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1D Chemical Modeling of coupled snow-atmosphere chemistry at Dome C Antarctica

Jaime E. Gil (1), Jennie Thomas (1), Roland von Glasgow (2), Slimane Bekki (1), Alexandre Kukui (1), Markus Frey (3), Bruno Jourdain (4), Michel Kerbrat (4), Christophe Genthon (4), Susanne Preuknert (4), and Michel Legrand (4)

(1) UPMC Univ. Paris 06; Université Versailles St-Quentin; CNRS/INSU; UMR 8190, LATMOS-IPSL, Paris, France (gilroca@latmos.ipsl.fr), (2) University of East Anglia, UK, (3) British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, UKDepartment of Earth Sciences, Royal Holloway University of London, Egham, Surrey, TW20 0EX, UK, (4) CNRS / UJF – Grenoble 1, Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE) UMR 5183, Grenoble, F-38041, France

High levels of nitrogen oxides NO_x (NO_x=NO+NO_2) generated by the photolysis of nitrate present in surface snow profoundly impact atmospheric composition and oxidizing capacity in the Antarctic boundary layer. In particular, NO_x emissions from sunlit snow increase OH values by effectively recycling HO_2 to OH. In order to better characterize this chemistry the OPALE campaign was conducted in December 2011/January 2012 at Dome C, Antarctica (altitude of 3,233 meters, 75 ˚S, 123 ˚E). The campaign included boundary layer profiling, measurements of the physical properties of snow, as well as a comprehensive suite of atmospheric chemistry measurements (including NO_x, HONO, OH and RO_2, H_2O_2, CH_2O, O_3).

We present results using the 1-D coupled snow-boundary layer model MISTRA-SNOW in combination with observations made during the measurement campaign to understand this chemistry. The model includes both chemistry at the surface of snow grains (aqueous chemistry), in firn air (gas phase chemistry), and gas/aerosol chemistry in the boundary layer. Model predictions of NO_x mixing ratios using a model sensitivity analysis approach are presented. The model was initialized using measured snow properties, including temperature, density, and snow grain size. In addition, the model dynamics are driven using the measured surface temperature at Dome C. To calculate the rate of snowpack ventilation, measured wind speeds during the campaign were used. The model was run varying the amount of nitrate and bromide available for reaction at the surface of snow grains and results are compared to measurements made in the atmospheric boundary from 2-4 January 2012. We test the hypothesis that very low concentrations of bromine may alter the ratio of NO/NO_2. We also investigate the influence of NO_x emissions from snow, and bromine (if present), on OH concentrations in the boundary layer on the Antarctic plateau.