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Importance of data quality and assessment of solution quality in local earthquake tomography: Application to the Alpine region

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In arrival time tomography the minimum resolvable velocity perturbation depends on model parameterization and data quality. The quality of arrival time data is governed by picking accuracy and by consistency. While effects of the former in seismic tomography are dealt with by damping, effects of inconsistency are much more difficult to control. In this study we investigate the effect of inconsistently picked arrival time data in local earthquake tomography by comparing results from the Alpine region which were obtained using two data sets: i) a rather small data set of 13'000 arrival times that has been obtained by automated quality-weighted re-picking and ii) a rather large data set of 95'000 arrival times that has been taken from the ISC Bulletin. Three-dimensional P-wave velocity models were computed for each data set using the same model parameterization, ray tracing technique, and damping. Our results indicate that the upper crust is rather well resolved by the lower quality ISC data set due to higher data coverage compared to the smaller high-quality data set. Structures in the lower crust, however, are more clearly resolved by the smaller data set. To assess the solution quality, we ran several tests with synthetic velocity models and increasing noise level. Our results suggest that the ISC data set in principle has the potential to resolve structures with a high detail at all depth ranges but it is likely contaminated by a significant number of inconsistently picked data. Our results demonstrate that low-quality and inconsistent data can severely degrade the solution quality in seismic tomography. We further conclude that the effect of inconsistent data on the solution quality in seismic tomography can only be assessed through tests with synthetic velocity models.