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FTIR spectroscopic studies of the simultaneous condensation of HCl and H2O at 190 K – Atmospheric applications

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Abstract. Type II polar stratospheric cloud particles are made up of ice that forms by water vapor condensation in the presence of numerous trace gases, including HCl. These gaseous species can co-condense with water molecules and perturb ice structure and reactivity. In order to investigate the effect of co-condensing dopants on the structure of ice, we have designed an experimental system where ice films can be stabilized at 190 K, a temperature relevant to the polar stratosphere. We have co-condensed different HCl:H_2O gaseous mixtures, with ratios 5:1, 1:10, 1:50 and 1:200 and studied the solids formed by infrared spectroscopy. The IR spectra obtained show that: (1) HCl is likely undergoing ionic dissociation when it is incorporated by co-condensation into the ice at 190 K; (2) this dissociation is done by several water molecules per HCl molecule; and (3) significant differences between our spectra and those of crystalline solids were always detected, and indicated that in all cases the structure of our solids retained some disorganized character. Considering the major impact of HCl on ice structure observed here, and the well known impact of the structure of solids on their reactivity, we conclude that the actual reactivity of stratospheric ice particles, that catalyze reactions involved in ozone depletion, may be different from what has been measured in laboratory experiments that used pure ice.

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