MSc internship - 6 months - 2027

Unveiling atoll dynamics from SWOT High Resolution surface water measurements

Context

Low-lying coral atolls are among the coastal environments most vulnerable to climate change. Sea-level rise, changing storminess and reef degradation are expected to alter the processes controlling ocean-lagoon exchanges, with consequences for lagoon flushing, flooding, sediment transport and the habitability of reef islands (Storlazzi et al., 2018; Lindhart, 2022). Tidal propagation through reef passes and wave setup over reef flats are key hydrodynamic drivers (Callaghan et al., 2006; Sous et al., 2019; Grimaldi et al., 2022), but they remain poorly understood because in situ data are scarce and satellite observations lack the required resolution.

The SWOT mission, with its Ka-band Radar Interferometer (KaRIn), provides 2D observations of water surface elevation, wave height and wind speed at scales from tens of metres to kilometres (Fu et al., 2024). In particular, SWOT KaRIn can operate in a high-resolution mode (approximately 10-70m) to enhance the representation of small-scale surface features, particularly suitable for detailed analyses of rivers, lakes, estuaries, and coastal processes. To date, SWOT High-Resolution Pixel Cloud (L2_HR_PIXC) acquisitions in the coastal zone have primarily been used for topographic applications in intertidal environments (Salameh et al., 2024; Yeasmin et al., 2026). However, to our knowledge, these observations have not yet been exploited to investigate topography and nearshore hydrodynamic processes within coral atolls.

Scientific Objectives

This project will exploit SWOT HR PIXC observations over Rangiroa Atoll (French Polynesia) to improve our understanding of lagoon water-level dynamics driven by tides and waves. It addresses three questions:

- Can SWOT HR reveal fine-scale water-level gradients linked to tide- and wave-driven circulation in atoll passes and across reef flats?
- Can it provide useful topographic information on emerged reef structures?
- Can discharge or flow velocity in the passes and across the reef be derived by combining SWOT gradients, wave model outputs, topo-bathymetry and field observations?

Rangiroa, the largest atoll of the Tuamotu archipelago is the focus of ongoing research activites at LOPS (Postec et al., 2025, 2026; Cottour et al., 2026). An extensive field survey was carried out in 2025 within the ANR PPR FUTURISKS project. This internship will focus on two areas: (i) the Avatoru and Tiputa passes in the north, the main pathways for lagoon-ocean exchange, and (ii) the southern reef sector, exposed to long-period Southern Ocean swells.

Proposed work

All available SWOT HR PIXC acquisitions over the study areas will be collected, together with the Expert-product corrections and quality indicators. Recently developped mean sea surface products will be intercompared, with attention to the complex atoll margins, to assess their suitability for deriving coastal sea surface height anomalies. Acquisitions will be classified by hydrodynamic forcing (swell height and direction, wind, tidal amplitude and phase) to allow meaningful comparisons.

First, acquisitions over the southern reef flat will be examined for partially emerged and highly spectular reef structures. Elevations and detected structures will be compared with UAV and GNSS transects from the 2025 campaigns. Spatial gradients in water surface elevation along the passes and across the southern reef will then be quantified and compared with lagoon and pressure data and FES2022 tidal predictions. Simplified hydraulic formulations, using topo-bathymetric data and bottom-friction parameterizations, will be used to convert SWOT gradients into discharge through the passes, to be validated against ADCP measurements and model outputs. Finally (and if time allows), acquisitions during energetic swell events will be compared with a high-resolution wave model to assess SWOT's ability to capture wave setup across the reef flat during energetic swell conditions.

Working Conditions

The internship will be based at Ifremer in Brest, within the LOPS laboratory (SIAM team), supervised by Guillaume Dodet and and Swen Jullien. Compensation is 800 €/month.

Requirements

- M2 in Physical Oceanography or Marine Geophysics, with Remote Sensing coursework
- Strong understanding of coastal dynamics and radar altimetry
- Proficiency in Unix, and in Python and/or Matlab
- Good oral and written English

Send CV and cover letter to guillaume.dodet@ifremer.fr

References

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