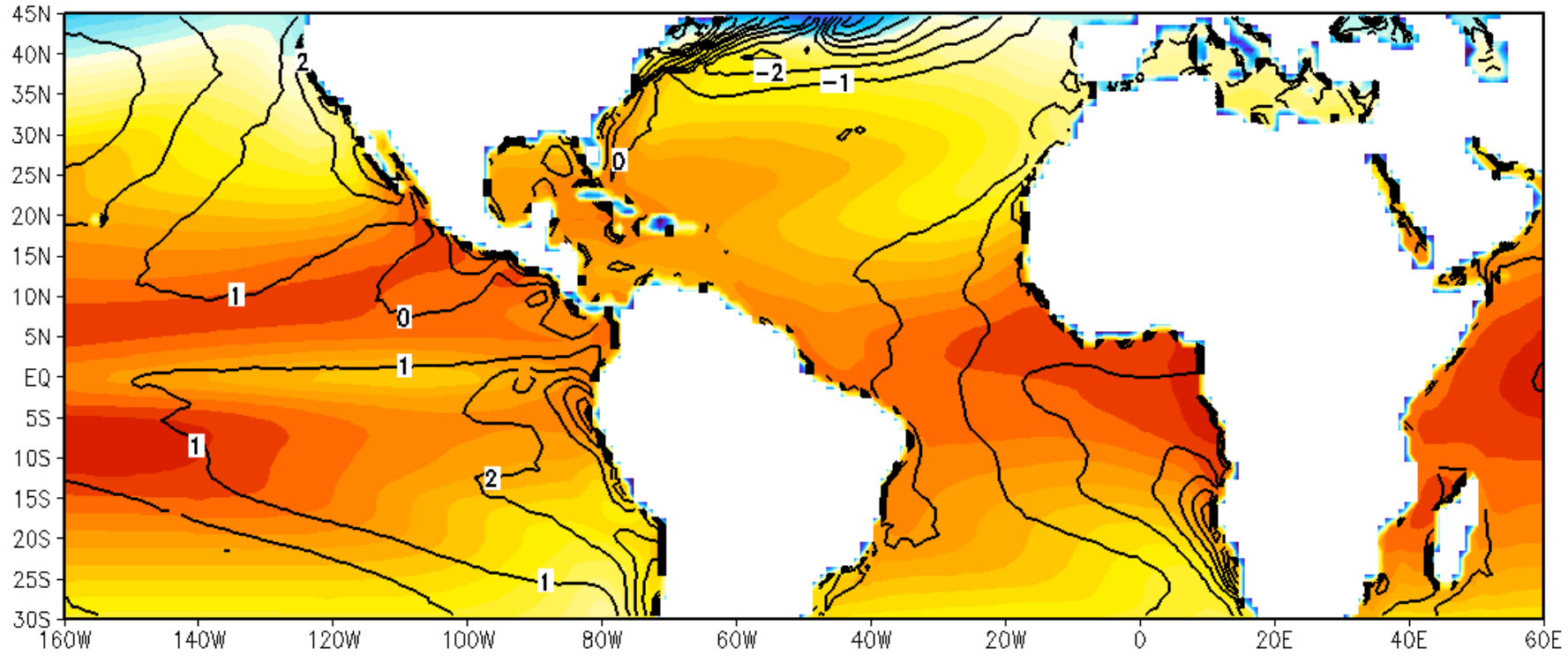
UNIVERSITY
OF MIAMI
ROSENSTIEL
SCHOOL of MARINE &
ATMOSPHERIC SCIENCE

CCS | CENTER FOR COMPUTATIONAL SCIENCE
UNIVERSITY OF MIAMI

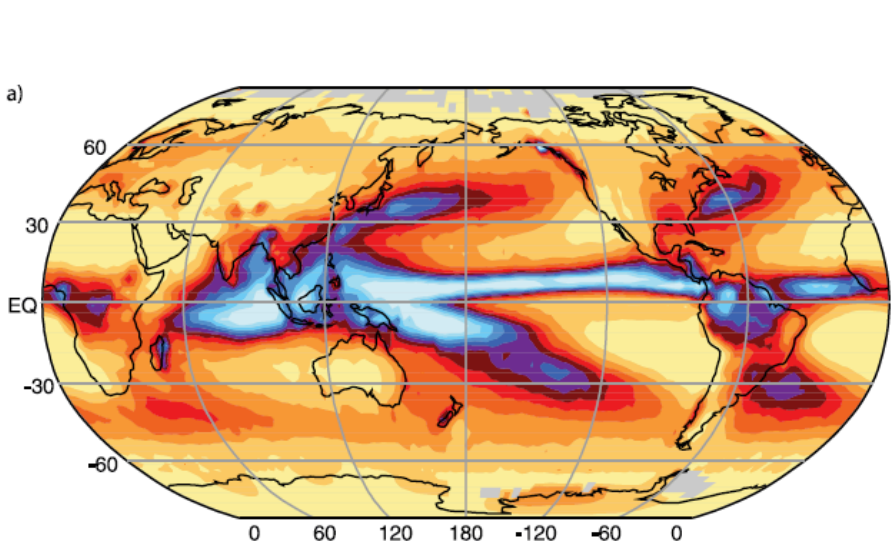
Tropical Atlantic Biases: A Biased Global Coupled Model Perspective

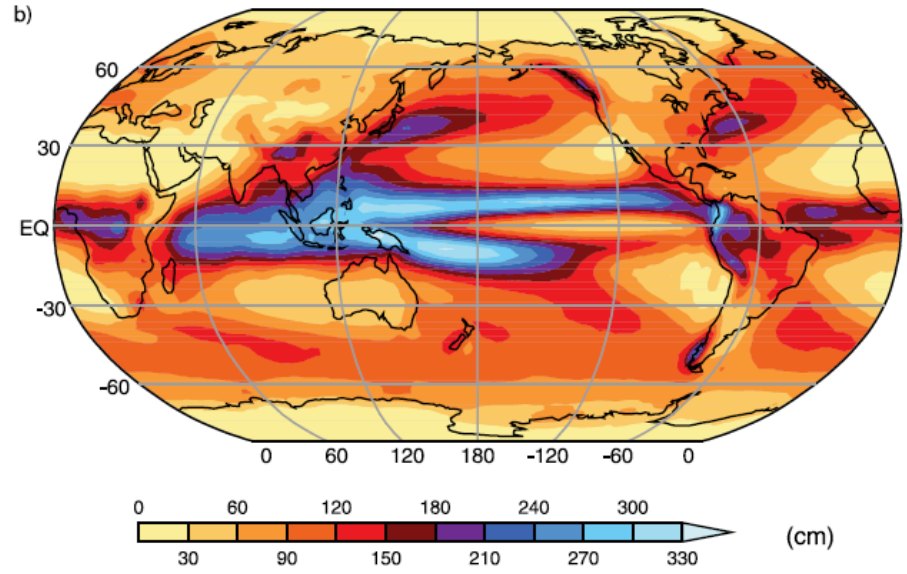


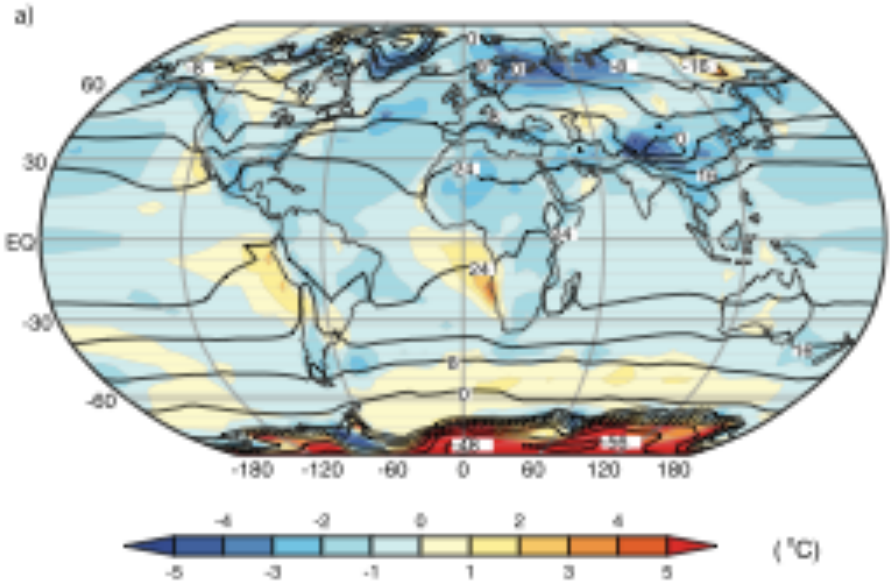
Biased Perspective of Biases

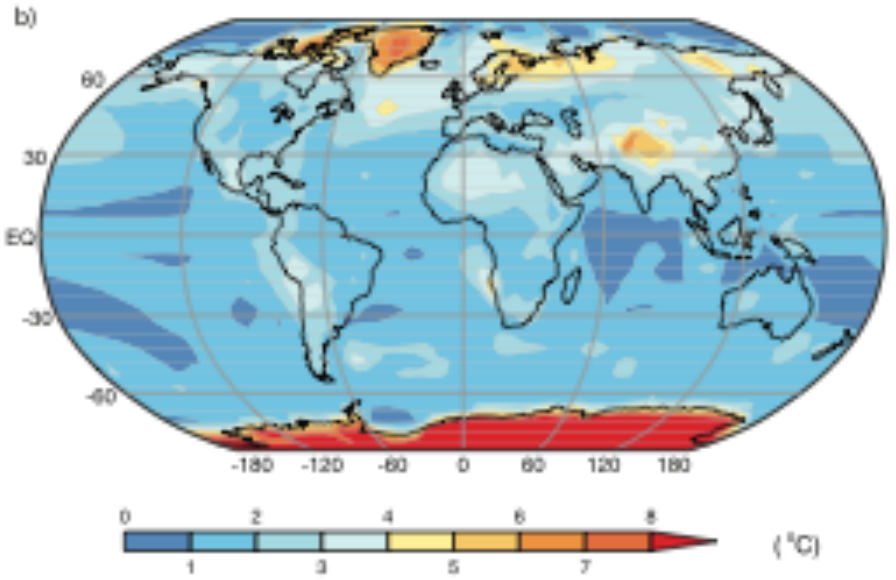
- **Attribution**
- **Parameterization Development and Improvement:**
  - Processes
  - Seamless Approach
  - Uncertainty Quantification (Stochastic-Dynamic)
- **Resolution:**
  - AGCMs
  - OGCMs (eddy resolving vs. eddy permitting)

CMIP3 Errors: Rainfall and SST

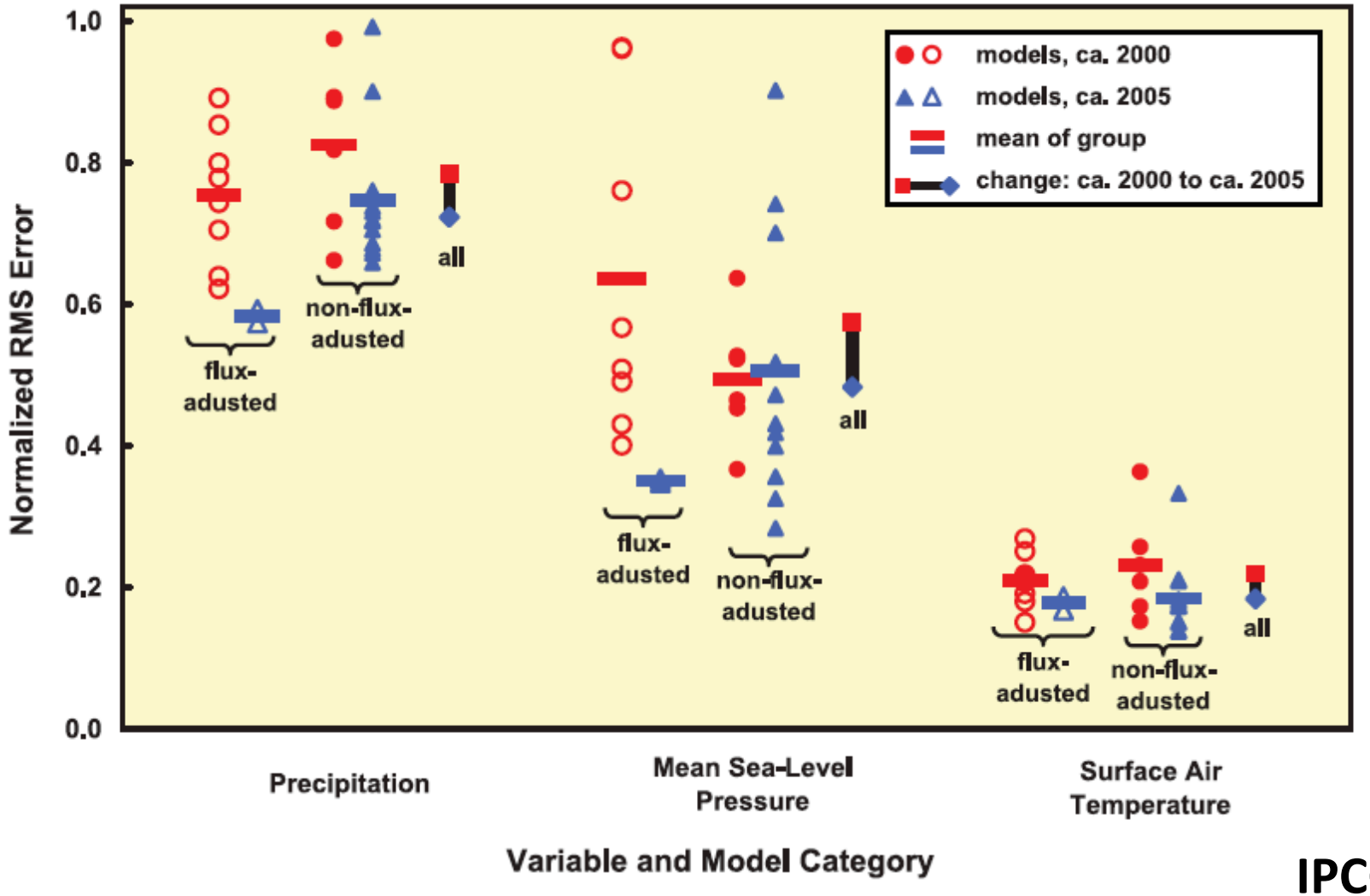








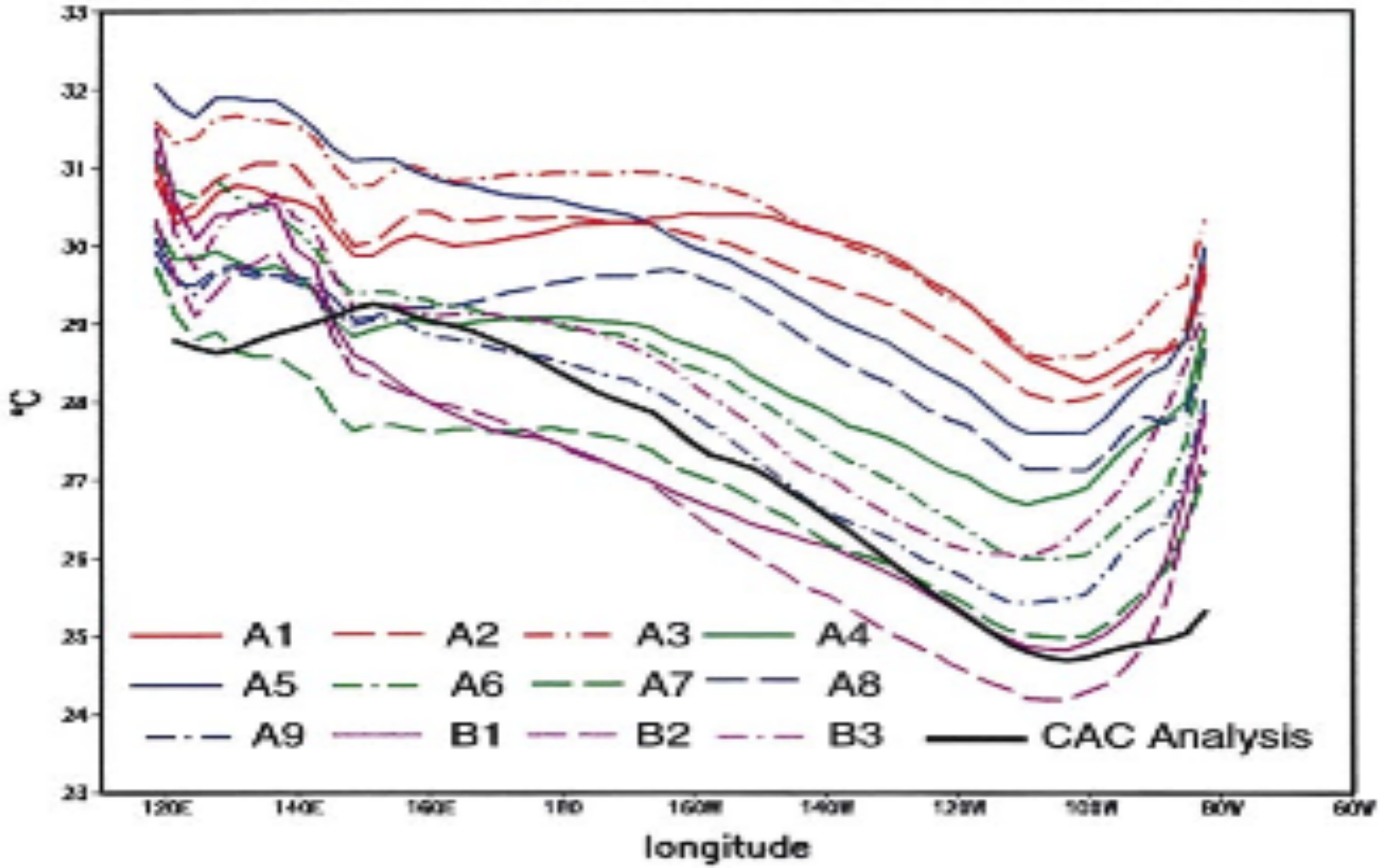
Have Models Improved?
Maybe, Not in the Atlantic



IPCC 2007

Biased Perspective of Biases

- **Attribution**
- **Parameterization Development and Improvement:**
  - Processes
  - Seamless Approach
  - Uncertainty Quantification (Stochastic-Dynamic)
- **Resolution:**
  - AGCMs
  - OGCMs (eddy resolving vs. eddy permitting)



Schneider (2002):

"… atmospheric models … are primarily responsible for differences …"

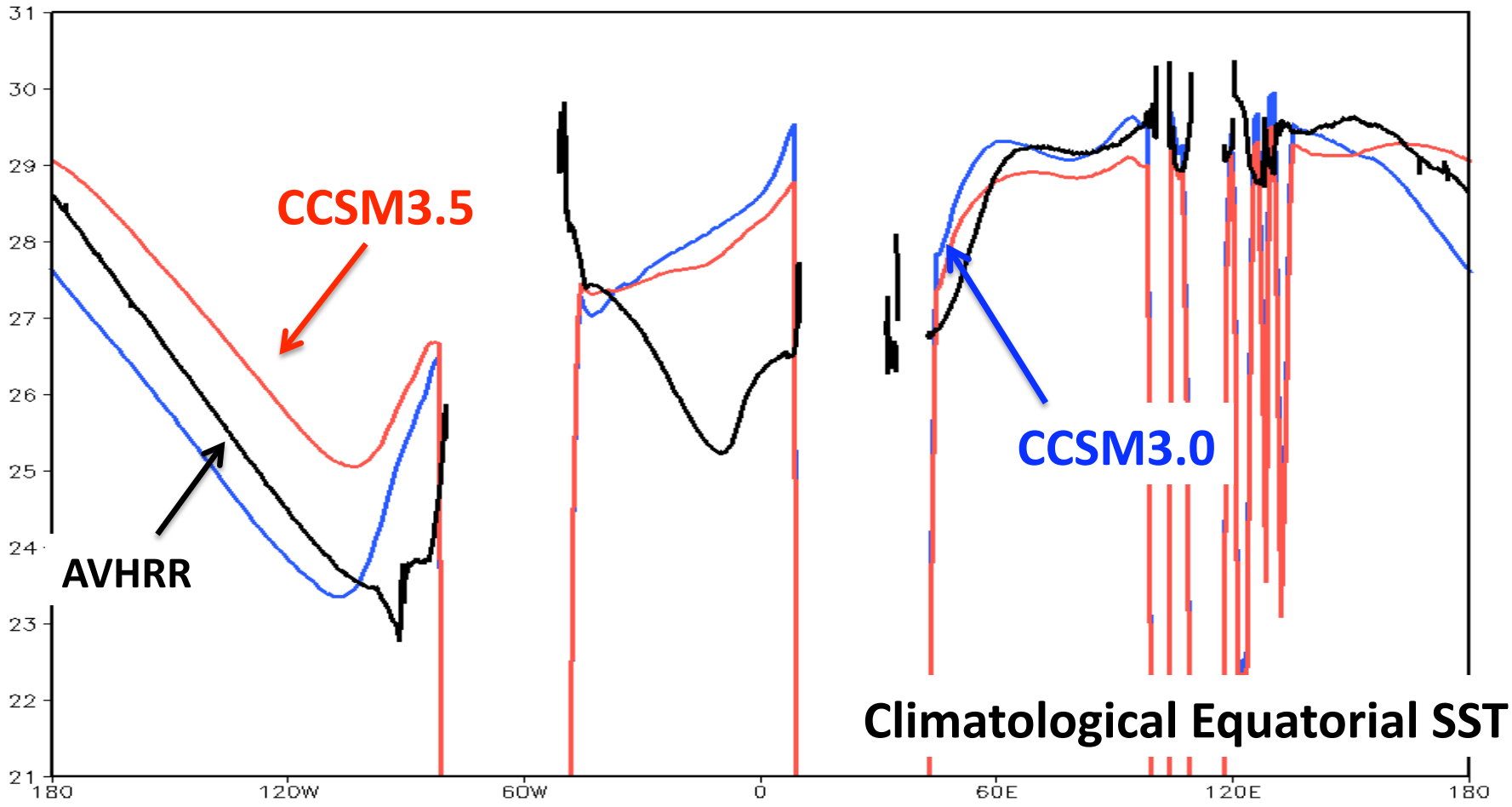
"… no dominant process … that explains the differences…"

Biased Perspective of Biases

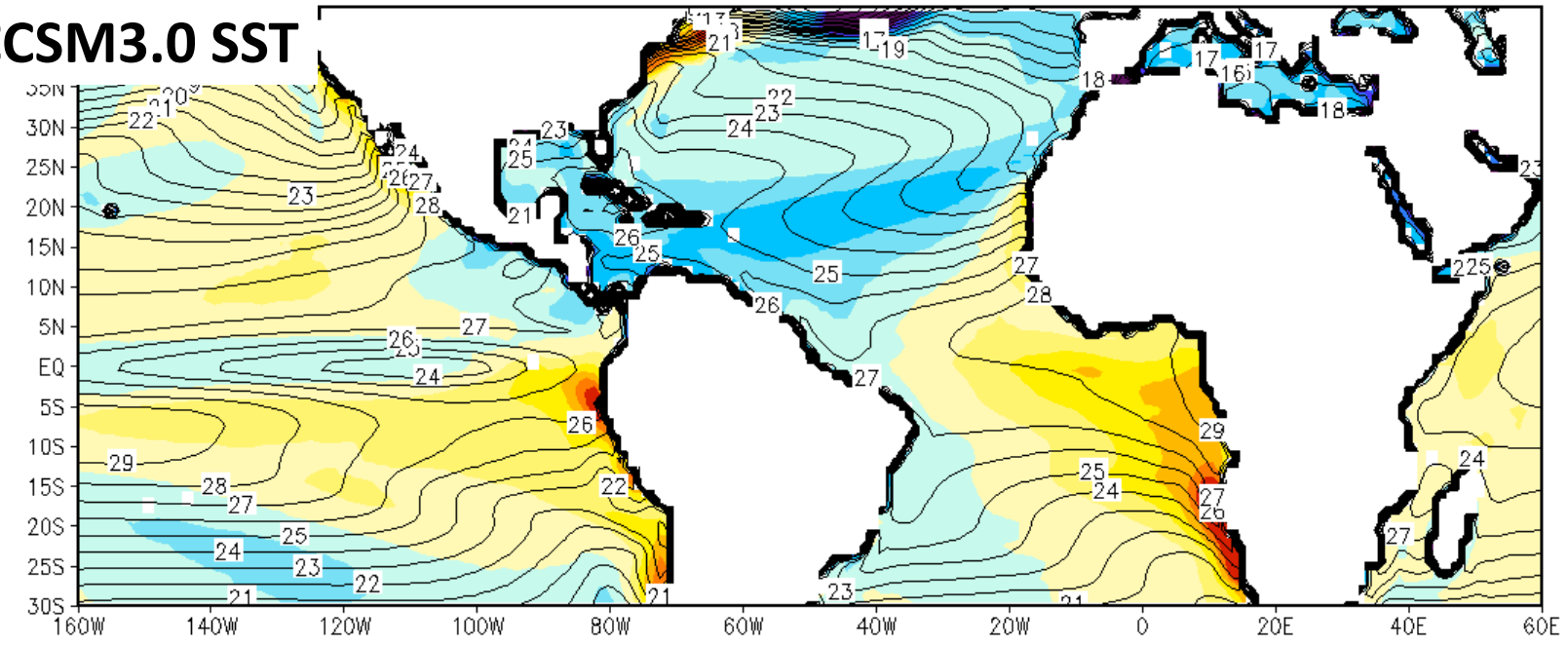
- **Attribution**
- **Parameterization Development and Improvement:**
  - Processes
  - Seamless Approach
  - Uncertainty Quantification (Stochastic-Dynamic)
- **Resolution:**
  - AGCMs
  - OGCMs (eddy resolving vs. eddy permitting)

Affect of Improved Parameterized Physics

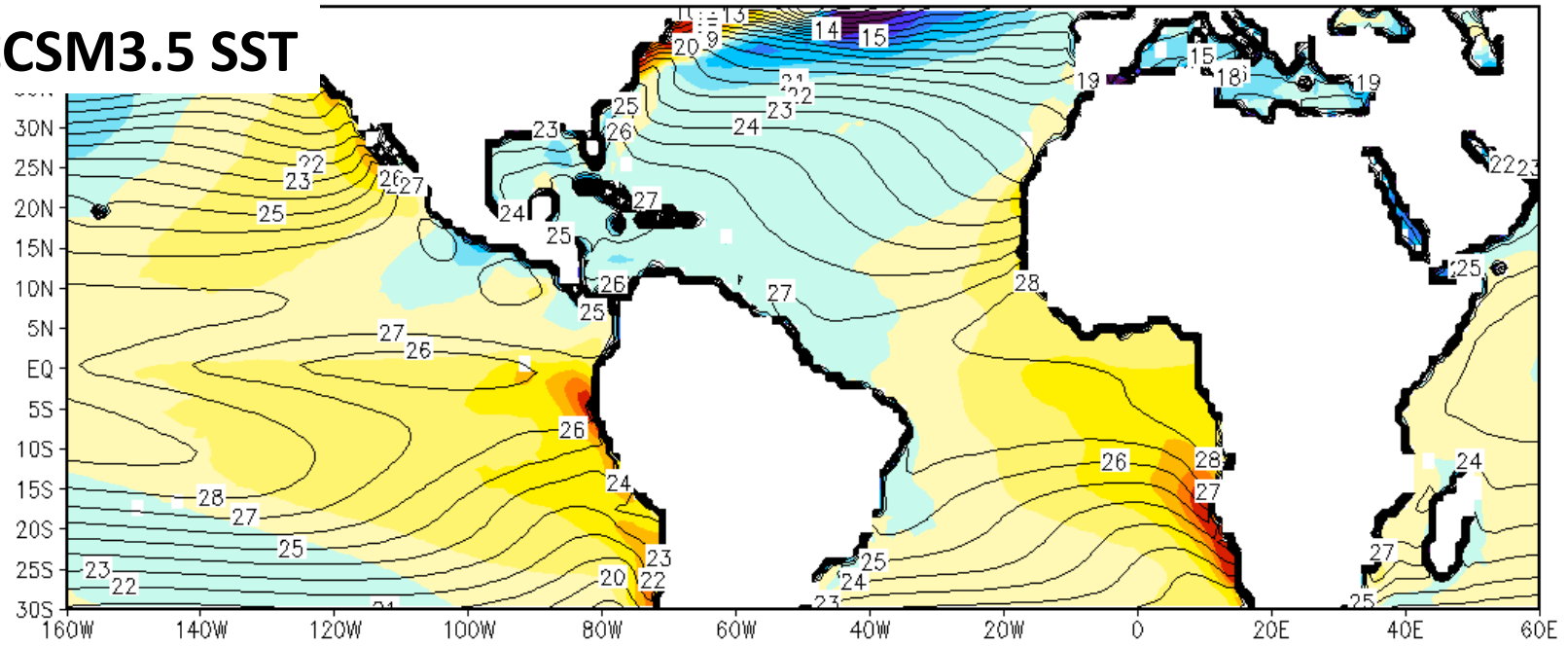
- **CCSM3.0 vs CCSM3.5**
  - **Atmosphere: T85; Ocean 1x1**



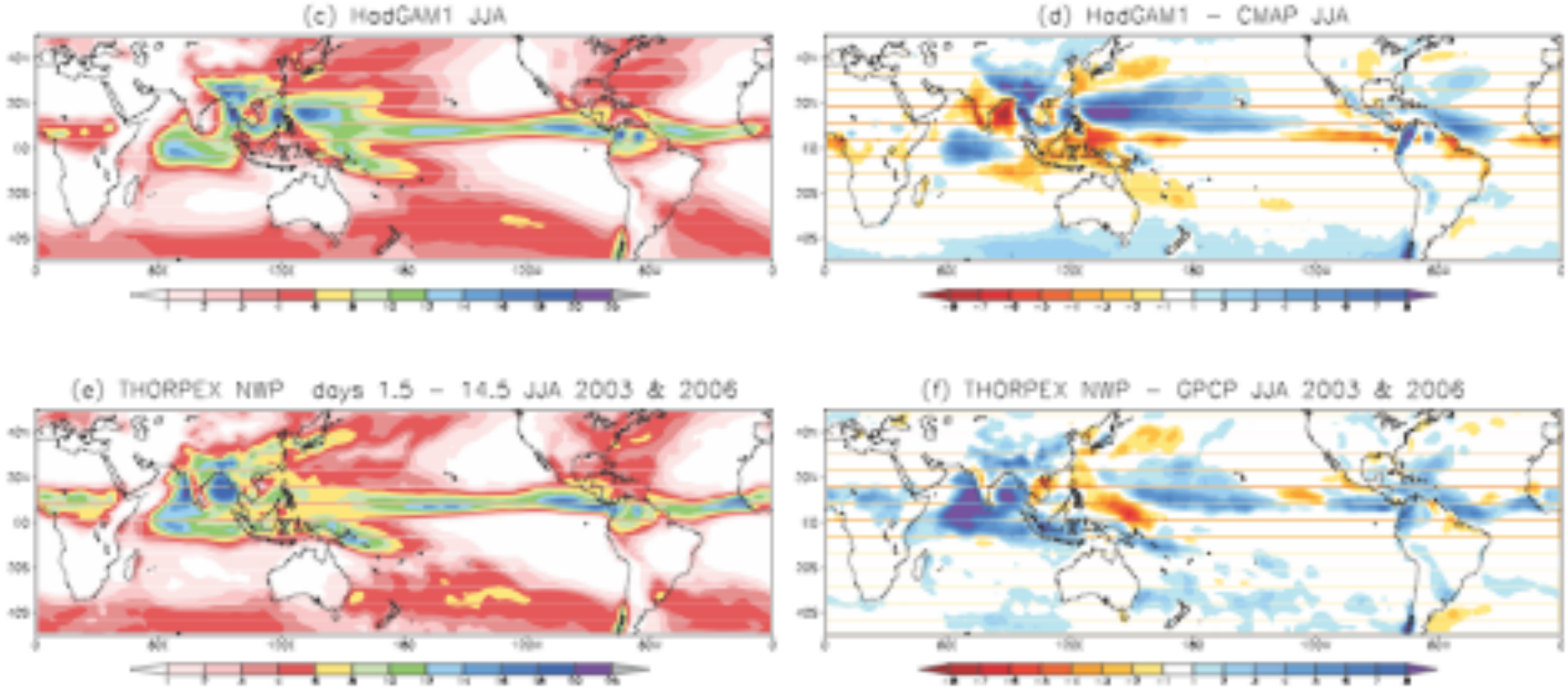
CCSM3.0 SST



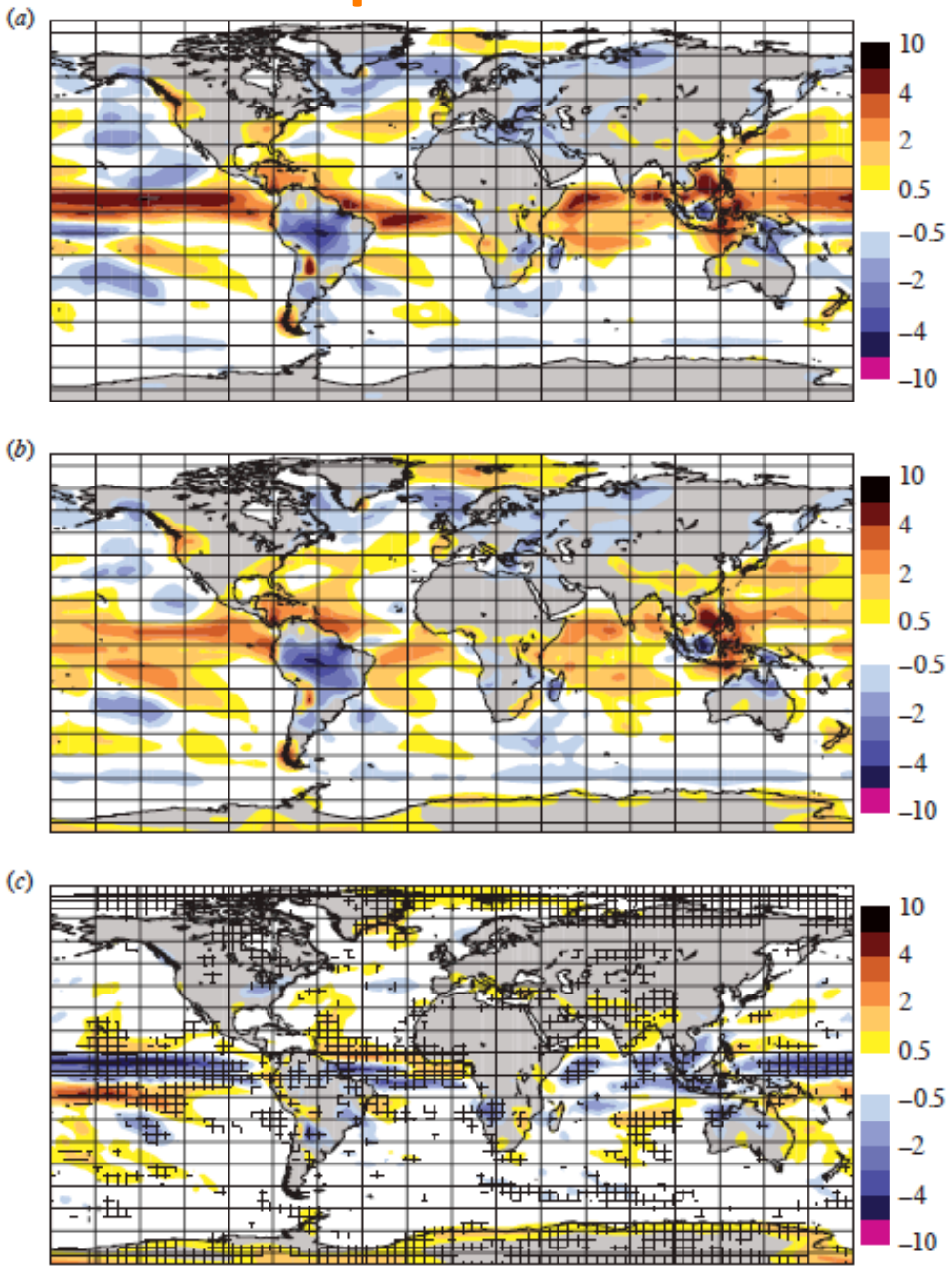
CCSM3.5 SST



Martin et al. (2010): Reduction of Systematic Errors through a Seamless Approach to Modeling Weather and Climate



Precipitation Bias



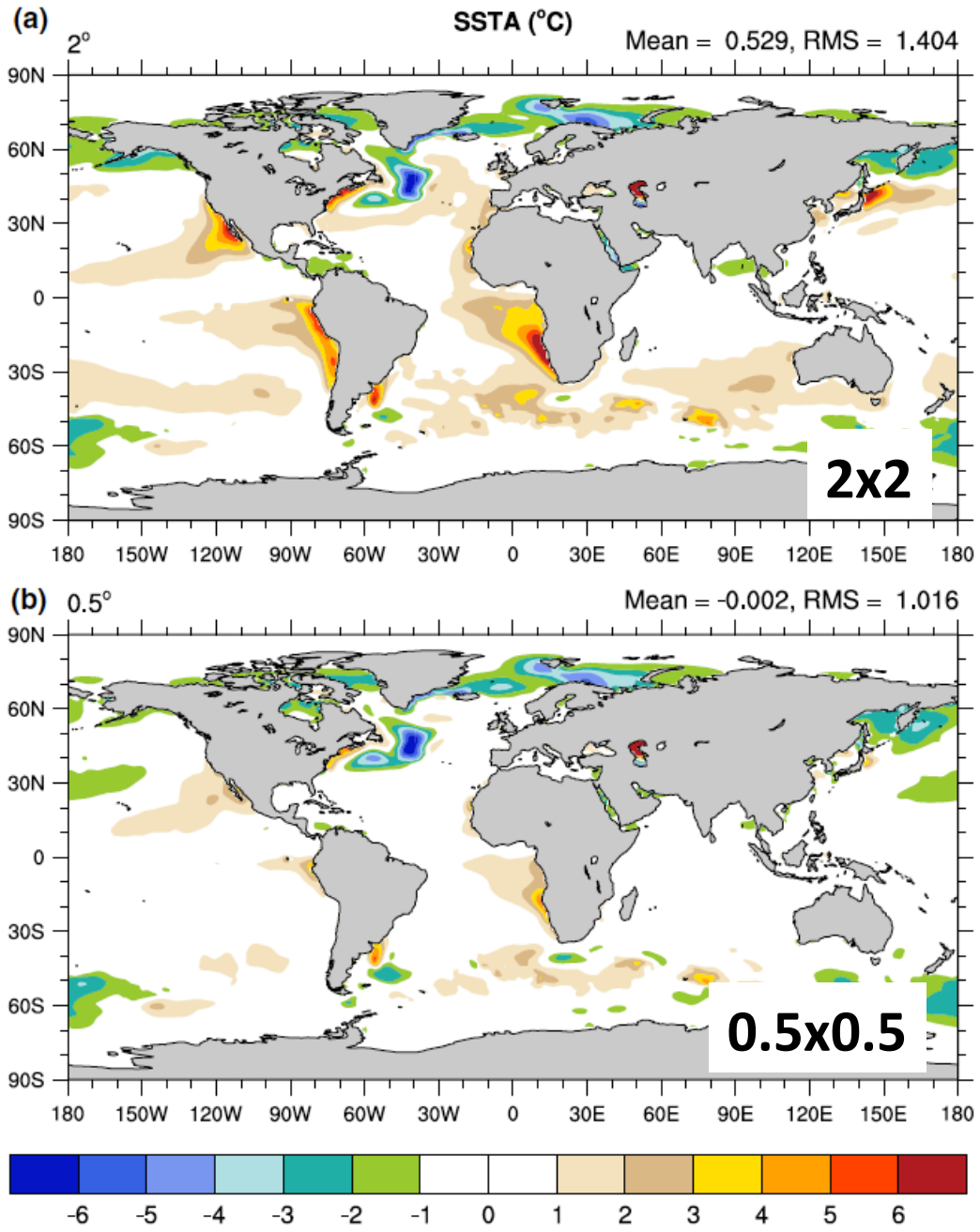
Parameterization of Model Uncertainty:

Stochastic-Dynamic Approaches (Palmer 2001)

Stochastic Physics (Buizza et al. 1999)
Stochastic Backscatter (Berner et al. 2008)

Biased Perspective of Biases

- **Attribution**
- **Parameterization Development and Improvement:**
  - Processes
  - Seamless Approach
  - Uncertainty Quantification (Stochastic-Dynamic)
- **Resolution:**
  - AGCMs
  - OGCMs (eddy resolving vs. eddy permitting)



Increasing AGCM Resolution:
2x2 vs 0.5x0.5

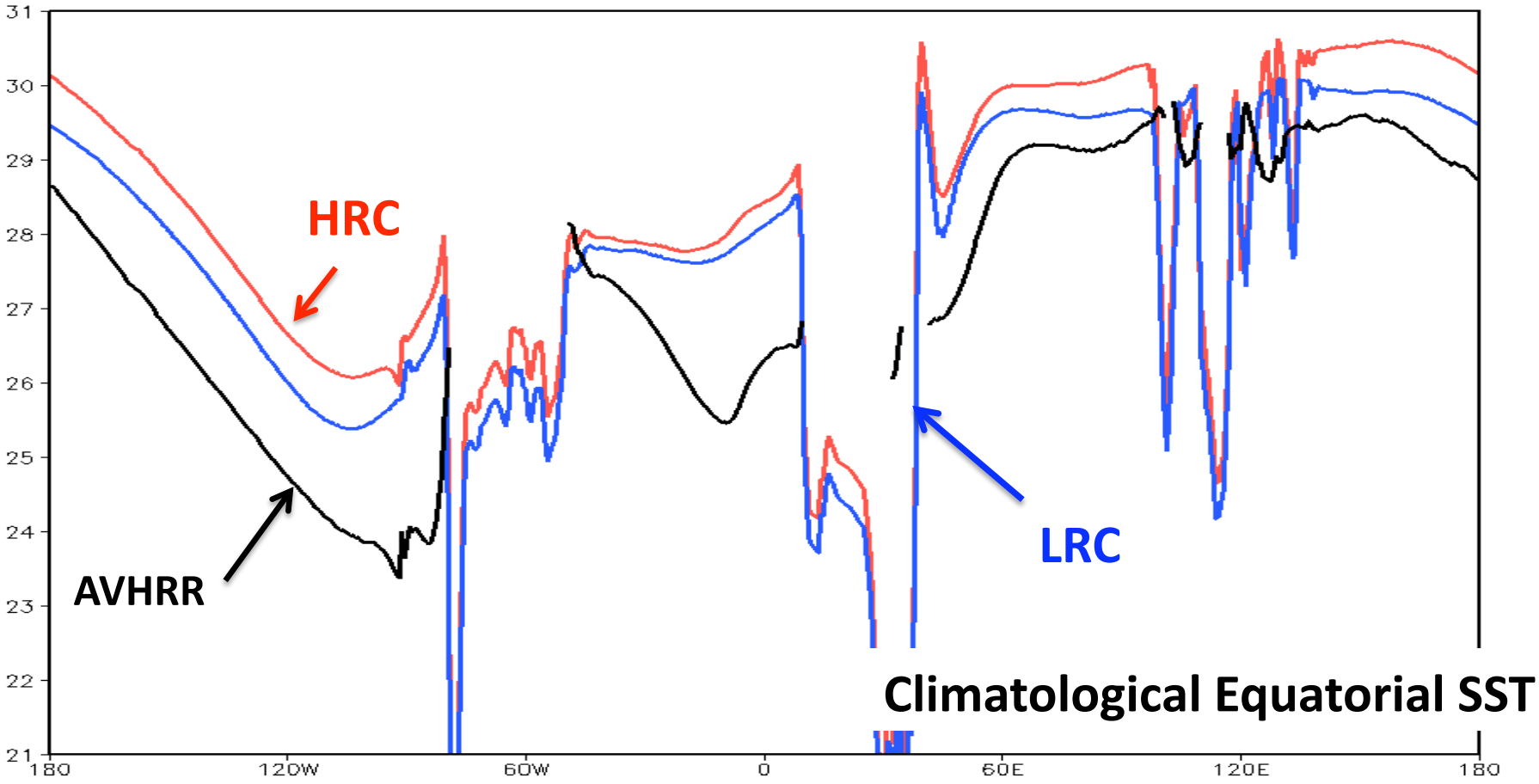
Gent et al. 2010

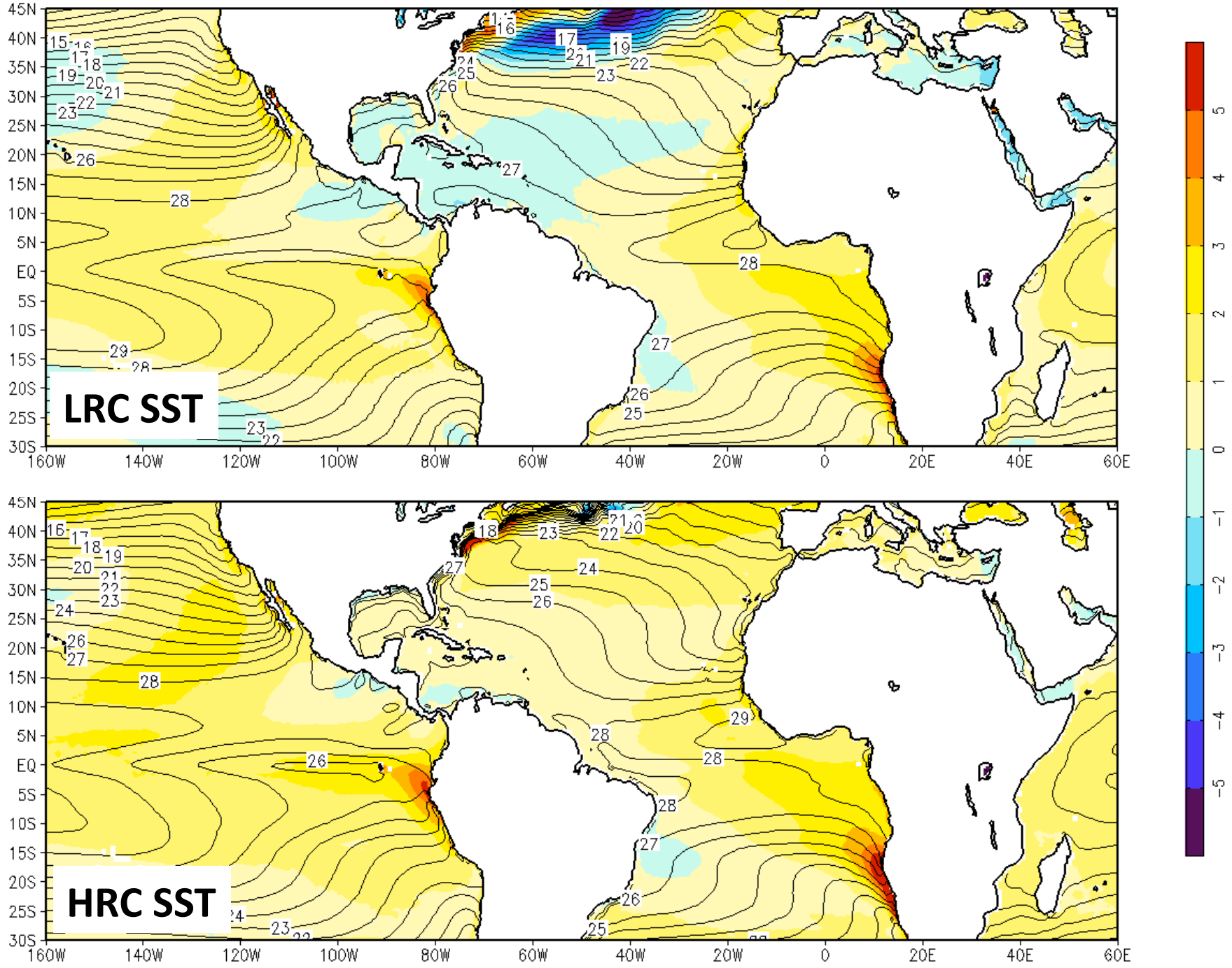
Biased Perspective of Biases

- **Attribution**
- **Parameterization Development and Improvement:**
  - Processes
  - Seamless Approach
  - Uncertainty Quantification (Stochastic-Dynamic)
- **Resolution:**
  - AGCMs
  - **OGCMs (eddy resolving vs. eddy permitting)**

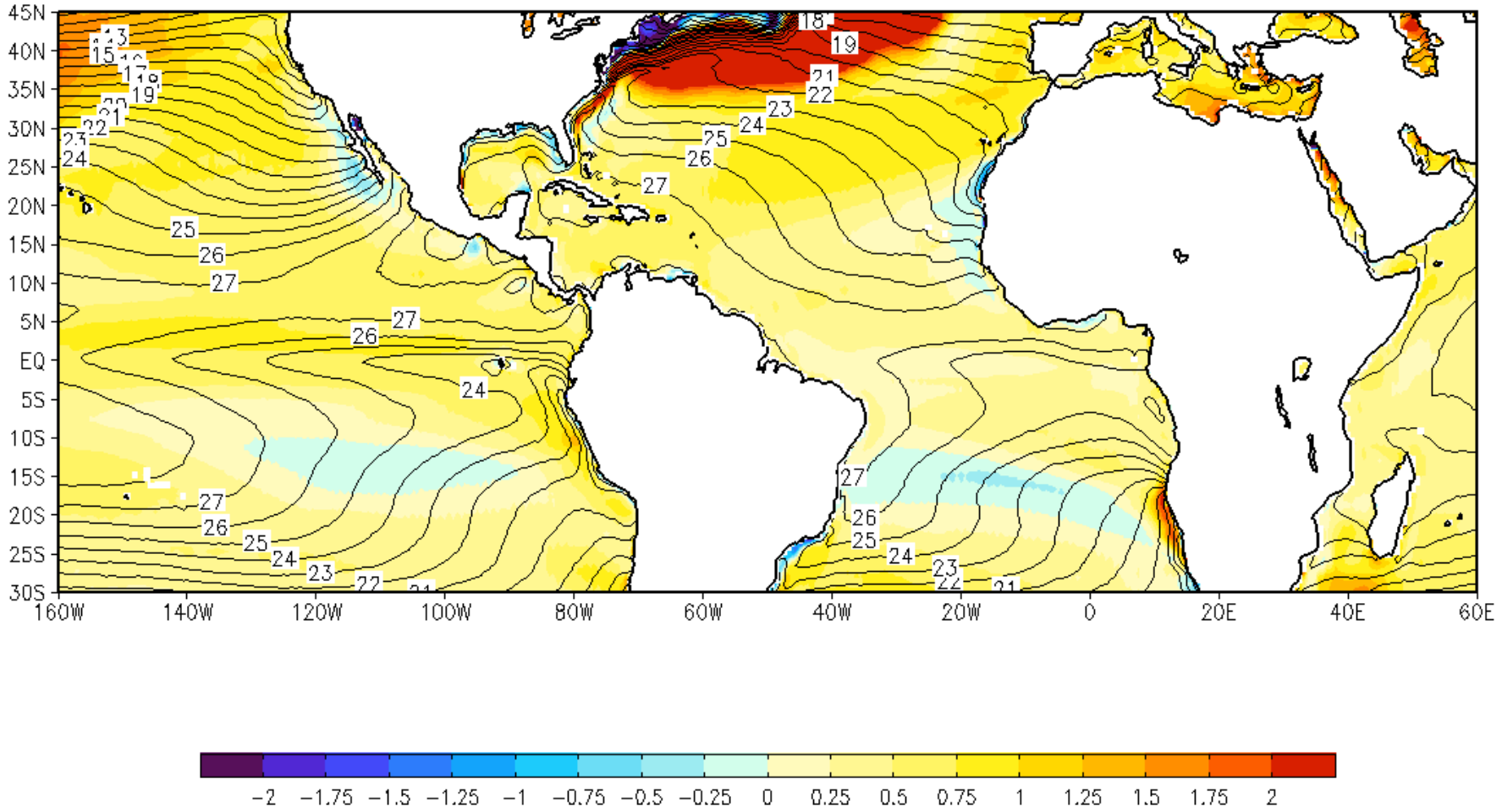
Affect of Resolved Ocean Eddies

- **CCSM4**
  - **Atmosphere: 0.5x0.5**
  - **Two Versions: 1x1 [LRC] and 0.1x0.1 [HRC]**

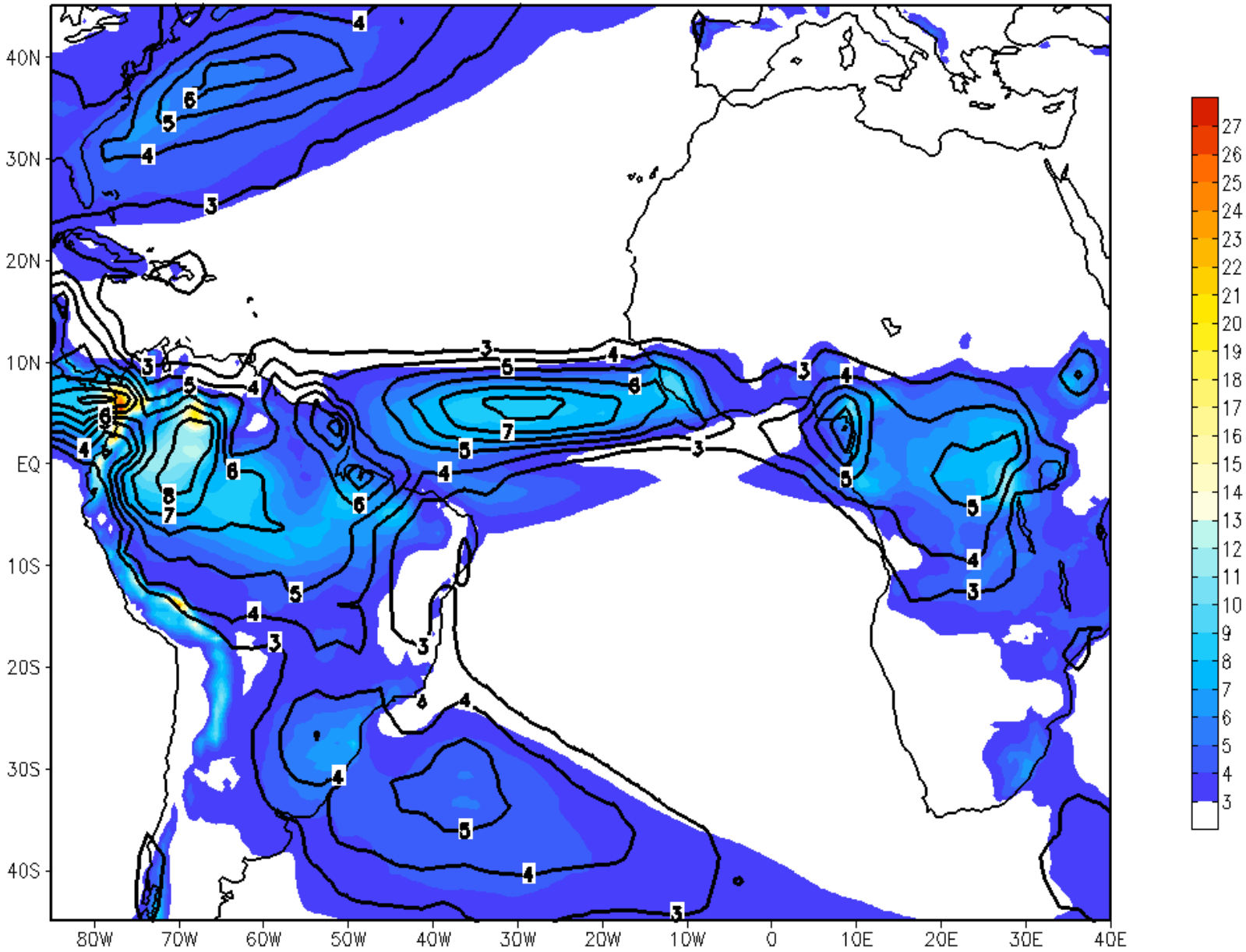



LRC SST
HRC SST
45N
40N
35N
30N
25N
20N
15N
10N
5N
EQ
5S
10S
15S
20S
25S
30S
160W
140W
120W
100W
80W
60W
40W
20W
0
20E
40E
60E
5
4
3
2
1
0
−1
−2
−3
−4
−5

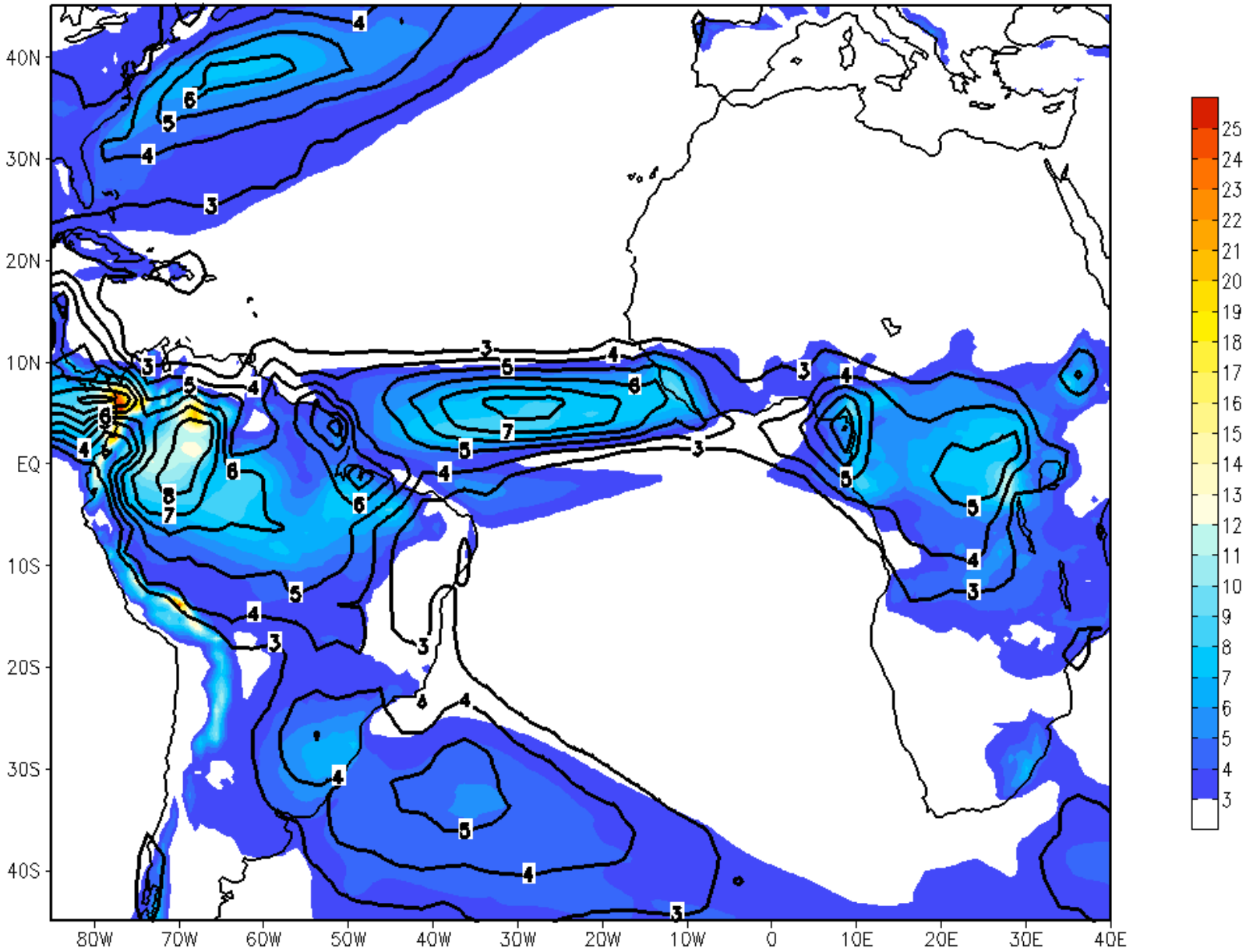
HRC-LRC SST


45N
40N
35N
30N
25N
20N
15N
10N
5N
EQ
5S
10S
15S
20S
25S
30S
160W
140W
120W
100W
80W
60W
40W
20W
0
20E
40E
60E
−2
−1.75
−1.5
−1.25
−1
−0.75
−0.5
−0.25
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2

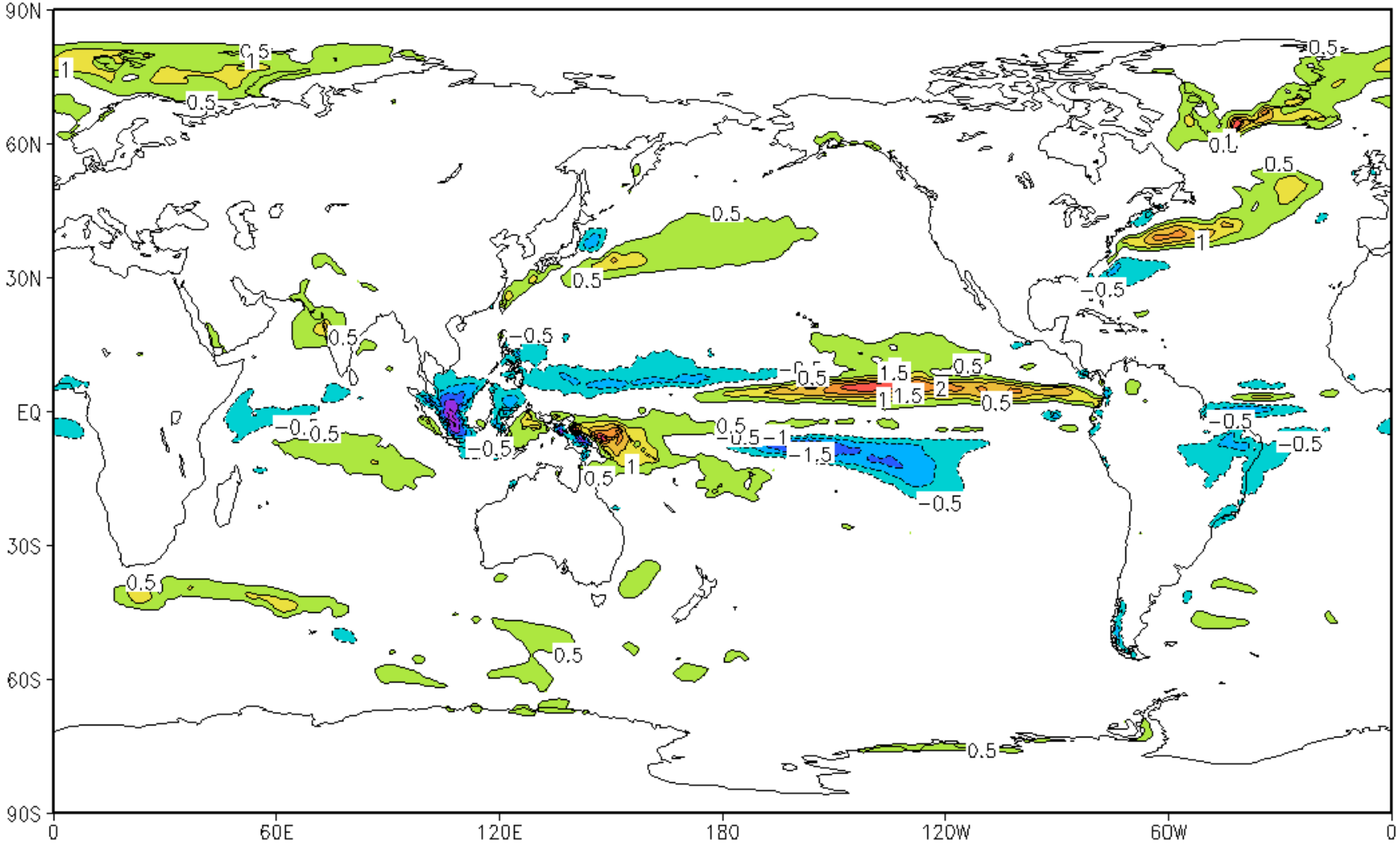
Annual Mean Rainfall LRC, CMAP



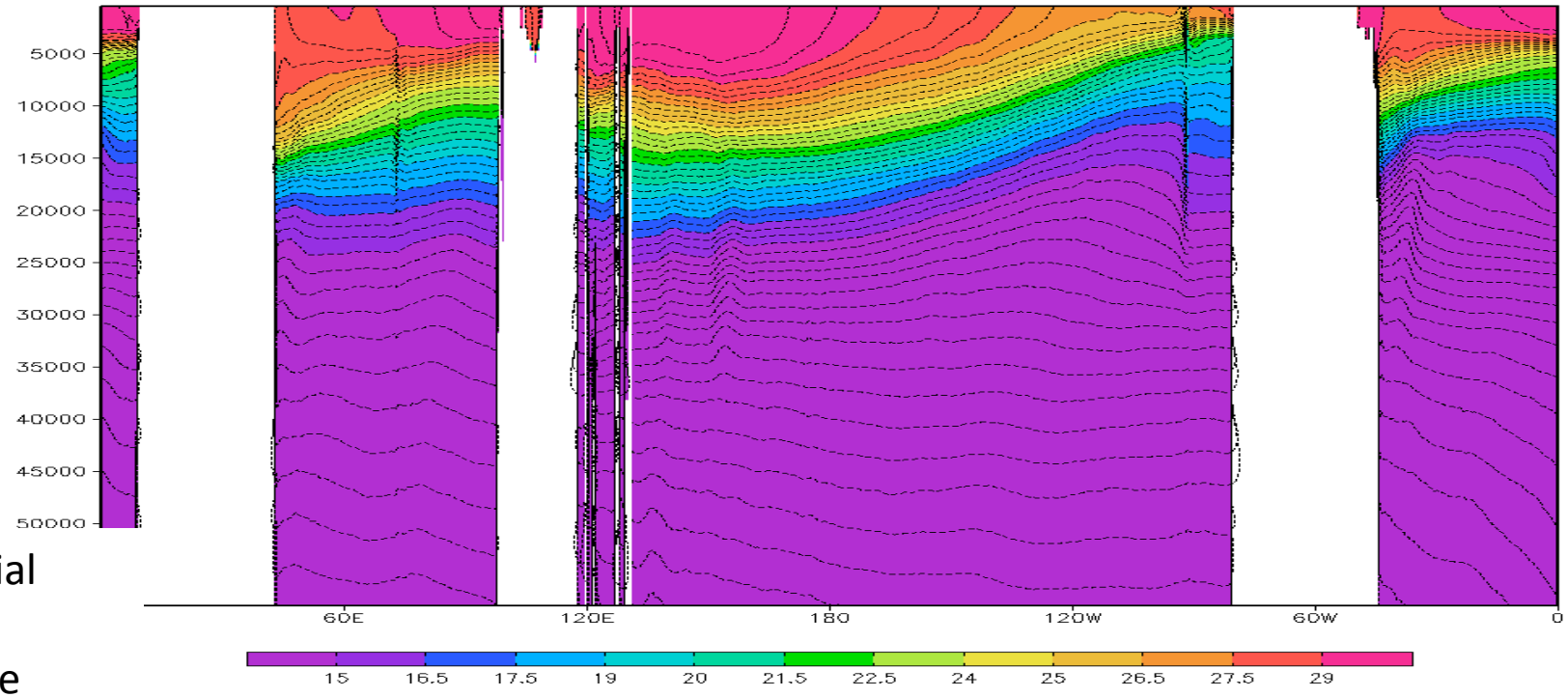
Annual Mean Rainfall HRC, CMAP



Annual Mean Precipitation HRC−LRC

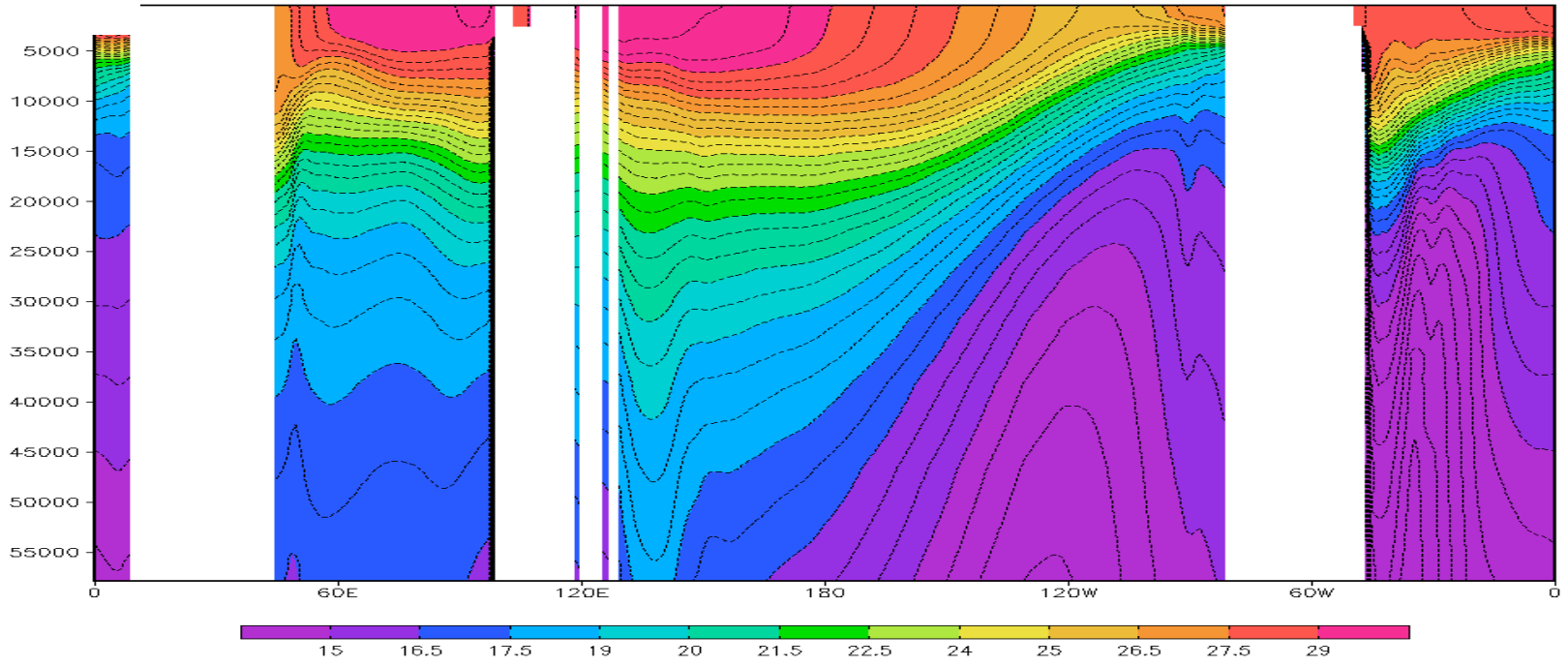


HRC



Equatorial Thermal Structure

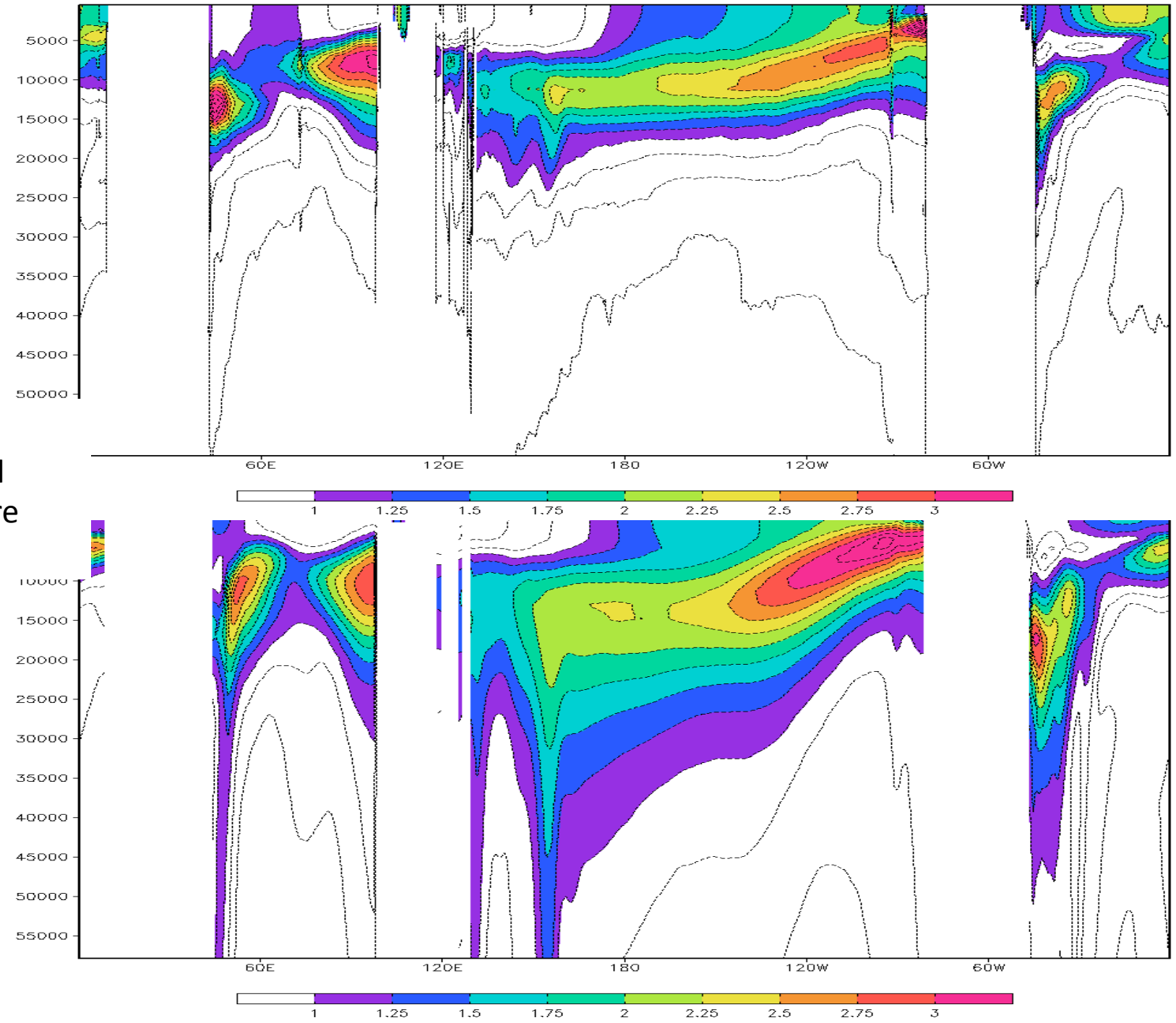
LRC



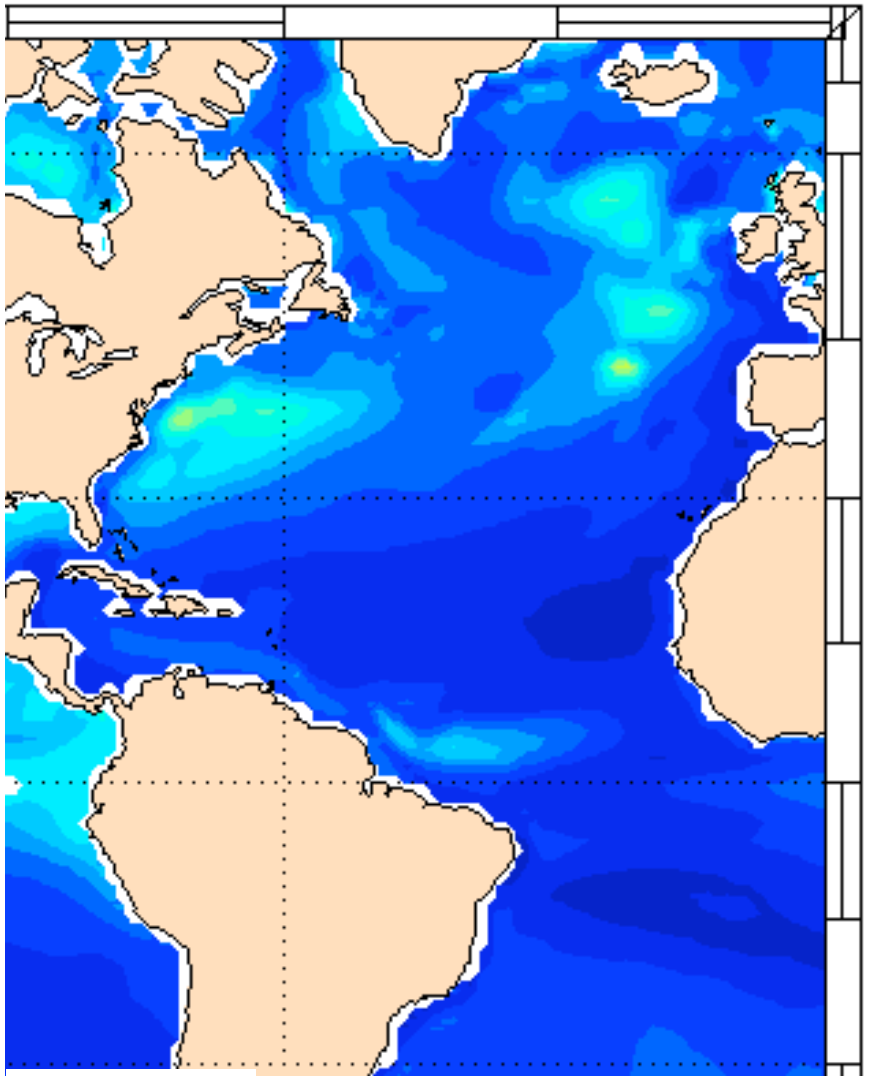
HRC

ENSO Thermal Structure

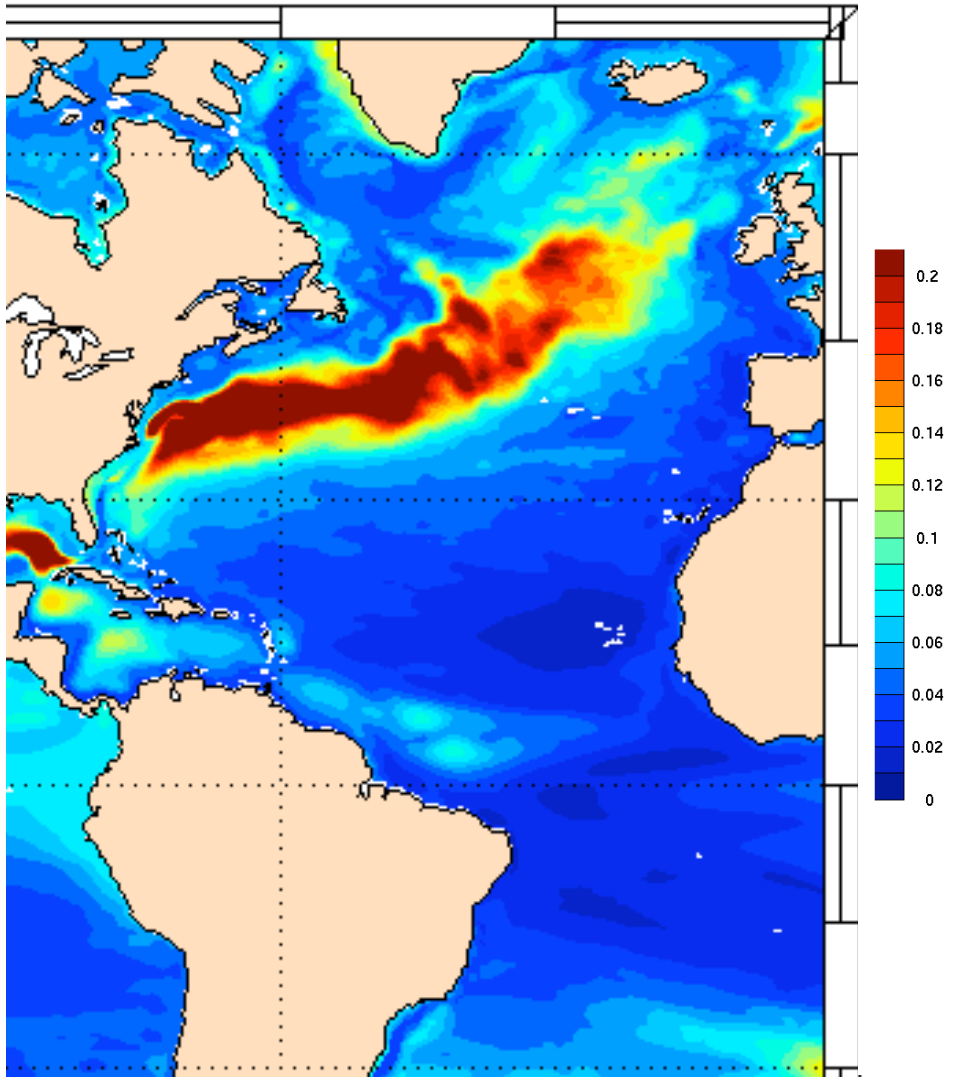
LRC



Sea Surface Height Standard Deviation

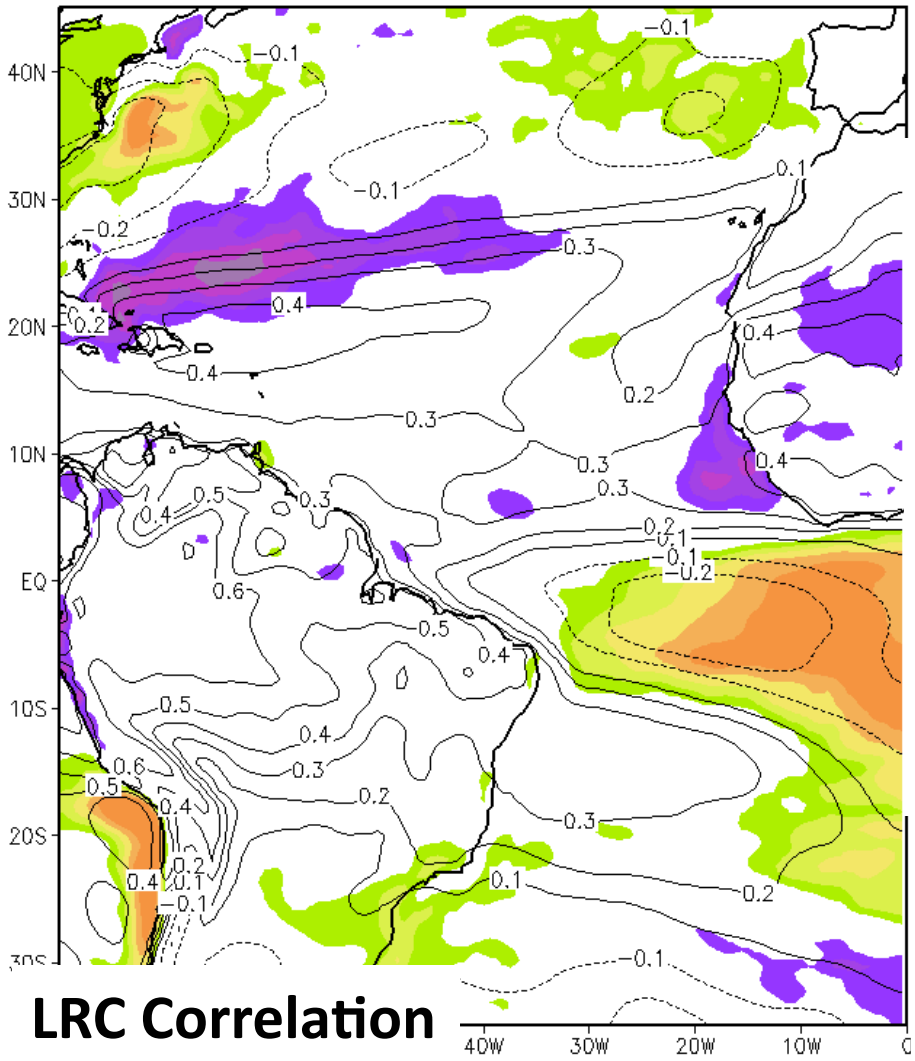


LRC SSH

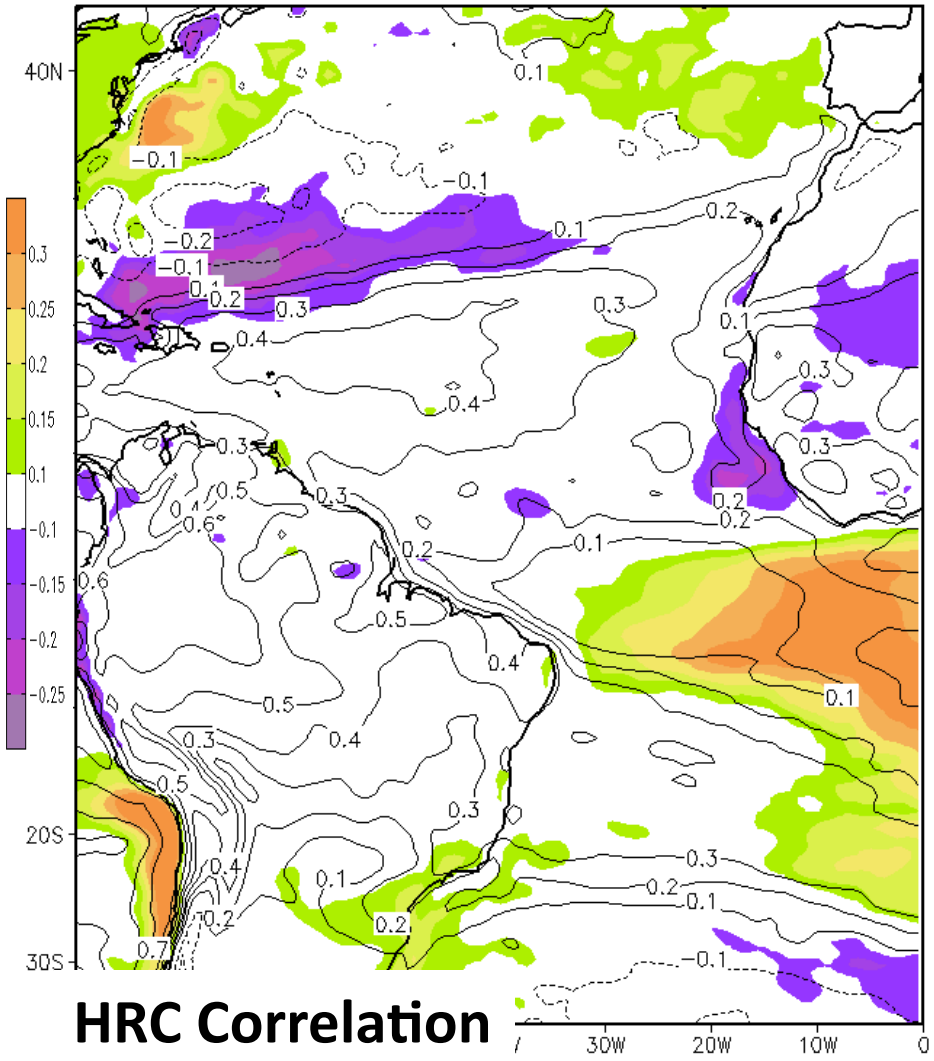


HRC SSH

Local SSTA Co-Variability with ENSO

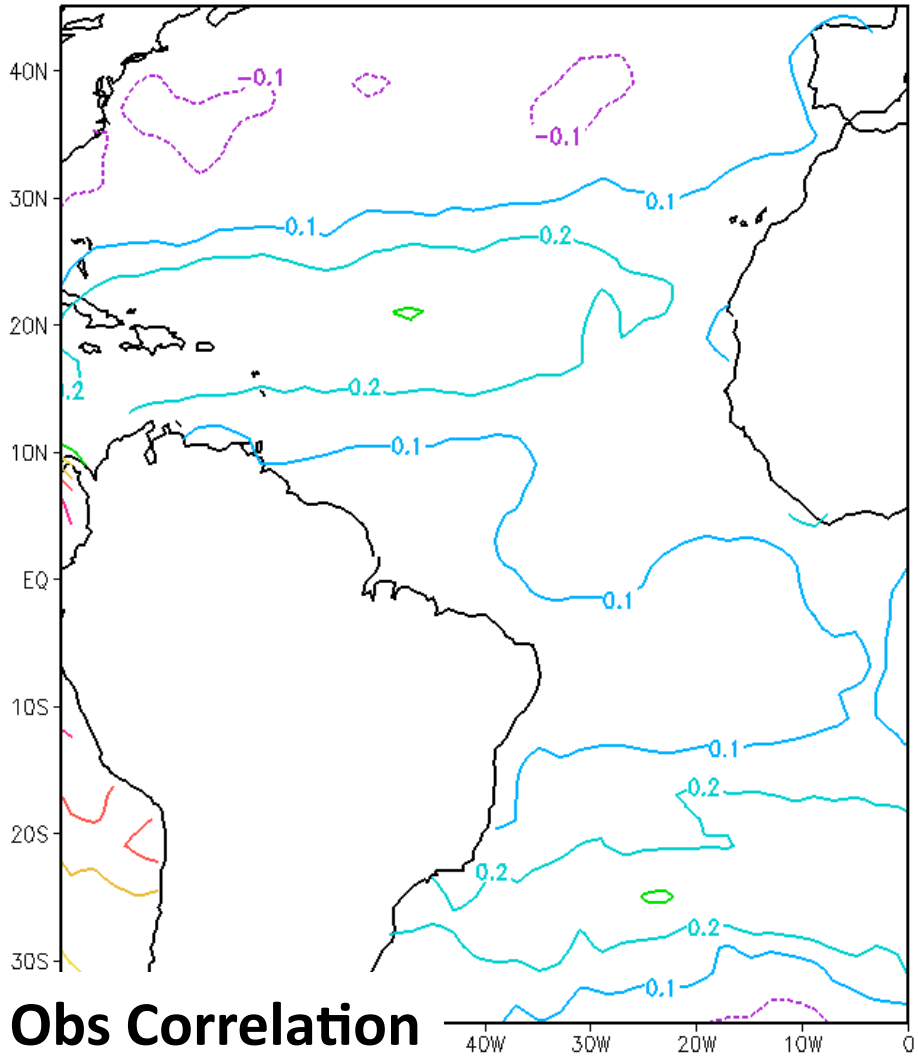


LRC Correlation

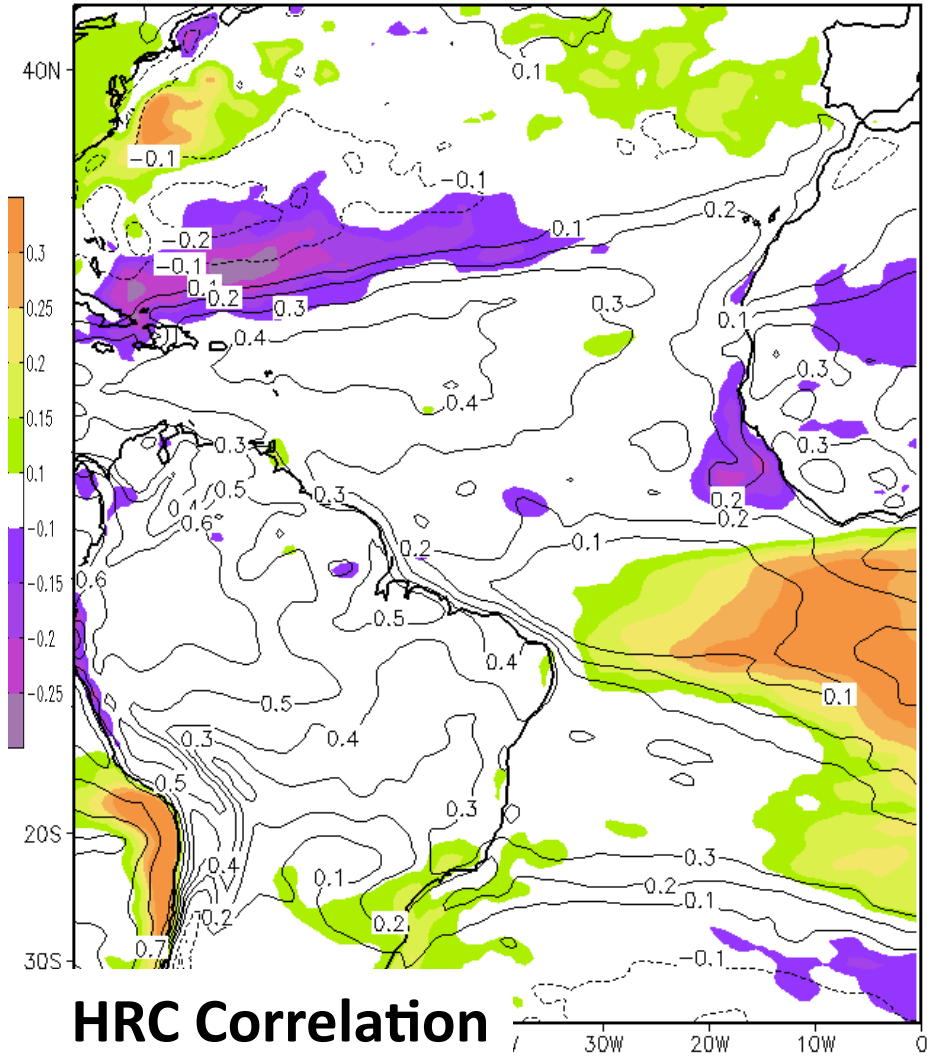


HRC Correlation

Local SSTA Co-Variability with ENSO

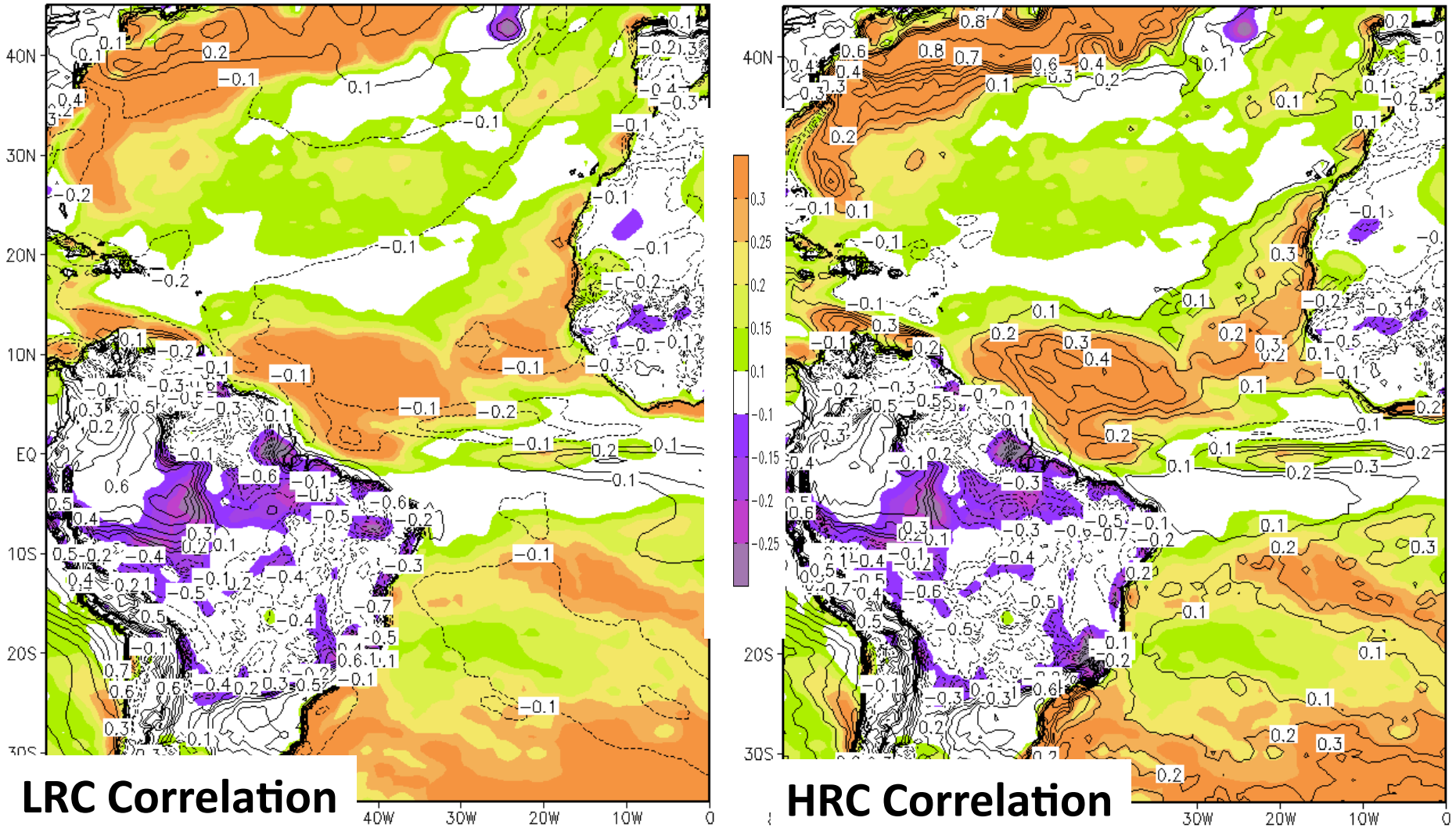


Obs Correlation



HRC Correlation

Local SSTA-Latent Heat Flux Correlation



LRC Correlation

HRC Correlation

Biased Perspective of Biases

- **Attribution**
- **Parameterization Development and Improvement (Progress):**
  - Processes
  - Seamless Approach
  - Uncertainty Quantification (Observational Basis)
- **Resolution (Not Simple/Not Solved):**
  - AGCMs
  - OGCMs (Stratification and Co-Variability)