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Consistent earthquake catalog derived from changing network configurations: Application to the Rawil Depression in the southwestern Helvetic Alps

Timothy Lee (1), Tobias Diehl (1), Edi Kissling (2), and Stefan Wiemer (1)
(1) Swiss Seismological Service, ETH Zurich, 8092, Switzerland, (2) Institute of Geophysics, ETH Zurich, 8092, Switzerland

Earthquake catalogs derived from several decades of observations are often biased by network geometries, location procedures, and data quality changing with time. To study the long-term spatio-temporal behavior of seismogenic fault zones at high-resolution, a consistent homogenization and improvement of earthquake catalogs is required. Assuming that data quality and network density generally improves with time, procedures are needed, which use the best available data to homogeneously solve the coupled hypocenter – velocity structure problem and can be as well applied to earlier network configurations in the same region. A common approach to uniformly relocate earthquake catalogs is the calculation of a so-called "minimum 1D" model, which is derived from the simultaneous inversion for hypocenters and 1D velocity structure, including station specific delay-time corrections. In this work, we will present strategies using the principles of the "minimum 1D" model to consistently relocate hypocenters recorded by the Swiss Seismological Service (SED) in the Swiss Alps over a period of 17 years in a region, which is characterized by significant changes in network configurations.
The target region of this study is the Rawil depression, which is located between the Aar and Mont Blanc massifs in southwestern Switzerland. The Rhone-Simplon Fault is located to the south of the Rawil depression and is considered as a dextral strike-slip fault representing the dominant tectonic boundary between Helvetic nappes to the north and Penninic nappes to the south. Current strike-slip earthquakes, however, occur predominantly in a narrow, east-west striking cluster located in the Rawil depression north of the Rhone-Simplon Fault. Recent earthquake swarms near Sion and Sierre in 2011 and 2016, on the other hand, indicate seismically active dextral faults close to the Rhone valley. The region north and south of the Rhone-Simplon Fault is one of the most seismically active regions in Switzerland and therefore a prime target to study the mechanics of active fault zones in the Swiss Alps. In the presented study, existing travel-time data from the SED bulletin from the entire instrumental era (1984-today) are used to calculate a "minimum 1D" model for the region. The dataset is complemented by data of three broadband stations, recently installed to further densify the seismic network of the SED in the Rawil area. The new model is compared to previous local and regional 1D and 3D models. The derived model is used for systematic relocation of the seismicity in the Rawil region and will be used as reference model for high-resolution 3D models imaging the velocity structure of the Rawil fault zone in a next step. The presented procedure is of relevance for similar studies planned in other regions of the Alps, which have been densified by AlpArray stations.