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The influence of organic-containing soil dust on ice nucleation and cloud properties

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Natural mineral dust from desert regions is known to be the most important contributor to atmospheric ice-nucleating particles (INP) which induce heterogeneous ice nucleation in mixed-phase clouds. Its ability to nucleate ice effectively is shown by various laboratory (Hoose and Möhler 2012) and field results (DeMott et al. 2015) and its abundance in ice crystal residuals has also been shown (Cziczo et al. 2013). Thus it is an important player when representing mixed-phase clouds in climate models.

MODIS satellite data indicate that $1/4$ of the global dust emission originates from semi-arid areas rather than from arid deserts (Ginoux et al. 2012). Here, organic components can mix with minerals within the soil and get into the atmosphere. These so-called 'soil dust' particles are ice-nucleating active at high sub-zero temperatures, i.e. at higher temperatures than pure desert dust (Steinke et al. 2016).

In this study, soil dust is incorporated into the Norwegian Earth System Model (NorESM, Bentsen et al. 2013) and applied to a modified ice nucleation parameterization (Steinke et al. 2016). Its influence on the cloud ice phase is evaluated by comparing a control run, where only pure desert dust is considered, and a sensitivity experiment, where a fraction of the dust emissions are classified as soil dust. Both simulations are nudged to ERA-interim meteorology and they have the same loading of dust emissions.

NorESM gives a lower annual soil dust emission flux compared to Ginoux et al. (2012), but the desert dust flux is similar to the MODIS-retrieved data. Although soil dust concentrations are much lower than desert dust, the NorESM simulations indicate that the annual INP concentrations from soil dust are on average lower by a just a factor of 4 than INP concentrations from pure desert dust. The highest soil dust INP concentrations occur at a lower height than for desert dust, i.e at warmer temperatures inside mixed-phase clouds. Furthermore, soil dust INP distributes only to a small extent towards subtropical regions, but does not expand further poleward than desert dust INP.

Due to the current setup, with simulations nudged to ERA-Interim meteorology, only small changes in the cloud variables are possible. However, the experiment still shows clear influences of soil dust INP on the cloud ice phase. Due to an increased number of ice particles in regions with $T<-15^{\circ}C$, the formation of precipitation particles is larger.

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