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Mass eruption rate retrieved from satellite measurement of atmospheric fine ash

M. Gouhier[1]; J.Eychenne[1]; A.Guillin[2]; N. Azzaoui[2]

[1]Laboratoire Magmas et Volcans, Université Blaise Pascal-CNRS-IRD, OPGC, Aubière, France.

[2]Laboratoire de Mathématique, Université Blaise Pascal-CNRS, Aubière, France.

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Ash clouds emitted during volcanic eruptions have long been recognized as a major hazard likely to have dramatic consequences on aircrafts, environment and people. Volcanic Ash Advisory Centers (VAACs) provide forecast maps of ash cloud concentration using volcanic ash transport and dispersion models (VATDs). Those models use input parameters such as plume height, particle size distribution, and mass eruption rate (MER), the latter being a key parameter as it directly controls the amount of ash injected into the atmosphere. However, the MER is currently impossible to measure accurately in real-time. VAACs make indirect estimates using well-known empirical relationships between MER and plume height. This method bears large uncertainties, limiting its application to risk mitigation. Here we propose an alternative method to assess the MER from satellite measurements of fine ash dispersion rate, which can be obtained up to every five minutes from geostationary satellites. We tested on ?20 eruptions the relationship between the rate of fine ash dispersion in the atmosphere (retrieved from satellite measurements) and the averaged MER inferred from tephra fall deposits. We demonstrate that a reliable statistical relationship exists that improves significantly the MER prediction. Using a generalized linear model, we combined these data with additional parameters likely to have an effect on the formation of fine ash (e.g., phreatomagmatism, magma composition, volatile content). We used advanced statistic modelling based on model selection, with AIC-type (Akaike Information Criterion) penalization methods. The relationship we evidence greatly improves our prediction capability of the source MER as compared to the one based on the plume height solely. When available in real-time, satellite data can be advantageously used by the VAACs, as we demonstrate by applying our method to the Eyjafjallajökull 2010 eruption (Iceland).