Earthquake Cycle Simulations on a 2D Strike-Slip Fault Surrounded by Damaged Zones

Prithvi Thakur

University of Michigan

prith@umich.edu

01-10-2019

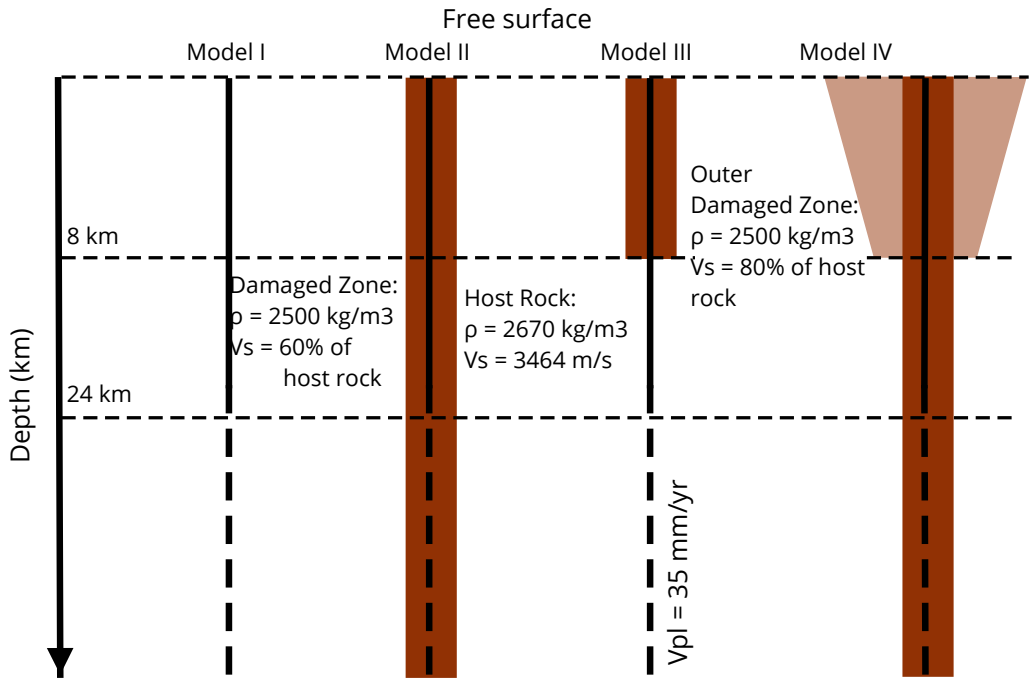
Overview

- 2D Numerical simulation of long-term fault slip using a spectral element method. Fully dynamic scheme for nucleation, rupture propagation, and postseismic deformation integrated with the aseismic phase.
- Strike-slip fault with mode III rupture (e.g., San Andreas), surrounded by a narrow damaged zone of low rigidity (Damaged Fault Zone).
- Spatial extent and material properties of damaged fault zones: how do they influence the earthquake sequence behavior?

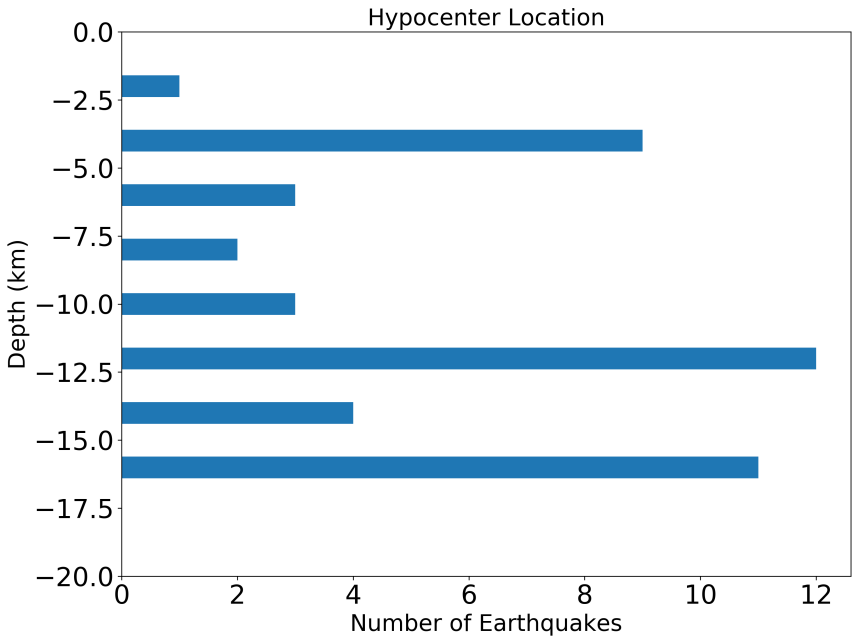
Research Questions

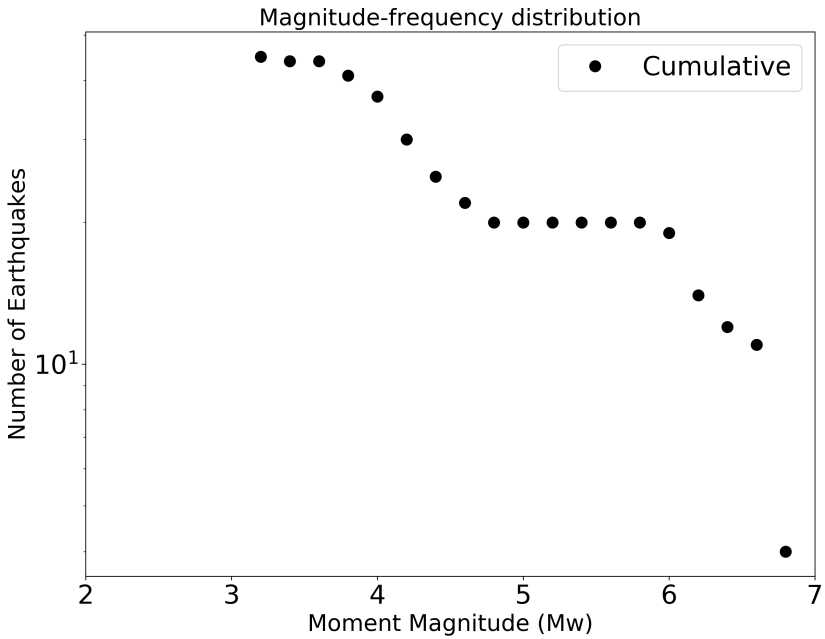
- How does the damaged fault zone control the nucleation site (hypocenter) of the earthquakes? How does this change over subsequent cycles?
- What contributes to the power law behavior of earthquakes: is it the friction, or the material heterogeneities, or both?
- What other earthquake complexities can be explained by the damaged fault zone properties?

Model Description

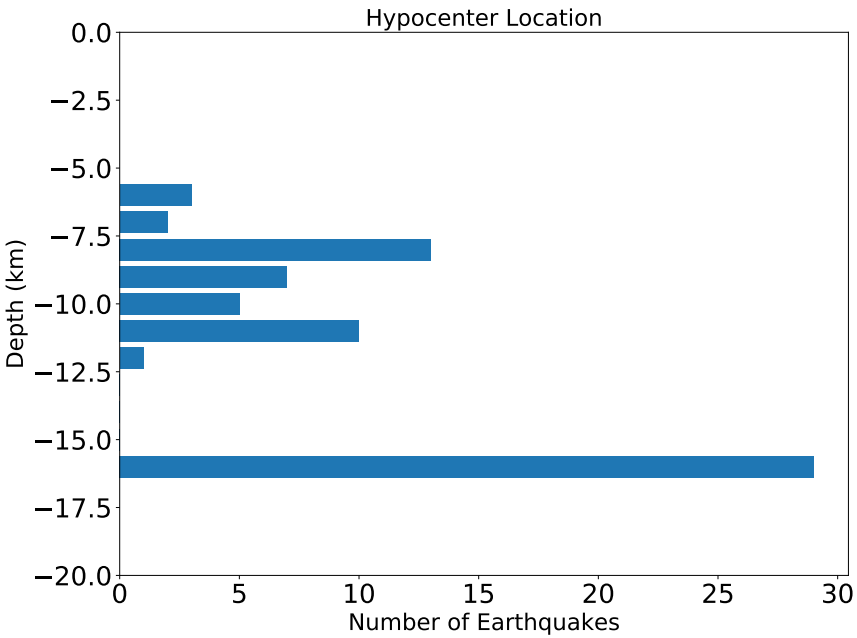


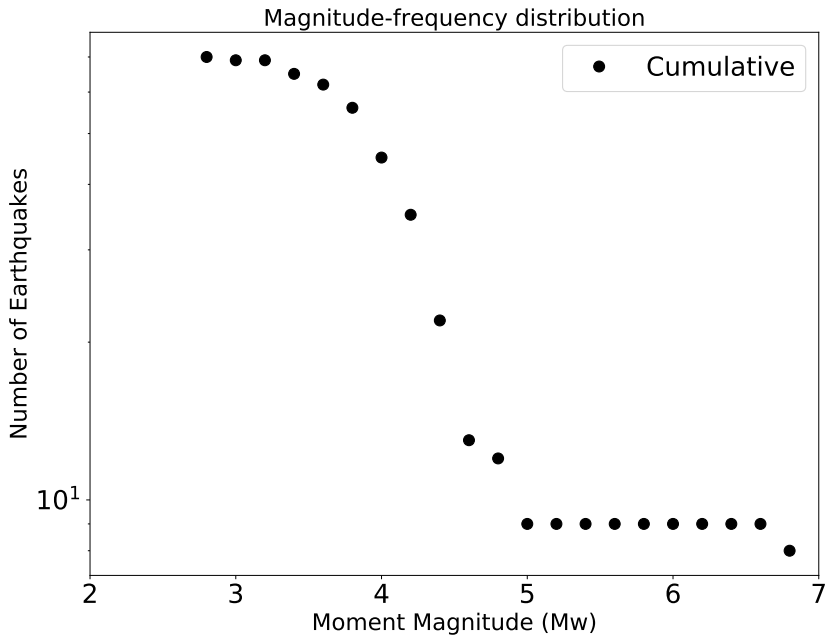
Simulated Results: Homogeneous Medium



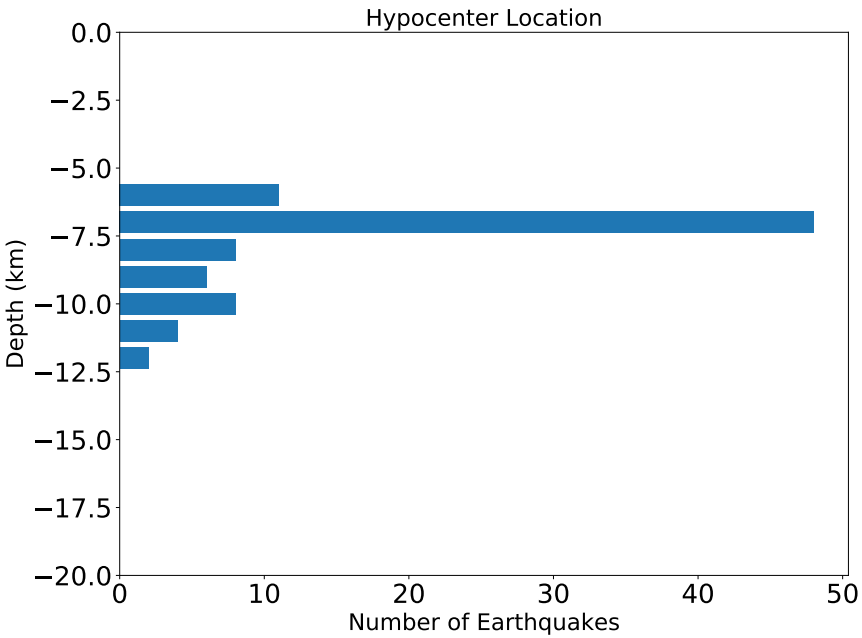


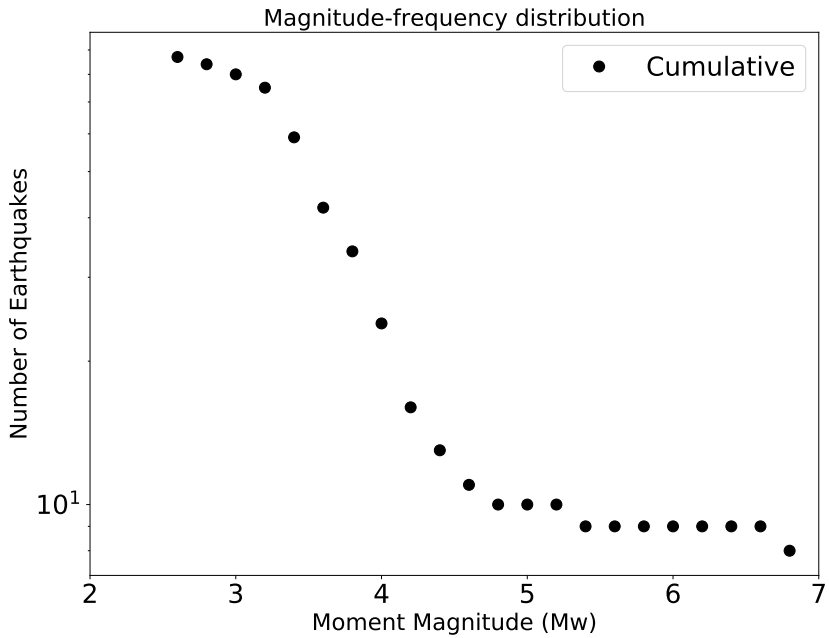
Simulated Results: Fault Zone throughout the domain



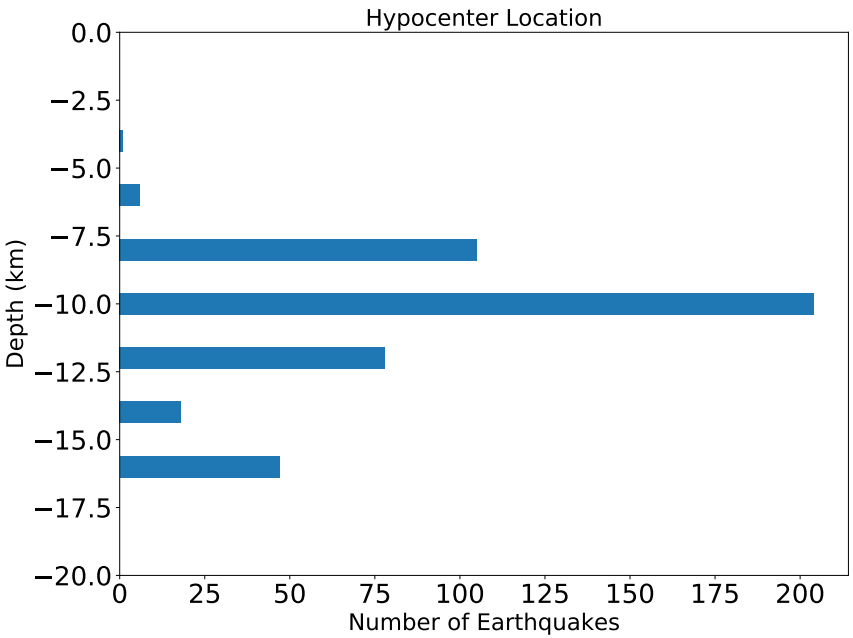


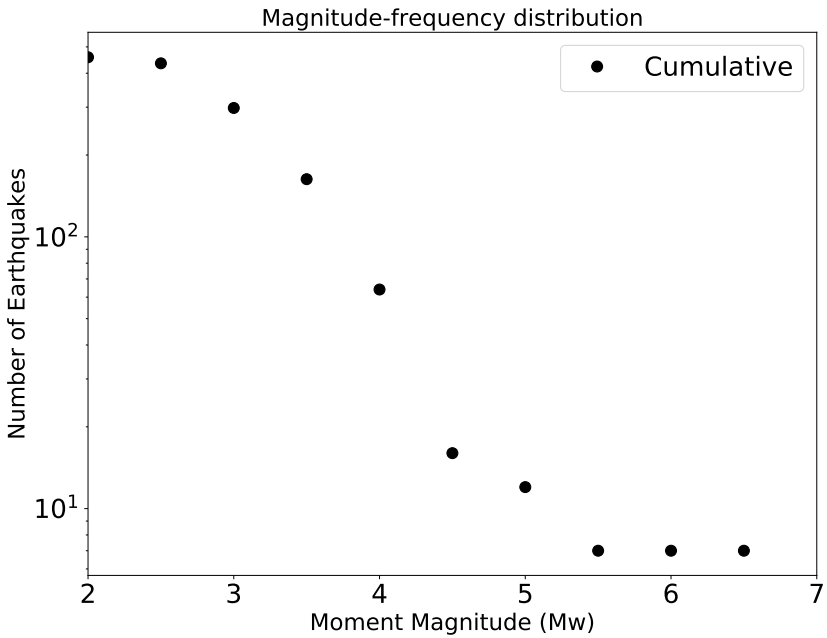
Simulated Results: Shallow Fault Zone: 8km deep





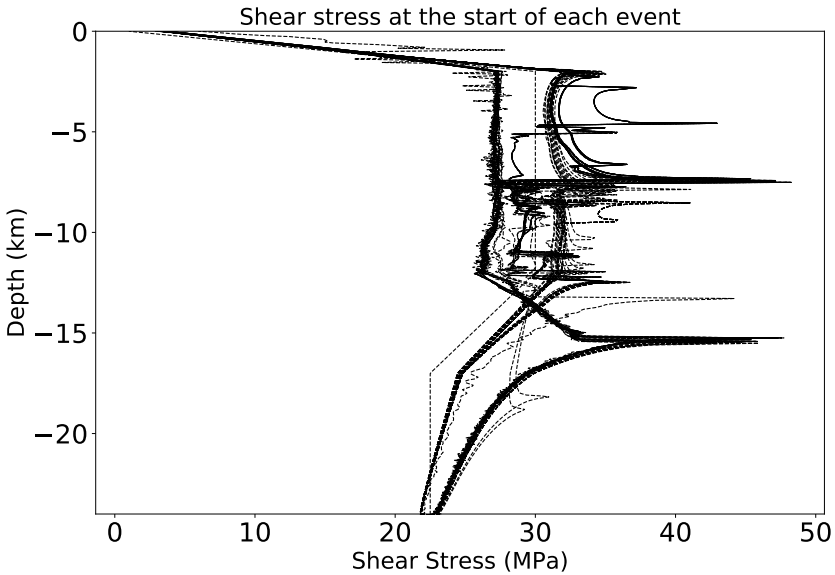
Simulated Results: Nested Fault Zone-Trapezoid Shaped



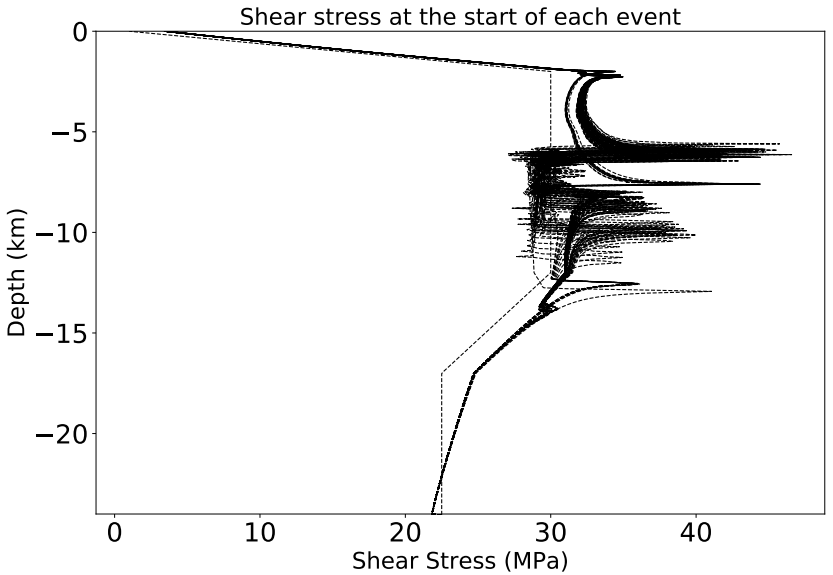


Simulated Results: Shear Stress Distribution

Deep Fault Zone



Shallow Fault Zone



Conclusions

- The presence of fault zone promotes stress heterogeneity.
- This stress heterogeneity gives rise to a power law distribution of earthquakes.
- The distribution is more similar to characteristic type earthquake distribution.
- Material heterogeneities are very common in the real faults and they can possibly explain some of the complexities in the earthquake behavior.

Future Work

Damage Evolution: damage increment during seismic event and healing during interseismic periods

Paleoseismic studies in Southern California: average recurrence of large earthquakes on multiple faults. How can we explain the variability in their recurrence? Are the large earthquakes on adjacent faults independent of each other?

Geological outcrops can tell us about older damged zone architecture in great detail. How do the different geometries (flower structure vs hourglass structure) affect the evolution of slip and stress over multiple earthquake sequences?

Write a code for Mode II rupture: dip-slip faults and along-strike variations in strike-slip faults.

That's All Folks!!