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Modeling of photochemical reactions in surface snow: Comparison with field measurements obtained during the OASIS spring campaign 2009 at Barrow, AK

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The boundary layer composition in polar or snow covered regions is strongly affected by physical and chemical processes, which take place in the surface snow. Photolysis reactions initiated by solar radiation are particularly important. Among the reactive chemical species present in snow, nitrate can be ubiquitously found and is known to be photolyzed to produce nitrogen oxides, which are subsequently released to the overlying atmosphere. We developed a reaction mechanism for N-containing species in snow to describe the transformation of nitrate to NOx. Laboratory experiments using artificial snow were used to constrain a box model including the snow nitrate chemistry. This allowed to identify major reactions occurring after the photolysis of nitrate as an initial step. The mechanism was further extended to include reactions of hydrogen peroxide and formaldehyde. Finally, the box model was applied to investigate the surface snow chemistry in a natural, polar environment. The model was compared to results obtained in a 36-hour experiment carried out during the OASIS spring campaign 2009 at Barrow, AK. During this period, surface snow samples were collected every 2 hours in order to monitor the concentration evolution of the major reactive species in the snow. The samples were analyzed for compounds like nitrate, nitrite, formaldehyde, hydrogen peroxide, and further non-reactive sea salt components. Moreover, photolysis rates of nitrate, nitrite, and hydrogen peroxide in the snow were calculated based on measurements of in-snow spectral irradiance at different depths within the snow. The box model for snow chemistry was applied to this data set and used to elucidate the role of the various (photo)chemical reactions in the overall budgets of the measured species. Moreover, the effect of the chemical and physical processes on the composition of snow and the exchange of reactive compounds between the surface snow and the atmospheric boundary layer will be presented.