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A consistent and uniform research earthquake catalog for the AlpArray region

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We take advantage of the new large seismic data set provided by the AlpArray Seismic Network (AASN) as part of the AlpArray research initiative (www.alparray.ethz.ch), to provide consistent and precise hypocenter locations and uniform magnitude calculations across the greater Alpine region. The AASN is composed of more than 650 broadband seismic stations, 300 of which are temporary. The uniform station coverage provides an unique occasion to study the laterally strongly variable seismicity that is presently monitored and reported by a dozen individual observatories. A homogeneous earthquake catalog in terms of location and magnitude is a prerequisite to improve our understanding of seismo-tectonics and the seismic hazard in the greater Alpine region.

Our catalog covers four years of seismicity with a targeted magnitude of completeness of 2.5 from 2016 to 2019 and results from scanning ≈ 1000 broadband stations (≈ 60 TB of data). First, we detect and analyse events in the region using the STA/LTA based detector of the SeisComp3 monitoring system in off-line mode. Later, after an initial location has been obtained, we apply a high-quality semi-automated re-picking approach defining the consistent phase arrival times in combination with timing uncertainties and phase identification assessment. This automatic re-picking framework is implemented with the QUAKE library (Bagagli et al., 2019), an object-oriented Python package that exploit different waveform information both frequency- and energy- related by taking advantage of different well-established picking algorithms. The QUAKE picker has been tuned and tested against a consistent phases reference data set (P-, S- and secondary phases) of ≈ 2500 phases manually picked for 10 events ($M \geq 2.5$) homogeneously distributed in the region.

Subsequently, the high-quality automatic picks of selected well-locatable earthquakes are used to calculate a minimum 1D P-wave velocity model for the region with appropriate stations corrections. Finally, all events are relocated with the NonLinLoc algorithm in combination with the updated 1D model and a final estimate of the magnitude is given. We compare our locations and magnitudes with existing regional and local earthquake catalogs (ISC, EMSC, national catalogs) to assess and discuss the completeness and quality of the derived AlpArray research catalog.