

EGU25-86, updated on 28 Apr 2025

<https://doi.org/10.5194/egusphere-egu25-86>

EGU General Assembly 2025

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First Observation of Co-seismic Ionospheric Disturbances from a Deep-Focus Earthquake in Brazil: Ground Uplift and TEC Analysis

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Co-seismic ionospheric disturbances (CIDs) are well-documented phenomena typically following medium to large earthquakes. However, several factors influence the detectability of CIDs, and deep-focus earthquakes (depth > 300 km) have long been considered ineffective in generating significant ionospheric disturbances. Consequently, regions like Brazil, which are known for deep-focus seismic activity, have not reported CIDs associated with such events. On January 20, 2024, a deep-focus earthquake of magnitude 6.6 struck near Tarauacá, Brazil, at a depth of 607 km. Although no surface damage was reported, this event marked a significant seismic occurrence in a region influenced by the subducted Nazca Plate. In this study, we used Global Navigation Satellite System (GNSS) Total Electron Content (TEC) data from the Brazilian Network for Continuous Monitoring of GNSS Systems (RBMC) and seismic data from the IRIS network to analyze the earthquake's impact on both the ground surface and the ionosphere. The results revealed clear ionospheric disturbances, or ionoquakes, characterized by "N-wave" patterns in the TEC data, originating from infrasonic-acoustic waves generated by the earthquake's crustal displacement. These ionoquakes were detected 5.5 - 12.3 minutes after the earthquake, traveling at speeds between 550 m/s and 743 m/s. This is the first report of CIDs associated with a deep-focus earthquake in Brazil. Spectral analysis showed a TEC amplitude peak in the 14–16 mHz frequency range, suggesting high-frequency infrasonic-acoustic wave dynamics.