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Exploring early seismo-ionospheric signs preceding the February 6, 2023, Turkey earthquake (Mw 7.8): Preliminary results

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This study investigates the early seismo-ionospheric signals preceding the 7.8 magnitude Turkey earthquake sequence on February 6, 2023. The main shock struck at 01:17:35 UTC in Şehitkamil, Gaziantep in southern Turkey near the northern border of Syria. About nine hours later, a strong 7.5 magnitude aftershock occurred to the northeast of the first main quake.

The present work is based on the analysis of the ionospheric behavior in response to these successive major earthquakes, using space-based GPS/GNSS (Global Positioning System/Global Navigation Satellite Systems) data. Employing geodetic data derived from both Turkish national (TUSAGA) and international (IGS) permanent receivers, we generated a local ionospheric map covering the seismogenic zone of southern Turkey. The aim is to reconstruct the time series of ionospheric Total Electron Content (TEC) and discern any potential anomalies in this signal. The diurnal variation of the ionospheric TEC shows homogeneity in the spatiotemporal pattern of the GNSS_TEC signal, except for January 12, 2023. At noon on this day, the ionospheric TEC reaches its maximum value (98.41 TECu), exceeding 250% of the mean value in the temporal series. This anomalous behavior prompted application of a robust statistical approach to exclude outliers, combined with wavelet transform analysis to capture the time-frequency characteristics of the ionospheric responses. These steps validated the results, indicating a potential seismic influence on the ionosphere approximately three weeks before the mainshock.

This research represents an important step to understanding seismo-ionospheric interactions, highlighting the complex relationship between crustal motions and ionospheric dynamics. Anomalies identified in the ionosphere prior to the major seismic event in Turkey suggest that the approach developed could be promising for predicting earthquakes. Further validation and collaboration are essential to refine these results and advance seismic risk assessment.

Keywords: 2023 Turkey earthquake, GPS/GNSS-TEC data, Pre-earthquake ionospheric anomaly, Crustal-Ionospheric Synergy.