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·SPECIAL REPORT·

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Solar and Diffuse Sky Radiation at Geneva, New York

TOTALS AND MEANS 1970 - 1982

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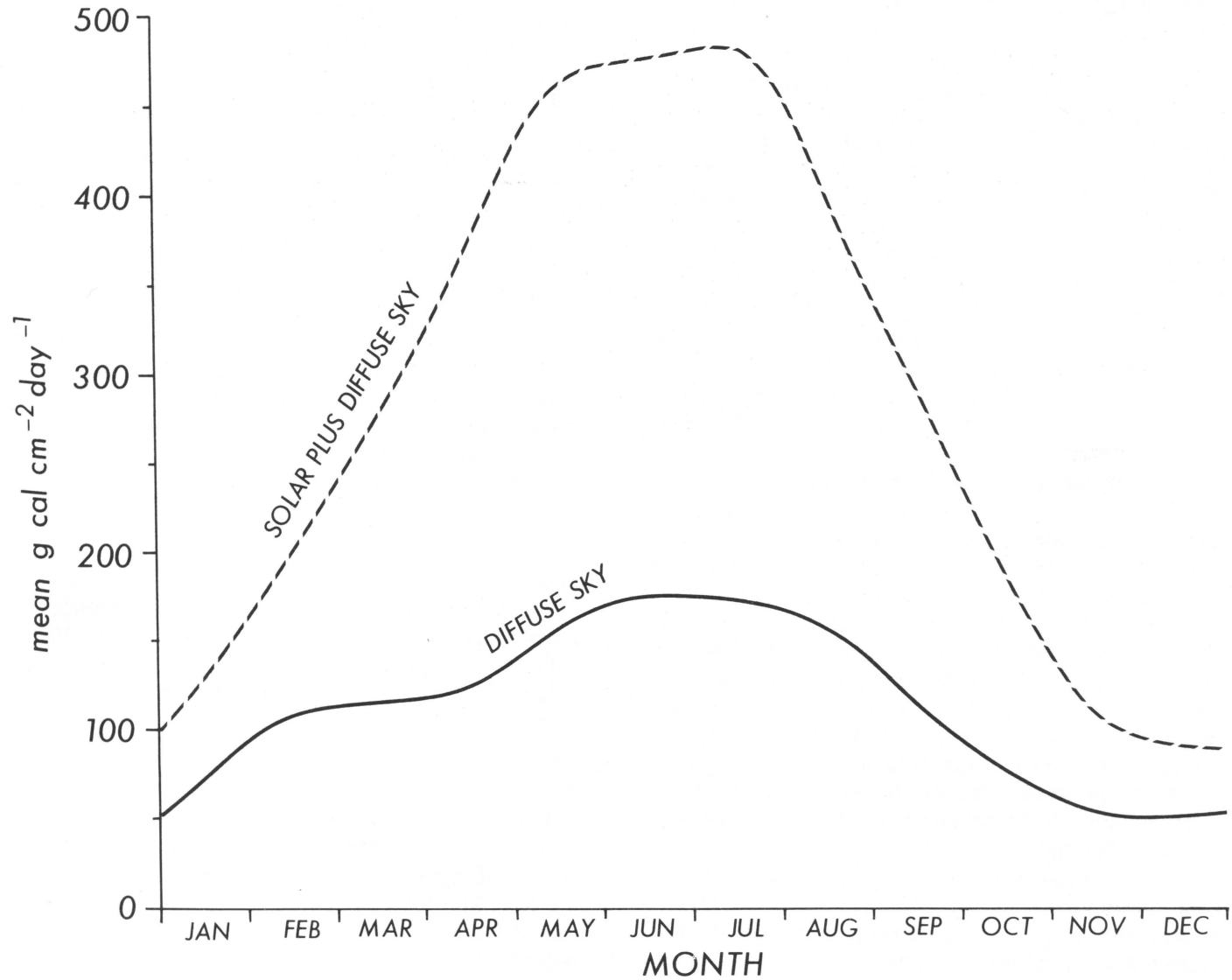


Figure 1—Solar plus diffuse sky radiation and diffuse sky radiation at Geneva, N.Y. 1977-1982.

INTRODUCTION

Total incoming (direct solar plus diffuse sky) radiation, hereafter called solar radiation, and diffuse sky radiation, hereafter called diffuse radiation, are measured at the climatological reference station maintained by this Experiment Station. The location is latitude 42°53'N, longitude 77°02'W, and elevation 718 feet (219 m) above sea level.

Previous publications (7,9) summarized total solar radiation at this location for the period 1953-1969. Another publication (8) summarized variations that occurred in intensity and duration of solar radiation 1964-1973. The present report summarizes solar radiation for the period 1970-1982, and diffuse radiation for the period 1977-1982.

Solar radiation and diffuse radiation are intercepted on a horizontal surface of pyranometers manufactured by the Eppley Laboratory, Inc., Newport, RI. The pyranometers used are described in Table 1. The interceptors of solar and diffuse radiation used at Geneva from 1961 to 1971 have been described previously (7). Since September 1971, Eppley Model 2 PSP pyranometers have been used. According to the manufacturer, this unit has a receiver coated with Parsons' black lacquer (nonwavelength-selective absorption). The inner and outer concentric hemispheres over the sensing elements are clear glass transparent from a wavelength of about 285 to 2,800 millimicrons. Solar and diffuse radiation intercepted by the pyranometer sensing element generates an electromotive force (emf) proportional to the intensity of the radiation. The emf is recorded on a strip chart recorder with a chart speed of 2 inches (5.08 cm)/hour. Intensity and duration of solar and diffuse radiation is computed as g cal cm^{-2}. Hourly values of solar and diffuse radiation are recorded on the hour (true solar time) ending the 60 minute interval.

Diffuse radiation is measured by shielding the sensing element of the pyranometer from direct solar radiation with a metal band. The band, painted black, is 4 inches (10.16 cm) wide and 23 inches (58.42 cm) radius from the sensing elements, designed by the University of California, Department of Agricultural Engineering, College of Agriculture, Davis, CA. The adjustment for solar declination was modified at Geneva by placing screw rods on each side for calibration bars and connecting the screw rods with sprockets and a roller chain for simultaneous adjustments on both sides. The band is adjusted every 4 days. No correction is made for diffuse radiation shielded by the band.

The potentiometer strip charts are read by means of a Summagraphics digitiser connected to a time shared computer. For a general description of software for reading meteorlogical charts see Seem, et al. (10) and Blume, et al. (2). A copy of the fortran program written by E. J. Broderick, will be supplied to anyone who requests it.

Hourly values for solar radiation since January 1, 1970 and for diffuse radiation since April 1, 1976 are available from the New York State Agricultural Experiment Station (Geneva).

Table 2

Total solar radiation for each month during 1970-1982 is given in Table 2. The highest solar mean radiation occurred in July, while the lowest occurred in December.

Table 3

Total diffuse radiation for each month during 1977-1982 is given in Table 3. As with solar radiation, highest mean diffuse radiation occurred in July and lowest occurred in December.

Table 4

Diffuse radiation followed a similar yearly cycle pattern as solar radiation (Table 4 and Fig. 1). Diffuse radiation was 32 per cent of solar radiation in April and 58 per cent in January. The relationship between solar and diffuse radiation depends upon the cloudiness of the sky (1,3,6,11). When the sky is clear, diffuse radiation is a lower percentage of solar radiation than when the sky is cloudy.

Tables 5 and 6

The mean number of hours of solar radiation within 10 intervals ranging from 0 to 90 g cal $cm^{-2}hr^{-1}$ during 1970-1982 are given in Table 5 and during 1977-1982 are given in Table 6. The hourly values are for 16 hours per day from the hour ending at 05 to the hour ending at 20 true solar time. The highest number of hours with 80.1-90.0 g cal $cm^{-2}hr^{-1}$ occurred in May, while the highest number of hours with 0.0-1.0 g cal $cm^{-2}hr^{-1}$ occurred in December.

Table 7

The mean number of hours of diffuse radiation within 10 intervals ranging from 0.0-90.0 g cal $cm^{-2}hr^{-1}$ during 1977-1982 is given in Table 7. Solar and diffuse radiation may be related to plant responses (4,5).

Table 8

The solar radiation within each hour, from the hour ending at 5 to the hour ending at 20 true solar time, within each month during 1977-1982 is given in Table 8. The highest value for solar radiation occurred during the hour ending at 12 during the month of May.

Table 9

The diffuse radiation within each hour, from the hour ending at 5 to the hour ending at 20 true solar time, within each month during 1977-1982 is given in Table 9.

The highest value of diffuse radiation occurred during the hour ending at 12 true solar time during the month of June.

SUMMARY

These solar and diffuse radiation data represent the amount (intensity, duration, and time distribution) of energy that is available for physical processes such as heating the soil and buildings, and biological processes such as growth, development, and maturation of plants.

Table 1. Pyranometers used to intercept direct solar plus diffuse sky radiation and diffuse sky radiation on a horizontal surface 2 meters above a grass sod.

Latitude 42°53′ N, longitude 77°02′ W, elevation 718 feet (219 m)

Date installed	Pyranometer			Calibration
	Make	Model	Serial Number	millivolts / cal cm^{-2} min^{-1} (Int.)
Solar plus diffuse sky radiation				
Nov 1962	Eppley	50 Junction	1868	6.65
1 Sep 1971	Eppley	2 PSP	10273F4	4.89
12 Sep 1977	Eppley	2 PSP	12433F3	6.76
23 Jun 1978	Eppley	2 PSP	10273F4	5.22 Recalibrated 6 Oct 1977
continued in use through 31 Dec 1982				
Diffuse sky radiation				
1 Apr 1976	Eppley	2 PSP	10568F4	4.82
31 Jul 1978	Eppley	2 PSP	12433F3	6.78 Recalibrated 11 Jul 1978
continued in use through 31 Dec 1982				

1 cal cm^{-2} min^{-1} = 697.3 watts $meter^{-2}$

Table 2. Total solar radiation, 1970-1982.

MONTH	Year													
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	MEAN
	g cal cm^{-2} $month^{-1}$													
Jan	4722	4388	4283	4117	3570	3716	4521	4560	4113	3132	3468	4536	3549	4052
Feb	6102	4555	5836	6305	6130	5069	5207	5029	7314	6061	5610	4597	5330	5627
Mar	8195	8098	9364	7432	8384	8382	8420	9652	10082	8176	7312	8076	8416	8461
Apr	11550	9759	12316	10548	11505	12726	12861	12284	11865	9788	10161	10835	12628	11448
May	12616	12268	14074	10066	13228	16000	11208	18266	13591	12539	14330	15040	13117	13565
Jun	14018	13570	13303	15744	14486	14638	15670	15386	15558	14304	13449	14131	12610	14374
Jul	13450	13935	16177	17258	16865	17164	14021	16215	14252	14575	14693	14792	15878	15329
Aug	12778	12074	13651	13079	13708	13386	13754	13347	12691	11242	12857	12286	11772	12817
Sep	8354	8423	9632	10276	9435	8641	9525	8354	9532	10164	9872	7379	8977	9120
Oct	5404	6060	5965	7349	6854	6790	6450	6295	6342	4700	5386	5439	6642	6129
Nov	2514	3492	3087	3072	3239	4168	4260	2790	3652	3009	3105	3695	2910	3307
Dec	2712	2389	1683	2580	2461	2626	3525	3050	2860	2581	2849	2878	2519	2670
Total	102416	99012	109371	107825	109866	113308	109422	115229	111852	100271	103093	103685	104348	106900

Table 3. Total diffuse radiation, 1977-1982.

MONTH	Year						
	1977	1978	1979	1980	1981	1982	MEAN
	g cal cm^{-2} $month^{-1}$						
Jan	2699	2521	2017	1811	2468	1957	2245
Feb	2921	4030	3222	3263	2212	2609	3043
Mar	2903	4179	3448	3149	4174	3545	3566
Apr	3519	3421	3573	3605	3783	3728	3605
May	4300	4852	4637	5219	5114	4958	4847
Jun	4802	5189	5319	5085	5731	5563	5281
Jul	5243	5781	6000	5073	5067	4911	5346
Aug	4949	5190	4960	5097	4766	4839	4967
Sep	3778	3063	3270	3224	3699	3621	3443
Oct	2439	2437	2768	2176	2099	2709	2438
Nov	1737	1504	1638	1570	1443	1746	1607
Dec	1463	1679	1366	1420	1834	1617	1563
Total	40753	43845	42217	40693	42392	41804	41951

Table 4. Comparison of solar and diffuse sky radiation, 1977-1982.

MONTH	Solar		Diffuse		(Solar / diffuse) x 100
	Monthly Mean	Daily Mean	Monthly Mean	Daily Mean	
	g cal cm^{-2} $month^{-1}$	g cal cm^{-2} day^{-1}	g cal cm^{-2} $month^{-1}$	g cal cm^{-2} day^{-1}	%
Jan	3893	126	2245	72	58
Feb	5657	200	3043	108	54
Mar	8619	278	3566	115	41
Apr	11260	375	3605	120	32
May	14480	467	4847	156	33
Jun	14240	475	5281	176	37
Jul	15067	486	5346	172	35
Aug	12366	399	4967	160	40
Sep	9046	302	3443	115	38
Oct	5801	187	2438	79	42
Nov	3194	106	1607	54	50
Dec	2790	90	1563	50	56
Total	106413		41951		

Table 5. Hours of solar radiation within 10 intervals, 1970-1982.

MONTH	g cal cm^{-2} hr^{-1}									
	0.0-1.0	1.1-10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0	50.1-60.0	60.1-70.0	70.1-80.0	80.1-90.0
	mean number of hours $month^{-1}$ within each interval									
Jan	247.6	96.5	63.4	52.2	30.9	5.3	0.0	0.0	0.0	0.0
Feb	184.3	84.5	59.1	46.8	39.1	28.4	8.4	1.1	0.0	0.0
Mar	162.6	101.0	63.8	45.9	39.2	34.2	27.9	16.2	5.2	0.0
Apr	117.9	92.4	60.4	43.1	37.0	36.1	29.2	33.7	23.3	6.9
May	83.2	106.9	66.3	44.0	43.7	33.6	39.0	33.9	28.6	16.4
Jun	69.8	91.7	56.2	54.5	44.2	38.4	41.2	37.2	29.8	15.8
Jul	71.9	86.7	55.8	48.9	50.5	42.9	48.8	46.7	32.4	10.8
Aug	97.5	88.9	63.3	49.5	45.0	48.2	46.1	38.2	17.0	2.4
Sep	138.2	100.2	56.8	47.5	39.7	39.6	37.6	17.2	3.2	0.0
Oct	197.0	107.0	60.4	48.2	39.9	31.8	10.8	0.9	0.0	0.0
Nov	239.2	119.3	56.9	37.8	22.2	4.6	0.0	0.0	0.0	0.0
Dec	269.4	123.2	60.1	31.8	11.4	0.2	0.0	0.0	0.0	0.0
Total	1878.5	1198.4	722.5	550.1	442.8	343.3	289.1	225.2	139.5	52.2

Table 6. Hours of solar radiation within 10 intervals, 1977-1982.

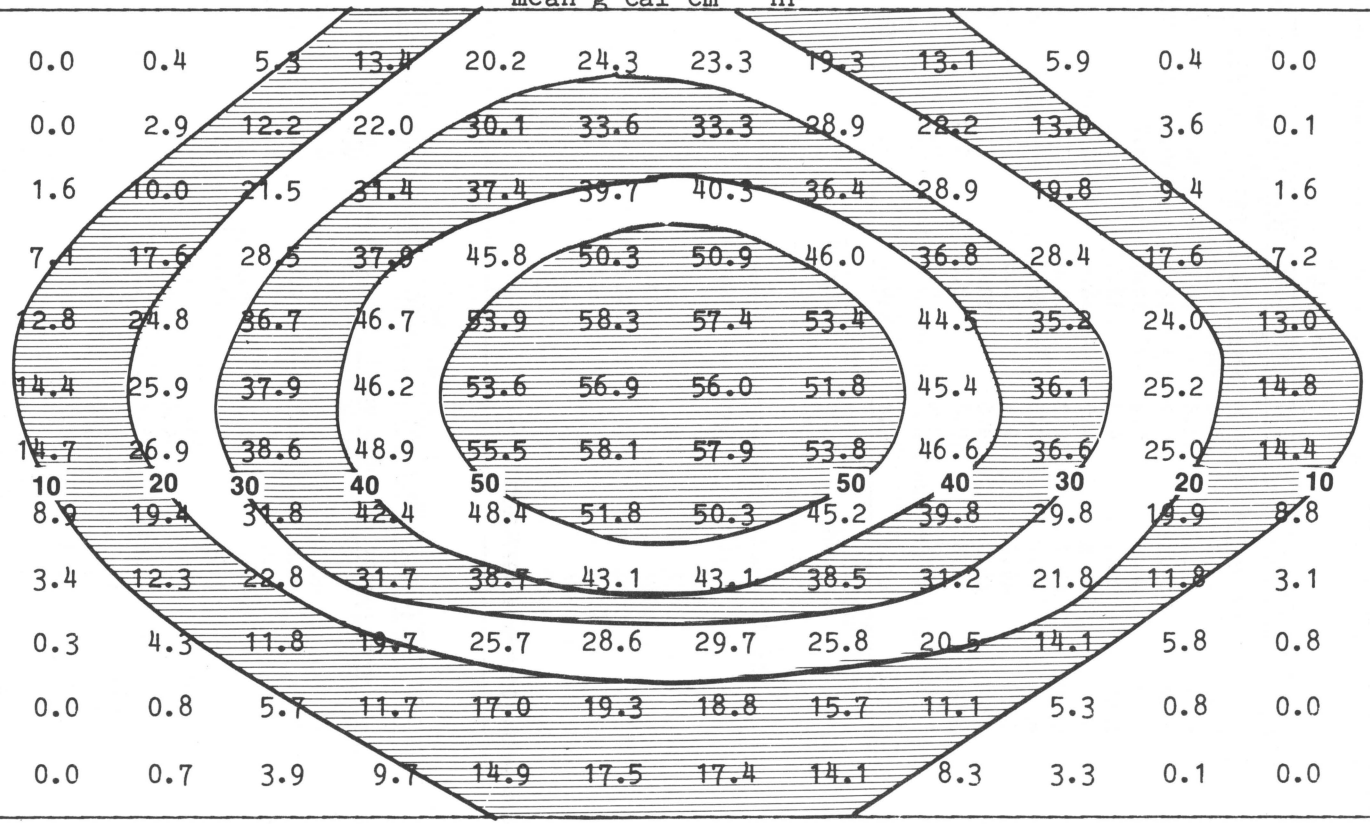
	g cal cm^{-2} hr^{-1}									
MONTH	0.1-1.0	1.1-10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0	50.1-60.0	60.1-70.0	70.1-80.0	80.1-90.0
	mean number of hours $month^{-1}$ within each interval									
Jan	248.8	95.2	68.7	53.0	27.2	3.2	0.0	0.0	0.0	0.0
Feb	183.2	83.2	56.7	47.7	42.8	28.0	8.8	0.3	0.0	0.0
Mar	162.5	96.8	64.8	42.2	39.7	38.2	30.5	18.3	3.0	0.0
Apr	116.5	96.0	61.2	44.5	33.8	34.3	29.7	35.2	24.8	4.0
May	81.3	94.5	66.8	39.5	46.3	33.8	42.5	39.2	36.2	15.5
Jun	72.0	88.8	58.5	53.8	44.0	36.0	42.3	40.7	32.0	11.2
Jul	73.3	86.0	60.0	47.7	50.2	42.0	47.2	48.8	35.7	5.2
Aug	98.2	90.7	66.3	50.7	43.3	48.7	47.2	37.8	12.8	0.3
Sep	136.8	98.8	57.8	49.0	40.8	41.5	40.0	14.2	1.0	0.0
Oct	197.0	113.0	63.0	46.0	39.0	30.5	7.5	0.0	0.0	0.0
Nov	239.7	121.0	58.5	36.8	20.7	3.3	0.0	0.0	0.0	0.0
Dec	266.7	117.0	65.0	36.7	10.5	0.2	0.0	0.0	0.0	0.0
Total	1876.0	1181.0	747.3	547.5	438.3	339.7	295.7	234.5	145.5	36.2

Table 7. Hours of diffuse radiation within 10 intervals, 1977-1982.

	g cal cm^{-2} hr^{-1}									
MONTH	0.0-1.0	1.1-10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0	50.1-60.0	60.1-70.0	70.1-80.0	80.1-90.0
	mean number of hours $month^{-1}$ within each interval									
Jan	260.3	137.7	82.5	15.5	0.0	0.0	0.0	0.0	0.0	0.0
Feb	198.5	124.8	79.2	42.2	5.5	0.5	0.0	0.0	0.0	0.0
Mar	183.7	168.2	92.0	44.0	7.3	0.8	0.0	0.0	0.0	0.0
Apr	141.3	204.8	81.0	45.0	7.7	0.2	0.0	0.0	0.0	0.0
May	101.7	206.8	107.2	59.0	20.7	0.7	0.0	0.0	0.0	0.0
Jun	83.2	177.0	128.2	67.0	23.5	0.7	0.5	0.0	0.0	0.0
Jul	91.2	184.8	129.5	66.2	23.8	0.5	0.0	0.0	0.0	0.0
Aug	118.8	165.3	123.3	74.3	14.0	0.2	0.0	0.0	0.0	0.0
Sep	159.0	172.8	103.5	41.0	3.7	0.0	0.0	0.0	0.0	0.0
Oct	213.7	181.0	90.0	11.3	0.0	0.0	0.0	0.0	0.0	0.0
Nov	259.0	161.8	57.8	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Dec	280.7	155.7	58.5	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Total	2091.0	2040.8	1132.7	468.0	106.2	3.5	0.5	0.0	0.0	0.0

Table 8. Hourly solar radiation within 16 intervals. 1977-1982.

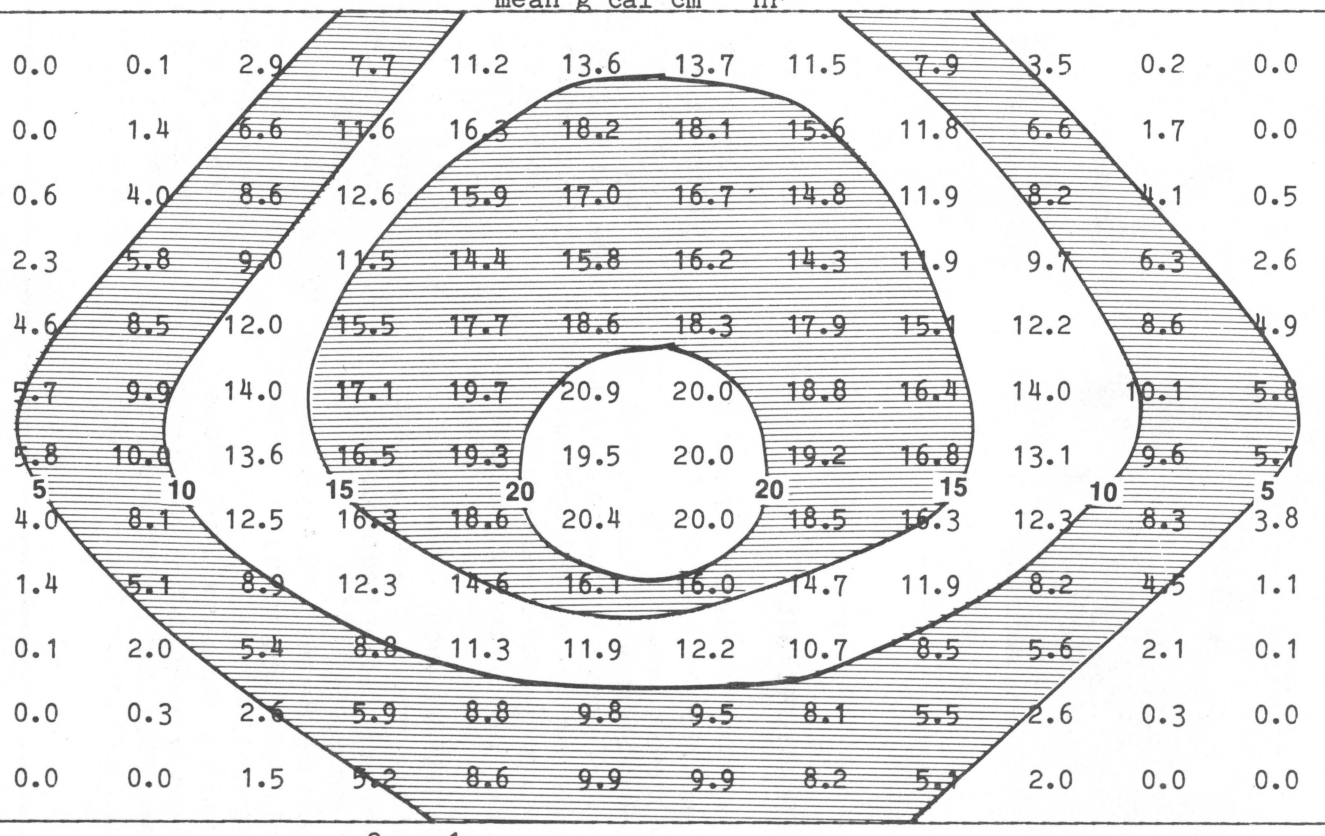
Month	Hourly intervals ending at 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	mean g cal cm^{-2} hr^{-1}															
Jan	0.0	0.0	0.0	0.4	5.3	13.4	20.2	24.3	23.3	19.3	13.1	5.9	0.4	0.0	0.0	0.0
Feb	0.0	0.0	0.0	2.9	12.2	22.0	30.1	33.6	33.3	28.9	28.2	13.0	3.6	0.1	0.0	0.0
Mar	0.0	0.0	1.6	10.0	21.5	31.4	37.4	39.7	40.3	36.4	28.9	19.8	9.4	1.6	0.0	0.0
Apr	0.0	0.6	7.4	17.6	28.5	37.8	45.8	50.3	50.9	46.0	36.8	28.4	17.6	7.2	0.7	0.0
May	0.0	3.1	12.8	24.8	36.7	46.7	53.9	58.3	57.4	53.4	44.5	35.2	24.0	13.0	3.3	0.0
Jun	0.2	4.8	14.4	25.9	37.9	46.2	53.6	56.9	56.0	51.8	45.4	36.1	25.2	14.8	5.3	0.3
Jul	0.0	4.4	14.7	26.9	38.6	48.9	55.5	58.1	57.9	53.8	46.6	36.6	25.0	14.4	4.3	0.1
Aug	0.0	1.3	8.9	19.4	31.8	42.4	48.4	51.8	50.3	45.2	39.8	29.8	19.9	8.8	1.2	0.0
Sep	0.0	0.0	3.4	12.3	23.8	31.7	38.7	43.1	43.1	38.5	31.2	21.8	11.8	3.1	0.0	0.0
Oct	0.0	0.0	0.3	4.3	11.8	19.7	25.7	28.6	29.7	25.8	20.5	14.1	5.8	0.8	0.0	0.0
Nov	0.0	0.0	0.0	0.8	5.7	11.7	17.0	19.3	18.8	15.7	11.1	5.3	0.8	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.7	3.9	9.7	14.9	17.5	17.4	14.1	8.3	3.3	0.1	0.0	0.0	0.0



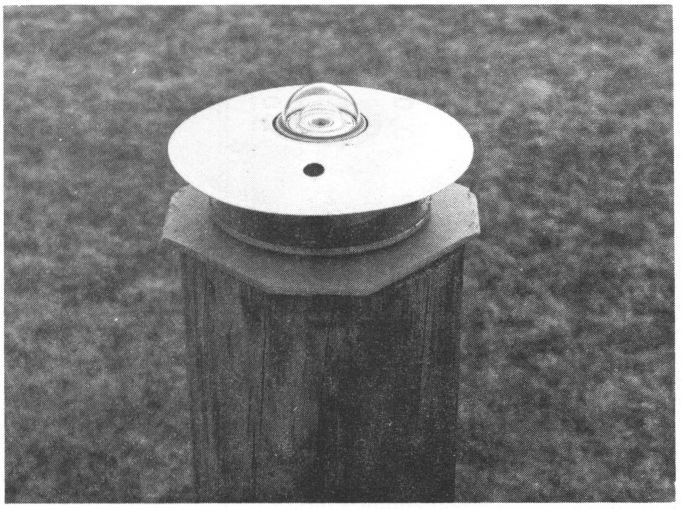
Isopleths at 10, 20, 30, 40 and 50 g cal cm^{-2} hr^{-1}.

Table 9. Hourly diffuse radiation within 16 intervals. 1977-1982.

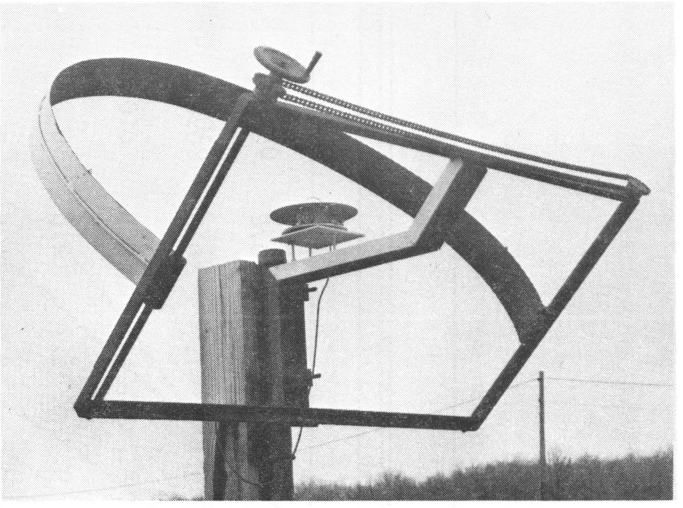
Month	Hourly intervals ending at 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	mean g cal cm^{-2} hr^{-1}															
Jan	0.0	0.0	0.0	0.1	2.9	7.7	11.2	13.6	13.7	11.5	7.9	3.5	0.2	0.0	0.0	0.0
Feb	0.0	0.0	0.0	1.4	6.6	11.6	16.3	18.2	18.1	15.6	11.8	6.6	1.7	0.0	0.0	0.0
Mar	0.0	0.0	0.6	4.0	8.6	12.6	15.9	17.0	16.7	14.8	11.9	8.2	4.1	0.5	0.0	0.0
Apr	0.0	0.1	2.3	5.8	9.0	11.5	14.4	15.8	16.2	14.3	11.9	9.7	6.3	2.6	0.2	0.0
May	0.0	1.1	4.6	8.5	12.0	15.5	17.7	18.6	18.3	17.9	15.1	12.2	8.6	4.9	1.3	0.0
Jun	0.0	1.9	5.7	9.9	14.0	17.1	19.7	20.9	20.0	18.8	16.4	14.0	10.1	5.8	1.9	0.0
Jul	0.0	1.7	5.8	10.0	13.6	16.5	19.3	19.5	20.0	19.2	16.8	13.1	9.6	5.7	1.6	0.0
Aug	0.0	0.5	4.0	8.1	12.5	16.3	18.6	20.4	20.0	18.5	16.3	12.3	8.3	3.8	0.5	0.0
Sep	0.0	0.0	1.4	5.1	8.9	12.3	14.6	16.1	16.0	14.7	11.9	8.2	4.5	1.1	0.0	0.0
Oct	0.0	0.0	0.1	2.0	5.4	8.8	11.3	11.9	12.2	10.7	8.5	5.6	2.1	0.1	0.0	0.0
Nov	0.0	0.0	0.0	0.3	2.6	5.9	8.8	9.8	9.5	8.1	5.5	2.6	0.3	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	1.5	5.2	8.6	9.9	9.9	8.2	5.1	2.0	0.0	0.0	0.0	0.0



Isopleths at 5, 10, 15 and 20 g cal cm^{-2} hr^{-1}.



Pyranometer used to intercept total (direct solar plus diffuse sky) radiation.



Pyranometer used to intercept diffuse sky radiation. The metal band shields the sensing element from direct solar radiation.

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