

Abrahamson & Silva NGA Model

Sep 25, 2006

Recommendation

- Report not submitted on time
- Not sufficient documentation to use model in national maps
- Weights for A&S 97 should go to 3 other NGA models

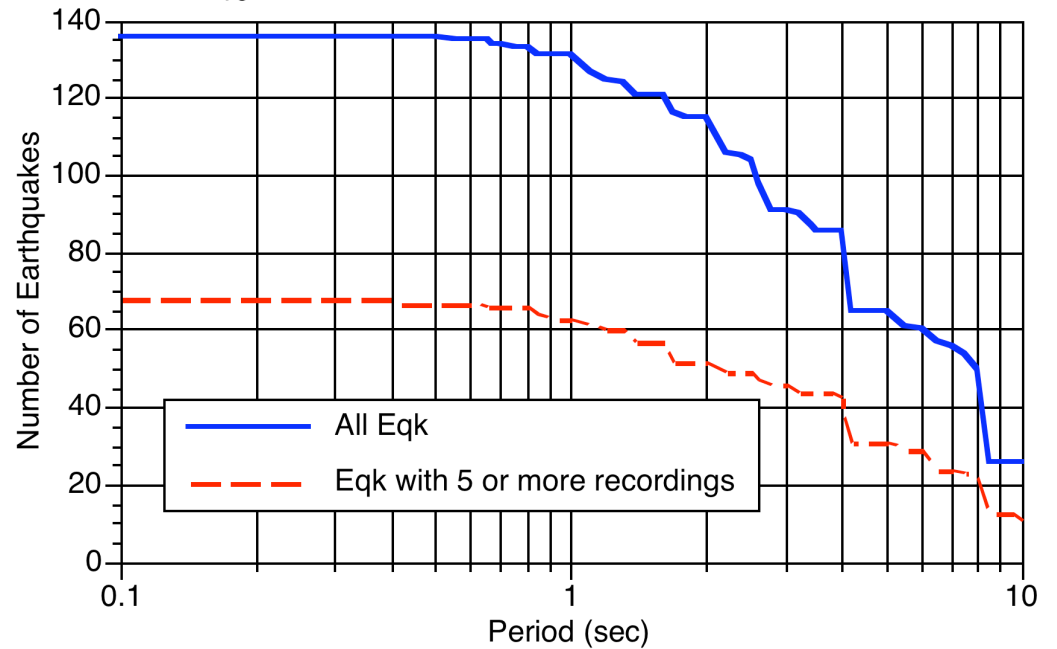
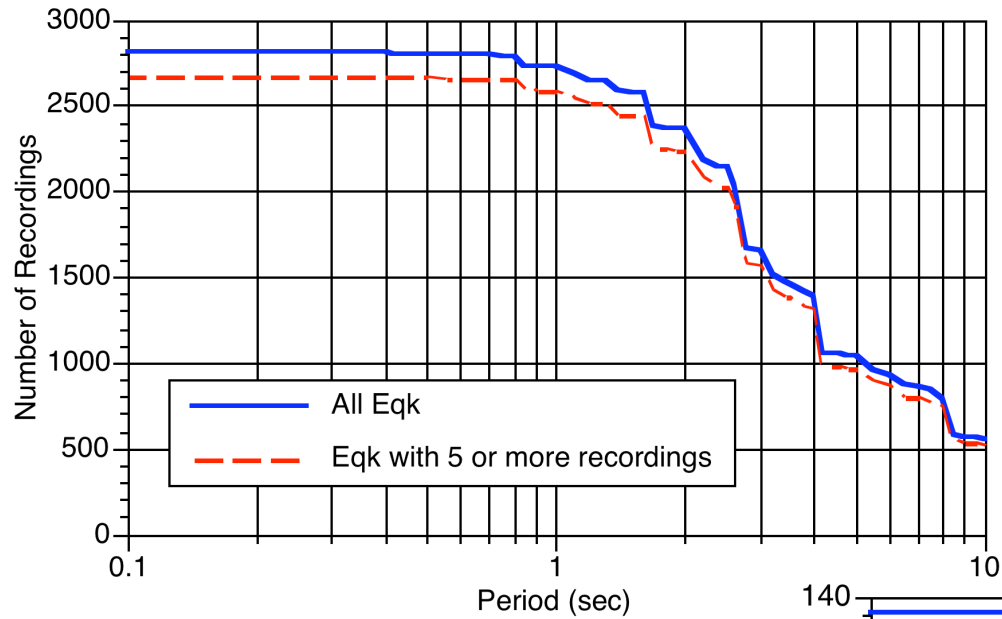
Regression Approach

- Random Effects
 - Accounts for correlation between residuals of data from a single earthquake
 - e.g. an earthquake may produce systematically high or low ground motions
 - Well recorded earthquakes do not dominate the event scaling (e.g. mag, style-of-faulting, depth to top)
 - Well recorded earthquakes do dominate the distance, VS30, HW scaling

Data Set Approach

- Include ground motions from shallow crustal earthquakes in active regions around the world
 - $R < 100$ km outside of WUS
 - $R < 200$ km for WUS
 - 130 earthquakes
 - 2810 recordings
- Include aftershocks
 - 1258 out of 2810 are from Chi-Chi aftershocks

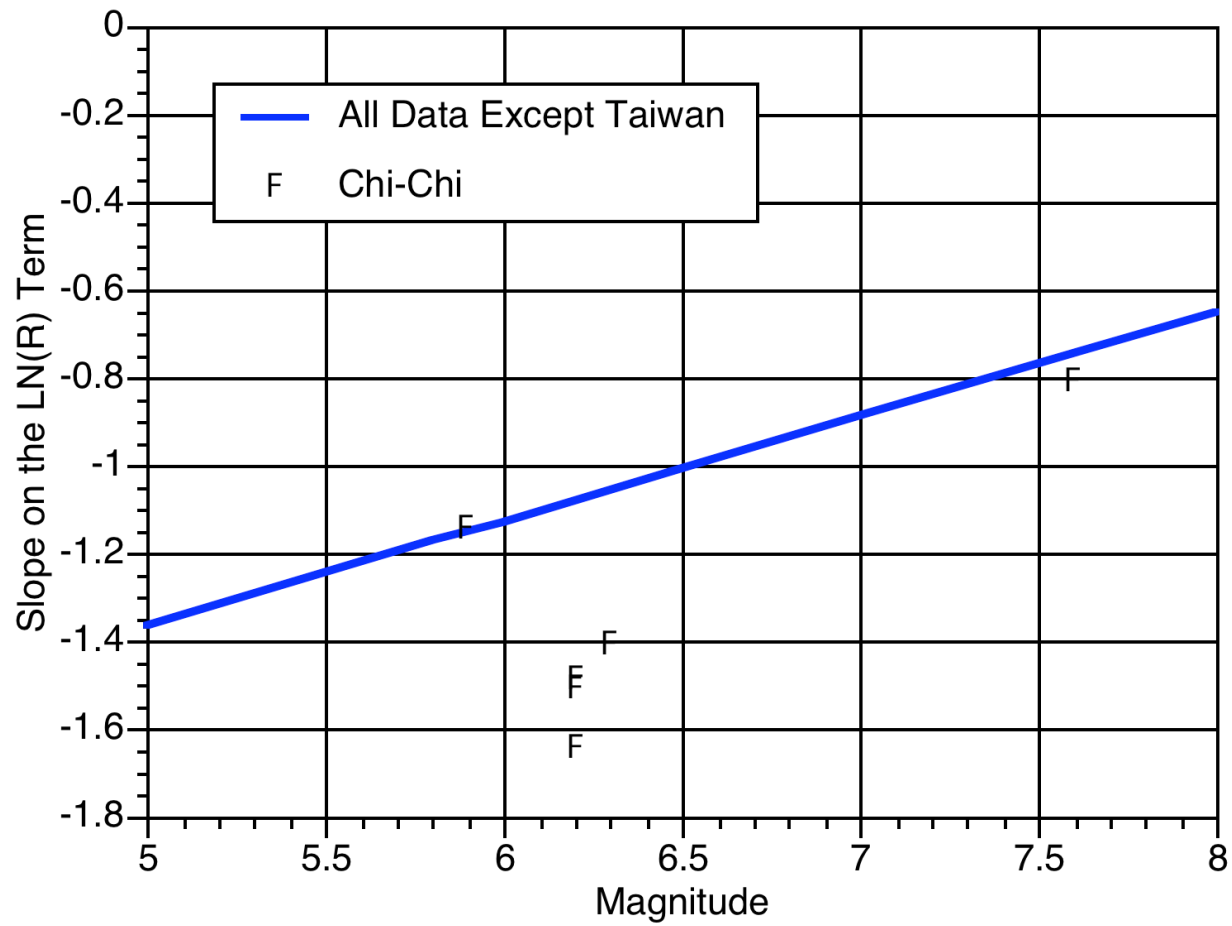
Size of Data Set



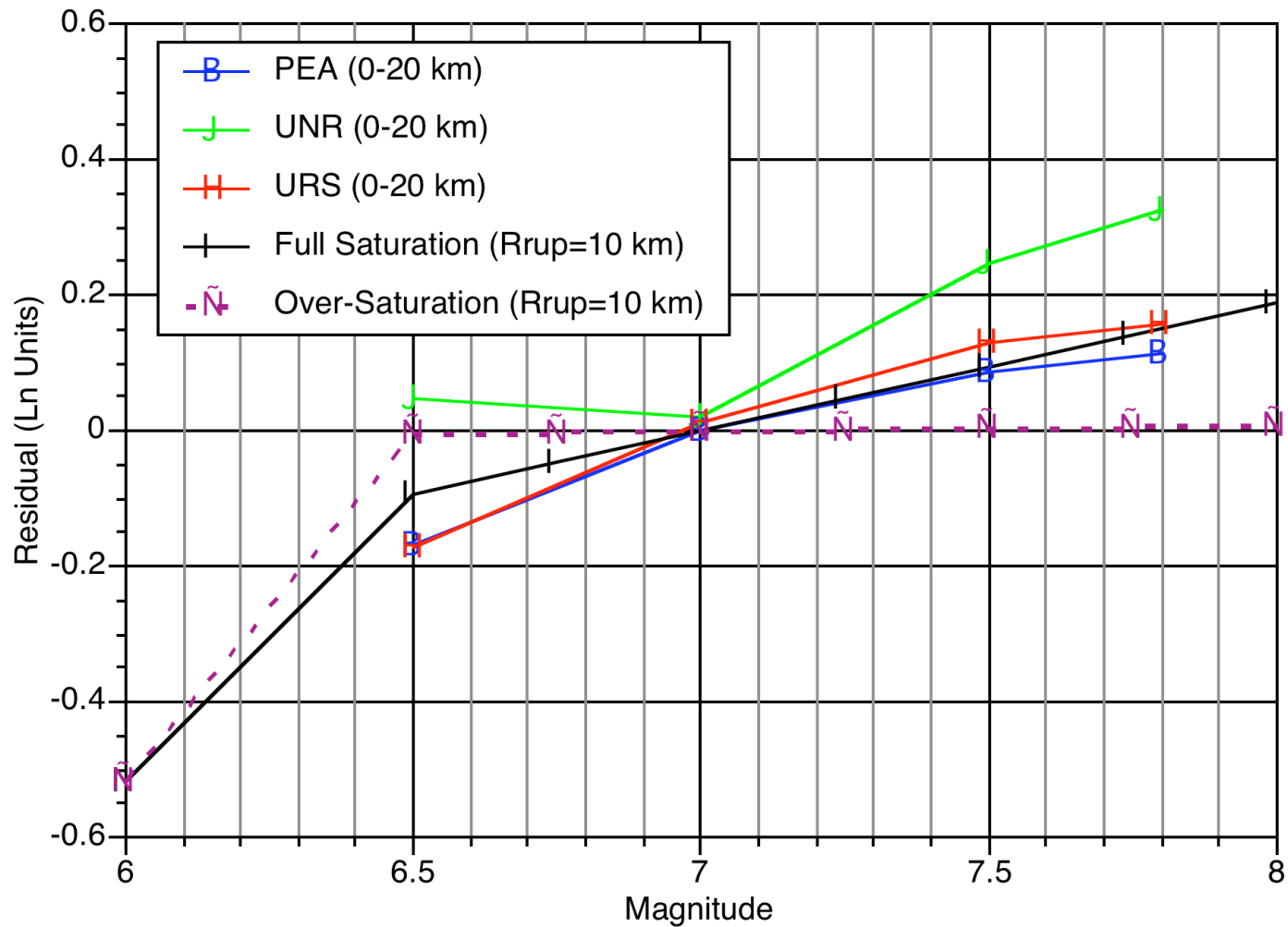
Changes to Previous Versions

- Simplified model
 - Removed aspect ratio
 - Removed source-site angle (for HW)
- Changes to functional form
 - Added Depth to top effects at all magnitudes
 - Changed to a cubic term in magnitude
 - Added SCEC 3-D basin effects
 - Added Q term for small magnitudes
 - Changed treatment of 4 chi-chi aftershocks
 - Added break in VS30 scaling

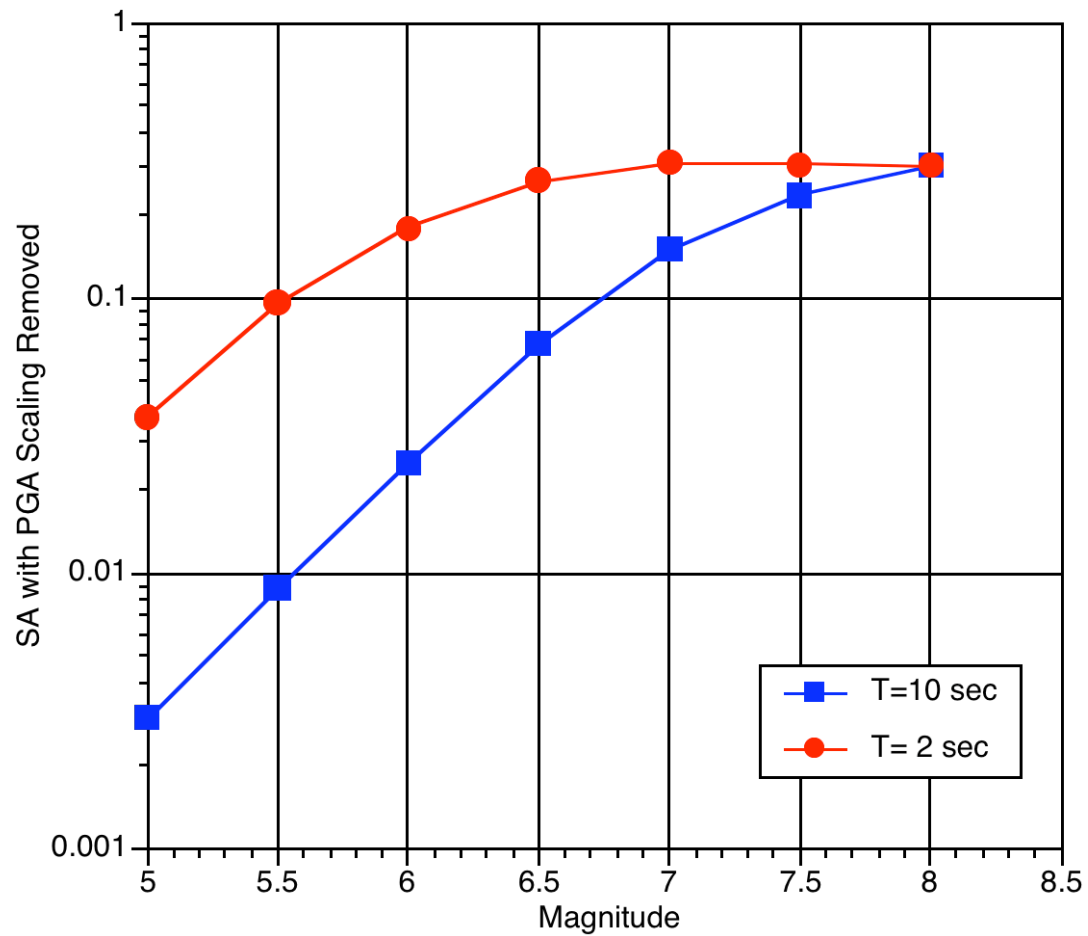
Chi-Chi Aftershocks



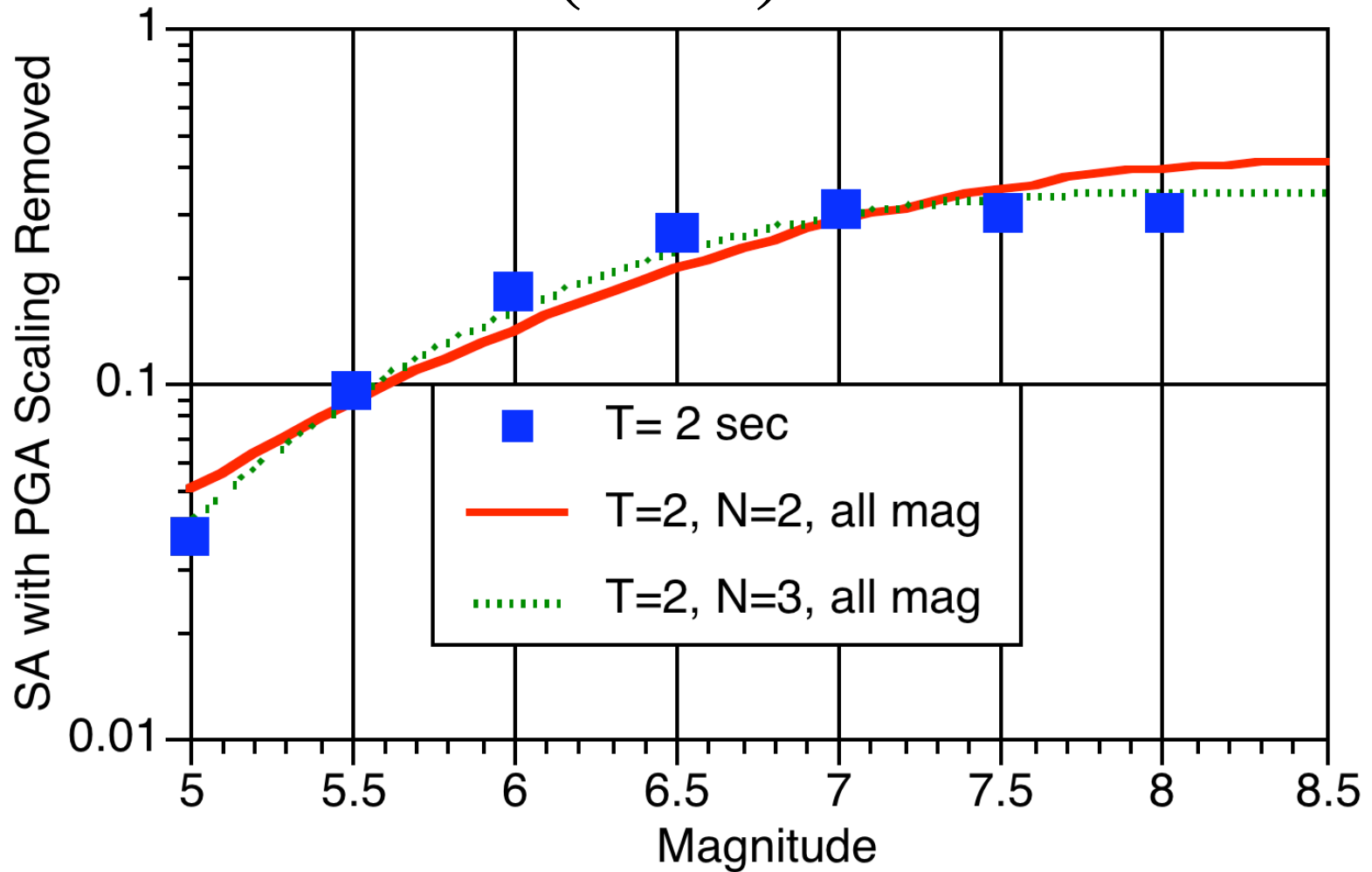
Magnitude Saturation (PGA)



Higher Order Mag Scaling

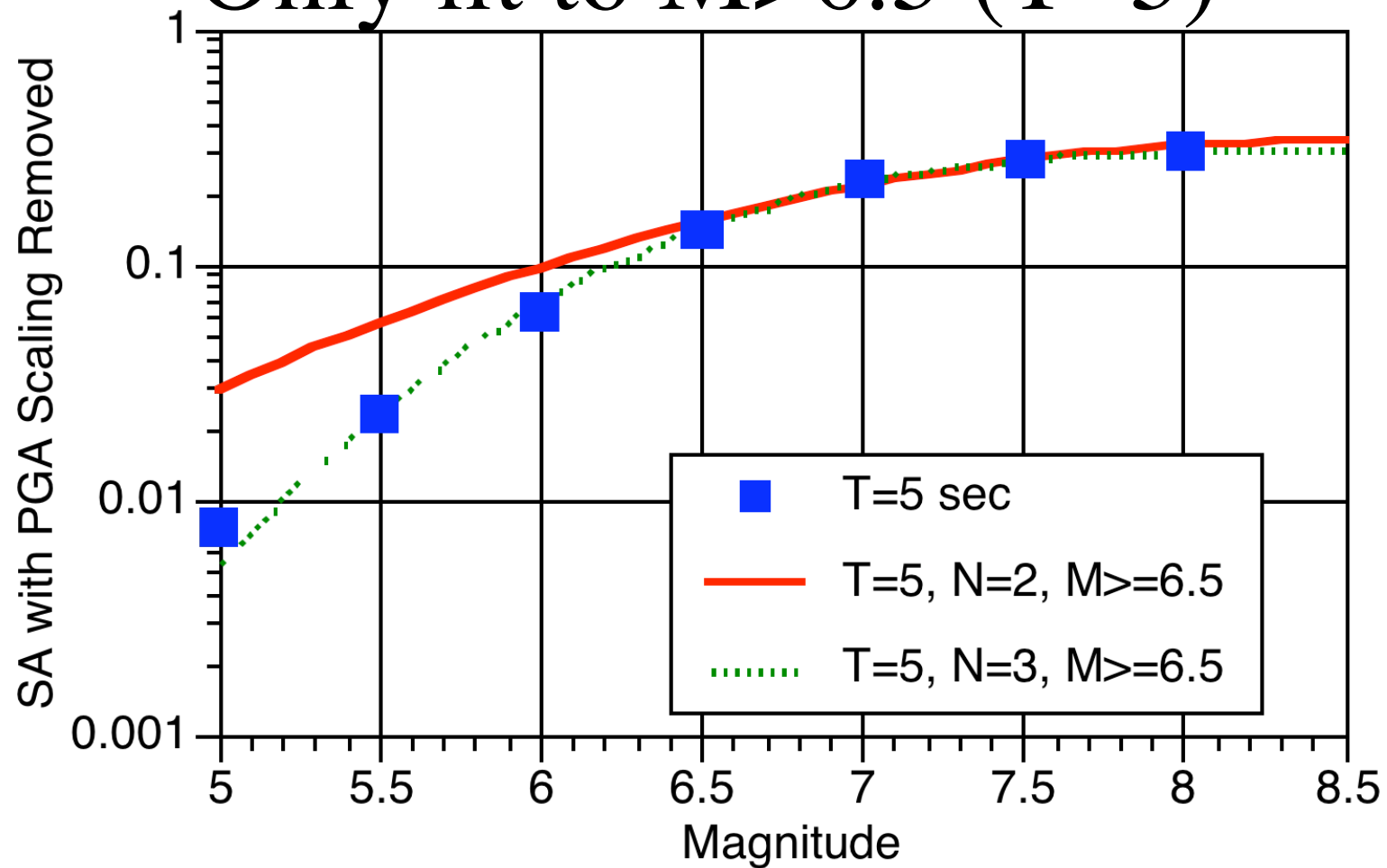


Higher Order Mag Scaling ($T=2$)

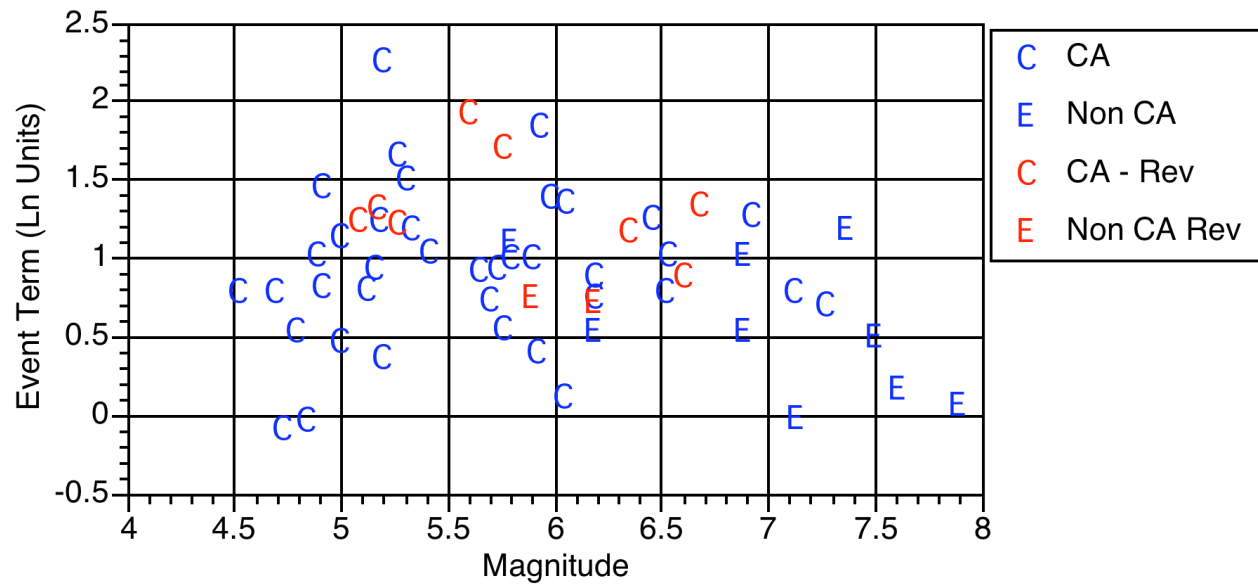
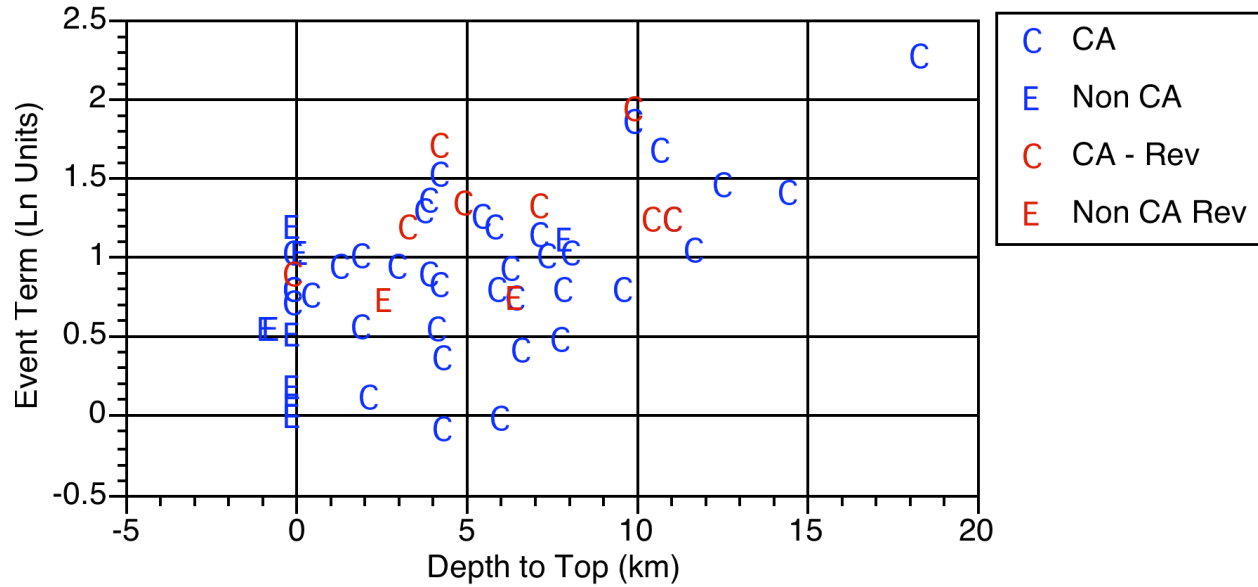


Higher Order Mag Scaling

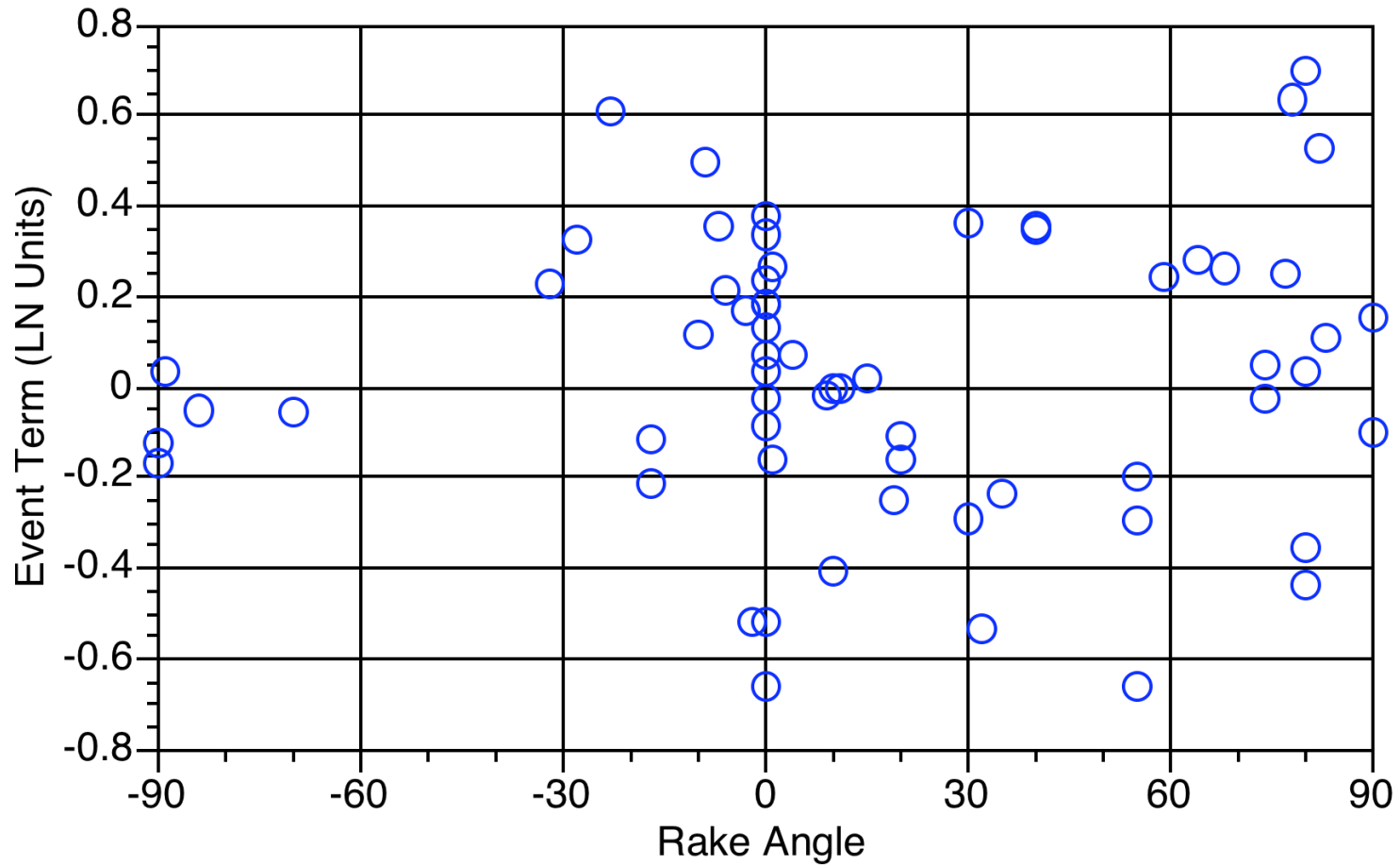
Only fit to $M > 6.5$ ($T=5$)



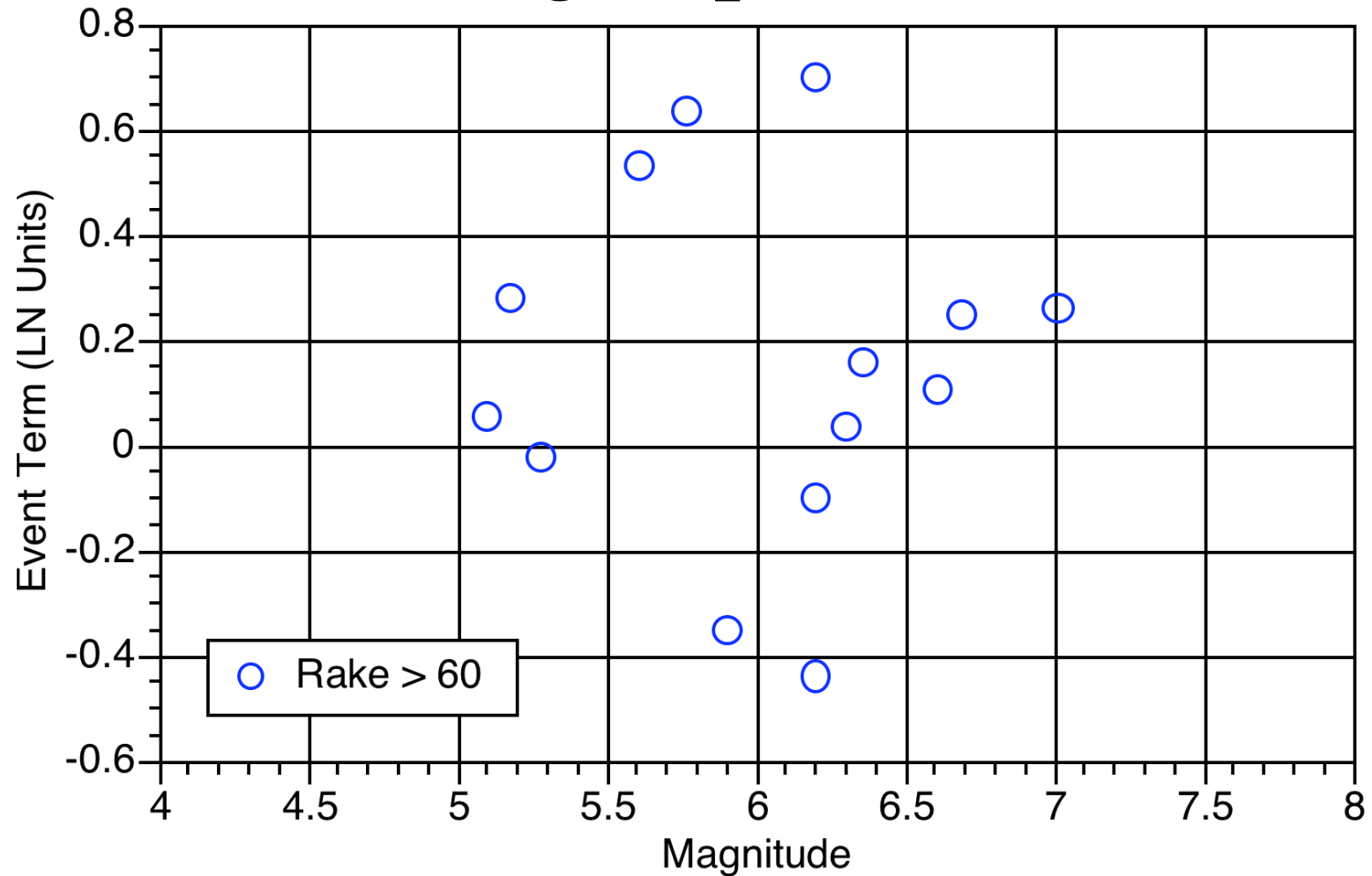
Depth to Top (PGA)



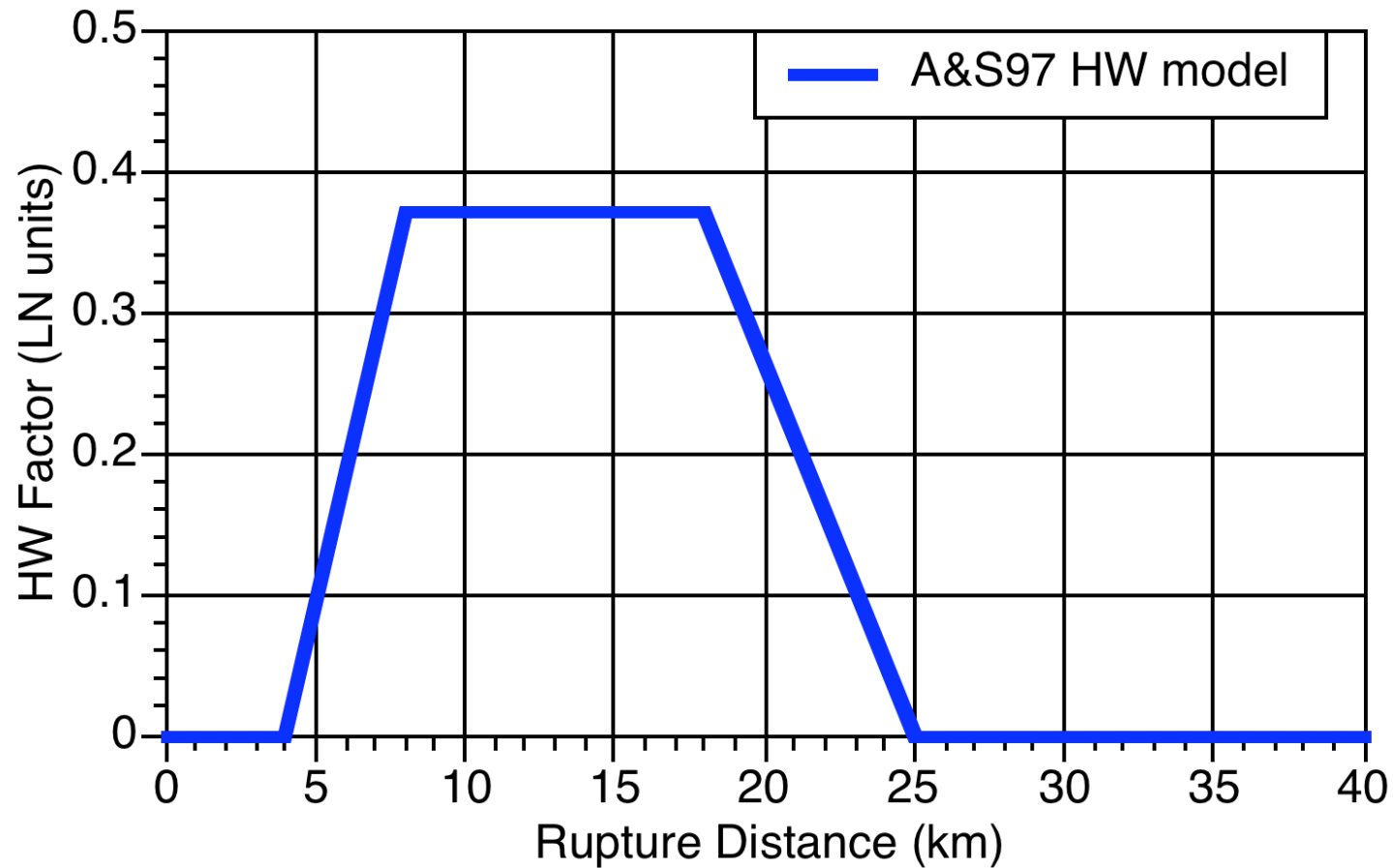
Style-of-Faulting (PGA)



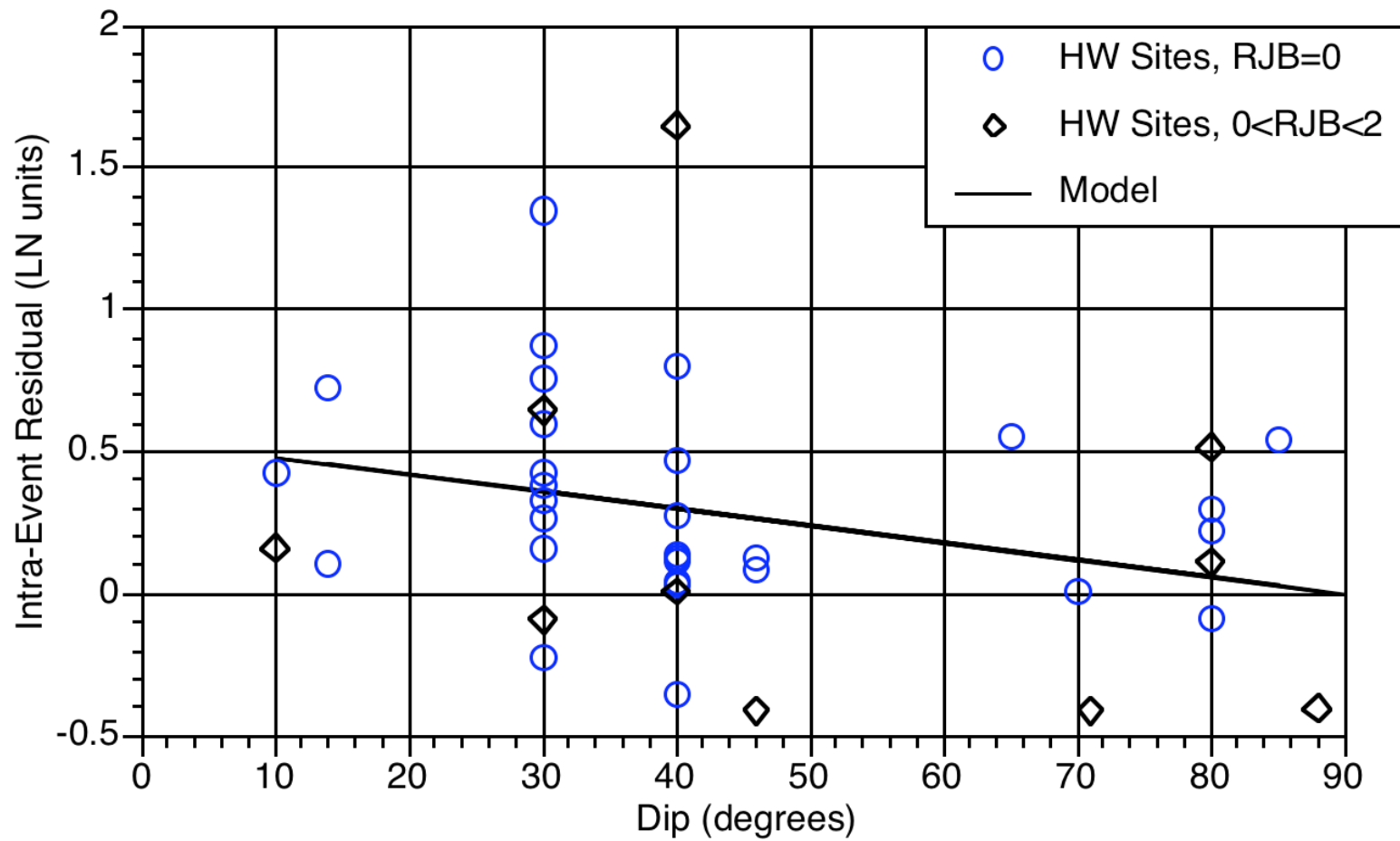
Style-of-Faulting (PGA) no mag dependence



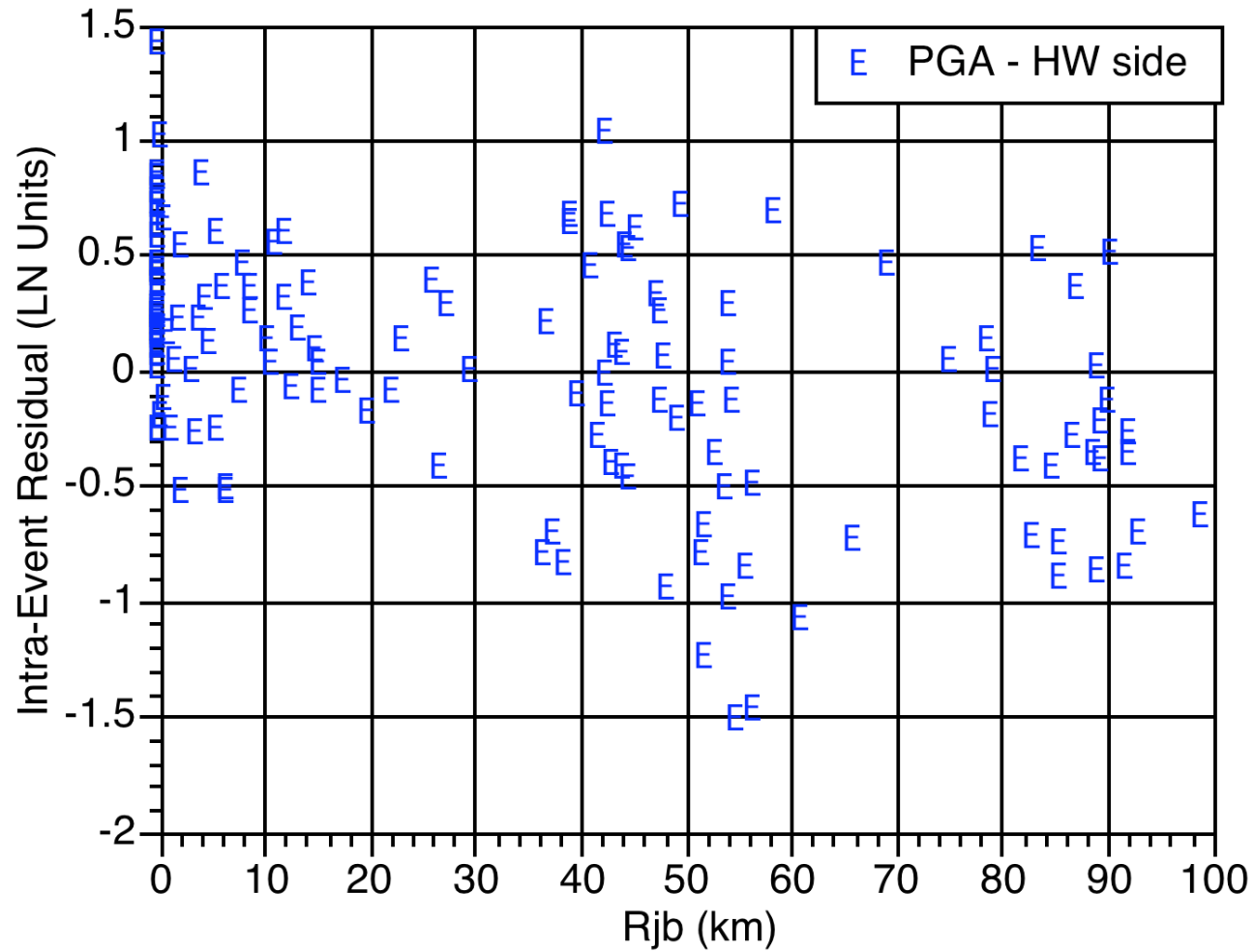
HW factor from A&S (1997)



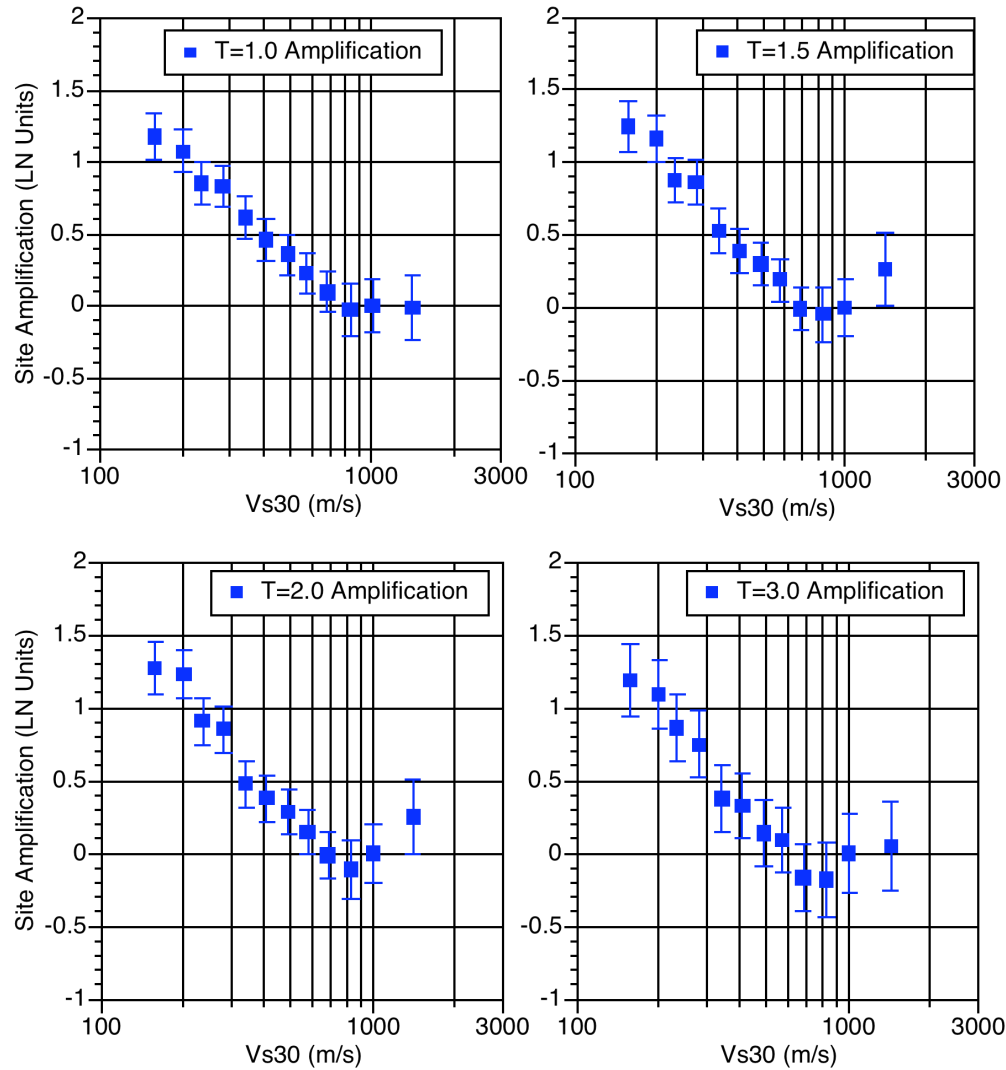
HW Factor - Dip



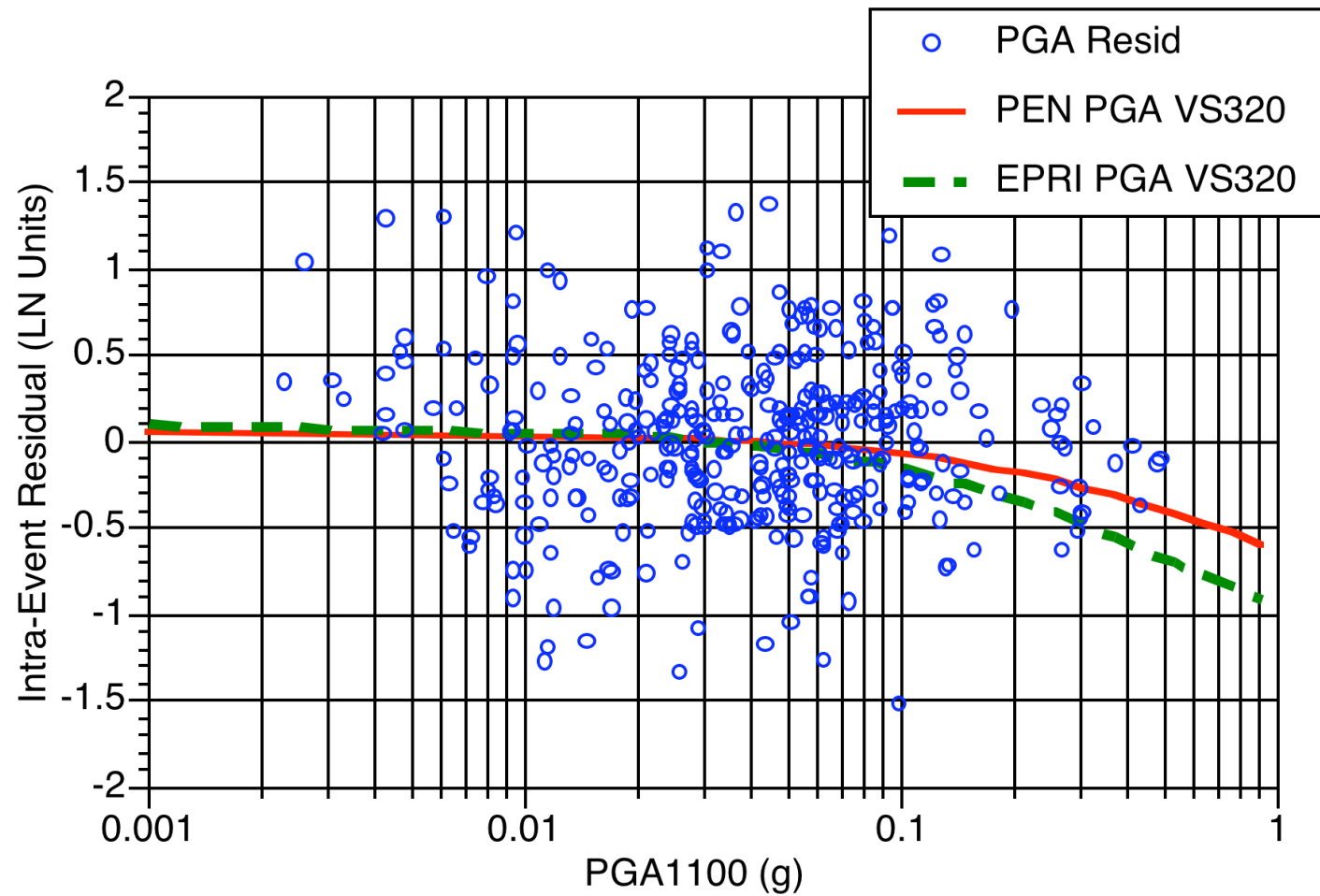
HW Factor - Distance



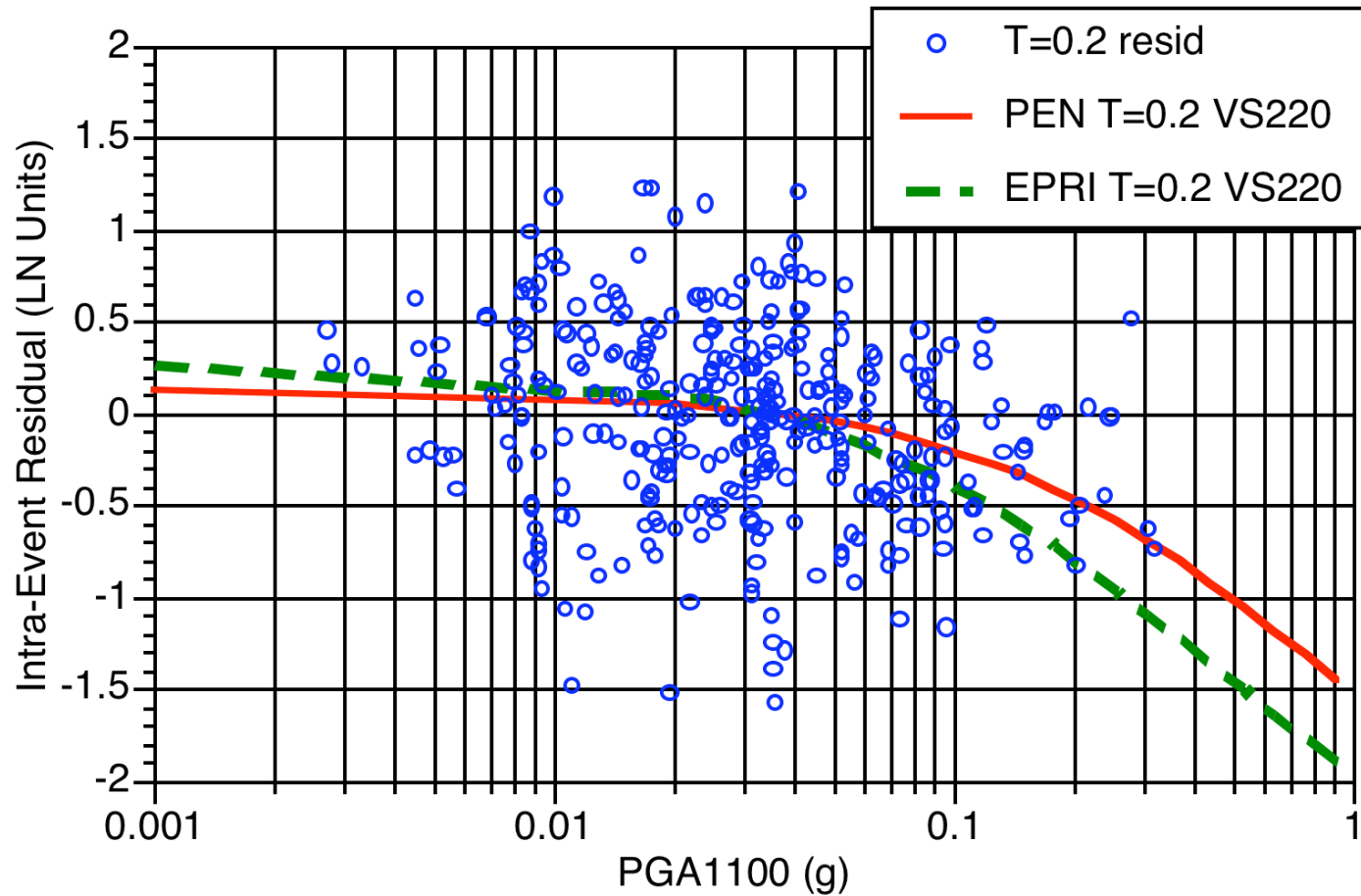
Break in VS30 scaling for large T



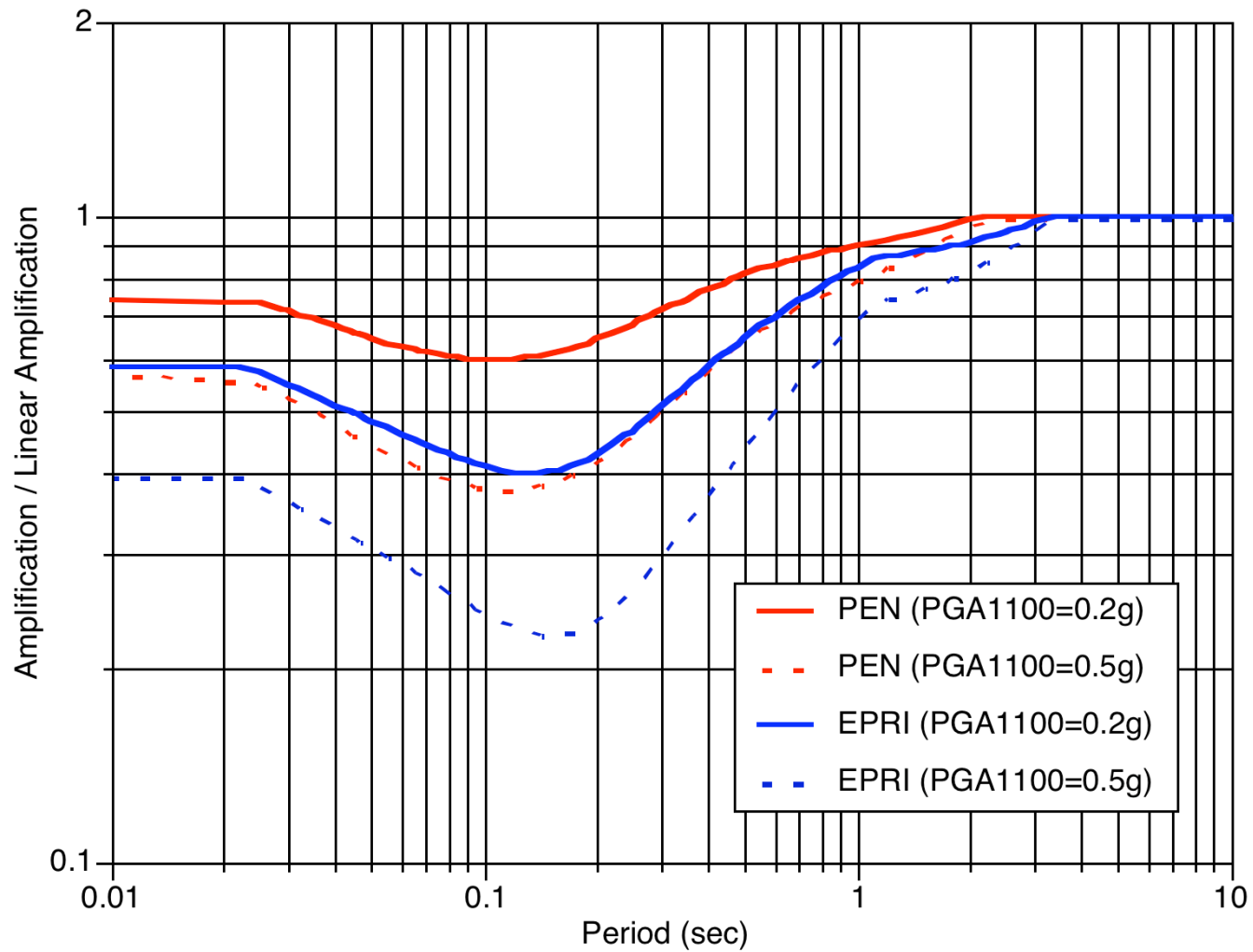
Non-Linear Site (PGA)



Non-Linear Site (T=0.2)



Non-Linear Site



3-D Basin Effects

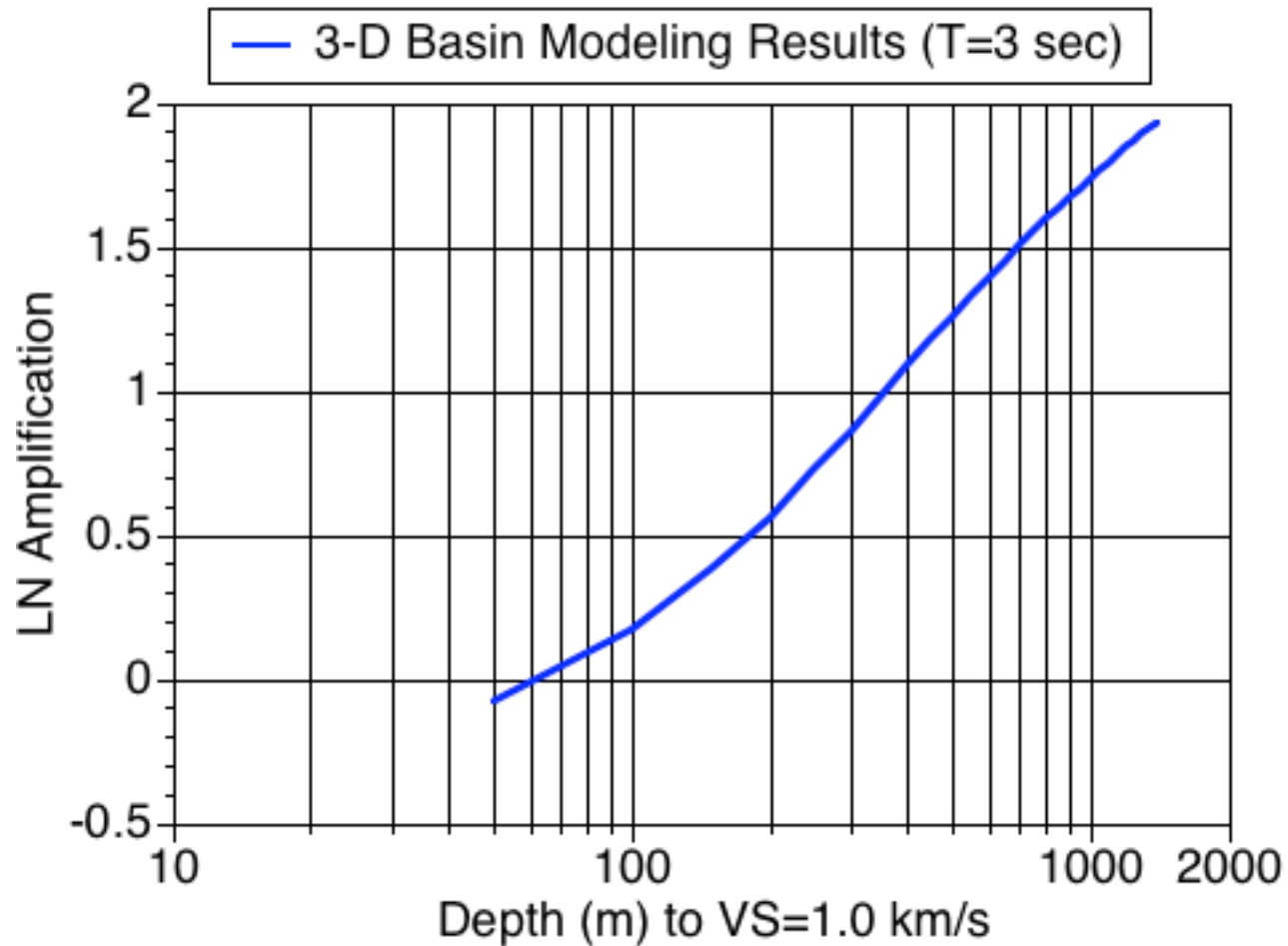
- Considered several parameters:
 - Basin depth
 - Distance from edge
 - Basin edge locations
- Results parameterized in terms of median amplification as a function of the depth to a VS isosurface
 - Z1.0 = depth to VS=1.0 km/s
 - Z1.5 = depth to VS=1.5 km/s
 - Z2.5 = depth to VS=2.5 km/s
- Variability scale factors were not parameterized
- The Z1.0, Z1.5, and Z2.5 parameters were added to NGA data base where available
 - Not available for 80% of the data in NGA data set

3-D Basin Effects

- Used 3-D Basin results from SCEC simulations
- Issues of Implementation
 - Z1.0
 - Similar to typical definitions of “engineering rock”
 - Can be reasonably estimated for projects
 - Z2.5
 - Better metric to use, but difficult to obtain for engineering projects

Scaling with Basin Depth

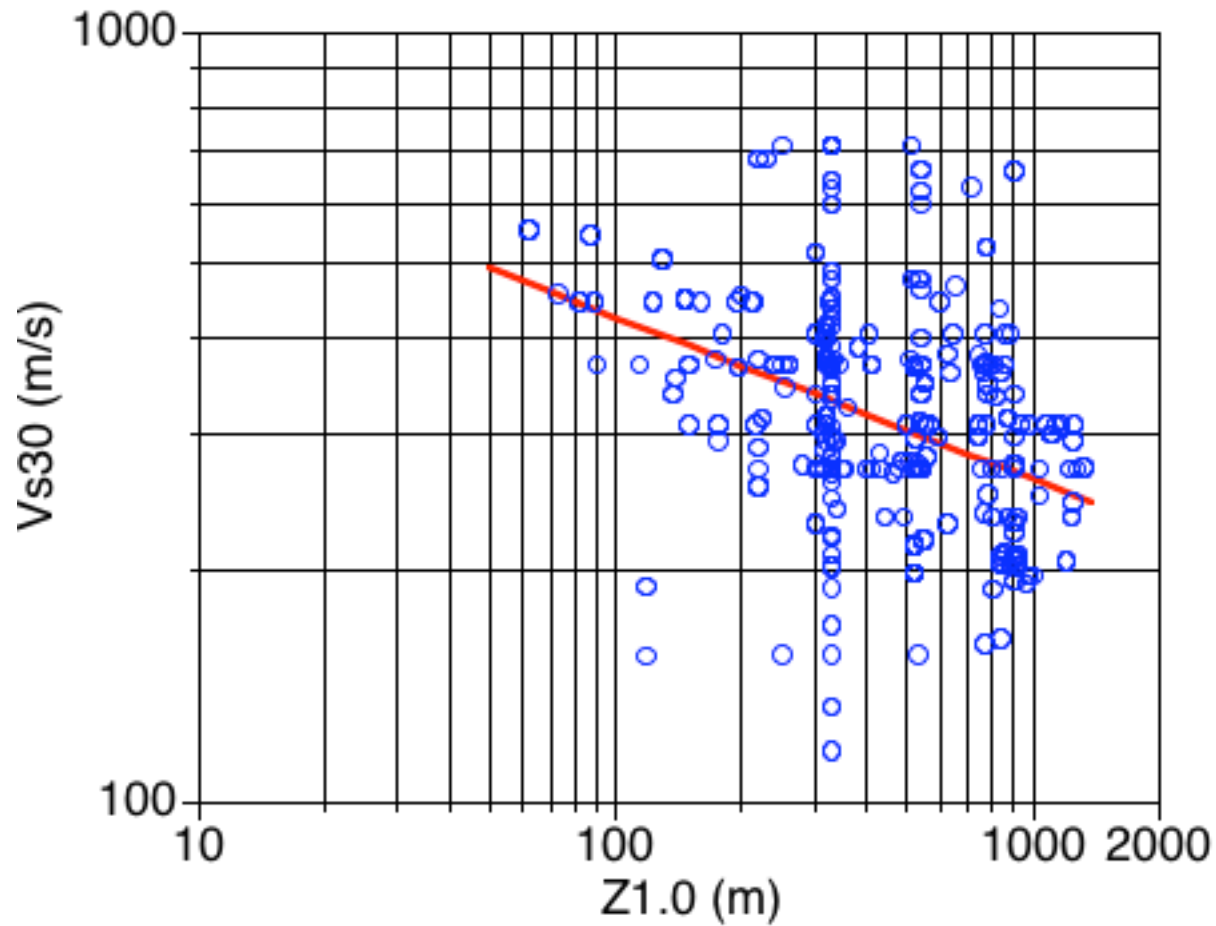
T= 3 sec



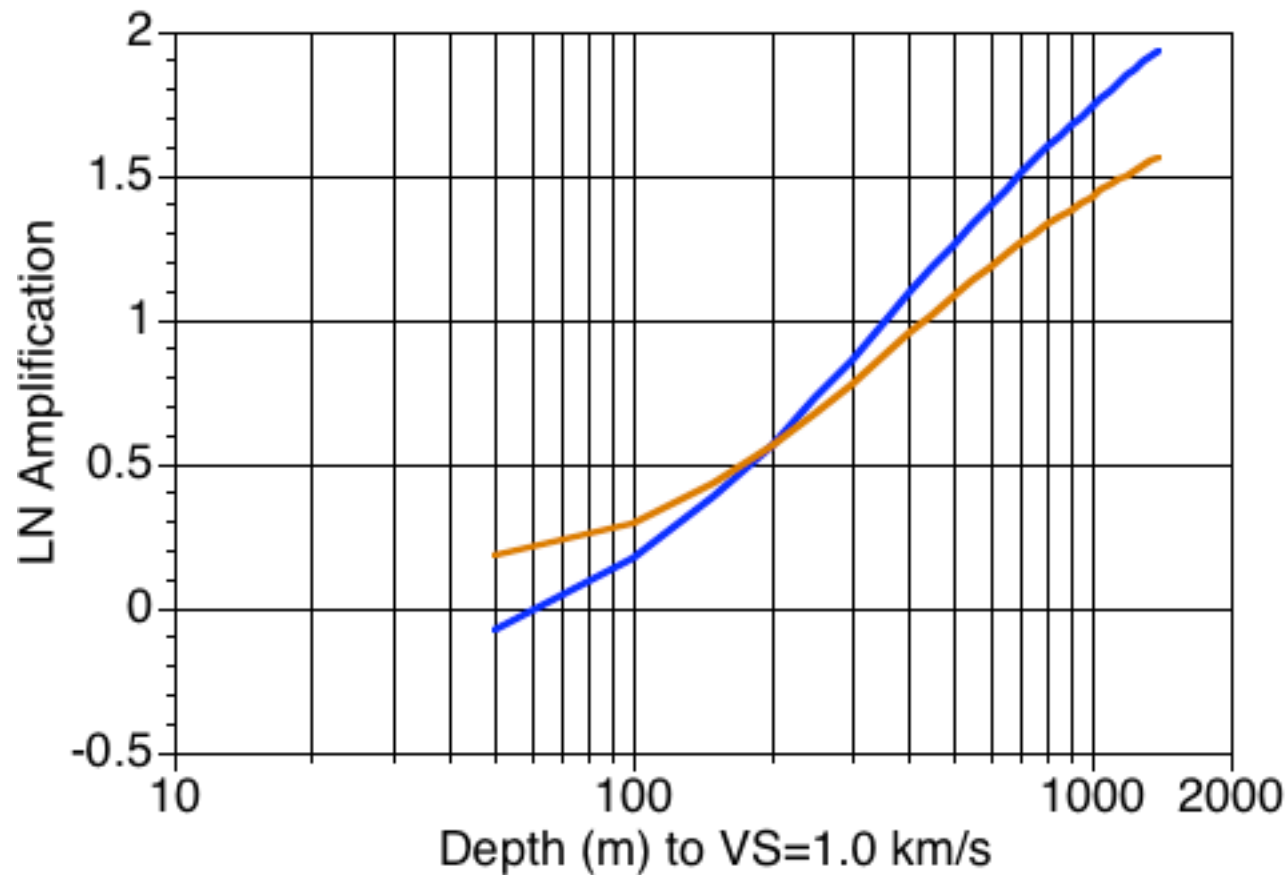
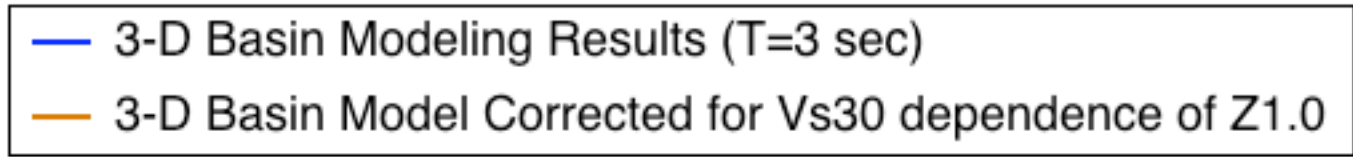
Issues with Using 3-D Modeling Results

- Model is in terms of Z1.0
- Correlation of Z1.0 and Vs30
 - Some of the scaling with Z1.0 is already included in the empirical model Vs30 scaling
- Need to remove the Vs30 scaling effects
- Need to normalize to the median Z1.0 for a given Vs30

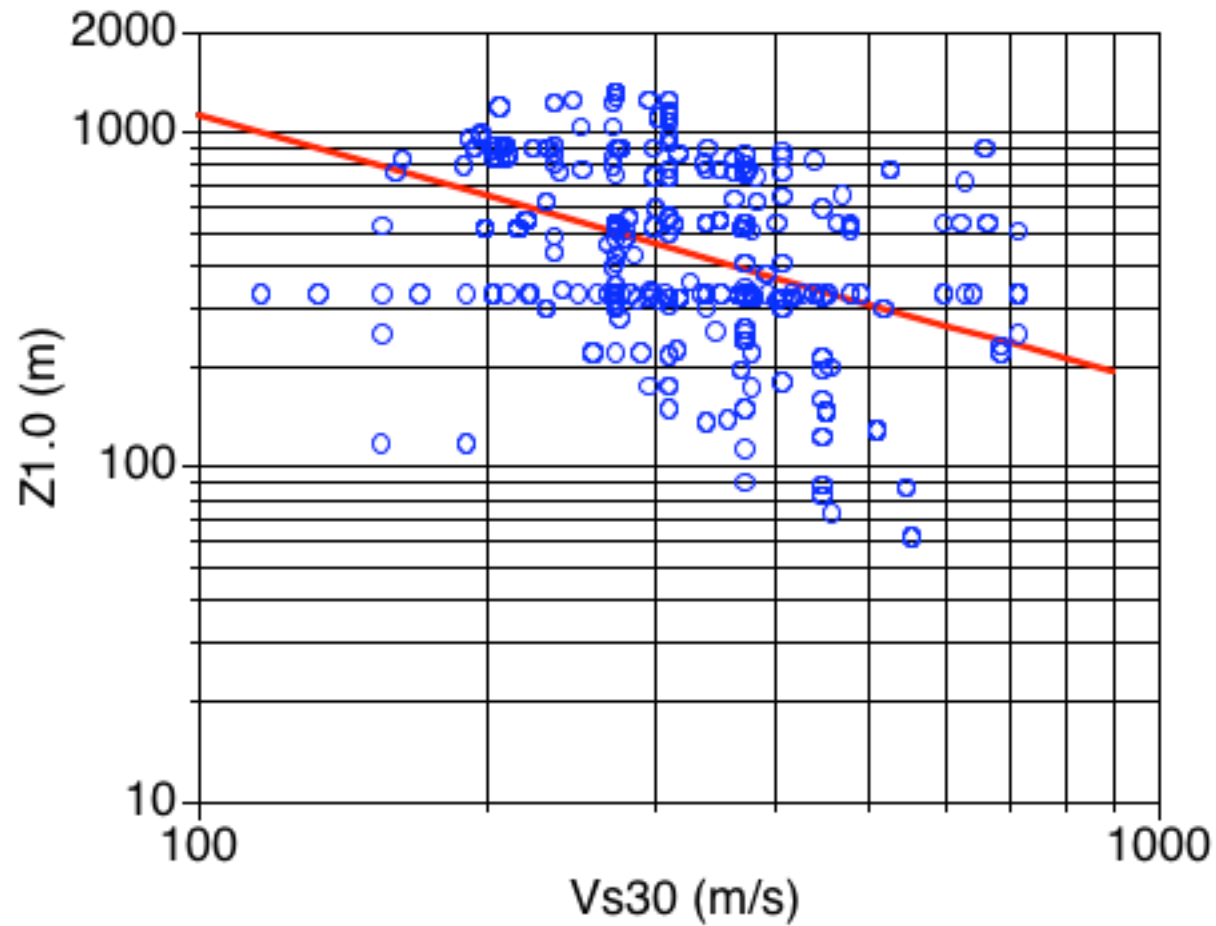
Correlation of Vs30 and Z1.0 (SCEC Model only)



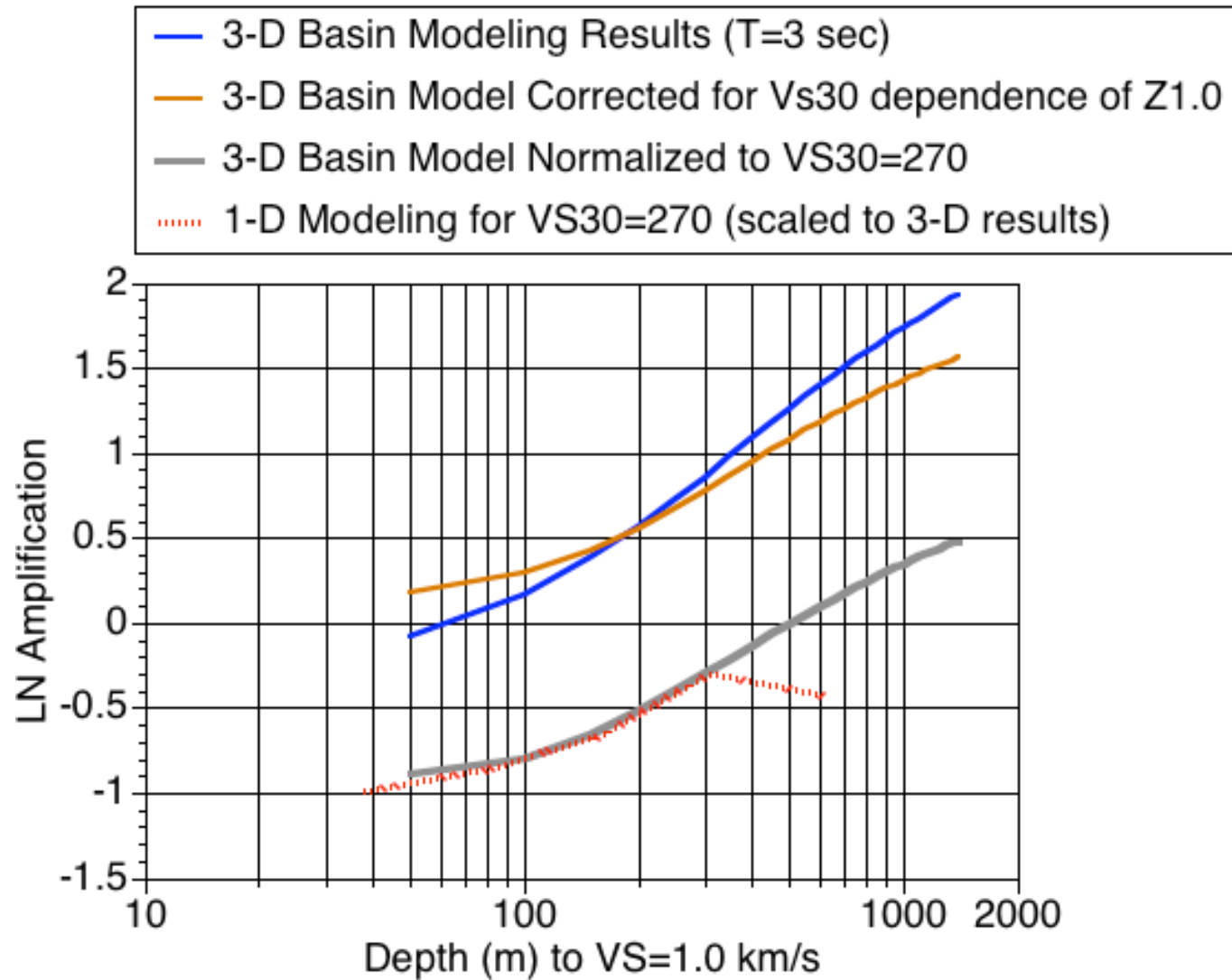
Scaling with Basin Depth



Correlation of Z1.0 and Vs30 (SCEC Model only)

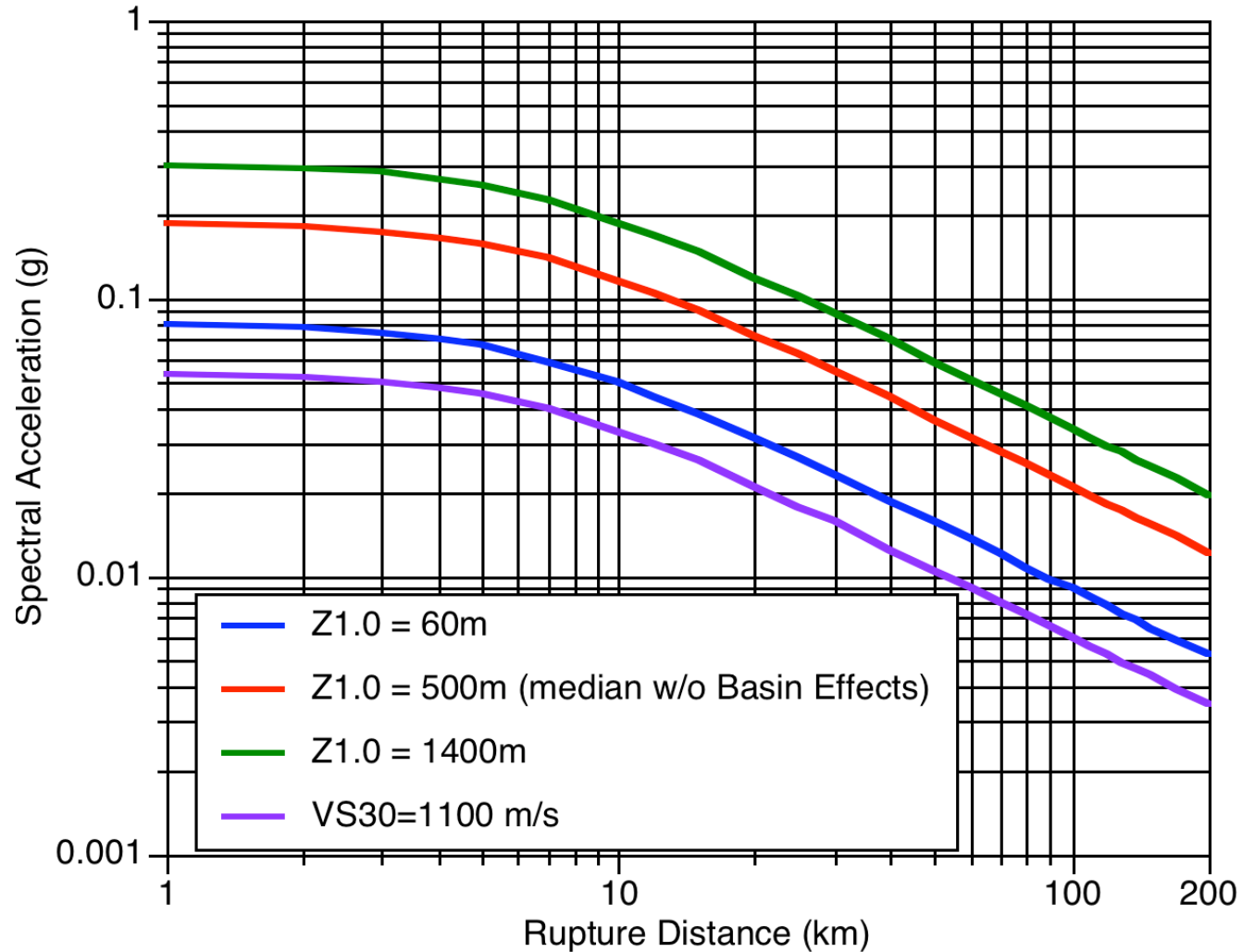


Scaling with Z1.0, T=3

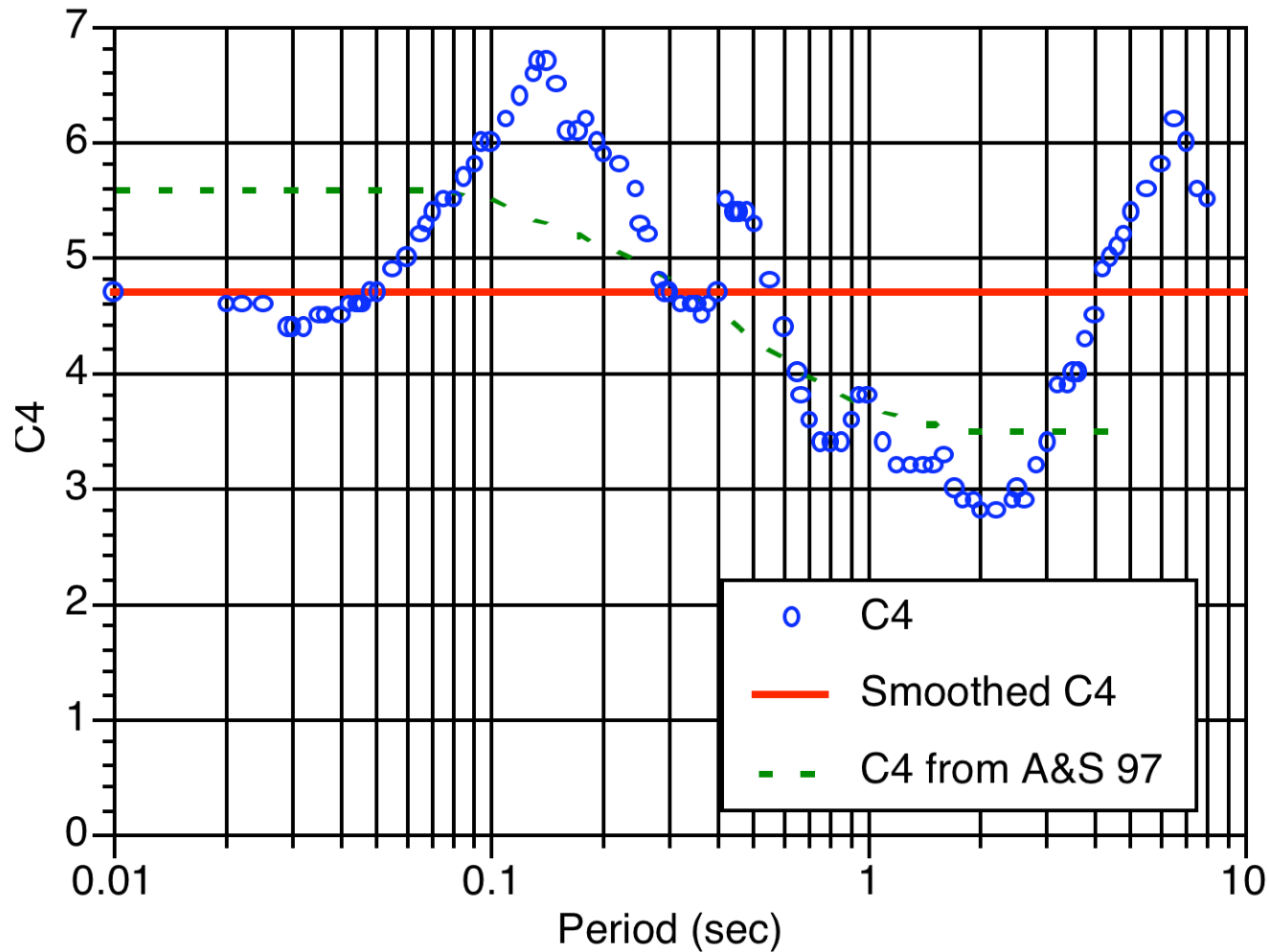


Scaling with Z1.0 Vs270

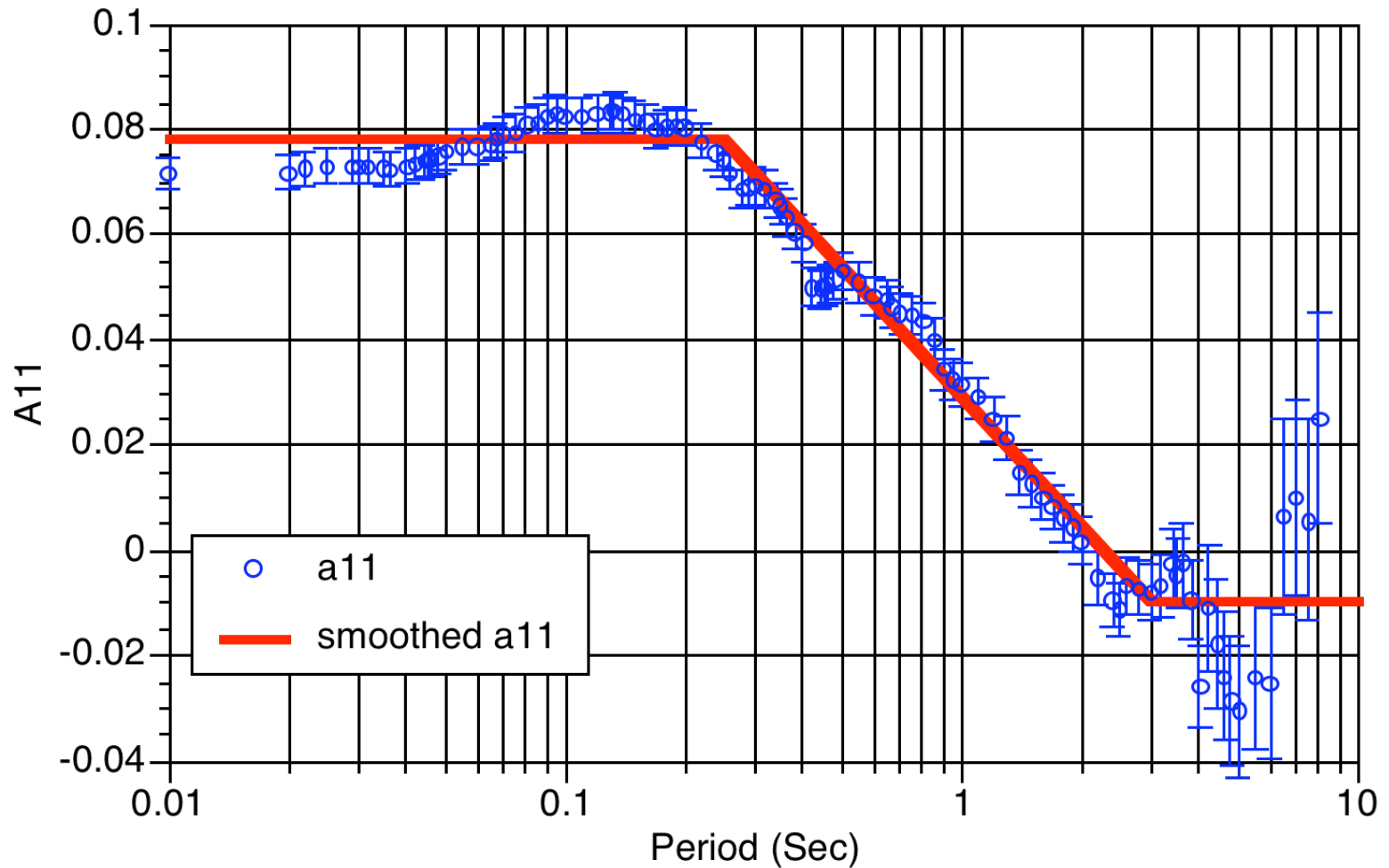
T=3



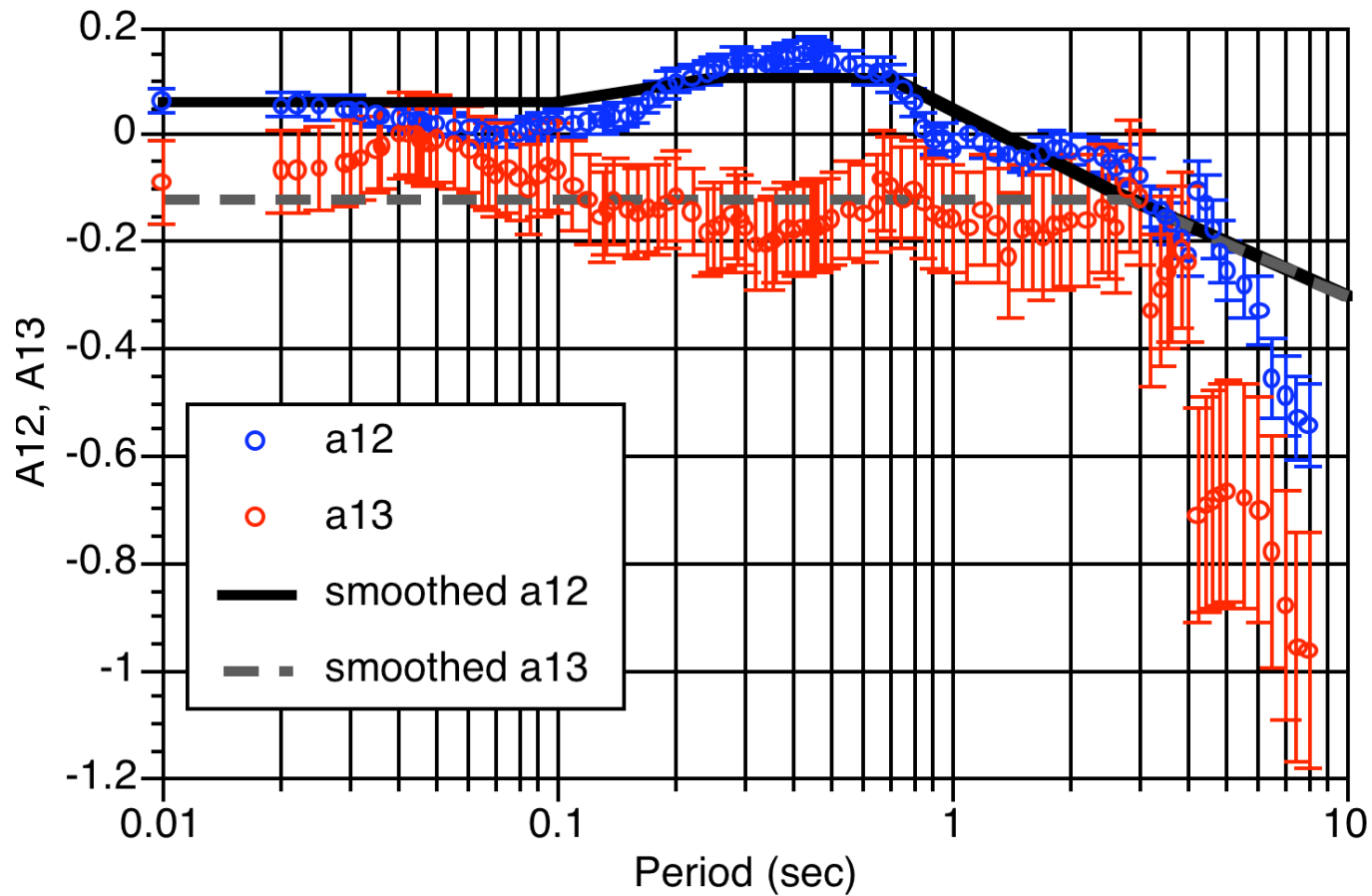
Strong Smoothing of Fictitious Depth



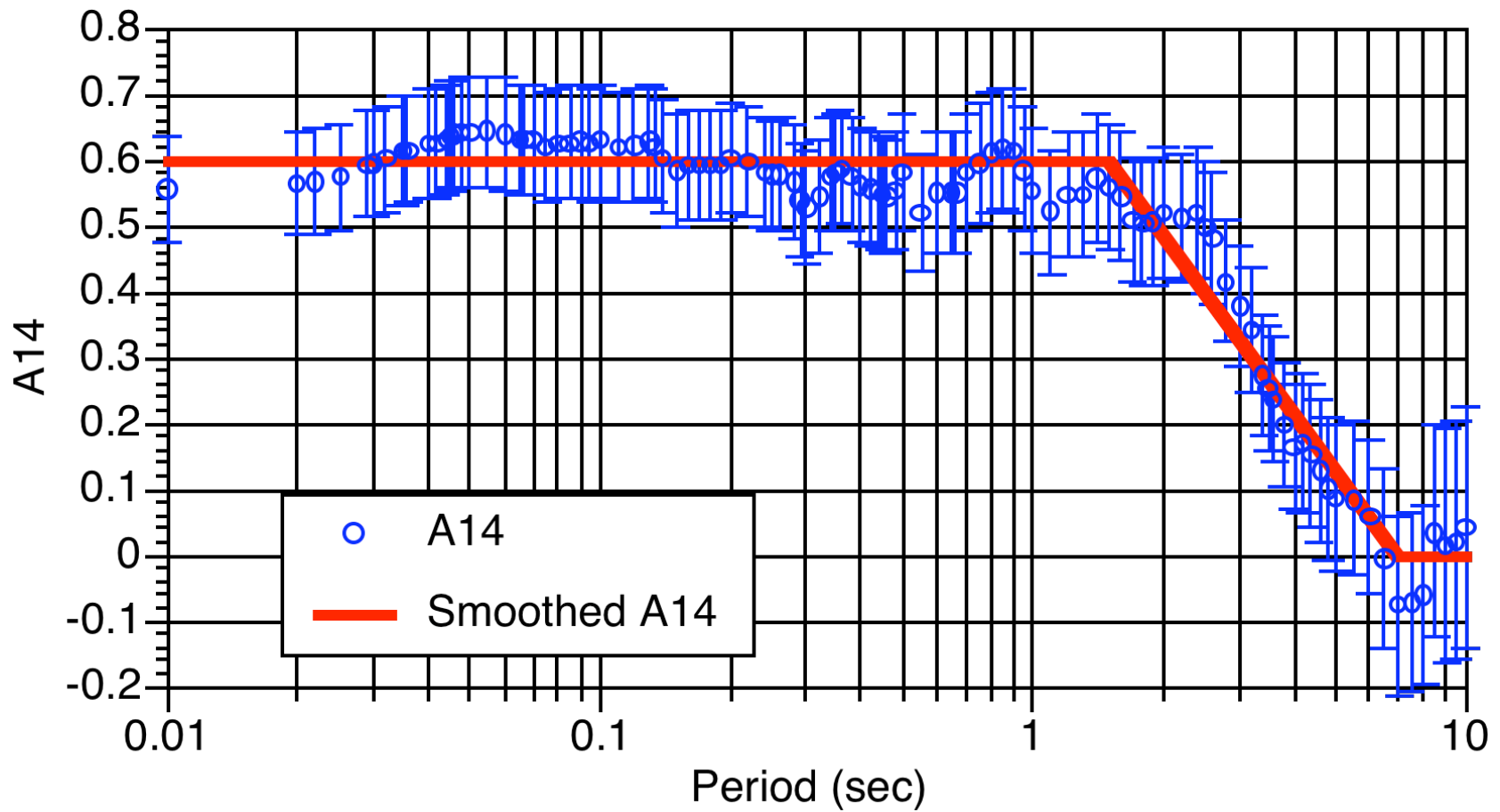
Depth to Top Factor



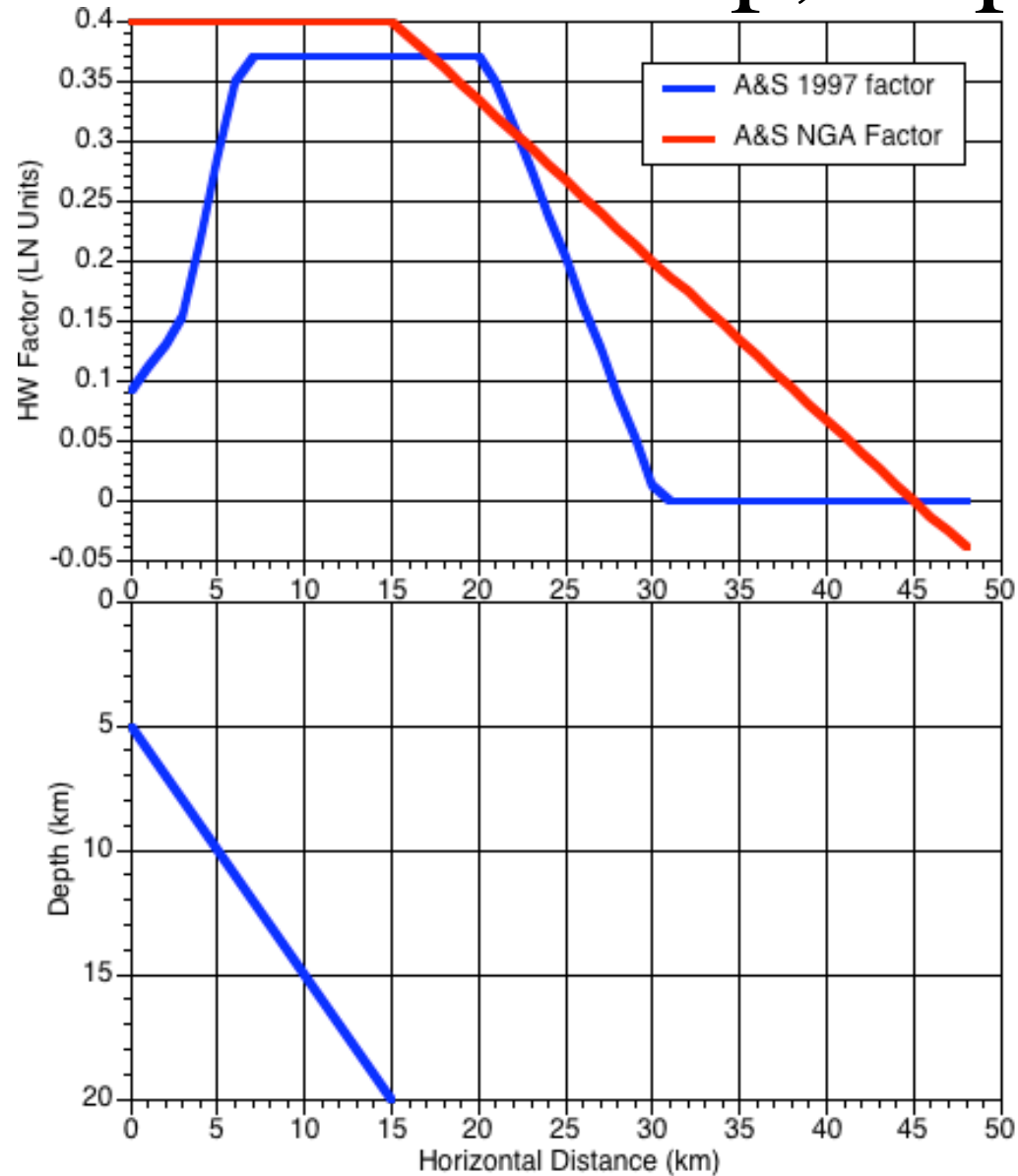
Style-of-Faulting Factor



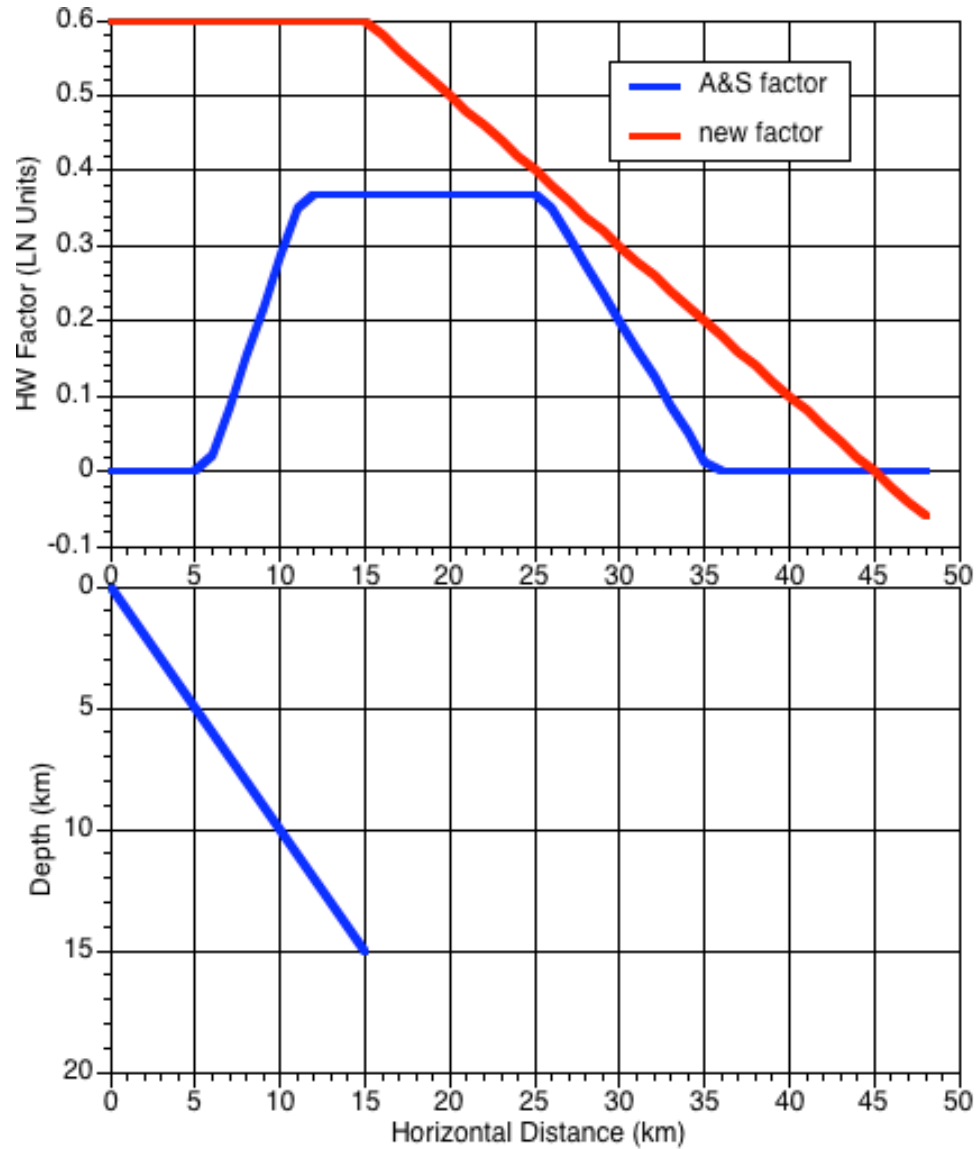
HW Scaling (Surface, 45 dip, $M > 6.5$)



HW Factor: 45 dip, Top=5



HW Factor: 45 dip, Top=0



Report Status

- Need to add:
 - Smooth cross-correlation of PGA and SA residuals
 - Plots of residuals
 - Comparison with A&S 97