AEROLOGICAL OBSERVATIONS

By RICHMOND T. ZOCH

Free-air temperatures were close to normal at Groesbeck and Broken Arrow and mostly below normal at Ellendale and Due West. At Royal Center free-air temperatures were below normal near the surface and above normal at higher levels. (Table 1.)

At the higher levels at Groesbeck and Due West free-air relative humidities were below normal and at all other stations they were mostly above normal.

Free-air vapor-pressures were above normal in the lower levels at Groesbeck and Broken Arrow and in the higher levels at Royal Center. In all other cases they were below normal.

Table 2 is not closely comparable with Table 1 because flights were made at the Naval Air stations on comparatively few days during the month.

The resultant winds were variable in the lower levels throughout the United States. At the 1,000-meter level they were westerly. At higher levels they veered to northwesterly. (Table 3.)

The number of flights (Table 4) made during the month was larger than usual on account of the series made on the 27th and 28th, at which time a special sounding-balloon series was made at 10 other stations.

TABLE 4.—*Observations by means of kites, captive and limited-height sounding balloons during December, 1929*

	Broken Arrow, Okla.	Due West, S. C.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.
Mean altitudes (meters), M. S. L., reached during month	2,678	2,579	2,630	2,270	2,390
Maximum altitude (meters), M. S. L., reached and date	[1] 4,536	[2] 5,036	[3] 5,501	[4] 3,807	[5] 4,333
Number of flights made	33	38	37	31	36
Number of days on which flights were made	24	29	27	23	28

[1] 27th. [2] 31st. [3] 5th. [4] 30th. [5] 28th.

In addition to the above there are approximately 120 pilot balloon observations made daily at some 50 Weather Bureau stations in the United States.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during December, 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)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Meters										
Surface	3.7	−0.5	5.6	−2.1	−10.4	−0.9	9.1	0.0	−3.6	−1.9
500	4.2	+0.5	5.9	−1.6	−10.5	−1.1	9.0	+0.5	−4.0	−0.9
1,000	4.0	+0.8	5.3	−1.6	−7.7	−0.7	8.6	+0.2	−2.7	+1.0
1,500	3.6	+0.8	4.4	−1.2	−6.5	0.0	7.5	0.0	−3.1	+0.8
2,000	1.3	−0.2	3.0	−1.0	−8.6	−1.0	5.8	−0.2	−4.2	+0.9
2,500	−0.8	−0.3	1.1	−1.0	−10.7	−1.1	3.2	−0.8	−6.4	+0.5
3,000	−2.6	+0.2	−0.9	−0.8	−13.2	−1.1	1.2	−0.5	−8.7	+0.4
4,000	−10.1	−2.0	−5.5	+0.1	−17.6	0.0			−13.9	+0.9
5,000			−12.1	+0.1	−24.7	−1.2				

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during December, 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)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Meters—Continued										
Surface	71	+1	78	+5	81	0	80	+6	87	+7
500	62	−2	65	0	79	0	70	+3	84	+7
1,000	54	+1	59	0	68	+3	54	−3	74	+8
1,500	44	+1	48	−7	59	+1	42	−7	64	+8
2,000	41	+3	40	−11	57	+2	28	−14	59	+7
2,500	39	+3	38	−8	55	0	21	−18	54	+3
3,000	37	+1	39	−3	57	+3	21	−15	49	−2
4,000	63	+29	38	−3	33	−20			51	−1
5,000			38	−3	44	−2				

VAPOR PRESSURE (*mb.*)

Surface	6.50	+0.23	7.73	−0.63	2.34	−0.34	11.11	+1.68	4.57	−0.06
500	5.88	+0.31	6.61	−0.90	2.31	−0.33	9.67	+1.35	4.31	+0.26
1,000	4.68	+0.20	5.72	−0.76	2.31	−0.10	6.98	+6.21	4.01	+0.68
1,500	3.14	−0.45	4.39	−1.06	2.18	−0.01	4.67	−0.59	3.19	+0.45
2,000	2.44	−0.47	3.22	−1.15	1.75	−0.12	2.42	−1.54	2.76	+0.47
2,500	1.96	−0.42	2.57	−0.88	1.40	−0.18	1.05	−2.11	2.22	+0.26
3,000	1.65	−0.36	2.16	−0.61	1.13	−0.13	0.80	−1.74	1.85	+0.15
4,000	1.39	−0.06	1.70	−0.29	0.02	−0.76			1.57	+0.38
5,000			1.37	−0.29						

TABLE 2.—*Free air data determined at naval air stations during December, 1929*

Altitude m. s. l.	Temperature (° C.)			Relative humidity (%)		
	Pensacola, Fla.	San Diego, Calif.	Washington, D. C.	Pensacola, Fla.	San Diego, Calif.	Washington, D. C.
(*Meters*)						
Surface	6.4	17.5	−0.3	88	58	75
500	7.6	16.7	0.9	75	47	65
1,000	8.0	16.7	0.3	66	32	61
2,000	6.2	12.9	−2.1	51	22	60
3,000	3.1		−5.6	43		50
4,000			−10.4			60

TABLE 3.—*Free-air resultant winds (m. p. s.) based on pilot balloon observations made near 7 a. m. (e. s. t.) during December, 1929*

Altitude m. s. l.	Broken Arrow, Okla. (233 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,868 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (65 meters)		Key West, Fla. (11 meters)		Los Angeles, Calif. (40 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
Meters	°		°		°		°		°		°		°		°		°		°	
Surface	S. 36 W.	1.5	S. 13 W.	1.4	N. 82 W.	5.7	S. 60 W.	2.4	N. 38 W.	3.1	S. 30 W.	0.9	S. 65 W.	2.4	N. 17 W.	1.7	N. 46 E.	3.3	N. 55 W.	2.2
500	S. 61 W.	5.4	S. 54 W.	3.6			N. 87 W.	8.2	N. 39 W.	3.9	S. 42 W.	5.1			N. 63 W.	2.1	N. 79 E.	6.9	N. 31 E.	0.6
1,000	S. 82 W.	8.3	S. 79 W.	5.9			N. 85 W.	8.6	N. 35 W.	8.1	N. 80 W.	5.7	S. 67 W.	7.1	S. 70 W.	4.2	N. 88 E.	5.5	N. 8 E.	1.5
1,500	N. 69 W.	6.7	N. 89 W.	9.2			N. 84 W.	9.5	N. 37 W.	10.8	N. 71 W.	6.4	S. 89 W.	10.9	S. 88 W.	5.9	S. 63 E.	3.4	N. 9 W.	2.0
2,000	N. 74 W.	10.4	N. 86 W.	11.6	N. 79 W.	8.5	N. 88 W.	11.6	N. 43 W.	11.3	N. 81 W.	7.8	N. 80 W.	11.5	S. 83 W.	7.0	S. 65 E.	2.0	N. 33 W.	2.8
2,500	N. 67 W.	11.0	N. 89 W.	12.3	N. 72 W.	14.2	N. 84 W.	12.5	N. 52 W.	11.6	S. 89 W.	8.4	N. 69 W.	15.7	S. 85 W.	9.7	S. 5 E.	1.0	N. 44 W.	3.5
3,000	N. 62 W.	12.1	N. 70 W.	14.5	N. 66 W.	13.3	N. 82 W.	15.0	N. 52 W.	13.6	N. 87 W.	10.2	N. 63 W.	20.3	S. 86 W.	11.1	S. 27 W.	1.7	N. 49 W.	4.8
4,000	N. 29 W.	16.3	S. 80 W.	4.7	N. 64 W.	9.3	N. 85 W.	19.6	N. 54 W.	9.4	N. 54 W.	10.9			S. 88 W.	11.1	N. 84 W.	1.8	N. 43 W.	6.9
5,000	N. 45 W.	9.0			N. 2 W.	6.7	N. 81 W.	24.3	N. 68 W.	12.0	N. 45 W.	12.0			N. 80 W.	9.6	N. 59 W.	3.3		

Altitude m. s. l.	Medford, Oreg. (446 meters)		Memphis, Tenn. (145 meters)		New Orleans, La. (25 meters)		Omaha, Nebr. (313 meters)		Royal Center, Ind. (225 meters)		Salt Lake City, Utah (1,280 meters)		San Francisco, Calif. (60 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (67 meters)		Washington, D. C. (34 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
Meters	°		°		°		°		°		°		°		°		°		°	
Surface	S. 5 W.	0.4	S. 41 W.	2.9	N. 17 W.	0.8	N. 42 W.	1.0	S. 50 W.	2.4	S. 13 E.	2.5	S. 27 E.	0.9	N. 67 E.	1.3	S. 48 E.	1.6	S. 49 W.	0.7
500	S. 3 W.	0.5	S. 71 W.	9.3	N. 54 W.	1.1	N. 56 W.	4.8	S. 74 W.	5.6			N. 71 E.	1.3	N. 47 E.	2.9	S. 19 W.	5.2	N. 89 W.	7.1
1,000	S. 16 W.	2.3	S. 83 W.	10.2	S. 86 W.	2.0	N. 51 W.	9.5	S. 86 W.	8.4			N. 13 E.	0.7	N. 16 W.	3.4	S. 31 W.	6.9	N. 78 W.	8.5
1,500	S. 38 W.	2.5	N. 73 W.	9.7	S. 84 W.	4.2	N. 56 W.	10.9	N. 87 W.	8.8	S. 3 E.	5.0	N. 32 W.	2.3	N. 40 W.	6.8	S. 58 W.	8.2	N. 78 W.	12.4
2,000	N. 76 W.	2.6	N. 49 W.	11.7	N. 64 W.	7.8	N. 56 W.	11.5	N. 77 W.	11.8	S. 20 W.	3.6	N. 33 W.	2.1	N. 75 W.	5.4	S. 68 W.	6.0	N. 85 W.	12.4
2,500	N. 31 W.	4.3	W.	12.0	N. 64 W.	7.9	N. 57 W.	12.2	N. 89 W.	13.5	S. 86 W.	3.4	N. 16 W.	3.2	S. 67 W.	7.1	N. 87 W.	10.3	S. 75 W.	15.7
3,000	N. 48 W.	7.8					N. 58 W.	13.0	S. 68 E.	9.0	N. 47 W.	5.8	N. 79 W.	3.9			S. 67 W.	7.0	S. 80 W.	17.0
4,000	N. 27 W.	3.9					N. 43 W.	12.0			N. 70 W.	10.1	N. 68 E.	6.0			W.	6.0		
5,000							E.	7.0			N. 82 W.	10.2								

AEROLOGICAL OBSERVATIONS FOR THE YEAR 1929

By RICHMOND T. ZOCH

Free-air temperatures for the year were below normal at all levels at all stations. (Table 1.) In most cases, especially at the lower levels, the departures were moderately large.

Free-air relative-humidity departures were of small magnitude. The were variable at Ellendale and Groesbeck, positive at all levels at Broken Arrow and Royal Center and at most levels at Due West.

Vapor-pressure departures were mostly negative, except at Due West and in the upper levels at Broken Arrow. They were mostly of moderate magnitude.

Table 2 contains a summary of the upper-air observations made during the year. In addition to the observations indicated in this table there were 34 sounding-balloon observations made at Broken Arrow and 40 made at 10 other Weather Bureau stations in connection with the International Month, December, 1929.

There were 52 pilot-balloon stations operating at the close of the year.

TABLE 2.—*Observations by means of kites, captive and limited-height sounding balloons during the year 1929* [1]

	Broken Arrow, Okla.	Due West, S. C.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.
Mean altitudes, M. S. L., reached during year	2,571	2,313	2,715	2,291	2,622
Maximum altitude, M. S. L., reached and date	[2] 6,131	[3] 5,036	[4] 5,588	[5] 5,930	[6] 5,103
Number of kite flights made	299	268	334	291	285
Number of captive balloon flights made	3	37	1	1	13
Number of limited height sounding balloon flights made	29	3	18	13	1
Number of days on which flights were made	313	284	319	290	284

[1] There were approximately 40,000 pilot-balloon observations made during the year.
[2] Nov. 22.
[3] Dec. 31.
[4] Apr. 28.
[5] Apr. 12.
[6] May 27.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during year 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)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Meters										
Surface	14.0	−1.5	15.6	−1.2	4.6	−0.9	16.1	−1.9	8.9	−2.1
500	12.8	−1.3	14.2	−0.6	4.4	−1.0	15.2	−1.0	7.1	−1.8
1,000	11.4	−0.9	12.2	−0.3	3.5	−1.0	13.9	−0.7	5.2	−1.5
1,500	9.6	−0.9	9.9	−0.2	2.1	−1.1	12.3	−0.6	3.4	−1.3
2,000	7.4	−0.9	7.6	−0.1	−0.2	−1.2	10.2	−0.6	1.4	−1.2
2,500	4.8	−0.9	5.1	−0.2	−2.8	−1.2	7.7	−0.7	−0.8	−1.1
3,000	2.2	−0.7	2.7	−0.1	−5.5	−1.1	5.1	−0.7	−3.4	−1.2
4,000	−3.2	−0.4	−3.1	−0.4	−10.7	−0.7	−0.6	−0.9	−9.0	−1.6
5,000	−8.7	−0.3	−9.7	−1.5	−16.3	−0.7	−7.3	−2.0	−14.9	−1.5

RELATIVE HUMIDITY (PER CENT)

Meters										
Surface	70	+2	72	+6	68	−4	80	+6	74	+4
500	68	+3	68	+3	67	−3	73	+2	73	+4
1,000	62	+2	66	+2	61	−2	62	−1	69	+4
1,500	58	+3	65	+2	58	0	54	−1	63	+3
2,000	54	+3	62	+2	56	0	49	0	57	+1
2,500	53	+5	59	+2	55	0	47	+2	54	+2
3,000	52	+5	55	+1	56	+2	45	+3	54	+4
4,000	48	+4	41	−10	48	−4	44	+4	52	+6
5,000	48	+7	41	−5	53	+3	29	−7	52	+7

VAPOR PRESSURE (mb.)

Meters										
Surface	13.29	−0.47	14.43	+0.43	7.30	−0.75	16.44	−0.36	10.19	−0.60
500	11.92	−0.25	12.59	+0.22	7.12	−0.72	14.15	−0.53	8.98	−0.39
1,000	9.80	−0.18	10.72	+0.27	5.73	−0.63	10.87	−0.73	7.47	−0.30
1,500	7.95	−0.11	9.08	+0.44	4.75	−0.50	8.17	−0.89	5.93	−0.36
2,000	6.28	−0.06	7.28	+0.40	3.85	−0.44	6.46	−0.55	4.63	−0.31
2,500	5.07	+0.10	5.79	+0.36	3.10	−0.41	5.27	−0.30	3.63	−0.15
3,000	4.09	+0.15	4.58	+0.27	2.56	−0.27	4.31	−0.16	2.98	+0.03
4,000	2.82	+0.37	2.11	−0.71	1.56	−0.26	3.14	+0.17	1.88	+0.12
5,000	2.55	+0.94	1.78	−0.02	1.26	+0.08	1.94	−0.20	-------	-------