Comparative Study of the Variations of Ionospheric Total Electron Content and Geomagnetic Field over Abuja, Nigeria

A. A Obafaye *[1] , T.T Ayorinde[1], B. C. Isikwue[2] and A.B Rabiu[3]

[1] Space Environment Research Laboratory, Centre for Atmospheric Research, National Space, Research and Development Agency, Abuja, Nigeria

[2]Dept of Physics, University of Agriculture, Makurdi, Nigeria

[3]Centre for Atmospheric Research, National Space Research and Development Agency, Anyigba, Nigeria

(E-mail: easyronke2@gmail.com)

ABSTRACT

This work studied the diurnal, monthly and seasonal total electron content (TEC) and Geomagnetic field (H) Variations using the GPS facilities and ground based magnetometers located at Abuja (9° 40'N, 7° 29'E), Nigeria. The hourly variation of 'H' and 'TEC' exist for quiet days throughout the year. The daytime (0700-1800hrs) variations are greater than the night-time (2000-0700hrs through 2400hr) variations values for all the months. Maximum variability for 'H' and 'TEC' under quiet conditions occurs during the September Equinox and December solstice respectively. The variation in H lags behind that of TEC which is likely due to some geodynamic factors not affecting TEC variability. Sample correlation analyses of H and TEC on quiet days were performed. The correlation between H and TEC is 0.65.These means that the hourly variability of H and TEC are significantly related. They are affected by the same factors. This can be deduced from their similar diurnal variation patterns.

Key words: TEC, Geomagnetic field, Ionosphere, Equatorial Electrojet, Thermospheric wind

Aim of the study.

The aim of this work is to carry out a comparative study of the variation of ionospheric Total Electron Content and Geomagnetic field over Abuja, Nigeria.

The following are the specific objectives of this study

1. To investigate the diurnal variation of the Horizontal component of the geomagnetic field (H) and the ionospheric TEC

2. To investigate the monthly variation of the Horizontal component of the geomagnetic field (H) and the ionospheric TEC

3. To investigate the seasonal variation of the Horizontal component of the geomagnetic field(H) and the ionospheric TEC

Scope of the study

This work is limited to Abuja station within the Equatorial anomaly region using Geomagnetic and TEC data for the year 2011.

Results

Diurnal Variations in H and TEC

From the Figures obtained, it shows that hourly variations of 'H' and 'TEC' exist for quiet days throughout the year. The daytime (0700-2000hrs) is greater than the night-time (2000-0700hrs) through 2400hr values for all the months.

The hourly variability peaks during the day time mostly around the local noon within the range (1100-1400 hrs) for all the months. This is in agreement with the work of [1] who studied the TEC variations during low solar activity period near the Equatorial Ionospheric Anomaly Crest region of India; and discovered that the diurnal variation of TEC showed pre-dawn minimum for a short period of time, followed by a steep early morning increase and then reached maximum value between 14:00 LT and 16:00 LT. The diurnal pattern of TEC exhibits a steady increase from about sunrise to an afternoon maximum and then falls to attain a minimum just before sunrise

The quiet day diurnal variation of H of the magnetic elements which appears directly proportional to the Total Electron Content TEC arises in daytime in consistency with the atmospheric dynamo theory of the geomagnetic day variation [3]. In most quiet days, the diurnal variation is not symmetrical about the hour of its maximum.

Monthly /Seasonal Variation in H and TEC

From the monthly and seasonal plots variation, there are clear indications that seasonal variation occurs in 'H' and 'TEC'. Maximum variability for 'H' and 'TEC' under quiet conditions occurs during the September Equinox and December solstice respectively. This could be due to the fact that the Sun shines directly over the equatorial region during the equinoctial months and thus leads to strongest ionization over this region. The electrodynamic effects of local winds could also account for seasonal variability since the winds are subject to hourly and seasonal variability. During the quiet days of the Equinox, the night time hourly variation is almost perfectly flat for all the four months.

The variation in H as seen in Figure 1 lags behind that of TEC which is likely due to some geodynamic factors not affecting TEC variability. We also noticed that there is more daytime increase in H over TEC, but this does not continue as the TEC tends to rise above H in the night time. This has been discussed by [2] that the large H variation has been due to large ionospheric currents in the dynamo region over the dip equator and has been named Equatorial Electrojet. However, the enhancement of the currents does not continue till the night time due to the depletion of E-layer ionozation. Perturbation of the electric fields and thermospheric winds, which produce fluctuations in the E and F layer are being considered as the main cause of day-to-day variability in the ionospheric parameters including TEC [4].

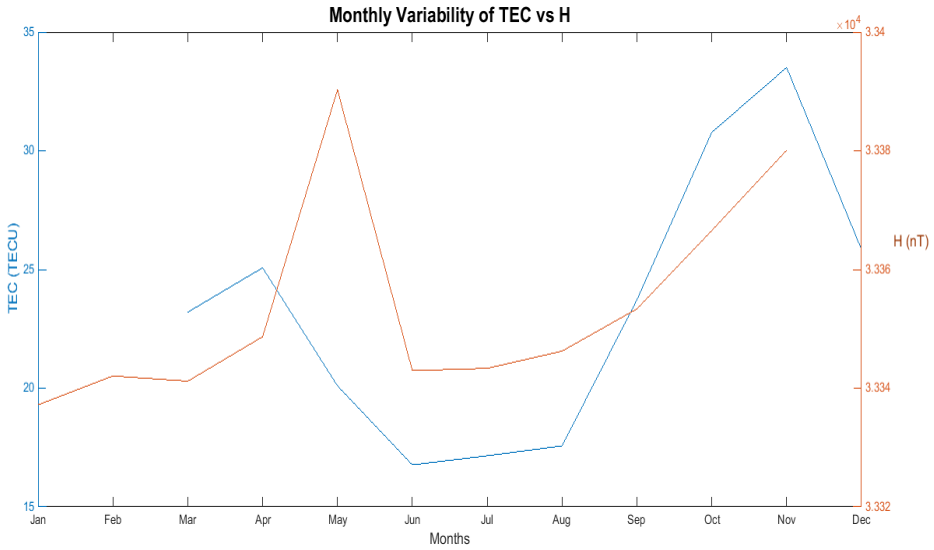

Figure 1. Monthly Variability of TEC and H

Conclusions

The comparative study of variations of ionospheric total electron content and geomagnetic field over Abuja, Nigeria has been carried out. The main conclusions include the following:

1. The ionosphere over Abuja exhibits diurnal, monthly and seasonal variations in H and TEC throughout the year. This variation in H lags behind that of TEC which is likely due to some geodynamic factors not affecting TEC variability
2. The seasonal variation is attributed to electrodynamics effect of local wind.
3. The correlation coefficient between H and TEC is 0.65. This means that the hourly variability of H and TEC are significantly related. They are affected by the same factors. This can be deduced from their similar diurnal variation patterns.

References

[1] Bagiya S. M., Joshi H. P., Iyer K.N., Aggarwal M., Ravindran S. and Pathan B.M. (2009). TEC variations during low solar activity period (2005-2007) near the Equatorial Ionospheric Anomaly

[2] Chapman. S., (1951). The equatorial electrojet as detected from the abnormal electric distribution above Huancayo,Peru and elsewhere, *Arch.Mateorol.Geophys.Bioklimatol.,A*, 4, 368-390

[3] Onwumechili C. A., 1992a. "A study of rocket measurements of Ionospheric currents - 11. Ionospheric current outside the dip equatorial zone" *Geophysical Journal International* 108, pp. 641-646.

[4] Sharma, D. K., Rai, J., Israil, M. & Garg, S. C. (2002). Temperature and Density variation in Ionospheric plasma over different locations in India *Proceedings of National Conference on Advances in Contemporary Physics & Energy, IIT Delhi*, Pages 265-278.