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Hunting liquid micro-pockets in snow and ice: Phase transition in salt solutions at the bulk and interface with X-ray photoelectron spectroscopy.

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Sea salt, and in particular chloride, is an important reactant in the atmosphere. Chloride in air-borne sea salt aerosol is – once chemically converted to a molecular halogen (Cl2, BrCl) and released to the atmosphere – well known as important atmospheric reactant, driving large-scale changes to the atmospheric composition and in particular to ozone levels in remote areas, but also in coastal mega cities. Similar chemistry has been proposed for sea salt deposits in polar snow covers. A crucial factor determining the overall reactivity is the local physical environment of the chloride ion. For example, the reactivity of liquid aerosols decreases significantly upon crystallization. Surprisingly, the phases of NaCl-containing systems are still under debate, partially due to the limited availability of in situ measurements directly probing the local environment at the surface of frozen NaCl-water binary systems.

Using core electron spectroscopy of the oxygen atoms in water, we previously showed that these systems follow the phase rules at the air-ice interface. This finding contrasts some earlier observations, where the presence of liquid below the eutectic point of bulk solutions was postulated. In the present study, we present new electron yield near-edge X-ray absorption fine structure spectroscopy (NEXAFS) data obtained at near-ambient pressures up to 20 mbar of NaCl frozen solutions. The method is sensitive to small changes in the local environment of the chlorine atom. The measurements were performed at the PHOENIX beamline at SLS. The study indicates frapant differences in the phases of NaCl - water mixtures at temperatures blow the freezing point for the surface of the ice vs. the bulk. This has significant impact on modelling chemical reactions in snow or ice and it's environmental consequences.