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Optimization of marine biogeochemial parameters against climatologies of nutrients and oxygen

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Global biogeochemical ocean models usually contain a variety of different biogeochemical components, which are described by many parameters. The values of many of these parameters are empirically difficult to constrain, due to the fact that in the models they represent processes for different groups of organisms. Therefore, these models are subject to a high level of parametric uncertainty. This may be of consequence for their skill with respect to accurately describing the relevant features of the present ocean, as well as their sensitivity to possible environmental changes. We here present a framework for the optimization of global biogeochemical ocean models on short and long time scales.

The framework combines an offline approach for transport of biogeochemical tracers with an Estimation of Distribution Algorithm, a type of evolutionary algorithm in which the probability distribution is parameterized. We explore the performance and capability of this framework by optimizations of different biogeochemical parameters against different data sets. Optimization of six parameters, mostly tied to the surface biogeochemical processes, against a climatology of observations of annual mean dissolved nutrients and oxygen, reveals that parameters, that act on large spatial and temporal scales are determined earliest, and with the least spread. Parameters more closely tied to surface biology, which act on shorter time scales, are more difficult to determine. Encouragingly, optimized models show a better fit to estimates of global mean biogeochemical fluxes such as production, export, and grazing, although these fluxes did not enter the misfit function. We finally investigate if, and to what extent, we can achieve an equally good fit to observed tracer fields with a model of strongly reduced biogeochemical complexity.