Anticipating abrupt shifts in temporal evolution of probability of eruption

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Estimating the probability of eruption by jointly accounting for different sources of monitoring parameters over time is a key component for volcano risk management. In the present study, we are interested in the transition from a state of low-to-moderate probability value and to the one of high probability value: the latter value generally supports the call for evacuation. By using the data of MESIMEX exercise at the Vesuvius volcano, we investigated the potential for time-varying indicators related to the correlation structure or to the variability of the probability time series for detecting in advance this critical transition. We found that changes in the power spectra and in the standard deviation estimated over a rolling time window both present an abrupt increase, which marks the approaching shift. Our numerical experiments revealed that the transition from an eruption probability of 10-15% to >70% could be identified up 4 hours in advance, ∼2.5 days before the evacuation call (decided for an eruption probability >80% during the MESIMEX exercise). This additional lead time could be useful to place different key services (e.g., emergency services for vulnerable groups, commandeering additional transportation means, etc.) on a higher level of alert before the actual call for evacuation.