A SEMI-AUTOMATIC ARRIVAL-TIME PICKING ALGORITHM BASED ON THE SIMILARITY BETWEEN WAVEFORMS OF EARTHQUAKE MULTIPLETS: THE CASE OF THE EFPALIO 2010 AFTERSHOCK SEQUENCE

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On 2010 January 18 and 26 two earthquakes of magnitude M_w=5.1 occurred near the city of Efpalio, Greece, situated in the western Corinth rift. The mainshocks were followed by an important aftershock sequence covering an epicentral area of about 5x10km^2. Several stations of the HUSN and CRL networks are installed in local and regional distances from the epicenters. A semi-automatic arrival-time picking algorithm, based on waveform similarity, was developed in order to pick a large number of smaller events, most of which would be hard to be analyzed manually because of their low energy content. This procedure takes advantage of the large number of earthquakes which are densely clustered in space and time during aftershock sequences. It is common for such events to exhibit similarities in their waveform recordings due to the comparable values of their source parameters.

The applied methodology uses a correlation detector to match the similar parts of the P- or S-waves of selected, well-recorded, master-events to the corresponding waveform recordings of large groups of smaller, non-located, slave events. These events are detected by a reference station, situated close to the aftershocks epicentral area. Cross-correlation matrices are constructed using the event-waveforms recorded at the reference station to provide information about the similarity between event-pairs. A nearest-neighbor linkage method is used to construct multiplet clusters with an appropriate cross-correlation threshold. At least one of the stronger events is selected from each cluster. These are called Master-events and their P- and S-wave arrival-times have to be picked manually with great precision. The automatic algorithm that follows uses the P- or S-wave part of the master-events recordings as a correlation detector in order to find the best matching part in each of the slave-event recordings. An automatic arrival-time is then imposed for the slave-event at the corresponding station. The fitting process is performed on each of the 3 components and every pick is characterized by an observation weight according to the quality of the fit, the type of the available waveform components and the consistency between multiple measurements.

A series of tests have been performed for the evaluation of the correlation detector under variable SNR levels. Statistics were also applied on several parameters that are being measured during the fitting procedure, in order to calculate appropriate multipliers which were used for the calculation of a combined observation weight. The developed methodology has the potential to increase the amount of available information by about ten times and provide sufficient detail for a subsequent analysis of the spatiotemporal distribution of a seismic series. The manual analysis of these automatically located events can provide important details for the geometry of the activated faults, contributing to studies of the seismotectonic characteristics of an area.