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FEM-based inversion of DInSAR data to infer coseismic slip distribution along Pernicana Fault System at Mt Etna

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Eruptive sequences and local seismicity on Etna volcano have often revealed a significant temporal correlation between the occurrence of large earthquakes along the main volcano-tectonic structures and period of volcanic unrest. One of the most outstanding tectonic structures is the Pernicana Fault System (PFS), which delineates the northern border of the sliding eastern flank of Etna volcano. The PFS is characterized both by aseismic continuous "slow" movements associated with the eastern flank sliding and by shallow earthquakes, which can cause severe damage to the man-made infrastructures. The 22 September 2002 M 3.7 earthquake preceded the 2002-2003 eruption by nearly a month, representing a potential early-warning for magmatic intrusion inside the northern sector of the volcano. However, in several cases the PFS releases seismicity without preceding an eruption as observed for the 2 April 2010 M 4.2 event, during which only an overall inflation of the volcano edifice was evidenced. These two events offer good case studies to gain insight into the complex kinematic of the PFS as a response to accommodate the stress change induced both by recharging phase of an intermediate storage and the pre-eruptive intrusion of the magma.
A procedure, based on the Finite Element Method (FEM) for high-resolution geodetic data inversion, was developed to estimate the non-uniform slip distribution along the 22 September 2002 and along the 2 April 2010 surface ruptures in order to investigate a possible relationship between PFS and volcanic activities. FEM-generated synthetic Greens functions in a 3D domain are combined with an inverse algorithm to simulate ground deformation of the earthquake that takes into account the distribution of material properties of the volcanic edifice.
The inversion of Interferometric Synthetic Aperture Radar (InSAR) data, which warrant a wide spatial coverage and high temporal resolution, provides a detailed slip distribution along PFS during both seismic events. The comparison between the slip distribution patterns obtained from geodetic inversions could allow to discriminate the behaviour of the PFS between rest and unrest periods and to gain hints into the stress state of the volcano edifice.