On the Influence of Sunspot Activity on Sporadic Radio Meteors

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The effect of sunspot activity on sporadic meteor rates has been investigated. The data of Christchurch (lat., 43°37' S) for the periods Feb. 1960-Jan. 1961 and 1963-65; of Ottawa (lat., 45° N) for the period 1958-62 and of Waltair (lat., 17°43'N) by forward scatter of radio waves from Dehra Dun (lat., 30°30'N) for the period Dec. 1974-Nov. 1975 have been considered. The lowest recorded mean hourly meteor rate on any day in a month is considered to be typical of sporadic meteor activity for that month, and the corresponding value of sunspot number on that day is considered for this correlation study. In no case the correlation has been found to be significant at \( P = 0.01 \) level. The data for Ottawa for five years have been divided into four seasons each year and an analysis similar to the above is carried out in respect of all echoes or only long duration ones. In all the cases the correlation has been found to be insignificant. Finally, the plots of \( N \) (the normalized percentage deviation) against sunspot activity also reveal no preferential alignment for the scatter of the points. Hence it is concluded that there is no correlation between sunspot activity and sporadic meteor rates.

1. Introduction

A recent investigation by Ellyett\(^1\) indicates a negative correlation between meteor rates and sunspot activity. A somewhat similar analysis of Canadian meteor data by Rao and Rao\(^2\) also indicates a negative correlation between all meteor rates and sunspot activity. While Ellyett has not eliminated the seasonal effects on meteor activity, Rao and Rao\(^3\) have eliminated them by adopting the method of moving averages.

It is known that meteor shower activity changes from year to year depending upon the way that the meteor debris is distributed in the cometary orbits. These variations have to be eliminated while attempting any correlation study with sunspot activity. Even Rao and Rao\(^3\) have not considered this aspect in their studies. Hence it is felt that the subject needs further investigation considering only sporadic meteor rates which, if they vary from year to year, could probably have some association with the variation of sunspot activity.

The data used for the present analysis consists of the recorded meteor rates from Christchurch (lat., 43°37' S) for the periods Feb. 1960-Jan. 1961 and 1963-65, from Ottawa (lat., 45° N) for the period 1958-62, and from Waltair (lat., 17°43'N) by forward scatter of radio waves from Dehra Dun (lat., 30°30'N) for the period Dec. 1974-Nov. 1975. Thus the data used for the analysis cover both the northern and southern hemispheres and both high and low solar activity periods.

2. Method of Analysis

In the present work an yearwise analysis is carried out by the authors and sunspot numbers are used as a measure of solar activity. The minimum value of the daily mean hourly meteor rates in any month is taken as representative of sporadic meteor activity in that month. The lowest meteor count is noted for each month and the corresponding value of sunspot number on that day is considered for this correlation study. In no case the correlation has been found to be significant at \( P = 0.01 \) level. The data for each year 12 pairs of values are obtained corresponding to the 12 months and the correlation coefficient is determined corresponding to these 12 pairs of values.

The correlation coefficients thus obtained for each year, for the 5-yr data of Ottawa (1958-1962), 4-yr data of Christchurch (1960, 1963-65) and 1-yr data of Waltair (1975) have all been found to be insignificant at the probability level\(^3\) \( P = 0.01 \) as shown in Table 1. Thus it appears that the sporadic meteor rates at any station in the northern or southern hemispheres are not influenced by sunspot activity.

It is known that the sporadic meteor rates generally show a seasonal variation, with a minimum in Feb. and maximum around Aug. in the northern hemisphere. Hence it may be a good idea to study the influence of sunspot activity on sporadic meteors separately for different seasons, so that the seasonal variation inherently presented in the data of...
Table 1—Comparison of Correlation Coefficients for Waltair, Ottawa and Christchurch

<table>
<thead>
<tr>
<th>Station</th>
<th>Year</th>
<th>Average of SSA</th>
<th>Correlation coefficient</th>
<th>P-Level (Ref. 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waltair</td>
<td>1974-75</td>
<td>18.29</td>
<td>&lt;0.01</td>
<td>NS</td>
</tr>
<tr>
<td>Ottawa</td>
<td>1958</td>
<td>161.33</td>
<td>+0.28</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>1959</td>
<td>171.33</td>
<td>-0.39</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>1960</td>
<td>109.91</td>
<td>-0.10</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>1961</td>
<td>52.00</td>
<td>+0.07</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>1962</td>
<td>39.33</td>
<td>+0.01</td>
<td>NS</td>
</tr>
<tr>
<td>Christchurch</td>
<td>1960</td>
<td>101.83</td>
<td>-0.53</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>1963</td>
<td>29.36</td>
<td>-0.46</td>
<td>&gt;0.1</td>
</tr>
<tr>
<td></td>
<td>1964</td>
<td>16.25</td>
<td>+0.04</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>1965</td>
<td>92.00</td>
<td>+0.15</td>
<td>NS</td>
</tr>
</tbody>
</table>

Note: NS = Not significant at P=0.01 level; SSA = Sunspot activity

meteor rates, does not vitiate the value of the correlation coefficient. The 5-yr data of meteor rates from Ottawa are now divided into four seasons, namely winter (Nov., Dec. and Jan.), spring or vernal equinox (Feb., Mar. and Apr.), summer (May, June and July) and autumnal equinox (Aug., Sep. and Oct.). The minimum daily mean hourly meteor rate recorded during each month is taken as the sporadic rate for that month. Fig. 1 is the mass plot of sporadic meteor rates versus sunspot numbers for 4 seasons and it shows random distribution of the points. The same is the case whether all meteor echoes or those with long durations (> 8 sec) are considered (Fig. 2). Correlation coefficients are also computed between these minimum daily mean hourly meteor rates and the corresponding sunspot numbers and their values are found to be very insignificant (Table 2).

It is also known that sporadic meteors generally show a sinusoidal diurnal variation with maximum around 0600 hrs and minimum around 1800 hrs L T, the meteor counts at 1200 and 2400 hrs L T being the same. The value of normalized percentage
deviation \( N \) of \( H_{12} \) from \( H_{24} \) on any day is given by:

\[
N = \frac{2(H_{24} - H_{12})}{(H_{24} + H_{12})} \times 100
\]

where \( H \) represents the hourly rate at any particular hour specified by the suffix. In the case of sporadic meteors this deviation will be low, the deviation being large when showers are active. Positive values of \( N \) indicate the presence of nighttime showers and negative values indicate presence of daytime showers. A large value of \( N \) indicates a major meteor shower and a moderate value indicates a minor meteor shower. An attempt is made to study the variation of \( N \) with solar activity in the case of sporadic meteors observed at Waltair. The days of minimum activity in each month are taken as days of sporadic activity. A plot of \( N \) versus sunspot activity shows both positive and negative values, the points being scattered with no preferential alignment indicating no correlation between the two phenomena (Fig. 3).

The three methods tried in the present investigation to study if there is any influence of sunspot activity on sporadic meteor rates, have showed that no such correlation exists between them. Hence the negative correlation reported by earlier workers appears to be only accidental. A detailed study of the \( N \) versus sunspot activity for all meteors including showers may throw some more light on the possible negative correlation reported earlier.

**Acknowledgement**

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**References**