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Time dependent numerical models of surface deformation in volcanic areas

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In the last years, the development and diffusion of remote sensing analyses changed perspective to the way of observing, measuring and monitoring the surface displacements at volcanoes. Among several approaches, Differential Synthetic Aperture Radar Interferometry (DInSAR) provided a revolution in volcano geodesy, significantly increasing the spatial resolution of surface deformation measurements with respect to the classical ground-based techniques (e.g. Leveling, EDM). Moreover, advanced DInSAR processing algorithms, developed for the generation of mean deformation velocity maps and displacement time series (e.g. the Small BAseline Subset (SBAS) algorithm), highlighted that often at volcanoes the deformation signal is characterized by spatial and temporal non-linear behaviors. However, despite such an increase on the spatial and temporal resolution of observations, most of the modeling attempts are still based on the assumption that the Earth's crust behaves as a homogeneous linear elastic material.

In this work, we use numerical modeling to investigate how different assumptions of the continuum mechanics theory may affect the understanding of surface deformation in volcanic areas. Using the Finite Element Method, we compare surface displacements simulated by using models that assume static behavior with those that consider time dependent rheological properties, under stationary and transient conditions. As an application, we show the results of an advanced numerical optimization performed on real measured data, referred to as the SBAS-DInSAR time series relevant to the Campi Flegrei caldera (Southern Italy), and spanning from 1992 to 2009.