Towards real-time double-difference earthquake location in Switzerland

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1. Introduction

Detailed information on the spatio-temporal migration of seismic activity within earthquake sequences provides an important seismotectonic context for rapid hazard evaluation. For these applications, monitoring the migration of seismicity requires the precise location of hypocenters in real time. The double-difference (DD) location method in combination with differential times measured from arrival-time picks and waveform cross-correlation (Waldhauser & Ellsworth 2000) provides high-resolution images of seismic activity. The method was adopted for real-time application (Waldhauser 2009). The concept of this approach is an algorithm locating a new event with respect to a background catalog using the DD-formulation.

In the present work, we applied waveform cross-correlation and double-difference relocation to the entire digital archive of the Swiss Seismological Service (SED) to derive a background catalog for real-time DD applications. We present the first results of the relocation approach and compare them with similar studies of isolated earthquake sequences and quarry blasts in Switzerland.

2. Time-Domain Waveform Cross-Correlation

Waveform cross-correlation (CC) of neighboring events (separation < 3 km) is used to improve the resolution of different times. CC windows are based on manual picks of predicted travel times from a 3D velocity model ("guides"). Lengths of time windows and maximum time lags depend on phase type (P or S) and available "guides." Frequency band for all events is 1 - 30 Hz (4th order). Thresholds for CC-coefficients, signal-to-noise ratios, and the number of local maxima in the CC function close to the global maximum are used as quality criteria for the CC-measurements to be used in the double-difference location.

3. Waveform Similarities & Clusters from Waveform Cross-Correlation

4. Double-Difference Relocation: Earthquakes

5. Double-Difference Relocation: Explosions

6. Towards Real-Time Implementation in the SC3 Environment

The chart on the right shows the real-time DD procedure operational in the Northern California Seismic Network (Waldhauser 2009). In red we show our strategy to implement a similar real-time DD approach in the SeisComp framework of the Swiss National Network (Waldhauser 2009). In blue we show the operation of the Swiss Seismological Service.

References: