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Long term surface deformation analysis of Tenerife island, Spain, by using the SBAS-DInSAR technique

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Differential Synthetic Aperture Radar Interferometry (DInSAR) is a microwave imaging technique allowing to investigate Earth surface deformation with a centimeter to millimeter accuracy. The DInSAR methodology has been applied first to investigate single deformation events and, more recently, to analyze the temporal evolution of the detected displacements via the generation of deformation time series.

In this work we focus on the advanced DInSAR technique referred to as Small BAseline Subset (SBAS) approach [1] that allows the generation of mean deformation velocity maps and time series relevant to the investigated area.

In particular, we apply the SBAS-DInSAR technique for investigating the ongoing deformation phenomena affecting the Tenerife island (Spain), dominated by the (3718 m high) Pico del Teide volcano.

More specifically, a set of 55 SAR data (track 352, frame 3037) acquired by the ERS-1 and ERS-2 satellites from descending tracks, spanning the April 1992 – October 2005 time interval, is exploited.

The SBAS-DInSAR analysis reveals several displacement phenomena; first of all, we

observe that the summit area of the volcano is generally affected by extended deformation mostly occurring in correspondence to the top and the eastern flank. Moreover, more localized displacement patterns are detected in the north-western part of the island.

The availability of spatial and temporal information on the detected displacements allows us to perform an extended analysis on the retrieved DInSAR results. In particular, we perform first a comparison between the SBAS-DInSAR data and those available through GPS measurements, clearly showing the good agreement between the two data set.

Subsequently, we investigate the correlation between the topography of the volcano and the retrieved deformation signals. In particular, we first observe that some “oscillation phenomena”, characterizing the deformation time series relevant to the higher topography areas, are very likely related to seasonal artifacts modulated by the steep topography of the volcano. Finally, we investigate possible correlation between the retrieved long term deformation trend and the volcano topography. In this case, at variance of what discussed for the previously mentioned oscillation effects, the topography related long term deformation signal cannot be due to tropospheric artifacts. Indeed, this result would imply a tropospheric induced phase component that temporally correlates during the overall investigated time interval (nearly 15 years) and that is consistently increasing with time. Since this is not a realistic hypothesis we may conclude that this long term deformation component is a real displacement signal; a possible explanation for this effect, related to gravitational phenomena, is discussed.

References

[1] P. Berardino, G. Fornaro, R. Lanari and E. Sansosti, “A new Algorithm for Surface Deformation Monitoring based on Small Baseline Differential SAR Interferograms,” IEEE Trans. Geosci. Remote Sens , vol. 40, pp. 2375-2383, November 2002.