THE ANNUAL VARIATION OF RADIO METEOR ECHOES OBSERVED FROM 1981 TO 1985

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ABSTRACT. The radio observations of meteor echoes using FM broadcasting were carried out from January, 1981 to June, 1985. The annual variation of meteor rates in the 5 years was obtained from the observations made from 25h through 29h in local time (16h-20h UT).

Some features in this annual variation can be explained by the occurrence of the major meteor showers. After the effects of these major showers are removed there remains a significant annual variation which shows higher rates in the winter half of the year (October to March). This seems to be caused by the annual variation of non-shower meteors radiating from the apex region.

1. INTRODUCTION

In Japan, meteor radio observations using FM broadcasting have been carried out since 1970. The method of observation is to count the appearances of meteors by utilizing the fact that meteor ionized columns reflect VHF waves (Suzuki 1976). The observations from 25h through 29h local time (LT) have been continued with the same observational equipment since 1981. The time (from 25h through 29h LT) was selected for the following reasons: (1) The radio condition at midnight is undisturbed. (2) There are a lot of data observed optically. (3) Meteor trails radiating from the apex source are obtained mainly in the period 25h-29h LT.

2. APPARATUS AND METHODS OF OBSERVATION

If we have an ordinary audio FM tuner, we can observe the meteor echoes. There are nearly 200 FM stations in Japan, and they are broadcasting in the frequency bands of 76-90 MHz. Tuning an audio FM tuner to a distant FM radio station which is not usually received, we can count the number

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of meteor occurrences as the momentary enhancements of FM broadcasting reception.

The aerial used for this observation is a 5-element Yagi antenna. It is directed to the zenith, and is elevated 5 m above the ground. The echo receiver consists of 2 FM tuners. One of these is used for a noise canseller. The transmitting station is the FM Tokyo (frequency:80.0 MHz, peak power: 10 kW), which is located in Tokyo (long.139.7° E, lat.35.7° N). On the other hand, the receiving station is located at Toyokawa site (long.137.3° E, lat.34.8° N). The transmitting station is about 240 km east-northeast of our receiving site in Toyokawa.

The ground waves of the FM Tokyo usually cannot be received at night. Therefore, tuning the receiver to the FM Tokyo (80.0 MHz), the meteor echoes are recorded on the chart of a pen-recorder as a signal increase. The recorded echoes are divided into 5 classes according to the received power, and counted respectively.

3. RESULTS OF OBSERVATION

From January, 1981 through June, 1985, the observation of meteor echoes were carried out for 4 hours (25h through 29h LT) every day. Echoes whose received power was larger than 0.5 mV were recorded, and the number of hourly meteor echoes was counted. As a result of simultaneous observations of a TV camera equipped with Image-Intensifier and this

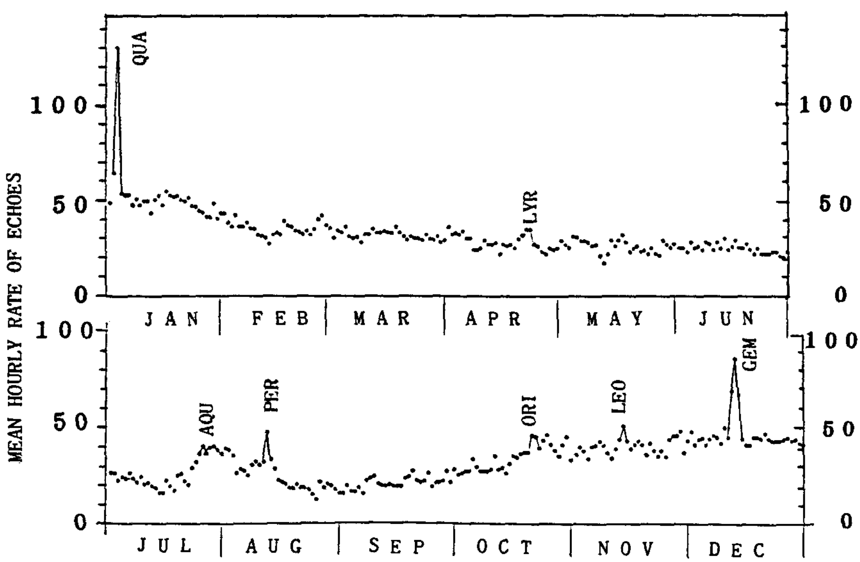

FIGURE 1. The daily mean hourly rates of meteor echoes observed during 25h-29h LT in the 5 years (1981 to 1985).

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radio method, it was ascertained that meteors brighter than about +6 visual absolute magnitude were observed by our method. Fig. 1 shows the annual variation of the mean hourly rates of radio meteor echoes observed during 1981 to 1985.

4. MAJOR METEOR SHOWERS AND THE ANNUAL VARIATION

Several sharp or smooth peaks caused by the activities of meteor showers are shown in Fig. 1. These are major meteor showers observed every year. As the observational period is limited to only 4 hours a day, not all meteor showers can be found in Fig. 1. The three letter marks indicate the following meteor showers: Quadrantids in January, Lyrids in April, δ Aquarids in July, γ Perseids in August, Orionids in October, Leonids in November and α Geminids in December. Their dates of activities, normal and maximum hourly rates are given in Table 1.

Even if the effects of major meteor showers are removed, there seems to remain a significant annual variation. In order to confirm this, mean monthly hourly rates, excluding the periods of shower activities shown in Table 1, are calculated and plotted in Fig. 2. Of course, it is possible that the echoes belonging to several minor showers are included, therefore, some influences of showers may remain in the annual variation in Fig. 2. The annual variation revealed from our observations shows higher rates in the winter half of the year (October to March).

TABLE 1. The major showers observed by our method during 25h- 29h LT in 1981-1985.

Major Shower	Duration (UT)	Normal Hourly Rate	Max. (UT)	Maximum Hourly Rate
Quadrantids (QUA)	Jan. 2-4	82	Jan. 3	120 – 180
Lyrids (LYR)	Apr. 21-23	34	Apr. 22	30 – 50
δ Aquarids (AQR)	July 26-30	39	July 29	40 – 50
γ Perseids (PER)	Aug. 11-13	37	Aug. 12	40 – 60
Orionids (ORI)	Oct. 21-25	44	Oct. 22	40 – 60
Leonids (LEO)	Nov. 16-18	42	Nov. 17	40 – 50
α Geminids (GEM)	Dec. 10-14	63	Dec. 13	70 – 120

5. DISCUSSIONS AND CONCLUSION

The annual variation of visual or radio meteor rates has been investigated by a number of meteor scientists. A proposed model of the radiant distribution of non-shower meteors has three main point sources: apex, helion, and antihelion. Stohl (1968) derived the annual variation of non-shower meteors radiating from each source. According to his result,

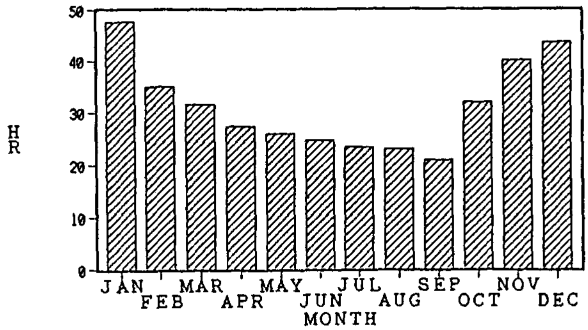

FIGURE 2. The annual variation excluding major meteor showers.

the annual variation for the apex source has its maximum in December, and its minimum in April.

Because of our geometrical relation between the transmitting station and the receiving site, meteor echoes radiated from the apex source are received effectively at 25h-29h LT. In this observation period, echoes radiated from the helion source cannot be obtained as it is below the horizon, and equally those from the antihelion source can hardly be obtained as it has just crossed the meridian. Therefore, the annual variation shown in Fig. 2 is supposed to be caused mainly by the non-shower meteors radiating from the apex region.

Hasegawa (1989) investigated a number of cometary orbits which intersect the earth's orbit, and he pointed out that more cometary orbits encounter the earth in the last quarter of the year. The annual variation observed by our method approximately coincides with this. That is to say, the annual variation of non-shower meteors radiating from the apex region may be caused by the comets coming near the earth.

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