1.5 GHz Scintillation Observation and Nighttime Total Ionospheric Electron Content Enhancement in Low Latitude

Onanong Petnim Narong Hemmakorn
Faculty of Engineering and Research Center for Communications and
Information Technology, King Mongkut's Institute of Technology Ladkrabang
3-2, Chalongkrung Rd., Ladkrabang, Bangkok 10520, Thailand, E-mail : khnarong@kmitl.ac.th

K. Igarashi
Communication Research Laboratorty,
2-1, Nukui-Kitamachi 4-chome, Koganei-shi, Tokyo, Japan, E-mail : igarashi@crl.go.jp

1. Introduction

Many investigations on ionospheric scintillation and total electron content (TEC) have been carried out. It has been reported by some authors that the nocturnal fluctuations of TEC are sometimes associated with the occurrence of ionospheric scintillations. It has long been realized that total electron content of the ionosphere does not decrease throughout the night in the way predicted by simple theory but shows anomalous enhancements under a wide range of geophysical conditions. The studies conducted to date on the various characteristics of the nighttime TEC enhancements such as, time of occurrence, time duration.

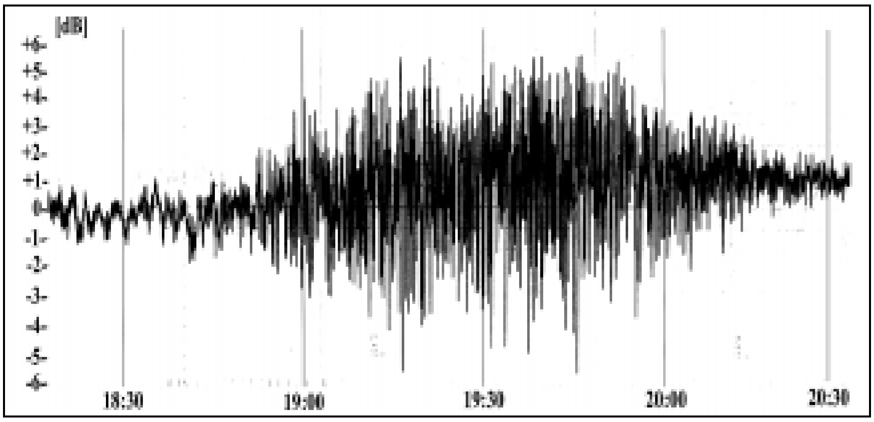


Fig. 1 An example of the record of ionospheric scintillations on 4 Oct. 98.

For the monitoring of satellite signal transmissions, the examination of the records has shown times at which fluctuations in total electron content, particularly nighttime increases, are apparently linked to the occurrence of amplitude scintillation. In this paper we present the results of investigation of this phenomenon at one geographic location, where a preliminary examination of the data indicated that the association was most marked. We examined the level fluctuation of the L-band scintillation above India Ocean Region (IOR) by the elevation angle 45°. The observation period from Jan. - Dec., 98 in term of peak to peak values using a sampling period of three minutes. And observed the variation of Total Ionospheric Electron Content (TEC) in Bangkok simultaneously. In Fig. 1 shows the typical of amplitude scintillation in L-band, we found that the occurrence number of scintillation usually occur around 1900-2300LT

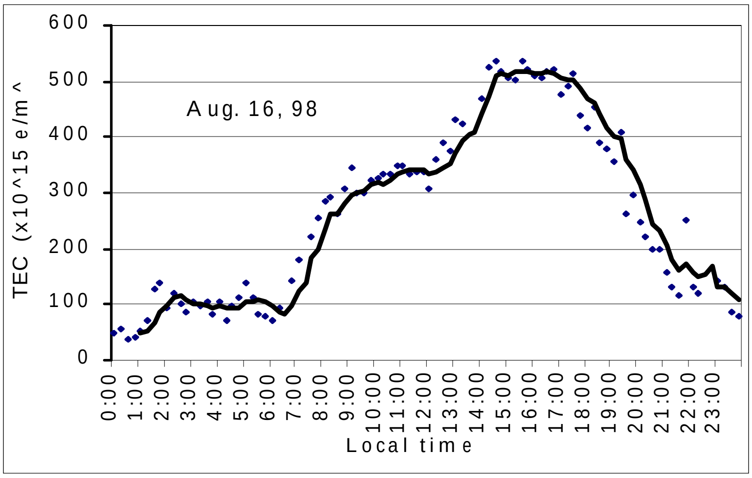


Fig. 2 The diurnal variation of TEC

Fig. 2 shows the example of the diurnal variation in TEC, we found that the minimum value is near sunrise, then TEC increase until maximum value is around 1400-1500 LT., after that decrease through the night.

But, it is remarkable that in some day of month, it has some increase of TEC in the evening so-called Nighttime Enhancement or postsunset enhancement occur around 1900-2300 LT.

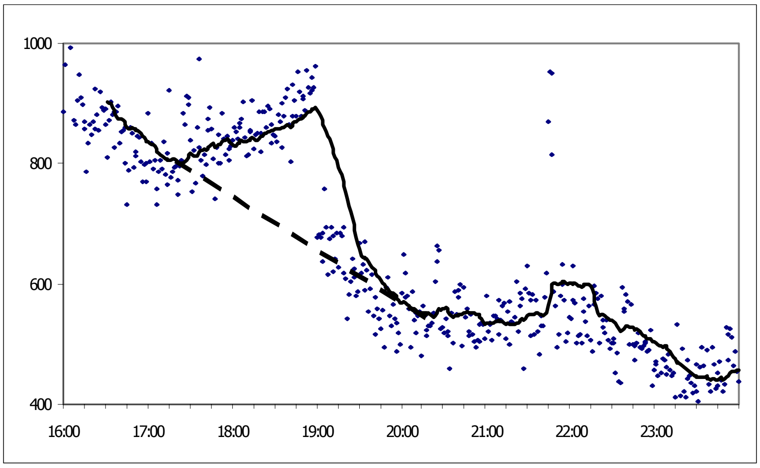


Fig. 3 Typical TEC variation showing postsunset enhancement as observed on 17 Apr., 98.

Typical variation in the nighttime TEC and its anomalous enhancements as well as their mean variation are shown in Fig. 3. This presented example occur apparently on 17 Apr. 98, the increase during 1730-2100 LT is approximately $240\times10^{15} e/m^2$, which is about 17% of the diurnal maximum.

From Fig. 3, we can explain Nighttime Enhancement by the prereversal enhancement of TEC. In daytime equator electric field is eastward (The upward plasma drift occurs around the equator because of the interaction it and geomagnetic field). The Nighttime enhancement is related with the phenomena so called "Pre-reversal enhancement" because local time variation of vertical plasma drift shows upward enhancement around 1800 LT., After that vertical plasma drift turns downward. Upward drift moves electron to higher altitude, after that electrons move downward along the magnetic field line, this electrons appear as the "increase of electron density".

In the E layer, this mapped electric field generates the hall current which direction is west ward (the direction of electron flow is east ward). In the daytime, conductivity is better than that of nighttime, so this hall current (J_h) exists only daytime (or, very weak at night time region). Boundary layer between daytime and nighttime, electrons are stored up due to the hall current. o near the boundary layer, the stored up electron (or charged region) makes Eastward electric field (E_s) at daytime region. This Eastward electric field is mapped to F region show in Fig. 5.

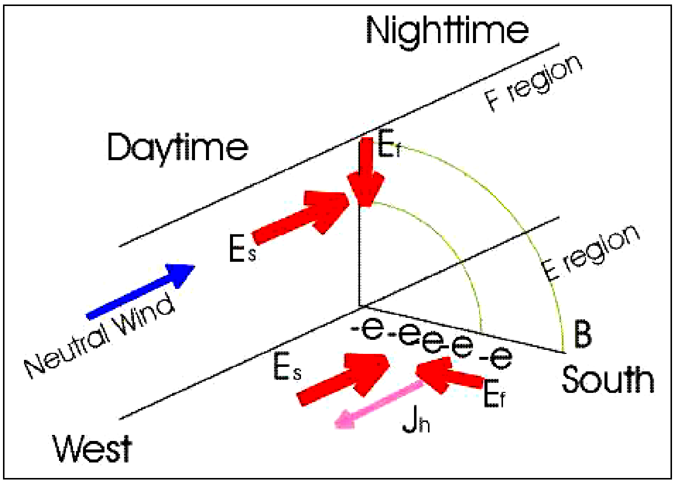


Fig. 5 Boundary layer.

This Eastward electric field enhances the upward plasma drift by the interaction of the geomagnetic field ($\overline{E} \times \overline{B}$ drift). Near the geomagnetic dip equator, at the height balancing the lifting force and gravity force, (see Fig. 6) electron move along the magnetic field line (Charged particles tend to move along the magnetic field line). The electron density increases about -15 degree to 15 degree (Sub equatorial) latitude. (Usually above dip equator TEC enhancement or electron density enhancement are not seen) This electron density enhancement continues the time when there is no sunlit at the E layer height because F layer dynamo influences to E layer under the condition of good conductivity.

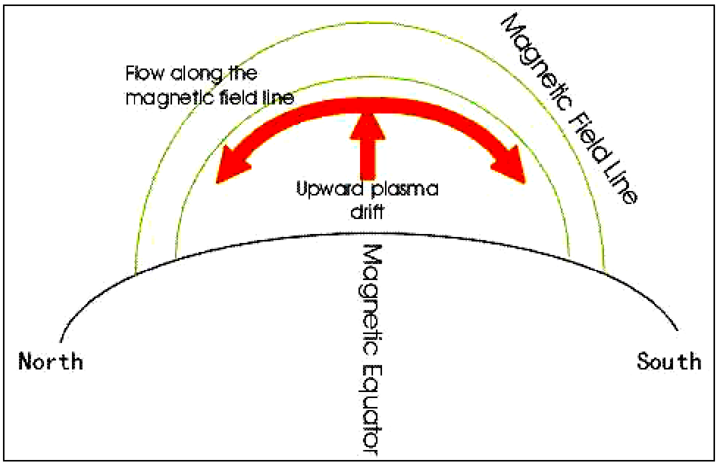
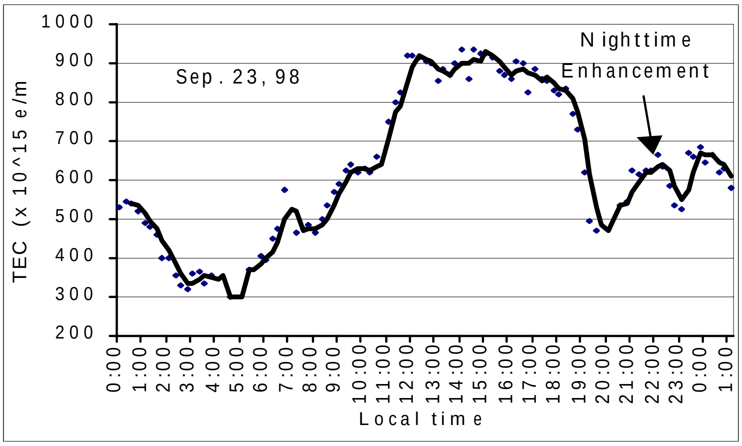
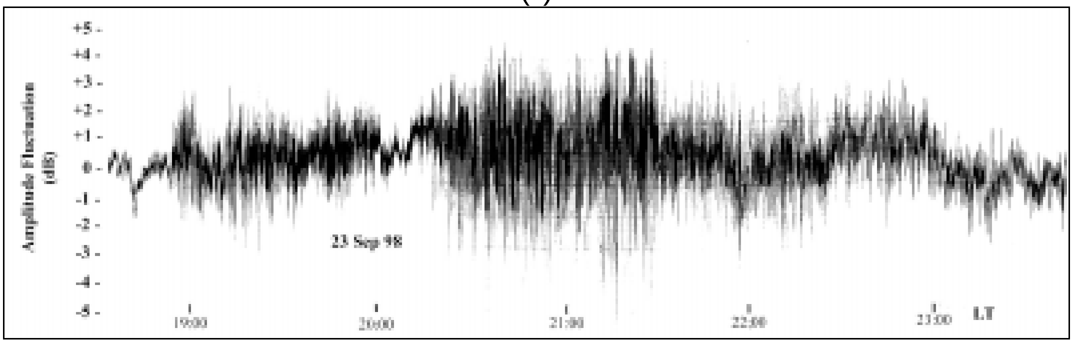


Fig. 6 Electron contents increases.

The selected example of the diurnal variation in TEC on 23 Sep. 98 exhibits a prominent nighttime ledge during 1900-2300 LT, which occurred simultaneously with the strong postsunset scintillation as seen in Fig. 7 (a) and (b).



(a)



(b)

Fig. 7 (a) The diurnal variation of TEC showing the nighttime enhancement around 1900-2300
(b) An ionospheric scintillation observing on 23 Sep. 98.

5. Conclusions

In the work presented in this paper we have described the occurrence of enhancements in TEC together with their links to nighttime scintillations found in the records at subionospheric point, Bangkok. The occurrence patterns, times of appearance and amplitude fluctuation of the scintillation have been investigated from the records for the 12 months of observations. Examination of the records has shown enhancement-peaks in TEC are apparently liked to the occurrences of amplitude scintillation as a function of times.

Acknowledgements

This TEC experiment was supported by the POST-PARTNERS promotion council which is an organization formed by the Ministry of Posts and Telecommunication(MPT) in Japan.

We wish to express our appreciation to Prof. Y. Moriya for many helpful discussion.

References

N. Balan, K. N. Iyer, “Equatorial anomaly in ionospheric electron content and its relation to dynamo currents”, J. Geophys. Res.,Vol.88, No.A12, pp.10,259-1,262,Dec. 1,1983.

N. Balan, P. B. Rao, “Relationship between nighttime total electron content enhancements and VHF scintillations at the equator”, J. Geophys. Res.89, 9009, 1984.

Kenneth Davies, “Review of recent progress in ionospheric predictions”, Radio Sci., Vol.16, no.6, pp. 1407-1430, Nov.-Dec., 1981.

K. Igarashi, et al “ Total ionospheric electron content observation and ETS-V Beacon experiment for studying GHz-band scintillation in the equatorial zone”, Adv. Space Res., Vol.19, No.1, pp.(1)177-(1)180, 1997.

L. J. Lanzerotti, et al, “Latitude Dependence of ionosphere total electron content: Observations during sudden commencement storms”, J. Geophys. Res., Vol.80, No.10, pp.1287-1306, Apr. 1 1975.