SCEC Broadband Platform Validation Project – Summary for the Site Effects Workshop

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PEER

an NSF + USGS center

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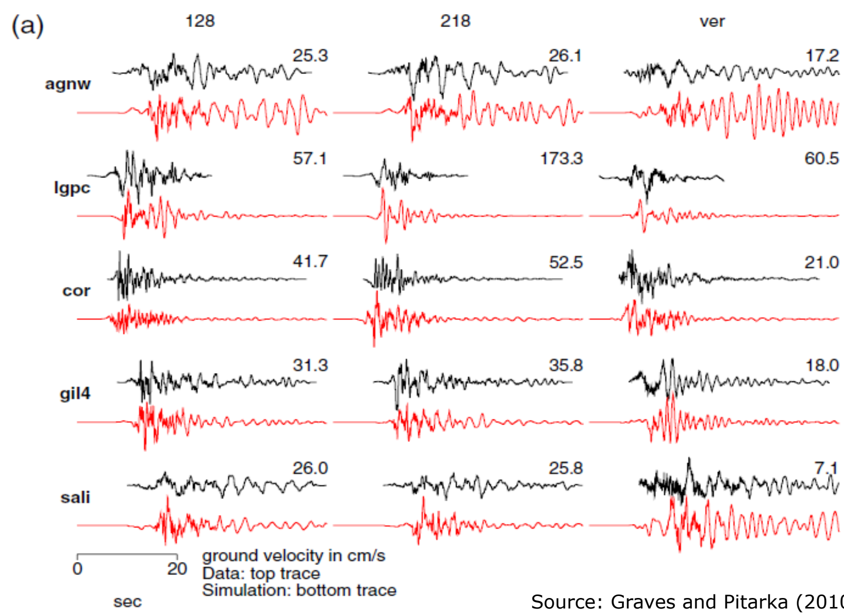
Other contributors: F. Wang, K. Wooddell, R. Kamai

Driven by need of seismic hazard projects

- South-Western U.S. utilities (SWUS)
- PEER NGA-East project (new CENA hazard model)
- PEER NGA-West projects?

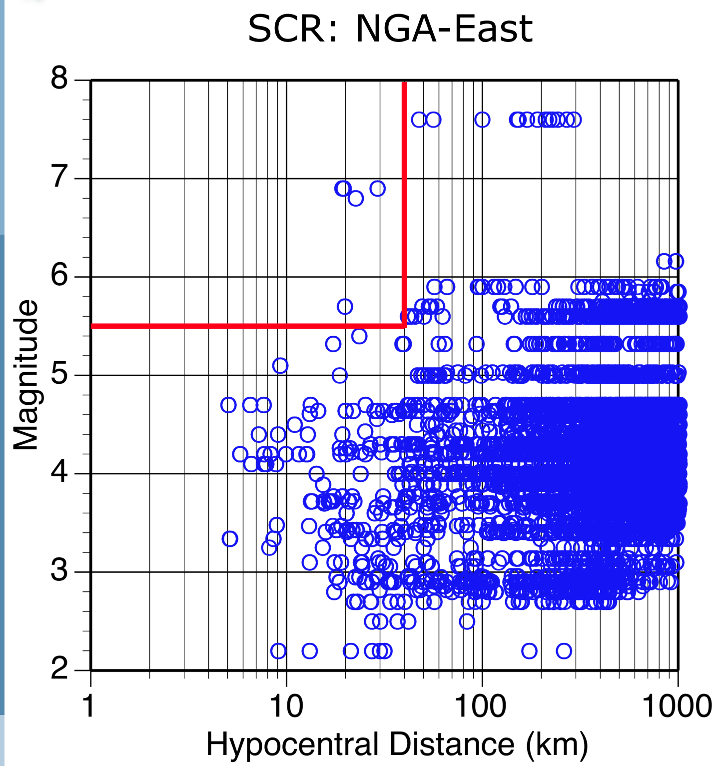


Source: Graves and Pitarka (2010)

This exercise:

Quantitative validation of **median** ground motions for **forward** simulations in **engineering** problems

Motivation and objective



- Short term goal: supplement data for development of hazard models (SWUS, NGA-East)
- Long term goal: develop acceptance of simulations for engineering applications

- Key focus: 5% damped elastic “average” PSA (*f*=0.1-100 Hz/ T=0.01-10 s)
  - Correlates well with structural response – basis of design
  - “Aggregates” complex ground motions into a simple parameter

Simulation Methods and Modelers

Method Name(s)	Method type – Finite fault models	Contact(s) and Institution
Composite Source Model (CSM)	Broadband deterministic	J. Anderson (UNR)
UCSB		R. Archuleta, J. Crempien (UCSB)
EXSIM	Stochastic Brune spectrum	K. Assatourians, G. Atkinson (UWO)
Graves and Pitarka	Hybrid: deterministic LF and stochastic HF	R. Graves (USGS)
SDSU (BB Toolbox)		K. Olsen (SDSU)

Key lessons learned – past validations

- Need more transparency...
- Need to validate against many events
- Need clear documentation of fixed and optimized parameters from modelers for each region
- Need source description that is *consistent* between methods
- Use unique crustal structure (V, Q) for all models (Vs30=863 m/s)
- Consider multiple source realizations
- Correct data to reference Vs empirical site factors
- Make all validation metrics computation and plots in uniform units/format – implement post-processing pipeline on BBP
- Need to tie-in to specific code version

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Validation schemes

- A. Against recorded earthquake ground motions
- B. Against GMPEs for generic scenarios

Validation process allows

- **for development of region-specific rules (source scaling, path)**
- **Method refinements**

Selection of events and stations

Region	Event Name	Year	Mw	# Records < 200 km
WUS	**Loma Prieta**	1989	6.94	59
WUS	**Northridge**	1994	6.73	124
WUS	**Landers**	1992	7.22	69
WUS	**Whittier Narrows**	1987	5.89	95
WUS	**North Palm Springs**	1986	6.12	32
JAPAN	**Tottori**	2000	6.59	171
JAPAN	**Niigata**	2004	6.65	246
WUS	**Alum Rock**	2007	5.45	40
WUS	**Chino Hills**	2008	5.39	40
CENA	**Saguenay**	1988	5.81	11
CENA	**Riviere-du-Loup**	2005	4.60	21
CENA	**Mineral, VA**	2011	5.68	10
WUS	El Mayor Cucapah	2010	7.20	134
WUS	Hector Mine	1999	7.13	103
WUS	Big Bear	1992	6.46	42
WUS	Parkfield	2004	6.50	78
WUS	Coalinga	1983	6.36	27
WUS	San Simeon	2003	6.50	21
JAPAN	Chuetsu-Oki	2007	6.80	286
JAPAN	Iwate	2008	6.90	186
TURKEY	Kocaeli	1999	7.51	14
TAIWAN	Chi-Chi	1999	7.62	257
ITALY	L' Aquila	2009	6.30	40
NEW ZEALAND	Christchurch	2011	6.20	26
NEW ZEALAND	Darfield	2010	7.00	24

- Large dataset (25 EQs)
- Many regions & tectonic environments
- Span wide magnitude range (Mw 4.6 to 7.62)
- Variety of mechanisms
- Well-recorded (16 EQs with> 40 records within 200 km)
- Select large subset of stations (~40) that are consistent with mean and standard deviation PSa of the full dataset.

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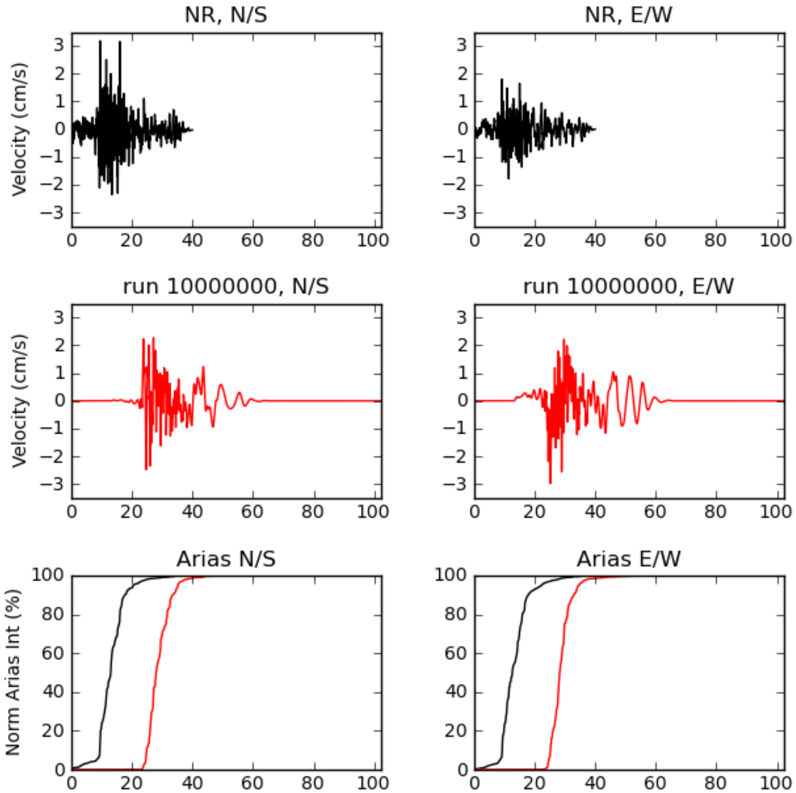
Process and nomenclature

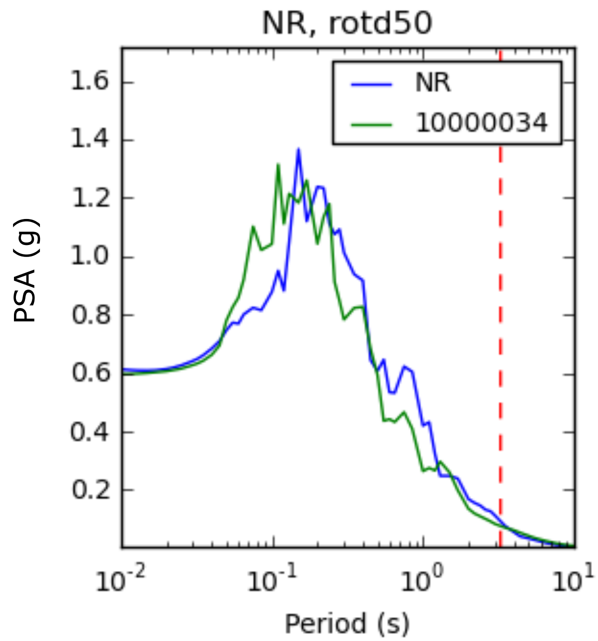
For each scenario, specification of:

- Source: **M**, geometry, location, hypocenter
- Path: consistent with 1D velocity model – Vs30 prescribed as 863 m/s
- Site (as-recorded to reference): empirical site correction factors from GMPEs (e.g. Boore et al, 2014)

Evaluation products

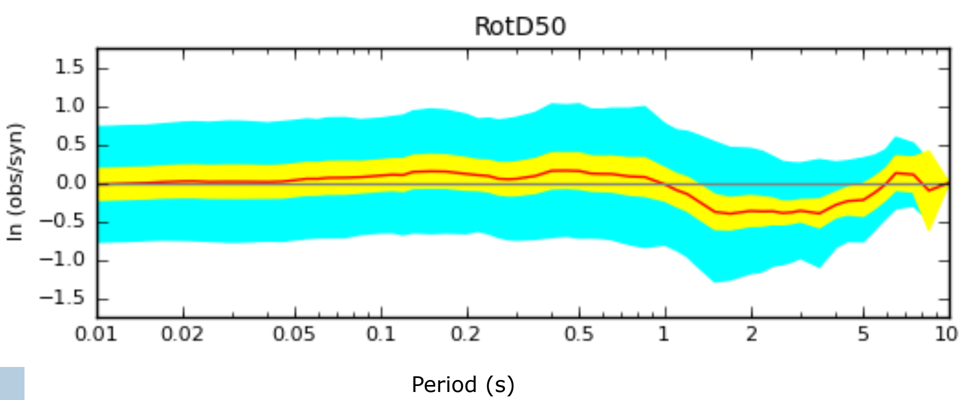
Northridge PSA, station SCE Vs. 1000034

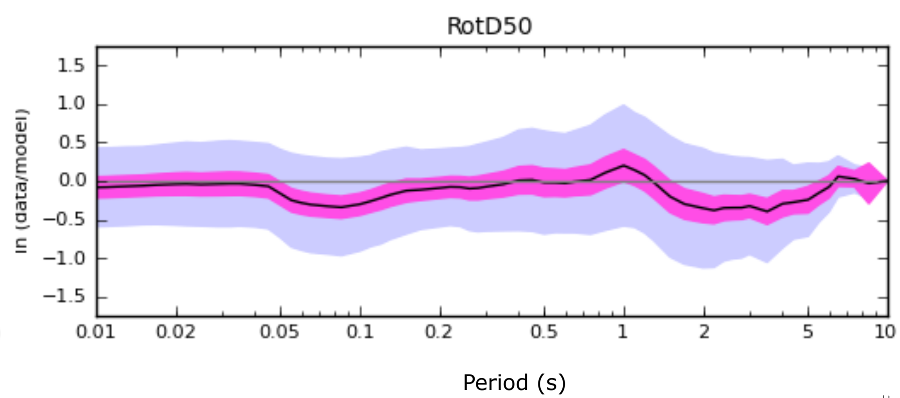




Evaluation products

- Goodness-of-fit measures for PSA
  - *Average residuals/ GOF with T for all stations within an event*
  - *Average GOF with T for all realizations (all stations)*





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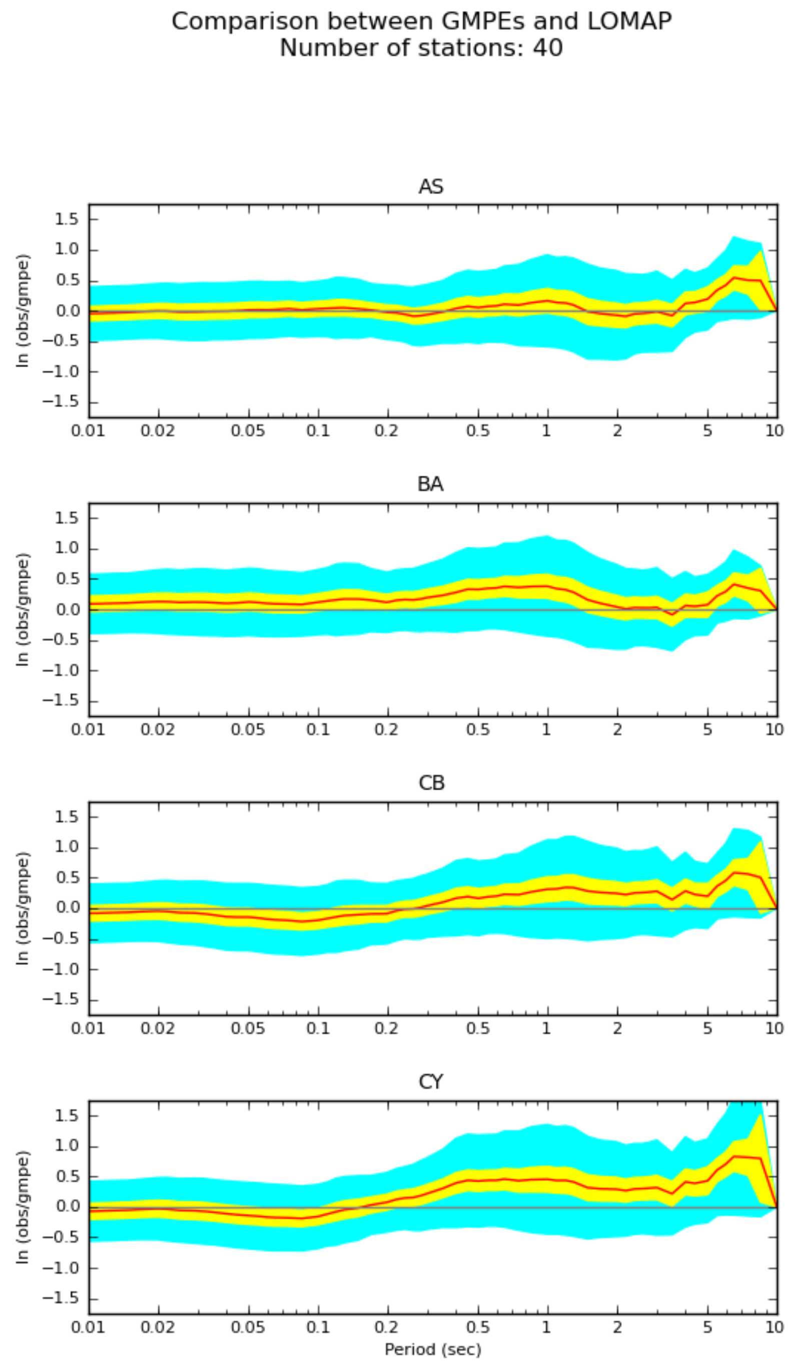
Evaluation products

- GOF plots also developed for
  - NGA-West1 (2008) GMPEs
  - SMSIM (point-source stochastic)

Allows to see trends/event terms

Part A (comparison with recordings)



Needs in site response

So we can 1) look at time domain metrics and 2) do validation against records with as-recorded conditions...

For NOW

- Computationally efficient method
- Ideally should use generic metric (Vs30) instead of profile
- Would be applied in time domain (or in FAS), but better than taking a PSA model in FAS space...

For the future

- More sophisticated approach that could take longer to compute (wave propagation, 1D, 3D)
- Could use a site-specific soil profile or a suite of generic profiles as input
- Would also be applied in time domain (or FAS)

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