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Deformation monitoring from Synthetic Aperture Radar Interferometry (INSAR) Sentinel data in Quito, Ecuador

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The Quito Fault System (QFS) is part of the Inter-Andean depression (ID) in Ecuador and extends from 0°N to 60 km southward along strike of the Western Cordillera. It consists of N-S striking, steep west-dipping blind thrusts. Quito megapolis and urban area lies at 2300 to 3200 meters above sea level and extends from the western flank of active Pichincha volcano eastward to the QFS´s hanging wall and the extinct Ilalo volcano, in highly vulnerable settings. Beauval et al. (2014), described the seismic hazard calculations of the QFS as locked; higher values are obtained for several sites located above the hanging wall. The fault´s activity over 600 kyrs uplifted the hanging wall of Quito´s historical center by ~600 m over the rest of the ID, such as the Chillos Valley. Surprisingly, no major historical earthquake is directly related to the QFS during the last 500 years. Indeed, the historical seismic record shows that Quito experienced MSK intensities of VIII and damages were associated to activity on distal fault systems. Results of instrumental monitoring from geodetic and InSAR surveys, suggests that the QFS has spatial variability in slip distribution, with shallow creep reaching the surface along its central segment, while the northern and southern segments show interseismic coupling and no notable movement. The geodetic data interpretation also argues for transient aseismic deformation in the area during interseismic loading on the fault zone. Since InSAR is an efficient technique to monitor large scale surface deformation, we propose to use the NSBAS chain package (Doin et al. 2011) to be able to describe the entire fault zone and correct from atmospheric biases. We selected and processed 105 images of the new SAR data of Sentinel-1 (ESA-C band, descending track) from October 2014 to November 2018. Data are downloaded from the CNES-PEPS catalog and the precise orbital data from ESA and small temporal baselines (<2 months) were used in order to preserve coherence. Atmospheric corrections are calculated using the ERA5 meteorological data from ECMWF showing atmospheric patterns elongated along the mountain range. In the Quito region, these patterns are dominated by wave patterns (locally deflected by the surrounding volcanic peaks) and we thus applied various filters to optimize coherence. We here present time series of the line of sight surface displacements, in a first attempt to identify any type of deformation accumulated since 2014 on the QFS and in a second attempt better characterize such transient signals at the scale of the entire QFS.

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