4.150 Characterization of individual ice nucleating particles by the single droplet freezing method.

Early Career Scientist

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Abstract:

Ice nucleation in clouds substantially affects the climate by having a significant impact on the radiation balance and precipitation process. Although the physical and chemical properties of ice nuclei play an essential role in the formation of ice crystals, a considerable uncertainty still exists as to the response of ice nucleation processes to the changes in the aerosol properties.

In order to better characterize ice nucleating (IN) atmospheric particles, we investigated the chemical composition, mixing state, and morphology of individual particles that nucleate ice under conditions relevant for mixed phase clouds. Standard mineral dust samples were compared with actual aerosol particles collected at Kanazawa City, Japan during Asian dust events in February and April 2016. Following droplet activation by particles deposited on substrate under supersaturated air, individual IN particles were located using an optical microscope by cooling the temperature to -30 °C. Then, both the IN particles and non-active particles were analyzed by Atomic Force Microscopy, micro-Raman spectroscopy, and Scanning Electron Microscopy coupled with Energy Dispersive X-ray spectroscopy.

The results showed that, most of the IN particles formed ice below -28 °C, but lower than the freezing temperatures of standard mineral dust samples of pure components. These IN particles were predominantly irregular solid particles that showed clay mineral characteristics (or mixtures of several mineral components). Moreover, sea salt particles were predominantly found in the non-active fraction, and internal mixing with sea salt clearly acted as a significant inhibiting agent for the ice nucleation activity of mineral dust particles. In this study, we demonstrated the capability of the combined single droplet freezing method and thorough individual particle analysis to characterize the IN particles. We also found that dramatic changes in the particle mixing states during long-range transport had a complex effect on the ice nucleation activity of the host aerosol particles.