Incorporating Seismic Attenuation in Strong Ground Motion Applications

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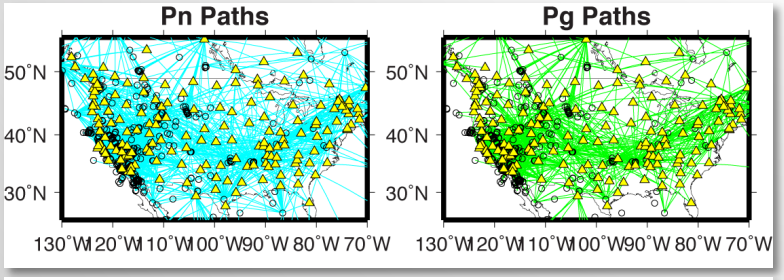
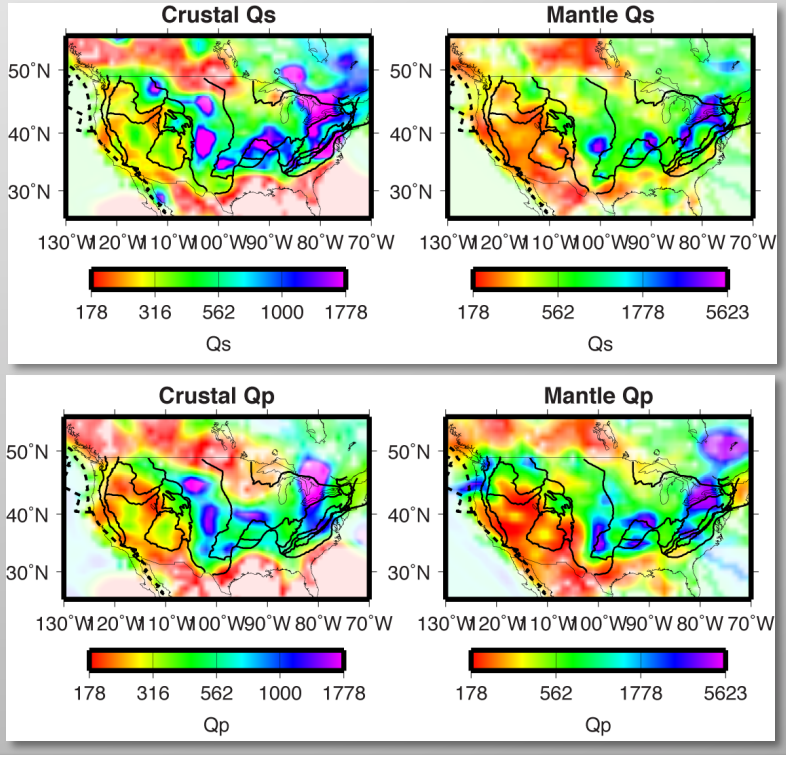
Lithospheric Attenuation Model of North America



We measure amplitudes of regional phases (Pn, Pg, Sn, Lg) to produce a Q map of the crust and upper mantle over a wide frequency band (0.5-8 Hz)

These weak-ground motions are frequent-enough to be plentiful even in regions of low seismicity, such as central and eastern North America.



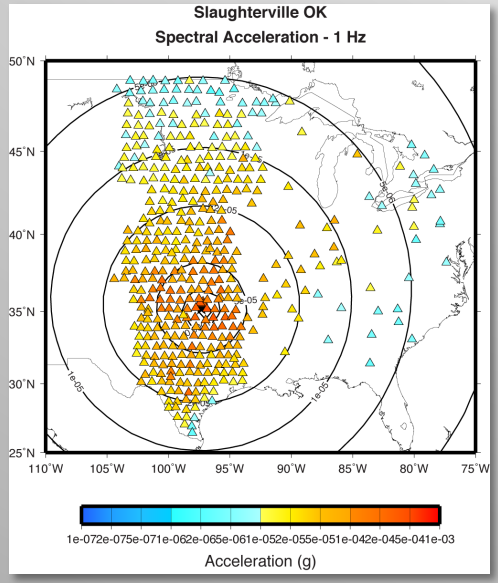
We see large variations between areas west of the Rockies (low Q) and areas east of the Rockies (high Q).

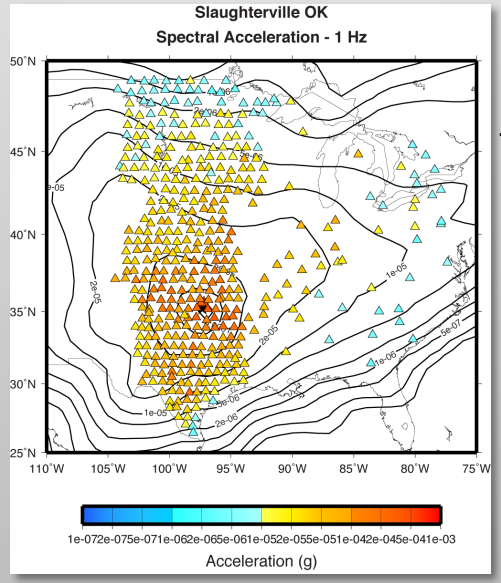
We also observe large variations within these regions that correspond to tectonic features.

We find low Q along the Gulf Coast and in other offshore regions

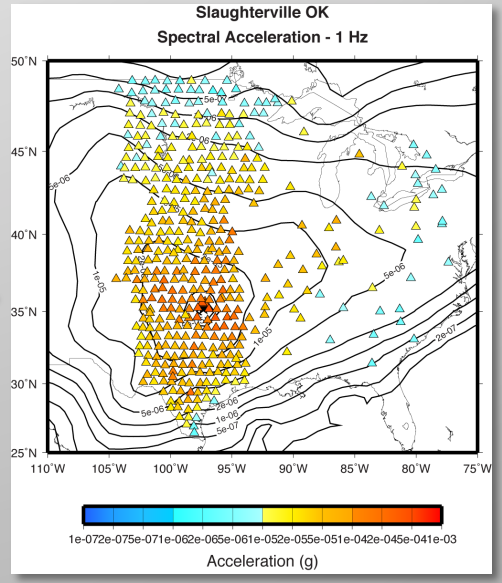
Incorporating Attenuation in Ground Motion Prediction Eqs

1-D GMPEs	1-D GMPEs w/ 2-D crustal Q	3-D model with 2-D Q
Easiest to implement	Still easy to implement	More difficult to implement
No variable attenuation	Variable crustal attenuation	Variable crust and upper mantle attenuation
No variable crustal thickness	No variable crustal thickness	Variable crustal thickness





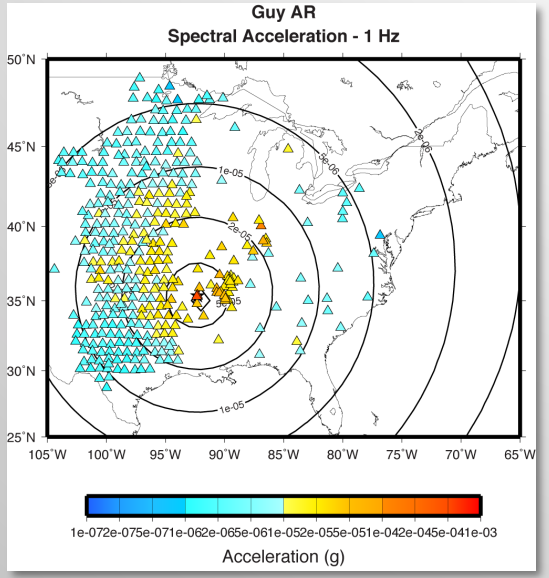
These give similar results

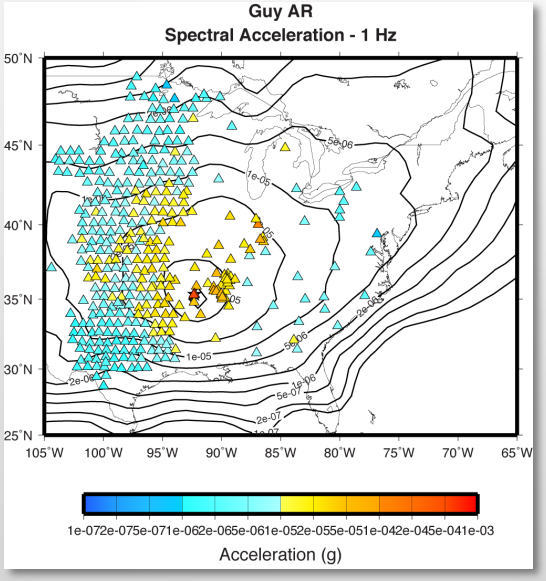


1 Hz Spectral Accelerations

Example of an earthquake in Guy, AR

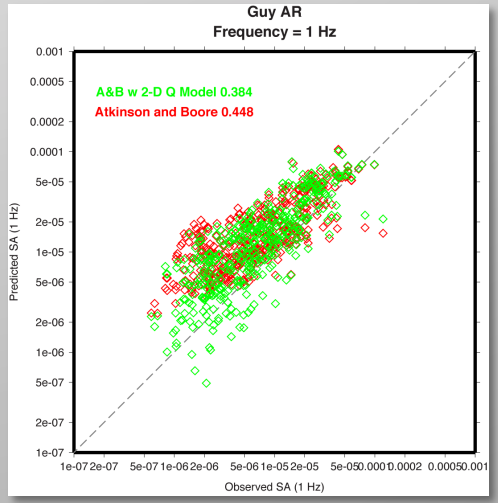
1 Hz SA





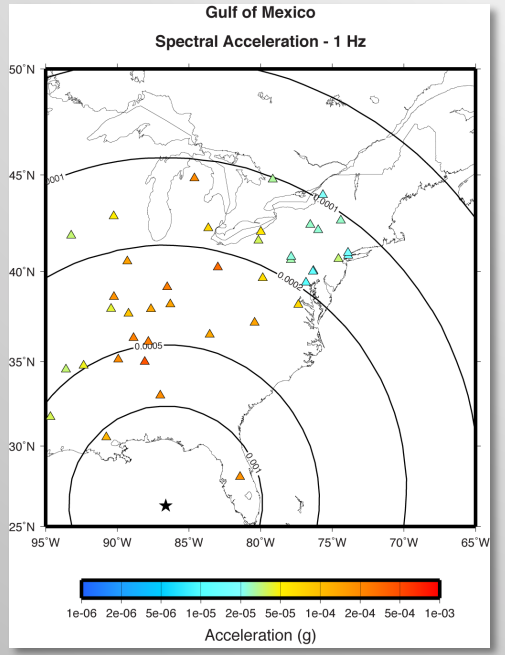
This EQ is in the middle of the CEUS region and is well-recorded by USArray stations

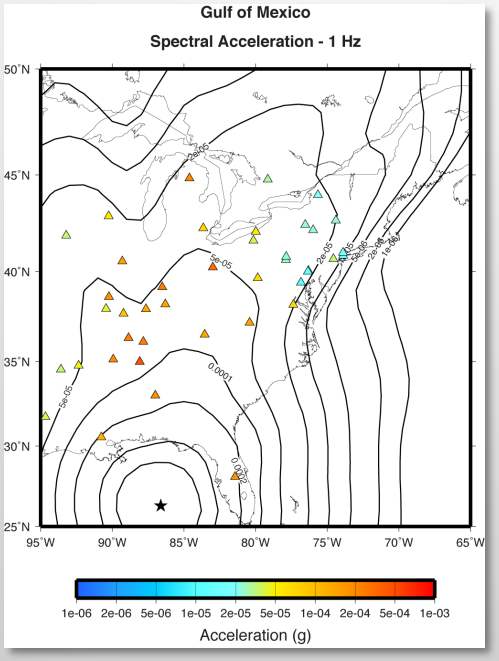
Including 2-D Q improves our misfit from an RMS of 0.448 with 1-D to 0.384



Example of an earthquake in the Gulf of Mexico

1 Hz SA

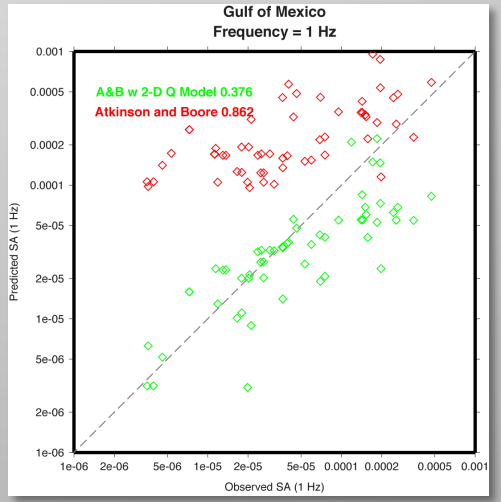




The Gulf of Mexico has

- thin crust
- thick sediments
- low crustal Q

The inclusion of this information significantly improves our SGM predictions (RMS 0.862 ➔ 0.378)



Conclusions

We use information from the amplitude recordings of more frequent weak ground motions to develop an attenuation model of the crust and upper mantle which can be used to improve estimates of strong ground motions.

Future Work

- Continue to improve the attenuation model
- Understand how we can most easily incorporate Q into existing GMPEs
- Validate the performance of the ground motion predictions against more observed data and at different frequencies
- Incorporate the attenuation model in ground motion simulations