Geophysical Research Abstracts
Vol. 12, EGU2010-10125-1, 2010
EGU General Assembly 2010


# 3D displacements maps of the L'Aquila earthquake by applying SISTEM method to GPS and ENVISAT and ALOS DInSAR data

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We present an application of the novel SISTEM (Simultaneous and Integrated Strain Tensor Estimation from geodetic and satellite deformation Measurements) approach [Guglielmino et al., 2009] to obtain a 3D estimation of the ground deformation pattern produced by the April 6, 2009, Mw 6.3 L'Aquila earthquake, the most destructive in the Abruzzo region since the huge 1703 earthquake [Boschi et al., 2000; Chiarabba et al., 2005]. The focal mechanism of the main shock is of normal faulting with NE-SW oriented T-axis [INGV, 2009]. Most of the aftershocks, located by the INGV seismic network, are in the depth range 5÷15 km, depicting a SW dipping fault plane [INGV, 2009]. Field observations [EMERGEO working group, 2009] have identified surface ground cracks with centimeter to decimeters throws over a wide belt running along the Paganica Fault.

A closely spaced GPS (Global Positioning System) network was set up in this sector of the Apennines after 1999 [Anzidei et al., 2005] and more than 10 Continuous GPS (CGPS) stations have been operating in this region over the last years. On March 30 2008, INGV installed five GPS receivers on selected benchmarks of the Central Apennine Geodetic Network (CaGeoNet) bordering the L'Aquila basin in order to detect the eventual ground movements during the seismic sequence.

These stations were crucial to resolve the near-field co-seismic deformation pattern properly, allowing direct observation of the details of co-seismic displacement related to the main shock. Thanks to the ESA Earth Watching project, which made Envisat data quickly available after their acquisition, we performed a DInSAR (Differential Interferometric Synthetic Aperture Radar) analysis of ascending and descending images sampling the date of the earthquake. In particular, we analyze the descending pair for the interval 27/04/2008 – 12/04/2009 (tbline = 350 days; Bperp = 44m) and the ascending pair for the interval 11/03/2009 - 15/04/2009 (tbline = 35 days; Bperp = 227m).

We also analyzed ALOS PALSAR interferograms produced with images acquired along two different ascending tracks and relevant to the 3/7/2008 - 21/5/2009 time interval (track 638; tbline = 322 days; Bperp = 665 m ) and 2/3/2007 - 22/4/2009 time interval (track 639; tbline = 782 days; Bperp = 466 m ).

In order to derive 3D surface motion maps, we apply the SISTEM method to the available geodetic dataset (both GPS and DInSAR). The SISTEM method performs an integration of GPS and DInSAR data for computing displacements on each point of the studied area. The SISTEM is based on elastic theory, and provides the complete 3D strain and the rigid body rotation tensors in the same solution. To achieve higher accuracy and get better the constraint of the 3D components of the displacements, we improved the standard formulation of SISTEM approach, based on a single DInSAR data, in order to take into account both ascending and descending interferograms and the DInSAR data acquired by different sensors(ALOS and ENVISAT).

The SISTEM integration results show a complex kinematics, where the main movements (max westward movement of 165 mm associated with a max lowering of 260 mm) are recorded in the area between the surface evidence of the Paganica fault and Monticchio-fossa fault.

These results, which provide both accurate and fine spatial characterization of ground deformation, are hence promising for future studies aimed at improving the knowledge of the kinematic of the Paganica fault and identification of additional faults responsible of the seismic sequence and that have contributed to the observed ground deformation.

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