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Evaluating the agreement between recordings and simulation results: use of both seismological and engineering criteria within the framework of Euroseistest Verification and Validation Project (E2VP)

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Numerical prediction of the ground motion is a major challenge for seismic hazard assessment, especially in regions of low to moderate seismicity where only few data are available. With the continuous improvement of the 3-D numerical methods and the increase of computational power, it is now possible to simulate earthquake ground motion even for realistic configurations, for example large models (size of tens of kilometers) including low shear wave velocities (< 200 m/s) and site effects up to 4-5 Hz. However at those frequencies the ground motion is affected by a large variety of features: for examples lithology of the rocks, geometry of the free surface and of the near-surface structures, damping. The diversity and the potential combination of these features slow down the understanding of the ground motion in the high-frequency range and thus increase the difficulty to obtain a satisfying agreement between predicted and recorded waveforms.
We perform a comparison exercise between recorded waveforms and their predictions by 3-D numerical methods. This work is based on the international project E2VP (Euroseistest Verification and Validation Project) on the Mygdonian basin, northwest of Thessaloniki, Greece.
It is not so simple to decide the criteria of what is good or poor agreement between recordings and their numerical predictions. The experience in E2VP shows the answer could be a matter of point of view. Our goal is to evaluate the reliability of the simulation tools for civil engineering design purposes, but it is definitely necessary to include the seismologist point of view as well; their expertise is essential in order to identify the reason of discrepancy between recordings and their numerical predictions, and thus to suggest ways of improvement.
We discuss on the respective interest of several seismological and engineering parameters (including PGA, elastic spectral acceleration, Arias intensity, relative significant duration, transfer functions, and full waveform criteria) to estimate the level of agreement between predicted and recorded waveforms. Each parameter is associated to a characteristic of the waveform and a short selection of parameters is proposed in order to cover different and representative characteristics. The scaling of the level of agreement for each parameter is also discussed. The comparison exercise performed in E2VP shows that the agreement between predicted and recorded waveforms is excellent when considering specific parameters while it can be bad when considering other parameters. Those differences in agreement are finally related to 1) lessons learned from the previous verification exercise in E2VP that consisted in identifying key factors affecting the accuracy of 3-D simulations, and 2) uncertainties on the source parameters and on the details of the model, associated to the intrinsic variability of the ground motion.