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Data Assimilation in a Multi-Scale Model

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Data assimilation for multi-scale models is an important contemporary research topic. Especially the role of unresolved scales and model error in data assimilation needs to be systematically addressed. Here we examine these issues using the Ensemble Kalman filter (EnKF) with the two-level Lorenz-96 model as a conceptual prototype model of the multi-scale climate system. We use stochastic parametrization schemes to mitigate the model errors from the unresolved scales. Our results indicate that a high-order auto-regressive process performs better than a first-order auto-regressive process in the stochastic parametrization schemes, especially for the system with a large time-scale separation. Model errors can also arise from imprecise of model parameters. We find that the accuracy of the analysis (an optimal estimate of a model state) is linearly correlated to the forcing error in the Lorenz-96 model. Furthermore, we propose novel observation strategies to deal with the fact that the dimension of the observations is much smaller than the model states. We also propose a new analog method to increase the size of the ensemble when its size is too small.