An evaluation of a regional scale pre-operation forecast system for the Eastern and Southeastern Brazilian Shelf-Slope Region

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1 – Introduction

The Regional Ocean Model System (ROMS) was implemented to the Brazilian coast south of 13°S (Figure 1) aiming to provide regional scale oceanic forecasts for the eastern and southeastern shelf-slope regions.

This initiative is part of the objectives of a research and development consortium called Oceanographic Modeling and Research Network (with Portuguese acronym REMO), which was built in 2007.

REMO is a partnership between Brazilian universities and public institutions that works for the common objective of developing assimilative numerical oceanic models for the Brazilian shelf/slope region.

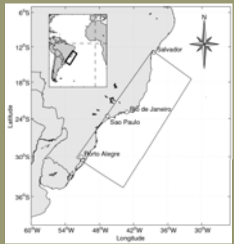

Figure 1: The rectangular area indicates the domain of the regional scale Operational Oceanic Forecast system.

2 – The study region

The circulation at the region is influenced by forcings at different time and space scales. For instance, the large scale processes are mostly related to (i) the wind-driven circulation associated with the subtropical gyre (Figure 2) and (ii) the termohaline circulation (Figure 3), which are important to represent seasonal to interannual features. The Bifurcation of the South Equatorial Current (BiSEC), at the northern limb of the subtropical gyre is an additional feature that adds complexity to the system. The BiSEC not only varies latitudinally at the time scales mentioned above, but also varies with depth (Figure 3).

Meso-scale processes at the region can be associated to the Brazil Current (BC) activity and to the variations in the atmospheric forcings, which among other processes, contribute to the formation of upwelling regions along the area.

Finally, at various regions, tidal currents also affect the coastal and continental shelf circulation, adding more complexity to the system.

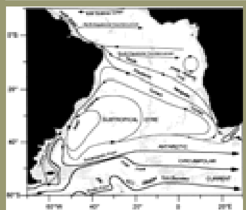

Figure 2: Schematic representation of the large-scale, upper-level geostrophic currents and fronts in the South Atlantic Ocean. Extracted from Peterson & Stramma (1991).

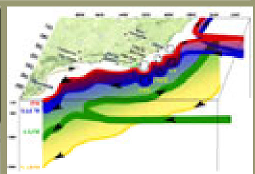

Figure 3: A schematic of the oceanic circulation features off southeast Brazil. The BC transports both Tropical Water (TW) and South Atlantic Central Water (SACW). AAIW represents the Antarctic Intermediate Water, while the North Atlantic Deep Water (NADW) is associated to the poleward Deep Western Boundary Current. Extracted from Calado et al (2008).

3 – Operational Modeling Setup

In order to achieve a horizontal resolution of few kilometers along the cross-shore region, a rotational grid (180 x 245) aligned with the coastline was adopted. The vertical axis has 32 s-levels and the bottom topography was based on the NGDC/MGG-ETOPO1 Global Relief Model (Figure 4). To incorporate the large-scale circulation described in Section 2, the model was nested into the Ocean Circulation and Climate Advanced Modeling Project (OCCAM) monthly climatology (horizontal resolution of 1/4° x 1/4°), which provides the initial and boundary conditions of the thermohaline and momentum fields. The model also incorporates the tidal forcing from the TPXO 7.1 global tidal model (horizontal resolution of 1/4° x 1/4°).

Before starting the operational stage, the model was forced with 6-hourly NCEP/DOE AMIP-II Reanalysis-2 atmospheric data (horizontal resolution of 1.8° x 1.8°) for 9 years, between 2000 and 2008 (Table 1 and Figure 5).

The second stage of spin up of the Operational Oceanic Forecast (OOF) started at the beginning of 2009, when the meteorological forcing was switched to the 6-hourly NCEP/GFS (horizontal resolution of 1° x 1°).

At the beginning of July 2009, when the OOF was finally initiated, the meteorological forcing was switched to the 3-hourly GFS. Other additional changes that were incorporated in the OOF are illustrated in Table 1.

An evaluation of the performance of the model against *in situ* data is presented at Figure 6. The model is capable of reproducing the Western Boundary Current Dynamics, with a poleward BC and an opposing Intermediate Western Boundary Current. At depths below 1000 m, the flow is again poleward and associated with the NADW.

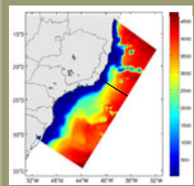

Figure 4: Bottom topography of the regional scale Operational Oceanic Forecast system. The black line indicates a cross-shore section near the city of Cabo Frio.

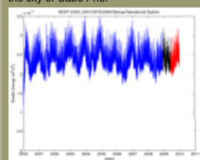

Figure 5: Time evolution of the volume-averaged kinetic energy for the OFS. Each color represents a stage of the OFS, as described in Table 1.

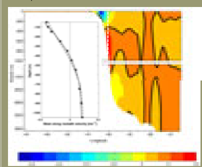

Figure 6: Mean alongshore current near the city of Cabo Frio (Figure 4) during the spin-up Phase 1. The inside graphic represents the mean alongshore current based on 10 currentmeters moored during 1 year, according to Silveira et al (2008).

Table 1: Development stages of the OOF.

	Spinup Phase 1	Spinup Phase 2	Op Phase 1	Op Phase 2	Op Phase 3
Lateral Forcing	OCCAM 1/4			OCCAM 1/12	Large Scale Ocean Model
Surface forcing	NCEP2	GFS 6h, 1° Forecast 00h	GFS 3h, 1°	GFS 3h, 0.5°	Regional High Resolution Model
	2000 //	2009	1-jul	1-oct 2010	

4 – Data visualization: an upwelling event

The OOF is available at **http://oceano.fis.ufba.br/~mma/oof** and here, an upwelling event is presented in Figure 7 to illustrate some of the capabilities of the system. Figure 7a shows the NE favorable winds at the previous day, which resulted in a temperature decrease of up to 5°C at the signed area in Figure 7b (based on a satellite image). Figure 7c presents the SST forecasted by the OOF, which was able to capture very well the geographic location of the event, but with a less intense temperature variation. Finally, Figure 7d shows the temperature at the 100 m depth and illustrates the BC poleward flow and the interaction with the shelf-slope region.

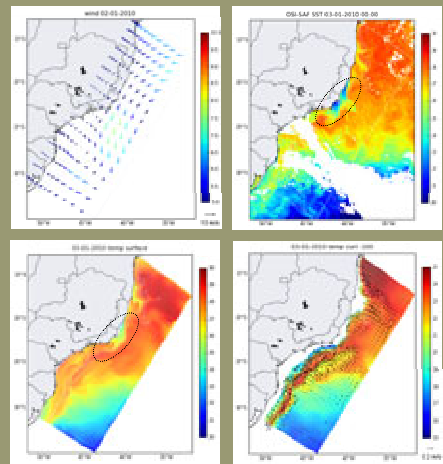

Figure 7: (a) Daily average of the wind field at 02/01/2010, (b) SST derived from Ocean and Sea Ice Satellite Application Facility – EUMETSAT at 03/01/2010, Daily average of the (c) SST at 03/01/2010 and (d) temperature at 100 m depth with the imposed velocity field for the same day.

5 – Conclusions and Future Plans

The OOF releases 5 days forecasts since July 2009. The system has shown its capability to reproduce the dynamics of the shelf-slope regions at various scales. The OOF is in a robust evaluation process based on in situ data, in order to produce error maps to access the model skills. In the near future the OOF will receive lateral conditions from a large scale ocean model and surface conditions from a Regional High resolution atmospheric model. Our goal is the improvement of the OOF forecasting skills.

References

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