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VISUAL DATA OF MINOR METEOR SHOWERS LIMITS OF THE METHOD

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Abstract Visual meteor observations are carried out on a regular basis by many experienced observers worldwide, thus supplying information about activity of meteor showers. The limits of the method are determined by the accuracy of the detection of the meteor trail. This study shows that visual meteor observations provide reliable data for an observable hourly rate of ≥ 3.

Introduction

Most analyses and model calculations of meteor showers deal with so–called major showers which deliver a reasonable sample within rather short time intervals. In the case of low number density or/and low geocentric velocity the number of observable meteors is quite low ("minor showers").

Many data at hand were obtained by visual single–station observations. Their main disadvantage is the limited accuracy of the shower association of any meteor. In order to improve the material, the Visual Commission of the *International Meteor Organization, IMO,* formulated rules which visual observers should follow. Three essential quantities which can be obtained by well trained visual observers are considered for the shower association of meteors:

(i) direction of the trail (tracing back the line must meet the radiant of a certain size)

(ii) apparent trail length must not be longer than half the distance from its (possible) radiant; exception: fireballs penetrating to low end heights

(iii) the angular velocity in dependence on the meteor's elevation and its distance from the radiant

In order to distinguish shower meteors from different showers as well as from the sporadic background, the observer is forced to look not more than 40° away from the radiant(s) under study. Furthermore, a radiant should be situated at least 30° above horizon. Otherwise the commonly used correction of the activity to zenith position becomes too large and the result is then uncertain.

Sporadic Pollution of Shower Activity

Gyssens (1989) analysed the probability that a sporadic meteor will be classified as belonging to a shower radiant assuming uniform distribution of sporadic meteors. For a radiant of 10° in diameter situated at the zenith this probability amounts to 5.6 percent.

Recent analyses confirm this quite well. We considered two "radiants" at 30° and 60° elevation and of 10° diameter each. The assumed radiants were distant enough from known ecliptical showers, and activity periods of Quadrantids as well as Lyrids were excluded. For each radiant we did three searches: Firstly we looked for an alignment of the meteor trails only (no velocity information and thus identically to the model of Gyssens (1989)). Secondly we assumed a geocentric velocity of $v_\infty = 60$ km/s for both radiants, and finally we considered $v_\infty = 30$ km/s. The results are given in table 1.

Table 1: Portion of all observed meteors which may be associated with the assumed radiant of 10°diameter including the criteria described above. 1757 meteors observed by experienced observers in the period Jan – Jun 1990 and Jan – Apr 1991 were included in the sample.

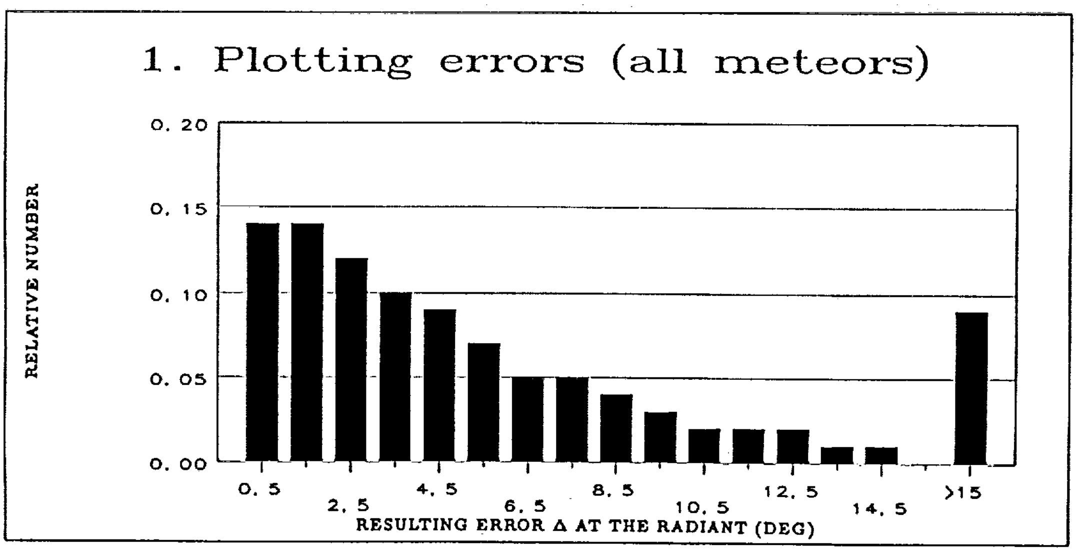
	elevation 60°	elevation 30°
v_∞ "unknown"	8.1 %	8.4 %
$v_\infty = 60$ km/s	4.7 %	4.6 %
$v_\infty = 30$ km/s	2.6 %	3.1 %

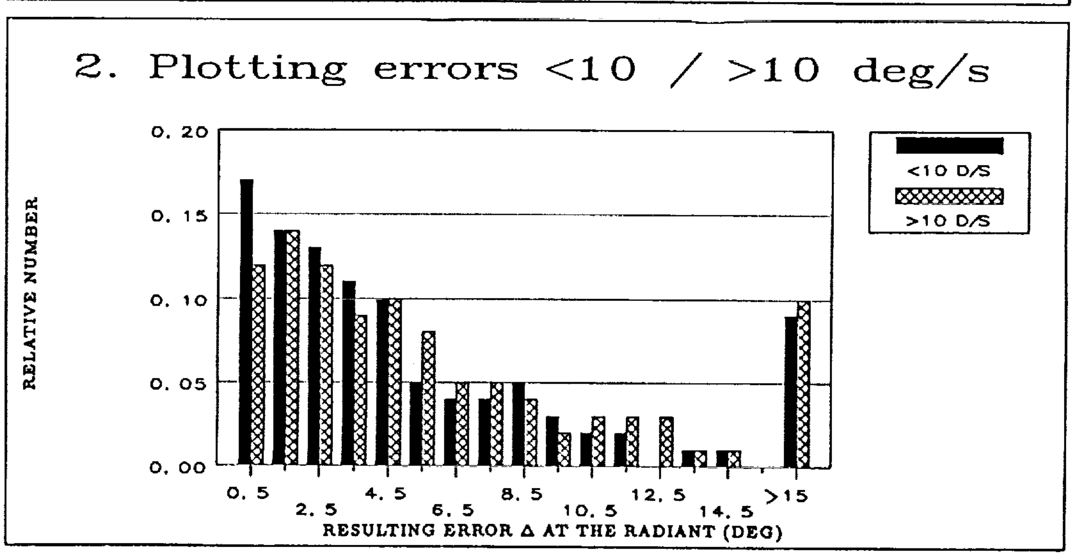
The pollution of the rate for a shower with known geocentric velocity by sporadic meteors may be expected to be less then 5 percent of the total rate. The total rate varies between about 5 in spring and 20 in autumn. Consequently, the pollution by sporadic background can be neglected for most periods.

Plotting Errors

On the other hand, there occurs a "loss" caused by the limited accuracy of visual observations. The main source of this is the uncertainty of the recorded direction. Most visual observers use gnomonic star charts to plot meteor trails. Different effects, which are hard to separate, cause tilts ε of the plotted trails. As a consequence, backwards traced shower meteors do not longer cross the radiant area and the rate should be lowered. Earlier analysis of plotting accuracy (e.g. Štohl and Lindblad, 1982) do not consider angular errors. But errors in length are not that much critical for the shower association. In order to obtain information about scatter in the directions of plots we analysed double or multiple plots on gnomonic star charts of the Atlas Brno by a team of experienced observers in October 1990. A detailed description will be given by Koschack (1991).

Fig. 1 shows the resulting errors at the radiant Δ (that is the minimal distance of the backwards prolongation of a meteor to its radiant) depending on the distance between meteor and radiant D for the whole sample.

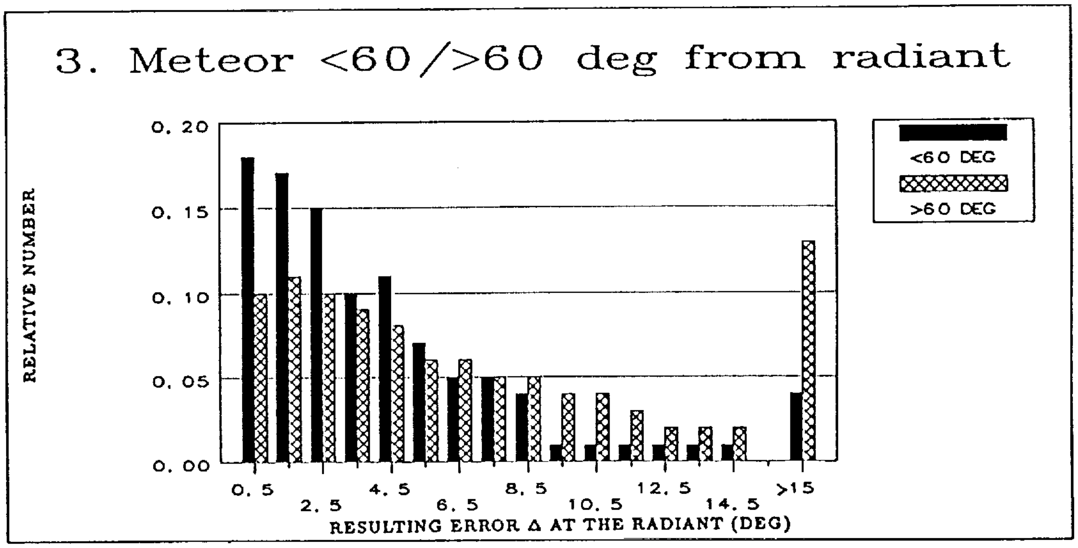




The result of Štohl and Lindblad that meteors of lower angular velocity are recorded with better accuracy can be confirmed (fig. 2), although the effect is not very significant.
The obvious difference for meteors observed in a distance < 60° or > 60° from the radiant shown in fig. 3 is of greater importance. A certain tilt ε of the trail causes an error Δ at the radiant depending on its distance to the radiant D:

$$\Delta = \varepsilon \times \sin D$$

Thus the rule fixed by the Visual Commission of IMO to center the field of view near the radiants under study is reasonable.



What are the conclusions from this study? The "loss" of true shower meteors due to plotting errors does not allow the assumption of small radiant sizes for visual work. Of course radiant positions and sizes are known from observations based on other techniques. To compensate the loss, a radiant diameter of at least 10° is required and the observer is forced to include the other criteria (see introduction) for shower association.
Consequently, activity analyses of showers with neighbouring radiants from visual data do not make sense (e.g. several Aquarid radiants). Furthermore a radiant diameter of 15° causes a sporadic pollution of about 8 percent of the total rate. Both, the "loss" and the pollution set a limit to the observability of minor showers to a rate in the order of 3 per hour, as for this rate the ratio *true shower meteors : pollution by sporadics* is about 3 : 1 which should be considered as a limit for serious analyses.

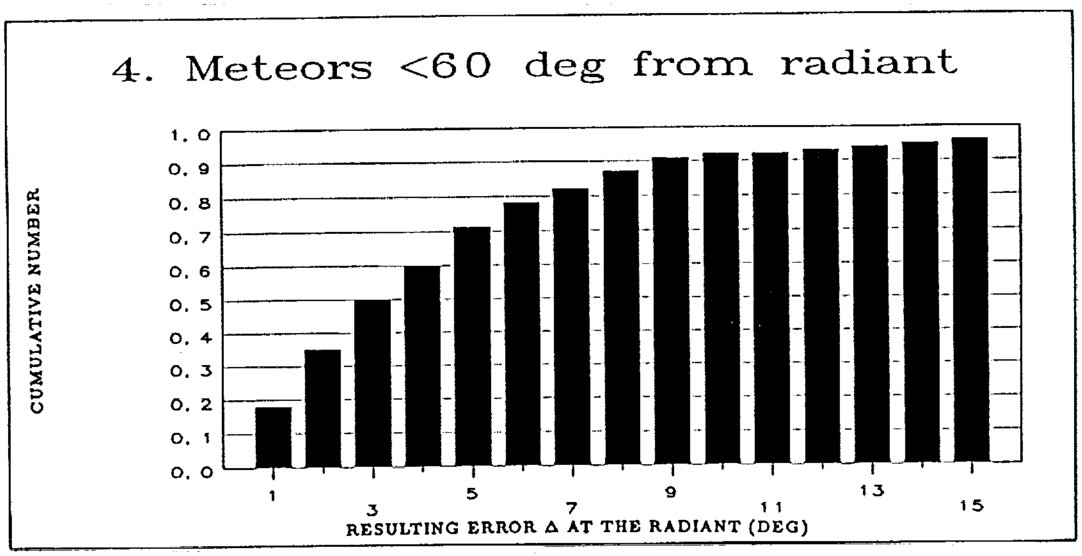
Conclusions

Visual meteor observations may be used to analyse minor showers as soon as their activity reaches an hourly (observable) rate of about 3 and the field of view of the observer is near the radiant position (< 40° distance). The radiant diameter should be assumed to be in the order of 10°. Fig. 4 shows the cumulative number of meteors having resulting errors $\leq \Delta$ at the radiant. This sample was obtained from plots of meteors seen $\leq 60°$ from their radiant by experienced observers. Consequently, the radiant diameter which has to be assumed for shower association should urgently be included if visual meteor data are requested (as, for example, by Drummond (1991) or Hughes (1990)). Otherwise the material does not allow any valuable conclusion.
Minor showers producing hourly rates below 3 certainly exist. But visual observations are not appropriate for studies of their activity. We propose the use of video technique for studies of such showers. Even single station data may be useful since the method provides direction as well as precise angular velocity.
In the IMO working list of showers for visual work are included only showers that

(i) reach a certain level of activity (ZHR ≈ 3), and

(ii) have known orbital elements (thus known geocentric velocity).

All other meteors are regarded to be sporadic. Since the meteor trails are plotted on gnomonic charts (except the periods of high activity near major shower maxima), searches for radiants being of interest only later, can be done from the stored trails. Furthermore, IMO prepared a positional database (PosDat). It contains positional data of visual and telescopic meteors and is connected with a radiant search program. This allows an effective search for instance for a possible activity of asteroid related radiants.



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