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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING AUGUST, 1929

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, 1929, 57:26.

Table 1 shows that solar radiation intensities averaged below the normal values for August at all three stations.

Table 2 shows an excess in the total solar radiation (direct + diffuse) received on a horizontal surface at Washington, Madison, and Chicago, the excess at Washington exceeding 13 per cent. A deficiency is shown at Lincoln and New York.

Skylight polarization measurements obtained on four days at Washington give a mean of 54 per cent and a maximum of 58 per cent on the 2d. At Madison, measurements obtained on seven days give a mean of 51 per cent and a maximum of 63 per cent on the 15th. The values obtained at Washington are close to the August averages for that station. Those for Madison are nearly 10 per cent below the corresponding August averages, no doubt principally due to smoke from forest fires.

TABLE 1.—*Solar radiation intensities during August, 1929*

[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 meridian 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.*
Aug. 1	17.96					1.03					15.11
Aug. 2	10.97					1.28					7.87
Aug. 5	8.81		0.84								6.50
Aug. 16	10.21	0.44	0.55	0.70	0.90						9.14
Aug. 17	12.24	0.41	0.50	0.62	0.82						12.24
Aug. 20	7.87	0.61	0.74	0.91	1.09	1.33	1.01	0.83	0.78		7.57
Aug. 21	10.59				0.86	0.93					7.04
Aug. 26	13.13			0.85	1.01	1.25	1.01	0.75	0.58	0.45	9.14
Aug. 31	10.21	0.60	0.68	0.82	1.06						7.57
Means		**0.52**	**0.66**	**0.78**	**0.96**	**1.16**	**(1.01)**	**(0.79)**	**(0.68)**	**(0.45)**	
Departures		**−0.10**	**−0.01**	**+0.03**	**+0.04**	**−0.06**	**−0.01**	**−0.08**	**−0.05**	**−0.18**	

Madison, Wis.

Aug. 7	11.81				0.91	1.14					10.97
Aug. 10	15.65			0.59	0.82						17.37
Aug. 15	8.48			1.04	1.19	1.37					8.48
Aug. 19	8.48			0.97	1.12	1.29					9.47
Aug. 23	10.97					1.19					10.59
Aug. 24	12.24			0.63	0.84	1.16					14.10
Aug. 27	9.14			0.86	1.03	1.38					8.48
Aug. 31	11.38			0.62	0.79	1.20					12.24
Means				**0.78**	**0.96**	**1.25**					
Departures				**−0.16**	**−0.14**	**−0.06**					

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during August, 1929*—Contd

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

Lincoln, Nebr.

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 meridian 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.*
Aug. 5	11.38						0.89	0.78	0.62		13.61
Aug. 23	15.65					1.31	0.92	0.72	0.88	0.48	17.37
Aug. 24	15.65					1.28					14.10
Means						**(1.30)**	**(0.90)**	**(0.75)**	**(0.60)**	**(0.48)**	
Departures						**±0.00**	**−0.17**	**−0.14**	**−0.16**	**−0.22**	

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	Fresno	La Jolla	Washington	Madison	Lincoln	Chicago	New York
1929	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
July 30	558	494	492	361	381	556	687	394	+109	+31	−29	−5	+11
Aug. 6	394	463	450	374	307	----	658	459	−40	+7	−54	+18	−39
Aug. 13	529	464	527	415	298	----	585	449	+97	+24	+32	+53	−33
Aug. 20	522	433	499	362	359	----	609	460	+109	−2	+14	−6	+45
Aug. 27	436	416	468	351	303	----	606	443	+11	+8	+6	−6	−14
Excess or deficiency since first of year on Sept. 2									+5,152	−672	−2,050	−441	−4,109

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	
1929								
Aug. 1 (Naval Observatory)	*h.*	*m.*	°	°	°			
	10	59	−62.5	288.8	−3.5	--------	185	--------
			−9.0	342.3	+21.5	--------	37	--------
			+30.0	21.3	+9.0	--------	15	--------
			+42.0	33.3	−21.0	--------	154	--------
			+46.5	37.8	−11.0	9	--------	--------
			+64.0	55.3	−11.0	--------	62	--------
			+76.5	67.8	+7.0	31	--------	493
Aug. 2 (Naval Observatory)	11	32	−48.0	289.7	−3.5	--------	154	--------
			−19.0	318.7	+12.5	--------	9	--------
			+6.5	344.2	+21.0	22	--------	--------
			+11.0	348.7	−12.5	--------	25	--------
			+33.0	10.7	+9.0	3	--------	--------
			+46.0	23.7	+9.0	6	--------	--------
			+56.0	33.7	−21.0	--------	123	--------
			+79.0	56.7	−11.5	46	--------	388

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	
1929	h. m.	°	°	°			
Aug. 3 (Mount Wilson)	13 0	−35.0	288.7	−5.0		221	
		−5.0	318.7	+12.0		7	
		+18.0	341.7	+21.0		4	
		+61.0	24.7	+10.0		4	
		+70.0	33.7	−20.0		57	293
Aug. 4 (Naval Observatory).	10 57	−42.0	269.6	−2.0		108	
		−21.0	280.6	−3.5		185	293
Aug. 5 (Naval Observatory).	10 44	−86.0	212.5	−9.0	185		
		−68.0	230.5	−22.0		31	
		−28.0	270.5	−2.5		77	
		−7.5	291.0	−3.5		185	
		+48.0	346.5	−13.5		31	509
Aug. 6 (Naval Observatory).	10 38	−83.0	202.3	−16.0	123		
		−70.0	215.3	−10.0	123		
		−57.0	228.3	−21.5		62	
		−15.5	269.8	−3.0		31	
		+6.5	291.8	−4.0		185	
		+64.5	349.8	−13.0	9		533
Aug. 7 (Naval Observatory).	12 14	−69.5	201.7	−15.5	123		
		−56.5	214.7	−9.5	108		
		−42.0	229.2	−21.0		52	
		+21.0	292.2	−4.0		170	
		+38.5	309.7	+12.5	9		462
Aug. 8 (Naval Observatory).	14 58	−56.5	200.0	−15.0		108	
		−41.5	215.0	−8.5		139	
		−25.0	231.5	−19.5		31	
		+28.0	284.5	+8.5		22	
		+36.0	292.5	−3.5		123	423
Aug. 9 (Naval Observatory).	10 49	−45.0	200.6	−15.0		108	
		−30.0	215.6	−9.0	123		
		−13.5	232.1	−19.5		31	
		+38.5	284.1	+8.5		62	
		+48.5	294.1	−4.0		123	
		+68.0	313.6	+12.5		93	540
Aug. 10 (Naval Observatory).	10 45	−80.0	152.4	+3.0		93	
		−75.0	157.4	−10.0	9		
		−32.5	199.9	−16.0		154	
		−17.5	214.9	−9.0	185		
		0.0	232.4	−19.5	15		
		+53.5	285.9	+8.0		62	
		+63.5	295.9	−5.0		108	
		+79.5	311.9	+12.5		77	703
Aug. 11 (Naval Observatory).	10 45	−65.5	153.7	+3.5		46	
		−61.0	158.2	−10.0	6		
		−18.5	200.7	−15.5		123	
		−3.0	216.2	−9.5	154		
		+3.0	222.2	+20.5		46	
		+13.5	232.7	−19.5	3		
		+68.5	287.7	+7.0	31		
		+77.0	296.2	−5.0	123		532
Aug. 12 (Naval Observatory).	10 51	−52.0	153.9	+3.0		93	
		−50.0	155.9	−7.5		62	
		−47.0	158.9	−11.0	15		
		−34.0	171.9	−20.5	3		
		−6.5	199.4	+8.5	3		
		−5.5	200.4	−15.5	77		
		+10.0	215.9	−9.5	154		
		+18.0	223.9	+20.5	22		
		+41.0	246.9	−7.0	6		
		+80.0	285.9	+5.0	22		457
Aug. 13 (Naval Observatory).	10 59	−38.5	154.1	+3.0		123	
		−35.5	157.1	−8.0		185	
		−33.5	159.1	−11.0	3		
		−11.5	181.1	−18.5	3		
		−1.5	191.1	+21.5	6		
		+7.0	199.6	−15.5		123	
		+23.0	215.6	−9.5	139		
		+32.5	225.1	+21.0	6		588
Aug. 14 (Naval Observatory).	10 50	−44.0	135.5	+18.5	3		
		−30.5	149.0	+7.5	25		
		−26.5	153.0	+18.5		6	
		−26.0	153.5	+3.0		123	
		−22.0	157.5	−8.0		340	
		+2.0	181.5	−19.0		108	
		+13.0	192.5	+21.5		62	
		+21.0	200.5	−15.5		62	
		+36.5	216.0	−10.0	123		852
Aug. 15 (Naval Observatory).	10 45	−78.5	87.8	+1.5	46		
		−74.5	91.8	−6.0	62		
		−61.0	105.3	+15.0	3		
		−17.0	149.3	+7.5	19		
		−12.5	153.8	+19.0		6	
		−12.5	153.8	+3.0		154	
		−8.5	157.8	−8.0		417	
		+14.5	180.8	−19.0		108	
		+27.5	193.8	+22.0		93	
		+33.5	199.8	−15.5	55		
		+50.0	216.3	−9.5	93		1,056

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	
1929	h. m.	°	°	°			
Aug. 16 (Naval Observatory).	10 45	−68.0	85.1	+2.0		139	
		−68.0	85.1	−15.0		93	
		−60.0	93.1	−5.5	62		
		−46.5	106.6	+3.0	3		
		−3.0	150.1	+7.5	19		
		+1.0	154.1	+3.5		123	
		+5.0	158.1	−8.5		448	
		+28.5	181.6	−19.5		139	
		+42.0	195.1	+22.0		77	
		+47.0	200.1	−15.5	31		
		+63.5	216.6	−9.5	62		1,196
Aug. 17 (Naval Observatory).	10 47	−55.5	84.3	−14.5		77	
		−54.5	85.3	+2.0		123	
		−47.0	92.8	−5.0	46		
		+15.0	154.8	+3.5		62	
		+18.5	158.3	−7.5		448	
		+42.5	182.3	+14.5		46	
		+43.0	182.8	−18.5		170	
		+55.5	195.3	+22.5		93	
		+60.5	200.3	−15.0	19		
		+76.5	216.3	−9.0	62		1,146
Aug. 18 (Naval Observatory).	10 42	−42.5	84.2	+2.0		77	
		−42.0	84.7	−14.5		77	
		−34.0	92.7	−4.5		43	
		+28.5	155.2	+3.5		25	
		+32.0	158.7	−7.5		463	
		+57.0	183.7	−18.5		154	
		+58.0	184.7	+13.5		108	
		+69.5	196.2	+22.5		123	
		+73.5	200.2	−16.0	15		1,085
Aug. 19 (Naval Observatory).	10 53	−47.5	65.8	−6.5	6		
		−42.5	70.8	−19.5		12	
		−28.5	84.8	+2.0		25	
		−27.0	86.3	−14.5		77	
		−21.0	92.3	−4.5		46	
		−10.0	103.3	+15.0	9		
		+46.5	159.8	+3.5	3		
		+46.5	159.8	−7.5		417	
		+70.5	183.8	−18.5		170	
		+73.0	186.3	+12.0		123	
		+85.0	198.3	+22.0	154		1,042
Aug. 20 (Naval Observatory).	10 45	−32.0	68.2	−6.5	6		
		−28.5	71.7	−19.5		25	
		−9.5	90.7	−13.5		77	
		−7.5	92.7	−5.0		34	
		+2.5	102.7	+15.0		93	
		+60.5	160.7	−7.5		340	
		+80.0	180.2	−22.0	62		637
Aug. 21 (Naval Observatory).	10 45	−31.5	55.5	+27.5		37	
		−17.5	69.5	−6.0	3		
		−15.0	72.0	−19.0		93	
		−2.0	85.0	+3.0		9	
		+4.0	91.0	−13.5	62		
		+5.5	92.5	−5.0	19		
		+15.5	102.5	+15.0		123	
		+45.0	132.0	+18.5	3		
		+74.5	161.5	−7.5		340	689
Aug. 22 (Naval Observatory).	10 44	−58.5	15.3	+11.0	9		
		−5.5	68.3	−6.5		9	
		−1.5	72.3	−19.0		170	
		+18.0	91.8	−13.5	46		
		+19.0	92.8	−5.0	12		
		+31.0	104.8	+15.0		108	354
Aug. 23 (Naval Observatory).	13 44	−44.0	14.9	+8.5	12		
		−30.0	28.9	+23.0	3		
		−8.5	50.4	+36.0	3		
		+8.0	66.9	−7.0		22	
		+13.0	71.9	−19.5		201	
		+32.5	91.4	−13.0	46		
		+33.5	92.4	−5.5	9		
		+46.5	105.4	+15.0		123	419
Aug. 24 (Naval Observatory).	10 45	−39.5	7.8	−0.5	6		
		−36.0	11.3	+12.0		15	
		+21.5	68.8	−7.5		25	
		+24.5	71.8	−19.5		185	
		+44.5	91.8	−13.0		49	
		+45.5	92.8	−5.5	9		
		+62.0	109.3	+15.0	77		366
Aug. 25 (Naval Observatory).	12 11	−37.0	356.3	−9.0	3		
		−14.0	19.3	+22.5	3		
		−7.0	26.3	−10.0	3		
		+36.5	69.8	−6.0		139	
		+39.0	72.3	−19.0		154	
		+58.5	91.8	−13.0		77	
		+59.5	92.8	−6.0	6		
		+76.5	109.8	+15.0	77		462
Aug. 26 (Naval Observatory).	10 46	−26.0	354.9	−8.0		15	
		+50.5	71.4	−5.5		154	
		+51.5	72.4	−19.5		108	
		+72.0	92.9	−13.0	25		302

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	
1929	h. m.	°	°	°			
Aug. 27 (Naval Observatory).	11 3	−13.0	354.5	−7.0	-------	34	-------
		+64.5	72.0	−5.5	-------	123	-------
		+66.5	74.0	−19.5	-------	93	250
Aug. 28 (Naval Observatory).	12 15	−24.0	329.7	+4.0	-------	9	-------
		+1.5	355.2	−7.0	-------	19	-------
		+79.0	72.7	−5.0	-------	123	-------
		+82.0	75.7	−19.5	-------	93	244
Aug. 29 (Naval Observatory).	11 31	−13.0	327.9	+4.5	6	-------	-------
		+15.0	355.9	−7.0	-------	46	52
Aug. 30 (Naval Observatory).	11 30	−26.5	301.2	−13.5	6	-------	-------
		+29.0	356.7	−7.5	-------	46	52
Aug. 31 (Naval Observatory).	11 20	−17.0	297.5	+2.0	6	-------	-------
		−5.5	309.0	−37.5	6	-------	-------
		+14.5	329.0	+4.0	6	-------	-------
		+43.0	357.5	−7.0	-------	6	24
Mean daily area for August							530

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR AUGUST, 1929 [1]

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

August, 1929	Relative numbers	August, 1929	Relative numbers	August, 1929	Relative numbers
1	66	11	[2] [3] E 62	21	-------
2	[2] 70	12	[2] 74	22	[2] 74
3	47	13	[2] [3] M 76	23	[3] M 67
4	[3] E 37	14	[3] M 101	24	54
5	41	15	132	25	54
6	[2] [4] 56	16	[2] [5] 125	26	[3] E 47
7	[4] 61	17	115	27	32
8	48	18	[3] W 107	28	32
9	54	19	43	29	27
10	[3] M 61	20	[3] E	30	28
				31	10

Mean, 29 days=62.1.

[1] Dependent alone on observations at Zurich and its station at Arosa.
[2]= Passage of an average-sized group through the central meridian.
[3]= New formation of a large or average-sized center of activity—E, on the eastern part of the sun's disk; W, on the western part; M, in the central zone.
[4]= Entrance of a large or average-sized center of activity on the east limb.
[5]= Passage of a large group through the central meridian.

AEROLOGICAL OBSERVATIONS

By RICHMOND T. ZOCH

Free-air temperatures were above normal at all levels at Broken Arrow, Ellendale, and Groesbeck and mostly below normal at Due West, Royal Center, and Washington. (See Table 1.)

Free-air relative humidities were below normal and nearly all levels at all stations. Vapor pressures were also mostly below normal, although in a few cases the departures were small. The total precipitation for the month was below normal at all of these stations.

From the 1,000-meter level to the highest levels observed the resultant winds over the northern and eastern part of the country had a northerly component. (See Table 2.) Over the western part of the country the resultant winds were variable to the 2,000-meter level, above which a southerly component prevailed.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during August, 1929*

TEMPERATURE (°C.)

Altitude m. s. l.	Broken Arrow, Okla. (233 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)		Washington, D. C. (Naval air station) (7 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Meters												
Surface	26.5	−0.2	25.5	−0.4	21.2	+1.0	24.7	−2.1	19.9	−3.6	24.8	+0.3
500	25.5	+0.2	23.3	+0.1	21.2	+1.2	24.4	+0.1	18.3	−2.9	20.8	−1.1
1,000	24.0	+1.1	20.3	+0.2	19.9	+1.8	22.6	+0.4	15.9	−2.1	18.5	−0.9
1,500	20.8	+1.0	17.4	+0.3	18.0	+2.5	20.1	+0.6	13.3	−1.8	15.9	−0.5
2,000	17.5	+1.1	13.8	−0.3	16.1	+3.5	16.9	+0.3	10.9	−1.4	13.2	−0.4
2,500	14.3	+1.3	10.8	−0.3	13.6	+4.0	13.7	0.0	8.3	−1.4	10.4	−0.4
3,000	11.2	+1.4	7.7	−0.7	10.6	+4.0	11.2	+0.2	5.5	−1.4	8.2	+0.1
4,000	------	------	−1.0	−3.7	4.0	+3.2	5.9	0.0	0.9	−0.7	3.7	+2.3

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during August, 1929*—Continued

RELATIVE HUMIDITY (%)

Altitude m. s. l.	Broken Arrow, Okla. (233 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)		Washington, D. C. (Naval air station) (7 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Meters												
Surface	60	−7	69	0	61	−5	76	+3	70	+3	65	−7
500	57	−7	68	−3	59	−5	66	−8	64	−2	66	−3
1,000	54	−7	69	−3	49	−9	52	−10	61	−6	62	−4
1,500	55	−6	70	−1	46	−11	49	−11	56	−9	63	−5
2,000	54	−9	72	+3	44	−11	54	−5	49	−12	62	−6
2,500	54	−9	60	−7	43	−11	50	−7	52	−3	57	−8
3,000	51	−12	59	−7	42	−12	44	−9	50	−1	52	−8
4,000	------	------	66	−4	34	−16	40	+1	55	+9	61	−3

VAPOR PRESSURE (*mb.*)

Surface	20.52	−2.47	22.41	−0.34	14.81	−0.33	23.52	−1.81	16.24	−3.01	20.69	−1.68
500	18.44	−1.99	19.24	−0.78	14.42	−0.34	19.71	−2.49	13.64	−3.16	16.64	−1.94
1,000	15.95	−0.75	16.22	−0.55	11.08	−0.78	14.21	−2.32	11.07	−2.98	13.68	−1.48
1,500	13.46	−0.43	13.85	+0.01	8.96	−0.86	11.38	−2.16	8.52	−2.91	11.87	−1.09
2,000	10.73	−0.87	11.20	+0.06	7.50	−0.39	10.71	−0.48	6.41	−2.48	9.82	−0.96
2,500	8.65	−0.70	7.56	−1.39	6.34	−0.08	8.74	−0.42	5.69	−0.96	7.49	−0.92
3,000	6.81	−0.66	6.02	−1.31	5.25	−0.07	7.44	+0.06	4.71	−0.39	5.78	−0.46
4,000	------	------	3.83	−1.54	2.52	−0.96	6.20	+2.01	3.75	+0.51	4.61	+1.24

The total number of observations made during the month (see Table 3) includes 5 captive balloons and 21 limited-height sounding-balloon flights.