The SCEC Broadband Platform:

From a Research Platform to an Industry Tool

2013 SCEC Annual Meeting

Katie Wooddell

USER SPECIFIED INPUTS

- Strengths:
  - Only 2 input files required per scenario
  - Minimal number of user inputs required
  - Scenarios easy to define
- Interface Issues:
  - Redundant information included in .src file
  - Fault input and output specified in different coordinates
  - Need figures to provide a visual check on the scenario
    - Map of the fault relative to the stations
    - Option to preview and select desired rupture models

.SRC Inputs

```
MOMENT = 7.54297215e+19
MAGNITUDE = 7.2
FAULT_LENGTH = 106.890000
FAULT_WIDTH = 15.000000
DEPTH_TO_TOP = 0.0
STRIKE = 338.1446
RAKE = 180
DIP = 90
LAT_TOP_CENTER = 36.366200
LON_TOP_CENTER = -121.552200
HYPO_ALONG_STK = 22.28
HYPO_DOWN_DIP = 9.87
DWID = 0.1
DLEN = 0.1
DT = 0.1
SEED = 1343642
```

$M_W = 2/3\log(M_O) - 6.07$

-OR-

$M_W = \log(A) + 4$

$M_O = 10\text{^}(3/2M_W + 9.1050)$

Where: M_O (Nm)

.SRC Inputs

```
MOMENT = 7.54297215e+19
MAGNITUDE = 7.2
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DEPTH_TO_TOP = 0.0
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```
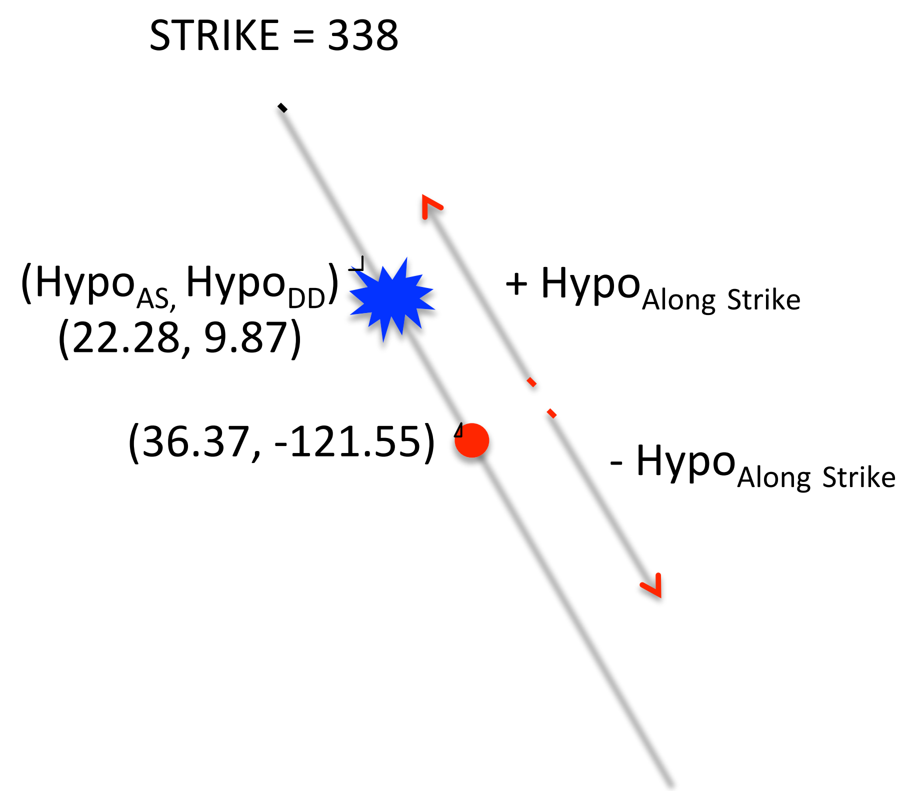
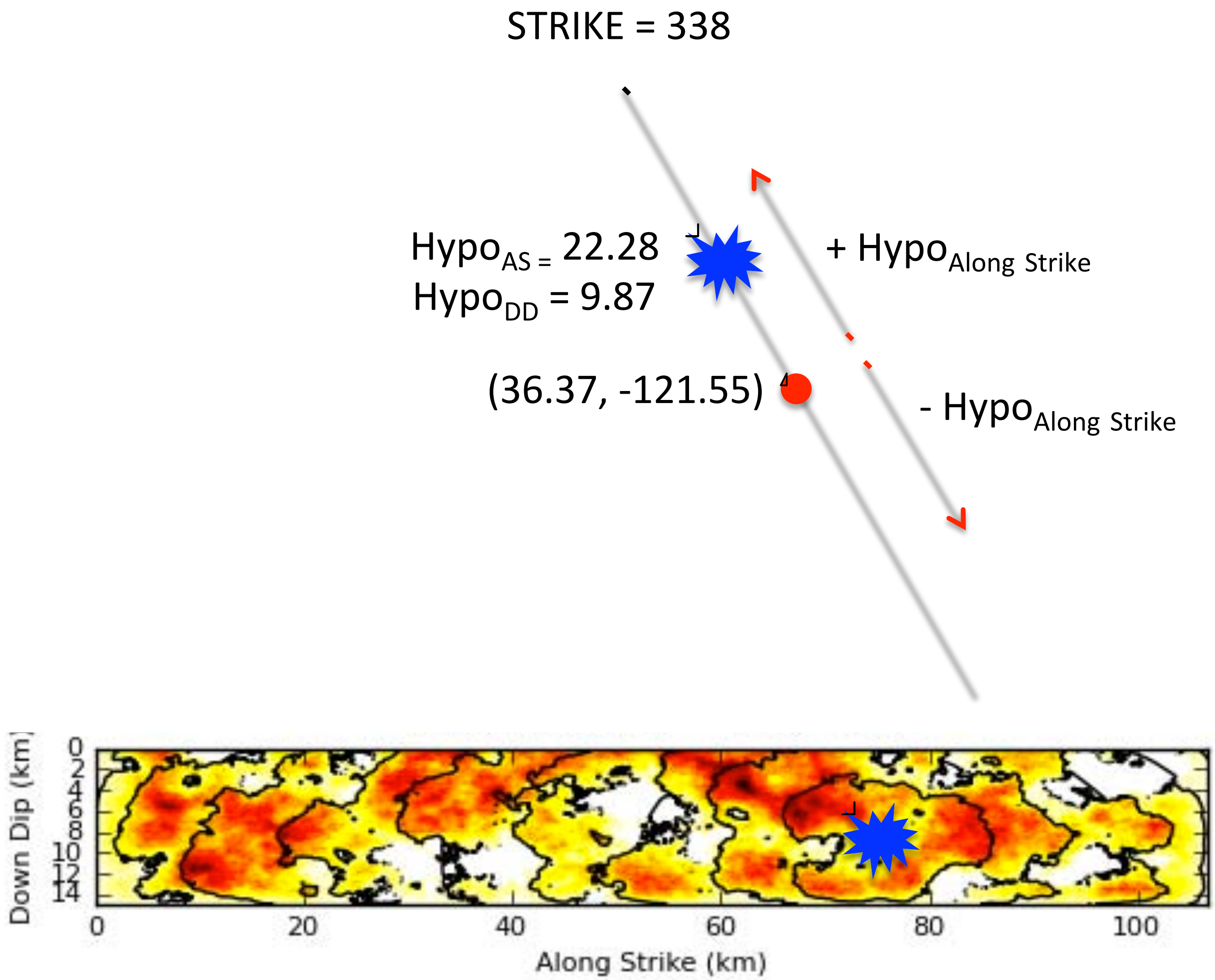
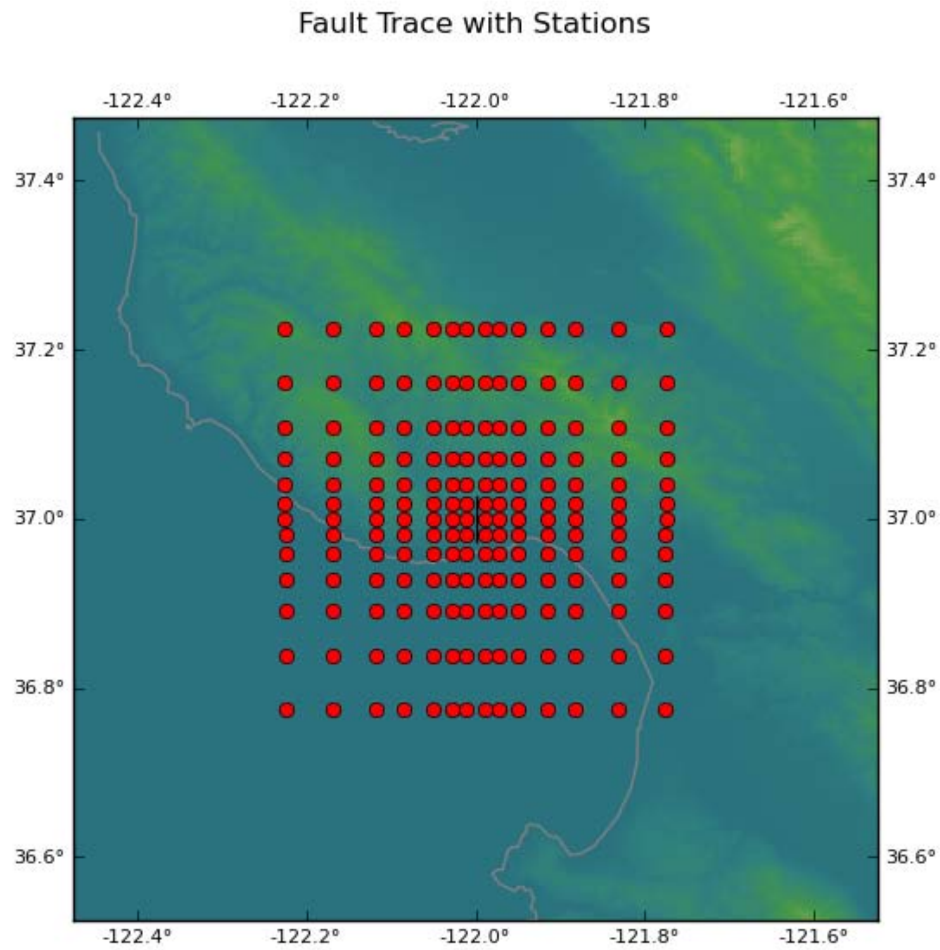
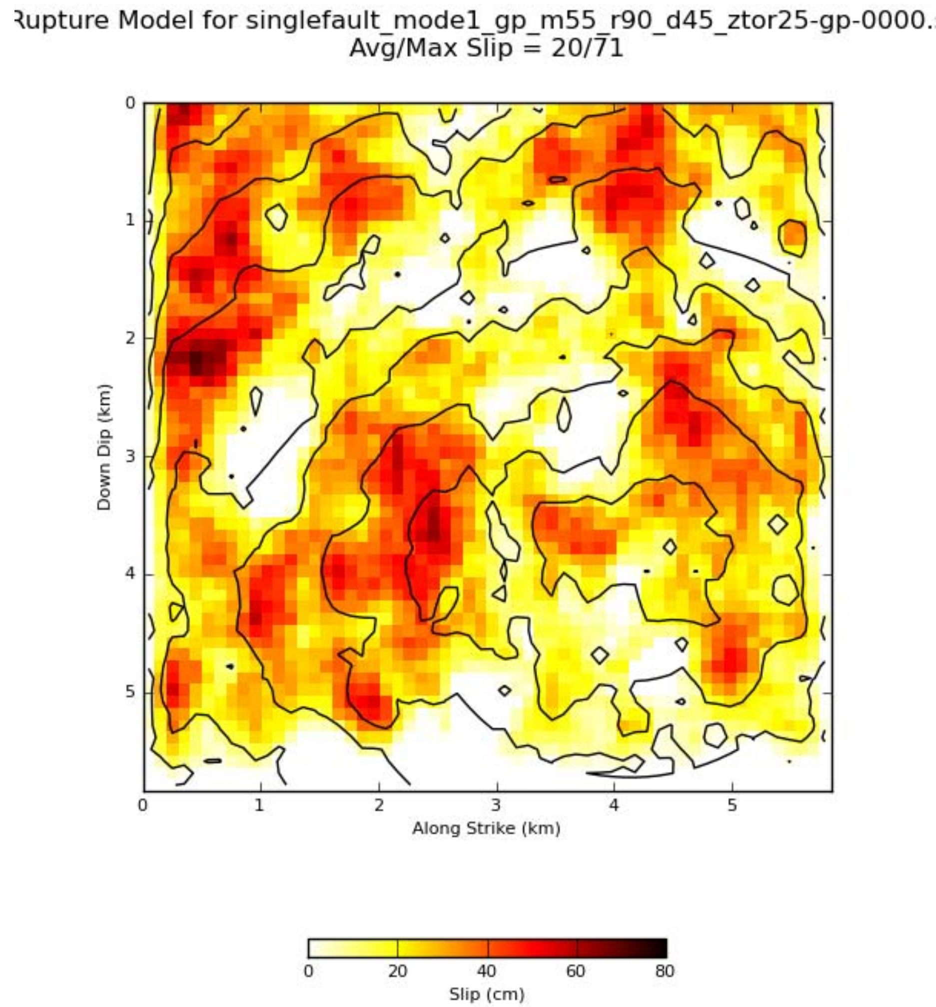





$Hypo_{AS}$ = Flength/2 + $Hypo_{AS}$ = 75.73
$Hypo_{DD}$ = 9.87

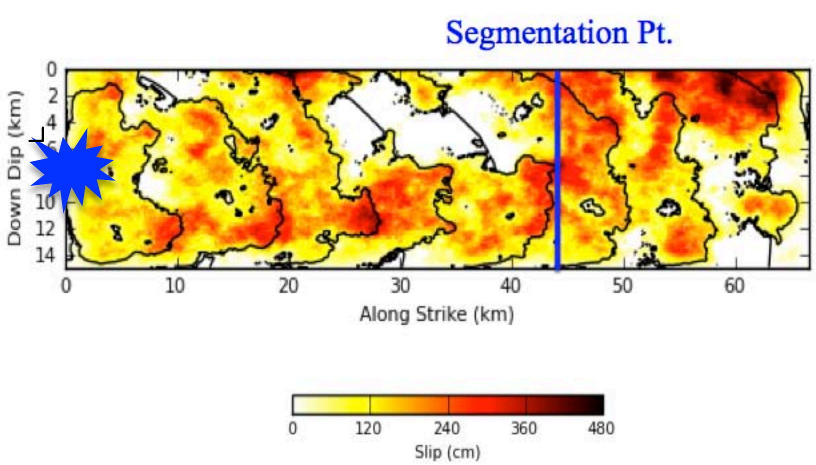
FIGURES

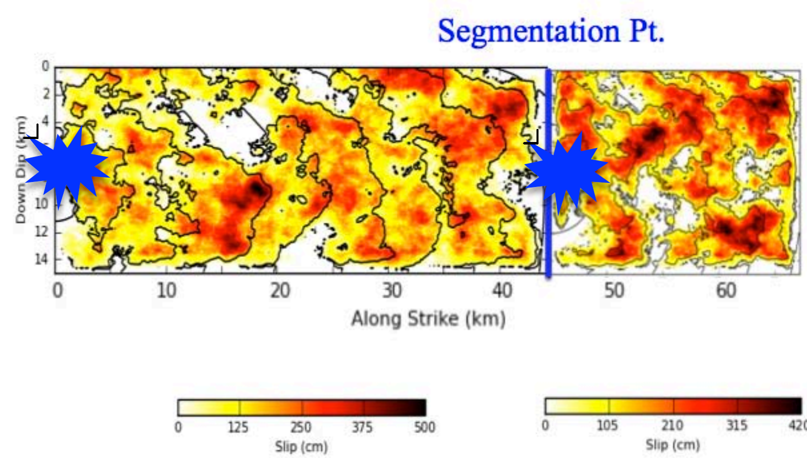

Fault Trace with Stations
-122.4°
-122.2°
-122.0°
-121.8°
-121.6°
37.4°
37.2°
37.0°
36.8°
36.6°


Rupture Model for singlefault_mode1_gp_m55_r90_d45_ztor25-gp-0000.
Avg/Max Slip = 20/71
Down Dip (km)
Along Strike (km)
0
1
2
3
4
5
0
20
40
60
80
Slip (cm)

JOINING MULTI-SEGMENT AND COMPLEX RUPTURES

- Interface Issue:
  - Platform designed for single, planar fault ruptures
  - Various ways to link faults, each implying something different about the physics of how linked faults rupture





M-A SCALING FOR FORWARD SIMULATIONS

- Interface Issue:
  - Specification of M_W and Area from Seismic Source Characterization (SSC) (potentially violates scaling assumptions / restrictions used by modelers)

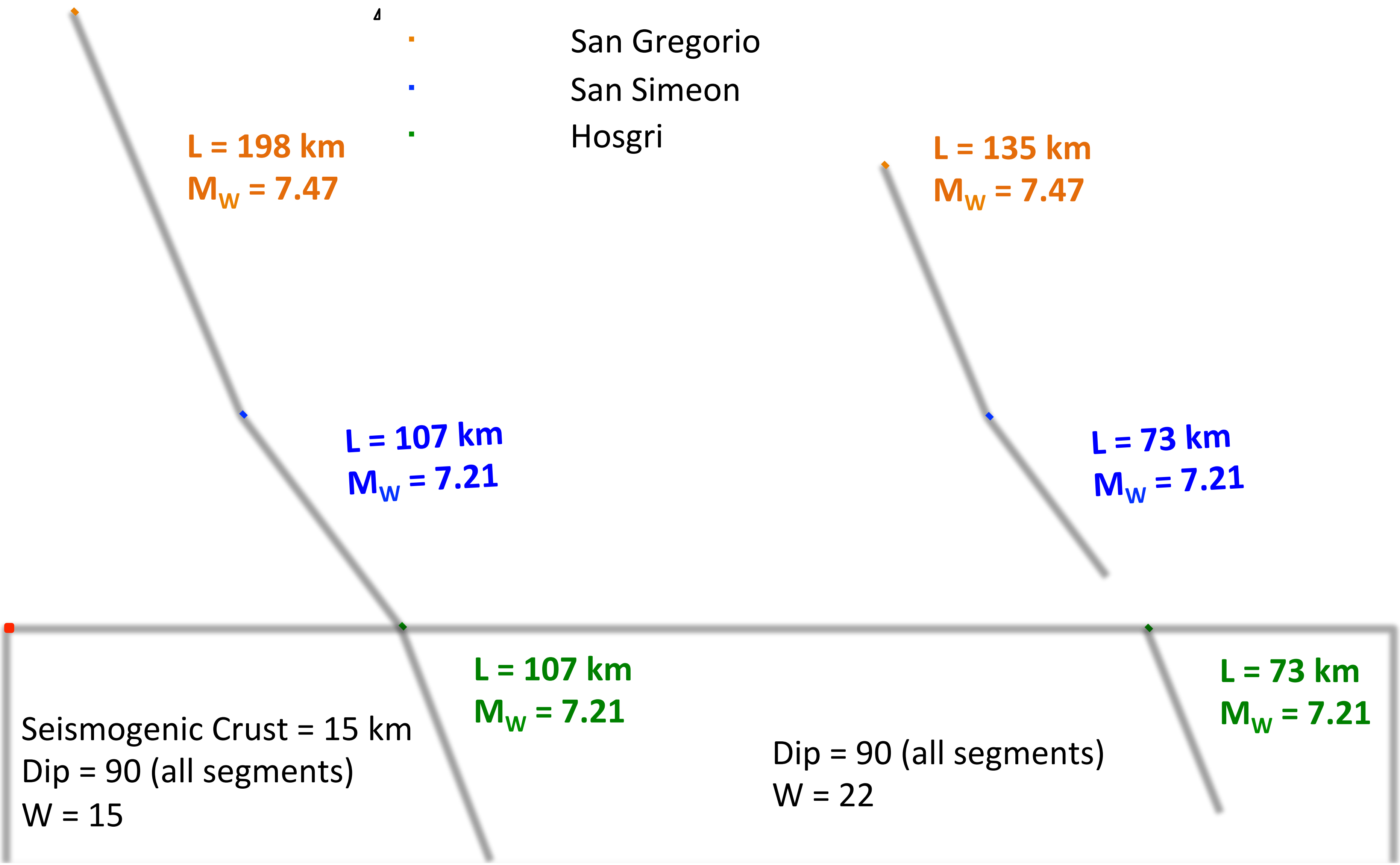
Table 1: Relations for parameter specification in active tectonic regions.

Parameter	**Relationship**	**Reference**
fault area and dimensions	$M_w = \log_{10} A + 4$ If length (L) specified, determine down-dip width (W) from W = A/L. Otherwise, use following to determine L: $M_w = 1.67 \log_{10} L + 4.24$ (dip slip, $M_w > 5$) $M_w = 1.67 \log_{10} L + 4.17$ (strike slip, $5 < M_w < 7.1$)* then determine width from W = A/L. *For strike slip Mw > 7.1, set W = 22km and determine length from L = A/W.	Leonard (2010) *Modified so that maximum down-dip width for strike-slip is set to 22km (Leonard uses 19km).

Seismic Source Characterization Parameters

"THIN CASE"
(FROM GEOLOGICAL INVESTIGATION)

"THICK CASE"
(FROM SCALING MODELS)



SIMULATION RESULTS: THIN VS. THICK CASE

THIN

M_W = 7.21

W = 15 km

L = 107 km

FIXED HYPOCENTER

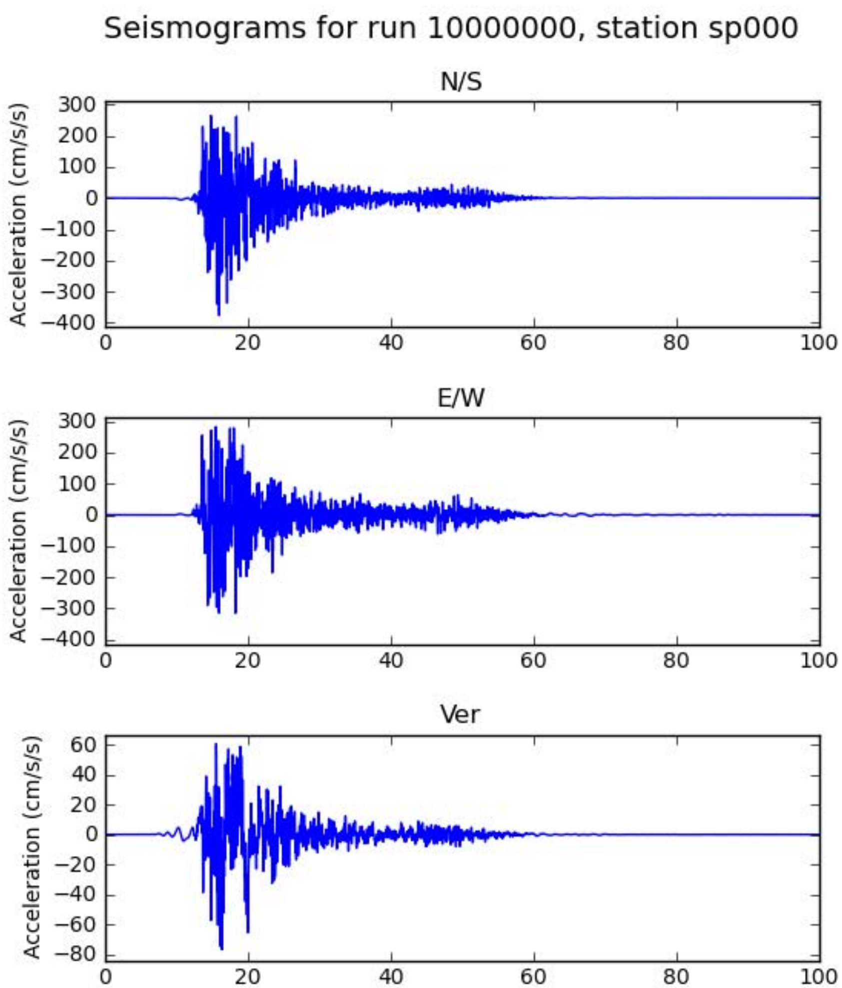
32 REALIZATIONS

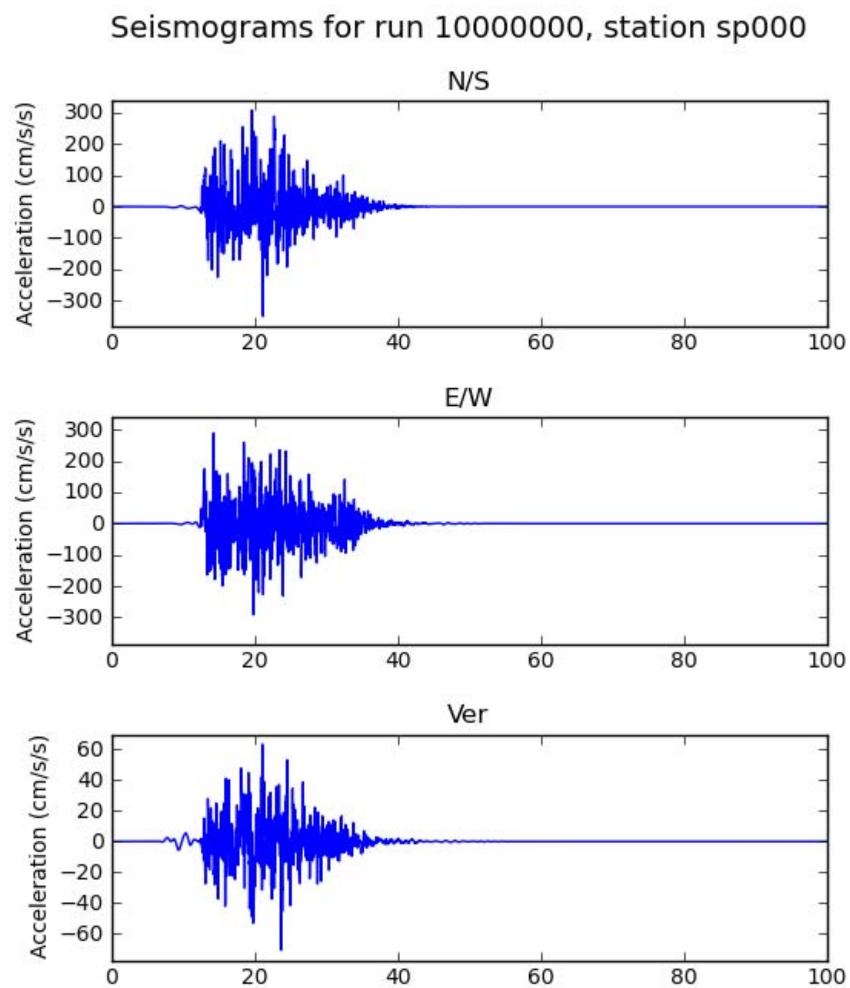
THICK

M_W = 7.21

W = 22 km

L = 73 km





SIMULATION RESULTS: THIN VS. THICK CASE

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$M_W = 7.21$
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L = 107 km

FIXED HYPOCENTER
32 REALIZATIONS

THICK

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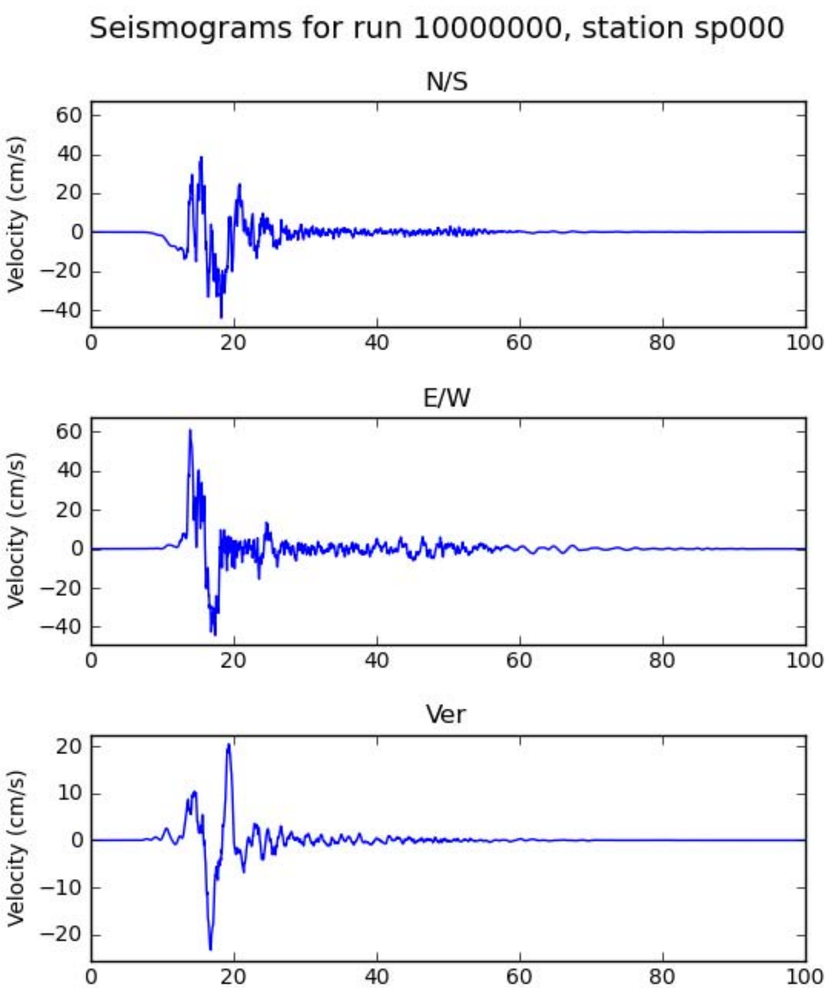

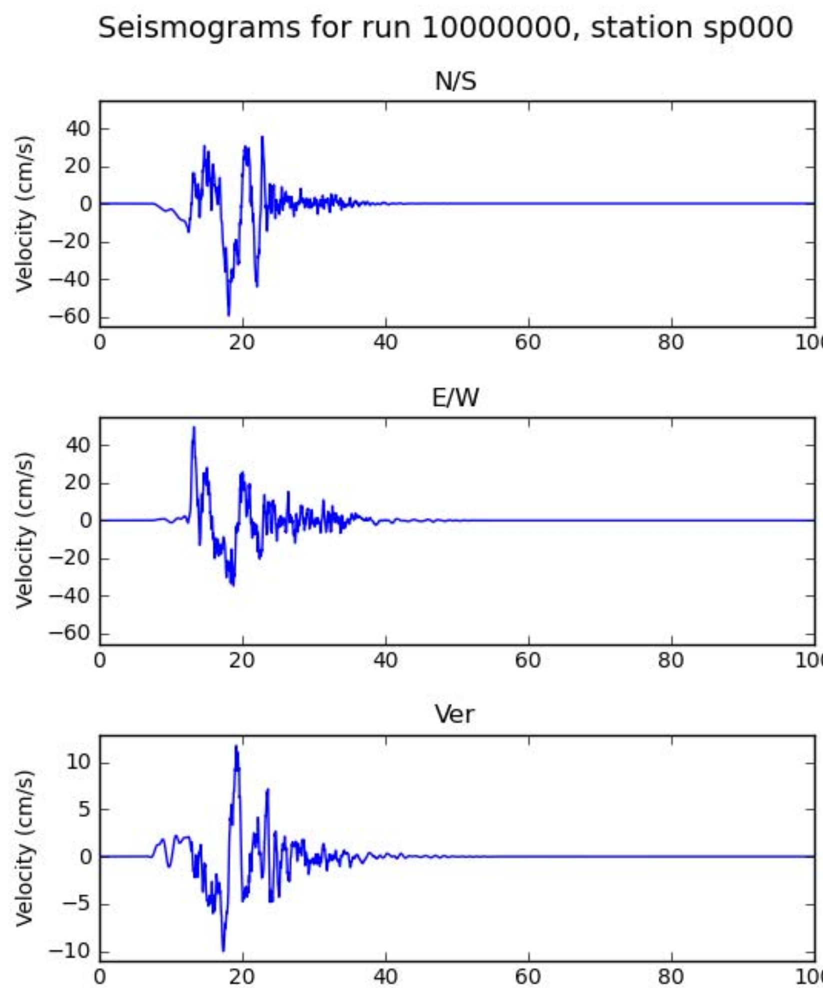

SIMULATION RESULTS: THIN VS. THICK CASE

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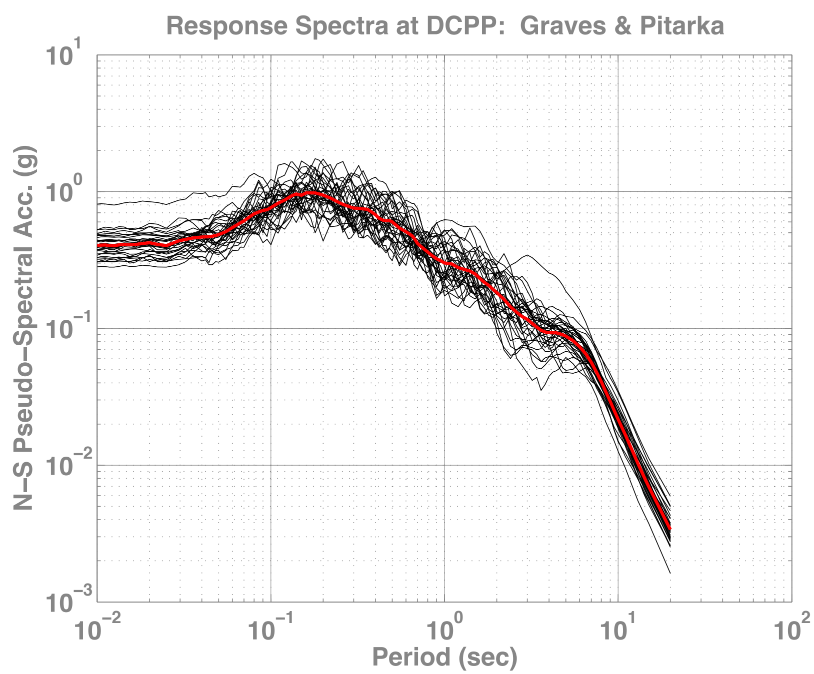

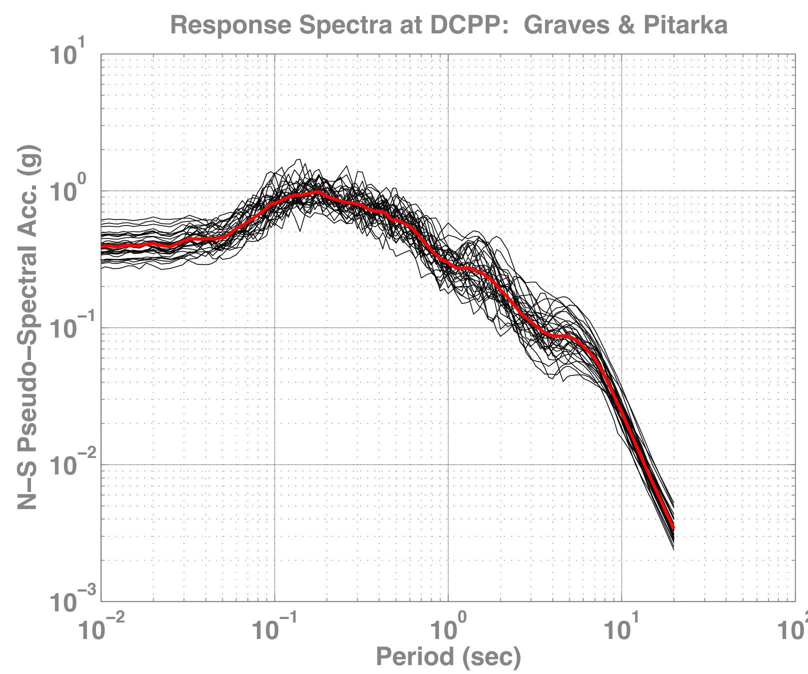

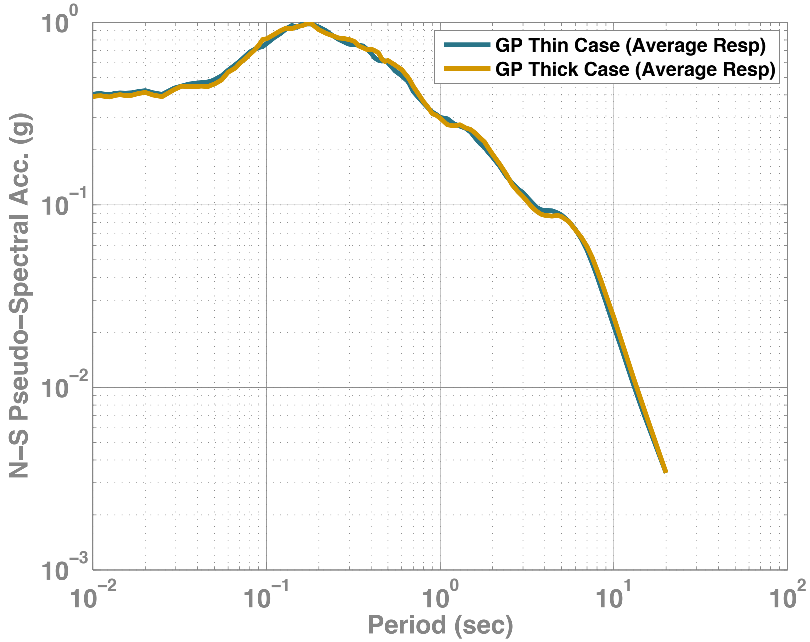

FIXED HYPOCENTER
32 REALIZATIONS

THIN	**THICK**
M_W = 7.21	M_W = 7.21
W = 15 km	W = 22 km
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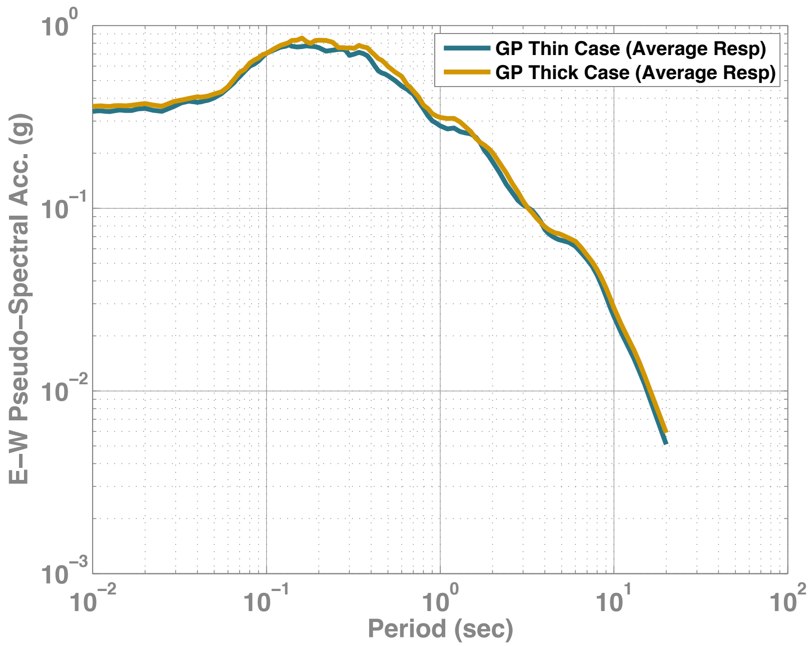

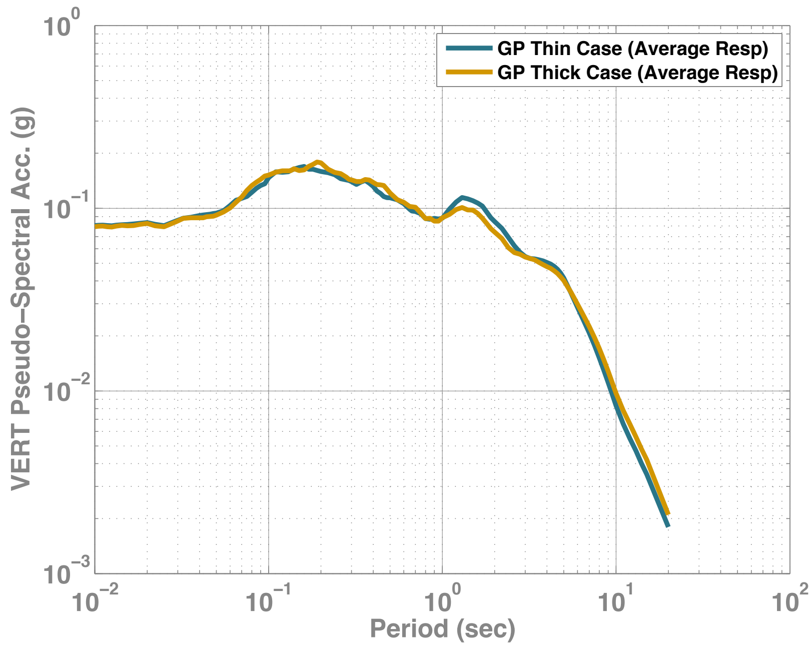

SIMULATION RESULTS: THIN VS. THICK CASE

THIN
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RANDOM HYPOCENTER
32 REALIZATIONS

THICK
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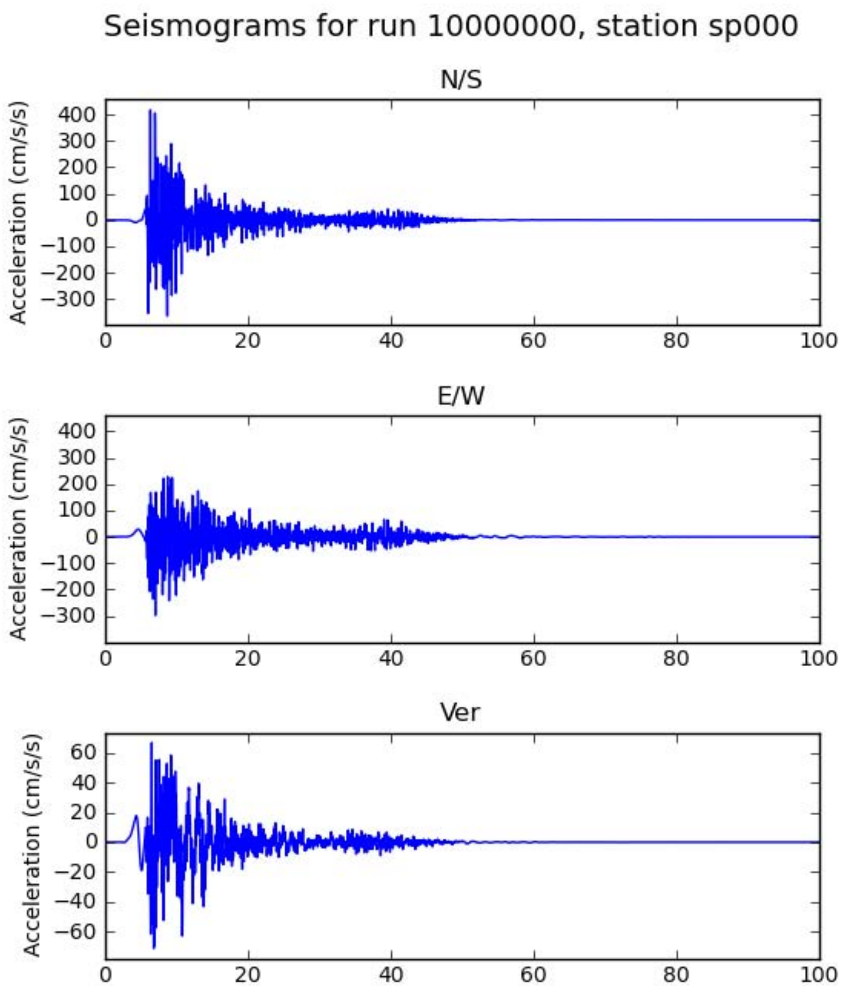

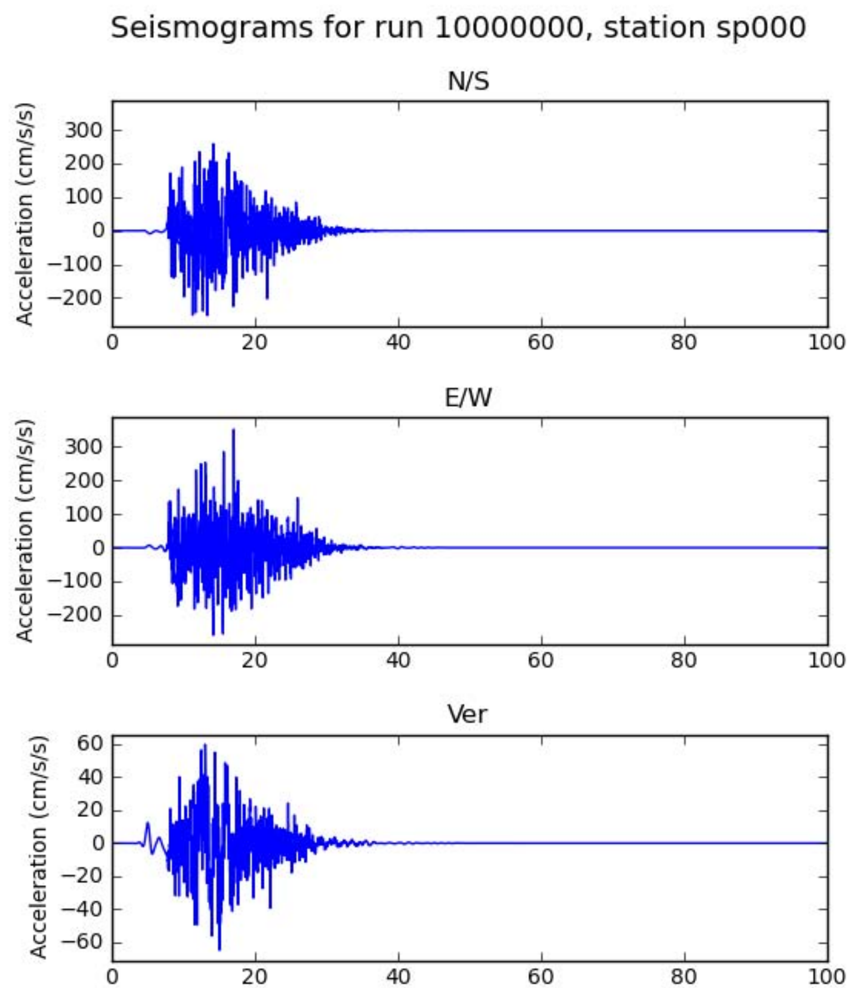

SIMULATION RESULTS: THIN VS. THICK CASE

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RANDOM HYPOCENTER
32 REALIZATIONS

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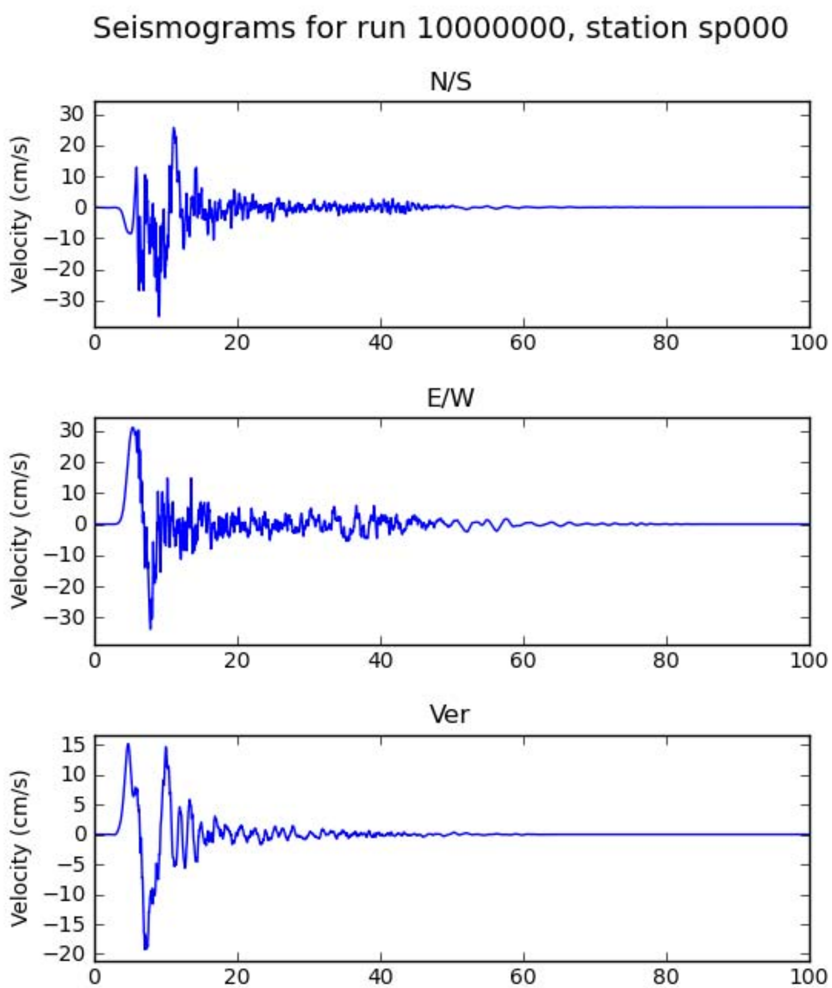

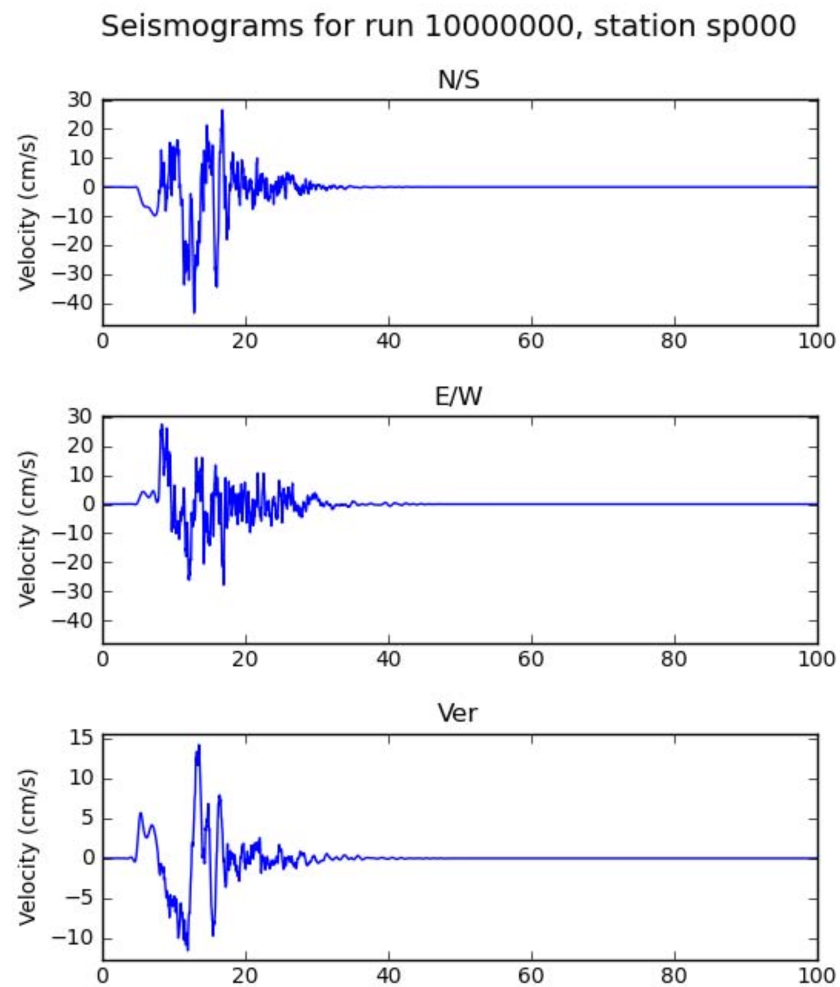

SIMULATION RESULTS: THIN VS. THICK CASE

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RANDOM HYPOCENTER
32 REALIZATIONS

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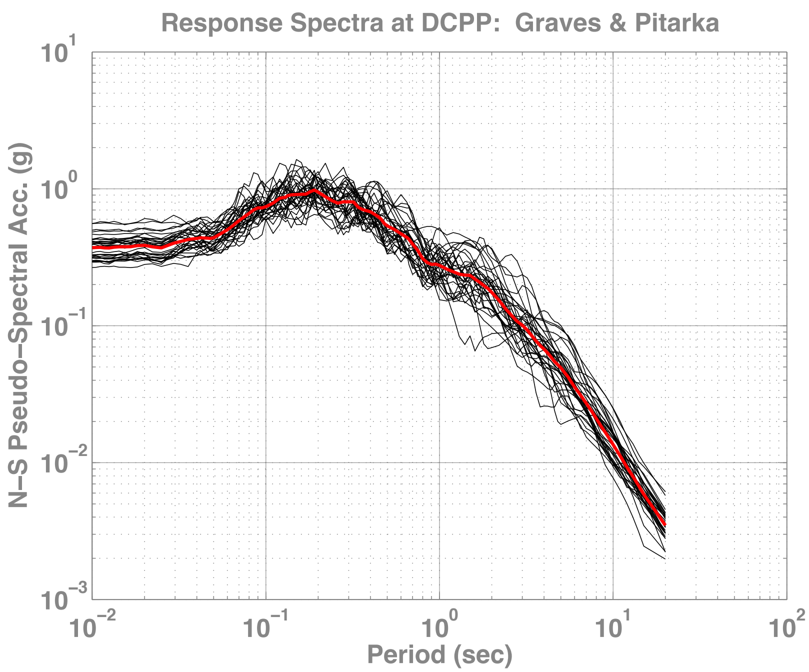

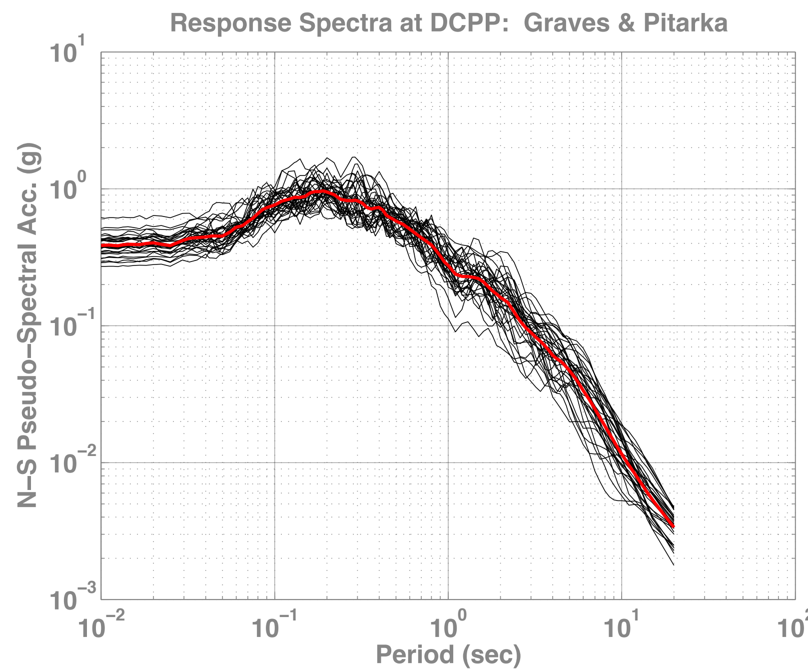

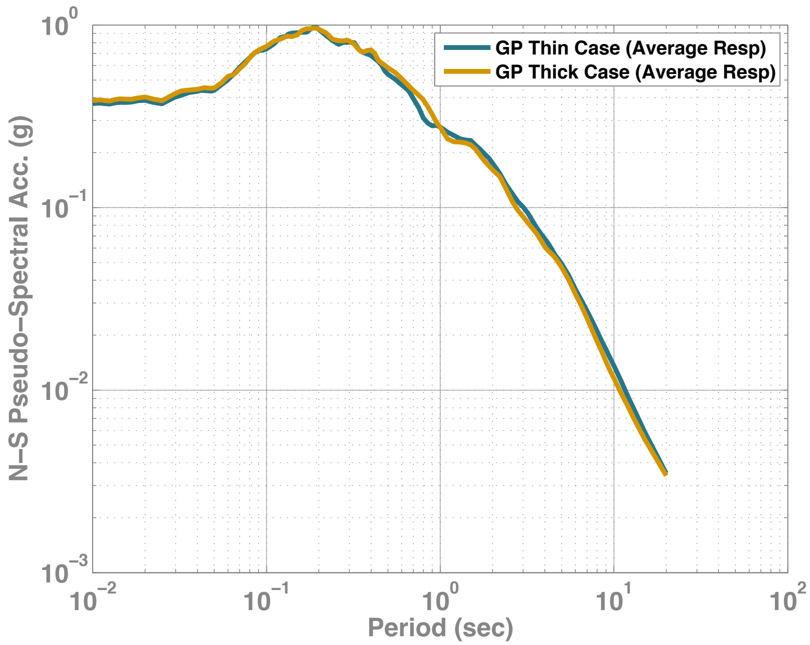

RANDOM HYPOCENTER
32 REALIZATIONS

THIN	**THICK**
$M_W = 7.21$	$M_W = 7.21$
W = 15 km	W = 22 km
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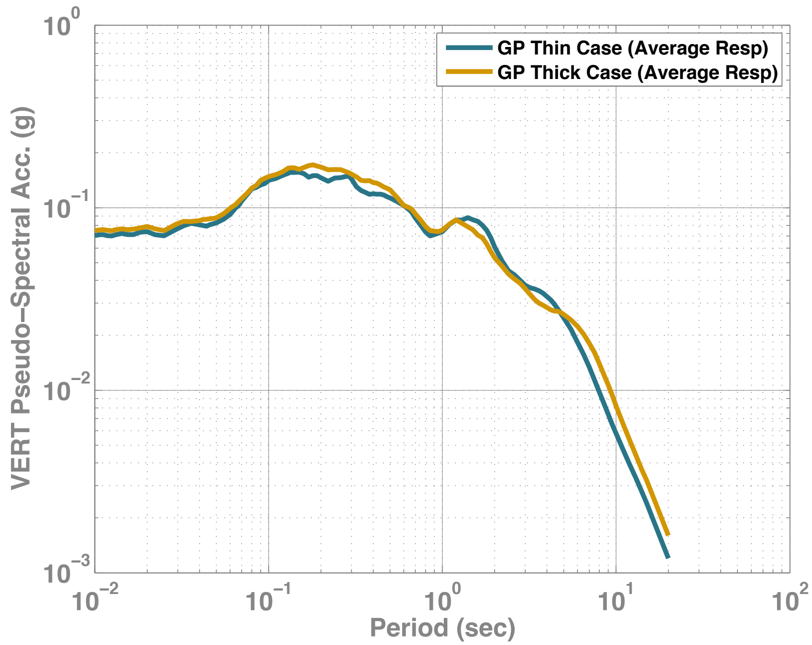


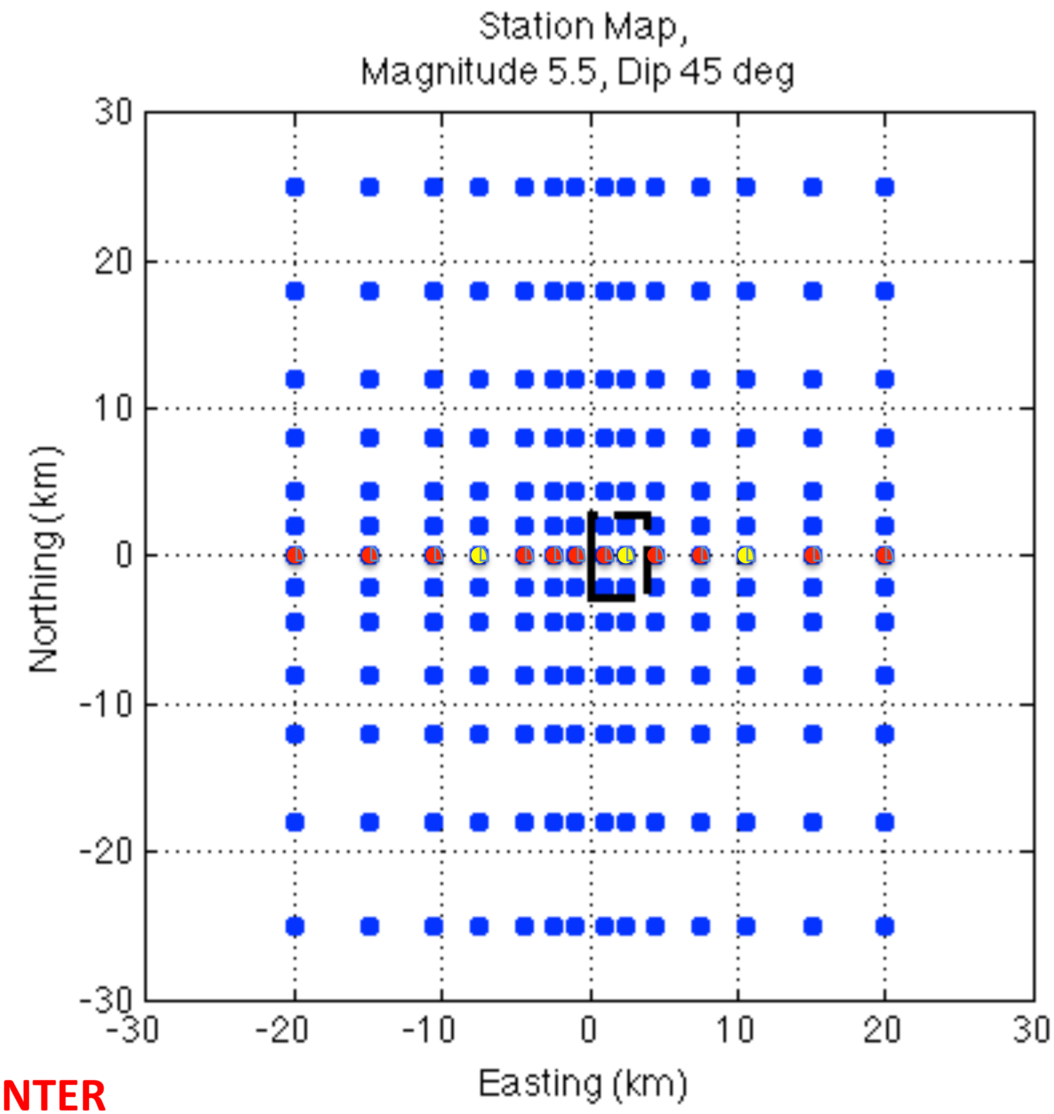
GREEN'S FUNCTIONS

- Interface Issues:
  - Add Green's Function capability into the platform or handle them outside?
  - Adequacy of the current Green's functions. Do we need full F-K solutions?

PREVIEW OF RESULTS

- NUMBER OF CASES
  - ~860,000 scenarios submitted in early August
  - Approx. 75% complete

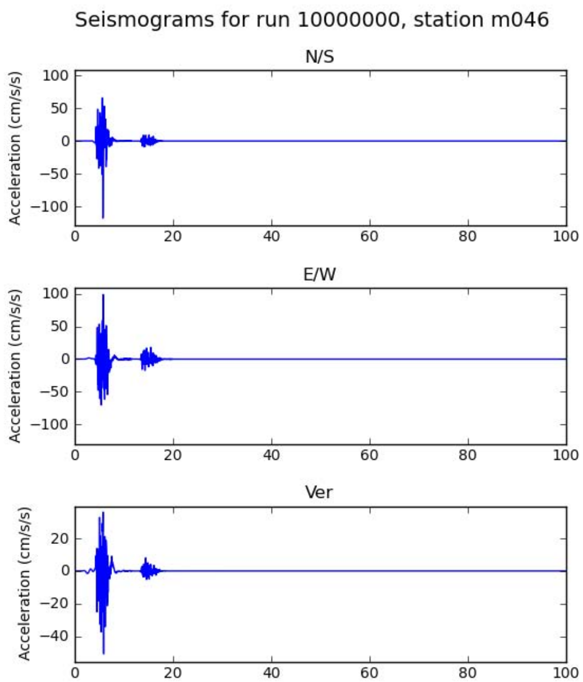
- PRELIMINARY SCENARIO RESULTS
  - M5.5 Reverse fault with (dip = 45, ZTOR = 2.5)
  - Comparison between GP, SDSU, and ExSIM

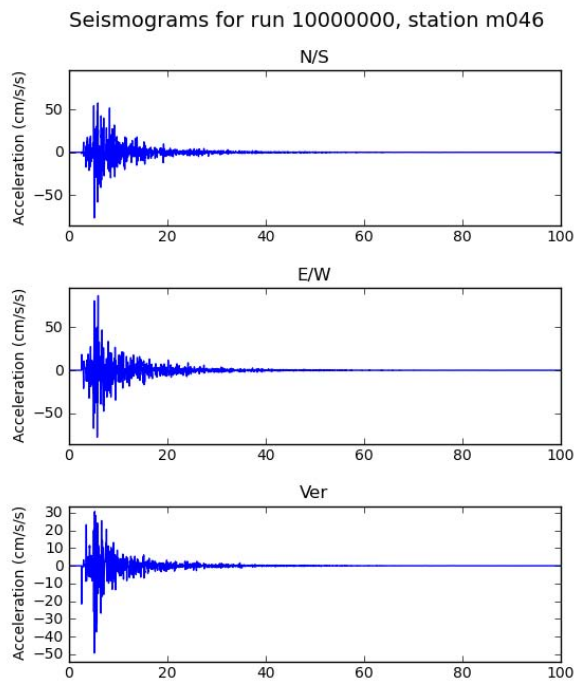


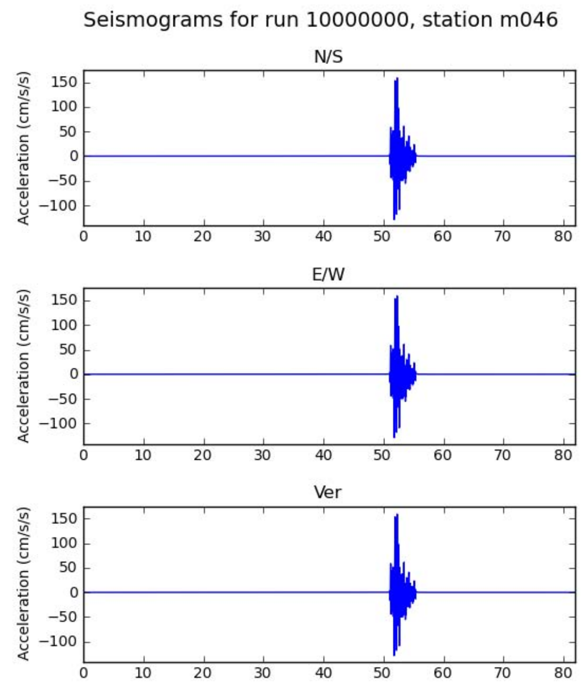
RANDOM HYPOCENTER
32 REALIZATIONS
ZTOR = 2.5 km
REVERSE SLIP

WAVEFORM COMPARISON: GP, SDSU, & ExSIM

STATION ON FOOTWALL SIDE: R_X = -7.5 km, R_{JB} = 7.5 km, R_{RUP} = 7.9 km

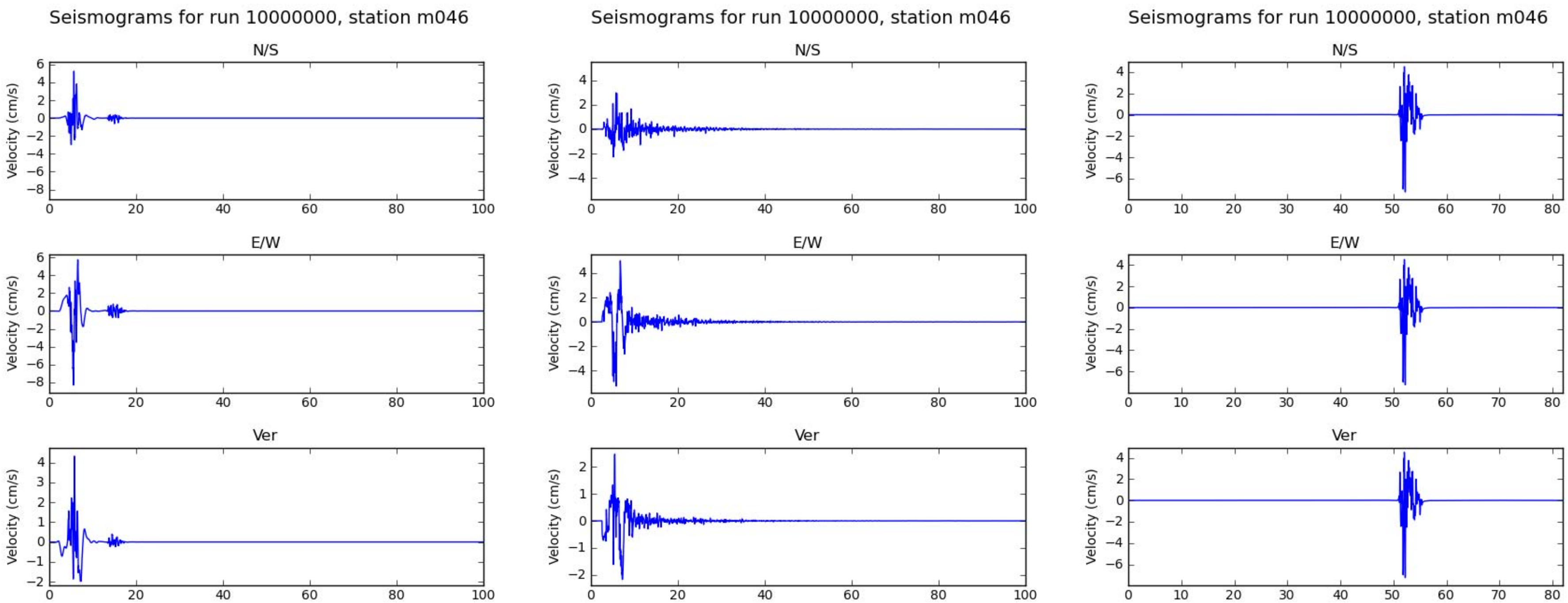




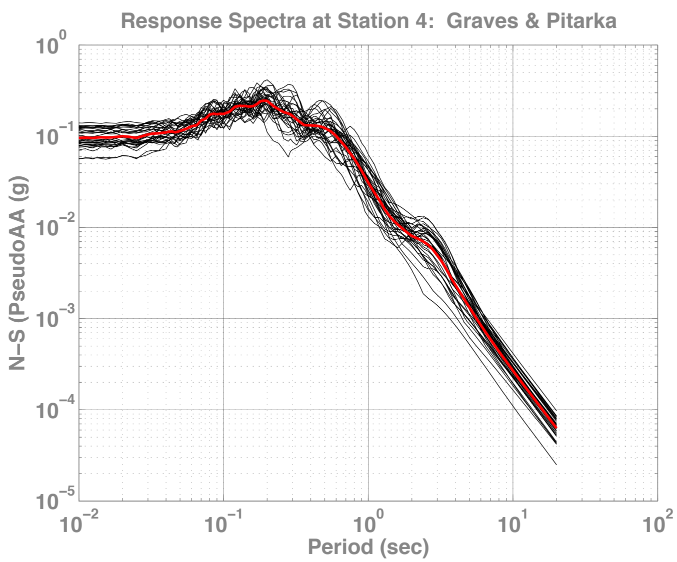


WAVEFORM COMPARISON: GP, SDSU, & ExSIM

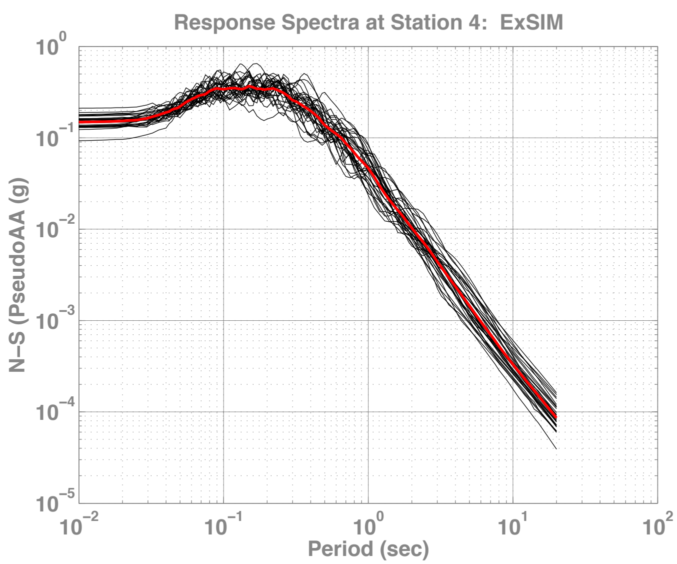
STATION ON FOOTWALL SIDE: R_X = -7.5 km, R_{JB} = 7.5 km, R_{RUP} = 7.9 km

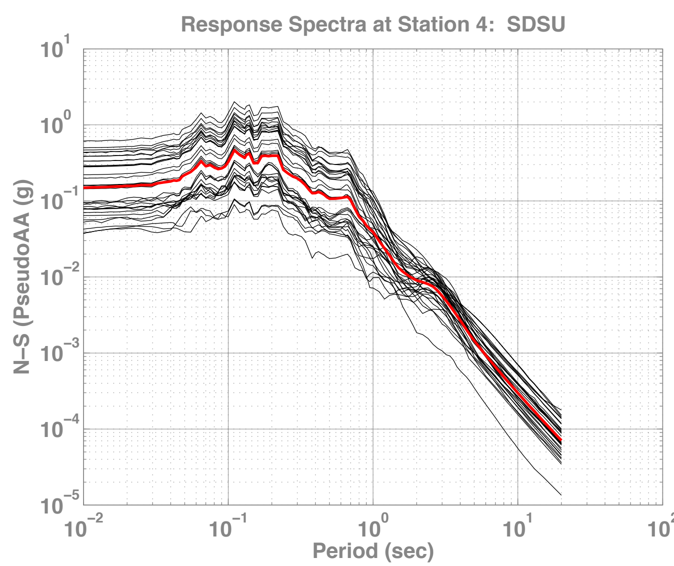


N-S RESPONSE SPECTRA: GP, SDSU, & ExSIM

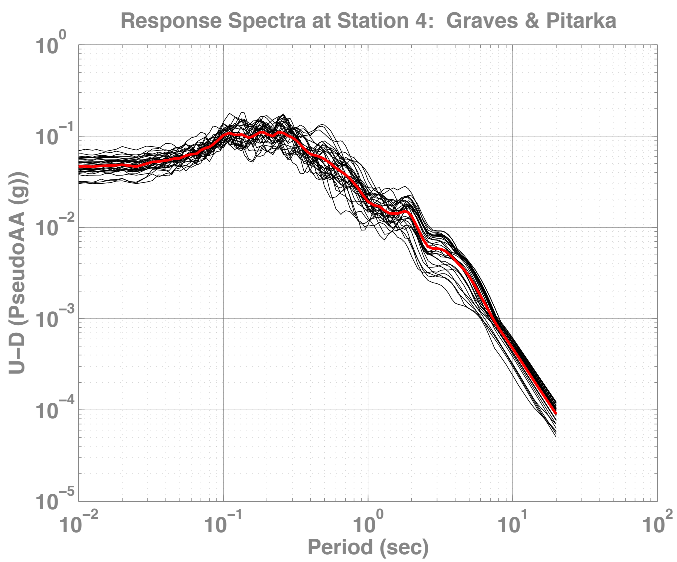


STATION ON FOOTWALL SIDE:
R_X = -7.5 km
R_{JB} = 7.5 km
R_{RUP} = 7.9 km





N-S RESPONSE SPECTRA: GP, SDSU, & ExSIM

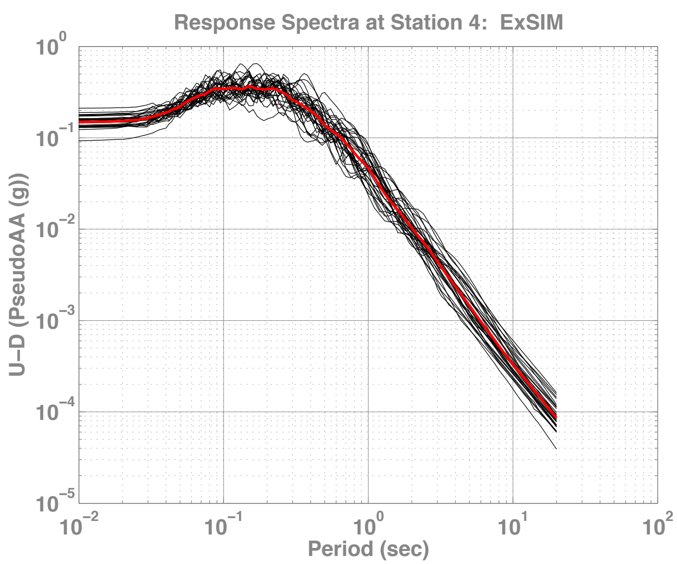


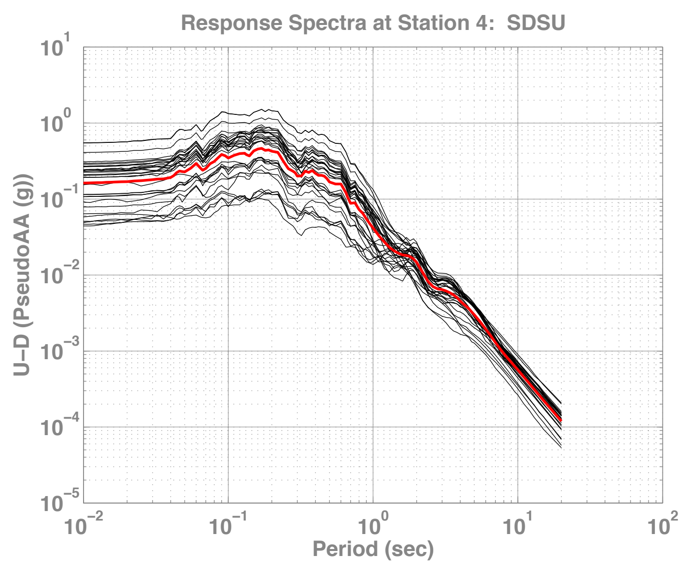
STATION ON FOOTWALL SIDE:

R_X = -7.5 km

R_{JB} = 7.5 km

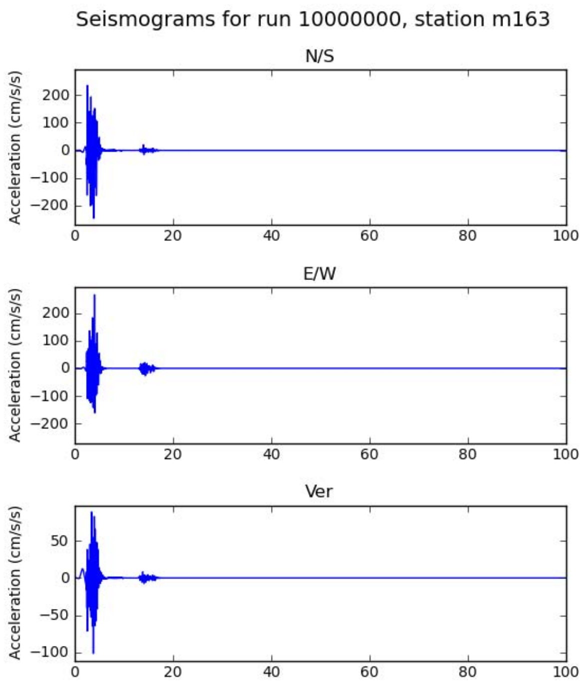
R_{RUP} = 7.9 km

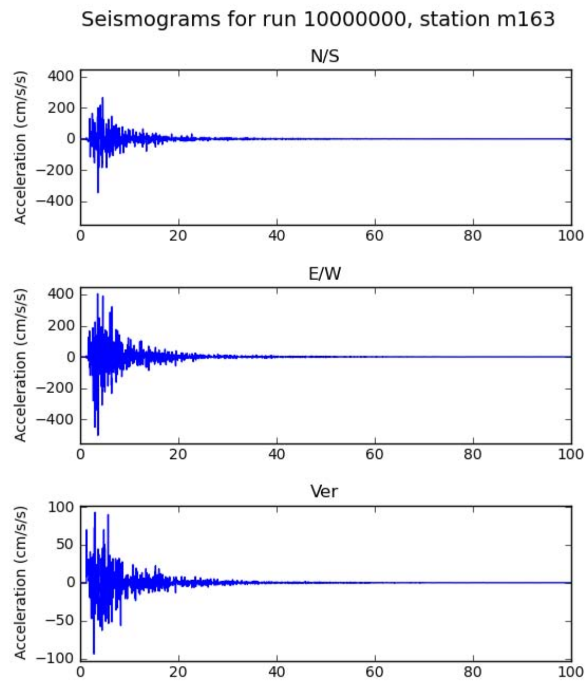


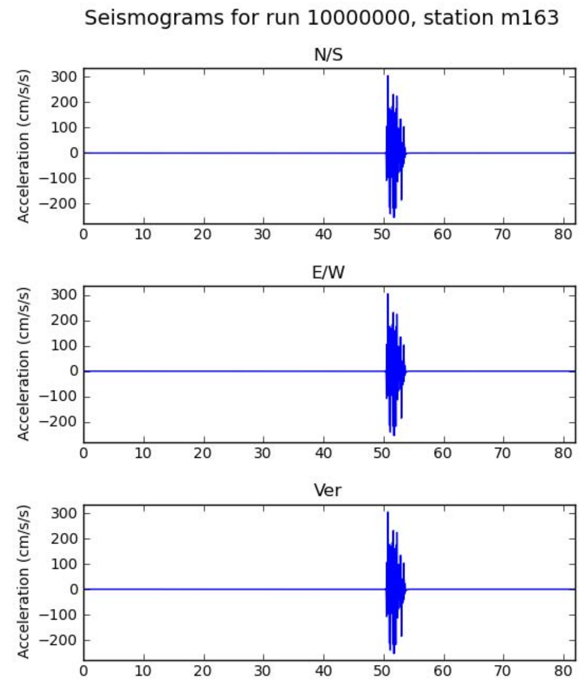


WAVEFORM COMPARISON: GP, SDSU, & ExSIM

STATION OVER FAULT PLANE: R_X = 2.5 km, R_{JB} = 0 km, R_{RUP} = 3.5 km

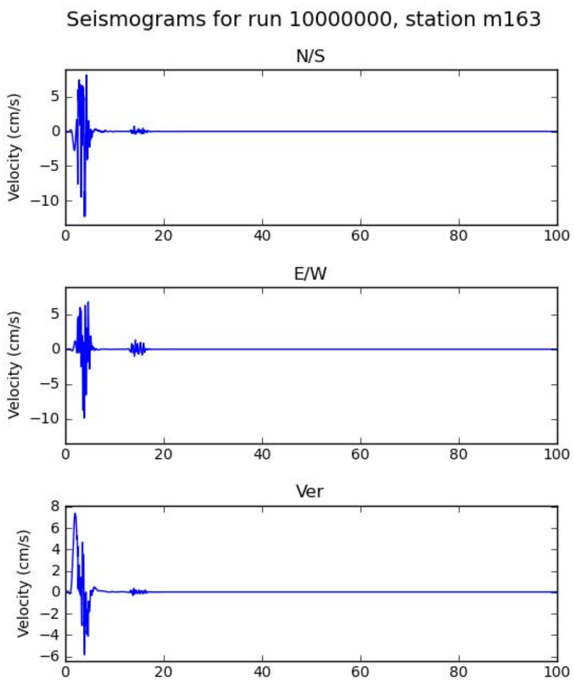


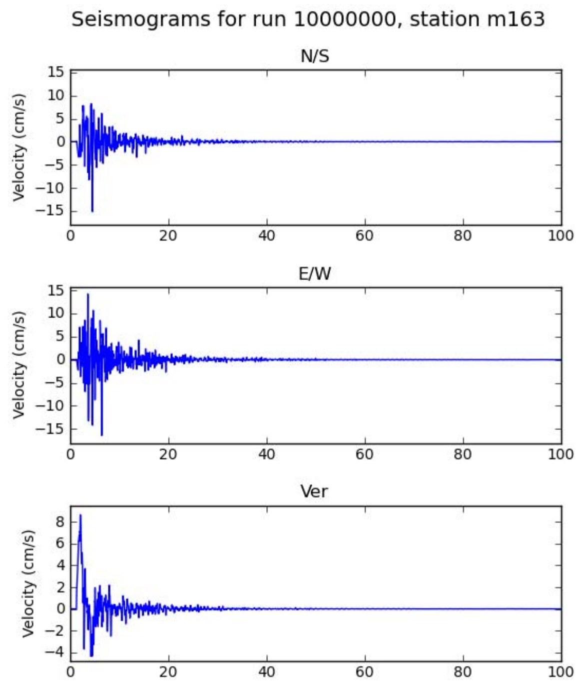


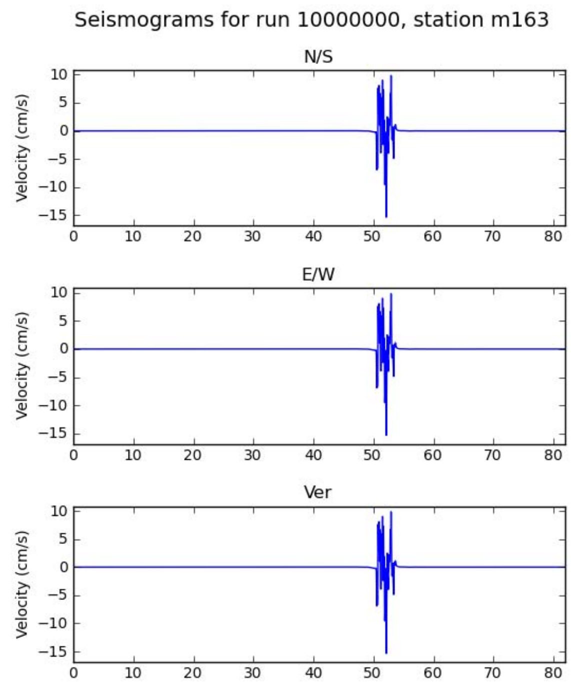


WAVEFORM COMPARISON: GP, SDSU, & ExSIM

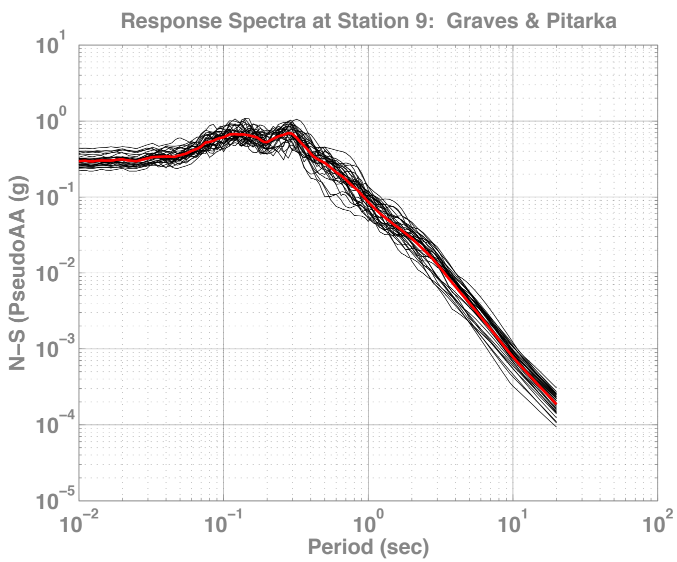
STATION OVER FAULT PLANE: R_X = 2.5 km, R_{JB} = 0 km, R_{RUP} = 3.5 km



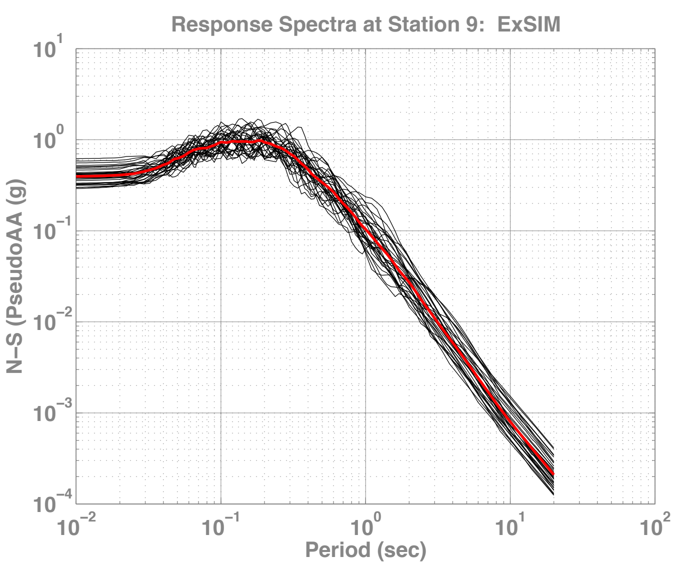


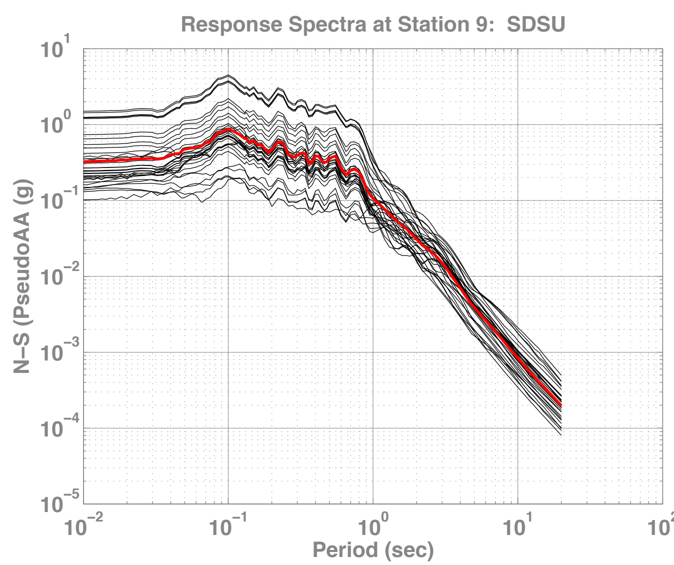


N-S RESPONSE SPECTRA: GP, SDSU, & ExSIM

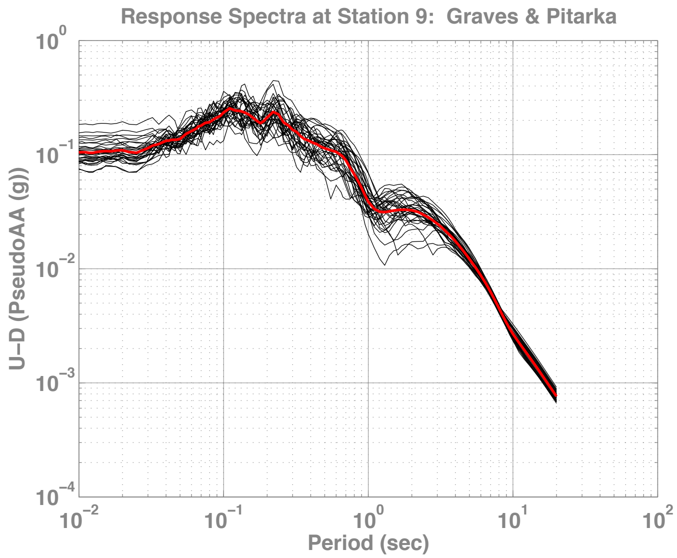


STATION OVER FAULT PLANE:
R_X = -2.5 km
R_{JB} = 0 km
R_{RUP} = 3.5 km

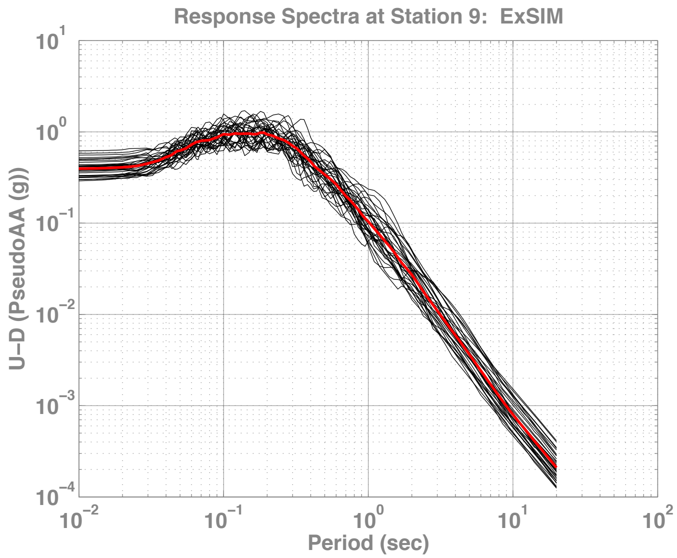


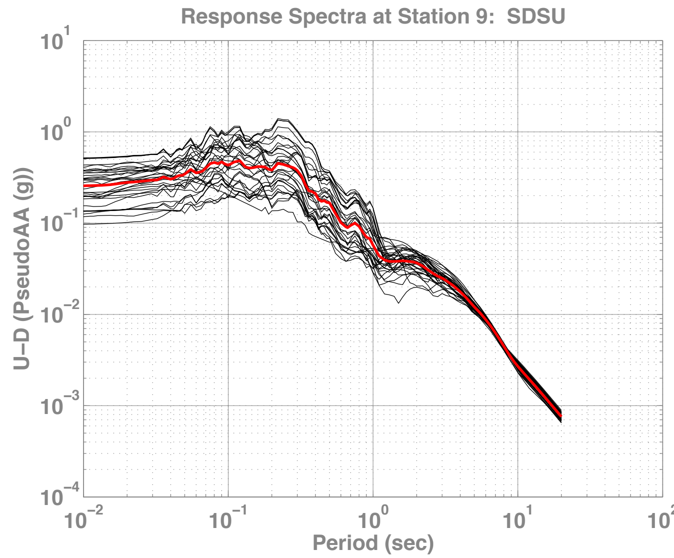


VERT RESPONSE SPECTRA: GP, SDSU, & ExSIM



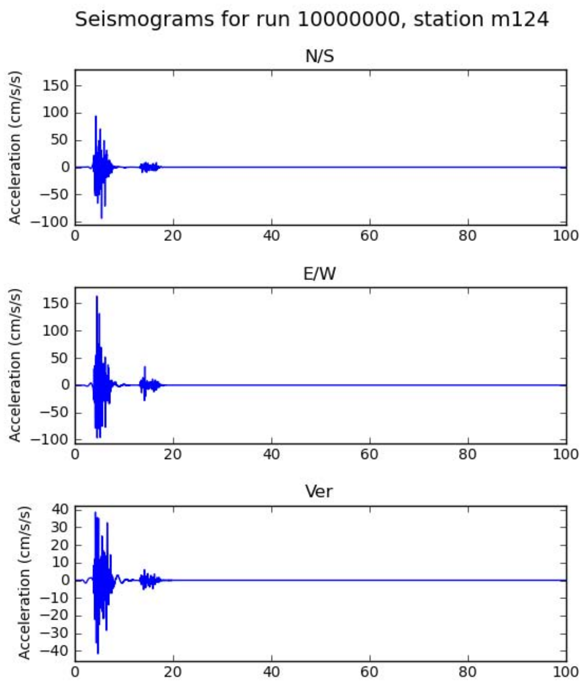
STATION OVER FAULT PLANE:
R_X = -7.5 km
R_{JB} = 7.5 km
R_{RUP} = 7.9 km

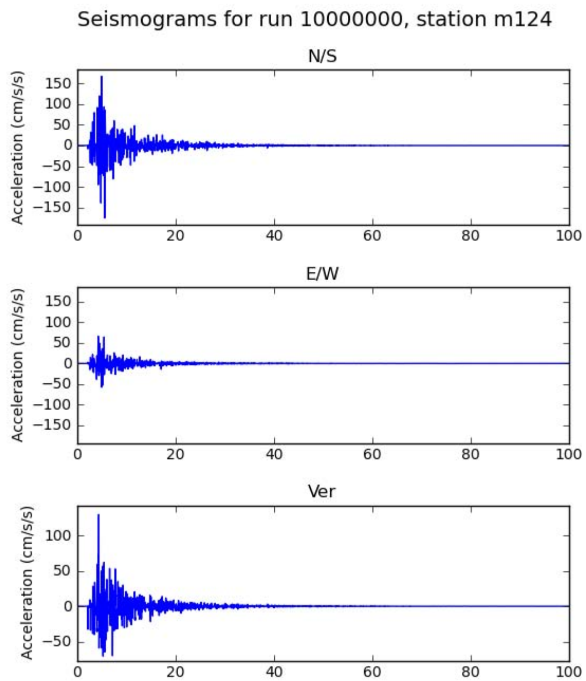


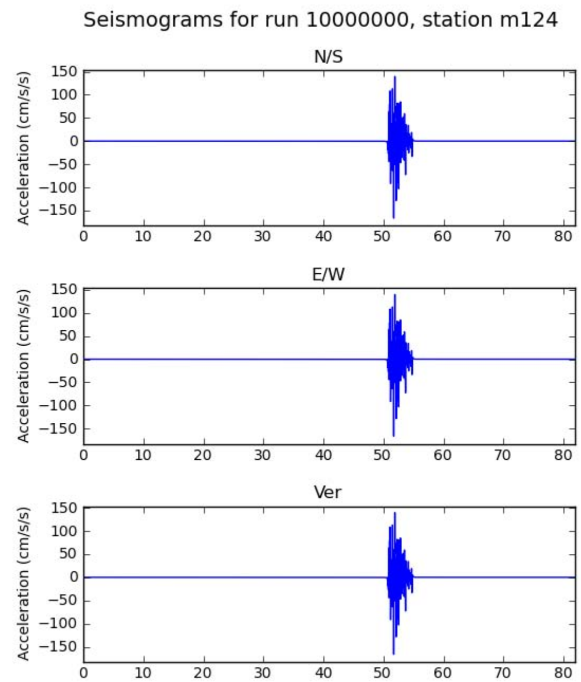


WAVEFORM COMPARISON: GP, SDSU, & ExSIM

STATION ON HANGING-WALL SIDE: R_X = 10.5 km, R_{JB} = 6.5 km, R_{RUP} = 9.2 km







WAVEFORM COMPARISON: GP, SDSU, & ExSIM

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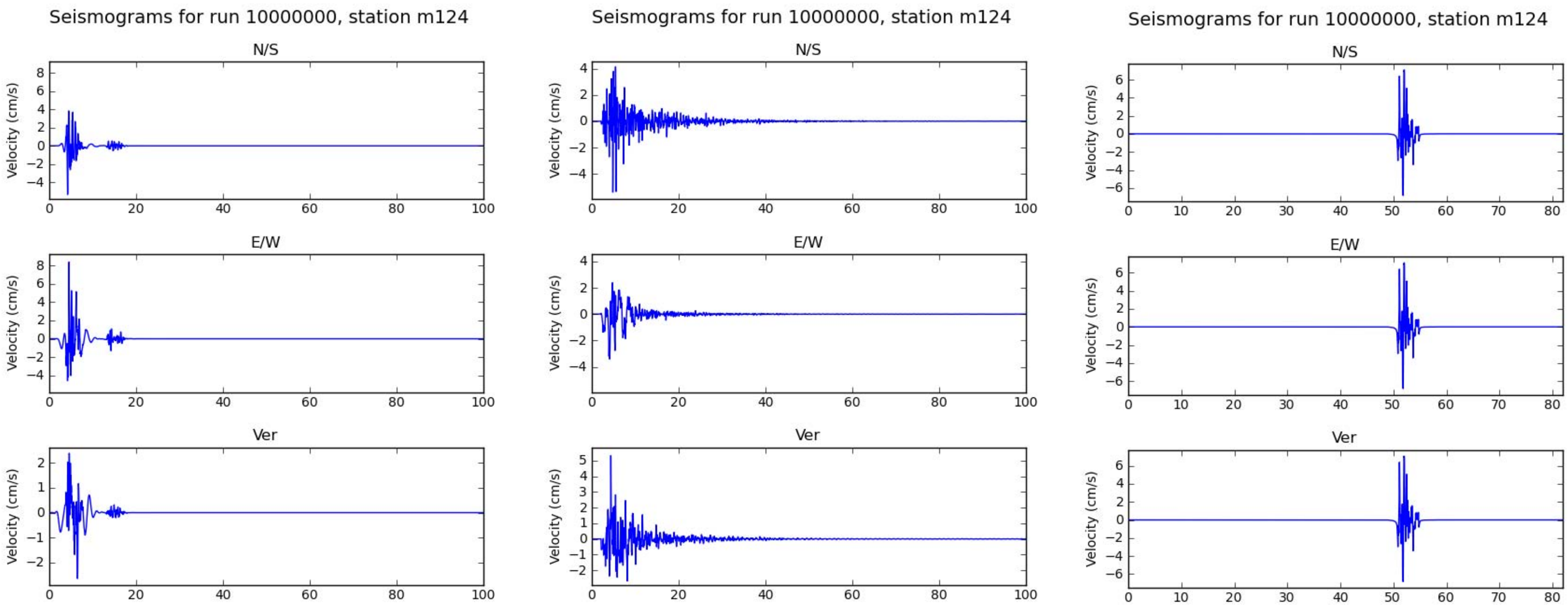
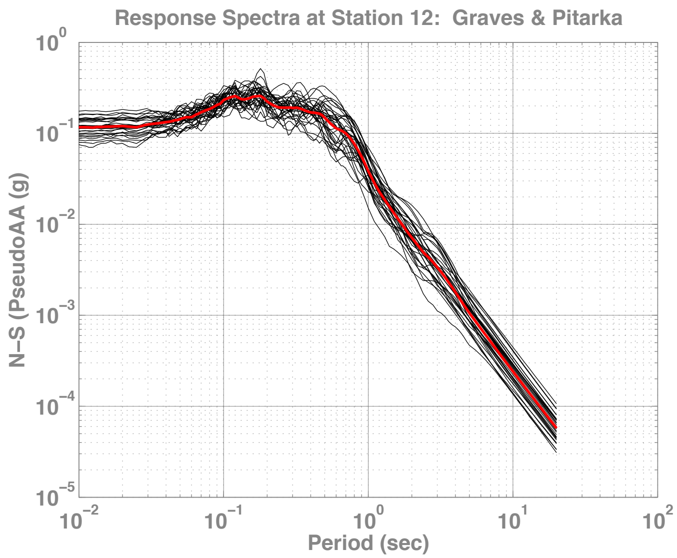


N-S RESPONSE SPECTRA: GP, SDSU, & ExSIM



STATION ON HANGING-WALL SIDE:
R_X = -2.5 km
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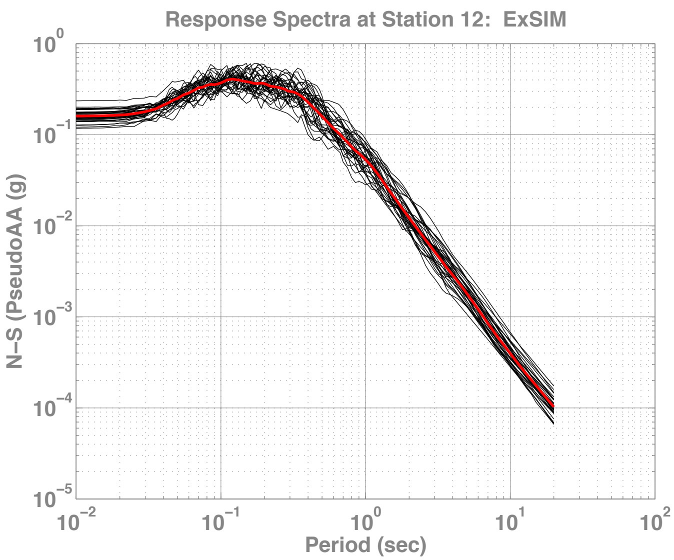
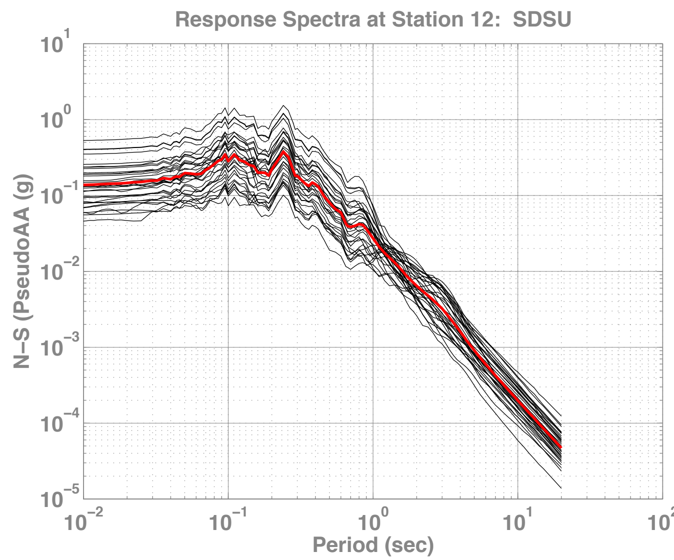
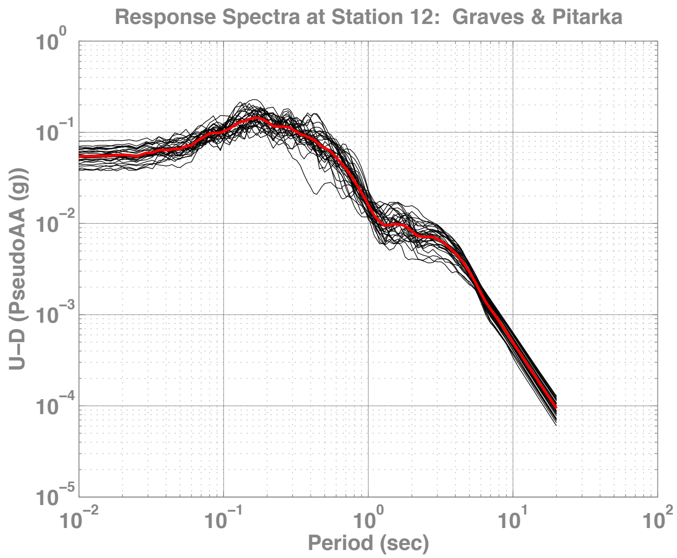
R_{RUP} = 3.5 km

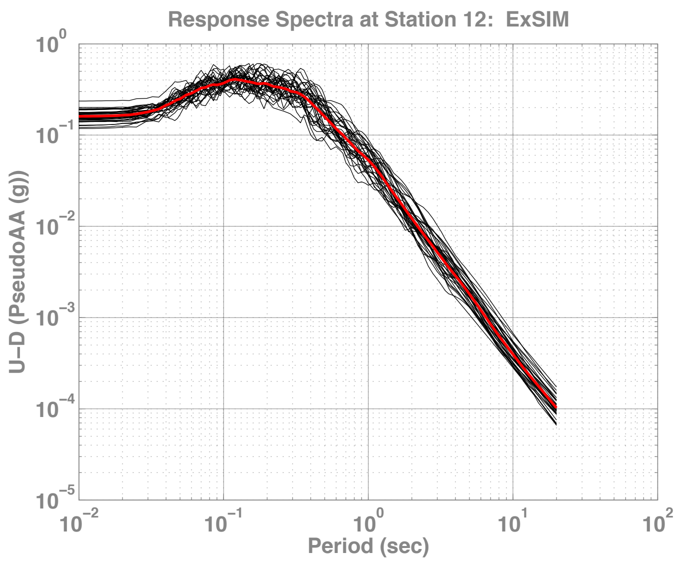


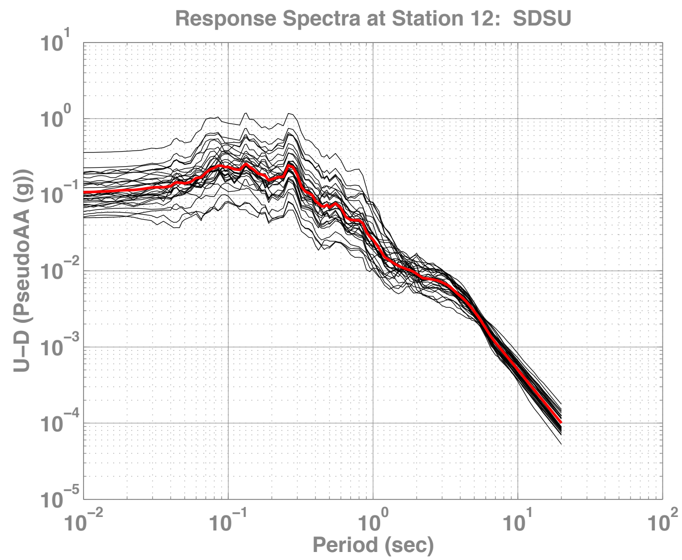


N-S RESPONSE SPECTRA: GP, SDSU, & ExSIM

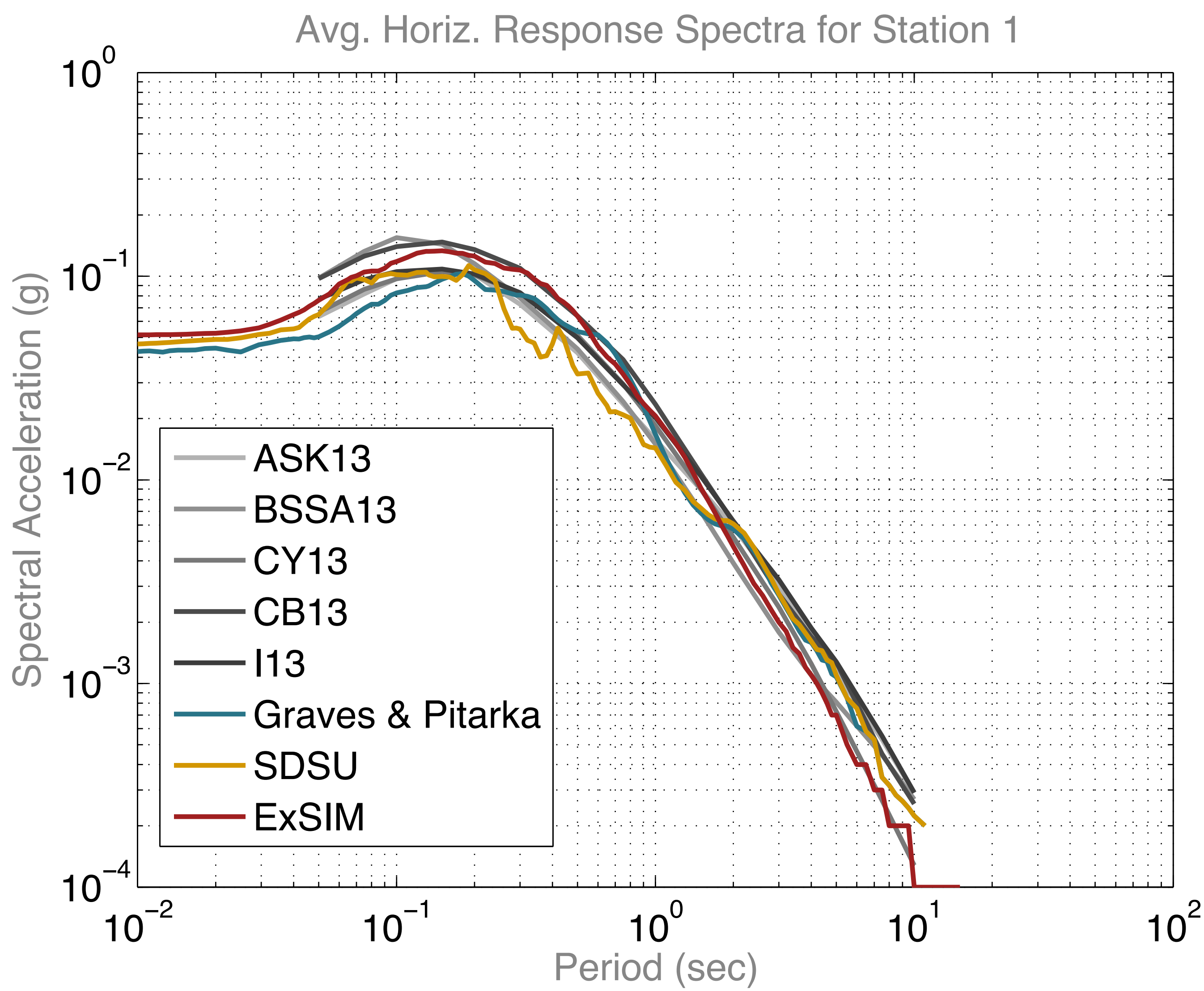


STATION ON HANGING-WALL SIDE:
R_X = -2.5 km
R_{JB} = 0 km
R_{RUP} = 3.5 km

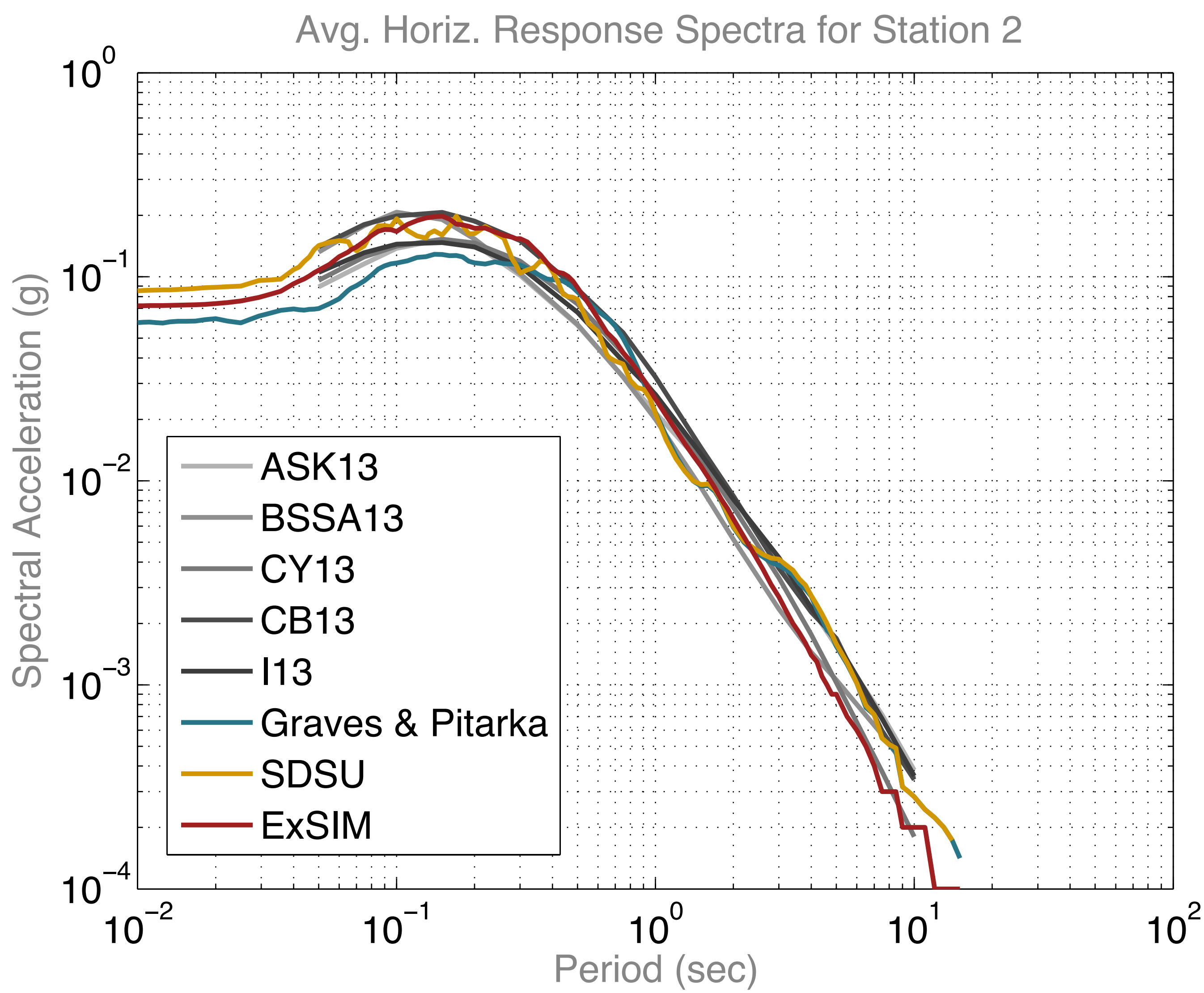




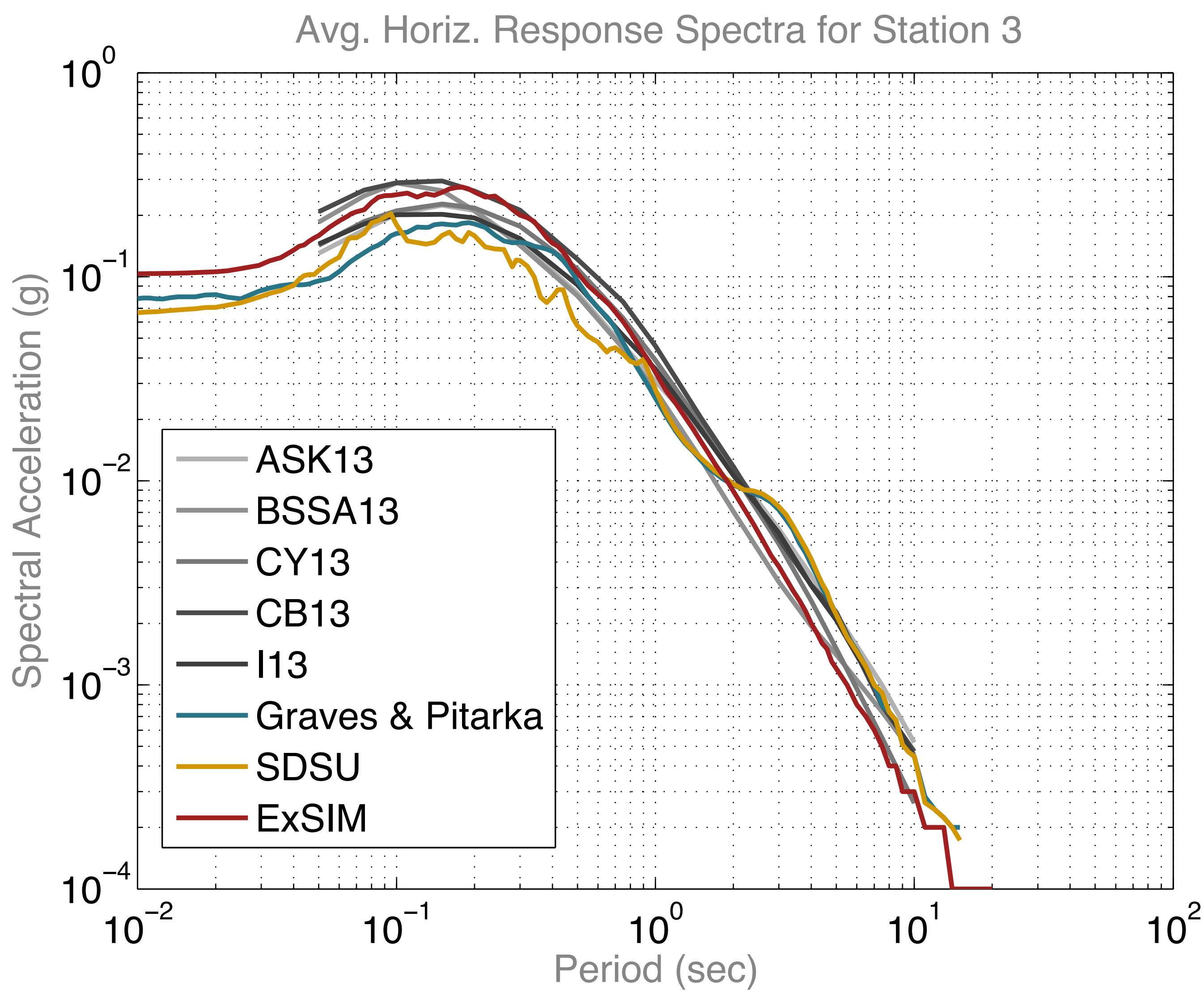
STATION ON FOOTWALL SIDE: R_X = -20.0 km, R_{JB} = 20.0 km, R_{RUP} = 20.2 km



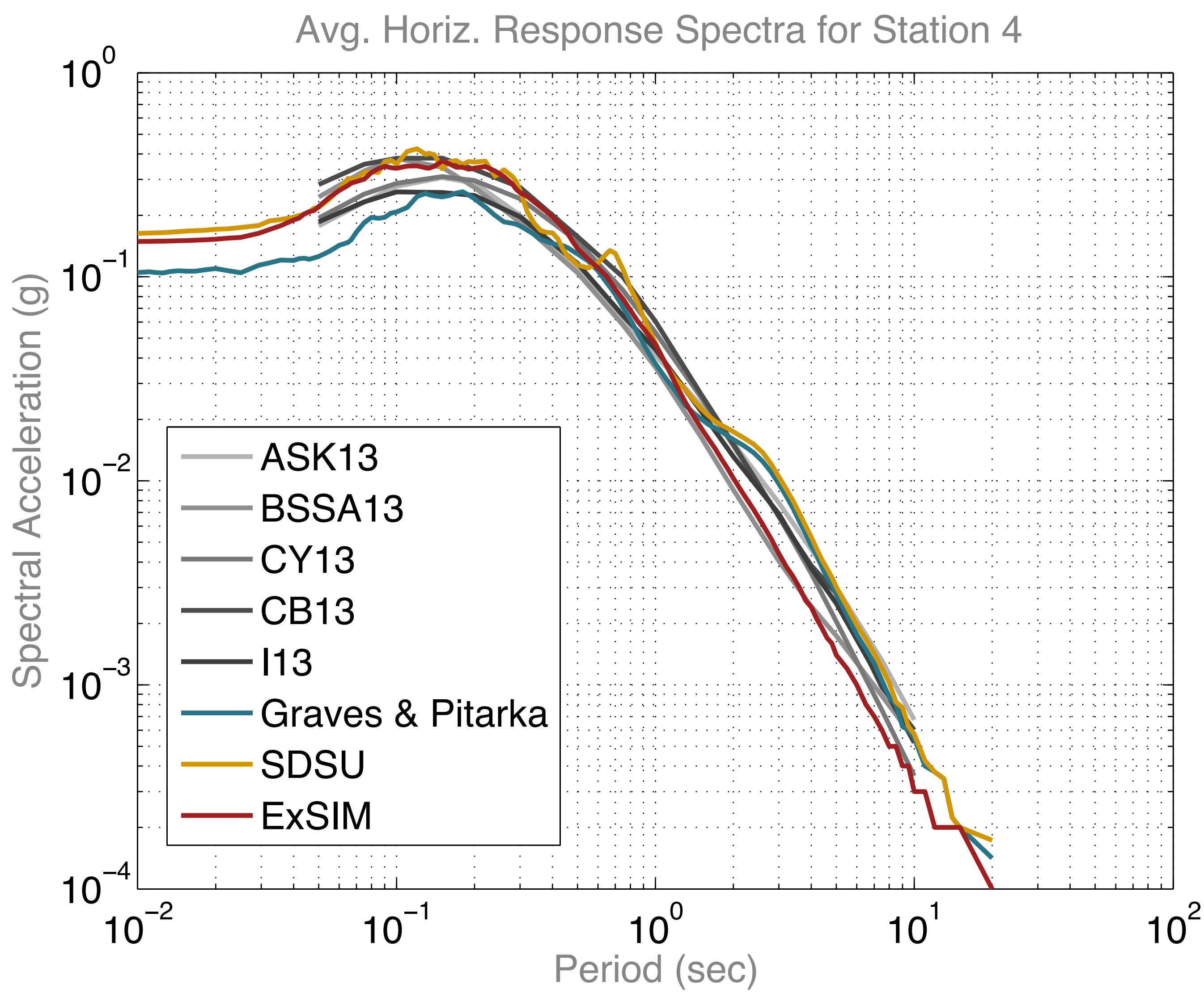
STATION ON FOOTWALL SIDE: R_X = -15.0 km, R_{JB} = 15.0 km, R_{RUP} = 15.2 km



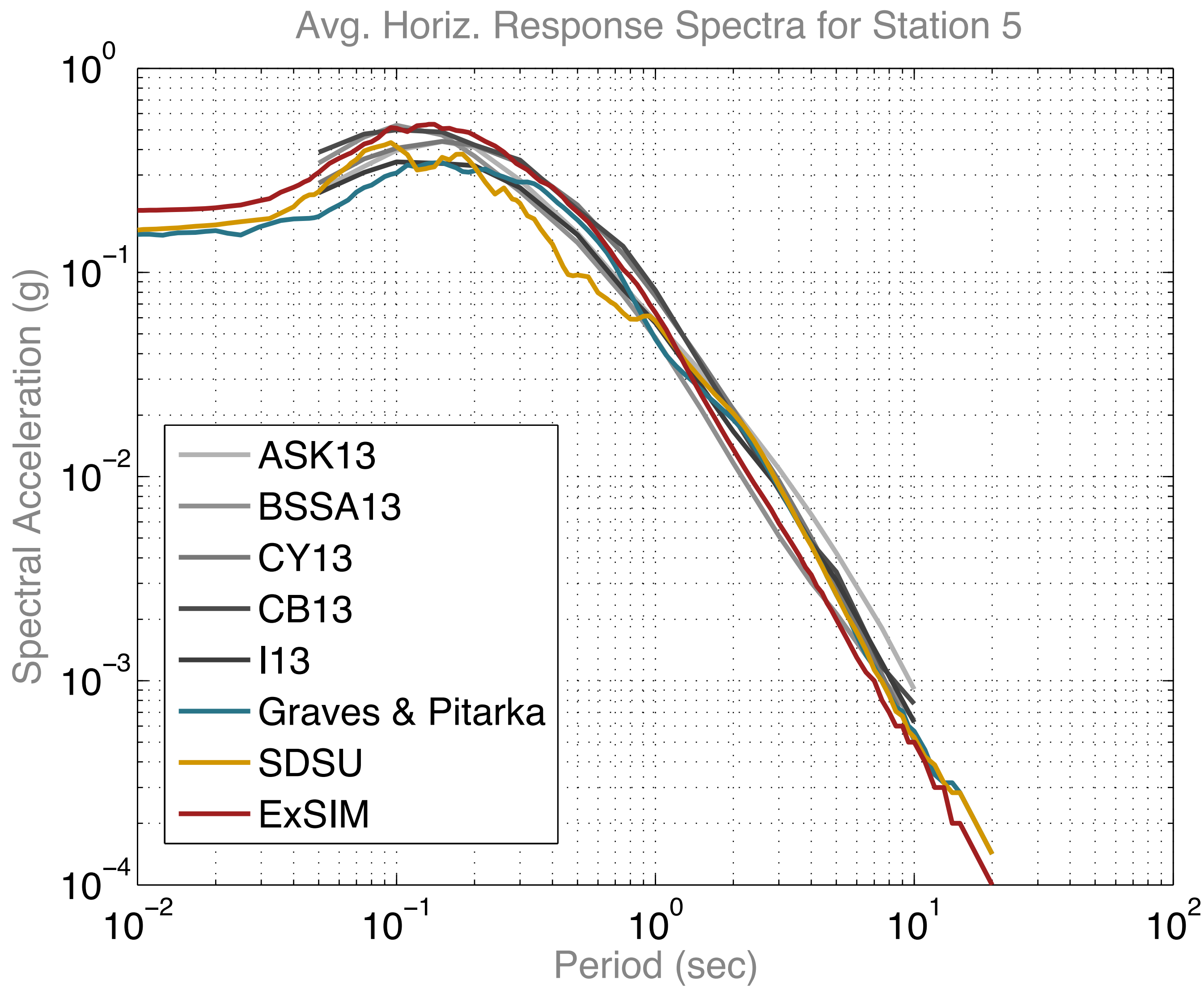
STATION ON FOOTWALL SIDE: R_X = -10.5 km, R_{JB} = 10.5 km, R_{RUP} = 10.8 km



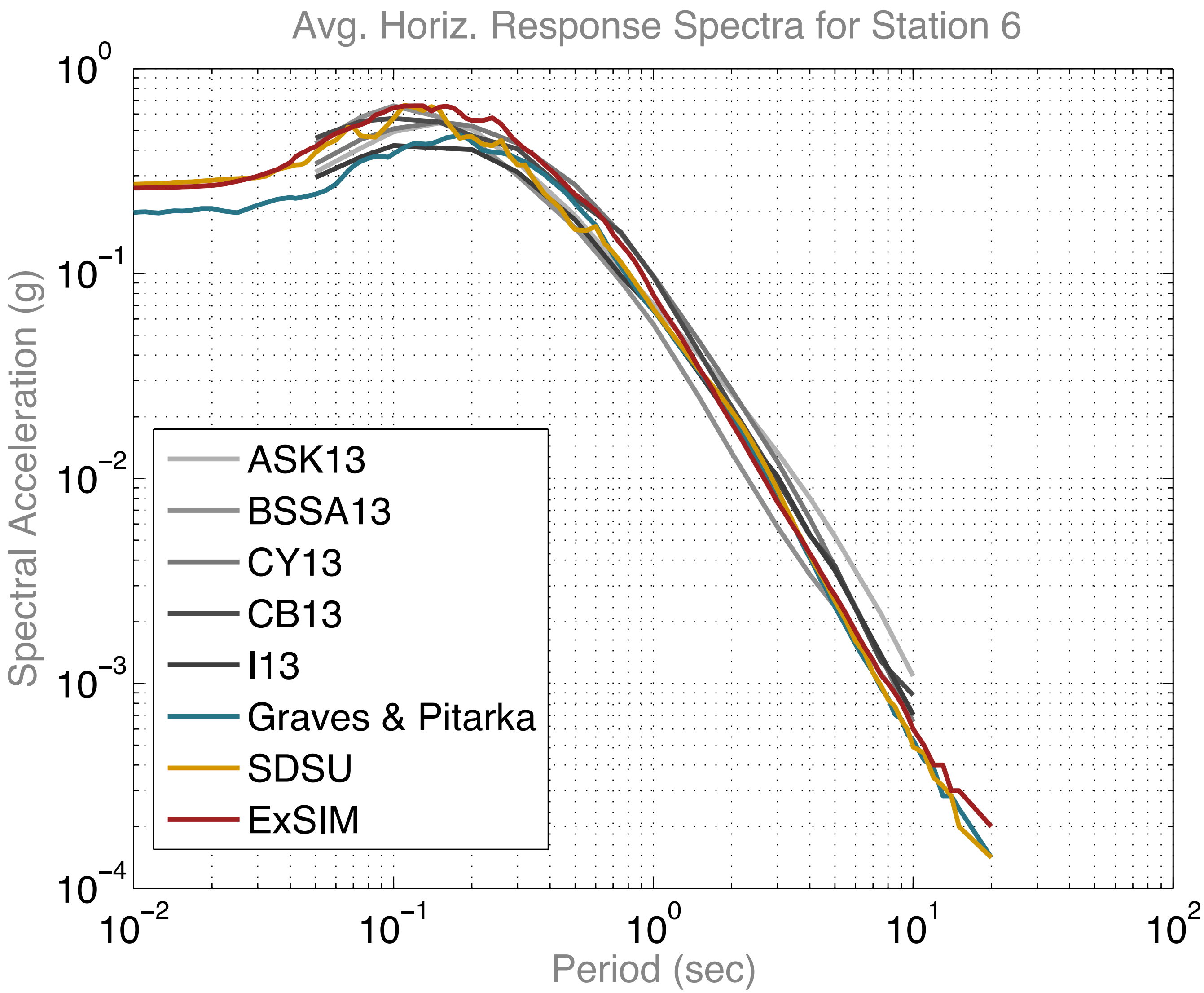
STATION ON FOOTWALL SIDE: R_X = -7.5 km, R_{JB} = 7.5 km, R_{RUP} = 7.9 km



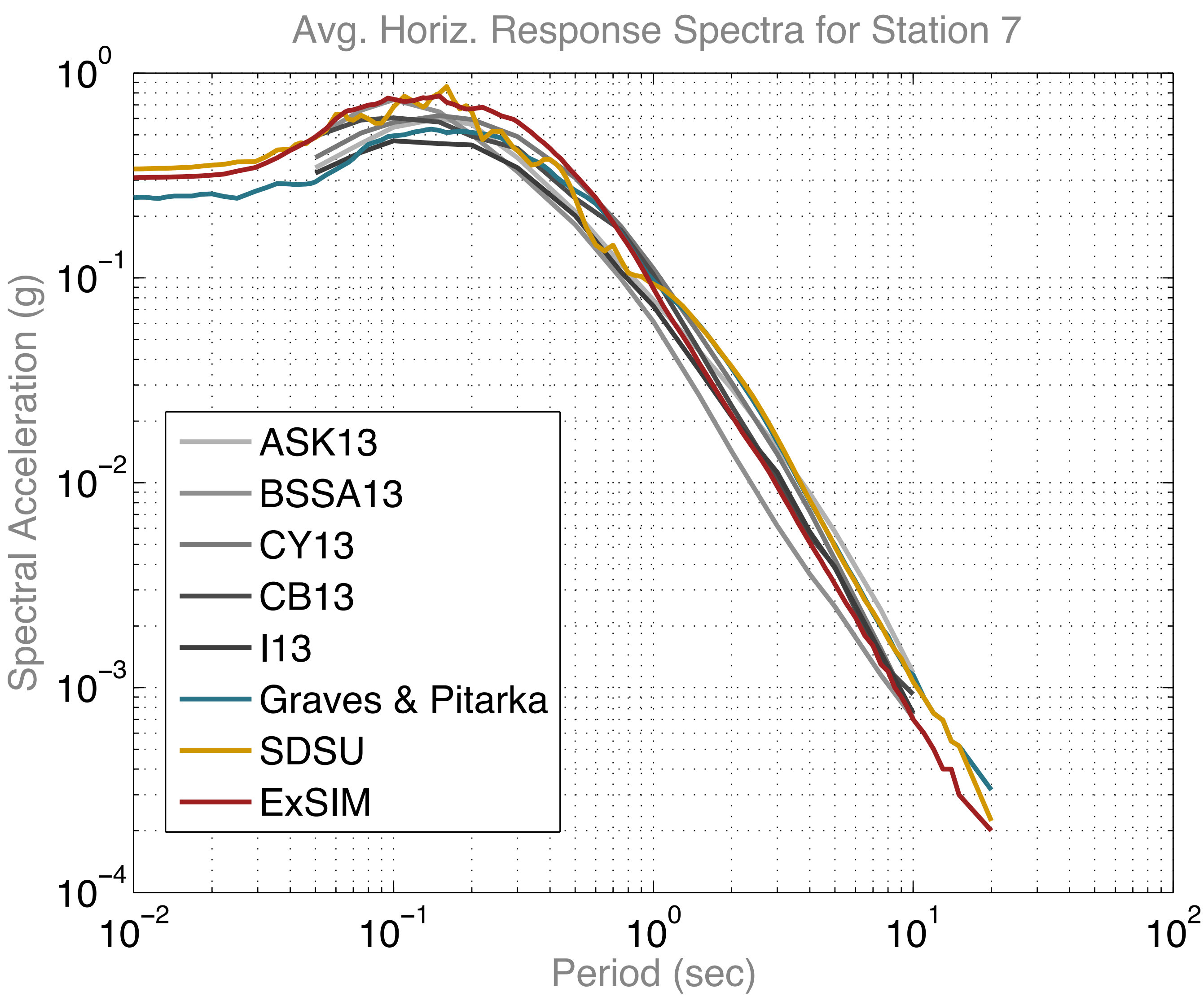
STATION ON FOOTWALL SIDE: R_X = -4.5 km, R_{JB} = 4.5 km, R_{RUP} = 5.1 km



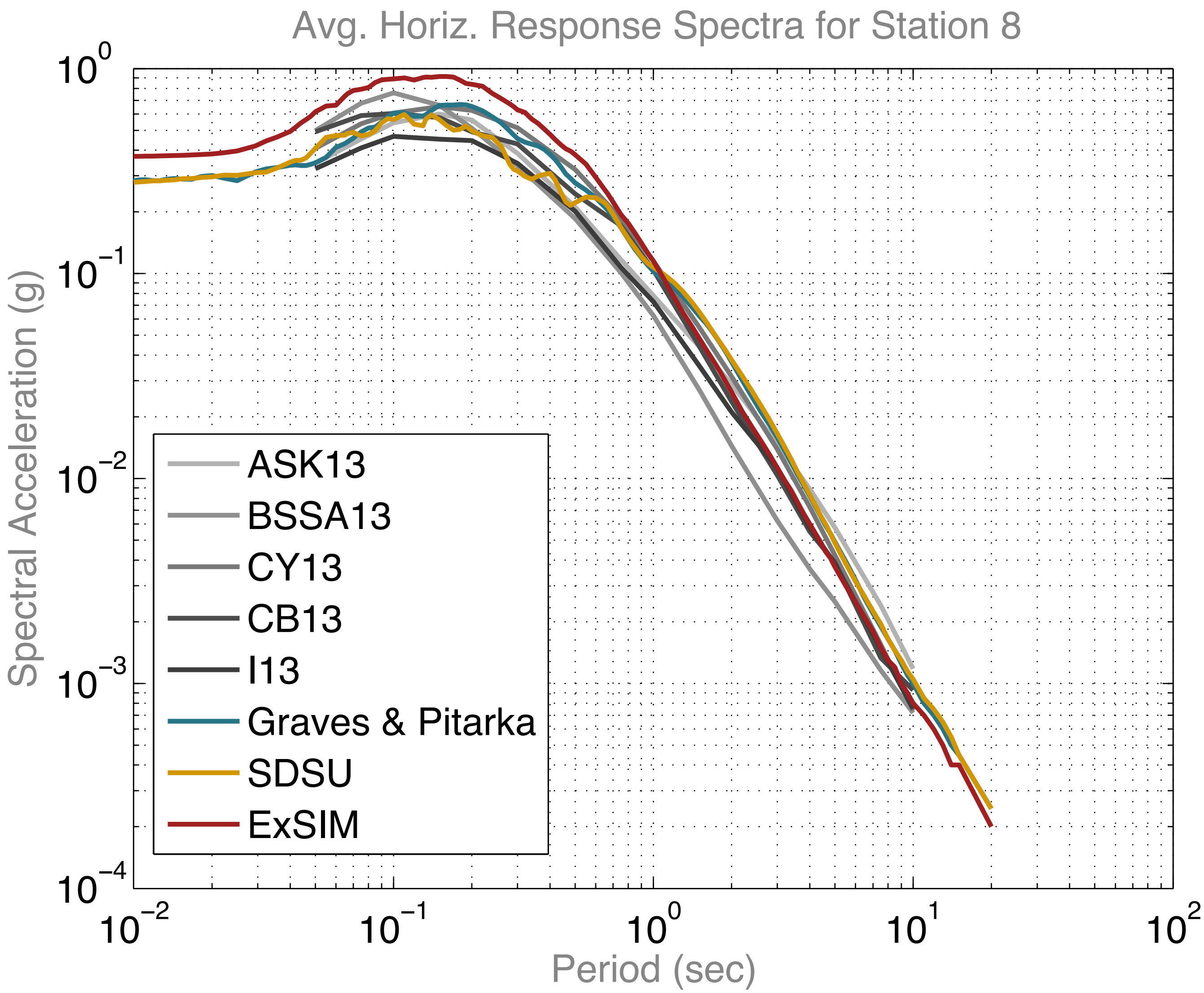
STATION ON FOOTWALL SIDE: R_X = -2.5 km, R_{JB} = 2.5 km, R_{RUP} = 3.5 km



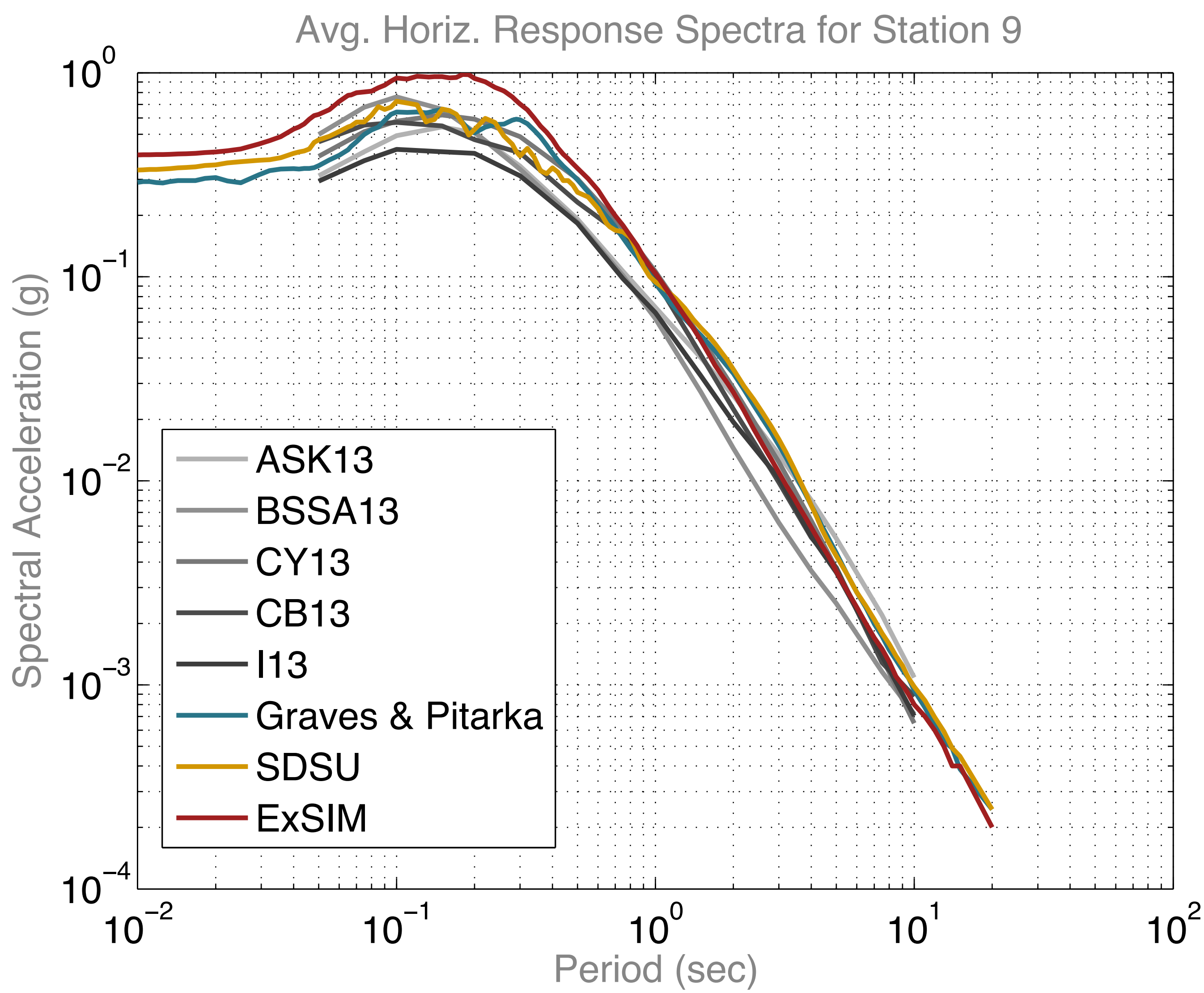
STATION ON FOOTWALL SIDE: R_X = -1.0 km, R_{JB} = 1.0 km, R_{RUP} = 2.7 km



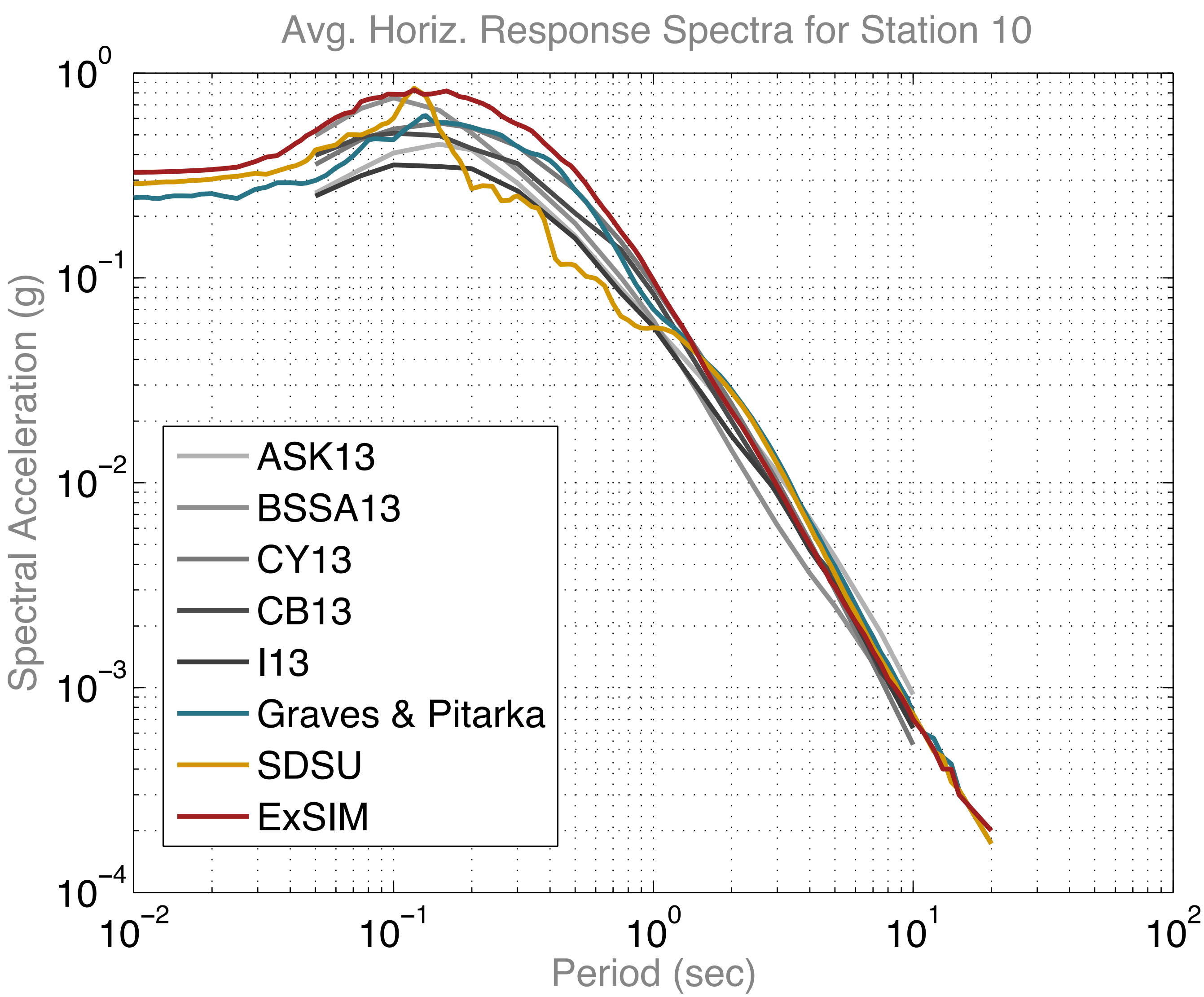
STATION OVER FAULT PLANE: R_X = 1.0 km, R_{JB} = 0.0 km, R_{RUP} = 2.7 km



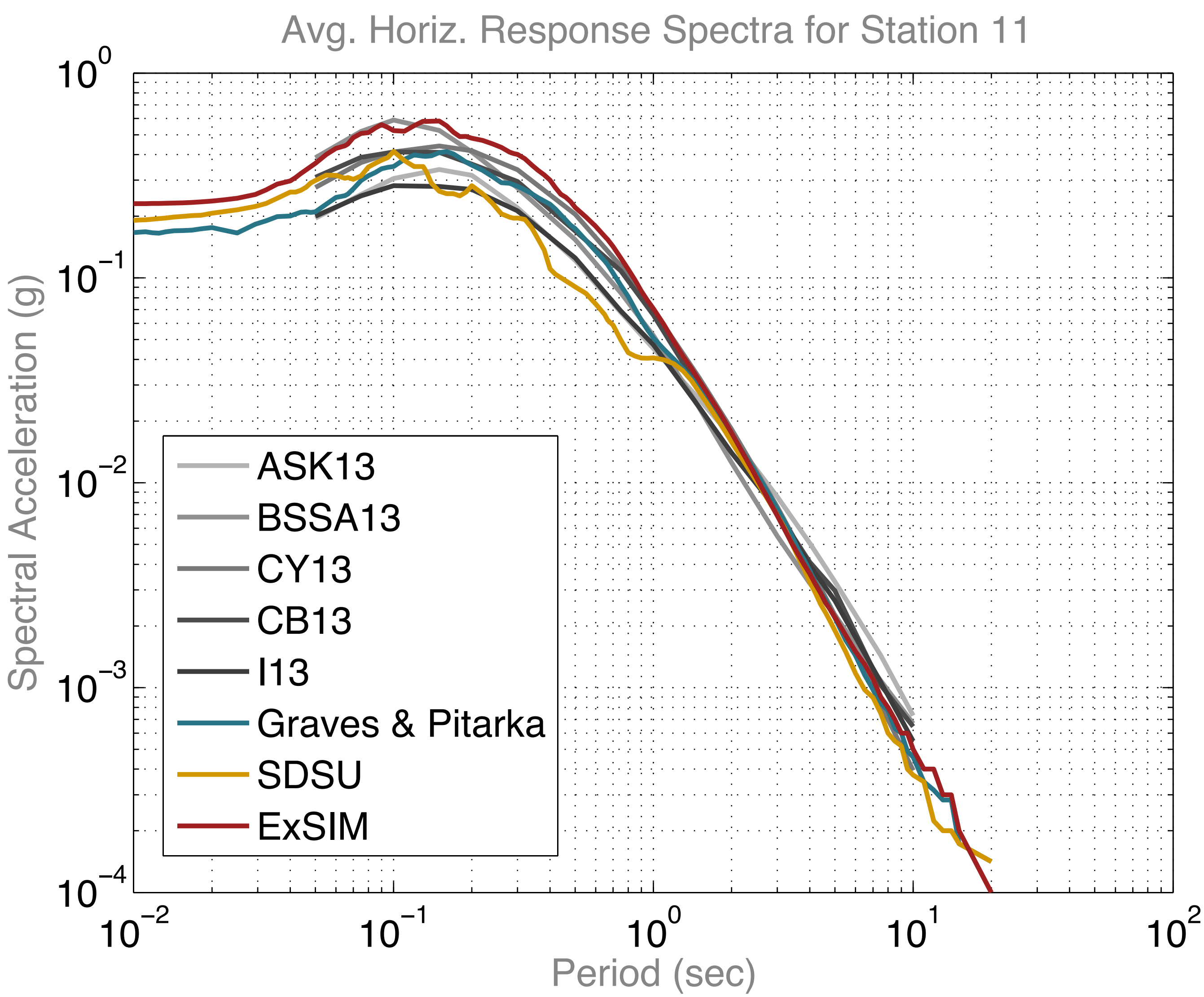
STATION OVER FAULT PLANE: R_X = 2.5 km, R_{JB} = 0.0 km, R_{RUP} = 3.5 km



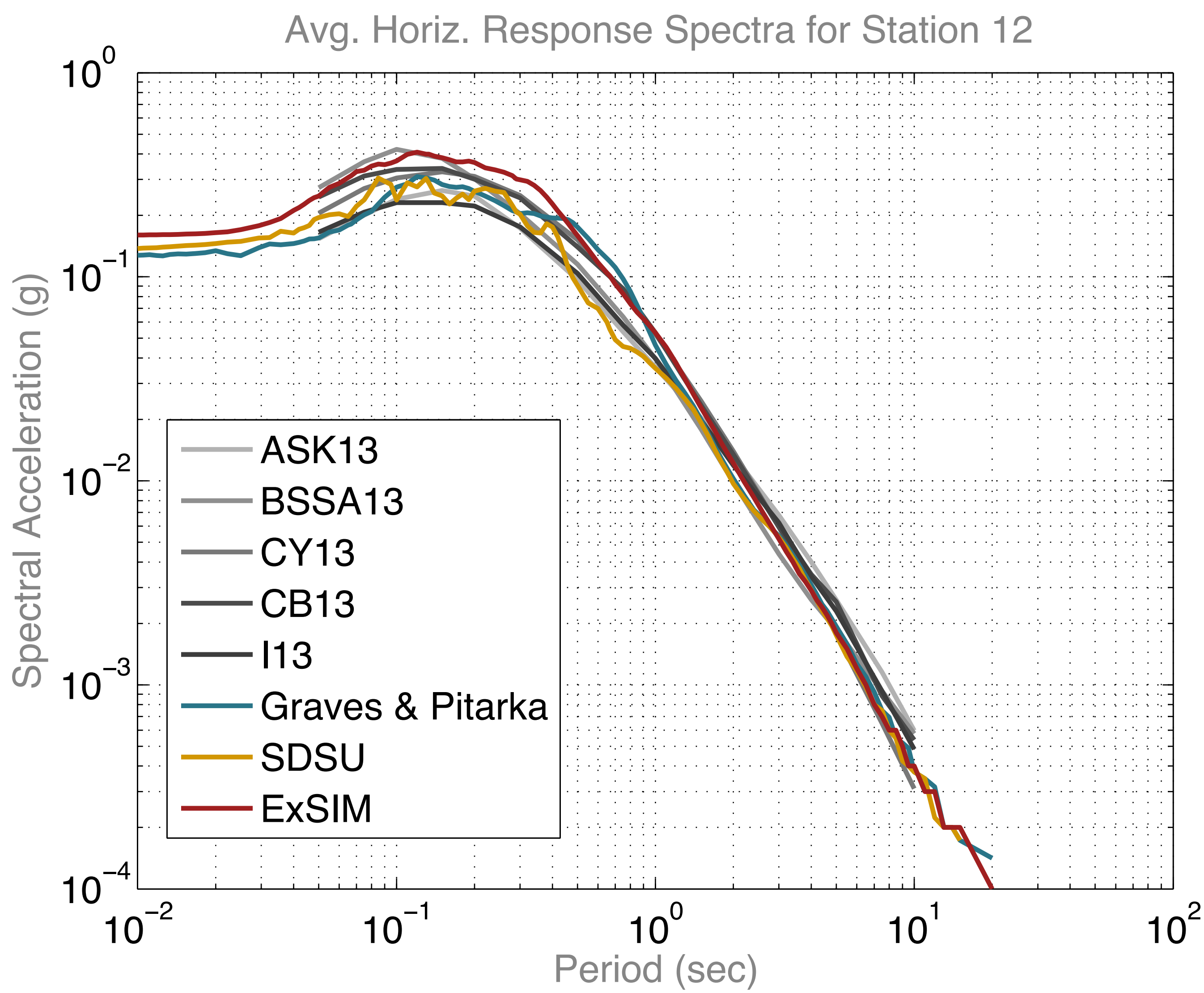
STATION ON HANGING-WALL SIDE: R_X = 4.5 km, R_{JB} = 0.5 km, R_{RUP} = 4.9 km



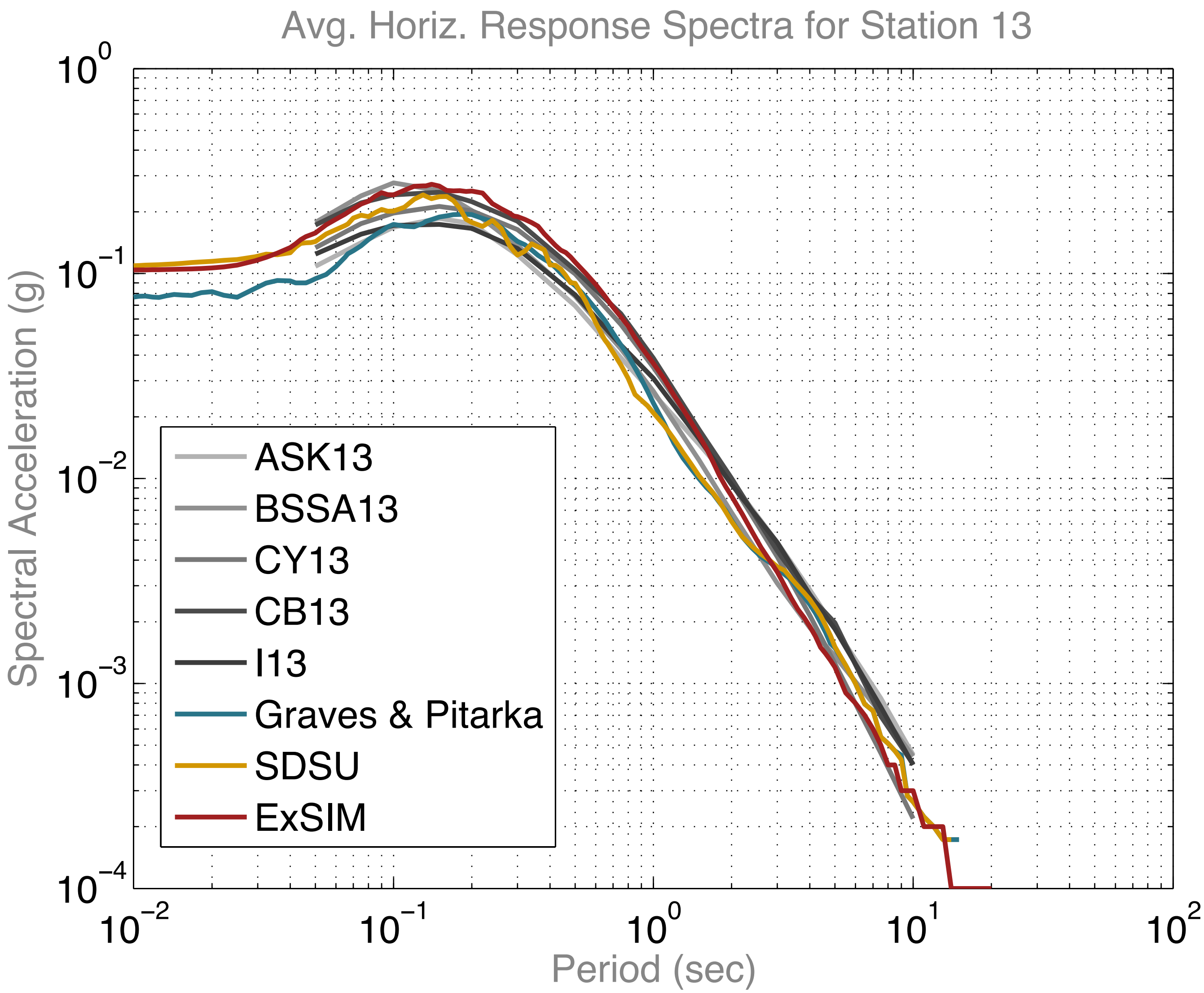
STATION ON HANGING-WALL SIDE: R_X = 7.5 km, R_{JB} = 3.5 km, R_{RUP} = 7.1 km



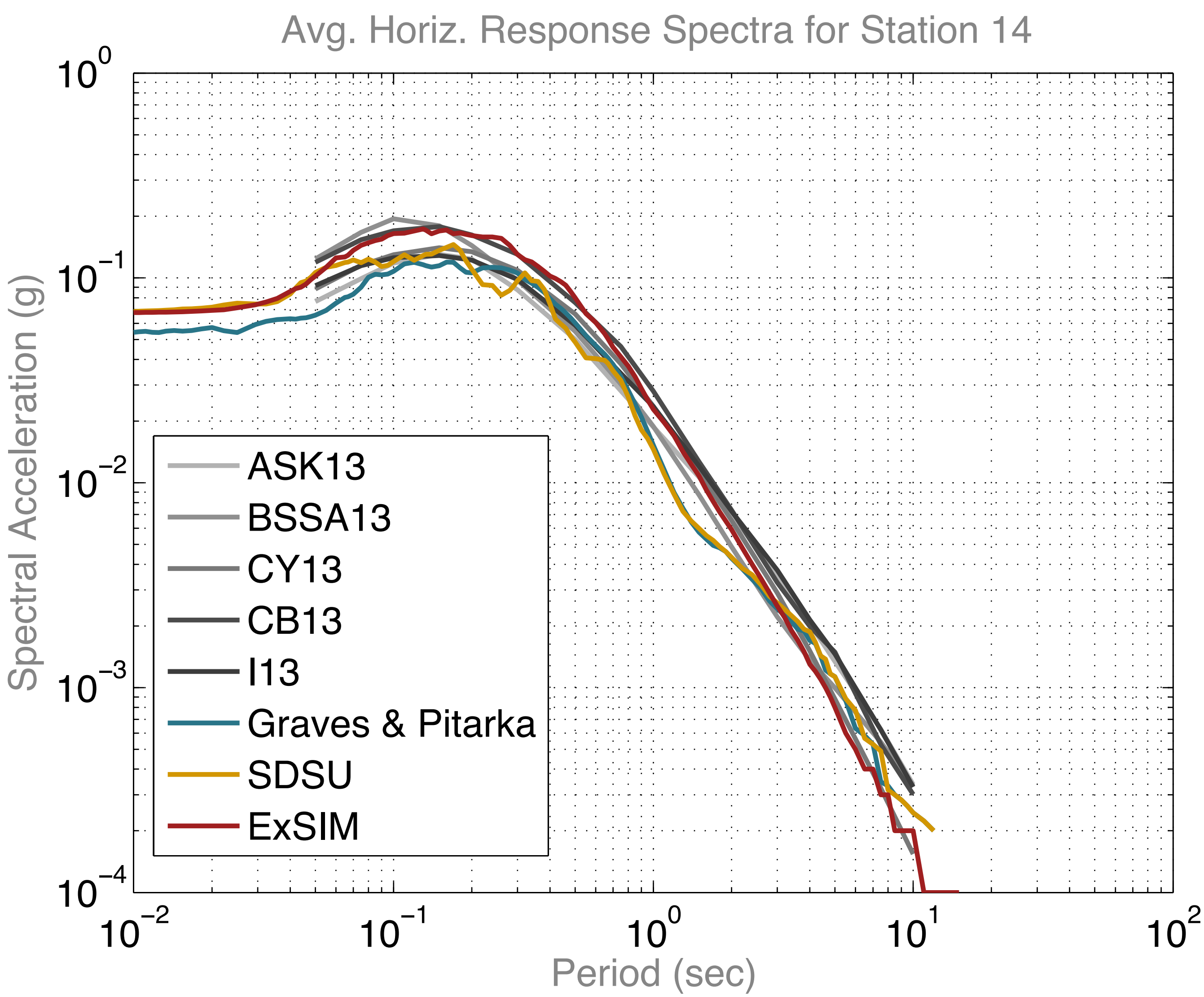
STATION ON HANGING-WALL SIDE: R_X = 10.5 km, R_{JB} = 6.5 km, R_{RUP} = 9.2 km



STATION ON HANGING-WALL SIDE: R_X = 15.0 km, R_{JB} = 11.0 km, R_{RUP} = 12.8 km



STATION ON HANGING-WALL SIDE: R_X = 20.0 km, R_{JB} = 16.0 km, R_{RUP} = 17.3 km



CONCLUSIONS

- Expanding the platform to handle multi-segments faults is very important if we want to use the BBP for forward modeling and validation against past events.

- Need explanation regarding differences between the models.