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Simulating volcanic plumes in a numerical weather prediction model

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In the event of a volcanic eruption, the estimation of mass flux is a crucial task for Volcanic Ash Advisory Centres (VAACs). Typically, this estimate would be based upon a knowledge of the rise height of the plume and the background wind. Converting this information to a mass flux is performed via a combination of historical data and idealised models of plume behaviour - the latter implicitly rely on assumptions regarding plume entrainment (expressed in the form of entrainment coefficients). Such models typically have correspondingly idealised background wind profiles.

We will describe a modification of a state-of-the-art numerical weather prediction (NWP) model that can simulate volcanic plumes. Rise heights and entrainment coefficients can be extracted from the NWP simulations for arbitrary background wind profiles, allowing the mass flux inversion described above to have a much wider range of applicability. The method is also suitable to the modelling of other extreme convective events, since in this approach the plume is buoyancy-driven. The inclusion of more complex physical processes, such as those related to topography and microphysics, is also possible. Results will be given for idealised wind profiles (for comparison with theory) and for more complex cases. A further extension to this model framework, allowing the simulation of dense volcanic plumes, will also be presented.