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Application of terrestrial LiDAR topographic data to reconstruct offset geomorphic markers along the Fuyun strike-slip fault, Xinjiang, China

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Tectonically offset geomorphic markers such as stream channels, terrace risers, alluvial fan surfaces and other types of ridges and troughs record the surface signature of successive earthquakes on active faults. Increasingly detailed 3D surface measurements, together with multiple age constraints, now yield a much-improved understanding of the long-term seismic behavior of such faults. Using sub-metric-resolution Quickbird optical satellite images, we obtained a dense horizontal offset dataset (553 measurements) along the right-lateral Fuyun fault. The most recent rupture along this fault, which is remarkably well preserved due to the arid climate, was generated by the Ms 7.9, august 11, 1931 Fuyun earthquake. For 5 successive earthquakes of similar size, the dataset is consistent with characteristic seismic behavior ($\approx 6 \pm 1$ m of co-seismic slip).

To complement and validate this dataset, we acquired terrestrial LiDAR topographic data over a total length of 7.5 km at 4 sites where multiples of the 1931 offsets were measured on Quickbird images. Using the new LiDAR DEMs obtained, we were able to map fault scarps more accurately, and the restoration of horizontal offset measurements was improved using apparent vertical offsets. The identification and definition of the markers with the 3D LiDAR data is unambiguous, and qualitative differences in the apparent ages of the markers may be assessed, increasing the confidence level in the reconstructions. On the thrust segments of the rupture, knickpoint retreat can be quantified, opening the way to a better understanding of the interaction between erosion and seismic surface deformation in shaping the landforms.

Field observations, HR optical satellite images and LiDAR topographic data ideally complement one another to test the repeatability of offset measurements and constrain the densest possible vertical and horizontal slip distributions along active faults. By combining them, we are starting to build unique datasets to test earthquake cycle models on large Asian strike-slip faults.