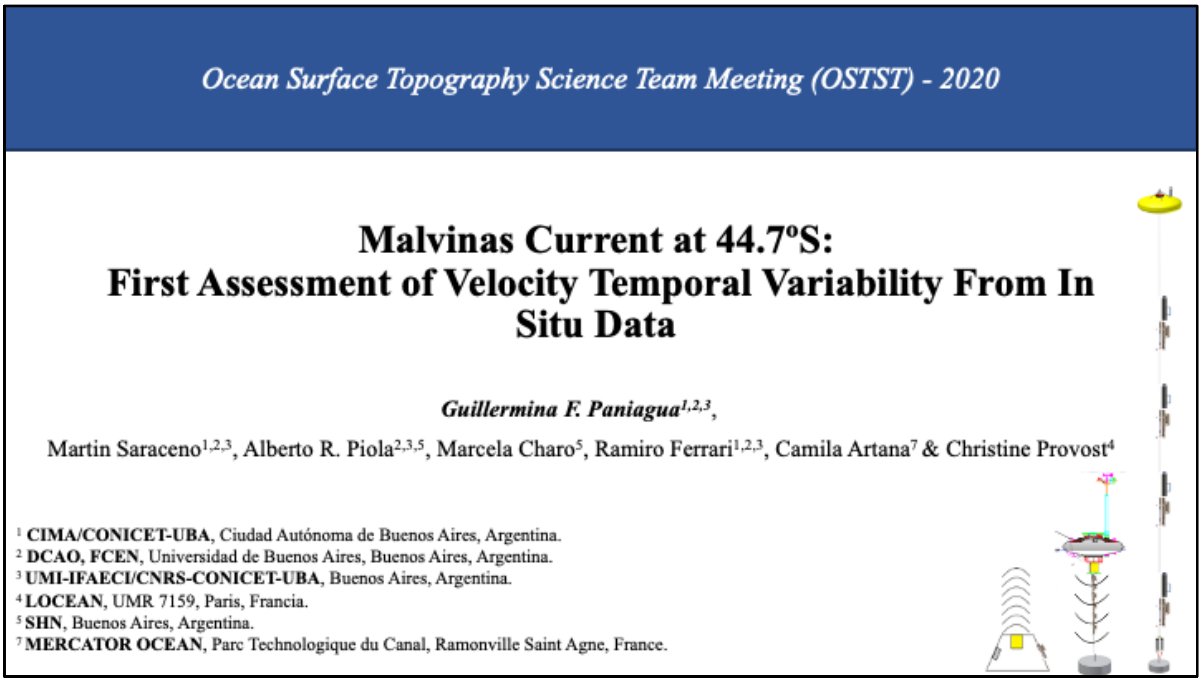
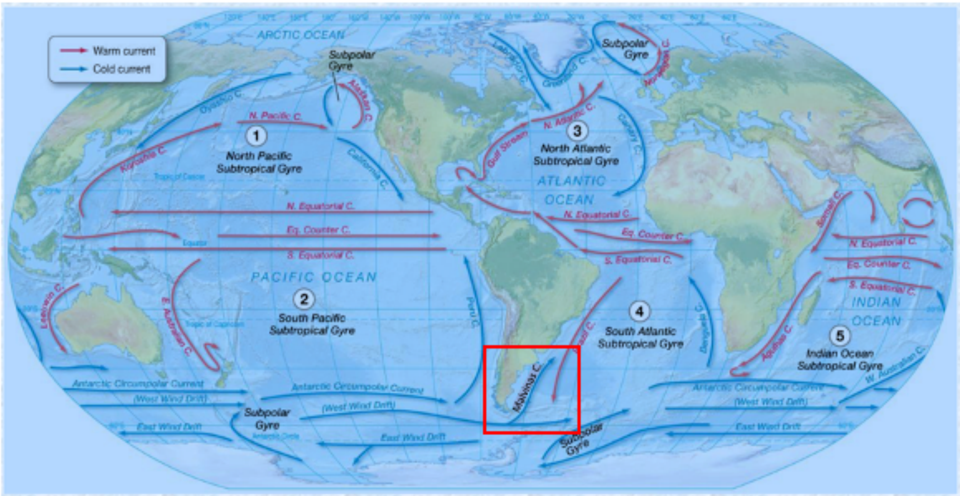


Hello everybody, this work is part of my PhD at the university of Buenos Aires.

Today, I'm going to share our result related with the Malvinas currents variability and its origins. Starting from in-situ velocity currents analysis, we found the presence of oscillations that are compatible with mesoscale structures (or eddies).

During this presentation, I will show you the observations that bring us to this result and will discuss from where the eddies come from.

Malvinas Current (MC)



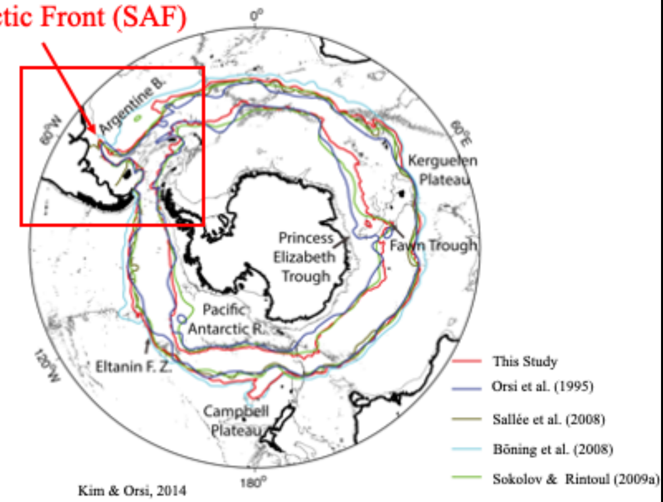
Malvinas current is a not typical western boundary current. This is because of:

- First of all, doesn't belong to the largest subtropical gyres.

- Secondly, the majority of the western boundary currents are highly baroclinic. On the contrary, Malvinas current is highly barotropic.

Malvinas Current (MC)

- Generates the largest worldwide subpolar waters intake, towards the equator up to approximately 38° S.



Kim & Orsi, 2014

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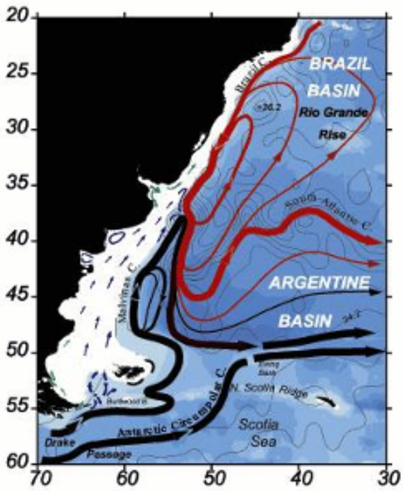
The Malvinas current is located in the Southwestern Atlantic over the continental slope.

One of the most remarkable characteristic is that is the current that carries subpolar waters closer to the equator.

Malvinas Current (MC)

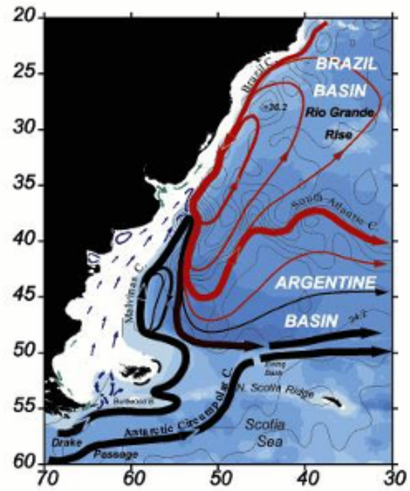
- Generates the highest intake of subpolar waters towards the equator up to approximately 38º S.
- Contributes to heat transport between different latitudes.



Thus, contributes to heat transport between different latitudes.

Malvinas Current (MC)

- Generates the highest intake of subpolar waters towards the equator up to approximately 38º S.
- Contributes to heat transport between different latitudes.
- Transport waters rich in oxygen and nutrients.



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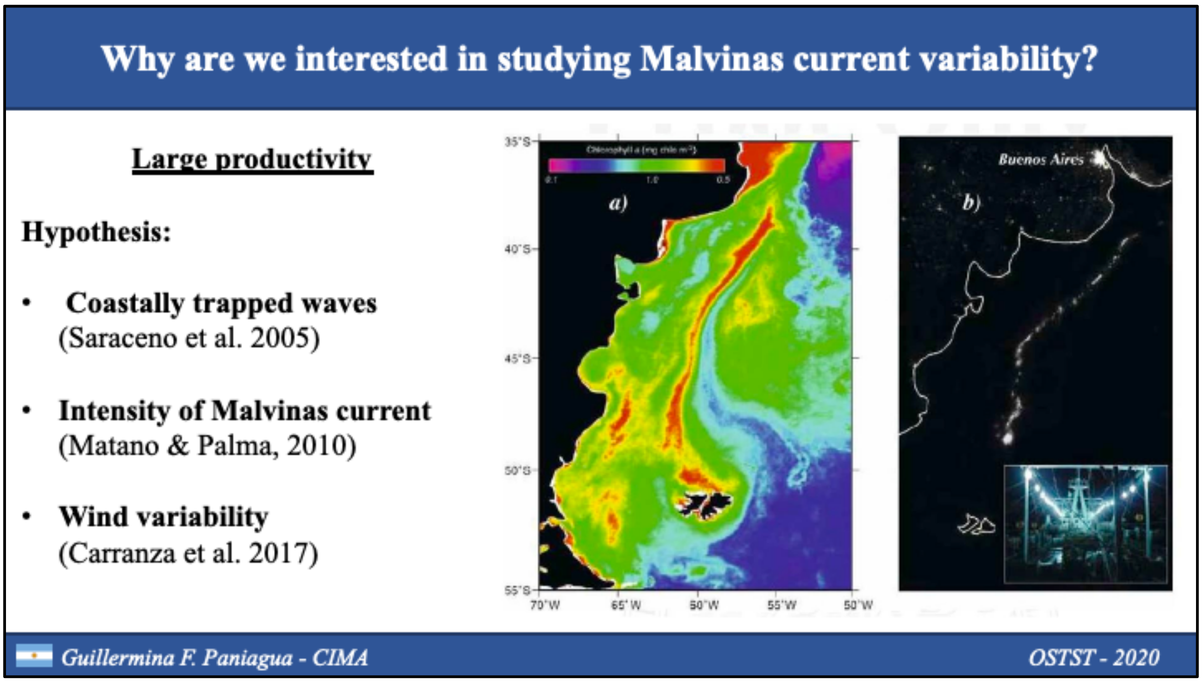
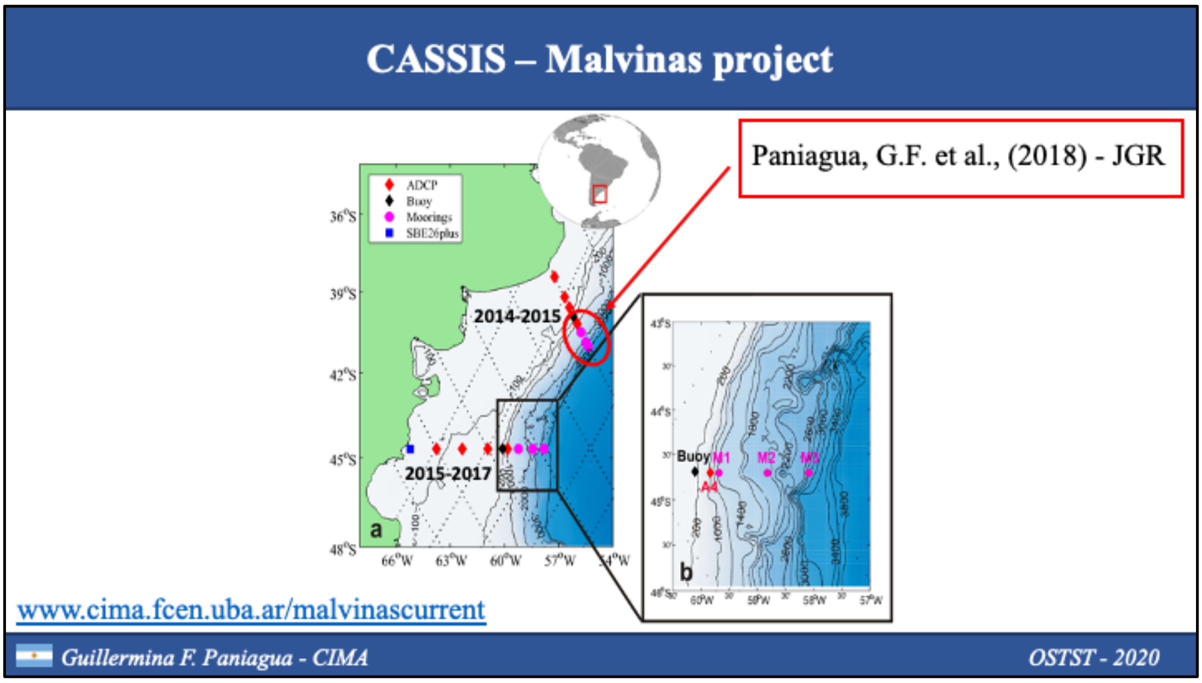
Thus, contributes to heat transport between different latitudes.

Other relevant characteristic is that flowing towards north, transport waters rich in oxygen and nutrients.



Oxygen and nutrients are used along the shelf-break and are responsibly of the large chlorophyll concentration. We can see on the left figure, the high chlorophyll concentration in red, situated over the Malvinas current, and, on the right, through a satellite image at nighttime, how this large productivity is associated to one of the largest fisheries of squid in the world. All the white spots are the lights of fishing vessels and we can compare the concentration of fishing vessels with the lights of Buenos Aires city.

Some hypothesis that suggest the mechanisms that may explain the origin of the shelf-break upwelling that regulates the primary productivity over the continental slope are: the intensity of the MC, wind and internal waves.

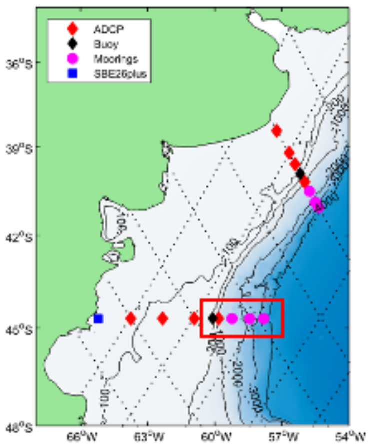


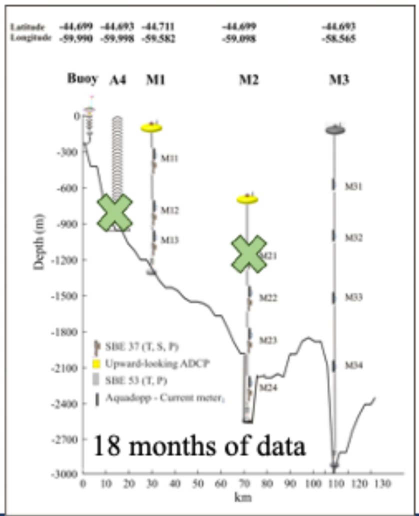
The data analyzed on this work, were obtained in the framework of the French-Argentine "CASSIS-Malvinas" project.

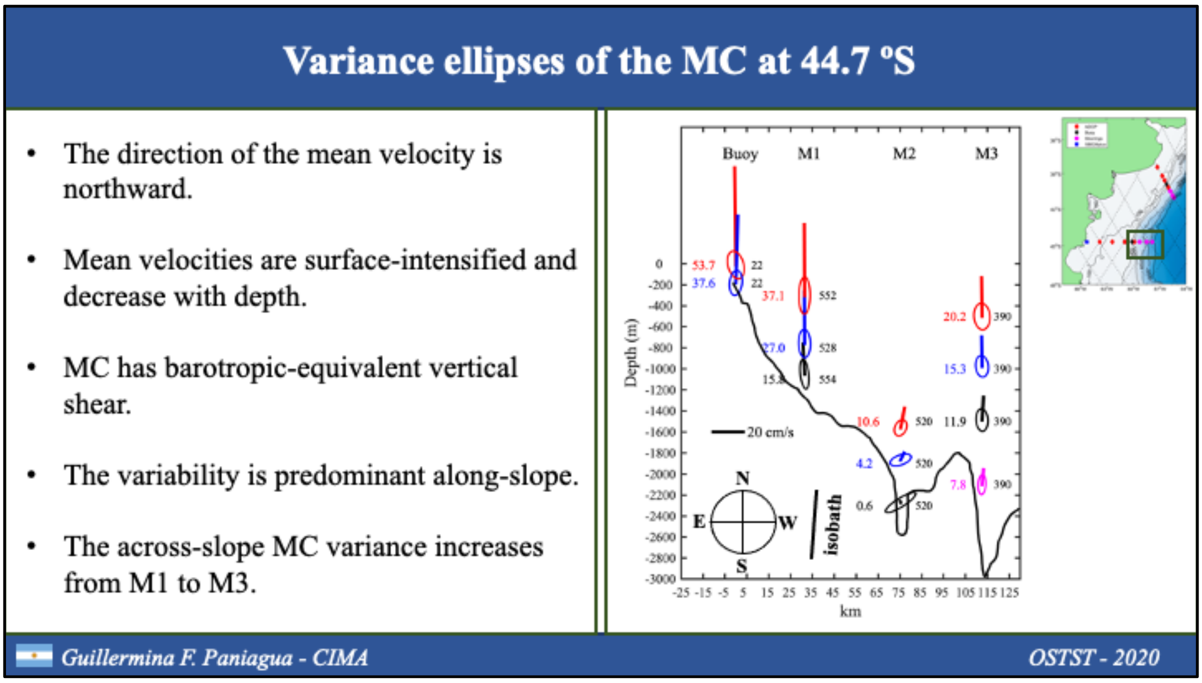
During 2015-2017, nine mooring arrays were deployed in a zonal section at 44.7°S over the continental shelf and shelf-break. In this study we focus in the shelf-break mooring arrays analysis.

Is important to remark that, this is the first time ever, that we count with long-term current measurements at this latitude.

Data analyzed here





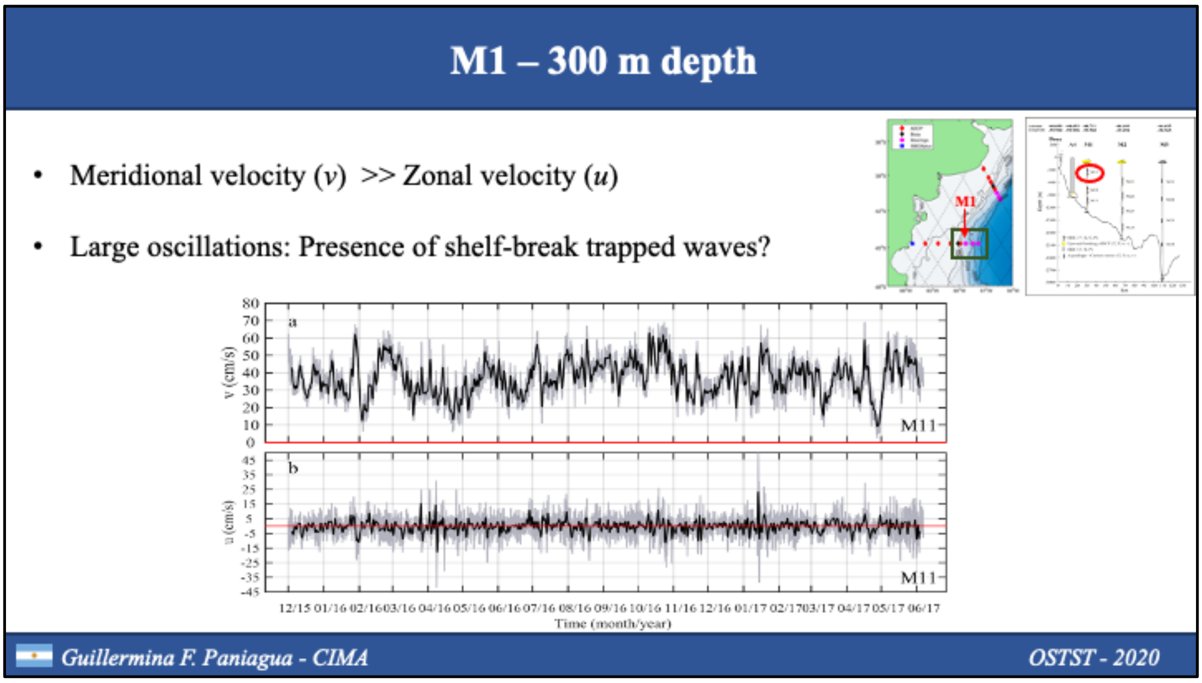


The figure shows all the mean vectors and variance ellipses from each current meter measurements in their position.

Numbers in black shows the amount of days of measurement by each instrument and in colours the mean velocities.

We can deduce the following results:

- The direction of the main velocity is northward.
- Mean velocities are surface-intensified and decrease with depth.
- Malvinas current have a barotropic-equivalent vertical shear.
- The variability is predominant along-slope.
- The across-slope variance increase from M1 to M3.

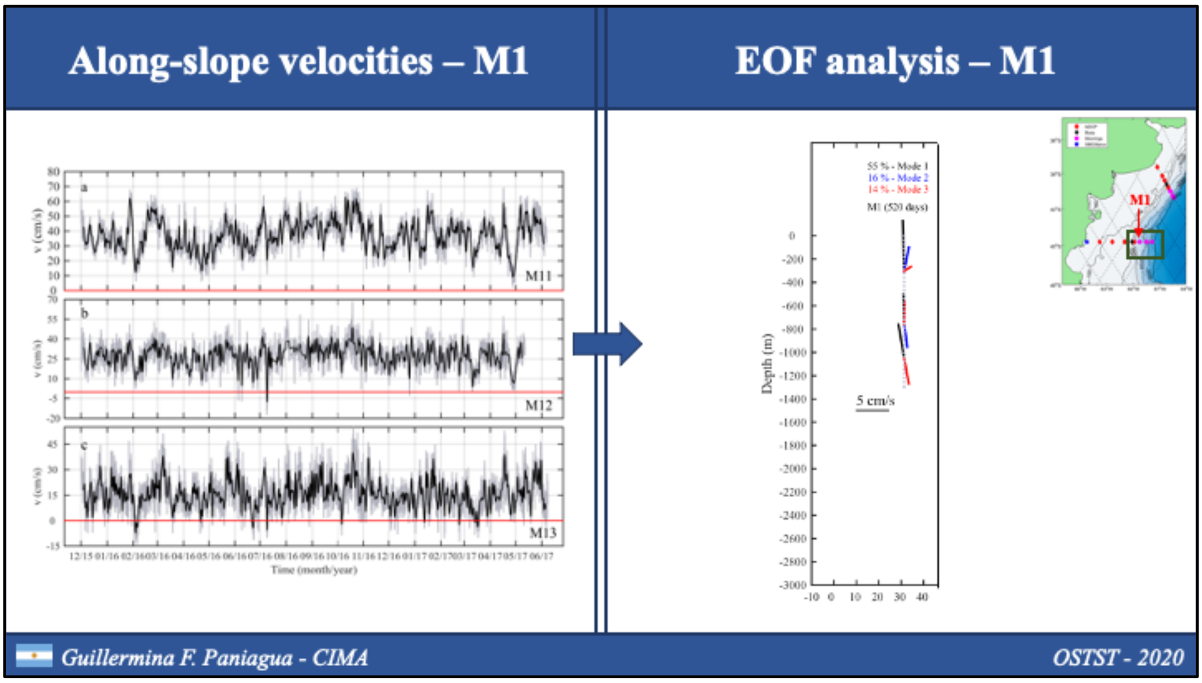


I would like to share the time series *of v* and *u* velocity components from the shallowest current meter located at M1 at 300 meters depth.

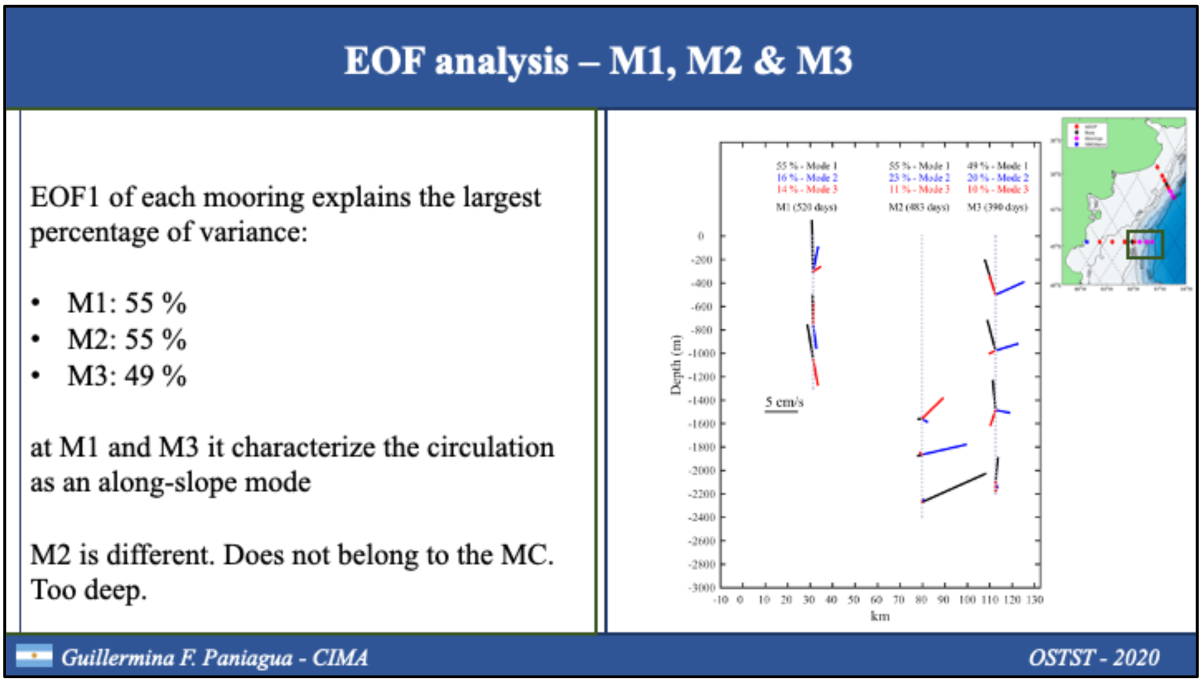
Time series show that the meridional velocity (v) was much larger than the zonal velocity (u). Meridional velocities reached 63 cm/s and the zonal velocity fluctuated around 0.

Furthermore, we observed large oscillations in the meridional velocity time series. This large oscillations can be due to the presence of mesoscale structures (or eddies) passing over the continental slope.

Similar observation are observed in all the current meter measurements analyzed.



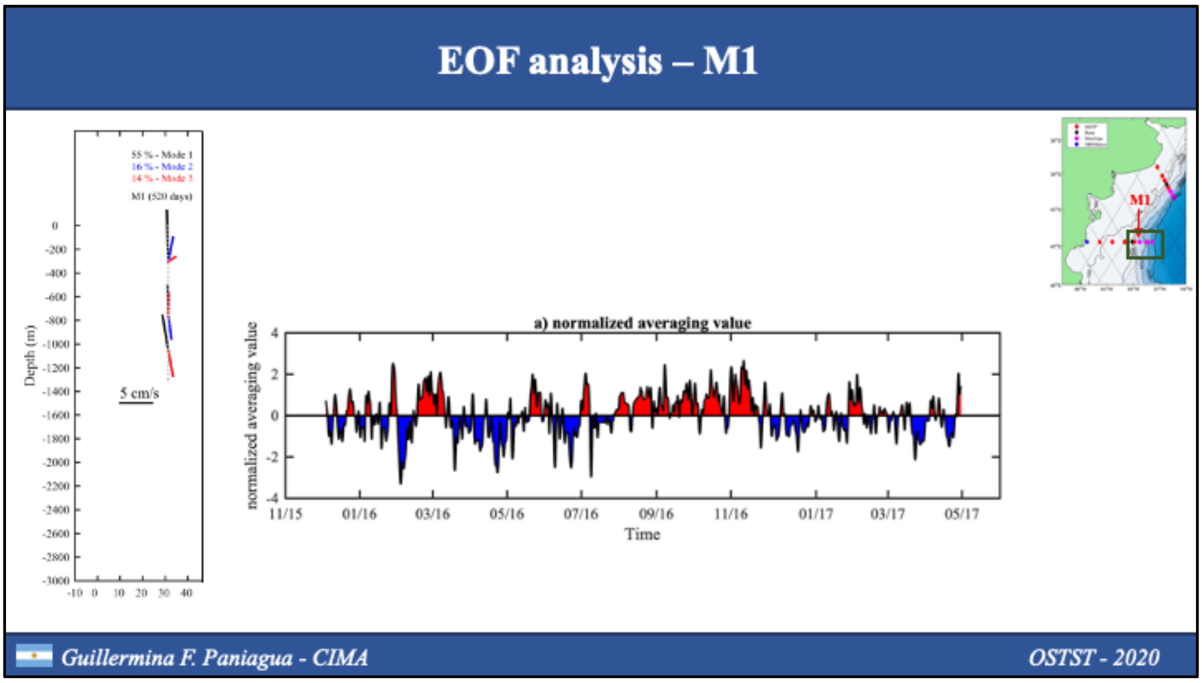
In order to understand the along-slope velocities in the entire water column, and considering that the MC has a barotropic structure, we performed an EOF analysis from all the time series measured at each mooring. Here is the example for M1, the EOF was made by a spatial-mode figure. The vectors represent the first 3 modes of variability. Same methodology was used for M2 and M3.



As a result I would like to remark, that the first mode explains the largest percentage of variance and

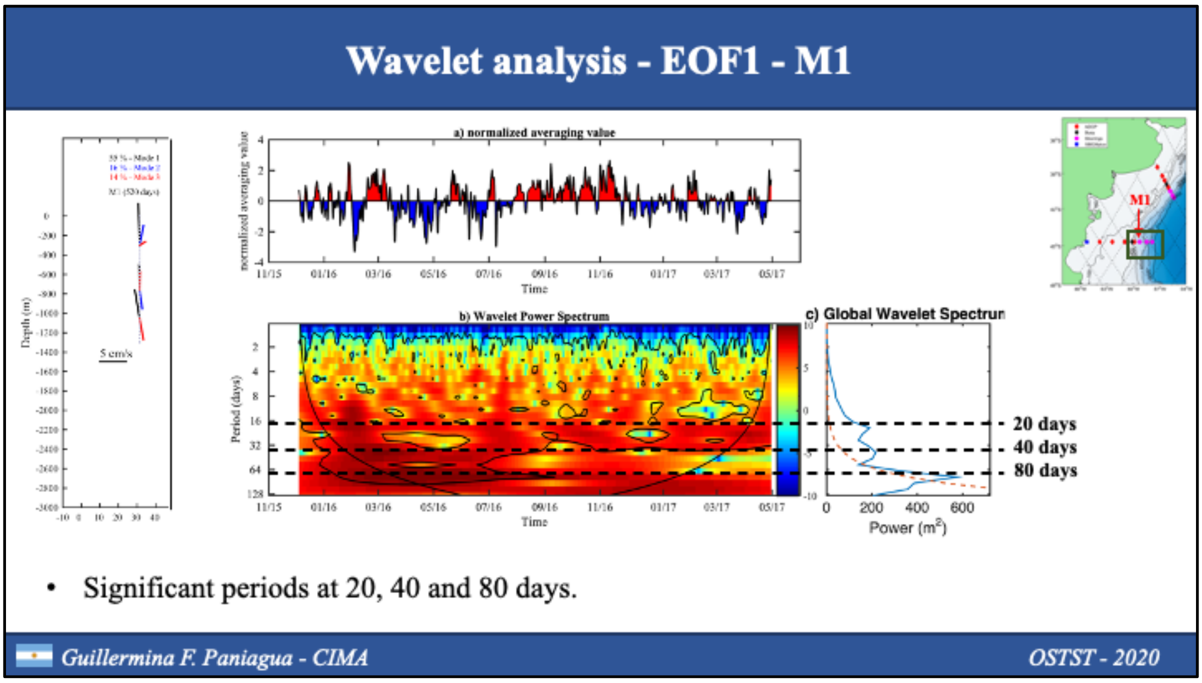
At M1 and M3 it characterize the circulation as an along-slope mode in M1 and M3.

M2 is different. Does not belong to the MC. Due to this, we are no longer analyzing M2 measurements.

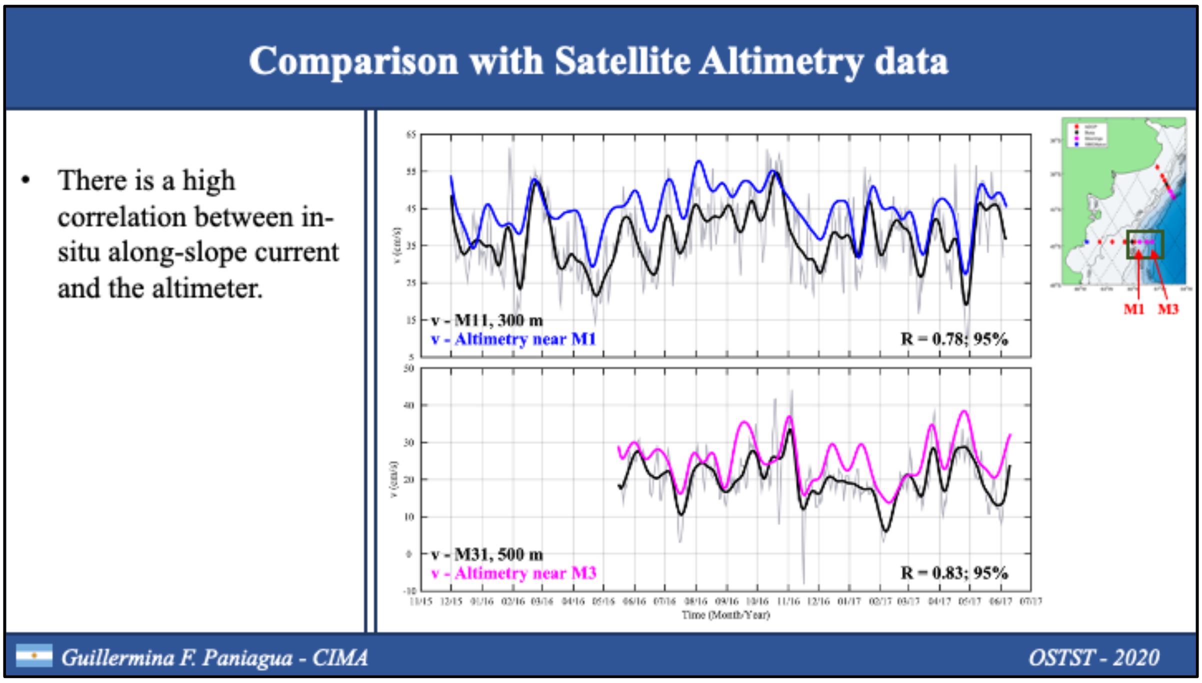


Here we can see the spatial pattern and the temporal time series of first mode analyzed at M1 and again, the presence of oscillations, that are not observed during the hole time period.

To understand the presence in time of these oscillations, we did a Wavelet analysis for this time series.

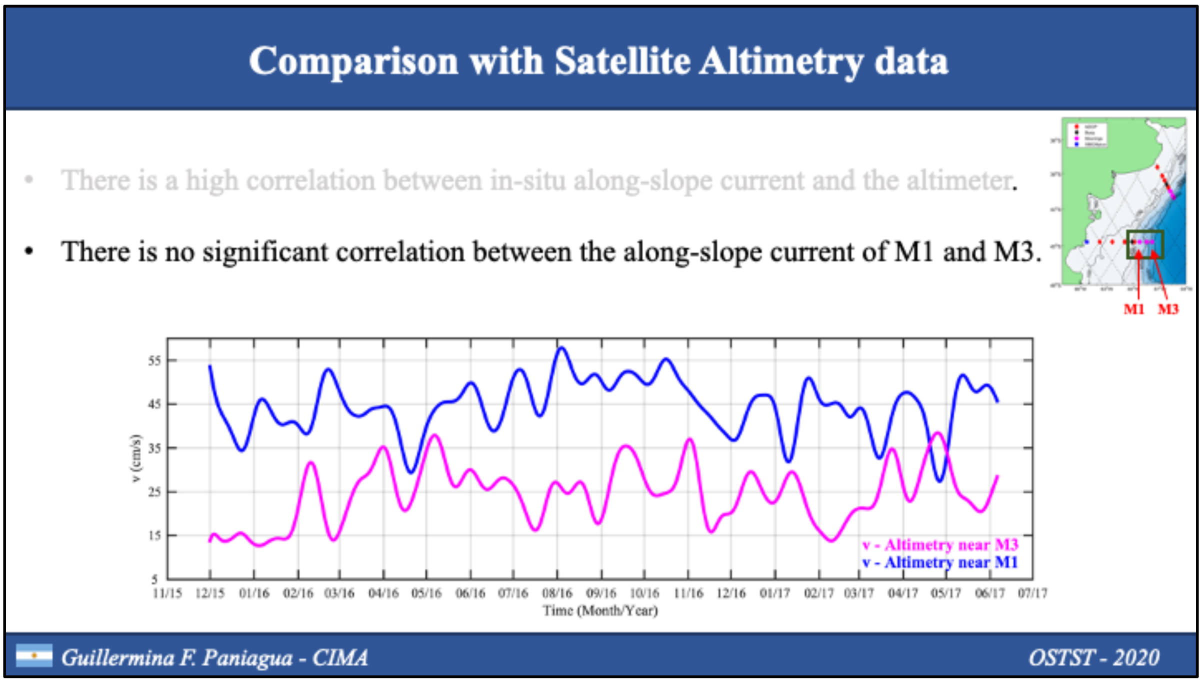


and shows significant **periods** at 20, 40 and 80 days with different frequencies along the time.

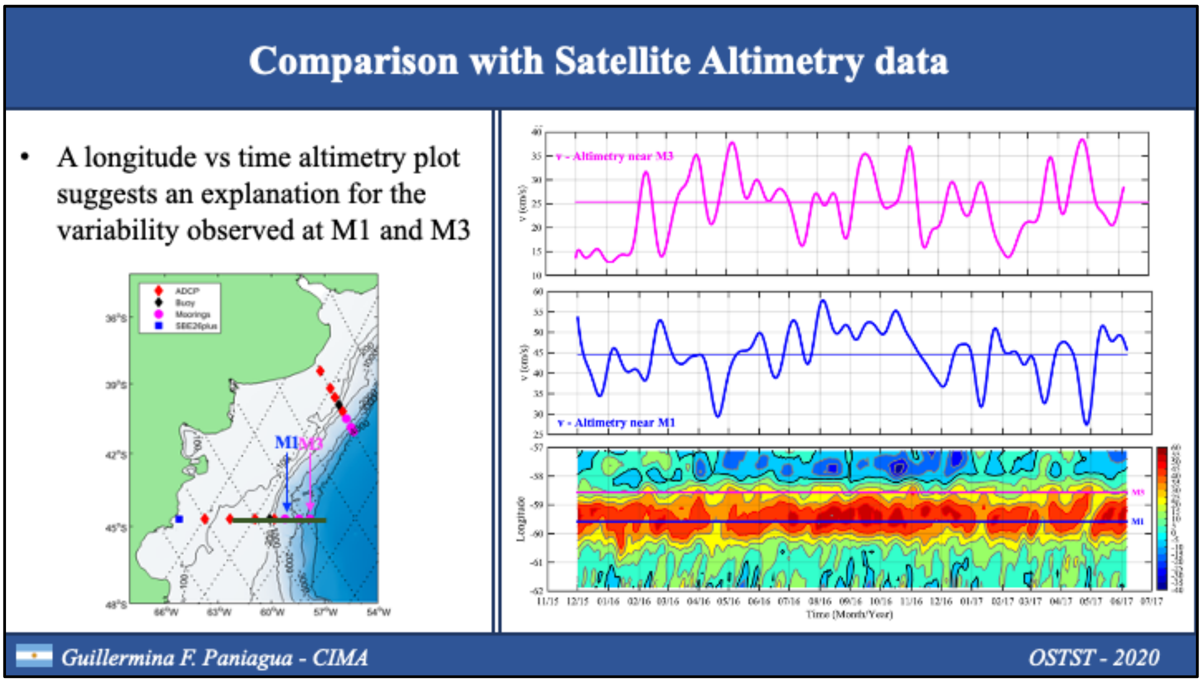


To better understand this oscillations we used altimetry data and we observed that there is a high correlation between with in-situ along-slope velocity and the altimeter.

We found a 0.78 correlation with M1 data and .83 with M3.



In spite of the proximity between M1 and M3 (80 km), there is no significant correlation between along-slope velocities.

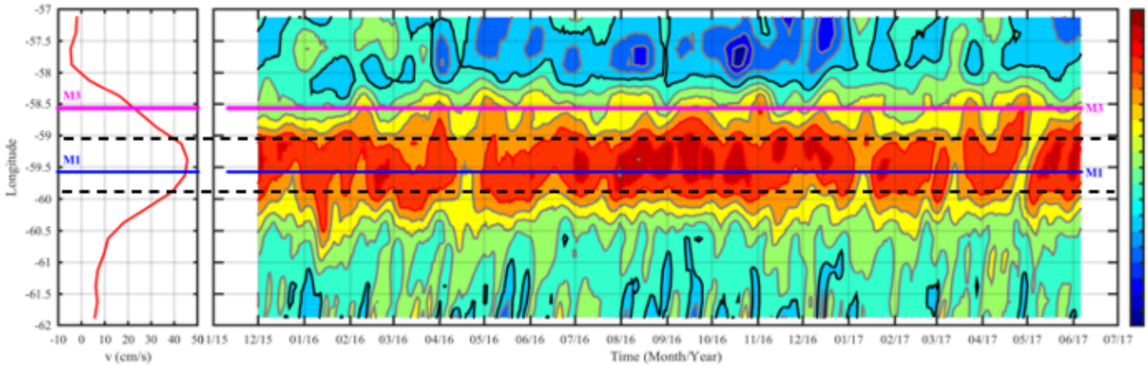


A longitude vs time altimetry plot suggests an explanation for the variability observed at M1 and M3

The magenta and blue lines represent the longitudes of M1 and M3.

Comparison with Satellite Altimetry data

- Most of the time the core of MC is very close to M1 (mean along-slope values > 40 cm s^{-1}).



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We can conclude that, most of the time, the core of MC is very close to M1, reaching values over 40 cm/sec.

Comparison with Satellite Altimetry data

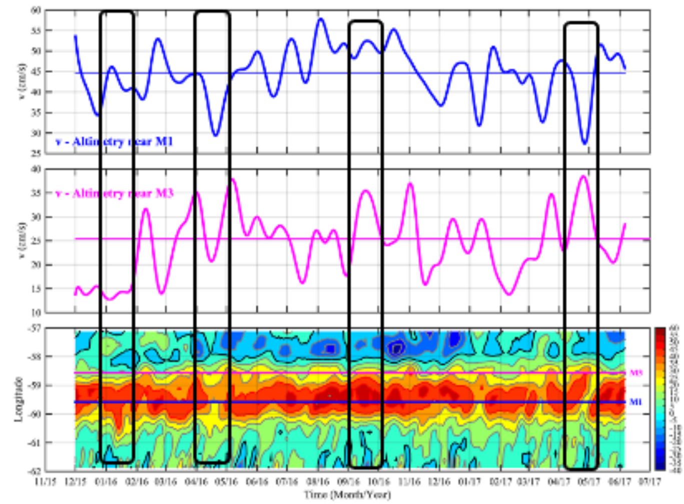
- The core of the MC varies in time and space. Examples:

1) We observed a Malvinas jet shift on the continental shelf.

2) April 2016:
   - Large decrease over M1 & M3.

3) September 2016:
   - Increase at both moorings.

4) April 2017:
   - Large increase over M3
   - Large decrease over M1



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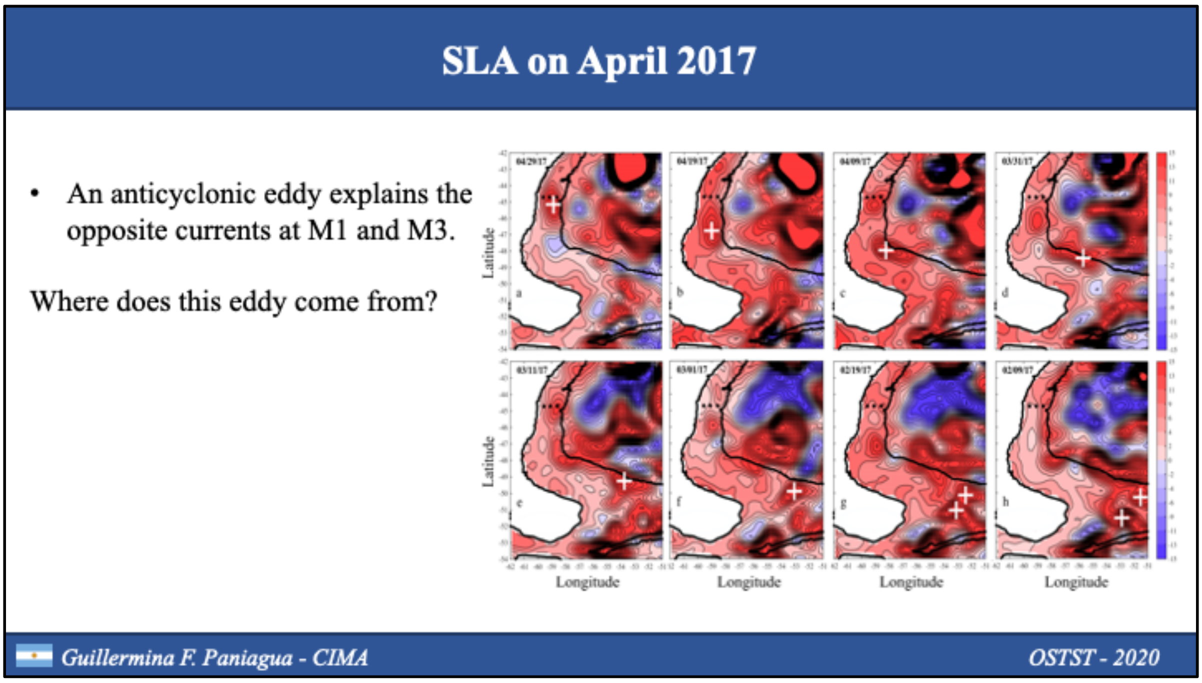
4) Finally, in April 2017, there was an opposite behavior.



This effect is caused by the presence of an anti-cyclonic eddy between the moorings. Going back in time, we can see the origin of this effect. Please follow the white cross.

We observed that the eddy found in April 2017 was originated by the merge of 2 separate eddies coming from the South.

This result give us the idea that a portion of the along-slope velocity variability is due to the variability of the SLA.

Currents and Sea Level Anomaly

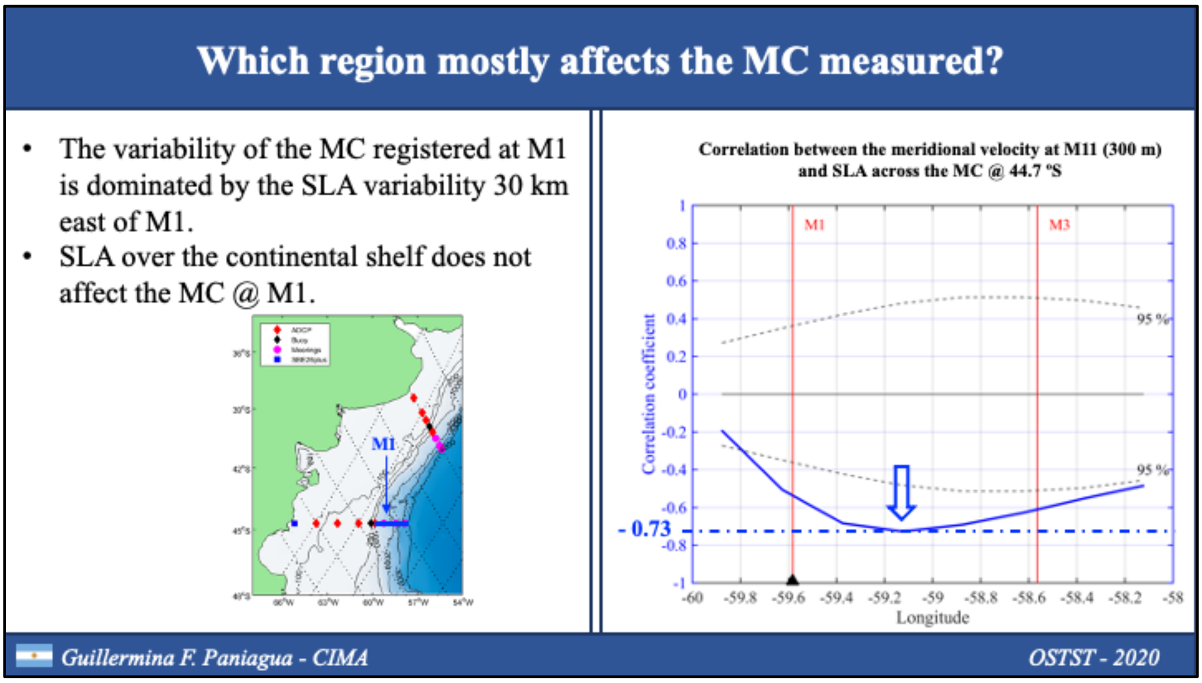
Along-slope velocity variability is due to the variability of the SLA:

$$\boxed{\boldsymbol{V_g = -g/f * (sla2 - sla1)/dx}}$$

Where does SLA variability mostly affect the MC?

or

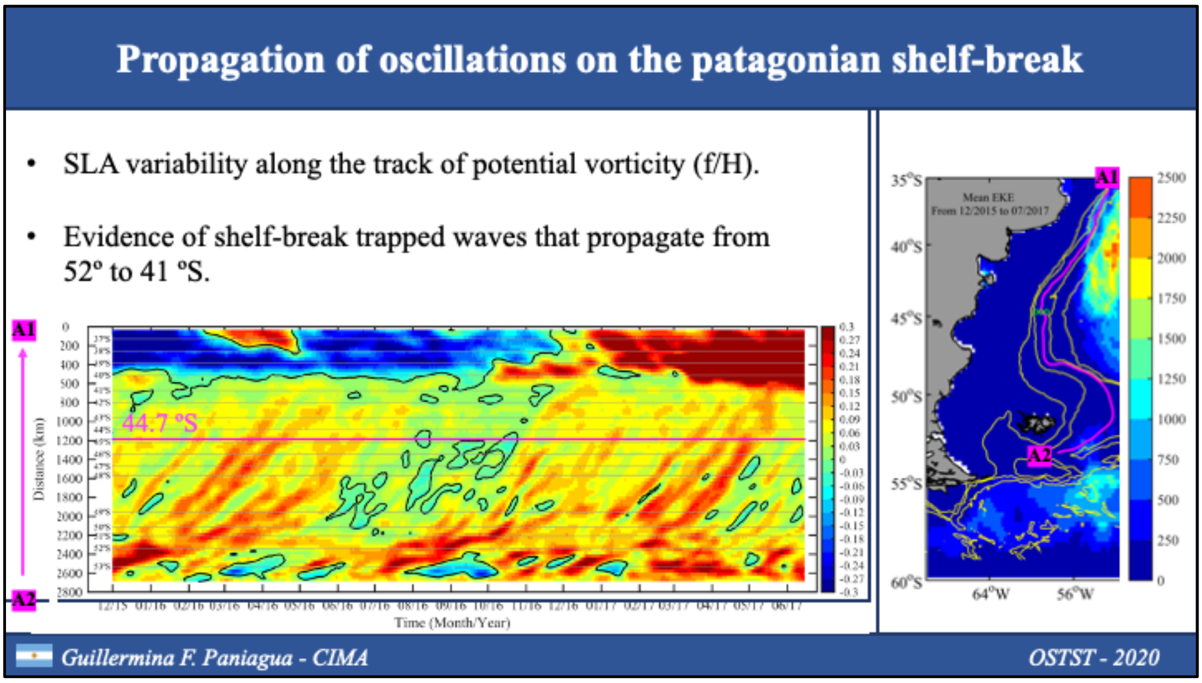
Where is the correlation bewteen SLA and in-situ along-slope velocity larger?



For answer the question, we made the correlation between the meridional velocity at M1 and SLA across the MC at 44.7°S

As result, we found that the variability of the MC registered in M1 is dominated by the SLA further east. The highest correlation was - .73

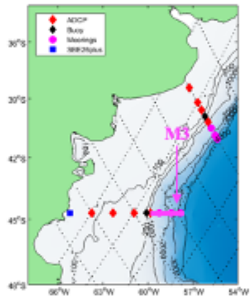
In addition, the sea level anomaly over the continental shelf does not affect the MC at M1.

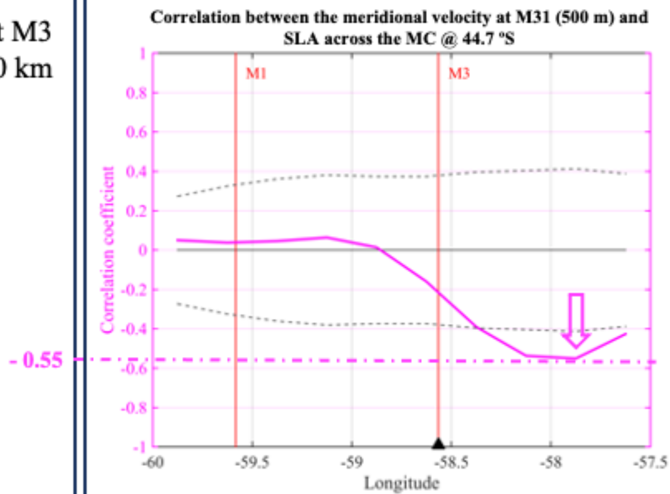


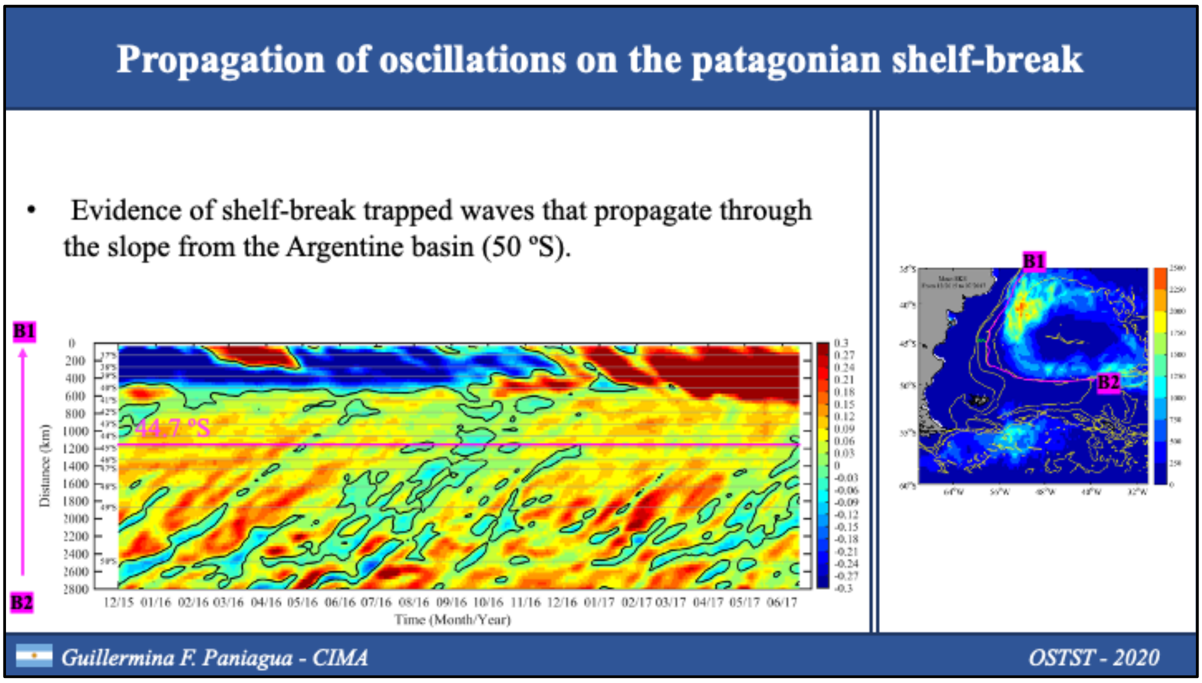
Looking the SLA variability along the contour of equal potential vorticity in the location of máximum correlation with the along-slope velocity measure at M1 we can see from where the oscillations come from. Evidence of SLA signals that propagate from 52º to 41 ºS.

Which region mostly affects the MC measured?

- The variability of the MC registered at M3 is dominated by the SLA variability 40 km east of M3.







Evidence of SLA signals that propagate through the slope from the Argentine basin (50 ºS)

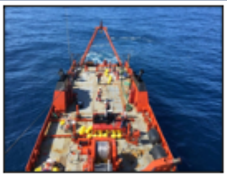
Take home message

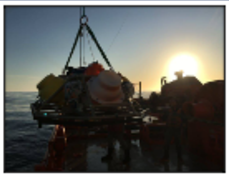
1) For the first time, we present in-situ (> 1 year) time series of the MC on the Patagonian shelf-break at 44.7ºS;

2) Measurements show that the MC:
   - Flows northward along the continental shelf-break (as expected)
   - Eastern and western sides of the MC are not correlated
   - MC has large oscillations that are compatible with the propagation of mesoscale structures (or eddies).

3) Satellite altimetry data allows to:
   - confirm the presence of the mesoscale structures (or eddies).
   - track the region form where the eddies originate

guillermina.paniagua@cima.fcen.uba.ar



Thank you for your attention ☺

guillermina.paniagua@cima.fcen.uba.ar