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Robust method to detect and locate local earthquakes by means of amplitude measurements.

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In this study we present a robust new method to detect and locate medium and low magnitude local earthquakes. This method is based on an empirical model of the ground motion obtained from amplitude data of earthquakes in the area of interest, which were located using traditional methods. The first step of our method is the computation of maximum resultant ground velocities in sliding time windows covering the whole period of interest. In the second step, these maximum resultant ground velocities are back-projected to every point of a grid covering the whole area of interest while applying the empirical amplitude – distance relations. We refer to these back-projected ground velocities as pseudo-magnitudes. The number of operating seismic stations in the local network equals the number of pseudo-magnitudes at each grid-point. Our method introduces the new idea of selecting the minimum pseudo-magnitude at each grid-point for further analysis instead of searching for a minimum of the L2 or L1 norm. In case no detectable earthquake occurred, the spatial distribution of the minimum pseudo-magnitudes constrains the magnitude of weak earthquakes hidden in the ambient noise. In the case of a detectable local earthquake, the spatial distribution of the minimum pseudo-magnitudes shows a significant maximum at the grid-point nearest to the actual epicenter. The application of our method is restricted to the area confined by the convex hull of the seismic station network. Additionally, one must ensure that there are no dead traces involved in the processing. Compared to methods based on L2 and even L1 norms, our new method is almost wholly insensitive to outliers (data from locally disturbed seismic stations). A further advantage is the fast determination of the epicenter and magnitude of a seismic event located within a seismic network. This is possible due to the method of obtaining and storing a back-projected matrix, independent of the registered amplitude, for each seismic station. As a direct consequence, we are able to save computing time for the calculation of the final back-projected maximum resultant amplitude at every grid-point.

The capability of the method was demonstrated firstly using synthetic data. In the next step, this method was applied to data of 43 local earthquakes of low and medium magnitude (1.7 < magnitude scale < 4.3). These earthquakes were recorded and detected by the seismic network ALPAACT (seismological and geodetic monitoring of Alpine PAnnonian ACtive Tectonics) in the period 2010/06/11 to 2013/09/20. Data provided by the ALPAACT network is used in order to understand seismic activity in the Mürz Valley - Semmering - Vienna Basin transfer fault system in Austria and what makes it such a relatively high earthquake hazard and risk area. The method will substantially support our efforts to involve scholars from polytechnic schools in seismological work within the Sparkling Science project Schools & Quakes.