How may primary production be influenced by ocean DMS emissions: a climate modelling study of the CLAW hypothesis

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Charlson et al. (*Nature*, 1987; 326:655-661) proposed a feedback mechanism on the earth's climate involving the release of dimethylsulphide (DMS) by ocean plankton. The so-called CLAW hypothesis suggests DMS emitted from the ocean, via atmospheric chemistry producing sulphate aerosol, can alter the properties of clouds. Changes in cloud lead to changes in solar radiation and temperature at the ocean surface, producing a change in the conditions under which the plankton live and potentially feeding back to ocean production of DMS. The Hadley Centre's coupled atmosphere/ocean climate model, HadCM3, is used to simulate the DMS feedback on climate. Schemes for representing ocean DMS concentration and the atmosphere sulphur cycle are included to make these simulations possible. Ocean DMS concentrations are predicted from an empirical fit to data.In sensitivity simulations, increased DMS emissions increase cloud albedo and cloud cover though the production of sulphate aerosol from DMS. A consequence is less solar radiation penetrating beneath the cloud and the earth is cooled. There is a reaction of the ocean ecosystem to the induced changes in climate and this is the emphasis of the presentation. Phytoplankton growth in the simulations is temperature and light dependent, hence primary production is decreased in high latitudes under the cooler, 'darker' conditions experienced with increased ocean DMS emissions. Also changes to climate induced by changes in oceanic DMS emissions will impact on atmospheric dust, i.e. dust production over land, dust transport in the atmosphere and dust deposition in the ocean. A consequence is a potential further feedback mechanism, with changes in atmospheric dust deposition impacting on primary production in iron limited ecosystems. Through modelling the production, transport and deposition of atmospheric dust, dust deposition in the Southern Ocean is found to vary regionally under the different climates induced by changes in oceanic DMS emissions. Some regions experience increases in dust deposition and others decreases. This suggests any feedback to primary production through iron supply to the Southern Ocean will be complex and not have the same sign everywhere.