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Automatic detection and location of induced microseismicity in geothermal fields: Testing Waveloc and Loki methods.

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One of the main challenges in seismic monitoring in geothermal fields, is to automatically detect and locate induced microseismicity using dense networks. Manual detection and picking is a reliable method, however as the number of stations increases, this strategy becomes inefficient, slow and time consuming.

To overcome these problems, several approaches have been proposed for detection. One of the most common ones is the ratio of Short-Time and Long-Time Averages (STA/LTA), which is very stable and fast. However, lowering the detection thresholds leads to inaccurate results. Other approaches based on picking approximations have been proposed, mostly based on the measurement of statistical conditions. For example: skewness, kurtosis or the Akaike information criterion. These picking methods are often combined with location and migration techniques in order to increase their sensitivity and discriminate real events from fake signals.

In this work, we tested two automatic detection approaches to evaluate their performances in geothermal environments.
The first one relies on P-wave detection, obtained by kurtosis computation in continuous records followed by a migration-based event detector and locator (WAVELOC, Langet et. al. 2014). The second one is based on coherence analysis using waveform stacking for simultaneous detection and location of seismic events (LOKI, Grigoli et al. 2016, 2018). The method uses STA-LTA of characteristic functions processed with the PCA technique to enhance the singnal to noise ratio of the P and S arrivals. The location is further refined by using a master event approach.

We applied the two methods to a dataset collected in the Soultz-sous-Forêts geothermal field (France) during the stimulation of the well GPK2 in 2000. During the stimulation, more than 30,000 events were detected in ten days by a borehole network and more than 14,000 at the surface stations. From this catalogue, more than 11,000 earthquakes were manually picked and about 7,200 located with an accuracy of less than 100 m (Cuenot et al., 2008).
In this work we evaluate how the two automatic methods performed, showing statistical comparison of the results with respect to the hand-made catalogue.

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