Geophysical Research Abstracts
Vol. 18, EGU2016-9658, 2016
EGU General Assembly 2016

Autonomous Long-Path DOAS Measurements of Tropospheric Trace Gases at Neumayer Station III, Antarctica: First Results

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Reactive Halogen Species (RHS, like IO, BrO, ClO, etc.) have an important impact on atmospheric chemistry. In Polar Regions, the role of halogen radical chemistry has been subject of intensive research for more than two decades. Among the most prominent effects of RHS on the Polar atmosphere are the change of the oxidative capacity of the troposphere including wide-spread and frequently virtually complete destruction of tropospheric ozone, in particular during springtime, as well as the oxidation and subsequent deposition of gaseous elemental mercury.

The number of field observations and the understanding of the underlying processes varies greatly between bromine, iodine and chlorine compounds. While elevated BrO concentrations resulting from autocatalytic processes (the so-called bromine explosion mechanism) are frequently observed, the abundance and influence of iodine is still subject to discussions and available observations give no consistent picture. With only a few direct observations of chlorine compounds, such as ClO and OClO, the role of tropospheric chlorine chemistry remains poorly understood to date, despite strong evidence for its relevance. The lack of observations of chlorine radicals is mainly due to the challenging detection, particularly in the case of ClO. Scattered sunlight DOAS measurements, which are available from a number of Polar locations, are not sensitive for ClO, due to insufficient radiation intensity in the UV spectral region (<308nm) where this molecule is absorbing.

Here we present the overall design and first results of a novel Long Path DOAS (Differential Optical Absorption Spectroscopy) instrument with an active light source suitable for the detection of ClO. It has been set up at the German Research Station Neumayer III in coastal Antarctica during the summer season 2015/16 and is planned to operate autonomously for at least one year. The instrument is able to detect - in addition to ClO - many trace gases absorbing in the UV/Vis including BrO, OClO, IO, I_2, OIO, ozone, NO_2, H_2O, O_4, and SO_2 simultaneously at a temporal resolution of 1-3 minutes. Due to its active light source, it can continue measurements during the (Polar) night and hence complements the time series of a scattered light (MAX-DOAS) instrument we have been operating at Neumayer since 1999.