Seasonal Variability of Salt in The Western Atlantic Tropical

Alvarez, Y.G.[12] *Belem, A.L.*[12]
1 Universidade Federal Fluminense, Programa de Pós-graduação em Dinâmica dos Oceanos e da Terra
2 Observatório Oceanográfico - Universidade Federal Fluminense
Contact: yacialvarez@id.uff.br

EGU General Assembly 2020

Introduction

The Western boundary regime of the tropical South Atlantic Ocean is the main pathway of an important meridional transfer of warm and cold water masses that balances the global temperature on Earth, known as Atlantic Meridional Overturning Circulation (AMOC). The AMOC is a system that depends on a delicate balance of heat and salt effects on density, and is considered one of the main elements of the terrestrial system (Stouffer *et al*, 2006; Caesar *et al*., 2018). The objective of this work was to study the interdecadal salt transport variability in the Western Tropical Atlantic Ocean, in order to identify anomalies associated with the main water masses involved in the Atlantic Meridional Overturning Circulation, which may be related to climate change.

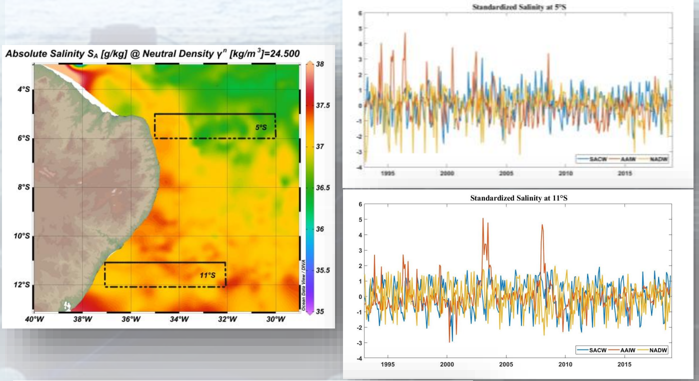
Data and Methods

Three decades of hydrographic observations (1993 – 2019), available at the World Ocean Database – NOAA, of two important sections crossing the western Brazilian margin at 5°S and 11°S, were analyzed. The time series gaps were filled with Copernicus *dataset-armor-3d-rep-monthly*. The neutral density surfaces (Jackett & McDougall, 1997), absolute salinity, geostrophic transport and salt transport were calculated using the GSW Tollbox (McDougall & Barker, 2011), to distinguish the salt transport variability in different water masses horizons. The salt transport was calculated as function of absolute salinity, velocity and density. The neutral density (γ^n) surfaces were calculated to distinguish the salt transport in different water masses, following the reference values proposed by Hummels et al. (2015) at the Table 1.

Table 1 Neutral density surfaces used to distinguish the water masses at the sections 5°S and 11°S.

Water Mass	Neutral Density (γ^n)
Surface water - SACW	24,5 kg m^{-3}
SACW - AAIW	26,8 kg m^{-3}
AAIW – NADW	27,7 kg m^{-3}
NADW - AABW	28,135 kg m^{-3}

Figure 1: Map of surface absolute salinity at γ^n 24.5 with the location of the Sections 5°S and 11°S and the variability of absolute salinity standardized by water mass at the Sections.



Results and discussion

In general, the results reveal a coherent interannual change pattern in salinity in 5°S and 11°S. In the upper limb, both water masses, the South Atlantic Central Water (SACW) and the Antarctic Intermediate Water (AAIW), presented an increase of the salinity. The AAIW shows small trends with a decrease in salinity values in the upper part of the layer and an increase at the border to the North Atlantic Deep Water (NADW) (Figure 1). The salt transport at the sections (Figure 2) suggests a variability on interannual and quasi-decadal time-scales.

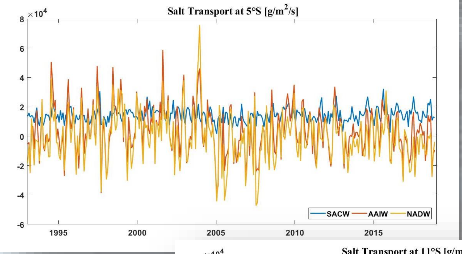
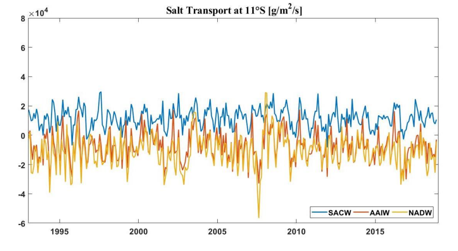


Figure 2: Variability of Salt transport by water mass at 5°S and 11°S Sections.



Results and Discussion

Using the algorithm of Grinsted et al. (2004) we were able to assess the periodic behavior of the salt transport at 5°S and 11°S considering the three water masses horizons (SACW, AAIW and NADW). The results (figure 4) showed a markedly seasonal signal at the SACW, due to its interaction with ventilated waters, as well as a marked 1 year period at AAIW horizon, suggesting the seasonal influence on its formation and spreading. It is interesting to note the presence of a (less) significant sign in the 4 years period band, markedly on the horizon of AAIW at 11°S and at NADW. The 4 years period band usually represents the main oscillation band for events in El Niño / La Niña. It is not yet clear how such a sign can appear so noticeably at the core of NADW's salt transport, but clearly this is a point of further investigation.

Figure 3: 3D View of the salt transport variability in the 5° S and 11° S sections over the years (Alvarez & Strehl, 2020).

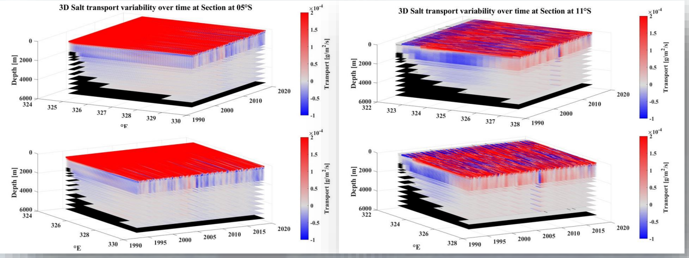
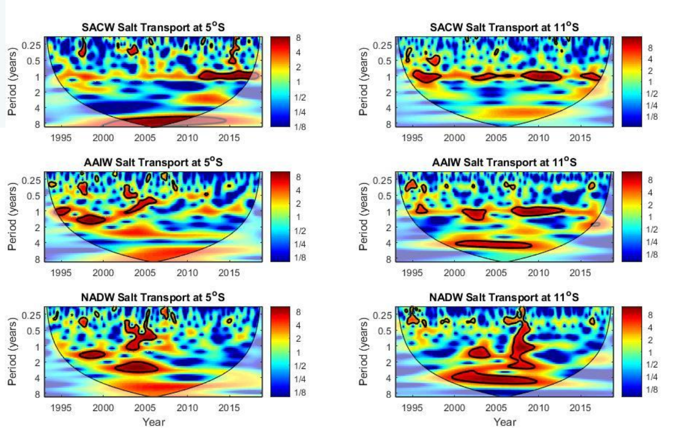


Figure 4: The continuous wavelet power spectrum for the salt transport time series at 5°S and 11°S, for the calculated horizons of SACW, AAIW and NADW. The thick black contour designates the 5% significance level against red noise and the cone of influence (COI), where analyzed frequencies are constrained by the time series length, is shown as a lighter shade.



Conclusions

The geostrophic and salt transports suggest a multidecadal variability and the changes in upper limb salinity are consistent with an increased Agulhas Leakage, as described in literature (i.e. Biastoch, *et al* - 2009). In the deep ocean, water mass changes seem to be likely related to changes in weather patterns in the North Atlantic as well as in tropical circulation changes.

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Acknowledgment

CAPES CNPq INPE

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A Closer Look at Results and Discussion

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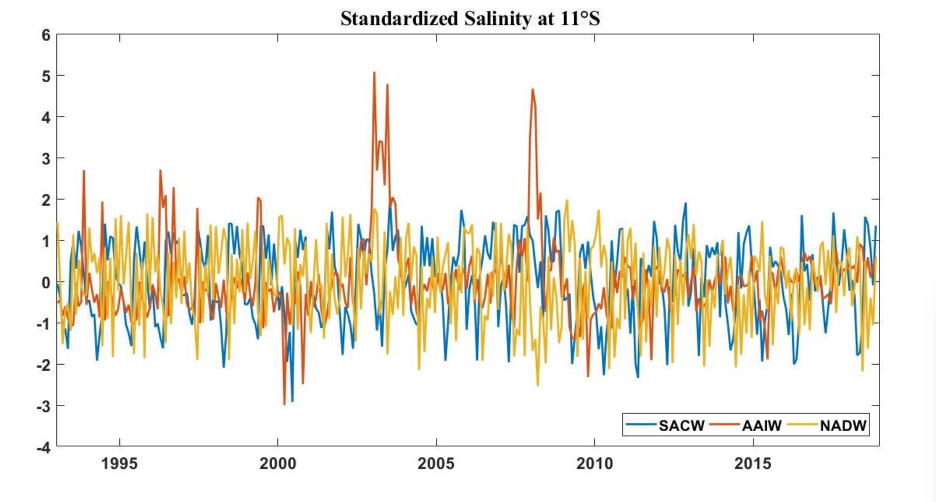

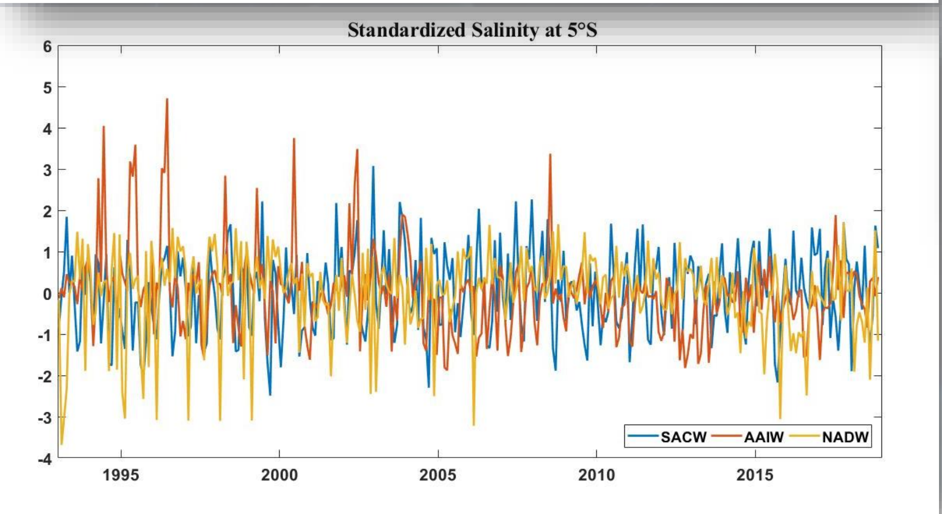

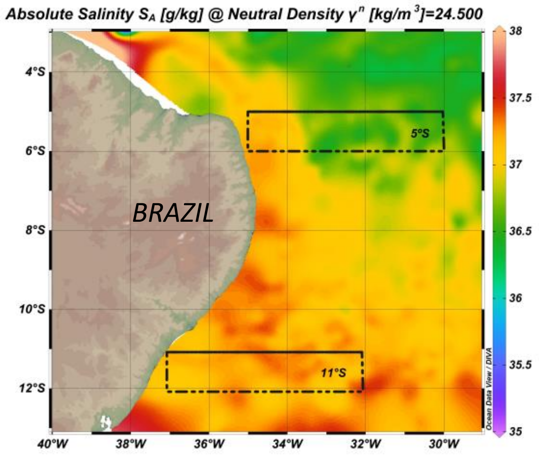

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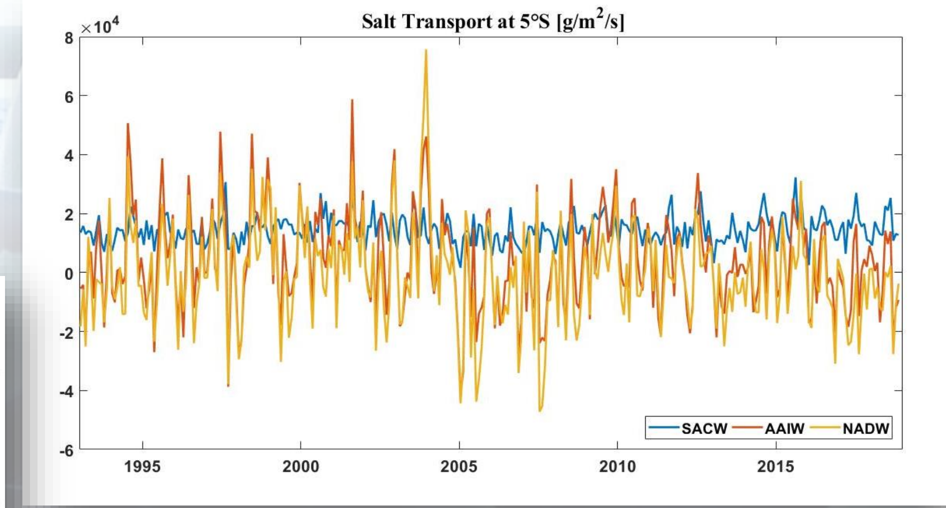

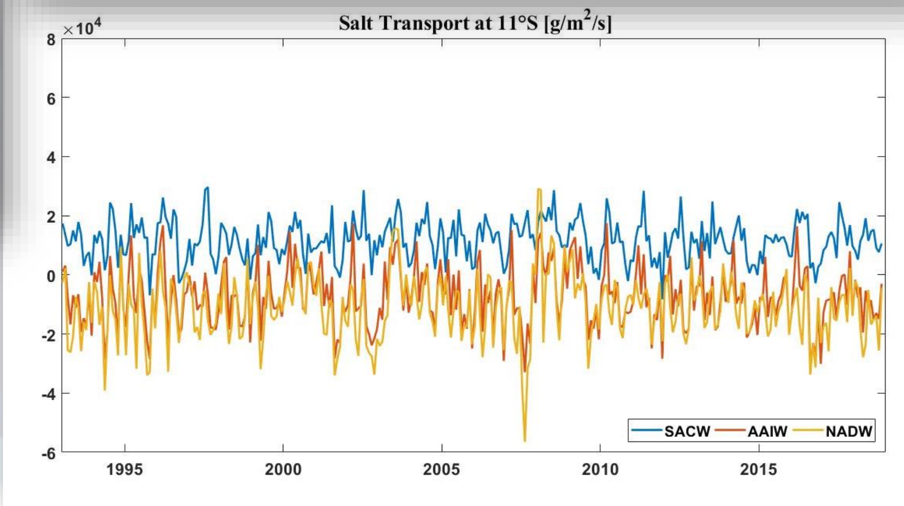

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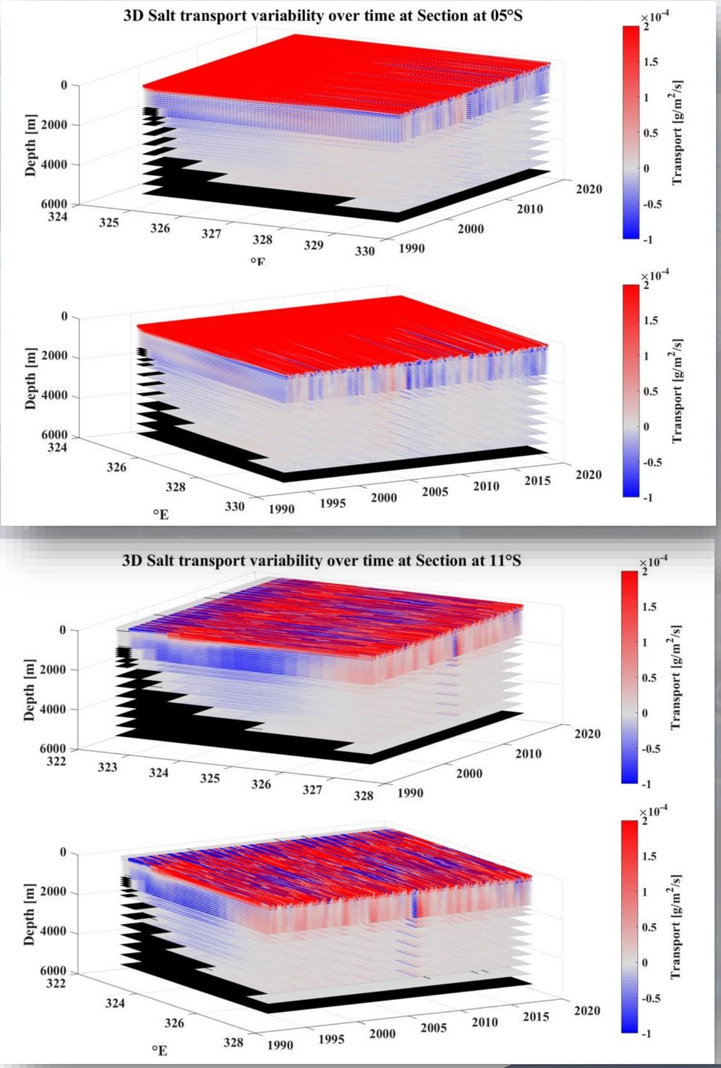

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