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Sensitivity and optimization study using an implicit biogeochemistry ocean model and in-situ phosphate, alkalinity, and DIC data

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We have developed an implicit biogeochemistry ocean model for systematic model sensitivity and optimization studies. We examine the Redfield ratio of carbon to phosphorus and of nitrogen to phosphorus, and ocean carbon processes parameterized in OCMIP-2. The parameters include the fraction of organic carbon production allocated into particulate organic matter (POM), ratio of $CaCO_3$ production to organic carbon production, first order decay constant of dissolved organic matter (DOM), and remineralization profiles for POM and $CaCO_3$. We first optimize the Redfield ratio and the model parameters using formal optimization algorithms and global climatology data for phosphate, alkalinity, and dissolved inorganic carbon (DIC). The cost function comparing the simulation to the three global data set is examined to better constrain those optimized parameters. We also present spatial sensitivity patterns of equilibrium solutions to those model parameters to help understand the role of each parameter in distribution of the tracers on the regional and global scale. Our optimization study suggests that longer residence time of semi-labile DOM at the surface and shallower remineralization depth of $CaCO_3$ than values provided by OCMIP-2 improve model-observation agreement. Atmospheric pCO_2 is shown to be sensitive to remineralization profiles of soft tissue and hard tissue fluxes. The implicit solver used in this study is described in this presentation. Our overall finding that the biogeochemical processes are coupled with ocean circulation in terms of tracer redistribution emphasizes the need to examine the sensitivity to ocean transport in addition to ocean biogeochemical processes.