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Ground motion prediction and earthquake scenarios in the volcanic region of Mt. Etna (Southern Italy

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One of the principal issues in the assessment of seismic hazard is the prediction of relevant ground motion parameters, e. g., peak ground acceleration, radiated seismic energy, response spectra, at some distance from the source. Here we first present ground motion prediction equations (GMPE) for horizontal components for the area of Mt. Etna and adjacent zones. Our analysis is based on 4878 three component seismograms related to 129 seismic events with local magnitudes ranging from 3.0 to 4.8, hypocentral distances up to 200 km, and focal depth shallower than 30 km. Accounting for the specific seismotectonic and geological conditions of the considered area we have divided our data set into three sub-groups: (i) Shallow Mt. Etna Events (SEE), i.e. typically volcano-tectonic events in the area of Mt. Etna having a focal depth less than 5 km; (ii) Deep Mt. Etna Events (DEE), i.e. events in the volcanic region, but with a depth greater than 5 km; (iii) Extra Mt. Etna Events (EEE), i.e. purely tectonic events falling outside the area of Mt. Etna. The predicted PGAs for the SEE are lower than those predicted for the DEE and the EEE, reflecting their lower high-frequency energy content. We explain this observation as due to the lower stress drops. The attenuation relationships are compared to the ones most commonly used, such as by Sabetta and Pugliese (1987)for Italy, or Ambraseys et al. (1996) for Europe. Whereas our GMPEs are based on small earthquakes, the magnitudes covered by the two above mentioned attenuation relationships regard moderate to large magnitudes (up to 6.8 and 7.9, respectively). We show that the extrapolation of our GMPEs to magnitues beyond the range covered by the data is misleading; at the same time also the afore mentioned relationships fail to predict ground motion parameters for our data set. Despite of these discrepancies, we can exploit our data for setting up scenarios for strong earthquakes for which no instrumental recordings are available. Our small earthquakes provide useful information, in particular with respect to the effects of wave propagation. This information can be used for the calibration of input parameters used in synthetic modeling of larger earthquakes. We discuss the application of a finite-fault stochastic simulation method of ground motion (i.e. EXSIM software by Motazedian and Atkinson, 2005) considering the small earthquakes as being representative for the subfaults foriming the extended sources. With this strategy we are able to resolve basic discrepancies between our GMPEs and those reported in the literature, especially regarding to the decay of peak ground motion parameters with distance and their dependence on magnitude. We show case-studies for both instrumentally recorded events as well as stronger historical earthquakes for which only macroseismic data are available.