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Systematic investigation of bromine monoxide in volcanic plumes from space by using the GOME-2 instrument

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Bromine monoxide (BrO) plays a key role as a catalyst in the depletion of both tropospheric and stratospheric ozone (O_3), e.g. during springtime in polar regions. In addition to sources like salt lakes or the surface of sea ice in polar regions, it turned out that volcanic emissions are a further natural source of BrO. The injection of bromine compounds from persistent degassing volcanoes as well as during major eruptions, might therefore have an important impact on atmospheric chemistry. Since the first observation of BrO in the volcanic plume of Soufrière Hills in 2002 by ground-based Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) measurements, similar observations have been made at several volcanoes worldwide.

While a first investigation of data from the GOME and SCIAMACHY satellite instruments failed to detect volcanic BrO also from space for selected volcanic events, large amounts of BrO were detected for the first time in the plume of the Kasatochi eruption in August 2008 by GOME-2. This showed the capability of GOME-2 to monitor such events and that satellite instruments offer in principle the unique opportunity to investigate the behavior of BrO inside volcanic plumes for large scales, what is usually not possible with ground-based measurements.

In order to detect further events of volcanic unrest, where BrO might be present in the vicinity of the plume, we systematically investigated the whole dataset of the GOME-2 satellite instrument from the beginning of the measurements in January 2007 until June 2011. Almost 800 volcanic plumes were automatically extracted from the data by using sulfur dioxide (SO_2) as a proxy and the slant column densities (SCDs) for BrO were additionally retrieved. While the majority of the captured volcanic plumes showed no signs for enhanced BrO, several other plumes were found with clear evidence for volcanic BrO next to SO_2, even for minor eruptions. In the latter case, the resulting SCDs for both species were analyzed for a possible correlation and the BrO/SO_2 ratios are discussed. The results show, that a close correlation between SO_2 and BrO only occurs for some of the observed eruptions or only for certain parts of the examined volcanic plumes. For some other cases, only a rough spatial correlation can be found. We discuss possible explanations for the occurrence of different spatial SO_2 and BrO distributions in aged volcanic plumes.