On the influence of GCM biases on seasonal prediction skill in the tropical Atlantic

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Rationale for studying biases

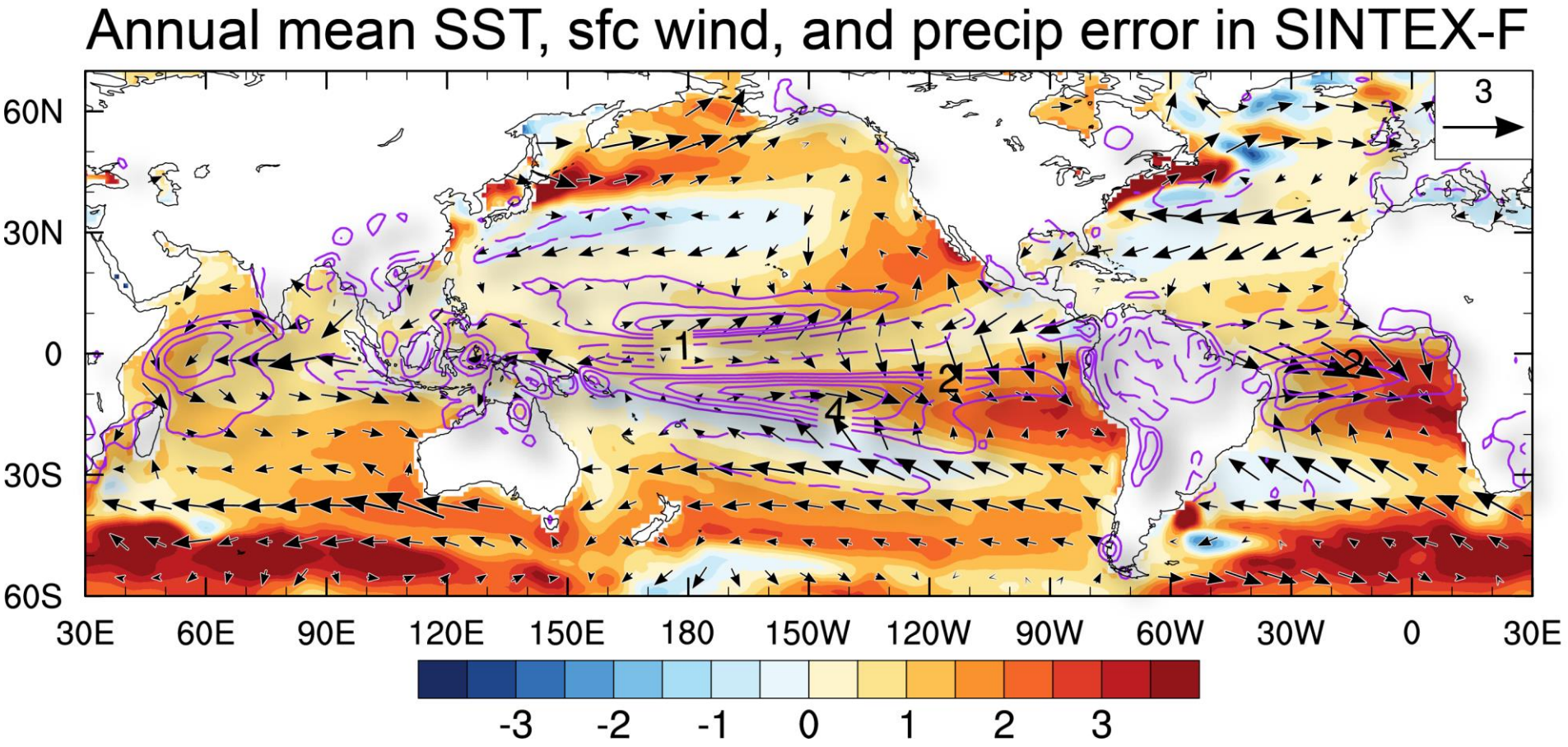
- *"GCM biases negatively affect prediction skill and undermine confidence in climate change projections"*
- statements to this effect are often used as motivation to examine GCM biases
- rationale: understand bias sources → improve model → improve predictions and projections
- few studies have tested these notions

Approach of this study

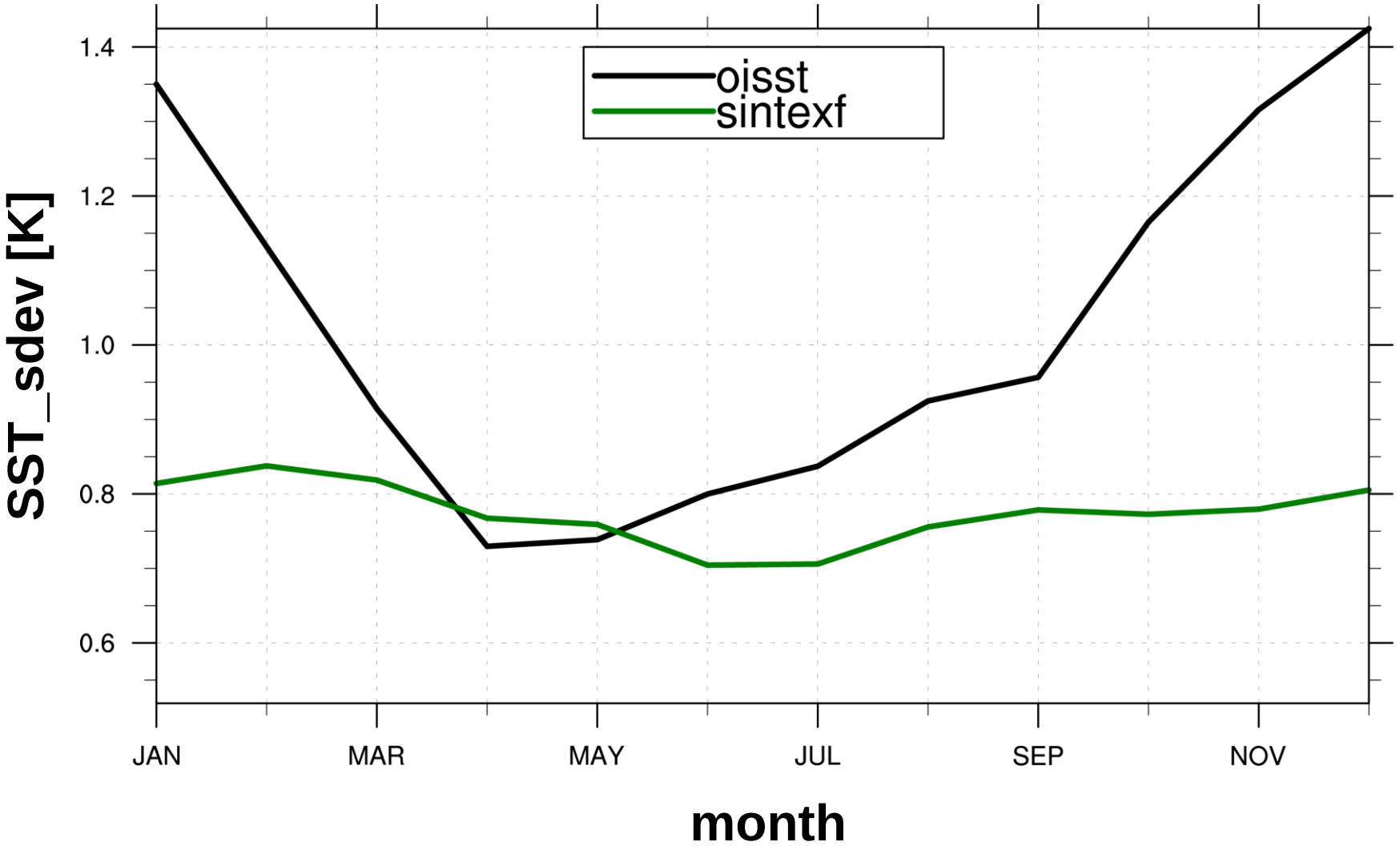
- focus on seasonal predictions (easier than projections due to verification problem)
- focus on surface wind and precipitation biases (important elements of prediction)
- focus on AMIP-style runs (easy to experiment)
- this amounts to assessing 0-lead predictions or “nowcasts”

A quick look at coupled biases and prediction skill

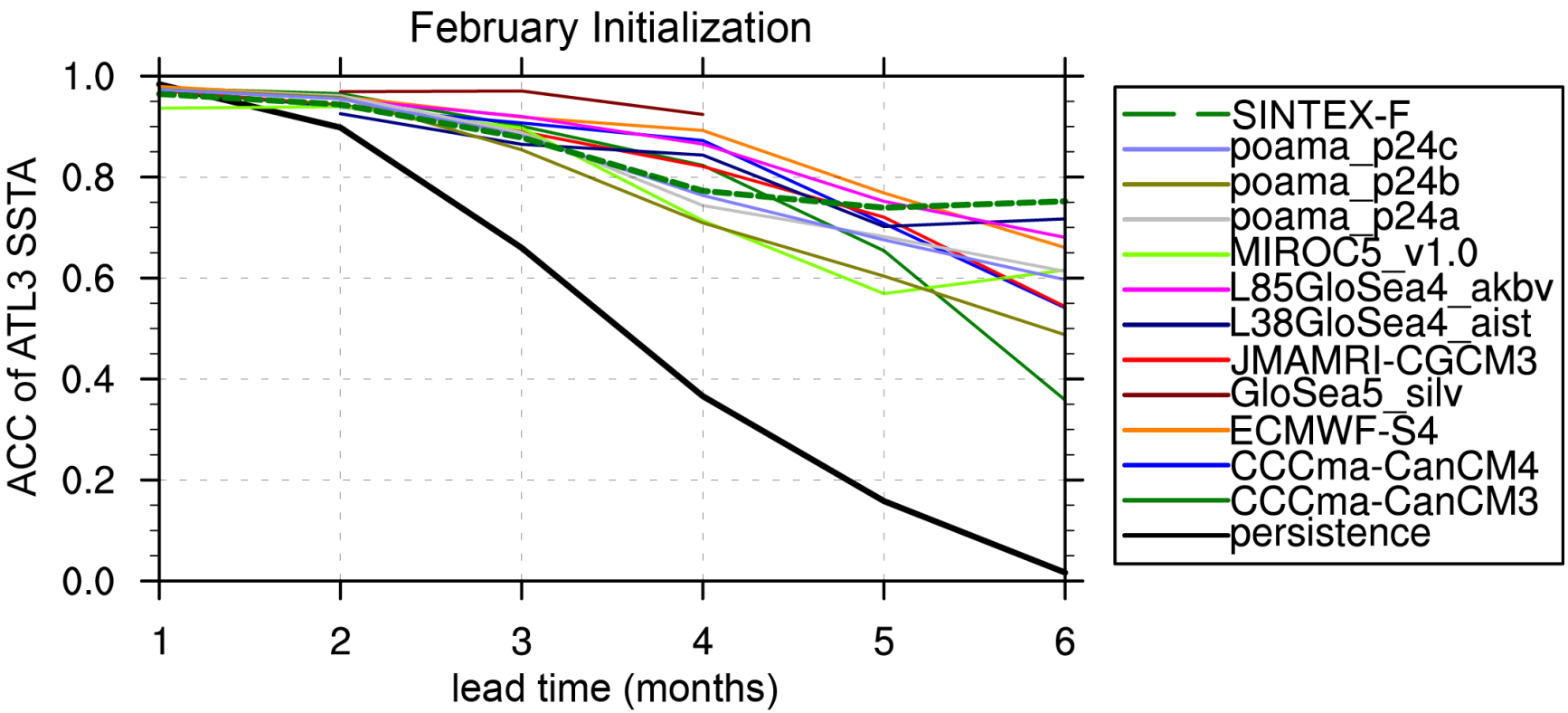
Example: Biases in free-running SINTEX-F



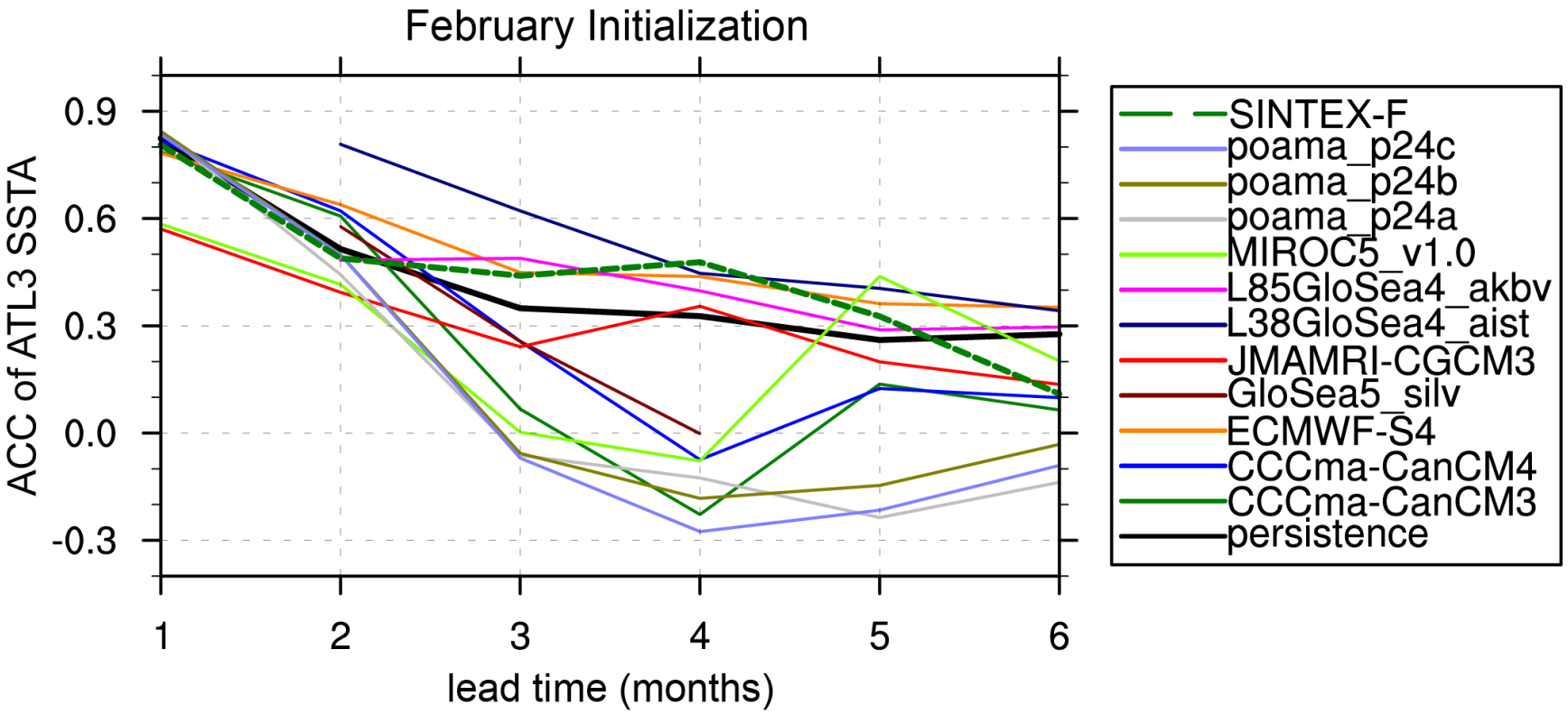
Standard deviation of nino 3.4 SST



Prediction skill in the equatorial Pacific



Prediction skill in the equatorial Atlantic



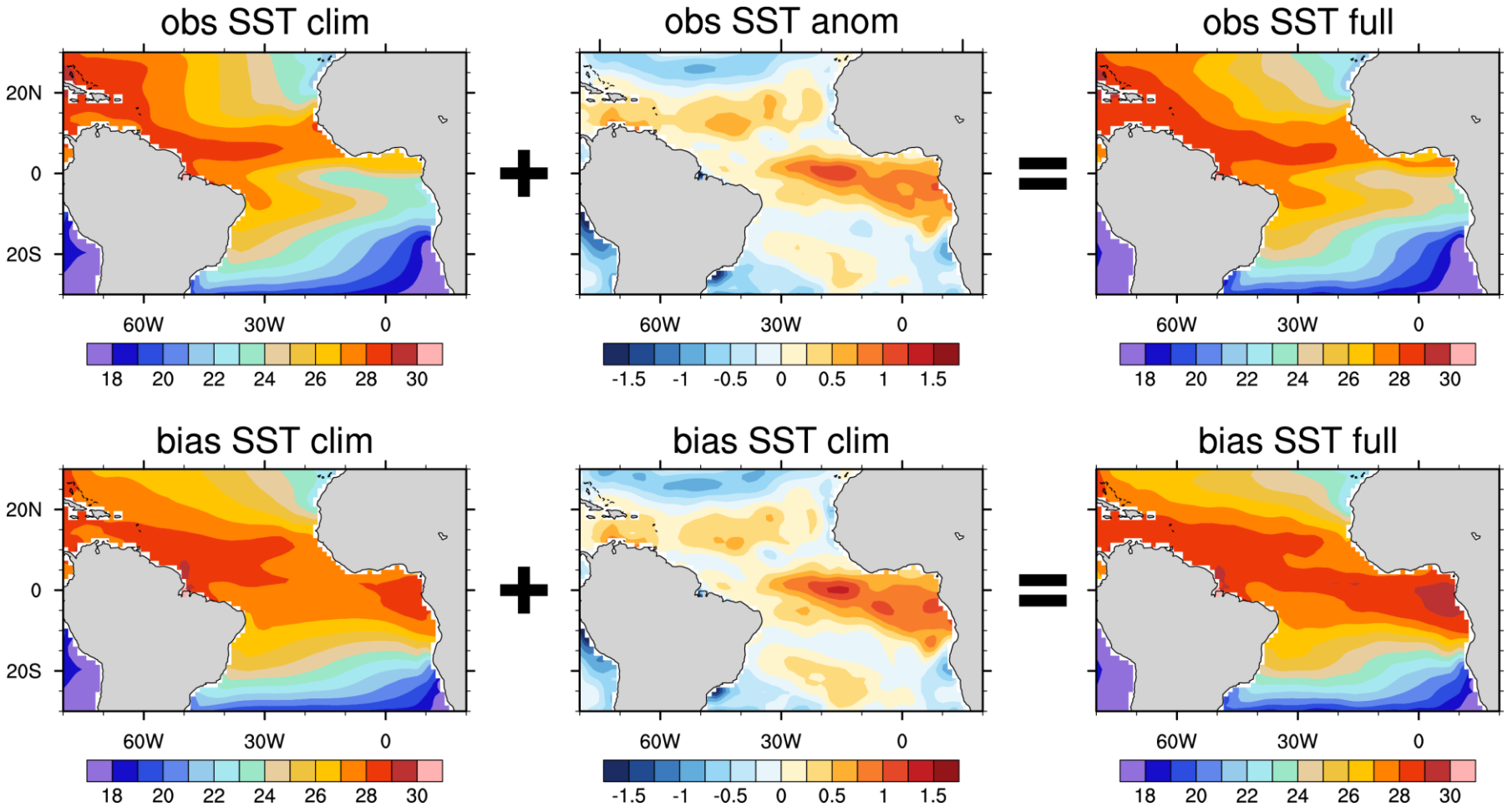
from *Richter et al. 2016*

Experiment design

- use SINTEX-F1 runs with strong SST restoring (SST nudging runs, 1-d time scale)
- CTRL: SST restored to OISST obs.
- sensitivity tests: replace OISST climatology with that from SINTEX-F1 free-running control simulation
- test to what extent SST biases deteriorate “predictions”
- Atl_bias: SST biases in tropical Atlantic
- Pac_bias: SST biases in tropical Pacific

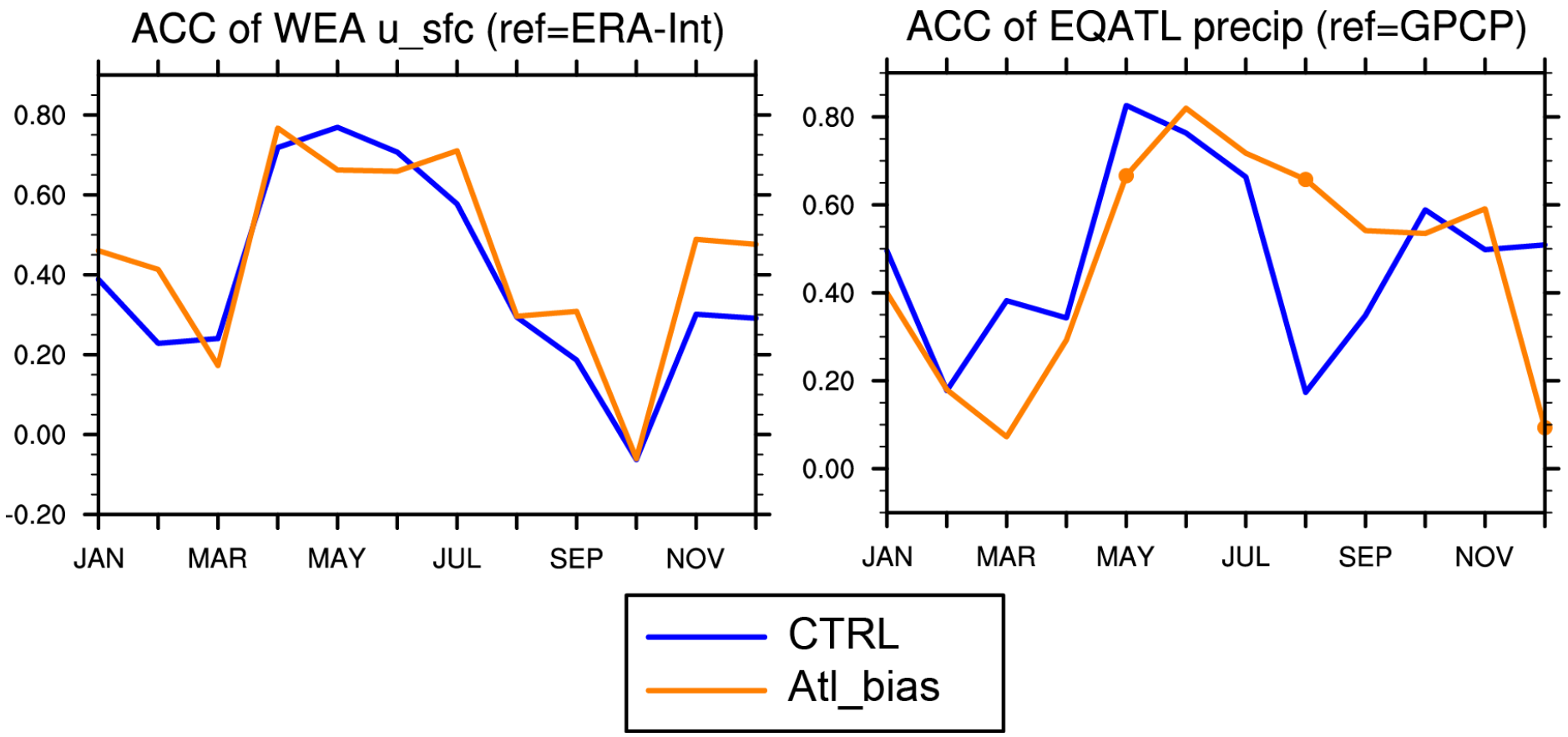
July 1988 SST in CTRL and Atl_bias

Atlantic Niño event



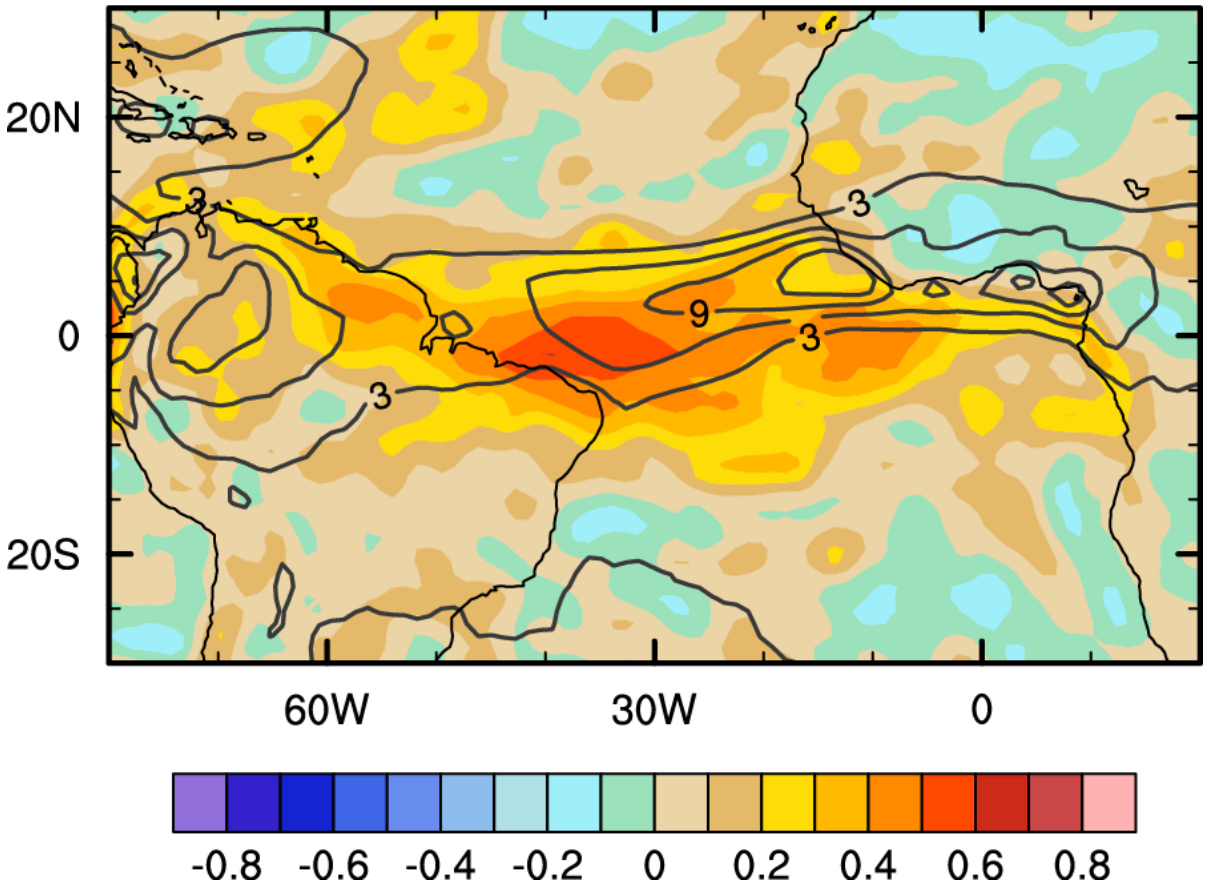
Equatorial Atlantic

ACC of WEA u_sfc and eqAtl precip



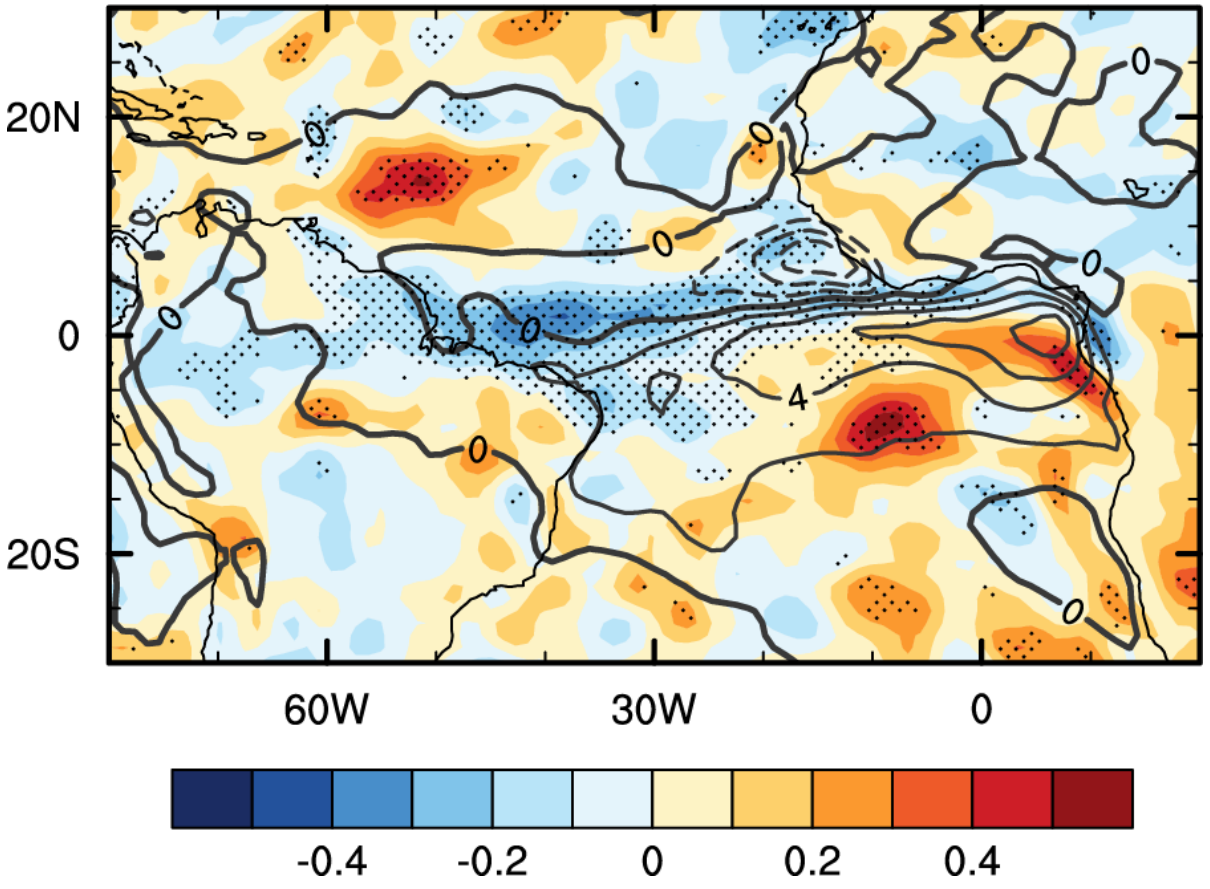
ACC of precipitation in CTRL

AMJ



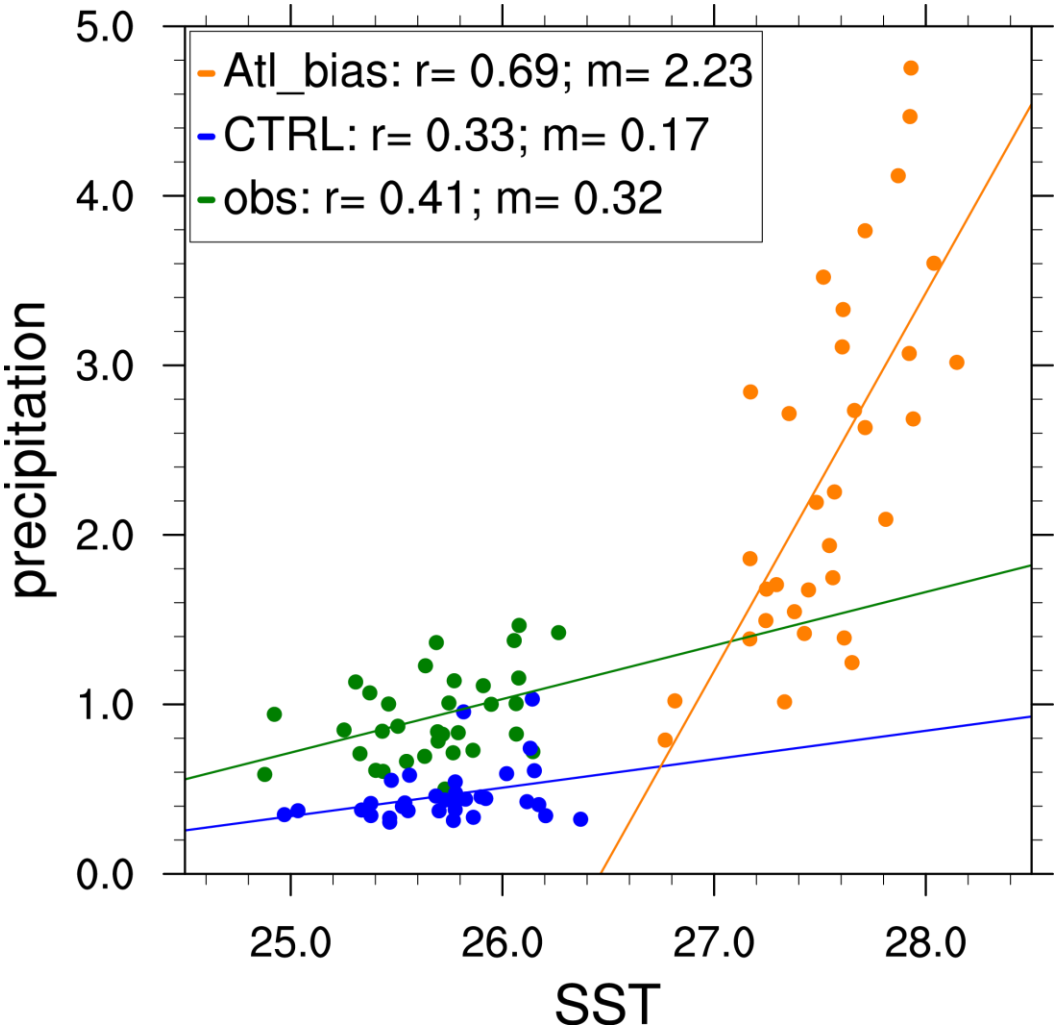
ACC of precipitation: Atl_bias – CTRL

AMJ



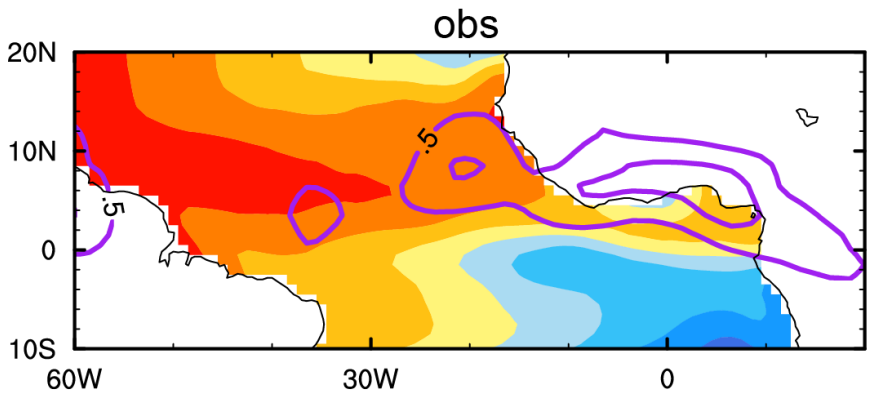
Simulated vs. observed precipitation

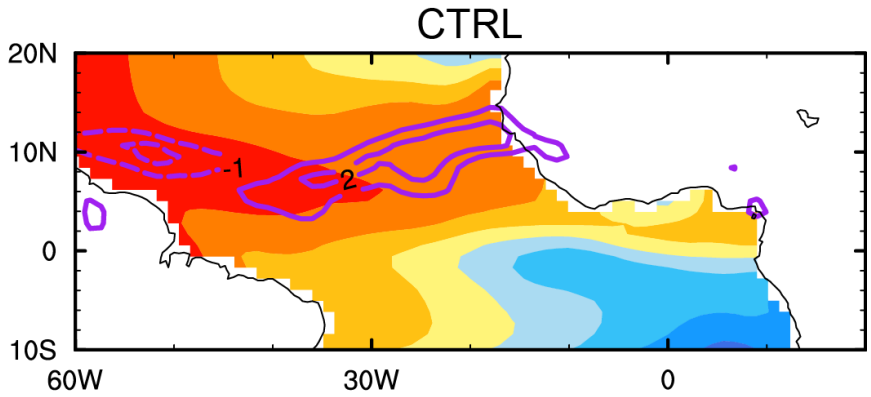
EQATL: 50W-10E, 5S-5N; August

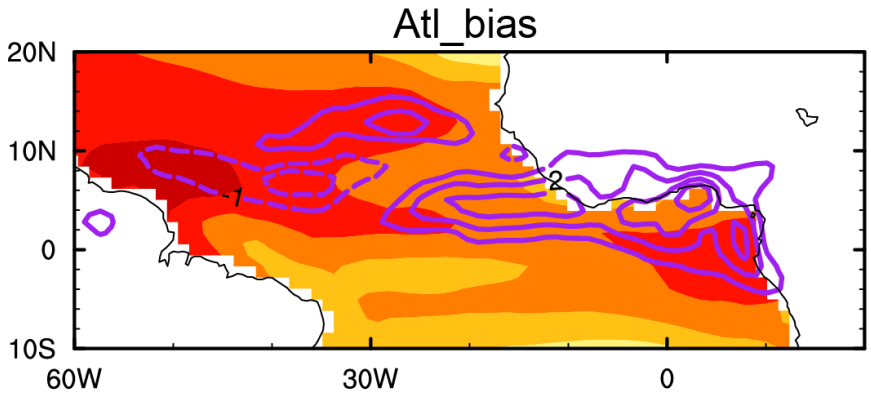


SST (shading) and precipitation (cnt)

composited on 0.5 std of EQATL precip



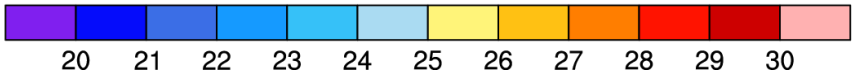




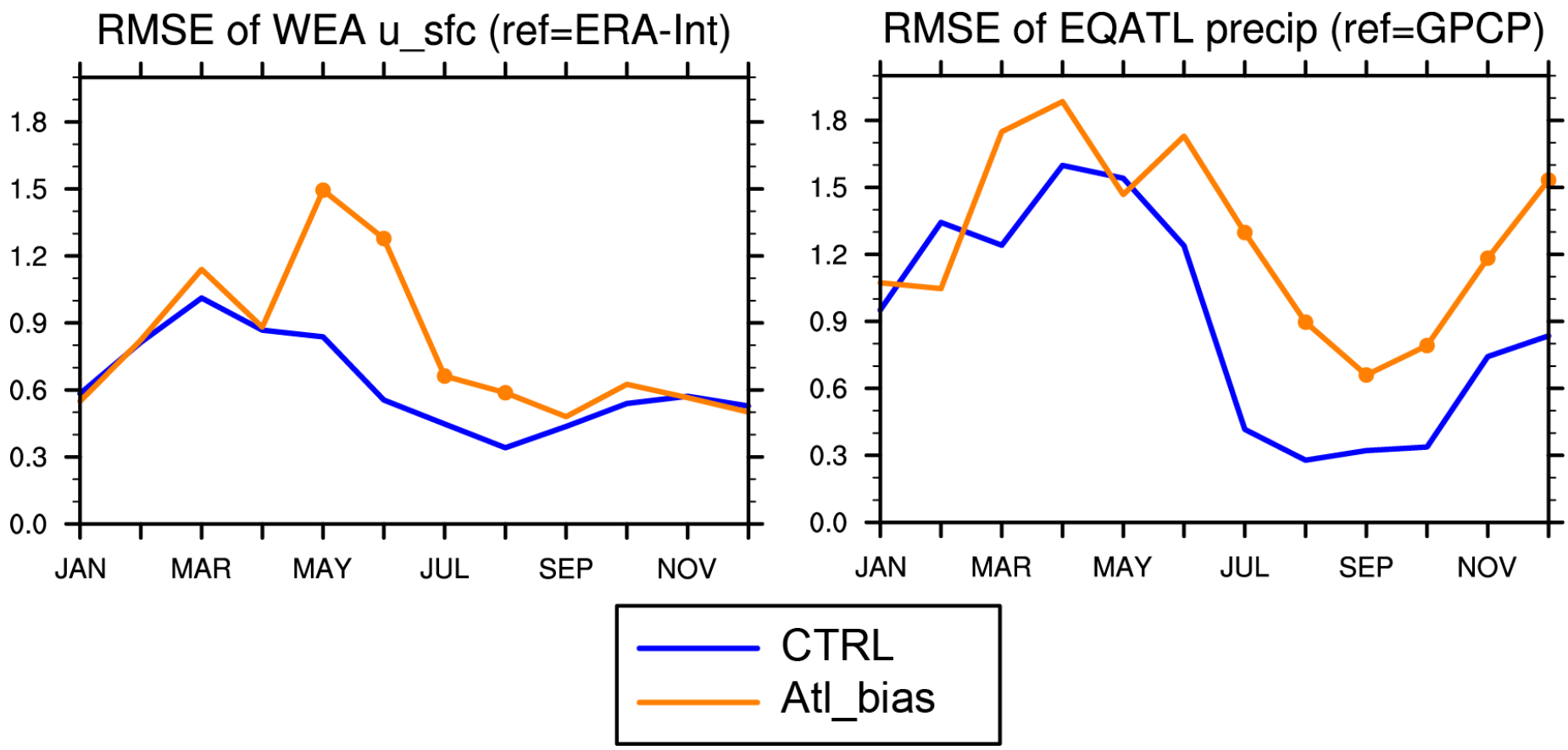
pattern correlation with GPCP:

CTRL: 0.25

Atl_bias: 0.45



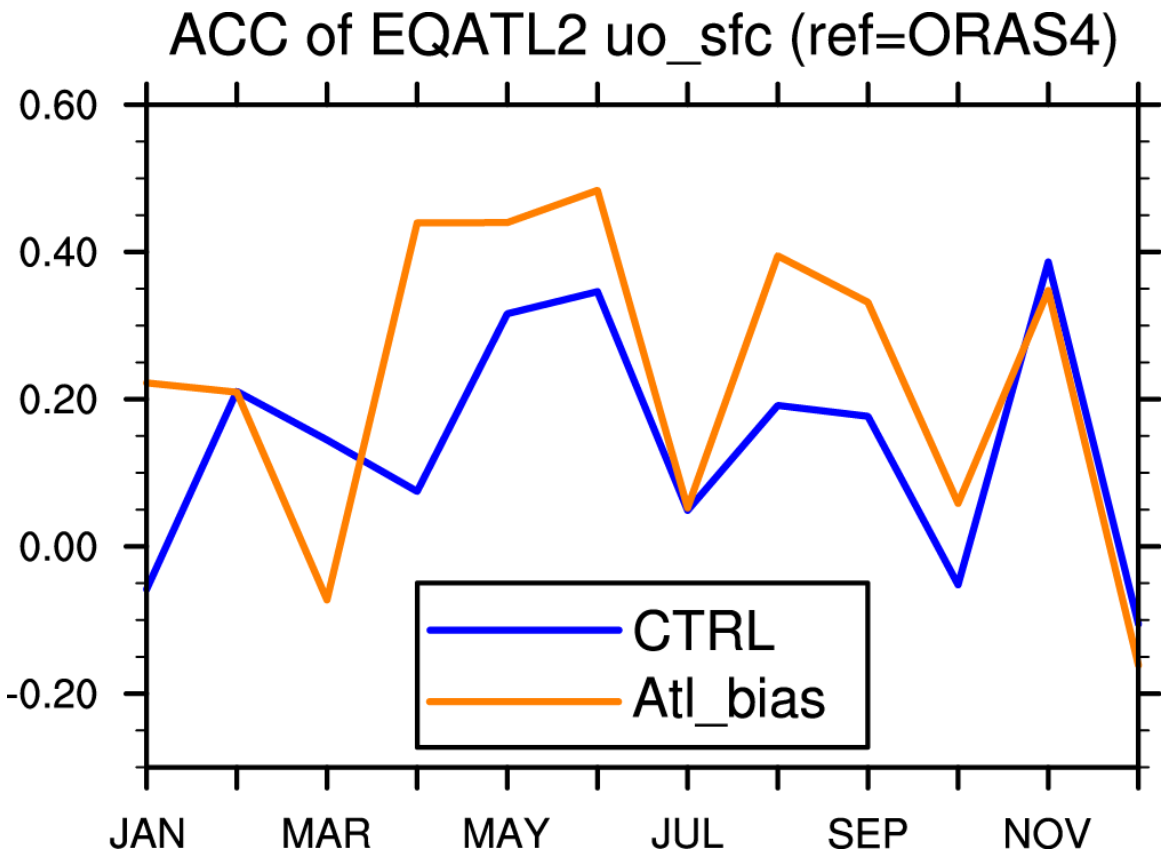
RMSE of WEA u_sfc and eqAtl precip



Surface Currents

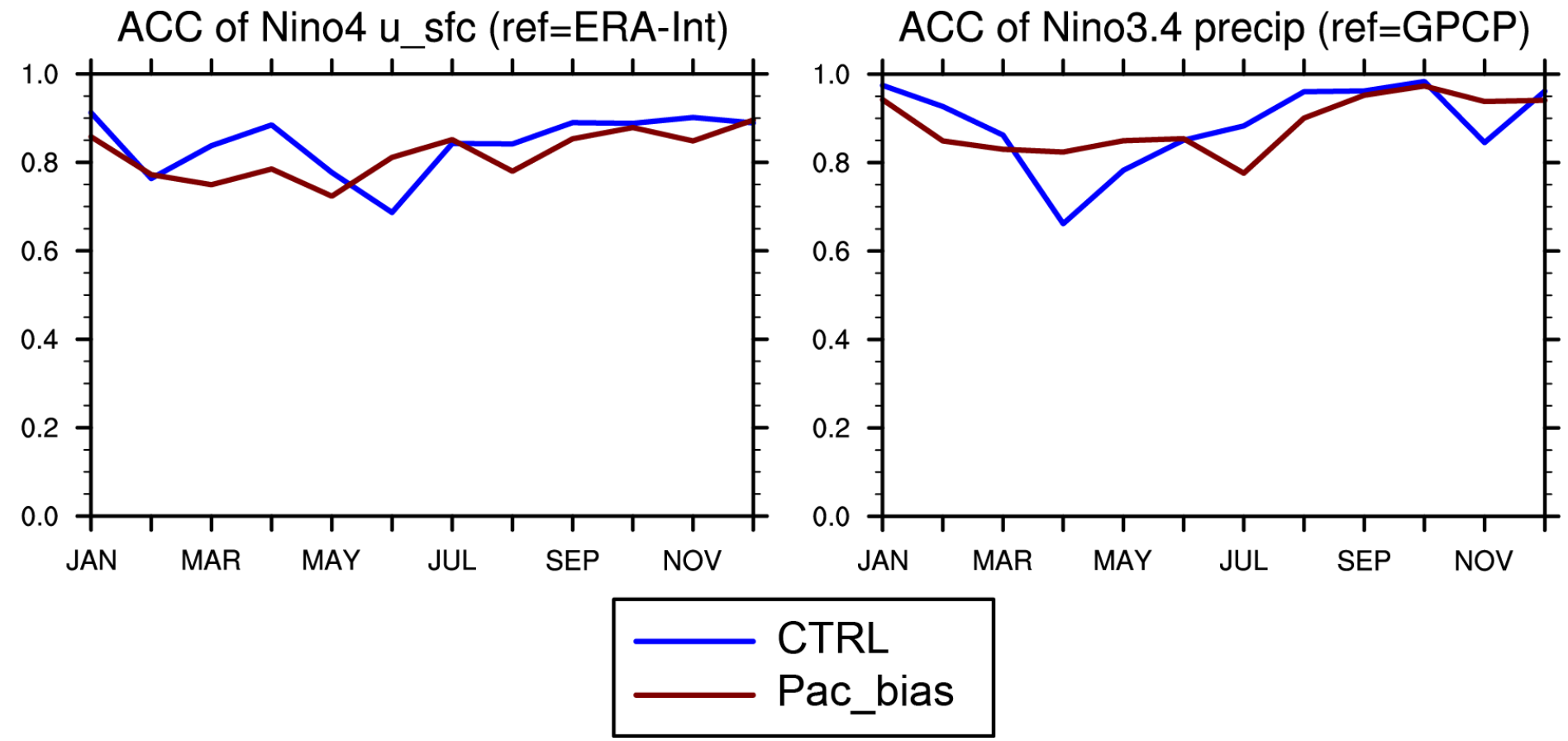
ACC of surface zonal currents

equatorial Atlantic (50-10E, 5S-5N)



Equatorial Pacific

ACC of Niño 4 u_sfc and Niño 3.4 precip



Conclusions

- skill of precip and sfc winds in the equatorial Atlantic quite robust to prescribed SST biases
- anomaly initialization may overcome some problems of current prediction models
- in SINTEX-F, ACC tends to decrease where mean precip is low and vice versa ➔ fixing excessive precip may deteriorate skill
- increased ACC of precip comes at a price: root-mean-square-error increases
- role of coupled errors not discussed here

Tropical Atlantic Blog

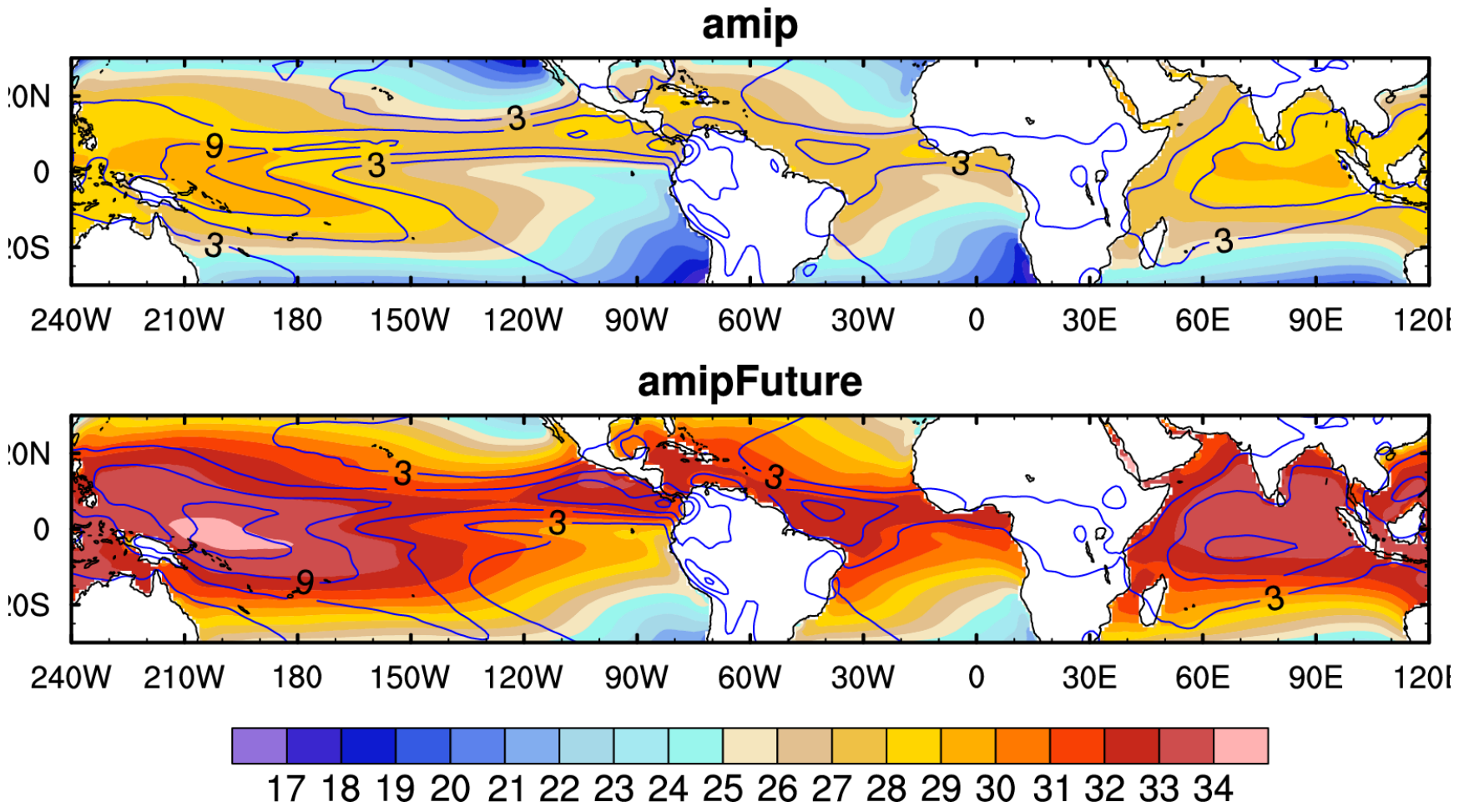
(www.jamstec.go.jp/aplinfo/climate)

more advertising:
JpGU meeting on
"Climate variations in the Atlantic Ocean and their representation in climate models"
Chiba, Japan
21-25 May 2017

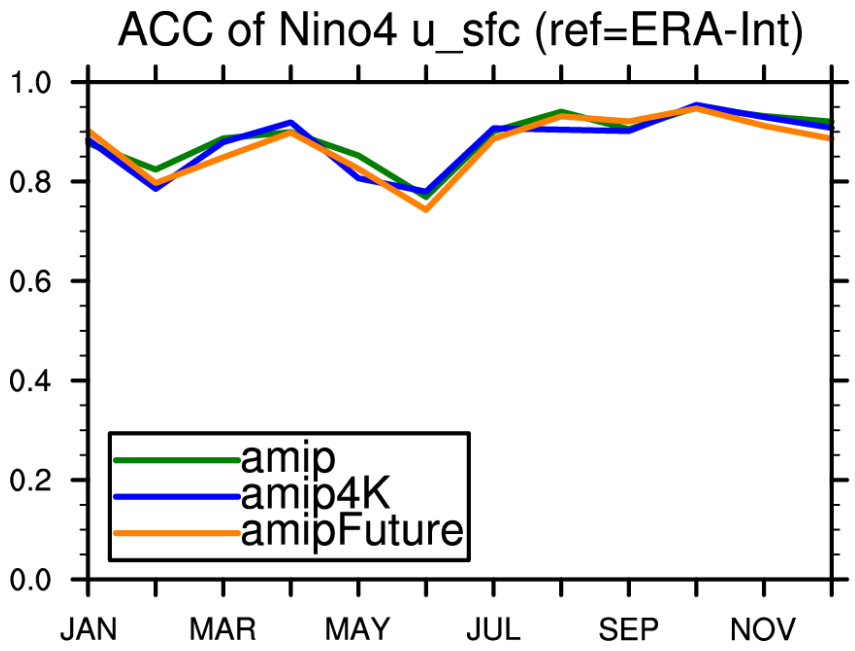
AMIP Experiments with prescribed SST warming

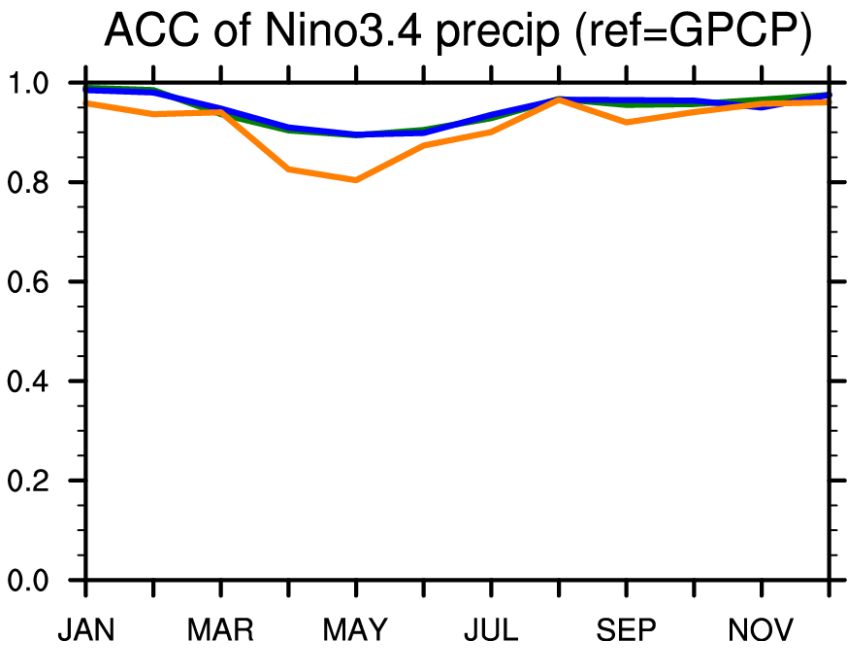
AMIP and amipFuture

SST and precipitation (annual mean)

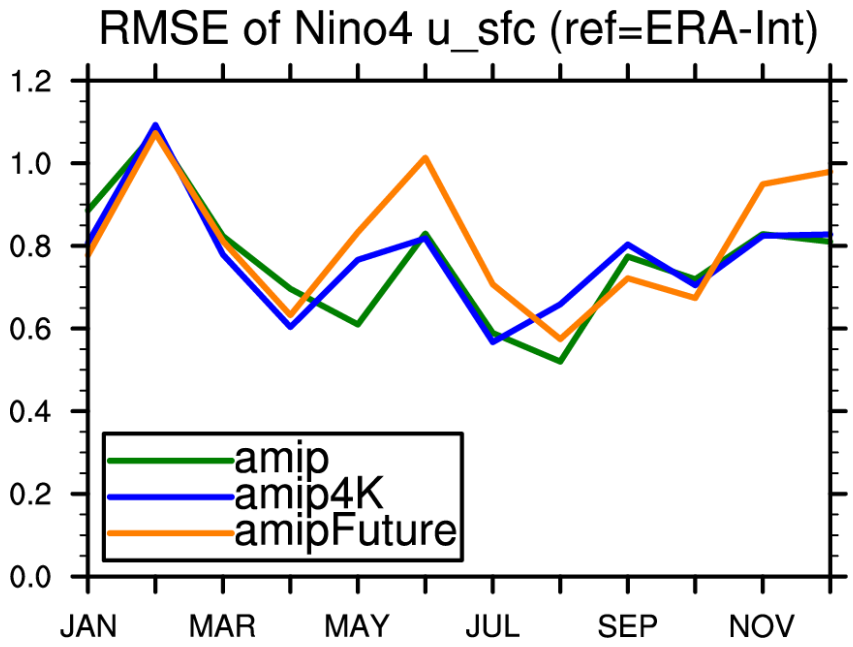


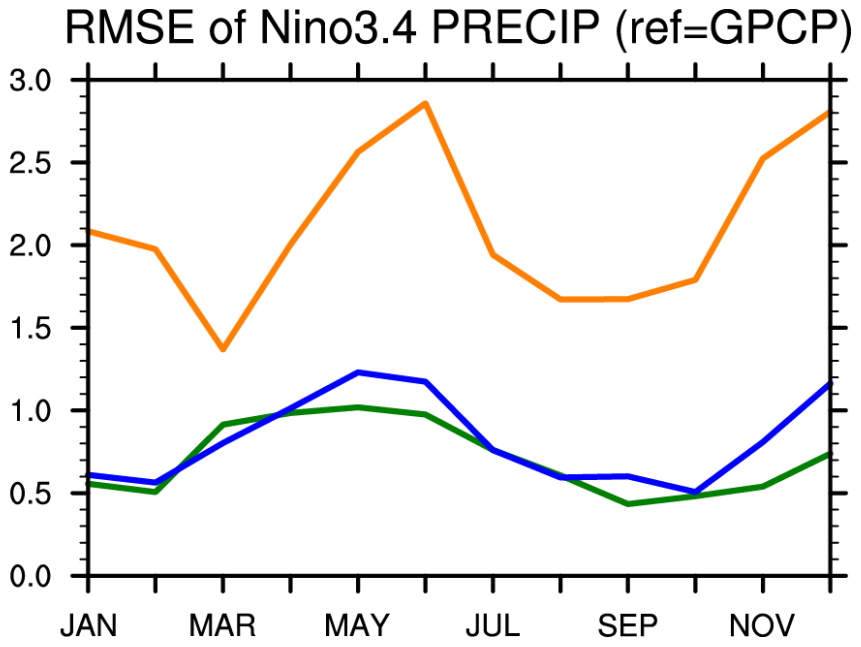
ACC of Niño 4 u_sfc and Niño 3.4 precip



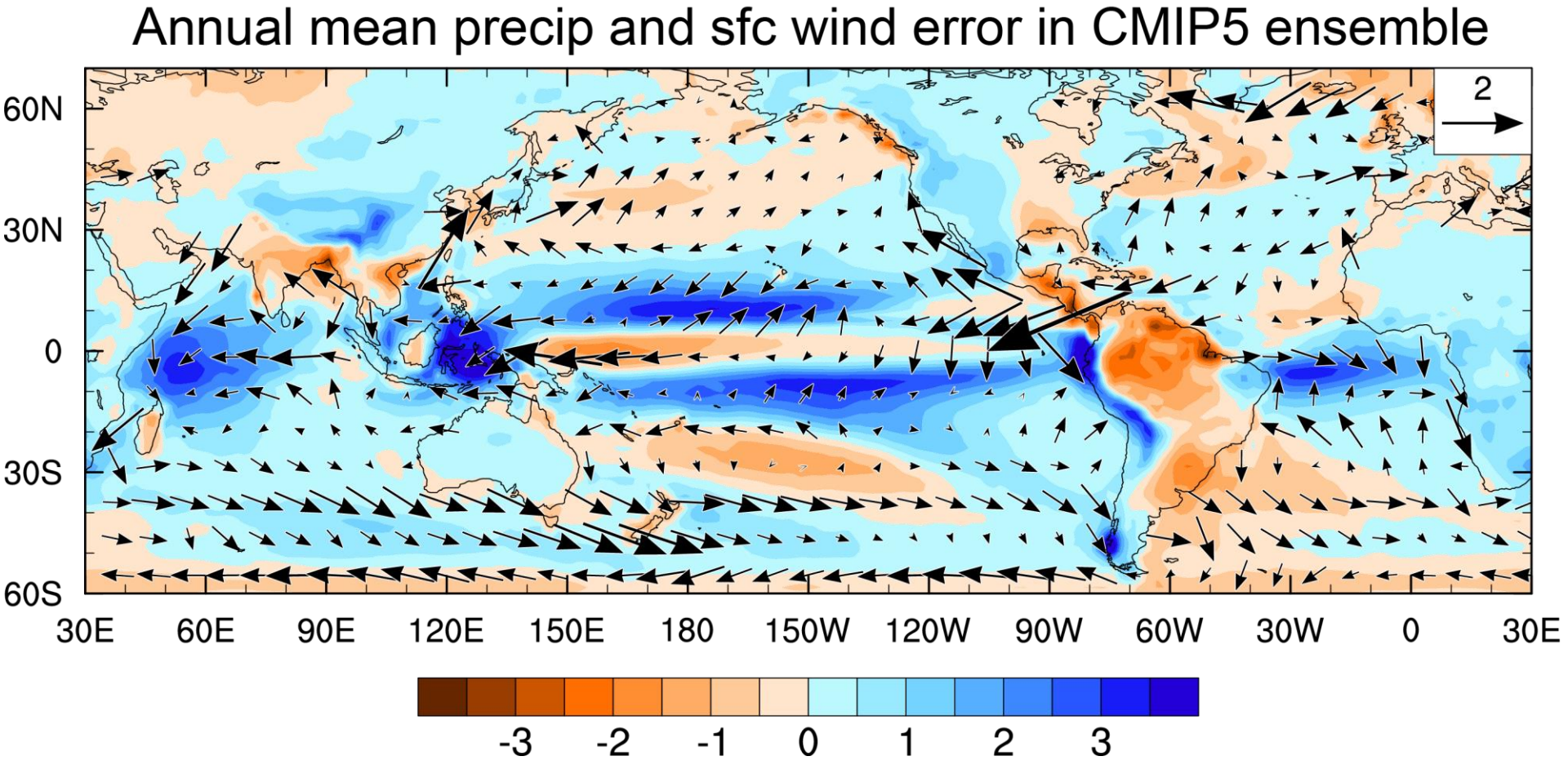


RMSE of Niño 4 u_sfc and Niño 3.4 precip

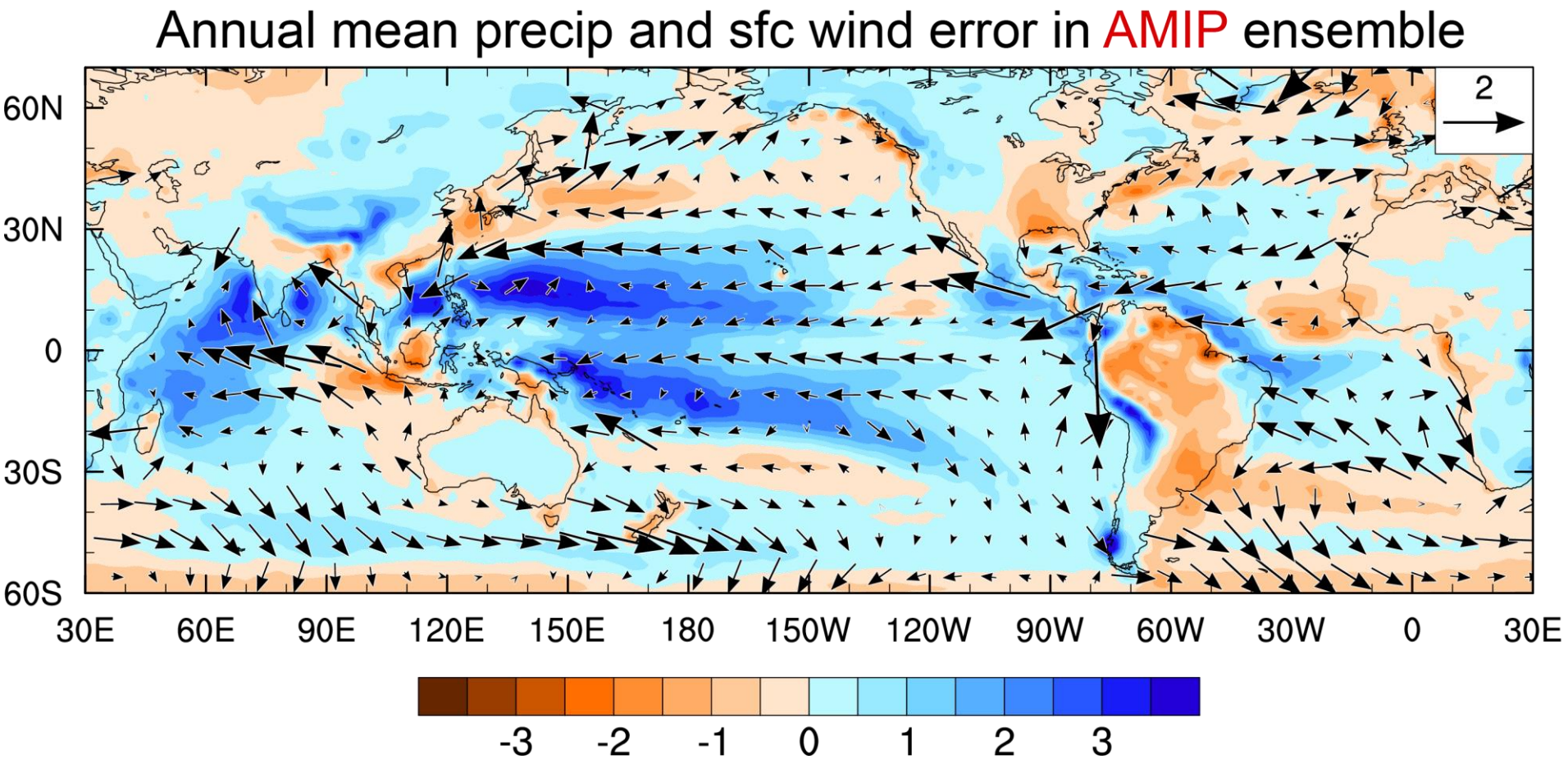




Precip and Wind Biases in Coupled GCMs

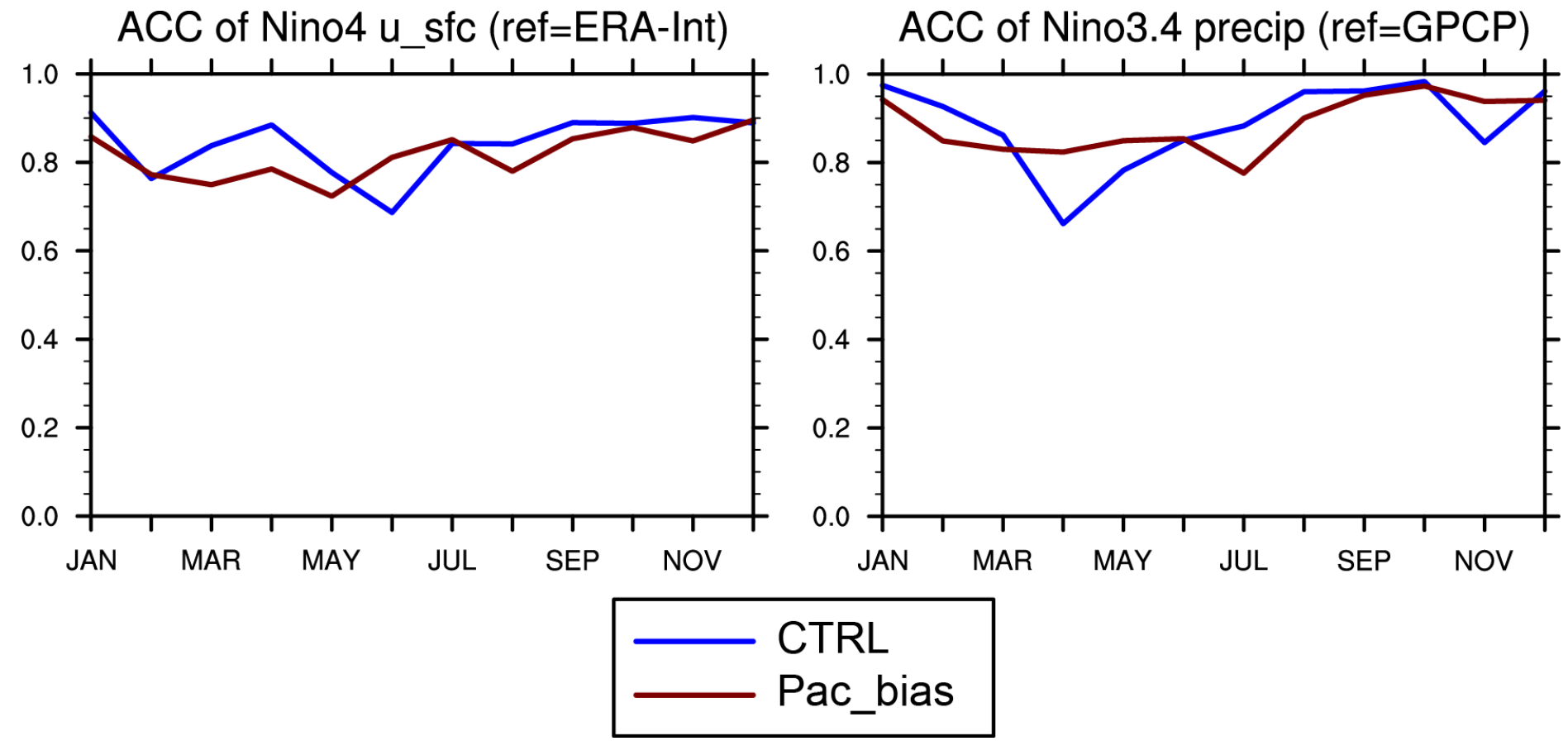


Precip and Wind Biases in atmospheric GCMs

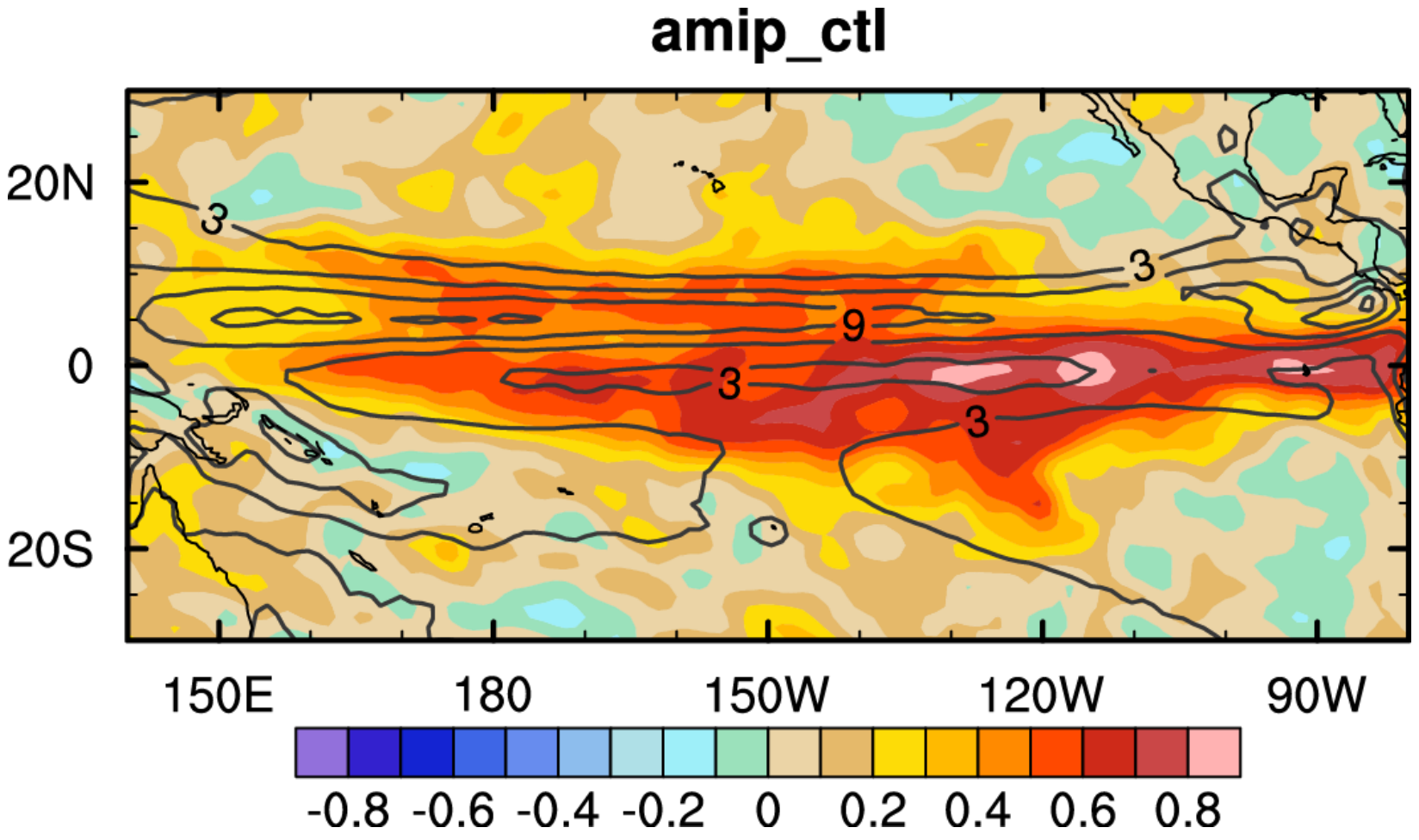


Equatorial Pacific

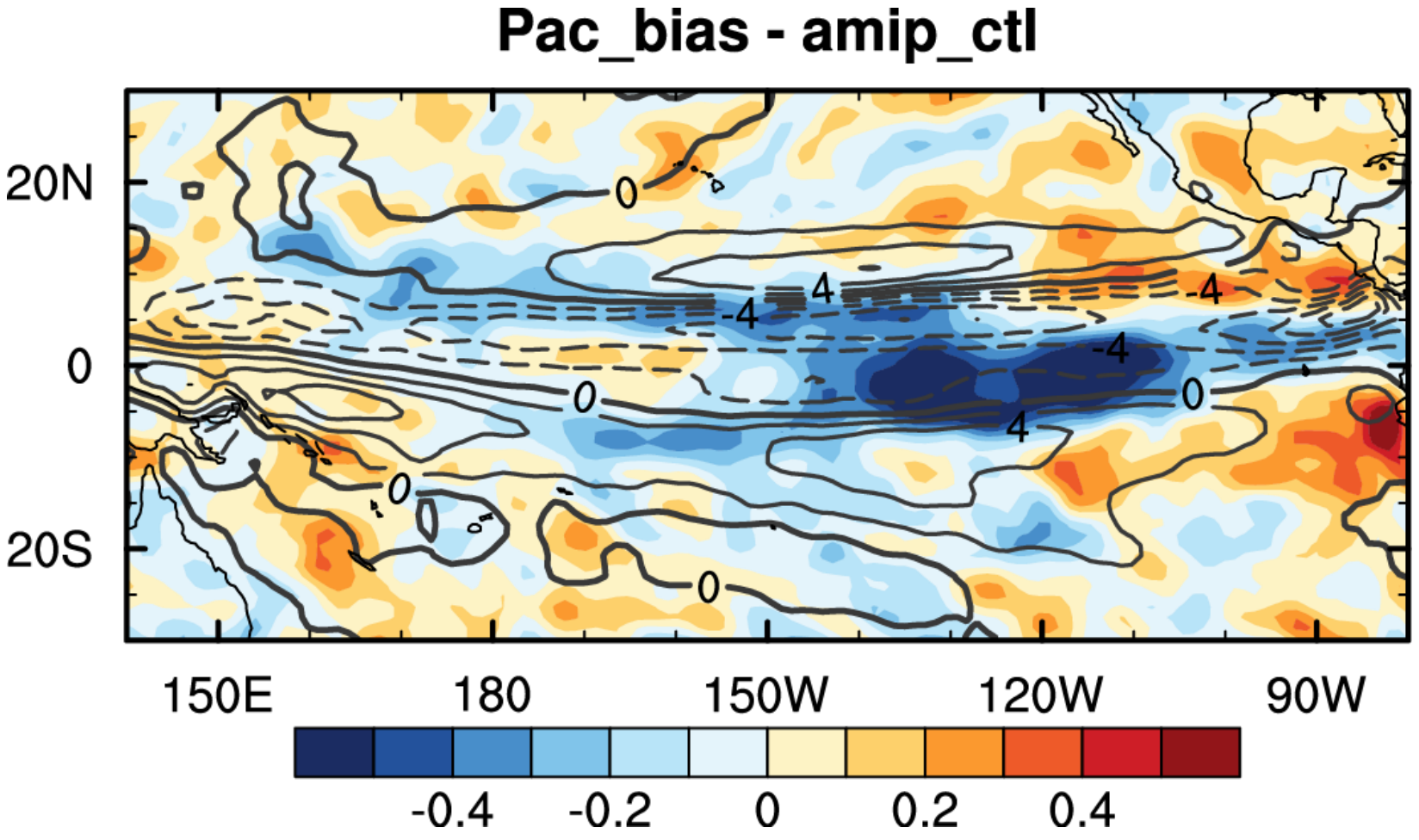
ACC of Niño 4 u_sfc and Niño 3.4 precip



ACC of precipitation in CTRL

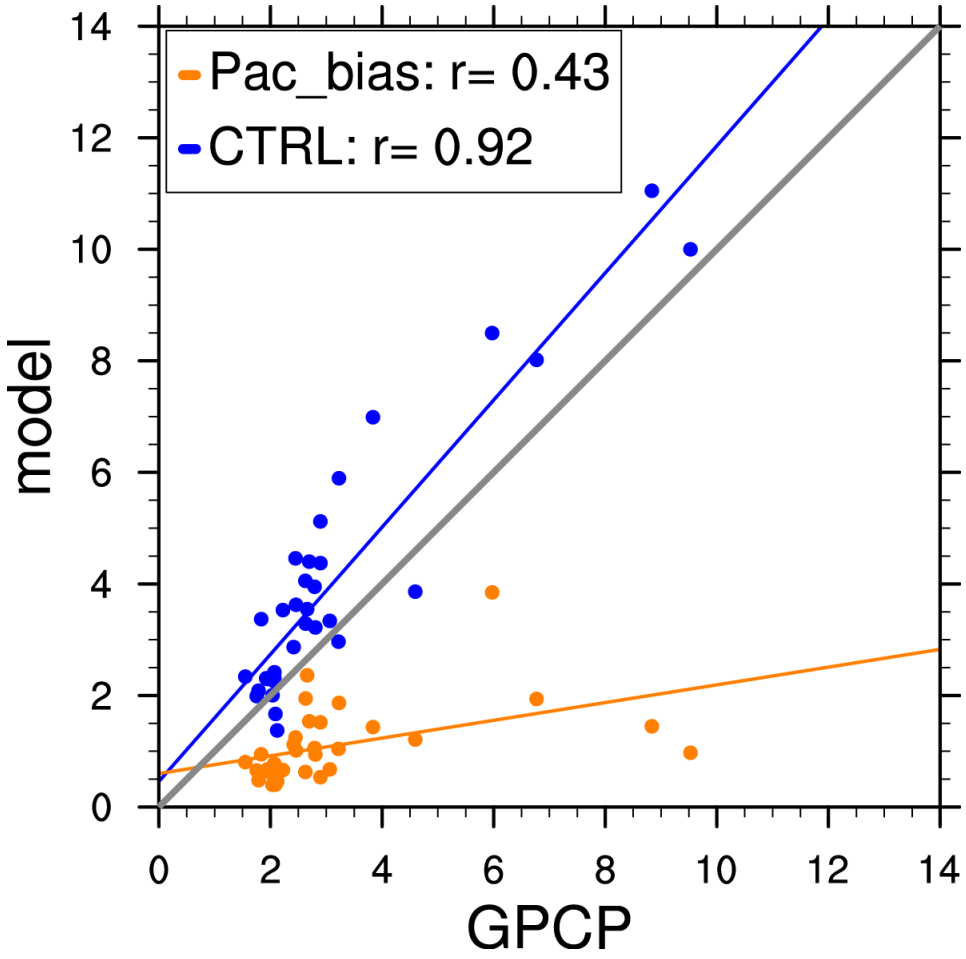


ACC of precipitation: Pac_bias - CTRL



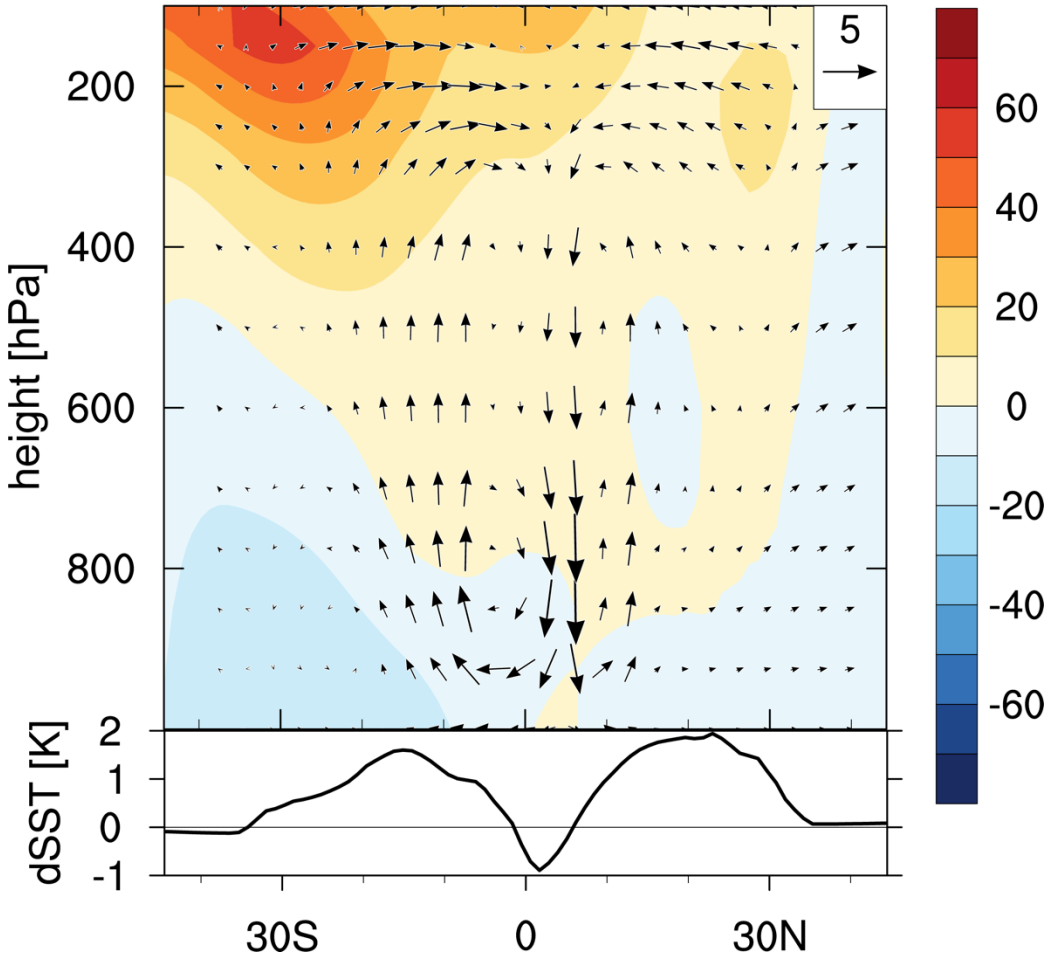
Simulated vs. observed precipitation

140-105W, 5S-5N; MAM



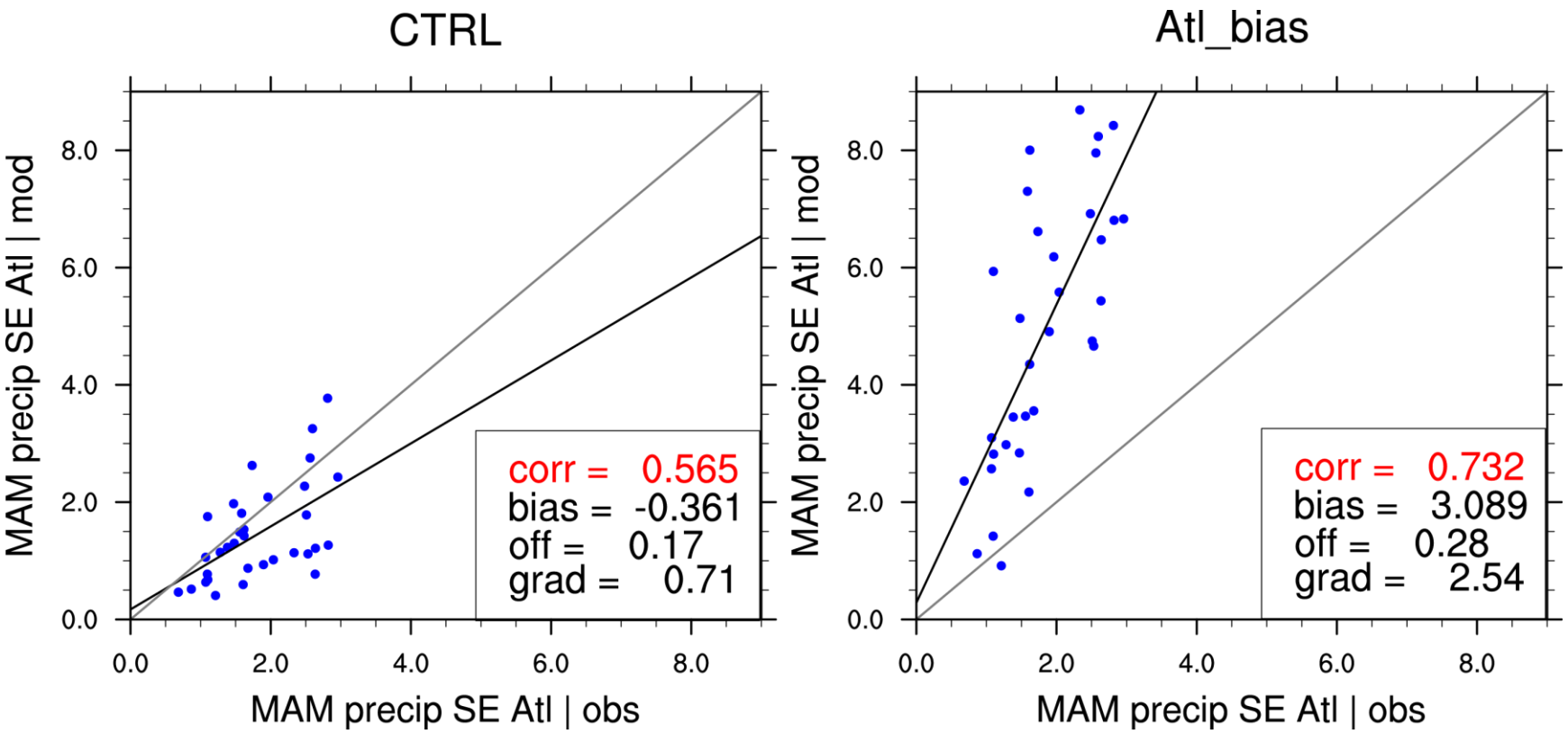
Geopotential (shading) and V/Omega

average: 140-105W; difference Pac_bias-CTRL

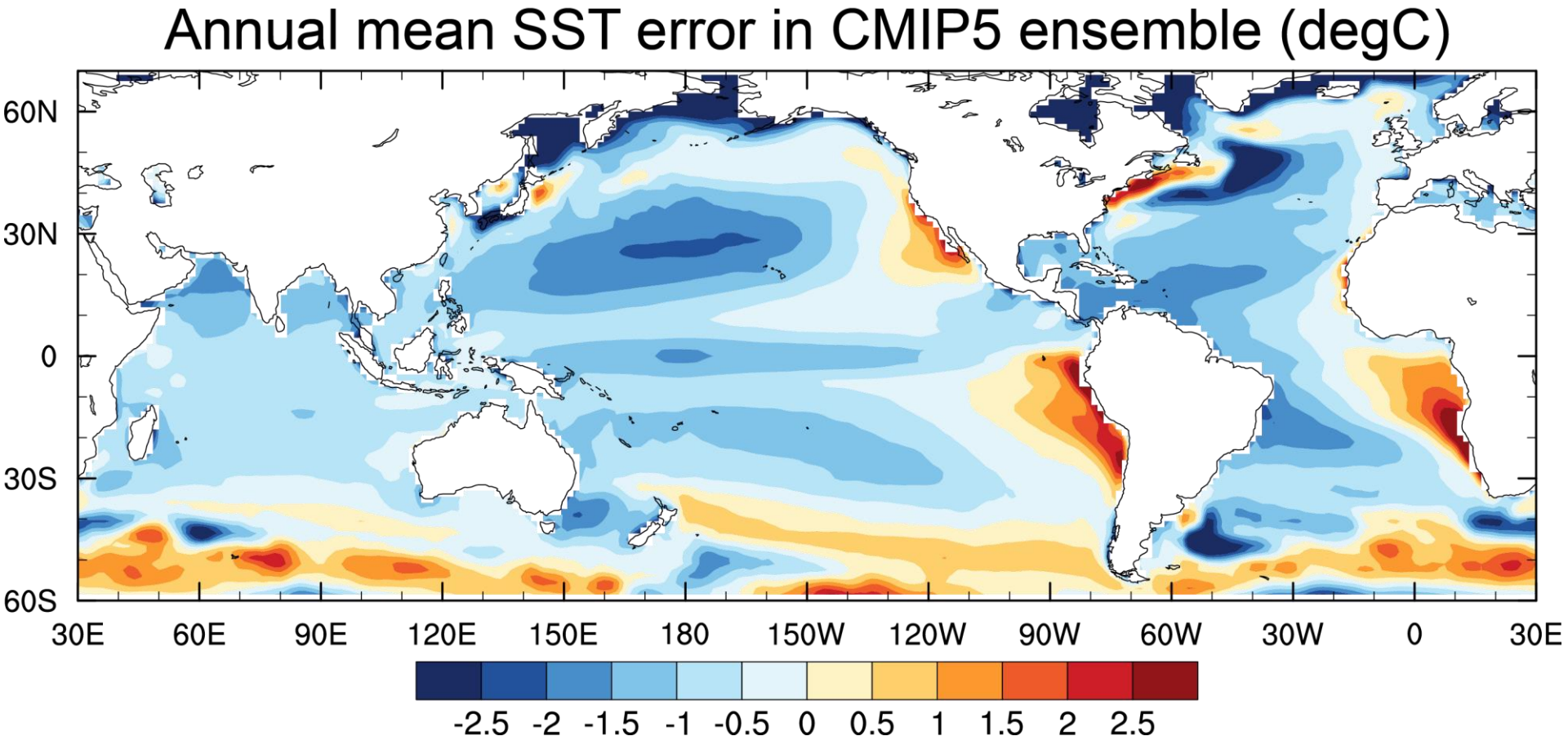


Simulated vs. observed precipitation

10W-10E, 10S-EQ; MAM

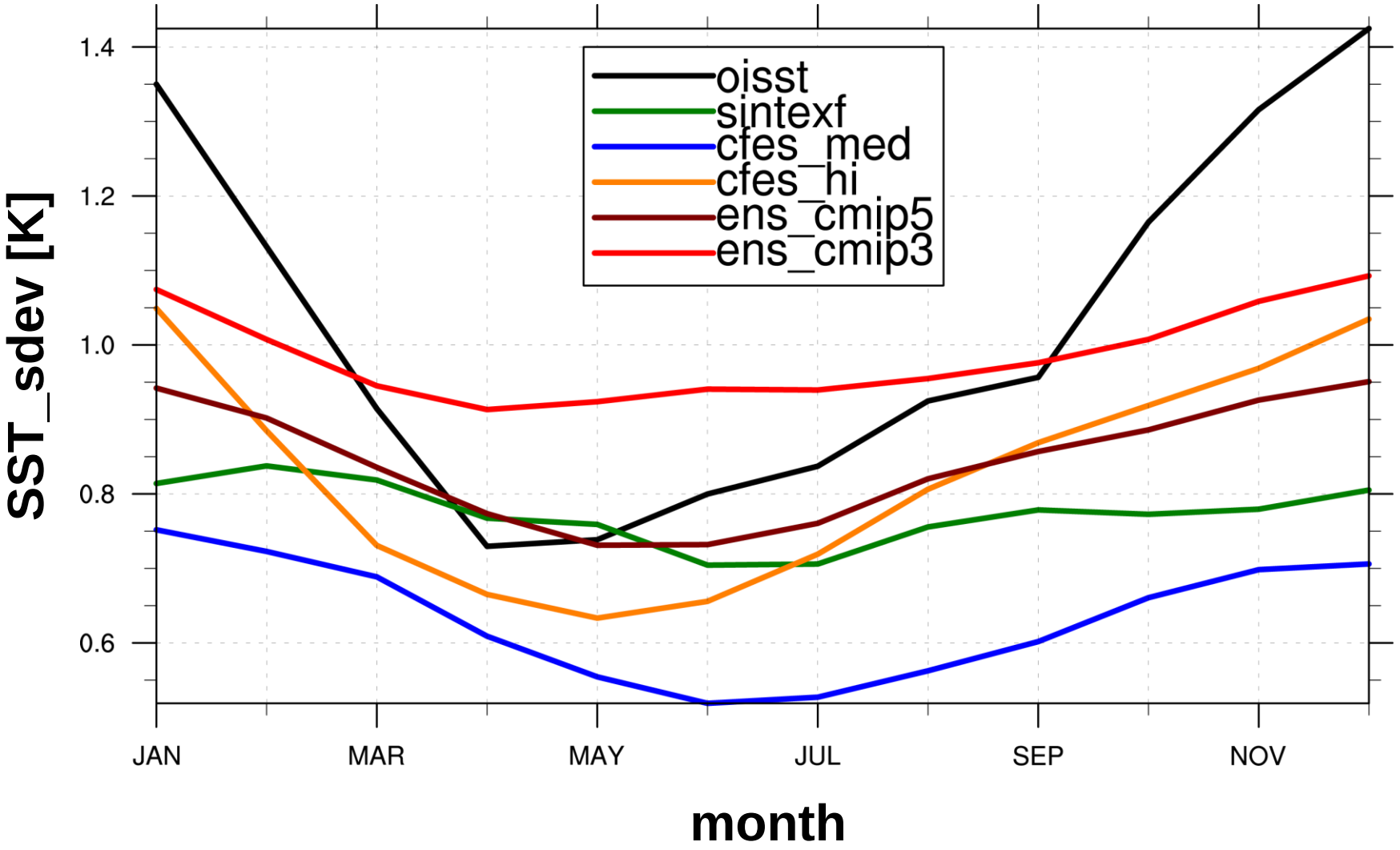


Example: SST Biases in Coupled GCMs

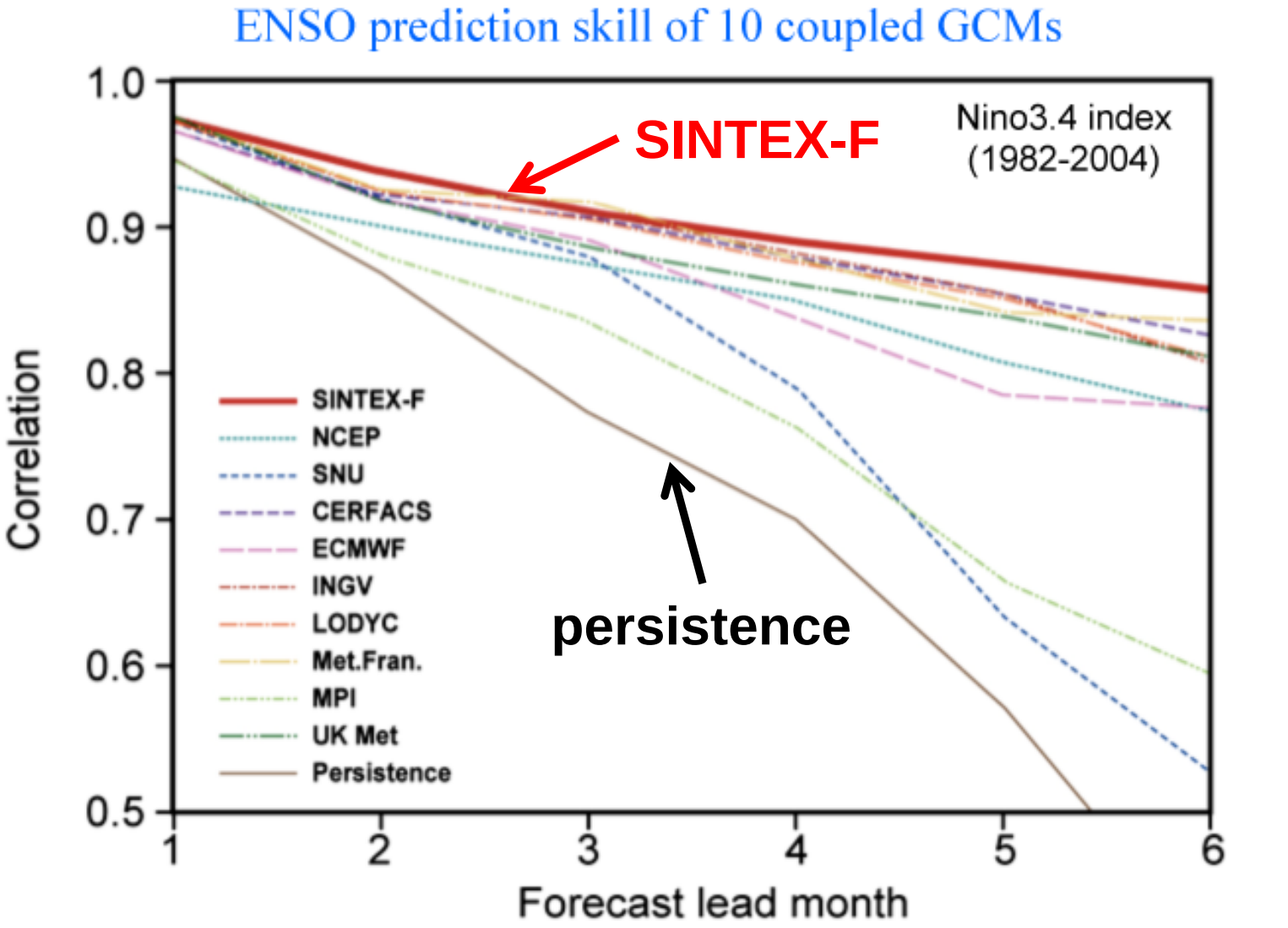


from *Richter et al. 2016a*

Standard deviation of nino 3.4 SST



SINTEX-F prediction skill for nino3.4 SSTA



Adapted from Jin et al. 2008, APCC CliPAS