Geophysical Research Abstracts
Vol. 15, EGU2013-7684, 2013
EGU General Assembly 2013

Influence of soluble material on immersion freezing of mineral dust

André Welti (1), Zamin A. Kanji (1,2), Olaf Stetzer (1), and Ulrike Lohmann (1)

(1) Institute for Atmospheric and Climate Science, ETH, 8093 Zürich, Switzerland (andre.welti@env.ethz.ch), (2) now at Air Quality Research Division, Environment Canada, 4905 Dufferin St., Toronto, ON

The effect of soluble substances present on the surface of mineral dust particles on their ice nucleation ability in the immersion mode is examined. Often mineral dust particles contain various soluble components (Herich et al., 2009) or are contaminated by e.g. sea spray (Buseck and Posfai, 1999). It has been proposed that the effect of the solute could be due to surface modifications of the mineral dust particles in the early stage of droplet condensation when the concentration of the solution is highest.
Previous experiments on the influence of the soluble compounds lead to contradictory results. Hoffer (1961) suggested that the heterogeneous freezing temperature of droplets containing illite, kaolinite or montmorillonite particles is not affected by small salt concentrations. For increasing salt concentrations progressively lower freezing temperatures were reported. The opposite effect was found by Reischel and Vali (1975) who reported up to 4K higher freezing temperatures for droplets containing $(NH_4)_2SO_4$ and NaCl in concentrations, Hoffer (1961) would have considered as high.
We present a comparison of immersion freezing measurements of singly immersed size selected mineral dust particles from not washed and thoroughly washed samples of ATD and illite. The washing procedure reduced the soluble content of the samples by a factor up to 25. We find a systematic decrease in the frozen fraction of droplets containing washed particles, which corroborate the trend found by Reischel and Vali (1975). The effect is most pronounced for large particle sizes and depends on the dust species. We interpret this dependence as a size and species dependent abundance of soluble material. Finally we propose several mechanisms how the soluble compounds could influence ice nucleation on dust particles.

References:

Buseck, P. and Posfai, M.: Airborne minerals and related aerosol particles: Effects on climate and the environment, Proc. Nat. Acad. Sci., 96, 3372 – 3379, 1999.
Herich, H., Tritscher, T., Wiacek, A., Gysel, M., Weingartner, E., Lohmann, U., Baltensperger, U., and Cziczo, D. J.: Water uptake of clay and desert dust aerosol particles at sub- and supersaturated water vapor conditions, Phys. Chem. Chem. Phys., 11, 7804 – 7809, 2009.
Hoffer, T. E.: A Laboratory Investigation of Droplet Freezing, J. Meteo., 18, 766–778, 1961.
Reischel, M. and Vali, G.: Freezing nucleation in aqueous electrolytes, Tellus, 27 (4), 414 – 427, 1975.