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Interpretation of volcanic surface deformation using a 3D multi-source approach

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Volcano geodetic observation is a valuable tool to infer location, strength and geometry of magmatic plumbing systems. The availability of high precision and spatial resolution, spanning decades, deformation data from satellite radar observation and Global Navigation Satellite Systems (GNSS) can give us important information for detecting and characterizing their temporal variations as well as other possible geodynamic sources acting in the volcanic area. For this objective inversion techniques are necessary which help us to obtain the maximum of information from these new datasets. We present a new, original methodology to carry out a multi-source inversion of ground deformation data to better understand the subsurface causative processes (Camacho et al., 2020). The methodology uses a nonlinear approach which permits the determination of location, size and three-dimensional configuration, without any a priori assumption as to the number, nature or shape of the potential sources. The proposed method identifies a combination of pressure bodies and different types of dislocation sources (dip-slip, strike-slip and tensile) representing magmatic sources and other processes such as earthquakes, landslides or groundwater-induced subsidence through the aggregation of elemental cells. This approach carries out a simultaneous inversion of the deformation components and/or line-of-sight (LOS) data; and a simultaneous determination of diverse structures such as pressure bodies or dislocation sources, representing local and regional effects. Both things are done in a fully 3D context and without any initial hypothesis about the number, geometry or types of the causative sources is necessary. We show results from the application of this new methodology to synthetic and real test cases (e.g., Mt. Etna).

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