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New Models of the Flexible Response of Plankton Ecosystems: from Theory to Practical Implementation

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For over two decades, detailed models have been developed to reproduce the flexible response of phytoplankton, and to a lesser extent of zooplankton, as well known from laboratory experiments. This research has yielded scientific insights, and some of those detailed models have been applied in coupled physical-biological ocean models. However, such detailed models are in general too complex for practical applications in large-scale and long-term ocean modeling studies. Therefore, most current marine ecosystem models do not account for the flexible physiological response of plankton. Nevertheless, large-scale and long-term ocean modeling studies are necessary in order to test the theoretical ideas embodied in these detailed models against oceanic observations and to explore the impact of flexibility on the response of plankton ecosystems to environmental change. In order to advance scientific understanding of plankton ecosystems in the ocean, we aim to reconcile the results of laboratory experiments, theoretical modeling, and oceanic observations. For this purpose, we are developing new, relatively simple models of the flexible response of interacting phytoplankton and zooplankton communities, which can be applied in practical ocean modeling. Recent results will be presented from one-dimensional (vertical) coupled physical-biological models of the ocean compared to oceanic observations. These results include: 1) the impact of the process of photo-acclimation on the vertical distributions of phytoplankton biomass, particulate organic nitrogen, and chlorophyll, and 2) the potential role of the hypothesised *Kill-the-Winner* grazing effect for sustaining plankton biodiversity.

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