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2014-2016 Mt. Etna Ground deformation imaged by SISTEM approach using GPS and SENTINEL-1A/1B TOPSAR data

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In the frame of the EC FP7 MED-SUV project (call FP7 ENV.2012.6.4-2), and thanks to the GEO-GSNL initiative, GPS data and SENTINEL 1A/1B TOPSAR acquired on Mt. Etna between October 2014 and November 2016 were analyzed. The SENTINEL data were used in order to combine and integrate them with GPS, and detail the ground deformation recorded by GPS on Mt. Etna, during the last two-year's volcanic activity.
The Sentinel data were processed by GAMMA software, using a spectral diversity method and a procedure able to co-register the SENTINEL pairs with extremely high precision (< 0.01 pixel). In order to optimize the time processing, a new software architecture based on the hypervisor virtualization technology for the x64 versions of Windows has been implemented. The DInSAR results are analysed and successively used as input for the time series analysis using the StaMPS package.
On December 28, 2014 eruptive activity resumed at Mt. Etna with a fire fountain activity feeding two lava flows spreading on the eastern and south-western upper flanks of the volcano, producing evident deformation at the summit of the volcano. GPS displacements and Sentinel-1A ascending interferogram were calculated in order to image the ground deformation pattern accompanying the eruption. The ground deformation pattern has been perfectly depicted by the GPS network, mainly affecting the uppermost part of the volcano edifice, with a strong decay of the deformation, according to a very shallow and strong dyke intrusion. The Sentinel 1A SAR data, covering the similar time spanning, confirmed that most of displacements are related to the dike intrusion, and evidenced a local gravity-driven motion of the western wall of the Valle del Bove, probably related to the dike intrusion.
To monitor the temporal successive evolution of ground deformation, we performed an A-DInSAR SENTINEL analysis using the Small BAseline Subset (SBAS) approach included with the StaMPS processing package. The April 2015-December 2015, SBAS Time series, shown a volcano inflation, with an uplift of about 28 mm localized in the central and western area of the volcano. Suddenly, in the first days of December 2015, volcanic activity abruptly restarted at the central crater with a very strongly explosive eruption; this kind of activity continued, with a decreasing intensity, with other episodes at the same crater and then involving, in turn, all the other three summit craters of the volcano. On December 8, when the eruptive activity was concluding, a seismic swarm affected the uppermost part of the Pernicana fault where it joins the NE-Rift. The SBAS time series have then been integrated by the SISTEM algorithm with the ground displacements measured by two GPS surveys carried out on the NE flank of the volcano at the end of April and in mid-December 2015. Results of this data integration provide a very detailed picture of the ground deformation pattern on the volcano, preceding and accompanying the vigorous eruption and the seismic swarm; besides the general inflation of the edifice during the pre-eruptive period.
The January 2016 – November 2016 is the last period analyzed, characterized by the kinematic of the eastern unstable flank, with displacement involving both the Pernicana fault and the other structures dissecting this sector of the volcano.