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Radio Meteor Rates Observed with Meteor Wind Radar during Non-shower Period*

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Results of a study of meteor activity observed with meteor wind radar at Waltair during non-shower period are presented. The diurnal variation of echo rates recorded on 27/28 Nov. 1977 are discussed and the results are compared with the observations made by other techniques, such as vhf meteor backscatter radar at Waltair, meteor forwardscatter communication link between Waltair and Dehra Dun and visual meteor observations at Waltair.

1. Introduction

Radio echoes from ionized meteor trails yield information concerning the meteor influx into the earth's upper atmosphere with altitude range of 80-110 km. These meteors can be classified as shower meteors and non-shower or sporadic meteors. Sporadic meteors do not have well defined streams but rather seem to move in random orbits. Therefore, sporadic meteors have radiants that appear to be randomly distributed over the sky and are mostly concentrated towards the ecliptic plane, the plane of the earth's orbit and move in the same direction around the sun as does the earth.[1] The meteor wind radar at Nagarampalem, the field station of the Space Research Laboratories, Andhra University, Waltair (lat. 17° 43′ N, long. 83° 18′ E) was operated on 27/28 Nov. 1977 and a total number of 1325 radio meteor echoes were observed in 24 hr, in a sector of the sky covered by the radar antenna.

The earlier investigations on the radio and visual meteor activity were based on an omnidirectional coverage of the sky. The aim of the present study is to see how the sporadic meteor activity varies over a day in a particular sector of the sky. The meteor wind radar antenna faces in north-west direction at an elevation of about 30° and has a beam width of 25°.

2. Technical Set-up

The meteor wind radar is a sophisticated pulse Doppler radar of 20 kW peak power, operating at 36 MHz with a prf of 450 Hz and a pulse width of 25 μsec. In addition to detecting the sporadic meteors, the radar measures the range, rate of decay of the meteor trail and the speed of bodily movement of the meteor traildue to neutral winds present at those altitudes. The antenna used for both transmission and reception consists of a twin Yagi, of eight elements each, and has an approximate beam elevation of 30° and a beam width of 25° in the azimuthal plane. In fact the radar consists of two such antennas, one pointing towards north-west and the other towards south-west so that two separate regions of the sky can be covered by manual switching of the appropriate antenna. The results presented in the following sections confine to the sector of the sky covered by the north-west antenna.

3. Results and Discussion

Fig. 1 illustrates the rate of incidence of sporadic meteors on the earth. On the morning side of the earth, meteors are swept up by the forward motion of the earth in its motion around the sun. On the evening side the only meteors reaching the earth are those which overtake it.

3.1 Diurnal Variation of Echo Rates

Fig. 2 represents the diurnal variation of sporadic meteor activity observed on 27/28 Nov. 1977. This variation shows a maximum at 0500 hrs IST and a minimum at 1800 hrs IST. The early morning peak and the evening dip in meteor activity is well known as due to the relative motion between the earth and the meteors. Whipple[2] and Lovell[3] reported that the orbits of the larger sporadic meteors are concentrated in the plane of the ecliptic. If sporadic meteors

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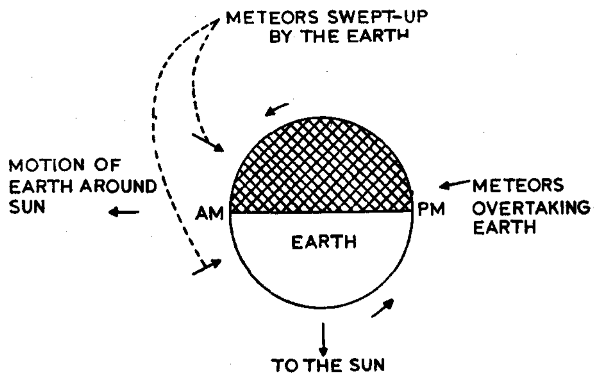

Fig. 1 — Diurnal variation of meteor incidence rate

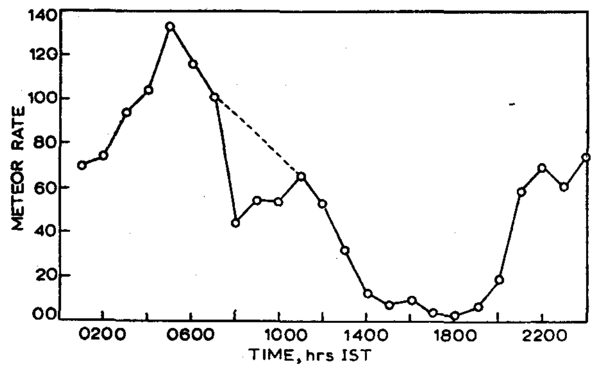

Fig. 2 — Diurnal variation of radio meteor rate during non-shower period

were distributed randomly with respect to sun, the average velocity at which the particles are moving with respect to the earth, will be a function of the time of day and the geographical location of observer. So the observations at the equator and at moderate latitudes will find a more number of meteors in the early morning hours and less in the cvening hours. The observed crest of meteor activity in the early morning hours and the trough in the evening hours, therefore, represent this expected diurnal variation.

If the relative motion between meteors and the earth alone is considered the diurnal variation in meteor activity should follow a cyclic variation with crest in the early morning hours and trough at evening hours and nearly equal activity at noon and midnight. The observed peak at 0500 hrs IST and the dip at 1800 hrs IST and nearly equal activity at 1200 and 0000 hrs IST confirm this fact. However, a sharp dip in activity is found to occur at 0800 hrs IST recovering to the expected normal values at 1100 hrs IST. This depletion in meteor activity is represented by the curve below the dotted line in Fig. 2. This depletion in activity may be due to the rapid increase in absorption at D-region height[4,5]. The unsteady conditions in the ionosphere around this time resulting in rapid layer movements may also be a cause for the decreased activity. Since most of the earlier work on sporadic meteor activity carried out at Waltair was based on visual methods,[6,7] there were no data during the sunlit hours. However, a diurnal variation of sporadic meteor activity was established by Ramachandra Rao *et at.*[8] in course of a meteor forward scatter link experiment between Waltair and Dehra Dun. Their results also showed a sharp fall in meteor activity at 0800 hrs IST in the diurnal variation.

3.2 Range Distribution of the Meteor Echoes

Since the meteor radar gives the slant range of each echo, all the observed echoes are grouped into various echo ranges and a histogram is plotted (Fig. 3). This histogram gives a spatial distribution of the meteor trails within the beam of the antenna and also serves as a cross-check for the radiation pattern of the antenna in the elevation plane. Fig. 3 shows that out of the total number of 1325 echoes, 715 echoes occurred in the range interval of 200-300 km and the rest of them are distributed over various ranges from 100 to 700 km. These variations are attributed to the variations in the velocity, mass and radiant of the concerned meteor. The higher velocity particles produce reflections at higher levels whereas the particles of higher mass produce reflections at lower levels. Also trails with greater zenith angles reach their ionization maximum at greater heights and so the reflections from higher levels.[9]

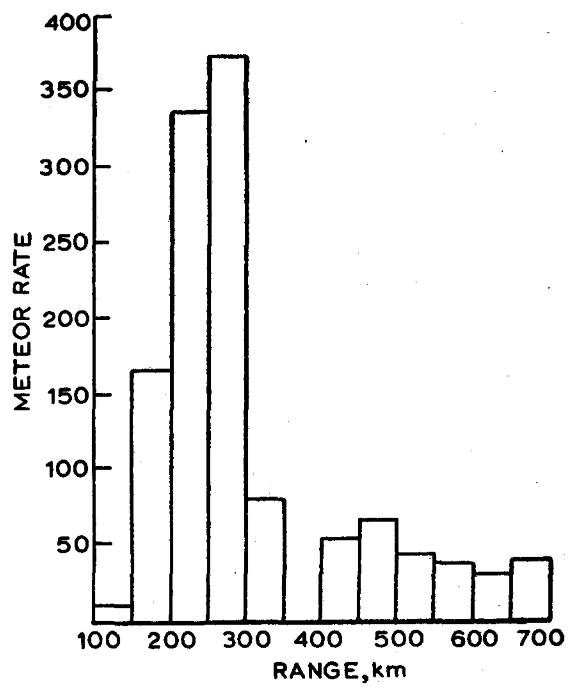

Fig. 3 — Histogram of height variation of meteor rate

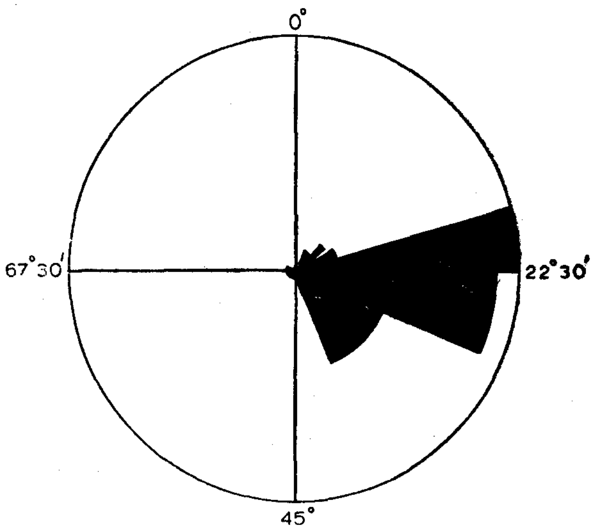

Fig. 4 — Elevation diagram of antenna beam deduced from meteor count

3.3 Prediction of the Antenna Radiation Pattern in Elevation Plane

Since the radar did not have the height finding facility at the time of these observations it was not possible to know the actual height of the specular reflection point for each meteor echo. However, following the practice adopted by earlier investigators,[10] an average height of 95 km is assumed and the observed range distribution is converted into a distribution of elevation angles and a normalized polar plot of the same is represented in Fig. 4. It can be inferred from Fig. 4 that the maximum number of meteors are detected in the elevation range of 18-28° and this is in conformity with the expected elevation of about 25-30° for a horizontal 8-element twin Yagi antenna situated at a height $\lambda/2$ above the earth's surface.

Acknowledgement

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