universität wien

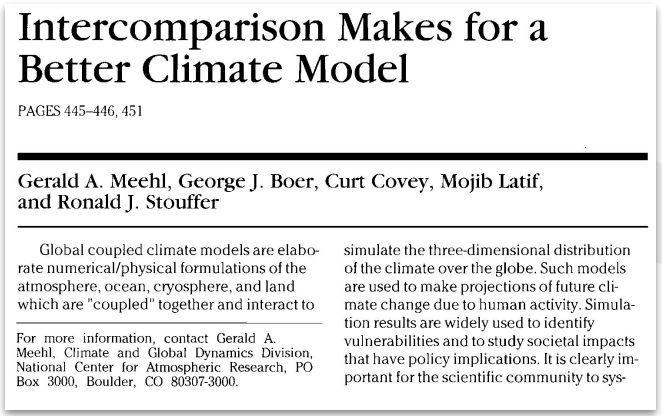
ETH zürich

Investigating 25 years of coupled climate modeling using model output

Lukas Brunner, Ruth Lorenz, Erich M. Fischer, Anna L. Merrifield Könz, and Reto Knutti

EGU 2022 Session CL5.3.2 | May 27th 2022

The DECK experiments connect all generations of CMIP



Intercomparison Makes for a Better Climate Model

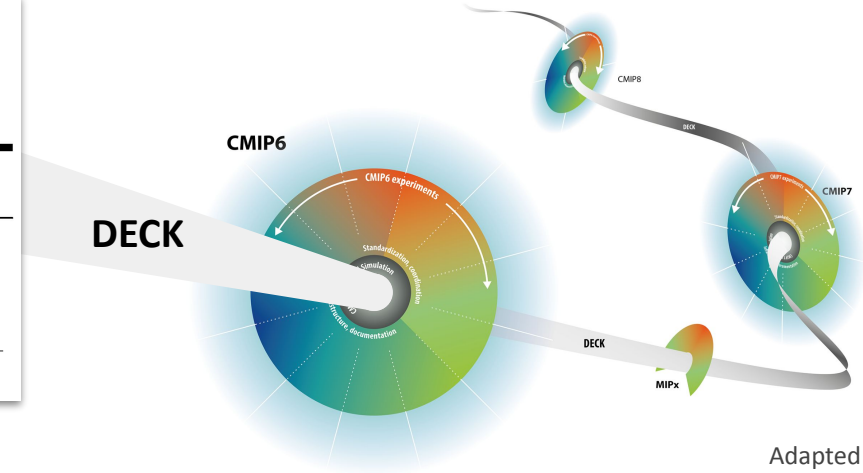
PAGES 445–446, 451

Gerald A. Meehl, George J. Boer, Curt Covey, Mojib Latif, and Ronald J. Stouffer

Global coupled climate models are elaborate numerical/physical formulations of the atmosphere, ocean, cryosphere, and land which are "coupled" together and interact to simulate the three-dimensional distribution of the climate over the globe. Such models are used to make projections of future climate change due to human activity. Simulation results are widely used to identify vulnerabilities and to study societal impacts that have policy implications. It is clearly important for the scientific community to sys-

For more information, contact Gerald A. Meehl, Climate and Global Dynamics Division, National Center for Atmospheric Research, PO Box 3000, Boulder, CO 80307-3000.

Meehl et al. (1997)



Adapted from Eyring et al. (2016)

DECK: Diagnostic, Evaluation and Characterization of Klima

universität wien

A quick word about the model data

- CMIP1 (1996): pre-industrial control
- CMIP2 (1997): 1% CO_2
- CMIP3 (2005)
- ~~CMIP4~~
- CMIP5 (2012)
- CMIP6 (2020)
  - HiResMIP

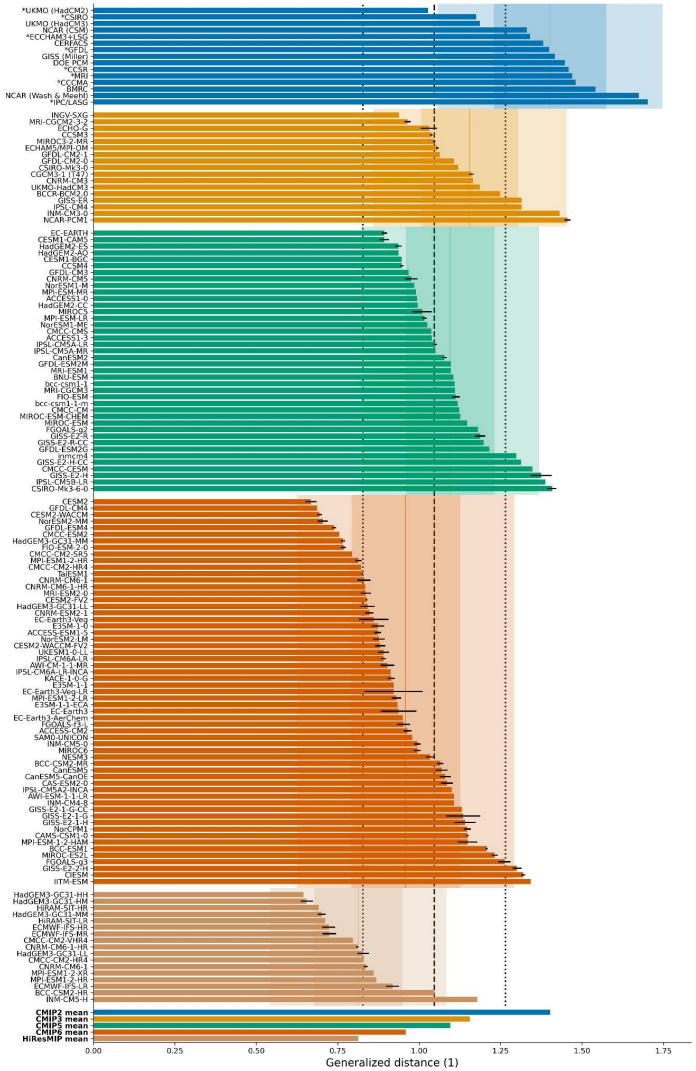
} Termed CMIP2 here

Performance and independence analysis based on
pre-industrial control runs with global mean removed.

universität wien

Models have improved their representation of temperature and precipitation climatologies

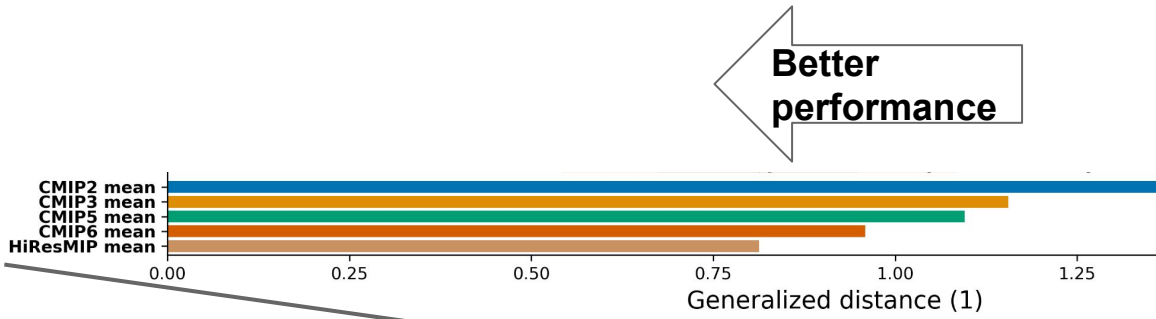
Generalized distance: Combined (dimensionless) area-weighted RMSE of temperature and precipitation climatologies (1980-1999) relative to ERA5

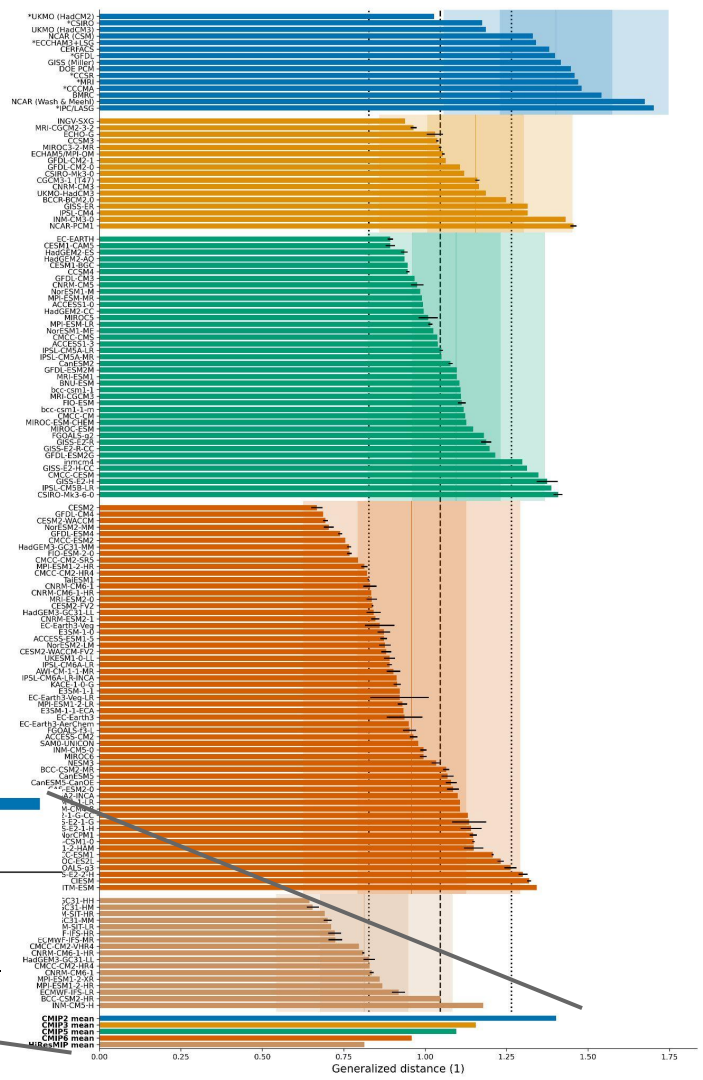


universität wien

Models have improved their representation of temperature and precipitation climatologies

Generalized distance: Combined (dimensionless) area-weighted RMSE of temperature and precipitation climatologies (1980-1999) relative to ERA5



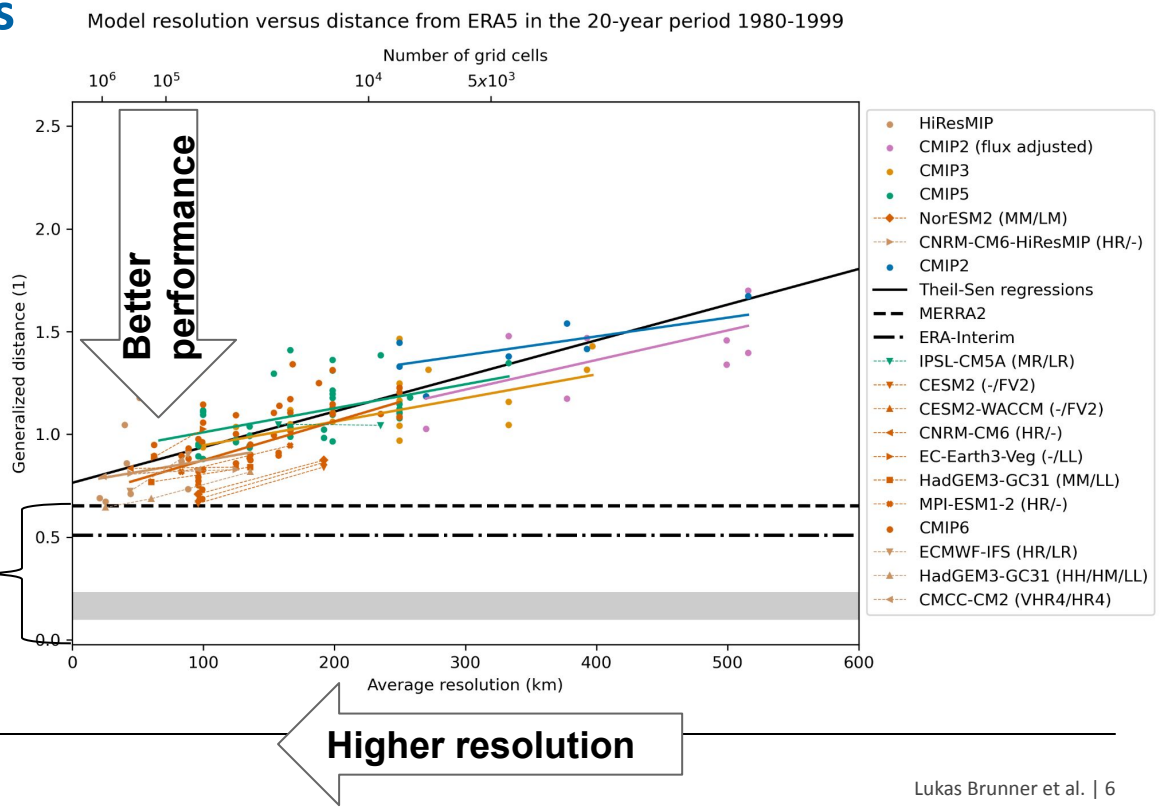


Model performance increases with increasing resolution

This relation is robust

- across generations of CMIP
- within generations of CMIP
- within models (using low/ high resolution pairs)

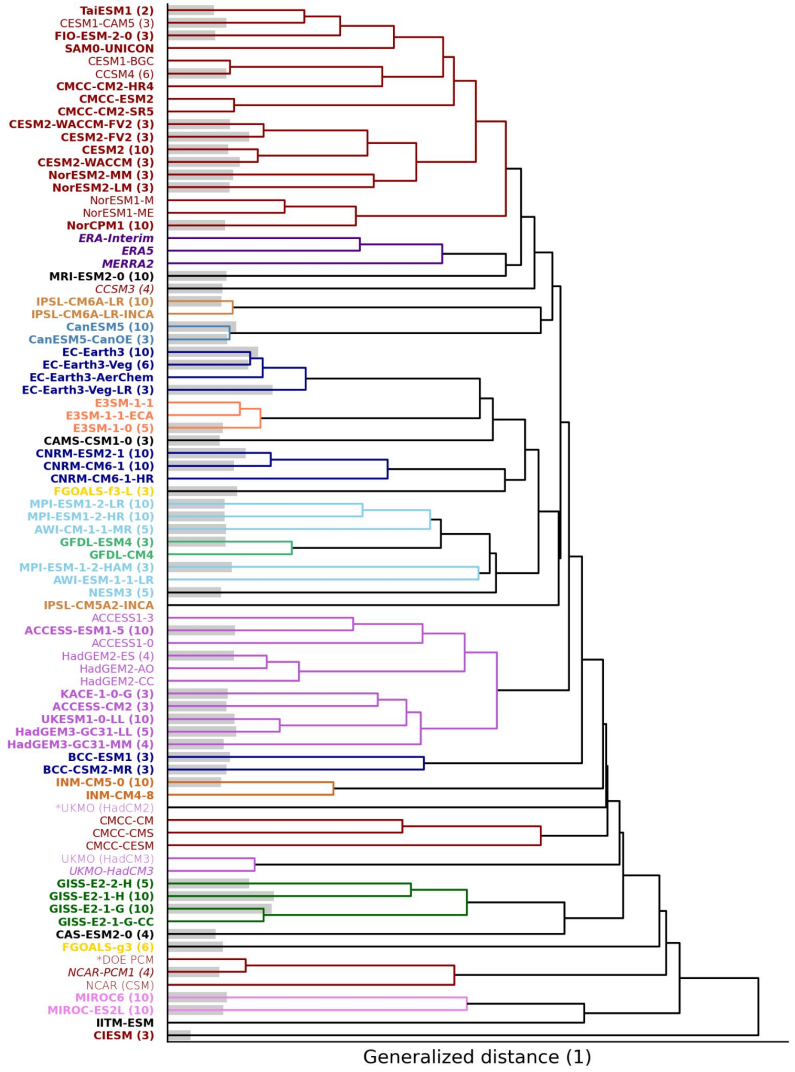
Distance between different reanalysis datasets



universität wien

CMIP6 - bold
CMIP5 - normal
CMIP3 - italics
CMIP2 - light

Models from the same ‘family’ cluster together even across generations of CMIP

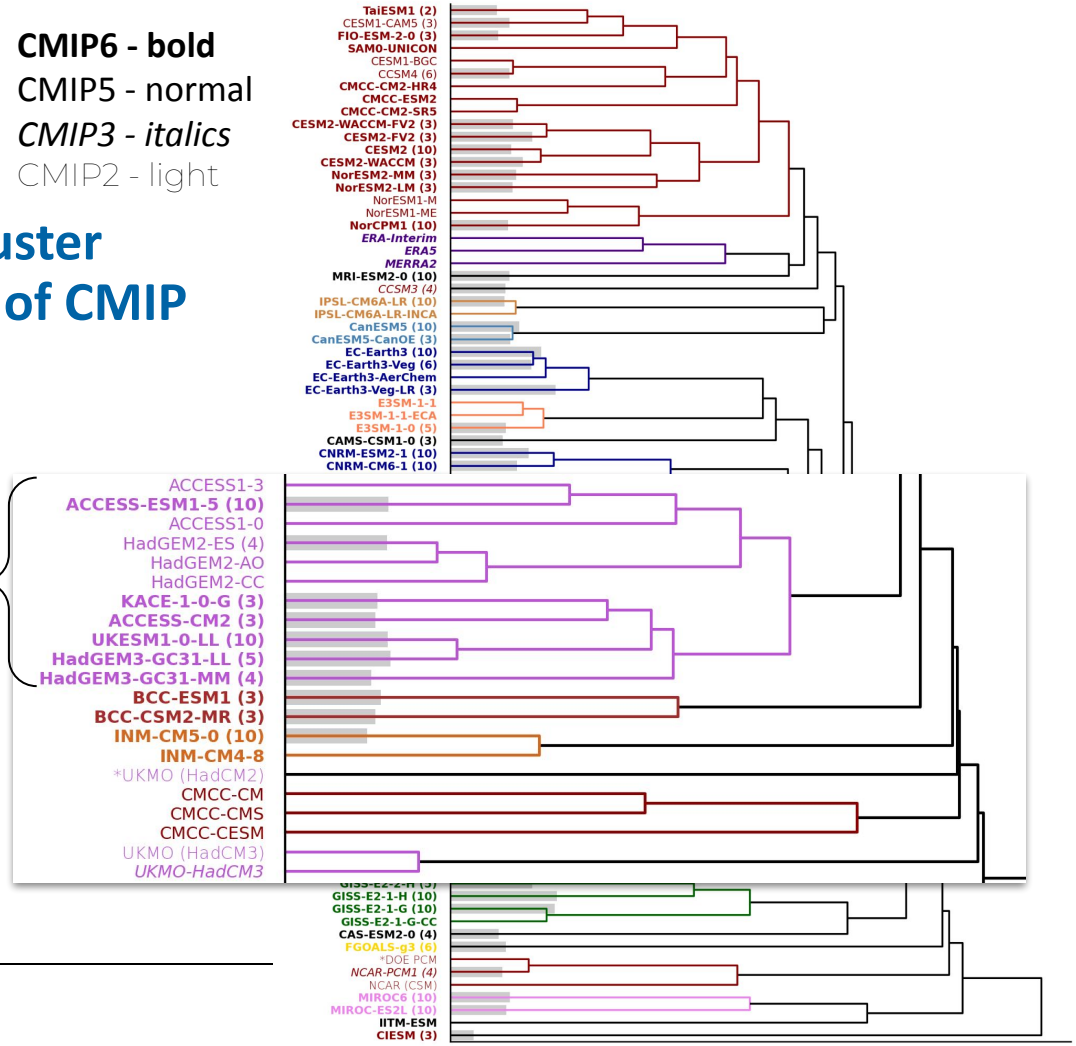


universität wien

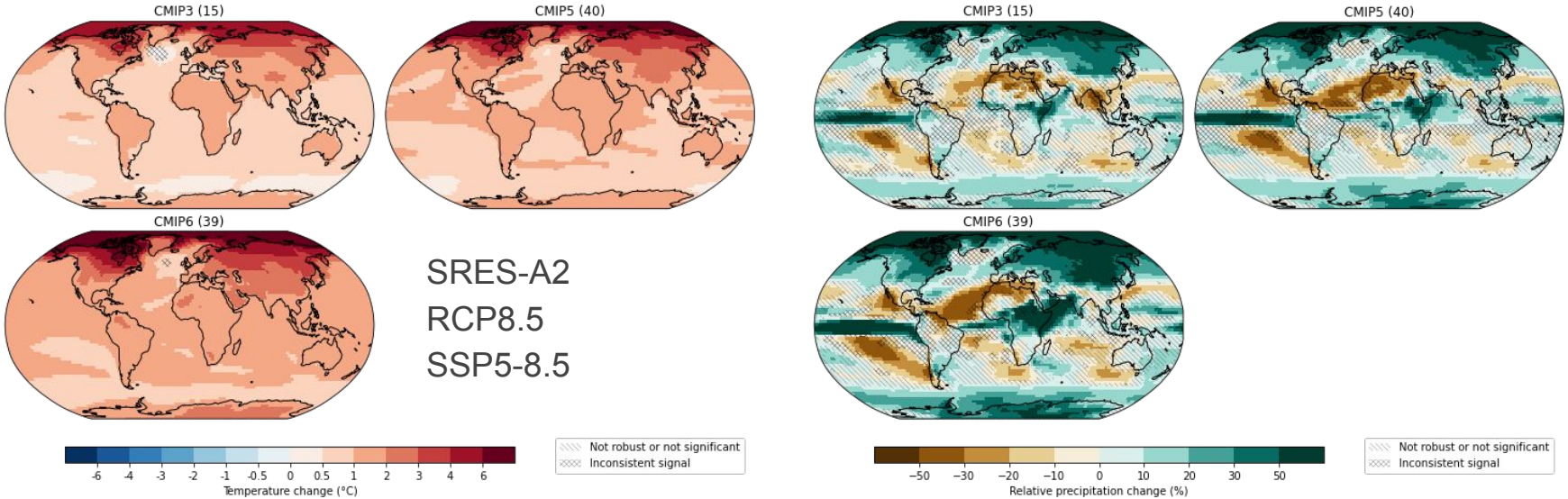
CMIP6 - bold
CMIP5 - normal
CMIP3 - italics
CMIP2 - light

Models from the same ‘family’ cluster together even across generations of CMIP

Models cluster according to larger family rather than generation for CMIP5 & 6



Patterns of change and model consistency persist across CMIP generations

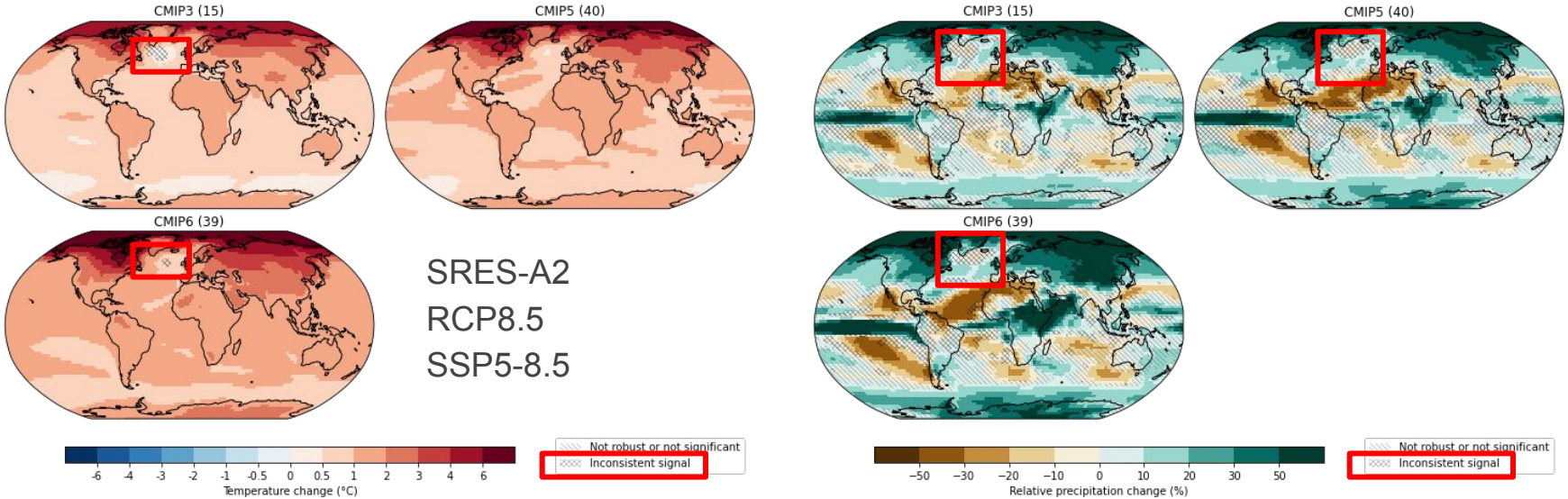


Multi-model mean temperature (left) and precipitation (right) change in the period 2081-2100 relative to 1986-2005.

universität wien

Patterns of change and model consistency persist across CMIP generations

Inconsistent: Statistically significant but not robust



Multi-model mean temperature (left) and precipitation (right) change in the period 2081-2100 relative to 1986-2005.

universität wien

Summary

- Model climatologies keep improving across CMIP generations but considerable model spread remains
- Increased resolution (and thereby resolvinging previously parameterized processes) is correlated with increased performance
- Models can be identified to belong to the same family even after years of continued development between CMIP generations
- Large scale pattern of change in temperature and precipitation as well as regions of model disagreement persist across generations

Please reach out for any questions!

l.brunner@univie.ac.at