Characterization and removal of shadow bias from Optical Image Correlation; application to the 2013 Balouchistan earthquake

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Abstract

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In recent years, optical image correlation (OIC) has become a powerful geodetic tool (in compliment to InSAR) for the retrieval of near-field earthquake ground deformations using optical satellite data. However, because optical satellite images are acquired throughout the year, the changing illumination conditions at the time of each acquisition may be expected to subtly influence the shadow content of each pixel, which in turn may bias the correlation process, resulting in contaminated displacement maps. We use the Landsat8 archive of satellite images acquired several years after the 2013 Balouchistan earthquake (Mw 7.8; left-lateral strike-slip with thrust) to investigate the influence of seasonal variations in sun illumination on the resulting deformation field retrieved with OIC. We find the displacement field varies seasonally as a function of the difference in pre- and post-image sun elevation. The amplitude of the seasonal artifacts correlate strongly with topography (slope angle), and are greatest in the north-south displacement component, which is subject to the largest variation in shadow movement. By correlating different combinations of images, we develop functions for each pixel in the correlation describing how the seasonal displacement varies as a function of the pre- and post-image sun elevation. We then remove seasonal artifacts from various correlations derived from Landsat8 combinations spanning the co- and post-seismic periods. Finally, we invert our illumination-corrected correlations using the NSBAS processing chain, which takes advantage of the large data redundancy to produce a more robust deformation time-series. These two approaches allow us to significantly increase the precision of OIC, such that we can retrieve small (