

Spectroscopic investigations on organic compounds in desert dust particles.

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Mineral dust particles are the most abundant ice nucleating particles (INPs) found in the atmosphere. Their mineralogical composition in part dictate if they can act as strong INPs or not. Certain minerals such as microcline show an exceptionally strong ice nucleating potential, yet its presence in a desert dust particle alone does not seem to be the determining factor for ice nucleation. In a mixed phase particle, strong ice nucleating minerals may not come to their full potential due to chemical and mechanical aging that can inactivate their nucleation sites or due to an interference with compounds that coat the particles, yet only contribute very little to its overall mass. Carbonic acids, for example, are well known to hinder ice nucleation to a certain extent and other compounds may simply be able to shield, or react with the surface in a way that antagonizes the nucleation active sites. What kind of surface chemicals could be present on dust particles can vary highly depending on the source of the particle but also on the atmospheric conditions it encounters during transport.

In this study, we investigate how mineralogy, crystal water, and heat labile organic compounds on dust particles affect the ice nucleating behavior of desert dust collected from the soil or after atmospheric transport. Before and after heating three dust samples to 573 K, we measured their ice active surface site density (ns) in the deposition and condensation mode and used X-ray diffraction (XRD), and Raman- and Infrared- spectroscopy to search for the cause of observed differences in ns. Infrared spectroscopy was conducted on the bulk material and Raman spectroscopy on single particles by means of micro-Raman mapping of impacted dust. Indications for heat labile organic compounds were found in two samples as well as indications for soot. However, also the inorganic composition in the form of crystal water – and its subsequent change in mineralogic composition due to its loss – seems to play a role for one sample. While the ns of this sample increased after heating, in a second sample the release of heat labile organic compounds led to suppression of the ice nucleation ability. Our study shows that apart from mineralogy, other factors such as organics and crystal water can alter the ice nucleation behavior of desert dust during atmospheric transport in various ways.