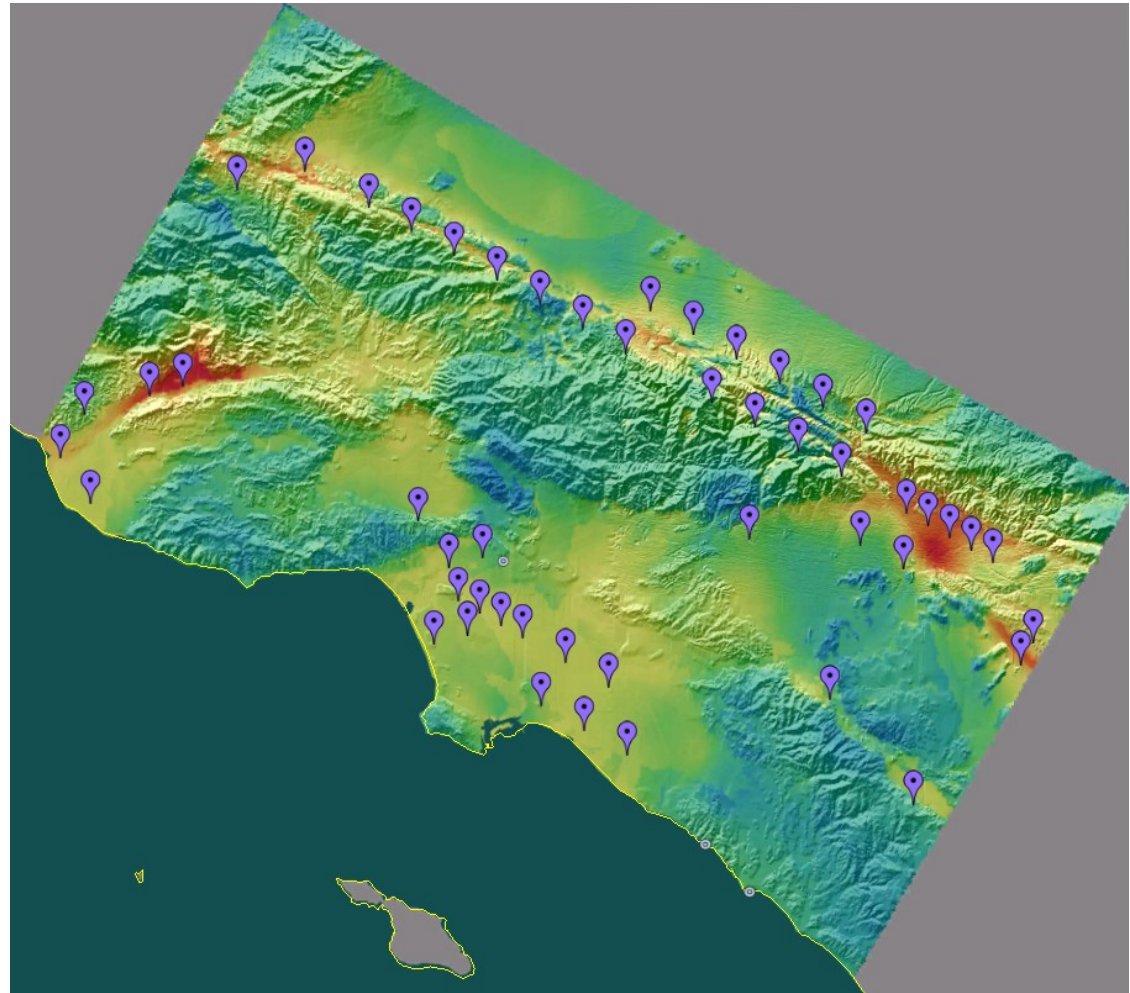


CyberShake Broadband Calculation

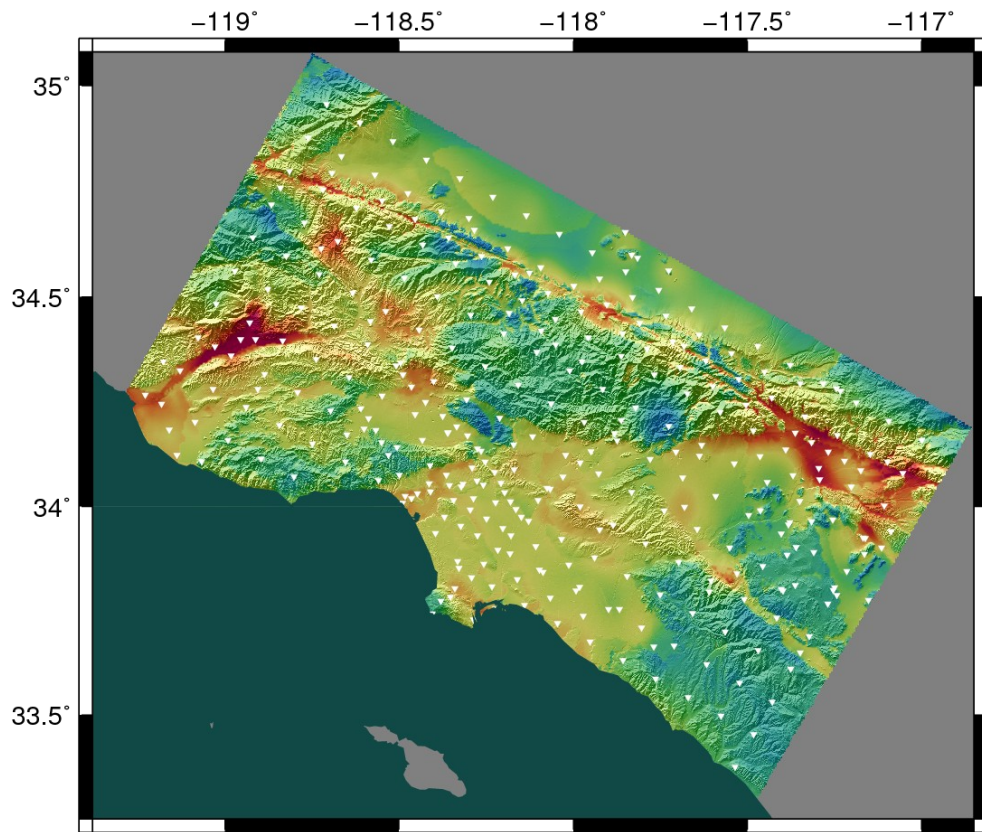
Scott Callaghan
UGMS Meeting
November 30, 2015

CyberShake Study 15.4 Review

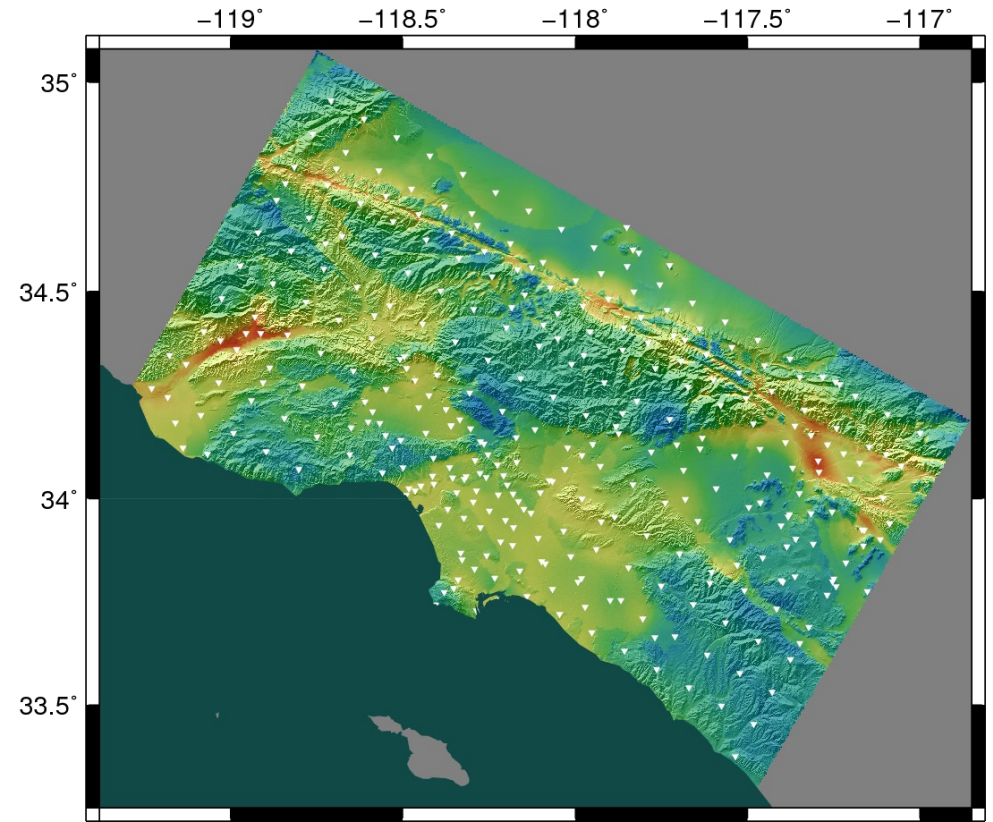
- 1 Hz maximum deterministic frequency
- CVM-S4.26 velocity model
- 336 sites (50 new ones)
 - Includes 14 UGMS sites
- Graves & Pitarka (2014) rupture generator
- UCERF 2 ERF
- $V_s \text{ min} = 500 \text{ m/s}$
- AWP-ODC SGT code
- No background seismicity
- 100 m grid spacing



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:
$$Vs30 = 30 / \{ \Sigma (1 / Vs \text{ sampled from } [0.5,29.5] \text{ in 1 meter increments }) \}$$
 - Vref = 865 m/s

Deterministic Seismograms

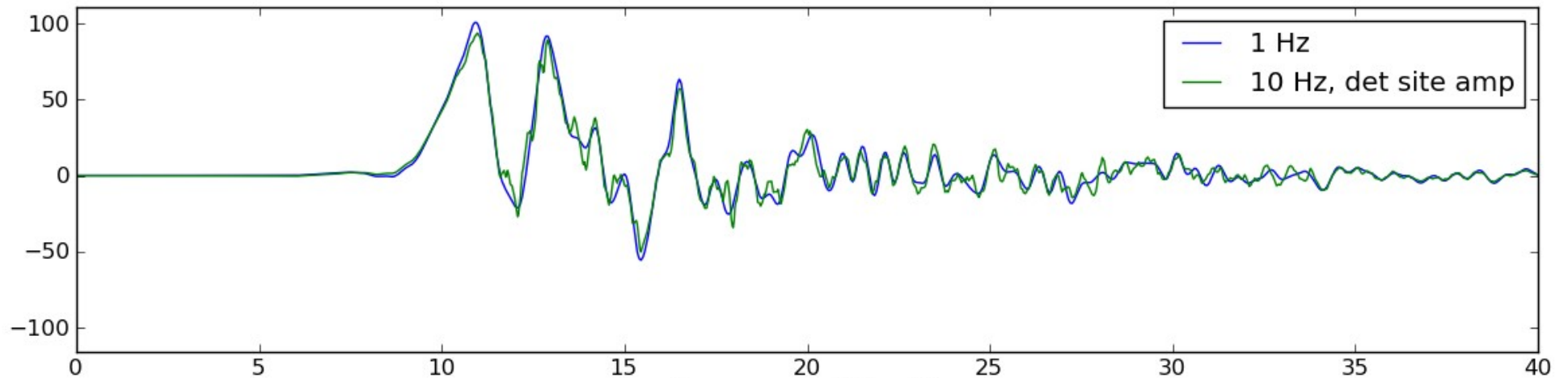
- Taken from Study 15.4 for the same site
- Site response applied
 - Vs30 from 3D velocity model (CVM-S4.26)
 - $Vs30 = 30 / \{ \Sigma (1 / Vs \text{ sampled from } [0.5,29.5] \text{ in 1 meter increments }) \}$
 - $V_{ref} = Vs30 \times [VsD500 / Vs500]$
 - Vs500: travel-time average, like Vs30
 - $= 500 / \{ \Sigma (1 / Vs \text{ sampled from } [0.5,499.5] \text{ in 1 meter increments }) \}$
 - VsD500: discrete travel-time average
 - $= 5 / \{ 0.5/Vs(Z=0) + 1/Vs(Z=100m) + 1/Vs(Z=200m) + 1/Vs(Z=300m) + 1/Vs(Z=400m) + 0.5/Vs(Z=500m) \}$
 - Vs 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

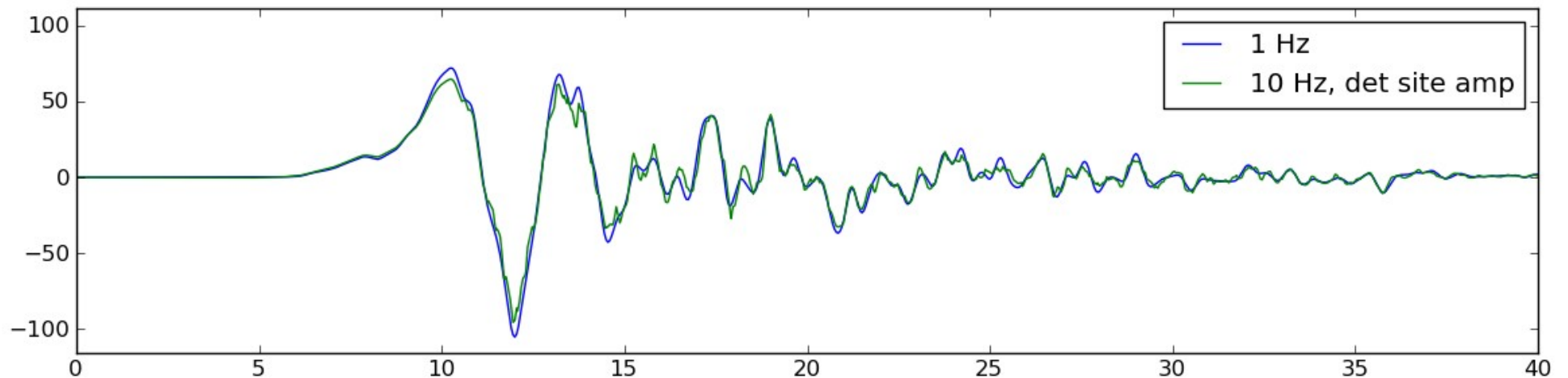
- **Deterministic seismograms processed**
 - Low-pass filtered at 1 Hz (4th order Butterworth, 2 pass)
 - Resampled to stochastic dt (0.05 → 0.025 sec)
- **Stochastic seismograms processed**
 - High-pass filtered at 1 Hz (4th order Butterworth, 2 pass)
- **Seismograms added together**
- **Intensity measures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

Sample Seismogram (PAS)

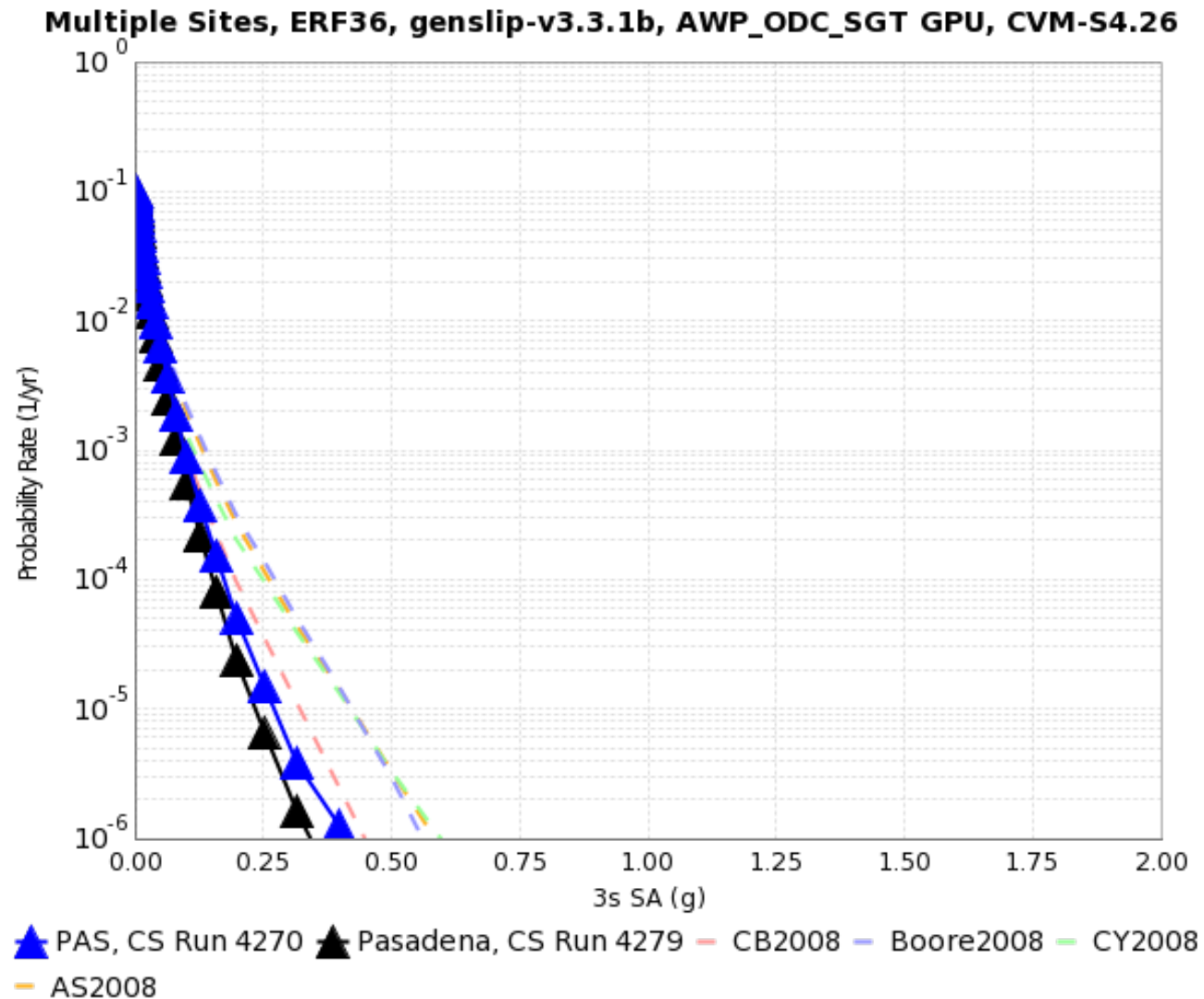
X component (cm/s)



Y component (cm/s)

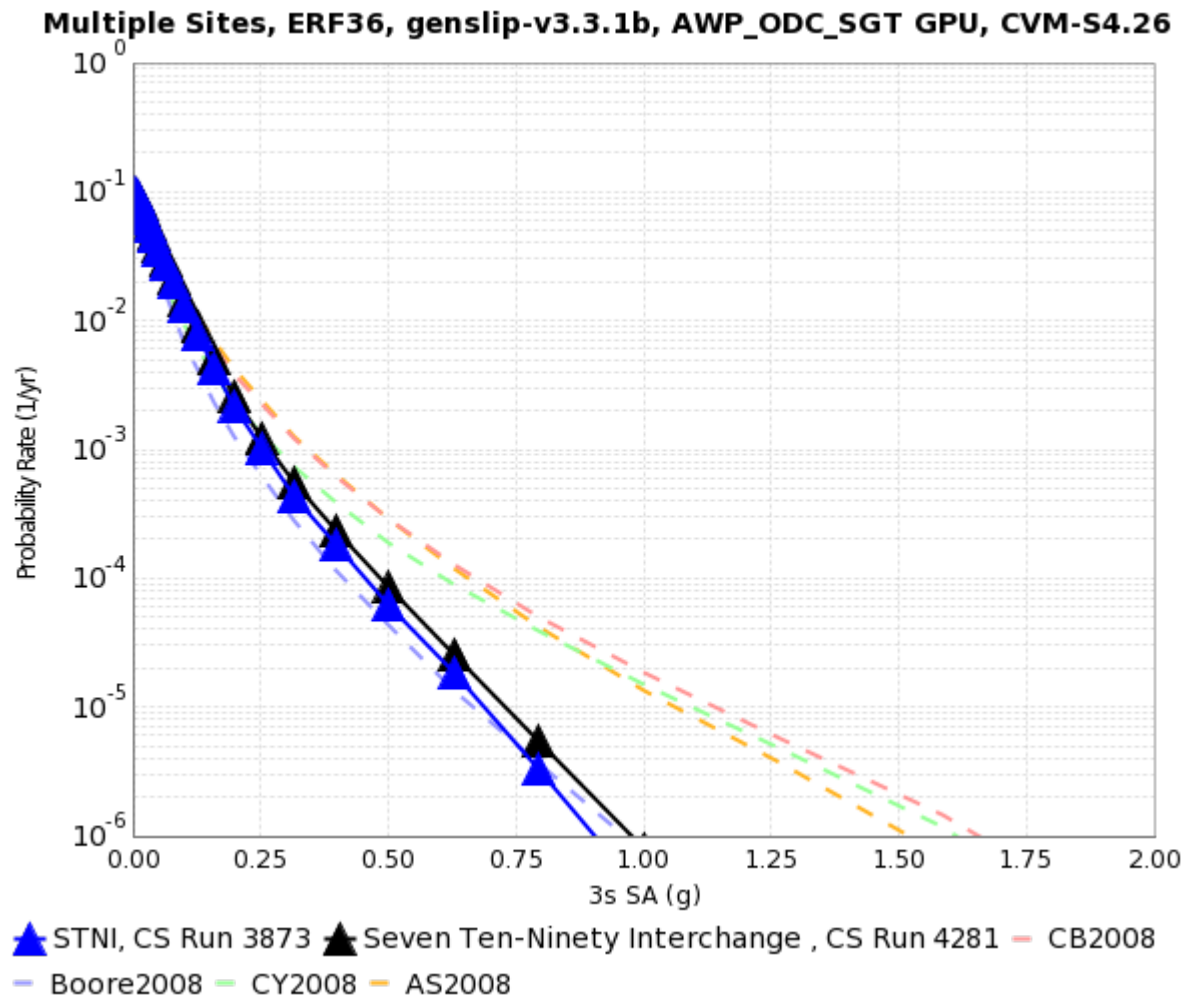


Deterministic Site Amp (PAS)



Blue: no deterministic site amplification
Black: deterministic site amplification

Deterministic Site Amp (STNI)



Blue: no deterministic site amplification
Black: deterministic site amplification

Broadband CyberShake Status

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

