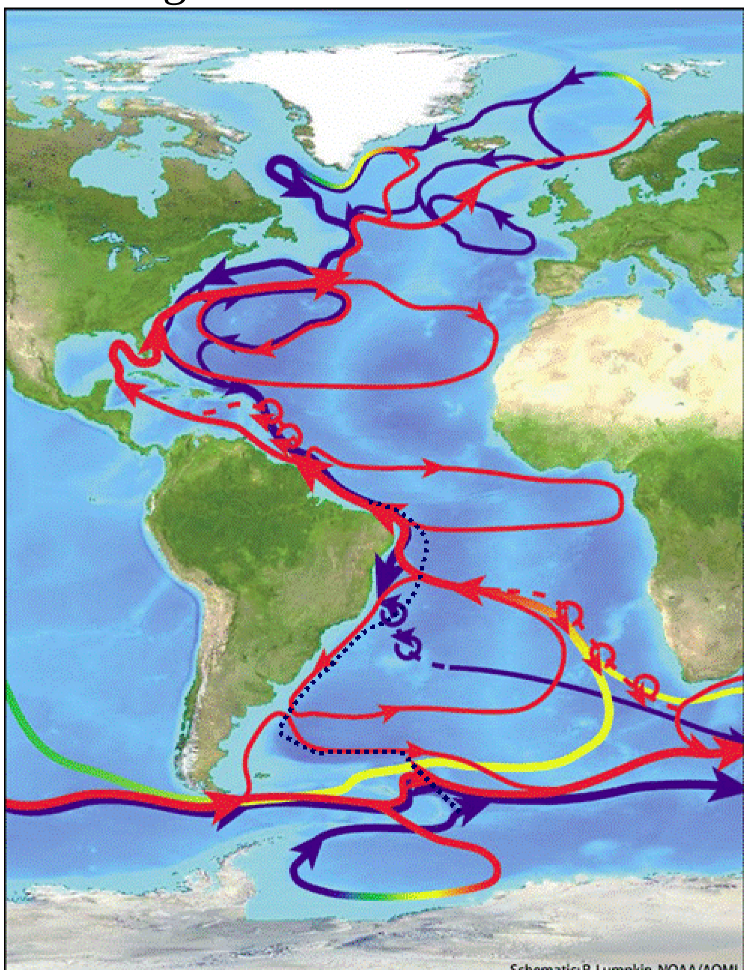
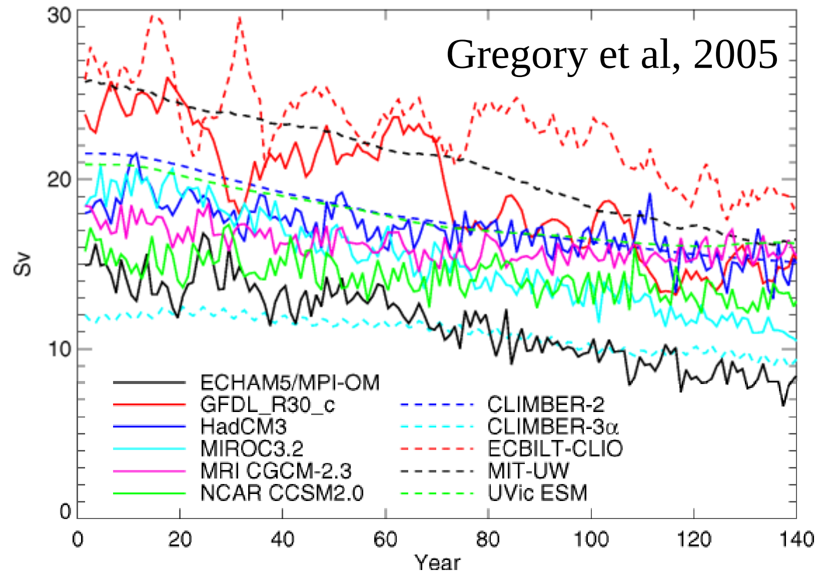
Meridional Overturning Circulation

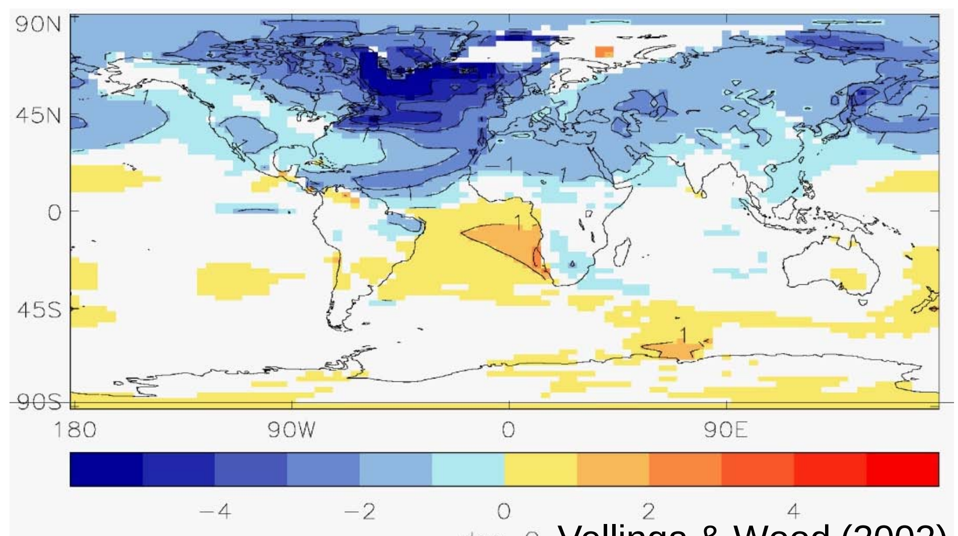
Molly O. Baringer

JSOST Ocean Research Priority Plan:
Charting the course for Ocean Science

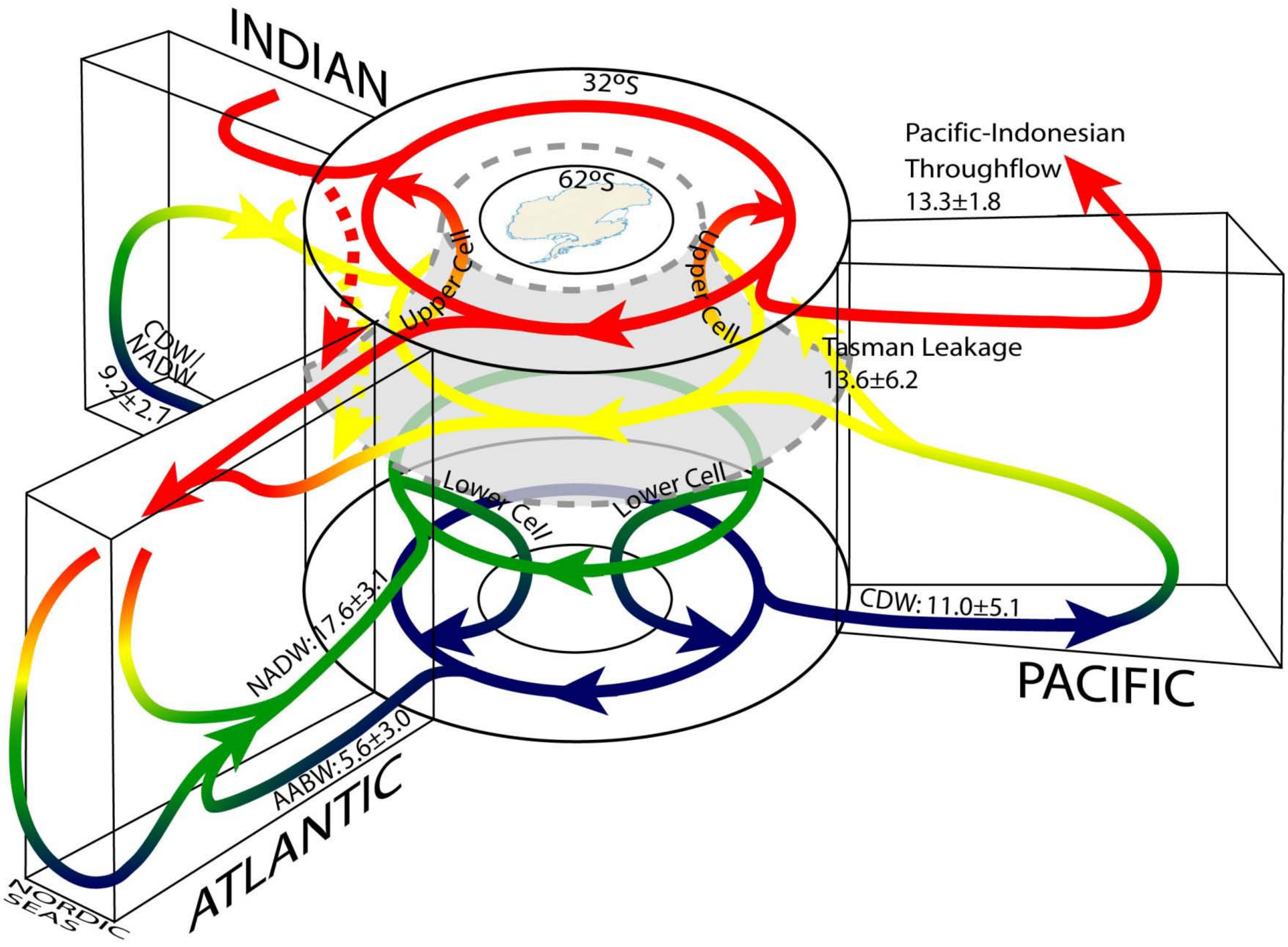




Gregory et al, 2005



Vellinga & Wood (2002)



(Lumpkin and Speer, 2007)

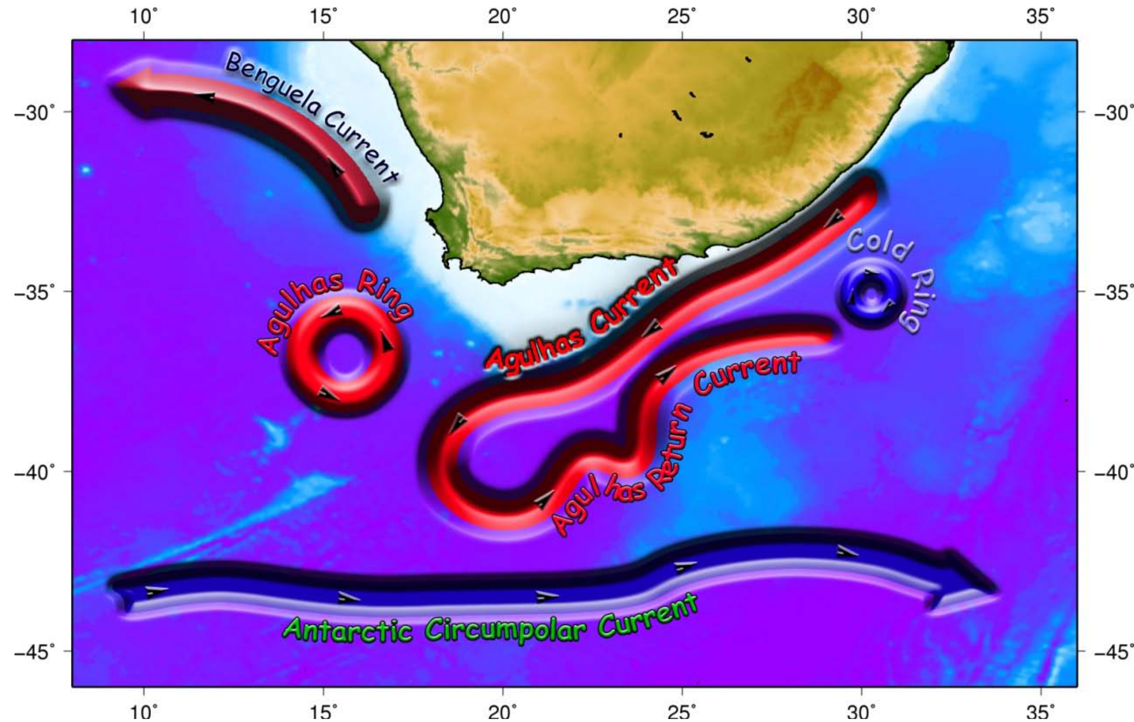
Inter-ocean exchanges

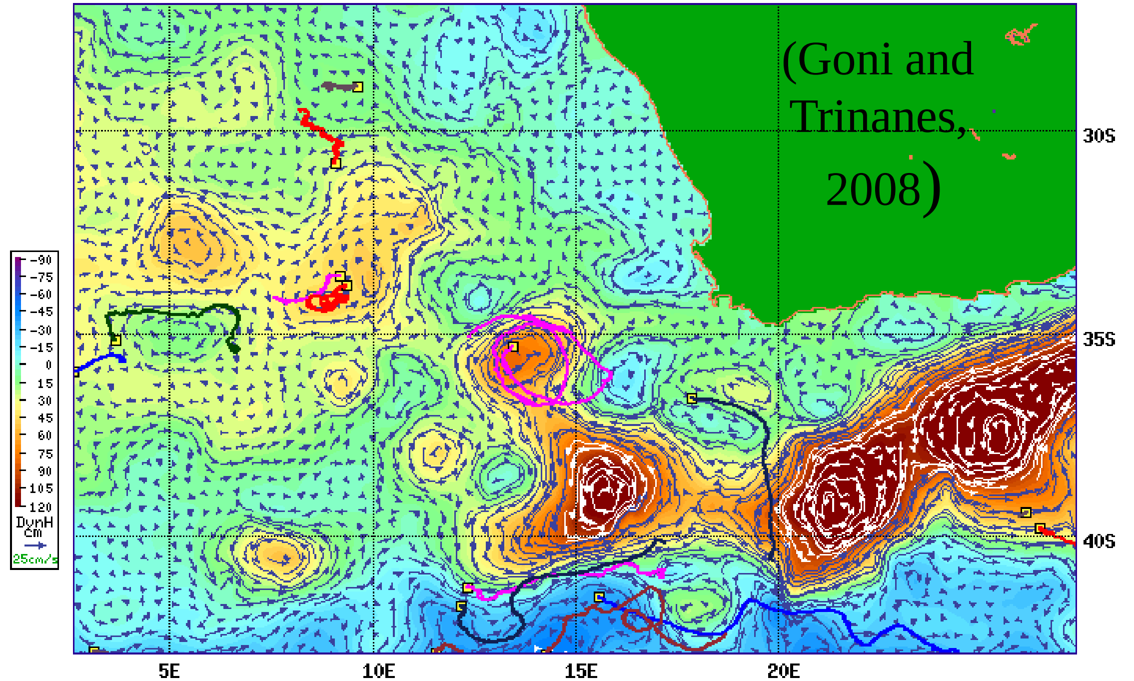
Observations include altimetry, floats, drifters, RAFOS, inverted echo sounders, hydrography

5-8 Rings per year
•2.6-3.8 Sv per year
•Highly variable! (7 month gaps have been observed)

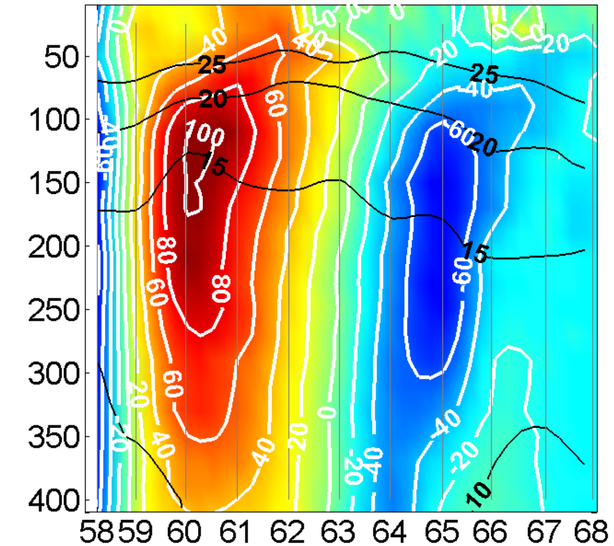
13-15 Sv Mean Transport of Benguela Current and Extension
•50% South Atlantic
•25% Indian Ocean
•25% Blend of Agulhas and tropical waters

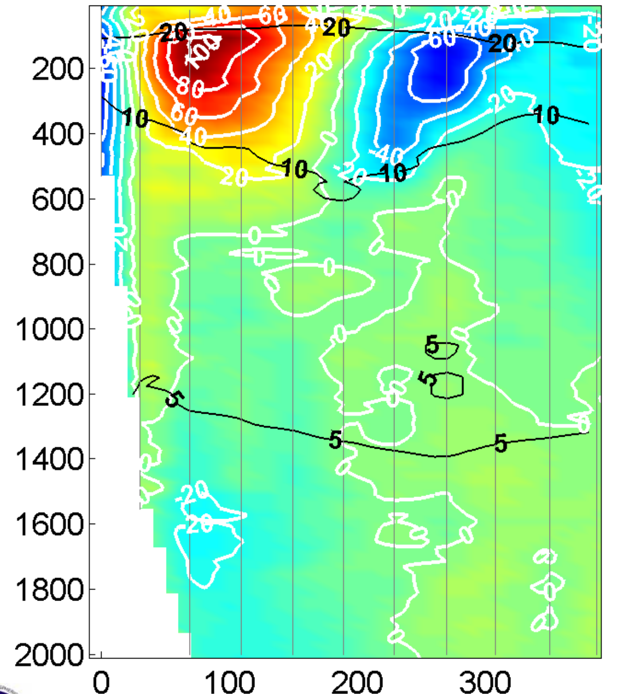
(Garzoli and Gordon, 1996; Garzoli and Goni, 2000; Garzoli and Richardson, 2002; Schmid et al 2002)





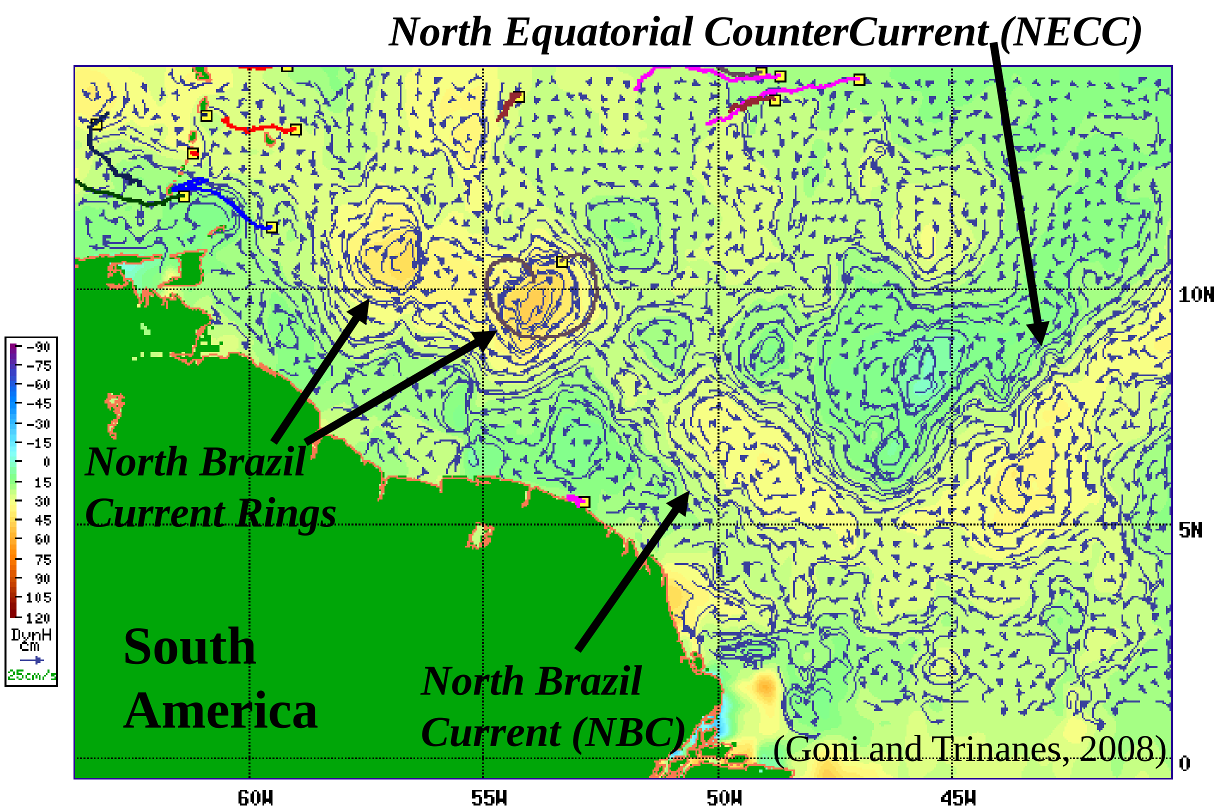
Inter-hemisphere exchanges



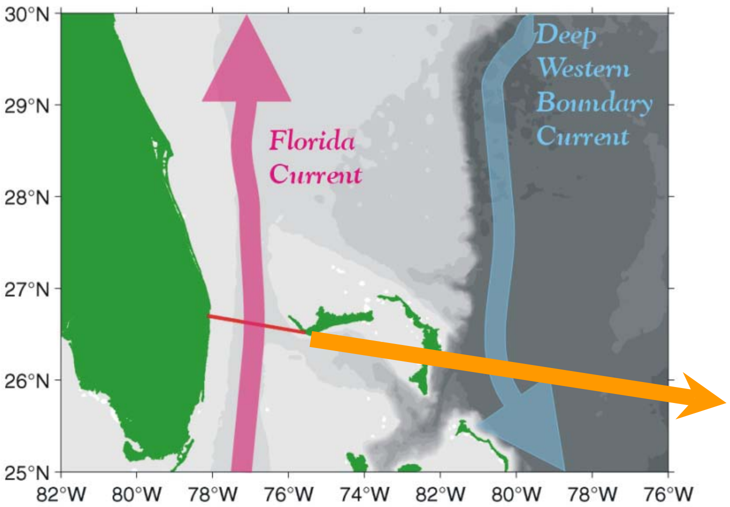


- •50% of the MOC carried in Brazil Current Rings
- •8 Sv
- •0.54 PW
- •3-7 Rings each year
- •Some rings have no surface expression!

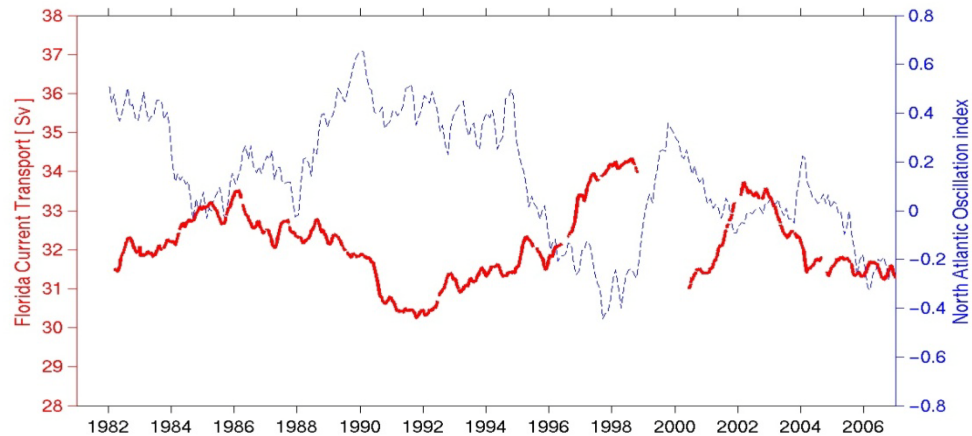
(Garzoli et al, 2003, Goni and Johns, 2003)



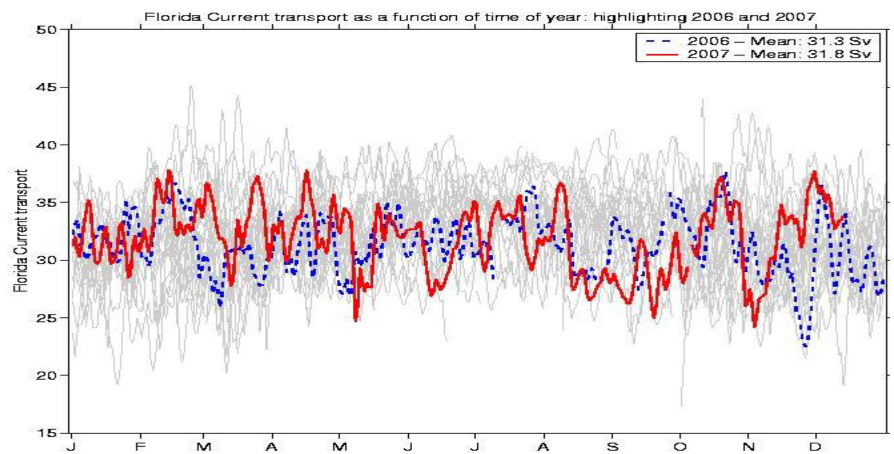
Florida Current Transport



Florida Current oceanic heat transport provides the energy necessary to maintain moderate climates in northern latitudes.



- Long term mean transport of the Florida Current remains near 32 Sv
- Variability in transport is related to the NAO and wind stress curl
- Annual mean transports show no "collapse" of the MOC



(Baringer and Larsen, 2001; Meinen et al., 2006; Baringer and Meinen 2007 and 2008; DiNezio et al 2008; Meinen et al 2008)

Deep Western Boundary Current Monitoring

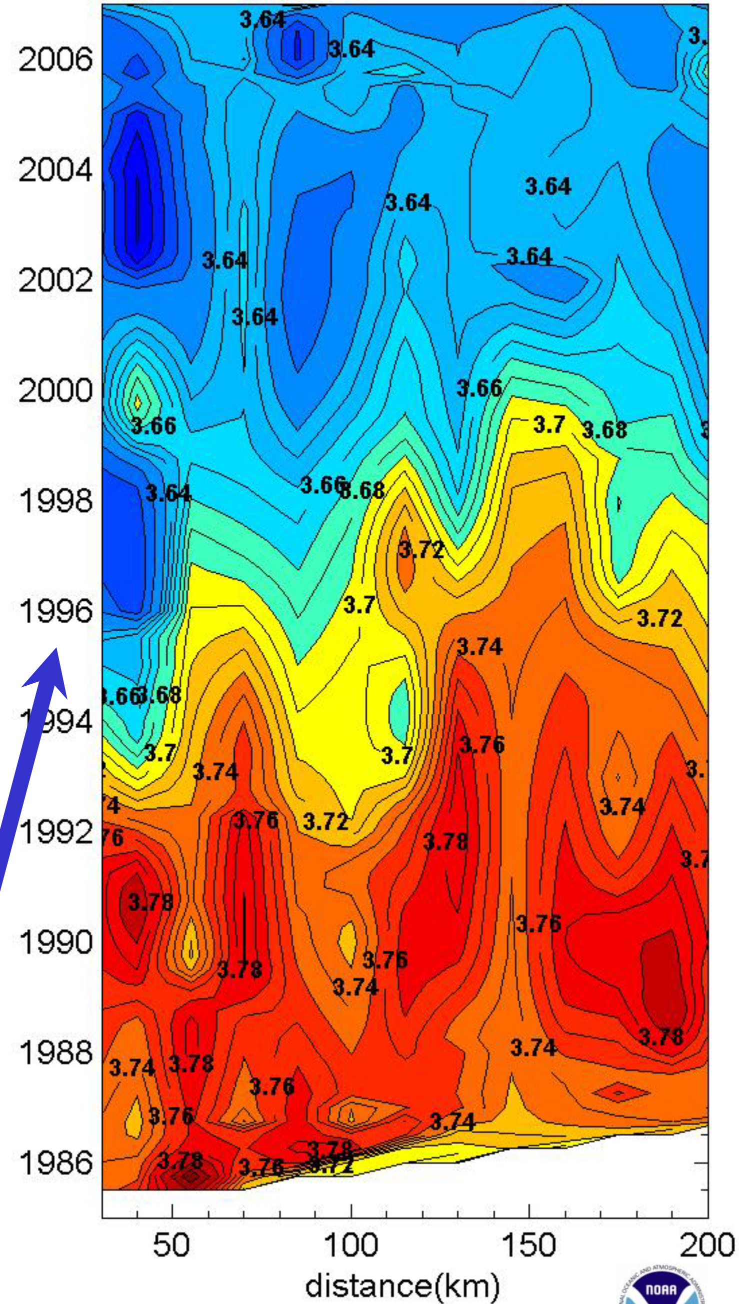
What we observed: Time series of Temperature and Salinity in the DWBC show a pronounced cold, fresh pulse of water that appeared in 1994, less than eight years after it was produced in the Labrador Sea. Results indicate a "Conveyor Belt" twice as fast as previously thought.

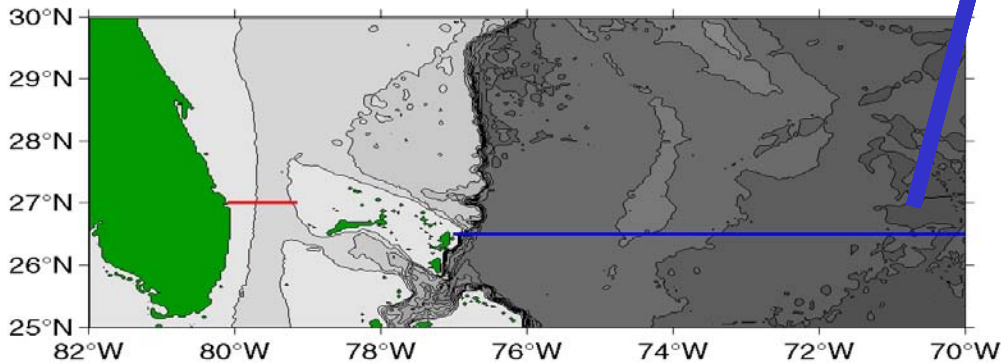
Changes in LSW properties are linked to transport changes. LSW transport increases as the deep DWBC decreases.

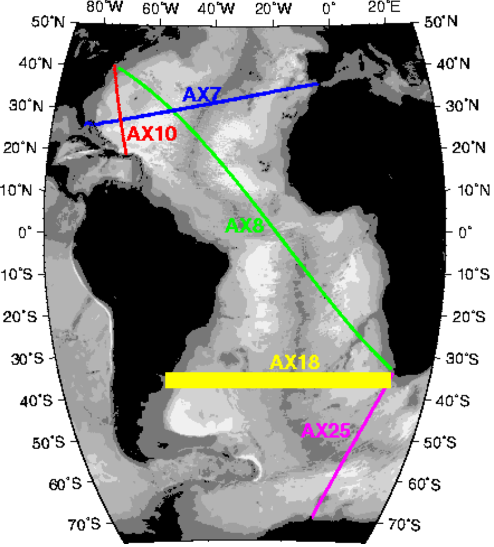
DWBC data provide a benchmark, needed for model validation, on the state of the overturning circulation intensity.

(Molinari et al 1998; Macdonald et al 2003; Meinen et al 2004 and 2006; Baringer and Meinen, 2007; Longworth, Bryden and Baringer 2008)

Pot. Temp. at LSW density







Meridional heat flux – model comparisons

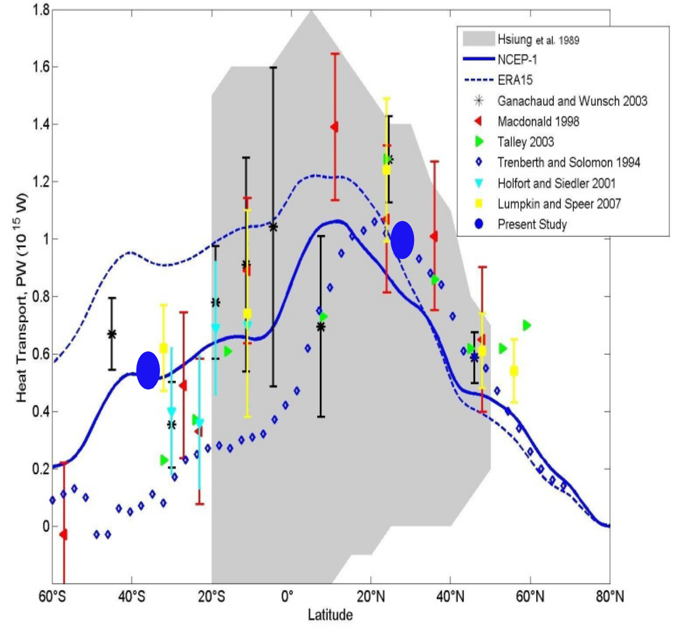
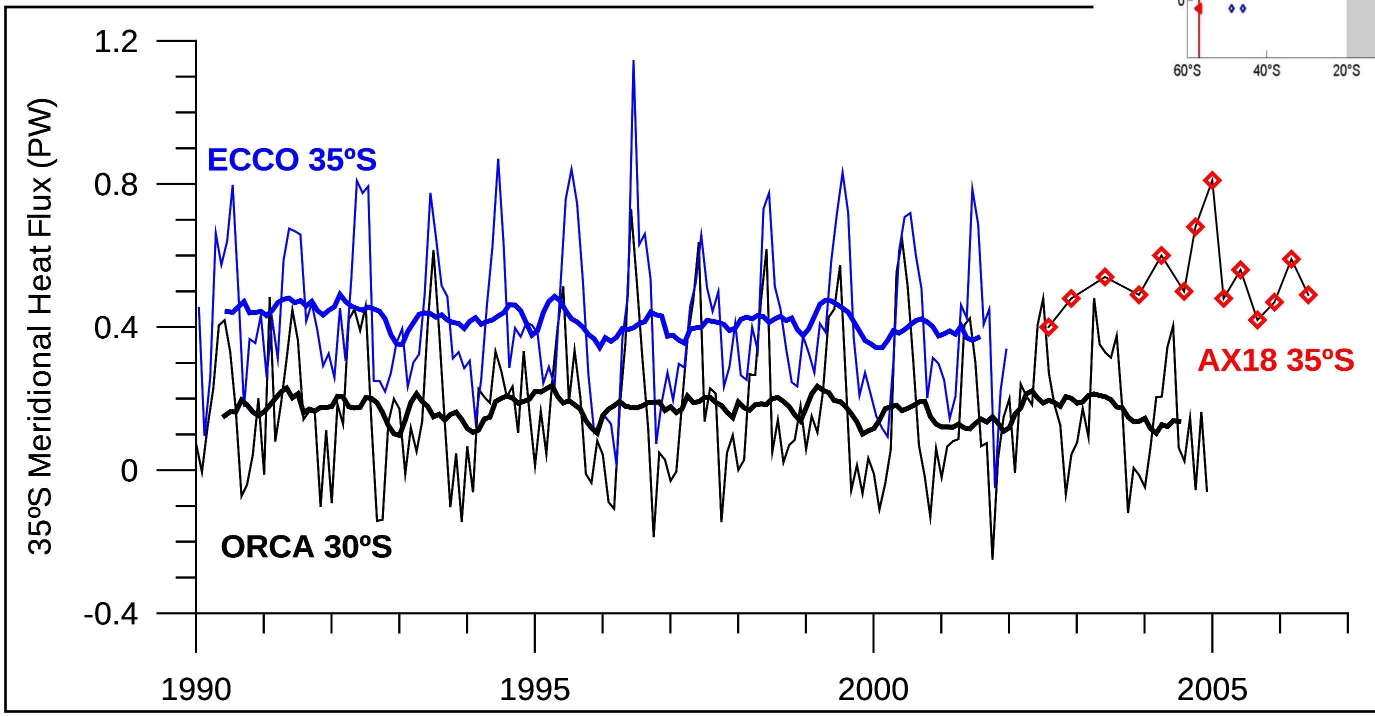


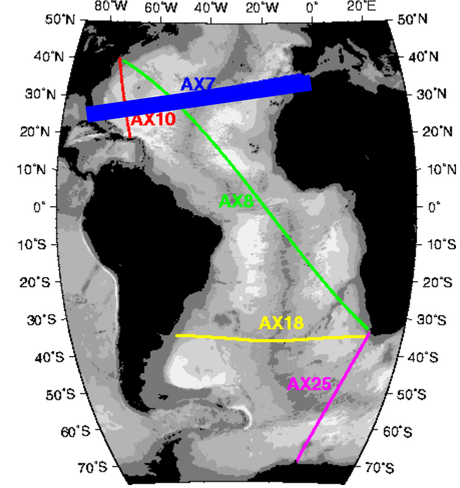
Figure 13.

Garzoli and Baringer 2007
Baringer and Garzoli 2007

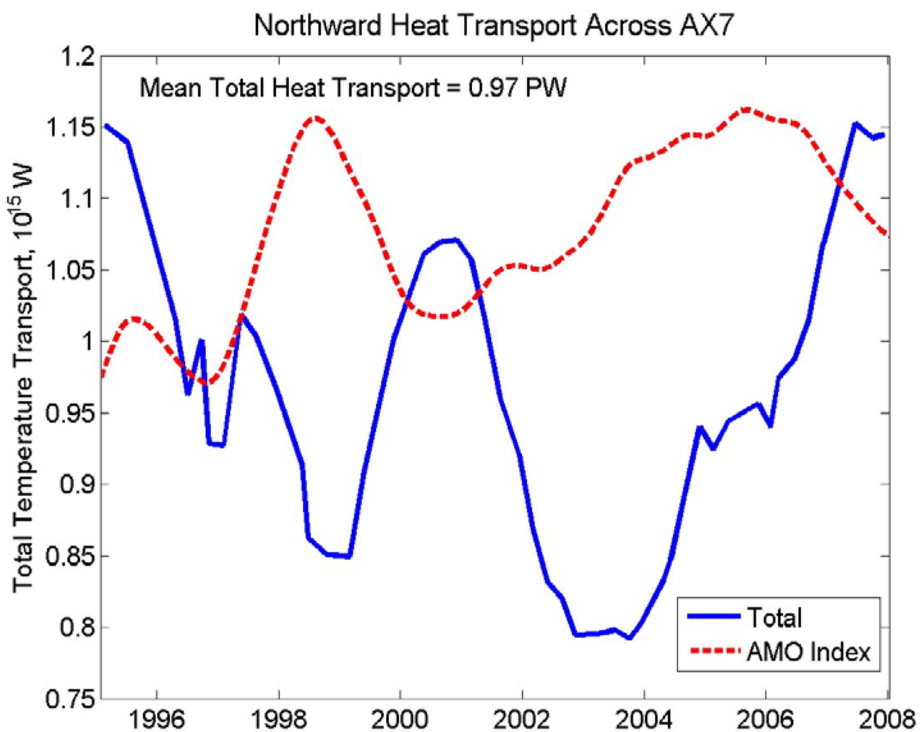


AOML

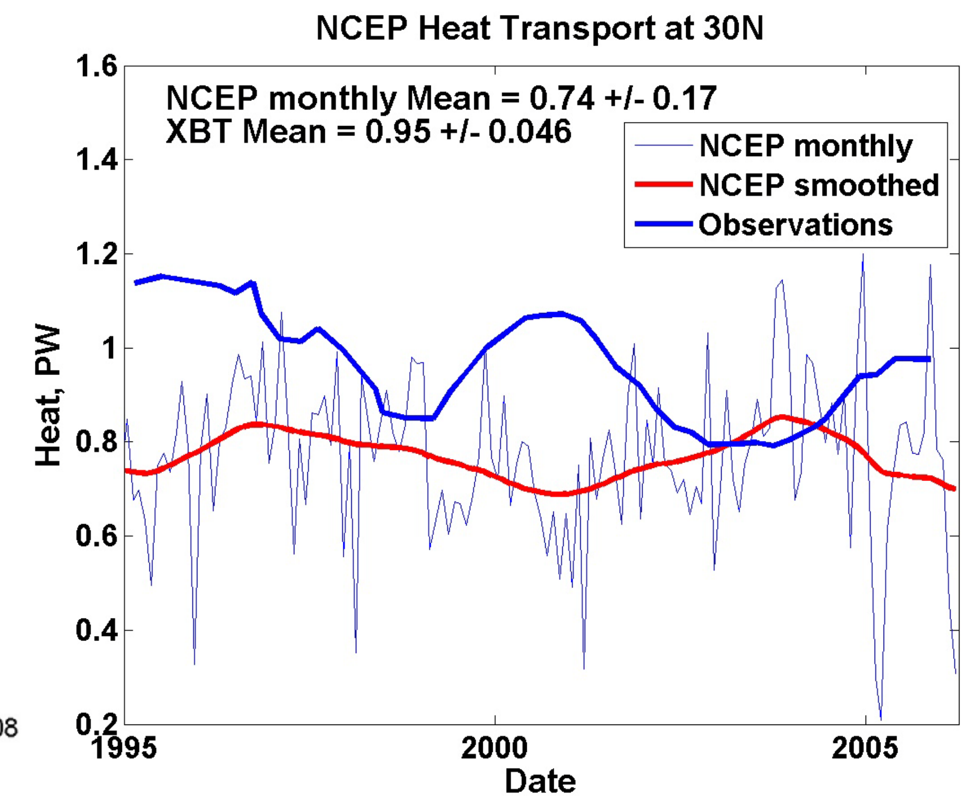
Atlantic Heat Transport estimated using data from expendable bathythermograph (XBT) lines.



Objective: *Quantify the state of the ocean meridional oceanic heat transport variability by ocean currents in the Atlantic where poleward heat transport is near a maximum (North Atlantic section, AX7) and where heat transport is highly variable and uncertain (South Atlantic Section, AX18)*



Time series of total heat transport in the center of the subtropical gyre in the North Atlantic Ocean.



Baringer, 2008

MOC Array 26N

NERC – Rapid Climate Change:

Jochem Marotzke, Harry Bryden, Stuart Cunningham, Torsten Kanzow and Joel Hirschi

Moorings, Transatlantic hydrography

NSF – MOCHA (Meridional Overturning and Heat Transport Array:

Bill Johns, Molly Baringer, Lisa Beal and Chris Meinen

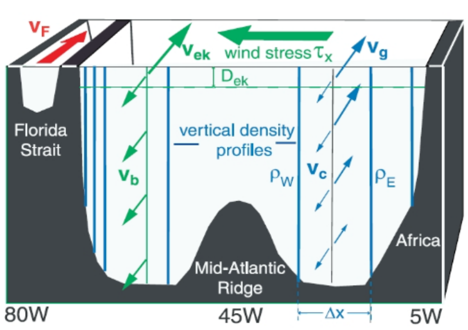
Moorings (Western Boundary)

NOAA – WBTS (Western Boundary Time Series):

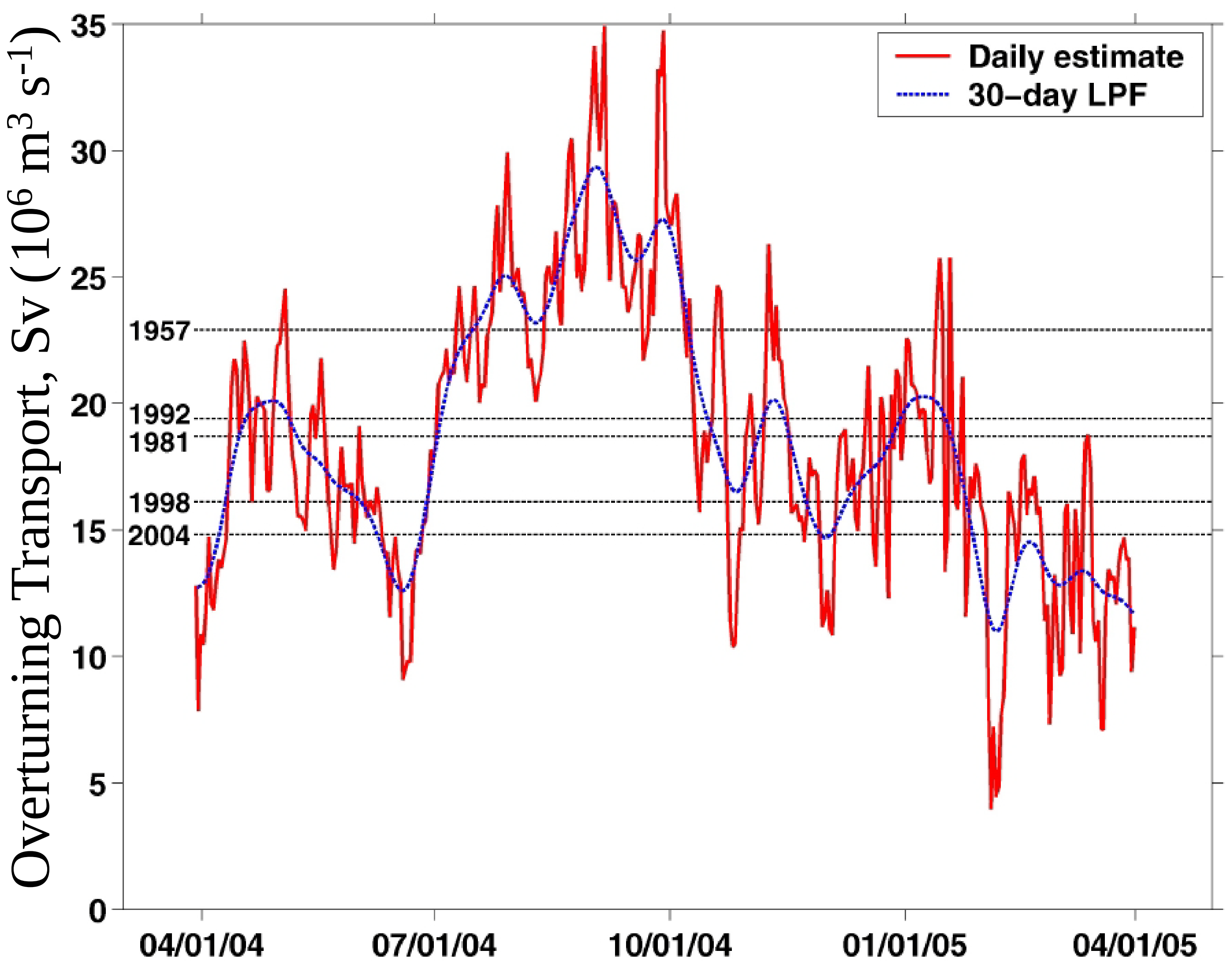
Molly Baringer, Chris Meinen and Silvia Garzoli

Florida Current, DWBC Hydrography, DWBC IES transport

Continuous Monitoring of the MOC at 26 N



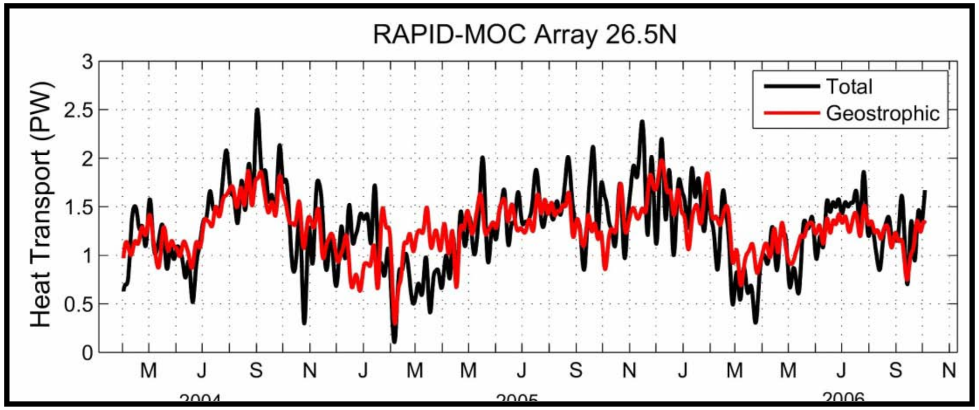
Total Meridional Overturning Circulation at 26 N for 2004



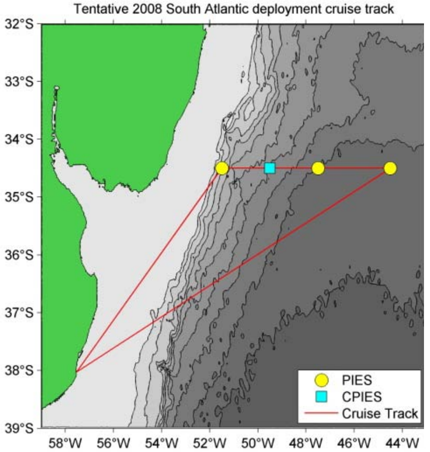
Kanzow et al., 2007; Cunningham et al., 2007; Johns et al 2008; Baringer and Meinen 2008

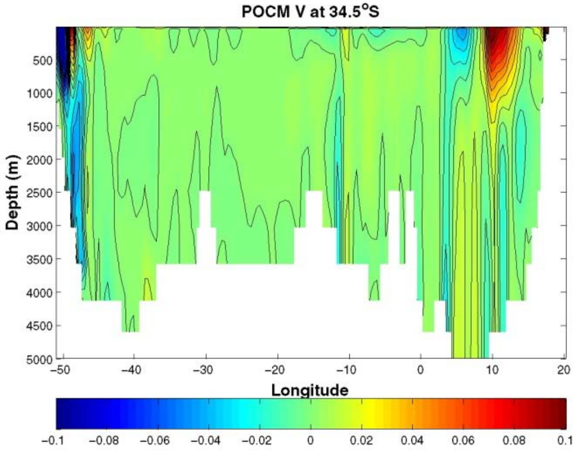
What’s next?

Heat transport from MOCHA
Zonal partition of variability



Monitoring system for the MOC in the South Atlantic (e.g. mooring array of C-PIES) with Univ. Brest on East





Southern Ocean box including Drake Passage, South of Africa and 34 S

Large Scale global hydrographic section (CLIVAR Repeat Hydrography)

Impact of MOC related data on assimilating models