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The role of marine organic ice nuclei in a global climate model

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Ice particle concentrations are a key parameter for cold clouds, exerting a strong influence on cloud lifetime, precipitation release, and the cloud radiative effect. The availability of ice-nucleating particles (INPs) and the temperature range in which they become activated determine the rate of ice formation in clouds (Hoose und Möhler, 2012). Particles from marine sources may contribute to ice formation in clouds, as they are abundant in the atmosphere and some of them have been found to be ice-nucleating active, but the extent of their influence on clouds is not known (Wilson et al., 2015).

Wilson et al. (2015) collected marine INPs from the sea surface microlayer and analyzed their ice nucleation efficiency with a cold stage. Even in cirrus clouds, marine INPs may play a role, as their ice nucleation surface site density as a function of RH_{ice} at -40˚C has been shown to be larger than for mineral dusts (ATD, kaolinite, and feldspar).

In this study, we test the influence of marine organic aerosols on clouds via immersion freezing with the earth system model NorESM2 (Version 2 of the Norwegian Earth System Model; Bentsen et al., 2013). The model is based on the Community Earth System Model (CESM1.2) and its atmospheric part (CAM5 Oslo) is based on the Community Atmosphere Model (CAM5.3). The parameterization of ice nucleation of marine INPs is expressed as an exponential function of temperature multiplied by the total organic content. Marine organic aerosols are part of the sea spray aerosol and are ejected during bubble bursting. INPs are associated with exudates or other macromolecules mainly from diatoms. Hence, their concentration is related to the sea salt aerosols in the model simulation.

Our first results indicate that the high marine INP concentrations at around 850 hPa occur at high latitudes. These regions have low mineral dust concentrations, which might increase the influence of marine INP on clouds. However, they do not coincide with regions of high winds and therefore large sea spray aerosol concentrations, contrary to model simulations in Wilson et al. (2015) with the global aerosol process model (GLOMAP), but are shifted further polewards. Therefore, marine INP concentrations strongly depend on temperature and do not necessarily coincide with large sea spray concentrations. At mid-latitudes, marine INP concentrations rank below dust INP by at least one order of magnitude.

Further, this presentation will describe the influence of marine INP on cloud properties and give an estimate of the cloud radiative effect of marine INP.

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