

# Objective

[engineer perspective]

Improving ground motion prediction  
in near field for seismic resilience

[seismologist perspective]

Bringing a physical explanation  
to the origin of initial stress heterogeneity  
— one of the observed source complexities

# How to? Our starting point is nature

Step 1: Targetting a Mw 7 strike-slip Californian earthquake

Step 2: Gathering regional data of  
Gutenberg-Richter & seismicity-depth distributions

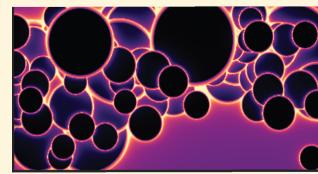
Step 3: Stochastic generation of past events  
on preset fault plane

Step 4: Computing stress left by  
each past event



1 past event = 1 circle/barrier  
High stress around barriers

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$$\Delta\tau = -\Delta\tau_e \left[ \left( 1 - \frac{c^3}{x^3} \right)^{-1/2} - 1 \right], \quad x > c \quad (20)$$

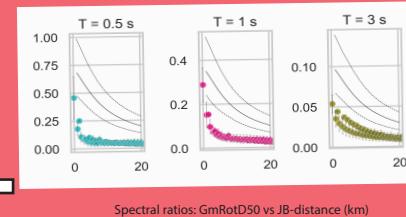
(Dieterich, 1994)

# Numerical modeling of rupture dynamics constrained by past seismicity for ground motion prediction

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Homogeneous stress &  
Homogeneous medium  
underestimates ground motion

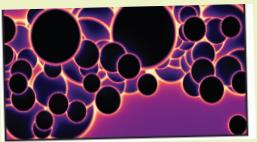


Spectral ratios: GmRotD50 vs JB-distance (km)

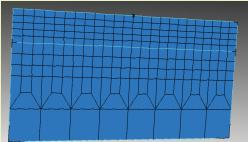
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# General flow

1. Preparing  
initial stress  
heterogeneity



2. 3D modeling of  
rupture dynamics &  
wave propagation



\* Linear slip  
weakening law

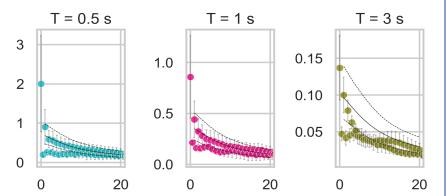
\* Stratified medium  
(3 Hz resolution)

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Outputs: rupture & ground motion

# WITH stress heterogeneity

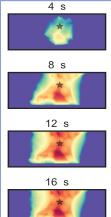
-a satisfactory GMPE fit at all periods



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-a family of rupture models compatible with statistics

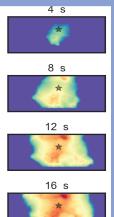
reference  
Mw 7



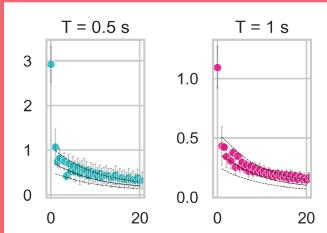
alternative stochasticity  
Mw 7.07



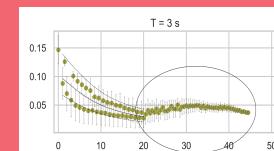
more past events  
Mw 7.1



-Adding  
medium  
stratification  
(still homogeneous  
stress) improves the  
GMPE fit  
...



... BUT  
outliers at long period



# What is missing

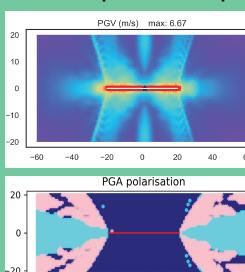
a realistic  
site response?

a longer rupture  
by incorporating  
other source  
complexities?

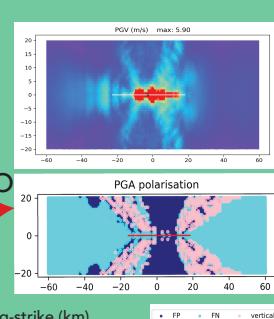
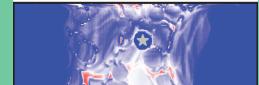
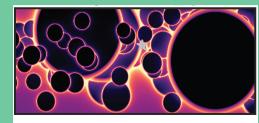
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# Signatures of stress heterogeneity

- heterogeneous pattern of  
ground motion amplitude & polarisation



-local  
supershear  
at initially  
high-stress  
patches



HETERO

Top view: Off-fault (km) vs along-strike (km)