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Picking vs Waveform based detection and location methods for induced seismicity monitoring

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Microseismic monitoring is a common operation in various industrial activities related to geo-resouces, such as oil and gas and mining operations or geothermal energy exploitation. In microseismic monitoring we generally deal with large datasets from dense monitoring networks that require robust automated analysis procedures. The seismic sequences being monitored are often characterized by very many events with short inter-event times that can even provide overlapped seismic signatures. In these situations, traditional approaches that identify seismic events using dense seismic networks based on detections, phase identification and event association can fail, leading to missed detections and/or reduced location resolution. In recent years, to improve the quality of automated catalogues, various waveform-based methods for the detection and location of microseismicity have been proposed. These methods exploit the coherence of the waveforms recorded at different stations and do not require any automated picking procedure. Although this family of methods have been applied to different induced seismicity datasets, an extensive comparison with sophisticated pick-based detection and location methods is still lacking. We aim here to perform a systematic comparison in term of performance using the waveform-based method LOKI and the pick-based detection and location methods (SCAUTOLOC and SCANLOC) implemented within the SeisComP3 software package. SCANLOC is a new detection and location method specifically designed for seismic monitoring at local scale. Although recent applications have proved an extensive test with induced seismicity datasets have been not yet performed. This method is based on a cluster search algorithm to associate detections to one or many potential earthquake sources. On the other hand, SCAUTOLOC is more a “conventional” method and is the basic tool for seismic event detection and location in SeisComp3. This approach was specifically designed for regional and teleseismic applications, thus its performance with microseismic data might be limited. We analyze the performance of the three methodologies for a synthetic dataset with realistic noise conditions as well as for the first hour of continuous waveform data, including the Ml 3.5 St. Gallen earthquake, recorded by a microseismic network deployed in the area. We finally compare the results obtained all these three methods with a manually revised catalogue.