Proponent Model for Simple Correcting for Recorded Motions to Reference Rock Conditions

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SSHAC Workshop 2
Proponent Discussions and Remaining Critical Issues and Data Needs

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Geotechnical Working Group
Next Generation Attenuation for CEUS (NGA-East)

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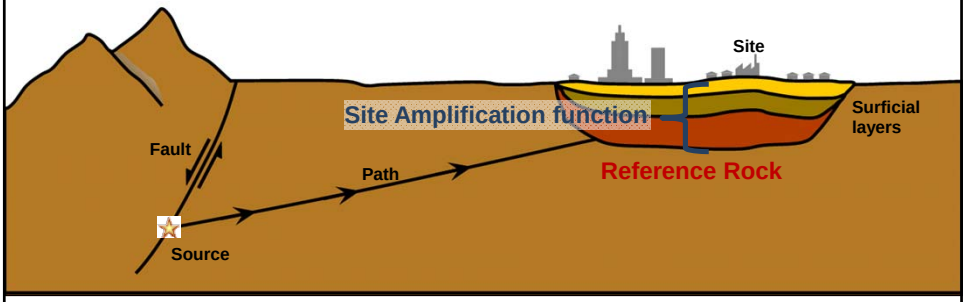
Goal: Remove site amplification from recorded motions



Outline

- Key Assumptions
- Site Characterization Model
  - $V_{s,30}$ relationships
  - Comparison $V_{s,30}$ estimates
- Empirical Amplification Model
  - Amplification model
  - Observed amplification
  - Site amplification model
- Example Corrections
- Deliverables

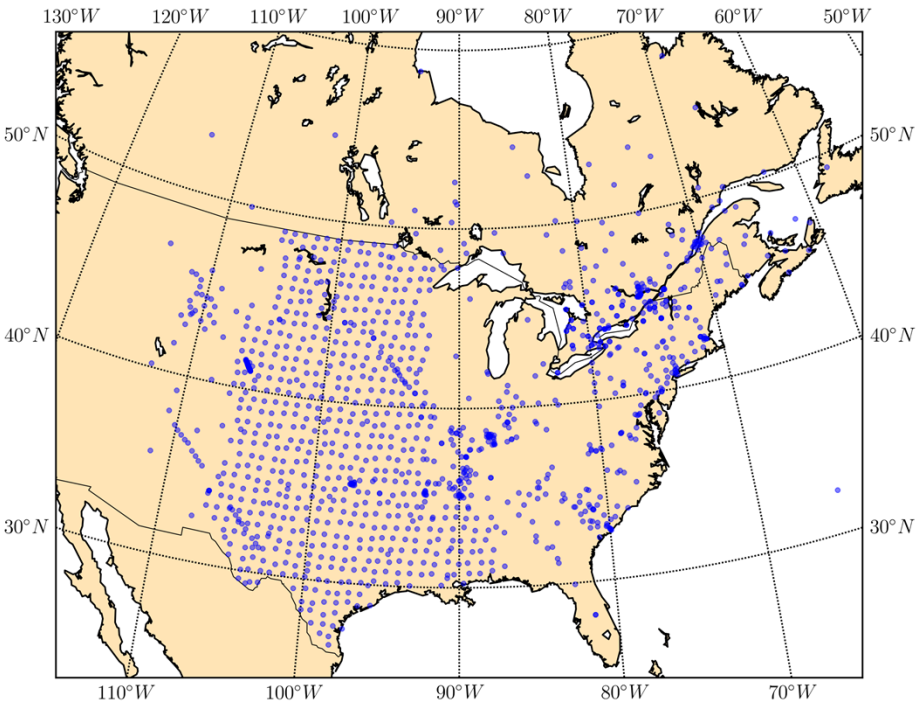
Why use $V_{s,30}$ to characterize the site?

- Corrected motions needed promptly
- Established as a proxy for site amplification
- Published relationships for estimating $V_{s,30}$ based on site characteristics are available

- *NB: Members of GWG find that $V_{s,30}$ is not necessarily a suitable metric for site amplification (e.g shallow soil over hard rock, or deep soil column)*

$V_{s,30}$ Models

- NGA East database (v2.0, 9/29/11):
  - recordings at 1282 sites
  - 44 sites with measured $V_{s,30}$ (3.4%)
- Need to estimate $V_{s,30}$ at sites with no measurements
- Published Models:
  - Wald and Allen (2007) – topographic slope
  - Yong et al. (in press) – terrain
  - Wills and Clahan (2006) – geology



$V_{s,30}$ Estimated By Topographic Slope

- Proposed by Wald and Allen (2007) and implemented by the USGS
- Slope measured using remote sensing (SRTM30)
- Calibrated for stable tectonic regions with:
  - 432 sites in Tennessee, Missouri, Kentucky, and Arkansas
  - 88 sites across Australia
- Values for our study extracted from USGS gridded data

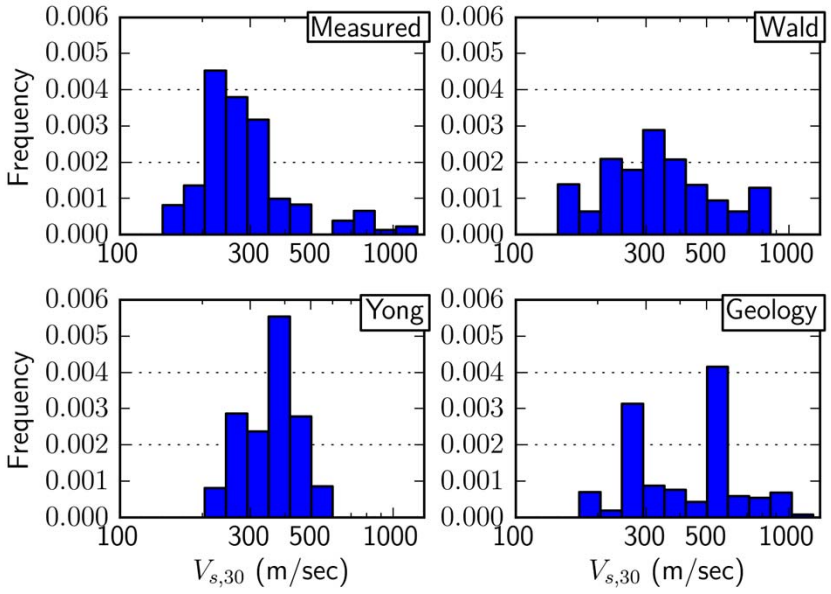
$V_{s,30}$ Estimated By Terrain

- Proposed by Yong et al. (in press)
- 16 terrain types identified from:
  - slope gradient
  - local convexity
  - surface texture
- $V_{s,30}$ estimates from California sites
- Shows better predictive power for sites in the CENA region compared to slope based methods

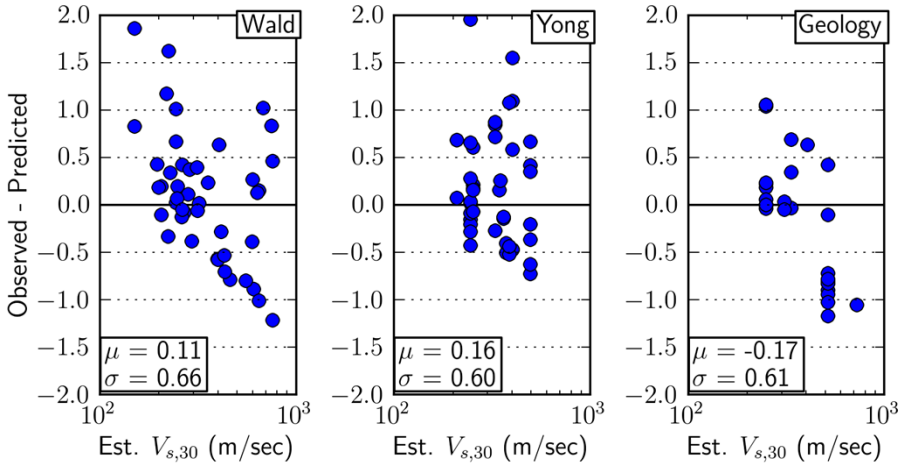
$V_{s,30}$ Estimated By Geology

- Approach based on Withers (2007)
- Use GIS to determine surficial geologic unit
  - Data from Fullerton et al. (2003)
  - Provides:
    - Unit description
    - Thickness range
- Assign velocity based on unit description
- Compute $V_{s,30}$ using the soil velocity, soil maximum thickness, and a weathered rock velocity of 1100 m/s

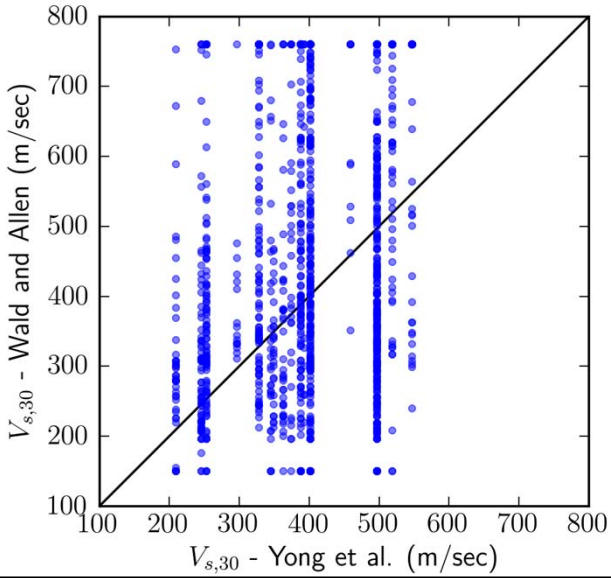
Distribution of $V_{s,30}$ Values



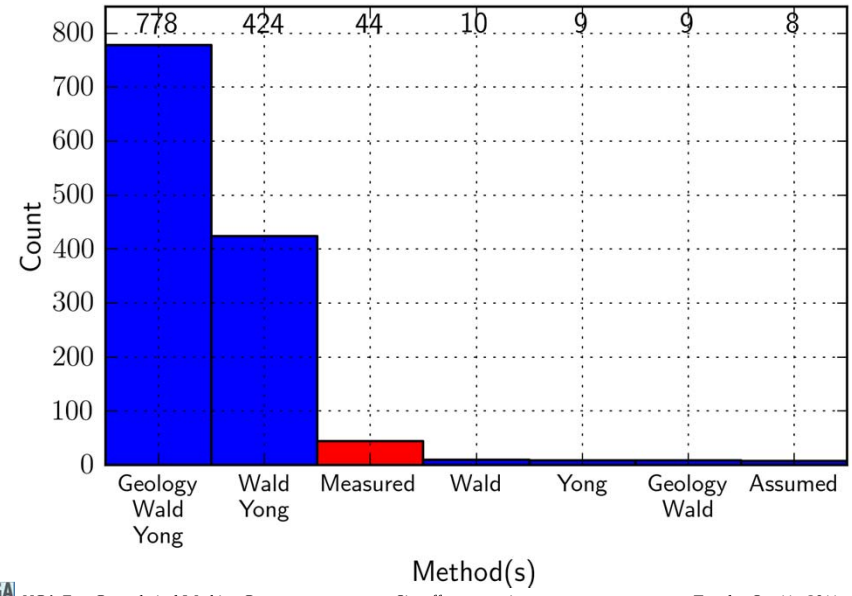
Comparison of Residuals of ln(Vs)



Comparison of Wald and Allen (2007) and Yong et al. (in press) Estimates



Available $V_{s,30}$ Values



Proposed $V_{s,30}$ Model

- Measured if available
- Geometric mean of available estimates

- Poor agreement between various methods.
- Significant uncertainty in the $V_{s,30}$ estimate due to lack of data in the region.
- Better estimates will be available after data collection has been completed.

Empirical Amplification

1. Compute predicted rock response spectrum using GMPE
2. Remove rock response from observed response spectrum
3. Remaining portion is site amplification

Ground Motion Models

- Atkinson and Boore (2011)
  - BC Boundary (760 m/sec)
  - Hard rock (2000 m/sec)
  - Corrected magnitude scaling to their 2006 model
- Campbell (2003) – 2800 m/sec
- Tavakoli and Pezeshk (2005) – 2900 m/sec

Linear Site Amplification Model

- Linear amplification:

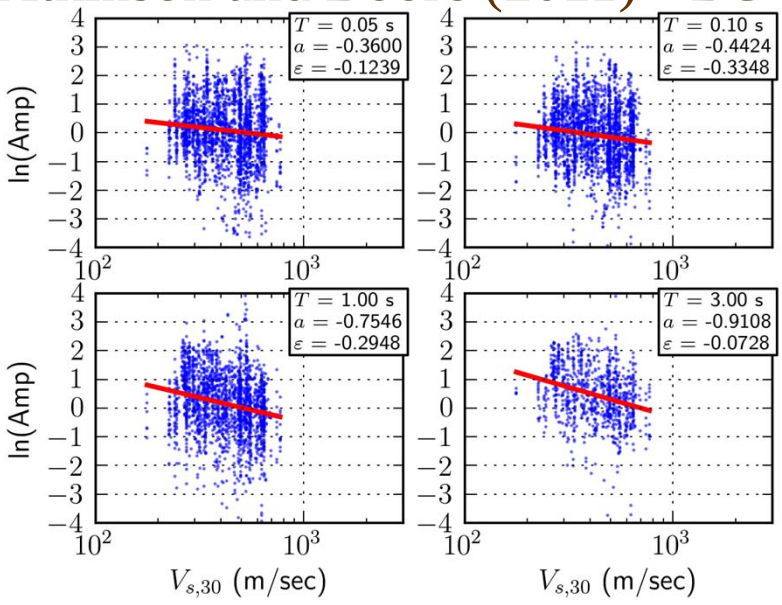
$$\ln(Amp) = a \ln\left(V_{s,30}\right) + b$$

or…

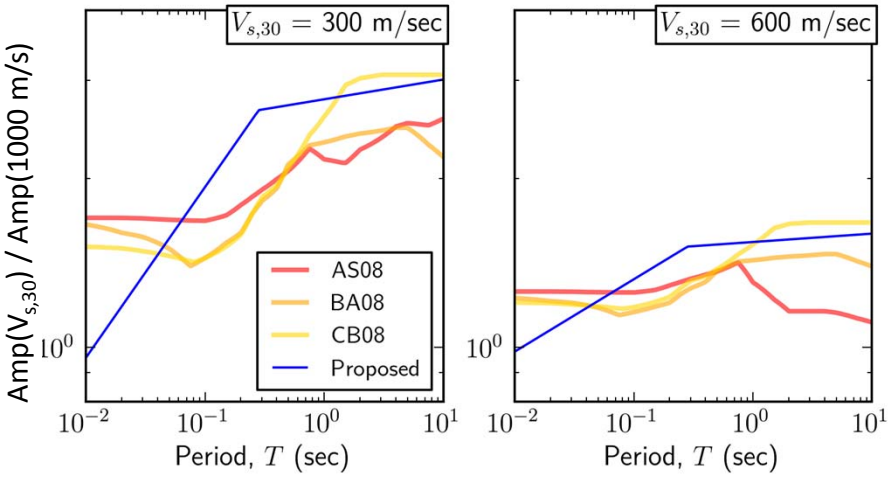
$$\ln(Amp) = a \ln\left(\frac{V_{s,30}}{V_{s,\mathrm{ref}}}\right)$$

- Used by:
  - Boore et al. (1997)
  - Choi and Stewart (2005) linear portion
  - Walling et al. (2008) linear portion

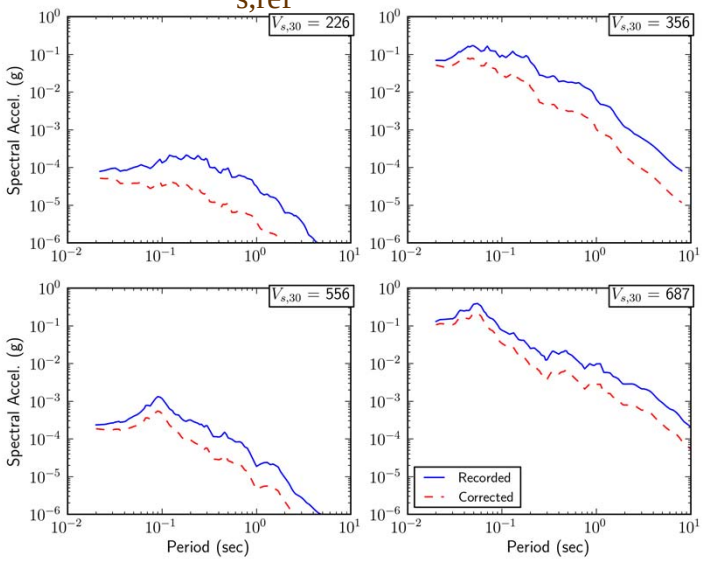
Atkinson and Boore (2011) – BC



Comparison with NGA Site Amplification
$V_{s,ref}$=3000m/sec



Application of Correction Factors,
$V_{s,ref}$=3000m/sec



Deliverables

- Response spectra corrected for site amplification for evaluation of ground motion models
- Fourier amplitude spectra compatible with response spectra for evaluation of seismological models.