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Forecasting volcanic ash dispersal: developments and application of the System Calpuff

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Although the large amount of damages produced by the volcanic ash, until now an efficient predictive instrument able to forecast the ash dispersal dynamics does not exist yet. To this aim we have adopted and further developed the System CALPUFF with the specific objective to produce a robust and accurate tool able to describe the ash dispersal from its emission into the atmosphere until its deposition on the ground.
The CALPUFF System, originally employed in air quality modelling, is a Lagrangian dispersion model used to simulate release of particulate material and its transport in the atmosphere. It describes the emitted material as a sequence of packets, called *puffs*, each subjected to advection, diffusion and deposition. In a previous study, we have applied CALPUFF in its original version, thus showing a number of limitations in its application to the volcanological case. As a consequence, a number of developments have been recently carried out regarding the dynamics of the rising plume and the dispersal of the ash cloud.
CALPUFF describes the rising phase of the plume by using an Eulerian approach. The original version of the code assumed that the mixture emitted is composed only by gases obeying the perfect gas law. As a consequence, in order to make the model appropriate for the volcanological application, transport and constitutive equations were modified for accomodating a mixture composed by different volcanic gases and solid pyroclasts.
Once the plume has reached its maximum height under the action of the specified wind field, horizontal and vertical dispersion takes place due to atmospheric motions and properties. Since the original code was developed to describe the dispersion of particulate matter typically produced by farms (of the order of few microns in diame-

ter), a further extension of the model was carried out to overcome this limit and be able to treat pyroclasts up to a few millimeters in diameter. To this aim a new description of puff vertical movements directly affected by gravitative falling of solid particles, was implemented and tested versus real observations of industrial test-cases.
Finally, the model was extended to consider the non-sphericity effects of volcanic particles. As a result, the current version of the model allows to determine the settling velocity of each particle size, as a function of sphericity, according to various semi-empirical correlations.
The new model was applied to the carrying out specific parametric studies with particular reference to the Mt.Etna July 2001 dispersal event.
Influence of the meteorological data, formulation of the plume model, effect of grain-size distribution and source description are some of the issues investigated that will be presented.