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Exploring stochastic model errors in fully nonlinear joint state and parameter estimation in high-dimensional systems

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Joint state and parameter estimation is a nonlinear estimation problem. When the system dimension is high standard nonlinear MCMC methods and standard particle filters become extremely inefficient. However, when it is realised that models are never perfect, and a stochastic model error is introduced, extremely efficient particle filters can be derived by using the proposal density freedom. This has been explored in state estimation using particle filters that are non-degenerate by construction, such as the Implicit Equal-Weight Particle Filter. That filter enforces equal weights of the particles at the expense of a small bias.

In this work we extend this efficient particle filter to include parameter estimation in a very high-dimensional parameter space. Crucial is the construction of a joint stochastic proposal model for the state and the parameters, which forces them to be consistent with eachother. The new method will be explained and applied to high-dimensional highly nonlinear models with a very large numbers of unstable modes. Results and limitations will be discussed.