

Ocean Surface Topography Science Team Meeting (OSTST)

19 – 23 October, 2020
Virtual meeting



Analysis of a 25-year long volume transport time series derived from satellite altimetry data and in situ measurements

Loreley Lago^{1,2,3}, Martin Saraceno^{1,2,3}, Alberto Piola^{4,2}, Laura Ruiz-Etcheverry¹

¹ Centro de Investigaciones del Mar y la Atmósfera (CIMA- CONICET - UBA), Argentina

² Departamento de Ciencias de la Atmósfera y de los Océanos, FCEN UBA, Buenos Aires, Argentina

³ Unité Mixte Internationale - Instituto Franco-Argentino para el Estudio del Clima y sus Impactos (UMI- IFAECI/CNRS-CONICET-UBA), Buenos Aires, Argentina

⁴ Servicio de Hidrografía Naval Argentina (SHN), Buenos Aires, Argentina

loreley.lago@cima.fcen.uba.ar

19 – 23 October 2020

Ocean Surface Topography Science Meeting (OSTST)

Virtual meeting

I would like to acknowledge my coauthors Martín Saraceno, Alberto Piola and Laura Ruiz-Etcheverry for their knowledge and valuable inputs in the analysis presented in this study.

The Argentine Continental Shelf

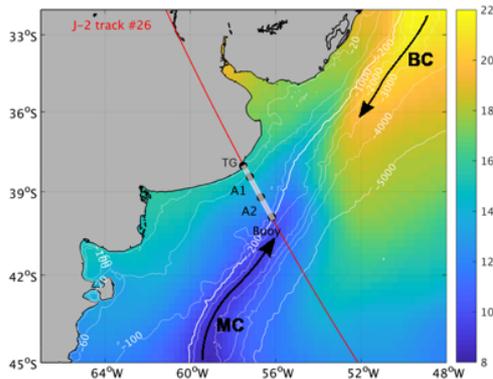


Figure 1: Northern Argentine Continental Shelf.

Continental shelves host large **primary productivity** and contribute significantly to the carbon balance of the global ocean. Still, in many regions the shelf circulation is still poorly understood.

The analysis of the in situ velocities can be found in Lago et al. (2019).

OBJECTIVE: Evaluate and analyze the along-shore transport in the section that extends from the coast to the 200 m isobath under track #26 of Jason 2 satellite mission.

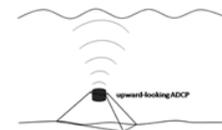


Figure 2: Northern Argentine Continental Shelf.

19 – 23 October 2020

Ocean Surface Topography Science Meeting (OSTST)

Virtual meeting

Figure 1 shows the location of the mooring used in this study. A1 and A2 counted on an upward-looking 300 KHz Acoustic Doppler Current Profiler (ADCP, Figure 2) and temperature (T), salinity (S) and pressure (P) sensors. The ADCPs provided zonal and meridional currents at 4 m vertical bins. These moorings, along with the oceanographic buoy, were deployed within the bilateral project between Argentina and France (CASSIS <http://www.cima.fcen.uba.ar/malvinascurrent/en/>). We obtained 11-month long hourly time series starting in december 2014, except the buoy that was active only during 2 months. TG is the tide gauge located in Mar del Plata. The red line in Figure 1 shows track #26 of Jason 2 satellite mission.

Comparison of In Situ and Satellite **Velocities**

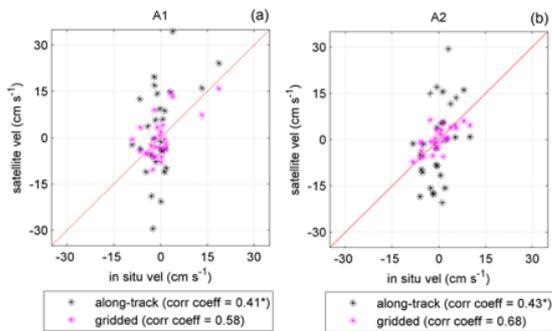


Figure 3: Scatter plot of the in-situ along-shore barotropic velocity and satellite along-shore velocity, at A1 (a) and at A2 (b). Scatter between in situ data and the gridded (along-track) product is depicted in magenta (black).

Satellite along-shore velocity:

- ALES along-track 1 Hz product (<https://openadb.dgfi.tum.de/en/>)
- Multi-satellite gridded product produced by AVISO (<https://www.marine.copernicus.eu>).

Significant correlation (95% confidence level) was obtained between in situ and the gridded satellite product, that provides a higher temporal resolution (1 day instead of the 10 days resolution of the along-track data).

This result highlights the importance of improving the **temporal resolution** of the satellite products. Especially in continental shelves strongly affected by low-frequency meteorological forcing.

Both satellite velocities were linearly interpolated to each location of the deployments. The comparison between in situ and satellite along-shore velocities was carried out only for the dates coincident with the along-track data. The * mark next to the correlation coefficients in Figure 3 indicate that the correlation is not significant at the 95% confidence level.

In Situ and Satellite **Transports**

- In situ and satellite along-shore transport are significantly correlated (0.74) during the period of in situ measurements.
- Mean satellite transport = **2.3 Sv towards the NE**
- Satellite transport std = 0.7 Sv
- Satellite transport Variability is dominated by the **annual cycle** (maximum in austral autumn) and by oscillations of periodicities between 12 days and 2 months.
- Analysis of the along-shore satellite velocities over the continental shelf and the Malvinas Current transport shows that **MC affects the along-shore transport only in the outer 30 km of the continental shelf.**

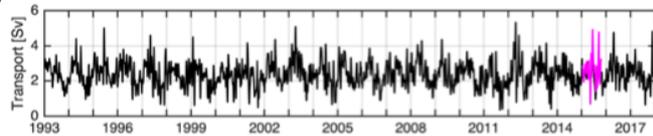


Figure 4: 25-year long along-shore transport time series derived from the gridded satellite altimetry data (black). Overlapped is the in situ transport with a 20 days low-pass filter (from December 2014 to November 2015, magenta).

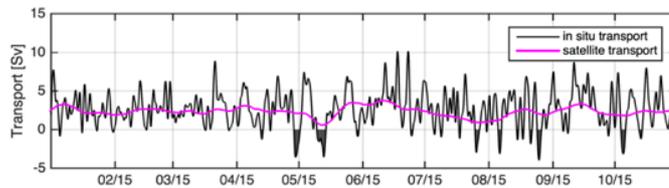


Figure 5: Along-shore satellite transport (magenta) and in situ transport (black) for the period of in situ measurements.

The relative **minimums** on the satellite transport are indicators of **reversal events**, clearly shown by the in situ transport.

These reversals, transport towards the SW, might have a strong influence on the larvae and early life stages of the species that spawn in this region.

19 – 23 October 2020

Ocean Surface Topography Science Meeting (OSTST)

Virtual meeting

The analysis of the direct velocity observations highlighted the barotropic character of the along-shore circulation and its uniformity along the section considered. This makes possible to rigorously compute the along-shore transport without the need of a denser array of measurements.

Satellite transport was computed using the geostrophic velocities derived from Sea Surface Height altimetric data. Velocities were interpolated to the section considered for the analysis (Figure 1).

Figure 5 shows that reversal events (transport towards the SW) are identified in the in situ transport due to the high temporal resolution of in situ data. This is hourly data that represents accurately the synoptic meteorological range associated to these reversal events. The peak-to-peak range is reduced for the satellite transport, whose temporal resolution is lower. Still, minimums found in the satellite transport are representative of reversal events

Interannual Satellite **T**ransport

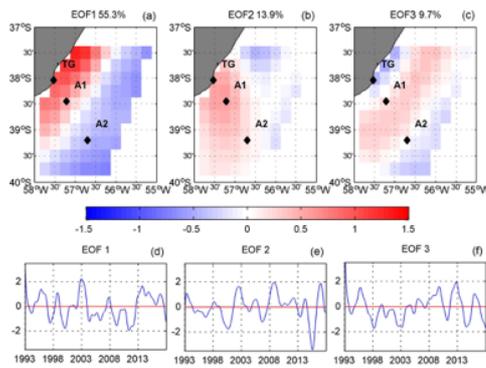


Figure 6: First (a), second (b) and third (c) EOF modes [cm] of the interannual SLA residual and (d, e, f) their corresponding time series.

EOF analysis of the interannual SLA residual

- The 1st and 3rd mode explain together 65% of the variance and their patterns show a cross-shore SLA gradient associated to an along-shore circulation. **The combination of the time series related to these modes is representative of the satellite interannual transport (corr coeff = 0.8). It is also inversely correlated (-0.5) to the Southern Annular Mode (SAM) index.**
- The 2nd mode explains 14% of the variance and is related to the cross-shore circulation, that is beyond the scope of this study.

To further understand the interannual circulation in the region of study we carried out an EOF analysis of the interannual sea level anomaly (SLA). The 1st mode explains 68% of the variance and is correlated (0.5, 95% CL) to with the first mode of the ocean mass changes measured by GRACE during the period 2003-2016. As it shows weak SLA gradients, its influence on the circulation is low. Hence, we repeated the EOF analysis to the SLA residual (without considering the 1st mode, Figure 6).

SAM-induced along-shore wind stress anomalies over the region modulate the cross-shore pressure gradient that, in turn, modulates the along-shore transport variability. In particular, over the region of study between 37°S and 40°S, when the SAM is in its positive (negative) phase, it induces a weakening (strengthening) of the southwesterly winds. The wind anomalies produce a cross-shore pressure gradient that modulates the intensity of the southwesterly winds.