CMIP5 GCM evaluation: a downscaling perspective

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Motivation · Scientific questions

- How good are CMIP5 GCMs?
  - Downscaling perspective:
    How good are the fields I use as input for downscaling?
- What kind of defects do they show?
  - Downscaling perspective:
    Can I correct them before use?

    In principle, only relevant for SD
    but, see: Collette et al 2012(GRL), Xu & Yang, 2012(JC)

Submitted to Climate Dynamics

How well do CMIP5 Earth System Models simulate present climate conditions in Africa and Europe?

A performance comparison for the downscaling community

S. Brands · S. Herrera · J. Fernández · J.M. Gutiérrez

Data

Code	Name	Height	Unit	Acronyms
Z	Geopotential	500hPa	$m^2 s^{-2}$	Z500
T	Temperature	2m, 850hPa, 500hPa	K	T2, T850, T500
Q	Specific humidity	850hPa	$kg\,kg^{-1}$	Q850
U	U-wind	850hPa	$m\,s^{-1}$	U850
V	V-wind	850hPa	$m\,s^{-1}$	V850
SLP	Sea-level pressure	mean sea-level	Pa	SLP

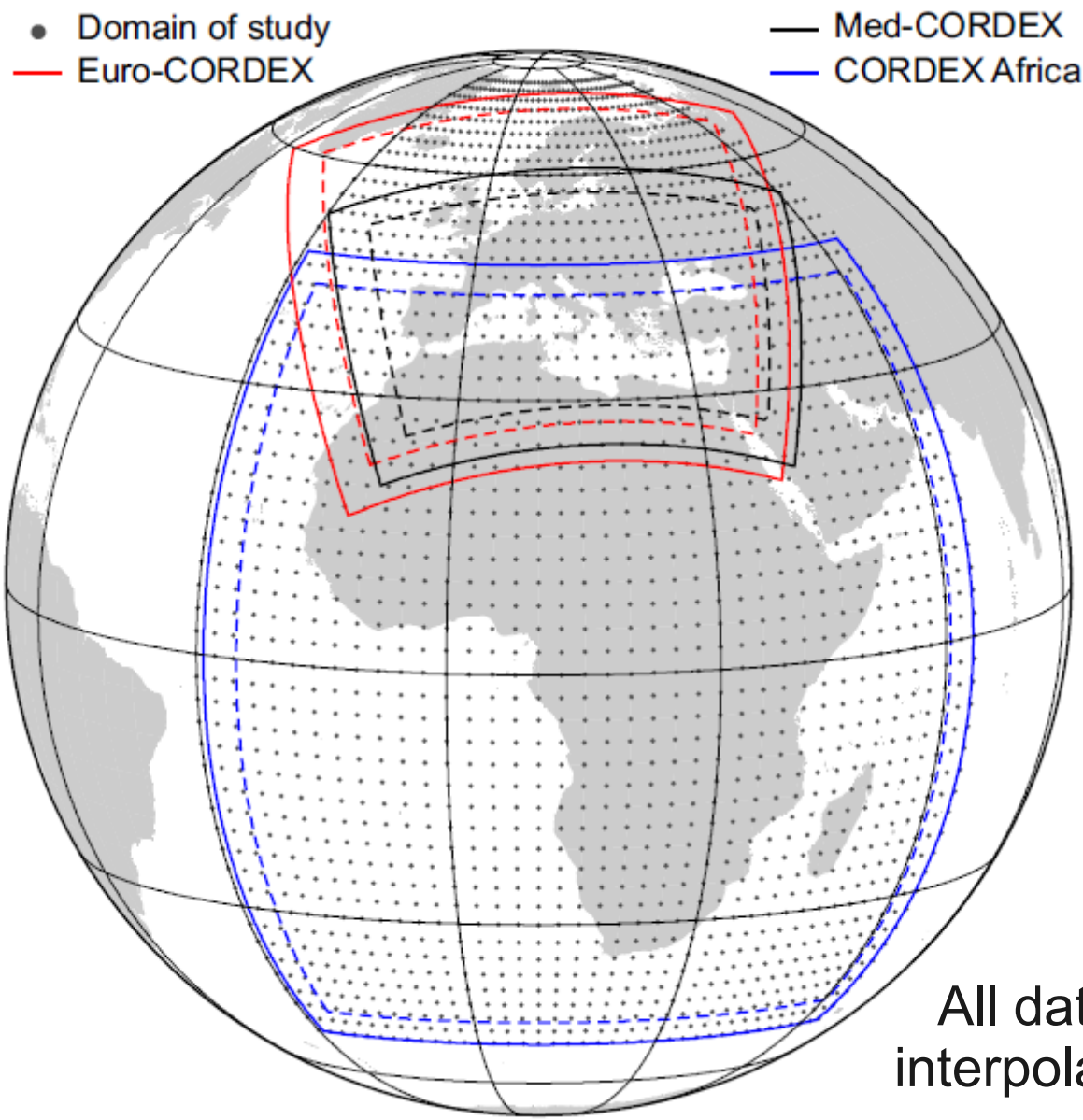
"Observations": ERA-Interim, JRA25

GCMs: CMIP5

Period: 1979-2005

Model	Hor. Resolution	Reference
CanESM2	$2.8° \times 2.8°$	Chylek et al (2011)
CNRM-CM5	$1.4° \times 1.4°$	Voldoire et al (2012)
HadGEM2-ES	$1.875° \times 1.25°$	Collins et al (2011)
IPSL-CM5-MR	$1.5° \times 1.27°$	Dufresne et al (submitted)
MIROC-ESM	$2.8° \times 2.8°$	Watanabe et al (2011)
MPI-ESM-LR	$1.8° \times 1.8°$	Raddatz et al (2007); Jungclaus et al (2010)
NorESM1-M	$1.5° \times 1.9°$	Kirkevag et al (2008); Seland et al (2008)

Domain of study



All data were (bilinearly) interpolated to a 2.5ºx2.5º regular grid

Evaluation approach

JRA25 ⟷ Reference: **ERA-Interim** ⟷ CMIP5 Earth System Models (ESMs)

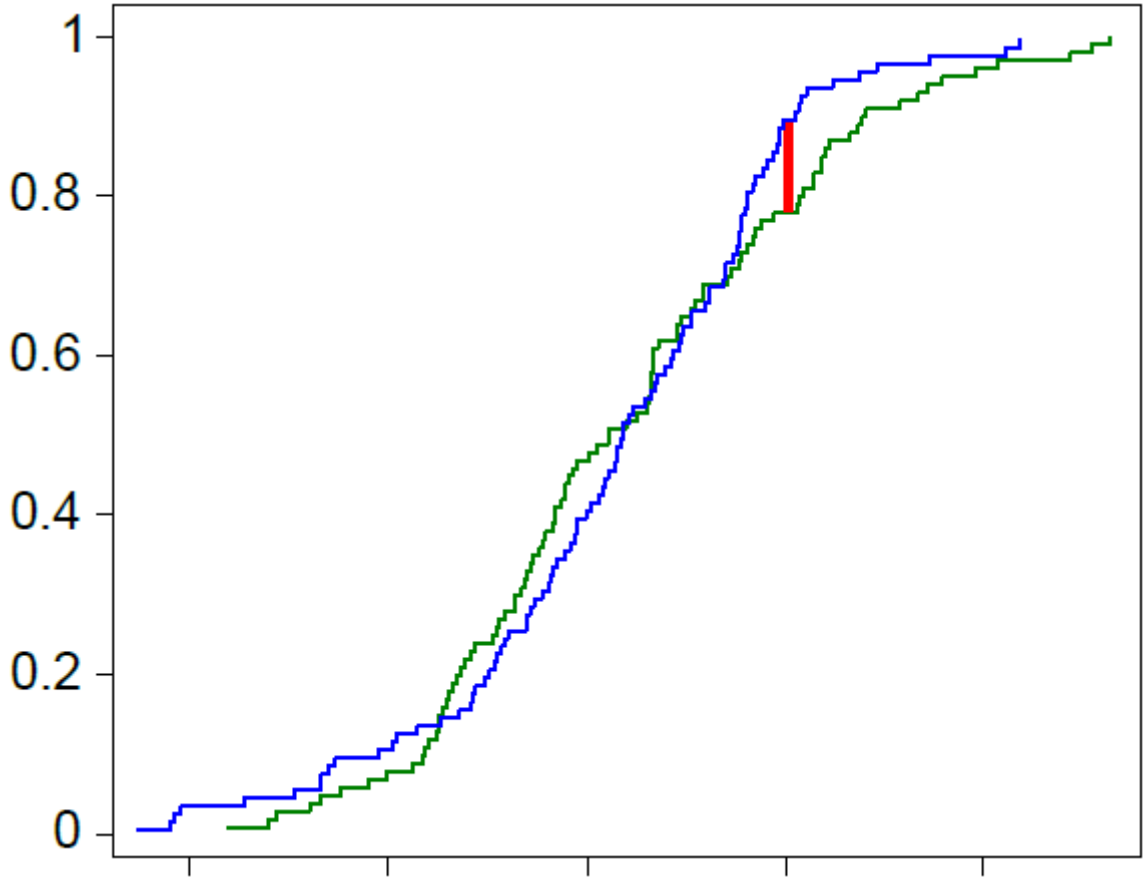
Observational uncertainty < **ESM error**

?

Method

KS statistic

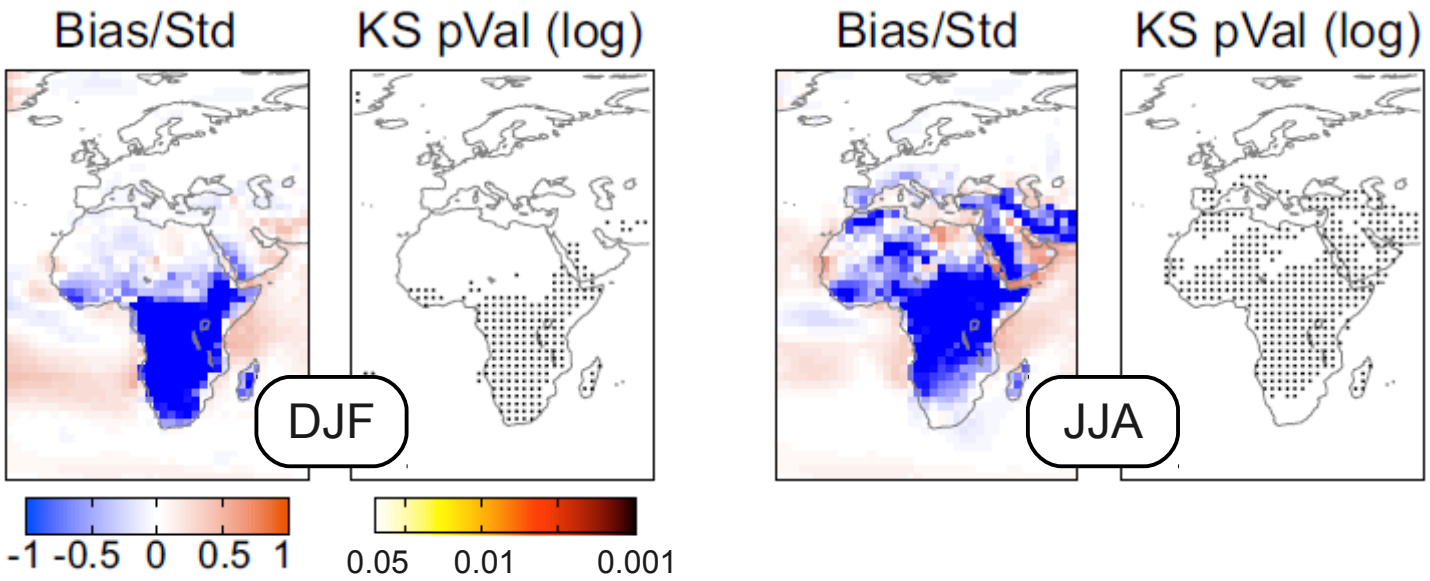
- Measures the distance between ECDFs
- Bounded in [0,1]. The smaller, the more similar



KS statistic p-value

- Measures the odds that both ECDFs differ that much, if they really came from the same population
- Bounded in [0,1]. The smaller, the more significant is the difference
- Only values below 0.05 are plotted (i.e. above 95% confidence)
- To avoid significant differences due to different mean values (i.e. due to a bias), the series were centered before comparing their CDFs

SLP

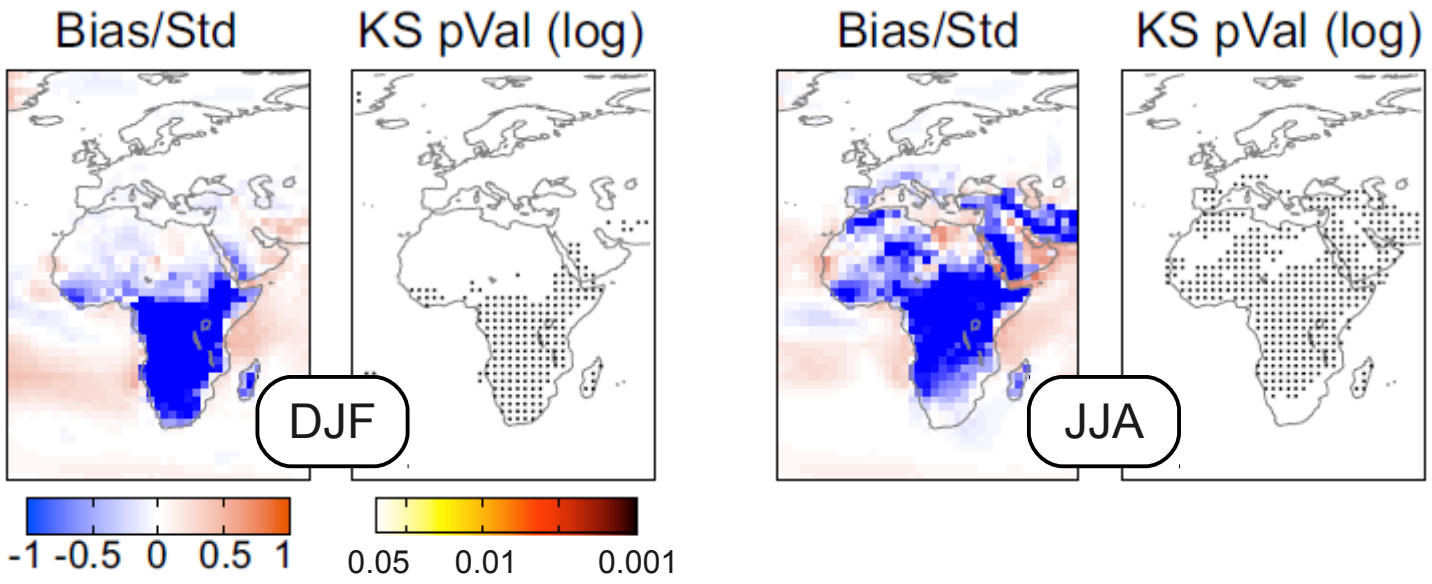


JRA25 *vs.* ERA-Interim

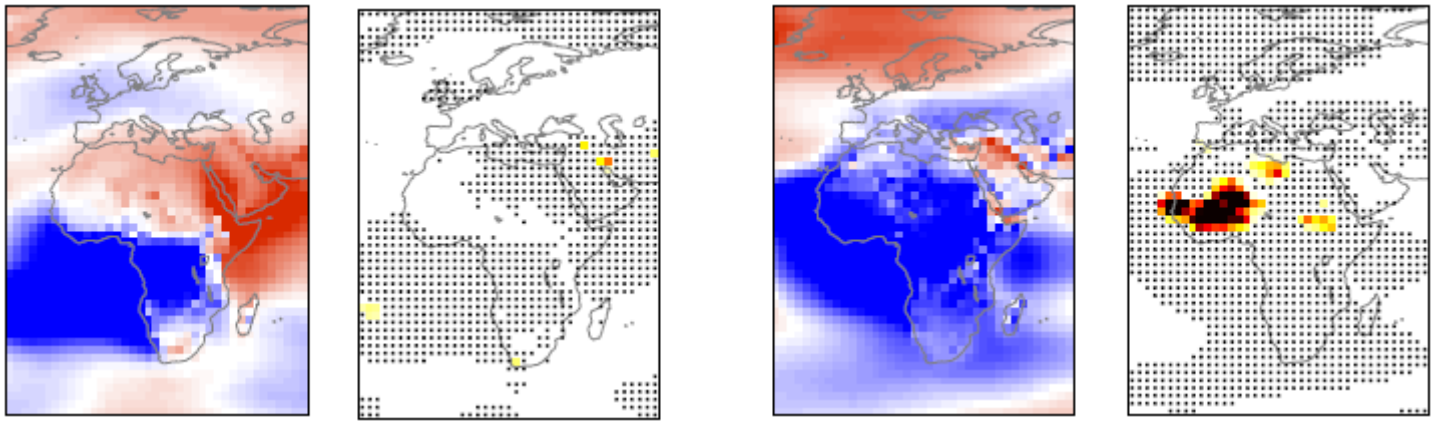
Large differences over southern Africa

Black dots → significant KS becomes non-significant after centering

SLP



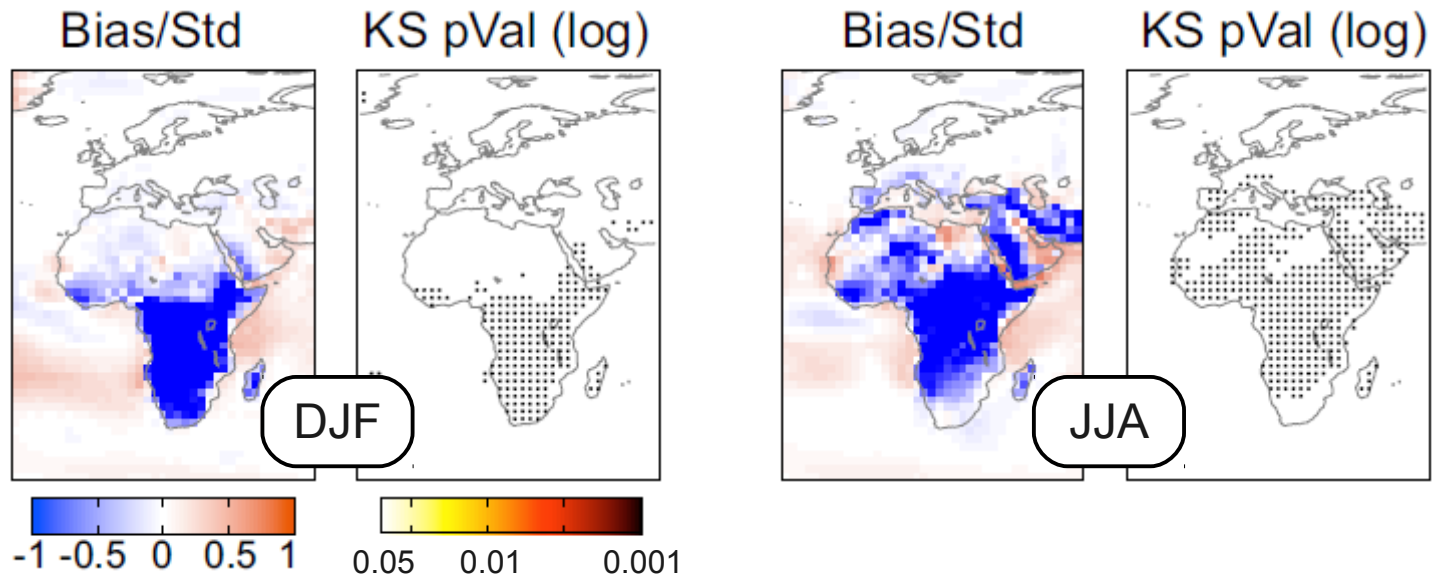
JRA25 *vs.*ERA-Interim



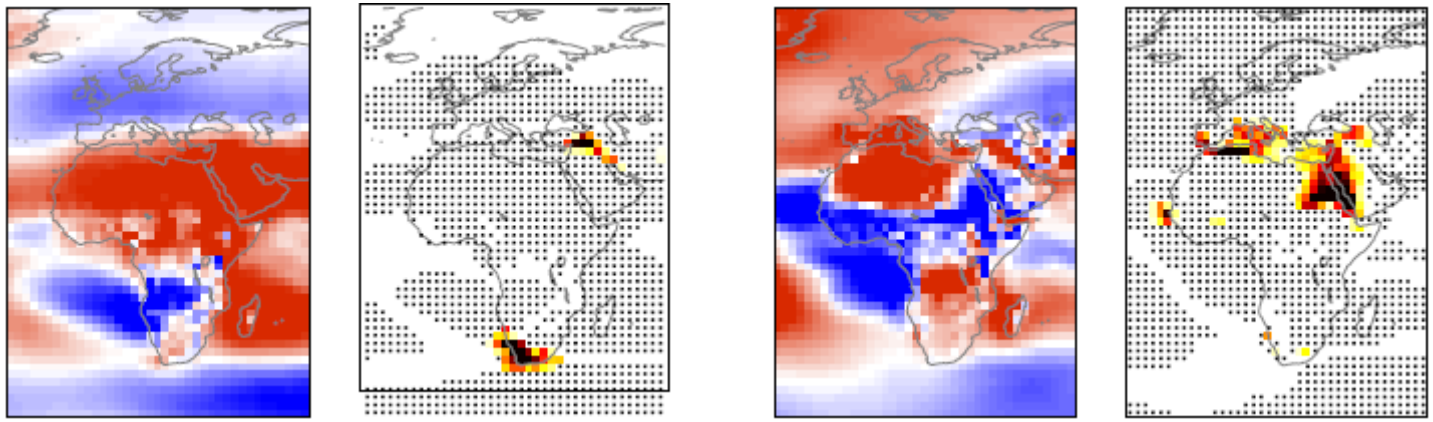
CNRM-CM5
vs. ERA-Interim

Black dots → significant KS becomes non-significant after centering

SLP



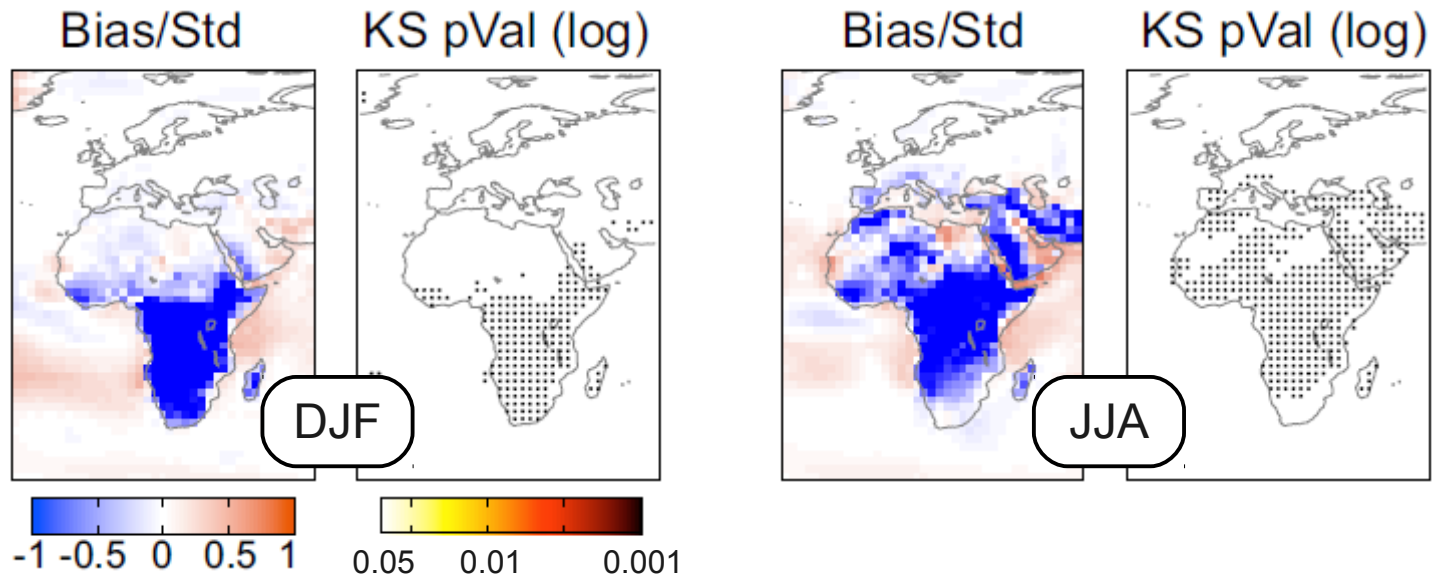
JRA25 *vs.*ERA-Interim



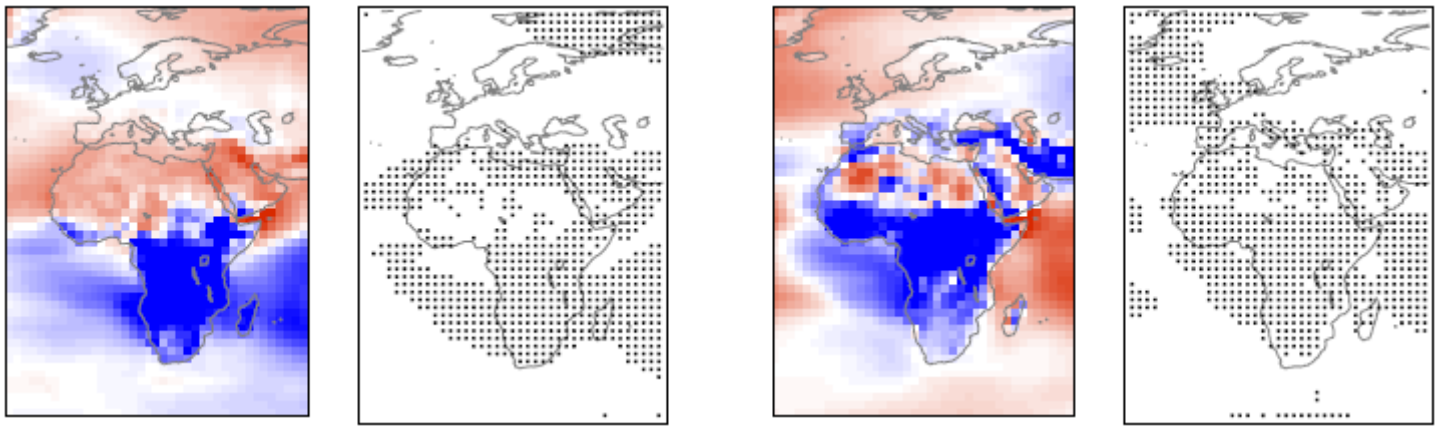
MIROC-ESM
vs. ERA-Interim

Black dots → significant KS becomes non-significant after centering

SLP



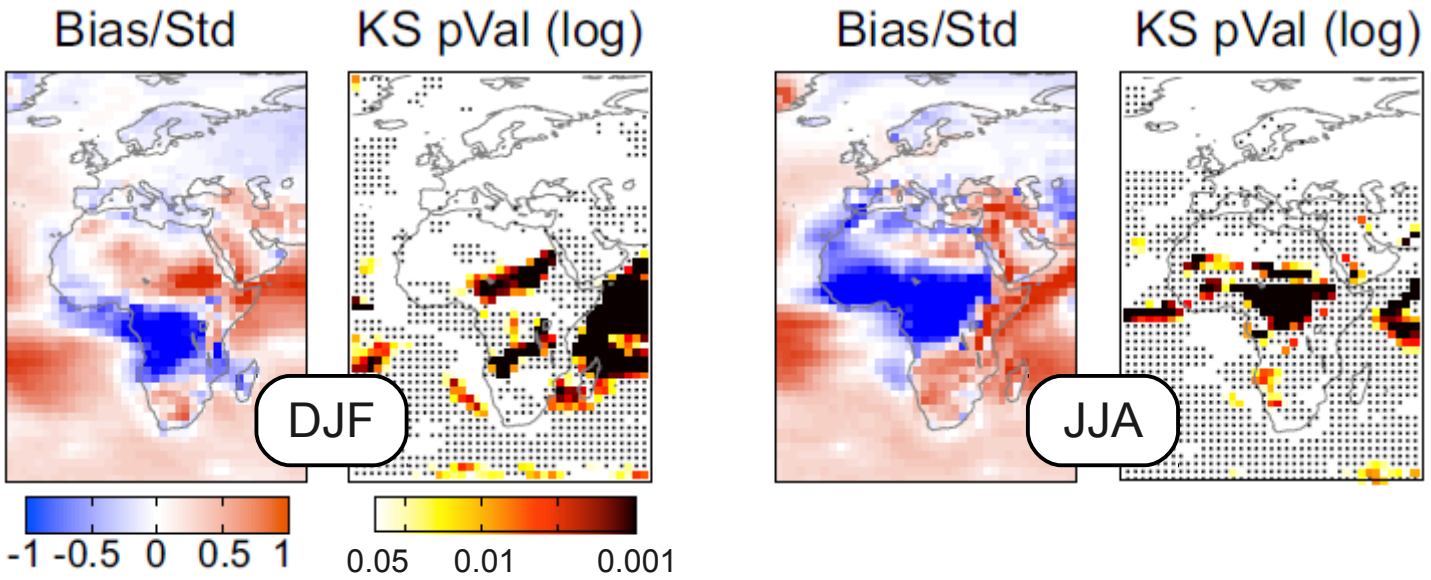
JRA25 *vs.*ERA-Interim



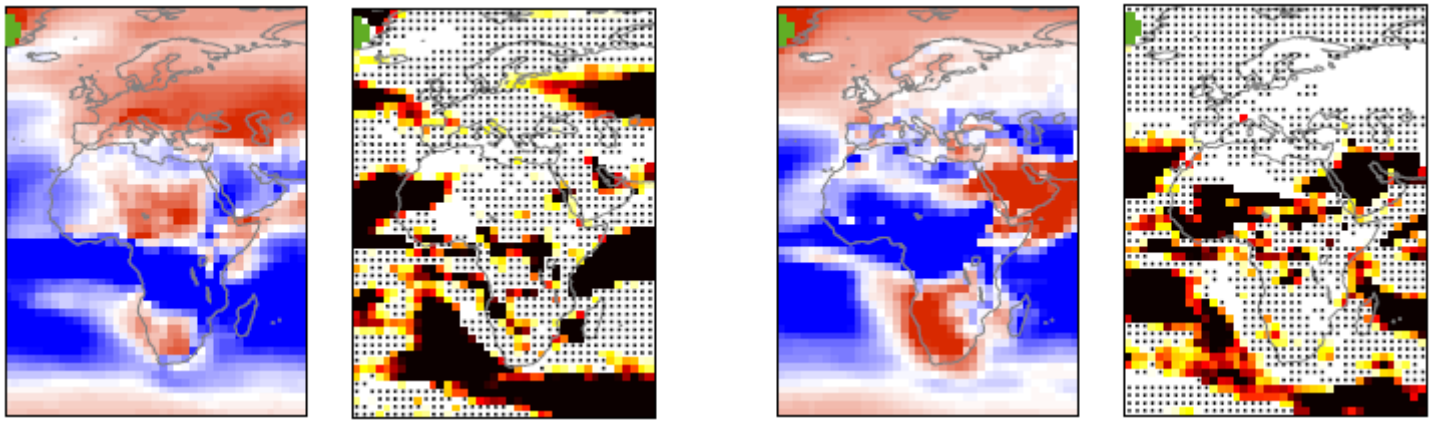
HadGEM2-ES
vs. ERA-Interim

Black dots → significant KS becomes non-significant after centering

Q850



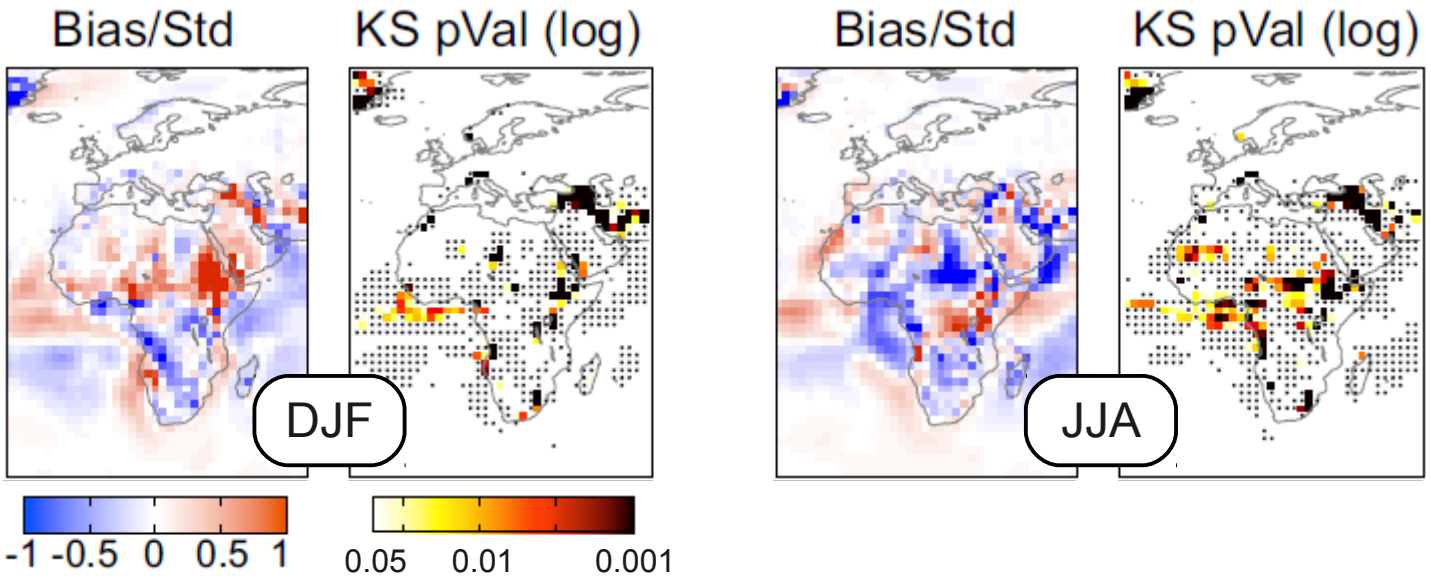
JRA25 *vs.*ERA-Interim



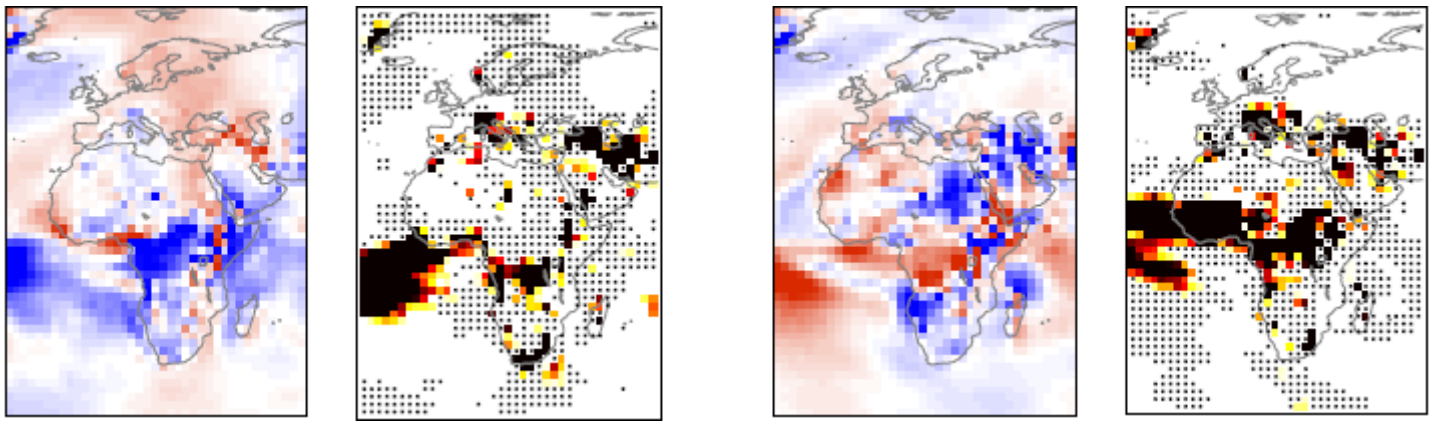
MIROC-ESM
vs. ERA-Interim

Black dots → significant KS becomes non-significant after centering

V850



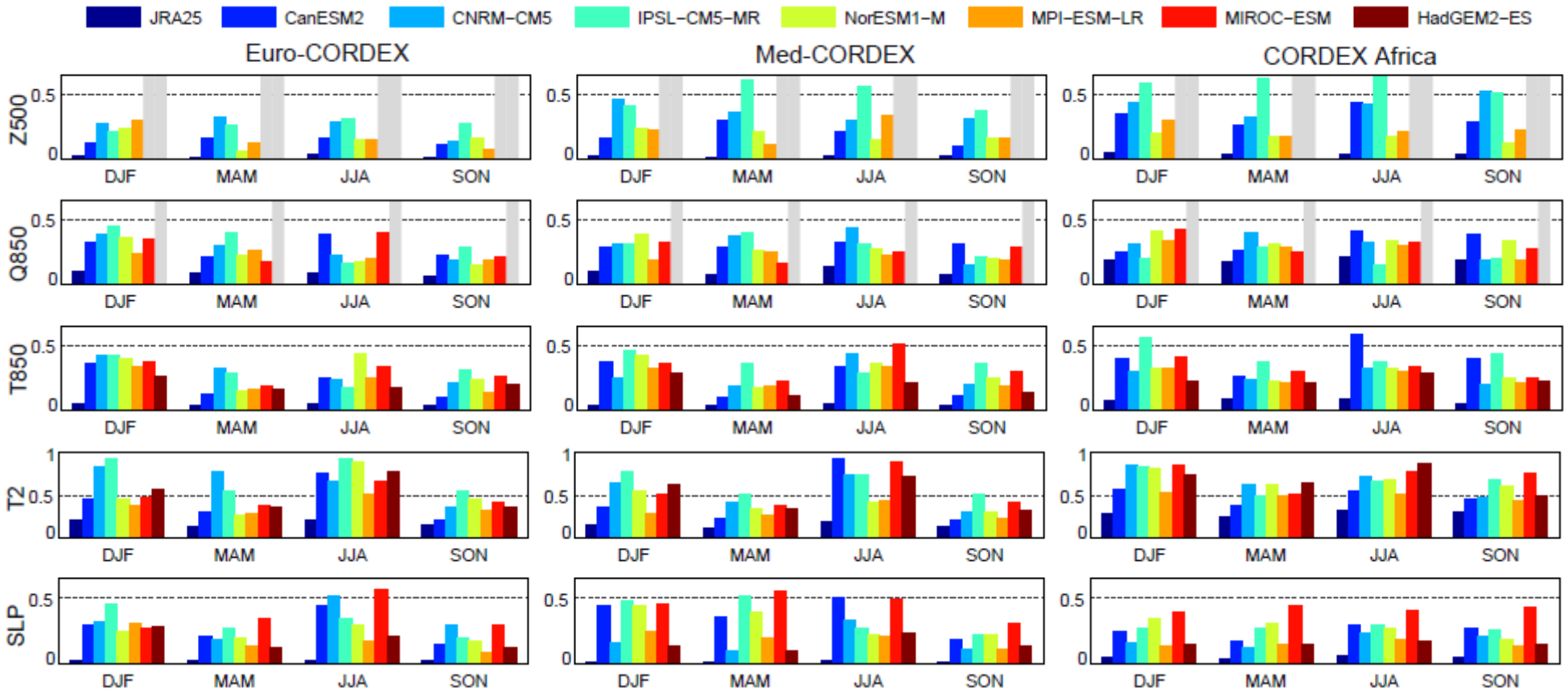
JRA25 *vs.*ERA-Interim



MPI-ESM-LR
vs. ERA-Interim

Black dots → significant KS becomes non-significant after centering

Median bias at the boundaries



Conclusions

- How good are CMIP5 GCMs?

  Overall, they behave well but …

- What kind of defects do they show?

  … some of them show biases (notably, over Africa) which can be simply corrected. Additionally, there are also problems with higher-order moments (variability, skewness, …) over selected regions and variables.

- Any recommendation for CORDEX?

  HadGEM2-ES and MPI-ESM-LR seem to outperform the rest of the models in most region boundaries and variables tested.

However, good current climate does not imply good response to a changing forcing.

Which models should we downscale?

Work in progress...

- The same analysis is currently under way in all CORDEX regions and ...
- … considering multiple runs for each GCM, to assess the role of internal variability in the results.

Thank you!

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