Sequential data assimilation for fluid flows with reduced order models.

Laboratory: **Rennes INRIA Center, Fluminance** group (http://www.irisa.fr/fluminance)

Research program:

The analysis and prediction of fluid flows has many applications in experimental fluid mechanics studies or in environmental sciences (meteorology, oceanography). In this context, data assimilation aims at coupling models and data in order to estimate the fluid flow state. In order to deal with the high-dimensionality of such fluid flow systems, reduced order models have been proposed that are based for instance on the proper orthogonal decomposition (POD), also called PCA (principal component analysis). These approaches consist in projecting the dynamical model of the flow onto a lower dimensional subspace, leading to a reduced order spatio-temporal dynamical model gathering the main characteristics of the flow.

The objective of this post-doctoral research work will be to investigate the use of data assimilation techniques for such reduced models. In particular, we will focus on Monte Carlo sequential filtering techniques (Ensemble Kalman filter, particle filter) that allow formulating data assimilation in a temporal recursive way and which can be applied to general non linear systems.
The first task will consist in defining a reduced order model of the flow, starting from a recently proposed stochastic evolution law of fluid flows. Such a stochastic Eulerian expression integrates uncertainty on the flow particles locations and allows taking into account approximations or truncation effects performed within the dynamics analytical constitution steps. Projecting this stochastic evolution law onto the low dimensional subspace will lead to a reduced model formulated as a system of stochastic differential equation. This model will then be coupled to discrete-time data with a filtering approach. Within this sequential filtering framework, the main challenge will be the estimation of the drift parameters of the SDE, in order to adapt sequentially the reduced model to new available data, and try to improve the forecast skills of such reduced systems.

Context :

The post-doctoral candidate will closely collaborate with Anne Cuzol and Etienne Mémin. The research work will be done at the INRIA Rennes research center. The duration of this post-doctoral position is scheduled for 16 months with a starting in October. The net salary is 2138€.

Required skills:

Good mathematical background, good knowledges in statistics, probability.
Knowledges in fluid mechanics.
Programming skills (C, C++, Matlab).

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