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Ground motion prediction equations for intermediate-depth earthquakes in the Southern Aegean Subduction Zone : Identification of significant along-arc/back-arc differences and their impact on seismic hazard

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Ground-motion equations for earthquakes that occur in subduction zones are an important input for seismic-hazard analyses. Interplate thrust earthquakes as well as large events that occur within the subducting slab along the Hellenic arc can pose significant hazard to the broader South Aegean area. In order to study the impact of significant intermediate-depth earthquakes (M4.5-6.7) in the seismic hazard of the area, a response spectra database is compiled from hundreds of high quality data from both acceleration-sensor and broadband velocity-sensor instruments. The size of this database is much larger than the available one for previous empirical regressions, which enables improved determination of the various parameters of ground motion attenuation. New terms accounting for the highly complex propagation of seismic waves in the Greek subduction zone are introduced based on the hypocentral depth and location of the event, as these factors control the effects of the back-arc low-velocity low-Q mantle wedge on the seismic wave propagation. The derived results show a strong dependence of the recorded ground motions on both hypocentral depth and distance, which leads to the classification of the data set into three depth-hypocentral distance categories. Ground motions from in-slab earthquakes with h>100km, are amplified for along-arc stations, probably due to channeled waves through the high-velocity slab, as well as attenuated in back-arc ones, due to the low-Q mantle wedge, independent of their hypocentral distance. On the other hand for shallower events, 60km<h<80km and 80km<h<100km, the corresponding differentiation of seismic motion for along-arc and back-arc stations is observed beyond a specific critical hypocentral distance range. Moreover, for longer periods, both along-arc amplification and back-arc attenuation factors strongly diminish, suggesting that the longer wavelengths of seismic waves “ignore” the complex geophysical structure, resulting in similar ground motions for both back-arc and along-arc stations. Finally, the impact of the revised attenuation relations on seismic hazard is demonstrated through synthetic maps, as well as their incorporation in a revised hazard analysis for the Southern Aegean area using random catalogues.