Geophysical Research Abstracts
Vol. 19, EGU2017-16805, 2017
EGU General Assembly 2017

Ice nucleation of natural desert dust including organics sourced from nine deserts worldwide

Yvonne Boose (1,2), André Welti (1,3), James Atkinson (1), Anja Danielczok (4), Heinz Bingemer (4), Michael Plötze (5), Ulrike Lohmann (1), and Zamin A. Kanji (1)

(1) ETH Zürich, Institute for Atmospheric and Climate Science, Zürich, Switzerland, (2) now at Karlsruhe Institute of Technology, IMK-IFU, Garmisch-Partenkirchen, Germany, (3) now at: Leibniz Institute for Tropospheric Research, Leipzig, Germany, (4) J. W. Goethe-University, Institute for Atmospheric and Environmental Sciences, Frankfurt am Main, Germany, (5) ETH Zürich, Institute for Geotechnical Engineering, Zürich, Switzerland

The extraordinary high ice nucleation (IN) potential of microcline, a K-feldspar mineral, at temperatures (T) above 248 and up to 271 K has been show recently. However, it is unclear if microcline is also found at the surface of airborne mineral dust particles or if chemical and mechanical aging processes lead to its destruction or shielding and thus reduced IN ability in the atmosphere. It is suggested that instead organic material mixed with inorganic minerals is responsible for cloud glaciation at T $\geq$ 253 K.
We collected airborne Saharan dust at 4 locations at different distances from the desert and 11 samples from the surface of 9 of the major deserts worldwide. We studied immersion IN on these samples between 235 - 263 K using the IMCA-ZINC (immersion mode cooling chamber - Zurich ice nucleation chamber) setup and the FRIDGE (Franfurt Ice Nuclei Deposition Freezing Experiment) instrument run in droplet freezing mode. By correlating the results with the bulk mineralogy of the dust samples, determined by X-ray diffraction analysis, we show that at 253 K, K-feldspar indeed predicts best the IN behavior of the samples. At lower T (238 - 245 K) however, quartz and the total feldspar contents correlate best. Furthermore, microcline is only found in one of the airborne Saharan dust samples (3.9 wt%) while in the others the amount is below the detection limit or completely absent.
Relative humidity (RH) scans at constant T = 238, 240 and 242 K were additionally performed with the portable ice nucleation counter, PINC. Above and below water saturation a similar prominent role of quartz is found as in the immersion mode. To investigate the role of organic material on the IN ability, we heated some of the samples at 573 K for 10 h and repeated the RH-scans. Furthermore, we performed thermogravimetric analysis of the dusts. The two tested airborne Saharan samples loose between 2.8 and 7.5 % of their mass at T $\leq$ 573 K, partly due to water release, partly due to evaporating organic material. Interestingly, the sample with the highest mass loss shows an increase in IN ability at subsaturated conditions, while one sample completely loses its ice nucleation ability after heating but only loses 2 % of its mass at T $\leq$ 573 K. The most IN active samples, all surface-collected, show no significant mass loss, i.e. a low organic content is expected, and also no change in ice nucleation activity after heating.
The results suggest that airborne desert dust can contain a significant amount of organic material which is released during heating to 573 K. This organic material, however, seems to be diverse in nature and in the sign of its effects on the ice nucleation ability: in one case it seems to have inhibited the ice nucleation ability of the dust while in another it substantially improved it.