

Abstract

The earthquake with a magnitude of Mw 6.9 (according to Kandilli Observatory and Earthquake Research Institute-KOERI) occurred 8 km north of Samos Island at a depth of 16 km, on 30.10.2020, at 11:51:24 UTC. It took place on the north-dipping normal fault zone of approximately 40 km length in the sea between Samos Island of Greece and Kuşadası Bay of Turkey. After the mainshock, a tsunami with the height exceeding 1 meter occurred in Seferihisar region, south of Izmir, and north side of Samos Island. In this study, a geodetic investigation of the Samos-Izmir earthquake using GNSS and SAR techniques was carried out. Within the scope of this study, 1Hz observations of Turkey National Continuous GNSS Network-Active (TUSAGA-Aktif) stations in the earthquake zone, were used, and it was aimed to reveal the co-seismic deformation caused by the earthquake. In addition to GNSS data, the InSAR process has been performed by using ESA Sentinel-1 SAR data, and the vertical deformations were clarified with the unwrapped interferogram. The GNSS data were processed using web-based online processing services according to the relative and absolute positioning techniques as static and kinematic modes. In conclusion, considering the absolute and relative static processing of pre- and post-earthquake GNSS data, the maximum horizontal deformations were observed at CESM and IZMI GNSS stations located in the north of the fault. Due to the earthquake, these points moved to the north direction and the maximum horizontal deformations were found as 5.5 cm and 3.5 cm, respectively. According to the kinematic processing of the GNSS data, instantaneous horizontal movements of 12 cm and 4 cm towards the north were observed at the same stations, respectively, at the time of the earthquake. On the contrary, DIDI and AYD1 GNSS stations, which are located in the south of the fault, moved to the south-east direction and the magnitude of horizontal deformations were smaller. Considering the InSAR results, it was seen a 10 cm uplift in the west of the island of Samos and a 10 cm subsidence at the northernmost part. Besides this, a 5 cm subsidence was observed in Izmir territory, the north side of the fault, by means of the interferogram.

General Information

- 1Hz observation data of AYD1, CESM, DIDI and IZMI CORS-TR GNSS stations were used for Geodetic Investigation.
- Inter-seismic velocity vectors of the GNSS stations were shown in Figure1.
- 2D deformation vectors, obtained with PPP-Static method by using Canadian Spatial Reference System Precise Point Positioning (CSRS-PPP) web-based service were shown in Figure 2.
- 2D and height displacements, obtained by kinematic PPP method using CSRS-PPP service, were shown in Figure 3 (as scatter plot) and Figure 4 (as time series).
- Time series of Relative Static Positioning Solutions for GNSS stations were given in Figure 5.
- The line of sight (LOS) displacement map in the Figure 6 was produced using Sentinel-1 SAR data dated 24.10.2020 and 30.10.2020.

Geodetic Investigation

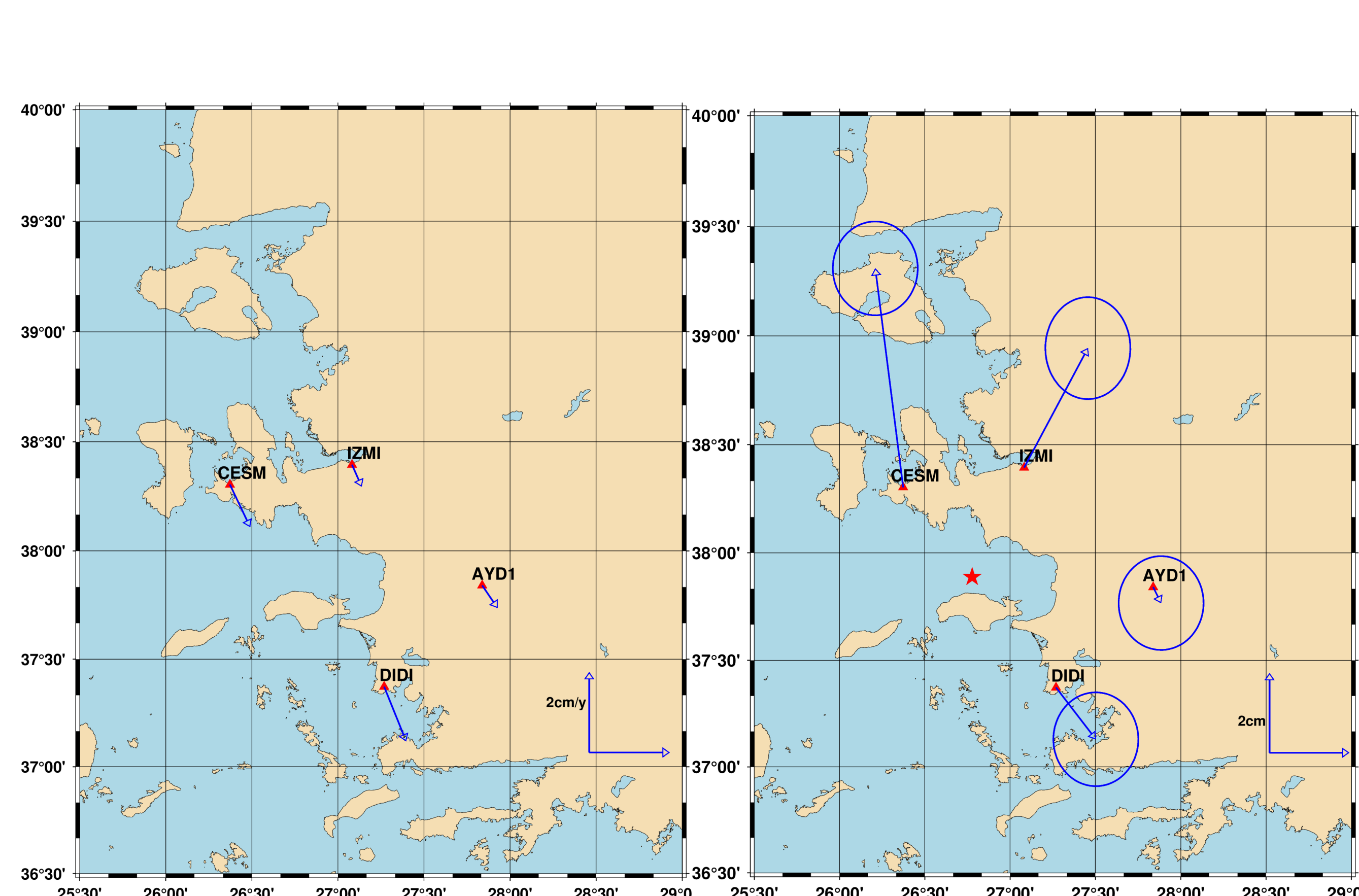


Figure1. Inter-seismic velocity vectors of the GNSS stations.

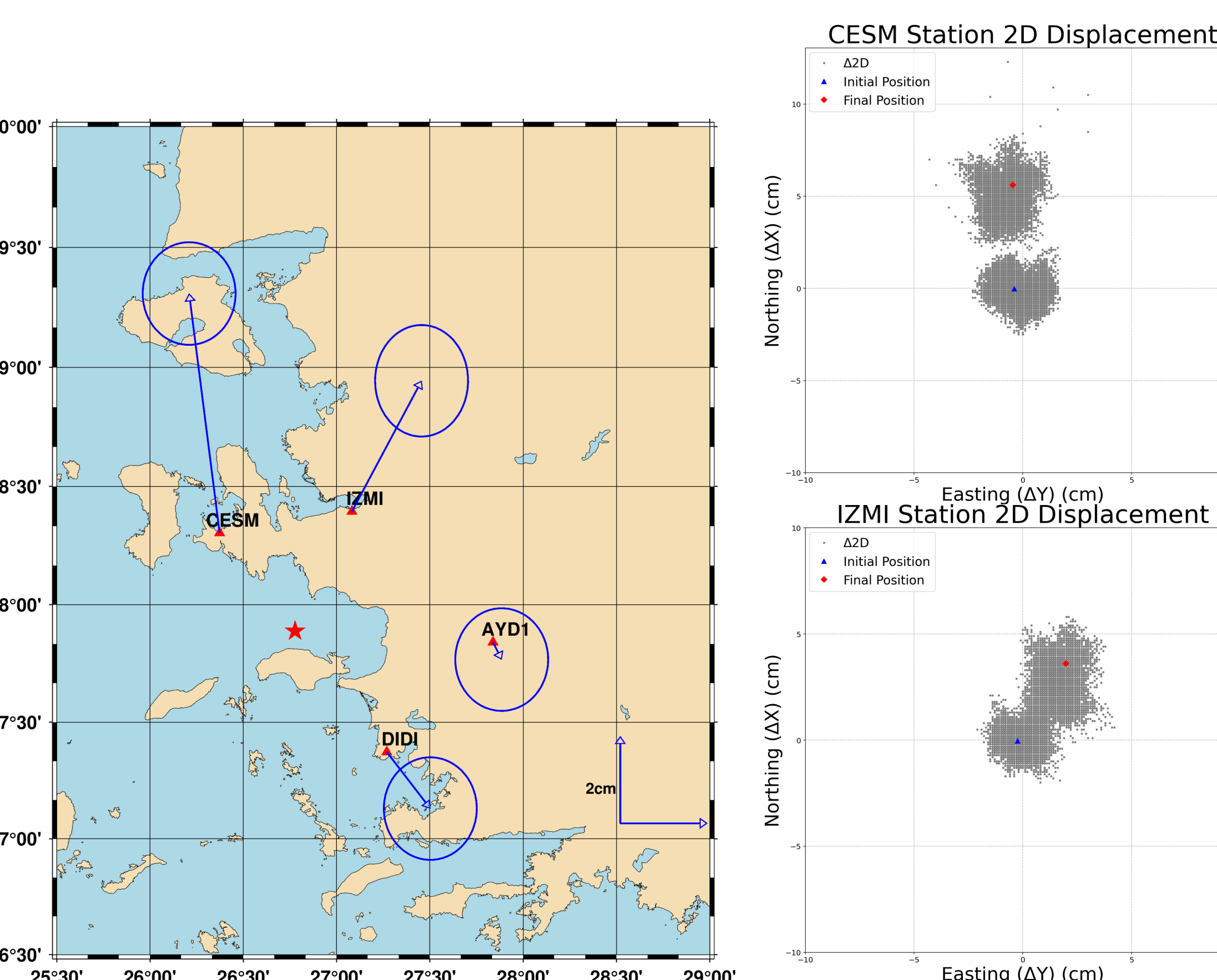


Figure2. Co-seismic deformation vectors of GNSS stations in 95% confidence level.

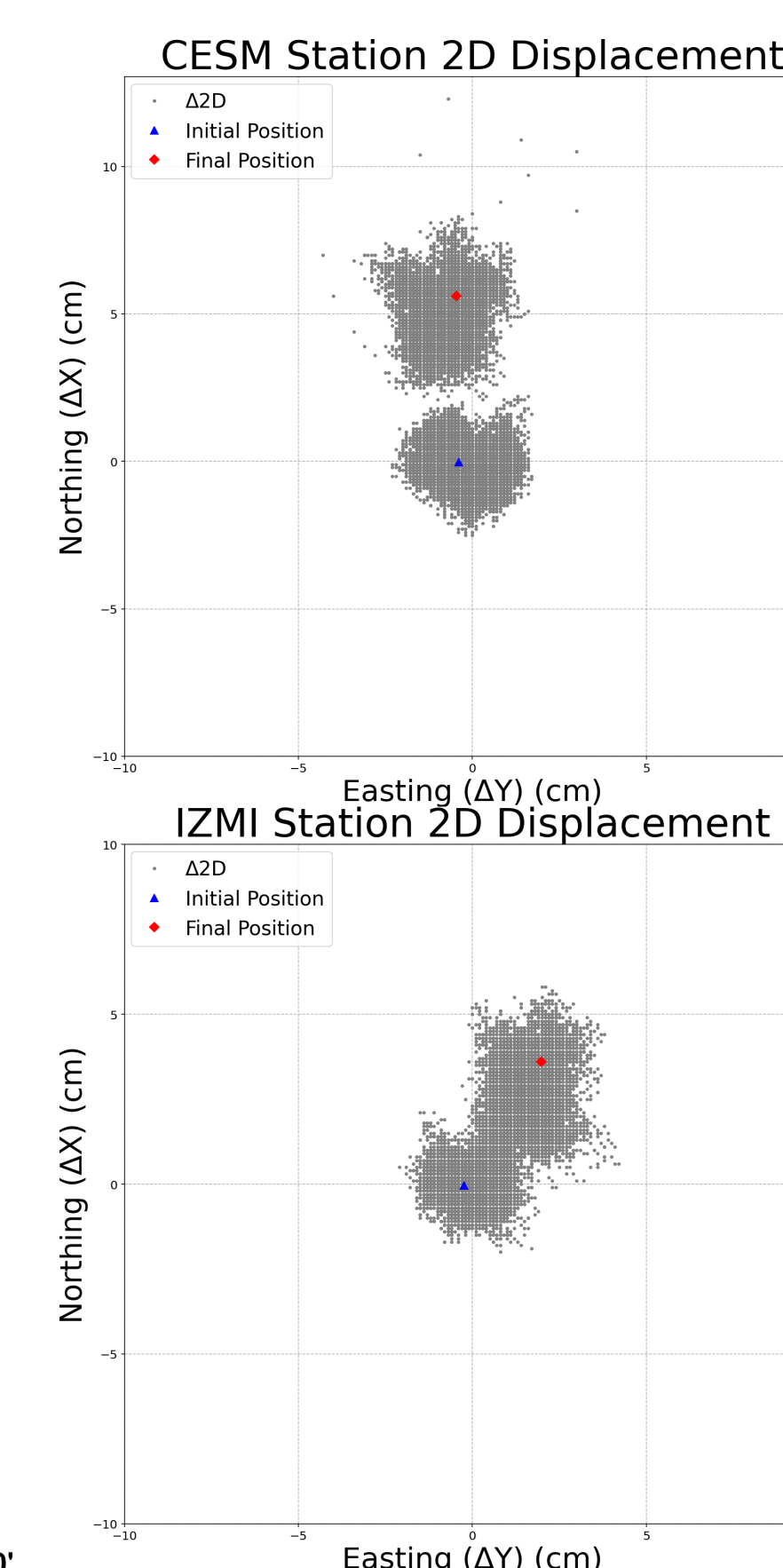


Figure3. Scatter plot of the CESM and IZMI stations.

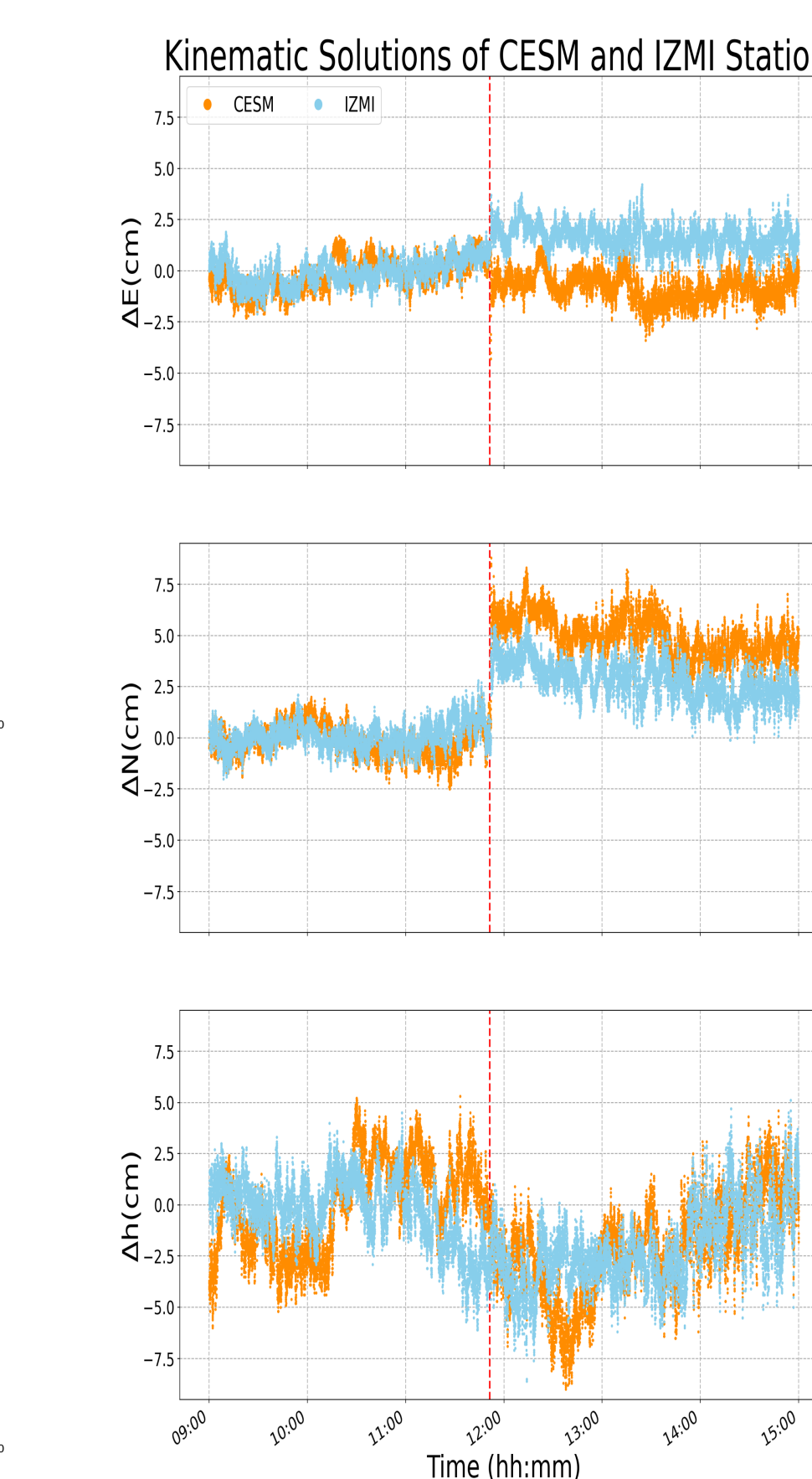


Figure4. PPP-Kinematic displacement plots for CESM and IZMI stations.

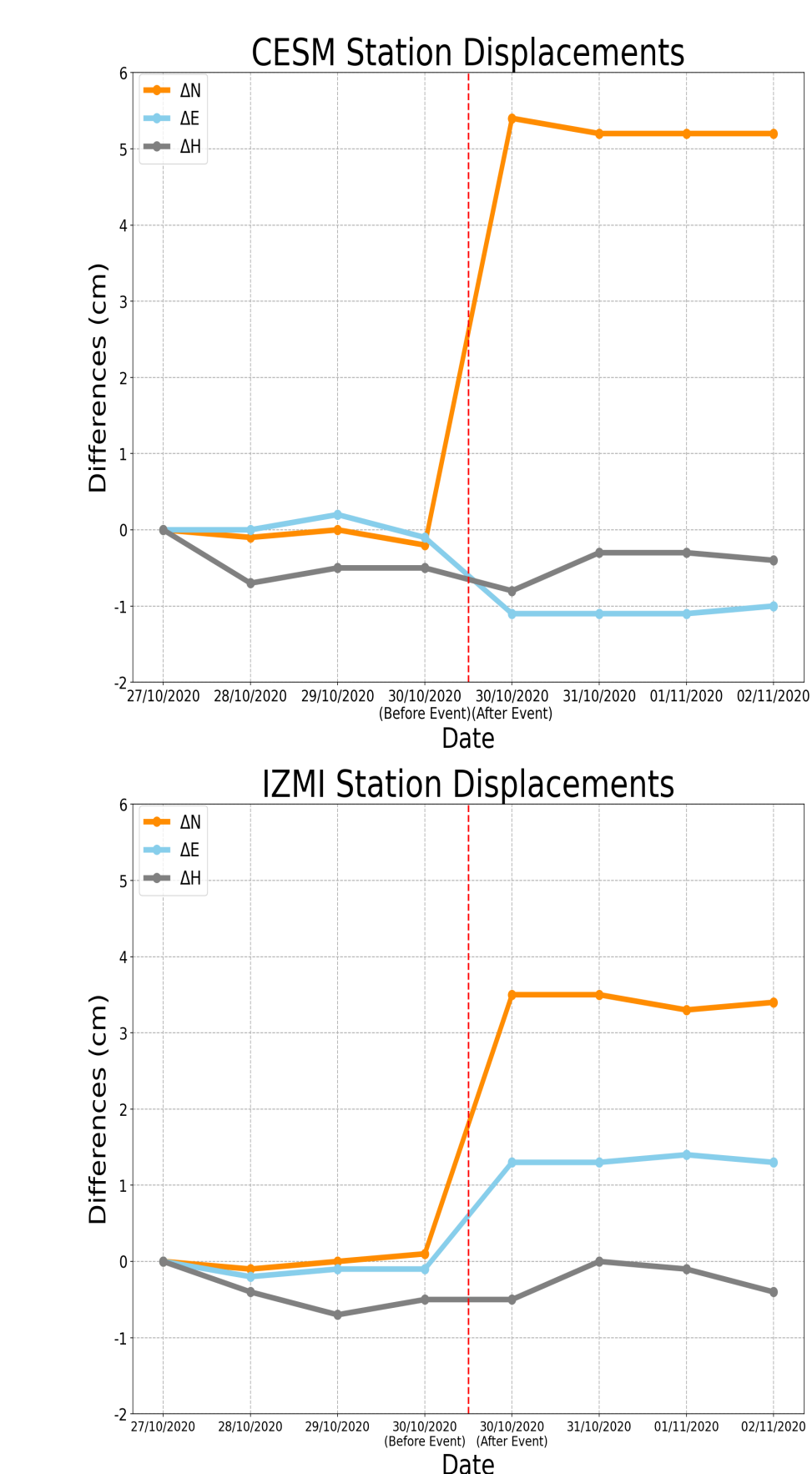


Figure5. Relative Static Solutions displacement plots for CESM and IZMI stations.

InSAR Technique (ESA-Sentinel)

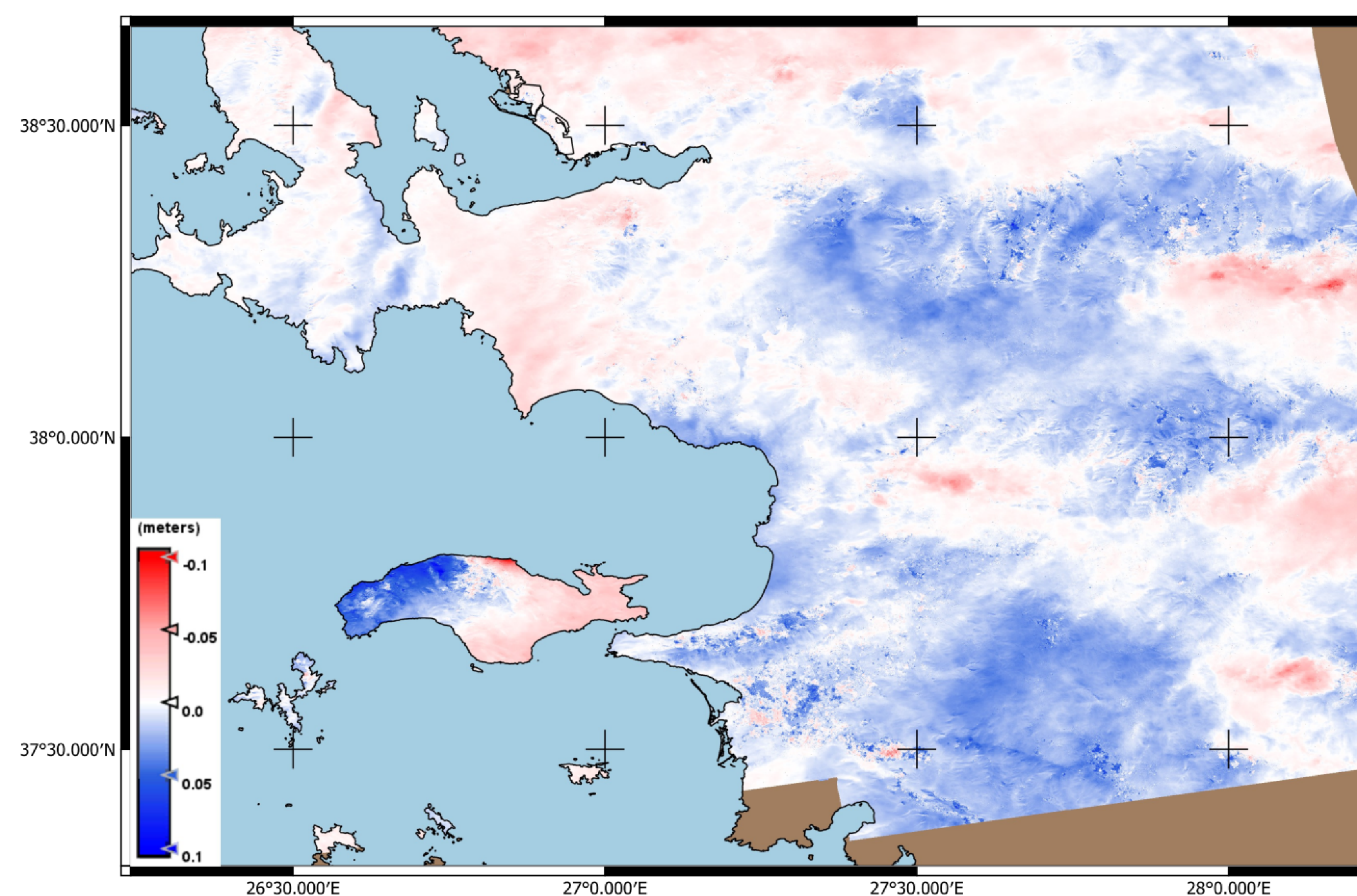


Figure6. Line of sight (LOS) displacement map obtained by using InSAR technique.

Conclusion

- CESM and IZMI stations have significant deformations according to %95 confidence level.
- Horizontal displacements for CESM and IZMI were obtained as 5.5 cm and 3.5 cm, respectively.
- The displacement in the northern component of the CESM station instantaneously reached 12 cm at the time of the earthquake (11:51:24 UTC) and then decreased to 6 cm. In addition, the point instantly moved 7 cm in the east-west direction during the earthquake and then remained stable in this direction. When the scatter-plot of the CESM station is examined, similar to the static analysis, the point has moved 5.5 cm in the north direction.
- IZMI station moved 4 cm north and 2 cm east during the earthquake. As a result of the kinematic analysis, the horizontal movement at the point is 4.5 cm and the point has moved to the north-east direction.
- According to the InSAR results, there was a 10 cm uplift in the west and a 10 cm subsidence at the northern part of the Samos island.