Geophysical Research Abstracts
Vol. 16, EGU2014-5707, 2014
EGU General Assembly 2014

Immersion freezing by SnomaxTM particles: Comparison of results from different instruments

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Within the DFG funded research unit INUIT (Ice Nucleation research UnIT, FOR 1525), an effort was made to compare results on immersion freezing from a suite of different instruments. Besides mineral dusts, SnomaxTM was picked as one of the substances that were examined by all participating groups. Here, the comparison of the results for SnomaxTM is presented. Every participating group used SnomaxTM from the same batch and, as far as possible, the same particle generation set-up.
Instruments participating in the comparison were, in alphabetical order, an acoustic levitator (Diehl et al., 2009), AIDA (Connolly et al., 2009), BINARY (Budke et al., 2013), FINCH (Bundke et al., 2008), LACIS (Hartmann et al., 2011), PINC (Chou et al., 2011) and the Mainz vertical windtunnel (Diehl et al., 2011). Some of the instruments examined droplets directly produced from SnomaxTM suspensions, where the suspensions could have a wide range of concentrations. Other instruments used size segregated particles which were generated via atomization from a SnomaxTM suspension and subsequent drying, followed by size selection with a DMA (Differential Mobility Analyzer). These particles were then activated to droplets and cooled subsequently. For these, the number of ice nucleation active protein complexes present in the droplets depended on the original particle size (for details see e.g. Hartmann et al., 2013). Also, the different measurements spanned a range of different time scales. The shortest residence time of roughly 1 second was used for LACIS measurements, and the longest one was about 6 seconds used in the BINARY setup with a cooling rate of 1 K/min.
All data were evaluated using two different approaches: 1) a time dependent approach following Classical Nucleation Theory which included the use of a contact angle distribution (see Niedermeier et al., 2014); 2) a singular approach using an active site density per mass (see Vali, 1971, Murray et al., 2012). Both approaches were found to work equally well, hence freezing by SnomaxTM can be considered to show no time dependence. Particularly data from LACIS and BINARY, i.e. from the “fastest” and “slowest” measurements, were found to agree very well.

Acknowledgement: This work was done within the framework of the DFG funded Ice Nucleation research UnIT (INUIT, FOR 1525).

Literature

Budke et al. (2013), Investigation of Heterogeneous Ice Nucleation Using a Novel Optical Freezing Array, AIP Conference Proceedings, 1527, 949-951, doi: 10.1064/1.4803429.
Bundke et al. (2008), The fast Ice Nucleus chamber FINCH, Atmos. Res. 90, 180-186.
Chou et al. (2011), Ice nuclei properties within a Saharan dust event at the Jungfraujoch in the Swiss Alps, Atmos. Chem. Phys., 11, 4725-4738.
Connolly, et al. (2009), Studies of heterogeneous freezing by three different desert dust samples, Atmos. Chem. Phys., 9, 2805-2824.
Diehl et al. (2011), The Mainz vertical wind tunnel facility: A review of 25 years of laboratory experiments on cloud physics and chemistry. In: J.D. Pereira (Ed.), Wind tunnels: Aerodynamics, models, and experiments. Nova Science Publishers, Inc., Chapter 2.
Diehl et al. (2009), Homogeneous freezing of single sulfuric and nitric acid solution drops levitated in an acoustic trap, Atm. Res., 94, 356-361, doi:10.1016/j.atmosres.2009.06.001.
Hartmann et al. (2011), Homogeneous and heterogeneous ice nucleation at LACIS: Operating principle and

theoretical studies, Atmos. Chem. Phys., 11, 1753–1767.
Hartmann et al. (2013), Immersion freezing of ice nucleating active protein complexes, Atmos. Chem. Phys., 13, 5751-5766.
Murray et al. (2012), Ice nucleation by particles immersed in supercooled cloud droplets, Chem. Soc. Rev., 41, 6519-6554.
Niedermeier et al. (2014), A computationally-efficient description of heterogeneous freezing: A simplified version of the Soccer ball model, Geophys. Res. Lett., 10.1002/2013GL058684.
Vali, G. (1971), Quantitative evaluation of experimental results on heterogeneous freezing nucleation of supercooled liquids, J. Atmos. Sci., 28(3), 402-409.