

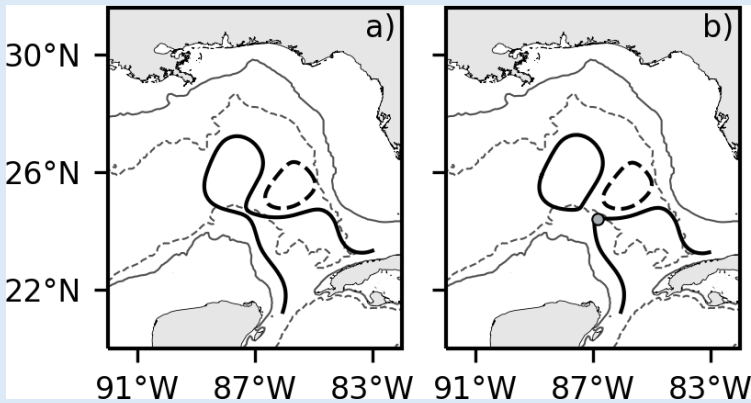
OSEs in the Gulf of Mexico: Impact of adaptive observations

Eric Chassignet

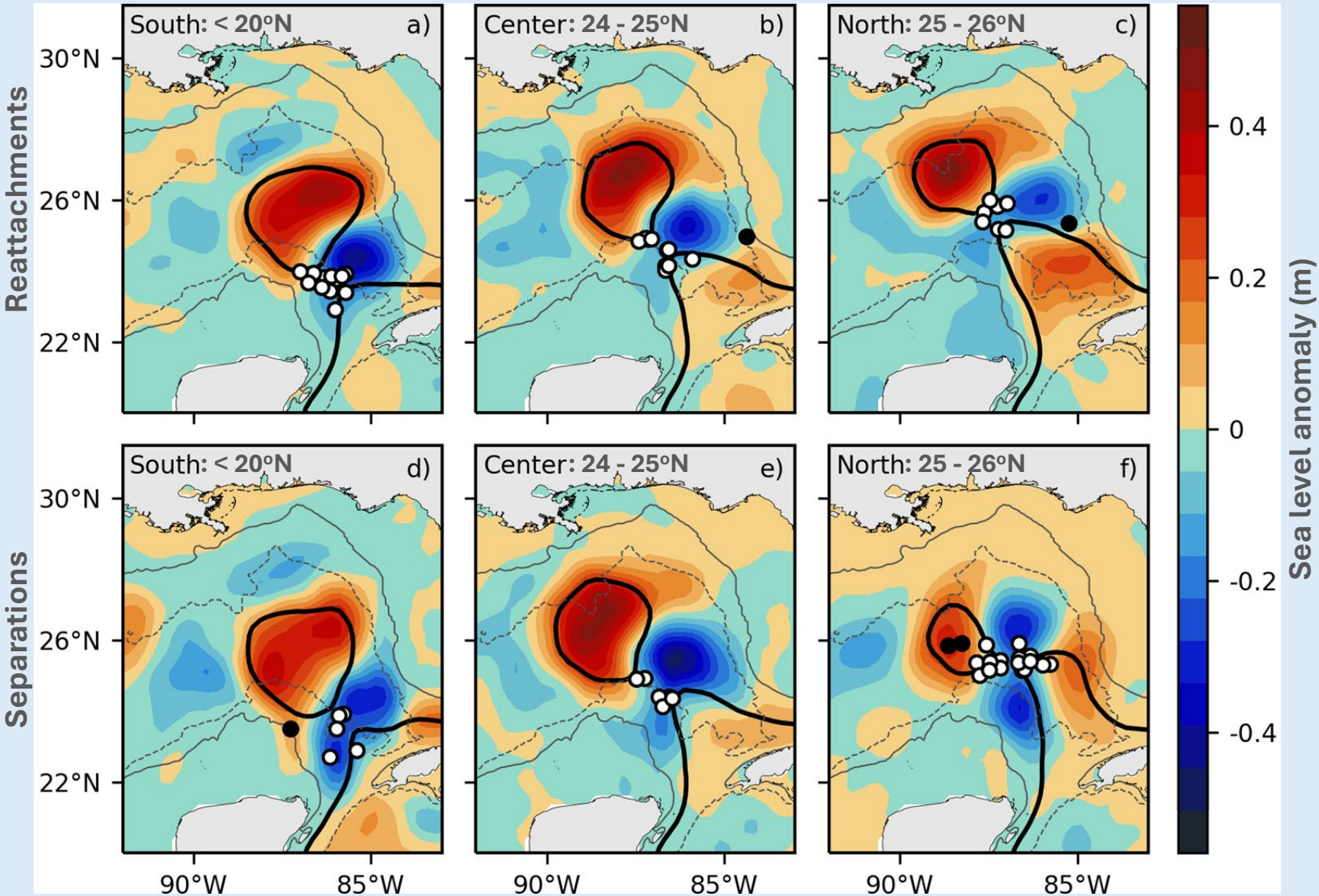
Center for Ocean-Atmospheric Predictions Studies
Florida State University

Statistics from AVISO 25 km gridded maps from (1993-2022)

Sea level anomaly composites during detachment events



White dots correspond to the locations where and eddy sheds from the Loop Current



Statistics from AVISO 25 km gridded maps from (1993-2022)

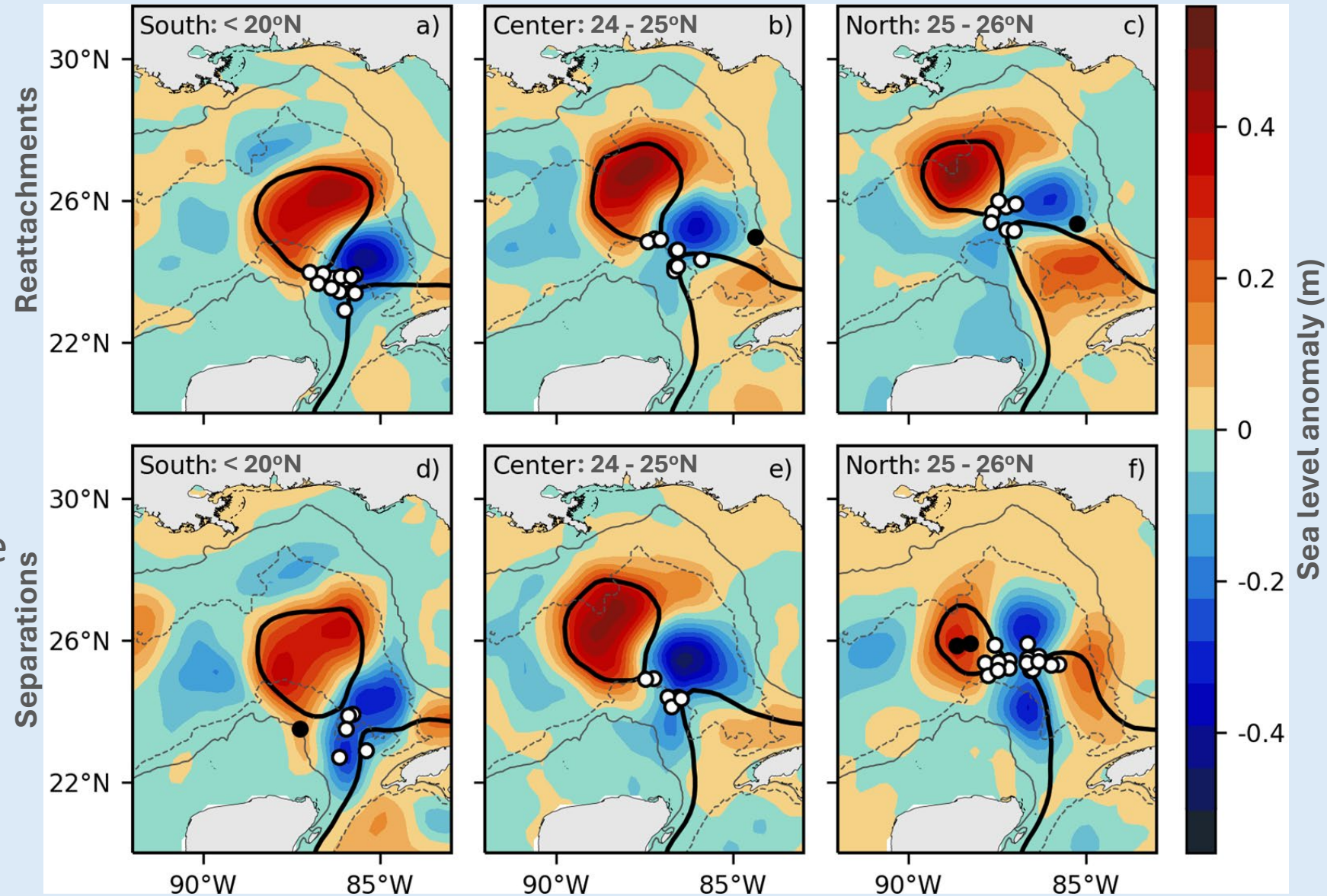
Sea level anomaly composites during detachment events

Reattachments involve:

- Cyclonic eddies only to the east of the Loop Current

Separations involve:

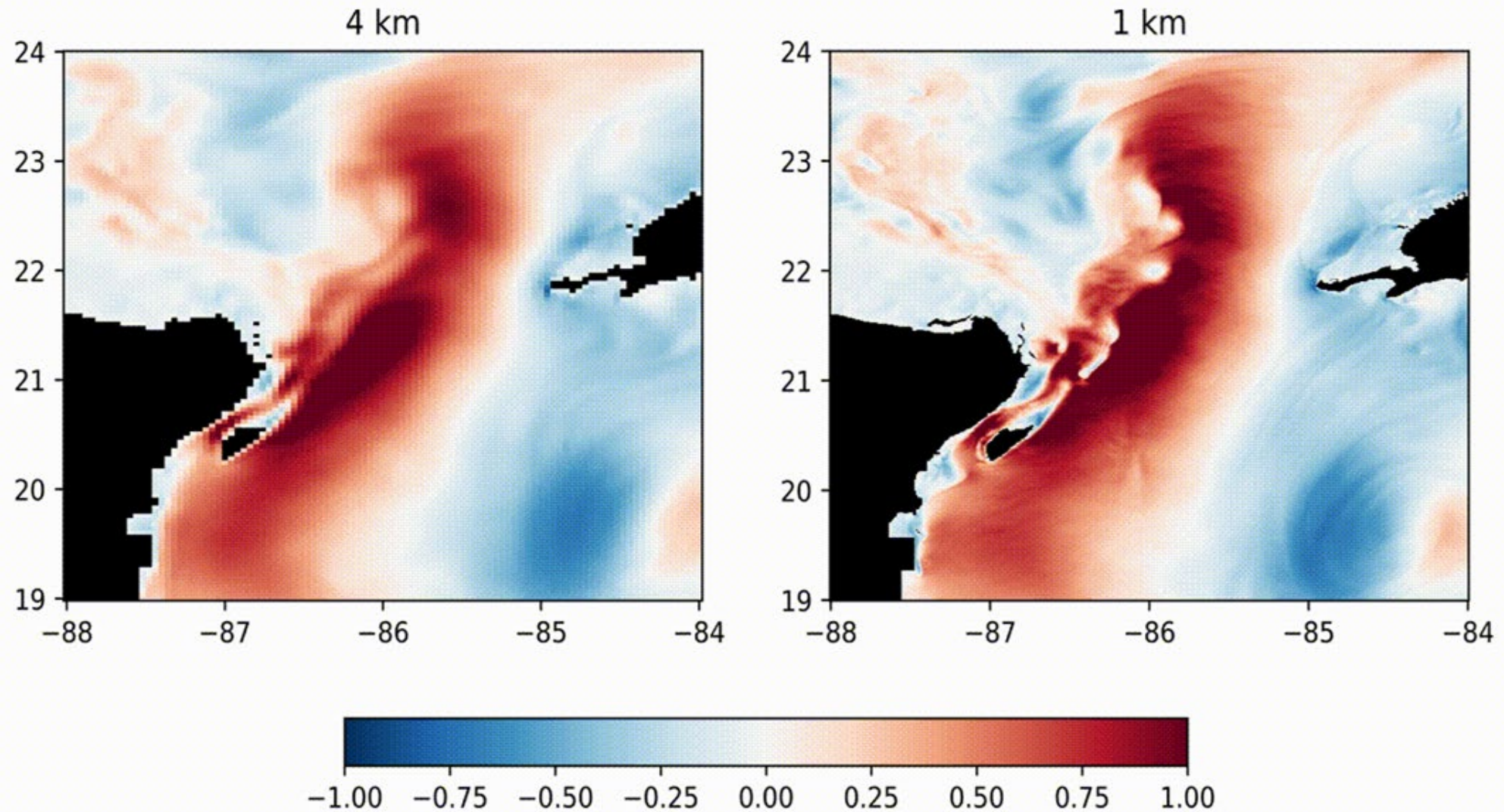
- Cyclonic eddies both to the east and west of the Loop Current



Question

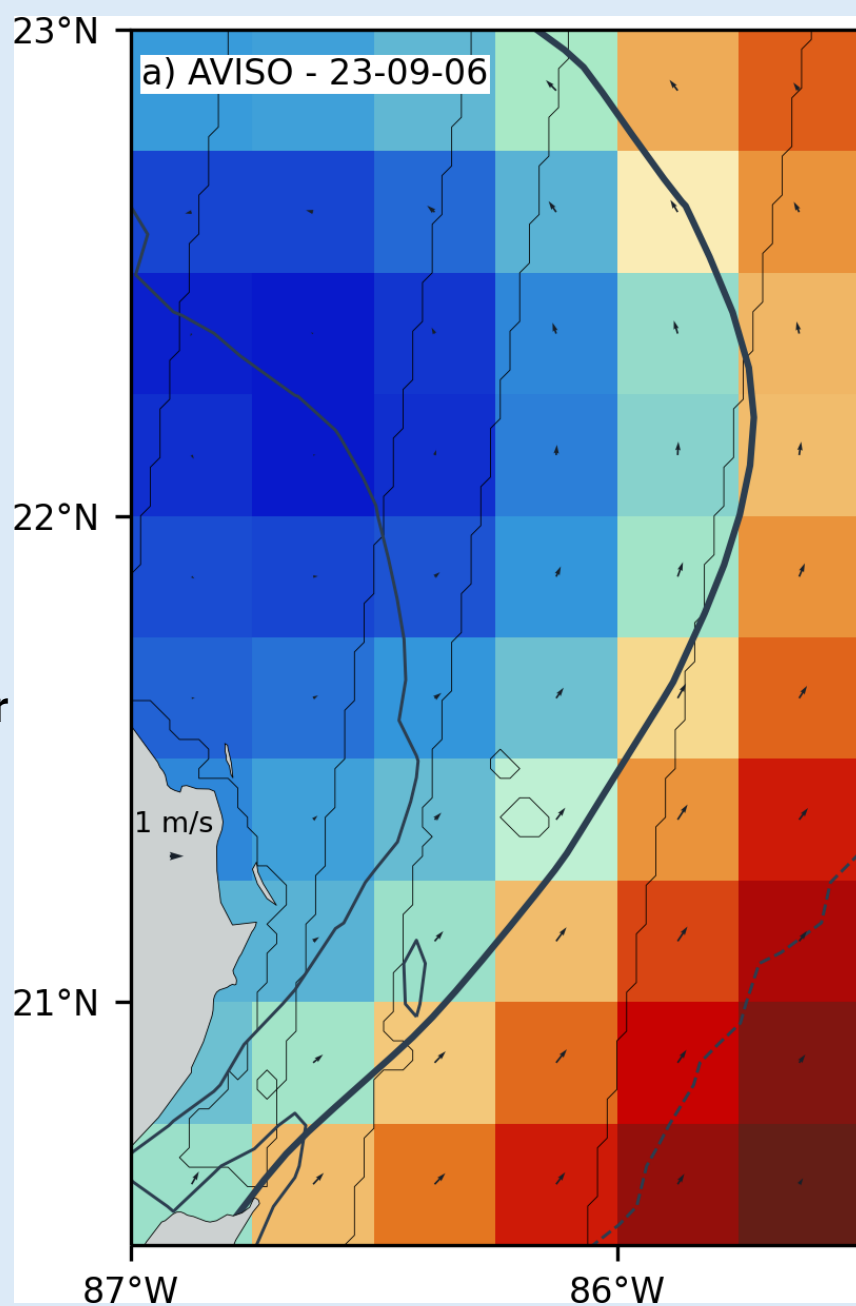
Can a better positioning of the cyclonic eddies around the Loop Current improve eddy separation predictions?

v-velocity, Date: 2020-01-22:00

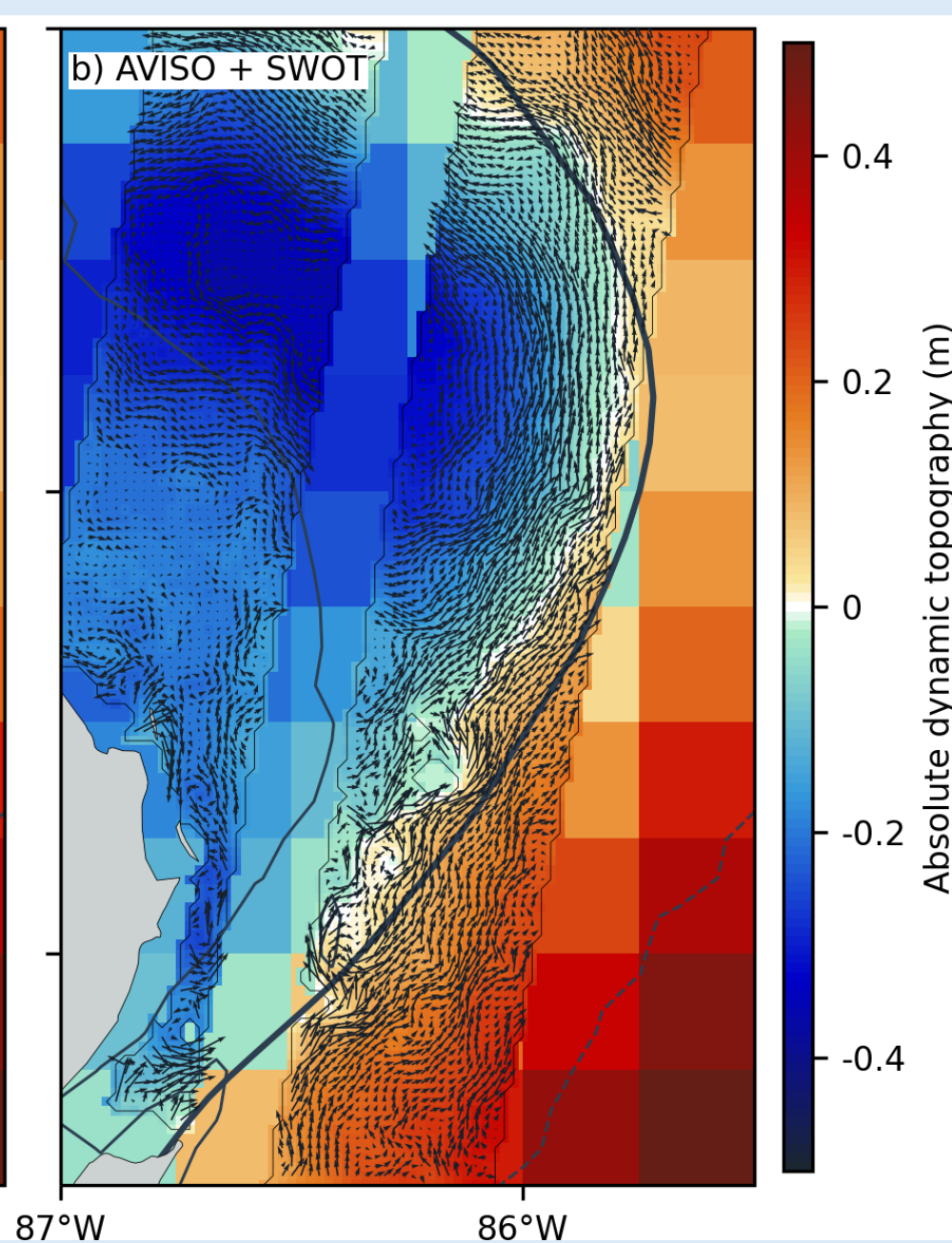


Significant differences in the bathymetry => generation of cyclonic eddies downstream of Cozumel in the 1 km HYCOM configuration

AVISO
interpolated Nadir
altimeters



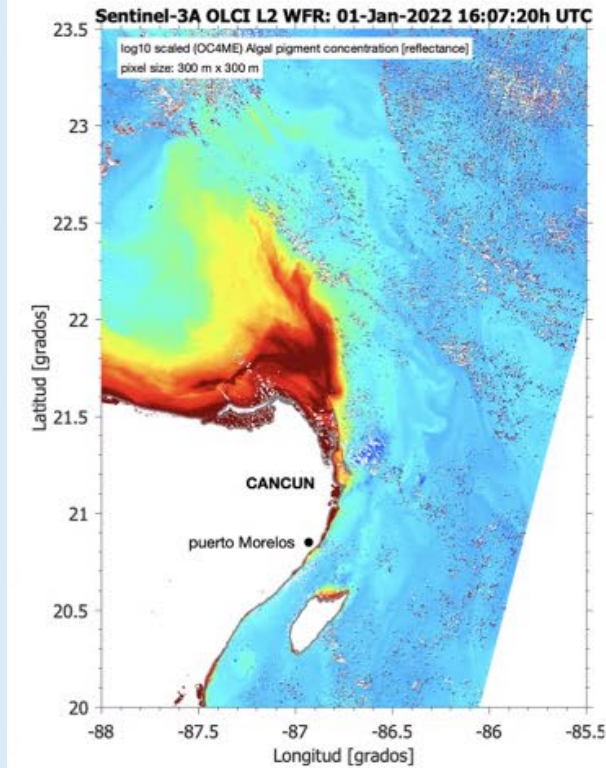
Geostrophic velocities



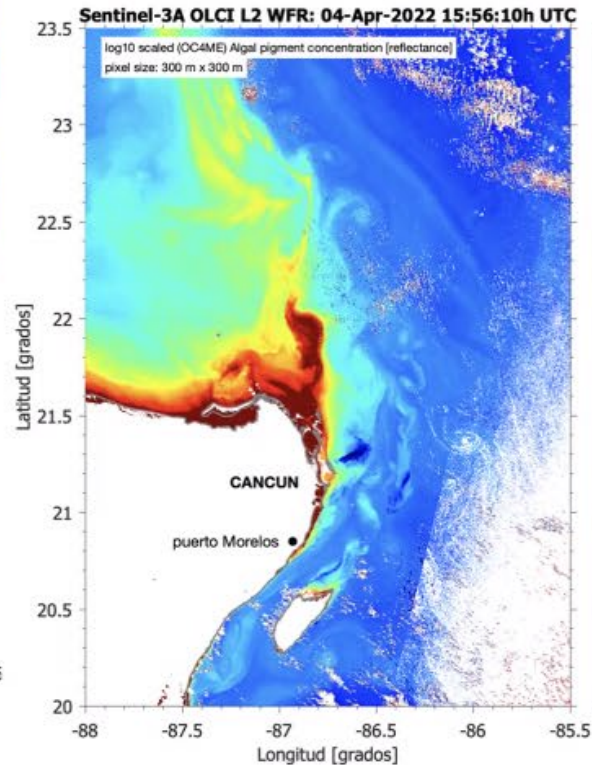
SWOT

Small cyclonic eddies (~10km) at the western side of the Yucatán Channel

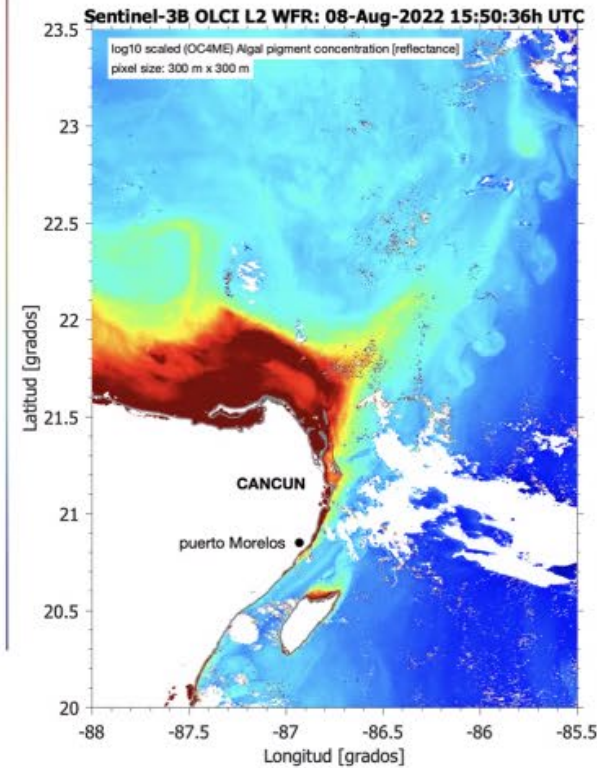
...they appear to be persistent throughout the year!



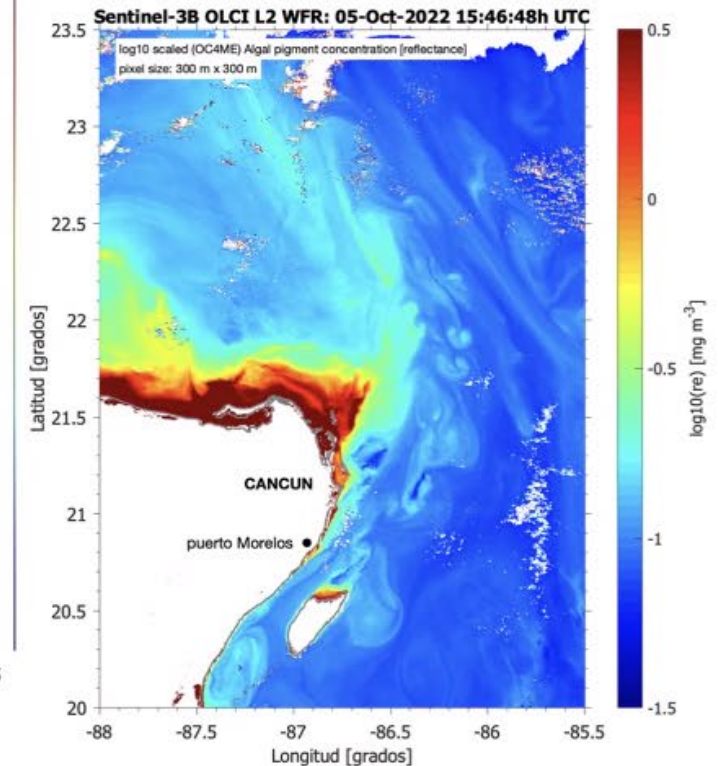
1 January 2022



4 April 2022



8 August 2022



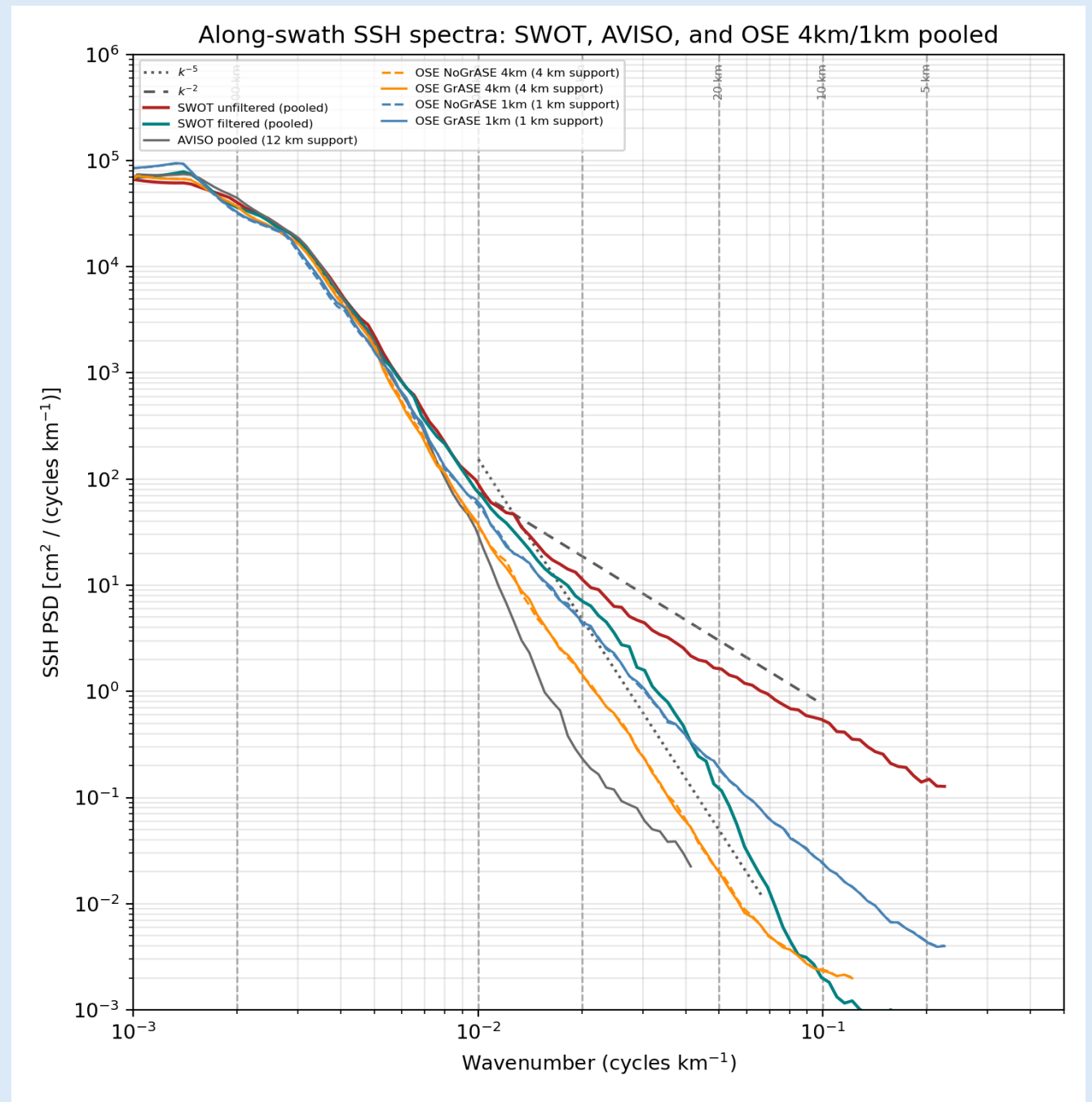
5 October 2022

source: Sentinel-3 L2 WFR product: Algal pigment concentration (OC4ME) in [mg m⁻³]

Slide courtesy of J. Sheinbaum (CICESE)

Hindcasts Metrics: SSH spectra along SWOT swaths

Deep red : SWOT unfiltered
Green: 16km Gaussian filtered SWOT
Blue: 1km HYCOM
Orange: 4km HYCOM
Black: AVISO 1/8° gridded

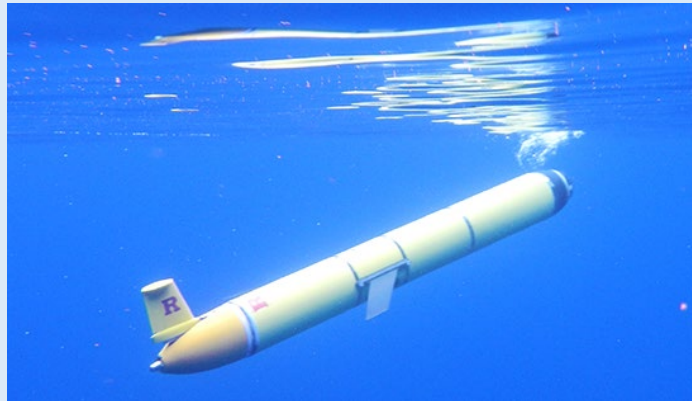


GRand Adaptive Sampling Experiment (GRASE) adaptive sampling targets

Goal: Assess the value of adaptively sampled observations for improving forecasts of the Gulf of Mexico Loop Current System

1. Cyclonic eddies associated with LC meanders and the Tortugas Eddy
2. Yucatan Current structure and eddies
3. The so-called barrier eddy, a cyclonic feature that forms between a retracted LC and recently shed LCE

Value of adaptively sampled observations (gliders and floats) and SWOT to be assessed through ocean model Observing System Experiments (OSE) – data withholding



Observing system experiments (OSEs)

Steps:

- Perform **hindcast** with usual observations (SLA, SST, ARGO etc...) from **April 1st 2025 to the end of September 2025**.
- Perform **hindcast** with usual observations + **GRASE gliders (8) and profiling floats (6)** from **April 1st, 2025 to the end of September 2025**.
- Perform 3-month **forecasts** *every week* between April 15th, 2025 and end of September 2025, with initial conditions from hindcast **with** GRASE observations
- Perform 3-month **forecasts** *every week* between April 15th, 2025 and end of September 2025, with initial conditions from hindcast **without** GRASE observations

Hindcasts: HYCOM-TSIS 1 km

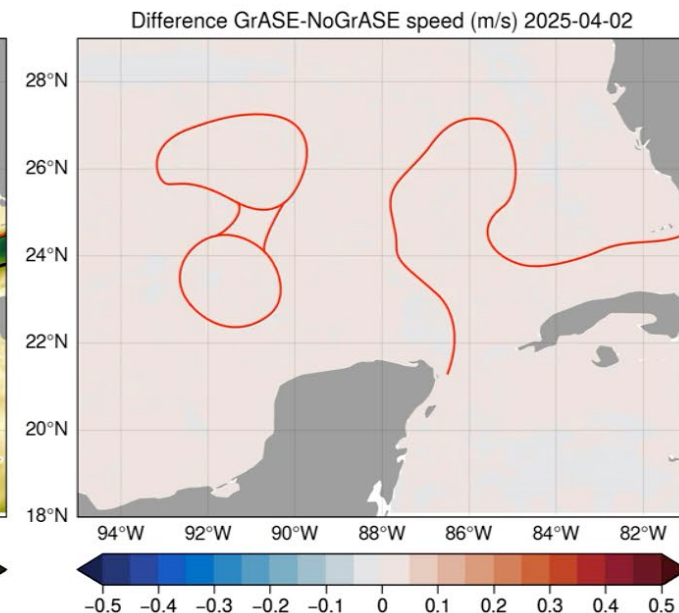
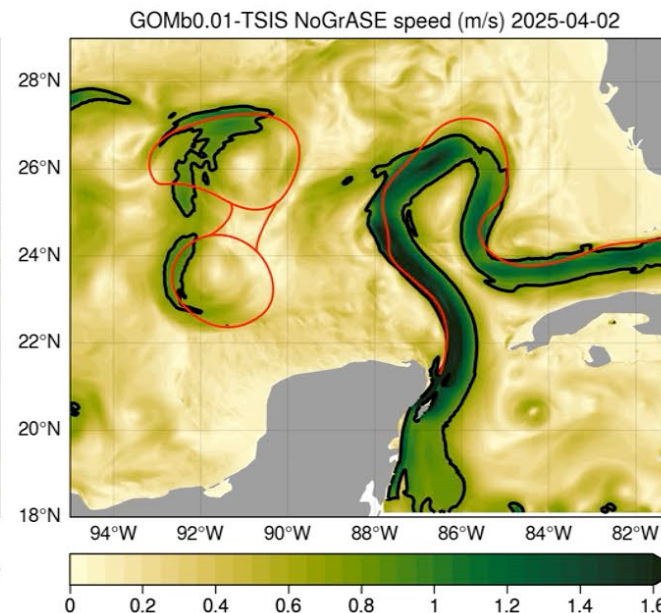
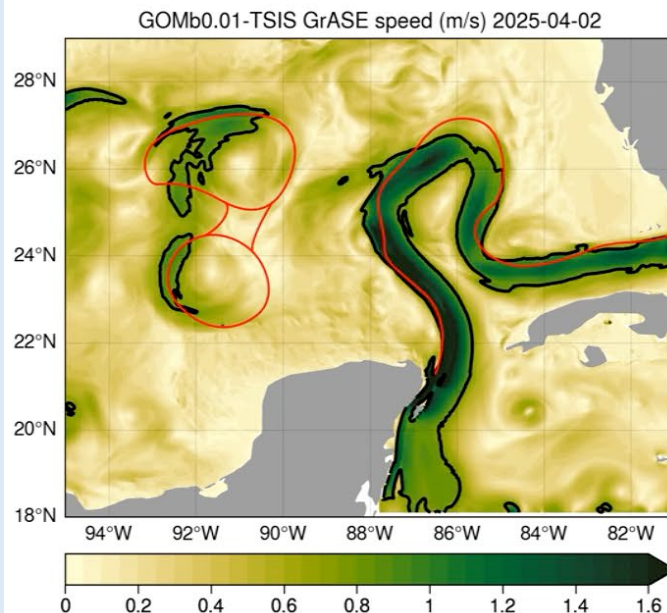
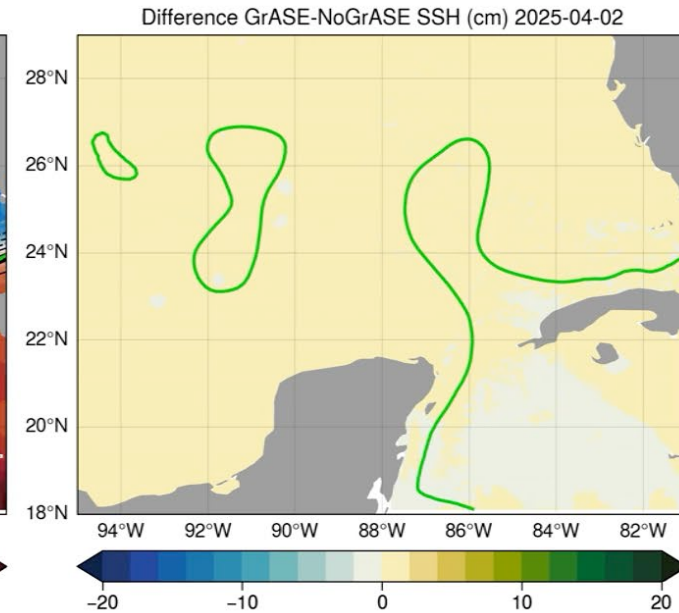
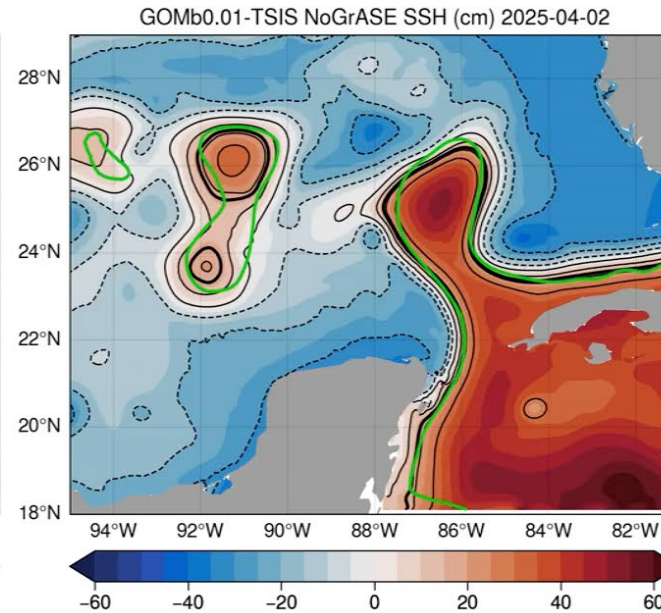
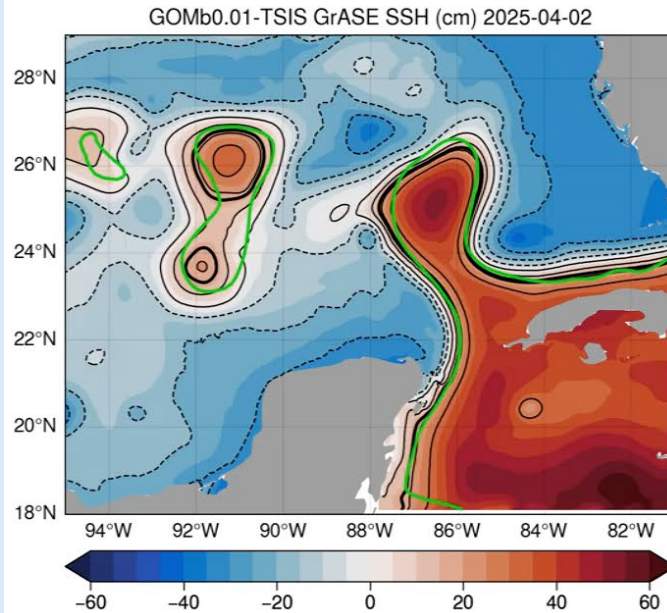
Green contour:
17cm AVISO
Black contour:
17cm model

SST

GRASE

NoGRASE

GRASE-NoGRASE



Red contour: WHG
front line
Black contour:
1.5knot model

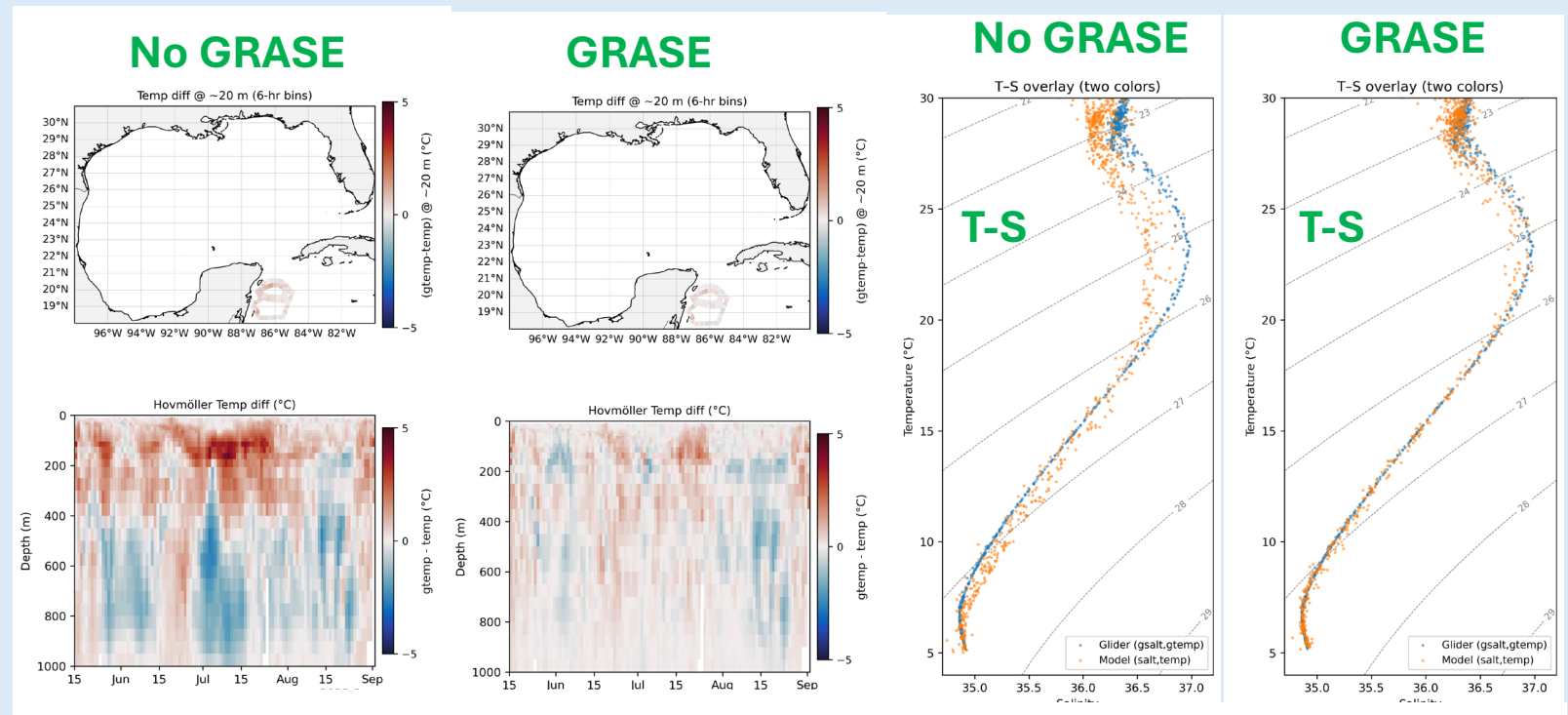
Speed

Red dots: gliders
Green stars: APEX floats

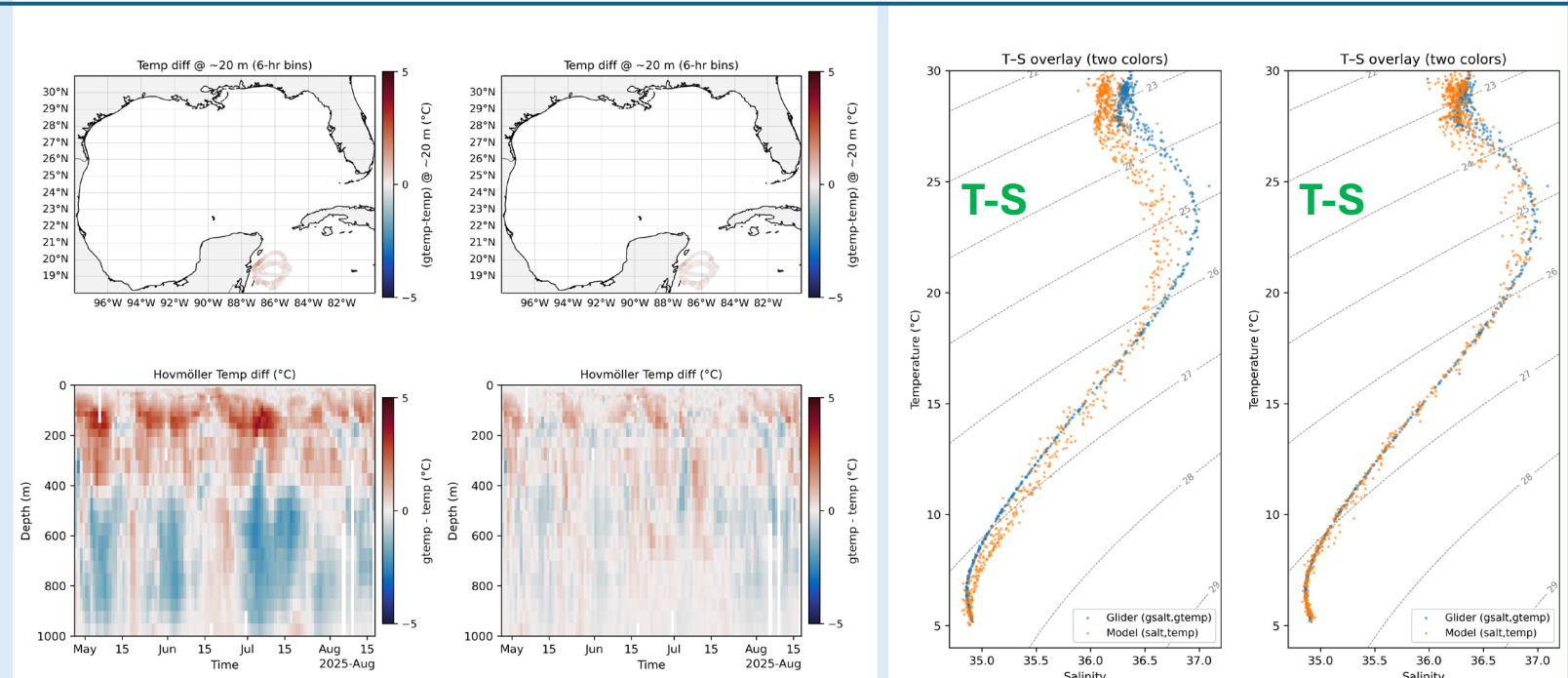
Hindcasts: Assimilation of gliders in HYCOM

Difference between HYCOM
and gliders profiles closer
after assimilation

Temperature
Glider sg622

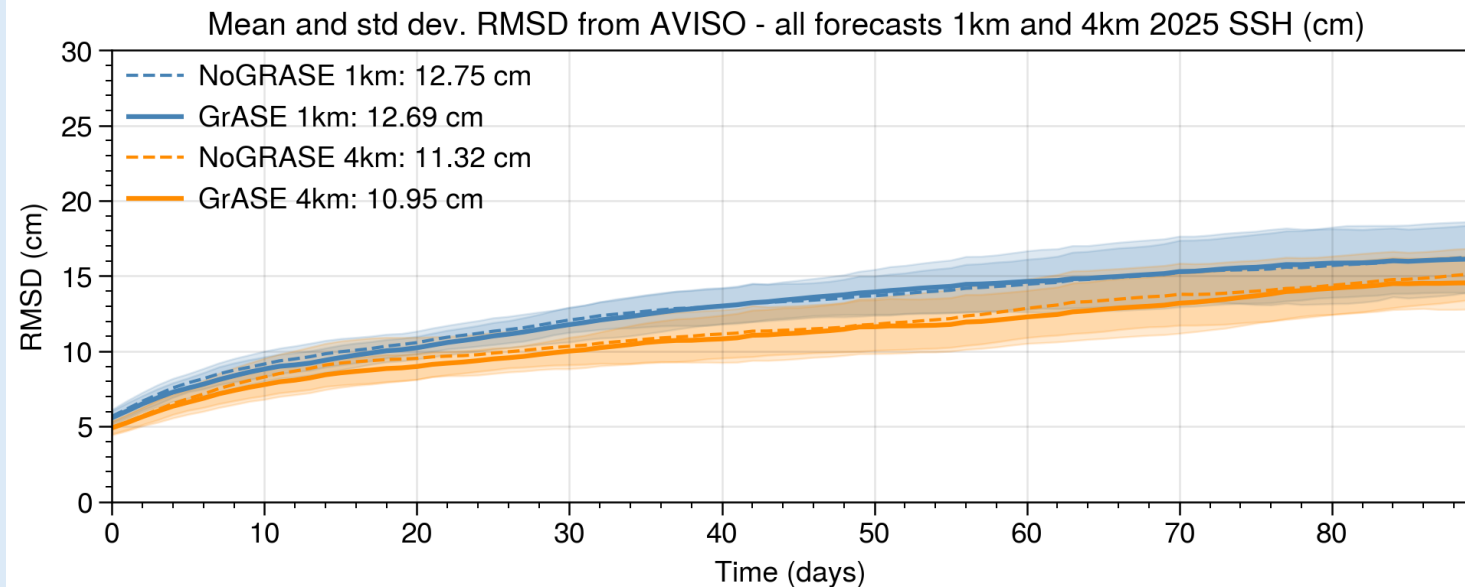
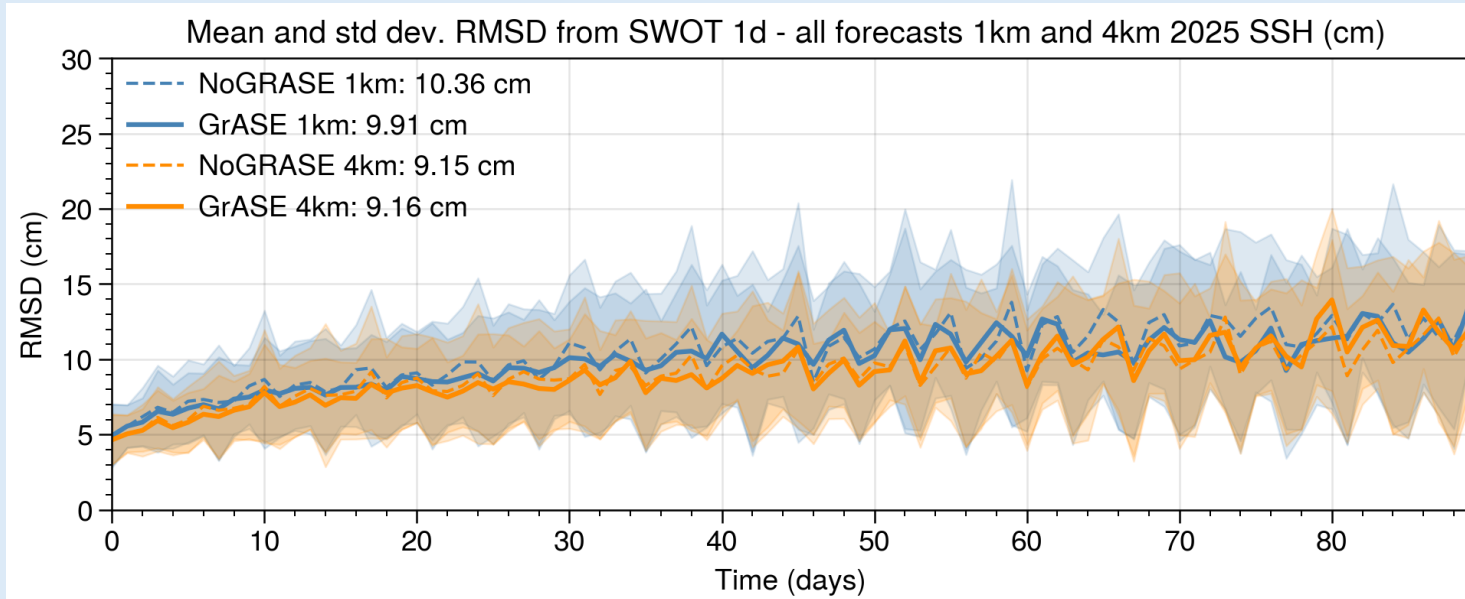


Temperature
Glider sg651

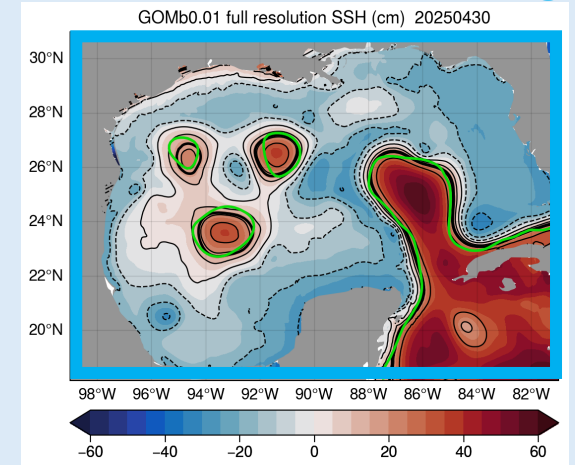


Forecasts Metrics: RMSD vs SWOT 1 day and AVISO

1 km vs. 4 km



RMSD calculated in this region

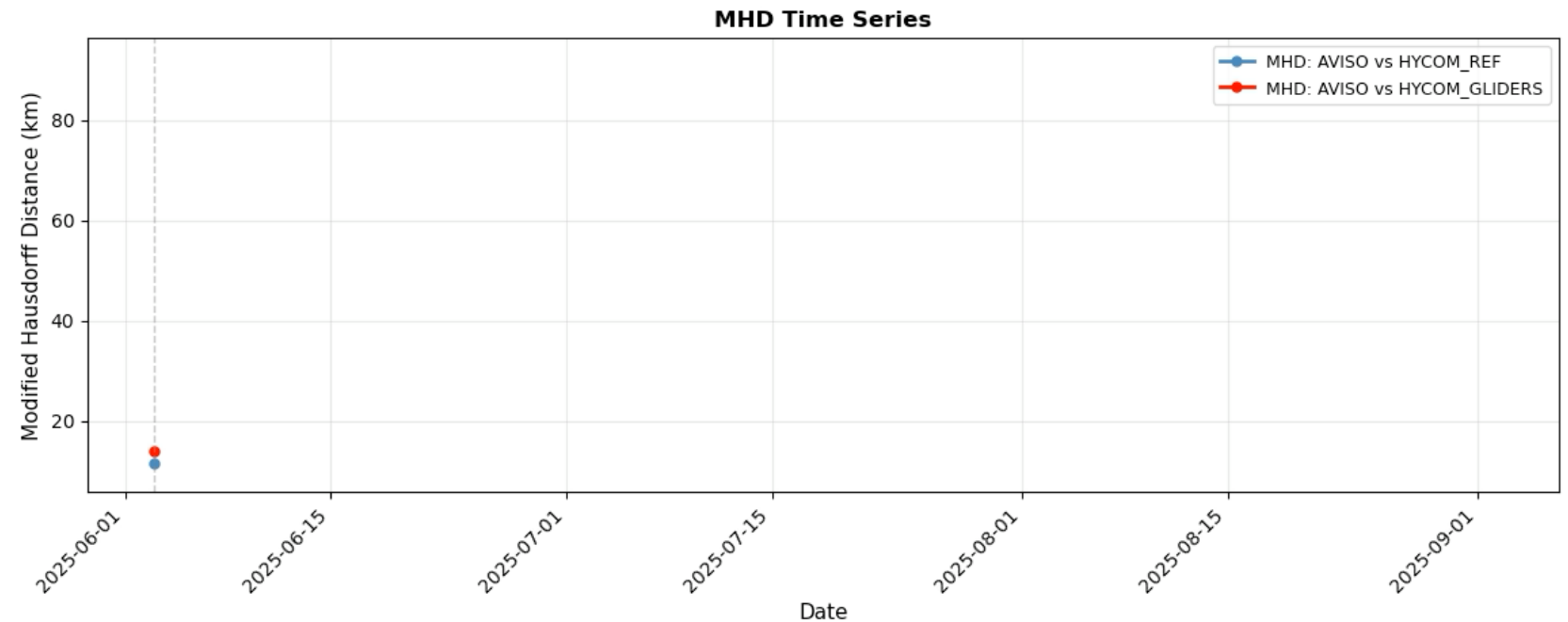
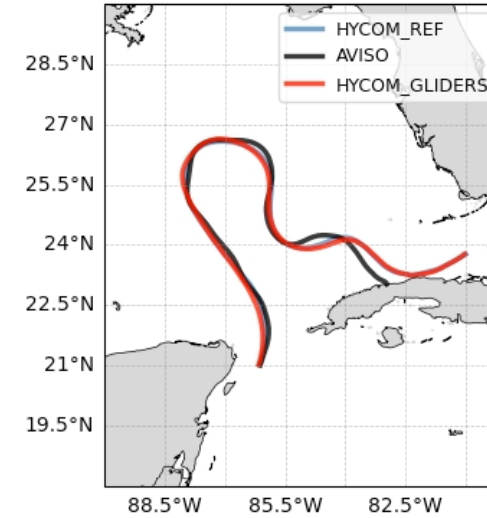


Metrics: Modified Hausdorff Distance (MHD)

Modified Hausdorff Distance (MHD):

- **Measures shape similarity:** Quantifies similarity between contours by computing distances between corresponding points.
- **Uses mean nearest-neighbor distances:** For each point in one contour, finds the distance to the nearest point in the other contour, then takes the mean.
- **Symmetric metric:** Computes distances in both directions and returns the maximum of the two means.

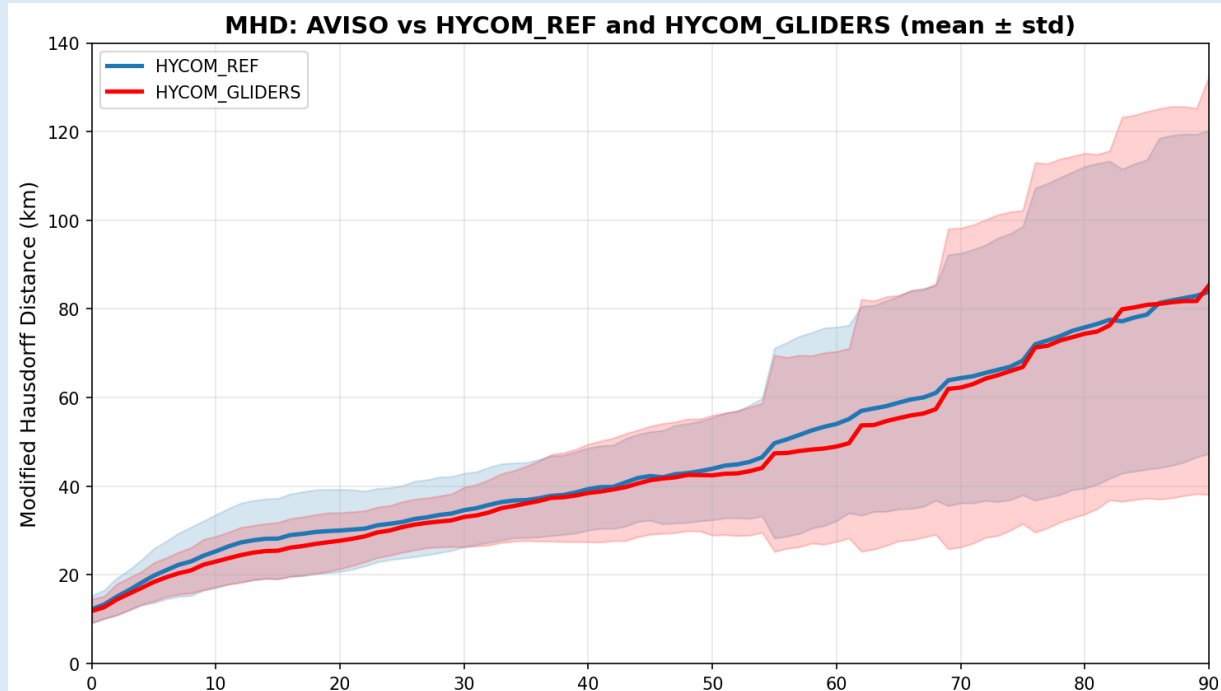
Loop Current & Mean LCE Contours - 06/03/2025



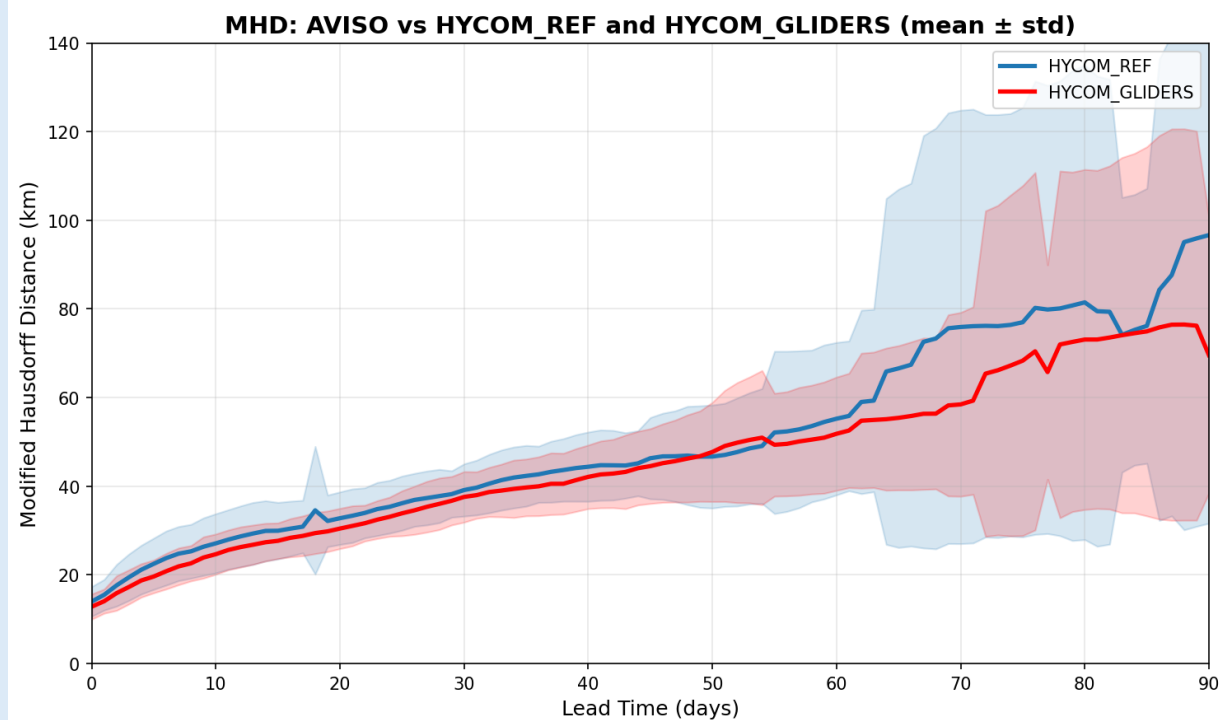
Forecasts Metrics: MHD 1 km and 4 km (92W-81,21N-29N)

Forecasts with **GRASE** data
slightly lower **MHD** in the 4 km
and 1 km **HYCOM**

4km



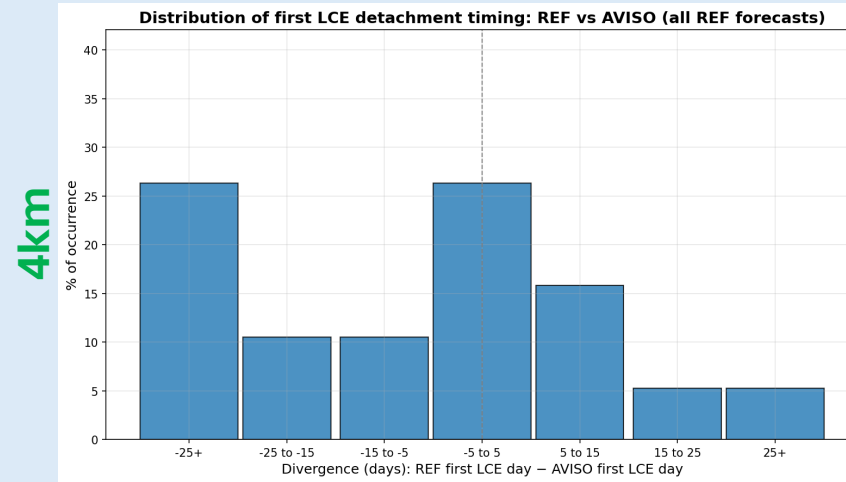
1km



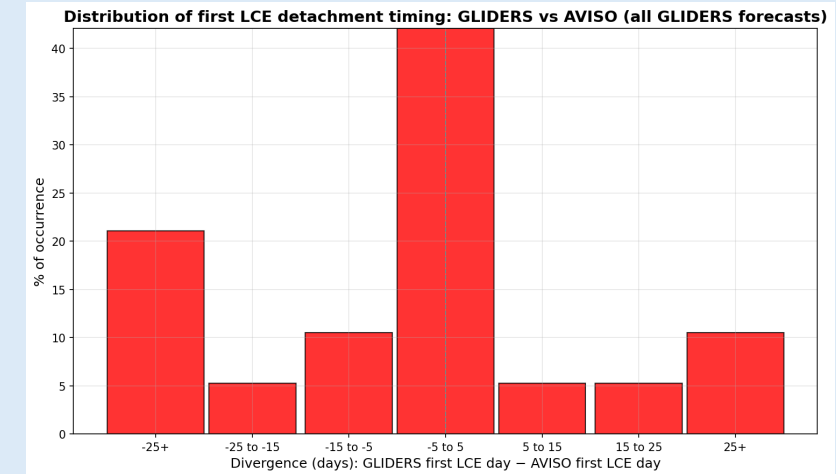
Forecasts Metrics: LCE detachment distribution vs. AVISO (92W-81W;21N-29N)

- **Northernmost LC extension** latitudes are obtained
- A **drop of at least 2°** indicates an LCE **detachment**

NoGRASE

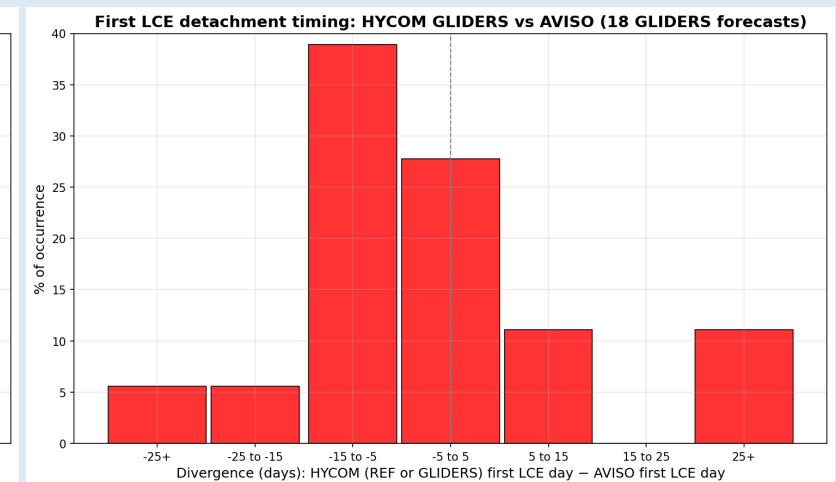
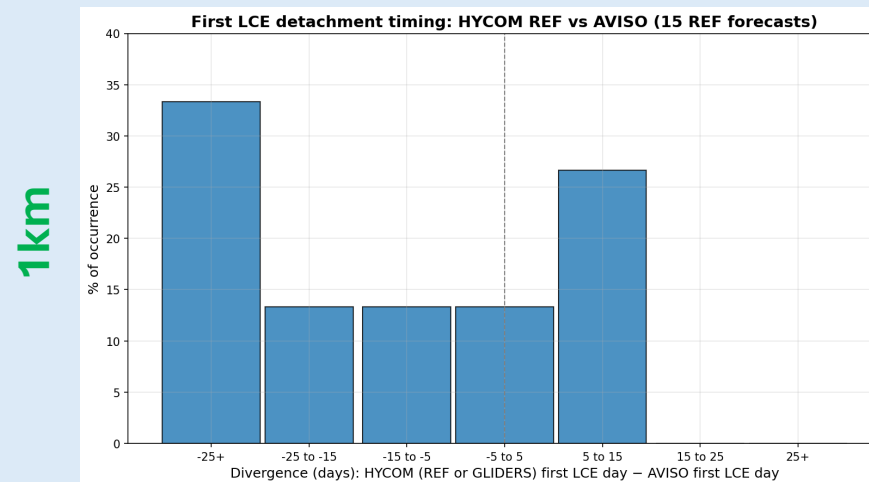


GRASE



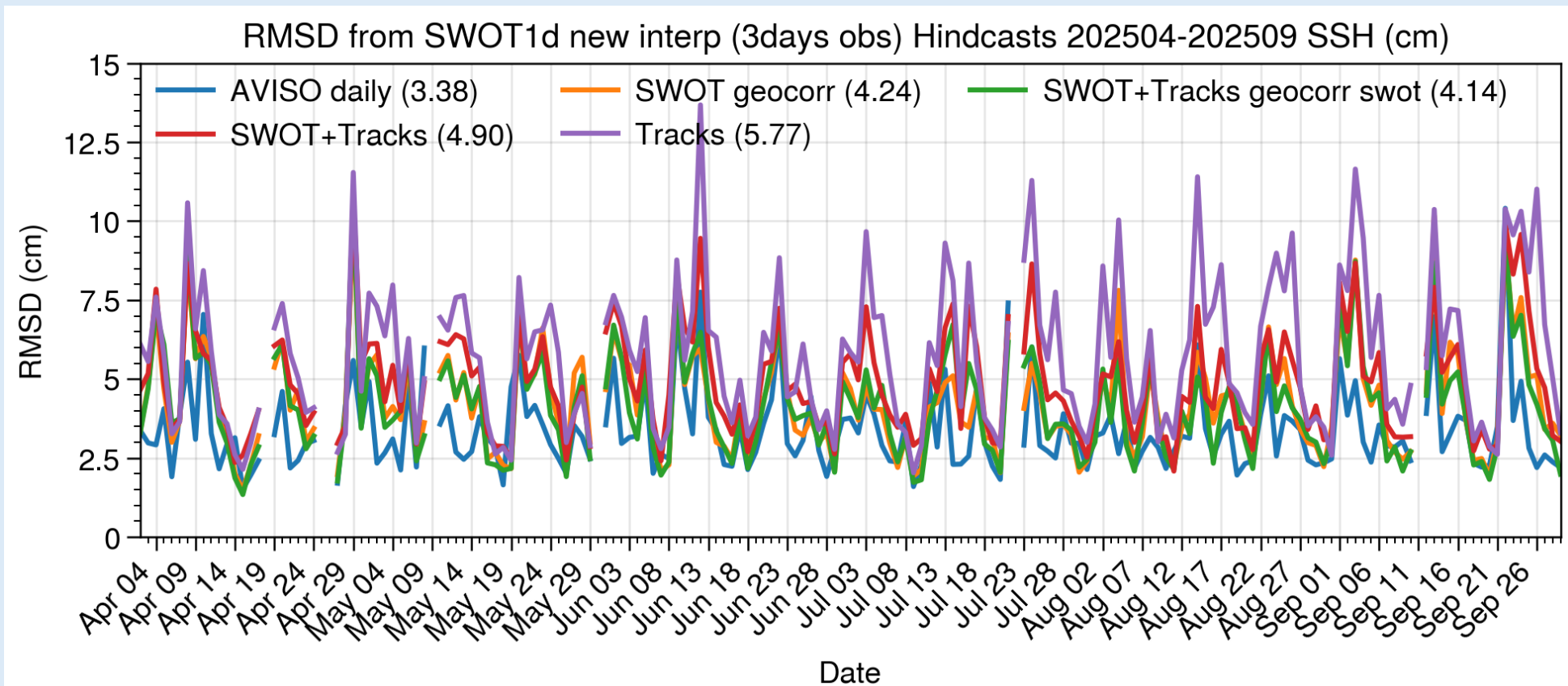
Distribution of the timing of the first LCE detachment in HYCOM :

- **Positive values** indicate that AVISO LC detaches first
- **Negative values** indicate that HYCOM LC detaches first
- **Value 0**: both HYCOM and AVISO LC detach at the same time



Summary

- Assimilation of GRASE measurements has a positive impact on eddy separation, slightly better in the 1km configuration.
- In progress, quantification of the impact of assimilating the SWOT SLAs on hindcasts and forecasts



MHD from AVISO

