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Surface deformation time-series analysis at Ischia Island (South Italy) carried out via multi-platform monitoring systems

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Ischia Island, located at the North-Western corner of the Gulf of Napoli (South Italy), is a volcanic area, whose state of activity is testified from eruptions (the last one occurred in 1302), earthquakes (the most disastrous in 1881 and 1883), hydrothermal manifestations and ground deformation.
In this work we present the state of the art of the Ischia Island ground deformation phenomena through the joint analysis of data collected via different monitoring methodologies (leveling, GPS, and Differential SAR Interferometry) during the last twenty years. In particular, our analysis benefits from the large amount of periodic and continuous geodetic measurements collected by the 257 leveling benchmarks and the 20 (17 campaign and 3 permanent) GPS stations deployed on the island. Moreover, it takes advantage from the large archives of C-band SAR data (about 300 ascending and descending ERS-1/2 and ENVISAT images) acquired over the island since 1992 and the development of the advanced Differential SAR Interferometry (DInSAR) technique referred to as Small BAseline Subset (SBAS). The latter, allows providing space-time information on the ground displacements measured along the radar line of sight (LOS), and thanks to the availability of multi-orbit SAR data, permits to discriminate the vertical and east-west components of the detected displacements.
Our integrated analysis reveals a complex deformative scenario; in particular, it identifies a spatially extended subsidence pattern, which increases as we move to higher heights, with no evidence of any uplift phenomena. This broad effect involve the Northern, Eastern, Southern and South-Western sectors of the island where we measure velocity values not exceeding -6 mm/year; moreover, we identify a more localized phenomenon affecting the North-Western area in correspondence to the Fango zone, where velocity values up to -10 mm/year are retrieved. In addition, our study shows a migration of the Eastern sector of the island towards West with velocity values of -1/-2 mm/year. Conversely, a not clear behaviour of the central and South-Western areas is found; indeed, while the GPS velocity vectors are primarily Northward directed, the DInSAR measurements reveal a migration of these sectors towards East; in both cases we measure deformation velocity values of a very few mm/year. This discrepancy is very likely related to the fact that the North deformation component does not contribute to the measured LOS displacement component due to the nearly polar characteristics of the radar sensor orbits.
The performed integrated time-series analysis can significantly contribute to the comprehension of the volcanic island dynamics, especially in the case of long-term observations that promote the investigation, modelling and interpretation of the physical processes behind the deformation phenomena at different temporal and spatial scales.