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Photo-enhanced reductions in ice by organic matter

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Photolysis reactions at the Earth's snow cover are a current focus of research, because of their ability to modify the composition of the overlaying air and to alter the fate of trace compounds within the snow pack. Emissions of nitrogen oxides, halogens, and elemental mercury or of some volatile organics have been linked to such photolysis reactions, to name only a few examples.

In this context, we will present new results on two different light-driven reductions of atmospheric trace species on ice surfaces in the presence of organic matter. Earlier, we have shown that photochemical reactions are enhanced on surfaces of pure organics. One example is the photosensitized reaction of NO2 to HONO with humic acid in the visible range of the solar spectrum.
The number of measurements of organics in snow is limited, but one might expect that these are ubiquitous and present at significant concentrations. Here we will show the influence of such organic dopants in ice, i.e. at low concentration, on light-driven reduction of two trace species relevant for atmospheric science - of the atmospheric trace gas NO2 and of divalent mercury contained in snow.

We will start with the discussion of the photosensitized reduction of NO2 in the visible range of the solar spectrum, which is of atmospheric importance as the product, HONO, impacts the oxidative capacity of the atmosphere, i.e. the air quality. The results of recent experiments, at low humic acid content, are compared to earlier experiments on pure humic acid films and on humic acid aerosol.
Also, ongoing experiments on the enhancement of the photolytic reduction of divalent mercury in an ice matrix by the presence of UV light and humic acid are shown. The importance of such a conversion to elemental mercury lies in the subsequent removal of mercury from the snow to the atmosphere. This transfer might thus reduce the amount of toxic mercury captured in the snow that will enter the aquatic system and the food web during snowmelt. Also, better knowledge of this loss process is important for paleoclimate research, e.g. for interpreting mercury profiles in ice cores.

Focusing on the most recent results, some general conclusions on the importance of and the mechanism of light-driven reactions in ice and snow in the presence of organic matter will be highlighted.