Validation of ground-motion simulations using precarious rocks

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We develop ground motion simulations for a major reverse fault in central Otago, New Zealand, and use ancient precariously-balanced rocks (PBRs; unstably balanced rocks on top of pedestals) to validate the simulations, rather than the standard approach of using instrumental strong motion records for validation. The Dunstan Fault, a 60 km long reverse fault, is responsible for the uplift of the Dunstan Mountains (1500-1600 m). PBRs are abundant within a few km of the southwestern end of the fault, and are therefore conveniently located for validating simulated ground motions from $M \geq 7$ near-field Dunstan Fault earthquakes. The fragility age (age since the PBR reached the present unstable morphology), and fragility (the peak ground acceleration (PGA) required to topple the PBR, based on field-based estimates), are compared to the recurrence interval and simulated ground motions of Dunstan Fault earthquakes. Earlier studies show cosmogenic Be^{10} exposure dates for two PBRs are in the range of 40,400 to 55,300 years B.P., and the Dunstan Fault to show a recurrence interval of about 8000 years. Therefore, the PBRs have likely experienced repeated large earthquakes where ground-motions did not exceed their fragilities (i.e. PGAs no greater than 0.7 g). The PBR fragilities fall within the range of PGAs produced by the simulations (0.16-1.33 g), with about 16% of them exceeding the highest fragility. Decreasing kappa from the default value of 0.04 to a value more representative of Otago (0.016) results in an overall increase of simulated PGAs by about 30%, with 36% of them exceeding the highest PBR fragility (0.7 g). We are currently identifying the parameters responsible for the high PGAs in the 36% of simulations. Our research represents the first effort at using PBRs to validate ground-motion simulations in New Zealand, and has been jointly supported by University of Otago, QuakeCoRE, and GNS Science.