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New perspectives on halogen chemistry in the polar troposphere from two years of continuous observations at Neumayer III/Antarctica

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Reactive Halogen Species in the lower polar troposphere (IO, BrO, ClO, etc.) play an important role for atmospheric chemistry and have been subject of intense research for over three decades. Ozone Depletion Events and the coincidental oxidation of gaseous elemental mercury are frequently observed phenomena both occurring in Arctic and Antarctic. An autocatalytic release mechanism from saline surfaces (sea ice or aerosols) after the return of sunlight in springtime, the so-called bromine explosion, has been identified as the likely cause of the rapid increase of inorganic bromine mixing ratios over large areas. Many other aspects of the atmospheric halogen chemistry, like chlorine release or the role of iodine species, however, remain less clear.

Since January 2016, we are operating an automated Long-Path Differential Optical Absorption Spectroscopy (LP-DOAS) instrument at the German research station Neumayer III in coastal Antarctica. Measuring in the UV and visible spectral range, a wide range of trace gases including ClO, BrO, OClO, IO, O_3 and NO_2 can be detected at temporal resolutions of 5-30 minutes. Due to the use of an artificial light source, measurements are independent of solar radiation and only disrupted by poor atmospheric visibility. A wide range of co-located instruments (e.g. MAX-DOAS, ozone monitor, CPC, SMPS, nephelometer) and extensive meteorological observations at Neumayer III station (in addition to standard parameters e.g. daily radio sonde launches, radiation measurements or ceilometer observations) complement the LP-DOAS and allow a detailed interpretation of the data set.

The analysis of the past two years data reveals several surprising findings, which give new insights into polar halogen chemistry. Unexpectedly strong bromine activity in late summer and autumn (in addition to the well-known springtime events) was observed with BrO mixing ratios frequently exceeding 20 ppt and peaks up to unprecedented 110 ppt. Furthermore, ClO and OClO mixing ratios of up to 90 ppt and 10 ppt, respectively, could be detected. The source mechanism for reactive chlorine, however, remains unclear. We will give an overview of the available data set of all detectable species and discuss interesting case studies with regard to chemistry and meteorology.