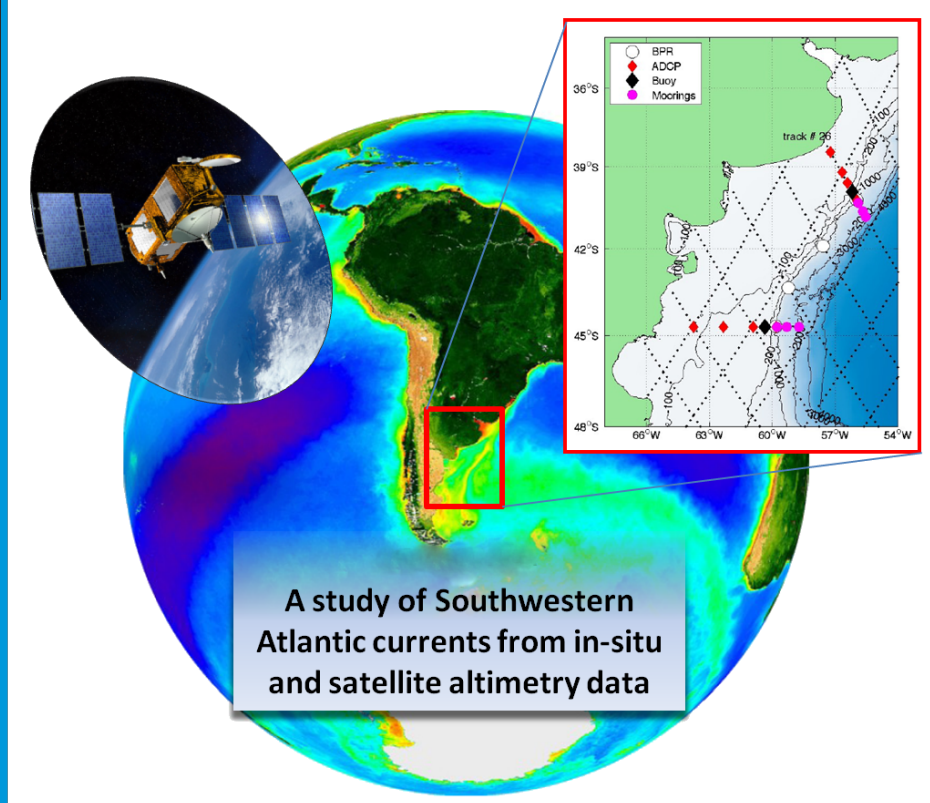
Ocean Surface Topography Science Team Meeting (OSTST)

19-23 October, 2020
Virtual meeting

Towards High Resolution Altimetry: evaluation of products in the Southwestern Atlantic. Summary of results from CASSIS project

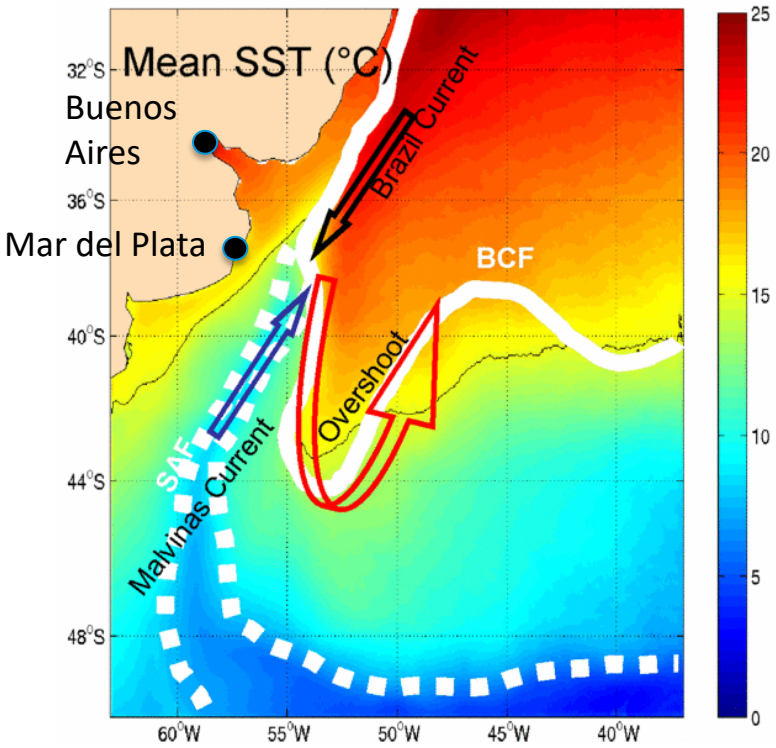
Martin Saraceno, Christine Provost, Alberto R. Piola, Raúl Guerrero, Ramiro Ferrari, Camila Artana, Loreley Lago, Guillermina F. Paniagua

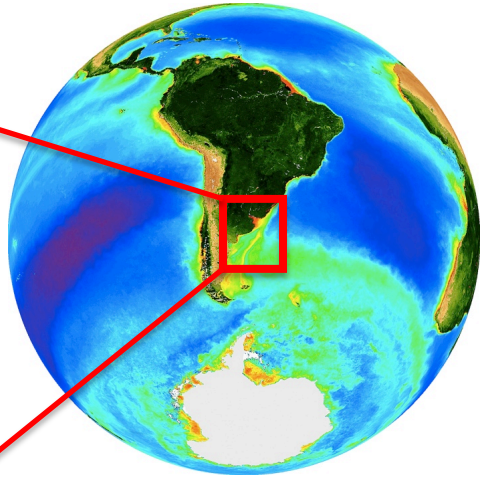


CASSIS

A project of Unité Mixte International Institut Franco-Argentin Etudes Climat et Impact (UMI-IFAECI/CNRS-UBA-CONICET)

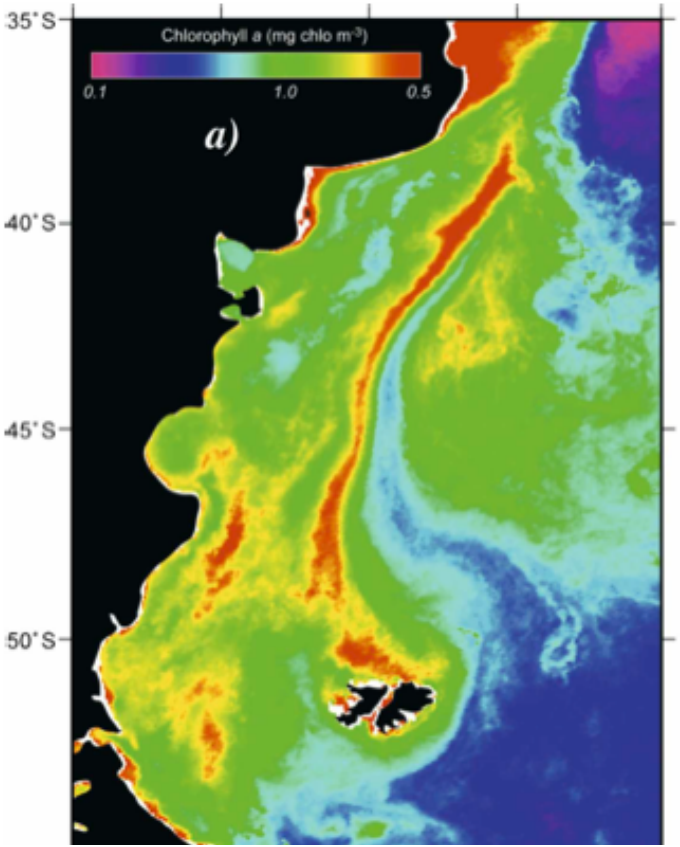
Why currents in the Southwestern Atlantic (SWA) are important?



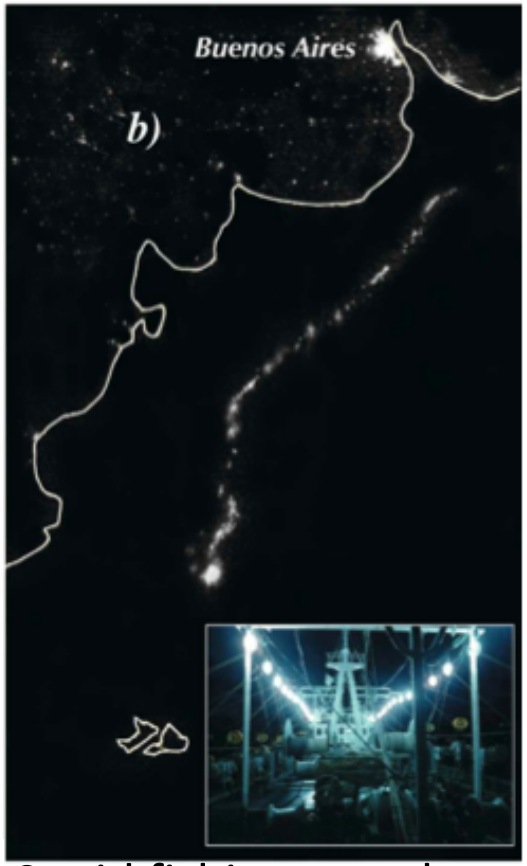


1. Malvinas Current (MC) brings cold and nutrient rich waters to the North
2. The MC is the main source of nutrients in the Southwestern Atlantic

Why currents in the Southwestern Atlantic (SWA) are important?



Average of Chlorophyll-a, mg/m3

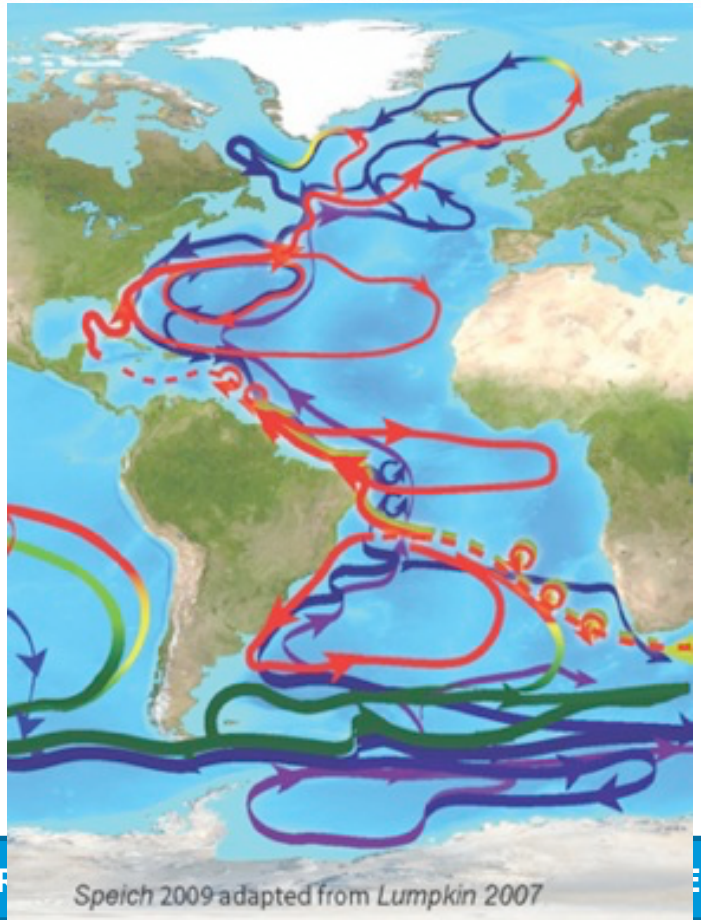


Squid fishing vessels

2. The interaction of the MC with the bottom is responsible to maintain the sustained upwelling observed along the shelf-break that is the main source of nutrients that maintains important fisheries

Matano and Palma, 2008

Why currents in the Southwestern Atlantic (SWA) are important?



4. MC is part of the Meridional Overturning circulation in the Atlantic:
It contributes to regulate the climate of the Earth thanks to the exchange of heat and salt that occurs at the Brazil-Malvinas confluence region

Warm (red lines) and cold (blue and green) paths of the Meridional Overturning Circulation; Lumpkin 2007

Why currents in the Southwestern Atlantic (SWA) are important?

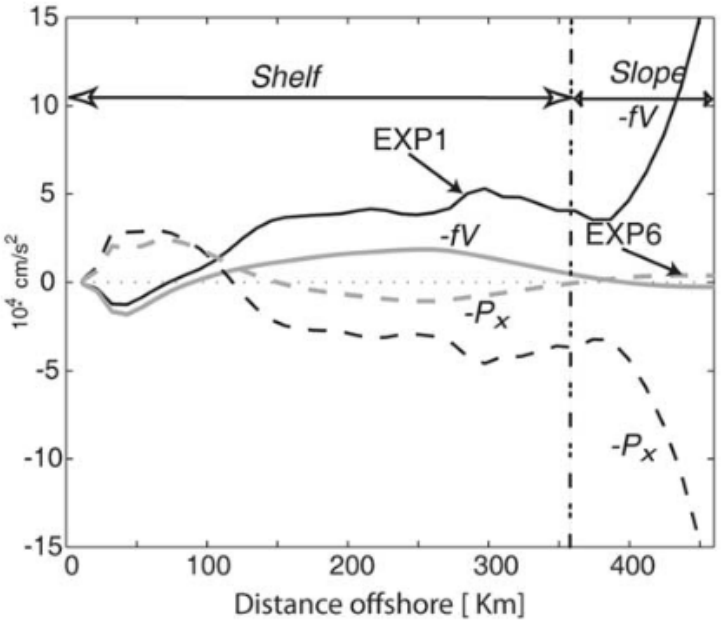


Figure 17. Comparison of the annual mean depth-averaged cross-shelf momentum balance at the NACS section (C3) of experiment EXP6 (no boundary current inflow, gray lines) and experiment EXP1 (including the MC, black lines).

5. The intensity of the MC is proportional to:

- transport of currents over the shelf &
- Intensity of the upwelling in the shelf-break

Matano and Palma, 2008

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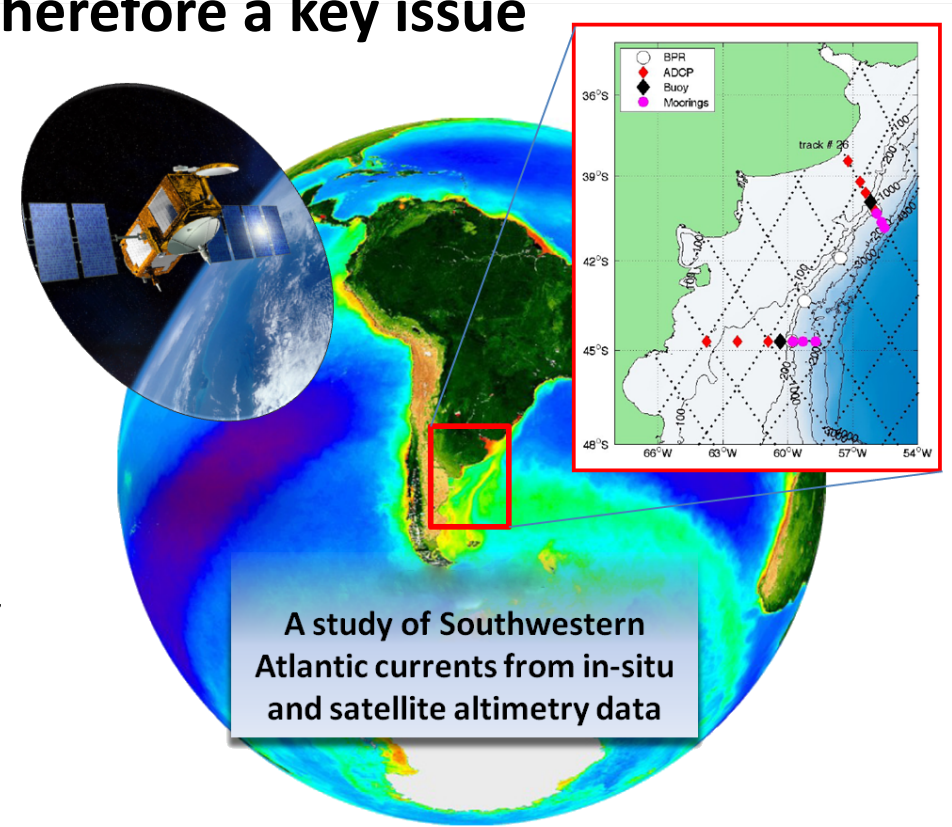
Monitoring the MC is therefore a key issue

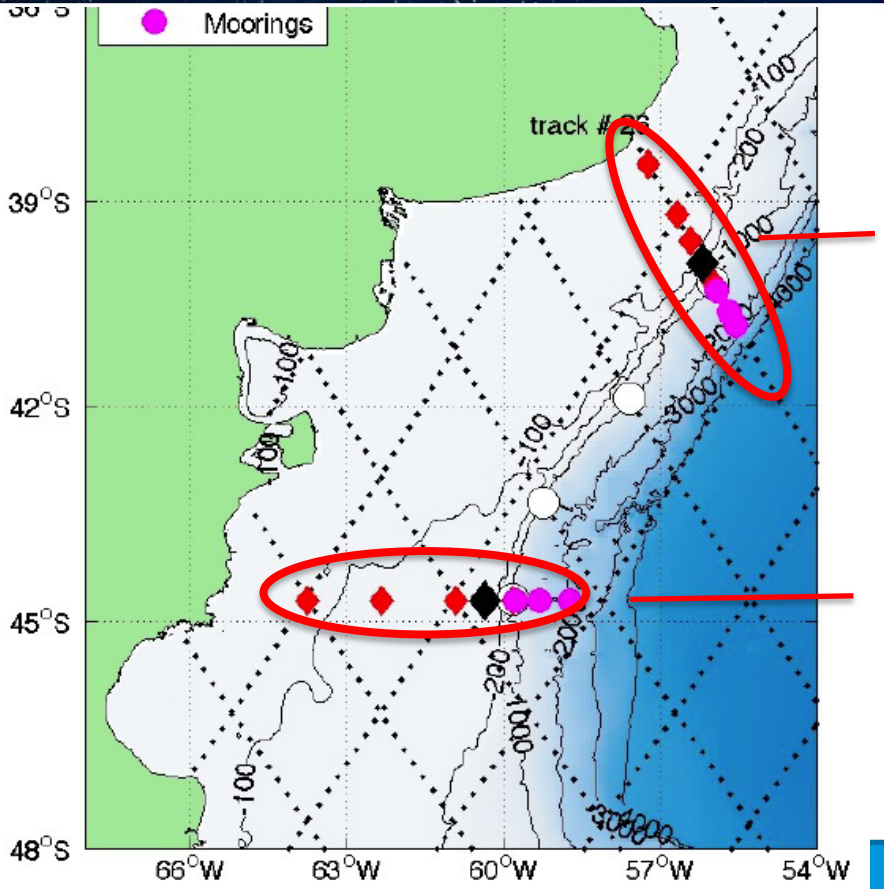
C A S S I S

Southwestern Atlantic currents from satellite and in situ data

A project of Unité Mixte International Institut Franco-Argentin Etudes Climat et Impact (UMI-IFAECI/CNRS-UBA-CONICET)



CASSIS project: Mooring array



2014-2015

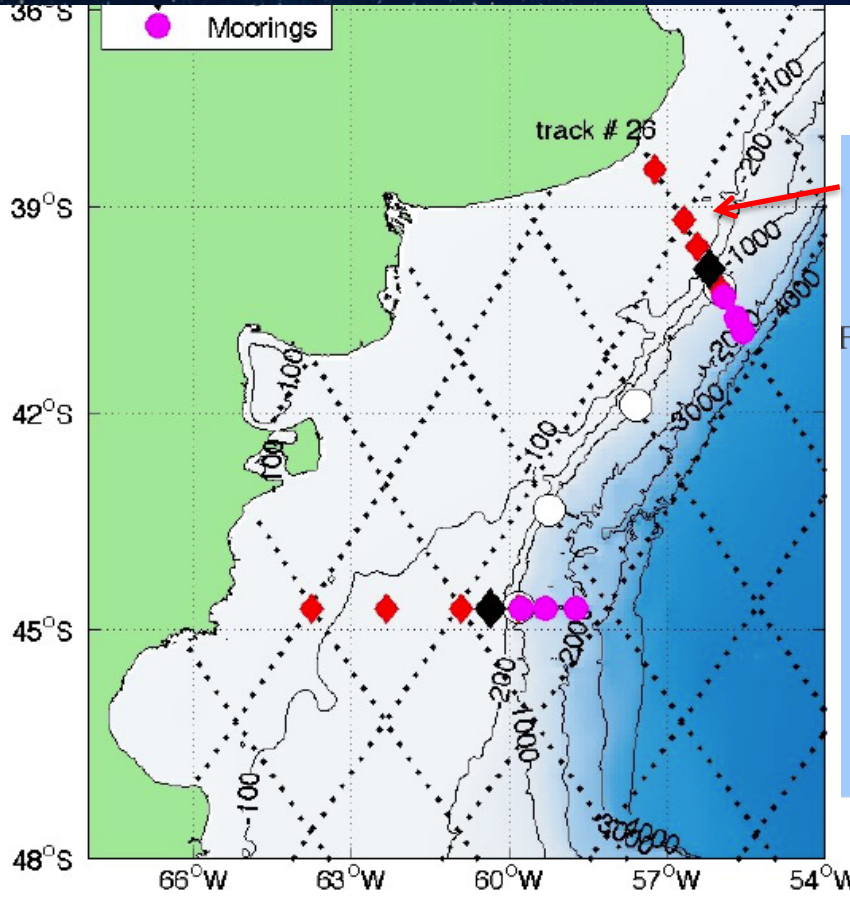
2015-2017

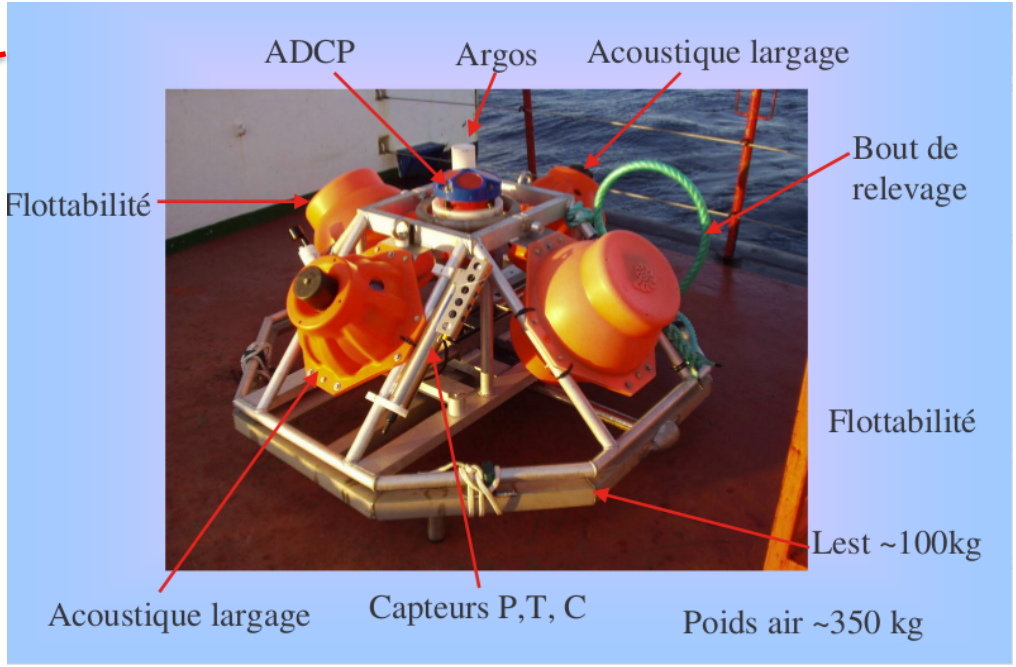
8 moorings:
- 4 upward-looking ADCP
- 1 oceanographic buoy
- 3 tall moorings

- Along-track #26: 1 year (Dec 2014- Nov 2015)

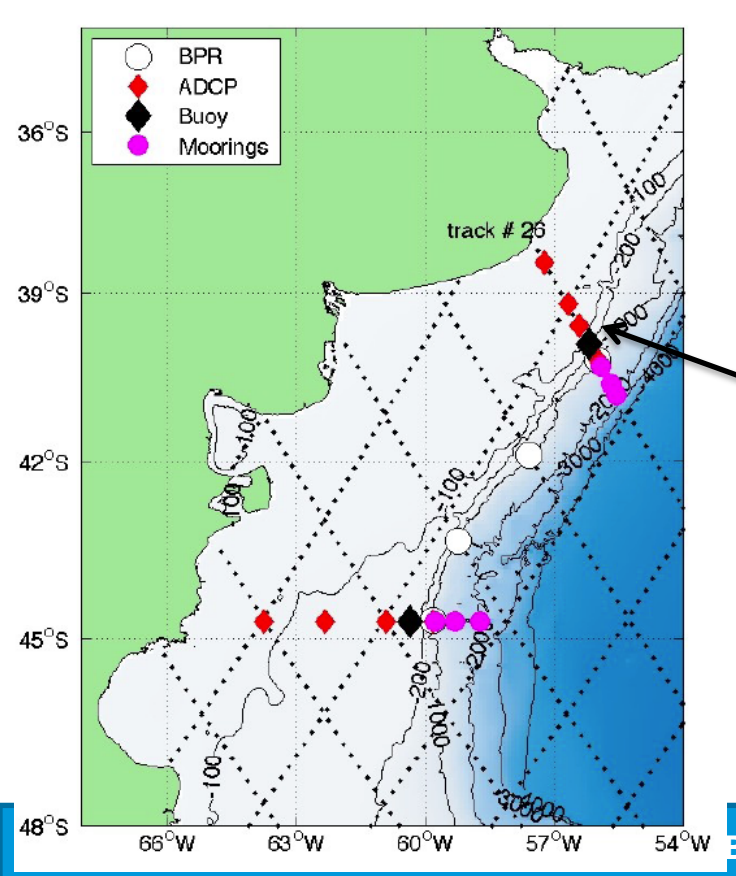
- Section at 44.7 S: 1.5 year
- (Dec 2015- May 2017)

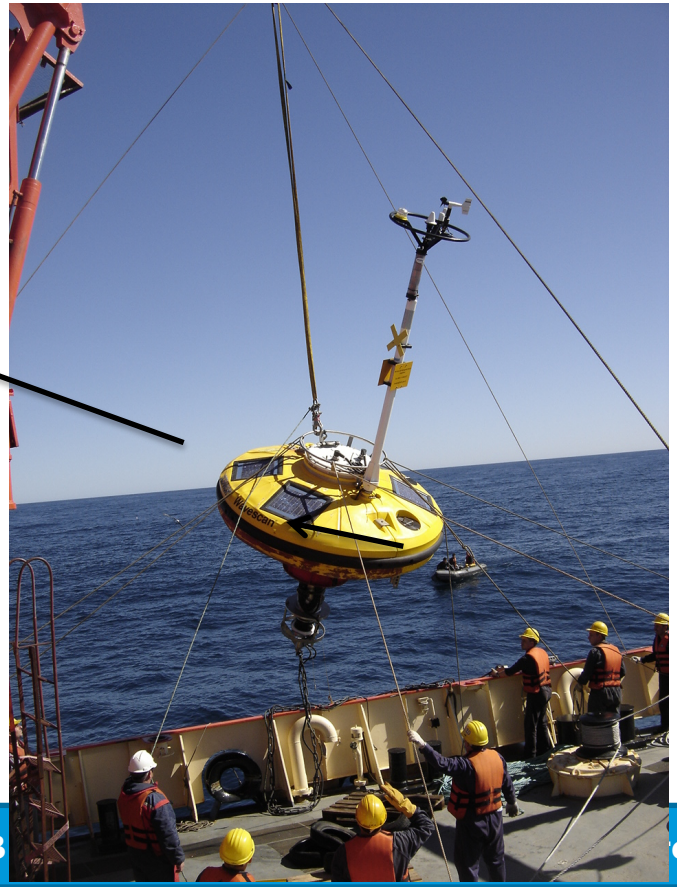
Upward looking ADCP





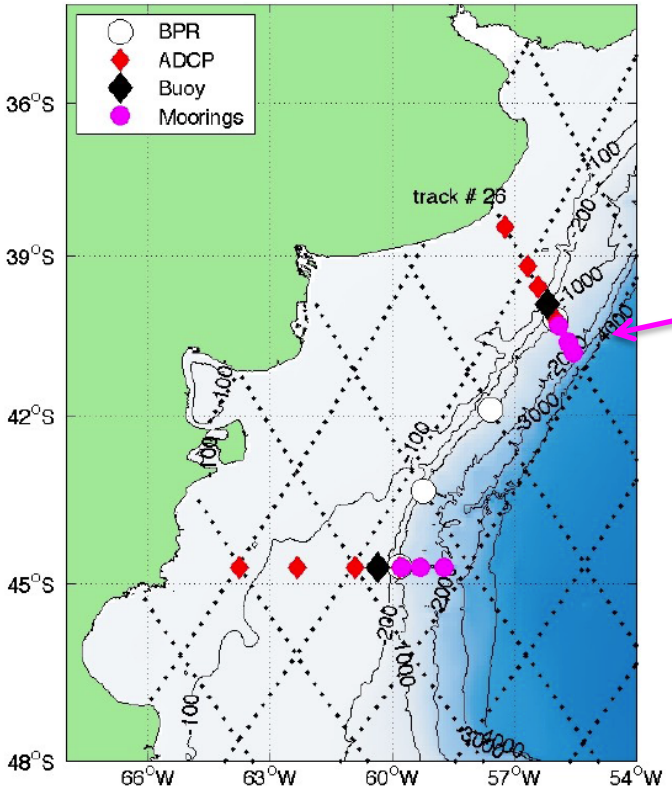
Full oceanogaphic buoy

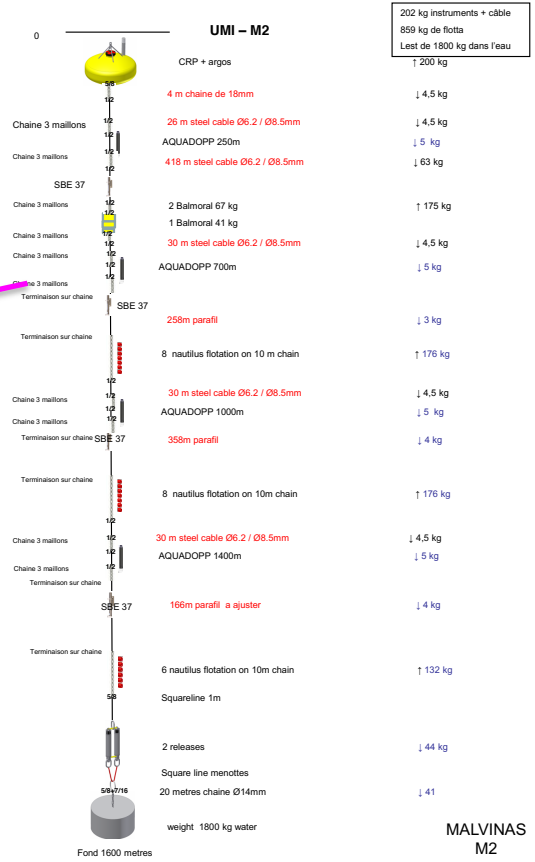




- 1 Downward-looking ADCP
- 5 CTD SBE37
- Meteorological station at surface (wind speed and direction, relative humidity, sea level pressure and air temperature sensors)
- Satellite Inmarsat C transmission for real-time data telemetry
- Powered with in-hull batteries rechargeable via solar panels.

Tall moorings

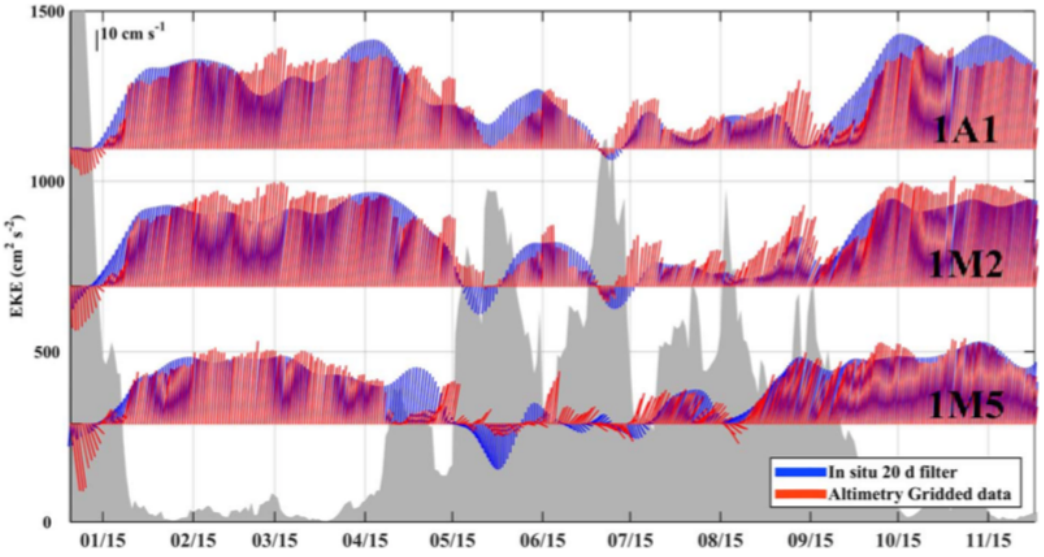




Results highlights

1. Ferrari, R., Artana, C., Saraceno, M., Piola, A. R., & Provost, C. (2017), **Satellite altimetry and current-meter velocities in the Malvinas Current at 41°S: Comparisons and modes of variations**. Journal of Geophysical Research: Oceans. https://doi.org/10.1002/2017JC013340

- Gridded altimetry data compare well with 20-day low-pass-filtered in situ data (r=0.85)
- Brazil-Malvinas Confluence dominates the variability of the currents at 41°S
- Variability is related to standing wave train like structures in the Argentine Basin

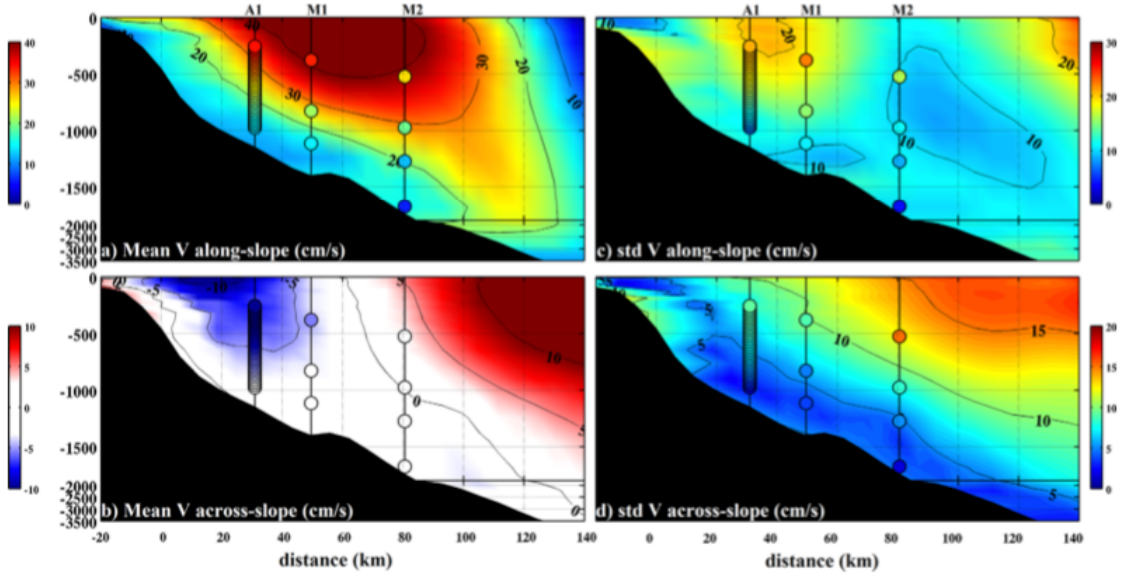


Results highlights

2. Artana, C., Lellouche, J., Park, Y., Garric, G. , Koenig, Z. , Sennéchael, N. , Ferrari, R., Piola, A. R., Saraceno, M. and Provost, C. (2018), **Fronts of the Malvinas Current System: Surface and Subsurface Expressions Revealed by Satellite Altimetry, Argo Floats, and Mercator Operational Model Outputs**. J. Geophys. Res. Oceans. https://doi.org/10.1029/2018JC013887

- Mercator correctly reproduces the general circulation and the complex hydrographic including the vicinity of the Brazil-Malvinas Confluence.

- The model outputs accurately match the observations except in June 2015, when uncertain SST data seem to have prevailed over the altimetric data in the assimilation scheme of the model.



Results highlights

3. Paniagua, G. F., Saraceno, M., Piola, A. R., Guerrero, R., Provost, C., Ferrari, R., Lago, L. S. and Artana, C. I. (2018), **Malvinas Current at 40°-41°S: First Assessment of Temperature and Salinity Temporal Variability**. J. Geophys. Res. Oceans. https://doi.org/10.1029/2017JC013666

- Two distinct regimes characterized by strong and weak along-slope velocities were present during 2014-2015.
- the weak regime is due to a deflection to the east of the Malvinas Current, upstream of the mooring position
- Large SST anomalies are observed during the two regimes
- Altimetry-derived currents correlate better to the in situ data during the weak regime

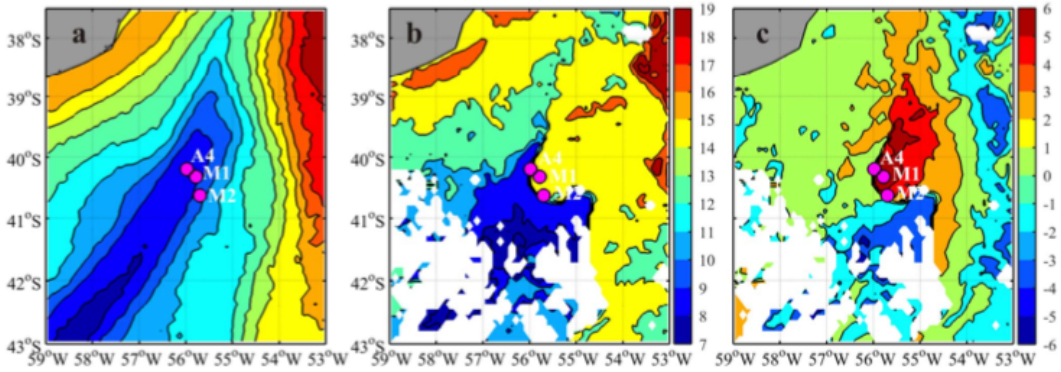


Figure 6. (a) SST climatology calculated by all images obtained during May by MODIS Aqua from 2002 to 2017; (b) SST 8 day average from 9 to 16 May 2015; (c) Difference between plots a and b.

Results highlights

4. Artana, C., Ferrari, R., Koenig, Z., Sennéchael N., Saraceno, M., Piola, A. R. and Provost, C. (2018), **Malvinas Current volume transport at 41°S: a 24-year long time series consistent with mooring data from 3 decades and satellite altimetry**, Journal of Geophysical Research: Oceans. https://doi.org/10.1002/2017JC013600

- Since 1993, annual mean transports have varied from 32 to 41 Sv
- Maxima are related to cyclonic eddies that propagate northwestward following the 4,000–5,000 m isobaths
- Minima are due to southward migrations of positive sea level anomalies shed by the Brazil Current

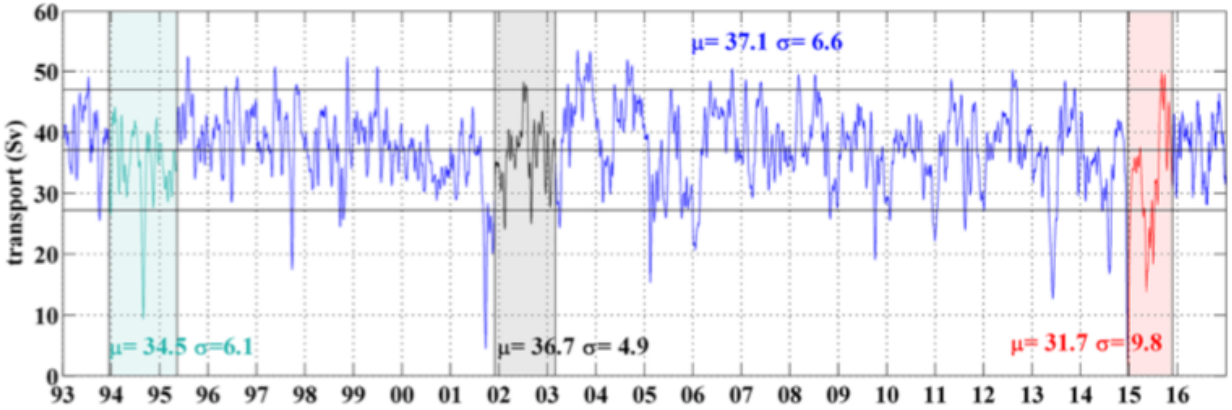
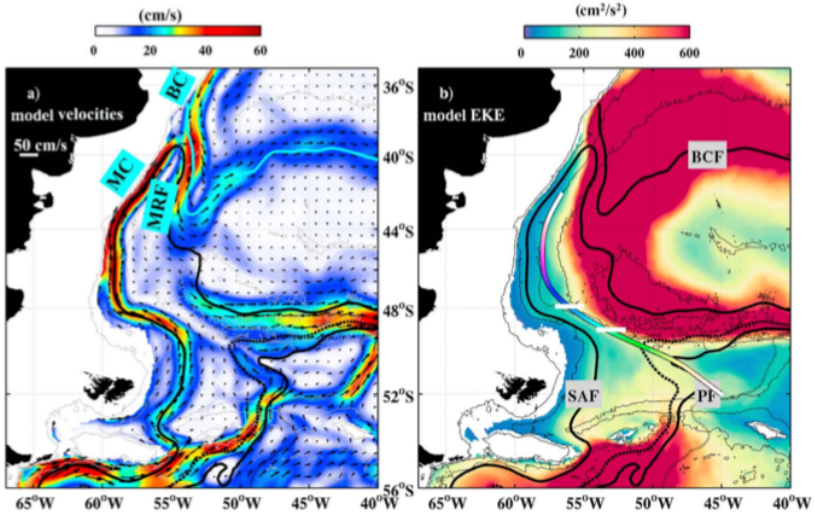


Figure 7. Volume transport (in Sv) in the upper 1,500 m computed with the LUT method using the fitted near-surface shear. The in situ measurement periods are indicated in colors. Horizontal lines indicate the mean and 1.5 standard deviation on each side of the mean.

Results Higlights

5. Artana C., J.-M. Lellouche, N. Sennéchael and C. Provost (2018). **The open-ocean side of the Malvinas Current in Argo float data and 25 years of reanalyses from Mercator operational system**. Journal of Geophysical Research: Oceans, https://doi.org/10.1029/2018JC014528.

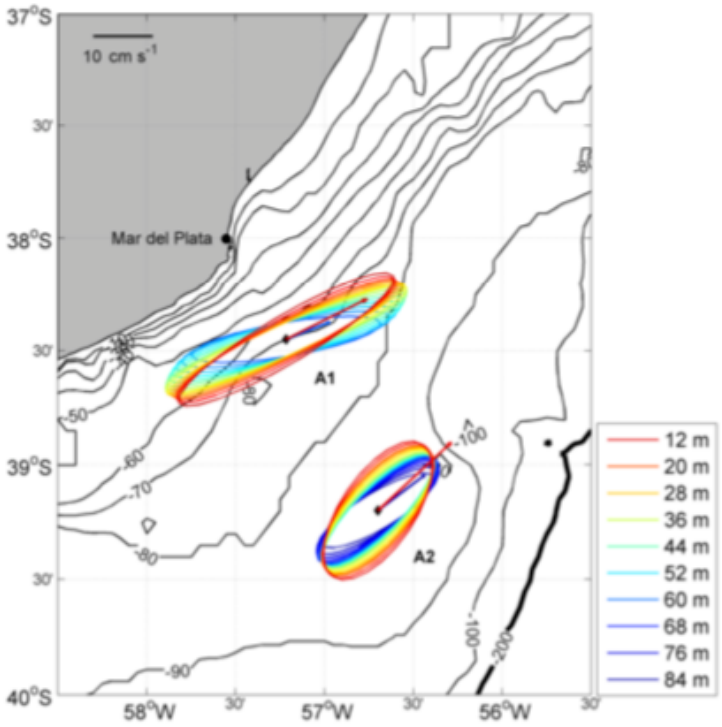
- Polar waters recurrently feed a cyclonic recirculation region north of 49 degrees south on the open-ocean side of the Malvinas Current
- The three-dimensional structure of blocking and feeding events at 49 degrees south is characterized for the first time
- A 1997-2003 salinity minimum observed in the recirculation region corresponds to a period with reduced feeding events at 49 degrees south



Results Highlights

6. Lago L.S., Saraceno M., Martos P., Guerrero R.A., Piola A.R., Paniagua G.F., Ferrari R., Artana C.I. and Provost C. (2019), **On the wind contribution to the variability of ocean currents over wide continental shelves: a case study on the northern Argentine continental shelf**, Journal of Geophysical Research: Oceans, https://doi.org/10.1029/2019JC015105

- Eleven months of in situ velocities at two sites of the Argentine continental shelf are analyzed
- The barotropic component explains 83% of the total variance and the alongshore velocities at the two sites are highly correlated (0.86)
- Alongshore wind stress causes across-shore pressure gradients that modify the along-shore currents

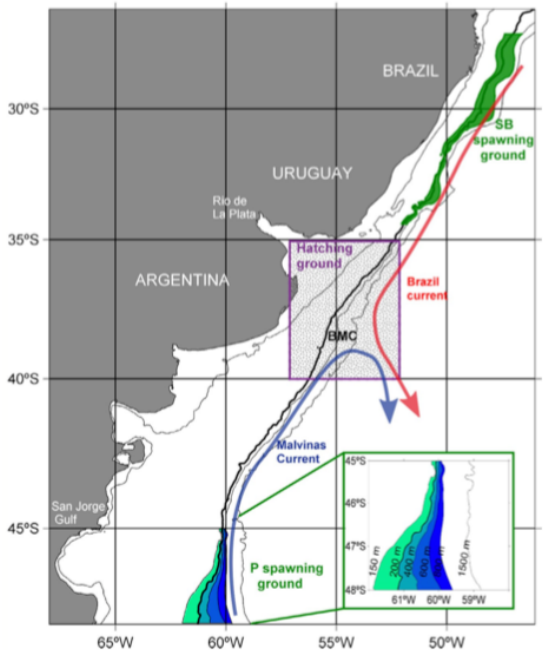


Results Highlights

7. Torres Alberto, M. L., Bodnariuk, N., Ivanovic, M., Saraceno, M., & Acha, E. M. (2020). **Dynamics of the Confluence of Malvinas and Brazil currents, and a southern Patagonian spawning ground, explain recruitment fluctuations of the main stock of Illex argentinus.** *Fisheries Oceanography*, https://doi.org/10.1111/fog.12507

- Satellite data of geostrophic velocities derived from sea surface height and of SST were employed to model the advection of the squid egg masses of Illex argentinus along the external shelf and slope and to estimate the annual recruitment success.

- Results show that if spawning occurs in Patagonia, 52% of the recruitment variability could be explained.



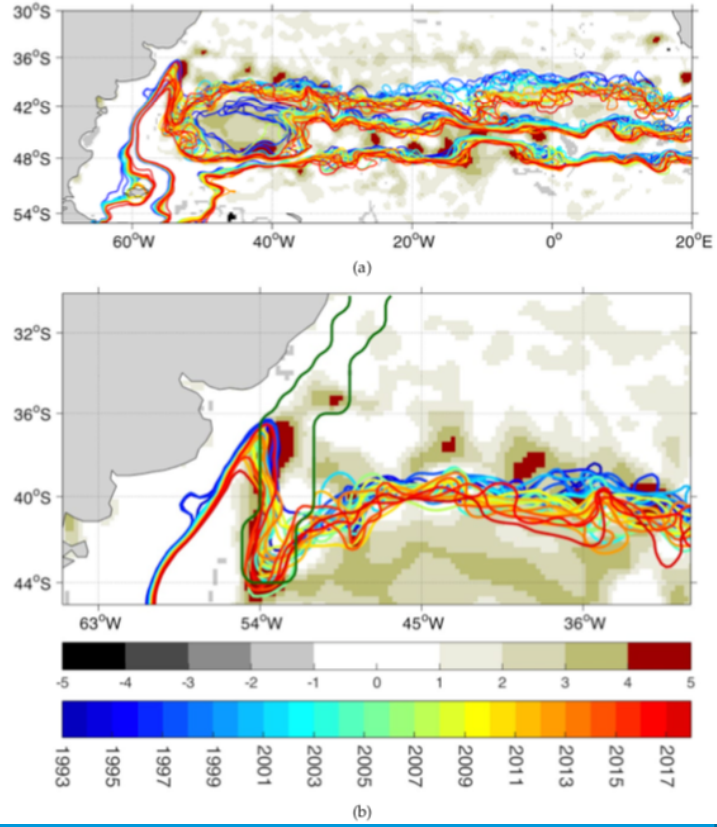
Results Highlights

8. Ruiz-Etcheverry LA, Saraceno M. (2020) **Sea Level Trend and Fronts in the South Atlantic Ocean**. *Geosciences*. https://doi.org/10.3390/geosciences10060218

- The 25-years South Atlantic mean sea level (SAMSL) trend is 2.65 ± 0.24 mm/yr and is mostly explained by ocean mass trend, which is 2.22 ± 0.21 mm/yr.

- Between 50°S–33°S, the steric height component constitutes the main contribution in comparison with the ocean mass component.

- A southward displacement of the Subtropical, Subantarctic, and Polar Fronts is observed. The southward shift of the fronts is associated with the strengthening and polar shift of westerly winds and contributes to a clear thermosteric trend that translates to the SLA trend observed



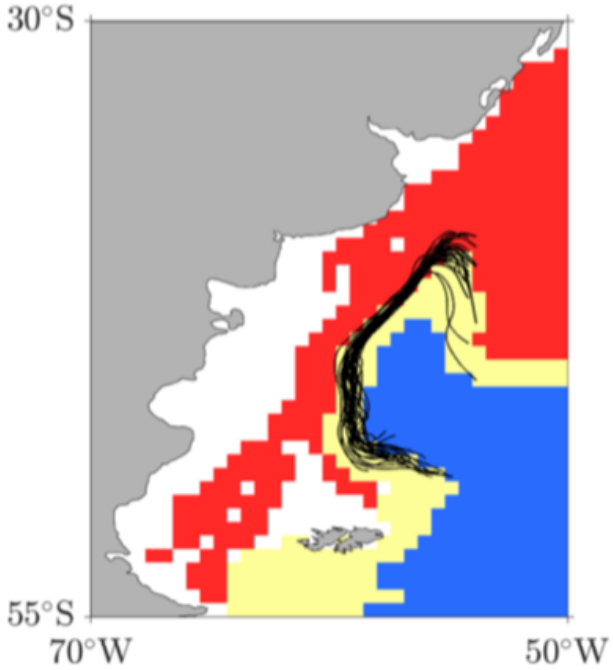
Results Highlights

9. Beron-Vera, F. J., Bodnariuk, N., Saraceno, M., Olascoaga, M. J., and Simionato, C. (2020) **Stability of the Malvinas Current.** Chaos: An Interdisciplinary Journal of Nonlinear Science, https://doi.org/10.1063/1.5129441

- Deterministic and probabilistic tools from nonlinear dynamics are used to assess enduring near-surface Lagrangian aspects of the Malvinas Current.

- The deterministic tools are applied to a multiyear record of velocities derived from satellite altimetry data, revealing a resilient cross-stream transport barrier.

- The probabilistic tools are applied on a large collection of historical satellite-tracked drifter trajectories, revealing weakly communicating flow regions as basins of attraction for long-time asymptotic almost-invariant sets on either side of the altimetry-derived barrier.



Data collected are in public repositories

- Saraceno M., R. Guerrero A. Piola, C. Provost, F. Perault, R. Ferrari, G. F. Paniagua, L. Lago and C. Artana (2017), Malvinas Current 2014-2015: Mooring velocities SEANOE. https://doi.org/10.17882/51492

- Saraceno M., Guerrero R., Piola A., Provost C., Perault F., Ferrari R., Paniagua G., Lago L., Artana C. (2019). Argentine continental shelf currents 2014-2015: velocities, pressure and temperature. SEANOE. https://doi.org/10.17882/61777, https://doi.org/10.17882/61777

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