Short–term eruption forecasting with BET_EF: applications and results

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Bayesian Event Tree for Eruption Forecasting (BET_EF) code was proposed several years ago as a tool to quantify probabilities, and associated uncertainty, of the most relevant outcomes of volcanic unrest, such as the detection of the state of unrest, and the probability of (i) magma actively causing unrest, (ii) eruption, (iii) vent position and(iv) eruptive type or size or class. The proposed code computes the probabilities based on heterogeneous sources of information, such as volcanological conceptual models, observed frequencies, monitoring data and expert opinion. The importance of the different pieces of information depends on the time scale of the expected changes in the volcano state, that is, ultimately, on the time term of the forecast: the most relevant evidence is respectively represented by volcanological models and observed past frequency for a long–term forecast, and monitoring information and expert opinion in the short-term.

Here, we summarize the results obtained and the lessons learned by applying the code in simulation exercises (MESIMEX in 2006 at Vesuvius, Italy; RUAUMOKO in 2008 at the Auckland Volcanic Field, New Zealand; COLIMA in 2012 at Colima, Mexico) and in an ongoing, several years long, application at Campi Flegrei, Italy, heavily based on real monitoring data and sessions of expert elicitation.

Although it is still an ongoing evaluation, one of the most important lessons learned from the application of BET_EF is that its output probabilities have so far reproduced the opinion of a pool of experts. In this view, such probabilities are a clear example of "subjective" probability, representing a "degree of belief" on the likelihood of the occurence of an uncertain–outcome event, rather than the "expected frequency" of occurrence of a generic type of events. This is enforced also by the widespread belief, within the volcanological community, that every volcano (if not every eruption) has some peculiarities, and so a "unique" model for the forecast of eruptions, based on catalogs from many volcanoes and valid for all of them, is not possible. This approach has similarities with the one taken by many hazard assessment made by the seismological communities (Marzocchi and Zechar, 2011); a recent example is Uniform California Earthquake Rupture Forecast that aims at providing, by means of expert opinion, a comprehensive framework for computing a rupture forecast for California. The testability of the "degree of belief" is still a subject of discussion, and it is not yet available a self–consistent probabilistic framework to test such a kind of probabilistic approach. In this presentation we summarize why a subjective probability is fundamental for taking decisions in managing volcanic unrest and the current initiatives that aim at evaluating scientifically such a kind of forecasts.