Simultaneous Response of NmF2 and GPS-TEC to Storm Events at Ilorin, Nigeria

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ABSTRACT

Simultaneous measurement of vertical columnar electron content (TEC), peak electron density of the F2 layer (NmF2), and its height of occurrence (hmF2) at Ilorin (Geog. Lat. 8.50^{o}N, Long. 4.50^{o}E, dip. -7.9^o) an equatorial station were used for this study. IMF-Bz, Dst and AE-indices were used for the storm observation. Four moderate storms at low solar activity period were used in observing their effects on these parameters. Distinct changes in the morphology of the ionospheric parameters used were observed during the storm events. The result revealed that in terms of percentage changes, the signature of magnetic storm is stronger on NmF2 than on TEC for these storms. The strongest of the three storms caused a decrease in hmF2 when there were increases in TEC and NmF2.

Key words: Total electron content, F2 layer, magnetic storm, equatorial ionosphere

Introduction:

Investigations on geomagnetic storm effects on the ionosphere have been a subject of great interest in the field of space weather observations. This is because of the effect of magnetic storms on space and ground based technologies. In the effort to understand ionospheric behavior during magnetic storm event, the deviation of magnetically quiet days vertical columnar electron content (TEC) or peak electron density of the F2 layer (NmF2), from those during geomagnetic disturbances period have been used ([1], [2], [3], [4], [5]). This study aims at investigating the simultaneous response of the F2 region peak parameters (FoF2 and hmF2) and TEC to four moderate storms. One of the storms occurred in April, two in May and one in August 2010. The use of more than one parameter enhances the understanding of ionospheric storm effects.

Data and Method:

Data from digisonde portable sounder (DPS-4) and GPS receiver co-located at Ilorin (Geog. Lat. 8.50^{o}N, Long. 4.50^{o}E, dip - 7.9^o), an equatorial station in the African sector were used for the study. The dual frequency GPS receiver at Ilorin belongs to the Scintillation Network and Decision Aid (SCINDA) GPS receivers. Diurnal variations of TEC and NmF2 on storm days were compared with those of the averages for the five most quiet days of the month in which the storm occurred. Percentage deviations were also computed. The analysis covered

two days before and after the storm events. To characterize the magnetic field during both the quiet and disturbed days, the interplanetary magnetic field (IMF-Bz), Aurora electrojet index (AE), Dst-index, and the horizontal component of the magnetic field intensity (H) of the geomagnetic field at Ilorin were employed.

Results:

Figure 1 shows the result for the storm event of 4-7 April, 2010. Enhancement in both TEC and NmF2 occurred during this storm. The noon bite-out in quiet day NmF2 was still present during the main phase of the storm but the difference in time of occurrence of the two daytime peaks was reduced. There was no noon bite out in quiet day TEC but it appeared on storm days with two peaks similar to those of NmF2. A slight decrease occurred in hmF2 and this coincided with the time of occurrence of the first daytime peak in both TEC and NmF2. The changes in the morphology of these parameters show that during the magnetic storm, the drift of electron away from the equatorial region which characterizes the quiet time variation is reduced. The observations from the other three storms also show similar results with some variation, particularly with regards to changes in morphology of TEC and NmF2. Generally, the deviations from quiet time behavior were higher in the NmF2 (about -73 to 674%) than the TEC (about -31 to 112%). In most cases, increases in TEC and NmF2 values were observed during the main phase of the storm events, with corresponding decrease in hmF2 values. The observation of AE index helped in explaining some features of TEC and NmF2 which are seen some times before the commencement of the storm.

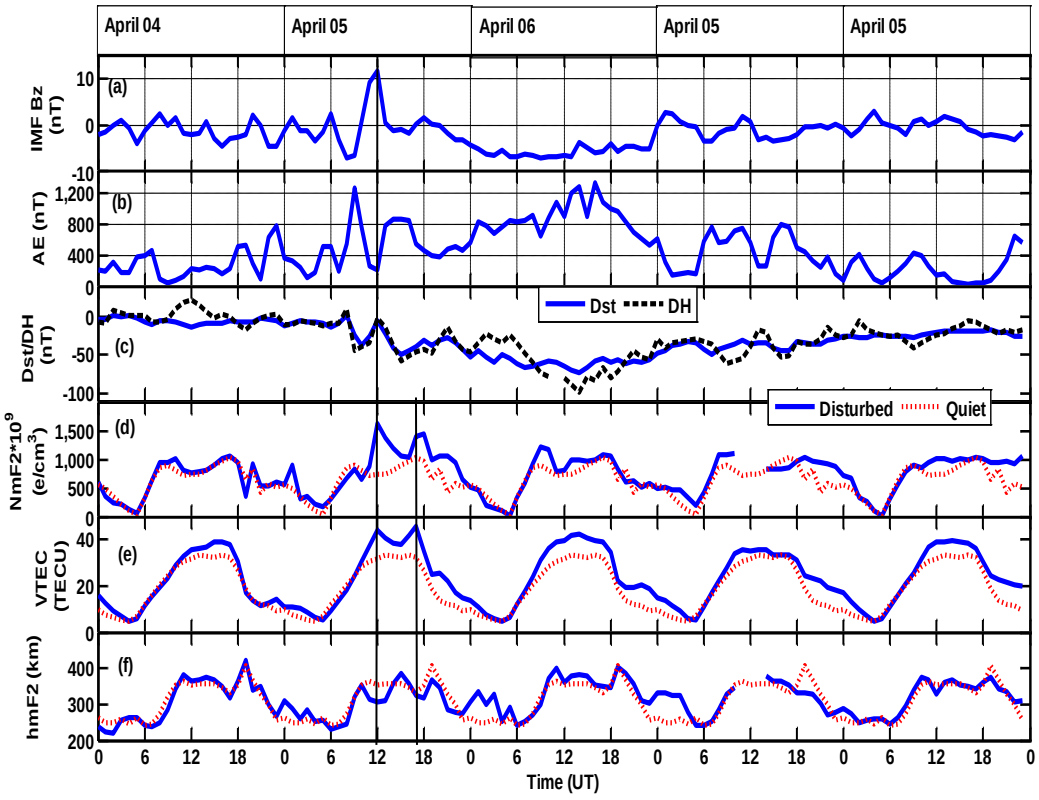

Figure 1. The Diurnal variation of (a)IMF Bz, (b) AE index, (c) Dst index and DH, (d) NmF2 (e) VTEC, and (f) hmF2 during the moderate geomagnetic storm event of April 4-8, 2010.

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