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Study of Es occurrences during meteor shower periods at Hyderabad by using FM radio signals

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Abstract. Sporadic-E occurrences are found to be more during meteor shower periods when compared to non-shower periods. Meteor activity can be estimated by recording the radio signals reflected by meteor trails. In the present paper, the results of the data obtained from recording of the radio signals of a distant FM radio broadcasting station, received after reflection from meteoric ionisation trails, are presented. From these results, it is observed that the radio echoes are found to be more during shower periods and early morning hours, when the meteor activity is expected to be more. Present observations show that the occurrence of Es is found to be more during Geminid meteor shower period compared to other periods. This shows a clear evidence of occurrence of Es due to meteoric ionization.

Key Words : forward-scatter radar, sporadic-E, meteor shower, sporadic meteor

1. Introduction

As a meteoroid enters Earth's atmosphere and vaporizes, it produces not only a streak of light but also a train of ionized gas. These ionization columns in the meteor region (80 - 120 km above the surface of the earth), act like miniature ionosphere and reflect back radio waves transmitted from the ground (Bhar 1937; McKinley 1961; Sugar 1964; Millman and McIntosh 1964; Saksena 1979; Smith and Davis 1981; Yellaiah and Sudershan Reddy 1994, Grebowsky et al. 1998; Saksena 1998). These echoes can be received by using a suitable radio receiver. Like a visual meteor, the ionization column reflecting radio signals also a short-lived one. The signal received may last for a fraction of a second to several seconds. Many investigators have reported the occurrence of sporadic-E from their observations by ionosonde, rocket experiments and MST radar observations (Bourdeau 1963, Young et al. 1967, Aikin et al. 1974, Gupta 1990, Lokanadham et al. 2000). The formation of Es, coinciding in height and time with metallic-ion layers of meteoric origin at E-region heights, has been well established in these experiments.

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In the present study we are using the forward scatter radio meteor observational technique for estimating Es occurrences during meteor shower periods. In this simple technique, the radio frequency signals of a distant FM radio broadcasting station such as National Channel of AIR and other FM station transmitting at 107.2 MHz is received at Hyderabad, after reflection from the ionization columns produced by meteors, in the E-region.

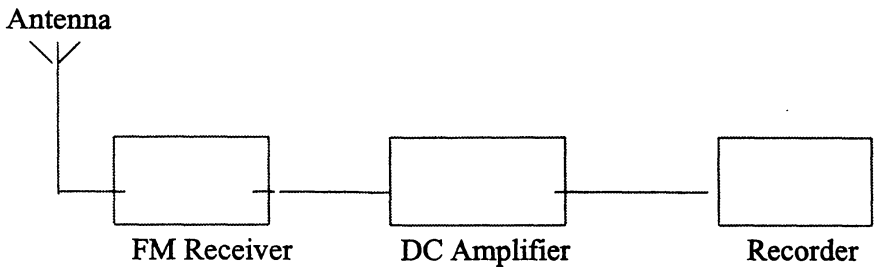
The FM broadcast band provides an excellent opportunity to detect radio echoes because of the abundant high-power transmitting stations scattered across all over India. These signals are received by using a low cost FM receiver, constructed around the receiver IC chip 5591 A. The receiver is tuned to receive the signals of a distant FM station that normally cannot be received.

2. Observations and results

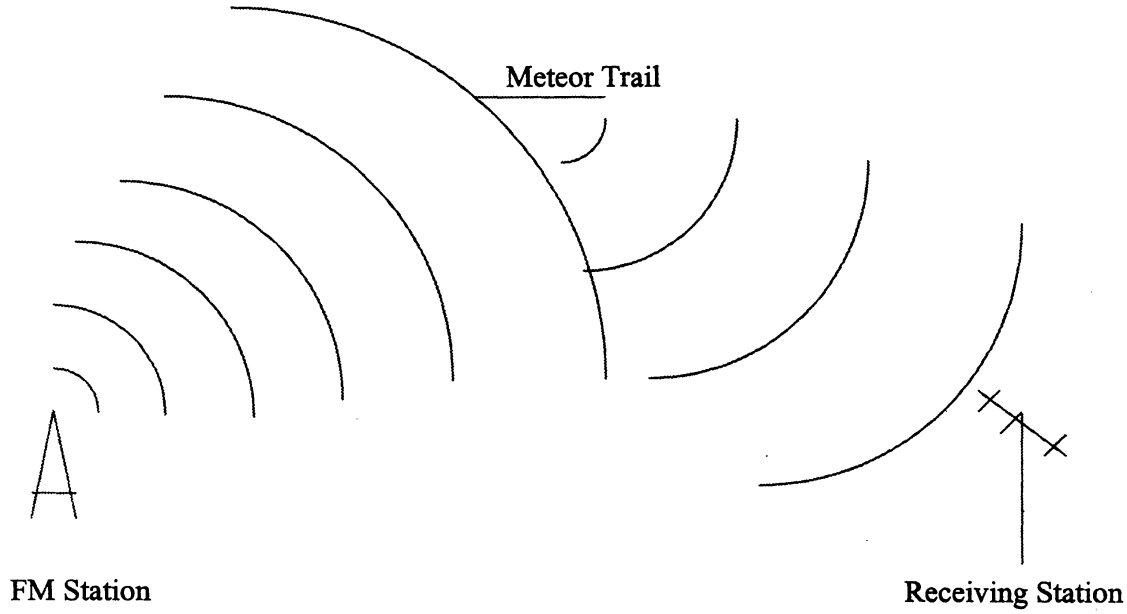
In the present observations, the forward-scatter radar technique is used to obtain percentage of Es occurrence during meteor shower periods. The FM radio signals are received after reflection from the ionization columns produced by meteors as shown in fig. 1(b). The receiving system consists of a three-element Yagi antenna, FM receiver, DC amplifier and a strip-chart recorder for recording the signals. The block diagram of the receiving system is shown in fig 1(a). A low cost FM receiver, constructed around FM/AM receiver chip IC 5591A, is used to receive the radio signals. The output signal from the IF stage of the receiver is fed to a DC amplifier for getting sufficient amplification of the signal to drive the recorder. The DC amplifier and Buffer are constructed around the OP AMP chip LM 324. The output of the DC amplifier is then connected a strip-chart recorder to record the signals round the clock through out the year. The data is collected during some major meteor shower periods and non-shower periods also, for comparison. From these recordings the percentage occurrence of Es is estimated by taking the echoes greater than 2 dB.

The diurnal variation in percentage occurrence of Es during Geminid meteor shower period (13th December, 1999) is shown in fig 2. The percentage occurrence of Es during non-shower period (5th December, 1999), is also shown as a dotted curve in the same figure, for comparison. From this figure it is seen that the percentage occurrence of Es during shower period is about 65 at the time of peak activity of the shower i.e. 03-00 hours. The duration of the maximum occurrence of Es is found to be about two hours.

The diurnal variation in percentage occurrence of Es during Quadrantid meteor shower (3rd January, 2000) is shown in fig. 3. The percentage occurrence of Es during non-shower period (14th January, 2000) is drawn as a dotted curve, in the same figure, for comparison. The Quadrantid shower shows a sharp peak with a percentage occurrence of Es, about 26 at around 09-00 hours. The occurrence of Es during non-shower period is about 5 observed at about 06-00 hours. There is also a minor peak of Es occurrence in the evening hours i.e., around 18-00 hours.



(a). Block Diagram of FM Radio Receiver System



(b). Reflection of Radio signal from a Meteor Trail

Figure 1. Forward scatter meteor radar.

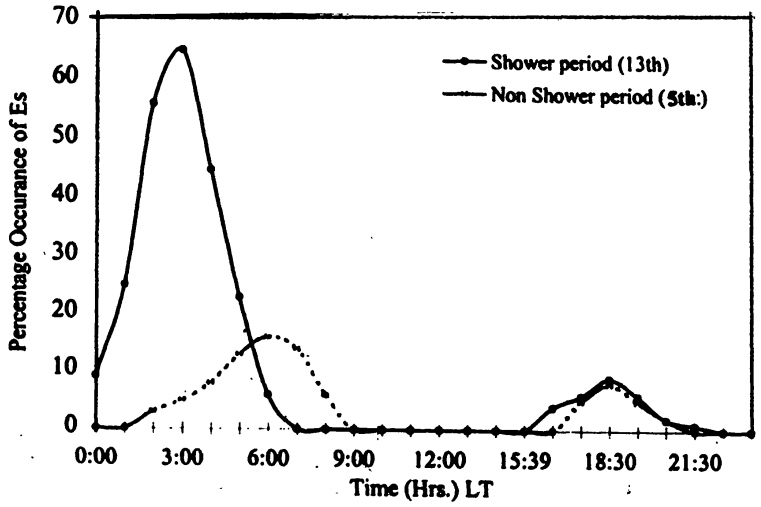


Figure 2. Diurnal variation of Es occurence during Geminid meteor shower (December - 1999).

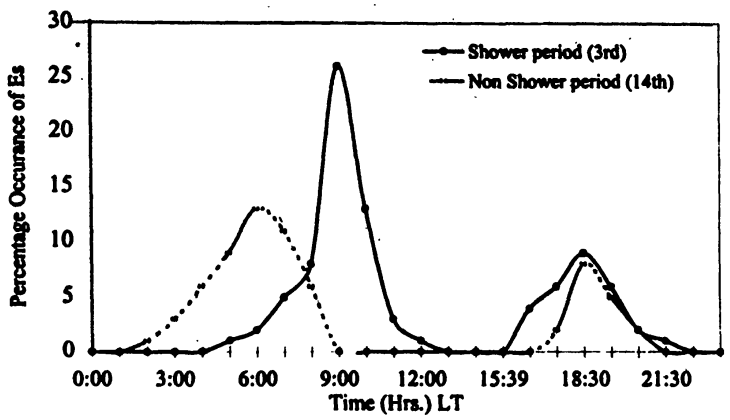


Figure 3. During variation of Es occurence during Quadrantid meteor shower (January - 2000)

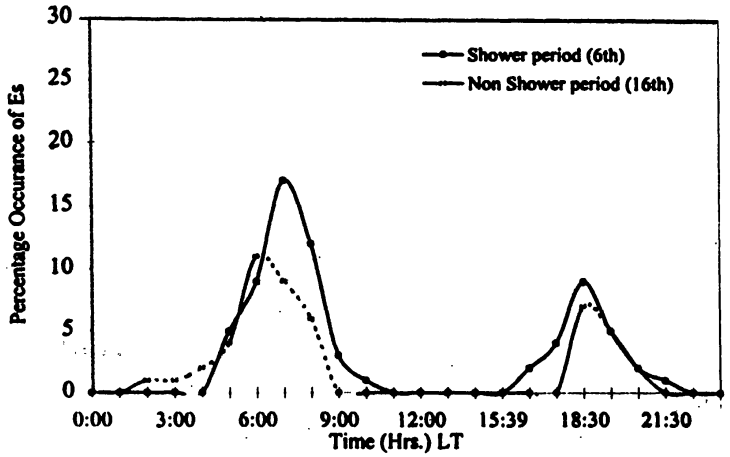


Figure 4. Diurnal variation of Es occurence during Eta-Aquarid meteor shower (May - 2000).

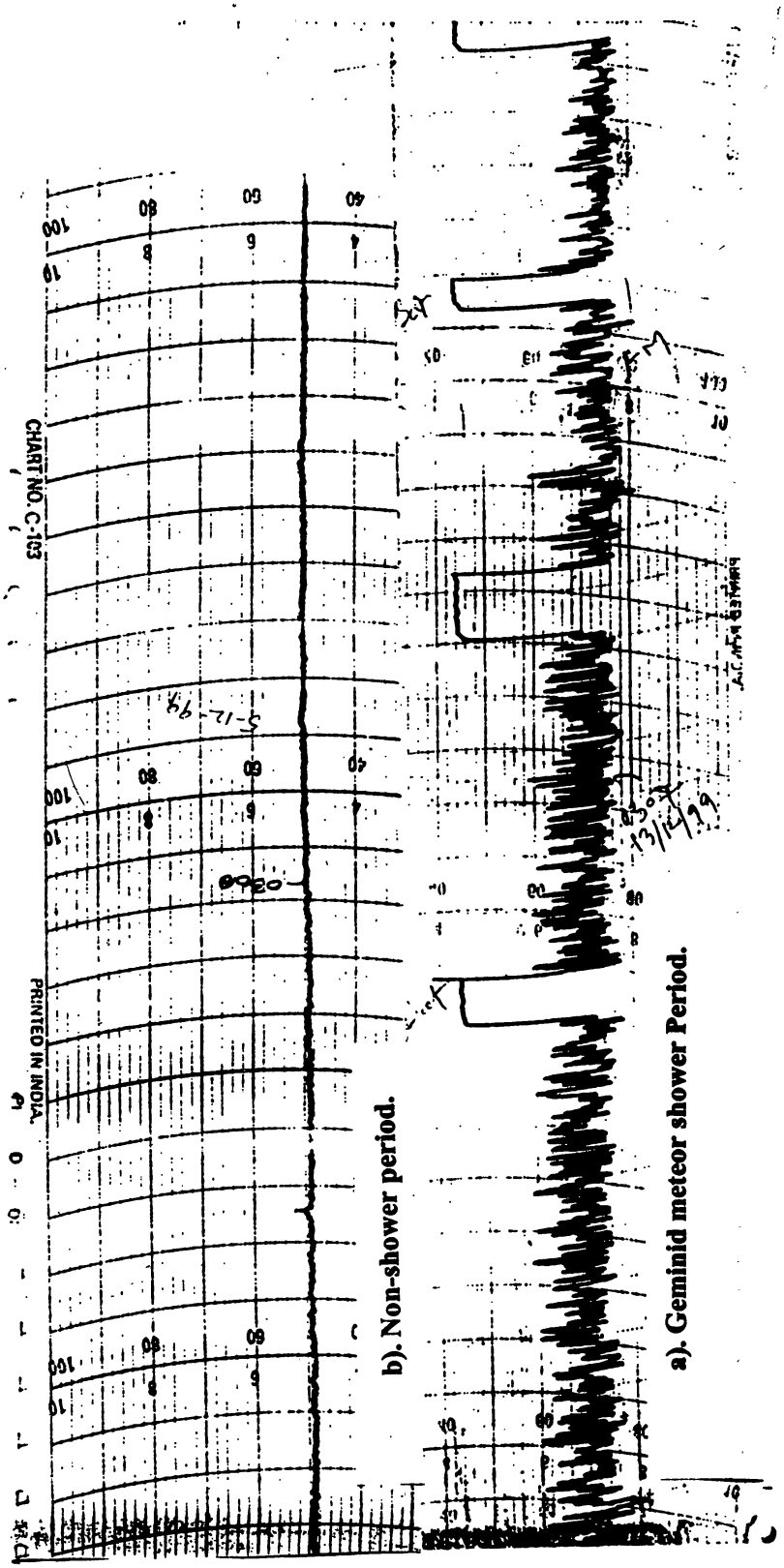


Figure 5. A sample recording of Es occurrences.

The diurnal variation in percentage occurrence of Es during Eta-Aquarids meteor shower period (6th May, 2000) and non-shower period (16th May, 2000) is shown in fig. 4. From this figure it is seen that a moderate percentage occurrence of Es, about 17, is observed during shower period. A very small peak of Es occurrence is observed during non-shower period.

A sample recording of Es occurrence observed during Geminid meteor shower period is given in Fig. 5.

3. Discussion and conclusions

From the present observations of Es occurrences during major meteor shower periods like Geminids, Quadrantids and Eta-Aquarids it is found that the Geminid shower, which is producing consistent activity of meteors for the past nine centuries (Lovell 1954), produced strong Es occurrences compared to other showers. The duration of Es occurrence is also found to be more during this shower period when compared to other periods. A small percentage occurrence of Es has also been found during non-shower periods on all the days of observations. These results are in confirmation with the results obtained by other workers. Further observations, during other shower periods, for many more years is needed to get a firm evidence of Es occurrences during meteor shower periods.

We conclude that the occurrence of Es produced by meteoric ionizations can also be obtained by using a simple technique of forward-scatter radar observations.

The percentage occurrence of Es during Geminid meteor shower, a strong shower, period is more when compared to other shower periods. A small percentage occurrence of Es is also found in the early morning (~ 6-00 hours), in variably on all the days. This shows that the sporadic meteors, whose activity is more during early morning hours, also produce ionization columns in the E-region of the earth's ionosphere.

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