Asteroids, Comets, Meteors 1991, pp. 625–627
Lunar and Planetary Institute, Houston, 1992 S146-89

- - 141061
N93-19259

METEOR RADIANT MAPPING WITH MU RADAR

J. WATANABE[1], T. NAKAMURA[2], T. TSUDA[2], M. TSUTSUMI[2], A. MIYASHITA[1], *and* M. YOSHIKAWA[3]
1:National Astronomical Observatory of Japan
2:Radio Atmospheric Science Center, Kyoto University
3:Communications Research Laboratory

Abstract

We carried out the radiant point mapping of meteor showers with the MU radar by using a modified mapping method originally proposed by Morton and Jones(1982). The modification is that we weighted each meteor echo by using the beam pattern of the radar system. In this paper, we present a preliminary result of the radiant point mapping of the Geminids meteor shower in 1989.

1 Introduction

It is important to monitor the annual activities of meteor showers in order to know the structure and evolution of meteor streams. There are two merits to utilize radar systems for this purpose. One is that the radar observations realize the uniform and stationary observational conditions, which is the most important for monitoring. The other merit is that the radar observes generally fainter meteors, that is, smaller particles than usual optical methods. Because both the radiation pressure and the Poynting-Robertson effect cause the mass segregation in the streams, the radiant point determined by the optical observations may differ from that in the radar method. Therefore, the radiant point mapping by the radar observations is useful for knowing the evolutionary stage of each meteor stream. The mapping method for the radiant points of meteor showers with an all sky radar systems was proposed by Morton and Jones(1982), and its application to some major showers has been carried out by Poole and Roux(1989). In this paper, we present the modified mapping method along with the result of its application to the 1989 Geminids meteor shower.

2 MU Radar

The MU radar located at Shigaraki, Japan(34.85°N, 136.10°E), is a Mesosphere Stratosphere and Troposphere radar with the frequency and the peak power of $46.5MHz$ and $1MW$, respectively, which was mainly designed to observe atmospheric dynamics of the middle and upper atmosphere(Fukao et al. 1985a,b). One of the characteristics of this radar is the fast beam steering by means of the active phased array antenna, which enables us to investigate the tridimensional structure of the atmospheric motions with a high resolution.

This radar is also characterized by the versatility of the antenna array. By using four antennas out of 475 Yagi arrays and four receiver channels, more than several hundred echoes from the ionized meteor trails can be received efficiently(Nakamura et al. 1991). The beam pattern of the MU radar has been measured. This gives us a useful information for correcting the meteor echo counting.

3 Radiant Point Mapping of Meteor Showers

The principle of our mapping method is the same as Morton and Jones(1982). The radar echo comes from a meteor trail which is perpendicular to the MU radar. The radiant point of each meteor exists upon the great circle of which the pole is the direction of the echo. Because of the uncertainty of the echo direction, we must think a band region of the possible radiant point for each meteor. Piling up each band region, we obtain the position of the radiant point statistically. Figure 1 is the radiant point mapping for the 1989 Geminids with the correction of the beam pattern. The principle of this correction is that the echoes from the position of the larger zenith angle should be counted more than 1.0. The band region of the possible radiant point has generally a higher value with the larger zenith angle. The weight for the echo in the zenith angle Z is given by $W = 1.0/L$, where L is the loss of the antenna, and depends on the zenith angle as $L = K - Gt(Z) - Gr(Z)$, where Gt and Gr are the Gain of TX and RX antenna, respectively, and K is a constant of the system($-74.414dB$). The zenith angle dependence of the weight is shown in figure 2. The height of the radiant point contour level becomes larger than the original mapping method. This means that the correction of the beam pattern is effective for such radiant point mapping, especially in the case of the minor meteor showers. Analyzing the data obtained in the 1989 Geminids, we found the daily motion of the radiant point toward the east(P.A.= $70° \pm 10°$). Although we changed the beam pattern as an experiment for the atomospheric observations, this motion is recognized. The motion is more than 2 degrees per day, which is larger than usual value in the optical observation. The main reason of this difference is not clear.

We are planning to monitor the activities of the Leonids until 1999.

REFERENCES

Fukao S., Sato T., Tsuda T., Kato S., Wakasugi K., and Makihira T.(1985a) The MU radar with an active phased array system, 1. Antenna and power amplifiers. Radio Sci., 20, 1155–1168.

Fukao S., Tsuda T., Sato T., Kato S., Wakasugi K., and Makihira T.(1985b) The MU radar with an active phased array system, 2. In-house equipment. Radio Sci, 20, 1169–1176.

Morton J.D., and Jones J.(1982) A method for imaging radio meteor radiant distributions. Mon. Not. R. astr. Soc., 198, 737–746.

Nakamura T., Tsuda T., Tsutsumi M., Kita K., Uehara T., Kato S., and Fukao S.(1991) Meteor wind observations with the MU radar. Radio Sci.,26, 857–869.

Pool L.M.G., and Roux D.G.(1989) Meteor radiant mapping with an all-sky radar. Mon. Not. R. astr. Soc.,236, 645–652.

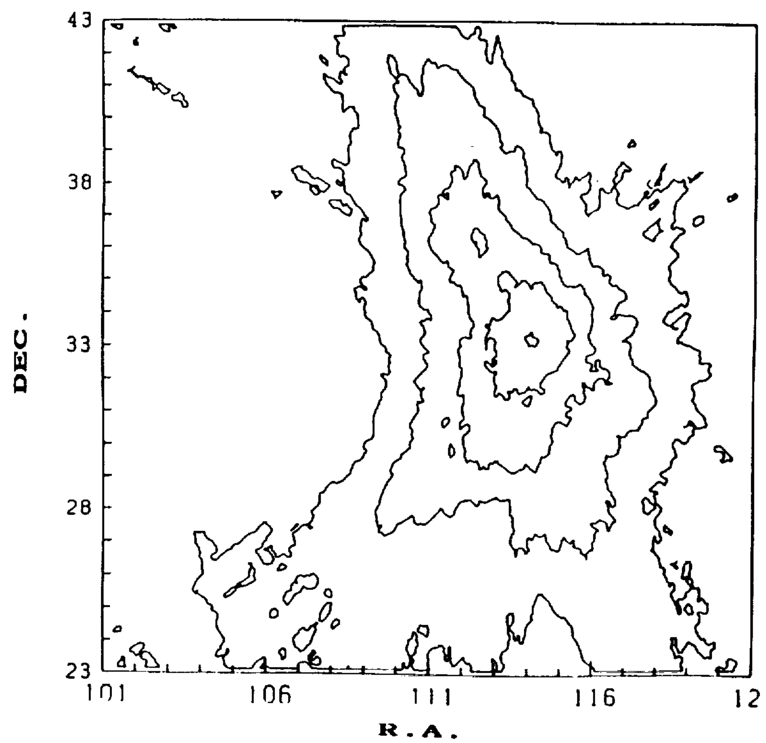

Figure 1: Radiant point mapping of the Geminids on December 12 1989.

Figure 2: The zenith angle dependence of the weight for an echo W for the correction of the beam pattern.