Learning strategies for an improved representation of air-sea interactions in oceanic forecasting systems

- **Contract type** : Fixed-term contract
- **Duration of contract** : 2 years
- **Starting date** : Fall 2021
- **Level of qualifications required** : Master's/engineering degree
- **Function** : Scientific engineer
- **Level of experience** : Recently graduated (in 2019-2020 or 2020-2021)

1 Job environments

The proposed work will be carried out in the framework of a strategic R&D and innovation partnership agreement between Inria and Atos as part of the "French recovery plan". The project is a collaborative work between the Inria AIRSEA team and the Atos AI4Sim group around the theme "Artificial Intelligence and Ocean, Atmosphere, Climate". The Inria AIRSEA project-team (http://team.inria.fr/airsea/) carries out research work in applied mathematics for the modeling of oceanic and atmospheric flows. The team is particularly active on four areas of research : 1) modeling oceanic and atmospheric flows 2) model / dimension reduction 3) managing uncertainties 4) designing numerical algorithms suitable for high performance computing. The team works in close collaboration with geophysicists, e.g. from CERFACS, ECMWF, Mercator-Océan, Météo-France and numerous laboratories attached to the National Institute of Sciences of the Universe (INSU), and also contributes strongly to the development of realistic modeling systems such as the NEMO and CROCO ocean models. The Atos BDS R&D AI4Sim group designs and develops Deep Learning (DL) solutions to make physical modeling and numerical simulation more precise and efficient. The team also studies and implements advanced data coupling strategies between machine learning, inference and classical simulations.

The proposed work should contribute to the improvement of numerical forecasting systems by making it possible 1) to reduce the associated computational costs and the energy footprint of numerical simulations 2) to fill in the gaps in the understanding of certain physical processes by learning techniques.

2 Assignments

In order to improve the consistency between the scales resolved by oceanic models and the scales present in surface fluxes at the air-sea interface (often calculated using low-resolution atmospheric data), an aggregation (a.k.a. downscaling) of atmospheric data available at low resolution to the resolution of the oceanic model will be developed via a supervised learning strategy. The training data will mainly consist of high-resolution coupled ocean-atmosphere simulations.

In this context, we are recruiting a data engineer to

1. design a set of training data available from numerical simulations and/or observations
2. implement a supervised learning strategy using AI4Sim solutions
3. develop benchmarks to assess production models

3 Main activities

The proposed work follows on from work already initiated within the Inria AIRSEA project team (Lemarié et al., 2021[1]) which resulted in the design of a simplified atmospheric boundary layer model via a so-called physically based low-fidelity approach. For this approach, a priori assumptions on the important physical processes to be taken into account for coupling with the ocean have made it possible to derive a simplified system of equation. The atmospheric boundary layer model thus defined was implemented in the NEMO ocean code and was tested on a series of idealized and realistic benchmarks. The objective here would be to tackle this model reduction problem using learning techniques. An important part of the work to be done will be the constitution of the training data which involves the processing of a large volume of data. In terms of learning techniques, no methodological development is planned and the work will be carried out using

1. Lemarié, F., Samson, G., Redelsperger, J.-L., Giordani, H., Brivoal, T., and Madec, G. : *A simplified atmospheric boundary layer model for an improved representation of air-sea interactions in eddying oceanic models : implementation and first evaluation in NEMO (4.0)*, Geosci. Model Dev., 14, 543–572, https://doi.org/10.5194/gmd-14-543-2021, 2021.

"standard" methods and will be based on the tools developed within the Atos AI4Sim team. The learned prediction function will be evaluated initially by using the series of benchmarks presented in Lemarié et al. (2021). Secondly, a more in-depth evaluation on realistic cases is planned through collaborations with geophysicists specializing in ocean-atmosphere coupling.

4 Skills

Essential

- Master's/engineering degree in data Science or scientific computing obtained either in 2019-2020 or in 2020-2021.
- Software development experience in languages like Python, C/C++, or Fortran
- Familiar with linux environment and development tools (e.g. Git, Jenkins, ...)
- Excellent communication skills and willing to work in a dynamic and collaborative environment.
- Strong analytical and creative problem-solving skills.

Desired

- Knowledge of machine learning and data coupling tools and concepts would be appreciated
- Knowledge of typical data format used in the ocean-atmosphere community (e.g. NetCDF, GRIB)

5 Instruction to apply

Please send your detailed Resume, a covering letter showing your interest and letters of recommendation by email to : Florian Lemarié - Inria researcher - florian.lemarie@inria.fr. Consideration of applications will begin immediately.