MODELLING BIOPHYSICAL INTERACTIONS: PRELIMINARY RESULTS ON THE DYNAMICS OF THE SOUTHEAST BRAZIL BIGHT USING ROMS

Daniela Faggiani DIAS; Douglas F. M. GHERARDI; Luciano Ponzi PEZZI

Remote Sensing Division – National Institute fo Space Research -INPE, PO Box 515 - 12201-970
Sao Jose dos Campos - SP, Brazil.
faggiani,douglas,luciano@dsr.inpe.br

Introduction

The target species is the Brazilian sardine, the most important fishries in the Brazilian coastal waters, characterized by strong interannual fluctuations of biomass. These fluctuations are controlled by ocean-atmosphere interactions, which interfere in the development of the Brazilian sardine eggs and larvae (ichthyoplankton) (1,2).

The influence of atmospheric and oceanic conditions on ichthyoplankton can be modelled using Individual Based Models (IBMs). IBMs incorporate the biological characteristics and ecological requirements of each individual to forecast its trajectory based on physical-chemical conditions of the environment. It is very important that IBMs are forced by reliable hydrodinamic models and that these models resolve the main physical processes in scales which allow the accurate representation of bilogical processes.

For that purpose, the Regional Ocean Modelling System (ROMS) (3) has been chosen for its ability to represent mesoscale physical processes. ROMS has been used worldwide and comparisions with observational data show that the model is capable of resolving accurately mesoscale processes, including fronts, eddies and upwellings.

The relation between regional ocean processes and the dispersal of the Brazilian sardine ichthyoplankton is still an unresolved issue and it the subject of the present research. Here, the preliminary results on the representation of the physics of the South Brazil Bight (SBB) are shown based on an experiment using ROMS.

Materials and Methods

- Grid:
  - Horizontal resolution: 1/12 °;
  - Domain: latitudes from 20°S to 30°S, longitudes from 40°W to 50°W;
  - Vertical discretization: 30 sigma-levels;
  - Coast Line: *World Coast Line*;
  - Bathymetry: SRTM30_plus.

- Input – reanalysis products:
  - Oceanic contours: *Simple Ocean Data Assimilation* (SODA);
  - Atmospheric forcing: *National Center for Environmental Prediction – Climate Forecast System Reanalysis* (NCEP-CFSR);

- Experiment: carried out along 27 years (from 1980 to 2007);
- Comparision with satellite data :
  - Sea Surface Temperature (SST): ROMS – AVHRR data;
  - Sea Surface Height (SSH): ROMS – AVISO data;
  - Geostrophical Currents: ROMS – AVISO data.

  } 1993 to 2007

A schematic representation of the research project is shown in Figure 2. The IBM to be used is the Ichthyop (4), available on the website <http://www.ur097.ird-.fr/projects/ichthyop/>.

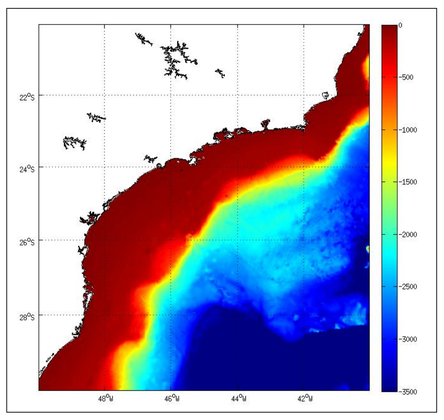

Figure 1: Bathymetry (m)

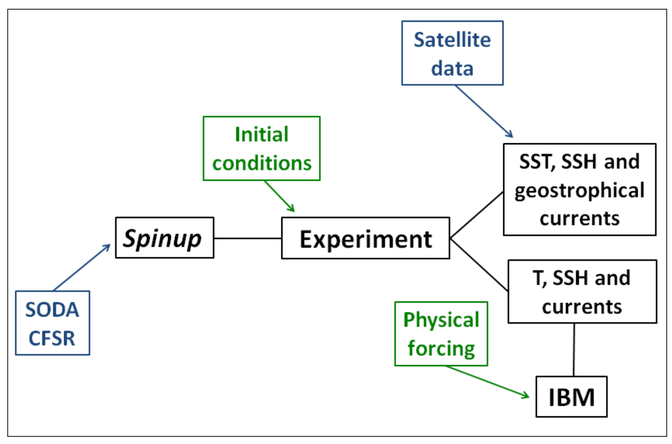

Figure 2: Flowchart with the next steps to be taken

Results and discussion

Results of monthly mean Sea Surface Temperature (MSST) and Sea Surface Height (MSSH) indicate that the numerical solutions of the model are stable, with no warming or cooling trend over the years, and the seasonal cycle is well represented. The model correctly represented the position and shape of important structures: the upwelling near Cape Frio, the intrusion of coastal cold waters, near the Cape of Santa Marta, on winter, the position of Brazil current along the continental shelf and slope and its intensification in summer months.

Figure 3 shows the differences between overall mean of ROMS minus satellite data, for SST, SSH and zonal and meridional geostrophic currents. ROMS underestimates SSH, as shown in figure 3A, with differences mostly negative and around 0,5 m. For SST, the model tends to underestimate temperatures in upwelling areas and overestimates in the Brazil Current region, with differences mostly around ±1°C (Figure 3B). As for geostrophical currents, the differences presented are around ±0,5 m/s (Figures 3C and 3D), in a few points. The largest differences are seen near to the coast, possibly because of the low resolution (1/3°) of the AVISO dataset.

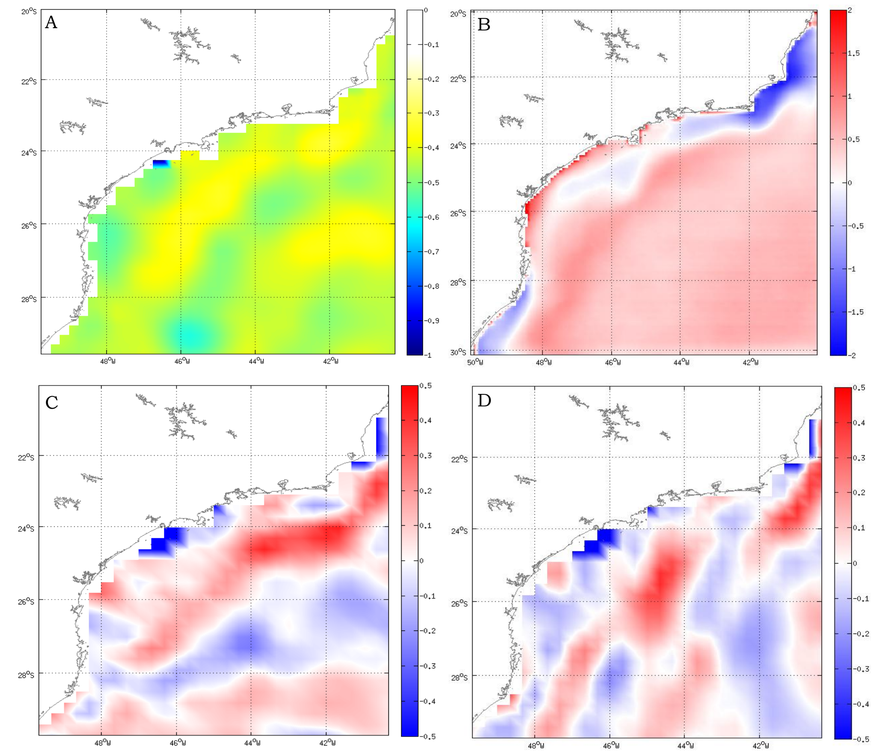

Figure 3: Diference maps between mean ROMS minus satellite data: (A) SSH, (B) SST, and geostrophic (C) zonal and (D) meridional currents.

Final considerations

The simulation realized presented estable and coherent numerical results, when compared with observational data. These preliminary results suggest that the model is suitable for biophysical experiments with Ichthyop.

As a result, we expect to identify the scales of dispersion and aggregation of eggs and larvae of the Brazilian sardine and compare with ichthyoplankton survey results os spatial models (1, 5).

References

1. GIGLIOTTI, ES; GHERARDI DFM; PAES, ET; SOUZA, RB; e KATSURAGAWA, M, 2010. Spatial analysis of egg distribution and geographic changes in the spawning habitat of the Brazilian sardine *Sardinella brasiliensis*. **Journal of Fish Biology**, doi:10.1111/j.1095-8649.2010.02802.x.
2. SOARES, HC; PEZZI, LP; GHERARDI, DFM; PAES, ET, 2011. Oceanic and atmospheric patterns during spawning periods prior to extreme catches of the Brazilian sardine (*Sardinella brasiliensis*) in the southwest Atlantic. **Scientia Marina**, v. 75, n. 4, p. 665-677.
3. SHCHEPETKIN, AF; MCWILLIAMS, JC. 2005. The regional oceanic modeling system (ROMS): a split-explicit, free-surface, topography-following-coordinate oceanic model. **Ocean Modelling**, v. 9, p. 347–404.
4. LETT, C, 2008. A Lagrangian tool for modelling ichthyoplankton dynamics. **Environmental Modelling and Software**, v. 23, p. 1210-1214.
5. MORAES, LES; GHERARDI, DFM; KATSURAGAWA, M; PAES, ET, 2012. Brazilian sardine spawning and nursery habitats: spatial-scale partitioning and multiscale relationships with thermohaline descriptors. **ICES Journal of Marine Science**, doi: 10.1093/icesjms/fss061.

Support

CAPES