Behavior of three broadband ground motion simulation techniques for a suite of earthquake scenarios using multiple rupture model generators on the SCEC BBP

GMSV TAG Meeting

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Objectives

- Analyze the behavior of the three broadband simulation methods currently on the SCEC Broadband Platform with their default settings

- Analyze scenario events using both rupture generator methods currently on the SCEC Broadband Platform (GP and UCSB).

- Provide insight as to how the results of the methods, in their most basic, default form, compare given the same input rupture model.

- These insights will serve as a baseline for referencing the future differences observed between models:
  - when default settings are adjusted
  - when forward earthquake simulations are performed

Simulation Techniques Considered

- GP (Graves and Pitarka, 2010)
- UCSB (Schmedes et al., 2010, 2011; Liu, 2006)
- SDSU-ETH (Mai et al., 2010; Mena et al., 2010)

Caveats

- The UCSB and SDSU techniques have not been finalized.
  - UCSB: updating frequency dependent Q scheme (new Green's functions) and corner frequency/source time function
  - SDSU: changes to code base in progress (scaling procedures)
- Final "frozen" versions of these codes should be provided soon, and this analysis can be re-done. For this reason, only results from the first earthquake scenario are presented.

Metrics for Comparing Results

1. "Ratio" = the natural log of the ratio of RotD50 Sa at a given period (*T*) calculated from one simulation technique relative to another.

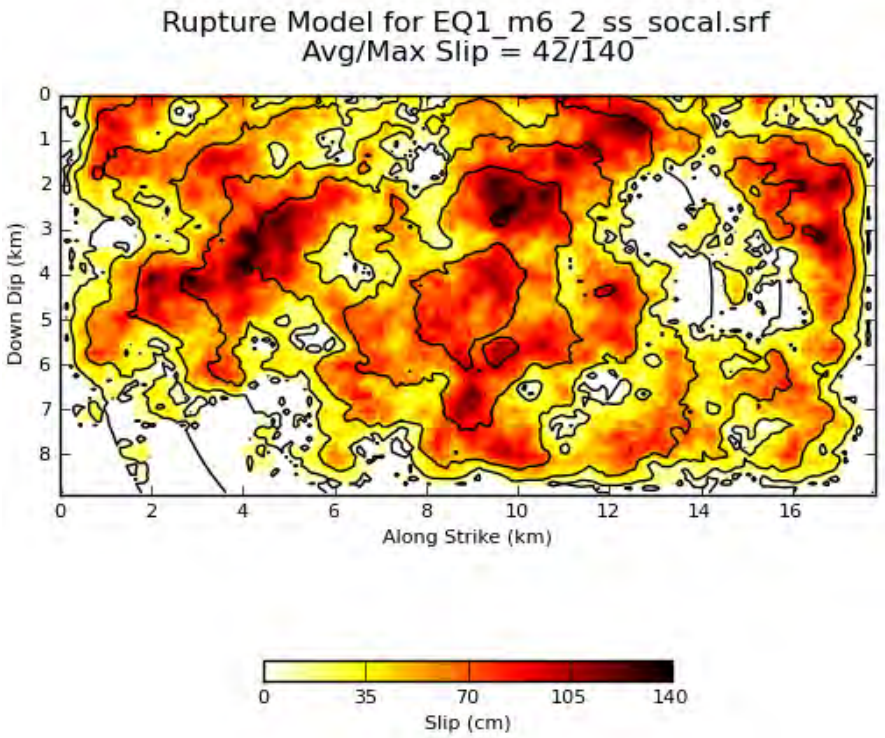
   – Averaged over all 60 recording stations and plotted versus period (similar to GOF).
   – Plotted spatially for each station, given T.

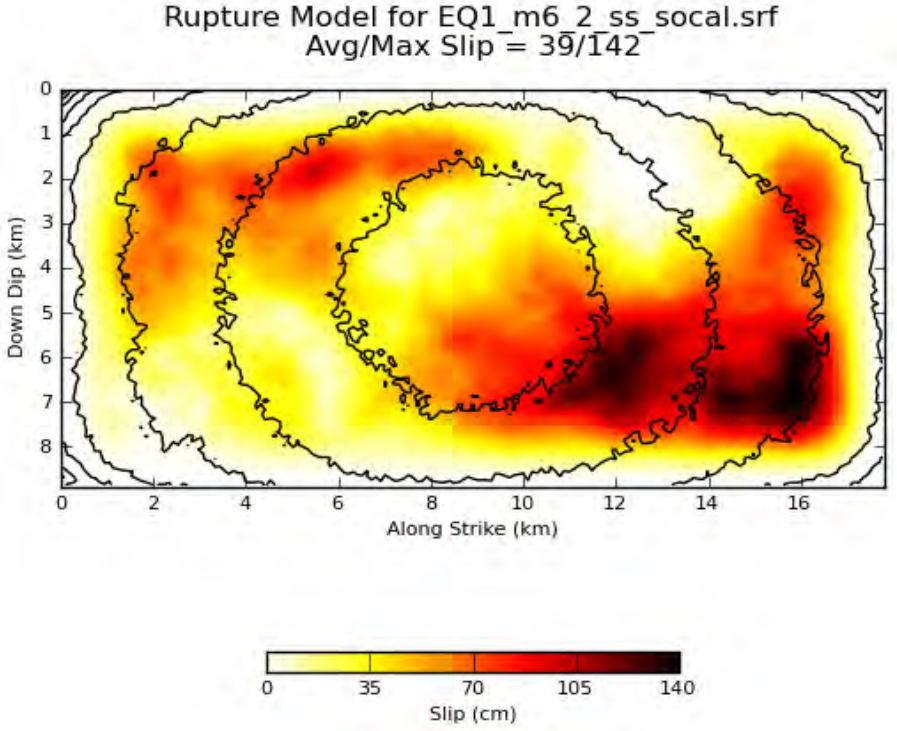
2. GMPE residuals: average of the four NGA-West1.

   – Plotted spatially, given T.

EQ1: M6.2 Strike-Slip in So-Cal

L=17.8; W=8.9; strike=0; rake=180; dip=90





GP rupture generator

UCSB rupture generator

Very different!

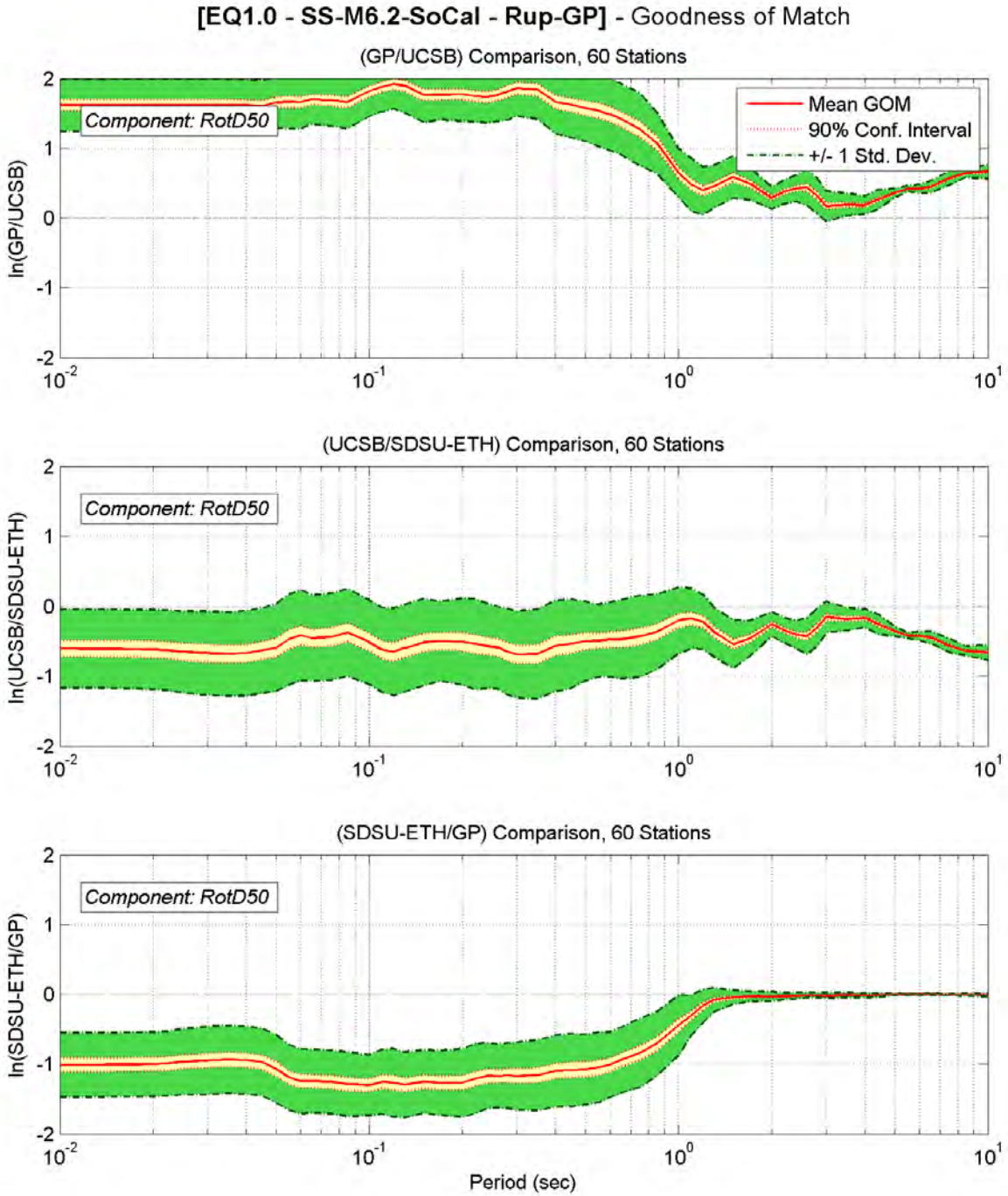
1. Simulation Technique “Ratios”

(GP Rupture)

ln(GP/UCSB)

ln(UCSB/SDSU)

ln(SDSU/GP)



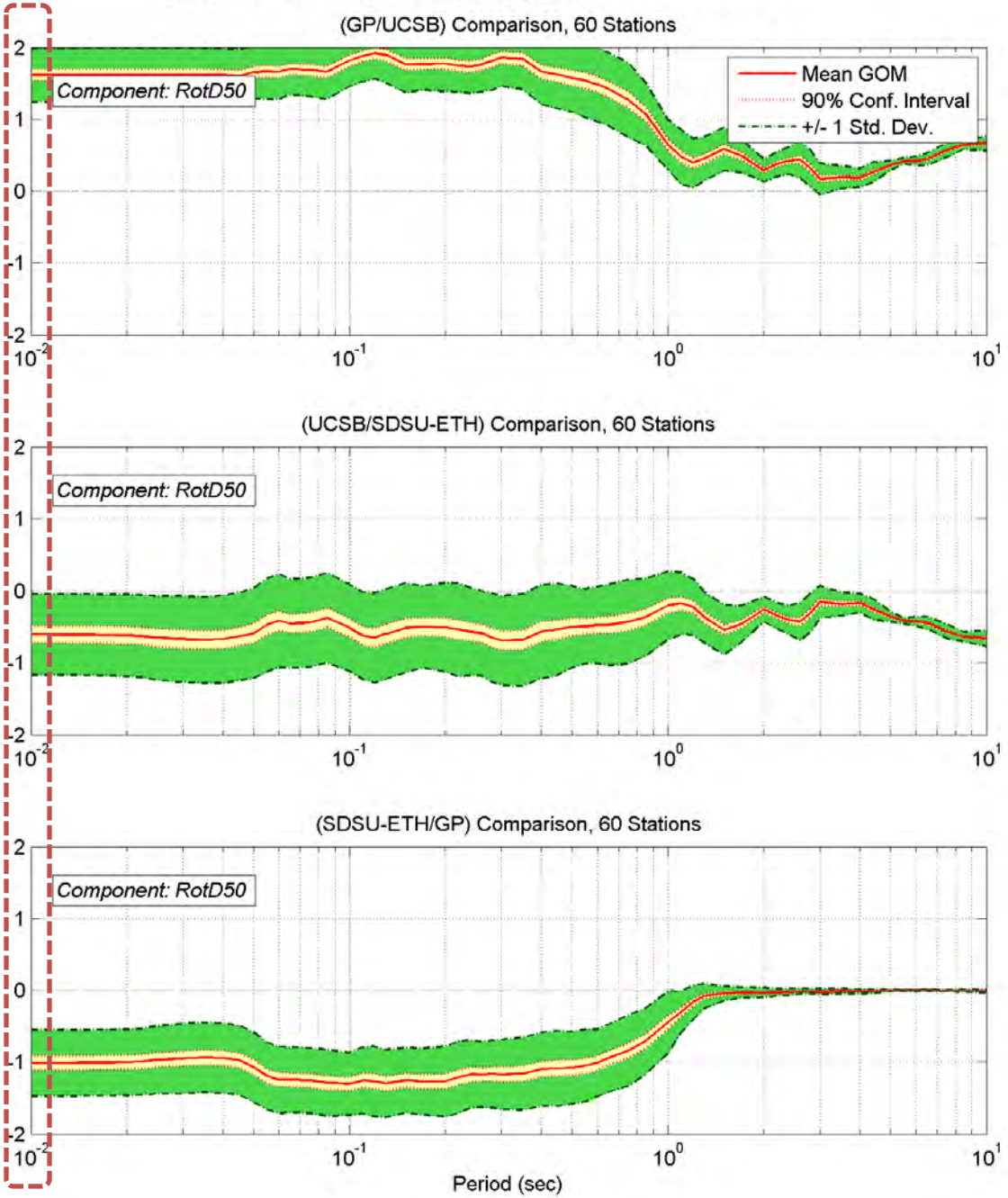
[EQ1.0 - SS-M6.2-SoCal - Rup-GP] (GP Rupture)

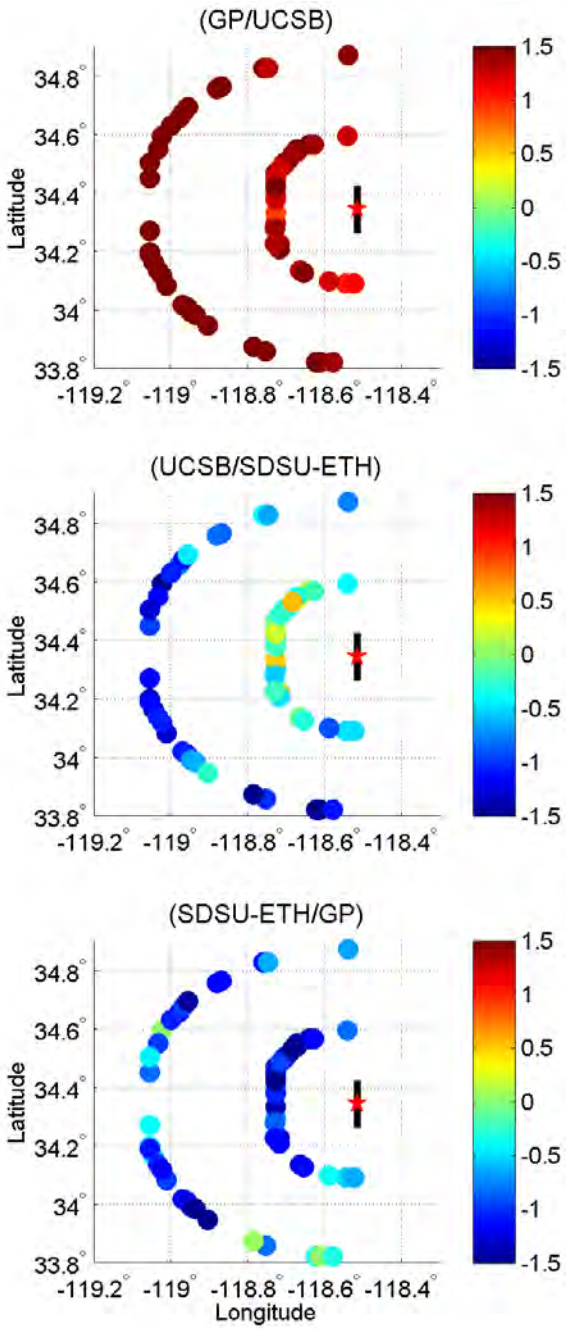
PGA

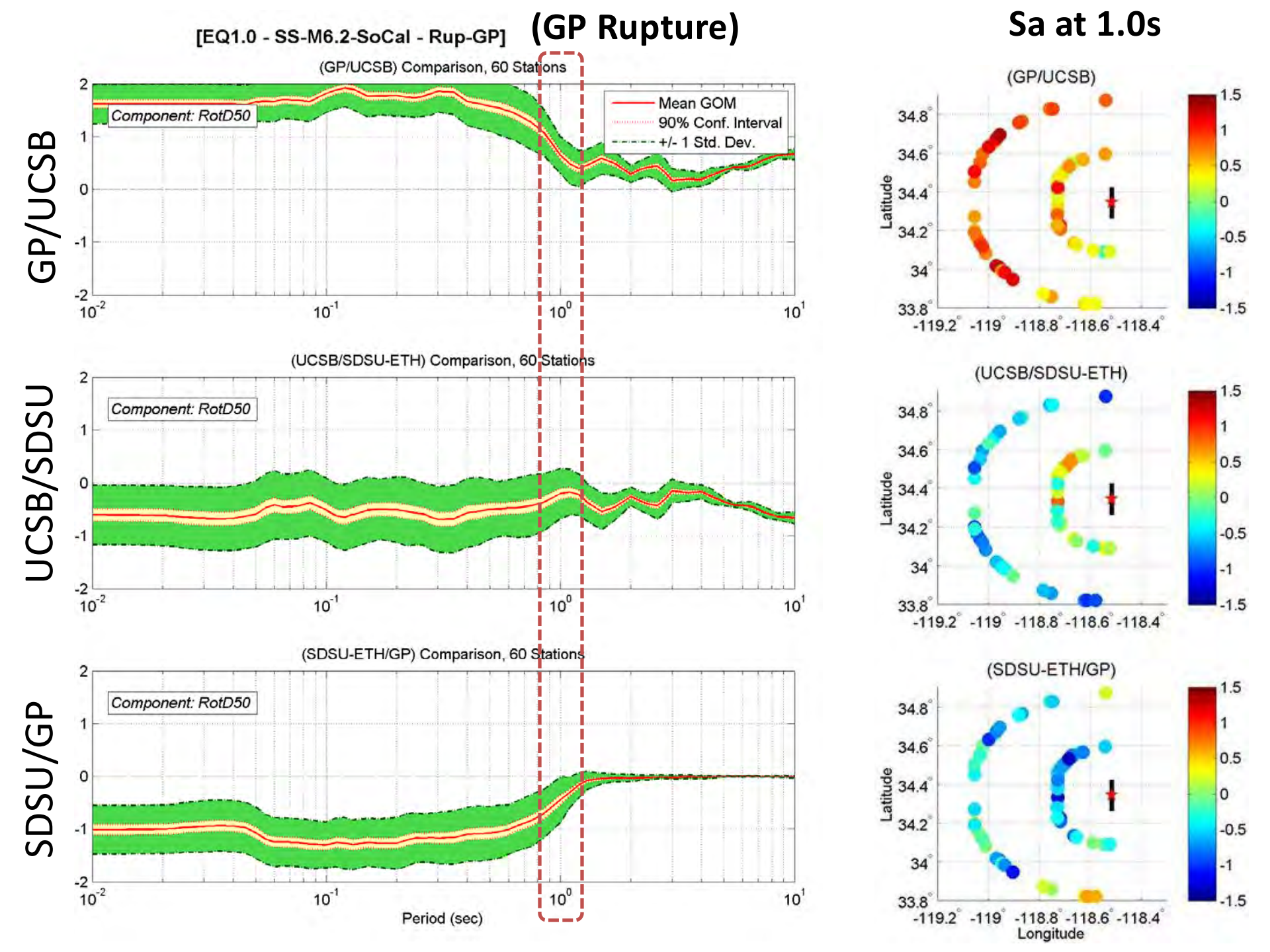
GP/UCSB

UCSB/SDSU

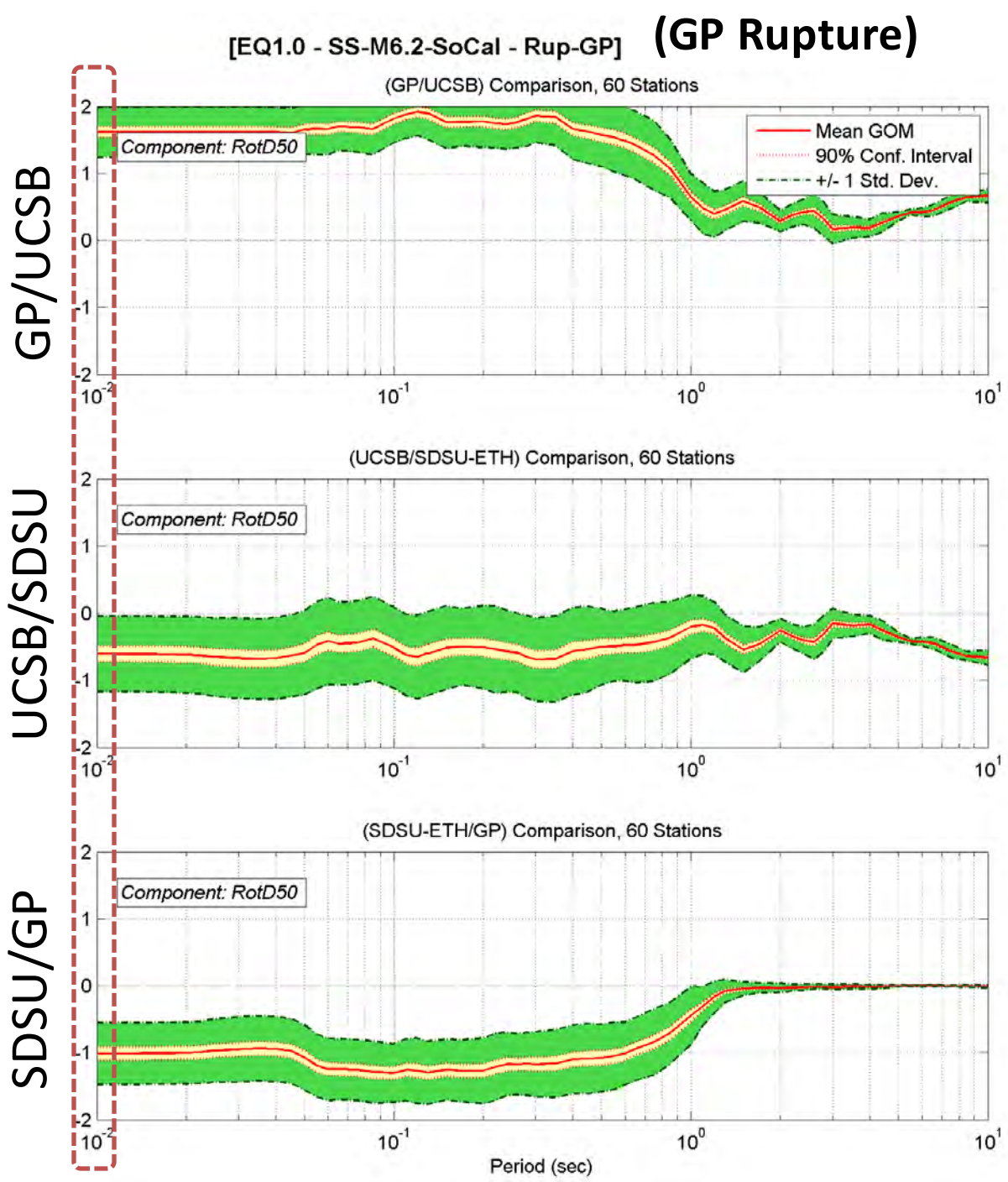
SDSU/GP

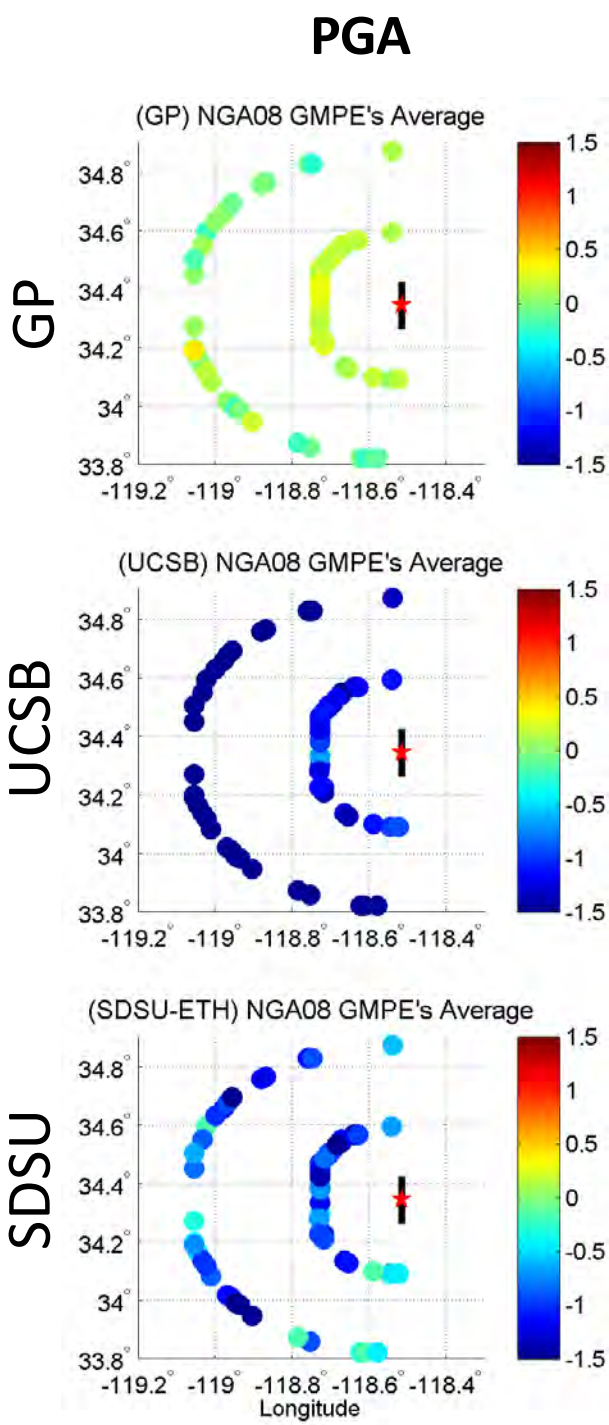


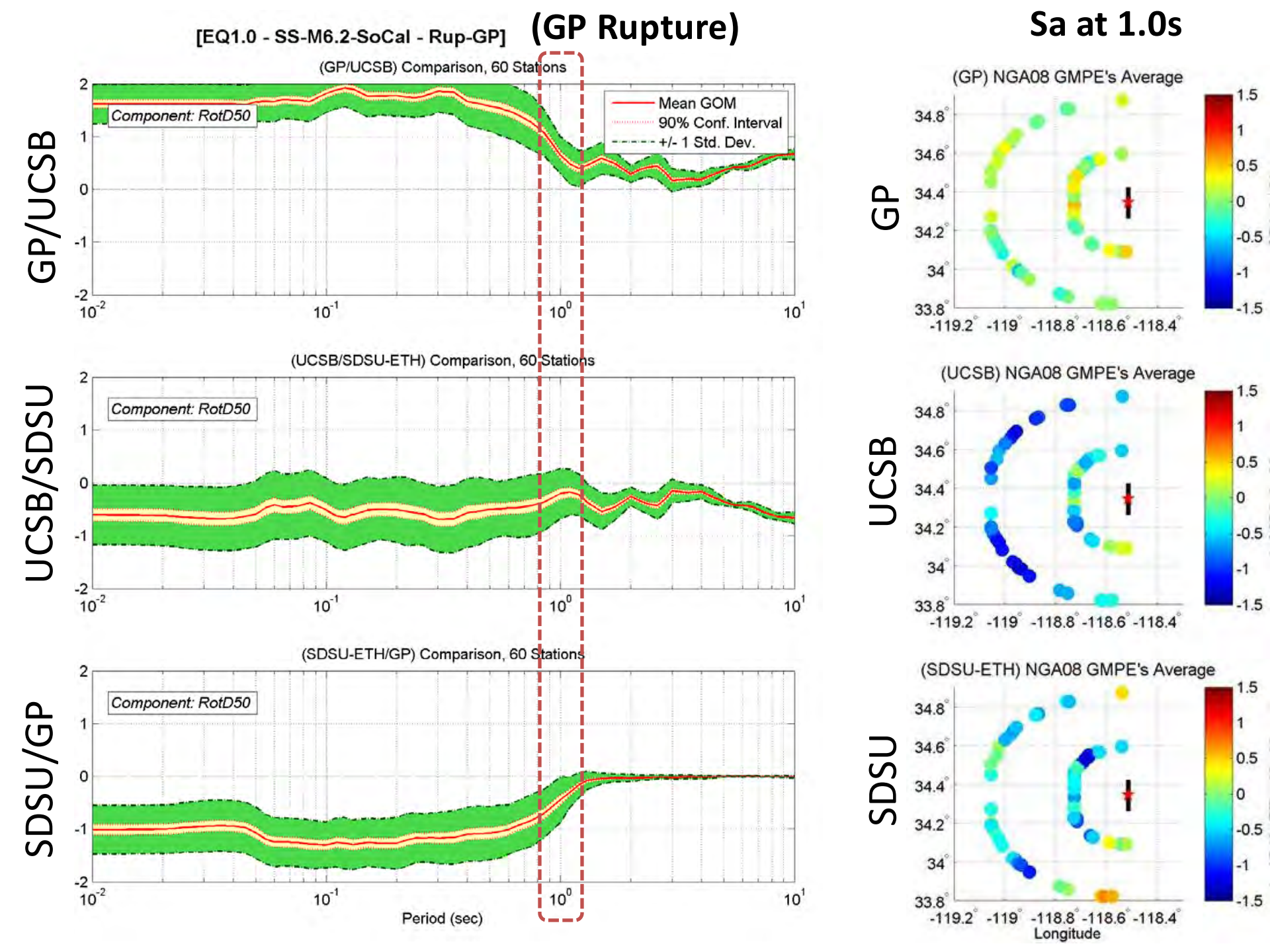



[EQ1.0 - SS-M6.2-SoCal - Rup-GP]
(GP Rupture)
Sa at 1.0s
GP/UCSB
UCSB/SDSU
SDSU/GP
(GP/UCSB) Comparison, 60 Stations
(UCSB/SDSU-ETH) Comparison, 60 Stations
(SDSU-ETH/GP) Comparison, 60 Stations
Component: RotD50
Mean GOM
90% Conf. Interval
+/- 1 Std. Dev.
Period (sec)
Latitude
Longitude

2. GMPE Residuals


[EQ1.0 - SS-M6.2-SoCal - Rup-GP]
(GP Rupture)
GP/UCSB
(GP/UCSB) Comparison, 60 Stations
Component: RotD50
Mean GOM
90% Conf. Interval
+/- 1 Std. Dev.
UCSB/SDSU
(UCSB/SDSU-ETH) Comparison, 60 Stations
Component: RotD50
SDSU/GP
(SDSU-ETH/GP) Comparison, 60 Stations
Component: RotD50
Period (sec)


PGA
GP
(GP) NGA08 GMPE's Average
UCSB
(UCSB) NGA08 GMPE's Average
SDSU
(SDSU-ETH) NGA08 GMPE's Average
Longitude


[EQ1.0 - SS-M6.2-SoCal - Rup-GP]
(GP Rupture)
Sa at 1.0s
GP/UCSB
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(GP/UCSB) Comparison, 60 Stations
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(GP) NGA08 GMPE's Average
(UCSB) NGA08 GMPE's Average
(SDSU-ETH) NGA08 GMPE's Average
GP
UCSB
SDSU
Longitude

General Comments

Model Comparisons

- Techniques are most different at short T (peak between 0.1 - 1.0 s)
- GP: larger predictions than the other two at T < 1.0s
- Longer Period (T > 1.0s) behavior more closely matches

GMPE residuals

- Generally better predictions on 20km track than 40km for all models
- SDSU: interesting behavior in “directivity zones”

Rupture Generators (not shown)

- *Overall trends* of results are similar between GP and UCSB rupture models for EQ1:
  - Shape of ratio plots are similar, differences more extreme
  - Predictions different on north and south ends of fault (likely due to asymmetric rupture model)