PHD #1

Contribution of SWOT altimetry observation to understand the coastal ocean dynamic

This 3 years PhD position will take place at LIENSs laboratory in La Rochelle, France (https://lienss.univ-larochelle.fr). LIENSs is an Interdisciplinary Joint Research Unit (UMR 7266 La Rochelle University and CNRS). It integrates expertise in many scientific fields across environmental sciences and social sciences to address issues on the **sustainable development of the littoral zone**. Part of its research activities focuses on the functioning of the coastal ocean and its response to climate change. LIENSs presently hosts 80 researchers, 29 permanent engineers and technicians, 24 post-doctoral researchers and invited researchers, and 40 PhD students. The PhD student will be host by the Ocean Coastal Dynamic team of the LIENSs where he/she will interact with a group of scientist's experts in the sea level analysis and observation, satellite geodesy and marine geodesy, high resolution numerical modeling of the coastal ocean.

Subject:

Part of the coastal dynamics, and in particular the part governing the transfer of elements (pollutants, nutrients, sediments ...) is very poorly known in coastal areas and yet this dynamics plays a major role in the evolution of ecosystems and coastal morphology (erosion processes, siltation, etc...). On December 16, the SWOT (Surface Water Ocean Topography) satellite was launched into orbit from the American base of Vandenberg (https://swot.cnes.fr/fr). This satellite will observe the water on the Earth's surface with a definition improved by a factor of 10 compared to previous altimetry missions. This mission, which follows a series of conventional altimetry missions (Topex/Poseidon and Jason), is dedicated to both continental hydrology, offshore and coastal oceanography. This is made possible by a technological breakthrough related to a new instrument: a wide-swath interferometric radar. The satellite will observe the topography of the oceans and surface waters on both sides of its trajectory on bands of 50 km wide. For the first time, this new instrument will provide near-global observations of offshore and coastal ocean water masses with a resolution never reached before. The "coastal" products will be distributed with a pixel resolution of 250 m. This mission will also allow for the first time to monitor more than 95% of terrestrial water reservoirs by providing height, width, slope and flow information on rivers over 100 m wide and on almost all lakes. This mission will provide a better understanding of fine-scale ocean dynamics and will allow a global monitoring of the water cycle on Earth. The SWOT mission will start with a 1-day phase repetitive orbit on a reduced number of tracks in order to allow the validation and interpretation of this new type of data.

The core of the PhD student's work will be to use and develop existing tools in the laboratory to adapt them to SWOT datasets, mainly for the high resolution (250m) "ocean" product, but also for the "hydrology" product. In a first phase of the thesis, the PhD student will get familiar with the tools developed by the team, in particular the high resolution hydrodynamic model set up in the Pertuis (Tranchant et al. 2021) to be able to run simulations corresponding to the satellite passage periods. The PhD student will first work with the 1-day fast-sampling dataset over the Noumea lagoon in New Caledonia. During this 1-day phase, campaign measurements using GNSS carpet were made during the SWOTALIS campaign lead by LEGOS (https://www.legos.omp.eu/en/homepage/) and will be used by the PhD student to evaluate the quality of the new satellite data. When switching to the "science" phase (21-day repeat orbit), the data will be available for all and on the whole globe including the Pertuis (see Figure 1). The PhD student will conduct an exhaustive study of the quality of the SWOT data and of the different products (open ocean, high resolution coastal ocean, rivers and lakes) in the Charentais Pertuis area and on some rivers of Nouvelle-Aquitaine.

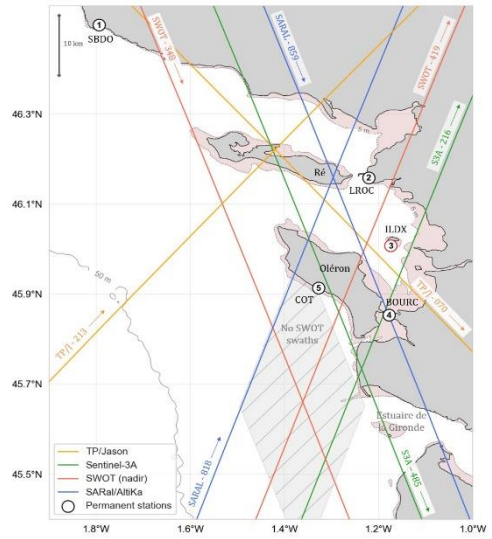

Figure 1: Map of the tracks of the main satellite altimetry missions that fly over the Charente Pertuis region. The only area not covered by the new SWOT satellite is shown in gray. The permanent tide gauge stations are indicated by the circled numbers. Foreshore areas are in pink.

Based on the knowledge acquired during the "fast-sampling" phase, the PhD student will make a complete and detailed analysis of the scientific added value of SWOT data in coastal regions and by combining the model and SWOT data will study the main component of the coastal ocean circulation. She/He will base his work on all the data (tide gauges, in-situ campaigns, in situ data, conventional altimetry, ...) acquired in the region and on the studies produced in the region for the understanding of coastal processes (tide, waves, geoid, currents, ...). The PhD student will have in situ data in New Caledonia (data from the SWOTALIS campaign) and in the Pertuis (coastal tide gauges, GNSS buoy anchored in the Pertuis under a satellite track). The PhD student will also contribute to developing extraction and analysis tools for the new SWOT data, for his research that will be useful for other users at LIENSs (in connection with the LIENSs geomatic service) and eventually for a larger community.

The two supervisors of this thesis (Laurent Testut and Valérie Ballu) have been working for many years with conventional altimetry data, which they have applied to topics as varied as the study of ocean tides (Testut et al., 2016), the validation of coastal hydrodynamic models (Testut et al., 2012), long-term variations in sea level (Testut et al., 2016) or marine geodesy (Ballu et al., 2013). Over time, we have built at LIENSs a solid experience in satellite-based altimetry, which we have developed in recent years by applying it to the coastal regions of the Pertuis Charentais and New Caledonia. The proposed thesis will be in the continuity of the of two previous PhD students : Tranchant Yann-Treden (2018-2022) and Chupin Clémence (2018-2022) who have developed innovative research based on the use of the USV PAMELi, GNSS buoys and the development of digital tools (kinematic GNSS data processing chain, high resolution numerical modeling of the Pertuis, Python toolbox...) which now allow us to better understand the physics of the radar measurement and its behavior in coastal areas (role of foreshores in the radar footprint, improvement of geophysical corrections using wave models or GNSS data, ...) (Chupin et al., 2020, Tranchant et al., 2021).

The salary will be aligned with the CNRS PhD funding (~2100 € Brut /Year)

How to apply:

Your application files must include :

- a curriculum vitae
- a covering letter
- reference letters (optional)
- an academic transcript (Bachelor + Master 1 and first semester Master 2 if available)
- a copy of the last scientific report (article, Master 1 report, python notebook)

Deadline for submitting your files is before 2 of June 2023

All the documents should be included in zip file YOURNAME.zip and sent to :

laurent.testut@univ-lr.fr, valerie.ballu@univ-lr.fr

via email or filesender system if zip file is too large

Required knowledge and skills

- Master in Geoscience with a background in physical oceanography.
- Aptitude and interest for data analysis, ocean physical process and programming
- Strong programming skills in Python (numpy, pandas, xarray, …) and good background in statistic

Références :

Ballu, V., P. Bonnefond, S. Calmant, M. -N. Bouin, B. Pelletier, O. Laurain, W. C. Crawford, C. Baillard, et O. de Viron. 2013. « Using Altimetry and Seafloor Pressure Data to Estimate Vertical Deformation Offshore: Vanuatu Case Study ». *Advances in Space Research, Satellite Altimetry Calibration and Deformation Monitoring using GNSS*, 51 (8): 1335-51. https://doi.org/10.1016/j.asr.2012.06.009.

Chupin, Clémence, Valérie Ballu, Laurent Testut, Yann-Treden Tranchant, Michel Calzas, Etienne Poirier, Thibault Coulombier, Olivier Laurain, Pascal Bonnefond, et Team FOAM Project. 2020. « Mapping Sea Surface Height Using New Concepts of Kinematic GNSS Instruments ». *Remote Sensing 12 (16).* https://doi.org/10.3390/rs12162656.

Chupin, Clémence, Valérie Ballu, Laurent Testut, Yann-Treden Tranchant, et Jérôme Aucan. 2022. « Noumea: A New Multi-Mission Cal/Val Site for Past and Future Altimetry Missions? » EGUsphere, juillet, 1-37. https://doi.org/10.5194/egusphere-2022-514.

Testut, L., F. Birol, et C. Delebecque. 2012. « Regional Tidal Modeling and Evaluation of Jason-2 Tidal Geophysical Correction ». *Marine Geodesy 35 (SUPPL. 1)*: 299-313. https://doi.org/10.1080/01490419.2012.718642.

Testut, L., V. Duvat, V. Ballu, R.M.S. Fernandes, F. Pouget, C. Salmon, et J. Dyment. 2016. « Shoreline changes in a rising sea level context: The example of Grande Glorieuse, Scattered Islands, Western Indian Ocean ». *Acta Oecologica 72: 110-19*. https://doi.org/10.1016/j.actao.2015.10.002.

Testut, L., et A.S. Unnikrishnan. 2016. « Improving modeling of tides on the continental shelf off the west coast of India ». *Journal of Coastal Research 32 (1):* 105-15. https://doi.org/10.2112/JCOASTRES-D-14-00019.1.

Tranchant, Yann-Treden, Clémence Chupin, Laurent Testut, et Valérie Ballu. 2021. « Assessing Tide Correction under Altimetry Tracks: An Innovative Validation Methodology Using USV (Unmanned Surface Vehicle) in-Situ Measurements ». *EGU21-16339. Copernicus Meetings.* https://doi.org/10.5194/egusphere-egu21-16339.

Tranchant, Yann-Treden, Laurent Testut, Clémence Chupin, Valérie Ballu, et Pascal Bonnefond. 2021. « Near-Coast Tide Model Validation Using GNSS Unmanned Surface Vehicle (USV), a Case Study in the Pertuis Charentais (France) ». *Remote Sensing 13 (15)*: 2886. https://doi.org/10.3390/rs13152886.