Geophysical Research Abstracts
Vol. 13, EGU2011-5059, 2011
EGU General Assembly 2011

On bromine, nitrogen oxides and ozone depletion in the tropospheric plume of Erebus volcano (Antarctica)

Marie Boichu (1,2), Clive Oppenheimer (1), Tjarda Roberts (3), Vitchko Tsanev (4), and Philip Kyle (5)

(1) University of Cambridge, Department of Geography, Cambridge, United Kingdom (mb632@cam.ac.uk), (2) Laboratoire de Météorologie Dynamique, Institut Pierre Simon Laplace, Ecole Polytechnique, Palaiseau, France, (3) Norwegian Polar Institute, Polar Environmental Centre, Tromso, Norway, (4) University of Cambridge, Department of Chemistry, Cambridge, United Kingdom, (5) New Mexico Institute of Mining and Technology, Department of Earth and Environmental Science, Socorro, USA

Since the discovery of bromine oxide (BrO) in volcanic emissions, there has been much interest in the ability of reactive bromine chemistry to destroy atmospheric ozone (O_3). We report the first measurements using Differential Optical Absorption Spectroscopy (DOAS) of BrO in the tropospheric plume of persistently degassing Erebus volcano (Antarctica) in December 2005. These are also the first observations from a highly alkaline phonolitic magma. The BrO/SO_2 ratio of 2.5 x 10^{-4} is close to ratios measured at arc andesitic volcanoes. We show that, based upon our estimations of HBr flux and BrO production rate, reactive bromine chemistry may be the cause of the 35 % loss of tropospheric O_3 observed by Oppenheimer et al. (2010) in the Erebus plume 8-12 km from source.

NO_x species can play a significant role on reactive bromine chemistry by slowing down the formation of BrO. Erebus volcano has the rare peculiarity of hosting a permanent lava lake, which can potentially produce large amounts of NO_x by thermal fixation of atmospheric N_2 on the hot lake surface. However, the presence of NO_2 could not be detected in our DOAS observations in 2005 pointing to the plume at $\sim$ 400 m above the lake. Based on the detection limit of our analysis, an upper bound of NO_2/SO_2 ratio $\leq$ 0.012 was estimated, which is one order of magnitude lower than previously reported. This new result suggests that the abundance of NO_y species observed in the distant plume can be explained by a rapid oxidation of NO_x in the vicinity of the lava lake. This finding is confirmed by a simulation of Erebus plume chemistry which shows that only negligible amounts of NO_x can be present at source to explain the abundance of BrO observed in the few minutes old plume.

Consequently, this study places new constraints on the interaction between reactive nitrogen and bromine chemistries in a volcanic plume, and its effects on ozone.