over the continent, descending here and there to the earth's surface. All that portion of the continent that is under the influence of this descending wind is subject to dry, warm fœhn winds, and, at the best, relatively light rains. If the lower current on the windward side of the range is relatively feeble and but little rain is deposited on the windward side, then but little wind will flow thence over the continent, the volume of the descending dry fœhn winds will diminish, and the chances for local rains in the interior will increase.

In general, the quantity and frequency of rain depends upon the heights of clouds whose very formation itself depends upon the upper and lower winds. The absolute quantity of rain depends, also, upon the dew-point, and, other things being equal, is, therefore, greater for moist winds than for dry; but the relative quantity and the relative frequency of rain in successive seasons are the features that determine a drought, in ordinary agricultural usage, for any locality, and these depend essentially upon the relative movements of the atmosphere in the respective seasons. If the movements are downward, or feebly upward, or if they introduce cooler or drier air than usual, the result is drought; if they are more strongly upward than usual, they bring cloud and rain. These principles are abundantly illustrated by the winds and rains that prevail in the interior of India, Australia, and North America.

WATER MEASUREMENTS FOR IRRIGATION.

The attention of the Editor has been called to the fact that on page 209 of the MONTHLY WEATHER REVIEW for May, 1897, he has adopted the British Imperial gallon, which is used in many parts of this country, and has said nothing about the British wine gallon, which is also used. The imperial gallon contains 10 pounds of water, or 277.274 cubic inches. The wine gallon contains 8.3389 pounds of water, or 231 cubic inches. Records expressed in imperial gallons may be converted into wine gallons by multiplying them by the factor 10/8.3389 or 1.21.

CHINOOKS IN IOWA.

If the term "fœhn wind" is to be used as a general name for all warm, dry, descending winds then, of course, there may be a similar propriety in the use of the word "chinook," but as "fœhn" has the priority of many years of meteorological usage, and as we have both dry chinooks in Montana, and wet chinooks in Oregon and Washington, the Editor would prefer the unambiguous Swiss or Helvetian word "fœhn."

The Climate and Crop Report from Iowa for the month of December contains two interesting notes by observers. At Clarinda, A. S. Van Sandt says:

> On the morning of the 29th the wind was in the northwest, soon veering to west. It was as mild as May and reminded me of what I have read of the chinook. Query: Was it the tail end of one? The snow, which was very compact from previous melting, lost one-third of its depth.

At Odebolt, E. Starner says:

> December 4.—Chinook at midnight that settled the snow about 6 inches.

Before studying the weather maps to ascertain whether conditions were favorable for descending winds on these dates, the Editor would say that, in general, such winds may occur at any spot on the globe. The fact that they are peculiarly frequent and effective in certain regions, such as Switzerland, Greenland, western Montana, New Zealand, and northern India should not prevent us from recognizing the fact that they are recurring frequently in almost every other region. Whenever some air ascends other air must descend. There can be no doubt but that the famous hot winds that occur occasionally from Texas northward to Canada are descending winds.* It is scarcely proper to speak of the fœhn wind in Iowa as the tail end of a chinook that had spread from Montana down to that State, because both these terms are generally more restricted in extent. The hot winds of Iowa and of Montana are generally separate local chinooks.

On examining the weather maps for December 4 and 29, we find that on the morning of the 4th the temperature had risen remarkably in western Nebraska, eastern Wyoming, and northward through Dakota and Montana into Canada. The winds were from the southwest, the air was descending the eastern Rocky Mountain Slope, the pressure was 30.70 over the region around Salt Lake City, and 29.70, or less in Manitoba, everything was favorable for a chinook in the intermediate regions. By the 5th, a. m., the warm winds had covered a large region southeastward to the Mississippi Valley. Evidently the whole mass of air flowing eastward from the region of high pressure was descending along the surface of the ground and did not begin to rise until it came within the influence of the low pressure near the Lake Region. On the 4th, a. m., at Havre, Mont., the temperature was 56° higher than on the 3d, a. m. This was an intense chinook. Iowa had temperatures 12° or 14° higher, and during the whole day experienced a moderate chinook. All the intermediate regions had their descending dry and relatively warm winds.

On December 29 the conditions were very similar. The high pressure was over the Salt Lake region; the lowest pressure was over Lake Superior; the whole eastern Rocky Mountain Slope was covered with a layer of descending air, clear and dry, and, in general, warmer to such an extent that Iowa, Minnesota, and Wisconsin were from 20° to 50° warmer than on the 28th. The chinook—if it may be so called—prevailed from the Rocky Mountains eastward to the Mississippi. Iowa did not get the tail end of it but was in the midst of it.

If "chinook" and "fœhn" are terms that are to be restricted to intense local manifestations of descending winds, and if by the "hot winds" of the western plains we designate only those that occur at the time of the ripening of the wheat and corn, when they do such injury to crops, then we ought perhaps to devise some term specifically appropriate to these widespread areas of descending winds that bring dry, clear, warm weather to one-half of the Mississippi watershed.

Not only does the eastern slope of the Rocky Mountain region have its descending chinook winds, but so also has the eastern slope of the Appalachian range, a fact that was pointed out by the Editor as long ago as 1872. The westerly winds that bring fog and possibly rain or snow to Buffalo, Pittsburg, Knoxville, and Chattanooga frequently descend upon New York, Washington, Lynchburg, Columbia, S. C., and Atlanta as clear dry winds, and on the average a very little warmer than on the windward side of the mountain range. One of the first indications of this action of descending winds was observed soon after the station at Lynchburg was opened in 1871, when it was found that so-called clearing up weather and the first clear sky began at that station some hours before it reached Washington, and even a whole day earlier in the case of very slowly moving changes.

An area of high pressure apparently represents a region in which air is descending so slowly to the earth's surface that it cools by radiation faster than it warms up by compression. When such an area is central, as occurred so frequently during December, over the middle Plateau Region, the atmosphere is pushed not merely eastward down the eastern slope, but also northwestward into California, Oregon, and Washington. It is the relatively rapid descent down these slopes that causes the air, which is compressed by its own

*See the article "Summer Hot Winds on the Plains," by Dr. I. M. Cline, Weather Bureau Observer, in the Bull. Phil. Soc. Washington, XII, 1894.

weight, to become heated so rapidly as to produce a decided chinook; consequently, during the current December Mr. B. S. Pague, Section Director for Oregon, reports that—

The month was generally warmer than usual, that in fact it was abnormal so far as the absence of any extreme cold is concerned. Two well-defined chinooks were experienced; viz, from the 5th to the 8th and from the 26th to the 28th.

These dates correspond to those of the warm winds on the eastern slope, showing that the same area of descending air can produce chinooks on both sides of the Plateau Region. Mr. Pague says:

The cause of the mild temperature throughout the month was the dynamic heating of the air, due to the high pressures over the Plateau Region and the high latitude in which the low pressures passed from the ocean eastward. Had the high pressures been persistent to the north of Montana, then they would not have been over the Plateau Region, and the result would have been different; the low pressures would have traveled south of the normal path, and the cold air from the northeast would have lowered the temperatures much below the normal.

If the dry air from the Plateau Region descends with sufficient slowness it may cool by radiation rapidly enough to counterbalance the warming by compression. This latter warming is quite an exact quantity and amounts to about 1° C. for every 100 meters of descent, or to 1° F. for every 183 feet, consequently air that has descended 5,500 feet vertically must have been warmed up 30° F. Now, clear, dry air, rolling along on the surface of frozen or snow-covered ground in the winter season when the sun is low, can easily cool more than 30° in twenty-four hours. Thus, northerly winds and cold weather in Texas may sometimes be a direct continuation of air that was quite warm when it rapidly descended the eastern slope of the Rocky Mountains a few days before in Montana, Nebraska, or Kansas. But most frequently the cold waves of Texas are due to the southward flow of cold air from the Canadian regions into the Mississippi watershed; the divide between the Mississippi and Canada is scarcely 2,000 feet above sea level and the cold air generally lies below the 3,000-foot contour line. The progress of such a cold wave, south and east, is frequently described as dense air underflowing, pushing aside, and lifting up the warmer, lighter air of the Mississippi Valley. Above this cold air the observers on mountain tops and plateaus, or in balloons, generally find air that is potentially warmer, that is to say, air that if brought down to the earth's surface would by compression have a higher temperature than the air of the cold wave.

METEOROLOGICAL TABLES AND CHARTS.

By A. J. HENRY, Chief of Division of Records and Meteorological Data.

Table I gives, for about 130 Weather Bureau stations making two observations daily and for about 20 others making only the 8 p. m. observation, the data ordinarily needed for climatological studies, viz, the monthly mean pressure, the monthly means and extremes of temperature, the average conditions as to moisture, cloudiness, movement of the wind, and the departures from normals in the case of pressure, temperature, and precipitation; the altitudes of the instruments, the total depth of snowfall, and the mean wet-bulb temperatures are now given.

Table II gives, for about 2,400 stations occupied by voluntary observers, the extreme maximum and minimum temperatures, the mean temperature deduced from the average of all the daily maxima and minima, or other readings, as indicated by the numeral following the name of the station; the total monthly precipitation, and the total depth in inches of any snow that may have fallen. When the spaces in the snow column are left blank it indicates that no snow has fallen, but when it is possible that there may have been snow of which no record has been made, that fact is indicated by leaders, thus (....).

Table III gives, for about 30 Canadian stations, the mean pressure, mean temperature, total precipitation, prevailing wind, total depth of snowfall, and the respective departures from normal values. Reports from Newfoundland and Bermuda are included in this table for convenience of tabulation.

Table IV gives detailed observations at Honolulu, Republic of Hawaii, by Curtis J. Lyons, meteorologist to the Government Survey.

Table V gives, for 26 stations, the mean hourly temperatures deduced from thermographs of the pattern described and figured in the Report of the Chief of the Weather Bureau, 1891-92, p. 29.

Table VI gives, for 26 stations, the mean hourly pressures as automatically registered by Richard barographs, except for Washington, D. C., where Foreman's barograph is in use. Both instruments are described in the Report of the Chief of the Weather Bureau, 1891-92, pp. 26 and 30.

Table VII gives, for about 130 stations, the arithmetical means of the hourly movements of the wind ending with the respective hours, as registered automatically by the Robinson anemometer, in conjunction with an electrical recording mechanism, described and illustrated in the Report of the Chief of the Weather Bureau, 1891-92, p. 19.

Table VIII gives, for all stations that make observations at 8 a. m. and 8 p. m., the four component directions and the resultant directions based on these two observations only and without considering the velocity of the wind. The total movement for the whole month, as read from the dial of the Robinson anemometer, is given for each station in Table I. By adding the four components for the stations comprised in any geographical division one may obtain the average resultant direction for that division.

Table IX gives the total number of stations in each State from which meteorological reports of any kind have been received, and the number of such stations reporting thunderstorms (T) and auroras (A) on each day of the current month.

Table X gives, for 56 stations, the percentages of hourly sunshine as derived from the automatic records made by two essentially different types of instruments, designated, respectively, the thermometric recorder and the photographic recorder. The kind of instrument used at each station is indicated in the table by the letter T or P in the column following the name of the station.

Table XI gives a record of rains whose intensity at some period of the storm's continuance equaled or exceeded the following rates:

Duration, minutes..	5	10	15	20	25	30	35	40	45	50	60	80	100	120
Rates pr. hr. (ins.)..	3.00	1.80	1.40	1.20	1.08	1.00	0.94	0.90	0.86	0.84	0.75	0.60	0.54	0.50

In the northern part of the United States, especially in the colder months of the year, rains of the intensities shown in the above table seldom occur. In all cases where no storm of sufficient intensity to entitle it to a place in the full table has occurred, the greatest rainfall of any single storm has been given, also the greatest hourly fall during that storm.

Table XII gives the record of excessive precipitation at all stations from which reports are received.