Swot Coastal Ocean and Estuarine Products Usability Study (SCOEPUS)

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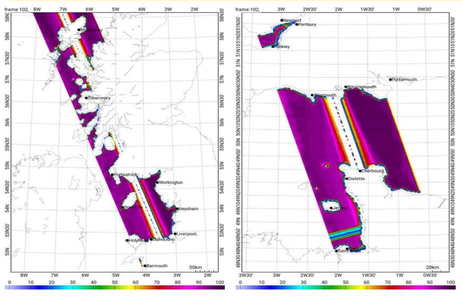
Main objectives of the SCOEPUS project

(1) evaluate SWOT products (data, corrections, flags) on the shelf and in estuaries and coastal lagoons,
(2) explore the contribution of SWOT and multisensor data to the study of water level variability and circulation in estuaries and coastal lagoons,
(3) use SWOT data to study coastal circulation from the coast to the shelf break,
(4) study the observability of internal tides.
(5) test the consistency between SWOT observations and our numerical simulations given their respective error bars, using an ensemble-based probabilistic approach

Preliminary investigations on SWOT CalVal phase observations (L3, track 016) on European shelf



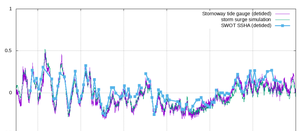
Track CalVal 016 : tide gauges location and number of "approved" SWOT data

Detided sea level (SSHA + DAC) → variability clearly dominated by the storm surge signal (shelf and coastal seas), which can be quite accurately simulated by numerical models, and is fairly well sampled by the ~ 1-day repeat orbit (contrary to tides).

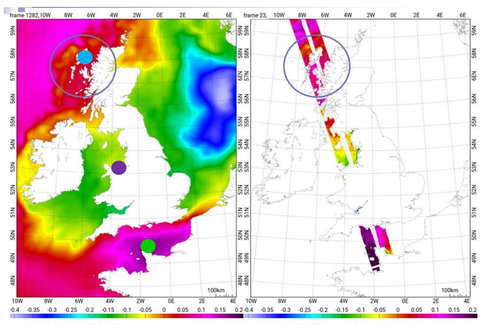
We found more convenient to compare a physical signal (surges) in simulations, tide gauges and SWOT observations rather than residuals (SSHA), especially to compare 2D structures from SWOT and numerical simulations.

SWOT validation at tide gauge locations

- high correlation between the detided (using harmonic analysis) tide gauge observations and storm surge simulations → predominance of storm surge signal in detided sea level and accuracy of the storm surge model.
- SWOT data : compare favorably with TG observations in most locations
- anomalies detected in a few places, such as the Severn estuary mouth



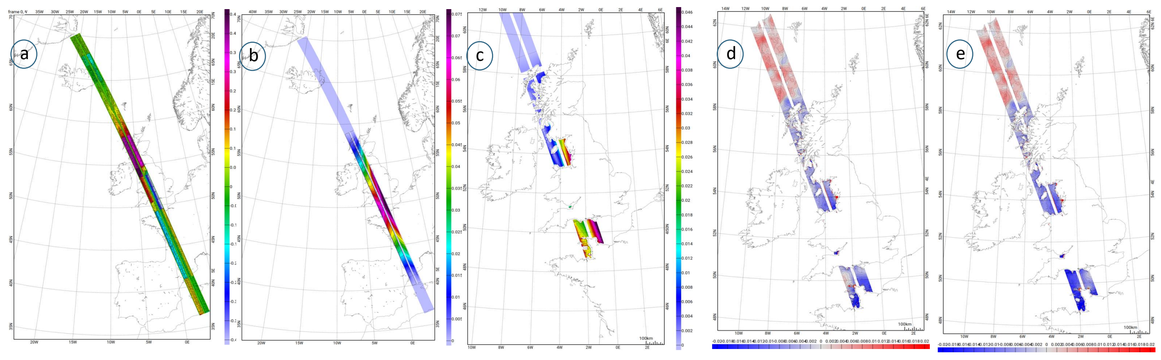
SWOT observation 2D patterns validation against storm surge simulation snapshots:



Track 016, 2023/04/24 : storm surge simulation (left) and CalVal SWOT data (SSHA+DAC-10cm, right)

- similarities between SWOT and simulation patterns in the northern part of the study area
- comparison less convincing in the English Channel

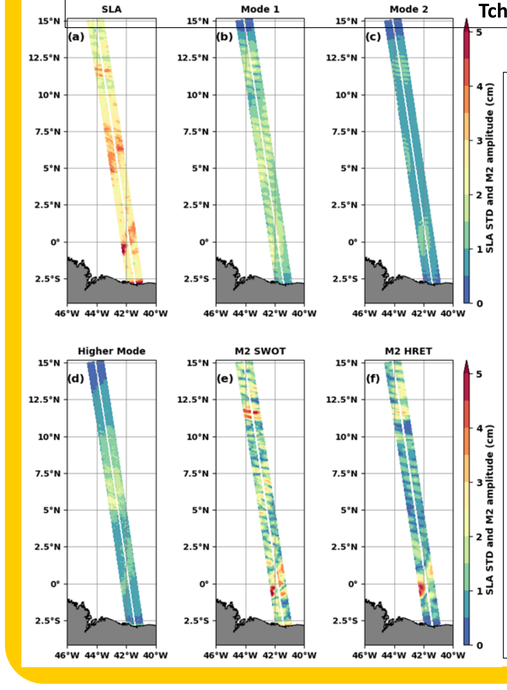
In addition to tidal correction possible defects, we suspect some specific issues in the L3 cross-track correction (see along track derivative in figure (a)). We are investigating the possibility to derive an alternative correction based on a linear interpolation between safe limits of the track, i.e. located in open ocean, from north of Scotland down to Mediterranean Sea. The challenge is to assess errors in GDR correction and which correction performs better. So far, we note that the difference between two corrections has a signal at M2 frequency (figure c), and that using a more precise DAC correction will show different improvements in SSHA variance (figure d and e).



The preliminary examination of storm surge signal to assess SWOT performances looks promising. This (on-going) study also emphasizes that the cross-track correction in coastal regions will be quite challenging for SWOT observations near-shore usability

Can we observe internal tides with SWOT data ?

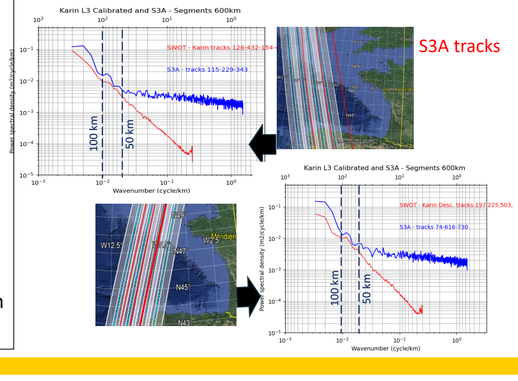
Internal tides observation off-shore the Amazone plume
Tchilibou et al., in press



SWOT Karin data on the 1-day CalVal cycle can observes the SLA over a wide range of scales: mode 1 (b, 180-90 km), mode 2 (c, 80-60 km) and high modes (d, 50 - 2 km).
The high modes induce variances comparable to mode 1. The high modes induce SLA variances comparable to mode 1. We combined PCA and harmonic analysis to derive an internal tide model from SWOT observations. For M2, SWOT (e) gives similar results to HRET (f; Zaron 2019).

Along-track spectra of SWOT and nadir altimetry in the North-East Atlantic
(coll. O. Vergara, R. Morrow, L. Gourdeau)

SWOT spectra are calculated by averaging across the swath the spectra along the tracks; L3 calibrated products at 2km are used. Ascending and descending tracks are considered separately because of the anisotropy of the circulation, in particular due to internal tides.
The comparison with S3A spectra highlights discrepancies at small scales (< 50km). The analysis is under progress



Usability of SWOT data in estuaries

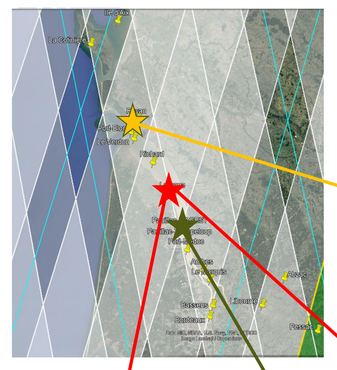
Objectives
- study of the interactions between tides and river discharge from models and in situ data
- accurate modelling of 2D tidal elevation to provide solutions for detiding SWOT data
- study of the 3D circulation in the estuary-plume continuum from models, in situ observations and SWOT data

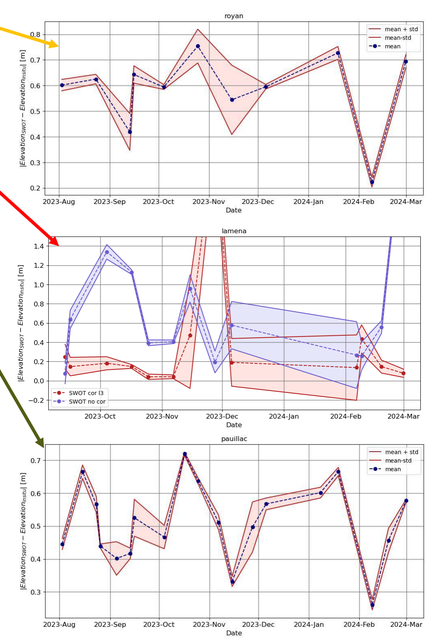
T-UGO modelling in the Seine and Elbe estuaries are done in coll. with B. Laignel and I. Turki (Univ. of Rouen) and with L. Fenoglio (Univ. of Bonn) and Noveltis (Toulouse) respectively.

Gironde

PhD of L. Caubet (LEGOS) (see her poster)

Many tide gauge stations are available in the Gironde estuary, from which we aim to assess the SWOT SSHA error budget.
We use the French Geography Institute (IGN) geoid as the vertical reference both for altimetry and in situ observations.





So far, no general conclusions can be drawn, some stations showing a ~20cm fit with SWOT (as Lamena), some others showing much larger discrepancies (as Pauillac and Royan).

SWOT and tide gauge SSHA at Lamena station (in m)

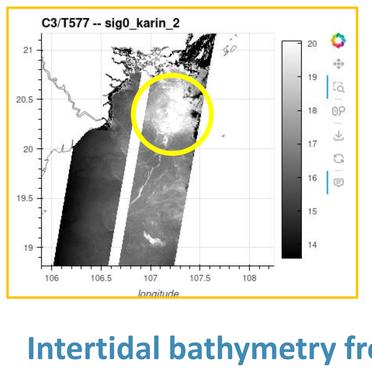
SWOT versus tide gauge SSHA difference in m)

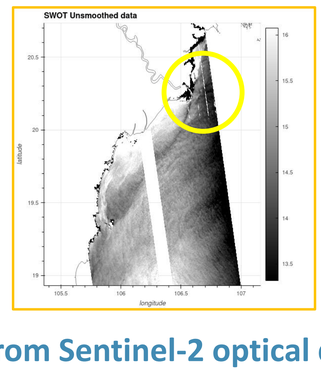
Deltas and coastal circulation Vietnam from models and SWOT

In the Red River delta and Gulf of Tonkin

What are the signature in SWOT of the interactions between tides and river discharge, of the 3D estuarine circulation and of the plume dynamics ?
Can we infer some information from the sediments dynamics and salt wedge variability ?
What are the surface circulation dispersive properties using Lagrangian diagnostics from HF radars, SWOT data, numerical simulations and buoys trajectories ?

SWOT data analysis will be carried out using numerical simulations based on work carried out by our team over several years (Piton et al., 2020, 2021; Nguyen-Duy et al., 201, 2023; Pénicaud et al., 2024)





First view at the LR 'unsmoothed' product (here sigma0) for two cycles of the orbit science.
→ structures that could be related to a plume are visible in both images, which leads us to believe that we can indeed study the plume from these data and those in SSHA.
→ there are nevertheless suspicious signals or anomalies to be analyzed, such as those indicated by yellow circles.

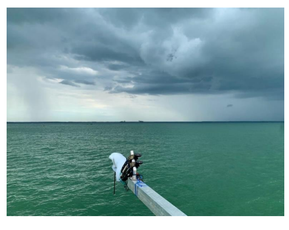
Intertidal bathymetry from Sentinel-2 optical data

M2 internship of N.T. Dao, LEGOS, in coll. with J. Khan and S.S. Tong (USTH)

Objectives: build an intertidal bathymetry at high resolution ((O20m)) in the Gulf off Tonkin
- to use in our numerical models
- to serve as a reference for SWOT data and the discrimination of measurements on land, ocean and intertidal zones.

Sentinel 2 image and waterline depiction (in yellow) in the Red River delta

PLUME Campaign along the Vietnamese coasts on board R/V ANTEA Spring 2024



PIs: S. Ouillon and M. Tedetti (MIO/USTH)
In coll. with M. Calzas (DT-INSU) and P. Bonnefond (Obs de Paris)

- dynamics of the water and associated material flows in Red River and Mekong river plumes
- interdisciplinary campaigns (physics, biology and contaminants)
- sea level measurements by the Cyclopée altimeter

Cyclopée at the bow of the ship (Photo: courtesy of M. Herrmann).

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