Dimethyl sulfide production: what is the contribution of the coccolithophores?

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Summary

It is hard to find a research paper or book on coccolithophores that does not include a few sentences on the role of this fascinating and enigmatic marine phytoplankton group in the production of dimethyl sulfide ($(CH_3)_2S$; DMS). Our aim here is to provide some general background information on DMS for non-specialists, but also to highlight current knowledge and what we believe to be significant gaps, for those with a specific interest in coccolithophores, other haptophytes and DMS.

Introduction

Lovelock et al. (1972) first discovered that DMS was ubiquitous in the sea and suggested that sea-to-air emission of this compound was a key pathway in the global sulfur cycle. Marine DMS emissions are thought to account for about 23% of the sulfur entering the global atmosphere but, because anthropogenic sulfur tends to deposit rapidly and close to source, the biogenic flux contributes 42% of the atmospheric column burden (Chin and Jacob 1996). Hence DMS inputs to the atmosphere are of greatest significance in areas that are distant from anthropogenic sulfur sources (Bates et al. 1987; Savoie and Prospero 1989; Twomey 1991). Once in the air DMS oxidizes quite rapidly mainly via hydroxyl radicals during the day, nitrate radicals at night (the latter being more significant in polluted areas), and reactions with halogen oxides may also be significant (Plane 1989; Ravishankara et al. 1997; Ballesteros et al. 2002). DMS oxidation leads to the formation of a number of sulfur compounds including sulfur dioxide, sulfate, methanesulfonic acid (CH_3SO_3H; MSA), dimethylsulfoxide ($(CH_3)_2SO$; DMSO) and dimethylsulfone ($(CH_3)_2SO_2$; $DMSO_2$).

In the 1980's and early 1990's research largely focused on the contribution of natural DMS emissions to the global sulfur budget, and the wet and dry deposition

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of the acidic atmospheric oxidation products of DMS (natural 'acid rain'). However, there was a substantial shift in emphasis after Charlson et al. (1987) picked up on the earlier suggestion of Shaw (1983) and put forward the hypothesis that sulfate aerosols derived from marine DMS emissions influenced cloud albedo and global climate. A simple depiction is shown in Fig. 1. Sulfur aerosol influences climate in two ways: directly since aerosol particles scatter incoming radiation reflecting some of it back into space, and indirectly because the aerosols

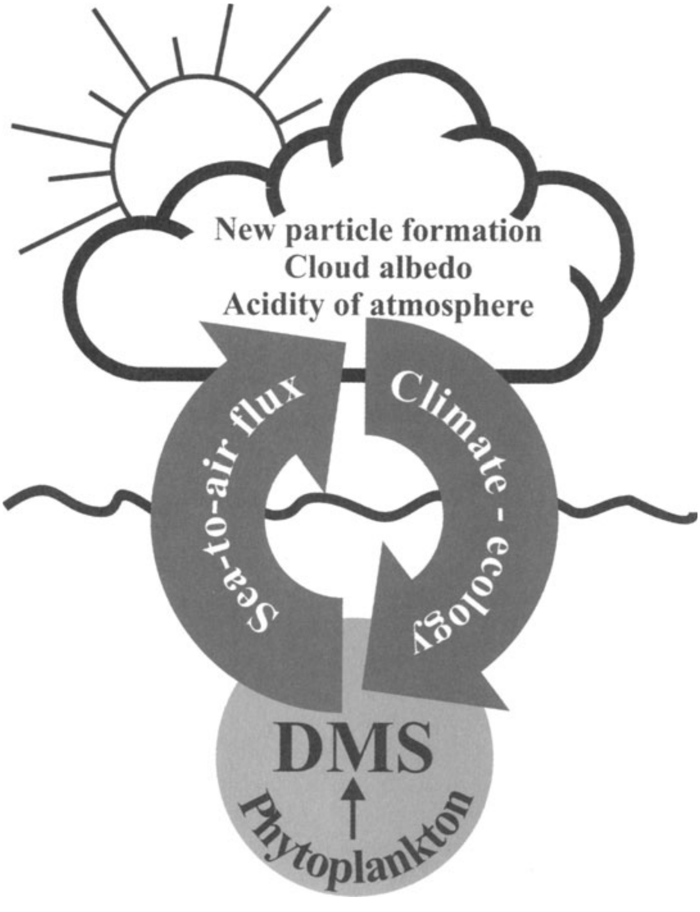

Fig. 1. Research on DMS has been stimulated by the "plankton-climate connection" hypothesis of Charlson et al. (1987). DMS derived from phytoplankton is emitted to the air and is the primary source of the sulfur particles that form in the atmosphere over the remote oceans. These acidic particles stimulate cloud formation and increase the Earth's reflectivity (albedo). In turn these processes affect climate and may also influence upper ocean ecology.