Regional climate simulations for West Africa

On the importance of bias correction of driving global model data

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Global climate trends on regional scales

Mean total monthly rainfall in some stations in the Sahel (mm/month)

1951 - 1960
1981 - 1990
1991 - 2000

Ouahigouya

Niamey

Bamako

N'Djamena

<500mm/yr
500mm/yr
1000mm/yr
2000mm/yr
3000mm/yr

Source: Nicholson Sharon E. (2001), Agrhymet Regional Centre (2007)

© Sahel and West Africa Club / OECD 2007
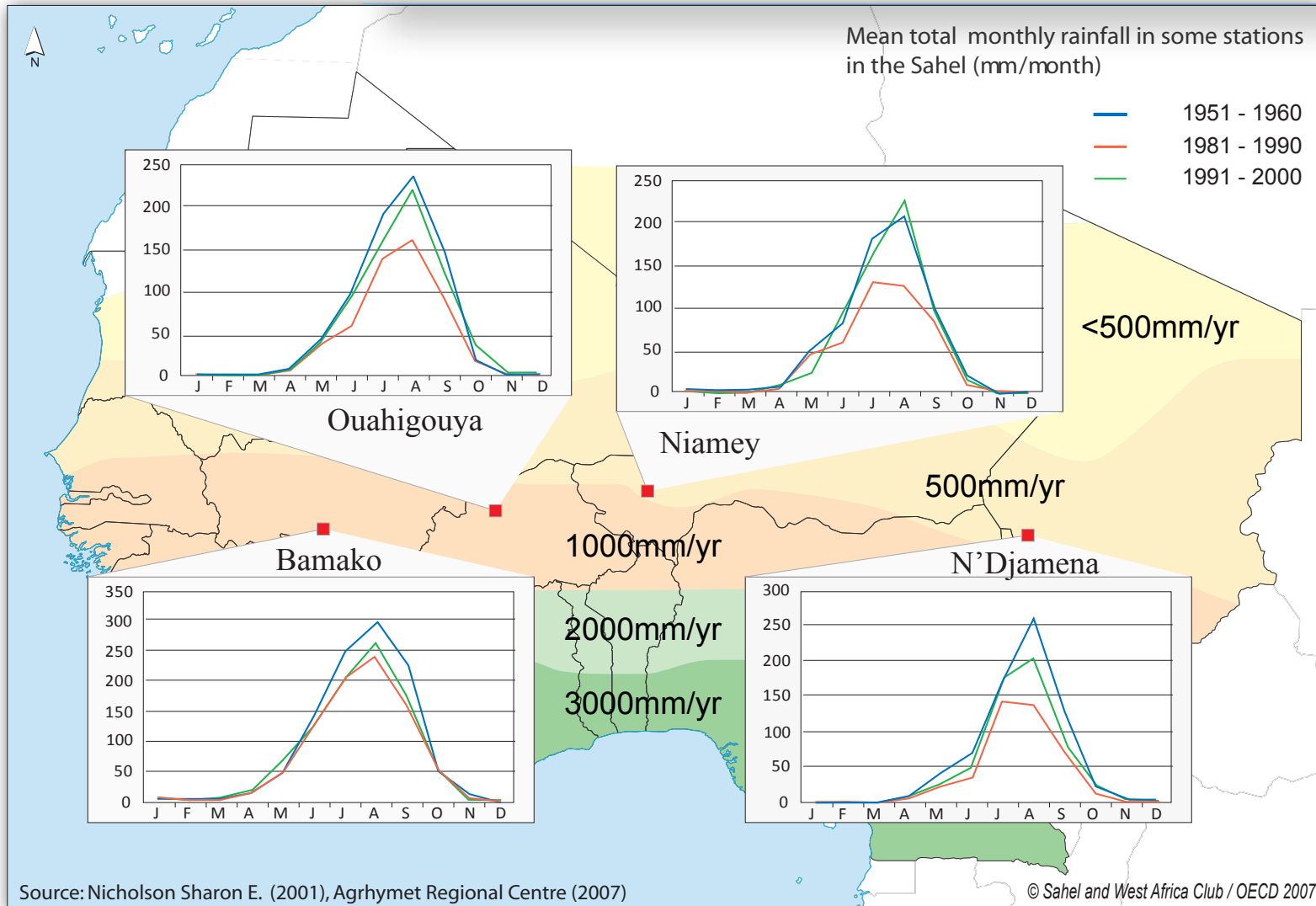
Global climate trends on regional scales
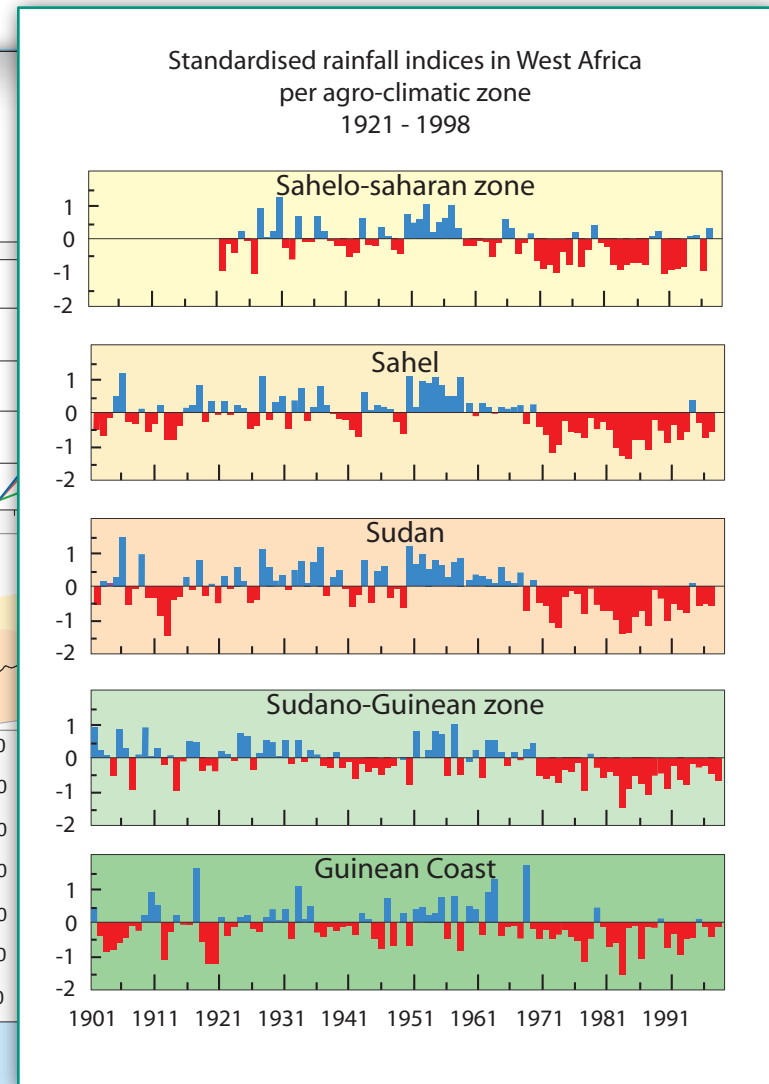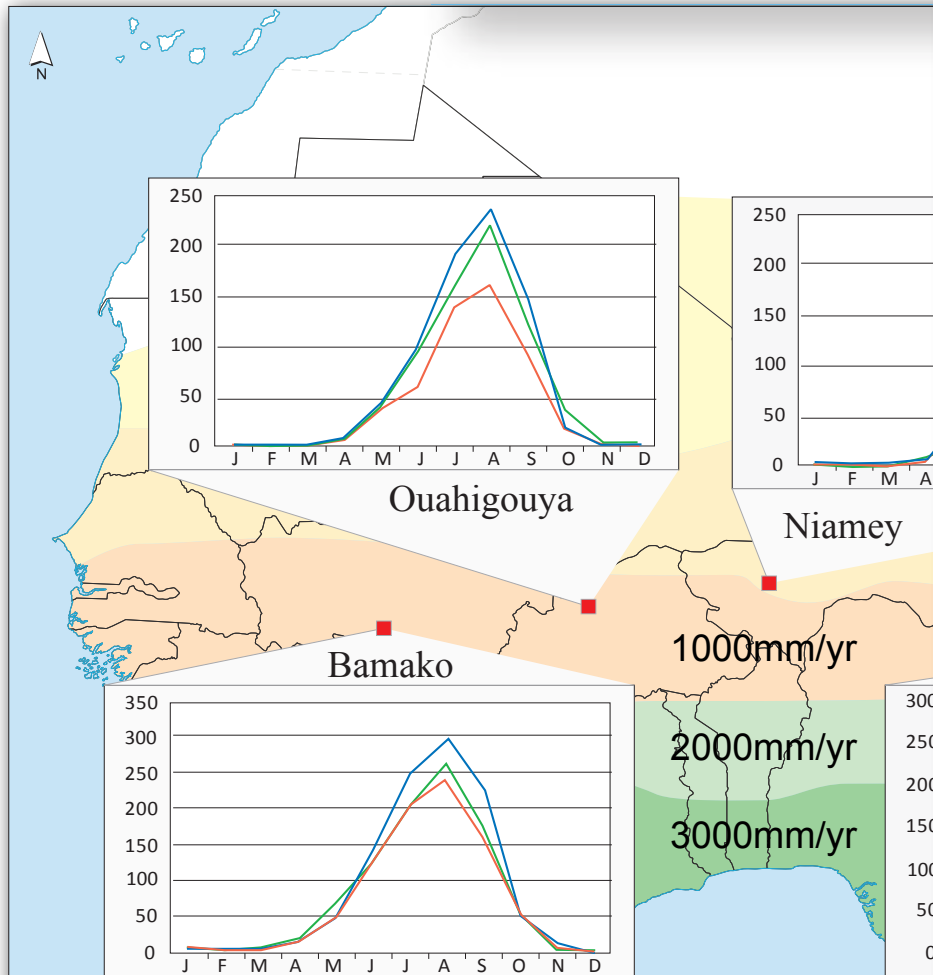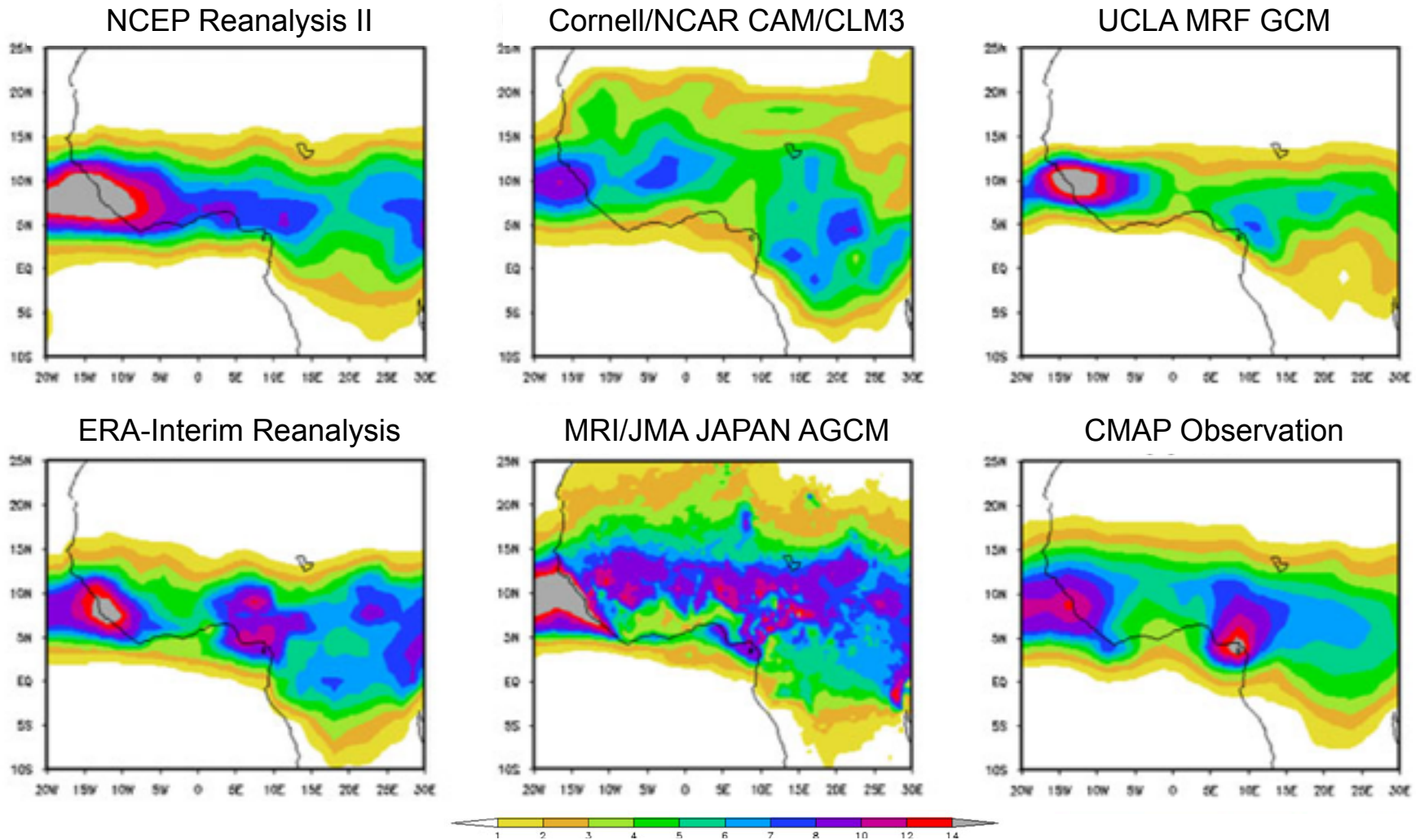

Source: Nicholson Sharon E. (2001), Agrhymet Regional Centre (2007)

© Sahel and West Africa Club / OECD 2007

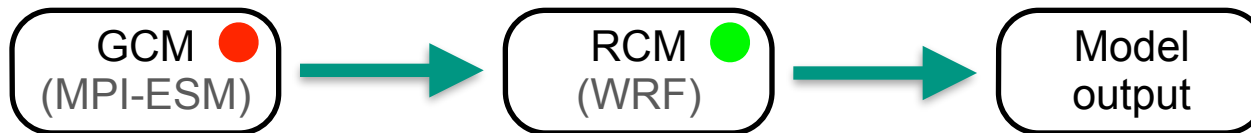# The failure of global climate projections

NCEP Reanalysis II   Cornell/NCAR CAM/CLM3   UCLA MRF GCM

ERA-Interim Reanalysis   MRI/JMA JAPAN AGCM   CMAP Observation

June-August 2003-2006 mean precipitation [mm/day]   Xue et al. (2010)

"Garbage in, garbage out"

On two occasions I have been asked, "Pray, Mr. Babbage, if you put into the machine wrong figures, will the right answers come out?" ... I am not able rightly to apprehend the kind of confusion of ideas that could provoke such a question.

Charles Babbage, *Passages from the Life of a Philosopher*

GCM 🔴 (MPI-ESM) → RCM 🟢 (WRF) → Model output

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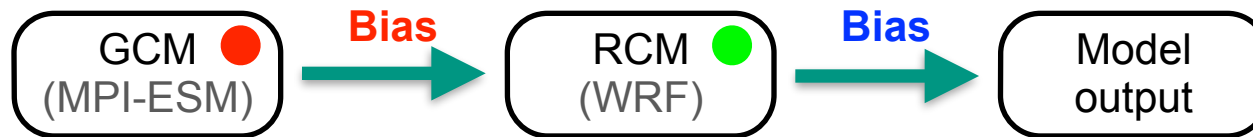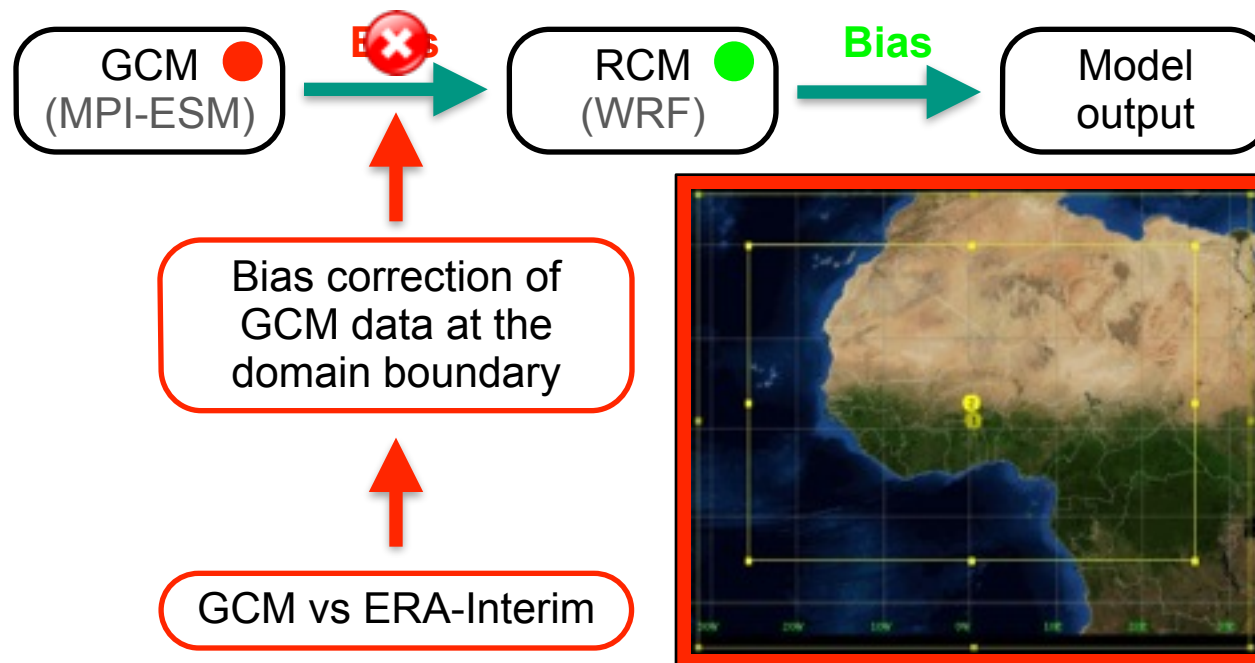
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Bias correction of GCM data at the domain boundary

GCM vs ERA-Interim

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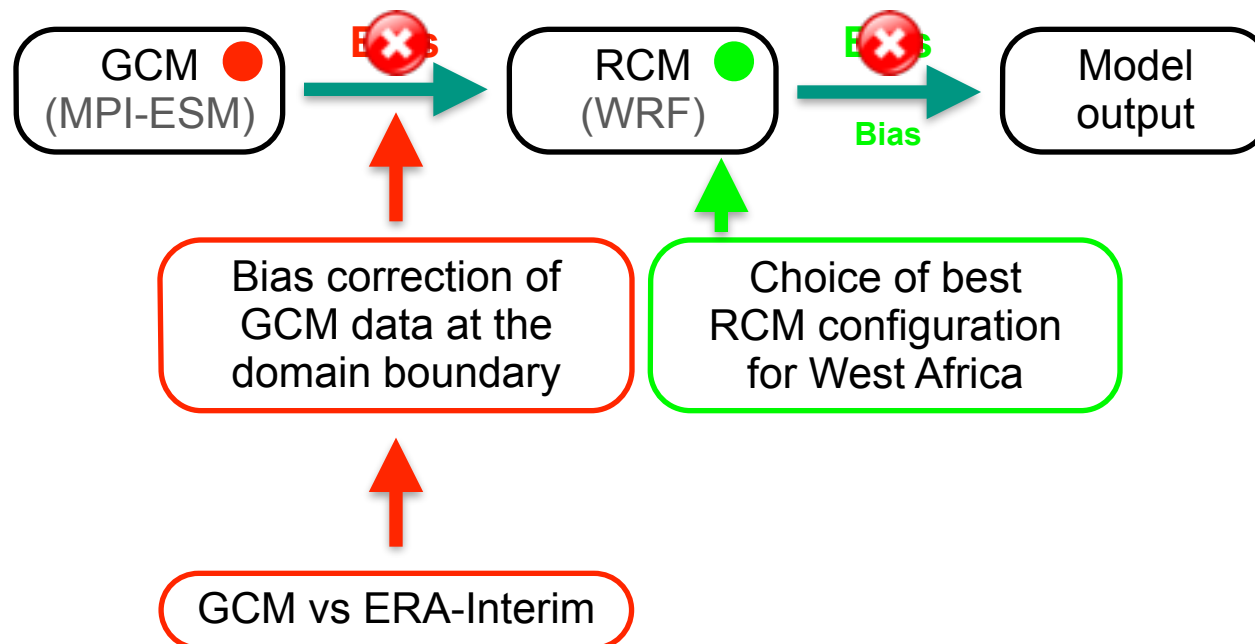
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GCM ● (MPI-ESM) → Bias ✕ → RCM ● (WRF) → Bias ✕ → Model output

Bias correction of GCM data at the domain boundary

Choice of best RCM configuration for West Africa

GCM vs ERA-Interim

"Garbage in, garbage out"

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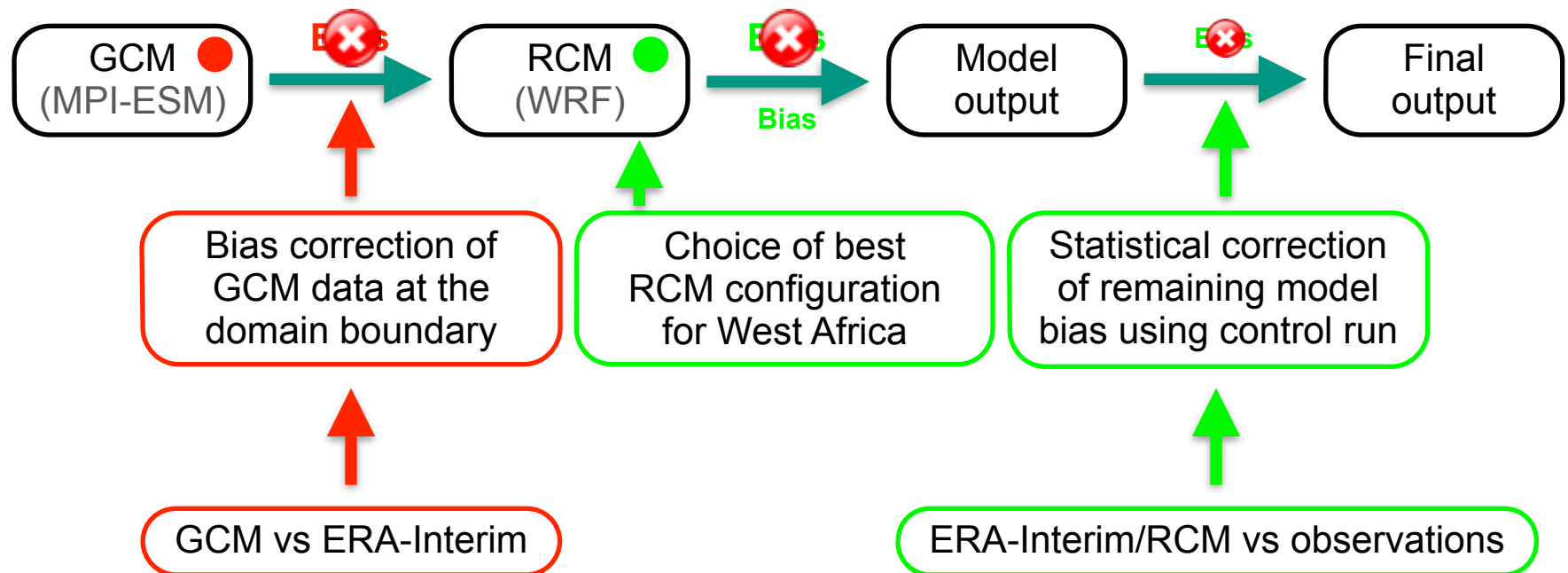Charles Babbage, *Passages from the Life of a Philosopher*

Two concurring bias correction algorithms

past: 1990-2000; "future": 2000-2010

Pseudo-global warming
Rasmussen et al. (2011)

Monthly mean of past GCM

Monthly mean of "future" GCM

Warming signal future - past

+

ERA Interim Reanalysis for past period

Two concurring bias correction algorithms

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Monthly mean of past GCM

Monthly mean of "future" GCM

A Interim Reanalysis for past period

Allows one to see how current weather would look like in the future. Assumes that key climate features do not change.

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A Interim Reanalysis for past period

Perturbed average climate
Done et al. (2012)

Average annual cycle of GCM for past → Substract from future gives GCM'

Average annual cycle of REA for past → Use average annual cycle of past $\overline{REA}$

Revised climate data GCM = $\overline{REA}$ + GCM'

Two concurring bias correction algorithms

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Perturbed average climate
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Average annual cycle of GCM for past

Average annual cycle of REA for past

Revised climate data GCM = $\overline{REA}$ + GCM'

Allows one to look at changes in weather and climate. Assumes that model biases are stationary in the future.
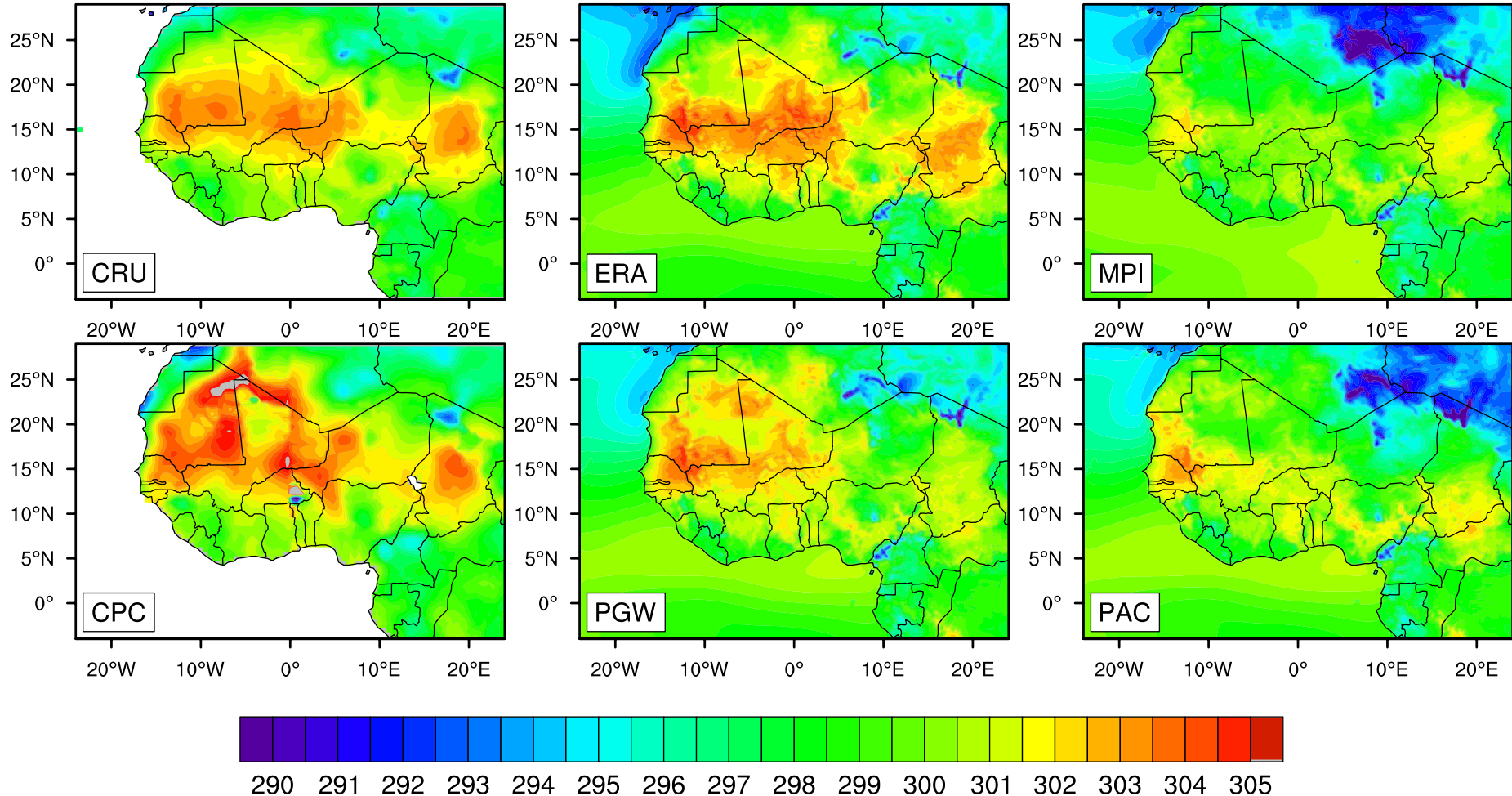
Bias correction of sea surface temperature

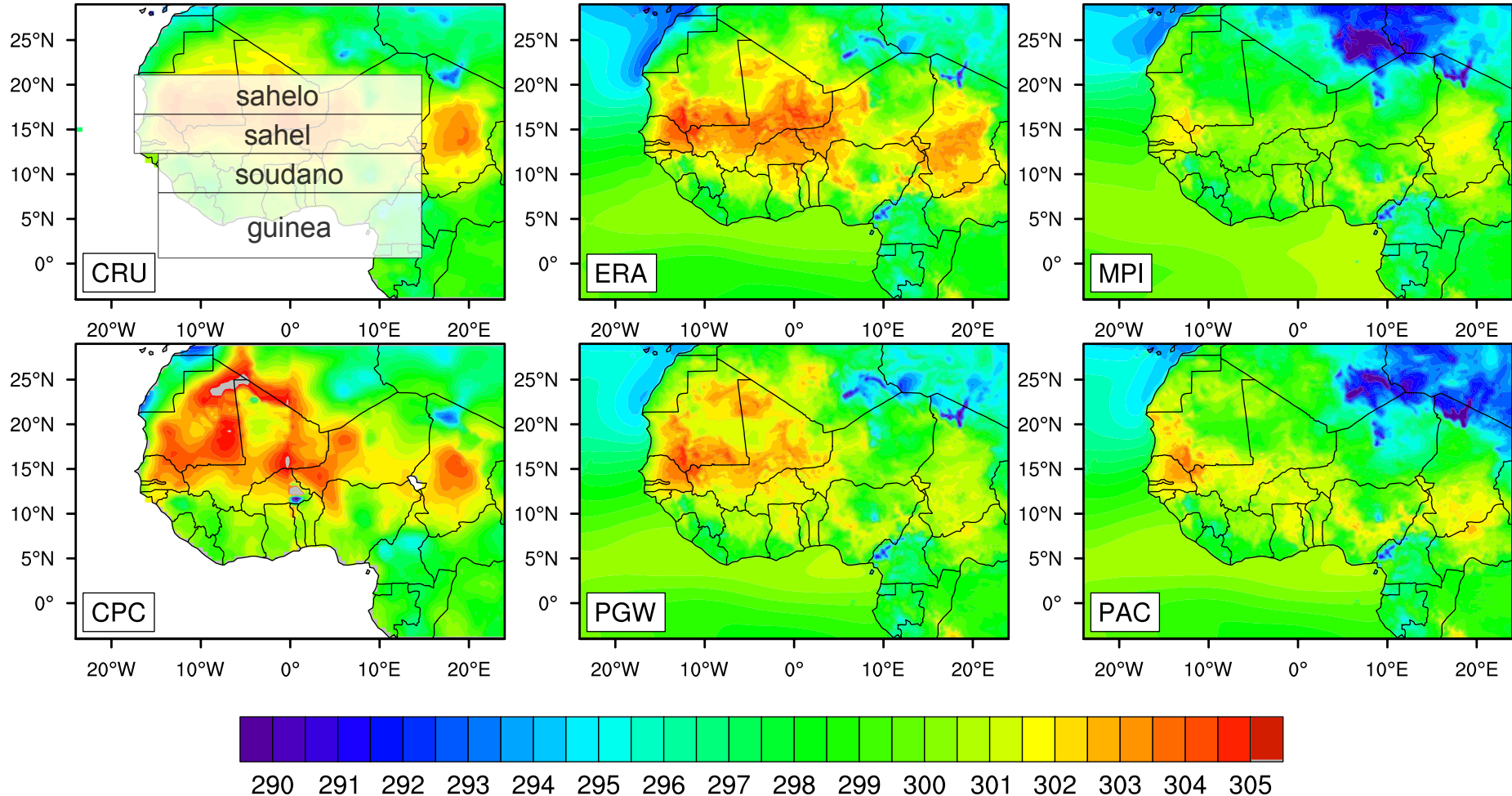## Model *input* 10-year mean sea surface temperature [K]
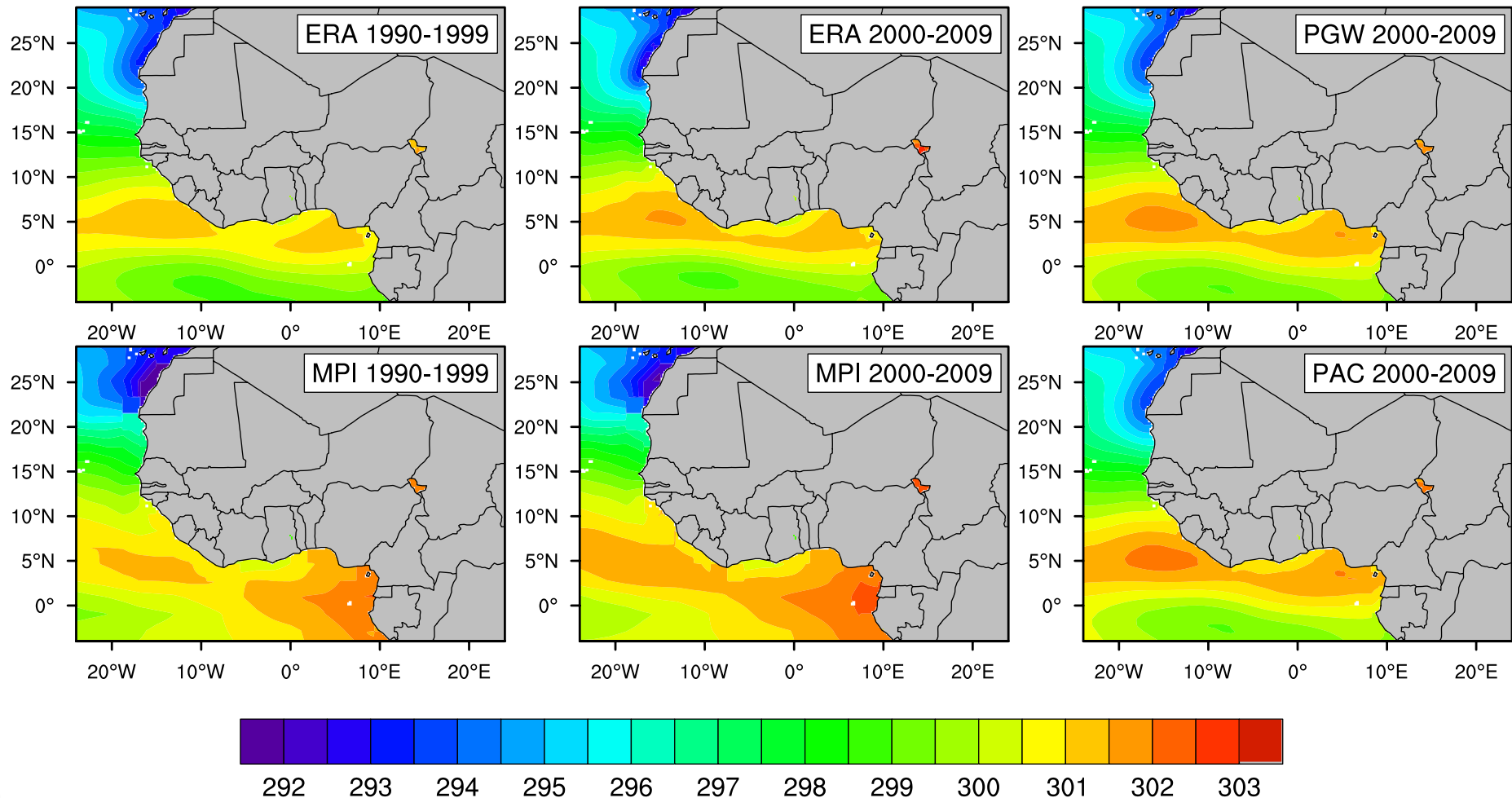
Pseudo-global warming is closer to the truth …

Model *output* monthly mean 2m temperature 2001-2009 [K]
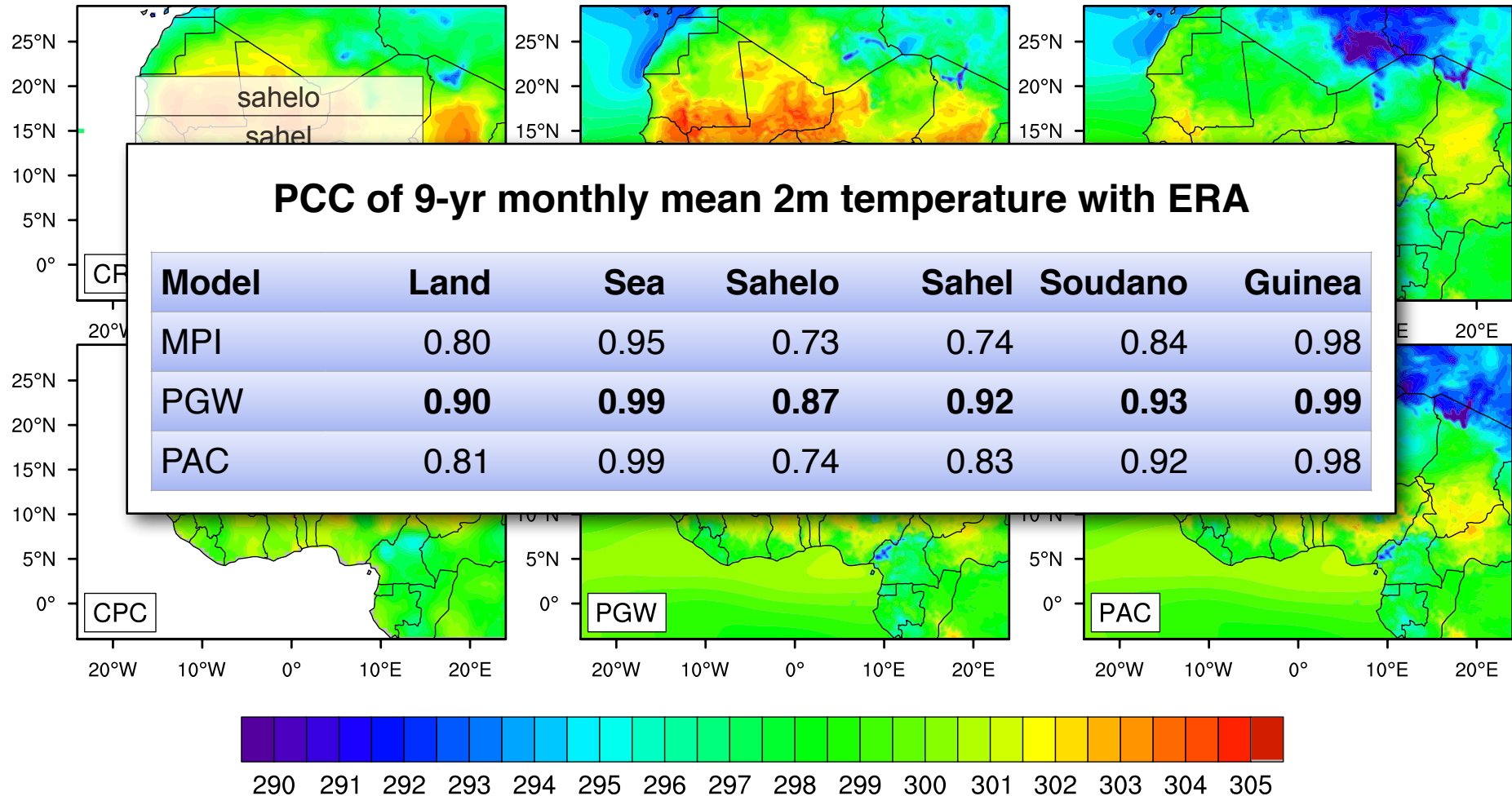
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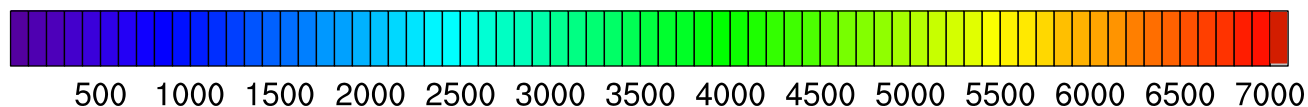
Model *output* monthly mean 2m temperature 2001-2009 [K]

Pseudo-global warming is closer to the truth …

Model *output* monthly mean 2m temperature 2001-2009 [K]

PCC of 9-yr monthly mean 2m temperature with ERA

Model	Land	Sea	Sahelo	Sahel	Soudano	Guinea
MPI	0.80	0.95	0.73	0.74	0.84	0.98
PGW	**0.90**	**0.99**	**0.87**	**0.92**	**0.93**	**0.99**
PAC	0.81	0.99	0.74	0.83	0.92	0.98

… and beats the raw global climate model

Model *output* mean annual rainfall 2001-2009 [mm]

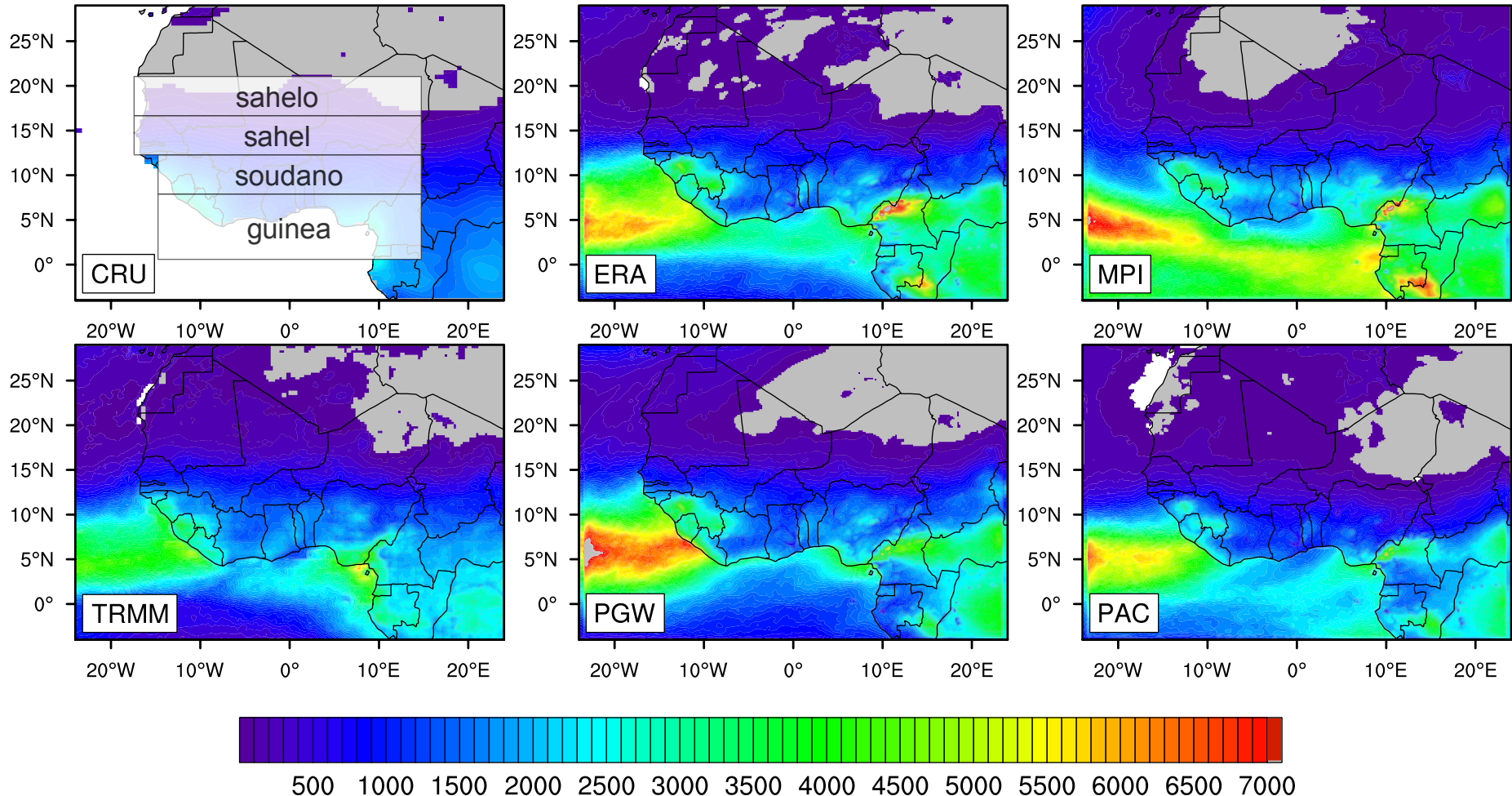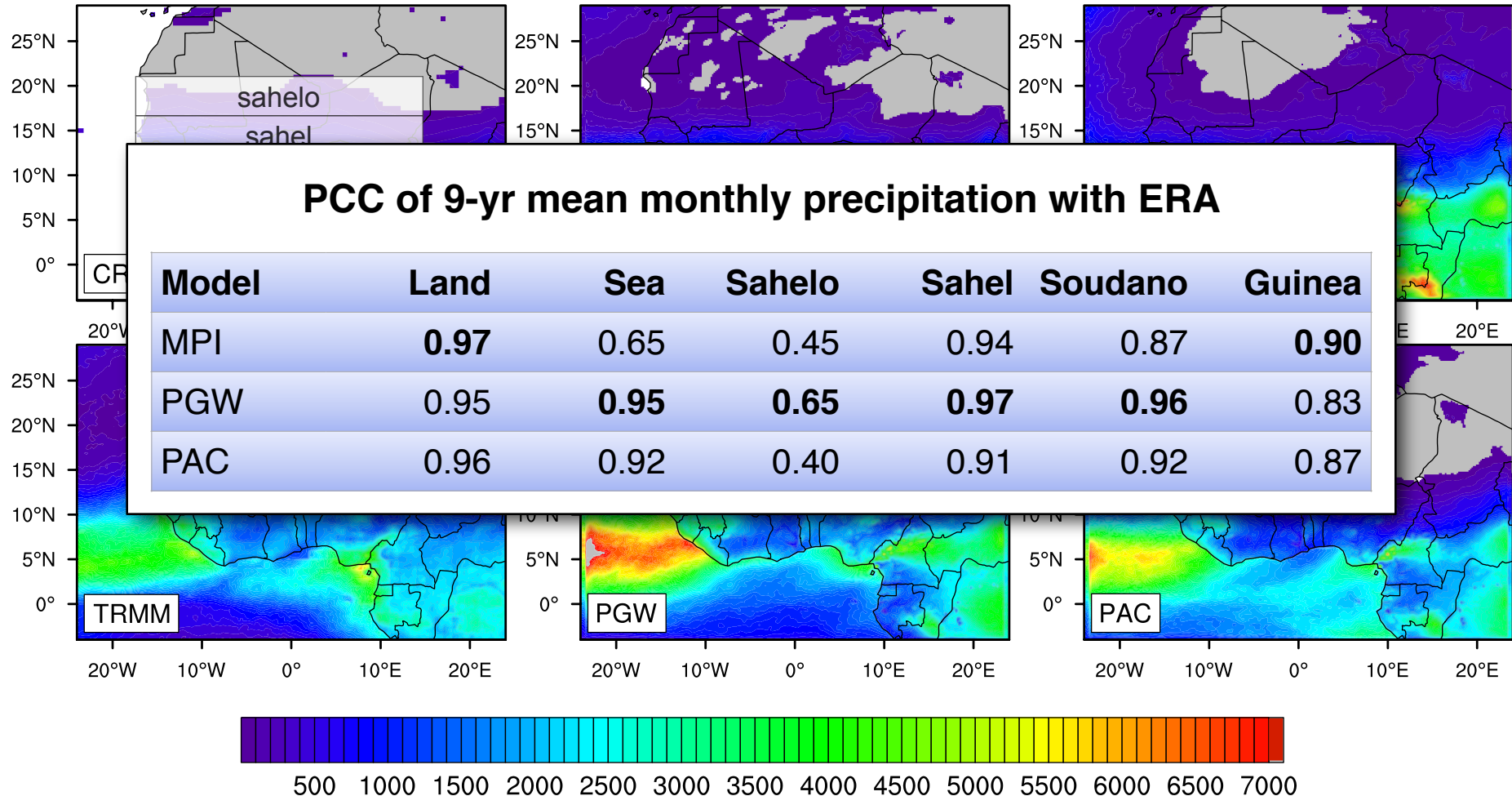# … and beats the raw global climate model

Model *output* mean annual rainfall 2001-2009 [mm]

… and beats the raw global climate model

Model *output* mean annual rainfall 2001-2009 [mm]

PCC of 9-yr mean monthly precipitation with ERA

Model	Land	Sea	Sahelo	Sahel	Soudano	Guinea
MPI	**0.97**	0.65	0.45	0.94	0.87	**0.90**
PGW	0.95	**0.95**	**0.65**	**0.97**	**0.96**	0.83
PAC	0.96	0.92	0.40	0.91	0.92	0.87
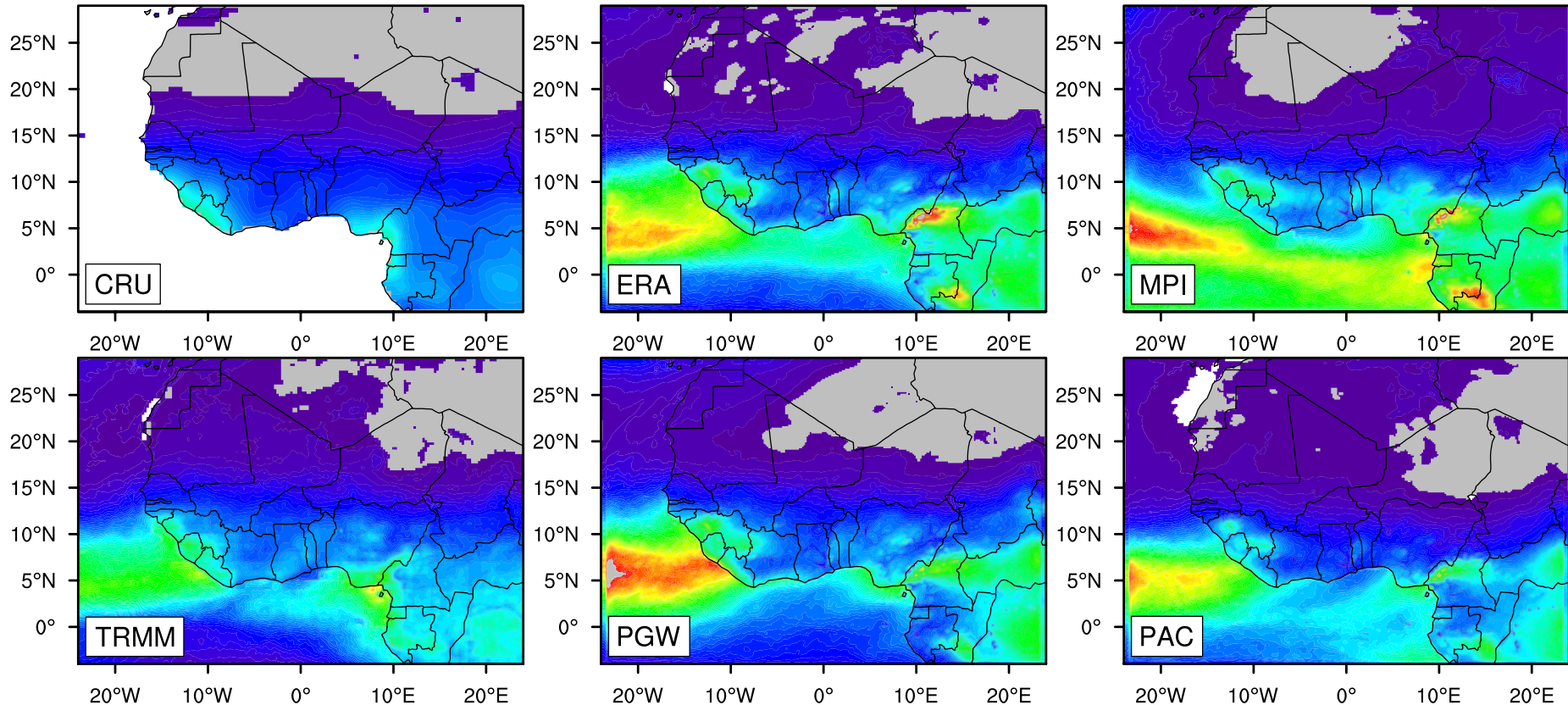
Status quo and next steps

PGW method improves model results for rain and temp., PAC seriously underestimates rain ➔ check monsoon/wind patterns in the models

10-year periods may not be enough to smooth out patterns of inter-annual variability (El Niño…) ➔ use 20-year reference/application periods

Choice of best WRF model setup is a tricky one and depends on the problem one wants to solve ➔ see Conni's talk Wednesday (CL6.6, 8.30am)

Choice of truth/reference data is crucial: ERA Interim control runs should use high-res. SST data ➔ substitute ERA SST data with NCDC data

Current bias correction code requires machines with >300Gb memory, bottle-neck is I/O ➔ parallel I/O, fit code on "normal" machines

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Sunset over the Sissili river, Northern Ghana (Nov. 2013)