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Fernandina Volcano (Galápagos) ground deformation modeling via multi-orbits DInSAR data

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We study the temporal and spatial ground deformation at Fernandina Volcano (Galápagos) between 2004 and 2013, by using two different DInSAR data set, acquired by ENVISAT C-Band satellite and COSMO-SkyMed X-Band constellation, respectively; we use both ascending and descending orbits for each system.

To this purpose, we use the SBAS-DInSAR approach and combine ascending and descending time series to produce vertical and E-W components of the mean deformation velocity and associated deformation time series.

More specifically, the long-term components analysis, carried out by using the ENVISAT sensor, revealed a broad uplift phenomenon of about 4 cm on the SE slope of the volcano; similarly, a large subsidence with maximum vertical displacement of about 2 cm on NE flank, is found. For what concern the horizontal components, the performed analysis showed a westward displacement of the southeast flank of the island.

The most relevant aspect, which arises from the analysis of the DInSAR vertical eformation time series, is a strong, high rate subsidence phenomenon, that followed the 2009 eruptive event. This tendency is localized in the region around the caldera rim where the circumferential structures border the summit caldera.

The multi-orbits X-Band data processing showed a new uplift phenomenon: between March 2012 and July 2013 the vertical component is characterized by a radially symmetric deformation pattern with a maximum uplift of about 20 cm strongly concentrated inside the caldera rim. This symmetry is also observed in the E-W horizontal mean velocity map, showing a maximum displacement of about 12 cm towards East for the SE flank, and 12 cm towards West for the NW flank of the volcano.

In particular, the deformation time series show a rather linear uplift trend from March to September 2012, interrupted by a low deformation rate interval lasting until January 2013. After this stage, the deformation shows again a linear behaviour with an increased uplift rate.

In this context, we performed a 3D time dependent structural numerical model in creeping flow approximation, in order to evaluate the stress temporal evolution inside the volcano conduit during the unrest phenomena.

The optimization results emphasize that: (i) the stress source responsible of the 2012-2013 unrest phenomena is the located at shallow depth; (ii) the temporal evolution of the deviatoric stress is characterized by a linear trend concentred in the areas corresponding to the circumferential eruptive fissures.