



Sensitivity to deliberate injections of sea salt into marine clouds - observations and model simulations

Kari Alterskjær and Jón Egill Kristjánsson

Department of Geosciences, Meteorology and Oceanography Section, University of Oslo, Oslo, Norway

Sea salt seeding of marine clouds to increase their albedo is a proposed technique to counteract or slow global warming. The objectives of this study are (i) to find areas where the global albedo is influenced the most by changes in the amount of sea salt or cloud condensation nuclei, (ii) to study whether these areas are reproduced by a leading climate model, and (iii) to study the magnitude and the location of forcing resulting from increased sea salt concentrations through simulated sensitivity experiments. The study was based both on results from a global climate model (NorESM) and on satellite observations of cloud droplet number concentration (CDNC), cloud optical depth, and liquid cloud fraction from the MODIS (Moderate Resolution Imaging Spectroradiometer) instruments.

We created a susceptibility function which is based on cloud albedo, CDNC and the solar zenith angle to map areas that are sensitive to particle number increase. The susceptibility is large for intermediate values of cloud albedo, small CDNC and low solar zenith angles. Combining this function with data on cloud fraction, we find areas where an increase in particle number should influence the global albedo the most. Results compare well between simulations and observations and show that stratocumulus regions off the west coasts of the major continents along with large regions in the Pacific and the Indian oceans are sensitive. However, the results vary significantly depending on what cloud fraction is used in combination with the susceptibility function.

The sensitivity experiments included a uniform increase of $1.0\text{e-}09 \text{ kg m}^{-2} \text{ s}^{-1}$ in the emissions of $0.13 \mu\text{m}$ radius sea salt over ocean, an increased emission rate considered plausible in recent publications. The increased sea salt concentrations and the resulting change in marine cloud properties due to aerosol-cloud interactions led to a globally averaged forcing of -5.9 Wm^{-2} at the top of the atmosphere. By comparison, a doubling of atmospheric CO_2 concentrations has a forcing of approximately 3.8 Wm^{-2} . The magnitude of the forcing from increased cloud reflectivity may therefore be sufficient to counteract global warming, depending on future greenhouse gas concentrations. The sensitivity experiments also show that the forcing is large in areas found to be sensitive by using the susceptibility function, especially in the region between 30° south and 30° north. The susceptibility function therefore seems to be a good proxy for the areas where seeding of marine clouds would have the largest impact on the global albedo.