Development of an Ocean Forecast System for the Western South Atlantic Ocean

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Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa de Engenharia

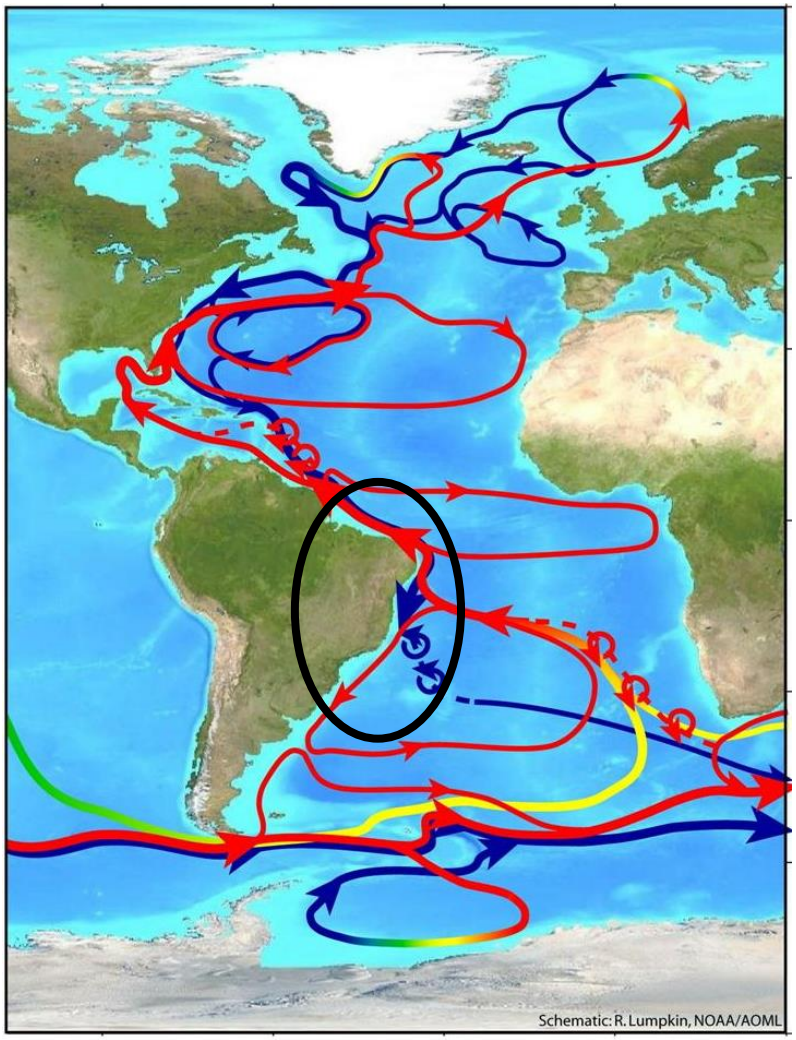
SYMPOSIUM OP'24

In partnership with unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

FUGRO

Challenges: high variability of dynamic regimes



Source: BIO, 2015.

Large scale (O 10^3 km)

✓ **Western Boundary Currents**
✓ **(WBCs)**

✓ **NBC & NBUC:**
✓ North Brazil Current and Undercurrent

✓ Brazil Current & Intermediate WB Current
✓ **BC-IWBC system**

✓ **DWBC –** Deep Western Boundary Current

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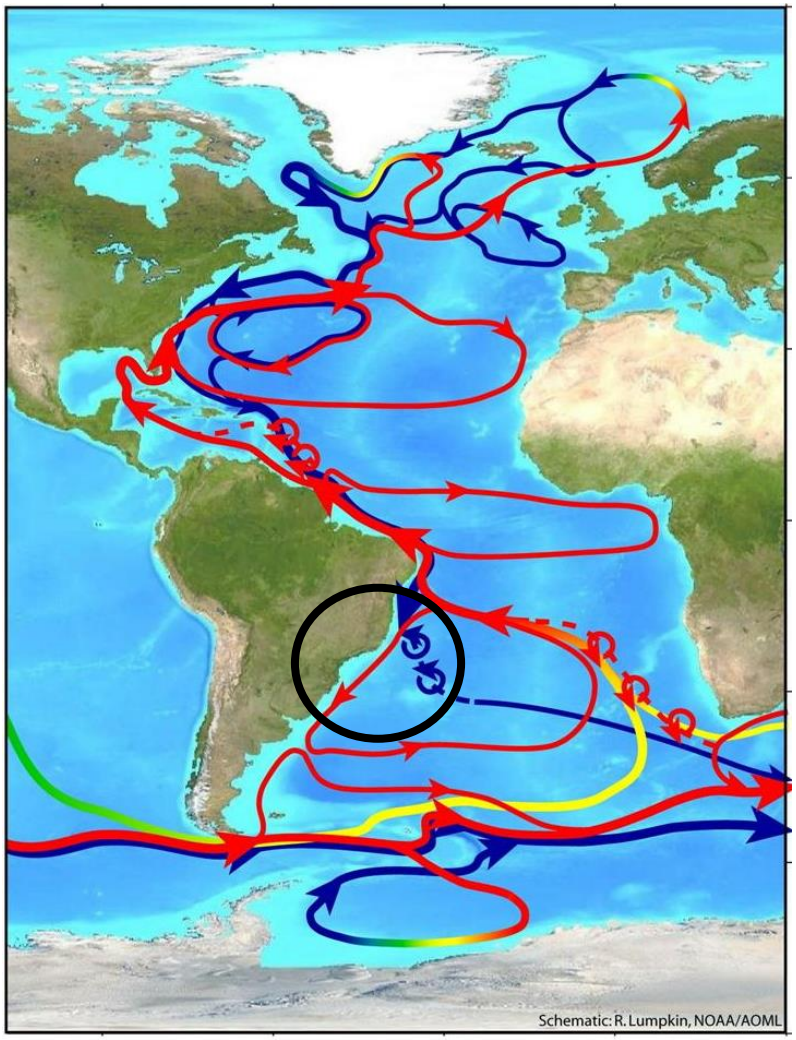

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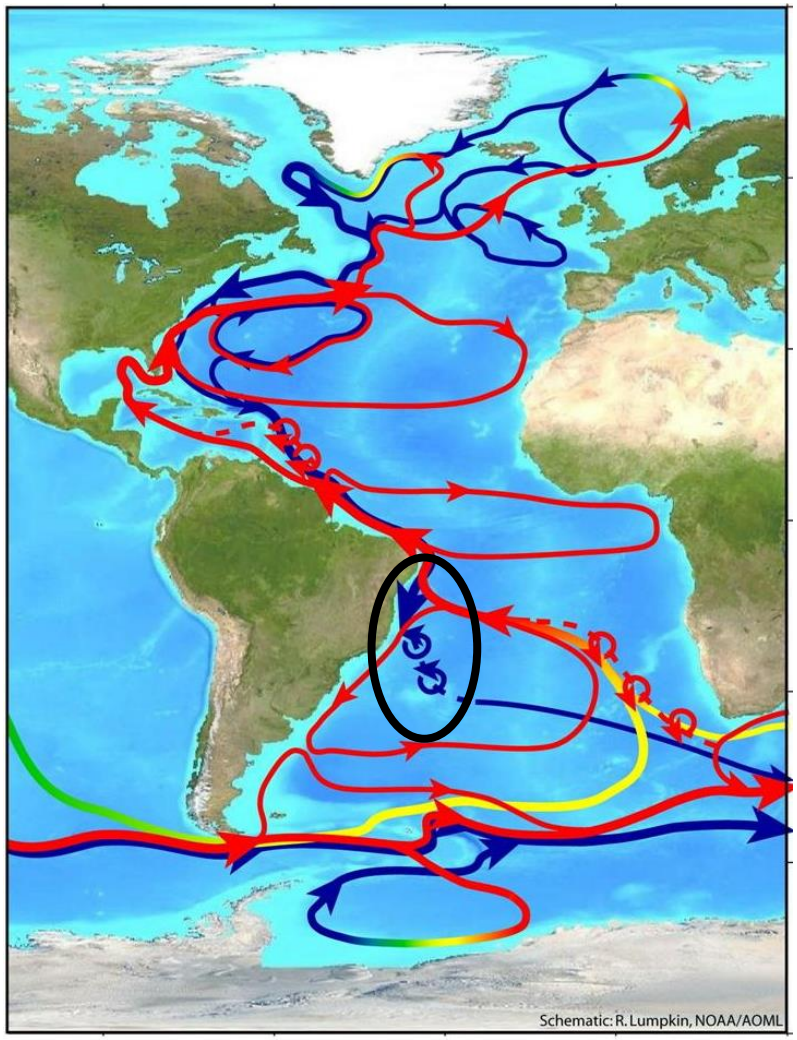

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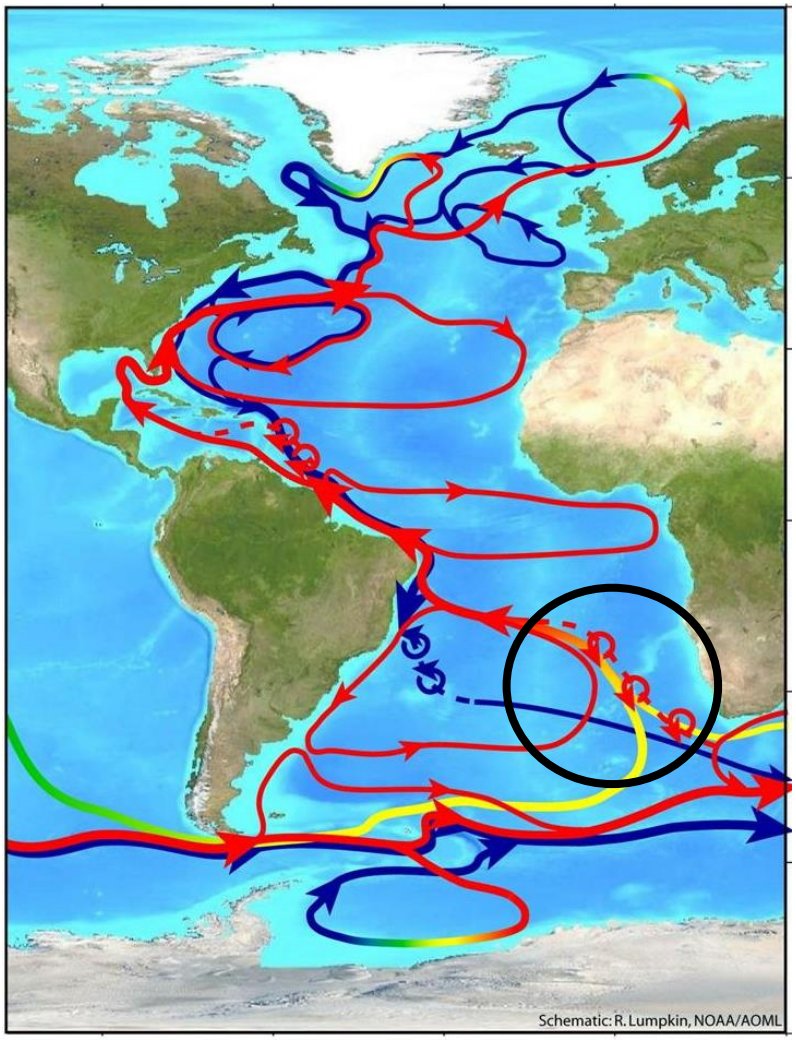

Source: BIO, 2015.

Mesoscale (O 10^2 km)

- ✓ **Arrival of westward propagating eddies from remote origin – Agulhas Rings (Guerra et al., 2018; Laxenaire et al., 2018)**
- ✓ **Meandering of Brazil Current, eddy formation, eventual ring detachment**

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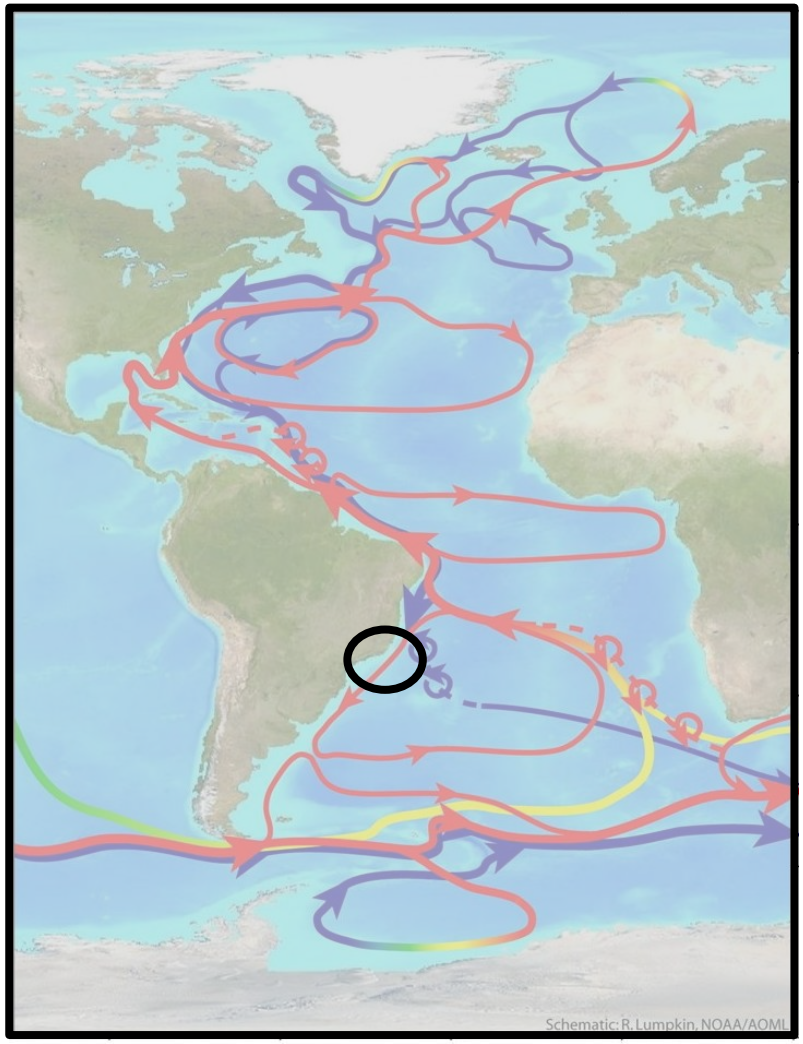

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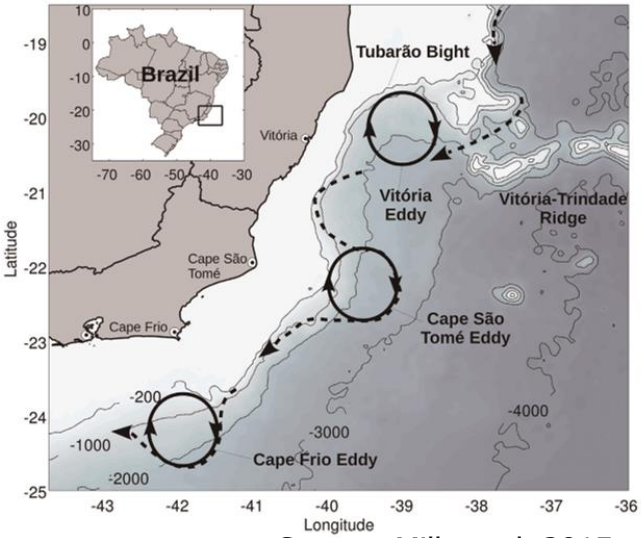


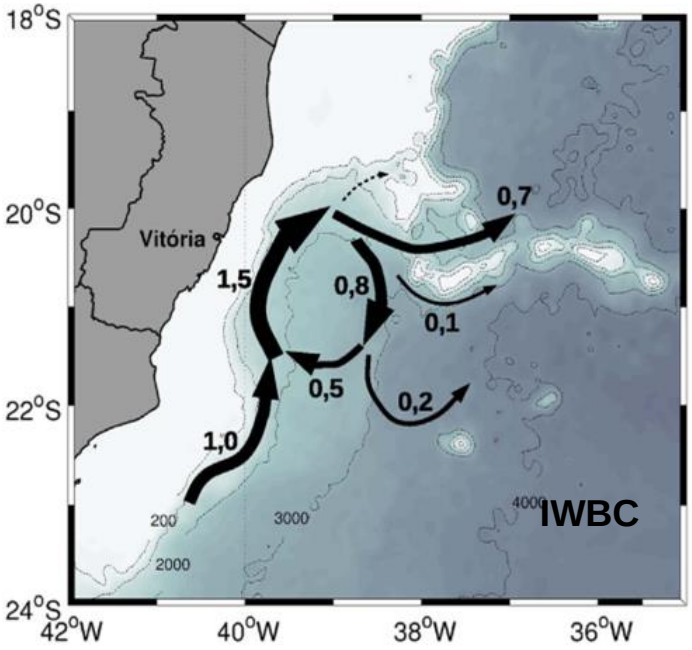
Source: Mill, et al. 2015.

Challenges: high variability of dynamical regimes

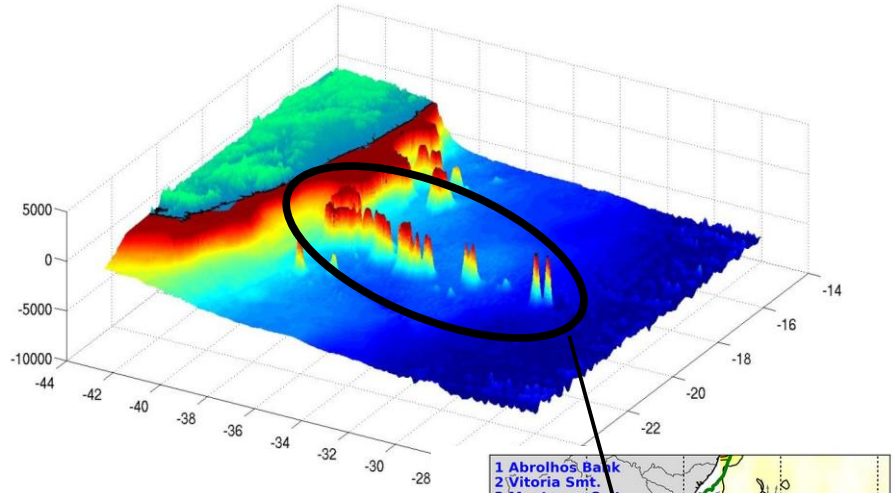
Bathymetry

✓ Vitória-Trindade Ridge

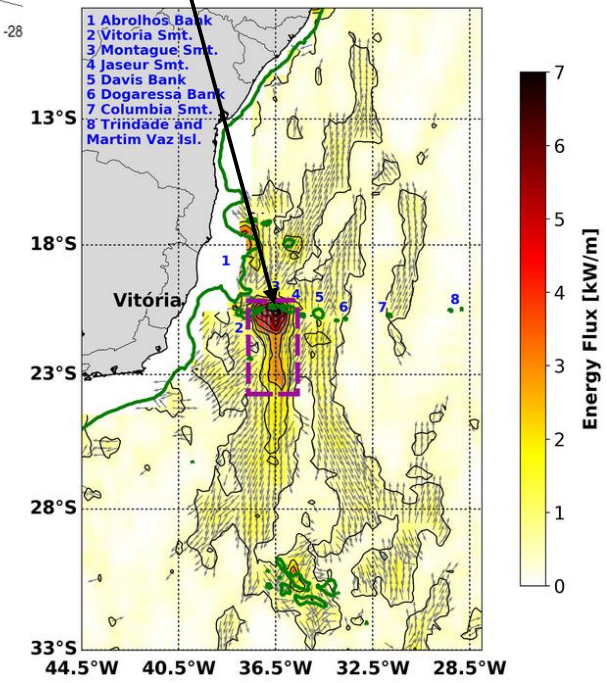
✓ Barrier to the WBCs



Source: Costa et al., 2017.



Generation of Internal Tides



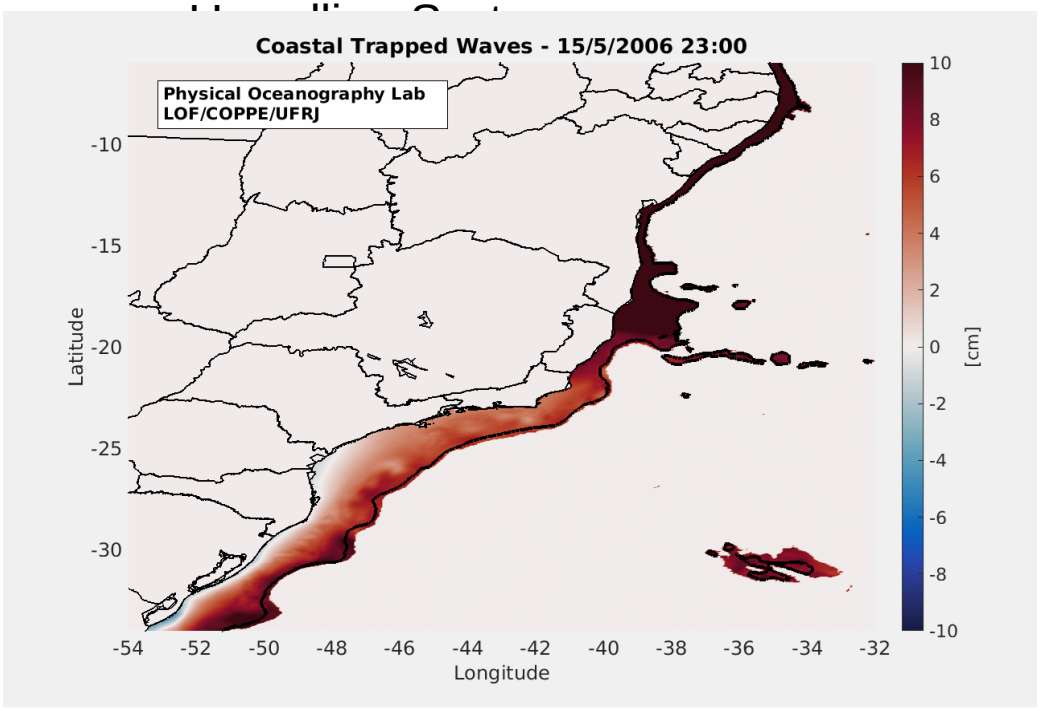
Fonte: Paiva *et al.*, 2018.

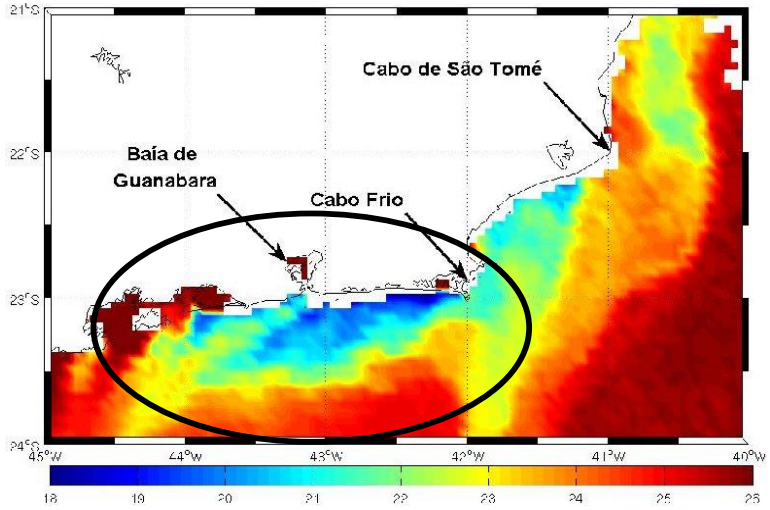
Challenges: high variability of dynamical regimes

Bathymetry

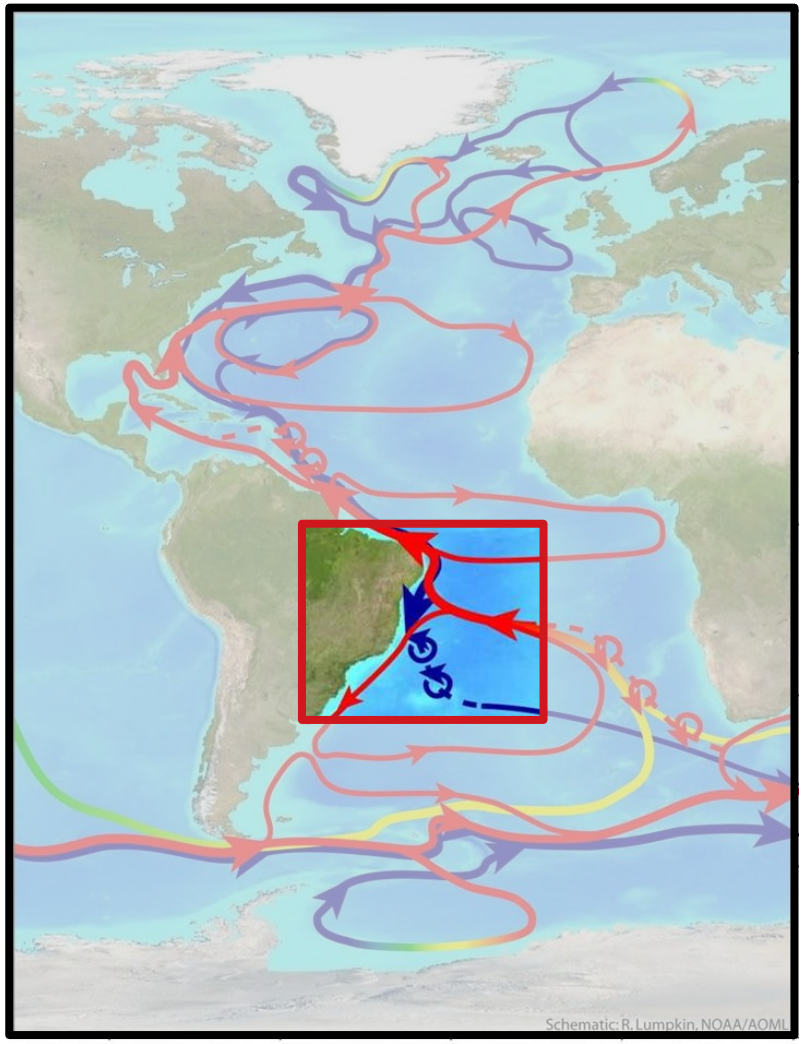
✓ continental shelf of varying width (from ~20 to ~250 km)

- ✓ Propagatoin of CTWs





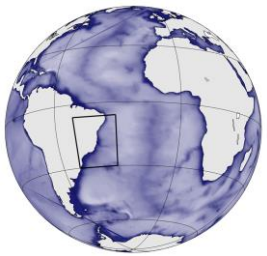
Objective:



Source: BIO, 2015.

To develop an open-access ocean forecast system, providing 3D information on large and mesoscale ocean circulation, plus tides, along the Western South Atlantic Ocean

LSE36-LOF/COPPE Ocean Forecast System



✓ HyCOM - Hybrid Coordinate Ocean Model

✓ (Bleck et al., 2002)

1/36 ^{0} horizontal resolution (~2,5 km)
32 hybrid layers
ETOPO1 + measurements from Brazil Navy

✓ Data Assimilation: T-SIS V2.0

Tendral Statistics Interpolation System

(Srinivasan et al., 2021)

near-real-time data availability:

~~*in situ*~~

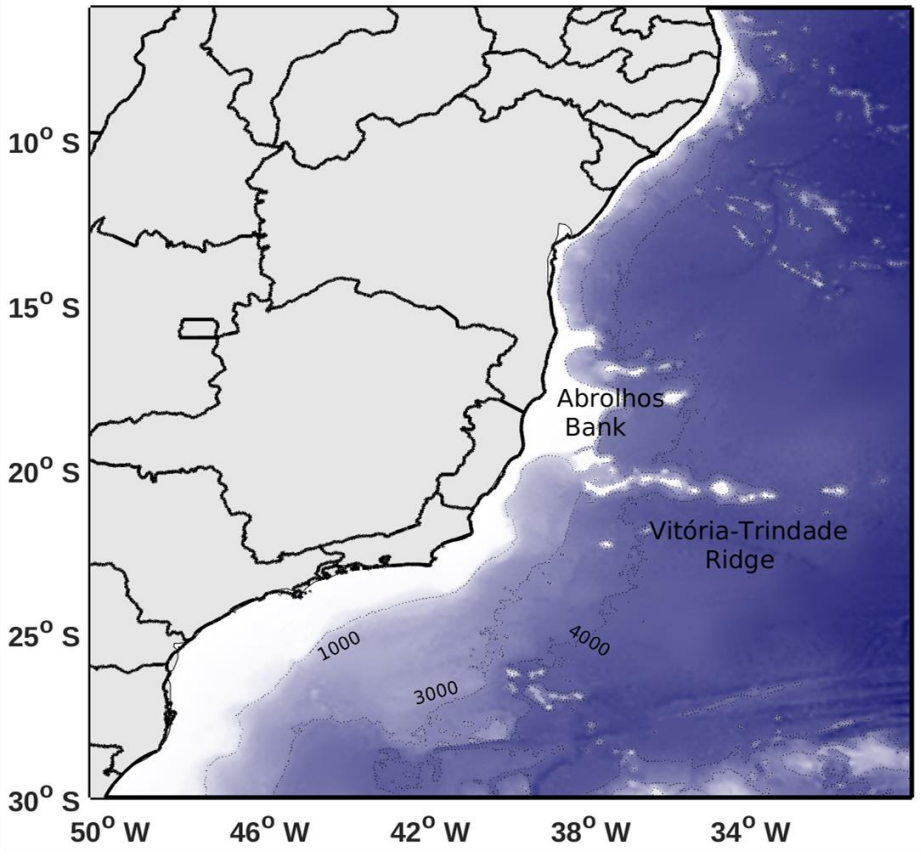
✓ remote sensing: **SST & SLA**

✓ Boundary Condition

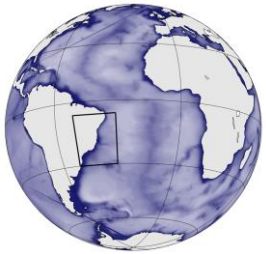
✓ GOFS 3.1: 1/12° Global Ocean F. System
TPXO9.v5 tides

✓ Atmospheric Forcing

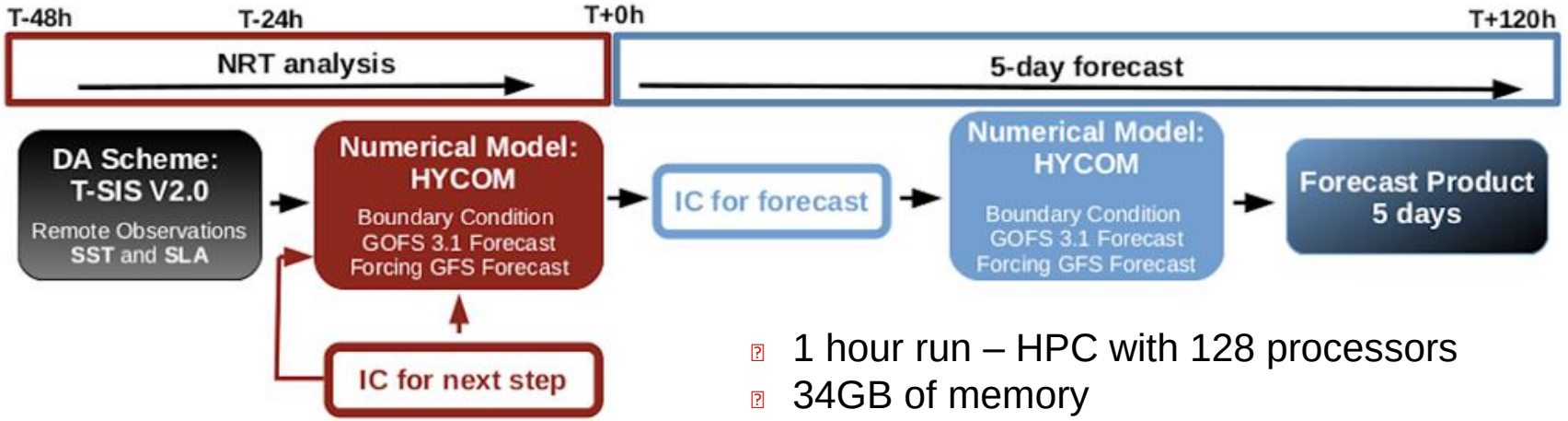
✓ GFS: Global Forecast System



LSE36-LOF/COPPE Ocean Forecast System



Daily Production Cycle



- 1 hour run – HPC with 128 processors
- 34GB of memory

LSE36-LOF/COPPE Ocean Forecast System

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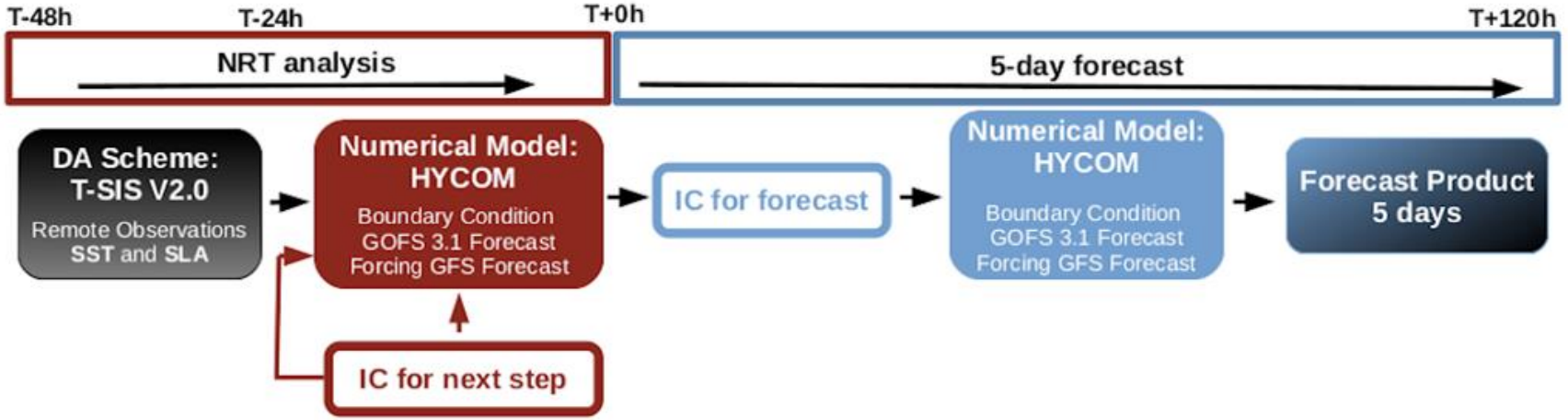
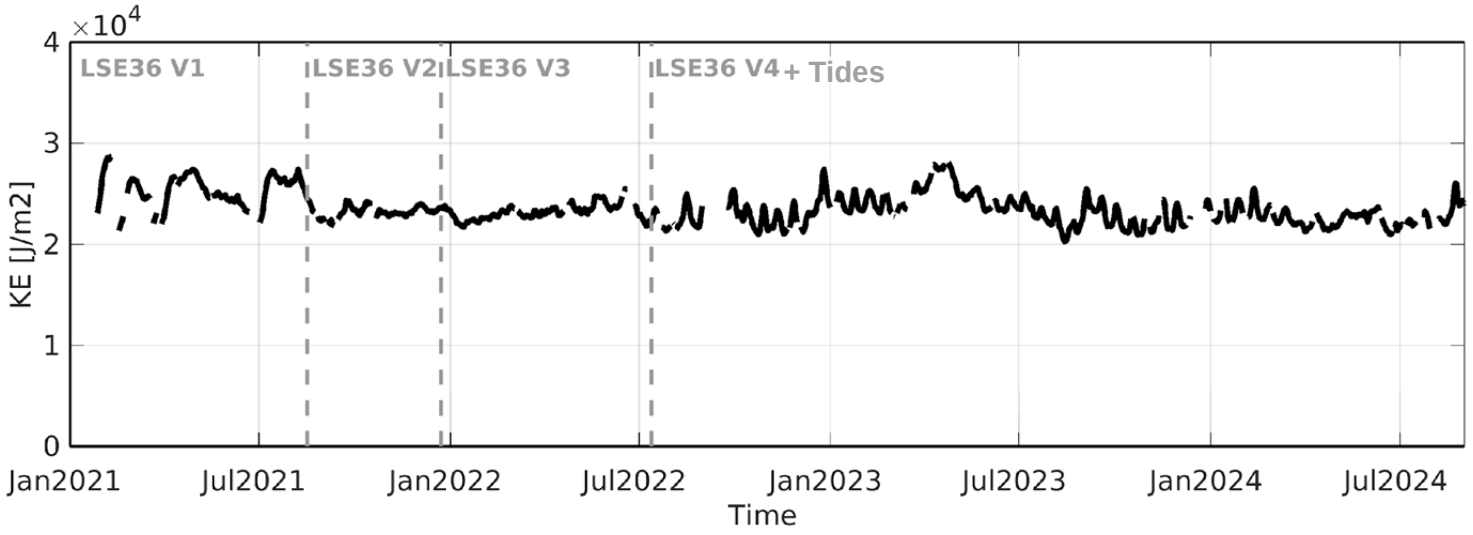
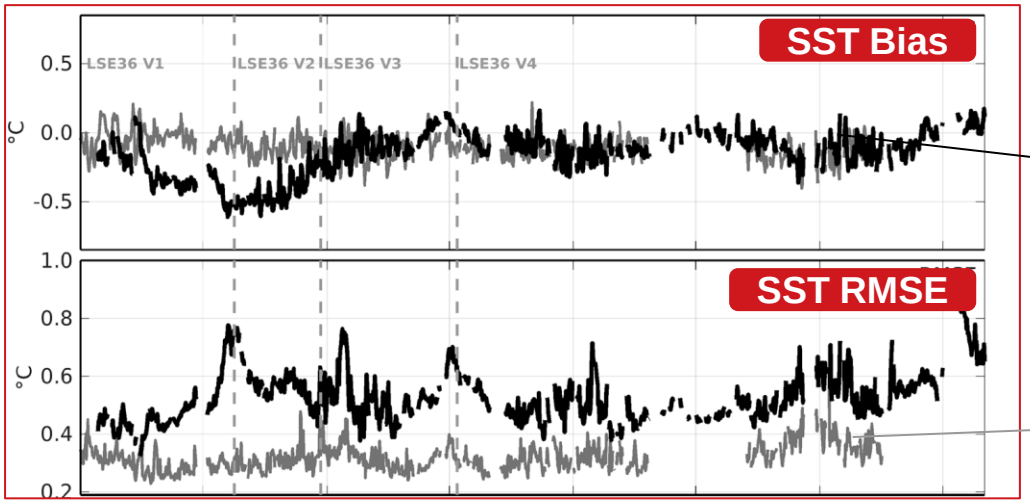




DA performance: assimilated remote observations



Analysis
LSE36-LOF/COPPE

GOF 3.1

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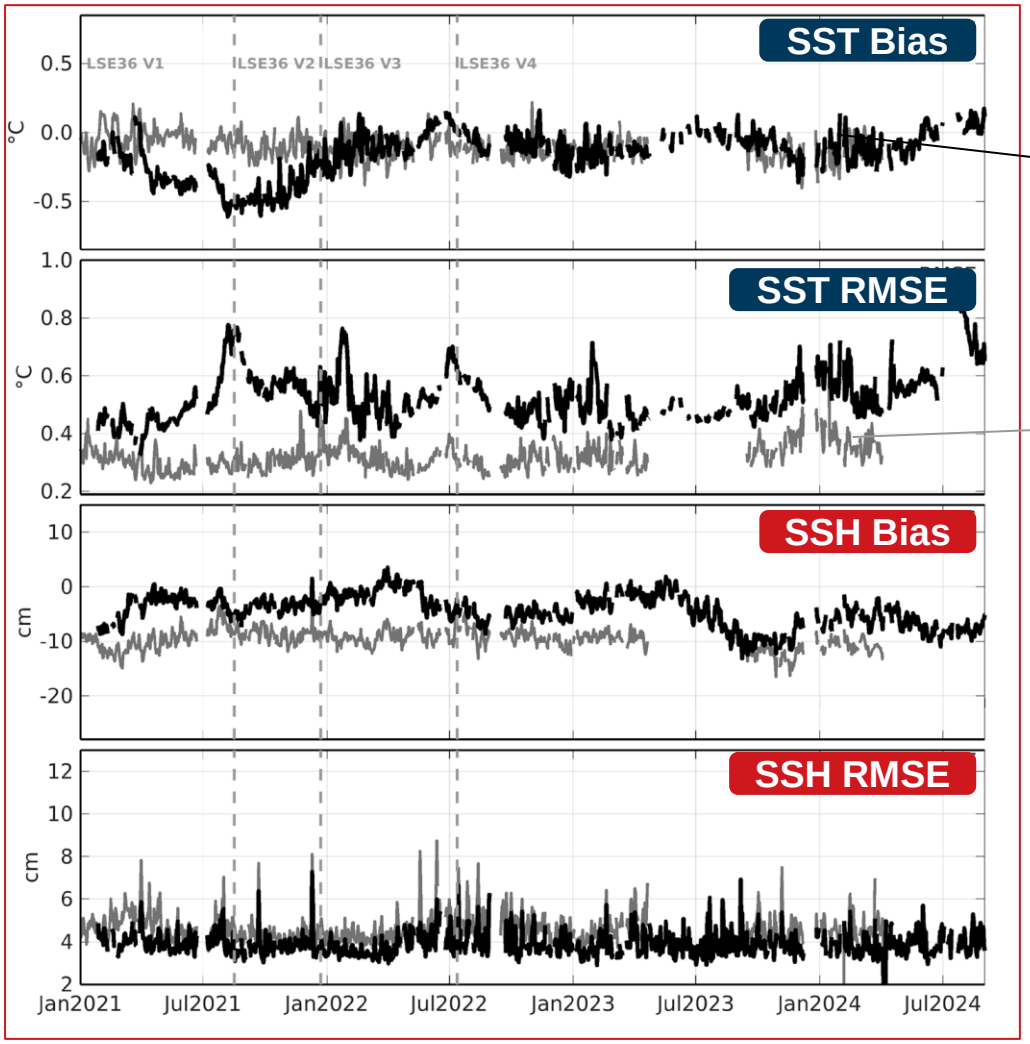

Analysis
LSE36-LOF/COPPE

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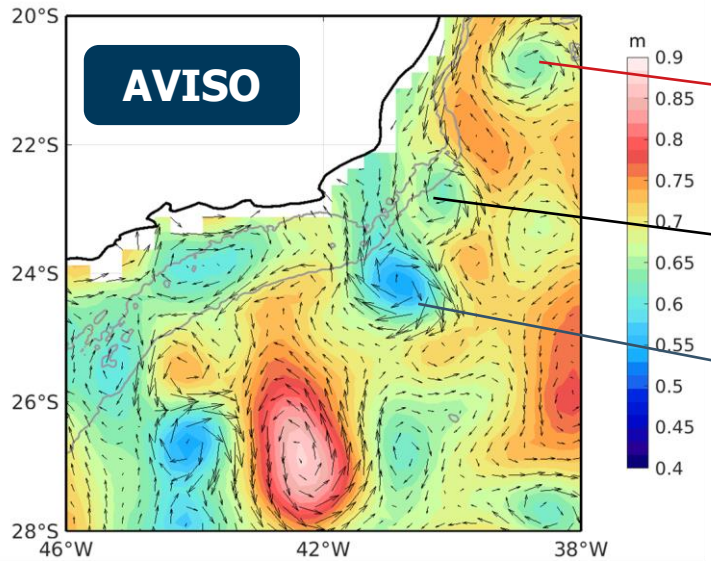
DA performance: mesoscale features



Vitória Eddy

Sao Tome Eddy

Cabo Frio Eddy

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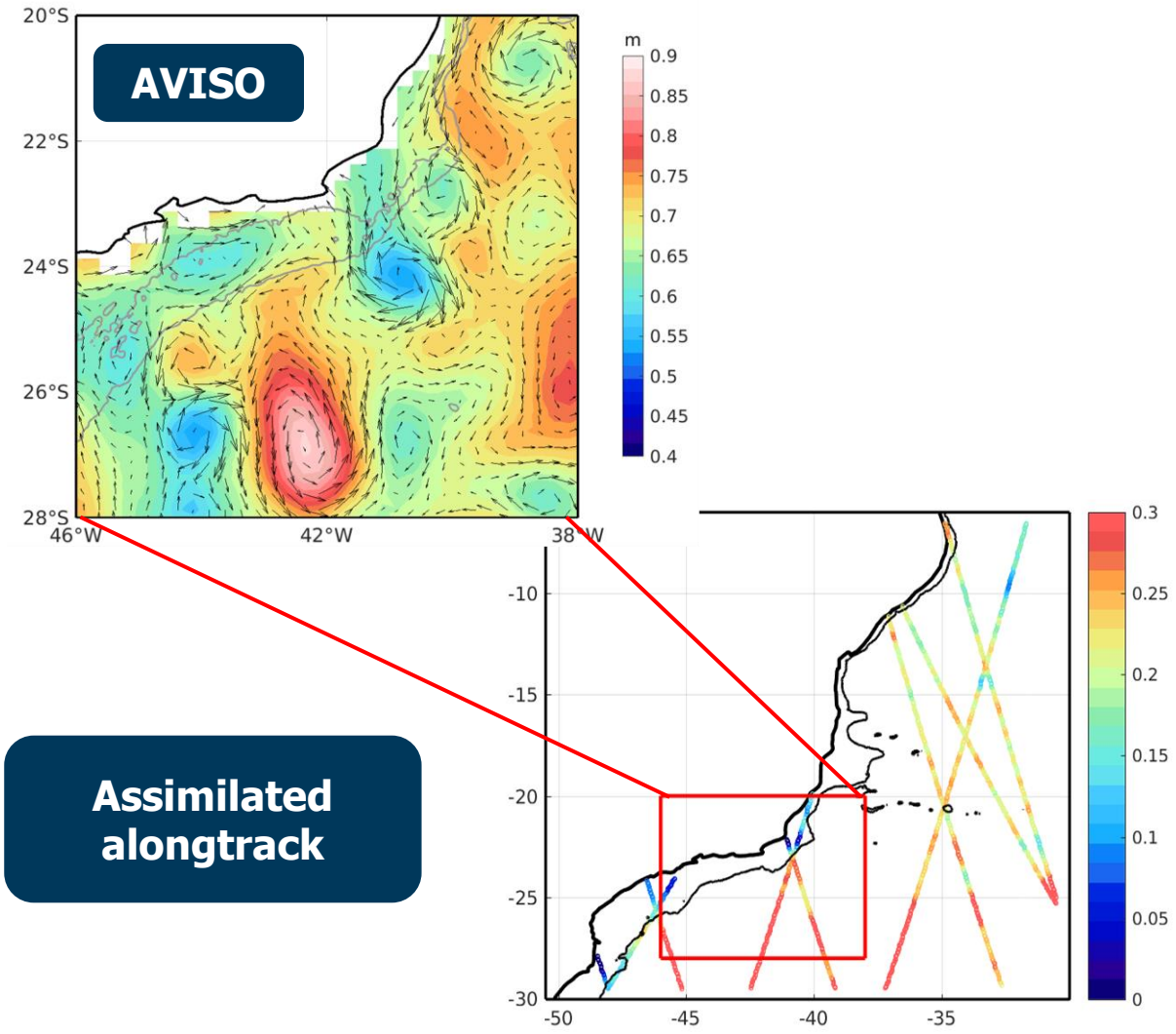
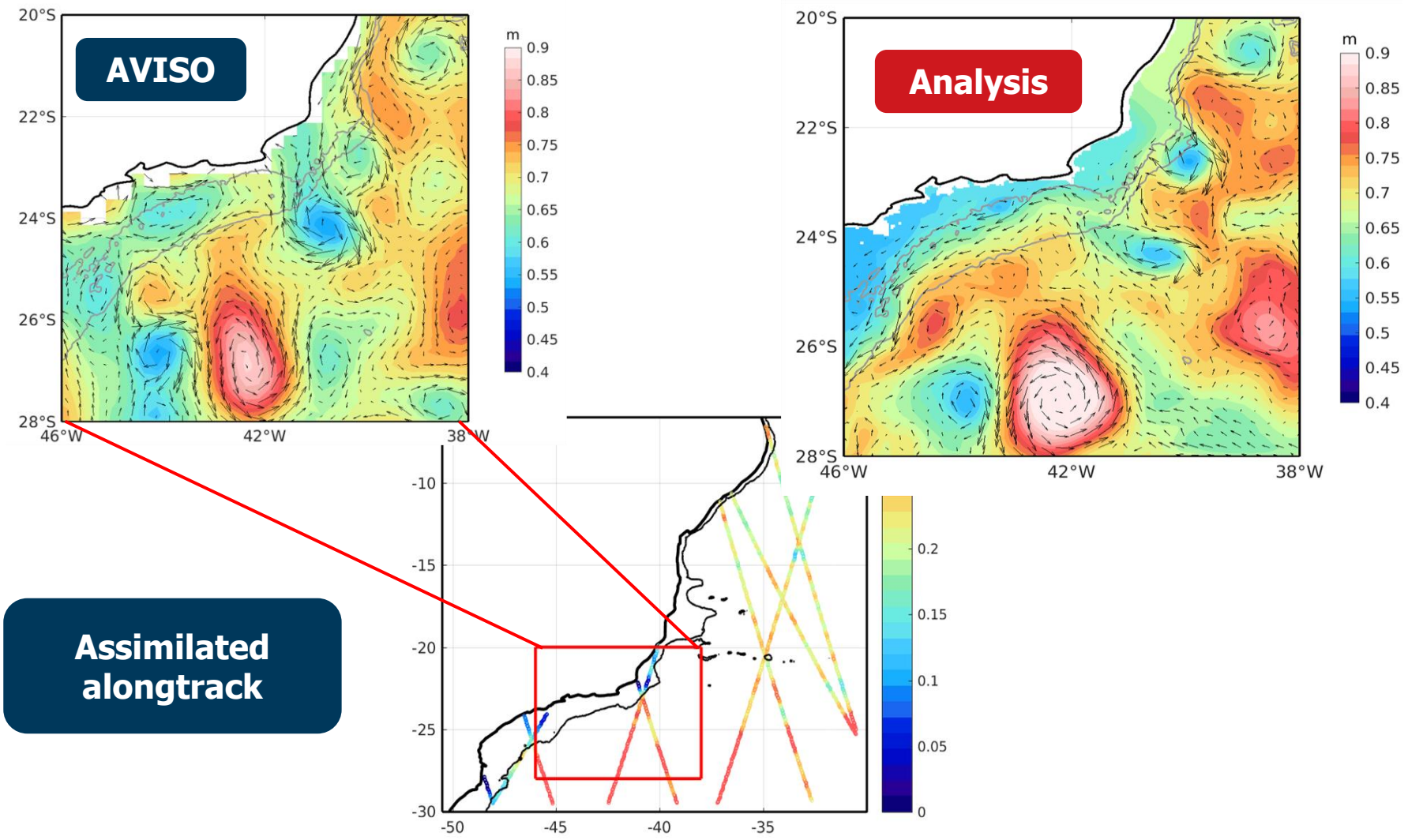


Assimilated alongtrack

DA performance: mesoscale features



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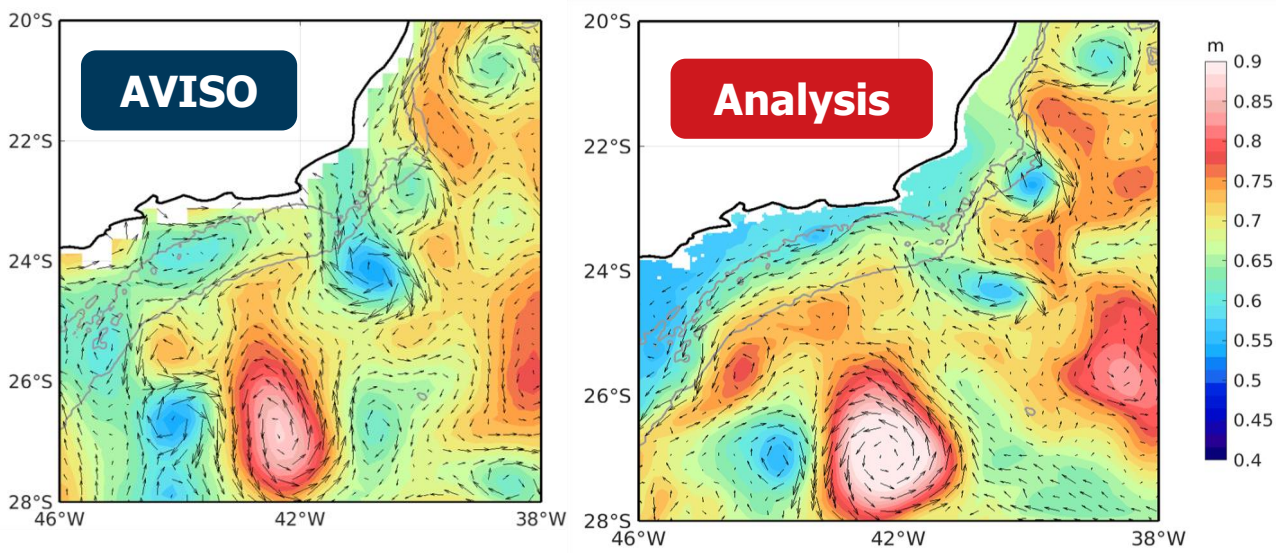
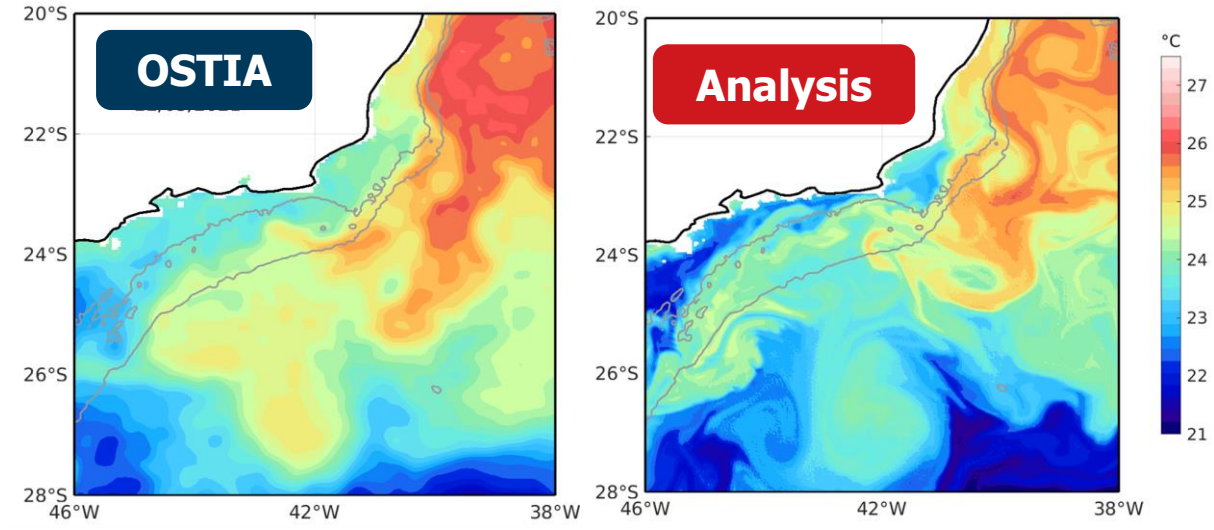


SSH



TSM

LSE36-LOF/COPPE System Predictability:

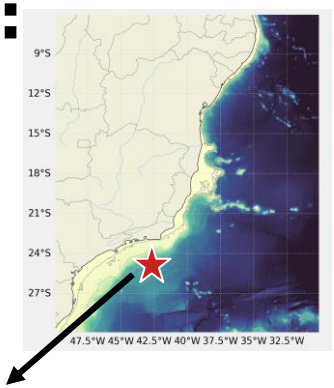
$$SKILL = \frac{2(1+R)}{\left(\frac{\sigma_m}{\sigma_d} + \frac{\sigma_d}{\sigma_m}\right)^2}$$

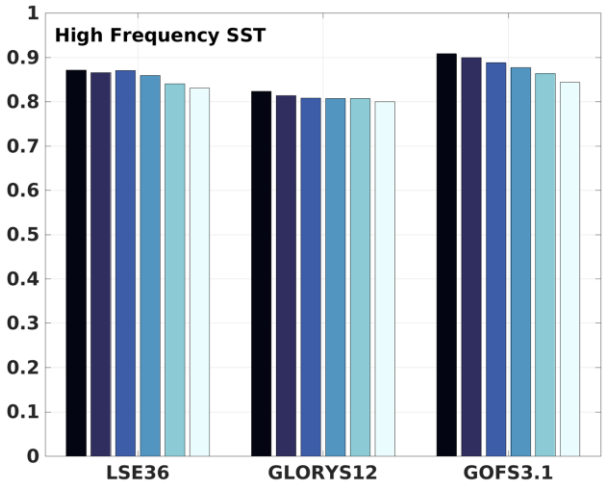
$R = Correlation\ coefficient$

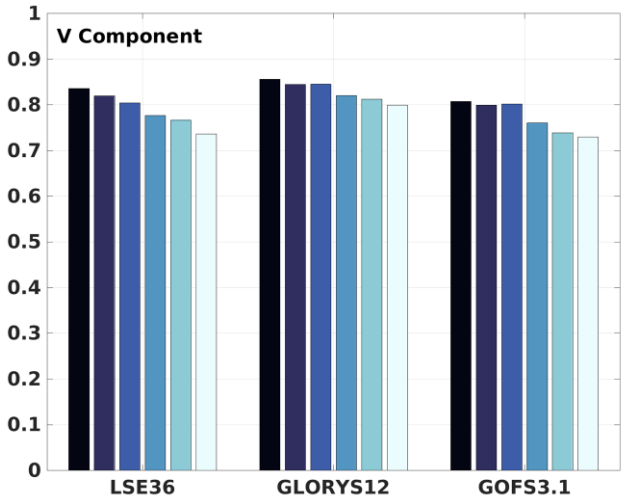
$\sigma_m = Model\ results\ standard\ deviation$

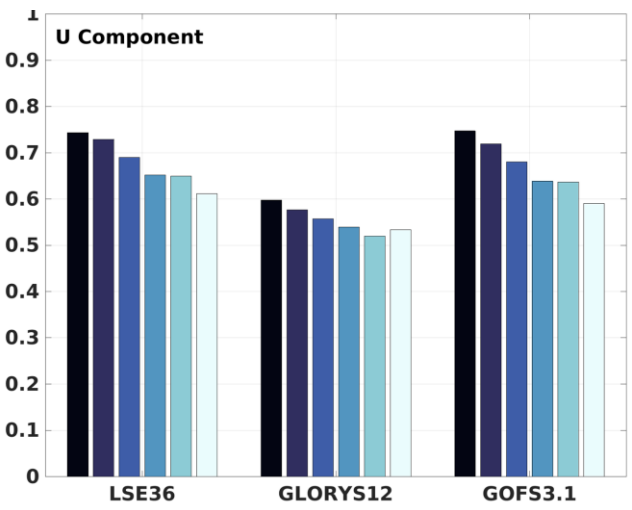
$\sigma_d = Data\ standard\ deviation$

(Taylor, 2001)









Final remarks:

- ✓ **LSE36-LOF/COPPE forecast system simulates the main features of the local ocean circulation, both their mean and variability for all important frequency bands observed in the data.**

- ✓ **Data assimilation was proven effective in reducing certain model biases, and particularly in accurately positioning mesoscale features, such as the Brazil Current meanders and eddies.**

- ✓ **The generated forecasts are on par, and at times outperform, the available global forecast systems.**

Higher resolution + Tides ✓

LSE36-LOF/COPPE
progress in ocean forecast in Brazil

Physical Oceanography Laboratory
LOF/COPPE

Thank you!

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