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Variations of the BrO/SO_2 ratios from Tungurahua volcano, Ecuador

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The amount and composition of volcanic gas emissions can yield information about magmatic processes. Apart from the SO_2 emission rate, which is used as a widespread tool in monitoring volcanoes, the molar ratio of BrO/SO_2 in a volcanic plume has shown the potential for interpreting volcanic activity. The evaluation of long-term spectral data collected with UV-scanning spectrometers through the Network for Observation of Volcanic and Atmospheric Change (NOVAC) using the DOAS technique can help to obtain a better understanding of the BrO/SO_2 molar ratio and its correlation to magmatic processes. BrO and SO_2 emissions as well as the BrO/SO_2 ratio have been successfully retrieved from NOVAC data at Nevado del Ruiz (Colombia), where a decrease of the BrO/SO_2 ratio was observed prior to a large eruption.

We apply this evaluation algorithm to determine the plume composition of Tungurahua volcano, Ecuador, which is part of NOVAC since 2007. Different from Nevado del Ruiz the retrieved column densities of SO_2 and BrO at Tungurahua are typically more than a factor of two lower during the respective period of observation. In addition, changes in the volcanic activity appear on a smaller timescale, as Tungurahua displays a succession of activity and quiescence phases. In order to still obtain robust BrO/SO_2 ratios at Tungurahua, it is necessary to improve the data evaluation as well as applying a more sophisticated scheme to calculate the BrO/SO_2 ratio. By combining both methods we create a time series of the BrO/SO_2 ratio for several eruptive phases between 2007 and 2014. The ratio shows values between 2 and 8×10^{-5}. The variation of the BrO/SO_2 ratio during these eruptive phases is compared to seismic data and volcanological phenomenological observations as well as satellite and ground based SO_2 measurements. During several eruptive phases we observe an increase in the BrO/SO_2 ratio on the transition from high explosive activity to low explosive activity. During the eruptive phase from November 2010 to January 2011 for example, we observe a BrO/SO_2 ratio around 5.1×10^{-5} during the initial period characterized by high explosive activity and an increased ratio of around 8.5×10^{-5} during the following period with low explosive activity.