Radar observations of the Perseid meteor shower in 1992

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Abstract. The activity of the Perseid meteor shower observed by a forward scatter (FS) bistatic meteor radar (baseline Bologna-Lecce, Italy) in the period August 6-15, 1992, is investigated. The shower activity is compared with the visual data recorded in 1992 and a double maximum of the shower at the solar longitudes 138.78°and 139.06°(equinox 1950.0) was observed.

Key words: Perseid meteor shower – forward scatter radar

The bistatic FS meteor radar with the transmitter at Budrio ($\Phi_B = 44.6°$ N; $\lambda_B = 11.5°$ E), near Bologna, and the receiver at Lecce ($\Phi_L = 40.3°$ N; $\lambda_L = 18.2°$ E), Southern Italy, utilizes a continuous wave transmitting frequency at 42.7 MHz with a fixed modulating tone at 1 kHz and a 0.1 ÷ 1 kW power. The FS transmitting and receiving antennas at the two separated places are horizontally and vertically polarized with and elevation angle of 15° along the Bologna-Lecce direction (azimuth of 137°).

Radar observations of meteor trains were carried out continuosly on August 5-15, 1992 in the period including the peak activity of the Perseids, utilizing the power level of the equipment of 100 W. Observational data have been analyzed in terms of arrival rate of meteor trains exceeding a minimum signal-to-noise ratio (SNR). A dynamic SNR threshold was utilized on account of the observed variable noise level induced by ionospheric disturbances and irregularities which sometimes inhibited meteor detection. The results are here presented in the form of distributions of the numbers of underdense and overdense trains separated according to the different durations (all echoes, $T < 2$ s, $T \geq 2$ s and $T \geq 32$ s).

Figure 1 and 2 show the contour plots of 3-D time variations of the hourly echo numbers N_h of echoes (shower and sporadic) observed on August 9-15, 1992 (A and B - all echoes; B1 - *underdense echoes* of $T < 2$ s; B2 - *overdense echoes* of $T \geq 2$ s and B3 - $T \geq 32$ s). The shades on Fig. 1 and 2 depict the relative abundance of the recorded echoes; the lighter the area is, the more echoes were recorded in given period. The trends of overdense meteors show a prominent

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peak on August 11, 1992 at 21 LT (20 UT) (solar longitude 138.8, eq. 1950.0) mainly for longer duration echoes, with 83% and 52% of the hourly flux for $T \geq$ 2 s and $T \geq 8$ s, respectively (and even with 17% for $T \geq 32$ s).

This peak activity of long enduring echoes is well separated from the regular and traditional visual maximum of the Perseids at the solar longitude 139.4°(Lindblad 1986). Less than 2 hours after the prominent peak particularly rich in large meteoroids, the number of echoes decreased to the average hourly rate. This is in an agreement with visual observations reported by Brown et al. (1992), Xu Pin-Xu (1992) and others. The presence of echoes of longest durations remains evidently at least a day longer. On the other hand, the underdense trains were in that period almost absent and their peak occurred earlier, on August 10 at about 02 LT (solar longitude 137.1°).

The plots shown in Figs. 1 and 2 are related to all echoes (shower and sporadic) observed in the period August 9-15, 1992. To discriminate the Perseid meteor activity, the sporadic background echo counts have to be subtracted from the counts of all echoes in the corresponding hours during the activity of the shower. For sporadic meteors, the counts recorded on August 5 a 6 (the first two days of the campaign) were taken. The result is depicted in Fig. 3, where the Perseid shower activity in four days around the maximum vs. solar longitude (1950.0) is plotted. The plot exhibits shower maximum at the solar longitude 138.78°and a prominent secondary peak at the solar longitude 139.06°. The maximum practically coincides with the nodal longitude of the parent comet Swift-Tuttle and with visual observations of the Perseids in 1992 (Brown et al. 1992). Results of the 1992 Perseid back scatter radar observations were discussed by Šimek (1993); the shower activity profile showed dominant peaks at the solar longitude 138.7°and 139.15°. A multiple peak of the 1992 Perseid was observed also by radio observers (Kristensen 1992) on August 11 between 17:30- 21:10 UT, 23:15-01:25 UT and on August 12 before noon, between 09:5-12:30 UT. The first peak well coincides with the here presented FS results.

Šimek and McIntosh (1986) in their extensive analysis of the Perseids from 16 years obtained by the Springhill meteor radar, put the stable maximum of overdense echoes to the solar longitude 139.2°, stressing their broader structure and a lack of small particles. The proportion of their underdense to overdense trains is between 1.5 to 2.0, very close to our data. Similar results were given also by Lindblad and Šimek (1983) from 25 years of Onsala data. Šimek (1987) has then summarized the long term observations from Sweden and Canada, with the secondary maxima displayed at the solar longitudes 138.3°, 138.8°, 139.8°and 141.3°, and the maximum of the overdense trains from Ondřejov radar data (1958-62, 1972, 1980-85) at the solar longitude 139.2°.

From the analyses of long-term data and from the comparison of the relatively stable central maximum of the Perseids with the secondary peak, it seems correct to ascribe the traditional known maximum to the old belt of the stream and the secondary maxima to the younger ejecta, connected with the last passages of the comet throughout the inner solar system. In this case, also the mass

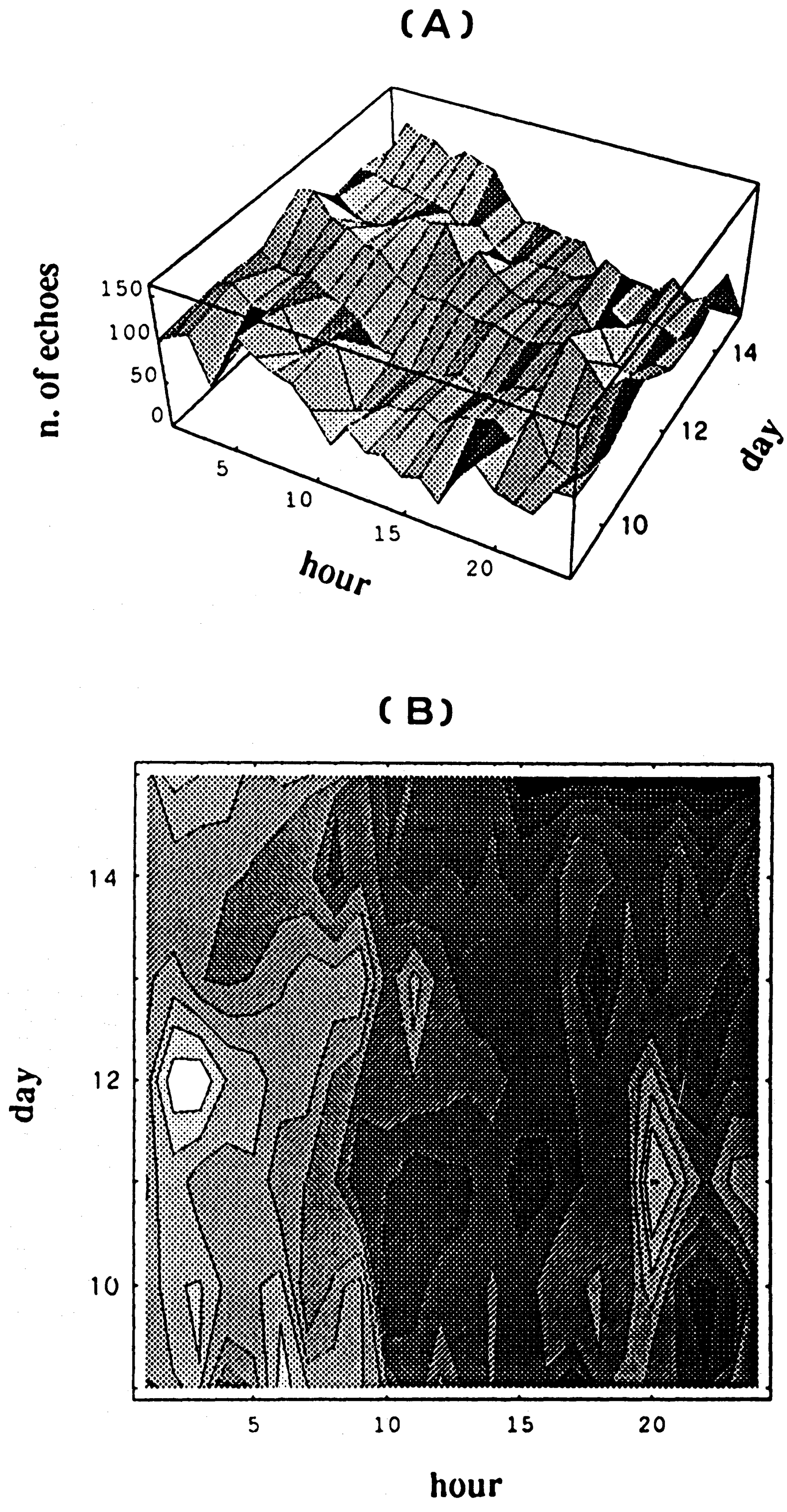

Figure 1. Contour plots of 3-D time variations of the number of echoes N_h recorded on August 9-15, 1992 (A, B - *all echoes*).

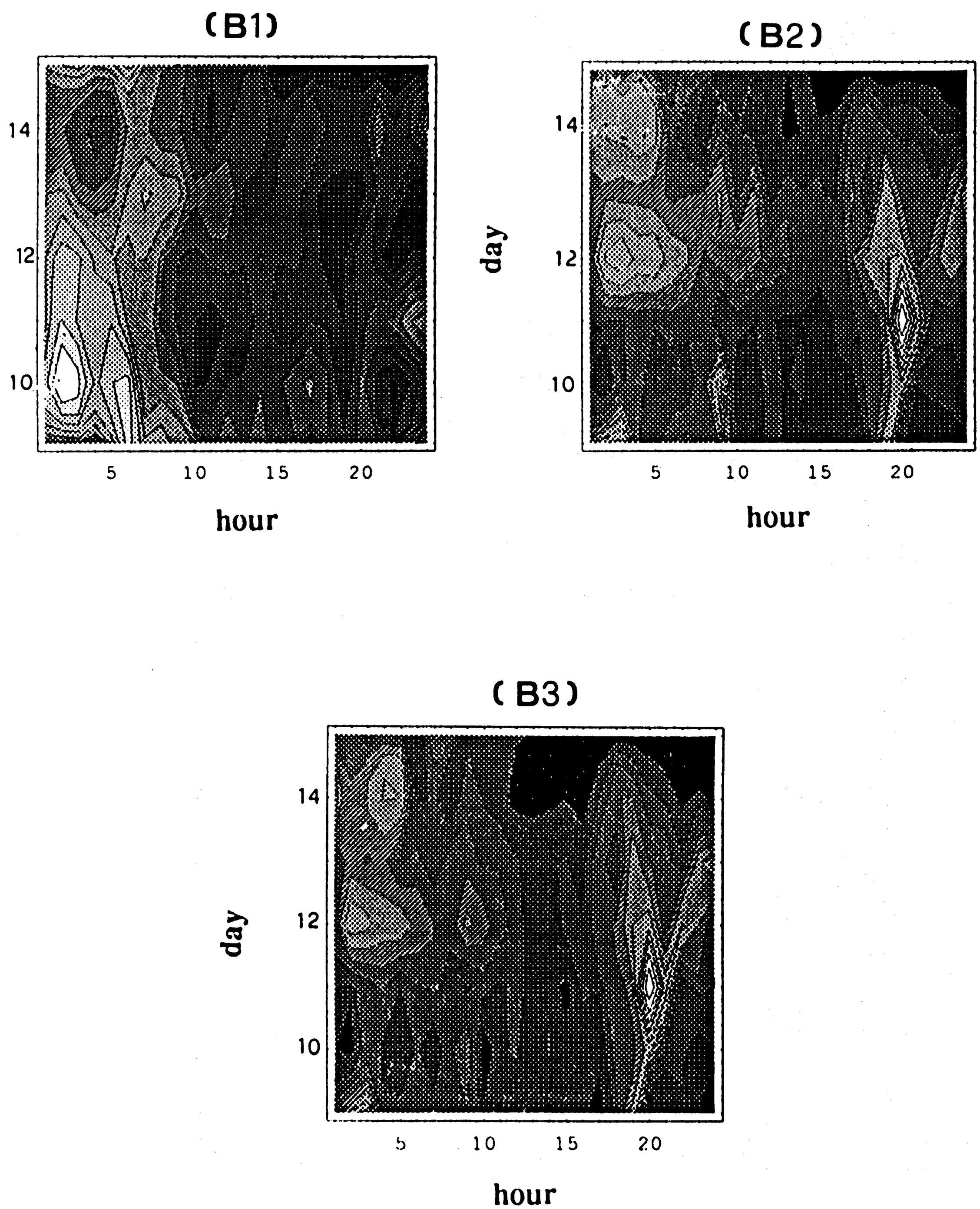

Figure 2. Contour plots of 3-D time variations of the number of echoes N_h recorded on August 9-15, 1992, depicted for various groups of echo duration (B1 - *underdense echoes* of duration $T < 2$ s; B2 - *overdense echoes* with $T \geq 2$ s and B3 - $T \geq 32$ s).

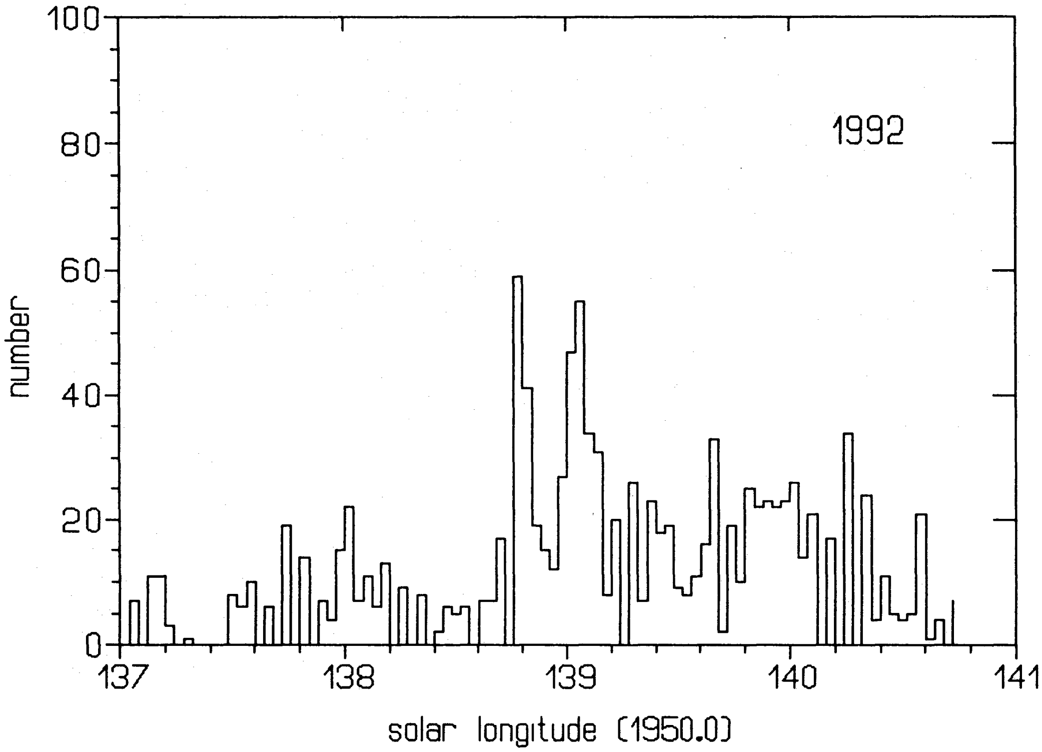

Figure 3. Activity of the Perseid meteor shower in 1992 vs. solar longitude (eq. 1950.0) - echoes of duration $T \geq 2$ s.

distribution of particles would differ considerably, day-to-day, depending on the observed periods.

The number distribution of echo duration is, at least in its part belonging to the longest duration categories, influenced by the equipment facility. Hence it should be advisable to exclude the influence of these instrumental effects on the echo numbers; however, preliminary calculations we made, confirm mass indices for underdense trains larger than for the overdense ones, as derived from visual data (Koschack et al., 1993). Some preliminary investigation from FS radar observations in Italy during August 1991 and 1992 give values of the mass index s lower than 1.5 mainly for overdense meteors as pointed out by Cevolani and Hajduk (1992) for Perseids 1991. The relationship between FS radar counts and backscatter radar counts needs further studies and should be discussed on the basis of simultaneous observational campaigns.

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References

Brown, P., Gyssens, M., Rendtel, J.: 1992, *WGN, the Journal of the IMO* **20**, 192

Cevolani, G., Hajduk, A.: 1993, in *Meteoroids and Their Parent Bodies*, eds.: I.P. Williams and J. Štohl, Astron. Inst. SAV, Bratislava, 253

Koschack, R., Rainer, A., Rendtel, J.: 1993, *WGN, the Journal of the IMO* **21**, 152

Kristensen, G.M.: 1993, *WGN, the Journal of the IMO* **21**, 203

Lindblad, B.A.: 1986, in *Asteroid, Comets, Meteors II*, eds. I. Lagerkvist, B.A. Lindblad, H. Lundstedt and H. Rickman, 531.

Lindblad, B.A., Šimek, M.: 1983, 25 years of Swedish observations of Perseids, in *Asteroid, Comets, Meteors*, eds. I. Lagerkvist and H. Rickman, 431

Šimek, M., McIntosh, B.A.: 1986, *Bull. Astron. Inst. Czechosl.* **37**, 146

Šimek, M.: 1987, *Bull. Astron. Inst. Czechosl.* **38**, 1

Šimek, M.: 1993, *WGN, the Journal of the IMO* **21**, 13

Xu Pin-Xin: 1992, *WGN, the Journal of the IMO* **20**, 198