A Collaborative Project: Comparison and Validation of Earthquake Simulators

Southern California Earthquake Center Research Summary 2009

Ramón Arrowsmith
&
Olaf Zielke
School of Earth and Space Exploration (SESE)
Arizona State University
Tempe, AZ 85287-1404, U.S.A.
ramon.arrowsmith@asu.edu

We continue to participate in the Southern California Earthquake Center (SCEC) earthquake simulator workshops and code validation effort. This includes running earthquake simulations for simple fault geometries (single fault) as well as also complex, state-wide (California) fault systems including tens to hundreds of faults (Figure 1). The specific parameters used in these simulations (e.g., fault geometries, frictional parameter, tectonic loading functions) were and continue to be discussed and defined during workshops and group meetings as well as conference calls. The resulting synthetic seismic catalogs are compared with results from other groups participating in this effort during these meetings to outline further progression in validating individual earthquake simulators. The participants of earthquake simulator workshops (including our group) aim to identify metrics that characterize the success i.e., correctness of the simulator results. These metrics, particularly for large, state-wide models will be of statistical nature and should be comparable with natural seismicity.

Much of the work is still underway, but major activities include

- Simple simulations for single faults to compare behavior between relatively simple friction and rate and state friction implementations
- Standardization of data I/O and post-processing of the seismic catalogs for ease of comparison and exchange.
- Refinements of Northern California fault array simulations. Figure 1 shows 3 simulated events rupturing the full seismogenic thickness.
- Computation of magnitude frequency for earthquakes along the Northern California Fault array (Figure 2). Even in the complex array (Figure 1), the events tend to be clustered in space with the successive events being within ~ 1 source dimension of each other (Figure 2B).

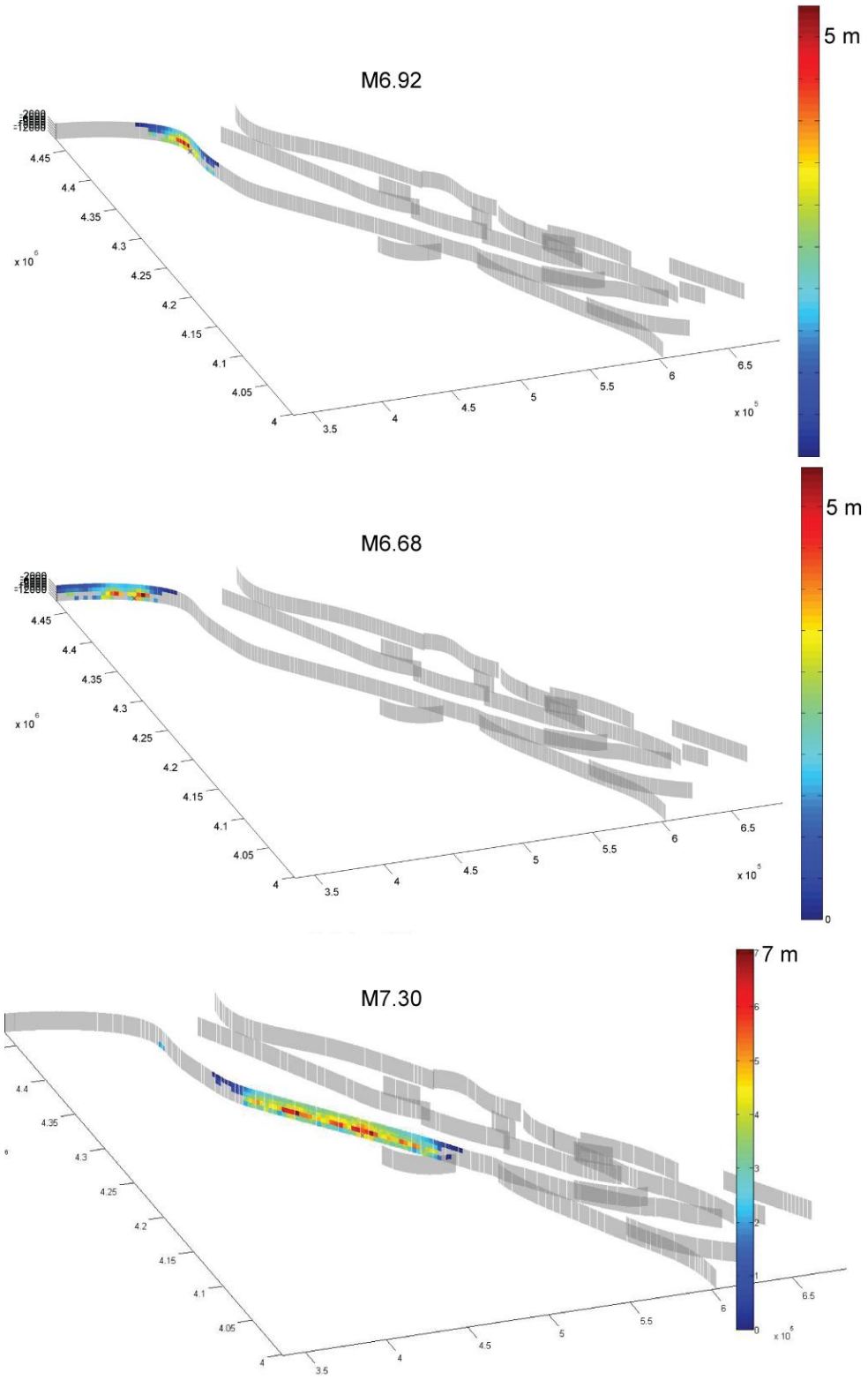

Figure 1. Three full rupture simulated earthquakes within the Northern California Fault array. Figure 2 shows further analysis of the associated simulated catalog.

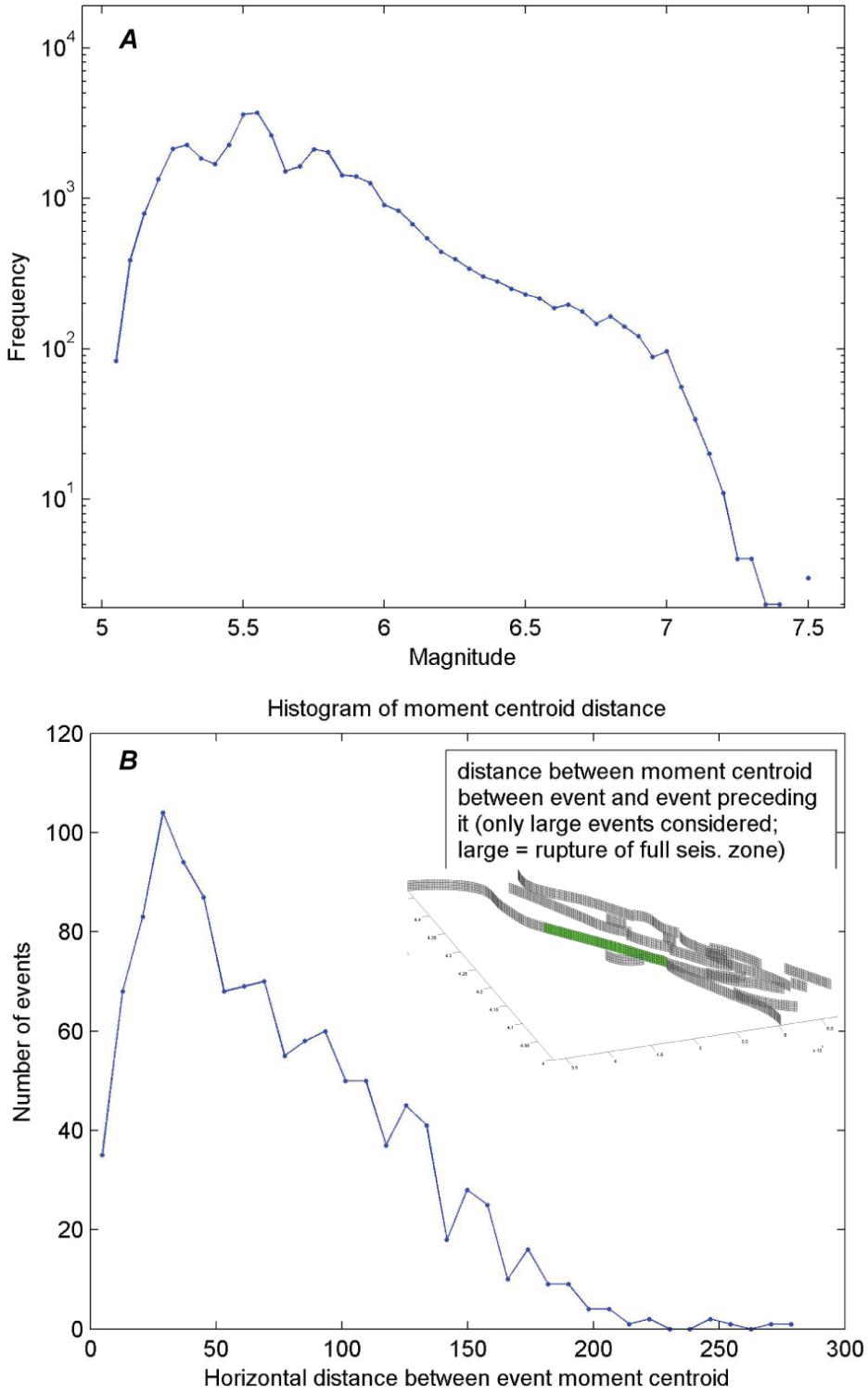

Figure 2. Analysis of the simulated catalog for Northern California fault array (Figure 1). A) Frequency versus magnitude plot. B) Distance between moment centroid position (as opposed to hypocenter location) of successive full-rupture earthquakes (relative to green segment). The peak in the distribution is at about 30km and indicates a tendency for large events to rupture near each other. Thus triggering is important feature of these simulated full rupture events.