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Modeling the global cycle of marine dissolved organic matter and its influence on marine productivity

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A three-dimensional numerical model is developed for studies on the marine biogeochemical cycles by dealing with coupling of planktonic and microbial processes. The coupling is achieved by explicitly representing generation and consumption of dissolved organic matter (DOM). The model is applied to investigate mechanisms by which the global cycle of marine DOM influences marine productivity. Two categories, biodegradable (DOMb) and refractory (DOMr), are considered for DOM. DOMb is generated through phytoplankton exudation, zooplankton excretion, detritus decomposition, and photodissociation of DOMr. Bacteria consume DOMb and generate DOMr. After the long-term adjustment, the observed amount of DOM was reproduced from homogenous conditions of nutrients and plankton. Spatial distribution of bacterial abundance is reasonably validated against recently observed large-scale data. Sensitivity experiments indicated that: i) over a multi-decadal timescale, contribution of DOMr to global biogeochemical cycles is negligible, ii) the existence of DOM significantly reduces the global marine primary productivity, and iii) DOMb originated from phytoplankton exudation is transported to subtropical regions, leading to enhanced primary productivity there as a consequence of nutrient supply associated with remineralization of transported DOMb.

Keywords: marine biogeochemical cycles, dissolved organic matter, microbial loop, marine productivity, numerical modeling