Calculation of CyberShake MCER Results

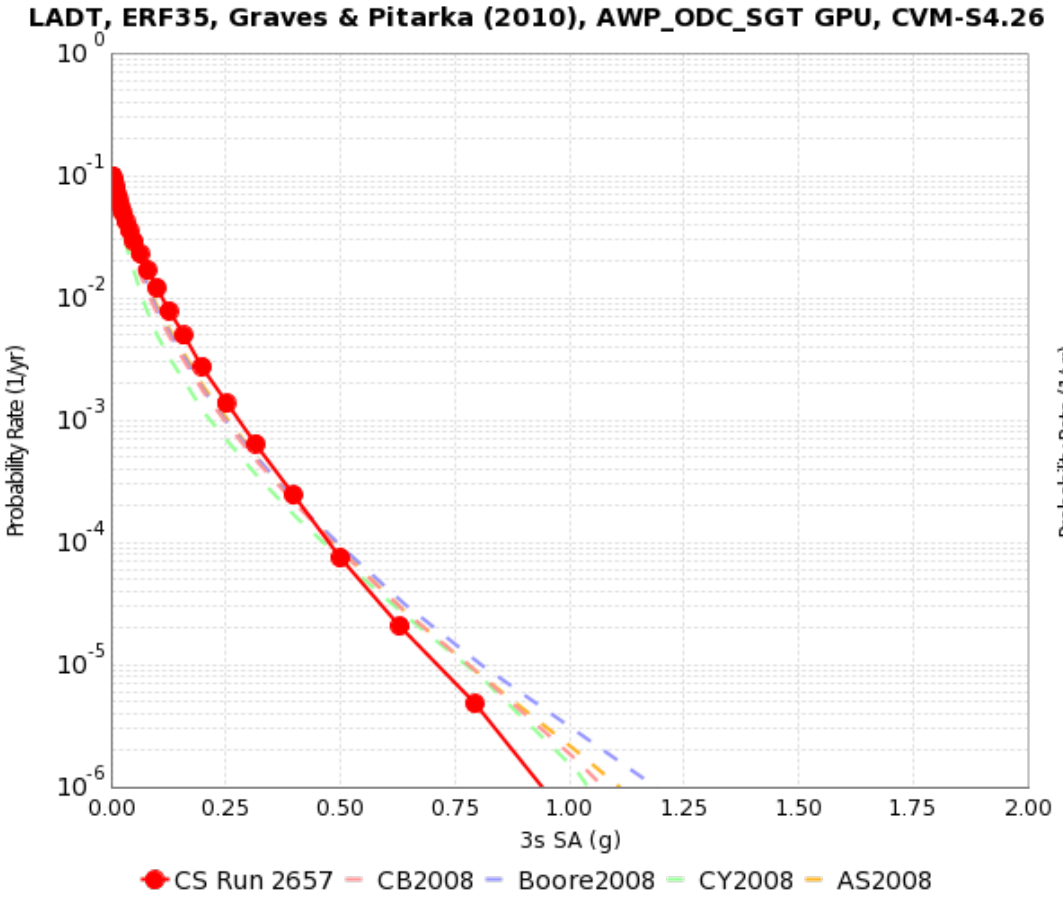
Scott Callaghan
UGMS Meeting
May 4, 2015

CyberShake Data Products

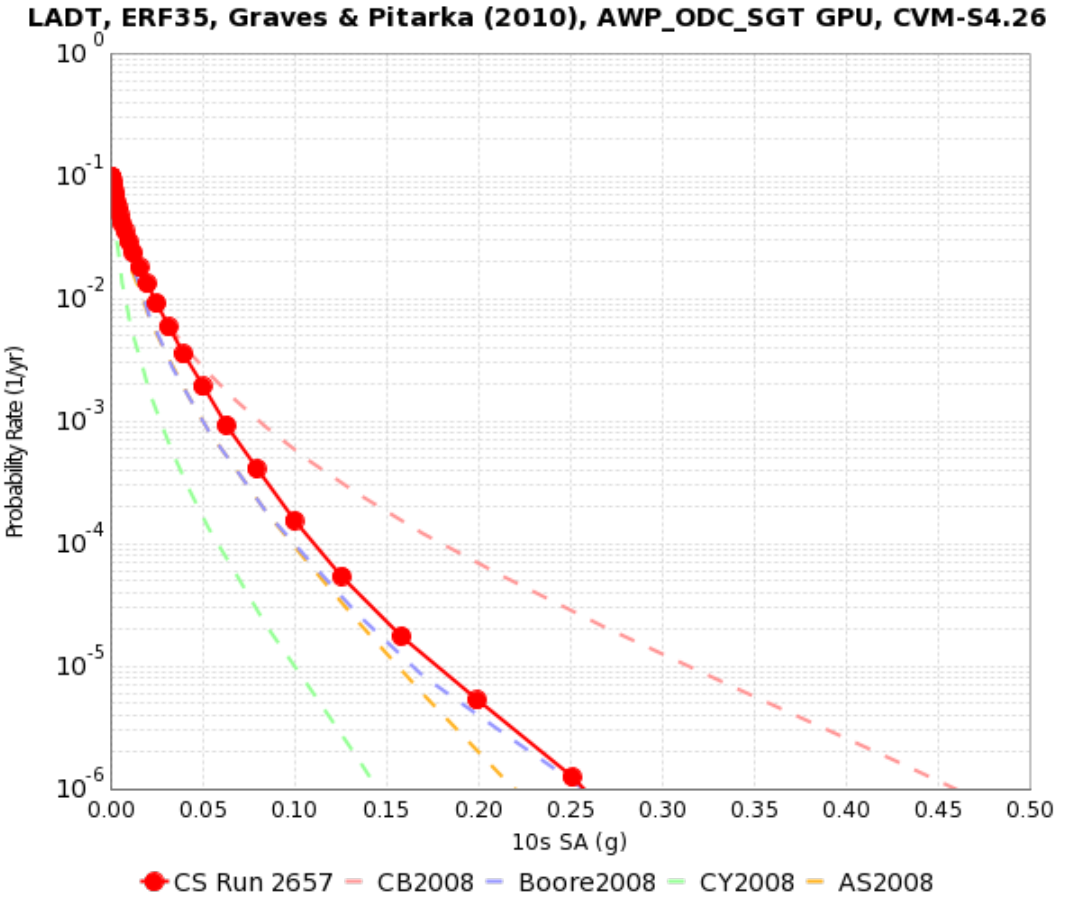
- For each CyberShake site:
  - 2-component seismograms for each of 400,000+ events
  - Intensity measures for each 2-component seismogram
    - Peak Spectral Acceleration at 44 periods
    - RotD100 and RotD50 at 16 periods
  - Intensity measures combined with probabilities from UCERF2 ERF to produce hazard curves

PSHA Hazard Curves

- Produced for each site, at various periods
  - For RotD100, 2, 3, 4, 5, 7.5, 10 sec



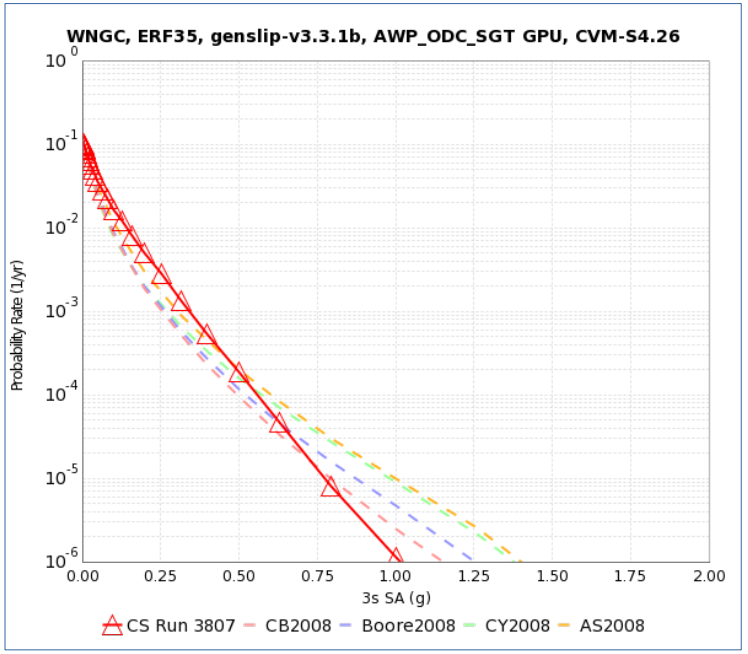
RotD100, 3 sec



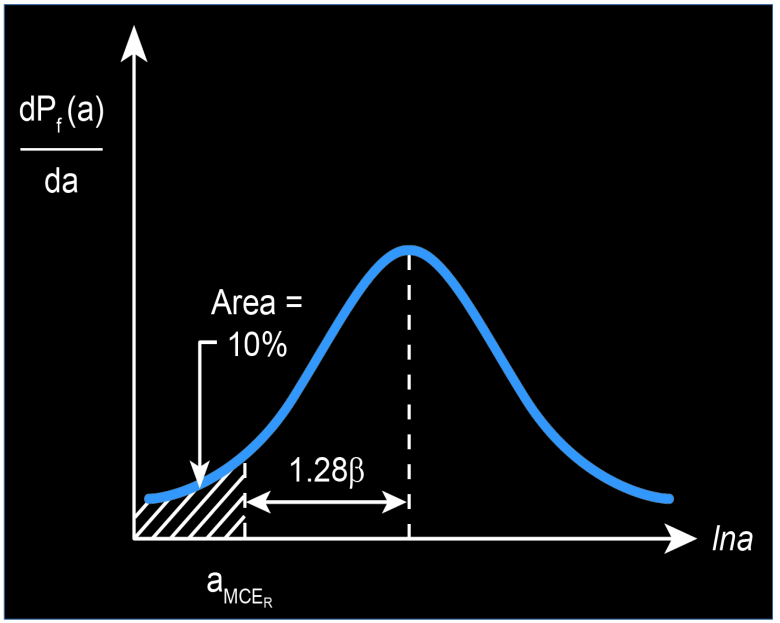
RotD100, 10 sec

Probabilistic MCER

- Construct a PSHA hazard curve using RotD100
- Convolve with fragility function
- Obtain period-dependent MCER value
- Same procedure for CyberShake and NGAs



+



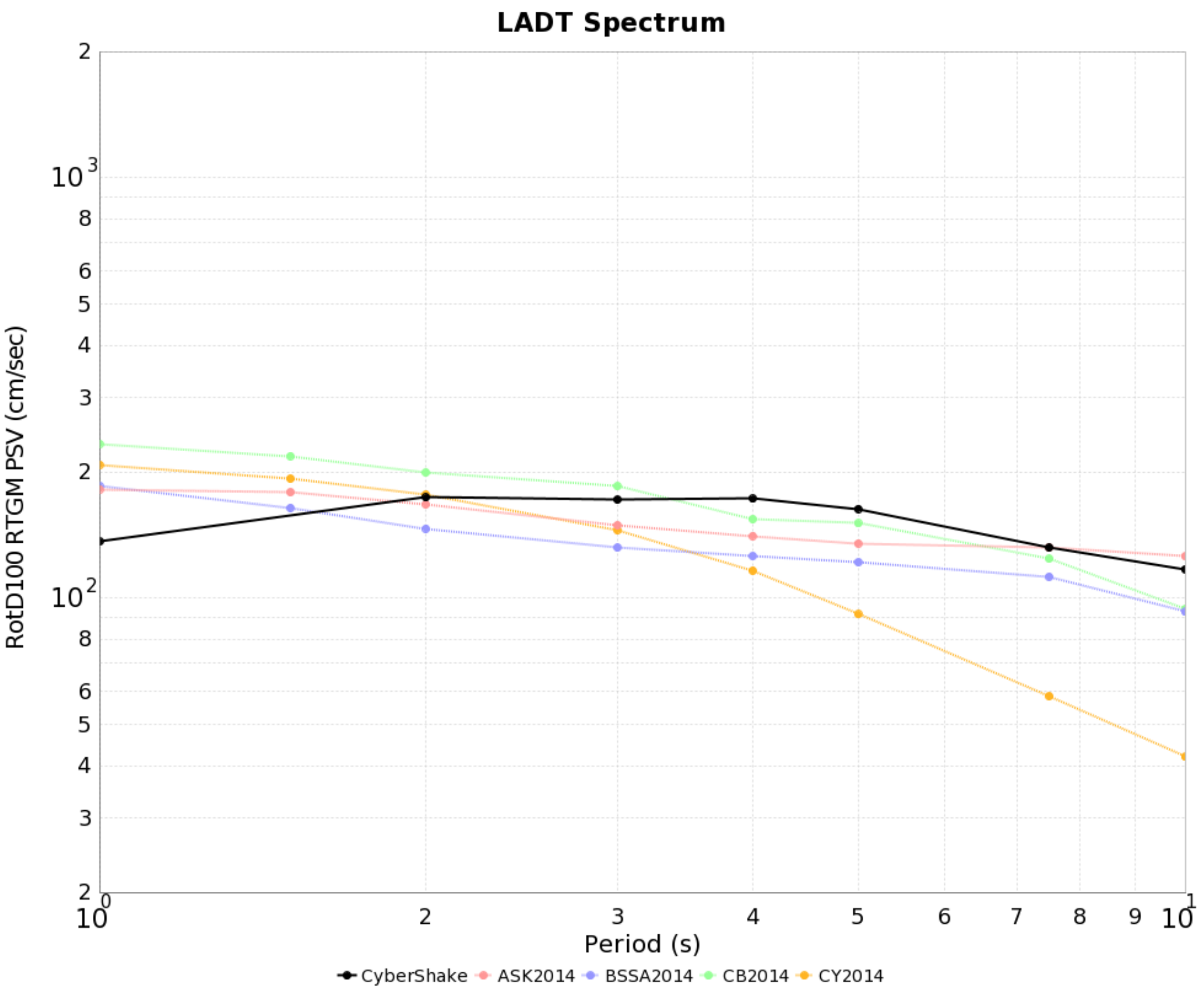
→ 3 sec SA, 0.603 g

How RotD100 was obtained

- CyberShake
  - Seismograms reprocessed to obtain RotD100
  - Used modified, verified RotD code from BBP
- 2008 NGAs
  - Originally calculated using GMRotI50
  - Scaling factors taken from Boore 2010
- 2014 NGAs
  - Originally calculated using RotD50
  - Scaling factors taken from Shahi & Baker 2014

Probabilistic Plots

- CyberShake
- 2008 NGAs
  - Campbell and Bozorgnia
  - Boore and Atkinson
  - Chiou and Youngs
  - Abrahamson and Silva
- 2014 NGAs
  - Campbell and Bozorgnia
  - Chiou and Youngs
  - Idriss
  - Boore, Stewart, Seyhan, and Atkinson
  - Abrahamson, Silva & Kamai

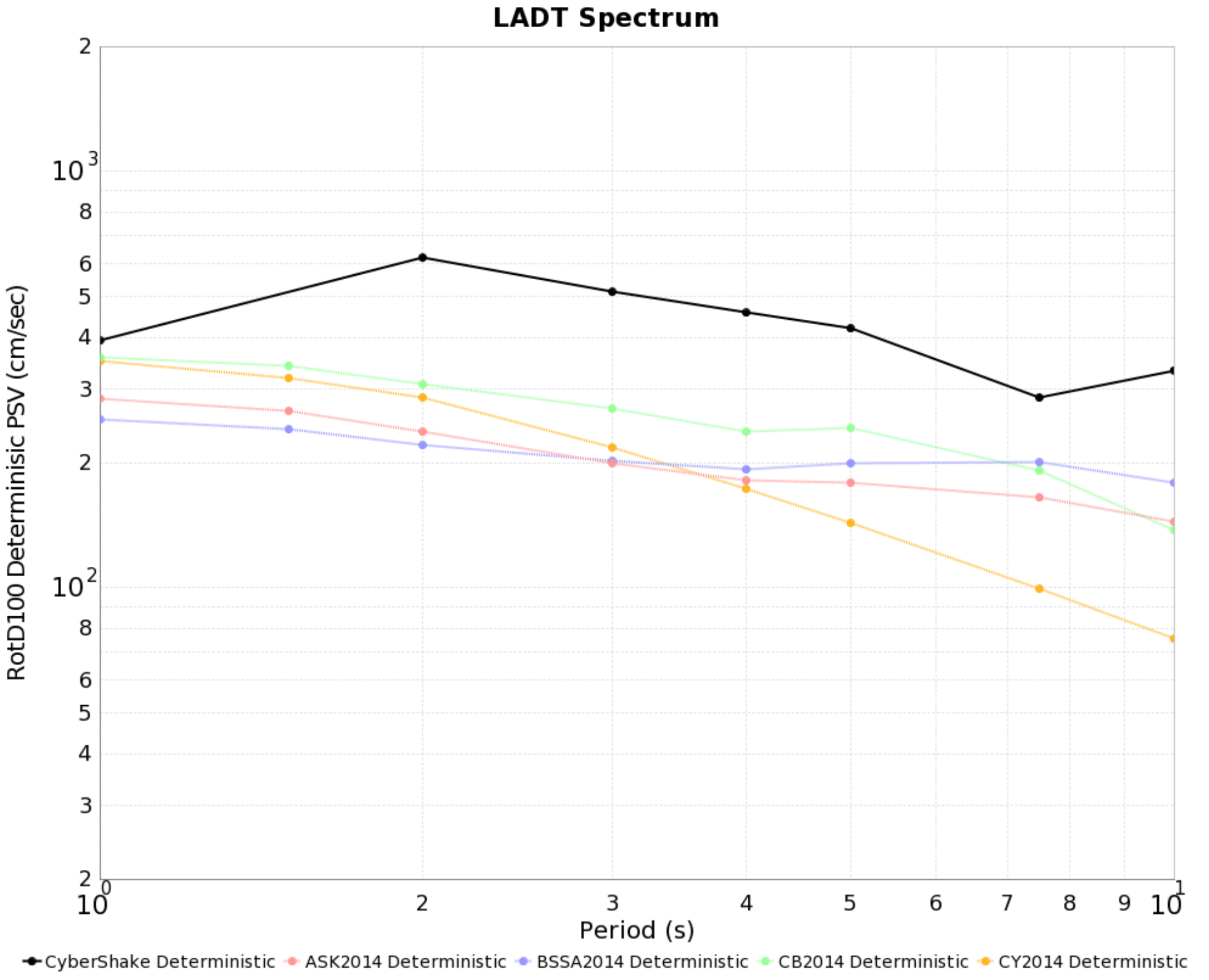

LADT Spectrum
RotD100 RTGM PSV (cm/sec)
2
10^3
8
6
5
4
3
2
10^2
8
6
5
4
3
2
10^0
2
3
4
5
6
7
8
9
10^1
Period (s)
CyberShake
ASK2014
BSSA2014
CB2014
CY2014

Deterministic MCER (NGAs)

- For each UCERF 2 rupture within 200 km of the site:
  - Get the log(mean) and standard deviation from the GMPE
  - Extract the 84th percentile for this rupture from a log-normal distribution
- Select the largest of the 84th percentile values

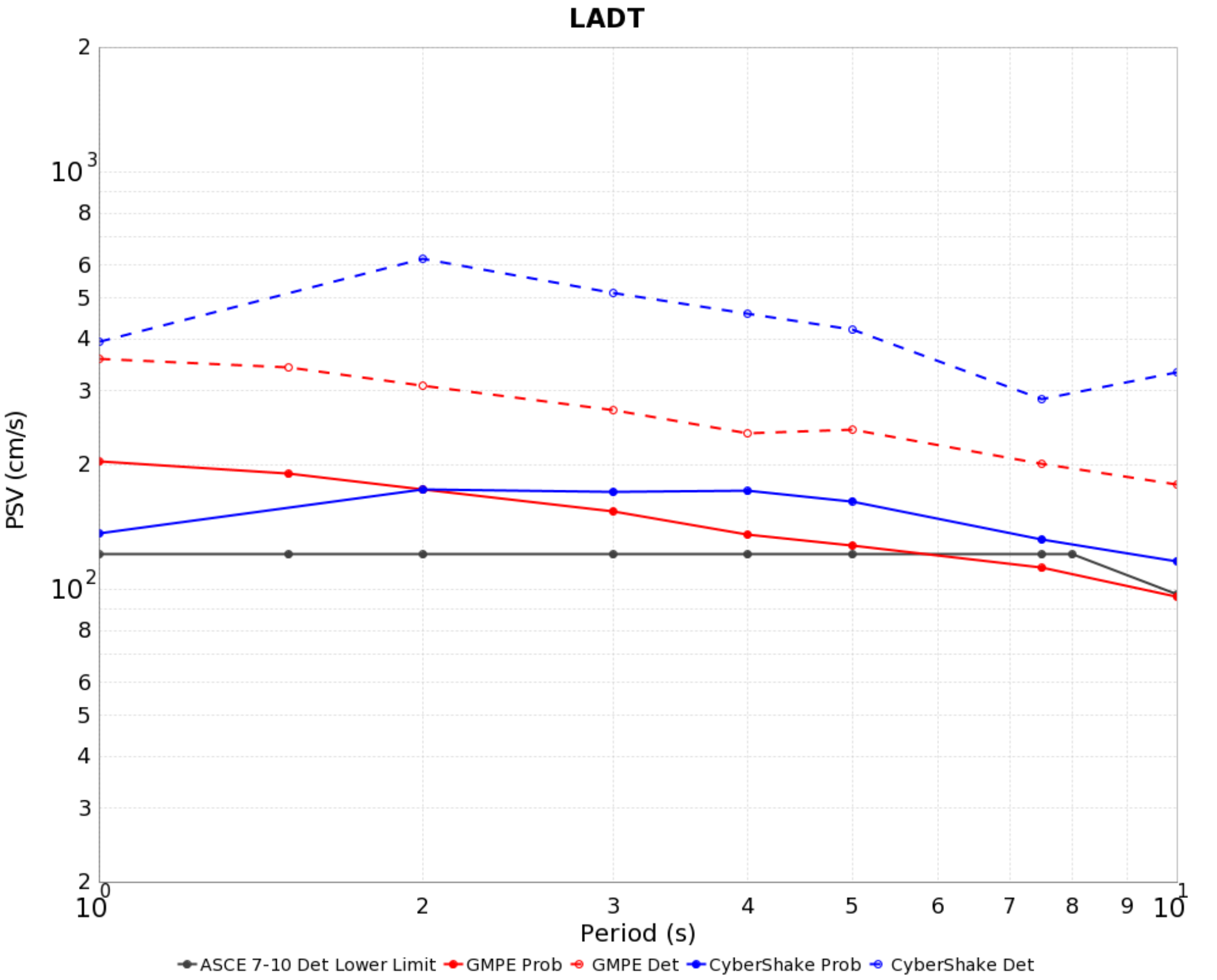
Deterministic MCER (CyberShake)

- For each UCERF 2 source within 200 km of the site:
  - Determine the maximum magnitude for any rupture of this source, M_{max}
  - Select the ruptures with $M \geq M_{max} - 0.1$
  - Get the peak SA value (RotD100) for all rupture variations for all selected ruptures
  - Determine the 84^{th} percentile peak SA value
- Select the largest 84^{th} percentile peak SA value as the period-dependent deterministic MCER


LADT Spectrum
RotD100 Deterministic PSV (cm/sec)
Period (s)
CyberShake Deterministic
ASK2014 Deterministic
BSSA2014 Deterministic
CB2014 Deterministic
CY2014 Deterministic

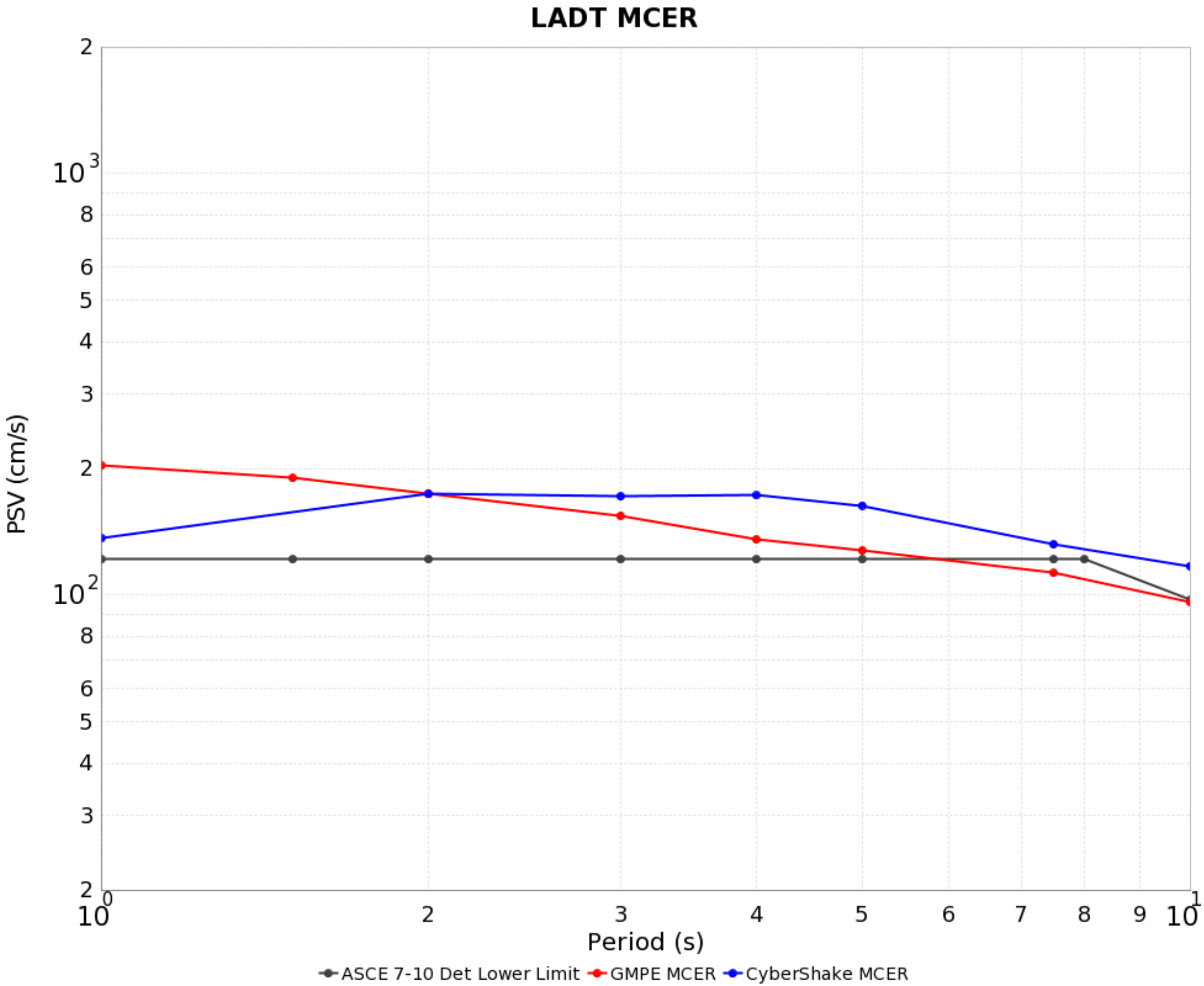
Combined Plots

- Probabilistic CyberShake
- Deterministic CyberShake
- Average of probabilistic 2014 NGAs
  - Curves averaged, then convolution applied
- Average of deterministic 2014 NGAs
  - Average of MCER values
- Also plotted ASCE 7-10 Det Lower Limit


LADT
PSV (cm/s)
Period (s)
ASCE 7-10 Det Lower Limit
GMPE Prob
GMPE Det
CyberShake Prob
CyberShake Det

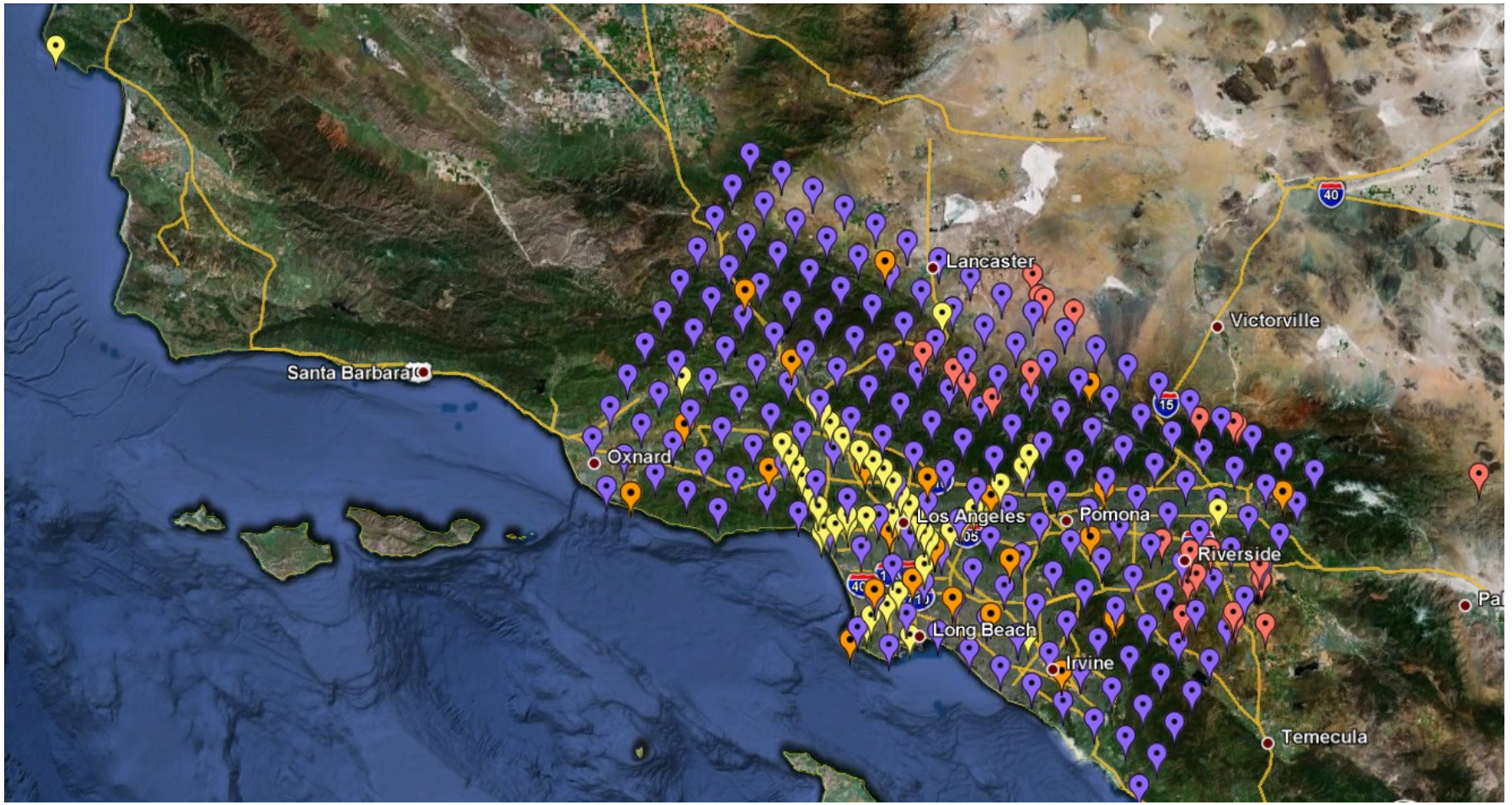
Overall MCER site plots

- For each period
  - Take the higher of the deterministic curve and the deterministic lower limit curve to get the deterministic MCER
  - Take the lower of the probabilistic MCER and the deterministic MCER to get the overall MCER
- Follow this process for both CyberShake and average of 2014 NGAs
- Also plotted ASCE 7-10 Det Lower Limit


LADT MCER
PSV (cm/s)
Period (s)
ASCE 7-10 Det Lower Limit
GMPE MCER
CyberShake MCER

Site List

- 286 sites identified in Southern California
- Hazard curves and MCER results calculated for each



Calculating MCER Maps

- For a given period, plot MCER result for each CyberShake site
- Interpolate between sites
- Connect with contour lines
- Can produce maps from each product (probabilistic, deterministic, all, overall)