Physics > Data Analysis, Statistics and Probability

Particle filtering in high-dimensional chaotic systems

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We present an efficient particle filtering algorithm for multiscale systems, that is adapted for simple atmospheric dynamics models which are inherently chaotic. Particle filters represent the posterior conditional distribution of the state variables by a collection of particles, which evolves and adapts recursively as new information becomes available. The difference between the estimated state and the true state of the system constitutes the error in specifying or forecasting the state, which is amplified in chaotic systems that have a number of positive Lyapunov exponents. The purpose of the present paper is to show that the homogenization method developed in Imkeller et al. (2011), which is applicable to high dimensional multi-scale filtering problems, along with important sampling and control methods can be used as a basic and flexible tool for the construction of the proposal density inherent in particle filtering. Finally, we apply the general homogenized particle filtering algorithm developed here to the Lorenz'96 atmospheric model that mimics mid-latitude atmospheric dynamics with microscopic convective processes.

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