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Towards the evaluation of the success rate of deterministic eruption forecasting

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The material Failure Forecast Method (FFM, Voight, 1988) is the most frequently used approach for deterministic eruption forecasting. However, despite some encouraging results, the number of study cases published in international journals is still limited (~30 papers concerning 14 volcanoes). These papers generally describe forecasts in hindsight, i.e. using the whole sequence of observations until the eruption, and there are very few attempts in real-time. Furthermore, while the literature mainly presents successful cases, systematic studies including many eruptions with both successful and unsuccessful forecasts are still rare. The FFM is based on the detection of accelerated increase of an observable, such as the rate of seismic event or ground deformation. An empirical power law is fitted to the observations and the predicted time of eruption is given by the location of the vertical asymptote of the function. Although the principle of FFM is relatively simple, the physical bases and the methodology for its implementation are still not well-established. For example, the choice of the observable, of the power law exponent, and of the fitting window, as well as the estimation of the uncertainties and confidence level of the time of eruption, are complex issues that must be carefully addressed. A statistically significant and unbiased evaluation of the success rate and reliability of FFM is still needed and would require international and cooperative efforts based on the large databases obtained in the last years. For this purpose, we propose a rigorous Bayesian approach of FFM designed for real-time applications, coupled with an automatic recognition system of seismic events. 23 years of continuous recordings from 3 volcanoes, including 64 eruptions, have been analised. 36 % of the eruptions could have been forecast in real-time. However, when the reliability criteria are fulfilled, the success rate of forecast increases to 83 %.