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Western boundary circulation in the tropical Atlantic at 11°S

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Introduction

The tropical Atlantic plays an important role for climate variability in the Atlantic region. A key region within the tropical Atlantic is the western boundary current system, where the variability of the North Brazil Undercurrent (NBUC) and the Deep Western Boundary Current (DWBC) exhibit variations of the meridional overturning ciculation (AMOC, Fig. 1) and the subtropical cells (STCs).

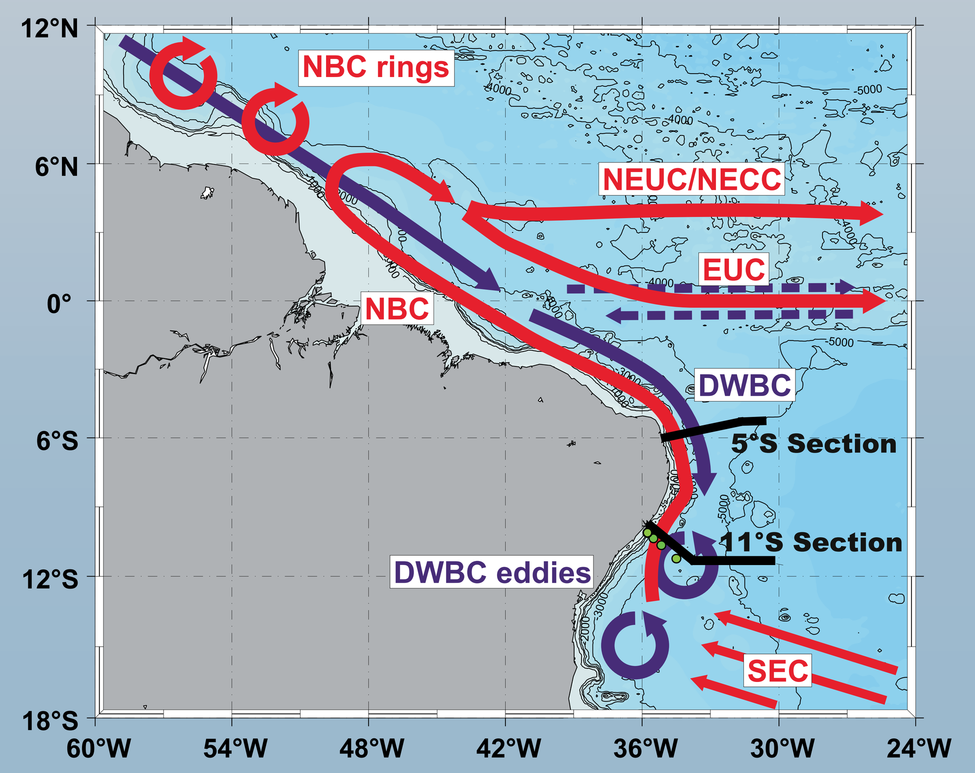

Fig.1: Circulation sketch of the western tropical Atlantic (from Dengler et al., 2004). Warm and cold water routes of the AMOC are indicated in red and blue. The sections at 5°S and 11°S are marked in black and the mooring array is indicated with green circles.

Measurement program

The western boundary current system off the coast of Brazil at 11°S (see Fig. 1) is investigated with a mooring array and ship based observations including direct current as well as hydrographic measurements. The observational campaign aims at assessing the variability of the western boundary current system on time scales from intraseasonal to decadal. Two research cruises in 2013 and 2014 delivered first insights into changes in the currents and water mass properties nowadays compared to similar observations taken during the period of 2000-2004. In addition, the data of the first mooring period was successfully retrieved in May 2014 with an instrument performance of over 90%.

Velocity and transport variability

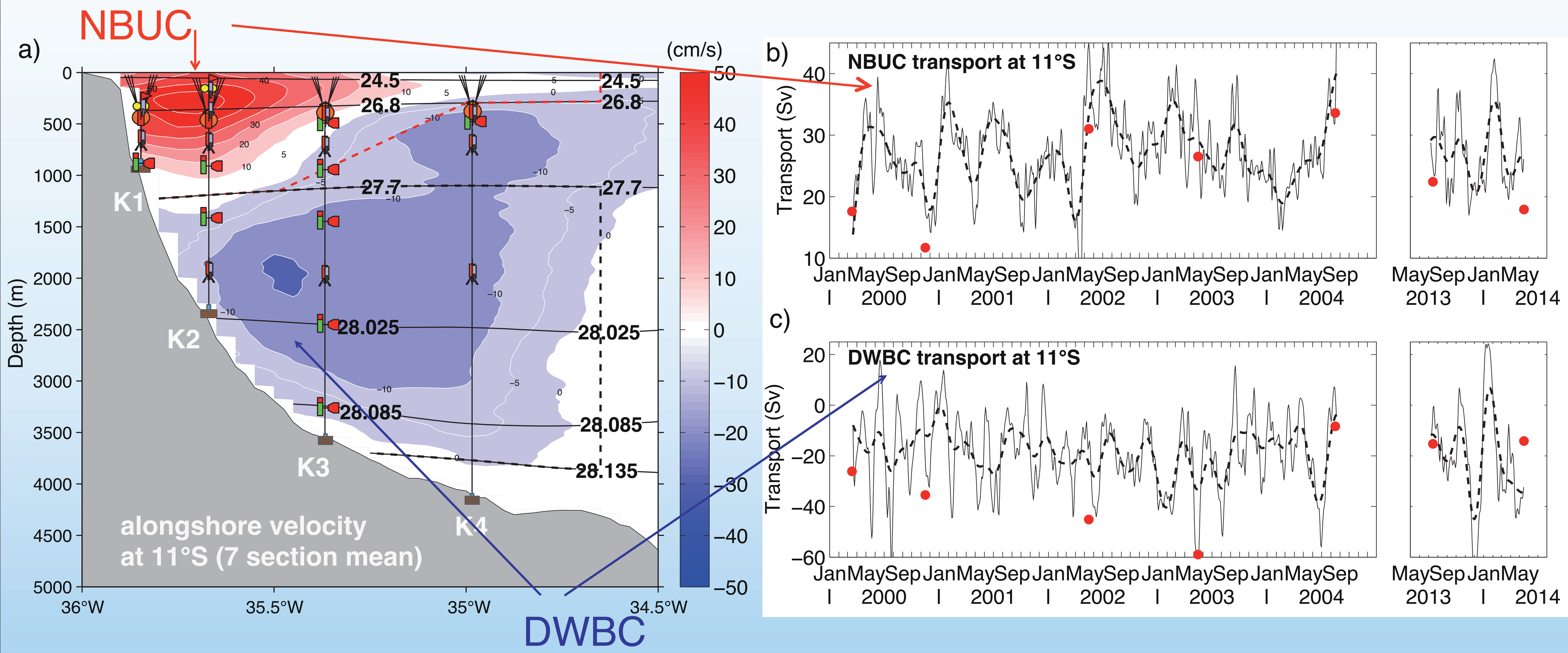

Fig. 2: Average ship section of alongshore velocity with mooring array design (a), NBUC (b) and DWBC (c) transport time series obtained from morred observations. Red and black dotted lines mark boxes used for transport calculations. Red dots in b) and c) indicate transport estimates from ship sections.

The high intraseasonal variability below 1500m depth was previously associated with the passage of deep eddies accomplishing the transport within the DWBC instead of a laminar flow (Fig. 1, 2, 4). The characteristics of the intraseasonal variability within the DWBC between the two observational periods (2000/2004, 2013/2014) are similar (Fig. 2c, 4). On longer timescales the transport variability of both NBUC and DWBC is reduced and no significant changes between the two observational periods are apparent (Tab. 1).

Salinity and oxygen changes

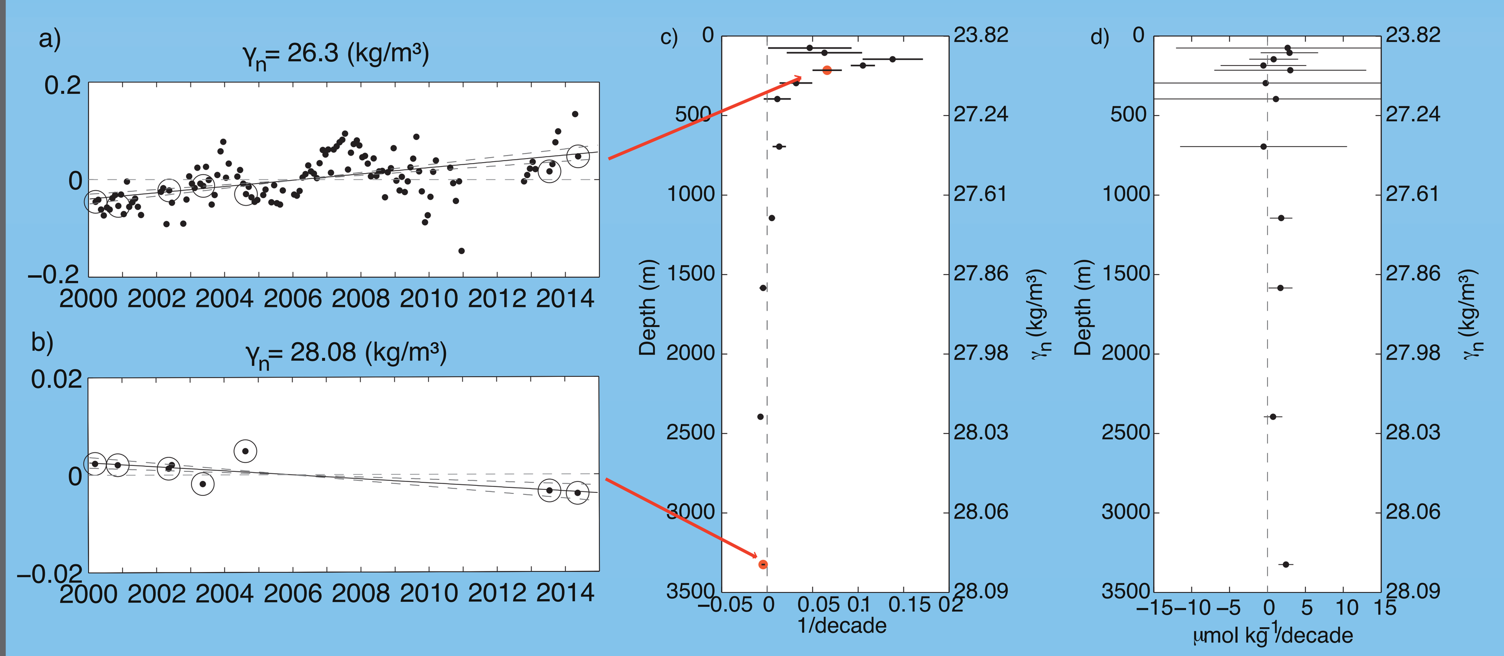

Fig. 3: Time series of salinity anomalies on neutral density surfaces (a, b) and inferred salinity and oxygen trends as a function of depth (c, d). For salinity all available profiles from ship cruises, the World Ocean Atlas, Argo and the Brazilian Navy in a box between 40°W and 30°W and 12°S and 8°S are combined, for oxygen only data of the 7 cruises is used.

The observed decadal salinity increase in the central water range (100-600m) is consistent with previous estimates (Biastoch et al. 2009) as well as the interannual variability of the salinity anomalies (Fig. 3a, Kolodziejczyk et al. 2014).
The inferred vertical structure of salinity and oxygen trends (Fig. 3c, d) can be related to changes in water mass formation regions as well as circulation changes in remote regions of the Atlantic.

Transport variability in numbers

Average transport estimates [Sv]				Annual transport estimates [Sv]				
	Total average	2000-2004	2013-2014	7/2000-7/2001	7/2001-7/2002	7/2002-7/2003	7/2003-7/2004	7/2013-5/2014
NBUC (S)	23 +/-3	24 +/-4	20.2 +/-2.3					
NBUC (M)	27.1 +/-1.1	27.1 +/-1.1	27 +/-1.8	26.3	25.9	30.2	24.7	27
DWBC (S)	-29 +/-7	-34.8 +/-8.6	-14.7 +/-0.6					
DWBC (M)	-18.9 +/-1.7	-18.6 +/-1.7	-20.4 +/-6	-16.4	-19.2	-22.8	-18.5	-20.4

Tab. 1: Average NBUC and DWBC transports from ship sections (S) and mooring observations (M).

Deep eddies

For a decrease of the DWBC north of 11°S Dengler et al. (2004) suggested a laminar flow instead of deep eddies. Transport time series (Fig. 2c) as well as velocity time series at 1900m depth (Fig. 4) show that deep eddies are still present.

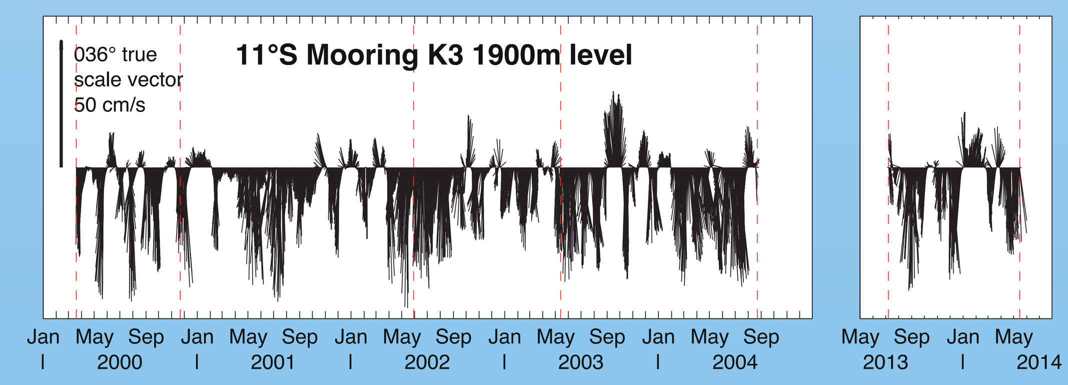

Fig.4: Time series of alongshore velocity at K3 (Fig. 2a) at 1900m depth. Red dashed lines ndicate the time of the ship sections.

Summary

- no significant transport changes between the observational periods
- DWBC eddies are still present with similar characteristics
- positive (negative) decadal salinity trend within the central water (DWBC layer)
- **Outlook:** relate assessed variability patterns at the western boundary at 11°S to AMOC variablity in remote regions of the Atlantic

References
Biastoch A., C. W. Boning, F. U. Schwarzkopf, and J. R. E. Lutjeharms (2009), Increase in Agulhas leakage due to poleward shift of Southern Hemisphere westerlies, Nature, 462(7272), 495-498, doi:10.1038/nature08519
Dengler M., F. A. Schott, C. Eden, P. Brandt, J. Fischer, and R. J. Zantopp (2004), Break-up of the Atlantic deep western boundary current into eddies at 8 degrees S, Nature, 432(7020), 1018-1020, doi: 10.1038/nature03134
Kolodziejczyk, N., G. Reverdin, F. Gaillard, and A. Lazar (2014), Low-frequency thermohaline variability in the Subtropical South Atlantic pycnocline during 2002–2013, Geophysical Research Letters, 41(18), 2014GL061160.

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