ings sent to the Rogue River Valley were not specially timely or accurate.—*T. Francis Drake, Local Forecaster.*

San Francisco District.—The only important warnings issued during March were those for frosts on the 23d and 24th. Frosts occurred quite generally on the mornings of the 24th and 25th, but moderate winds and some cloudiness prevented any serious injury.—*G. H. Willson, District Forecaster.*

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ON PRESSURE-CHANGE CHARTS.

By EDWARD H. BOWIE, District Forecaster.

[Dated: Washington, Nov. 27, 1915.]

An important change in the construction of the pressure-change charts prepared at the central office of the Weather Bureau became effective on August 1, 1915. During many years previous to this date[1] there were entered on these charts the 24- and 12-hour changes and the departure from the normal sea-level pressures for all stations from which both the 8 a. m. and 8 p. m. (seventy-fifth meridian time) observations were received by telegraph from the area comprising the United States and southern Canada. The 12-hour changes were made after the application in each case of a correction for the diurnal fluctuation that made the 8 a. m. comparable with the pressure observed at the previous 8 p. m. observation, and similarly the 8 p. m. with the pressure at the preceding 8 a. m. observation. There was obviously no correction necessary in making the 24-hour changes. The pressure changes having been computed, lines (isallobars) in red were drawn for each 0.10 inch rise and fall in 24 hours and a heavier red line drawn through points of no change. Similarly, blue lines (isallobars) for each 0.10 inch rise and fall were drawn for the 12-hour pressure changes. The revised chart omits the 24-hour changes and the red lines drawn to these changes. On the new chart isobars for sea-level pressures are drawn in red and superposed on these are blue lines (isallobars) drawn through points having equal 12-hour changes, a line being drawn through each 0.10 inch fall or rise and a heavier line for zero change. In addition to these lines, the "barometric tendency" or pressure change in the two hours immediately preceding the time of observation at any station is entered in green figures when telegraphed. The "barometric tendency" is telegraphed from selected stations only when the change in pressure equals or exceeds 0.04 inch in the two hours immediately preceding the observation. Figures 1 and 2 (Chart XLIV–34, 35) show the old form of pressure-change maps, and figures 3 and 4 are reproductions of the revised maps. The "barometric tendency" is indicated by large bold-faced figures in red.

The change was made that the forecaster might see at once the relation between the highs and lows and the pressure changes that have taken place during the time between the current observation and that which immediately preceded it, and it is the consensus of opinion of the forecasters at the central office of the Weather Bureau that the new form of pressure-change chart has many advantages over the one previously in use and is a valuable aid in forecast work.

NATURE OF THE PRESSURE CHANGES.

There have been published a number of theories as to the origin and nature of the areas of rise and fall in pressure as shown by the pressure-change maps. Hanzlik in a paper on "Relations between velocities of lows and the areas of rising and falling pressure accompanying them" (MONTHLY WEATHER REVIEW, May, 1906, **34:** 205) writes:

> The results of the investigation on the relation of areas of falling and rising pressure to the lows are given by Sresnewsky:
>
> (1) The center of the cyclone is always to the left of the point of most rapid fall of pressure. (2) This is explained as due to the greater eccentricity of the outer isobars of the cyclone and also due to the difference of barometric gradients on both sides of cyclones. (3) The area of most rapid decrease in the southeast quadrant of the cyclone coincides with the area of strongest storms and moves nearly parallel to the center of the cyclone. (4) There are cases when the area of fall moves apparently independently of the cyclone while the latter remains nearly stationary in the extreme north of Europe. These are the most important points in Sresnewsky's investigation that concern the relation of cyclones to the areas of fall and rise.
>
> The atmospheric waves are, in Ekholm's opinion, very important phenomena. When there are strong storms in Swedish waters the areas of fall and rise follow similar tracks parallel to each other, while the cyclone keeps somewhat to the left of the track of the area of fall. When the cyclone reaches the land the intensity of the storm diminishes, the velocity of motion of the storm decreases, and the areas of fall and rise, with some delay, move in a southern or southwestern direction as if there were no apparent connection between them and the cyclonic area. The continued study of these areas of change in their relation to the cyclones led Ekholm to believe that for the weather and wind these are of greater importance than the cyclones themselves. "It seems to me highly probable," says Ekholm,[2] "that these oscillations are caused by the cyclones and anticyclones of higher levels, which sometimes but not always cause a corresponding cyclone or anticyclone on the surface of the earth." Worthy of mention is the cyclonic character of the area of fall, namely, the overcast sky and the occurrence of rain. Ekholm closes his paper with some remarks on the charts of change for other meteorological elements.

Hanzlik expressed a view concerning the areas of rise and fall that is quite different from that of Ekholm. He would bring the moving areas of falling and rising pressure into close connection with both the currents assumed to produce the lows. He associates the northerly winds with the areas of rise and the southerly warm winds with the areas of fall, (1) because the extreme temperature changes lie within the areas of rise and fall, and (2) because these two currents are assumed to be the primary cause which gives rise to the low.

The present writer is of the opinion that these areas of rising and falling pressure are not independent phenomena, although they may seem to be, but that they arise directly from the movements of and changes in pressure in highs and lows, with which they are associated. This, it is believed, is demonstrable and an effort will be made herein to show the truth of this statement.

OBSERVATIONS ON MAXIMUM PRESSURE-CHANGE AREAS.

One hardly needs to demonstrate the truth of the fact that a symmetrical low is, at any given moment, moving toward that point or region within its area where the pressure at the moment of observation is falling most rapidly. This maximum fall within the area of a low lies somewhere along a line passing through the center of the low and in the direction of advance of the low center and normal to the closed concentric isobars. The least change in pressure will be, of course, along two lines parallel to the direction of movement of the low, one on

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[1] The preparation of pressure-change charts in the Forecast Division, U. S. Weather Bureau, began in 1872, when observations were telegraphed thrice daily and charts for 8-hour intervals were prepared until June 20, 1888.

Figures E. H. B. 1 to E. H. B. 8 form charts XLIV–34 to 45.

[2] Ekholm, *in* Meteorol. Ztschr., August, 1904, 21: 355.

each side of the low center, and tangent to the outer closed isobar.

Assuming that there be moving eastward at a uniform rate of progression on a given map, in the same latitude, a symmetrical low preceded by a symmetrical high; suppose these to be in tandem formation, of equal area and uniform pressure gradients, and that neither undergoes any change in configuration of isobars, in pressure level, nor in the linear distance from the center to center in a given interval of time. Then at the end of the given time interval, the region of maximum pressure fall will be along a straight line extending from the position of the center of the low at the end of the assumed interval to the position of the center of the preceding high at the beginning of the assumed interval. This is shown by the red lines on the chart figure 5, which represents an ideal weather map on which only one low and one high appear. On this chart (XLIV–38) A is the position of the center of the low at the beginning and A_1 the position of the center of the low at the end of the assumed interval; similarly B is the position of the center of the high at the beginning and B_1 the position of the high at the end of the assumed interval of time. The distance AB is the same as that between A_1 and B_1. The changes in pressure are made at each point where an isobar of A or B crosses an isobar of A_1 or B_1, and red lines are drawn for each 0.10-inch fall. It will be found that the maximum change is along a line connecting A_1 and B. Now, if in the example given above, where the distance between the low and the high that precedes it does not change, the pressure rise or fall say 0.20 inch in A and a similar amount in B, then the region of maximum fall will still lie on a line connecting A_1 and B. If, however, the pressure level in A fall 0.20 inch in the assumed time interval during which the low moves to A_1, while the pressure undergoes no change in B, then the maximum fall will be near the center of A_1, as shown by figure 6 (XLIV–39). Should the pressure undergo no change in the high but rise in the low, then the maximum pressure fall will be near the center of the high, B, as shown by figure 7 (XLIV–40). If the pressure level fall in the high, B, while moving to B_1 but does not change in the low, then the maximum fall is also near the position of B, as will be seen by figure 8 (XLIV–41). If the pressure level rise in the high and undergo no change in the low, then the maximum pressure fall is near the center of the low, A_1, as shown by figure 9 (XLIV–42).

In the examples given the distance between the low and the preceding high remained unchanged. If, however, the distance increase or decrease, the maximum pressure fall varies both in amount and position. Thus, in figure 10 (XLIV–43), the high moves faster than the low and the distance between the two at the end of the interval is greater, then the position of the maximum pressure fall is near the center of the high, B. Similarly in figure 11 (XLIV–44), if the low move faster than the high and the distance between the two is less at the end of the interval, the position of the maximum pressure fall is near the center of the low, A_1. The daily pressure-change map will show changes, such as these, that arise from similar movements of and changes in pressure in highs and lows.

Many other examples could be given of how the position of the area of maximum pressure fall varies with the movements of the highs and lows, and some of the results are astonishing. For example, it has been commonly supposed that the area of maximum pressure fall is always in front of and in the line of advance of lows that move rapidly, but it is possible to show that *a low that moves with great speed may have the maximum pressure fall, in the given interval, in its rear. This occurs when the low moves beyond the position occupied by the high at the beginning of the interval, and it is seen occasionally on the weather map.* This is shown by figure 12 (XLIV–45). On this chart the low, A_1, is assumed to have moved from A to beyond the position of the high, B, at the preceding observation, while the high, B, is moving ahead of it. The position of the high, B_1, at the end of the interval is not shown.

Nothing has been said concerning the areas of maximum rise, but it is believed that these can be shown to be dependent, as are the areas of maximum pressure fall, on the changes in intensity, speed, and direction of movement of highs and lows. It follows that the isallobaric charts are but representations of pressure changes that result directly from the movements of and changes of pressure level in highs and lows, and nothing more. It is obvious, however, that the nature of these maximum pressure changes being known, many precepts that will materially aid the forecaster may be found. But it is not the intention of the present writer to consider this phase of the question.

These charts, as stated above, are assumed to represent the ideal types of lows and highs as seen portrayed on the weather maps of the United States with this important difference, that the pressure-gradients here represented as uniform, increase in nature from the high to the low. This natural increase in the pressure-gradient from the high toward the center of the low places the area of maximum presure fall nearer the center of the low and modifies somewhat the configuration of the isallobars. Nevertheless, the rules herein stated hold good in principle for ideal types of highs and lows as shown by weather charts of the United States. The pressure changes resulting from complicated cases of isobars surrounding highs and lows do not make it easy to formulate precepts concerning them. There are, moreover, pressure oscillations, generally small in amount, which take place uniformly and gradually over larger areas and independently of the movement of highs and lows. These oscillations result, in all probability, from changes in the general circulation and are shown first in modifications of the subpermanent areas of high and of low pressure, or the so-called centers of action.

FIRE-WEATHER WARNINGS.

By HENRY E. WILLIAMS, Meteorolgist in charge of Forecast Division.

The following extracts from reports rendered and papers prepared by the district forecasters are published with a view to bringing down to date the available information relating to the fire-weather warning service, as this project is hereafter to be designated. This service was authorized in the Portland and San Francisco forecast districts in the summer of 1913 on the recommendation of District Forecaster E. A. Beals, at the suggestion of officials of the United States Forest Service and the Western Forestry and Conservation Association. Only one or two warnings were issued during 1913, and those for the Portland District. None were issued in the San Francisco District. In 1914 the service was extended to all the other forecast districts, and the reports from these districts show warnings issued as follows:

Fire-weather warnings issued by the several forecast districts during 1913, 1914, and 1915.

Forecast district.	1913	1914	1915
Washington	None.	None.	None.
New Orleans [1]	None.	None.	None.
Denver	None.	None.	1
Chicago	None	6	5
San Francisco [2]	None.	(?)	(?)
Portland, Oreg.	2	17	8

[1] Warnings only on request of district foresters. [2] Record incomplete.