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From local to national scale DInSAR analysis for the comprehension of Earth's surface dynamics.

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Earth Observation techniques can be very helpful for the estimation of several sources of ground deformation due to their characteristics of large spatial coverage, high resolution and cost effectiveness. In this scenario, Differential Synthetic Aperture Radar Interferometry (DInSAR) is one of the most effective methodologies for its capability to generate spatially dense deformation maps with centimeter to millimeter accuracy. DInSAR exploits the phase difference (interferogram) between SAR image pairs relevant to acquisitions gathered at different times, but with the same illumination geometry and from sufficiently close flight tracks, whose separation is typically referred to as baseline. Among several, the SBAS algorithm is one of the most used DInSAR approaches and it is aimed at generating displacement time series at a multi-scale level by exploiting a set of small baseline interferograms. SBAS, and generally DInSAR, has taken benefit from the large availability of spaceborne SAR data collected along years by several satellite systems, with particular regard to the European ERS and ENVISAT sensors, which have acquired SAR images worldwide during approximately 20 years.
While the application of SBAS to ERS and ENVISAT data at local scale is widely testified, very few examples involving those archives for analysis at huge spatial scale are available in literature. This is mainly due to the required processing power (in terms of CPUs, memory and storage) and the limited availability of automatic processing procedures (unsupervised tools), which are mandatory requirements for obtaining displacement results in a time effective way. Accordingly, in this work we present a methodology for generating the Vertical and Horizontal (East-West) components of Earth's surface deformation at very large (national/continental) spatial scale. In particular, it relies on the availability of a set of SAR data collected over an Area of Interest (AoI), which could be some hundreds of thousands of square kilometers wide, from ascending and descending orbits.
The exploited SAR data are processed, on a local basis, through the Parallel SBAS (P-SBAS) approach thus generating the displacement time series and the corresponding mean deformation velocity maps. Subsequently, starting from the so generated DInSAR results, the proposed methodology lays on a proper mosaicking procedure to finally retrieve the mean velocity maps of the Vertical and Horizontal (East-West) deformation components relevant to the overall AoI. This technique permits to account for possible regional trends (tectonics trend) not easily detectable by the local scale DInSAR analyses.
We tested the proposed methodology with the ENVISAT ASAR archives that have been acquired, from ascending and descending orbits, over California (US), covering an area of about 100.000 km2.
The presented methodology can be easily applied also to other SAR satellite data. Above all, it is particularly suitable to deal with the very large data flow provided by the Sentinel-1 constellation, which collects data with a global coverage policy and an acquisition mode specifically designed for interferometric applications.