CyberShake Broadband Calculation

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CyberShake Study 15.4 Review

- 1 Hz maximum deterministic frequency
- CVM-S4.26 velocity model
- 336 sites (50 new ones)
  - Includes 14 UGMS sites
- Graves & Pitarka (2014) rupture generator
- UCERF 2 ERF
- Vs min = 500 m/s
- AWP-ODC SGT code
- No background seismicity
- 100 m grid spacing
CyberShake Study 15.4 Results

2sec SA, 2% in 50 yrs

3sec SA, 2% in 50 yrs
Broadband CyberShake Approach

• Calculate stochastic seismograms (to 10 Hz) using Graves & Pitarka code from the SCEC Broadband Platform
• Combine with low-frequency results from Study 15.4 to produce broadband seismograms
• Calculate intensity measures from broadband seismograms
• Calculate data products
Stochastic Calculation

- Use 1D Southern California velocity profile
- Calculate 0-10 Hz seismogram (dt=0.025)
- Apply site response (BBP code)
  - Graves method requires 2 parameters, Vs30 and Vref
  - Vs30 comes from 3D velocity model used in Study 15.4 (CVM-S4.26)
    - Calculated by performing travel time average:
      \[ Vs30 = 30 / \left\{ \sum \left( \frac{1}{Vs \text{ sampled from } [0.5,29.5] \text{ in 1 meter increments}} \right) \right\} \]
  - Vref = 865 m/s
Deterministic Seismograms

- Taken from Study 15.4 for the same site
- Site response applied
  - $Vs_{30}$ from 3D velocity model (CVM-S4.26)
    - $Vs_{30} = \frac{30}{\sum (\frac{1}{Vs} \text{ sampled from [0.5,29.5] in 1 meter increments})}$
  - $V_{ref} = Vs_{30} \times \left[ \frac{Vs_{D500}}{Vs_{500}} \right]$
  - $Vs_{500}$: travel-time average, like $Vs_{30}$
    - $= \frac{500}{\sum (\frac{1}{Vs} \text{ sampled from [0.5,499.5] in 1 meter increments})}$
  - $Vs_{D500}$: discrete travel-time average
    - $= \frac{5}{0.5/Vs(Z=0) + \frac{1}{Vs(Z=100m)} + \frac{1}{Vs(Z=200m)} + \frac{1}{Vs(Z=300m)} + \frac{1}{Vs(Z=400m)} + 0.5/Vs(Z=500m)}$
  - $Vs \text{ min (500 m/s)}$ applied to samples before averaging
  - These values were chosen to reflect the structure without being unduly influenced by the surface
Merging

- Deterministic seismograms processed
  - Low-pass filtered at 1 Hz (4\textsuperscript{th} order Butterworth, 2 pass)
  - Resampled to stochastic dt (0.05 → 0.025 sec)
- Stochastic seismograms processed
  - High-pass filtered at 1 Hz (4\textsuperscript{th} order Butterworth, 2 pass)
- Seismograms added together
- Intensity measures computed (PSA, RotD)
- Hazard curves computed for 0.1-10 sec
Sample Seismogram (PAS)
Deterministic Site Amp (PAS)

Blue: no deterministic site amplification
Black: deterministic site amplification
Deterministic Site Amp (STNI)

Blue: no deterministic site amplification
Black: deterministic site amplification

Plot: Probability Rate (1/yr) vs. 3s SA (g)

Graph legend:
- STNI, CS Run 3873
- Seven Ten-Ninety Interchange, CS Run 4281
- CB2008
- Boore2008
- CY2008
- AS2008
Broadband CyberShake Status

- 14 UGMS sites completed
- Will calculate results for remaining 322 sites