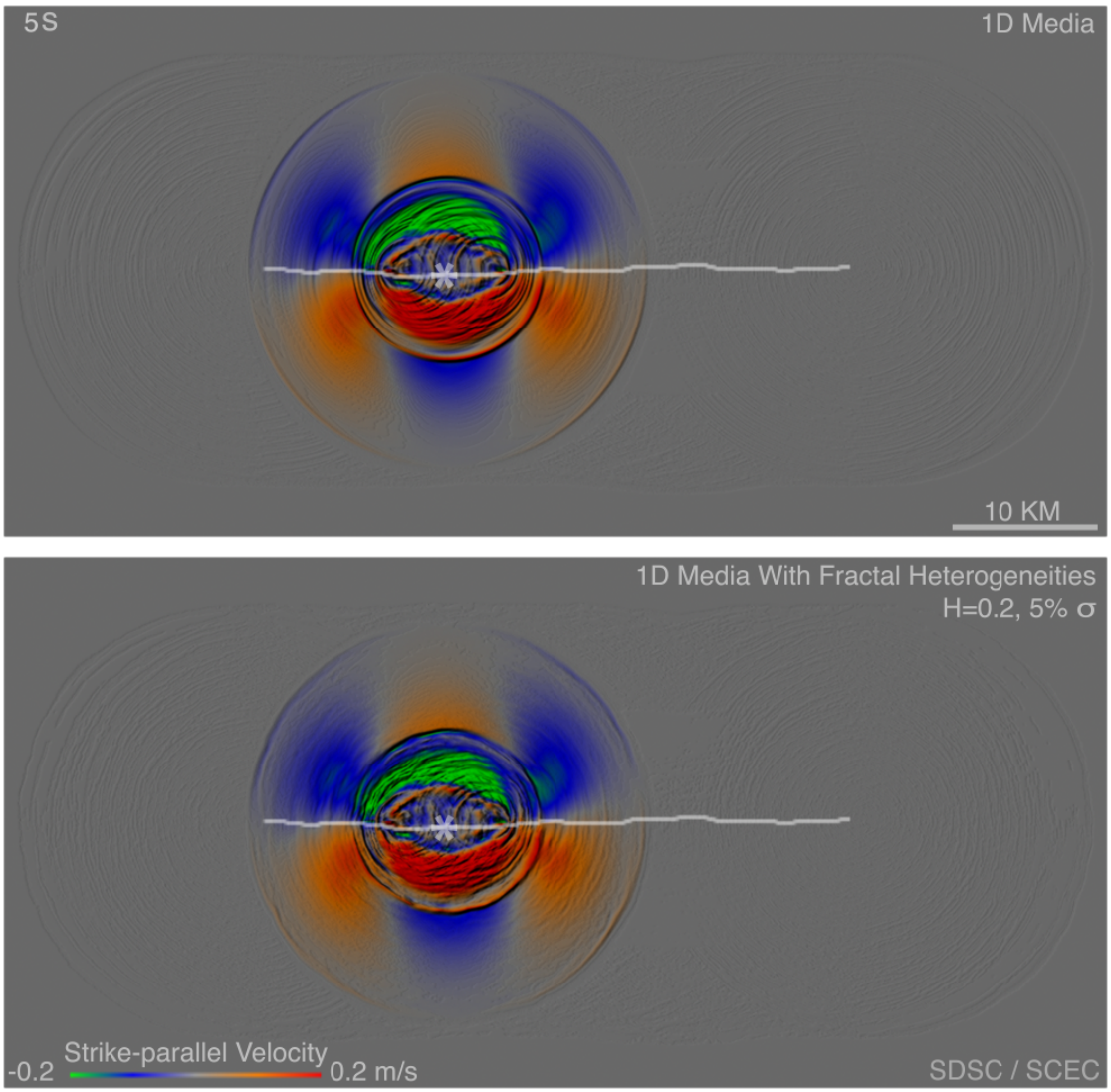
Visualization Of Deterministic High-Frequency Ground Motions From Simulations Of Dynamic Rupture Along Rough Faults With And Without Medium Heterogeneity Using Petascale Heterogeneous Supercomputers

Amit Chourasia, Yifeng Cui, Efecan Poyraz, Kim B. Olsen, Jun Zhou, Kyle Withers, Scott Callaghan, Jeff Larkin, Clark C. Guest, Dong Ju Choi, Zheqiang Shi, Steven M. Day, Philip J. Maechling, Thomas H. Jordan

ABSTRACT: The accuracy of earthquake source descriptions is a major limitation in high-frequency (~>1 Hz) deterministic ground motion prediction, which is critical for performance-based design by building engineers. Here, we attempt to quantify the contributions to high-frequency (up to ~10 Hz) ground motion from small-scale complexities in both fault geometry and media. We perform wave propagation simulations using a complex kinematic source from a simulation of dynamic rupture along a rough fault. Calculation of ground motions is extended to a distance of 35 km from the fault with a highly scalable fourth-order staggered-grid finite difference method (GPU-based AWP).

The animation shows the evolution of an earthquake rupture as well the waves radiated to the surrounding medium. The vertical plane shows details of how the relative movement of two sides of the fault evolve, which leads to the release of large amount of seismic waves causing the ground to shake. These simulations demonstrate the importance of including small-scale heterogeneities in ground motion models, in that they can cause the rupture front to break up and cause both defocusing and focusing of the wavefield. The result is a modified distribution of predicted peak ground motion, an important parameter used by engineers to establish building codes. There is also a significant amount of backscatter behind the initial waves, lengthening the duration of ground shaking. Both the rough fault and medium heterogeneities will become increasingly important in the field of earthquake hazard prediction as more powerful computers enable ground motion prediction to higher frequencies.

Movie URL: http://visservices.sdsc.edu/projects/scec/hh/movies/hh.mp4



Visualization snapshot