**Electronic Supplement to**

***Ground-Motion Models for Very-Hard Rock Sites in Eastern North America: An Update***

**By David M. Boore**

This electronic supplement includes residual figures for periods of 0.1, 0.2, 0.5, 1.0, and 2.0 s, for ground-motion models (GMMs) derived from nine attenuation models and two stress parameters: $\Delta\sigma_{200}$ and $\Delta\sigma_{600}$. It also contains a residual figure for $\Delta\sigma_{200}$ and a period of 5.0 s. It also contains zip files containing the BCA10D, AB14mod1, and AB14mod2 GMMs and the parameter files and random-vibration adjustment files used in the stochastic model simulations.

**Figures**:

In all figures, each figure part (a--h) shows residuals for a different attenuation model (as shown in the boxed comment within each part).

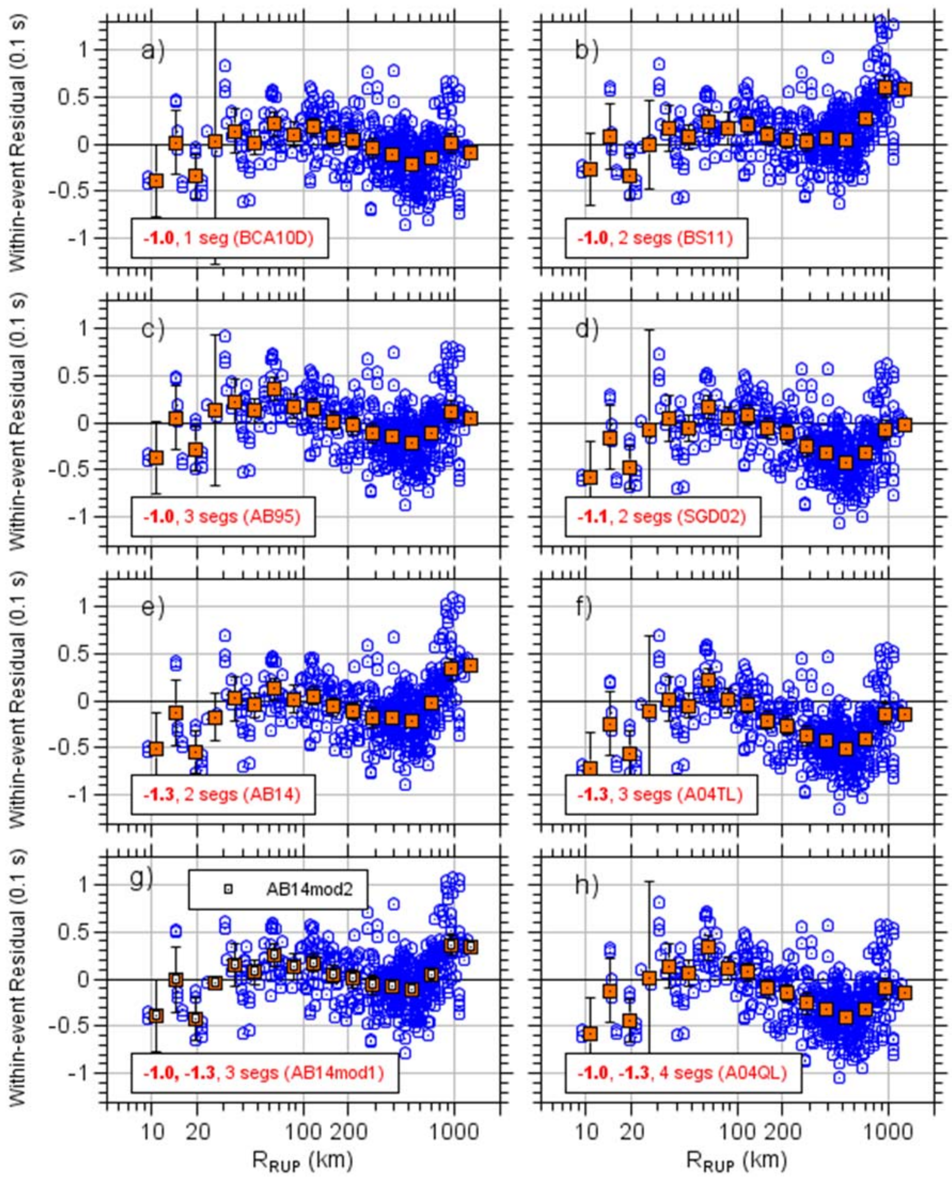


Figure S1. Within-event residuals of $T = 0.1$ s pseudoacceleration response spectra (PSA) (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{200}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g), the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

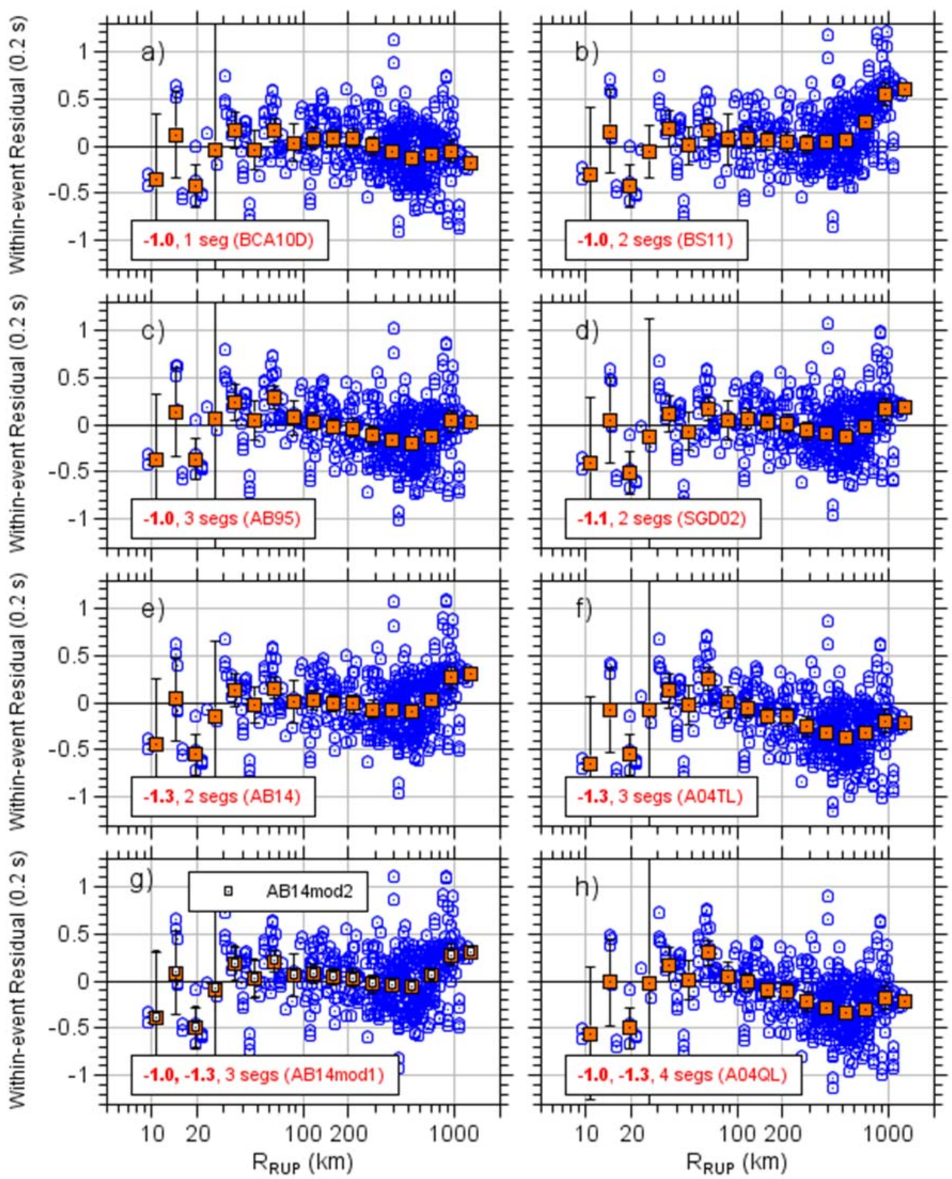


Figure S2. Within-event residuals of $T = 0.2$ s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{200}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g), the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

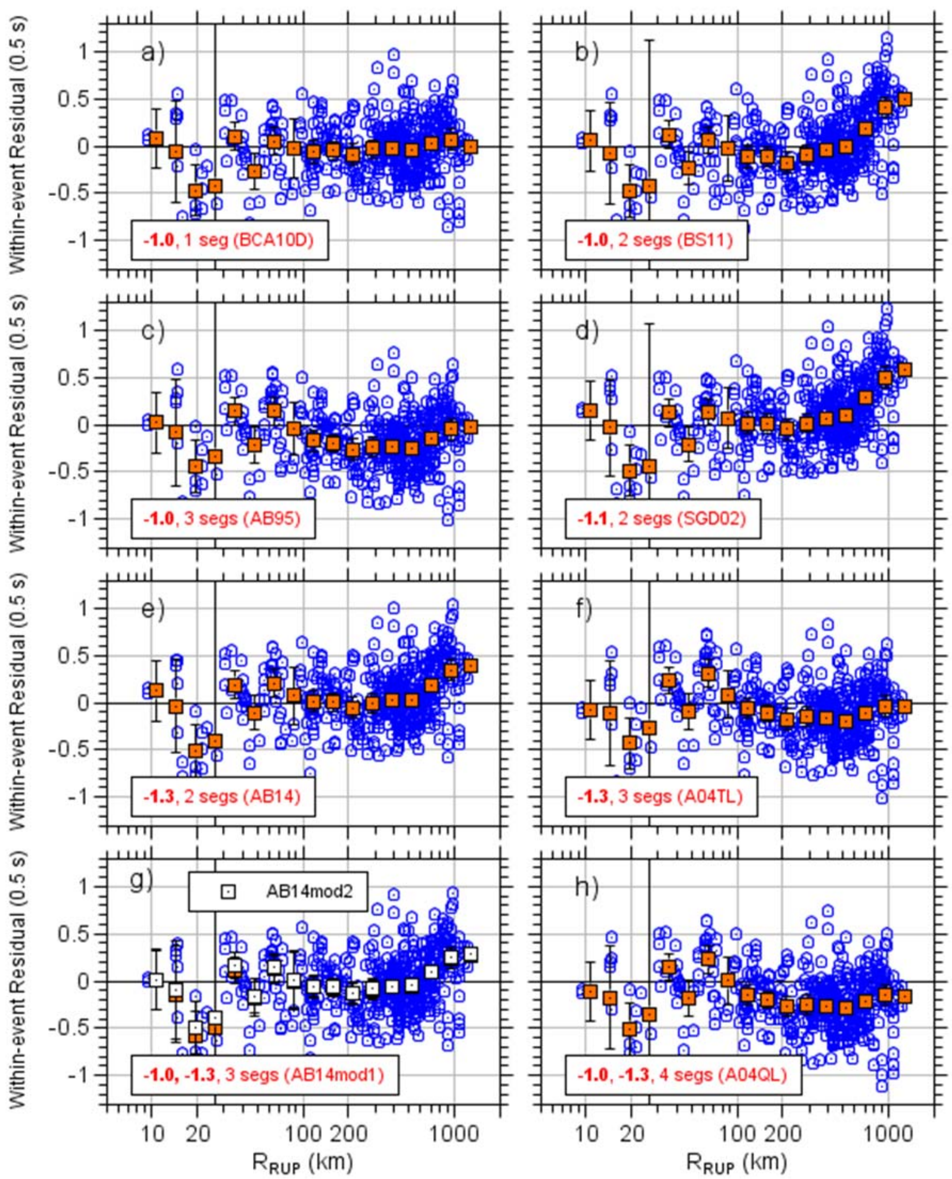


Figure S3. Within-event residuals of $T = 0.5$ s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{200}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g) the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

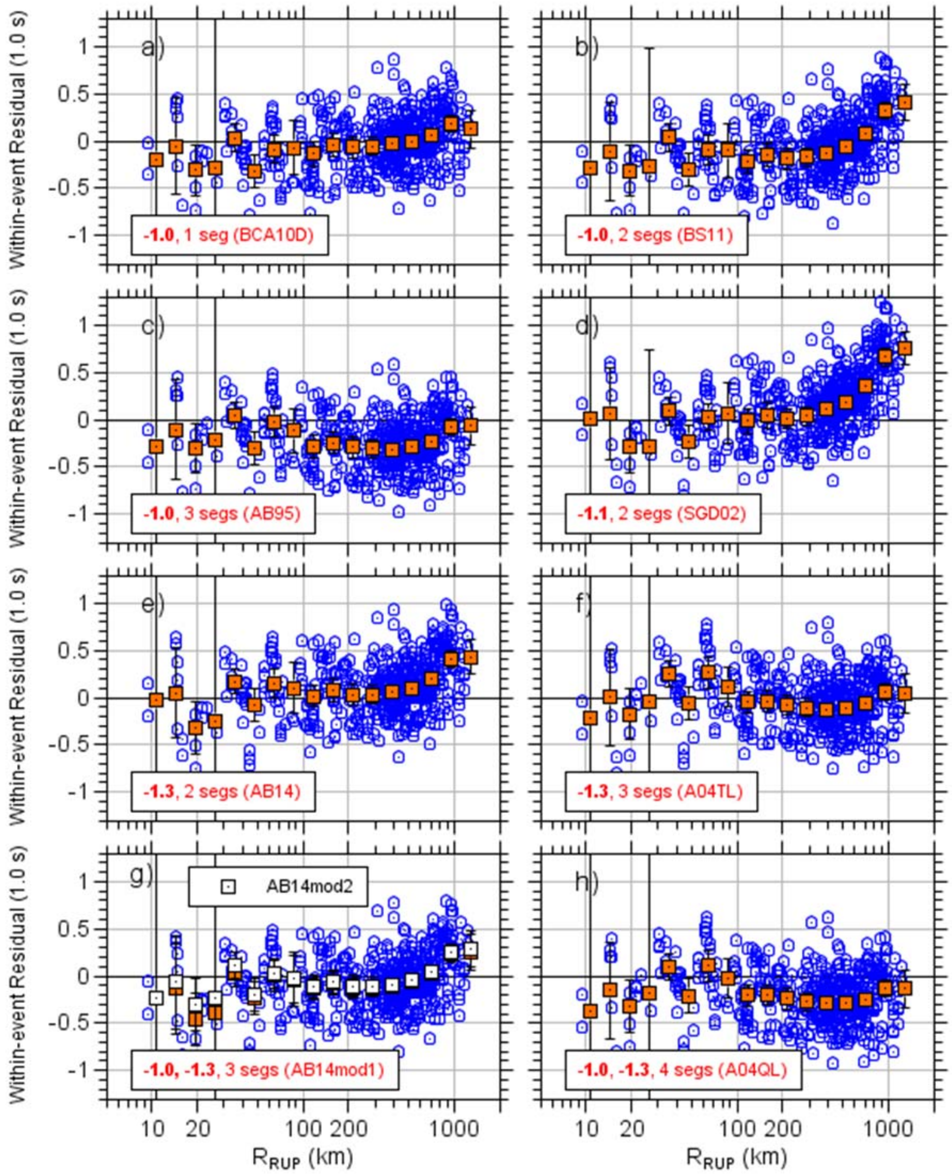


Figure S4. Within-event residuals of $T$ = 1.0 s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{200}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g) the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

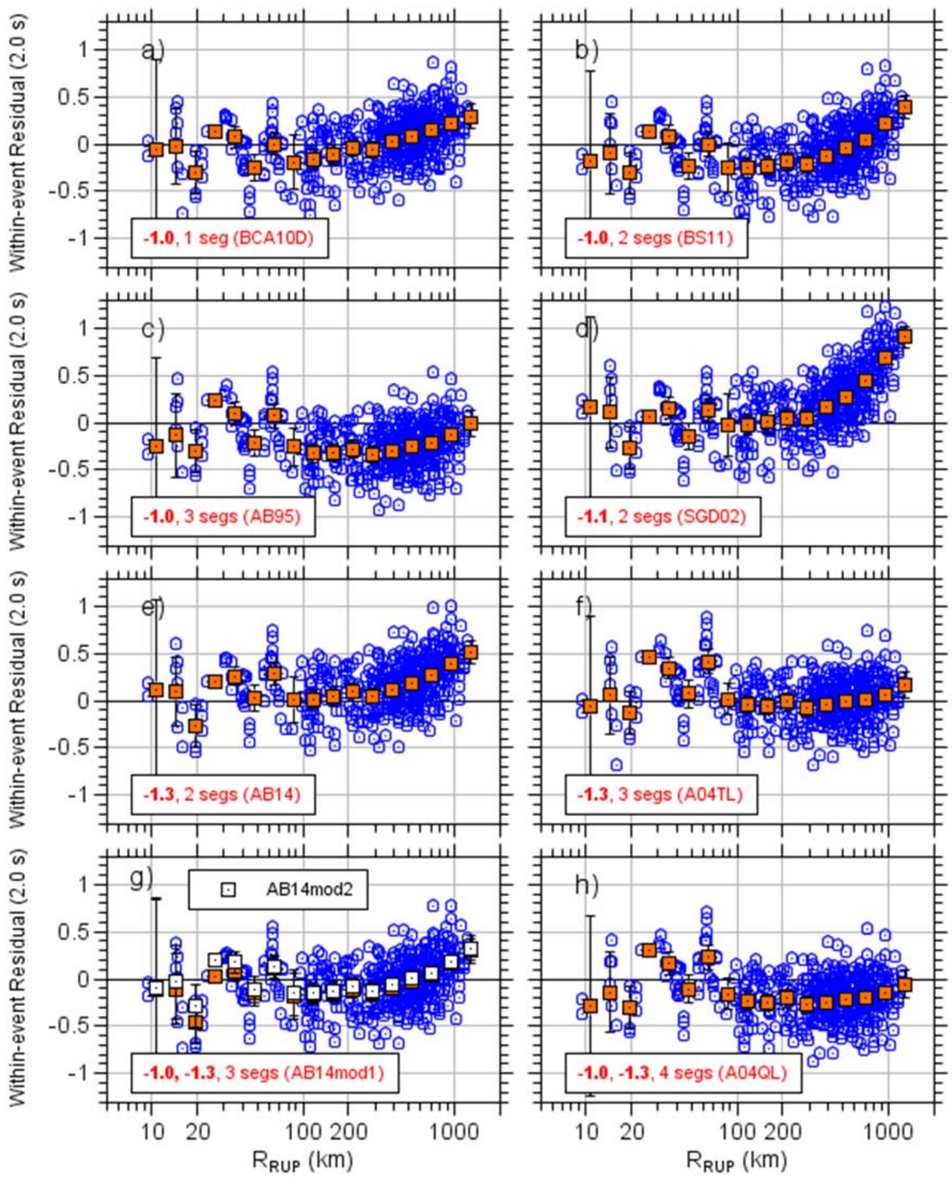


Figure S5. Within-event residuals of $T$ = 2.0 s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{200}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g) the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

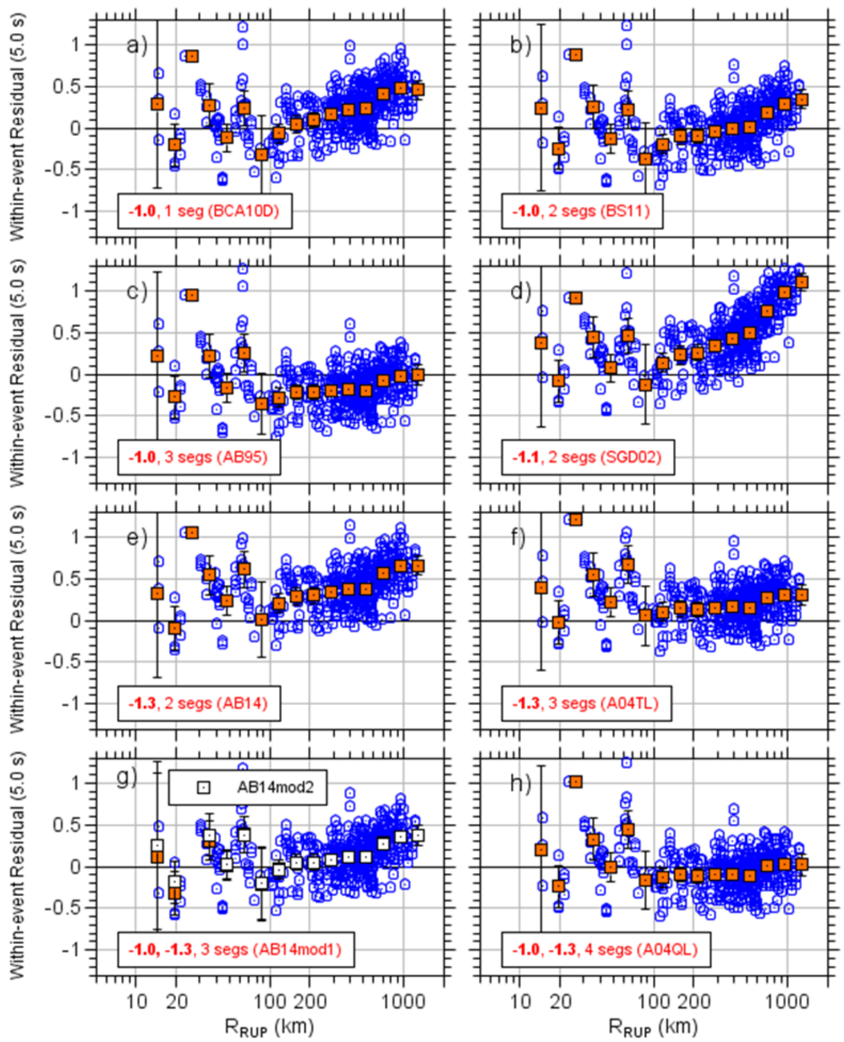


Figure S6. Within-event residuals of $T = 5.0$ s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{200}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g) the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

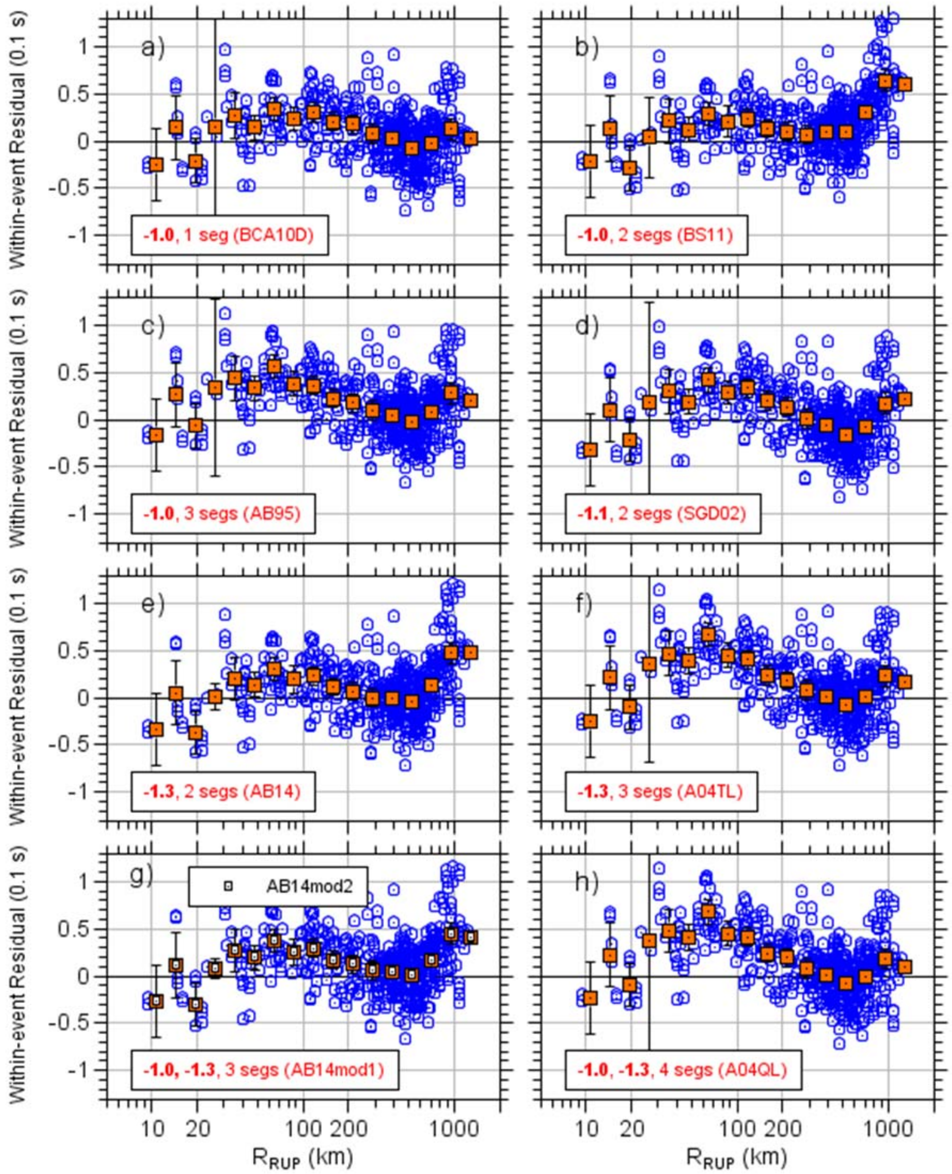


Figure S7. Within-event residuals of $T$ = 0.1 s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{600}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g) the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

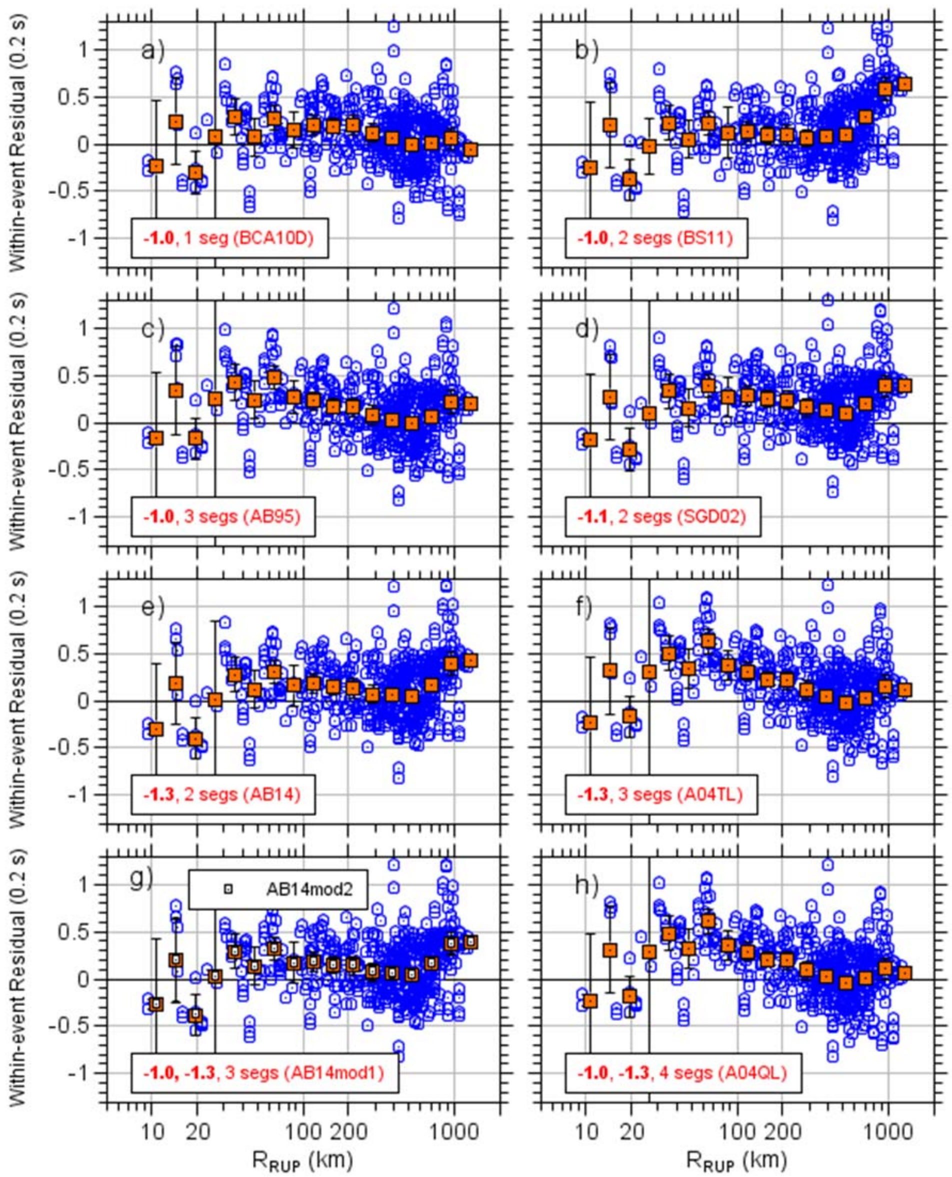


Figure S8. Within-event residuals of $T = 0.2$ s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{600}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g) the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

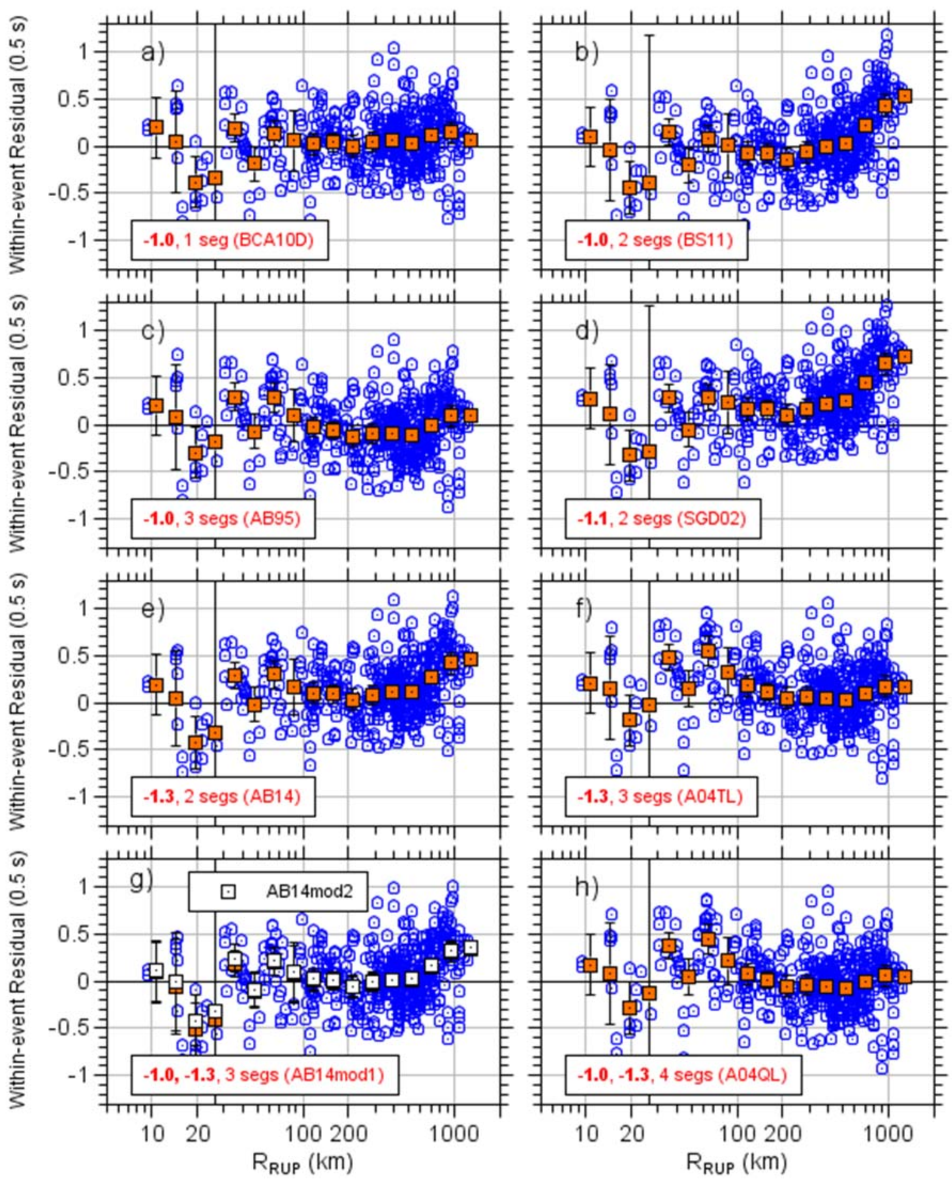


Figure S9. Within-event residuals of $T = 0.5$ s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{600}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g) the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

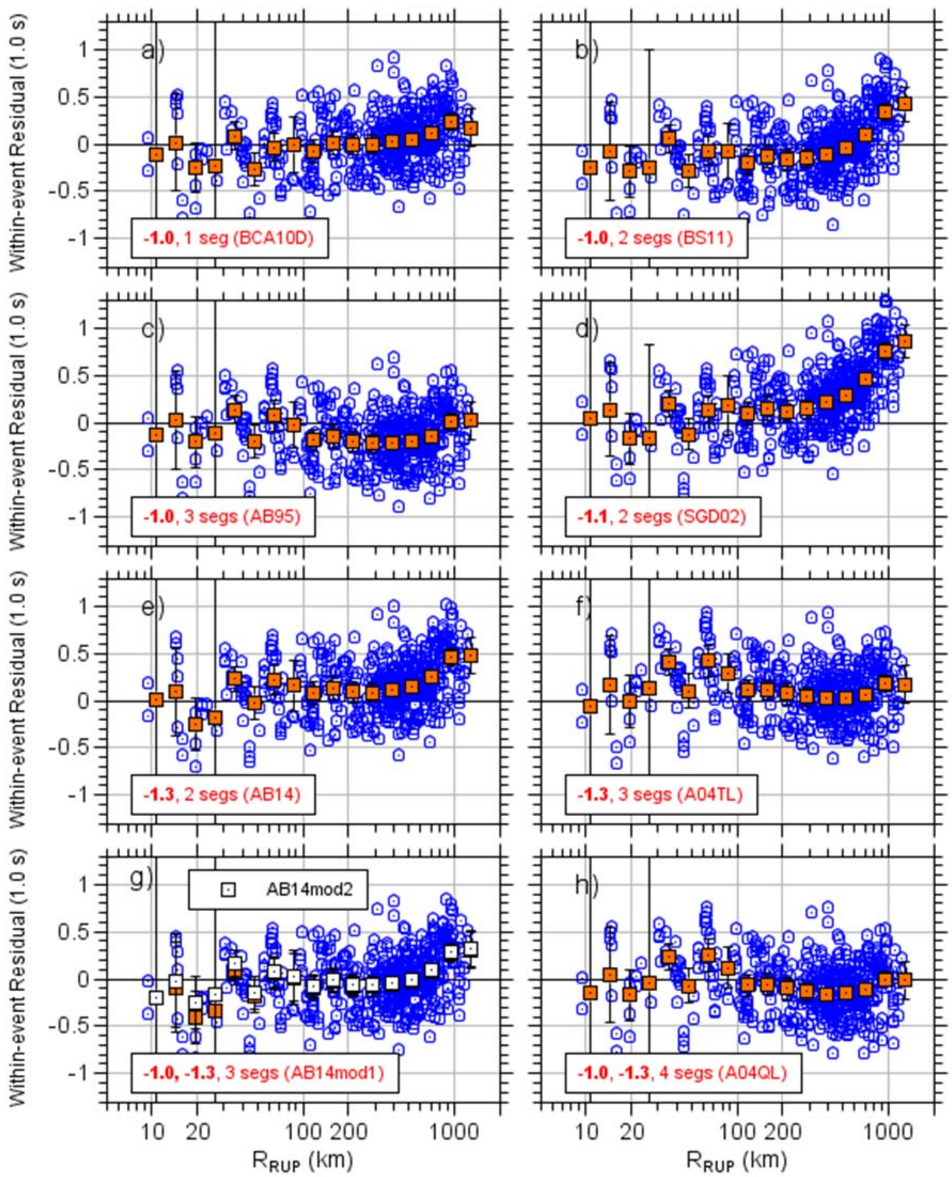


Figure S10. Within-event residuals of $T$ = 1.0 s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{600}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g) the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

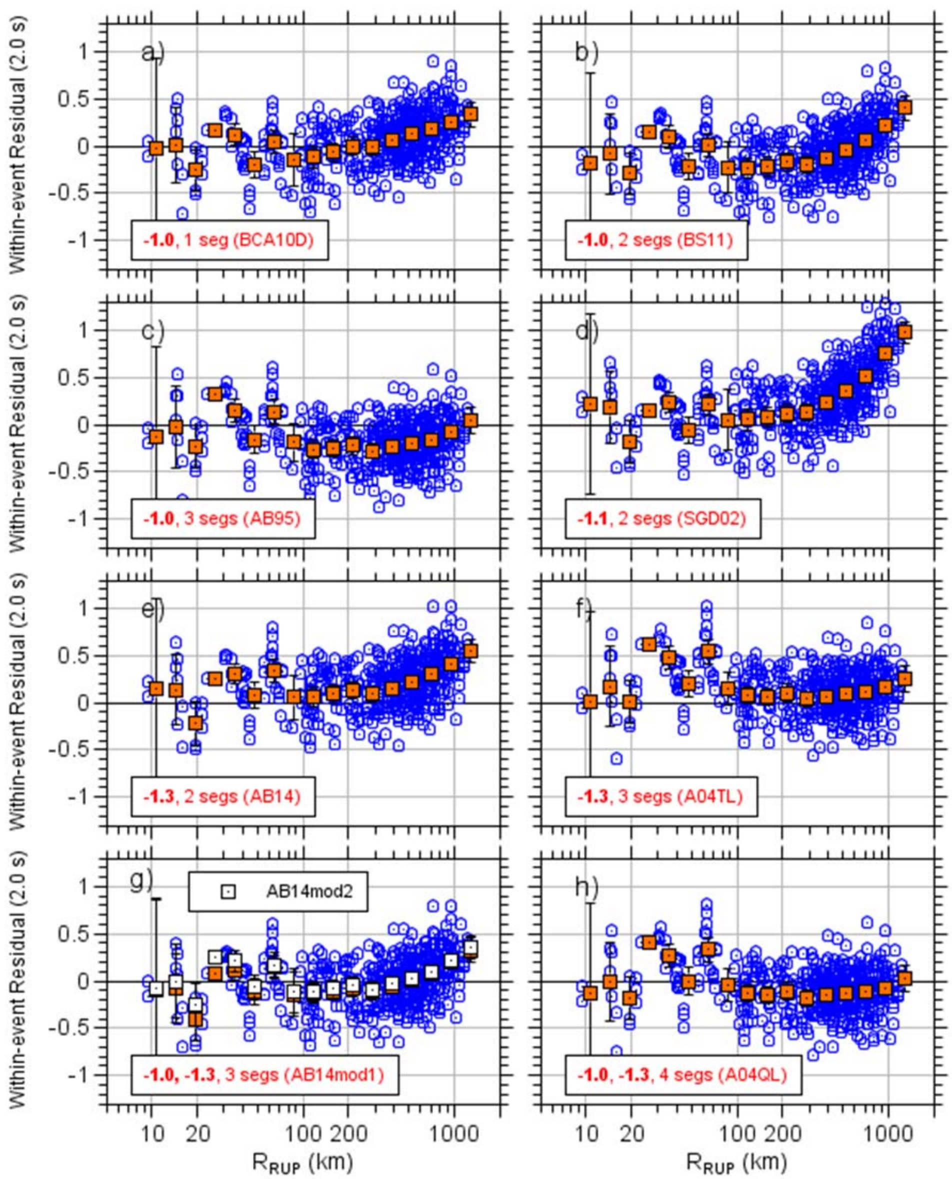


Figure S11. Within-event residuals of $T$ = 2.0 s PSA (circles), after adding back the overall bias $c_k$, as a function of distance, for each of the attenuation models (and $\Delta\sigma_{600}$). The filled squares are averages in distance bins for the models given in the boxed comments; in (g) the unfilled squares are bin averages for the AB14mod2 model. The bars, barely visible for the larger distances, are 95% confidence intervals of the bin averages for the models in the boxed comments.

## Other

### Ground-Motion Models Archives

**Download:** ab14mod1_gmm.vs30_3kps.zip [zipped plain text files; ~2.0 MB]. The ground-motion models for the AB14mod1 attenuation model and a site with $V_{S30}$ = 3.0 km/s.

**Download:** ab14mod2_gmm.vs30_3kps.zip [zipped plain text files; ~2.0 MB]. The ground-motion models for the AB14mod2 attenuation model and a site with $V_{S30}$ = 3.0 km/s.

**Download:** bca10d_gmm.vs30_3kps.zip [zipped plain text files; ~2.0 MB]. The ground-motion models for the BCA10D attenuation model and a site with $V_{S30}$ = 3.0 km/s.

**Download:** ab14mod1_gmm.vs30_2kps.zip [zipped plain text files; ~2.0 MB]. The ground-motion models for the AB14mod1 attenuation model and a site with $V_{S30}$ = 2.0 km/s.

**Download:** ab14mod2_gmm.vs30_2kps.zip [zipped plain text files; ~2.0 MB]. The ground-motion models for the AB14mod2 attenuation model and a site with $V_{S30}$ = 2.0 km/s.

**Download:** bca10d_gmm.vs30_2kps.zip [zipped plain text files; ~2.0 MB]. The ground-motion models for the BCA10D attenuation model and a site with $V_{S30}$ = 2.0 km/s.

The above-mentioned zip files contain a set of files with tables of ground motion, one file per ground-motion intensity measure, as indicated in each file's name. For example, in ab14mod2_gmm.vs30_3kps.zip, the file reformat.tmrsk_loop_rv_drvr.ab14mod.3kps_amps.bt15scr_fff.col.T_PGA.out contains peak ground acceleration (PGA) for the AB14mod2 model (also known as the AB14mod model, hence the file name). The motions are for a site with $V_{S30}$ km/s (this was the $V_{S30}$ specified for the GMMs in the Next Generation Attenuation-East [NGA-East] project), and the simulations used the Boore and Thompson (2015) finite-fault factor (fff) for stable continental regions (scr).

As another example, in ab14mod1_gmm.vs30_3kps.zip, the file reformat.tmrsk_loop_rv_drvr.ab14rlt10mod.3kps_amps.bt15scr_fff.col.T0.100.out contains response spectra (all response spectra are for a 5% damped oscillator) for a period of 1.0 s, for the AB14mod1 attenuation model (called the AB14Rlt10mod model during model development, hence the file name). I have also provided GMMs for $V_{S30}$ = 2.0 km/s, as indicated in the names of the zip files. This $V_{S30}$ is more appropriate for hard-rock sites in eastern North America (ENA) than $V_{S30}$ = 3.0 km/s is. The columns in each file have these meanings and units: Per, oscillator period (in s); Freq, oscillator frequency (in Hz); M, moment magnitude; Rrup, closest distance from the site to the fault rupture (in km); Rps, the point-source distance used in the stochastic model simulations (in km); Yg, the ground-motion intensity measure indicated in the file name (in units of *g*); and Ycgs, the ground-motion intensity measure indicated in the file name (in units of cm/s$^2$).

## Files Used in Stochastic Method Simulations

**Download:** files_for_smsim.zip [zipped plain text files; ~126 KB]. This zip file contains 18 parameters files (nine attenuation models and two crustal amplification models for each attenuation model). It also contains the Boore and Thompson (2015) time-domain to random-vibration oscillator adjustments. The parameter files have the extension "params" with filenames such as "ena.scf.bt15scr_fff.ab14mod1_atten.bt15_dp.dmb_3kps_amps_aoi_00.bt15e_drms.params." This example file is for ENA simulations using a single corner frequency (scf) source model, the Boore and Thompson (2015) (bt15) scr fff, and AB14mod1 (ab14mod1) attenuation model, the Boore and Thompson (2015) source duration model (bt15_dp), my crustal amplifications for a site with $V_{S30}$ = 3 km/s (dmb_3kps_amps) computed assuming an angle of incidence (aoi) of 0°, and the Boore and Thompson (2015) time-domain to random-vibration oscillator adjustments for the root mean square (rms) duration (drms) in ENA (bt15e_drms). Note that the stress parameters used in the simulations were set in the program tmrsk_loop_rv_drvr and are not those appearing in the params files.

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## Reference

Boore, D. M., and E. M. Thompson (2015). Revisions to some parameters used in stochastic-method simulations of ground motion, *Bull. Seismol. Soc. Am.* **105**, 1029–1041.