Assimilation of Surface Residual Currents from HF radar in the Jeju Strait

High frequency (HF) radar is an instrument that measures surface currents by emitting short waves from antennas to the sea surface and analyzing the phase difference of the reflected waves from the sea surface. The Korea Institute of Ocean Science and Technology (KIOST) is currently operating HF radar ocean observing system in the Jeju Strait. The Jeju Strait, the study area, is heavily influenced by tides, predominantly the M2 semi-diurnal tide, which plays a crucial role in vertical and horizontal mixing due to its seasonal and spatial variability. For effective data assimilation of HF radar currents into an ocean circulation numerical model, the tidal characteristics observed by the HF radar and simulated by the numerical model must be similar. However, correlation coefficients between HF-Radar and the ocean circulation numerical model currents are 0.75 and 0.44 for u and v components, respectively. This study proposes a method to assimilate residual currents, derived by removing tidal components from HF radar surface current data, into the ocean circulation numerical model. The model was constructed using the Regional Ocean Modeling System (ROMS) for the Jeju Strait area, with initial and boundary conditions from the Hybrid Coordinate Ocean Model (HYCOM) at daily intervals. Atmospheric forcing was provided by the European Centre for Medium-Range Weather Forecasts (ECMWF) data at hourly intervals. Data assimilation was conducted using the Ensemble Kalman filter (EnKF) method, assimilating the residual currents obtained through harmonic decomposition of the HF radar surface current data. The assimilation was performed every three hours for July 2020. Observation errors, ranging from 0.1 to 50 cm/s, were determined based on Geometric Dilution of Precision (GDOP) to account for spatial error variability. The effectiveness of the data assimilation was evaluated by comparing model results with independent ocean buoy and drifter data, as well as full-depth ADCP data. The correlation coefficient for the surface u component improved from 0.42 in the FR to 0.50 in the DA, and for the v component from 0.36 in the FR to 0.45 in the DA. Currents at depths also showed improvement with ADCP data, even though only surface residual currents were assimilated. In conclusion, the assimilation of surface residual currents from HF radars using EnKF enhanced the accuracy of the ocean currents in the numerical model of the Jeju Strait. These results suggest that even in regions with strong tidal current influences effective assimilation of HF radar data can enhance ocean prediction systems.

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