Open PostDoc positions on ocean modelling

Odyssey team, Inria (Rennes, France)

The Odyssey team (`team.inria.fr/odyssey`) has several open postdoc positions on ocean modelling. Odyssey (for Ocean DYnamicS obSErvation analYsis) is a recently created team involving researchers from Inria (Rennes, France), Ifremer (Brest) and IMT Atlantique (Brest). Inria (`www.inria.fr`) is one of the leading research institute in Computer Sciences in France, and Odyssey is also affiliated to the mathematics research institute of the Rennes University (IRMAR). The team expertise encompasses mathematical (stochastic) and numerical modelling of ocean flows, observational and physical oceanography, data assimilation and machine learning. Gathering this large panel of skills, the team aims at improving our understanding, reconstruction and forecasting of ocean dynamics, and more specifically to bridge model-driven and observation-driven paradigms to develop and learn novel representations of the coupled ocean-atmosphere dynamics ocean models.

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Internal Tide modelling and data assimilation for SWOT era (contact: Noé Lahaye)

There is one postdoc position available in the context of the ModITO project (Modelling the Internal Tide in the Ocean), which aim at improving our understanding of ocean internal tides and its mapping from satellite altimeter data, in particular in the context of the SWOT mission. The main objective of the project is to develop and exploit simplified dynamical models of internal tides dedicated to the assimilation of data from satellite altimeter and other sources of observations (e.g. surface drifters). In particular, accounting for the loss of coherence (time regularity) of ITs – arising from interactions between ITs and mesoscale balanced flow – is of crucial importance and is one of the main focus of the project. The work is expected to have a great impact in the physical oceanography community: on the one hand, mapping the internal tide field – and more precisely to disentangle the internal waves and the balanced motions – is of critical importance in the context of the SWOT mission. On the other hand, a better quantification of the internal tides and the related dynamical processes are key to better understand the ocean circulation and improve parametrizations of ocean models. The ModITO project will consistently leverage a dynamical framework based on vertical mode decomposition of the primitive equations for analysing outputs from state-of-the-art high-resolution realistic simulations, formulating theoretical expectations and developing internal tide models, following recent efforts on the subject[1].

Depending of the skills and aspiration of the postdoc, her/his role in the project will consists of theoretical developments on internal wave propagations in the ocean, the analysis of state-of-the-art high-resolution realistic simulations, or the actual formulation and implementation of a data-assimilation model of the internal tide.

Required skills: As mentioned above, the precise workload assigned to the postdoc can be adjusted depending on his skills and affinities. A background in (geophysical) fluid dynamics, as well as good coding skills (Python, with a decent knowledge of scientific libraries – pytorch/jax is a plus) and knowledge in data assimilation, are valuable. The postdoctoral researcher will work with Noé Lahaye (Inria, Rennes), but close collaborations with other members of the team, in particular with A. Ponte (Ifremer), are expected.

[1] Le Guillou, F. *et al.* 2021: Joint Estimation of Balanced Motions and Internal Tides From Future Wide-Swath Altimetry. *J. Adv. Model. Earth Syst., 13(12).* doi: 10.1029/2021MS002613

Duration and working environment: 2 years position funded by ANR JCJC project ModITO. The postdoctoral researcher will work with Noé Lahaye (Inria, Rennes), but close collaborations with other members of the team, in particular with A. Ponte (Ifremer), are expected.

Stochastic modelling of ocean dynamics (contact: Etienne Mémin)

For accurate climatic predictions, it is essential to have plausible forecasts of the future ocean state. Ideally, high-resolution ocean simulations would be used for this purpose. However, due to their associated computational costs, this approach is currently infeasible, and we must rely only on large-scale ocean representations. To address this challenge and the urgent need to generate various likely scenarios, there has been a growing interest in geophysical sciences and climate studies in developing flow models that incorporate noise to account for modelling uncertainties or errors.

The introduction of noise into ocean dynamics models must be done on a theoretically rigorous ground. Ad-hoc choices for model noise can fundamentally disrupt the corresponding fluid dynamics models, leading to unrealistic properties. Rigorously justified methodologies for deriving stochastic dynamics models have been recently introduced in the Odyssey team within the ERC STUOD and a longstanding collaboration with Imperial College and Ifremer. The theoretical framework on which we rely, referred to as "modelling under location uncertainty", decomposes the flow in terms of a resolved smooth component and a rapidly oscillating random component. The stochastic dynamics is then defined from a stochastic representation of the Reynolds transport theorem. From this modelling principle, stochastic equivalents of the classical geophysical flow models can be defined.

A set of models ranging from multi-layers quasi-geostrophic models to primitive equations have been in this way defined and numerically implemented. Ensemble data assimilation are currently under development as well as simplified ocean atmosphere coupled models. Within the STUOD project we have the possibility of opening **two years post-doc positions or PhD positions**.

The different positions we are offering aim to explore one topic related to the following issues:

- Modelling/simulation of stochastic ocean models for ensemble forecasting and uncertainty quantification
- Physical analysis of the new stochastic models and calibration on real data
- Data driven dynamics specification and learning from high-resolution data
- Hierarchical Data assimilation ensemble strategies to couple stochastic ocean model and high resolution satellite data
- Use of stochastic transport for satellite image motion analysis and interpolation

The precise definition of the different positions' objectives will be defined with respect to the candidates' profile and willing. These positions will be coupled to several PhD positions and will provide the opportunity to participate to the supervision of several PhD students.

Skills and profile: The candidate should have a solid background in applied mathematics and/or in fluid mechanics and/or in geophysical dynamics. She/he must have a good knowledge of Fortran/C/C+/ .

Research team & environment: The candidate will be hosted in the Odyssey Inria team located in Rennes (Brittany) and will work in close collaboration with Ifremer Brest, Imperial College London. These position are funded by the ERC project STUOD.