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Developing a Near Real-time System for Earthquake Slip Distribution Inversion

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Advances in observational and computational seismology in the past two decades have enabled completely automatic and real-time determinations of the focal mechanisms of earthquake point sources. However, seismic radiations from moderate and large earthquakes often exhibit strong finite-source directivity effect, which is critically important for accurate ground motion estimations and earthquake damage assessments. Therefore, an effective procedure to determine earthquake rupture processes in near real-time is in high demand for hazard mitigation and risk assessment purposes. In this study, we develop an efficient waveform inversion approach for the purpose of solving for finite-fault models in 3D structure. Full slip distribution inversions are carried out based on the identified fault planes in the point-source solutions. To ensure efficiency in calculating 3D synthetics during slip distribution inversions, a database of strain Green tensors (SGT) is established for 3D structural model with realistic surface topography. The SGT database enables rapid calculations of accurate synthetic seismograms for waveform inversion on a regular desktop or even a laptop PC. We demonstrate our source inversion approach using two moderate earthquakes (Mw$\sim$6.0) in Taiwan and in mainland China. Our results show that 3D velocity model provides better waveform fitting with more spatially concentrated slip distributions. Our source inversion technique based on the SGT database is effective for semi-automatic, near real-time determinations of finite-source solutions for seismic hazard mitigation purposes.