Geophysical Research Abstracts
Vol. 21, EGU2019-16085, 2019
EGU General Assembly 2019

Modelling stratospheric volcanic eruptions using sulfur isotopes

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Explosive Plinian volcanic eruptions inject large amounts of sulfur dioxide (SO_2) in the stratosphere. These stratospheric eruptions enhance the stratospheric sulfur aerosol layer (and deplete the ozone layer) which attenuates the radiation balance and affect global climate on a multiyear scale. The enhanced sulfate is observed in ice records coinciding with large volcanic eruptions. Isotope information can potentially provide more detailed information about the nature and height of the eruption because SO_2 photolysis and photo-excitation reactions in the stratosphere are associated with sulfur isotope mass-independent fractionation (S-MIF). Under normal conditions, the stratospheric ozone layer absorbs the high energy photons required for these reactions, but in stratospheric volcanic plumes, the SO_2 can be lifted above the ozone layer where sufficient UV radiation is available. In fact, mass-independent fractionation signals have been observed in sulfate deposits on the polar ice sheets related to volcano eruptions. These S-MIF signals might be an indication of eruption height and strength. The transfer of this signal from the stratosphere to sulfate in ice is however not well understood, especially how isotopically different reservoirs separate physically during transport to polar ice sheets. A three-dimensional chemistry transport model is required to explicitly link the processes that produce the sulfur isotopic anomalies in the stratosphere (photolysis and photoexcitation) to sulfur deposited in ice. Such a model should adequately incorporate atmospheric radiative transfer, microphysical processes to form sulfate aerosols, stratospheric chemistry, and transport in the stratosphere in order to constrain the height of past volcanic eruptions. We will present first analysis on simulations of photolysis MIF signals in a volcanic plume using a radiative transfer model, especially to better understand self-shielding in a such a plume and stratospheric plume chemistry that includes both photoexcitation and photolysis of SO_2 isotopologues.