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Ice nuclei ability of kaolinite particles in the contact freezing mode

luis antonio ladino moreno, Olaf Stetzer, Felix Lüönd, Andre Welti, and Ulrike Lohmann
Institute for Atmospheric and Climate Science, ETH-Zurich, Zurich, Switzerland (luis.ladino@env.ethz.ch)

Contact freezing experiments were conducted with the newly developed CoLlision Ice Nucleation CHamber (CLINCH) using cloud droplets radius of 12.8 $\pm$ 0.6 μm in a laminar flow. Kaolinite is found in desert dust, and is therefore examined as a representative mineralogical compound of natural desert dust. We used size selected industrial kaolinite particles as ice nuclei with diameters of 400 nm and 800 nm. As a proof of concept study we investigated the influence of the aerosol concentration on the measured frozen fraction of droplets. Moreover, we studied the IN size relevance for contact freezing of supercooled cloud droplets. In order to distinguish between liquid droplets and ice crystals, we use a custom-made depolarization detector (Ice Optical DEtector, IODE) [Nicolet et al., 2010]. With this instrumentation we measured the frozen fraction of droplets at temperatures down to 235 K.

We could clearly distinguish between homogeneous and heterogeneous freezing experimentally. We found a threshold between these two freezing mechanisms at 238.6 K. Therefore, we found that the tested kaolinite particles act as ice nuclei above this temperature. We found that in contact mode, ice formation starts at higher temperatures (248 K) as compared to immersion freezing (243 K) for the same ice nuclei and particle size [Lüönd et al., 2010]. This temperature difference is similar to the one observed in previous wind tunnel and the cold plate experiments. At low aerosol concentrations (< 100 cm−3) contact freezing could not be observed within the measurement uncertainty. However, when the IN concentration was increased to 300-1000 cm−3, ice formation due to contact freezing increased with increasing aerosol concentration. A big advantage of our experimental setup is that we can study contact freezing for cloud droplets and atmospheric IN sizes as compared to previous studies. By controlling the aerosol concentration and particle size, which are important factors for collision efficiency, we are able to calculate the number of collisions as a function of time, temperature and relative humidity.

References

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