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Laboratory studies of ice formation: cubic ice and heterogeneous nucleation of ice on soot

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Under atmospheric conditions both cubic ice (ice Ic) and hexagonal ice (ice Ih) can be obtained. However, it is almost always assumed that ice Ih, the thermodynamically stable phase, is the only polymorph that forms under atmospheric conditions. Recently, we carried out a set of experiments where aqueous solution droplets were homogeneously frozen, and the crystalline phase that precipitated was determined with X-ray diffraction. The results from this study show that at temperatures less than 200 K the droplets crystallize as the metastable phase of ice, ice Ic. As pointed by Murphy [Geophysical Research Letters, 2003] the transient presence of ice Ic in the upper troposphere may result in ice clouds with larger ice crystals that have a greater sedimentation velocity, thus enhancing dehydration of the upper troposphere. We have also investigated in detail the formation and stability of cubic ice in pure water droplets. Our results show that as the size of the water droplets decreased from 17.0 microns to 5.6 microns, the formation of cubic ice was favored. Our results are consistent with previous suggestions that cubic ice is the crystalline phase that nucleates when pure water droplets freeze homogeneously at $\sim$235 K. In the stability measurements, we observe cubic ice up to 243 K, much higher in temperature than observed in many of the previous studies.

Heterogeneous ice nucleation on several soot types were also investigated between 258 K and 243 K, which is in the region important for the lower troposphere. In these experiments we focus on deposition freezing, which refers to water vapor adsorbing onto a solid surface and transforming into ice. Soot particles were found to be poor ice nuclei over this temperature range and below water saturation. Based on our measurements, we concluded that soot particles are most likely not an important ice nuclei in the Earth's atmosphere (unless the soot particle concentration is extremely high) at temperatures above 238 K and in the deposition mode. The combined results will be

presented and discussed.