Enhancement of marine cloud albedo via controlled sea spray injections: a global model study of the influence of emission rates, microphysics and transport

http://www.firstlight.cn 2010-05-03

Modification of cloud albedo by controlled emission of sea spray particles into the atmosphere has been suggested as a possible geoengineering option to slow global warming. Previous global studies have imposed changes in cloud drop concentration in low level clouds to explore the radiative and climatic effects. Here, we use a global aerosol transport model to quantify how an imposed flux of sea spray particles affects the natural aerosol processes, the particle size distribution, and concentrations of cloud drops. We assume that the proposed fleet of vessels emits sea spray particles with a wind speed-dependent flux into four regions of persistent stratocumulus cloud off the western coasts of continents. The model results show that fractional changes in cloud drop number concentration (CDNC) vary substantially between the four regions because of differences in wind speed (which affects the spray efficiency of the vessels), transport and particle deposition rates, and because of variations in aerosols from natural and anthropogenic sources. Using spray emission rates comparable to those implied by previous studies we find that the predicted CDNC changes are very small (maximum 20%) and in one of the four regions even negative. The weak or negative effect is because the added particles suppress the in-cloud supersaturation and prevent existing aerosol particles from forming cloud drops. A scenario with five times higher emissions (considerably higher than previously assumed) increases CDNC on average by 45–163%, but median concentrations are still below the 375 cm−3 assumed in previous studies. An inadvertent effect of the spray emissions is that sulphur dioxide concentrations are suppressed by 1–2% in the seeded regions and sulphuric acid vapour by 64–68% due to chemical reactions on the additional salt particles. The impact of this suppression on existing aerosol is negligible in the model, but should be investigated further in the real environment so that inadvertent impacts can be excluded.

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