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A new Near-Fault Earthquake Ground Motion Model for Iceland from Bayesian Hierarchical Modeling

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The strongest earthquakes in Southwest Iceland take place on a large number of North-South near-vertical dextral strike-slip faults located side-by-side along the entire zone. The capital region along with multiple small towns are in close proximity or on top of this fault system, along with all infrastructure and lifelines of our modern society. As a result, seismic hazard is the highest in this region and performing a probabilistic seismic hazard assessment (PSHA) as the most used procedure to reduce the ruinous effects of large earthquakes is vital. A reliable PSHA requires a reliable ground motion models (GMMs) that can appropriately describe the ground shaking at any given location. However, past PSHA efforts in Iceland did not account for the complex near-fault effects in the form of long-period, high-amplitude velocity pulses that are the most damaging feature of ground motions in the near-fault region. Recently, a new 3D finite-fault system model of the entire bookshelf zone has been proposed for Southwest Iceland. The model has been balanced against the rate of the tectonic plate motions and its seismic activity has been shown to be variable along the entire zone. Given the unknown fault locations, the model allows both for deterministic and random fault locations, and each fault is completely specified in terms of its maximum magnitude, its dimensions and its long-term slip and moment rate. In collaboration with ChEESE project, a realization of a 3000-year finite-fault earthquake catalogue based on the 3D finite-fault system model has been implemented in the CyberShake platform and the ground motion of each earthquake have been simulated for a dense grid of 594 stations. The simulation has been carried out on high-performance computing systems of the Barcelona Supercomputing Centre in Spain. The variation of hypocentral locations and slip distribution on each finite-fault has produced 18 million event-station pairs of synthetic two-horizontal-component low-frequency ground motion time histories that have just become available, those that are simulated less than 40 km from the faults contain near-fault high-amplitude velocity pulses at larger magnitudes, where actual data is nonexistent in Iceland (i.e., above 6.5). Therefore, the purpose of this study is to use a new and vast near-fault dataset of synthetic ground motions to develop a near-fault GMM using an advanced Bayesian Hierarchical Modeling (BHM) for Southwest Iceland.