MULTISCALE FAULT ZONE DEFORMATION CONTROLLED BY RUPTURE DYNAMICS DURING THE 2021 MW7.4 MADUO EARTHQUAKE

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The existence of fault zones has been widely acknowledged through geological and geophysical observations. However, the physical connection between fault zone deformations and rupture dynamics remains poorly understood. In this study, we use various published datasets spanning spatial resolutions from meters to kilometers to characterize the fault zone deformation of the 2021 Mw7.4 Maduo earthquake, where the immature Jiangcuo fault has accommodated ∼4-5 km in the middle and ∼0.8–1.2 km near the eastern end. Geodetic offset data from optical image correlations, surface cracks, and relocated aftershocks reveal an inverse power decay law with multiscale decay distances at the surface and in depth. To understand the physical control of rupture dynamics on these observations, we construct a series of dynamic rupture simulations assuming an elastoplastic half-space solid. We systematically test various parameters in dynamic rupture models and find that (1) the decay distance of plastic strain at the shallowest depth is consistent with that of observed surface cracks; (2) the decay distance of the shear stress in the upper crust is consistent with that of observed aftershocks. Our results illustrate the critical roles of dynamic ruptures on multiscale fault zone deformation and provide important implications for the dynamics of large earthquakes.