Study on Sporadic E occurrences observed at New Delhi with Modern Digital Ionosonde

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ABSTRACT

The National Physical Laboratory has operated a Modern Digital Ionosonde (KEL - IPS 71) at New Delhi (28.3 N, 77.1E, dip 42.4 N) since July 2000 and being operated every 15 min. interval round the clock. One of the clearest phenomena observed by this Ionosonde is existence of Strong Sporadic E. In the present study the ionosonde data (July 2000 to December 2001) has been analysed to study the diurnal and seasonal variations in the occurrence of Sporadic E. The occurrence of Sporadic E are also examined during magnetically disturbed and quiet days to check the influence of geomagnetic activity on the their occurrence. The Sporadic E is generally start forming during morning hours (around 0800 LT) and appear less by noon time and then appear again during evening hours before they disappear. Its occurrences shows two peaks, one between 0900 to 1030 LT and the other around 1700 to 1800 LT and their seasonal occurrence was observed to be maximum during summer months (May-August). It is also noted that in general, occurrence of sporadic E is not showing any clear relationship with magnetic activity. The occurrence of blanketing Sporadic E layer is maximum during summer months which will give other mode for High Frequency communications. To explain the results the related mechanisms or processes in the formation of Sporadic E such as wind shear theory, particle precipitation, plasma instabilities and gravity waves are investigated in detail.

INTRODUCTION

Sporadic E is a thin layer with dense patches of ionization around E region altitudes. Sporadic E generally observed between heights of 95 km and 120 km. Some earlier studies on Sporadic E has done at India by some workers using Ionosonde data and also Rocketborne measurements. The Es Structures and the related winds and wind shears for the formation of Es at magnetic Equator (Thumba, dip 2^0 N) provided in detail by Sridharan etal [1]. Various processes like gradient drift instability, two stream instability and wind induced effects at E region height at Thumba and at SHAR(dip 10^0 N) is well discussed by Gupta [2]. Sequential Sporadic E layers at low latitudes in the Indian sector are presented by Jayachandran etal [3] by comparing Waltair (dip 20^0 N) with Thumba and SHAR. They provide the experimental evidence for the winds shear theory for the formation of descending night time Sporadic E layers by using the three Ionosonde data. They concluded that the night time descending sporadic E layers are produced by the combined effect of the equatorward propagating gravity wave and the increased poleward nutral wind which brings the ionization downward through the field line. The type of Sporadic Es, the relation to magnetic activity and its occurrence statistics at Delhi is studied by Saksena [4,5] with earlier available Ionosonde data at Delhi and compared with other low latitude stations from Japan.

In the present study Sporadic E layer behaviour over New Delhi (28.3 N, 77.1E, dip 42.4 N) is studied in detail using a modern digital ionosonde (IPS-71) which has been installed in the campus of National Physical Laboratory, New Delhi during July 2000. This fully computer controlled ionosonde operates in the vertical incidence mode and provides amplitude, Doppler, HF Spectrum Surveillance Modes. In the case of the normal vertical incidence ionogram, the coverage of frequency range is 1-22 MHz and the height range is 0-1000 km. The ionosonde also has computerised scaling, local and remote control capabilities. One of the clearest Phenomena observed at these Ionograms is enhanced Ionization at Es region height which is called Sporadic E. The low latitude Es is not yet fully explained as that of auroral Es. This paper presents the preliminary results of analysis of Sporadic E data obtained from digital Ionosonde at Delhi. The Es layer parameters and the occurrence of Es are studied in detail. The blanketing Sporadic E is interesting to investigate in the aid of HF communications.

RESULTS AND DISCUSSION

The present study is based on the hourly data from Digital ionosonde at New Delhi from July 2000 to December 2001. The parameters of the Es layer used in the present study are foEs (critical frequency of Sporadic E layer) and fbEs (the blanketing frequency of the layer). They are averaged to obtain monthly mean diurnal variation for the periods representative of Summer (May, June, July and August) Winter (November, December, January and February) and Equinoxes(March, April, September and October). The occurrence of sporadic E, expressed as percentage of total observation of Es layer is studied in detail for different months at hourly interval.

Figure 1 shows the average percentage occurrence of Sporadic E layer (foEs) during Summer, Winter and Equinox months. It is characterized by two maxima, around 0700 – 0800 LT in the morning and 1700 LT in the evening for the all three seasons. But the more pronounced occurrence of foEs is noted during summer months as compared to other winter and Equinox months. The occurrence of Es is high (80% or more) during 0800 LT and 1700 LT. The double maximum feature is in agreement with results of Abdu and Batista [6], they have shown Sporadic E layer phenomena over Cachoeira Paulista (22.6^0 N, 45^0 W) which is located in the vicinity of the Brazilian geomagnetic anomaly center. They have shown the double maximum feature in the occurrence of Es for summer season with less pronounced during equinox not shown in Winter months.

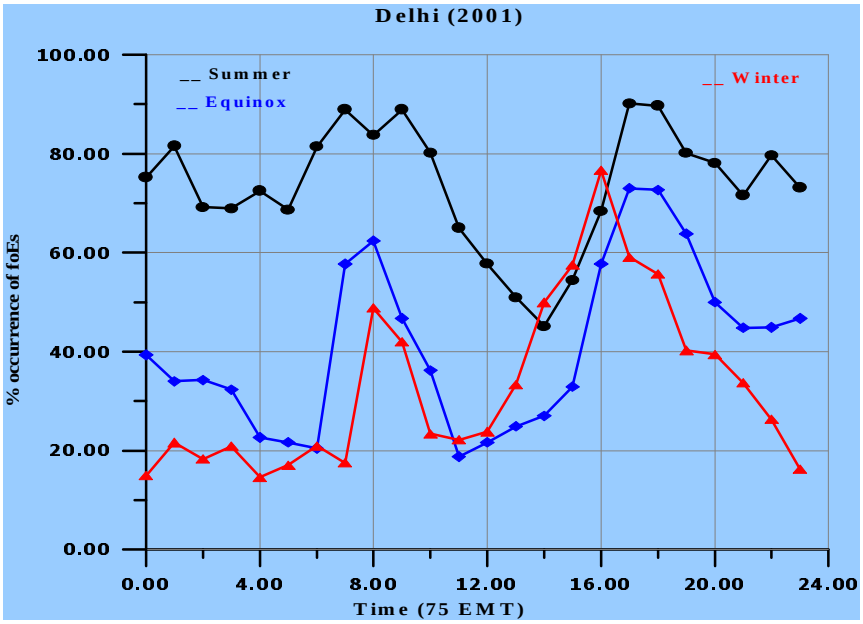

Fig. 1. The percentage occurrence of Sporadic E for all seasons at Delhi.

Figure 2 shows the diurnal variation of average frequency foEs(MHz) for three seasons. It is noted that the maximum frequency (foEs) observed at local noon time for all the seasons. But more average frequency is about 7 MHz observed during summer season as compared to other seasons. The blanketing sporadic E (fbEs) is more observed in Summer season and its average diurnal variation is shown in figure 3. The maximum frequency is noted during local noon time which is about 13 MHz. The variation of Es layer virtual height (h'Es) for all the seasons are presented in figure 4. The rise in layer height is noted during morning hours around 0700 – 0800 LT. The Es layer height decreases during local noon time but again increased during evening hours. It is interesting to note that the Es layer height is showing double peak which is similar in the case of occurrence of Es layer (Fig. 1). This double maximum feature might be due to the dominance of the semidiurnal tidal mode in the zonal wind at the E region heights. In study of tidal effects in the E region from incoherent scatter observations [6] found zonal wind maxima in the morning and late afternoon. The Equatorial Es is different from the present observations. Abdu etal [6] reported the similar double maximum in Es occurrence for some mid latitude stations in European sector.

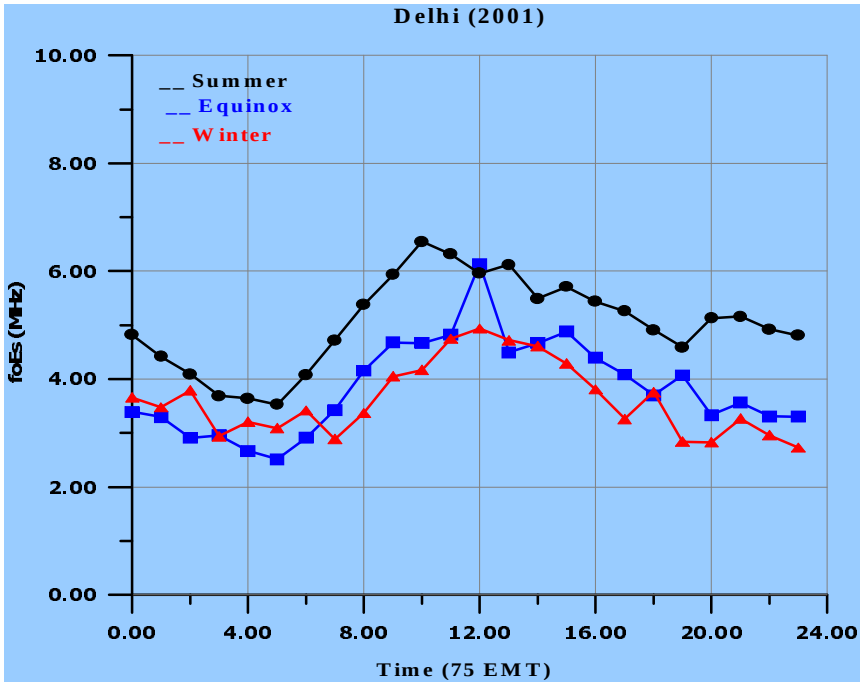

Fig. 2. The diurnal variation of average foEs (MHz) for all seasons.

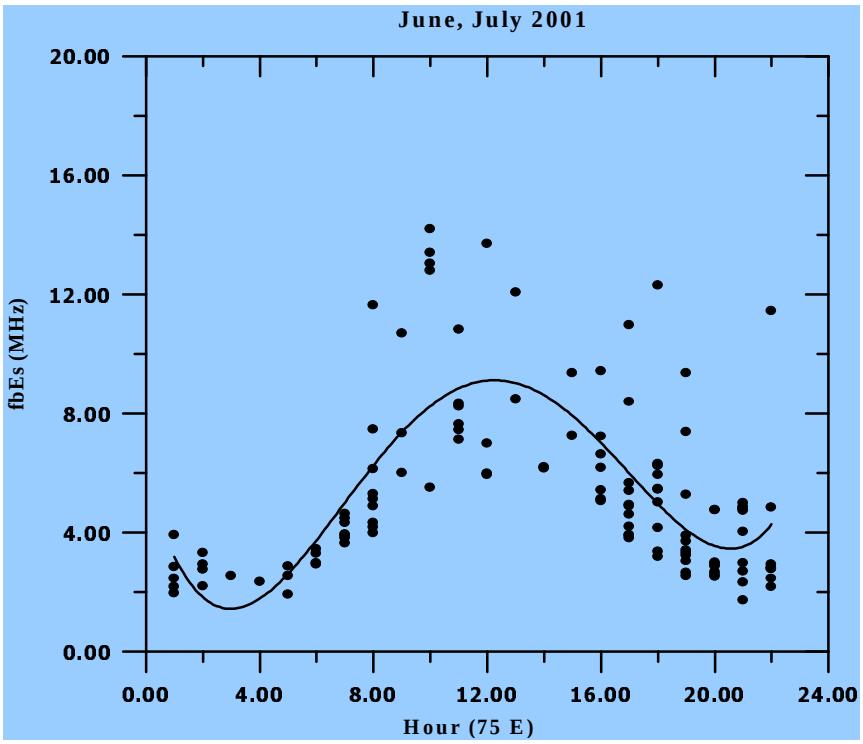

Fig. 3. The diurnal variation of Blanketing Sporadic E (fbEs) during summer months.

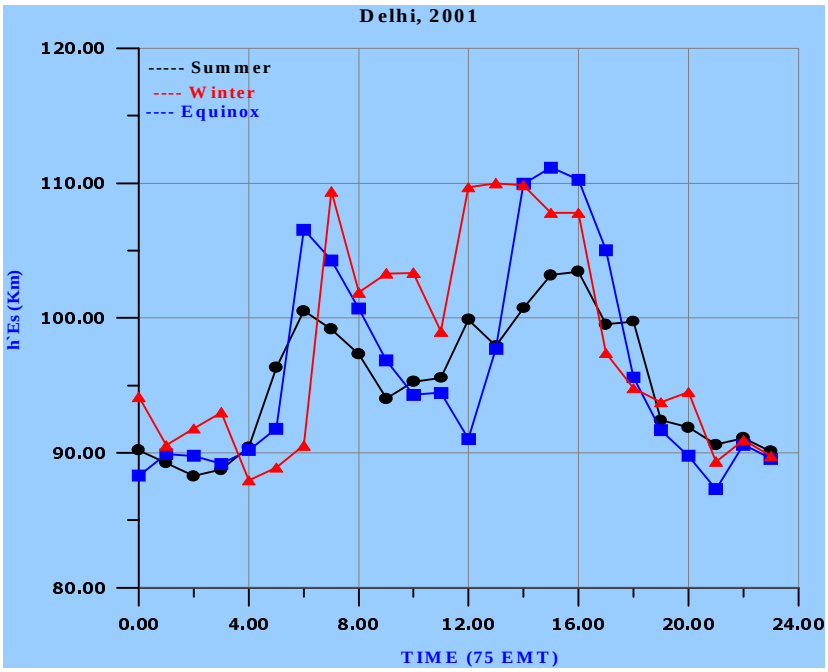

Fig. 4. The diurnal variation of average height of Es layer for all seasons.

In the present study, the HF field strength data (using Japanese Field strength meter 428-B) for particular link between Lucknow and Delhi with frequencies (4.880 MHz and 7.105 MHz) is analysed during day time (09 to 1400 LT) for particular strong blanketing and non blanketing Es days and it is noted that the received signal strength values were higher on Es layer days as compared to the values of non Es layer days and also the monthly median values. It is because of HF propagation is also supported by mode from Es layer. High values of foEs gives large operational frequencies (due to obliquity factor) for HF links which will enable efficient radio communications over long distances and Es reflections contribute to lower transmitter powers. The prediction of Es occurrences is useful for planning of HF and VHF communications

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