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Dynamic Models of Earthquakes and Tsunamis in the Santa Barbara Channel, California

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The Santa Barbara Channel and the adjacent Ventura Basin in California are the location of a number of large faults that extend offshore and could potentially produce earthquakes of magnitude greater than 7. The area is also home to hundreds of thousands of coastal residents. To properly evaluate the earthquake and tsunami hazard in this region requires the characterization of possible earthquake sources as well as the analysis of tsunami generation, propagation and inundation. Toward this end, we perform spontaneous dynamic earthquake rupture models of potential events on the Pitas Point/Lower Red Mountain faults, a linked offshore thrust fault system. Using the 3D finite element method, a realistic nonplanar fault geometry, and rate-state friction, we find that this fault system can produce an earthquake of up to magnitude 7.7, consistent with estimates from geological and paleoseismological studies. We use the final vertical ground deformation from our models as initial conditions for the generation and propagation of tsunamis to the shore, where we calculate inundation. We find that path and site effects lead to large tsunami amplitudes northward and eastward of the fault system, and in particular we find significant tsunami inundation in the low-lying cities of Ventura and Oxnard. The results illustrate the utility of dynamic earthquake modeling to produce physically plausible slip patterns and associated seafloor deformation that can be used for tsunami generation.