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Investigation of interseismic deformation of active faults in eastern Iran: contribution of Spaceborn radar Interferometry

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Active tectonic in Iran is related to the Arabia-Eurasia convergence and it is accommodated on the mountainous belt in the south (Zagros) and in the North (Alborz and Kopeh-Dagh). Part of this shortening that is not absorbed in Zagros, is created about 15 mm/yr N-S right-lateral shear between central Iran and Afghanistan. This NS shear in Eastern Iran is localized on NS oriented right-lateral faults surrounding the aseismice Lut block and on EW oriented left-lateral faults, Dorouneh and Dasht-e-Bayaz faults, at the northern boundary of Lut Block. Previous studies on these two major faults in Eastern Iran show discrepancies between the GPS interseismic slip rate (less than 1 mm/yr on the Dorouneh fault), geological slip rates (2.4$\pm$0.3 mm/yr) and predictions from a tectonical model ($<$ 10 mm/yr). These discrepancies between short time (GPS) and long term (geomorphological and tectonical) slip rates motivated us to use other geodetic techniques to investigate the fault activity in the area. The spatial coverage and precision of space-borne radar interferometry (InSAR) in measuring ground deformation makes it an appropriate geodetic tool to address the following question: Are the sparse GPS measurements representative of the regional present-day interseismic deformation or does more deformation occur either on portion of the Dorouneh and Dasht-e-Bayaz faults not well sampled by GPS or on other geological structures in the region? This is an important issue to better understand the regional tectonics and the seismic hazard in Eastern Iran.

Several InSAR studies have been already successful in measuring long-wavelength ground displacements related to interseismic fault deformation on similar continental strike-slip fault (like the North Anatolian fault or the Haiyuan fault). However, in our case, the expected slip rates of the Dorouneh and Dasht-e-Bayaz faults are lower (1 to 3 mm/yr), making InSAR measurements more challenging, even if the East-West orientation of these strike-slip faults and their arid environment are favorable to it. In this study, we use ENVISAT ASAR images from 2003 to 2010, in descending orbits. The 400 by 400 km studied area that includes the eastern part of the Dorouneh fault is covered by four satellite tracks (435, 392, 163 and 120). The raw radar images are processed with ROI_PAC to construct the interferograms and unwrapped them. The topography phase contribution is estimated from the SRTM Digital Elevation Model (DEM) at 90 m spatial resolution. We first performed a careful visual inspection of interferograms, looking for short wavelength signals (1-10 km scale) that could be related to superficial creep along faults. We found deformation related to subsidence phenomena in some valleys but no evidence over the 2003-2010 period for a sharp creep deformation signal located along fault.

Then, we started to analyze the long wavelength (30-300 km scale) ground deformation looking for interseismic strain accumulation related to elastic deformation caused by fault creep at depth (above which the fault is locked). We correct for the stratified part of tropospheric delay correlated with elevation using the observed phase-elevation correlation. A twisted plane is also fitted to remove orbital errors. As turbulent atmospheric signal is still dominating the corrected interferograms, a stacking approach using selected interferograms is applied in order to enhance the tectonic signal. The selection of interferograms is based on a noise energy function that measures the quality of each interferogram. Our analysis is completed by a comparison of the interseismic velocity map derived from InSAR with simple direct elastic models based on the Savage and Burford model (1973) using different fault slip rates.