Geophysical Research Abstracts
Vol. 20, EGU2018-16072, 2018
EGU General Assembly 2018

Detection of weak microseismicity in the frequency domain based on non-parametric statistics: the NpD algorithm

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Robust event detection of low signal-to-noise ratio (SNR) events is a common challenge among existing detection algorithms. In particular cases when the hypothesis of stationary background noise levels and normal distribution of the dataset cannot be made, the gap in the existing algorithms needs to be filled. We introduce the NpD (Non-parametric detection) algorithm, an automated detection algorithm that discriminates events by calculating the excess energy contained within small, individual time segments of a recording compared to the energy contained within longer time windows of the same recording. We prove that the NpD algorithm can detect small in magnitude events, less than ML -0.6, from short-period microseismic recordings without any pre-filtering of the data. Another significant advantage is that the NpD algorithm uses non-parametric statistics for the description of the statistical properties of the recorded data, which is the most suitable analysis approach for most passive seismic data sets in which the background noise is highly variable in both time and space. We compare NpD's performance with two other event detection methods, the commonly used STA/LTA, and another highly efficient algorithm based on Power Spectral Density (PSD). We found the NpD algorithm outperforms both the STA/LTA and PSD methods. When compared to the STA/LTA algorithm, the NpD detects a higher number of weak (visually confirmed) events while keeping the number of false positives at a reasonable level. A comparison to the PSD method shows the NpD algorithm detects the same number of weak events but triggers fewer false positives than the PSD method.