Untangling the effects of individual-level acclimation and inter-specific competition on the modeled dynamics of phytoplankton community size structure

*S. Lan Smith[1], Taketo Hashioka[1], Bingzhang Chen[1]

1. Marine Ecosystem Dynamics Research Group, Research Centre for Global Change, Japan Agency for Marine-Earth Science and Technology

A variety of ecosystem models have been developed that resolve the size distribution of phytoplankton using multiple (now up to hundreds of) discrete size classes. Although such models have proven useful as research tools, they require a great many calculations for large-scale and long term modeling studies. As an alternative, continuous size-distribution models, which require many fewer calculations, could in principle be used for faster large-scale simulations. However, few such models even exist, and their ability to reproduce observations has not been well tested. This study compares the discrete and continuous approaches, and furthermore aims to clarify the relative importance of acclimation (at the individual or species level) and competition between multiple size-classes (or species) for the dynamics of size-based phytoplankton communities. We compare the performance of discrete and continuous size-distribution models, each formulated with and without flexible physiological response (acclimation) for each size class. All four models were implemented in a 0-D (box) model of the oceanic mixed layer and fitted to data from two contrasting time-series observation stations in the North Pacific, including size fractionated chlorophyll observations. Unexpectedly, the continuous size distribution model with acclimation reproduces the observations better than the corresponding discrete model. However, accounting for acclimation response makes more difference for model results than does the choice of discrete or continuous size representation. Finally we compare modeled relationships to observed patterns of size-fractionated chlorophyll vs. total chlorophyll, to clarify how the acclimation response and inter-specific competition impact the dynamic size structure of phytoplankton communities.

Keywords: ecosystem model, biodiversity, adaptive dynamics, chlorophyll