## CYCLONES AND ANTICYCLONES.

By W. P. DAY.

About half of the low-pressure areas were of the Alberta type with centers of minimum pressure north of the Canadian border. The really important storms of the month were two from the North Pacific and a secondary development over central districts.

HIGHS were mostly of North Pacific origin and were not important factors in temperature control. The only Alberta HIGH of the month appeared in the northwest about the 29th and was responsible for the only important temperature reduction. In fact, the character and movement of the high and low pressure areas were about as would be expected considering the abnormal warmth which prevailed over most sections.

## FREE-AIR SUMMARY.

By L. T. SAMUELS, Meteorologist.

The abnormally high mean temperatures, particularly at the northern aerological stations, present the most striking feature of the free-air conditions for the month. (See Table 1.) An intense cold wave occurred at the close of the month reaching Ellendale late on the 28th, Drexel on the 29th, Broken Arrow early, and Groesbeck late, on the 30th. The severity of this cold wave appreciably affected the monthly means and to exclude its influence at Ellendale, for example, would be to increase the monthly mean 2° C. When this is taken into consideration it is even more clearly seen how exceptionally warm the greater part of the month was. In general, at the northern stations the departures decreased with increase in altitude while at the southern stations the reverse was true.

Relative humidity departures were mostl negative at those stations having large positive temperature departures, being small at practically all stations except Groesbeck where they were considerably above normal for all levels.

Vapor pressures were mostly above normal except at Ellendale where an appreciable deficiency in the monthly precipitation occurred. At Groesbeck the reverse condition was found, vapor pressures being unusually high considering the average temperatures at this station, while a great excess of precipitation fell during the month.

The resultant winds as shown in Table 2 did not differ essentially from their normals, the largest variations being found at Drexel and Due West, where the monthly values contain either a more southerly or less northerly component and at Groesbeck a smaller southerly component than normally. This is in harmony with the average temperatures found at these stations.

Pilot-balloon observations from 13 stations east of the Rocky Mountains show the resultant winds at the surface for the month to have been from a southerly quarter except at Ellendale. A north component becomes dominant, however, at stations to the southward with increasing elevation so that at 4,000 m. all of the stations, including Key West, have a north component.

An unusual turning of the wind with altitude occurred over the Plains States on the 4th. The map of this date shows a LOW of wide extent central over the lower Mississippi Valley and high pressures to the westward with another disturbance approaching from the northwest. Both morning and afternoon pilot-balloon observations at Ellendale and Drexel showed northeast winds above 3,000 m., continuing to at least the level of the stratosphere. As a rule upper easterly winds are not of very great velocity but in this case a steady increase occurred, reaching 40 m. p. s. (90 m. p. h.), at the highest levels. It is noted that by the following day the Mississippi LOW had greatly increased in intensity and it seems probable, therefore, that the upper northeasterly winds at Ellendale and Drexel were part of this cyclonic circulation.

On the next day (5th) an unusual temperature distribution prevailed over the middle of the country when a strong temperature inversion at Ellendale caused a rise of 14°C. from the surface to 350 m. altitude. Above this, the temperatures continued higher at this station than at those to the southward, as far as Groesbeck. This condition extended to unusually high altitudes and at the highest point reached by the kites the temperatures at Ellendale continued 5°C. higher than at Broken Arrow. The following table shows the temperatures and wind directions observed this date.

*Altitude, M. S. L. meters.*

| Stations. | Time. | Surface. | 250 | 500 | 750 | 1,000 | 1,250 | 1,500 | 2,000 | 2,500 | 3,000 | 3,500 | 4,000 | 4,500 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wind directions and temperatures (°C.). | | | | | | | | | | | | |
| Ellendale | 8 a. m. | SSW.<br>−5.5 | ..... | SSW.<br>−3.2 | SSW.<br>7.0 | SW.<br>7.9 | SW.<br>7.2 | WSW.<br>6.5 | W.<br>4.4 | WNW.<br>1.5 | NW.<br>−1.6 | NW.<br>−5.1 | NW.<br>−8.5 | ..... |
| Drexel | 6 p. m. | S.<br>1.6 | ..... | S.<br>2.8 | S.<br>1.8 | SW.<br>3.2 | WSW.<br>2.6 | W.<br>1.3 | WNW.<br>−1.3 | WNW.<br>−1.7 | ..... | ..... | ..... | ..... |
| Broken Arrow | 9 a. m. | N.<br>1.5 | N.<br>1.4 | N.<br>−0.3 | NNW.<br>−2.0 | NNW.<br>−3.1 | N.<br>−1.6 | N.<br>−2.4 | NNW.<br>−4.1 | NNW.<br>−5.3 | NNW.<br>−7.7 | NNW.<br>−10.1 | ..... | ..... |
| Groesbeck | 8 a. m. | NW.<br>4.3 | NW.<br>4.5 | NW.<br>4.9 | NW.<br>4.3 | NW.<br>2.7 | NW.<br>1.1 | NW.<br>0.8 | NW.<br>−1.0 | NW.<br>−3.5 | NW.<br>−5.8 | NW.<br>−6.5 | NW.<br>−8.7 | ..... |

For the explanation of such a reversal of the normal temperature gradient we inquire first as to the source of the imported air. It is found that on this morning Ellendale was in the southern quadrant of a strong LOW with SSW. winds at the surface, veering to WNW. at 2,000 m. and backing to WSW. at 6,000 m. That the air brought in over the northern stations was relatively warm is conclusively shown in the above table. The high temperatures at Ellendale did not continue long as is shown by a "series" of continuous kite flight made here on this date. The rapid eastward movement of this LOW caused the winds here soon to shift to NW. at all levels and the free-air temperatures fell steadily throughout the day. The flight at Drexel was not made until evening and so is not comparable in view of the rapid movement of the pressure areas. Flights at Broken Arrow and Groesbeck, however, made at the same time as at Ellendale, were under the influence of the LOW central over the Ohio Valley and winds were mostly N. at all levels.

During the period 16–18, inclusive, there occurred over the interior of the country easterly winds extending to 5,000 m. and higher. These are shown in the following table.

*Altitude, m. s. l., meters.*

| Stations. | Surface. | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 5,000 | 6,000 | 7,000 | 8,000 | 9,000 | 10,000 | 11,000 | 12,000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wind directions and velocities, m. p. s. | | | | | | | | | | | | | |
| Broken Arrow: | | | | | | | | | | | | | | |
| 16 a | N.-2 | NE.-7 | NE.-8 | ENE.-10 | ENE.-14 | ENE.-20 | E.-14 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 16 p | NNW.-2 | ENE.-3 | NE.-4 | E.-12 | E.-15 | ENE.-13 | ENE.-13 | E.-12 | ..... | ..... | ..... | ..... | ..... | ..... |
| 17 a | NNE.-3 | SSE.-3 | S.-2 | ESE.-9 | E.-7 | E.-8 | E.-5 | NW.-3 | SW.-12 | ..... | ..... | ..... | ..... | ..... |
| 17 p | N.-1 | S.-1 | SE.-2 | ESE.-3 | ESE.-8 | ESE.-7 | ESE.-4 | SSE.-5 | ..... | ..... | ..... | ..... | ..... | ..... |
| 18 a | NE.-2 | SSE.-7 | SSE.-7 | SE.-15 | SE.-15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Denver: | | | | | | | | | | | | | | |
| 15 p | S.-4 | S.-3 | WNW.-2 | ENE.-5 | NNE.-9 | NE.-11 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 16 p | SSW.-6 | SSW.-7 | S.-6 | N.-3 | N.-2 | NNE.-3 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 17 p | S.-2 | S.-2 | S.-3 | ESE.-3 | ESE.-4 | E.-6 | ESE.-4 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 18 p | NW.-1 | NE.-2 | NE.-2 | E.-5 | ESE.-8 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Drexel: | | | | | | | | | | | | | | |
| 17 p | SSW.-10 | WSW.-17 | WSW.-17 | WSW.-12 | W.-12 | W.-9 | W.-7 | NW.-4 | NNE.-7 | NNE.-6 | ENE.-10 | NE.-7 | WNW.-8 | NW.-15 |
| Memphis: | | | | | | | | | | | | | | |
| 16 p | E.-2 | NE.-5 | ENE.-10 | ENE.-8 | ENE.-5 | NNW.-3 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 17 p | NE.-3 | NE.-7 | NE.-7 | ENE.-5 | ENE.-6 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

The pressure was above normal over this region at the time and it is found that the temperatures up to considerable altitudes were higher to the northward than to the southward. In fact, at Ellendale on the 18th all previous December high records were broken from 1,000 m. to 3,000 m. This reversal of the normal horizontal temperature gradient resulted in the easterly winds observed.

During the cold wave at the end of the month kite observations showed remarkable strong temperature inversions extending to great heights. For example, Ellendale on the 31st had a temperature only 2° C. lower at 2,850 m. altitude than at the surface; on the 30th at Drexel the temperature at 1,250 m. was 8° C. higher than at the surface; on the 31st only 4° C. lower at 2,200 m. than at the surface; at Broken Arrow on the 30th it was 6° C. higher at 1,730 m. than at the surface, while at Groesbeck it was 12° C. higher at 1.960 m. than at the surface. Such marked inversions are infrequent and are only found during severe cold waves.

Lansing reported on the 9th a light NE. wind extending to 2,000 m. where a backing occurred to WSW. with a rapid increase in velocity reaching 54 m. p. s. (121 m. p. h.) at 6,000 m., the highest level. At the time this station was on the eastern edge of an extensive HIGH with a steep south to north horizontal temperature gradient prevailing over this region. On the 12th Due West observed a wind of 47 m. p. s. (105 m. p. h. from NW. at 11,000 m. This occurred in the center of a circular HIGH which during the next 24 hours moved rapidly eastward. Key West on this date reported 33 m. p. s.(74 m. p. h.) from the NNW. at 10,000 m.

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

TEMPERATURE (°C.).

| Altitude. m. s. l. (m.) | Broken Arrow, Okla. (233 m.) | | Drexel, Nebr. (396 m.) | | Due West, S. C. (217 m.) | | Ellendale, N. Dak. (444 m.) | | Groesbeck, Tex. (141 m.) | | Royal Center. Ind. (225 m.) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean. | Departure from 6-yr. mean. | Mean. | Departure from 9-yr. mean. | Mean. | Departure from 3-yr. mean. | Mean. | Departure from 6-yr. mean. | Mean. | Departure from 6-yr. mean. | Mean. | Departure from 6-yr. mean. |
| Surface | 6.4 | +0.7 | − 0.5 | +3.2 | 10.7 | +1.4 | −5.3 | +2.4 | 10.2 | 0 | 2.6 | +3.3 |
| 250 | 6.3 | +0.6 | ..... | ..... | 10.6 | +1.4 | ..... | ..... | 9.7 | −0.3 | 2.6 | +3.4 |
| 500 | 5.3 | +0.3 | −0.3 | +3.3 | 9.9 | +1.2 | −4.9 | +2.6 | 8.9 | −0.6 | 2.3 | +4.1 |
| 750 | 4.8 | −0.0 | 0.8 | +3.8 | 9.2 | +0.9 | −3.1 | +3.4 | 8.7 | −0.6 | 1.6 | +3.8 |
| 1,000 | 5.2 | −0.1 | 0.9 | +3.1 | 8.6 | +0.7 | −2.7 | +2.9 | 8.7 | −0.5 | 1.0 | +3.4 |
| 1,250 | 5.2 | −0.2 | 0.6 | +2.4 | 8.0 | +0.7 | −2.7 | +2.4 | 8.6 | −0.2 | 0.6 | +3.1 |
| 1,500 | 5.0 | −0.1 | 0.5 | +2.5 | 7.2 | +0.8 | −3.1 | +2.1 | 8.6 | +.4 | 0.1 | +2.8 |
| 2,000 | 3.9 | +0.4 | −1.5 | +2.0 | 5.7 | +0.9 | −5.1 | +1.5 | 7.8 | +1.2 | −1.2 | +2.8 |
| 2,500 | 2.3 | +0.9 | −4.2 | +1.6 | 4.7 | +1.7 | −7.5 | +1.4 | 6.1 | +1.6 | −3.4 | +2.6 |
| 3,000 | −0.2 | +0.9 | −7.0 | +1.3 | 2.4 | +1.7 | −10.2 | +1.4 | 4.0 | +1.9 | −5.9 | +2.4 |
| 3,500 | −2.8 | +0.9 | −9.7 | +1.2 | 0.0 | +1.5 | −13.3 | +1.2 | 2.0 | +2.6 | ..... | ..... |
| 4,000 | −5.8 | +0.8 | −11.7 | +1.9 | −3.3 | +1.3 | −15.9 | +1.5 | −0.4 | +2.9 | ..... | ..... |
| 4,500 | −9.4 | +0.2 | ..... | ..... | ..... | ..... | −16.9 | +3.0 | −3.1 | +2.5 | ..... | ..... |
| 5,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | −6.0 | +2.2 | ..... | ..... |

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

RELATIVE HUMIDITY (%).

| Altitude. m. s. l. (m.) | Broken Arrow, Okla. (233 m.) | | Drexel, Nebr. (396 m.) | | Due West, S. C. (217 m.) | | Ellendale N. Dak. (444 m.) | | Groesbeck, ex. (141 m.) | | Royal Center. Ind. (225 m.) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean. | Departure from 6-yr. mean. | Mean. | Departure from 9-yr. mean. | Mean. | Departure from 3-yr. mean. | Mean. | Departure from 6-yr. mean. | Mean. | Departure from 6-yr. mean. | Mean. | Departure from 6-yr. mean. |
| Surface | 75 | +4 | 75 | −3 | 76 | +1 | 72 | −9 | 84 | +9 | 81 | +2 |
| 250 | 75 | +4 | ..... | ..... | 76 | +2 | ..... | ..... | 83 | +10 | 80 | +1 |
| 500 | 68 | +3 | 69 | −5 | 73 | +4 | 70 | −9 | 80 | +11 | 75 | 0 |
| 750 | 62 | +2 | 61 | −6 | 72 | +6 | 59 | −12 | 77 | +12 | 71 | +1 |
| 1,000 | 54 | +2 | 56 | −5 | 71 | +7 | 55 | −9 | 73 | +14 | 67 | +3 |
| 1,250 | 46 | 0 | 54 | −2 | 69 | +7 | 52 | −7 | 69 | +15 | 60 | +2 |
| 1,500 | 42 | 0 | 51 | −3 | 65 | +5 | 49 | −7 | 63 | +13 | 55 | +1 |
| 2,000 | 35 | −2 | 46 | −5 | 60 | +5 | 49 | −4 | 54 | +12 | 49 | −1 |
| 2,500 | 34 | −2 | 46 | −5 | 51 | +3 | 48 | −5 | 51 | +14 | 48 | −1 |
| 3,000 | 37 | 0 | 48 | −5 | 48 | +5 | 47 | −6 | 50 | +16 | 50 | +1 |
| 3,500 | 37 | 0 | 50 | −1 | 51 | +7 | 49 | −4 | 44 | +12 | ..... | ..... |
| 4,000 | 36 | −1 | 59 | +7 | 53 | +8 | 55 | +3 | 40 | +9 | ..... | ..... |
| 4,500 | 36 | −1 | ..... | ..... | ..... | ..... | 47 | +1 | 40 | +10 | ..... | ..... |
| 5,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 40 | +10 | ..... | ..... |

VAPOR PRESSURE (*mb.*).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface | 7.68 | +0.83 | 4.53 | +0.71 | 10.51 | +1.12 | 3.00 | +0.01 | 11.43 | +1.29 | 6.10 | +1.21 |
| 250 | 7.61 | +0.83 | ..... | ..... | 10.42 | +1.15 | ..... | ..... | 11.00 | +1.20 | 6.06 | +1.23 |
| 500 | 6.58 | +0.67 | 4.24 | +0.53 | 9.78 | +1.33 | 2.98 | +0.03 | 10.14 | +1.18 | 5.43 | +1.19 |
| 750 | 5.85 | +0.58 | 3.92 | +0.51 | 9.29 | +1.39 | 2.86 | +0.08 | 9.48 | +1.33 | 4.95 | +1.16 |
| 1,000 | 5.22 | +0.62 | 3.54 | +0.36 | 8.63 | +1.32 | 2.60 | −0.02 | 8.80 | +1.61 | 4.57 | +1.14 |
| 1,250 | 4.46 | +0.40 | 3.33 | +0.33 | 7.80 | +1.17 | 2.35 | −0.14 | 8.20 | +1.86 | 4.12 | +1.02 |
| 1,500 | 4.03 | +0.41 | 3.18 | +0.33 | 7.29 | +1.47 | 2.12 | −0.19 | 7.50 | +2.01 | 3.69 | +0.87 |
| 2,000 | 3.04 | +0.13 | 2.51 | +0.15 | 5.92 | +0.95 | 1.73 | −0.20 | 5.80 | +1.94 | 3.19 | +0.87 |
| 2,500 | 2.56 | +0.14 | 2.13 | +0.11 | 4.75 | +0.87 | 1.38 | −0.24 | 4.93 | +1.96 | 2.60 | +0.67 |
| 3,000 | 2.37 | +0.21 | 1.84 | +0.16 | 4.28 | +1.08 | 1.07 | −0.22 | 4.15 | +1.81 | 2.46 | +0.84 |
| 3,500 | 2.02 | +0.18 | 1.66 | +0.28 | 3.69 | +1.17 | 0.86 | −0.15 | 3.20 | +1.46 | ..... | ..... |
| 4,000 | 1.71 | +0.09 | 1.64 | +0.56 | 3.42 | +1.14 | 0.73 | −0.09 | 2.59 | +1.15 | ..... | ..... |
| 4,500 | 1.40 | −0.08 | ..... | ..... | ..... | ..... | 0.41 | −0.16 | 2.29 | +1.08 | ..... | ..... |
| 5,000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2.10 | +1.06 | ..... | ..... |

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

| Altitude, m. s. l. (m.) | 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. | | 6-year mean. | | Mean. | | 9-year mean. | | Mean. | | 3-year mean. | | Mean. | | 6-year mean. | | Mean. | | 6-year mean. | | Mean. | | 6-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 | S. 88° W. | 1.6 | S. 51° W. | 1.2 | S. 69° W. | 2.2 | S. 86° W. | 1.2 | S. 49° W. | 2.3 | S. 55° W. | 1.3 | N. 66° W. | 3.2 | N. 56° W. | 3.3 | N. 36° W. | 1.1 | N. 87° W. | 1.1 | S. 54° W. | 2.3 | S. 50° W. | 2.2 |
| 250 | S. 86° W. | 1.6 | S. 45° W. | 1.4 | ..... | .... | ..... | .... | S. 47° W. | 2.6 | S. 53° W. | 1.6 | ..... | .... | ..... | .... | N. 59° W. | 1.3 | S. 68° W. | 1.5 | S. 47° W. | 2.9 | S. 49° W. | 2.5 |
| 500 | S. 68° W. | 2.7 | S. 47° W. | 3.1 | S. 72° W. | 3.6 | S. 88° W. | 2.0 | S. 57° W. | 3.9 | S. 63° W. | 3.5 | N. 67° W. | 3.6 | N. 62° W. | 3.6 | N. 83° W. | 2.3 | S. 55° W. | 3.1 | S. 55° W. | 6.5 | S. 57° W. | 5.1 |
| 750 | S. 67° W. | 3.7 | S. 51° W. | 4.1 | S. 89° W. | 5.6 | N. 78° W. | 3.8 | S. 59° W. | 5.6 | S. 70° W. | 5.1 | N. 62° W. | 6.2 | N. 60° W. | 5.8 | S. 78° W. | 2.5 | S. 54° W. | 4.3 | S. 64° W. | 7.8 | S. 66° W. | 6.8 |
| 1,000 | S. 81° W. | 4.9 | S. 64° W. | 4.6 | N. 86° W. | 6.8 | N. 77° W. | 5.0 | S. 64° W. | 7.5 | S. 76° W. | 6.5 | N. 62° W. | 6.9 | N. 58° W. | 7.0 | S. 81° W. | 5.6 | S. 56° W. | 5.6 | S. 76° W. | 9.2 | S. 78° W. | 8.0 |
| 1,250 | S. 81° W. | 5.5 | S. 78° W. | 4.9 | N. 77° W. | 7.6 | N. 76° W. | 5.7 | S. 65° W. | 8.4 | S. 75° W. | 7.7 | N. 66° W. | 7.3 | N. 58° W. | 7.7 | S. 79° W. | 6.6 | S. 63° W. | 6.5 | S. 85° W. | 10.0 | S. 83° W. | 9.8 |
| 1,500 | S. 79° W. | 6.3 | S. 81° W. | 5.5 | N. 81° W. | 7.7 | N. 78° W. | 7.1 | S. 70° W. | 10.0 | S. 83° W. | 8.8 | N. 65° W. | 7.9 | N. 59° W. | 8.6 | S. 74° W. | 6.2 | S. 65° W. | 7.3 | W. | 10.9 | S. 87° W. | 10.9 |
| 2,000 | S. 84° W. | 5.6 | S. 85° W. | 6.7 | N. 88° W. | 9.0 | N. 80° W. | 8.8 | S. 74° W. | 11.0 | S. 86° W. | 10.2 | N. 62° W. | 9.2 | N. 61° W. | 9.9 | S. 74° W. | 7.7 | S. 71° W. | 8.5 | N. 89° W. | 13.1 | N. 89° W. | 12.4 |
| 2,500 | S. 89° W. | 8.0 | N. 89° W. | 9.4 | N. 70° W. | 9.6 | N. 78° W. | 11.2 | S. 76° W. | 10.5 | N. 88° W. | 11.7 | N. 62° W. | 10.0 | N. 64° W. | 11.8 | S. 86° W. | 9.1 | S. 77° W. | 9.6 | N. 86° W. | 14.0 | N. 87° W. | 13.4 |
| 3,000 | S. 68° W. | 9.6 | N. 88° W. | 11.1 | N. 80° W. | 12.9 | N. 80° W. | 13.3 | S. 75° W. | 10.2 | N. 87° W. | 14.0 | N. 55° W. | 11.0 | N. 68° W. | 13.0 | S. 83° W. | 11.6 | S. 74° W. | 11.4 | S. 73° W. | 11.7 | S. 85° W. | 13.5 |
| 3,500 | S. 63° W. | 10.6 | S. 88° W. | 11.8 | N. 79° W. | 13.6 | N. 83° W. | 15.1 | S. 83° W. | 14.6 | W. | 13.8 | N. 57° *M.* | 15.4 | N. 74° W. | 14.9 | S. 78° W. | 13.1 | S. 74° W. | 12.0 | S. 68° W. | 14.9 | S. 84° W. | 11.3 |
| 4,000 | S. 71° W. | 9.9 | W. | 10.4 | N. 79° W. | 11.2 | N. 85° W. | 16.5 | S. 80° W. | 14.0 | N. 88° W. | 12.7 | N. 60° W. | 15.2 | N. 75° W. | 14.7 | N. 89° W. | 14.4 | S. 75° W. | 11.5 | ..... | .... | ..... | .... |
| 4,500 | N. 80° W. | 11.3 | N. 80° W. | 12.4 | N. 45° W. | 13.0 | N. 70° W. | 17.6 | S. 77° W. | 16.0 | N. 88° W. | 14.0 | N. 67° W. | 17.8 | S. 81° W. | 15.8 | N. 89° W. | 16.3 | N. 88° W. | 12.0 | ..... | .... | ..... | .... |
| 5,000 | ..... | .... | ..... | .... | ..... | .... | ..... | .... | ..... | .... | ..... | .... | N. 45° W. | 21.2 | N. 89° W. | 14.9 | N. 81° W. | 20.0 | N. 83° W. | 14.7 | ..... | .... | ..... | .... |

## THE WEATHER ELEMENTS.

By P. C. DAY, Meteorologist, in Charge of Division.

### PRESSURE AND WINDS.

The outstanding feature of the weather during December, 1923, was the persistence of unusual warmth over the districts from the Rocky Mountains eastward, both in Canada and the United States.

This was brought about mainly through the large number of high-pressure areas entering the United States along the Oregon and California coasts, their slow rate of movement over the middle Plateau and Rocky Mountain regions, and their far southward drift in passing thence eastward to the Atlantic coast. This resulted in most low-pressure areas passing eastward north of the International Boundary, with resultant southerly winds over nearly all districts from the Great Plains eastward to the Atlantic coast.

Not until near the end of the month did a fully-developed anticyclone of the Alberta, or usual winter, type, overspread the country.

Late in the month pressure began to rise in Alaska reaching nearly 31 inches at Eagle, near the Arctic Circle, on the 28th and 29th, with temperatures 50° or more below zero. By the morning of the 30th this anticyclone had overspread the Canadian Northwest and was central over southern Alberta, Canada, and northern Montana, attended by severe cold, the temperature on the following morning reaching an extreme low reading of 53° below zero in Montana.

During the closing day of 1923 the anticyclone moved southeastward to the middle Plains, and by the first day of the new year its influence had extended into practically all parts of the country from the Rocky Mountains eastward, attended by the coldest weather of the month from Montana, the Dakotas and Minnesota, southward to the Rio Grande and the West Gulf coast.

As stated previously many of the cyclones of the month passed eastward over southern Canada, and as is usual in such cases the storms were mainly unimportant in their effect upon the weather of the United States as to precipitation, but they did induce relatively warm southerly winds far to the northward of their usual winter limits.

The first important cyclone of the month appeared in the far Southwest early in the month, and moving eastward gave mostly light precipitation over the southern mountain and Great Plains districts, reaching the lower Mississippi Valley by the morning of the 4th, at which time rain had become heavy near the center. During the following two or three days the storm moved slowly toward the lower Lakes and St. Lawrence Valley, increasing greatly in severity and attended by precipitation, mostly rain, over practically all districts from the Mississippi River eastward. Heavy rains occurred during this storm over many portions of the Gulf States, Ohio Valley, and Atlantic coast States, particularly in southern New England.

A cyclone, indifferently outlined, appears to have moved from the far West to the southern Plains by the morning of the 9th and to the west Gulf coast during the following 48 hours, attended by local rains or snows. Immediately following this another storm moved into southern Arizona and during the 10th and 11th overspread the southern mountain and Plateau States, attended by unusually heavy snow and high winds over New Mexico and portions of adjacent States. Drifting snow completely tied up automobile traffic, nullified railroad schedules, and cold weather over the same districts immediately following caused a number of deaths from freezing and much suffering to automobilists and others unable to reach shelter.

The middle portion of the month was mainly free from stormy conditions, but beginning about the 20th moderately low pressure developed in the far Southwest and extending northeasterly toward the Great Lakes gave more or less scattered precipitation over extensive areas to the eastward during the first half of the last decade. The amounts of precipitation were mostly small, however, save over the Gulf States and Ohio Valley where, toward the end of the period, they were more general and frequently heavy.

A moderately well-defined cyclone entered the far Northwest on Christmas Day, and with more or less definite character moved to the lower Missouri Valley by the morning of the 27th and thence to the St. Lawrence Valley and Canadian Maritime Provinces by the 29th. This was likewise attended by widely scattered precipitation, though mostly light, with some snow over the more northern districts.

Immediately preceding the main anticyclone of the month, low pressure developed over Colorado and vicin-