2018-00698 - Data assimilation for coupled ocean-atmosphere models [PhD campaign]

Level of qualifications required: Graduate degree or equivalent
Fonction: PhD Position

About the research centre or Inria department

Grenoble Rhône-Alpes Research Center groups together a few less than 800 people in 35 research teams and 9 research support departments.

Staff is localized on 5 campuses in Grenoble and Lyon, in close collaboration with labs, research and higher education institutions in Grenoble and Lyon, but also with the economic players in these areas.

Present in the fields of software, high-performance computing, Internet of things, image and data, but also simulation in oceanography and biology, it participates at the best level of international scientific achievements and collaborations in both Europe and the rest of the world.

Context

Airsea is a research project-team in applied mathematics and scientific computing, focusing on the development of mathematical and numerical methods for direct and inverse modelling in ocean-atmosphere applications. The scientific backdrop of this project-team is the design of complex forecasting systems, our overall applicative aim being to contribute to the improvement of such systems, especially those relating to natural hazards: climate change, regional forecasting systems for the ocean and the atmosphere,...

Team's website: https://team.inria.fr/airsea/en/

Key words: Inverse problems, Numerical modelling, Schwarz methods, Coupling methods, Ensemble Kalman filtering/smoothing methods, model reduction.

Assignment

The development of modelling systems is currently an important aspect in most disciplines. Almost no system can be considered as truly self-contained therefore one has an increasingly tendency to develop the coupling of several models (e.g. fluid-structure, ocean-atmosphere,...).

In particular, recent years have seen a growing need for ocean-atmosphere numerical forecasts. Historically dedicated to long-term climatic applications, they are more and more used for shorter meteorological range. In order to use such numerical models it is necessary to estimate their initial and boundary conditions. This can be done combining models and observations through so-called data assimilation methods. This is used routinely in meteorology or oceanography for every-day forecasts. However, these methods have been designed for stand-alone models. Going from simple systems (a single uncoupled model) to complex systems (coupled models) requires improving the assimilation methods, which are in that case currently suboptimal.

The development of efficient data assimilation methods for coupled models is a crucial step to improve the simulation and forecast of complex phenomena. Indeed, combining heterogeneous information (coupling heterogeneous models scale, multi-fluid, multi-phase and observations of all kinds) optimally will not come easily. Moreover in the case of ocean-atmosphere coupling this is complicated by the complex turbulent relationship between the two media at their interface.

Main activities

Key elements that need to be sorted out to achieve high quality coupled initialization are first to ensure physical consistency between both media throughout the data assimilation process, and second to estimate and account for the cross (ocean-atmosphere) error correlations. These are the main goals of this PhD. Possible leads for the former are to draw into theories of multi-physics
domain decomposition and optimal control with strong and/or weak constraint. Convergence of such methods in this context will need to be carefully studied. In conjunction with these approaches, the latter could be tackled using so-called Ensemble iterative Kalman smoothers and the implementation of 4D cross-domain localization techniques. The use of reduced models to represent air-sea interactions within the data assimilation process could also be considered.

Bibliography


- R. Pellerej, A. Vidard, and F. Lemarié, 2016 : 'Toward variational data assimilation for coupled models : first experiments on a diffusion problem’ hal.archives-ouvertes.fr/hal-01337743/document

Skills

Background in numerical analysis, optimisation and/or statistics.

Programming skills in python and/or Fortran.

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration


Monthly salary after taxes : around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year. (medical insurance included).