Abstract ID: PO14E-2859

Interannual to Decadal Changes in the Western Boundary Circulation in the Atlantic at 11°S

Rebecca Hummels[*,1], Peter Brandt[1], Marcus Dengler[1], Jürgen Fischer[1], Moacyr Araujo[2], Doris Veleda[2] and Jonathan Durgadoo[1]

(1) Geomar - Helmholtz Centre for Ocean Research, Kiel, Germany
(2) DOCEAN - Department of Oceanography UFPE, Recife, Brazil
*contact: rhummels@geomar.de

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).

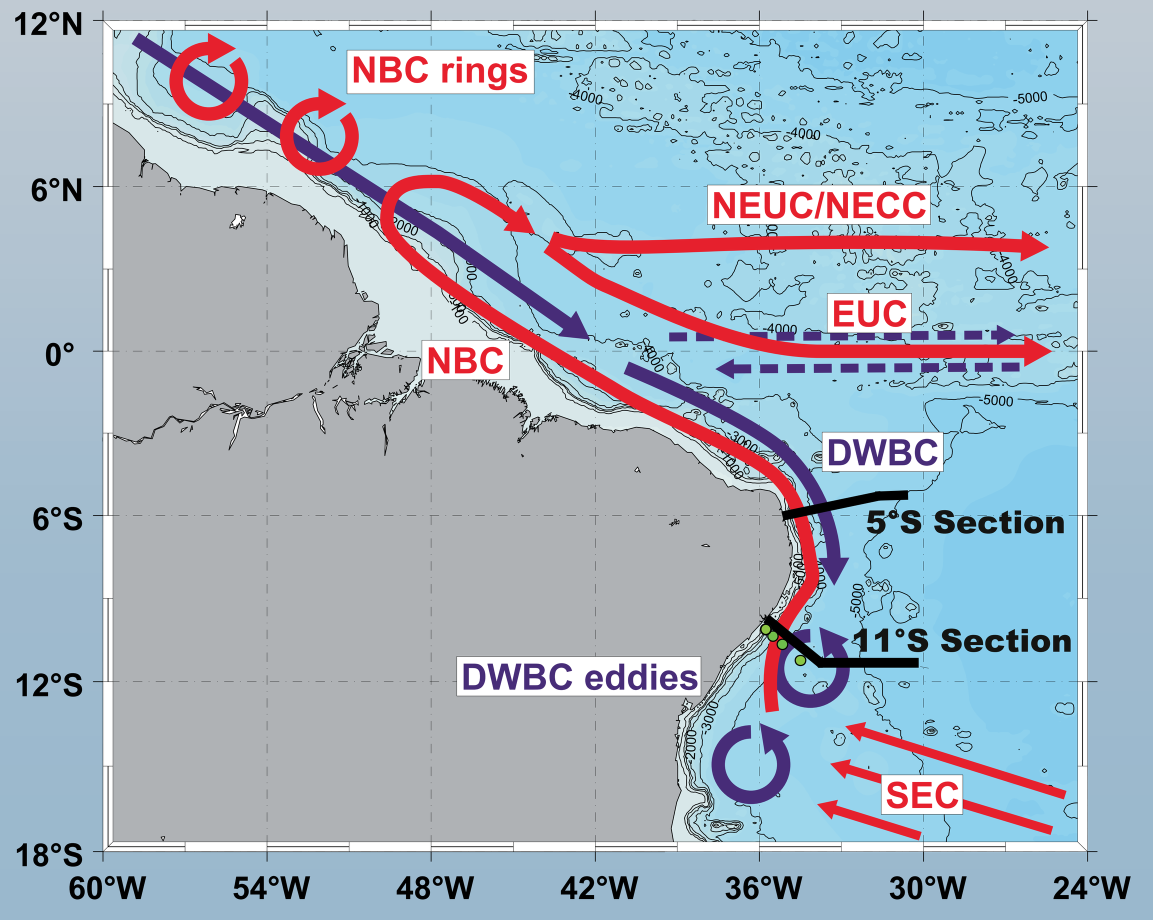


Fig.1: Circulation sketch of the western tropical Atlantic (from Dengler et al., 2004). Warm and cold water routes of the AMOC are indicated in red and blue. The sections at 5°S and 11°S are marked in black and the mooring array is indicated with green circles.

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. Three research cruises in 2013, 2014 and 2015 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 two mooring periods was successfully retrieved with an overall instrument performance of over 90%. The next cruises to maintain the moored array are planned for 2016 and 2018.

Velocity and transport variability

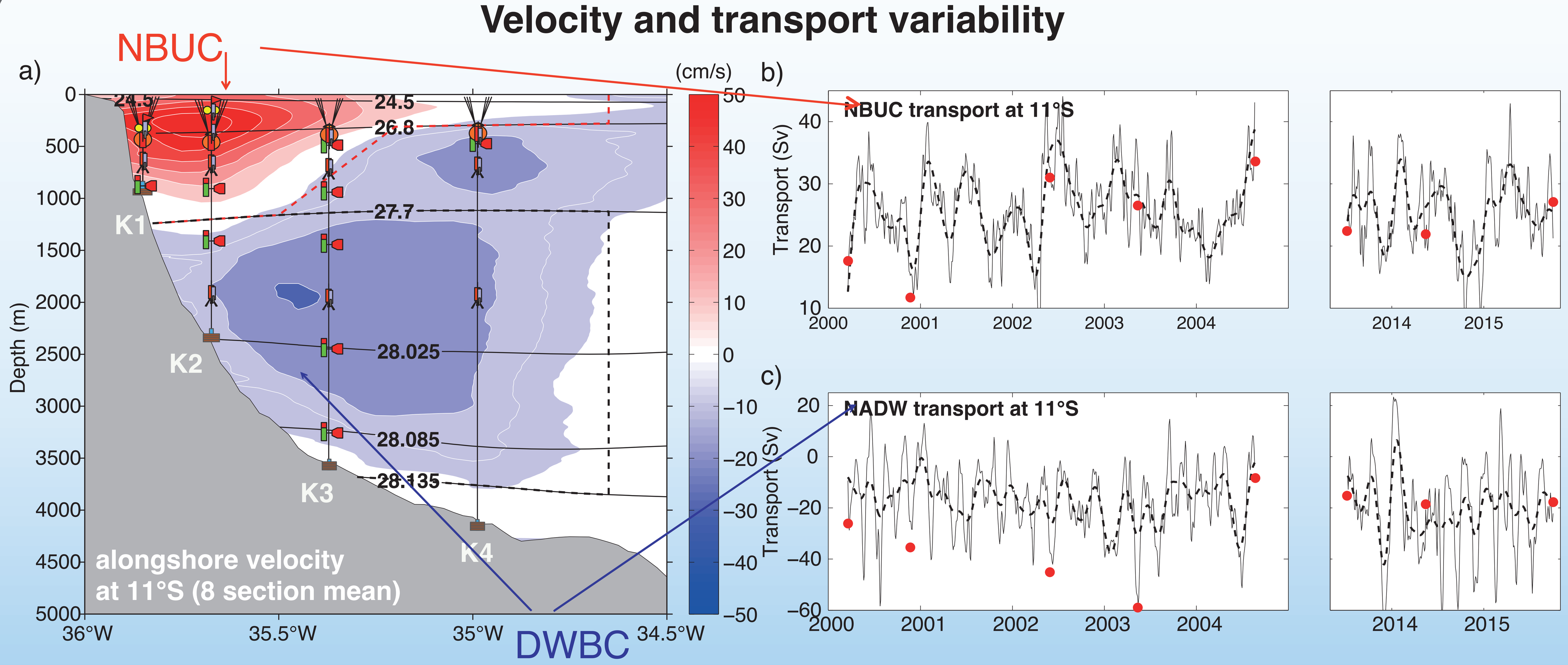


Fig. 2: Average ship section of alongshore velocity with mooring array design (a), and NBUC (b) and DWBC (c) transport time series obtained from morred observations. Red and black dotted lines in a) mark boxes used for transport calculations. Red dots in b) and c) indicate transport estimates from ship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

The high intraseasonal variability below 1500m depth was previously associated with the passage of deep eddies, which accomplish the transport within the DWBC layer instead of a laminar flow (Fig. 1, 2). The characteristics of the intraseasonal variability within the DWBC between the two observational periods (2000/2004, 2013/2015) are similar and the deep eddies are still present (Fig. 2c). On longer timescales the transport variability of both NBUC and DWBC is reduced and on average no significant changes between the two observational periods are yet apparent (NBUC: 25.8±1.2 Sv (2000-2004) vs. 25.5±1.3 Sv (2013-2015); DWBC: -17±1.6 Sv (2000-2004) vs. -20.5±2.7 Sv (2013-2015) from the moored observations).

Salinity and oxygen changes

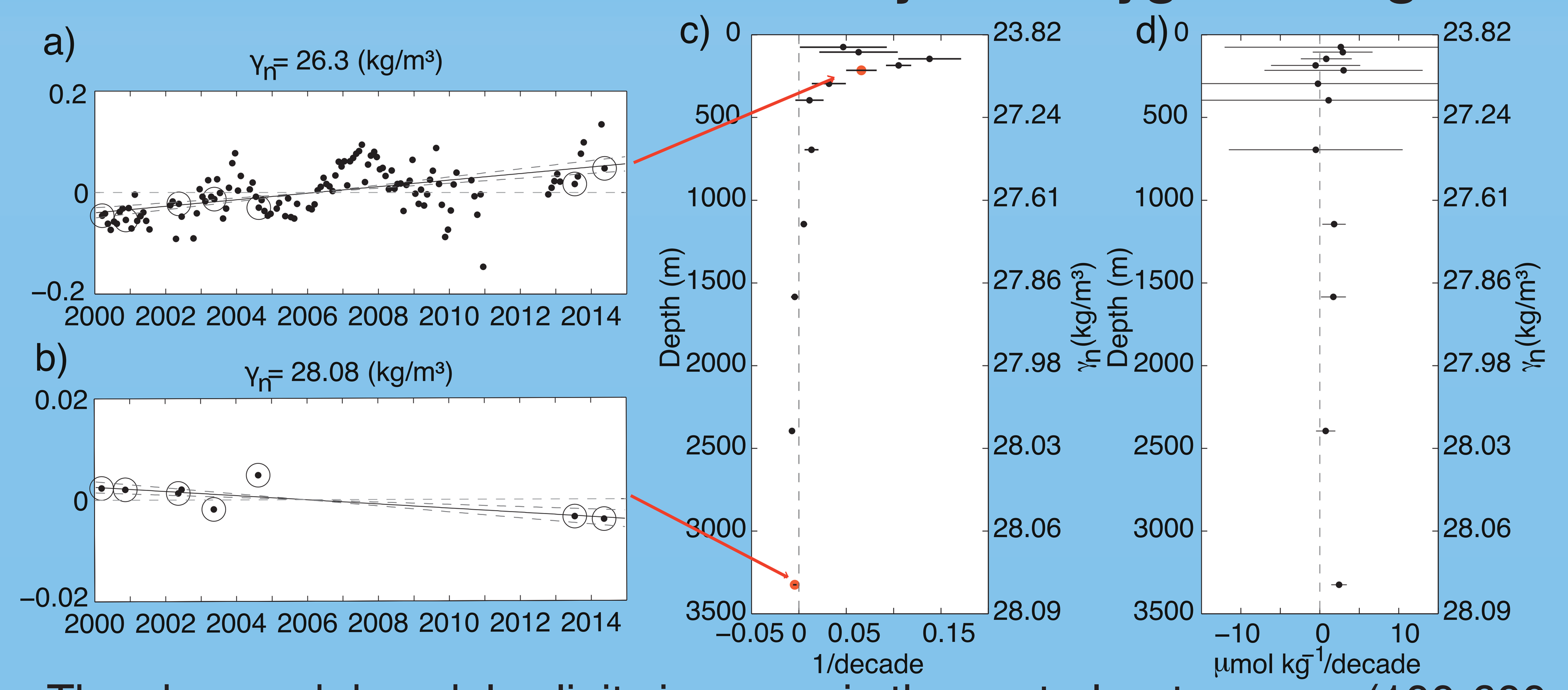


Fig. 3: Time series of salinity anomalies on neutral density surfaces (a, b) and inferred salinity and oxygen trends as a function of depth (c, d). For salinity all available profiles from ship cruises, the World Ocean Atlas, Argo and the Brazilian Navy in a box between 40°W and 30°W and 12°S and 8°S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

Longterm NBUC variability

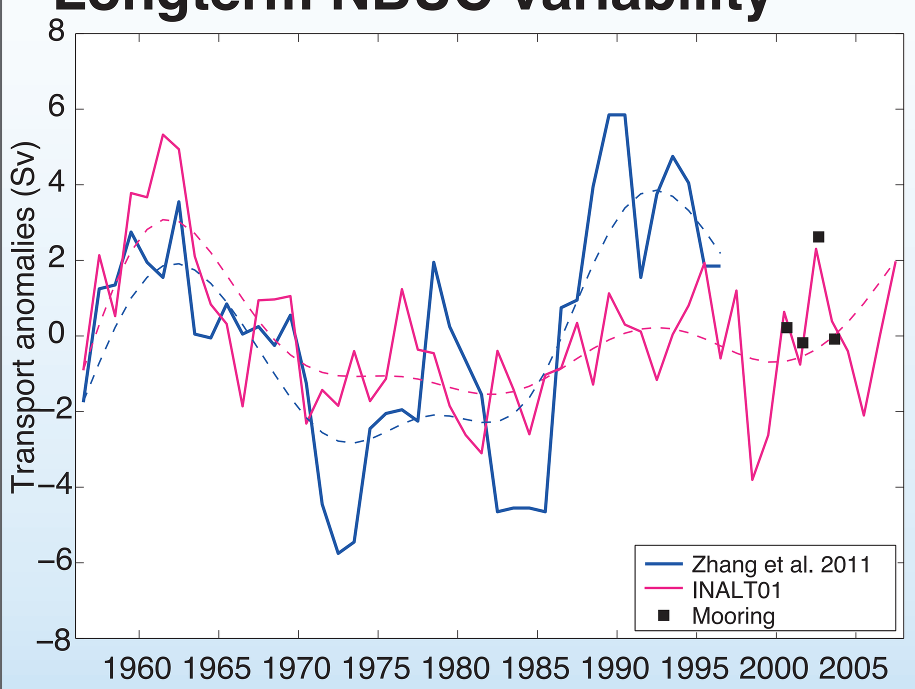
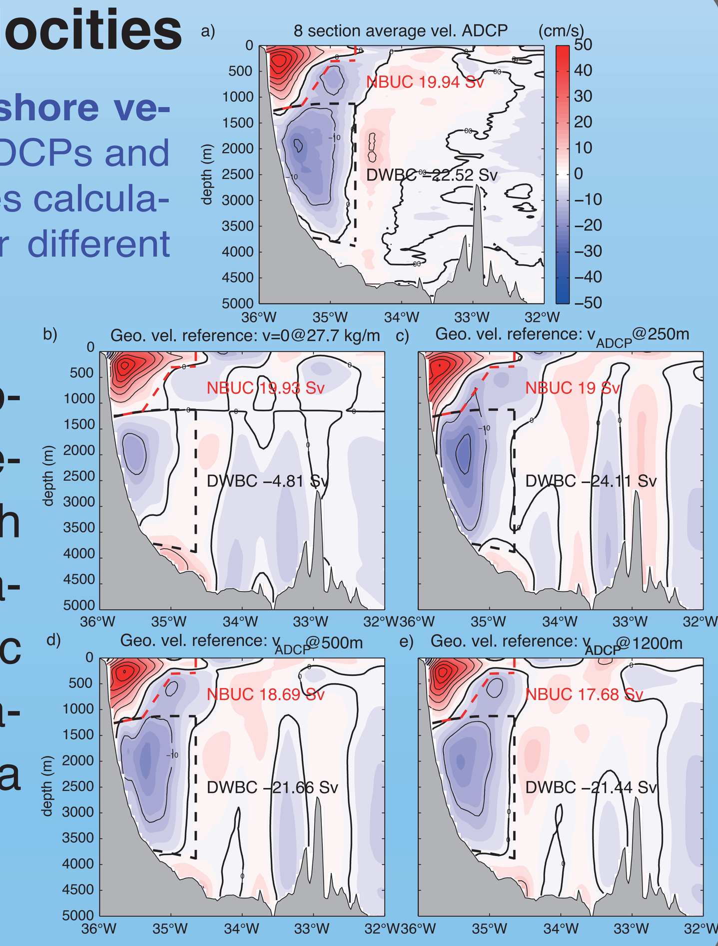


Fig.4 NBUC transport anomalies. 15, 16 and 25 Sv are subtracted for the numerical simulation INALT01, the geostrophic transports of Zhang et al. (2011) and the moored observations respectively.

Interannual variability agrees among moored estimates and INALT01. Decadal variability (dashed) is similar in INALT01 and the geostrophic estimates.

Geostrophic velocities

Fig.5 Sections of alongshore velocity a) observed with ADCPs and b)-e) geostrophic velocities calculated from CTD profiles for different referencing techniques.



To construct a geostrophic transport timeseries overlapping with the moored observations, geostrophic transports from available hydrographic data will be obtainted.

Summary

- no significant transport changes between the observational periods; DWBC eddies are still present
- interannual to decadal variability agrees among moored observations, numerical simulations and geostrophic estimates
- 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

Hummels R., P. Brandt, M. Dengler, J. Fischer, M. Araujo, D. Veldeda, and. J. Durgadoo (2015), Interannual to decadal changes in the western boundary circulation in the Atlantic at 11°S, Geophys. Res. Lett., 42, 7615–7622, doi:10.1002/2015GL065254.

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.