

## INTRODUCTION

Our research interest is focused on detecting deformations of the Earth's crust resulting from earthquakes recorded in the Aegean Region. The Aegean Region is a seismically active tectonic zone with high deformation rates due to its location at the convergence area of the African and Eurasian plates, including the Aegean-Anatolian microplate.

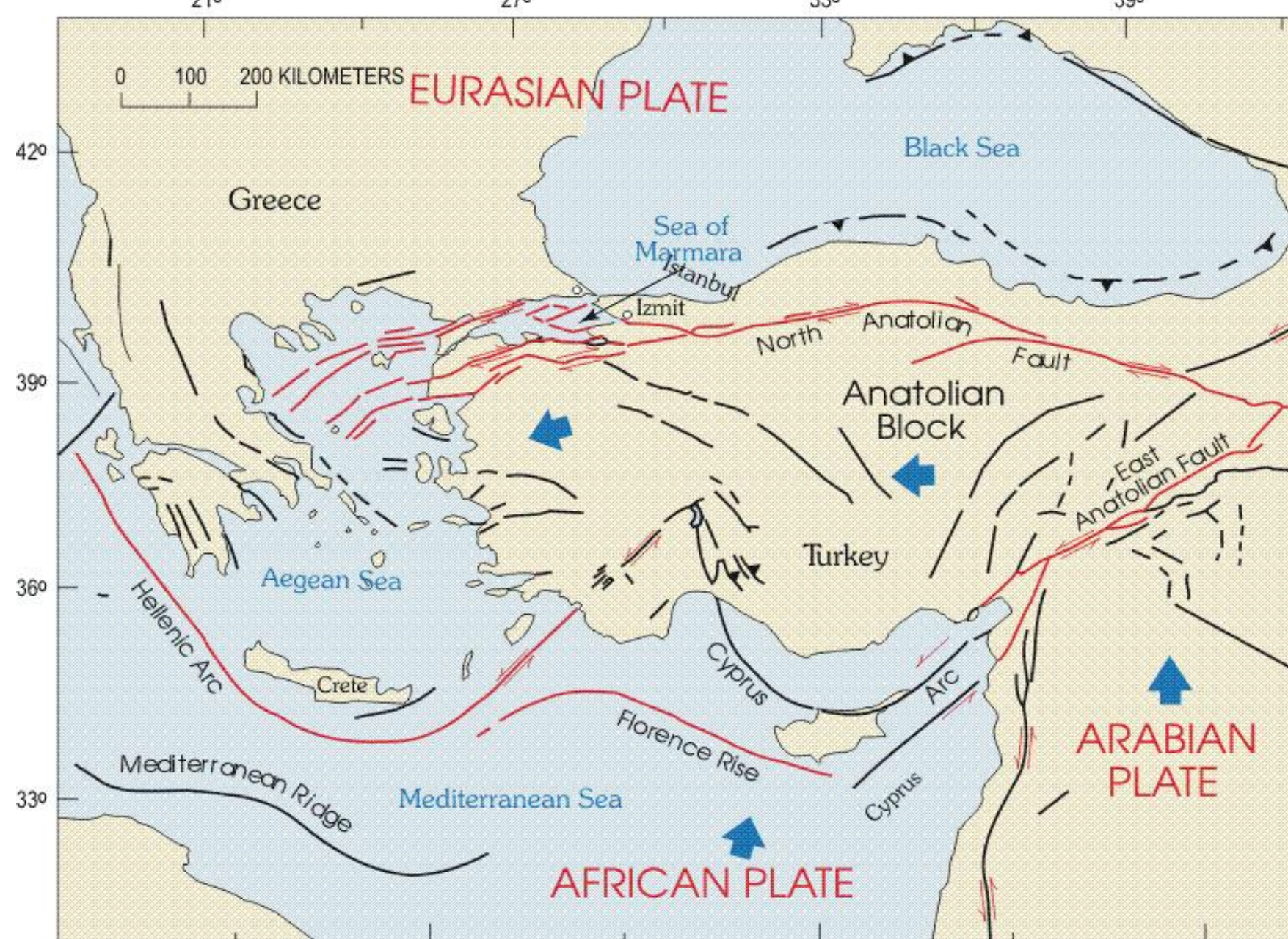


Fig. 1. Tectonic map USGS [1]

The westward movement of the Anatolian block results from: differences in rates of motion between the Arabian and African plates; different directions of motion between the Anatolian block and Eurasian plate to the north; subduction of the African plate beneath the Anatolian block at the Hellenic and Florence trenches. The Arabian plate is moving to the north faster than the African plate, both relative to a stable Eurasian plate. The result is a westward moving wedge incorporating most of Turkey and Greece. Before the crust under the Aegean Sea was described as a part of the Anatolian plate, and the different directions of motion were explained as the plate rotating counterclockwise (see above). New measurements found that motion of the Aegean region differed from the previous model, so the Anatolian and Aegean Sea plate are now considered distinct from each other. A map of the region with the main plates and movements is shown in Figure 1.

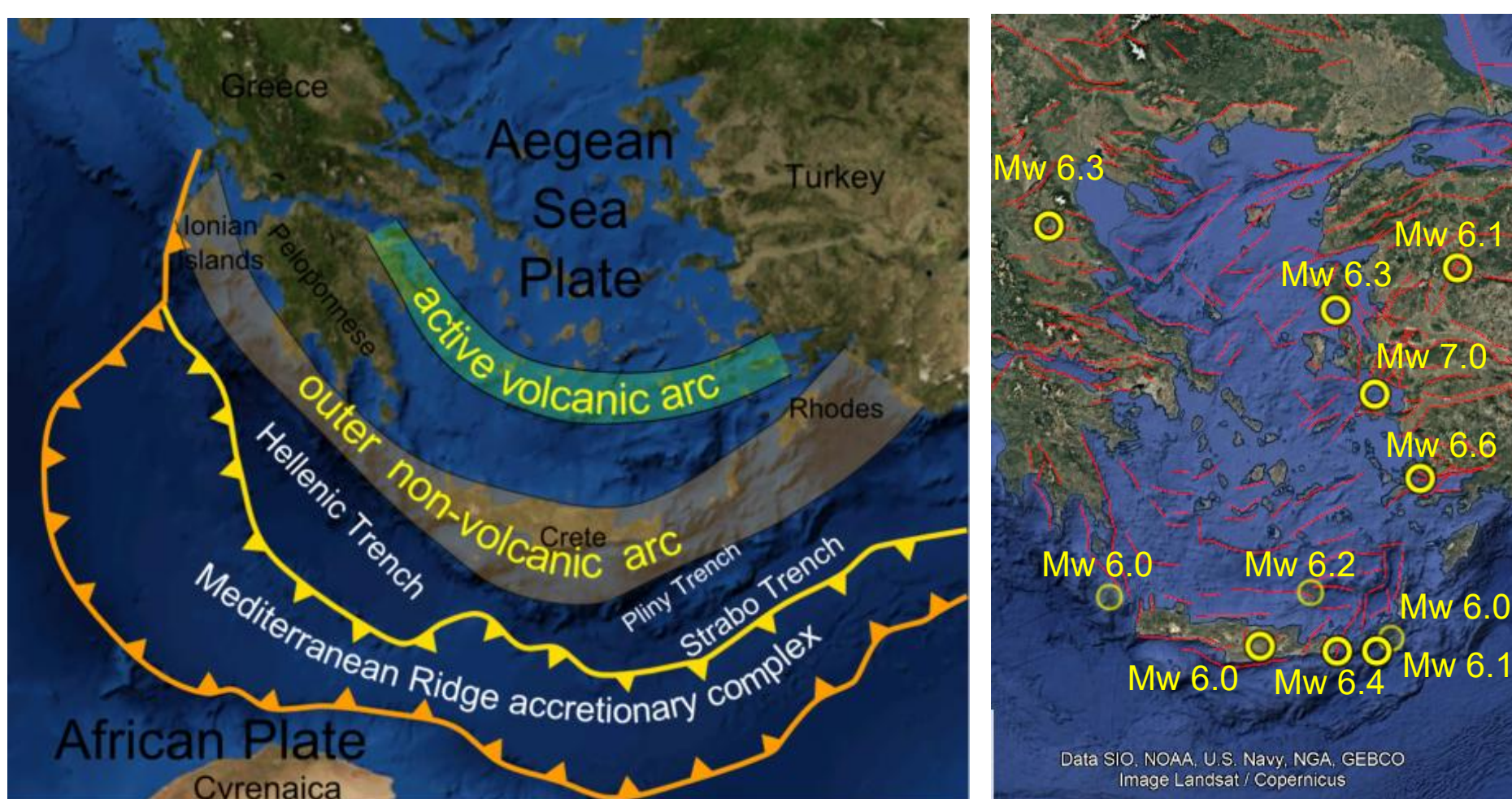


Fig. 2. Main tectonic and volcanic structures of the Aegean region [2]

The Aegean Volcanic Arc (also known as the Hellenic Arc) is formed by the subduction of the African Plate under the Eurasian Plate, extending from the Isthmus of Corinth on the Greek mainland to the Bodrum Peninsula on the Turkish mainland. The active part of the arc consists of numerous dormant and active volcanoes, some of which are Milos, Santorini, Columbo, Kos, Nisyros, etc. The Santorini-Amorgos Fault Zone, characterized by frequent earthquakes, highlights the tectonic complexity of the Aegean Sea.

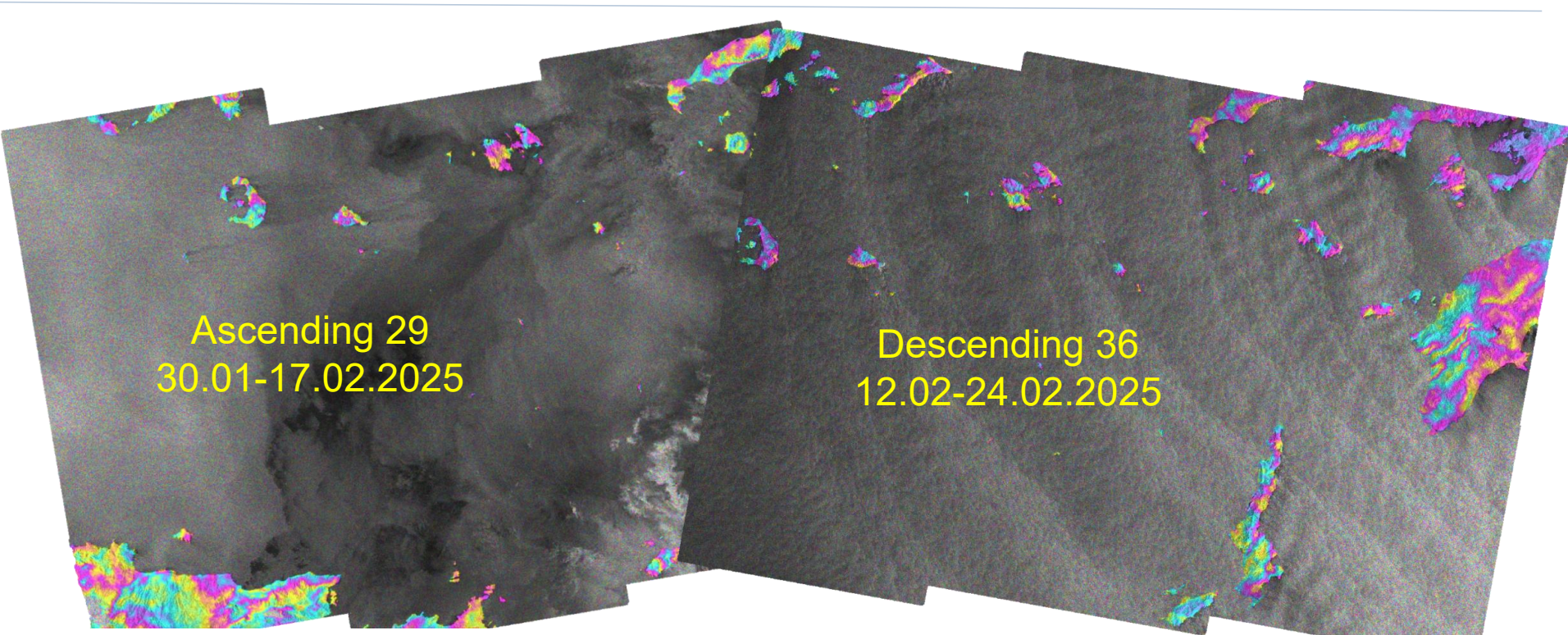


Fig. 3. Map Earthquake Mw>6.0 EMSC [3]

Time series of interferograms for the Nisyros volcanic area processed using the GAMA software over 12 days from 01Jan 2021 to today (or 6-day) are available on VERTEX /ASF Alaska. The area of the island of Santorini falls within the range of the interferograms provided by ASF, for the same time period for ascending orbit 29 and descending orbit 36 ( example see fig.5) [4] .

Fig. 5. Interferograms for Santorini by VERTEX /ASF Alaska [4]

## METHODS

InSAR provides a valuable tool for seismic risk assessment in case of active seismic regions. The DInSAR method is used to assess the consequences of the earthquake and its related events, such as landslides, collapses, the failure zone. To register the displacements that occurred in the area, we process SAR images from Sentinel-1 TOPS - Terrain Observation with Progressive Scan, from two overlapping ascending and descending orbits.

There are various possibilities for using processed products from SAR data acquired by Sentinel -1.

In this study Multi-Temporal Interferometric Synthetic Aperture Radar (MT-InSAR) technique was applied to monitor land deformation in the period between 01/01/2019 and 31/12/2023 with Sentinel 1 data obtained from European Space Agency (ESA). The processing was done European Ground Motion Service (EGMS). From the analysis of the results (see fig. 4), in the Aegean region is occurring surface movement at a moderate rates in the west in confirmation of the statements about the movement of the Aegean-Anatolian micro plate. During the investigations were observed coseismic deformation the areas marked with blue in the fig.4. [5]

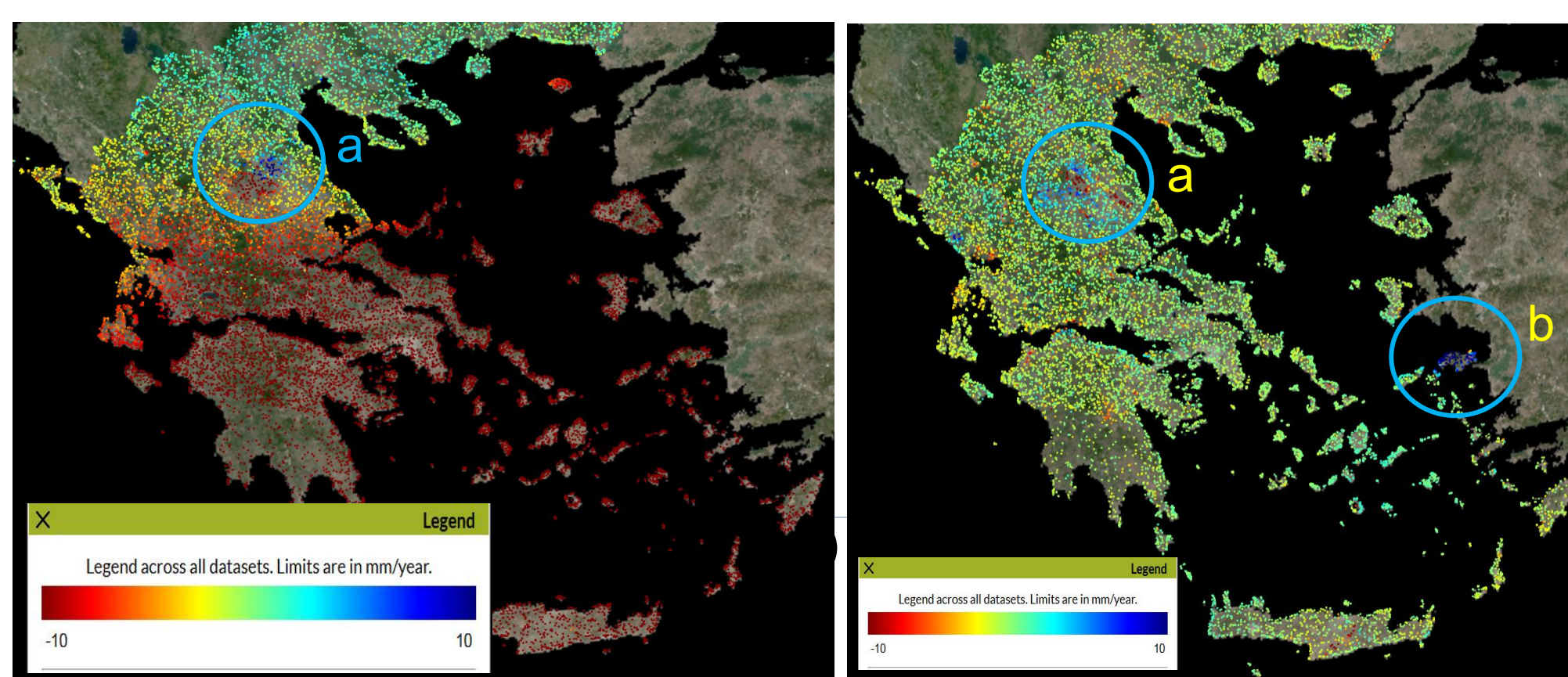


Fig. 4. Horizontal (East/West) and Vertical component determined by MT-SAR for period 2019-2023 from EGMS [5]  
 a) 3 March 2021 Mw 6.3 Larisa Earthquake [6];  
 b) 30 October 2020 Mw 6.9 Samos-Izmir Earthquake

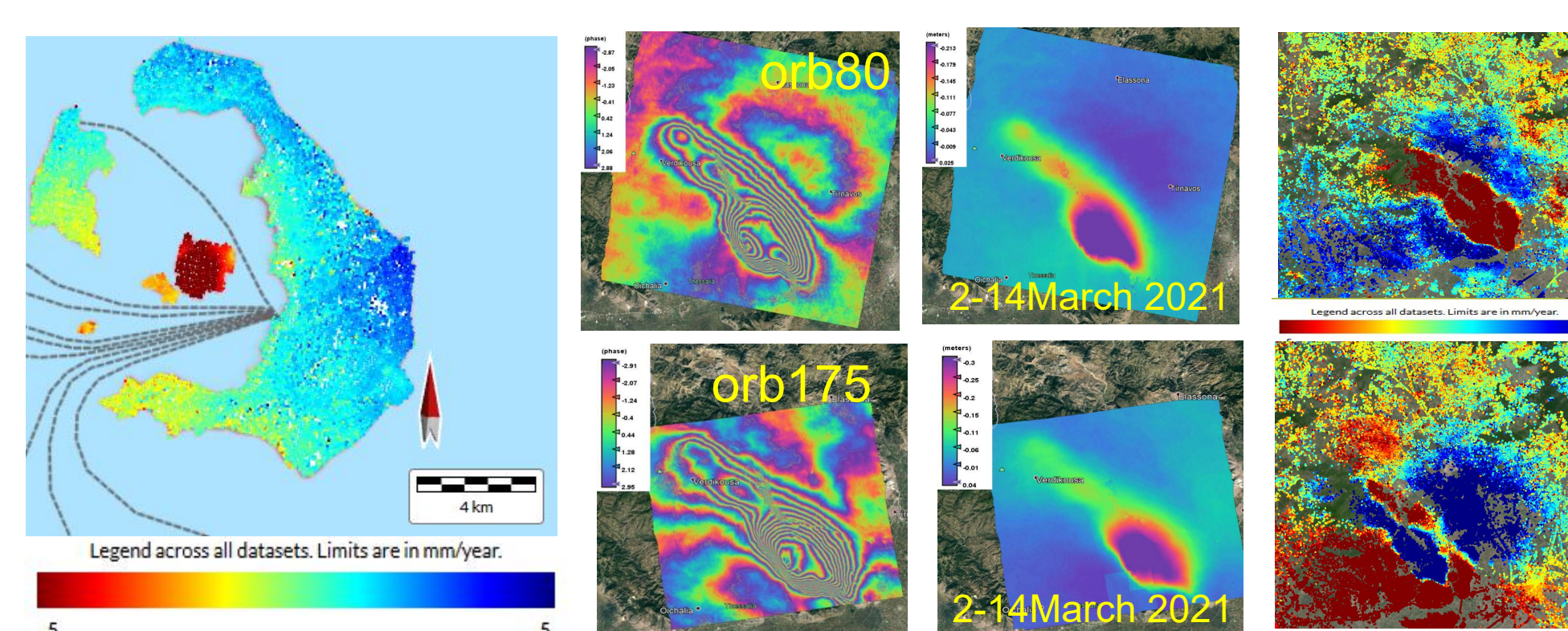


Fig. 6. Vertical movement by MT-SAR for period 2019-2023 from EGMS [5]

Fig. 8. Interferometric images of the area of the Larissa earthquake and displacement maps along the LoS direction determined by the two types of orbits [6]

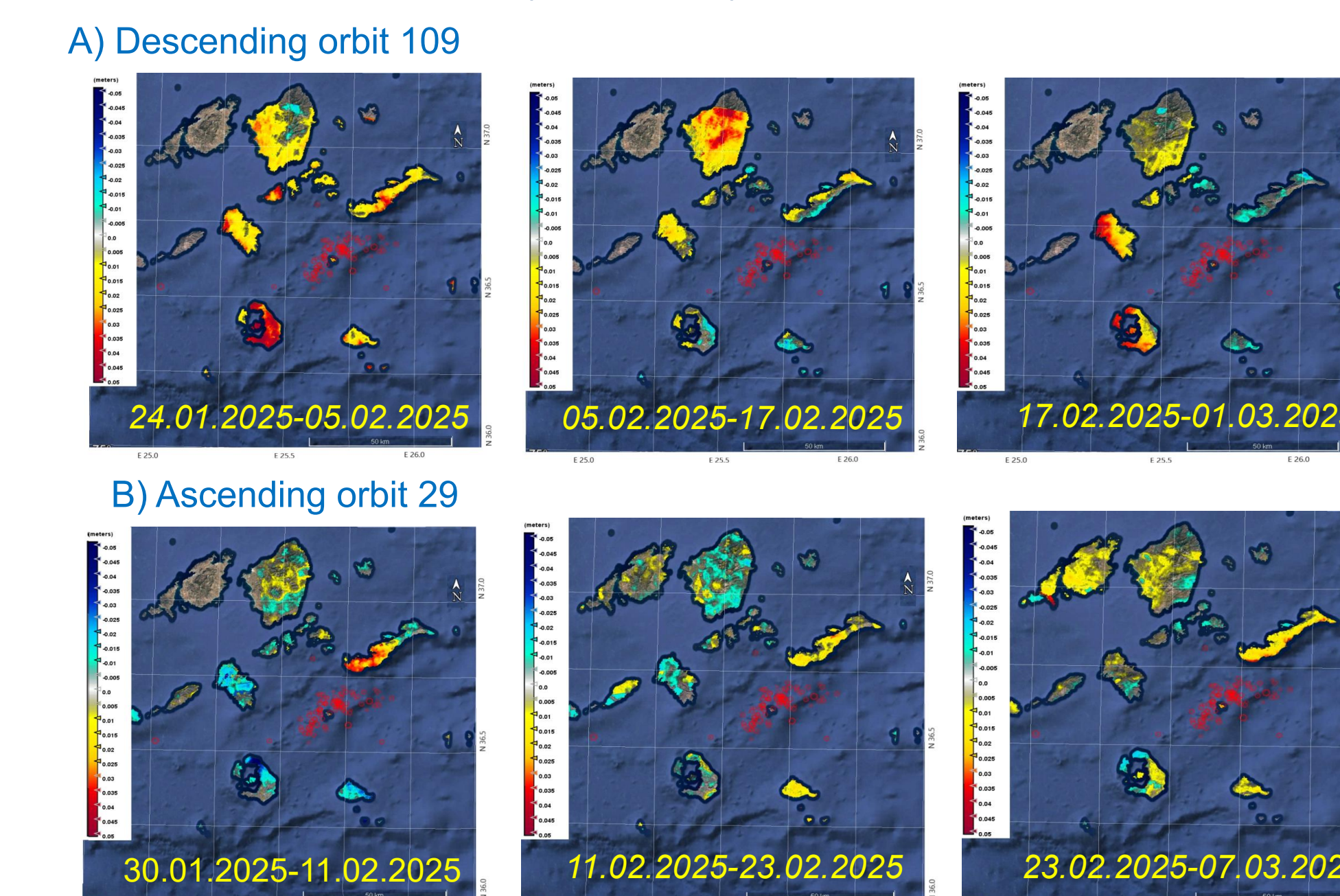


Fig. 7. A) SAR displacement along the LoS from descending 109 orbit and B) SAR displacement along the LoS from ascending 29; Location seismic swarm of earthquakes - red points EMSC [7]

Co-seismic displacement after the earthquakes evented Northeast the Santorini Island in the February 2025 were estimated (see fig. 7). This ongoing activity, classified as an earthquake swarm, has produced a maximum recorded magnitude of 5.3 Mw, but no recorded salt movements on the earth's surface.

## RESULTS

The latest strong earthquake with magnitude M 6.1, shook the northwestern Turkish province of Balikesir, causing the collapse of dozens of buildings. We took the opportunity the next day from event to determine the size and extent of the areas affected by coseismic deformations.

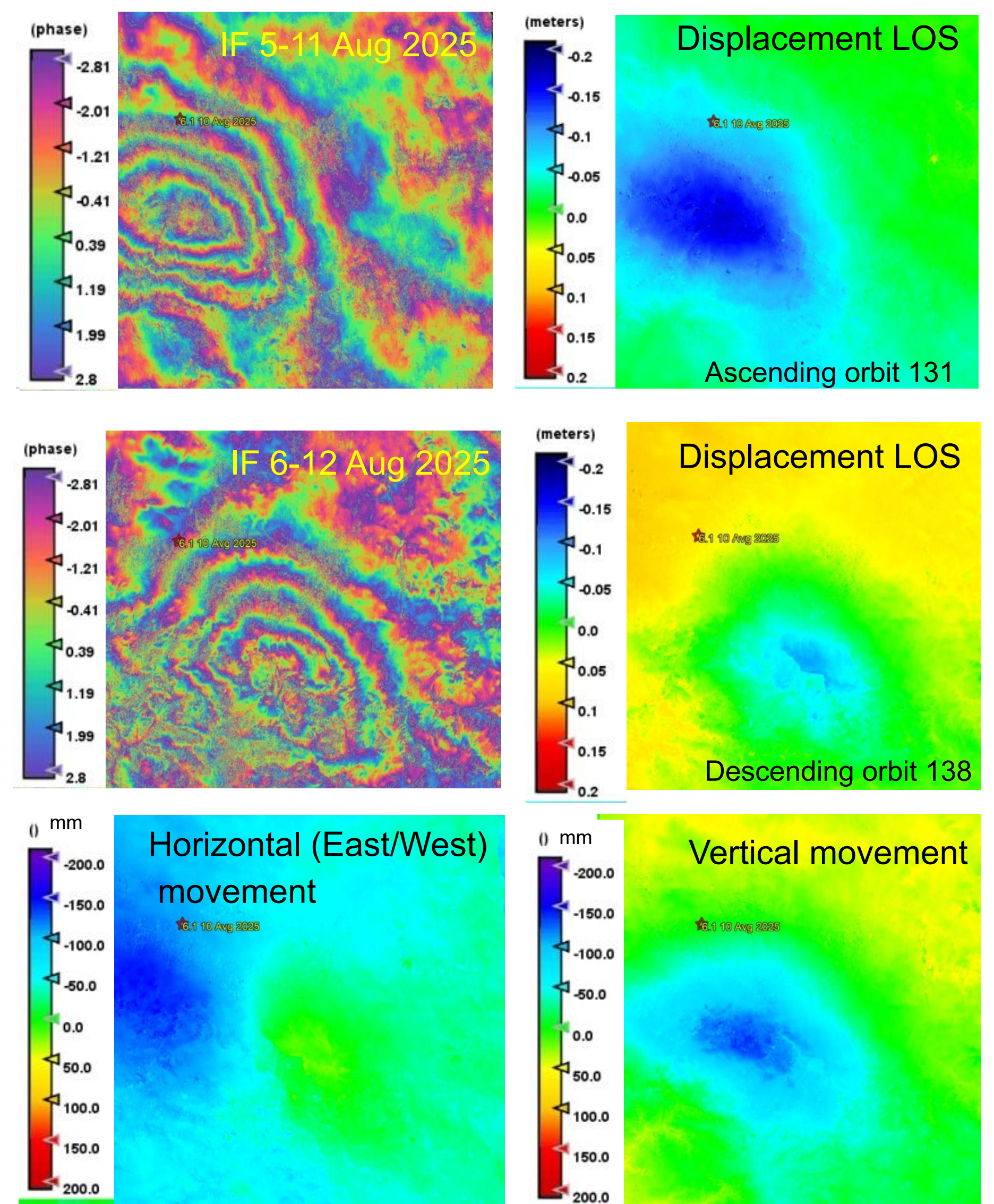
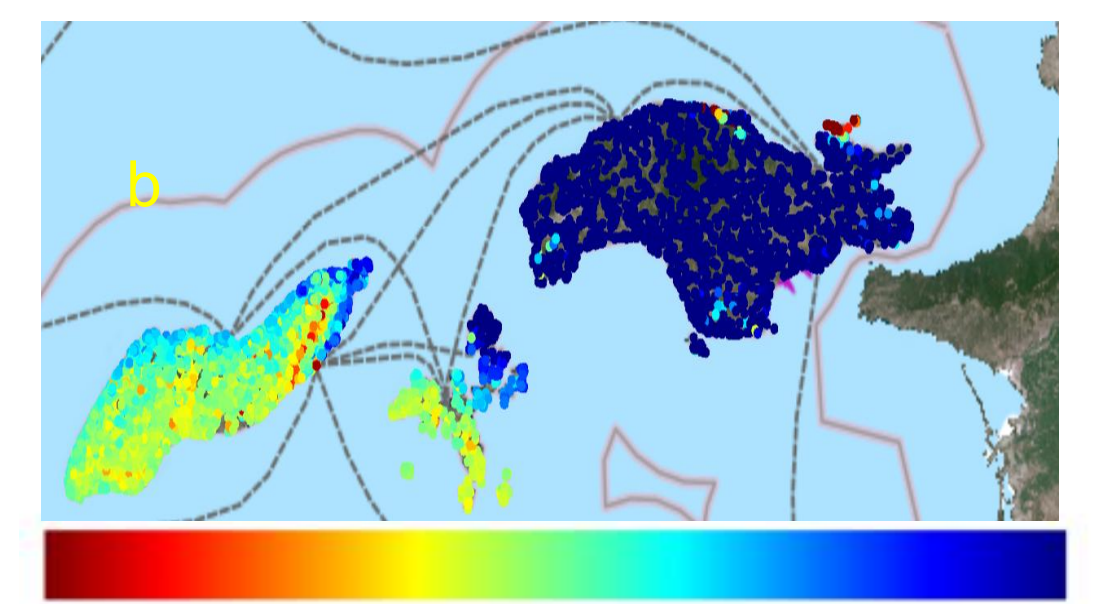


Fig. 10. Earthquake August 10 th 2025, Mw 6.1 Balikesir  
 The Samos island is located in the eastern Aegean Sea, a well-known extensional terrain, as it is found on the back-arc area behind the Hellenic subduction.

Fig. 11 Vertical movement determined by MT-SAR for period 2019-2023 from EGMS [5] from event 30 October 2020 Mw 6.9 Samos-Izmir Earthquake



## CONCLUSIONS

1. The presented examples demonstrate the application of InSAR technologies for Earth observation for the study and monitoring of the seismogenic areas of the Aegean region and their importance and advantages in establishing regularities in the movements in these zones.
2. Interpretation of the spatial distribution on coseismic deformations caused by large earthquakes occurred in the Aegean region provides clarity studying into geodynamic and tectonic processes.
3. The applied DinSAR methodology, successfully generates displacement maps, that visually depict the displacements around the epicenters and the have possibility of determining the degree of deformation of the earth's surface and to prepare geo risk maps that might be used by a large number of experts in different fields.

## REFERENCES

1. Map Hellenic arc, [https://en.wikipedia.org/wiki/Hellenic\\_arc](https://en.wikipedia.org/wiki/Hellenic_arc)
2. Map Aegean Sea [https://en.wikipedia.org/wiki/Aegean\\_Sea\\_plate](https://en.wikipedia.org/wiki/Aegean_Sea_plate)
3. EMSC <https://www.emsc-csem.org/>
4. VERTEX /ASF Alaska <https://search.asf.alaska.edu/#/>
5. EGMS <https://egms.land.copernicus.eu/>
6. Atanasova M. Nikolov H.(2024) Complex analysis of co-seismic deformations using SAR satellite data: application for the Balkan Peninsula, Proceedings Volume 13195, Microwave Remote Sensing: Data Processing and Applications III; 131950N (2024) <https://doi.org/10.1117/12.3031731>
7. Atanasova M. Angelova P. (2025) Detection of coseismic displacement in the Cyclades region, Eleventh International Conference on Remote Sensing and Geoinformation of Environment 17-19 March, 2025 - Paphos, Cyprus