28*th* IUGG Conference on Mathematical Geophysics, June 7-11, 2010, Pisa, Italy
Session 8: Data assimilation and model validation

Implementation of the nonlinear filtering problem and balanced dynamics

Aneesh C. Subramanian[1], Ibrahim Hoteit[2], Lisa Neef[3], Hajoon Song[1]

[1]*Scripps Institution of Oceanography, La Jolla, U. S. A.*
[2]*King Abdullah University of Science and Technology, Thuwal, Saudi Arabia*
[3]*Royal Netherlands Meteorological Institute, De Bilt, Netherlands*

Keywords: *modeling; data assimilation; nonlinearity*

We investigate the role of the linear analysis step of the ensemble Kalman filters (EnKF) in exciting spurious gravity waves in atmospheric motion models. This is achieved through the comparison of the behaviors of an EnKF and a fully nonlinear particle-based filter (PF) with a simple model of balanced dynamics. The filters have very similar forecast step but their analysis steps are different. More specifically, the analysis step of the PF generalizes the optimality of the EnKF analysis to non-Gaussian distributions. The model admits a chaotic vortical mode coupled to a comparatively fast gravity wave mode. It can be initialized such that it evolves on a so-called slow manifold, where the fast motion is suppressed. It can also be initialized such that the fast varying variables are diagnosed from the slow varying variables. This is called the slaved mode of the model. To determine how well the nonlinear analysis step preserves dynamical balance in the solution, identical twin assimilation experiments are performed, wherein the true state is balanced, but the observational errors project onto all degrees of freedom, including the fast modes. EnKF and PF capture the variables in slow manifold well since, once the variables are attracted towards the slow manifold, they stay there. PF captures slaved modes better implying nonlinear jumps in dependent variables are captured better. Results also include testing other PFs on the model to see which PF performs best in the fully nonlinear Lorenz86 model.