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An Adaptive Smoothing Algorithm in the TSN Modeling of Rupture Propagation with the Linear Slip-weakening Friction Law

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We present an adaptive smoothing algorithm for reducing spurious high-frequency oscillations of the slip-rate time histories in the finite-element—traction-at-split-node modeling of dynamic rupture propagation on planar faults with the linear slip-weakening friction law. The algorithm spatially smoothes trial traction on the fault plane. The smoothed value of the trial traction at a grid point and time level is calculated if the slip is larger than 0 simultaneously at the grid point and 8 neighboring grid points on the fault. The smoothed value is a weighted average of the Gaussian-filtered and unfiltered values. The weighting coefficients vary with slip.

Numerical tests for different rupture propagation conditions demonstrate that the adaptive smoothing algorithm effectively reduces spurious high-frequency oscillations of the slip-rate time histories without affecting rupture time. The algorithm does not need an artificial damping term in the equation of motion.

We implemented the smoothing algorithm in the finite-element part of the 3D hybrid finite-difference—finite-element method. This makes it possible to efficiently simulate dynamic rupture propagation inside a finite-element sub-domain surrounded by the finite-difference sub-domain covering major part of the whole computational domain.