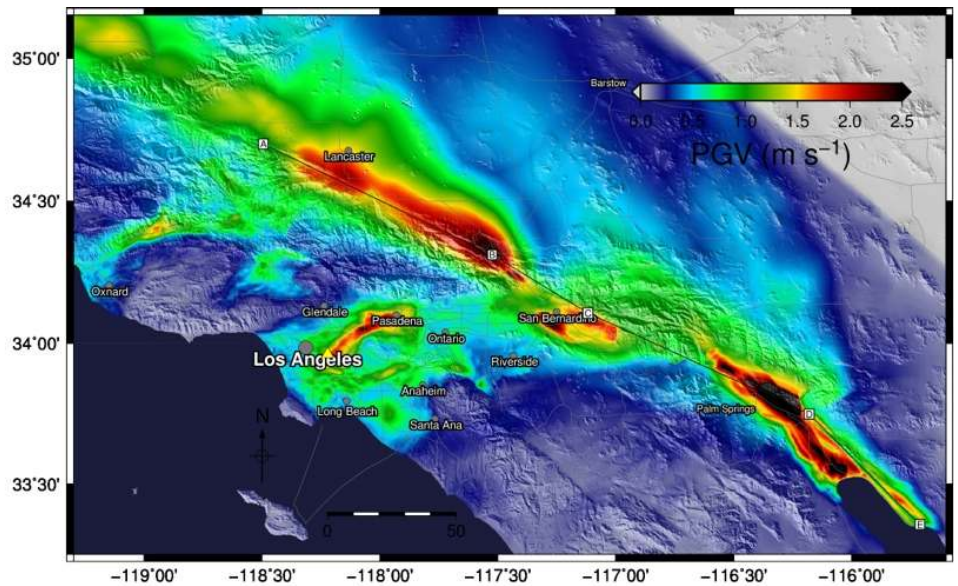
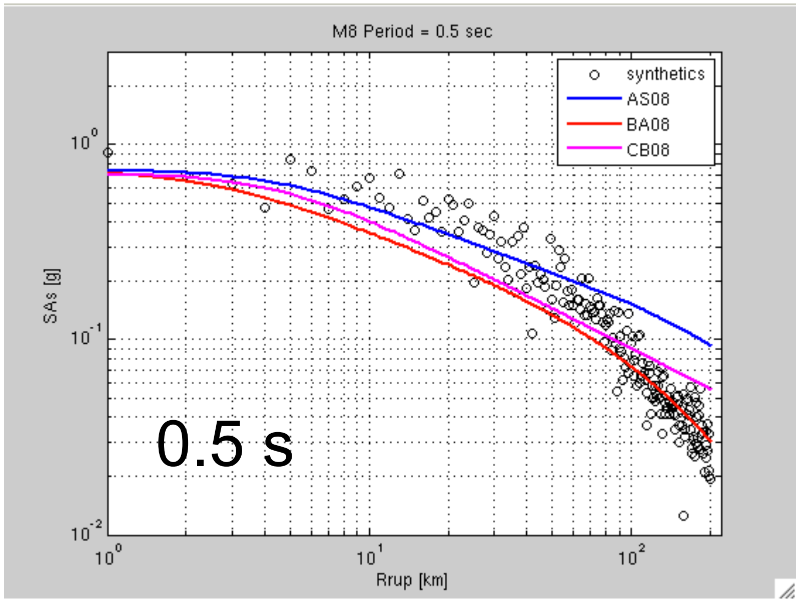
Some Questions for the Future

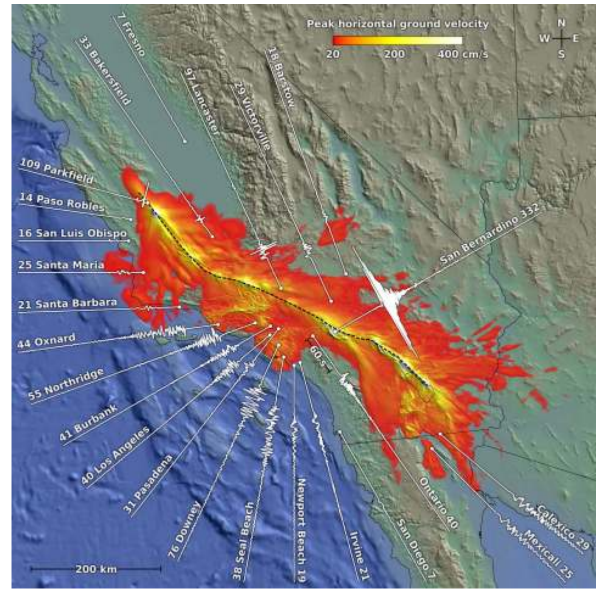
- Are current long-period synthetics appropriate for large magnitude events?

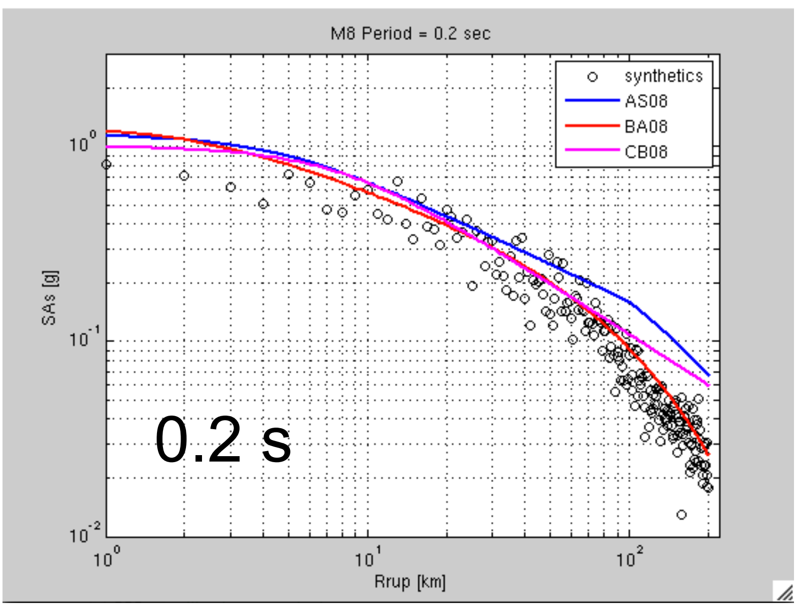


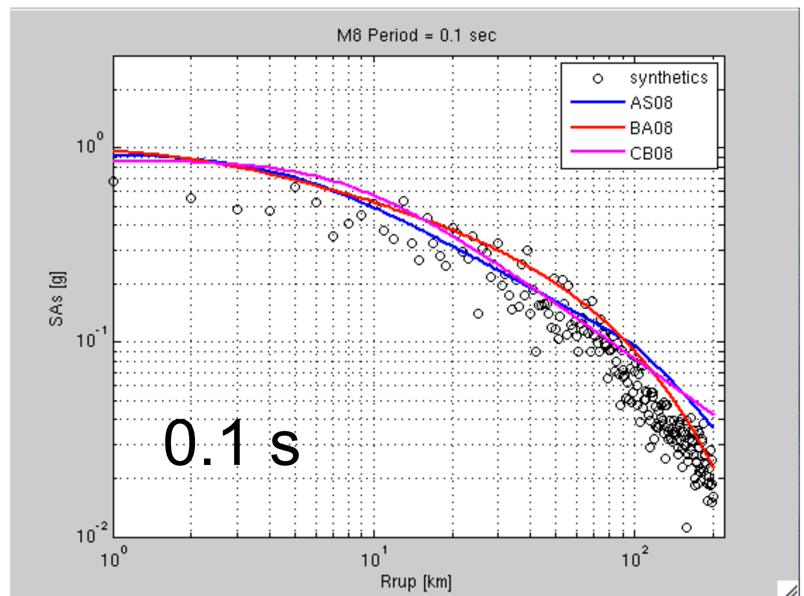
- What are the prospects for realistic deterministic synthetics up to 5-10Hz?

Self Assessment Supporting Information for >M_w7.3: M8 Generally Agrees with GMPEs









Ground Motions From Large Magnitude Events

Roten, D.[1], **Olsen, K.B.**[2], Day, S.M.[2], and Fäh, D.[1]

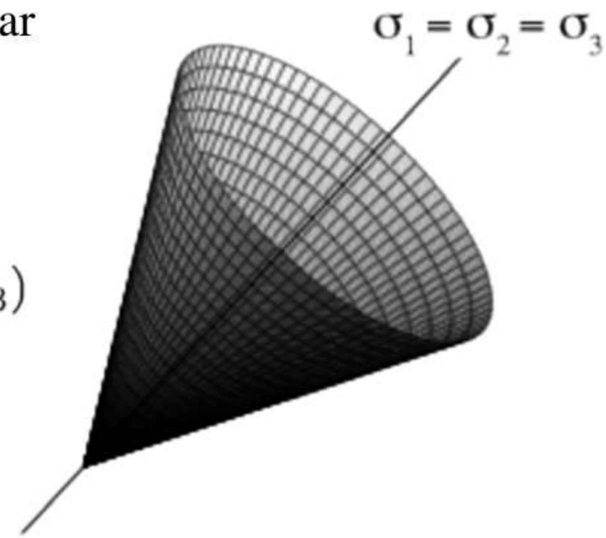
- SWUS project Includes M 7-8 events
- Long-period wave guide effects in LA (ShakeOut)
- Caused by Love waves
- Can the wave propagation be considered linear for ShakeOut-type scenarios?

1 Swiss Seismological Service / ETH Zürich
2 San Diego State University

SAN DIEGO STATE UNIVERSITY

Implementation of damage rheology in AWP-ODC

Non-associative Drucker-Prager plasticity with yielding in shear (based on guidelines from SCEC/USGS Spontaneous Rupture Code Verification Project):



Mean stress $\tau_m = \frac{1}{3}(\tau_{11} + \tau_{22} + \tau_{33})$

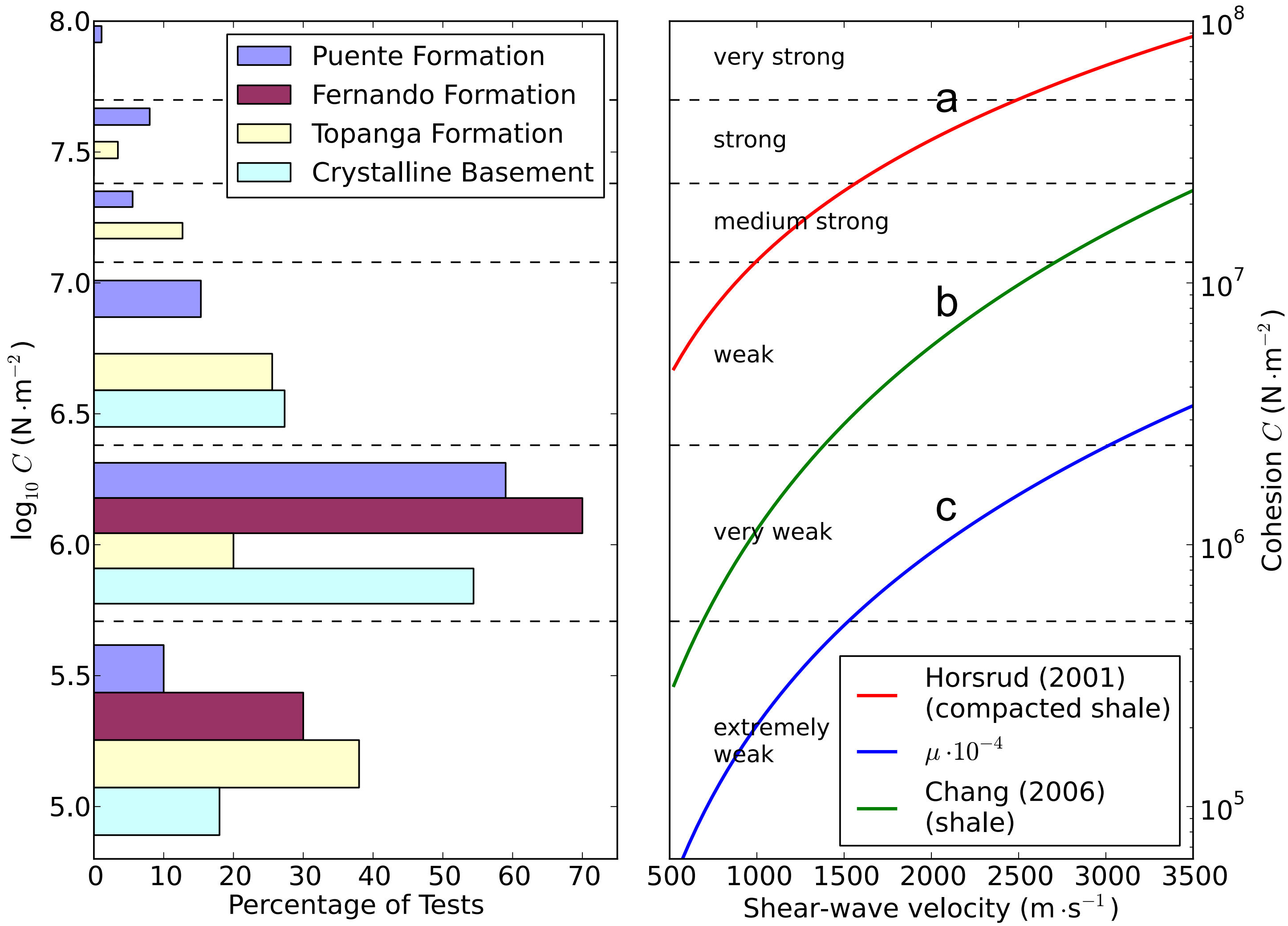
Stress deviator $s_{ij} = \tau_{ij} - \tau_m \delta_{ij}$

2nd invariant of stress deviator $J_2(\tau) = \frac{1}{2} \sum_{i,j} s_{ij} s_{ji}$

Drucker-Prager yield stress $Y(\tau) = \max(0, c\cos\varphi - (\tau_m + P_f)\sin\varphi)$

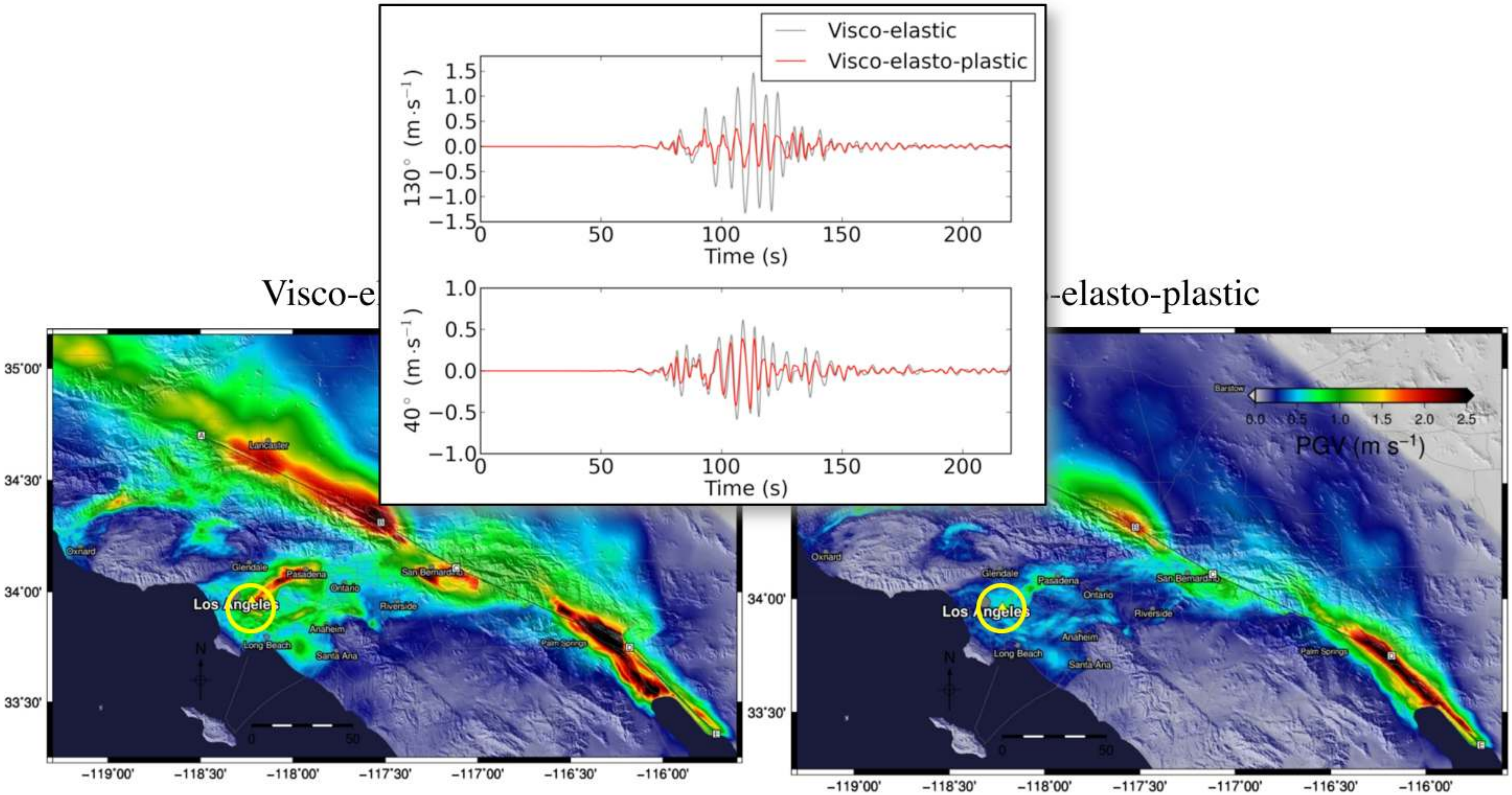
Drucker-Prager yield function $F(\tau) = \sqrt{J_2(\tau)} - Y(\tau)$

Material behaves **elastically** if $F(\tau) < 0$ and **plastically** if $F(\tau) = 0$.



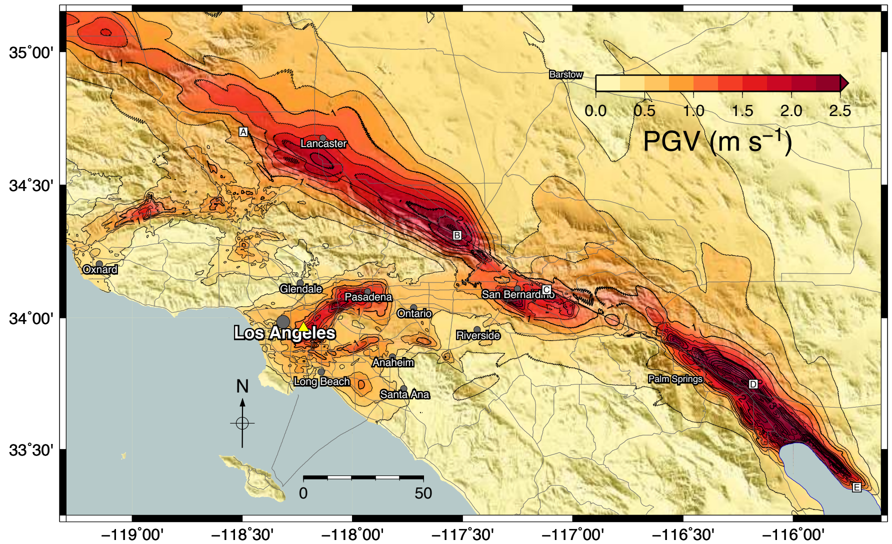
Initial stresses: Major principal stress σ_1 along 22.5°E
Intermediate principal stress σ_2 vertical
Lithostatic load
$\sigma_1=4/3\sigma_2$, $\sigma_3=2/3\ \sigma_2$

ShakeOut Earthquake Scenario with Plasticity

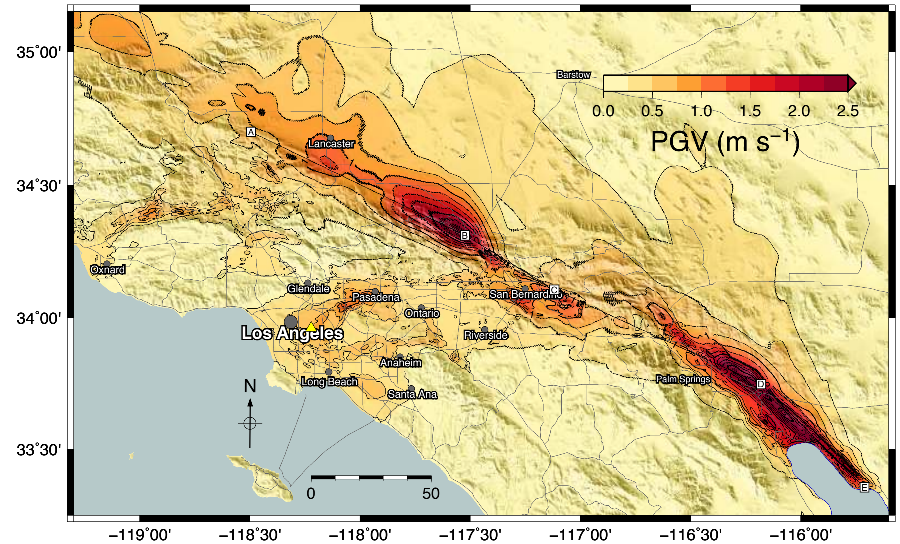


PGV Reduction – Cohesion Model B

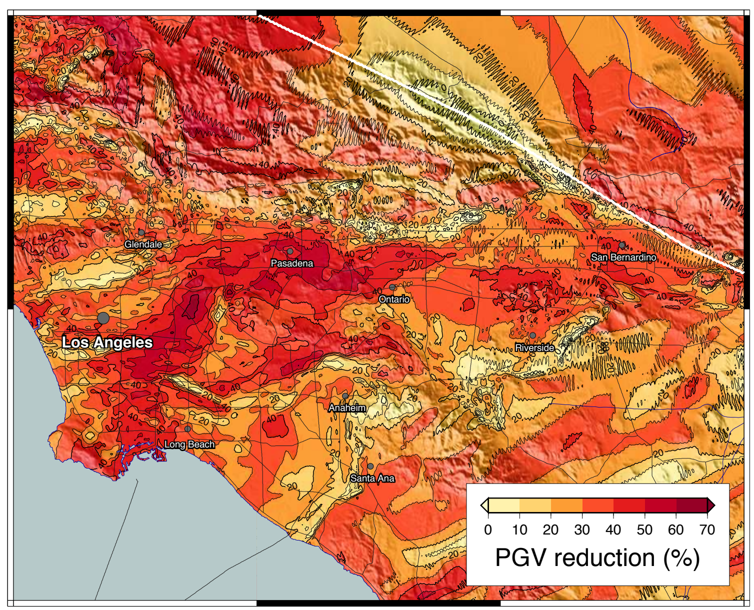
Visco-elastic



Visco-elasto-plastic (Cohesion model B)

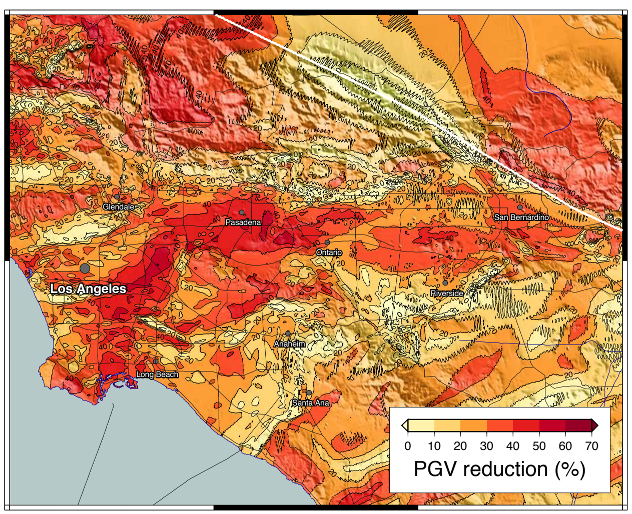


Cohesion model B

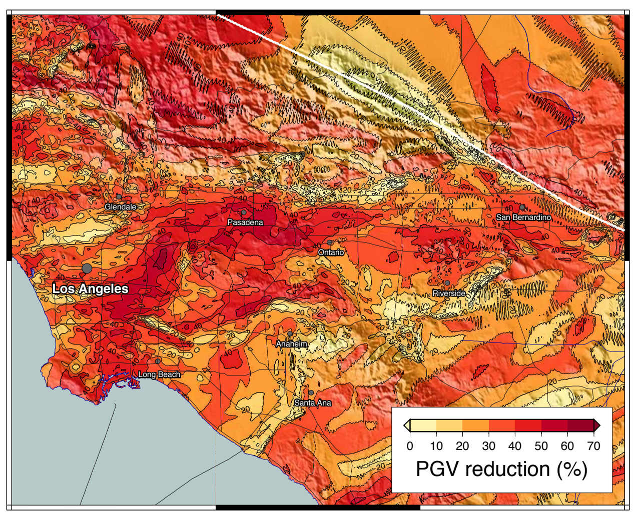


PGV Reduction

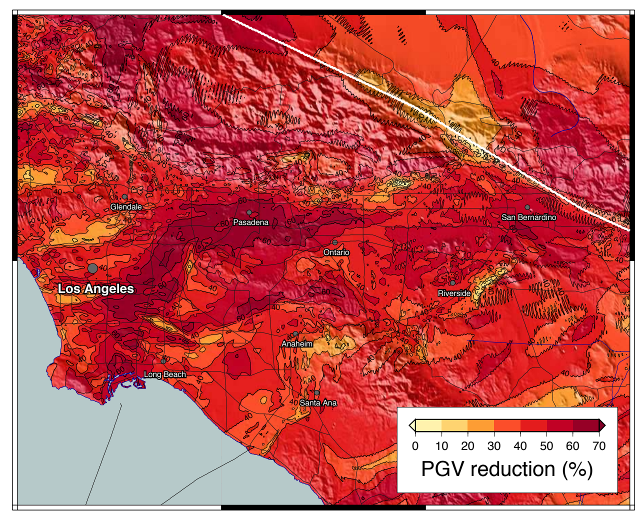
Cohesion model A



Cohesion model B

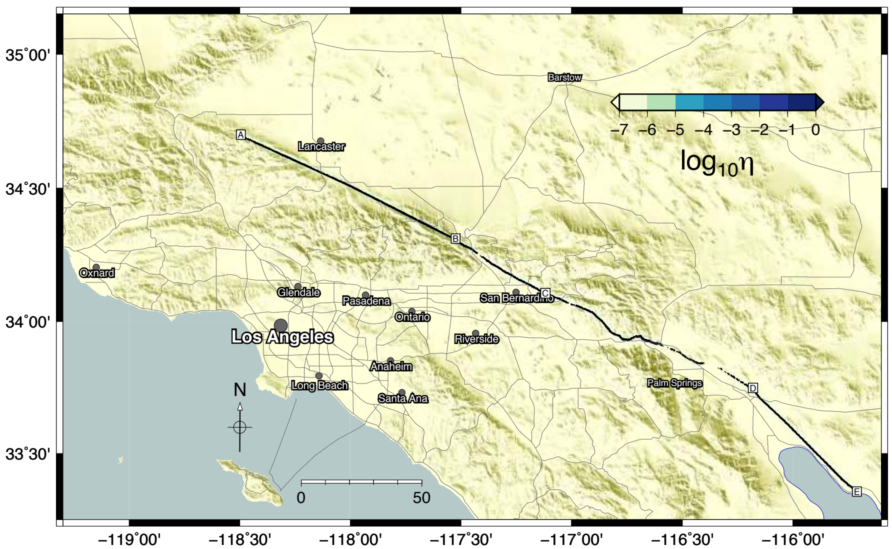


Cohesion model C

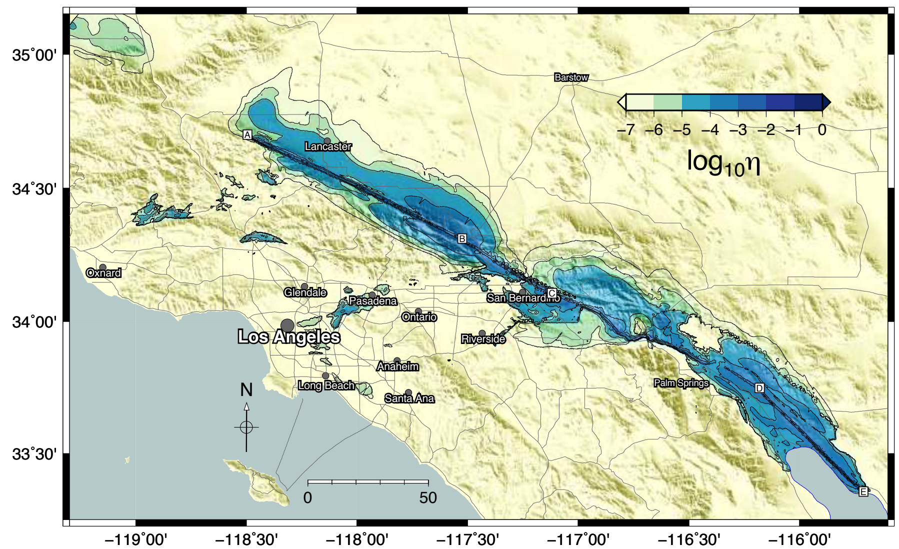


Final Principal Plastic Strain

Cohesion model A

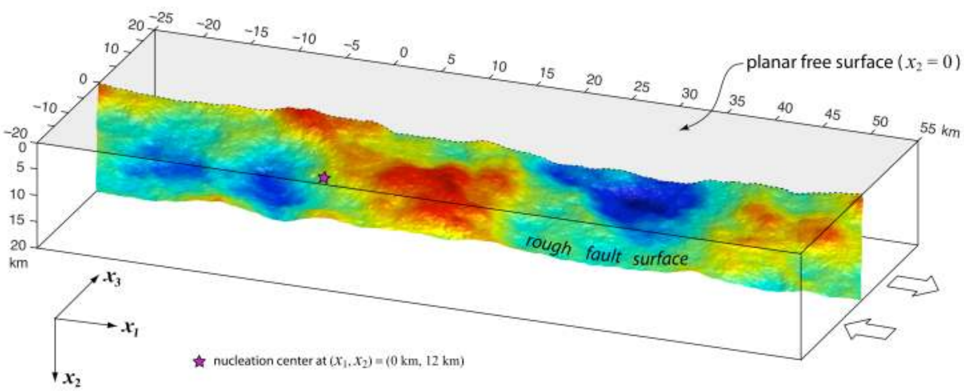


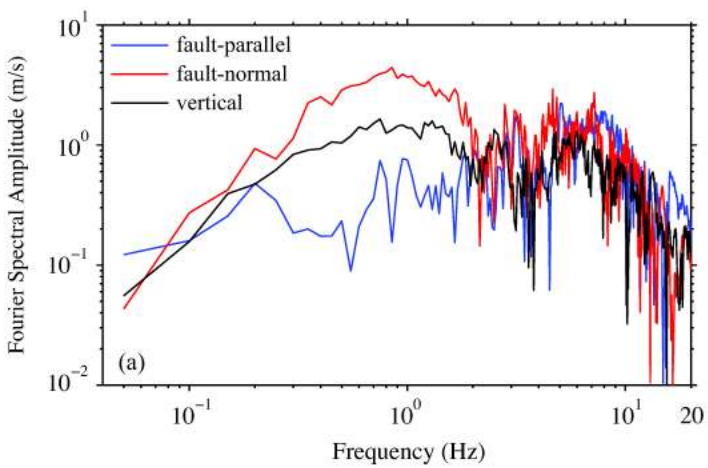
Cohesion model C

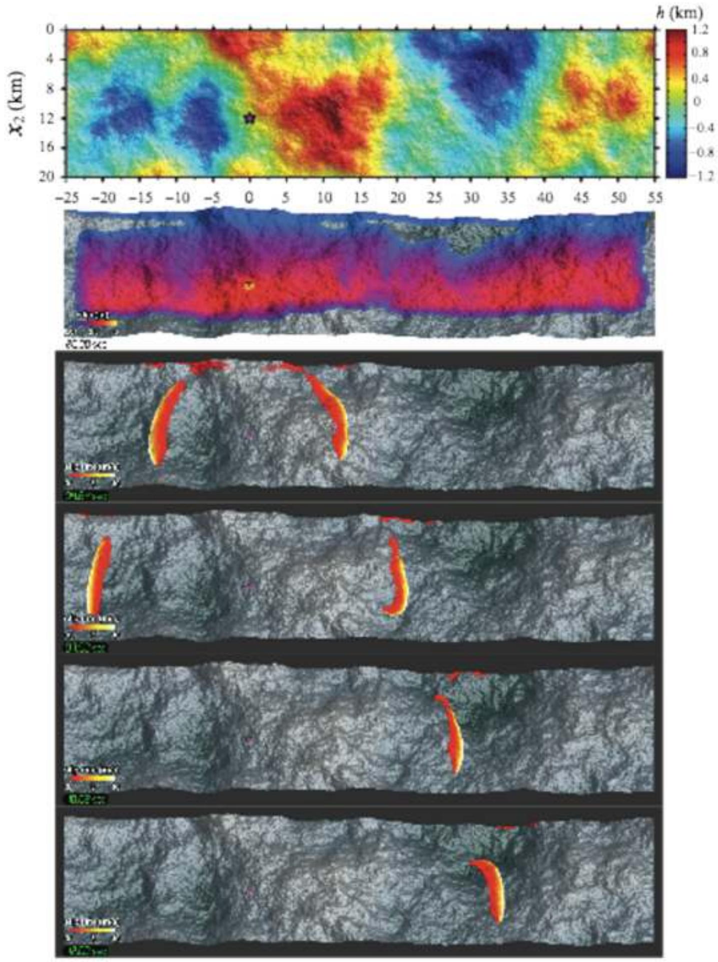


Source Complexity to 10Hz

(Shi and Day, 2013)

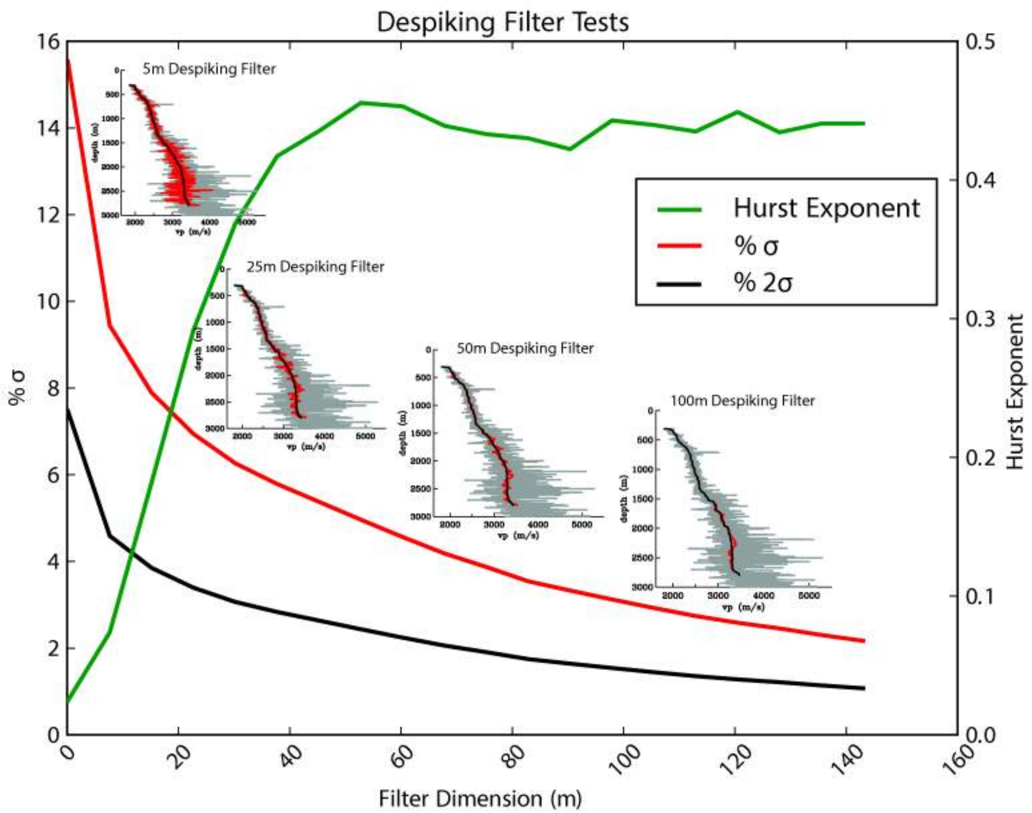






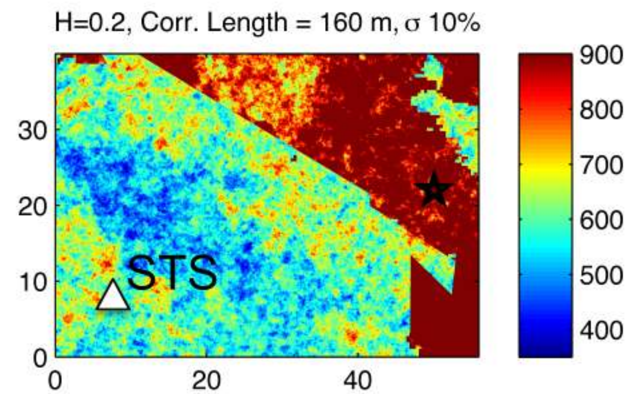
Effects of Small-scale Heterogeneities on Ground Motions

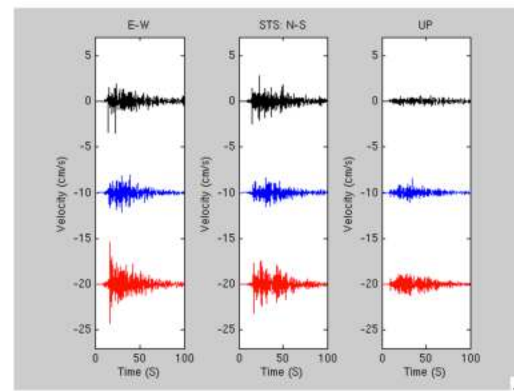
Savran, Olsen, Jacobsen (2013)

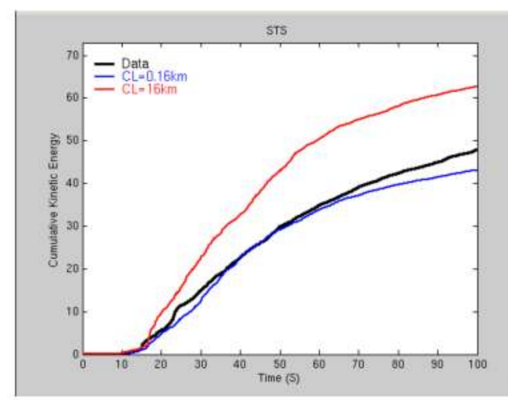


Analysis of 38 LA basin sonic logs:	
Vertical Correlation Length	25-100m
Hurst Exponent	0-0.1
σ	5-10%

Chino Hills Test Case – (short) correlation length from data provides better

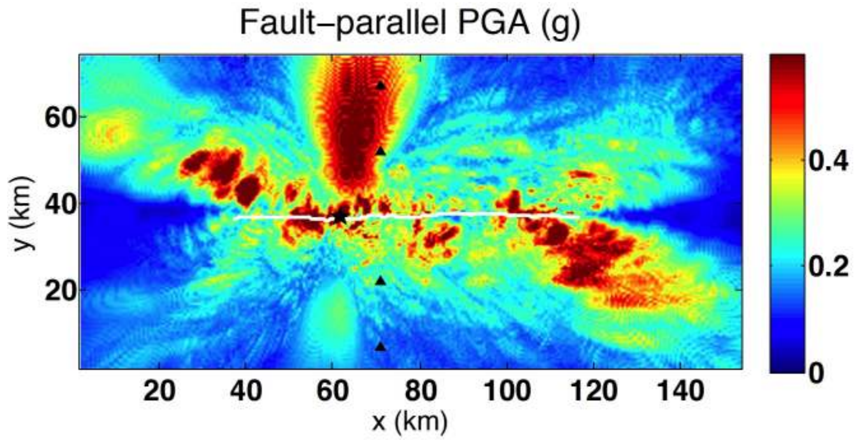




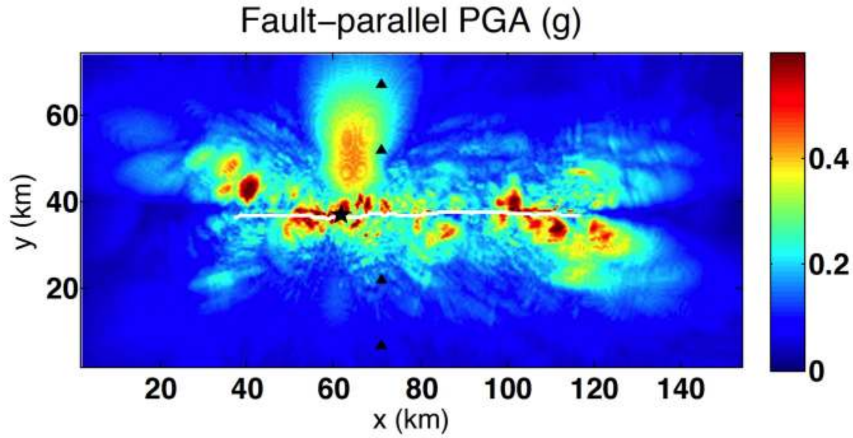


PGA with and without Attenuation/Heterogeneities

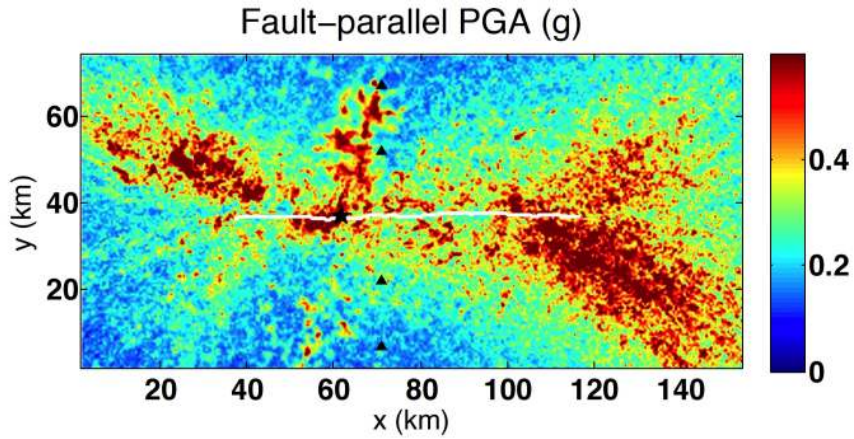
No Attenuation and no Heterogeneieties



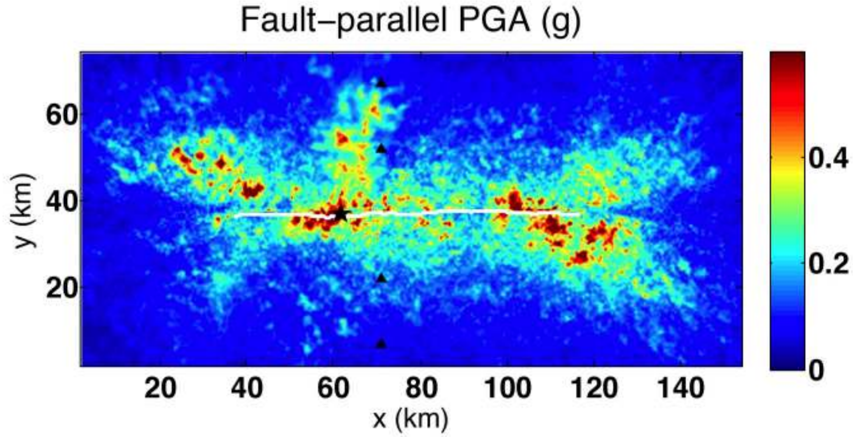
With Attenuation and no Heterogeneieties



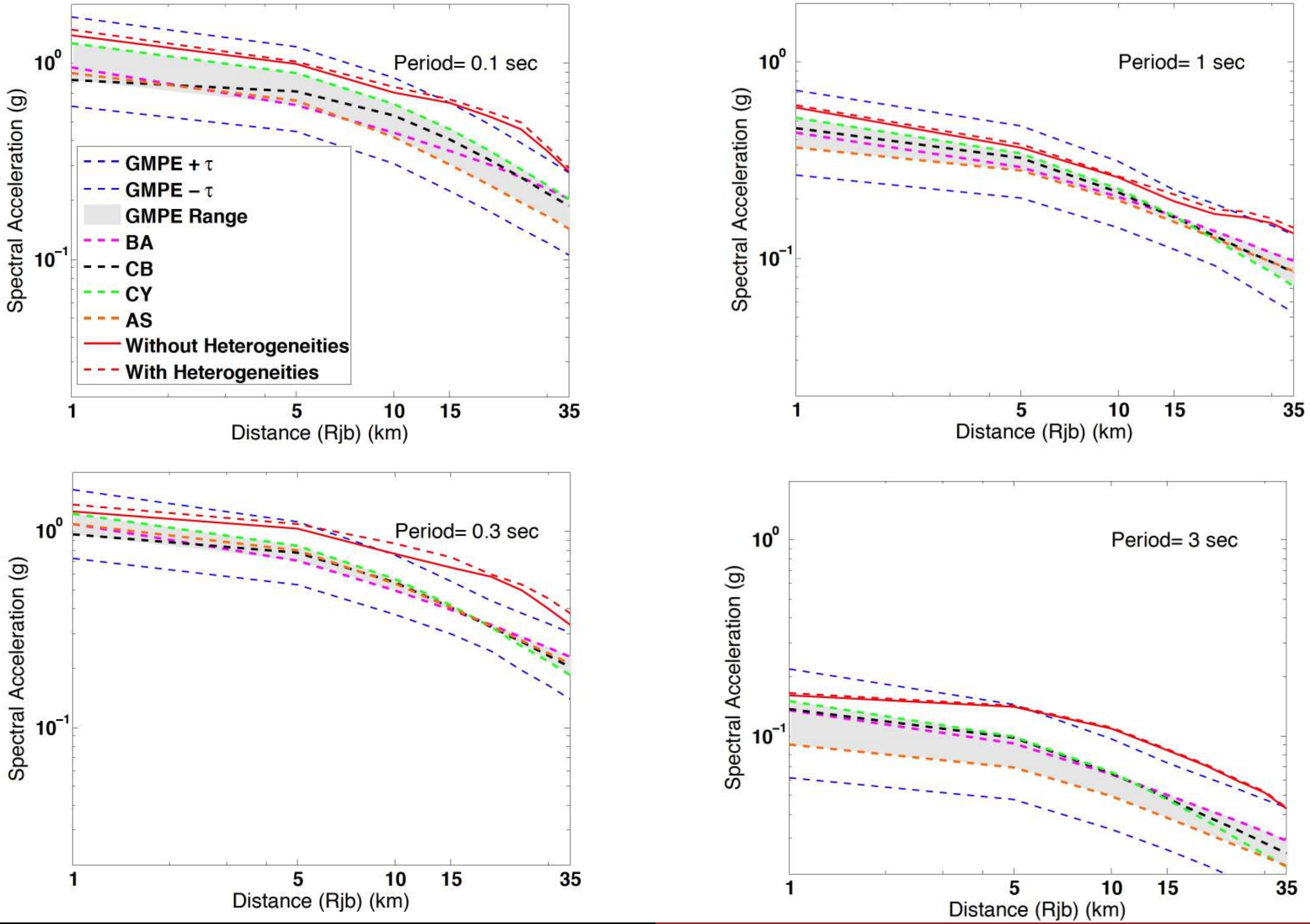
No Attenuation with Heterogeneieties



With Attenuation with Heterogeneieties



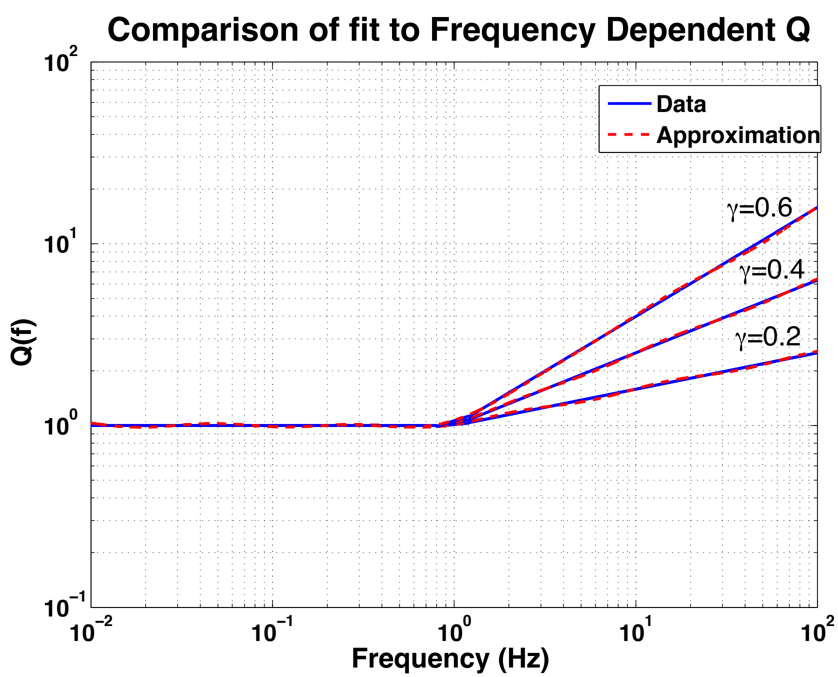
SA (with Intrinsic Attenuation)



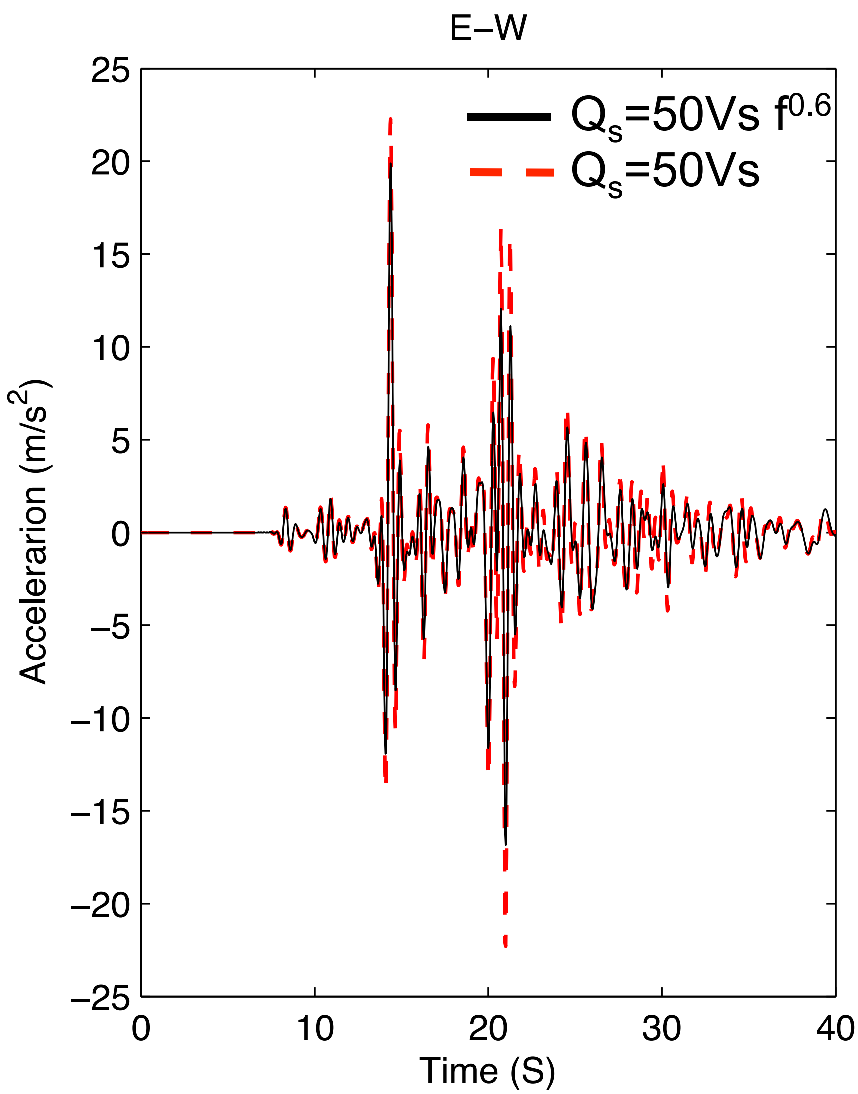
Implementation of Q(f)

Withers, Olsen, Day (2013)

As frequencies increase (>~1Hz), frequency-dependent anelastic attenuation becomes increasingly important. We have achieved a preliminary power law implementation of Q_s frequency dependency $Q_s(f) = Q_o\ f^{\,n}$ in AWP-ODC.



Deep basin site DLA for 0-2.5 Hz Chino Hills – comparison of contant Q and frequency-dependent Q.



Fractal Distribution

- In 3D, a fractal distribution has a high wave-number decay of the power spectrum $P(k)$ as:

$$P(k) = P_0(1 + \frac{k}{k_{corner}})^2)^{-(1.5+H)}$$

where H is the Hurst number, k_{corner} is the wavenumber below which the spectrum is approximately constant .

- Here we used $H = 0.2$ generating a self-similar distribution throughout the entire medium with a standard deviation of 5%