EFFICIENT FINITE DIFFERENCE CODE FOR DYNAMIC STRONG MOTION INVERSIONS

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Dynamic source inversions aim to optimize distributions of dynamic parameters governing the rupture propagation to fit observed seismograms. Due to strong nonlinearity between data and model parameters, employing Monte Carlo methods is advisable. The dynamic inversions thus require fast and accurate solution of the forward problem, mainly the simulation of the spontaneous rupture propagation. We have improved the finite difference staggered grid code FD3D by Madariaga and Olsen [1998], by implementing the traction-at-split method as the fault boundary condition and perfectly matched layers (PML) as the absorbing boundary condition. In addition to the slip-weakening friction law, rate-and-state friction law with strong rate weakening has been also implemented. We test the new code FD3D_TSN on USGS/SCEC benchmarks TPV5 (slip-weakening friction) and TPV104 (fast rate weakening friction) [Harris et al., 2018]. We observe considerable improvements in the accuracy, especially in the case of the heterogeneous prestress. The code has been also ported to GPU using OpenACC directives. The speed-up is approximately 10 times with respect to the CPU version. Moreover, we present two applications of the code: i) dynamic rupture simulations with reduced S-wave speed in the fault zone inducing pulse-like behaviour in accordance with Huang et al. [2014], and ii) dynamic source inversion of the 2014 Mw6.0 South Napa, California, earthquake.