Geophysical Research Abstracts, Vol. 8, 05780, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05780

A new Automatic Pattern Recognition Approach for the Classification of Volcanic Tremor at Mount Etna, Italy

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In this study, an automatic pattern recognition approach is developed for the classification of volcanic tremor at Mount Etna, Italy. A Support Vector Machine (SVM) classifier is trained by means of a supervised learning algorithm to recognize time series recorded during different states of the volcanic system. The classification of the signal is based on the seismic data recorded at the three-component, broadband station ESPD, located about 6 km southeast from the summit craters. In particular, we analyze the data recorded throughout the 17 July - 9 August, 2001 flank eruption. This episode, with its 23 days-long effusive activity, allows us to investigate thoughtfully the whole development of the volcano unrest. Our analysis covers the time span from 1 July to 15 August, 2001, i.e., it includes several days before the onset and after the end of the flank eruption. Up to 142 time series are extracted as windows of approximately 10 minutes for each component of station ESPD. Then spectrograms are calculated for each time series applying a sliding window technique, and the values obtained averaging the rows of each spectrogram are used as classification features. Following this approach, the frequency content averaged over time is hence used for discriminating different states of activity. In particular, we distinguish four stages, i.e., pre-eruptive, lava fountains, eruptive and post-eruptive. Following a boot-strap strategy, we repeat a random selection of the training set (ca. 80% of the entire data set) and testing set (ca. 20%) 100 times. On the basis of the data set encompassing the three components (426 examples), SVM correctly classifies 94.65 +/- 2.43% of the data. Classification performances can be further improved by reducing the number of classes, namely considering lava fountains as either pre-eruptive or eruptive states depending on their position in time. In this case, SVM correctly classifies 97.25 +/- 1.63% of the data.