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[Lecture]

Why a Minor Storm Did More Harm Than a Super One: Effects of the 2022 February G2 and 2024 May G5 Geomagnetic Storms

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Abstract: This study investigates the impact of minor geomagnetic storm of 03–04 February 2022 and super geomagnetic storm of 11 May 2024 on the variations of ionospheric responses across the low, mid, and high-latitudes while assessing potential connection of failure of Starlink satellites from variations of solar wind parameters (Bz, density, speed and plasma beta) perspective. The analysis utilizes Global Navigation Satellite System (GNSS) and Digisonde measurements, and models (International Reference Ionosphere, IRI 2020 and IRI-Plas 2017) to examine variations in the critical frequency (foF2) and height of peak electron density (hmF2) at F2-layer and Total Electron Content (TEC). The peak diurnal Digisonde-derived foF2 and GNSS TEC values observed on 01 February 2022 (a relatively quiet day) were significantly enhanced by about 61% and 70%, respectively on 04 February 2022 (recovery phase), near the Starlink satellite launch station (EG931). The substantial increases in foF2 and TEC values may be attributed to heightened solar wind parameters (notably 350% peak Bz decrease and 638% plasma beta increase on 03 February 2022, 125% Bz decrease, 300% density and 95% plasma beta increase on 04 February 2022 compared to 01 February 2022). The 11 May 2024 storm produced reductions in both foF2 and TEC values on most of the time during the

main phase compared to the initial and recovery phases. However, compared to the quiet time variations the parameters show enhancements, with the highest (about 219%) being seen by the diurnal GNSS TEC values at the low latitude station of AS00Q.

Keywords: Geomagnetic storm, foF2, hmF2, TEC, low latitude, mid latitude, high latitude