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Near-field strong ground motion from dynamic earthquake ruptures in heterogeneous stress fields

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Our study aims at improving the understanding of the dependence of ground motion parameters and their variability on the physical source properties. In particular we investigate the near-field ground motion resulting from dynamic rupture models with heterogeneity in the initial shear stress parameterized in a stochastic manner.

The ground velocity seismograms are synthesized by convolving the time histories of slip velocity obtained from spontaneous dynamic rupture models with Green's functions of the medium response calculated with a discrete wavenumber/finite element method.

Peak ground velocity (PGV) estimated on the synthetics generally matches well with an empirically derived attenuation relation, whereas spectral acceleration (SA) only shows an acceptable match at periods longer than 1s. Usage of the geometric mean to average the two orthogonal components leads to a systematic bias for the synthetics, in particular at the stations closest to the fault. This bias is avoided by using orientation independent measures.

The contribution from stress heterogeneity to the overall ground motion variability is found to be strongest close to the fault and in the backward directivity region of unilaterally propagating rupture. In general, the intra-event variability originating from the radiation pattern and the effect of directivity is on the same order or larger than the inter-event variability. The inter-event ground-motion variability itself originates to a large extent from the differences in hypocenter position and to a lesser extent from the differences in the dynamic rupture process due to the stress heterogeneity.