Offre n°2025-08985

PhD Position F/M Reduced-order modelling of internal tide for altimetry data assimilation

Type de contrat : Fixed-term contract

Niveau de diplôme exigé : Graduate degree or equivalent

Fonction : PhD Position

Niveau d'expérience souhaité : Recently graduated

A propos du centre ou de la direction fonctionnelle

The Inria Rennes - Bretagne Atlantique Centre is one of Inria's eight centres and has more than thirty research teams. The Inria Center is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute, etc.

Contexte et atouts du poste

The thesis will be directed by Etienne Mémin and supervised by Noé Lahaye and Gilles Tissot, at Inria in Rennes.

The "Odyssey" inter-institute team involves members of Ifremer, Laboratoire d'Océanographie Physique et Spatiale (UMR 6523), IMT Atlantique in Brest and the Inria centre at the University of Rennes. It will provide an extremely rich working environment and collaborations for the candidate. The main aim of this team is to develop innovative, cross-disciplinary research areas (satellite observation / physical modelling / applied mathematics / numerical methods) based on the analysis of

observation data and numerical modelling, in order to improve our understanding and knowledge of ocean dynamics.

The candidate will also benefit from the intense research activity around the stochastic modelling of surface dynamics (ERC STUOD).

Mission confiée

Internal tide waves are disturbances in currents and densities that propagate in the ocean, and are generated by the interaction of the astronomical tide and the underwater topography. They play a major role in ocean dynamics, as they contribute to the transfer and dissipation of energy and to mixing in the ocean, affecting global ocean circulation and its climatic role.

Despite their importance, however, they remain poorly represented in general circulation models, due to the wide range of spatial and temporal scales they cover and their complex and intrinsically non-linear dynamics. In addition, their estimation using observation methods such as satellite altimetry is currently imperfect, mainly because of the temporal variability of the waves and the temporal sampling of the satellites. Among the main dynamic processes involved, the interactions between internal waves and “balanced” turbulence (eddies and jets) are a major source of uncertainty in our understanding of ocean dynamics.

In this thesis, we will seek to develop approaches for modelling the internal tide that take account of these interactions with balanced turbulence and provide a basis for estimating the internal tidal wave field from satellite observations. This thesis is connected with the ‘SWOT’ wide swath oceanographic mission, operational since December 2023, and for which the separation between internal waves and equilibrated flows is crucial.

Principales activités

The methodology used in this thesis will be based on resolvent analysis. This method, derived from fluid mechanics, consists of investigating the spectrum associated with realisations of a non-linear flow by searching for the response/forcing pairs of the linearised system (the resolvent operator), in which the forcing represents the non-linear terms. By constructing a modified formulation of this formalism, we can extract the incoherent part of the wave as being a response to the interaction between the coherent part, assumed to be regular in time, and fluctuations in the balanced dynamics, the latter then appearing in the forcing term. The idea is to identify two bases: one associated with currents and one associated with waves, where each of the modes of one base is dynamically linked to the corresponding mode of the other base.

First, the candidate will implement this formulation in an idealised context, the reference for which will be provided by simulations in the (non-linear) rotating shallow water model. Then, he/she will extend this formulation to a more realistic context, in particular by allowing the multi-frequential character of the coherent part of the internal tide to be taken into account. Another advantage of the proposed formulation, compared with so-called a posteriori strategies, is that it avoids problems of convergence of the basis, which is a fundamental obstacle in the realistic framework.

Secondly, the candidate will formulate a reduced model based on a Galerkin projection of the dynamic equations (linearised shallow water equations) on the basis of resolved modes. The aim will then be to set up a data assimilation model using this reduced model and a variational formalism (4Dvar) to estimate the internal tide from a set of sea level observations. Again, this assimilation system will first be deployed and tested in an idealised configuration, but it is expected that the thesis will include the application of this methodology to realistic configurations: first on realistic numerical simulations (which give access to a reference solution, or “ground truth”) and then on data from the wide-swath satellite “SWOT”.

Compétences

The thesis project is at the interface between geophysical fluid dynamics and applied mathematics. Either a background in physics, fluid mechanics or physical oceanography with strong mathematical skills and an interest in numerical simulation, or a background in applied mathematics with a strong interest in fluid mechanics modelling and numerical simulation is sought.

Basic programming skills in Python or Julia and Fortran or C++ will be appreciated.

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Rémunération

Salary gross : 2200€

Informations générales

- **Thème/Domaine :** Earth, Environmental and Energy Sciences
  Scientific computing (BAP E)
- **Ville :** Rennes
- **Centre Inria :** Centre Inria de l'Université de Rennes
- **Date de prise de fonction souhaitée :** 2025-10-01
- **Durée de contrat :** 3 years
- **Date limite pour postuler :** 2025-08-05

Contacts

- **Équipe Inria :** ODYSSEY
- **Directeur de thèse :**
  Tissot Gilles / gilles.tissot@inria.fr

A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'e?orce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

Consignes pour postuler

Please submit online : your resume, cover letter and letters of recommendation eventually

Sécurité défense :
Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

Politique de recrutement :
Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.