Data assimilation techniques for coupled ocean-atmosphere models.

MSIAM (MSCI / DS) research Internship proposal

Supervisors

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Location

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Keywords

Data assimilation, Schwarz methods, model coupling, optimal control, stochastic filtering.

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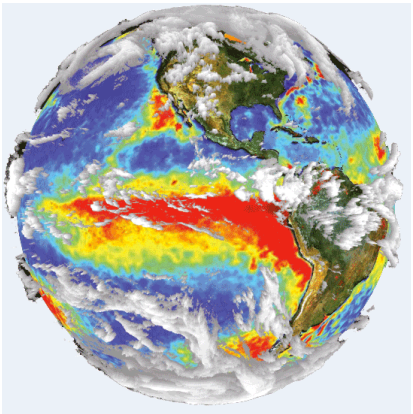
Context

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 (eg 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 constructed to be applied on stand-alone models. Going from simple systems (a single uncoupled model) to complex systems (coupled models) requires to improve the assimilation methods, which are in that case currently suboptimal.



This internship proposal is linked to collaborative projects with Mercator-océan, the french operational oceanography institute, and a broader European project.

Topic description

For practical and scientific reasons a good starting point is generally to couple the assimilation systems rather than the model themselves. Current practice is to first assimilate data into the atmospheric model, correcting the ocean-atmosphere interface, and then use this corrected interface during the data assimilation into the ocean model. This ad-hoc approach can actually be seen as a first iteration of a more theoretically-grounded Schwarz iterative domain decomposition method and therefore the result consistency could be improved by repeating the process several times.

Some preliminary results were obtained by our team following that path. This internship aims at going a step further, the trainee student will extend it to hybrid variational/stochastic data assimilation schemes such as the Iterative Ensemble Kalman Smoother (IenKs)). It will lead to

- Formulate the IEnKS algorithm for ocean-atmosphere coupling.
- Perform a theoretical study on a simple linear problem.
- Perform numerical experiments with coupled (pre-existing) non-linear models.

prerequisites

- Basic knowledge in numerical analysis and optimisation.
- Programming skills in python and/or Fortran.

Bibliography

E. Arnaud : Lecture notes in inverse methods and data assimilation. [PDF]

M.J. Gander and L. Halpern : Méthodes de décomposition de domaines. [PDF]

R. Pellerej, A. Vidard, and F. Lemarié, 2016 : 'Toward variational data assimilation for coupled models : first experiments on a diffusion problem' [PDF]