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NIGHTTIME ENHANCEMENT IN TEC NEAR THE CREST OF EQUATORIAL IONIZATION ANOMALY REGION BHOPAL DURING LOW SOLAR ACTIVITY PERIOD

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ABSTRACT

This paper presents the results of vertical total electron content (VTEC) data from a dual-frequency GPS - GSV 4004A receiver installed at the Space Science Laboratory, Department of Physics, Barkatullah University Bhopal ((23.2°N, 77.6°E). Enhancement in nighttime total electron content (TEC) near the crest of equatorial ionization anomaly at Bhopal has been studied for the solar minimum period March 2004-February 2005. For the present study, only those enhancements, which had amplitudes greater than 20% of the background content, were considered. The majority of the enhancements were found to have a single peak. However, in the case of enhancements having multiple peaks, only the prominent peak was considered for the statistical study. The enhancement can occur both before and after midnight.

Keywords— GPS, Low Solar Activity Period, Night-time Enhancement in TEC.

I. INTRODUCTION

Global Positioning System (GPS) measurements are commonly used to investigate the structure and dynamics of the ionosphere. In general, after midnight (LT) TEC starts increasing and in post noon period it becomes maximum, after that it starts decreasing and attains quite minimum or low value around 2200 to 2400 hours local time. Simple theory suggests that after sunset, when thermosphere is no longer exposed to radiation from the sun, TEC would decay steadily as recombination occurs.

The nighttime enhancement in TEC and its various characteristics at low latitude were first reported by [1]. The nighttime enhancements in TEC were studied by [2] for a low latitude station Hawaii with the result that all the characteristics of the TEC enhancements have seasonal and solar cycle dependence.

The enhancement characteristics such as frequency of occurrence, amplitude and duration are positively correlated with solar activity. [3] suggested that the time of the enhancement peak is independent of solar and magnetic activity. The latitudinal variation of the enhancements has also been reported by [4]. They have shown that the TEC enhancements are strongly correlated with geomagnetic activity at high and mid latitudes and show

no significant correlation at low latitude. [5], suggested that at the equatorial anomaly latitudes, the enhancement characteristics and their seasonal and solar activity variation are in good agreement with the fact that primary source of an enhancement is the post sunset increase in equatorial fountain.

The main objective of our work is to get some further knowledge about this Anomalous Nighttime Increase (ANI) phenomenon in TEC based on the GPS data provided by the receiving station Bhopal (23.23° N, 77.54°E) near the crest of the equatorial anomaly from March 2004 - February 2005 during solar minimum. To study the behaviour of TEC in nighttime, we use hourly values of the TEC data for the 12-month period (March 2004 - February 2005) received by GPS.

II. DATA AND METHOD OF ANALYSIS

TEC have been analyzed to study the nighttime enhancement in TEC for the period March 2004 – February 2005 using GPS measurements. The local time can be obtained by adding 5h 30 min to the UT. Since the received signal at low elevation angles of the satellite may suffer from the multi-path reflections. Therefore observations for elevations angles lower than 15^0 not considered in the study. The enhancements are divided into pre-midnight (1800 – 2300 h LT) and post-midnight (0000 – 0600 h LT) period, depending on the time of peak (LT) at which the prominent peak of the enhancement occurred. In characterizing nighttime TEC enhancement, the same criterion as that adopted by [6] and the references their in) was applied. For the present study, only those enhancements, which had amplitudes greater than 20% of the background content, were considered. The majority of the enhancements were found to have a single peak. However, in the case of enhancements having multiple peaks, only the prominent peak was considered for the statistical study.

III. RESULTS

The hourly data of the total electron content has been analyzed statistically and morphologically to investigate the anomalous nighttime enhancement in TEC using GPS measurements for the period of March 2004 - February 2005 at Bhopal. The events were looked at in terms of their amplitude, probability of occurrence, time of occurrence, their duration, peak time and their dependence upon local time. All the characteristics of enhancements in nighttime TEC were analyzed in local time.

3.1 Explicit Features of Nighttime Enhancement

The enhancements were classified on the basis of their time of peak in pre midnight and post midnight hours. The results indicates that the enhancements are predominant during post midnight hours at Bhopal during solar minimum.

Fig. 1 illustrates some paradigm of the nighttime TEC variations observed during low solar activity at Bhopal during March 2004 – February 2005.

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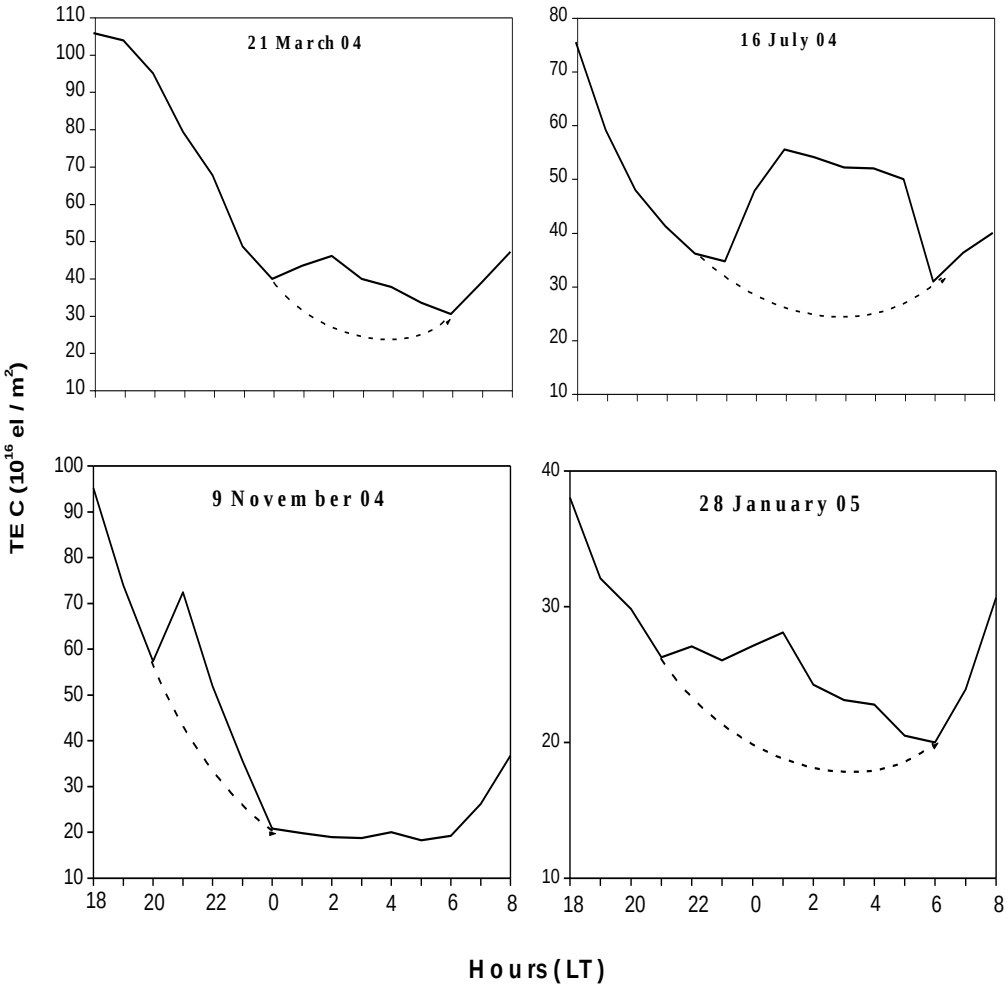

figure 1: Behavior of nighttime variation in TEC for the period March 2004 – February 2005 at Bhopal (low solar activity period).

We have considered that the increase in TEC is excess content or mean peak amplitude (ΔTEC), as regards the nighttime bottom level in the diurnal TEC course. The outcomes indicates that

1. The TEC enhancements occur at the pre midnight hours as well as during post midnight hours at Bhopal.
2. Majority of events have a single peak, but some of them exhibit double (or triple) peaks.
3. There are some cases of strong TEC increases, which have ΔTEC greater than 25%.
4. The duration of enhancements is often large (about 5 hr and more).
5. The peak time during anomalous nighttime enhancement is likely in the interval of 1900 – 0300 LT.
6. The most probable range of peak amplitude in nighttime TEC is approximately (4 -12) x 10^{16} e/m^2.
7. Some examples show a complex character of the nighttime increases in TEC.
8. Nighttime enhancement in TEC occurs in all seasons.

IV. DISCUSSION & CONCLUSIONS

The data analysis allows us to investigate the morphology of nighttime enhancements in TEC and their characteristics at Bhopal (23.23° N, 77.54° E), near the crest of anomaly using GPS measurements. The observations reported in this work were in general agreement with the results reported in earlier studies [2], [6], [7], [8], [9], [10].

At Bhopal both pre midnight as well as post midnight peaks were observed in nighttime TEC. The distinct and systematic behaviour of each of the two enhancements (Pre midnight and Post midnight) indicates that different physical mechanisms lead to their formation. It is well known that the electrodynamic drift and winds are prominent causes which produce storm associated ionospheric changes at low latitudes. At the same time these are also the two probable processes behind nighttime enhancements in TEC. This may be the possible reason for large values of nighttime enhancements in TEC (>20% of the background content). Thus, the primary source of the nighttime enhancement in TEC at equatorial anomaly latitudes is the pre-reversal increase in **ExB** vertical drift and the neutral air winds, which modulate the process. The longitude of the station play important roles in controlling **ExB** drift and affect the neutral wind, which in turn, affects the distribution of plasma in the ionosphere [8].

We believe that the results obtained in our study will expand the available knowledge base of global morphology and statistical characteristics of the nighttime TEC variations.

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