SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING SEPTEMBER, 1928

By HERBERT H. KIMBALL, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1924, **52**:42; January, 1925, **53**:29, and July, 1925, **53**:318.

Table 1 shows that in general solar radiation intensities averaged close to normal values for September at all three stations.

Table 2 shows that the total radiation received on a horizontal surface directly from the sun and diffusely from the sky was above the September normal at Madison and Lincoln, and below at Washington.

Skylight polarization measurements made at Washington on four days give a mean of 52 per cent with a maximum of 55 per cent on the 26th. At Madison measurements made on 6 days give a mean of 66 per cent with a maximum of 73 per cent on the 4th. These are below the corresponding averages for September at Washington, but close to normal at Madison.

TABLE 1.—*Solar radiation intensities during September, 1928*

[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	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Washington, D. C.											
Sept. 10	14.10	0.21	0.30	0.41	0.68	0.89	0.72				15.11
Sept. 13	18.59					1.33					15.11
Sept. 14	12.24	0.76	0.91	1.02	1.16	1.47	1.13	0.93			10.59
Sept. 22	10.97				1.21	1.55					5.79
Sept. 24	6.76	0.71	0.79	0.92	1.17						4.75
Sept. 26	4.95	0.83	0.94	1.06	1.19	1.44					4.95
Sept. 27	6.76				1.24						6.27
Sept. 28	6.02	0.69	0.81	0.94	1.16	1.45					4.57
Means		**0.64**	**0.75**	**0.87**	**1.12**	**1.36**	**(0.92)**	**(0.93)**			
Departures		**−0.05**	**±0.00**	**±0.00**	**+0.07**	**+0.03**	**−0.13**	**+0.08**			
Madison, Wis.											
Sept. 4	7.29			1.05	1.22	1.44					7.57
Sept. 6	8.18				1.07	1.26					7.57
Sept. 7	8.81				0.87	1.11					9.83
Sept. 19	7.57				1.14		1.22				7.29
Sept. 20	8.48					1.35					7.87
Sept. 21	8.48					1.50					6.76
Sept. 22	5.79		0.99	1.12							6.76
Sept. 24	3.81				1.27						3.45
Sept. 27	3.81	0.97	1.04	1.13	1.29	1.50	1.28				4.75
Sept. 29	6.02				1.16	1.27	1.00				7.04
Means		**(0.97)**	**(1.02)**	**1.10**	**1.15**	**1.35**	**1.17**				
Departures		**+0.08**	**+0.11**	**+0.06**	**−0.02**	**−0.03**	**+0.01**				
Lincoln, Nebr.											
Sept. 3	6.27			1.14	1.26	1.59					5.79
Sept. 4	6.50						1.20				7.87
Sept. 5	9.14		0.83	0.98	1.16	1.39					10.59
Sept. 7	10.97		0.72	0.84	1.03	1.32		0.83	0.69	0.58	10.97
Sept. 8	10.59		0.73	0.87	1.06	1.36	1.05	0.88	0.74	0.64	14.10
Sept. 12	10.97		0.95	1.03	1.23	1.48					11.38
Sept. 15	8.18		0.94	1.05	1.20	1.46	1.18	0.97	0.80	0.72	6.50
Sept. 18	6.27						0.94	0.68	0.54		5.79
Sept. 21	6.02			1.09	1.28	1.45	1.23	1.14	1.02	0.91	5.16
Sept. 22	5.36		0.91	1.05	1.21		1.21	1.09	0.95	0.83	6.27
Sept. 24	5.16					1.33	1.24	1.08	0.94	0.82	5.16
Sept. 25	2.87					1.45	1.22	1.03	0.81	0.76	2.87
Sept. 27	4.37				1.12	1.39					3.81
Sept. 28	6.76						0.95				7.87
Sept. 29	5.36	0.87	0.94	1.09	1.29	1.50	1.29	1.04	0.97	0.77	3.81
Means		**(0.87)**	**0.84**	**1.00**	**1.17**	**1.42**	**1.15**	**0.97**	**0.83**	**0.75**	
Departures		**+0.11**	**−0.03**	**−0.01**	**−0.02**	**+0.02**	**±0.00**	**−0.01**	**±0.00**	**+0.02**	

* Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation						Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Twin Falls	Washington	Madison	Lincoln
1928	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Sept. 3	268	451	503	370	272	600	−108	+82	+66
Sept. 10	397	292	456	322	283	536	+22	−50	+51
Sept. 17	249	411	396	348	251	586	−99	+77	+12
Sept. 24	278	367	392	303	242	546	−58	+76	+49
Excess or deficiency since first of year on Sept. 30							−2,501	+976	−520

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. C. S. Freeman, Superintendent U. S. Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Yerkes, and Mount Wilson Observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1928	*H. m.*	°	°	°			
Sept. 1 (Naval Observatory).	11 54	−70.5	8.1	−15.0	77		
		−52.5	26.1	−16.0	6		
		−39.5	39.1	+20.0	12		
		−33.0	45.6	+8.0	93		
		+27.5	106.1	+5.5	46		
		+51.0	129.6	+16.0		185	
		+64.0	142.6	+14.5	154		
		+71.0	149.6	−21.0	62		635
Sept. 2 (Naval Observatory).	13 27	−57.0	7.5	−14.5	77		
		−38.0	26.5	−16.0	25		
		−18.5	46.0	+8.0	77		
		+32.5	97.0	−8.5		46	
		+41.5	106.0	+5.5	37		
		+43.5	108.0	−14.0	9		
		+67.0	131.5	+16.0		185	
		+79.5	144.0	+14.0	154		610
Sept. 3 (Naval Observatory).	12 2	−75.0	337.1	−16.5	31		
		−71.0	341.1	−17.0	62		
		−44.5	7.6	−13.5	56		
		−6.0	46.1	+7.5	77		
		+15.5	67.6	−2.0		46	
		+45.5	97.6	−8.5		93	
		+52.5	104.6	+5.5		31	
		+59.5	111.6	+12.5		62	
		+80.0	132.1	+15.5		154	612
Sept. 4 (Naval Observatory).	13 34	−61.0	337.0	−16.5	25		
		−56.0	342.0	−17.0	62		
		−29.5	8.5	−13.5	62		
		−3.0	35.0	+0.5	6		
		+8.0	46.0	+7.5	62		
		+28.5	66.5	−1.5		25	
		+33.0	71.0	−1.0		22	
		+59.0	97.0	−8.5		154	
		+67.0	105.0	+5.5	9		
		+73.0	111.0	+12.5		62	489
Sept. 5 (Mount Wilson)	13 30	−43.0	342.0	−19.0		27	
		−16.0	9.0	−15.0	67		
		+6.5	31.5	+19.0	4		
		+23.0	48.0	+7.0	76		
		+49.0	74.0	−2.0	16		
		+54.5	79.5	+8.0	6		
		+73.0	98.0	−8.0		30	226
Sept. 6 (Mount Wilson)	12 45	−79.0	293.1	+15.0		312	
		−30.0	342.1	−17.0		31	
		−3.0	9.1	−14.0	49		
		+18.0	30.1	+19.0		11	
		+36.0	48.1	+7.0		65	
		+63.0	75.1	−2.0	8		476
Sept. 7 (Harvard)	10 16	−63.0	297.0	+16.0	453		
		+10.0	10.0	−13.5	55		
		+49.5	49.5	+6.0	69		577
Sept. 8 (Naval Observatory).	11 5	−60.5	286.1	+13.5		185	
		−53.5	293.1	+13.5		463	
		−36.0	310.6	+8.5		77	
		−31.5	315.1	+8.0		123	
		−23.5	323.1	+12.5		15	
		−3.0	343.6	−17.5		22	
		+22.5	9.1	−14.5	46		
		+45.0	31.6	+17.5	6		
		+61.0	47.6	+6.0	123		1,060
Sept. 9 (Naval Observatory).	11 44	−47.0	286.0	+13.5		185	
		−39.0	294.0	+14.0		494	
		−22.5	310.5	+8.5		247	
		−16.5	316.5	+7.5		123	
		−11.0	322.0	+12.0		6	
		+11.0	344.0	−17.0	9		
		+36.0	9.0	−14.5	56		
		+60.5	33.5	+18.5		15	
		+75.0	48.0	+6.0	93		1,228

Positions and areas of sun spots—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1928	*H. m.*	°	°	°			
Sept. 10 (Naval Observatory).	11 45	−30.0	289.8	+13.5		401	
		−24.5	295.3	+14.0		370	
		−11.0	308.8	+8.5	108		
		−7.5	312.3	+9.0		93	
		−2.5	317.3	+7.5	123		
		+49.5	9.3	−14.5	46		1,141
Sept. 11 (Naval Observatory).	11 48	−77.0	229.6	−11.0	309		
		−21.0	285.6	+13.0		93	
		−16.5	290.1	+13.5		494	
		−12.0	294.6	+15.0		247	
		−8.5	298.1	+12.5	123		
		+2.0	308.6	+8.5	139		
		+5.0	311.6	+9.0		93	
		+11.5	318.1	+6.0	139		
		+62.5	9.1	−14.5	46		1,683
Sept. 12 (Naval Observatory).	11 45	−62.0	231.4	−11.0	247		
		−8.0	285.4	+13.5		93	
		−2.5	290.9	+13.5		401	
		+2.0	295.4	+14.5		278	
		+5.0	298.4	+13.0	108		
		+15.5	308.9	+8.5		139	
		+26.0	319.4	+6.0		93	
		+35.0	328.4	+12.5		15	
		+59.5	352.9	+10.0	31		
		+77.5	10.9	−14.5	46		1,451
Sept. 13 (Naval Observatory).	11 40	−49.0	231.2	−11.0	247		
		+10.0	290.2	+13.5		432	
		+15.0	295.2	+14.5	185		
		+18.0	298.2	+13.0	108		
		+28.5	308.7	+8.5		108	
		+40.0	320.2	+6.0	108		
		+73.0	353.2	+10.0	31		1,219
Sept. 14 (Naval Observatory).	11 54	−35.5	231.4	−11.0	185		
		+20.5	287.4	+15.0		93	
		+24.0	290.9	+13.5		278	
		+28.0	294.9	+14.5	216		
		+31.0	297.9	+13.5	216		
		+42.0	308.9	+8.5		93	
		+52.5	319.4	+7.0		123	1,204
Sept. 15 (Naval Observatory).	10 58	−22.0	232.2	−11.0		185	
		+38.0	292.2	+13.5		185	
		+41.5	295.7	+14.5	262		
		+44.5	298.7	+14.5		293	
		+54.5	308.7	+8.5	31		
		+55.5	309.7	+8.0		31	
		+65.5	319.7	+7.0	93		1,080
Sept. 16 (Naval Observatory).	11 33	−8.5	232.2	−11.0	154		
		+51.5	292.2	+14.0		401	
		+54.5	295.2	+14.5		216	
		+58.5	299.2	+14.0		370	
		+69.0	309.7	+8.0	31		
		+80.5	321.2	+6.5	77		1,249
Sept. 17 (Naval Observatory).	11 48	−83.5	143.8	+15.0	864		
		−74.0	153.3	−17.5		309	
		+5.5	232.8	−11.0	170		
		+63.5	290.8	+13.5		633	
		+71.5	298.8	+14.0		463	2,439
Sept. 18 (Mount Wilson).	13 20	−75.0	138.4	+15.0		1,274	
		−74.0	139.4	−22.0		216	
		−61.0	152.4	−19.0	243		
		+20.0	233.4	−11.0	232		
		+46.0	259.4	+17.0		17	
		+80.0	293.4	+15.0	1,372		3,354
Sept. 19 (Mount Wilson).	9 30	−78.5	123.8	+15.0	450		
		−68.0	134.3	+15.0		1,221	
		−65.0	137.3	−22.0		644	
		−49.0	153.3	−18.0	207		
		+31.0	233.3	−11.0	168		
		+60.0	262.3	+17.0		39	2,729
Sept. 20 (Naval Observatory).	11 29	−65.5	122.4	+15.0	278		
		−56.5	131.4	+14.0		93	
		−53.5	134.4	−21.0	355		
		−50.5	137.4	+15.0		478	
		−47.5	140.4	−18.0		293	
		−46.5	141.4	+15.0	355		
		−34.5	153.4	−17.5		185	
		+44.5	232.4	−11.0	108		
		+71.0	258.9	+17.5		93	2,238
Sept. 21 (Naval Observatory).	11 31	−75.5	99.2	−14.5	123		
		−52.0	122.7	+15.0	293		
		−40.0	134.7	−21.0	293		
		−38.5	136.2	+15.0		463	
		−32.5	142.2	+15.5	370		
		−32.5	142.2	−17.5		201	
		−20.5	154.2	−17.0	154		
		+58.5	233.2	−11.5	154		2,051

Positions and areas of sun spots—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1928	*H. m.*	°	°	°			
Sept. 22 (Naval Observatory).	11 20	−67.5	94.1	−16.5		293	
		−66.0	95.6	−10.0		31	
		−60.5	101.1	−14.0	170		
		−39.5	122.1	+15.5	201		
		−28.0	133.6	−21.0	201		
		−25.5	136.1	+15.0		417	
		−20.0	141.6	+15.5	401		
		−20.0	141.6	−17.0		247	
		−8.0	153.6	−16.5	123		
		+71.0	232.6	−11.5	123		2,207
Sept. 23 (Harvard)	15 17	−45.5	101.0	−15.0		1,256	
		−20.0	126.5	+15.5		281	
		−5.5	141.0	−18.5		59	
		−5.0	141.5	+15.5		1,043	
		+10.5	157.0	−16.5		224	2,863
Sept. 24 (Naval Observatory).	11 52	−36.0	98.9	−15.0		957	
		−11.5	123.4	+15.0		216	
		−1.0	133.9	−21.0		231	
		+1.5	136.4	+15.5		401	
		+6.0	140.9	−17.5		170	
		+6.5	141.4	+15.5	340		
		+18.5	153.4	−17.0		93	2,408
Sept. 25 (Mount Wilson).	11 30	−22.0	100.5	−17.0		1,552	
		−2.0	124.5	+15.0		223	
		+16.0	138.5	+15.0		774	
		+20.0	142.5	−18.0		190	
		+34.0	156.5	−16.0	131		2,870
Sept. 26 (Naval Observatory).	12 10	−73.0	35.4	+18.0		77	
		−9.5	98.9	−15.0		1,481	
		+14.5	122.9	+15.5		139	
		+27.5	135.9	+15.5		309	
		+29.0	137.4	−20.0		154	
		+32.0	140.4	+15.5	324		
		+45.5	153.9	−17.0	123		2,607
Sept. 27 (Naval Observatory).	12 24	−58.5	36.5	+17.5		62	
		+4.5	99.5	−15.0		1,481	
		+26.5	121.5	+15.5		62	
		+37.0	132.0	−21.5	93		
		+40.5	135.5	+15.5		201	
		+46.0	141.0	+15.5	355		
		+46.0	141.0	−18.0		93	
		+59.5	154.5	−17.0	123		2,470
Sept. 28 (Naval Observatory).	11 37	−48.0	34.3	+18.0		77	
		−26.5	55.8	−14.0		46	
		+13.0	95.3	−17.5		772	
		+21.0	103.3	−13.5		648	
		+39.5	121.8	+16.0	31		
		+53.0	135.3	+15.0		201	
		+55.0	137.3	−21.0		108	
		+58.5	140.8	+15.5	370		
		+71.5	153.8	−17.0	123		2,376
Sept. 29 (Harvard)	11 54	−33.0	36.0	+21.0		105	
		+33.5	102.5	−16.5		1,675	
		+76.0	145.0	+15.0		1,082	2,862
Sept. 30 (Mount Wilson).	12 00	−24.0	31.7	+19.0		37	
		−13.0	42.7	−17.0		32	
		+4.0	59.7	−14.0		12	
		+18.0	73.7	−7.0	8		
		+43.0	98.7	−17.0		1,063	
		+80.0	135.7	−21.0		32	
		+82.0	137.7	+15.0		257	1,441
Mean daily area for September							1,662

PROVISIONAL SUNSPOT RELATIVE NUMBERS FOR SEPTEMBER, 1928

[Data furnished by Prof. A. Wolfer, University of Zurich, Switzerland]

September	Relative numbers	September	Relative numbers	September	Relative numbers
1	63	11		21	98
2	47	12	89	22	109
3	76	13		23	115
4	73	14	54	24	130
5	57	15	56	25	144
6	47	16		26	136
7	55	17	46?	27	152
8	96	18		28	111
9	89	19	85	29	107
10	85	20	103	30	111

Number of observations, 26; mean, 89.8.