Magnitude-Frequency Distribution of Simulated Earthquake Cycles in Damaged Fault Zones

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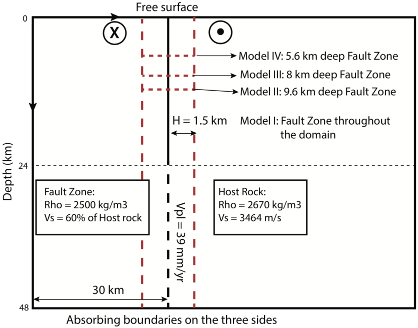
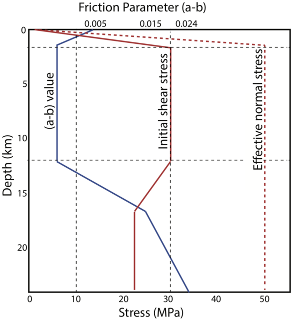
Overview

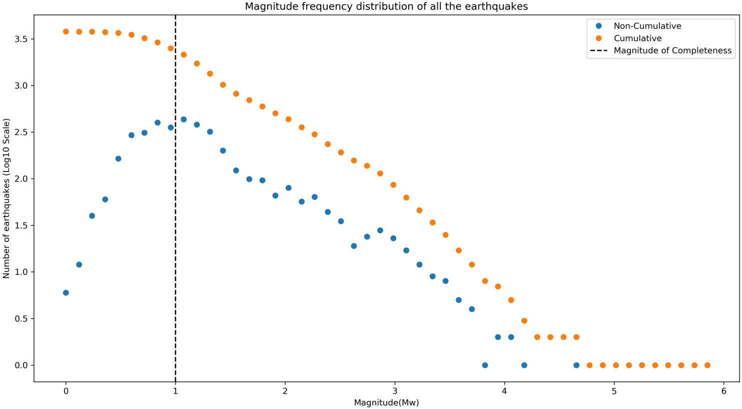
- 2D Numerical simulation of long-term fault slip using a spectral element method.
- Strike-slip fault with mode III rupture (e.g., San Andreas), surrounded by a narrow damaged zone of low rigidity (Fault Zone).
- Studied the effect of varying fault zone depth on the location of earthquake hypocenter.
- Rewrote the matlab code in Julia with some modifications: vectorization, encapsulation of subroutines. The speed is approx. 2.5 times faster than matlab.

Model Description

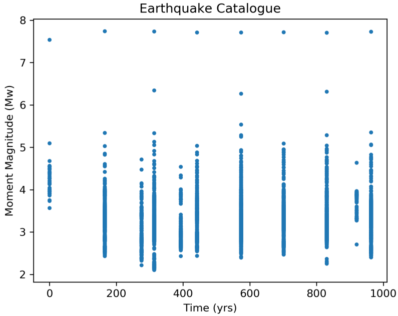


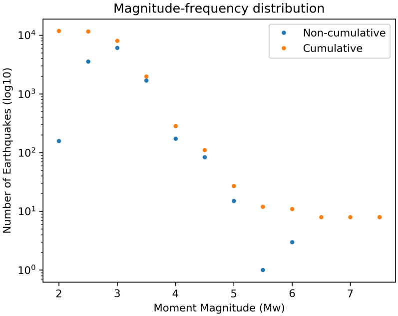


Observations from San-Andreas Fault

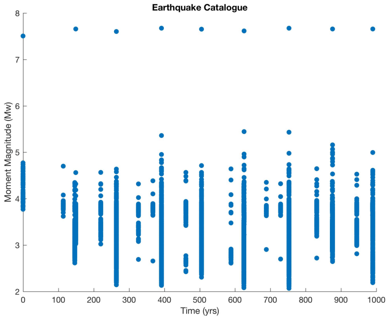


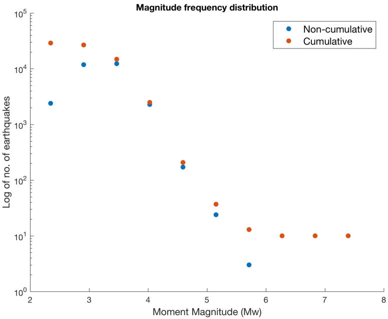
Simulated Results: Fault Zone Depth throughout the Domain



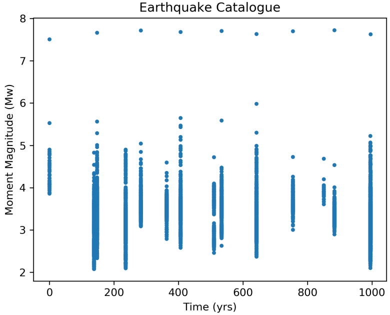


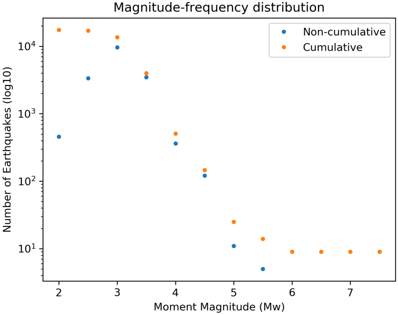
Simulated Results: Fault Zone Depth 8km



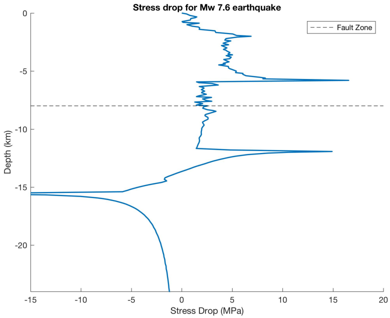


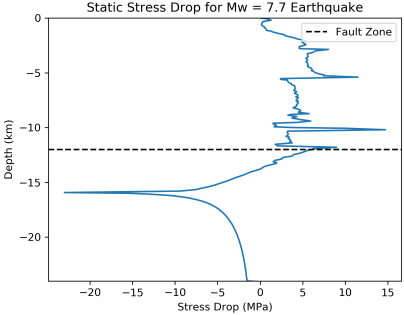
Simulated Results: Fault Zone Depth 12km



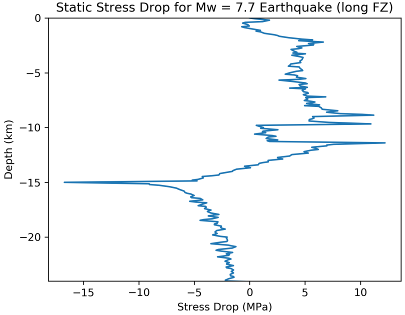


Simulated Results: Stress Drop for Larger Earthquakes





Simulated Results: Stress Drop for Larger Earthquakes



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.
- Earthquake cycle simulations with dynamic treatment of inertial effects gives a more realistic view of earthquake distribution in the presence of a material heterogeneity.

Future Work

- Implement parallel programming in the code.
- A parameter study with a narrower fault zone (400m). Velocity contrast: 20%, 40%, 60%, 80%. Fault Zone Depth: 5km, 7.5km, 10km, 12.5km, 15km.
- Increase cumulative damage after each earthquake cycle.
- Write paper and qualifying exam proposal.

That's All Folks!!