The Fate of Fresh Water from the La Plata River in the SW Atlantic: Synergistic Use of Altimeter and Other Satellite Data with Model Fields

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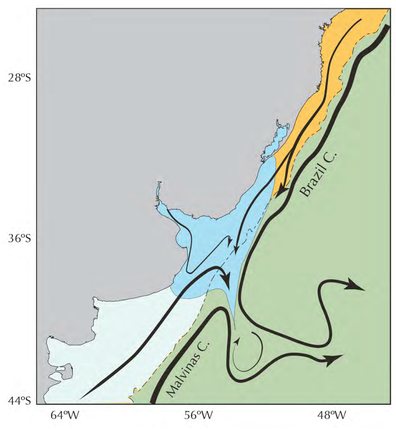
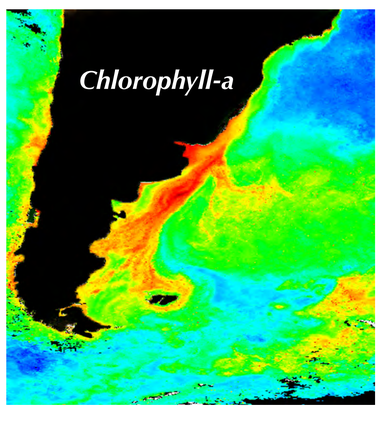
Summary: Comparisons of tidal corrections, SLA and tide gauge data give us confidence in the use of altimeter SLA fields over the continental shelf. Combining the altimeter sea level anomaly (SLA) data with a mean dynamic height field (from a realistic model) produces fields of absolute dynamic surface topography and ocean velocities over the broad shelf next to Argentina, Uruguay and Brazil in the SW Atlantic Ocean. Addition of sea surface salinity (SSS) fields from the Aquarius mission allows us to determine the fate of fresh water from the La Plata River outfall at approximately 35°S. In winter, southerly winds force northward and onshore surface currents, trapping the river's freshwater plume next to the coast north of the river outfall. In summer, those winds and the flow over the shelf reverse, advecting the fresh water to the south and delivering it to the confluence of the Brazil and Malvinas Currents, which is found offshore of the shelf break near 37°-38S°. Chlorophyll-a pigment concentrations join with the salinity and altimeter data to follow the shelf water into the eddy field offshore of the shelf break. EOF modes separate the dominant control of salinity over the shelf (winds), salinity in the mouth of the RdlP estuary (runoff) and offshore fresh water plumes (the position of the Brazil/Malvinas Confluence).

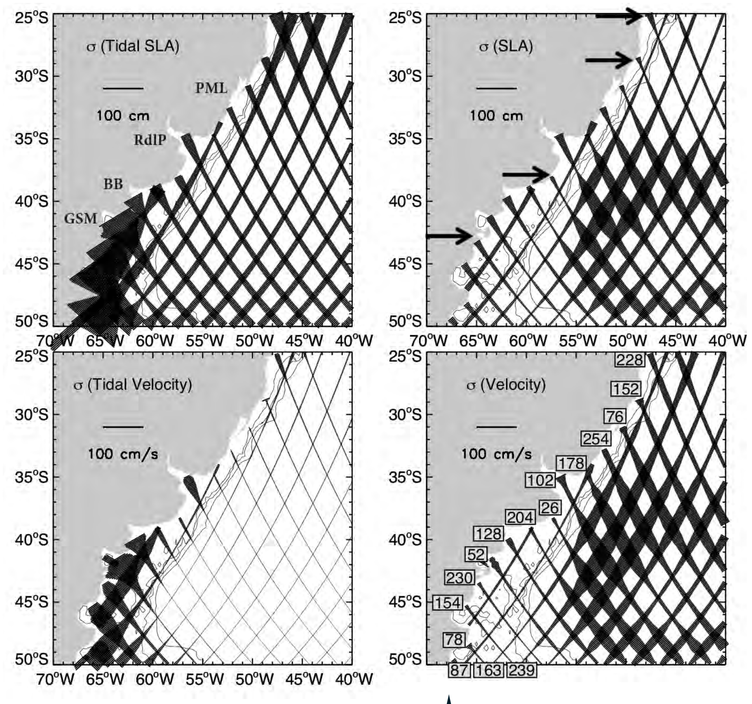
1. Background



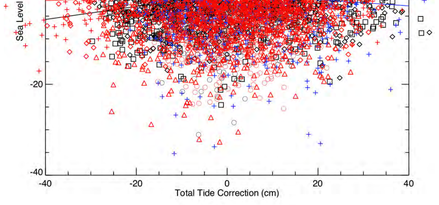


The left panel shows a schematic of the SSS and circulation in the southwestern Atlantic region. The regions filled with light blue colors represent the spreading of the La Plata River and the Patos/Mirim freshwater plumes. The right panel shows a chorophyll-a snapshot illustrating the impact of the shelf discharges on the deep ocean.

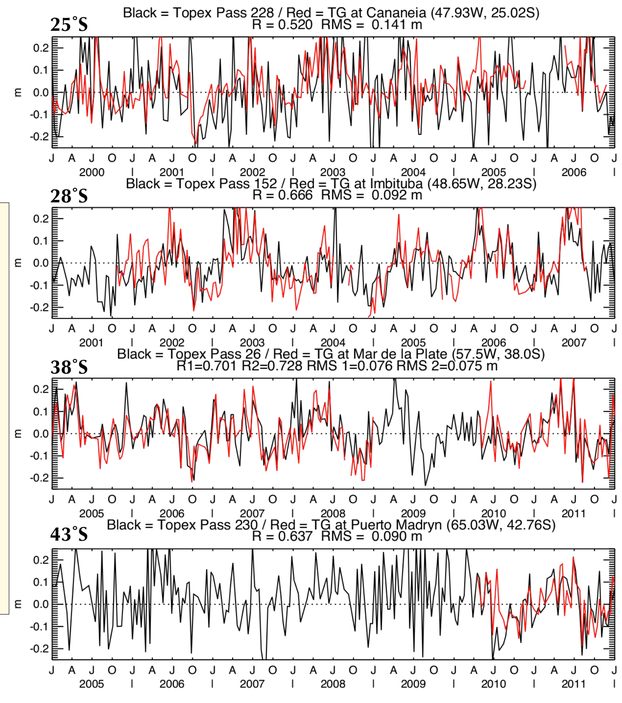
2. Sea level and wind observations



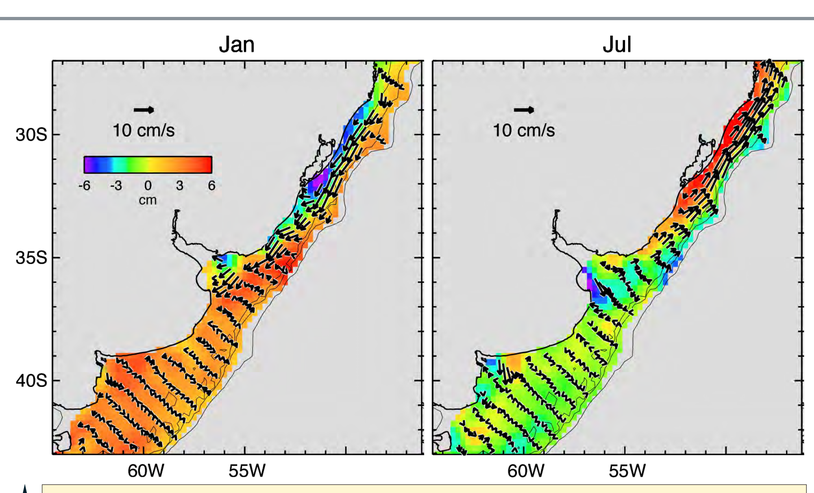
Upper panel: Variances of SLA along the tracks (**top**) and the geostrophic cross-track velocities calculated from the gradients of those heights (**bottom**). Values are calculated from the full tidal corrections (**left**) and the corrected SLA (**right**). Arrows in the top right panel show tide gauge locations (see below).



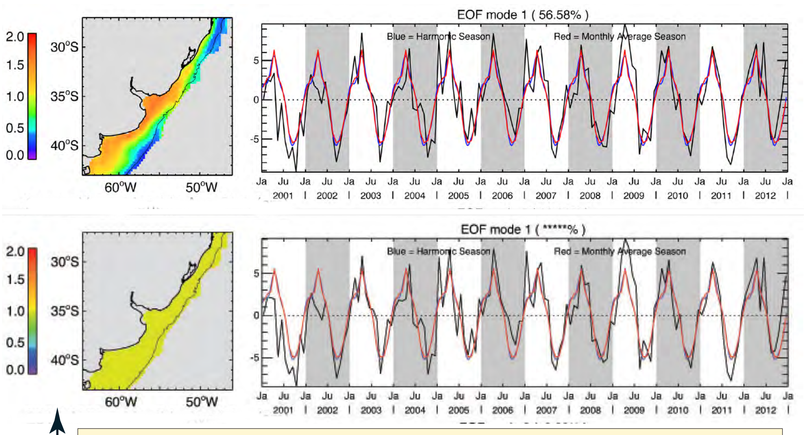
Left panel: Scatterplot of the corrected SLA values vs the full tidal correction over the shelf.



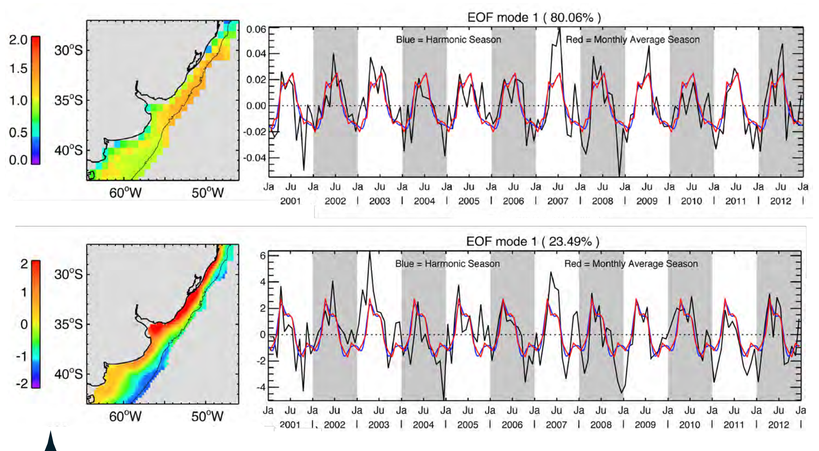
Comparison of tide gauge data (red) to the nearest along-track altimeter data (black). A temporal mean has been removed from each pair of time series using only the time periods when tide gauge data are available



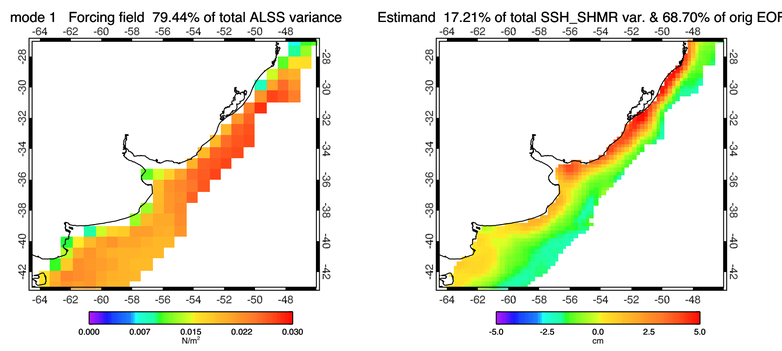
January and July monthly mean SLA (colors) from AVISO along with their associated geostrophic velocity anomalies, using data from January 1, 2001–December 31, 2012.



First EOFs of the raw SLA (top; 57% of variance) and averaged SLA over the shelf (bottom).



Upper panel: First EOF of alongshore wind stress. **Bottom panel:** First EOF of SLA after removing the mean over the shelf.



Upper panel: First Principal Estimator Patterns, relating spatial patterns of alongshore wind stress (**top left**, nearly 80% of the variance) to those of the SLA after removing the spatial mean of each monthly field (**top right**), approximately 17% of the variance). Both patterns vary with the amplitude of the time series shown in the **bottom panel**.

References

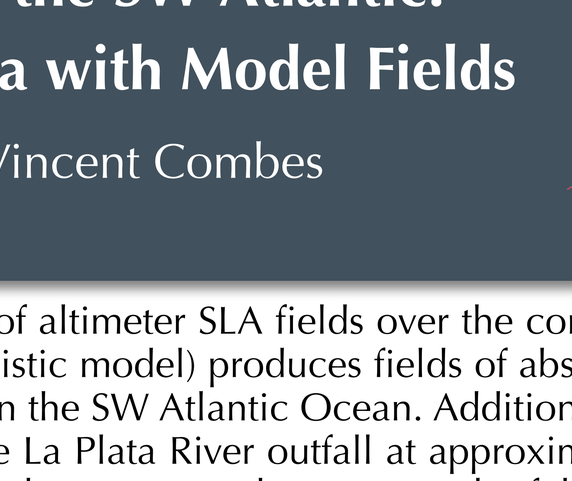
Combes, V., and R. P. Matano, 2014: A two-way nested simulation of the oceanic circulation in the Southwestern Atlantic, *J. Geophys. Res. (Oceans)*, 119, doi:10.1002/2013JC009498.

Guerrero, R., A. et al., 2014: The salinity signature of the cross-shelf exchanges in the southwestern Atlantic Ocean: satellite observations. *J. Geophys. Res. (Oceans)*. In press.

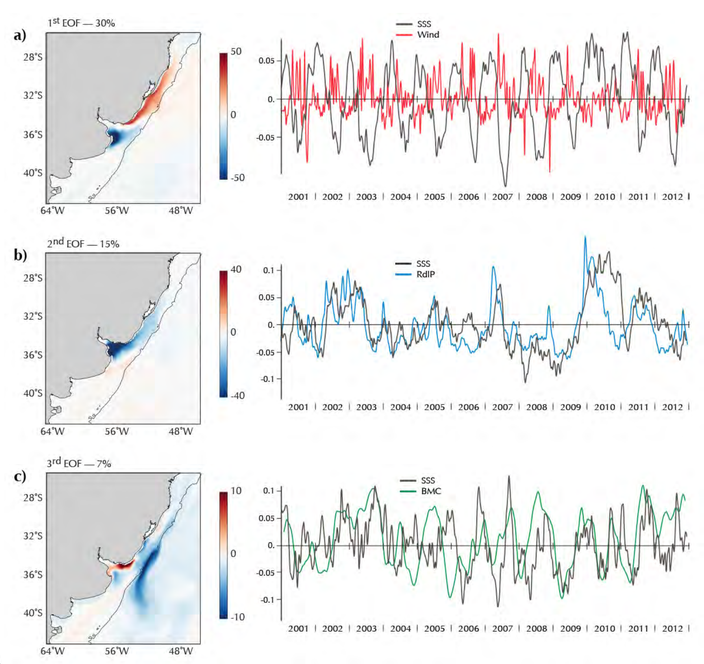
Matano, R. P. et al., 2014: The salinity signature of the cross-shelf exchanges in the southwestern Atlantic Ocean: numerical simulations. *J. Geophys. Res. (Oceans)*. In press.

Strub, P. T. et al., 2014: Altimeter derived sea surface circulation on the SW Atlantic shelf: 27°-43°S. Manuscript in preparation.

3. Model sea surface salinity

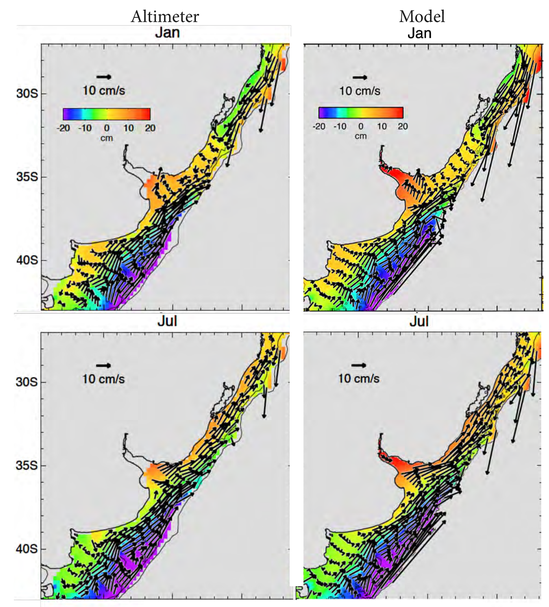


Snapshots of SSS in the nested model . **Top:** domain of the parent model (1/4° resolution). **Bottom left:** first child model (1/12°). **Bottom right:** Second child model (1/24°). The grey line in panel c) marks the location of the 200 m isobath (the shelf-break).

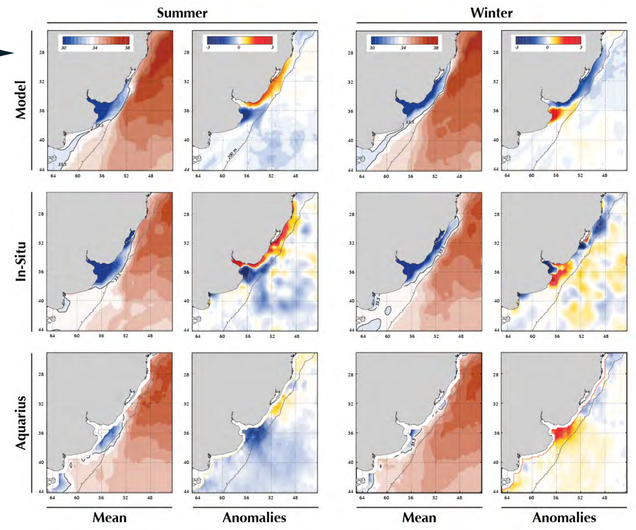


SSS EOFs: **Top:** 1st mode, the red line is the alongshelf component of the wind stress. **Middle:** 2nd mode, the blue line is the Rio de la Plata discharge. **Bottom:** 3rd. EOF the green line is the relative latitudinal variations of the Brazil/Malvinas Confluence.

4. Altimeter ADT and velocity — Aquarius and model salinity



Left panel: Absolute dynamic topography (ADT, color) formed by adding SLA to the model mean SSH. Vectors represent geostrophic surface velocities calculated from SSH. Top: January. Bottom: July. **Right panel:** Model SSH and corresponding geostrophic velocities.



Comparison of the seasonal SSS fields in the model (**top**), in-situ observations (**middle**) and Aquarius (**bottom**). The two left panels show the mean values and the two right panels the anomalies