



RACE!

REGIONAL ATLANTIC CIRCULATION AND GLOBAL CHANGE



Variability of the Boundary Circulation Systems at 11°S

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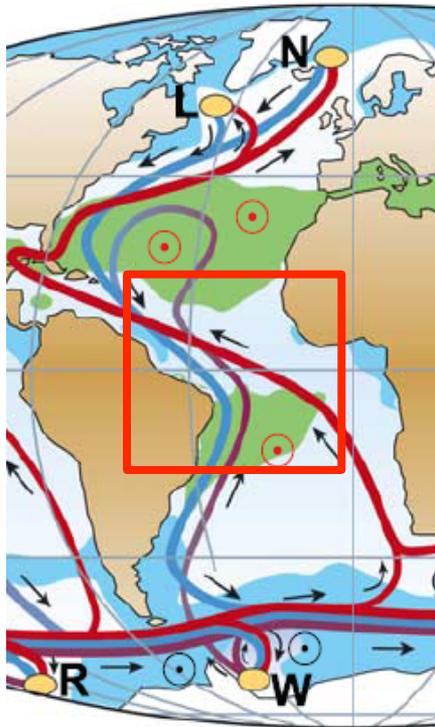
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²*DOCEAN Department of Oceanography UFPE Recife, Brazil*

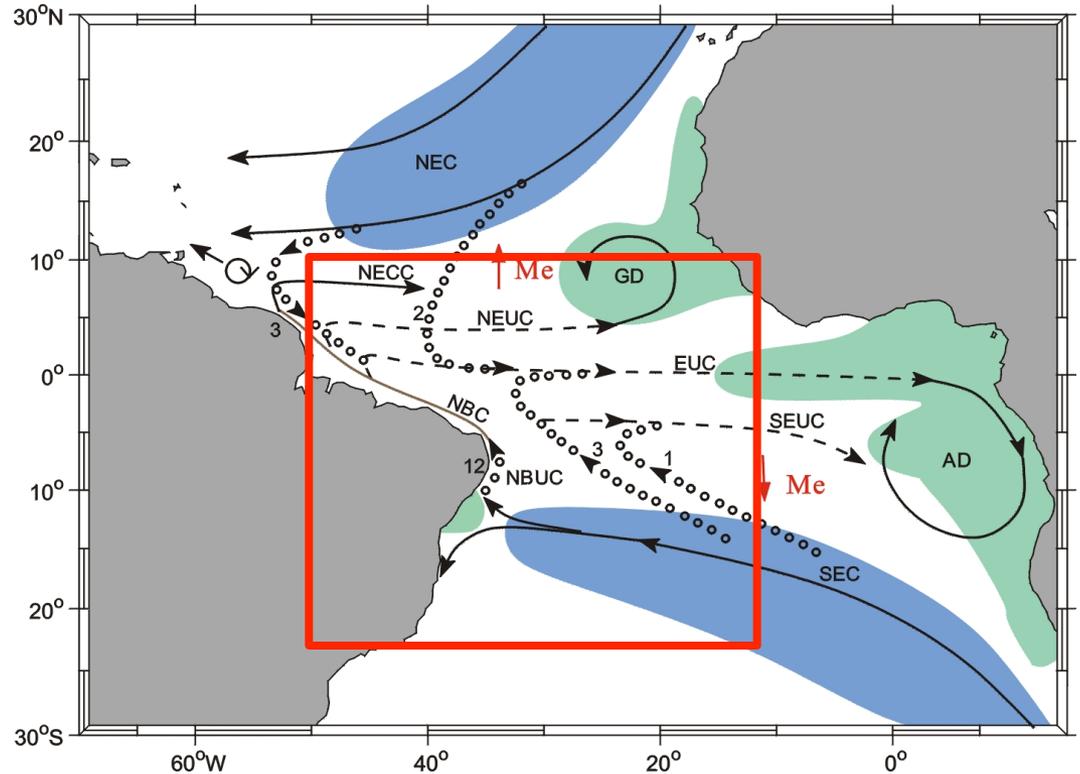
Western Boundary Circulation System (WBCS)

Atlantic thermohaline circulation (ATHC)

Shallow Subtropical-tropical Cells (STC)



Kuhlbroedt et al. 2007

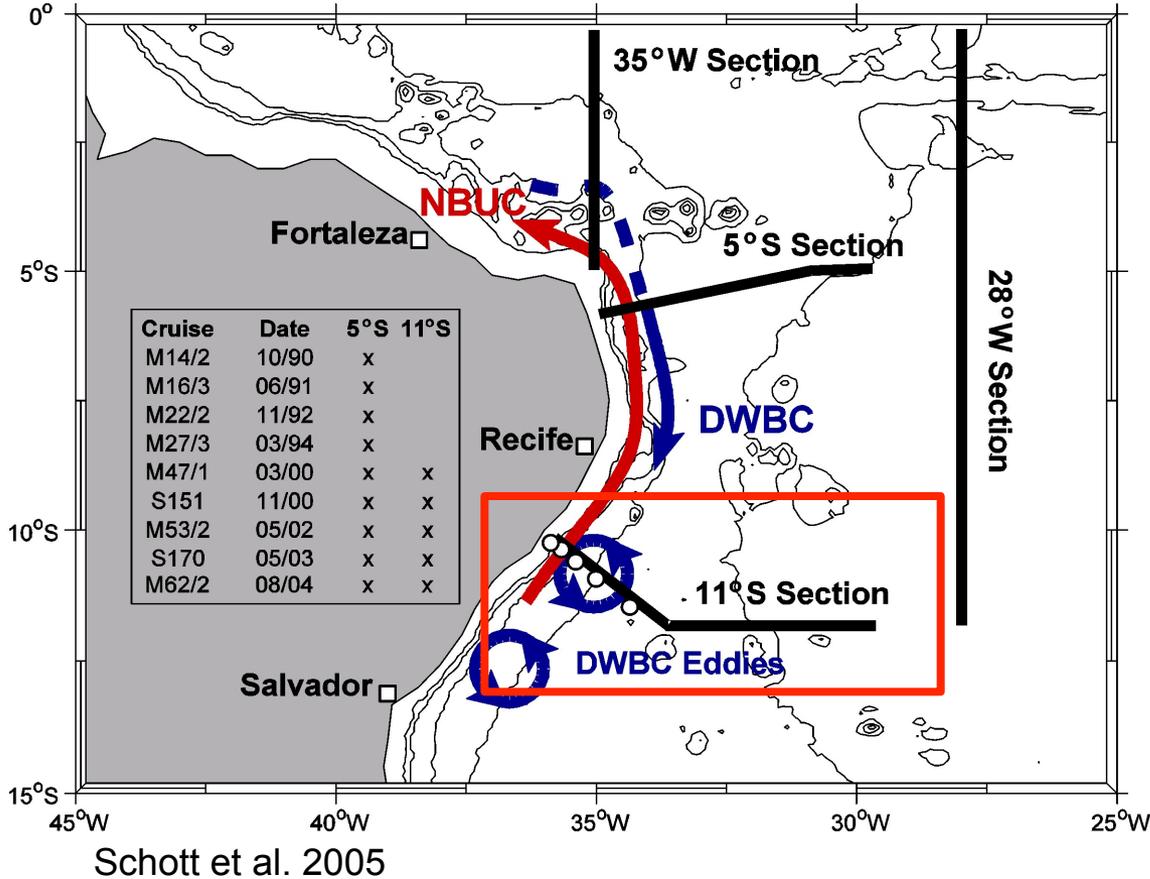


Schott et al. 2004

- Interaction between the hemispheres is focused on the western boundary

Western Boundary Circulation System (WBCS)

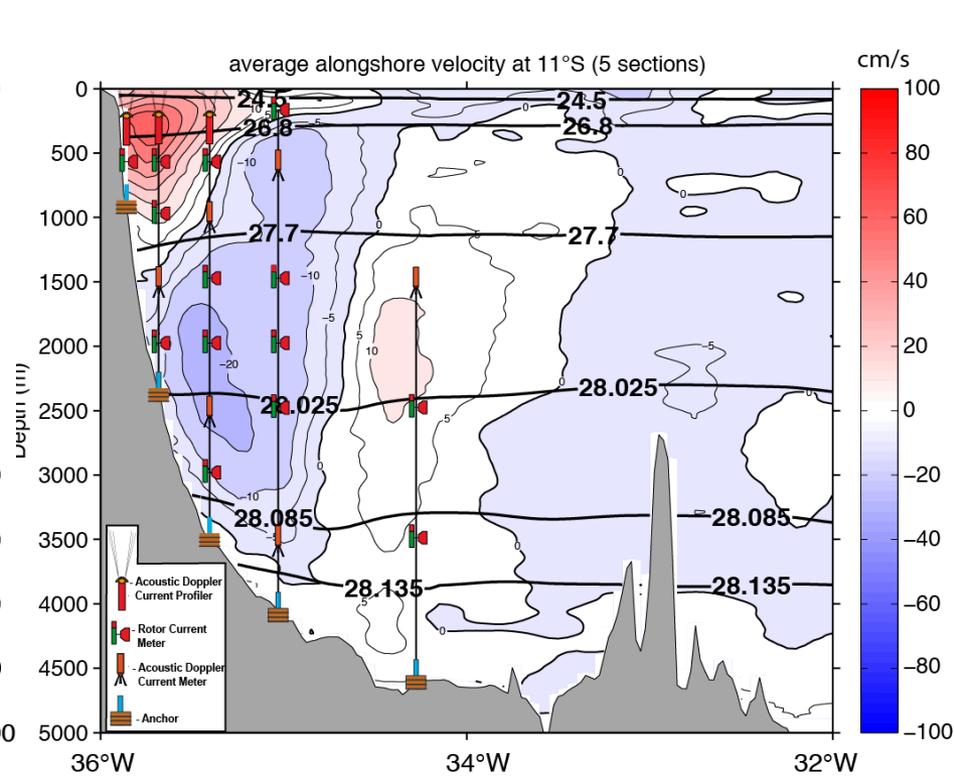
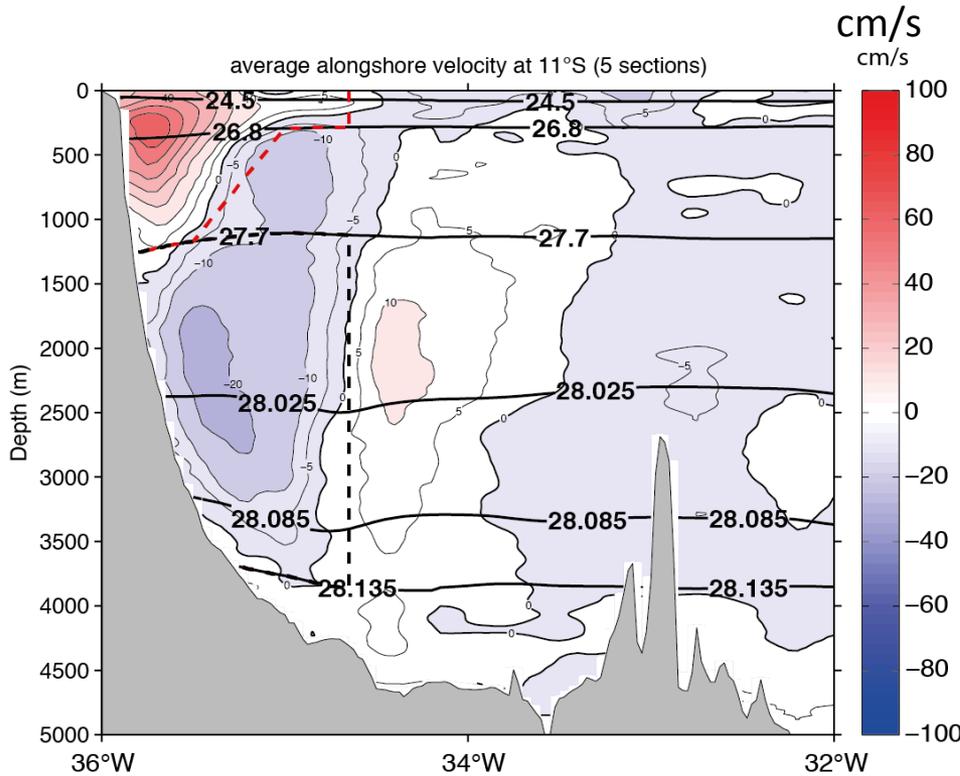
Observations at 5°S and 11°S between 1990-2004:



- 9 research cruises: repeatedly occupied the 5°S and 11°S section
- Mooring array at 11°S 2000-2004

Western Boundary Circulation System (WBCS)

Observations at 11°S between 2000-2004: Mean state



Average transports at 11°S (ship):

NBUC 24 +/- 4 Sv [= $1 \times 10^6 \text{ m}^3\text{s}^{-1}$]

DWBC -34.8 +/- 8.6 Sv

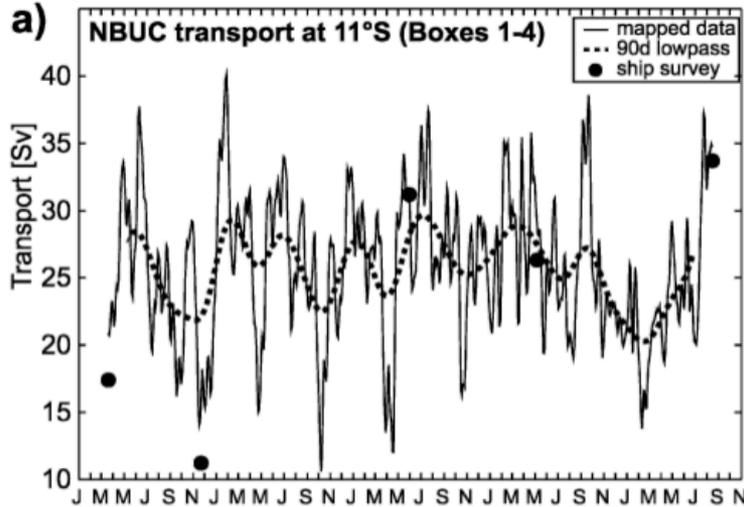
Average transports at 11°S (mooring):

NBUC 27.1 +/- 1.1 Sv

DWBC -18.6 +/- 1.7 Sv

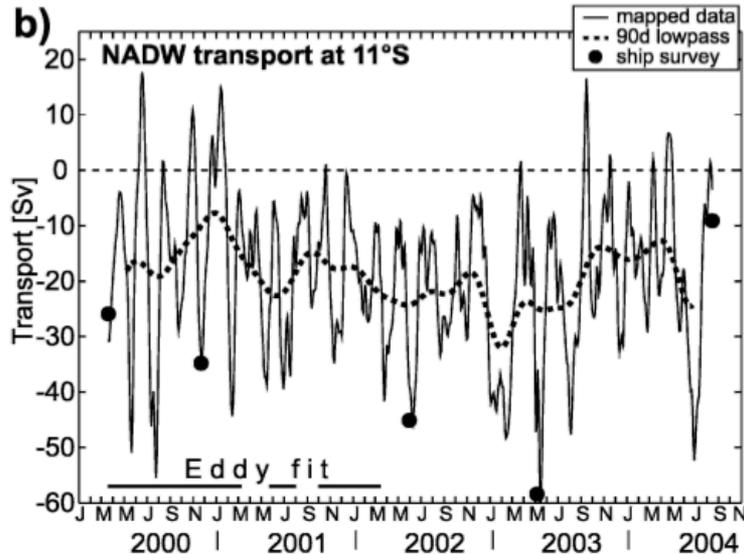
Western Boundary Circulation System (WBCS)

Observations at 11°S between 2000-2004: Intraseasonal to Seasonal Variability



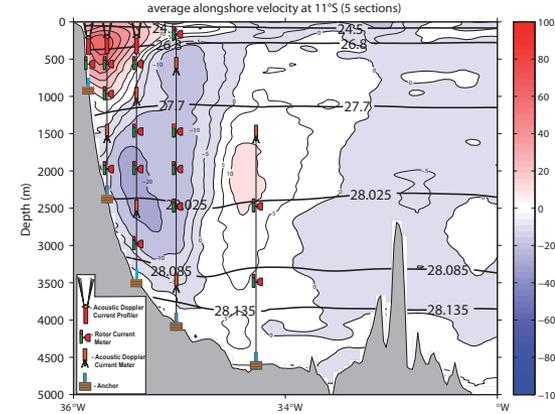
NBUC:

- Average transport is similar to ship sections



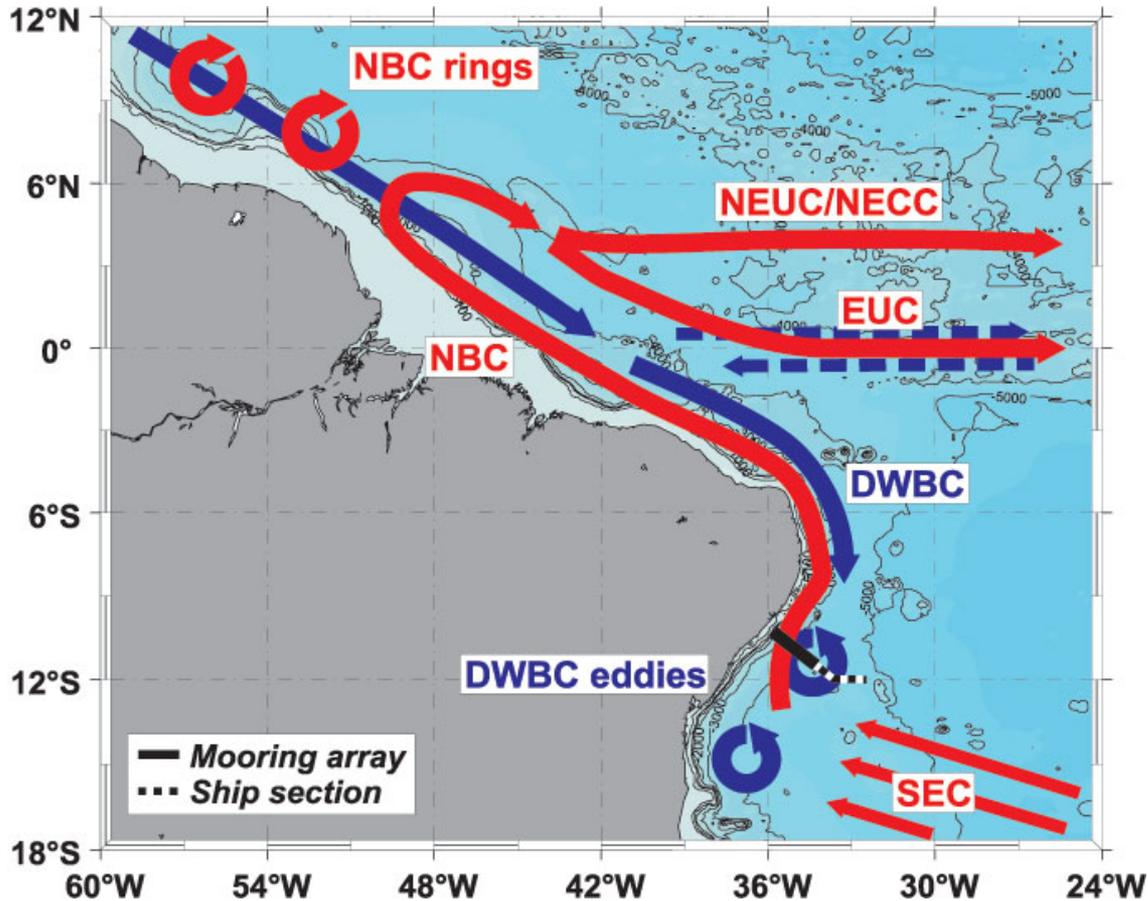
DWBC:

- Average transport is lower than from ship sections
- Spectral peak at 60-70 days period associated with deep eddies



Western Boundary Circulation System (WBCS)

Observations at 11°S between 2000-2004

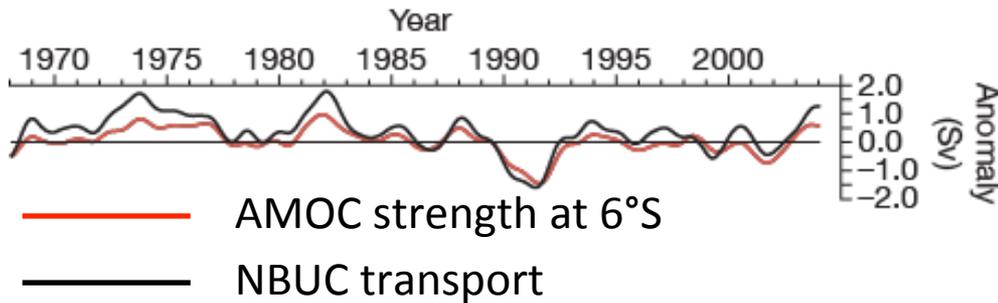


- Break up of DWBC in to deep eddies at around 8°S

Dengler et al. 2004

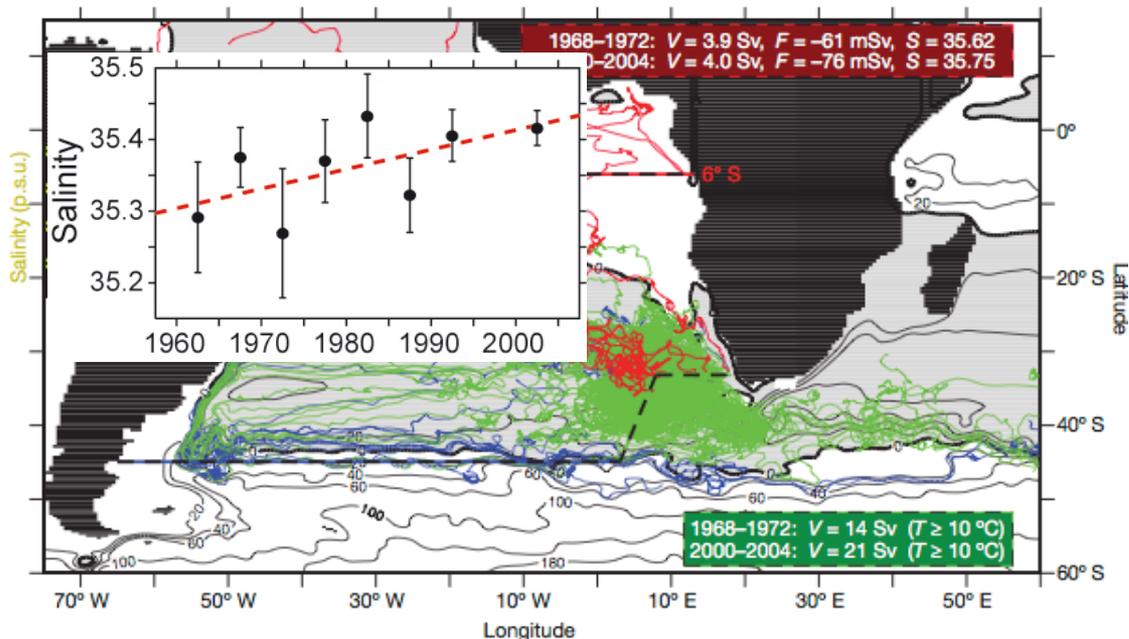
Western Boundary Circulation System (WBCS)

Other studies after observational period



- close correspondence between AMOC strength and NBUC transport on inter-annual time scales

Biastoch et al. 2008



- Salinity anomalies within the NBUC are related to the variability of the Agulhas leakage and might have implications for further evolution of MOC

Biastoch et al. 2009

Western Boundary Circulation System (WBCS)

New observations at 11°S: velocities

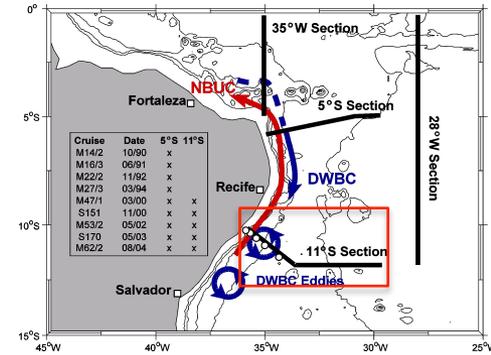
4 new research cruises:

M98 (July 2013)

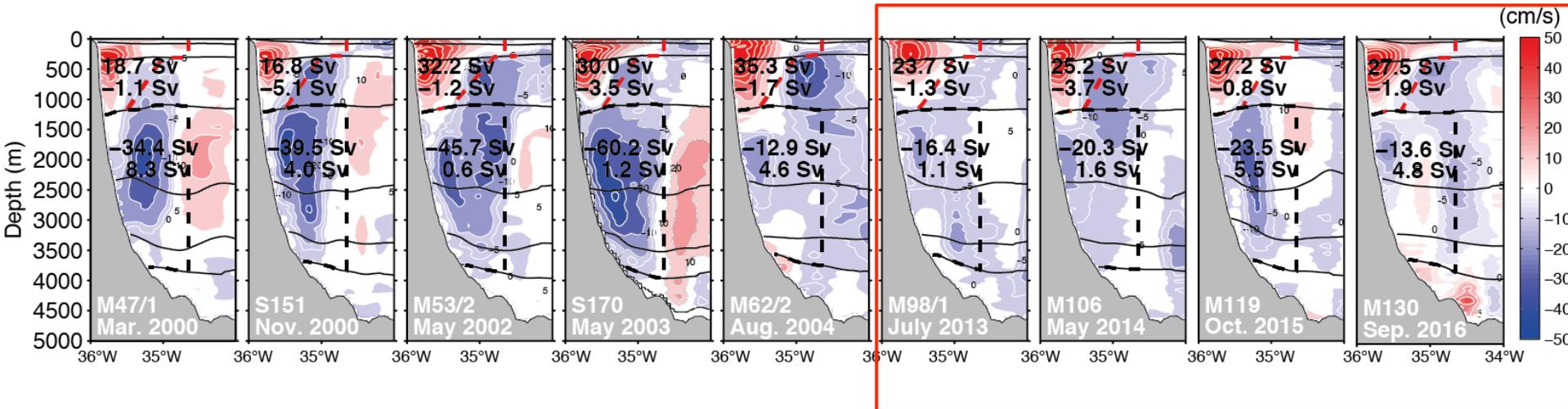
M106 (May 2014)

M119 (October 2015)

M130 (September 2016)



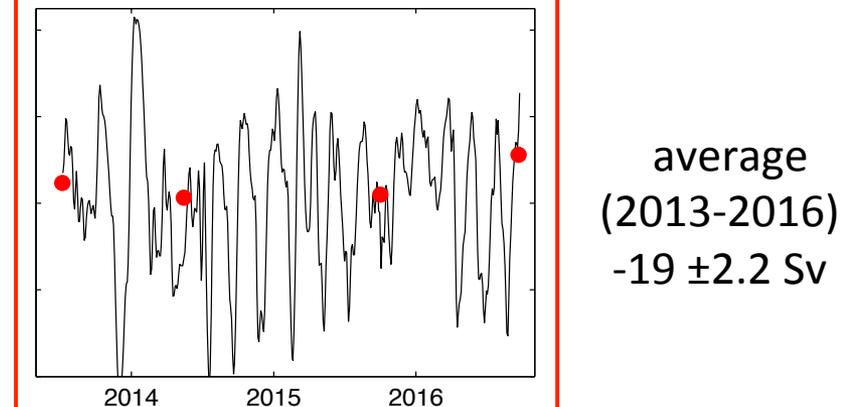
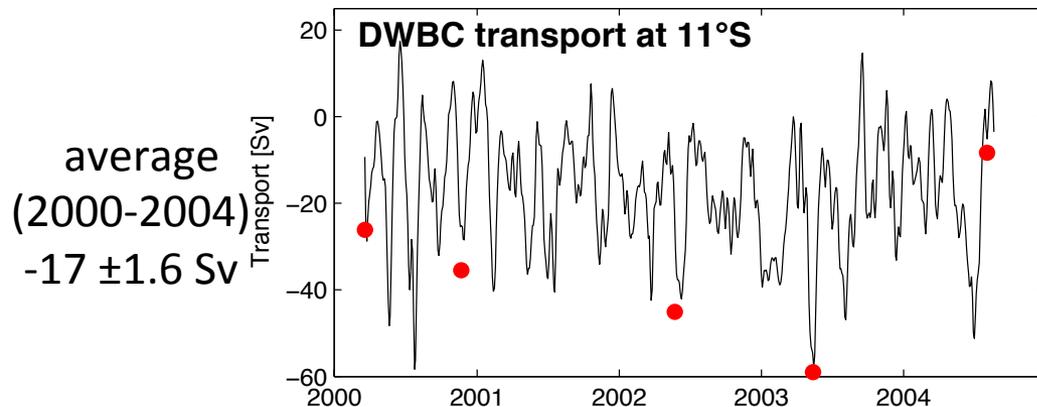
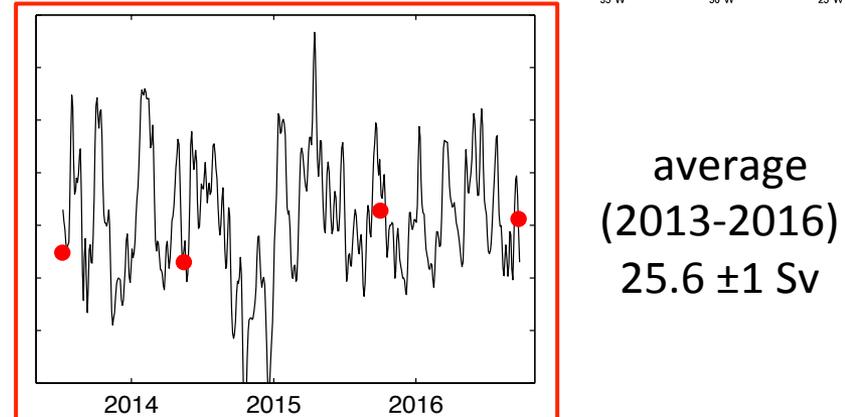
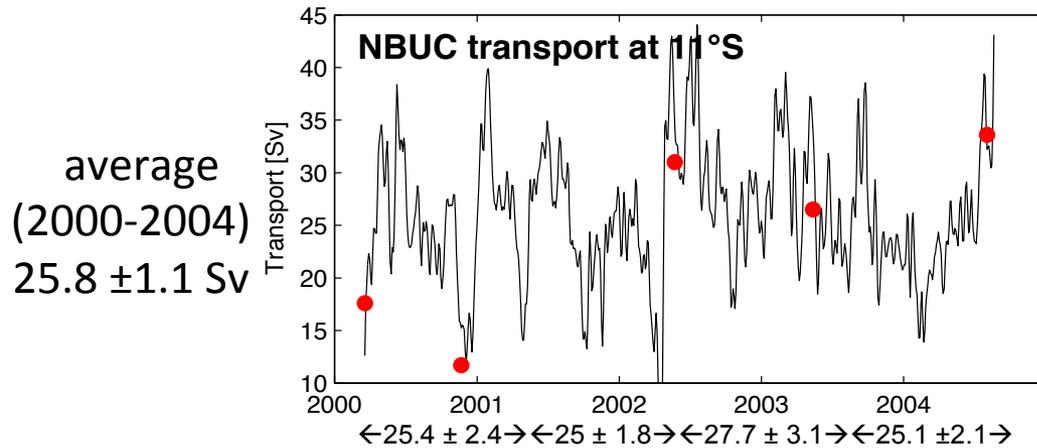
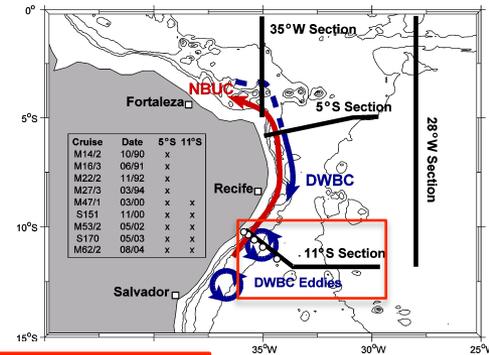
redeployment of mooring array in 2013



Western Boundary Circulation System (WBCS)

New observations at 11°S: velocities

redeployment of mooring array in 2013

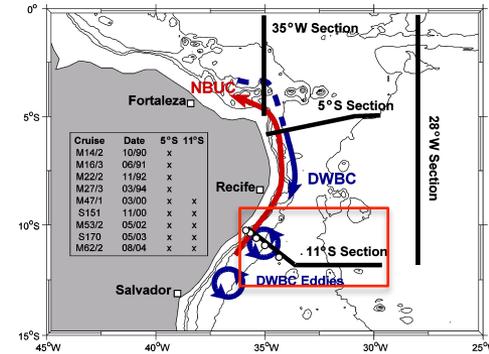


update from Hummels et al. 2015

Western Boundary Circulation System (WBCS)

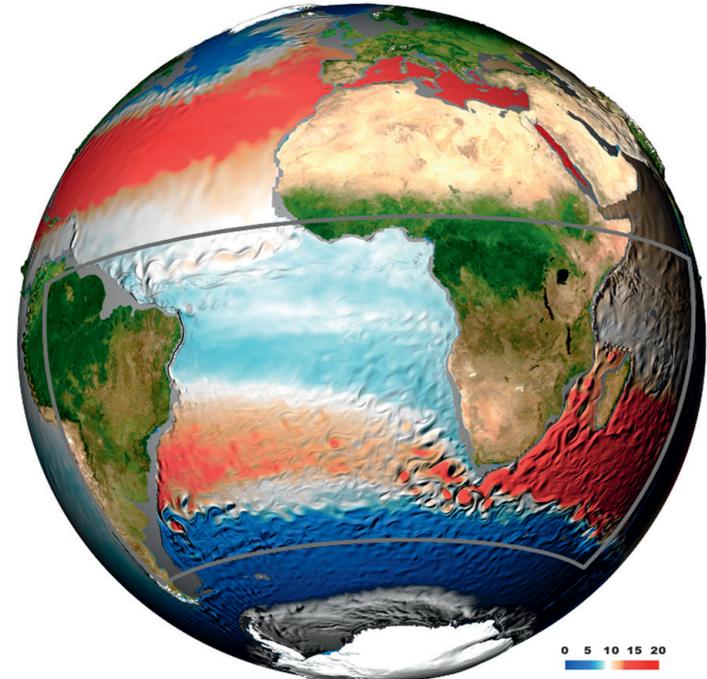
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What is INALT01?

- global 0.5° horizontal resolution (ORCA05)
- 1/10° horizontal resolution within the nest
- 46 vertical levels
- forced with CORE2b dataset

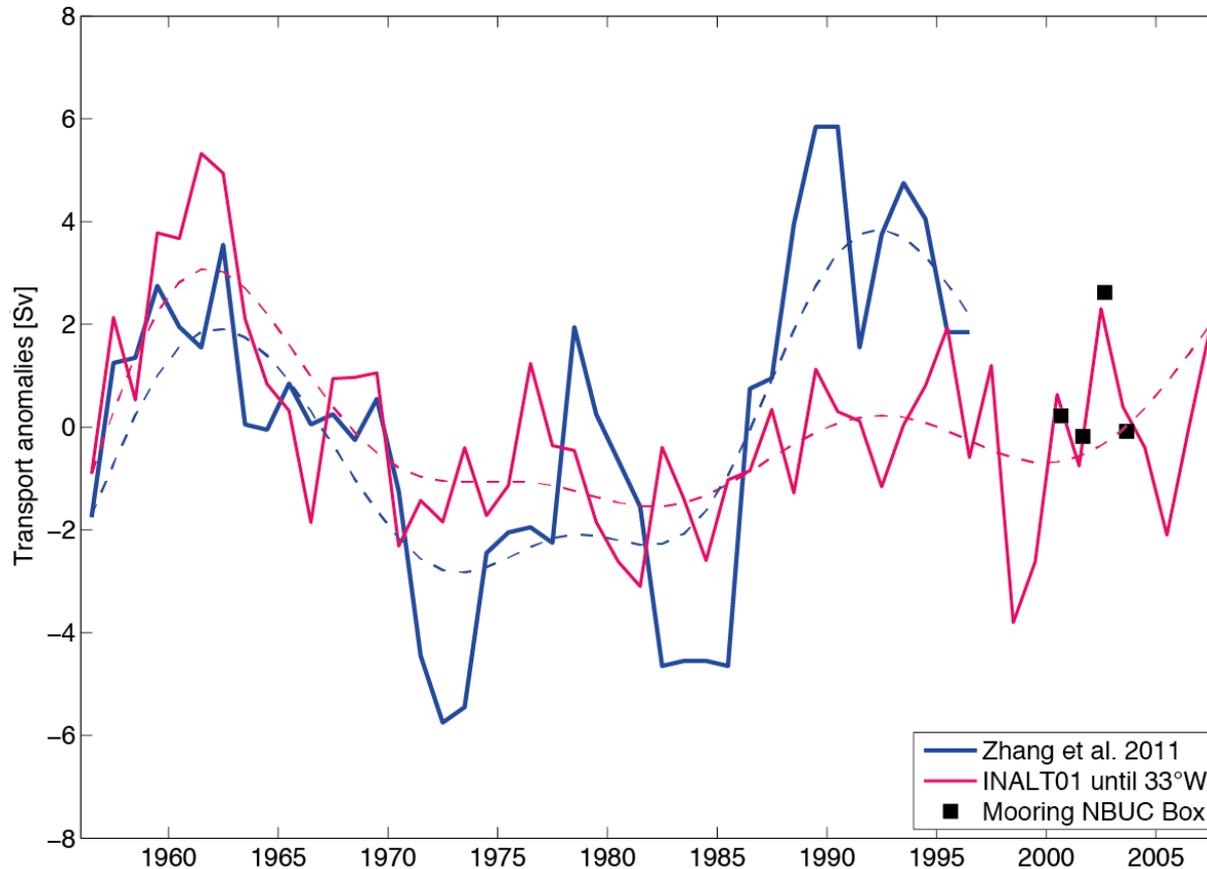
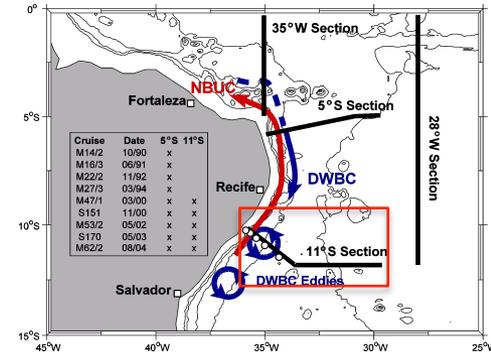


Durgadoo et al. 2013

Western Boundary Circulation System (WBCS)

New observations at 11°S: velocities

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Averages subtracted:

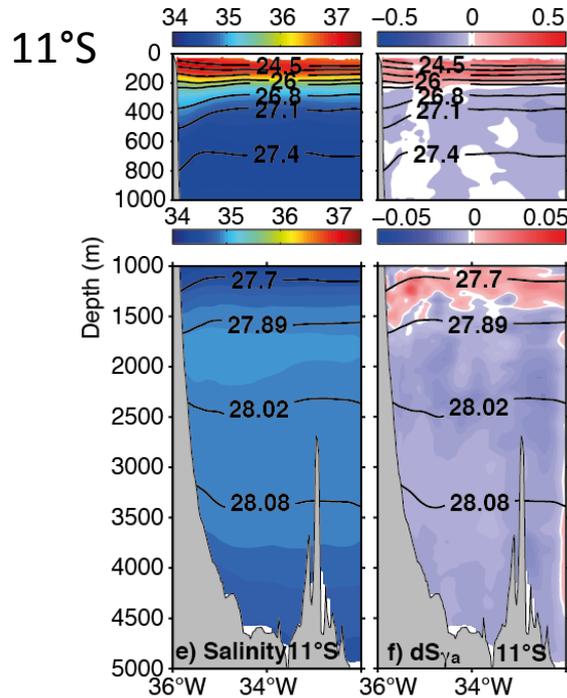
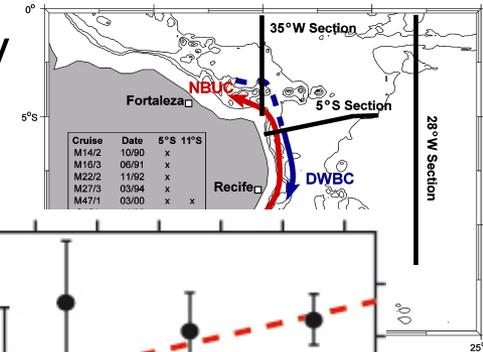
25.2 Sv Mooring

14.9 Sv INALT01

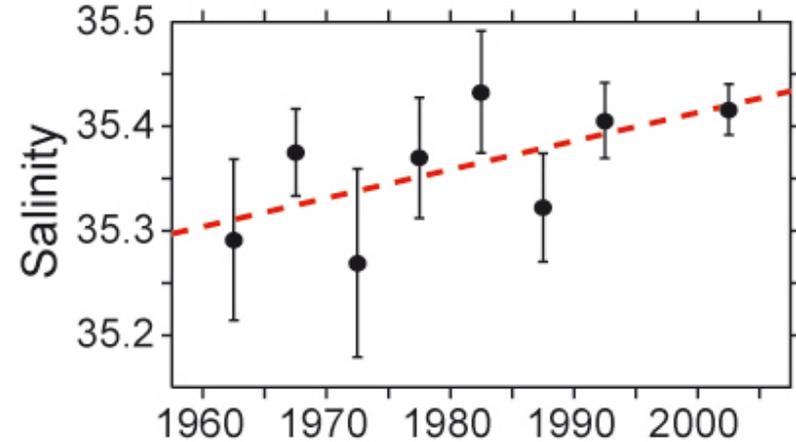
16.3 Sv Zhang '11

Western Boundary Circulation System (WBCS)

New observations at 11°S: hydrography



Hummels et al. 2015



Biastoch et al. 2009

trend: **+0.028 psu / decade**
(100-600m NBUC region)

Average salinity differences across section:

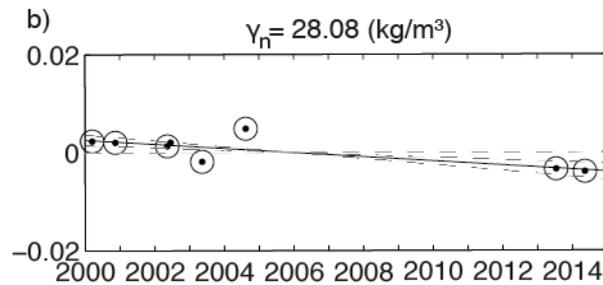
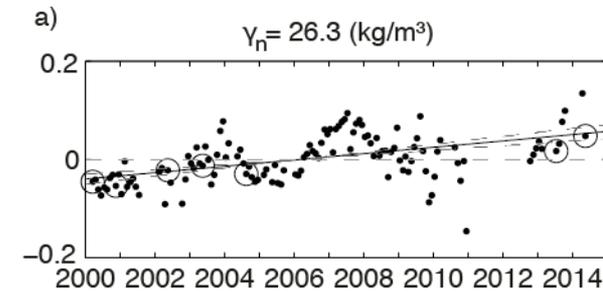
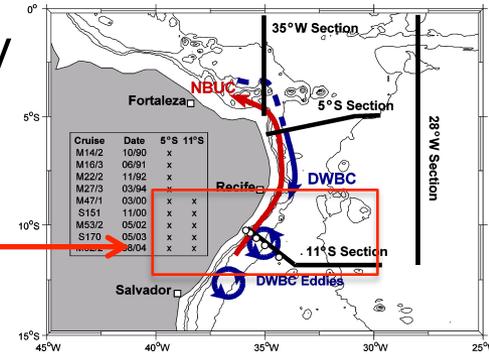
$$dS_{\gamma} (100-600m) = 0.024 / \text{decade}$$

$$dS_{\gamma} (1500-4000m) = -0.007 / \text{decade}$$

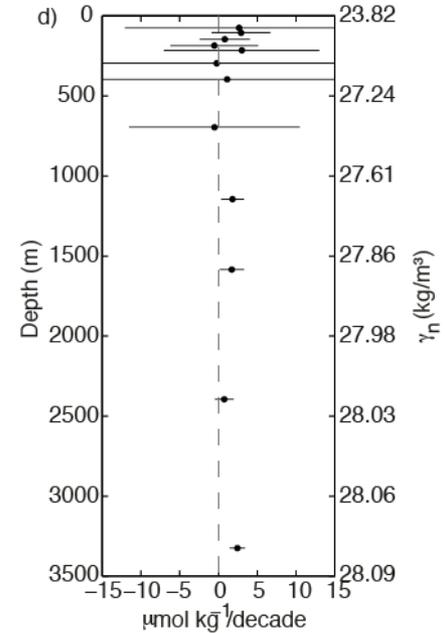
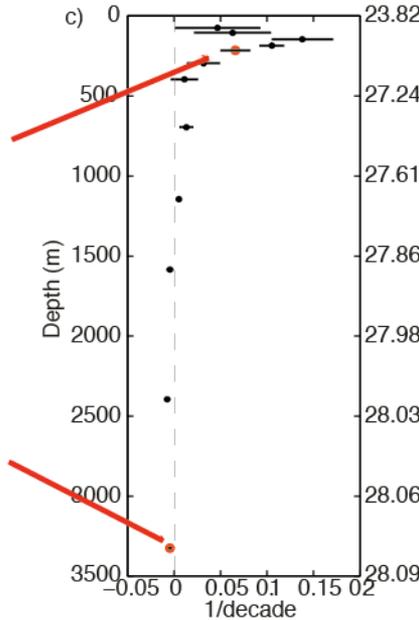
Western Boundary Circulation System (WBCS)

New observations at 11°S: hydrography

All available hydrographic data between 40°W-30°W and 12°S-8°S



Hummels et al. 2015



Eastern Boundary Circulation System (EBCS)

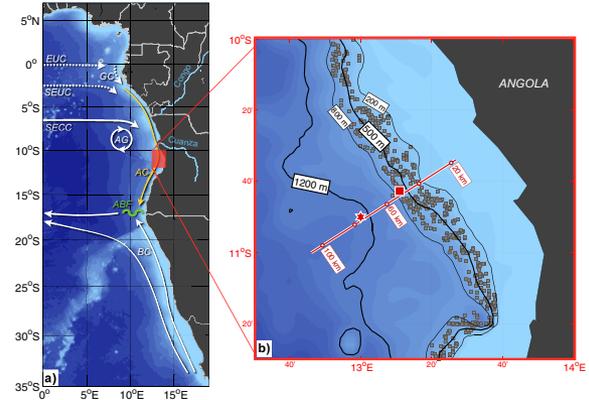
3 research cruises

M98 (July 2013)

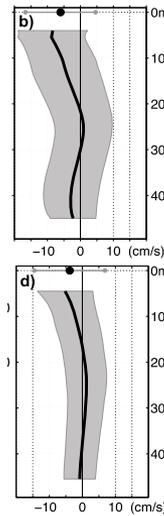
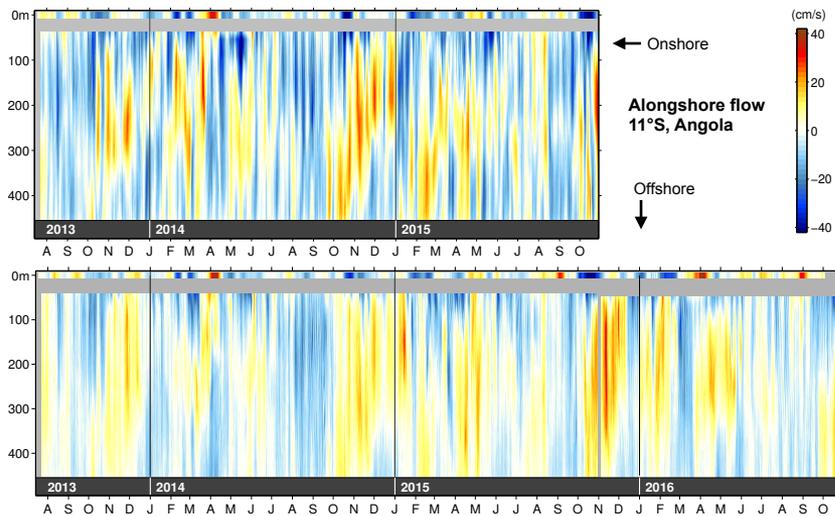
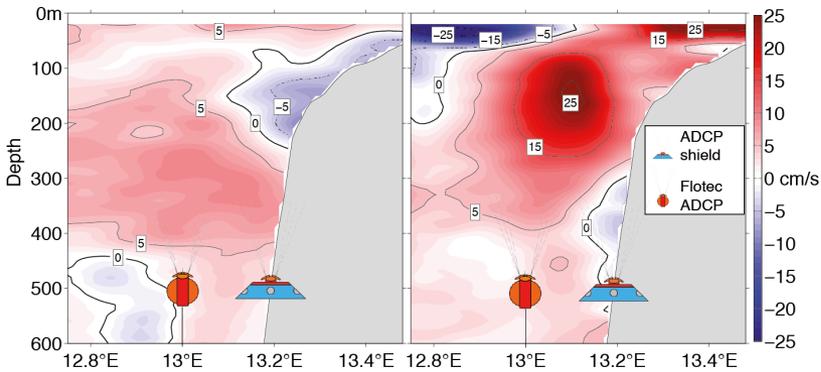
M120 (November 2015)

M131 (October 2016)

deployment of mooring array in 2013



- Alongshore velocities highly variable (alternating between north-and southward) with a weak mean southward flow of about 5-8 cm/s
- Seasonal variability is dominated by 120-day, semi-annual and annual oscillations



Eastern Boundary Circulation System (EBCS)

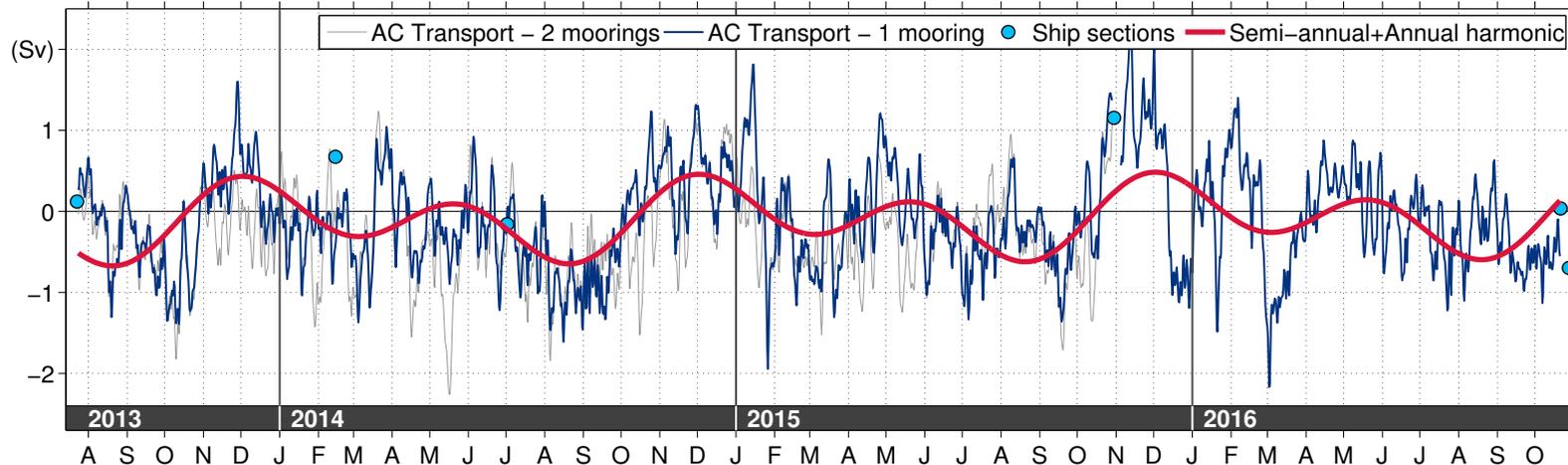
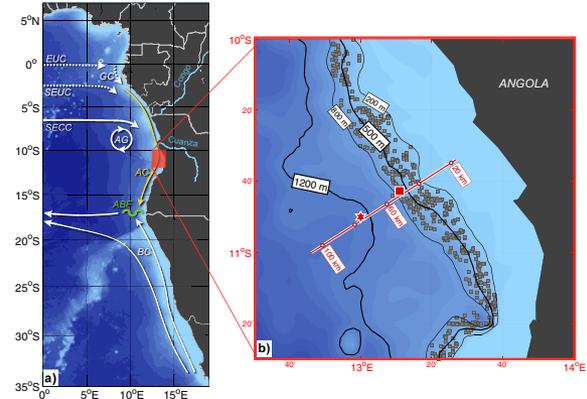
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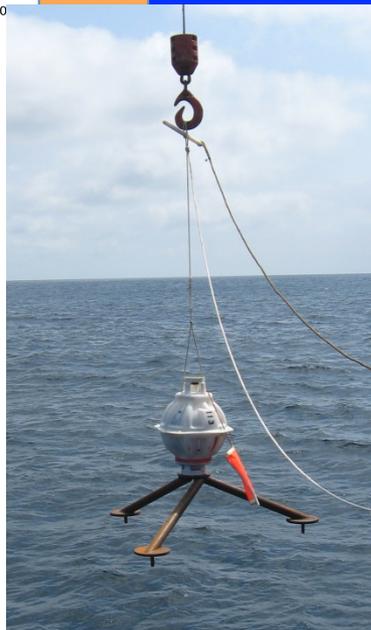
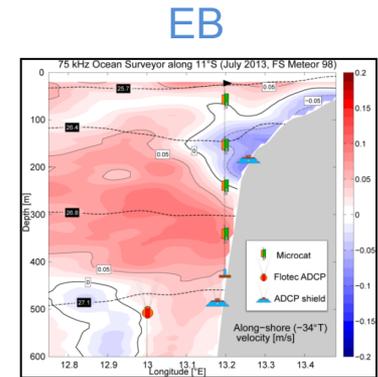
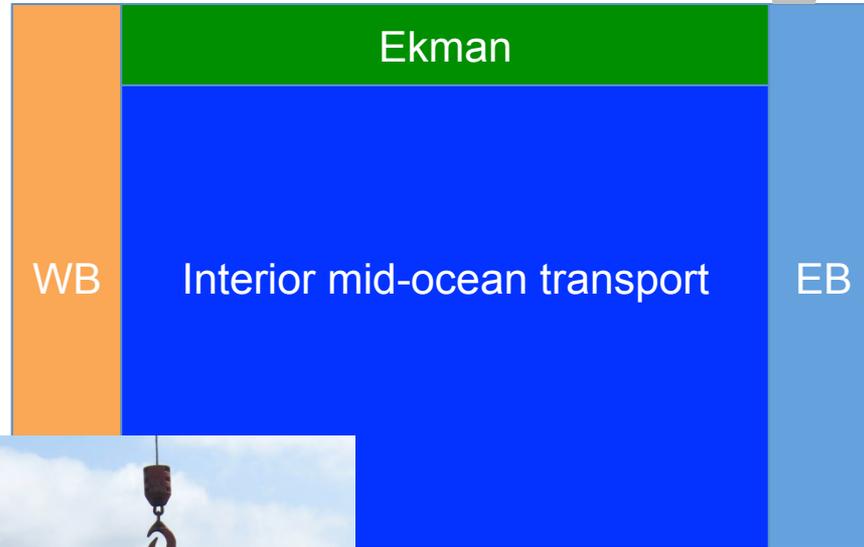
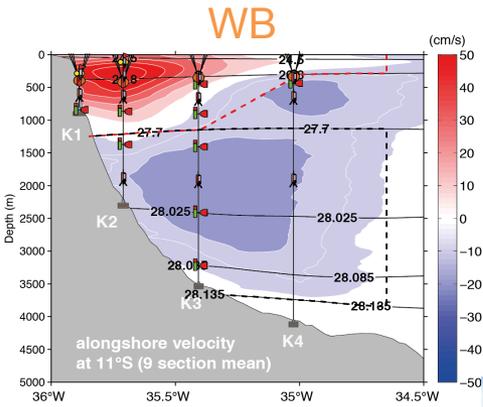


update from Kopte et al. 2016

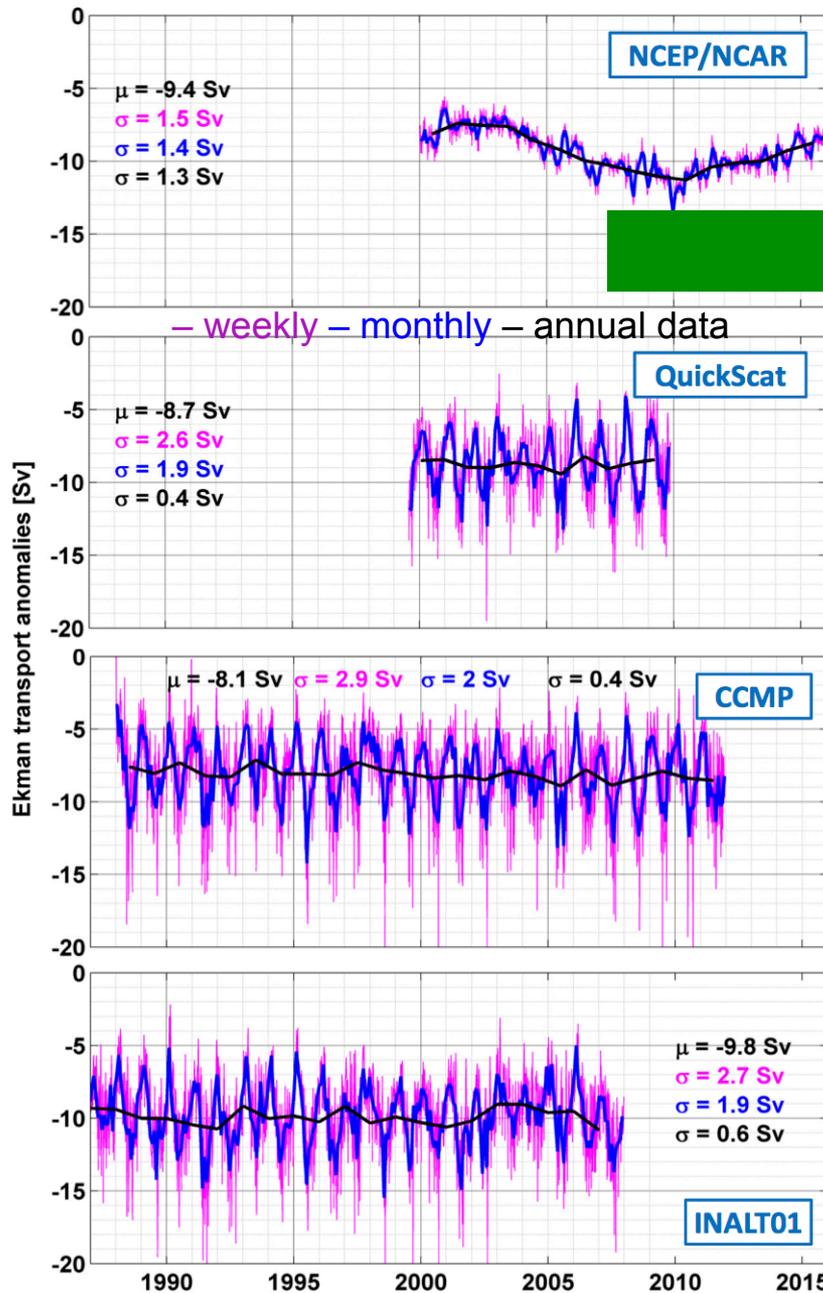
- The Angola Current (AC) transport shows a mean of -0.32 ± 0.05 and its semiannual cycle is quasi-synchronized with semiannual coastal Kelvin waves.

AMOC estimate at 11°S

$$T_{AMOC}(t) = T_{UMO}(t) + T_{EK}(t) + T_{NBUIC}(t) + T_{EB}(t)$$



AMOC estimate at 11°S



Ekman

- large differences can arise depending on the method used to estimate wind stress from the wind products
- Wind stress is estimated from wind at 10m after Large and Yeager (2004) assuming neutral stability
- mean Ekman transports range between 8.1-9.8 Sv among products and is dominated by seasonal variability (~ 2 Sv)
- NCEP/NCAR: weak seasonal variability and spurious decadal trend



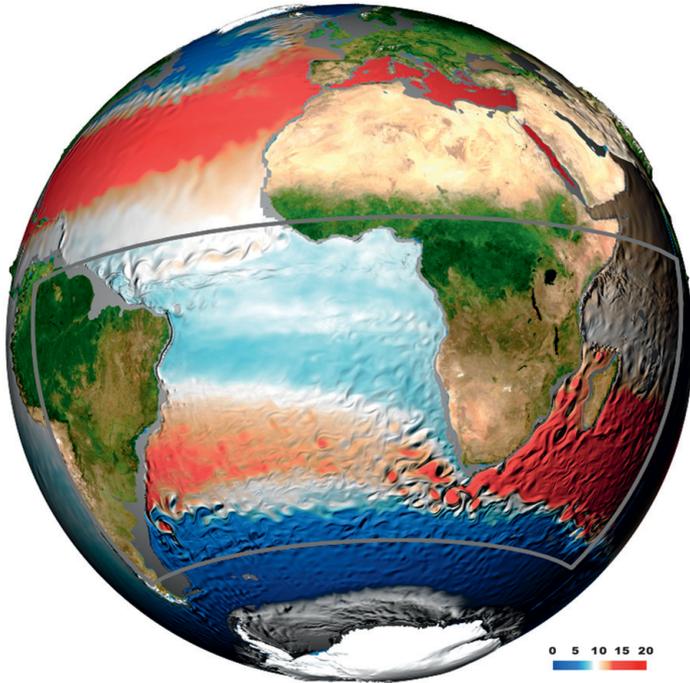
AMOC observations in the North Atlantic particularly including BMBF RACE measurements are well established.

The tropical array measurements will significantly contribute to the understanding of AMOC coherence and propagation of signals of northern and southern hemisphere origin.

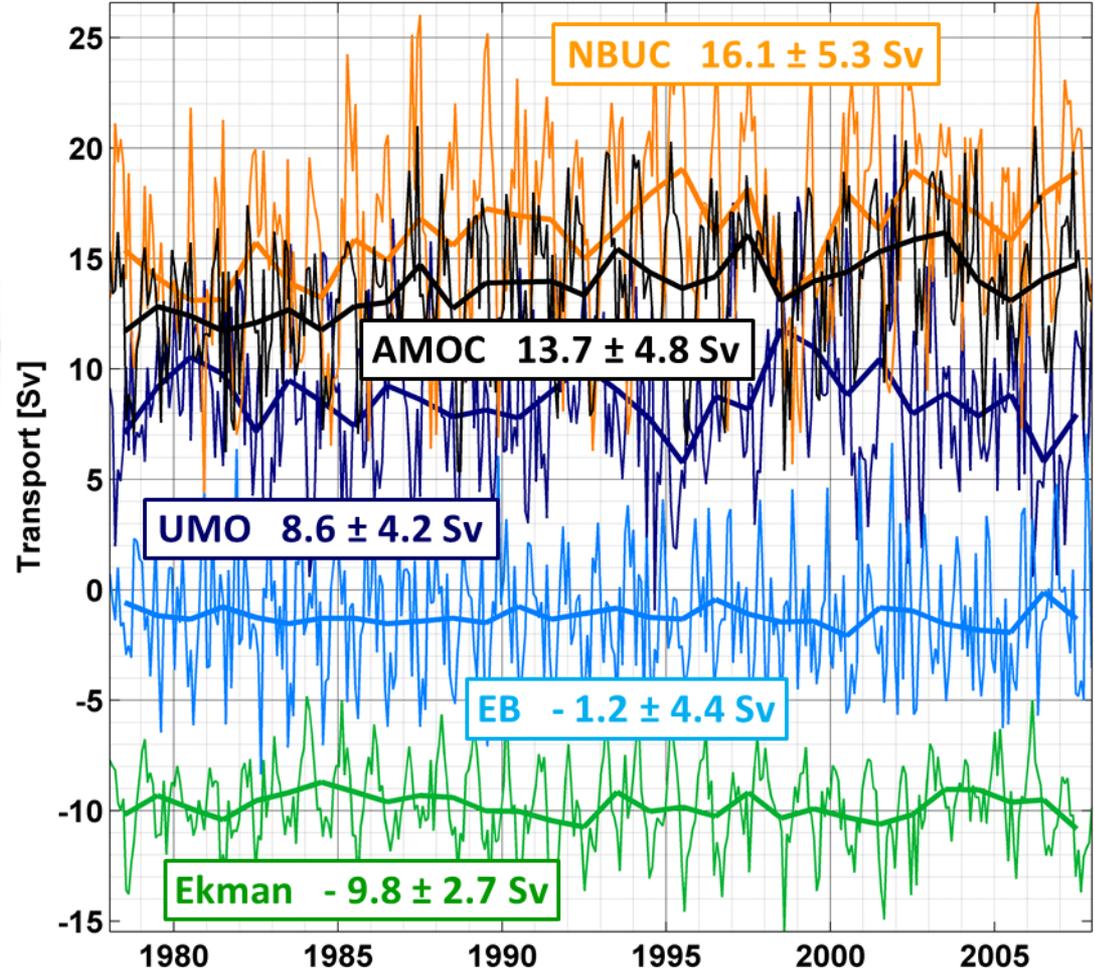


AMOC estimate at 11°S

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Durgadoo et al. 2013, INALT01



Western Boundary Circulation System (WBCS)

Summary

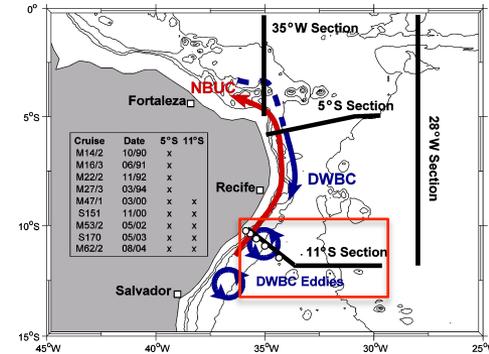
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redeployment of mooring array in 2013

- no significant transport changes between the observational periods, which are a decade apart
- interannual variations in NBUC transport from observations fit to numerical simulations (INALT01)
- decadal variability of NBUC transport is similar in INALT01 and the geostrophic transports estimated in Zhang et al. 2011 and should be detectable with the currently installed observing system
- positive (negative) decadal salinity trend within the central water (DWBC layer) consistent with changes in the large scale circulation of the Atlantic

Further plans and aims

- 2 research cruises: September 2015, March 2017
- mooring array at least until 2017

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- analyze the connection between assessed NBUC variability at 11° S and EUC variability at 23°W on the equator and its relevance for climate variability

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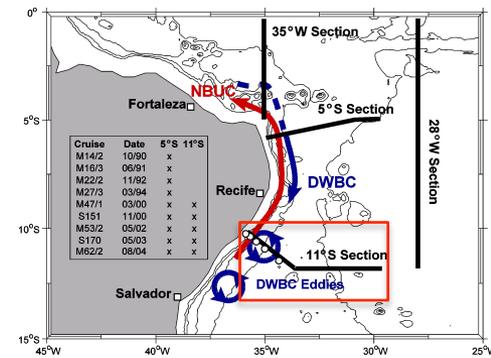
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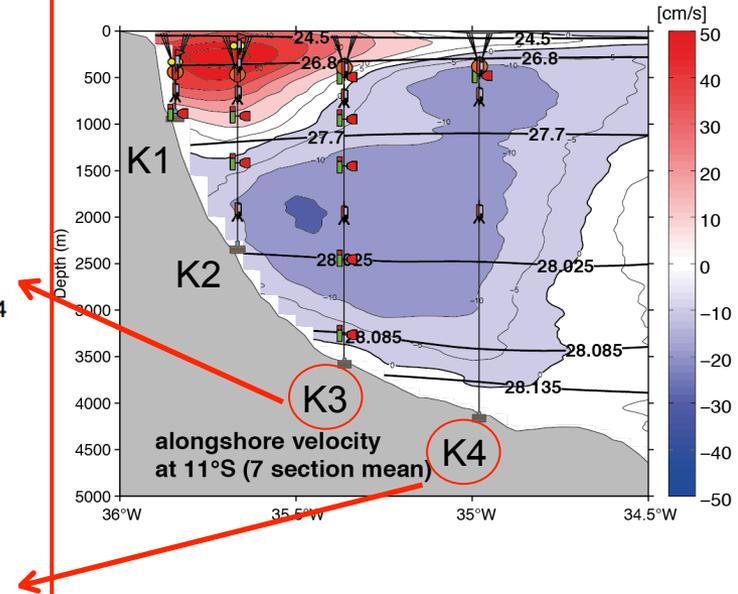
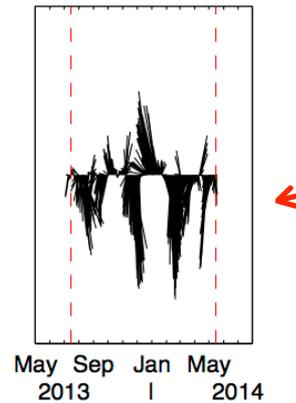
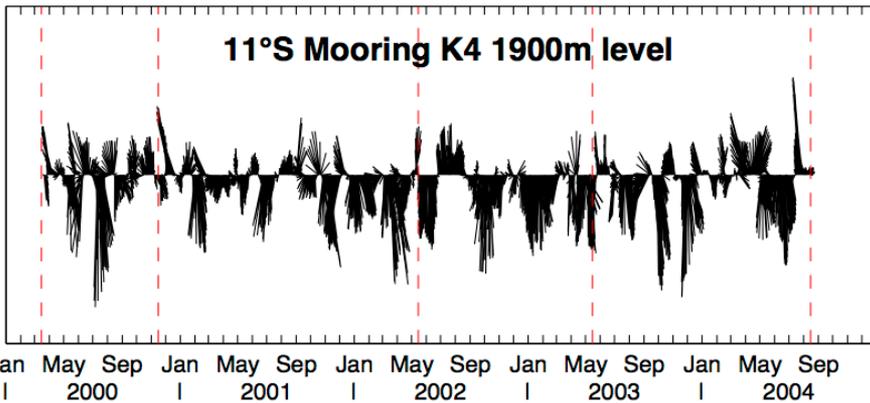
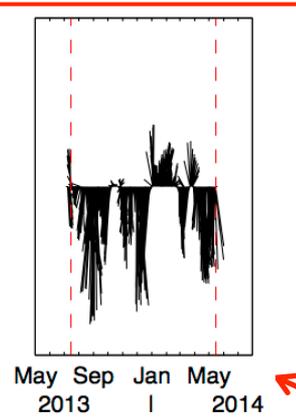
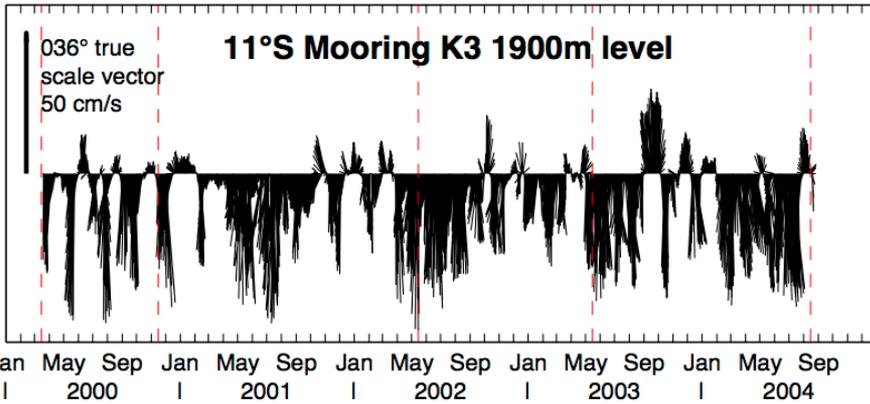
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- analyze the propagation of water mass anomalies in the AMOC, which can e.g. be caused by the variability in the Agulhas leakage
- investigate the variability of the basin-wide (S)AMOC at 11°S

New observations at 11°S: velocities

2 research cruises:
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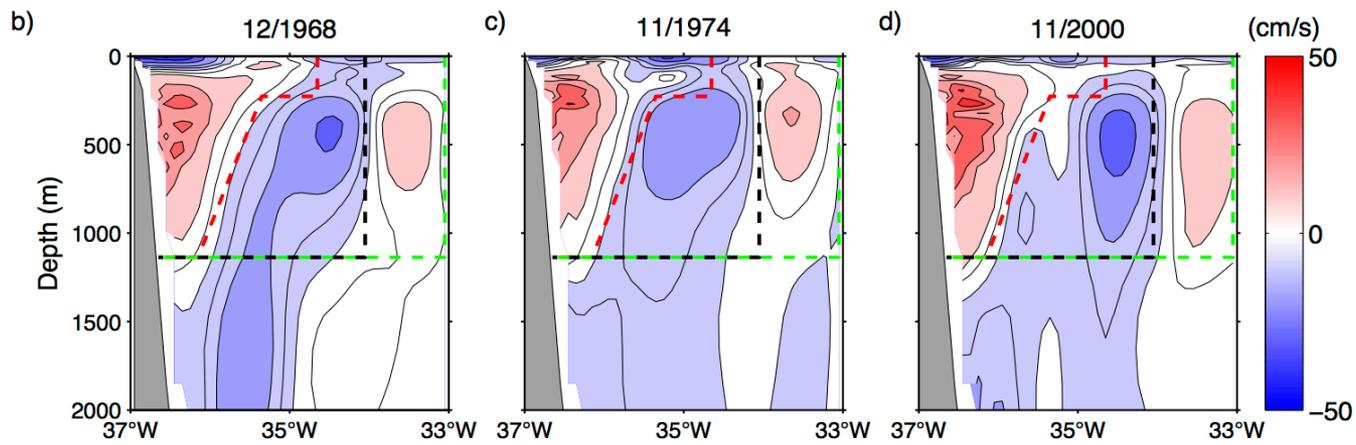
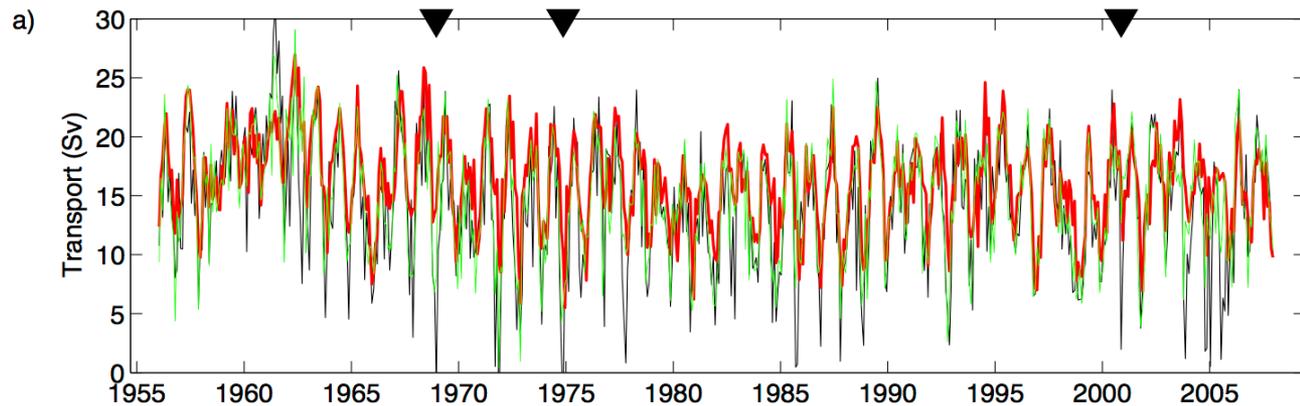
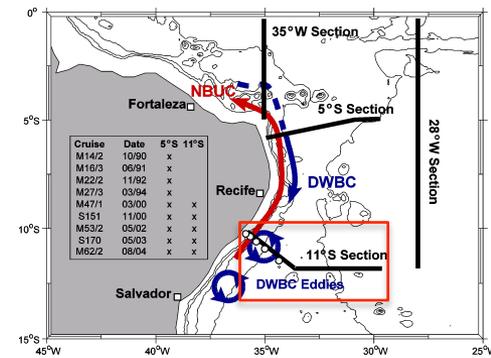
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