HYCOM global simulations with CORE forcings on icosahedral and logically rectangular grids

Shan Sun[1] and Rainer Bleck[1,2]

[1]NOAA Earth System Research Laboratory

[2]NASA Goddard Institute for Space Studies

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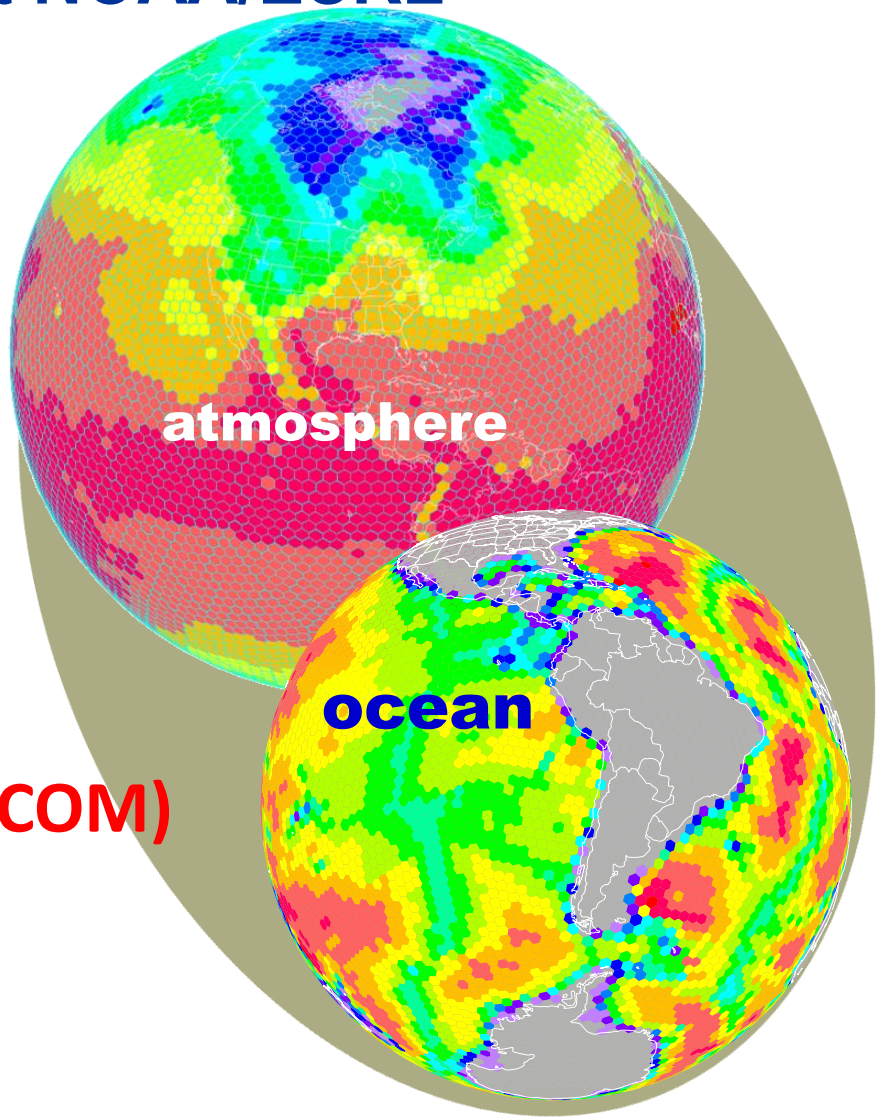
Coupled Atmospheric-Ocean Modeling on an Icosahedral Grid at NOAA/ESRL

Flow-following* finite volume Icosahedral Model (FIM)

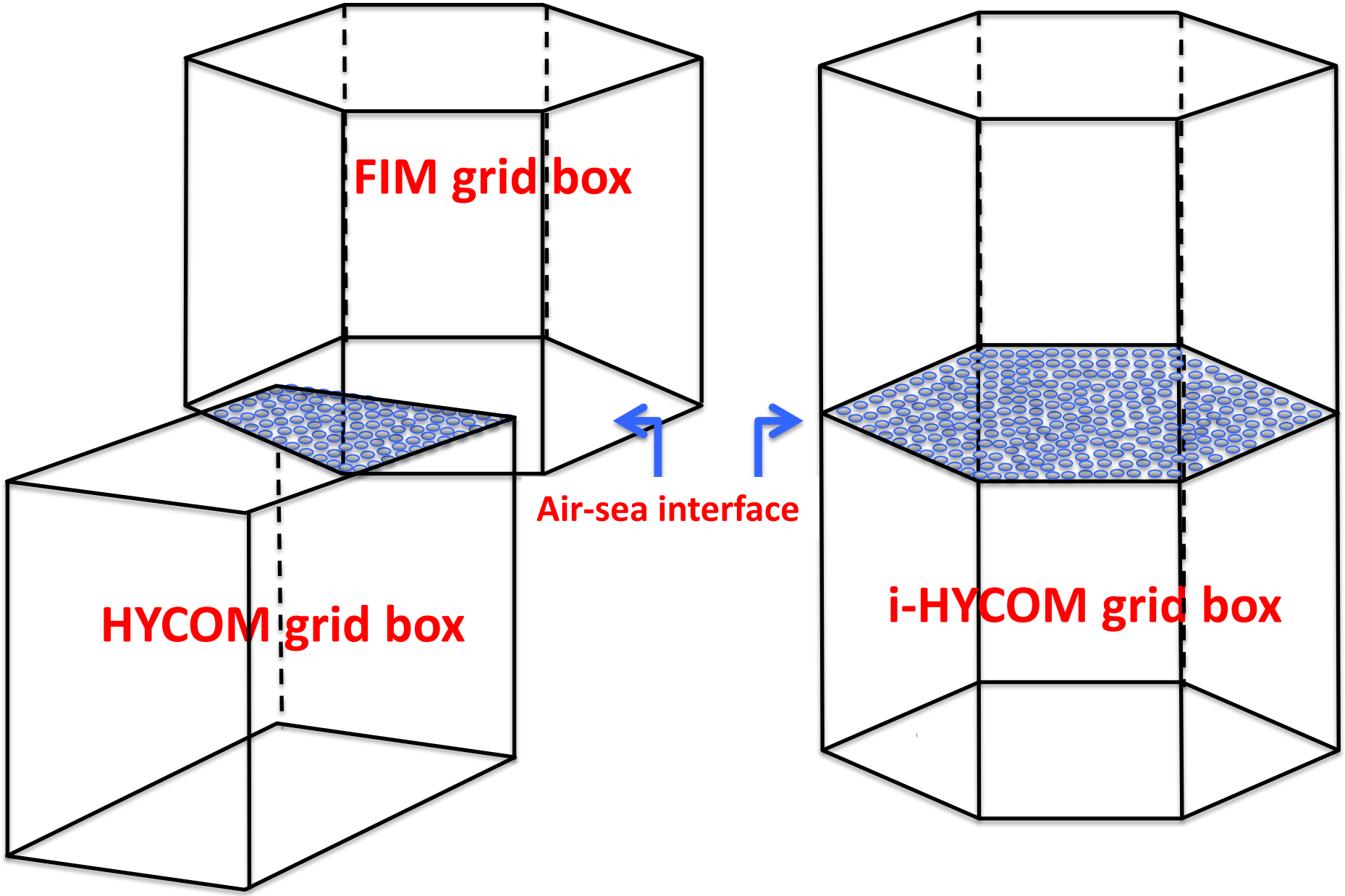
Icosahedral Ocean Model (i-HYCOM)



* flow-following = vertically quasi-Lagrangian

Coupled Atmosphere/Ocean at NOAA/ESRL

- **FIM atmospheric model**
  - Flow-following, finite volume, quasi-Lagrangian vertical coordinate, hydrostatic dynamics
  - On the icosahedral horizontal grid
  - Developed at NOAA/ESRL in collaboration with NCEP: GFS column physics
  - Running operationally with comparable scores to NCEP GFS **(http://fim.noaa.gov)**
- **i-HYCOM ocean model: icos HYCOM**
  - HYCOM ocean model rewritten for icosahedral grid
  - Sharing multiprocessor environment developed for FIM
  - No need for flux coupler at the air-sea surface


FIM grid box
HYCOM grid box
Air-sea interface
i-HYCOM grid box

Goal: improved S2S (subseasonal to seasonal) forecast

Experiments for seasonal forecast: coupled FIM/i-HYCOM

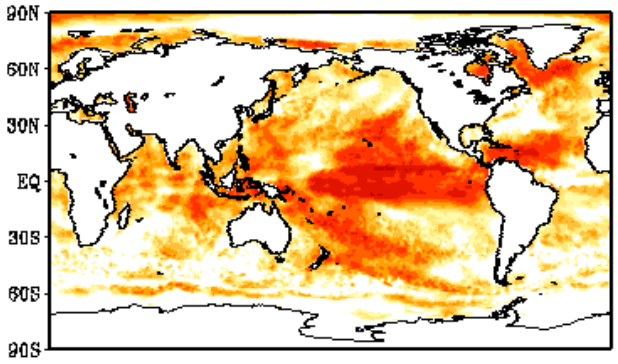
- Horizontal resolution: 60km
- Vertical: Atmos: 64 layers
  - Ocean: 26 layers
  - Both using vertically adaptive grid
- Initial conditions: CFSR atmos & ocean
- Initial time: August 1st, 1982:2010
- Ensemble members 1 for each August 1st
- Forecast duration: 9 months

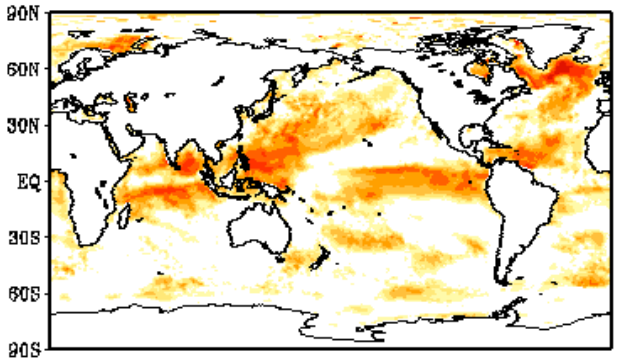
Anomaly Correlation of SST prediction with Aug ICs

SON (1 month lead)

DJF (4 month lead)

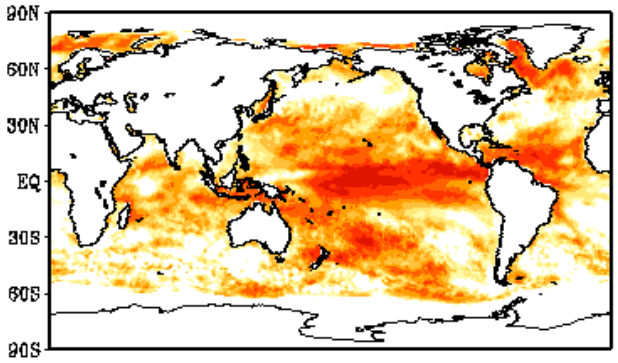
FIM
1 member



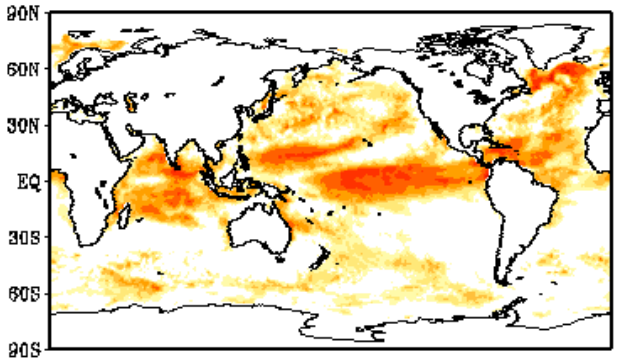


CFSv2
1 member

CFSv2 1 member (Aug IC for SON)

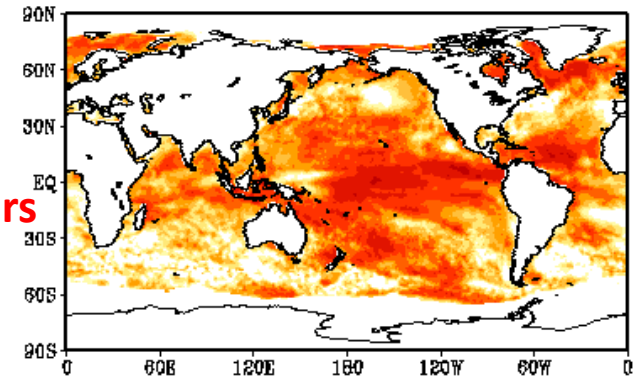


CFSv2 1 member (Aug IC for DJF)

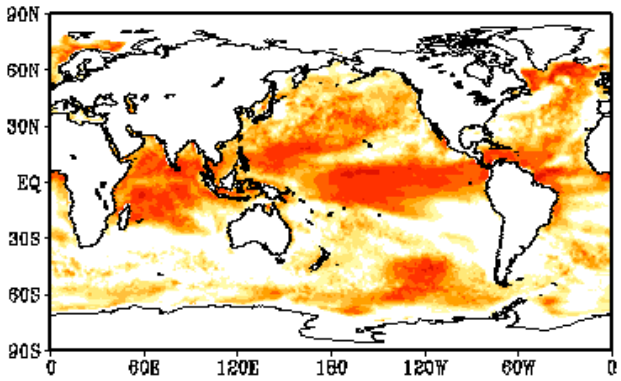


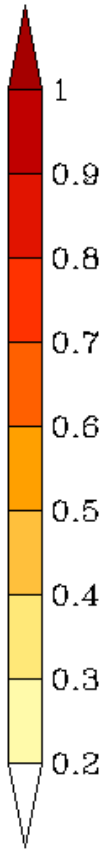
CFSv2
10 members

CFSv2 10 member (Aug IC for SON)



CFSv2 10 member (Aug IC for DJF)





Model Inter-comparison Setup

	HYCOM	i-HYCOM
Horizontal grid	Mercator (lat <= 57^{O}N): 1^{o}x1^{o}cos(lat) Bipolar (lat>57^{O}N): 30km at NP	0.5^{o} Icosahedral
Grid staggering	C-grid	A-grid
Mode splitting	yes	no
Vertical grid	Hybrid pres & isopycnic 26 layers	same
Initial conditions	Observed climatology temperature & salinity	same
Atmospheric forcings	CORE2	same
Conservation properties	T/S conserving	same

Prescribed Atmospheric Forcings

Common Ocean-ice Reference Experiments (CORE) II

years 1949 – 2008; cycled

- 6-hourly fields: 2m air temperature and humidity, surface U/V wind;
- Daily fields: downward shortwave & longwave;
- Monthly fields: precipitation (& sea surface salinity);
- Annual field: runoff

version 2 forcing for common ocean-ice reference experiments (core)

Datasets on this page are sponsored by the CLIVAR Working Group for Ocean Model Development (WGOMD) for use in their Common Ocean-ice Reference Experiments (CORE). There are datasets just for the interannually varying forcing (IAF), as developed by Large and Yeager (2008) at NCAR. The datasets are Version 2 of the CORE-IAF. This web page is maintained by GFDL scientists in collaboration with NCAR for use by the international modeling community.

Documentation

Support Code

Support data

Corrected Inter-Annual Forcing Version 2.0 (CIAF)

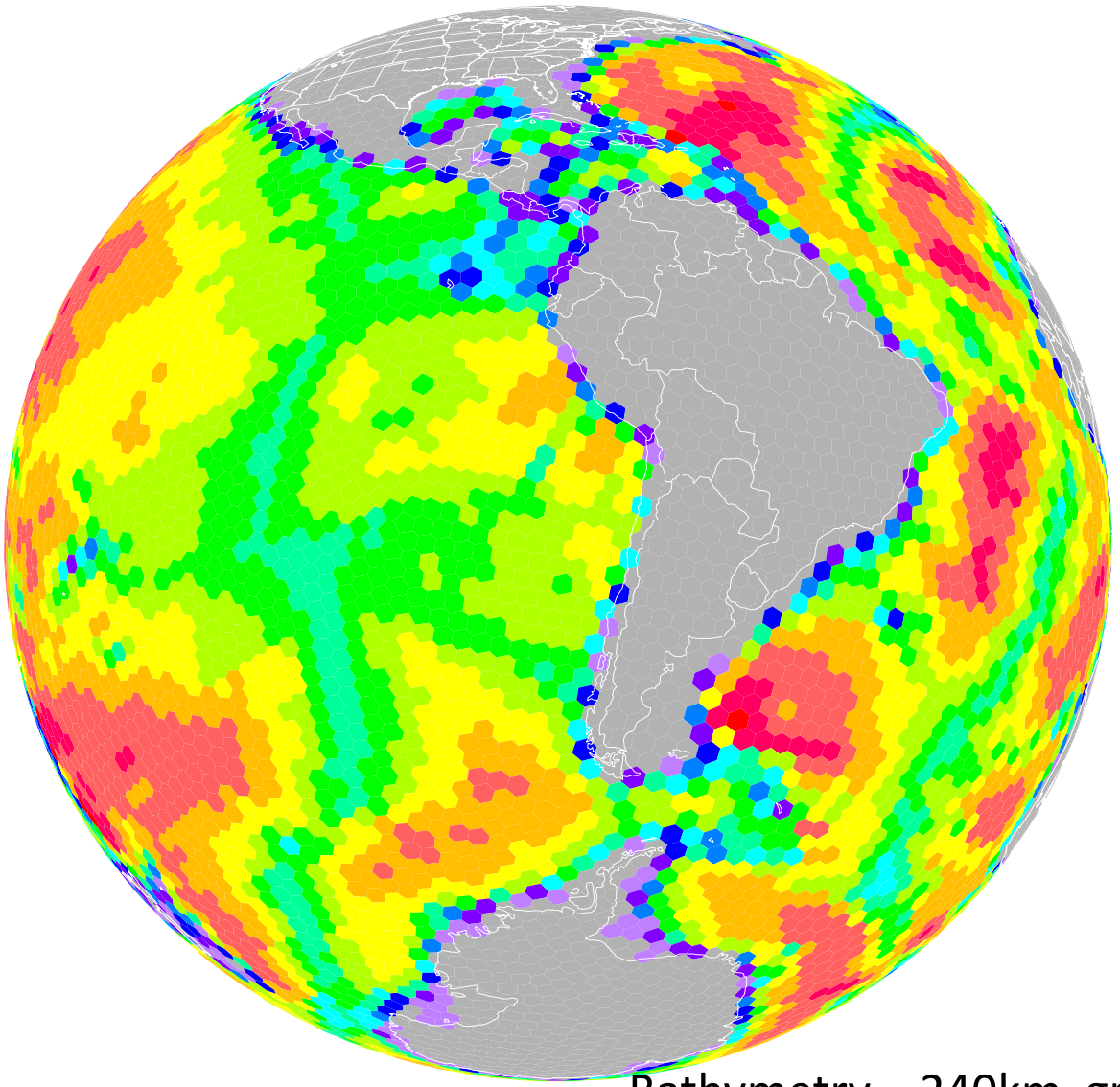
un-Corrected Inter-Annual Forcing Version 2.0 (unCIAF)

Corrected Normal Year Forcing Version 2.0 (CNYF)

un-Corrected Normal Year Forcing Version 2.0 (unCNYF)

HYCOM on icosahedral grid: **i-HYCOM**

Many hexagons and 12 pentagons (always 12, regardless of grid resolution)

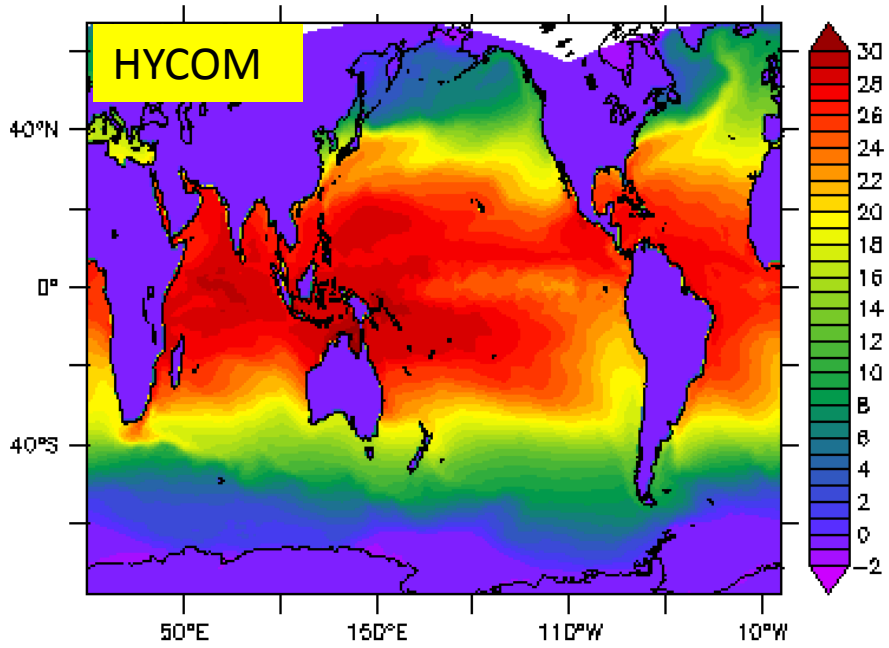


Bathymetry – 240km grid resolution (before closing Panama isthmus)

Simulation at Year 100

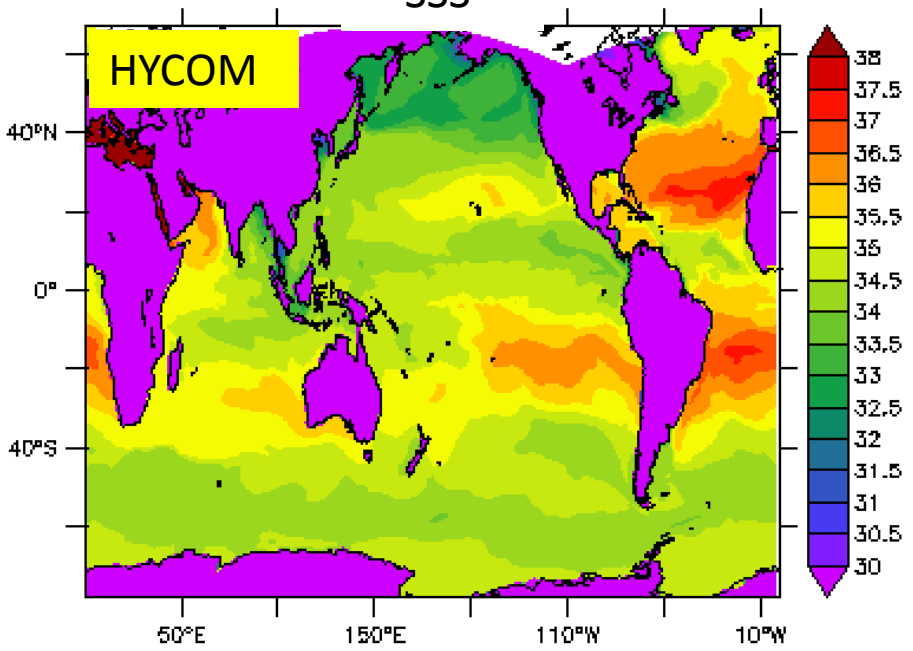
SST

HYCOM



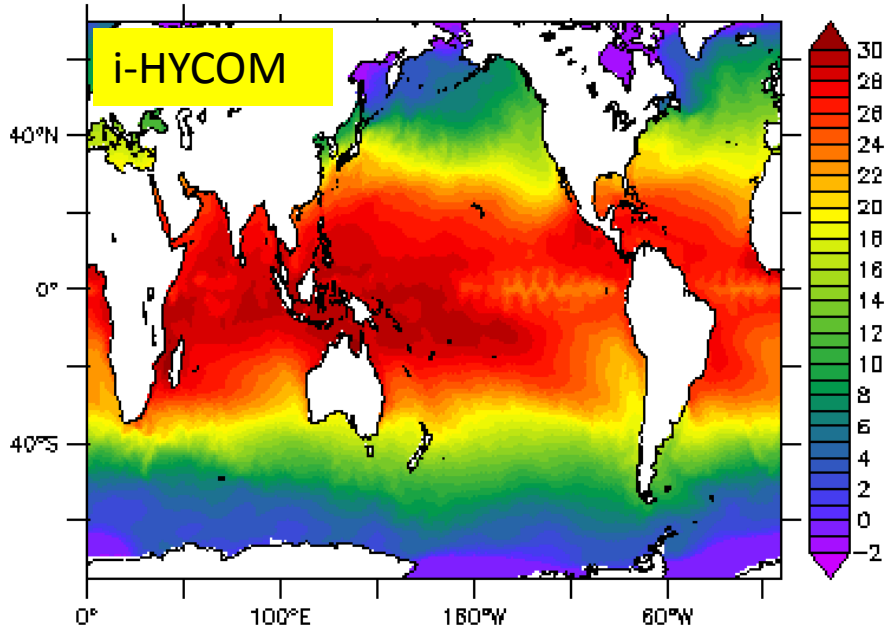
SSS

HYCOM



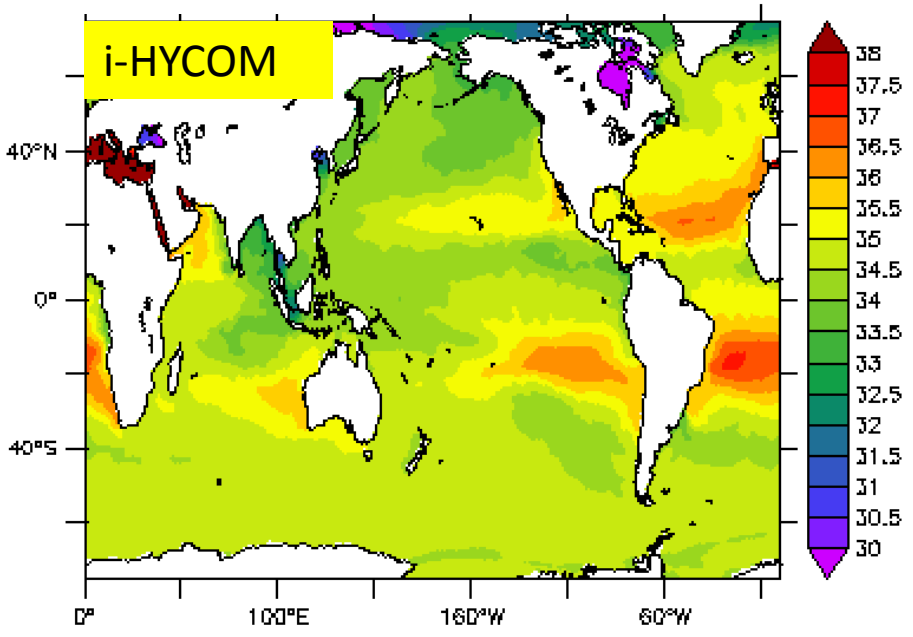
SST

i-HYCOM



SSS

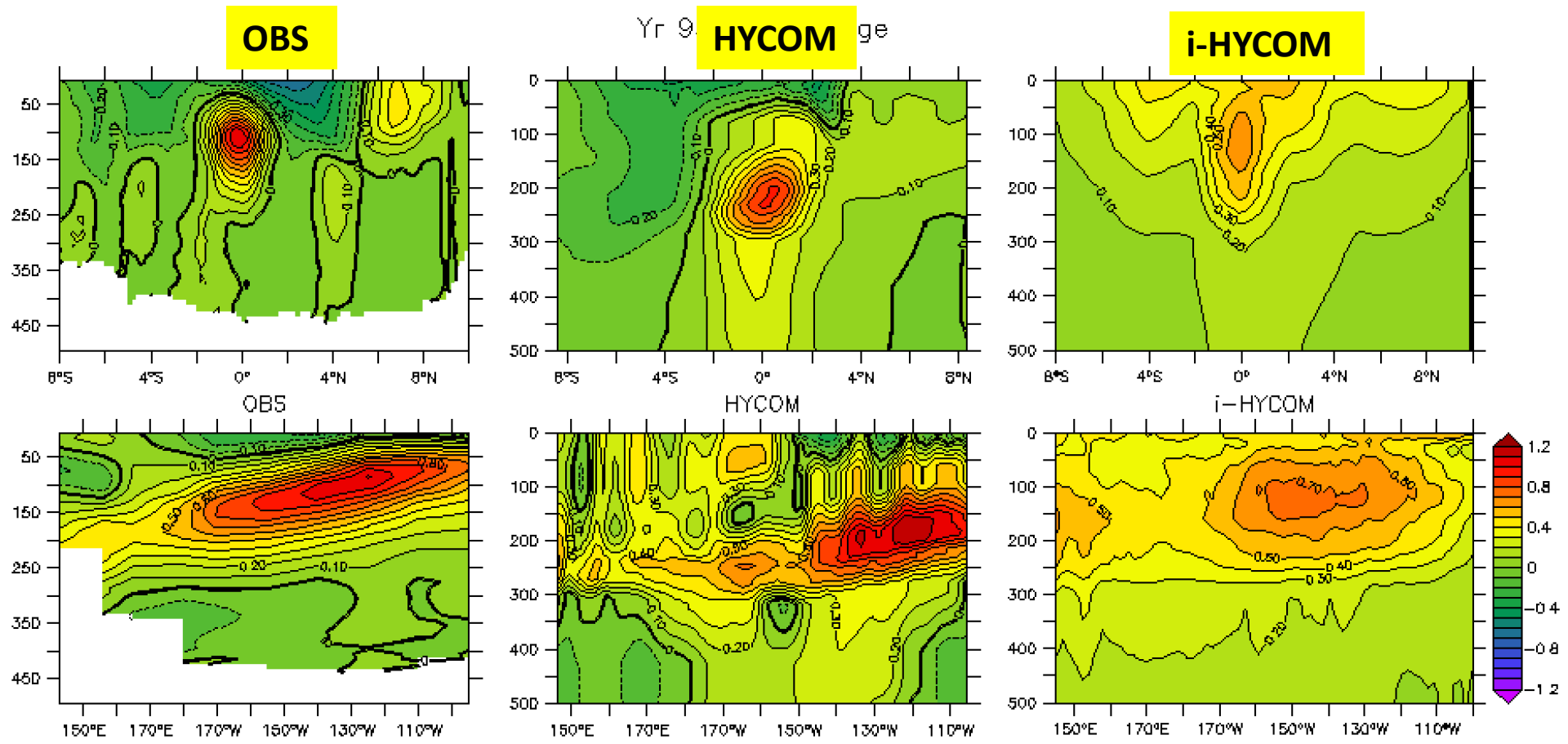
i-HYCOM



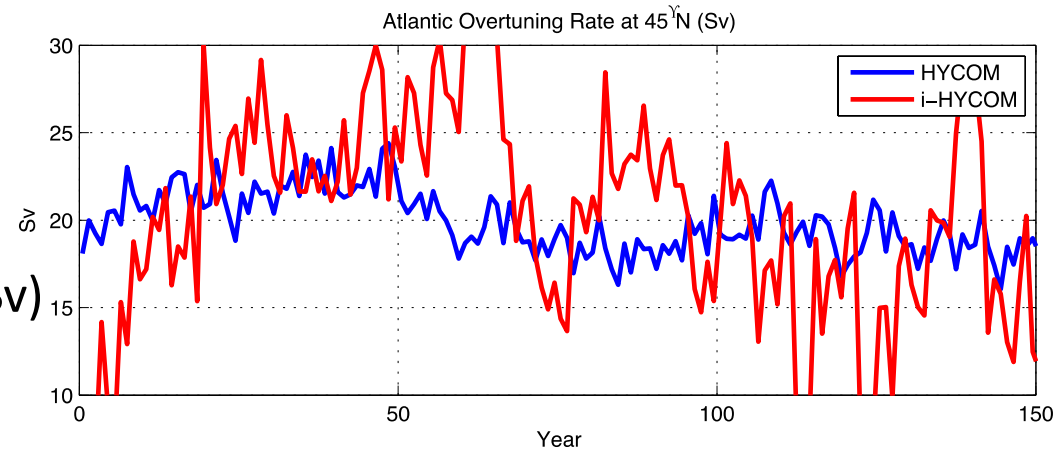
Simulation at Year 95:100

Eastward velocity (m/s) cross-sections against depth

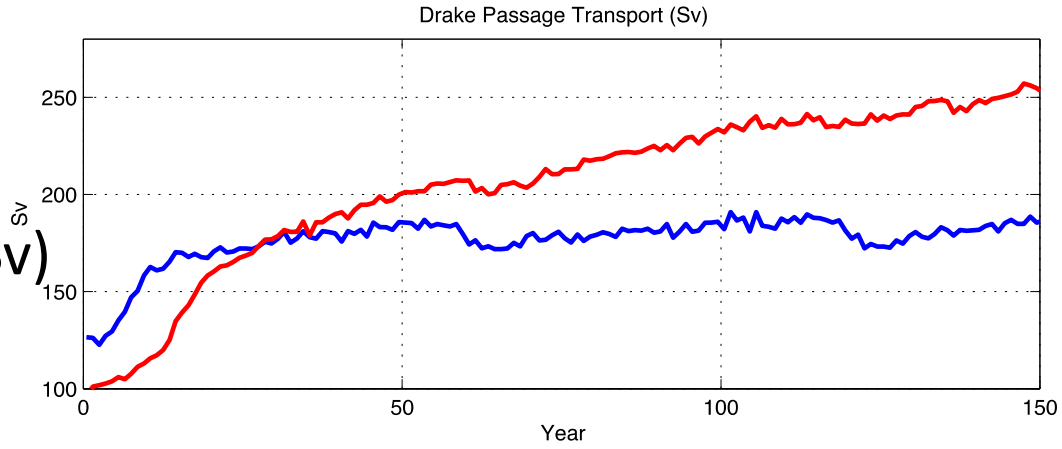
Upper: meridional section at 140°W
Lower: zonal section at equator



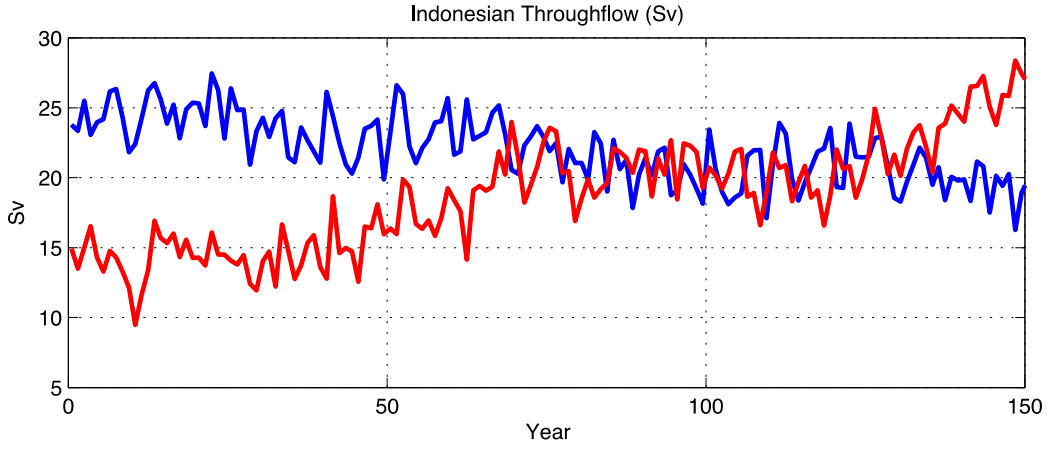
Atlantic Overturning Rate at 45°N (Sv)



Drake Passage Throughflow (Sv)



Indonesian Throughflow (Sv)

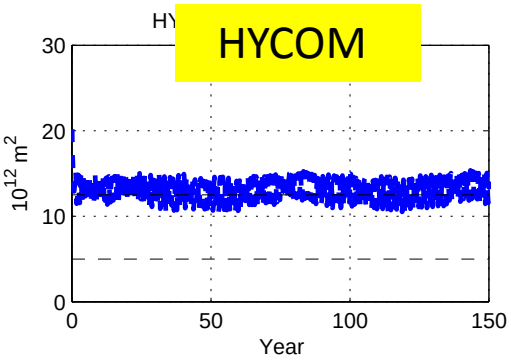


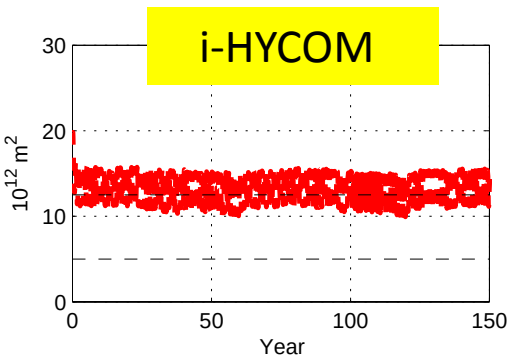
NH ice coverage ($10^{12}m^2$)

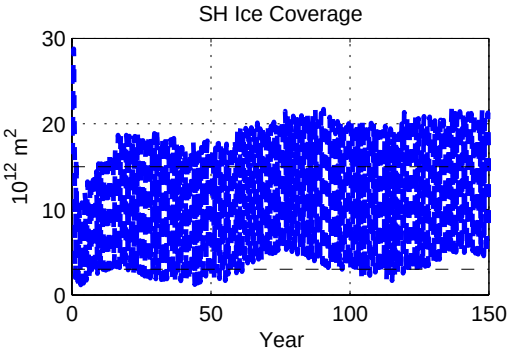
SH ice coverage ($10^{12}m^2$)

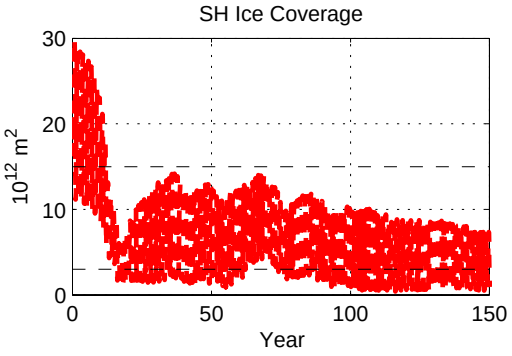
NH ice thickness (m)

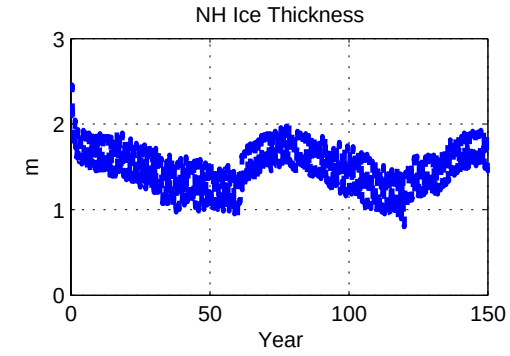
SH ice thickness (m)

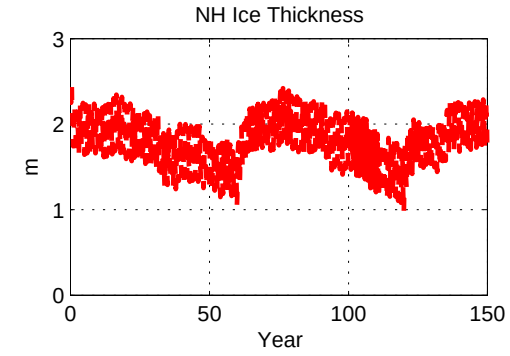


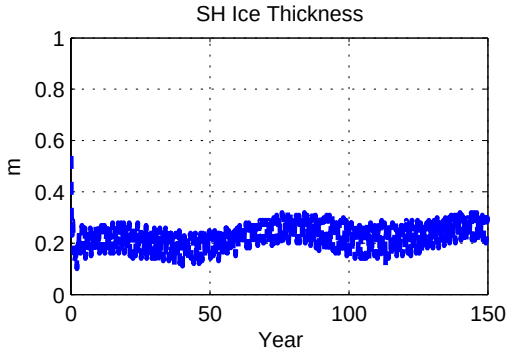


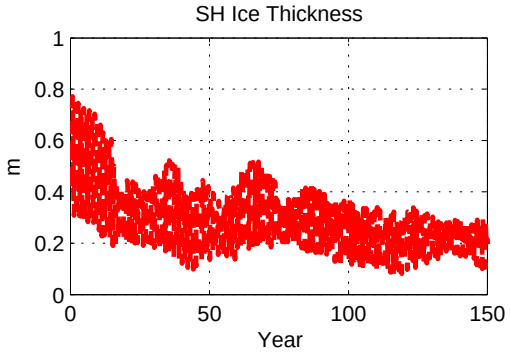












Summary

- Both HYCOM & i-HYCOM maintain a steady AMOC when forced by CORE II atmospheric forcings, although its fluctuation in i-HYCOM is bigger;
- The ice coverage and thickness in the northern and southern hemisphere in both models are close to observations;
- There are large regional temperature and salinity biases (blame forcing fields?);
- Results from i-HYCOM are still inferior to HYCOM on century time scales;
- Using identical atmospheric-ocean grids is still considered advantageous in seasonal high-resolution simulations.