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Impact of Geomagnetic Storm on Ionosphere

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Abstract : This research investigates the impact of the geomagnetic storm occurring from April 22 to April 26, 2023, on the Earth's ionosphere, with a focus on analyzing specific ionospheric parameters to understand the storm's effects on ionospheric stability and GNSS signal propagation. Geomagnetic storms, caused by intensified solar wind-magnetosphere interactions, can significantly disturb ionospheric conditions, impacting electron density, Total Electron Content (TEC), and thermospheric composition. Such disturbances are particularly relevant to satellite-based navigation and communication systems, as fluctuations in ionospheric parameters can degrade signal integrity and reliability. In this study, data were obtained from multiple sources, including OMNIWeb for parameters like Dst, Kp, Bz, Electric Field, and solar wind pressure, GUVI for O/N_2 ratio maps, and TEC data from low-, mid-, and high-latitude stations available on the IONOLAB website. Additional Equatorial Electrojet (EEJ) and geomagnetic data were acquired from INTERMAGNET. The methodology involved comparing storm-affected data from April 22 to April 26 with quiet days in April 2023, using statistical and wavelet analysis to assess variations in parameters like TEC, O/N_2 ratio, and geomagnetic indices. The results show pronounced fluctuations in TEC and other ionospheric parameters during the main phase of the storm, with spatial variations observed across latitudes, highlighting the global response of the ionosphere to geomagnetic disturbances. The findings underline the storm's significant impact on ionospheric composition, particularly in mid- and high-latitude regions, which correlates with increased GNSS signal interference in these areas. This study contributes to understanding the ionosphere's response to geomagnetic activity, emphasizing the need for robust models to predict and mitigate space weather effects on GNSS-dependent technologies.

Keywords : geomagnetic storms, ionospheric disturbances, space weather effects, magnetosphere-ionosphere coupling
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