RATE-AND-STATE SIMULATIONS OF THE DELAYED DYNAMIC TRIGGERING OF THE 2019 MW 7.1 RIDGECREST MAINSHOCK BY NEARBY FORESHOCKS

Jeena YUN [1], ***Yuri FIALKO*** [1], ***Alice-Agnes GABRIEL*** [1,2]

[1] Scripps Institution of Oceanography, University of California, San Diego, La Jolla, USA
[2] Institute of Geophysics, Ludwig-Maximilians-Universität München, Munich, Germany

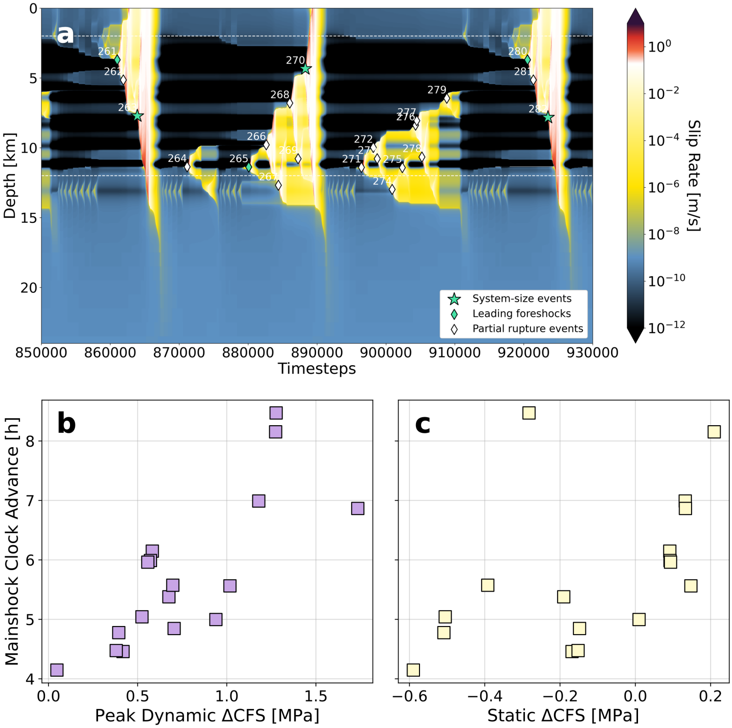
contact: j4yun@ucsd.edu

Earthquake dynamic triggering often exhibits a time delay with respect to the largest stress perturbation. For example, the 2019 Mw 7.1 Ridgecrest, CA, mainshock occurred 16 hours after a nearby Mw 5.4 foreshock that likely caused significant dynamic stress changes at the mainshock hypocenter. Here, we investigate the physical mechanisms that prevent instantaneous triggering due to a large stress perturbation on a fault that is already on the verge of runaway rupture.

We first evaluate spatio-temporal changes in dynamic and static Coulomb stress changes (dCFS) at the Ridgecrest mainshock hypocenter caused by the foreshock using 3D dynamic rupture simulations (SeisSol). We then perform quasi-dynamic seismic cycle simulations on a 2D strike-slip fault governed by rate-and-state friction (Tandem). We incorporate stress and strength heterogeneities to produce complex earthquake sequences on the mainshock fault. Our model exhibits a cascade of foreshocks leading to mainshocks over a range of hypocenter depths. Lastly, our cycle models are perturbed using the stress change history. Most of our perturbed cycle models show a clock advance of several hours, even when the static dCFS is negative. The amplitudes of static and dynamic dCFS positively correlate with the mainshock clock advance. We observe instantaneous triggering only when the peak stress perturbation is elevated to 17.5 MPa. We compare our aging law results to models using different evolution laws. While the slip law yields comparable clock advances to the aging law, the stress-dependent law leads to a systematic decrease in clock advance.

Our results have important implications for a first-order understanding of the controlling factors of near-field triggering and the scarcity of instantaneous triggering.

Note: Figure is on the next page.


a
Depth [km]
Timesteps
Slip Rate [m/s]
System-size events
Leading foreshocks
Partial rupture events
b
c
Mainshock Clock Advance [h]
Peak Dynamic ΔCFS [MPa]
Static ΔCFS [MPa]