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Revisiting the ‘transfer function’ of stratospheric sulfur loading from volcanic sulfate deposited on polar ice sheets

Andrea Burke¹, Herman Fuglestad², Liz Thomas³, Lauren Marshall⁴, and Kirstin Krüger²

¹School of Earth and Environmental Sciences, University of St Andrews, St Andrews, United Kingdom (ab276@st-andrews.ac.uk)

²University of Oslo, Oslo, Norway

³British Antarctic Survey, Cambridge, United Kingdom

⁴Durham University, Durham, United Kingdom

Records of the volcanic forcing of climate prior to the satellite era depend on scaling the flux of sulfate deposited on polar ice sheets using a ‘transfer function’, a number calibrated based on radioactivity in Greenland from thermonuclear testing as well as Antarctic sulfate flux records from the 1991 Pinatubo eruption (e.g. Gao et al., 2007). For high latitude eruptions, this transfer function is based solely on model simulations of sulfate flux to Greenland from the Icelandic Laki eruption in 1783 and the Alaskan Katmai/Novarupta eruption in 1912 (Gao et al., 2007). Since the initial determination of this transfer function, the number of ice cores containing sulfate from the Pinatubo eruption has increased eight-fold, and sulfur isotope measurements at high resolution over sulfate peaks in the ice has allowed for discrimination between stratospheric sulfate and sulfate transported at lower levels in the atmosphere from different sources (e.g. Burke et al., 2023). Here we revisit the estimation of the transfer function in light of these new data-based constraints from eruptions in the 20th century, and we reassess the uncertainty associated with the application of a single transfer function across volcanic eruptions in the past.

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