SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING JULY 1934

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged slightly above normal for July at all three Weather Bureau stations.

Table 2 shows an excess in the total solar and sky radiation received on a horizontal surface at all stations except Madison, Chicago, Pittsburgh, and Miami. The cumulative data now show that the country as a whole is considerably above normal for the first 7 months of the year. This, of course, has been a most appreciable factor in causing the recent drought conditions.

Table 3 shows rather high turbidity factors and low water-vapor content of the atmosphere, as might be expected because of the unusual dryness of the soil.

Polarization measurements made on 8 days at Washington give a mean of 55 percent, with a maximum of 61 percent on the 7th. At Madison, measurements made on 8 days give a mean of 58 percent, with a maximum of 62 percent on the 28th. All the above values are slightly below the July normals.

TABLE 1.—*Solar radiation intensities during July 1934*

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

WASHINGTON, D.C.

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	*1.0	2.0	3.0	4.0	5.0	e
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
July 3	17.37					1.12					15.65
July 5	18.59				0.86						21.28
July 6	20.57					1.20					22.00
July 7	19.23			0.88	1.05						20.57
July 16	16.20				.92	1.27					14.10
July 17	9.47		0.66	.79	1.00	1.36					10.97
July 18	15.11			.92	1.09						11.38
July 19	16.79				.90	1.31					19.89
July 21	20.57				.98	1.08					16.79
July 31	16.20			.84	1.01	1.28					15.65
Means			(.66)	.86	.98	1.23					
Departures			−.02	+.07	+.06	+.02					

* Extrapolated.

TABLE 1.—*Solar radiation intensities during July 1934*—Continued

MADISON, WIS.

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	1.0	2.0	3.0	4.0	5.0	e
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
July 2	11.81		0.85	0.96	1.11	1.33					11.81
July 7	9.47		.93	1.09	1.24	1.44					8.18
July 17	9.47		.83	.92	1.09	1.33					14.10
July 19	15.65					1.31					18.59
July 20	17.37				1.06	1.21					21.85
July 23	15.65				.89	1.30					21.85
July 24	17.96					1.36					16.20
July 25	19.23		.68	.83	1.00	1.26					17.96
July 28	8.81			1.07	1.28	1.49					9.14
July 30	10.59				1.22	1.42					10.59
July 31	10.97	0.63	.76	.89	1.07	1.37					10.59
Means		(.63)	.81	.96	1.11	1.35					
Departures		−.06	+.01	+.04	+.04	+.05					

LINCOLN, NEBR.

July 3	13.13				1.04	1.21					15.11
July 6	12.24						1.28	1.11	1.02	0.89	8.81
July 7	8.18		0.99	1.10	1.24	1.54	1.13	.96	.80	.66	10.59
July 10	12.68		.73	.88	1.02						14.10
July 12	17.96					1.33	1.04	.82	.70		13.61
July 14	15.11			.84	1.05	1.32	1.11	.93	.77	.61	13.61
July 16	14.60	0.68	.81	.95	1.11	1.28					9.83
July 17	16.20					1.26	1.03	.82	.67		13.61
July 18	10.21				1.11						7.57
July 19	8.81						1.01	.82	.68		6.76
July 20	7.29				1.04	1.31					5.79
July 21	9.83		.69	.84	1.05	1.26					9.83
Means		(.68)	.80	.92	1.08	1.31	1.10	.91	.77	.72	
Departures		−.02	+.02	+.02	±.00	±.00	+.03	+.02	+.01	+.01	

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July 2	14.1				1.00	1.39	1.13	0.98	0.84		10.6
July 3	18.0					1.19	.54				17.4
July 4	12.2				1.02	1.33	1.13				11.0
July 5	8.5					1.35					9.8
July 7	19.9				.89	1.11					19.2
July 8	12.7						1.15	1.04			11.8
July 9	9.5			1.01	1.20	1.45	1.23				9.5
July 11	12.2			1.12	1.23	1.35					20.6
July 12	11.8						1.23	1.01	.84		18.6
July 13	14.1				.74	1.21					16.8
July 16	14.6					1.42					12.7
July 17	9.1				1.20	1.43	1.13				7.6
July 18	9.5					1.43					6.3
July 19	11.0					1.35	1.00				9.5
July 22	10.6					1.39	1.24	1.10	.97		9.1
July 23	8.5						1.10				9.1
July 24	10.2					1.38	1.13	.90	.73		9.8
July 30	14.6					1.42	1.10				15.6
Means				1.06	1.04	1.35	1.09	1.01	.84		

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

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Frida Harbo
	Gram-calories per square centimeter														
1934	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*
July 2	662	477	587	440	512	771	431	379	688	452	513	386	617	590	645
July 9	594	470	598	440	526	761	438	360	733	517	530	448	627	616	489
July 16	607	493	650	(1)	612	751	520	340	680	466	503	505	619	616	545
July 23	436	541	574	(1)	346	714	510	366	625	650	462	378	574	390	592
	Departures from weekly normals														
July 2	+146	−51	+7	−22	+78	+70	−45	−52	+66	+10	−29	+4			
July 9	+100	−62	+22	−4	+75	+66	−50	−47	+127	+106	−8	+70			
July 16	+123	−24	+74		+191	+74	+33	−58	+82	+24	−37	+32			
July 23	−49	+33	+24		−77	+62	+28	−17	+43	+224	−72	+28			
	Accumulated departures on July 29														
	+2,793	+2,394	+6,888	+6,489	[2] +12,117	+6,300	−2,156	−537	+5,397	+12,796	−3,864	+6,447			

[1] Pyrheliometer broken.

[2] Readings reduced by 2½ percent since change in recorder characteristics.

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during July 1934, and determinations of atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

Date and hour angle	Solar altitude		Air mass	I_m	I_y	I_r	βI_{m-r}	βI_{y-r}	β_{mean}	$\frac{I_{w=o}}{1.94}$ (Percentage of solar constant)	$\frac{I_{w=o}-I_m}{1.94}$ (Percentage of solar constant)	w	Air-mass type
AMERICAN UNIVERSITY, WASHINGTON, D.C.													
July 6	°	′	m	gr. cal.	gr. cal.	gr. cal.						mm	
1:39 a	63	43	1.12	1.136	0.902	0.720	0.140	0.130	0.135	72.4	11.1	21	TG.
1:36 a	63	58	1.11	1.129	.905	.721	.148	.130	.139	72.0	11.9	30	
July 17													
5:22 a	20	20	2.86	.806	.670	.591	.112	.176	.144	48.5	5.7	2	PC.
5:17 a	21	17	2.74	.832	.671	.592	.095	.180	.138	50.0	5.6	2	PP aloft.
5:04a	23	46	2.47	.894	.753	.620	.095	.101	.098	59.4	11.8	14	
4:59 a	24	43	2.38	.928	.755	.622	.085	.105	.095	61.5	12.0	15	
4:55 a	25	30	2.32	.932	.771	.636	.092	.118	.105	60.0	10.4	9	
4:51 a	26	19	2.25	.941	.772	.637	.090	.124	.107	59.0	9.0	5	
4:47 a	27	03	2.20	.970	.794	.644	.085	.089	.087	63.7	12.1	16	
4:43 a	27	49	2.14	.965	.795	.645	.088	.092	.090	65.8	14.4	39	
July 31													
4:48 a	25	14	2.28	.927	.759	.619	.085	.089	.087	62.5	13.1	21	PC.
4:44 a	26	00	2.28	.946	.760	.620	.078	.092	.085	63.5	13.0	22	PP aloft.
3:34 a	39	35	1.57	1.130	.878	.700	.070	.088	.079	72.8	13.1	32	
3:29 a	40	33	1.54	1.141	.879	.701	.075	.091	.083	72.0	11.6	16	
2:20 a	53	23	1.25	1.112	.882	.699	.115	.115	.115	73.4	13.2	31	
2:18 a	53	54	1.24	1.141	.882	.699	.095	.118	.106	74.0	13.6	32	
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July 2													
4:11 a	35	07	1.65	1.109	0.776	0.622	0.083	0.100	0.092	70.3	11.1	14.0	N_{PP}.
3:37 a	41	24	1.51	1.164	.803	.644	.076	.106	.091	72.3	10.3	10.0	
2:39 a	52	54	1.25	1.235	.860	.675	.084	.071	.078	77.6	11.8	25.0	
2:16 a	55	54	1.20	1.306	.910	.703	.069	.029	.049	82.7	13.1	40.0	
0:19 a	70	26	1.06	1.365	.955	.746	.071	.033	.052	83.6	11.9	43.0	
1:37 a	62	10	1.13	1.312	.905	.699	.055	.037	.046	83.5	13.6	47.0	N_{PC}.
4:04 p	36	31	1.68	1.191	.833	.656	.054	.058	.056	76.0	12.5	24.0	
4:26 p	32	19	1.87	1.150	.828	.649	.059	.048	.054	74.3	13.0	24.0	
July 4													
3:12 a	45	09	1.41	1.270	.891	.696	.055	.043	.049	80.2	12.5	28.0	P_C.
2:57 a	48	36	1.33	1.312	.920	.719	.053	.037	.045	81.7	12.2	27.0	
July 5													
1:45 p	60	44	1.14	1.302	.888	.695	.140	.063	.102	75.8	6.4	2.9	N_{PC}.
3:28 p	42	54	1.47	1.190	.826	.665	.080	.101	.090	72.9	9.5	7.3	T_C aloft.
July 7													
1:17 a	64	47	1.10	1.081	.767	.608	.166	.188	.177	68.3	10.7	19.0	T_C.
July 8													
5:24 p	21	21	2.74	1.067	.736	.582	.073	.047	.060	66.5	10.6	5.4	P_C.
5:39 p	17	55	3.23	1.015	.729	.578	.026	.040	.033	70.3	16.2	60.0	
July 9													
3:10 a	45	56	1.39	1.329	.922	.724	.033	.033	.033	83.1	12.9	35.5	P_C.
2:32 a	57	42	1.18	1.372	.941	.729	.036	.022	.029	85.8	12.2	25.0	
1:10 a	66	10	1.09	1.428	.974	.760	.032	.025	.028	86.7	10.6	19.0	
0:09 p	70	04	1.06	1.425	.980	.764	.036	.019	.028	87.1	11.2	35.0	
1:27 p	69	24	1.07	1.418	.959	.749	.032	.031	.032	86.5	10.9	22.0	N_{PC}.
3:33 p	41	43	1.50	1.343	.919	.720	.035	.028	.032	82.4	10.9	14.0	
4:22 p	32	39	1.86	1.262	.885	.705	.033	.045	.039	78.5	11.0	13.0	
July 10													
3:35 a	41	17	1.51	1.256	.880	.697	.056	.058	.057	77.5	10.6	10.6	N_{PC}.
2:17 a	55	11	1.22	1.349	.921	.727	.044	.057	.050	82.1	10.2	9.9	
0:27 a	69	14	1.07	1.407	.962	.752	.043	.034	.038	85.6	10.5	18.0	
1:26 p	69	18	1.07	1.401	.958	.738	.033	.008	.020	88.2	13.6	49.0	N_{PC}.
3:07 p	46	24	1.38	1.313	.904	.705	.039	.037	.038	82.5	12.6	30.0	
4:30 p	31	02	1.94	1.227	.872	.672	.030	.008	.019	81.4	16.0	60+	
July 11													
4:00 a	36	35	1.67	1.264	.886	.702	.043	.045	.044	78.3	11.0	14.0	N_{PC}.
3:21 a	43	46	1.44	1.260	.880	.698	.062	.062	.062	80.7	13.6	38.0	
0:06 a	69	51	1.06	1.335	.908	.710	.075	.062	.068	81.7	9.6	12.0	
July 13													
2:36 a	51	38	1.27	1.048	.749	.594	.150	.142	.146	68.5	12.7	34.0	N_{PC}.
0:39 a	67	05	1.09	1.154	.808	.641	.136	.136	.136	73.0	11.6	39.0	T_C aloft.
July 24													
3:15 a	43	40	1.45	1,328	.927	.729	.045	.035	.040	81.2	9.5	8.0	N_{PC}.
2:03 a	56	03	1.20	1.380	.963	.760	.052	.041	.046	83.1	8.7	27.0	T_C aloft.
July 30													
4:50 p	25	56	2.28	1.068	.778	.609	.056	.046	.051	71.0	13.4	27.0	P_C, T_C aloft.

Atmospheric conditions.
July 6. Wind, SW. 7; temperature, 22°C., visibility, 12 miles.
July 17. Wind, NE. 10; temperature, 21° C., visibility, 20 miles.
July 31. Wind, SW. 3; temperature, 20° C., visibility, 30 miles.

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during July 1934, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated.*—Continued

Atmospheric conditions during solar radiation measurements—Blue Hill Meteorological Observatory of Harvard University

Date and time from apparent noon	Air temperature	Wind (Beaufort scale)	Visibility. Scale, 0–10	Sky blueness	Cloudiness and remarks
July 1934	°C.				
2; 4:11 a	23.3	WNW 4	8	7	2 Ci.
2; 3:37 a	25.6	WNW 3	8	6	1 Ci.
2; 2:16 a	25.6	WNW 4	8	7	1 Ci.
2; 0:19 a	26.7	WNW 4	8	8	Few Ci; 1 Cu.
2; 1:37 p	27.8	WNW 4	9	6	1 Ci, 2 Cu. Wind gusty.
2; 4:04 p	28.3	W 4	8+	8	3 Cu; Wind gusty.
4; 3:12 a	21.7	NW 2	9	6	1 Ci, 1 Cu.
5; 1:45 p	26.1	WSW 4	9	6	Few Ci, 2 Acu.
5; 3:28 p	22.2	SWxW 5	9	6	2 Ci, 3 Acu, few Cu.
7; 1:17 a	29.4	SW 3	6–7		Few Ci, Cu, Stcu, Frcu; moderate haze.
8; 5:24 p	22.2	SExE 2	9	7	3 Acu, few Cu.
9; 3:10 a	18.6	NNE 6	8	5	1 Acu.
9; 1:10 a	19.7	NE 4	9	6	1 Acu; lt. hz.; smoke to the N-SW.
9; 1:27 p	20.3	ENE 2	9	7	1 Acu, few Frcu; smoke over Boston.
9; 4:22 p	21.9	E 1	9	7	2 Ci, few Cu.
10; 2:17 a	18.3	ENE 2	8	5	Few Acu, Cu.
10; 0:27 a	18.3	ENE 2	8	5	1 Stcu.
10; 3:07 p	20.0	NE 3	9	5	1 Cu. Smoke NW of Boston.
11; 4:00 a	18.3	SSE 1	8	5	2 Ci in NW; smoke on horizon.
11; 3:21 a	20.0	SExS 1	7–8	5	2 Ci in NW; smoke on horizon.
11; 0:06 a	27.2	SE 1	8	4	10 Ci, very thin sheet.
13; 2:36 a	20.6	SSW 2	7–8		2 Ci, few Cu, moderate haze.
13; 0:39 a	25.0	SSW 2	8		4 Stcu.
24; 3:15 a	21.7	ENE 1	8	5	2 Ci, few Cu.
24; 2:03 a	21.7	N 1			4 Ci, few Cu.
30; 4:30 p	22.4	ENE 3	8		1 Acu in south; few Ci in southeast.

POSITIONS AND AREAS OF SUN-SPOTS

Communicated by Capt. J. F. Hellweg, U.S. Navy, Superintendent U.S. Naval Observatory. Data furnished by the U.S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1934	h. m.	°	°	°				
July 1	12 0	No spots						Mount Wison.
July 2	11 14	No spots						U.S. Naval.
July 3	11 18	No spots						U.S. Naval.
July 4	12 20	No spots						U.S. Naval.
July 5	11 4	No spots						U.S. Naval.
July 6	14 30	−80.5	271.8	+21.5	448		448	Harvard.
July 7	11 15	−68.0	272.8	+24.0	153		153	Mount Wilson.
July 8	13 4	−55.5	271.2	+24.0		93	93	U.S. Naval.
July 9	11 9	−42.5	272.0	+24.0		131	131	U.S. Naval.
July 10	14 28	−28.0	271.4	+24.0		131	131	U.S. Naval.
July 11	11 15	−79.0	209.0	+2.0	46			U.S. Naval.
		−15.5	272.5	+24.0	123		169	
July 12	14 55	−63.0	209.7	+1.5	46			U.S. Naval.
		−1.0	271.7	+24.0	108		154	

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during July 1934, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated.*—Continued

POSITIONS AND AREAS OF SUN-SPOTS—Continued

Date	Eastern standard time	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1934	h. m.	°	°	°				
July 13	13 25	−50.0	210.3	+1.0	69			U.S. Naval.
		+11.0	271.3	+24.0	108		177	
July 14	11 5	−37.5	210.8	+1.0	69			U.S. Naval.
		+23.0	271.3	+24.0	108		177	
July 15	18 0	−20.0	211.3	+1.0	122			Mount Wilson.
		+41.0	272.3	+25.0	137		259	
July 16	11 8	−11.0	210.9	+1.0	62			U.S. Naval.
		+49.5	271.4	+25.0	108		170	
July 17	13 20	+3.0	210.4	+1.5	54			U.S. Naval.
		+63.0	270.4	+25.0	62		116	
July 18	11 13	+17.0	212.4	+1.5	46			U.S. Naval.
		+76.0	271.4	+25.0	46		92	
July 19	11 16	+30.0	212.1	+1.5	39		39	U.S. Naval.
July 20	13 26	+44.0	211.7	+1.5	8		8	U.S. Naval.
July 21		No spots						Harvard.
July 22	13 48	No spots						U.S. Naval.
July 23	11 17	No spots						U.S. Naval.
July 24	13 21	No spots						U.S. Naval.
July 25	11 38	No spots						U.S. Naval.
July 26	13 16	No spots						U.S. Naval.
July 27	9 0	No spots						Mount Wilson.
July 28	11 10	−10.0	53.0	+11.0		5		Mount Wilson.
		+10.0	73.0	−25.0		5	10	
July 29	11 15	+23.0	72.8	−25.0		7	7	Mount Wilson.
July 30	11 32	No spots						U.S. Naval.
July 31	11 29	No spots						U.S. Naval.
Mean daily area for 31 days							75	

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR JULY 1934

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

July 1934	Relative numbers	July 1934	Relative numbers	July 1934	Relative numbers
1	0	11	*d* 24	21	7
2	0	12	*b* 24	22	0
3	0	13	25	23	0
4	0	14	24	24	7
5	0	15	17?	25	8
6	*d* 8	16	23	26	0
7	8	17	17	27	7?
8	11	18	17	28	7
9	11	19	17	29	0
10	18	20	8	30	0
				31	0

Mean: 31 days=9.3.

b=Passage of a large group or spot through the central meridian.
d=Entrance of a large or average-sized ctener of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. Little, in charge]

By L. T. SAMUELS

It will be noted that table 1 contains marked differences both in the names and number of stations from those given heretofore. This is owing to the expanded aerological program which became effective July 1, 1934, according to which daily flights are made at a number of Army and Navy stations in addition to those at Weather Bureau stations. The latter have been relocated in all cases, except Omaha, in order to obtain a better distribution over the country as a whole. Also, the times of observations, and maximum heights attained, at the military stations have been standardized to conform to those of the Weather Bureau in practically all cases. Because of the large number of new stations, it is impossible at present to determine departures from the normals, except in a few cases.

The free-air temperatures for July averaged highest over San Diego and lowest over Spokane. It is interesting to note the free-air temperatures at Billings and Cheyenne as compared with those far to the south. The action of insolation over this Plateau to cause higher temperatures of the air for considerable elevations above the surface, in contrast to those of the free air over adjacent low-lying regions for corresponding elevations above sea level, is thus brought out. Moreover, Cheyenne showed the most pronounced average temperature inversion directly off the surface of all the stations.