

## Ground-motion prediction equations: Past, present, and future

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Ground-motion prediction equations (GMPEs) typically give amplitudes of ground motion as a function of distance from earthquakes of a particular magnitude. They are the foundations on which the seismic hazard maps used in building codes are built, they provide motions for the design of critical structures, and they and the databases used in their derivation conveniently summarize a large amount of information about the seismic waves radiated from earthquakes. The development of GMPEs requires knowledge of many aspects of seismology, including data acquisition, data processing, source physics, the determination of crustal structure, the effects of that structure on the propagation of seismic waves, the measurement and characterization of the geotechnical properties near the Earth's surface, and the nonlinear response of soils to strong shaking. Generally, GMPEs are developed for three regions: active crustal regions (ACR), stable continental regions (SCR), and subduction zones (SZ). Most GMPEs in ACRs and SZs are based on empirical analysis of observed ground motion, while those in data-poor areas such as SCRs rely primarily on simulations of ground shaking. As data sets increase and theoretical simulations improve, previous GMPEs are revised and new ones are proposed. As a result, many hundreds of GMPEs have been published, and more are on their way. As an example of the current state-of-practice for GMPEs in ACRs, I will discuss a recent multi-year project undertaken by the Pacific Earthquake Engineering Research Center (PEER). The future is bound to bring more data, but most of these data will be for magnitudes and distances where present GMPEs are well constrained by existing data, at least in ACRs. Significant gaps will continue to exist in our knowledge of ground shaking in certain distance and magnitude ranges for ACRs and for SCRs in general. For this reason, combinations of simulated and observed motions will be used to create future GMPEs.