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Adsorption of trace gases to ice surfaces: surface, bulk and co-adsorbate effects

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Atmospheric ices frequently interact with trace gases and aerosol making them an important storage, transport or reaction medium in the global ecosystem. Further, this also alters the physical properties of the ice particles with potential consequences for the global irradiation balance and for the relative humidity of surrounding air masses.

We present recent results from a set of laboratory experiments of atmospheric relevance to investigate the nature of the uptake processes. The focus of this talk will be placed on the partitioning of acidic acid and nitrous acid on ice surfaces.The presented results span from very simple reversible adsorption experiments of a single trace gas onto ice surfaces to more complex, but well controlled, experimental procedures that successfully allowed us to

- Disentangle surface adsorption and uptake into the ice matrix using radioactive labelled trace gases.

- Show that simultaneous adsorption of acetic acid and nitrous acid to an ice surface is consistent with the Langmuir co-adsorption model.

The experiments were done in a packed ice bed flow tube at atmospheric pressure and at temperatures between 213 and 253 K. The HONO gas phase mixing ratio was between 0.4 and 137 ppbv, the mixing ratio of acetic acid between 5 and 160 ppbv . The use of the radioactive labelled nitrous acid molecules for these experiments enabled in situ monitoring of the migration of trace gas in the flow tube. The measurements showed that the interactions do not only occur through adsorption but also via diffusion into polycrystalline ice. A method is suggested to disentangle the bulk and the surface processes. The co-adsorption of acetic and nitrous acids was also investigated. The measurements are well reproduced by a competitive Langmuir adsorption model.