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Parameter estimation for ocean biogeochemical component in a global model using Ensemble Kalman Filter: a twin experiment

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Ocean biogeochemical (BGC) models utilize a large number of poorly-constrained global parameters to mimic unresolved processes and reproduce the observed complex spatio-temporal patterns. Large model errors stem primarily from inaccuracies in these parameters whose optimal values can vary both in space and time. This study aims to demonstrate the ability of ensemble data assimilation (DA) methods to provide high-quality and improved BGC parameters within an Earth system model in idealized twin experiment framework. We use the Norwegian Climate Prediction Model (NorCPM), which combines the Norwegian Earth System Model with the Dual-One-Step ahead smoothing-based Ensemble Kalman Filter (DOSA-EnKF). The work follows on Gharamti et al. (2017) that successfully demonstrates the approach for one-dimensional idealized ocean BGC models. We aim to estimate five spatially varying BGC parameters by assimilating Salinity and Temperature hydrographic profiles and surface BGC (Phytoplankton, Nitrate, Phosphorous, Silicate, and Oxygen) observations in a strongly coupled DA framework – i.e., jointly updating ocean and BGC state-parameters during the assimilation. The method converges quickly (less than a year), largely reducing the errors in the BGC parameters and eventually it is shown to perform nearly as well as that of the system with true parameter values. Optimal parameter values can also be recovered by assimilating climatological BGC observations and challenging sparse observational networks. The findings of this study demonstrate the applicability of the approach for tuning the system in a real framework.

References:

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