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A Dynamic Bayesian Network for Mt. Etna Volcano State Assessment

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Nowadays, the real-time monitoring of Mt. Etna volcano is mostly delegated to one or more human experts in volcanology, who interpret the data coming from different kind of monitoring networks. Among their duties, the evaluation of the volcano state is one of the most critical task for civil protection purposes. Unfortunately, the coupling of highly non-linear and complex volcanic dynamic processes leads to measurable effects that can show a large variety of different behaviors. Moreover, due to intrinsic uncertainties and possible failures in some recorded data the volcano state needs to be expressed in probabilistic terms, thus making the fast volcano state assessment sometimes impracticable for the personnel on duty at the 24h control room. With the aim of aiding the personnel on duty in volcano monitoring, here we present an expert system approach based on Bayesian networks to estimate automatically the ongoing volcano state from all the available different kind of measurements. A Bayesian network is a static probabilistic graphical model that represents a set of random variables and their conditional dependencies via a directed acyclic graph. We consider model variables both the measurements and the possible states of the volcano. In order to include the time in the model, we use a Dynamic Bayesian Network (DBN) which relates variables to each other over adjacent time steps. The model output consists of an estimation of the probability distribution of the feasible volcano states. We build the model by considering the long record of data from 2011 to 2014 and we cross-validate it by considering 3 years for parameter estimation and 1 year for testing in simulated real-time mode.