Earth Interactions: **Vol. 8, Paper 11.**

Ecodynamic and Eddy-Admitting Dimethyl Sulfide Simulations in a Global Ocean Biogeochemistry/Circulation Model

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Received 10 October 2003; accepted 16 March 2004

ABSTRACT: The authors describe planetary-scale modeling of mixed-layer dimethyl sulfide (DMS) processing and distributions, conducted at a resolution of 0.28° using the Parallel Ocean Program (POP). Ecodynamic routines embedded within POP track the interactions of bacteria, multiple phytoplankton species, zooplankton, and both dissolved and detrital organics. Biogeochemistry linked to the ecosystem includes full elemental cycling for iron, nitrogen, silicon, carbon, and the portion of the sulfur cycle leading through the formation of intracellular dimethyl sulfoniopropionate (DMSP) to dissolved DMS. The two reduced sulfur compounds are emitted from the numerical plant bins at average rates proportional to the taxonomically dependent DMSP content. Within the water column they are subjected to photolysis, interconversion, consumption by the bacterial pool, and loss into the troposphere. Biogeochemical species distributions were calculated synchronously with the POP ocean circulation for the period 1995–2000. The DMS concentration patterns generated agree with available global climatologies in several important aspects. Average values fall consistently between tenths to several nanomolar and remain near the low end of the interval within the oligotrophic gyres, while maxima favor the spring hemisphere. Mesoscale coupling of eddies and geocycles leads to strong variability in the 10–100-km range that is superimposed upon local baselines. Integrated flux into the atmosphere lies toward the low end of the envelope of some recent independent calculations. This is primarily attributable to a slight but persistent underprediction of concentration. Several clear deficiencies remain in the sulfur cycle mechanism. For example, bacterial uptake and the taxonomic dependence of exudation are closely linked and together may require improved parameterization.

KEYWORDS: Dimethyl sulfide; Concentration distributions; Biogeochemistry; Sea–air transfer; Ecodynamics; Eddy resolution; OGCM.