Observations of surface fault deformation from high-resolution optical image correlation: case of the 2021 M_w7.4 Maduo, Tibet, earthquake

Antoine, S. L.[1], Liu, Z.[1], Klinger, Y[2], Delorme, A[2]

(1) NASA Jet Propulsion Laboratory, California Institute of Technology, California, USA
(2) Université de Paris Cite, Institut de Physique du Globe de Paris, CNRS, Paris, France

Surface deformation associated with continental earthquake ruptures generally includes localized deformation on the faults and distributed and/or diffuse deformation of the off-fault medium. However, the interplay between the different deformation components, and their relative role in the rupture process is not yet well understood, especially for the diffuse component. Moreover, the analysis of the deformation processes relies on our ability to measure horizontal and vertical ground displacements across different spatial scales, from the inner fault zone to the far-field, and connect those measurements to the source processes occurring at depth. In this work, we use high-resolution optical image correlation to measure the surface displacements associated with the 2021 Mw7.4 Maduo, Tibet, rupture. Our results show that slip along the primary faults represents only ~45% of the surface deformation budget, with the other ~55% that correspond to distributed and diffuse deformation. The detailed analysis of the deformation patterns along the rupture area reveals a spatially variable localization of the surface deformation as a function of coseismic slip, including diffuse bulk yielding in regions where no or less slip occurred on the primary faults. For the case of the Maduo earthquake, such diffuse behavior is found primarily in the epicentral area, where the earthquake displacement and associated stresses are lower due to the smaller size of the nascent rupture patch. Towards improving the observations of earthquake surface displacements and developing future Earth surface observing systems, we finally quantify the effects of optical imagery and topography data ground resolutions on the measurement of surface fault displacement for this case study. This analysis sheds light on the potential bias in the displacement measurements and derived scientific interpretations due to the use of low-resolution (> 3m) data.