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Second Catalog of Hourly Meteor Rates

By Charles P. Olivier

Washington, D. C.

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SECOND CATALOG
OF HOURLY METEOR RATES

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1965

Publications of the Astrophysical Observatory

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Second Catalog of Hourly Meteor Rates

Charles P. Olivier¹

The first catalog of hourly meteor rates (Olivier 1960) contained data collected by the American Meteor Society for the interval 1901 to 1958. For brevity, this earlier catalog will be referred to in this contribution as K3, the present one as K4. This latter contains data for the interval 1958 to 1963 inclusive; it also includes some material for 1964 which arrived in time for inclusion, as well as a considerable amount obtained earlier than 1958 which, for a variety of reasons, was not used in K3 (see references).

While the existence of the data given here has been mentioned in some detail in the Annual Reports of the American Meteor Society (AMS) few if any hourly rates have been published. However, thanks to the kindness of Professor Kojiro Komaki of the Kanaya Observatory, Japan, and Chairman of the Japanese Meteor Committee, who also has been a valued AMS member for several decades, the annual provisional reports from Japan have been made available. These do give, in most cases, the corrected hourly meteor rates. The Japanese meteor observers in recent years have done an immense amount of work, and their observations probably account for between 30 and 40 percent of all the rates used as the basis of this paper. Hence this catalog is based almost entirely on work done in the United States and Japan. Less than one percent came from the Southern Hemisphere and Europe.

In addition to members of the AMS, contributors in the United States include scores of others who occasionally observed, particularly on the dates of the chief annual showers. A few reports from ships, made on these dates, are available also. Copies of some reports made by persons working on the meteor program for the International Geophysical Year were sent in. The tables follow exactly the

same form as in the K3. They summarize all observations available in our files and not used in K3, with the exception of certain material which was omitted:

1. Great efforts were made to have as many nonmembers as possible observe during the Perseid epoch, particularly from 1929 to 1934. Hence tens of thousands of meteors were reported, seen mostly from August 9 to 13 inclusive, and the records are available. The observations used in these tables represent primarily those considered superior, for any reason, and quite typical of the whole. Thousands were omitted. However, much material not used in K3 was entered in K4.

2. Similar remarks hold for the Leonid epochs, for the period 1930 to 1940, and much material left out of K3 is included in K4.

3. As in the previous catalog rates obtained on Oct. 9 and 10, 1946 in the great Draconid shower are omitted as being wholly atypical.

4. Rates were omitted when they were obtained by two or more observers and there seemed no way of finding out what the rate for a single observer was. The unit in the table is the number of meteors seen by one observer in one hour. Many thousands of otherwise good observations were hence useless for K4.

5. Certain observers, including some of the best of the Japanese, at times gave average rates for periods of from 2 to 4 hours of continuous observing. Since there was no way of determining what the rates were for each separate hour, some thousands of these good observations were necessarily omitted.

6. Occasionally an observer, not an AMS member, has reported highly unusual rates, quite contrary to what might be expected under the prevailing circumstances and local conditions. Such rates are open to suspicion and have been omitted.

This is perhaps the place for a few general

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remarks about meteor observations. The more reports are studied, the more apparent it becomes that rates such as those given in this catalog can have meaning only when based upon the work of many observers over a period of several years. Even in the same place and on the same night, observers standing side by side may get different rates. Some eyes are better than others; some observing stations have clearer skies than others. Observations made in different directions, on the same night and at the same place, may give different rates—in fact, they usually do. This realization was one of the chief reasons the writer decided to compile this second catalog. It should of course be used in connection with K3, and the results for the same dates and same hours compared. If they agree approximately, we can be fairly sure that the rates given are about correct. If they disagree badly, more work for these dates should be carried out in the future. Obviously, the rates that depend upon large numbers of observations are more reliable than those depending on few. In fact, little confidence can be placed in rates that depend upon the work of fewer than three observers, unless confirmed approximately by those in K3.

In the tabulation, an asterisk * indicates that the rate given depends entirely on reports from Australia. If a rate is enclosed in parentheses (), it is considered uncertain, either because the observer's percentage estimate (F) was smaller than usual or the observer worked somewhat less than a full hour. Such uncertain values are given only when no others are available. The rates usually show a decrease for the last hour of a given night. There are two obvious reasons: the approach of morning twilight and the probable fatigue of the observer.

The larger part of all the observations consisted of meteors that were either plotted or described. When plotting or describing a given meteor, an observer will miss any meteors appearing during the interval. Therefore, to obtain the true hourly rate of meteors that could have been observed during the period and in the prevailing atmospheric conditions, a correction was applied to the number of meteors reported. The correction is given in the following formula:

$$n_0 = \frac{60n}{60 - pn}, \quad (1)$$

where n_0 is the number of meteors that could have been observed had the observer been counting rather than plotting or describing them; n is the number of meteors actually observed; and p is the time taken to plot or describe each meteor; pn in the formula is expressed in minutes of time. The value of p is an estimate based on the author's opinion of the skill of the particular observer. In applying the formula, the writer used tables giving the appropriate corrections for the various values of p ; those values of p were set as 20, 30, 40, and 60 seconds.

Another correction is usually necessary because the number of meteors observed during a given hour depends to some extent on the conditions for seeing, and whether visibility was impaired by clouds, fog, moonlight, etc. In the following formula,

$$n_1 = \frac{n_0}{F}, \quad (2)$$

n_1 represents the average number of meteors that could have been counted by a skilled observer during that period under ideal conditions. The number of meteors actually observed usually represents only a percentage of the total observable under such conditions; the factor F represents the observer's estimate of this percentage. Under ideal conditions, F was taken as 1.0; when F was 0.5 or less, the observations were considered very uncertain and were usually omitted. For the majority of American reports used, the factor F was 0.7 or higher; there were comparatively few for which F was 0.6 or 0.5.

For a few observations the author changed the estimated F when the data themselves obviously indicated that the original estimate had been in error. In most cases, however, the observer's estimate of F was used.

The correction for time lost (formula 1) must always be applied before that for visibility (formula 2). Otherwise the hourly rate will be too high.

When the observer merely counted the meteors, no correction was necessary for time

lost in plotting or describing, and therefore formula 1 was not used, although the correction for visibility conditions was still applied if the value of the factor F was less than 1.0.

No system of correction can give perfect results. Nevertheless, when one considers the inherent difficulties in seeing and recording all meteors that presumably appear in the observer's field of view, one may conclude that the methods of correction given here yield a close approximation to the true rates. However, experience shows that when the rate is over about 25 per hour, and the observer plots the meteor paths, formula 1 becomes less and less accurate. This is proved by certain instances in which two persons worked side by side, one plotting what he observed, the other counting only. The latter nearly always obtained higher rates. This source of error, however, is relevant for only a few nights in the year, and they are dates for which we have so much data that the final averages are little affected.

Professor Komaki corrects the Japanese observations by using a factor F which presumably is the same as ours. It is noted, however, that the values of F used by him seem to average lower than in America. No attempt was made here to further use formula 1 on the Japanese observations since they were doubtless made in a variety of ways by persons of widely different experience. This would seem to mean that, if corrected by formula 1, the rates would be somewhat higher in certain cases, but this possible error is probably compensated for by the lower value of F used.

It is safe to assume that the vast majority of observers everywhere faced an area of the sky centered at altitude about 50° , and somewhere between northeast and southeast, as the AMS instructions advise. Practically all observers were in latitudes from 20° N to 50° N, the majority between 25° N and 45° N. As to longitudes, all the United States and Japan and part of Canada were adequately covered.

The rates published in this table are of course higher (on the average, 20 percent) than the rates of meteors an observer will actually see, unless he is counting under ideal atmospheric conditions. In using this catalog, researchers must keep this fact in mind. In general, the figures given represent the number of meteors

that might have been counted by a skilled observer at a good station on a moonless, clear night when factor F was equal to 1.0. Under conditions that fall short of this ideal in any way, the number of meteors actually observed will usually be smaller than the number given in the table.

One sees a great disparity in the number of reports for the various months, largely because of the impossibility of inducing most American observers to do much if any observing in the period roughly from Dec. 15 to June 15. Of course there are many honorable exceptions. The Japanese did far better for this interval.

Acknowledgments

Without the hard work and active cooperation of many hundred observers, the data on which the table is based would not have been available, and the preparation of the catalog would have been impossible. The names and number of reports of the American observers are given in our "Annual Reports"; the names and contributions of the Japanese observers are fully given in the "Provisional Reports of Japanese Meteor Committee," prepared by Professor Kojiro Komaki. To all the persons whose names appear in the publications just mentioned and whose work could be used in K4, our most grateful thanks are due.

The actual preparation of the catalog by the author has been a continuous, and sometimes major, occupation during the interval from 1958 to the present. In this he has had practically no clerical help.

Finally, the greatest appreciation is due to Professor Kojiro Komaki for his invaluable aid in securing, preparing, and submitting the Japanese work, and to Dr. Fred L. Whipple, Director of the Smithsonian Astrophysical Observatory, for publishing the completed catalog.

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AVERAGE HOURLY RATES OF VISUAL METEORS

Month and Day	Local Astronomical Time																							
	M ^{6h} O	M ^{7h} O	M ^{8h} O	M ^{9h} O	M ^{10h} O	M ^{11h} O	M ^{12h} O	M ^{13h} O	M ^{14h} O	M ^{15h} O	M ^{16h} O	M ^{17h} O	M ^{18h} O											
January																								
1				11	2			7	1	6	1	12	3	10	4	11	6	10	3					
2		12	2	5	1	7	5	10	3	9	5	5	3	12	3	17	13	20	11	16	16	16	13	
3	8	2	9	3	14	2	14	6	11	5	12	9	22	6	16	15	30	13	35	24	42	28	43	19
4		(22)	1	12	3	17	2			4	1			14	2	14	4	18	10	15	15	19	13	
5		4	1	8	4	5	1	4	1	6	4	2	3	6	1			10	1	15	1	14	2	
6		5	2	7	1	5	4			5	1	3	1											
7					5	1								12	1	9	1	10	1					
8		7	2	4	2	4	2	3	2	4	3	4	2	4	1	17	1	15	1	8	1	9	3	
9				3	2	4	2	3	1	10	1							8	1	8	1	8	1	
10		12	2	7	5	14	2	16	1	10	2	7	1	4	2	4	1	6	2	20	1	15	2	
11	(16)	1	10	2	8	2	10	2	6	4									14	1	14	1		
12	1	1	2	2	4	2		6	1			11	1	21	1	16	4	10	1	5	4	8	1	
13		4	2	3	1			4	1	6	2			9	2			8	2	11	1	22	1	
14	7	2	7	5	4	1	4	1	6	2	5	2	1	1	4	1	4	2	10	1	18	2	13	4
15	20	1	6	4	5	3	0	1	5	3	4	1												
16			2	1	6	5	6	1	10	1	4	1						9	1	(3)	1			
17		8	2	3	2	6	2	4	2					8	1			32	1	16	4			
18	17	1	10	2	7	3	10	2	14	3	10	1	6	2	8	2	9	2	11	1	14	1		
19		2	1	5	3	4	3	12	4	9	6	6	2					4	1	4	2	13	1	
20		3	1	6	2	9	2	6	2	9	1							11	1	10	3			
21		2	1	5	5	4	6	4	5	8	2								(12)	1	14	1		
22		13	1	5	1	2	2	3	3	2	2	5	1				12	2			15	1		
23		13	1	6	2			3	1												12	1		
24		2	1	5	4	1	1	4	2	2	2	3	1			8	1				8	1		
25		12	2	5	6	3	2			8	1	2	1	6	1	3	1				11	1		
26		(40)	1	9	7	5	7	3	1	6	1	7	1	9	2	10	2	10	3	18	1			
27		3	3	6	6	7	3			2	1	7	1	7	1			7	1					
28		15	4	5	3	7	1					4	1					4	1					
29		4	1	6	5	5	3							14	1					21	1	(4)	1	
30		6	1	4	4	12	2			8	2	9	1					4	1	9	3	9	3	
31		2	2	7	6	6	6	6	2	4	2	4	1											

TOTAL FOR JANUARY: 9018

February																								
1		6	3	5	3	6	3	8	2	12	2	11	1	7	1	5	1	10	1					
2		7	1	6	2	8	4	15	1	6	2	11	2	9	2	8	1	13	4	12	1	8	2	
3		17	1	8	5	10	4	12	2	6	1	8	1	12	3	9	3	12	2	10	2	22	1	
4		9	3	8	7	10	1			3	1			7	2	7	2	11	2	8	4	12	5	
5				3	2	4	1	10	1											6	2	6	2	
6		4	1	4	5	2	3					4	1							7	1	11	1	
7		4	1	4	4	4	2	4	2	2	2			10	1	12	1	14	1	6	2	8	1	
8		6	1	4	4	5	3	4	1	11	1	13	1							14	1			
9				2	2	4	5							5	1	6	1							
10		3	1	2	2			6	2															
11	(18)	1	12	2	15	1				6	1											6	3	
12		2	3	3	4	6	2							14	1	8	2	6	1			7	1	
13		1	1	4	2																	6	2	
14	9	1	10	2	7	5	9	4	9	2		12	3	14	1	14	2							
15		2	1	7	3			4	2	4	2													
16		1	1	6	4	8	1	17	1															
17		1	1	8	3	12	2	2	1															
18		4	3	5	5	6	3	1	1	2	1			4	1	6	2	12	1	10	1			
19		5	1	5	4	4	1	3	1															
20				3	3	4	2			7	1					13	1	5	1	9	1			
21		5	3	4	5	4	3	7	5											6	1			
22	1	1	2	3	5	11	7	7	6	9	6	6	2	2	6	2	6	2	12	1	7	3	4	1
23		7	3	3	6	8	4	6	3	7	1			9	5	6	2	20	6	15	4			
24		5	1	8	6	16	2	2	1			3	1	7	1	12	2	10	2	8	3	9	2	
25				6	2	6	3	6	2	10	1	16	1					10	2	13	1			
26				11	3	9	3			9	2	8	2					5	1	(3)	1			
27		10	1	6	7	6	4	9	1	0	1			10	1			7	1					
28				5	4	4	2	7	2	6	3	6	1			8	1	5	2					
29		4	1	9	1													5	1					

TOTAL FOR FEBRUARY: 2960

M=corrected average number of meteors observed. O=number of observations on which M is based. 6^h=0601 to 0700; 7^h=0701 to 0800, etc.

AVERAGE HOURLY RATES OF VISUAL METEORS—Continued

Month and Day	Local Astronomical Time												
	M ^{6h} O	M ^{7h} O	M ^{8h} O	M ^{9h} O	M ^{10h} O	M ^{11h} O	M ^{12h} O	M ^{13h} O	M ^{14h} O	M ^{15h} O	M ^{16h} O	M ^{17h} O	M ^{18h} O
March 1		12 1	6 4	6 5	9 1	2 1	8 2		10 2	8 2	6 3		
2		3 1	3 5	5 1		3 1	11 1	19 2	20 2		6 1		
3			4 1	4 1		4 1		8 2	14 1	4 2	7 1		
4			4 5	6 1	9 3	7 2	11 2	9 1				8 2	
5			6 1		3 3	8 3	13 2						
6			3 3	3 1	3 1	4 1	9 1			5 2			
7					10 2	9 3	12 2	12 2	14 1	6 4	8 2		
8			5 2	7 3	10 1	5 1	2 1	9 1	4 1			6 1	
9		3 1	8 3							10 1	10 1		
10		5 1	3 1	9 1	7 1	5 2	6 1	5 2	5 3	5 1	8 3	7 1	
11		5 1	3 3	4 1	6 2		(14) 1	7 1	12 2				
12		10 2	15 2		26 1	5 3	3 1		8 2		5 1		
13		4 1	2 1		4 1								
14		3 1	6 5	8 5	3 2	7 1				4 2	9 3		
15		4 2	5 3	4 3	5 5	5 5					8 2		
16		4 1	3 5				3 1	4 1	6 1				
17		1 1	7 7	10 3	18 1		7 1	5 2	15 1				
18		2 1	3 3	2 1	4 1		3 1						
19			1 2	5 2	6 2	8 2		4 1	4 1				
20		3 1	4 5	4 5	4 1	10 1					11 1		
21		1 2	3 3	3 1	3 1	5 1				8 1			
22		7 1	13 3	10 8	8 3	5 5	5 4	5 5	4 3	6 2	8 2		
23		17 2	6 6	4 2	4 5	8 5	10 8	8 5	5 3	8 1	8 1		
24			4 5	5 7	4 2	11 1	11 1		9 1		6 1		
25		6 1	4 6	4 4	5 1	4 2	10 2	6 1	9 3		11 1		
26		2 1	5 3	4 1	7 1	4 1	4 1		10 1				
27			7 8	5 5	6 3	9 3	5 1			6 3	5 1		
28		4 2	3 3		6 3	13 1		3 1	5 2	8 4	8 5	3 1	
29			6 3	6 1	5 3	7 2	5 3	4 2	8 1		4 1		
30		4 2	3 2	10 4	12 4	4 2	6 1	5 3	7 4	10 3	6 3		
31			5 6	4 2	5 2	4 1		6 2	4 2	6 1	7 1		

TOTAL FOR MARCH: 3141

April 1			1 3	3 1	5 3	8 1	6 1						
2			16 2	20 2	13 2	9 3	9 2	6 2	6 2	11 3	9 2		
3			9 1										
4		5 1	4 2	5 2	11 1			6 1					
5			2 1	4 4	2 2	2 4	3 2		5 1	8 2	12 2		
6			5 4	6 3					10 1		27 1		
7			2 2	2 2		10 1		12 1	6 1		(20) 1		
8				10 2	1 1	0 1	6 1			9 3	(18) 1		
9		(10) 1	4 1		9 3	4 1							
10		7 2	1 3	13 1	9 3	10 2	5 1		4 1				
11			6 2	2 1									
12			5 3	4 2	5 2								
13		4 2	8 9	6 7	6 7	6 5	7 2						
14		3 1	4 5	7 2	3 2	4 3	5 2	8 1		6 1	6 2		
15			11 2	8 4	8 5	4 4	8 2	(4) 1					
16		1 1	2 2	8 1	6 3	5 3	10 2	16 1	6 1	6 1	9 1		
17		2 1	3 3		1 3	8 4	7 7	3 1	5 1	6 2	2 1		
18		1 1	3 6	3 5	6 2	4 3	9 1	2 2	9 4	11 4	8 1		
19		3 1	6 4	29 1	12 2	4 2	6 6	8 8	6 7	9 6			
20			5 7	5 9	9 12	8 19	15 24	9 17	9 15	8 14	3 1		
21			6 5	6 2	4 8	6 8	10 15	12 22	12 15	12 16	5 1		
22			8 6	6 6	10 9	10 8	7 4	11 4	14 4	8 2			
23		4 2	6 6	5 1	22 1		19 1	22 1	14 2	6 2			
24		5 1	7 2	6 2	26 1	21 1		4 1		(3) 1			
25		3 1	4 7	10 2	6 2	17 1	15 5	11 6	8 4	9 3			
26			8 5	7 8	7 3	10 2	14 4	7 2	12 2	8 2			
27			2 2	4 4	4 4	5 3	11 1	11 1	5 2	11 3			
28			5 5	5 6	6 5	5 3	9 3			10 2		16 1	
29			2 2	6 1		10 2	12 1	4 2	10 1	4 1			
30			9 1	4 4		7 1		4 1	7 1				

TOTAL FOR APRIL: 5365

M=corrected average number of meteors observed. O=number of observations on which M is based. 6h=0601 to 0700; 7h=0701 to 0800, etc.

AVERAGE HOURLY RATES OF VISUAL METEORS—Continued

Month and Day	Local Astronomical Time												
	M ^{6h} O	M ^{7h} O	M ^{8h} O	M ^{9h} O	M ^{10h} O	M ^{11h} O	M ^{12h} O	M ^{13h} O	M ^{14h} O	M ^{15h} O	M ^{16h} O	M ^{17h} O	M ^{18h} O
May 1		3 1	2 1	6 2	5 2	13 1		2 1	7 2	12 5	14 1	17 1	
2				5 7	3 1	6 2	9 2	3 1	10 10	13 11	15 1	17 1	
3					9 1		0 1		12 6	29 6	22 2	21 1	
4				12 2	2 1	5 3	6 3	12 6	17 10	18 12	17 6		
5			2 1	9 4	14 5	13 4	12 2	6 3	9 10	12 14	13 5		
6			5 2	8 5	7 6		15 1		8 4	12 6			
7			4 2	4 2	5 2	7 1			10 3	12 6			
8			3 1	9 1	4 2	3 1	3 1	3 1		16 1			
9			0 1	5 1	2 2	2 1	5 1		9 2	9 4			
10			6 2	4 2	9 1	9 2	3 1	3 1		9 6			
11													
12			6 2	2 2	11 1	6 3	6 2		13 3	9 3			
13			2 1	3 3	7 2	6 2			8 2	9 4			
14				5 3		3 1	5 1	5 1		12 3			
15			4 2	1 1	6 1	7 2	6 1			9 1			
16			6 2	16 2	11 4	16 3			12 1	8 1			
17			7 1	9 6	6 5	4 3	8 2	4 1	5 1	8 1			
18		0 1	6 2	12 2	11 6	11 6	14 3	23 2	17 1				
19			6 2	2 2			3 1		8 1				
20		1 1	11 4	13 3	14 3	7 1	5 2	6 2					
21		1 3	4 4	3 1	4 2	8 2	3 1	0 1	8 2	2 2			
22			8 5	4 11	6 6			9 3	7 1	10 1			
23			7 1	6 5	4 3		2 1		3 1	0 1			
24			4 2	4 5	5 5	6 5	7 4	6 4	4 4	7 4			
25			5 4	5 13	6 7	7 5	14 1		3 1	6 1			
26			6 2	6 3	5 6	6 3		6 1	3 1	15 1			
27			8 2	2 1			6 1	9 1	4 1				
28				4 7	4 1	14 3							
29			6 1	6 6	7 7	9 4	8 4	8 2	11 1	0 1			
30			4 3	4 12	5 3	8 2	10 1		7 4				
31			4 5	4 14	3 17	6 5	4 5	24 1	17 5	(27) 1			

TOTAL FOR MAY: 5084

June 1		3 1	3 1	4 2	7 1		7 1	6 2	10 2				
2			4 2	7 3		4 1	3 1	9 2	3 1				
3			7 3	5 6	5 8	6 8	10 3	21 1			10 1		(8) 1
4				15 1	8 3	5 3	8 2						
5			4 1	3 3	4 2	6 2	4 3	4 2	14 1	1 1			
6			2 1		3 1		5 2	7 1	10 2				
7			4 1	6 3	5 1	8 2	21 1	19 1					
8				(15) 1	3 2		9 1	12 1					
9			6 1	7 2	6 2	5 3	6 2	10 2					
10				3 1	2 1	6 3	5 4	4 3	0 1				
11					1 1	4 2	4 2						
12			5 3	4 3	6 5	8 4	2 2	6 2	5 1	4 2			
13		4 1	6 1	6 1	4 3	4 4	7 3	8 1	14 1				
14		4 1		20 1	13 2	12 1	6 1	8 1	4 2		16 1		
15				4 6	7 5	12 5	8 5	8 4	12 4	8 2			
16				5 3	7 9	15 3	10 5	9 5	11 3	7 1			
17			9 1	6 5	6 9	8 2	9 5	9 4	13 1				
18				11 6	10 5	6 5	8 1	12 3	7 1	9 1			
19				9 4	8 4	9 4	10 4	9 6	8 4				
20			6 1	4 4	4 7	5 3	9 5	7 6	7 4	7 3			
21			3 1	8 8	7 13	8 9	8 8	9 7	13 6	2 1			
22			2 1	8 12	8 16	9 11	10 10	12 8	12 8	10 2			
23			4 4	9 9	10 9	4 2	8 4	16 1		8 1			
24			4 2	5 9	5 3	8 4	5 4	10 4	7 4	10 1			
25				7 8	7 8	8 4	10 4	12 7	8 6				
26			4 2	6 9	5 8	5 10	5 7	9 7	10 6	8 2			
27			3 1	5 5	8 6	6 4	10 5	10 5	11 5	6 2			
28			5 1	2 2	4 5	8 4	9 7	10 6	9 5	8 2			
29				7 5	6 7	5 7	13 5	12 9	10 5	5 1			
30				7 3	8 4	6 3	5 3	5 3	13 2	10 1			

TOTAL FOR JUNE: 5561

M=corrected average number of meteors observed. O=number of observations on which M is based. 6h=0601 to 0700; 7h=0701 to 0800, etc.

AVERAGE HOURLY RATES OF VISUAL METEORS—Continued

Month and Day	Local Astronomical Time													
	M ^{6h} O	M ^{7h} O	M ^{8h} O	M ^{9h} O	M ^{10h} O	M ^{11h} O	M ^{12h} O	M ^{13h} O	M ^{14h} O	M ^{15h} O	M ^{16h} O	M ^{17h} O	M ^{18h} O	
July 1				12 3	6 4	6 3	10 3	9 3	25 1					
2			3 1	12 7	13 3	3 2	6 4	5 2	7 3	0 1	0 1			
3				7 5	11 7	8 2	14 3	13 1	5 2	7 1				
4		4 1	3 1	10 5	10 5	8 4	7 3	7 3	8 3	5 1				
5			3 1	12 5	13 6	14 4	14 3	16 1	18 1	22 2				
6			5 1	5 4	7 5	11 3	11 5	6 2	16 2	6 1				
7			4 1	5 6	9 5	10 9	13 11	7 3	4 2	10 1				
8			14 2	7 9	8 6	9 6	12 6	20 2	4 1	9 1				
9				6 1	3 1	2 2	8 6	10 5	12 6	8 2				
10			4 2	6 4	7 4	4 4	7 6	13 3	12 1	6 1				
11			7 1	6 6	4 3	8 5	6 5	7 2	11 1	11 1				
12		1 1	14 2	12 9	13 8	21 2	7 5	17 3	8 1	7 1				
13			2 2	9 11	6 13	11 8	10 7	5 3	14 3	7 4	9 2			
14			4 3	7 10	8 11	9 10	10 6	5 3	9 3					
15				4 2	6 8	8 8	10 2	10 2	9 1					
16			5 1	5 10	8 8	9 6	11 11	10 8	9 1	9 1				
17				9 7	7 11	8 10	12 10	12 6	14 6	21 1				
18			4 3	7 6	9 8	8 8	7 4	11 6	11 5	5 2				
19			10 2	5 3	8 10	8 8	8 9	11 6	17 2					
20			9 2	10 10	11 15	8 18	11 15	12 11	18 9	14 3	8 1			
21			11 1	7 6	11 5	12 10	14 7	12 9	10 2	12 1				
22			5 4	8 11	7 11	10 5	12 6	11 6	7 3	11 1				
23			5 3	7 4	5 8	11 12	10 6	7 6	19 1	14 3	11 1			
24		2 1	6 2	12 11	9 9	12 7	9 7	15 5	19 3	11 2				
25		5 1	5 7	6 11	8 19	7 11	12 9	15 5	17 3	10 6				
26			7 3	9 13	11 18	10 23	15 18	15 14	15 14	15 5	20 1			
27			11 2	8 14	13 14	13 21	14 23	25 22	18 16	21 14				
28			3 3	14 15	11 18	13 28	14 34	18 30	16 21	21 12	20 2			
29			6 6	9 18	10 18	15 26	20 27	21 23	20 20	17 9	13 3			
30			6 6	7 19	11 17	18 21	19 31	20 39	19 24	20 15	13 2	12 1		
31		1 1	5 7	10 7	9 4	8 3	17 13	23 14	20 10	20 6	32 1			

TOTAL FOR JULY: 20833

August	M ^{6h} O	M ^{7h} O	M ^{8h} O	M ^{9h} O	M ^{10h} O	M ^{11h} O	M ^{12h} O	M ^{13h} O	M ^{14h} O	M ^{15h} O	M ^{16h} O	M ^{17h} O	M ^{18h} O
1			7 4	9 7	10 5	17 8	18 9	18 9	18 9	15 9	15 2		
2			9 3	9 13	14 11	11 9	11 5	14 13	11 9	15 5	24 1		
3			9 1	9 10	9 13	13 9	11 5	10 3	18 3	19 5	18 1		
4			6 2	9 10	10 16	10 14	11 11	13 9	13 3	23 4			
5			2 1	10 7	11 10	11 8	10 8	14 12	12 10	14 8	15 4	16 1	
6			10 8	8 11	11 12	12 8	10 8	14 9	15 8	22 5	47 1		
7			11 5	14 11	13 12	15 7	13 11	15 12	17 15	18 11	15 3	20 1	
8			12 6	12 11	13 7	11 8	14 18	13 21	10 16	12 10	10 2		
9			13 6	12 12	13 20	17 12	18 19	18 25	19 20	17 15	13 4	4* 1	
10			12 19	12 53	14 69	16 48	18 63	22 59	23 54	25 41	19 9		
11			12 30	18 79	22 102	25 122	30 129	34 120	37 114	38 68	35 11		
12			17 13	19 36	21 55	24 60	30 76	32 69	34 68	40 35	44 8	13 2	
13			13 15	16 41	18 33	18 35	20 39	21 38	24 29	22 11	20 4		
14			14 10	14 26	15 26	15 25	19 25	20 23	24 20	22 10	22 1		
15			26 7	14 15	15 21	9 11	15 11	16 11	17 8	17 6	3 1		
16			9 1	10 9	9 13	11 10	14 7	17 8	15 8	16 4			
17			8 3	10 12	17 13	14 16	22 9	22 11	10 1	9 1	26 1		
18			4 6	6 7	10 11	13 9	11 8	13 6	14 2	8 2			
19			8 5	12 9	9 9	16 4	16 3	20 2	17 1	4 1	12 1		
20		4 1	5 4	7 8	15 7	7 7	2 13	2 12	1 14	2 18	2 1		
21			6 5	8 6	16 8	11 1	10 2	14 1	10 4	10 3	10 1		
22			8 2	7 4	9 10	12 5	6 1	14 1		19 1			
23			6 4	11 4	11 5	14 2	13 2		12 1	12 1	13 1		
24			6 2	9 11	12 13	12 6	21 5	21 4	17 3	13 1			
25		9 1	9 7	8 11	8 10	9 3	16 4	15 3	14 3				
26			12 11	10 7	8 10	12 9	12 7	16 6	15 4	14 4			
27			7 3	8 8	10 4	16 2	12 4	9 4	10 4	10 3	10 1		
28			8 2	6 4	6 6	10 4	11 4	11 3	18 2	15 5	11 1		
29			5 2	8 6	6 6	8 4	8 4	15 4	17 3	22 2	15 1		
30			7 1	9 8	5 7	6 8	5 4	8 3	14 2				
31			6 2	6 7	6 4	8 3	20 1	10 4	14 5	14 2			

TOTAL FOR AUGUST: 67082

M=corrected average number of meteors observed. O=number of observations on which M is based. 6h=0601 to 0700; 7h=0701 to 0800, etc.

AVERAGE HOURLY RATES OF VISUAL METEORS—Continued

Month and Day	Local Astronomical Time												
	M ^{6h} O	M ^{7h} O	M ^{8h} O	M ^{9h} O	M ^{10h} O	M ^{11h} O	M ^{12h} O	M ^{13h} O	M ^{14h} O	M ^{15h} O	M ^{16h} O	M ^{17h} O	M ^{18h} O
September 1			6 2	14 4	10 2		4 2	10 2	10 4	8 2			
2			4 1	7 7	12 2	14 2	8 1		8 2	(5) 1			
3			5 3	8 10	12 7	(2) 1		15 1					
4		4 1	8 2	7 2	11 3	3 1	1 2	5 3	10 2	7 2	(6) 1		
5			5 9	8 6	9 6	9 2	11 3	14 4	10 2				
6			1 1	8 5	10 5	17 5	12 1	16 1		4 2			
7			19 3	12 5	10 4	7 3	(9) 1			8 1			
8			6 1	10 5	15 3	8 2		8 1	6 4	10 2			
9			18 2	7 5	5 4	9 1	10 1	12 1	8 1	8 1	2 1		
10			12 2	12 5	8 3	6 5	10 2	8 2	10 4	18 2			
11			3 2	5 5	4 2	8 3	11 1	10 4	3 1	10 4	14 1		
12		6 1	10 2	5 2	18 2		12 2		6 2	8 2	14 1		
13				8 7	13 3	16 1	8 1	14 2	15 1				
14			6 1	9 3	12 3	12 1	18 2	21 1					
15		14 3		5 1	21 2						6 1		
16		4 1	13 4	27 1	21 1	11 2	13 3	24 1	14 2	6 2	7 1		
17			12 4	9 7	7 3	12 2	8 3	16 2		13 1			
18		7 4	7 1	11 6	10 3	4 3		22 2	8 1				
19		2 2	4 7	2 4	4 2		9 1		10 2	8 2	16 1	(4) 1	
20		7 2	7 8	6 5	8 3	8 4	16 2		9 1	3 1	3 1		
21		6 3	7 11	6 9	8 2	10 3	16 3	15 2			18 2		
22		10 3	6 3	6 4	8 2						15 1		
23		3 3	3 3	9 1	10 2	4 2	8 2	10 1	12 3	15 2	20 2		
24			6 3	8 4	8 3	9 2			4 1				
25		6 2	6 4	5 4					11 2	12 1	8 1		
26		6 2	5 5	10 3	6 2	6 2	11 3	8 2	12 1	16 2			
27			5 7	10 3	7 3	10 1	4 1	15 2			11 1		
28			7 1			6 2	6 2	10 4	10 6	13 6	13 3	10 2	(6) 1
29		6 2	4 3	11 4	10 3	10 3	10 1	10 1	12 4	13 5	11 2		
30		6 3	2 2	11 1	7 2	4 2		6 1	11 3	11 3			

TOTAL FOR SEPTEMBER: 5329

October 1			16 2	6 1				4 1	5 1	10 1	9 1		
2			4 2	6 2	8 1	8 1			6 1		17 1		
3						5 1							
4			3 2	4 2	3 1	1 1							
5		14 2	2 1	10 1	9 1	14 2	10 2	13 2	17 3	3 2			
6		9 4	10 3	7 2	7 3	12 3	10 3	11 4	16 2		10 1		
7		10 2	7 8	6 5	6 2	12 1	10 1	18 2	17 2	9 1	11 1		
8			7 9	12 8	14 6	5 3	4 2	5 3	6 2	14 3	18 1		
9		4 1	6 9	5 9	5 6	8 5	13 3	16 5	11 4	12 5	16 5	12 4	
10			5 9	9 14	12 9	6 8	9 6	9 4	16 2	13 3	10 1	10 2	
11			5 4	9 6	7 9	7 9	7 7	6 4	12 4	11 4	10 1		
12			4 4	10 11	8 11	10 10	12 10	12 6	16 3	9 4			
13				4 2	8 3	8 2	6 3	12 2			14 3	16 1	
14		25 1	9 4	13 3	11 1	12 2	13 5	10 3	14 2	9 1	5 1		
15		6 3	6 6		10 1	12 3	13 6	18 3	26 1	22 1	12 2		
16		6 3	10 2		4 1	8 2	17 3		21 1	11 2	16 1		
17		6 4	8 13	8 5		12 3	11 3	8 4	12 4	18 5	25 2	11 2	
18		9 2	11 4	9 9	10 5	4 2	15 2	10 7	14 8	12 4	16 7	17 7	
19		24 1	9 1	11 8	8 5	12 6	14 4	19 10	15 12	21 9	24 12	18 13	3 1
20			10 3	15 12	10 3	16 3	10 7	20 16	25 16	21 10	26 8	44 3	22 1
21			10 2	6 3	8 2	10 3	14 7	16 11	20 21	19 19	25 11	24 12	22 3
22			14 5	9 4	6 2	14 4	22 6	16 10	19 15	22 14	20 13	24 9	18 1
23			6 1	13 3	11 3	8 4	14 4	13 5	15 6	18 7	22 11	23 5	
24		7 1	9 10	6 6	15 5	9 4	17 8	17 12	16 8	17 7	17 5	6 1	
25			7 3	9 1	5 1	14 3	17 7	17 6	23 3	14 4	14 6		
26			5 4	7 3	9 5	14 5	12 2	8 1	4 1	19 1	12 1	8 2	
27			17 1	12 4	6 4	10 4	4 2	13 4	11 3	21 1	13 1	13 2	
28				10 2	8 1			14 1		16 2	13 3	12 5	
29			10 1	8 2	14 2	12 2					17 1	17 2	
30			6 2	6 3	9 4	12 4	9 2	20 1	20 4	12 4	14 3	13 1	
31				6 2	12 3	14 2	14 1		10 2	10 2	12 3		

TOTAL FOR OCTOBER: 15214

M=corrected average number of meteors observed. O=number of observations on which M is based. 6^h=0601 to 0700; 7^h=0701 to 0800, etc.

AVERAGE HOURLY RATES OF VISUAL METEORS—Continued

Month and Day	Local Astronomical Time													
	M ^{6h} O	M ^{7h} O	M ^{8h} O	M ^{9h} O	M ^{10h} O	M ^{11h} O	M ^{12h} O	M ^{13h} O	M ^{14h} O	M ^{15h} O	M ^{16h} O	M ^{17h} O	M ^{18h} O	
November 1		6 2	9 3	6 2	11 2	10 2	20 2	20 1	17 1					
2				6 2	14 2	17 3	9 1	6 2	7 1	10 1		8 1		
3		9 1	12 2	8 1	8 2	7 1		13 1		4 2	8 2			
4		5 2	8 5	11 6	12 3	14 2	18 5	13 4	16 2		10 3			
5		8 4	8 9	5 1	10 5	11 7	6 5	6 6	5 7	12 2	15 1			
6		3 2	3 1		14 1	11 3	4 1	6 2		16 1				
7	7 1	5 4	6 4	14 3	7 9	8 8	11 8	17 5	17 5	14 4	16 6			
8	4 1	4 1	5 2	4 3	3 1	6 1	10 1	5 1	3 1	14 2	11 6			
9			6 2	13 3	6 2	18 6	16 8	16 2	18 2	12 6	12 6	4 1		
10		6 2		4 3	7 3	14 5	8 4	2 2	6 3	8 2	6 3	9 1		
11		9 3	13 5	6 4	6 3	7 3	15 2	12 2	15 6	17 10	12 10	15 1		
12			4 2	10 2	10 2	12 1	18 1	12 2	6 2	8 4	15 5			
13		7 1	10 3	6 2		13 1	8 2	2 1	14 2	12 6	18 2	20 1		
14		5 1	5 4	7 4	10 7	11 7	9 10	14 11	17 12	15 18	16 6	18 4		
15		8 2	2 2	3 1	8 1	10 5	10 12	16 17	23 24	27 23	22 18	20 3		
16	11 1	14 2	8 4	11 11	14 12	13 15	15 19	18 31	25 32	34 33	33 25	31 16	15 2	
17	5 1	7 1		8 2			7 2	8 8	13 9	13 13	18 11	29 7	5 1	
18		8 2	8 3	7 5	4 4	2 2	2 2	19 1	8 2	11 4	22 5			
19		4 1	8 8	9 5	11 3	7 2	3 1	9 4	9 4	17 3	28 2			
20	2 1	4 5	6 5	5 5	2 3	4 1	6 1	6 1	13 3	14 8	16 9	22 2		
21		7 2		7 1	4 1	7 1	7 1			14 2	13 7	12 4		
22		1 1	4 2	8 2	11 3	8 1	11 3	10 2	12 3	14 1	27 1	9 1		
23		10 1	8 5	8 5	17 1	7 3	8 4	9 5	15 3	15 3	9 3	8 1		
24	2 1	25 3	6 7	5 6	16 3	10 1	9 4	11 4	10 5	11 4	12 5			
25	2 1	4 1	18 3		6 1	7 1	12 1	19 1		19 3	16 3			
26	3 1	8 3	4 2	10 1	8 2	4 1	4 1		8 2	6 3	15 9	19 3		
27			4 2	7 3	9 5	10 2	10 2	11 1		22 2	21 3	12 3		
28		4 1	6 4	6 3			10 2		6 1	7 1	12 2	12 1		
29		6 3	6 6	12 2	4 1	11 3	8 2			11 2	14 2	11 1		
30	4 1	6 2	9 5	6 5		12 1		14 1	14 2	6 1				

TOTAL FOR NOVEMBER: 15993

December	M ^{6h} O	M ^{7h} O	M ^{8h} O	M ^{9h} O	M ^{10h} O	M ^{11h} O	M ^{12h} O	M ^{13h} O	M ^{14h} O	M ^{15h} O	M ^{16h} O	M ^{17h} O	M ^{18h} O
1			6 2	15 1	23 5	21 5	14 2	16 2	10 3	12 2	14 2	17 1	
2	7 1	3 3	5 6	6 6	8 6	18 1	6*	1 13	1 20	1 1			
3		4 3	4 4	6 2		18 3	15 2	12 1		18 1	10 2	20 1	
4		8 2	7 1	16 3		11 1	11 3	14 2	14 2	16 4	15 1	17 2	
5			9 6	5* 4	12*	1 5	1 1						
6		3 1	4 3	8 2	7 3	12 2	10 2			14 2	15 3	24 2	
7			7 4	5 3	4 4	13 3	10 2		5 1	19 3	17 7	8 2	
8		6 2	6 3	7 4	6 3	10 3	21 3		13 1	15 3	16 3	14 3	
9		5 2	13 5	7 4	11 3	14 5	13 4	8 4	8 2	11 1	14 2	19 2	
10		5 2	5 3	5 5	7 7	13 6	11 2	16 3	18 3	22 4	20 6	16 4	
11		4 1	13 5	10 7	14 7	20 10	21 9	21 10	18 6	20 4	21 9	16 3	
12			17 4	15 7	19 14	24 16	36 22	38 17	35 8	32 5	22 5	22 11	
13	16 2	20 4	26 8	33 30	36 30	45 26	48 30	55 25	49 20	60 12	57 15	54 4	
14			66 9	58 13	18 9	20 22	30 18	28 10	32 5	44 5	32 3	19 1	
15			9 4	8 6	4 3	6 2	17 5	16 3	13 3	22 2	20 4	22 4	
16	6 1	2 1	6 2	10 3	10 2			12 2	21 2	18 1	2 1	16 1	
17			6 1	12 3						13 1	14 1		
18		3 1	12 2	8 4	14 1			16 1	16 2			8 2	
19		3 1	9 4	4 1	14 1						24 1	9 1	
20			4 4	4 3	7 1	14 3	20 1			17 1	14 1	12 2	
21		4 3	5 4	6 6	10 1		8 3	13 6	10 4	12 5	13 5	14 3	
22	21 1		12 2	19 1	11 4	7 4	4 1	12 3	11 3	14 2	8 2	11 1	14 1
23		5 4	8 2	13 3	4 2								
24			5 1	9 1			10 1	13 1	4 2	5 3	8 2	8 3	
25	3 1	3 3	4 4	6 4	4 2	11 2		3 1		9 1	14 2		
26		6 2	5 3	4 1	8 4		5 1	7 1	6 1	10 1		13 1	
27		3 1	4 1	4 4		3 1	1 1	1 1	1 1	3 1	13 1	14 1	
28		7 3	4 3	6 6	7 1	6 2	1 1	2 1	11 1	9 1	8 1	9 1	
29		5 3	4 2	3 1	1 1	1 1					10 2	8 2	
30		4 2	7 5	2 1	3 1			8 1		10 2			
31		3 2	4 2	6 2	10 2		8 1	9 1			18 2	11 2	

TOTAL FOR DECEMBER: 22351
GRAND TOTAL: 177931

M=corrected average number of meteors observed. O=number of observations on which M is based. 6^h=0601 to 0700; 7^h=0701 to 0800, etc.

