Geophysical Research Abstracts
Vol. 16, EGU2014-3128, 2014
EGU General Assembly 2014

Laboratory measurements of contact freezing by dust and bacteria at temperatures of mixed phase clouds

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Contact nucleation of ice is thought to play a significant role in the atmosphere where the freezing of water droplets remains one of the biggest uncertainties in current models of the atmosphere. Contact freezing efficiencies for various atmospherically relevant aerosols are reported for the temperature range 0 to -20 °C. The results are discussed in the context of mixed phase clouds, and we find that dry, micron sized dust aerosols can have substantive impact on warm temperature nucleation. Bacteria has the potential to be even more effective. Samples of Pseudomonas syringae and Pseudomonas fluorescens had widely varying freezing behavior. Nucleation threshholds cannot be easily predicted by the gene markers ice-positive or ice-negative as was done in past years for immersion freezing. In all cases the contact mode dominates the immersion mode freezing.

For Arizona Test Dust, feldspar, or rhyolitic ash, more than $10^3(10^5)$ particles sized between 0.3um - 10.0um are required to initiate a freezing event at -20 °C (-15 °C) in the contact mode. An ice negative strain of Pseudomonas fluorescens is an order of magnitude more effective than the mineral dusts at every temperature tested. We find that an ice positive strain of Pseudomonas syringae reaches its maximum nucleating efficiency of 0.1 twelve degrees earlier than does the Pseudomonas fluorescens, similar to the behavior of ice negative and positive bacteria in the immersion mode, as discovered 40 years ago [Maki et al., 1974; Vali et al., 1976]. Surprisingly, cells of the ice positive strain (CC94) Pseudomonas syringae which did not express the ice+ gene, showed no contact freezing activity, whereas the ice- strain of Pseudomonas fluorescens did.