

The Path Forward

Establishing a new Ground Motion Simulation, Validation & Utilization (GM-SVU)

Technical Activity Group

Workshop
Website:



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Community
Survey:



13th National Conference on
EARTHQUAKE ENGINEERING
PORTLAND, OREGON | JULY 13-17, 2026

Resilience Through **Community Engagement** and **Technology**



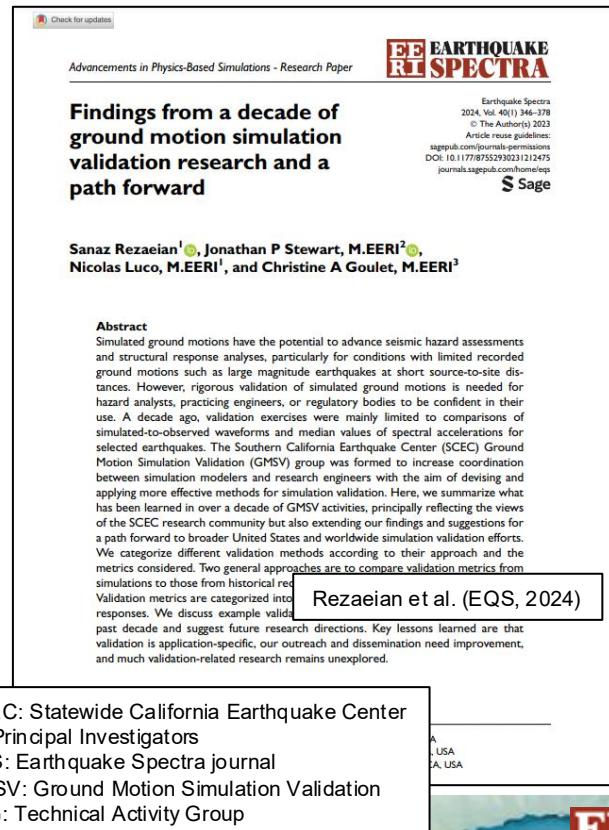
Rooms E141&E142
July 13, 2026 (9:00 AM – 12:00 PM)



Previous GMSV TAG & Conclusion:

- 2011 → 2021 (SCEC Award #2114)
- Co-PIs: Rezaeian, Stewart, Luco, Goulet
- 2024 EQS Synthesis Paper – A Community Product

We acknowledge the invaluable participation and continued interactions of the group members, particularly appreciating the efforts of **Thomas Jordan, Jack Baker, Gregory Deierlein, Farzin Zareian, Carmine Galasso, Paul Somerville, Andreas Skarlatoudis, Jeff Bayless, Nenad Bijelic, Ting Lin, Kuanshi Zhong, Jawad Fayaz, Peng Zhong, Huda Riadh Munjy, Luis Dalguer, Iunio Iervolino, Kioumars Afshari, Brendon Bradley, Caroline Holden, Leonardo Ramirez Guzman, Marco Stupazzini, Seok Goo, Jongwon Lee, John Vidale, and Brianna Birkel**. Special thanks go to SCEC simulation modelers and practicing engineers who have attended our workshops and provided feedback and advice to this group, including but not limited to **Robert Graves, Kim Olsen, Ralph Archuleta, Philip Maechling, Fabio Silva, Scott Callaghan, C.B. Crouse, and Farzad Naeim**. Noteworthy to mention are participants of a Special Interest Group session we held at the 2022 Seismological Society of America (SSA) annual meeting in Bellevue, WA, to obtain feedback from the community on publishing the present paper. Early reviews from **Jeff Bayless, Kim Olsen, Morgan Moschetti, and Kyle Withers** helped us to further improve this manuscript. Technical reviews from **Roberto Paolucci, Arben Pitarka, and Brendon Bradley** were much appreciated and resulted in improving this synthesis paper.



Previous GMSV TAG Objective:

... develop and implement, via collaboration between ground motion modelers and engineering users, testing and rating methodologies for the use of ground motion simulations in engineering applications.

- Focus on validation (consistency with observations) of simulation methods
- Not on verification (code debugging)
- Not on evaluation of individual simulated records, but “vetted” sets requested



Ground Motion Simulation Validation:

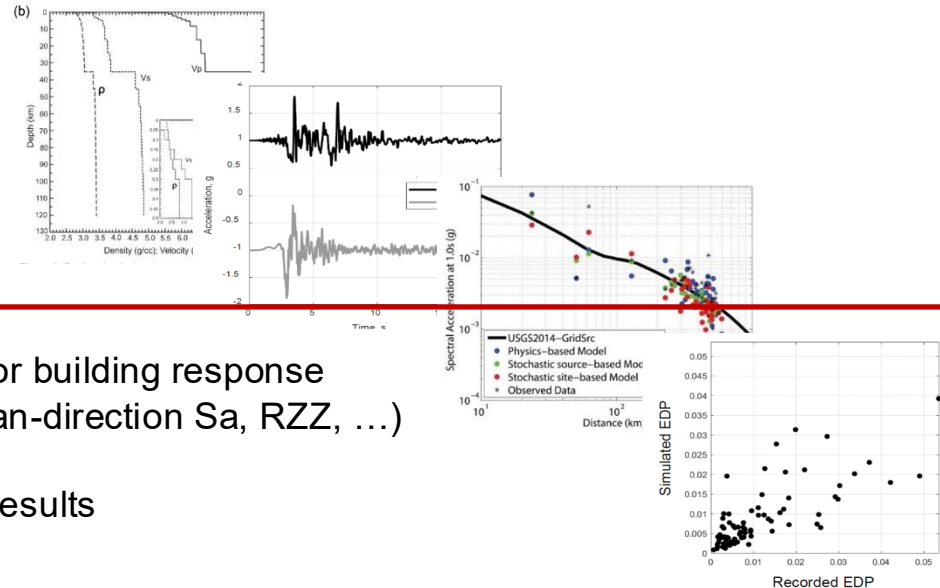
Simulations can be validated by comparisons to “*data from past earthquakes*” or to “*empirical models*” based on such data. This can be done at various levels:

- Model Components
(e.g., velocity model)
- Seismogram Waveforms

Tried to
developed
Validation
Gauntlets!

- Response Spectra (S_a)
- Simple proxies beyond S_a for building response
(e.g., Duration, max/median-direction S_a , RZZ, ...)
- Building response analysis results

Our prev. TAG focus!



RZZ parameters and Figures from Rezaeian et al. (EQS, 2024)

Unifited Language - Validation:

Table 1 categorizes methods and lists example publications

- A “validation method” is defined by a “validation metric” (rows) and a “validation approach” (columns)
- Acknowledged that other categorizations have been suggested and are possible (Bradley et al., 2017, focus on spatial extent)
- Future:
 - “Validation Application”
 - Validation Gauntlets

		Validation Approach: Compare to ...		
		A. Historical Records	B. Semi-Empirical Models	
Validation Metric	Ground Motion Characteristics	a) Waveforms	e.g., Graves and Pitarka (2010), Irikura and Miyake (2011)	Rezaeian and Der Kiureghian (2010) Yamamoto and Baker (2013)
		b) Response Spectral Intensity Measures (IMs) and Peak Parameters*	Dreger et al. (2015) Goulet et al. (2015) Chen and Baker (2019) Lee et al. (2020, 2022)	Star et al. (2011) Seyhan et al. (2013) Burks and Baker (2014) Dreger et al. (2015) Goulet et al. (2015) Pitarka et al. (2017, 2020) Nweke et al. (2022)
		c) Other Intensity Measures (IMs)**	Rezaeian et al. (2015) Luco et al. (2016) Bayless and Abrahamson (2018) Wong et al. (2019) Song et al. (2021)	Anderson (2004) Smerzini and Villani (2012) Paolucci et al. (2015) Burks and Baker (2014) Luco et al. (2016) Afshari and Stewart (2016)
	Structural Responses***	d) Idealized Structural Models	Bazzurro et al. (2004) Iervolino et al. (2010) Olsen and Mayhew (2010) Galasso et al. (2012) Galasso et al. (2013) Galasso et al. (2018)	Tothong and Cornell (2006) Burks and Baker (2014)
		e) More Realistic Structural Models	Galasso et al. (2013) Zhong (2016) Burks et al. (2019) Zhong et al. (2020) Fayaz et al. (2021)	Munjy et al. (2022)

Outreach, Dissemination, and Utilization

Consistent feedback received in reviews of our multi-PI proposals & in workshops:

Example from the review of SCEC Award #21144:

“The ... believes this is a critical activity for ..., facilitating broader impacts of earthquake science research. The group has been very active, but urgently requires publications that document **lessons** and **recommendations**. Specifically, the SPC asks the group to include recommendations on multiple subjects including plans for future GMSV-related projects, and their engineering perspective on how a next-generation ... research center can set up effective collaborations with civil engineering groups in the future....”

Example feedback from workshops including engineers:

Engineers need **“guidelines”** & **“vetted sets”** of simulations with **demonstrated utilizations** in engineering applications.

Outreach, Dissemination, and Utilization

- **Past Decade+:**

The GMSV group has helped to improve development of simulation methods and validation metrics for engineering applications through multi-PI projects, workshops and focus-group meetings, and coordination with other SCEC groups (e.g., UGMS).

- **Current Status:**

Despite all the above efforts to date, simulations are still not commonly used in engineering practice.

- **Path Forward:**

Key needs to further the utilization of simulations:

1. continued validation **research**
2. comprehensive and documented simulation **databases**
3. improved means of communication to share knowledge on simulations (**guidelines**)

UGMS: Utilization of Ground Motion Simulations

Outreach, Dissemination, and Utilization

Strengthen this coordination → collaborating



- **Path Forward:**

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Outreach, Dissemination, and Utilization

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- **Validation exercises are most effective:**
 - Provide guidance for engineers on simulation methods suitable for use “now”
 - Inform ground motion modelers how to improve their methods for “future” use

New GM-SVU TAG:

- Technical Activity Group Proposed in 2026 (SCEC Award #26089)
- **Next Generation** Ground Motion Simulation, Validation, & Utilization (**GM-SVU**) in Seismic Hazard & Engineering Applications
- Co-PIs:
 - Sanaz Rezaeian (USGS) – Validation
 - Scott Callaghan (SCEC) – Simulations
 - Chukwuebuka (Buka) Nweke (USC) – Engineering (PSHA) Users
 - Farzin Zareian (UCI) & Maha Kenawy (OSU) – Engineering (RHA) Users
- A Community Effort
 - Seeking Collaborations, Workshop Involvements, Online Feedback Form
- Deliverables for both:
 - Hazard (PSHA) Applications
 - Engineering (RHA) Applications

PSHA: Probabilistic Seismic Hazard Analysis
RHA: Response History Analysis
USC: University of Southern California
OSU: Oklahoma State University

GM-SVU TAG Goals – Year 1:

1. Community-informed research priorities and validation focus areas
2. An initial vetted set of simulation dataset (pre-improvement baseline)
3. Draft guidelines for validation of simulations for use in PSHA applications
4. Draft guidelines for validation of simulations for use in RHA applications, including benchmark studies on relevant intensity measures, and demands on building structures
5. Defined feedback framework for iterative simulation improvements and re-validation

Session 1 - Community Discussion: Ground Motion Simulation Validation

What key lessons, user needs, and priorities should help guide our future GMSV activities and applications?

Reminder:
Community Survey
Open



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Session 2 - Community Discussion: Simulation Infrastructure & Accessibility

What computing, storage, access, and analysis needs should help guides future development and utilization of large-scale ground motion simulations?

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