The hydrogen bonding structure of adsorbed water on silver iodide and Feldspar minerals

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The hydrogen bonding structure of adsorbed water on a solid substrate may control deposition nucleation, which is a pathway of heterogeneous ice nucleation. Hydrogen bonding of water molecules is also controlling the interface between the solid and liquid water relevant for other heterogeneous freezing modes. The hydrogen bonding structure may be affected by short and long-range interactions between the substrate and the water molecules nearby. Electron yield near edge X-ray absorption fine structure (NEXAFS) spectroscopy at the oxygen K-edge is used to experimentally explore the difference between the hydrogen bonding structure of interfacial H₂O molecules under different conditions of temperature and water vapor pressure. Experiments reported in this work were performed at the in-situ electron spectroscopy endstation at the ISS beamline at the Swiss Light Source (PSI, SLS). We report electron yield oxygen K-edge NEXAFS spectra and X-ray photoelectron spectra from silver iodide (AgI) particles and milled feldspar samples exposed to water vapor at high relative humidity, but subsaturated with respect to ice. AgI serves as a well-studied reference case; and it contains no oxygen in its lattice, which simplifies the analysis of NEXAFS spectra at the O K-edge. The feldspar samples include a potassium containing microcline and a sodium-rich albite. The analysis of the NEXAFS spectra indicate rather tetrahedrally coordinated adsorbed water molecules on AgI particles. On the feldspars, the mobility of ions, as directly observed by the XPS spectra appears to have a strong impact on the hydrogen bonding structure, as apparent from substantial differences between samples previously immersed in pure water or as prepared. To sum up, we attempt to understand the behavior of the hydrogen bonding structure, which provides rich information about the arrangement of water molecules in the vicinity of a solid surface, that is linked to the ability of the solid to induce ice formation.