

Course 12.951 – Spring 2008

The Meridional Overturning Circulation of the Atlantic Ocean: A Reading Course

Instructors: Raffaele Ferrari (rferrari@mit.edu) 54-1420
Jeffery Scott (jscott@mit.edu) 54-1724

Website: <http://wind.mit.edu/~jscott/AMOC>

Prerequisite: 12.800

Requirements: for credit (3-0-3), participation in class presentations of papers

Class meetings (3:00-4:30 PM):

Feb. 4 – Organizational meeting to determine meeting time

Feb. 8 – Raf, Jeff overview/historical lecture

Feb. 15 – Dynamics/Scaling/Energetics

Feb 22 – Dynamics/Scaling/Energetics

Feb. 29 – Dynamics/Scaling/Energetics

Mar. 7 – **no class**, Ocean Sciences week

Mar. 14 – Dynamics/Scaling/Energetics

Mar. 21 – Dynamics/Scaling/Energetics

Mar. 28 – **no class**, Spring Break

Apr. 4 – Multiple Equilibria

Apr. 11 – Multiple Equilibria

Apr. 18 – Atmospheric Forcings/Climate Change

Apr. 25 – Atmospheric Forcings/Climate Change

May 2 – Atmospheric Forcings/Climate Change

May 9 – Atmospheric Forcings/Climate Change

May 16 – AMOC and the Carbon Cycle (?)

List of papers to discuss (some of these left for outside reading):

Overview class:

- Broecker, W.S. (1991) The great ocean conveyor. *Oceanography* 4, 79-89.
- Warren, B. (1983) Why is no deep water formed in the North Pacific? *JMR* 41, 327-347.
- Eady, E.T. (1957) The general circulation of the atmosphere and oceans. In: *The Earth and Its Atmosphere*, ed. D.R. Bates. New York, Basic Books, 130-151.

Dynamics/Scaling/Energetics:

- Bryan, F. (1987) Parameter sensitivity of primitive ocean general circulation models. *JPO* 17, 970-985.
- Marotzke, J. (1997) Boundary mixing and the dynamics of three-dimensional thermohaline circulations. *JPO* 27, 1713-1728.
- Samelson, R.M. (1998) Large-scale circulation with locally enhanced vertical mixing. *JPO* 28, 712-726.
- Marotzke J., and J.R. Scott (1999) Convective mixing and the thermohaline circulation. *JPO* 29, 2962-2970.
- Wunsch, C., and R. Ferrari (2004) Vertical Mixing, Energy, and the general circulation of the oceans. *Annual Rev. Fluid Mech.* 36, 281-314.
- Munk, W.H., and C. Wunsch (1998) Abyssal recipes II: Energetics of tidal and wind mixing. *DSR* 45, 1977-2010.
- Huang, R.X. (1999) Mixing and energetics of the ocean thermohaline circulation. *JPO* 39, 727-746.
- Colin de Verdiere (1988) Bouyancy-driven planetary flows. *JMR* 46, 215-265.
- Nilsson J., G. Broström, and G. Walin (2003) The thermohaline circulation and vertical mixing: does weaker density stratification give stronger overturning? *JPO* 33, 2781-2795.
- Klinger B.A., and J. Marotzke (1999) Behavior of double hemisphere flows in a single basin. *JPO* 29, 382-399.
- Vallis, G.K., (1999) Large-scale circulation and production of stratification: Effects of wind geometry, and diffusion. *JPO* 30, 933-954. (see also Gill, A.E., and K. Bryan (1971) Effects of geometry on the circulation of a three-dimensional southern-hemisphere ocean model, *DSR* 18, 685-721.)
- Samelson, R.M. (1999) Geostrophic circulation in a rectangular basin with a circumpolar connection, *JPO* 29, 3175-3184.
- Toggweiler, J.R. and B. Samuels (1995) Effect of Drake Passage on the global thermohaline circulation. *DSR* 42, 477-500.
- Gnanadesikan, A. (1999) A simple predictive model for the structure of the ocean pycnocline. *Science* 283, 2077-2079.

Multiple Equilibria:

- Stommel, H. (1961) Thermohaline convection with two stable regimes of flow. *Tellus* 13, 224-230.
- Rooth, C. (1982) Hydrology and ocean circulation. *Progress in Oceanography*, 11, 131-149.
- Broecker, W.S. et al. (1985) Does the ocean-atmosphere system have more than one stable mode of operation? *Nature* 315, 21-26.
- Bryan, F. (1986) High-latitude salinity effects and interhemispheric thermohaline circulations. *Nature* 323, 301-304.
- Manabe, S., and R.J. Stouffer (1988) Two stable equilibria of a coupled ocean-atmosphere model. *J. Climate* 1, 841-866.
- Marotzke, J., and J. Willebrand (1991) Multiple equilibria of the global thermohaline circulation. *JPO* 21, 1372-1385.

Atmospheric Forcings/Climate Change:

- Manabe, S., and R.J. Stouffer (1994) Multiple-century response of a coupled ocean-atmosphere model to an increase of atmospheric carbon dioxide. *J. Climate*, 7, 5-23.
- Rahmstorf, S. (1995) Bifurcations of the Atlantic thermohaline circulation in response to changes in the hydrological cycle. *Nature* 378, 145-149.

(depending on class interest, there are a number of different directions we can pursue in the last few classes... possible topics include boundary conditions/role of salinity forcing, global warming experiments, abrupt climate change, and/or the paleo-AMOC. Please talk to us regarding preferences and suggestions for papers to discuss)