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Bromine monoxide/sulphur dioxide molar ratios in volcanic plumes from S5-P/TROPOMI

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We present investigations of the potential of the recently launched TROPOMI instrument to detect volcanic plume composition. We focus here on the analysis of sulphur dioxide (SO_2) and bromine monoxide (BrO). Bromine is a halogen radical altering – among others – the atmospheric ozone chemistry. Further, BrO and in particular the molar BrO/ SO_2 ratio in volcanic gas emissions have been suggested as proxy for monitoring volcanic activity on several accounts. Those studies were undertaken by ground based measurements.

So far, BrO in volcanic plumes has been successfully retrieved from satellite only during major eruptions. The higher spatial resolution of S5-P/ TROPOMI (3.5 km x 7 km) and the daily coverage allows for an investigation of volcanic BrO during smaller eruptions and even during continuous passive degassing.

In this study, we present BrO as SO_2 column densities retrieved using Differential Optical Absorption Spectroscopy (DOAS) and BrO/ SO_2 molar ratios in volcanic plumes with varying emission strength from TROPOMI data. We illustrate and discuss differences in the plume composition between different volcanoes (e. g. Ambrym/Ambae, Etna, Agung). By deriving time series we investigate the variation of the BrO/SO_2 molar ratio and discuss its implications to the state of the volcanic system and its degassing mechanisms. For example, the spatial resolution of TROPOMI allows a clear separation of the plumes from the neighbouring volcanoes Ambrym/Ambae. The respective time series reveal very different BrO/SO_2 signatures of typically less than 5×10^{-5} (Ambae) and between $5 - 10 \times 10^{-5}$ (Ambrym).