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Immersion Freezing of Potassium-feldspar and related Natural Samples

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Ice nucleation activities of mineral dust particles were investigated. The experiments were carried out using cryo-microscopy which is an oil-emulsion based method. The immersion freezing mode was addressed with this experimental setup. The studied samples were common inorganic atmospheric aerosols. Single minerals and natural samples were tested [1].

Mineral dust particles are active ice nuclei in the immersion freezing mode up to 256 K. Only recently potassium-feldspar has been identified as the by far most active ice nucleus followed by other silicates [2, 3]. Natural samples which contain more than 5% K-feldspar are also active. The activity of K-feldspar can be attributed to its surface structure and the presence of potassium ions in the surface. Ice nucleation on mineral dust particles takes place at certain nucleation sites. These sites are domains of molecular sites where water is stabilized in an ice-like structure. To form a good ice nucleation site, the site density of molecular sites needs to be high. More molecular sites are able to form larger domains on the surface, leading to better nucleation sites. This suggests further that the nucleation temperature of mineral dust particles scales with the surface area. The exact configuration of a molecular site is material specific and influenced by the local chemistry and structure of the dust particle surface. A favourable arrangement of the functional groups like surface hydroxyl and oxygen is proposed for the K-feldspar. Potassium ions seem to have a positive or neutral effect on the ice nucleation property of a silicate surface while cations with a higher charge density like calcium and sodium have a negative influence. K-feldspar is abundant in the environment and actually is the most important dust ice nucleus in the atmosphere. The nucleation temperatures of the K-feldspar particles are sufficient to enable further meteorological glaciation processes in high altitude clouds.

References

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