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The Vertical Distribution of BrO and Aerosols in the Arctic: Measurements by Active and Passive DOAS

Udo Friess (1), Holger Sihler (1), Rolf Sander (2), Denis Pöhler (1), and Ulrich Platt (1)

(1) Institute of Environmental Physics, University of Heidelberg, Germany (udo.friess@iup.uni-heidelberg.de), (2) Max Planck Institute for Chemistry, Mainz, Germany

We present results from Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) and Long-Path DOAS (LP-DOAS) measurements performed at the North Slope of Alaska from February to April 2009 as part of the OASIS Barrow 2009 campaign. For the first time, vertical profiles of aerosol extinction and BrO concentration in the boundary layer were retrieved simultaneously from MAX-DOAS measurements using optimal estimation. Even at very low visibility, retrieved extinction profiles and aerosol optical thickness are in good agreement with co-located ceilometer and Sun photometer measurements, respectively. BrO surface concentrations of MAX-DOAS and LP-DOAS are in very good agreement, and it has been found that useful information on the vertical distribution of BrO can be retrieved from MAX-DOAS even in cases when blowing snow strongly affects the light path. The retrieved BrO and extinction vertical profiles allow for a thorough characterization of the vertical structure of the boundary layer during numerous ozone depletion events observed during Barrow 2009. High BrO concentrations are usually present during the onset of ozone depletion events, and BrO disappears as ozone concentrations approach zero. The finding that elevated BrO concentrations mainly occur under the presence of high extinction near the surface strongly suggests that BrO release on airborne aerosols and/or ice particles at high wind speed plays an important role. Back trajectory calculations indicate that the particles were transported from the frozen ocean to the measurement site, and that the release of BrO from sea ice and/or frost flowers occurs when low temperatures (< 250 K) are present in the regions where reactive bromine is emitted.