A Numerical Study of the Tide and Tidal Dynamics Effects in the Amazon River Plume

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2012 ROMS/TOMS User Workshop

Introduction

The North Brazil Continental Shelf (NBCS) is a high energetic coastal region that shelters the plume of the world's largest river in terms of freshwater discharge, the Amazon River [1], along with an intense western boundary current (North Brazil Current - NBC), persistent trade winds and tidal amplitude over 3 m [3].

The plume extends for hundreds of miles offshore and along the northwest coast of Brazil and interacts with the NBC, which has an important role in the exchange of water between the two hemispheres. Lentz and Limeburner [6] revealed that the Amazon Plume over the shelf is typically 3–10 m thick and between 80 and 200 km wide. Hu et al. [5] showed that the plume change the vertical structure of the Equatorial West Ocean, which has an important role in ocean-atmospheric changes.

Knowing the effects that influence the plume dispersion and fresh water mixture rates is extremely important to understand this region. Our aim was to analyze tidal currents influences on the Amazonas River's plume through numerical model.

Methods

A numerical study of the NBCS water circulation was carried out with ROMS (*Regional Ocean Modeling System*) to investigated the influence of the tidal currents in the vertical stratification of the Amazon River plume as well as the alongshore plume water spreading.

The model was configured with:

- 1/24° spatial resolution;
- 10 vertical levels;
- ETOPO bathymetry data;
- NCODA salinity data as initial condition;
- TPXO tide data;
- ANEEL river discharge measured.

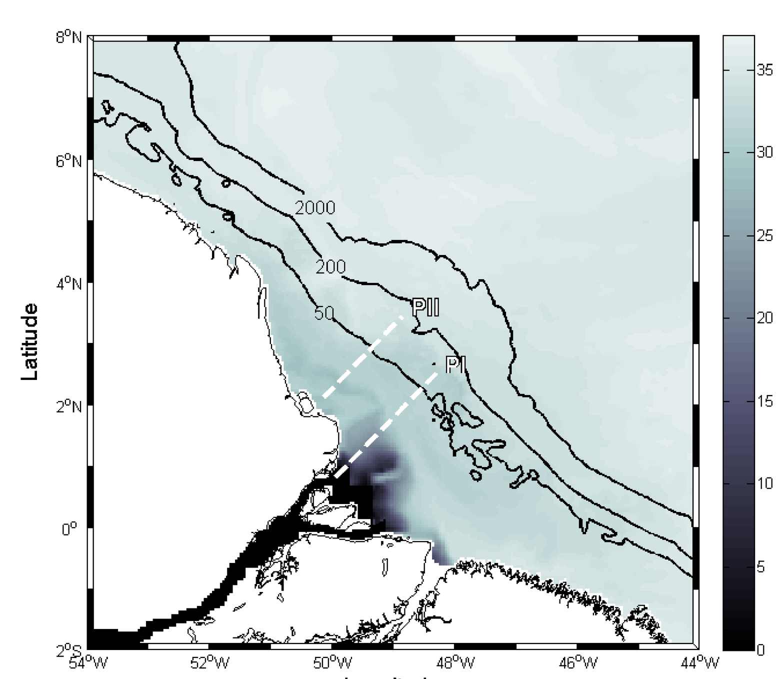

Figure 1: Salinity initial condition in surface with bathymetric lines. The lines PI and PII represents the across-shelf profiles.

The boundary conditions used in the simulations were: *Chapman* [2] for the sea surface height, *Flather* [4] for barotropic velocity and Orlaski's radiation condition [7], *Radiation*, for baroclinic velocity, salinity and temperature.

Model Simulation

Two experiments were carried out for 400 days, the first (experiment one) with river inflow and wind stress and the second (experiment two) with tidal currents as well. The experiments were compared with each other.

Results and discussion

Monthly composed average salinity maps were made for two across-shelf vertical profiles during the months of high and low runoff. Figure 2 shows the vertical profile at PI and Figure 3 shows the vertical profile at PII.

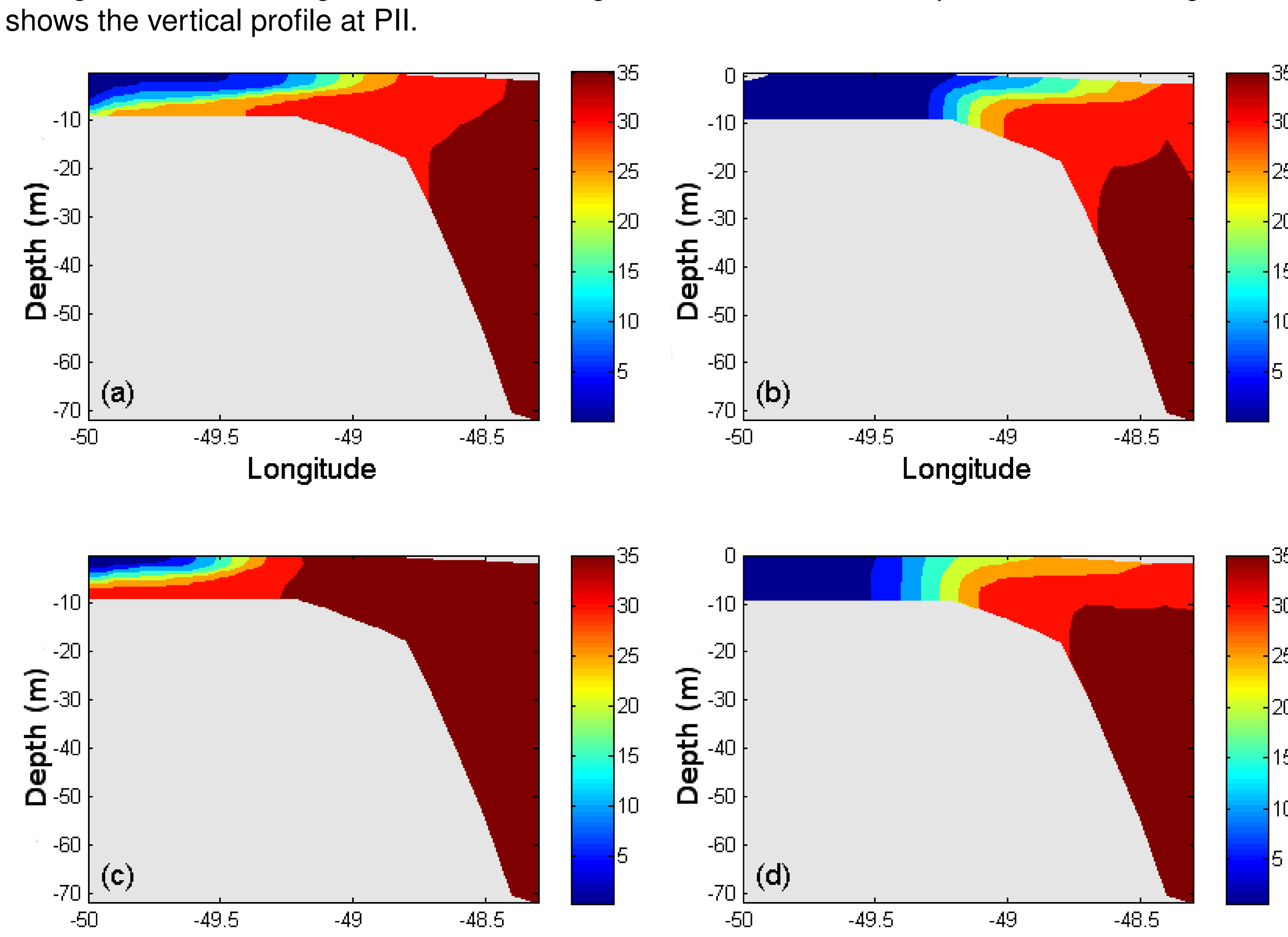

Figure 2: Vertical profiles at PI; Monthly composed average salinity during (a) high river runoff in experiment one; (b) high river runoff in experiment two; (c) low river runoff in experiment one; (d) low river runoff in experiment two.

Experiment One
- Low salinity bulk near the shore;
- High vertical stratification;
- Low vertical mixture;
- Salt water intrusion through the bottom.

Experiment Two
- Low salinity water near the shelf break;
- High horizontal stratification;
- High vertical mixture;
- No salt water intrusion through the bottom.

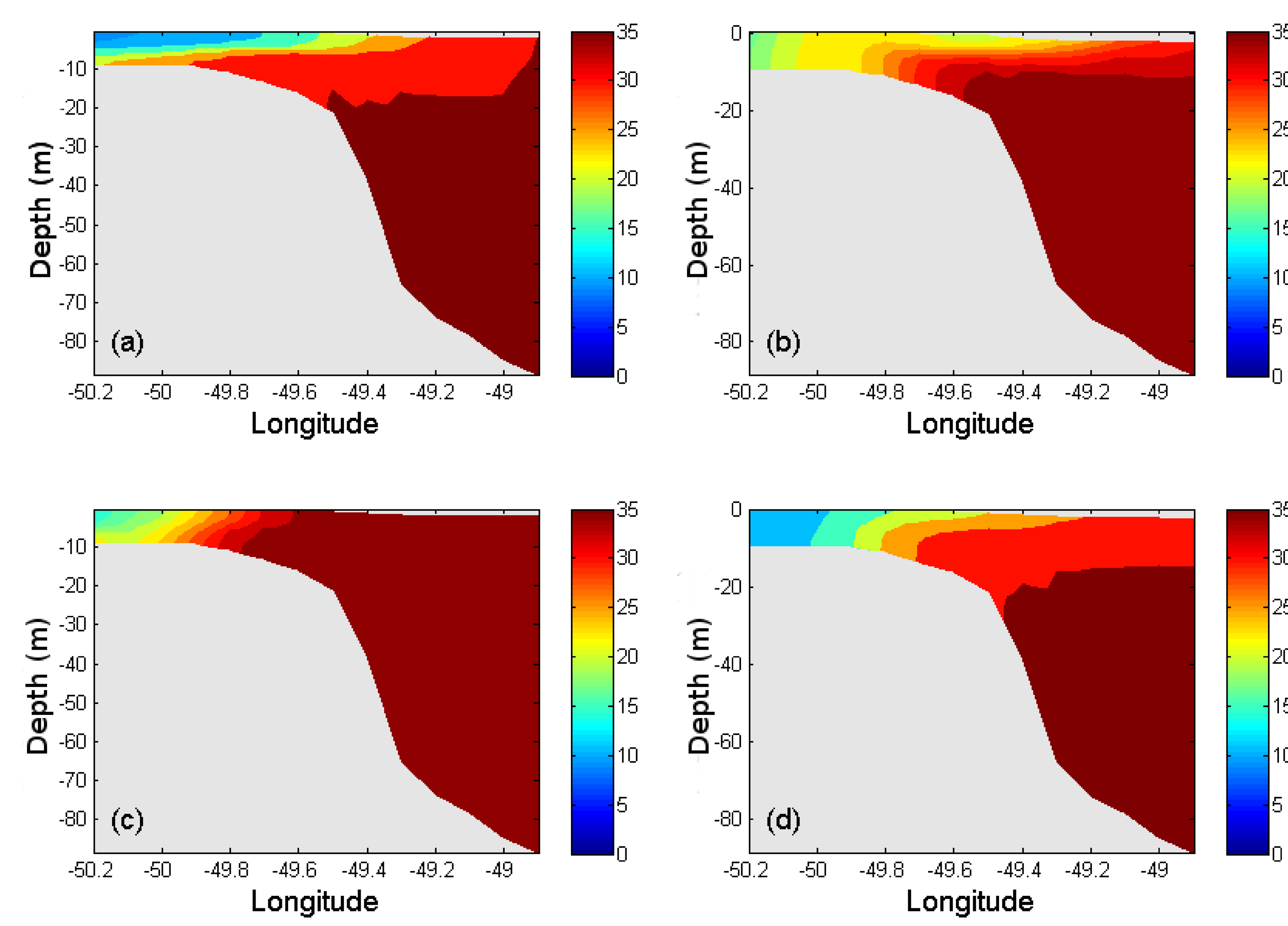

Figure 3: Vertical profiles at PII; Monthly composed average salinity during (a) high river runoff in experiment one; (b) high river runoff in experiment two; (c) low river runoff in experiment one; (d) low river runoff in experiment two.

Experiment One
- Low salinity water concentrated near the coast;
- High vertical stratification.

Experiment Two
- Low salinity water along the whole continental shelf;
- Low vertical stratification.

Conclusions

The results show that the tide has great influence on the vertical and horizontal structure of the plume. By changing the plume water vertical stratification, tidal mixing allows fresh water to spread across the continental shelf, reaching the continental slope, beyond the shelf limits.

Acknowledgements

This work was supported by Associação Atlantis para o Desenvolvimento da Ciência and by the Universidade Federal de Rio Grande (FURG). The authors are thankful to the Msc. Hugo Bastos and Msc. Igor Monteiro for their valuable comments and suggestions for improvement.

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