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Activity regimes inferred from automatic classification of volcanic tremor at Mt. Etna, Italy

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A renewal of eruptive activity at Mt Etna started from the Southeast Crater on 14 July 2006, about 16 months after the end of the last effusive episode. This new eruption reiterated the importance of continuous volcanic monitoring as well as the need of automatic processing and classification of those signals which might be used to disclose such impending eruptive stages. Among seismic signals, volcanic tremor - the persistent background radiation continuously recorded on open conduit, basaltic volcanoes like Mt Etna - is of utmost importance for the identification of different regimes of volcanic activity. Indeed, changes in amplitude and frequency content of volcanic tremor usually herald the unrest of the volcano. The application of the Support Vector Machine classifier to spectrograms of volcanic tremor was carried out on data recorded at Mt Etna in 2001, in a time span of 46 days encompassing episodes of lava fountains and effusive activity. Moving on from the positive results obtained from this automatic classification - with less than 6 % of misclassifications - we propose a new application using tools with supervised (Artificial Neural Networks, Support Vector Machine) and unsupervised (Cluster Analysis) learning to the new data set recorded in July 2006. In doing so, we discuss issues such as data transformations for the definition of the patterns, learning and testing strategies as well as the optimization of the classifier configuration (e.g., trial and error, Genetic Algorithms). The performance of each method is analyzed and discussed in terms of identification of the different states of the volcano. Finally, we carry out a careful a-posteriori analysis of the misclassifications, devoting particular attention to their temporal distribution and relation to transitional states of volcanic activity.