Abstract:

Analysis of pre- and post-earthquake topographic data provides an opportunity to deliver the full 3D displacement field of the ground’s surface. However, direct differencing of airborne- and post-earthquake digital topography model (DEM) generally leads to biased estimation of the vertical component of the deformation of the pre- and post-earthquake DEM exhibit horizontal mis-registration. We use the COSI-Corr sub-pixel correlation algorithm to estimate the relative horizontal offset between the pre- and post- 2010 El Mayor – Cucapah earthquake high-resolution LiDAR acquisitions. Compensating for the horizontal offset between the two LiDAR acquisitions allows us to estimate accurately the vertical component of the surface fault rupture. We also show the limitations of the available dataset, such as aircraft jitter artifacts, which impaired accurate displacement measurement for the complete vertical slip component of the rupture induced by the Mw 7.2 2010 El Mayor – Cucapah earthquake, sampled at every 5 m, over a length of about 125 km, and with a vertical accuracy of ±1 cm. Variations in the vertical component of the oblique slip earthquake are presented, with breaks along multiple fault-ends showing opposite dip directions and diffuse boundaries. Vertical displacement profiles across the entire fault rupture and selective horizontal displacement profiles will be shown. With the availability of high precision pre- and post-earthquake data, COSI-Corr has the ability to accurately document the variability of 2D surface and strike slip of an earthquake rupture. Such data can be used to investigate the causes of this variability, and improve our understanding of its influence on the pattern of ground shaking.

Conclusions:

- We successfully used COSI-Corr to recover 3D deformation of the pre- and post-earthquake LiDAR acquisitions for the first time.
- Aircraft jitter is the largest limitation in recovering the horizontal component of the deformation.
- We densely mapped the full extent of the vertical slip distribution associated with the El Mayor – Cucapah earthquake.
- Unbiased field measurements, COSI-Corr has the ability to measure distributed slip away from the main rupture.
- Dense coverage of unbiased slip distribution can be used to investigate the causes of slip variability, and improve our understanding of its influence on the pattern of ground shaking.

Data preparation:
Pre-earthquake LiDAR with average point-cloud density 2.6 points/m² was acquired in 2006 by INEGI was interpolated into a gridded 5 m-resolution by CICESE. Post-earthquake high-resolution LiDAR was collected by NCALM grid at 5m resolution by CICESE. Post-earthquake high-resolution LiDAR was acquired in 2006 by INEGI was interpolated into a 5 m resolution by CICESE. Pre-earthquake LiDAR (with average point cloud density 2.6 points/m²) was acquired in 2006 by INEGI was interpolated into a gridded 5 m-resolution by CICESE. The ENVI plug-in “BCAL Corr [Leprince et al, 2007].” The post-earthquake DEM was then warped onto the pre-earthquake DEM according to the relative horizontal offset field measured, produced by the COSI-Corr analysis on pre-earthquake and post-earthquake LiDAR acquisitions.

References:


Surface rupture and slip variation induced by the 2010 El Mayor – Cucapah earthquake, Baja California, quantified using COSI-Corr analysis on pre- and post-earthquake LiDAR acquisitions

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