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Co- and post-seismic crustal deformation of the 2014 Iquique-Pisagua Earthquake observed with InSAR and GPS data

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The western margin of South America is dominated by a 6000 km long subduction zone that drives the seismogenic processes of megathrust earthquakes along the Chilean coast. Almost all seismotectonic segments at this highly active plate boundary have broken within the last decades producing great earthquakes (MW>8.5). The only segment that has not ruptured since 1877 is known as Northern Chile-Southern Peru seismic gap. It is located between 18°-22°S latitude and has the potential of generating a Mw=9+ earthquake. On 1 April 2014, the Iquique-Pisagua earthquake (MW>8.5) affected the north-central part of this gap. This earthquake was proceeded by a transient deformation 15 days before the main shock and followed by a MW=7.6 aftershock.
In this study, we analyze and model the co- and postseismic crustal deformation related to the Iquique-Pisagua earthquake by means of InSAR and GPS measurements. In the modeling, we perform a joint inversion of InSAR and GPS data by applying principle component analysis and the decomposition of displacement vectors in an elastic half-space. Our InSAR observations include three TerraSAR-X images from three years before the earthquake and one, resp. 79 days after the event. This dataset allows us to separate deformation caused by the main event and the aftershock two days later. Moreover, we present five Radarsat-2 scenes from four days before and three, 19, 44 and 76 days after the earthquake. Our GPS data include time-series of more than 40 continuous stations of the Integrated Plate Boundary Observatory Chile (IPOC) and 60 survey-mode GPS data. The co-seismic interferograms show a circular deformation pattern centered at the North Chilean coast near the city of Iquique. The cGPS recorded a maximum horizontal displacement of 80 cm trenchward. In the post-seismic interferograms the deformation is much smaller and somewhat less symmetric. The first two month of postseismic deformation show a cumulative GPS displacement up to 10 cm around the rupture area.
The relatively low magnitude of the main event indicates that the seismic gap was only partially closed. This fact leads to an ongoing high level of observational attention at this segment. Our study contributes to a better understanding of the kinematic processes that occur before, during and after earthquakes.