Climate Simulations Using the GISS/HYCOM Coupled Model

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Sun & Bleck 2001; Bleck & Sun 2003; Sun & Hansen 2003
Coupled Model Activities at GISS

GISS AGCM

GISS Sea Ice

Ocean A
obs sst & ice

Ocean B
Q-flux ML

Ocean C
GISS ocean

Ocean D
GFDL ocean

Ocean E
MICOM/HYCOM
Model Setup

  12 layers, 4° x 5° resolution
- OGCM: Hybrid version of Miami Isopycnal Coordinate Ocean Model (HYCOM, Bleck et al. 1992, Bleck 2002)
  16 $\sigma_2$ layers in the vertical, 2° at Equator
- Sea ice: thermodynamic ice only (Russell et al. 2000)
Flux Coupler

- AGCM passes heat flux, freshwater flux and momentum flux to OGCM
- OGCM (include sea ice) passes sea and ice surface temperature and ice coverage
- Flux integral is conserved during coupling
- No flux correction applied
Initial Conditions for the Coupled Model

- AGCM: observed 1950 atmospheric composition
- OGCM: temperature and salinity from observed climatology (Levitus, 1994)
- No spin up
Ocean Heat Storage 1951-1998

Ocean Heat Storage (W year/m²m) 1951–1998

Observed 9.60
Ocean A 11.83
Ocean E 7.75
Ocean E (run 1) 6.56
Ocean E (run 2) 7.06
Ocean E (run 3) 6.91
Ocean E (run 4) 7.51
Ocean E (run 5) 10.67
Ocean E (run 6) 10.04

Legend:
-351.15 -70 -50 -30 -10 0 10 30 50 70 90 110 130 150
-70 -50 -30 -10 0 10 30 50 70 90 110 130 150 210 270 330 390
Ocean Heat Storage 2000-2050 (ALT)
Zonal-mean Ocean Heat Storage

1951 - 1998

2000 - 2050
Spurious Diapycnal Mixing in HYCOM
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Summary

- Coupled GISS/HYCOM model is able to reproduce many observed features, including deep water formation.
- Atlantic thermohaline circulation appears to be stable during global warming.
- There is more ocean heat storage and less surface warming in ocean E than in ocean B.
- Spurious diapycnal diffusion in HYCOM is small with increased vertical resolution.