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# A Quantitative Assessment of DInSAR Measurements of Interseismic Deformation: The Southern San Andreas Fault Case Study

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*Abstract*—We investigate the capabilities and limitations of the Differential Interferometric Synthetic Aperture Radar (DInSAR) techniques, in particular of the Small BAseline Subset (SBAS) approach, to measure surface deformation in active seismogenetic areas. The DInSAR analysis of low-amplitude, long-wavelength deformation, such as that due to interseismic strain accumulation, is limited by intrinsic trade-offs between deformation signals and orbital uncertainties of SAR platforms in their contributions to the interferometric phases, the latter being typically well approximated by phase ramps. Such trade-offs can be substantially reduced by employing auxiliary measurements of the long-wavelength velocity field. We use continuous Global Positioning System (GPS) measurements from a properly distributed set of stations to perform a pre-filtering operation of the available DInSAR interferograms. In particular, the GPS measurements are used to estimate the secular velocity signal, approximated by a spatial ramp within the azimuth-range radar imaging plane; the phase ramps derived from the GPS data are then subtracted from the available set of DInSAR interferograms. This pre-filtering step allows us to compensate for the major component of the long-wavelength range change that, within the SBAS procedure, might be wrongly interpreted and filtered out as orbital phase ramps. With this correction, the final results are obtained by simply adding the pre-filtered long-wavelength deformation signal to the SBAS retrieved time series. The proposed approach has been applied to a set of ERS-1/2 SAR data acquired during the 1992–2006 time interval over a 200 × 200 km area around the Coachella Valley section of the San Andreas Fault in Southern California, USA. We present results of the comparison between the SBAS and the Line Of Sight (LOS)—projected GPS time series of the USGC/PBO network, as well as the mean LOS velocity fields derived using SBAS, GPS and stacking techniques. Our analysis demonstrates the effectiveness of the presented approach and provides a quantitative assessment of the accuracy of DInSAR measurements of interseismic deformation in a tectonically active area.

**Key words:** Deformation time series, differential SAR interferometry, Small BAseline Subset (SBAS), interseismic deformation, San Andreas Fault.

## *1. Introduction*

Differential Synthetic Aperture Radar Interferometry (DInSAR) is a microwave remote sensing technique that allows measuring surface deformation with a centimeter to millimeter accuracy at high resolution (tens of meters) and large spatial coverage (GABRIEL *et al.*, 1989). The DInSAR technique exploits the phase difference (interferogram) between two temporally separated SAR acquisitions to provide a measure of the ground deformation along the radar Line Of Sight (LOS).

Initially applied to characterize sizeable deformation events (MASSONNET *et al.*, 1993, 1995; PELTZER and ROSEN, 1995; RIGNOT, 1998; AMELUNG *et al.*, 1999; FIALKO *et al.*, 2001), the DInSAR methodology has successively been adapted to analyze the temporal evolution of surface deformation via the generation of LOS displacement time series. For this purpose, the information available from each interferometric SAR data pair must be properly related to that contained in other pairs by generating and inverting an appropriate sequence of DInSAR interferograms. In this context, several advanced DInSAR approaches have been implemented; they can be grouped into two main categories: the Persistent Scatterer (PS) (FERRETTI *et al.*, 2000; WERNER *et al.*, 2003; HOOPER *et al.*, 2004) and the Small Baseline (SB) (BERARDINO *et al.*, 2002; MORA *et al.*, 2003; PRATI *et al.*, 2010) methods, although a solution that incorporates both the PS and SB approaches has also been recently proposed (HOOPER, 2008). The first

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