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Automatic detection and characterization of low frequency seismicity: Long Period events detection and clusterization into families. An example case for Mt. Etna.

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Low frequency seismicity of a volcano renders important information to understand its internal structure. Features like the long-period (LP) events magnitude, their source location, polarization properties or frequency components provide a picture of the source mechanisms producing them and their evolution in time.
Automatic processing adds very valuable tools to study the evolution of these long-period events: (i) Given seismic registers, the low-frequency band of interest can be isolated from undesired high frequencies related to noise or other seismic events that could mask the behavior under analysis; (ii) Noise can be reduced, increasing the signal-to-noise ratio and enhancing the relevant parts of the signal to ease the events detection. (iii) Once a processing strategy is proposed, the automatic processing of the high volume of seismic registers recorded during years of activity, produces an exhaustive and consistent analysis along time. Variations in the rate of occurrence and the characteristics of the events can be used to extract knowledge.
Precisely these variations in the characteristics of the long period events permit to cluster them into families. Families of long period events may share, under the common labeling of 'long period events', special spectral properties, polarization peculiarities, different locations, etc. that provide information about changes (of any type) in the source mechanisms producing them. Often families appear close in time and/or space and are due to changes in the internal structure of the volcano which is highly dynamic. The detection and comprehension of their particular family-based source mechanism idiosyncrasies will improve the overall picture of the subsurface.
In this scenario, known the peculiarities of the low frequency seismicity of Mt Etna during 2010, we propose an 'LP automatic detection and family clustering algorithm to analyze its activity'. Four families of events have been described by volcanologist experts for Mt Etna during that time. After a meticulous analysis, changes in frequency contents and amplitude evolution along occurrence of the long-period event seem to be the best indicators of the idiosyncrasy of each of the four families. Under that assumption, we propose the usage of: (i) the algorithm SALPED (García et al. 2017) to automatically detect LPs, followed by (ii) an automatic window-based analysis of the changes in frequency and amplitude during the onset, central part and coda of the event detected in (i). As a result, LPs are detected and identified (to a lower or greater extent depending on their nature) with one of the families defined. In addition, the algorithm provides a measure or the degree of affinity of the event and the family associated, to handle heterogeneous events corresponding to intermediate stages of the source mechanisms that could be associated to more than one family of LPs.
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