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SECTION III.—FORECASTS.

FORECASTS AND WARNINGS FOR APRIL, 1917.

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During the month of April, over the Aleutian Islands and Bering Sea, the pressure was abnormally high on all days except from the 8th to 12th and the 14th to 18th, when normal or subnormal pressures were recorded. The pressure was also abnormally high over central and southern Alaska except on the 4th and 5th, and 9th to 12th. In the vicinity of the Hawaiian Islands the fluctuations in pressure were not decided; readings slightly above normal were recorded during the month, except from the 11th to 14th and 9th to 21st, when the pressure was relatively low. The only important depression in the barometer over these islands occurred on the 26th, 27th, and 28th.

Over the western portion of the Atlantic Ocean, as shown by the reports from St. Johns, Newfoundland, and Hamilton, Bermuda, the pressure was low during the month, although pressure above the normal was recorded from the 16th on to the 22d.

In the United States the month showed a greater number of HIGHS and LOWS than is normally expected; 14 well-defined LOWS and 8 HIGHS were charted. Of the LOWS, 2 made their first appearance over Alaska, 3 off the North Pacific coast, 3 over California, and 6 were of the Colorado type. Of the HIGHS, 3 made their first appearance over Alaska, 3 off the North Pacific coast, 1 over the northern Rocky Mountains region, and 3 north of the Great Lakes. As might be inferred from the number of HIGHS and LOWS that were charted, the month was one of marked variability in temperature and frequent changes from dry weather to days with precipitation. Moreover, many of the LOWS followed tracks that reached to low latitudes and consequently were attended by general precipitation, while 6 of the 10 HIGHS charted were of continental origin, being first observed in southern Canada, and brought with them unseasonably low temperatures. This was particularly true over the northern and western States.

WASHINGTON DISTRICT.

April, 1917, opened with a disturbance over the lower Mississippi Valley, whence it moved rapidly northeastward, being central the morning of the 2d over the lower Lakes, and on the 3d over the St. Lawrence Valley. This disturbance was attended by general rains and thunderstorms in the Great Central Valleys and the Gulf States, and by strong shifting winds on the middle Atlantic and New England coasts. On the morning of the 1st when the storm was central over Arkansas, small-craft warnings were displayed on the east Gulf coast, and on the 2d storm warnings were displayed on the Atlantic coast at and north of Delaware Breakwater. The highest velocities reached during the 3d were 38 miles at Baltimore and 44 miles at New York City. Following this disturbance the pressure rose rapidly, and frost warnings were required for the Ohio Valley and Tennessee. Another

storm area formed over the southern Plains States on the 3d, and by the morning of the 4th its center had moved eastward to northwestern Arkansas, and on the morning of the 5th its center was over Indiana, where the pressure was below 29.45 inches. This storm at this time had already been attended by general rains and thunderstorms in the South and Middle Atlantic States, and the Mississippi and Ohio Valleys, and by snow in the Upper Lakes region. In expectation that this storm would further increase in intensity, storm warnings were displayed the morning of the 5th on the Atlantic coast from Jacksonville, Fla., to Eastport, Me. On the 6th the center of this disturbance was over eastern Pennsylvania and strong winds had already prevailed along the entire Atlantic coast in the area where storm warnings were displayed. Snow continued along the northern international boundary and in the upper Ohio Valley, and there were general rains throughout the Atlantic States. The center of this storm passed northeastward off the New England coast during the 7th, but the gales on the north Atlantic coast did not subside until the night of that date.

Another storm made its appearance over Colorado on April 5, passed eastward to the middle Mississippi Valley on the 7th, and on the morning of the 8th its center was over Tennessee, from which position it moved rapidly eastward, reached North Carolina by 8 p. m. of that day, and then turned northward, increasing in intensity and attended by shifting gales along the Atlantic coast from North Carolina northward. It also caused rains and snows in the middle Mississippi and Ohio Valleys, and in the Middle Atlantic and New England States. When the center of this disturbance was over North Carolina, on April 8, storm warnings were ordered displayed on the Atlantic coast from Cape Hatteras to Cape Cod, and on the morning of the 9th the display was extended northward to Eastport, Me. The warnings were timely and fully verified.

After this storm the pressure rose decidedly and the weather became much colder and comparatively quiet generally east of the Mississippi River; it was necessary to issue frost warnings for the Ohio Valley, Tennessee, and the east Gulf and South Atlantic States, except the Florida Peninsula, and warnings of freezing temperatures for the Middle Atlantic States.

Storm warnings were not again required until the morning of April 25, when they were ordered for the Great Lakes with the exception of extreme western Lake Superior and southern Lake Michigan. The storm under consideration (— on Chart III) was central, the morning of the 25th, over Illinois, whence it advanced northeastward, increasing in intensity, and on the morning of the 26th its center was over eastern Lake Superior. This disturbance was attended by rains, snows, and shifting gales over practically the entire Lakes Region. A disturbance formed during the 28th over the western Plateau Region, advanced eastward, and on the morning of the 30th its center was over Arkansas. This disturbance developed rapidly in intensity during the succeeding 12 hours, and at 3 p. m. of that date the necessary storm

warnings were displayed on Lake Michigan; at 10 p. m. on the same day, the warnings were extended over Lakes Huron, Erie, and Ontario. This disturbance moved north-eastward gaining greatly in intensity, and was attended by gales on the Great Lakes and by severe local thunderstorms in the lower Ohio Valley.

WARNINGS FROM OTHER DISTRICTS.

Chicago district.—Unseasonably low temperatures prevailed throughout this forecast district during April, so that vegetation was not sufficiently advanced to require frost warnings until after the 20th, except in southern Illinois, Missouri, and extreme eastern Kansas. Warnings were issued for portions of these States on April 4, 5, 7, 8, 12, 13, and 21. The warnings were fully verified, as a rule. Between the 20th and the end of the month warnings were required as far north as Nebraska, Iowa, and extreme southern Wisconsin.

On the 25th a disturbance was centered over northern Illinois, moving northeastward, and was followed by an area of high pressure and freezing temperature from the Northwest. Frost warnings were issued for portions of Illinois, Iowa and Missouri, and were only partially verified. No further warnings were required until the 30th when a disturbance was central over southern Missouri, with rising pressure and abnormally cold weather to the west and northwest. Accordingly, frost warnings were issued for Missouri, Kansas, Nebraska, and eastern Iowa, and were fully verified, except in portions of eastern Missouri.—*Chas. L. Mitchell, Assistant Forecaster.*

New Orleans district.—Frost warnings were issued as follows: On April 1 to western Texas, frost south, freezing north; to Oklahoma, heavy frost, probably freezing; to Arkansas, frost, probably heavy in northwest portion; to northeastern Texas and northern Louisiana, frost. On April 2 to Arkansas, Oklahoma, and the northeastern portion of eastern Texas and northern Louisiana. On April 4 to western Arkansas, southeastern Oklahoma, and northeastern Texas. On April 5 to Arkansas and northern Louisiana. On April 7 to Oklahoma, frost in southern, freezing in northern portion; to western Texas, frost except in southeastern portion, freezing in the Panhandle; to eastern Texas, frost in northwest portion. On April 8 to Louisiana, frost in interior; to Arkansas, heavy frost in the south, freezing in the north; to Oklahoma, freezing; to western Texas, frost in south, freezing in north; to eastern Texas, frost in interior, heavy frost in north. On the 12th to Oklahoma and the northern portion of Texas. On the 13th to Arkansas. On the 14th to Arkansas and northern Louisiana; on the 20th to Arkansas, Oklahoma, and extreme northern portion of Texas; on the 25th to the Texas Panhandle and northern Oklahoma; on April 30 to Oklahoma, northwestern Arkansas, and the extreme northern portion of Texas. All of the foregoing warnings were verified, except those issued on the 14th and 25th when weather disturbances moved somewhat more rapidly than was anticipated, causing cloudiness over the area for which frost was forecast.

Fire-weather warnings were issued on April 4, 6, 27, and 30, and were justified.

Storm warnings were ordered for the Texas coast on April 27 and storm winds occurred at some stations.—*I. M. Oline, District Forecaster.*

Denver district.—April, 1917, was marked by two stormy periods during which rain or snow fell over a large part of the district, greatly benefiting agricultural interests.

A warning of frost for the vicinity of Phoenix was issued on the morning of April 1 because an anticyclonic area on the middle Pacific coast was expected to spread eastward to Arizona. Frost occurred as forecast.

Fire-weather warnings were issued on the evening of the 2d for northern Arizona and southern New Mexico on account of falling pressure. The wind velocity at Roswell, N. Mex., at the evening observation on the 3d was 32 miles per hour, while in western Arizona it attained a velocity of 52 miles per hour. On the morning of the 3d an anticyclonic area, attended by low temperature, was moving eastward over the northern Plateau region and frost warnings were issued for western Colorado, central and southeast Arizona and northwestern Utah, and warnings of heavy frost or freezing temperature were distributed for southeast New Mexico in the evening of the 3d. Freezing temperature or frost prevailed on the morning of the 4th, except in southern Arizona. Frost or freezing temperature warnings were again issued for southeast New Mexico on the morning of the 4th and a killing frost with a temperature of 28° occurred at Roswell, N. Mex., the following morning. On the morning of the 6th an anticyclonic area was moving eastward across the northern Rocky Mountain region and frost was forecast for northern Utah. Frost occurred the following morning at Salt Lake City, with a temperature of 34°. On the morning of the 7th the HIGH had extended southward into Colorado and freezing temperature was forecast for southeastern New Mexico. These warnings were repeated on the morning of the 8th and were justified.

Fire-weather warnings for Arizona and southwest Utah were issued on the evening of the 8th and for New Mexico on the evening of the 9th. Moderately high winds occurred in localities. Moderately high pressure prevailed in the district on the morning of the 12th, with an anticyclonic area over northern California, and warnings of frost or freezing temperature were issued for southeast New Mexico, frost for south-central Arizona, and heavy frost for northern Utah. Heavy frost, with a temperature of 34° occurred at Salt Lake City. In the southern portion of the district, however, falling pressure prevented the expected fall in temperature. Frost warnings for northern Utah were repeated on the 13th and frost occurred the following morning followed by rising temperature. Fire-weather warnings for Utah, Arizona, and New Mexico were issued on the evening of the 14th as a storm of marked character had developed over Utah. A velocity of 40 miles per hour occurred at Santa Fe and 34 miles at El Paso. Moderately high winds occurred locally in other parts of the district. On the morning of the 15th the center of the storm was over western Colorado and warnings of heavy frost for central Arizona and freezing temperature or heavy frost for Utah and northwest Colorado were issued. A killing frost with a temperature of 28° occurred at Salt Lake City, but the development of a secondary depression over Utah was attended by precipitation in Arizona and southern Utah and cloudy skies in western Colorado.

On the morning of April 19 an anticyclonic area was spreading eastward over the Plateau Region and warnings of freezing temperature or heavy frost were issued for Colorado, eastern New Mexico, northern Utah, and southeast Arizona. Freezing temperatures occurred in practically the entire area covered by the warning. As the anticyclonic area had overspread the district with no decrease in intensity, freezing temperature warnings were repeated on the 20th for Colorado and eastern New

Mexico. Freezing temperatures again occurred in Colorado and temperatures of 34 to 36° in eastern New Mexico. An area of high pressure was over western Montana on the morning of the 24th and freezing temperature or frost warnings were issued for Colorado and northwestern Utah. The rapid eastward movement of the anticyclonic area and the development of cyclonic conditions on the western slope was attended by cloudy weather, and although the temperature fell 10 to 20° in central Colorado and slightly at Salt Lake City, the freezing point was not reached except in localities in northeastern Colorado. A disturbance was developing over the Plateau Region on the 25th and fire-weather warnings were issued for localities in southern New Mexico, Arizona, and Utah. Wind velocities of 40 miles per hour occurred at Modena, 46 miles at El Paso, and over 30 miles in northern Arizona. Warnings of freezing temperature were issued for Colorado and northern and western Utah on the morning of the 27th, and for Colorado, Utah, and eastern New Mexico on the 28th. Freezing temperatures occurred throughout Colorado and generally in Utah. At Denver 24° was recorded.—*Frederick W. Brist, Assistant Forecaster.*

Portland, Oreg., district.—Owing to prevailing high pressure over northern Alaska, LOWS from the Pacific Ocean entered the United States farther south than usual, and no well-developed HIGHS moved from the California coast north to Washington and thence east. Such pressure conditions caused a preponderance of cold, and wet weather in this district. The cold weather was largely due to low afternoon temperatures rather than to cold nights. Warnings for light frost were issued on no less than 12 days for portions of the district and for the most part they were verified; but no damaging frosts occurred in localities where vegetation was far enough advanced to be injured by them.

Storm warnings were ordered at all stations twice, and at the entrances to the Strait of Juan de Fuca, Strait of Georgia, and the Columbia River on two occasions. Two were partly verified and the other two were failures. Those that were failures had been ordered because of threatening conditions which could not be covered after dark by small-craft warnings, and the displays were ordered down early the next morning. Small-craft warn-

ings were ordered on 4 days and they were either partly or fully verified.

A live-stock warning was issued to all stations on April 25 to cover a 3-day period of wet weather, and it was fully verified. Live-stock warnings if issued on the 13th would have been of benefit to stockmen. The bad weather following this date—weather due to the development of stormy conditions over the district instead of to their moving in from the west—was not foreseen sufficiently far enough in advance of its occurrence to enable a warning to be issued. Such developments are generally indicated by the pressure-change map, but in this case it apparently failed to give sufficient information to justify the issuing of a warning.

The whole of April with its low temperatures and wet weather was hard on stock, which, besides being exposed to inclement weather, was underfed in consequence of a shortage of hay and of poor pasturage which made scarcely any growth. At no time during the month was it safe to advise the stockmen that a period of good weather would prevail for more than 36 hours ahead, while ordinarily in April several days of dry sunshiny weather occur when the Pacific HIGHS follow their normal track, and move up the coast from California to Washington, and thence eastward. Stockmen generally kept their herds close to the home feeding grounds for fear they might wander too far in search of feed, and thereby not be able to reach shelter should stormy weather set in.—*E. A. Beals, District Forecaster.*

San Francisco district.—No general storms occurred in this district during April, 1917, and only a few periods of showery weather when the heaviest precipitation was confined to the mountain regions. More than the usual number of frosts occurred, and the one on the morning of the 16th caused some damage to peaches and apricots in portions of the Sacramento valley. Warnings were issued on the morning of the 15th.

Southeast storm warnings were issued for the northern coast on the 13th, but verifying velocities did not occur. Southwest warnings were issued along the southern coast on the 26th, and were verified. The month as a whole was dry and until the last week the temperatures were generally below the normal.—*G. H. Willson, District Forecaster.*