SOLAR OBSERVATIONS

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

SOLAR RADIATION OBSERVATIONS, OCTOBER 1939

By IRVING F. HAND

Measurements of solar radiant energy received at the surface of the earth are made at nine stations maintained by the Weather Bureau, and at ten 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 descriptions 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 7:30 a. m. and at 1:30 p. m. (75th meridian time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, then 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 below normal at Washington, Madison, Lincoln, and Blue Hill.

Total solar and sky radiation was above normal at all stations except La Jolla, Twin Falls, and Miami. Data for the missing stations will be published as soon as they are available.

Polarization observations made at Madison on 3 days give an average of 64 percent, with a maximum of 69 percent on the 1st. These are close to normal for November.

LATE REPORTS

The total solar and sky radiation values obtained at Twin Falls for the weeks beginning Sept. 3, 10, 17, and 24, and Oct. 1, 8, 15, and 22 are 488, 368, 436, 393, 207, 290, 296, and 229 respectively, with corresponding departures of +8, −82, +26, +26, −157, −57, −29, and −61. Similar data for the same weeks in October at Miami are 373, 364, 307, and 363, with corresponding departures of −27, −5, −51, and −26.

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

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

Date	7:30 a. m.	Sun's zenith distance 78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.0°	75.7°	78.7°	1:30 p. m.
	75th mer. time	Air mass A. M.					P. M.				Local mean solar time
	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.*
WASHINGTON, D. C.											
Nov. 13	4.17		1.02	1.10	1.23						2.69
Nov. 15	4.57	0.40	.48	.69	1.07						5.79
Nov. 16	3.63	.85	1.00	1.18	1.32						2.16
Nov. 17	4.57	.66	.79	1.00	1.07		1.05				4.17
Nov. 24	3.00	.64									3.81
Nov. 27	1.68	.95									3.30
Nov. 28	4.57	.62	.75	.99	1.32						3.45
Nov. 29	3.30	.87	1.01	1.10	1.34						2.62
Means		.71	.84	1.01	1.22		(1.05)				
Departures		−.04	−.05	0.00	+.03		−.13				
MADISON, WIS.											
Nov. 2	3.15			1.24	1.39	1.57					2.87
Nov. 3	2.87			1.21							2.62
Nov. 8	2.87				1.42						2.74
Nov. 11	1.96							1.13			2.74
Nov. 13	3.30				1.02						4.17
Nov. 14	3.99							1.03			4.75
Nov. 16	4.57	0.79	1.02	1.14		1.62		1.13			4.75
Nov. 17	5.36	.75	.94	1.05		1.59		1.15			6.27
Nov. 27	2.62	.95	1.05	1.22		1.67		1.21			4.17
Nov. 28	2.87	.86	.95	1.13		1.48		1.05			3.81
Means		.84	.99	1.16	1.28	1.58		1.12			
Departures		−.05	−.01	0.00	−.03	+.03		0.00			
LINCOLN, NEBR.											
Nov. 1	1.78		1.13	1.26	1.43						2.49
Nov. 3	1.96	.50	.67	.92	1.21			1.20	1.05	0.93	2.87
Nov. 4	1.96	1.02	1.16	1.27	1.42						2.62
Nov. 8	3.30	.79	.94	1.17	1.37			1.14	1.02	.90	3.45
Nov. 10	2.36	1.03	1.15	1.29	1.42			1.28	1.11	.98	2.16
Nov. 14	3.15	.97	1.08	1.25	1.42			1.25	1.11	.96	3.30
Nov. 15	3.45	1.02	1.12	1.29	1.47			1.21	1.06	.95	3.63
Nov. 16	3.63	.93	1.06	1.18	1.36			1.19	1.00	.82	4.57
Nov. 20	2.16	.72	.79	.94				1.02	.89	.76	4.57
Nov. 21	2.16	.77	.63	.81	1.37						3.99
Nov. 22	1.60	.35	.41	.67				1.19	1.09	.97	4.75
Nov. 27	1.96	.51	.73	.91				1.04	.89	.76	3.45
Nov. 29	3.63	.47	.59	.79				.90	.77	.65	5.16
Means		.76	.88	1.06	1.39			1.14	1.00	.87	
Departures		−.14	−.14	−.11	+.03			−.04	−.04	−.05	
BLUE HILL, MASS.											
Nov. 1	4.2	0.81	0.96	1.11	1.25		1.20	1.00			3.6
Nov. 2	4.4	.51	.63	.77	.98						4.6
Nov. 3	3.6	.82	.91	1.04	1.19		1.20	1.07	0.96	0.85	5.6
Nov. 4	2.8	.77	.87	1.00			1.18	1.00	.86	.75	4.4
Nov. 6	3.2	.90	1.00	1.12	1.25		1.25	1.05	.91	.79	4.6
Nov. 7	3.3	.56	.73	.88	1.26						4.0
Nov. 9	2.9				1.30		1.29	1.06	1.05	.93	1.9
Nov. 11	4.4			1.05	1.16		1.15	1.04	.88	.76	3.0
Nov. 12	2.8	.84	.95	1.06	1.21		1.21				2.8
Nov. 14	1.3	.87	.99	1.08	1.23		1.23	1.11	.98	.91	1.7
Nov. 15	2.2	.93	1.01	1.12	1.27		1.27	1.12	.98	.91	3.3
Nov. 17	4.2				1.28		1.28	1.13	1.01	.90	2.8
Nov. 18	2.8						.97	.71	.56	.41	4.6
Nov. 23	2.9	.85	.95	1.05	1.21		1.21	1.03	.86	.77	4.0
Nov. 26	2.1						1.28	1.21	1.13	1.06	.9
Nov. 28	3.2			.97	1.17		1.17	.94	.83	.73	3.5
Nov. 29	3.2	.74	.85	.98	1.11						3.8
Means		.78	.89	1.02	1.19		1.21	1.04	.92	.82	
Departures		−.13	−.12	−.10	+.03		−.04	−.06	−.05	−.01	

[1] Extrapolated.

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

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	San Juan	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Newport	Friday Harbor	Cambridge	Albuquerque
	Gram-calories per square centimeter																	
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Oct. 29	254	199	290	137	202	345	472	47	243	303	228	--------	337	248	255	199	223	458
Nov. 5	278	217	253	179	203	292	536	76	236	159	318	308	252	229	251	62	222	300
Nov. 12	274	237	240	210	246	288	408	32	208	334	223	119	306	259	278	78	234	402
Nov. 19	114	105	184	76	127	256	453	12	191	292	313	316	292	119	142	121	124	314
Nov. 26	155	115	158	80	141	228	436	12	102	286	322	262	255	200	191	96	173	186
	Departures of daily total normals																	
Oct. 29	+7	+12	+50	−18	+20	+1	+21	+8	+21	−13	−92	--------	+32	+22	+9	+64	--------	--------
Nov. 5	+51	+47	+7	+43	+45	−13	+94	+39	+26	−135	−24	+15	−49	+22	−1	−47	--------	--------
Nov. 12	+76	+89	+31	+98	+111	+33	−32	+3	+42	+31	−108	−102	+9	+101	+70	−12	--------	--------
Nov. 19	−71	−27	−23	−42	0	+18	+11	−6	+34	+10	−18	+63	+18	−28	−11	+15	--------	--------
Nov. 26	−9	−10	−28	−12	+26	+6	−4	−1	−50	+17	+33	+38	−3	+39	+10	+1	--------	--------
	Accumulated departures since January 1																	
	+17,584	+12,348	+7,763	+19,026	+8,167	+763	+10,057	−1,386	−2,681	+3,822	−6,440	--------	−4,555	+3,591	+3,136	+5,957	--------	--------

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 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, total area of spots and groups, and total spot count]

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1939	*h. m.*		°	°	°	°				
Nov. 1	11 5	6662	−76	179	−7	75	436	12	G	U. S. Naval
		6661	−55	200	−18	58	145	10		
		6656	−4	251	−10	14	145	13		
		6657	+4	259	+5	4	630	39		
		6655	+11	266	+21	20	145	8		
		6652	+56	311	+13	55	97	1		
				(255)	(+4)		1,598	83		
2	11 8	6662	−63	178	−7	64	291	15	VG	Do.
		6661	−41	200	−18	46	194	13		
		(*)	−13	228	−17	24	48	4		
		6656	+9	250	−9	15	145	16		
		6657	+16	257	+5	17	679	45		
		6655	+24	265	+21	29	73	3		
		6652	+69	310	+13	67	97	2		
				(241)	(+4)		1,527	98		
3	11 16	6662	−49	179	−6	50	291	20	G	Do.
		6661	−28	200	−18	35	291	13		
		6663	−24	204	+20	28	24	3		
		6656	+23	251	−9	25	145	8		
		6657	+30	258	+5	30	630	20		
		6655	+37	265	+22	41	73	2		
		6652	+84	312	+14	83	97	1		
				(228)	(+4)		1,551	67		
4	12 37	6667	−75	139	+13	73	24	4	VG	Mt. Wilson
		6662	−35	179	−5	36	291	27		
		6661	−13	201	−17	24	242	35		
		6663	−9	205	+21	19	12	5		
		6665	−5	209	+13	10	12	1		
		6664	+2	216	−15	18	6	1		
		6656	+37	251	−9	38	97	3		
		6657	+44	258	+4	43	582	40		
		6655	+51	265	+21	53	73	4		
				(214)	(+4)		1,339	120		
5	13 2	6667	−60	141	+13	59	12	2	P	Do.
		6666	−39	162	−20	45	12	1		
		6668	−39	162	+9	38	48	4		
		6662	−21	180	−7	24	194	19		
		6661	+1	202	−17	20	242	10		
		6663	+4	205	+20	16	12	1		
		6664	+15	216	−16	24	12	1		
		6656	+51	252	−9	53	73	2		
		6657	+58	259	+4	57	436	18		
		6655	+63	264	+22	63	73	6		
				(201)	(+4)		1,114	64		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1939	*h. m.*		°	°	°	°				
6	10 57	6668	−27	162	+10	27	48	7	VG	U. S. Naval.
		6662	−9	180	−7	13	194	22		
		6661	+13	202	−17	23	242	27		
		6663	+18	207	+19	23	48	2		
		6656	+63	252	−9	64	97	1		
		6657	+70	259	+5	69	436	15		
		6655	+77	266	+21	76	48	2		
				(189)	(+4)		1,113	76		
7	10 54	6669	−88	88	−20	88	12	1	VG	Do.
		6668	−12	164	+10	13	24	1		
		6662	+6	182	−7	11	145	15		
		6661	+28	204	−16	33	145	11		
		6663	+29	205	+19	33	97	12		
		6656	+78	254	−9	77	97	1		
		6657	+85	261	+4	85	388	5		
				(176)	(+4)		908	46		
8	11 26	6672	−80	82	+11	79	36	3	G	Do.
		6669	−75	87	−20	77	145	1		
		6671	−38	124	−10	40	36	5		
		6662	+20	182	−7	23	73	13		
		6661	+42	202	−17	46	145	15		
		6663	+43	203	+20	45	48	5		
				(162)	(+4)		483	42		
9	10 21	6672	−67	82	+10	66	170	7	G	Do.
		6669	−61	88	−20	64	97	4		
		6671	−23	126	−11	26	48	6		
		6670	+10	159	+13	13	48	6		
		6662	+33	182	−7	39	48	10		
		6661	+57	206	−17	60	48	4		
				(149)	(+4)		459	37		
10	11 26	6673	−68	68	−9	68	6	1	G	Do.
		6672	−53	83	+11	53	194	17		
		6669	−48	88	−20	53	61	3		
		6671	−9	127	−10	16	97	10		
		6670	+24	160	+14	25	145	21		
		6662	+47	183	−7	49	12	3		
		6661	+70	206	−16	72	48	1		
				(136)	(+3)		563	56		
11	10 53	6675	−83	40	+27	80	48	2	VG	Mt. Wilson.
		6673	−55	68	−9	56	97	30		
		6672	−39	84	+11	40	291	30		
		6669	−34	89	−21	40	24	2		
		6671	+7	130	−10	14	97	14		
		(*)	+10	133	+21	21	12	1		
		6674	+15	138	−19	26	24	4		
		6670	+43	166	+14	44	194	28		
		6661	+80	203	−16	80	24	2		
				(123)	(+3)		811	113		