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Operational short-term Probabilistic Volcanic Hazard Assessment of tephra fallout: an example from the 1982-1984 unrest at Campi Flegrei

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Probabilistic Volcanic Hazard Assessment (PVHA) represents the most complete scientific contribution for planning rational strategies aimed at mitigating the risk posed by volcanic activity at different time scales. The definition of the space-time window for PVHA is related to the kind of risk mitigation actions that are under consideration. Short intervals (days to weeks) are important for short-term risk mitigation actions like the evacuation of a volcanic area.

During volcanic unrest episodes or eruptions, it is of primary importance to produce short-term tephra fallout forecast, and frequently update it to account for the rapidly evolving situation. This information is obviously crucial for crisis management, since tephra may heavily affect building stability, public health, transportations and evacuation routes (airports, trains, road traffic) and lifelines (electric power supply).

In this study, we propose a methodology for the short-term PVHA and its operational implementation, based on the model BET_EF, in which measures from the monitoring system are used to routinely update the forecast of some parameters related to the eruption dynamics, that is, the probabilities of eruption, of every possible vent position and every possible eruption size. Then, considering all possible vent positions and eruptive sizes, tephra dispersal models are coupled with frequently updated meteorological forecasts. Finally, these results are merged through a Bayesian procedure, accounting for epistemic uncertainties at all the considered steps.

As case study we retrospectively study some stages of the volcanic unrest that took place in Campi Flegrei (CF) in 1982-1984. In particular, we aim at presenting a practical example of possible operational tephra fall PVHA on a daily basis, in the surroundings of CF at different stages of the 1982-84 unrest. Tephra dispersal is simulated using the analytical HAZMAP code. We consider three possible eruptive sizes (a low, a medium and a high eruption "scenario" respectively) and 700 possible vent positions within the CF Neapolitan Yellow Tuff caldera. The probabilities related to eruption dynamics, and estimated by BET_EF, are based on the set up of the code obtained specifically for CF during a 6-years long elicitation project, and on the actual monitoring parameters measured during the unrest and published in the literature. We take advantage here of two novel improvements: (i) a time function to describe how the probability of eruption evolves within the time window defined for the forecast, and (ii) the production of hazard curves and their confidence levels, a tool that allows a complete description of PVHA and its uncertainties.

The general goal of this study is to show what, and how, pieces of scientific knowledge can be operationally transferred to decision makers, and specifically how this could have been translated in practice during the 1982-84 Campi Flegrei crisis, if scientists knew what we know today about this volcano.