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Earthquake source inversion for moderate magnitude seismic events based on GPS simulated high-rate data

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The development of GNSS technology with the potential of high-rate (up to 100Hz) GNSS (GPS, GLONASS, Galileo, Compass) records allows the monitoring of the seismic ground motions. In this study we show the potential of estimating the earthquake magnitude (Mw) and the fault geometry parameters (slip, depth, length, rake, dip, strike) during the propagation of seismic waves based on high-rate GPS network data and using a non-linear inversion algorithm. The examined area is the Valais (South-West Switzerland) where a permanent GPS network of 15 stations (COGEAR and AGNES GPS networks) is operational and where the occurrence of an earthquake of Mw$\approx$6 is possible every 80 years.

We test our methodology using synthetic events of magnitude 6.0-6.5 corresponding to normal fault according to most of the fault mechanisms of the area, for surface and buried rupture. The epicentres are located in the Valais close to the epicentre of previous historical earthquakes. For each earthquake, synthetic seismic data (velocity records) of 15 sites, corresponding to the current GPS network sites in Valais, were produced. The synthetic seismic data were integrated into displacement time-series. By jointly using these time-series with the Bernese GNSS Software 5.1 (modified), 10Hz sampling rate GPS records were generated assuming a noise of peak-to-peak amplitudes of $\pm$1cm and $\pm$3cm for the horizontal and for the vertical components, respectively.

The GPS records were processed and resulted in kinematic time series from where the seismic displacements were derived and inverted for the magnitude and the fault geometry parameters. The inversion results indicate that it is possible to estimate both, the earthquake magnitudes and the fault geometry parameters in real-time ($\sim$10 seconds after the fault rupture). The accuracy of the results depends on the geometry of the GPS network and of the position of the earthquake epicentre.