Geophysical Research Abstracts
Vol. 17, EGU2015-13444, 2015
EGU General Assembly 2015

A multi-source probabilistic hazard assessment of tephra dispersal in the Neapolitan area

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In this study we present the results obtained from a long-term Probabilistic Hazard Assessment (PHA) of tephra dispersal in the Neapolitan area.
Usual PHA for tephra dispersal needs the definition of eruptive scenarios (usually by grouping eruption sizes and possible vent positions in a limited number of classes) with associated probabilities, a meteorological dataset covering a representative time period, and a tephra dispersal model. PHA then results from combining simulations considering different volcanological and meteorological conditions through weights associated to their specific probability of occurrence. However, volcanological parameters (i.e. erupted mass, eruption column height, eruption duration, bulk granulometry, fraction of aggregates) typically encompass a wide range of values. Because of such a natural variability, single representative scenarios or size classes cannot be adequately defined using single values for the volcanological inputs. In the present study, we use a method that accounts for this within-size-class variability in the framework of Event Trees. The variability of each parameter is modeled with specific Probability Density Functions, and meteorological and volcanological input values are chosen by using a stratified sampling method. This procedure allows for quantifying hazard without relying on the definition of scenarios, thus avoiding potential biases introduced by selecting single representative scenarios.
Embedding this procedure into the Bayesian Event Tree scheme enables the tephra fall PHA and its epistemic uncertainties.
We have appied this scheme to analyze long-term tephra fall PHA from Vesuvius and Campi Flegrei, in a multi-source paradigm. We integrate two tephra dispersal models (the analytical HAZMAP and the numerical FALL3D) into BET_VH. The ECMWF reanalysis dataset are used for exploring different meteorological conditions.

The results obtained show that PHA accounting for the whole natural variability are consistent with previous probabilities maps elaborated for Vesuvius and Campi Flegrei on the basis of single representative scenarios, but show significant differences.
In particular, the area characterized by a 300 kg/m2-load exceedance probability larger than 5%, accounting for the whole range of variability (that is, from small violent strombolian to plinian eruptions), is similar to that displayed in the maps based on the medium magnitude reference eruption, but it is of a smaller extent. This is due to the relatively higher weight of the small magnitude eruptions considered in this study, but neglected in the reference scenario maps.
On the other hand, in our new maps the area characterized by a 300 kg/m2-load exceedance probability larger than 1% is much larger than that of the medium magnitude reference eruption, due to the contribution of plinian eruptions at lower probabilities, again neglected in the reference scenario maps.