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InSAR Time Series Analysis of Interseismic Deformation in Eastern Iran

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The high seismicity of Iran, with large and shallow destructive earthquakes, reflects its intense tectonic activity that takes place in the Alpine–Himalayan belt context. Active tectonics in the Iranian plateau is dominated by the convergence between the Arabian and Eurasian plates, taking place inside the political borders of the country. The part of the convergence that is not absorbed in Zagros at its SW border must be accommodated by shear deformation between Central Iran and the Helmand sub-plate to the east of Iran. Consequently, Eastern Iran has a crucial role in accommodating N-S right-lateral shear between Central Iran and Afghanistan. The tectonic deformation in eastern Iran is localized mainly on NS oriented right-lateral faults surrounding the aseismic Lut block, and EW left-lateral faults at the northern boundary of the Lut block. Previous studies on these major left-lateral faults in Eastern Iran show discrepancies especially between the GPS interseismic slip rate (less than 1 mm/yr on the Doruneh fault and geological slip rates (2.4$\pm$0.3 mm/yr). The spatial coverage, acceptable resolution and precision of space-borne radar interferometry (InSAR) make it a powerful technique to resolve some open questions of fault mechanisms and their role in the regional tectonics. Several InSAR studies have been already successful in measuring long-wavelength ground displacements related to interseismic fault deformation on similar continental strike-slip faults (like the North Anatolian fault or the Haiyuan fault). The most important difficulty of the present study is the slow slip rate of the targeted faults (1 to 3 mm/yr). Even if the East-West orientation of the Doruneh or Dasht-e-Bayaz strike-slip faults is favourable to the measurement from descending or ascending ENVISAT orbits, such low slip rate faults still require some methodological improvement with respect to conventional InSAR.

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 Doruneh fault is covered by seven satellite tracks (Descending: 120, 392, 163, 435 and 206 and Ascending: 156 and 385). The raw radar images are processed with ROI_PAC to construct the interferograms and unwrap them. The resulting differential interferogram phase is related to the deformation signal, changes of tropospheric delay, orbital and DEM errors and noise. We correct for the stratified part of tropospheric delay correlated with elevation using the observed phase-elevation correlation and for a twisted plane to remove orbital errors. Large scale seasonal atmospheric corrections are also investigated using the ERA-Interim meteorological model and GPS data. To investigate the long wavelength tectonic signal due to interseismic strain accumulation, a time series analysis of the selected images based on the small base line method (SBAS) has been done on a pixel basis in order to enhance the signal to noise ratio affected by a remaining atmospheric signal. The selection and the weighting of the interferograms are based on a noise energy function that measures the quality of each interferogram. The resulting displacement time series and a mean velocity map can be compared to GPS data.