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VOLCANO MONITORING AND EARLY WARNING ON MT ETNA, Italy, USING VOLCANIC TREMOR – METHODS AND TECHNICAL ASPECTS

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Recent activity on Mt Etna was characterized by 25 lava fountains occurred on Mt Etna in 2011 and the first semester of 2012. In summer 2012 volcanic activity in a milder form was noticed within the Bocca Nuova crater, before it came to an essential halt in August 2012. Together with previous unrests (e. g., in 2007-08) these events offer rich material for testing automatic data processing and alert issue in the context of volcano monitoring. Our presentation focuses on the seismic background radiation – volcanic tremor – which has a key role in the surveillance of Mt Etna. From 2006 on a multi-station alert system exploiting STA/LTA ratios, has been established in the INGV operative centre of Catania. Besides, also the frequency content has been found to change correspondingly to the type of volcanic activity, and can thus be exploited for warning purposes. We apply Self Organizing Maps and Fuzzy Clustering which offer an efficient way to visualize signal characteristics and its development with time. These techniques allow to identify early stages of eruptive events and automatically flag a critical status before this becomes evident in conventional monitoring techniques.

Changes of tremor characteristics are related to the position of the source of the signal. Given the dense seismic network we can base the location of the sources on distribution of the amplitudes across the network. The locations proved to be extremely useful for warning throughout both a flank eruption in 2008 as well as the 2011 lava fountains. During all these episodes a clear migration of tremor sources towards the eruptive centres was revealed in advance. The location of the sources completes the picture of an imminent volcanic unrest and corroborates early warnings flagged by the changes of signal characteristics.

Automatic real time data processing poses high demands on computational efficiency, robustness of the methods and stability of data acquisition. The amplitude based multi-station approach is not sensitive to the failure of single stations and therefore offers a good stability. On the other hand, the single station approach, exploiting unsupervised classification techniques, limits logistic efforts, as only one or few key stations are necessary. A common characteristics of both strategies is their robustness to disturbances (undesired transients like earthquakes, noise, short gaps in the continuous data flow). False alarms were not encountered so far.

A critical issue it the reliability of data storage and access. Therefore, a specific hardware cluster architecture has been proposed for failover protection, including a Storage Area Network system. We present concepts of the software architectures which allow easy data access following predefined user policies. We also envisage the integration of seismic data and those originating from other scientific fields (e. g., volcano imagery, geochemistry, deformation, gravity, magneto-telluric). This will facilitate cross-checking of evidences encountered from the single data streams, in particular allow their immediate verification with respect to ground truth.