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# Annual and Diurnal Variation of Meteor Rates by the Forward-Scatter Radio Observation

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**Abstract** Forward-scatter radio meteor observations have been made at Japan since 1996 using inexpensive and low-end equipment. The activity of some major meteor showers and the seasonal variability of sporadic meteors in 2006 are presented.

**Keywords** Meteor · Radio observation

## 1 Introduction

We know many previous studies for radio meteor observations. But there are only a limited number of reports for forward-scatter radio observations. We have been conducting radio meteor observations since April 1996 using a Ham band radio wave and some outbursts of the meteor showers such as Leonids in 1998 and June-Bootids in 1998 were detected (Maegawa 1999; Ueda and Maegawa 2001).

In this paper we describe the annual variations, yearly mean diurnal variations, seasonal variation of meteor echo rates.

## 2 Observation System and Analysis Method

Our Ham radio wave forward-scatter observation (HRO) for meteor echoes has been operating since 1996. A 50 W continuous wave at the frequency of 53.75 MHz is transmitting with no modulation except a few seconds morse code identification every 10 min. The transmitting antenna is a two-element Crossed Yagi antenna directed towards the zenith and the antenna pattern appears to be omni-directional at elevation angles above 15 degrees (see Figs. 1 and 2). The transmitting system has been operated by one of the

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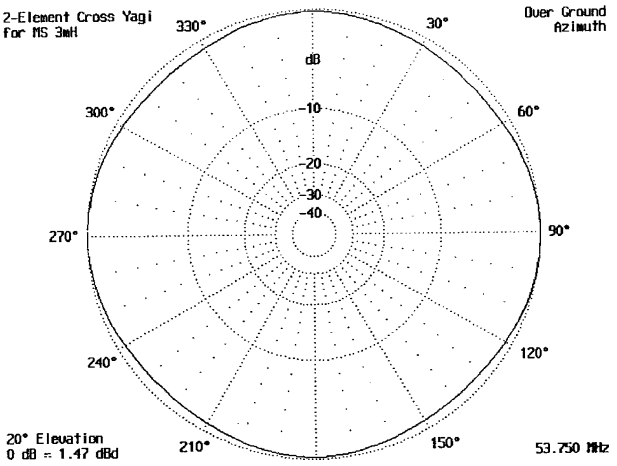


**Fig. 1** Horizontal radiation pattern of the transmitting antenna (simulated by the computer software named "EZNEC")

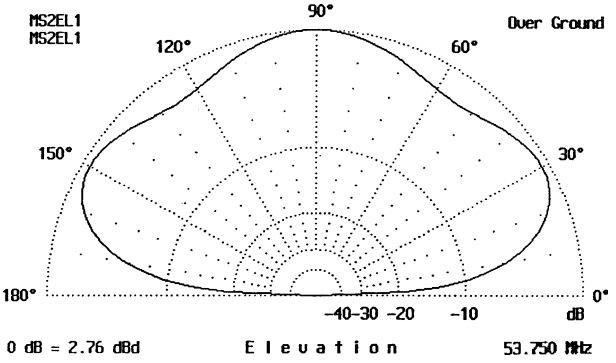


**Fig. 2** Vertical radiation pattern of the transmitting antenna (simulated by the computer software named "EZNEC")

authors as JA9YDB radio club station from Fukui National College of Technology (136.2 E, 35.9 N). The detail of the transmitting system was presented in previous papers (Maegawa 1999; Ueda and Maegawa 2001). Meteor echo reception was carried out at the Damine Meteor Observatory (137.5 E, 35.1 N, distance between the transmitting and receiving sites is about 120 km) in 1998, 1999, 2000 and 2001, and at NISSHIN (137.0 E, 35.1 N, the distance is about 90 km) in 2003, 2004, 2005 and 2006. Due to the reconstruction of the observatory no observation was conducted in 2002. The receiving system consists of two elements Yagi (HB9CV) antenna, IC-575 transceiver and personal computer installed meteor echo processing software. We used the software FFTDSP in 1998–2001 and HROFFT (sound spectral display and storage software with the sampling frequency of 8192 Hz) from 2002. Meteor echoes were identified by their sound spectral and sound power. Sporadic-E propagation was discriminated by the continuously constant sound spectral and the aircraft reflections were discriminated by their continuously variable sound spectral due to the Doppler shift. Long duration echo was made by overdense echo but short duration echo was underdense or overdense echo, therefore the identification of the underdense or overdense was not clear. For the study of the activities of sporadic meteors, the data based on the periods corresponding to major showers (January-Bootids,

**Table 1** The echo counts, observational time and the ratio of the observational time over the whole year

| Year | 1998 | 1999 | 2000 | 2001 | 2003 | 2004 | 2005 | 2006 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Echoes | 210821 | 233464 | 160556 | 145040 | 179586 | 166319 | 134714 | 206205 | 1436705 |
| OT | 6566 | 7702 | 5036 | 5531 | 7822 | 7801 | 6928 | 7835 | 55611 |
| Ratio | 0.79 | 0.88 | 0.57 | 0.63 | 0.89 | 0.89 | 0.79 | 0.89 | 0.79 |

OT, Observational time of each year and total (in h)

Ratio, The ratio of observational time over the whole year and mean of the 8 years

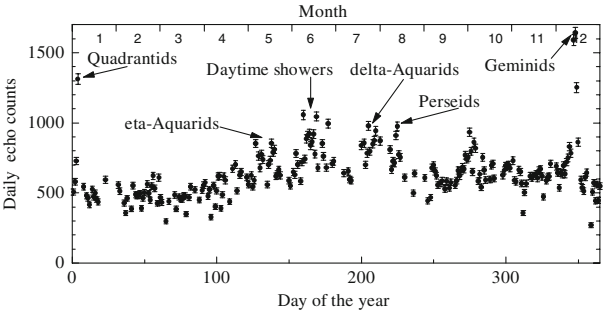


**Fig. 3** Annual variation of daily echo counts in 2006

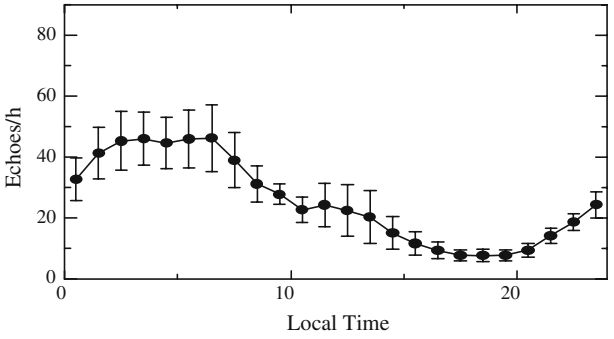


**Fig. 4** Yearly mean diurnal variation of meteor rates in 2006. Error bar shows s.d.

Arietids, Zeta-Perseids, Delta-Aquarids, Gamma-Perseids, Geminids) (Jenniskens 1994) was excluded. In case the observational time was less than 30 min $h^{-1}$ and/or the data quality was poor due to the ionosphere disturbances, the data was discarded.

## 3 Results

The total echo counts amounted to more than 1.4 million counts and the observational time amounted to more than 55.6 thousand hours. Table 1 shows that the ratio of the observational time over the whole year was 0.79.

The activities of major showers are clearly seen in Fig. 3. The maximum and minimum echo rates are detected at 6 LT 18 LT, respectively (see Fig. 4), and the yearly mean diurnal variations in 1998–2006 are similar to each other.

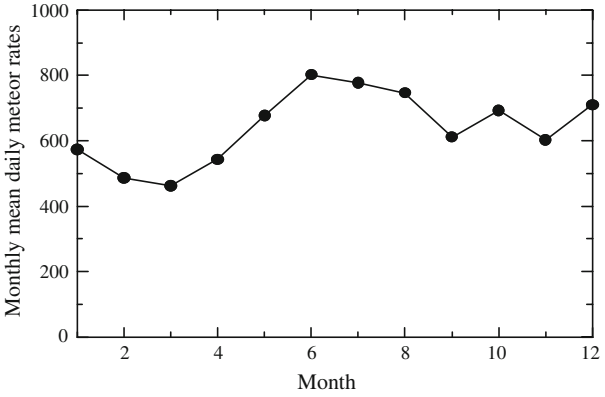


**Fig. 5** Monthly mean daily meteor rates in 2006

The maximum of the monthly mean daily meteor rates was detected in June in agreement with other observations on middle and higher latitudes of the northern hemisphere (see Fig. 5).

## 4 Summary

Useful meteor data such as annual variation, seasonal variations and activities of the major meteor shower were obtained by the radio meteor observations, which were conducted with inexpensive and low-end equipment.

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