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Pattern classification of volcanic tremor data related to the 2007-2012 Mt. Etna (Italy) eruptive episodes

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From March 2007 to April 2012 one of the main craters of Mt. Etna volcano, the South East Crater, was frequently active with spectacular, even though low dangerous, eruptions mainly in form of lava fountains. Thirty-three eruptive episodes occurred at that crater, encompassing thirty-two paroxysmal lava fountains (seven in 2007-2008 and twenty-five in 2011-2012), and a lava emission, started on 13 May 2008 and ended on 6 July 2009, along the upper eastern flank of the volcano. From the seismic point of view, the onset of all these eruptions was heralded by changes in the spectral characteristics of volcanic tremor recorded by digital broadband stations, which permanently monitor the volcanic region. On the basis of the tremor data collected between 2007 and 2009, some of us (Messina and Langer) developed a software which, combining unsupervised classification methods based on Kohonen Maps and the fuzzy cluster analysis, allows to identify transitions from pre-eruptive to eruptive activity through the classification of the tremor characteristics (i.e. amplitude and frequency content). Since 2010 an on-line version of this software is adopted at the Osservatorio Etneo as one of the automatic alerting tools to identify early stages of eruptive events. The software carries out the analysis of the continuous data stream of two key seismic stations, for which reference datasets were elaborated taking into account the tremor data recorded during the eruptive episodes from 2007 to 2009.
The numerous paroxysmal eruptions occurred in 2011-2012 and the improved network density, in particular on the summit crater area, after 2009, lead us to extend the application of automatic volcanic tremor classification by using a larger number of stations at different elevation and distance from the summit craters. Datasets have been formed for the new stations, while for the previous key stations, the reference datasets were updated adding new patterns of the tremor signal. We discuss the performances of the classifier for the various stations in terms of timing of the early variations and spatial distribution of the stations.