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Constraining parameters in state-of-the-art marine pelagic biogeochemical models. Is it sufficient to use typical observations of standing-stocks?

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In order to constrain potential feedbacks in the climate system, simple pelagic biogeochemical models (BGCMs) are coupled to 3-dimensional ocean-atmosphere models. These so-called earth system models are frequently applied to calculate climate projections. All BGCs rely on a set of rather uncertain parameters. Among them are generally the Michaelis Menten (MM) constants, utilized in the hyperbolic MM- formulation (which specifies the limiting effect of light and nutrients on carbon assimilation by autotrophic phytoplankton). All model parameters are typically tuned in rather subjective trial-and-error exercises where the parameters are changed manually until a "reasonable" similarity with observed standing stocks is achieved.

In the present study, we explore with twin experiments (or synthetic “observations") the demands on observations that would allow for a more objective estimation of model parameters. These parameter retrieval experiments are based on “perfect" (synthetic) observations which we, step by step, distort to approach realistic conditions. Finally, we confirm our findings with real-world observations. In summary, we find that even modest noise (10%) inherent to observations may hinder the parameter retrieval already. Particularly, the MM constants are hard to constrain. This is of concern since the MM parameters are key to the model‘s sensitivity to anticipated changes of the external conditions.