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# Analysis of environmental influences on tropospheric BrO in the Arctic using S5-P/TROPOMI measurements

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Halogen radicals can drastically alter the atmospheric chemistry. In the polar regions, this is made evident by the ozone depletion in the stratosphere (ozone hole) but also by localized destruction of boundary layer ozone during polar springs. These recurrent episodes of catalytic ozone depletion, better known as “ozone depletion events” (ODEs) are caused by enhanced concentrations of reactive bromine compounds. The proposed mechanism by which these compounds are released into the troposphere is called “bromine explosion” - reactive bromine is formed autocatalytically from the condensed phase.

In comparison to previous satellite missions, the TROPOspheric Monitoring Instrument (TROPOMI) onboard ESA’s S5-P satellite allows for an improved localization and a more precise specification of these events due to its superior spatial resolution of up to 3.5 x 5.5 $km^2$. Together with the better than daily coverage over the polar regions, this allows for investigations of the spatiotemporal variability of enhanced BrO levels and their relation to different possible bromine sources and release mechanisms.

We present tropospheric BrO column densities retrieved from TROPOMI measurements using Differential Optical Absorption Spectroscopy (DOAS). The advantage of our retrieval is its independence from any external input data. We used a modified k-means clustering and methods from statistical data analysis to separate tropospheric and stratospheric partial columns, thereby relying only on $NO_2$ and $O_3$ columns measured by the same instrument. This ensures in particular that the derived tropospheric BrO data set keeps the same spatial resolution as the TROPOMI instrument, because no model data with coarse resolution is used. In a second step, the BrO slant column densities (SCDs) are converted into vertical column densities (VCDs) by using an air mass factor (AMF). These AMFs are derived using a look-up table (LUT) generated by the McArtim radiative transfer model. From this LUT the AMF is calculated for each pixel using measured $O_4$ SCDs and reflectance data. In a last step, satellite pixels are differentiated by their sensitivity to the lower troposphere using the determined AMF. This allows the exclusion of measurements deemed not sensitive to the troposphere from the dataset and gives a high confidence in the remaining retrieved values.

Our retrieval algorithm avoids systematic biases from external data sets and climatologies and is therefore particularly well suited to compare the retrieved VCDs to additional environmental parameters suspected to alter the release and distribution of BrO during Arctic spring. We examine tropospheric BrO enhancements through case studies, with particular emphasis on the interconnection of ODEs and meteorology. We focus here on the relation of tropospheric BrO to mean sea level pressure, surface air temperature, sea ice age and wind speed and direction. In addition, the spatiotemporal extent of events is studied and compared to WRF-Chem simulations.