**2020-02847 - PhD Position F/M [LEMON]**

**Coupling near shore wave models**

**Niveau de diplôme exigé :** Bac + 5 ou équivalent  
**Fonction :** Doctorant

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**A propos du centre ou de la direction fonctionnelle**

The Inria Sophia Antipolis - Méditerranée center counts 34 research teams as well as 8 support departments. The center’s staff (about 500 people including 320 Inria employees) is made up of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrative staff. 1/3 of the staff are civil servants, the others are contractual agents. The majority of the center’s research teams are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Four teams are based in Montpellier and two teams are hosted in Bologna in Italy and Athens. The Center is a founding member of Université Côte d’Azur and partner of the I-site MUSE supported by the University of Montpellier.

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**Contexte et atouts du poste**

The main objective is to develop coupling methods of wave resolving models with porous media flooding. The scope is to study the risk assessment for urban floods in coastal areas and compare an already existing embedded approximation for buildings vs the coupling method with porous media flooding.

Coupling two models requires a good understanding, either at the continuous or discrete level, of the porous media representations so as to preserve for instance the overall accuracy and stability of the computational method. For the coupling of two models through an interface or a transition zone, boundary conditions have a major impact on the dynamics. We are interested on the coupling of a dispersive and a hyperbolic model.

Up to now this approach (the so-called hybrid approach) has been used, in the simulation of the wave breaking mechanisms embedded in dispersive Boussinesq type (BT) models. Wave breaking is an important modeling issue in near-shore environments. It dissipates wave energy through the generation of turbulence, including substantial air entrainment. BT equations are unable to describe this phenomenon and an additional mechanism is necessary. The last decade the hybrid BT-NSW (non linear shallow water) approach has gain a lot of attention due to its simplicity. In this approach we first estimate the location of breaking waves using explicit criteria and then the hyperbolic NSW equations are applied on the breaking regions and the BT equations elsewhere. This mechanism has been used by many authors in order to put a closure on their BT models, (see for example: Tonelli and Petti 2009, Lannes and Marche 2015, Filippini et al. 2016 among others). One of the limitations of this hybrid approach, which has not been extensively studied, is the difficulty of the performance of a stable switch between the BT and the NSW model, since unphysical oscillations appears in the switching zone between the two models and stability issues occur on finer meshes (Kazoleas and Ricchiuto 2018). For that reason, a mesh independent solution can not be obtained.

**UHAINA** is a new phase-resolving free surface wave model for coastal engineering problems devoted to model regional scale sea-level and storm surge as well as wave transformation processes in coastal modeling. It employs a non-classical version of the fully non-linear weakly-dispersive equations of Green-Naghdi, which allows an efficient solution strategy and numerical implementation. A hybrid strategy is implemented to model energy dissipation in breaking regions, by locally revert to the Shallow Water equations. The UHAINA model relies on libraries developed at the INRIA BSO center, such as AeroSol for its hydrodynamic core, and PaMPA and SCOTCH software to handle data management for distributed memory parallel computation.

**SW2D** (Shallow Water 2D), see https://lemon.gitlabpages.inria.fr/sw2d/) consists in upscaling the shallow water equations using averaging techniques with applications to urban floods. This leads to introducing storage and conveyance porosities, as well as additional source terms, in the mass and momentum balance equations. Various versions of porosity-based shallow water models have been proposed in the literature. The Shallow Water 2 Dimensions (SW2D) computational code embeds various finite volume discretization of these models. It uses fully unstructured meshes with arbitrary numbers of edges. The key features of the models and numerical techniques embedded in SW2D are:

- specific momentum/energy dissipation models that are active only under transient conditions. Such models, that are not present in classical shallow water models, stem from the upscaling of the shallow water equations and prove essential in modeling the features of fast urban flow transients accurately
- modified HLLC solvers for an improved discretization of the momentum source terms stemming from porosity gradients
- higher-order reconstruction techniques that allow for faster and more stable calculations in the presence of wetting/drying fronts.

**Collaboration between two Inria teams** (CARDAMOM + LEMON) in the framework of the SURF Inria challenge.

**SURF :** https://project.inria.fr/surf/  
**CARDAMOM :** https://team.inria.fr/cardamom/  
**LEMON :** https://team.inria.fr/lemon/

The PhD student will work with SW2D and Uhaina, two softwares developed by the Inria teams.

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**Informations générales**

- **Thème/Domaine :** Sciences de la planète, de l’environnement et de l’énergie  
- **Plateformes expérimentales logiciel (BAP E)**  
- **Ville :** Bordeaux ou Montpellier  
- **Centre Inria :** CRI Sophia Antipolis - Méditerranée  
- **Date de prise de fonction souhaitée :** 2021-01-01  
- **Durée de contrat :** 3 ans  
- **Date limite pour postuler :** 2020-08-31

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**Contacts**

- **Equipe Inria :** LEMON  
- **Directeur de thèse :** Rousseau Antoine  
- **Adresse e-mail:** antoine.rousseau@inria.fr

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**A propos d’Inria**

Inria est l’institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3500 scientifiques pour relever des 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 accueilli la création de plus de 180 start-up. L’institut s’efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l’économie.

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**L’essentiel pour réussir**

The candidate is expected to have strong interest in applied mathematics and numerical modelling (C++). Experience in free surface modeling will be highly appreciated.

The expected starting date can be as soon as possible. Salary will follow Inria rates.

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**Consignes pour postuler**

**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.

Attention : Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures doit être effectué en ligne jusqu’à la date limite de dépôt.

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**Informations détaillées**

- **Niveau de diplôme exigé :** Bac + 5 ou équivalent  
- **Experience :** 3 ans  
- **Langue :** Anglais  
- **Département :** Recherche  
- **Domaine d’intervention :** Mécanique des Fluides  
- **Spécialisation :** Modélisation des Ondes Pacifiques  
- **Stage ou permanent :** Permanent  
- **Informations supplémentaires :** Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures doit être effectué en ligne jusqu’à la date limite de dépôt.  
- **Adresse e-mail :** antoine.rousseau@inria.fr
The main location (Bordeaux or Montpellier) is to be decided with the candidate. Regular workshops (covered by Inria) between both teams will be organized.

References


Mission confiée

Assignments:
With the help of Maria Kazolea and Antoine Rousseau, the recruited person will be asked to conduct research on near shore wave models, both on theoretical and numerical aspects.

For a better knowledge of the proposed research subject:
The candidate is referred to Cardamom, Lemon and Surf websites.

Collaboration:
The recruited person will be in connection with both research teams CARDAMOM (Bordeaux) and LEMON (Montpellier)

Principales activités

Main activities:

[Modeling] the objective is to couple systems of equations that correspond to various physical processes, from wave development in the ocean to wave breaking and flood propagation in a coastal city. Indeed, in the submersion process leading to urban floods, both a correct estimation of the wave properties (height, period, velocity) and a realistic inland propagation in a complex network of streets are necessary. This will be done thanks to partial differential equations and coupling techniques. One of the first requirements will be to work on the local boundary conditions, which still remain a real scientific issue for the Green-Naghdi equations.

[Software] the output of the project will be a new software, mixing the capabilities of SW2D and UAHINA, able to simulate the inland impact of a tsunami wave.

Additional activities:

[Statistics] Using these deterministic tools, one possible extension to the PhD could be the use of statistical tools (multi-valued extreme value theory): the coastal risk itself will be defined and the impact of extreme forcing scenarios (storms, tsunami, heavy rains) on the risk itself could be quantified.

Compétences

The candidate is expected to have a master, preferably in applied mathematics and in any case with a strong mathematical background. A good knowledge in C++ is also mandatory. Some knowledge on free surface modeling and/or coupling techniques would be appreciated.

Languages: English is mandatory for scientific interactions with the research teams. French is a + for everyday life.

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

Duration: 36 months
Location: Sophia Antipolis, France
Gross Salary per month: 1982€ brut per month (year 1 & 2) and 2085€ brut/month (year 3)