Brazil Current behavior at 22°S controlled by surface forcing: A modeling approach

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Introduction

Understanding oceanic environments mean pattern and variability allows a full management of activities performed by the sea, where many of them boost their results applying hydrodynamic models. Considering that atmosphe plays a essential role over ocean upper levels state, the main objective of this work was evaluate the impacts of Climate Forecast System Reanalysis (CFSR - SAHA *et al*., 2010) and European Centre for Medium-Range Weather Forecasts Reanalysis Interim (ERAI - DEE *et al*., 2011) as surface forcing of the Regional Ocean Modeling System (ROMS - SHCHEPETKIN; MCWILLIAMS, 2005) for Brazilian east/southeast continental shelf (15ºS-30ºS; 30ºW-51ºW), especially on Brazil Current (BC) volume transport in 22ºS (Figure 1).

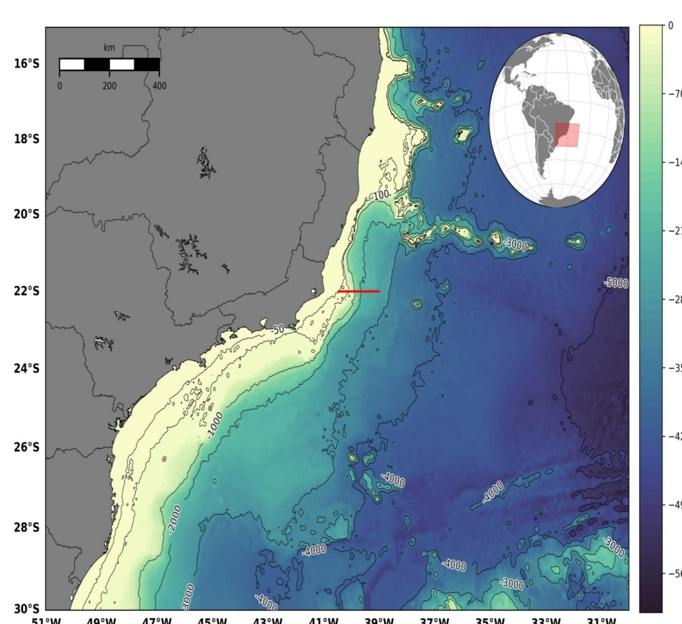

Figure 1: Bathymetry of Brazilian east/southeast continental shelf (15°S-30°S; 30°W-51°W). The red line indicates the cross-shelf section used for BC transport volume computation.

Materials and Methods

In order to define the hydrodynamic modeling period, the surface wind kinetic energy of the reanalysis was analyzed climatologically (1979-2010) through CFSR minus ERAI monthly anomaly and its 18-months moving average. Thus, the greatest energy difference period for the atmospheric data was from Dec. 1981 to May 1983 (Figure 2). From all modeled period, only last twelve months were analyzed to avoid spin-up. The two hydrodynamic experiments (EXP_{CFSR} and EXP_{ERAI}) presented daily results (1/12º and 40 sigma levels) and were conducted using a climatology computed from Mercator Global Ocean Analysis (1/12º; 2007-2017) as initial and boundary conditions and ETOPO1 bathymetry, modifying only the reanalysis as surface forcing. The main oceanographic structure analyzed, BC, was defined, at 22ºS, as all southward flow, vertically from surface to the South Atlantic Central Water (SACW) bottom edge (σ_0 = 26.8) and laterally from 40.5ºW (50m isobath) to 39ºW (TOSTE *et al*., 2017).

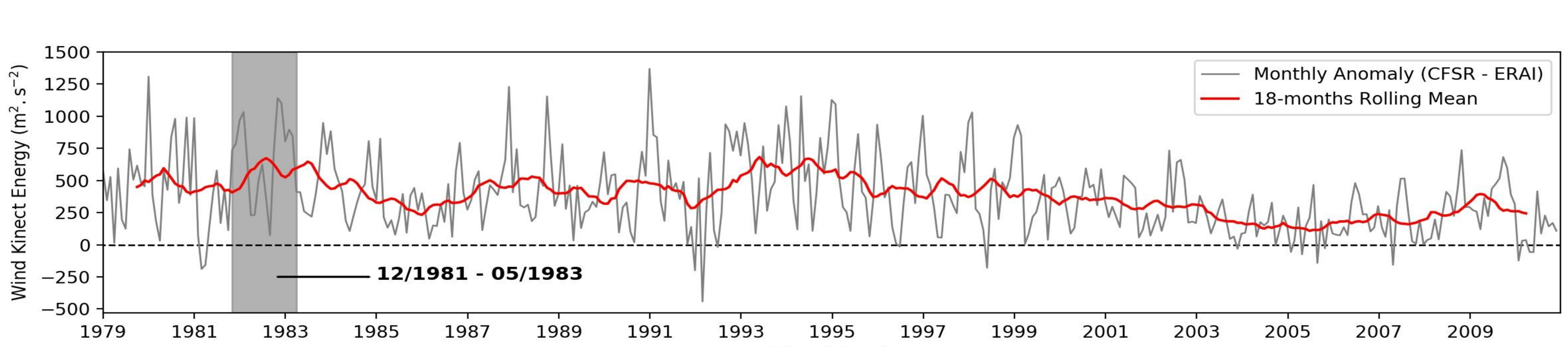

Figure 2: CFSR minus ERAI monthly surface wind kinetic energy anomaly (gray line) and its 18-months moving average (red line) integrated in all study area. Highlighted part represents the maximum difference period.

Results and Discussion

By conducted analysis, CFSR was evident temporally (Figure 2) and spatially (not shown) more energetic than ERAI, what reflected in modeled BC core depth and maximum speed and BC cross-section position. First two was evident in Figure 3 while latter was captured by changing offshore limit for BC volume transport. For daily average values in 22ºS and from 40.5ºW to 39.5ºW (2000m isobath), EXP_{CFSR} was 15% more intense than EXP_{ERAI} (-6.0 Sv and -5.2 Sv). Shifting the offshore limit to 39.3°W (PEREIRA *et al*., 2014), the BC volume transport difference was only 8% (-7.1 Sv and -6.6 Sv) and moving to 39°W no distinction were found in average values (-8.3 Sv and -8.3 Sv), demonstrating a more offshore position of BC in EXP_{ERAI}.

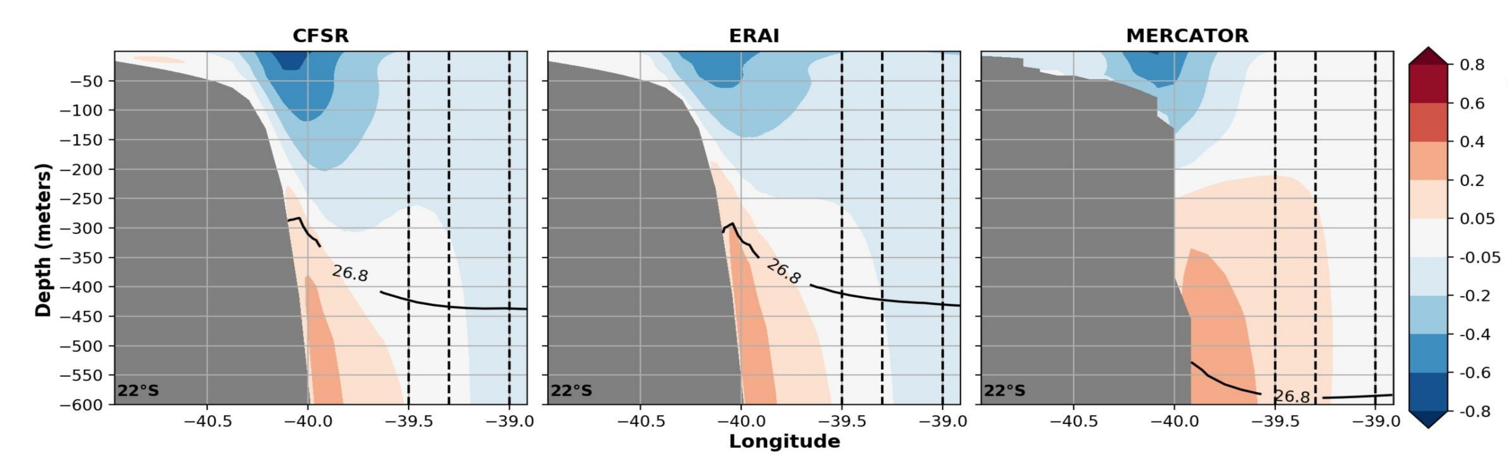

Figure 3: Mean cross-sectional speed component at 22ºS simulated in EXP_{CFSR} (left) and EXP_{ERAI} (center) and for Mercator climatology (right). Negative (positive) values correspond to southward (northward) fluxes. Vertical dashed lines represent the three proposed offshore limits of BC (39.5ºW, 39.3ºW and 39ºW). Solid line represent the bottom edge of SACW.

Was also possible to notice seasonal differences in depth and maximum speed of BC, with this being deeper and more intense in winter, spring and autumn for EXP_{CFSR} and only in summer for EXP_{ERAI} (Figure 4). Thus, it was evident that different sources of atmospheric forcing, even with similar characteristics, can affect the oceanographic features not only considering their energetic content but also their space and time distribution pattern (Figure 5).

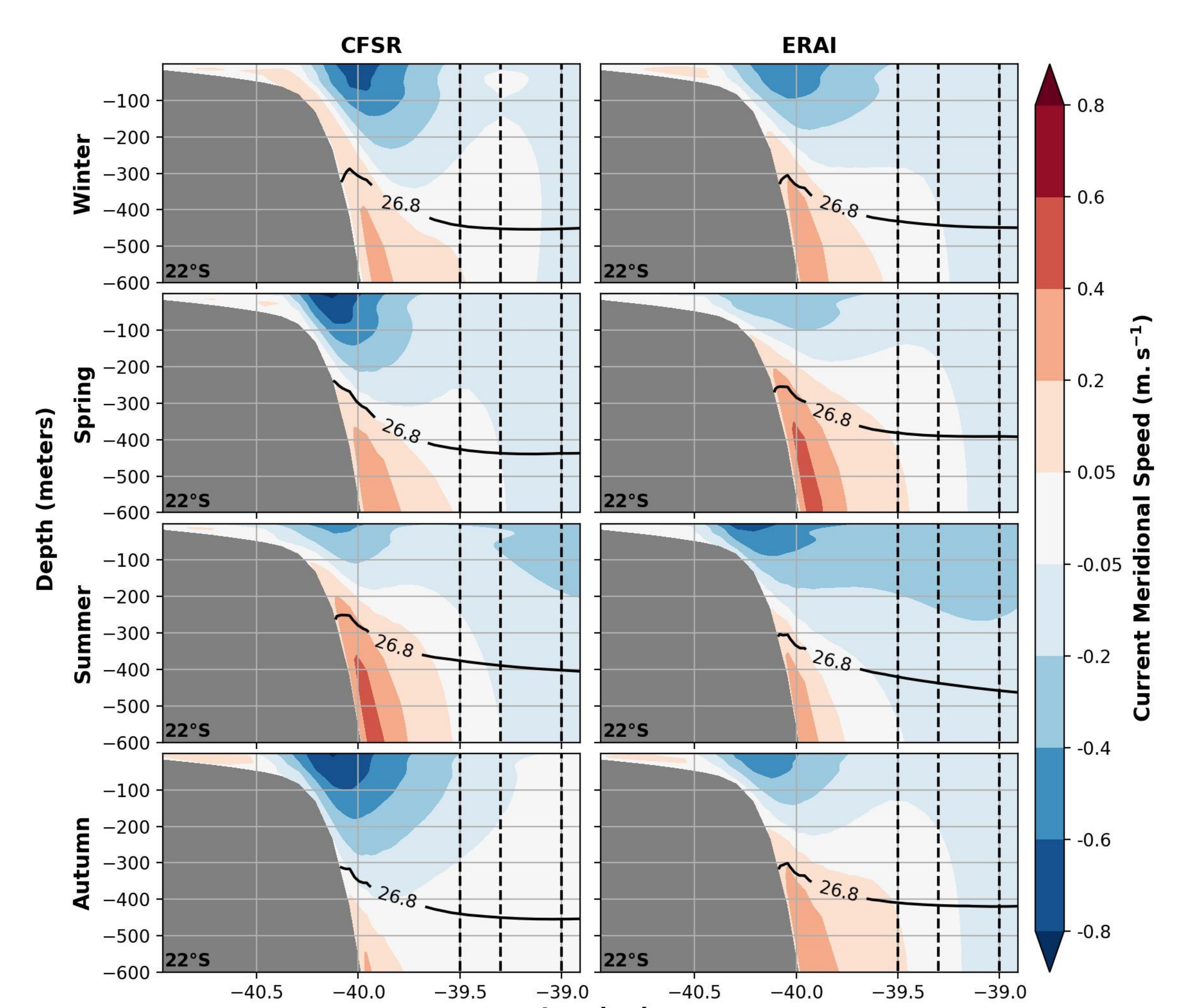

Figure 4: Seasonally mean cross-sectional speed component at 22ºS simulated for EXP_{CFSR} (left) and EXP_{ERAI} (right). Same extra information of Figure 3.

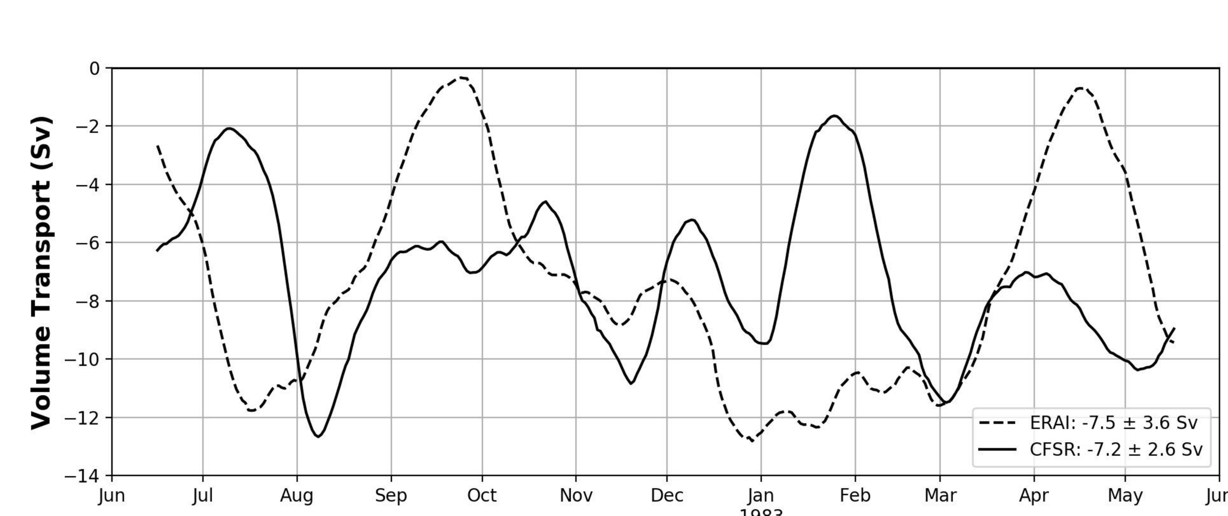

Figure 5: BC volume transport 30-days moving average in 22ºS from 40.5ºW to 39ºW of EXP_{CFSR} (solid line) and EXP_{ERAI} (dashed line). Legend present mean and standard deviation.

Key References

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