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Automatic Real-Time Estimation of Plume Height and Mass Eruption Rate Using Radar Data During Explosive Volcanism

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Plume height and mass eruption rate are the principal scale parameters of explosive volcanic eruptions. Weather radars are important instruments in estimating plume height, due to their independence of daylight, weather and visibility. The Icelandic Meteorological Office (IMO) operates two fixed position C-band weather radars and two mobile X-band radars. All volcanoes in Iceland can be monitored by IMO's radar network, and during initial phases of an eruption all available radars will be set to a more detailed volcano scan. When the radar volume data is retrived at IMO-headquarters in Reykjavík, an automatic analysis is performed on the radar data above the proximity of the volcano. The plume height is automatically estimated taking into account the radar scanning strategy, beam width, and a likely reflectivity gradient at the plume top. This analysis provides a distribution of the likely plume height. The automatically determined plume height estimates from the radar data are used as input to a numerical suite that calculates the eruptive source parameters through an inversion algorithm. This is done by using the coupled system DAKOTA-PlumeMoM which solves the 1D plume model equations iteratively by varying the input values of vent radius and vertical velocity. The model accounts for the effect of wind on the plume dynamics, using atmospheric vertical profiles extracted from the ECMWF numerical weather prediction model. Finally, the resulting estimates of mass eruption rate are used to initialize the dispersal model VOL-CALPUFF to assess hazard due to tephra fallout, and communicated to London VAAC to support their modelling activity for aviation safety purposes.