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Activity Regimes on Mt Etna inferred from Automatic Unsupervised Classification of Volcanic Tremor Data

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Mt Etna is among the best monitored basaltic volcano worldwide. High-quality, multidisciplinary data set are continuously available for around-the-clock surveillance. Seismic data sets cover decades long local recordings, obtained during different regimes of eruptive activity, from Strombolian eruptions to lava fountains and lava flows. Earthquakes swarms have often heralded effusive activity. However, volcanic tremor – the persistently radiated signal by the volcano - has proved to be a key indicator of impending eruptive activity. Changes in the volcano feeder show up in the signature of tremor, its spectral characteristics and source location.
We apply a recently developed software for the analysis of volcanic tremor, combining Kohonen Maps along with Cluster and Fuzzy Analysis, in order to identify transitions from pre-eruptive to eruptive activity. Throughout the analysis of the data flow, the software provides an unsupervised classification of the spectral characteristics (i.e., amplitude and frequency content) of the signal, which is interpreted in the context of a specific state of the volcano. We present an application on the eruptive events occurred during the 2007-2009 time period, encompassing 7 episodes of lava fountaining, periodic Strombolian activity at the summit craters, and a lava emission on the upper east flank of the volcano, which started on 13 May 2008 and ended on 6 July 2009. In this time span the source of volcanic tremor was always shallow (less than 3 km), i. e., within the volcano edifice. From the analysis we conclude that the upraise of magma to the surface was fast, taking several hours to a few minutes. We discuss the possible reasons of such variability in the light of the characteristics of the overall seismicity preceding the eruptions in the study period, taking into account field observations and rheology of the ascending magma as well.