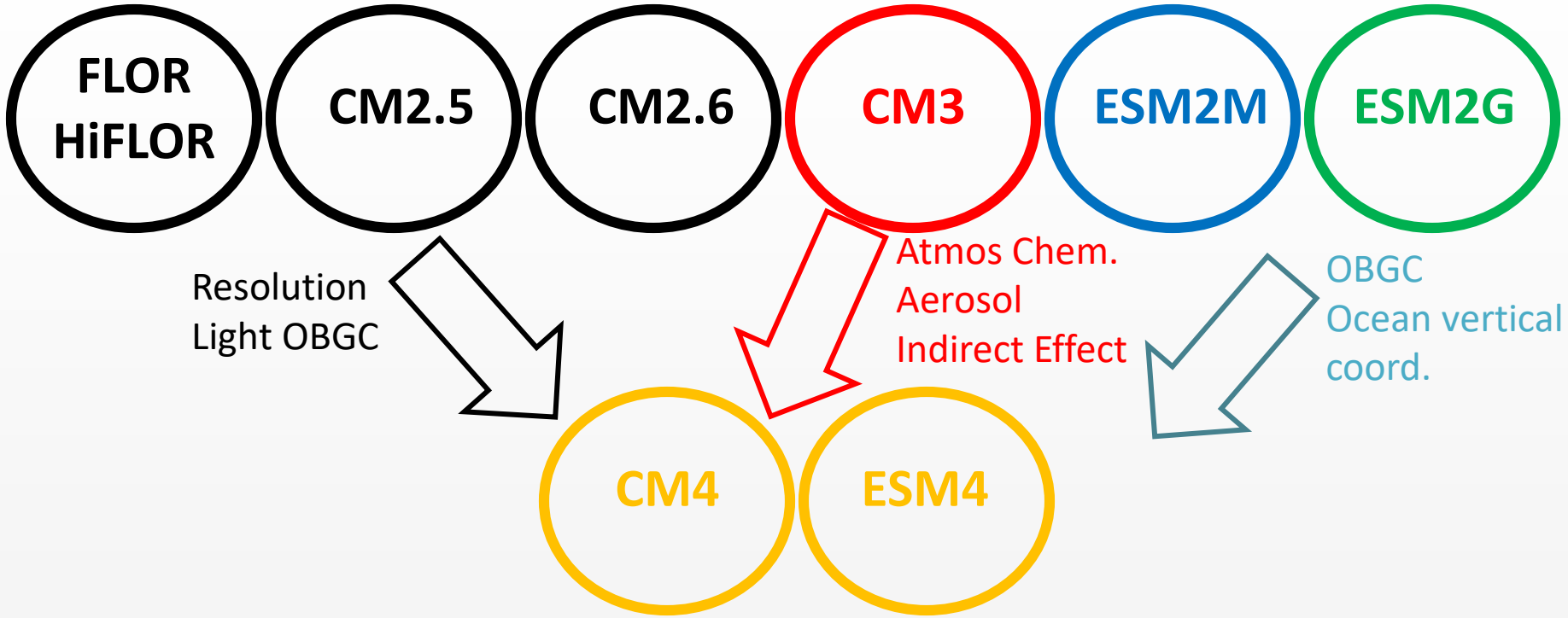
Status of CMIP6 and OMIP simulations at GFDL

Alistair Adcroft

CESM Ocean Model Working Group Meeting

Janurary 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

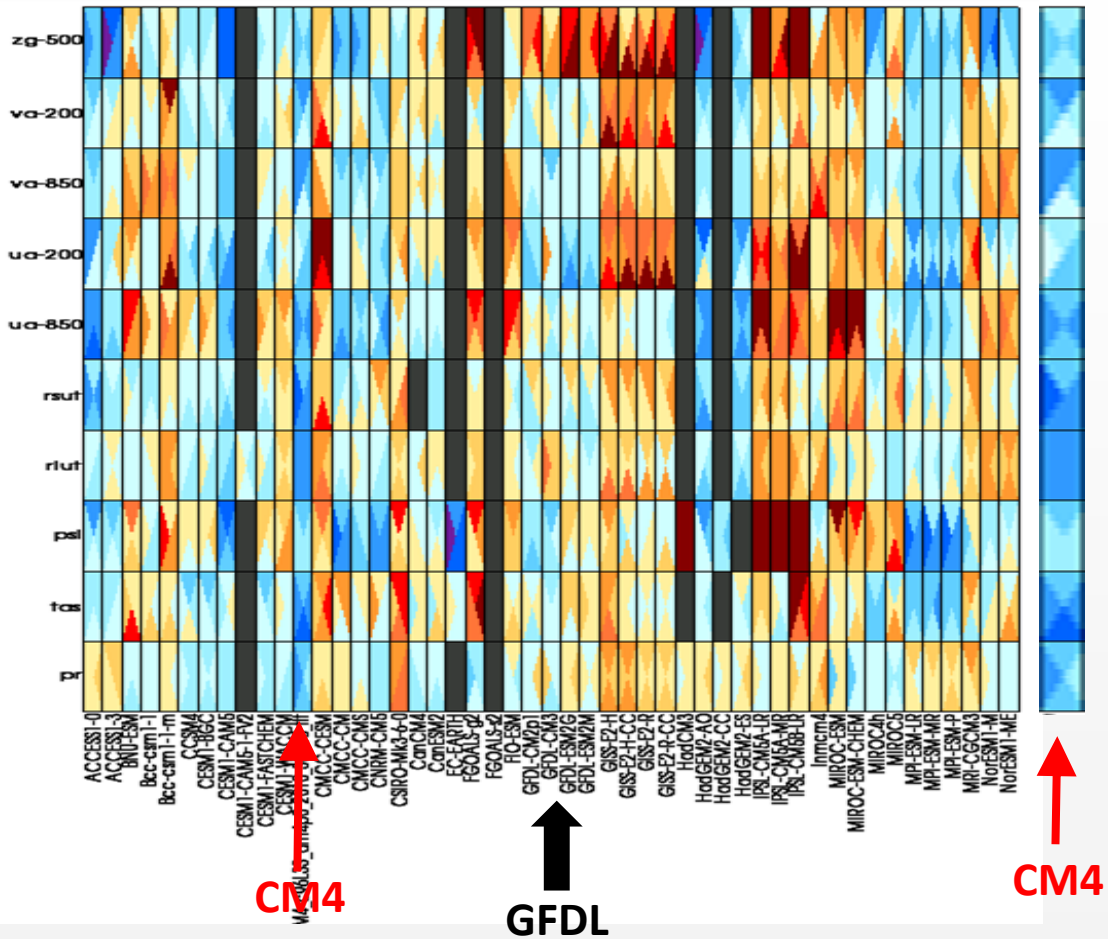
	CM4 (frozen, DECK re-started)	**ESM4(in final development)**
Atmosphere: AM4	100 km, 33 levels	100 km, 49 levels
Atmos. Chem	for aerosol (21 tracers)	aerosol+ozone (103 tracers)
Ocean: MOM6	1/4^{o}, 75 levels	1/2^{o}, 75 levels
Ocean BGC	BLINGv2 (6 tracers)	COBALTv2 (30 tracers)
Land	LM4.0	LM4.1 - PPA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

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

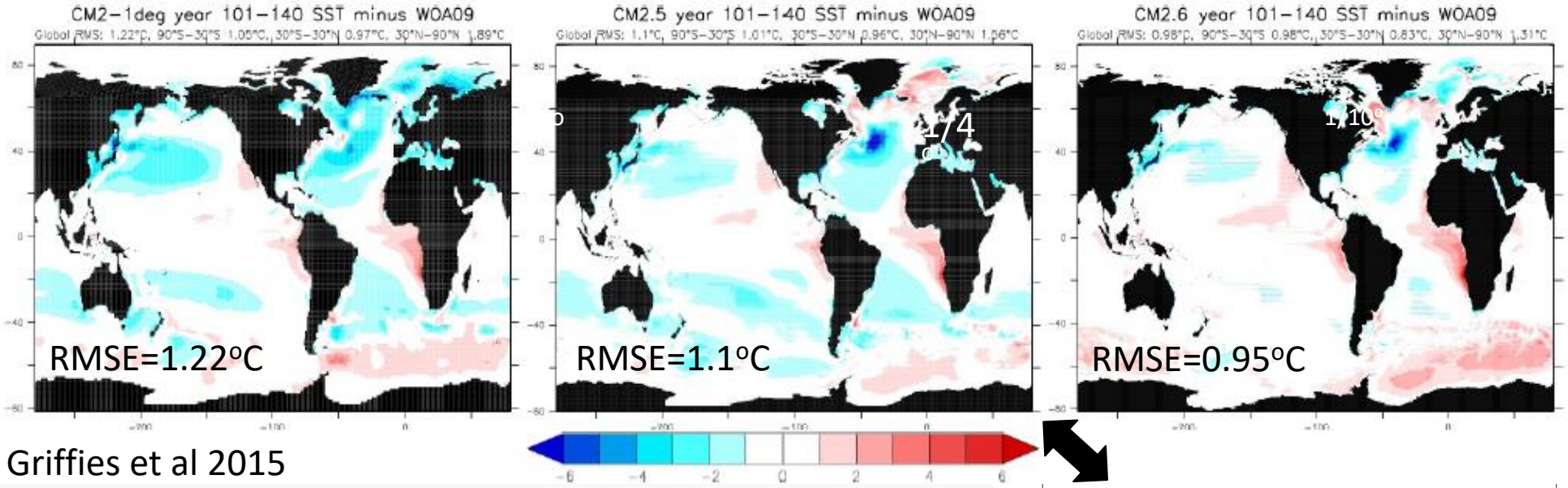
Note: All CM4 results shown are *preliminary* (based on potential vegetation historical, 1850- and 2010-forced experiments).

CM4 Surface Climate

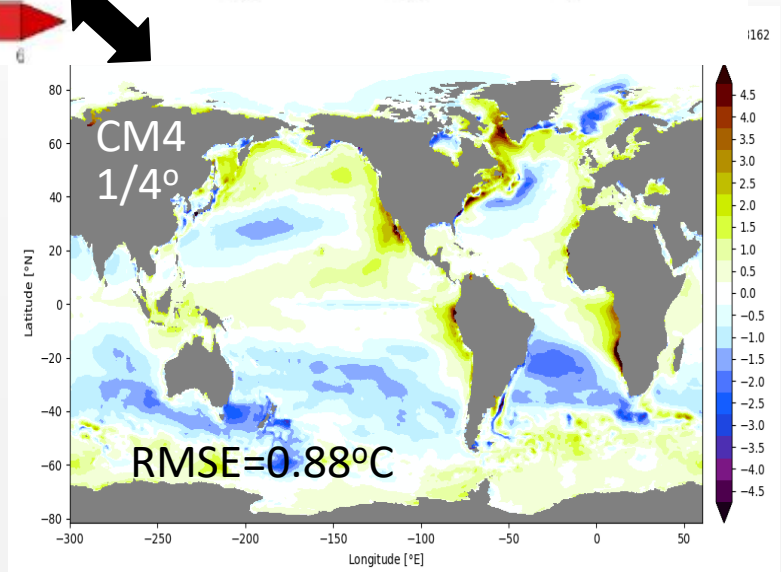
- CM4's climatology is a distinct improvement over previous GFDL models
- CM4 temp., precip., OLR and reflected SW are the best in this CMIP5 ensemble
- Wind fields are good but not the best



CM4 SST errors



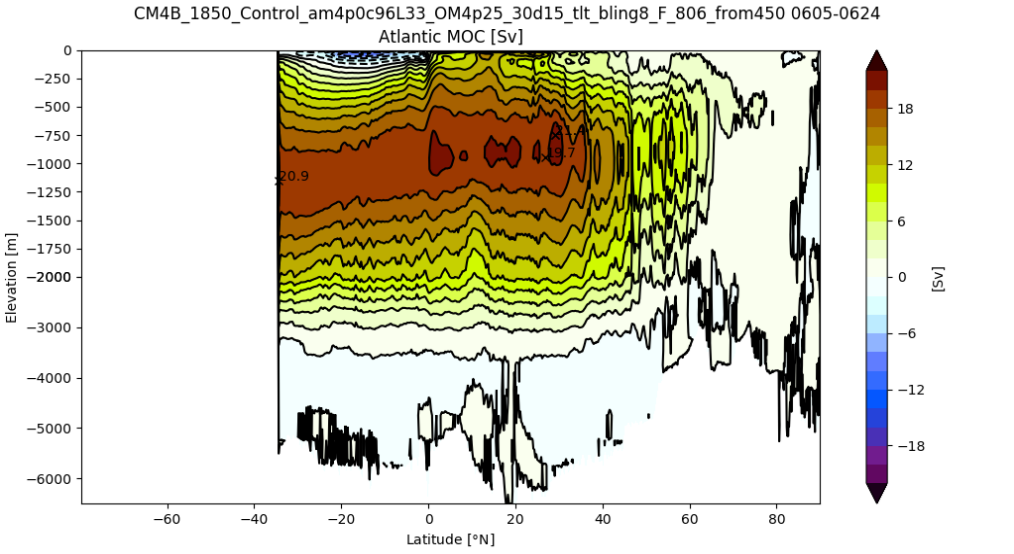
Griffies et al 2015

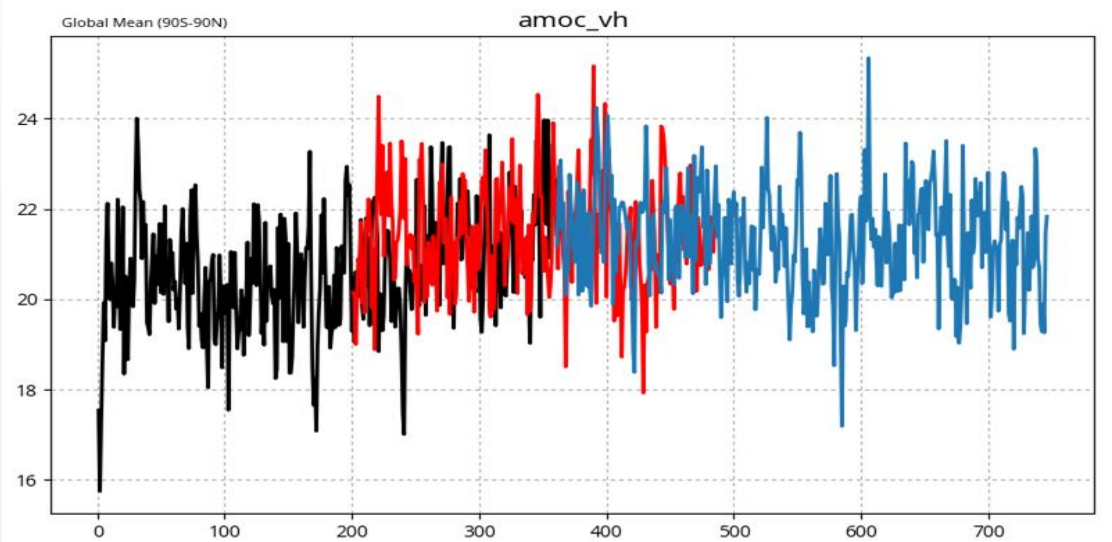


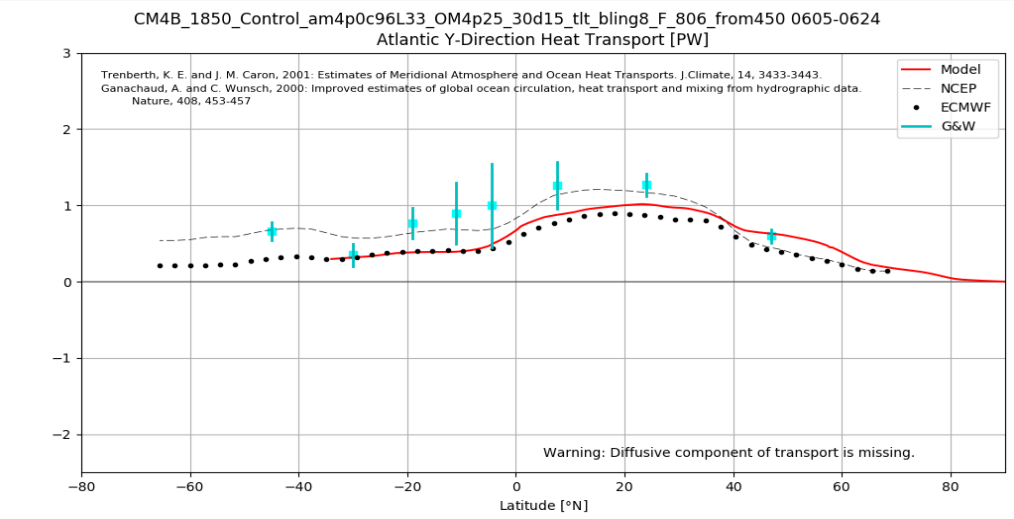
- CM4's SST errors are similar to CM2.6 (GFDL's previous best simulation)
- We expect these can be improved further with higher ocean resolution as was seen going from CM2.5 to CM2.6 or with an eddy parameterization

AMOC Simulation

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

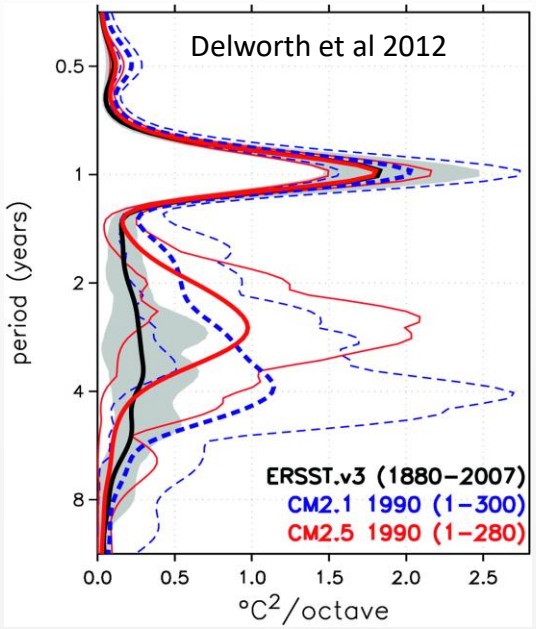




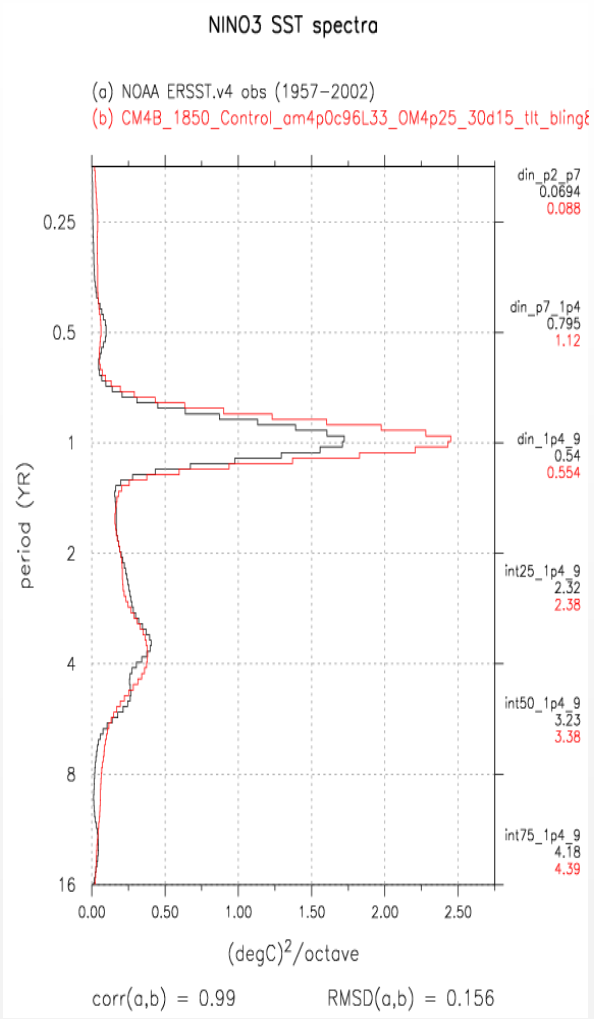


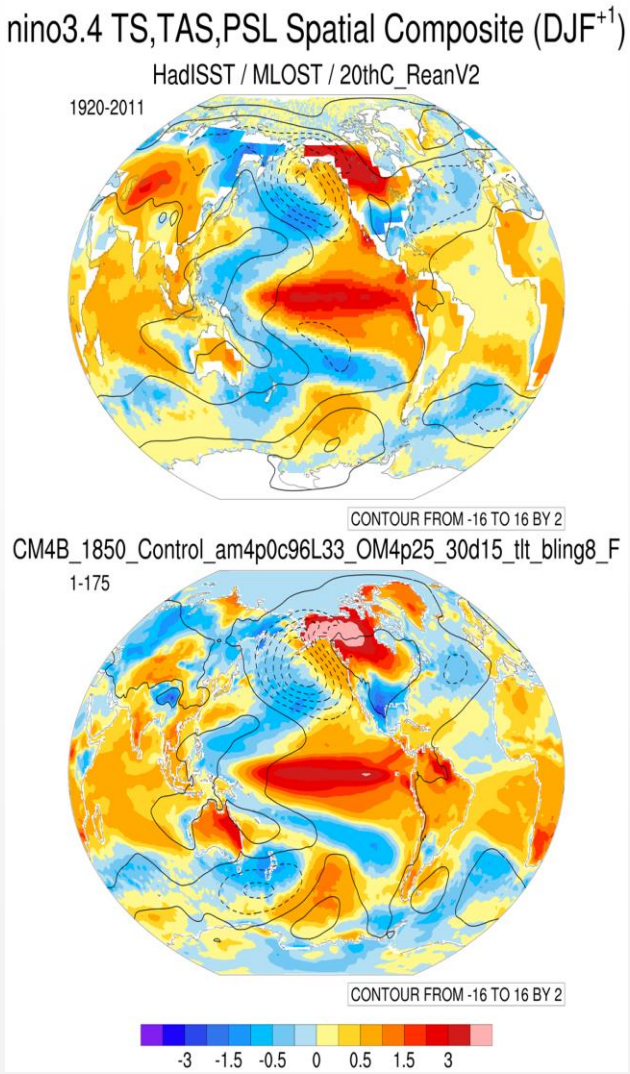
Variability: Improved ENSO

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

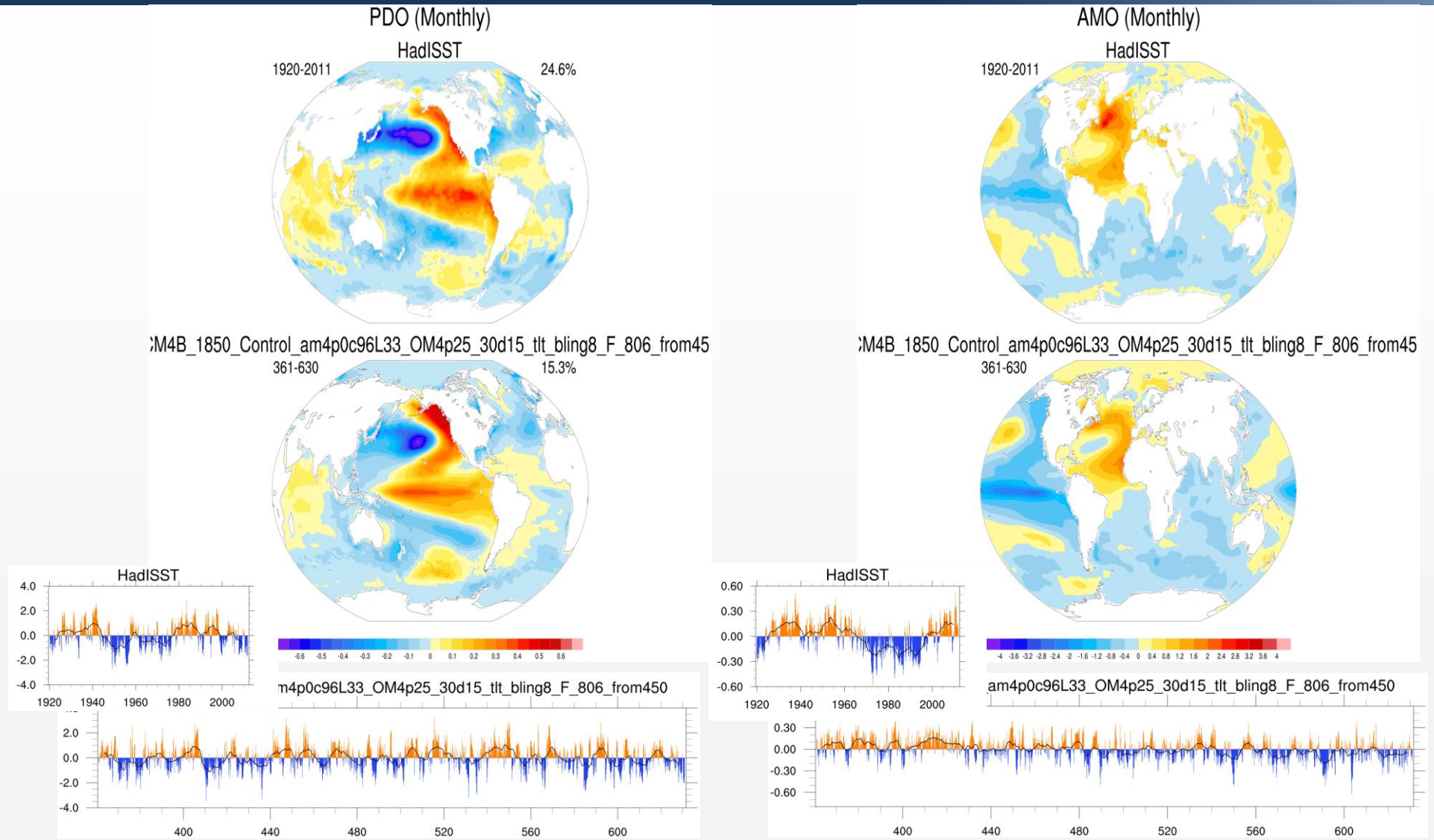


- ENSO teleconnection pattern is well simulated



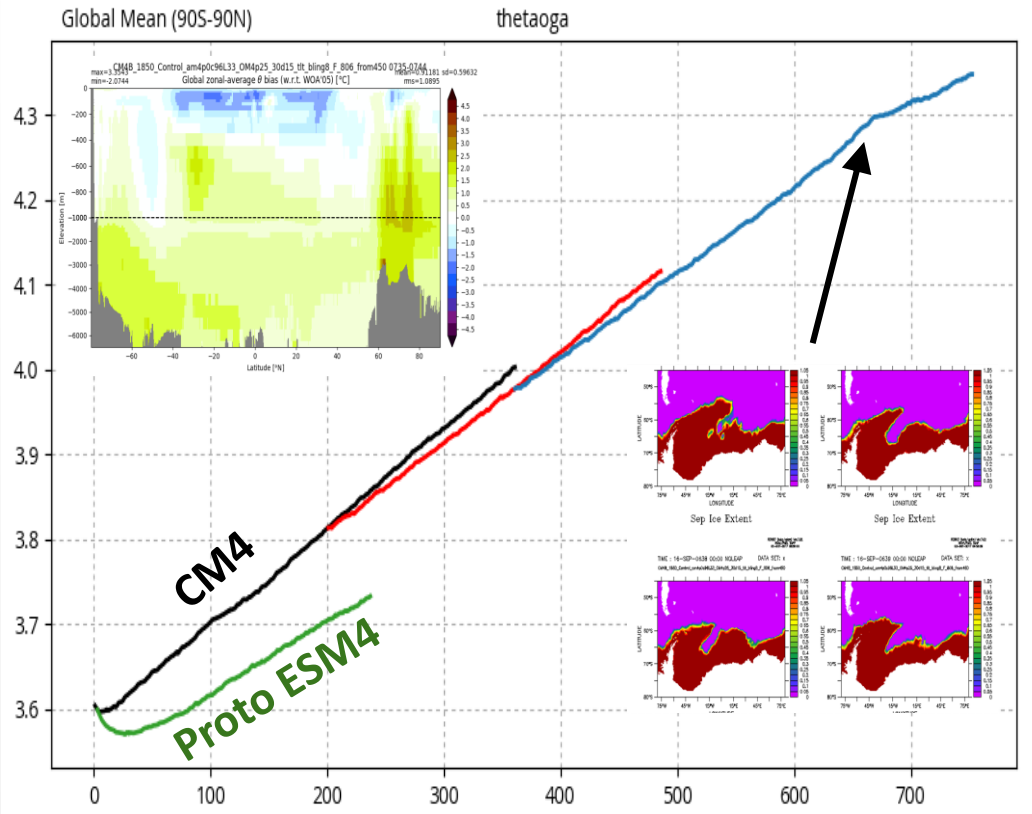


Variability: PDO / AMO patterns are well-simulated



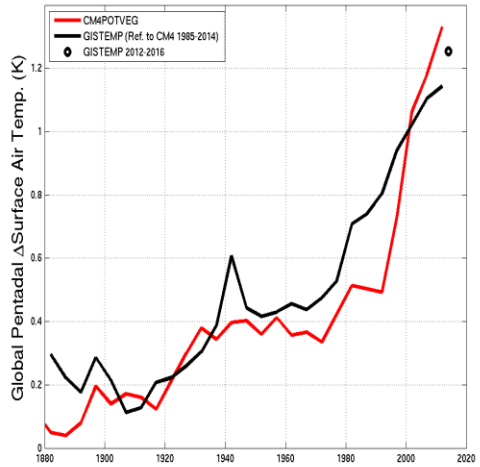
Global Ocean Temperature Drift

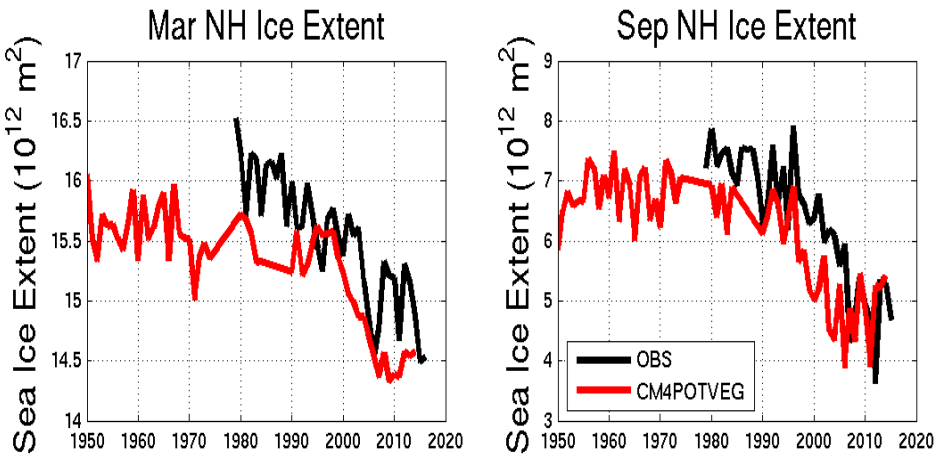
- Heat uptake is less than CM2.5 (also using 1/4° ocean)
- Heat uptake is less than the difference in heat uptake between CM2.6 and CM2.5 (eddy-permitting res. effect)
- Warming of deep water points to inadequacy of deep water formation representation (in both hemispheres)



Historical Simulation: NH Sea Ice Extent

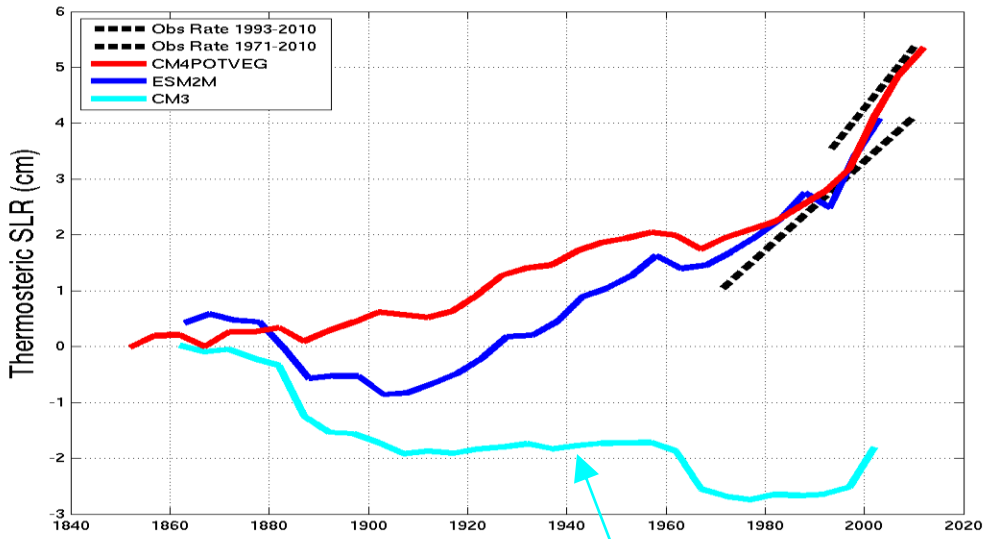
- Historical warming roughly consistent with observed with possible exception of post-Pinatubo period.
- Good simulation of NH extent and its satellite era trend.
- SH sea ice low biased in summer, high biased in winter; recent observed increase is not simulated

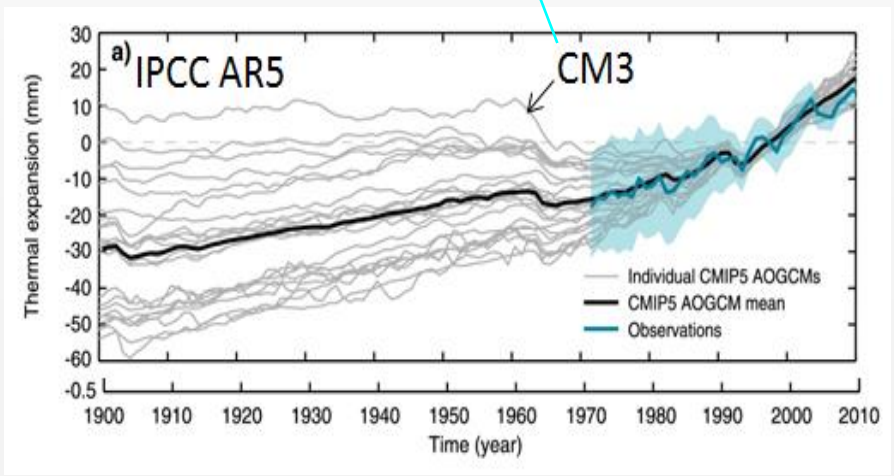




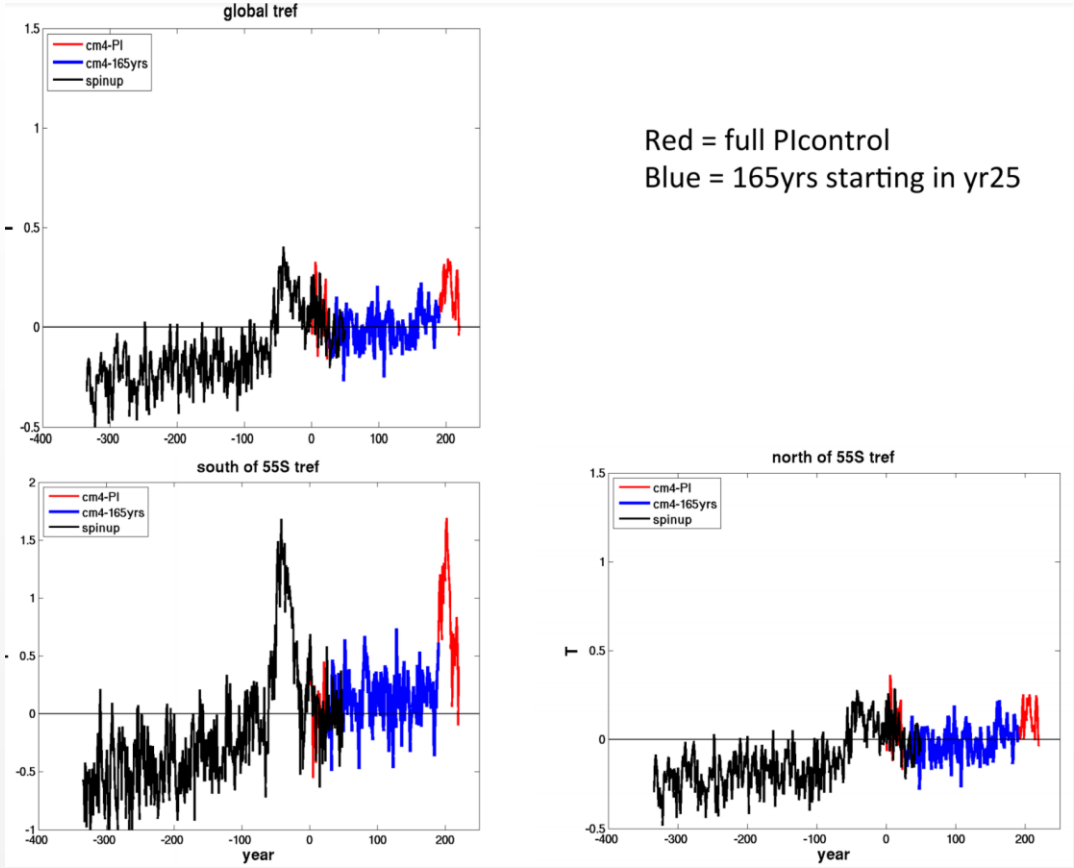
Thermosteric Sea Level Rise

- 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





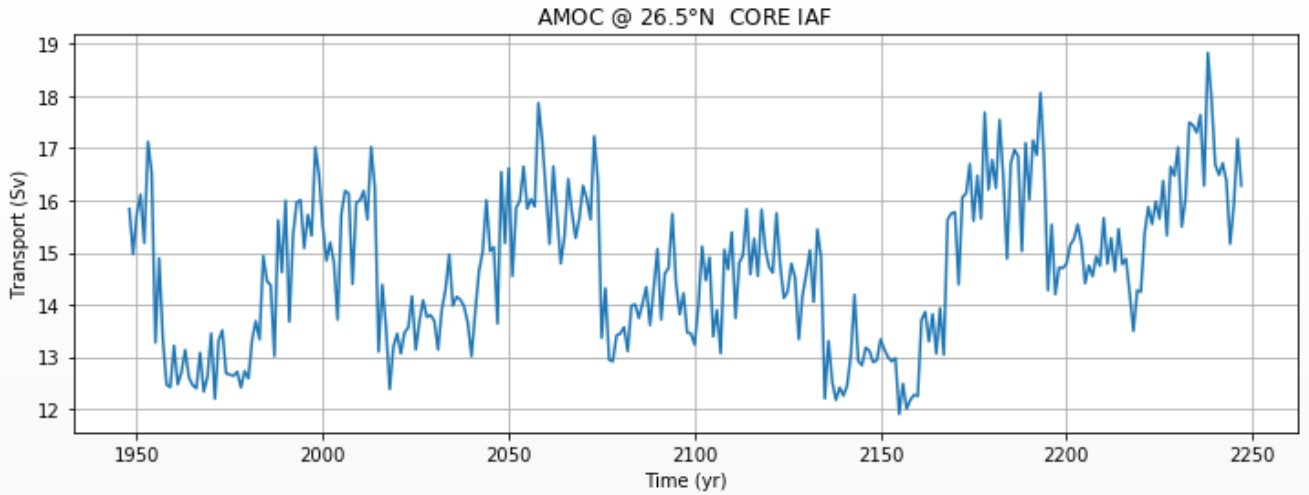
Plan “B”

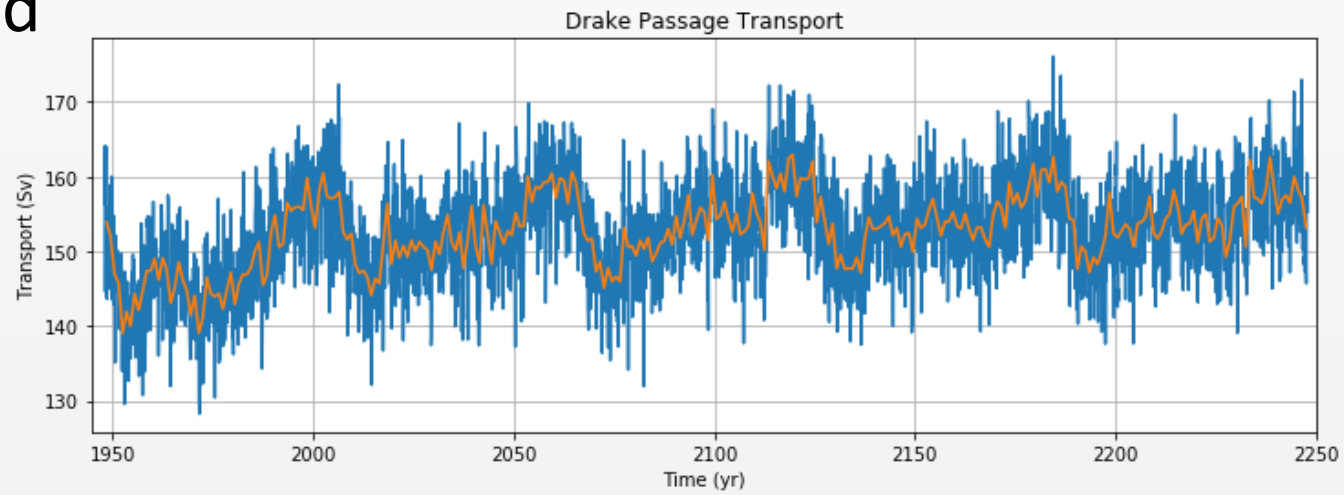


- Polynyas developed after the spin-up during the control
  - First in Weddell Sea
  - Third and largest in Ross Sea
- Lack of AABW found to be connected to a snow-on-glacier albedo being too dark
- Trying an alternative spin-up in January

OMIP status

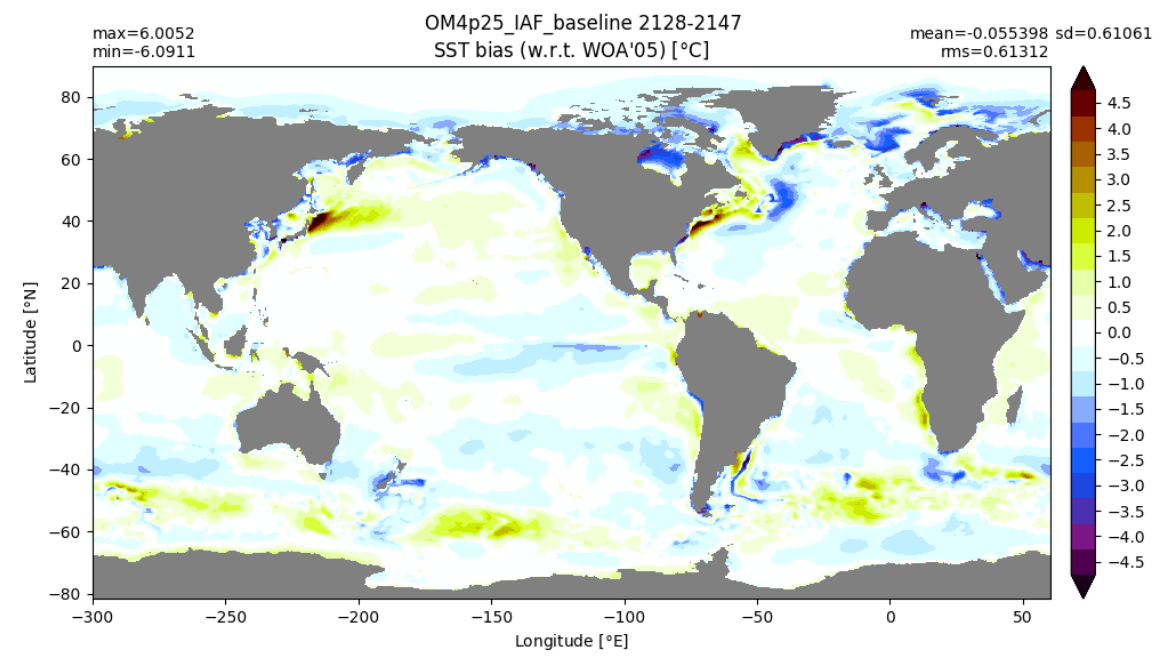
- JRA-55do was planned to start in November
  - Postponed due to JRA updates
- 5-cycles of OMIP CORE-II IAF
  - First time we ran OM4 IAF
  - All development made in coupled mode

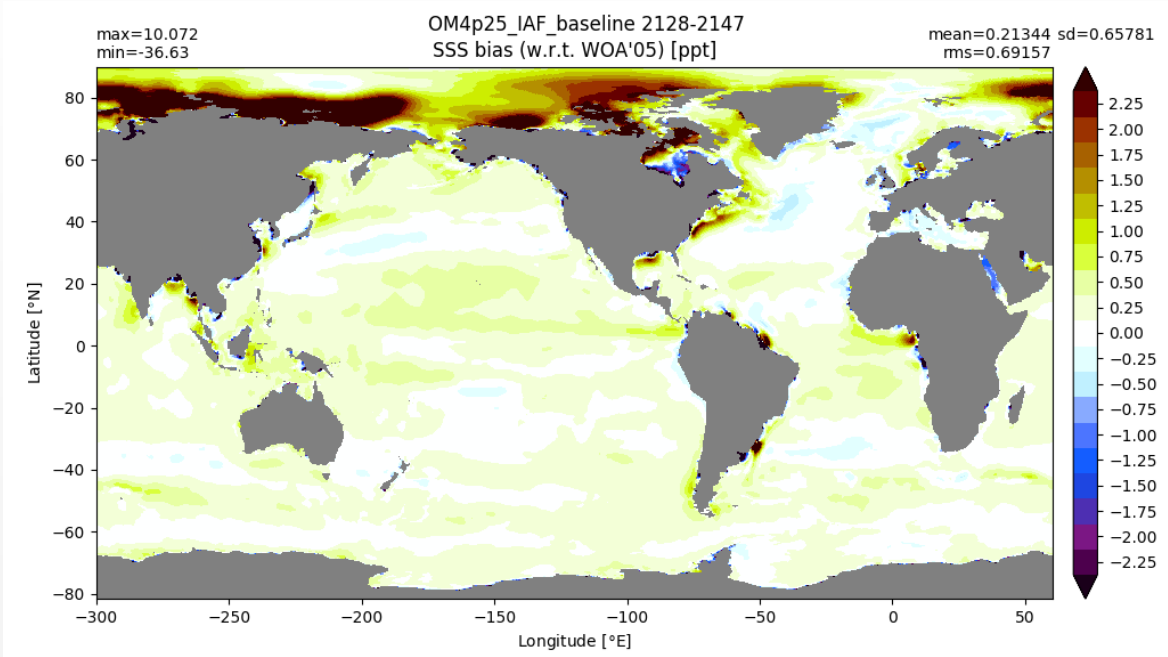




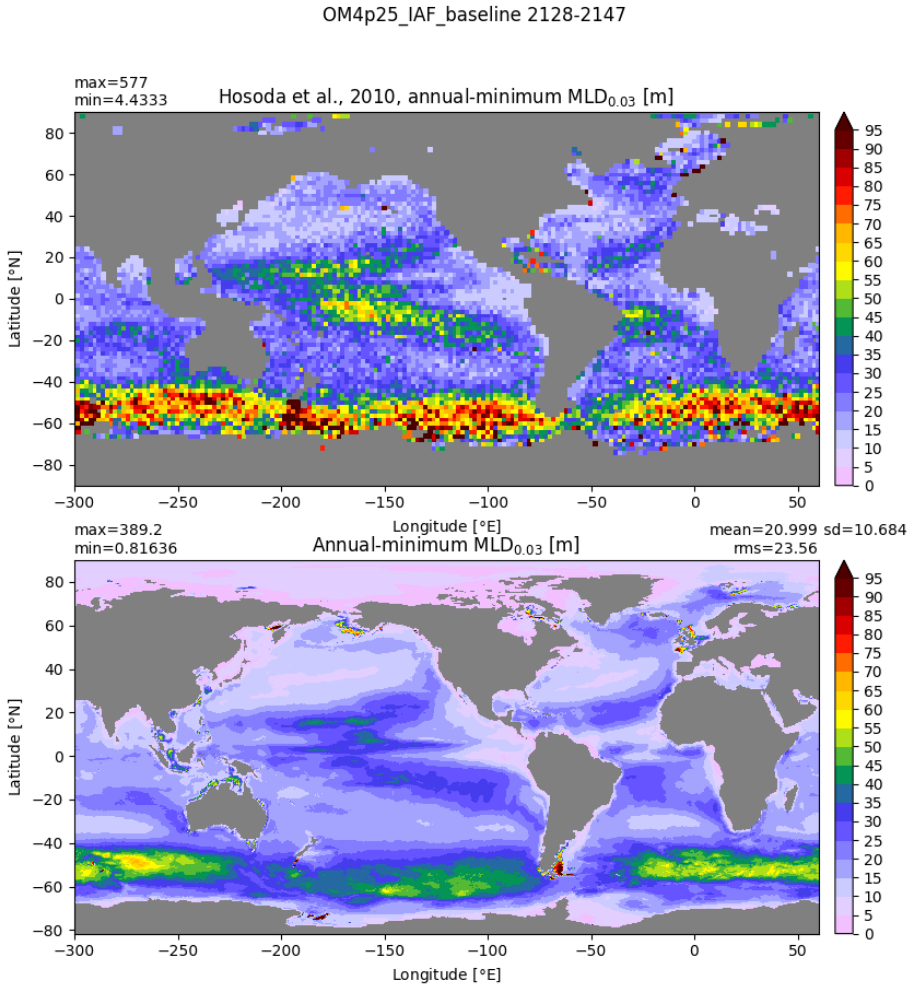
OM4 surface biases

- SST biases in OM4 only loosely related to CM4 biases
- Similar Artic SSS biases in OM4 and CM4

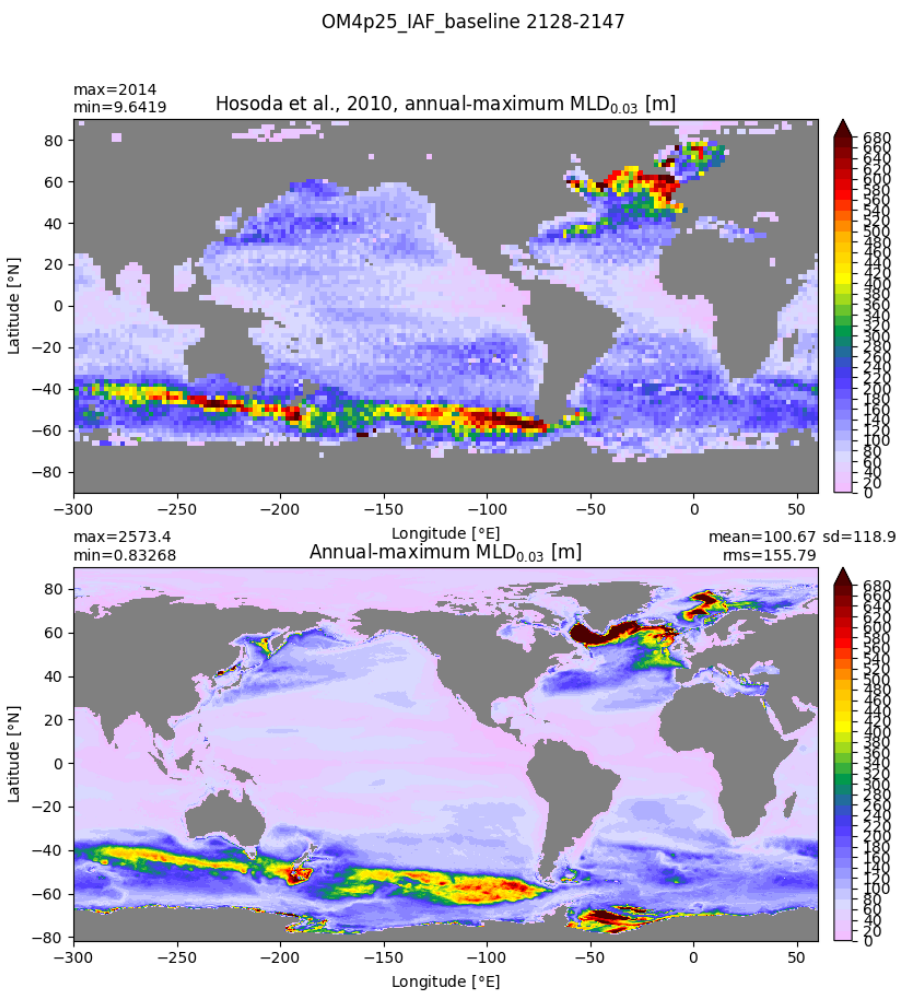




OM4 mixed layer



"Summer" mixed layer depth



"Winter" mixed layer depth

Summary

- 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 respectible but still have to do full analysis.
- CM4 spin-up re-started on January 5th in attempt to fix polynya problem.