Sentinel 1A Time series SAR Interferometry monitoring of Santorini volcano during post unrest period (2014-2016)

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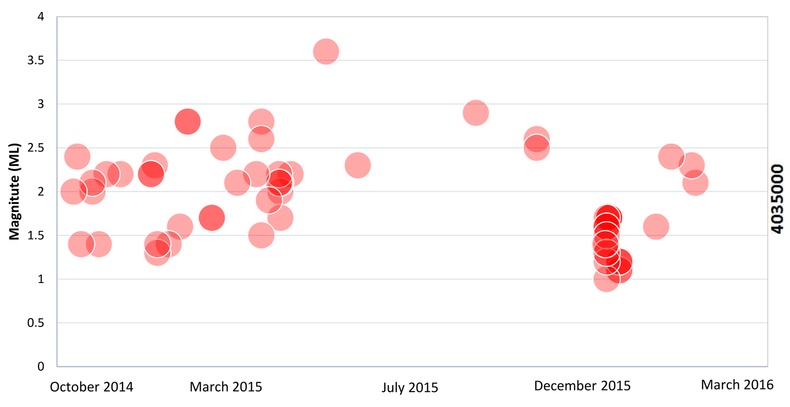
Motivation & Scope

Mitigation of volcanic risk is feasible and thus reducing damages can be achieved by knowing in detail about structure and history of the volcanoes, eruption mechanisms, unrest behaviour etc. The identification, analysis and evaluation of risk comprise the basis for timely, well oriented and essential disaster management. It is clear that reducing risk for volcanoes requires many steps (hazard and vulnerability assessment, exposure, coping capacity) to be addressed. Long-term hazard assessment presents the basic tool for the behaviour of a volcano especially in the case of dormant volcanoes due to the lack of plethora historical data.

Ground deformation monitoring is one of the main geoindicators that should be considered to assess volcanic hazard. Satellite Earth Observation data are used for different facets of risk management concerning volcanic hazards. Space-borne SAR interferometry has been used continuously since 1992 to measure or study the temporal evolution of surface deformation in volcanic areas in conjunction with ground-based geodetic measurements.

Santorini Volcanic Complex during the period 1992–2010 is characterized by the gradual deflation signal over Nea Kameni volcano. However, at the beginning of 2011 the volcano showed signs of unrest with increased microseismic activity and significant ground uplift. A gradual decrease of inflation rates within the first quarter of 2012 was confirmed from subsequent observations.

The goal of this study was to determine the characteristics of the current deformation status of the island, four years after the end of the unrest that occurred between February 2011 and May 2012 and to validate the interferometric results with ground based geodetic observations.



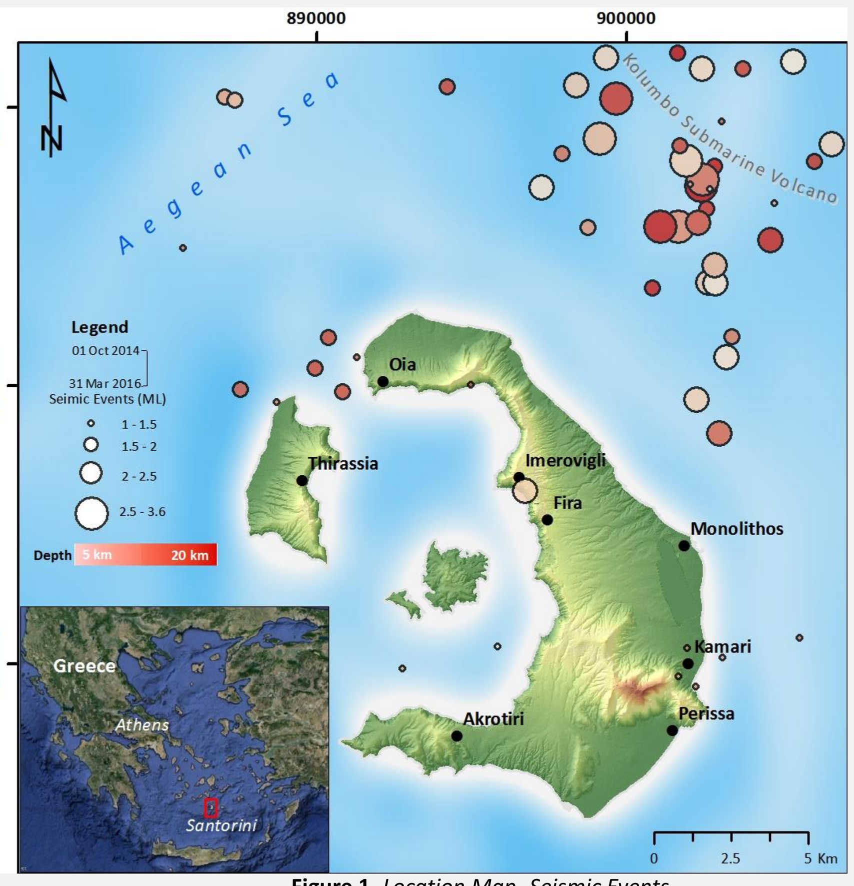


Figure 1. *Location Map -Seismic Events*

Data & Methods

In order to assess the deformation pattern behavior in Santorini Volcanic Complex, a hybrid method of multitemporal SAR interferometry was applied.

Two datasets of SLC Sentinel 1A ascending and descending scenes, consisting of 37 and 41 images respectively, covering the period October 2014 to March 2016 were used to achieve the aim of the project (Table 1). The fact that the volcano exhibits high coherence (Figure 2) independently of the time distance gave us the opportunity to achieve highly reliable results. The interferometric processing was carried out using GAMMA Remote Sensing Software. (Figure 3)

In addition, data from 11 permanent GNSS stations located on the island were analysed, available from three different data repositories, the two Greek EPOS GSAC repositories and the UNAVCO repository. The GNSS data were processed using GIPSY 6.4 software.

Orbit Pass Direction	Acquisition Period	Number of Scenes	Frame	Polarization
Ascending	Oct 19 2014 - Mar 30 2016	37	29	VV
Descending	Oct 13 2014 - March 24 2016	41	109	

Table 1. *Sentinel 1A Data Description*

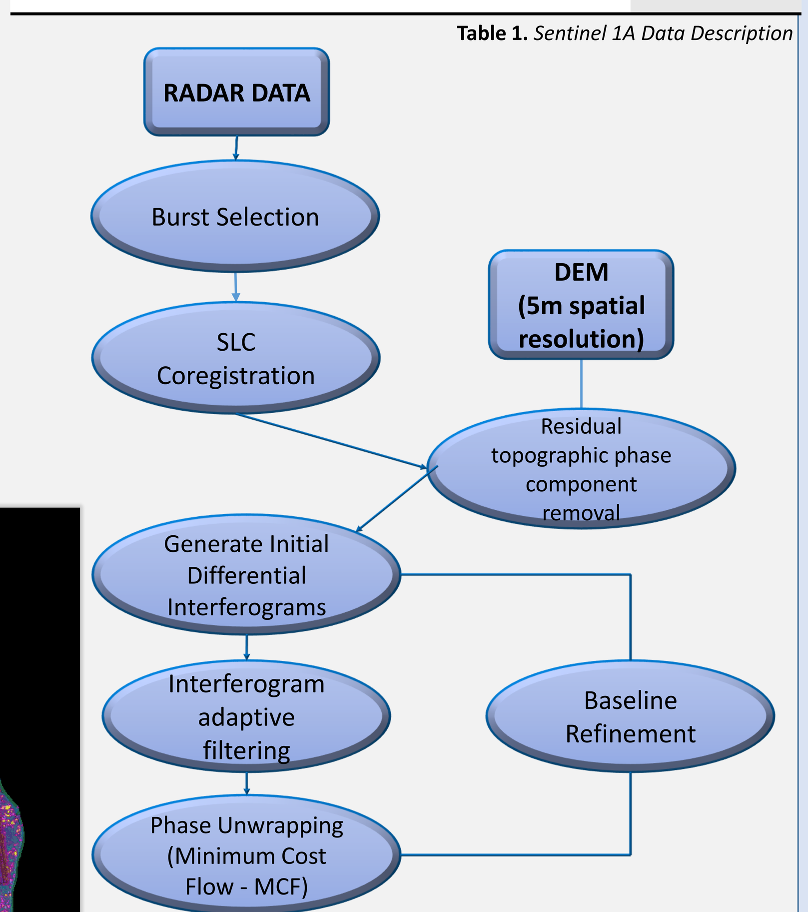


Figure 3. *Interferometric Processing Flowchart*

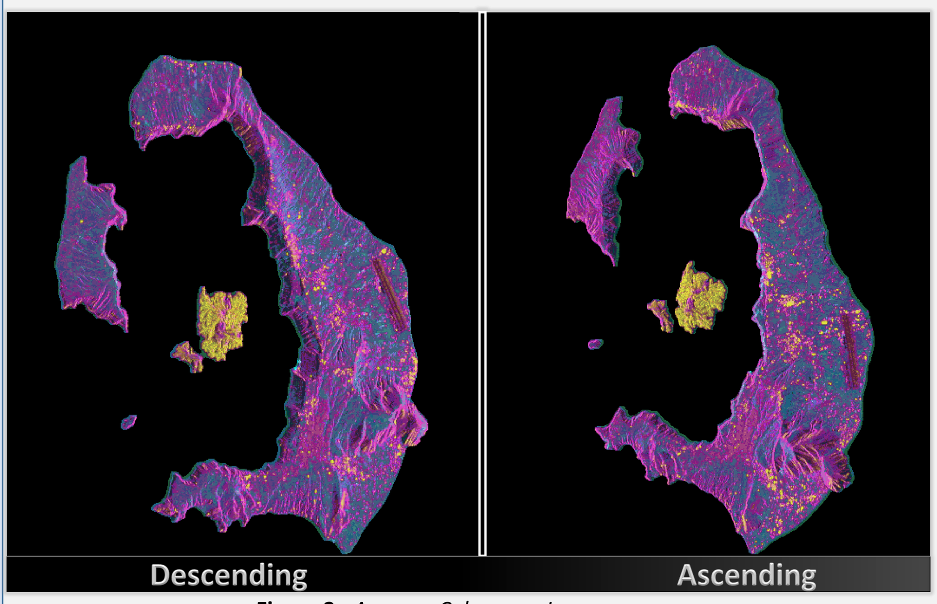


Figure 2. *Average Coherence Images*

Results

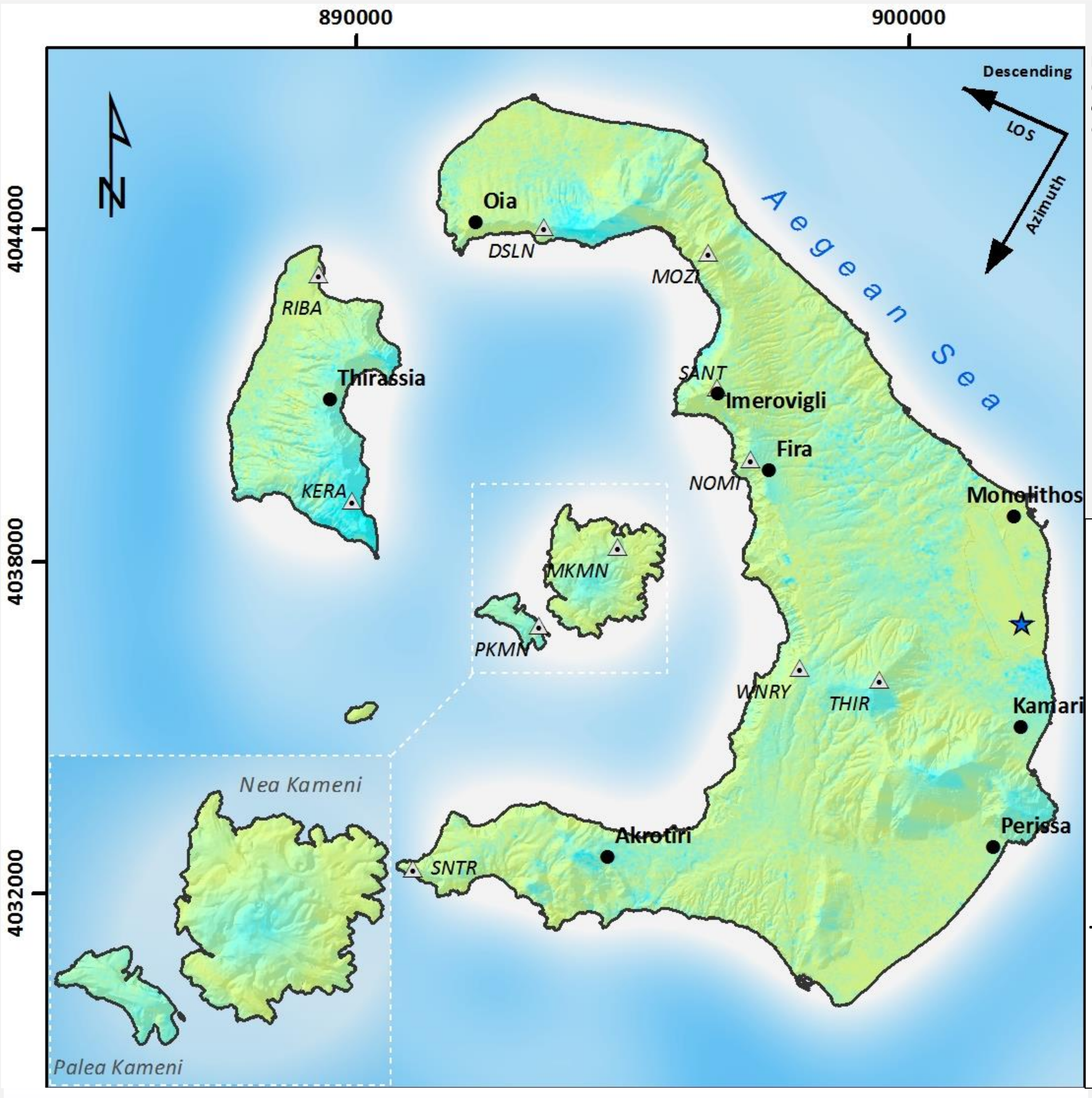
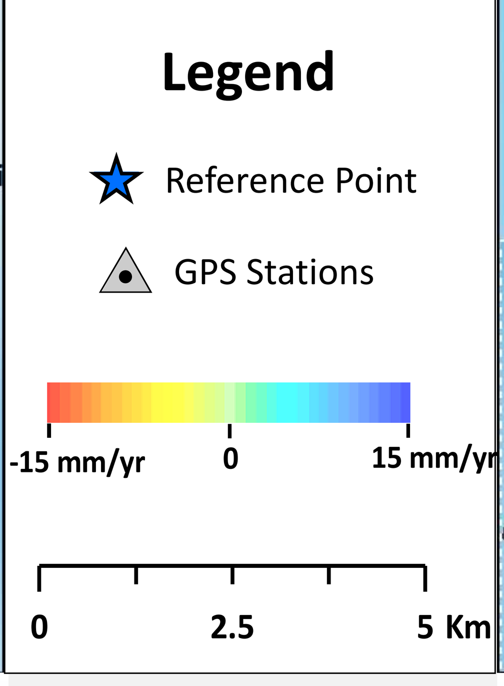
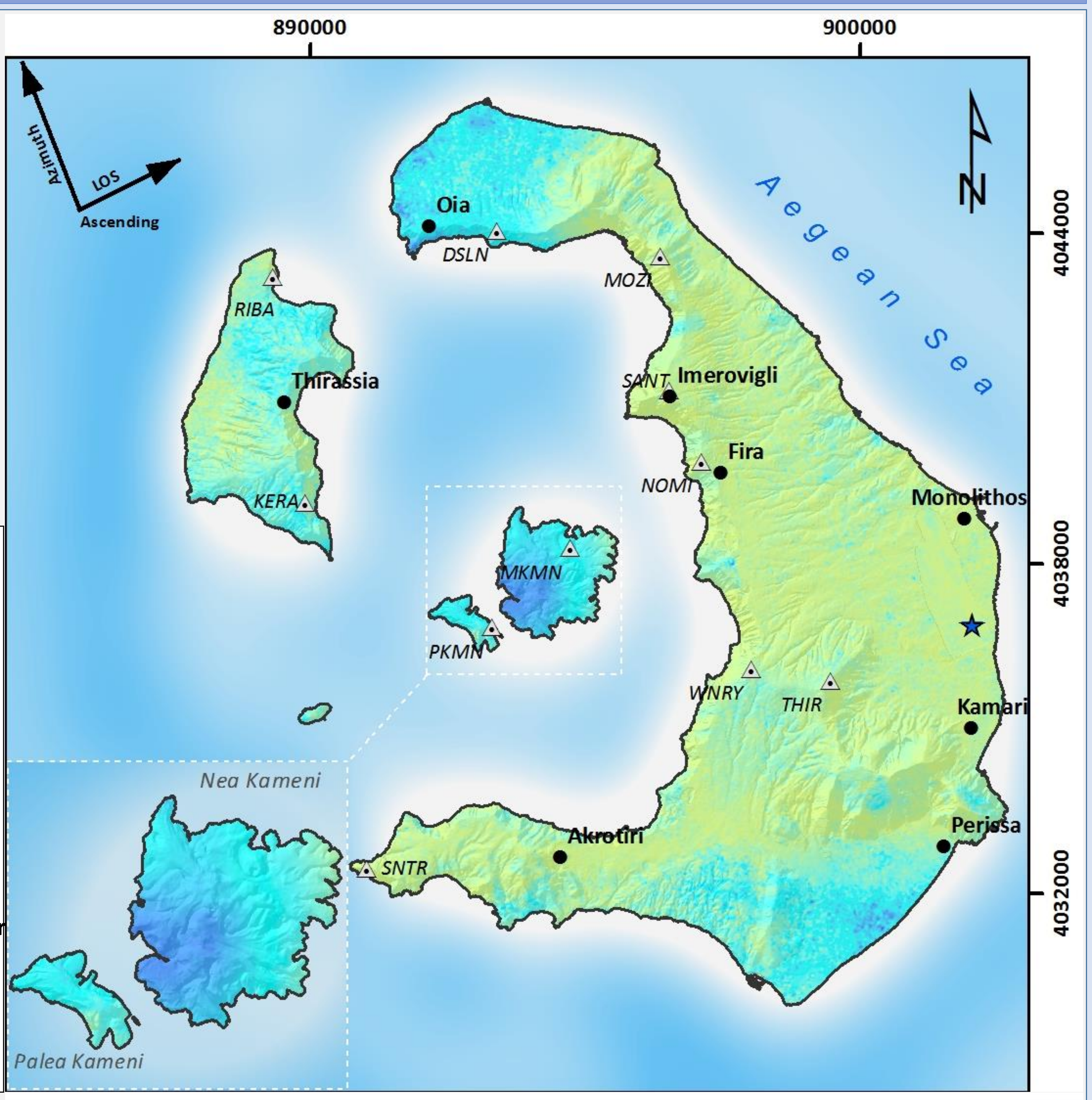


Figure 4. *Average LOS (Descending) Deformation over Santorini for the period Oct 2014- Mar 2016*

Figure 5. *Average LOS (Ascending) Deformation over Santorini for the period Oct 2014- Mar 2016*





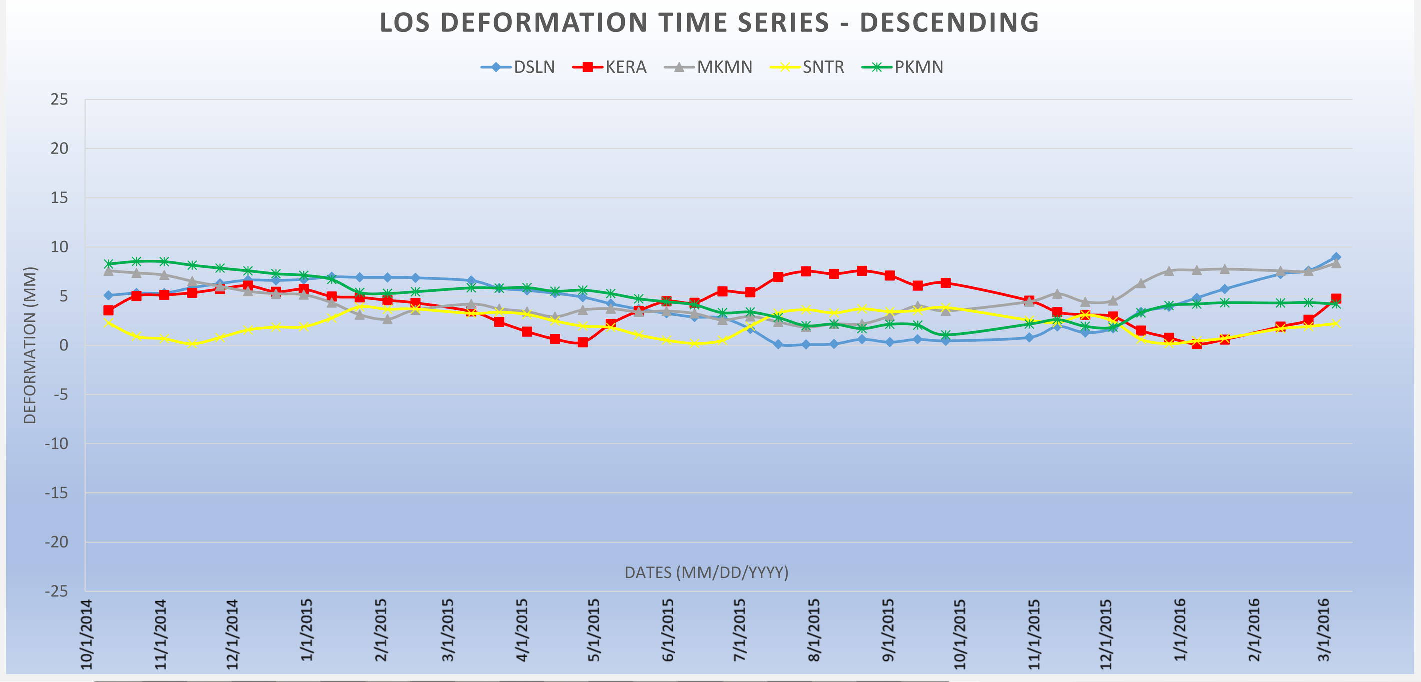
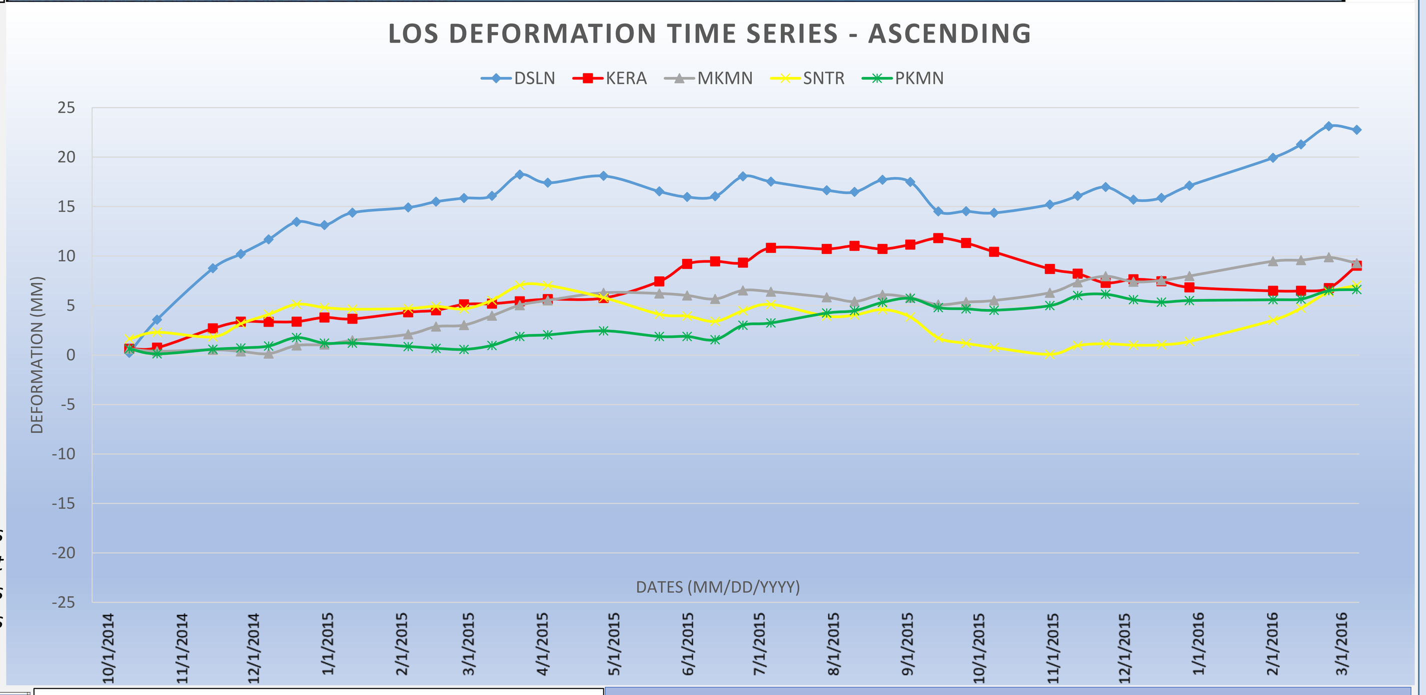


Figure 6. *InSAR Time Series LOS(Descending) displacement measured on the coordinates of selected GPS Stations*

Figure 7. *InSAR Time Series LOS(Ascending) displacement measured on the coordinates of selected GPS Stations*



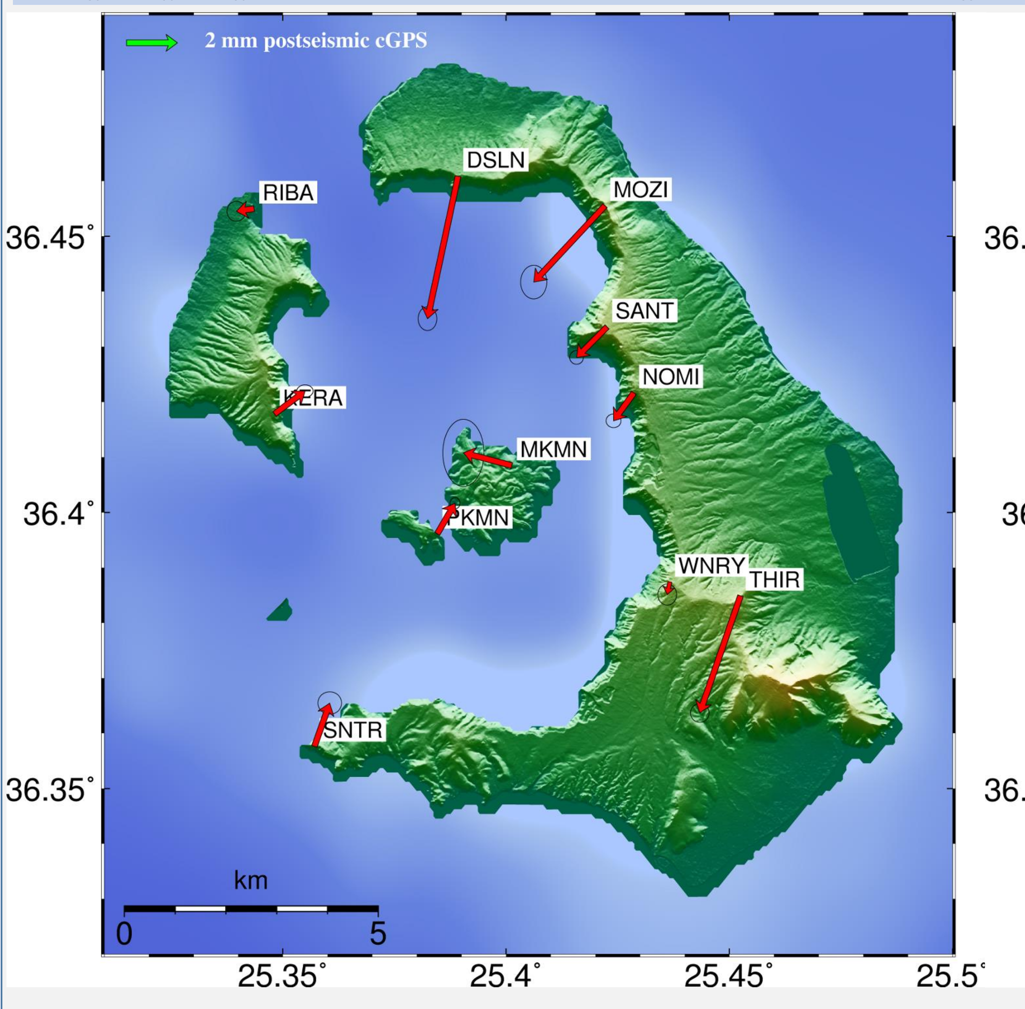


Figure 8. *Horizontal GPS ground velocity map (source: NOA, P. Elias)*

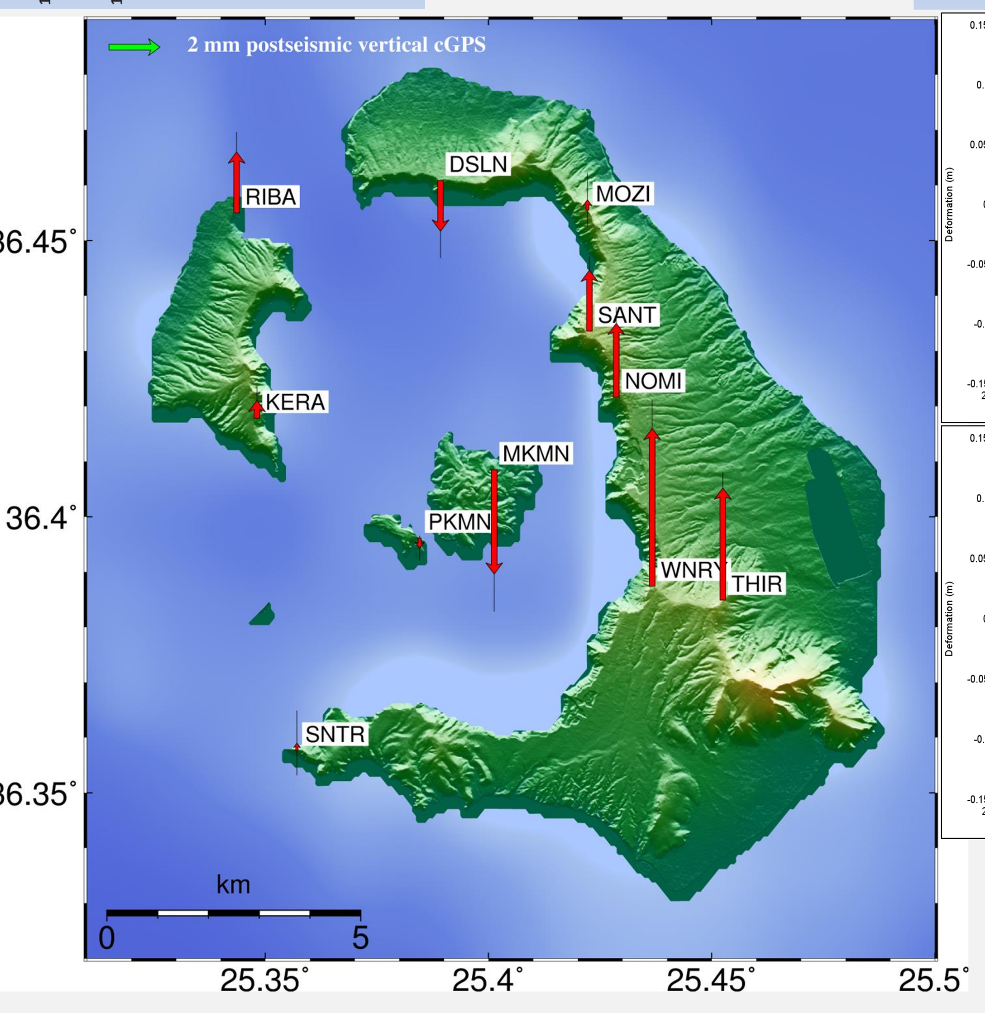


Figure 9. *Vertical GPS ground velocity map (source: NOA, P. Elias)*

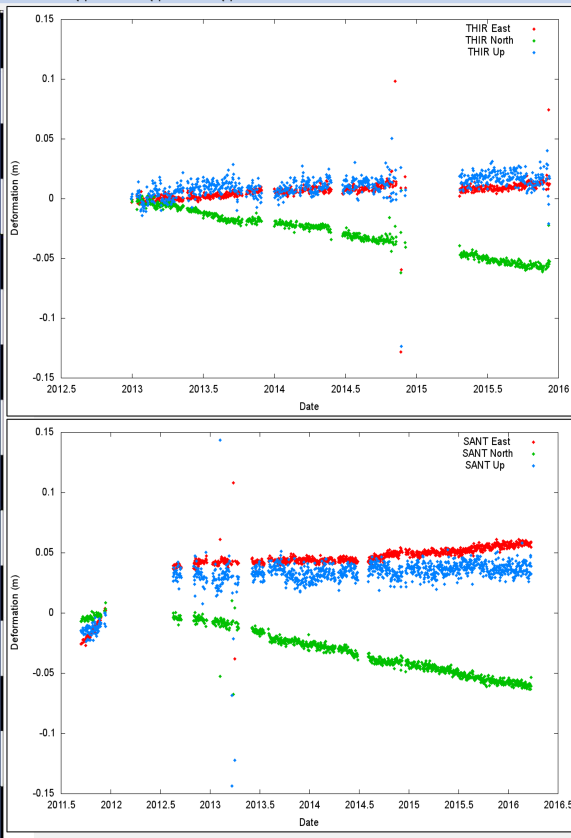


Figure 10. *GPS time series depicting the ground velocities, for THIR(up) and SANT(down) stations*

Discussion

In the present study, «the newcomer» Sentinel-1 data were used to assess the deformation pattern behavior in Santorini Volcanic Complex (SVC), an immensely active area, especially in Nea Kameni Island. Firstly, the potential of the DInSAR technique was demonstrated and the analysis of Sentinel-1 data succeeded to estimate the deformation pattern with a very good quality. The Sentinel-1 data revealed two important scientific characteristics, the first one is the possibility of the updated and contemporary data sets for the whole scientific community with no limitation and the second one is the quality of the results which yield from the interferometric processing. In addition, the results depict very important characteristics for the Santorini Volcanic Complex activity.

Acknowledgments: The authors would like to thank Panagiotis Elias (NOA) for carrying out the GNSS data processing.

QR code

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