Coupled and nonlinear data assimilation into a regional ocean-biogeochemical model

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Abstract

To improve the prediction of ocean ecosystem indicators related to the biogeochemistry and nutrients, satellite observations of sea surface temperature and chlorophyll are assimilated into an ocean biogeochemical model. We focus on the North Sea and Baltic Sea, utilizing a version of operational model system of the Monitoring and Forecasting Center for the Baltic Sea of the Copernicus Marine Service. This consists of the ocean model NEMO coupled to the biogeochemical model ERGOM running at a resolution of 1.8km. To incorporate observational data, the model is coupled to data assimilation functionality provided by the parallel data assimilation framework (PDAF, https://pdaf.awi.de). We leverage ensemble data assimilation in which the uncertainty of the model state is estimated by a dynamic ensemble of 30 model state realizations. The uncertainty in the biogeochemical fields is represented utilizing perturbed uncertain process parameters. Satellite observations of sea surface temperature and chlorophyll from Sentinel satellites, provided via the Copernicus Marine Service, are assimilated daily. We focus on the effects of the coupled data assimilation assessing how well the observations from one model component can constrain the other component. We further assess the effect of a hybrid filter method that combines a nonlinear filter with an ensemble Kalman filter taking into account the non-Gaussianity of ensemble distributions. Here, the hybrid filter yields improvements over the Kalman filter in the state estimates in particular for the simulated chlorophyll.