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Investigating the Creeping Segment of the San Andreas Fault using InSAR time series analysis

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We exploit the advanced Interferometric Synthetic Aperture Radar (InSAR) technique referred to as the Small BAseline Subset (SBAS) algorithm to analyze the creeping section of the San Andreas Fault in Central California. Various geodetic creep rate measurements along the Central San Andreas Fault (CSAF) have been made since 1969 including creepmeters, alignment arrays, geodolite, and GPS. They show that horizontal surface displacements increase from a few mm/yr at either end to a maximum of up to ∼34 mm/yr in the central portion. They also indicate some discrepancies in rate estimates, with the range being as high as 10 mm/yr at some places along the fault. This variation is thought to be a result of the different geodetic techniques used and of measurements being made at variable distances from the fault. An interferometric stack of 12 interferograms for the period 1992-2001 shows the spatial variation of creep that occurs within a narrow (<2 km) zone close to the fault trace. The creep rate varies spatially along the fault but also in time. Aseismic slip on the CSAF shows several kinds of time dependence. Shallow slip, as measured by surface measurements across the narrow creeping zone, occurs partly as ongoing steady creep, along with brief episodes with slip from mm to cm. Creep rates along the San Juan Bautista segment increased after the 1989 Loma Prieta earthquake and slow slip transients of varying duration and magnitude occurred in both transition segments The main focus of this work is to use the SBAS technique to identify spatial and temporal variations of creep on the CSAF. We will present time series of line-of-sight (LOS) displacements derived from SAR data acquired by the ASAR instrument, on board the ENVISAT satellite, between 2003 and 2009. For each coherent pixel of the radar images we compute time-dependent surface displacements as well as the average LOS deformation rate. We compare our results with characteristic repeating microearthquakes that occurred along the CSAF. These small (M < 3.5) seismic events, which occur in a narrow zone (<2 km wide) along the fault between depths of 1 and 12 km are believed to be driven by spatially and temporally variable creep, and so their distribution may correlate with creep patterns in both space and time.