State, global and local parameter estimation using ensemble Kalman filters for model error correction

Marc Bocquet*[1], Quentin Malartic[1], and Alban Farchi[1]

[1]École des Ponts ParisTech – CEREA – École des Ponts ParisTech 6-8 avenue Blaise-Pascal Cité Descartes 77455 Champs-sur-Marne Marne-la-Vallée cedex 2, France

Abstract

We investigate data-driven techniques based on an ensemble Kalman filters (EnKF) in order to either learn the dynamics or a model error parametrisation thererof. The (local) EnKF can be used to gradually learn both the state and the dynamics as observations are collected. The surrogate model, which represents the dynamics learned in the process, is parametrised (typically as a neural network) and the update is a two-step process: a state update, possibly localised, and a parameter update consistent with the state update. In this framework, the parameters of the surrogate model are assumed to be either global, local or both. To that end, we show how to rigorously extend the classical augmented state parameter EnKF method to the case where the surrogate model admits both global and local parameters. This results in a collection of useful new algorithms, based on either covariance localisation or domain localisation, applied to the state and/or to the parameters. Finally, these algorithms are implemented and tested with success on the chaotic 40-variable Lorenz model. The method is also illustrated on a more challenging two dimensional non-homogeneous multi-layer Lorenz model with radiance-like non-local observations, where a hybrid domain and covariance localisation is implemented.

Keywords: EnKF, localisation, data driven, machine learning, model error, parameter estimation, non local observations

*Speaker