

and considerable loss of life. It was particularly severe in the northern Departments, whence come reports of numbers of persons killed and injured. Telegraph and telephone lines were blown down, cutting communications generally. The storm off the coast stopped virtually all marine traffic * * *.—*Brooklyn Eagle*, March 9, 1922.

Paris, March 23.—On the second day of spring surface transportation in Paris was demoralized by a small blizzard worse than any seen during the winter, and all France is white with an unusual snow.—*Brooklyn Eagle*, March 23, 1922.

Switzerland.—Geneva, March 15.—Winter in the Swiss Alps has been so severe that scores of wild boars, wolves, and other animals have been driven to the towns and lowlands in search of food * * *.—*New York Evening Mail*, March 15, 1922.

Italy.—Venice, March 23.—A Central News dispatch from Venice says that a tidal wave late last night inundated the city, the water rising to a depth of more than 3 feet in some of the public squares.—*Washington Post*, March 24, 1922.

Genoa, March 25.—The tidal wave which the past few days has swept the Adriatic shores of Italy to-day shifted to the Mediterranean side and extended throughout the Italian Riviera. Many of the railroads and streets of Genoa were inundated, forcing traffic to deviate in order to reach the center of the city. Ships anchored at various places along the coast suffered damage.—*Associated Press*.

Arabia.—Aden.—It is stated in the *Times* on March

28 that unusually heavy rains have filled all but one of the historic reservoirs of Aden.¹

Africa.—Tetuan, Morocco, March 24.—A severe snow-storm and intense cold has interrupted the movements of the Spanish troops in this vicinity. Communications with the outlying posts have been cut, as the hills surrounding the city are covered with a thick layer of snow.—*Washington Post*, March 24, 1922.

Lourenco, Portuguese East Africa, March 4.—Serious loss of life and damage to property was caused by a tornado which recently swept the seaport town of Chinde, in this territory, destroying the Government office and many other buildings and causing the sinking of numerous launches and other craft in the port * * *.—*Washington Star*, March 5, 1922.

Japan.—Tokio, March 1.—Tokio to-day was in the grip of a severe cold wave and snowstorm, according to dispatches * * *.—*United Press*, March 1, 1922.

Hawaii.—Honolulu, March 19.—Semitorrential rains which have visited the Hawaiian Islands during the past week caused much damage and marooned many tourists and sightseers * * *. Extremely rough weather accompanied the rain, interisland vessel captains reporting the hardest voyages in years.—*Washington Evening Star*, March 19, 1922.

Brazil.—There were destructive floods in the States of Rio de Janeiro and Sao Paulo. * * * While in the northeast the cotton crop is suffering from lack of rain, the rice crop in the South is being damaged by abnormally heavy precipitation.¹

¹ Meteorological Magazine, April, 1922.

DETAILS OF THE WEATHER IN THE UNITED STATES.

GENERAL CONDITIONS.

The outstanding feature of the month was perhaps the excess of rainfall as shown in detail on the inset of Chart V. Heavy rains in March are due to the course taken by cyclonic systems of wind circulation which cross the United States.

During the current month these systems moved from Texas northeastward, crossing the Mississippi in the vicinity of Cairo, Ill., moving thence up the Ohio Valley, and then passing almost directly eastward to the coast. By a movement such as described these storms cross successively the western tributaries of the Mississippi, south of the Missouri, and thus precipitate a large quantity of water in the several basins so crossed. Continuing up the Ohio Valley, the river of the same name must also reach flood stage. While the quantity of water contributed by the storms of the current month was not in itself sufficient to produce a large flood, it doubtless laid the foundation for the great flood which, at this writing (May 1), is passing down the lower Mississippi.

Another exceptional feature of the weather was the high mean pressure over the outlet through which pass the great majority of storms which traverse the United States, viz, New England and the St. Lawrence Valley. Reference to the inset of Chart II, shows the extent to which pressure was above the mean in that locality. This excess was due to the fact that more than the usual number of anticyclones passed over the region in question, which may be simply another way of expressing the belief that the flow of polar air equatorward, for some reason, followed the Hudson Bay-Halifax route.

East of the Rocky Mountains the month was warm and wet; to the westward it was cold and relatively dry. The usual details follow.

CYCLONES AND ANTICYCLONES.

By W. P. DAY, Observer.

The month was unusually active, both HIGHS and LOW exceeding the normal. Most of the important storms began as secondary developments over the southern slope of the Rockies or in the Great Basin and moved east-northeast to pass off the north Atlantic coast. High-pressure areas were not so strong as during the preceding month and few important ones were charted south of Canada, but the total number charted was the same in each case.

LOWS.	Al-ber-ta.	North Pa-cific.	South Pa-cific.	North-ern Rocky Moun-tain.	Colo-rado.	Texas.	East Gulf.	South At-lantic.	Central.	Total.
March, 1922.....	6.0	6.0	1.0	.....	7.0	.....	.....	3.0	1.0	24.0
Average number, 1892-1912, in-clusive.....	3.6	2.1	1.1	0.3	1.9	1.3	0.4	0.3	0.7	11.8

HIGHS.	North Pacific.	South Pacific.	Al-ber-ta.	Plateau and Rocky Mountain region.	Hudson Bay.	Total.
March, 1922.....	5.0	3.0	5.0	.....	1.0	14.0
Average number, 1892-1912, inclusive.....	0.9	0.7	5.6	0.9	0.5	8.5

FREE-AIR CONDITIONS.

By W. R. GREGG, Meteorologist.

As indicated in Tables 1 and 2, free-air conditions at all six kite stations and at all altitudes were, for the month

as a whole, not far from normal. Temperatures were slightly below at and near the surface and slightly above in the higher levels.¹ Comparatively low temperatures were general from the 1st to 3d and from the 19th to 21st (later in each case at eastern than at western stations) in connection with northerly winds between a well-developed cyclone and a following anticyclone. The lowest temperature recorded was -21.7° C. at an altitude of 5,500 meters at Ellendale on the 9th.

Relative humidity was, in general, slightly above normal at all levels except near the surface at Groesbeck. Very low humidities in the upper levels were observed at all stations on the 3d to 4th, 11th to 12th, and 15th to 17th. Vapor pressure departures from normal were similar to those of temperature, with, however, a somewhat larger positive tendency, owing to the excess in relative humidity values.

Resultant winds were about normal, except near the surface at northern stations, where an east component predominated. In the higher levels they were WSW. for the most part. Wind speeds were slightly above normal at Groesbeck and slightly below at other stations. Unusually high winds were observed as follows:

[By means of kites.]

Station.	Date.	Direction.	Velocity.		Altitude.
			m. p. s.	Meters.	
Drexel, Nebr.	22	sww	32	1,000	
Groesbeck, Tex.	2	ws	31	3,800	
Do.	9	ssw	30	2,900	
Do.	10	wnw	32	1,800	
Do.	13	sse	31	1,600	
Do.	19	nw	34	1,600	
Do.	31	wnw	31	3,300	
Royal Center, Ind.	6	sw	37	1,200	
Do.	11	nne	31	1,700	
Do.	13	ssw	30	2,700	
Do.	15	nnw	40	3,200	
Do.	18	ese	31	600	
Do.	19	se	38	1,800	
Do.	23	w	34	1,900	
Do.	25	ws	34	1,900	

[By means of pilot balloons.]

Station.	Date.	Direction.	Velocity.		Altitude.
			m. p. s.	Meters.	
Aberdeen Proving Ground, Md.	16	nw	47	4,800	
Do.	18	nnw	34	3,500	
Bolling Field, D. C.	3	w	31	4,500	
Do.	16	nw	30	2,500	
Broken Arrow, Okla.	3	ne	35	7,100	
Do.	6	w	35	2,400	
Do.	20	nw	39	4,800	
Burlington, Vt.	14	w	34	3,000	
Camp Benning, Ga.	7	w	35	2,500	
Do.	8	w	42	6,400	
Do.	11	w	30	3,000	
Do.	17	nw	35	6,300	
Camp Bragg, N. C.	7	wnw	33	2,500	
Denver, Colo.	12	sw	33	5,100	
Drexel, Nebr.	22	sw	31	1,800	
Due West, S. C.	8	nw	35	4,800	
Do.	15	ws	32	3,500	
Do.	16	nw	30	8,500	
Do.	21	w	32	4,200	
Do.	31	sw	35	3,200	
Edgewood Arsenal, Md.	3	w	33	4,500	
Do.	17	nw	39	3,300	
Ellendale, N. Dak.	7	nne	30	8,200	
Do.	13	w	36	3,600	
Do.	14	w	40	7,100	
Do.	15	wnw	31	7,100	
Ellington Field, Tex.	10	wnw	45	1,700	
Do.	14	wnw	42	1,200	
Groesbeck, Tex.	7	wnw	37	3,900	
Do.	14	w	32	3,300	
Do.	15	wnw	35	10,400	
Kelly Field, Tex.	2	ws	31	4,000	
Key West, Fla.	2	nw	37	13,000	
Lansing, Mich.	2	ws	33	10,500	
Do.	8	w	32	5,800	
Do.	15	wnw	36	4,600	
Do.	18	nw	36	6,500	
Do.	29	ws	32	5,700	
Lee Hall, Va.	9	w	40	7,600	
Madison, Wis.	13	w	30	3,100	
Do.	15	wnw	33	4,600	

¹ In Chart IV (climatological) it is shown that surface temperatures were somewhat above normal over most of the region in which kite stations are located. A similar discrepancy was noted in January and its explanation was briefly discussed in the MONTHLY WEATHER REVIEW for that month, p. 34.

[By means of pilot balloons.]

Station.	Date.	Direction.	Velocity.	Altitude.
McCook Field, Ohio	3	sw	38	11,700
Do.	30	sw	34	2,000
Mitchel Field, N. Y.	3	w	33	4,200
Do.	16	nw	34	2,000
Do.	29	w	36	4,200
Rockwell Field, Calif.	12	n	40	4,800
Ross Field, Calif.	8	n	36	2,500
Do.	17	nnw	31	1,000
Royal Center, Ind.	3	ne	34	7,300
Do.	4	nne	35	6,900
San Diego, Calif.	1	nw	32	3,500
San Francisco, Calif.	29	nw	33	4,200

With the passing of winter conditions and the accompanying diminution in the poleward temperature gradient, the frequency of free-air easterly winds shows a very considerable increase. It will be recalled that on February 28 (see discussion in MONTHLY WEATHER REVIEW for that month, pp. 101-102) easterly winds in the upper levels were quite general over the north-central and western portions of the country. This condition not only continued but intensified, being particularly pronounced on March 3, when, as shown in the table of maximum winds above given, northeasterly winds exceeding 30 m. p. s. were observed at 7 to 8 kilometers above Broken Arrow and Royal Center. At other places easterly winds of less speed, but nevertheless fairly strong, occurred on the 3d, as follows: Drexel, N. to NE. at 3 to 5 kilometers; Ithaca, NNE. at 3 to 8 kilometers; Lansing, NNE. to ENE. at 2 to 10 kilometers, increasing considerably in speed with altitude; Madison, SE. at 2 to 3 kilometers and NE. at 4 to 11 kilometers, with speed above 15 m. p. s. in highest levels; and Scott Field, (Belleville, Ill.), NE. to ENE. at 2 to 4 kilometers. In practically all of these cases winds with a west component prevailed at and near the surface, in conformity with the sea-level pressure conditions shown on the weather map of that day. High pressure was central over Texas and low pressure north of the Dakotas. The significant feature of the map, however, is the entire absence of any poleward temperature gradient. On the other hand, the weather was somewhat colder in northern Texas than it was in northern Montana. Moreover, this altitudinal reversal in temperature was greater in the free air than at the surface, as shown in the following table:

Altitude, m. s. l.	Ellendale, N. Dak.	Groesbeck, Tex.
Meters.	°C.	°C.
1,000	6.2	-4.8
2,000	5.0	-1.8
3,000	1.6	-5.6

The reversal in free-air pressure gradients and the resulting easterly winds above westerly winds are thus easily accounted for. It is uncertain to what height this reversal extended, since easterly winds persisted to the greatest heights reached—about 11 or 12 kilometers. However, much the same, though somewhat less pronounced, condition prevailed on the 1st and 2d, and one observation on the former date, at Ellendale, showed the easterly wind ceasing at 12 kilometers. Above this level the direction was NNW. up to 19 kilometers, the highest altitude reached. At 9 to 10 kilometers the NE. wind had a speed of about 15 m. p. s. With the change to NNW. the speed diminished to about 6 m. p. s., but again increased to 10 or 12 at 18 and 19 kilometers.

Free-air easterly winds continued at Lansing and Royal Center on the 4th, but of greatly diminished speed.

Easterly winds at moderate altitudes prevailed quite generally also from the 9th to 12th and from the 14th to 17th (later at eastern than at western stations) in connection with well-developed cyclones which moved from Texas east-northeastward to the Atlantic coast. In neither case, however, were the winds as strong nor did they extend to as great altitudes as those from February 28 to March 4.

TABLE 1.—Free-air temperatures, relative humidities, and vapor pressures during March, 1922.

TEMPERATURE (° C.).

Altitude, m. s. l. (m.)	Broken Arrow, Okla. (233m.)		Drexel, Nebr. (396m.)		Due West, S. C. (217m.)		Ellendale, N. Dak. (444m.)		Groesbeck, Tex. (141m.)		Royal Center, Ind. (225m.)	
	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.
	Surface	10.4	-0.8	1.9	-2.4	13.2	-2.3	0.0	12.1	-2.1	5.7	-0.4
250	10.2	-0.9			12.9			11.7	-1.9	5.9	-0.2	
500	9.9	-1.3	1.4	-2.5	10.7		0.0	10.6	-1.7	4.2	+0.4	
750	9.5	-1.5	0.9	-1.9	9.0		0.0	9.3	-1.9	3.9	+0.6	
1,000	9.1	-1.2	0.9	-1.5	7.9		+0.3	7.7	-1.8	3.9	+1.3	
1,250	8.9	-1.0	1.3	-0.9	6.9		+0.1	7.3	-1.4	3.9	+1.7	
1,500	8.5	-0.8	1.4	-0.5	5.0		+0.4	7.7	-1.3	3.9	+1.6	
2,000	7.3	-0.8	-0.4	-0.5	3.9		+0.6	6.9	-0.7	0.9	+1.6	
2,500	1.5	-0.7	-2.7	-0.3	1.8		+1.3	4.9	-0.3	-1.1	+1.7	
3,000	-1.1	-0.7	-4.8	+0.3	0.1		+1.4	2.4	-0.3	-2.7	+2.4	
3,500	-3.9	-0.8	-7.2	+0.7	-2.6		+1.6	-0.6	-0.4			
4,000	-7.2	-0.5	-3.5	+1.1	-5.2			-0.3				
4,500	-10.7	-0.4						-0.7				
5,000								-1.1				

TABLE 1.—Free-air temperatures, relative humidities, and vapor pressures during March, 1922—Continued.

RELATIVE HUMIDITY (%).

Altitude, m. s. l. (m.)	Broken Arrow, Okla. (233m.)		Drexel, Nebr. (396m.)		Due West, S. C. (217m.)		Ellendale, N. Dak. (444m.)		Groesbeck, Tex. (141m.)		Royal Center, Ind. (225m.)	
	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.
	Surface	67	0	77	+10	68		82	+6	68	-2	77	+6
250	67	0			68				67	-3	76	+5
500	69	+3	76	+10	69		80	+6	64	-3	73	+4
750	69	+5	73	+9	69		71	+4	64	0	71	+5
1,000	65	+3	67	+7	69		65	+2	61	0	66	+3
1,250	59	+1	57	+3	60		58	+1	58	+2	62	+2
1,500	54	0	51	+1	62		53	-1	54	+3	63	+3
2,000	45	-1	48	0	68		56	+3	47	+8	62	+6
2,500	43	-1	50	+2	57		57	+3	41	+7	65	+9
3,000	32	0	50	0	47		56	+3	36	+6	62	+9
3,500	32	0	49	0	53		61	+7	37	+7		
4,000	35	+1	49	0	54		58	+4	40	+9		
4,500	34	0			58		58	+12	45	+12		
5,000					67		67	+9	40	+9		

VAPOR PRESSURE (mb.).

Altitude, m. s. l. (m.)	Broken Arrow, Okla. (233m.)		Drexel, Nebr. (396m.)		Due West, S. C. (217m.)		Ellendale, N. Dak. (444m.)		Groesbeck, Tex. (141m.)		Royal Center, Ind. (225m.)	
	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.	Mean.	Departure from normal.
	Surface	8.77	-0.74	5.59	+0.04	10.88		4.29	+0.17	10.41	-1.81	7.13	+0.02
250	8.71	-0.72			10.74				9.93	-1.74	6.97	+0.00
500	7.75	-0.85	5.27	+0.03	9.63		4.12	+0.12	8.78	-1.57	6.11	+0.12
750	6.94	-0.82	4.76	+0.07	8.72		3.47	-0.03	8.16	-1.17	5.65	+0.26
1,000	6.23	-0.66	4.31	+0.11	7.83		3.06	-0.18	7.48	-0.82	5.14	+0.27
1,250	5.51	-0.75	3.72	-0.04	7.36		2.76	-0.27	6.87	-0.39	4.78	+0.33
1,500	4.81	-0.73	3.35	-0.03	6.61		2.56	-0.26	6.03	-0.12	4.39	+0.27
2,000	3.84	-0.61	2.85	+0.02	5.17		2.50	+0.08	4.90	+0.77	3.95	+0.45
2,500	2.96	-0.48	2.60	+0.20	3.73		2.13	+0.09	3.64	+0.72	3.65	+0.60
3,000	2.35	-0.35	2.25	+0.21	2.73		1.60	-0.03	2.81	+0.64	3.32	+0.58
3,500	2.12	-0.22	1.79	+0.12	2.64		1.47	+0.14	2.45	+0.58		
4,000	1.91	-0.05	1.67	+0.20	2.06		1.28	+0.20	2.31	+0.57		
4,500	1.77	+0.05					1.14	+0.30	2.20	+0.54		
5,000							1.06	+0.41	1.79	+0.31		

TABLE 2.—Free-air resultant winds (m. p. s.) during March, 1922.

Altitude, m. s. l. (m.)	Broken Arrow, Okla. (233m.)				Drexel, Nebr. (396m.)				Due West, S. C. (217m.)		Ellendale, N. Dak. (444m.)				Groesbeck, Tex. (141m.)				Royal Center, Ind. (225m.)			
	Mean.		Normal.		Mean.		Normal.		Mean.		Mean.		Normal.		Mean.		Normal.		Mean.		Normal.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 3° E.	2.6	S. 1° E.	3.2	N. 74° E.	0.2	S. 38° W.	0.9	S. 57° W.	3.2	N. 37° E.	0.9	N. 48° W.	1.5	S. 59° W.	2.0	S. 5° W.	1.6	S. 60° E.	3.0	S. 24° W.	2.0
250	S. 3° E.	2.6	S. 1° E.	3.4					S. 55° W.	3.3					S. 44° W.	2.6	S. 1° W.	2.5	S. 55° E.	3.3	S. 23° W.	2.2
500	S. 2° W.	3.8	S. 6° W.	5.2	S. 41° E.	0.7	S. 38° W.	1.1	S. 52° W.	3.8	N. 42° E.	0.7	N. 59° W.	1.4	S. 49° W.	5.3	S. 10° W.	4.7	S. 22° E.	5.8	S. 37° W.	4.8
750	S. 5° W.	4.6	S. 9° W.	6.7	S. 9° E.	1.5	S. 63° W.	2.2	S. 53° W.	4.6	N. 15° E.	0.3	S. 85° W.	2.1	S. 56° W.	6.4	S. 23° W.	5.4	S. 19° E.	7.5	S. 42° W.	6.2
1,000	S. 17° W.	5.4	S. 21° W.	7.6	S. 38° W.	1.3	S. 75° W.	3.0	S. 47° W.	5.6	S. 27° W.	1.2	S. 80° W.	1.7	S. 63° W.	6.8	S. 33° W.	6.1	S.	5.1	S. 51° W.	6.4
1,250	S. 39° W.	5.9	S. 31° W.	8.2	S. 76° W.	1.6	S. 87° W.	3.8	S. 55° W.	7.0	S. 62° W.	1.4	S. 89° W.	3.6	S. 68° W.	7.6	S. 40° W.	6.4	S. 3° W.	4.7	S. 59° W.	7.5
1,500	S. 47° W.	7.1	S. 48° W.	7.1	N. 82° W.	1.5	S. 87° W.	4.9	S. 58° W.	9.1	S. 51° W.	2.3	W.	5.0	S. 77° W.	7.7	S. 46° W.	6.5	S. 14° W.	5.3	S. 61° W.	8.5
2,000	S. 52° W.	8.1	S. 62° W.	6.9	S. 86° W.	2.9	S. 83° W.	6.6	S. 66° W.	11.9	S. 57° W.	5.0	N. 88° W.	7.4	S. 86° W.	10.4	S. 59° W.	7.6	S. 36° W.	7.5	S. 68° W.	10.2
2,500	S. 64° W.	9.0	S. 67° W.	8.0	S. 83° W.	1.9	S. 86° W.	8.3	S. 83° W.	13.1	S. 66° W.	6.2	N. 83° W.	10.1	S. 77° W.	11.0	S. 63° W.	9.4	S. 69° W.	8.8	S. 77° W.	11.0
3,000	W.	8.2	S. 79° W.	8.7	S. 84° W.	3.6	S. 86° W.	10.6	S. 88° W.	13.0	S. 78° W.	8.3	N. 80° W.	11.1	S. 66° W.	9.8	S. 67° W.	9.2	N. 89° W.	10.7	S. 83° W.	13.4
3,500	S. 76° W.	11.5	S. 69° W.	11.4	S. 73° W.	3.3	N. 86° W.	14.1	S. 80° W.	10.6	S. 78° W.	12.5	N. 86° W.	12.8	S. 80° W.	12.2	S. 76° W.	11.8	N. 22° W.	32.2	S. 78° W.	15.5
4,000	S. 68° W.	11.5	S. 77° W.	13.2	N. 85° E.	8.7	N. 79° W.	16.6	S. 83° W.	12.4	S. 65° W.	12.5	S. 89° W.	15.2	S. 68° W.	14.4	S. 69° W.	13.6				
4,500	S. 45° W.	11.5	S. 70° W.	11.5					S. 67° W.	23.0	S. 64° W.	13.9	S. 86° W.	16.1	S. 72° W.	11.8	S. 85° W.	13.1				
5,000	S. 45° W.	11.5	S. 71° W.	12.5							S. 68° W.	13.8	N. 87° W.	17.4	S. 62° W.	17.0	S. 84° W.	16.2				