Optimisation of biogeochemical model parameters using BGC-ARGO profiling floats

Numerical models of ocean biogeochemistry are becoming a major tool to detect, predict the impact of climate change on marine resources and monitor ocean health. The skill of these models relies on one hand, on the mathematical functions that describe biogeochemical processes and on the other hand on the accuracy of their parameters. In general, the values of these parameters are derived from laboratory experiments. This approach is not particularly suitable for ocean simulations where the parameter values should represent diverse environmental and ecological conditions. Ensemble-based data assimilation techniques are a promising method to optimize model parameters for global simulations. Here, we present the results of an optimization experiment in which a Particle Filter algorithm is used together with the data from a BGC-Argo float that profiled in the North Atlantic to optimize the parameters of a 1D configuration of PISCES (French biogeochemistry model). We first show that the optimized version of PISCES 1D better represents the seasonal cycle of surface nutrients, chlorophyll, and carbon (particulate organic and dissolved inorganic) in the North Atlantic than the default setting of PISCES-1D as well as the CMEMS global ocean forecast system. The RMSE is reduced by an average of 10 % compared to the 1D reference model. In addition, we find that the optimized version of PISCES 1D also outperforms the default setting of PISCES 1D in estimating the net primary production and the export of particulate organic carbon (POC) in the North Atlantic, as evaluated against satellite measurements. We have also implemented these optimised parameter values in the IBI 3D operational model (the CMEMS operational BGC model for European waters). We have improved the representation of phosphate and nitrate concentrations compared to a parallel simulation using reference parameter values. Our study demonstrates the potential of ensemble-based data assimilation techniques for optimizing biogeochemical model parameters and improving the accuracy of numerical models of ocean biogeochemistry, which are critical tools for monitoring ocean health, predicting the impacts of climate change on marine resources, and informing policy decisions.

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