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Kaolinite particles as ice nuclei: learning from the use of different types of kaolinite and different coatings

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The heterogeneous ice nucleation behaviour of particles from two different sources of kaolinite (one from Fluka, one from the Clay Mineral Society (CMS, KGa-1b)) was examined. For this, we used LACIS (Leipzig Aerosol Cloud Interaction Simulator) in its immersion freezing mode (Hartmann et al., 2011), in parallel to a CFDC (Continuous Flow Diffusion Chamber, Rogers et al., 2001; DeMott et al., 2010), which measured both, immersion freezing and deposition ice nucleation. Results reported here were collected for particles with a mobility diameter of 300nm. Pure kaolinite particles were examined, as well as kaolinite particles coated with thin coatings of either sulphuric acid, levoglucosan or succinic acid.

In general, it was found that even the smallest amounts of any of the coatings strongly reduced deposition ice nucleation (Tobo et al., 2012). This was even true for coatings which did not produce a complete monolayer around the dust particles.

In the immersion freezing mode, ice nucleation rates J(het) from both, LACIS and the CFDC measurements, agreed with each other. J(het) values for pure Fluka kaolinite particles were the same as those found for Fluka kaolinite particles coated with either levoglucosan or succinic acid, i.e. the coating did not have an influence on the particles ability to nucleate ice. It can be assumed that these two types of coating did not alter the ice active dust surface chemically, and that the comparably thin coatings were diluted enough in the droplets that were formed in LACIS and the CFDC prior to the immersion freezing so that freezing point depression did not play a major role.

However, Fluka kaolinite particles which were coated with either pure sulphuric acid or which were first coated with the acid and then exposed to additional water vapour both showed a reduced ability to nucleate ice, compared to the pure particles in the immersion mode.
Interestingly, for the CMS kaolinite particles, the ability to nucleate ice in the immersion freezing mode was similar for all examined particles, i.e. for the pure ones and the ones with the different types of coating. Moreover, J(het) derived for the CMS kaolinite particles was similar to J(het) derived for kaolinite particles coated with sulphuric acid. This is suggestive for the Fluka kaolinite possessing a type of ice nucleating surface feature which is not present on the CMS kaolinite, and which can be destroyed by reaction with sulphuric acid.

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