MAX-DOAS Measurements of Reactive Halogens at Greenland Summit in 2007 and 2008

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Introduction and Summary

A multi-axis differential absorption spectroscopy MAX-DOAS instrument has been operating at Greenland Environmental Observatory (GEOSummit) on the summit of the Greenland Ice Sheet (72 °N, 38°W, 3200 m.a.s.l.) since late summer 2006. Here we present the measurements of BrO during the Greenland Summit OH-BrO Study, 2007.

The motivation for the GEOSummit campaign was to further investigate observations of unusual O3HNO3, ratios made at GEOFennoscandia in 2003 [Street et al., 2007; Chen et al., 2007]; BrO has been known for its very effective destruction of tropospheric O3 in polar coastal, sea ice, and salt lake environments [Hansen et al., 1994, Heidtner et al., 1999] as well as for its influence on H2O mixing ratios [Stutz et al., 1999].

Elevated BrO episodes were observed during several occasions during GEOSummit. Air mass factors (AMFs) were calculated using TRACI II for periods with good visibility to determine the concentrations of BrO for two different viewing geometries, “day” and “night”. The BrO mixing ratios often reached over 2 pptv in the boundary layer on the west side of Summit Greenland field observations, 2003, 7806-7820, DOI: 10.1016/j.atmosenv.2007.06.014, 2007. We greatly appreciate heavy airlift provided by the NY ANG, and permission to conduct research at Summit granted by the Danish Polar Center and Greenland Home Rule. The support of the Summit staff, especially in monitoring and maintaining the MAX-DOAS was essential and is greatly appreciated.

Instruments and Set Up

The MAX-DOAS instrument was developed as a long-term trace gas measurement capability, and as such, it includes some new features designed to make it suitable for autonomous operation in this extreme polar environment. It is installed in the greenhouse, located down inside the clean air sector at Summit, as shown in the figure to the right, which also shows the LP-DOAS location during GEOSummit. Panes a-c of the figure below show the physical, optical, and schematic layout and basic operation of the MAX-DOAS. The telescope is mounted on the roof of the greenhouse and measurement and control equipment is in two modules in a lab.

The telescope assembly contains five small f/4 telescopes, all pointed at infinity. Four telescope set at fixed angles of 0°, 1°, 3°, and 10° relative to the optical bench and a fifth telescope at 90° collect scattered light from the sky. All telescopes collect light through 45° windows, which are flushed with warm air. A 144 fiber slit made of 200 μm N A 0.12 UV grade silica fibers is located at the focus of the telescope, and it is oriented with respect to the zenith angle (SZA) and the elevation viewing angle, respectively. The vertical column density, VCD, is related to the measured SCD by the air mass factor, AMF: VCD = SCD/AMF. The MAX-DOAS method determines differential SCDs: DSCD = SCD/DSCD.

Using this formulation, for a known or assumed boundary layer height or trace-gas-containing height interval, the concentration of a trace gas is determined with the vertical column density (VD) over the height interval and with the AMF calculated with TRACY II for the given height interval.

References