Geophysical Research Abstracts, Vol. 8, 00173, 2006
SRef-ID: 1607-7962/gra/EGU06-A-00173

Statistical dynamical and ensemble quasi-diagonal square root filters.

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A recently developed statistical dynamical model for inhomogeneous 2-D turbulent Rossby wave flow over topography is used, in conjunction with ensemble averaged direct numerical simulations, to develop and compare spectral data assimilation techniques based on quasi-diagonal square root filter methods. In addition to having infinite ensemble size the generalized statistical dynamical square root filter (SDSF) allows for the incorporation of memory effects and higher order moments through renormalized time history integral representations and regularized interaction coefficients. We compare the SDSF to quasi-diagonal ensemble averaged Kalman (QEnKF) and square root filters (QEnSF) for atmospheric barotropic flows when rapidly growing instabilities due to the formation of large scale coherent structures are present. The role of sample size and in particular observational error perturbations that are flow correlated is examined. It is shown that the under prediction of forecast error covariances in the EnKF due to the traditional use of uncorrelated observational error perturbations is only partially related to insufficient sampling and that more generally flow correlated observational errors are preferred for generating forecast error perturbations.