Results of the new set of forward finite-fault simulations to address splay ruptures

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Overview

- Purpose
- Scenarios
- Approach
- Results
- Conclusions

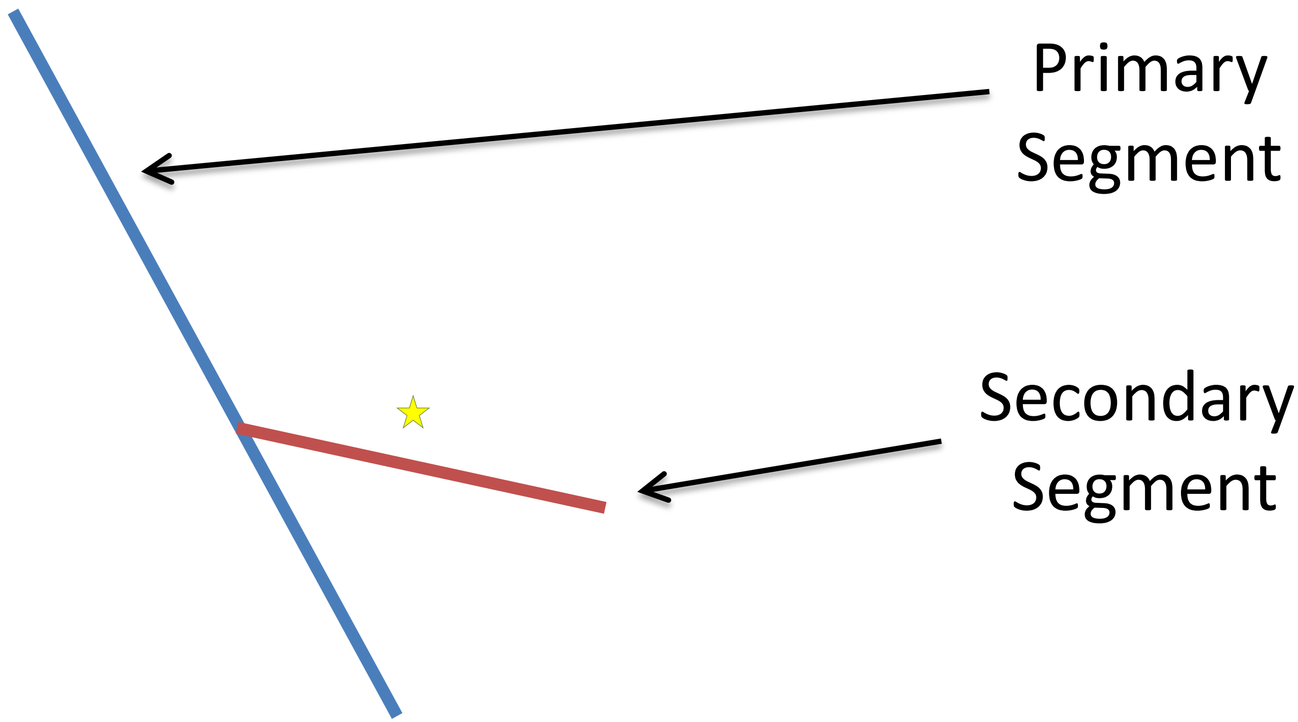
Purpose

- To address the technical issue of how to adjust GMPEs in important ranges for complicated ruptures; areas where there is very little recorded data.

- At DCPP, changes in geometry and faulting style are located near the site, where the definition of many GMPE input parameters (including dip, rake, depth, distance, magnitude etc.) are unclear.

- We consider multiple methods for defining GMPE input parameter rules for splay faulting adjustments
  - These methods are compared using the simulation results as a guide
  - Comparisons covered by Katie Wooddell in the next talk

Terminology
for Splay Faults

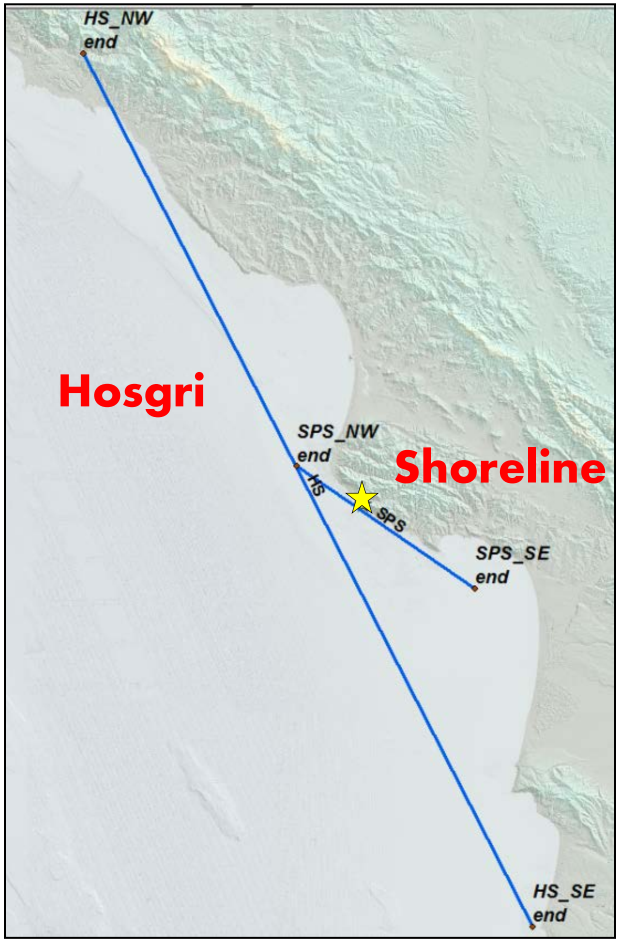


Separate simulation for each segment.

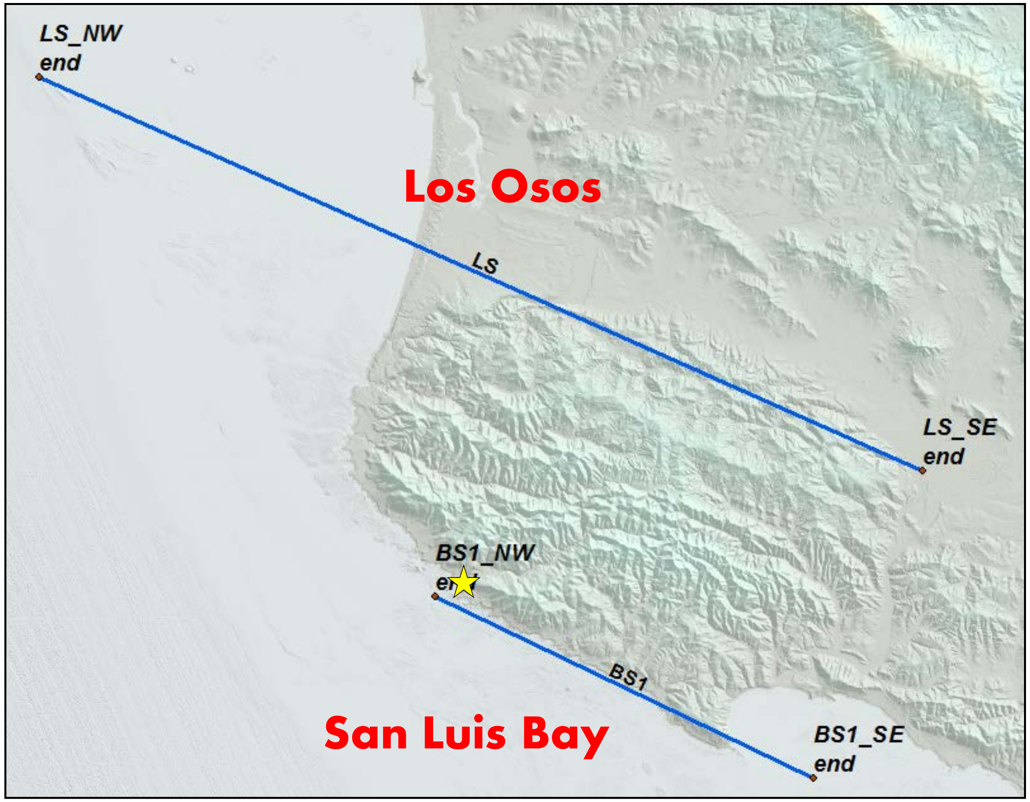
Splay Scenarios

(each with 32 randomized realizations, for Mw 7.0, 7.2, 7.4)

1. Hosgri-Shoreline



2. Los Osos-San Luis Bay



Splay Scenarios

- Simulations were performed for each segment separately (primary and secondary)

- Three simulation methods: GP, SDSU, EXSIM

- Waveforms combined in the time domain
  - With appropriate time lag based on hypocenter location

- RotD50 computed from 2 horizontal components

- Take the average of 32 realizations

- Compute the ln ratio of the Combined to Primary segment
  - Compare this ratio with GMPEs (Next Talk)

Splay Scenarios

Broadband Platform Source described by:

Mw, Strike, Dip, Rake, Dimensions, Hypocenter Location

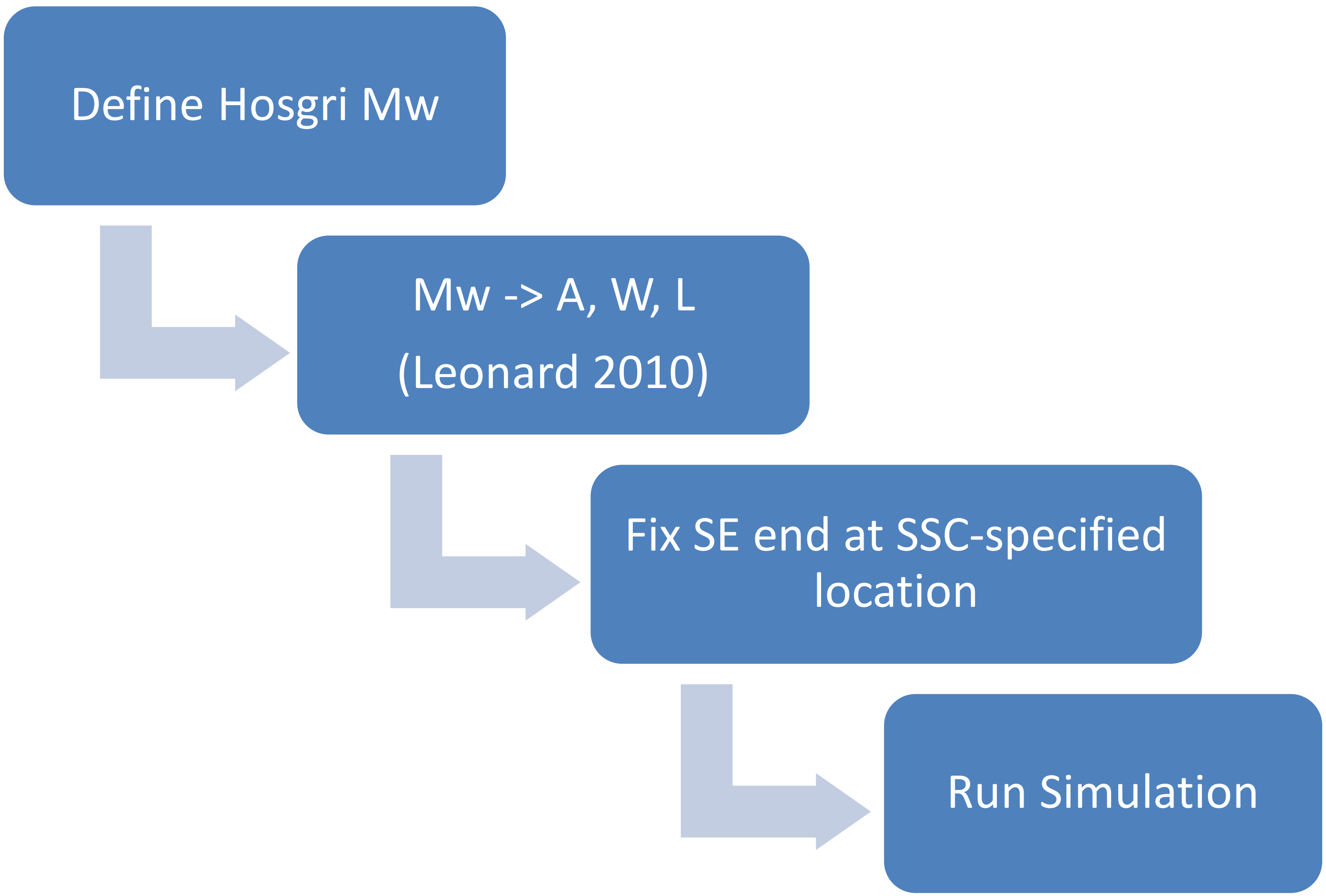
Scenarios were defined by considering a combination of factors:

- The SSC team recommendations for Mw, Location, style of faulting, etc.
- Compatibility with validated BBP simulations methods
  (Leonard 2010)
- Meaningful contributions to research goals
  (bumped up Mw for secondary faults in order to have relevant impact)

Splay 1: Hosgri – Shoreline

Method for Determining Scenario Properties

<u>Hosgri (Primary Segment)</u>



Splay 1: Hosgri – Shoreline

Method for Determining Scenario Properties

Shoreline (Secondary Segment)

Compute avg slip from Hosgri sims

Scale Hosgri slip by 30%, use this slip for Shoreline (secondary)

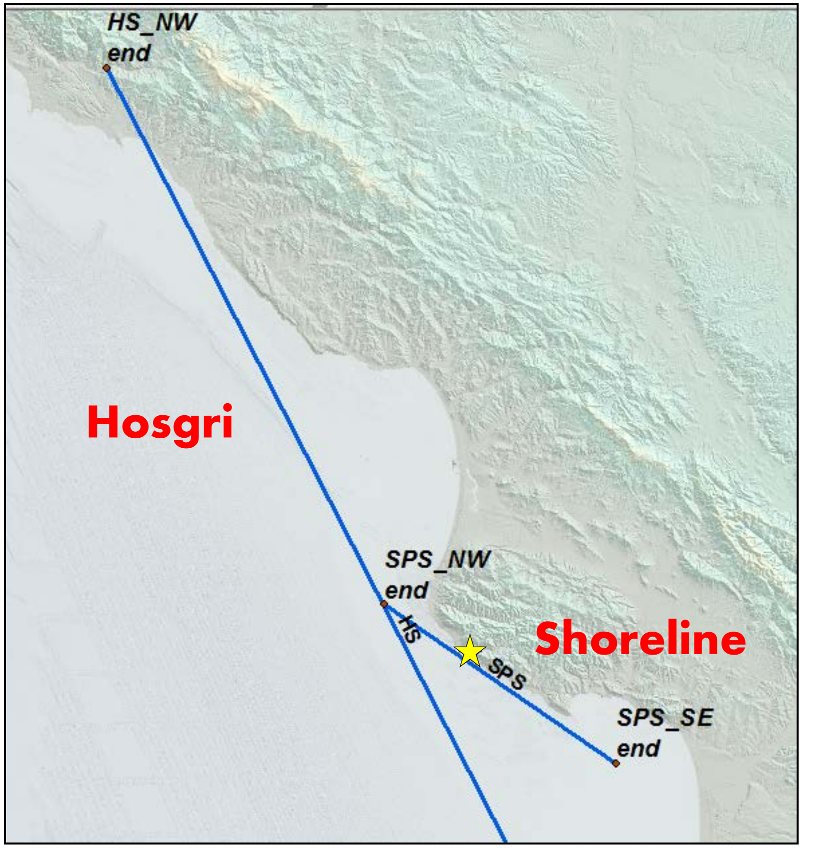
Slip→ L→ W→ A→ Mw (Leonard 2010)

Fix NW end at Hosgri intersection

Run Simulation

Splay 1: Hosgri - Shoreline

This presentation will focus on the
Hosgri Mw=7.4, Shoreline Mw=6.43 case

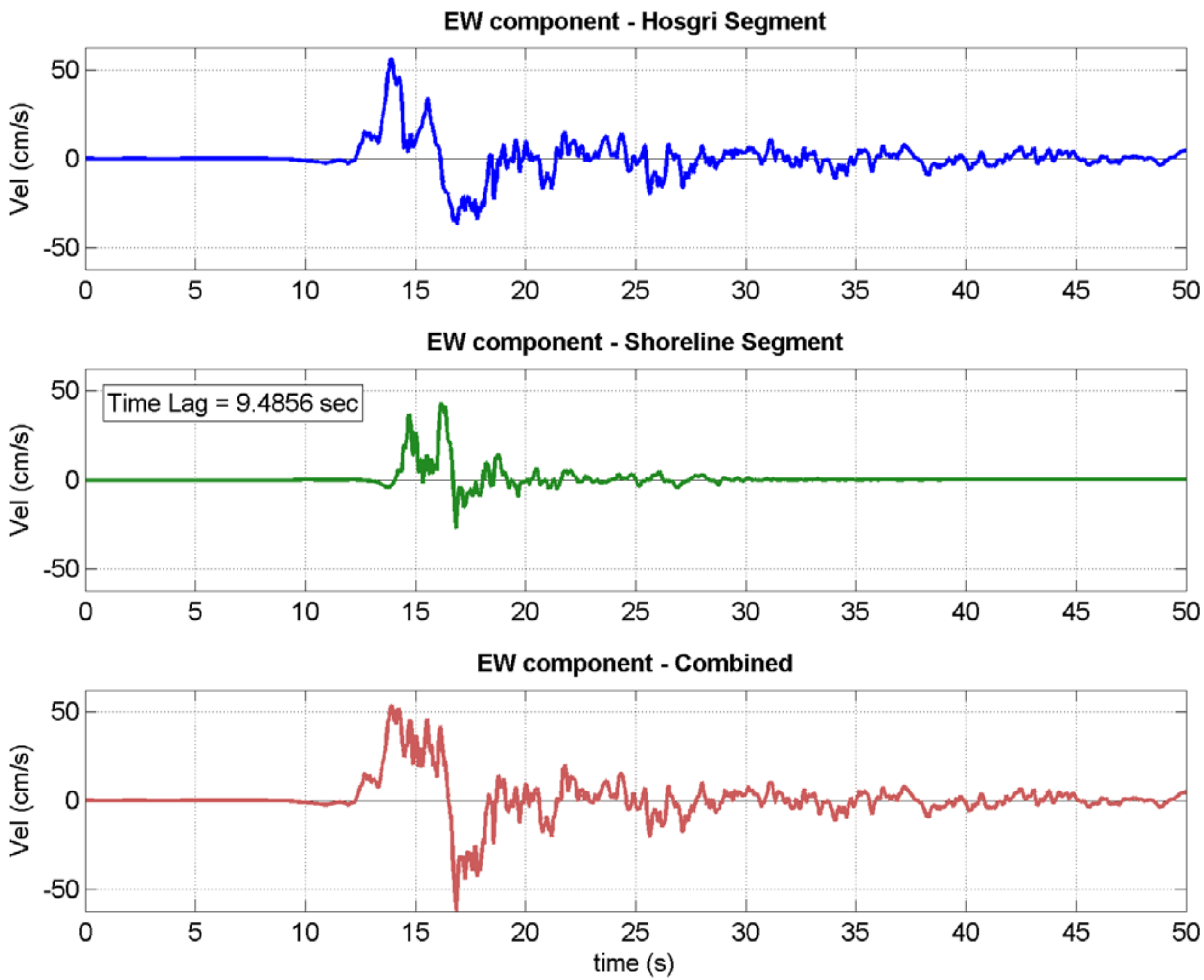


Segment	Rrup	Rjb	Rx
Hosgri	5.1	5.1	5.1
SL	0.66	0.66	0.66

Segment	Mw	Strike	Rake	Dip	Ztor	L	W
Hosgri	7.4	334.2	180	90	0	114.18	22.0
SL	6.43	305.7	180	90	0	22.44	11.93

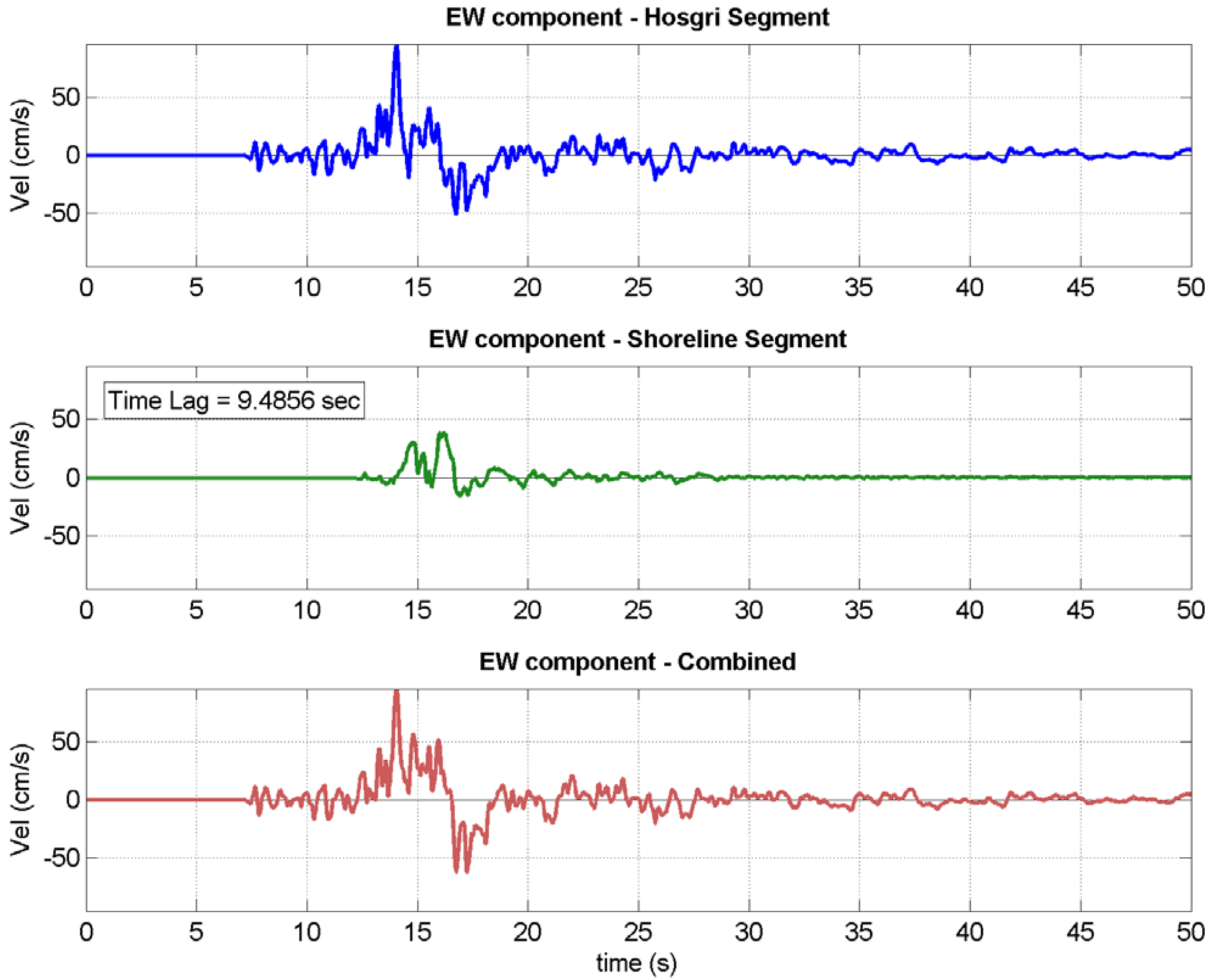
Splay 1: Hosgri – Shoreline

Example Waveforms - (GP Method, Realization 18)



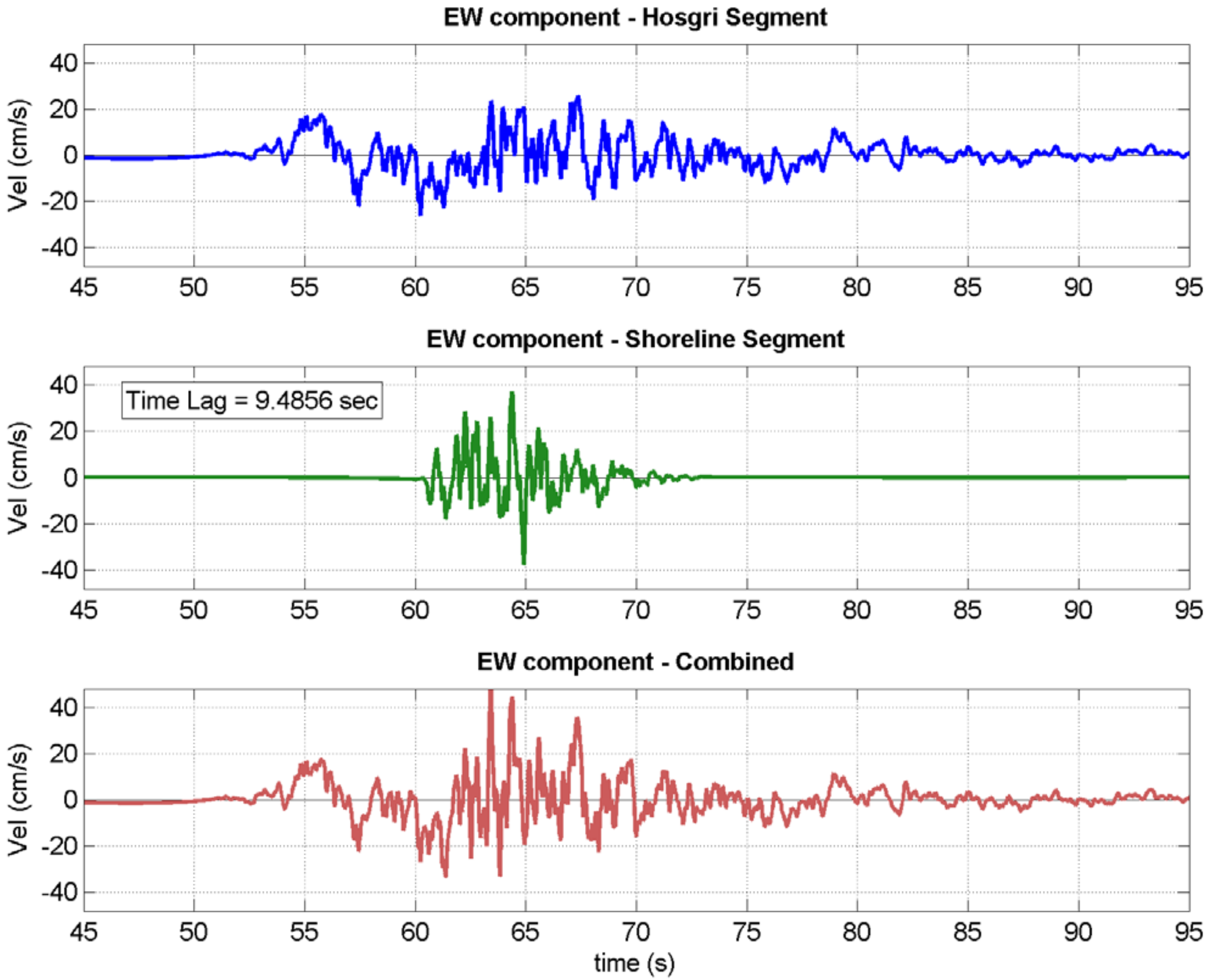
Splay 1: Hosgri – Shoreline

Example Waveforms - (SDSU Method, Realization 18)



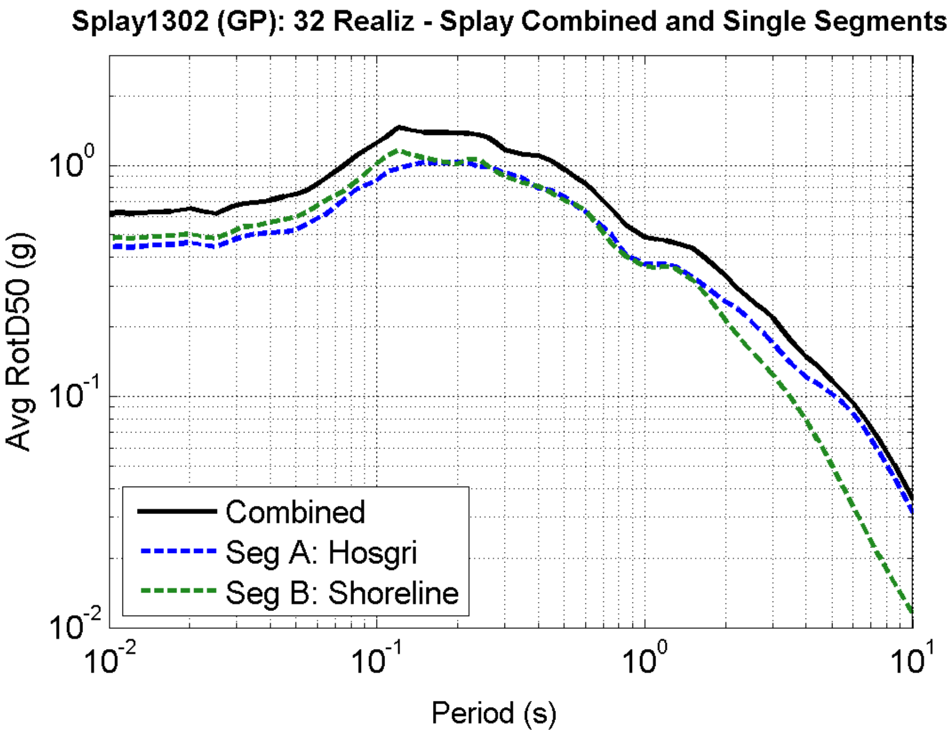
Splay 1: Hosgri – Shoreline

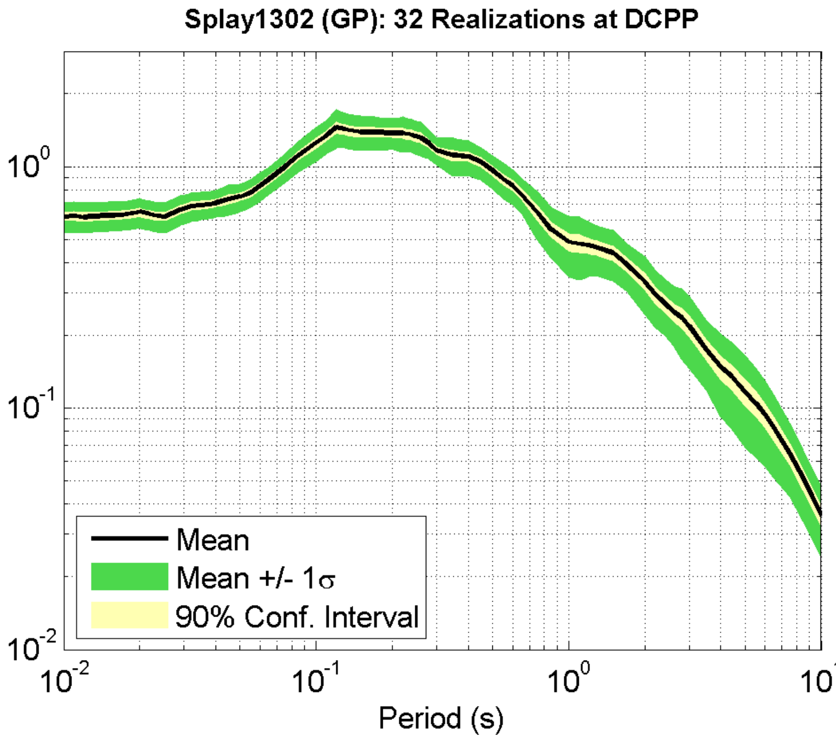
Example Waveforms - (ExSim Method, Realization 18)



Splay 1: Hosgri - Shoreline

Results - GP



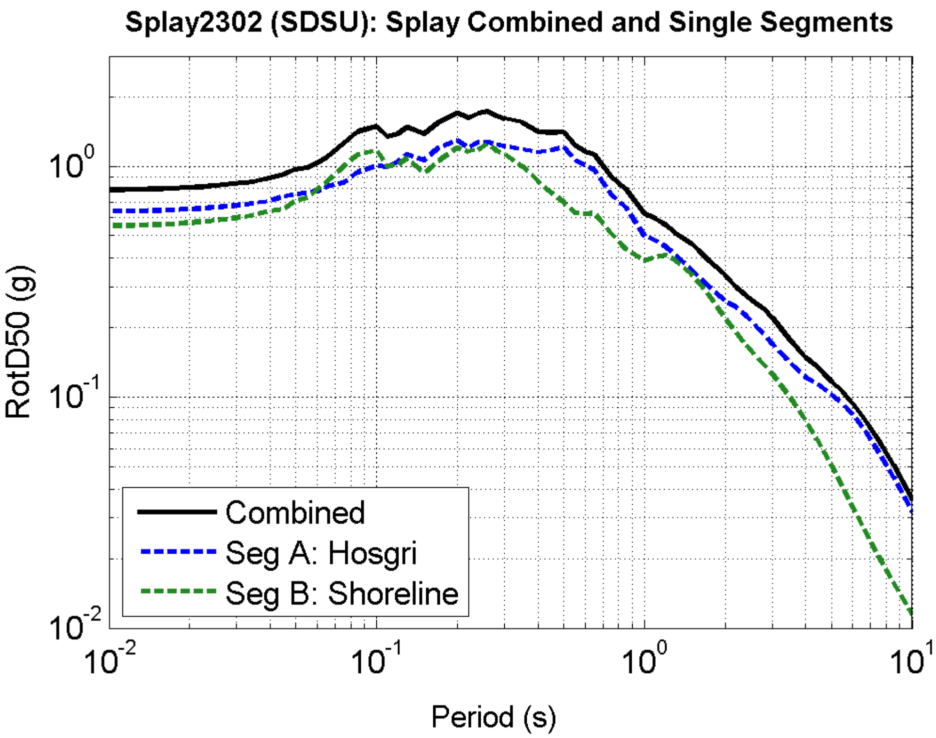


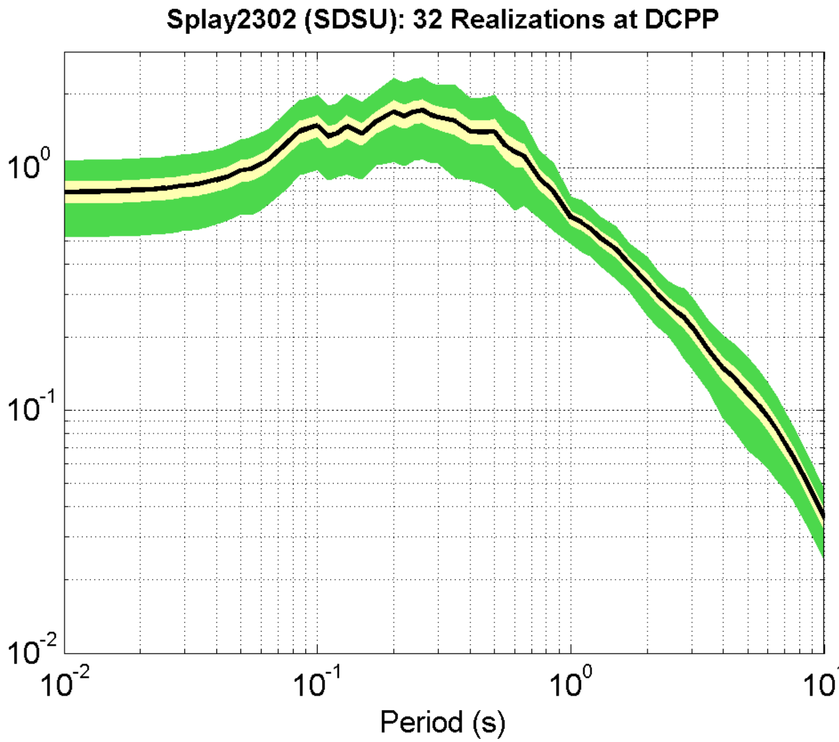
Segment A: Hosgri Mw=7.4, R=5.1

Segment B: Shoreline Mw=6.43, R=0.66

Splay 1: Hosgri - Shoreline

Results - SDSU



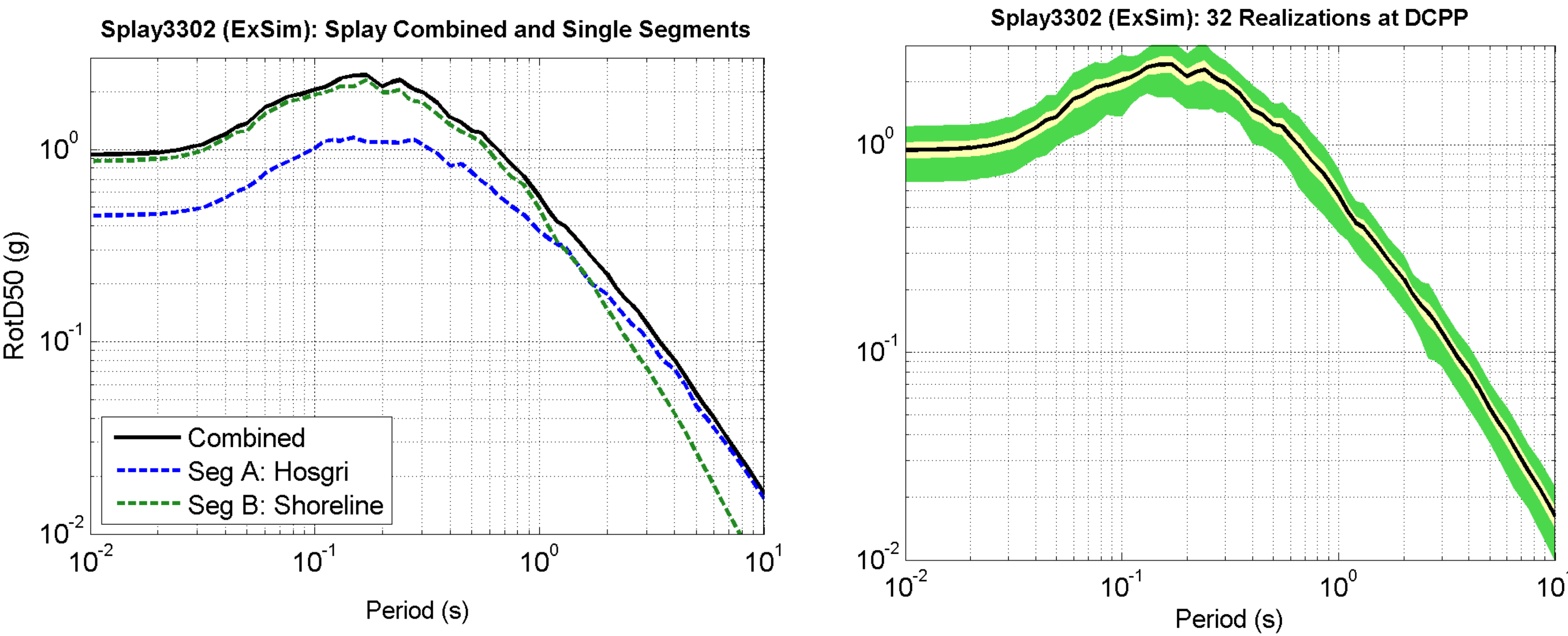


Segment A: Hosgri Mw=7.4, R=5.1

Segment B: Shoreline Mw=6.43, R=0.66

Splay 1: Hosgri - Shoreline

Results - ExSim

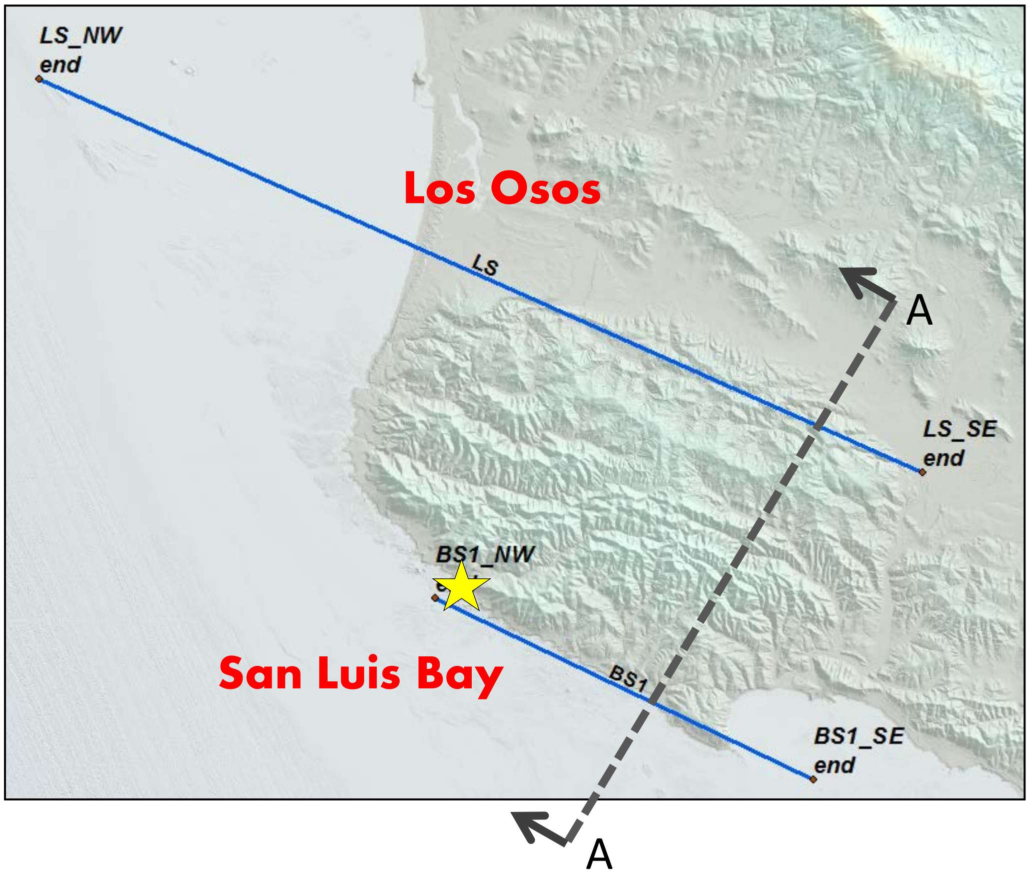


Segment A: Hosgri Mw=7.4, R=5.1

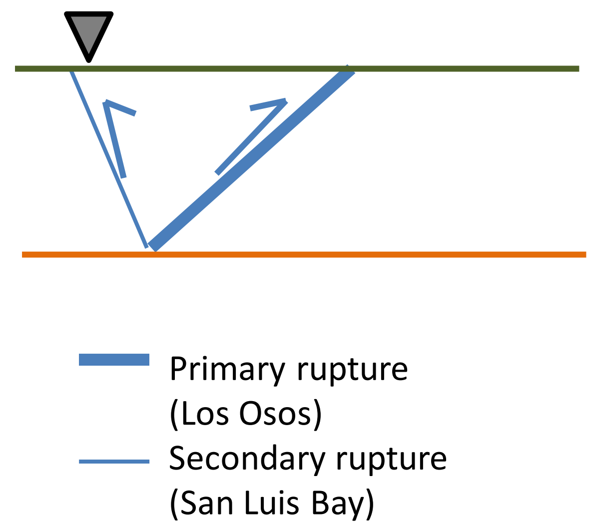
Segment B: Shoreline Mw=6.43, R=0.66

Splay 2: Los Osos – San Luis Bay

Geometry



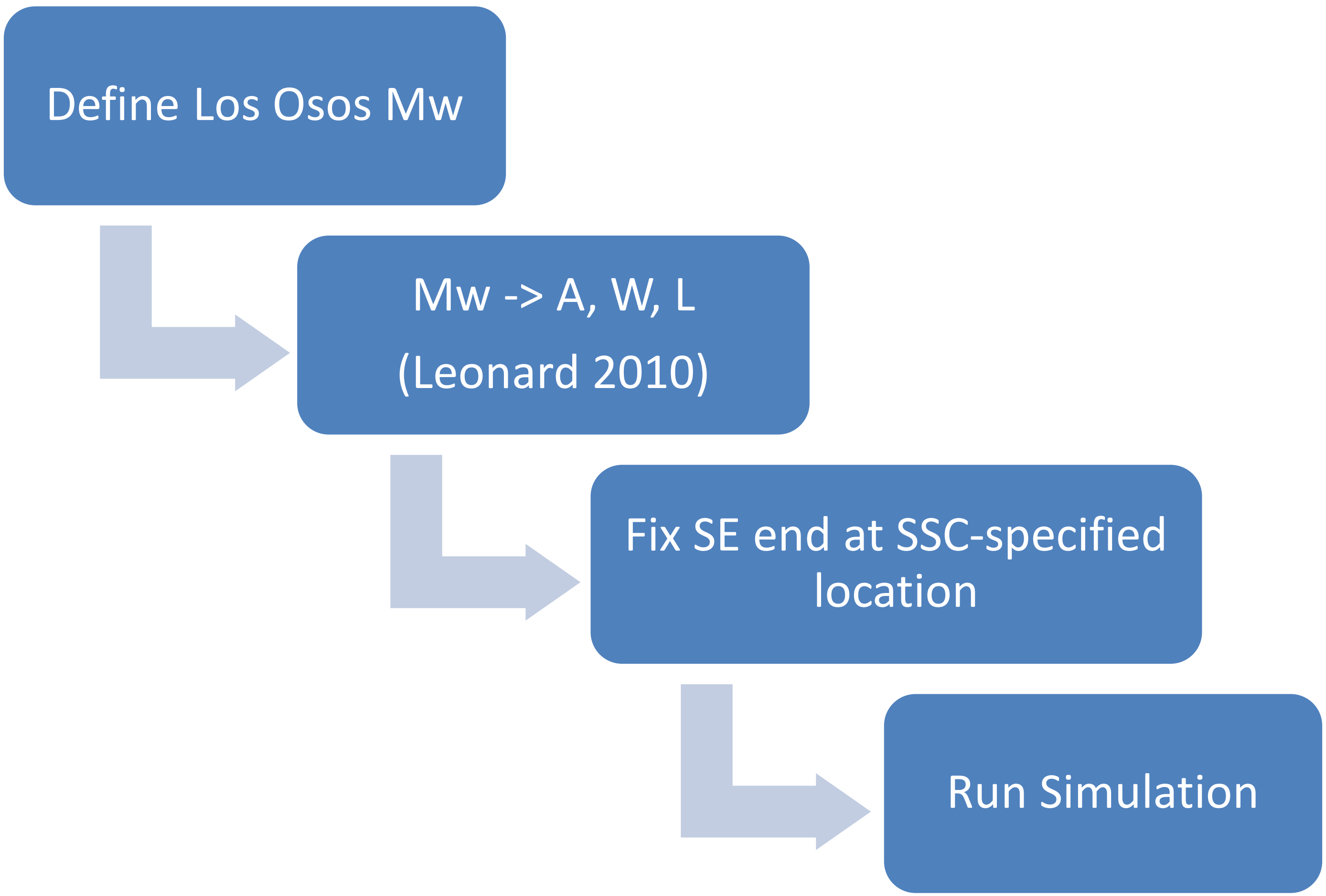
Cross-section A-A:



Splay 2: Los Osos – San Luis Bay

Method for Determining Scenario Properties

Los Osos (Primary Segment)



Splay 2: Los Osos – San Luis Bay

Method for Determining Scenario Properties

<u>SLB (Secondary Segment)</u>

1. W=12.7 km fixed from SSC recommendations
2. W→ L→ A→ Mw (Leonard 2010)
3. Fix SE end at SSC-specified location
4. Run Simulation

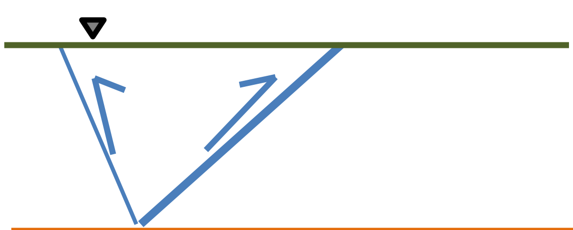
Splay 2: Los Osos – San Luis Bay

Summary of Scenario Properties

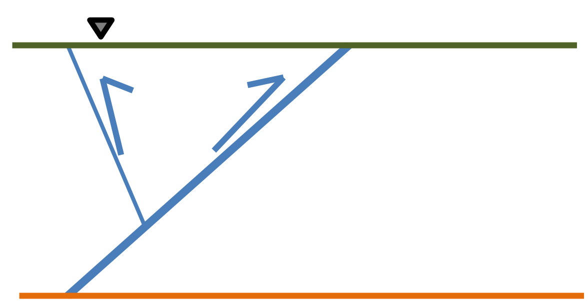
- SLB using fixed SSC defined W=12.7 km
  - Leonard (2010): Mw=6.39, L=19.55 km

- LO (primary) using Mw= 7.0, 7.2, 7.4
  - Leonard gives: W=22, 26.6, 32 km respectively
  - SLB slip is 50% , 40%, 32% of LO slip, respectively
  - LO extends beyond depth of SLB

So instead of this:

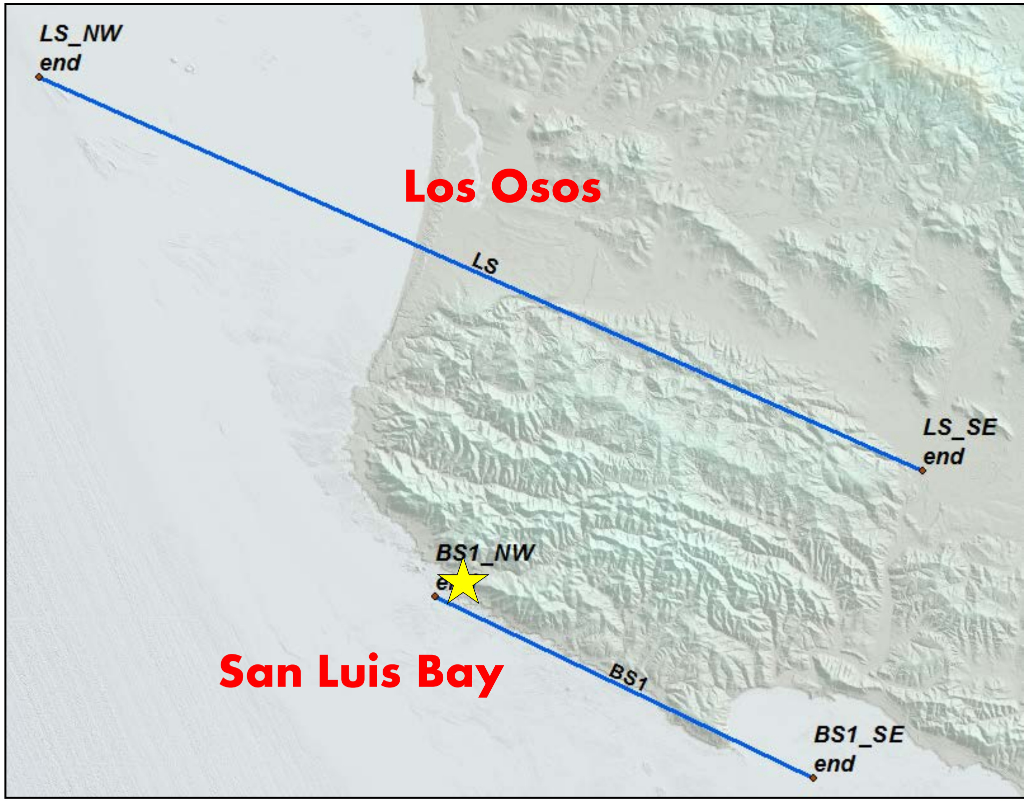


We have this:



Splay 2: Los Osos – San Luis Bay

This presentation will focus on the
Los Osos Mw=7.4,
Shoreline Mw=6.39 case

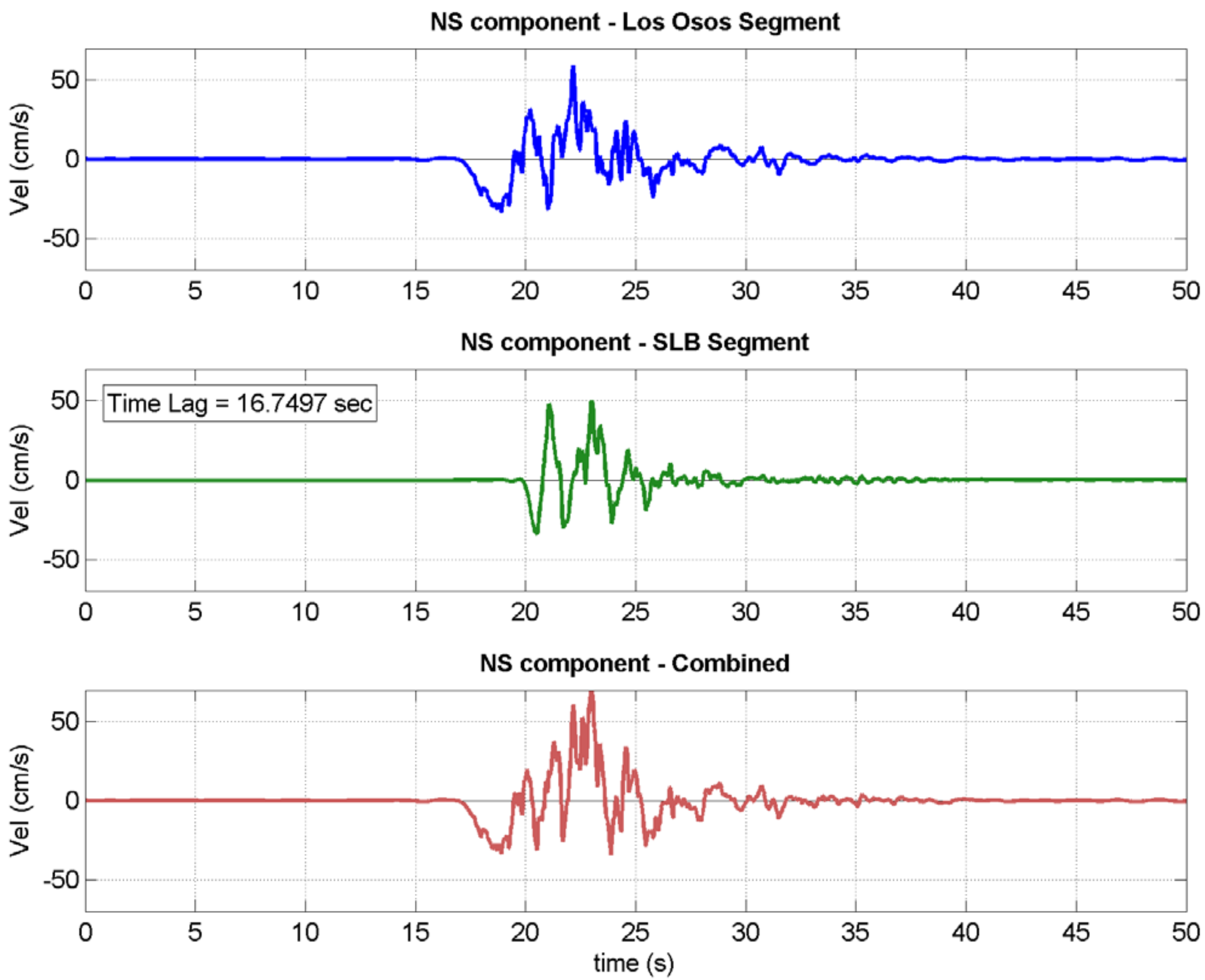


Segment	Rrup	Rjb	Rx
Los Osos	8.57	0.00	9.90
SLB	1.00	0.00	1.07

Segment	Mw	Strike	Rake	Dip	Ztor	L	W
Los Osos	7.4	115.4	90	60	0	78.19	32.0
SLB	6.39	295.4	90	70	0	19.55	12.7

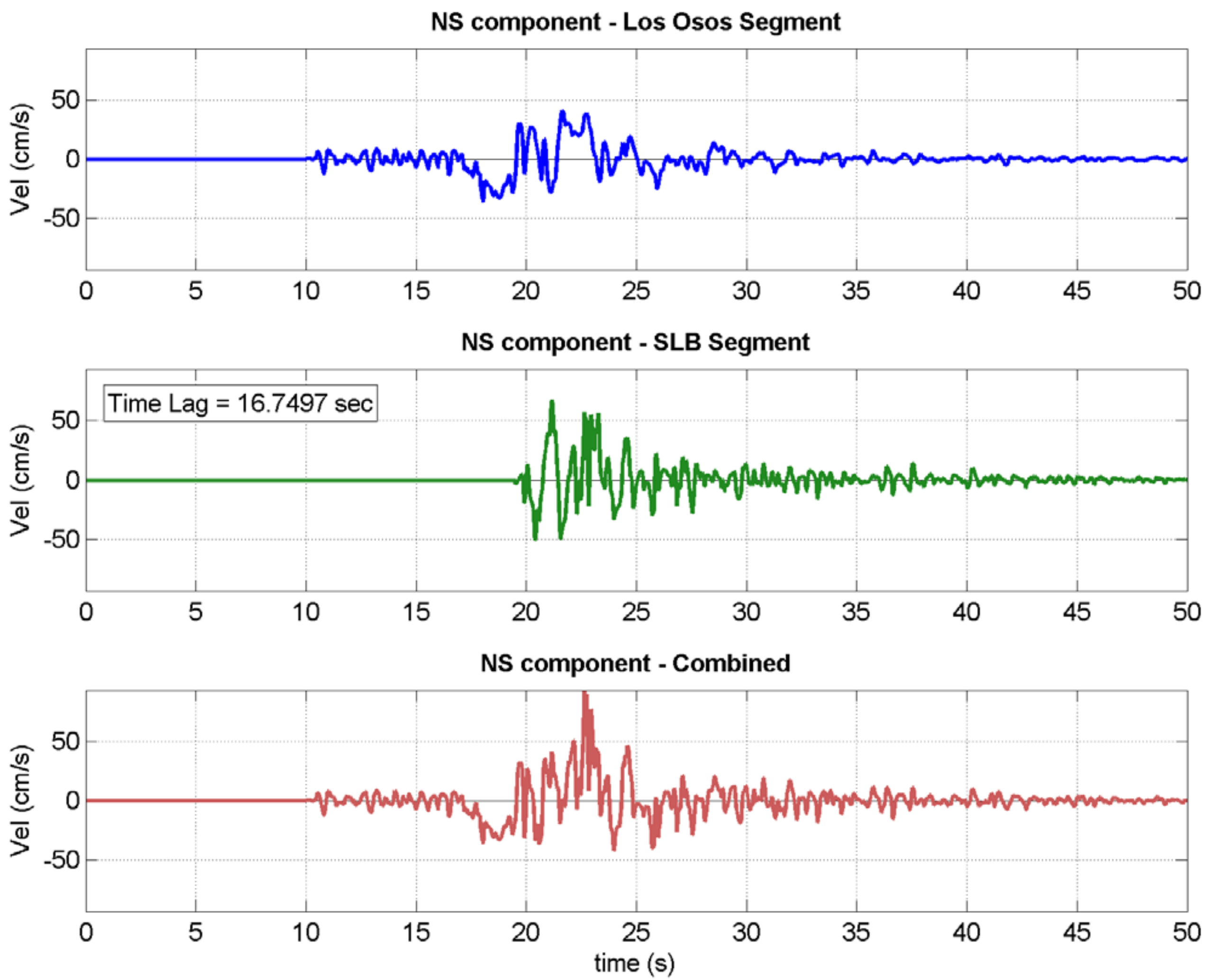
Splay 2: Los Osos – San Luis Bay

Example Waveforms - (GP Method, Realization 06)



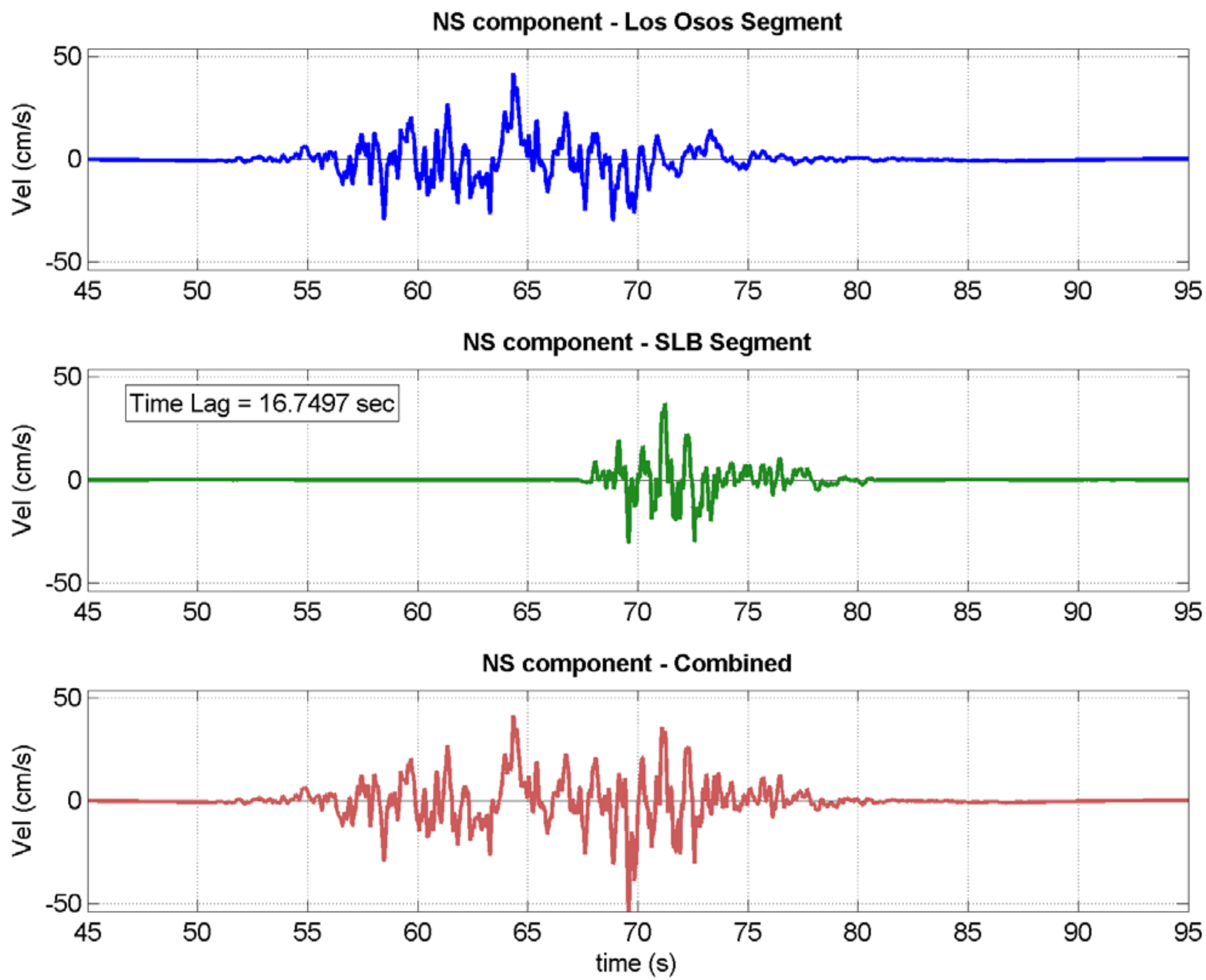
Splay 2: Los Osos – San Luis Bay

Example Waveforms - (SDSU Method, Realization 06)



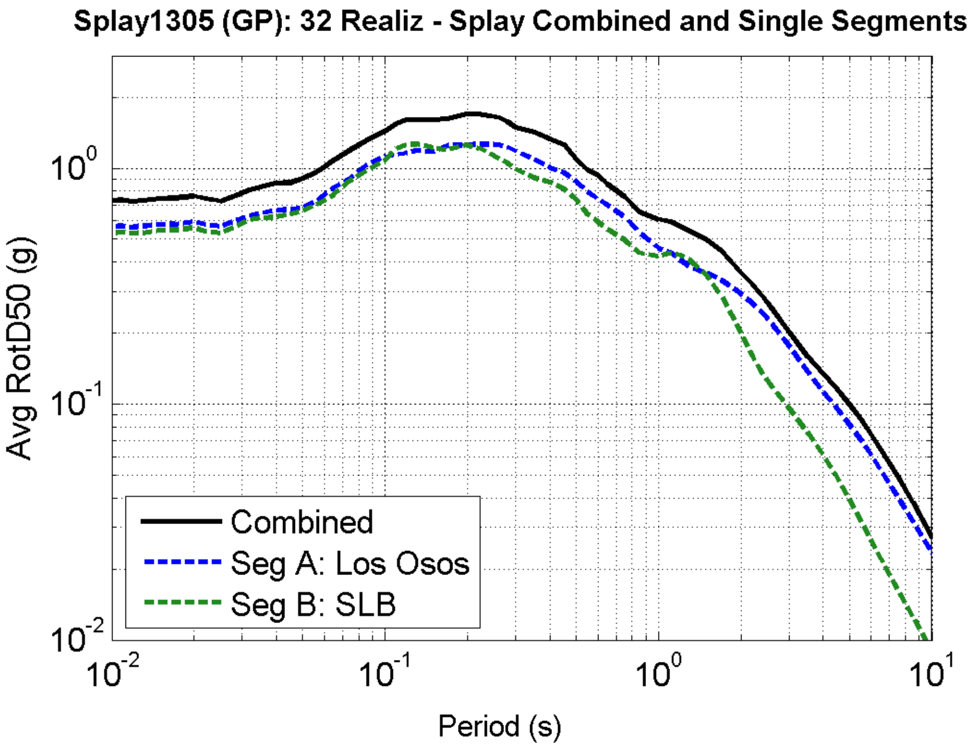
Splay 2: Los Osos – San Luis Bay

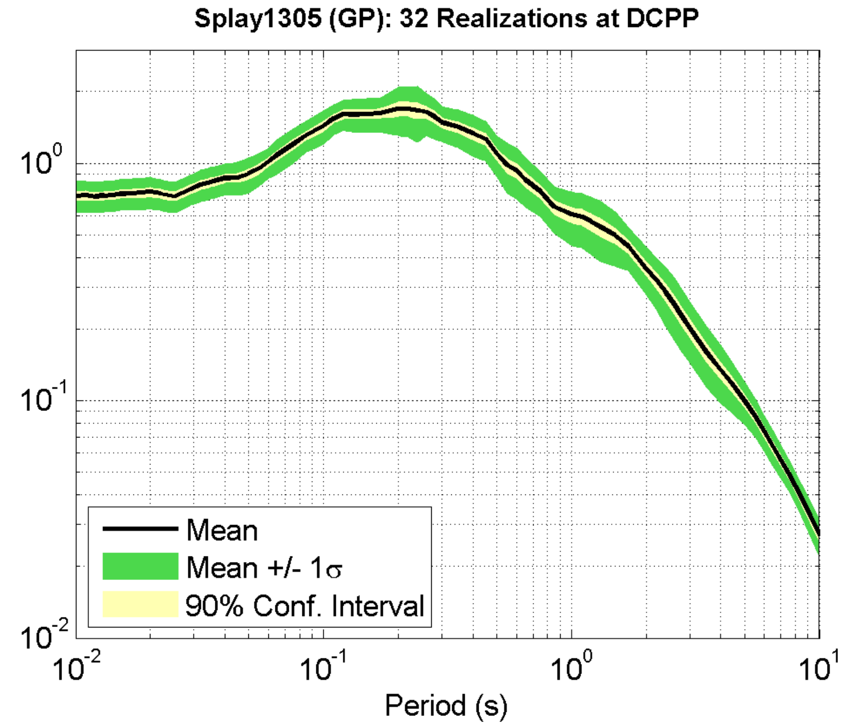
Example Waveforms - (ExSim Method, Realization 06)



Splay 2: Los Osos – San Luis Bay

Results - GP



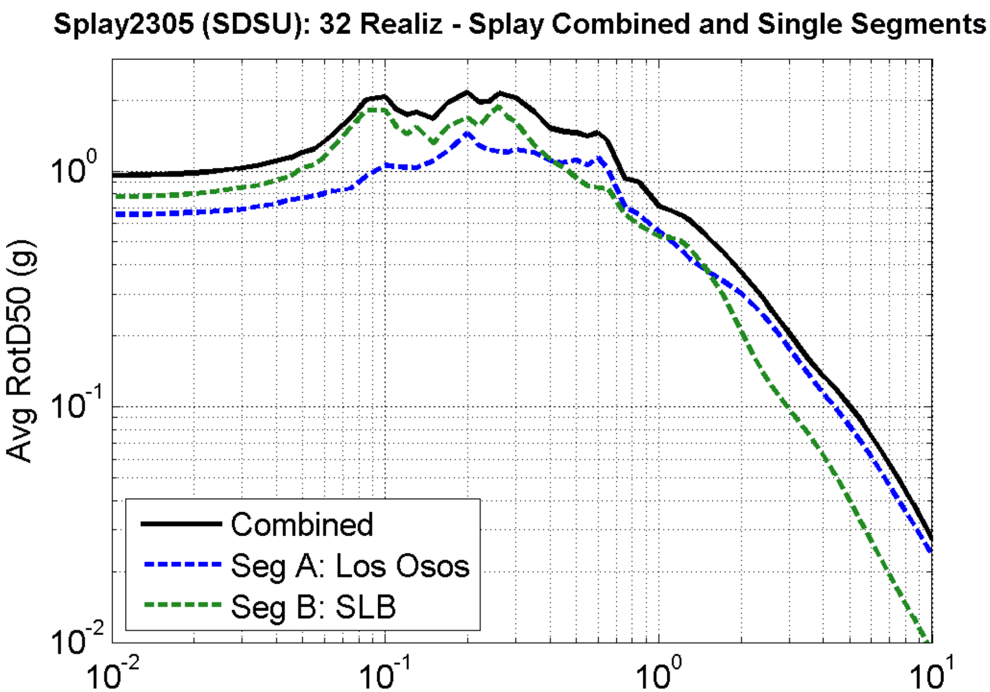


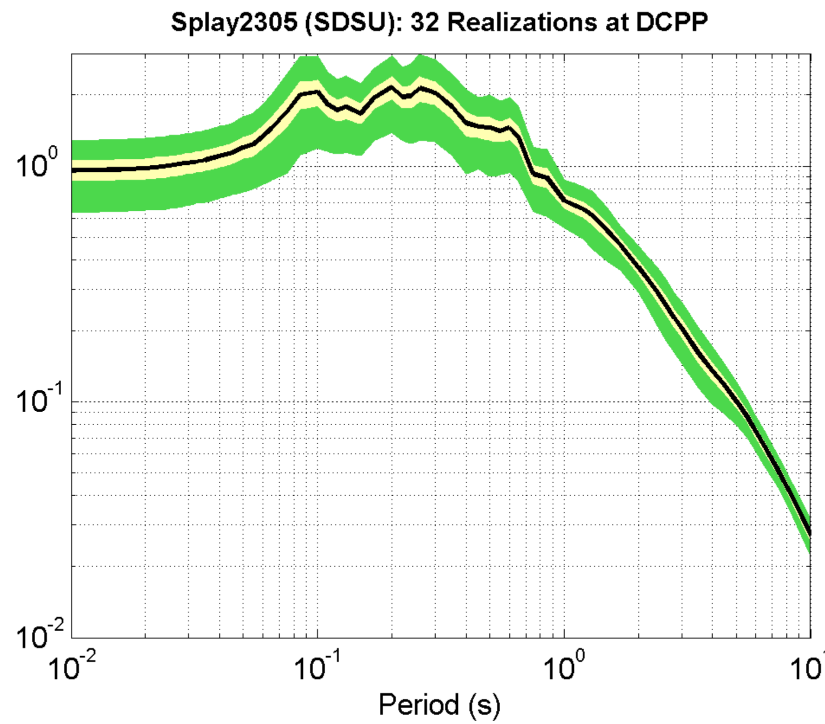
Segment A: Los Osos Mw=7.4, Rx=9.9

Segment B: SLB Mw=6.39, Rx=1.07

Splay 2: Los Osos – San Luis Bay

Results - SDSU

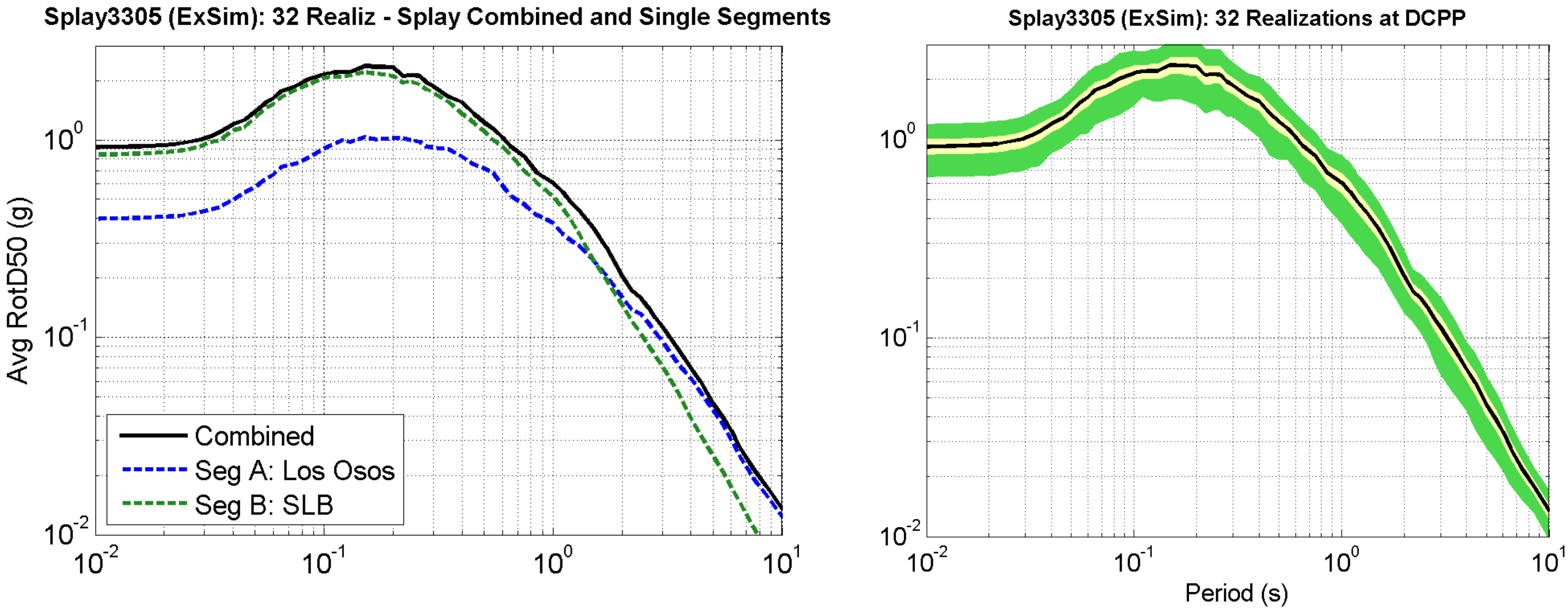




Segment A: Los Osos	Mw=7.4, Rx=9.9
Segment B: SLB	Mw=6.39, Rx=1.07

Splay 2: Los Osos – San Luis Bay

Results - ExSim



Segment A: Los Osos Mw=7.4, Rx=9.9

Segment B: SLB Mw=6.39, Rx=1.07

Conclusions

Observations based on the Combined Rupture RotD50

- Generally (both SS and Rev scenarios), GP spectral amplitudes are lower than ExSim and SDSU for f > 1 Hz
- Generally (both SS and Rev scenarios), ExSim spectral amplitudes are lower for f < 1 Hz
- High frequency amplitudes for ExSim are significantly higher than GP and SDSU for the strike-slip scenario (Hosgri-SL), and are significantly higher than GP for the reverse scenario (LO-SLB).
    - This is largely due to the strong contribution of the secondary rupture (smaller Mw, R≈1 km) which predicts larger motions than GP and SDSU by a factor of up to around 2 for the strike-slip case.