Lessons Learned from Assimilating Altimeter Data into a Coupled General Circulation Model with the GMAO Augmented Ensemble Kalman Filter

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Satellite altimetry measurements have provided global, evenly distributed observations of the ocean surface since 1993. However, the difficulties introduced by the presence of model biases and the requirement that data assimilation systems extrapolate the sea surface height (SSH) information to the subsurface in order to estimate the temperature, salinity and currents make it difficult to optimally exploit these measurements. This talk investigates the potential of the altimetry data assimilation once the biases are accounted for with an *ad hoc* bias estimation scheme. Either steady-state or state-dependent multivariate background-error covariances from an ensemble of model integrations are used to address the problem of extrapolating the information to the sub-surface.

The GMAO ocean data assimilation system applied to an ensemble of coupled model instances using the GEOS-5 AGCM coupled to MOM4 is used in the investigation. To model the background error covariances, the system relies on a hybrid ensemble approach in which a small number of dynamically evolved model trajectories is augmented on the one hand with past instances of the state vector along each trajectory and, on the other, with a steady state ensemble of error estimates from a time series of short-term model forecasts. A state-dependent adaptive error-covariance localization and inflation algorithm controls how the SSH information is extrapolated to the sub-surface. A two-step “predictor corrector” approach is used to assimilate future information.

Independent (not-assimilated) temperature and salinity observations from Argo floats are used to validate the assimilation. A two-step projection method in which the system first calculates a SSH increment and then projects this increment vertically onto the temperature, salt and current fields is found to be most effective in reconstructing the sub-surface information. The performance of the system in reconstructing the sub-surface fields is particularly impressive for temperature, but not as satisfactory for salt.