

Hi [REDACTED],

I wanted to pass along to you an insight I had recently about the influence of the specific spectral model for the earthquake source on ground motion. I suspect that this comes too late for your review, but did want to mention it to you.

I was recently reviewing work one of our postdocs is doing on the spectra of induced earthquakes. Her work shows that, at least for one high quality data set, the 1980 spectral model of Boatwright fits the spectral shape of the data significantly better than Brune's 1970 model.

The equation for the Brune model is

$$u_1(f) = \frac{M_0}{1 + \left(\frac{f}{f_{c1}}\right)^2}$$

and that for the Boatwright model is

$$u_1(f) = \frac{M_0}{\sqrt{2} \sqrt{1 + \left(\frac{f}{f_{c1}}\right)^2}}$$

Boatwright's model has a sharper corner than Brune's model and as a consequence radiates more energy near the corner for the same seismic moment and high-frequency acceleration asymptote. At the corner, the amplitude is 1.4 times that of the Brune model (actually $\sqrt{2}$), and the total radiated energy is greater by a factor of about 3.25.

Earlier studies by Abercrombie found that both models fit data equally well, although the data was not of the same quality. So, at a minimum, the Boatwright model should be considered as a candidate for the source spectrum.

By considering only the Brune model, the GMPEs presented by Bommer et al., may be underestimating the ground motions. This could be handled by logic tree branches (epistemic uncertainty), but might also be resolved by careful analysis of the seismograms if the data is of sufficient

quality. Perhaps this is something that we at Stanford could investigate if there was an interest.

Let me know if you have any questions about this or the report.

Cheers,

Bill

Here's the reference for Boatwright:

Boatwright, John. "A spectral theory for circular seismic sources; simple estimates of source dimension, dynamic stress drop, and radiated seismic energy." *Bulletin of the Seismological Society of America* 70, no. 1 (1980): 1-27.