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3D displacement maps of the 2016 central Italy seismic sequence, by applying the SISTEM method to GPS data and Sentinel 1A/1B SAR data

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We present an application of the SISTEM (Simultaneous and Integrated Strain Tensor Estimation from geodetic and satellite deformation Measurements) approach, to obtain the dense 3D ground deformation pattern produced by 2016 central Italy seismic sequence.
We analyzed GNSS and Sentinel SAR data over 6 moths (March-November 2016); during this time interval, this area was characterized by the seismic sequence started with the August 24th Mw 5.4 and Mw 6 "Amatrice earthquakes", followed by October 26th Mw 5.9 and Mw 5.4 "Visso earthquakes" and October 30th Mw 6.5 "Norcia earthquake", among thousands of minor seismic events .
The SAR processing was performed using the SBAS (Small BASeline) approach. The time series shows that no evident ground deformation was visible until the Amatrice earthquakes when a displacements of about 20 cm along the LOS (Line Of Sight) has been recorded; the following Visso earthquakes, produced a new displacement field northwards; after 4 days the Mw 6.5 Norcia earthquake produced a biggest ground displacement (a maximum coseismic subsidence of $\sim$80cm near the Castelluccio plain) filling the gap between the previous one.
We integrated the GNSS and SAR data encompassing the period from March to November 2016 for producing a detailed map of the 3D ground motion and then we inverted the SISTEM results, using an optimization algorithm based on the Genetic Algorithm, providing an accurate spatial characterization of ground deformation.
Our results improve previous solutions for the principal faults kinematics and, thanks to the unprecedented details provided by SISTEM approach, it was possible to identify the kinematic of other additional faults that activated during the seismic sequence and that have contributed to the observed total ground deformations.
SISTEM results are in good agreement with seismological, geodetic and geological data, including the contribution of the post-seismic signal to the modeled deformation.