Introducing phytoplankton size structure in an ocean biogeochemical model OECO2

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The biodiversity ecosystem functioning (BEF) caused by biodiversity affects the ecosystem services that humans receive, through the enhancement of productivity, stability, resistivity against invasive species, nutrient dynamics, etc. Many previous studies for marine ecosystems suggested that biodiversity generally has positive impacts on the ecosystem functioning. For instance, increasing biodiversity enhances the productivity through selection effects and niche complementarity. The underlying mechanism, however, has yet to be revealed. Recently, trait-based marine ecosystem models are gaining increasing attention due to their ability to explore the ecological and biochemical mechanism of biodiversity, which can take the environmental variability into account and complement spatiotemporal sparseness of field observation. However, development of a trait-based model has mostly been separated from the achievements of classical non-trait-based plankton functional type models, which is widely used in the global scale modeling. Therefore, this study aim at introducing trait factors in the existing non-trait-based marine ecosystem model, and exploring the relationship between phytoplankton diversity and ecosystem functions. The biogeochemical component OECO-v2a for an earth system model MIROC-ES2L is used to do this extension, which is run with the physical environmental field driven by the average external forces during 1981–2000. To represent phytoplankton biodiversity and reduce the number of parameters in the model, we introduce the concept of relative volume and determine physiological parameters, such as the rate of nutrient uptake, using size-based power laws. Based on this BEF model, we will discuss the relationship between phytoplankton diversity and BEF such as primary production and export production in the North Pacific under changing environments.

Keywords: trait-based ecosystem modeling , size scaling, biodiversity ecosystem functioning

