Harvard University, Solid Earth Physics Seminar
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4th Floor Faculty Lounge, Hoffman Laboratory, 20 Oxford St.

Effects of the free surface and low-velocity layers on seismic and aseismic fault slip

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Abstract:

Fault processes involve complex patterns of seismic and aseismic slip. It is important to simulate both seismic and aseismic modes of slip as they influence each other and together determine fault behavior, e.g., the nucleation of future earthquakes. Previous modeling studies on this subject have used boundary integral methods (BIM), which are accurate and efficient but readily applicable only to faults embedded into a uniform elastic space. Here we present our developments of a spectral element method (SEM). An SEM has flexibility of a finite element method and accuracy of a spectral method. We have developed an SEM that enables us to simulate single dynamic ruptures as well as long-term fault slip histories on faults with true representations of the free surface embedded into layered media. Inclusion of the off-fault plasticity/damage is currently under development. Applications of SEM to supershear transition of earthquake rupture due to the free surface and to the origin of shallow slip deficit in large strike-slip earthquakes will be discussed. In the former study, we find that locally supershear rupture near the free surface can occur due to (i) the generalized Burridge-Andrews mechanism, that is, supershear loading field between P- and SV-wave arrivals, and (ii) phase conversion, analogous to SV to P-diffracted waves. In the latter study, we show that coseismic slip deficit can be caused by a shallow velocity-strengthening region, but not by low-velocity shallow bulk materials.