Ocean circulation over the continental slope of Northeast Brazil

Nathanaël A. Dossa[1], Alex C. Silva[1], Alexis Chaigneau [2], Gérard Eldin[2], Arnaud Bertrand[1,2]

e-mails: nath2dossa@gmail.com, alexsilvaufpe@gmail.com, arnaud.bertrand@ird.fr

[1]Department of Oceanography - DOCEAN/UFPE, Recife (Brazil)

[2]Institut de Recherche pour le Développement (IRD)

Address: Universidade Federal de Pernambuco, Centro de Tecnologia, Av Arquitetura, S/N - Cidade Universitária 50740-550 - Recife, PE - Brazil

1. Introduction

The western tropical Atlantic ocean is a region of great importance in the inter hemispheric exchanges of heat, salt and water mass (Gordon, 1986; Schmitz and McCartney, 1993). It is a region, where the boundary currents play major roles in the surface return flow of the Atlantic meridional overturning circulation (AMOC) (Schott et al., 2002). However, not much is known about the spatial and temporal variability of the NBUC over the continental slope nor about the influence of the mesoscale activities on the ocean circulation of that region. Here, we present observations of meridional and zonal currents in the first 500 m of water column over the continental slope of the northeast Brazil during two ABRAÇOS cruises carried out in Austral spring 2015 and austral fall 2017.

2. Data and methods

SADCP data (ADCP 75Khz)
•Zonal & meriodional componants of velocity
•Periods:
September 28-October 21,2015.
April 9 - May 8,2015

Altimetric sea-level anomaly data (SLA)
•Geostrophic components of velocity (Ug & Vg)

•Methods
•Definition of the core of NBUC

$$V_{min} = V_{max} - \alpha V_{max}$$

where α = 30% and Vmin and Vmax are respectivly the minimum and the maximum value of the current core

•Eddy detection (methods of Chaigneau et al., (2009))

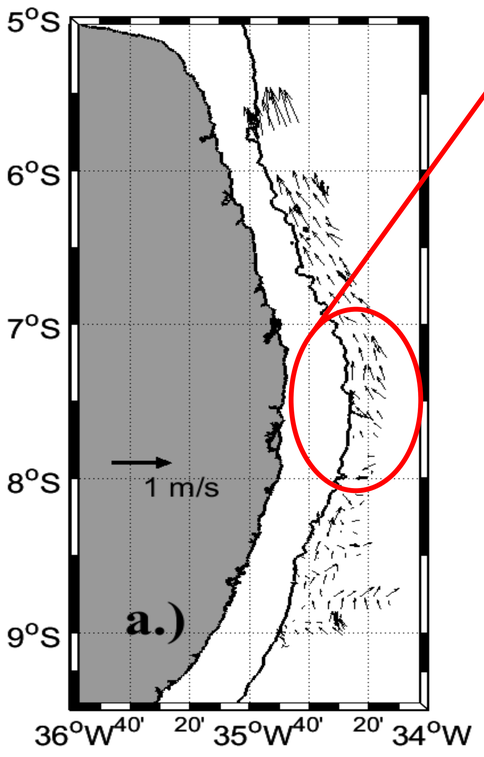

Figure 1: Mean velocity current obtained from ADCP profiles between 19-35m in Spring 2015.

3. Results and discussion

3.1 Mean circulation

3.1.1 Spring 2015 conditions

In October 2015, the dominant upper layer (19-35 m) flow was northward in the study area (Fig. 1). However, between 8.3° S and 7.8° S we observed a mesoscale structure where the circulation is routed with weak velocities (~0.1 $m.s^{-1}$) and even a southward flow between 8.1 and 8.3S (~-0.1 $m.s^{-1}$) .

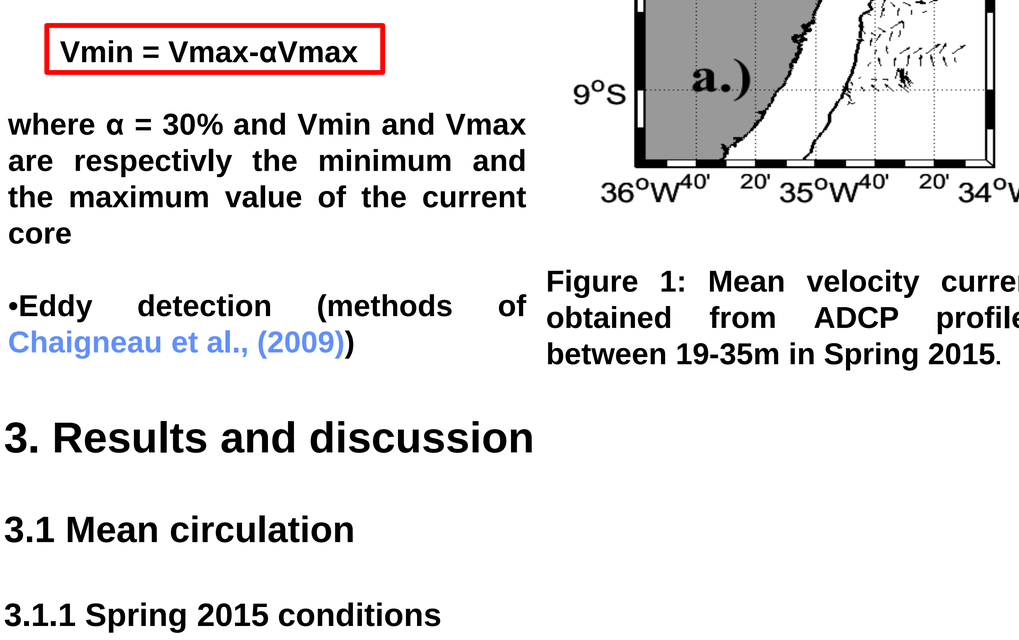

Figure 2: Mean velocity current (c) and mean alongshore velocity (d) obtained from ADCP profiles between 1100-500 m in Spring 2015.

In the deep water layer (100 -500 m) a consistent northward flow was observed (Fig. 2c,d) following the coast orientation. This pattern reveal the dominance of the NBUC that originates from south of 10° S and flows along the coastal until the north of 5° S (Silveira et al., 1994). However an intensification of the flow occurs between 8° S and 7° S with maximum velocity values that can reach 1.1 $m.s^{-1}$ (Fig. 2d).

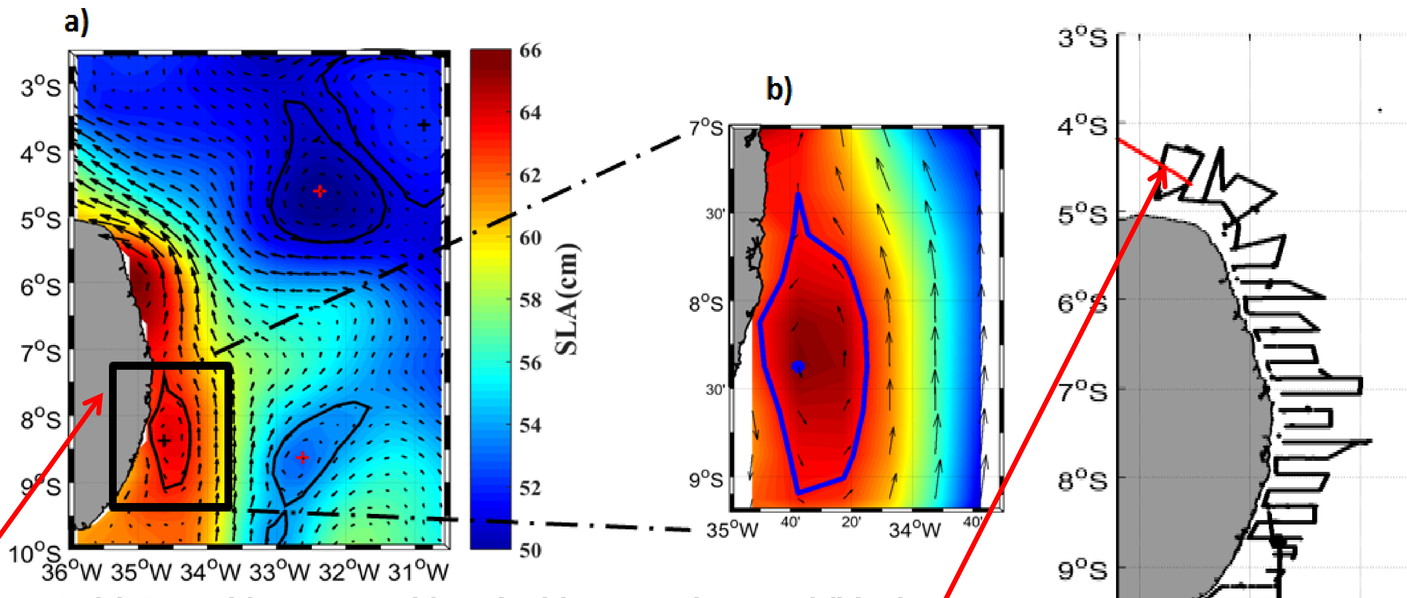

Figure 3: (a) SLA with geostrophic velocities superimposed (black arrows) for 16 October 2015. In (b) a zoom of a selected region with anticyclonic eddy is shown.

3.1.2 NBC/NBUC evidence between 5° S and 4° S

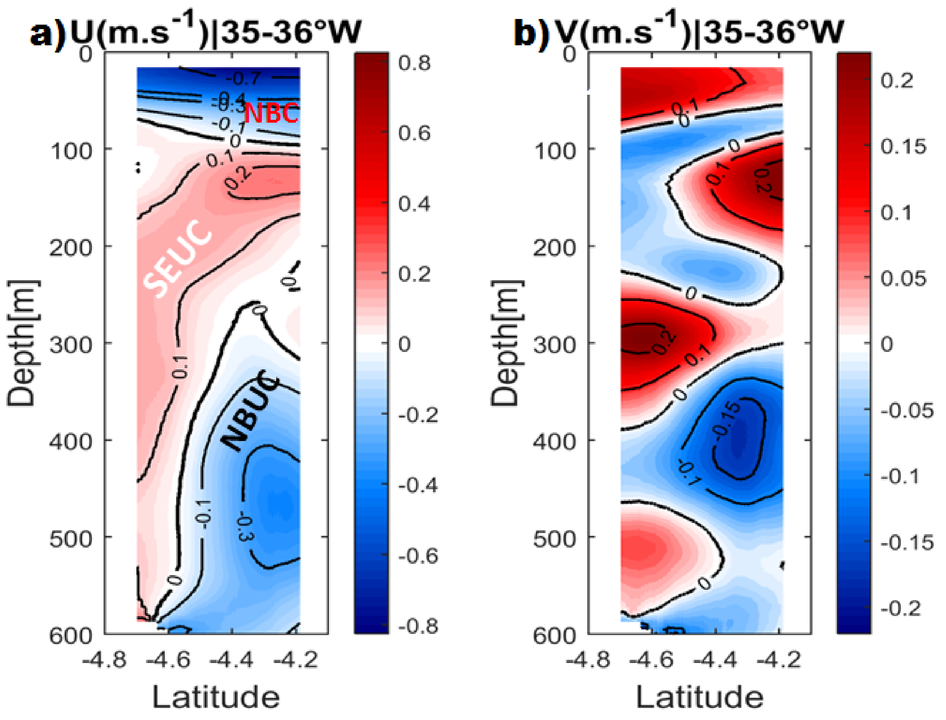

Figure 4: Zonal (a) and meridional (b) components of velocity in the region extended over 4.8-4.1° S ;35-36° W

Between 5° S and 4° S, there is a clear intensified westward flow in the surface layer (0-100 m) with velocities that reach 0.8 $m.s^{-1}$ (Fig 4). In the subsurface layer two distinct zonal flow are presented. The eastward flow is associated with SEUC with velocities up to 0.4 $m.s^{-1}$ .T In the layer (2200-600 m), the presence of the westward flow with velocities up to 0.6 $m.s^{-1}$ confirms the NBUC presence after the apparition of the NBC,

Spring 2015 (Fig 5a & 6a)

- Clear increase in strengh from 9° S to 6° S
- Slight rising from 200-400m to 100-300
- Intensification of the core at 7.1° S

Fall 2017 (Fig 5b & 6b)

- Slight rising from 9.2° S to 4.5° S
- Increase in the strength from 9° S to 5° S
- Evidence of NBC pattern at 5-4° S

3.1.3 Seasonal variability of regional circulation

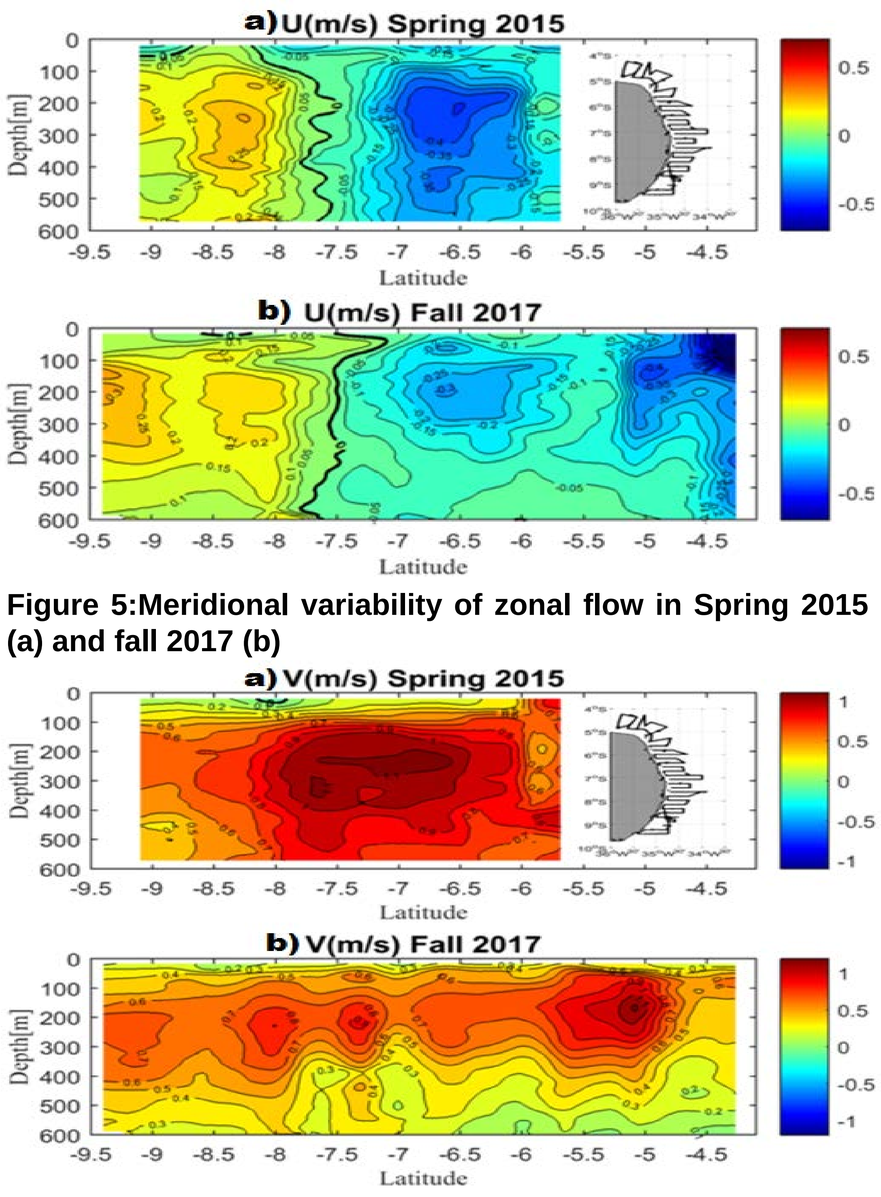

Figure 5:Meridional variability of zonal flow in Spring 2015 (a) and fall 2017 (b)

Figure 6: Meridional variability of meridional flow in Spring 2015 (a)and fall 2017 (b)

4. Acknowledgments

The authors wish to thank CAPES for the research grant and the officers and crew of the R/V Antea for their help and cooperation

5. References

Chaigneau, A., G. Eldin, and B. Dewitte (2009), Eddy activity in the four major upwelling systems from satellite altimetry (1992–2007), Prog.Oceanogr., 83, 117–123, doi:10.1016/j.pocean.2009.07.012.

Gordon, A. L. (1986), Interocean exchange of thermocline water, J. Geophys. Res., 91, 5037–5046.

Schmitz, W. J., and M. S. McCartney (1993), On the North Atlantic circulation, Rev. Geophys., 31(1), 29–49.

Schott, F., P. Brandt, M. Hamann, J. Fisher, and L. Stramma (2002), On the boundary flow off Brazil at 5–10?S and its connection to the interior tropical Atlantic, Geophys. Res. Lett., 29(17), 1840, doi:10.1029/2002GL014786.

Silveira, I. C. A. da; Miranda, L. B.; Brown,W. S.,(1994), On the origins of theNorth Brazil Current. Journal of Geophysical Research, v. 99, p. 22501–22512.