Surface rupture characteristics of the 2016 Kumamoto earthquake from correlation of lidar topography

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The Kumamoto earthquake sequence of April, 2016 included a Mw 6.2 foreshock on April 14th, followed two days later by the Mw 7.0 mainshock. Here we present an investigation of the mainshock surface rupture, its shallow slip characteristics, and geometrical rupture propagation effects. We use a combination of fault offsets surveyed on the ground by the Geological Survey of Japan, together with near-field surface displacements calculated from differential airborne lidar data. We use two 0.5 meter-resolution digital surface models provided by Asia Air Survey, Co. that are derived from lidar surveys flown following the foreshock on April 15th, and eight days after the mainshock on April 24th. Although the surface models have not been processed to remove vegetation, the close temporal spacing of acquisitions minimizes non-tectonic surface changes. The datasets are correlated using two methods: pixel tracking with the COSI-Corr software package to compute horizontal displacements, and an iterative closest point tracking algorithm in LIBICP that provides the full 3D displacement field. Results for both methods are compared for internal consistency and surface offsets are computed along fault-perpendicular transects. Where lidar- and field-measured offsets are co-located they are generally in good agreement, but the lidar offsets can also be used to fill in significant gaps in the field data (up to ~3 km). Both datasets reveal a strikingly smooth along-strike slip distribution as well strain partitioning into strike-slip and dip-slip components along distinct rupture planes, rare observations in large earthquakes.

Keywords: Kumamoto earthquake, slip distribution, iterative closest point, pixel tracking, differential lidar, rupture characteristics

