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Seismic full moment tensors with uncertainties for mass movements in Switzerland

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We estimate seismic full moment tensors with uncertainties for large mass movements in the Swiss Alps and vicinity. The mass movements considered here have total volume estimates between 1,000–4,000,000 m^3. We analyze the waveforms that were generated by these events and recorded at broadband seismic stations predominantly from the Swiss Seismological Service (SED). The waveforms show a broad range of signals, from long-periods up to 100 seconds for the larger events to frequencies of 1 Hz and higher for smaller events. We use an algorithm for moment tensor inversion that performs a grid search over the six-dimensional space of moment tensors, generating synthetic waveforms at each moment tensor grid point and then evaluating a misfit function between the observed and synthetic waveforms. The synthetic waveforms are computed using a 1-D structure model for the region; this approximation requires careful assessment of time shifts between data and synthetics, as well as careful choice of the bandpass for filtering. For each moment tensor we characterize its uncertainty in terms of waveform misfit, a probability function, and a confidence curve for the probability that the true moment tensor lies within the neighborhood of the optimal moment tensor. Whether the moment tensor can be applied to seismic sources related to mass movements depends, as expected, on the source dimension, characteristics of the mass movement including topography, rheology of the mass material, etc. The moment tensors estimated here are for events with predominantly long-period signals. Within the range of the reported volumes for the mass movements, these signals are observable for volumes of about 200,000 m^3 and higher. Here we discuss these results, in particular the recent event in Bondo, Switzerland that occurred on 2017-08-23 and is estimated to have a total volume of about 4,000,000 m^3. Our preliminary magnitude estimate for this event is Mw 4.6 which is comparable to the largest earthquake in Switzerland in 2017.