Impact of physiological flexibility on the dynamics of phytoplankton biomass, production, and nutrient distribution in a 1-D model of the near-surface ocean

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We compare results from the recently developed FlexPFT (Flexible Phytoplankton Functional Type) model, which includes the flexible physiological response (i.e., photo-acclimtation) of phytoplankton, to those of a typical inflexible control PFT (CtrlPFT) model, as applied in most NPZD-type models. Both models have been embedded within the General Ocean Turbulence Model (GOTM), which is here applied as a 1-D (vertical) model of mixing and transport within the upper few hundred meters of the ocean. Simulations were conducted of two contrasting time-series observation sites in the North Pacific: subarctic stn. K2 (47 degrees N, 160 degrees E) and subtropical stn. S1 (30 degrees N, 145 degrees E), both of which are maintained by JAMSTEC: http://ebcrpa.jamstec.go.jp/k2s1/en/. The FlexPFT model is better able to reproduce consistently the observed vertical distributions of chlorophyll, primary production, and particulate organic nitrogen, compared to the CtrlPFT. This is because the FlexPFT accounts for changes in the chl:N:C ratio of biomass with changing environmental conditions. Therefore vertical profiles and seasonal response obtained from the FlexPFT differ substantially from those obtained from the CtrlPFT. Although the importance of photo-acclimation has long been recognized in subtropical regions, our results suggest that this process may also be quite important in subarctic regions as well. We discuss some implications of this result for understanding biogeochemical cycles and plankton ecosystems.

Keywords: plankton, physiology, ecosystem, model, photo-acclimation

