Advancing Simulations of Sequences of Earthquakes and Aseismic Slip

Modeling of Multifault Systems

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Marion Thomas



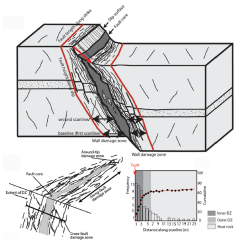
Ankit Gupta

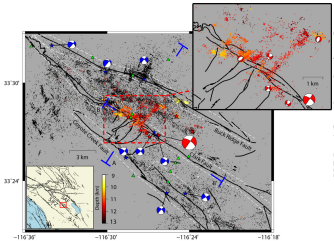


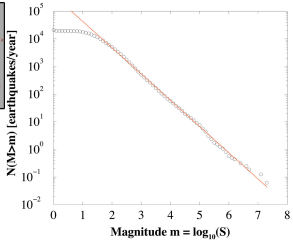
Harsha S. Bhat

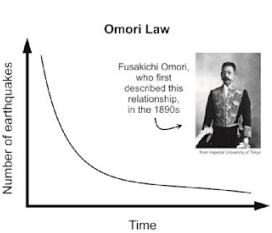
Unifying earthquake statistics and dynamics

To understand earthquake statistics, we need to consider the fault volume, rather than a single fault.



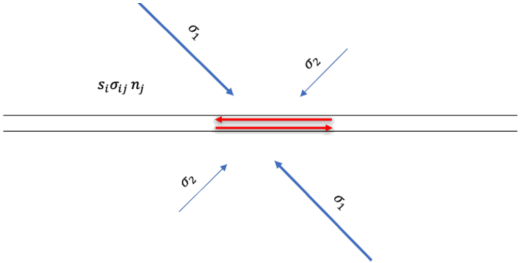




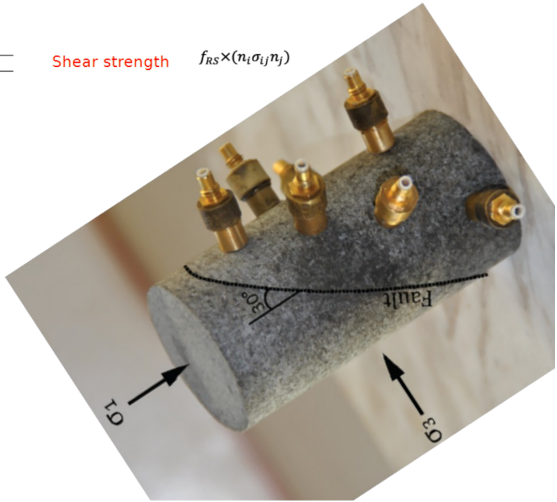


Joint work with Michelle Almakari, Carlos Villafuerte, Marion Y. Thomas, Ankit Gupta, Pierpaolo Dubernet, Jinhui Cheng and Harsha S. Bhat

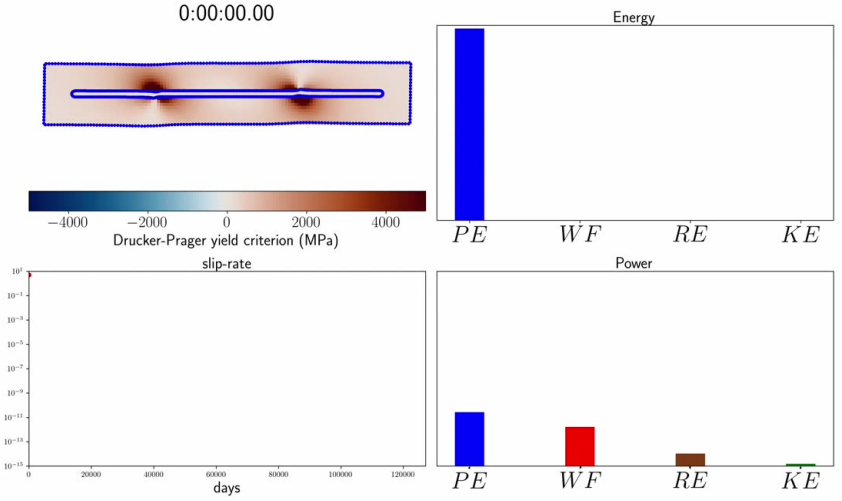
A single fault: a characteristic earthquake



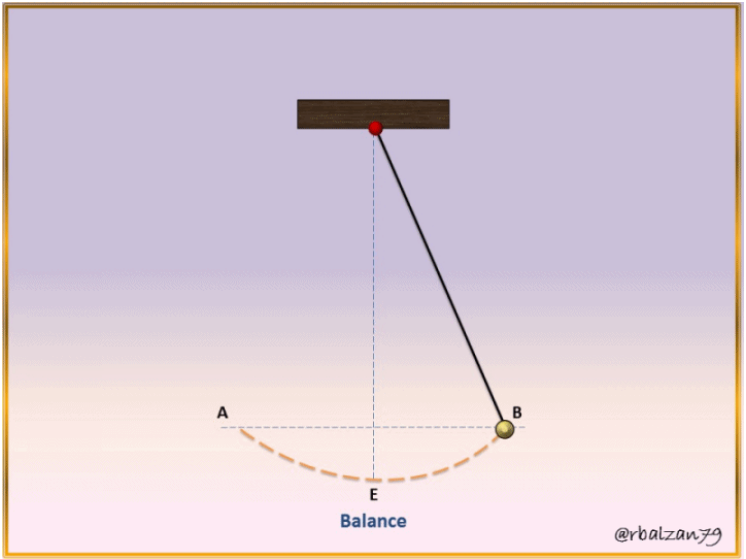
Shear strength $f_{RS}\times(n_i\sigma_{ij}n_j)$



A single fault: seismic cycle and energy budget



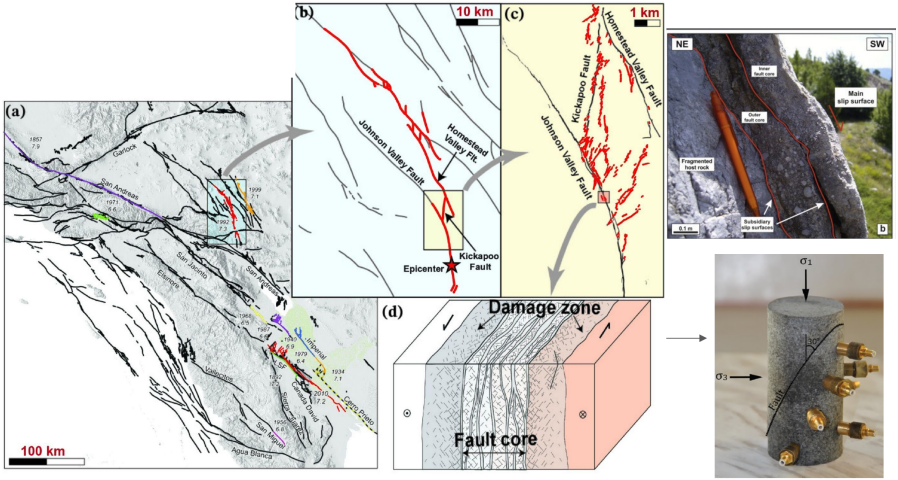
Analogy: a single pendulum



Analogy: a multi-link pendulum

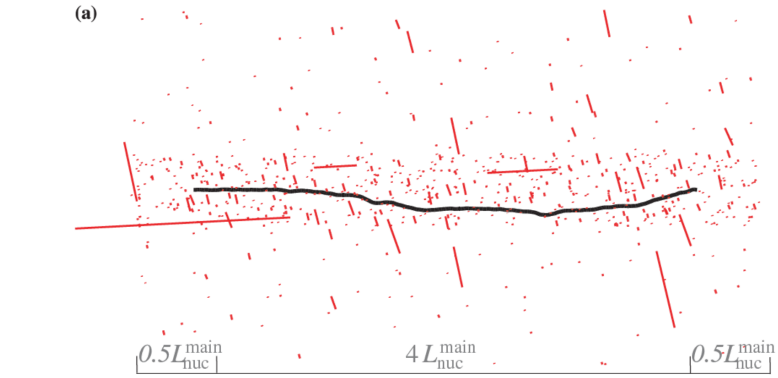


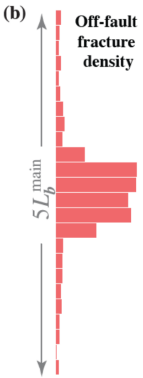
Hierarchical fault structure over multiple scales

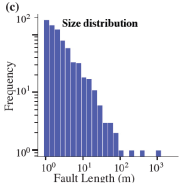


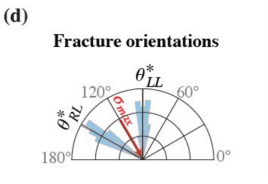
What is the seismic footprint of this hierarchical structure?

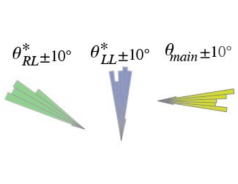
Off-fault fractures around the main fault

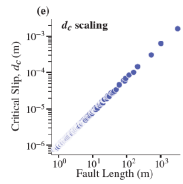




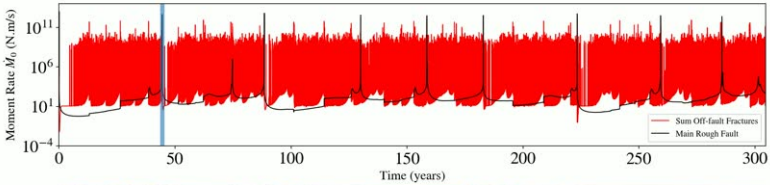




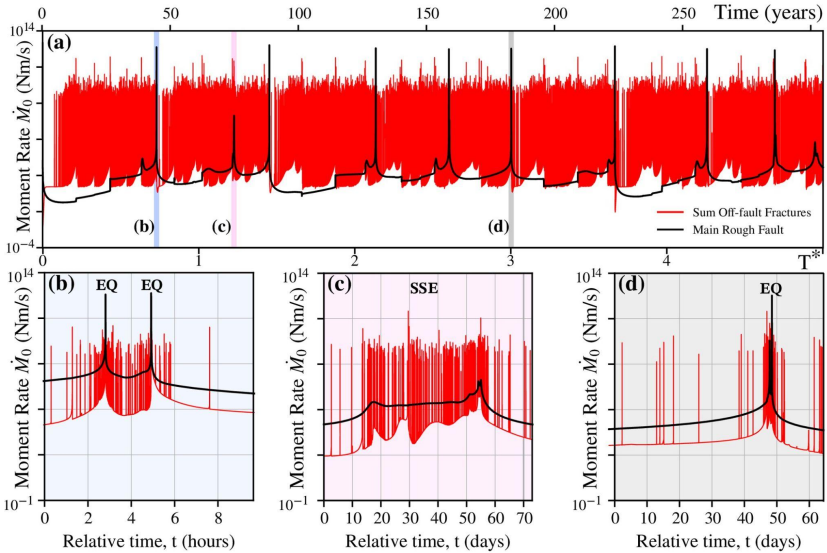




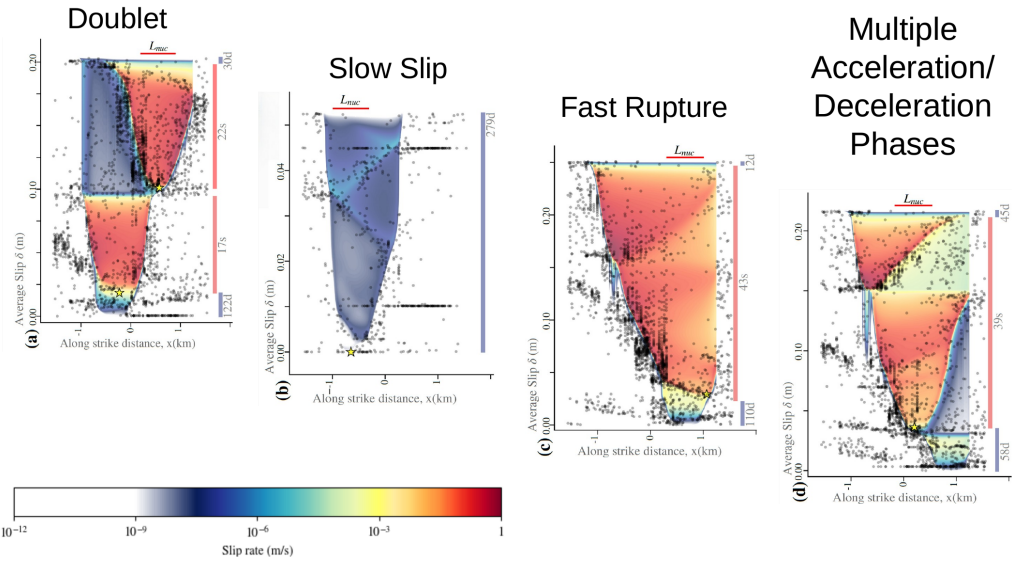
Fault zone dynamics: moment rate and strain rate



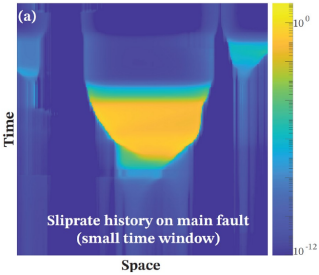
Earthquakes and slow-slip events

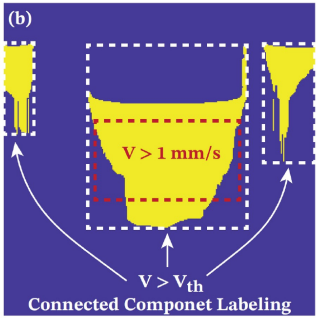


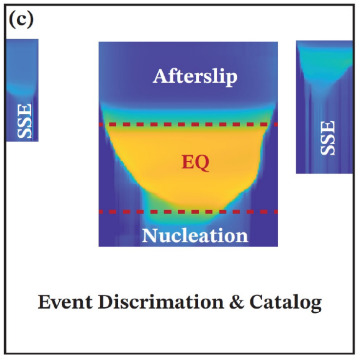
Diverse rupture styles



Building an event catalog from slip rate

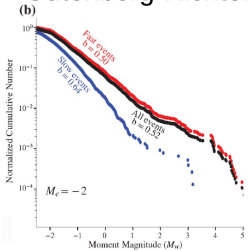




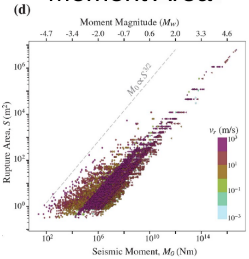


Statistics from the catalog

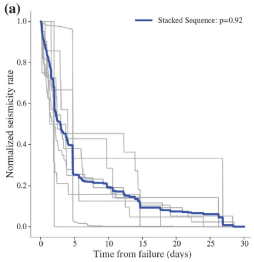
Gutenberg-Richter



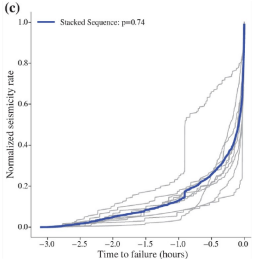
Moment Area



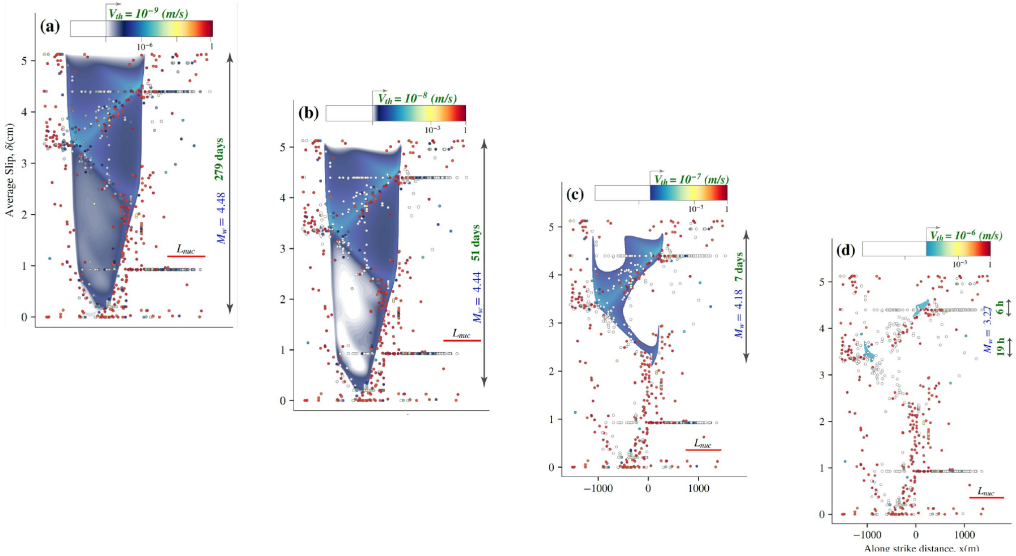
Omori Law



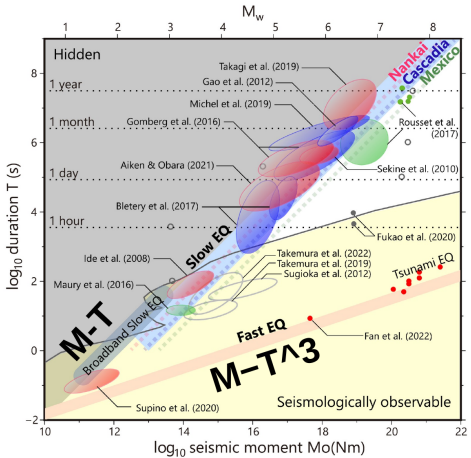
Inverse-Omori Law



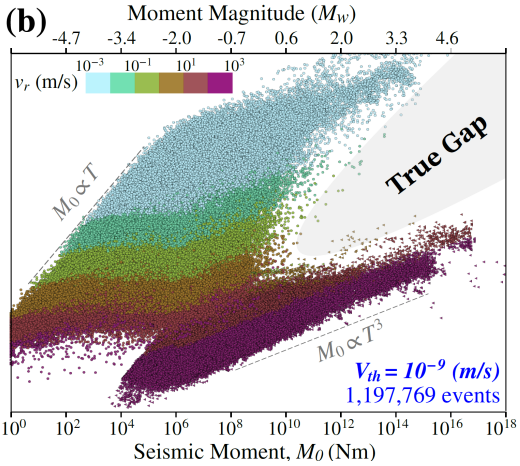
Examples of extracted events



Moment–duration scaling



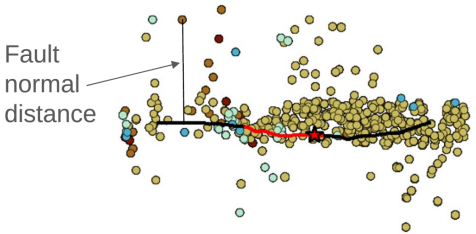
Observations (Ide & Beroza, 2023)

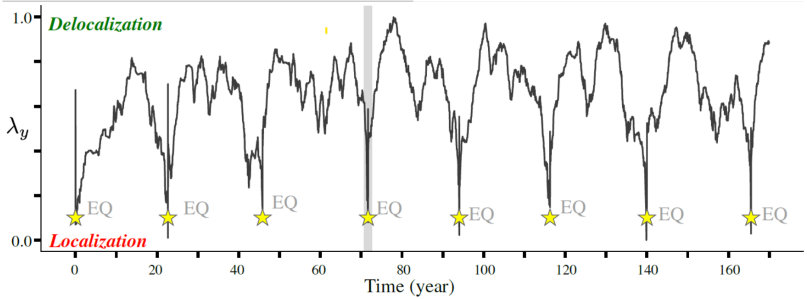


Simulated catalog

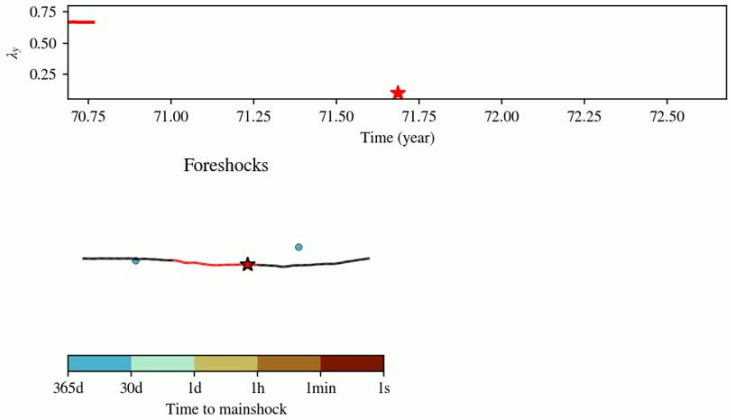
Localization and delocalization of seismicity

λ_y = std of y component of epicenters from main fault in 500 event batch

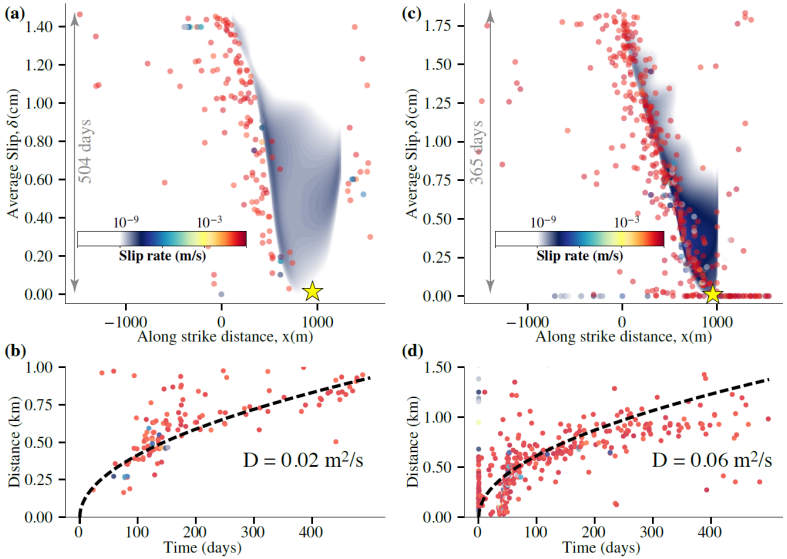




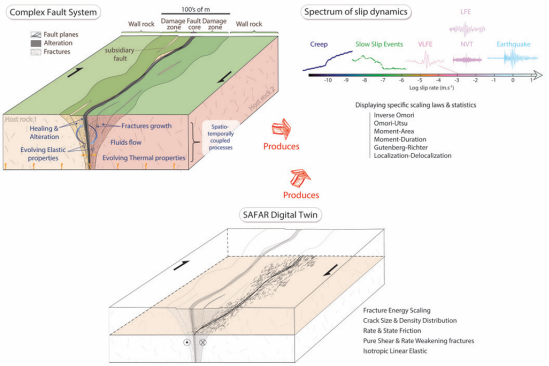
Localization before a large event: foreshocks and aftershocks



Diffusion without fluids?



Conclusion



Paper:
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