

Fault Segmentation Effects on Sequences of Dynamic Events

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One of the biggest assumptions, and a source of some of the biggest uncertainties in earthquake hazard estimation is the role of fault segmentation in controlling large earthquake ruptures. We have developed a model which spontaneously produces complex segmented fault geometries, and on this complex fault network generates long sequences of dynamic rupture events. Using this model, we have studied a number of aspects of ruptures relevant to hazard questions. We have examined the cascading of large events across segments, finding support for a modified segmentation hypothesis whereby segments both break in power law small events and occasionally participate in cascading multisegment larger ruptures, but also predominantly break as a unit. We have examined the probability of jumping segment stepovers, finding a systematic dependence on stepover distance. We have looked at the variation of ruptures, finding an increase in variation at the ends of segments and a decrease in variation for the longest segments. We have examined the initiation, propagation, and termination of ruptures, and their relationship to fault geometry and shaking hazard. We find concentrations of epicenters near fault stepovers and ends; concentrations of terminations near fault ends; and persistent propagation directivity effects. Taking advantage of long sequences of dynamic events, we directly measure shaking hazards, such as peak ground acceleration exceedance probabilities, without need for additional assumptions. This provides a new tool for exploring shaking hazard from a physics-based perspective.