Introduction

I used the database created under the NGA-East project provided to Electric Power Research Institute (EPRI) at the beginning of 2013 and created by Chris Cramer et al. (2013).

In contrast to the Western US (WUS) this strong motion record database for the Central and Eastern US (CEUS) is not sufficient to create purely empirical ground motion prediction equations (GMPE) covering required magnitude and distance range. Recorded data are sparse and cover mostly range of magnitudes Mw<6.0 with only three data points from Nahanni 1985 M=6.8 earthquakes. There are also only few near-field recordings which complicates constraining GMPE even more.

I used GMPE models prepared by EPRI (2013) and Pezeshk et al. (2011) as main constraints especially for large magnitudes.
### Database

#### Magnitude - Distance

![Magnitude vs Distance Graph]

- Cramer et al., 2013

#### Magnitude - Vs30

![Magnitude vs Vs30 Graph]

- Cramer et al., 2013
PGA ATTENUATION MODEL

My ground motion prediction equations (GMPE) model is based on the same modular filter based approach developed by Graizer and Kalkan for active tectonic environment (2007, 2009, and 2011). There are a number of simplifications relative to the original model developed for active tectonic environment:

– No bump in the near-field since there are no data to support it
– No basin effect
– No distinguishing between different fault styles
– Developed for average $V_{S30} = 1100$ m/sec

Preliminary G-14 PGA CEUS model

\[ \ln(PGA) = \ln(G_1) + \ln(G_2) + \ln(G_3) + \ln(G_4) + \sigma_{\text{GMCEUS}} \]

**Modular**

\[ \ln(G_1) = -0.5056 \times (1 - r_3^2) + 4\ln(\sigma_{\text{GMCEUS}}} \]

\[ \ln(G_2) = -0.5 \times \ln(\sigma_{\text{GMCEUS}}} \]

\[ \ln(G_3) = 0 \]

\[ \ln(G_4) = 0 \]

where:

\[ r_3 = R / R_i \]

\[ R_i = c_s M + c_o \]

$D_j = 6.7$

**Estimator Coefficients**

<table>
<thead>
<tr>
<th>$c_1$</th>
<th>$c_2$</th>
<th>$c_3$</th>
<th>$c_4$</th>
<th>$c_5$</th>
<th>$c_6$</th>
<th>$c_7$</th>
<th>$c_8$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.34</td>
<td>0.50</td>
<td>0.40</td>
<td>2.23</td>
<td>-7.54</td>
<td>-0.32</td>
<td>1.19</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\sigma_{\text{GMCEUS}}$</th>
<th>$F$</th>
<th>$\sigma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>2.232</td>
<td>0.53</td>
</tr>
</tbody>
</table>

*Note: R = Closest fault distance and M = Moment magnitude*
PGA Attenuation and Corner Distances Dependence on Magnitude

\[ G_2(M, R, C_2) = \frac{1}{\sqrt{\left[1 - \frac{R}{R_c}\right]^2 + 4D_2^2 \left(\frac{R}{R_c}\right)}} \]

Magnitude Scaling

In my new model the first filter, \( G_1 \) is for magnitude scaling and style of faulting scaling with the same approximation function type as for WUS (Graizer and Kalkan, 2007):

\[ A(M, F) = \left[ c_1 \arctan(M + c_2) + c_3 \right] F \]

Magnitude scaling is basically coming from EPRI (2013).

Since we can’t distinguish for style of faulting based on available data \( F \) is assumed same for all fault styles.
**Attenuation**

I varied geometrical spreading from $R^{-1}$ to $R^{-1.3}$ and found that $R^{-1}$ fits data and EPRI 2013 GMPEs better.

Geometrical spreading of $R^{-1}$ combined with anelastic attenuation $Q_0$ is used.

The $G_3$ filter adjusts distance attenuation rate by including anelastic attenuation given as:

$$G_3 = \exp\left(-\frac{c_{11} + c_{12}M}{Q_0}\right)R$$

where $Q_0$ is the regional quality-factor for propagation of seismic waves from source to the site at a frequency of 1 Hz, and $c_{11}$ and $c_{12}$ are coefficients ($c_{12}$ is negative).

**Preliminary G-14 SA CEUS model**
Examples SA Functions at R = 1 and 10 km for 4.0<M<9.0

Comparison of G-14 GMPE for the M=7.5 with EPRI (2013)
Comparison of G-14 GMPE for the M=7.5 with EPRI (2013)

Comparison of G-14 GMPE for the M=5.0 with EPRI (2013)
Comparison of G-14 GMPE for the M=5.0 with EPRI (2013)

Comparison of the G-14 Model with Empirical Data
Comparison of the G-14 Model with Empirical Data
Residuals (in log units)

Standard Deviation of G-14 Model for 4.5<M≤6.76

Standard Deviation (log units)

\[ y = 0.0002x + 0.375 \]
Correction for Shallow Site Conditions from $V_{S30} = 760$ to 2800 m/s from EPRI 2013

G-14 Model Limitations

- Stable continental environment
- Functional form works for $4.0 < M_w < 9.0$
- Actually tested for $4.5 < M_w < 7.5$
- Rupture distances $0 < R < 1000$ km
- Period range 0.01 to 10 sec (tested on data up to 2 sec)
- Average $V_{S30} = 1100$ m/sec
Areas of Improvements

• Constrain/adjust magnitude scaling hopefully based on the ground motion simulations
• Enhance empirical data set with ground motion simulations for large magnitudes and short distances
• Hope to get recommendations on shallow site condition scaling
• Standard error recommendations