POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, Superintendent U. S. Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Yerkes, Perkins, 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	
1931	h	m	°	°	°			
May 1 (Naval Observatory)	11	21	+60.0	273.2	+15.0		46	46
May 2 (Naval Observatory)	14	10	+72.0	270.5	+18.0	46		46
May 3 (Naval Observatory)	11	18	−52.0	134.8	+27.0	3		
			−38.0	148.8	+2.0	19		22
May 4 (Naval Observatory)	11	16	+60.5	234.1	−10.0		46	46
May 5 (Naval Observatory)	10	52	−7.5	153.1	+10.5	22		22
May 6 (Naval Observatory)	10	49	−17.0	130.4	−2.0	3		
			+9.0	156.4	+11.0	31		34
May 7 (Naval Observatory)	13	16	−70.0	62.9	+5.0		123	
			+22.0	154.9	+13.0	15		138
May 8 (Naval Observatory)	10	48	−61.0	60.0	+5.0		108	
			−49.0	72.0	+2.0	6		114
May 9 (Naval Observatory)	10	59	−50.0	57.7	+7.5		185	185
May 10 (Naval Observatory)	10	59	−37.5	57.0	+9.0		216	
			−1.0	93.5	+34.0	9		
			+40.0	134.5	+1.5		123	348
May 11 (Naval Observatory)	11	27	−21.0	60.0	+8.5		154	
			+55.0	136.0	+1.5		77	231
May 12 (Mount Wilson)	11	30	−8.0	59.7	+9.0		121	
			−7.0	60.7	+7.0	133		
			+41.0	108.7	+5.0		5	
			+71.0	138.7	−1.0	161		420
May 13 (Mount Wilson)	9	40	+4.0	59.4	+8.0		99	
			+4.0	59.4	+7.0	124		
			+55.0	110.4	+5.0		6	
			+87.0	142.4	+0.5	51		280
May 14 (Naval Observatory)	11	5	+20.0	61.5	+10.0		139	139
May 15 (Naval Observatory)	12	22	−71.0	316.6	+8.5	31		
			−60.0	327.6	−17.5	31		
			−13.0	14.6	−6.0	3		
			+34.0	61.6	+10.5		216	281
May 16 (Naval Observatory)	10	45	−65.0	310.2	+11.0		6	
			−50.0	325.2	−17.5		170	
			−2.5	12.7	+11.0	3		
			+47.0	62.2	+10.5		185	364

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	
1931	h	m	°	°	°			
May 17 (Naval Observatory)	10	55	−60.5	301.4	+15.0	8		
			−37.5	324.4	−15.0		108	
			−9.5	352.4	+14.0	3		
			+60.0	61.9	+11.0		77	191
May 18 (Naval Observatory)	10	54	−23.0	325.7	−16.0		201	
			−2.5	346.2	+11.0	15		
			+73.0	61.7	+12.0		93	309
May 19 (Naval Observatory)	10	55	−10.0	325.5	−15.0		262	
			+14.0	349.5	+11.0	6		268
May 20 (Naval Observatory)	11	5	+2.5	324.6	−15.5		401	
			+62.0	24.1	+17.5	3		404
May 21 (Naval Observatory)	13	12	−60.0	247.8	+12.0		15	
			+11.0	318.8	−5.0	6		
			+18.0	325.8	−15.0		370	391
May 22 (Naval Observatory)	11	8	−40.5	255.2	+10.5	3		
			−10.0	285.7	+10.5		9	
			+31.0	326.7	−13.0		31	43
May 23 (Naval Observatory)	11	19	−30.0	252.3	+11.5		31	
			+3.0	285.3	+10.5		46	
			+43.0	325.3	−13.0		247	324
May 24 (Naval Observatory)	11	17	−15.0	254.1	+10.5		31	
			+18.0	287.1	+11.0		62	
			+57.0	326.1	−13.0		154	247
May 25 (Naval Observatory)	11	11	−2.5	253.4	+10.5		46	
			+30.0	285.9	+11.0		15	
			+43.0	298.9	−10.0	6		
			+70.0	325.9	−14.0		108	175
May 26 (Naval Observatory)	10	59	+8.5	251.3	+18.0	3		
			+11.5	254.3	+10.5		62	
			+37.5	280.3	+6.0		31	96
May 27 (Naval Observatory)	11	6	+26.0	255.5	+12.5		77	
			+52.0	281.5	+8.0		62	
			+80.0	309.5	+6.0	3		142
May 28 (Naval Observatory)	11	5	+45.0	261.8	+12.0	31		
			+68.0	284.3	+8.0	46		77
May 29 (Naval Observatory)	11	20	+55.0	257.9	+12.5		93	
			+80.0	282.9	+8.0	3		96
May 30 (Naval Observatory)	11	54	−80.0	109.4	+2.5		108	
			+67.0	256.4	+18.0	31		139
May 31 (Naval Observatory)	10	51	−70.0	106.7	+5.0		93	93
Mean daily area for May								184

AEROLOGICAL OBSERVATIONS

[The Aerological Division, W. R. GREGG in Charge]

By L. T. SAMUELS

Free-air temperatures for May were below normal in the lower levels and above normal in the upper levels except at Due West, where the departures decreased appreciably with altitude but remained negative at all levels. (Table 1.)

The relative humidity averaged above normal in the lower levels and mostly below normal in the upper levels.

Vapor pressure departures were in agreement with those for temperature, except that the former remained negative at all levels at Broken Arrow.

The data for Groesbeck have been omitted from Table 1, as kite observations were discontinued at that station on May 16.

Free-air resultant winds for the month at the 1,000-meter level were mostly westerly except on the Pacific coast, where they were very light and variable, and in the extreme southern part of the country, where they were mostly southerly and easterly. (Table 3.)

At 4,000 meters the resultant directions were westerly at practically all stations except in the extreme northern part of the country, where a pronounced northerly component prevailed. The highest resultant velocities at this level occurred over the upper Lakes and New England regions.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during May, 1931*

TEMPERATURE (°C.)

Altitude (meters) m. s. l.	Broken Arrow, Okla. (233 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	16.6	−3.1	18.5	−1.8	11.4	−1.7	14.9	−1.2
500	15.0	−2.8	16.9	−0.9	10.9	−1.8	12.5	−0.9
1,000	12.9	−2.7	14.5	−0.4	8.7	−0.8	10.0	−0.2
1,500	11.0	−2.4	11.2	−0.6	6.7	+0.1	7.4	0.0
2,000	8.4	−2.4	8.1	−0.8	5.1	+1.5	4.8	−0.2
2,500	5.4	−2.6	5.2	−0.9	2.6	+1.9	2.6	0.0
3,000	2.9	−2.0	2.4	−0.7	−0.2	+1.9	0.3	+0.5
4,000	−1.0	+0.3			−5.6	+2.4	−4.1	+2.2
5,000	−5.2	+1.4			−11.6	+2.5	−9.3	+2.8

RELATIVE HUMIDITY (%)

Surface	71	+1	69	+4	62	+2	67	+3
500	70	+1	65	0	62	+2	67	+3
1,000	66	−1	59	−5	59	0	65	+2
1,500	58	−4	59	−5	57	−3	60	−1
2,000	56	−3	57	−5	55	−5	54	+3
2,500	55	−1	55	−4	55	−4	50	−1
3,000	53	−1	47	−8	56	−1	53	+6
4,000	37	−18			48	−5	47	+1
5,000	21	−32			50	−1	44	+2

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during May, 1931*—Continued

VAPOR PRESSURE (*mb.*)

Altitude (meters) m. s. l.	Broken Arrow, Okla. (233 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	13.70	−2.78	14.98	−0.46	8.41	−0.67	11.54	−0.34
500	12.06	−2.32	12.90	−0.53	8.14	−0.69	9.89	−0.22
1,000	9.82	−1.99	10.21	−0.91	6.47	+0.58	8.01	−0.20
1,500	7.48	−1.84	8.37	−0.79	5.58	−0.31	5.97	−0.61
2,000	5.93	−1.48	6.73	−0.57	4.82	+0.05	4.38	−0.73
2,500	4.86	−0.91	5.17	−0.58	4.12	+0.37	3.42	−0.34
3,000	4.00	−0.58	3.74	−0.67	3.49	+0.58	3.25	+0.55
4,000	2.60	−0.57			1.78	+0.13	2.37	+0.85
5,000	1.43	−0.64			1.35	+0.42	1.69	+0.91

TABLE 2.—*Free-air data obtained by airplanes at naval air stations during May, 1931*

Altitude (meters) m. s. l.	Temperature (°C.)					Relative humidity (%)				
	Hampton Roads, Va.	Pensacola, Fla.	San Diego, Calif.	Seattle, Wash.	Washington, D. C.	Hampton Roads, Va.	Pensacola, Fla.	San Diego, Calif.	Seattle, Wash.	Washington, D. C.
Surface	18.7	22.0	19.4	18.8	16.4	70	74	72	60	66
500	15.9	19.2	15.8	14.1	15.2	62	73	83	66	59
1,000	13.8	16.7	15.7	10.1	13.8	58	63	67	64	54
2,000	8.7	10.7	13.4	3.2	9.4	45	53	37	61	47
3,000	2.0	4.8	6.2	−1.8	3.7	45	49	27	51	41
4,000					−0.7					11

TABLE 3.—*Observations by means of kites, captive and limited-height sounding balloons during May, 1931*

	Broken Arrow, Okla.	Due West, S. C.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.
Mean altitudes (meters), m. s. l., reached during month	2,853	2,727	3,268	2,498	3,366
Maximum altitude (meters), m. s. l., reached	[1] 5,906	3,570	[1] 5,600	3,840	[1] 5,737
Number of flights made	33	31	31	[2] 9	30
Number of days on which flights were made	31	30	30	[2] 9	29

[1] Limited-height sounding balloon observation.
[2] Covers period from May 1 to 16, inclusive, only.

In addition to the above, there were approximately 176 pilot balloon observations made daily at 60 Weather Bureau stations in the United States.

TABLE 4.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a. m. (E. S. T.) during May, 1931*

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,528 meters)		Brownsville, Tex. (12 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,873 meters)		Chicago, Ill. (198 meters)		Cleveland, Ohio (245 meters)		Dallas, Tex. (154 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (14 meters)		Key West, Fla. (11 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	N	0.6	S 51 E	1.0	S 44 W	2.9	N 70 W	3.3	S 18 W	0.3	S 10 W	2.0	S 21 E	0.8	N 84 W	0.5	N 37 W	2.4	S 85 W	1.1	N 77 W	0.6	N 57 E	1.7
500			S 23 E	6.0	S 25 W	5.7			S 74 W	3.0	S 45 W	4.7	S 22 W	3.3	W	3.4	N 45 W	2.5			S 69 W	1.2	N 79 E	3.2
1,000			S 14 E	5.5	S 76 W	5.5			N 85 W	5.4	S 80 W	5.2	S 59 W	4.2	S 76 W	3.7	N 84 W	2.5	S 76 W	3.2	S 48 W	1.8	S 86 E	2.4
1,500			S 10 E	4.4	S 87 W	7.1			S 88 W	6.8	S 81 W	5.3	S 71 W	4.7	S 87 W	3.4	N 59 W	3.4	N 89 W	3.4	S 58 W	1.5	S 65 E	0.7
2,000	S 74 W	1.1	S 6 W	3.2	S 86 W	7.9	N 73 W	5.6	S 85 W	7.4	S 83 W	6.0	N 83 W	4.2	S 87 W	4.1	N 38 W	5.4	N 72 W	4.5	S 62 W	2.2	S 22 W	1.3
2,500	N 77 W	4.2	S 32 W	2.3	N 89 W	8.9	N 63 W	8.0	S 82 W	7.5	S 83 W	6.5	N 84 W	4.9	W	4.8	N 35 W	5.8	N 70 W	4.2	S 63 W	3.0	S 43 W	1.9
3,000	N 67 W	6.8	N 69 W	2.4	N 72 W	12.1	N 55 W	9.0	N 89 W	5.5	S 66 W	6.3	N 70 W	5.1	N 76 W	3.9	N 37 W	5.3	N 67 W	4.0	S 84 W	3.6	S 76 W	2.5
4,000	N 76 W	7.3	N 65 W	7.0	N 78 W	8.9	N 49 W	10.0			N 81 W	4.3	N 75 W	4.8	N 49 W	4.2	N 26 W	6.2	N 69 W	6.1	N 85 W	5.8	N 80 W	3.9
5,000	S 79 W	6.9	N 59 W	10.0			N 71 W	8.6					N 44 W	3.6	N 66 W	4.3	N 38 W	6.8	N 49 W	6.9	S 89 W	6.2	N 71 W	6.3

Altitude (meters) m. s. l.	Los Angeles, Calif. (127 meters)		Medford, Oreg. (410 meters)		Memphis, Tenn. (145 meters)		New Orleans, La. (25 meters)		Oakland, Calif. (8 meters)		Oklahoma, City, Okla. (392 meters)		Omaha, Nebr. (299 meters)		Phoenix, Ariz. (350 meters)		Salt Lake City, Utah (1,294 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (14 meters)		Washington, D. C. (10 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	N 66 E	0.8	N 79 W	0.3	S 51 W	0.9	N 29 E	0.5	N 8 W	1.6	S 37 W	1.0	N 14 E	0.8	N 66 E	0.9	S 28 E	2.7	N 27 E	0.5	S 32 E	0.5	S 54 W	0.9
500	S 75 E	1.0	N 66 W	0.6	S 85 W	3.5	S 70 W	0.5	N 24 E	1.4	S 40 W	2.5	N 6 W	0.8	N 83 E	0.8			N 87 E	0.6	N 12 W	0.9	N 84 W	3.7
1,000	N 83 W	1.7	N 58 W	0.8	N 89 W	5.3	S 50 W	1.8	N 16 E	4.3	S 79 W	5.4	N 86 W	2.9	N 28 W	0.4			N 79 W	1.8	S 50 E	0.4	N 59 W	4.9
1,500	S 59 W	2.7	N 61 E	0.7	N 78 W	6.2	S 62 W	3.3	N 29 E	3.5	N 84 W	4.5	N 79 W	4.5	N 67 W	1.3	S 15 E	3.5	N 65 W	3.7	S 53 W	1.0	N 79 W	6.0
2,000	N 60 W	1.4	N 15 E	1.2	N 77 W	6.2	S 79 W	3.1	N 22 E	4.4	N 85 W	6.0	N 79 W	5.6	N 73 W	1.5	S 24 W	2.5	N 79 W	5.3	N 79 W	3.2	N 80 W	6.9
2,500	S 81 W	2.8	N 41 W	1.8	N 71 W	5.5	N 87 W	3.8	N 7 E	3.6	N 77 W	6.2	N 66 W	5.5	S 76 W	2.1	S 83 W	3.5	N 79 W	7.0	N 82 W	5.2	N 76 W	5.9
3,000			N 46 W	3.6	N 70 W	3.8	N 72 W	4.8	N 21 W	7.5	N 71 W	4.8	N 64 W	7.2	S 72 W	2.1	N 87 W	4.4	N 72 W	8.8	N 63 W	4.8	N 80 W	4.9
4,000			N 56 W	6.2			S 89 W	6.6			N 70 W	5.7	N 79 W	6.2	S 57 W	2.8	N 72 W	6.9	N 25 W	10.8			N 79 W	4.9
5,000							N 57 W	4.8					N 52 W	7.7	N 70 W	6.2			N 27 W	12.8				