Earthquake Dynamic Triggering on a Multi-segment Fault

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Earthquake nucleation, together with its propagation and termination are among the most important aspects in earthquake studies and are of great interest to seismologists. (Harris, 1998)

We use a finite element method (Ma & Liu, BSSA, 2006) to calculate the dynamic spontaneous rupture on a simplified multi-segment normal fault model, which is derived from the Wasatch Fault Salt Lake City segment configuration. The fault trace is well constrained from the survey data while the dipping angles of the segments are less well known but are likely to be within the range of 45° to 60°.

Analytically, we model the problem from the perspective of energy balance with fracture energy and crack tip energy dissipation involved, following the classic literature (Andrews, 1976; Day, 1982). Time-dependent Coulomb stress increment is used to estimate the instantaneous stress change on one segment due to faulting on the other in order to analyze the conditions under which inter-segment triggering is possible.

Through the numerical and semi-analytical research, we want to focus on the following parts of the inter-segment dynamic triggering problem: (1) How does the fault geometry (e.g. dipping angles of the segments, degree of segment overlapping) influence the dynamic triggering process? (2) How does the seismic velocity structure (community velocity model) affect the remote triggering between segments? (3) What are the details of the initiation on the triggered segment, such as the depth and shape of the triggered patch? (4) How is inter-segment triggering process affected by heterogeneous initial stress distribution on the fault segments? The spatial variation of the initial stress is characterized by a power law and the stress at any point is characterized by a Cauchy distribution (Lavallée et al. GJI, 2006); both of which are derived from analysis of data and inversion results.

In this way we hope to shed some light on the interaction between normal fault segments during large magnitude earthquakes. More specifically, we need to understand the seismic hazard of the Wasatch Fault near Salt Lake City, which can generate Mw 7+ earthquakes and definitely one of the most seismically hazardous places in the US.