4.035 Can Viscous Liquids Provide Flexible Templates for Atmospheric Ice Nucleation? .

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Abstract:

Formation of water ice in the atmosphere is often facilitated by a solid compound which acts as a template catalyzing ice nucleation at warmer temperatures than otherwise possible. While poorly understood, the efficiency of organic aerosols to catalyze nucleation events has been observed to vary with a number of properties including particle size, chemical structure, oxidation state, and as we have recently discovered, aerosol phase. A wide range of solid organic aerosols, including soot, polycyclic aromatic hydrocarbons long chain organics, soot, and even cellulose can act as ice nucleating particles (INP). Surprisingly, we have recently observed that certain viscous liquid are also efficient INP. In this study, we use an optical ice microscope apparatus equipped with a sealed cooling stage and CCD camera to examine contact freezing events between a droplet and organic hydrocarbons, in their fresh and oxidized forms. Samples are exposed to ozone to represent atmospheric oxidative aging. Fresh and oxidized samples are characterized using two methods, Fourier Transfer Infrared Spectroscopy with Horizontal Attenuated Total Reflectance (FTIR-HATR) and Raman Microspectroscopy. For the liquids included in this study, squalane and squalene, the temperature dependence of the viscosity was measured. Our results demonstrate that viscous liquids are effective catalyze ice nucleation at temperatures comparable to octacosane, and at temperatures only slightly colder than the aromatic compounds studied. The observed behavior is consistent with a flexible template molecular model of ice nucleation events. The atmospheric implications of our results are highly significant since they imply that a wide range of previously ignored organic aerosols may catalyze ice nucleation in the atmosphere provided they exhibit adequately high viscosities at ice freezing temperatures. Further measurements are needed to understand the role of viscosity in catalyzing heterogeneous nucleation.