Displacement Field of the Kaikoura (New Zealand) M7.8 Earthquake Constrained by Spaceborne Geodetic Imaging Techniques

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Abstract

The Kaikoura (New Zealand) M7.8 earthquake occurred on November 13, 2016 and was quickly identified as a very complex event with multiple fault ruptures, of which several reaching the surface. Triggered secondary phenomena included numerous landslides, resulting in substantial damages to the road network. An improved understanding of seismic hazard and, consequently, the notion of risk, is critical to building resilient societies. This understanding implies, among others, accurate measurement of the displacement field induced by a seismic event. The Kaikoura event has once again highlighted the central role by spaceborne geodetic imaging techniques to improve our knowledge regarding surface deformation following an earthquake and allow us to take into account the complexity introduced by local conditions, and thus, better target impacted areas. In this work, we carry out analysis of satellite imagery by means of offset tracking techniques in order to refine our knowledge of the co-seismic displacement field of the Kaikoura earthquake. The Copernicus Sentinel-1 constellation, a joint initiative of the European Commission and the European Space Agency (ESA), together with imagery from the Landsat 8 mission, launched NASA and operated USGS, were utilized. Tailored processing of both optical and SAR data to enhance the detection of local displacement patterns was considered, including temporal smoothing of independent measurements and joint elaboration of errors for outlier minimization. The results were initially compared to regional GNSS observations, while further analysis of geodetic imaging results were realized at different spatial scales to serve the representation of the complexity of motion in the near-field context, focusing particularly on the interaction between the Papatea fault and the Kekerengu fault.

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