Updated Broadband CyberShake PSHA Model for Southern California

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CyberShake Overview

- SCEC's 3D physics-based probabilistic seismic hazard analysis (PSHA) platform
- Earthquake Rupture Forecast (ERF) provides list of relevant events with probabilities • 625,000 events per site
- Reciprocity-based approach to simulate lowfrequency seismograms
- Intensity measures derived from seismograms
- Hazard results from individual sites interpolated with GMM basemap



New Features in CyberShake Study 22.12

- Update to Study 15.4 and 15.12
- Broadband simulations
 - Deterministic (wave propagation + reciprocity) to 1 Hz
 - Stochastic (Graves & Pitarka module from SCEC Broadband Platform) to 50 Hz
 - Site corrections applied
 - Validated against historic events (Northridge, Whittier, Landers)
- Modifications to 3D velocity model
 - Goal is to resolve issues with high velocities at the surface
- Updates to rupture generation for individual events
 - Migrate to more recent kinematic rupture code
 - Sample additional variability





Velocity Model Merged Taper

- Previous studies used CVM-S4.26.M01
 - Tomography model + near-surface layer
 - High Vs values outside of basins
- Used Ely-Jordan approach to apply Vs30based taper down to 700m (*Hu et al., 2022*)
 - 1. Using taper, determine Vp, Vs, rho values at each grid point in the mesh
 - 2. Compare taper and non-taper Vs value
 - 3. Select smaller Vs value (and corresponding Vp and rho) to preserve basins



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Site Velocity Profiles



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Taper is selected at all depths to 700m

Vs30: 2573 m/s -> 400 m/s Z1.0: 0m -> 110m

Taper is only selected at surface point

Vs30: 500 m/s -> 500 m/s Z1.0: 580m -> 580m



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Updates to Rupture Generation

- New version of GP generator (v5.5.2, same as in latest BBP release)
 - Reduced correlation between slip and risetime
 - Reduced shallow fault rupture speed
 - Slightly weaker directivity
 - Variable strike & dip
- Rupture velocity is no longer fixed
 - 67.5%-87.5% of shear wave velocity
- Denser hypocentral spacing
 - 4.5 km -> 4 km
 - ~31% increase in rupture variations





Slip plot, v3.3.1 from Study 15.4 (top); v5.5.2 from Study 22.12 (bottom)

Study 22.12 Statistics

- Standard 335 SoCal sites
- Study performed over 76 days
- 772,000 node-hours on *Summit*
 - Averaged 422 nodes
 - Max of 3382 (73% of Summit)
- Managed ~2.5 PB of data



Study 22.12 site map

- 74 TB of data staged back to archival storage
 - 420 million two-component low-frequency and broadband seismograms
 - 83 billion intensity measures and durations

Low-Frequency Results



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Distribution of z-scores between 22.12 and ASK2014



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Distribution of z-scores between

Study 22.12: Data Access

- CyberShake data access tool is under development
 - Will streamline access to metadata, intensity measures, seismograms
 - On pace for completion in May
- In the meantime, data is available thru DB as with previous studies
- Email me (scottcal@usc.edu) if you're interested!

















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