Impacts of data source and resolution on the measurement of coseismic surface deformations using satellite optical image correlation methods: application to the case of the 2021 M_w7.4 Maduo earthquake

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The 2021 M_w7.4 Maduo earthquake generated a ~160 km-long fault rupture within the Eastern Tibetan plateau, at about 100-150 km to the south-west of the Eastern Kunlun fault. Comparison between fault offsets measured in the field, and Sentinel-2 optical image correlations (10 m ground resolution) suggests that ~20% of the coseismic surface displacements might have occurred on the faults. The remaining ~80% may take place as diffuse deformation in the surrounding medium. In this study, we assess the impact of optical data properties (satellite sensor, geometry of acquisition, resolution, and seasonal change) on the measurement of the localized and diffuse components of the deformation associated with the 2021 Maduo rupture using optical image correlation methods. Our preliminary results suggest that, to the first order, measurements accuracy depends on the spatial resolution of the satellite images. However, the geometry of image acquisition (number of images and viewing angle) also affects the quality of the derived pre- and post-earthquake Digital Surface Models used for orthorectification, and impact on the accuracy and noise of the resulting image correlations and derived products. As part of the investigation, we further assess the potential of each correlation result, obtained from different optical datasets, for deriving rotation and strain maps and thus, assessing the mechanisms contributing to the surface deformation. With this aim, we develop a denoising method, based on a polynomial moving-window interpolation that allows for reducing artefacts and noise, and extracting the low-frequency deformation gradients. This work describes the consequences of accessing or selecting different datasets on the measurement of coseismic ground deformations, and shows that the use of high-resolution (<0.5 m) stereo imagery is necessary for rigorously separating the localized and diffuse components of the deformation that occur at different spatial scales.

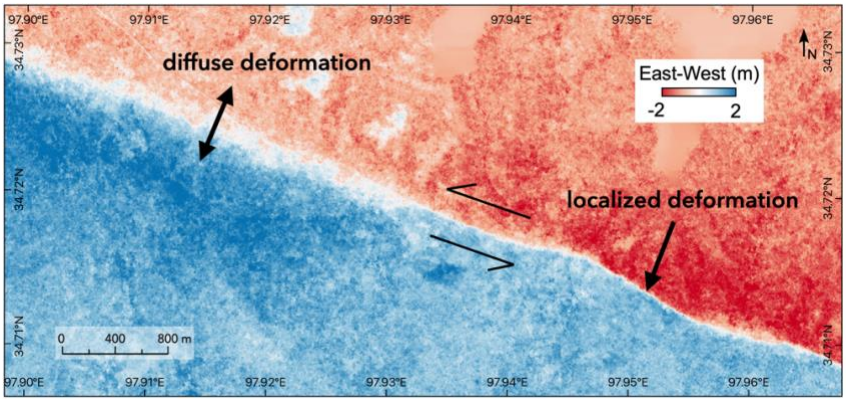

Figure 1: East-West displacement along the 2021 Mw7.4 Maduo, Tibet, rupture (~5 km long section located North-West of the earthquake epicenter) measured from sub-pixel correlation of SPOT6-7 and Pleiades satellite optical images (Antoine et al., in prep.).