Multi-Instrument detection of the ionospheric response to the 6 February 2023 Turkey Earthquake

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This research explores diverse ionospheric disturbances observed across Europe following the 10:24 UT earthquake of M_W=7.7 in Turkey on February 6, 2023. The results of such research are currently available in [1]. We can distinguish various disturbances characterised by different velocities and propagation mechanisms by leveraging data from Continuous Doppler Sounding Systems (CDSS), ionosondes, and GNSS receivers. Our analysis unveils co-seismic ionospheric disturbances near the epicentre and reveals ionospheric manifestations of acoustic waves resulting from seismic wave propagation. Unlike previous studies predominantly reliant on Total Electron Content variations, which reflect disturbances around the F-region peak, our study emphasises the detection of disturbances at different ionospheric altitudes. This is achieved by leveraging complementary ionospheric remote sensing techniques, particularly evident in earthquake-related signatures identified as multiple-cusp deformations on ionograms. These deformations, presenting additional cusps at the F-region base, are attributed to electron density perturbations generated by Rayleigh surface waves, giving rise to acoustic waves that propagate upward to the ionosphere. In addition, thanks to the large network of GNSS receivers available in the European and Middle-Eastern areas, it was possible to study both the near and far field response to the earthquake, allowing comparison between the TID parameters derived from different measurement techniques. Moreover, the CDSS also allows the comparison of the acoustic wave signature with the seismic wave derived from collocated seismometers. Thus, our study underscores the benefits of multi-instrument investigations in discerning the propagation of earthquake-related ionospheric disturbances at various ionospheric altitudes and distances from the earthquake epicentre.

[1] H. Haralambous *et al.*, 'Multi-Instrument Observations of Various Ionospheric Disturbances Caused by the 6 February 2023 Turkey Earthquake', *Journal of Geophysical Research: Space Physics*, vol. 128, no. 12, p. e2023JA031691, 2023, doi: 10.1029/2023JA031691.