

A satellite with large solar panels is shown in orbit above the Earth's ocean surface. The satellite has a central body with various instruments and two large, rectangular solar panel arrays extended outwards. The Earth's curvature and blue oceans are visible in the background.

# Science Status: Ocean, Coasts, and Cryosphere

Ocean Pls

Thanks to WG leads for their contributions!

SWOT-ST Meeting  
14-17 October 2025, Arcachon

A satellite with large solar panels is shown in orbit above the Earth's ocean. The satellite has a central body with various instruments and two large, rectangular solar panel arrays extended outwards. The Earth's surface is visible below, showing a deep blue ocean with white-capped waves. The horizon of the Earth is visible in the distance, with a thin layer of white clouds at the edge of the atmosphere.

# Science Status: Ocean, **Coasts**, and Cryosphere

F. d'Ovidio, T. Farrar, L.-L. Fu

Dedicated session this afternoon

SWOT-ST Meeting  
14-17 October 2025, Arcachon



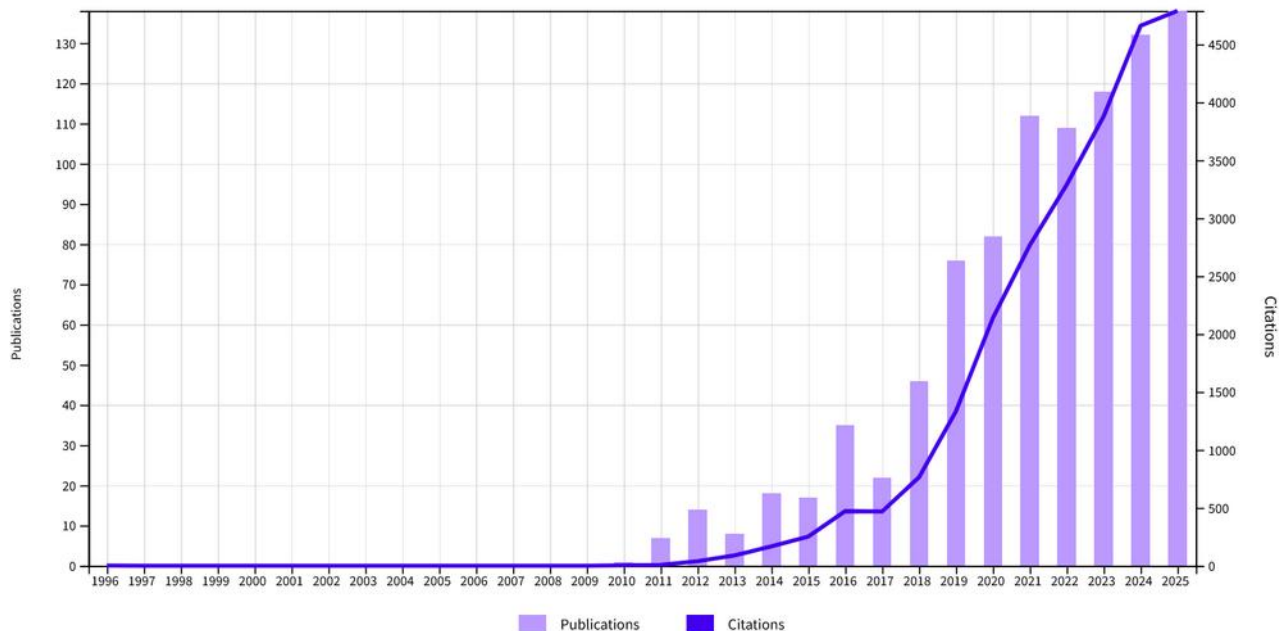
# Disclaimer

Too many beautiful results! This is not an exhaustive or even a representative account of what the SWOT ocean community is doing

SWOT-ST Meeting  
14-17 October 2025, Arcachon

# Some bibliometrics

Articles citing Durand et al., (2010), Biancamaria et al. (2016), or Morrow et al. (2019) (Web of Science)



This workshop: 325 abstracts

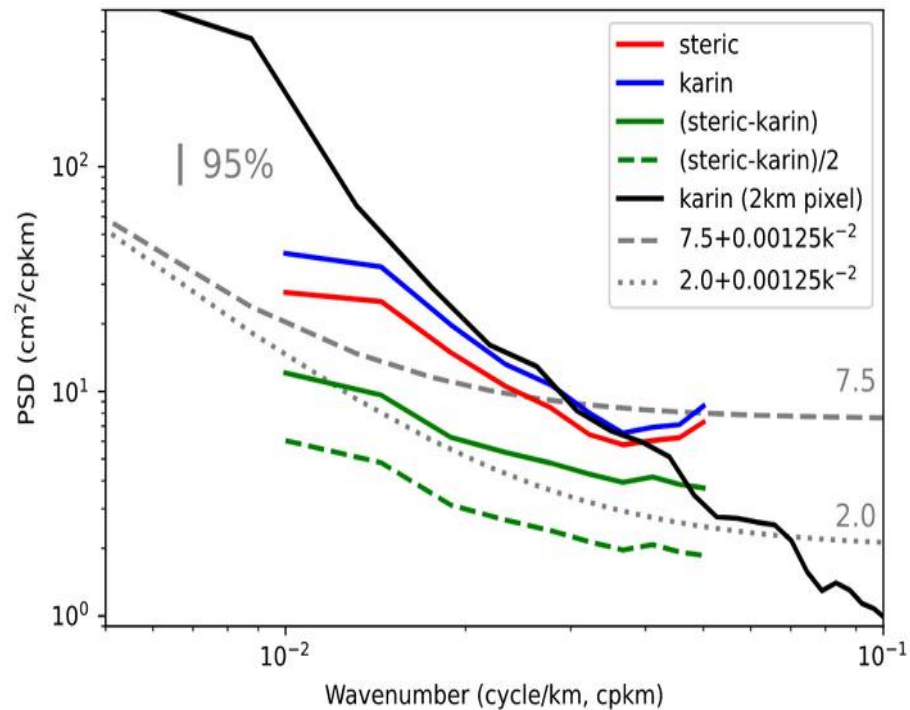
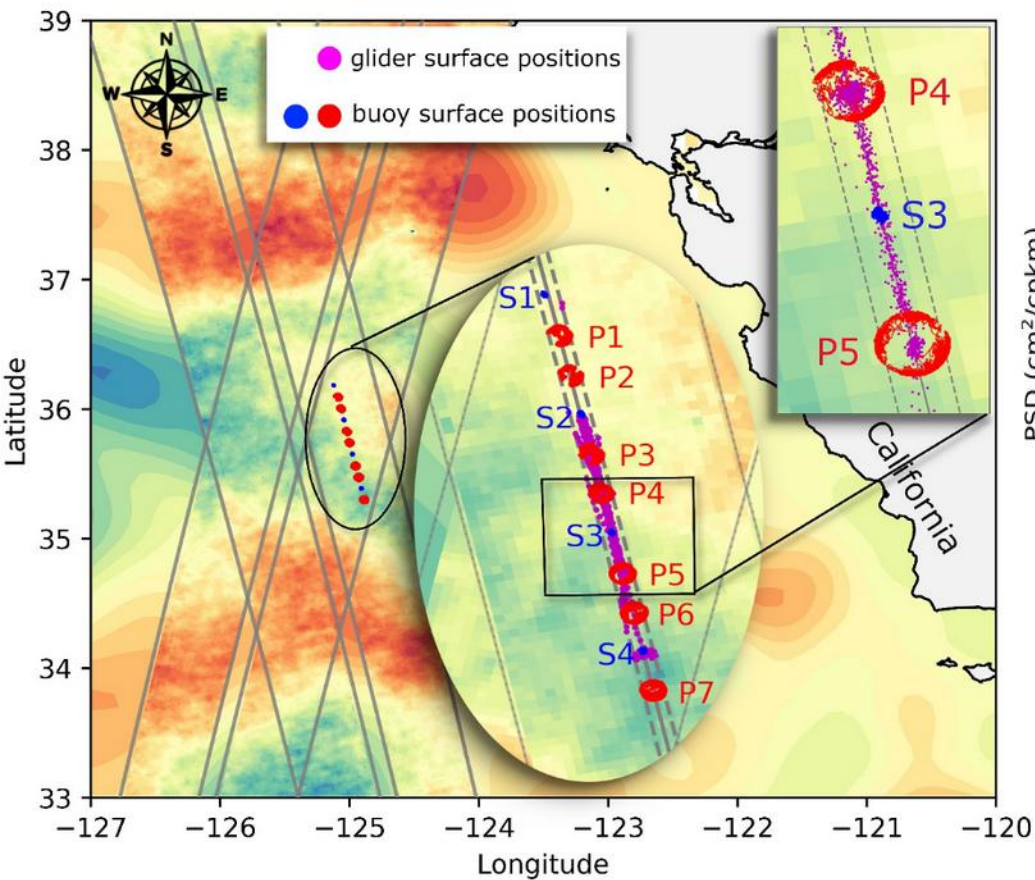
OSM-2026: 62 abstracts at the SWOT session





# Regional Validation

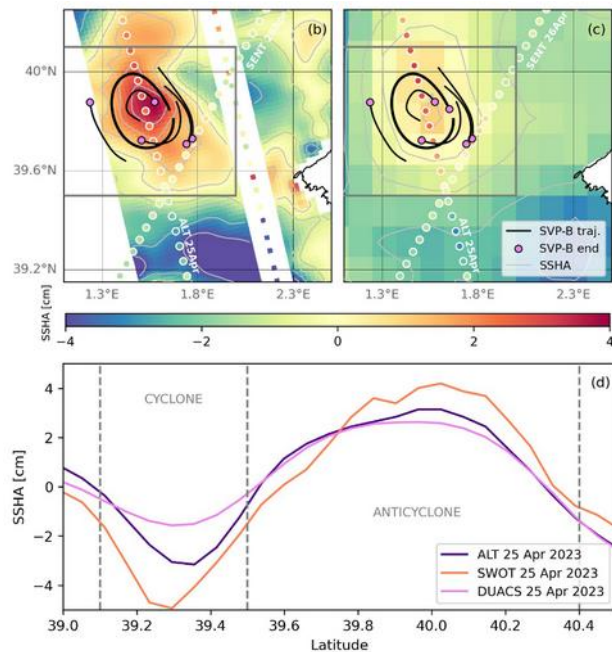
# Validation of science requirements



Wang et al., 2024

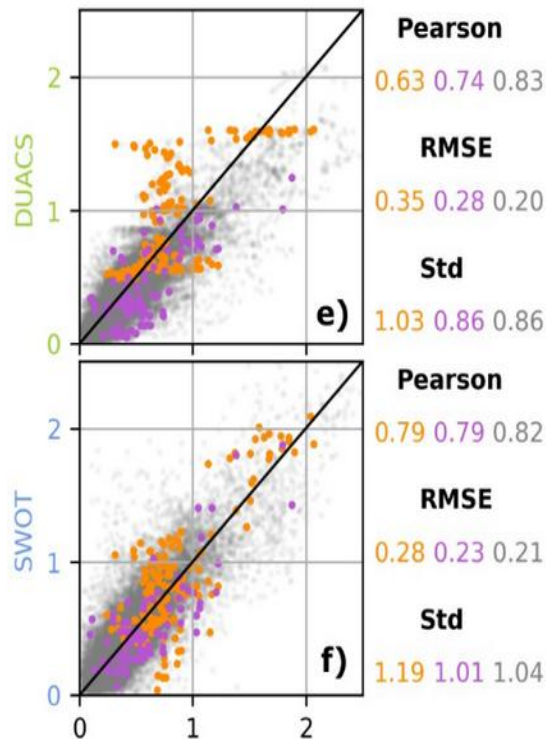


# Other examples of regional validation



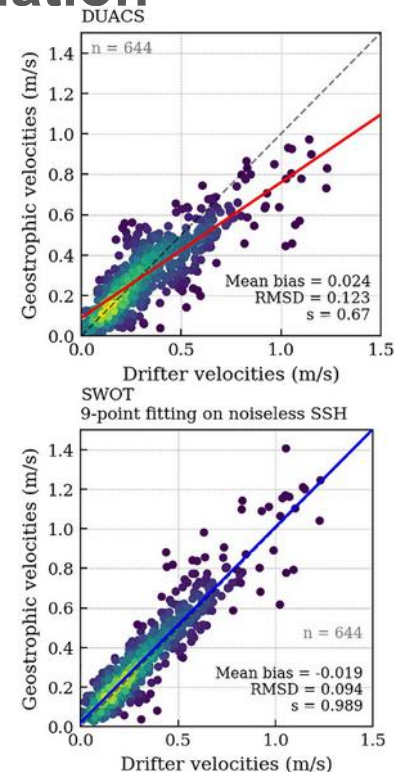
NW Mediterranean

Verger-Miralles et al. 2025



Agulhas

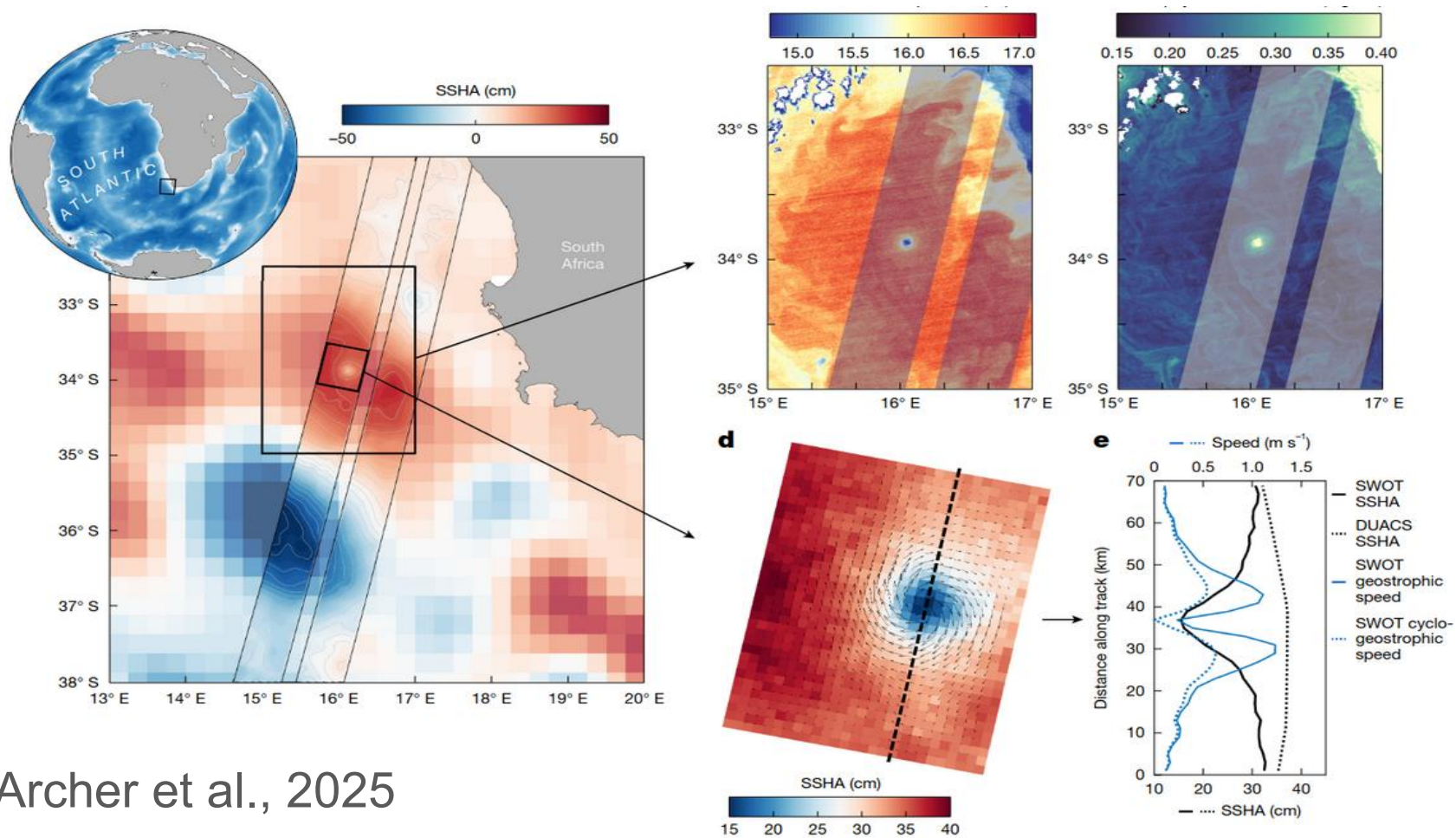
Coadou-Chaventon et al. 2025



Antarctic Circumpolar Current

Tranchant et al. 2025

# Going beyond the mesoscale



Archer et al., 2025

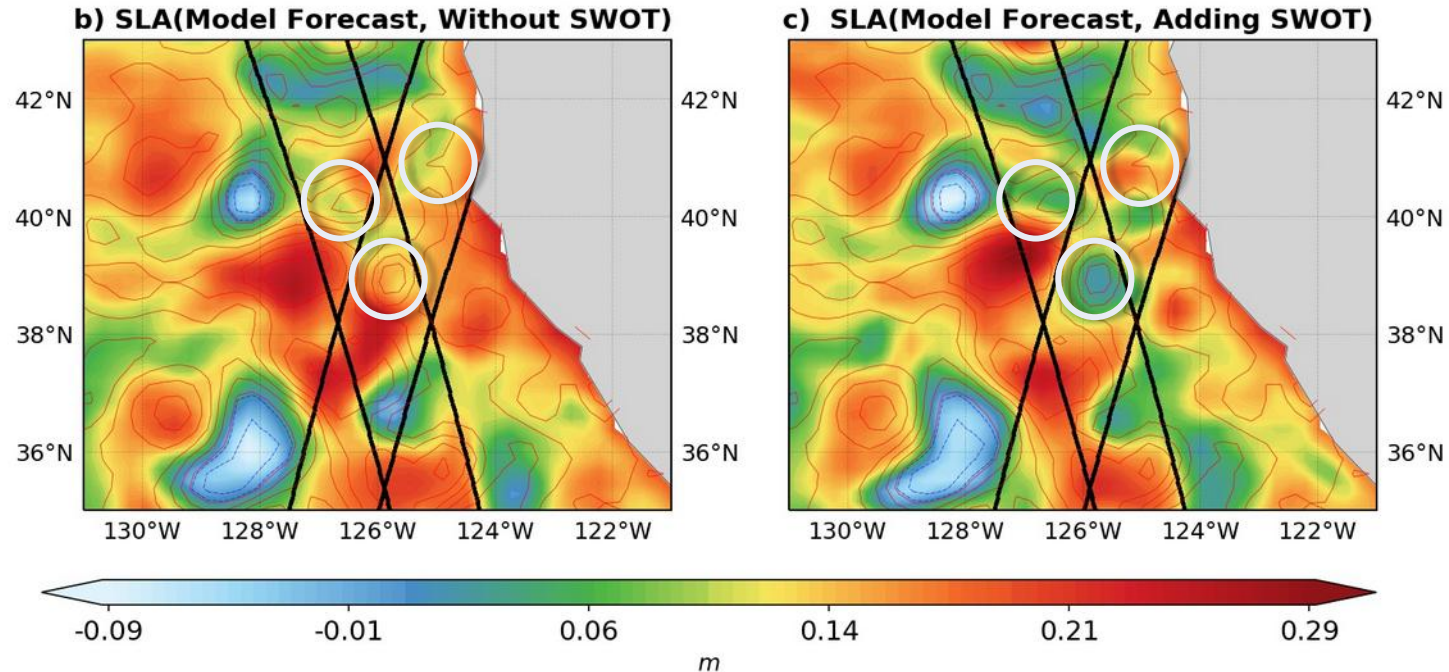




# **Inversion/Assimilation**

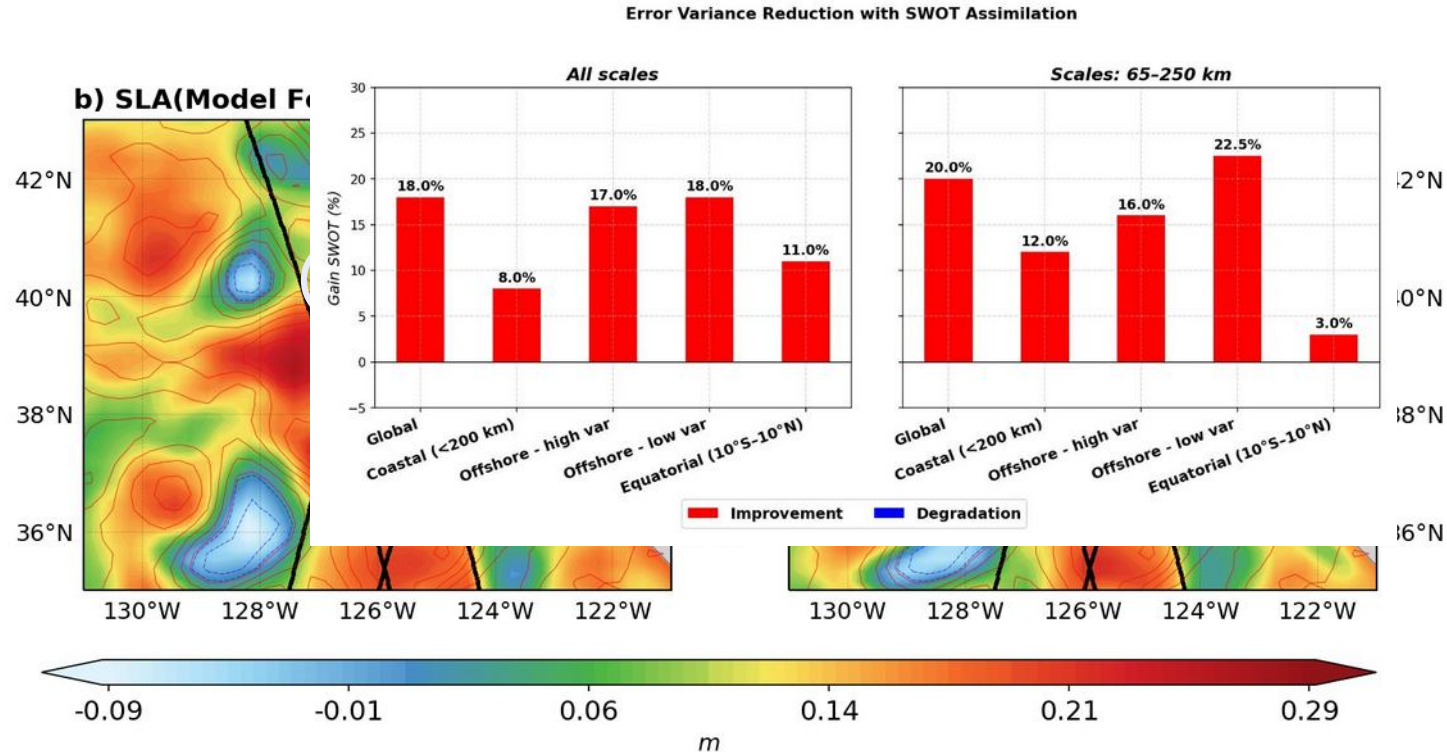
# Effects of including SWOT in assimilation (MERCATOR)

**SLA** (California Current, 20231114, Contour line : Duacs)



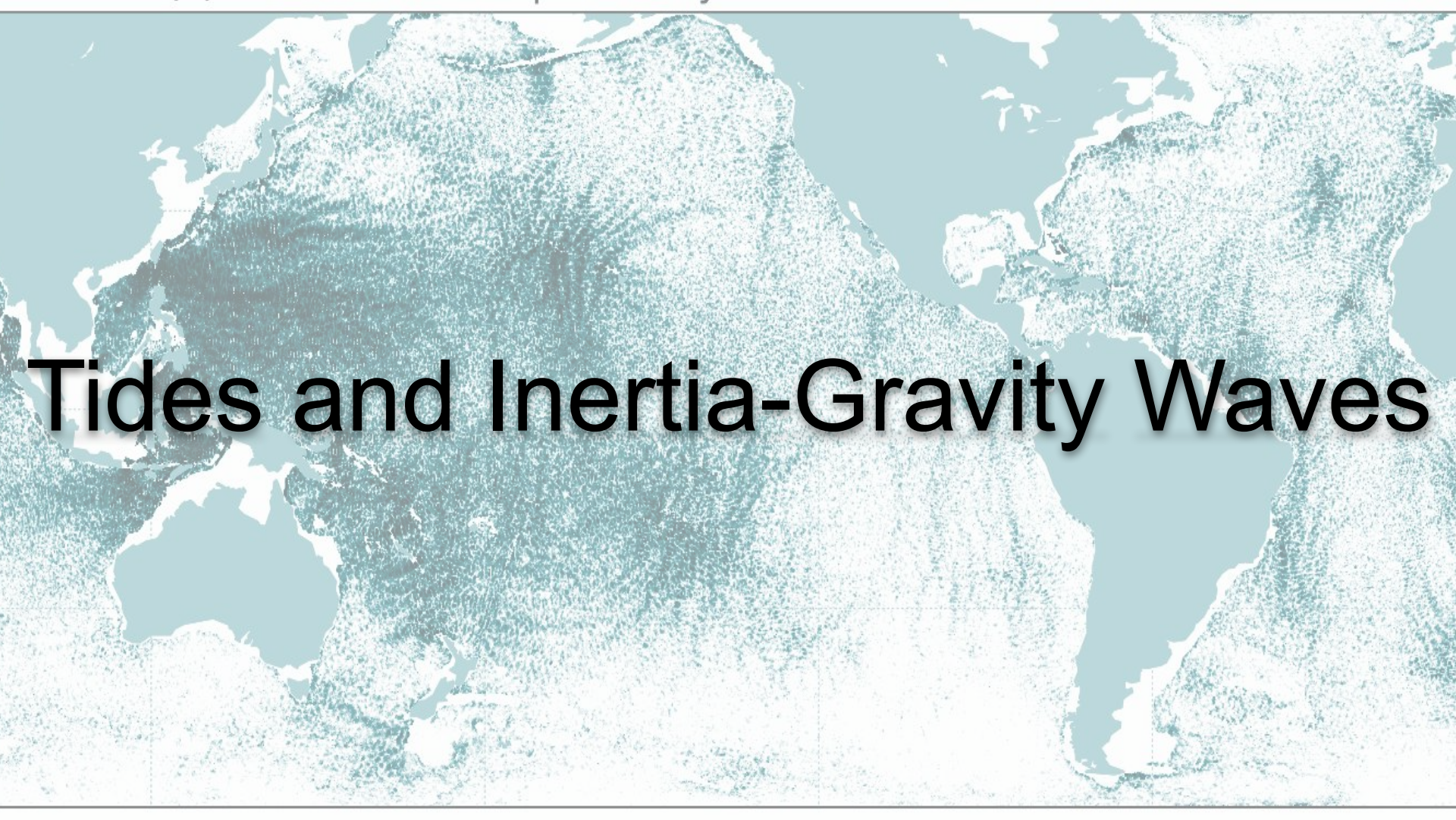
See M. Benkiran, E. Fouchet, P.-Y. Le Traon and E. Rémy talks/posters

# Effects of including SWOT in assimilation (MERCATOR)



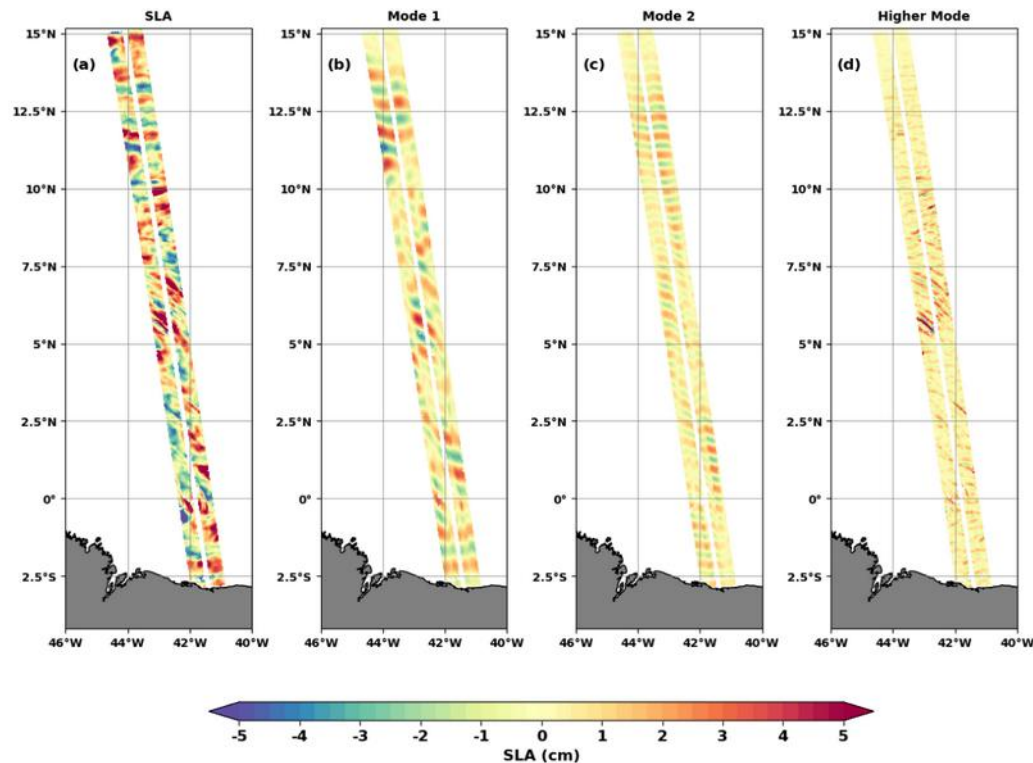
See M. Benkiran, E. Fouchet, P.-Y. Le Traon and E. Rémy talks/posters





# Tides and Inertia-Gravity Waves

# Validation of internal tides detected by SWOT off Amazonian coast

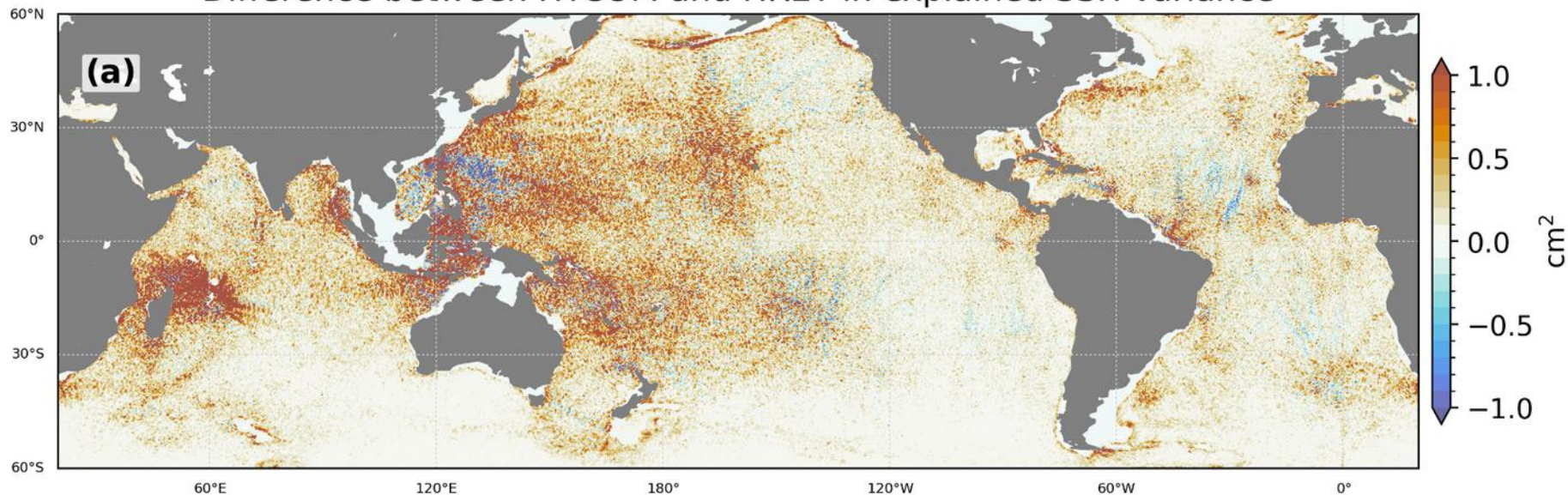


**Figure 2.** Snapshot of SWOT SLA on 8 April 2023. (a) Total SLA, (b) mode 1 FFT-filtered SLA (180–90 km), (c) mode 2 FFT-filtered SLA (80–60 km), and (d) higher-mode FFT-filtered SLA (50–2 km).



# SWOT-models comparisons: HYCOM does 20% better than HRET in a one-on-one comparison

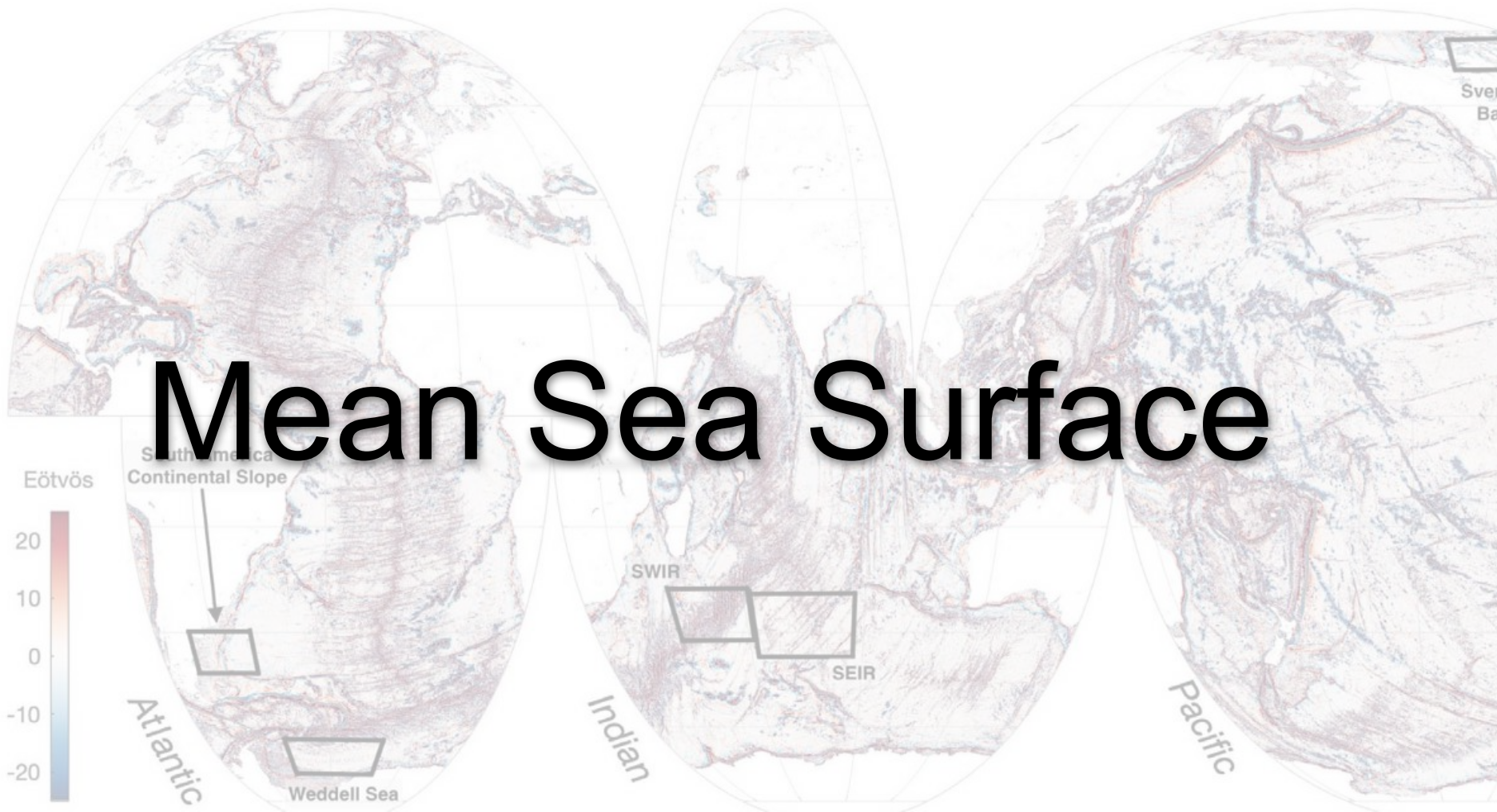
Difference between HYCOM and HRET in explained SSH variance

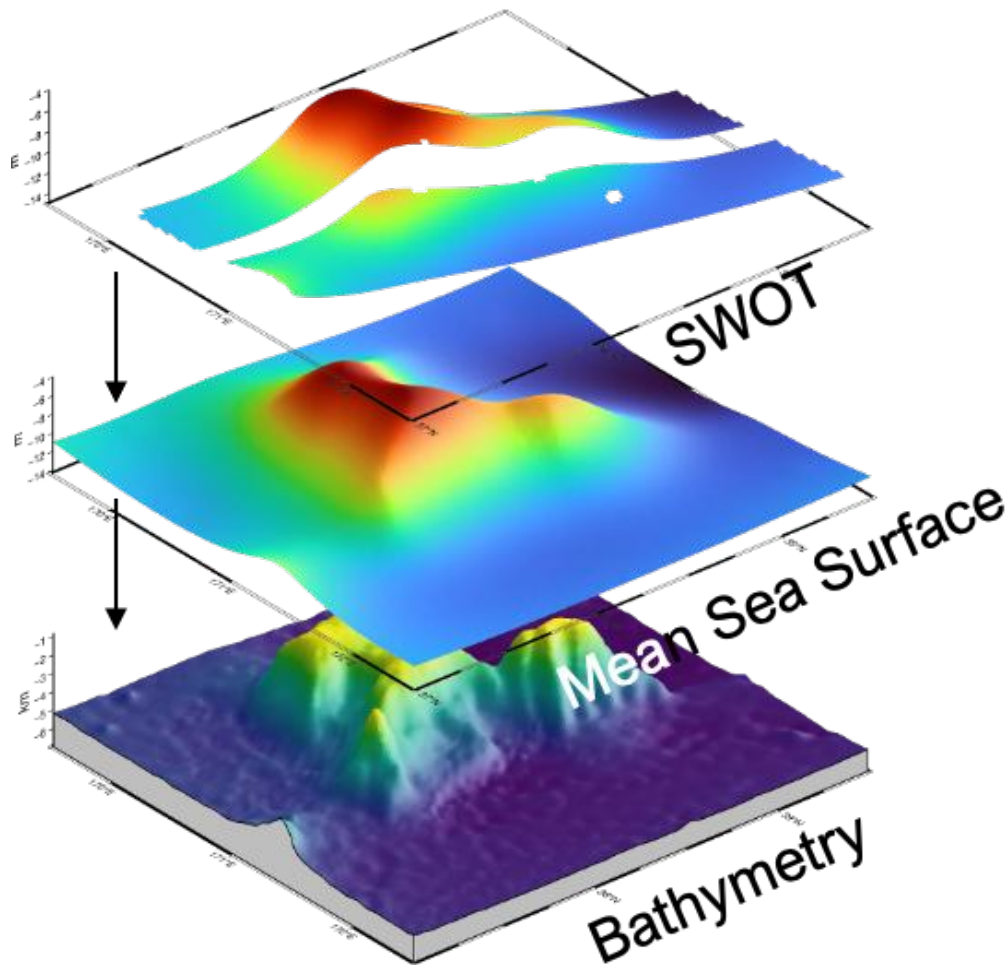


See Yadidya and Arbic presentation



# Mean Sea Surface

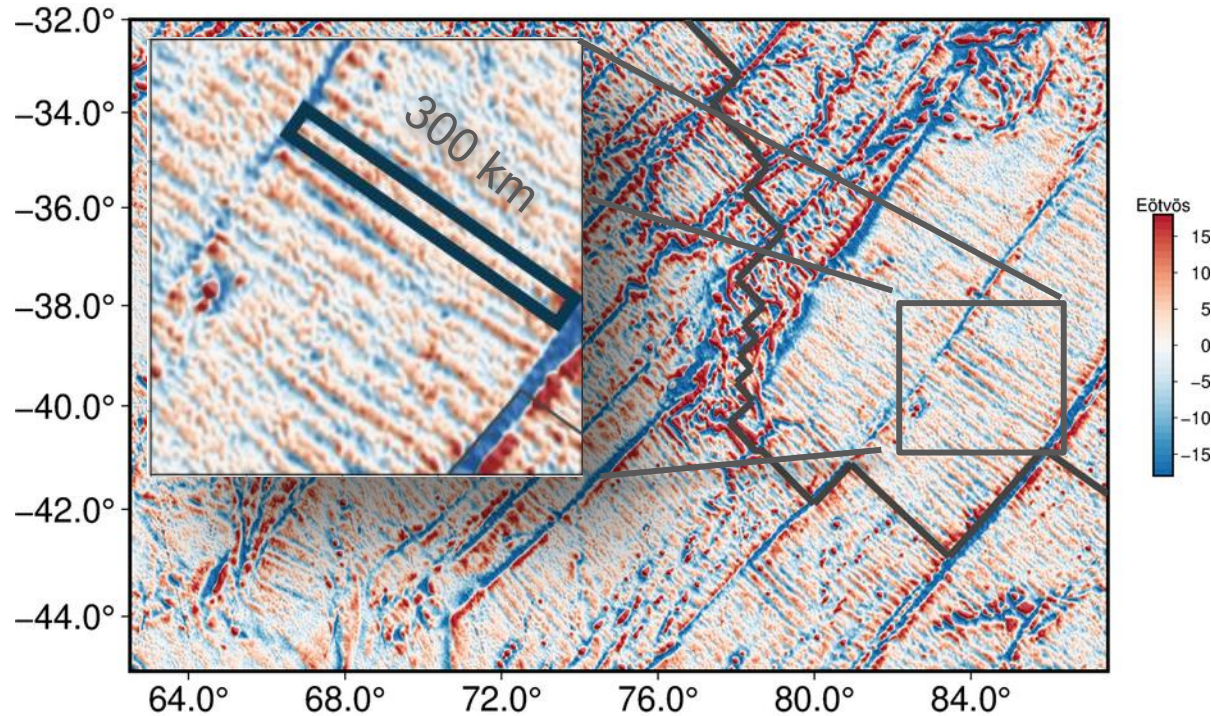




## Marine gravity field, mean sea surface (MSS), and bathymetry greatly improved

- geodetic signals in models down to  $\sim 8$  km wavelength,
- and oceanographic and altimetric noise.
- MSS, gravity and bathymetry improvements are unfortunately non-uniformly distributed over the oceans due to two diamond gaps in the SWOT observations increasing towards the Equator.

**“1 year of SWOT data offers more detailed information than 30 years of nadir altimetry”**



## **Example: Individual abyssal hills are now visible**

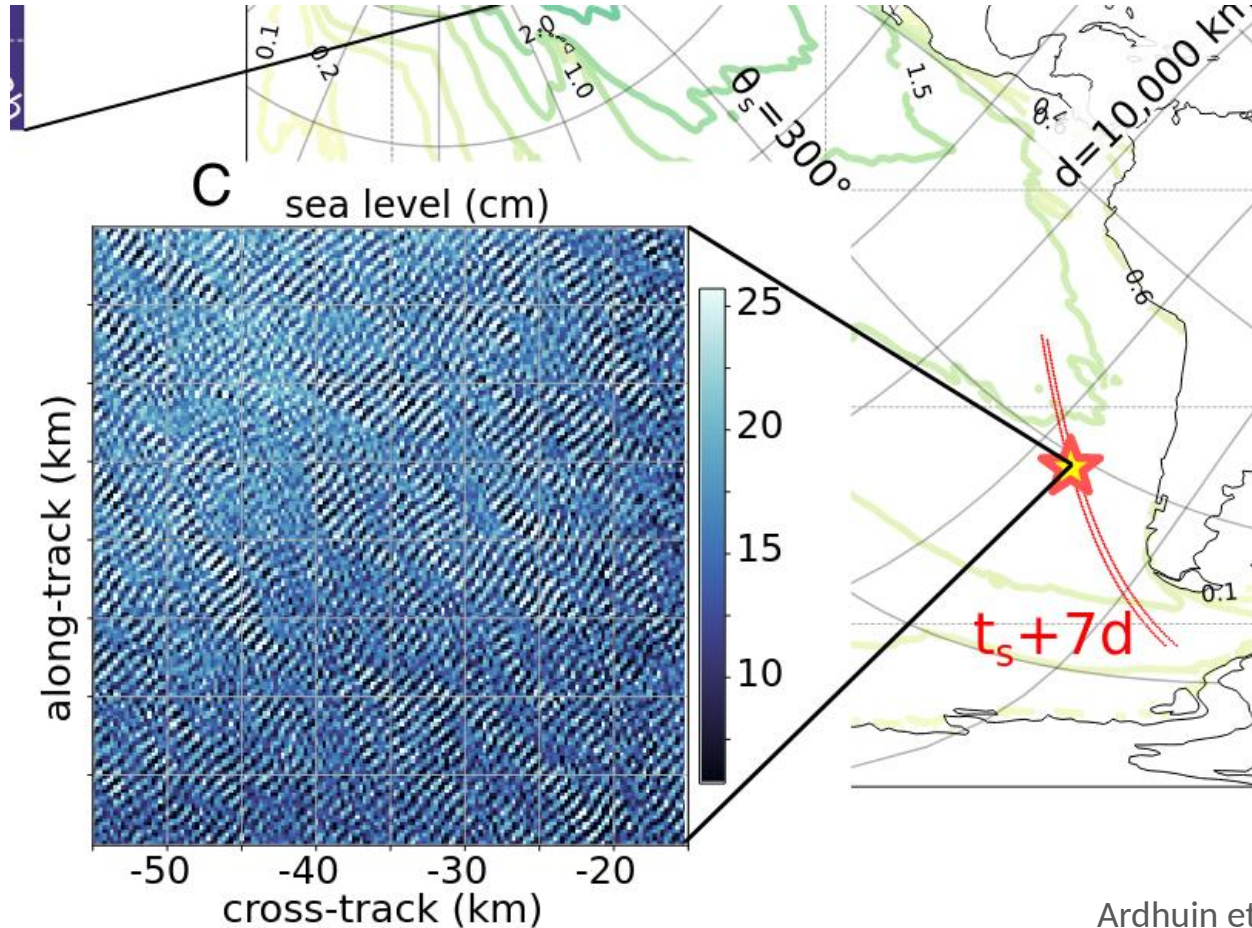
- Can be used to refine plate reconstruction models
- to inform local tectonic and volcanic history of formative ridge
- for modeling internal tide conversion



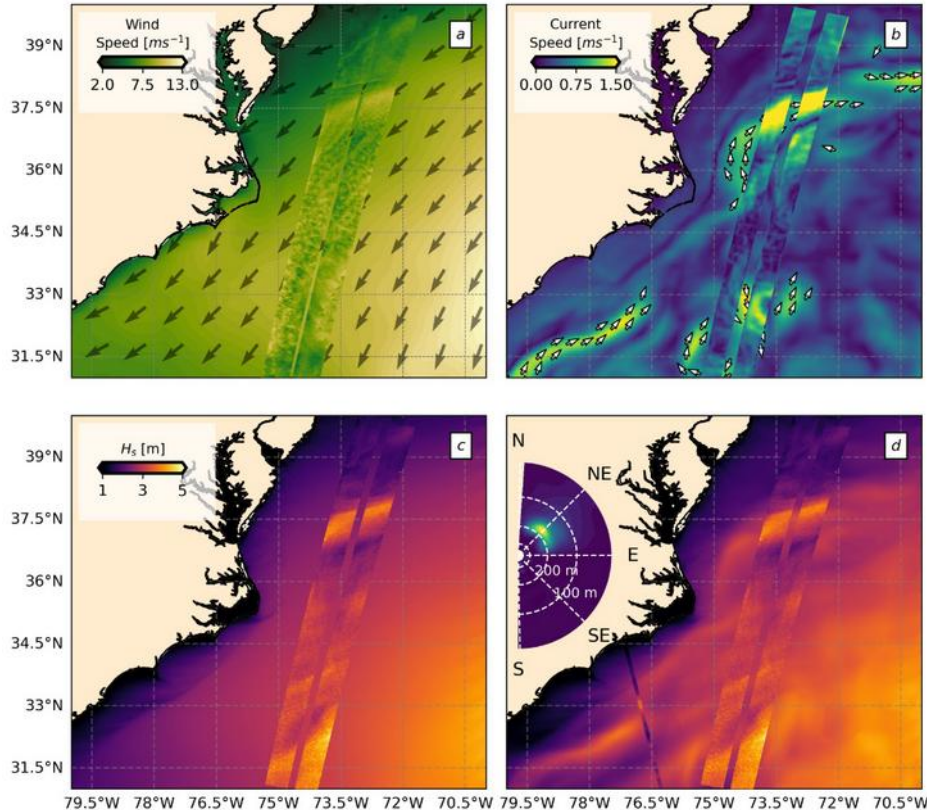
A black and white photograph of a turbulent sea with white-capped waves under a heavy, overcast sky. The text 'Wind and waves' is centered over the image.

# Wind and waves

# Example of swell detected by SWOT after the passage of a storm



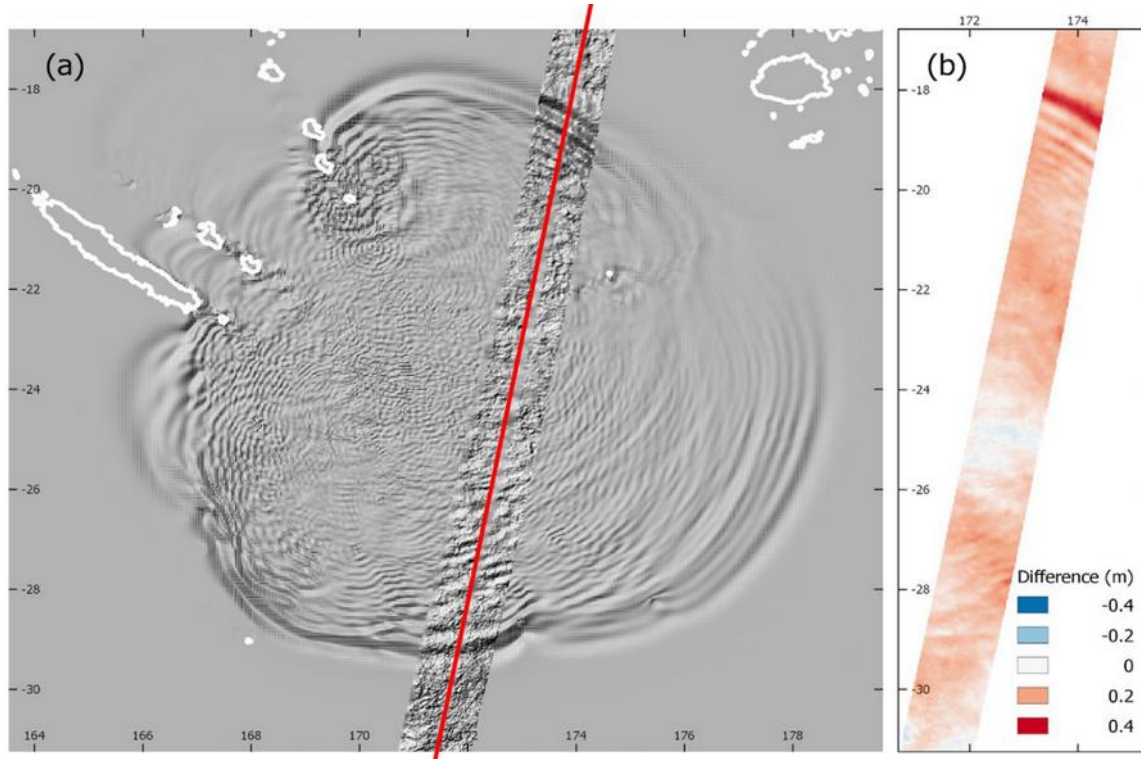
SWOT's concomitant high-resolution wave data and SSH “**represent a transformative advance in understanding Hs gradients**”, Villas Bôas et al. 2025



- Improvement of sea state operational models (navigation safety).
- Exploration of sea state gradients coupled to air-sea processes.



# 2D detection of tsunami's signal



- Synergies of SWOT with seismic networks
- Model improvement for tsunami generation, propagation, and dissipation
- More reliable and quantitative tsunami early warning



# Some challenges and perspectives

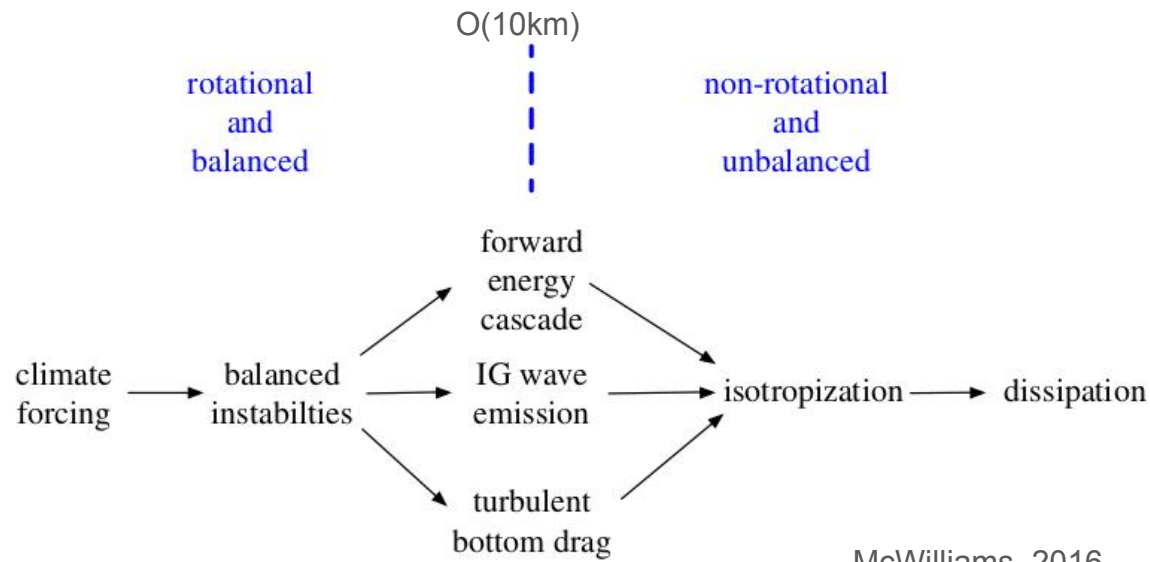
SWOT-ST Meeting  
14-17 October 2025, Arcachon





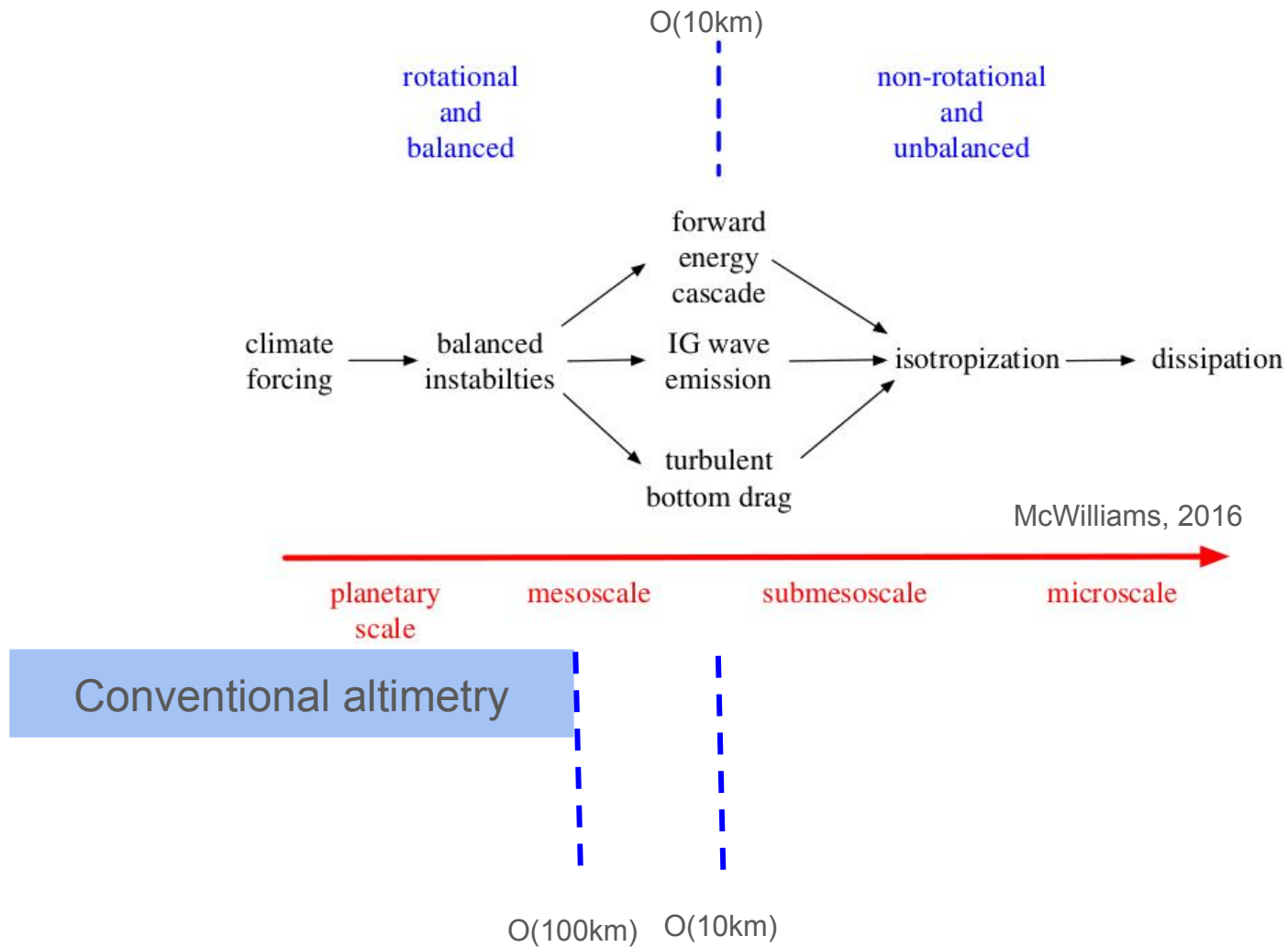
# 1. Velocities

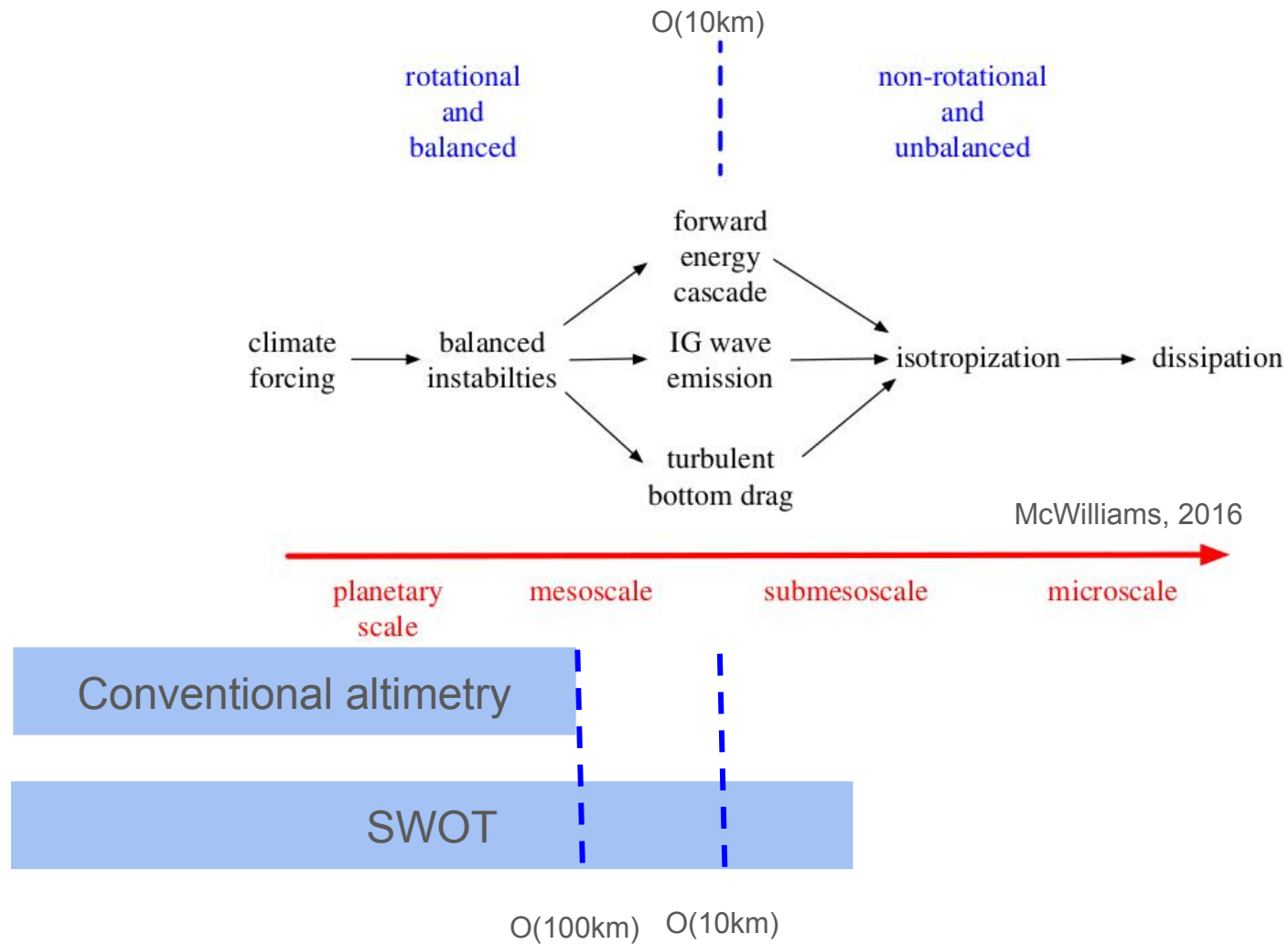




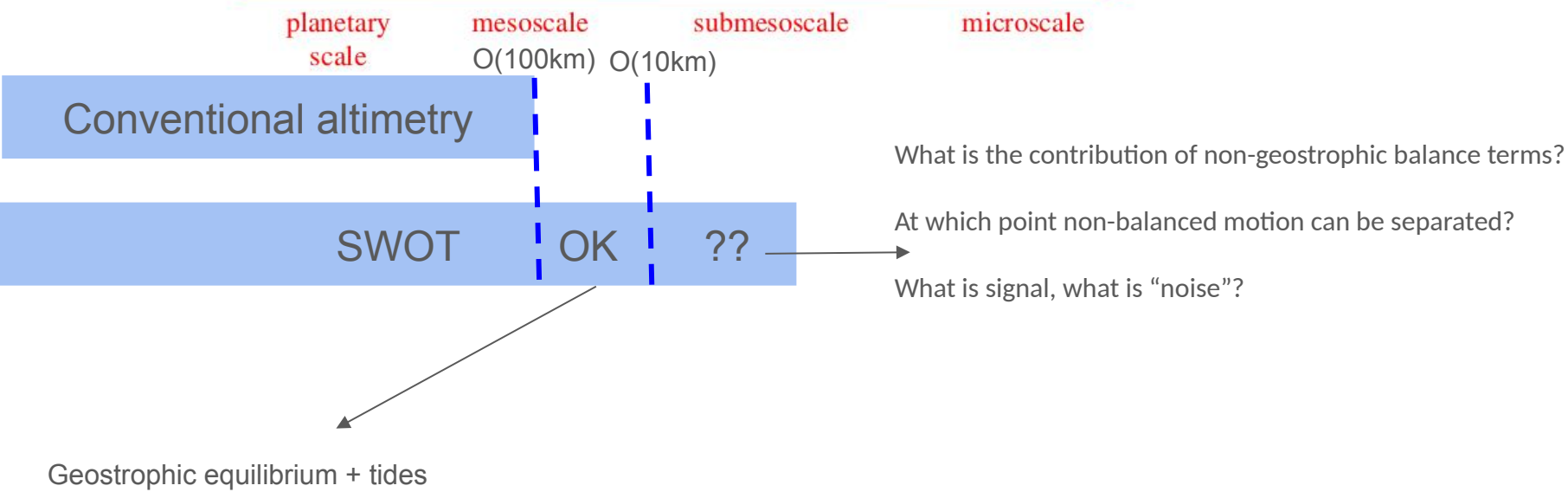
Key processes for the redistribution of energy, matter, and properties

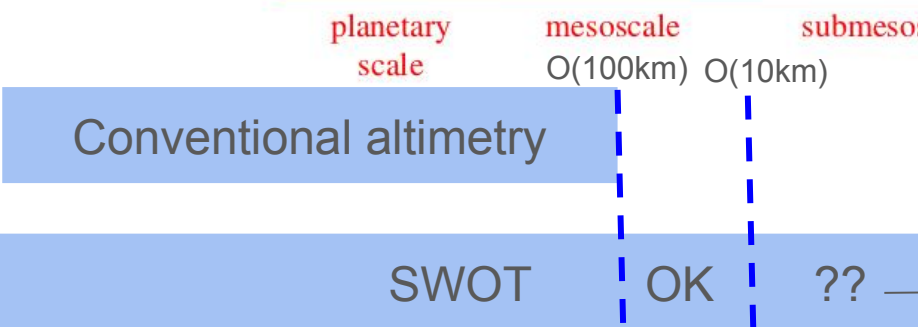
$O(10\text{km})$











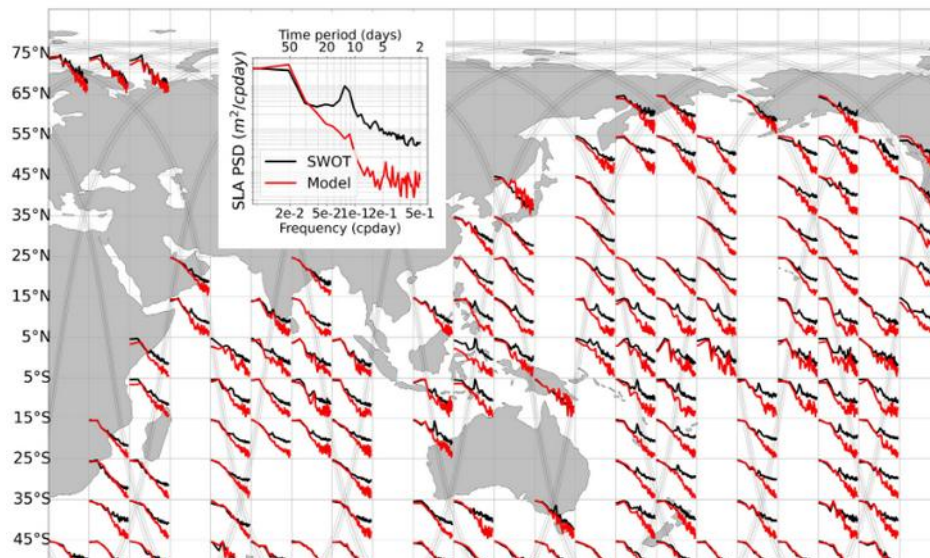
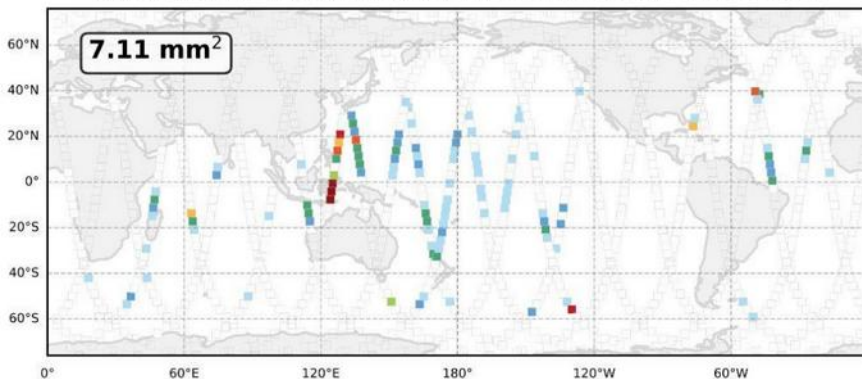
What is the contribution of non-geostrophic balance terms?

At which point non-balanced motion can be separated?

What is signal, what is “noise”?

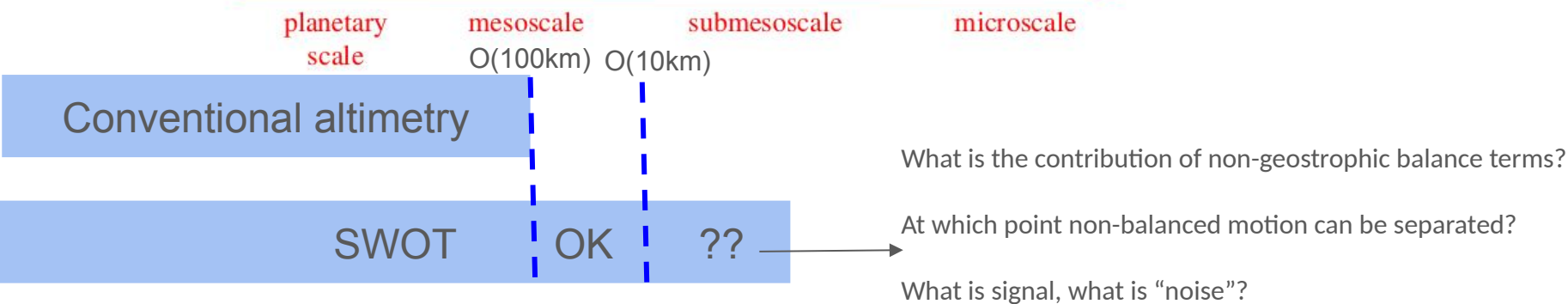
## Synergies with high resolution models

(d) Residual Variance after HYCOM Total IT Correction

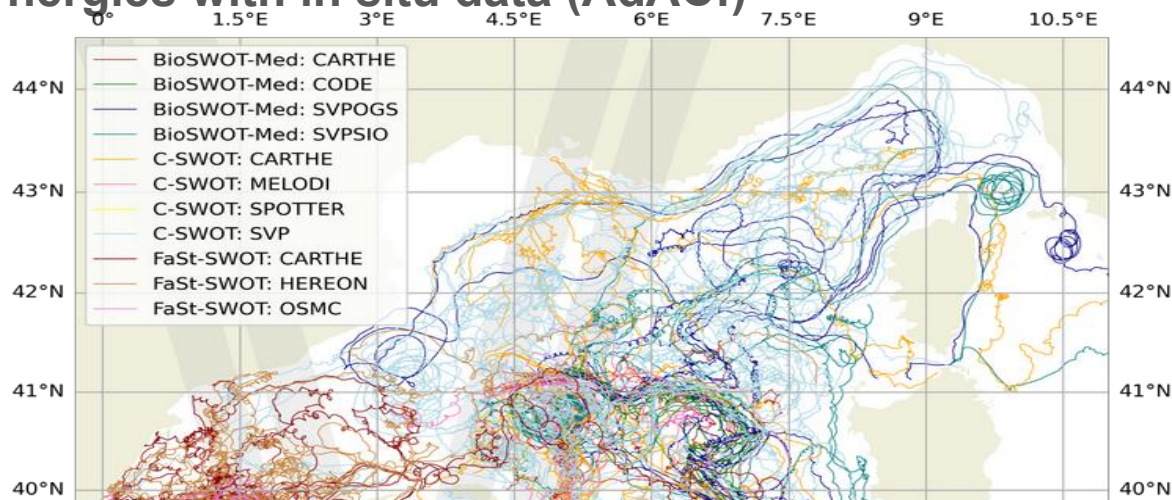


B. Arbic talk

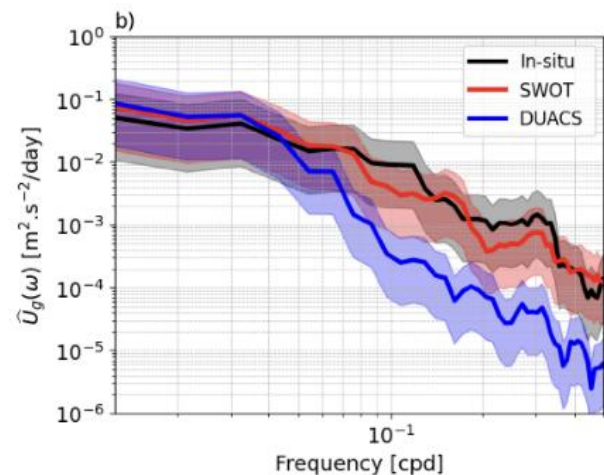
Fauchet et al. 2025



## Synergies with in situ data (AdAC!)



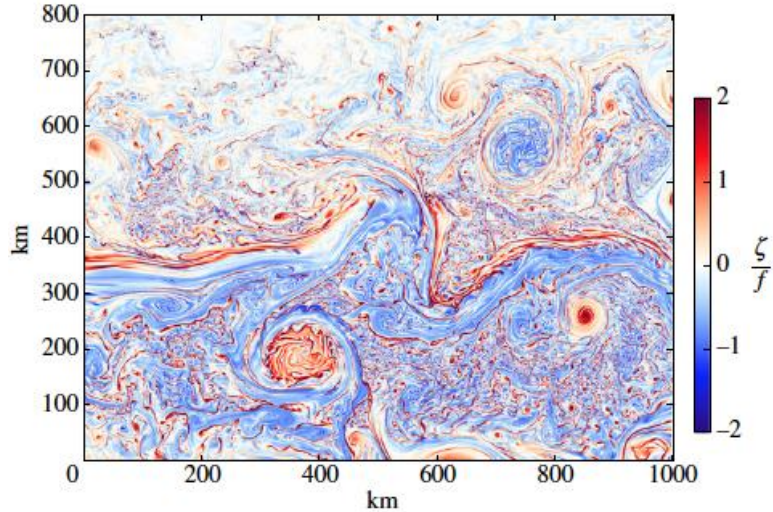
Demol et al. 2025, submitted



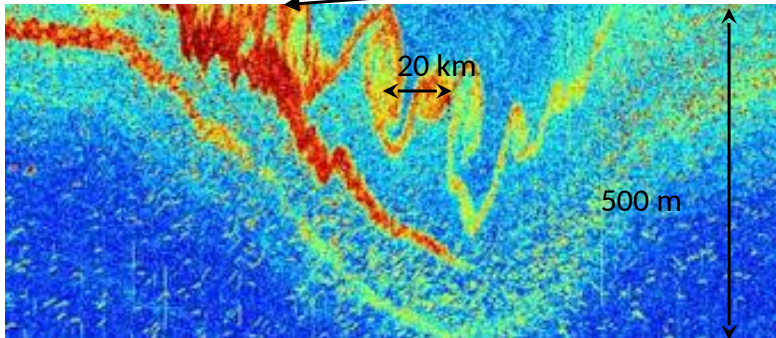
Cho et al. 2025, submitted



# Prelaunch Mission Goal: Vertical transport of heat and water properties in the ocean



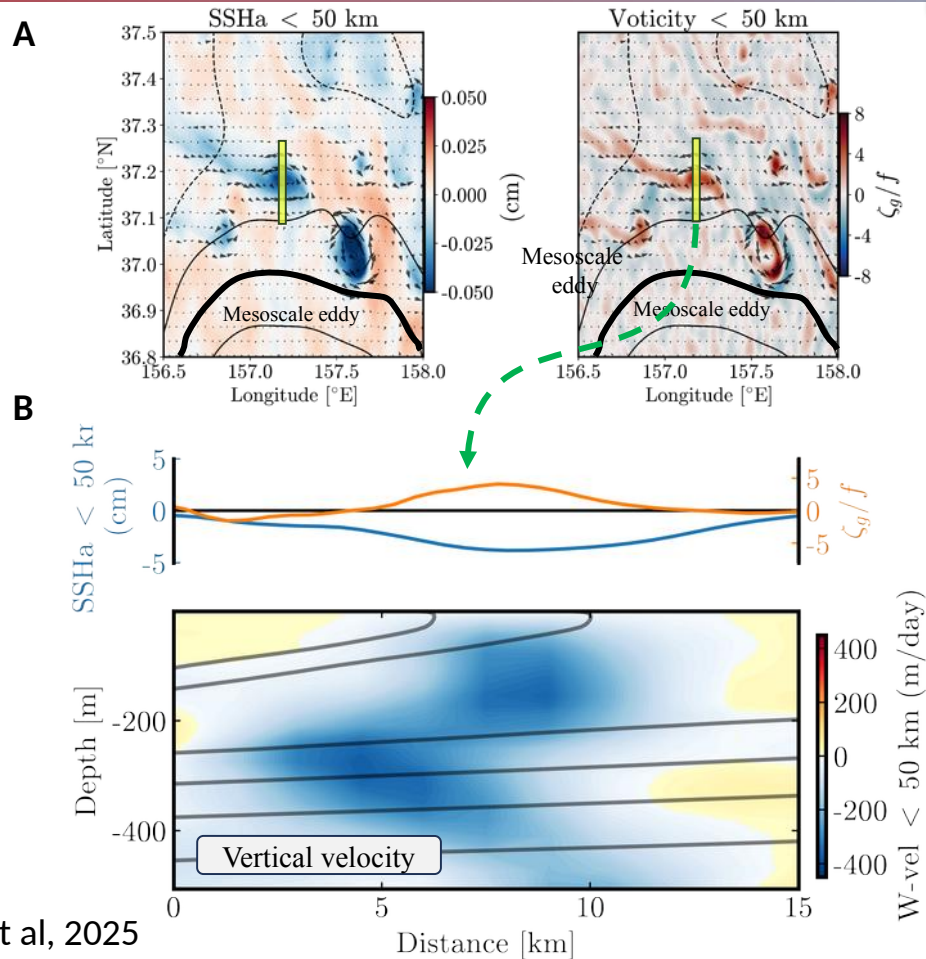
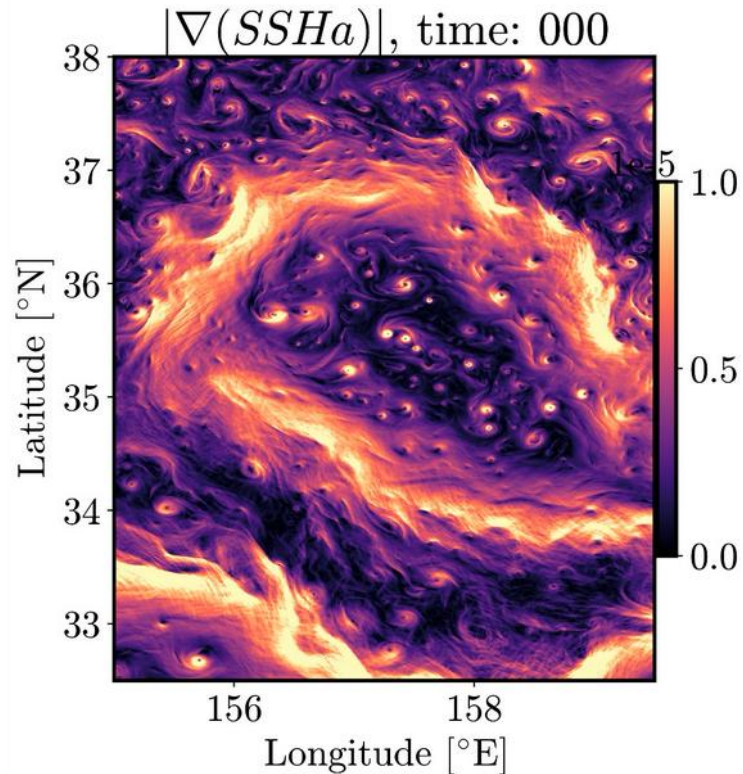
*Vorticity at the surface  
in the Gulf Stream  
(McWilliams, 2016)*



*Sea surface height variations  
are observed by SWOT for  
estimating ocean currents at  
depths.*

# Submesoscale cyclones coupling the surface and deep ocean from model

Simulated SSH gradients after removing IGWs





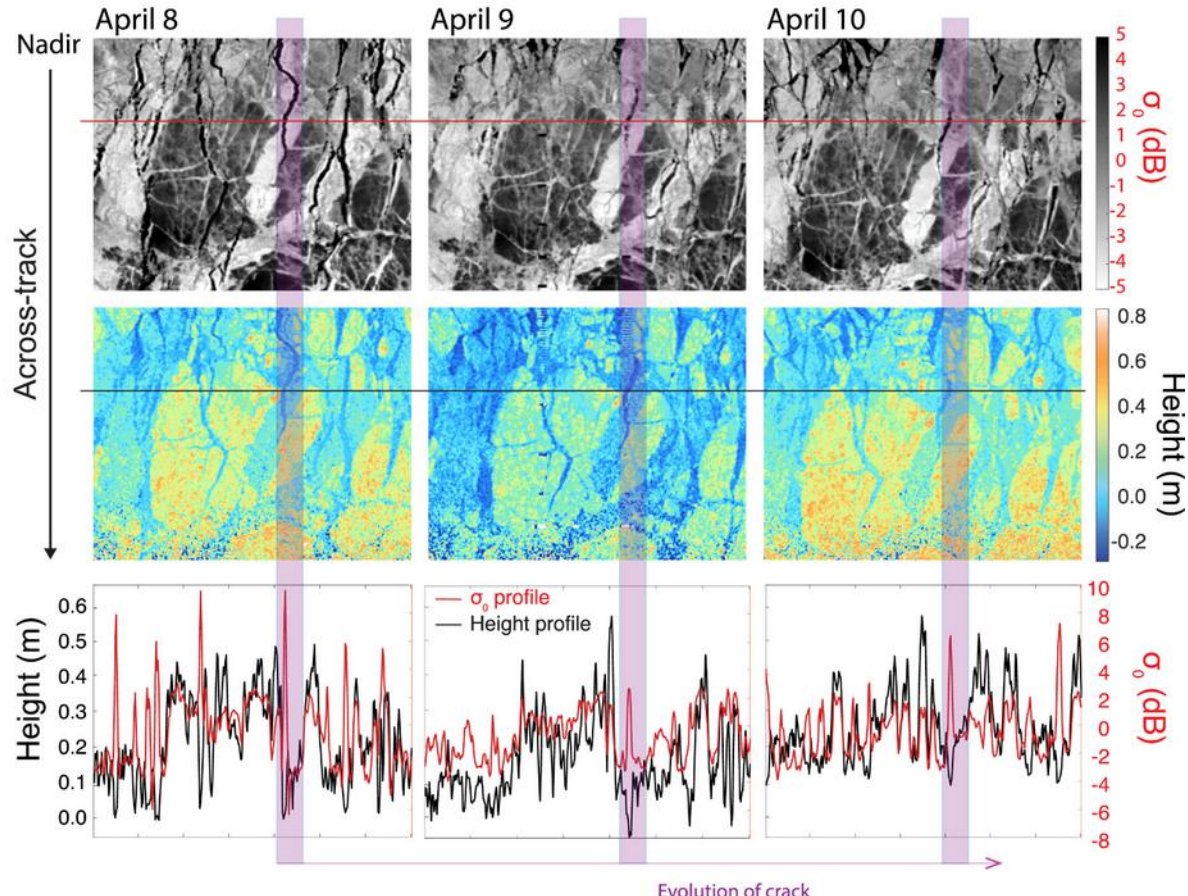
An aerial photograph of sea ice, showing a complex network of white and light blue ice floes separated by dark blue, narrow channels of open water. A faint, light blue grid is overlaid on the entire image, with lines spaced at regular intervals. The text "2. Sea ice" is centered in the middle of the image in a large, bold, black font.

## 2. Sea ice



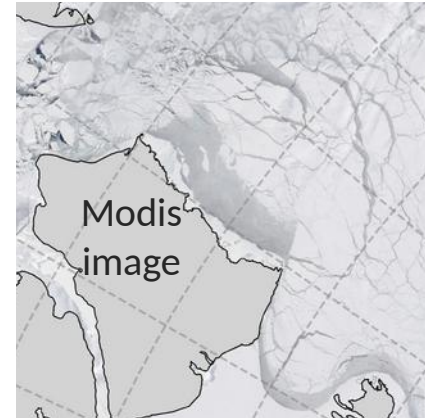
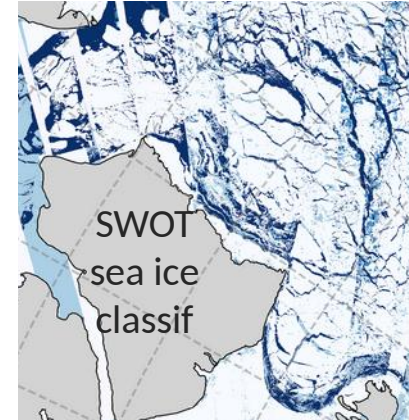
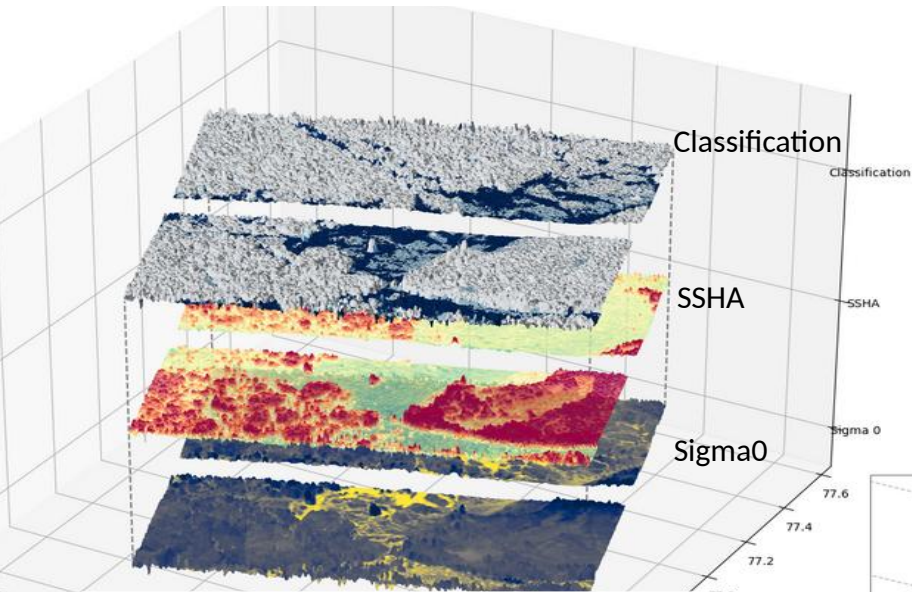
# Sea ice surface and height detection

a) Arctic



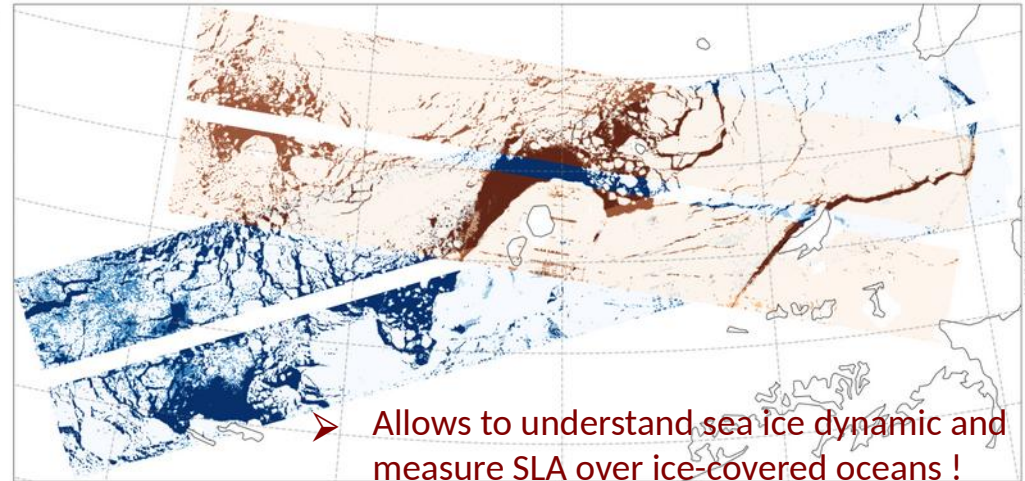
# SWOT SPIceSea: sea ice classification

Jestin et al., The Cryosphere, submitted



New L3 250m parameter !

surface type	flag
ocean (including leads and polynyas)	#0
probable ocean	#18
probable ice	#19
ice pack, ice floes	#20

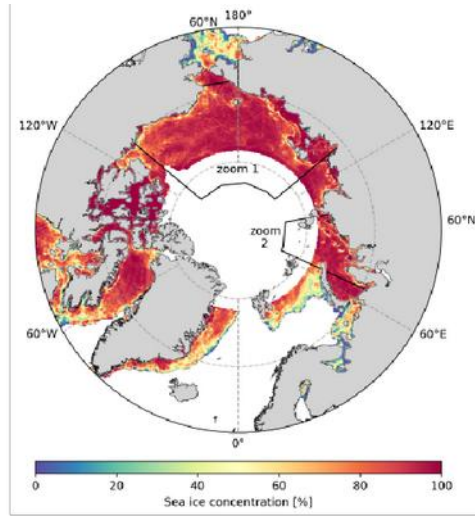


➤ Allows to understand sea ice dynamic and measure SLA over ice-covered oceans !

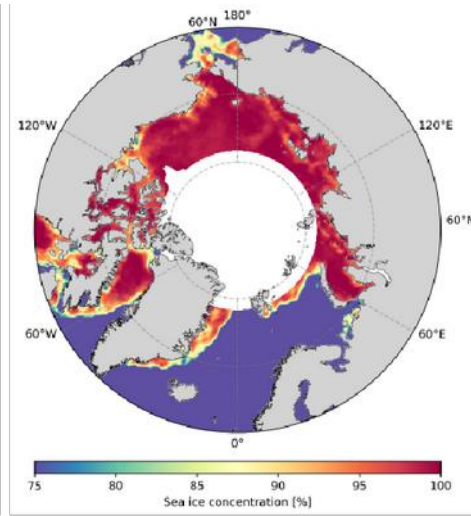
# SWOT SPiceSea: sea ice **concentration**

Jestin et al., The Cryosphere, submitted

SWOT sea ice  
concentration

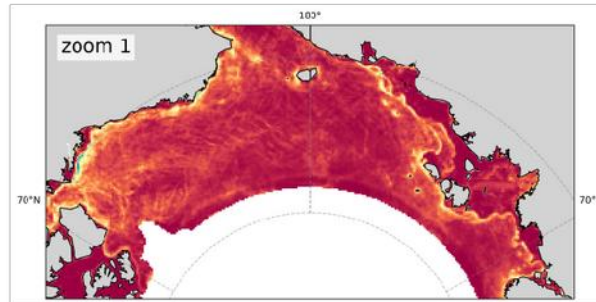


(a) Concentration derived from classification

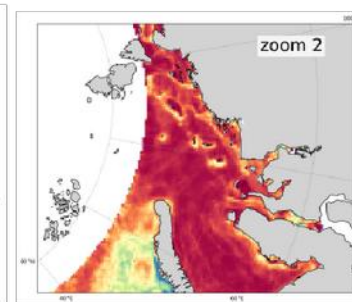


(b) OSI SAF concentration

SWOT sea ice  
concentration  
(zooms)



(c) North of Alaska and East Siberia



(d) Kara sea islands

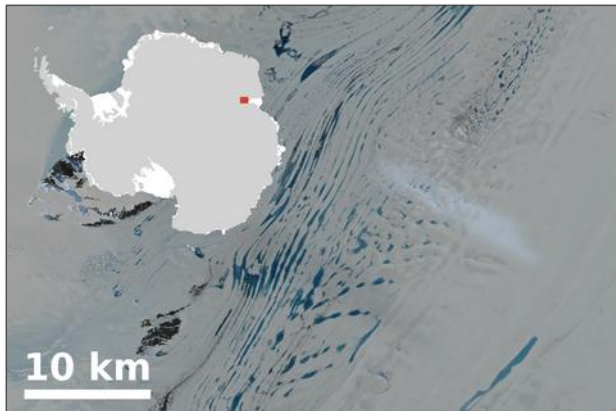
OSI-SAF/Copernicus  
reference product

➤ Towards an  
unprecedented  
improvement in sea ice  
concentration !

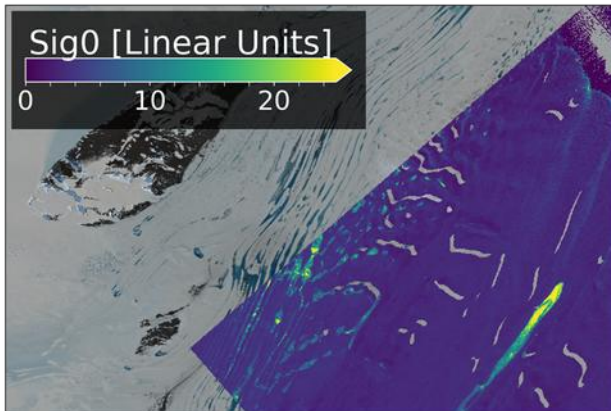


# Watching ice shelves crack open: Meltwater and crevasse evolution from SWOT

Sentinel-2: 2025-01-24 06:55:24

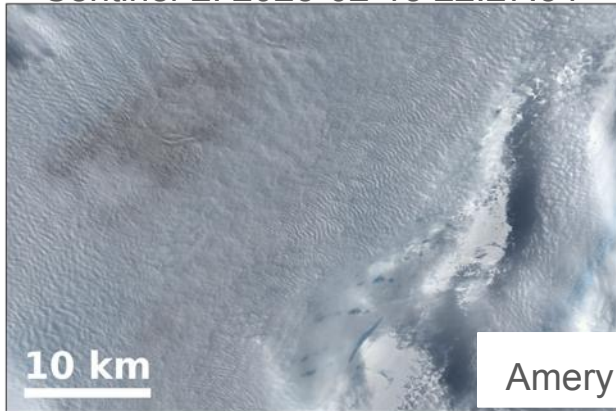


SWOT: 2025-01-26 01:42:30



Ka-band backscatter detects water-filled crevasses, even if cloudy

Sentinel-2: 2025-02-13 22:27:34



SWOT: 2025-02-15 22:27:34



Simultaneous height and backscatter measurements provide novel dataset for monitoring crevasse evolution

Zachary Katz  
zachary\_katz@mines.edu



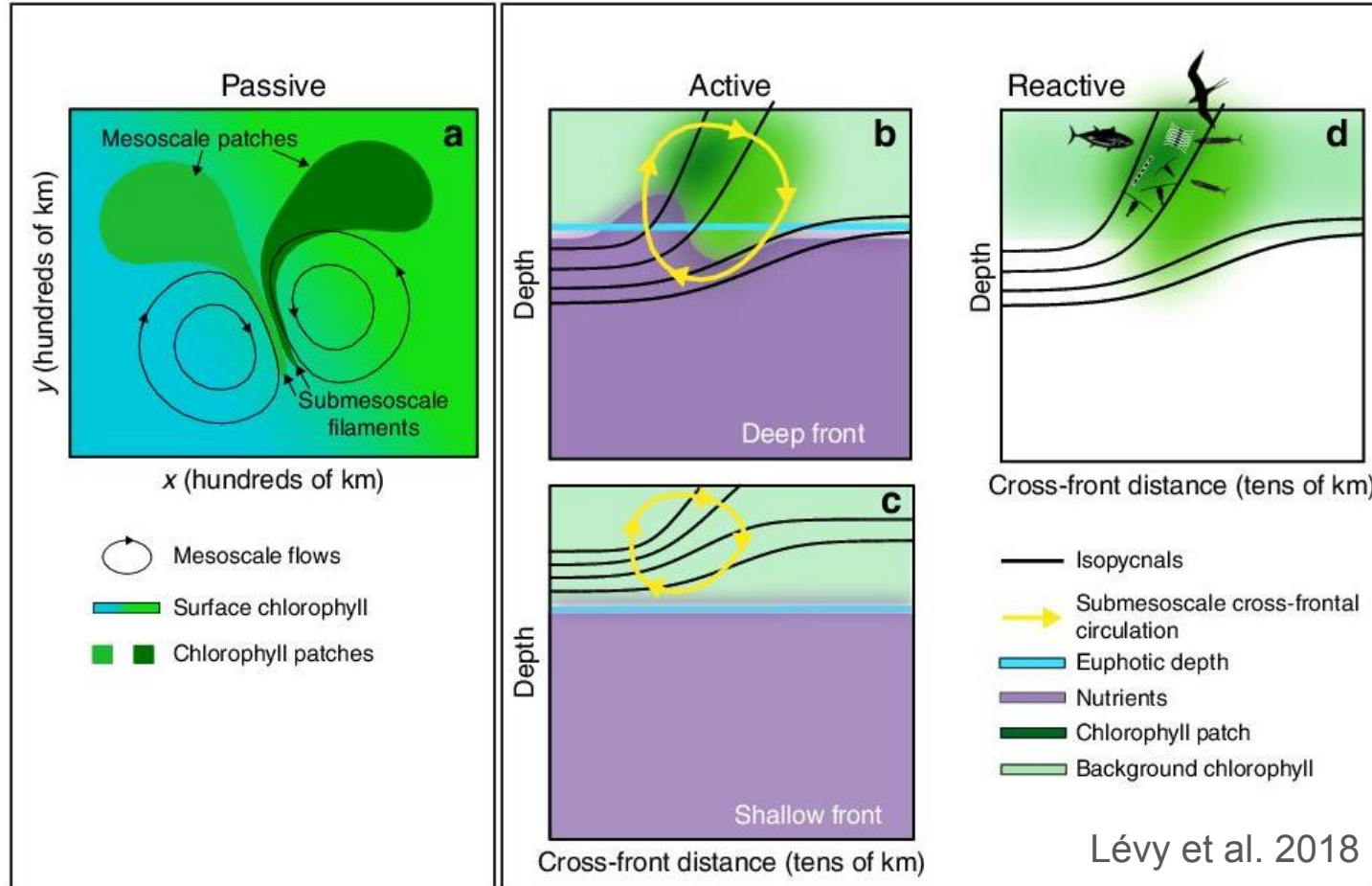
**COLORADO SCHOOL OF MINES**



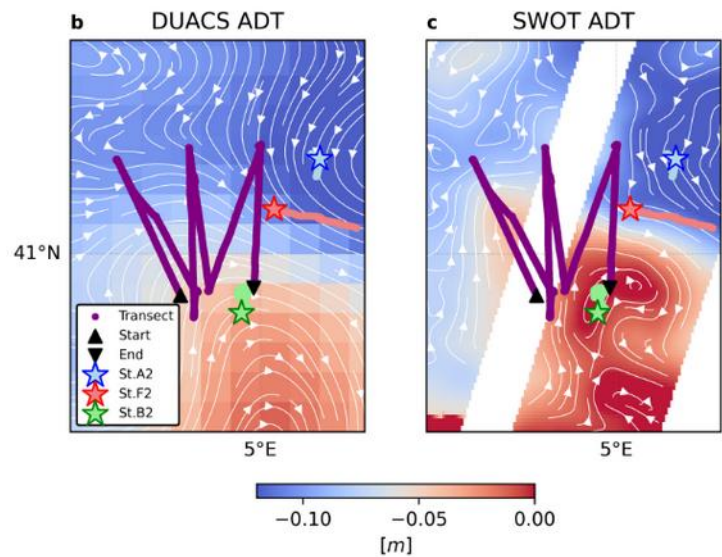
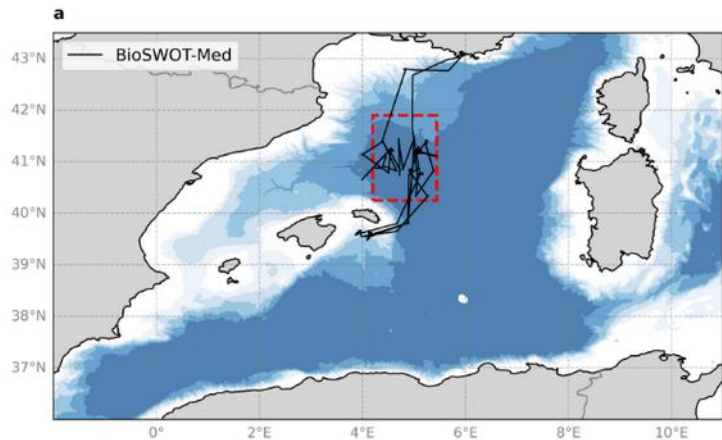
A detailed electron micrograph of a cell, likely a eukaryote, showing various organelles. A large, dark, circular nucleus is prominent in the center. Surrounding it are various membrane structures, including what appears to be the endoplasmic reticulum with its characteristic folded membranes. There are also smaller, circular vesicles or mitochondria visible. The overall image has a blueish tint and high contrast, typical of electron microscopy.

# 3. Biology

# Testing paradigms of biophysical coupling needs SWOT precision

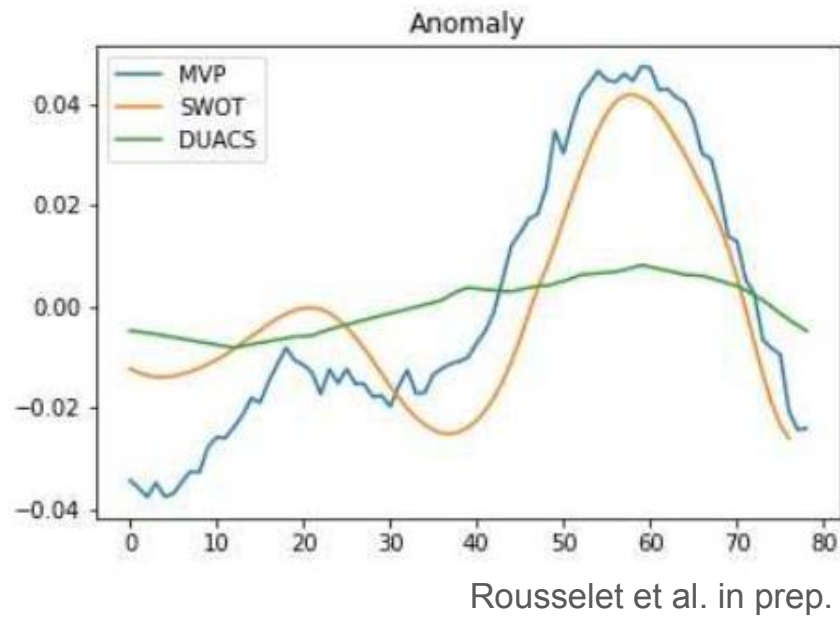


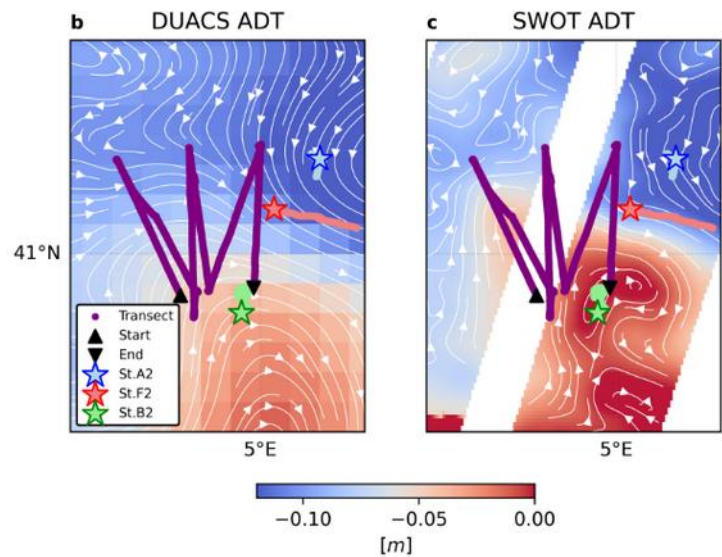
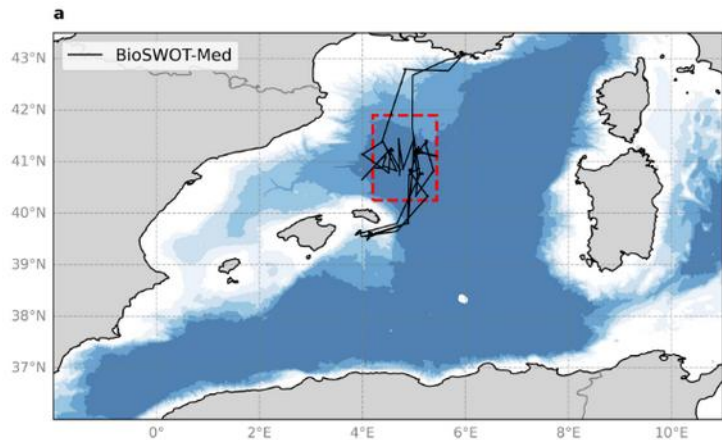




BIOSWOT-Med  
Bottom-up effect of an eddy at SWOT scales

CalVal

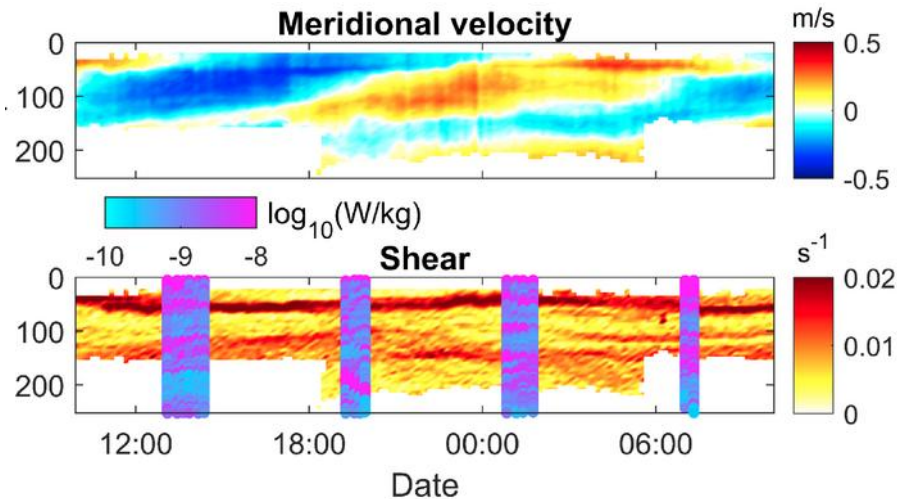


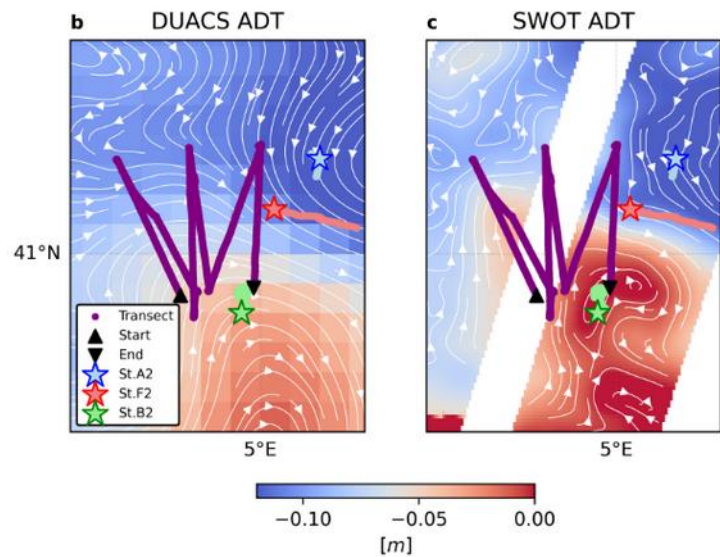
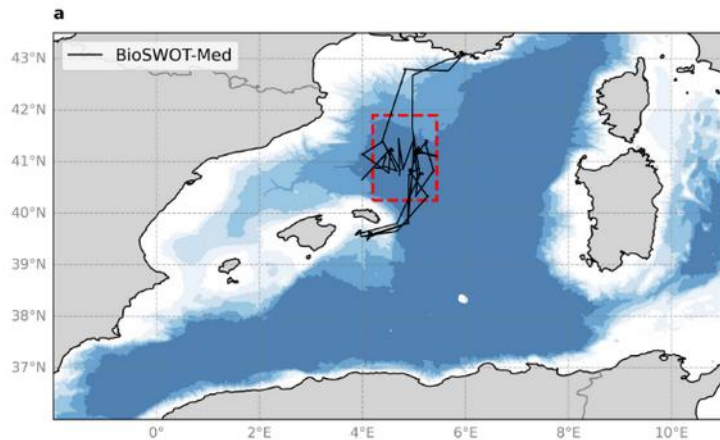


## BIOSWOT-Med

### Bottom-up effect of an eddy at SWOT scales

### Trapping of internal waves

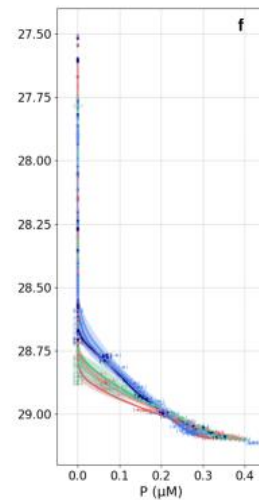
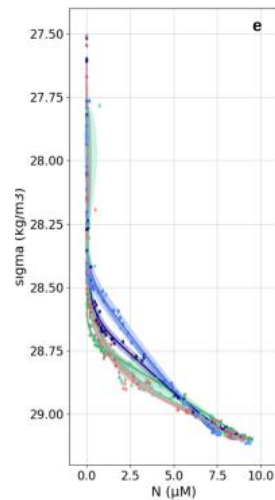




# BIOSWOT-Med

## Bottom-up effect of an eddy at SWOT scales

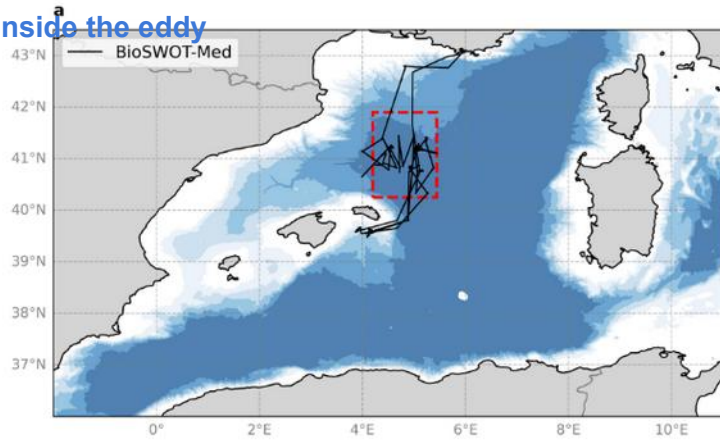
## Modulation of the nutrient field



inside the eddy  
outside the eddy  
frontal region



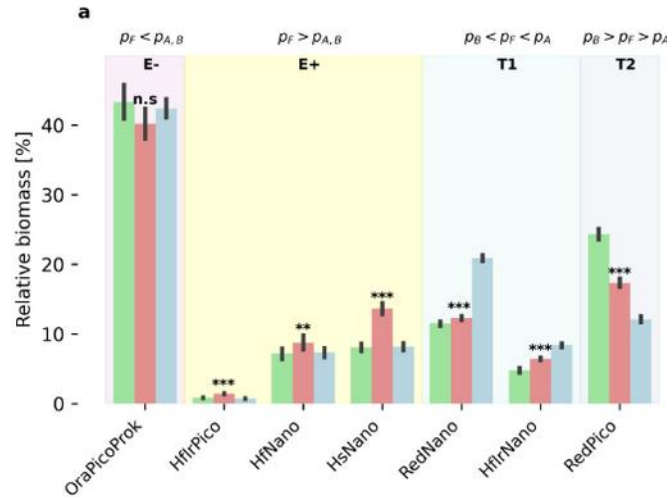
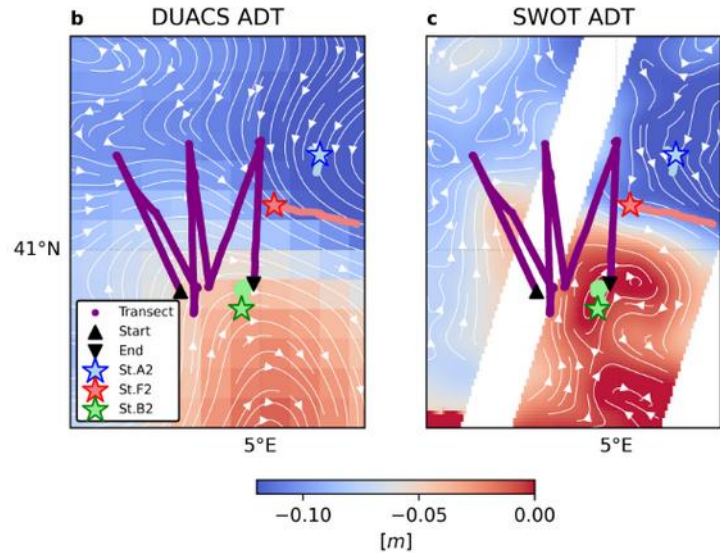
inside the eddy



BIOSWOT-Med

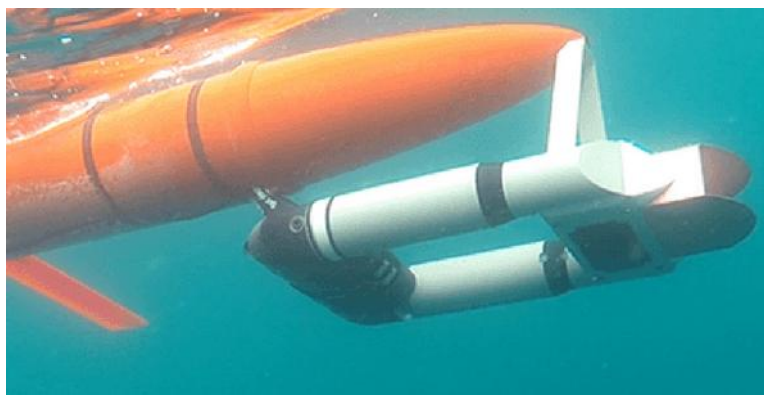
Bottom-up effect of an eddy at SWOT scales

Modulation of the phytoplankton community



inside the eddy  
outside the eddy  
frontal region

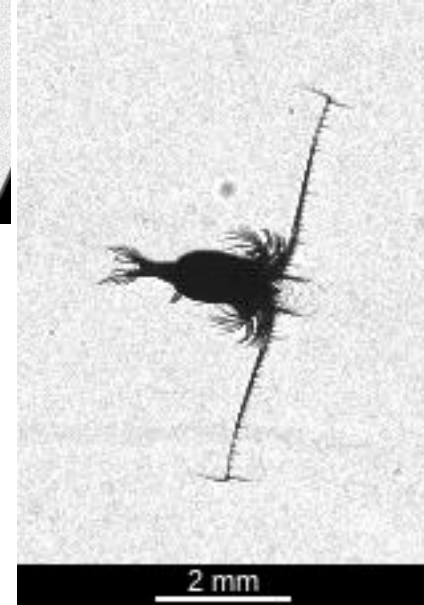
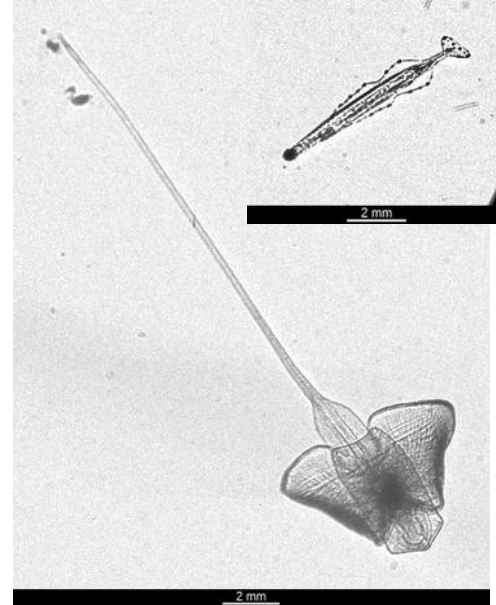
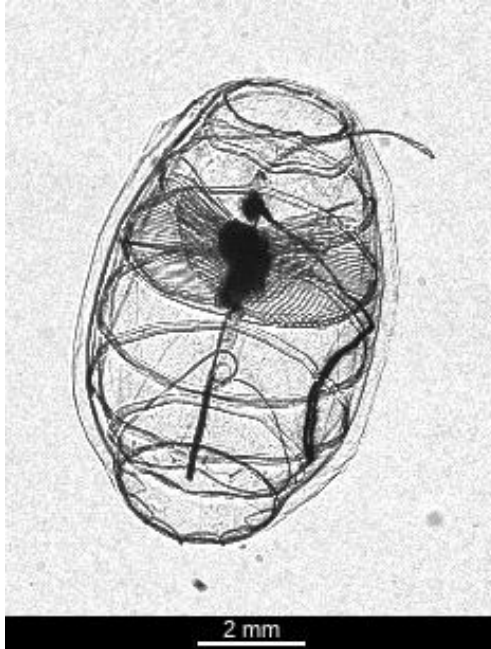
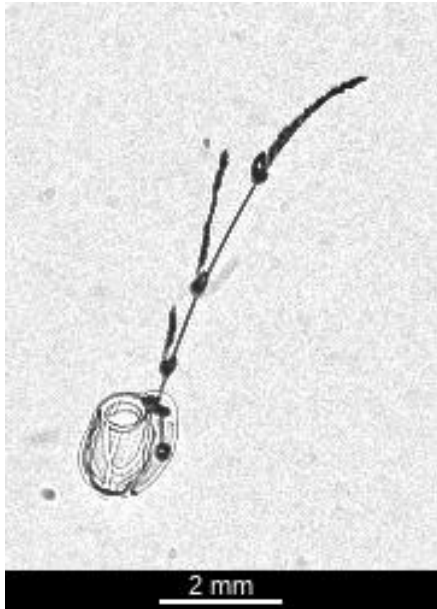
Oms et al. under revision



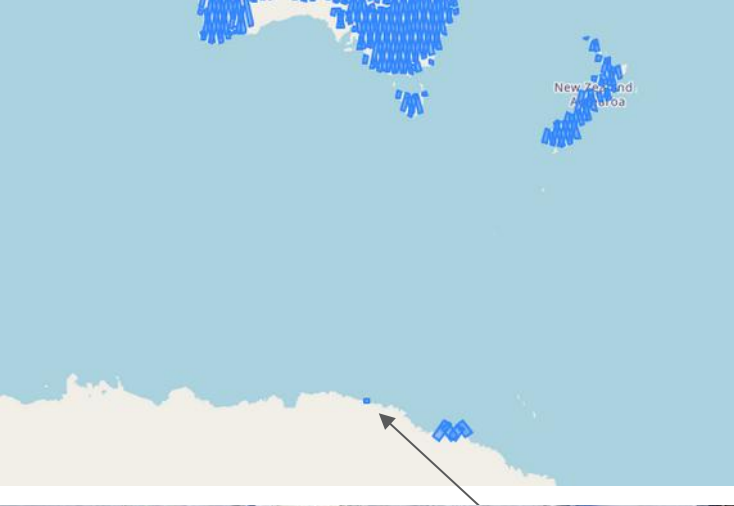
BIOSWOT-Med

Bottom-up effect of an eddy at SWOT scales

Ongoing study on the impact on zooplankton



Images courtesy of M. Ohman (Scripps)



November 2025: a CNES-funded collaboration with a Weddell seal for cross-validating freeboard estimation!



Sara Labrousse, LOCEAN-IPSL, program IPEV 1182



Thank you  
and enjoy  
the  
meeting!

F. d'Ovidio, T. Farrar, L.-  
L. Fu

Sara Labrousse, LOCEAN-IPSL,  
program IPEV 1182

A detailed 3D rendering of a satellite in orbit above the Earth. The satellite has a central gold-colored body with two large, rectangular solar panel arrays extended horizontally. Below the main body, there are several smaller instruments and antennas. The Earth's surface is visible below, showing a mix of blue oceans and white clouds, with the horizon line clearly defined. The background is a deep blue space.

# Some announcements

SWOT-ST Meeting  
14-17 October 2025, Arcachon

# SWOT and the new wave of oceanographers

Early Career Researchers speak about SWOT



## If you are Early Career:

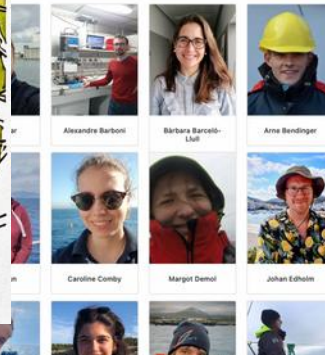
We want to hear what you think about SWOT!

More than 50 interviews to SWOT ECR already collected for Oceanography in an eBook.

Next edition will include hydrology, DEC, and the cryosphere. Please contact:

[tosca.ballerini@thalassa.one](mailto:tosca.ballerini@thalassa.one)

Early Career Researchers





# Post-launch community paper (Oceanography)



At O(100) papers in the past two years, it's time to review how SWOT confirmed, infirmed, and transformed what we know about the ocean mesoscale and submesoscale

Tentative title: "Ocean mesoscale and submesoscale as seen by the SWOT satellite mission"

Introduction and Conclusions -> Ocean Science Leads

Sections -> 3-5 pages for each Working Group, coordinated (written) by WG Leads

Journal: Progress in Oceanography ?

# We need your feedback

A satellite with large solar panels is shown in space, with a bright light source (the sun) creating a lens flare effect behind it. The satellite is positioned in the center of the frame, with its solar panels extended outwards.


SWOT-ST meetings are great opportunities for discussing community feedback and recommendations for our space agencies. Here are some possible points of discussion that we would like you to keep in mind during this week.

What is your preferred product lifecycle? (Any update as soon as there are some new features, one year or more,...)

How far would you like to push model-trained AI for denoising SWOT observations?

Please free to contact the Science Leads for any other community question that you feel can be relevant to raise!



A satellite with gold-colored structural elements and blue solar panels is shown in orbit above a dark, textured Earth surface. A bright sun is visible on the right side of the frame, creating a strong glare and illuminating the satellite and the Earth's surface.

Thank you and enjoy  
the meeting!

SWOT-ST Meeting  
14-17 October 2025, Arcachon