Evaluating Observing Systems with a Regional Ocean Circulation Model for the Northwestern Pacific

Both regional and global ocean observing systems provide essential data for ocean analysis and forecasting systems, allowing them to estimate optimal ocean state. Therefore, accessing the impacts of each observing system is crucial for their maintenance and improvement. In this study, the Regional Ocean Modeling System (ROMS) is used to simulate the ocean circulation in the northwestern Pacific region. The Ensemble Optimal Interpolation (EnOI) method is used for data assimilation. The EnOI, as a sequential data assimilation method, uses stationary ensemble of model simulations derived from a long free-run simulation. Given the importance of having an adequate ensemble spread, model simulations from 1994 to 2022 were used for calculating background error covariance. To investigate the impact of regional observing systems around Korea, we focused on two regional ocean observing systems: the National Institute of Fisheries Science (NIFS) and the Korea Hydrographic and Oceanographic Agency (KHOA) routine in situ observations. These observation networks regularly provide temperature and salinity profile data from conductivity-temperature-depth (CTD) measurements. In addition, the global ocean observing system offers sea surface temperature and surface geostrophic current data through the Copernicus Marine Environment Monitoring Service (CMEMS). To evaluate the contribution of each system, we conducted four sensitivity experiments: the control experiment (CTRL) which assimilates all observations; the NO NIFS experiment which excluded NIFS data; the NO KHOA experiment which excluded KHOA data; and the NO SGC experiment which excluded surface geostrophic current (SGC) data. All assimilation experiments were conducted from January 2019 to December 2020. Comparison of these experiments revealed that assimilating NIFS data significantly reduced the Root Mean Square Error (RMSE) for salinity in the Yellow Sea. Assimilation of KHOA data reduced the RMSE in the surface temperature and salinity in the Korea Strait. SGC data improved the meandering path of surface currents and subsurface density structure, especially in the East Sea. This study confirms the importance of maintaining and enhancing the currently available observing systems. In future works, regional and seasonal changes in decorrelation length scales during the assimilation will be further incorporated to increase the accuracy of the regional ocean forecasting system.

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