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Aleatory variability associated with GMPEs versus seismological models: the case of central Italy

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The prediction of the ground motion for any specific scenario of interest is a fundamental step of any seismic hazard assessment. Considering the intrinsic randomness of the physical processes controlling the generation and propagation of the seismic waves and the unavoidable assumptions inherent to any attempt of modeling such processes, the characterization of the ground motion variability requires the same level of attention as paid to assess its mean expectation. If, on one hand, the pragmatic approach of splitting the uncertainties in aleatory and epistemic components allow to easily propagate them through the probabilistic hazard computation, on the other hand it supports the development of physical-oriented approaches in defining ground motion models. In this study, we analyze a high-quality data set composed of more than 9000 acceleration and velocity waveforms recorded in Central Italy in the time period from 2008 January 1 to 2013 May 31, including the 2009 L'Aquila (Mw 6.1) sequence. The data set spans the magnitude range 3.0–6.1 and covers epicentral distances up to 120 km (Pacor et al., 2016; Geophys. J. Int. 204, 697–718). First, information about source, propagation and site effects are extracted by performing a generalized inversion (GIT) of the Fourier amplitude spectra. The results are interpreted in terms of standard seismological models (e.g., Brune model for the source spectra) and scaling relations among the source parameters are investigated as well. Then, standard mixed effect regressions are performed to derive GMPE for both Fourier and Response spectra, including random effects (RE) accounting for the source-to-source, station-to-station, and record-to-record variability. The RE distributions resulting from the different regressions are compared and interpreted in terms of source, propagation and site parameters as achieved through the generalized inversion. Finally, the seismological models are implemented in a stochastic framework to generate synthetic ground motion used, in turn, to define equivalent point source models for hazard assessment.