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Convolutive independent component analysis as a tool for an automatic discrimination among seismological sources

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The characterization of the source of volcano-tectonic (VT) earthquakes represents a fundamental task in volcano-seismology . Indeed, the discrimination of seismic events from the ambient background noise is crucial also for civil protection. In the recent years, many efforts have been made to solve the problem of a clear separation of different contributions in the seismic noise, in order to improve the earthquake detection, and many techniques have been proposed to classify seismic signals (Küperkoch et al., 2010).
We show some results obtained from a novel approach based on the Convolutive Independent Component Analysis (CICA) for the separation of different seismic sources. In particular we analyzed the continuous recordings at Campi Flegrei Caldera (Italy) during the 2006 ground uplift: Long Period events and Volcano-Tectonic earthquakes are clearly discriminated and extracted from the background seismic noise, mainly composed by meteo-marine and anthropogenic contributions.
CICA has been implemented for extracting the prominent seismic waveforms from continuously recorded signals and thus allowing for their further analysis. This technique is successful in the case of the blind source separation of convolutive mixtures: seismic signals are thought as the convolution of a source function with path, site and the instrument response. Moreover, time-delayed versions of the same source exist, due to multipath propagation typically caused by reverberations from some obstacle.
We remind that the VT activity at Campi Flegrei Caldera during the 2006 ground uplift (Saccorotti et al., 2007) was characterized by the occurrence of approximately 300 low-magnitude VT earthquakes (Md < 2; for the definition of duration magnitude, see Petrosino et al., 2008). Most of them were concentrated in distinct seismic sequences with hypocenters mainly clustered beneath the Solfatara–Accademia area, at depths ranging between 1 and 4 km b.s.l..
Besides VT earthquakes, LP signals were recorded during seven days, starting on October 23, 2006, and with the maximum rate on days 26 and 27. The events are located at depths of about 500 m b.s.l. beneath the southern rim of the Solfatara crater. Detailed studies on their hydrothermal origin have been made by Falanga and Petrosino (2012) and De Lauro et al. (2012).
Our procedure allows to improve the detection of both low-energy events and of the seismic signals with emergent onset arrivals often buried in the high-level ambient noise. Moreover, a prompt discrimination among different sources of natural/artificial seismicity both in time and frequency domain (FMPSDA) is allowed, by means of a coarse grained variable, i.e. the frequency corresponding to the maximum of power spectral density. This procedure allows the extraction of high-quality waveforms. Finally, the discrimination of small VT is at the basis of compilation of a more complete seismic catalog, having a threshold of completeness much lower , which can be used for further application and study on the source mechanism.