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Determine Earthquake Rupture Directivity Using Taiwan TSMIP Strong Motion Waveforms

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Inverting seismic waveforms for the finite fault source parameters is important for studying the physics of earthquake rupture processes. It is also significant to image seismogenic structures in urban areas. Here we analyze the finite-source process and test for the causative fault plane using the accelerograms recorded by the Taiwan Strong-Motion Instrumentation Program (TSMIP) stations. The point source parameters for the mainshock and aftershocks were first obtained by complete waveform moment tensor inversions. We then use the seismograms generated by the aftershocks as empirical Green's functions (EGFs) to retrieve the apparent source time functions (ASTFs) of near-field stations using projected Landweber deconvolution approach. The method for identifying the fault plane relies on the spatial patterns of the apparent source time function durations which depend on the angle between rupture direction and the take-off angle and azimuth of the ray. These derived duration patterns then are compared with the theoretical patterns, which are functions of the following parameters, including focal depth, epicentral distance, average crustal 1D velocity, fault plane attitude, and rupture direction on the fault plane. As a result, the ASTFs derived from EGFs can be used to infer the ruptured fault plane and the rupture direction. Finally we used part of the catalogs to study important seismogenic structures in the area near Chiayi, Taiwan, where a damaging earthquake has occurred about a century ago. The preliminary results show a strike-slip earthquake on 22 October 1999 (Mw 5.6) has ruptured unilaterally toward SSW on a sub-vertical fault. The procedure developed from this study can be applied to other strong motion waveforms recorded from other earthquakes to better understand their kinematic source parameters.