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]
  - \( f=0.1-100 \text{ Hz/ } T=0.01-10 \text{ s} \)
- 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 ($V_s$, $V_p$, $\rho$, $Q_s$, $Q_p$)
- 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 $X \sim 40$ 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.

- 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.
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?
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

Evaluation criteria

![Graves & Pitarka, Scenario: M6.2, SS, R=20 km](image.png)

- Median of 4 NGA Models
- Acceptance Criteria

![Graph](image.png)
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

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