Ionospheric signatures of the Samos 2020 M7.0 earthquake in the Mediterranean region

Lucilla Alfonsi1, Elvira Astafyeva2, Anna Belehaki3, Simon Bufferal4, Claudio Cesaroni1, Panagiotis Elias3, Manuel Hernández-Pajares5, Ioanna Tsagouri3, Heng Yang5

1. Istituto Nazionale di Geofisica e Vulcanologia, Italy
e-mail: lucilla.alfonsi@ingv.it, claudio.cesaroni@ingv.it
2. Institut de Physique du Globe de Paris, Université de Paris, France
e-mail: astafyeva@ipgp.fr
3. National Observatory of Athens, Greece
e-mail: belehaki@noa.gr, pelias@noa.gr, tsagouri@noa.gr
4. Laboratoire de Géologie, ENS Paris, France
e-mail: simon.bufferal@ens.fr
5. Polytechnic University of Catalonia, Spain
e-mail: manuel.hernandez@upc.edu, h.yang@upc.edu

On October 30, 2020, at 11:51 UT, a large Mw = 7.0 earthquake occurred in the Dodecanese sea in Greece, its epicenter located at 37.900°N 26.817°E, according to the National Observatory of Athens. The inversion of geodetic data reveals a fault laying north of Samos Island, its top ~1 km below the surface and ~2 km off-shore, dipping towards the north at 37° (Ganas et al., 2021). Part of the island uplifted up to 10 cm, but most of the deformation occurred off-shore, reaching, at the vertical component (subidence) the 1.2 m. This subsidence is the cause for the initiation of a tsunami wave impacting Greek and Turkish coasts with an observed run-up of more than 1 meter. Physically, the ground and sea-level displacements induced by the earthquake and the tsunami are transmitted into the atmosphere, where they produce acoustic and gravity waves penetrating upward. This paper presents the observations of the ionospheric impact of the earthquake and related tsunami, as observed by ionosondes and GNSS receivers in the Mediterranean region. The GNSS data have been analyzed to derive electron density 4D gradients. The GNSS TEC data and the ionosonde data concur to identify Medium Scale Travelling Ionospheric Disturbances (MSTIDs). Our preliminary results identify a significant increase, up to 100 mTECU/km, in the height component of the electron density gradient, with a strong uplift from 42 minutes up to 69 minutes after the earthquake main-shock at the south-east of the epicenter. Our analysis reveals also the presence of MSTIDs in the region, traveling with a speed of a few hundred m/s. A combined analysis of the earthquake deformation and tsunami evolution with the investigation of the ionospheric response is effectively adopted to provide a detailed picture of the ionospheric response at a regional level.

Figure 1. Vertical component of the 4D electron density gradient in the region 38-38° latitude, 26°-28° longitude on 30 October 2020 (the time is referred to the starting of the previous day in the horizontal axis). The time of the main-shock is identified with a green rectangle.
References