Implementation of a size-based, multi-element ecosystem model for global biogeochemical cycles

John P. Dunne, Robert A. Armstrong, Curtis A. Deutsch, Anand Gnanadesikan, Jorge L. Sarmiento, Panangady S. Swathi and Nicolas Gruber

Atmospheric and Oceanic Sciences Program, Princeton University, Address: P.O. Box CN710, Princeton, NJ 08544-0710, USA, Tel.: (609) 259-0979, Fax: (609) 258-2850, jdunne@princeton.edu

We have developed a model to simulate ecosystem dynamics relating to regenerated production, sinking particle export and transport of dissolved organic matter in the global ocean. A key feature of this model is a representation of grazing that reproduces observed allometric relationships between large and small phytoplankton. We present an extensive compilation of data on primary production and particle export, and use this data to calibrate this relatively simple, highly parameterized model of particle export and remineralization. Production is determined by forcing nutrients toward observations. Regeneration is described as a function of temperature and community structure, competing with the sinking of detrital material through the water column. Detrital sinking is described as a function of mineral ballast. Dissolved organic matter production is described as a function of phytoplankton production and nutrient limitation. This model has been calibrated through the generation of a synthesis of euphotic zone data on temperature, chlorophyll biomass, primary production and new production and/or particle export from over 100 sites. Where available, we have also utilized data on size-fractionated phytoplankton biomass and the carbon:chlorophyll ratio of phytoplankton. The resulting model has been incorporated into the Princeton Ocean Biogeochemical Model to diagnose total production, phytoplankton biomass, particle export and dissolved organic matter transport through restoring of surface nitrate, phosphate, silicate and alkalinity in the MOM3 general circulation model. Model results are compared with a synthesis of dissolved organic carbon survey data and satellite-based phytoplankton biomass from ocean color.