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Site-Effects Model for Central and Eastern North America Based on Peak Frequency and Average Shear Wave Velocity

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We develop an empirical site amplification model for sites in central and eastern North America (CENA) using the peak frequency of the site response transfer function (fpeak) and the time-averaged shear-wave velocity in the upper 30 m (VS30). The database for the study includes peak ground-motion amplitudes and 5%-damped pseudo spectral acceleration extracted from the Next-Generation-Attenuation-East database. The site terms are derived by analyzing the residuals calculated from the empirical data with respect to a selected regional GMPE model developed for hard-rock reference site conditions (Atkinson et al., 2015). We develop two alternative site effects models for CENA, each of which assumes that either fpeak or VS30 is the main site variable, then models any remaining residual trends with respect to the other parameter. For the first alternative, assuming that VS30 is the main model parameter, we obtain a frequency-dependent VS30 scaling term that is similar in form to that obtained in previous studies for sites in Western North America (WNA). However, the scaling term is less significant in amplitude for CENA in comparison to that for WNA, suggesting that VS30 is not as indicative of site response in CENA. For the second alternative, assuming that fpeak is the main site-effects parameter, a frequency-independent VS30 scaling term is obtained for CENA, which is much smaller in amplitude compared to the VS30 scaling effect derived in the first approach. This shows that by using fpeak as the primary site-effects modeling parameter, we remove most of the VS30 scaling effects that are implied by the data. Finally, we provide recommendations on the effective use of fpeak and VS30 to model site effects in CENA, differentiating between glaciated and non-glaciated sites. Glaciated sites show larger amplifications compared to non-glaciated sites, especially at intermediate-to-high frequencies, presumably due to the high impedance contrast at the base of the soil profile.