Meeting the Need for Site-Specific, Long-Period MCE_R Response Spectra: The SCEC UGMS Tool for LA

Edric Pauk (USC/SCEC)

UGMS Committee: *C. B. Crouse (Chair)*, N. Abrahamson, J. Anderson, B. Bachman, J. Baker, J. Bielak, A. Frankel, J. Gebelein, C. Goulet, R. Graves, R. Hamburger, C. Haselton, J. Hooper, M. Hudson, T. Jordan, C. Kircher, M. Lew, N. Luco, F. Naeim, and P. Somerville.

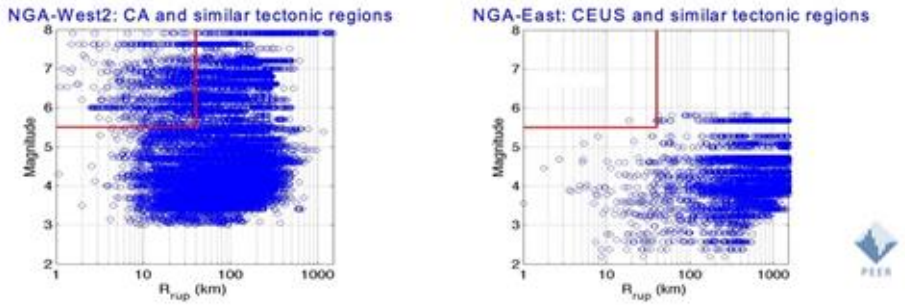
July 13, 2026 SCEC GM-SVU Workshop @ 13NCEE, Portland, OR

The large-earthquake data gap

Structural Engineers needed site-specific ground motion data for Los Angeles to **design tall buildings** resilient to large earthquakes.

The Problem

Sparse ground motion recordings from large earthquakes in California limit GMPEs' ability to account for the LA region's complex geology.



Goulet 2018, SCEC Ground Motion Simulation Validation Planning Workshop, southern.scec.org/workshops/2018/gmsv-aug

Potential Solution?

Leverage SCEC's CyberShake simulations to fill the large-earthquake data gap.

How to adopt ground motion simulations?

The Committee for the Utilization of Ground Motion Simulations

Develop long-period response spectral acceleration maps for inclusion in NEHRP and ASCE 7 Seismic Provisions and in Los Angeles City Building Code.

Convened by SCEC in 2013

UGMS Members

C. B. Crouse (Chair) — Structural Engineers
Norm Abrahamson — Ground Motion Modelers
John Anderson — Engineering Seismologists
Bob Bachman — Geotechnical Engineers
Jack Baker — Seismologists
Jacobo Bielak — City & State Bldg Officials
Art Frankel
Josh Gebelein
Christine Goulet
Rob Graves
Ron Hamburger
Curt Haselton
John Hooper
Marty Hudson
Tom Jordan
Charlie Kircher
Marshall Lew
Nico Luco
Farzad Naeim
Paul Somerville

WORKING WITH

SCEC Researchers, Computer Scientists, & Software Engineers

SCEC Team

Scott Callaghan
David Gill
Phil Maechling
Xiaofeng Meng
Kevin Milner
Edric Pauk

Building consensus was critical.

UGMS Committee **meetings held twice a year** built the trust needed for results to be adopted.

southern.scec.org/research/ugms

2013
UGMS Committee formed to develop long-period response spectral acceleration maps for inclusion in NEHRP, ASCE 7, and the Los Angeles Building Codes.

2014
UGMS established the technical framework for integrating CyberShake simulations with NGA-West2 GMPEs aligned with ASCE 7 MCER procedures and selected benchmark sites in Los Angeles.

2015
Validation studies at benchmark sites demonstrated the feasibility of using simulation-enhanced spectra for design across the Los Angeles region.

2016
UGMS methodology proposed as an amendment to ASCE 7-16 for adoption by the City of Los Angeles.

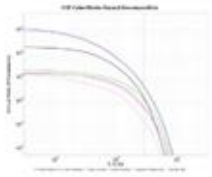
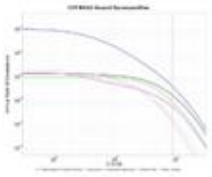
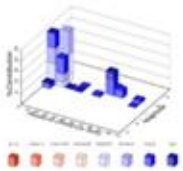
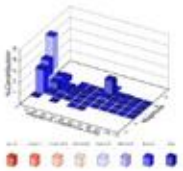
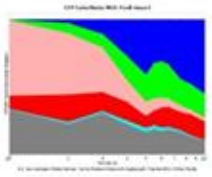
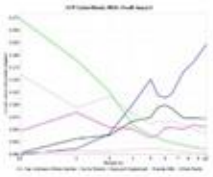
2017
Beta web access tool prepared to support code implementation with site-specific MCER spectra.

2018
Public UGMS MCER tool released; and implementation discussions began with LATBSDC and City of Los Angeles.

UGMS Tool for MCER in LA

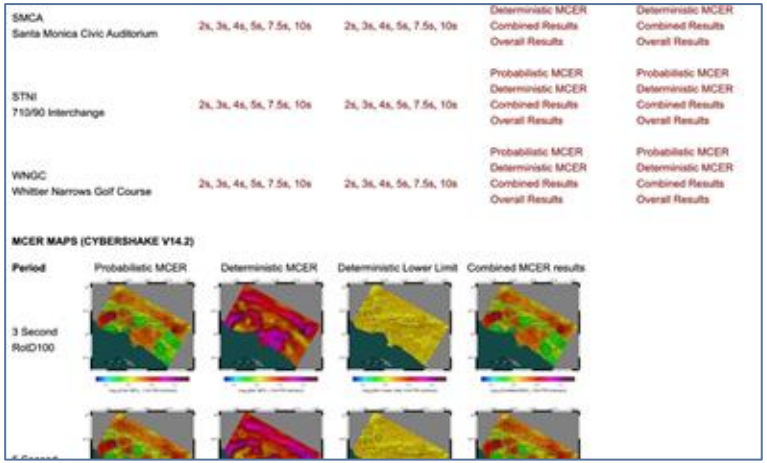
Evaluated datasets: GMPE versus CyberShake simulations

1 of 60+ sites evaluated

Site	Location Map	5s CyberShake Fault Hazard Curves	5s GMPE Fault Hazard Curves	5s CyberShake Distance/Mag Disaggregation	5s GMPE Distance/Mag Disaggregation	CyberShake Relative Fault Exclusion Impact	CyberShake Fault Exclusion Impact
CCP							

Data Product Needed

- Site-specific MCE_R and Design Earthquake response spectra
- Site-Specific Design Params (S_{MS}, S_{M1}, S_{DS}, S_{D1})
- MCE_G parameter (PGA_M)



Validation Process

Select benchmark sites (14 then 60+) to compare CyberShake and GMPE results.

Leverage the strengths of each dataset

Consensus achieved on the methodology in 2016

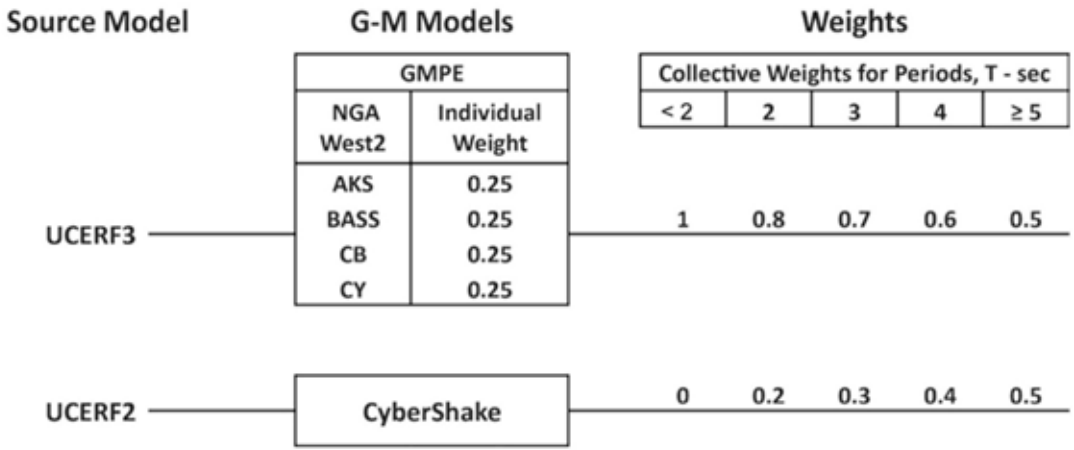
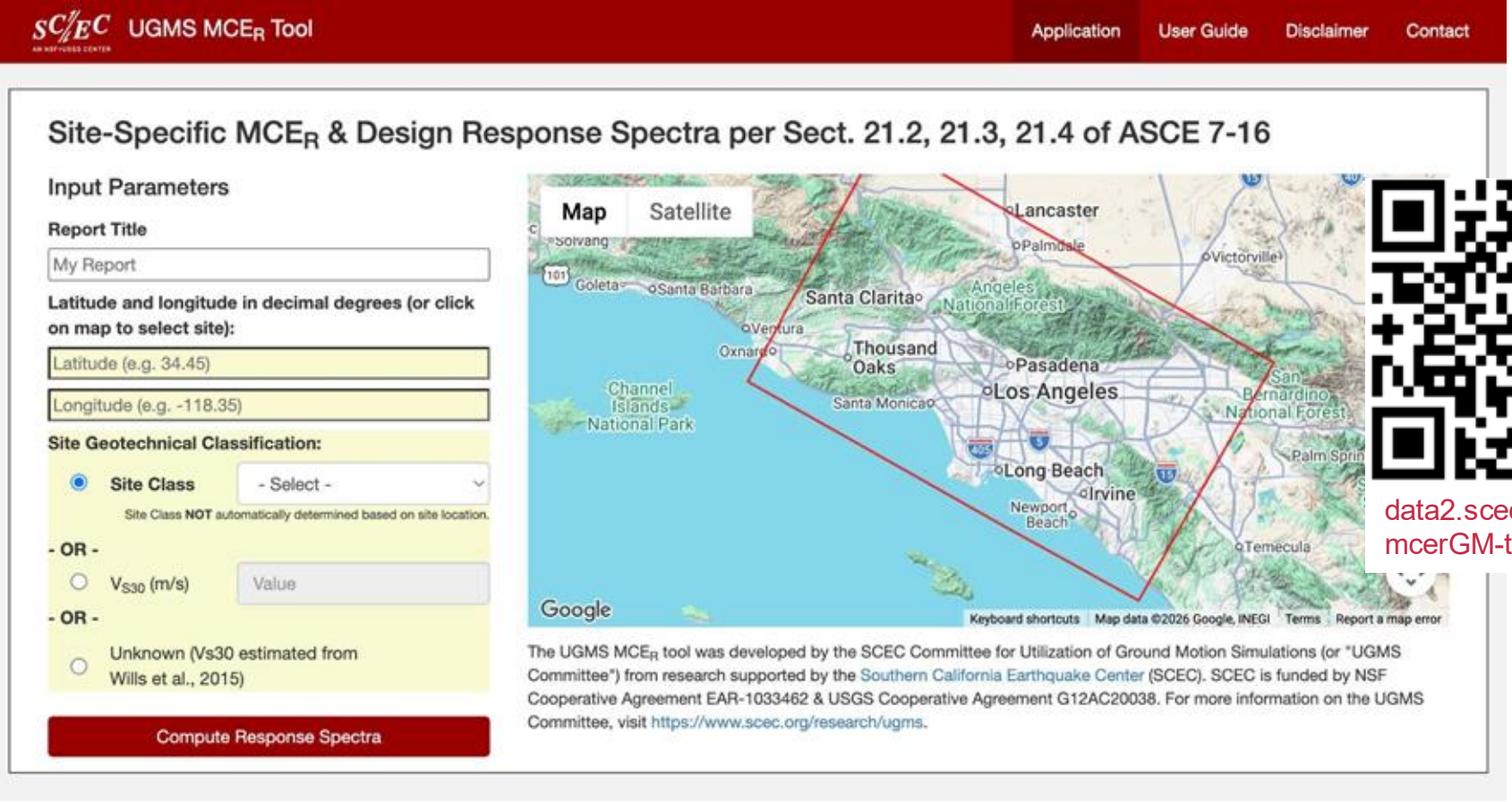


Figure 1. Logic tree illustrating the collective weights applied to MCE_R response spectra from the NGA West2 and CS-LA15.4 models.

SOURCE: Crouse, C., Jordan, T. H., Milner, K. R., Goulet, C. A., Callaghan, S., & Graves, R. W. (2018, 06). Site-Specific MCER Response Spectra for Los Angeles Region based on 3-D Numerical Simulations and the NGA West2 Equations. Oral Presentation at 11th National Conference in Earthquake Engineering. Paper #518. https://files.scec.org/s3fs-public/11NCEE-000518.pdf

- **weighted geometric average** of the MCER response spectra from the NGA West2 GMPEs and from the CyberShake simulations;
- the weights assigned to each vary depending on the **natural period, T**
- "averaged" MCER response spectra **cannot be less than the MCER response spectra from NGA West2 equations**, [restriction] was imposed to account for the underestimation of the CyberShake MCER response spectra at T < ~3 sec.



data2.scec.org/ugms-mcerGM-tool_v18.4

Released in 2018, the UGMS data access tool was designed with and for structural engineers.

Criteria for Adoption

Useful
needed data products

Trusted
validated methodology

Useable
plugs into existing tools

Accessible
easy-to-use website

SCEC
AN NSF–USGS CENTER

Site-Specific MCE_R & Design Response Spectral Accelerations
USC ZHS

Input Parameters

Coordinates	34.019, -118.286
Site Class	B - Estimated (see Section 11.4.3)

Values used in Computation

V_{S30}	760 m/s

Calculated Results

Site-Specific Design Parameters

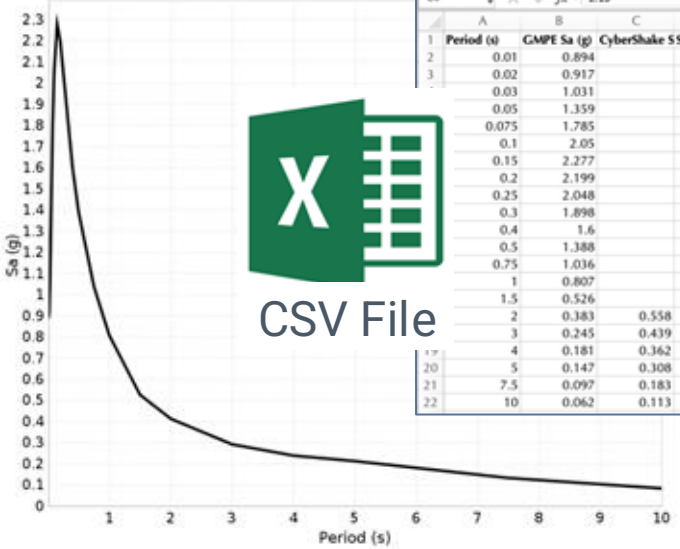
S_{DS}	1.319	S_{MS}	1.979
S_{D1}	0.551	S_{M1}	0.826

MCE_G Peak Ground Acceleration (Sect. 21.5)

PGA_M 0.804 g

PDF Report

MCE_R Response Spectrum



CSV File

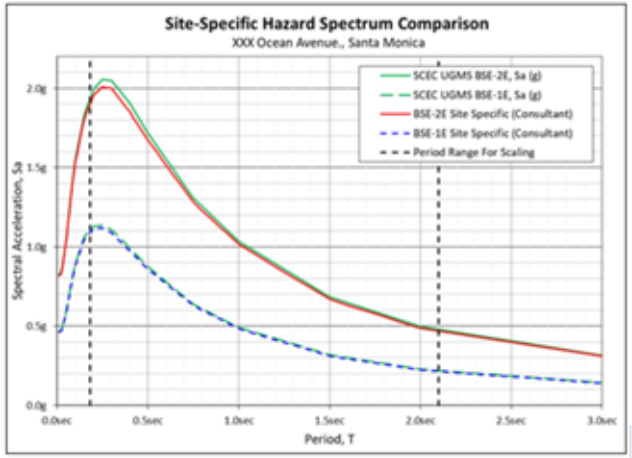
	A	B	C	D	E
1	Period (s)	GMPE Sa (g)	CyberShake S	Site Specific	Site Specific Design Response Spectrum (g)
2	0.01	0.894		0.894	0.596
3	0.02	0.917		0.917	0.611
	0.03	1.031		1.031	0.687
	0.05	1.359		1.359	0.906
	0.075	1.785		1.785	1.19
	0.1	2.05		2.05	1.367
	0.15	2.277		2.277	1.518
	0.2	2.199		2.199	1.466
	0.25	2.048		2.048	1.365
	0.3	1.898		1.898	1.265
	0.4	1.6		1.6	1.067
	0.5	1.388		1.388	0.926
	0.75	1.036		1.036	0.691
	1	0.807		0.807	0.538
	1.5	0.526		0.526	0.351
	2	0.383	0.558	0.413	0.275
	3	0.245	0.439	0.292	0.195
	4	0.181	0.362	0.239	0.159
20	5	0.147	0.308	0.213	0.142
21	7.5	0.097	0.183	0.133	0.089
22	10	0.062	0.113	0.084	0.056

From research to engineering practice

Sites queried by users on UGMS tool, 2022 - 2026
Source: Edric Pauk, web server logs

The Committee's work concluded in 2018—and the **UGMS MCER Tool continues to support engineering practice**.

1,000+ site reports generated (2022–2026).



We appreciate you sharing this beta version with us. I ran a quick comparison from a current project we're working on in Santa Monica. A geotechnical consultant provided the Site Specific hazard and, as you can see, a pretty consistent overlay.
—Structural Engineer Gareth M. (2020)

How to adopt ground motion simulations?

Start with a clear engineering need.
Focus on an actionable objective with a defined end user.

Leverage SCEC's simulation capabilities.
Extend analyses where observational data are sparse.

Build trust through collaboration.
Engage engineers, researchers, software developers, and decision-makers from the beginning.

Develop methods by consensus.
Build confidence in results before asking for adoption.

Deliver useful tools, not just data.
Create accessible products that integrate into engineering workflows.

What's next for UGMS tool?

Possible future directions:

- Support newer building standards
- Incorporate new data for RHA (searchable 3D physics-based broadband ground motions)
- Explore applications beyond LA

Meet the **SCEC team @13NCEE** to discuss more possibilities.

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