Data Assimilation Designed for Imperfect Model(s)

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Dynamic Days Europe Conference, Exeter

7 September 2015

Abstract

Data assimilation and state estimation for nonlinear dynamical models is a challenging task mathematically. Performing this task in real time is even more challenging as the models are imperfect: the mathematical system that generated the observations (if such a thing exists) is not a member of the available model class. To the extent that traditional approaches address structural model error at all, most fail to produce consistent treatments. This results in questionable estimates both of the model state and of its uncertainty. Pseudo-orbit based data assimilation (PDA) provides an attractive, alternative approach to produce more consistent estimates of the model state and to estimate the (state-dependent) model error simultaneously. Empirical results demonstrate improved performance over that of the two main traditional approaches of data assimilation (Ensemble Kalman Filter and four-dimensional variational assimilation). Applications of PDA in delay coordinates based model as well as in the partial observations cases are explored. The potential use of PDA for locating longer shadowing trajectories (model trajectories being consistent with observations) and integrating dynamical information from multiple models in time are discussed.

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