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3D co-seismic offsets during the 2016 MW 7.8 Kaikōura earthquake (New Zealand) from aerial photogrammetry

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For several earthquakes during the past decade, differencing of LiDAR point clouds has been used to map 3D co-seismic deformation. Point-cloud differencing is a very effective tool for mapping near-fault deformation, but its use is often restricted by an absence of pre-earthquake LiDAR data.

We use point clouds generated from pre- and post-earthquake aerial photographs (rather than LiDAR) to estimate co-seismic slip on three faults that slipped during the 2016 Kaikōura earthquake: the Kekerengu and Papatea faults and the Jordan Thrust. First, we validate our approach using: (1) differential LiDAR; (2) field observations of surface slip; (3) offsets from differential InSAR; and (4) sub-pixel correlation of satellite imagery. Second, we present detailed measurements of slip along the Jordan Thrust, Kekerengu fault and the Snowflake Spur fault, which was previously not mapped.

Our results demonstrate that point clouds generated from photogrammetry can be an effective tool for mapping near-fault co-seismic slip, particularly for hard-to-access ruptures like the Jordan thrust. Since almost all of New Zealand is covered by high-resolution aerial imagery, detailed mapping of surface deformation should be possible for future large earthquakes.