

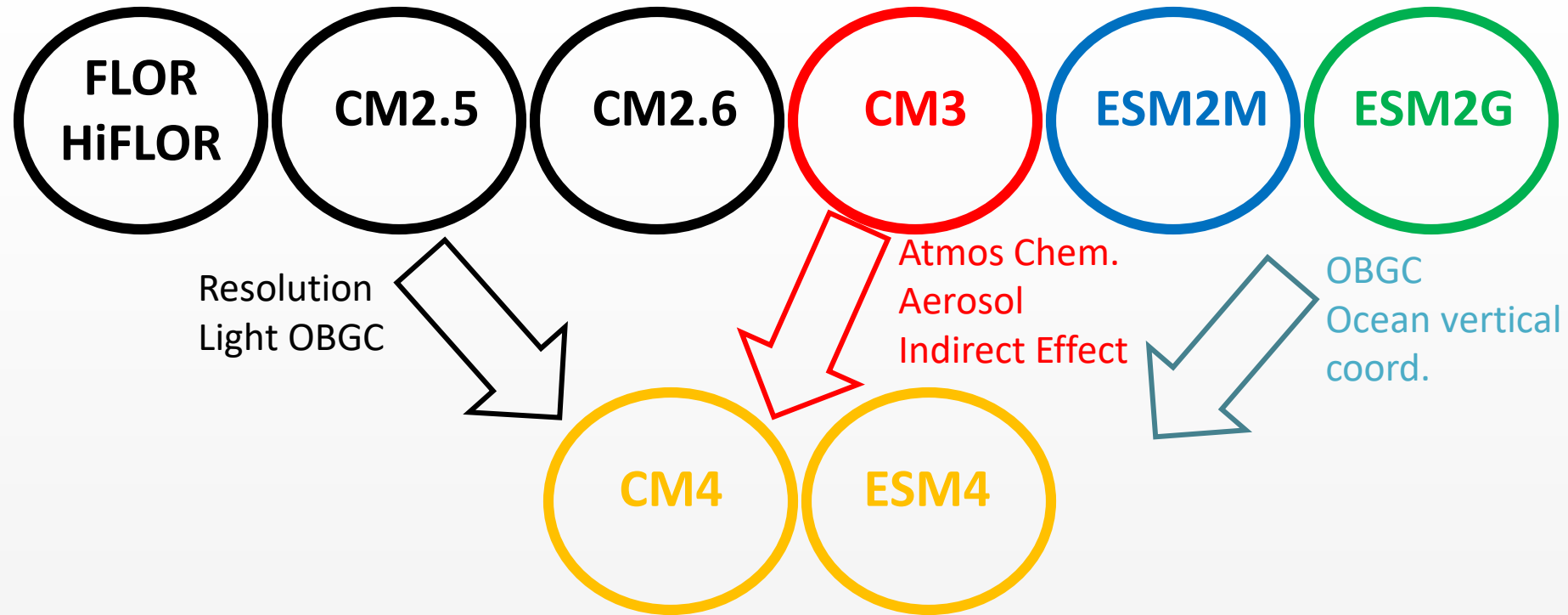
# Status of CMIP6 and OMIP simulations at GFDL

**Alistair Adcroft**

CESM Ocean Model Working Group Meeting  
January 11-12, 2018



# Rationalizing GFDL's CMIP5 generation models



**5-10 year Strategic Science Plan (2011) goal:**  
high resolution Earth System Model combining strengths of GFDL's  
multiple AR5 modeling streams

# GFDL's CMIP6 generation models: CM4 and ESM4

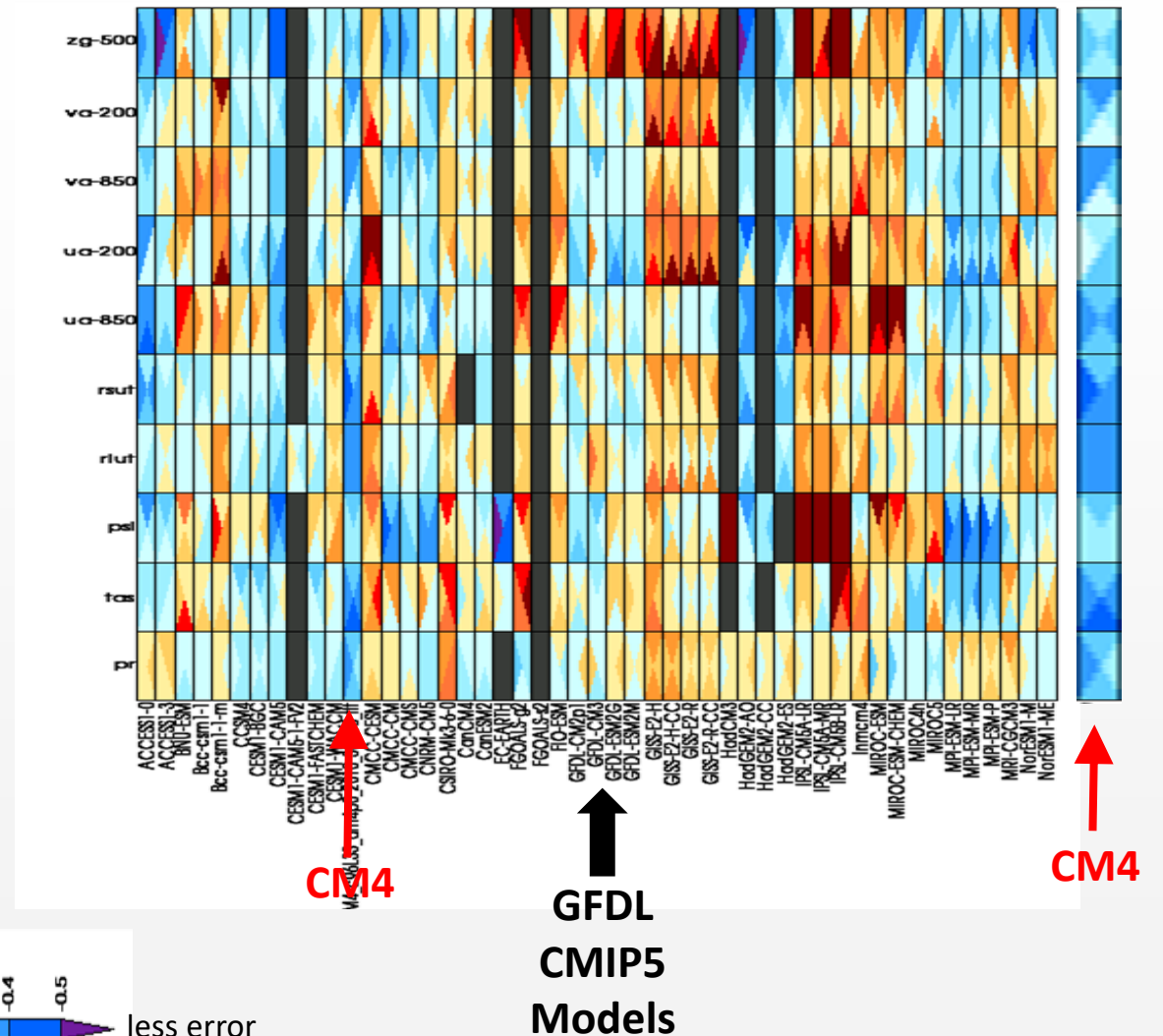
	<b>CM4 (frozen, DECK re-started)</b>	<b>ESM4(in final development)</b>
<b>Atmosphere: AM4</b>	100 km, 33 levels	100 km, 49 levels
<b>Atmos. Chem</b>	for aerosol ( 21 tracers)	aerosol+ozone (103 tracers)
<b>Ocean: MOM6</b>	1/4°, 75 levels	1/2°, 75 levels
<b>Ocean BGC</b>	BLINGv2 (6 tracers)	COBALTv2 (30 tracers)
<b>Land</b>	LM4.0	LM4.1 - PPA
<b>Sea Ice</b>	SIS2	SIS2

- All OM4 development was made in context of CM4 (i.e. we never ran CORE IAF until the end)

Note: All CM4 results shown are *preliminary* (based on potential vegetation historical, 1850- and 2010-forced experiments).

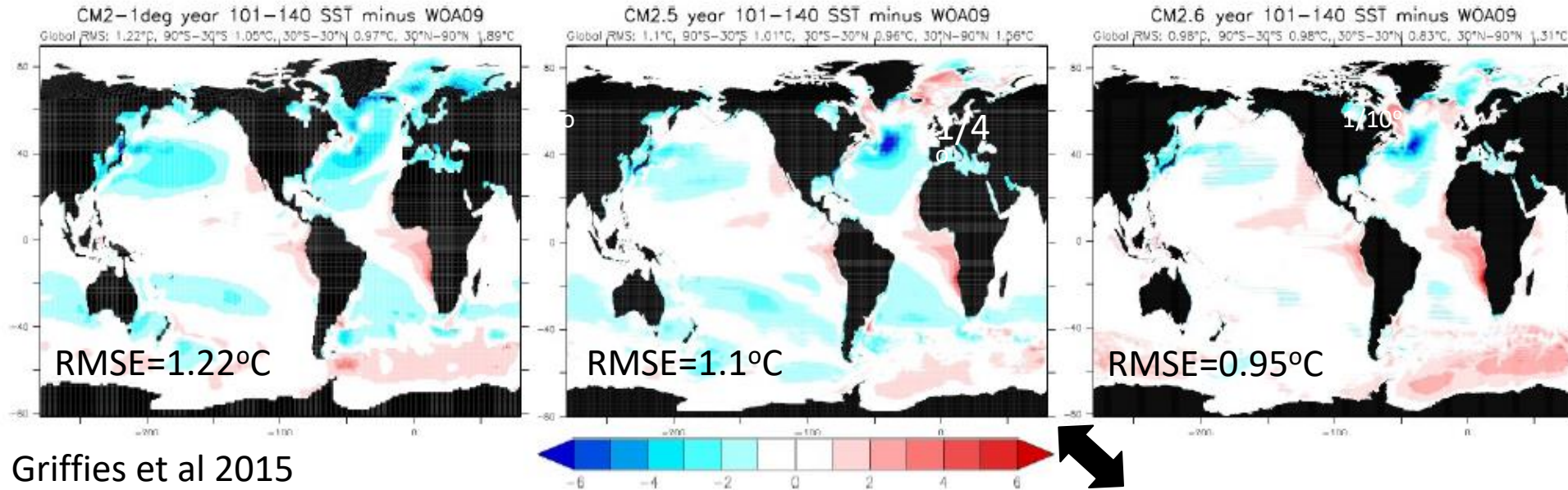
# CM4 Surface Climate

- CM4's climatology is a distinct improvement over previous GFDL models
- CM4 temp., precip., OLR and reflected SW are the best in this CMIP5 ensemble
- Wind fields are good but not the best



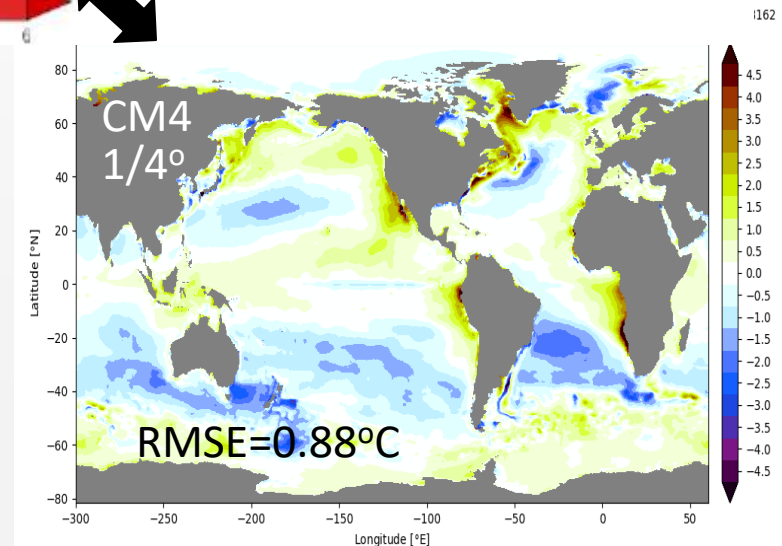


# CM4 SST errors



Griffies et al 2015

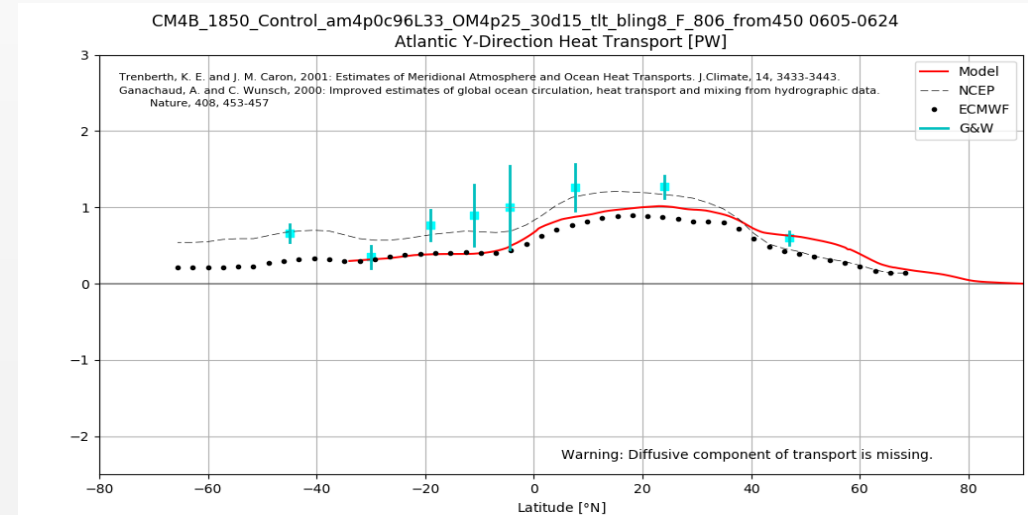
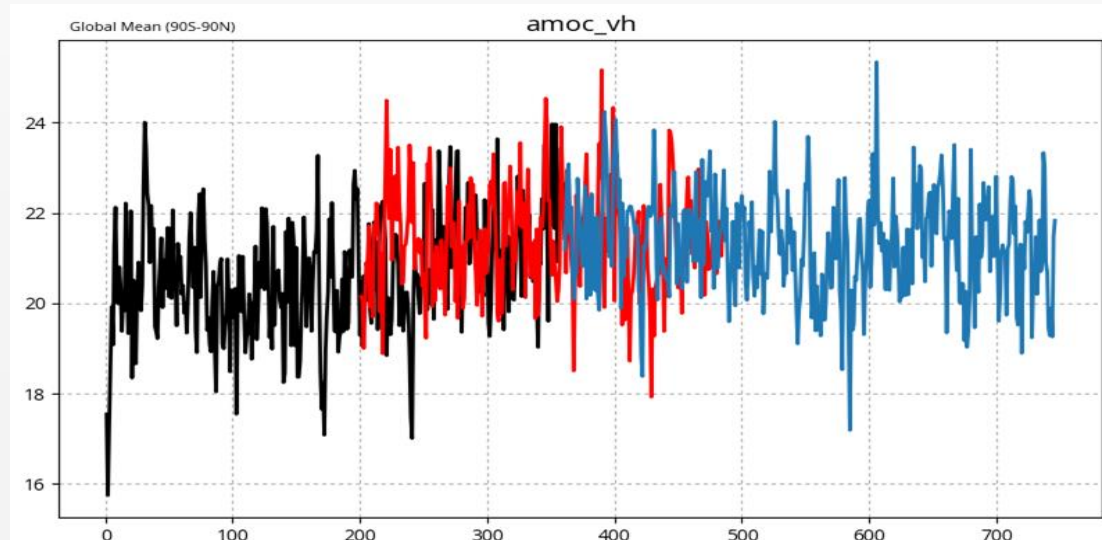
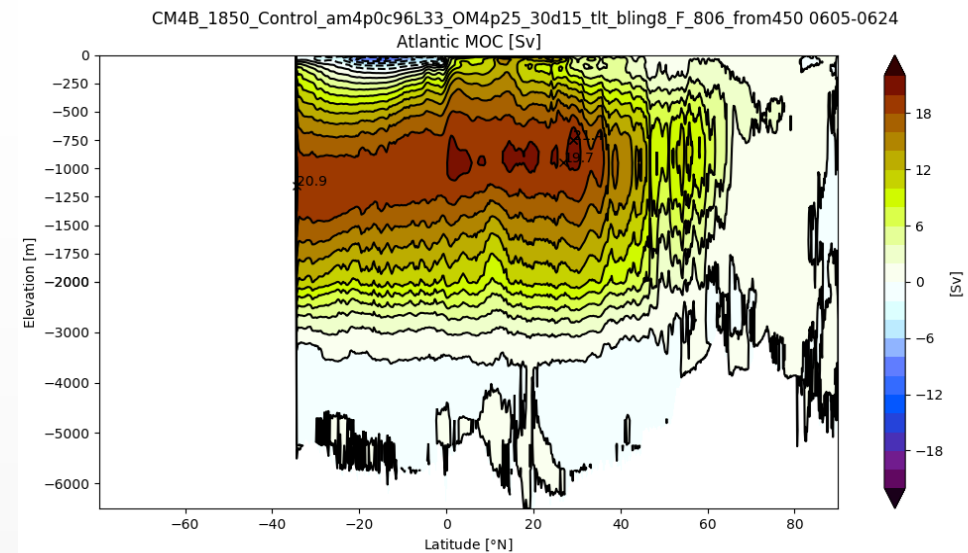
- CM4's SST errors are similar to CM2.6 (GFDL's previous best simulation)
- We expect these can be improved further with higher ocean resolution as was seen going from CM2.5 to CM2.6 or with an eddy parameterization



1162

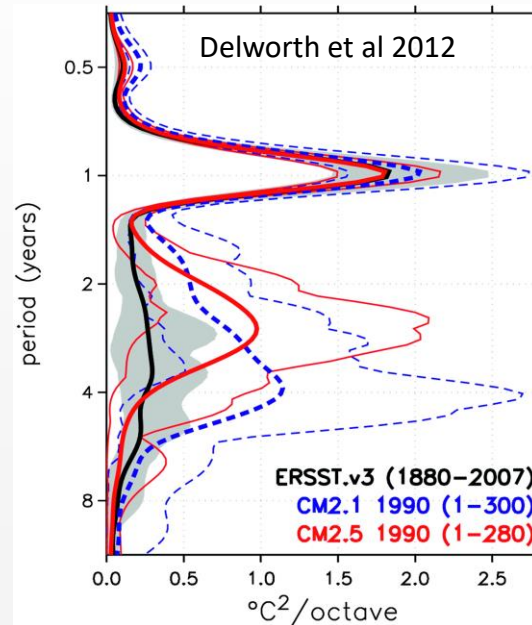
# AMOC Simulation

- Strong, stable AMOC
- Deep flow is too shallow and warm
- Heat transport less than observed

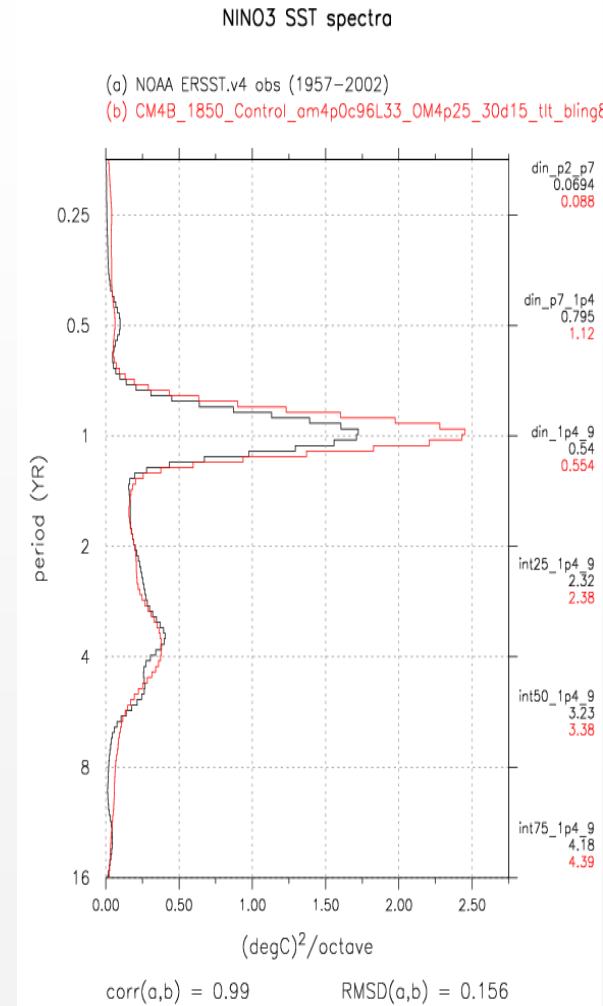


# Variability: Improved ENSO

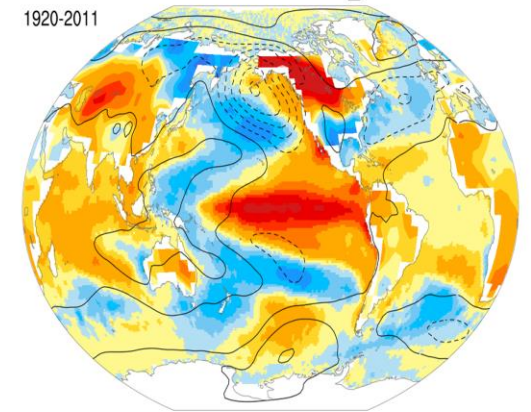
- ENSO magnitude is more realistic than previous GFDL models which tended to be too large



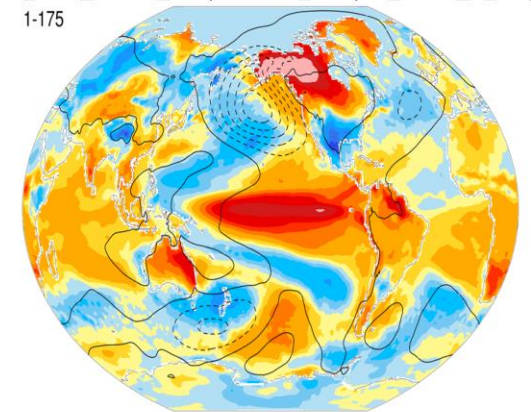
- ENSO teleconnection pattern is well simulated



nino3.4 TS,TAS,PSL Spatial Composite (DJF<sup>+1</sup>)  
 HadISST / MLOST / 20thC\_ReanV2

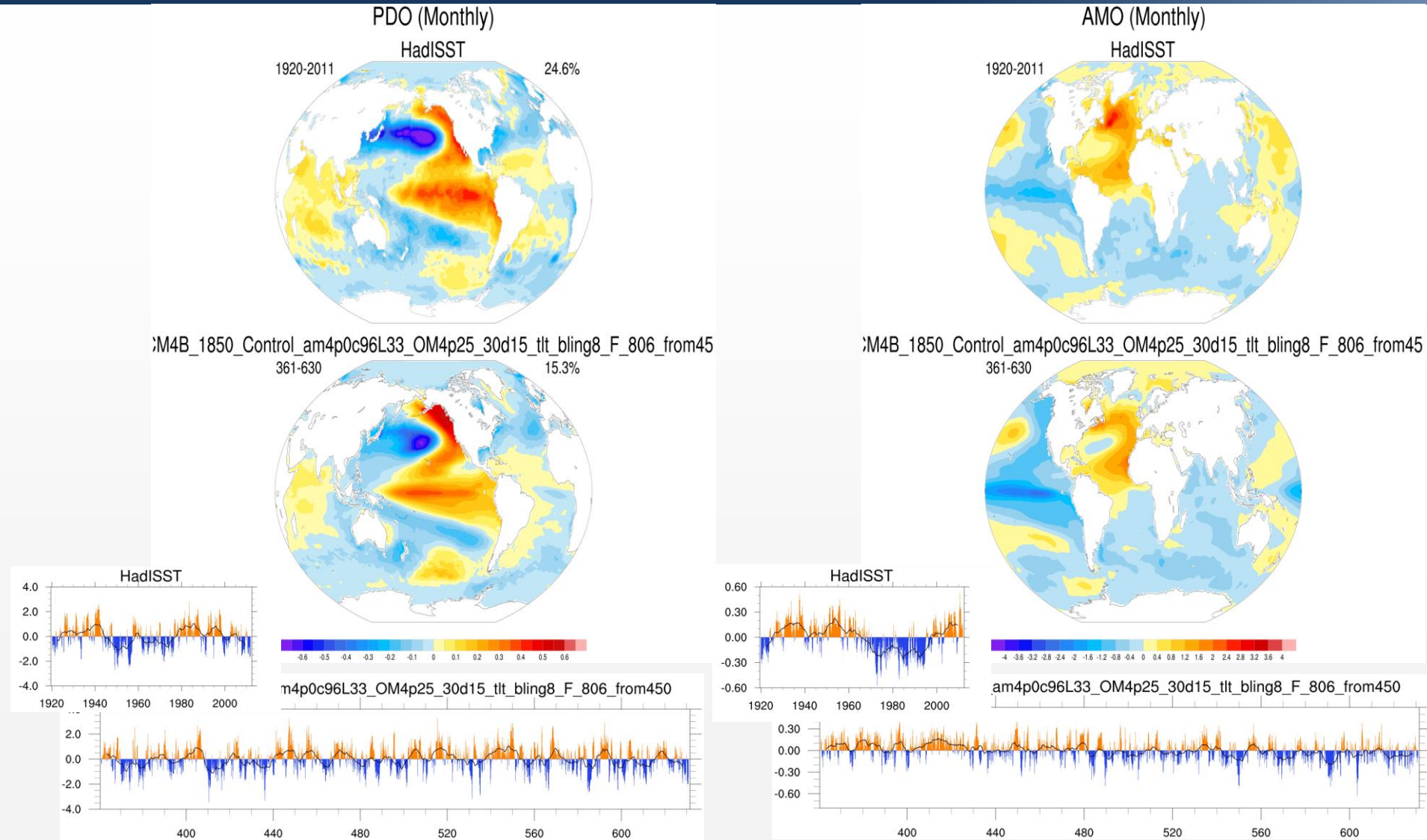


CONTOUR FROM -16 TO 16 BY 2  
 CM4B\_1850\_Control\_am4p0c96L33\_OM4p25\_30d15\_tlt\_bling8\_F  
 1-175





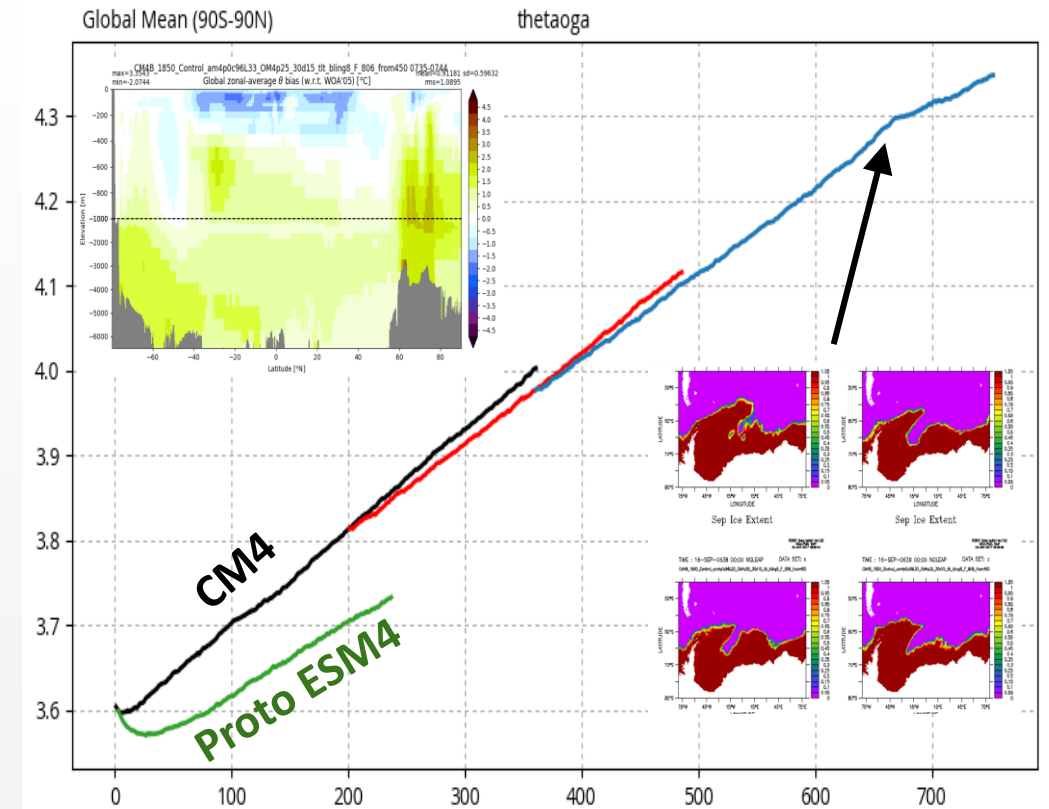
# Variability: PDO / AMO patterns are well-simulated





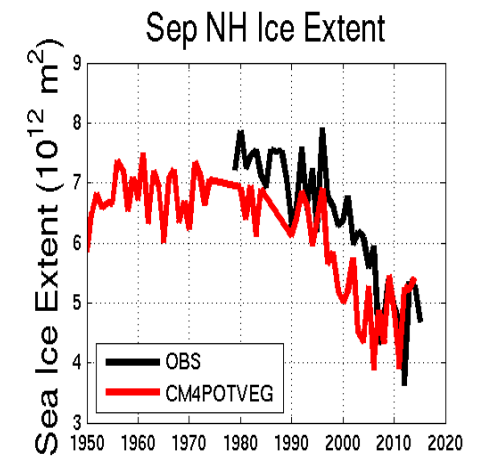
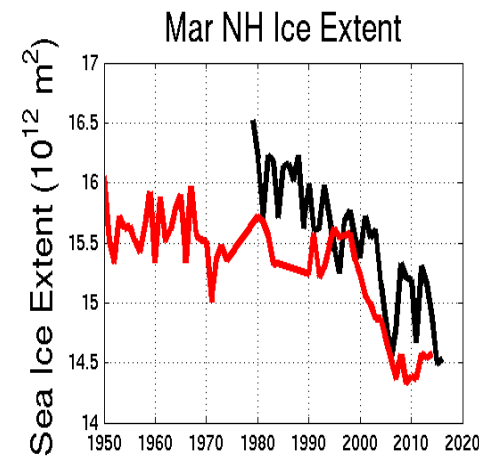
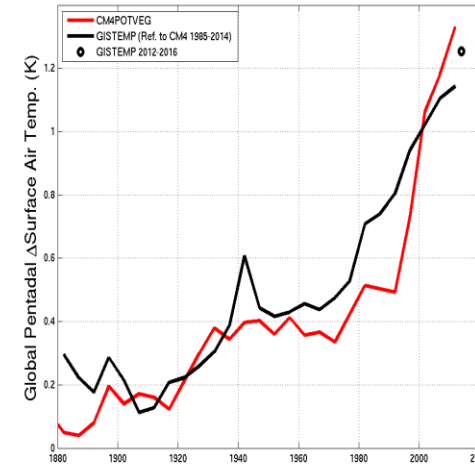
# Global Ocean Temperature Drift

- Heat uptake is less than CM2.5 (also using  $1/4^\circ$  ocean)
- Heat uptake is less than the difference in heat uptake between CM2.6 and CM2.5 (eddy-permitting res. effect)
- Warming of deep water points to inadequacy of deep water formation representation (in both hemispheres)



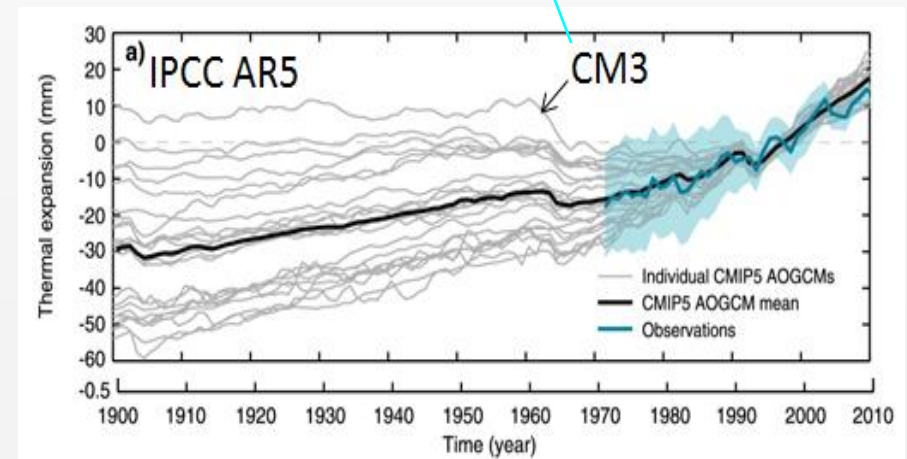
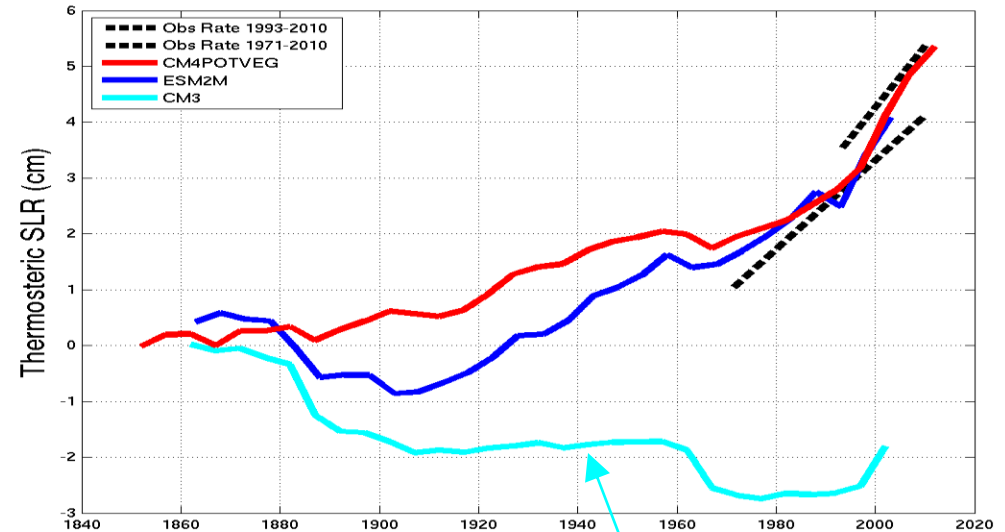
# Historical Simulation: NH Sea Ice Extent

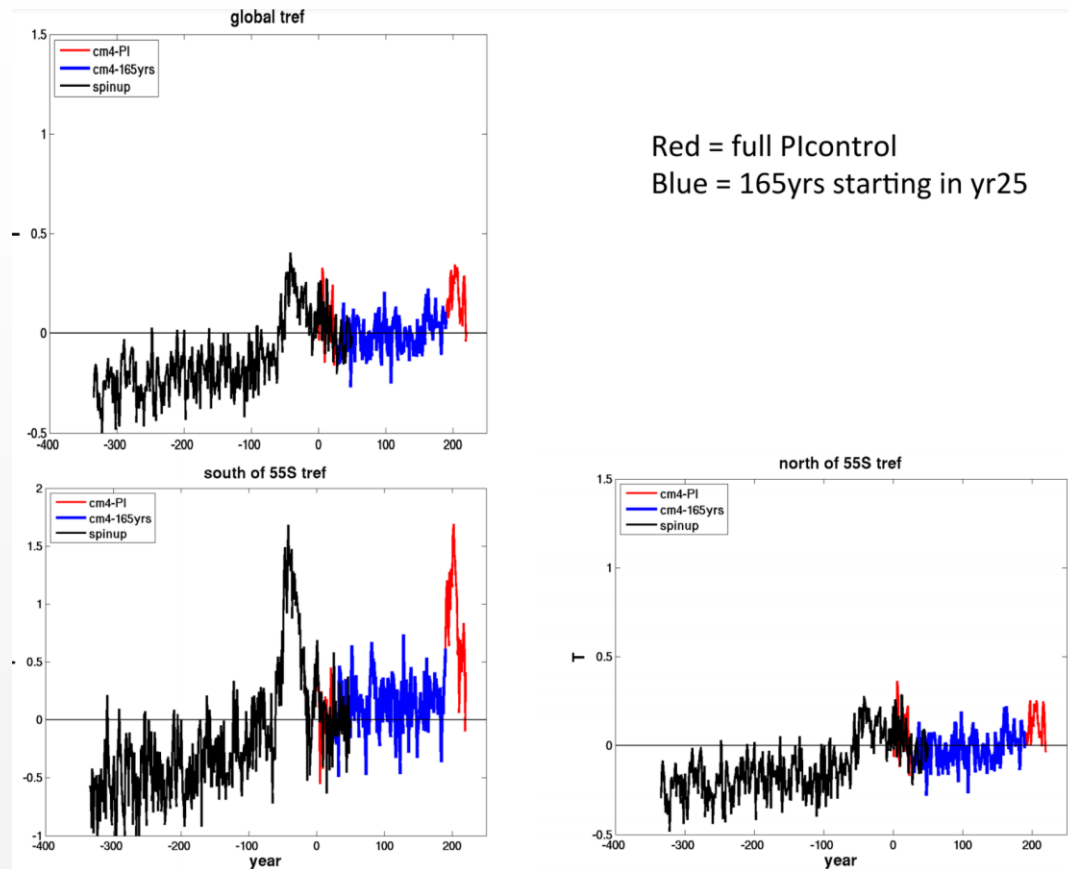
- Historical warming roughly consistent with observed with possible exception of post-Pinatubo period.
- Good simulation of NH extent and its satellite era trend.
- SH sea ice low biased in summer, high biased in winter; recent observed increase is not simulated



# Thermosteric Sea Level Rise

- CM3 thermosteric sea level rise problems:
  - Excessive response to volcanoes (common to all CMIP5 models) due to lack of volcanic forcing in control experiment
  - Lack of rise due to excessive aerosol forcing
- CM4 has reduced aerosol forcing and improved simulation of OHU / thermosteric SLR

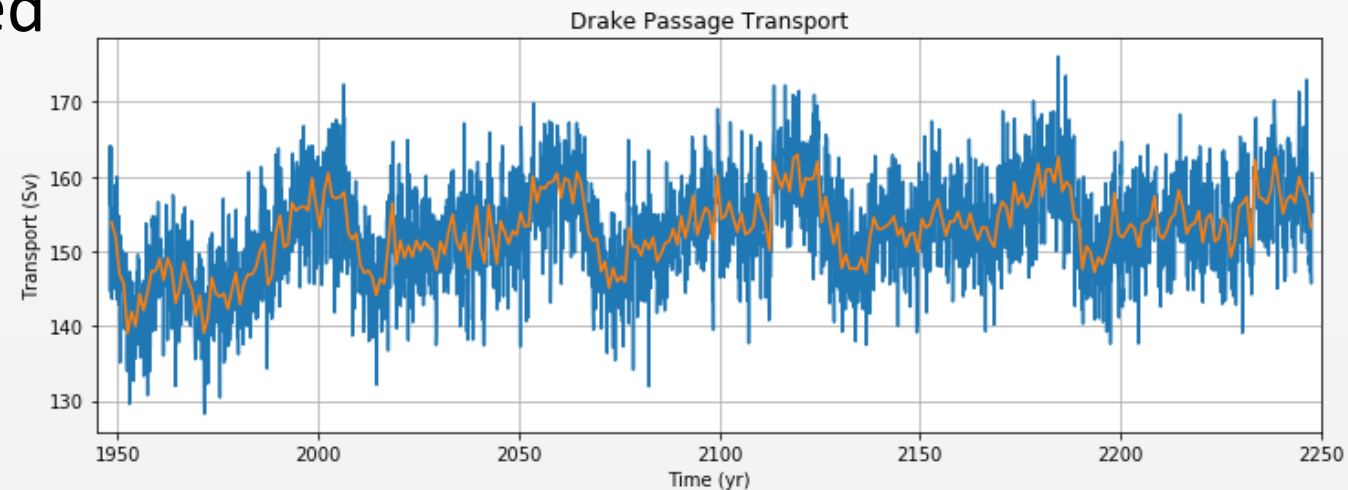
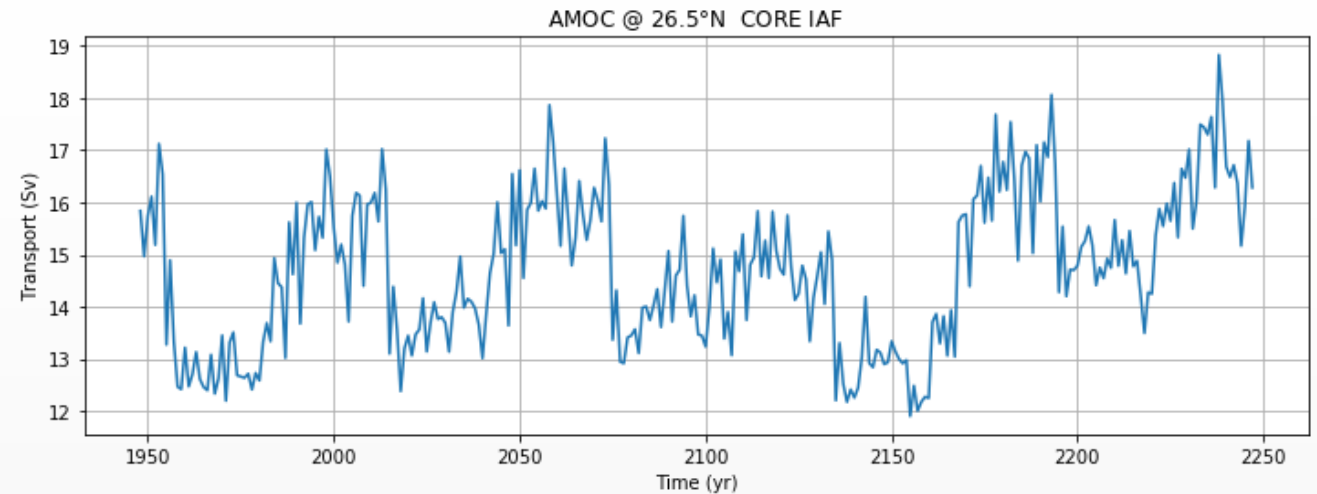




- Polynyas developed after the spin-up during the control
  - First in Weddell Sea
  - Third and largest in Ross Sea
- Lack of AABW found to be connected to a snow-on-glacier albedo being too dark
- Trying an alternative spin-up in January

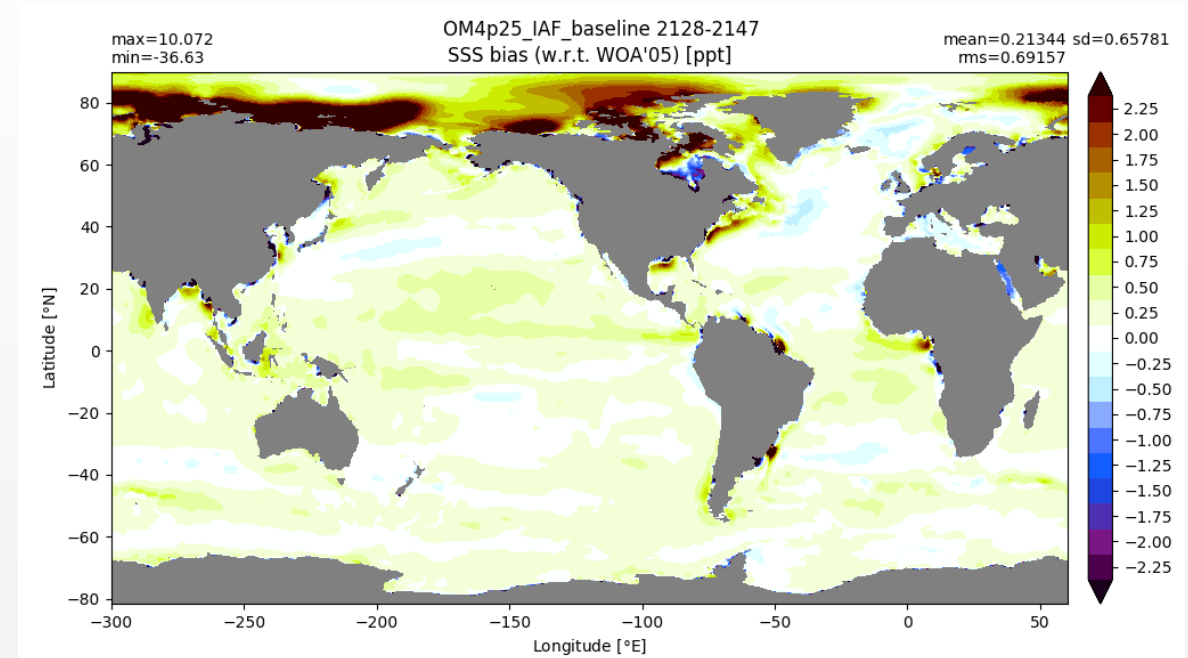
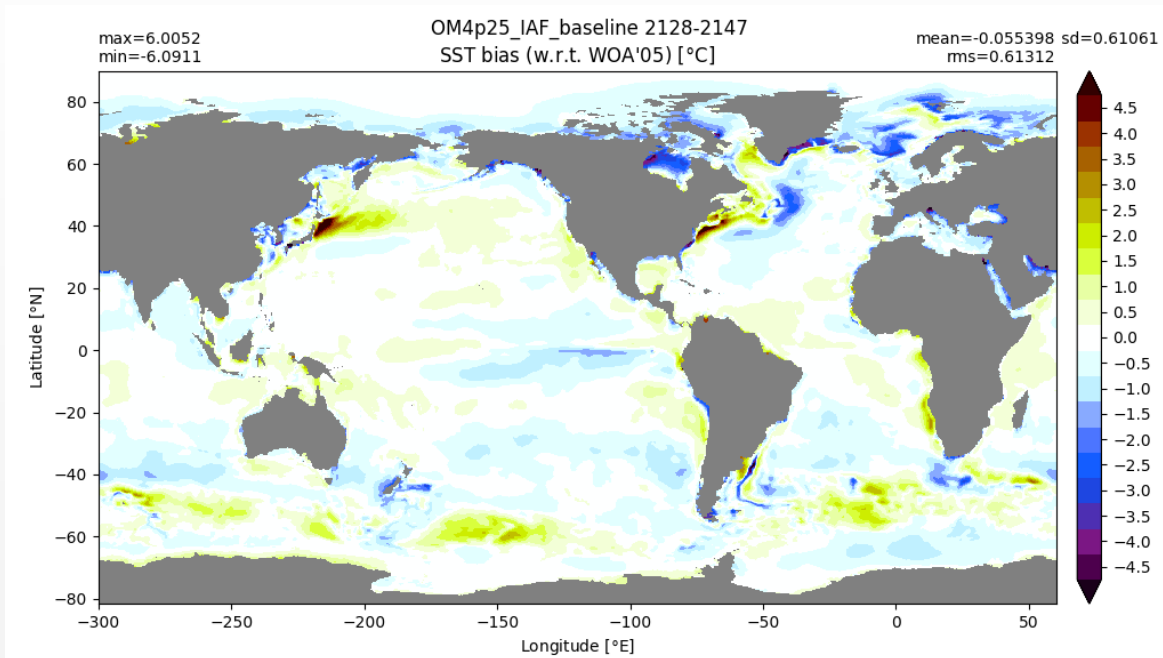


- JRA-55do was planned to start in November
  - Postponed due to JRA updates
- 5-cycles of OMIP CORE-II IAF
  - First time we ran OM4 IAF
  - All development made in coupled mode



- SST biases in OM4 only loosely related to CM4 biases

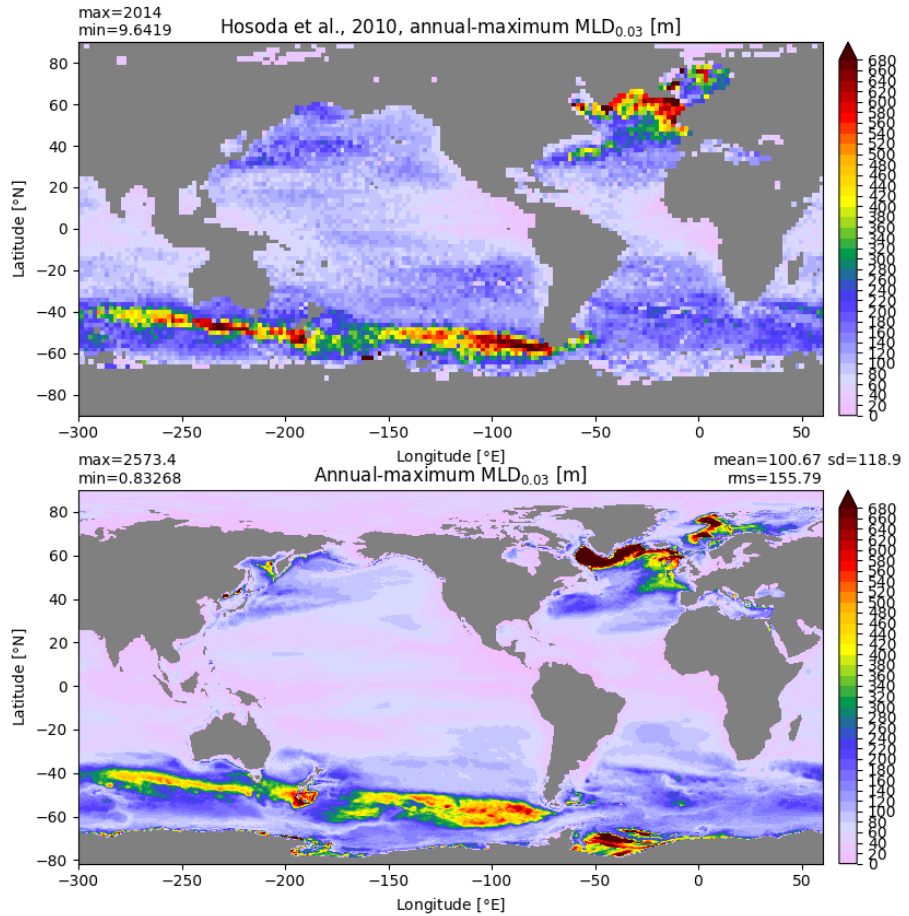
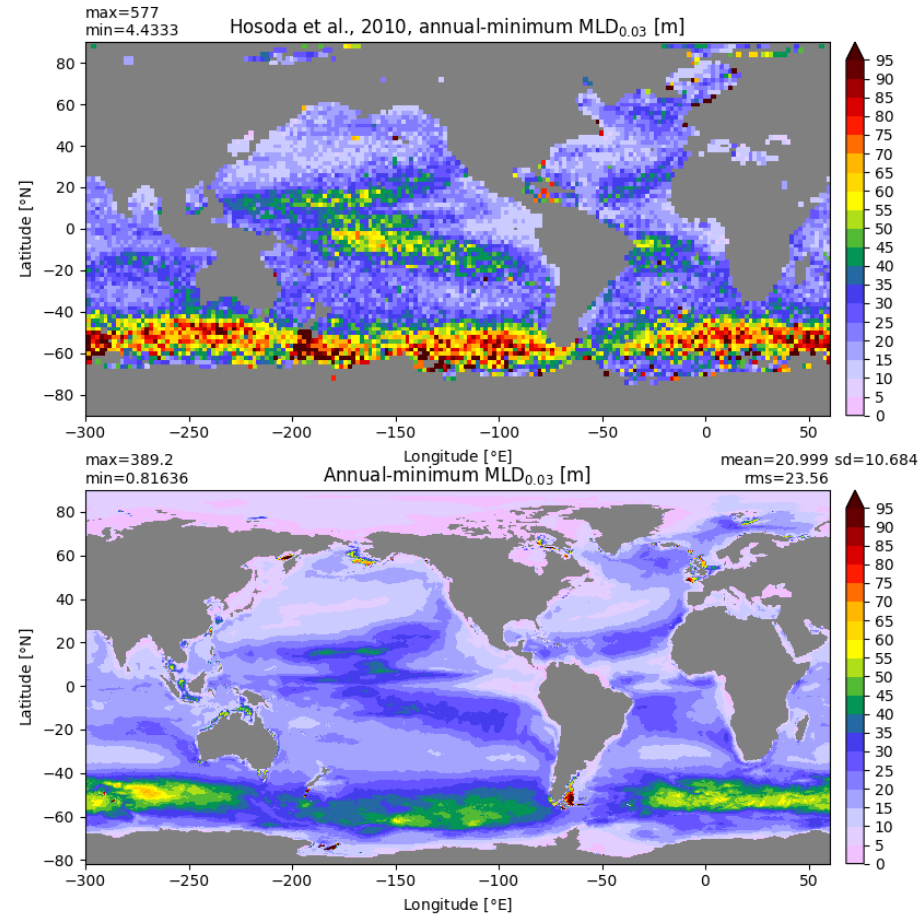
- Similar Arctic SSS biases in OM4 and CM4



# OM4 mixed layer

OM4p25\_IAF\_baseline 2128-2147

OM4p25\_IAF\_baseline 2128-2147



“Summer” mixed layer depth

“Winter” mixed layer depth

- CM4/ESM4 combine strengths of GFDL's CMIP5 generation of models into two, related models based on the same code with differing emphases on resolution and complexity.
- Expected CM4 strengths:
  - Surface climatology; ENSO variability; ENSO, AMO and PDO teleconnection patterns;
  - Reasonable historical climate change simulation;
  - Reduced drift compared to previous eddy-permitting GFDL model.
- Expected CM4 weaknesses:
  - NADW too shallow and warm as in previous models.
- OM4 (CORE-II IAF) looks respectable but still have to do full analysis.
- CM4 spin-up re-started on January 5<sup>th</sup> in attempt to fix polynya problem.