The role of coccolithophores in dimethylsulphide production and their potential impact on climate

Jeremy R. Young, Dan Franklin, Gill Malin, Alex Poulton, Ian Probert

Charlson *et al*. (1987) noted that cloud formation over the oceans is significantly influenced by the supply of cloud condensation nuclei, the predominant source of which appeared to be dimethylsulphide (DMS), which is produced by planktonic algae in sea water. Hence, increased phytoplankton productivity is liable to increase cloud cover and so global albedo. This system, commonly termed the CLAW hypothesis, was envisaged as acting as a significant negative feedback to the global warming effects of changed insolation regimes and so as a partial global thermostat. Subsequent research and modeling has confirmed the importance of DMS as a source of CCN, especially in the Southern Hemisphere, indeed potential global temperature impacts of up to 3.8 degrees centigrade have been calculated (Watson & Liss, 1998). However, research and modeling since Charlson (1987) has also shown that the system is more complex and harder to predict than initially thought. Indeed, it is not even clear whether the effect is likely to act as a positive or negative feedback to anthropogenic global change.

Complicating factors include that DMS is produced from a precursor molecule dimethylsulphoniopropionate (DMSP), and the pathway from intracellular DMSP to atmospheric DMS is convoluted, with strong influences from the food-chain dynamics. Moreover the DMSP content of phytoplankton varies greatly between species (Keller *et al*., 1989). Presumably as result of these two factors, there is often only a poor correlation between phytoplankton biomass or productivity and DMS levels.

The pioneering work of Keller *et al*. (1989) suggested that coccolithophores and dinoflagellates had much higher DMSP contents than other phytoplankton, especially diatoms. Hence it is possible that varying abundances of these phytoplankon groups may be a significant factor controlling DMS production. To test this we have carried out a combination of laboratory and cruisework investigations of the role of coccolithophores in DMS production. The laboratory investigations looked at variability in cellular DMSP content across the phylogenetic diversity of coccolithophores. This revealed a remarkably consistent pattern, with all coccolithophores maintaining similar concentrations of DMSP in their cells, supporting the interpretation that it plays a key role in cellular physiology, probably as a compatible solute. The cruise-based work consisted of parallel investigation of phytoplankton populations and the DMS-DLA-DMSP system during a transect through the Mauretanian upwelling system.

References

Charlson, R., Lovelock, J., Andreae, M. & Warren, S. 1987. Oceanic phytoplankton, atmospheric sulphur, cloud albedo and climate. *Nature*, **326**: 655-661.

Keller, M.D., Bellows, W.K. & Guillard, R.R.L. 1989. Dimethyl sulphide production in marine phytoplankton. *In*: E.D. Saltzmann & W.J. Cooper (Eds). *Biogenic sulfur in the environment. ACS Symposium Series No. 393*: 167-182.

Watson, A.J. & Liss, P.S. 1998. Marine biological controls on climte via the carbon and sulphur geochemical cycles. *Philosophical Transactions of the Royal Society of London*, **B353**: 41-51.