

An Update on CAM-CLUBB Simulations

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Thanks to: Cecile Hannay, Dan Grosvenor, Terry Kubar, Peter Caldwell, Robert Pincus, John Truesdale, Dave Williamson, Jen Kay, Sungsu Park, Matt Wyant, Huan Guo, Chris Golaz, Gokhan Danabasoglu, and many others...

Model Configurations

Physics	CAM5	CAM-CLUBB	CAM-CLUBB-Deep
Deep Convection	Zhang and McFarlane (1995)	Zhang and McFarlane (1995)	CLUBB
Shallow Convection	Park and Bretherton (2009)	CLUBB	CLUBB
PBL	Bretherton and Park (2009)	CLUBB	CLUBB
Macrophysics	Park	CLUBB	CLUBB
Microphysics	Morrison and Gettelman (2008) for stratiform cloud only	Gettelman and Morrison (2014) for stratiform and shallow convective cloud	Gettelman and Morrison (2014) for all cloud

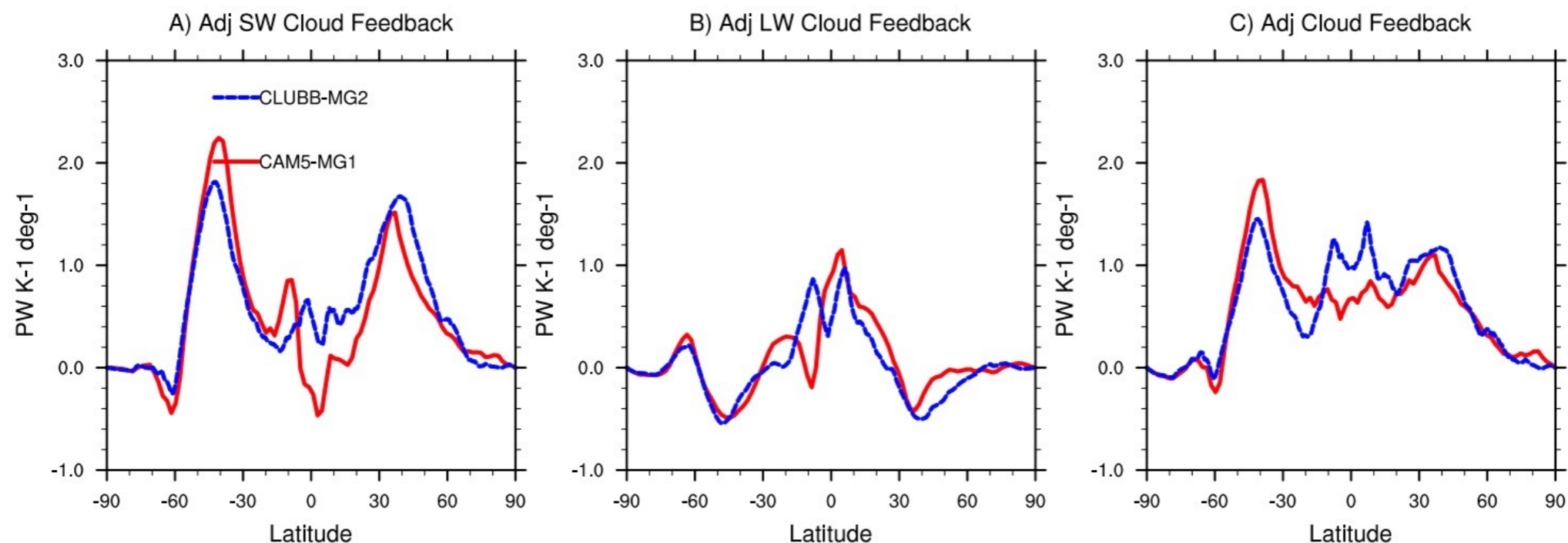
- Coupling between CLUBB and Microphysics:
 - Prognostic precipitation microphysics (Gettelman and Morrison 2014)
 - Sub-stepping of CLUBB and microphysics (Gettelman et al. 2014):
 - CLUBB time step is 5 min, physics time step is typically 30 mins.
 - Every time CLUBB is called, microphysics is called
 - Allows for the clouds, convection, turbulence to evolve with the microphysics

Simulations and Results

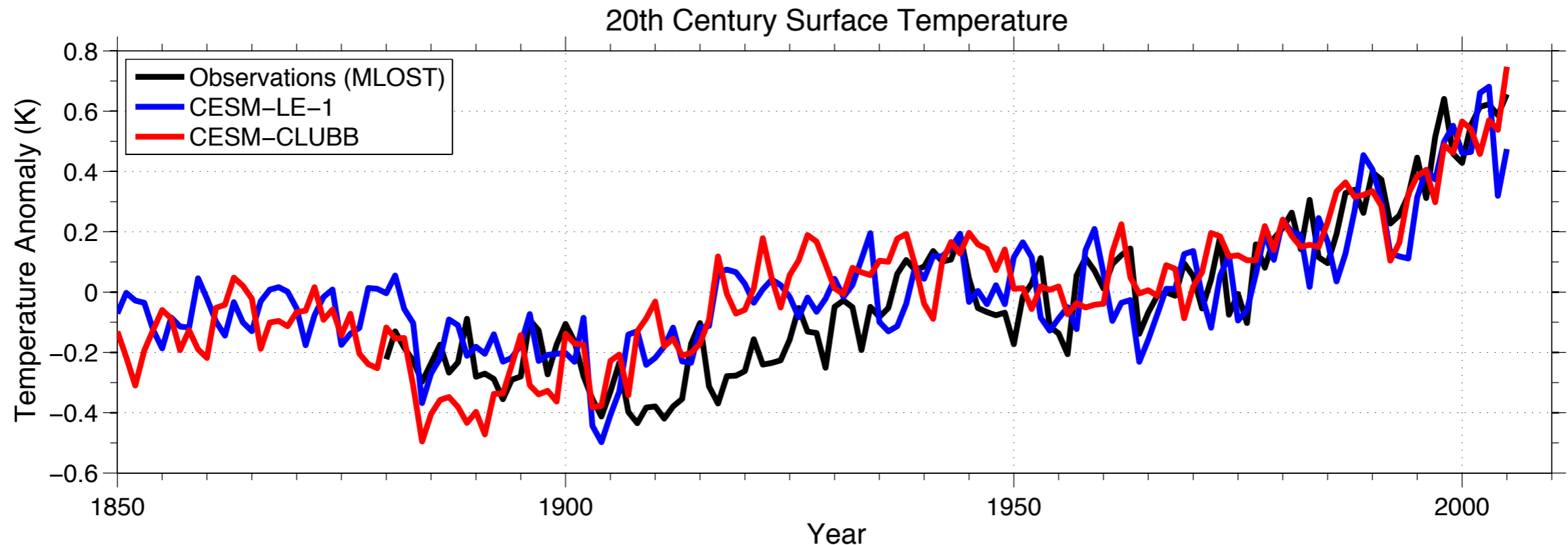
- Unless otherwise stated, all simulations are 1-degree using FV-dycore
- Simulations performed required for CAM5.5 panel review:
 - AMIP simulation (1979 - 2005, prescribed SSTs)
 - 10-year climatological SST run for both present day and pre-industrial aerosols (aerosol effects)
 - Century long pre-industrial control coupled simulation (B1850)
 - Slab Ocean experiments for both 1x and 2x CO₂ (climate sensitivity)
- Additional simulations performed:
 - 20th century coupled simulation (1850-2005)
 - High-resolution prescribed SST simulations (SE-dycore, ne120)
 - Experimental simulations of the CAM-CLUBB-DEEP configuration

Climate Sensitivity and Cloud Feedbacks

- Climate sensitivity of CAM-CLUBB is 3.8 K, slightly lower than CAM5 (4.1 K)
- Climate sensitivity of CAM-CLUBB thus far appears to be robust for several sets of SOM experiments performed over the last six months.
- Cloud feedbacks analysis (performed by Andrew Gettelman) suggests interesting differences compared to CAM5.



20th Century Transient Coupled Simulation



CEM-CLUBB simulations branched from the end of the 100-year pre-industrial control simulation.

Note: Both CEM configurations shown represent a single realization.

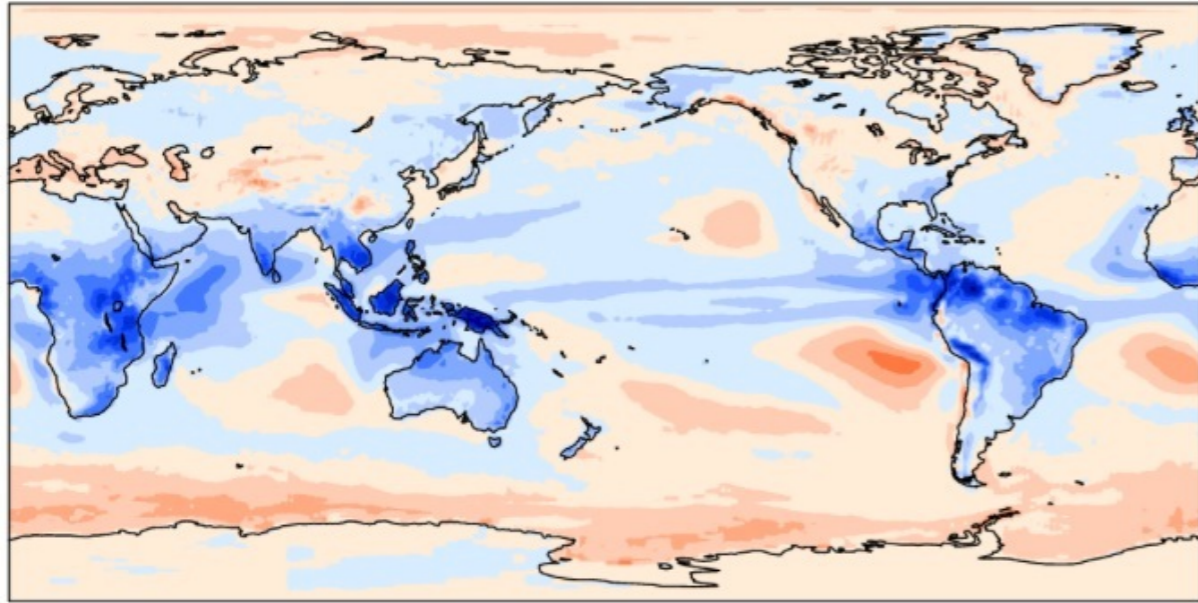
Analysis of ocean diagnostics needs to be performed for CEM-CLUBB

Shortwave Cloud Forcing Biases

AMIP

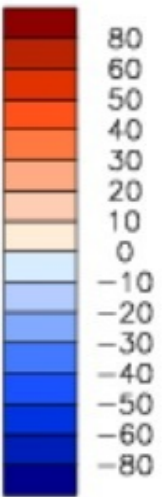
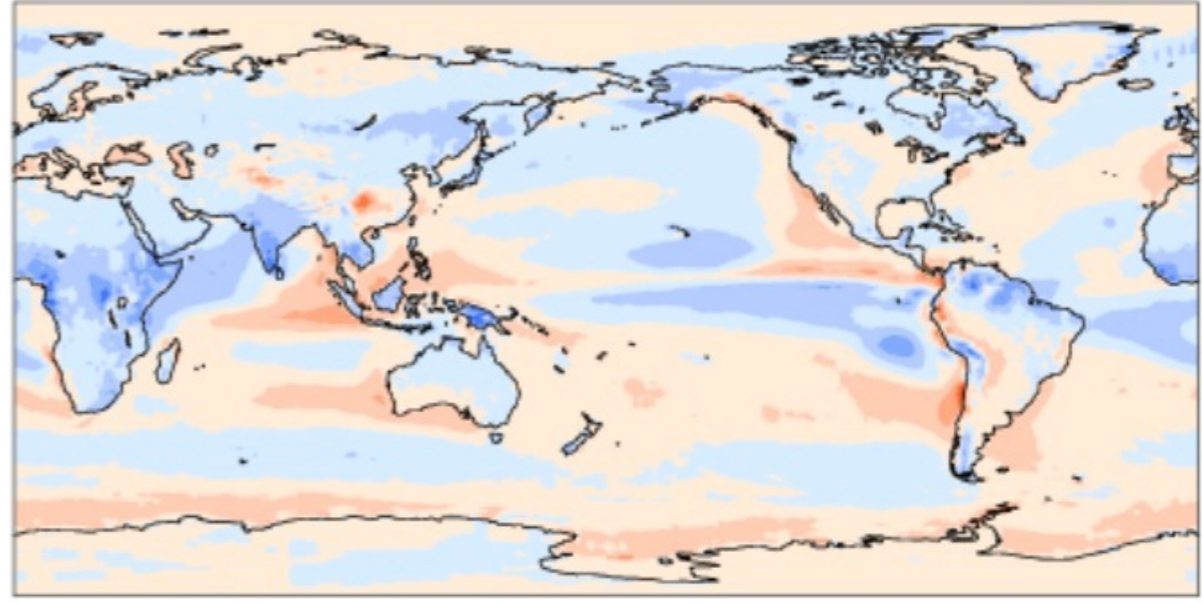
(1980-2005) CAM5 - CERES-EBAF

mean = -3.03 rmse = 13.72 W/m²



CAM-CLUBB - CERES-EBAF

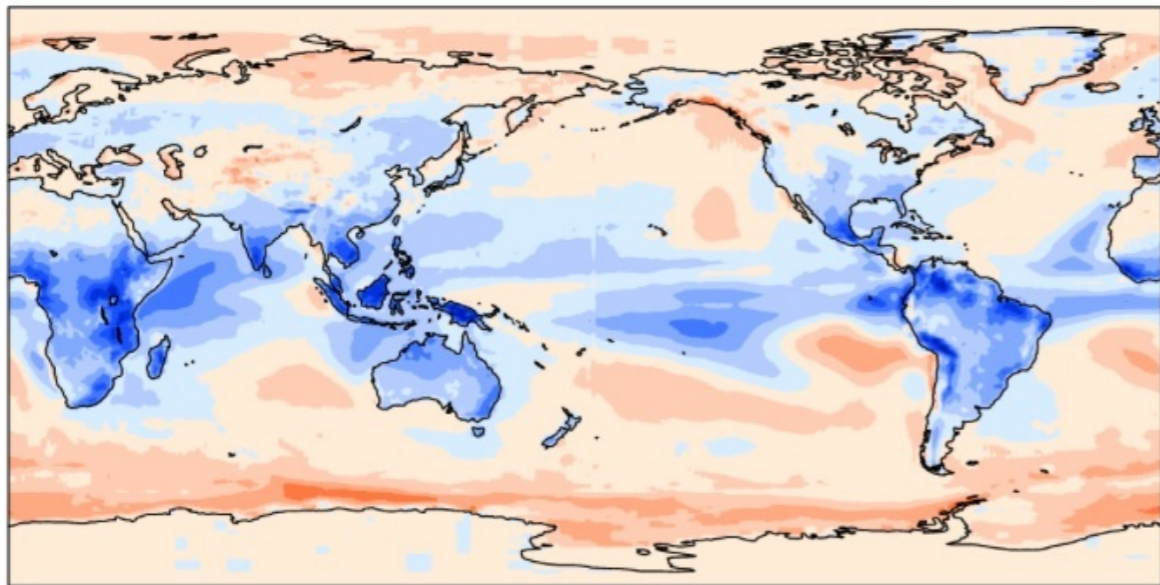
mean = 0.08 rmse = 8.73 W/m²



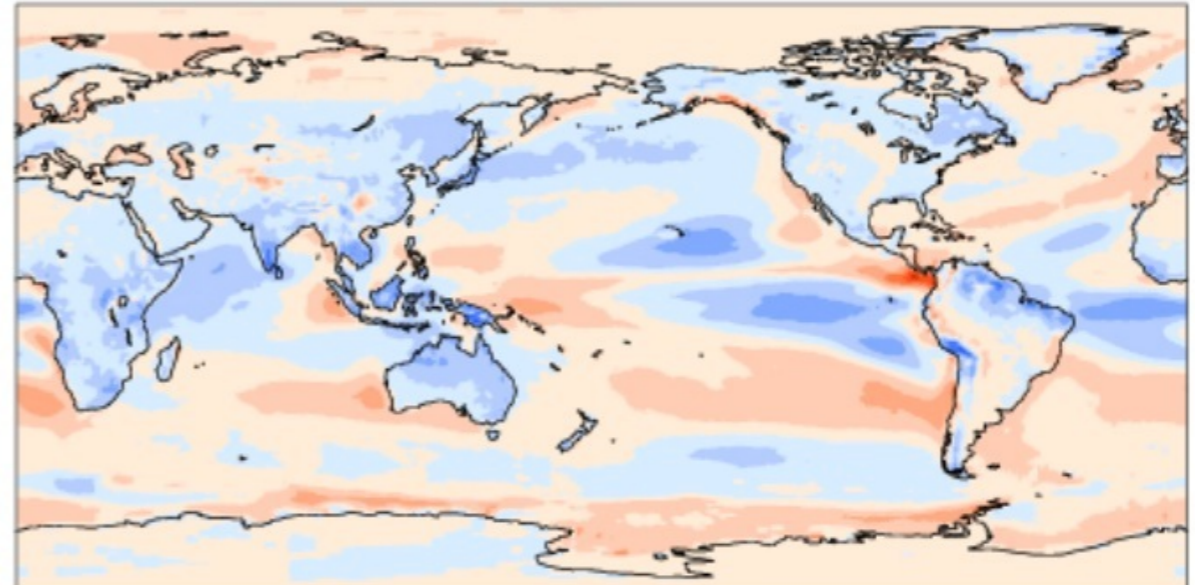
Coupled

(1980-2005)

mean = -2.61 rmse = 14.47 W/m²



mean = 0.41 rmse = 10.09 W/m²

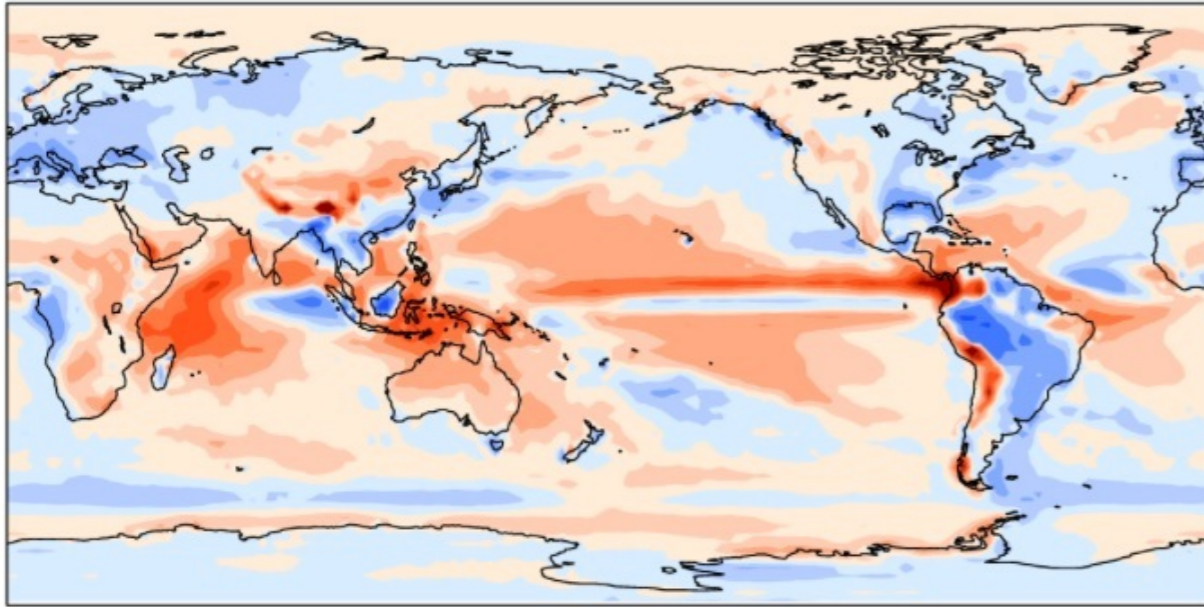


Precipitation Biases

AMIP

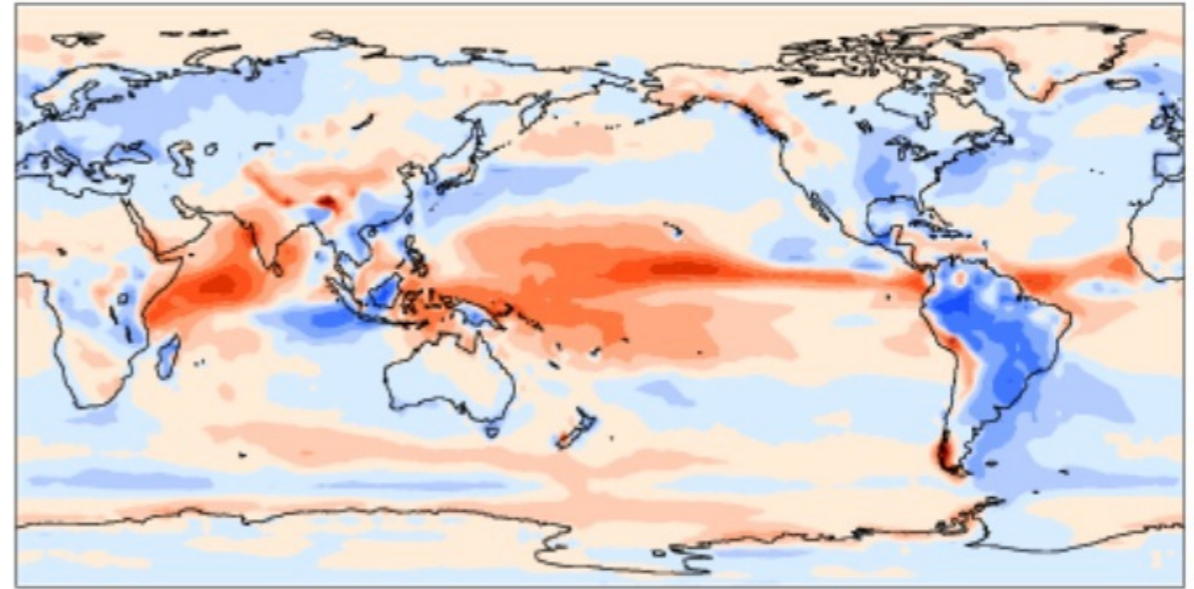
(1980-2005) CAM5 - GPCP

mean = 0.34 rmse = 1.12 mm/day



CAM-CLUBB- GPCP

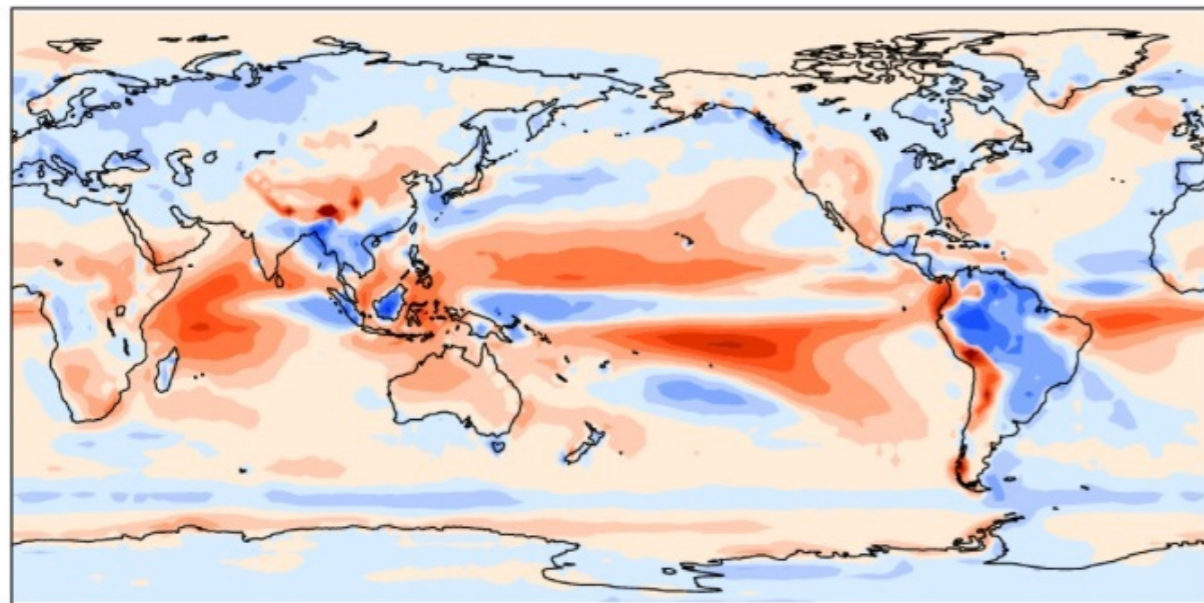
mean = 0.20 rmse = 1.03 mm/day



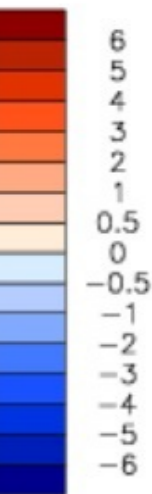
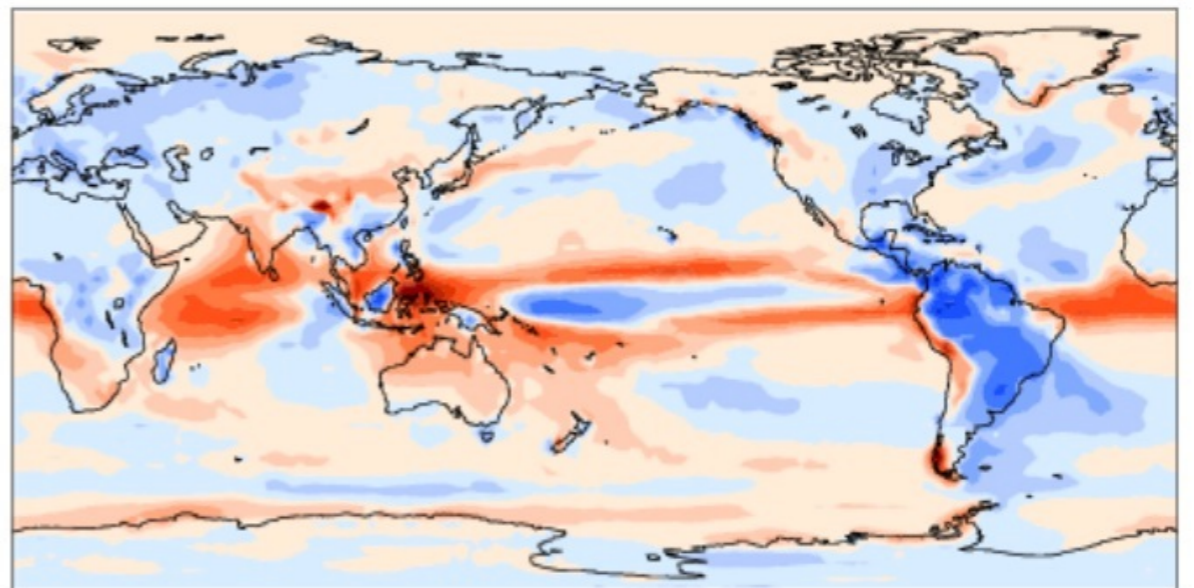
Coupled

(1980-2005)

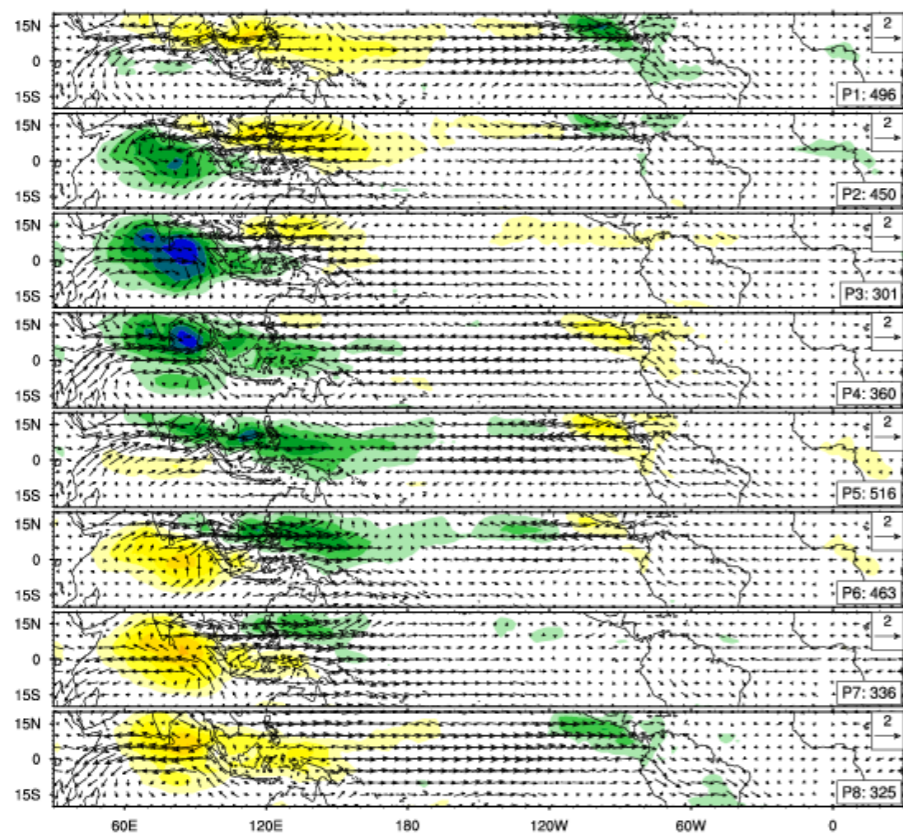
mean = 0.35 rmse = 1.14 mm/day



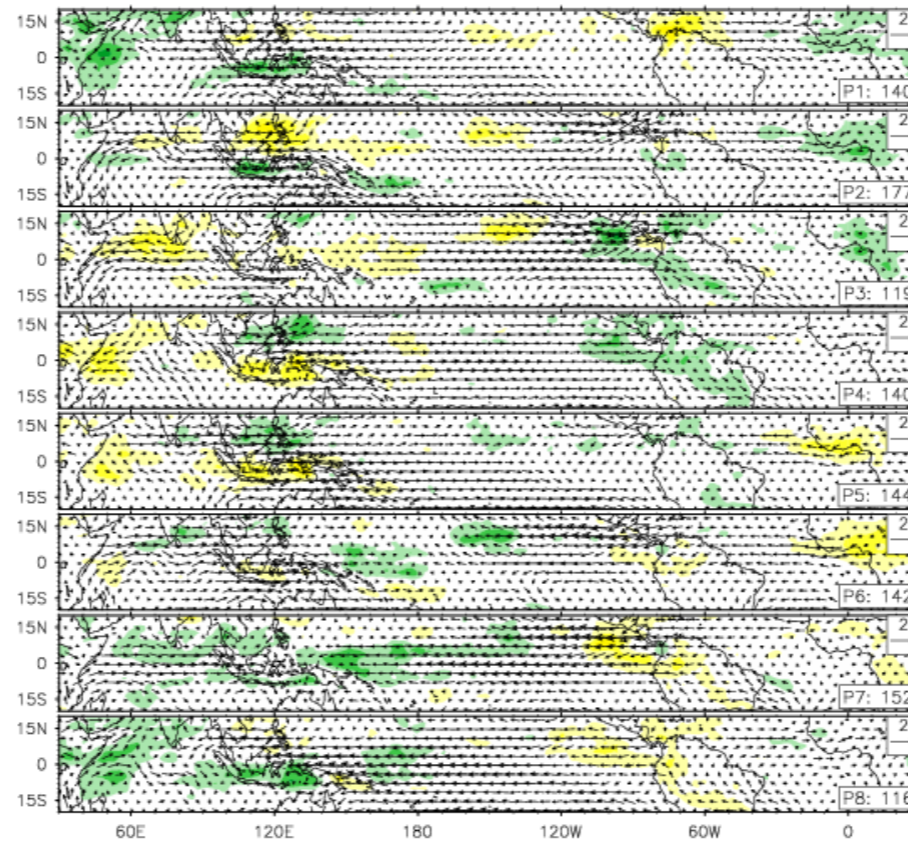
mean = 0.18 rmse = 1.14 mm/day



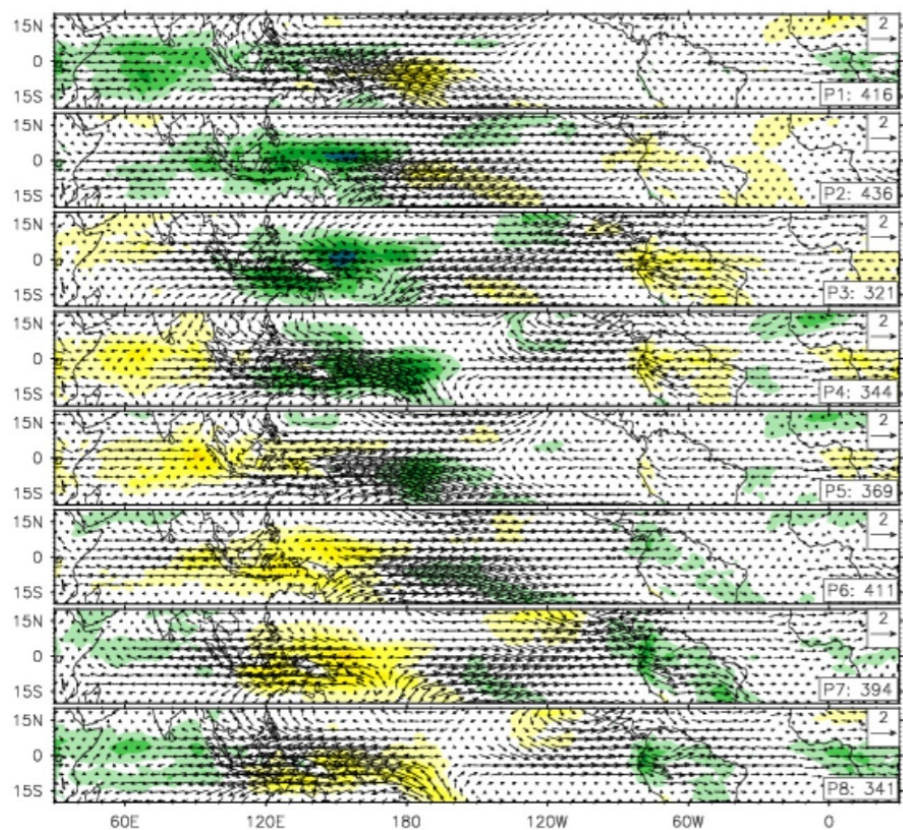
ERA



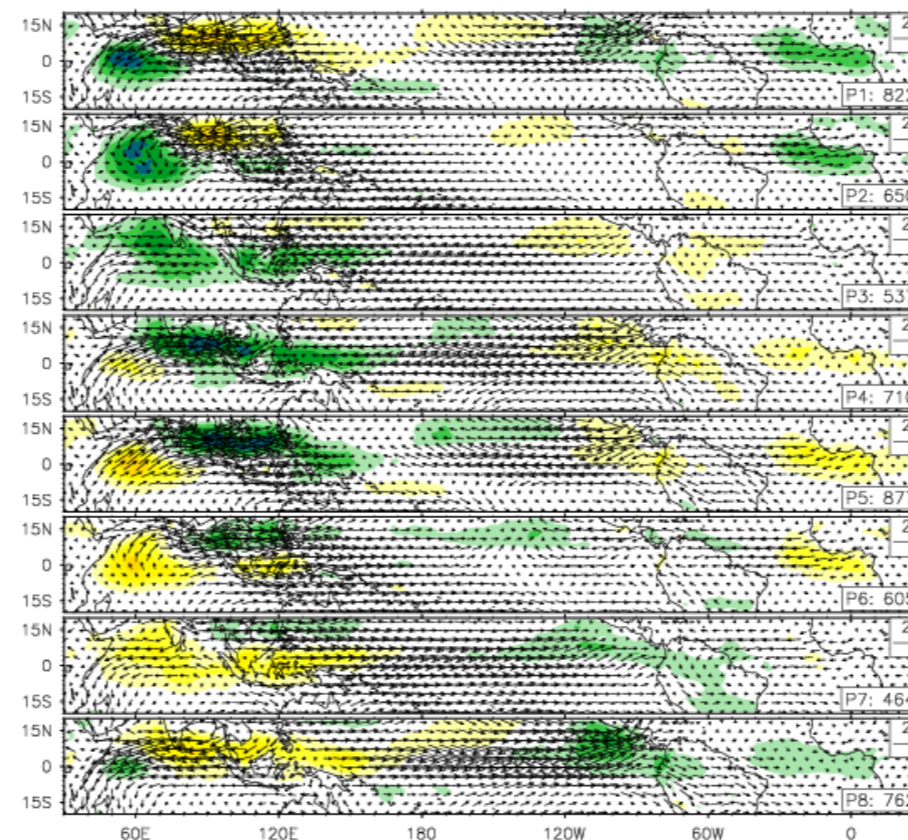
CAM5 (AMIP)



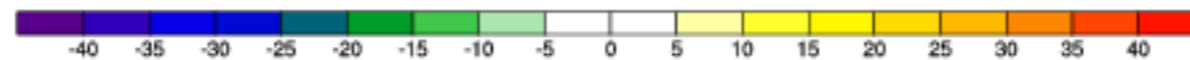
CAM-CLUBB (AMIP)



CAM-CLUBB (COUPLED)

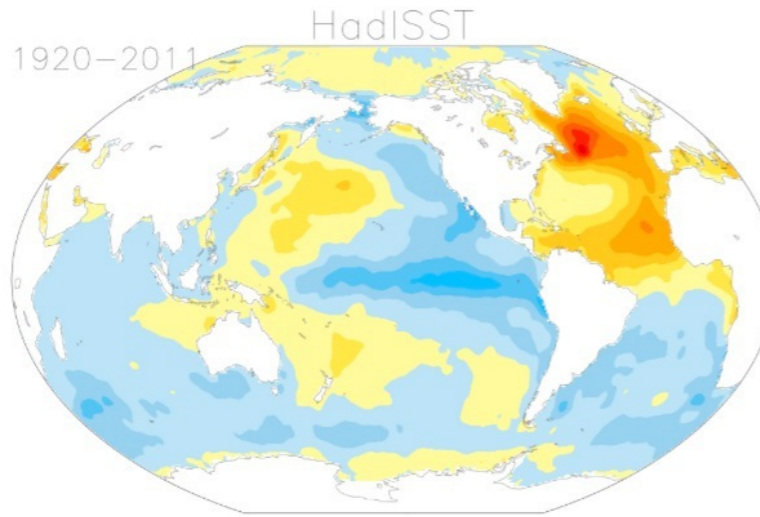


MJO
Composite
Lifecycles
(Boreal Winter,
1980 - 2005)

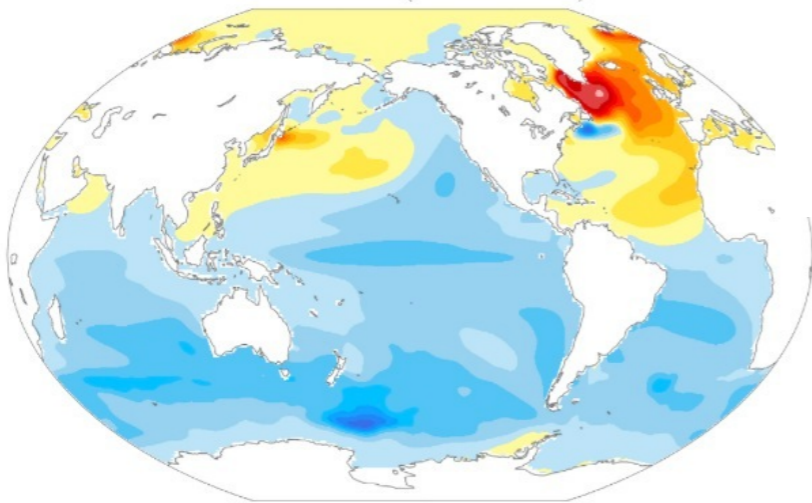


Atlantic Multidecadal Oscillation (AMO)

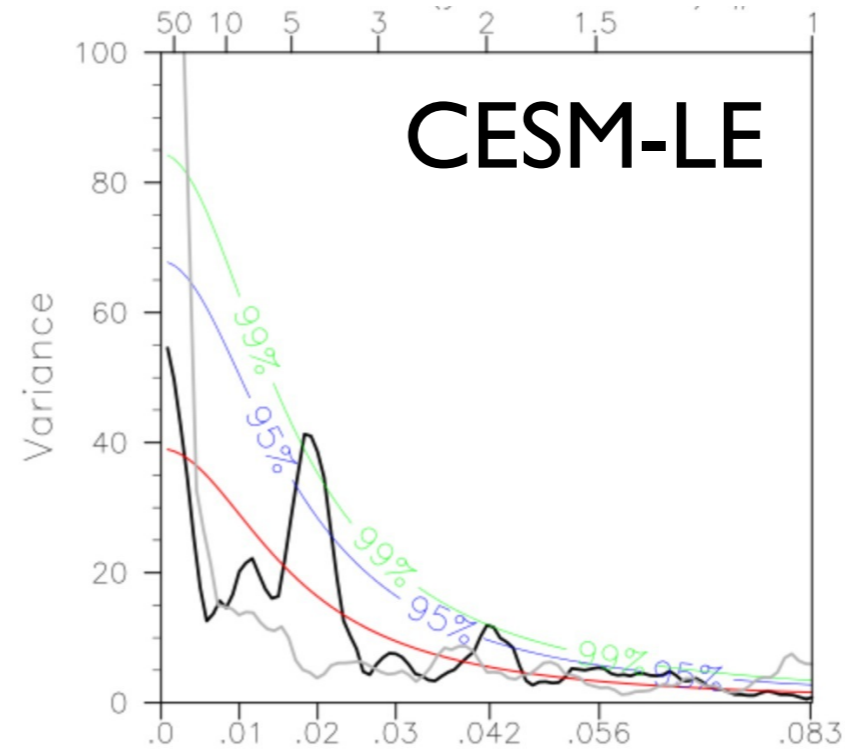
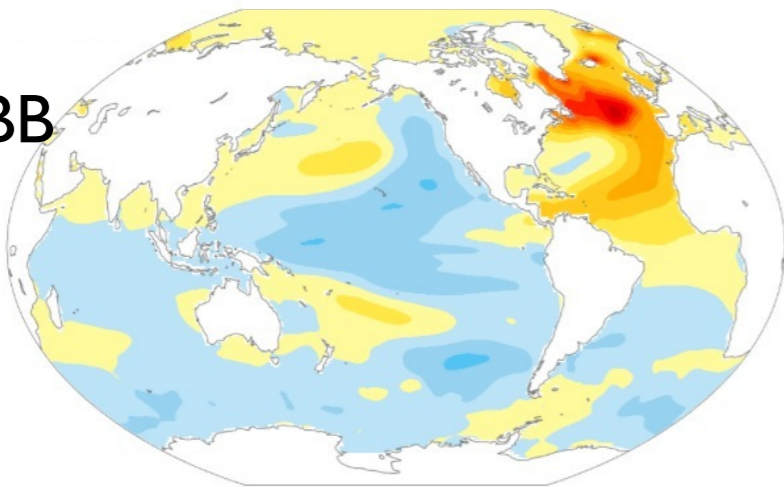
Observations
HADISST



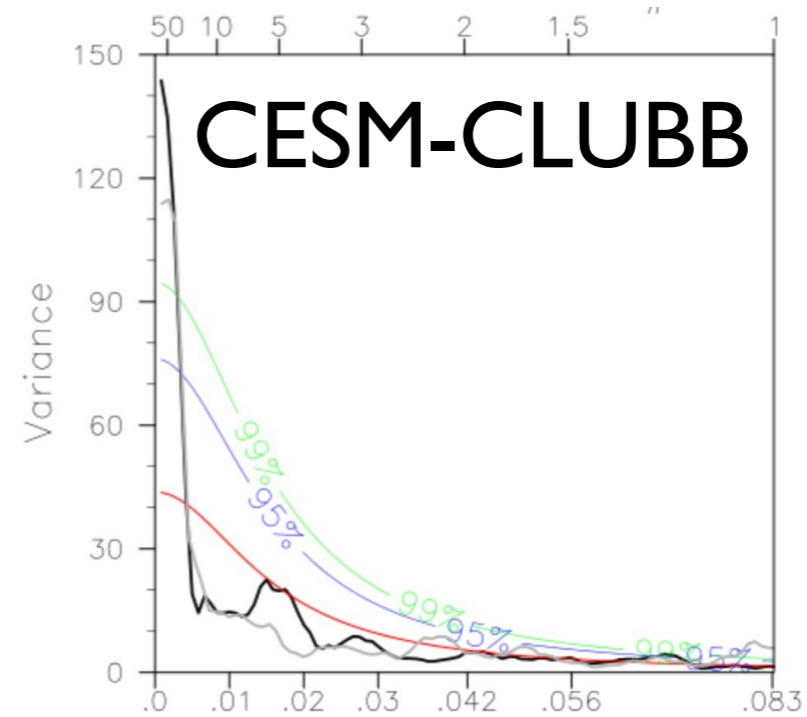
CESM



CESM-CLUBB



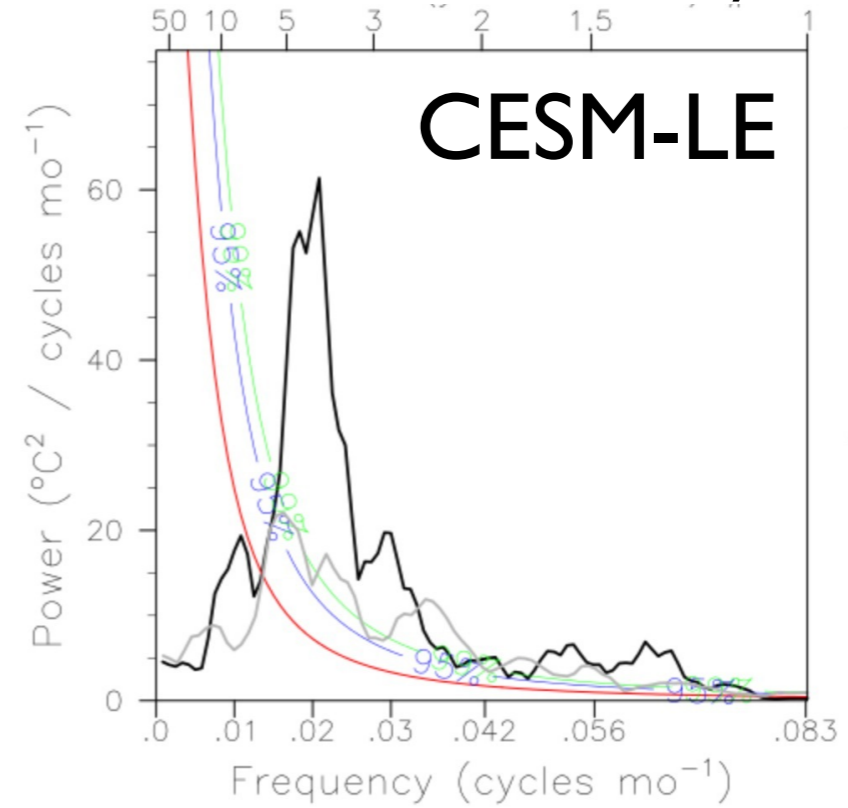
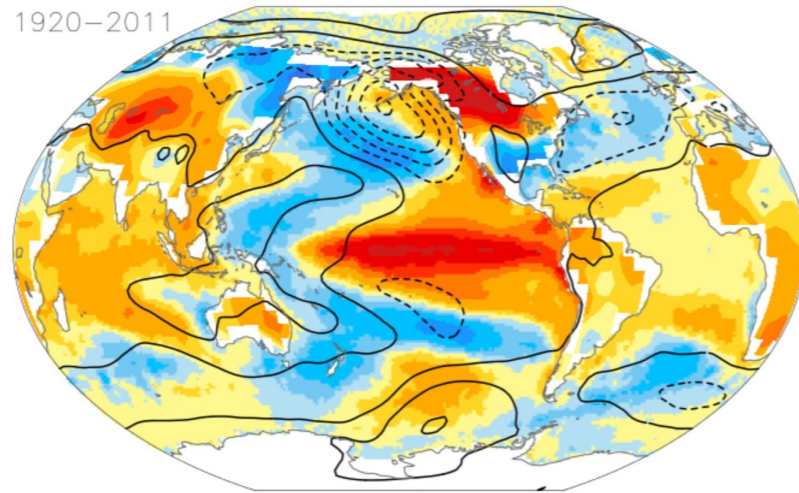
Black Line = Model
Gray Line = Obs



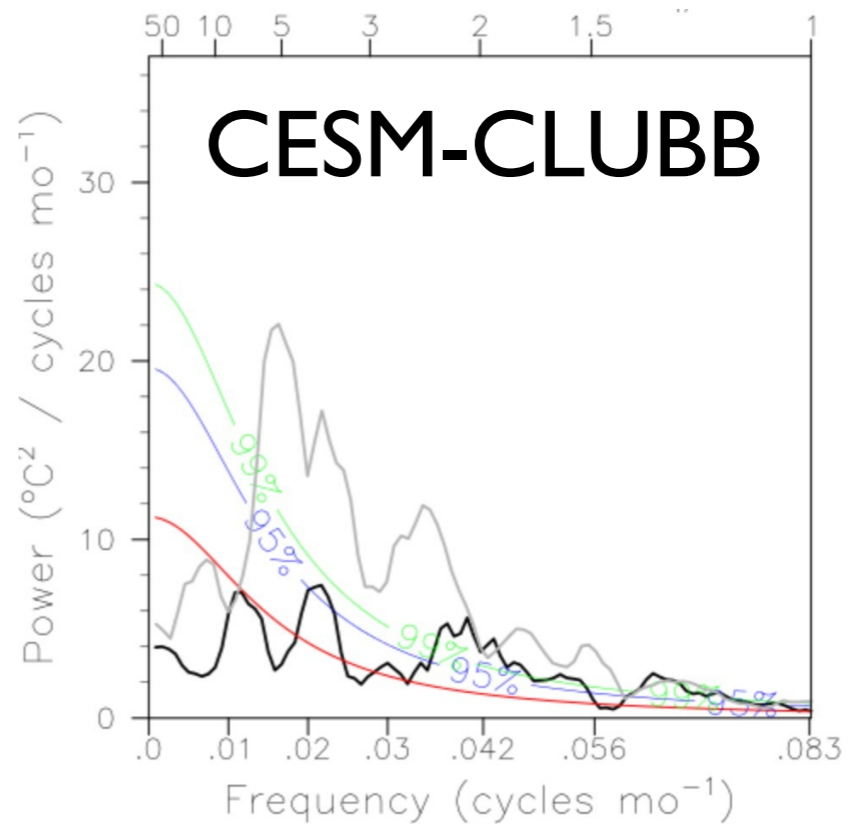
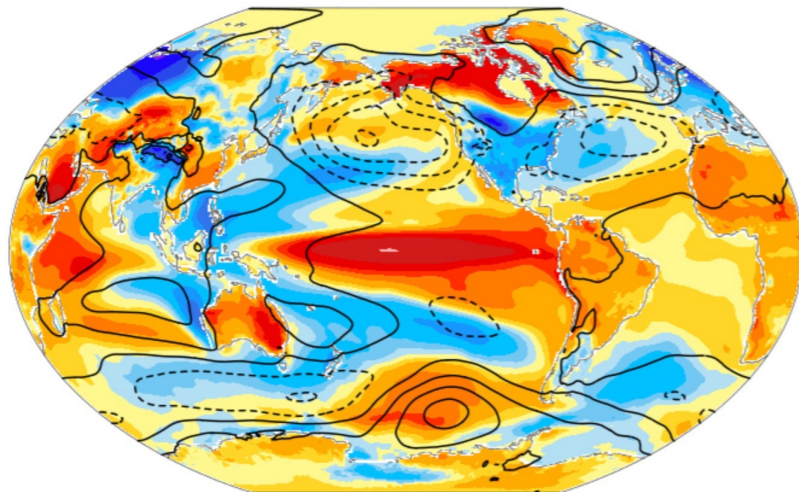
Whither ENSO?

Black Line = Model
Gray Line = Obs

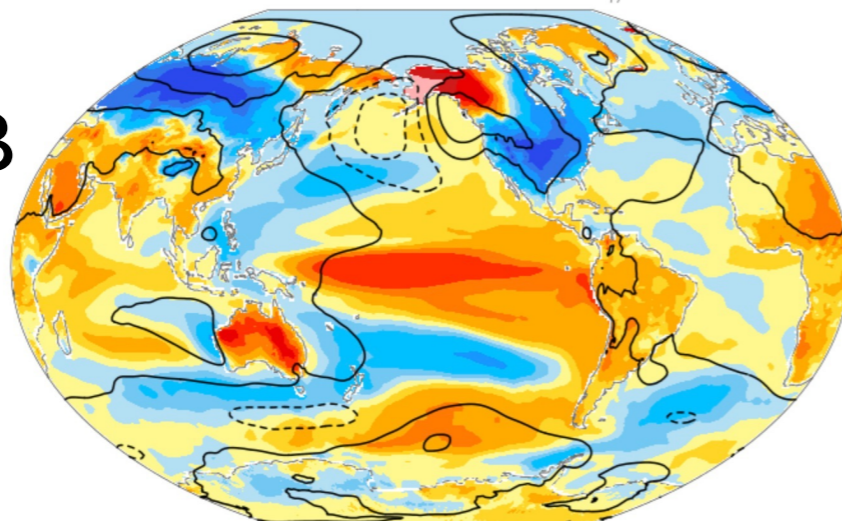
Observations
HADISST
MLOST



CESM



CESM-CLUBB





Whither ENSO?



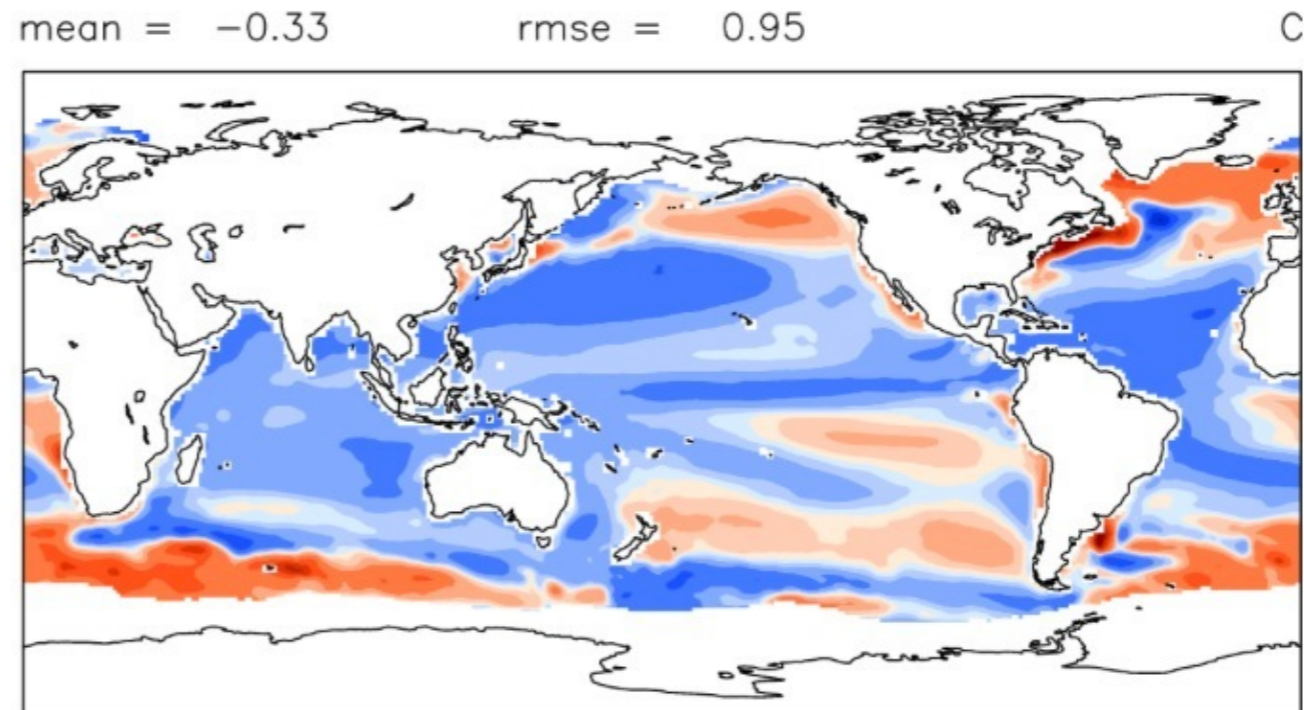
- Why such a degradation in ENSO amplitude and phase?
- Some possible smoking guns:
 - Tropical pacific surface stress too easterly
 - SSTs too cold in the Eastern Pacific
 - Thermocline too deep
- Currently reaching out to other working groups to help us ameliorate this problem
- Sensitivity experiments currently running

Sea Surface Temperature Biases

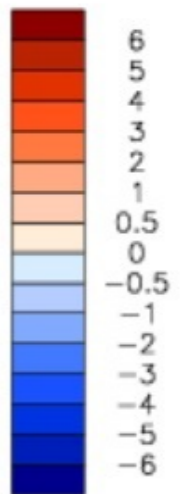
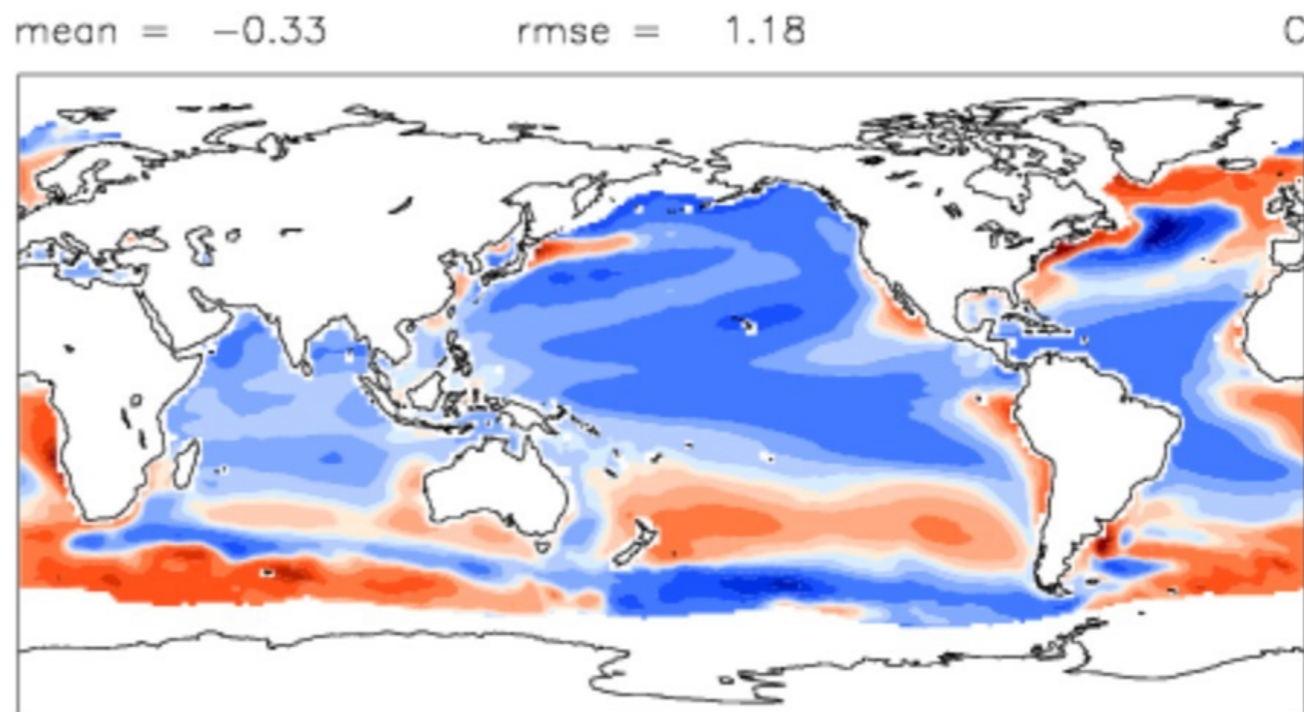
20th Century Coupled Run

Biases displayed are
from 1980-2005 period

CESM-LE #1



CESM-CLUBB



High Resolution Simulations

SE dynamical core, ne120, Prescribed SSTs

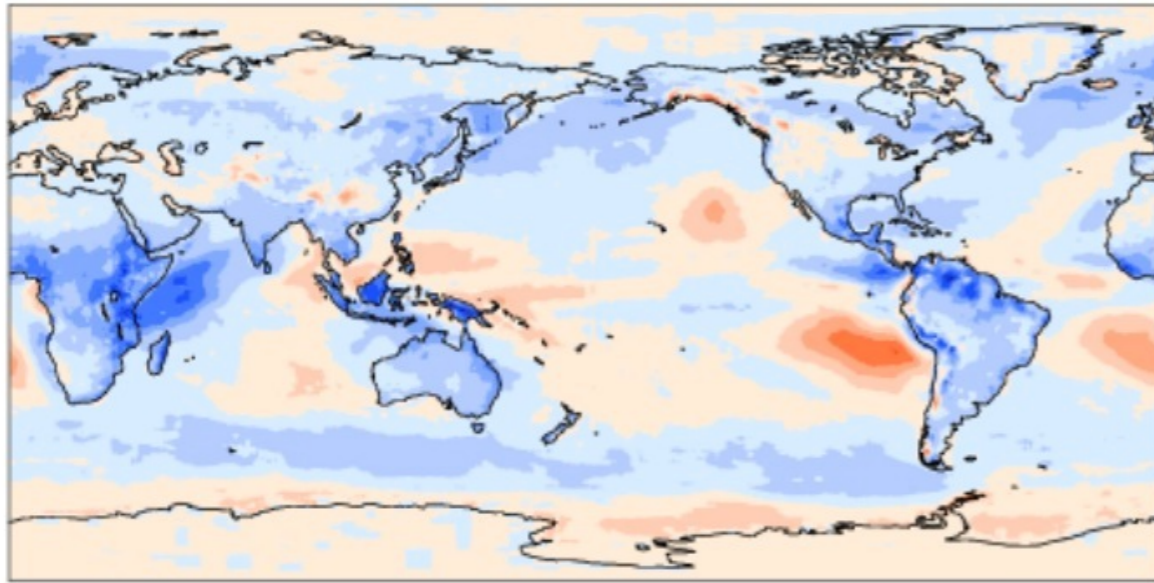
SWCF

CAM5 - CERES-EBAF

mean = -4.17

rmse = 12.07

W/m²

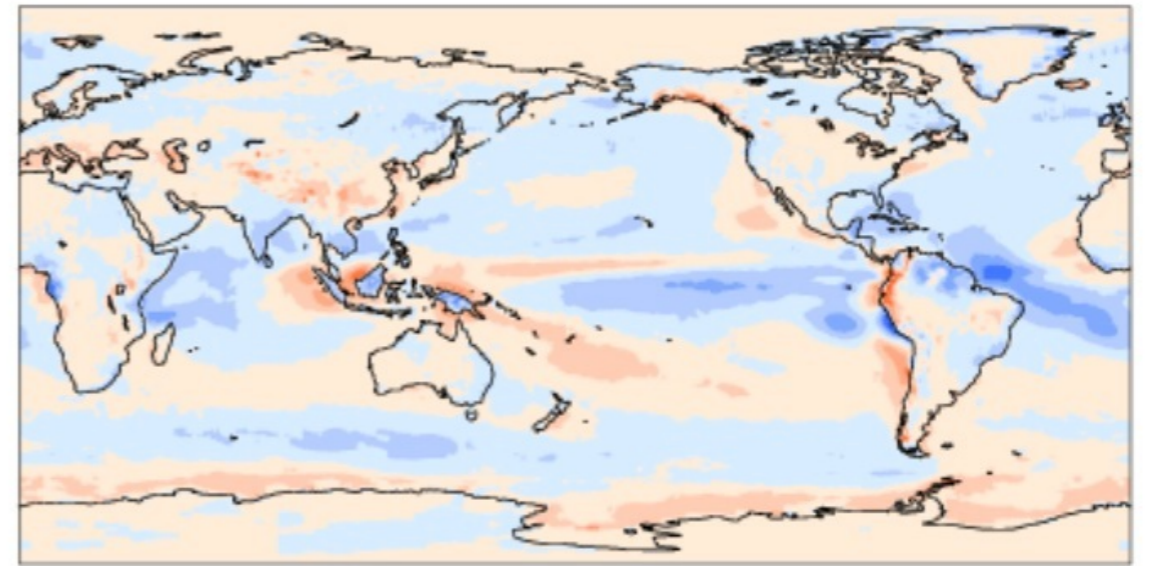


CAM-CLUBB - CERES-EBAF

mean = -0.49

rmse = 8.31

W/m²



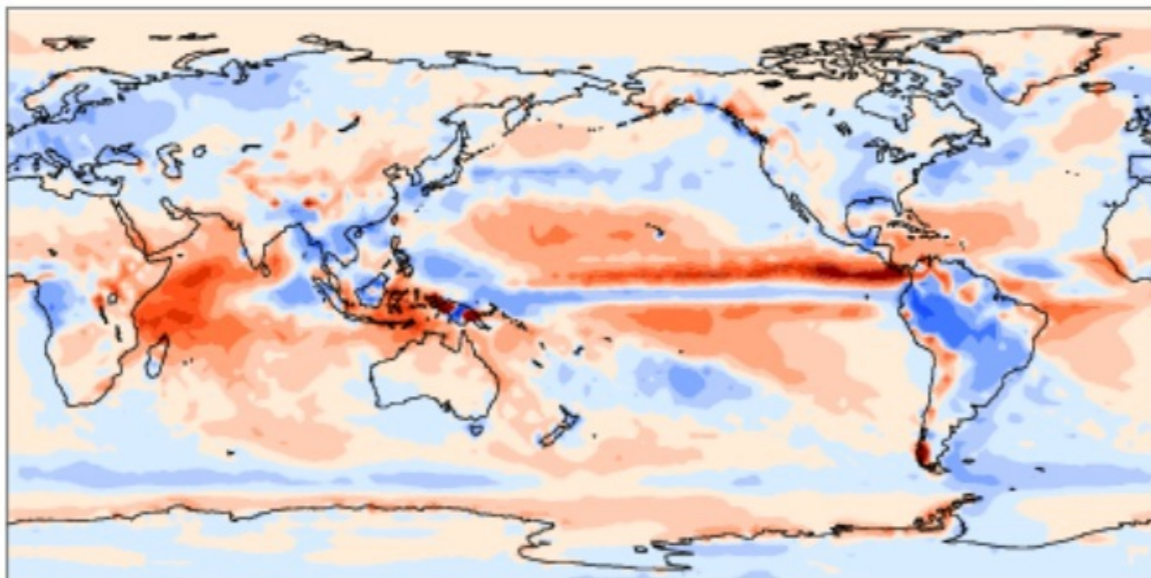
Precip.

CAM5 - GPCP

mean = 0.32

rmse = 1.29

mm/day

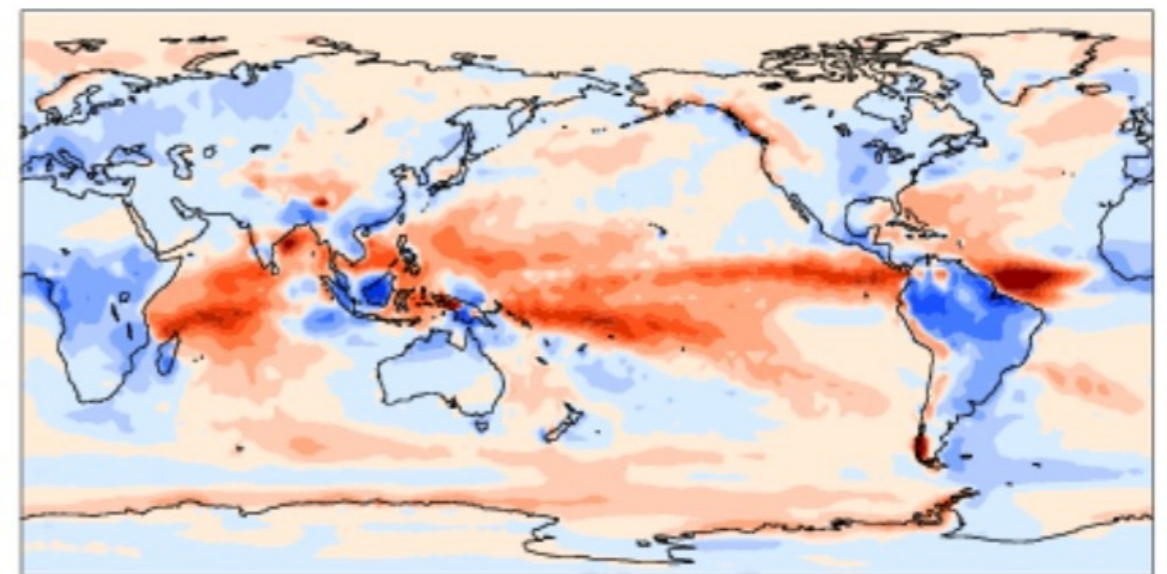


CAM-CLUBB - GPCP

mean = 0.28

rmse = 1.31

mm/day

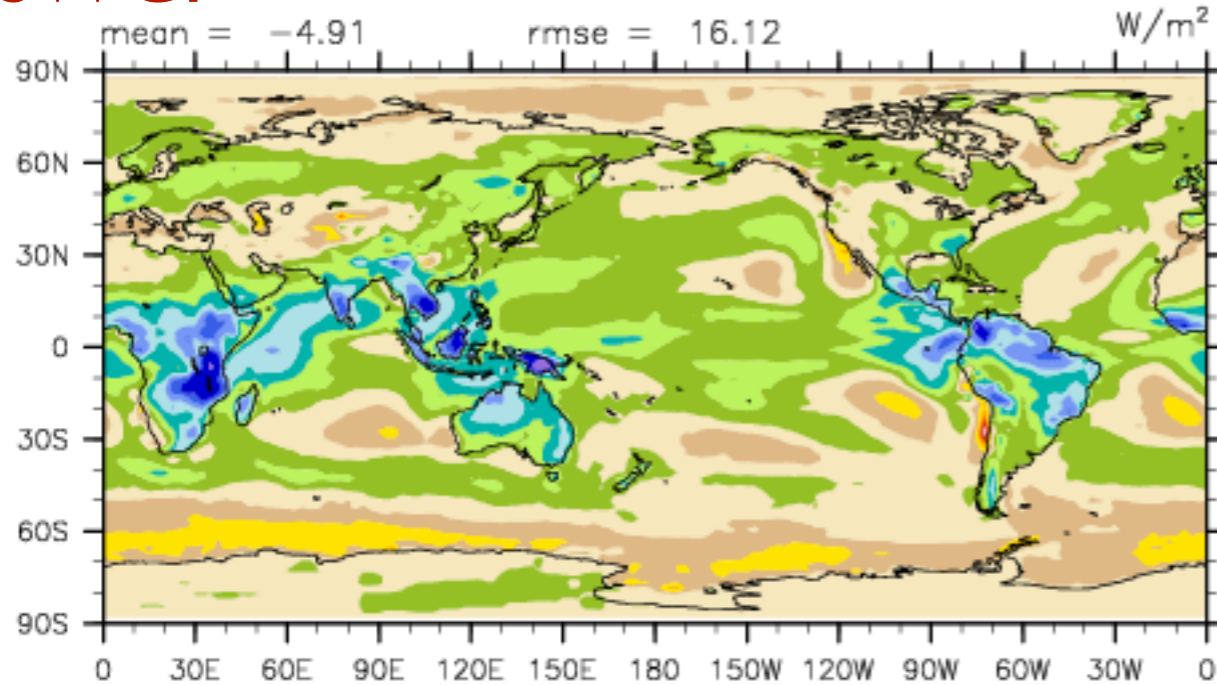


Huge thanks to John Truesdale for performing these simulations!

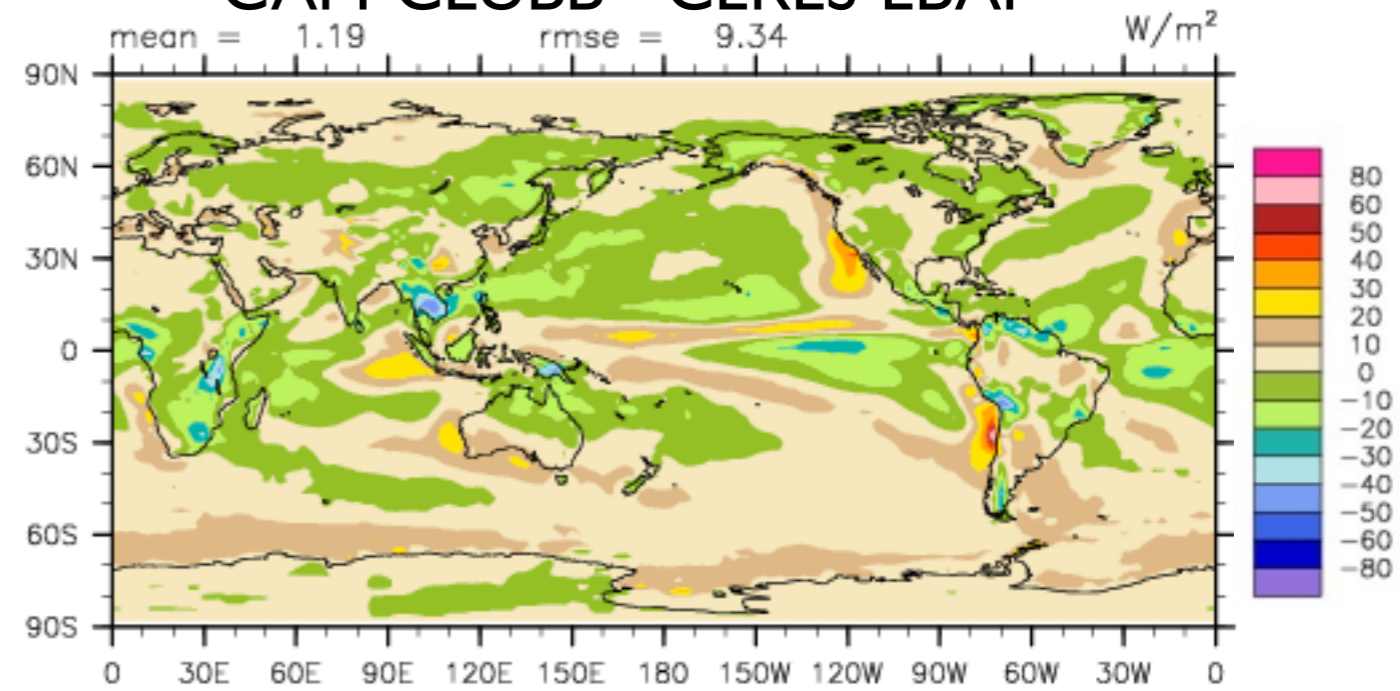
CAM-CLUBB-Deep Configuration (2-degree, FV dynamical core, prescribed SSTs)

SWCF

CAM5 - CERES-EBAF

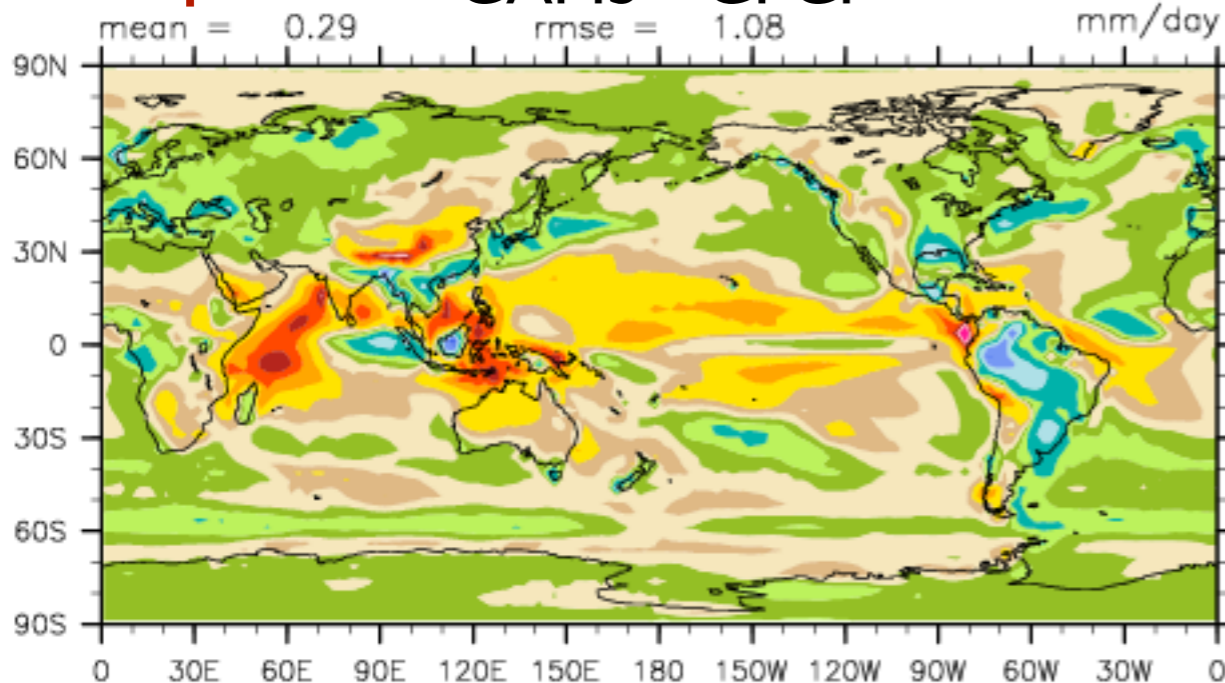


CAM-CLUBB - CERES-EBAF

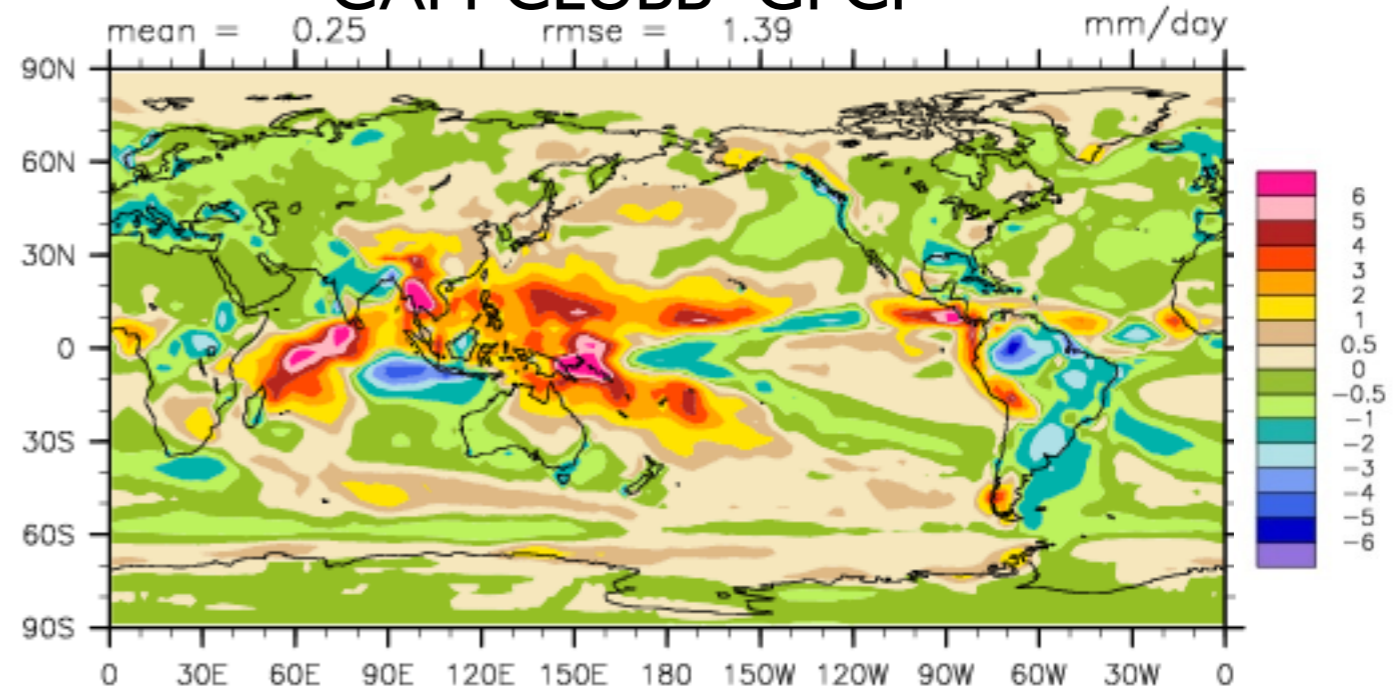


Precip

CAM5 - GPCP



CAM-CLUBB- GPCP





Summary



- CLUBB parameterization in CAM5 replaces the PBL, shallow convective, and macrophysics parameterizations.
- CAM-CLUBB improves many aspects of the mean state climate (i.e. stratocumulus to cumulus transition) with overall skill scores better than CAM5.
- CAM-CLUBB can successfully simulate the 20th century.
- Exploratory high resolution simulations and simulations with CLUBB acting as a deep convective scheme are underway.
- **PRIORITY:** Investigation needs to be performed to determine why ENSO is weakened in CESM-CLUBB.