The Southern Ocean in a suite of forced global ocean-ice simulations: The Coordinated Ocean-ice Reference Experiments phase II (CORE-II)

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The Coordinated Ocean-Ice Reference Experiment (CORE) version II is an experimental protocol for ocean-ice coupled simulations forced with interannually varying atmospheric data sets for the period 1948-2007 (Large and Yeager, 2009). This effort, involving several centers around the world, is coordinated by the CLIVAR Working Group on Ocean Model Development (WGOMD). The hindcast simulations provide a framework for both model evaluation and studying variability and change at seasonal to decadal time scales. We present preliminary results on the recent evolution (1948–2007) of the Southern Ocean as simulated by the different models. We focus on mean state and biases, variability of the Antarctic circumpolar current (ACC), of the meridional overturning circulation (MOC) and ocean heat transport (OHT). We consider the evolution of the drivers of these circulations and of the interior structure of the Southern Ocean.

- Models of different resolutions are considered, from coarse to eddy-permitting, and an attempt is made to evaluate the role of mesoscale eddies and their parameterization.
- All participating groups integrated their models for 300 years, corresponding to five cycles of the forcing data.
- Anomalies presented during the fifth cycle are computed as the difference between the periods (1988-2007) and (1948-1967).

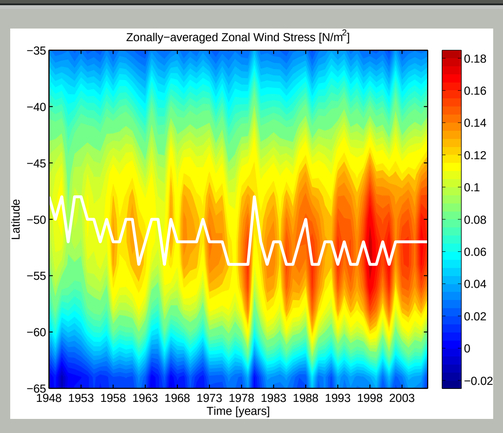
The intercomparison is focusing on *eddy saturation and compensation*, the relative role of wind stress and buoyancy changes, and variability of Southern Ocean water masses.

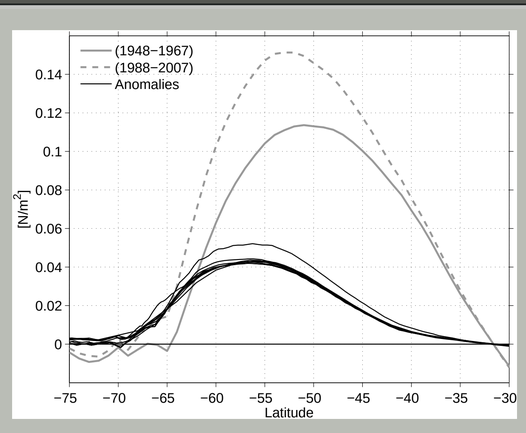
1. The Ocean and Sealce Models Participating

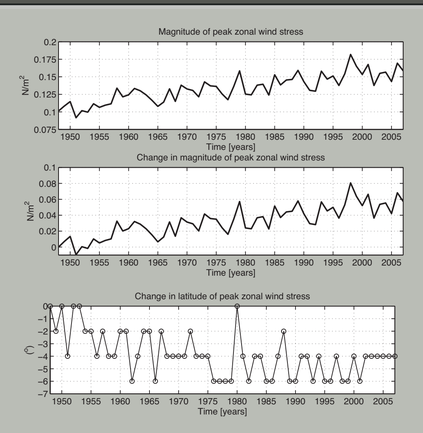
Summary of the ocean and sea-ice models. Models with different vertical coordinate and resolutions are contributing, and more models are expected to participate in this study shortly.

Group	Ocean model	Sea-ice model	Vertical	Orientation	Horiz. grid	Horiz. res.	SGS
1. ACCESS	MOM 4p1	CICE 4	z^* (50)	tripolar	360 × 300	nominal 1°	2D; variable
2. AWI			z (46)	displaced		nominal 1°	2D; fixed
3. BERGEN-NorESM	MICOM	CICE 4	ρ_2 (51)	tripolar	360 × 384	nominal 1°	2D; fixed
4. FSU-COAPS	HYCOM 2.2	CSIM 5	hybrid (32)	displaced	320 × 384	nominal 1°	2D; fixed
5. GFDL-MOM	MOM 4p1	SIS	z^* (50)	tripolar		nominal 1°	2D; variabale
6. GFDL-GOLD	GOLD	SIS	ρ_2 (59)	tripolar		nominal 1°	2D; fixed
7. ICTP	MOM 4p1	SIS	z^* (30)	tripolar	180 × 96	nominal 2°	2D; variable
8. INMOM	INMOM		σ (40)	displaced	360 × 340	1° × 0.5°	none
9. KIEL-GEOMAR	NEMO 3.1.1	LIM 2	z (46)	tripolar	722 × 511	nominal 0.5°	2D; variable
10. MRI-A	MRI.COM 3	MK89; CICE	z (50)	tripolar	360 × 364	1° × 0.5°	2D; fixed
11. MRI-F	MRI.COM 3	MK89; CICE	z (50)	tripolar	360 × 364	1° × 0.5°	2D; fixed
12. NCAR	POP 2	CICE 4	z (60)	displaced	320 × 384	nominal 1°	3D; variable

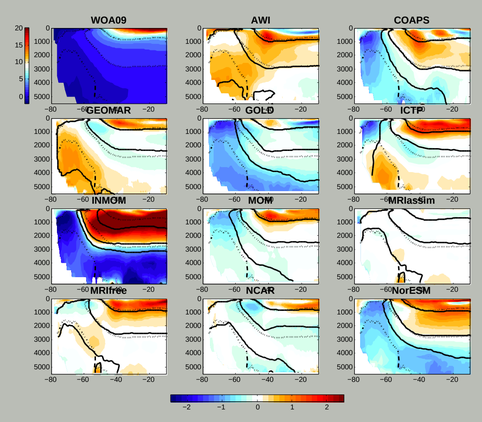
2. The Forcing: Wind Stress Evolution



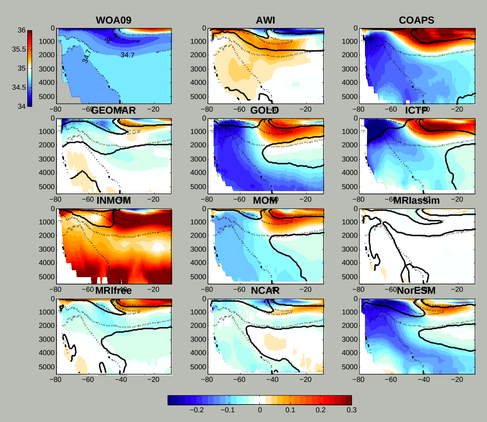




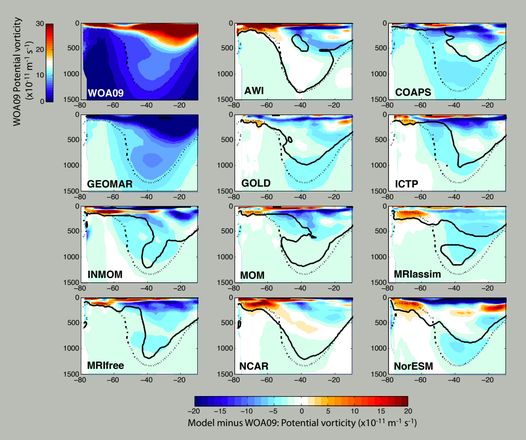
3. The Southern Ocean Temperature, Salinity and Potential Vorticity vs Observations, and the Time-mean MOC in the 5th Cycle



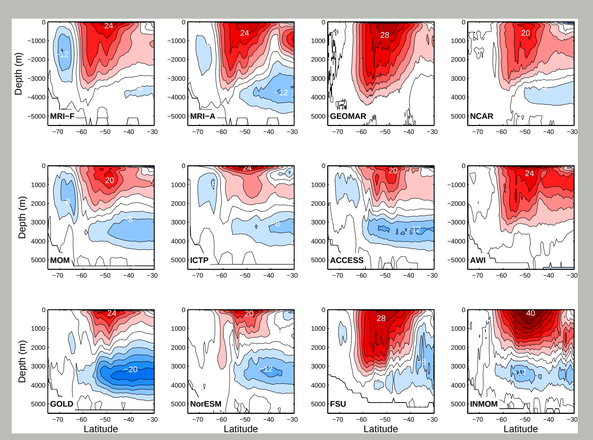
Zonally averaged TEMPERATURE difference from WOA09.



Zonally averaged SALINITY difference from WOA09.

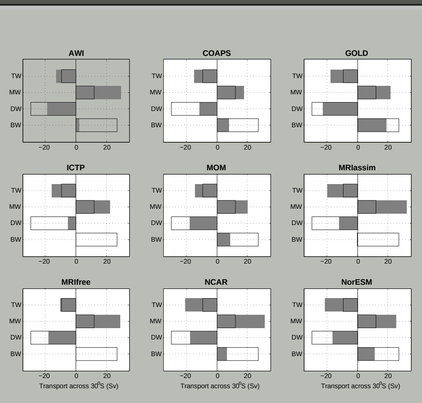


Zonally averaged PV difference from WOA09.

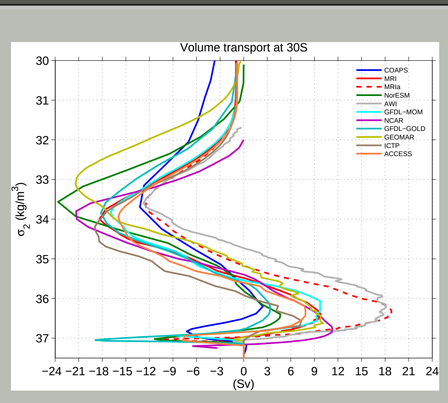


Residual MOC in depth-space.

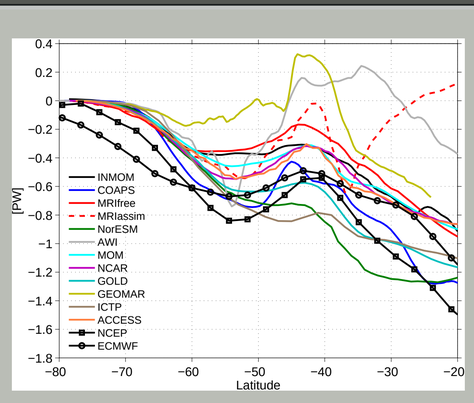
4. The Southern Ocean MOC, OHT and ACC



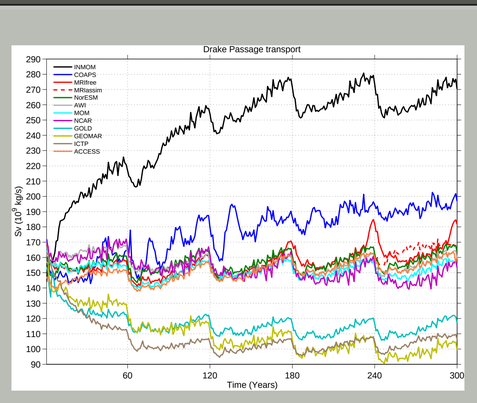
Transport across 30S in water mass layers.



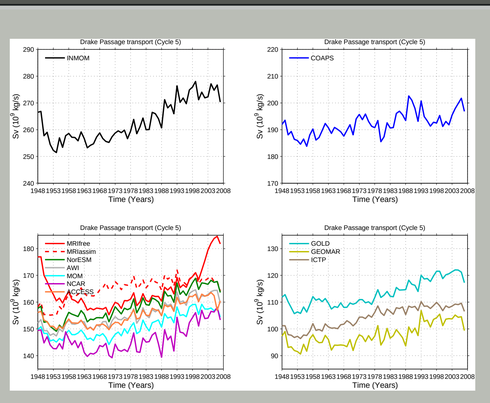
The volume transport at 30S in σ_2-space.



The time-mean Ocean Heat Transport.

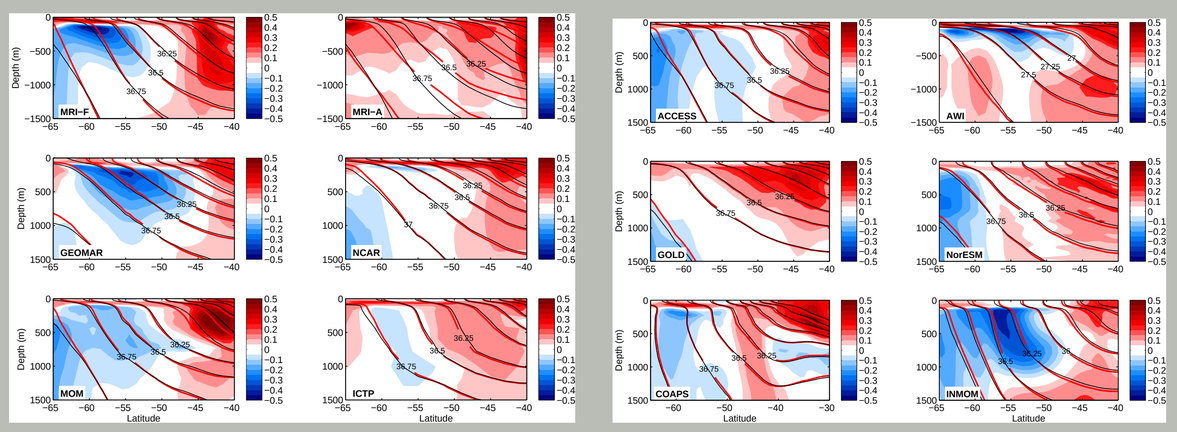


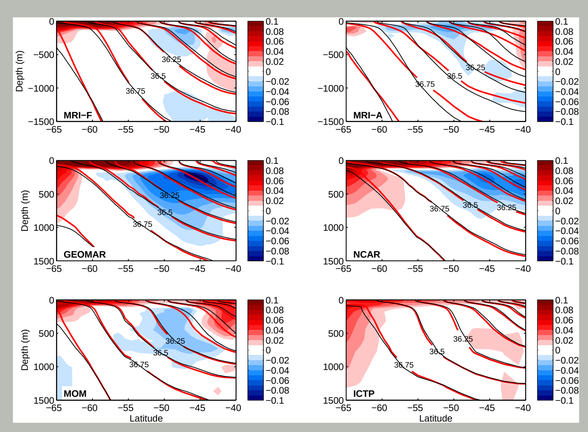
The ACC transport for all five cycles.



The ACC evolution during the fifth cycle.

5. Changes in Zonally Averaged TEMPERATURE and SALINITY (shading) and Isopycnal Surfaces (black: 1948-1967; red: 1988-2007)





6. Residual MOC Changes, 'Eddy' MOC vs Peak τ, OHT Change and Sealce Concentration Evolution during the 5th Cycle