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GEOMAGNETIC STORM EFFECTS ON F2 LAYER PEAK ELECTRON DENSITY AND OTHER PROFILE PARAMETERS AT HIGH SOLAR ACTIVITY AT AN EQUATORIAL STATION

George Atilade Àlàgbé
Department of Pure and Applied Physics,
Ladoke Akintola University of Technology, Ogbomoso, Nigeria
E-mail address:atiladealagbe@yahoo.co.uk

ABSTRACT
The IPS 42 ionosonde was used to collect data at Ouagadougou, Burkina Faso (12.4^{0}N, 1.5^{0}W, dip 5.9^{0}N), an equatorial station in West Africa, using IPS 42 ionosonde, were used for this work. Ionograms for years of high solar activity [1990 (Rz=143) and 1991(Rz=146)] were analysed. The parameters used for this study are the peak electron density (NmF2), height of occurrence (hmF2) and the slab thickness (TF2) of the F2 layer of the ionosphere respectively; as well as the IRI (international reference ionosphere) bottom side profile parameter B0, shape parameter B1, for the F2 region. The simultaneous effects of geomagnetic storms on these parameters were investigated.
Keywords: *Equatorial ionosphere, Magnetic storms, Electron density*

INTRODUCTION
Effects of geomagnetic storms on the F2 layer of the ionosphere have been investigated (Adeniyi, 1986; Lastovicka, 2002; Mendillo, 2006). Studies carried out on the storm effects on the F2 and F1 layers of the ionosphere simultaneously are very scanty. This simultaneous view is expected to broaden our perspective on the mechanism of the storm effects on the ionosphere. This paper extended the investigation of the storm effects on the ionosphere from the F2 region down to the E layer heights. Storm effects on the peak density characteristics are investigated along with other associated ionosphric parameters.

DATA ANALYSIS
Ionosonde data obtained at Ouagadougou, Burkina Faso (12.4^{o}N,1.5^o W, dip 5.9^{o}N) were used for this work. Data for 1990 (Rz= 143) and 1991(Rz=146) were considered. These years correspond to years of high solar activity. In order to identify quiet days, the geomagnetic index Ap with values less than 26 were used. Ap values greater than 26 were used to identify the disturbed days (Adeniyi, 1986). The Dst values were used to plot the storm description. These geomagnetic indices were selected from the geomagnetic planetary indices supplied monthly by the International Association of Geomagnetism and Aeronomy. Scaling of ionograms was done manually by means of the personal computer. Compressed ionogram files were decompressed to obtain the individual ionograms. We used software designed for scaling ionograms. Scaling gives one a list of the frequency, corresponding virtual height, and critical frequency. Through a polynomial analysis programme [POLAN], the scaled data was inverted to obtain the true height [Titheridge,1995].
Ionograms were scaled for 24 hours of each day. Values of each parameter were extracted from the POLAN output. Five of the most magnetically quiet days of the month (within the

month in which a magnetic storm occurred) were chosen and the ionograms scaled. The hourly average of the value each parameter for these five quiet days was calculated. These were then used as reference values and formed a basis for a standard of comparison with the disturbed days.The storm events in each month were identified and the ionograms scaled on hourly basis, covering the 24 hours of the days. These were done both years of high solar activity. Storms were classified using the method of Loewe and Prolss [1997]. Moderate storms were identified as those with Dst values in the range (-100nT < Dst < -50nT); strong storms (-200 nT < Dst < -100nT); severe storms (-350nT < Dst < –200nT) and great storms with Dst less than -350nT. This work covers only moderate to severe storms. The diurnal variation of each of the parameters was plotted.

RESULTS

Generally, regardless of the type of storm, the peak electron density of the F2 layer, NmF2, responded to the storm with an increase. Figures 1(a) and (b) show typical examples of the storm description and the response of Nm F2 respectively. The increases in NmF2 occurred during the main and recovery phases of the storms. The magnitude of the increase does not appear to be dependent on storm strength. The increase in NmF2 makes the noon bite-out in NmF2 on storm days less prominent or not to appear at all. The increases in NmF2 are usually accompanied by a decrease in the slab thickness of the F2 layer, TF2. The bottom side profile parameter B0 and TF2 were found to display a very strong positive correlation, even during storms. Consequently, the response of B0 to the storm was always in sympathy with that of the slab thickness, TF2. The height corresponding to the peak electron density, hmF2, responded to the storm with an increase. This increase in hmF2 occurred concurrently with the increase in NmF2. Figure 2 shows an example of the increase in hmF2 in response to storm. This was generally accompanied by a simultaneous decrease in the shape factor, B1 (figure 3). There were, however, some decreases in hmF2. An example of the decrease in hmF2 is shown in figure 4(b), which is a response to the storm event of 1991, April 2-5 (figure 4(a)), that appeared to be a multiple storm. This decrease in hmF2 was followed by an increase in B1 (figure 4(c)). The shape parameter, B1, responded to the storm with a decrease (figure 5) and an increase (figure 6).The decreases in B1 occurred more frequently than the increases at this solar epoch. Generally, B1 decreased simultaneously with the increase in NmF2. An example of this inverse relationship between B1 and NmF2 is shown in figures 7(a), (b) and 8(a), (b).

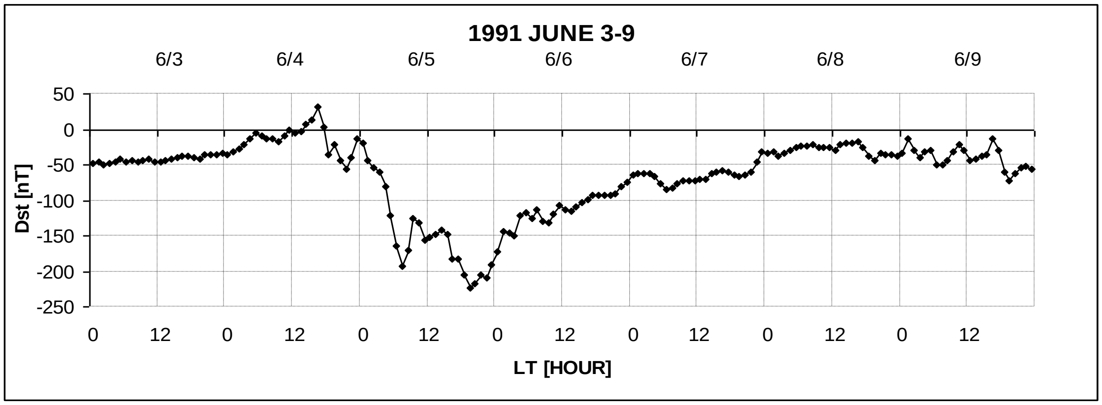

Figure 1(a): Description of the storm event of June 3-9, 1991

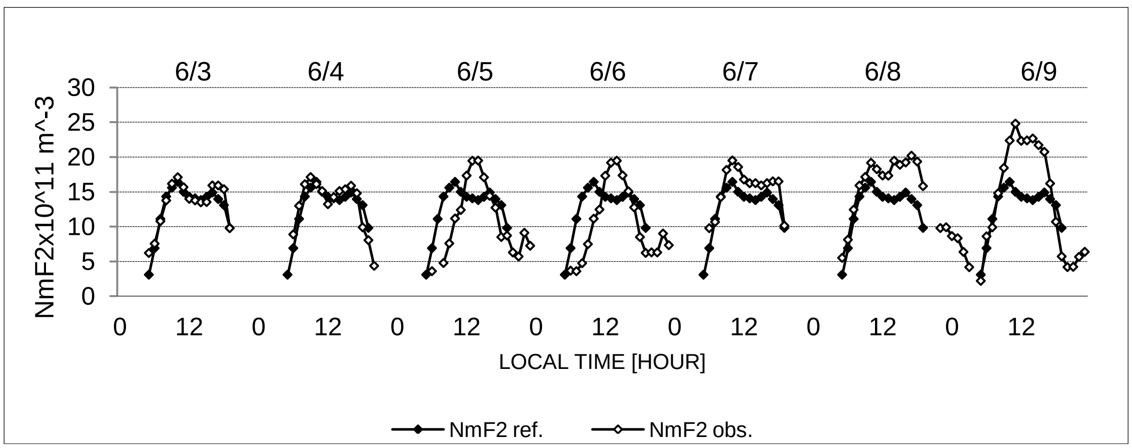

Figure 1(b): Positive response of NmF2 to storm

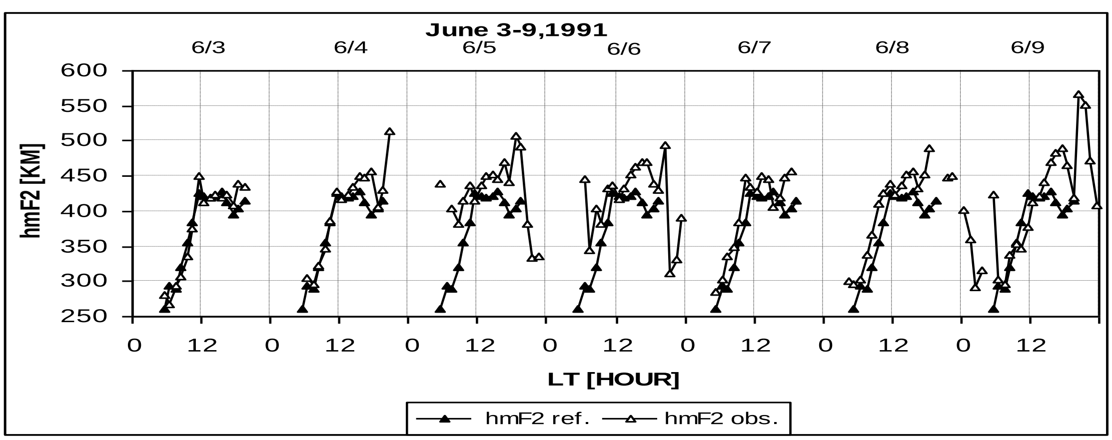

Figure 2: Increase of hmF2 during storm

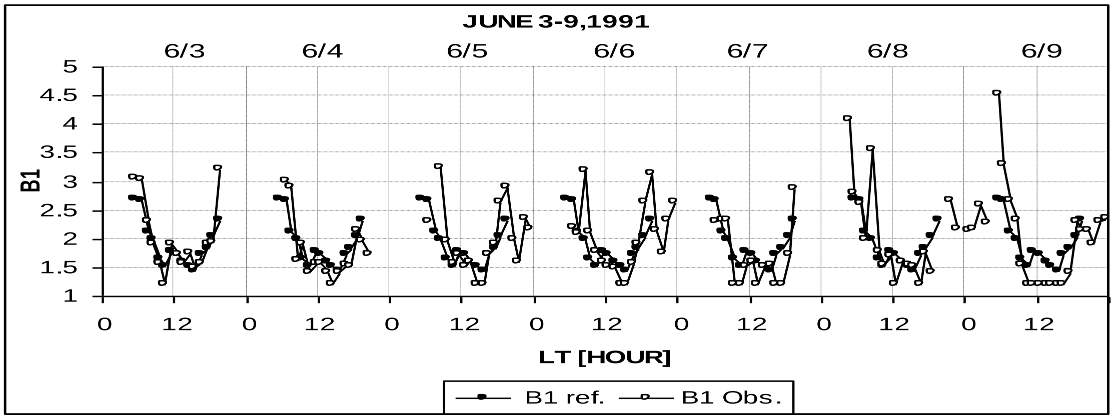

Figure 3: Response of B1 during storm

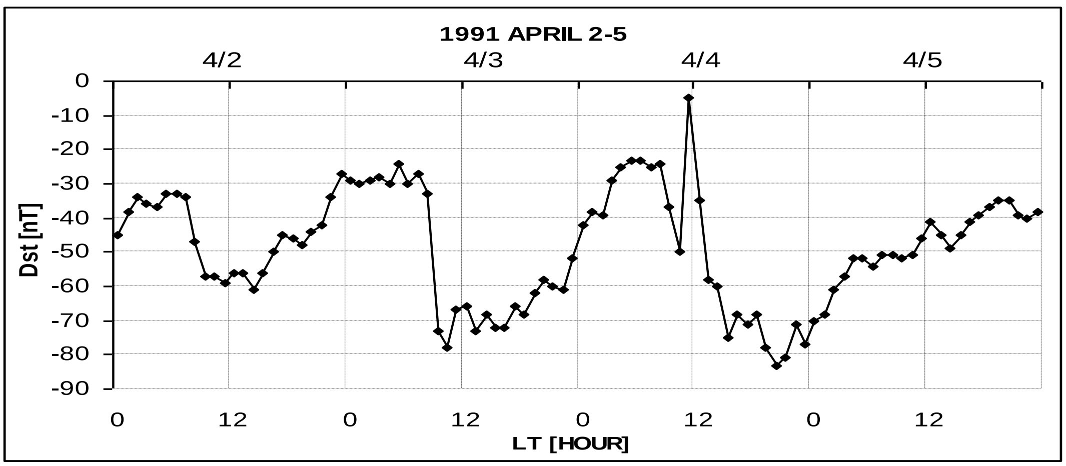

Figure 4.(a): Description of the storm event of April 2-5, 1991

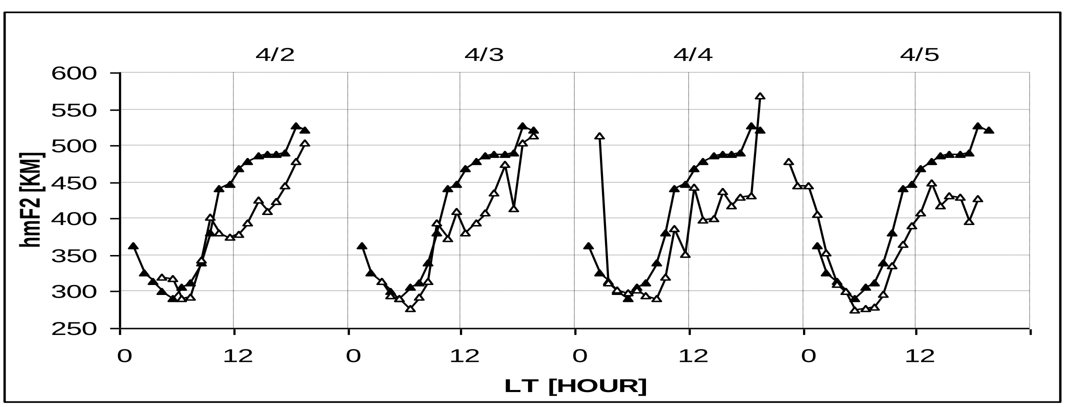

Figure 4(b): Decrease of hmF2 during Storm

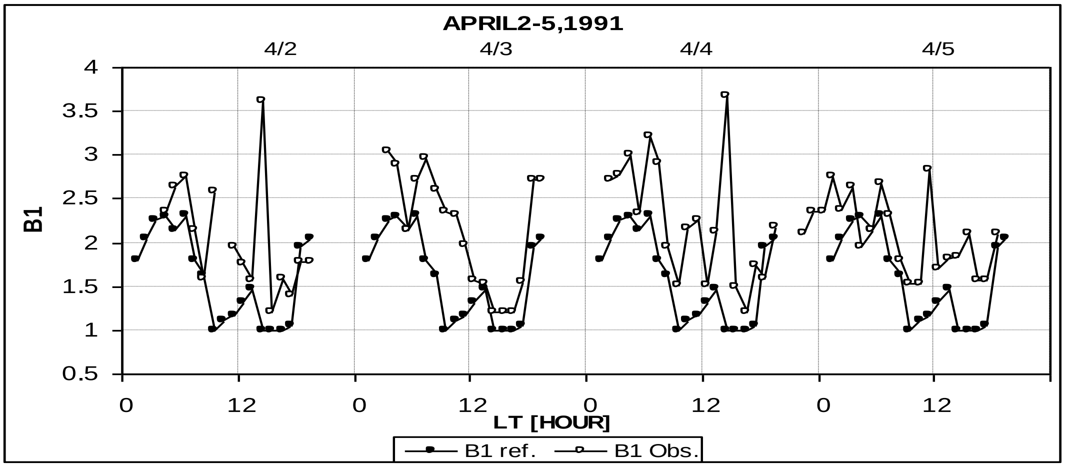

Figure 4(c): Simultaneous increase in B1

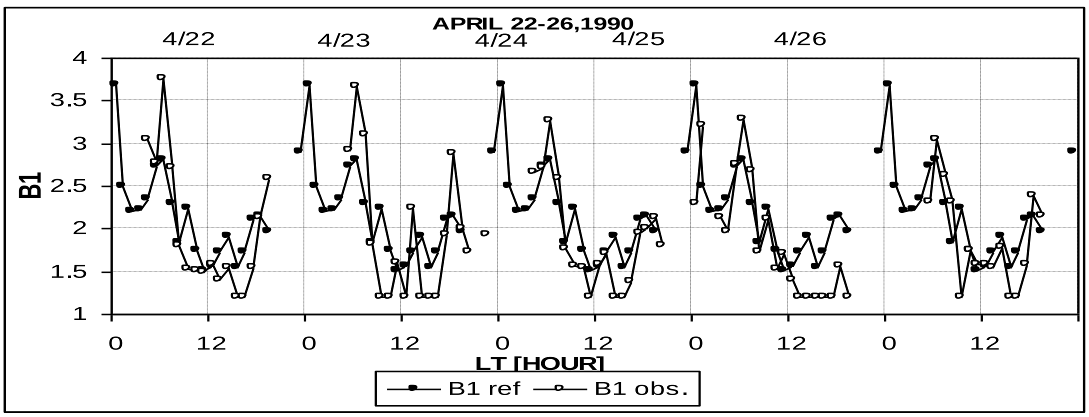

Figure 5: Decrease of B1 during Storm

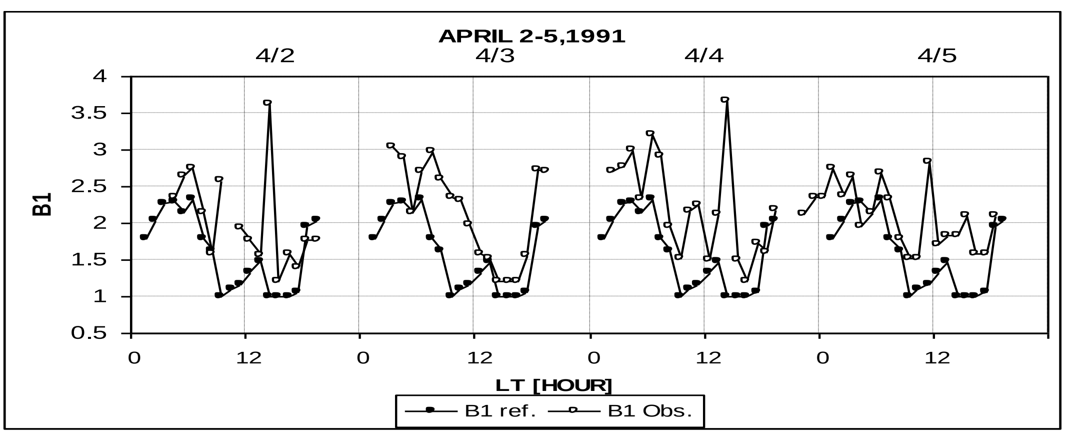

Figure 6: Increase of B1 during Storm

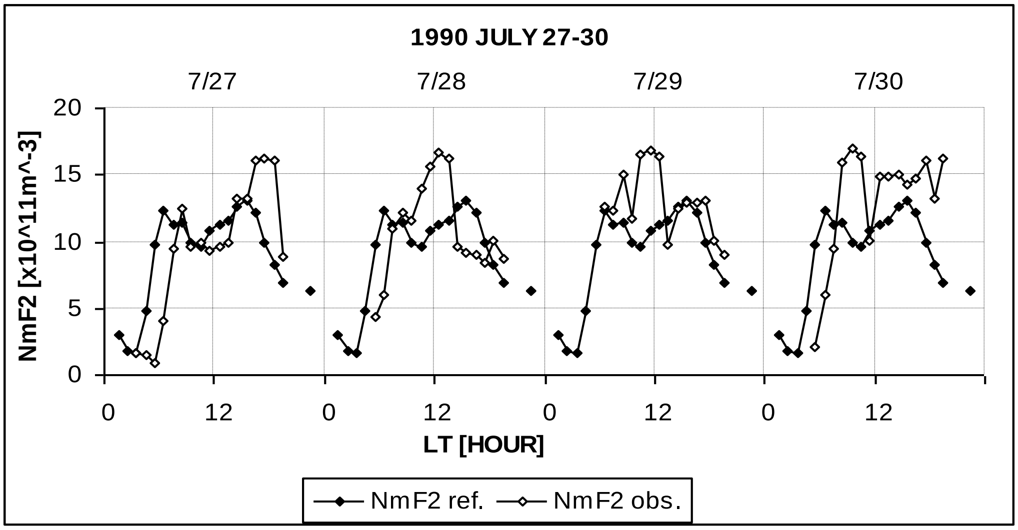

Figure 7(a): Increase in NmF2

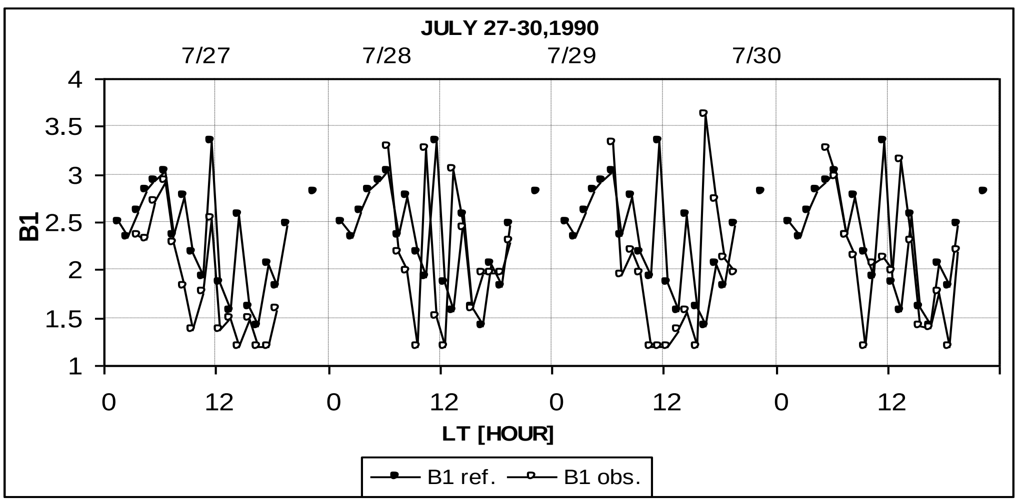

Figure 7(b): Decrease in B1

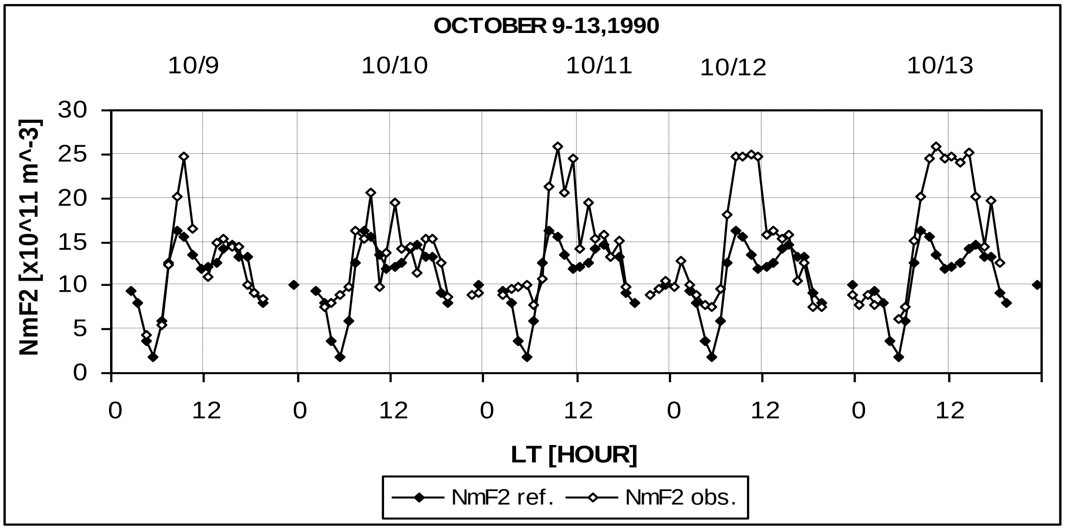

Figure 8(a): Increase in NmF2

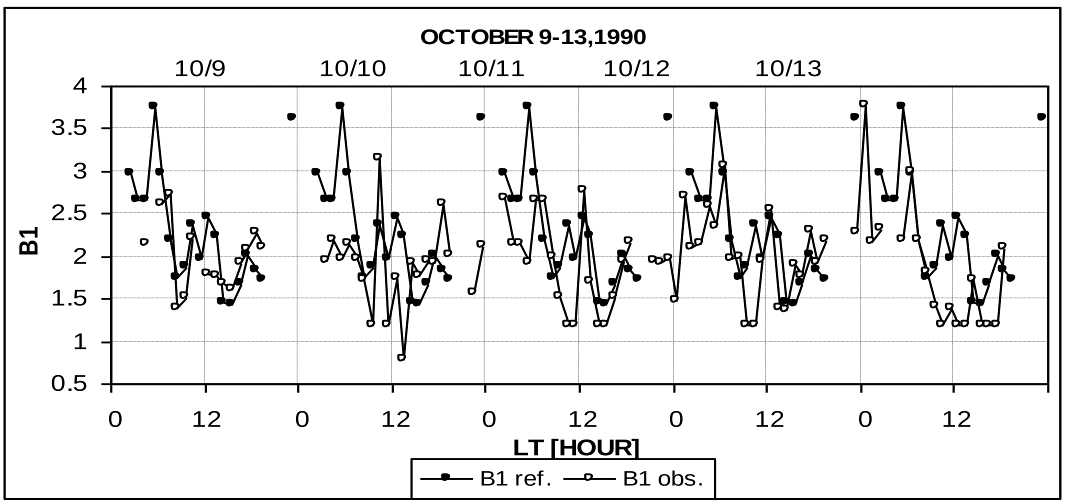

Figure 8(b): Decrease in B1

DISCUSSION AND CONCLUSION

The following are the general observations made. NmF2 increased in response to geomagnetic storm, regardless of the type of storm strength. These increases occurred during the main and recovery phases of the storms. The magnitude of the increase does not appear to be dependent on storm strength. The increases in NmF2 are usually accompanied by a decrease in the slab thickness of the F2 layer, TF2. The bottom side profile parameter B0 and TF2 were found to display a very strong positive correlation, even during storms. Generally, the height corresponding to the peak electron density, hmF2, responded to the storm with an increase. This increase in hmF2 occurred concurrently with the increase in NmF2. This was generally accompanied by a simultaneous decrease in the shape factor; B1. The decreases in B1 occurred more frequently than the increases. B1 decreased simultaneously with the increase in NmF2.

The increases in NmF2 were accompanied by a decrease in the thickness of the layer, as indicated by B0 and TF2.This is usually explained in terms of the movement of plasma by the **ExB** field. It is generally known that during geomagnetic disturbances, a decrease in the daytime electric field occurs (Matsushita and Balsley, 1972; Onwumechili et al, 1973). A reduction in the eastward electric field during the day will imply a decrease in the upward drift of the equatorial F2 layer in the daytime. This accounts for the observed increases in NmF2 during the day when geomagnetic storms occur. This produces the reduction in prominence or the absence of noon bite-out. In response to storms, B1, which is the shape factor, generally decreased simultaneously with the increase in NmF2 and with the increase in hmF2. A change in NmF2 and hmF2 is expected to change the shape factor. The explanation for this effect on B1 is not yet known.

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