SOLAR RADIATION MEASUREMENTS AT SANTA FE, N. MEX., AND MAXIMA AT OTHER STATIONS.

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Santa Fe, N. Mex., is at a high elevation in an arid region, and the atmosphere is generally very clear, except that cumulus clouds are apt to form before midday during the warm part of the year and dust storms are not infrequent during the fall months. There is also some smoke from chimneys in the vicinity of the Weather Bureau office, the extent of the disturbance arising therefrom depending upon the wind direction.

The first solar radiation measurements at Santa Fe, N. Mex., were made by the writer in September, 1910, with Smithsonian silver-disk pyrheliometer No. 1. The latitude of the station is 35° 41′ N. and the longitude is 105° 57′ W. The elevation of the pyrheliometer above sea level is 7,013 feet, or 2,138 meters. In October, 1912, a Marvin pyrheliometer of the spiral ribbon type (spiral No. VI) was installed in the Weather Bureau office. A window facing east is the only exposure available for the pyrheliometer, so that radiation measurements are possible during the morning hours only. While installing the apparatus I made measurements from the roof of the building with Smithsonian silver-disk pyrheliometer No. 1 on several afternoons. These measurements, together with those obtained in September, 1910, constitute all the afternoon measurements that have been made at Santa Fe.

Since October, 1912, practically all the observational work has been done by the station force, Mr. C. E. Linney, in charge, and Mr. J. B. Sloan, assistant, the latter making the instrumental readings. The observations have been reduced at Washington, D. C., under my supervision.

Standardization of instruments.—An attempt has been made to standardize Marvin pyrheliometers by measuring the heating effect of an electric current of known strength. As so standardized, however, they have generally given solar radiation measurements a few per cent lower than synchronous measurements by Smithsonian pyrheliometers. The final factors for reducing Marvin pyrheliometer readings to heat units have therefore been determined by comparisons with Smithsonian silver-disk pyrheliometer No. 1. This latter is frequently compared with pyrheliometers in use at the Astrophysical Observatory of the Smithsonian Institution, and no appreciable change in its constants has been detected since its purchase by the Weather Bureau in 1910.

Table 1 gives the results of the comparisons between Smithsonian silver-disk pyrheliometer No. 1 and Marvin spiral No. VI, obtained at Mount Weather, Va., between June 8 and August 24, 1912, from which the reduction factors for the Marvin instrument were first determined. The same table also presents comparisons obtained at Santa Fe on October 26, 1912, a few days after the installation of the Marvin instrument there, and again on April 9 and 11, 1915. The two series of comparisons obtained at Santa Fe indicate that during the intervening period the instrument underwent a change of such a nature as to make the reduction factors originally determined at Mount Weather too large. It is impossible to determine just when or how this change occurred. It is therefore assumed that it progressed at a uniform rate throughout the interval, and the reduction factors as originally determined have been corrected by multiplying by ratios uniformly interpolated for time between that for October 26, 1912, and the mean of those for April 9 and 11, 1915, given in column 5 of Table 1.

A similar change in Marvin spiral No. 1 was observed at Madison, Wis., between August, 1910, and November, 1911.[1]

TABLE 1.—*Summary of comparisons of Smithsonian silver-disk pyrheliometer No. 1 and Marvin spiral pyrheliometer No. VI.*

Date.	Place.	Smithsonian No. 1.	Marvin No. VI.	Ratio Smithsonian / Marvin.
1912.		*Gr.-cal.*	*Gr.-cal.*	
June 8	Mount Weather	1.302	1.324	0.983
June 21	Mount Weather	1.112	1.150	0.967
July 11	Mount Weather	0.961	0.964	0.997
August 15	Mount Weather	0.872	0.871	1.001
August 22	Mount Weather	0.956	0.956	1.000
August 24	Mount Weather	0.939	0.937	1.002
August 24	Mount Weather	0.962	0.953	1.009
October 26	Santa Fe	1.357	1.376	0.986
1915.				
April 9	Santa Fe	1.451	1.519	0.955
April 9	Santa Fe	1.501	1.561	0.962
April 11	Santa Fe	1.520	1.575	0.965
April 11	Santa Fe	1.535	1.608	0.955
Mean, April 9-11				**0.959**

Radiation observations.—In Table 5 are summarized all solar radiation measurements made by the Weather Bureau at Santa Fe, N. Mex. An inspection of this table reveals only slight variations in the radiation intensities for a given air mass during any one month as compared with the variations at stations nearer sea level and in a moister climate.

One notes the low radiation intensities obtained between October, 1912, and April, 1913, as compared with the intensities during corresponding months of the following years. The ratio of the mean intensities for October and November, 1912, to the means for the corresponding months of 1914 is 0.86. This is very closely in accord with the deficiency in radiation intensities measured at Mount Weather, Va., and Madison, Wis., and also at other points in the Northern Hemisphere, during these months.[2]

Table 6 shows the existence of an annual variation in radiation intensities for a given air mass, with a minimum in July and August and a maximum in December. The annual range is about twice as great as would be produced by the annual variation in the earth's solar distance. The monthly means are systematically higher than those published for Madison and Washington in the Bulletin of the Mount Weather Observatory, 1912, 5:182 (Tables 2 and 3), with the exception of the means for January and February for Madison. During the summer months they are from 10 to 15 per cent higher.

[1] Bulletin, Mount Weather Observatory, Washington, 1912, 5:174.
[2] Bulletin, Mount Weather Observatory, Washington, 1914, 6:208, fig. 1; and p. 206, Tables 1 and 2.

TABLE 2.—*Monthly maximum noon solar radiation intensities at Santa Fe, lat. 35° 41′ N., long. 105° 57′ W., altit. 7,013 ft.=2,138 m.; Madison, lat. 43° 05′ N., long. 89° 23′ W., altit. 974 ft.=297 m.; Mount Weather, lat. 39° 04′ N., long. 77° 54′ W., altit. 1,740 ft.=530 m.; Washington, lat. 38° 54′ N., long. 77° 03′ W., altit. 118 ft.=36 m.*

[Gram-calories per minute per square centimeter of normal surface.]

(1) MAXIMUM OBSERVED INTENSITIES.

Station.	Month.												Year.	Range.
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		
	Gr.-cal.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Santa Fe, N. Mex.	1.63	1.53	1.59	1.57	1.55	1.51	1.45	1.47	1.53	1.57	1.63	1.58	1.63	0.18
Madison, Wis.	1.49	1.57	1.60	1.58	1.47	1.41	1.36	1.38	1.42	1.38	1.42	1.47	1.60	0.24
Mount Weather, Va.	1.37	1.48	1.48	1.45	1.50	1.47	1.48	1.45	1.50	1.48	1.43	1.40	1.50	0.23
Washington, D. C.	1.42	1.50	1.47	1.49	1.45	1.43	1.47	1.40	1.45	1.45	1.48	1.48	1.50	0.10

(2) MAXIMUM INTENSITIES REDUCED TO MEAN SOLAR DISTANCE.

Santa Fe, N. Mex.	1.58	1.48	1.57	1.59	1.59	1.56	1.50	1.50	1.55	1.56	1.59	1.52	1.59	0.11
Madison, Wis.	1.44	1.54	1.57	1.58	1.50	1.45	1.42	1.41	1.44	1.39	1.40	1.42	1.58	0.19
Mount Weather, Va.	1.32	1.45	1.46	1.46	1.53	1.52	1.53	1.48	1.51	1.47	1.40	1.36	1.54	0.12
Washington, D. C.	1.38	1.47	1.46	1.49	1.49	1.47	1.52	1.43	1.46	1.44	1.46	1.43	1.52	0.14

In Table 2, part (1) gives the highest noon solar radiation intensities that have been measured at Weather Bureau stations, and in part (2) these intensities have been reduced to what they would have been had the earth been at its mean solar distance. The highest measured intensities at Santa Fe are obtained in the fall and early winter, and at Madison and Washington in the late winter and early spring, although at Washington there is little difference between the spring and late fall. At Mount Weather there is no decided maximum, but there is a decided minimum in the early part of winter. At Santa Fe, Madison, and Washington, the minimum occurs in summer.

Reduced to mean solar distance, the maximum noon radiation intensities for Santa Fe show little annual variation. Madison has a decided spring maximum, with a minimum in the fall. At Washington and Mount Weather, the maximum occurs at about the time of the summer solstice, and the minimum at about the time of the winter solstice.

TABLE 3.—*Maximum solar radiation intensities corresponding to certain zenith distances of the sun.*

[Gram-calories per minute per square centimeter of normal surface.]

Station.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	Gr.-cal.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Santa Fe, N. Mex.	1.59	1.67	1.60	1.53	1.41	1.28	1.26	1.16	.....	.....	.....
Madison, Wis.	1.58	1.61	1.57	1.58	1.47	1.36	1.28	1.18	1.17	1.12	.....
Mount Weather, Va.	1.53	1.48	1.43	1.34	1.27	1.20	1.15	1.09	1.04	1.00	0.96
Washington, D. C.	1.55	1.51	1.51	1.42	1.32	1.24	1.16	1.09	1.04	1.00	0.97

In Table 3 are given the maximum solar radiation intensities corresponding to certain zenith distances of the sun. At the time of the winter solstice the least solar zenith distance at Santa Fe exceeds 59°; at Washington and Mount Weather it exceeds 62°; and at Madison 66°. This explains the relatively high radiation intensities at solar zenith distance 66.5° for Madison, 60° for Washington, and 48.3° for Santa Fe. Radiation measurements at lesser zenith distances are obtained at these stations during the warm part of the year only, when the earth is at its maximum solar distance, and the sky contains more dust and moisture than in winter. In the same way, the fact that for zenith distances of the sun exceeding 60° higher radiation intensities have been measured at Madison than at Santa Fe, is to be attributed in part to the exceedingly small amount of dust and moisture in the atmosphere at Madison in winter during the passage of areas of high pressure and low temperature, when the ground is covered with snow. Many more measurements have been made at Madison than at Santa Fe, however.

In general the excess of the maximum radiation intensities measured at Santa Fe as compared with the maxima at low-level stations is much less than the excess shown by a comparison of mean intensities.

On some of the clearest days the radiation intensities for zenithal sun (air mass = 1) reduced to mean solar distance, have been computed by plotting several series of observations as shown in figure 1, and extrapolating to air mass 1. The results are given in Table 4. The winter intensities for Santa Fe and Madison are in close agreement. They fall between values computed by Abbot[3] for Mount Wilson and Mount Whitney, Cal. The value computed for Washington on December 26, 1914, equals Abbot's highest value computed from Mount Wilson observations. Those for Mount Weather, which are computed from observations obtained in the warm part of the year, and one for Santa Fe for September 8, 1910, fall considerably below the above.

TABLE 4.—*Solar radiation intensities for zenithal sun (m=1), and approximate values of the solar constant.*

[Gram-calories per minute per square centimeter of normal surface.]

Station.	Date.	Vapor pressure.	Radiation intensity.		Solar constant.
			m=1	m=0	
		m. m.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Santa Fe, N. Mex.	1910, Sept. 8, P. M.	7.00	1.57	1.87	2.05
Santa Fe, N. Mex.	1914, Nov. 20, A. M.	1.55	1.70	1.85	1.93
Madison, Wis.	1911, Mar. 4, A. M.	1.80	1.67	1.89	1.98
Madison, Wis.	1912, Feb. 22, A. M.	1.25	1.67	1.89	1.97
Washington, D. C.	1914, Dec. 26, A. M.	1.15	1.65	1.87	1.94
Washington, D. C.	1915, Feb. 28, P. M.	2.00	1.60	1.89	1.98
Mount Weather, Va.	1908, July 16, A. M.	8.00	1.55	1.82	2.02
Mount Weather, Va.	1914, Sept. 28, P. M.	5.00	1.57	1.76	1.90

In figure 1 it has not been practicable to plot the individual readings of each series of observations except when the sun was near the horizon. This is especially the case near mid-day, when the air mass (approximately the secant of the sun's zenith distance) is changing slowly. Hence the plotted points in figure 1 generally represent the mean of from two to eight readings. The nearer to noon the readings were made the greater the number that have been combined into a mean. It is seen that the observations for a given place and day plot very nearly in a straight line, or in a line slightly concave upward. Extending these lines to zero air mass, we obtain the values given in column 5 of Table 4. With the exception of those for Mount Weather, these values (m=0) range between 1.85 and 1.89. Following the Smithsonian

[3] *Abbot, C. G. and others.* New evidence on the intensity of solar radiation outside the atmosphere, Washington, 1915 (Smithsonian Misc. coll., **65**, No. 4), p. 53.

"Abridged procedure for determining approximately the value of the solar constant."[4] we obtain from the data of columns 3 and 5, Table 4, the solar constant values given in column 6. These average a little higher than the mean value given by Abbot and others.[5] We have no assurance, however, that this abridged procedure is applicable to observations obtained at stations whose climatic factors differ from those for Mount Wilson, Cal. Furthermore, the high value obtained from the Santa Fe observations of September 8, 1910, may be attributable to the fact that on that day the vapor pressure increased more than 50 per cent between 6 a. m. and 6 p. m.

zenith distance 60°, they average about 15 per cent higher throughout the year than the monthly means for Washington, D. C., and in summer are about the same per cent higher than the corresponding monthly means for Madison, Wis. In winter and early spring there is little difference between the radiation intensities at Santa Fe and Madison for like zenith distances of the sun.

Likewise, the monthly maximum radiation intensities measured at Santa Fe exceed those at low-level stations, with the exception of the maxima measured at Madison in the late winter and the early spring. The excess is less than half what it is in the case of the mean values, however.

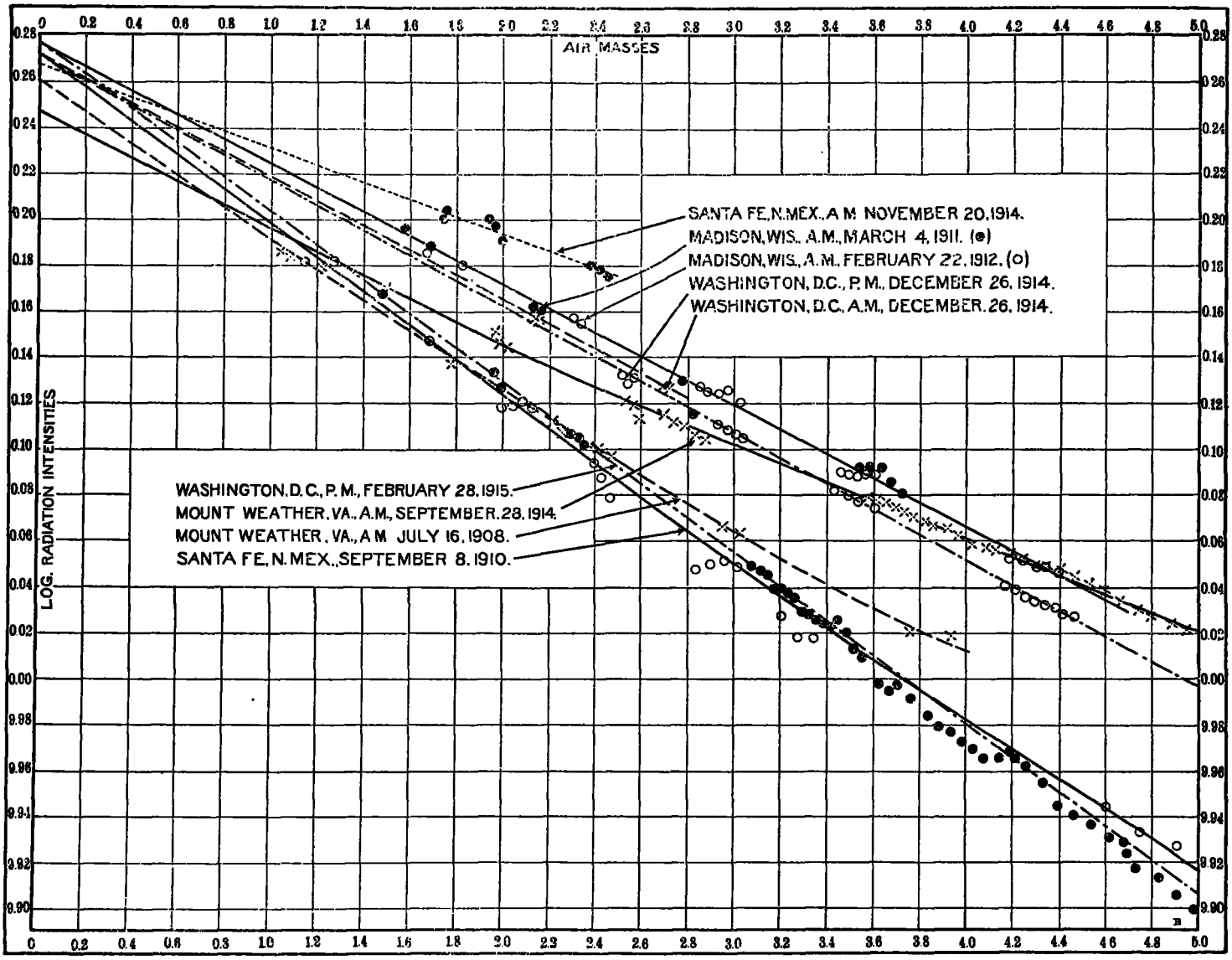

FIGURE 1—Radiation intensities reduced to mean solar distance.

SUMMARY.

Measurements of solar radiation intensity at Santa Fe, N. Mex., show higher monthly means, and much smaller departures from the means, than do measurements obtained at stations nearer sea level. With the sun at

Radiation intensities for zenithal sun with the earth at its mean solar distance—computed from some of the best series of observations that have been obtained at the different stations—give for Santa Fe a radiation intensity of 1.70 calories per minute per square centimeter of normal surface, for Madison 1.67 calories, and for Washington 1.65 calories. A value of 1.55 calories was obtained at Mount Weather in July.

Values of the solar constant computed from these same observations by the Smithsonian "abridged procedure,"

[4] Annals, Astrophysical Observatory of the Smithsonian Institution, Washington, 1908, 2:115.

[5] New evidence of the intensity of solar radiation outside the atmosphere. Washington, 1915. (Smithsonian misc. coll. 65:No. 4), page 3.

averaged 1.97 calories, or slightly higher than the mean value given by Abbot.

The relatively high radiation intensities obtained in the late winter and early spring at Madison, Wis., only 297 meters above sea level, are attributed to the local freedom of the atmosphere from moisture and dust during the passage of winter areas of high pressure and low temperature, when the ground is covered with snow.

The radiation intensities measured at Santa Fe during the latter part of 1912 and the early part of 1913 were below the average of following years by about the same amount as has been noted at many other stations in the northern hemisphere. The cause of this depression has been attributed to the presence of dust in the atmosphere derived from the violent eruption of Katmai Volcano in Alaska in June, 1912.

TABLE 5.—*Solar radiation intensities at Santa Fe, N. Mex.*

[Gram-calories per minute per square centimeter of normal surface.]

Date.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.3°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	Gr.-cal.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
A. M.—SEPTEMBER.											
1910: Sept. 9	1.54	1.38	1.30	1.19	1.10	1.05	0.98	0.95	0.89	0.87	0.82
10	1.49	1.39	1.29	1.21	1.13	1.12	1.06	1.00			
11	1.56	1.43	1.32	1.22	1.12	1.11					
13	1.55	1.44									
17	1.52	1.39									
18		1.42	1.33	1.25	1.18	1.13	1.06	1.01	0.96	0.91	0.87
19	1.49	1.40	1.35	1.29	1.24	1.19	1.12	1.09	1.05	1.03	1.00
20	1.52	1.41	1.32	1.23	1.14	1.10	1.03	0.98	0.92	0.91	0.87
1913: Sept. 1			1.13								
10	1.48	1.36	1.28	1.22							
13	1.52										
21		1.45	1.37	1.29							
29	1.55	1.46									
A. m. means	**1.52**	**1.41**	**1.30**	**1.24**	**1.15**	**1.12**	**1.05**	**1.01**	**0.96**	**0.93**	**0.89**
P. M.—SEPTEMBER.											
1910: Sept. 8	1.57	1.44	1.32	1.20	1.10	1.01	0.95	0.89	0.83		
13		1.46	1.37								
15		1.40	1.26	1.14							
P. m. means	**(1.57)**	**1.43**	**1.32**	**(1.17)**	**(1.10)**	**(1.01)**	**(0.95)**	**(0.88)**	**(0.83)**		
A. M.—OCTOBER.											
1912: Oct. 17		1.37	1.25								
18		1.45	1.33	1.16	1.08	1.05	1.01	0.96	0.92		
19		1.34	1.23	1.05	0.94	0.84	0.73				
21		1.21									
22		1.32	1.31	1.23	1.15	1.07	0.97				
24			1.07	0.99	0.91	0.77					
25		1.48	1.30	1.17	1.07	0.99					
26		1.36	1.33	1.19	1.09	1.00	0.91	0.87			
28		1.37									
29		1.38									
1913: Oct. 7		1.45									
8		1.45									
20		1.47									
21			1.43								
23		1.49									
24		1.46									
1914: Oct. 15		1.54	1.47	1.41							
16		1.55	1.46	1.38							
17		1.54	1.48								
27		1.54	1.47	1.40							
28		1.50	1.47	1.43							
A. m. means		**1.44**	**1.35**	**1.24**	**1.04**	**0.95**	**0.90**	**(0.92)**	**(0.92)**		

TABLE 5.—*Solar radiation intensities at Santa Fe, N. Mex.*—Continued.

Date.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.3°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	Gr.-cal.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
P. M.—OCTOBER.											
1912: Oct. 17		1.36	1.23	1.13	1.04	0.95	0.88	0.77	0.74		
18		1.44	1.30	1.19	1.10	1.00	0.91	0.83	0.76		
19		1.35									
21		1.42	1.18	1.11	0.99	0.86	0.80	0.78	0.78		
22		1.42	1.26	1.18	1.11	1.00	0.94	0.89	0.84		
25		1.48									
26		1.42									
29		1.39									
P. m. means		**1.41**	**1.24**	**1.15**	**1.06**	**0.95**	**0.88**	**0.82**	**0.78**		
A. M.—NOVEMBER.											
1912: Nov. 12		1.39	1.22			0.94	0.86	0.78			
13		1.51	1.31								
14		1.44	1.33								
22			1.47								
26			1.28								
1913: Nov. 29			1.41								
1914: Nov. 12		1.62	1.52	1.43	1.35						
19		1.61	1.51		1.36						
20		1.67	1.60	1.53	1.36						
28					1.17						
A. m. means		**1.54**	**1.41**	**(1.48)**	**1.31**	**(0.94)**	**(0.86)**	**(0.78)**			
A. M.—DECEMBER.											
1912: Dec. 11			1.39								
12			1.39								
14			1.53								
18			1.46	1.29							
23			1.42								
27			1.47								
31			1.39	1.30							
1913: Dec. 9			1.51								
10			1.50								
13			1.51								
28			1.51			1.28	1.22	1.16			
1914: Dec. 14			1.55	1.44							
15			1.57	1.50							
30			1.56	1.44							
A. m. means			**1.48**	**1.39**		**(1.28)**	**(1.22)**	**(1.16)**			
A. M.—JANUARY.											
1913: Jan. 9			1.46								
25		1.57	1.39	1.30							
27		1.40	1.28	1.12							
28		1.45	1.30	1.11							
31		1.46	1.38								
1914: Jan. 29			1.48								
30		1.59	1.49								
1915: Jan. 8					1.39		1.26				
27			1.58	1.49	1.41						
A. m. means		**1.49**	**1.42**	**1.26**	**(1.40)**		**(1.26)**				
A. M.—FEBRUARY.											
1913: Feb. 4		1.55	1.45	1.36							
1914: Feb. 13		1.53		1.24	1.13						
14				1.35							
20			1.35	1.31	1.27	1.22					
1915: Feb. 15		1.53	1.46	1.38							
A. m. means		**1.54**	**1.42**	**1.33**	**(1.20)**	**(1.22)**					

TABLE 5.—*Solar radiation intensities at Santa Fe, N. Mex.*—Continued.

Date.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.3°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	Gr.-cal.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
A. M.—MARCH.											
1913:											
Mar. 10	.....	1.33	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	.....	1.48	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	.....	1.40	.....	.....	.....	.....	.....	.....	.....	.....	.....
28	.....	1.39	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	.....	1.41	.....	.....	.....	.....	.....	.....	.....	.....	.....
1914:											
Mar. 12	.....	1.55	1.46	.....	.....	.....	.....	.....	.....	.....	.....
13	.....	1.54	1.45	1.36	.....	.....	.....	.....	.....	.....	.....
14	.....	1.57	1.45	1.36	.....	.....	.....	.....	.....	.....	.....
1915:											
Mar. 24	1.56	1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
A. m. means.	**(1.56)**	**1.46**	**1.45**	**(1.36)**	.....	.....	.....	.....	.....	.....	.....
A. M.—APRIL.											
1913:											
Apr. 14	1.47	.....	.....	1.21	1.13	1.04	.....	.....	.....	.....	.....
16	1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	.....	1.06	.....	.....	.....	.....	.....	.....	.....	.....	.....
28	1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	1.47	.....	.....	1.13	1.04	.....	.....	.....	.....	.....	.....
1914:											
Apr. 13	.....	1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	1.58	1.47	.....	1.33	1.21	.....	.....	.....	.....	.....	.....
25	1.59	1.48	1.37	1.28	.....	.....	.....	.....	.....	.....	.....
1915:											
Apr. 9	1.53	1.42	.....	.....	.....	.....	.....	.....	.....	.....	.....
11	1.56	1.49	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	.....	1.36	1.31	1.23	.....	.....	.....	.....	.....	.....	.....
24	.....	.....	.....	1.13	.....	.....	.....	.....	.....	.....	.....
27	1.48	1.36	1.27	1.18	1.10	.....	.....	.....	.....	.....	.....
29	.....	.....	.....	1.29	1.23	.....	.....	.....	.....	.....	.....
A. m. means.	**1.52**	**1.39**	**1.32**	**1.22**	**1.14**	**(1.04)**	.....	.....	.....	.....	.....
A. M.—MAY.											
1913:											
May 12	1.49	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	1.49	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	1.47	1.36	1.25	1.16	1.07	.....	.....	.....	.....	.....	.....
28	.....	.....	1.18	1.10	.....	.....	.....	.....	.....	.....	.....
29	1.56	1.45	1.34	1.23	1.13	.....	.....	.....	.....	.....	.....
31	1.47	1.31	1.18	.....	.....	.....	.....	.....	.....	.....	.....
1914:											
May 7	1.53	1.44	1.34	1.26	.....	.....	.....	.....	.....	.....	.....
16	1.46	1.35	1.22	.....	.....	.....	.....	.....	.....	.....	.....
26	1.53	.....	.....	1.23	.....	.....	.....	.....	.....	.....	.....
28	1.49	1.33	1.27	1.22	.....	.....	.....	.....	.....	.....	.....
1915:											
May 22	1.50	1.44	1.37	.....	.....	.....	.....	.....	.....	.....	.....
28	.....	1.38	1.32	1.26	.....	.....	.....	.....	.....	.....	.....
A. m. means.	**1.50**	**1.38**	**1.27**	**1.21**	**(1.10)**	.....	.....	.....	.....	.....	.....
A. M.—JUNE.											
1913:											
June 30	1.54	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1914:											
June 3	1.54	1.43	1.33	1.25	.....	.....	.....	.....	.....	.....	.....
5	1.52	1.42	.....	1.25	.....	.....	.....	.....	.....	.....	.....
9	.....	.....	1.32	1.28	.....	.....	.....	.....	.....	.....	.....
18	1.43	1.32	1.24	1.17	1.11	.....	.....	.....	.....	.....	.....
22	.....	.....	1.37	1.32	.....	.....	.....	.....	.....	.....	.....
27	1.50	1.42	1.35	1.28	.....	.....	.....	.....	.....	.....	.....
1915:											
June 6	.....	.....	1.36	1.31	1.22	.....	.....	.....	.....	.....	.....
7	.....	1.38	1.27	1.17	.....	.....	.....	.....	.....	.....	.....
11	1.50	1.41	1.32	1.24	.....	.....	.....	.....	.....	.....	.....
17	1.50	1.44	1.38	1.32	.....	.....	.....	.....	.....	.....	.....
A. m. means.	**1.50**	**1.40**	**1.33**	**1.26**	**(1.16)**	.....	.....	.....	.....	.....	.....

TABLE 5.—*Solar radiation intensities at Santa Fe, N. Mex.*—Continued.

Date.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.3°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	Gr.-cal.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
A. M.—JULY.											
1913:											
July 1	1.47	1.36	1.31	1.18	.....	.....	.....	.....	.....	.....	.....
7	1.43	1.25	1.06	.....	.....	.....	.....	.....	.....	.....	.....
11	1.45	1.31	1.17	.....	.....	.....	.....	.....	.....	.....	.....
12	1.45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1915:											
July 31	.....	1.40	1.32	1.26	.....	.....	.....	.....	.....	.....	.....
A. m. means.	**1.45**	**1.33**	**1.22**	**(1.22)**	.....	.....	.....	.....	.....	.....	.....
A. M.—AUGUST.											
1913:											
Aug. 10	.....	.....	.....	1.17	1.07	.....	.....	.....	.....	.....	.....
13	.....	.....	.....	1.08	.....	.....	.....	.....	.....	.....	.....
26	.....	.....	1.22	1.14	.....	.....	.....	.....	.....	.....	.....
27	.....	.....	.....	1.13	1.06	.....	.....	.....	.....	.....	.....
1914:											
Aug. 7	1.40	1.30	1.21	1.11	.....	.....	.....	.....	.....	.....	.....
14	1.46	1.36	1.27	1.20	.....	.....	.....	.....	.....	.....	.....
24	.....	1.35	1.26	1.19	1.11	.....	.....	.....	.....	.....	.....
25	.....	1.35	1.27	1.20	.....	.....	.....	.....	.....	.....	.....
26	1.43	1.31	.....	1.19	1.11	1.04	.....	.....	.....	.....	.....
27	1.49	1.42	1.35	1.29	1.23	1.17	.....	.....	.....	.....	.....
A. m. means.	**1.44**	**1.35**	**1.26**	**1.17**	**1.12**	**(1.10)**	.....	.....	.....	.....	.....

TABLE 6.—*Monthly means of solar radiation intensity at Santa Fe, N. Mex.*

[Gram-calories per minute per square centimeter of normal surface.]

Month.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
A. M.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
January	.....	1.49	1.42	1.26	(1.40)	.....	(1.26)	.....	.....	.....	.....
February	.....	1.54	1.42	1.33	(1.20)	(1.22)	.....	.....	.....	.....	.....
March	(1.56)	1.46	1.45	(1.36)	.....	.....	.....	.....	.....	.....	.....
April	1.52	1.39	1.32	1.22	1.14	(1.04)	.....	.....	.....	.....	.....
May	1.50	1.38	1.27	1.21	(1.10)	.....	.....	.....	.....	.....	.....
June	1.50	1.40	1.33	1.26	(1.16)	.....	.....	.....	.....	.....	.....
July	1.45	1.33	1.22	(1.22)	.....	.....	.....	.....	.....	.....	.....
August	1.44	1.35	1.26	1.17	1.12	(1.10)	.....	.....	.....	.....	.....
September	1.52	1.41	1.30	1.24	1.15	1.12	1.05	1.01	0.96	0.93	0.89
October	.....	1.44	1.35	1.24	1.04	0.95	0.90	(0.92)	(0.92)	.....	.....
November	.....	1.54	1.41	(1.48)	1.31	(0.94)	(0.86)	(0.78)	.....	.....	.....
December	.....	.....	1.48	1.39	.....	(1.28)	(1.22)	(1.16)	.....	.....	.....
P. M.											
September	(1.57)	1.43	1.32	(1.17)	(1.10)	(1.01)	0.95	(0.88)	(0.83)	.....	.....
October	.....	1.41	1.24	1.15	1.06	0.95	0.88	0.82	0.78	.....	.....