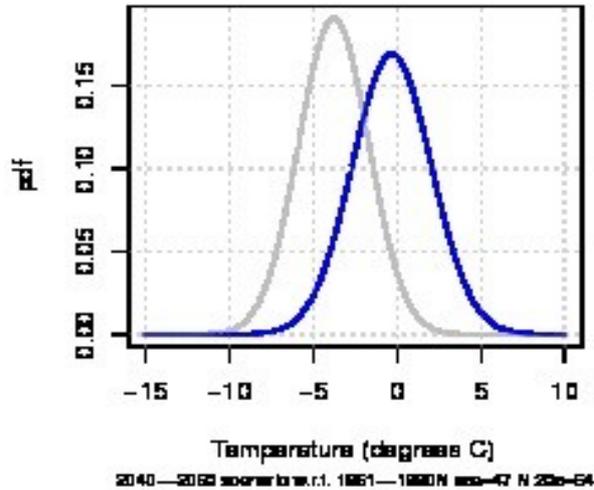
A topographic map of a region in Iceland, featuring contour lines, rivers, and place names such as Randen, Ranglarhöi, and Kjallhöi. A compass rose is positioned in the lower-left quadrant, and a thick red line traces a path across the map. The text 'Not completely blank' is centered at the top.

Not completely blank

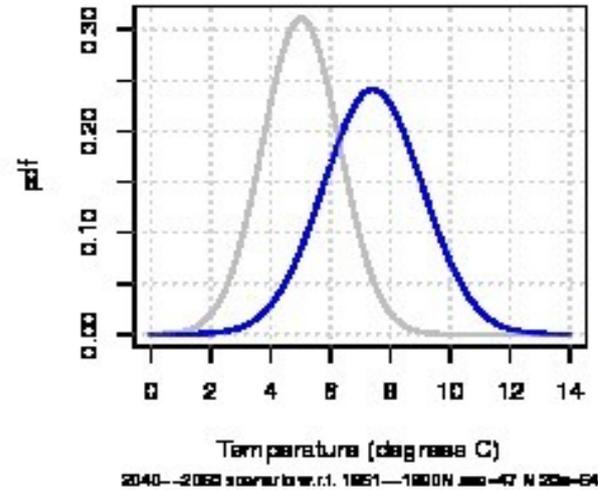
- **Despite knowledge gaps**
  - a good deal of information
  - past observations.

# Model uncertainties

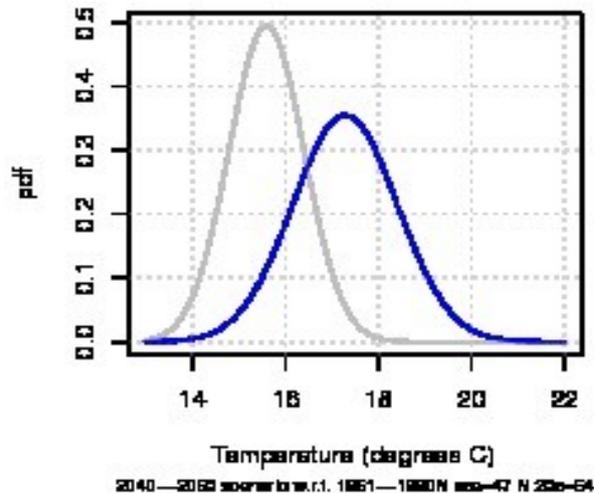
**Oslo (DJF)**



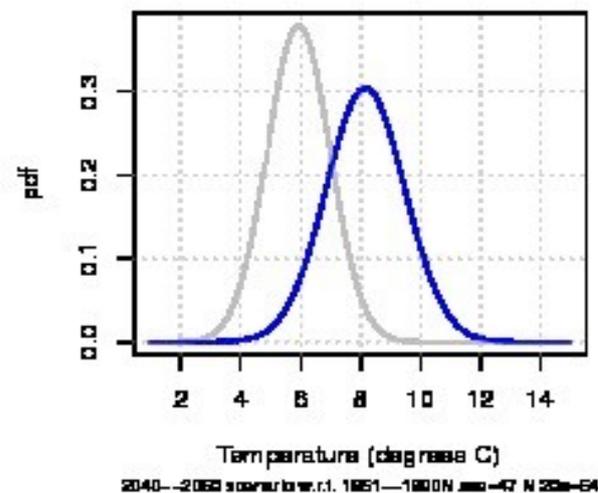
**Oslo (MAM)**



**Oslo (JJA)**

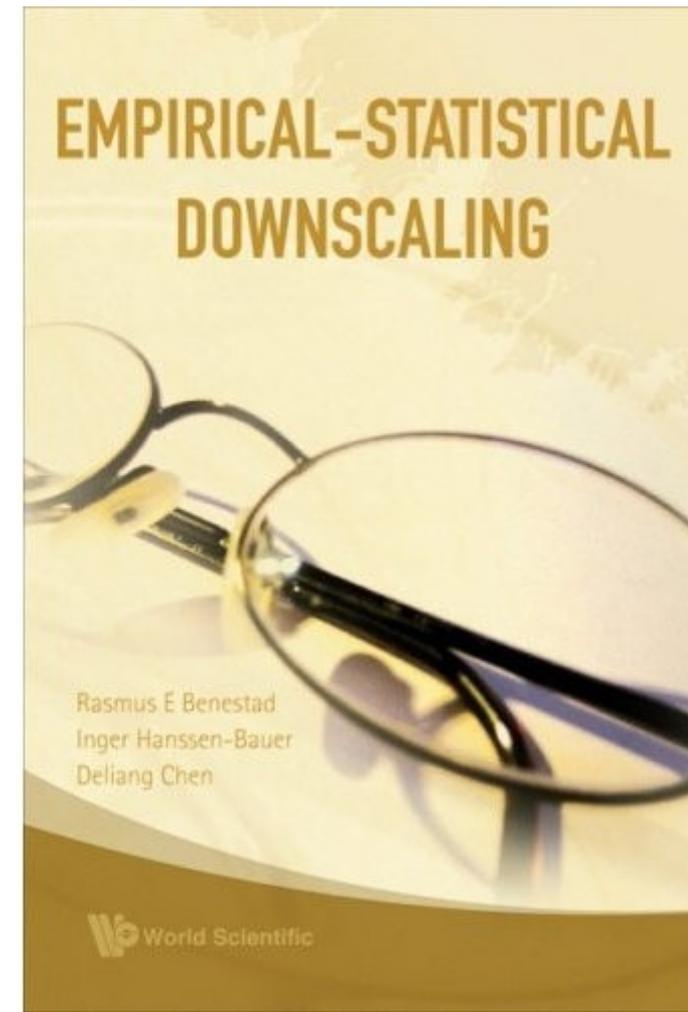


**Oslo (SON)**



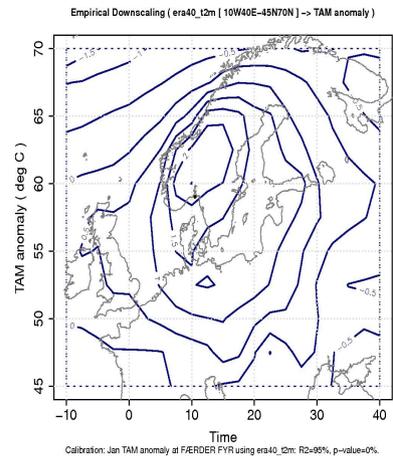
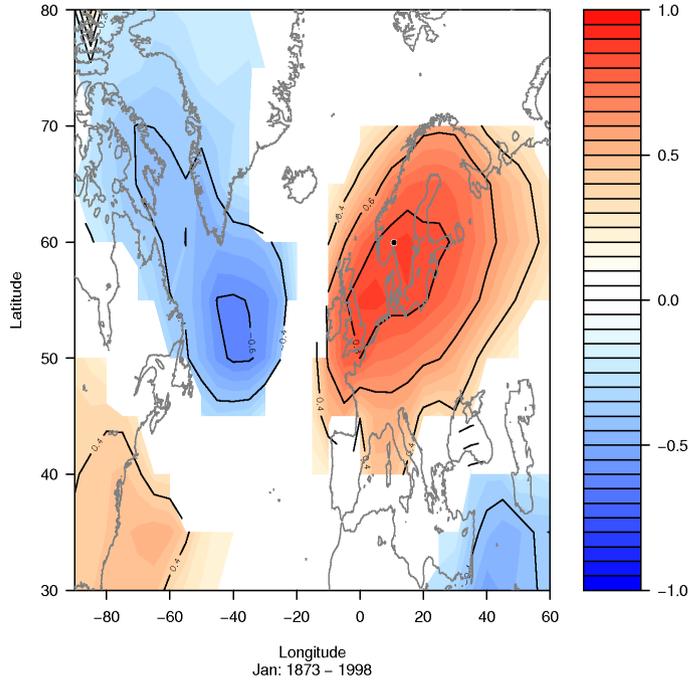
# Empirical-statistical downscaling

- **Transparent**
- **Diagnostics**
  - **uncertainties**
  - **Many GCMs.**
  - **PDFs explicitly**
  - **gridding**
- **Sites spread far apart**
- **RCMs & ESD complimentary**
- **Tied to the real world.**

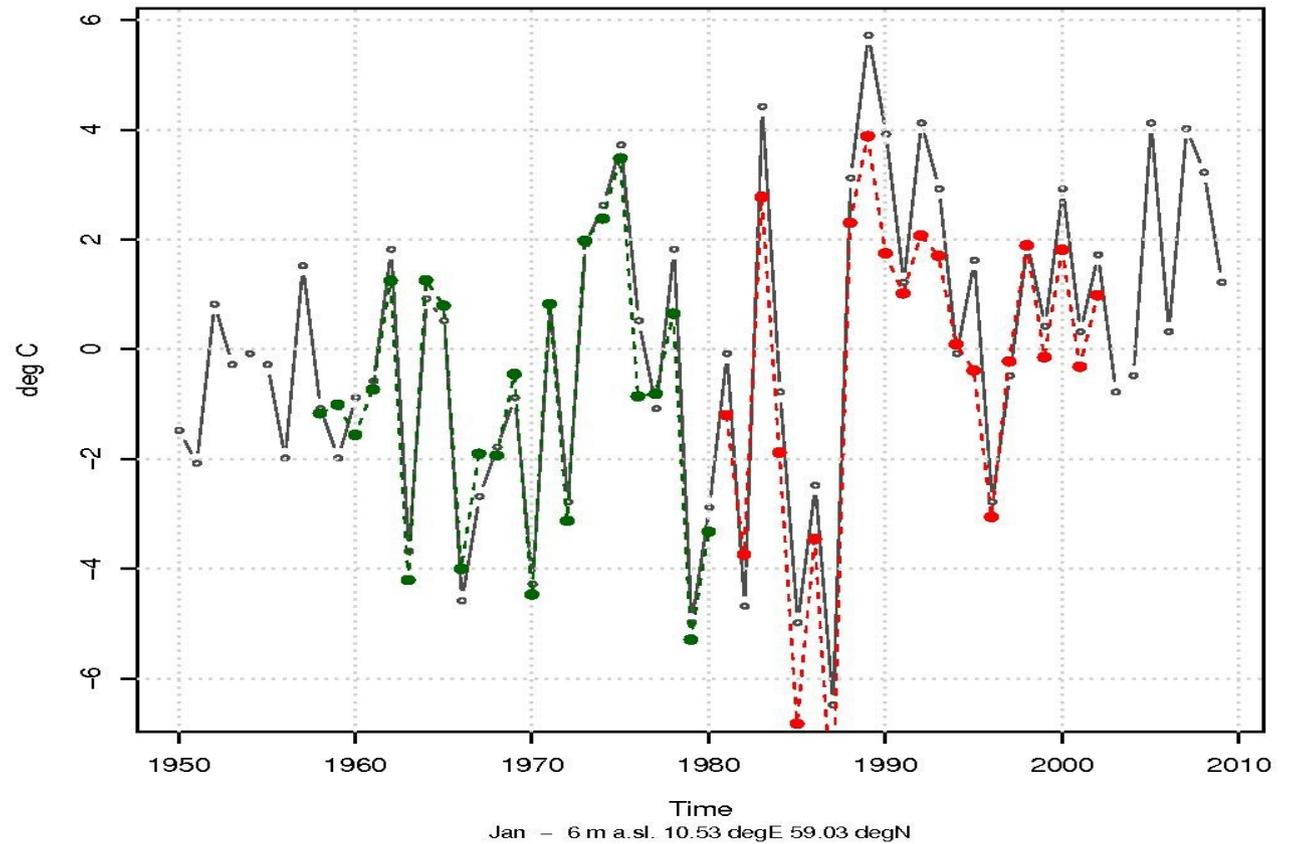


# What is ESD?

Correlation: t2m & mean T(2m) at Oslo



FÆRDER FYR TAM

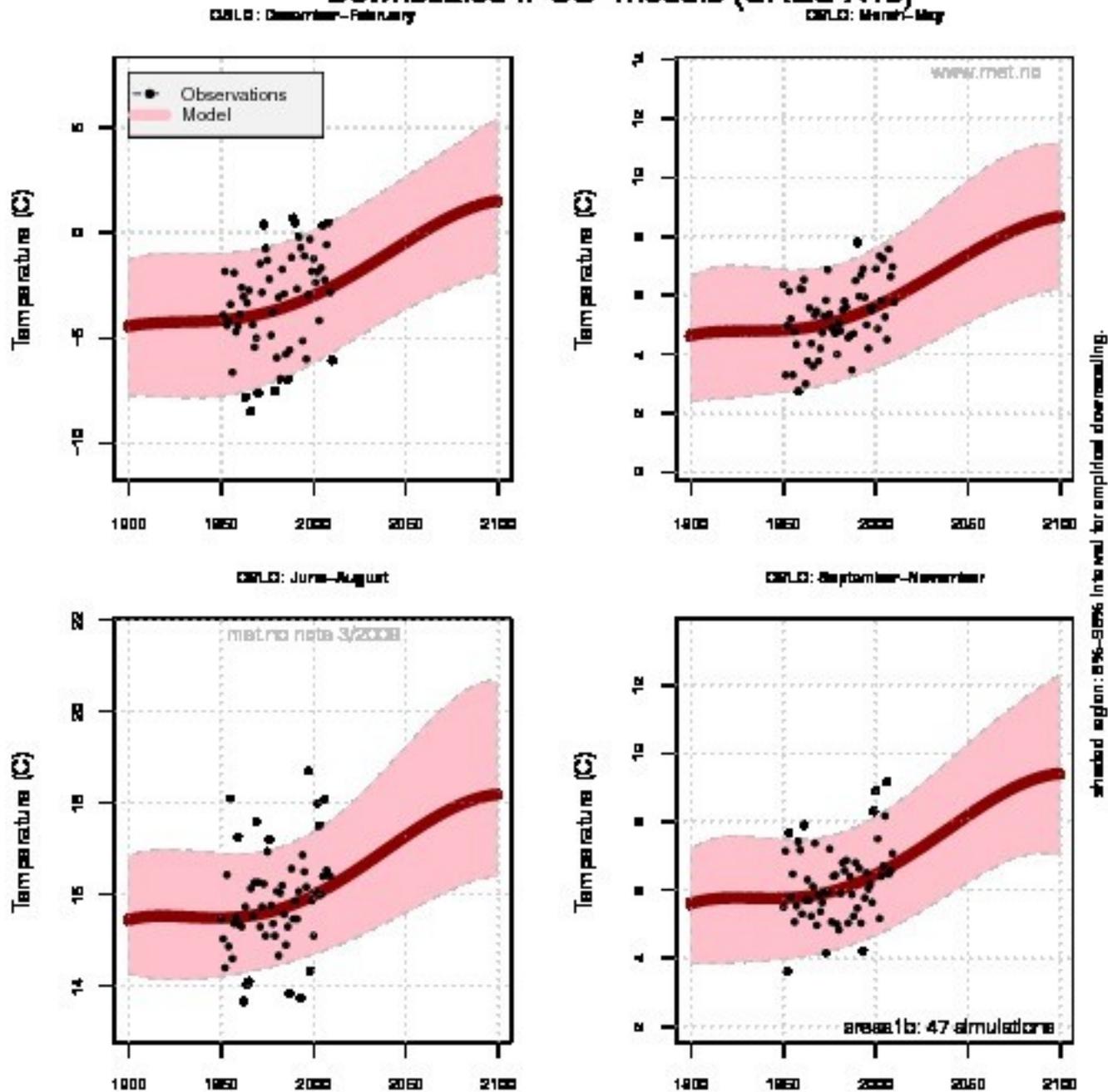


# Methods

- **Variable representing large-scale situation,  $X$** 
  - *Often EOFs and PCs*
- **Variable representing local climate,  $y$**
- ***Method & calibration***
  - *Linear models*
  - *Non-linear models*
- ***Prediction & diagnostics***
  - *Time series*
  - *Distributions and parameters*

# Temperature envelopes

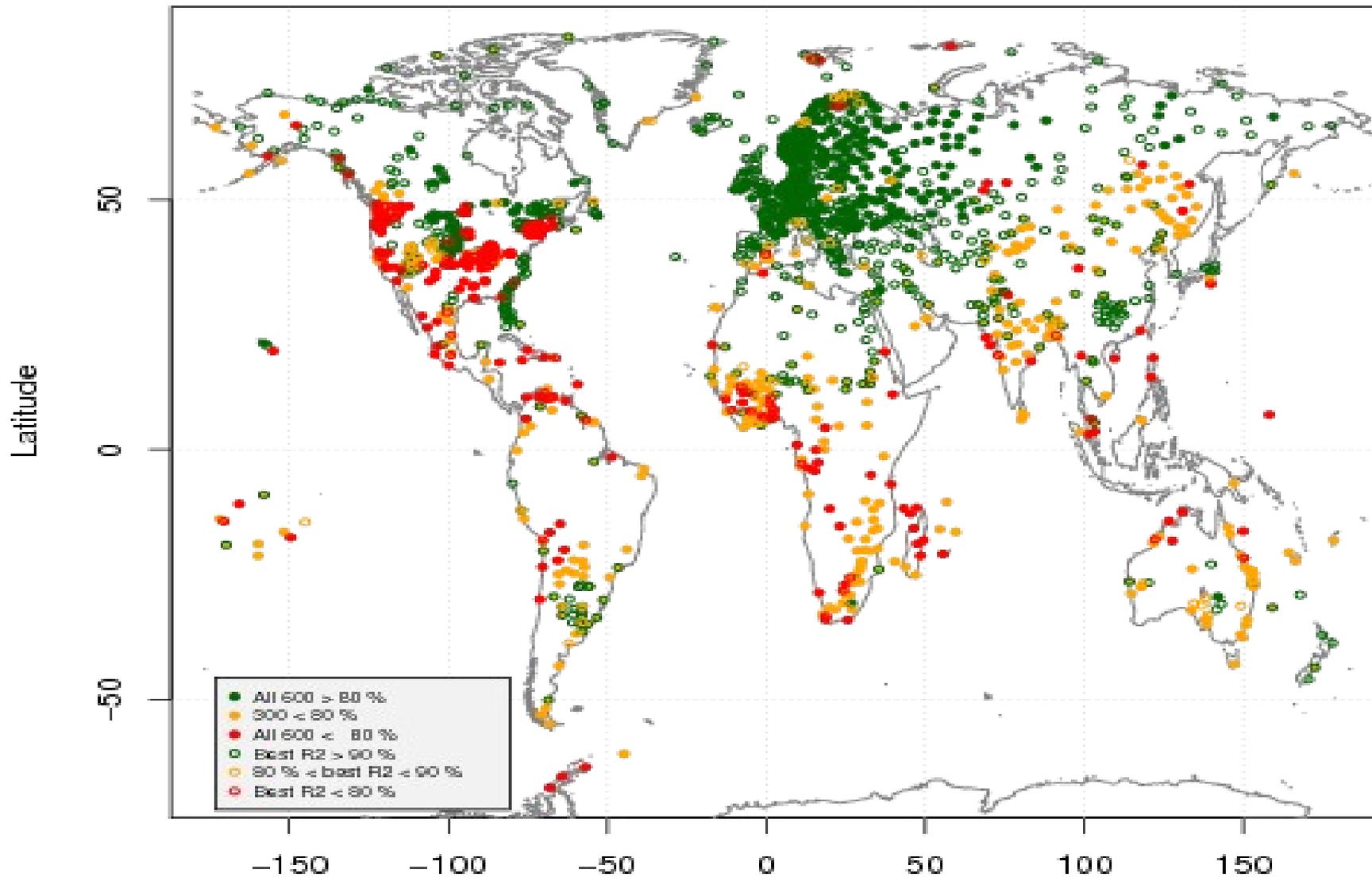
## Downscaled IPCC-models (SRES A1b)



observed region: 1996-2006. In the model for simplified downscaling.

# Quality flags

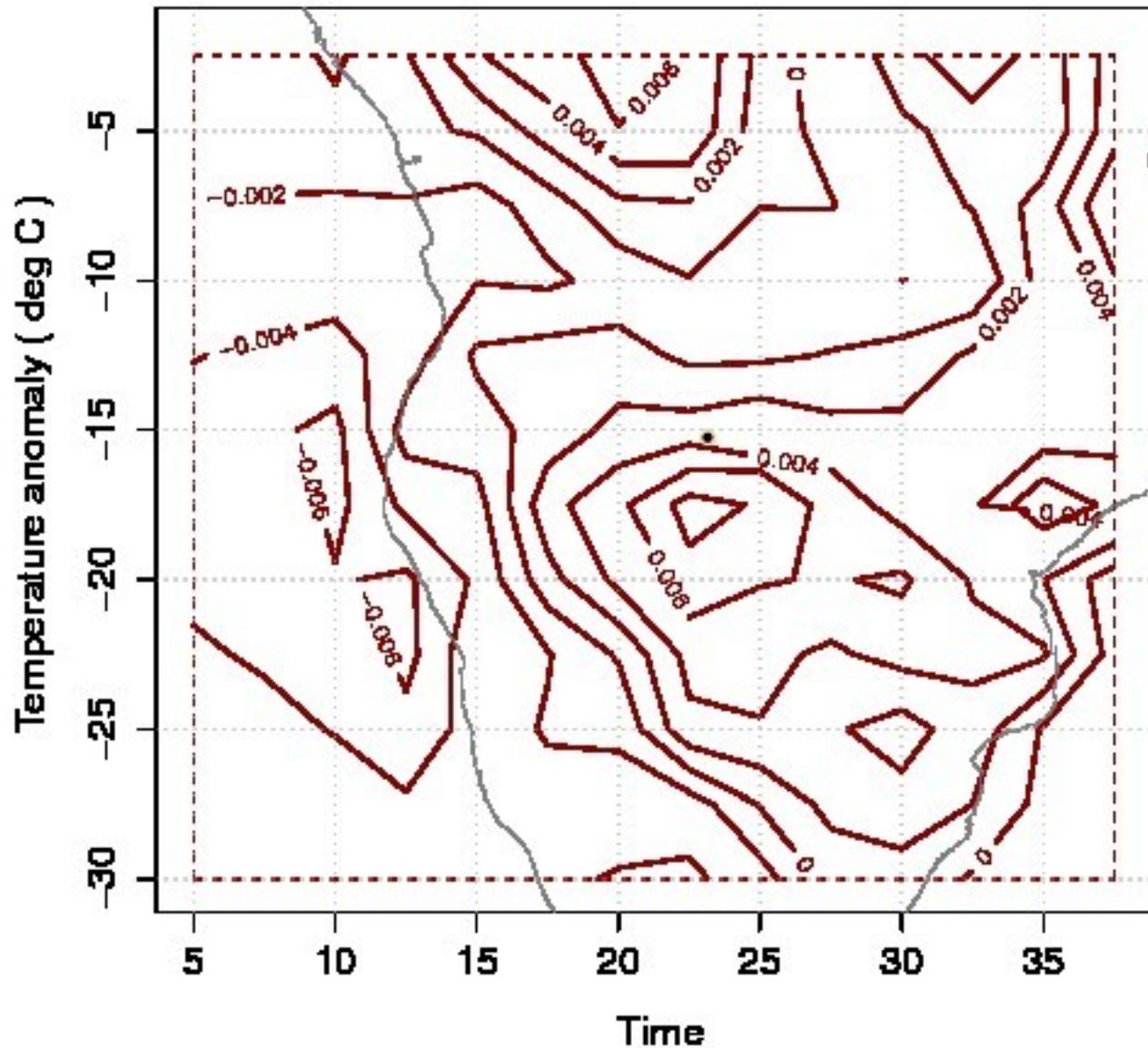
1630 locations with ESD-results: T(2m)



Quality of results. R threshold= 80 & 90 %; fract= 0.5

# Large-scale pattern

Empirical Downscaling ( `ens40_t2m [ 5E38E-30B2S ]` -> Temperature anomaly )

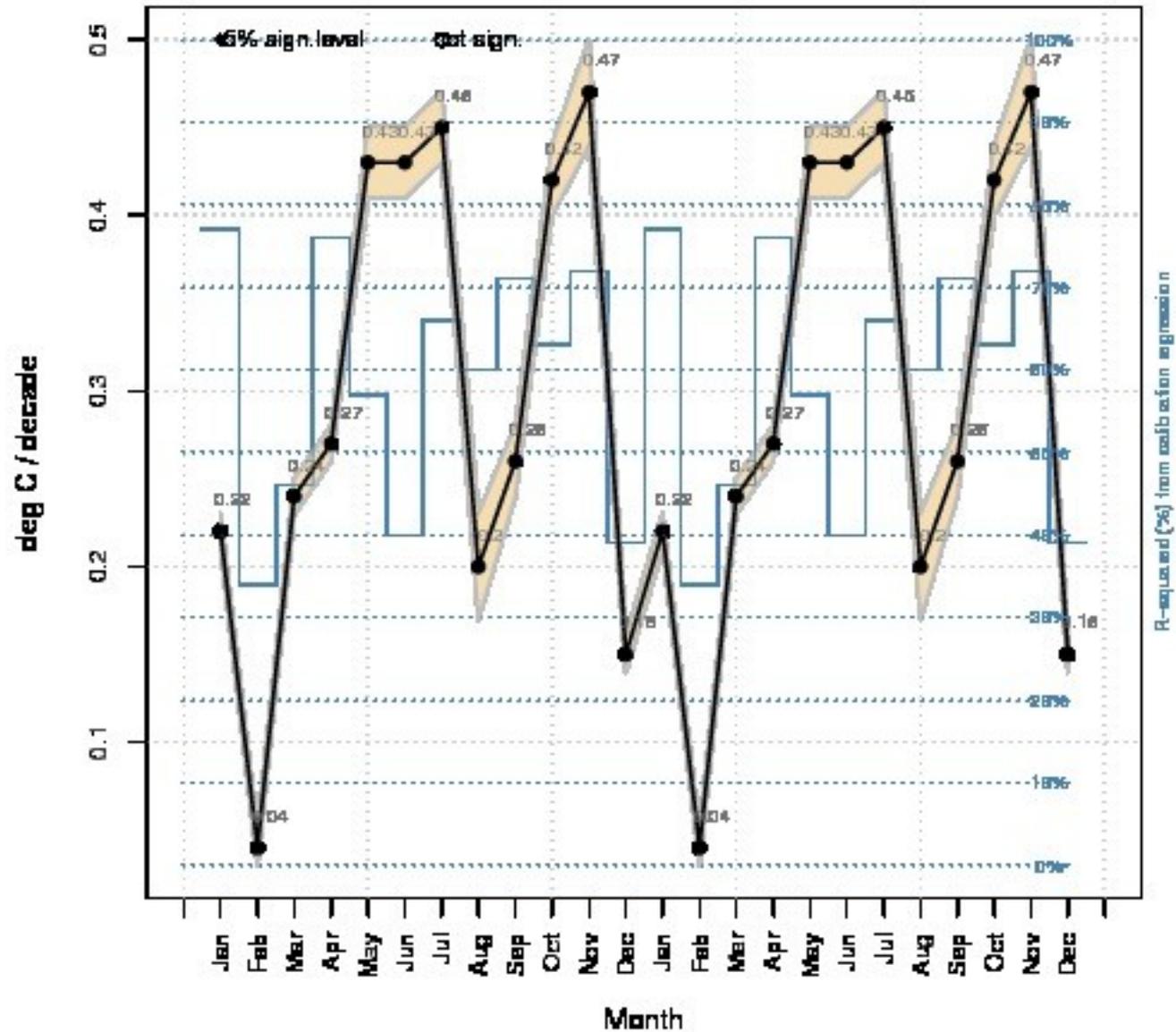


Calibration: Feb Temperature anomaly at -MONGU using `ens40_t2m`:  $R^2=34\%$ ,  $p\text{-value}=1\%$ .



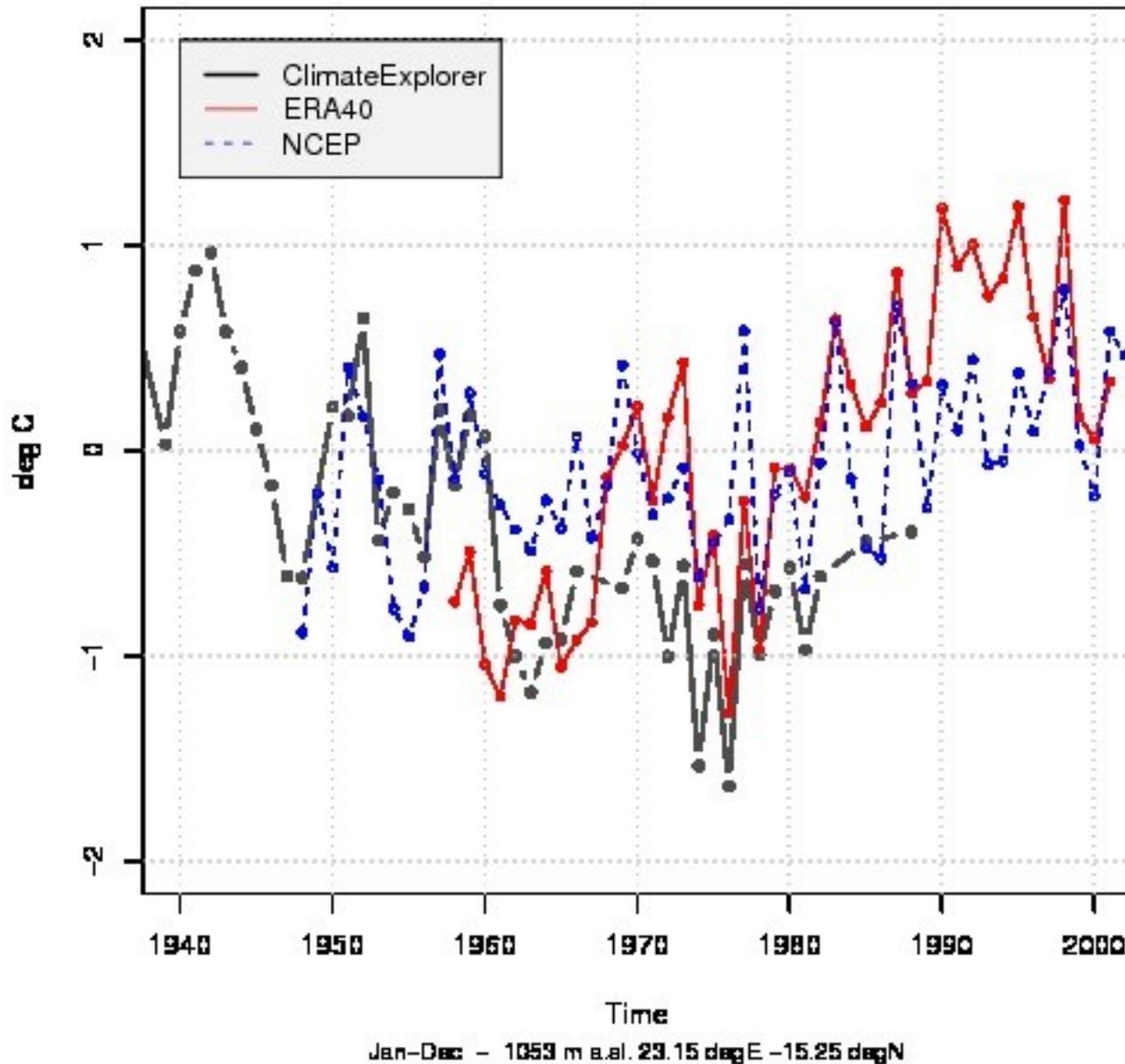
# Trends & regression stats

Linear trend rate Temperature anomaly dataset -MONGU (-19.25N/23.19E)

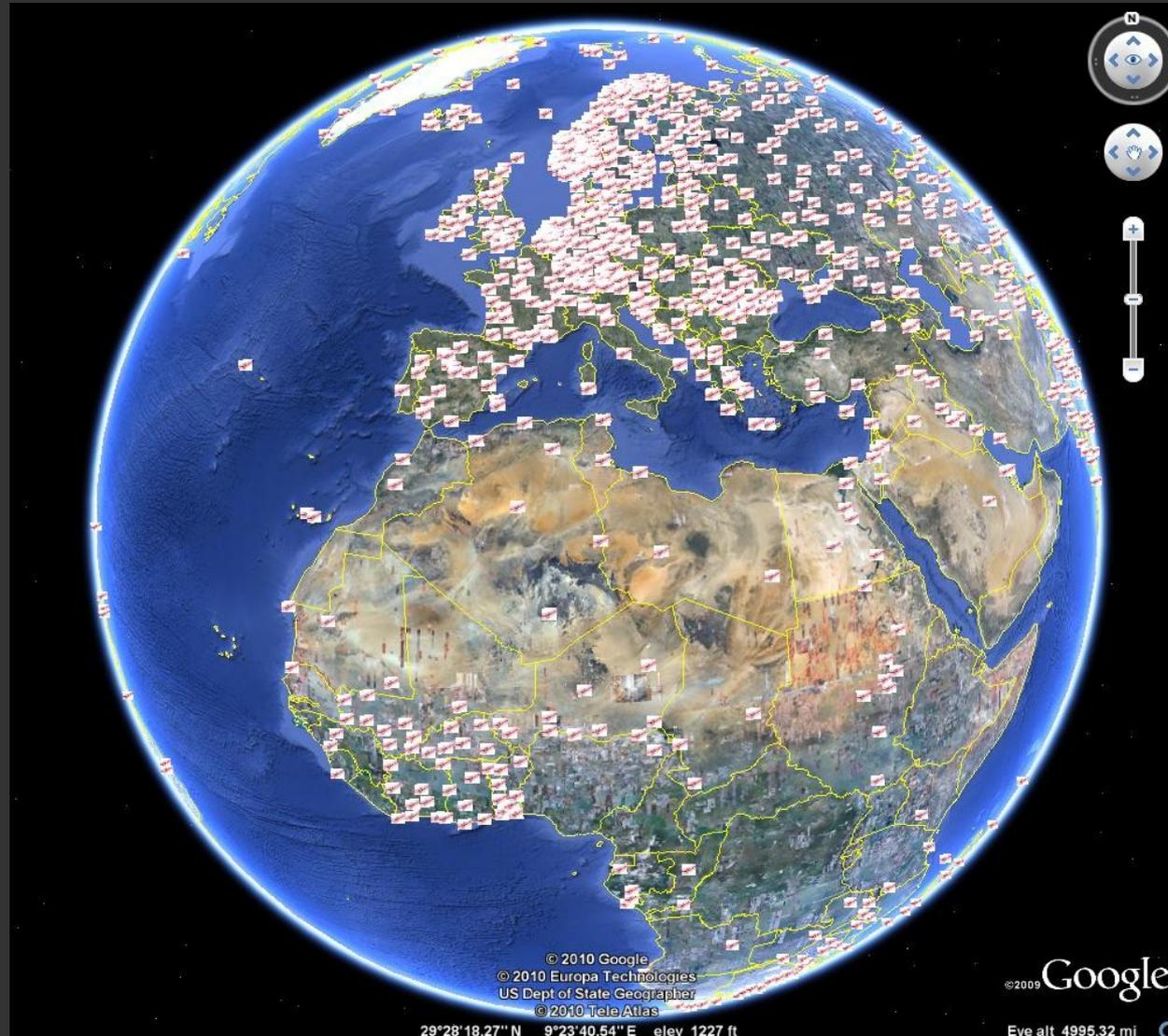


# Why the poor scores?

MONGU Temperature



# “A New Global Set of Downscaled Temperature Scenarios”



ESD results shown graphically in GoogleEarth

# Spatial analysis

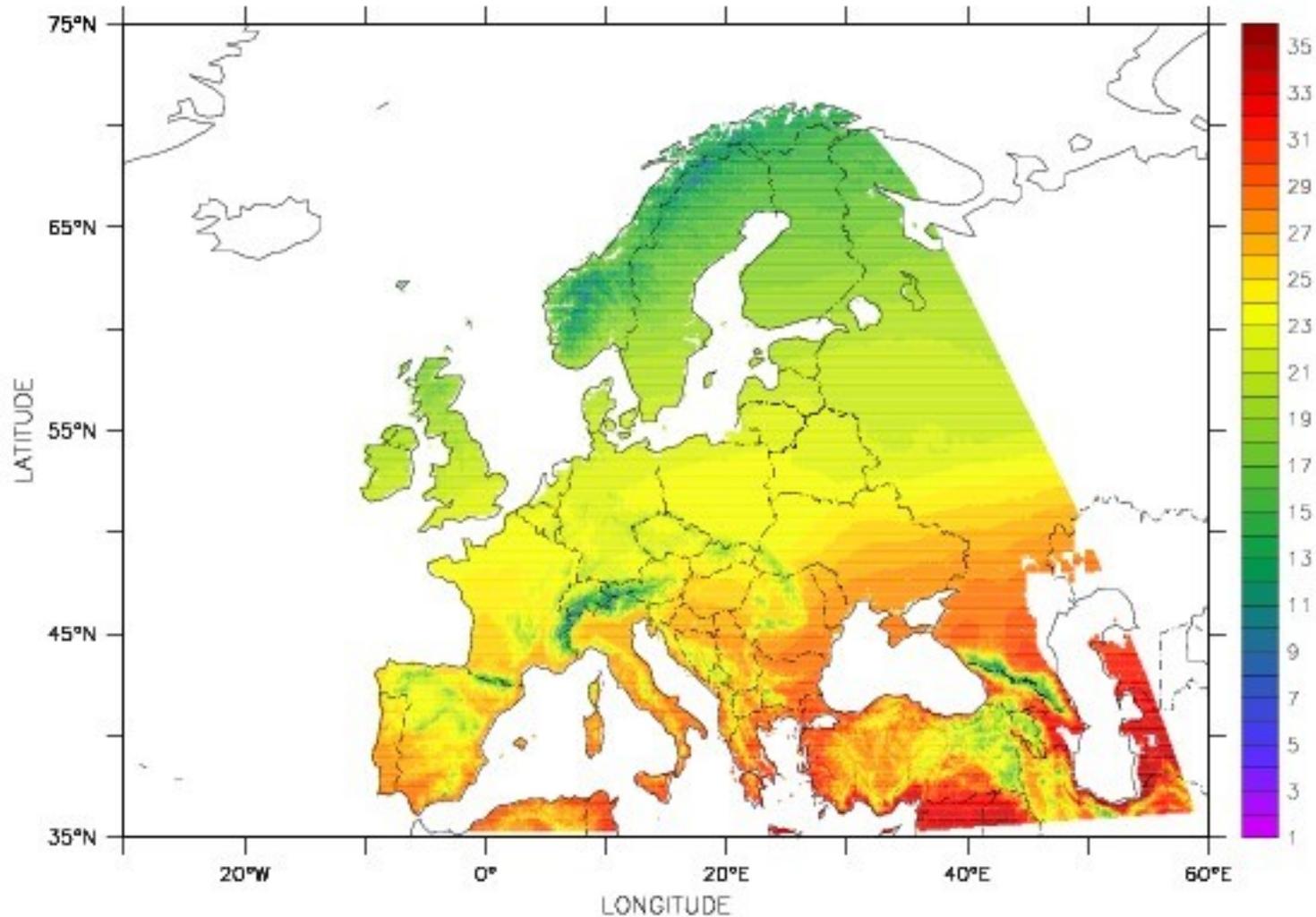
One way to shed light on the quality of the results

# Gridded ESD results

FERRET Ver. 6.2  
NOAA/PMEL TMAP  
Jun 3 2010 14:39:31

DATA SET: Europe\_ESD-q95map-2100

Climate change scenarios from multi-model IPCC AR4 climate simulations



q95 for JJA mean T(2m) in year 2100

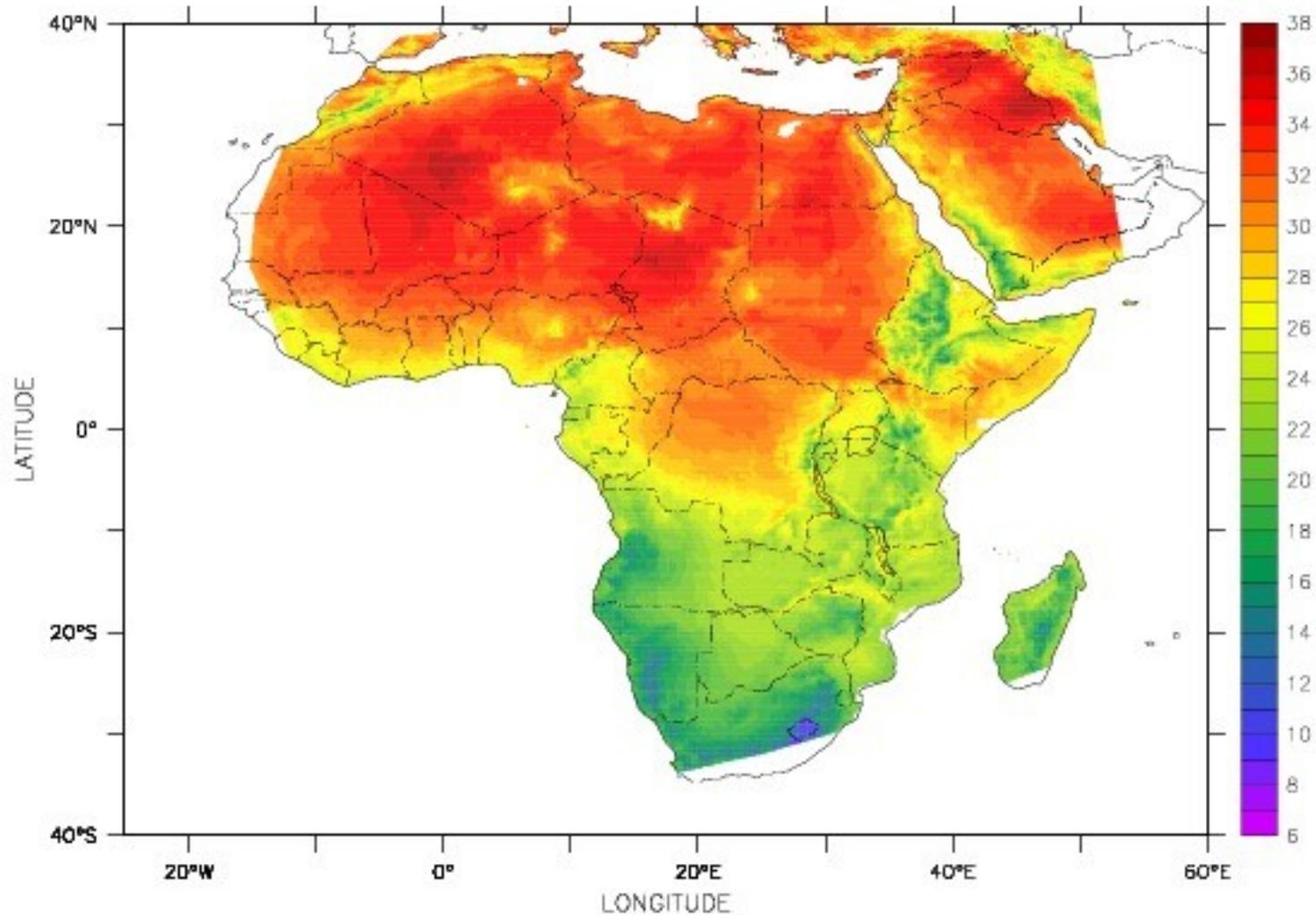
Benestad, R.E., 'A new global set of downscaled temperature scenarios', J. Climate, in-press, doi: 10.1175/2010JCLI3687.1

# Africa

FERRET Ver. 6.2  
NOAA/PMEL TMAP  
Jun 3 2010 14:01:14

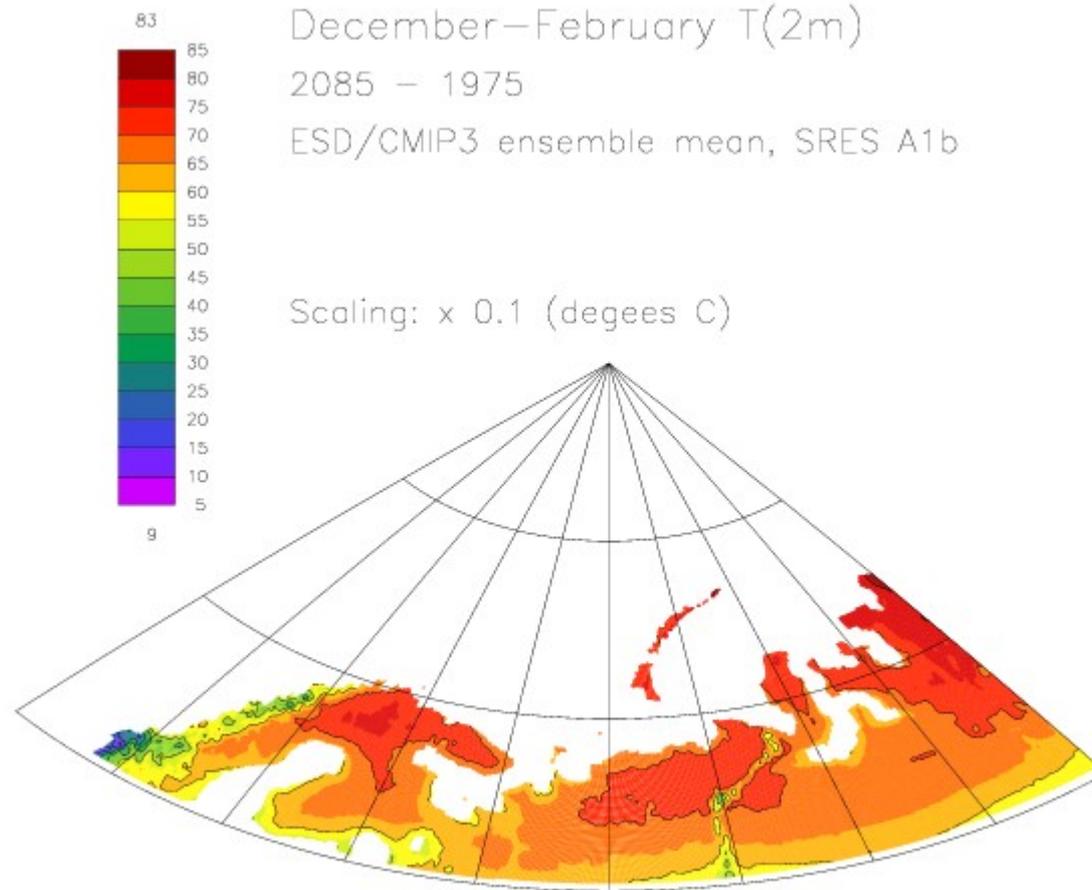
DATA SET: Africa\_ESD-q95map-2100

Climate change scenarios from multi-model IPCC AR4 climate simulations



q95 for JJA mean T(2m) in year 2100

# Projected change in Russia

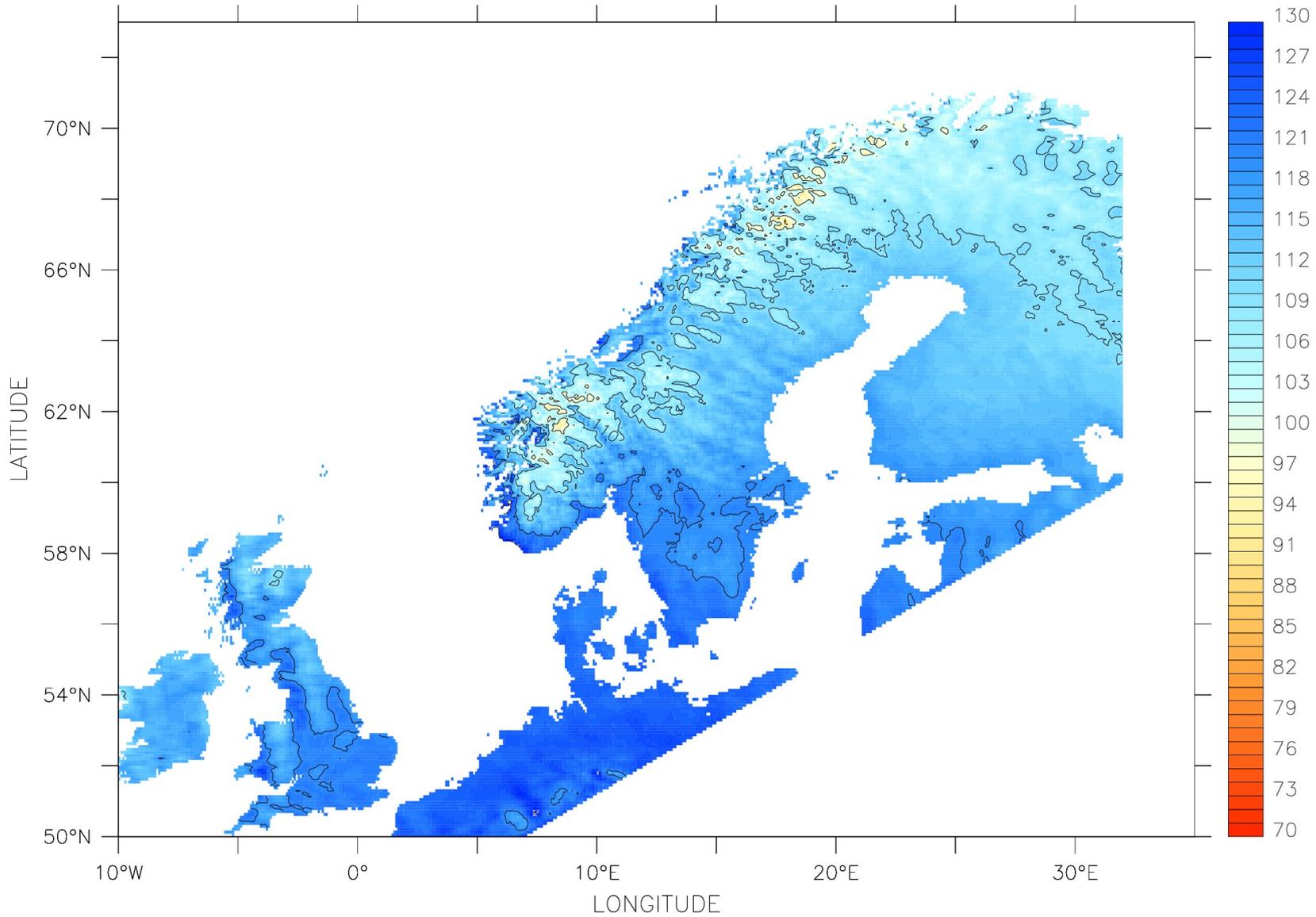


CHNC

after Benestad, A new global set of downscaled temperature scenarios, Journal of Climate, accepted 2010

# $q_{95}$ of 24-hr precipitation

Climate change scenarios for northern Europe from multi-model IPCC AR4 climate simulations

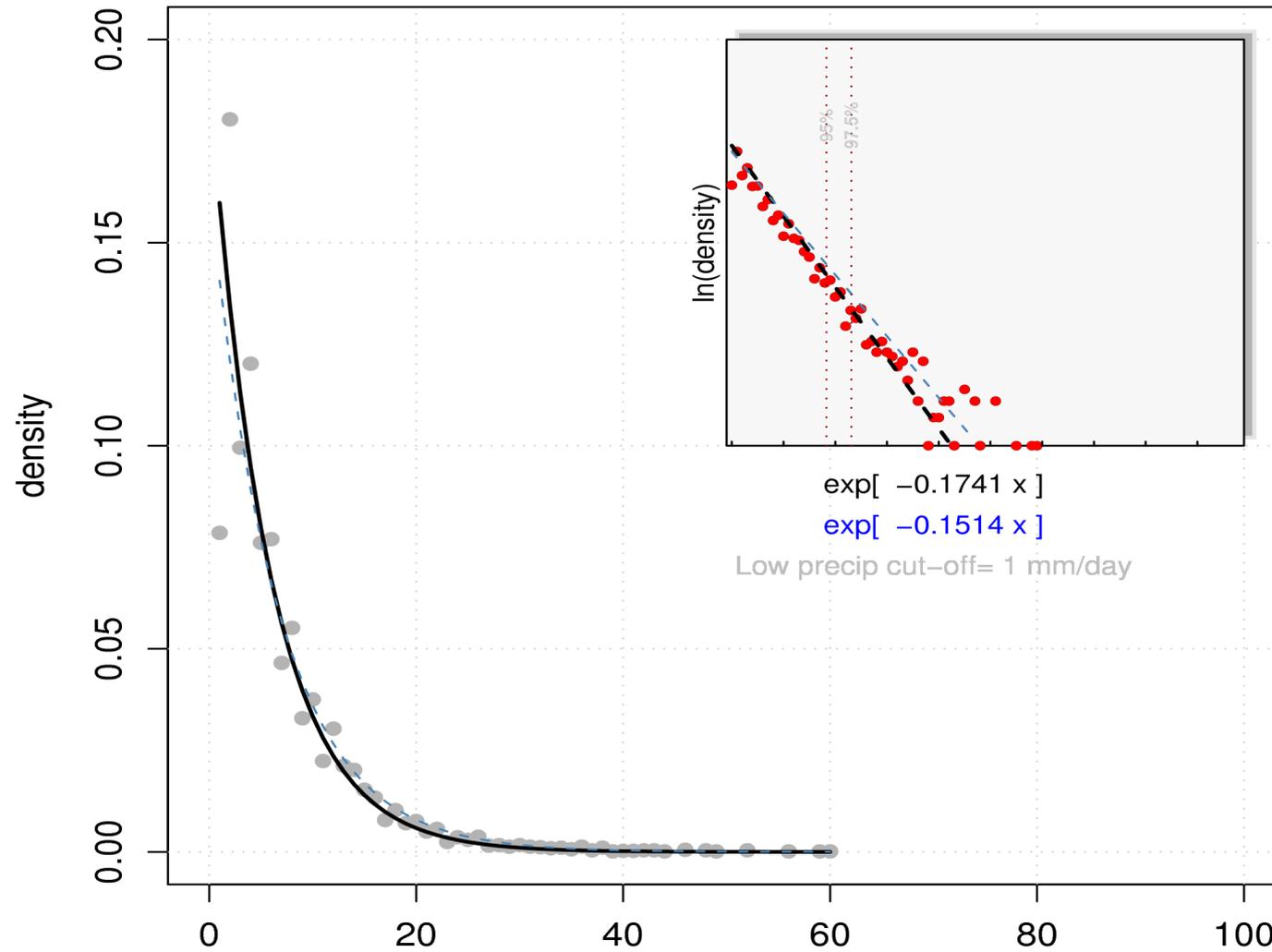


$$100 * \Pr(X \text{ g.t. } q_{95}) / 0.05$$

# Distribution and PDF

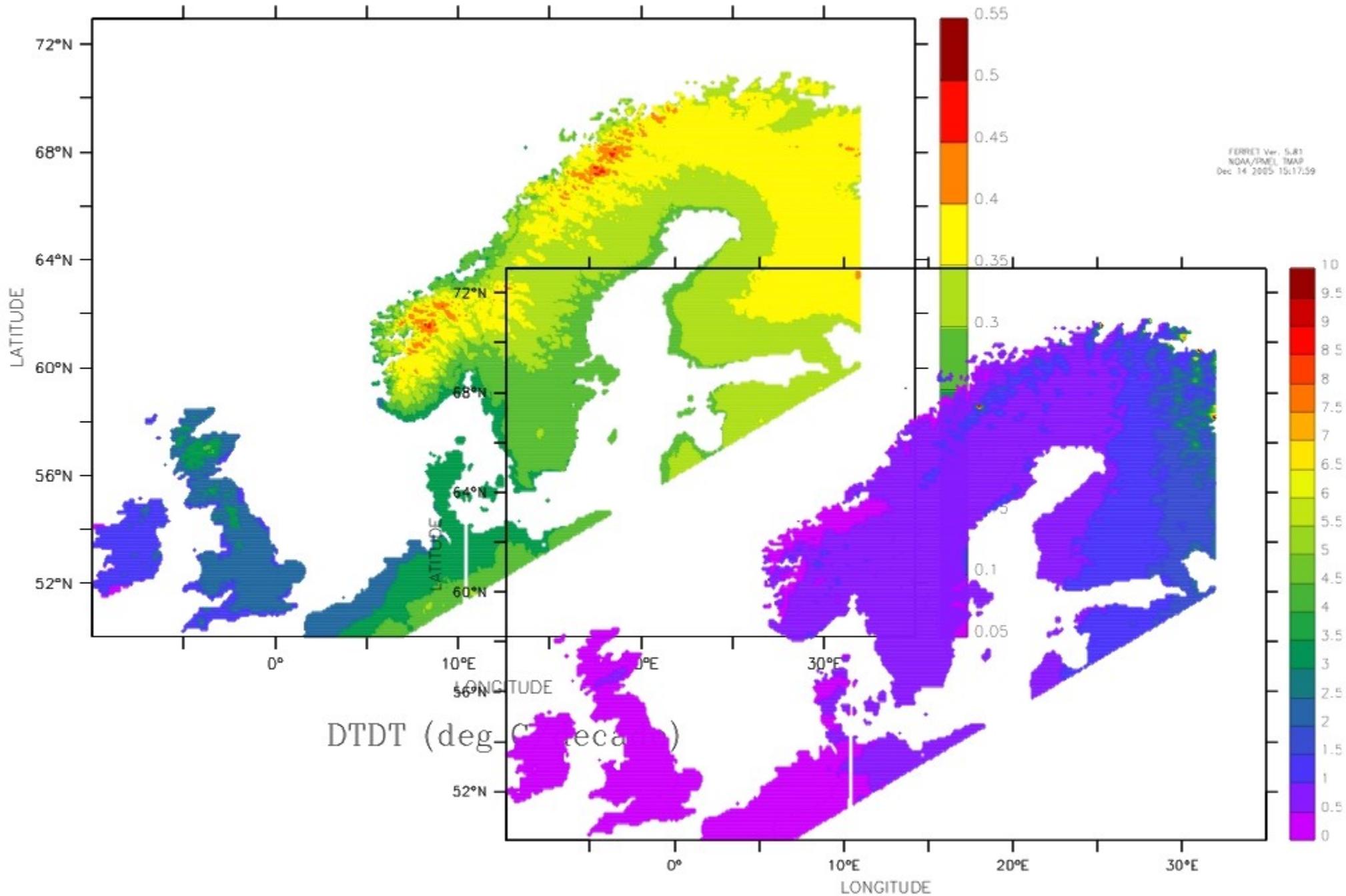


## OSLO – BLINDERN



### DATA SET: Europe\_E-SDS\_t2m-trend\_map

Climate change scenarios for northern Europe from multi-model IPCC AR4 climate simulations

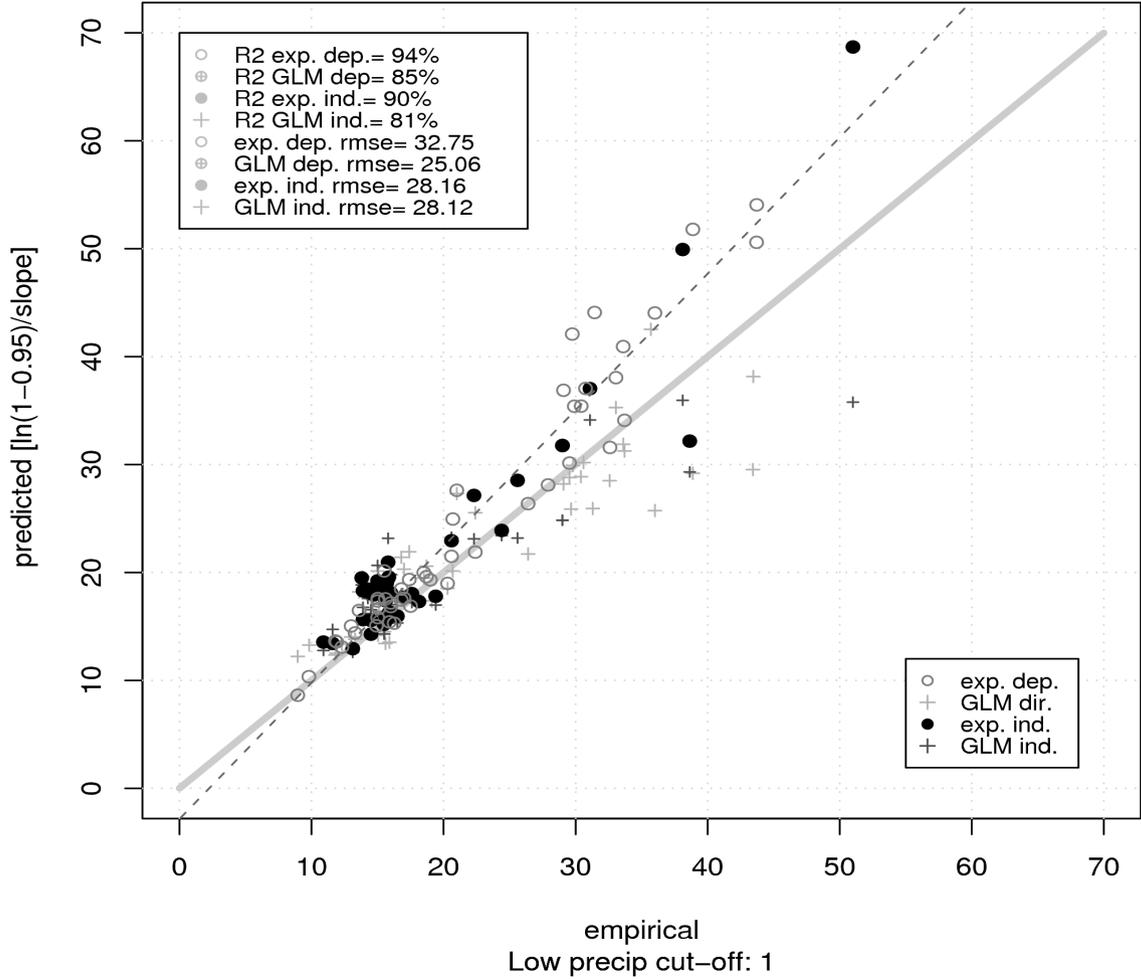


DTDT (deg C/decade)

Annual precipitation change (%/decade)

# Validation

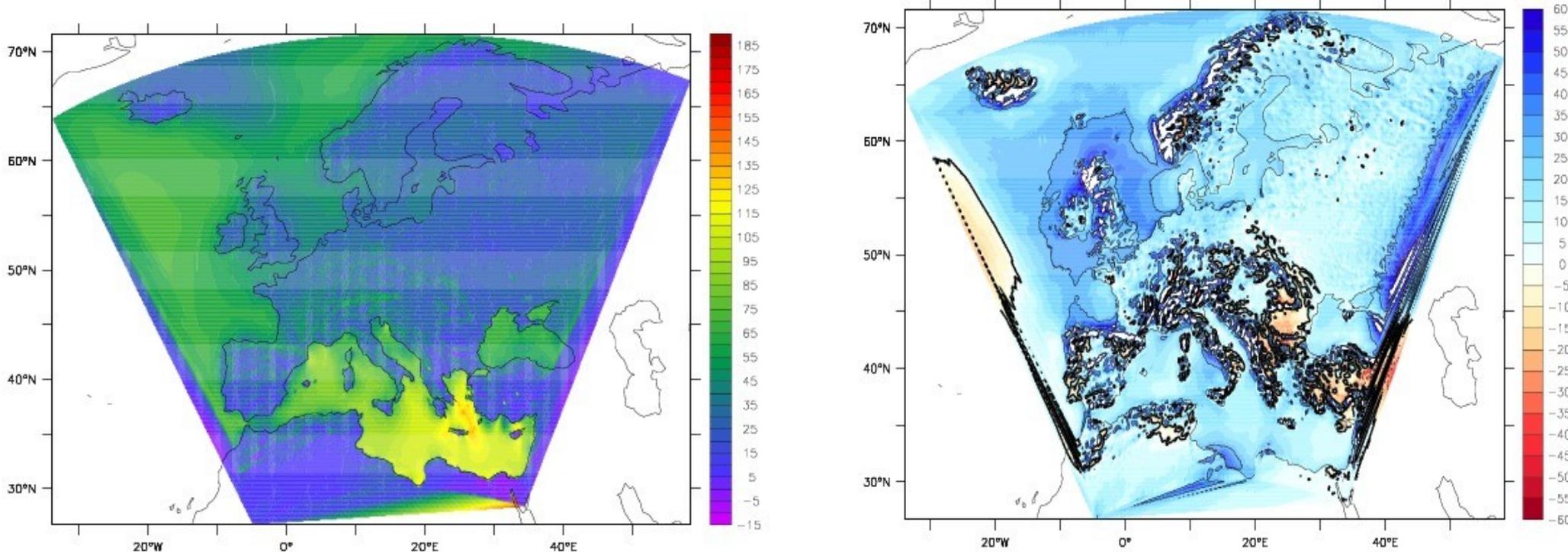
0.95 percentile: empirical v.s. theoretical



# Misconceptions

- Wrong to regard RCMs as 'physical consistent'
- Non-stationarity *not* only an ESD-relevant issue

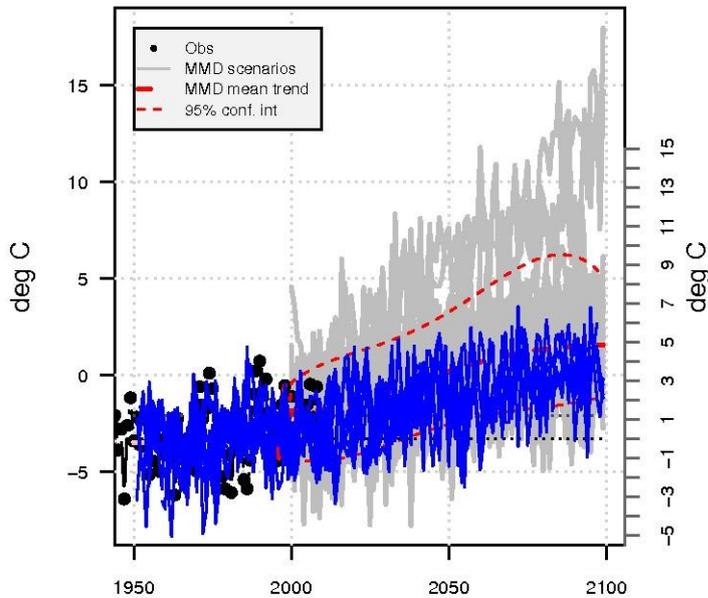
Latent heat flux at surface/precip: METNOHIRHAM driven by ERA40 - ERA40.



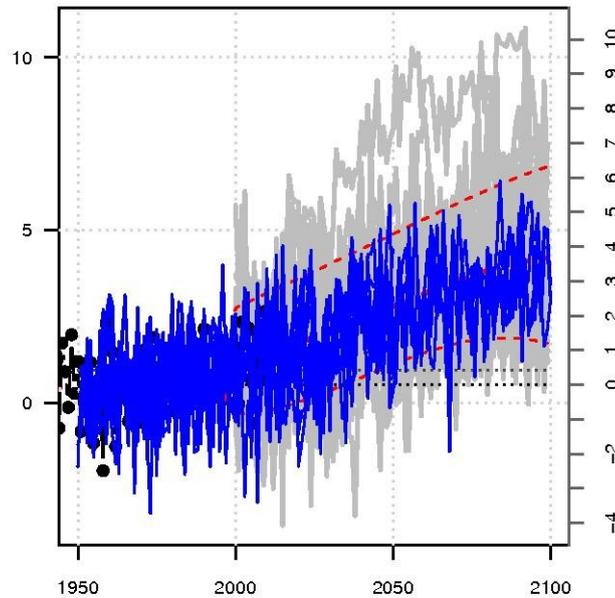
Implications for the large-scale vertical heat flow

# ESD & ENSEMBLES

Vestlandet\_TR-region2



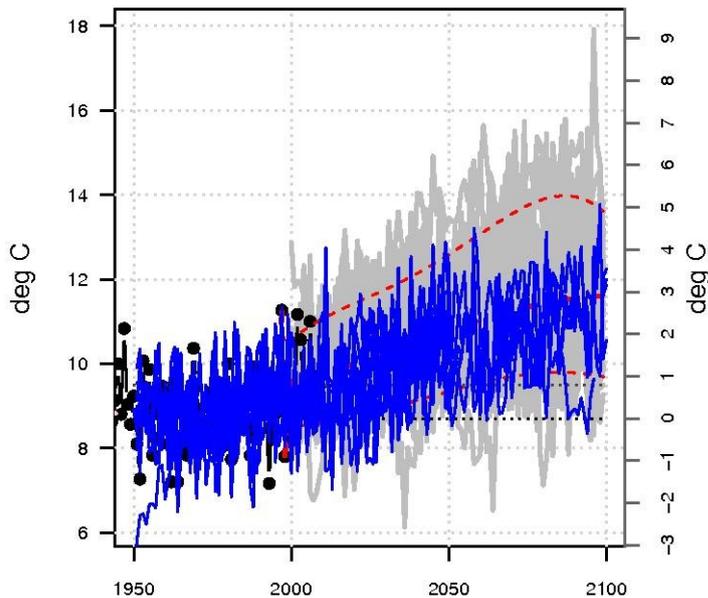
Vestlandet\_TR-region2



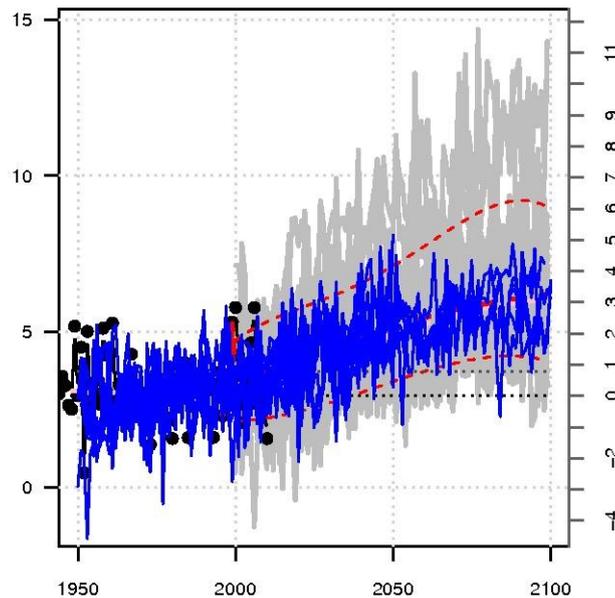
**T(2m):**  
Preliminary analysis

After bias  
Correction:

Vestlandet\_TR-region2



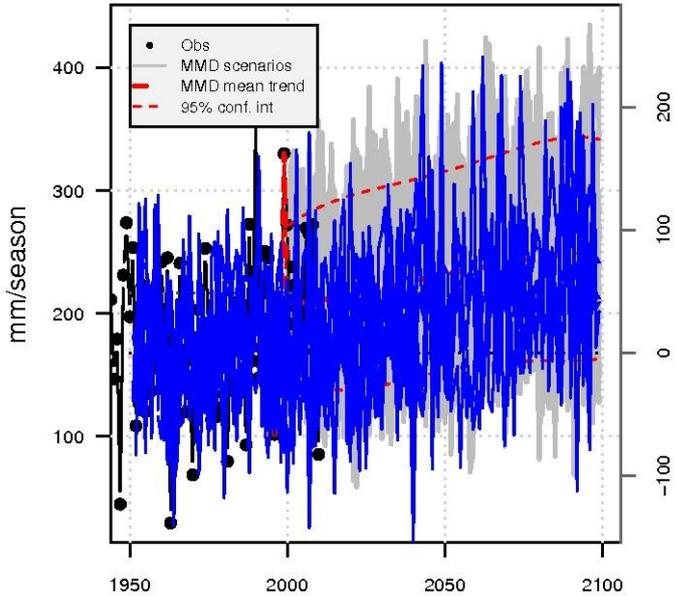
Vestlandet\_TR-region2



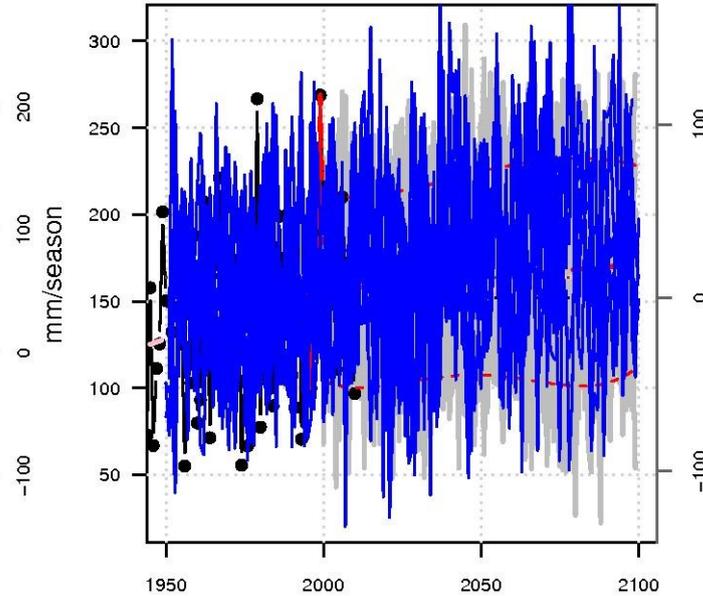
Consistent picture  
Robust response

# Combining different information

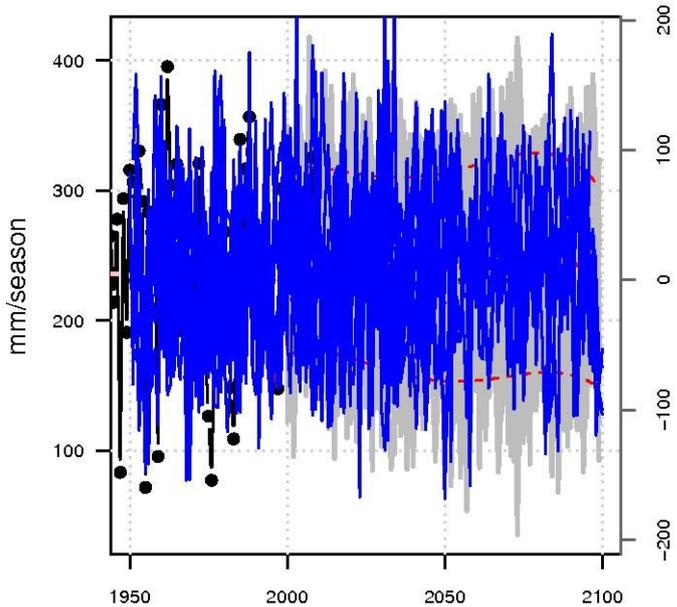
Austlandet\_NR-region1



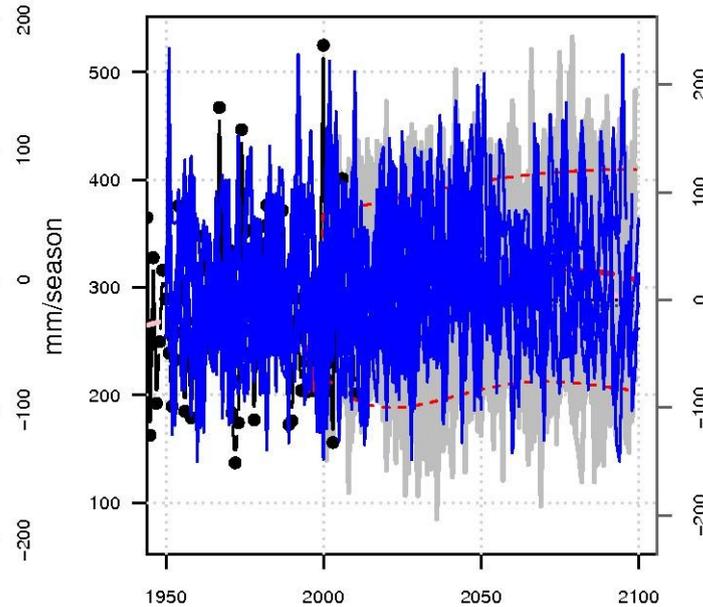
Austlandet\_NR-region1



Austlandet\_NR-region1



Austlandet\_NR-region1



Precipitation

ENSEMBLES -  
Fewer GCMs.

Similar picture.

Oreskes et al. &  
Palmer?  
GCMs.

# Summary

A tailored analysis for local climate

Suitable for uncertainty analysis

Adds independent information to RCMs

Independent strengths & weaknesses

Complementary!

Less affected by GCM biases – tied to real observations.

*Oreskes et al.* and Palmer papers don't acknowledge full extent of empirical knowledge.