Quasi-steady Lagrangian transport patterns on the Brazilian Coast

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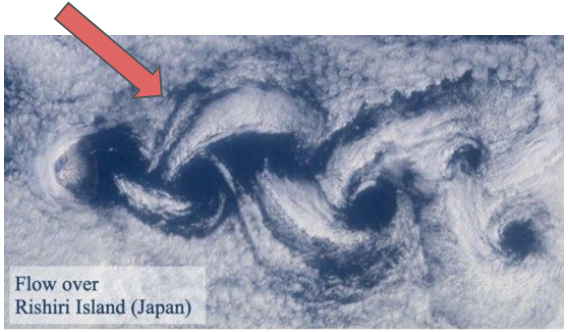
What are the Lagrangian Coherent Structures (LCS) ?

Haller, G. (2015). Lagrangian coherent structures *Annu. Rev. Fluid Mech*, *47*(1), 137-162.

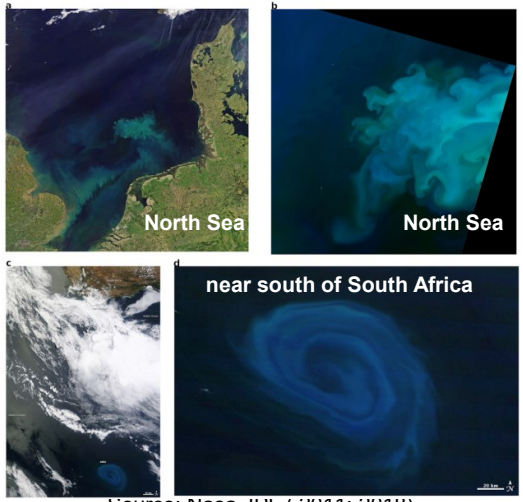
Peacock, T., & Haller, G. (2013). Lagrangian coherent structures: The hidden skeleton of fluid flows. *Physics today*, 66(2), 41.

An attracting (repelling) LCS takes the form of a material line that plays the dominant role in attracting (repelling) neighboring fluid elements onto (from) itself.



Source: Nasa JPL (2017)

LCS can't be crossed by material (barrier). Therefore, LCS can be relevant to study the pollution transport in the ocean surface, the search and rescue tasks, or oceanic turbulence.



Source: Nasa JPL (2011; 2018)

LCS approach identify key material lines that organize the fluid-flow transport.

Why compute climatological Lagrangian coherent structures (cLCS)?

Duran, R., Beron-Vera, F. J., & Olascoaga, M. J. (2018). Extracting quasi-steady Lagrangian transport patterns from the ocean circulation: An application to the Gulf of Mexico. *Scientific reports*, 8(1), 1-10.

The cLCS are used to extract important Lagrangian transport patterns from large velocity time series.

Pattern identification include:

1) isolated regions where trajectories are unlikely to leave or enter;
2) regions that attract nearby parcels of water;
3) quasi-steady Lagrangian transport patterns.

An advantage of cLCS is that it characterizes persistent or recurrent Lagrangian motion without the need for initial positions or an initial time while producing a broad yet detailed Lagrangian understanding.

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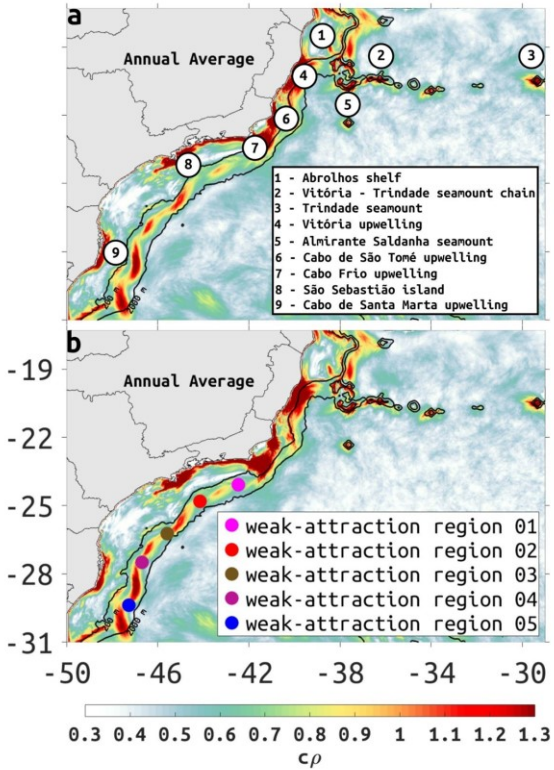
Gouveia, M. B., Duran, R., Lorenzzetti, J. A., Assireu, A. T., Toste, R., de F Assad, L. P., & Gherardi, D. F. M. (2021). Persistent meanders and eddies lead to quasi-steady Lagrangian transport patterns in a weak western boundary current. *Scientific reports*, *11*(1), 1-18.

➔ Main goal:

Determine the recurrent and predominant Lagrangian transport patterns and how they relate to intense mesoscale activity and pollutant dispersion on the Brazilian Coast.

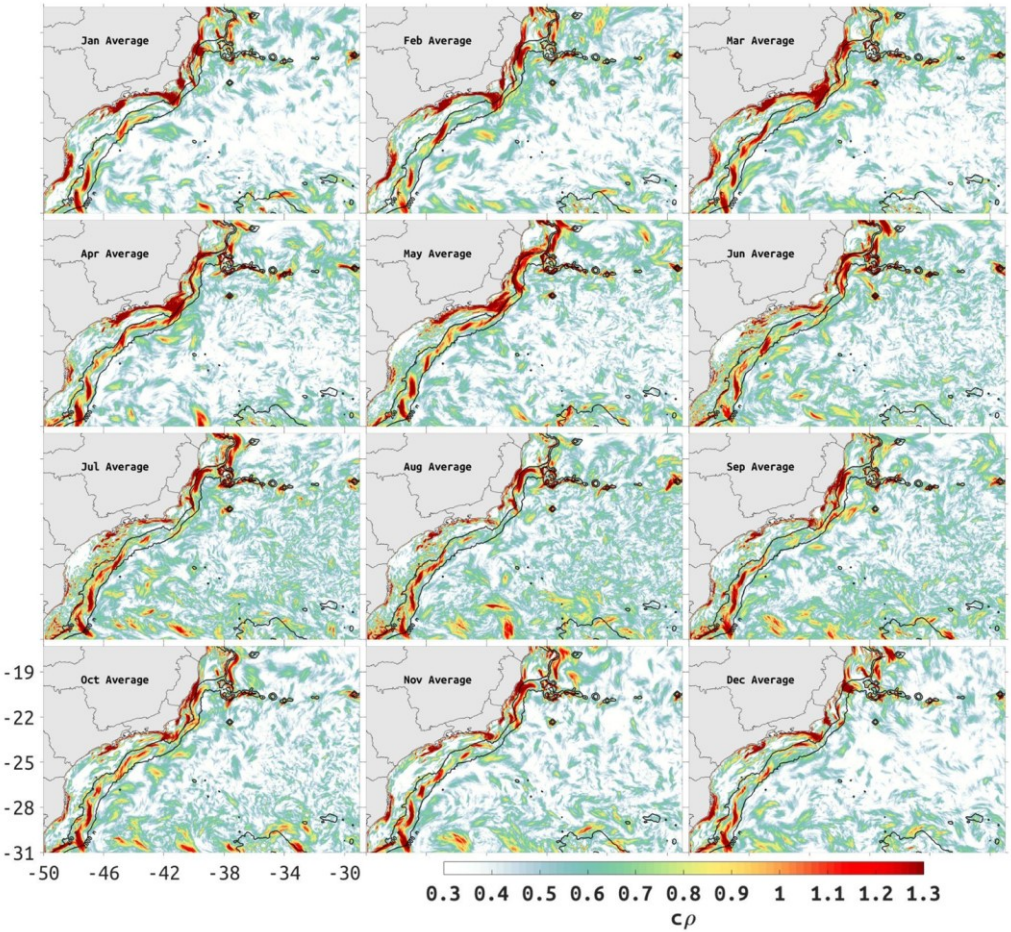
Despite being weak relative to other western boundary currents, the BC has been found to exert significant control over Lagrangian transport due to Strong mesoscale activity.

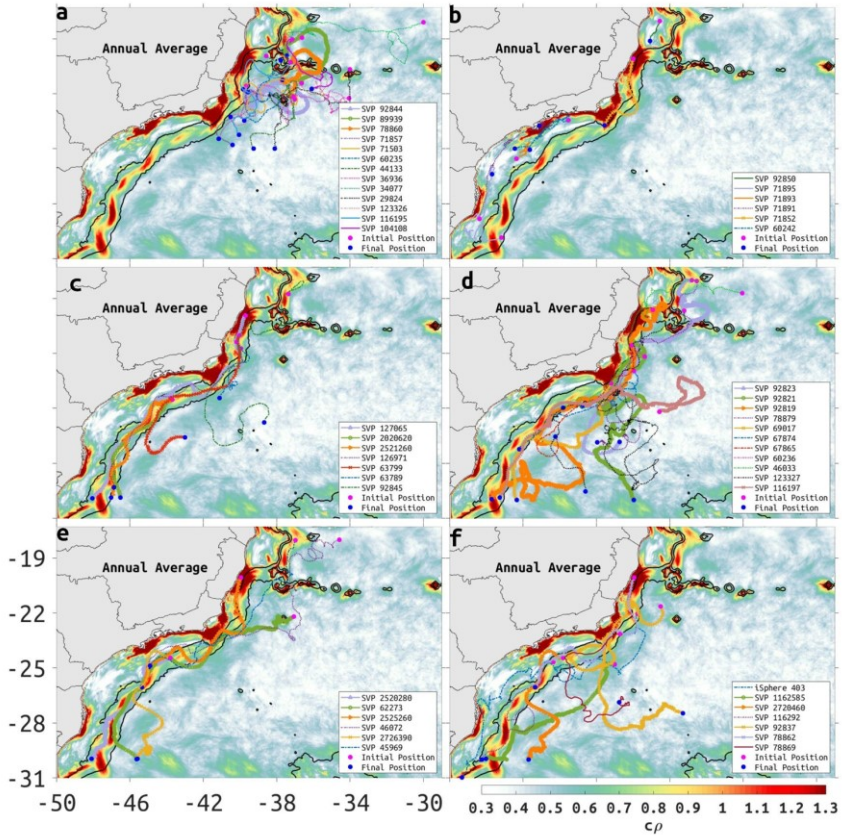
Variability on the Brazilian Current



➔ Climatological attraction (cρ):

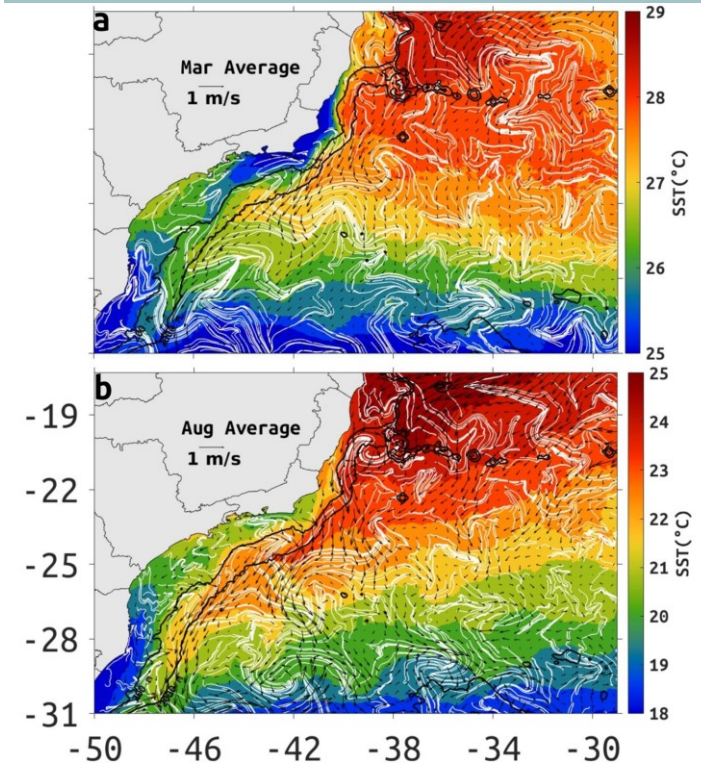
- High stretching values (cρ > 1 in logarithmic scale, or > 2.7 in linear units) are found near steep bathymetry areas and upwelling regions.
- Medium to high stretching values (cρ > 0.7, or >2 in linear units) are found adjacent to the BC core between 200- to 2000-m isobaths.
- Between 23–30S with regions of strong attraction interspersed by weakly-attracting regions.

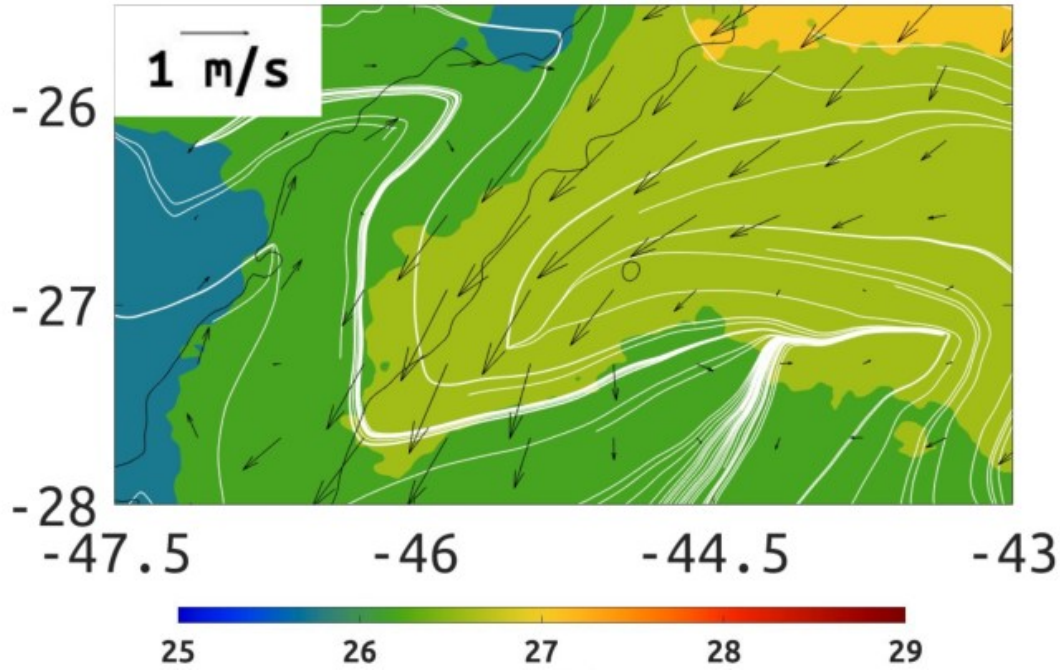




This variation in cρ suggests low-frequency variability of Lagrangian transport patterns with a tendency for some cross-slope transport where low cρ predominates.

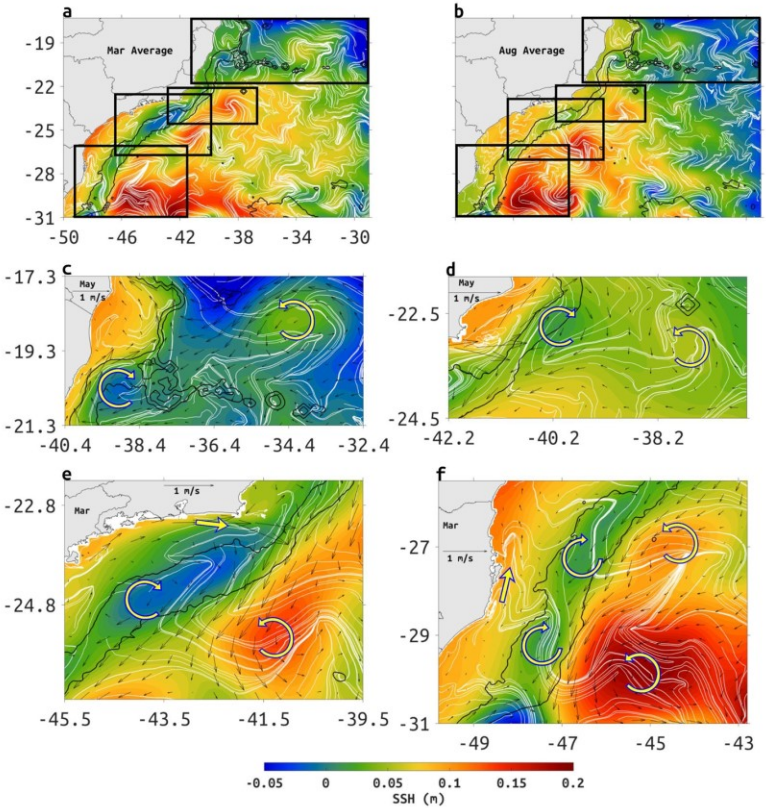
cLCS deformed as chevrons

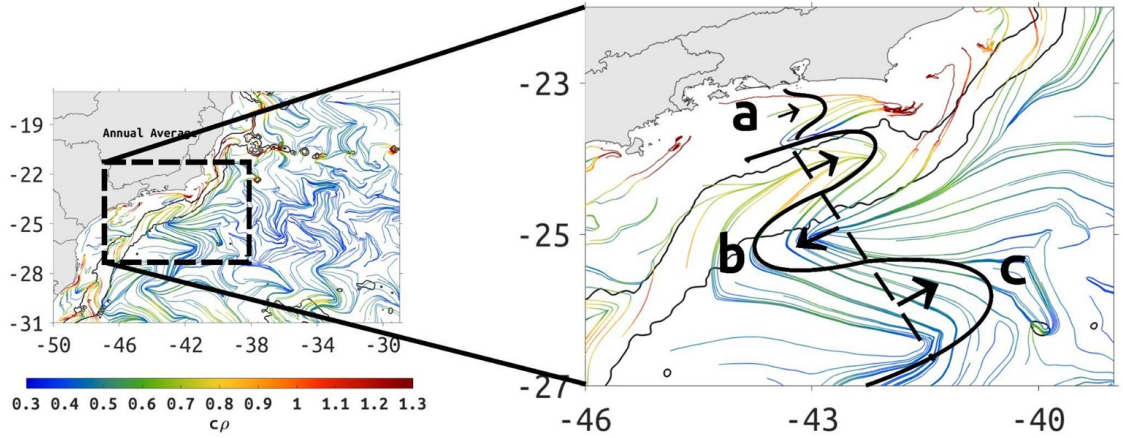




When cLCS deform as chevrons, they do not represent transport barriers, but instead, they identify a jet-like structure

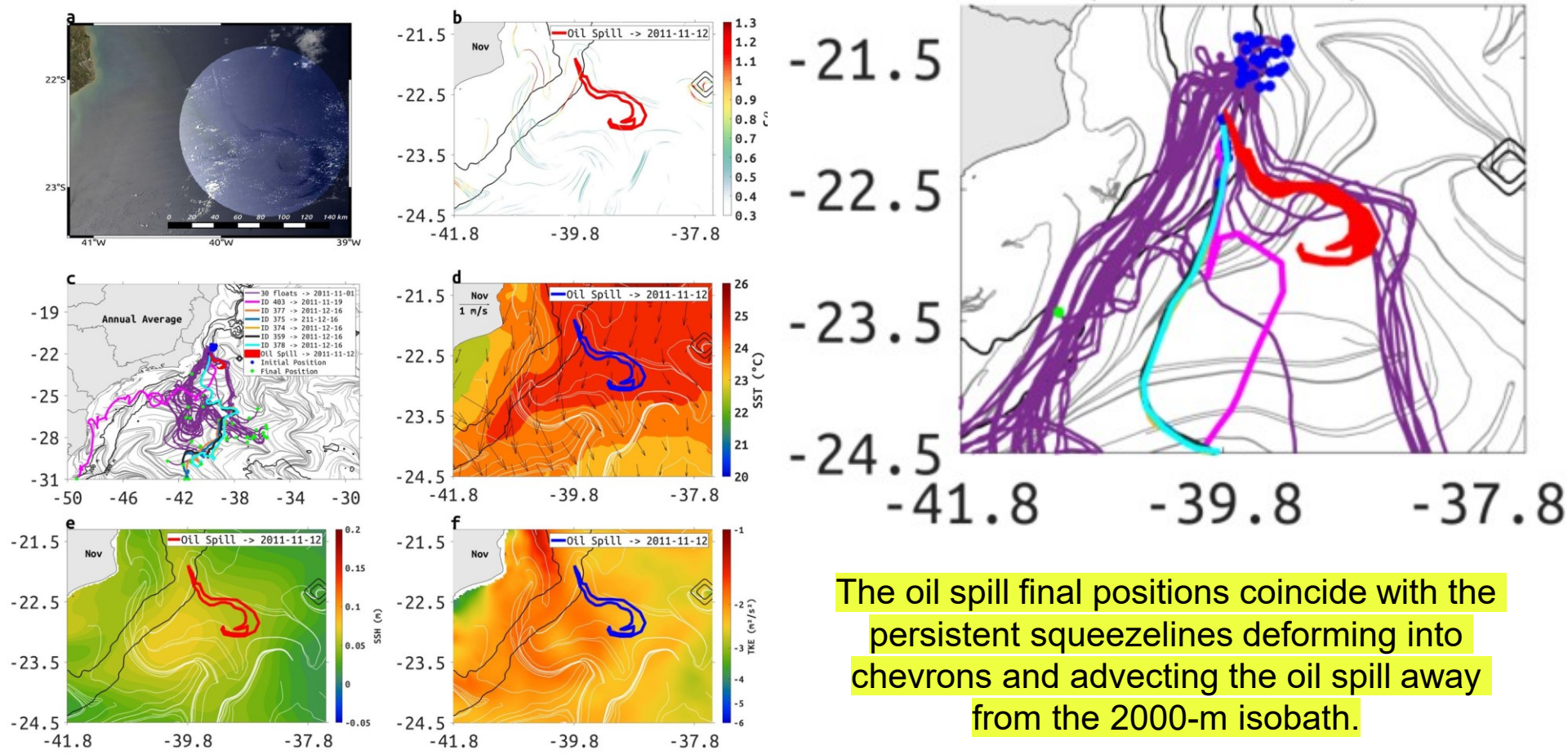
Persistent meanders and eddies lead to quasi-steady Lagrangian transport patterns in a weak western boundary current





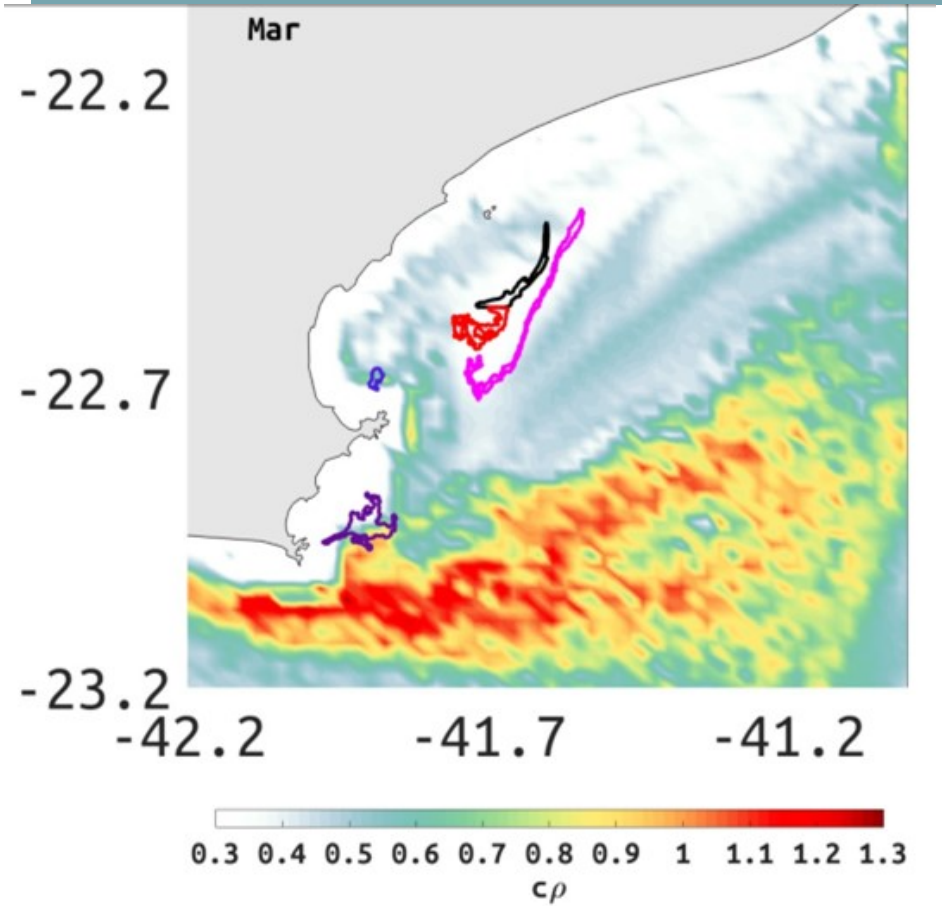
In the regions of low cp, where the chevrons are located, the presence of a couple of cyclonic and anticyclonic features causing an onshore-offshore-onshore-offshore sequence suggesting cross-shelf variations.

Frade's Field Case



The oil spill final positions coincide with the persistent squeezelines deforming into chevrons and advecting the oil spill away from the 2000-m isobath.

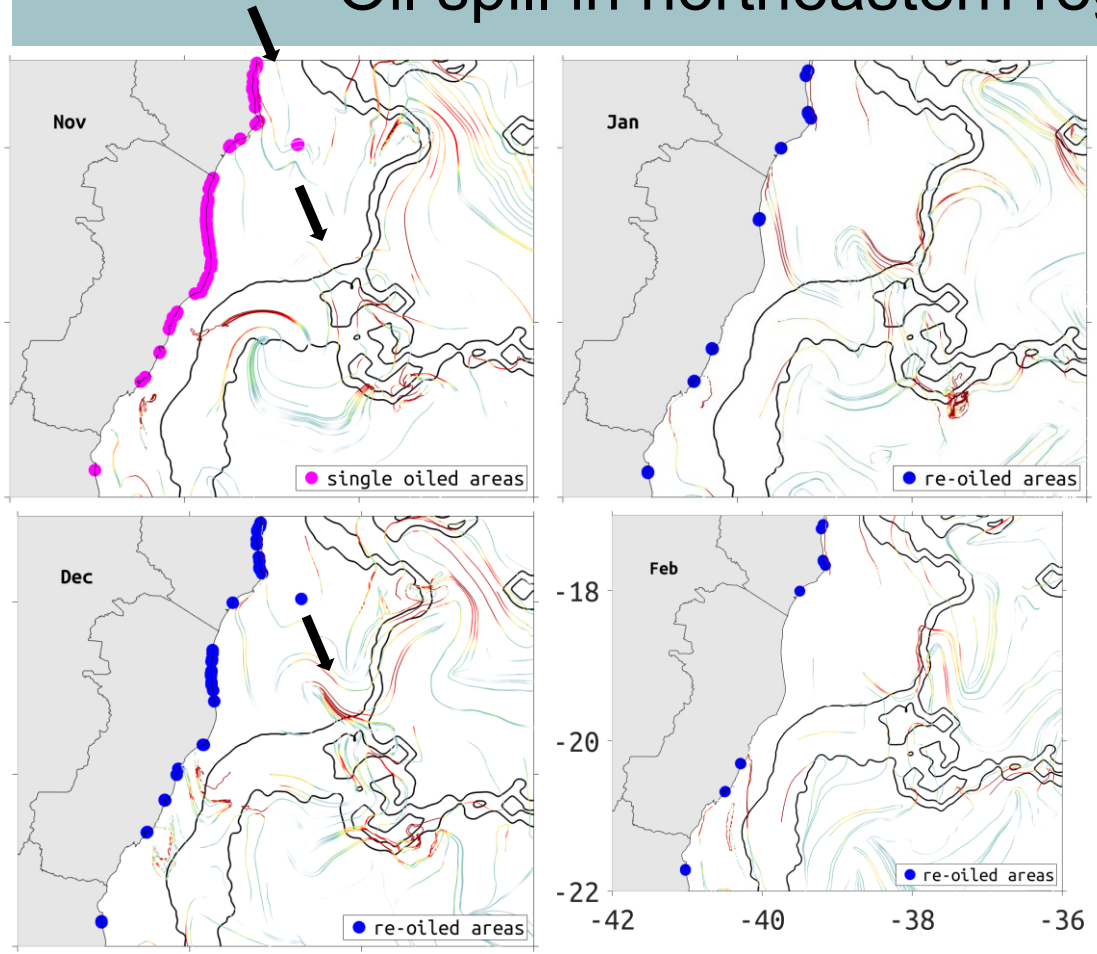
Tugboat Case



Oil spill detected in 2006/03/04 with 27 km²
Oil spill detected in 2006/03/06 with 37km²
Oil spill detected in 2006/03/06 with 5 km²
Oil spill detected in 2006/03/06 with 32 km²
Oil spill detected in 2006/03/06 with 30 km²

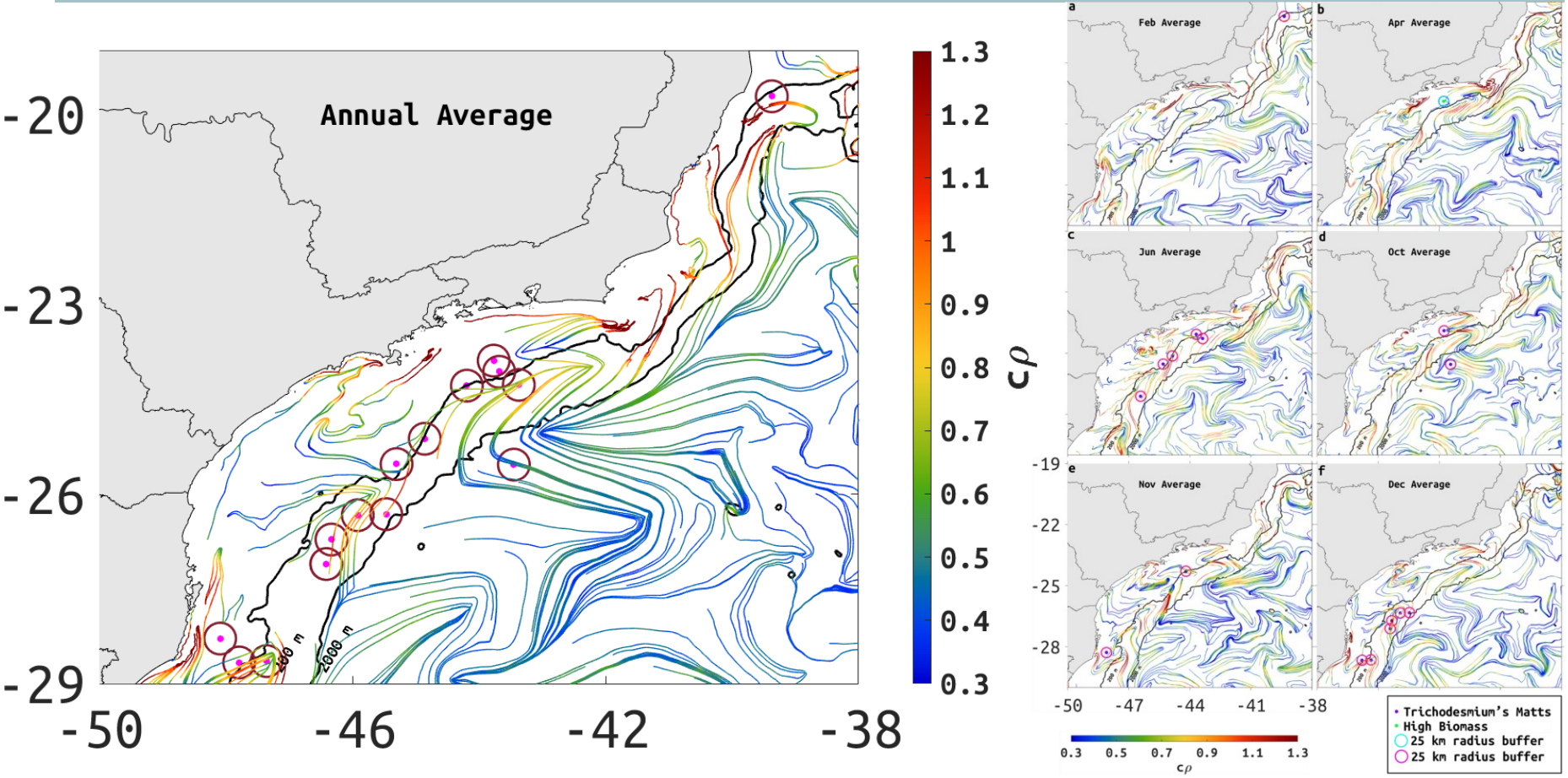
In regions of low cp values, also known as stagnant zones, the fuel spill tends to stay inside these regions (red, black and pink lines).
In purple, the patch spreads towards high cp values.

Oil spill in northeastern region of Brazil

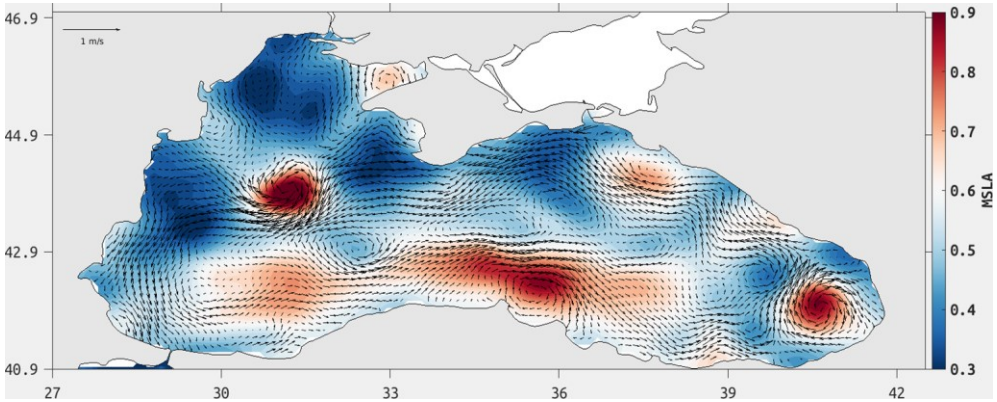


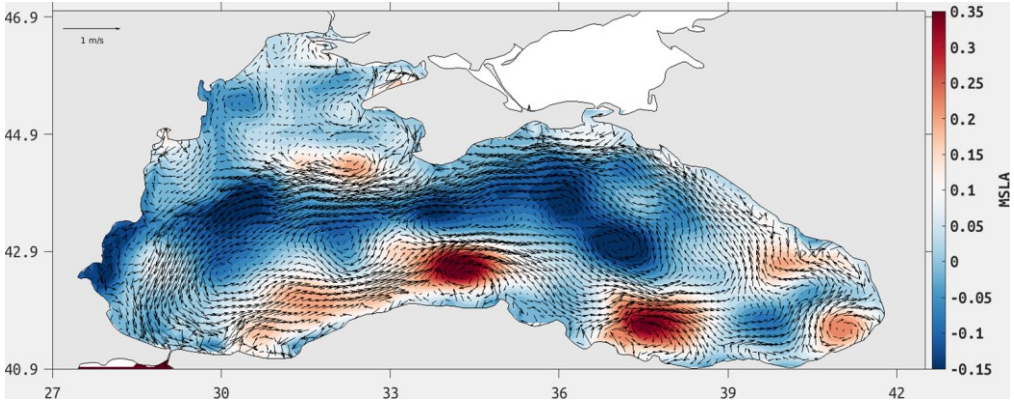
Attractive material lines leading the pollutant to enter and leave the Abrolhos region (black arrows).

Harmful blooms of Trichodesmiun's Matts



Next Steps





- Determine the quasi-steady Lagrangian transport patterns on the Black Sea.
- Analyze how water parcels and their properties spread in the Black Sea.
- Select coastal regions for wave buoys and ADCP launch strategies in order to the overall data coverage and the sampling of high kinetic energy features in the Black Sea have been optimized.

Questions?

How about a coffee break?

Support from:

Program of the Ministry of Education and Culture "Young scientists and postdoctoral fellows"

Thanks for your attention
мерси

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