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Disentangling the eruption source parameters that control the climate effects of volcanic eruptions

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Climatic cooling in the 1-2 years following a major volcanic eruption does not scale linearly with the mass of SO_2 injected into the atmosphere. The injection height of the emissions, the latitude of the volcano, the season and large scale atmospheric circulations, also influence the climatic response. Complex couplings exist between stratospheric chemistry and circulations, and aerosol induced heating and aerosol microphysical processes such as condensation and evaporation. As yet, there has been no systematic assessment of these relationships when considering different eruption source parameters. A series of simulations with a global composition-climate model with interactive stratospheric chemistry and aerosol microphysics are conducted, in which the eruption latitude and injection height are varied. Parameter combinations are chosen such that injections sample areas in the atmosphere where different chemical and dynamical influences are important (e.g. tropical vs. high latitude eruptions, injections near the tropopause vs. injections in the upper stratosphere). Each experiment is repeated for varying SO_2 injection magnitudes. We focus on the analysis of aerosol properties such as the stratospheric aerosol optical depth, effective radius and heating rates, and resultant perturbations to radiative fluxes. Initial results demonstrate the non-linearity in the climatic response as the injection magnitude is increased. Future work will focus on disentangling the contribution of each parameter to the climatic response with additional simulations to investigate the effect of season and the Quasi Biennial Oscillation. Results will aid in the understanding of the impact of past, present and future volcanic eruptions. By analysing sulfate deposition to the polar ice caps, we will assess the uncertainty in, and validity of, the historic volcanic radiative forcing deduced from ice cores.