Measurements and Modeling of Atmosphere-Snowpack Exchange of Ozone and Nitrogen Oxides at Summit, Greenland

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Snowpack is a reservoir for reactive nitrogen gases. Nitrogen oxides (NOx) are generated in the interstitial air of sunlit snowpack through photolysis of nitrate (NO3) in snow. Ozone (O3) scavenged by snowpack might react with nitrite (NO2) in snow and represent an additional source of NOx in interstitial air. Gradients in NOx mixing ratios between snowpack interstitial air and the Arctic boundary layer regulate transfer of NOx to/from snowpack and affect the O3 budget and climate at high latitude. We collected meteorological and chemical data at Summit, Greenland to investigate production of NOx in snowpack over glacial ice. Semi-continuous measurements of NO, NO2, and O3 mixing ratios were made at several depths in snowpack interstitial air and at 2 levels above the snow surface. A one-dimensional, process-scale model of atmosphere-snowpack exchange was developed to simulate profiles of NOx and O3 in the Arctic boundary layer and in snowpack interstitial air. The model includes detailed representations of snowpack chemical and physical processes and the physical and chemical dynamics of the overlying atmosphere that drive atmosphere-snowpack exchange. A more highly parameterized version of the process-scale model is incorporated into a global-scale model to assess impacts of cryosphere-atmosphere exchange on the Arctic O3 budget.

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