Precise double-difference locations based on automatic picker

Martin Bachura[(1)] and Tomáš Fischer[(1,2)]

Charles University in Prague, Faculty of Science
Institute of Geophysics, Czech Academy of Science

Seismic activity in the West Bohemia/Vogtland area expresses itself in the form fast event sequences with majority of earthquake swarm-type character. Thousands of events are recorded during each sequence whose efficient processing requires automation of the procedure.

Recently processing of the WEBNET data has been automated using the PEPiN picker and locator, which provides P and S-wave arrival time picks and preliminary location and magnitude determination; the automatic picks are then approved by human interpretor in routine processing. The error of automatic picks ranges within few first samples, which is expressed also in the rather low location residual with median of about 0.05 s.

In order to avoid the necessity of manual inspection we further enhance the accuracy of the automatically measured arrival times by measuring delay times within pairs of events using the waveform cross-correlations method. We cross-correlate the P and S-wave time windows that are derived from the automatic arrival time picks. The resulting delay times are, along with the automatic catalog picks, used as an input for hypoDD relocation software package. To limit the computation time we crosscorrelate only waveforms of the event pairs with similar locations, which is accomplished by clustering the events using the ph2dt code.

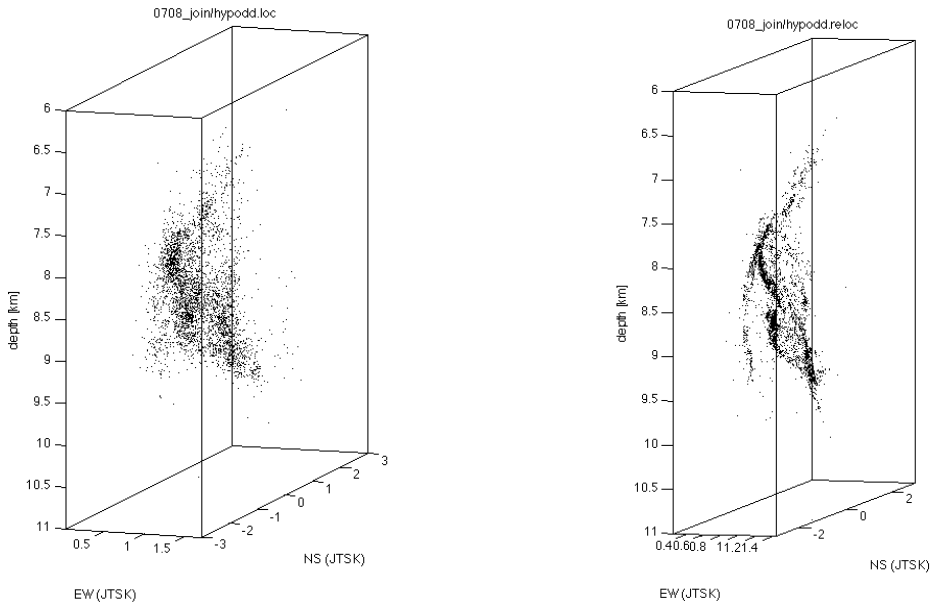

Figure 1. Hypocenters of 3700 ML<4.5 events occurred in May and August 2014 in the Nový Kostel region (West Bohemia) obtained by PEPiN automatic picker (left) and HypoDD relocations using cross-correlation delay time measurements (right).

We applied this fully automatic approach to data from 2011 earthquake swarm, which resulted in significant increase of the location precision (Figure 1). By application to the 2011 earthquake swarm we were able to compare the automatic locations with the manual ones: automatic picking has detected about 23 000 events compared to about 6000 of manual ones. However, the automatic picker skipped about 15% of the events with magnitudes up to 2.5; these events occurred mainly during fast earthquake sequences when the P and S phases of different events overlap in the station records. In total about 5900 events of the 2011 swarm (M_L range 0 to 3.5) and 3300 events of the 2014 earthquake sequences (M_L range 0 to 4.5) were successfully located.