CESM2 Update (Ocean)

Outline

- Primary new features in the ocean model,
- Progress since the Breckenridge Workshop (Frozen Labrador Sea),
- An assessment of pre-industrial control and 20th century simulations with CESM2.0^{-},
- Final configuration for CESM2

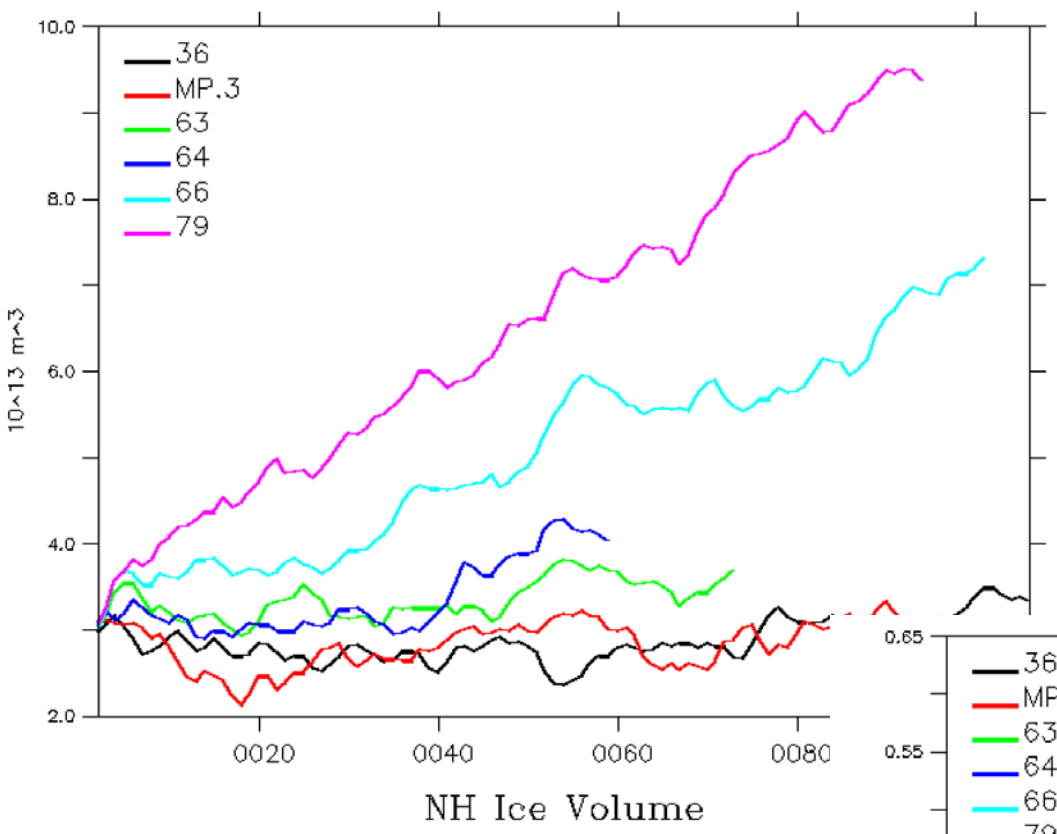
- CESM2.0^{-} solutions are compared to those of CCSM4 and Large Ensemble (LE) simulations
- A few fields of climatic interest, focusing on the 20th century simulations
- Means for the last 20-years and only one ensemble member are used
- Brief summary of trends in the pre-industrial control simulations

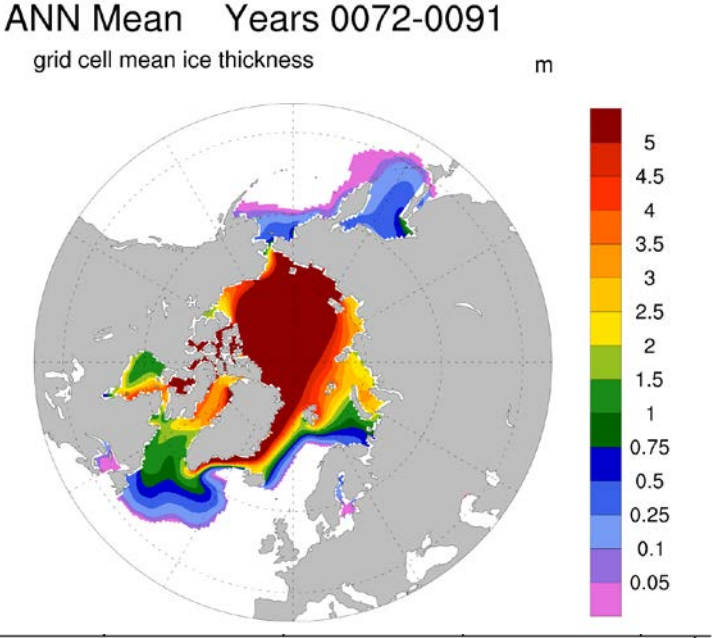
Primary New Features of the CESM2 Ocean Component

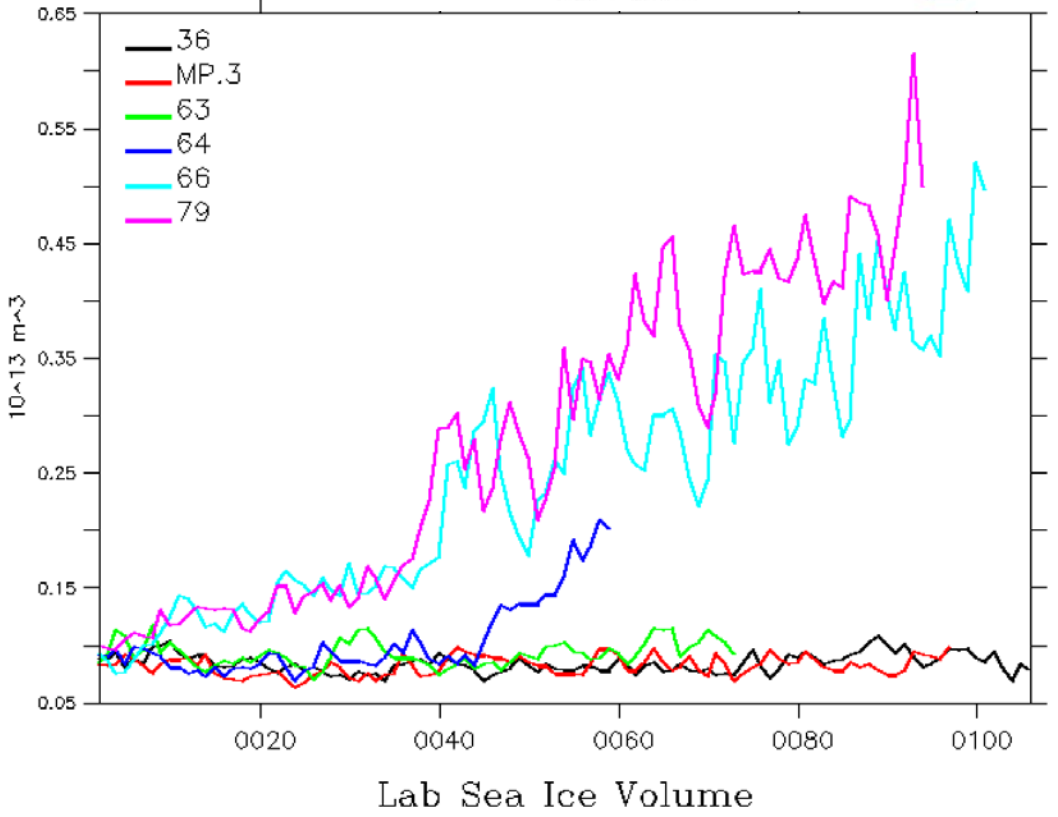
- ✓ Community ocean Vertical Mixing (CVMix) framework
- ✓ NOAA WaveWatch III as a new CESM component model
- ✓ “Langmuir mixing” parameterization
- ✓ Enhanced mesoscale eddy diffusivities at depth
- ✓ Prognostic chlorophyll for short-wave absorption
- ✓ Salinity-dependent freezing point temperature (also in CICE5)
- ✓ One-hour coupling frequency with Robert – Asselin time filter
- ✓ Estuary parameterization – Estuary Box Model (EBM)
- ✓ Caspian Sea transferred to the land model

Primary New Features of the CESM2 Ocean Component

- ✓ Community ocean Vertical Mixing (CVMix) framework
- ✓ NOAA WaveWatch III as a new CESM component model
- ✓ "Langmuir mixing" parameterization
- ✓ Enhanced mesoscale eddy diffusivities at depth
- ✓ Prognostic chlorophyll for short-wave absorption
- ✓ Salinity-dependent freezing point temperature (also in CICE5)
- ✓ One-hour coupling frequency with Robert – Asselin time filter → Two-hour coupling with default time stepping
- ✓ Estuary parameterization – Estuary Box Model (EBM)
- ✓ Caspian Sea transferred to the land model

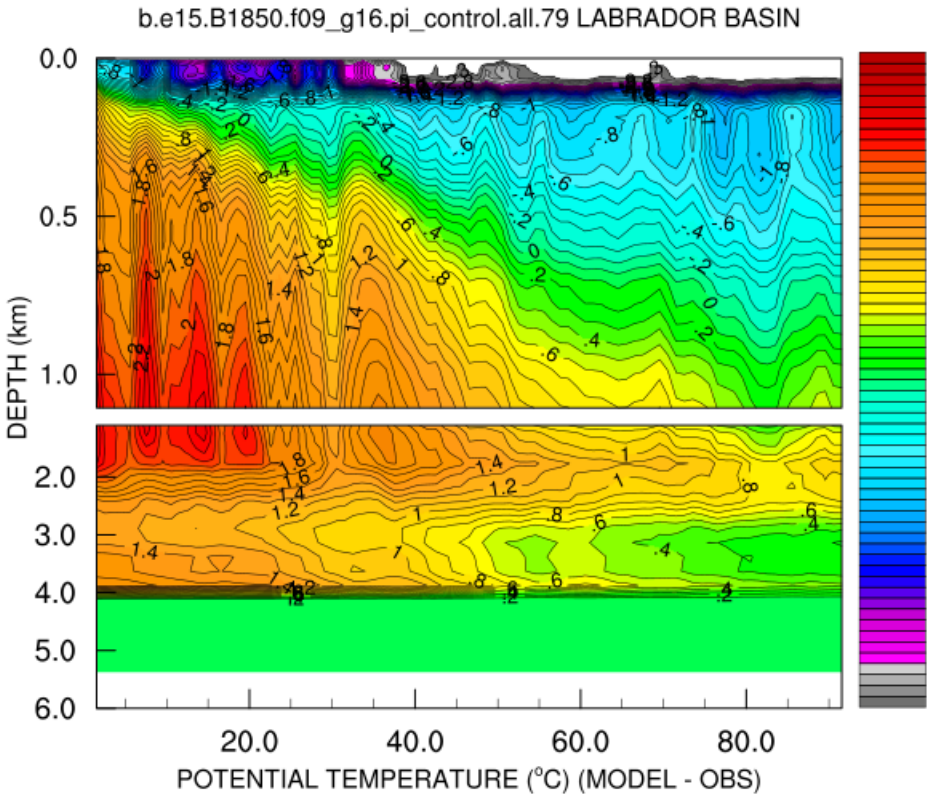


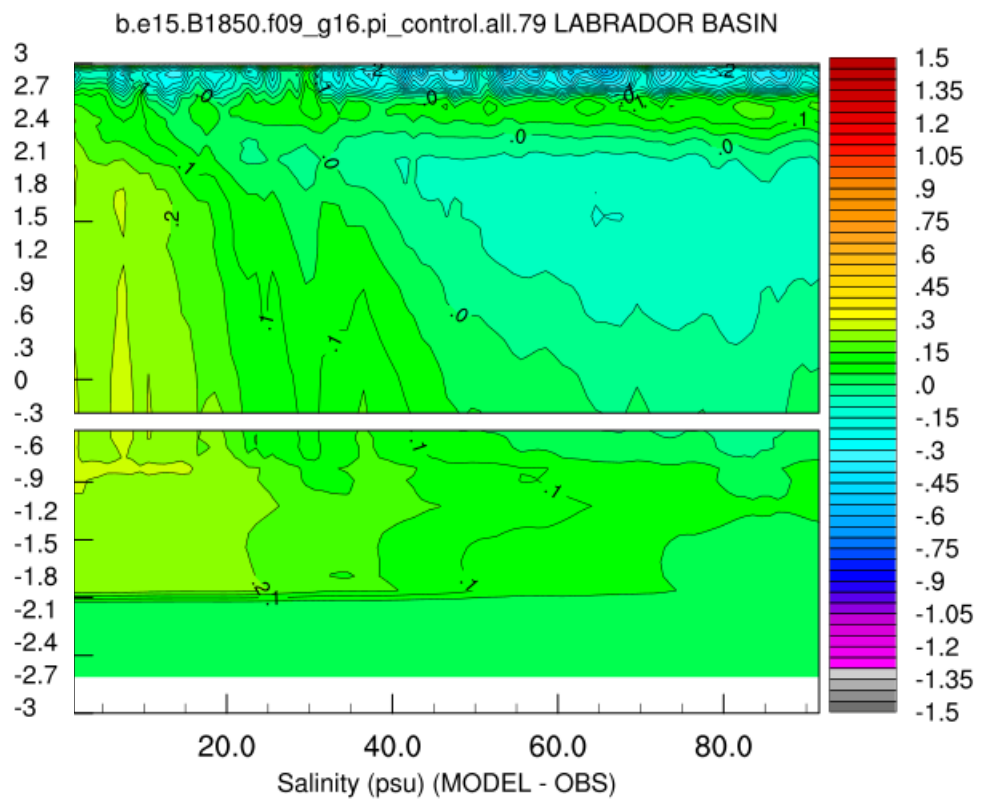




Keith Lindsay

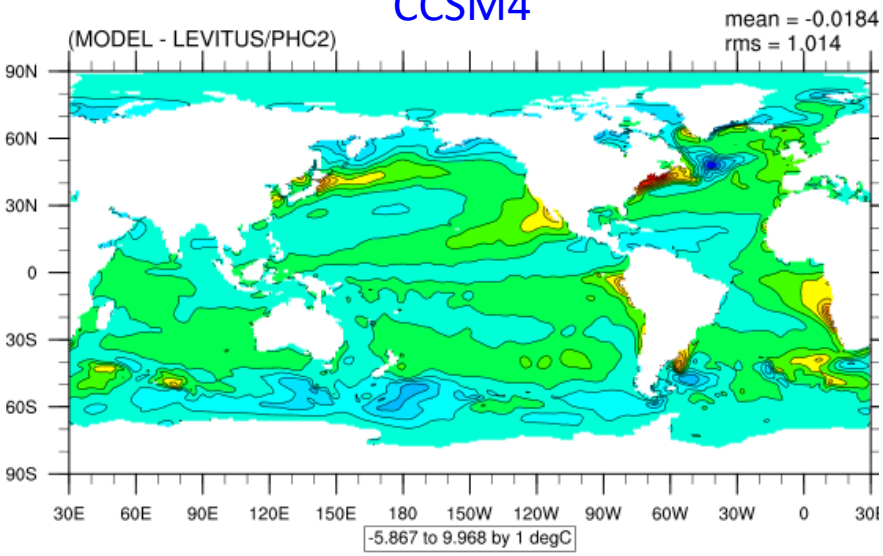
Labrador Sea Horizontal-Mean Temperature and Salinity Time Series (#79)



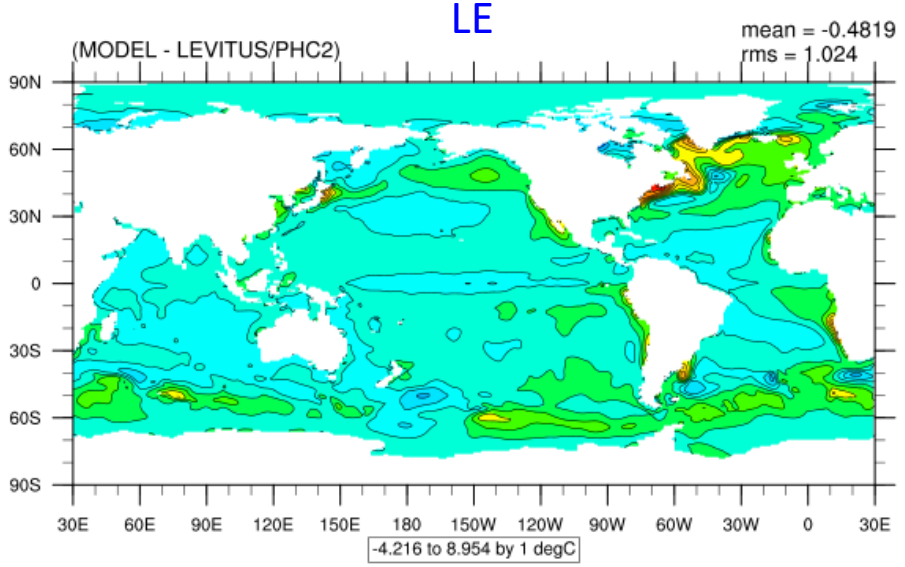


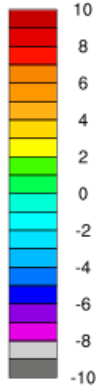
Sea Surface Temperature Differences from Observations

CCSM4

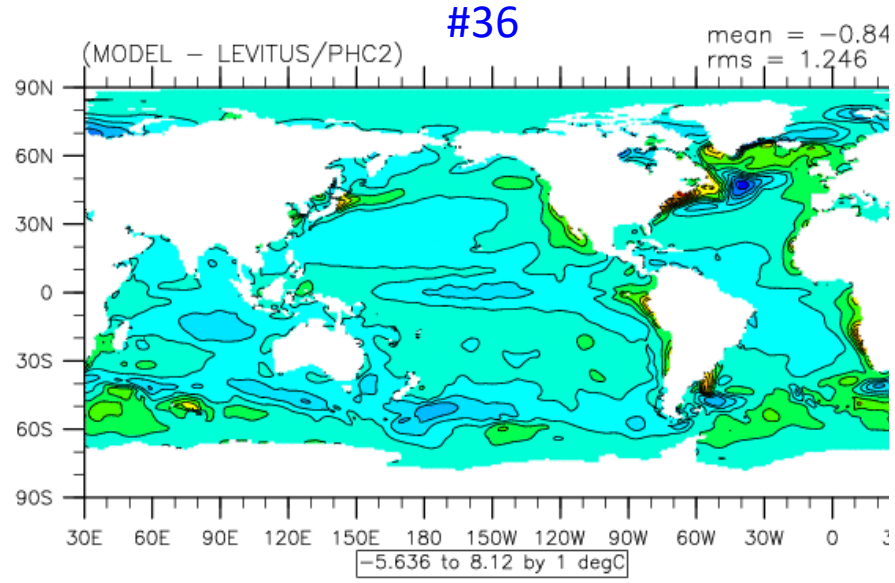


LE

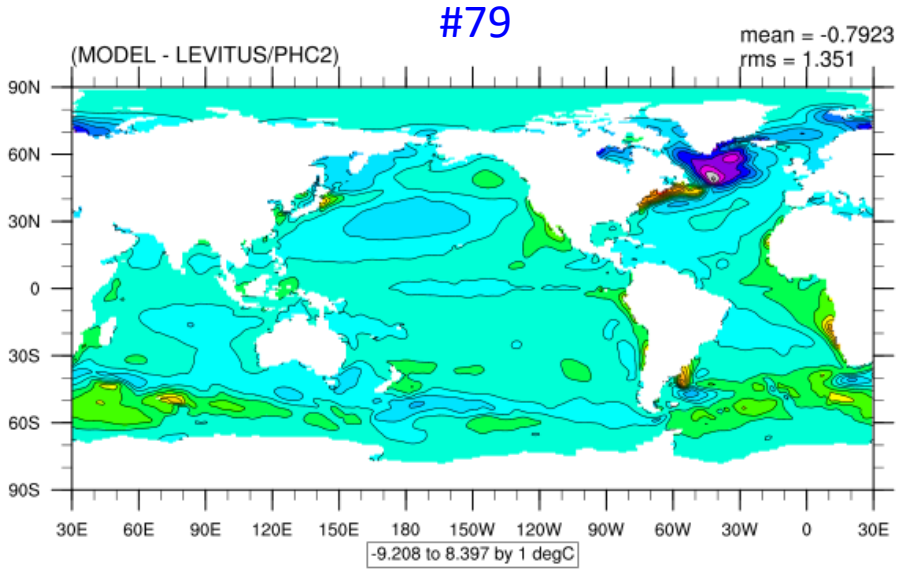


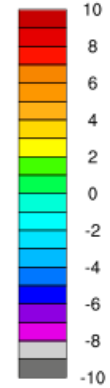


#36

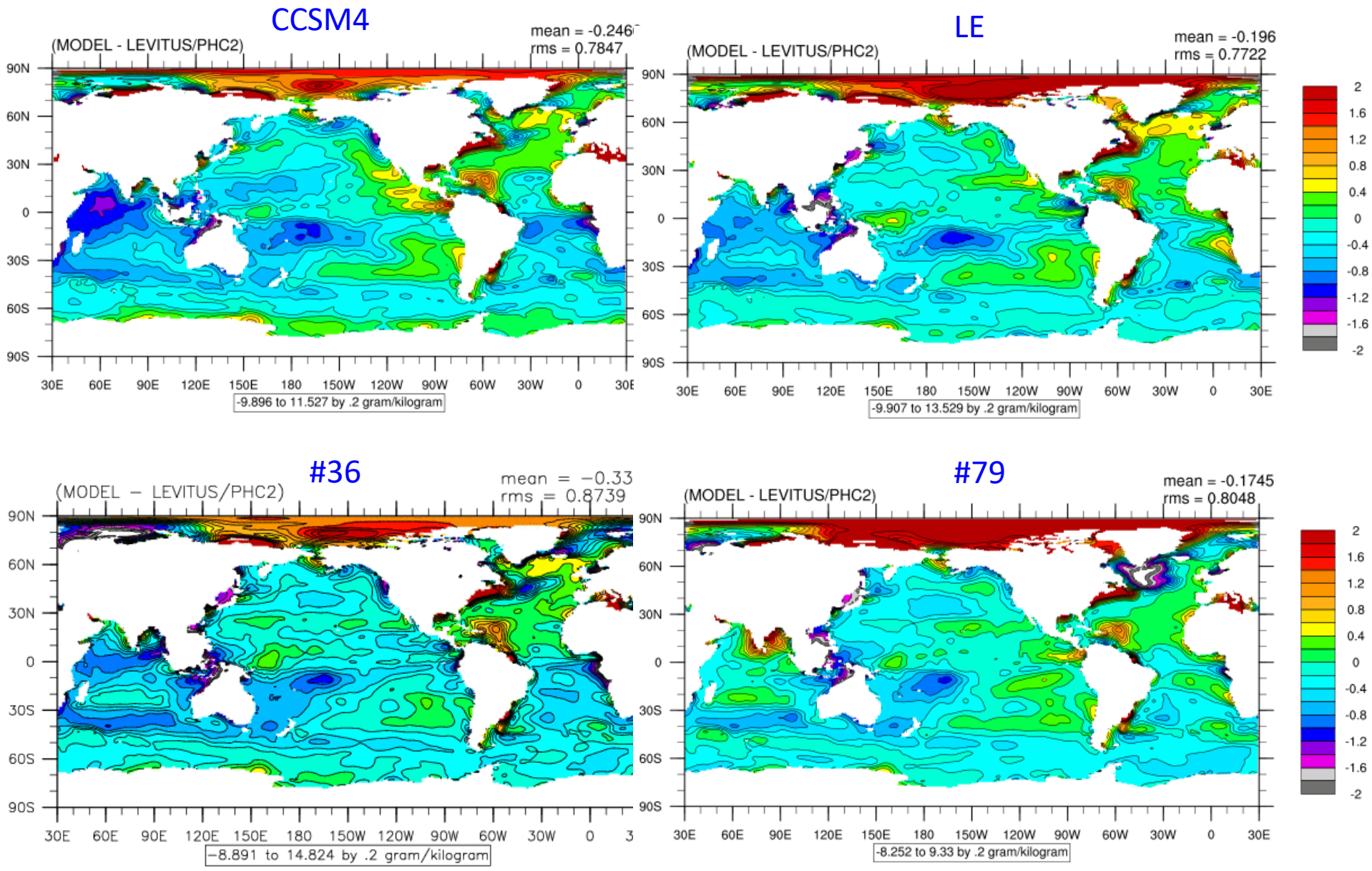


#79



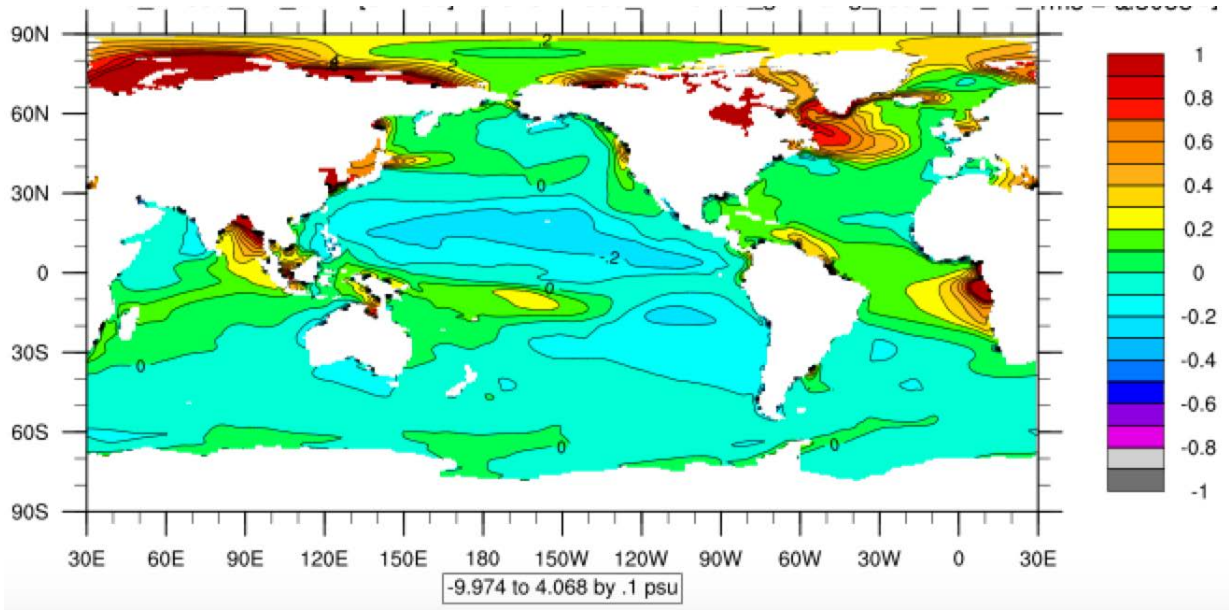


Sea Surface Salinity Differences from Observations

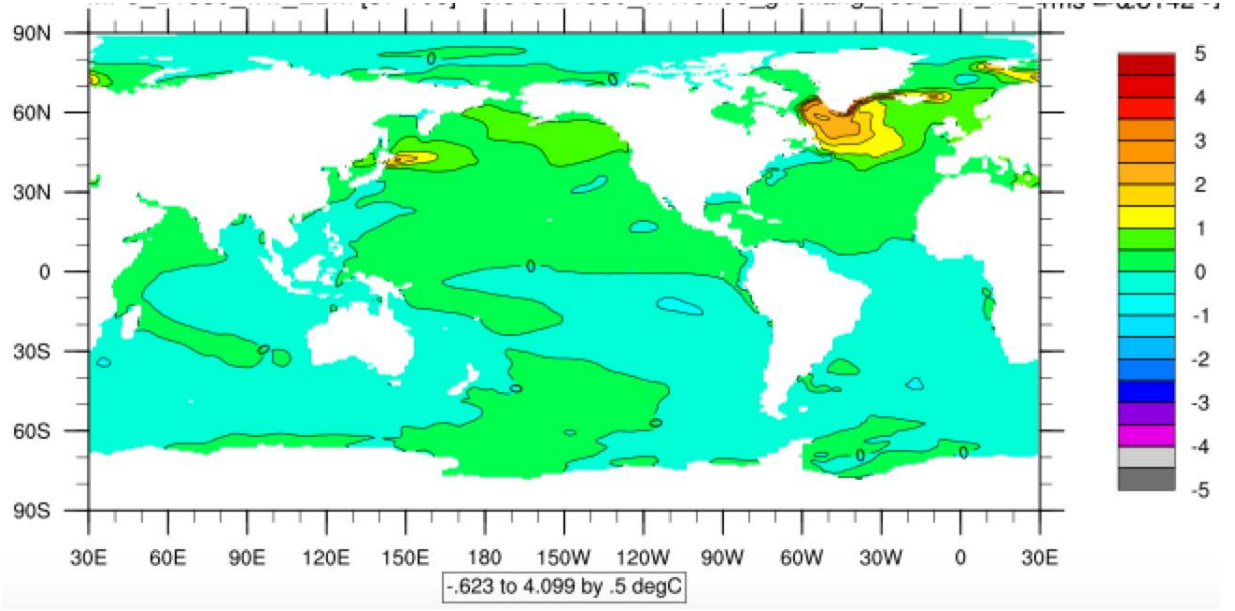


EBM to the rescue!

Sea surface salinity



Sea surface temperature



EBM – CONTROL (COUPLED)

However, there have been several bugs found since then …

CLUBB mpi broadcast error for turning on liquid super saturation ……order of cloud formation

Simulations

Pre-Industrial Control	Ocean Initial Conditions
CESM2.0^{-} (#125): 125 yrs	MP.3* @ year 97
CCSM4: 1300 yrs	PHC2 + 130 years
Large Ensemble (LE): 2200 yrs	PHC2

20th Century Integrations Start from PI Controls at year(s)

#125: 82

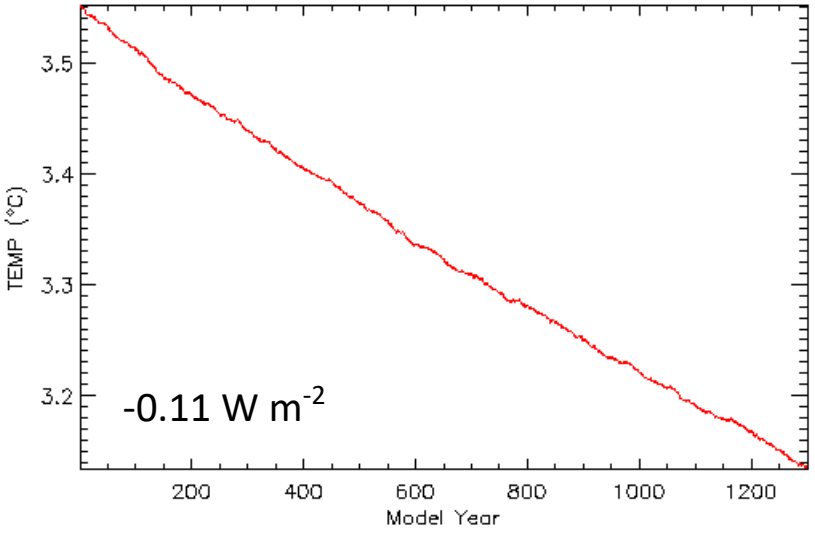
CCSM4: 863 – 1031

LE: 402

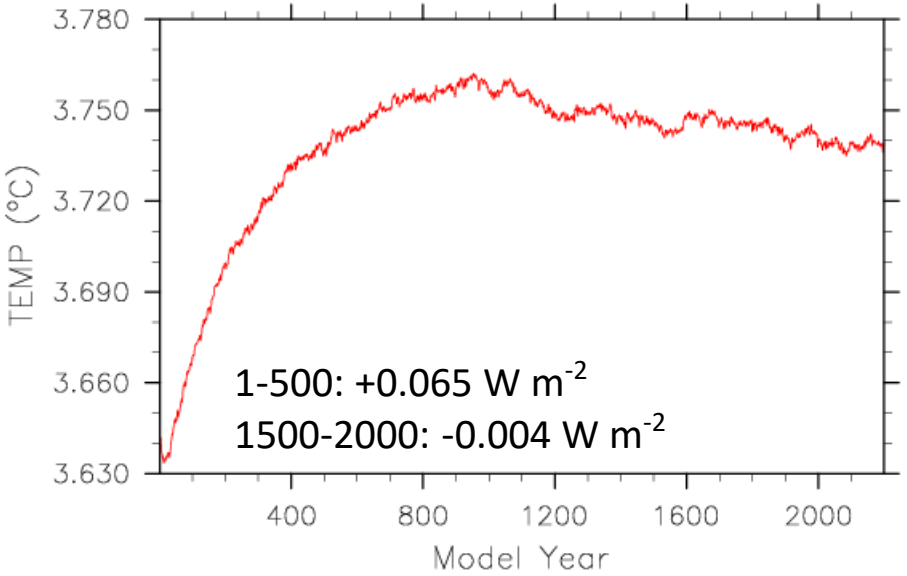
MP.3: yr 41 of #25 + yr 16 of #18 + yr 34 of #14 + 150 yrs of coupled simulation w/ CLUBB + unknown

Global-Mean Temperature Time Series (Pre-Industrial)

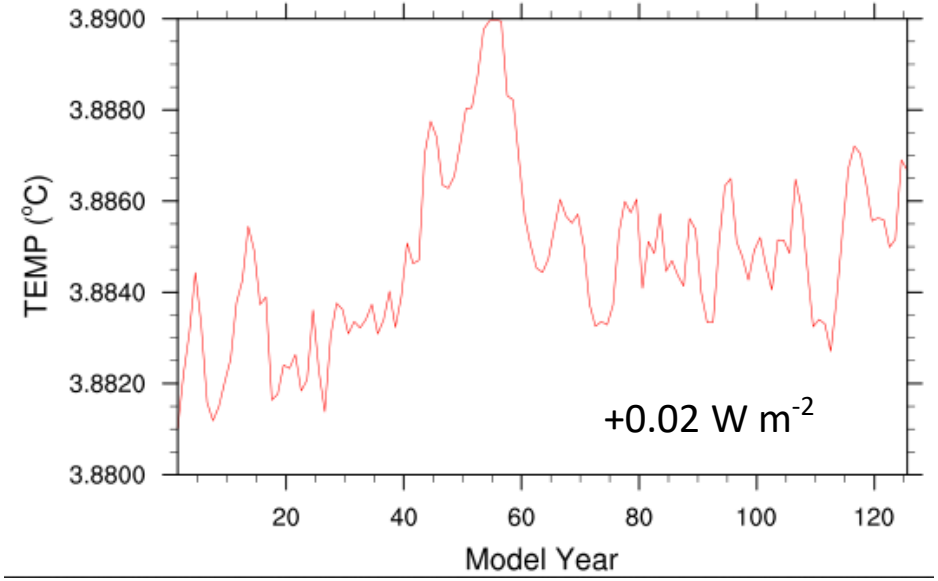
CCSM4



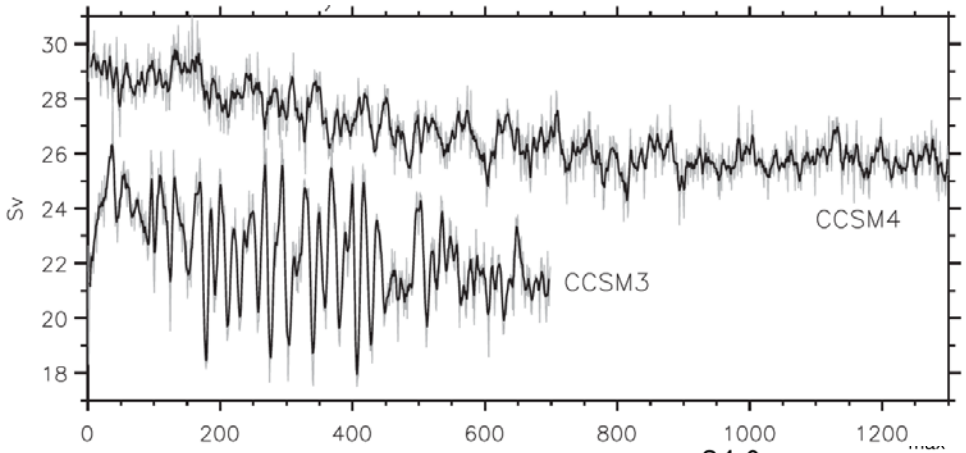
LE

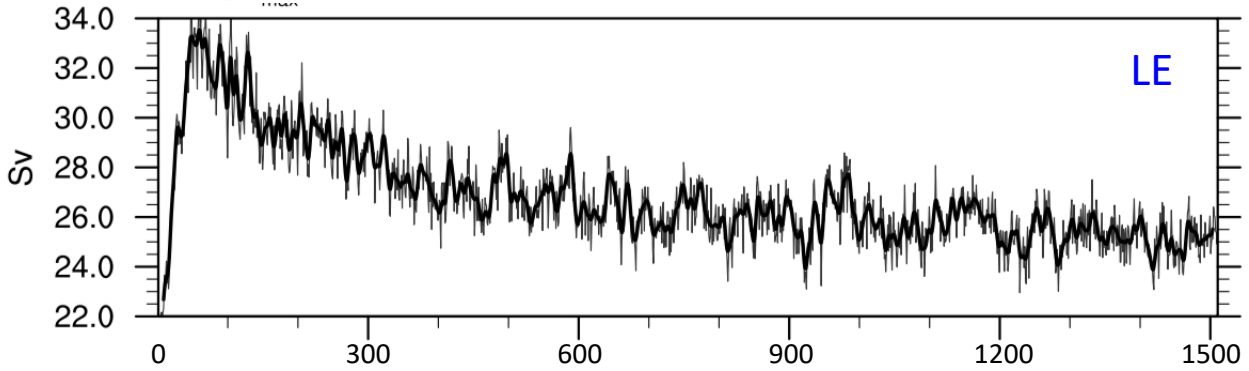


#125

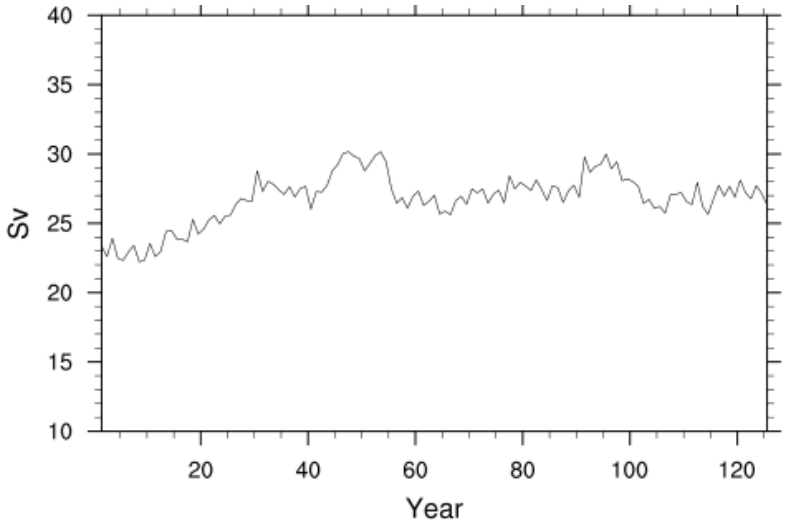


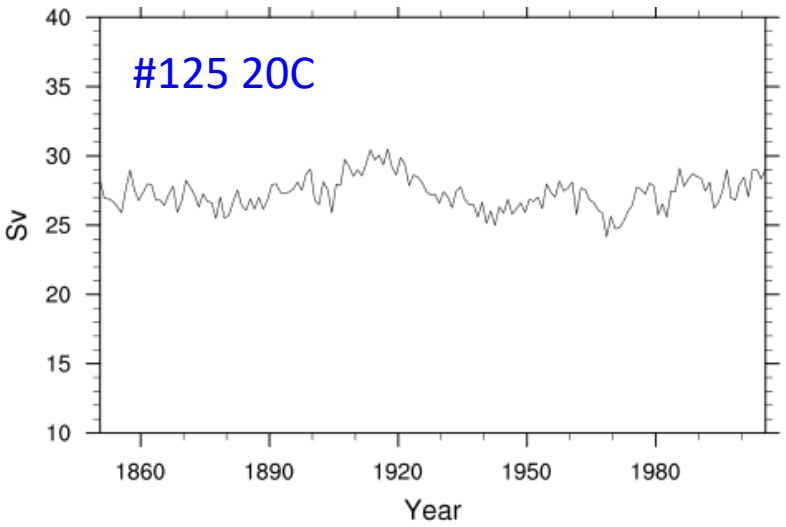
AMOC Maximum Transport Time Series (Pre-Industrial)





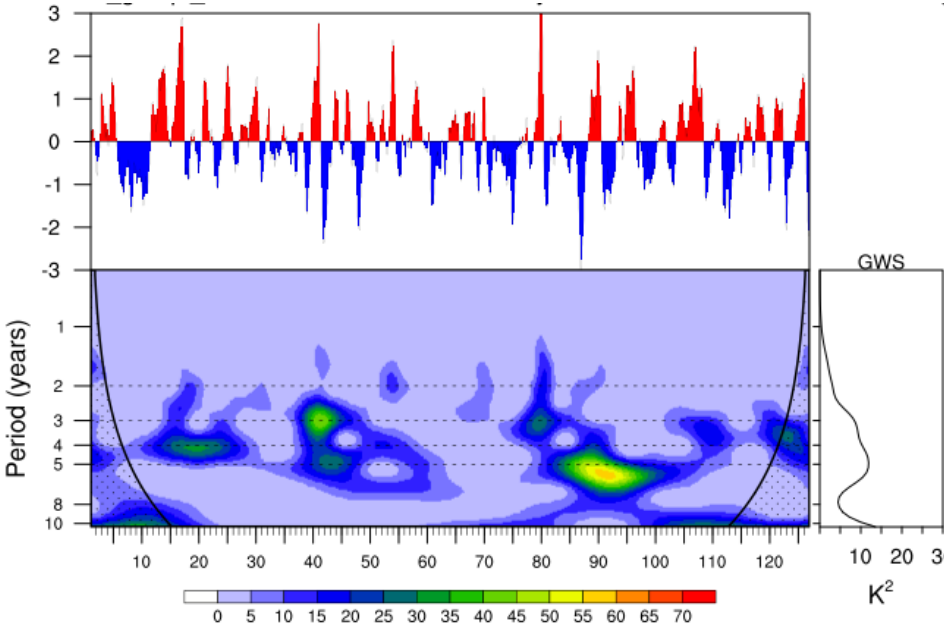
#125



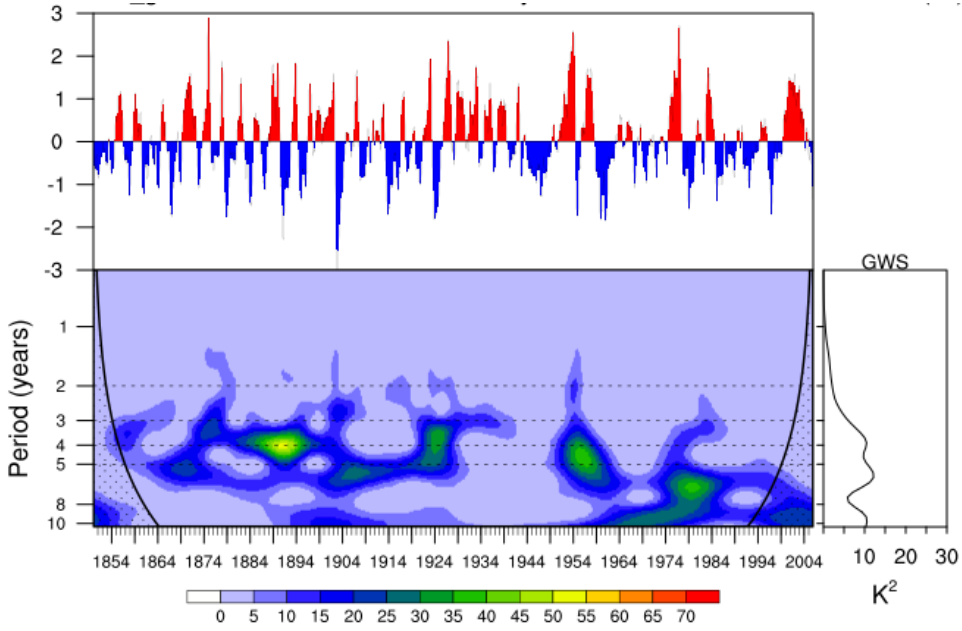


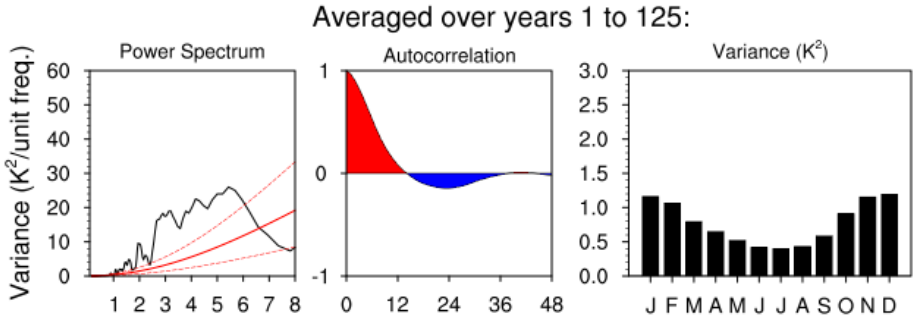
Nino 3.4

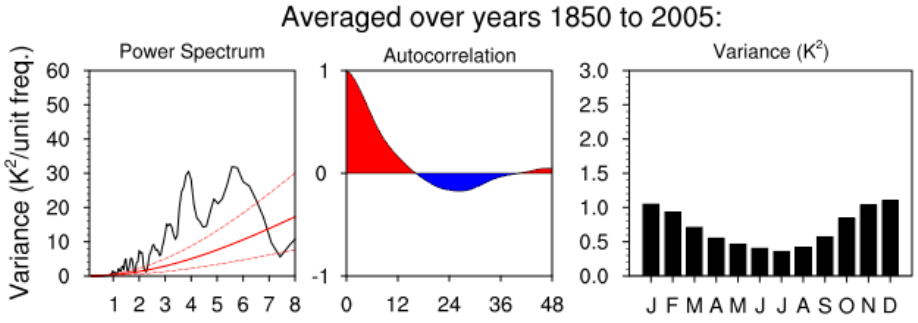
#125



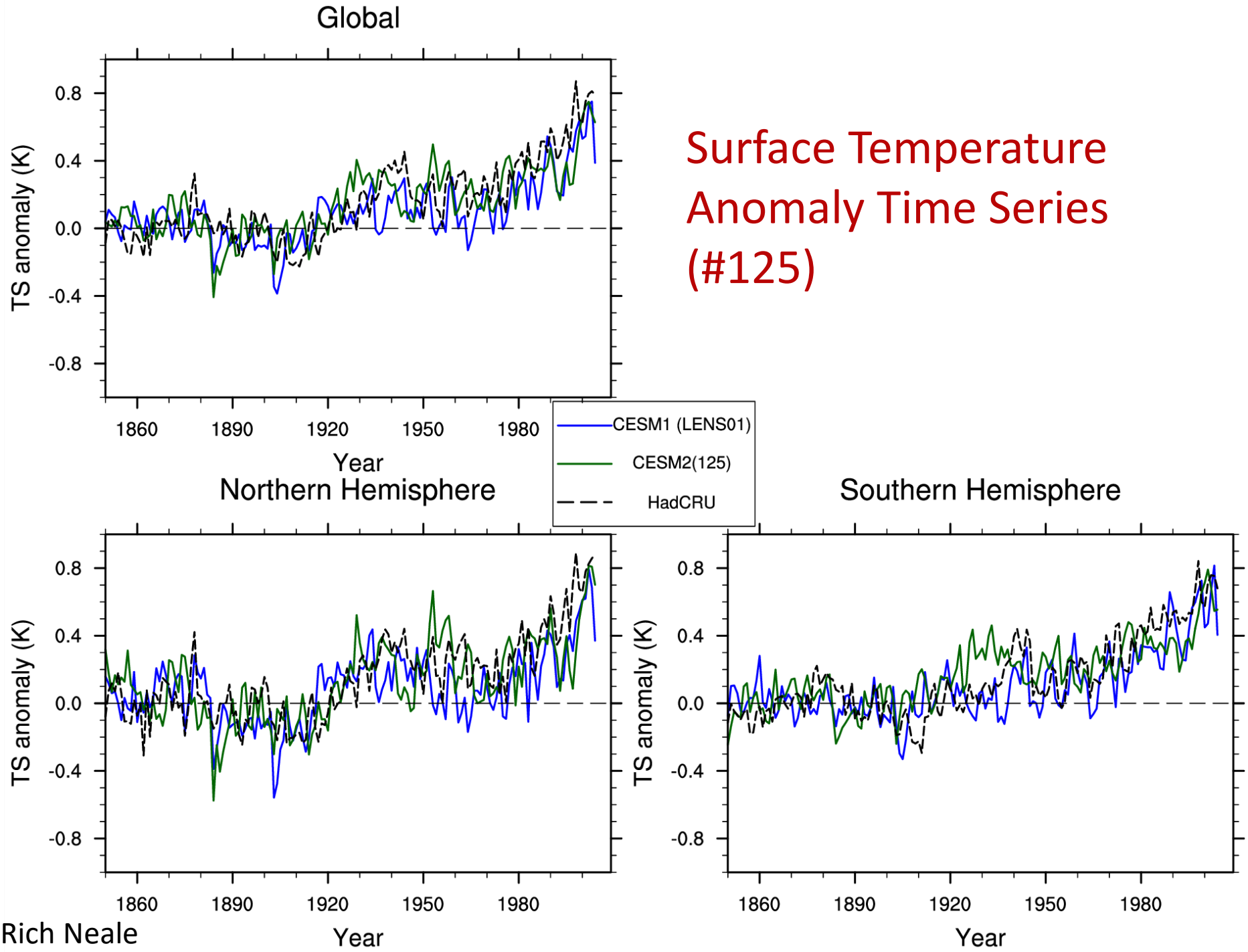
#125 20C







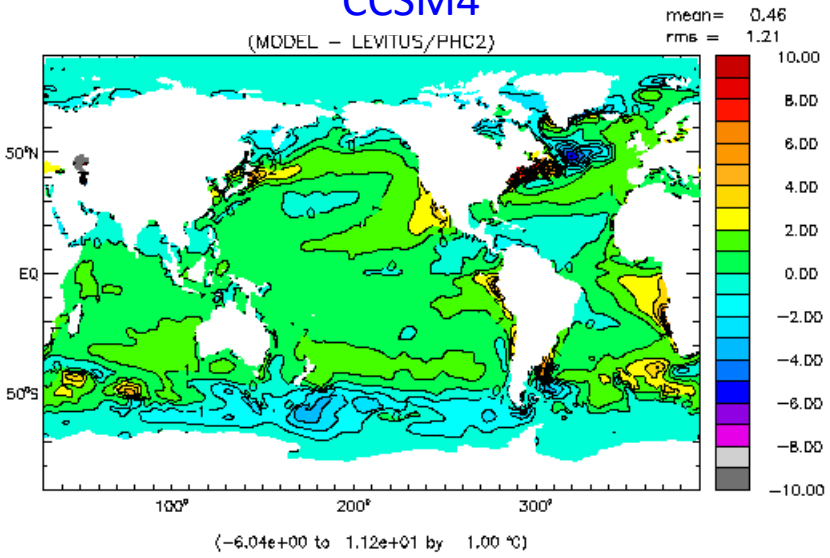
Surface Temperature Anomaly Time Series (#125)



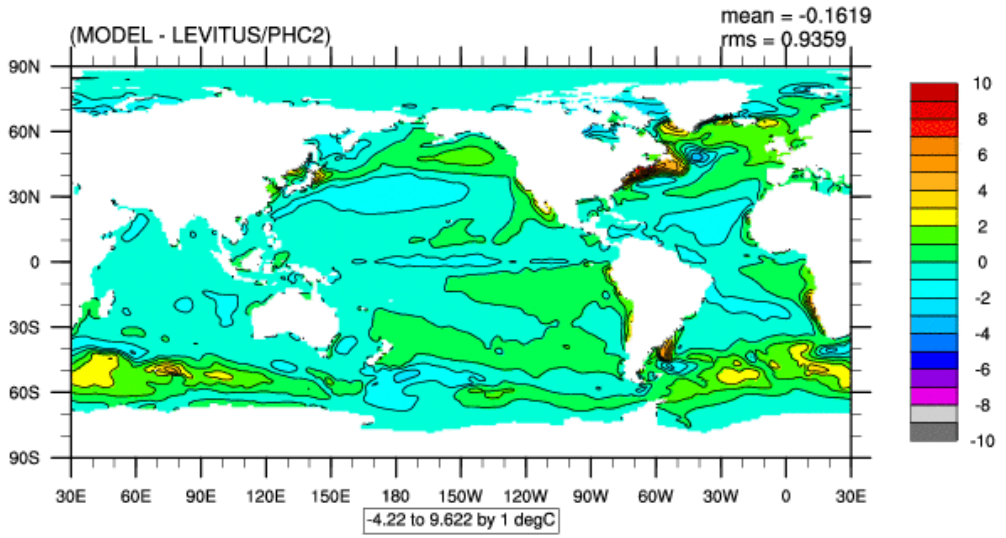
Rich Neale

Sea Surface Temperature (SST) Differences from Observations

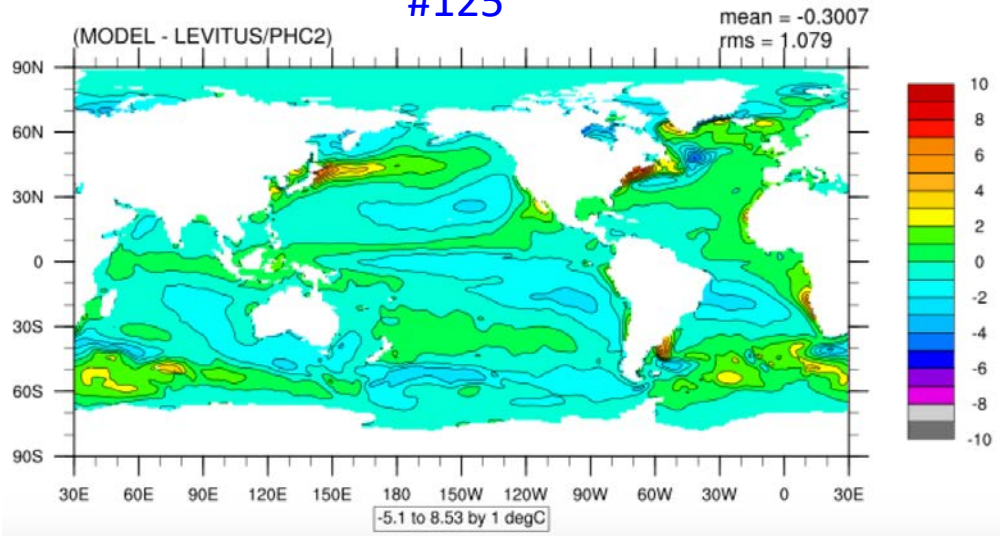
CCSM4



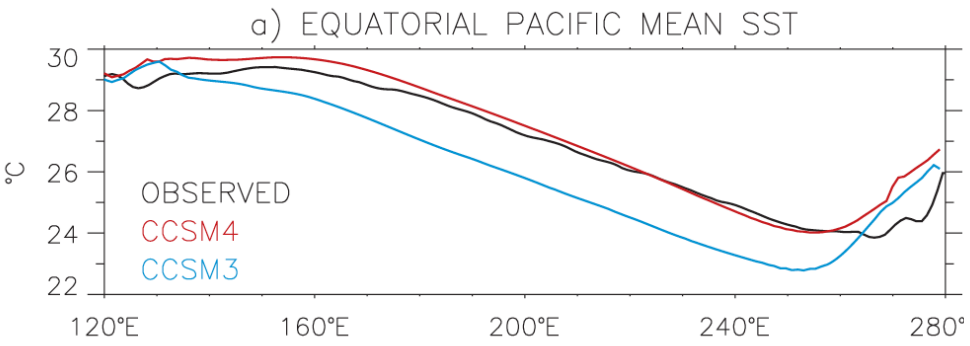
LE

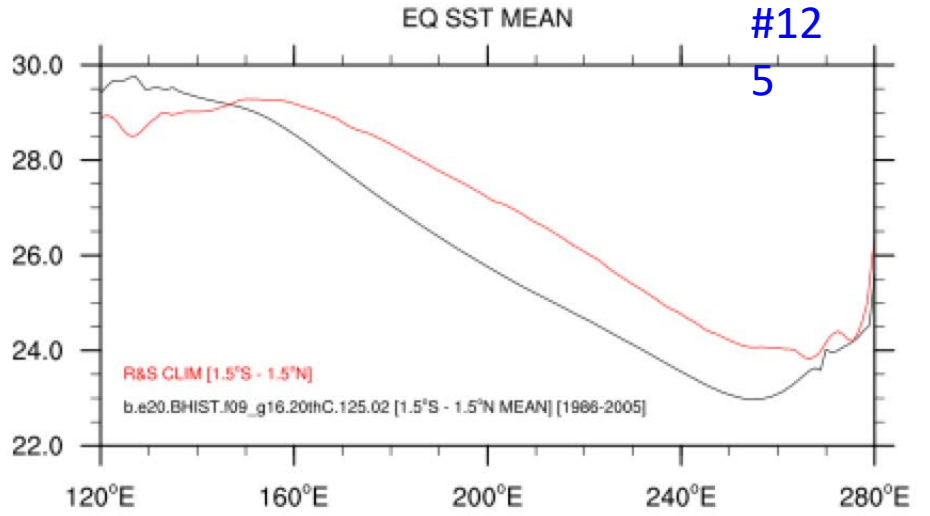


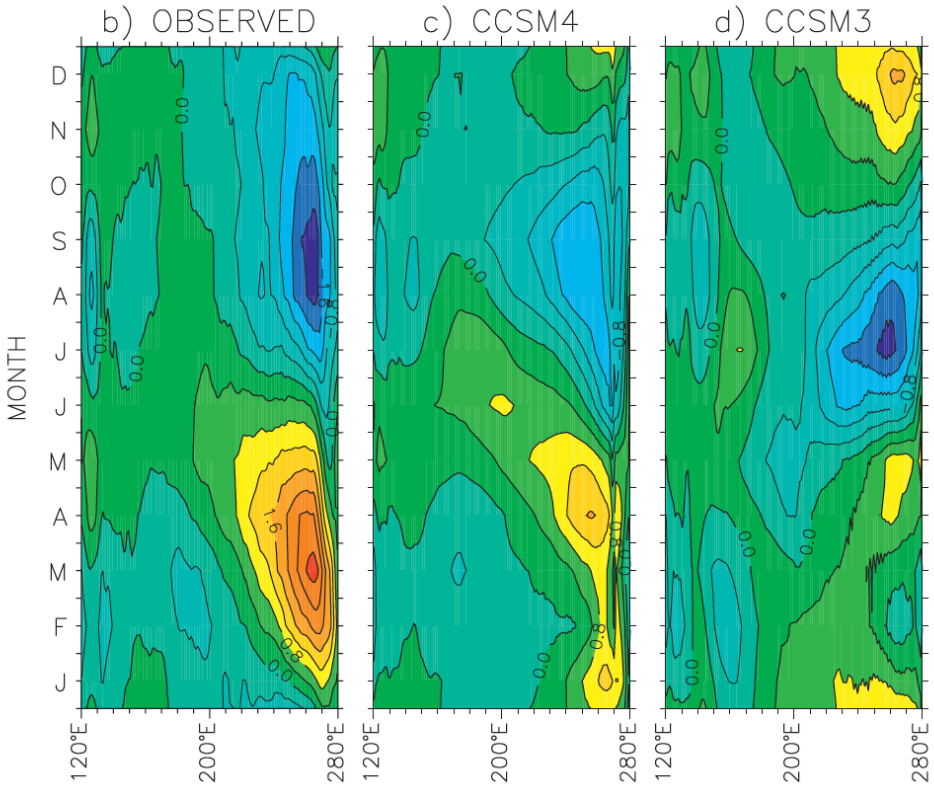
#125

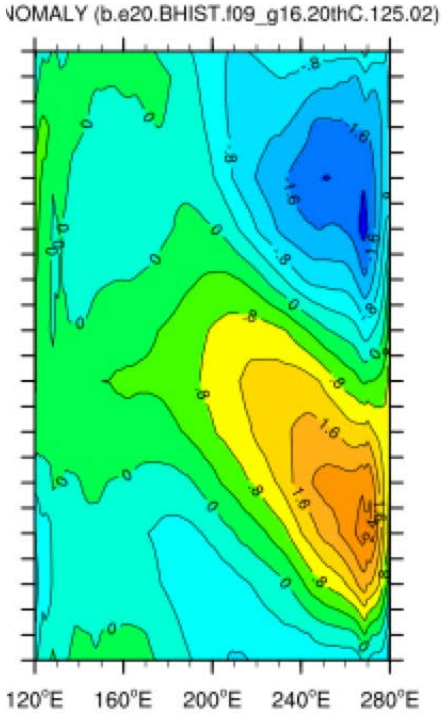


Equatorial Pacific Mean SST and its Seasonal Cycle



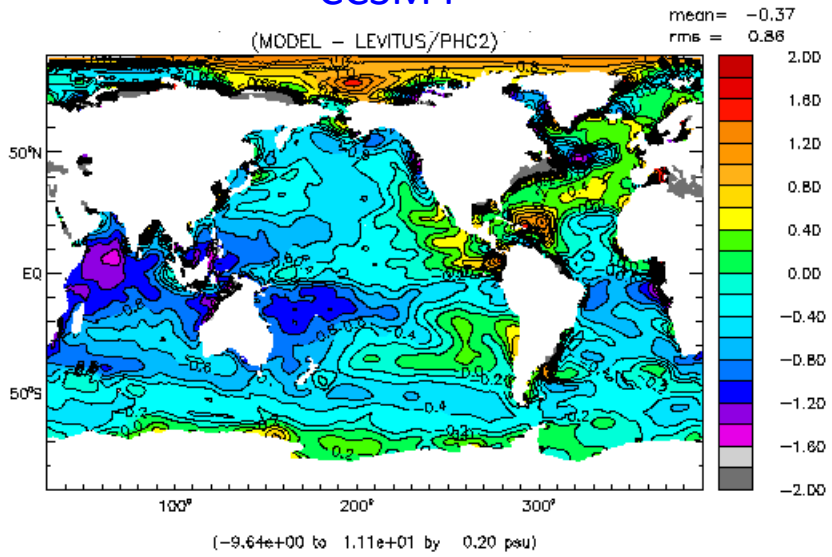




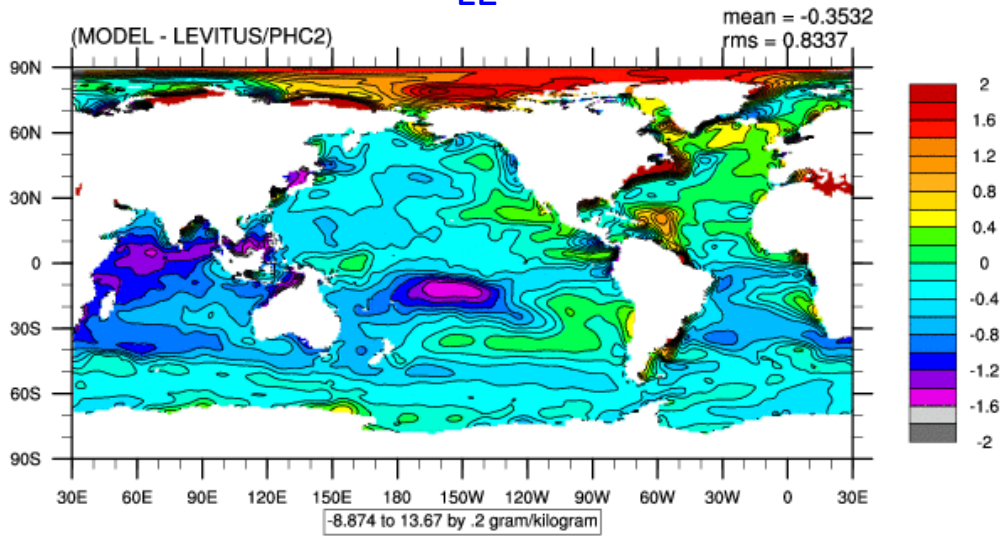


Sea Surface Salinity Differences from Observations

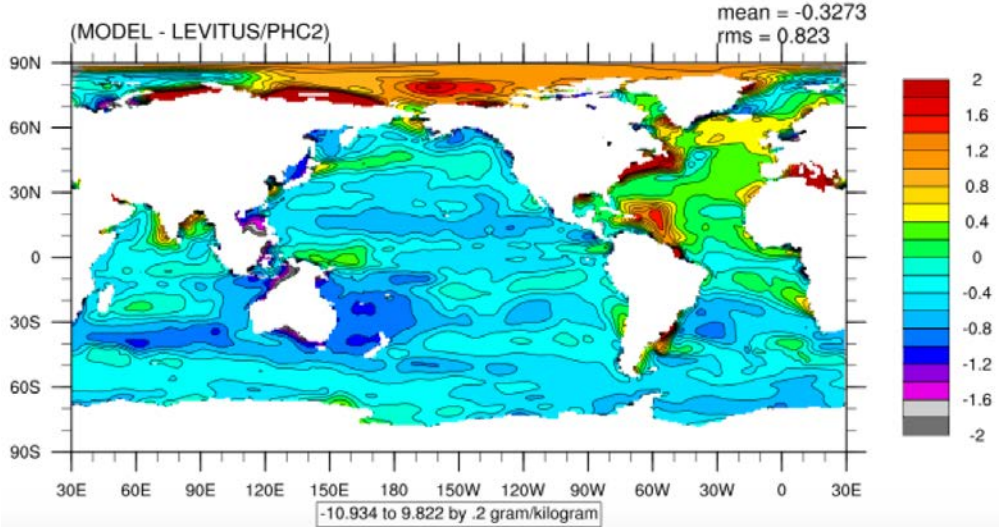
CCSM4



LE

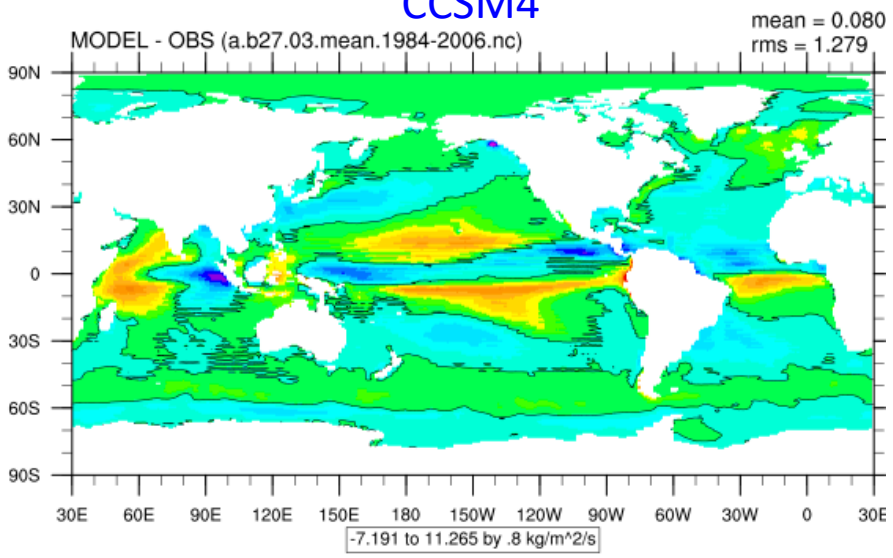


#125

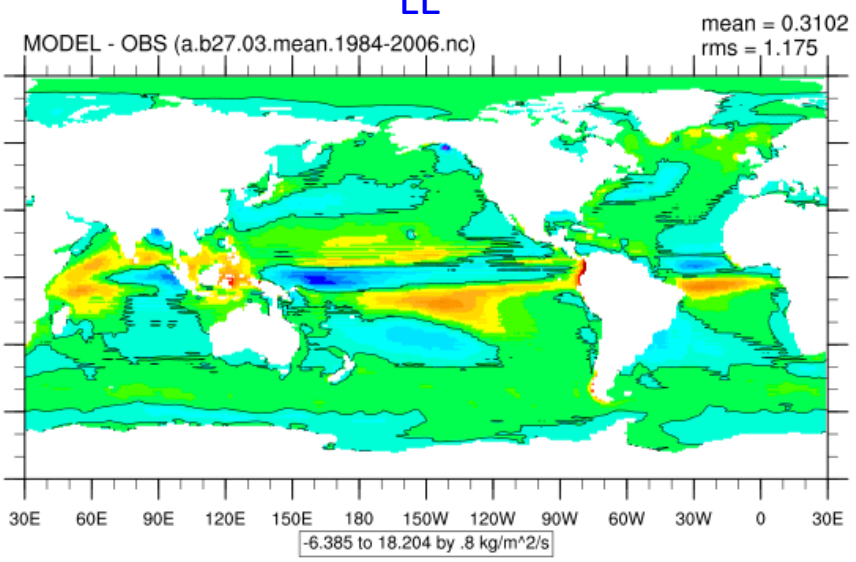


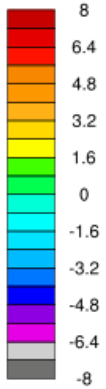
Precipitation Differences from Observations*

CCSM4

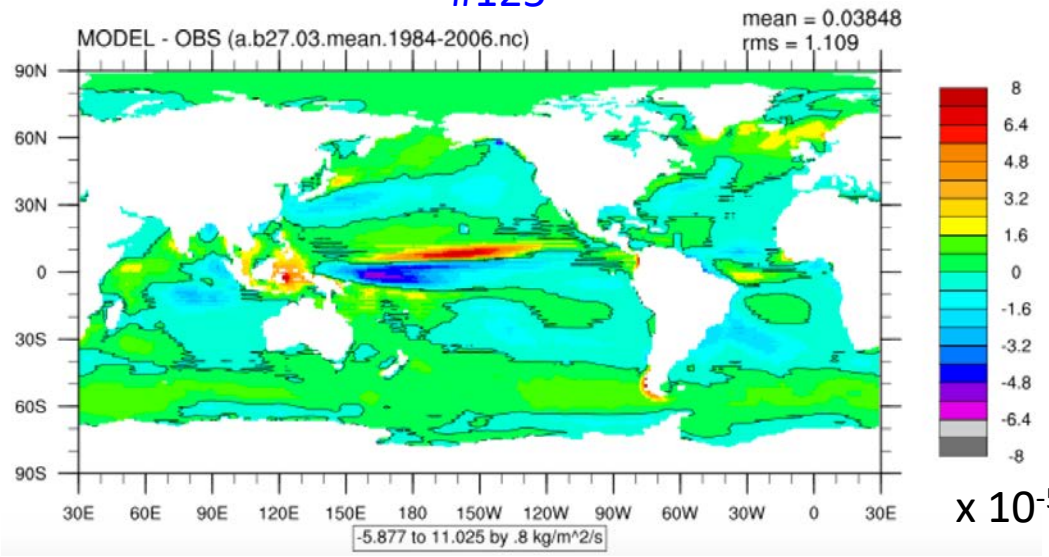


LE





#125

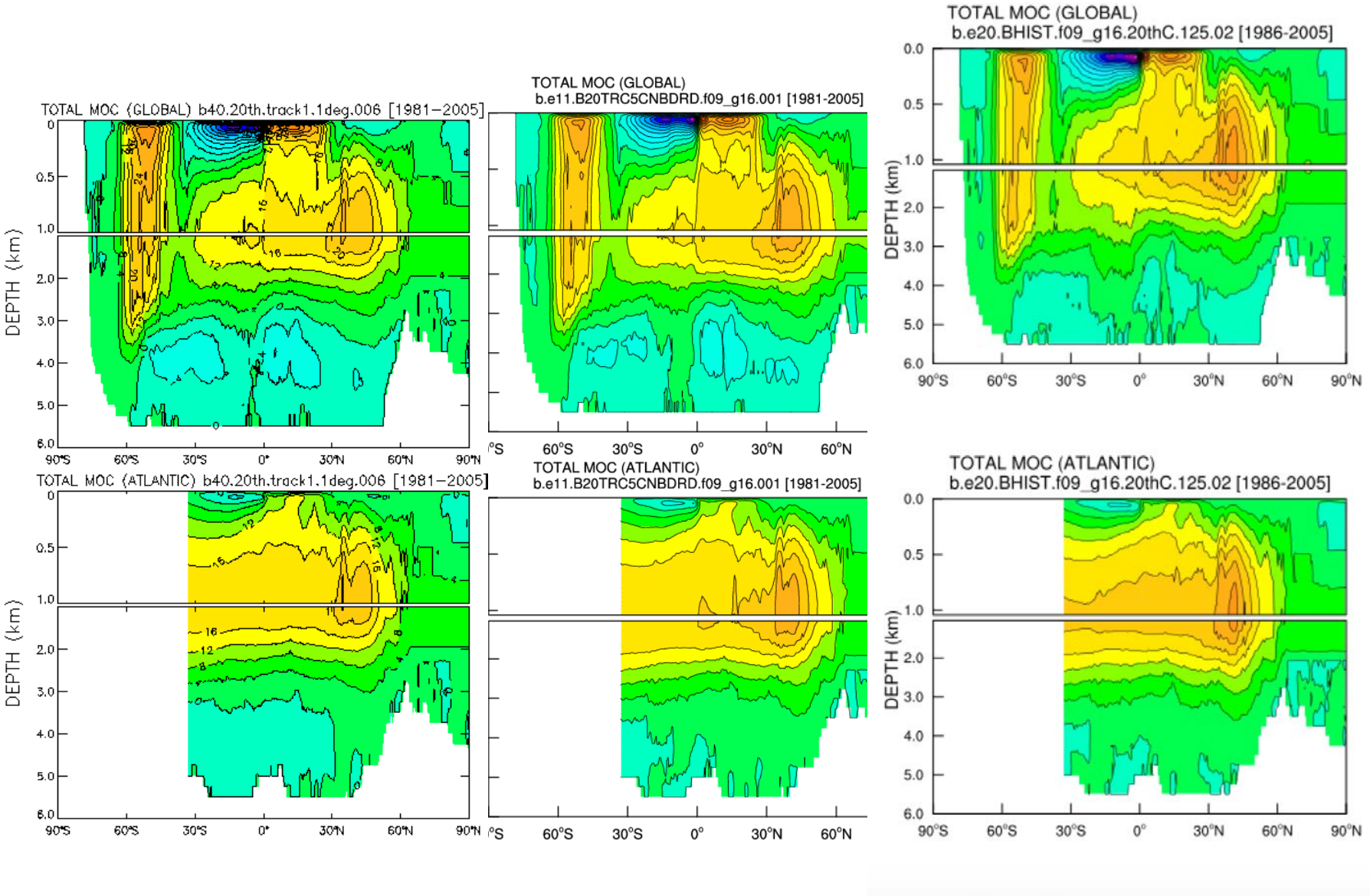


x 10^{-5}

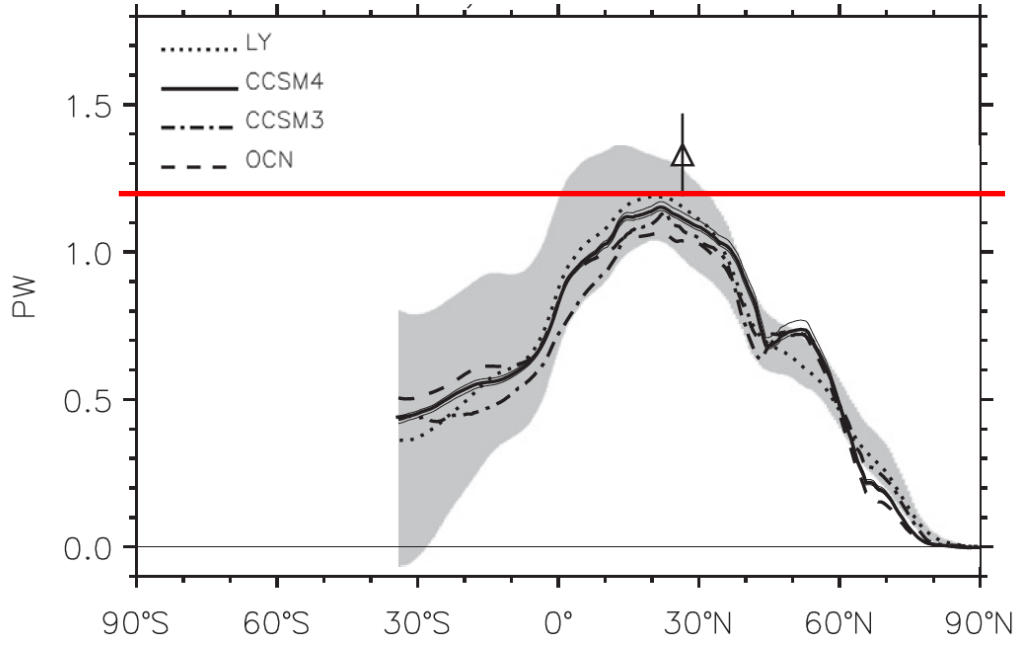
* CORE-II: Blending primarily of GPCP and CMAP

Global (top) and Atlantic (bottom) Meridional Overturning Circulations (Sv)

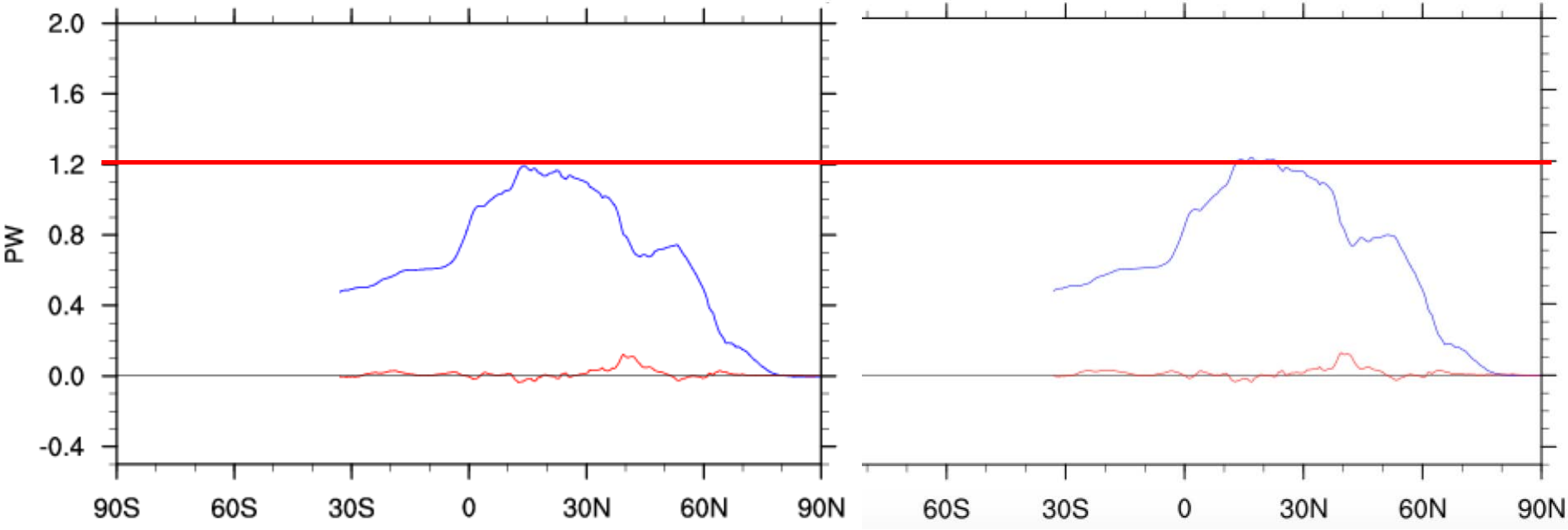
CCSM4 LE #125



Atlantic Northward Heat Transport

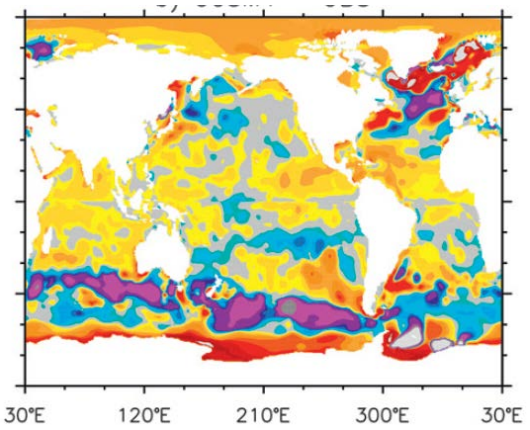


LE

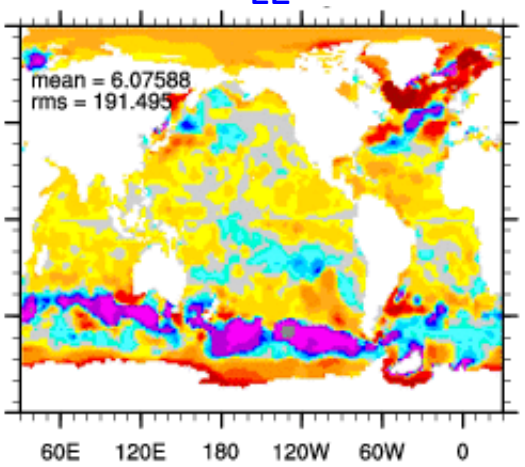


Winter-Mean Mixed Layer Depth (Model – Observations)

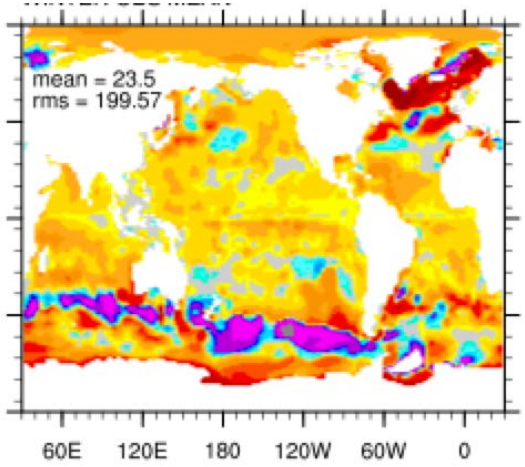
CCSM4



LE



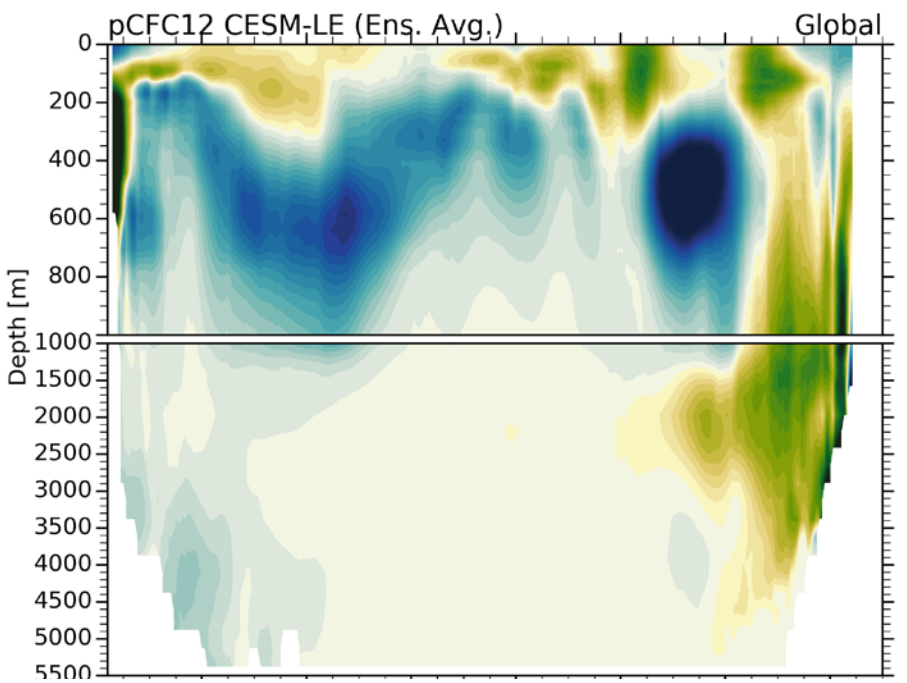
#125

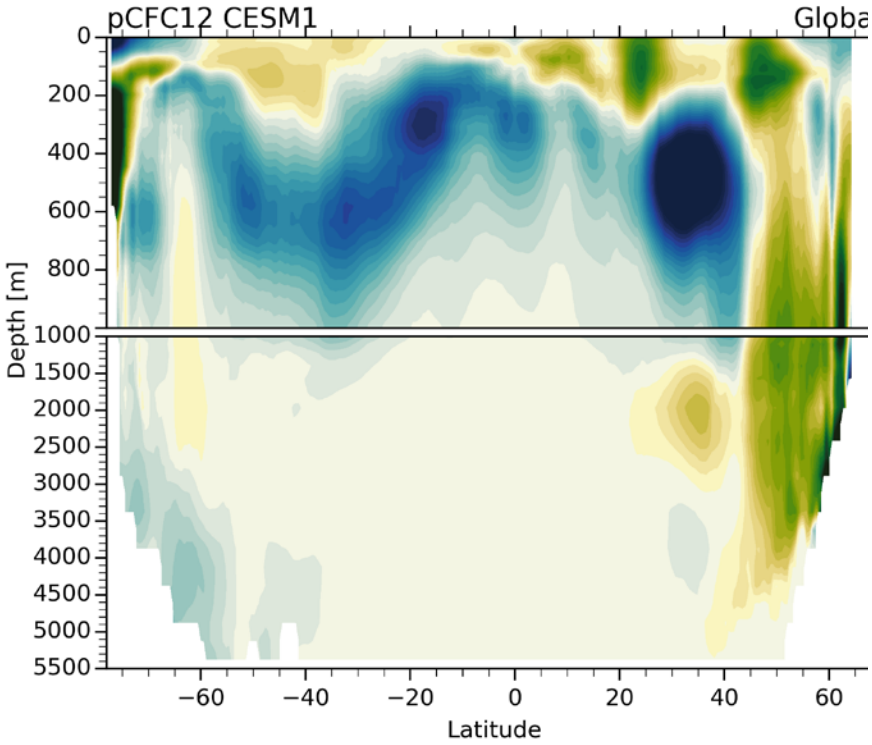


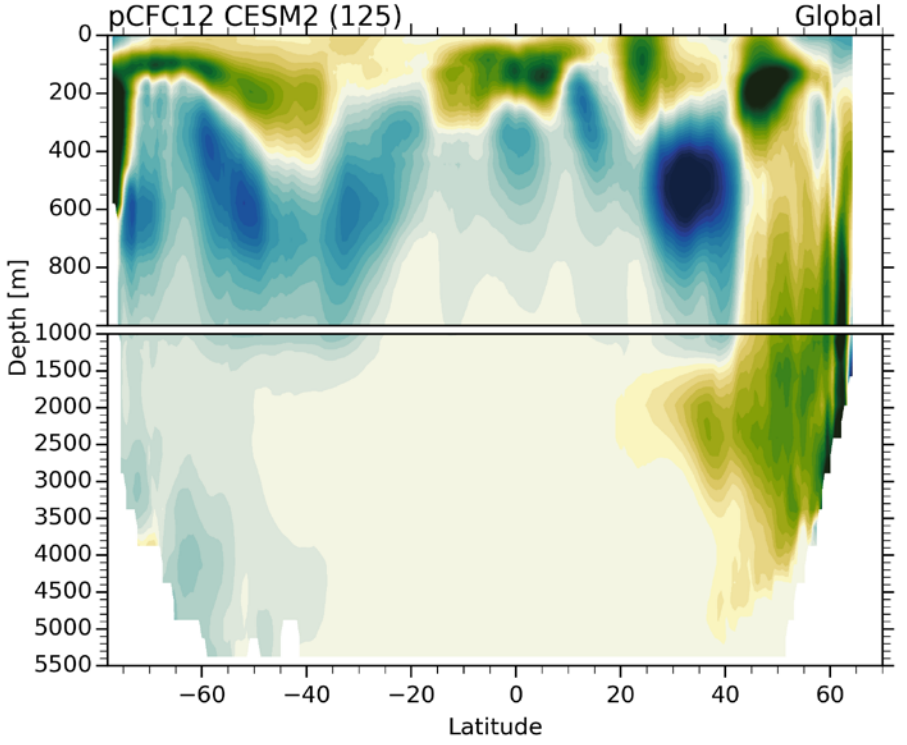
Delta rho = 0.125 kg m^{-3}

Global- and Zonal-Mean pCFC12 Differences from Observations

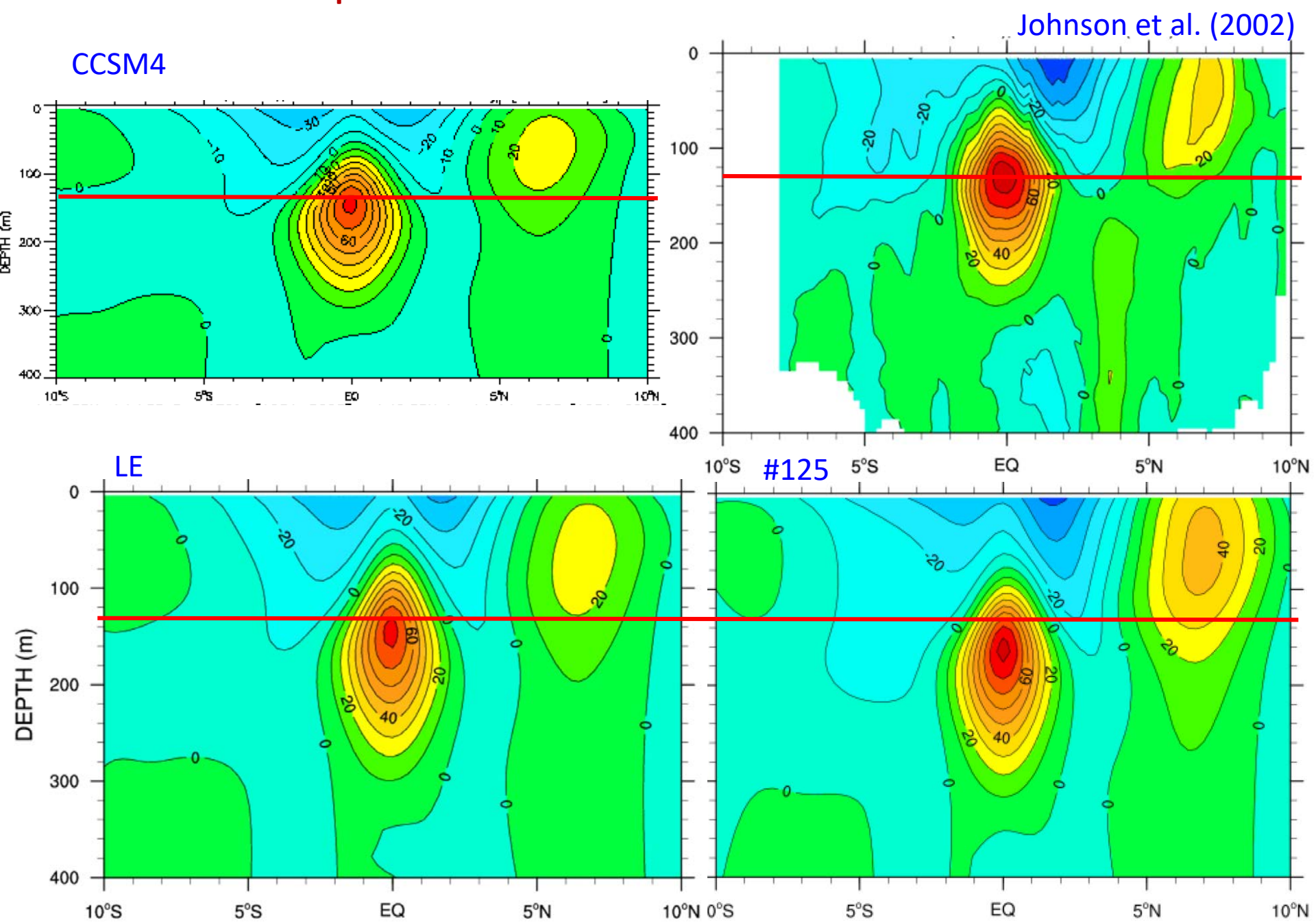
Matthew Long







Equatorial Pacific Currents at 205°E



Changes Beyond Simulation #125

Results from simulation #125 released to community on 09 February 2017

Changes for final version:

- Subgrid-scale topography representation around Greenland (different scale due to very strong winds)
- Caspian Sea: from ocean model to land model (lake)
- Update to land vegetation parameters (little climate impact, mostly for carbon-cycle improvements)
- CMIP6 emissions
- Hourly ocean coupling with Robert Filter
- Ocean initial conditions from LENS
- Dust tuning
- Ocean biogeochemisty