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Dimethyl Sulphide Biogeochemistry within a Coccolithophore Bloom: An Overview

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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 $\sim 52,000$ km² 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 $\sim 58^{\circ}56'N$ $02^{\circ}52'E$, and a 40-km² 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, dimethylsulphoniopropionate (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 $\mu\text{M m}^{-2}$, 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 $\text{dm}^{-3} \text{d}^{-1}$. 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 DMS lyase 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 $\mu\text{M m}^{-2} \text{d}^{-1}$, equivalent to $\sim 1\%$ 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.

Peter H. Burkill, Stephen D. Archer, Carol Robinson, Philip D. Nightingale, Stephen B. Groom, Glen A. Tarran and Mikhail V. Zubkov -- Dimethyl sulphide biogeochemistry within a coccolithophore bloom (DISCO): an overview -- 2863-2885

Claire E. Widdicombe, Stephen D. Archer, Peter H. Burkill and Stephen Widdicombe -- Diversity and structure of the microplankton community during a coccolithophore bloom in the stratified northern North Sea -- 2887-2903

Andrew P. Rees, E. Malcolm S. Woodward, Carol Robinson, Denise G. Cummings, Glen A. Tarran and Ian Joint -- Size-fractionated nitrogen uptake and carbon fixation during a developing coccolithophore bloom in the North Sea during June 1999 -- 2905-2927

Carol Robinson, Claire E. Widdicombe, Mikhail V. Zubkov, Glen A. Tarran, Axel E. J. Miller and Andrew P. Rees -- Plankton community respiration during a coccolithophore bloom -- 2929-2950

William H. Wilson, Glen Tarran and Mikhail V. Zubkov -- Virus dynamics in a coccolithophore-dominated bloom in the North Sea -- 2951-2963

Jane M. Foster and Graham B. Shimmield -- ²³⁴Th as a tracer of particle flux and POC export in the northern North Sea during a coccolithophore bloom -- 2965-2977

Stephen D. Archer, Geoff C. Smith, Philip D. Nightingale, Claire E. Widdicombe, Glen A. Tarran, Andrew P. Rees and Peter H. Burkill -- Dynamics of particulate dimethylsulphoniopropionate during a Lagrangian experiment in the northern North Sea -- 2979-2999

Michael Steinke, Gill Malin, Stuart W. Gibb and Peter H. Burkill -- Vertical and temporal variability of DMSP lyase activity in a coccolithophorid bloom in the northern North Sea -- 3001-3016

Mikhail V. Zubkov, Bernhard M. Fuchs, Stephen D. Archer, Ronald P. Kiene, Rudolf Amann and Peter H. Burkill -- Rapid turnover of dissolved DMS and DMSP by defined bacterioplankton communities in the stratified euphotic zone of the North Sea -- 3017-3038

Angela D. Hatton -- Influence of photochemistry on the marine biogeochemical cycle of dimethylsulphide in the northern North Sea -- 3039-3052

Angela D. Hatton -- DMSP removal and DMSO production in sedimenting particulate matter in the northern North Sea -- 3053-3065

Stephen D. Archer, Francis J. Gilbert, Philip D. Nightingale, Mikhail V. Zubkov, Arnold H. Taylor, Geoff C. Smith and Peter H. Burkill -- Transformation of dimethylsulphoniopropionate to dimethyl sulphide during summer in the North Sea with an examination of key processes via a modelling approach -- 3067-3101