Calibration of a new ground motion model to earthquake strong-motion in South Iceland

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The simulation of earthquake strong-motion for earthquake engineering applications is an important tool for the quantification of earthquake hazard and the management of seismic risk. The simulations should ideally be based on seismological models that have been calibrated on the basis of recorded data. While earthquake strong-motion records show considerable variability in key parameters such as peak ground acceleration and derived quantities such as spectral response, for a given earthquake magnitude and distance, this variability is generally not captured by ground motion prediction equations. However, this variability is especially important in various practical applications such as fragility analyses. A feasible way of incorporating such variability into simulations is to use a ground motion model that is centered on a simple, yet physically realistic model of the earthquake source. The specific barrier model provides the most complete, yet parsimonious, self-consistent description of the earthquake faulting process and applies both in the near-fault and far-field region. The seismic moment is distributed on the fault plane via subevents on the basis of moment and area constraints. Thus, the model allows for consistent ground motion simulations over a large range of frequencies and distances. For simulations in the far-field region the source acceleration spectrum exists in analytical form and accounts for a high degree of earthquake source complexity and source-site geometry. In the near-fault region, the near-fault velocity pulses, which are the most characteristic feature of near-fault strong-motion, scale with key parameters of the specific barrier model and may effectively be simulated using a phenomenological model. The key model parameter, the local stress drop, has been inferred from Icelandic strong-motion data. The variations in site conditions of the recording sites have been approximated with frequency dependent functions, which may contrast with recent results of site response on lava. The variation of the seismological model in terms of individual parameters is captured using Bayesian inference. Variations of the earthquake source spectra are introduced via theoretical models quantifying the effects of various subevent populations on the earthquake source and empirical models accounting for directivity effects. Finally we discuss the corresponding implications on the level of source complexity (subevent populations) of earthquakes of different magnitudes. That in turn has important implications for using the specific barrier model in modeling the earthquake as an extended source for near-fault simulations.