RELATION BETWEEN METEOR SHOWERS AND THE RAINFALL OF AUGUST, SEPTEMBER, AND OCTOBER

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Summary

The rainfall of approximately 300 stations over the globe during the 3 months August, September, and October show departures from the mean which are similar in character to those previously reported for the months November, December, and January. Peaks in the rainfall curve occur on the average 31 days after meteor showers, in good agreement with the value of 30 days arrived at for November, December, and January.

One of the best known meteor showers of the whole year, namely the Perseids, occurs during the period examined. This is a long-enduring stream which maximizes from August 10 to 14. Commencing 31 days later is the most prominent rainfall peak of the whole year, extending from September 10 to 24.

I. Introduction

The present paper is the continuation of a series which deals with the possible connexion between meteor showers and heavy rainfall in different parts of the globe. Previous papers (Bowen 1956*a*, 1956*b*) dealt with the rainfall of November, December, and January, and in the present paper it is proposed to examine the rainfall of August, September, and October. During these three months the meteor showers are not always as clearly defined and therefore not as well catalogued as for November, December, and January, but nevertheless the period is one of considerable interest as it contains some of the recently discovered daylight streams and the best known night-time meteor shower of the whole year, namely the August Perseids.

The hypothesis that meteoritic dust might be affecting rainfall has proved unacceptable to most meteorologists and it has been severely criticized both in the literature and in private. However, the criticisms have usually arisen from an examination of very inadequate amounts of data. The present analysis is advanced in the belief that a comparable amount of data has not been collected together or analysed elsewhere.

The stations used in the present investigation are the same as those given in a previous paper (Bowen 1956*b*) with the addition of the daily rainfall figures for 10 stations in South Africa chosen by officers of the South African Weather Bureau. A list of these is given in Appendix I. This provides a more complete sample of the southern hemisphere than was previously available and the records

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now contain data from three of the four land masses in that hemisphere. The characteristics of world rainfall are best indicated by combining the whole of the available data, and the curve which results is given in Figure 1. This has been prepared in the same way as Figure 8 of the previous paper (Bowen 1956*b*) and shows the departure of the daily rainfall from the mean for approximately 300 stations over a period averaging about 60 years.

The curve shows characteristics which are broadly similar to those of November-December-January. There are either two or three major peaks per month, and the greatest departures from the mean are approximately ± 20 per

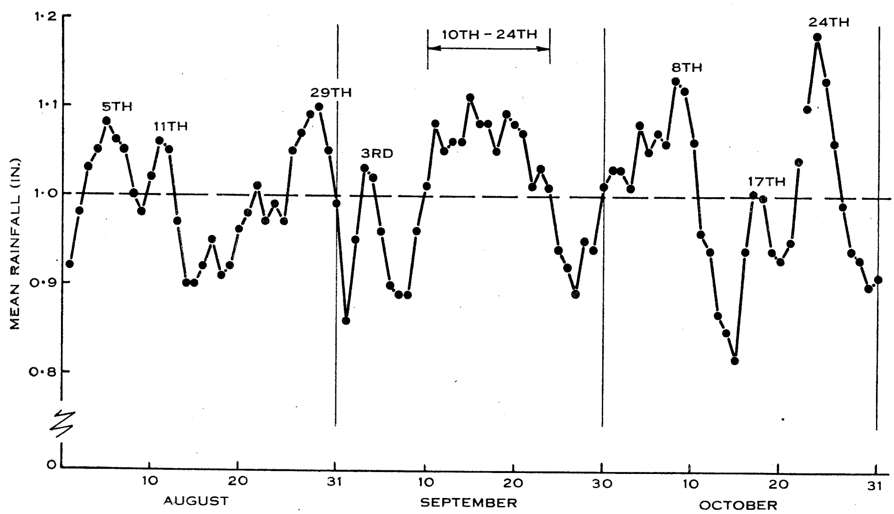

Fig. 1.—The mean daily rainfall of approximately 300 stations over the globe for the three months August, September, and October.

cent. It is possible therefore that these features arise from a similar physical cause, namely the nucleating action of dust from meteor showers which entered the top of the atmosphere about 30 days before the date of the rainfall peak. It is proposed to examine the rainfall month by month on this supposition.

II. August Rainfall

If a peak is defined as one which has a numerical value at least 5 per cent. greater than the troughs on either side of it, there are three which come within this definition during the month of August. These occur on the 5th, 11th, and 29th respectively. The only shower meteors during the previous month with a long and consistent record of appearances are the δ-Aquarids, which have a sharp maximum on July 28. The rainfall peak on August 29 occurs 32 days after this meteor shower, in fair agreement with the hypothesis.

The meteor activity during the early part of July is less well established, but Lovell (1954) has reported the β-Taurids on July 2 and the ν-Geminids on July 12, which are respectively 34 and 30 days before the rainfall peaks in the early part of August, again in fair agreement with the hypothesis. The dates on which the rainfall peaks occur, together with a list of these meteor streams, are tabulated in the first part of Table 1. In the last column of this table is the time difference in days between the rainfall peaks and the date of the meteor showers.

TABLE 1

COMPARISON OF DATES OF METEOR STREAMS AND RAINFALL PEAKS

Rainfall Peak	Meteor Shower	Authority	Date of Maximum	Difference (days)
Aug. 5	β-Taurids	Lovell	July 2	34
11	ν-Geminids	Lovell	12	30
29	δ-Aquarids		28	32
Sept. 3	Not known	——	——	—
10–24	Perseids		Aug. 10–14	—
Oct. 8	Sculptorids	Czech. Astro. Inst.	Sept. 9	29
17	γ-Pegasids	B.A.A.	17	30
24	α-Aurigids	B.A.A.	22	32
			Mean ..	31 days

III. SEPTEMBER RAINFALL

The September rainfall given in Figure 1 is characterized by a relatively sharp peak on September 3 and a broad maximum which extends from approximately September 10 to 24. No meteor shower is known which might correspond to the peak on September 3.

Considering the month as a whole, from September 10 to 24 inclusive there is a run of 15 successive values, all of which exceed the mean for the month. Calculation of the odds against this happening by chance give values which range 100,000 : 1 to 40 : 1, depending on the initial assumptions. Even the most pessimistic of these estimates indicates with a high degree of probability that this long consecutive series of high rainfall values is not a chance phenomenon and that it is due to a real physical cause. The broad peak between September 10 and 24 is in fact unique among the rainfall records for the whole year in extending over such a long period. Thirty days earlier there occurs the best-known and longest enduring meteor stream of the whole year, namely the Perseids. This stream has been recorded since earliest times, it endures for approximately 20 days and reaches its maximum between August 10 and 14. It is also known (Zacharov 1952) that it is accompanied by sufficient dust to influence the transparency of the atmosphere at this time of year. The fact that an unusually long run of high rainfall values follows an unusually extended period of meteor activity, and that the time interval between them is again approximately 30 days, provides good reason for associating the broad peak in the September rainfall with the Perseids meteor shower.

It should be noted that in any one area or in any one year, the period September 10–24 does not necessarily correspond to a long period of continuous rain and the broad peak exhibited in Figure 1 does not appear as such in the records of individual stations or groups of stations. It only appears in that form when data are integrated over large areas and over long periods of time.

IV. October Rainfall

The October rainfall given in Figure 1 shows peaks on the 8th, 17th, and 24th. There are few references to meteor showers during the previous month; in fact, the only records of meteor activity of any magnitude which can be found in the literature are:

(*a*) A southern hemisphere shower on September 9 reported recently by the Czechoslovakian Astronomical Institute (1956, 1957) and referred to earlier by Hoffmeister (1948). Weiss (1955) has also reported minor shower activity, possibly of different origin, on September 7.

(*b*) The γ-Pegâsids on September 17 reported by the British Astronomical Association (1924).

(*c*) The α-Aurigids on September 22 also reported by the British Astronomical Association.

These occur 29, 30, and 32 days respectively before the rainfall peaks, in good agreement with the hypothesis. These showers, like those of early July, must be treated with some reserve until they have been further investigated, but they are listed in Table 1 and tentatively associated with the rainfall peaks.

V. The Variations in Intensity of the Perseids

The Perseids are a long-established meteor stream which has shown some variations in intensity from year to year. The variations are not sufficiently well defined to allow the orbital period to be determined, but, from measurements of the velocity of individual meteors, Whipple (1938) and others have shown that the orbital period is about 110 years.

The Perseids are a northern shower, being incident at a declination angle of 58°. Their effects would therefore be expected to occur predominantly in the northern hemisphere, and the rainfall of this region will now be examined to see if any long-term variations have occurred which might be related to the Perseids. The only region in the northern hemisphere for which the raw data, broken down by days and years, are available to the author is that of the U.S.A. The rainfall peak thought to correspond to the Perseids extends from September 10 to 24, and the rainfall over this period has therefore been integrated for the 48 stations in the U.S.A., for each successive 10 years, from 1870 to 1950. The totals so obtained are plotted in Figure 2. It shows a steady decline in rainfall from 1870 to the 1910–1920 period, followed by a steady increase. Unfortunately the records do not cover a sufficient number of years for a period to be determined, but, assuming a 110-year period, the sine curve of best fit determined by the method of least squares is given in the dotted line in Figure 2. The minimum occurs in 1912.

The records of the Perseid meteors are not sufficiently complete for a corresponding curve of meteor intensity to be drawn, but it is known that there was a pronounced minimum in 1911 and 1912. The activity was then so low that Denning (1912) suggested that the stream had disappeared; but it has since reappeared with increasing activity. Without being conclusive, it can therefore be said that the variations in the rainfall of the U.S.A. over the period September 10–24 are consistent with the behaviour of the Perseid meteor shower. If the hypothesis connecting meteor showers with rainfall is correct, the rainfall of these particular two weeks will continue to increase and pass through a maximum about the year 1967.

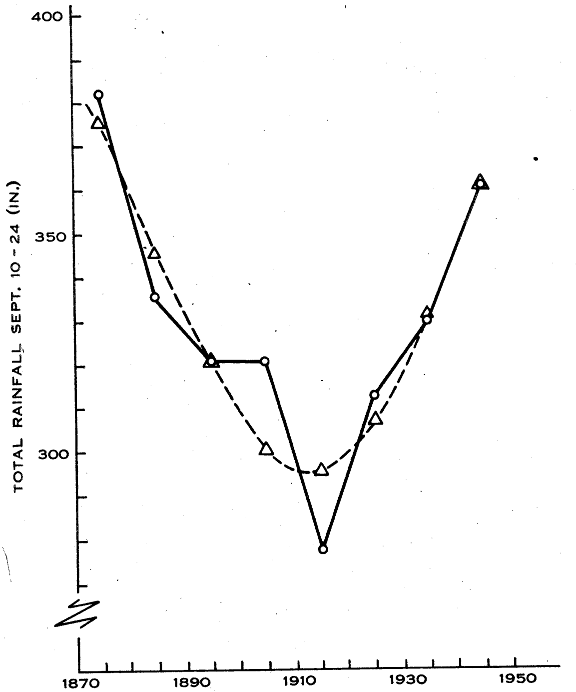

Fig. 2.—The rainfall of 48 stations in the U.S.A. integrated over the period September 10–24 for each 10-year interval from 1870 to 1950, shown by —O——O—. The sine curve of best fit, assuming a periodicity of 110 years, is shown by - - - △ - - - △ - - -.

VI. Conclusion

In spite of the uncertain nature of several of the meteor showers during the period under review, the peaks in world rainfall during the three months August, September, and October tend to occur approximately one month after the meteor showers. The time difference between them has a mean of 31 days with a greatest departure from this value of 3 days, as compared with a value of 30 ± 2 days derived from a study of the November-December-January data.

As indicated in a previous paper (Bowen 1956*b*), it is unlikely that a broad association between meteor showers and rainfall of the type attempted in this paper will be convincing to meteorologists. Definite knowledge of the effect of meteoritic dust on rainfall is more likely to come from physical measurements of the entry of the particles into the top of the atmosphere, their fall through the middle atmosphere, and their behaviour as rain-forming nuclei in the lower atmosphere. One purpose of the present paper is to give a comprehensive set of world rainfall figures against which such measurements can be compared.

VII. References

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Appendix I

List of 10 rainfall stations in South Africa which have been added to those given in previous publications

Durban	1900–1950
Pretoria	1906–1950
Capetown	1906–1953
George	1878–1950
Estcourt	1895–1950
Windhoek	1913–1950
Wellwood	1875–1950
Pietersburg	1905–1950
Tsumeb	1913–1950
Pt. Elizabeth	1867–1950