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InSAR and GPS time series analysis: Crustal deformation of the Southern Walker Lane, western Great Basin, United States

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It has been successfully demonstrated in several previous studies that long time series (e.g. >5 years) of GPS measurements can be employed to detect tectonic signals with a vertical rate greater than 0.3 mm/yr (e.g. Hill and Blewitt, 2006; Bennett et al. 2009). However, GPS stations are often sparse, with spacing from a few kilometres to a few hundred kilometres. Interferometric SAR (InSAR) can complement GPS by providing high horizontal spatial resolution (e.g. meters to tens-of metres) over large regions (e.g. 100 km $\times$ 100 km).

The southern Walker Lane (SWL) and Yucca Mountain region of the western Great Basin in the United States is chosen as the study site because 1) it is a zone of active crustal extension and shear deformation and 2) it has a dense, high-precision continuous GPS network and extensive radar archives. Presently the archives include >11 years of continuous GPS data and >17 years of ERS and ENVISAT radar acquisitions. Interferometric coherence is generally high owing to the relatively arid environment, even for long temporal baselines that span the existing C-band radar archives. A major source of error for repeat-pass InSAR is the phase delay in radio signal propagation through the atmosphere. The portion attributable to tropospheric water vapour can cause errors as large as 10-20 cm in deformation retrievals. InSAR Time Series analysis with Atmospheric Estimation Models (InSAR TS + AEM), developed at the University of Glasgow, is a robust time series analysis approach which uses interferograms with small geometric baselines to minimize the effects of decorrelation and inaccuracies in topographic data. InSAR TS + AEM can be used to separate deformation signals from atmospheric water vapour effects in order to map surface deformation.

The principal purposes of this study are to assess: (1) how consistent are InSAR-derived deformation time series with GPS; (2) how precise are InSAR-derived atmospheric path delays, and (3) what are the rates and patterns of vertical and horizontal crustal deformation in the SWL. Our results show that: (1) the InSAR LOS deformation map agrees with GPS measurements to within 0.46 mm/yr RMS misfit at the stations over a wide region (250 km x 100 km), (2) the RMS differences between InSAR and GPS derived path delays are about 5 mm, and (3) that the integrated InSAR+GPS deformation maps provide new information about surface deformation near active structures in the SWL.