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Applying Ensemble Kalman Filter to Regional Ocean Circulation Model in the East Asian Marginal Sea

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We successfully apply the ensemble Kalman filter (EnKF) data assimilation scheme to the East Sea Regional Ocean Model (ESROM). The ESROM solves the three dimensional ocean primitive equations with the hydrostatic and Boussinesq approximations. The domain of ESROM fully covers East Sea with grid intervals of approximately 0.1°. The ESROM has one inflow port, the Korea Strait, and two outflow ports, the Tsugaru and Soya straits. High resolution bathymetry of 1/60° (Choi et al., 2002) is adopted for the model topography. The ESROM is initialized using hydrographic data from World Ocean Atlas (WOA), and forced by monthly mean surface and open boundary conditions supplied from European Centre for Medium-Range Weather Forecast data, WOA and so on.

The EnKF system is composed of 16 ensembles and thousands of observation data are assimilated at every assimilation step into its parallel version, which significantly reduces the required memory and computational time more than 3-fold compared with its serial version. To prevent the collapse of ensembles due to rank deficiency, we employ various schemes such as localization and inflation of the background error covariance and disturbance of observations. Sea surface temperature from the Advanced Very High Resolution Radiometer and in-situ temperature profiles from various sources including Argo floats have been assimilated into the EnKF system.

For cyclonic circulation in the northern East Sea and paths of the East Korean Warm Current and the Nearshore Branch, the EnKF system reproduces the mean surface circulation more realistically than that in the case without data assimilation. Simulated area-averaged vertical temperature profiles also agrees well with the Generalized Digital Environmental Model data, which indicates that the EnKF system corrects the warming of subsurface temperature and the erosion of the permanent thermocline that are usually observed in numerical models without data assimilation. We also quantitatively validate the EnKF system by comparing its results with observed temperatures at 100 m for two years in the southwestern East Sea. We find that spatial and temporal correlations are higher and root-mean-square errors are lower in the EnKF system as compared with those systems without data assimilation.