

Qualifying GNSS sea surface height from shipborne sensors to validate SWOT measurements in the Mediterranean Sea

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Objective :

The aim of this 6-months internship is to develop a method for qualifying GNSS sea surface height measurements acquired by a marine drone and a low-cost sensor in the Mediterranean Sea during SWOT Cal/Val phase.

Background :

The main objective of the C-SWOT2023 campaign (Demol et al. 2023), conducted by Ifremer in spring 2023 in the Mediterranean Sea, was to observe the general circulation and mesoscale dynamics along the SWOT (Surface Water and Ocean Topography) satellite swaths. Measurements of sea surface height were also made using GNSS observations from the DriX (an unmanned surface vehicle developed by [Exail company](#)) and the *Cyclopée* system (a combination of an acoustic altimeter and a GNSS system), installed on board the N/O Thetys.

A previous internship made it possible to develop a methodology for processing the DRIX observations of the GNSS antenna and the inertial measurement unit in order to retrieve the sea level at the waterline (Ducarme 2023; Chupin et al. 2024). This GNSS processing methodology can be replicated on *Cyclopée* measurements, in order to obtain two comparable estimates of the *in situ* water level.

The main objective of this work is to carry on analysis these datasets, by proposing a qualification of the processing during static sessions and an inter-comparison of the two systems. Based on the work of Tranchant et al. (2021), an evaluation procedure will be developed based on points at sea revisited several times at different periods, or on parallel transects carried out by the two systems. The aim is to validate the various dynamic corrections used during processing (tide model, Mean Sea Surface model, atmospheric corrections, etc.).

Secondary, the aim is to use SWOT data on the area during the campaign and to analyse the SSHA (Sea Surface Height Anomaly) provided by the satellite. These observations will be validated using the *in situ* water level data previously analysed. These results can then be cross-validated with observations from the *Shom* (*Service hydrographique de la marine*), which also carried out a dedicated field campaign at the same time and in the same area. There will be regular discussions on the methodology and results with the post-doctoral researcher in charge of analysing the data for the *Shom*.

Expected outcomes:

- Qualification of GNSS observations from DriX and the *Cyclopée* system during static or docked sessions, in order to compare sensors and their performance.
- Implementation of a comparison method for water heights validation at revisit points and during transects (Tranchant et al. 2021) to validate all corrections used during GNSS data processing.
- Spatial interpolation of water height measurements and comparison with SSHA (Sea Surface Height Anomaly) provided by SWOT.

References :

Chupin, C., P. Bossier, A. Ducarme, and A. Ponte. 2024. Cartographie du niveau de la mer par systèmes GNSS pour la validation des données SWOT. Oral presentation presented at the Colloque G2 2024 - Géodésie marine, sous-marine et côtière, March 18, La Rochelle.

Demol, M., A. Ponte, F. Dumas, P. Garreau, I. Pairaud, V. Garnier, G. Giscard D'Estaing, S. Fercoq, M. Michel, and M. Hamon. 2023. C-SWOT2023 / WEMSWOT. Two combined campaigns dedicated to the mesoscale dynamics under SWOT swaths in the Mediterranean Sea.

Ducarme, A. 2023. *Mesure de la hauteur d'eau océanique par GNSS embarqué sur un drone marin de surface*. Mémoire de fin d'étude. CNAM/ESGT.

Tranchant, Y.-T., L. Testut, C. Chupin, V. Ballu, and P. Bonnefond. 2021. Near-coast tide model validation using GNSS Unmanned Surface Vehicle (USV), a case study in the Pertuis Charentais (France). *Ocean Remote Sensing. Recent Advances in Ocean Physics, Geochemistry and Biology from Unmanned Marine Vehicles*.

Organisation:

This internship will be supervised by Clémence Chupin, teacher-researcher at ENSTA (Brest site), with the help of Yann-Treden Tranchant, post-doctoral fellow at the University of Tasmania. The trainee will be based at ENSTA's Brest site¹ from October 2025 to March 2026.

A monthly allowance (624€/month) for the trainee has already been obtained thanks to a grant from the IsBlue program. The French Embassy in Australia can award scholarships to finance the Australian student's travel and its accommodation during the internship.

¹ ENSTA is a French engineering school with an established reputation in the maritime, defense and high-tech sectors. The Brest site offers the Hydrography-Oceanography speciality, the only one of its kind in France, which prepares engineers to measure and map the seabed and understand the dynamic mechanisms of the water column (currents, waves and tides). This Category A degree is accredited by the IHO (International Hydrographic Organisation). More informations here : <https://www.ensta-bretagne.fr/en>