SCEC GMSV TAG

SCEC BBP *Validation for Ground Motions Projects (SWUS, NGA-East)*

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Menu du jour

- Introduction
- Overview of simulation methods
- Validation framework and schemes
- Example preliminary results
- Progress and schedule

Interested parties and collaborations

- SWUS project
- PEER NGA-East project
- PEER NGA-West3 projects
- SCEC & Broad Band Platform (BBP)

SCEC evaluation committee includes reps from NGA-East and West3

Lessons learned – past validations

- Need clear documentation of fixed and optimized parameters from modelers for each region
- Provide source information so it is *consistent* between methods
- Provide a unique definition of crustal structure to be used by all groups (Vs, Q)
- Consider multiple source realizations
- Provide uniform orientation of motions
- Run simulations for reference site conditions – correct data with empirical site factors
- Make all validation metrics and plots in uniform units/ format
- Streamline the process to allow fast feedback to modelers – Use SCEC BBP
- Associate results with specific version of code (BBP and method)

Validation schemes

- Key focus: 5% damped elastic "average" PSa [RotD50]
  - (*f*=0.1-100 Hz/ T=0.01-10 s)
- A. Validation against recorded ground motions
  - tests the models given optimized source terms
- B. Validation against GMPE prediction for generic scenarios
  - tests model "centering" and the generation of source terms for future earthquakes
- Validation allows for development of region-specific rules (source scaling, path)

Simulation Methodologies

Stochastic methods

- SMSIM (point source)
- EXSIM (finite fault: sub-faults = point sources)

Kinematic sources:

Broadband using Green's functions

- UC Santa Barbara (UCSB) – randomness at HF in the source description
- UN Reno (UNR) – composite source model

Hybrid - Green's functions LF, Stochastic HF

- Graves and Pitarka (G&P) – sub-fault source spectra
- Sand Diego State University (SDSU) – scattering functions (kappa, Q, intrinsic attenuation)

Deterministic source – simplified stochastic wave propagation

- Irikura

Key elements of validation (Parts A & B, all scenarios)

Source: geometry and M specified (from src)

- Kinematic models: rules for slip, rise time, rake, etc.
- Stochastic models: sub-faults as point sources with time-dependent f_c

Path: 1D velocity model provided (V_s, V_p, ρ, Q_s, Q_p)

- Kinematic models: Green's functions computed with velocity models
- Stochastic models: Empirical geometrical spreading, Q(f) duration consistent with velocity models

Stations lat-long defined

Site effects:

- Part A. Recorded PSa corrected using empirical site factors f(V_{s30}, $Z_{1.0}$) – Boore et al. (2013!) Chiou and Youngs (2008)
- Part B. Use rock

For each scenario, seismograms generated for:

- 50 source realizations X ~ 40 stations

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Selection of events and stations

GOAL: Select a representative set of earthquakes covering a variety of events (magnitude, geometry, and mechanism) and tectonic settings.

EQ NAME	REGION	# RECORDS <200km (*<1000km)	Mag. (Mw)	Type	# SELECTED RECORDS
El Mayor Cucapah	WUS	134	7.20	SS	40
Northridge	WUS	124	6.69	REV	40
Hector Mine	WUS	103	7.13	SS	40
Landers	WUS	69	7.28	SS	40
Whittier Narrows	WUS	95	5.99	REV OBL	40
Big Bear	WUS	42	6.46	SS	28
Parkfield	WUS	78	6.00	SS	40
Loma Prieta	WUS	59	6.93	REV OBL	40
North Palm Springs	WUS	32	6.06	REV OBL	32
Coalinga	WUS	27	6.36	REV	27
San Simeon	WUS	21	6.50	REV	21
Saguenay	CENA	14*	5.90	REV OBQ	14
Riviere-du-Loup	CENA	98*	4.64	REV	40
Mineral, VA	CENA	94*	5.70	REV	40
Tottori	JAPAN	171	6.61	SS	40
Chuetsu-Oki	JAPAN	286	6.80	REV	40
Niigata	JAPAN	246	6.63	REV	40
Iwate	JAPAN	186	6.90	REV	40
Kocaeli	TURKEY	14	7.51	SS	14
Chi-Chi	TAIWAN	257	7.62	REV OBL	40
L' Aquila	ITALY	40	6.30	NML	40
Christchurch	NEW ZEALAND	26	6.20	REV OBL	26
Darfield	NEW ZEALAND	24	7.00	SS	24

- Large dataset (>20 EQs)
- Many regions & tectonic environments
- Span wide magnitude range (Mw 4.64 to 7.62)
- Variety of mechanisms
- Well-recorded (17 EQs with> 40 records)
- Select a large subset of stations (~40) that are consistent with mean and standard deviation PSa of the full dataset.

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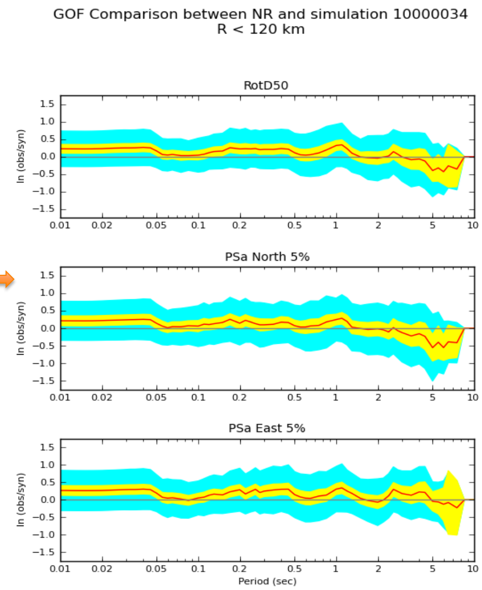
Evaluation criteria

- Goodness-of-fit measures for PSa and PGA
  - GOF with T at each station
  - *Average GOF with T for all stations within an event*



Part A (comparison with recordings)

Evaluation criteria

- PSa controlling factor in evaluation
- Look at waveforms as sanity check
- Other measures may be considered
- “Verdict” for each methodology
  - Applicable for a given region?
  - Applicable for a certain bandwidth?
  - Needs refinement?
- Also check against GMPEs – is there a benefit to use finite fault parameters Vs. strike, dip, distance?

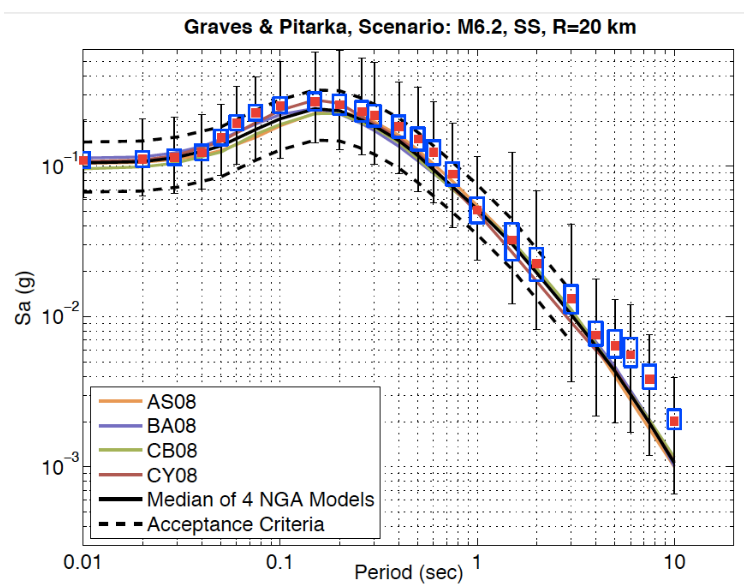
Part B (comparison with GMPEs)

Validation schemes

- Key focus: 5% damped elastic Psa (0.1 to 100 Hz)
- A. Validation against recorded ground motions (time series)
- B. Validation against GMPE prediction for generic scenarios – “model centering”
  - 3 scenarios in well constrained range of GMPEs (Mw~6.0-7.0, R~20-50 km)
  - Use as global check of models, also test the generation of source terms for future earthquakes (e.g. development of inputs for new scenarios)
  - Ran for NorCal and SoCal velocity structures
  - Randomized hypocenters

Part B (comparison with GMPEs)

Evaluation criteria



Schedule summary – completion dates

- April 2013 – method impl. On SCEC BBP
  - Completed: G&P, EXSIM, SDSU   Later: SMSIM
  - In progress: UCSB, Irikura, UNR
- May 2013 - Validation
  - Part A: 7 scenarios, all methods
  - Part B: all methods
- June 2013 – Documentation & forward sims
  - Modelers self-evaluation and documentation
  - Initial forward simulation test
- August 2013 - Evaluation
  - SCEC evaluation of methods report
  - Initial forward simulations

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Schedule summary – completion dates

- September 2013 - SCEC AM
  - Review initial forward sims results
- October 2013 – SWUS SSHAC WS 2
  - Review results, adjust scenarios if needed
- January 2014 – Forward sims, final set
- February 2014 – Review forward sims
- March 2014 - SWUS SSHAC WS 3
  - Incorporation of sims in GMPE logic tree

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