STUDY OF THE TEMPORAL EVOLUTION AND THE MARINE DYNAMICS IN THE SOUTH ATLANTIC

Delcourt, F.T. * Chapron, B. † Alonso, J.J. ‡

October, 2013

Abstract: The use of data provided by satellites is essential for the development of a spatiotemporal analysis of the variability of oceanographic parameters in the South West Atlantic region. The goal of this work is the study of the variations of the different spatiotemporal scales between the continental shelf and the open ocean, developing a methodology that combines data processing, remote sensing of the marine dynamics and the known biological systems in the Brazilian coast to find the relationships between them and their evolution. Through the classification of the South Atlantic in ecological provinces, the results have led to relate these provinces to exogenous events as westward Rossby waves propagation and coastal variability which contributes to the exceptional pattern of the variables, suggesting inter-relationships with the El Niño phenomenon.

Key words: Multi-satellite, Biogeographic Provinces, Boundary Currents, Physical and Biological Parameters.

1 Note

The oceanic circulation in the western South Atlantic Ocean (SAO) is dominated by the presence of boundary currents from the Anticyclonic Subtropical Gyre (ASG). By the joint action of trade winds and the Earth's

*PhD, Researcher at University of Cádiz, Cádiz, Spain. E-mail: flavia.tavaresdelcourt@alum.uca.es

†PhD, Head of Satellite Oceanography Laboratory at French Institute for the Research and Exploration of the Sea - IFREMER, Brest, France.

‡PhD, Profesor of Physics at University of Cádiz, Cádiz, Spain.

rotation, a displacement and accumulation of water in the west side of the Atlantic occur contributing for the occurrence of certain oceanographic phenomena, such as upwelling, ocean stratification and generation of eddies and meanders, influencing the ecosystems by standers. The use of the altimeters and sea surface temperature, surface wind, and the chlorophyll sensors on-board of satellites is essential for the development of a spatiotemporal variability analysis of those parameters in the South West Atlantic region. The goal of this work is to study the variations of the different spatiotemporal scales between the continental shelf and the open ocean, developing a methodology that combines data processing, remote sensing of the marine dynamics and the known biological systems in the Brazilian coast to find the relationships between them and their evolution.

In the southern area of the Atlantic ocean, the flow of some currents has relevant influence in the study between biological and physical forces and dynamics cycles. Remote sensing methods have been successfully used, since global images have contributed to elucidate many aspects of ocean biogeochemistry and ecosystems dynamics [14] [5] [9] [10]. The concurrent operation of the altimeter satellite TOPEX/Poseidon and the SeaWIFS ocean color satellite provide the opportunity to analyze correlations between sea surface levels and color anomalies with the El Niño and subsequent La Niña events [15]. The sea surface temperature (SST) seasonal cycle in the (SAO) accounts for over 90% of the variance [11] [12] [13] [8] and also regulates algal blooms [14]. References [1] and [8] suggested certain coupling between SST anomalies propagation and ENSO. Like that, previously studies have showed dominance by the interannual variability in amplitude time series from the Empirical Orthogonal Functions (EOF) modes during the ENSO cycle [16].

The data used in the study comprise monthly global fields provided by sensors like AVHRR from the satellite series NOAA (Pathfinder Version 5) for SST (4 Km resolution), MODISQ/AQUA and SeaWIFS for chlorophyll concentration - CHL (Version 3, 9 km resolution) [7], TOPEX/Poseidon radar altimeter for Sea Level Anomalies (SLA) (25 Km resolution), and Quikscat scatteromter for wind speed (WIND) (25 Km resolution). The archives of these four parameters (SST, CHL, SLA and WIN) cover a 15 year period from January 1998 to December 2012. The monthly time series we compare in this work consist of data sets, provided by different analyzed areas in the SAO, in order to find relationship between them and their evolution.

The methodology is based on basic statistical analysis techniques, methods of analysis and spectral decomposition of the satellite fields in time and space. Hovm´oller diagrams and variability analysis by the Empirical Orthogonal Functions were used to describe and understand the dynamics of the region and then identify oceanographic changes signs calling ecological responses to the events found.

The mean goal of this study is to investigate the relationships among ecological provinces in the SAO and physical and biological oceanographic parameters from a multidisciplinary point of view.

2 Conclusion

Early reviews [3] [2] [6] indicate that fluctuations in the SAO are probably caused by propagating waves whose signals are related to impacts on primary production. This interaction may refer to the entry of intricacies related to tropical instabilities waves, the influence of exogenous vorticity and coastal discharges in the zone.

The results found so far are represented by the anomaly signals which might be explained by the interannual and semi-annual variability. These results are consistent with the interannual variability of the physical processes presents in the EPs as upwelling events and coastal discharges variability. The coast area it's a complex region that receives many kinds of propagation from different zones. The influence of coast variability in the SAO seems to depict an immediate response of the atmospheric circulation to changes in the ocean. ENSO responses are present in the data from equatorial region. The extension of the influence zone can play an important role in the field of eddy propagation and the westward propagation signals related to the Rossby waves.

Based on the dynamic characteristics of the time series involved within the ecological provinces [4], exogenous events contributes to the exceptional pattern of the variables, suggesting inter-relationships with the El Niño phenomenon and the westward propagation related to the Rossby waves.

3 Acknowledgements

Orbital data were provided by the MODIS-AQUA project - NASA (http://modis.gsfc.nasa.gov/).

References

[1] CAMPOS, E.J.D, VELHOTE, D., SILVEIRA, C.A. **Shelf Break Upwelling driven by Brazil Current Cyclonic Meanders.** Geophys. Res.Let. 27(6), pp. 751-754, 2000.

[2] CHARRIA, G., DADOU, I., CIPOLLINI, P., DRÉVILLON, M., GARÇON, G. **Influence of Rossby waves on primary production from a coupled physical - biogeochemical model in the North Atlantic Ocean.** Ocean Sci., 4(3), pp. 199-213, 2008.

[3] CHELTON, D.B., SCHLAX, M.G. **Global observations of oceanic Rossby waves.** Science, 272, 234-238, 1996.

[4] DELCOURT, F.T., CHAPRON, B., ALONSO, J.J. **A classification of the South Atlantic by the SeaWIFS Chlorophyll concentration variability in Ecological Provinces.** Pluralidade (unpublished), 2013.

[5] GARCIA, C.A.E., GARCIA, V.M.T. **Variability of chlorophyll-a from ocean color images in the La Plata continental shelf region.** Continental Shelf Research, 28, pp. 1568-1578, 2008.

[6] GUTKNECHT, E., DADOU, I., CHARRIA, G., GARÇON, V. **Spatial and Temporal variability of the remotely sensed chlorophyll a signal associated with Rossby waves in the South Atlantic Ocean.** J. of Geophys. Res. 115, C05004, 2010.

[7] HOOKER, S., C. MCCLAIN. **The calibration and validation of SeaWiFS data.** Prog. Oceanogr., 45, 427-465, 2000.

[8] LENTINI, C.A.D., CAMPOS, E.J.D., PODESTÁ, G.P. **The annual cycle of satellite derived sea surface temperature on the western South Atlantic shelf.** Brazilian Journal of Oceanography, 48(2), 93-105. 2000.

[9] LONGHURST, A.R. A. **Ecological Geography of the Sea.** Academic, San Diego, California, 1998.

[10] MOORE, J.K., DONEY, S.C., GLOVER, D.M., FUNG, I.Y. **Iron cycling and nutrient limitation patterns in surface waters of the World Ocean.** Deep-Sea Research Part II: Topical Studies in Oceanography 49, pp. 463?507, 2002.

[11] PODESTÁ, G.P., BROWN, O.B., EVANS, R.H. **The Annual Cycle of Satellite-derived Sea Surface Temperature in the Southwestern Atlantic Ocean.** American Meteorological Society. Journal of Climate,pp. 457-467, 1991.

[12] PROVOST, C., GARCIA, O., GARÇON, V. **Analysis of satellite sea surface temperature time series in the Brazil-Malvinas current confluence region: dominance of the annual and semiannual periods.** Journal of Geophysical Research, 97(11), pp. 17841-17858, 1992.

[13] RIVAS, A.L. **Spatial variation of the annual cycle of temperature in the Patagonian shelf between 40 and 50 of south latitude.** Continental Shelf Research 14(13/14), pp. 1539?1554, 1994.

[14] RIVAS, A.L. **Spatial and temporal variability of the satellite-derived sea surface temperature in the southwestern Atlantic Ocean.** Continental Shelf Research, 30, pp. 752-760, 2010.

[15] WILSON, C., ADAMEC, D. **Correlations between surface chlorophyll and sea surface height in the tropical Pacific during the 1997-1999 El Niño-Southern Oscillation event.** J. Geophys. Res.,106 (12), 31, 175-31, 188, 2001.

[16] YODER, J.A., KENNELY,M.A. **Seasonal and ENSO variability in global ocean phytoplankton chlorophyll derived from 4 years of SeaWiFS measurements.** Global Biogeochemical Cycles, 17(4), pp. 1112, 2003.