Ocean mesoscale hot-spot at the Nordic high latitudes: the Lofoten Basin

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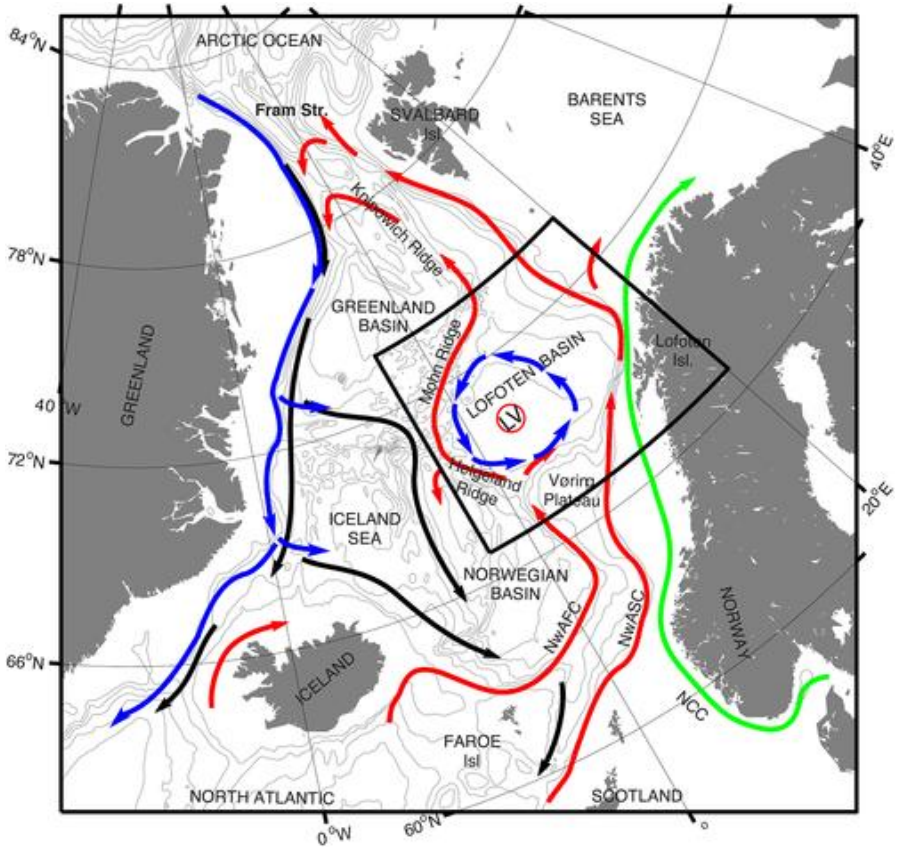
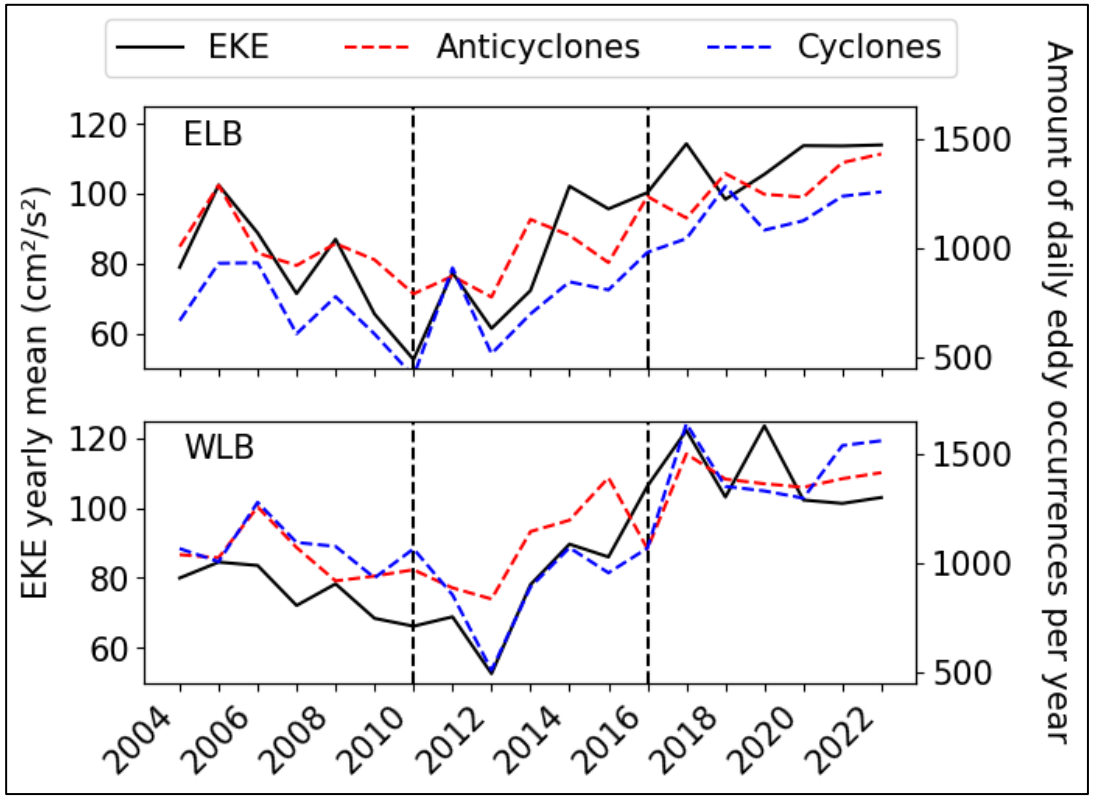
SWOT Science Team Meeting 2025
13th –17th October 2025, Arcachon, France

Mesoscale activity in the Lofoten Basin



(Raj et al., 2020)

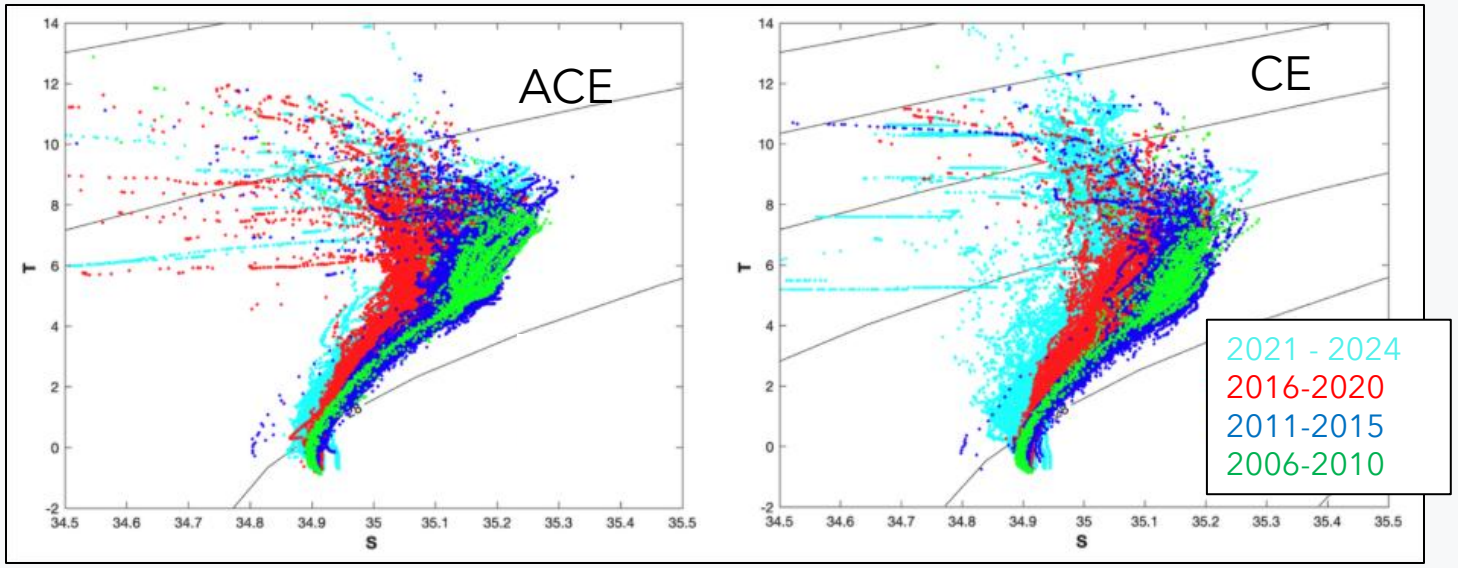


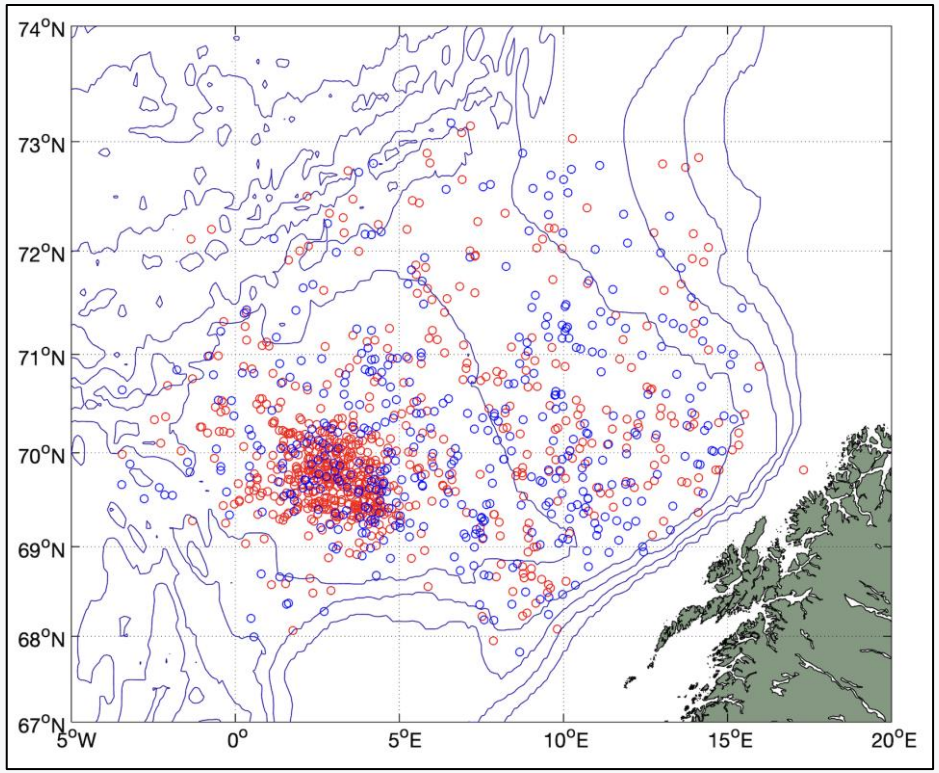
(Raj, et al., in prep.)

Eddy Kinetic Energy (EKE) values and the frequency of detected eddy occurrences, distinguishing between anticyclonic (red) and cyclonic (blue) eddies. The top graph shows the Eastern Lofoten Basin (ELB), while the bottom graph represents the Western Lofoten Basin (WLB).

Mesoscale activity in the Lofoten Basin

- Collocation with Argo profiling floats

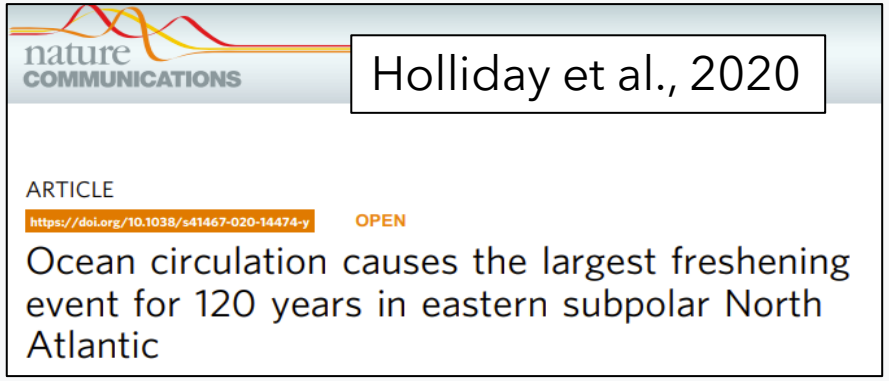




Argo floats collocated within anticyclonic eddies (red) and cyclonic eddies (blue)

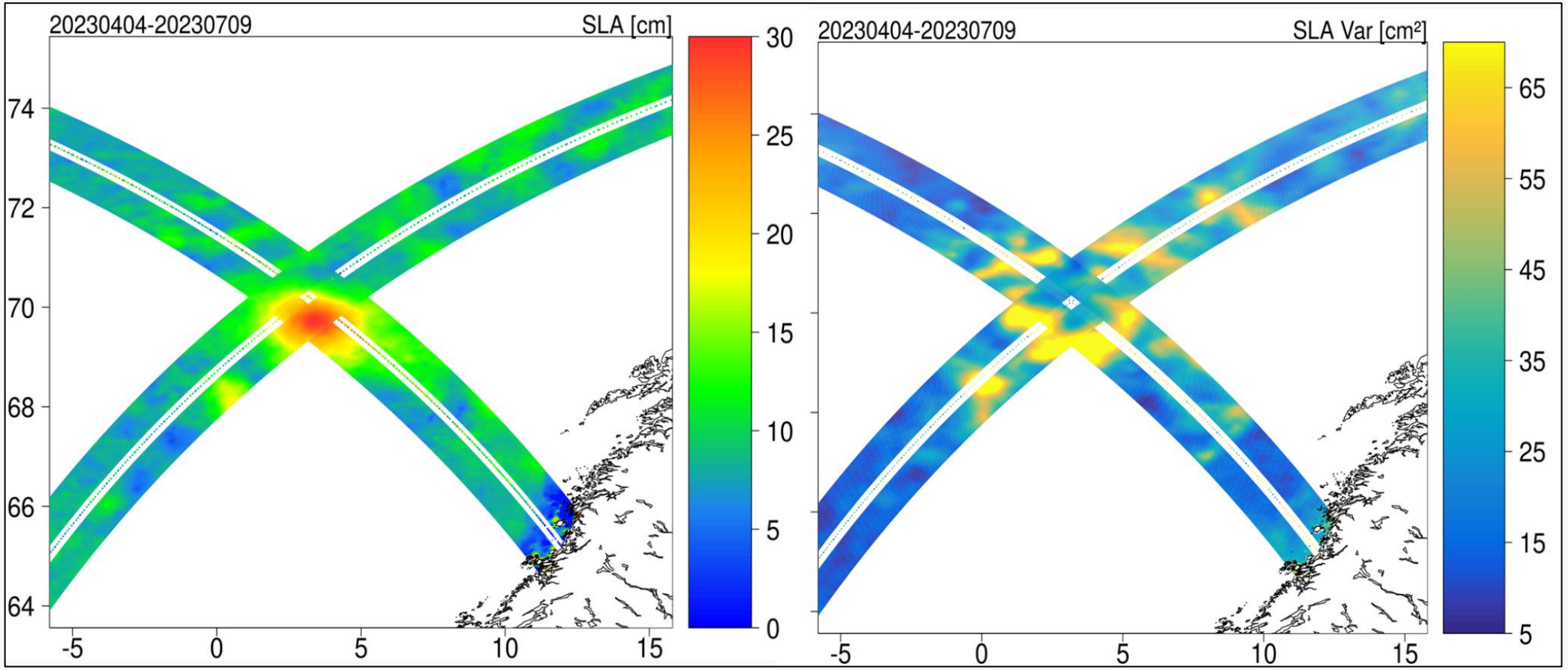
Freshening of mesoscale eddies starting from 2016 which keeps showing a prominent signature up to 2024. The latter underlines the propagation of the large salinity anomaly in the northern North Atlantic (Holliday et al., 2020).

(Raj et al., in preparation)



SWOT fast sampling phase: Lofoten Basin cross-over

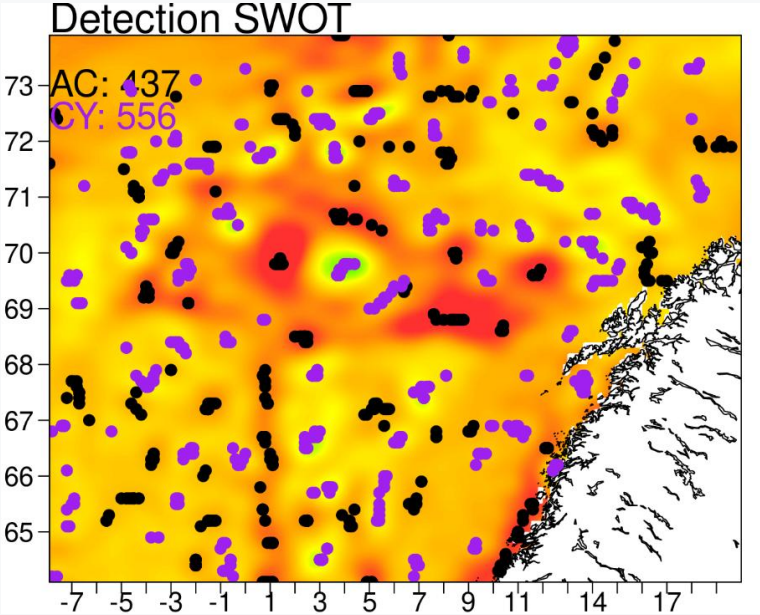
- Sea Level Anomaly (1-day repeat; April - July 2023)

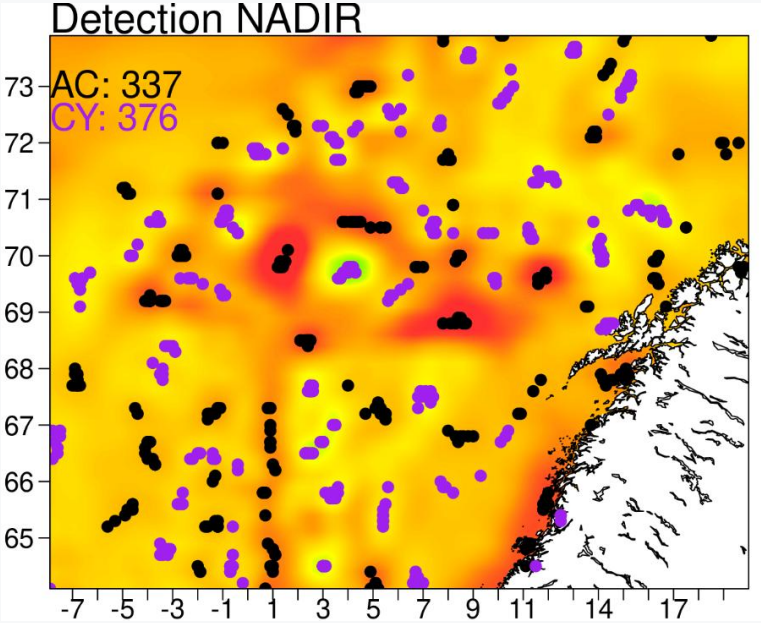


Poster Session
A. Bernigaud et al.
Oceanography: Regional Validation

- The **SLA averaged field (left)** clearly show the (anticyclonic) Lofoten Vortex, and smaller mesoscale features e.g. which paly an important role in modulation of cross-shelf exchanges.
- The **SLA variance (right)** shows the largest variability e.g. in the areas where the interaction between mesoscale eddies and the gyre circulation (Raj et al., 2020) in the Lofoten Basin is more prominent.

SWOT Science Phase: Eddy Detection

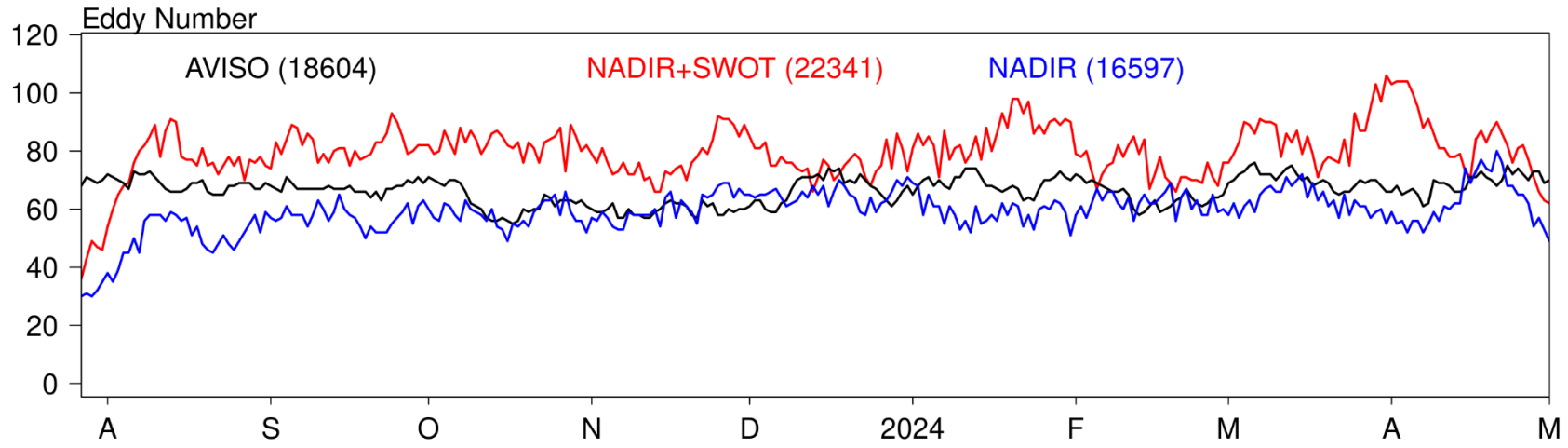




- MIOST* products in the Lofoten Basin (30th September - 10th October 2023)
- **SLA** (*cm*; background) and **eddy positions** (dots) considering lifetime > 10 days

* MIOST (Ballarota et al., 2025)

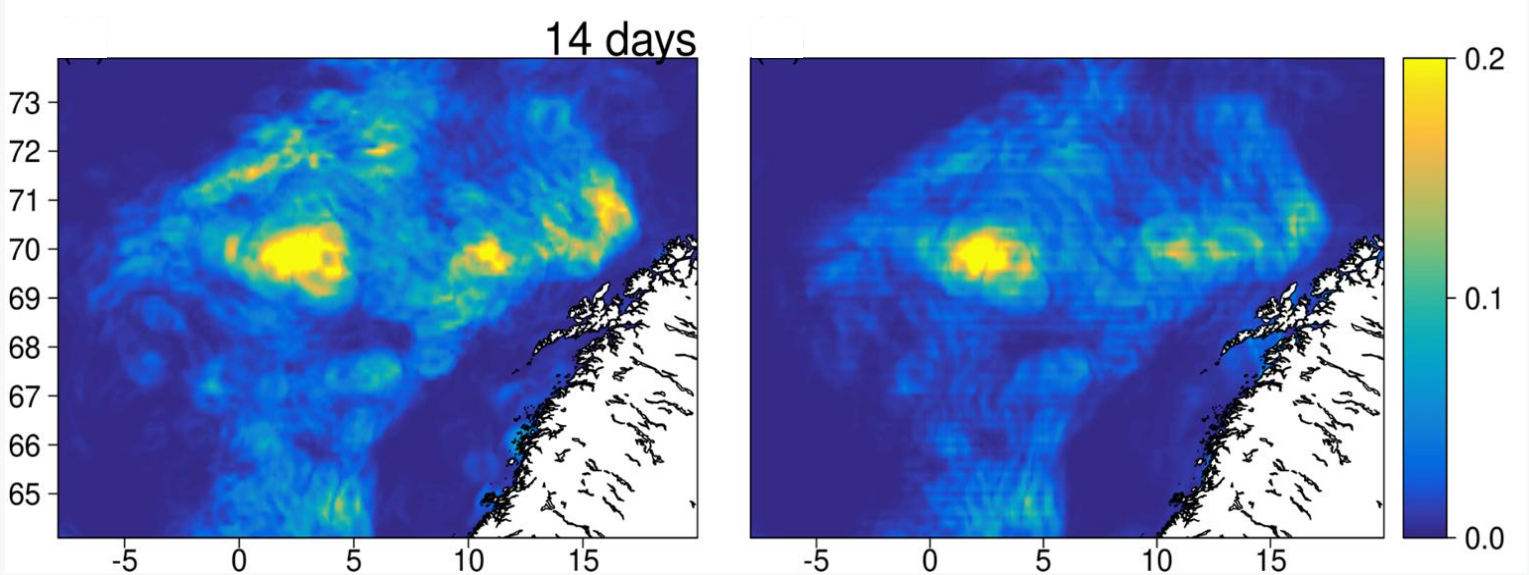
Number of Eddies : July 2023 – May 2024



- **Larger number of eddies** with SWOT+NADIR

ESA Water Project

SWOT Science Phase: Eddy Kinetic Energy



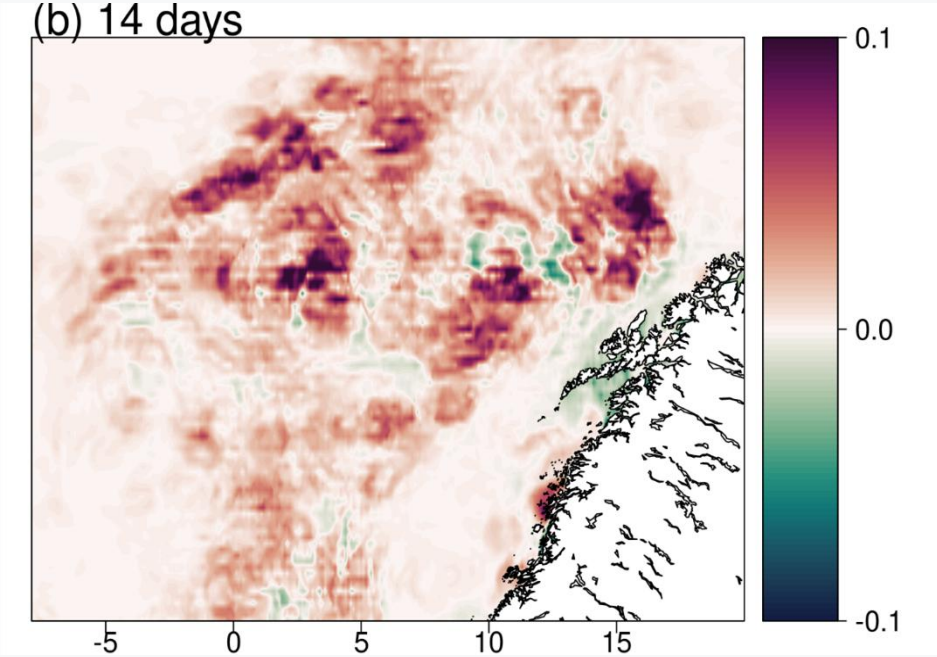
MIOST* → SSH estimation using nadir altimetry, SWOT

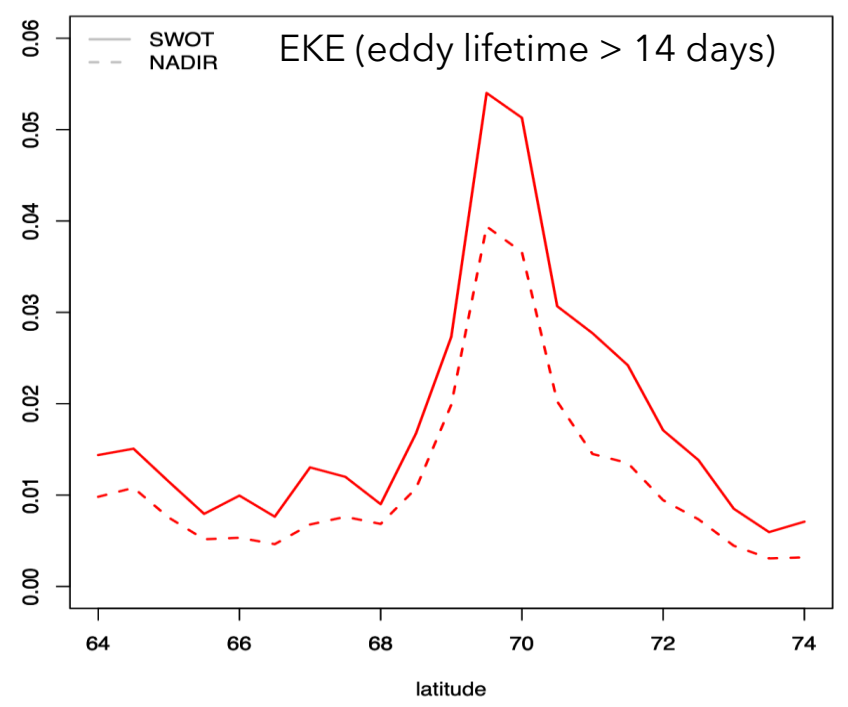
July 2023 - May 2024

EKE as a function of eddy lifetime (14 days)

- MIOST NADIR (right)
- MIOST NADIR+SWOT (left)

* MIOST (Ballarota et al., 2025)



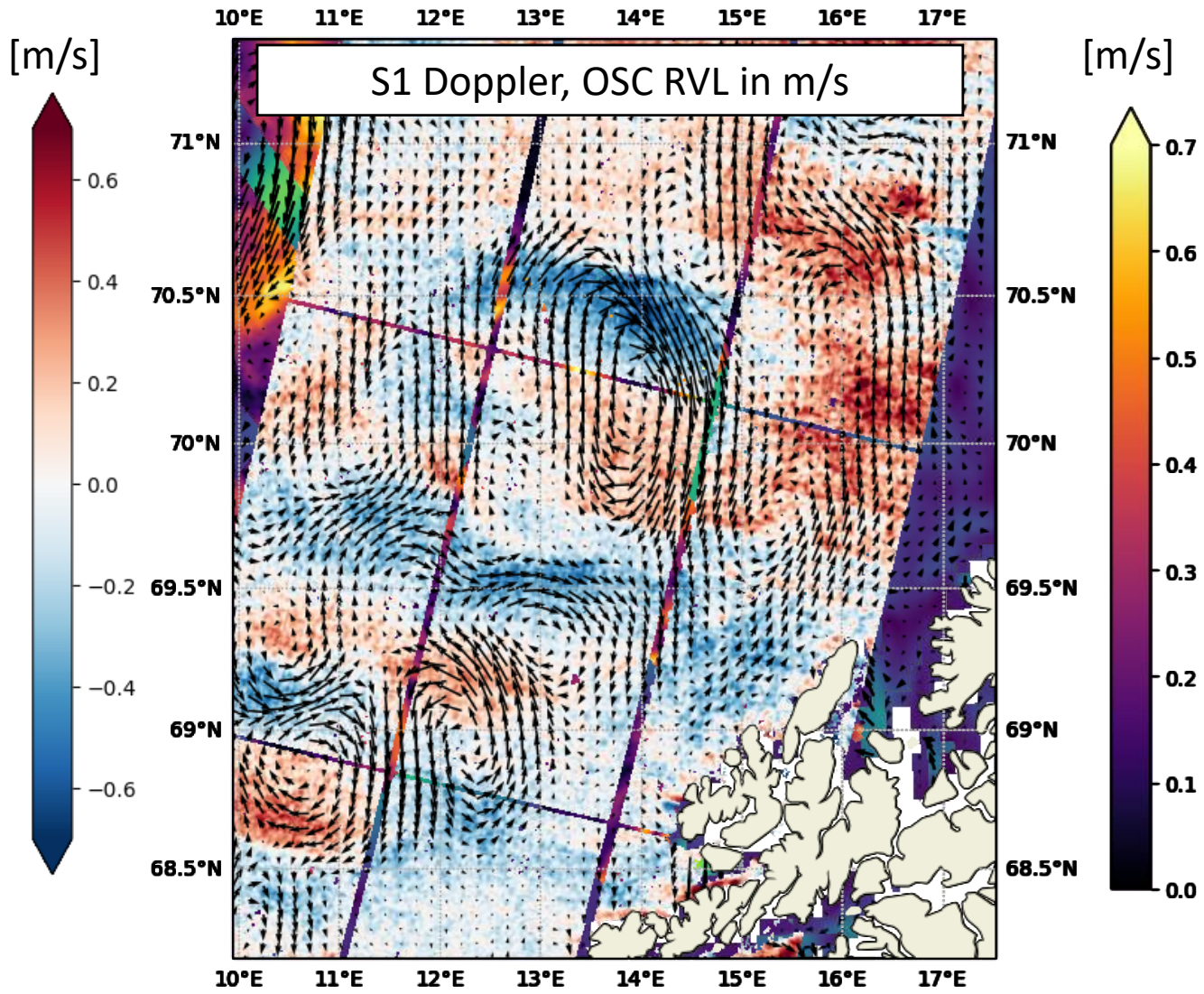


Differences are prominent both in the **eastern and western part of the Lofoten Basin**, Lofoten Vortex and Mohn Ridge

ESA Water Project

From Sentinel-1 Doppler, SWOT, QG L4 current, and Mercator 1/12 – science phase

Ocean Surface Circulation in Lofoten Basin on 29th July 2023



Input Data:

1. Mercator 1/12 surface current [8 km px s]
2. VarDyn* Currents from combination of SWOT and nadir altimeters [5 km px s]
3. Geostrophic Current from SWOT [2 km px s]
4. Total Surface Current Radial Velocity from Sentinel-1 Doppler [1 km px s]

Key points:

1. Good consistency between all products for features >> 30 km in terms of location (given time separation), magnitude, and direction
2. Small scale features (~10km) are not represented in the reconstruction but appear consistent between SWOT and Sentinel-1

*VarDyn (Le Guillou et al., 2025)

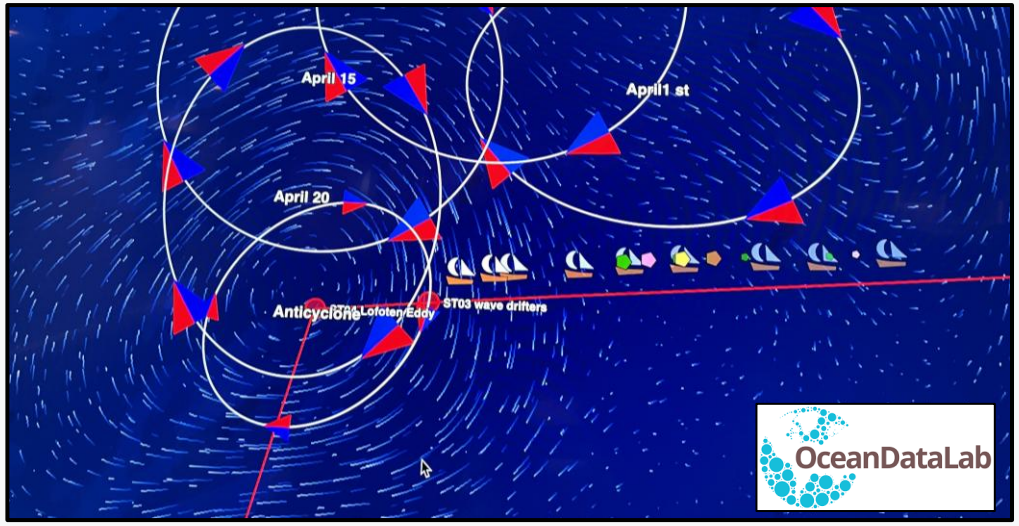
ESA – Advanced Ocean Training Course 2025 (OTC25)

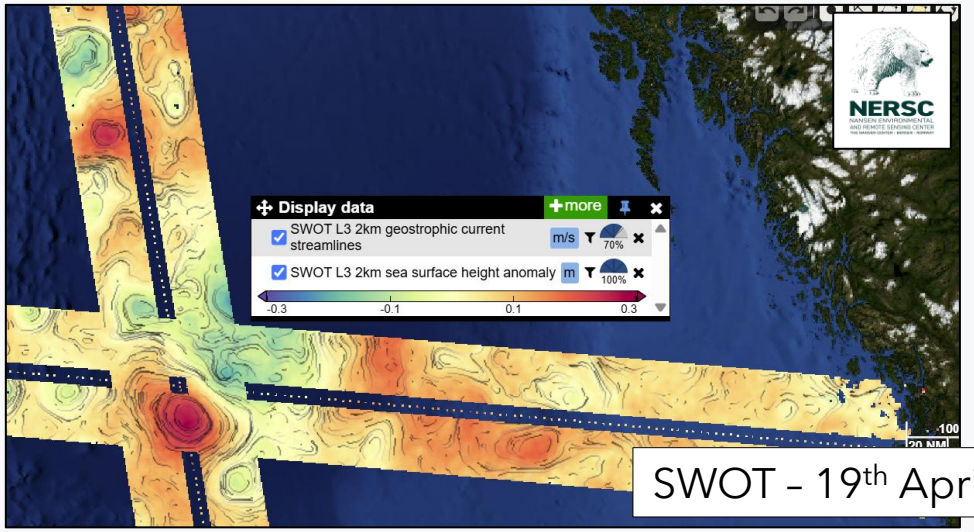
ONE OCEAN SCIENCE CONGRESS NICE FRANCE 3-6 June 2025

United Nations

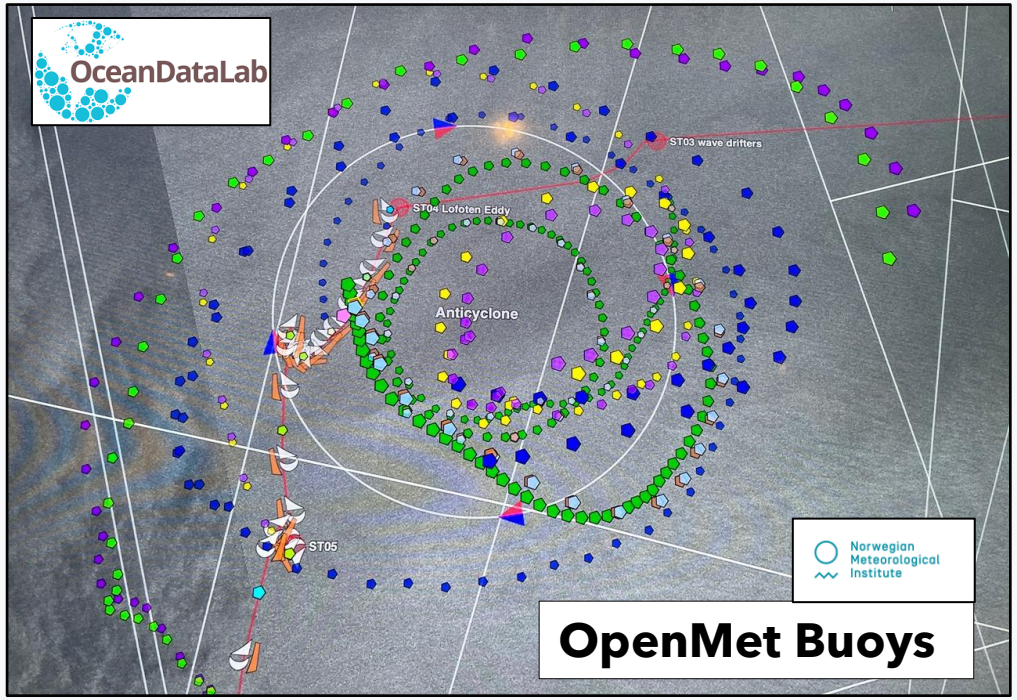
UNITED NATIONS OCEAN CONFERENCE
NICE, FRANCE 2025

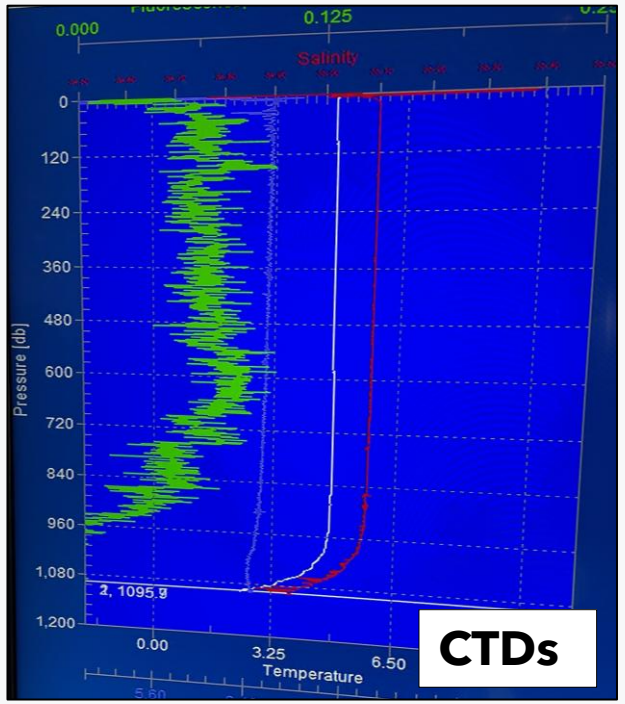
ESA OTC25 – Ship Track through the Lofoten Basin





SWOT – 19th April 2025

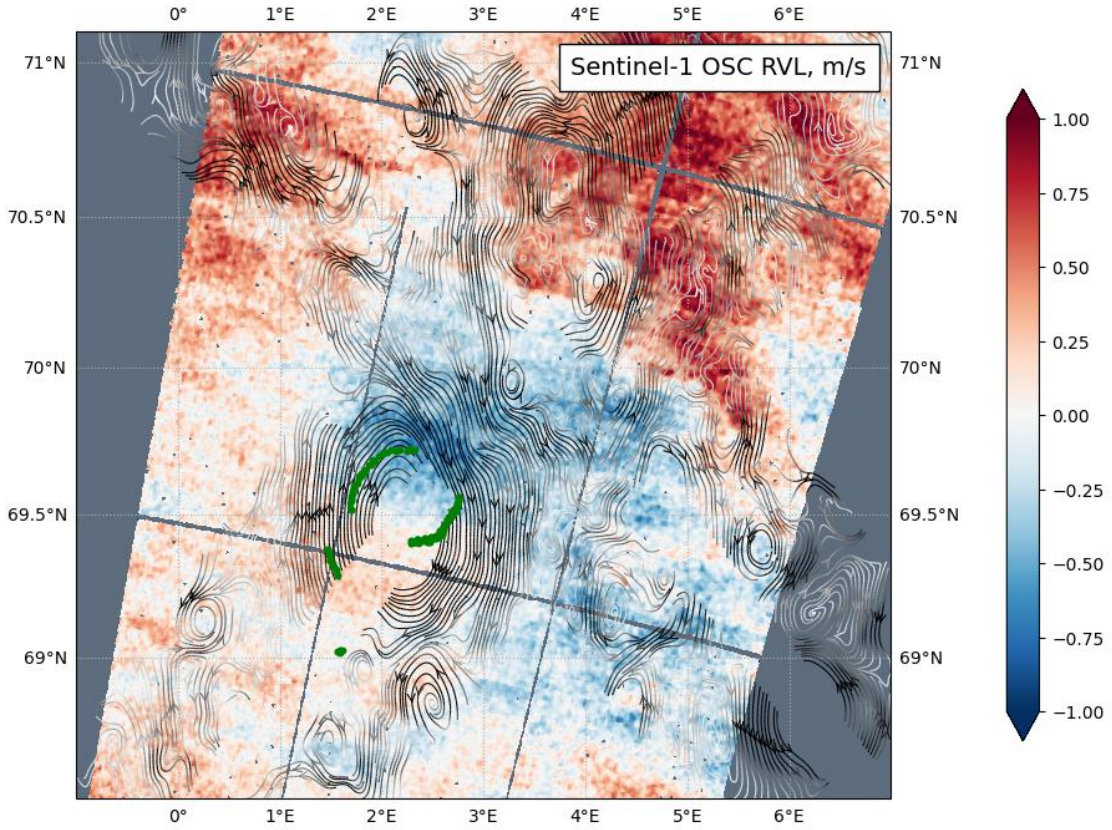




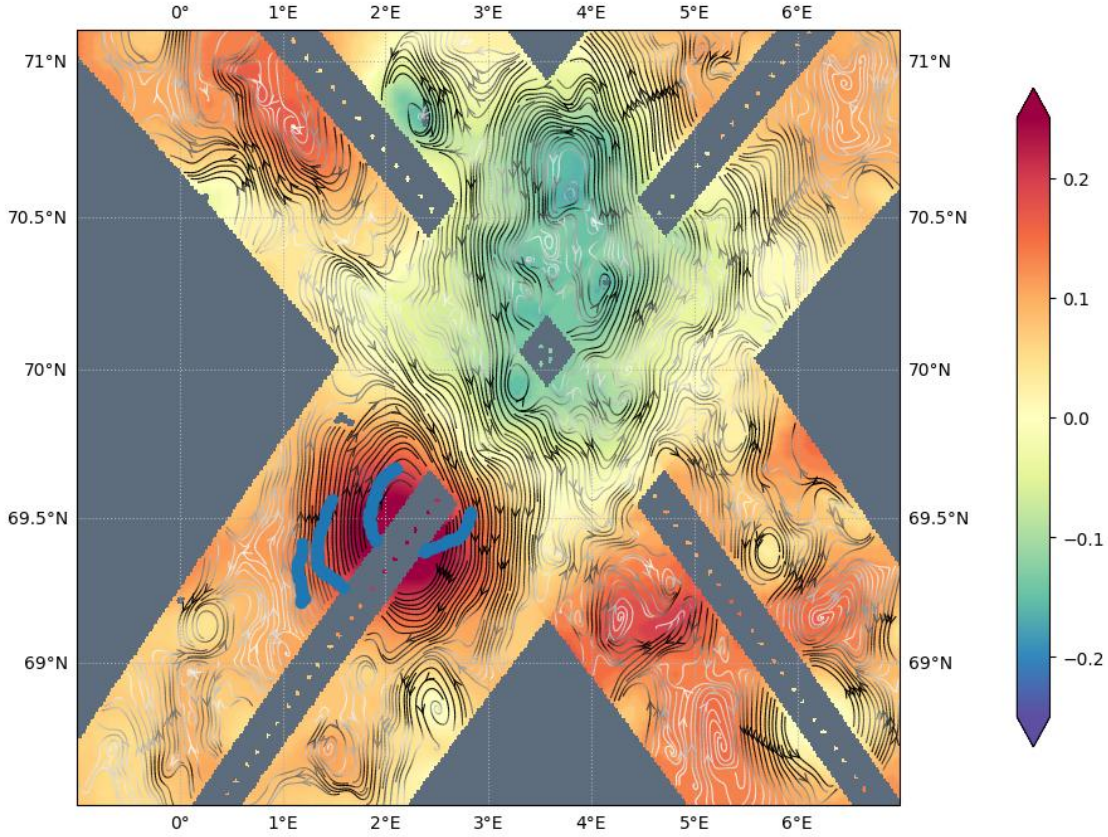
Synergies with Sentinel-1 Radial velocities

Ocean surface retrievals of the **SWOT** mission and **SAR Doppler**-based range surface velocities.

Sentinel-1A IW RVL on 26th April **2025** at 06:26



SWOT SSHA v2.0.1 on 29th April **2025** at 10:00

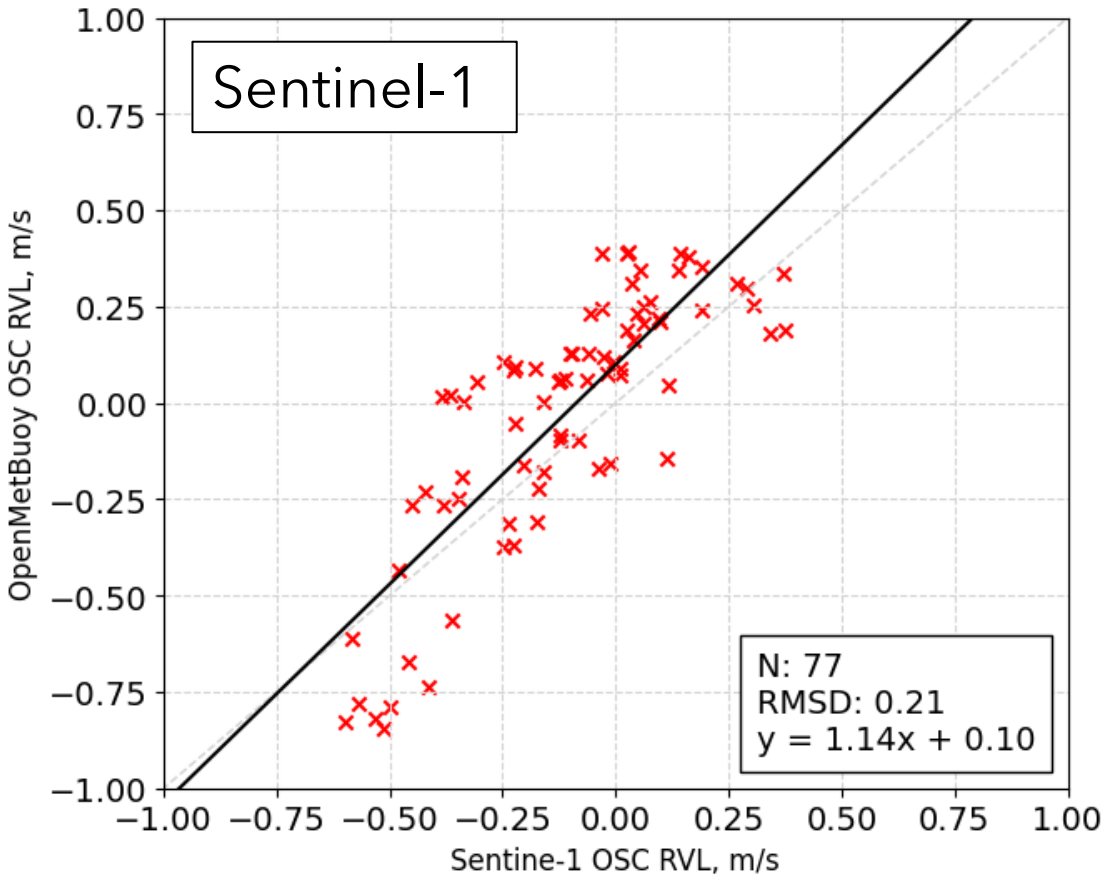


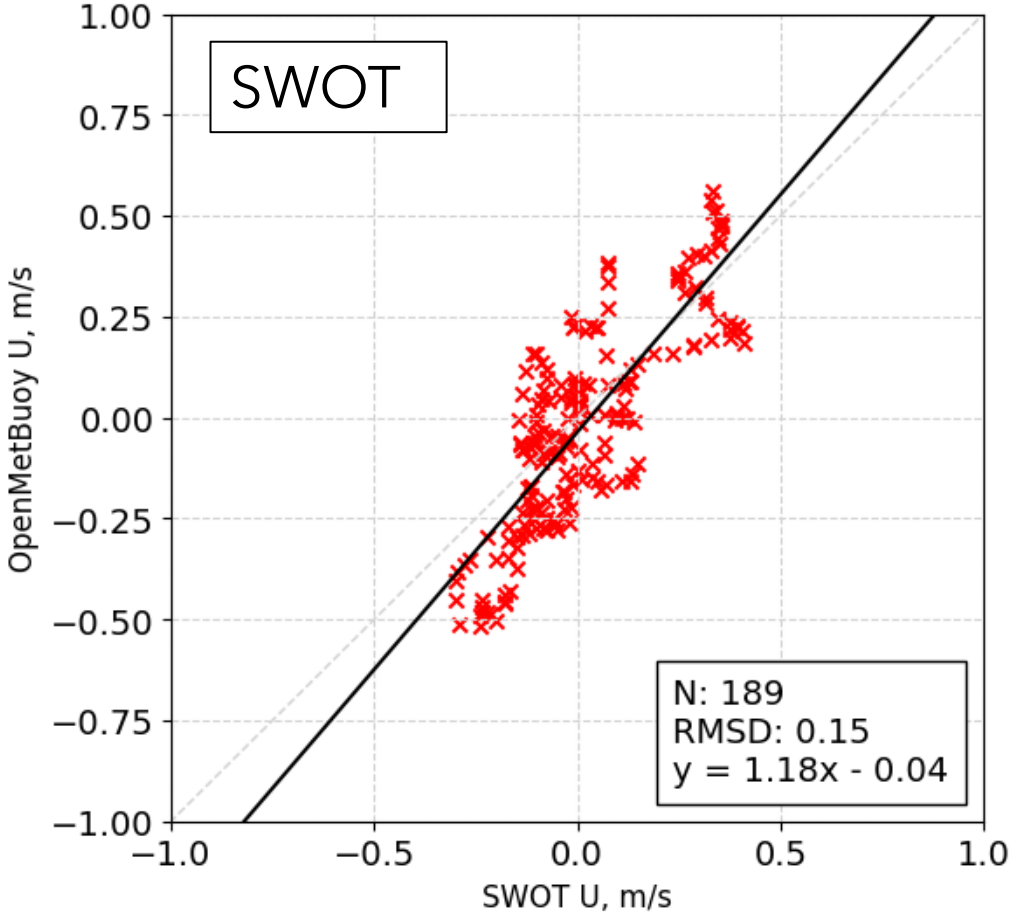
(Moisev et al., in prep.)

Streamlines represent the geostrophic current derived from **SWOT** SSHA (black is >= 0.4 m/s).
Green (left) and blue (right) dots are locations of OMB observations within +/- 12 hours from the satellite acquisition.

Synergies with Sentinel-1 Radial velocities and drifters

ESA Prodex: Sentinel-1 Doppler Validation Project





(Moisev et al., in prep.)

Take-home messages

- SWOT enhances the representation of the ocean mesoscale field (EKE) at the Nordic high latitudes where observing capabilities are reduced and Rossby radius gets small

- The enhanced capabilities of resolving mesoscale eddies also offer more opportunities for the collocation with other sensors (e.g. Sentinel-1).

- Potential for partitioning geostrophic and ageostrophic processes combining ocean currents from wide-swath altimetry (L3 and L4 products), SAR Doppler shift and in-situ measurements.

- SWOT Science Team: SWOT – NOR Project

Thank you!

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