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Origin of high frequencies in radiated seismic wave fields

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Understanding the origin of high-frequency generation in seismic wave fields radiated by propagating ruptures is important for earthquake-engineering application, but also of fundamental interest for earthquake physics. Studies using dynamic rupture models (Dunham et al., 2011; Shi and Day, 2013) revealed that spontaneous rupture propagating on faults with varying degree of surface-roughness naturally generates ground motions with realistic high-frequency amplitude spectra. These models are characteristic by complex shapes of source time functions. However, our previous results (Mai et al., 2017) indicate that amplitude spectra of dynamic model can also be produced by kinematic rupture model with rather simple regularized Yoffe function, as long as source parameters (rupture time, rise time, slip, acceleration time) are determined by the dynamic rupture model. Therefore, instead of trying to identify and parametrize correlations between various source parameters (which may be masking the underlying physics), we now focus on understanding the effects leading to high frequency radiation.

Our preliminary results indicate that proper variations of source parameters in space are important for high-frequency radiation, whereas complex shape of the source time function at a single source point is of lower importance. We then aim to parametrize and quantify the variations of source parameters along the fault as a next step towards being able to generate an arbitrary yet physically consistent rupture model. Thus, we propose an important new step for developing improved physics-based kinematic rupture models generating wave field with realistic frequency spectrum.

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