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Modelling the impact of chlorine and bromine emissions from large Plinian eruptions on ozone

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Large Plinian volcanic eruptions inject large amounts of atmosphere-relevant gases (e.g. S, Cl, Br) and materials into the stratosphere. If the eruption occurs in the tropics, it can have a global impact due to the dispersal through the large scale meridional overturning circulation. Most climate model studies concentrate on the sulfate aerosol effects on climate. In contrast, ozone-depletion initiated by volcanic halogens from tropical eruptions was believed to play an insignificant role for the global atmosphere, based on observations from the recent El Chichon and Pinatubo eruptions. New results regarding the halogen release by Plinian eruptions, as well as recent volcanic plume observations and model simulations facilitate now our investigation into what effect the combined chlorine and bromine emissions from large tropical eruptions have on ozone and the atmosphere in general. A complete halogen data set for the last 200 ka (Kutterolf et al., 2015), derived by the petrological method from paleo-eruptions of the Central American Volcanic Arc (CAVA), are used to force simulations with the advanced chemistry climate model WACCM (Whole Atmosphere Community Climate Model). The goal is to quantify the impact of volcanic halogens on the preindustrial atmosphere when the background chlorine levels were low compared to the present day with the main focus on stratospheric ozone.
We carried out 5 model simulations assuming that 10% of the Cl and Br (9.51e+6 kg Br and 2.93e+9 kg Cl) emitted from the average CAVA eruption is injected into the tropical stratosphere during January. The model response reveals a global impact on the ozone layer affecting via radiation also atmospheric dynamics for more than 5 years. Given the current decline in anthropogenic chlorine, the results will become relevant for future halogen-rich explosive eruptions in the tropics.

References:
Kutterolf, S., T. Hansteen, A. Freundt, H. Wehrmann, K. Appel, K. Krüger, and W. Pérez (2015), Bromine and chlorine emissions from Plinian eruptions along the Central American Volcanic Arc: From source to atmosphere, Earth and Planetary Science Letters, 429, 234–246, doi:10.1016/j.epsl.2015.07.064.