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Validation and Understanding of SWOT and coastal altimetric dataset

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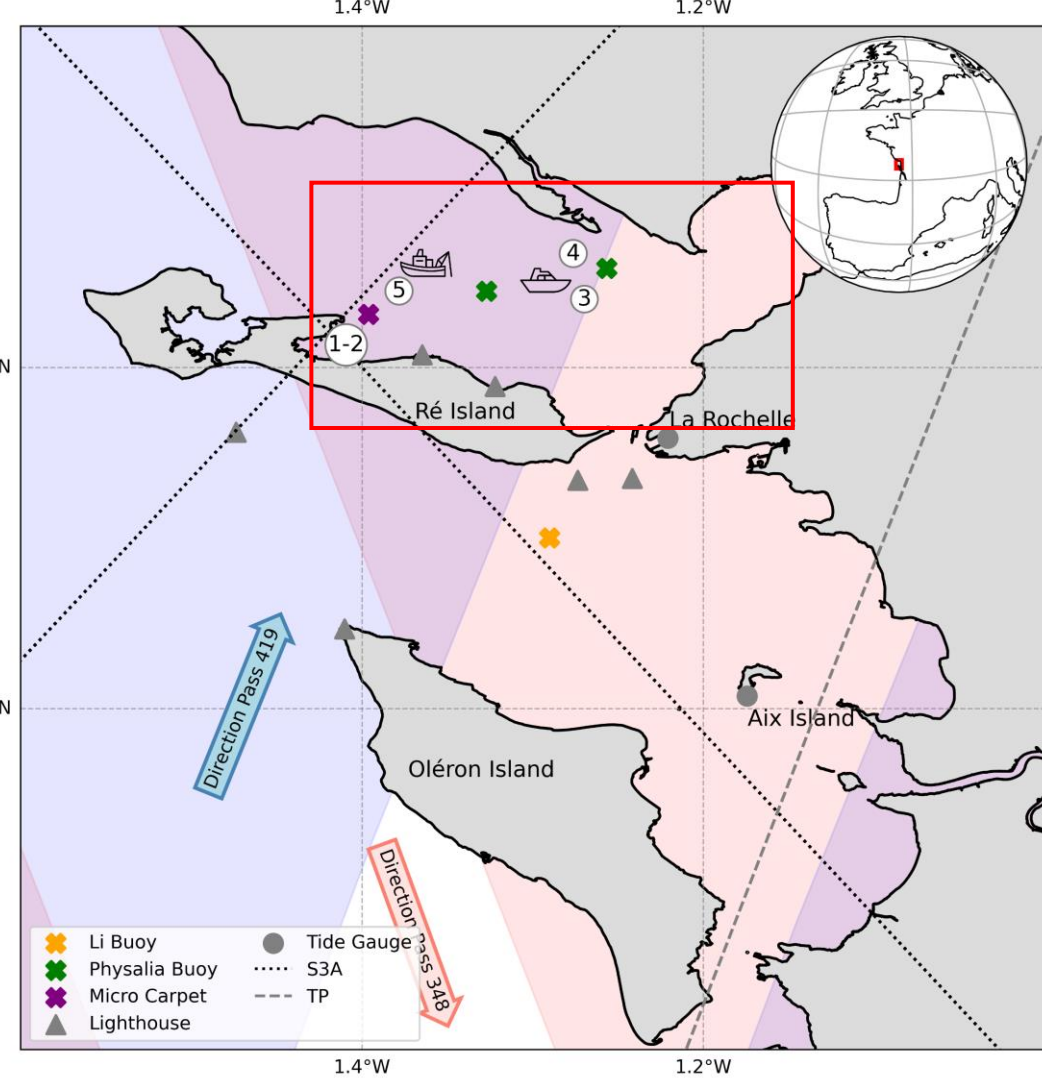
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Since 2023, the SWOT mission has been providing measurements with unprecedented spatial resolution over oceans and inland waters. Although several calibration and validation (Cal/Val) campaigns have been conducted, few have been focused on coastal regions. This study aims to assess the potential of SWOT measurements in the macro tidal area by comparing SWOT sea level data with in situ measurements.

Study Area

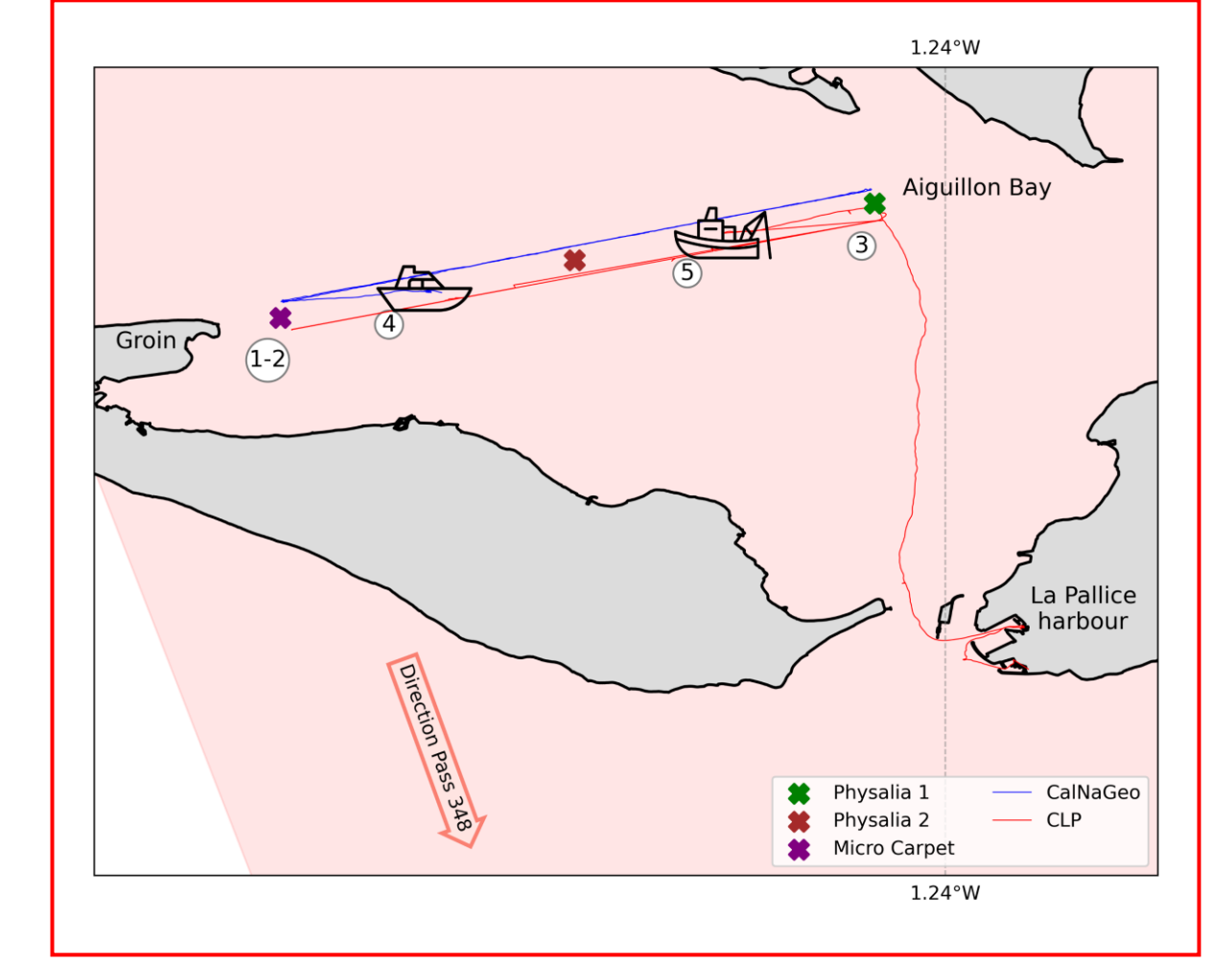


- The Pertuis Charentais coastal region is :
- Situated in Bay of Biscay, France
 - A semi enclosed macro tidal coastal regime of tidal range up to 5.5m .
 - covered by
 - 2 SWOT passes (348,419),
 - 2 Jason passes (70,213),
 - 2 S3A passes (216,102)

Study area with location of GNSS buoys, tide gauges, boats and lighthouses and altimetry tracks.

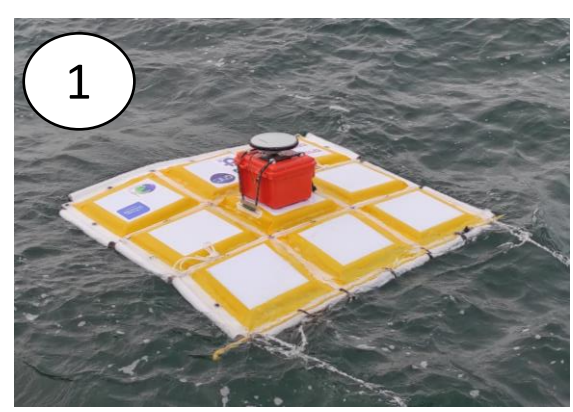
Campaigns

- ✓ 3 campaigns done : 10th June, 1st July and 22nd July 2024 under pass 348. This poster focuses on the 1st campaign.
- » 3 steps during the mission, the order depending on time SWOT passage :
 - static session for calibrating the deployed instrumentation at La Pallice tide gauge
 - a two way transects perpendicular to SWOT track with mobile GNSS
 - 5 static sessions along the transect with different instruments (GNSS+bottom pressure) during the passage of SWOT
- In addition, 2 pressure gauges have been deployed for several months at specific location in the Pertuis Charentais



Zoom on the campaign area with location of GNSS buoys and survey transects

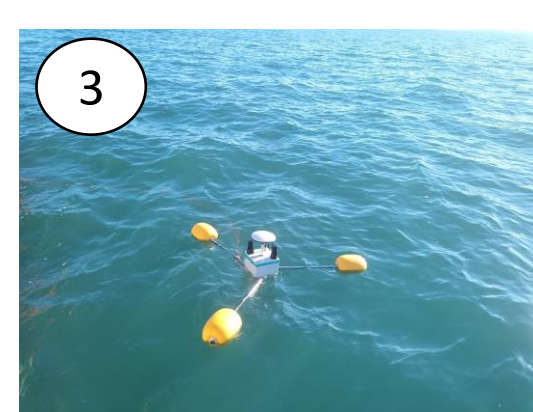
In situ instrumentation and sea level data



Micro-carpet



Pressure Gauge at Pointe de Grouin and Li Buoy



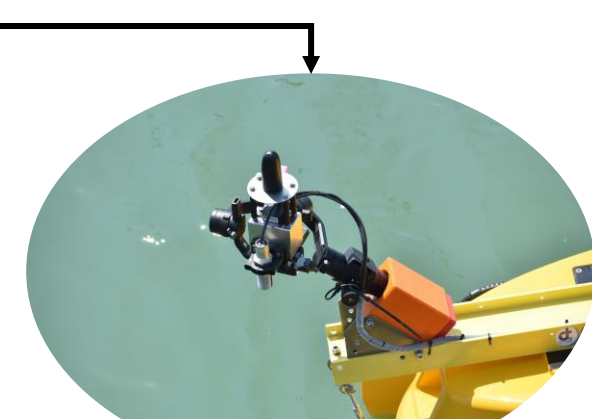
Physalia Buoy



GNSS carpet (CalNaGeo) towed by Tidalou boat



PAMELi with support vessel, Estran



Cyclopee system : GNSS antenna/receiver and altimeter

Description of data :

Instrument	Type	Receiver/Antenna/sensor	Sampling
1	GNSS floating device	Septentrio /Polant-x MF v2	1Hz
3	GNSS on floating device	Septentrio /Drotek	1Hz
4	GNSS on floating device	Septentrio /Polant-x MF	1Hz
5	Combined GNSS and acoustic	Trimble/HARXON D-HELIX	1Hz
2	Pressure data	RBR Solo 20m	1Hz/2Hz

La Pallice tide gauge 1 Hz data are provided by Shom.

Processing

GNSS Processing

- PYGNSS tools based on RTKlib

RTKlib configuration:

- Mode : kinematic differential
- Reference station : La Pallice GNSS station
- Constellation : GPS, GALILEO
- Elevation mask = 0°
- ionospheric corrections : broadcast
- tropospheric delay : Saastamoinen model
- precise ephemerides used

SWOT

Wide-swath 2D altimetry mission using Ka-band Radar Interferometry (KaRIn)

Repeatability: ≈21 days
 No dedicated product at the coast : **Both LR (Low Resolution for ocean) and HR (High Resolution for inland) coverage**

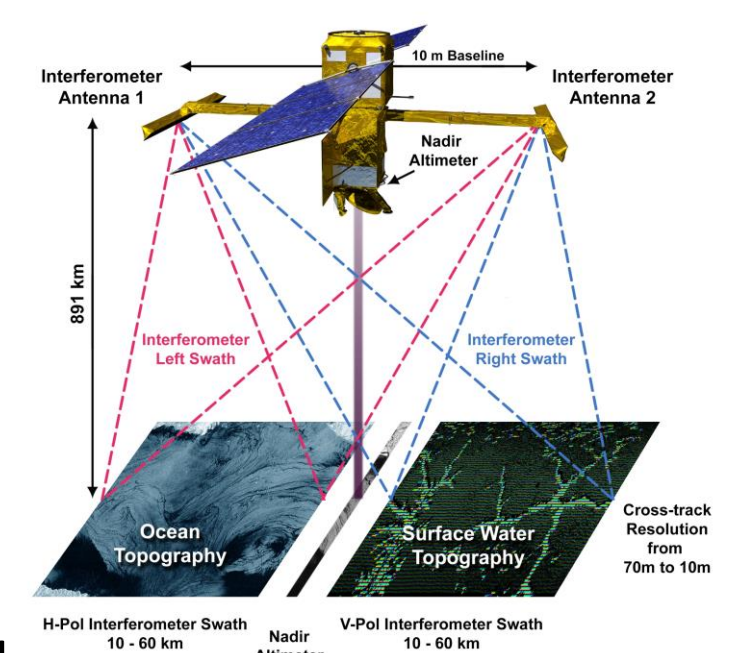
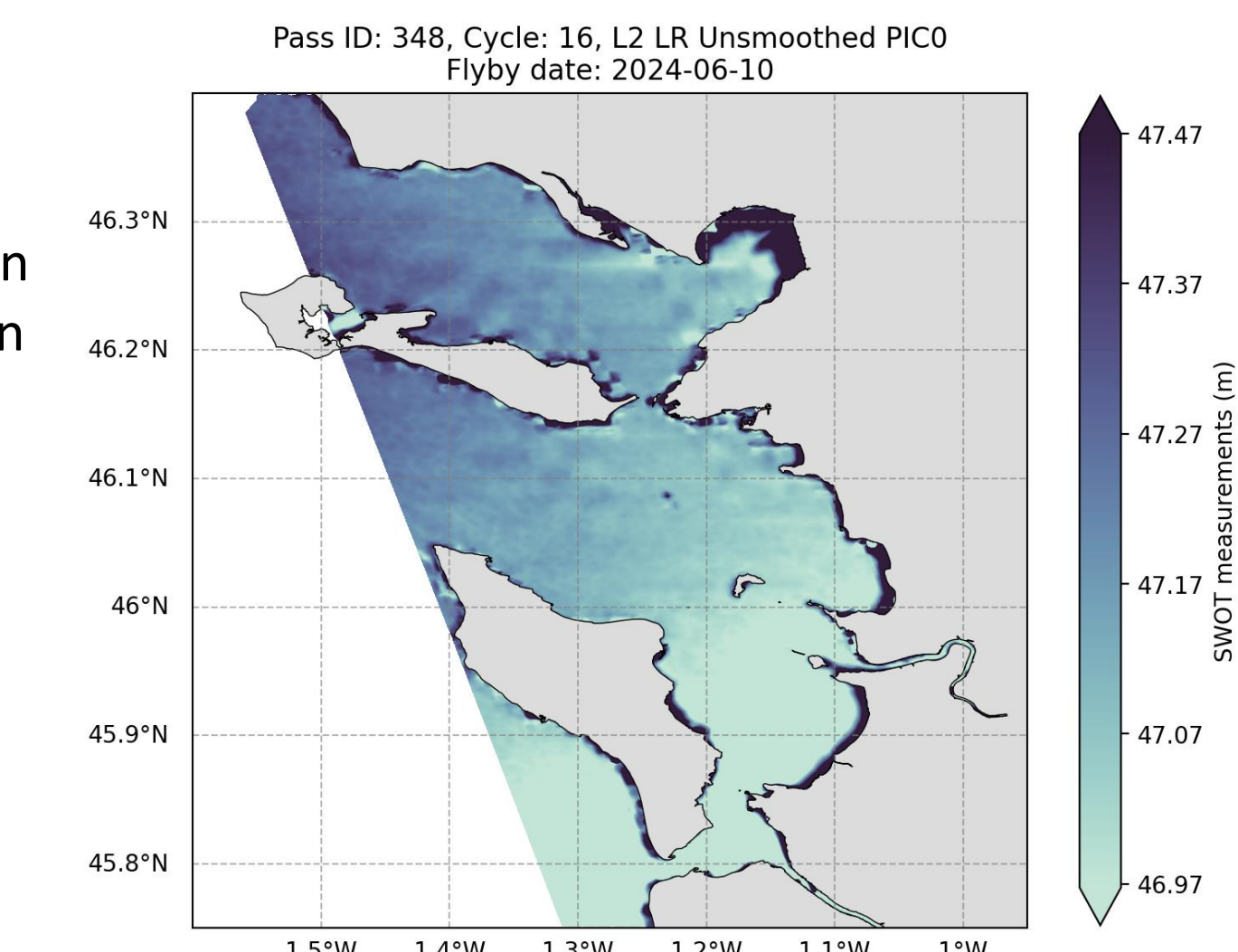


Diagram of SWOT Data Collection
<https://swot.jpl.nasa.gov/resources/104/diagram-of-swot-data-collection/>

Data used from SWOT product from level 2 LR unsmoothed product (250m resolution) :

- **ssh_karin_2 data** : sea surface Height (ssh) already corrected from instrument calibration, tropospheric delay, ionospheric delay, and sea state bias

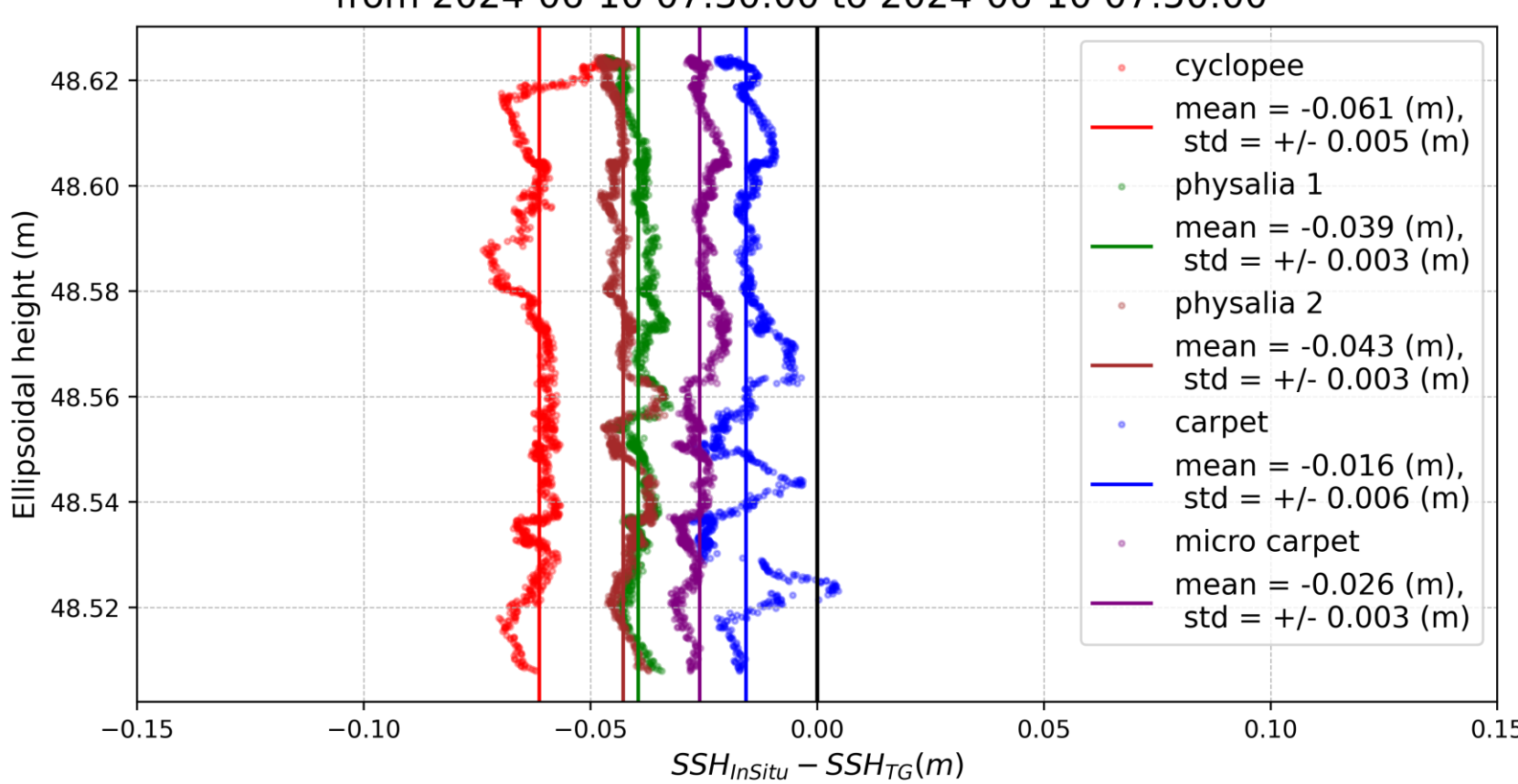
- Additional corrections applied on **ssh_karin_2 data** for comparison with in situ data:
 $additional_correction = crossover_{cor} - poletide - load\ tide - solid\ tide + sea\ state\ bias$



ssh_karin_2 with additional corrections applied

Preliminary results for the 10th of June Campaign

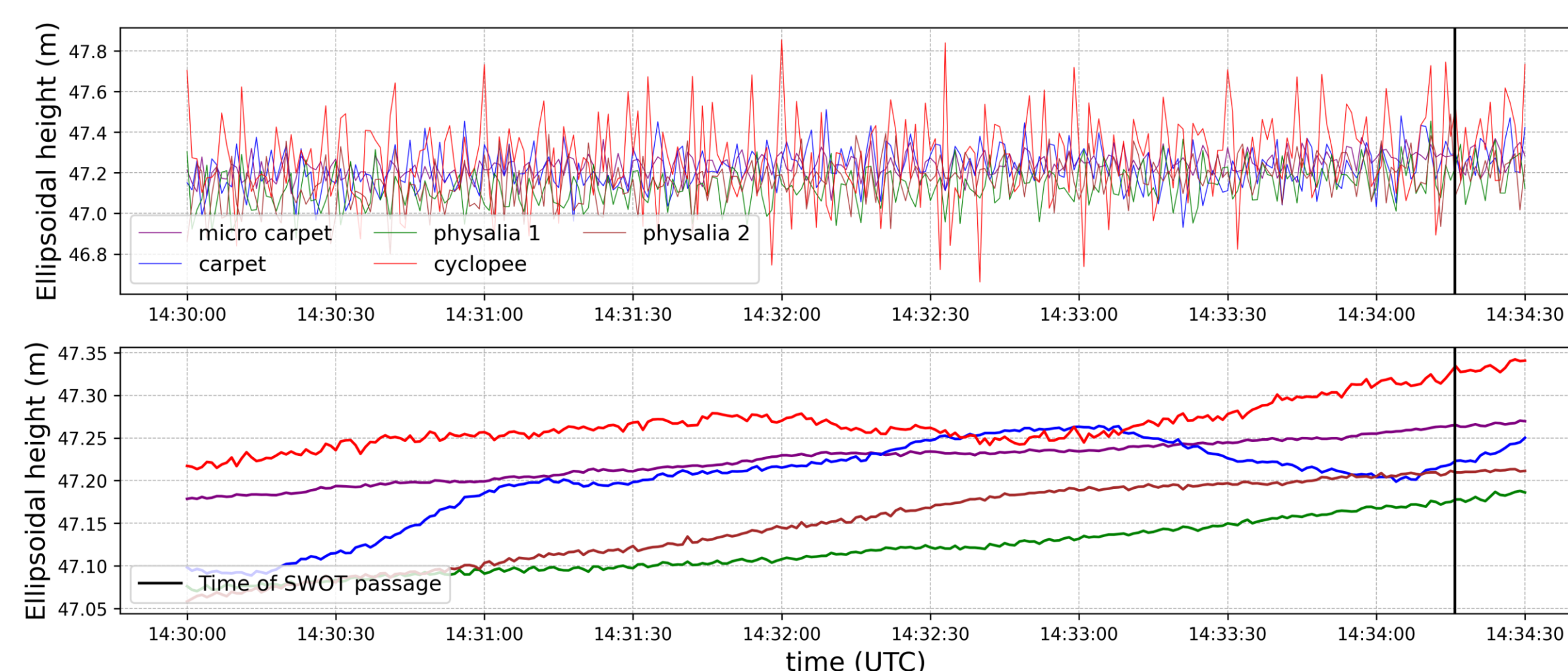
Sea-level height differences between La Pallice tide gauge and in situ ssh from 2024-06-10 07:30:00 to 2024-06-10 07:50:00



Comparison of in situ GNSS ssh data and La Pallice tide gauge ssh data (1-minute rolling mean applied) over 20 minutes

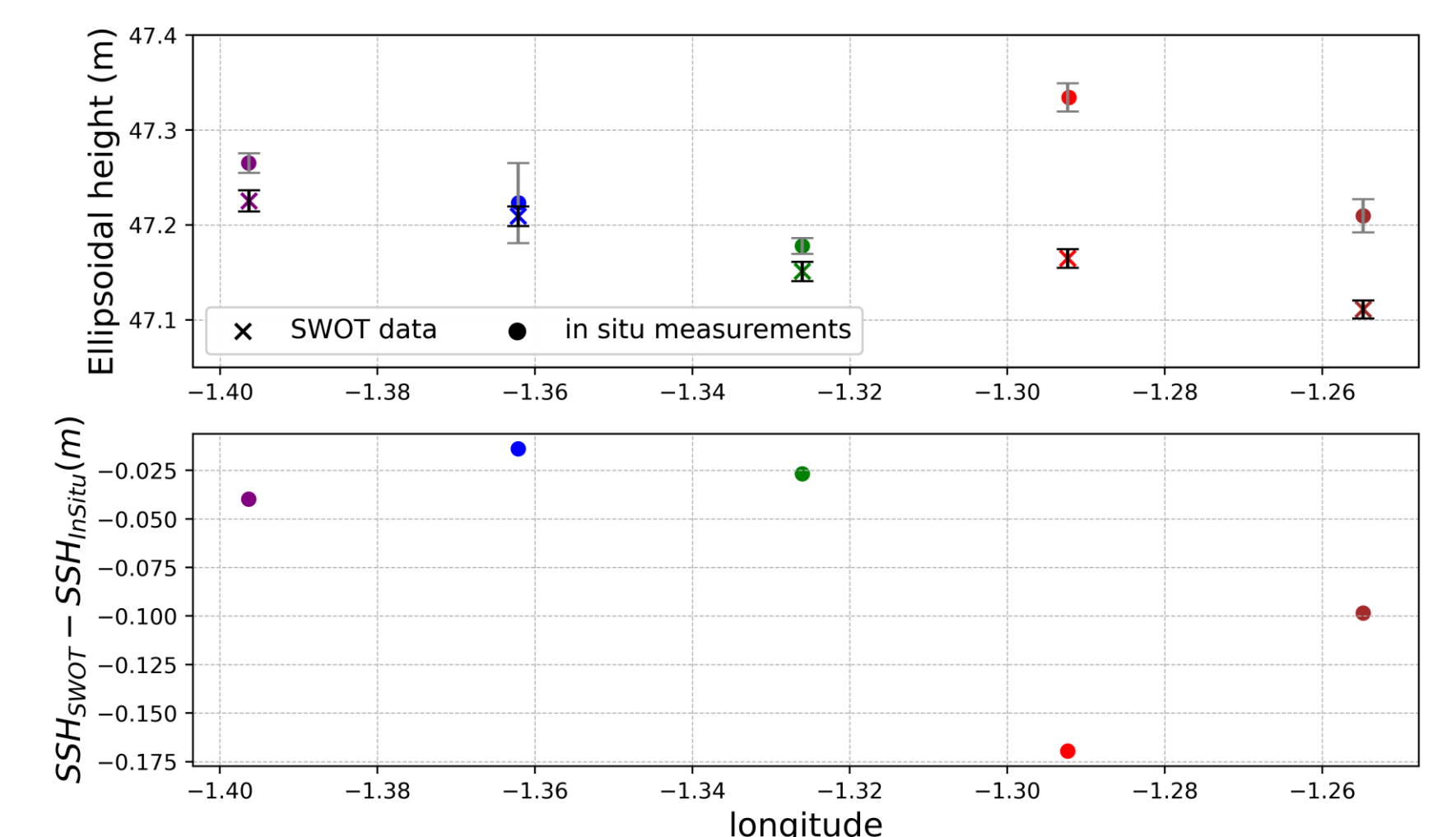
The sea level height differences between the tide gauge station and in situ measurements result in offsets ranging from 1.6 to 6.1 cm. While the causes of these offsets are not yet fully understood, they have been applied to the in situ SSH data for the subsequent results.

Time series during the SWOT passage



[Top panel] 1 Hz in situ GNSS ssh data from different instruments (offset applied) during SWOT passage . [Bottom panel] 1-minute rolling mean applied on 1 Hz in situ GNSS ssh data.

In Situ Measurements and SWOT ssh_karin_2 versus longitude



[Top panel] in situ GNSS and SWOT ssh data with respect to longitude. For GNSS in situ data, error bars are standard deviation computed over 1 min. For SWOT ssh data, error bars correspond to the σ provided in the L2 product. [Bottom panel] difference between SWOT ssh and in situ ssh at the time and location of the passage.

Conclusion and forward work

- ❑ 3 campaigns made in the Pertuis Charentais coastal region from June to July 2024 to collect GNSS data and make a first validation of SWOT ssh data. We present here results for the 1st campaign, and we will process the other datasets soon.
- ❑ For the June 10th campaign :
 - ❑ Processing is still ongoing,
 - ❑ The current bias estimate between GNSS sea level data and La Pallice tide gauge ranges from 1.6cm to 6.1cm.
 - ❑ The comparison between SWOT data and in situ measurements show differences ranging from a few centimeters up to a maximum of 17.5 cm.
 - ❑ Further investigations are needed to understand these biases and differences.

- ❑ When issues on in situ GNSS measurements biases will be resolved, we plan to work on SWOT cross over gradient determination. This will require the use of coastal regional model (see Nushrat's Yeasmin poster)
- ❑ Different post processing modes in kinematic differential and PPP will be used to refine the GNSS solutions and assess their quality.
- ❑ We plan to install a permanent GNSS buoy in our study area and to conduct campaigns below track 419 and 348.

references

<https://gitlab.univ-lr.fr/ensta/pygnss>
 Surface Water Ocean Topography (SWOT). 2024. SWOT Level 2 KaRIn Low Rate Sea Surface Height Data Product, Version 2.0. Ver. 2.0. PO.DAAC, CA, USA. Dataset accessed [2024-08-22] at <https://doi.org/10.5067/SWOT-SSH-2.0>
 SWOT Level-2 KaRIn Low Rate ssh Unsmoothed (v2.0) [Data set]. CNES. <https://doi.org/10.24400/527896/A01-2023.016>.