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Sentinel-1 TOPS interferometry for geophysical applications: Dyke intrusion imaged during 2014 Pico do Fogo eruption

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Since the inception of the European Space Agency ERS Synthetic Aperture Radar (SAR) mission in the 1990s, radar interferometry has become an indispensable geophysical tool for measuring surface ground deformation over wide areas with high precision. Ground deformation is a key observation to study and monitoring multiple applications in geophysics such as earthquake and tectonics, volcano, land subsidence and landslides study and monitoring. Therefore, the frequent acquisition of SAR data to compute differential interferograms is a long standing goal in observational geodesy. A new mission designed by ESA, the Sentinel-1 mission would provide routinely frequent acquisitions (every 12 days) over larger areas (250-350 km). In April 2014, the first of expected four successive and overlapping similar spacecrafts was launched to start a total 20-year continuous operational mission.

Terrain observation by progressive scans (TOPS) is a new radar acquisition mode, which provides with high quality radiometric radar amplitude images. TOPS mode allows us to acquire radar data over much wider areas than previous classical stripmap mode, and it is the default mode of acquisition of ESA Sentinel-1 satellite. However, due to a variable steering (ground scanning) of the antenna pattern, the corregistration of TOPSAR images result in a much higher demanding processing step. The higher precision azimuth SAR image corregistration and variable line-of-sight along azimuth direction intersect with the fact that image disparities on the order to a thousand of a pixel size also characterizes multiple geophysical phenomena (such as landslide dynamics, coseismic earthquake, fault creep or volcanic intrusions). In this paper, we present the first results using Sentinel-1 TOPS interferometry to measure an important deformation event. We successfully compute Sentinel-1 TOPS-InSAR and tested the effect of variable line-of-sight in azimuth, during the estimation of geophysical parameters.

We apply Sentinel-1 TOPS-InSAR to illuminate the deformation accompanying a recent volcanic eruption at Pico do Fogo volcano, Fogo (Cape Verde). The detected deformation is consistent with a shallow near-vertical dyke intrusion, which fed the fissure eruption. The modelling of the deformation interferograms do not seem affected largely by the variable LoS vector, in this case.

The presented results prove the potential of Terrain observation by progressive scans (TOPS) interferometry for geophysical applications, in particular using ESA Sentinel-1 mission.