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
1937	h. m.	°	°	°				
June 23		+38.0	138.3	−10.0	24			U. S. Naval.
		+66.0	166.3	+28.0		97		
		+76.0	176.3	+9.0	194			
		+85.0	185.3	−13.0	582		2,895	
June 24	11 5	−78.0	9.2	+18.0		194		Do.
		−48.0	39.2	−18.5		291		
		−32.0	55.2	−12.5		824		
		−14.0	73.2	+21.0		24		
		−3.0	84.2	+8.0	12			
		+20.5	107.7	−23.0	242			
		+26.0	113.2	+10.0	73			
		+33.0	120.2	+21.0		97		
		+49.0	136.2	+12.0		533		
		+80.0	167.2	+26.0	48		2,338	
June 25	11 14	−62.0	11.9	+19.0		121		Do.
		−35.0	38.9	−18.0	291			
		−19.0	54.9	−12.0		824		
		+33.0	106.9	−23.0	206			
		+39.0	112.9	+10.0	73			
		+44.0	117.9	+21.0		145		
		+62.0	135.9	+13.0		339	1,999	
June 26	10 52	−51.0	9.8	+10.5		48		Do.
		−49.0	11.8	+19.0		97		
		−21.5	39.3	+7.0		24		
		−21.0	39.8	−17.0	194			
		−6.0	54.8	−12.0		582		
		+47.0	107.8	−23.0	194			
		+50.0	110.8	+10.5		73		
		+59.0	119.8	+21.0		194		
		+78.0	138.8	+12.0	242		1,648	
June 27	9 9	−40.5	8.0	+19.0		97		Mt. Wilson.
		−9.5	39.0	+8.0		97		
		−9.0	39.5	−17.0	242			
		+8.0	56.5	−11.0		485		
		+62.0	110.5	−23.0	194			
		+68.0	116.5	+11.0		145		
		+86.0	134.5	+22.0	242		1,502	
June 28	11 11	+3.0	37.2	−17.0		242		U. S. Naval.
		+5.0	39.2	+9.0	16			
		+21.0	55.2	−11.0		485		
		+74.0	108.2	−23.0	194		937	
June 29	11 4	−61.0	320.0	−9.0		24		Do.
		−30.0	351.0	+15.0		73		
		−11.0	10.0	+19.0		48		
		−3.0	18.0	+18.0		48		
		+18.0	39.0	−17.0		194		
		+36.0	57.0	−11.0		218	605	

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
June 30	10 51	−78.0	289.9	+14.0	97			U. S. Naval.
		−45.5	322.4	−10.0	12			
		−17.0	350.9	+15.0		291		
		+1.0	8.9	+18.0		48		
		+10.0	17.9	+17.0		145		
		+31.0	38.9	−18.0		194		
		+48.0	55.9	−10.0		242	1,029	

Mean daily area for 30 days, 2,587.

PROVISIONAL SUN-SPOT RELATIVE NUMBERS, JUNE 1937

[Dependent along on observations at Zurich and its station at Arosa]

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

June 1937	Relative numbers	June 1937	Relative numbers	June 1937	Relative numbers
1	*Mc* 79	11	96	21	*d* 186
2	*d* 89	12	*MEacc* 134	22	*ad* 199
3	92	13	*Ec* 166	23	*Mac* 163
4	*bd* 116	14	185	24	133
5	*Wc* 128	15	*ad* 191	25	108
6	121	16	*Mabcd* 174	26	116
7	102	17	*b* 190	27	*b* 91
8	*a* 64	18	*a* 194	28	*a* 80
9	*Ecd* 73	19	185	29	*Ec* 80
10	*add* 98	20	*a* 183	30	93

Mean, 30 days = 130.3.

a = Passage of an average-sized group through the central meridian.
b = Passage of a large group or spot through the central meridian.
c = New formation of a group developing into a middle-sized or large center of activity; *E*: on the eastern part of the sun's disc, *W*: on the western part, *M*: in the central circle zone.
d = Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, *In Charge*]

By LOYD A. STEVENS

Mean free-air data, based on airplane weather observations during the month of June 1937, are given in tables 1 to 3.

The mean surface temperatures for June (see chart I) were slightly above normal over the greater portion of the country.

The mean free-air temperatures were, for the most part, near normal at all levels. The most consistent negative departures occurred along the Atlantic Coast, where at 5 kilometers departures of minus 2.3° C. and minus 2.5° C. were recorded at Norfolk and Lakehurst, respectively. At Cheyenne negative departures persisted at all levels and at Omaha, also, pronounced negative departures occurred up to 3 kilometers amounting to minus 2.3° C. at 1 kilometer. The greatest positive temperature departure occurred at Seattle, amounting to plus 2.1° C. at 1.5 kilometers. In general the mean free-air temperatures for June averaged from 3° to 4° C. higher at all levels than in May.

The mean free-air relative humidities were above normal at most stations but were below normal at San Antonio up to 2 kilometers (minus 7 percent at 1 and 1.5 kilometers) and at Seattle between 1 and 4 kilometers (minus 9 percent at 2 and 2.5 kilometers). The greatest positive departure (plus 11 percent) occurred at Omaha at all levels between 1 and 2.5 kilometers.

Monthly mean free-air barometric pressures and equivalent potential temperatures are shown in table 3. In general there was an increase in the average pressure, of June over May, of 1 to 2 mb. in the lower levels and of 3 to 5 mb. in the upper levels. The increase was most pronounced at 5 kilometers. The mean isobaric charts as drawn from the values in table 3, were characterized in the lower levels by relatively high pressure over the southeast and extreme northwest portions of the country and a trough of low pressure extending in a NE.-SW. direction across the central part of the country. The mean isobars shifted with altitude, however, and assumed approximately a W.-E. direction across the country above 3 kilometers. In the higher levels a low pressure center was located over Fargo and Sault Ste. Marie. The highest mean pressure was recorded at San Antonio at all levels. Changes in the mean pressure gradient from May to June were relatively unimportant except that there was, in general, decrease in gradient with latitude over the eastern part of the country in the higher levels.

Free-air resultant winds, based on pilot balloon observations made near 5 a. m. (75th meridian time), are shown in table 4. Along the Pacific coast from Oakland northward the resultant winds varied from the normal in a counterclockwise direction (i. e. toward the south) below 3 kilometers. The greatest variation occurred at

Medford at 1.5 kilometers where the current resultant direction was 156° (SSE.) while the normal was 286° (WNW.). The fact that the resultant directions indicated a more southerly origin than normal for the air reaching that part of the country, probably accounted for the above-normal temperatures at Seattle at all levels up to 4 kilometers. At Pensacola the current resultant directions varied from the normal by amounts of 30° to 81° between 2 and 4 kilometers; the variation being in a clockwise direction at 2 and 3 kilometers and in a counterclockwise direction at 2.5 and 4 kilometers. Except in the cases just mentioned, the resultant directions did not vary greatly from the normal. In general the free-air resultant velocities were below normal over the northeast, northwest, and extreme north central portions of the country and above normal elsewhere. At Oklahoma City, however, the departure was negative at all levels up to 3 kilometers. The greatest negative departure (minus 6.0 meters per second) occurred at Fargo at 4 kilometers and the greatest positive departure (plus 3.5 meters per second) occurred at Wright Field at 4 kilometers.

Table 5 shows the maximum free-air wind velocities and their directions for various sections of the United States during June, as determined by pilot balloon observations. The extreme maximum for the month was 47.7 meters per second from the WNW. at 6,975 meters above sea level over Modena, Utah.

The mean monthly equivalent potential temperatures and specific humidities are shown in tables 2 and 3, respectively. The increase in the mean equivalent potential temperatures of June over May amounted to approximately 10° A. at 1 kilometer, 7° at 3 kilometers, and 6° at 5 kilometers. The maximum increase (plus 18° A.) occurred at Murfreesboro at 0.5 kilometer and the minimum (plus 3° A.) occurred at Salt Lake City at 3, 4, and 5 kilometers, respectively. The average increase in the mean specific humidities of June over May was 2 to 3 grams in the lower levels and between 0.2 and 1.4 grams at 5 kilometers. As usual the locations of centers of the highest and lowest specific humidities and equivalent potential temperatures agreed closely with those of highest and lowest mean pressures.

The weather for the month was characterized by considerable activity in that a rather large number of P_C and P_P air masses, for this time of the year, passed across the country. There were several outbreaks of P_P and N_{PP} air from the semi-permanent North Pacific HIGH which usually passed inland at some point along the northern portion of the Pacific coast. Between these relatively cold air masses "LOWS" were formed with well-developed fronts along which relatively heavy precipitation occurred. The frequent passage of such fronts over the north and central Pacific coast area accounted for the above-normal precipitation which occurred there. Over the remainder of the country most of the precipitation which occurred was associated with thunderstorms and was therefore very unevenly distributed. The excess precipitation which occurred over certain portions of New Mexico, for example, resulted from cold-front thunderstorms brought about by certain P_P air masses, which moved farther south than usual and caused sharp temperature differences when they met T_M and S air over that area. Southeastward moving cold P_C air masses combined with T_A and T_M air circulating around the western edge of the Atlantic HIGH to cause above-normal precipitation in the Ohio valley and along the Atlantic coast. The advance of the P_C air masses from the northwest together with the recession of the Atlantic HIGH resulted frequently in the formation of low pressure troughs with well developed cold fronts along which numerous severe thunderstorms occurred.

TABLE 1.—*Mean free-air temperatures (t), °C obtained by airplanes during June 1937. (Dep. represents departure from "normal" temperature.)*

Station	Number of obs.	Altitude (meters) m. s. l.																	
		Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
		t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.
Barksdale Field [1] (Shreveport), La. (52 m)	30	23.6	+0.5	24.5	0.0	21.7	0.0	18.7	−0.2	15.8	−0.4	12.8	−0.6	9.9	−0.5	4.4	+0.1	−2.4	+0.2
Billings, Mont.[2] (1,089 m)	30	14.4	+0.2					16.5	+0.3	13.8	+0.3	10.2	+0.3	6.5	+0.4	−0.5	+0.5	−6.5	+1.3
Boston, Mass.[1] (5 m)	27	16.1		16.4		14.1		11.3		8.3		5.9		4.1		−0.7		−7.6	
Cheyenne, Wyo.[2] (1,873 m)	29	11.4	−0.2							12.7	−0.3	11.3	−1.2	8.0	−1.4	0.5	−1.4	−7.6	−1.3
Coco Solo, C. Z.[3] (15 m)	22	25.3		23.8		21.2		18.6		16.0		14.0		11.3		4.8		−1.2	
El Paso, Tex.[2] (1,194 m)	30	22.3						24.6		22.0		18.5		14.5		6.2		−1.2	
Fargo, N. Dak.[2] (274 m)	29	12.7	−0.5	16.7	+0.9	15.1	+0.7	12.0	+0.3	8.5	−0.4	5.6	−0.3	2.6	−0.4	−2.6	+0.1	−8.8	+0.2
Kelly Field (San Antonio), Tex.[1] (206 m)	26	24.1	+1.0	23.4	0.0	22.2	+0.3	19.9	+0.5	16.8	−0.1	13.9	−0.4	11.1	−0.3	4.9	+0.3	−1.7	+0.5
Lakehurst, N. J.[3] (39 m)	24	16.5	−1.2	19.3	+0.2	17.3	−0.1	13.9	−0.6	10.4	−1.1	7.5	−1.5	4.5	−1.9	−1.0	−2.4	−6.2	−2.5
Maxwell Field (Montgomery), Ala.[1] (52 m)	30	23.5	+0.9	24.1	+0.2	21.8	+0.4	18.4	+0.5	14.9	+0.4	11.9	+0.5	9.2	+0.5	3.4	+0.6	−2.4	+0.7
Miami, Fla.[2] (4 m)	29	22.9		22.8		19.3		15.5		13.2		10.5		8.1		2.7		−3.0	
Mitchel Field (Hempstead, L. I.), N. Y.[1] (29 m)	29	17.2	+0.6	18.0	+0.2	16.5	+0.6	13.8	+0.5	10.9	+0.4	8.0	+0.1	5.4	0.0	0.0	+0.1		
Murfreesboro, Tenn.[2] (174 m)	30	20.4	+0.7	22.5	+0.3	20.6	+0.3	16.9	−0.1	13.9	−0.1	10.8	−0.3	7.9	−0.4	2.2	−0.1	−3.8	−0.1
Norfolk, Va.[3] (10 m)	23	21.2	−1.2	21.1	−0.4	18.1	−1.2	14.7	−1.5	11.5	−1.7	8.5	−1.8	5.6	−2.2	−0.2	−2.2	−5.5	−2.3
Oakland, Calif.[2] (2 m)	30	14.8		15.3		16.5		15.4		12.9		10.1		7.1		1.2		−5.0	
Oklahoma City, Okla.[2] (391 m)	30	22.1	+1.1	23.3	+1.2	22.3	+0.7	19.7	+0.5	16.7	+0.1	13.2	−0.3	10.0	−0.2	3.0	+0.1	−3.9	+0.2
Omaha, Nebr.[2] (300 m)	30	18.0	−0.6	18.9	−1.0	17.9	−2.3	16.1	−1.8	13.6	−1.4	10.6	−1.0	7.7	−0.5	1.7	+0.1	−4.2	+0.9
Pearl Harbor, T. H.[3] (6 m)	30	22.7	−2.0	20.7	−1.0	17.3	−0.9	14.5	−1.0	13.6	+0.1	12.9	+0.8	11.2	+0.7	6.7	+0.2	1.3	0.0
Pensacola, Fla.[3] (13 m)	29	23.2	−1.4	23.5	+0.2	20.4	−0.1	17.2	−0.4	14.1	−0.6	11.7	−0.2	8.9	−0.1	3.3	0.0	−2.2	+0.3
St. Thomas, V. I.[3] (8 m)	30	28.1		23.9		20.0		17.4		15.5		13.6		11.0		4.8		−1.4	
Salt Lake City, Utah [2] (1,288 m)	30	14.1						17.3		15.2		11.8		8.3		0.9		−5.9	
San Diego, Calif.[3] (10 m)	29	18.2	−0.8	15.4	−0.5	18.9	+1.4	18.8	+1.0	17.5	+0.4	15.0	+0.5	12.2	+0.5	6.2	+0.7	−0.7	+0.7
Sault Ste. Marie, Mich.[2] (221 m)	30	10.7		14.6		13.5		10.7		7.6		5.1		2.6		−2.6		−8.8	
Scott Field (Belleville), Ill.[1] (135 m)	23	18.7	+1.1	21.6	+0.7	19.3	0.0	16.8	+0.2	14.2	+0.4	11.9	+0.9	9.1	+0.8	3.3	+0.9	−3.0	+0.8
Seattle, Wash.[2] (10 m)	23	12.5	−1.7	13.1	+0.7	12.2	+1.8	9.9	+2.1	7.1	+1.9	4.5	+1.6	1.8	+1.3	−3.9	+0.6	−10.7	−0.4
Selfridge Field (Mount Clemens), Mich.[1] (177 m)	28	15.3	+0.8	16.8	+0.4	14.6	+0.1	12.2	+0.5	9.8	+0.7	7.4	+0.8	4.5	+0.6	−1.1	+0.8	−7.0	+1.0
Spokane, Wash.[2] (596 m)	30	13.2				16.5		14.2		10.7		7.1		3.4		−3.7		−10.6	
Washington, D. C.[3] (13 m)	30	20.7	−0.5	20.6	+0.5	17.8	−0.2	14.4	−0.8	10.9	−1.5	8.1	−1.5	5.1	−1.8	−0.4	−1.1	−5.6	−0.6
Wright Field (Dayton), Ohio [1] (244 m)	27	16.9	+0.9	18.5	+0.1	17.4	0.0	14.8	+0.2	12.2	+0.4	9.4	+0.2	6.7	+0.3	0.8	+0.3	−5.6	+0.1

[1] Army. [2] Weather Bureau. [3] Navy.

Observations taken about 4 a. m., 75th Meridian Time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—The departures are based on normals covering the following total number of observations made during the same month in previous years, including the current month (years of record are given in parentheses following the number of observations): Barksdale, 76 (3); Billings, 89 (3); Cheyenne, 89 (3); Fargo, 89 (3); Kelly Field 80 (3); Lakehurst, 71 (3); Maxwell Field, 88 (3); Mitchel Field, 81 (3); Murfreesboro, 90 (3); Norfolk, 184 (9); Oklahoma City, 90 (3); Omaha, 180 (6); Pearl Harbor, 160 (7); Pensacola, 246 (10); San Diego, 210 (9); Scott Field, 82 (3); Seattle, 69 (3); Selfridge Field, 85 (3); Washington, 240 (11); Wright Field, 79 (3).

TABLE 2.—*Mean free-air relative humidities (R. H.), in percent, and specific humidities (q), in grams/kilogram, obtained by airplanes during June 1937. (Dep. represents departure from "normal" relative humidity.)*

Stations	Number of observations	Altitude (meters) m. s. l.																										
		Surface			500			1,000			1,500			2,000			2,500			3,000			4,000			5,000		
		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.	
			Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.
Barksdale Field, La	30	15.7	86	+3	13.3	66	+2	11.9	66	+3	10.4	66	+6	8.2	59	+7	6.2	51	+6	4.9	46	+6	3.3	39	0	2.3	39	+2
Billings, Mont	30	7.4	64	0	----	----	----	----	----	----	7.4	53	+2	6.5	53	+3	5.8	56	+2	4.9	58	0	3.7	63	+2	2.6	61	+5
Boston, Mass	27	9.5	83	----	8.1	66	----	7.3	65	----	7.0	71	----	6.4	74	----	5.3	68	----	4.2	58	----	2.7	47	----	1.6	41	----
Cheyenne, Wyo	29	7.5	72	−1	----	----	----	----	----	----	----	----	----	7.5	65	0	6.4	58	+6	5.3	56	+7	3.6	56	+6	2.3	58	+5
Coco Solo, C. Z	22	18.9	94	----	17.0	87	----	15.1	86	----	14.0	88	----	11.7	82	----	9.1	69	----	7.8	65	----	5.8	69	----	4.7	74	----
El Paso, Tex	30	7.3	38	----	----	----	----	----	----	----	8.7	38	----	7.6	37	----	6.6	38	----	6.0	41	----	4.5	49	----	3.2	50	----
Fargo, N. Dak	29	8.0	85	+5	7.8	62	−2	6.9	58	0	6.0	58	0	5.1	49	+2	4.3	56	−1	3.8	58	+2	2.5	50	+2	1.6	45	+1
Kelly Field, Tex	26	16.2	85	−5	15.7	83	−1	11.9	64	−7	10.2	60	−7	8.7	59	−1	7.3	56	+2	5.8	51	+2	4.0	47	0	2.4	40	−2
Lakehurst, N. J	24	10.5	90	+7	9.0	61	−2	7.6	55	−2	6.9	59	0	6.4	64	+3	5.7	66	+6	4.8	65	+9	3.5	59	+10	2.1	47	+6
Maxwell Field, Ala	30	15.4	86	+2	12.7	65	+2	11.1	61	+2	10.1	65	+3	8.9	66	+5	7.0	60	+3	5.8	56	+4	4.0	52	+5	2.9	49	+7
Miami, Fla	29	15.6	90	----	14.8	82	----	12.0	78	----	9.2	71	----	7.9	67	----	6.7	64	----	5.7	59	----	4.2	56	----	3.3	57	----
Mitchel Field, N. Y	29	10.6	87	−2	10.3	76	+1	9.9	76	+1	9.2	80	+1	8.0	78	+4	6.9	76	+6	5.5	70	+4	3.9	61	−1	----	----	----
Murfreesboro, Tenn	30	13.7	90	+10	12.3	69	+5	11.2	67	+4	10.0	71	+5	8.0	64	0	6.0	56	−2	4.7	50	−2	3.1	43	−4	2.1	42	−2
Norfolk, Va	23	13.6	86	+8	11.0	67	0	9.5	66	+3	8.6	70	+7	7.2	68	+6	5.8	63	+4	4.9	59	+4	3.1	52	0	2.0	46	+1
Oakland, Calif	30	8.8	84	----	9.1	80	----	8.3	64	----	6.8	52	----	5.9	46	----	4.4	43	----	3.7	41	----	2.8	42	----	2.0	43	----
Oklahoma City, Okla	30	13.8	80	+1	13.9	74	+1	12.9	69	+5	11.4	66	+5	9.9	66	+8	8.4	66	+11	6.6	60	+8	4.4	58	+6	2.8	52	+2
Omaha, Nebr	30	11.0	83	+3	10.7	74	+4	9.7	68	+11	8.8	65	+11	7.8	64	+11	6.9	65	+11	5.7	61	+8	4.0	58	+8	2.6	49	+5
Pearl Harbor, T. H	30	13.6	80	+8	12.7	80	+3	11.9	87	+5	10.2	84	+6	7.6	62	−6	4.9	40	−12	3.4	29	−10	2.1	21	−2	1.1	17	−4
Pensacola, Fla	29	16.3	92	+10	14.5	76	+1	12.2	73	+3	10.7	74	+7	9.0	73	+9	7.4	65	+6	6.5	65	+10	4.7	61	+11	2.6	45	+2
St. Thomas, V. I	30	17.6	75	----	16.6	86	----	14.7	90	----	11.8	81	----	9.0	66	----	6.6	52	----	5.0	43	----	3.5	42	----	2.7	41	----
Salt Lake City, Utah	30	6.8	58	----	----	----	----	----	----	----	7.1	49	----	6.1	45	----	5.3	46	----	4.7	48	----	3.6	55	----	2.7	57	----
San Diego, Calif	29	10.3	80	+6	9.5	83	+3	8.5	56	−2	6.4	40	0	4.9	31	+4	4.0	28	+5	3.2	27	+7	2.5	26	+7	1.6	25	+6
Sault Ste. Marie, Mich	30	7.3	89	----	7.3	66	----	6.8	63	----	6.5	68	----	5.8	70	----	4.9	67	----	4.2	65	----	3.0	58	----	2.0	54	----
Scott Field, Ill	23	12.2	90	+5	11.0	65	+3	10.3	66	+5	9.2	66	+5	8.0	63	+3	6.4	55	−2	5.3	52	−2	3.7	49	0	2.5	45	+2
Seattle, Wash	23	7.6	85	+9	7.2	72	0	6.2	63	−6	5.4	60	−8	4.5	57	−9	3.6	51	−9	3.0	49	−7	2.0	43	−5	1.2	41	0
Selfridge Field, Mich	28	9.4	85	0	8.2	65	+1	7.8	67	+4	6.6	63	0	5.5	58	−2	4.8	56	0	4.0	55	+2	2.8	50	+5	1.7	39	0
Spokane, Wash	30	7.7	76	----	----	----	----	7.8	59	----	7.0	58	----	6.2	61	----	5.5	65	----	4.7	68	----	3.0	66	----	1.8	60	----
Washington, D. C	30	13.0	86	+13	10.8	68	+5	9.3	66	+6	8.3	69	+9	7.3	71	+10	5.8	65	+8	5.0	65	+11	3.4	57	+10	2.2	44	+7
Wright Field, Ohio	27	10.9	89	+4	10.6	76	+5	9.6	69	+4	8.0	64	0	6.5	59	−1	5.4	55	0	4.5	52	0	3.1	50	0	2.4	51	+3

TABLE 3.—*Mean free-air barometric pressures (P), in mb, and equivalent potential temperatures (θ_E), in °A. obtained by airplanes during June 1937*

Station	Number of observations	Altitude (meters) m. s. l.																	
		Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
		P	θ_E	P	θ_E	P	θ_E	P	θ_E	P	θ_E	P	θ_E	P	θ_E	P	θ_E	P	θ_E
Barksdale Field, La	30	1,008	340	957	340	904	338	852	336	804	332	757	329	713	327	631	327	557	328
Billings, Mont	30	892	318	----	----	----	----	850	325	801	325	754	325	710	323	628	323	554	325
Boston, Mass	27	1,012	314	955	316	900	317	848	318	799	319	751	319	707	319	624	320	552	320
Cheyenne, Wyo	29	813	324	----	----	----	----	----	----	802	327	754	328	710	327	627	325	554	322
Coco Solo, C. Z	22	1,009	351	952	350	900	347	849	347	800	343	754	339	711	338	629	336	557	337
El Paso, Tex	30	880	329	----	----	----	----	849	339	802	338	756	337	713	336	633	333	560	332
Fargo, N. Dak	29	980	310	955	316	900	317	849	316	799	316	752	316	707	316	623	318	549	320
Kelly Field, Tex	26	992	344	961	345	908	338	857	336	809	334	762	332	718	330	637	330	565	328
Lakehurst, N. J	24	1,009	318	956	322	902	321	851	321	802	321	756	322	712	321	629	322	555	323
Maxwell Field, Ala	30	1,008	339	958	337	906	336	854	335	806	333	758	330	715	329	633	328	559	329
Miami, Fla	29	1,015	339	960	341	906	336	855	329	806	328	758	327	714	328	632	328	558	330
Mitchel Field, N. Y	29	1,010	319	956	324	903	327	851	328	802	326	755	325	710	324	628	325	----	----
Murfreesboro, Tenn	30	994	332	958	335	905	335	854	333	805	329	757	326	714	324	632	324	558	326
Norfolk, Va	23	1,012	331	956	330	902	327	851	327	802	324	754	323	711	322	628	322	554	324
Oakland, Calif	30	1,015	311	957	317	903	322	852	322	803	320	756	320	712	321	629	323	556	324
Oklahoma City, Okla	30	968	338	956	340	903	342	852	340	804	338	757	335	714	333	633	329	559	328
Omaha, Nebr	30	979	323	956	326	903	328	852	329	803	329	756	328	712	327	629	327	556	327
Pearl Harbor, T. H	30	1,017	332	962	333	908	332	856	330	808	328	761	324	718	323	637	325	564	327
Pensacola, Fla	29	1,015	340	960	341	906	337	854	335	805	333	757	331	713	331	631	330	561	328
St. Thomas, V. I	30	1,019	350	965	348	910	343	858	338	810	334	763	330	719	328	637	328	563	330
Salt Lake City, Utah	30	870	319	----	----	----	----	849	326	800	326	754	326	710	325	628	325	554	326
San Diego, Calif	29	1,013	319	956	318	902	326	850	325	802	324	756	325	712	325	632	327	558	328
Sault Ste. Marie, Mich	30	987	305	956	312	901	315	848	317	799	316	751	317	706	318	623	320	549	321
Scott Field, Ill	23	999	325	959	330	905	330	854	330	805	329	758	328	715	327	633	327	559	328
Seattle, Wash	23	1,016	305	958	310	902	311	849	313	800	312	752	313	707	313	624	315	548	316
Selfridge Field, Mich	28	992	315	956	317	902	319	850	318	801	318	753	319	709	319	626	320	552	321
Spokane, Wash	30	945	313	----	----	902	321	851	322	802	321	754	320	710	320	626	318	552	317
Washington, D. C	30	1,014	328	957	328	902	327	850	326	801	324	754	323	709	323	626	322	553	325
Wright Field, Ohio	27	985	321	956	326	902	327	851	325	801	324	755	323	711	322	629	323	555	325

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TABLE 1.—*Mean free-air temperatures (t), °C. obtained by airplanes during April 1937. (Dep. represents departure from "normal" temperature.)*

Stations	Number of observations	Altitude (meters) m. s. l. Surface t	Surface Dep.	500 t	500 Dep.	1,000 t	1,000 Dep.	1,500 t	1,500 Dep.	2,000 t	2,000 Dep.	2,500 t	2,500 Dep.	3,000 t	3,000 Dep.	4,000 t	4,000 Dep.	5,000 t	5,000 Dep.
Pearl Harbor, Territory of Hawaii[1] (6 m)	30	21.0	−0.8	19.5	−0.2	16.0	−0.3	13.3	−0.3	12.0	+0.1	10.4	−0.2	8.6	−0.2	3.9	−0.5	−2.0	−0.2

[1] Navy.

Observations taken at dawn.

NOTE.—The departures are based on normals covering the following total number of observations made during the same month in previous years, including the current month (years of record are given in parentheses following the number of observations): Pearl Harbor, 108 (4).

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TABLE 2.—*Mean free-air relative humidities (R. H.), in percent, and specific humidities (q), in grams/kilogram, obtained by airplanes during April 1937. (Dep. represents departure from "normal" relative humidity)*

Station	Number of observations	Altitude (meters) m. s. l. Surface q	Surface R. H. Mean	Surface R. H. Dep.	500 q	500 R. H. Mean	500 R. H. Dep.	1,000 q	1,000 R. H. Mean	1,000 R. H. Dep.	1,500 q	1,500 R. H. Mean	1,500 R. H. Dep.	2,000 q	2,000 R. H. Mean	2,000 R. H. Dep.	2,500 q	2,500 R. H. Mean	2,500 R. H. Dep.	3,000 q	3,000 R. H. Mean	3,000 R. H. Dep.	4,000 q	4,000 R. H. Mean	4,000 R. H. Dep.	5,000 q	5,000 R. H. Mean	5,000 R. H. Dep.
Pearl Harbor, Territory of Hawaii	30	12.6	82	+8	11.8	80	+4	10.9	87	+7	9.4	84	+6	6.9	63	−5	4.8	46	−7	3.6	37	−7	2.3	29	−2	1.5	27	−2

LATE REPORT

TABLE 3.—*Mean free-air barometric pressures (P), in mb, and equivalent potential temperatures (θ_E,) in °A. obtained by airplanes during April 1937*

Station	Number of observations	Altitude (meters) m. s. l. Surface P	Surface θ_E	500 P	500 θ_E	1,000 P	1,000 θ_E	1,500 P	1,500 θ_E	2,000 P	2,000 θ_E	2,500 P	2,500 θ_E	3,000 P	3,000 θ_E	4,000 P	4,000 θ_E	5,000 P	5,000 θ_E
Pearl Harbor, Territory of Hawaii	30	1,016	328	960	329	906	329	854	327	804	324	757	322	712	322	631	324	557	326

TABLE 4.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during June 1937*

[Wind from N. = 360°, E. = 90°, etc.]

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,554 m) Direction	Albuquerque Velocity	Atlanta, Ga. (309 m) Direction	Atlanta Velocity	Billings, Mont. (1,088 m) Direction	Billings Velocity	Boston, Mass. (15 m) Direction	Boston Velocity	Cheyenne, Wyo. (1,873 m) Direction	Cheyenne Velocity	Chicago, Ill. (192 m) Direction	Chicago Velocity	Cincinnati, Ohio (153 m) Direction	Cincinnati Velocity	Detroit, Mich. (204 m) Direction	Detroit Velocity	Fargo, N. Dak. (274 m) Direction	Fargo Velocity	Houston, Tex. (21 m) Direction	Houston Velocity	Key West, Fla. (11 m) Direction	Key West Velocity	Medford, Oreg. (410 m) Direction	Medford Velocity	Murfreesboro, Tenn. (180 m) Direction	Murfreesboro Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	346	2.2	272	1.1	302	2.7	351	1.3	266	2.9	343	0.3	325	0.6	285	1.0	160	0.5	202	0.6	137	1.9	324	0.7	202	0.7
500	----	----	270	3.8	----	----	353	3.2	----	----	236	.8	280	1.9	301	1.8	179	2.2	190	7.4	130	3.6	306	0.5	244	2.2
1,000	----	----	276	3.9	----	----	330	3.2	----	----	288	2.6	282	4.8	293	4.1	243	1.4	180	7.0	141	2.9	279	0.4	255	3.4
1,500	----	----	276	3.4	296	2.5	300	4.5	----	----	270	3.7	292	4.9	296	4.6	296	1.8	167	5.0	160	2.0	156	1.0	261	3.8
2,000	314	2.3	281	3.1	307	2.5	293	6.0	262	4.4	276	4.7	288	6.6	289	6.5	300	3.1	159	3.9	195	1.6	194	1.4	265	4.7
2,500	281	3.4	281	3.6	286	3.0	288	7.6	267	6.6	277	4.8	290	7.1	286	7.4	306	4.2	154	3.0	200	1.5	224	3.7	271	5.6
3,000	261	4.6	282	3.1	264	3.9	293	8.9	270	7.4	289	6.7	294	6.9	292	7.6	336	4.9	176	1.7	247	2.0	221	3.8	279	4.5
4,000	249	5.4	275	4.2	261	6.8	294	7.6	272	7.6	----	----	290	9.3	279	8.6	300	3.1	57	2.3	248	2.8	270	3.3	----	----
5,000	232	7.1	----	----	273	5.5	----	----	286	7.0	----	----	----	----	288	12.4	----	----	----	----	----	----	291	4.3	----	----

Altitude (meters m. s. l.	Newark, N. J. (14 m) Direction	Newark Velocity	Oakland, Calif. (8 m) Direction	Oakland Velocity	Oklahoma City, Okla. (402 m) Direction	Oklahoma City Velocity	Omaha, Nebr. (306 m) Direction	Omaha Velocity	Pearl Harbor, Territory of Hawaii[1] (68 m) Direction	Pearl Harbor Velocity	Pensacola, Fla.[1] (24 m) Direction	Pensacola Velocity	St. Louis, Mo. (170 m) Direction	St. Louis Velocity	Salt Lake City, Utah (1,294 m) Direction	Salt Lake City Velocity	San Diego, Calif. (15 m) Direction	San Diego Velocity	Sault Ste. Marie, Mich. (198 m) Direction	Sault Ste. Marie Velocity	Seattle, Wash. (14 m) Direction	Seattle Velocity	Spokane, Wash. (603 m) Direction	Spokane Velocity	Washington, D. C. (10 m) Direction	Washington Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	32	0.8	259	1.7	160	2.4	93	0.7	55	4.0	327	0.7	228	0.9	142	3.0	48	1.5	322	0.5	177	1.0	87	1.6	263	0.5
500	334	2.3	259	3.4	176	5.1	151	1.9	67	6.6	228	2.7	225	4.2	----	----	335	2.1	301	1.7	223	1.7	----	----	278	4.2
1,000	304	2.8	290	3.4	207	8.9	231	3.1	78	7.5	225	3.2	254	5.6	----	----	324	2.4	292	3.6	234	1.8	170	1.0	293	3.6
1,500	288	5.0	305	2.5	216	6.3	261	5.6	81	7.8	210	2.4	268	7.3	153	3.9	305	4.8	297	3.8	221	1.1	230	1.8	291	4.1
2,000	285	6.5	278	1.3	235	3.8	266	5.9	88	5.6	223	1.2	269	8.1	180	2.5	----	----	319	4.9	217	2.1	233	2.2	287	5.3
2,500	297	7.8	244	1.2	256	3.0	280	6.6	88	5.0	171	0.3	280	6.7	209	1.9	----	----	318	5.9	217	3.0	245	3.0	287	6.8
3,000	289	8.0	235	3.8	275	2.0	300	8.8	84	4.8	273	2.2	256	5.5	235	2.8	----	----	315	6.2	236	1.4	263	4.5	284	8.5
4,000	309	9.4	----	----	44	2.7	314	9.3	----	----	283	3.8	310	4.3	240	6.0	----	----	----	----	266	4.9	336	2.3	299	7.0
5,000	301	12.1	----	----	----	----	----	----	----	----	----	----	----	----	250	9.8	----	----	----	----	----	----	7	5.6	312	6.4

[1] Navy stations.

TABLE 5.—*Maximum free-air wind velocities, (M. P. S.), for different sections of the United States based on pilot-balloon observations during June 1937*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station
Northeast [1]	45.5	SW	1,000	14	Pittsburgh	39.2	W	4,130	14	Columbus	43.2	NNE	9,000	24	Albany.
East-Central [2]	28.4	W	2,190	10	Knoxville	28.0	W	3,059	10	Murfreesboro	40.0	NW	10,080	8	Greensboro.
Southeast [3]	26.3	NW	1,960	28	Spartanburg	26.7	NNW	3,640	22	Atlanta	34.4	NNW	5,740	22	Spartanburg.
North-Central [4]	27.9	SSE	1,688	17	Bismarck	31.2	NNW	3,070	21	Fargo	40.8	W	10,010	15	Detroit
Central [5]	47.3	WSW	2,200	5	Omaha	46.8	WSW	2,560	5	Omaha	34.0	SW	6,822	7	Indianapolis.
South-Central [6]	33.8	SW	1,530	9	Abilene	35.0	WSW	4,270	5	Amarillo	38.0	NW	9,960	7	Dallas.
Northwest [7]	30.8	NNE	670	7	Pendleton	35.4	SSW	4,293	21	Spokane	34.6	N	7,733	4	Spokane.
West-Central [8]	34.8	SSW	633	16	Redding	42.6	SSW	3,735	16	Modena	47.7	WNW	6,975	4	Modena.
Southwest [9]	35.8	WSW	1,704	9	Winslow	40.6	WSW	3,018	4	Winslow	37.4	WSW	5,960	9	Albuquerque.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, Southern Ohio, Kentucky, Eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and Northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD in charge]

By BENNETT SWENSON

The precipitation during June was normal or considerably above normal over most sections of the country while limited areas received only scanty amounts. The principal areas of above-normal precipitation were from Oklahoma northeastward to lower Michigan and New York, the Middle Atlantic Coastal Plains, New Mexico, northeastern Colorado, Washington, and in portions of Wyoming, Idaho, Oregon, and northern California. In portions of Washington the amounts were more than four times normal.

The floods resulting from excessive precipitation during the month are discussed below with a table of gage heights appearing at the end of the text.

Great Lakes drainage.—Floods in this section occurred from June 21 to 30 in the Red Cedar and Grand Rivers in Michigan, the St. Joseph River in Ohio and Indiana, and the Sandusky River in Ohio. These floods were the result of ample rains during the entire month with excessive rains occurring in the form of thunderstorms on the 20–21st and again on the 25th. The losses due to the floods were not extensive, except along the Sandusky River in Ohio, where damages amounting to $690,000 were reported, mostly to growing crops.

Atlantic slope drainage.—Minor floods occurred during the month in the Santee and Savannah Rivers in South Carolina. No damage was reported.

Upper Mississippi Basin.—Heavy local rains over northern Illinois on June 20–21 resulted in local floods in the Rock River from June 22–29. The flat character of the country permitted the overflow to spread out and the losses suffered were mainly damage to crops. Approximately 3,500 acres of growing crops were inundated with a loss of $200,000.

Minor flooding occurred in the Bourbeuse and Meramec Rivers in Missouri on June 10–12, but no losses of consequence were reported.

Missouri Basin.—Several local floods occurred in Montana during June but the most disastrous occurred at Billings, Mont., on the night of June 11–12. Among other localities flooded were Roundup, Klein, and Hinsdale, Mont. It is believed to be the first flood experienced at Billings in the 54 years of its history. The damage that occurred in the city and the immediate vicinity is conservatively estimated to be over $750,000.

Less severe floods in the Missouri Basin occurred in the upper Solomon River at Beloit, Kans., and in the lower Osage River in Missouri. The damage from the Solomon River was estimated at $12,000, most of which was to growing crops, and the Osage River, $45,500.

The greater portion of the Missouri River has been unusually low for a number of years as the result of deficient precipitation over much of the watershed. Sand bars and islands in the river that have not been inundated in the last few years are being used by farmers to an increasing extent to pasture cattle and some good crops have been produced of late on the bars that would, in most years, be flooded. For that reason, moderately high stages in the river after several years of low stages are of more than ordinary interest.

The unusually heavy rains from June 5–14 over Montana, Wyoming, North Dakota, and northern South Dakota resulted in a pronounced rise in the upper and middle Missouri River. Although the river exceeded flood stage only at Nebraska City, Nebr., it was necessary to issue warnings that the highest stage for several years during June would be reached from Bismarck, N. Dak., to St. Joseph, Mo., in order to protect livestock interests.

The high stages in the Missouri River resulted in damages amounting to about $285,000, mostly to growing crops. Heavy local rains on June 17 in the southern Black Hills region (Cheyenne River watershed) of South Dakota caused damages amounting to about $140,000 in the vicinity of Hot Springs, S. Dak.

Ohio Basin.—Floods in the Muskingum and Scioto Rivers in Ohio were caused by exceptionally heavy thunderstorms on June 21, together with abundant precipitation throughout the month, which left the ground in a saturated condition. The losses in the Muskingum River amounted to $712,000 and in the Scioto River, $100,000. The principal damage in each case was to growing crops.

Excessive rains occurred between 4 and 6 p. m. of the 21st over Gilmer and Lewis Counties in West Virginia and