DETAILS OF THE WEATHER IN THE UNITED STATES.

GENERAL CONDITIONS.

ALFRED J. HENRY.

Clearly, the sluggish movement of cyclones and anticyclones was directly responsible for the character of the weather of the month—rather heavy and persistent rainy, cloudy weather in the Gulf States, Texas excepted, the lack of rainfall in the Lake region and thence eastward to New England, the cool weather east of the Mississippi, and other less striking phenomena. The usual details follow.

CYCLONES AND ANTICYCLONES.

By W. P. DAY.

The general types and movements of low-pressure areas were typical of the season, the erratic and sluggish tendencies continuing over from the preceding month. As usual there were frequent developments over the elevated regions of the West and the Canadian Northwest; but only a portion of these reached the migrating stage. The three storms which reached the Canadian Maritime Provinces originated over the Southern Plateau region; the remainder of the low-pressure areas noted slowly dissipated or were lost in secondary developments.

Of the eight high-pressure areas charted, four were of the Alberta type, two from Hudson Bay, and two were offshoots from the pressure maximum normally over the North Pacific Ocean at this time of the year. The relative numbers of these types are about normal.

FREE-AIR SUMMARY.

By L. T. SAMUELS, Meteorologist.

Free-air temperatures (Table 1) for the month averaged in general below normal. The departures decreased, however, with increasing altitude, becoming positive in the highest levels at most of the stations. On the 8th the lowest temperatures on record for the month of May in the upper levels were observed at Drexel and Ellendale and on the 9th at Due West, Groesbeck, and Royal Center.

The mean relative humidities were for the most part below normal, except at Due West and in the higher levels at Royal Center. The apparent general increase in the departures with increase in altitude is largely caused by the fewer observations at higher levels and the large fluctuations of this element.

The vapor-pressure departures were practically the same as those for temperature.

The resultant wind directions and velocities for the month are shown in Table 2. It will be observed that in general the resultant velocities for the month do not differ greatly from the normals. The resultant directions, however, vary considerably in many cases. For example, at Drexel where this difference is greatest the south component is much less than the normal. At Broken Arrow and Groesbeck this is also true, although to a lesser degree.

The following stations reported pronounced easterly winds at altitudes of 5,000 meters or higher:

Station.	Date.	Altitude (meters).	Average velocity.
			m. p. s.
Drexel, Nebr.	28	Surface to 8,000	6
Due West, S. C.	2	1,000 to 6,000	4–10
Do	22	Surface to 5,000	2
Do	31	Surface to 6,500	8
Ellendale, N. Dak.[1]	16	4,500 to 8,000	5–10
Lansing, Mich.	3	Surface to 5,000	5
Do	24	Surface to 5,000	8–4
Do	28	Surface to 10,000	5
Do	30	Surface to 9,000	6
McCook Field, Ohio.	2	Surface to 7,000	8
Madison, Wis.	26	Surface to 7,000	5
Royal Center, Ind.	2	Surface to 5,000	8–4
Do	3	Surface to 5,500	8–16
Do	5	Surface to 5,000	10
Do	24	Surface to 5,000	8–2
Do	27	Surface to 5,000	8
Do	28	Surface to 9,000	8

[1] Closely verified by double-theodolite observation immediately after.

Ellendale reported a wind of 42 m. p. s. from the north at 4,200 meters on the 8th. This occurred on the eastern side of a strong HIGH, centered at that time over western North and South Dakota. As would be expected from this great velocity and such conditions a rapid movement south-southeastward of this HIGH occurred during the next 24 hours. As a matter of interest it may be mentioned that the velocity and direction found at the 3,000-meter level (NNW.-24 m. p. s.) gave an exceedingly true indication of the place at which the center of the HIGH was found at the end of 24 hours by assuming this as the rate and direction of movement.

Another observation worthy of note was made at Ellendale on the morning of the 14th when the velocity from the surface to 5,000 meters increased slightly from 2 m. p. s. to 10 m. p. s. but sharply from 5,000 meters to 8,000 meters where a speed of 37 m. p. s. was recorded. This high upper wind, indicative of a marked low pressure over the polar regions, the latter being produced by the low temperatures in that region as shown on the weather map of that date, would seem to signify a rapid movement of pressure areas during the next immediate period. The map of the next day strikingly confirms this assumption.

A kite flight at Drexel on the 8th, made in the front of a strong HIGH, showed unseasonably low temperatures in the upper levels. Minimum temperatures records for this month for the past 8 years at levels between 750 meters and 3,000 meters were exceeded, the temperature at 3,000 meters being $-14.6°$ (C.), as compared with a normal of $1.1°$ (C.). This departure is exceptionally large considering this high elevation where temperatures are beyond the influence of diurnal variations. By the next day (9th) this HIGH had moved so that the center extended from the Drexel region south-southeastward to the Gulf. Ordinarily a kite flight in the center of a HIGH is not successful owing to the light surface winds and therefore inability to reach the more favorable winds existing aloft. However, by starting exceptionally early (5:30 a. m.) the Drexel station force fortunately obtained a flight on that date. The wind veered from WNW. at the surface to NW. and NNW. at 3,000 meters while the velocity increased from less

than 3 m. p. s. at the surface to 23 m. p. s. aloft. A temperature lapse rate, in general, less than the normal was found with inversions between 2,000 meters and 2,760 meters and between 3,100 meters and 3,300 meters. At Groesbeck, also under the influence of the HIGH center, conditions were more favorable and a good kite flight was readily obtained reaching to 4,000 meters. At this station temperatures at all levels were found to be considerably below their normals. The lapse rate from the surface to 1,000 meters was close to the monthly normal, an inversion extended from 1,000 meters to 1,500 meters, above which the lapse rate exceeded the normal appreciably.

In connection with the special forecast issued from the Central Office on the morning of the 2d to the Army aviators at Mitchel Field for their record making nonstop flight to San Diego, the free-air conditions showed the prevalence of easterly winds from the Atlantic coast westward to the Rocky Mountains. While the successful accomplishment of the flight has since shown that favorable or at least navigable conditions prevailed over the entire route the lack of definite free-air observations from the far western region is clearly evident.

From the 21st to the end of the month the eastern half of the country experienced stagnation conditions with respect to pressure areas. During this period easterly winds were found to high altitudes almost continuously and velocities were light as would be expected. These conditions proved suitable for a number of exceptionally long pilot balloon observations, among the highest of which was the one made at Lansing on the 28th. This reached 24,570 meters and was made with a single theodolite. Velocities were light practically throughout with a tendency to increase in the highest levels where 20 m. p. s. was observed. The direction was mostly easterly to 10,000 meters, where a veering to NW. and finally N. occurred.

TABLE 1.—*Free-air temperatures relative humidities and vapor pressures during May, 1923.*

TEMPERATURE (°C)

Altitude m. s. l. (meters).	Broken Arrow, Okla. (233 meters).		Drexel, Nebr. (396 meters).		Due West, S. C. (217 meters).		Ellendale, N Dak. (444 meters).		Groesbeck, Tex. (141 meters).		Royal Center, Ind. (225 meters).	
	Mean.	Departure from 5-year mean.	Mean.	Departure from 8-year mean.	Mean.	Departure from 3-year mean.	Mean.	Departure from 6-year mean.	Mean.	Departure from 5-year mean.	Mean.	Departure from 5-year mean.
Surface	18.3	−1.7	13.7	−2.5	19.3	−1.1	12.9	−0.6	23.1	+0.1	15.7	−1.4
250	18.2	−1.7	.....	.....	19.0	−1.0	.....	.....	22.0	−0.1	15.5	−1.3
500	16.7	−1.3	13.1	−2.4	16.8	−0.8	12.7	−0.5	20.0	−0.3	13.3	−1.0
750	15.3	−1.1	11.7	−2.1	15.2	−0.6	11.2	−0.4	18.3	−0.6	11.6	−0.9
1,000	14.1	−1.0	10.6	−1.8	14.0	−0.4	9.8	−0.4	16.8	−0.7	10.3	−0.7
1,250	13.2	−0.7	9.2	−1.8	12.7	−0.3	8.3	−0.4	15.8	−0.6	8.7	−0.8
1,500	11.9	−0.8	7.7	−1.8	11.3	−0.3	6.6	−0.6	15.2	−0.1	7.2	−0.9
2,000	9.3	−0.8	5.0	−1.8	8.6	−0.4	3.8	−0.5	13.1	+0.1	4.5	−1.1
2,500	6.7	−0.5	3.0	−1.1	6.1	−0.3	1.4	0.0	10.4	+0.1	1.5	−1.6
3,000	3.9	−0.2	0.8	−0.3	3.8	+0.2	−1.0	+0.4	7.6	+0.1	−1.8	−2.2
3,500	1.1	−0.2	−1.6	+0.2	1.4	+0.6	−3.4	+0.5	5.0	+0.6	−5.2	−2.8
4,000	−1.9	−0.2	−4.7	+0.1	−2.0	+0.2	−6.4	+0.4	2.4	+1.0	−8.1	−3.0
4,500	.....	.....	−7.4	+0.5	−5.6	−0.4	−9.2	+0.4	−0.1	+1.6	.....	.....
5,000	.....	.....	−10.4	+0.9	−9.2	0.0	−11.8	−0.2	−2.8	+1.9	.....	.....

RELATIVE HUMIDITY (PER CENT).

Surface	73	−1	68	+2	71	+5	61	−2	66	−7	60	−2
250	73	−1	.....	.....	71	+5	.....	.....	68	−5	60	−2
500	72	−1	66	+1	72	+5	60	−2	70	−3	57	−5
750	71	−2	62	−2	73	+5	59	−1	70	−1	55	−6
1,000	69	−3	59	−4	71	+4	57	−3	68	−1	53	−7
1,250	65	−5	60	−3	70	+4	58	−3	64	−2	53	−6
1,500	64	−3	61	−2	69	+3	59	−2	57	−5	53	−5
2,000	62	−2	61	+1	66	+1	57	−3	52	−2	55	+1
2,500	59	−1	57	−1	64	0	52	−6	52	+2	56	+7
3,000	56	0	55	−3	61	+1	47	−10	55	+6	56	+11
3,500	54	+1	53	−5	61	+5	39	−13	48	+2	56	+13
4,000	42	−9	45	−12	63	+14	39	−12	47	+2	52	+12
4,500	.....	.....	48	−13	61	+18	40	−12	44	0	.....	.....
5,000	.....	.....	48	−14	60	+17	39	−6	54	0	.....	.....

VAPOR PRESSURE (mb).

Surface	15.87	−1.67	11.26	−1.06	16.09	+0.11	9.50	−0.46	18.55	−1.75	10.76	−1.41
250	15.73	−1.66	.....	.....	15.84	+0.15	.....	.....	17.93	−1.50	10.55	−1.39
500	14.01	−1.34	10.50	−1.16	14.19	+0.38	9.32	−0.38	16.38	−1.12	8.80	−1.40
750	12.58	−1.19	8.98	−1.31	12.96	+0.38	8.17	−0.35	14.89	−0.81	7.52	−1.45
1,000	11.37	−1.15	8.05	−1.24	11.74	+0.25	7.34	−0.36	13.29	−0.78	6.64	−1.39
1,250	10.00	−1.26	7.44	−0.97	10.79	+0.35	6.70	−0.37	11.65	−0.70	5.94	−1.24
1,500	8.84	−0.96	6.96	−0.61	9.65	+0.21	6.10	−0.31	10.00	−0.75	5.33	−1.04
2,000	7.28	−0.52	5.86	−0.13	8.00	+0.19	4.78	−0.29	7.98	−0.06	4.42	−.49
2,500	5.84	−0.16	4.81	0.0	6.82	+0.27	3.58	−0.32	6.71	+0.38	3.36	−.22
3,000	4.61	+0.07	4.21	+0.28	5.78	+0.40	2.46	−0.58	5.91	+0.67	2.37	−.12
3,500	3.99	+0.20	3.62	+0.46	5.17	+0.70	1.42	−0.83	4.48	+0.34	1.63	−.23
4,000	2.81	−0.33	2.17	−0.36	4.51	+0.93	0.71	−0.97	3.69	+0.29	.55	−.57
4,500	.....	.....	2.03	−0.08	3.81	+1.07	.....	.....	3.03	+0.22	.....	.....
5,000	.....	.....	1.94	+0.16	3.29	+0.98	.....	.....	3.01	+0.22	.....	.....

TABLE 2.—*Free-air resultant winds (m. p. s.) during May, 1923.*

Altitude, m. s. l. (meters).	Broken Arrow, Okla. (233 meters).				Drexel, Nebr. (396 meters).				Due West, S. C. (217 meters).				Ellendale, N. Dak. (444 meters).				Groesbeck, Tex. (141 meters).				Royal Center, Ind. (225 meters).			
	Mean.		5-year mean.		Mean.		8-year mean.		Mean.		3-year mean.		Mean.		6-year mean.		Mean.		5-year mean.		Mean.		5-year mean.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	N. 85° E.	1.1	S. 25° E.	2.1	S. 73° E.	1.0	S. 3° E.	1.4	S. 75° E.	0.8	N. 73° E.	0.8	S. 69° E.	0.6	S. 58° E.	0.6	S. 10° E.	1.6	S. 16° E.	1.9	N. 76° E.	2.2	N. 66° E.	1.2
250	N. 87° E.	1.2	S. 26° E.	2.1	.....	.....	.....	.....	S. 77° E.	0.9	N. 72° E.	0.8	.....	.....	.....	.....	S. 7° E.	1.9	S. 10° E.	2.4	N. 77° E.	2.3	N. 68° E.	1.2
500	S. 56° E.	1.8	S. 20° E.	2.9	N. 88° E.	1.2	S. 1° E.	1.6	S. 70° E.	1.3	N. 66° E.	1.1	S. 51° E.	1.2	S. 43° E.	0.8	S. 3° W.	2.4	S. 3° E.	3.6	N. 80° E.	2.6	N. 72° E.	1.0
750	S. 35° E.	2.0	S. 8° E.	3.3	S. 82° E.	1.8	S. 1° W.	1.7	S. 43° E.	2.1	N. 75° E.	0.8	S. 31° E.	2.3	S. 23° E.	1.4	S. 24° W.	2.8	S. 7° W.	4.1	N. 81° E.	2.4	N. 62° E.	0.7
1,000	S. 9° E.	1.5	S. 6° W.	3.4	S. 84° E.	1.7	S. 20° W.	2.1	S. 29° E.	1.8	N. 51° E.	0.5	S. 20° E.	2.7	S. 11° E.	1.7	S. 37° W.	4.0	S. 20° W.	4.7	N. 68° E.	1.9	N. 15° E.	0.5
1,250	S. 10° W.	1.0	S. 23° W.	3.5	S. 84° E.	1.5	S. 30° W.	2.4	S. 13° W.	2.9	S. 49° W.	0.8	S. 16° E.	2.8	S. 2° W.	2.1	S. 45° W.	4.8	S. 27° W.	5.0	N. 57° E.	1.6	N. 22° W.	1.0
1,500	S. 49° W.	1.1	S. 33° W.	3.7	S. 88° E.	0.9	S. 41° W.	3.0	S. 41° W.	4.0	S. 45° W.	1.8	S. 10° E.	3.1	S. 8° W.	2.6	S. 61° W.	4.5	S. 37° W.	5.0	N. 35° E.	0.9	N. 53° W.	1.1
2,000	S. 87° W.	2.6	S. 52° W.	4.2	N. 3° W.	1.2	S. 59° W.	4.0	S. 56° W.	5.1	S. 64° W.	2.9	S.	3.2	S. 22° W.	3.4	S. 78° W.	5.6	S. 48° W.	5.1	S. 8° W.	1.6	N. 80° W.	1.9
2,500	N. 64° W.	4.5	S. 73° W.	4.7	N. 28° W.	2.7	S. 70° W.	4.6	S. 69° W.	10.0	S. 74° W.	4.6	S. 4° W.	3.4	S. 29° W.	4.7	S. 86° W.	6.7	S. 64° W.	5.6	S. 31° W.	2.3	N. 89° W.	2.5
3,000	N. 58° W.	5.1	S. 88° W.	5.0	N. 54° W.	5.4	S. 77° W.	6.8	S. 78° W.	9.6	N. 82° W.	4.3	S. 3° W.	3.2	S. 38° W.	6.0	N. 83° W.	8.9	S. 75° W.	6.9	S. 66° W.	5.7	N. 77° W.	3.6
3,500	N. 67° W.	6.8	N. 75° W.	7.6	N. 58° W.	10.4	S. 84° W.	7.9	S. 85° W.	9.0	N. 74° W.	6.7	S.	4.5	S. 41° W.	5.4	N. 55° W.	8.5	S. 80° W.	7.6	S. 87° W.	6.3	N. 58° W.	4.8
4,000	N. 28° W.	14.0	N. 44° W.	12.0	N. 64° W.	9.5	N. 84° W.	8.7	N. 66° W.	16.4	N. 54° W.	9.4	S. 11° W.	7.1	S. 60° W.	5.9	N. 48° W.	12.5	N. 70° W.	11.6	S. 42° W.	6.2	N. 84° W.	5.9
4,500	N. 45° W.	19.8	N. 45° W.	19.8	N. 68° W.	17.3	S. 75° W.	10.4	W.	18.6	N. 58° W.	9.7	S. 16° W.	12.0	S. 20° W.	2.8	N. 39° W.	11.7	N. 65° W.	12.9	S. 68° W.	14.4	N. 86° W.	5.0
5,000	.....	.....	.....	.....	N. 69° W.	19.9	N. 89° W.	16.6	W.	20.6	N. 74° W.	16.5	S.	11.8	N. 73° E.	5.5	N. 74° W.	7.9	N. 88° W.	12.5	.....	.....	.....	.....