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Tropospheric chemistry of emissions from the Antarctic volcano, Mt. Erebus

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We report here measurements of gaseous species in the plume emitted by Erebus volcano, Antarctica, made during the austral summer of 2005. The first set of observations was recorded using a Twin Otter instrumented aircraft, which intercepted the plume at variable distances (up to 56 km) from the active crater. The second set of measurements was made by open-path infrared absorption spectroscopy with an FTIR instrument positioned on the crater rim. The airborne measurements sampled the plume up to 9 h in age, while the ground-based observations pertain to emissions less than 1 min after their release from the active lava lake contained in the crater. The species CO, OCS and SO_2 were measured using both air and ground based instruments. These observations revealed that, while CO and OCS were conserved in the plume during atmospheric transport, the abundance of SO_2 relative to CO was found to be lower by approximately two-thirds beyond the crater rim. However, over the entire length of the directly sampled plume, the ratio of CO:SO_2, did not significantly change. The airborne instrumentation also yielded further observations of volcanogenic H_2SO_4 and HNO_3 as well as the first volcanic plume observations of the trace gas species, HO_2NO_2. Interestingly, no NO_x was present. Since NO_2 has previously been detected in the proximal Erebus plume, we conclude that NO_x was quickly oxidized to nitric and pernitric acid, and probably nitrate in the aerosol phase. It is also possible that this occurred in tandem with the conversion of SO_2 to sulfate. If true, one can speculate that rapid heterogeneous chemical processes occurred by "cloud-processing" in an early stage of the plume's evolution in which liquid phase aerosol was abundant. In plumes older than about 4 h, we also report substantial ozone depletion, leading to the hypothesis that other nitrogen species were produced in the crater, which contain chlorine and bromine. We further speculate that the photolysis of these halo-nitrates could then release reactive halogens that would lead to O_3 depletion in air entrained into the plume.