TABLE 2.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a. m. (E. S. T.) during December, 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 29 E	1.1	N 78 W	1.6	S 27 W	1.3	N 74 W	4.2	S 76 W	0.9	S 69 W	1.9	S 87 W	0.5	N 48 E	1.2	N 60 W	1.0	S 66 W	2.2	N 48 E	0.7	S 78 E	3.4
500			S 9 W	1.7	S 64 W	4.5			S 86 W	4.2	S 77 W	5.7	S 54 W	3.2	N 65 W	1.4	N 65 W	1.4			S 12 E	3.8	S 69 E	8.9
1,000			S 22 W	3.0	N 83 W	7.4			S 84 W	6.7	N 84 W	7.9	S 70 W	4.2	S 83 W	2.9	N 51 W	3.6	S 62 W	6.9	S 5 W	3.8	S 59 E	8.0
1,500			S 19 W	4.4	N 62 W	10.6			N 83 W	12.8	N 87 W	10.7	S 49 W	5.5	S 84 W	5.8	N 60 W	5.0	S 79 W	9.5	S 41 W	4.4	S 57 E	6.0
2,000	N 23 W	1.8	S 72 W	5.2	N 62 W	14.1	N 82 W	7.4	N 87 W	10.3	N 85 W	11.3	S 60 W	6.9	W	8.8	N 64 W	8.3	N 89 W	9.3	S 57 W	5.2	S 54 E	5.1
2,500	N 71 W	3.9	S 44 W	7.0	N 61 W	16.3	N 86 W	9.3			N 87 W	12.9	S 64 W	8.9	N 83 W	8.1	N 70 W	8.5	N 87 W	9.4	S 44 W	5.5	S 52 E	3.9
3,000	N 71 W	5.8	S 51 W	9.2	N 55 W	21.3	N 82 W	7.1					S 67 W	10.5	S 89 W	8.9	N 76 W	9.9	N 87 W	10.7			S 57 E	4.3
4,000	N 79 W	8.7					S 89 W	9.0					S 80 W	10.2			N 70 W	14.5					S 40 E	3.4
5,000	S 77 W	7.2					S 88 W	6.8																
6,000							N 72 W	2.4																

Altitude (meters) m. s. l.	Los Angeles, Calif. (217 meters)		Medford, Oreg. (410 meters)		Memphis, Tenn. (89 meters)		New Orleans, La. (25 meters)		Oakland, Calif. (8 meters)		Oklahoma City, Okla. (392 meters)		Omaha, Nebr. (299 meters)		Phoenix, Ariz. (356 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 42 W	0.3	S 58 E	0.7	S 2 E	0.7	N 62 E	1.2	S 68 E	1.6	S 64 W	0.8	S 30 E	0.9	S 61 E	1.5	S 26 E	3.2	S 75 E	0.2	S 49 E	2.1	N 51 W	1.4
500	N 73 E	0.4	S 56 E	1.5	S 16 W	0.8	S 32 E	2.9	S 26 E	2.3	S 34 W	2.1	S 58 W	2.9	S 77 E	2.3			N 55 W	0.1	S 3 E	6.6	N 70 W	7.3
1,000	N 30 E	0.3	S 17 E	5.6	S 65 W	2.6	S 29 W	4.8	S 47 W	1.8	S 66 W	3.7	S 60 W	8.3	S 78 E	1.9			N 65 W	2.7	S 16 W	9.8	N 73 W	9.6
1,500	N 60 W	1.9	S 26 W	6.4	S 52 W	4.2	S 38 W	2.5	S 55 W	4.0	S 57 W	5.1	S 67 W	8.6	S 37 E	1.5	S 11 E	4.3	N 46 W	4.5	S 23 W	11.7	N 68 W	13.6
2,000	N 68 W	3.7	S 35 W	9.9	S 89 W	5.1	S 54 W	7.4	S 62 W	4.5	S 72 W	6.0	N 86 W	8.5	S 22 W	0.3	S 6 W	5.9	N 44 W	6.3	S 19 W	11.3	N 70 W	15.0
2,500	N 62 W	3.4	S 41 W	10.9	S 85 W	7.5	S 57 W	8.0	S 58 W	5.1	S 79 W	6.9	S 84 W	9.6	N 89 W	2.6	S 20 W	5.5	N 53 W	8.6				
3,000	N 47 W	3.8	S 44 W	12.3	N 78 W	10.8	S 52 W	5.8	S 72 W	3.4	S 78 W	8.9	N 89 W	9.4	N 73 W	4.4	S 48 W	3.9	N 34 W	7.1				
4,000			S 44 W	9.6					S 67 W	2.5	S 85 W	5.8	N 80 W	10.5	N 83 W	7.5	N 57 W	5.2						
5,000																								

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

	Dallas, Tex.[1]	Due West, S. C.[2]	Ellendale, N. Dak.[2]	Chicago, Ill.[1]	Cleveland, Ohio[1]	Omaha, Nebr.[1]
Mean altitudes, meters, m. s. l., reached during month	5,285	2,091	3,192	4,678	4,914	5,838
Maximum altitudes, meters, m. s. l., reached	5,962	3,570	5,161	5,273	5,671	6,547
Number of flights made	32	29	28	30	30	26
Number of days on which flights were made	31	29	28	30	30	25

[1] Airplanes. [2] Kite.

AEROLOGICAL OBSERVATIONS FOR THE YEAR 1931

[The Aerological Division, W. R. Gregg, in charge]

By L. T. SAMUELS

Table 1 shows the mean free-air temperatures and relative humidities for the year at Due West, Ellendale, and Washington, D. C., and for the parts of the year indicated at the other stations. Kite observations were discontinued during the year at Broken Arrow, Groesbeck, and Royal Center and regular daily airplane observations started at Chicago, Cleveland, Dallas, and Omaha.

An inspection of the departures from the normal free-air temperatures (not shown in table) for the corresponding periods at the various stations shows small negative values at all levels at Due West and moderately large positive departures at Ellendale and Washington, where full year records were obtained. Approximate normals for Dallas were obtained by interpolating latitudinally between Groesbeck and Broken Arrow. From these it is found that the free-air temperatures at Dallas and Omaha (the latter based on normals of the Drexel, Nebr., kite station) for the latter half of the year were above normal at all levels. The largest departures occurred at Omaha where they were nearly 4° C. at the 2,500 meter level. Positive departures of equal magnitude are found when the mean temperatures for Chicago are compared with the normals for Royal Center, situated 100 miles to the southeast.

TABLE 1.—*Mean free-air temperatures and humidities obtained by airplanes (or kites) during year 1931*

TEMPERATURE (°C)

Altitude (meters) m. s. l.	Broken Arrow, Okla.[1] (233 meters)	Chicago, Ill.[2] (190 meters)	Cleveland, Ohio[2] (245 meters)	Dallas, Tex.[2] (149 meters)	Due West, S. C. (217 meters)	Ellendale, N. Dak. (444 meters)	Groesbeck, Tex.[3] (141 meters)	Omaha, Nebr.[4] (299 meters)	Royal Center, Ind.[5] (225 meters)	Washington, D. C. (Naval Air Sta.) (2 meters)
Surface	9.3	12.6	12.4	18.2	15.3	7.3	10.4	10.4	8.3	11.8
500	8.6	13.4	13.3	19.3	14.5	7.3	9.8	11.1	6.7	11.7
1,000	7.0	12.8	12.8	18.6	12.6	7.5	7.9	12.3	4.7	10.2
1,500	4.9	10.6	10.4	16.6	10.0	6.1	6.5	11.3	2.7	------
2,000	2.8	8.0	8.1	14.1	7.5	3.9	4.5	9.3	0.7	5.8
2,500	0.2	5.5	5.8	11.5	4.9	1.2	2.1	6.8	−1.3	------
3,000	−2.4	2.8	3.4	8.8	2.2	−1.6	−0.4	3.9	−3.5	1.4
4,000	−8.6	−2.9	−1.5	2.5	−3.8	−7.5	−6.5	−2.6	−8.8	−3.8
5,000	−13.5	−8.9	−6.7	−2.0	−9.8	−13.9	------	−9.4	−14.7	−10.0
6,000	------	------	−12.3	−8.0	------	−19.6	------	−16.6	−21.6	------

RELATIVE HUMIDITY PER CENT

Surface	72	84	83	79	74	72	77	82	74	74
500	67	73	75	71	69	71	67	75	73	63
1,000	62	65	67	63	64	60	61	60	69	58
1,500	59	61	65	60	62	56	53	53	63	------
2,000	54	57	61	56	59	54	50	48	59	54
2,500	52	52	55	55	55	54	48	45	56	------
3,000	51	50	51	51	51	54	42	45	55	47
4,000	47	45	43	47	48	55	46	42	54	42
5,000	39	37	40	41	56	57	------	40	54	28
6,000	------	------	47	51	------	55	------	37	54	------

[1] January to May, inclusive, only.
[2] July to December, inclusive, only.
[3] January to April, inclusive, only.
[4] August to December, inclusive, only.
[5] January to June, inclusive, only.

The mean free-air temperatures for Royal Center for the first half of the year were slightly above the normals for the same period; those for Broken Arrow and Groesbeck for the first five and four months, respectively, were moderately below normal.

In Table 2 it will be noted that the highest average maximum altitude reached by airplane was 6,242 meters above sea level at Omaha and the highest single flight to 7,242 meters was also made at this station. An airplane flight was made on every day during the latter half of the year at Dallas; only one day was missed at Cleveland and this was due to mechanical trouble with the airplane; two days were missed at Chicago, and nine days at Omaha on account of unfavorable flying weather.

There were 14 new pilot balloon stations established and 2 closed during 1931, making a total of 69 such stations in operation at the end of the year. Of these, 3 are located in Alaska and 1 in Porto Rico.

TABLE 2.—*Observations by means of airplanes, kites, captive and limited-height sounding balloons during the year 1931*

	Broken Arrow, Okla.[1]	Chicago, Ill.[2]	Cleveland, Ohio[2]	Dallas, Tex.[2]	Due West, S. C.[1]	Ellendale, N. Dak.[1]	Groesbeck, Tex.[1]	Omaha, Nebr.[2]	Royal Center, Ind.[1]
Mean altitudes (meters), m. s. l., reached during month	2,861	4,861	5,586	5,526	2,679	3,254	2,334	6,242	3,219
Maximum altitude, (meters), m. s. l., reached	[3] 5,906	5,692	6,355	6,304	[3] 5,477	[3] 6,324	4,702	7,242	[3] 9,445
Number of flights made	165	182	183	184	362	355	99	139	182
Number of days on which flights were made	[4] 151	[5] 182	[5] 183	[5] 184	346	338	[6] 99	[7] 137	[8] 173

[1] Kites, captive or limited-height sounding balloons.
[2] Airplanes.
[3] Limited-height sounding balloon.
[4] January 1 to June 7, inclusive.
[5] July 1 to December 31, inclusive.
[6] January 1 to May 16, inclusive.
[7] August 8 to December 31, inclusive.
[8] January 1 to June 30, inclusive.

WEATHER IN THE UNITED STATES

[Climatological Division, OLIVER L. FASSIG, in charge]

THE WEATHER ELEMENTS

By M. C. BENNETT

GENERAL SUMMARY

The continuation of abnormally warm weather during December in practically all sections east of the Rocky Mountains, and generous widespread precipitation in the interior and Southern States, were the outstanding features. The temperature for the month ranged generally from 4° to 12° above normal east of the Great Plains, except that in the extreme Northeast it was not so warm. The greatest plus departures for the month extended from Kentucky, Missouri, and eastern Kansas northward. West of the Rocky Mountains, temperatures were unusually low in many places, while in the Pacific coast sections they were only slightly below the normal. The precipitation was above the average in most areas, though along much of the Atlantic coast, in the Rocky Mountain region, and eastward therefrom along the Canadian border to the Great Lakes it was generally below the normal. Between the Appalachian and Rocky Mountains, except in eastern Oklahoma and portions of the adjacent States, the amounts were unusually generous, with many sections having from one and one-half to four times the normal. It was heavy in California also, where some stations reported nearly two and one-half times the average. In the western mountains snowfall was unusually heavy, while in the East but little snow fell.

TEMPERATURE

The first half of December continued the temperature features of the latter part of November, the eastern half of the country having mild weather, as a rule, and the western half severe cold. The temperature at this time was particularly low, compared with normal, in the Plateau and Rocky Mountain regions, and the first week saw comparatively cold weather in Texas and Louisiana as well; while some portions of the Missouri Valley, the Lake region, and the extreme Northeast likewise were moderately colder than normal about the 4th to 7th.

After the middle of the month the western half of the country was usually warmer than normal, especially the Plains and Rocky Mountain regions and those far western districts which are close to the Canadian boundary. Exceptions were to be found in the middle and southern Plateau region, and in the lower half of the Rio Grande Valley where abnormal cold continued till about the 20th. This half of December was extraordinarily warm for the time of the year in the north-central portion of the country, and was far warmer than normal elsewhere east of the Plains, except in the extreme northeastern portion where it was only moderately warmer.

As a whole, December was warmer than normal in very nearly the same part of the country that November had been; that is, east of the Rocky Mountains. However, the northern portions of Washington and Idaho, almost all of Montana, and the eastern portions of Wyoming and Colorado changed from colder than normal in November to slightly warmer in December, while the middle Rio Grande Valley made the reverse change.

Parts of New York and New England averaged but slightly warmer than normal in December, but otherwise all the country from the eastern Plains region and the lower Mississippi Valley eastward was far warmer than normal. In much of Wisconsin and States adjoining, also in portions of the extreme Southeast the mean temperature was 9° to 12° above normal.

In north-central and southeastern districts the month was usually the warmest December during the last 40 years, but was not so warm as December, 1889, save in a few localities.

The highest temperatures were close to 90° in a few of the southernmost States, and not far from 60° in northern border States and in the middle Plateau region. They occurred largely about the 11th to eastward of the Mississippi River, but at various dates between the 17th and the end of the month in practically every State west of that river.

The lowest readings were much below zero in the mountainous portions of the far West, also in the Dakotas, New York, and New England. As far north as Iowa, Ohio, and the mountains of Maryland zero temperatures were not experienced, while in Florida the lowest reading was 36°. The lowest temperatures occurred usually during the first half of the month, except in some of the Atlantic States, where they occurred during the final week.