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Studies of ice nuclei at the Leipzig Aerosol Cloud Interaction Simulator and their implications

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Ice containing clouds permanently cover 40% of the earth's surface. Ice formation processes have a large impact on the formation of precipitation, cloud radiative properties, cloud electrification and hence influence both, weather and climate. Our understanding of the physical and chemical processes underlying ice formation is limited. However what we know is that the two main pathways of atmospheric ice formation are homogeneous and heterogeneous ice nucleation. The latter involves aerosol particles that act as ice nuclei inducing cloud droplet freezing at temperatures significantly above the homogeneous freezing threshold temperature. Particles acting as IN are e.g. dust particles, but also biological particles like bacteria, pollen and fungal spores. Different heterogeneous freezing mechanisms do exit, with their relative importance for atmospheric clouds still being debated. However, there are strong indications that immersion freezing is the most important mechanism when considering mixed phase clouds.

What we are still lacking is a) the fundamental process understanding on how aerosol particles induce ice nucleation and b) means to quantify ice nucleation in atmospheric models. Concerning a) there most likely is not only one answer, considering the variety of IN found in the atmosphere. With respect to b) different approaches based on either the stochastic or singular hypotheses have been suggested. However it is still being debated which would be a suitable way to parameterize laboratory data for use in atmospheric modeling.

In this presentation, both topics will be addressed. Using the Leipzig Aerosol Cloud Interaction Simulator (LACIS) (Hartmann et al., 2011), we examined different types of dust particles with and without coating, and biological particles such as bacteria and pollen, with respect to their immersion freezing behaviour. We will summarize our findings concerning the properties controlling the ice nucleation behaviour of these particles and present means for parameterizing their respective ice nucleation behaviour.

We will summarize our findings concerning the properties (surface area, concentrations of INA proteins, or macro molecules) controlling the ice nucleation behaviour of these particles and present means (nucleation rates, soccer ball model) for parameterizing their respective ice nucleation behaviour.

References:
Hartmann, S., D. Niedermeier, J. Voigtländer, T. Clauss, R. A. Shaw, H. Wex, A. Kiselev, and F. Stratmann (2011), Homogeneous and heterogeneous ice nucleation at LACIS: Operating principle and theoretical studies, Atmos. Chem. Phys., 11, 1753–1767.