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Towards merging of broadband ground motion simulations and ground motion prediction equations for probabilistic seismic hazard assessment

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One of ideal goals for probabilistic seismic hazard assessment is merging of broadband ground motion simulations and ground motion prediction equations. Ground motion prediction equations are widely used to provide stable values of average and sigma. However, even amplitude spectra from ground motion prediction equations are the same, ground motion time histories can be quite different due to how to model phase spectra. Rupture directivity pulses with large amplitude in short duration can be reproduced by simultaneous arrival timing of each period component. On the other hand, long-period ground motions with smaller amplitude in long duration can be reproduced by dispersive arrival timing of each period component. Recent ground motion prediction equations start to incorporate with phase spectra as a group delay time as well as amplitude spectra (e.g., Satoh et al., 2010). This new generation of ground motion prediction equations will provide broadband ground motion time histories based on empirical observations. For the next step, how to merge broadband ground motion simulations into ground motion prediction equations? Lessons from recent damaging earthquakes tell us that ground motion simulations for scenario earthquakes in advance are useful for less frequent events. In case of more frequent events for a given magnitude, overlaying huge amount of ground motion simulations including rupture directivity effect, hanging-wall effect, near-fault ground motions, and others, can provide average and sigma values for a single ground motion prediction equation. This merging explores the alternative establishment of probabilistic seismic hazard assessment with ground motion time histories based on empirical observations supported by simulations of unexpected scenario earthquakes.