Geophysical Research Abstracts
Vol. 12, EGU2010-9219, 2010
EGU General Assembly 2010

Atmospheric nitrogen oxides (NO and NO_2) at Dome C: first observations and implications for reactive nitrogen cycling above the East Antarctic Ice Sheet

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The nitrogen oxides NO and NO_2 (NO_x) play a key role in determining the oxidizing capacity of the boundary layer in high latitudes. This influence is achieved via the photolysis of NO_2 – the only source for in situ production of tropospheric ozone (O_3) – and through shifting HO_x radical partitioning towards the hydroxyl radical (OH) via the reaction NO + HO_2 $\rightarrow$ OH + NO_2. Previous field campaigns in the Arctic and Antarctic have demonstrated that the polar snow pack can release significant emissions of NO_x and that one of the major driving mechanisms is UV-photolysis of snow nitrate (NO_3^-). Unusually high levels of NO observed at South Pole and on an airborne campaign suggested that the East Antarctic Ice Sheet (EAIS) can be perceived as a gigantic chemical reactor, processing many chemical trace species at the surface and thereby modifying their concentration eventually preserved in ice cores. However, the database for a quantitative understanding of reactive nitrogen recycling across Antarctica is still weak.

Here, we present first measurements of atmospheric NO_x mixing ratios and fluxes at Dome C (DC), East Antarctica (75.1ºS 123.3ºE, 3233 m) during austral summer 2009/2010. As seen previously, NO mixing ratios were highly perturbed, ranging between 10 pptv and >600 pptv, but unlike at South Pole showed a strong diurnal variability. Concentration maxima occurring in the evening hours coincided with the strongest gradients between the snow surface and 4.0 m, highlighting the importance of the interplay between snow pack source strength and the evolution of boundary layer depth. Conversely, surface-near firn air levels of NO_x varied in phase with solar radiation, consistent with a photolytic source in the surface-near snow. Observed NO_x emissions were compared to calculations based on NO_3^- concentration profiles and e-folding depths of actinic flux measured in the upper snowpack.

Contrary to South Pole, surface observations at DC are thought to be more representative for the wider East Antarctic plateau region and are discussed as a significant step towards the parameterization of NO_x emissions in a quantitative model of reactive nitrogen recycling above Antarctica.