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Dynamic Rupture Scenarios of Large Earthquakes on the Rodgers Creek-Hayward-Calaveras-Northern Calaveras Fault System, California

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The Rodgers Creek-Hayward-Calaveras-Northern Calaveras fault system in California dominates the hazard posed by active faults in the San Francisco Bay Area. Given that this fault system runs through a densely populated area, a large earthquake in this region is likely to affect millions of people. This study produced scenarios of large earthquakes in this fault system, using spontaneous (dynamic) rupture simulations. These types of physics-based computational simulations require information about the 3D fault geometry, physical rock properties, fault friction, and initial stress conditions. In terms of fault geometry, the well-connected multi-fault system includes the Hayward fault, at its southern end the Central and Northern Calaveras faults, and at its northern end the Rodgers Creek fault. Geodetic investigations of the fault system's slip-rate pattern provide images of where the fault surfaces at depth are creeping or locked interseismically, and this helped us choose appropriate initial stress conditions for our simulations. A 3D geologic model of the fault system provides the 3D rock units and fault structure at depth, while field samples from rocks collected at Earth's surface provide frictional parameters. We used this suite of information to investigate the behavior of large earthquake ruptures nucleating at various positions along this partially creeping fault system. We found that large earthquakes starting on the Hayward fault or on the Rodgers Creek fault may be slowed, stopped, or unaffected in their progress, depending on how much energy is released by the creeping regions of the Hayward and Central Calaveras faults during the time between large earthquakes. Large earthquakes starting on either the Hayward fault or the Rodgers Creek faults will likely not rupture the Northern Calaveras fault, and large earthquakes starting on either the Northern Calaveras fault or the Central Calaveras fault will likely remain confined to those fault segments.