Investigation of ionospheric irregularities during the severe geomagnetic storm of 10–11 may 2024

Abstract

In the present study we investigated the ionospheric response to the 10–11 May 2024 intense geomagnetic storm (Dst index~-412nT) using data from seven Global Navigation Satellite System (GNSS) stations: Mestersvig (MSVG), Sutherland (SUTH), Belem (BELE), Mbarara (MBAR), Kantonkino (KANZ), Dunedin (DUND) and Baker Lake (BAKE). The GNSS-TEC data retrieved from each station were used to estimate detrended Total Electron Content (dTEC) and the Rate of Change of Total Electron Content Index (ROTI) derived from GNSS-TEC obtained from each station to quantify the occurrence of Ionospheric irregularities. Continuous wavelet transform (CWT) was also used to determine periodicities. The results showed that KANZ and MSVG experienced intense Ionospheric perturbations compared to other stations. Both long and short CWT periodicities were detected, suggesting multiple sources of Ionospheric disturbance, including travelling Ionospheric disturbances. A strong correlation was observed between ROTI and dTEC, with higher ROTI values corresponding to greater dTEC values, suggesting rapid TEC fluctuations. Regarding station location, MSVG, SUTH and KANZ exhibited higher levels of irregularity compared to MBAR, BAKE, BELE and DUND throughout the study period. The dTEC, ROTI and CWT results, consistently indicated the presence of Ionospheric irregularities during both quiet and storm periods across all the stations, albeit with varying intensity. However, storm days demonstrated more pronounced disturbances, characterized by higher dTEC and ROTI values and shorter periodicities.

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