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Impact of Atmospheric and Model Physics Perturbations On a High-Resolution Ensemble Data Assimilation System of the Red Sea

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The Ensemble Adjustment Kalman Filter of the Data Assimilation Research Testbed is implemented to assimilate observations of satellite sea surface temperature, altimeter sea surface height and in-situocean temperature and salinity profiles into an eddy-resolving 4km-Massachusetts Institute of Technology general circulation model (MITgcm) of the Red Sea. We investigate the impact of three different assimilation strategies (1) $Iexp$– inflates filter error covariance by 10%, (2) $IAexp$– adds ensemble of atmospheric forcing to Iexp, and (3) $IAPexp$– adds perturbed model physics toIAexp. The assimilation experiments are run for one year, starting from the same initial ensemble on 1[st]January, 2011 and the data are assimilated every three days.

Results demonstrate that the $Iexp$ mainly improved the model outputs with respect to assimilation-free MITgcm run in the first few months, before showing signs of dynamical imbalances in the ocean estimates, particularly in the data-sparse subsurface layers. The $IAexp$ yielded substantial improvements throughout the assimilation period with almost no signs of imbalances, including the subsurface layers. It further well preserved the model mesoscales features resulting in an improved forecasts for eddies, both in terms of intensity and location. Perturbing model physics in $IAPexp$ slightly improved the forecast statistics. It further increased smoothness in the ocean forecasts and improved the placement of basin-scale eddies, but caused loss of some high-resolution features. Increasing hydrographic coverage helps recovering the losses and yields more improvements in $IAPexp$ compared to $IAexp$. Switching off inflation in $IAexp$ and $IAPexp$ leads to further improvements, especially in the subsurface layers.