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Testing non-linear amplification factors used in ground motion models

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Non-linear site effects are mainly expected for strong ground motions and sites with soft soils and more recent ground-motion models (GMM) have started to include such effects. Observations in this range are, however, sparse, and most non-linear site amplification models are therefore partly or fully based on numerical simulations. We develop a framework for testing of non-linear site amplification models using data from the comprehensive Kiban-Kyoshin network in Japan. The test is reproducible, following the vision of the Collaboratory for the Study of Earthquake Predictability (CSEP), and takes advantage of new large datasets to evaluate whether or not non-linear site effects predicted by site-amplification models are supported by empirical data. The site amplification models are tested using residuals between the observations and predictions from a GMM based only on magnitude and distance. When the GMM is derived without any site term, the site-specific variability extracted from the residuals is expected to capture the site response of a site. The non-linear site amplification models are tested against a linear amplification model on individual well-recording stations. Finally, the result is compared to building codes where non-linearity is included. The test shows that for most of the sites selected as having sufficient records, the non-linear site-amplification models do not score better than the linear amplification model. This suggests that including non-linear site amplification in GMMs and building codes may not yet be justified, at least not in the range of ground motions considered in the test (peak ground acceleration < 0.2 g).