Improvement of temperature and salinity structure through data assimilation and open boundary bias correction in a regional model for the East Sea

Boundary conditions are crucial constraints for solving partial difference equations to determine the interior solution. Global ocean prediction models, such as Hybrid Coordinate Ocean Model (HYCOM) and Mercator International Ocean Model, have been used to provide boundary conditions for regional ocean models. However, in the Korea Strait, the simulated salinity by the global prediction model was lower than the in-situ observation data in winter and higher in summer, and the simulated temperature also had biases compared to the observation. These open boundary biases have caused high uncertainties when predicting temperature and salinity distribution in the East Sea using nested regional ocean circulation models. To reduce prediction errors in the interior of nested regional model domain, both open boundary bias correction and the data assimilation methods were applied using the observed temperature and salinity data. The effects of both methods were quantified from four numerical experiments: free run without boundary correction and data assimilation (Exp.CTRL), simulation with boundary correction (Exp.BC), with data assimilation (Exp.DA) and with both methods (Exp.BCDA). The root mean square errors (RMSEs) of temperature in the southwestern East Sea (Ulleung Basin) from Exp.CTRL, Exp.BC, Exp.DA, and Exp.BCDA were 1.59, 1.55, 0.88, and 0.92℃ at a depth of 10 m in 2019, respectively. The RMSEs of salinity from the four experiments were 0.36, 0.30, 0.33, and 0.27, respectively. In Exp.DA and Exp.BCDA, temperature errors were reduced by 44% and 42%, respectively. In Exp.BC and Exp.BCDA, salinity errors were decreased by 17% and 26%, respectively. Additionally, the root mean square different (RMSD) between Exp.BC and Exp.FR reached the maximum at 350 km from the open boundary (Korea Strait) for salinity, and became one-third of the maximum RMSE at 1200 km. While, in temperate RMSE, reached the maximum at 1300 km (Japan Basin) from the open boundary, and became one-third of that at 1700 km. Data assimilation and open boundary bias correction were effective in reducing the RMSE of temperature in the Ulleung Basin during winter and the RMSE of salinity in the Korea Strait and Ulleung Basin during summer, respectively. Therefore, open boundary bias correction and data assimilation are expected to improve the interior solution of salinity and temperature in regional ocean models.

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