Eruption Forecasting from Seismic Activity using Neural Networks

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Accurate eruption forecasting is one of the most important problems in volcanology. Methods based on analysis of precursors, including gas emissions, ground deformation, and seismic activity have been proposed. With the growing amount of sensor data for volcanic monitoring available in real-time, the automation of this forecasting process has become feasible, at least in principle.

We propose an approach for automated eruption forecasting from seismic activity based on neural networks. We generated a dataset of earthquake locations and magnitudes in the vicinity of 37 of the volcanoes in the Aleutian Arc from 1998 to 2016 by querying the ANSS (Advanced National Seismic System) Composite Catalog. The magnitudes of the earthquakes were binned at certain temporal intervals and crater-centered volumes and used as features for a three-layer neural network, which predicted the probability of an eruption. We evaluated our system using a leave-one-out cross-validation approach, testing the predictions with one volcano at a time, while training the network with data from the remaining 36. Using this approach, we could successfully predict the eruptions of Augustine (2006), Okmok (2008), and Redoubt (2009), while having a very low false positive rate.