The Sentinel-1 P-SBAS processing chain for local, national, and continental scale surface deformation analyses

Michele Manunta (1), Berardino Paolo (1), Manuela Bonano (2), Sabatino Buonanno (1), Francesco Casu (1), Claudio De Luca (1), Adele Fusco (1), Riccardo Lanari (1), Mariarosaria Manzo (1), Antonio Pepe (1), Giovanni Zeni (1), and Ivana Zinno (1)

(1) IREA-CNR, Napoli, Italy (manunta.m@irea.cnr.it), (2) IMAA-CNR, Tito Scalo, Italy

The well-known Small BAseline Subset (SBAS) algorithm is an advanced Differential Synthetic Aperture Radar (SAR) Interferometry (DnSAR) approach aimed at retrieving displacement time-series and corresponding mean deformation velocity maps with centimeter to millimeter accuracy, also dealing with different spatial scales and multi-sensor data. SBAS relies on an appropriate combination of differential interferograms produced by data pairs characterized by short temporal and orbital separation (baseline), in order to limit the decorrelation phenomena.
Recently, a parallel version of the SBAS algorithm, referred to as P-SBAS, has been developed, whose implementation relies on the proper exploitation of distributed computing infrastructures (i.e. grid and cloud) by benefiting from both multi-core and multi-node programming techniques.
In this work we present an efficient and automatic parallel processing chain for the generation of Sentinel-1 (S-1) Interferometric Wide Swath (IWS) products (mean deformation velocity maps and displacement time-series) through the P-SBAS algorithm. The developed processing chain fully benefits from the characteristics of the TOPS acquisition mode, used to acquire Sentinel-1 IWS SAR data and consisting of a series of independent bursts. Indeed, each burst can be considered as a separate image; thus it can be parallel and automatically processed by exploiting high-performance distributed computing infrastructures.
To demonstrate the effectiveness of our Sentinel-1 P-SBAS processing chain, the experimental results have been obtained by focusing on the latest advances in Cloud Computing solutions for the generation of Earth surface deformation time-series. In particular, we have implemented the P-SBAS Sentinel-1 processing chain through a Cloud Computing solution, based on an ad-hoc designed distributed-storage implementation within the Amazon Web Services (AWS) Cloud Environment.
In this paper, we concentrate on an extended area over the Italian peninsula and we present the deformation time-series, as well as the mean velocity maps generated through the P-SBAS processing of S1 data acquired both from ascending and descending orbits. In particular, we show the results obtained by processing the whole Sentinel-1 archive acquired along descending and ascending orbits between 2014 and 2017 over Italy (more than 3000 Sentinel-1 scenes) through the AWS Elastic Cloud Computing (EC2) platform. As a final output, by combining the Line Of Sight (LOS) displacement maps relevant to the ascending and descending sensor orbits, the maps of the vertical and East-West components of the ground displacements are also achieved.