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SOLAR OBSERVATIONS

SOLAR RADIATION OBSERVATIONS DURING SEPTEMBER 1936

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged slightly below normal for September at both Washington and Madison, and close to normal at Lincoln.

Table 2 shows a deficiency in the total solar and sky radiation received on a horizontal surface at Madison, Lincoln, Chicago, Twin Falls, Miami, and New Orleans, and an excess at all other stations.

Polarization observations taken at Washington on 6 days give a mean of 55 percent with a maximum of 64 percent on the 25th. At Madison, observations on 6 days give a mean of 62 percent with a maximum of 69 percent on the 24th. These values are close to the September normals.

TABLE 1.—*Solar radiation intensities during September 1936*

[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] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Sept. 1	10.21	0.50	0.60	0.76	0.98	------	------	------	------	------	10.21
Sept. 4	10.21	------	------	.60	.80	------	------	------	------	------	11.81
Sept. 5	11.38	------	------	.75	.92	------	------	------	------	------	10.97
Sept. 8	14.10	.58	.70	.83	1.02	1.29	------	------	------	------	11.76
Sept. 16	14.10	------	.64	.78	.98	------	------	------	------	------	14.60
Sept. 22	16.20	------	------	.64	.85	------	------	------	------	------	13.13
Sept. 23	16.20	------	.19	.54	.69	------	------	------	------	------	13.61
Sept. 25	5.56	------	1.06	1.19	1.35	1.50	1.30	1.20	1.10	1.05	5.36
Sept. 26	7.04	------	------	------	1.00	------	------	------	------	------	8.18
Means	------	(.54)	.64	.76	.95	(1.40)	(1.30)	(1.20)	(1.10)	(1.05)	------
Departures	------	−.15	−.11	−.10	−.09	------	+.23	+.33	+.35	+.36	------

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during September 1936*—Con.

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] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Sept. 4	10.59	------	------	.91	------	------	------	------	------	------	13.13
Sept. 8	13.61	------	.91	1.08	------	------	------	------	------	------	13.61
Sept. 17	6.02	------	------	------	------	1.46	------	------	------	------	6.50
Sept. 18	7.87	------	.79	.98	1.15	------	------	------	------	------	8.48
Sept. 21	8.81	------	.91	1.15	1.28	1.56	------	1.14	------	------	10.59
Sept. 22	12.24	------	------	------	------	------	1.17	------	------	------	17.37
Sept. 23	14.60	.62	.76	.90	1.09	------	------	------	------	------	17.37
Sept. 24	5.79	1.03	1.08	1.22	1.37	1.56	------	------	------	------	6.27
Sept. 25	6.50	.73	.81	.96	1.14	------	1.05	------	------	------	8.48
Means	------	.80	.88	1.03	1.21	1.53	(1.11)	(1.14)	------	------	------
Departures	------	−.04	−.03	.00	+.05	------	−.07	+.11	------	------	------

LINCOLN, NEBR.

Sept. 5	18.59	0.78	0.90	1.02	1.21	1.40	------	------	------	------	19.23
Sept. 9	13.61	.90	.98	1.11	1.26	1.49	1.25	1.10	0.96	0.84	13.13
Sept. 14	13.61	------	.92	1.08	1.23	------	------	------	------	------	15.11
Sept. 16	8.81	------	------	------	------	------	------	1.11	.98	.89	6.02
Sept. 17	6.76	------	1.02	1.15	1.35	1.55	1.28	1.05	.87	.76	5.16
Sept. 21	9.83	.83	.93	1.08	1.26	------	1.22	1.05	.90	.72	9.83
Sept. 22	12.24	.86	.96	1.10	1.26	------	------	------	------	------	13.13
Sept. 23	15.65	------	------	------	------	------	1.07	.80	.54	.41	6.27
Sept. 24	5.16	.84	.93	1.06	1.27	------	1.15	.93	.75	.63	4.95
Sept. 30	7.04	------	------	------	------	------	1.28	.75	.55	.49	8.81
Means	------	.85	.95	1.09	1.26	1.48	1.21	.97	.79	.68	------
Departures	------	+.11	+.11	+.12	+.13	------	+.05	−.01	−.05	−.05	------

BLUE HILL, MASS.

Sept. 1	8.2	------	------	1.10	1.18	1.28	1.02	0.88	0.77	0.62	6.8
Sept. 2	7.9	------	------	------	.98	------	------	------	------	------	10.3
Sept. 4	10.3	------	------	------	------	1.24	1.12	------	------	------	10.3
Sept. 6	10.7	0.82	0.91	1.01	1.17	1.28	------	------	------	------	11.1
Sept. 7	11.5	------	.48	.58	.76	------	------	------	------	------	12.8
Sept. 8	15.8	------	------	------	.96	1.10	------	------	------	------	17.5
Sept. 9	15.3	------	------	.67	.86	1.25	------	------	------	------	16.4
Sept. 11	11.9	------	------	------	------	1.21	.93	.73	------	------	13.7
Sept. 14	7.1	------	------	1.05	1.22	1.40	------	------	------	------	6.1
Sept. 16	12.3	------	------	------	------	1.16	.86	------	------	------	14.3
Sept. 17	14.7	------	------	.60	------	------	------	------	------	------	14.7
Sept. 19	9.6	------	------	1.08	1.25	1.44	------	------	------	------	8.8
Sept. 22	13.7	------	------	------	------	------	.91	------	------	------	11.5
Sept. 23	13.7	------	------	------	------	1.17	1.05	.92	.78	------	14.3
Sept. 24	14.3	------	------	------	------	1.35	------	------	------	------	15.3
Sept. 25	5.6	------	1.09	1.23	1.35	1.49	1.32	------	------	------	5.2
Sept. 26	6.1	------	.93	1.10	1.16	1.24	1.19	------	------	------	7.4
Sept. 28	11.1	------	------	------	------	1.44	1.18	------	------	------	5.1
Sept. 29	4.2	------	------	1.08	1.25	1.36	------	------	------	------	6.3
Means	------	.82	.85	.95	1.10	1.29	1.06	.84	.76	.62	------

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

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca
	Gram-calories per square centimeter															
1936	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Sept. 3	556	351	465	386	427	591	170	436	502	468	355	497	480	490	495	410
Sept. 10	371	202	378	288	330	590	271	424	514	406	318	479	316	560	361	322
Sept. 17	448	397	482	387	229	530	180	437	390	393	402	424	286	457	310	469
Sept. 24	293	263	297	222	274	478	140	402	390	319	307	445	406	454	357	265
	Departures from weekly normals															
Sept. 3	+173	−23	+6	+48	+113	+21	−17	−39	.....	+31	−68	+3	+120	.....	+84	+62
Sept. 10	+5	−133	−49	−6	+17	+45	+56	−30	.....	−18	−8	+17	−27	.....	+1	−30
Sept. 17	+82	+53	+61	−84	−70	+36	+33	+25	.....	−40	+94	−11	−46	.....	−39	+127
Sept. 24	−59	−29	−77	+9	−4	+13	+17	−29	.....	−88	−42	+32	+73	.....	+13	−27
	Accumulated departures on Sept. 30															
	+5,593	+2,422	+7,042	+10,766	+7,021	+5,089	+4,151	−1,806	.....	7,819	.....	−21	−434	.....	+553	+1,743

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during September 1936 and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w	Air-mass type
									Percentage of solar constant			
1936												
Sept. 1	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
1:12 a. m.	55 18	1.21	1.091	0.779	0.620	0.158	0.142	0.150	68.4	11.1	25.0	NPc
1:07 a. m.	54 49	1.22	1.086	.779	.620	.160	.138	.149	68.4	11.4	25.8	
Sept. 8												
3:10 a. m.	35 59	1.70	1.066	.770	.616	.110	.096	.103	66.6	11.1	13.0	NPc→TM
3:06 a. m.	36 41	1.67	1.057	.770	.616	.120	.098	.109	66.6	11.5	13.6	
Sept. 25												
4:11 a. m.	20 14	2.88	1.200	.880	.720	.040	.038	.039	67.8	5.9	1.8	NPc
4:06 a. m.	21 09	2.76	1.209	.880	.720	.042	.040	.041	67.6	4.1	1.0	
3:34 a. m.	26 55	2.20	1.306	.966	.783	.056	.028	.042	73.7	6.3	2.2	
3:31 a. m.	27 37	2.13	1.320	.960	.783	.053	.031	.042	73.9	5.8	2.1	
3:13 p. m.	30 40	1.95	1.312	.953	.748	.046	.010	.028	67.7	8.6	4.2	
3:18 p. m.	30 06	1.99	1.297	.953	.748	.054	.010	.027	66.9	9.4	4.8	

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), 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
1936	*h. m.*	°	°	°				
Sept. 1	11 20	−72.0	320.0	−17.0	15	.....	.....	U. S. Naval.
		−59.0	333.0	+14.0	.....	31	.....	
		+24.0	56.0	−27.5	.....	432	.....	
		+42.5	74.5	−22.0	15	.....	.....	
		+62.0	94.0	−11.0	.....	39	.....	
		+77.0	109.0	−17.0	15	.....	.....	
		+78.0	110.0	−25.5	.....	15	562	
Sept. 2	12 25	−70.0	308.2	+28.0	9	.....	.....	Mt. Wilson.
		−65.0	313.2	−19.0	.....	54	.....	
		−45.0	333.2	+14.0	32	.....	.....	
		+38.0	56.2	−26.0	.....	356	.....	
		+58.0	76.2	−21.5	11	.....	.....	
		+72.0	90.2	−9.0	.....	20	482	
Sept. 4	11 40	−45.5	306.7	−19.0	.....	123	.....	U. S. Naval.
		+21.5	13.7	−16.0	.....	93	.....	
		+62.0	54.2	−27.0	.....	370	586	
Sept. 5	11 12	−43.0	296.3	−18.0	.....	31	.....	Do.
		−32.0	307.3	−19.0	.....	216	.....	
		−18.0	321.3	+9.0	.....	93	.....	
		+35.0	14.3	−17.0	.....	31	.....	
		+76.0	55.3	−27.0	.....	216	587	
Sept. 6	13 10	−18.0	307.0	−19.0	.....	247	.....	Do.
		−2.0	323.0	+9.0	.....	216	463	
Sept. 7	10 50	−3.0	310.1	−18.5	.....	123	.....	Do.
		+10.0	323.1	+9.0	.....	154	277	

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
1936	*h. m.*	°	°	°				
Sept. 8	11 7	+11.0	310.7	−18.0	.....	108	.....	U. S. Naval.
		+24.0	323.7	+9.0	.....	123	231	
Sept. 9	11 4	+13.5	300.0	−15.5	.....	123	.....	Do.
		+25.0	311.5	−18.5	.....	123	.....	
		+39.0	325.5	+9.0	.....	278	524	
Sept. 10	15 21	−59.0	212.0	+24.0	15	.....	.....	Do.
		+29.5	300.5	−15.5	.....	247	.....	
		+40.0	311.0	−19.0	.....	154	.....	
		+55.0	326.0	+9.0	.....	370	786	
Sept. 11	13 11	−70.0	188.9	−19.5	62	.....	.....	Do.
		+42.0	300.9	−16.0	.....	340	.....	
		+52.0	310.9	−18.0	93	.....	.....	
		+68.0	326.9	+9.0	.....	278	773	
Sept. 12	12 9	−77.0	169.3	+16.0	8	.....	.....	Do.
		−68.0	178.3	+14.5	.....	154	.....	
		−58.0	188.3	−19.5	.....	123	.....	
		−42.0	204.3	+24.0	.....	93	.....	
		+55.0	301.3	−15.5	.....	494	.....	
		+66.0	312.3	−17.0	93	.....	.....	
		+81.0	327.3	+9.5	.....	154	1,119	
Sept. 13	12 0	−55.0	178.2	+16.0	.....	135	.....	Mt. Wilson.
		−41.0	192.2	−19.0	.....	105	.....	
		−29.0	204.2	+16.0	.....	5	.....	
		−28.0	205.2	+24.0	.....	9	.....	
		+17.0	250.2	−30.0	.....	127	.....	
		+48.0	281.2	+12.0	.....	9	.....	
		+68.0	301.2	+14.0	.....	7	.....	
		+70.0	303.2	−15.0	.....	571	.....	
		+80.0	313.2	−16.0	55	.....	.....	
		+88.0	321.2	+18.0	.....	33	1,056	