CORE Integrations with CCSM3/HYCOM

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Outline

1. *Background*

2. *Model configuration and CORE forcing*

3. *Results*

4. *Conclusion and future work*

Background

1. Systematically investigate the performance of the ocean model with hybrid vertical coordinate (HYCOM) in the climate model (CCSM)
2. As the first step, test the ocean-only or coupled ocean-ice model in the CCSM modeling system using the atmospheric forcing from the Coordinated Ocean-ice Reference Experiment (CORE)
3. Compare the CORE integrations between CCSM3/HYCOM and CCSM3/POP

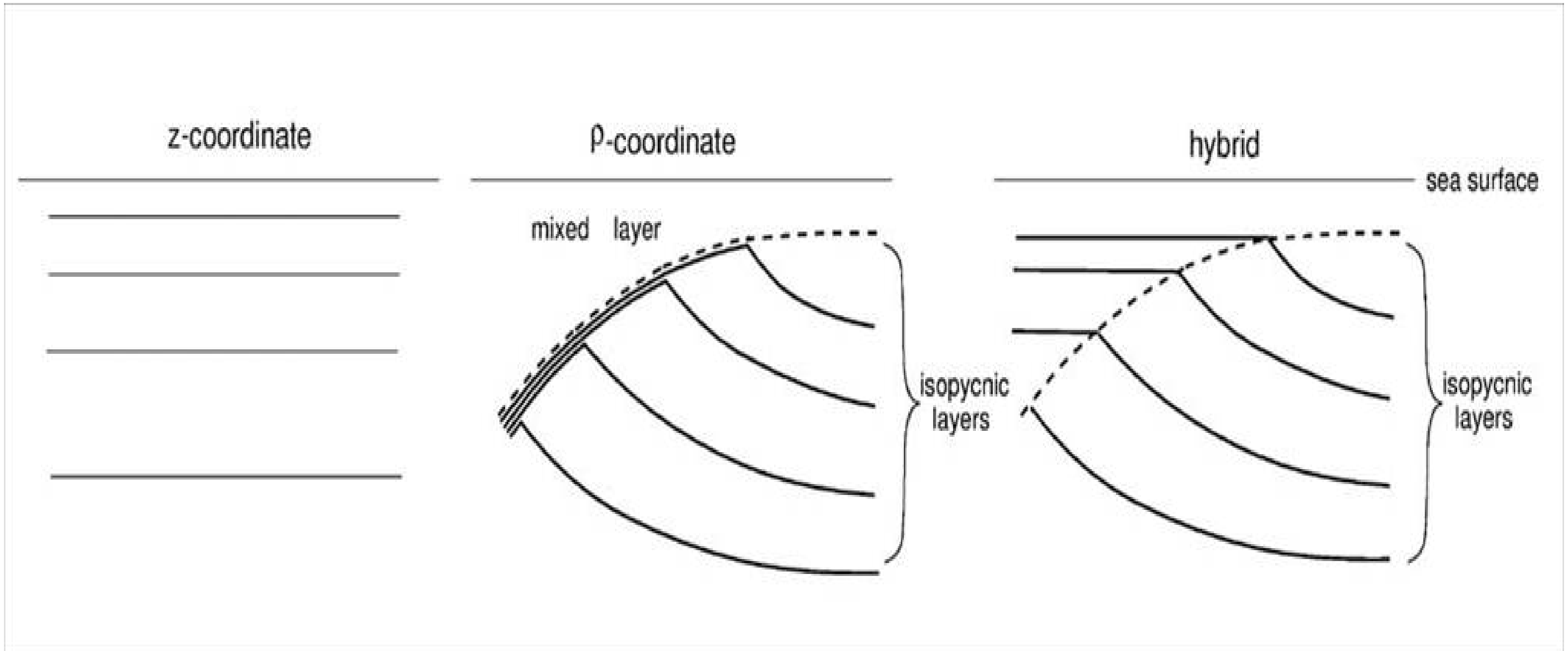
HYCOM Configuration

Configuration: NCAR's gx1v3 grid; 32 hybrid layers, sigma-2; integrated into the CCSM3 cpl6, http://hycom.rsmas.miami.edu for details

Parallelization: MPI, scale well up to 120 PEs

Initialization: January of the Poles Hydrographic Climatology, resting

Model speed: with 40 PEs of Blueice, 6 years/day



Coordinated Ocean-ice Reference Experiment

Atmospheric data: Large and Yeager, 2004

short-wave radiation, long-wave radiation, wind stress, wind speed, surface air temperature, relative humidity, precipitation, runoff

Thermal Forcing: bulk formula

Salinity Forcing:

(1) P-E+R

(2) P-E+R + weak relaxation to climatological SSS (50m/4year)

(3) P-E+R + strong relaxation to climatological SSS (50m/300 days)

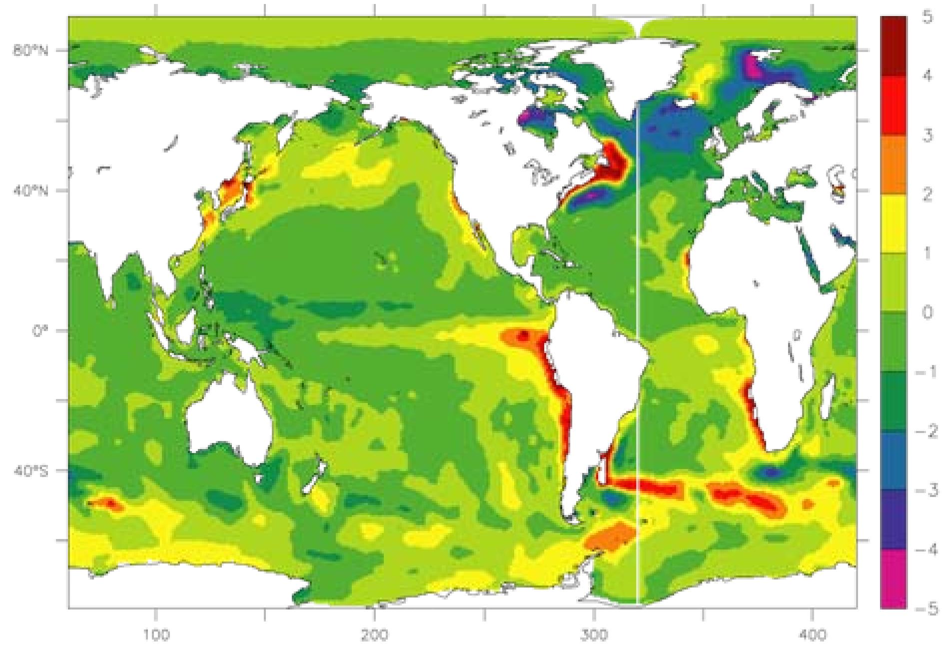
Model Integrations

Sponsored by the Breakthrough Science Computation

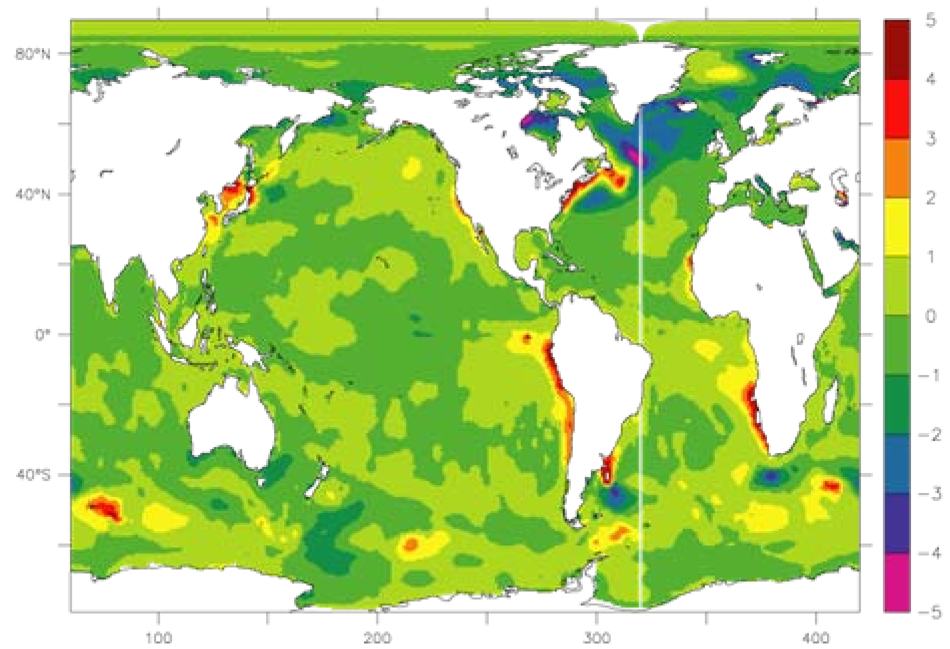
Model Runs	HYCOM	POP
Ocean-only without salinity restoring	√ 150	√ 150
Ocean-only with weak salinity restoring (50 m/4 years)	√ 150	
Ocean-only with strong salinity restoring (50 m/300 days)	√ 150	
Coupled ocean-ice without salinity restoring	√ 150	√ 150
Coupled ocean-ice with weak salinity restoring (50 m/4 years)	√ 300	?
Coupled ocean-ice with strong salinity restoring (50 m/300 days)	√ 150	

SST without surface salinity restoring (Y141-150)

HYCOM



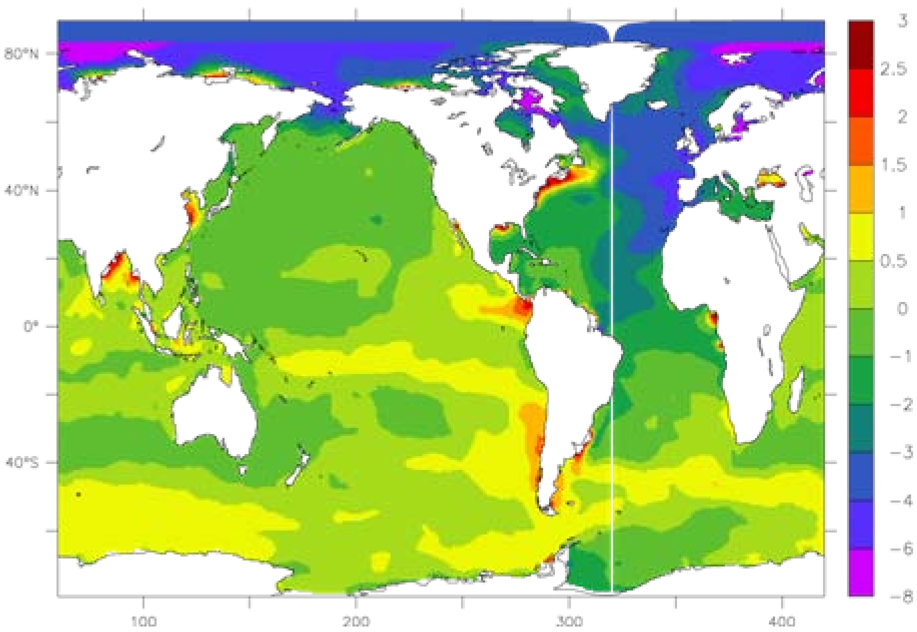
POP



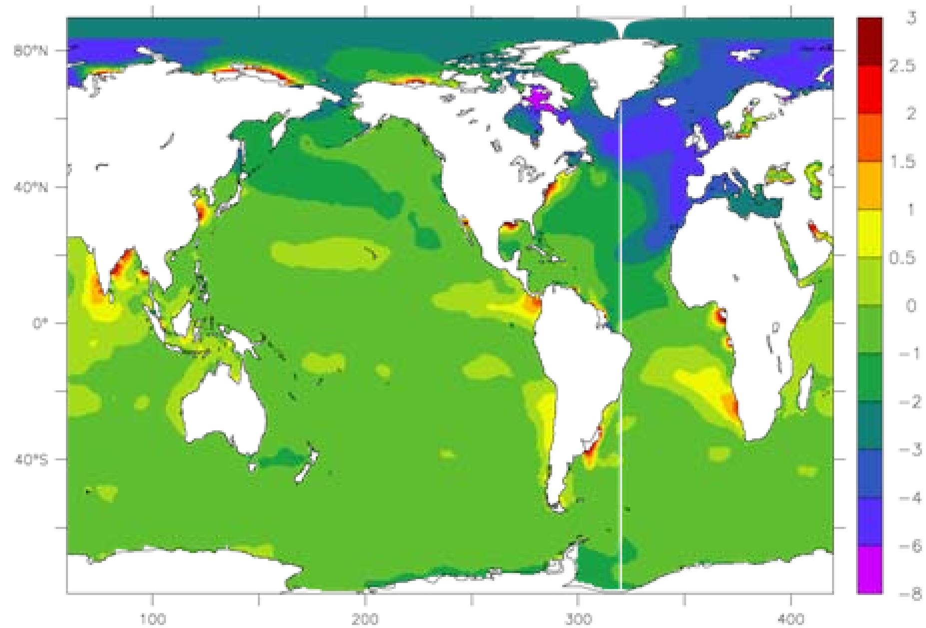
1. Coupled ocean-ice without salinity restoring
2. Simulation minus observation (PHC2, 2001)
3. Many common features: Large bias near the coastal region, Gulf Stream displacement, El Nino-like condition, large cooling in the high-latitude NA
4. The bias is relatively larger in HYCOM in some regions.

SSS without surface salinity restoring (Y141-150)

HYCOM



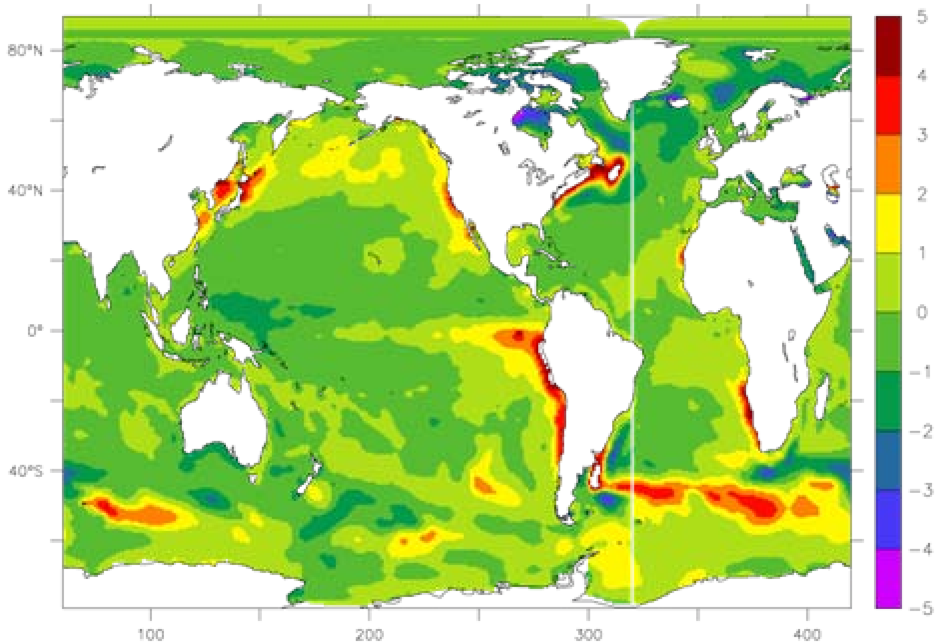
POP



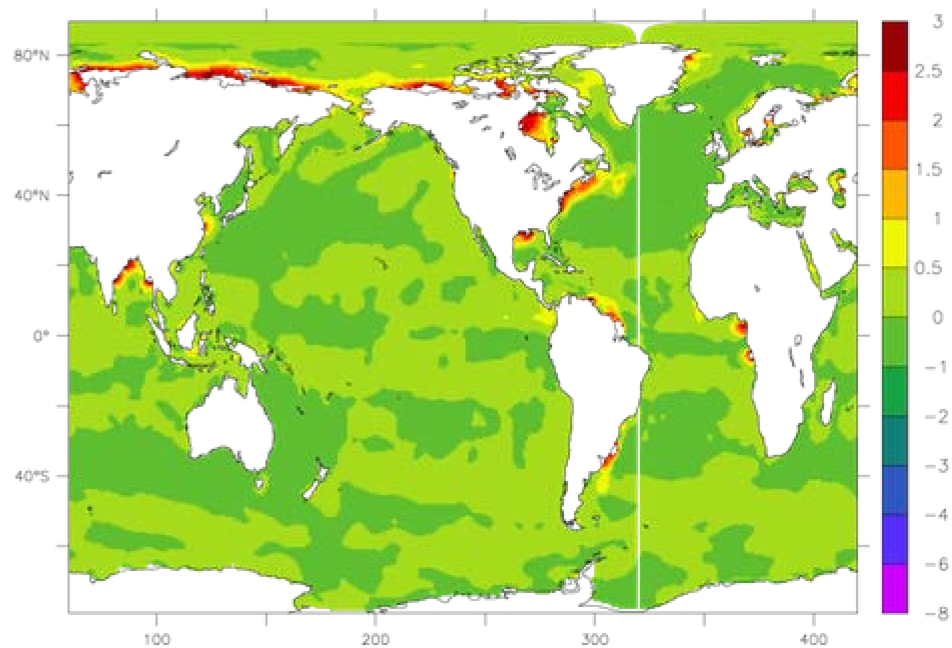
1. Coupled ocean-ice without salinity restoring
2. Simulation minus observation (PHC2, 2001)
3. SSS decreases significantly in the North Atlantic (the collapse of MOC)
4. Positive bias in Southern Hemisphere in HYCOM. Negative bias most ocean area in POP

HYCOM with surface salinity restoring (Y141-150)

SST

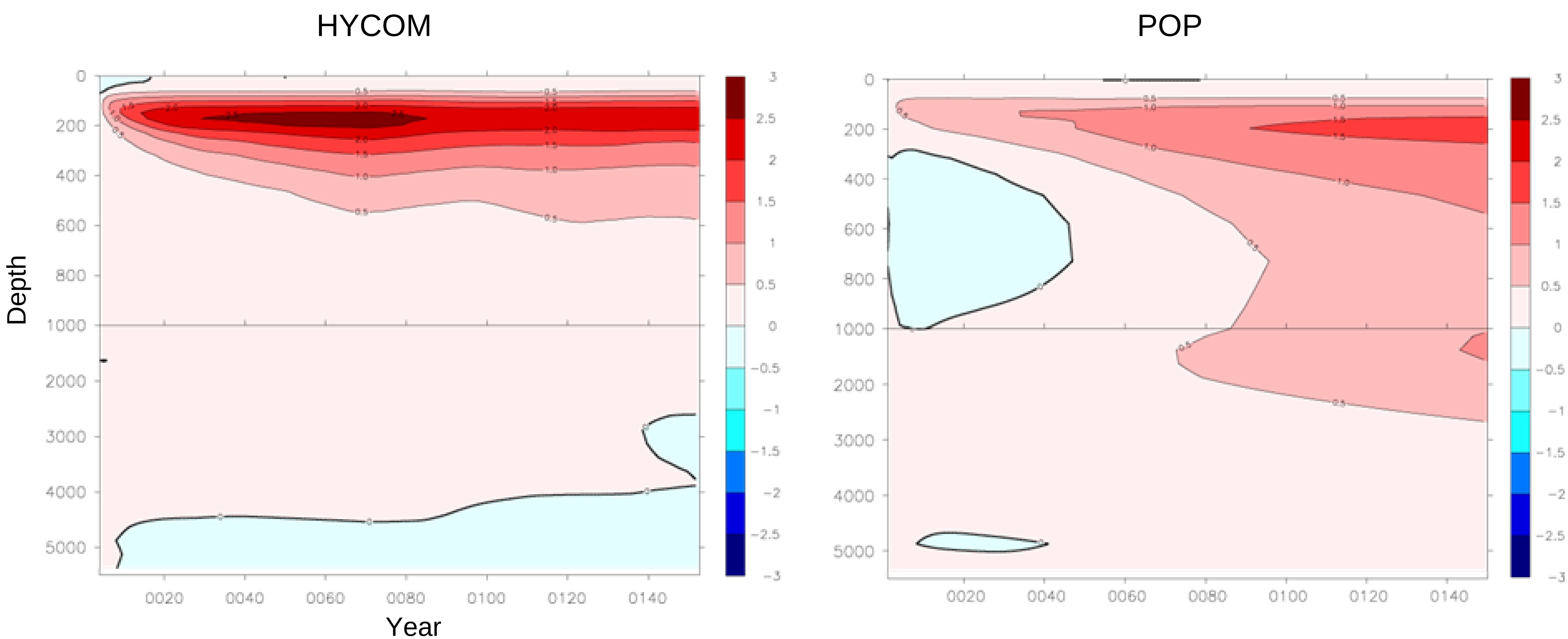


SSS



1. Coupled ocean-ice with weak salinity restoring (50 m/4years)
2. Simulation minus observation (PHC2, 2001)
3. SSS is close to observation
4. No improvement in SST bias

Ocean Temperature Drift
(without surface salinity restoring)

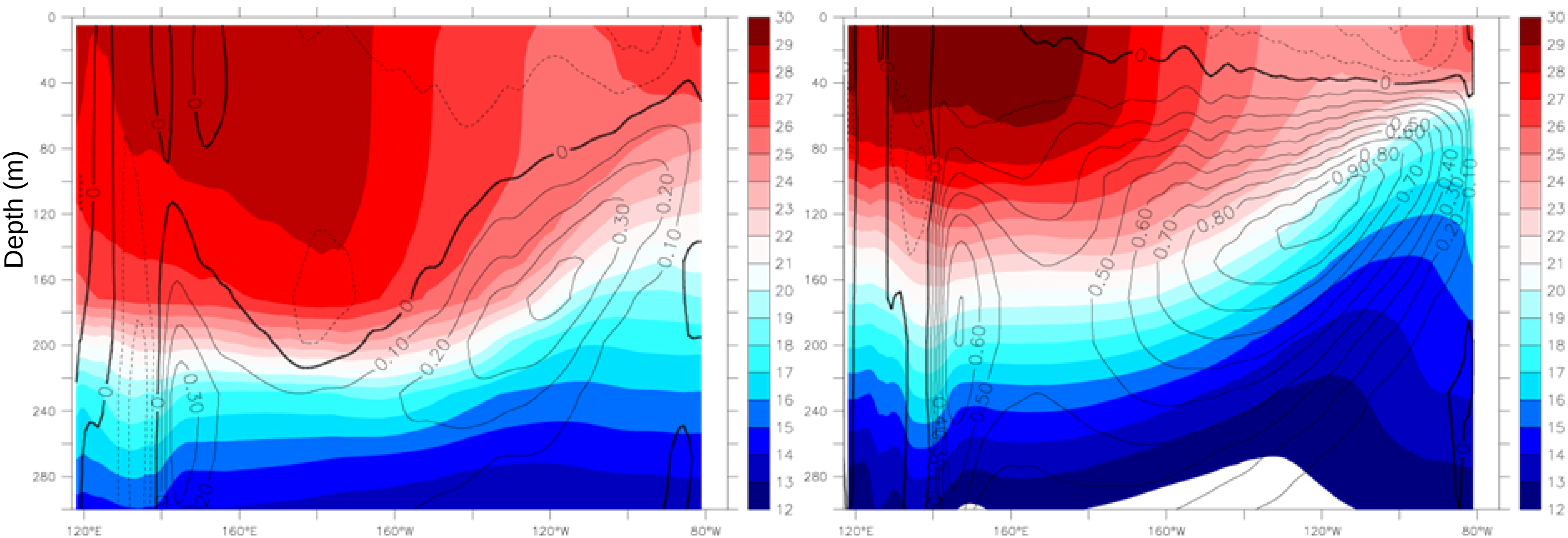


1. Simulation minus observation (PHC2, 2001)
2. Temperature drift in the upper 500 m is relatively larger in HYCOM
3. The bias confines to the upper ocean in HYCOM while it propagates into the deep ocean in POP

Temperature and Zonal Velocity along Equator

Y141-150 (without surface salinity restoring)

HYCOM POP



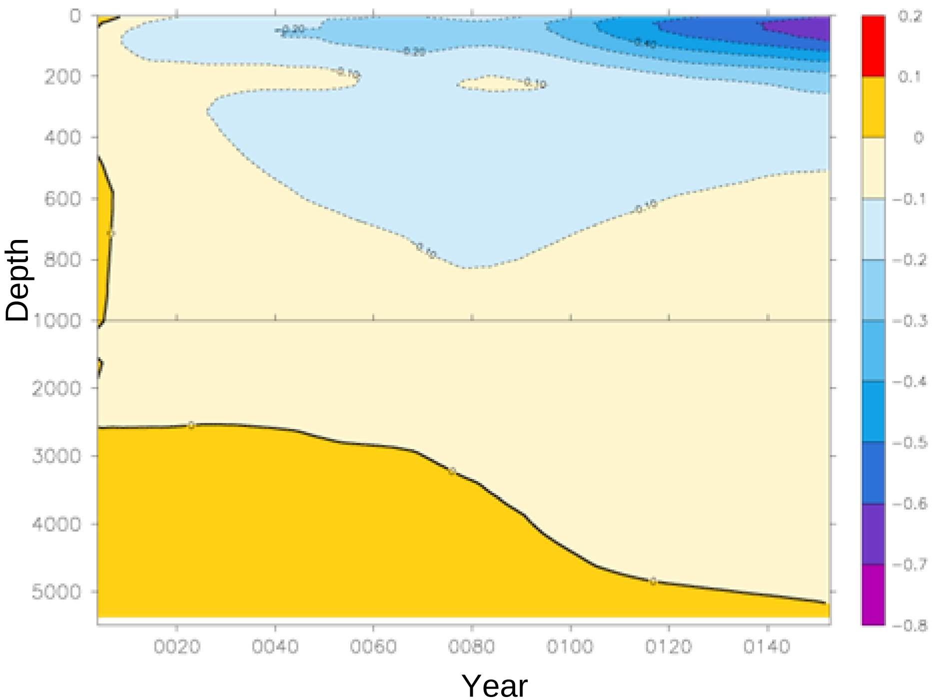
Western Pacific Eastern Pacific

1. Temperature (^{o}C) -shading, velocity (m/s) -contour
2. Upwelling in eastern equatorial Pacific and equatorial undercurrent is weaker in HYCOM than in POP
3. Will compared to observation and tuning of viscosity and diffusivity

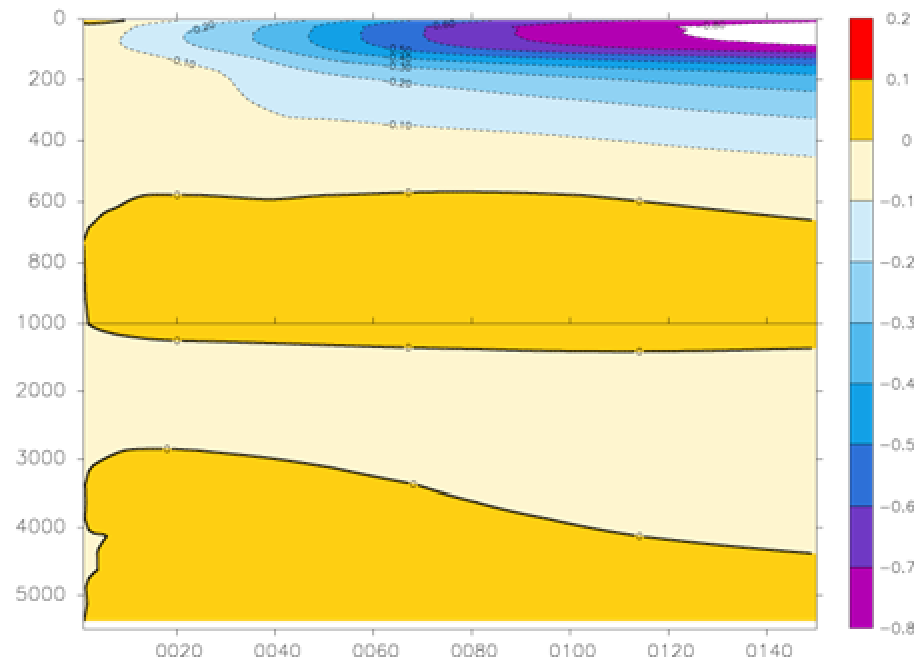
Ocean Salinity Drift

(without surface salinity restoring)

HYCOM



POP



1. Surface ocean tends to be fresher in both models
2. The freshening is faster in POP than in HYCOM

Conclusion and Future work

1. These first long-term simulations with CCSM3/HYCOM is reasonably well.

2. There are many common features between HYCOM and POP under CORE forcing.

3. Will continue to analyze the results from all HYCOM integrations: MOC, water mass, transport by different ocean circulations etc.

4. Some tuning work is probably necessary for HYCOM to further improve the simulations.

5. HYCOM results will be sent to CORE archive for the comparison with a broad spectrum of ocean models.

6. The integration with the fully coupled CCSM3/HYCOM will be carried out.