

SWOT

Science Team Meeting

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ARCACHON · France

14-17 OCT. 2025

Assessment of SWOT observations for monitoring nearshore and coastal waves

Presented by: Md Saiful ISLAM

PhD Student, University of Rouen Normandy

Co-authors:

Emma Imen Turki¹, Carlos Lopez Solano¹, Pascal Matte³, Xavier Chartrand³, Laurent Froideval², Edward Salameh², Benoit Laignel¹, Nicolas Picot⁴

1. University of Rouen Normandy, University of Caen Normandy, M2C Rouen
2. CNRS
3. ECC, University of Rimouski, Canada
4. CNES

16 October, 2025

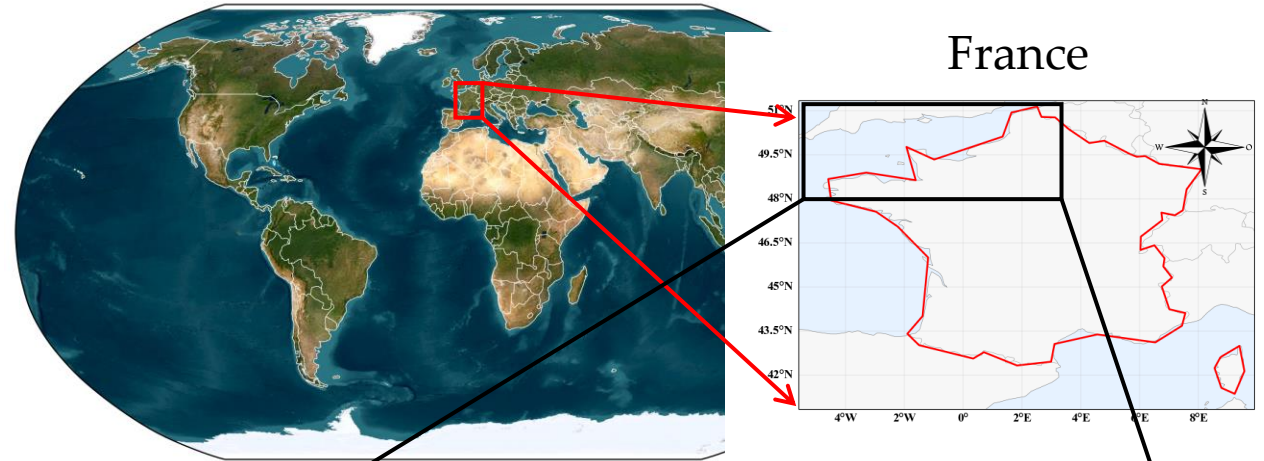
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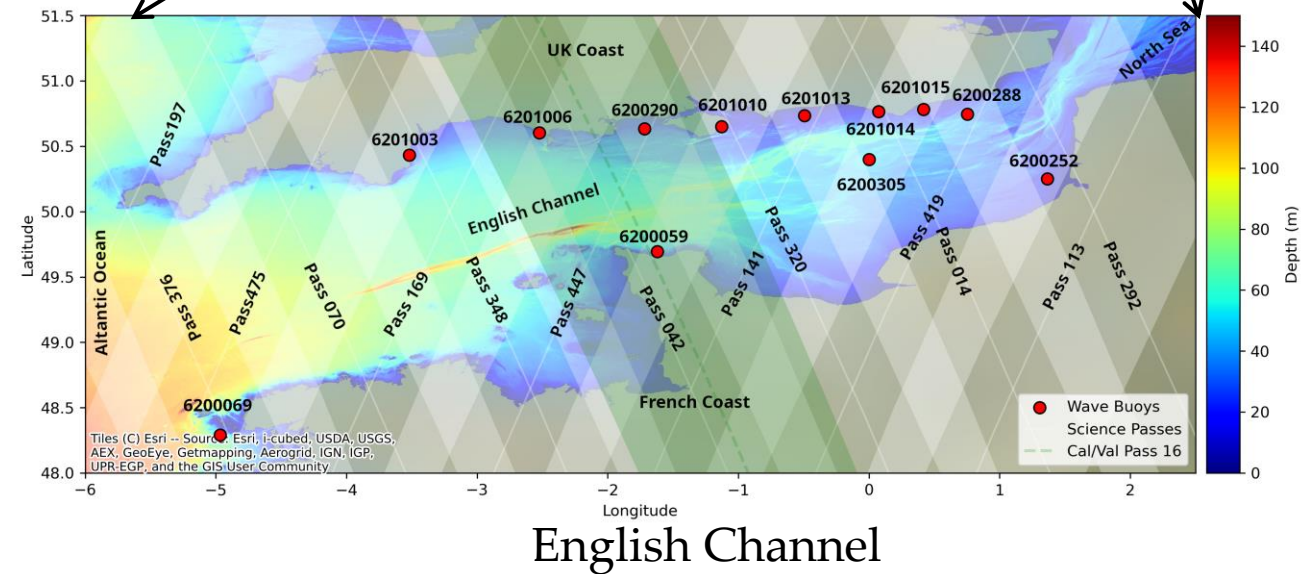
Mont- Saint- Michel



Etretat



- Complex geometry with capes and bays
- 78% of waves range between 1–4 m
- Primary wave direction from NNW to NE (>50%)
- In the eastern boundary, more than 90% of waves under 2 m

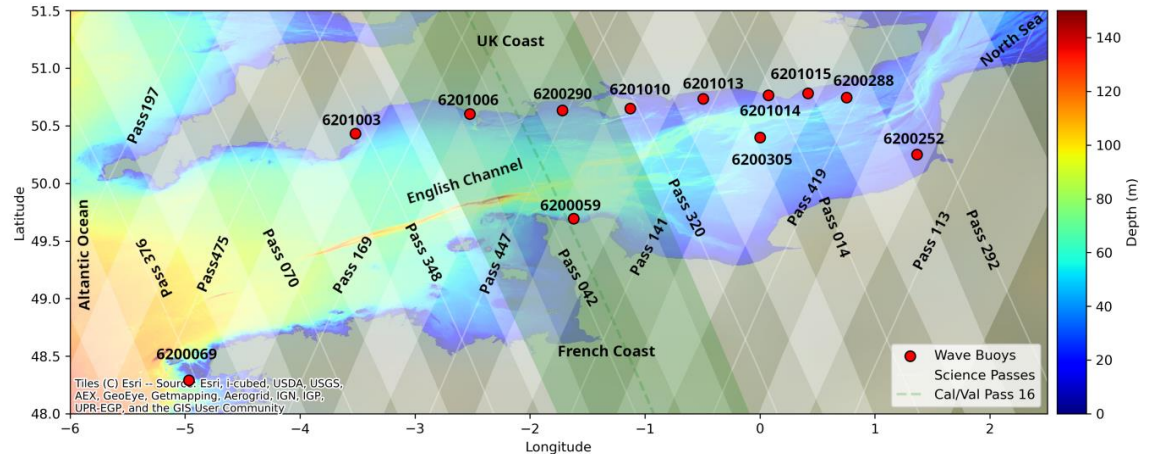
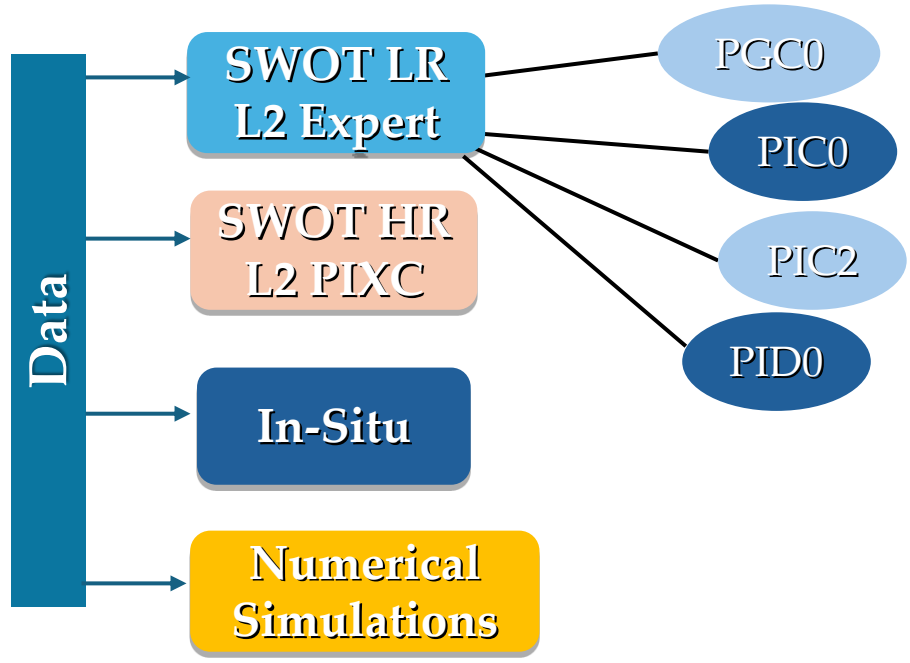


1. *Scientific Objective:*

- *Monitoring the wave field during storms from the nearshore to the coastline and quantify how its physical characteristics evolve, in order to:*
 - ✓ *improve process-level understanding of storm-wave transformation and to provide an accurate, well-characterized dataset for numerical model calibration and data assimilation.*

2. *Technical Objectives*

- ✓ *Investigate the consistency of SWOT observations against in situ data and numerical simulations at different depth*
- ✓ *Combine SWOT LR and SWOT HR PIXC for monitoring wave transformations from nearshore to coast during storms*
- ✓ *Applying the methodological approach for investigating coastal waves in Gulf of St. Lawrence*



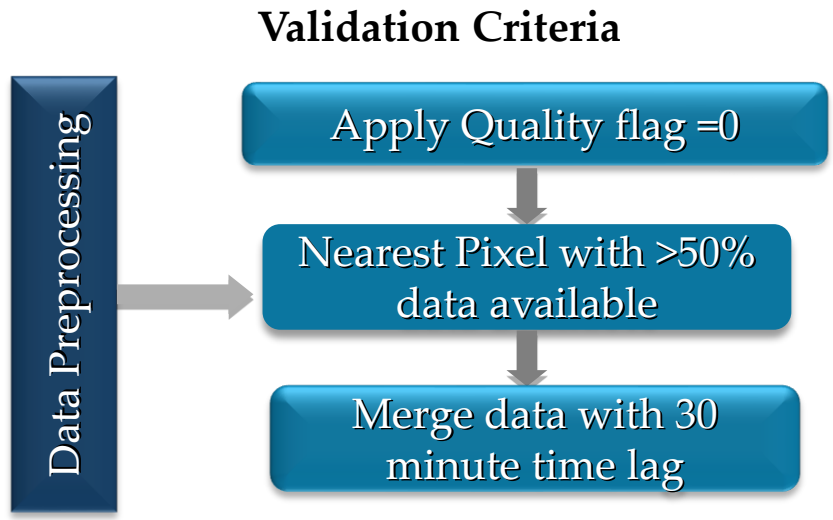
SWH Retrieval

Interferometric Correlation
 $\gamma = \gamma_{SNR} \times \gamma_{geo} \times \gamma_{ang} \times \gamma_{vol}$

Remove instrumental & geometric decorrelation
(γ_{SNR} , γ_{geo} , γ_{ang}) via onboard calibration

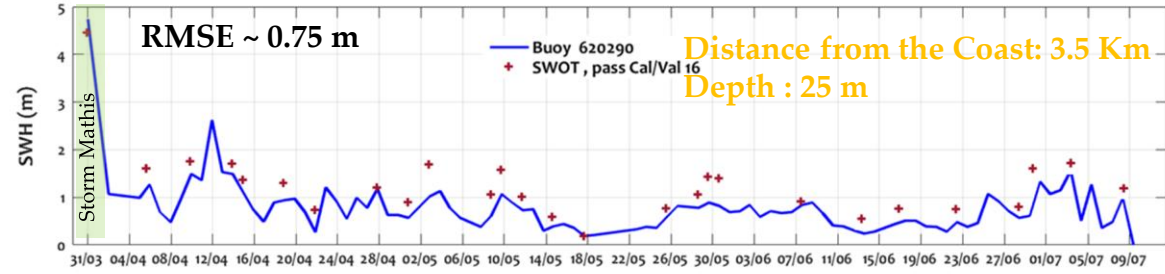
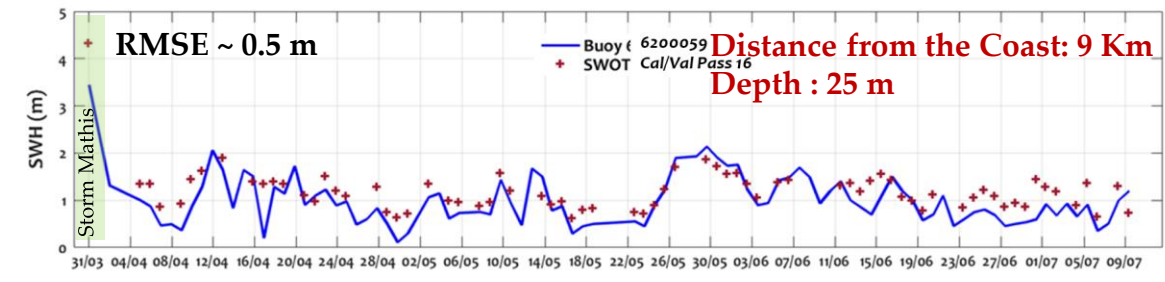
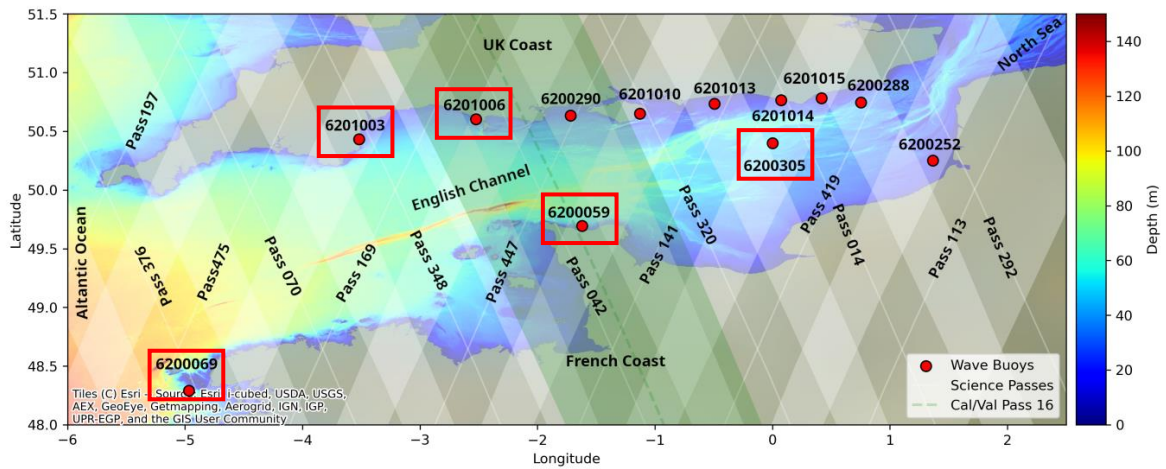
Invert γ_{vol}
Retrieve Significant Wave Height (Hs)

Bohé et al., 2025

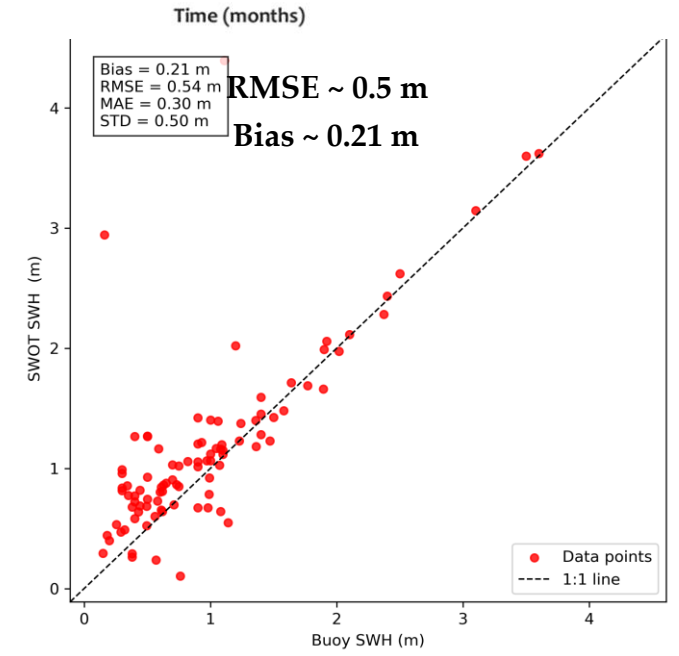
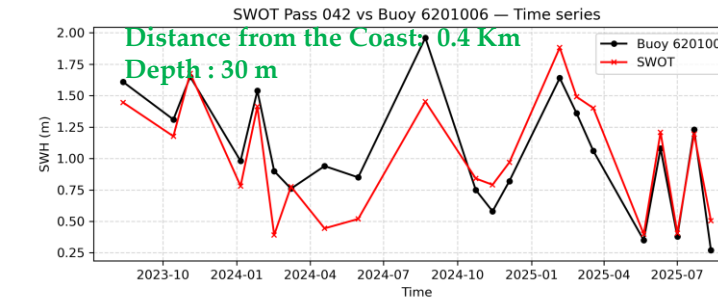
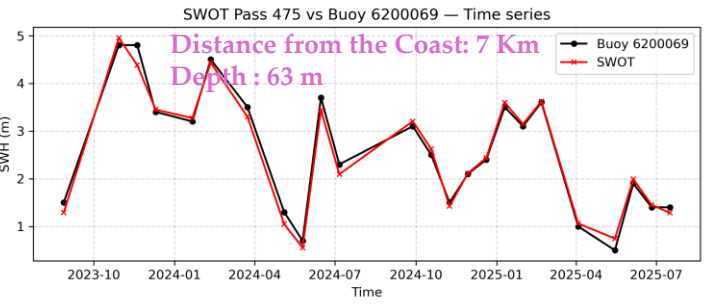
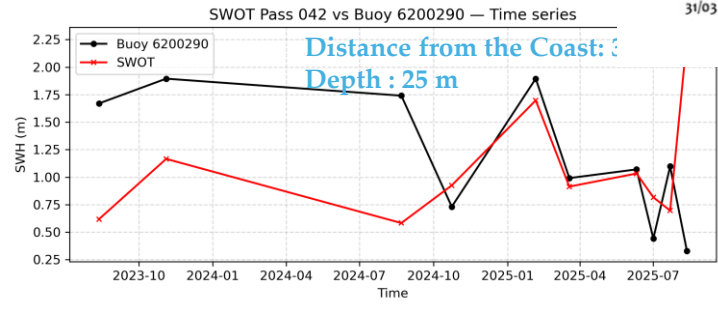
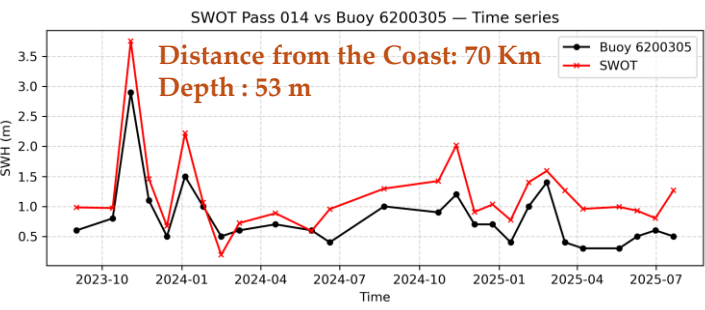


Data Preprocessing

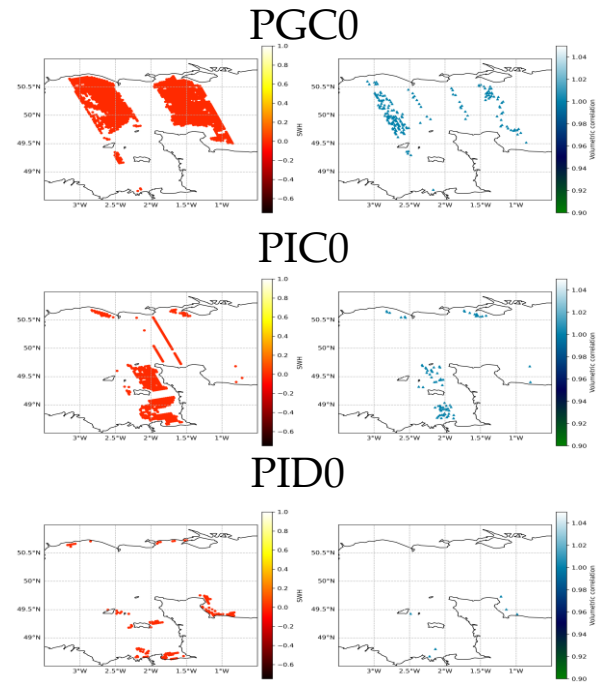
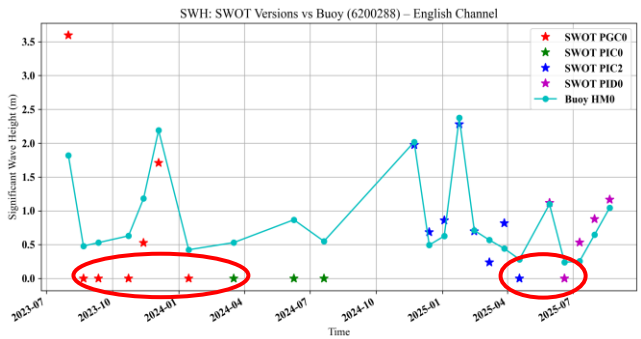
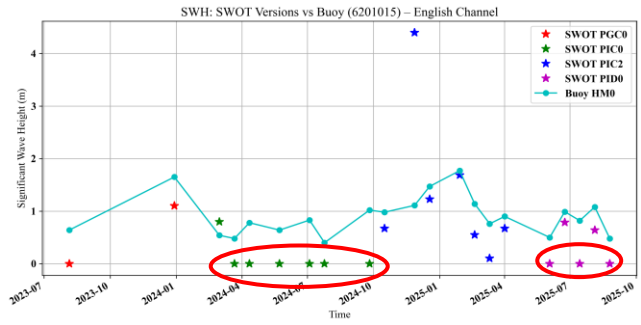
SWOT Cal/Val; SWH (L2 LR Experts)



SWOT Science; SWH (L2 LR Experts)

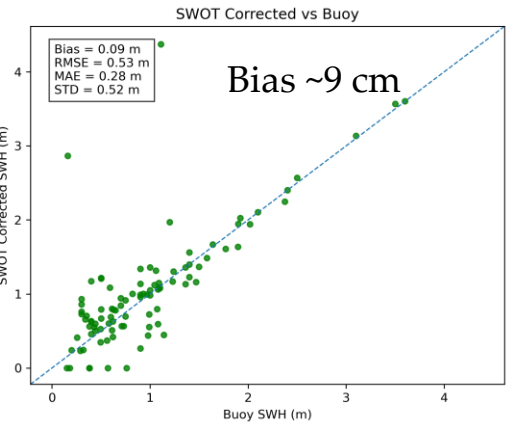
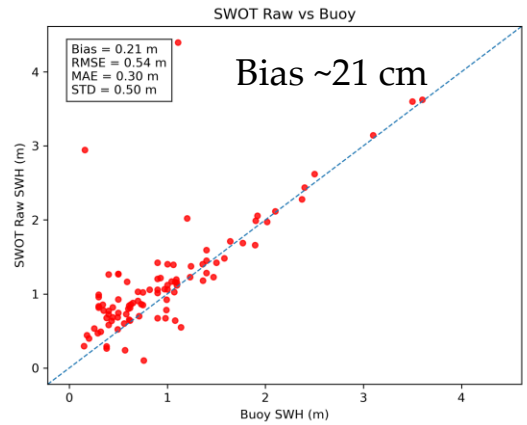


Accurate estimates within 3–4 km of the coastline Turki et al., 2025 (IJAEQG)
SWOT Science Team Meeting 2025

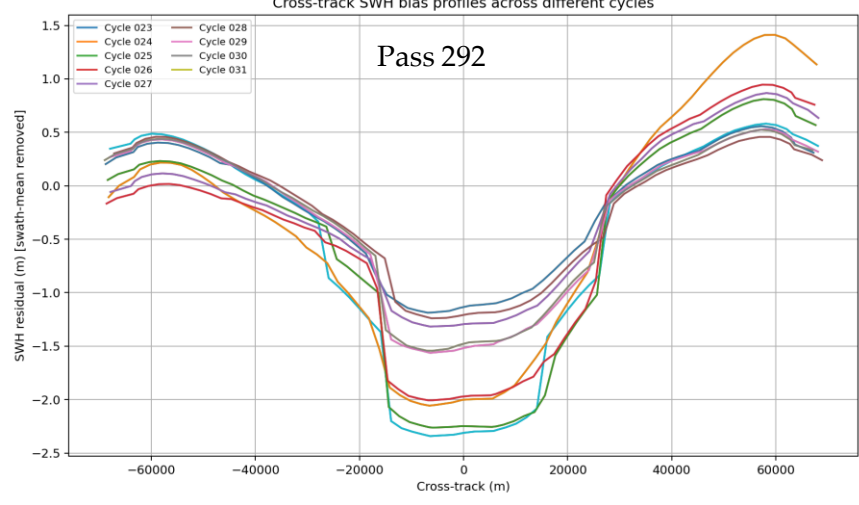


Valid SWH=0 $\gamma_{vol}=1$

- ✓ algorithm works only for 10-60 km from nadir
- ✓ algorithm could not detect smaller waves near the coast

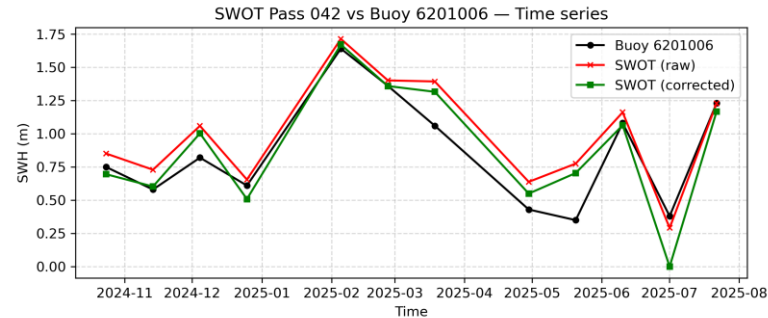
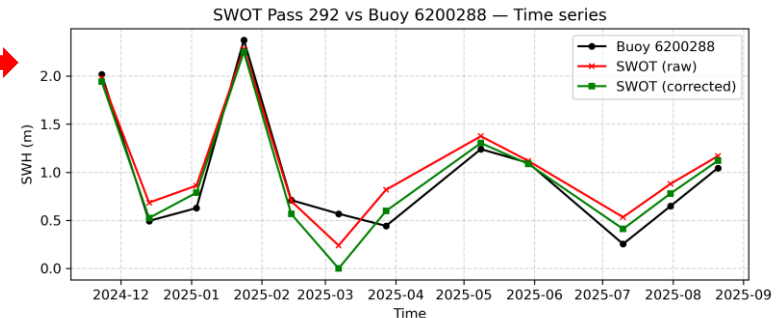


Cross track dependent bias

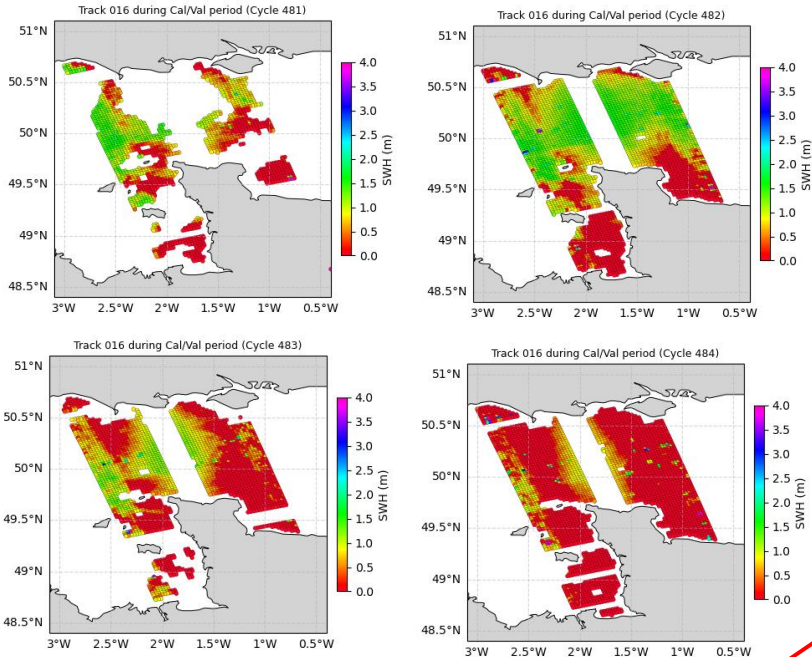


This cyclic pattern is beta dependent (Alejandro bohé, cnes)

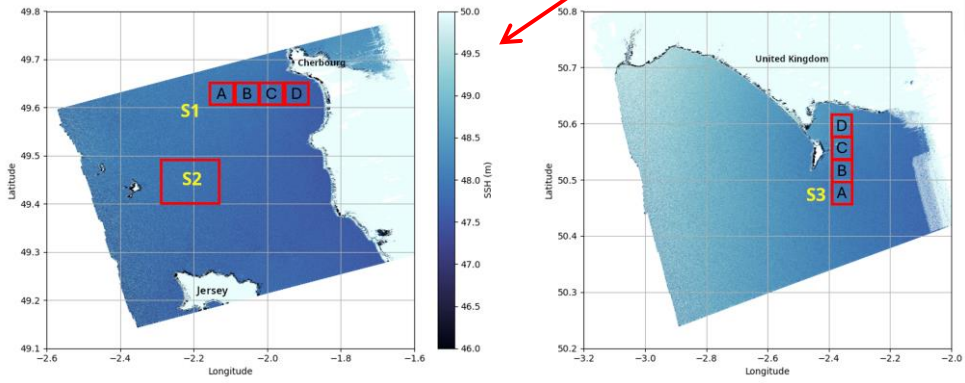
Applying correction



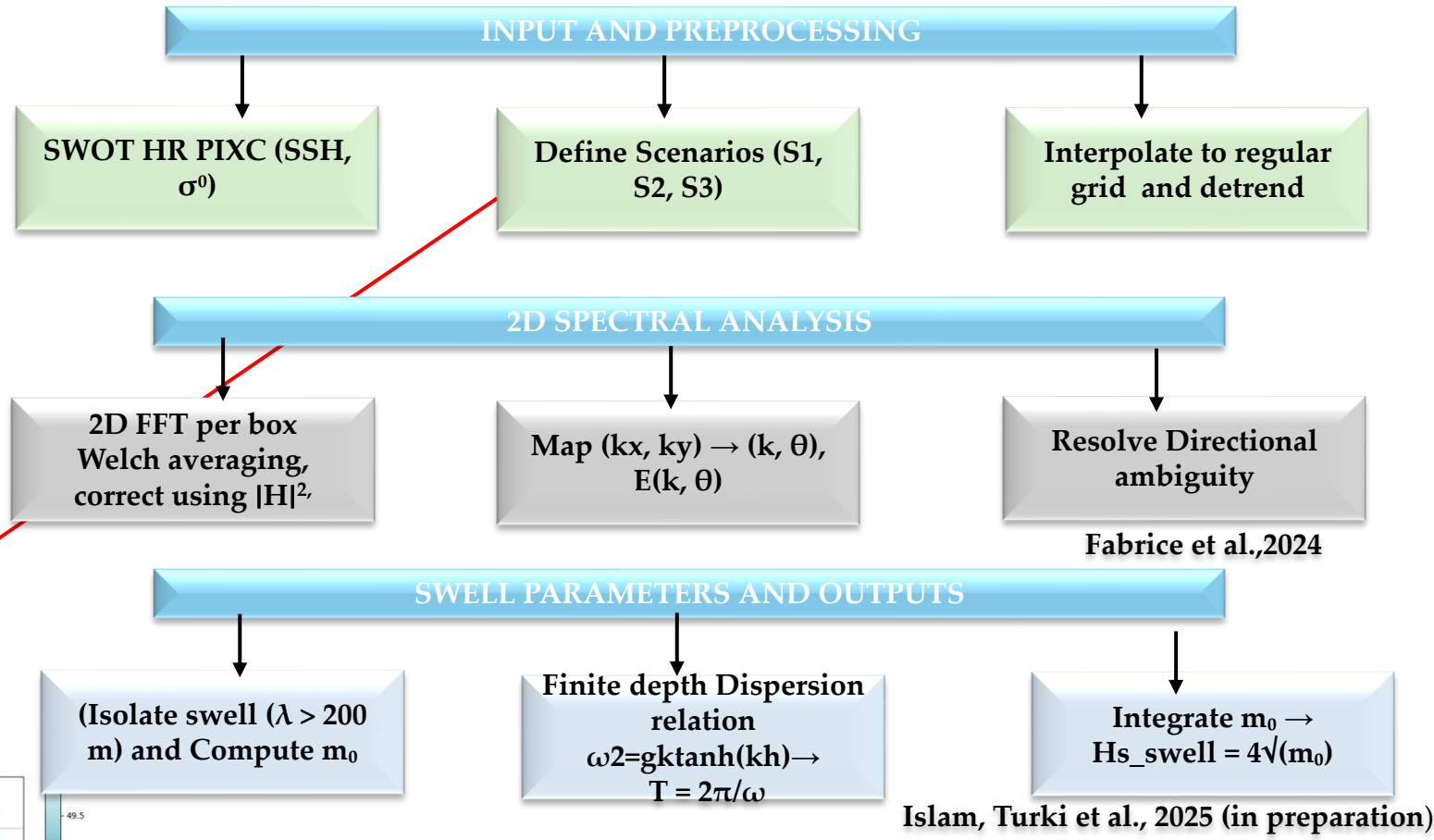
STORM MATHIS

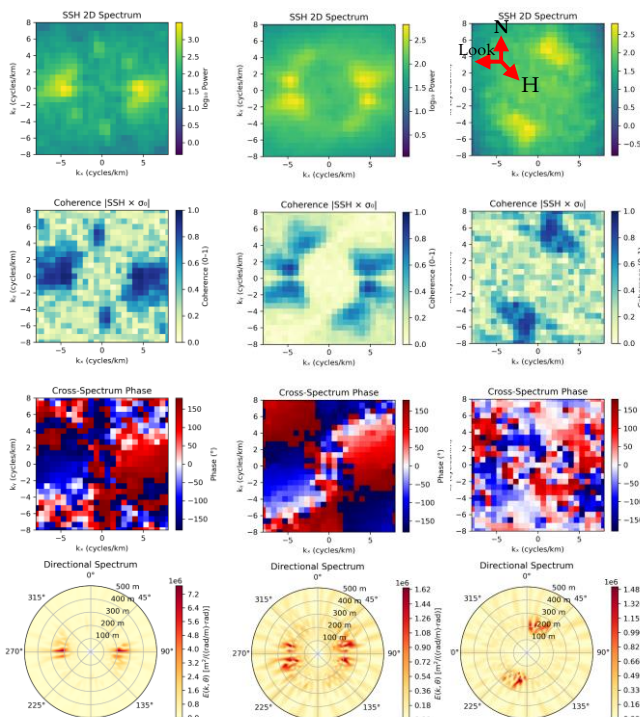


SWOT LR L2 SWH

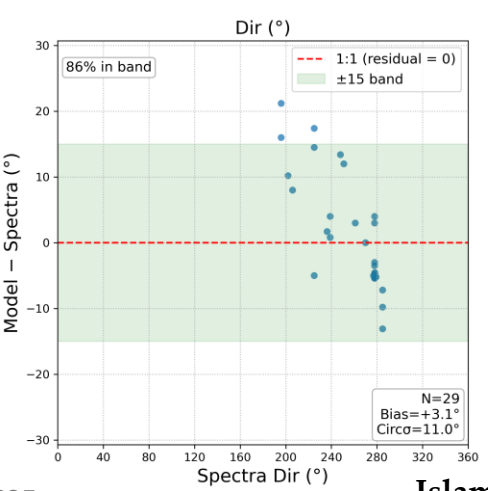
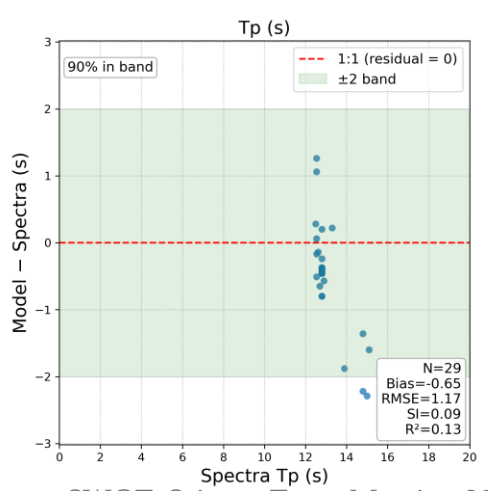
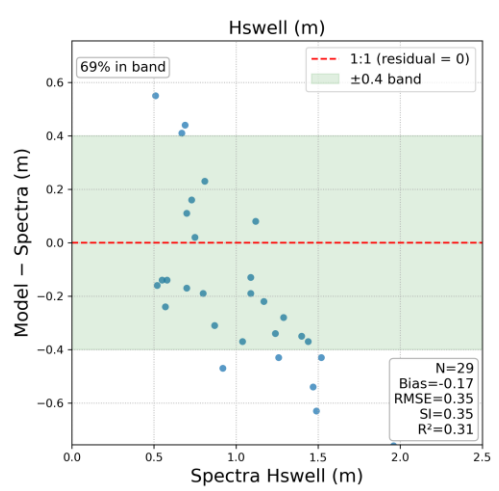
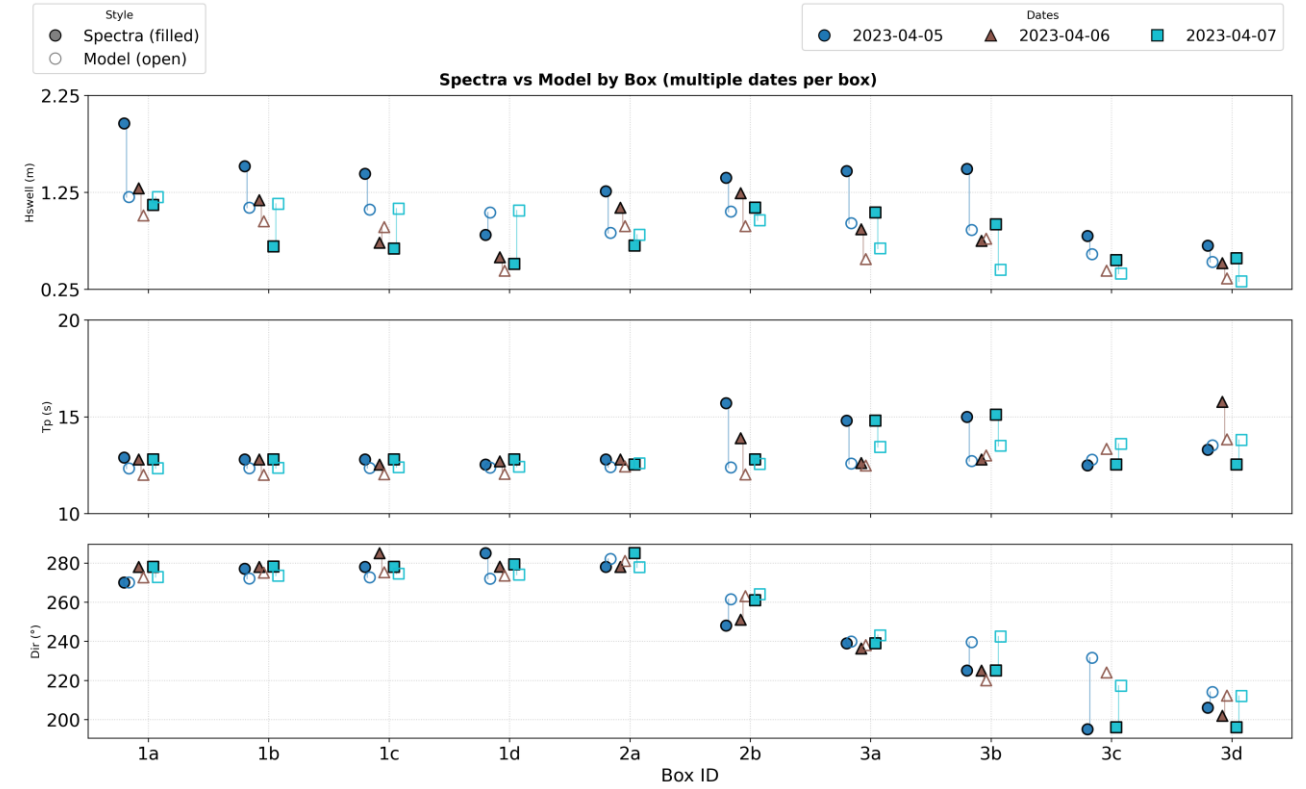
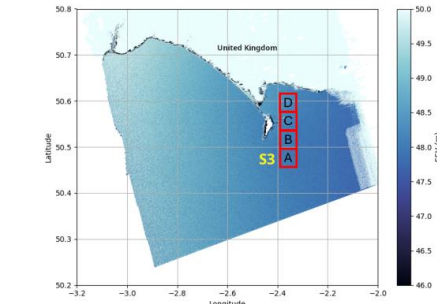
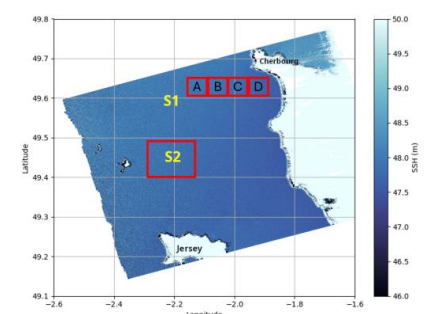


SWOT HR L2 PIXC Heights

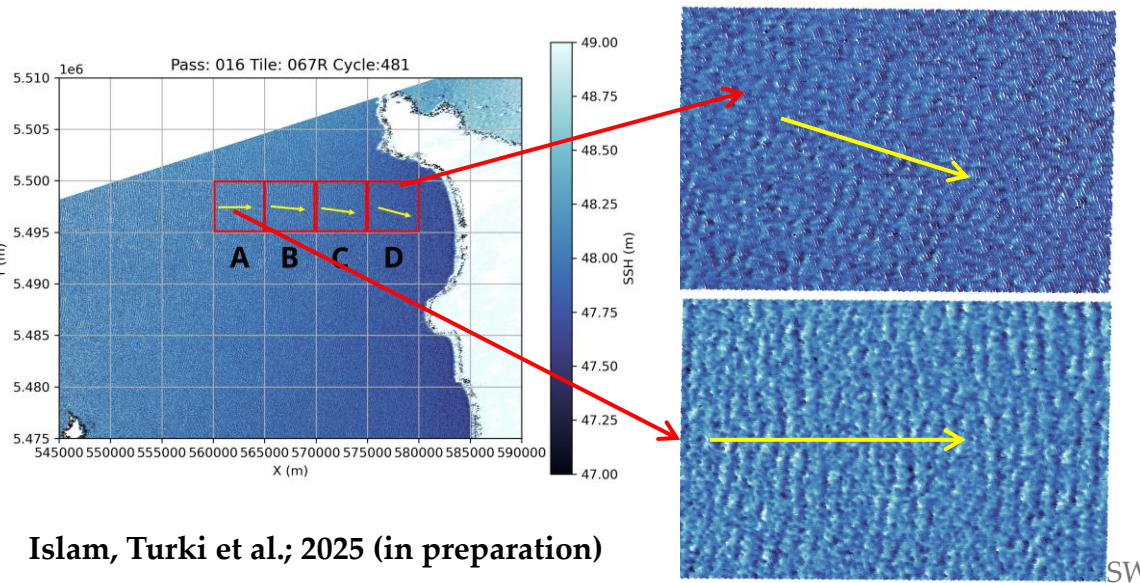
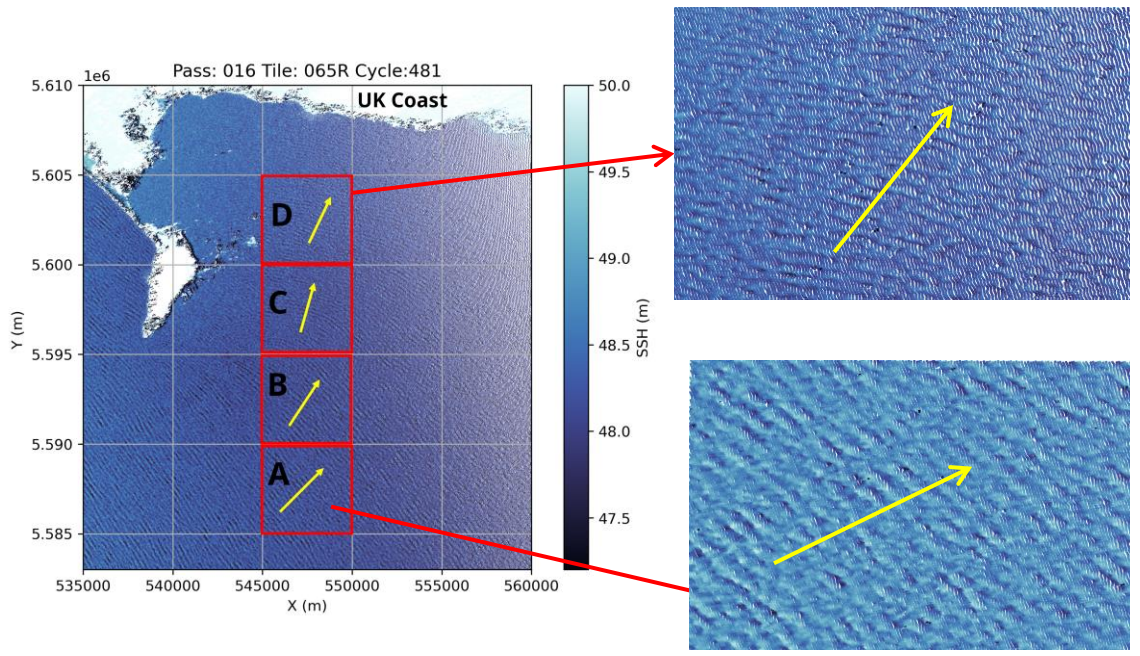




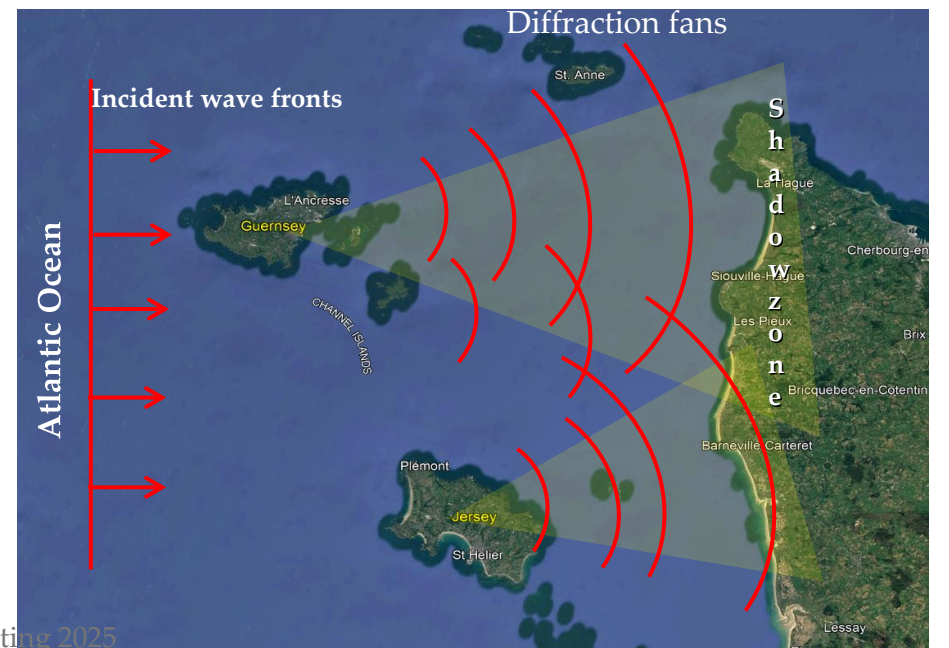
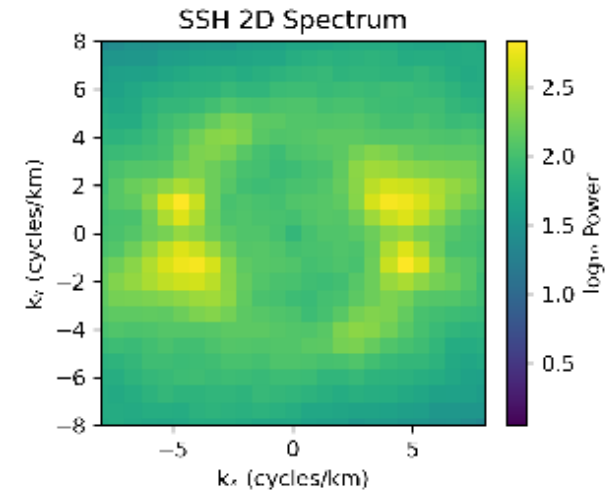
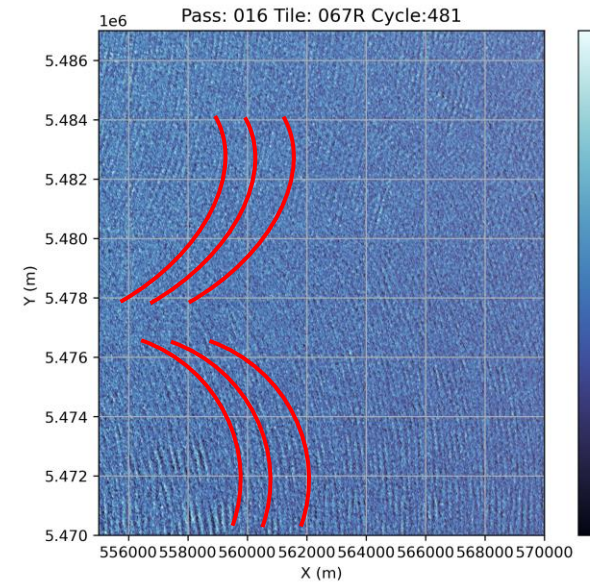
S1A S2 S3C

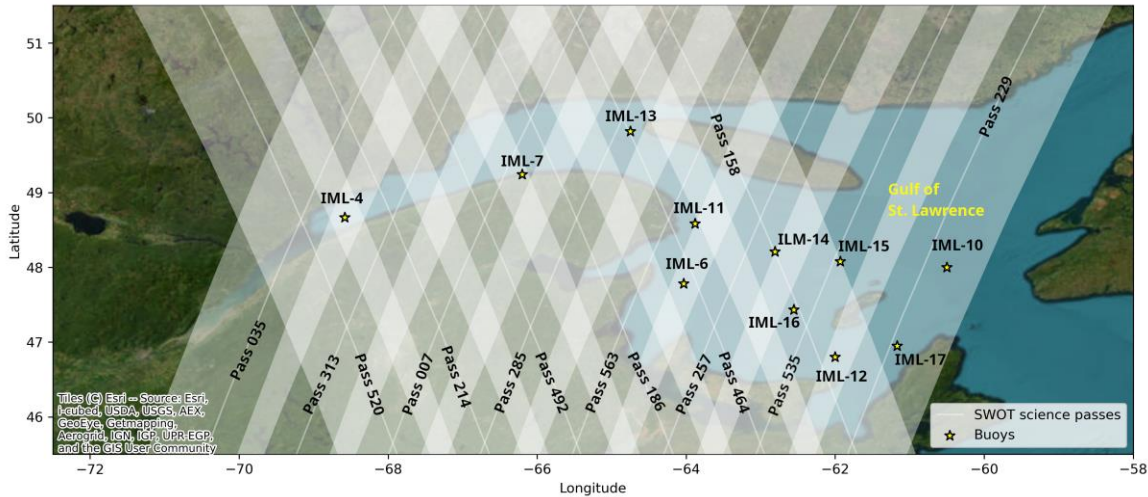


Coastal Refraction



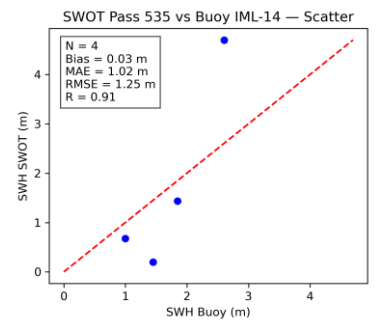
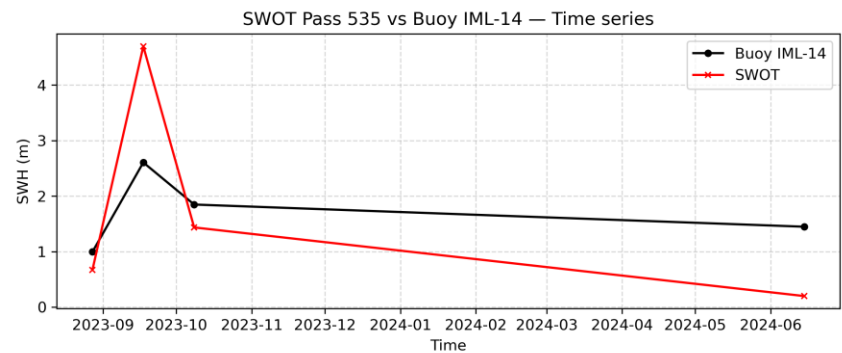
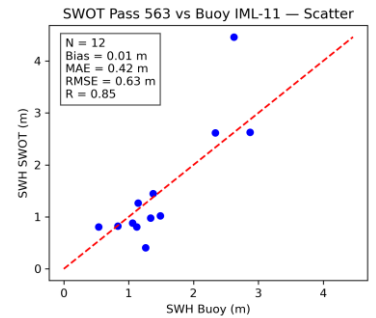
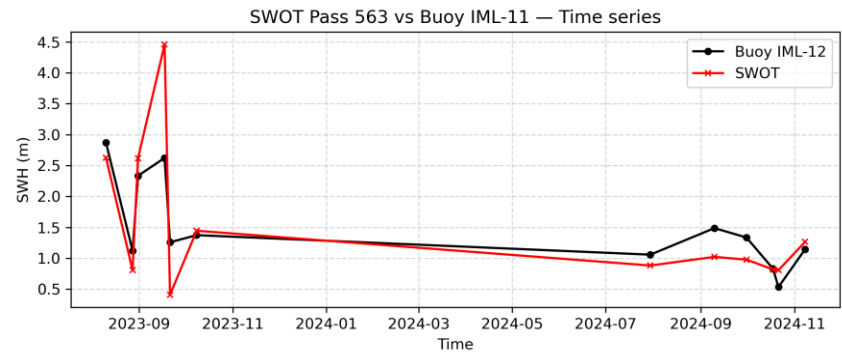
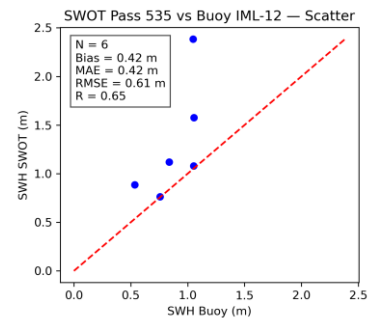
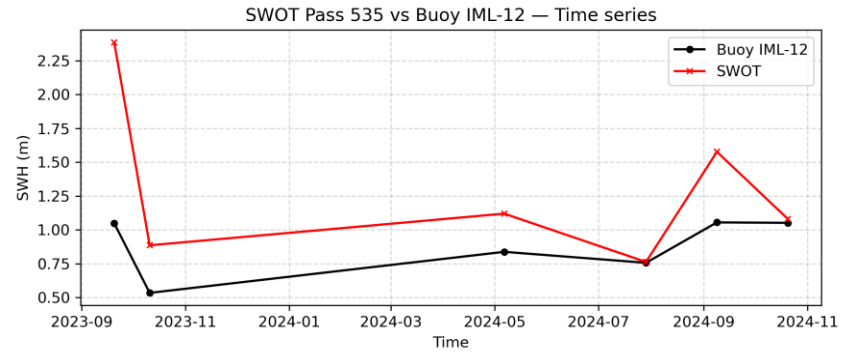
Coastal Diffraction





Gulf of St. Lawrence

- Similar as English Channel with islands
- Storm system coming from Atlantic
- Primary wave direction South-East to East
- Ice cover in winter attenuates waves



Average RMSE ~0.8m , Bias = 0.16m

Conclusion

- ✓ SWOT LR Expert SWH still have some issues near the coast and beta corrections application improves bias
- ✓ SWOT is capable of monitoring wave dynamics (Refraction and Diffraction) from nearshore to coast

Perspective

- Assess the accuracy of reprocessed version D products for monitoring waves
- Look for the σ_0 gradient near the coast
- Couple with airborne LiDAR and numerical models



Thanks for your attention!

ANNEX

Solar Beta Angle:

- Angle between satellite's orbital plane around earth and the geocentric position of the sun.
- High beta angle (near 90°) means satellite is almost always illuminated by sun causing increased thermal loads and potential instrument drift
- Low beta angle (near 0°) means satellite spends more time in earth's shadow, leading cooler condition and possible thermal cycling of on board components.

