Types of Radio-meteor Echoes & Meteor Rates Observed by vhf Forward Scatter

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Characteristics of different types of meteor echoes observed during the 12-month period from Dec. 1974 to Nov. 1975 over the vhf forward scatter radio link between Waltair and Dehra Dun (distance of 1760 km) at 48.2 MHz are studied. The diurnal and seasonal variations observed in the radio meteor rates are discussed. The data of hourly meteor rates show maximum around 0600 hrs and minimum around 1800 hrs during a day following the expected theoretical variation. The diurnal ratios show a double minimum around the equinoxial months. The monthly mean hourly meteor rates show a maximum in October and minimum in February.

1. Introduction

(i) The most frequently observed echoes are those which rise fairly suddenly and decay more or less exponentially to noise level within a few tenths of a second. These types of echoes are known as underdense echoes (line densities \( < 2.4 \times 10^{13} \text{cm}^{-2} \)) (Ref. 10.)

(ii) Occasionally the scattered signal from a meteor trail shows longer duration and has the form illustrated in Fig. 1 (b), usually lasting longer than those shown in Fig. 1 (a) and exhibit a "flat-top". This is a characteristic feature of the signals scattered from the overdense meteor trails.

(iii) Most long duration meteor echoes show shallow irregular fading during their life time at the flat top as shown in Fig. 1 (c). This fading may be caused by the trail moving with the winds and wind shears distorting the same.

(iv) There are still other types of echoes which do not have a sudden start, but develop shallow irregular fading. These echoes gradually rise out of the noise, attain a maximum response after a second or two and then decay like echoes of type (b). Echoes of this type are shown in Fig. 1 (d). The absence of the initial rise is probably due to the orientation of the trail being unfavourable for scatter reflection at the initial stages.

2. Characteristics of the Different Types of Meteor Echoes Recorded

Meteor echoes recorded in this experiment exhibit varied characteristics. Some of the recorded types of echoes are presented in Fig. 1. Their characteristics are given below.
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3.1 Diurnal Variation

The meteor signal rates for the corresponding hours in each month have been averaged and the average diurnal variation in the hourly meteor rates for all the individual 12 months are shown in Fig. 2. The average diurnal variation of the meteor signal rates for the whole year is shown in Fig. 3. The most common feature observed in all these curves is that they exhibit a maximum activity around 0600 hrs and minimum around 1800 hrs with some daytime fluctuations. These curves in general show wavelike structures with 2-4 cycles in a period of 12 hr during daytime. These may be due to the influence of gravity waves on the daytime ionosphere which affects absorption of meteor signals and hence rates. The general sinusoidal trend exhibited in all these diurnal variation curves is due to the well known “Apex effect,” assuming an isotropic distribution of sporadic meteor radiants. During the months Sep.-Dec. the 0600-hrs peak is shifted towards earlier hours probably due to the influence of meteor showers known to be active during this period.

3.2 Diurnal Ratio of Meteoric Activity

The degree of diurnal variation in meteor signal rates is of some importance to the communication engineer. It can be expressed in terms of the ratio of maximum to minimum rates over a 24-hr period. This ratio varies widely from day to day and season to season, which is enhanced particularly during the active periods of strong meteor shower activity. The
average diurnal ratios for the individual months have been obtained and presented in Fig. 4. The diurnal ratios for individual months lie in the range 2.4 to 4.6. This diurnal ratio curve shows a double minimum around the middle of the year and a maximum during December which is due to the highly active Geminid meteor shower.

3.3 Seasonal Variation

The seasonal variation of the meteor signal rates is illustrated in Fig. 5 together with daytime (average for the period 0600-1800 hrs) and nighttime (average for the period 1800-0600 hrs). The average signal rates observed during the nighttime values are greater than the daytime values. The salient feature of this curve is that the meteoric activity is low during the early months of the calendar year with a minimum in the month of February and high during the latter half of the year with a maximum in the month of October which is in good agreement with the results of McKinley. This is because the apex of the earth's way is above the horizon for an observer in the northern hemisphere for more number of hours each day during autumnal equinox (September) than it is during vernal equinox (March) so that the annual rates would be expected to show a maximum around September and minimum around March. Thus the experimental observations of the authors are in good agreement with the theoretical predictions.

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