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Investigation and sensitivity analysis of a mechanistic phytoplankton model implemented in a new modular numerical tool (Eco3M) dedicated to biogeochemical modelling

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Abstract

A new class of phytoplankton models with a mechanistic basis has been presented in a companion paper (Baklouti, M., Diaz, F., Pinazo, C., Faure, V., Queguiner, B., 2006. Investigation of mechanistic formulations depicting phytoplankton dynamics for models of marine pelagic ecosystems. Progress in Oceanography). It is the default class of models implemented in our new numerical tool *Eco3M*, which is dedicated to *Ecological, Mechanistic and Modular Modelling*. A brief overview of its main features is given in Section 2 of the present paper. In the next sections, a particular phytoplankton model among the aforementioned class has been tested with special emphasis on the mechanistic photosynthesis component relating the photosynthetic rate to the proportion of open photosystems II. The present study encompasses several essential steps that are inherent to any modelling, including model reduction, model sensitivity analysis and comparison of model outputs with experiments. The global sensitivity analysis of the plankton model for one-at-a-time parameter perturbations revealed a restricted set of parameters having major influence on the model outputs. Sensitivity tests involving simultaneous parameter perturbations within the range actually encountered in the literature provided a confidence interval for the outputs. Chemostat experiments performed on nitrate-limited diatoms grown under low (LL) and high-light (HL) conditions have been used for comparison with model outputs. The good fit between measured data and model outputs using the same parameter values in both the LL and HL cases demonstrates the ability of our model to represent the main features of phytoplankton dynamics including photoacclimation. Finally, *Eco3M* is ultimately intended to include explicit bacterial and zooplankton compartments, as well as to be coupled with ocean circulation models, but the intrinsic behavior of the phytoplankton model has been investigated first, independently of physical forcing.

Keywords: Ecological modelling; Phytoplankton; Mechanistic formulations; Sensitivity analysis

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