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Regional impacts of global ocean teleconnections: the influence of Rossby waves in the Southwestern Atlantic

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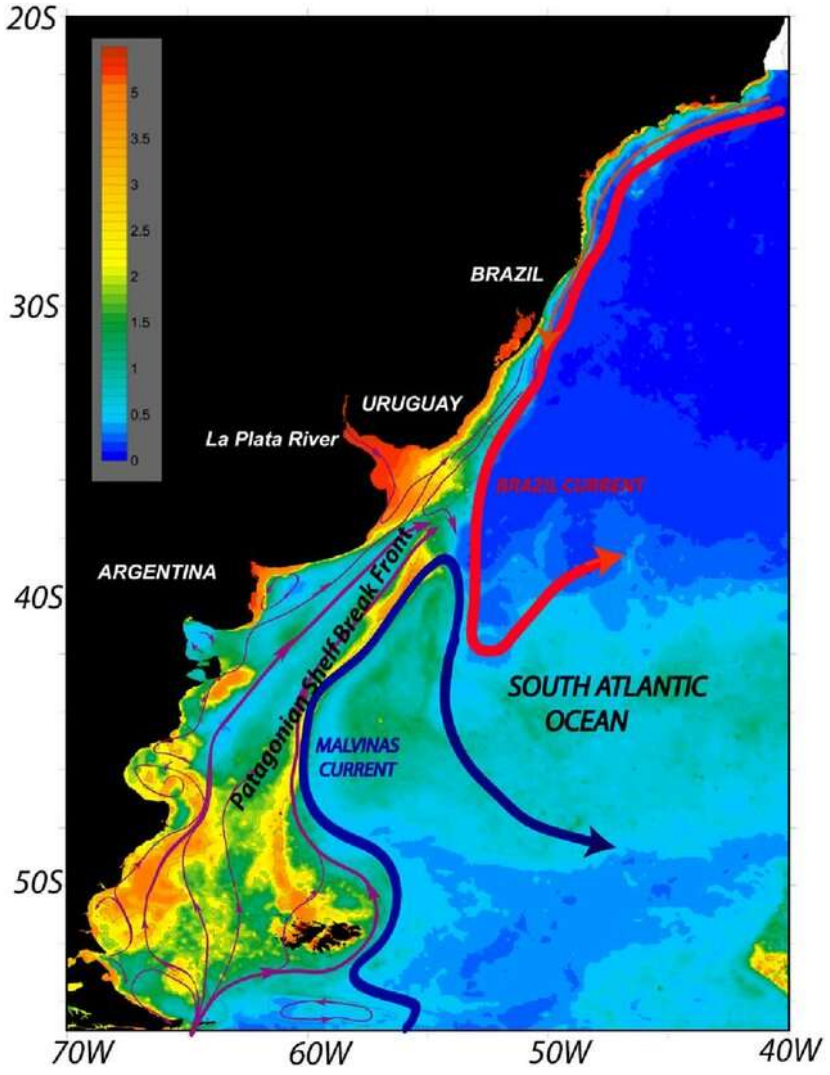


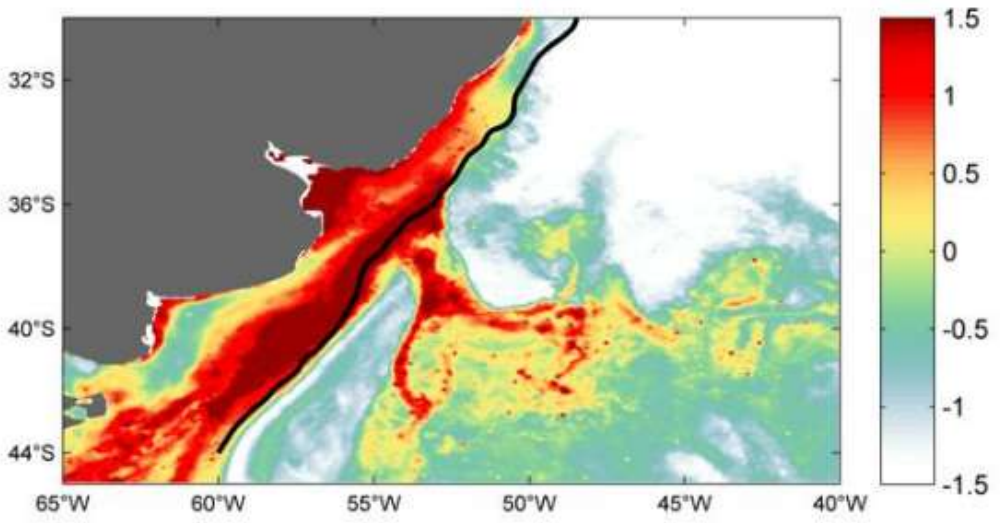
The study area

We focus on the Southwestern Atlantic Ocean and the continental seas of northern Argentina, Uruguay and southern Brazil

Schematic of the circulation in the SW Atlantic Ocean. The concentration of surface Chlorophyll-a (mg m^{-3}) obtained with the SeaWIFs radiometer (summer average) is shown in color. Magenta lines indicate the schematic shelf circulation. Franco et al., (2017).

The focus

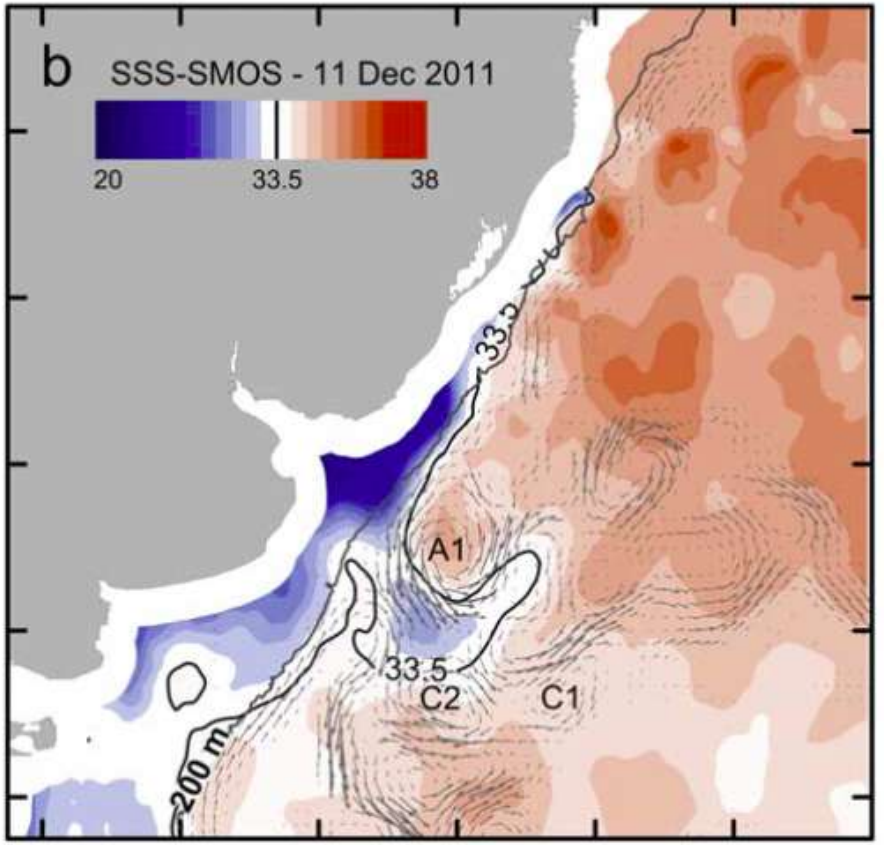
We are interested in the water fluxes across the shelf-break. Particularly, the **low-frequency variability of shelf water exportations**



Satellite Chlorophyl-*a* concentration (log) for November 2003 (SeaWiFS)

The motivation

Understanding the mechanisms that modulate the exportation could be potentially useful to explain:



The salinity signature of the cross-shelf exchanges in the Southwestern Atlantic Ocean: Satellite observations (Guerrero et al, 2014)

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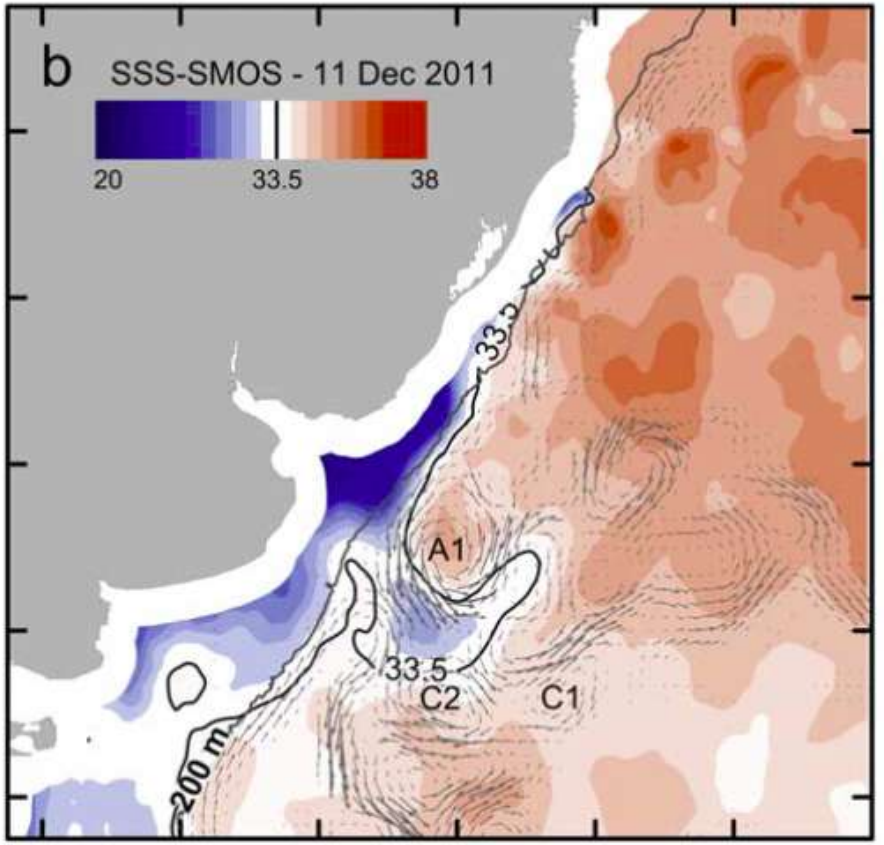
I. the variability of the abundance of many marine species



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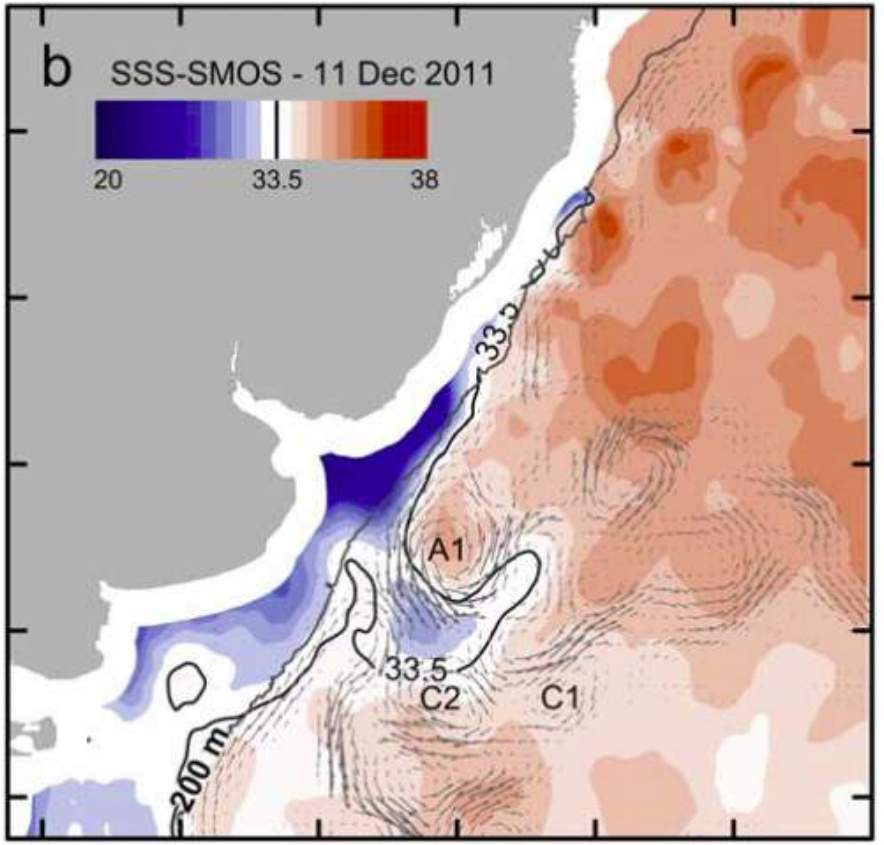
The motivation

Understanding the mechanisms that modulate the exportation could be potentially useful to explain:

I. the variability of the abundance of many marine species

II. high chlorophyll-*a* concentration in the open ocean (fertilization)



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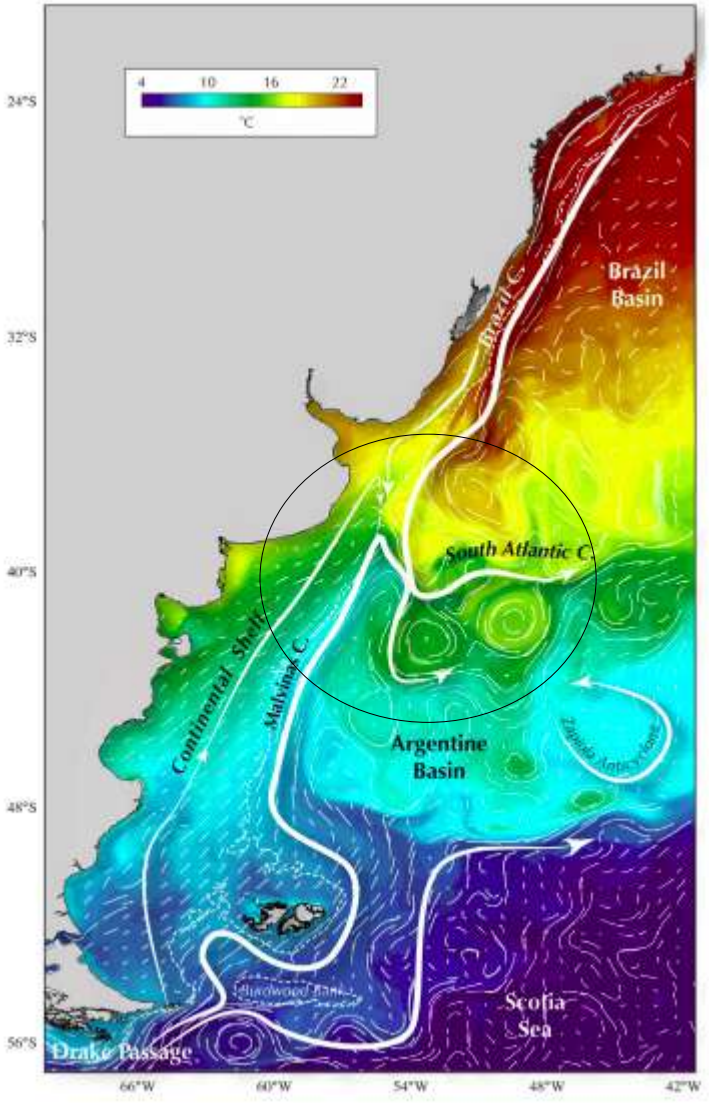

Hypothesis

On interannual timescales the **cross-shelf transport** is driven by the variability of Brazil and Malvinas currents

Schematic of the main features of the upper ocean circulation in the southwestern Atlantic Ocean. The background color is a sea surface temperatures snapshot from a high-resolution regional numerical model. Taken from Piola and Matano (2017)

Scientific questions

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2. What is the linkage with the **contour currents**?

3. What is forcing the **low-frequency variability** in the Brazil and Malvinas Current?

Data

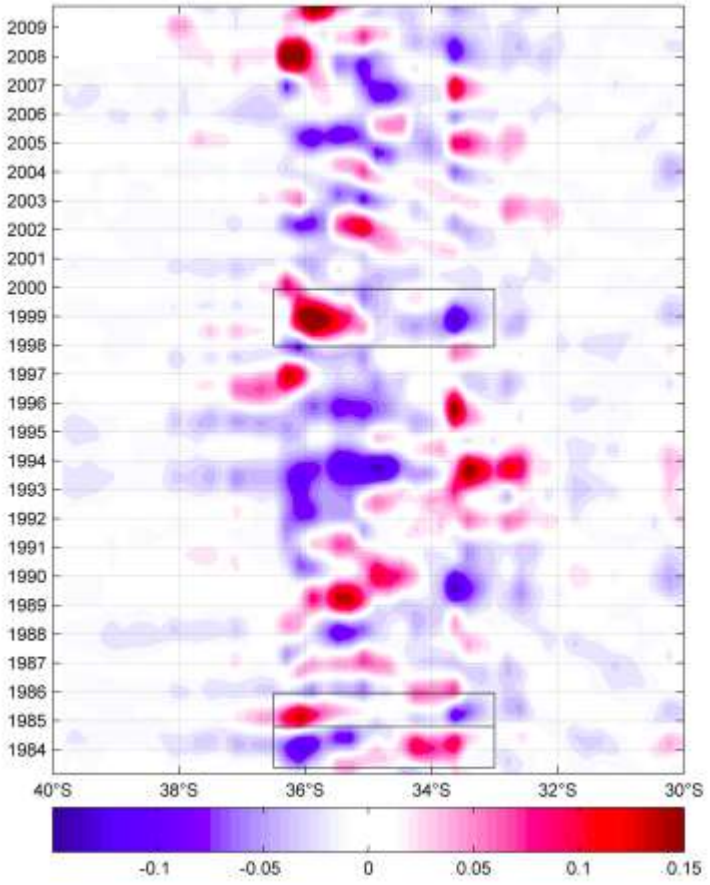
ORAP5.0 ocean reanalysis of the ECMWF and has been satisfactorily validated in the region (Bodnariuk et al., 2021 a, b, c)

- The product covers the 1979-2013 time period (35 years)

- It assimilates *in-situ* and satellite data

- ¼° spatial resolution and monthly temporal resolution

Suface normal velocities interannual anomalies (m/s)

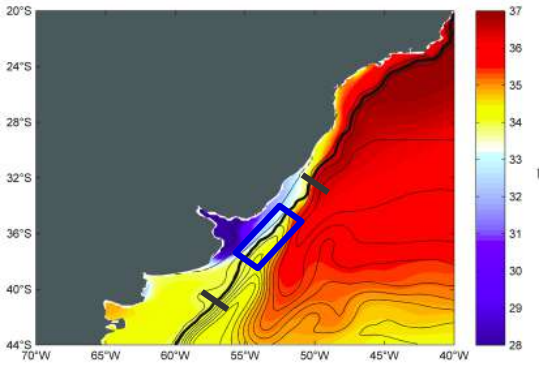


Methodology

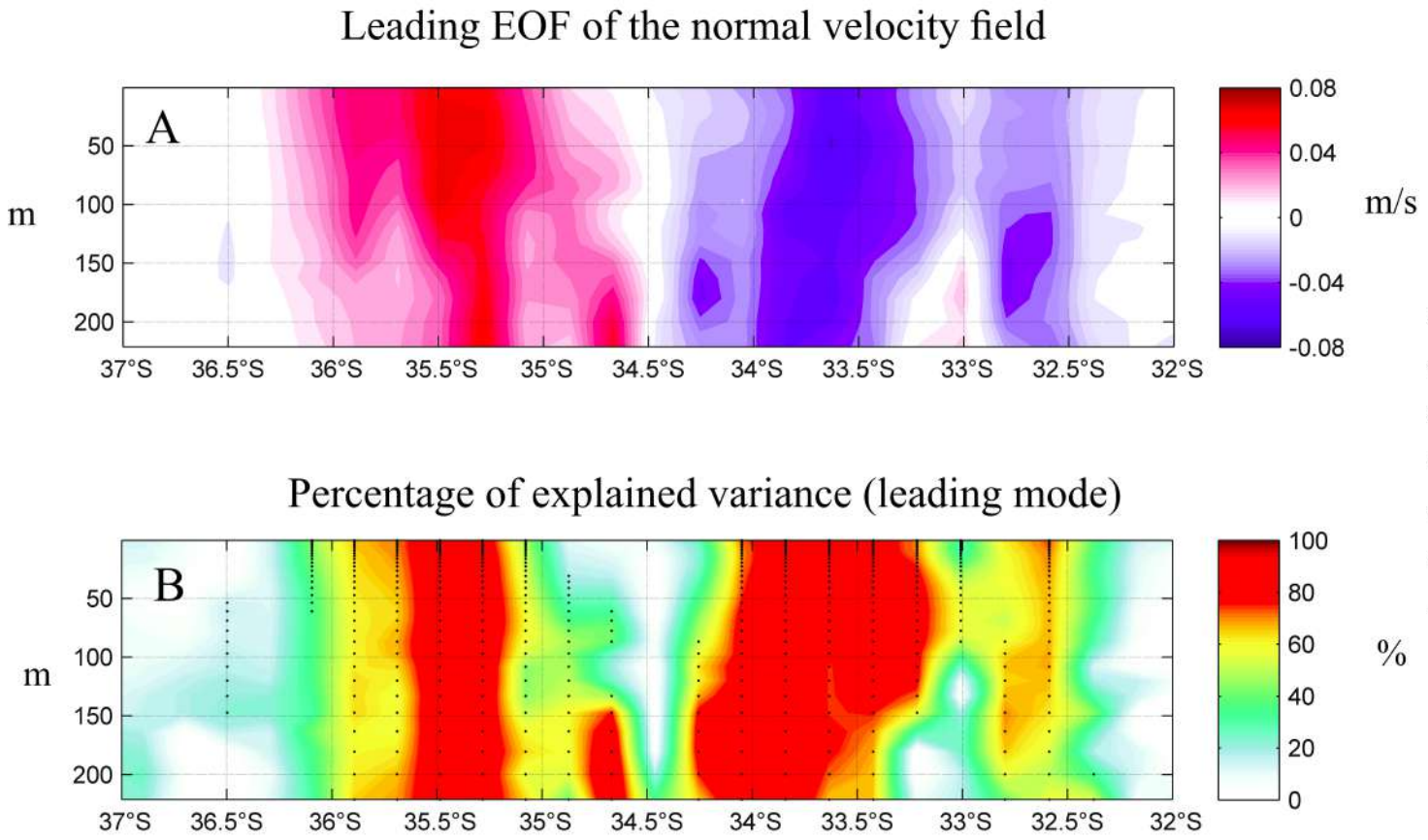
- Detrended and low-pass filtered (18 month cut-off frequency) to compute interannual anomalies.

Observation

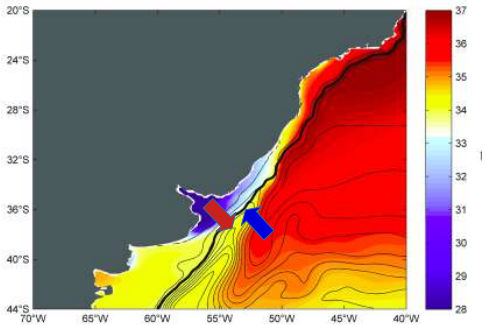
- Dipole structures are observed (repeat in time)



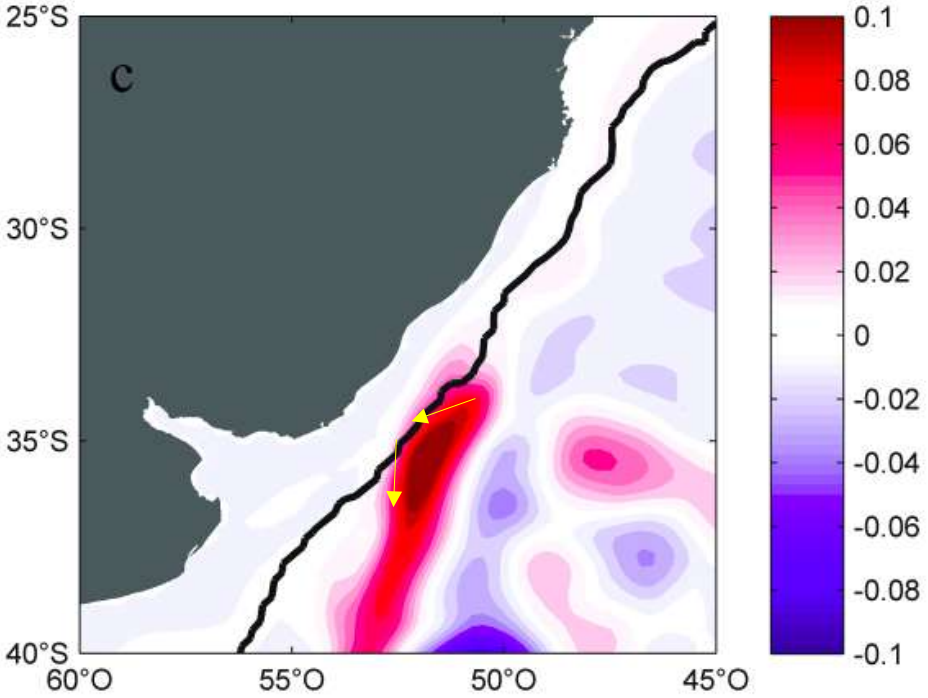
Variability modes of exportation based on velocity anomalies



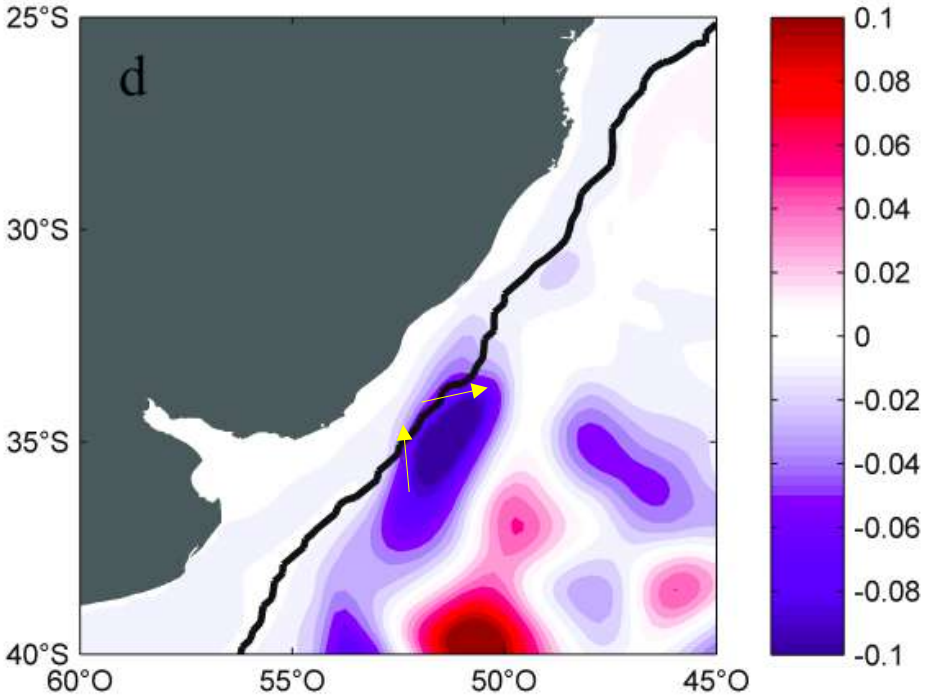
Explained variance (interannual): 66%



Composites of SSH anomalies for the active phases



Positive phase



Negative phase

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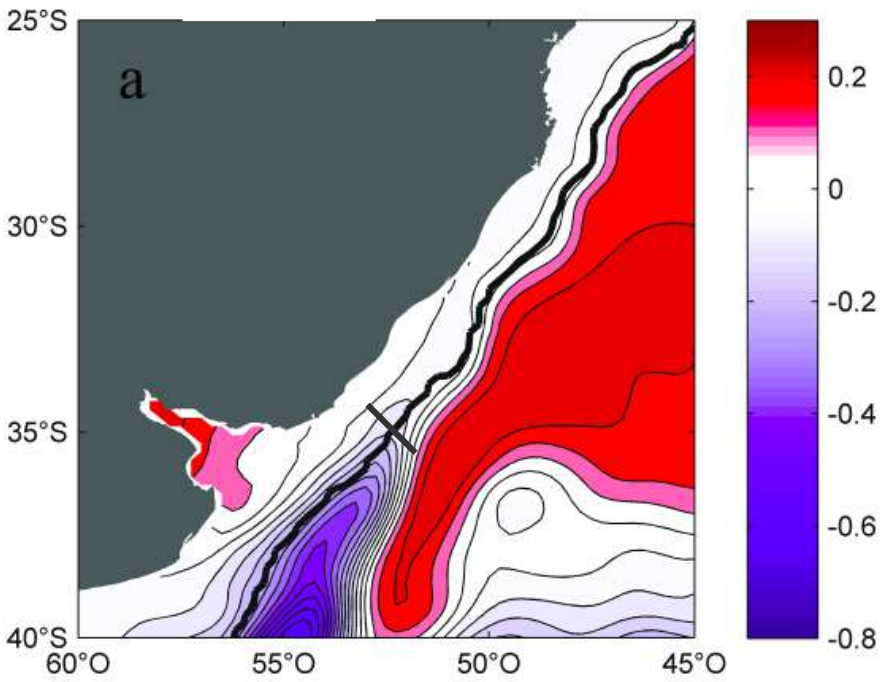

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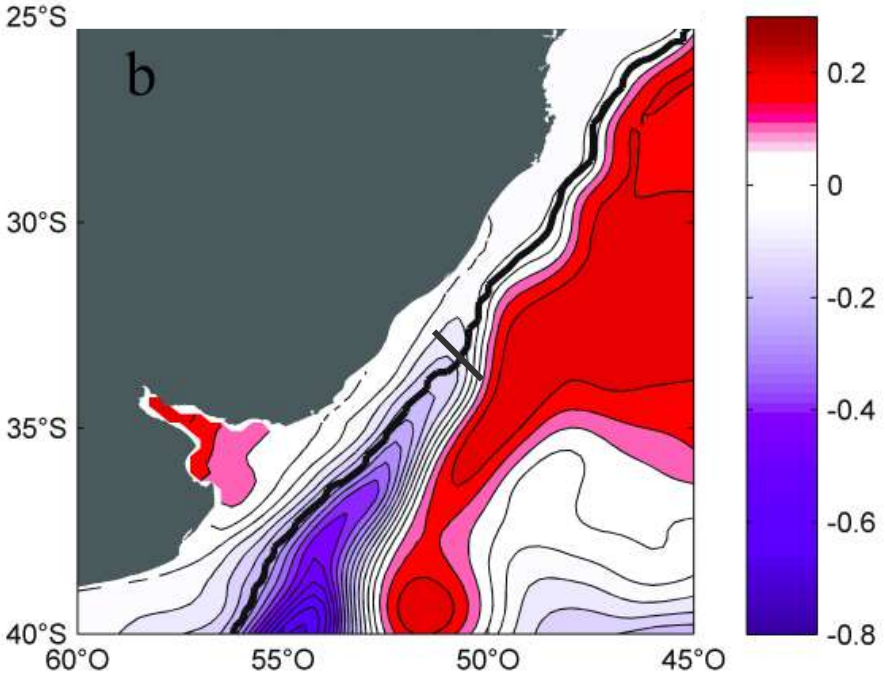
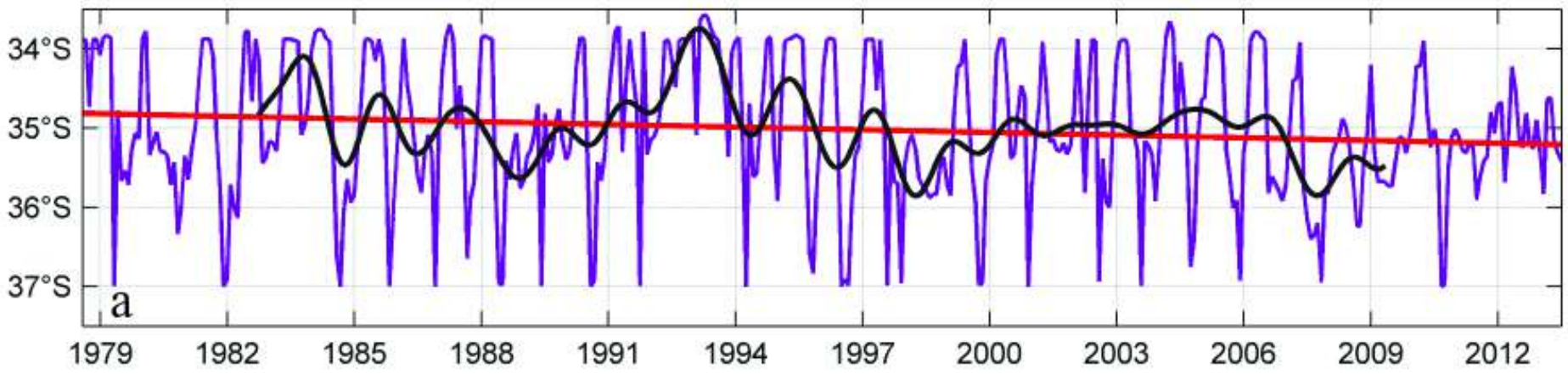


Negative phase

Latitude of separation of the Brazil Current

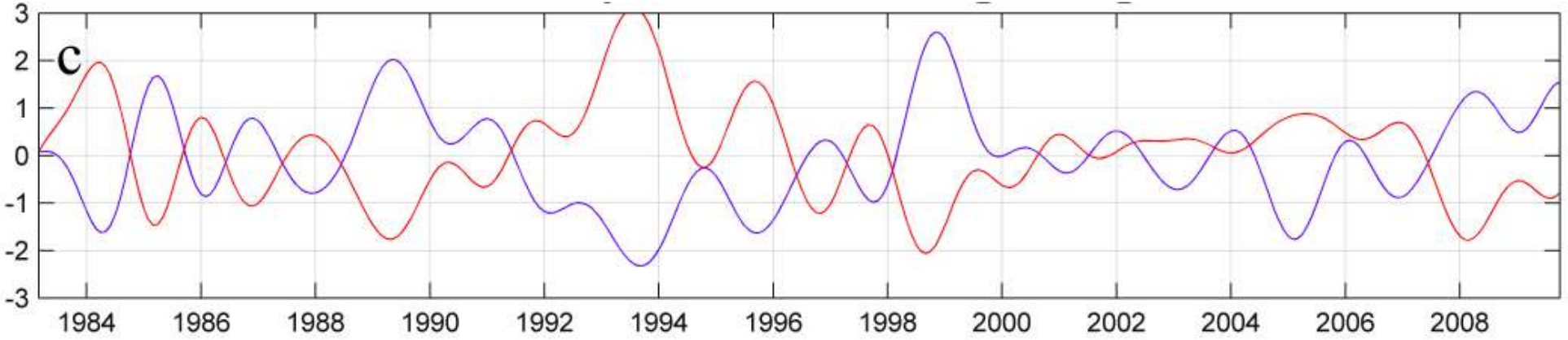


- Blue curve: monthly position value

- Black curve: low-pass filtered series

- Red line: linear trend (regression): displacement to the south

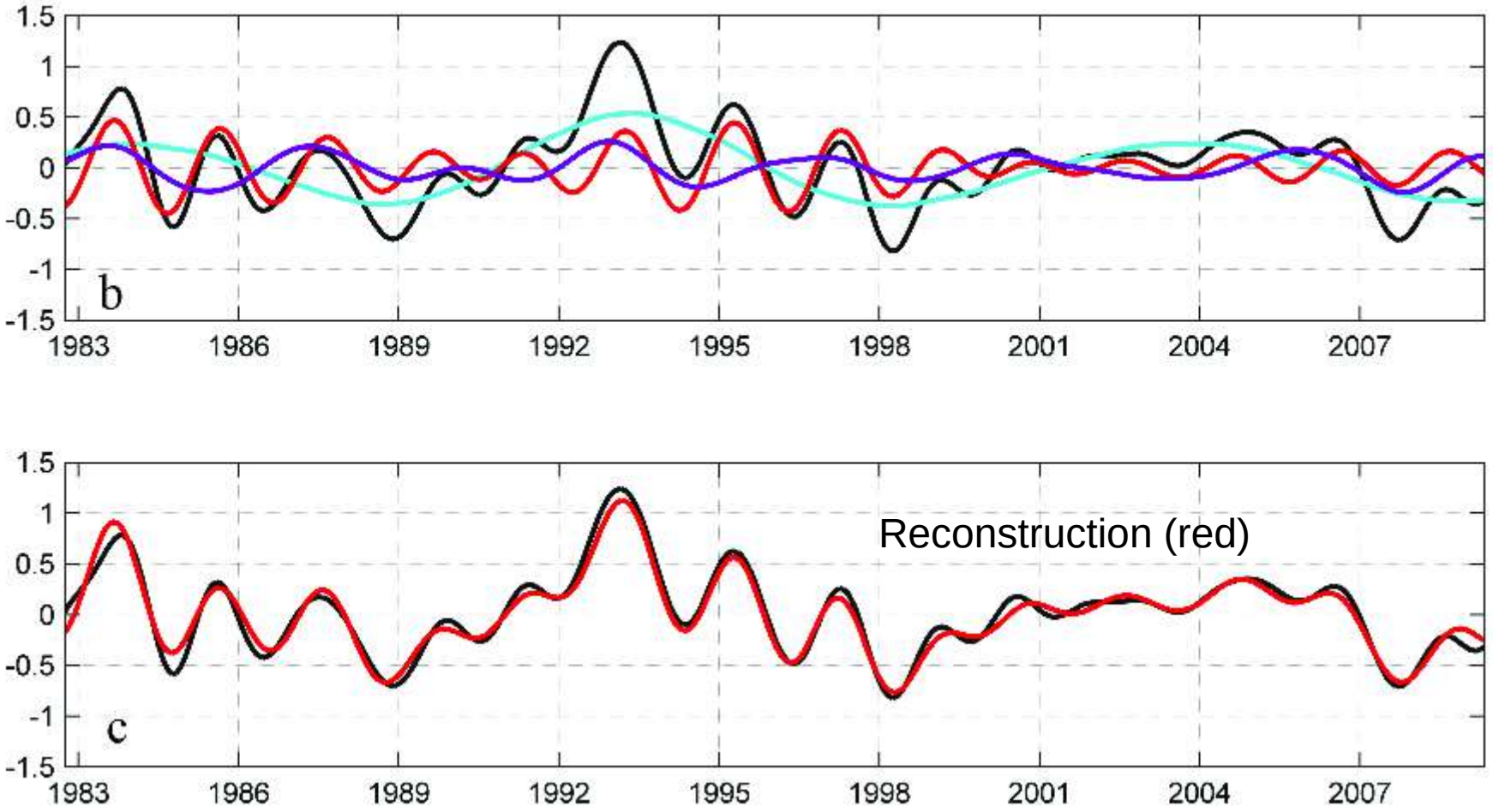
Linkage between exportation and the LSBC



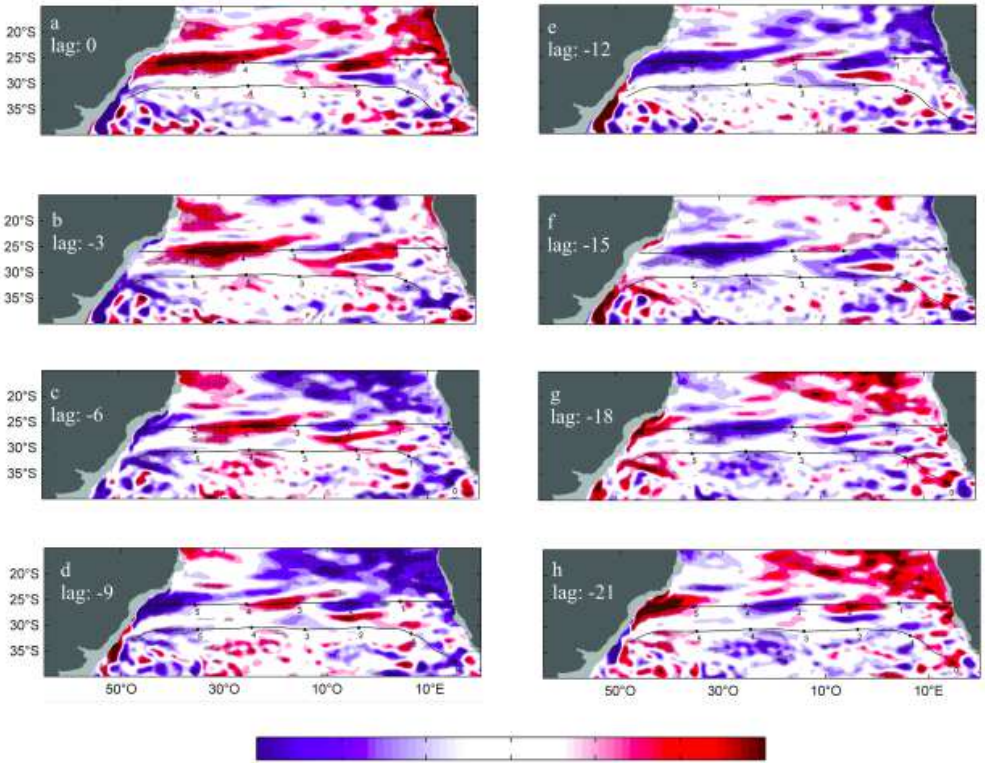
- Red curve: low-pass filtered LSBC series

- Blue curve: 1st principal component of interannual normal velocities anomalies

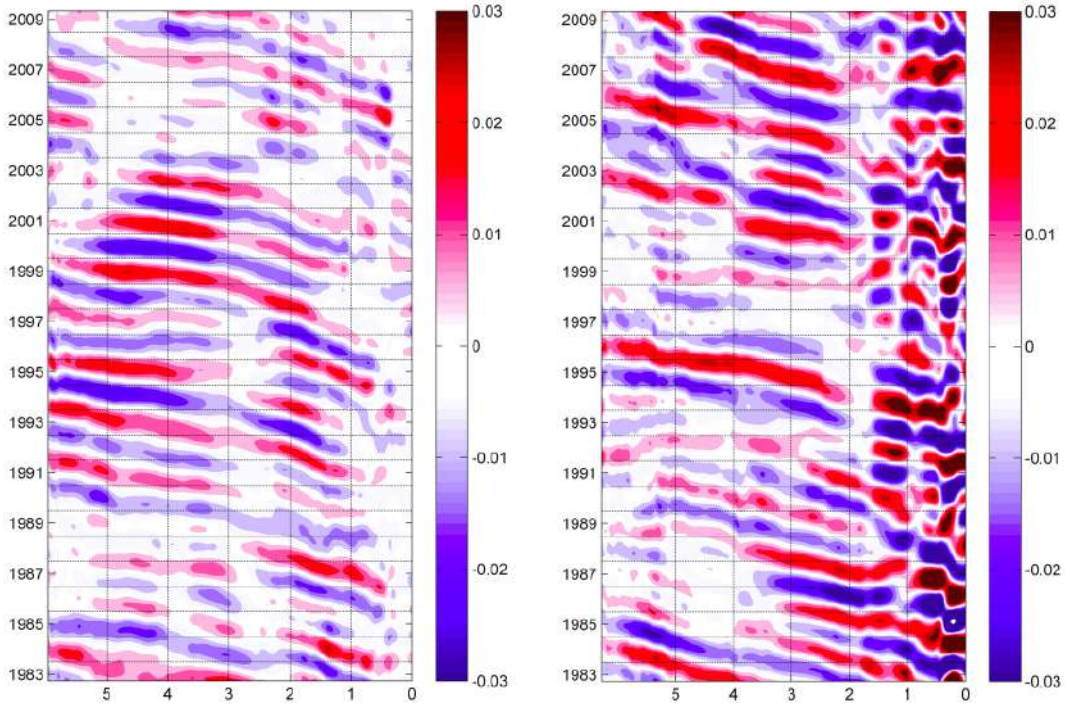
Detection of **pseudo-cycles** based on SSA analysis



SSH lagged correlation in the Atlantic: 2-years component

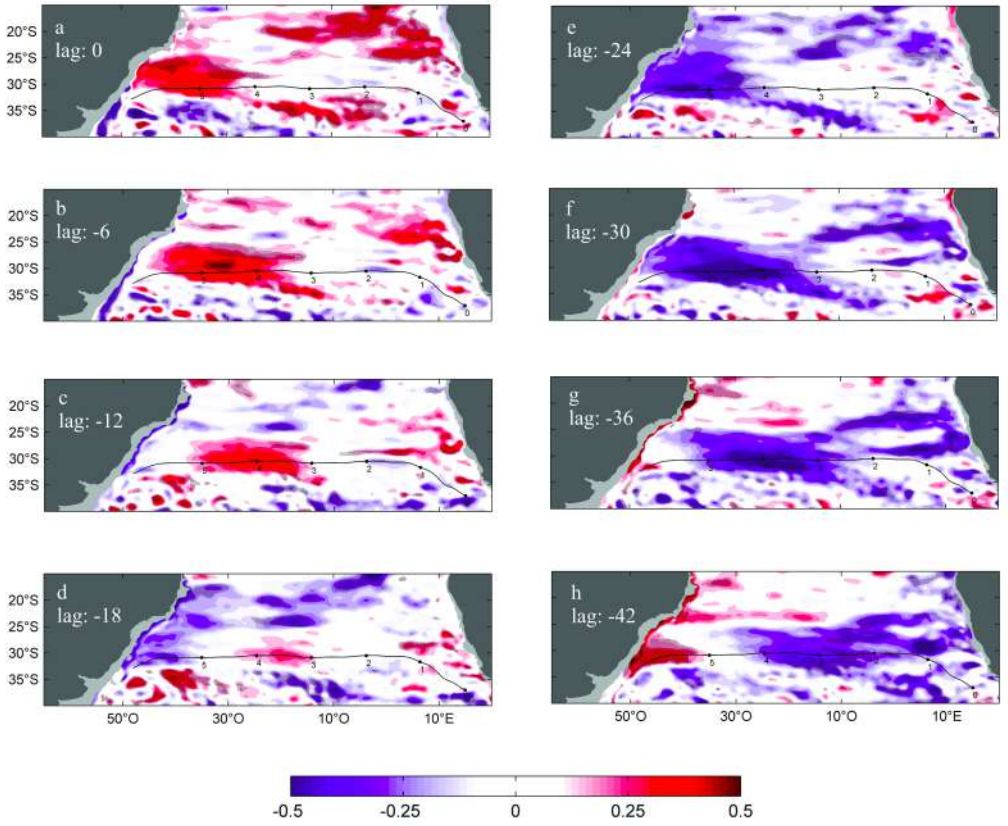


Propagation phases

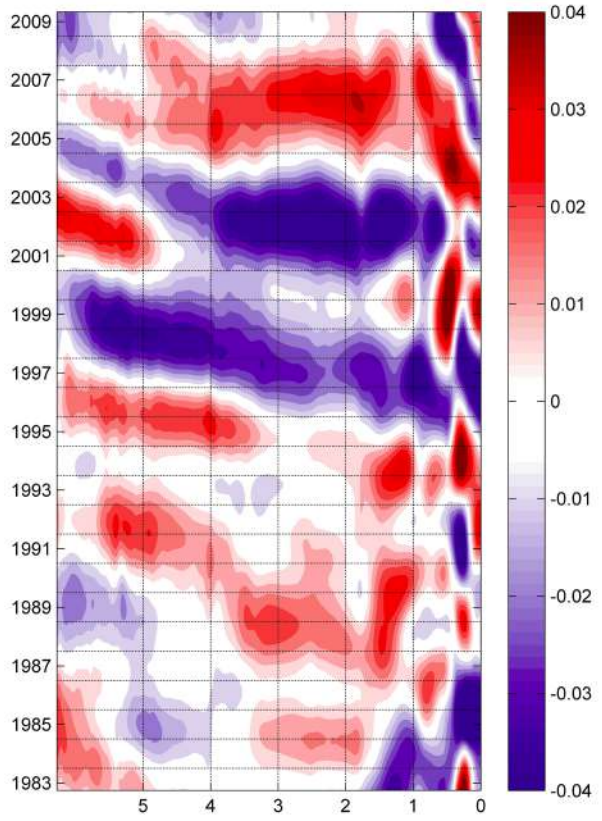


Hovmöller diagrams (left: north transect; right: southern transect)

SSH lagged correlation in the Atlantic: 4-years component

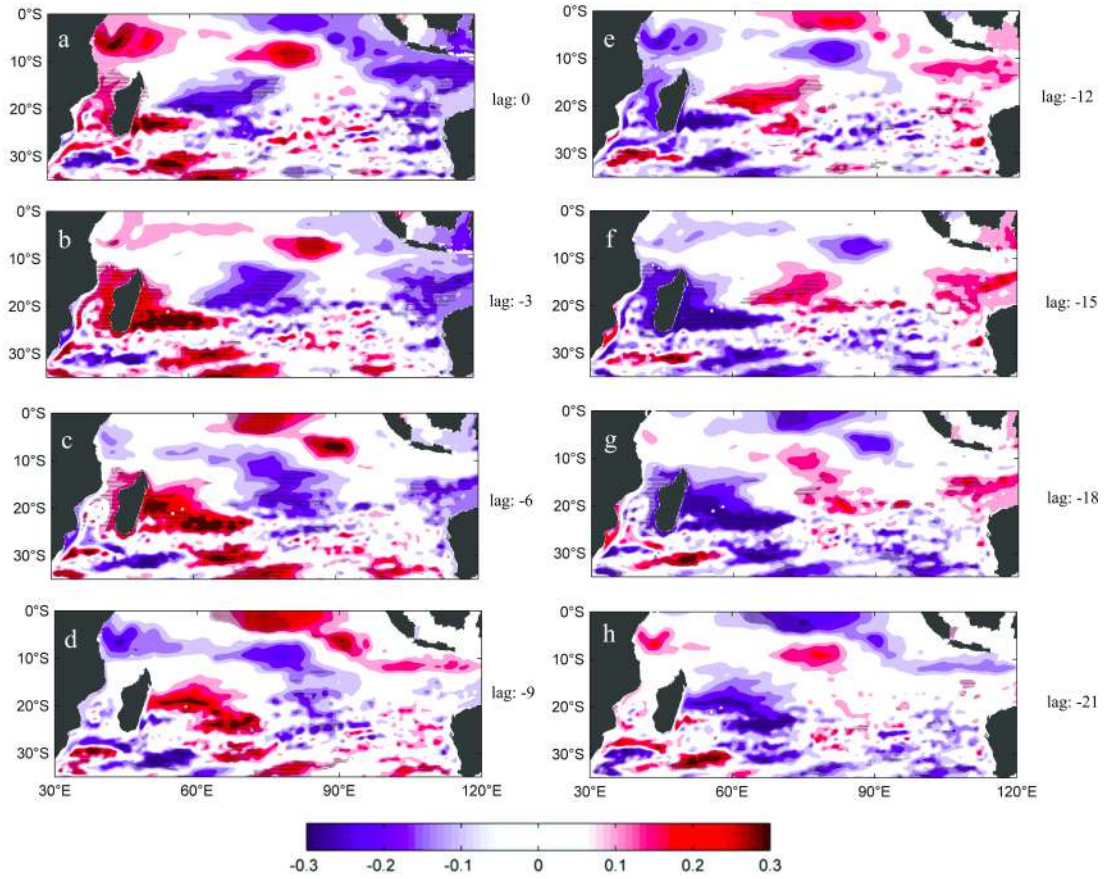


Propagation phases



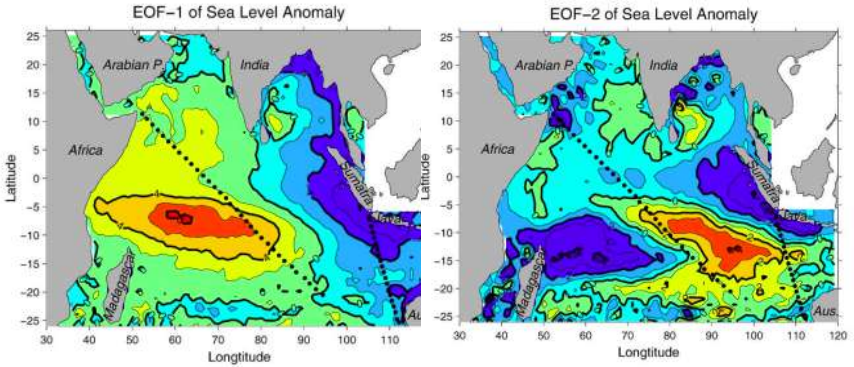
Hovmöller diagram

Remote connections (2-years component): The Indian Ocean



- Propagation patterns are osberved (NE-SW)

- A pattern reminiscent of the **Indian Ocean Dipole** (biannual signal)



Feng, M., & Meyers, G. (2003). Interannual variability in the tropical Indian Ocean: A two-year time-scale of Indian Ocean Dipole, Deep Sea Research

Conclusions

- The cross-shelf water exportation is modulated interannualy by a leading variability mode (**dipole pattern**).

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- This mode is closely associated to the latitudinal displacement of the Subtropical Shelf Front and exhibits 2, 4 and 10 years **pseudo-periodicities**.

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- The cross-shelf water exportation is modulated interannualy by a leading variability mode (dipole pattern).

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- Propagating perturbances (1st mode baroclinic **Rossby waves**) travel across the Atlantic and impinge in the Brazil Current, modulating its transport.

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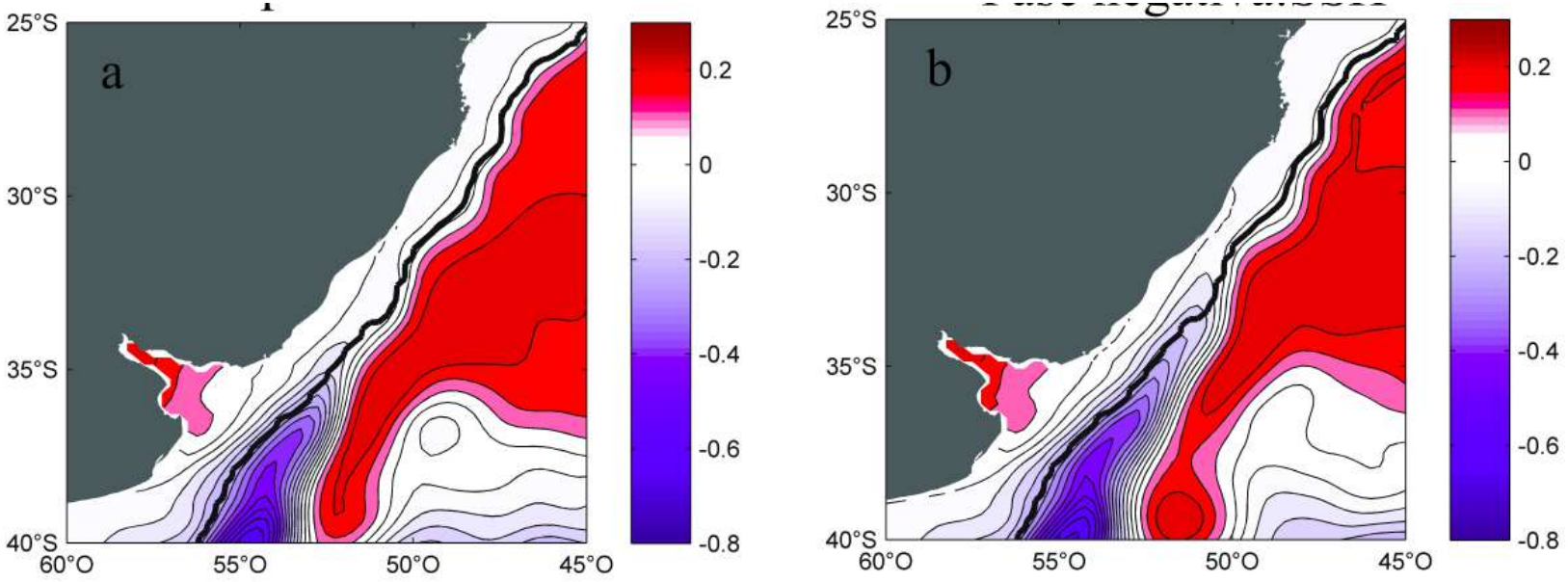
- This mode is closely associated to the latitudinal displacement of the Subtropical Shelf Front and exhibits 2, 4 and 10 years pseudo-periodicities.

- Propagating perturbances (1st mode baroclinic Rossby waves) travel across the Atlantic and impinge in the Brazil Current, modulating its transport.

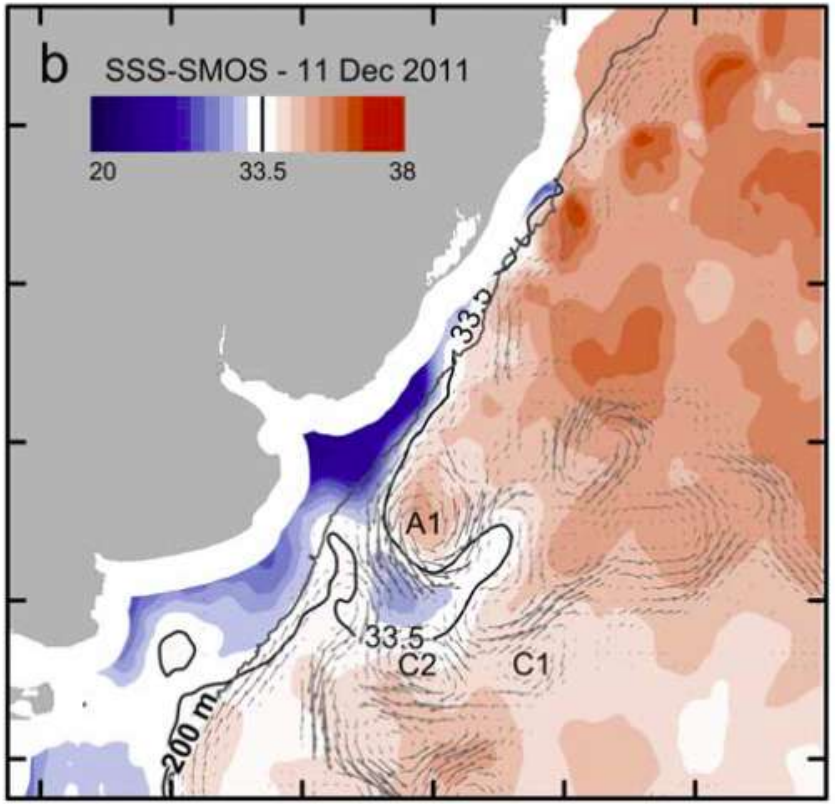
- These perturbances are excited in **remote regions**, in neighboring ocean basins and take years to reach the Southwester Atlantic region.

Envisaged future studies



¿Is the **Malvinas Current** also modulating the cross-shelf transport?

What could SWOT data reveal?



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- The impact of small-scale flow features embedded in the large-scale regional circulation

- Bathymetric features and exportation spots

Thanks for your attention !