The use of amplitude measurements for detecting and locating local earthquakes in the Austrian seismic network

Papí Isaba, María del Puy (Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Vienna, AUT);
Jia, Yan (Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Vienna, AUT);
Weginger, Stefan (Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Vienna, AUT)

This study focuses on testing the robust method to detect and locate earthquakes by means of amplitude measurements with data from the Austrian seismic network (ZAMG – Zentralanstalt für Meteorologie und Geodynamik).

The proposed localization method is based on the minimization of maximum resultant ground velocities in sliding time windows covering the whole registered event. The basic idea is that any small seismic source can produce large amplitudes, as long as it is located close enough to the seismic station sensor. The developed method is based on an empirical model of the ground shaking obtained from amplitude data of earthquakes in the area of interest, which were located using traditional methods. Using the Back-Projection approach, we can rapidly determine an event location and its magnitude without picking phases.

The maximum resultant ground velocities are back-projected to every grid point of the study area applying the empirical amplitude – distance relation. We refer to these back-projection values as Back-Projected Ground Velocities (BPGV) or pseudoMagnitudes. The number of operating seismic stations in the network equals the number of pseudoMagnitudes at each grid-point. The method introduces the new idea of selecting the minimum BPGV at each grid-point for further analysis. If no detectable earthquake (earthquake strong enough to exceed the detection threshold) occurred, the spatial distribution of the minimum pseudoMagnitudes constrains the magnitude of weakest earthquakes hidden in the ambient noise. In case of a strong enough earthquake, the spatial distribution of the minimum pseudoMagnitudes shows a significant maximum at the grid-point nearest to the actual epicentre. The application of this method is restricted to the area confined by the convex hull defined by the seismic station network. Additionally, one must ensure that there are no dead traces involved in the processing.

This approach is almost insensitive to outliers (data from locally disturbed seismic stations). The idea of obtaining and storing a Back-Projected Matrix (BPM), independent of the registered amplitude, for each seismic station has the advantage of saving computational time for the calculation of the final maximum pseudoMagnitude, at every grid-point.

The improved method is applied to a new data set obtained from the national Austrian seismic network (ZAMG). The method has been tested for a larger data set and for an extensive seismic network.