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Assessing volcanic ash hazard for human health and infrastructures: the case of Mt. Etna (Italy)

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We report results from advanced numerical modelling and new empirical measurements for characterizing the dispersal of volcanic ash at Mt Etna and its potential impacts on human health and infrastructures. Numerical simulations produced by the VOL-CALPUFF code are used to describe the transient and three-dimensional dynamics of ash dispersal produced by weak long-lasting plumes. Monte Carlo techniques are then used to capture the effects of volcanological uncertainties (such as eruption intensity and duration) and meteorological variability on ash concentration estimates. Our numerical simulations indicate the likelihoods of experiencing significant PM10 concentrations at various populated locations around the volcano, including the city of Catania (15 km southeastward from the summit), and at key facilities, such as airports and main roads. Ash deposit thicknesses and ambient air concentrations of PM10 are predicted each hour on the basis of contemporary weather forecasts. A re-suspension model allows the important secondary effects of anthropic activities on concentration levels to be taken into account. Results on visibility reduction are also reported. A DustTrak instrument has been deployed to provide empirical data of airborne ash particle concentration for comparison with modelling results, and PM10 measurements from a municipality monitoring network are also used to constrain the VOL-CALPUFF modelling. Our findings can inform civil protection mitigation measures to protect human health and manage road transport and aviation safety when tephra fallout occurs.