Testing the performance limits of eruption forecasting models using synthetic precursory data

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A range of models have been proposed to explain trends in eruption precursors, such as strain and seismicity. These models potentially promise quantitative forecasts of the timing of future eruptions. However, the models, and their forecasting power, remain largely untested. Here we use simulations to quantify variability in forecast eruption times based on the inverse Omori law in the 'best-case' scenario that uncertainty only arises from model parameter estimation from single realizations of a stochastic point process. A maximum-likelihood method yields the most reliable forecasts. For typical model parameter values, at 10 days before the eruption, 1 in 10 of the forecasts are more than 3 days early or late in the case that the power-law exponent is known a priori, and more than 5 days early or late if the power-law exponent is unknown. Much larger variability can be expected in practice. Methods to manage such uncertainties must be incorporated within hazard mitigation strategies. Our results demonstrate the large inherent uncertainty in eruption forecasts even in these ideal scenarios, and highlight the necessity for: (1) greater experimental and theoretical constraint on model parameters; and (2) the need for truly prospective testing of forecast performance.