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Temperature and Ocean Colour Assimilation onto an Pre-Operational Coastal Ocean-Biogeochemical Model: Assessment of Weakly and Strongly Coupled Data Assimilation

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The effect of the assimilation of satellite sea surface temperature and ocean colour onto the forecast quality of the coastal ocean-biogeochemical model HBM-ERGOM in the North and Baltic Seas is studied. The HBM-ERGOM model is currently in the test phase, pre-operationally, without data assimilation by the Germany Federal Maritime and Hydrographic Agency (BSH). The model is configured with nested grids with a resolution of 5km in the North and Baltic Seas and a resolution of 900m in the German coastal waters. The biogeochemical model ERGOM contains three phytoplankton groups (Cyanobacteria, Flagellates, Diatoms), two zooplankton size groups, four nutrient groups (nitrate, ammonium, phosphate and silicate), two detritus groups (N-Detritus and Si-Detritus) and oxygen to simulate the biogeochemical cycling in the coastal seas.

To improve the predictions of the HBM-ERGOM model, data assimilation was added by coupling the model to the parallel data assimilation framework (PDAF, http://pdaf.awi.de). The ensemble-based error-subspace transform Kalman filter (ESTKF) is applied for the data assimilation.

As a first step to improve the biogeochemical forecasts the impact of assimilating satellite sea surface temperature data is assessed. Two cases are considered. First, the impact of weakly coupled data assimilation. In this case, the assimilation of temperature only directly influences the physical model variables in the analysis step while the biogeochemical fields react dynamically to the changed physical model state during the ensemble forecasts using the coupled model. The second case is the strongly-coupled data assimilation in which next to the physical model fields also the biogeochmical fields are directly updated in the analysis step through the multivariate covariances estimated by the joined physical-biogeochmical ensemble of model states. Here, it is assessed whether these covariances are sufficiently well estimated to result in an improvement of the biogeochemical fields.

The second step is to assimilate both temperature and ocean colour under the same strongly-coupled data assimilation configuration as above to improve biogeochemical forecasts. Comparisons are then made between both steps to compare improvements made from assimilation of temperature to assimilation of both temperature and ocean colour data to assess to which degree the assimilation of ocean colour can improve the biogeochemical fields.