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Enhancing microearthquake detection through non-linear filtering

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The detection of microearthquakes is an important task in various seismological applications as volcano seismology, induced seismicity, and mining safety. Together with improvements in the seismic network technologies (e.g. network densification, borehole installations) it can benefit from techniques of digital signals processing, aimed at enhancing signals related to microearthquakes from the background noise, or in other words it is necessary to improve the signal/noise ratio.
In this work we propose a novel technique based on a non-linear filtering procedure, which has shown to be more efficient, compared to traditional filtering, in enhancing signals related to small microarthquakes from continuous recordings.
The implemented technique consists in a preliminary filtering of the signal followed by an adaptive spectral subtraction. Filter bandpass is between 5 Hz and 40 Hz to eliminate both low and very-high frequency noise. It is applied using a sliding window of 1024 samples in order to take into account gradual changes in the background noise spectrum. Windows are classified as "noise only" or "meaningful signal" (which can be either a microearthquake or any other relevant transient signal) using different features as the signal energy and the zero-crossing rate. Windows recognized to consist of noise only are continuously accumulated in a dynamic buffer which allows the average noise spectrum to be estimated in an adaptive manner.
We applied this procedure to some seismic swarms recorded by Red Sísmica Canaria, managed by Instituto Volcanológico de Canarias (INVOLCAN), on Tenerife and La Palma islands, comparing results from the proposed detection algorithm with standard approaches.