SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, SEPTEMBER 1939

By CHARLES M. LENNAHAN

Measurements of solar radiant energy received at the surface of the earth are made at eight stations maintained by the Weather Bureau, and at 10 cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory at Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data, obtained up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pp. 415 to 441; further descriptons of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parentheses). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian silver disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 8 a. m. (75th meridian time) and at noon (local mean solar time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, their departures from normal and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

Direct radiation intensities averaged above normal for September at Lincoln and slightly below normal at Madison and Blue Hill.

Total solar and sky radiation during September was above normal at all stations except Fresno, La Jolla, Miami, and Riverside.

TABLE 1.—*Solar radiation intensities during September 1939*

WASHINGTON, D. C.

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

Date	Sun's zenith distance										
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Sept. 5	14.60				1.03						10.21
Sept. 18	5.79				1.34						5.79
Sept. 23	10.97				.88						11.81
Sept. 25	13.13				.90						12.68
Means					**1.04**						
Departure					**−.01**						

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during September 1939*—Con.

MADISON, WIS.

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

Date	Sun's zenith distance										
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Sept. 5	8.81	0.86	0.94	1.10	1.26	1.42					8.81
Sept. 12	11.81	.47	.58	.74	.95	1.11					15.65
Sept. 14	15.11	.70	.80	.94	1.13	1.25	1.01				15.65
Sept. 15	15.11	.53	.61	.77	.95	1.13					13.61
Sept. 19	7.87	.71	.84	1.01	1.16	1.33	1.10				7.29
Sept. 20	9.83					1.42	1.31	0.75			6.50
Sept. 21	6.50		1.03	1.14	1.24	1.40	1.25	1.04			6.02
Sept. 22	6.02	.60	.74	.91							6.02
Sept. 27	5.79			.68	1.08	1.30	1.24	.95			7.87
Sept. 28	7.87	.61	.70	.80	.91	1.02	.80				10.21
Sept. 30	4.17		.45	.53							4.95
Means		**.64**	**.74**	**.86**	**1.08**	**1.26**	**1.12**	**.91**			
Departures		**−.14**	**−.14**	**−.14**	**−.07**	**−.13**	**−.06**	**−.11**			

LINCOLN, NEBR.

Sept. 5	8.48				1.00						9.83
Sept. 7	10.97						1.02	0.76	0.57	0.35	10.97
Sept. 8	9.47	0.44	0.54	0.67			1.00	.78	.61	.49	12.68
Sept. 9	8.18	.88	.98	1.13	1.32						8.48
Sept. 12	11.38						1.16	.96	.78	.62	11.81
Sept. 13	13.61	.83	.94	1.06	1.24				.62	.49	13.13
Sept. 14	11.81	.87	.97	1.09	1.26		1.15	.92	.78	.68	11.38
Sept. 15	12.68	.78	.90	1.05	1.23						11.38
Sept. 16	10.98	.84	.93	1.05							5.56
Sept. 18	5.56	.85	.95	1.09	1.27		1.26	1.06	.92	.78	7.04
Sept. 19	5.56	.76	.86				1.09				9.14
Sept. 20	6.02				1.34		1.35	1.17	1.03	.91	4.57
Sept. 21	3.63	.82	.93	1.08	1.24		1.25	1.07	.89	.79	4.57
Sept. 22	4.75	.89	1.00	1.14	1.32		1.21	.97	.82	.70	4.95
Sept. 26	4.75						1.19	.98	.82		4.75
Sept. 27	3.99				1.30		1.22	1.03	.85	.73	6.02
Sept. 28	7.04	.69	.82	.96	1.18						7.57
Sept. 29	4.37				1.28		1.35	1.18	1.06	.92	3.99
Sept. 30	3.30				1.30						4.17
Means		**.79**	**.89**	**1.03**	**1.25**		**1.19**	**.99**	**.81**	**.68**	
Departures		**+.05**	**+.05**	**+.06**	**+.11**		**+.03**	**+.01**	**−.02**	**−.04**	

BLUE HILL, MASS.

Sept. 1	11.5						0.82	0.55	0.42	0.33	11.5
Sept. 2	14.7		0.28	0.41	0.56	0.77	.61	.44	.33	.15	16.4
Sept. 4	14.7				.75		.75	.58	.45		15.3
Sept. 6	7.6	0.94	1.02	1.10	1.26	1.40	1.21				6.3
Sept. 7	7.6					1.40	1.22	1.02	.88	.78	5.6
Sept. 9	9.2	.81	.94	1.05	1.18	1.33	*1.05	.94	.82	.75	9.2
Sept. 11	8.8	.86	.96	1.07	1.22	1.36	1.22	1.06	.92	.82	8.8
Sept. 13	8.2					1.47					8.6
Sept. 14	10.3					1.49	1.18	1.02			9.2
Sept. 15	11.9				.85	1.13					13.7
Sept. 16	13.7				.83	1.05	.88	.67	.52	.44	17.5
Sept. 18	5.6					1.40	1.22	1.06	.92	.81	5.2
Sept. 19	6.5		1.00	1.12	1.25	1.47	1.28	1.10	.99	.90	6.5
Sept. 22	6.3	.92	1.01	1.11	1.24	1.36	1.16	1.01	.86	.75	5.4
Sept. 23	10.3				1.08	1.20					8.8
Sept. 24	8.8			.64	.85					.35	9.6
Sept. 28	9.2								.72	.63	10.3
Means		**.88**	**.87**	**.93**	**1.01**	**1.29**	**1.05**	**.86**	**.71**	**.61**	
Departures		**+.05**	**−.07**	**−.11**	**−.13**	**−.07**	**−.07**	**−.08**	**−.10**	**−.08**	

LATE REPORT

BLUE HILL, MASS.

Aug. 2	9.9					1.32	1.12	0.78			10.3
Aug. 3	12.8						.78	.60	0.48	0.39	14.3
Aug. 5	15.8						1.13	.93	.79	.50	10.3
Aug. 6	9.6							.91			9.2
Aug. 7	11.9									.37	14.3
Aug. 11	13.2			0.92	1.06		1.04	.88	.74	.60	6.1
Aug. 12	14.7			.86	1.03	1.21	1.12	.95	.83	.75	12.8
Aug. 14	16.9							.84	.68		13.2
Aug. 16	16.9				.68						16.4
Aug. 17	14.7		0.50	.58	.70						16.9
Aug. 23	13.2	0.62	.68	.77	.96	1.29	.95	.70	.52	.42	13.2
Aug. 24	12.8	.46	.58	.72	.89						13.7
Aug. 27	12.3								.64	.54	12.8
Aug. 28	11.1	.71	.80	.90							11.5
Means		**.60**	**.64**	**.79**	**.89**	**1.27**	**1.02**	**.82**	**.67**	**.51**	
Departures		**−.09**	**−.21**	**−.14**	**−.17**	**−.01**	**−.05**	**−.09**	**−.04**	**−.09**	

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Cambridge	Fairbanks	La Jolla	Miami	Riverside	Blue Hill	San Juan	Friday Harbor	Newport
	Gram-calories per square centimeter														
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Sept. 3	543	454	527	422	311	592	405	212	384	378	349	403	579	472	456
Sept. 10	467	441	511	449	392	503	435	160	405	415	381	456	623	373	476
Sept. 17	446	428	457	457	377	483	410	218	444	431	360	452	587	393	438
Sept. 24	325	289	418	280	215	375	235	133	346	382	340	262	627	321	240
	Departures of daily totals from normals														
Sept. 3	+156	+79	+69	+75	−18	+16	.....	+15	−83	−47	−131	+13	+8	+46	+11
Sept. 10	+98	+100	+78	+138	+73	−34	.....	−45	−76	−41	−71	+83	+48	−4	+64
Sept. 17	+81	+80	+29	+126	+76	−10	.....	+54	+40	−36	−54	+91	+29	+68	+79
Sept. 24	−22	−7	+38	+5	−65	−77	.....	+3	−10	+27	−60	−72	+91	+10	−89
	Accumulated departures since Jan. 1.														
	+16,415	+10,500	+6,643	+16,660	+6,144	+252	.....	+784	+3,143	−4,214	−5,157	+2,961	+8,391	+6,188	+2,597

LATE REPORTS

Station		Week beginning— July 30	Aug. 6	Aug. 13	Aug. 20	Aug. 27	Accumulated departures since Jan. 1
Twin Falls	Average daily total	534	597	569	469	[1] 489	+994
	Departure from normal	−16	+43	+66	−57	+3	
La Jolla	Average daily total	509	480	468	452	571	+4,046
	Departure from normal	−35	−36	−3	−61	+92	
Friday Harbor	Average daily total	674	601	621	516	370	+5,348
	Departure from normal	+105	+57	+81	+17	−57	

Station		Week beginning— July 2	July 9	July 16	July 23	Accumulated departures since Jan. 1
Twin Falls	Average daily total	574	591	688	580	+721
	Departure from normal	−21	−9	+73	+11	

[1] 6-day mean.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.) Superintendent, U. S. Naval Observatory. Data from measurements at the U. S. Naval Observatory from plates obtained at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millionths of Sun's visible hemisphere. For each day, below longitude, latitude, area of spot or groups, and spot count, are given respectively the assumed longitude of the center of the disk, assumed latitude of the center of the disk, tota larea of spots and groups, and total spot count]

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Longitude	Latitude	Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1939	*h m*		°	°	°					
Sept. 1	11 23	6592	−88	251	−18	87	242	2	VG	U. S. Naval.
		6591	−66	273	+4	65	121	2		
		(*)	−58	281	−11	62	12	3		
		6587	−26	313	−9	25	73	6		
		(*)	−23	316	−4	25	24	4		
		6586	−2	337	−8	16	194	8		
		6586	+5	344	−8	17	291	39		
		6585	+9	348	−15	24	1,939	63		
		6588	+20	359	+27	27	48	5		
		6590	+58	37	−5	60	12	2		
				(339)	(+7)		2,956	134		
Sept. 2	11 27	6592	−72	254	−18	76	339	2	G	Do.
		6591	−52	274	+4	52	97	1		
		6594	−40	286	+30	45	36	4		
		6587	−13	313	−9	20	36	2		
		(*)	+7	333	−18	24	24	4		
		6586	+11	337	−8	18	194	10		
		6586	+17	343	−8	23	291	30		
		6585	+22	348	−15	30	1,939	65		
		6588	+31	357	+28	36	97	11		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Longitude	Latitude	Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1939	*h m*		°	°	°					
Sept. 2		6588	+35	1	+24	38	24	2		
		6593	+36	2	+6	36	61	7		
		(*)	+55	21	−15	60	6	2		
				(326)	(+7)		3,144	140		
Sept. 3	12 14	6592	−58	254	−18	62	388	2	G	U. S. Naval.
		6591	−38	274	+4	38	73	3		
		6587	−1	311	−9	16	36	2		
		6586	+27	339	−8	32	145	7		
		6586	+32	344	−8	36	194	21		
		6585	+35	347	−15	41	1,891	50		
		6586	+36	348	−7	39	48	2		
		6588	+41	353	+29	45	97	10		
		6588	+46	358	+27	50	97	10		
		6588	+50	2	+25	52	12	3		
		6593	+50	2	+6	50	6	2		
				(312)	(+7)		2,987	112		
Sept. 4	11 4	6598	−80	220	−15	81	533	12	VG	Do.
		6598	−78	222	−12	80	436	7		
		6598	−70	230	−16	72	194	3		
		6597	−60	240	+19	61	145	13		
		6592	−45	255	−18	51	388	6		
		6596	−40	260	+12	41	12	3		
		6591	−25	275	+4	25	73	3		
		6587	+11	311	−9	19	36	6		
		6595	+25	325	+14	26	48	7		
		6586	+43	343	−8	45	339	31		
		6586	+49	349	−7	50	48	2		