Automated seismic event location combining waveform stacking and relative location techniques: An application to geothermal and volcanic environments

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Microseismic monitoring became a common operation in many applications, including monitoring of volcanic areas and underground industrial operations (i.e. induced seismicity). The analysis of microseismicity is challenging, because of the large number of recorded events often characterized by low signal-to-noise ratio. Such seismic datasets are often characterized by multiple events with short inter-event times or overlapping events; in this case, correct phase identification and event association are challenging, and errors can lead to missed detections and/or reduced location resolution. In the last years, to improve the performance of the current data analysis procedure various waveform-based methods for the detection and location of microseismicity have been proposed. These methods exploits the coherence of the waveforms recorded at different stations and do not require the automated picking and phase association procedures. When the recorded waveforms are very noisy, waveform based methods appear to be more robust than the traditional ones (based on phase picking). However, like any other absolute location method, the accuracy of locations strongly depends on the knowledge of the velocity model. Volcanic areas are generally characterized by complex 3D velocity and by a pronounced topography, for these reasons the use of simplified 1D velocity models may strongly affect the locations accuracy. In general, the largest source of error in the seismic event location process is related with the use of inaccurate velocity models (a condition which often occurs in volcanic areas). In this work we apply a location method which combines some features of relative location techniques (such as the source specific station correction term [Richards-Dinger and Shearer 2000]) with the waveform based location methods [Grigoli et al 2016]. This location approach inherits all the advantages of the full waveform location methods without the main drawback which characterizes all the absolute location procedures. In fact, this method is less dependent on the knowledge of the velocity model and presents several benefits, which improve the location accuracy: 1) it accounts for phase delays due to local site effects, e.g. surface topography or variable sediment thickness 2) theoretical velocity model are only used to estimate travel time within the source volume, and not along the entire source-sensor path. We tested this location approach with different datasets, including: a seismic swarm associated with magmatic fluid migrations in NW-Bohemia (Czech Republic) and to seismic swarms in volcanic environments (Piton de la Fournaise Volcano (La Reunion) and Masaya Volcano (Nicaragua)).

References:

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