Deep Sea Research II, 49(15), 2002

Dimethyl Sulphide Biogeochemistry within a Coccolithophore Bloom: An Overview

Peter H. Burkill, Stephen D. Archer, Carol Robinson

This volume presents insights of the dimethyl sulphide biogeochemistry within a coccolithophore bloom (DISCO), an integrated, multidisciplinary Lagrangian process study of the routes, rates and controls on the biogeochemical cycling of dimethyl sulphide (DMS) within a growing bloom of the coccolithophorid alga, *Emiliania huxleyi*. The Lagrangian study took place between 16 and 26 June 1999 in the northern North Sea. It was preceded by an 8-d survey of ~52,000 km^2 of the region to locate an *E. huxleyi* bloom suitable for study. Although not originally planned, the survey was carried out because heavy cloud cover precluded use of remote sensing to locate a suitable bloom. *E. huxleyi* blooms, typically common in the region during mid-summer, were unusually sparse in the study area. The bloom chosen for the process study was initially centred ~58°56'N 02°52'E, and a 40-km^2 patch of water was labelled for study with ~30 g sulphur hexafluoride (SF6) on 16 June. The original patch was re-infused with further SF6 on 24 June. During the process study, the SF6-labelled patch moved in a south-easterly direction and the study ended when the patch subducted underneath less dense Norwegian coastal water.

The process study comprised analyses of the time-varying biological, optical and physical properties of the patch as well as studies of DMS, dimethylsulphonioproprionate (DMSP), dimethylsulphoxide, nutrients, halocarbons, methylamines, carbon monoxide, dissolved organic carbon, and total dissolved nitrogen. The role of viruses, bacteria, phytoplankton, microzooplankton, and mesozooplankton, together with the dynamics of primary, new and bacterial production, plankton respiration, microzooplankton grazing, and sedimentation, were studied in relation to the biogeochemical cycling of DMS. Although the coccolithophore bloom water exhibited high optical backscatter, the algal community present was highly heterogeneous. Flagellates other than *E. huxleyi* were found to dominate the phytoplankton. A budget of the DMSP pools suggested that *E. huxleyi* accounted for only 13% of the stocks of particulate DMSP, showing that in this "*E. huxleyi* bloom", taxa other than *E. huxleyi* were important sources of DMSP. In this young bloom, particulate and dissolved DMSP and DMS concentrations averaged 1360, 155 and 60 $\mu M\ m^{-2}$, respectively, in the surface mixed layer. Surface-water particulate DMSP concentrations increased during the study at a net rate of 13% d^{-1}, as did concentrations of phytoplankton including *E. huxleyi*, confirming that the bloom was developing. Nutrient conditions were low in the mixed layer throughout the study, maintained by a strong pycnocline across which nitrate upflux was estimated to be ~2 $nM\ dm^{-3}\ d^{-1}$. Primary production was fuelled by regenerated nutrients, although nitrification rates in surface waters were found to be significant. Microzooplankton grazing accounted for 91% of the particulate DMSP degradation and was considered to be a major control on the DMSP concentration. Vigorous microzooplankton grazing together with rapid uptake of dissolved DMSP by bacteria suggest that microzooplankton were the main route for the production of dissolved DMSP. The bacterial community was dominated by one taxon, an α-proteobacteria related to *Roseobacter* that satisfied its entire sulphur demand by metabolising dissolved DMSP. Bacteriogenic DMS production amounted to 2 $nM\ d^{-1}$ and was considered the main route for DMS production. In vitro DMSPlyase activity was very high, but there was little evidence for high in situ activity. Over the study period, DMS flux to the atmosphere was estimated to be 7 $\mu M\ m^{-2}\ d^{-1}$, equivalent to ~1% of the DMSP sulphur produced in the surface mixed layer. A budget for DMS cycling in the upper mixed layer is presented based on the analytical and experimental measurements made in the DISCO study.