

frosts out promptly to as many truckers as possible, and railroads entering this city assisted by telegraphing the information to all their stations. An immense amount of growing stuff, strawberries, lettuce, etc., was protected, and the observer has been informed that many thousands of dollars were saved as a result of the warnings.

In California no damage by frost was reported, and at the close of the month fruit trees were in better condition than is usual at this season. In the north Pacific coast States the month was unusually cool and heavy frosts were frequent during the last of the month.

The month opened with destructive freshets in the rivers and streams of the Appalachian Mountain system, and during the last few days of the month destructive floods occurred in Mississippi, Alabama, Georgia, Tennessee, and Kentucky.

BOSTON FORECAST DISTRICT.

The weather of the month was unusually warm, with excessive precipitation, mostly in the form of rain, and a number of severe windstorms. Warnings were given of the approach of these storms.—*J. W. Smith, Forecast Official.*

NEW ORLEANS FORECAST DISTRICT.

March was unusually stormy, and warnings for high winds were issued on a number of dates. These warnings were timely, and no windstorms occurred without warnings. The cold waves and frosts of the month were also accurately forecast.—*I. M. Cline, Forecast Official.*

CHICAGO FORECAST DISTRICT.

Advisory messages for severe storms were issued from time to time to steamboat companies at the various ports on Lake Michigan where a winter service is maintained. A cold wave crossed the district from the 13th to the 17th. Warnings were sent well in advance of this cold wave, and were completely verified. In the Northwest the cold wave was accompanied by high winds and snow. Advices for these conditions were sent to railroads and other interests.—*H. J. Cor, Professor.*

DENVER FORECAST DISTRICT.

The feature of the month was the unusual number of storms that developed in this district. For only one, however, the storm of the 14-15th, was it necessary to issue warnings. These warnings were fully justified in Colorado east of the foothills, in western, and the greater part of eastern Wyoming, and practically throughout the area specified west of the mountains.—*F. H. Brandenburg, Forecast Official.*

SAN FRANCISCO FORECAST DISTRICT.

The month was one of unsettled weather, with fairly frequent rain, although the total rainfall for the month was below the average. The month opened with one of the most severe storms experienced for some time in this section. At Point Reyes Light on March 1 a wind velocity of over 100 miles was reported for several hours, with an extreme velocity of 120 miles.

Light and heavy frosts occurred generally in California on the morning of March 4. Ample warning was given and no damage was done to fruit. The month passed without the usual injurious frosts.—*A. G. McAdie, Professor.*

PORTLAND, OREG., FORECAST DISTRICT.

The month was unseasonably cool but not unusually stormy in this district. Sharp frosts occurred frequently in the North Pacific States from the 24th to the 30th, and they were almost without exception accurately forecast.—*E. A. Beals, Forecast Official.*

HAVANA FORECAST DISTRICT.

No general advices were issued during the month. On the 5th the following was telegraphed all regular and display stations in Cuba:

Fresh to brisk and occasionally high southwest wind, shifting to cooler brisk and high northwesterly, this afternoon and to-night over western Cuba, and over eastern Cuba during Thursday.

A daily, except Sunday, wind forecast was furnished the captain of the port of Havana for the information of departing vessel masters.—*W. B. Stockman, Forecast Official.*

AREAS OF HIGH AND LOW PRESSURE.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocity.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.										
I.....	2, p.m.	37	123	8, a.m.	32	65	Miles. 4,625	Days. 5.5	Miles. 841	Miles. 35.0
II.....	3, p.m.	53	108	10, a.m.	47	54	3,725	4.5	828	34.5
III.....	5, p.m.	53	108	10, a.m.	47	54	2,775	4.5	617	25.7
IV.....	7, a.m.	35	120	13, a.m.	32	65	3,600	4.0	900	37.5
V.....	12, p.m.	36	106	17, a.m.	47	54	3,575	4.5	794	33.1
	15, p.m.	54	113	20, a.m.	48	86	2,675	4.5	594	24.8
Suns.....							20,975	27.5	4,574	190.6
Mean of 6 paths.....							3,496		762	31.8
Mean of 27.5 days.....									763	31.8
Low areas.										
I.....	1, p.m.	32	81	5, a.m.	47	54	2,100	3.5	600	25.0
II.....	1, p.m.	35	120	6, a.m.	45	64	4,400	4.5	978	40.8
III.....	5, p.m.	45	123	10, a.m.	45	64	3,750	4.5	833	34.7
IV.....	9, p.m.	37	105	14, a.m.	47	54	3,500	4.5	778	32.4
V.....	12, a.m.	52	122	17, a.m.	48	63	3,950	5.0	790	32.9
VI.....	14, a.m.	51	120	15, a.m.	42	113	700	1.0	700	29.2
VII.....	19, a.m.	37	114	21, p.m.	32	91	1,500	2.5	600	25.0
VIII.....	24, a.m.	37	114	27, p.m.	50	97	1,550	3.5	443	18.4
IX.....	27, a.m.	27	97	30, a.m.	45	67	2,250	3.0	750	31.2
X.....	29, a.m.	32	100	1, a.m.*	48	68	1,975	3.0	658	27.4
Suns.....							25,675	35.0	7,130	297.0
Mean of 10 paths.....							2,568		713	29.7
Mean of 35.0 days.....									731	30.5

*April.

For graphic presentation of the movements of these highs and lows see Charts I and II.—*Geo. E. Hunt, Chief Clerk, Forecast Division.*

RIVERS AND FLOODS.

During the early days of the month the ice in the upper Mississippi River moved out quietly, the dates at the various stations being as follows: At St. Paul, Minn., La Crosse, Wis., and LeClaire, Iowa, on the 9th; at Prairie du Chien, Wis., and Dubuque, Iowa, on the 11th; at Davenport, Iowa, on the 5th; at Keokuk, Iowa, on the 4th, and at Hannibal, Mo., on the 5th.

Navigation, however, was not generally opened as the early movement of the ice had not been anticipated. In the lower Mississippi the stages were much higher, owing to the Ohio River flood of the early days of the month and the torrential rains from the 26th to the 28th, but danger-line stages were not quite reached. The Missouri River, from the mouth of the Platte northward, opened generally from the 5th to the 12th, and the ice passed quietly down the river. For a few days, however, gorges above Yankton, S. Dak., caused conditions to assume a very threatening aspect. Moderate water stages prevailed during the remainder of the month.

In the Ohio River and the rivers of the East and South flood stages were the rule, particularly in the East, where the floods attained proportions such as, with but a single exception, had never before been recorded.

On February 16 the depth of snow over the Ohio and the eastern river valleys ranged from 3 to 10 inches, while over the Allegheny Mountains as far south as North Carolina it was considerably greater. About the 22d of February indications of higher temperatures were such that a general thaw seemed imminent over the entire section, and the following preliminary warning was issued from the Central Office:

Conditions in rivers and mountain streams of Pennsylvania considered critical. Present conditions do not indicate cooler weather, and ice gorges may cause flooding of low-lying lands.

During the 22d the indications of warmer weather and rain became more pronounced, and on the 23d a supplementary warning was sent as follows:

Warmer weather indicated for next two days, with conditions favorable for rain Monday night. These conditions will be most favorable for a general breaking up of ice in the mountain rivers and streams of Pennsylvania, western Maryland, and West Virginia. Notify all interests concerned that danger from flood in low-lying land is imminent.

During the two succeeding days the high temperatures caused the snow to melt with great rapidity, and the water quickly found its way into the streams. A short time after this rain began to fall. It was heavy at times, and continued with but short intervals until nearly the middle of March.

In the Ohio River not much damage was done, although the danger line was exceeded from Parkersburg, W. Va., to the mouth of the Kentucky River. The most critical situations were encountered at Pittsburg and along the Susquehanna, Lehigh, Delaware, and Potomac rivers. At Pittsburg the situation for a whole week was most alarming. Lying between two large mountain rivers, both gorged with ice many feet in thickness, with the temperature rising, and rain frequently falling, it was impossible to foretell when the immense mass of ice would be released by the heat and rush down upon the city. If both rivers opened together, with a heavy rain, there would result a flood beyond all records, with enormous damage by ice and overflow, and very probably loss of life. Very fortunately the ice moved out of the Monongahela River on the 25th without gorging, greatly relieving the situation. That in the Allegheny River held until the 28th, when it also moved out on a rapidly rising river caused by melting snows on the mountains. From 8 a. m. February 28, to 6 p. m. March 1, the river on the Pittsburg gage rose from 13.1 feet to 32.4 feet, 10.4 feet above the danger line. At 8 p. m. the waters began to recede. Beginning with the 22d of February, as before stated, warnings of the coming flood had been given, and they were repeated frequently, with more accurate details until all danger had passed. As had been expected, much damage was done to property that could not be moved; nevertheless, property to the value of millions of dollars was saved by care and removal, and the warnings were highly commended on all sides. The warnings issued on the Ohio River to its mouth, although predicting more moderate floods, also proved of great value to farmers and lumbermen, as indicated by the many letters of commendation and thanks that have been received. A peculiar feature of this flood was the prolonged crest below Parkersburg, W. Va., due to the steady supply of water from the slow melting of the heavy snows of March 4 and 5. The Tennessee River contributed her usual quota to the flood history. Affected by the same general conditions that caused the Ohio and other floods of the East and South, the tributary streams rose rapidly on February 27 and 28, and on the latter date the head waters of the French Broad River were reported higher than ever before known. Warnings were promptly issued. They were repeated on March 1, and again on the 2d, with the information that a stage of between 36 and 38 feet might be expected at Chattanooga, Tenn. Lower Tennessee interests were also notified to this effect. The maximum stage reached was exactly 38 feet on the morning of March 4, being 5 feet above the danger line. The lower river warnings issued from Cairo, Ill., were also in excellent season, and equally accurate.

The maximum stages averaged about 5 feet above the danger lines. The crest of this flood was also long drawn out, owing to the slow melting of the heavy snow of the 4th over the headwaters. At Johnsonville, Tenn., the river continued to rise for nearly ten days after the fall set in at Chattanooga. There was not much damage done below Knoxville, Tenn., but above that place the losses were very heavy. On the Knoxville division of the Southern Railway the damage to roadbed and bridges alone amounted to from \$200,000 to \$250,000.

In the upper Cumberland River the stages ranged from 10 to 15 feet above danger lines, with a maximum stage of 65 feet at Burnside, Ky., being 3 feet above the previous record of 62 feet on March 31, 1886. In the lower river the stages were lower, averaging about 5 feet above the danger lines. The Susquehanna, Lehigh, and Delaware floods were the greatest of this period. As no river service is maintained on the two latter rivers, no detailed report can be given as to the damage. The flood was the greatest for a generation. An inspection over one month afterward of the territory covered afforded unmistakable evidence that the damage must have been most appalling. It is impossible to give any estimate in figures. The railroads lost many millions, and the losses of each individual community along the rivers ranged from thousands almost to millions of dollars. The following is an extract from a report on the Susquehanna flood:

The flood of March 2, 1902, was the fourth in point of magnitude that has occurred in the recorded history of the Susquehanna River. Considered from the standpoint of the amount of damage done to property, it probably stands second, if not first, in importance. The greatest flood on record, that of 1889, occurred on June 2, and consequently there was no ice to add to the damage done by the high water. It is probable that the damage done by the ice which came down on the flood of March 1 and 2 was greater, especially at Harrisburg, Pa., than in any flood during the past hundred years. * * * It is impossible to express in figures the amount of damage done, as the extent of the havoc caused by the high water, ice, and logs is so widespread and affects so many people and industries that it can never be determined. If the value of the property damaged and destroyed by this flood could be stated in dollars, it is probable that the amount would be so enormous as to be almost beyond belief.

The flood in the Potomac did not attain more than moderate proportions below the mouth of the Shenandoah River, and the damage was comparatively slight. The stages, however, were the highest since the famous flood of June 2, 1889. In the vicinity of Washington, D. C., the breaking of the ice by a fleet of steamers prevented a severe flood that must have otherwise resulted from gorges that would have formed at the Long Bridge. Along the upper Potomac, including Harpers Ferry, W. Va., the conditions were much different, and there was great destruction of property, especially of railroad beds and bridges. At Cumberland, Md., no trains arrived from the East for sixty hours, and much of the business portion of the town was inundated. The old Chesapeake and Ohio Canal suffered severely from washouts of its towpath and breaks in its dams. At Harpers Ferry on the evening of March 1 communication in the down town districts was possible only in boats.

The James River flood crested at 19 feet at Richmond, Va., on March 2, 7 feet above the danger line. Its coming had been foretold at the proper time, and no damage resulted that could have been averted. The docks and lower floors of warehouses near the river were flooded, street car service was interrupted and river traffic brought to a standstill. The flood continued until the morning of March 4.

The Roanoke River was above the danger line from February 26 to March 4, inclusive, with a maximum stage of 38.9 feet at Weldon, N. C., on March 1, 8.9 feet above the danger line. Warnings for a 40-foot stage were issued on February 25, a very close approximation of the stage actually reached. Supplementary warnings for the moderate flood in the Cape Fear River were also issued on February 28.

The first warnings for the South Carolina floods were issued

on February 25 for flood stages in the Great Pedee and Wateree rivers, and the danger lines were passed on the following day. There was a slight recession on the 27th, but additional heavy precipitation on the last two days of the month necessitated a supplementary warning on the 28th that a second flood was following close upon the first, and that a further rise might be expected by March 1. Warnings for the lower rivers were issued when necessary, including a well verified general forecast that the high water in the lower Pedee and the Santee rivers would continue until March 15.

The Savannah River flood lasted from March 1 to 3, inclusive, with a maximum stage on the 1st, at Savannah, Ga., of 34.6 feet, 2.6 feet above the danger line. Warnings of a 34-foot stage were issued on February 28. The warnings for the Chattahoochee River were also issued on this day, and the stages ranged from the danger line of 20 feet at Westpoint, Ga., to 16 feet above at Eufaula, Ala.

The first practical flood work of the new Macon, Ga., river district resulted in a saving of about \$125,000 to the various business interests along the Oconee, Ocmulgee, and Altamaha rivers. The first warnings were issued on the evening of February 27, and they were continued almost daily until the flood wave had receded. The warnings were accurate and well timed, and the service has been the subject of much favorable comment from those interested.

The first warnings for the Alabama River district were issued on February 27, and second ones on the 28th for still higher stages. That the warnings had the desired effect is evidenced from the following comment published in the Montgomery, Ala., Advertiser of March 4, 1902:

When it is remembered that the stages were quite low when the local office of the Weather Bureau issued its flood warnings, and that its estimates so well in advance of the flood crest have been so accurately verified, it increases the general confidence in this feature of the Bureau's work, which is of direct interest to various important interests along the rivers. As the milling, live stock, and lumbering interests alone that are affected by the floods in the Coosa and Alabama and tributaries approximate well up in the millions in value, the importance of such timely and well-distributed warnings can be appreciated.

Other press notices were equally commendatory.

The stages in the Tombigbee and Black Warrior rivers were several feet above the danger lines without unusual incident. Warnings were issued on February 28.

On the Pacific coast the crest of the Sacramento River flood reached the city of that name on March 1, with a stage of 28.2 feet, 3.2 feet above the river danger line. A warning of this rise was issued on February 25, and thereafter there was

a rise of about 1 foot a day until the crest was reached. The direct loss to buildings, stock, and movable property was small, as the warnings were timely and widely distributed, but the losses of crops and fruit lands caused by the escape of the waters through broken levees were very large.

There was still another flood over the southern rivers during the closing days of March, continuing into the first few days of April, and general warnings were once again in order. Over the middle portion of the Tennessee River great damage was done. At the Muscle Shoals Canal the loss to the Government works was about \$150,000, and navigation will be suspended until repairs can be made. It is estimated that the total losses in the State of Tennessee by the floods of the month were \$5,235,000, and 25 lives were reported as lost. In the south Atlantic rivers the later floods were not pronounced, but in Alabama and Mississippi they were abnormal, ranging generally from 13 to 20 feet above the danger lines. At Montgomery, Ala., the Alabama River reached a stage of 47.8 feet, 12.8 feet above the danger line, while at Tuscaloosa, Ala., the Black Warrior River reached a stage of 55.6 feet, 20.6 feet above the danger line. The damage resulting from this flood was very heavy, particularly in the central portion of the State of Alabama. Much land was badly washed and the railroads suffered severely. The estimated losses amount to over \$300,000. In eastern and southern Mississippi the destruction, as shown by press despatches, was even greater, though no reliable estimate could be obtained.

On March 10, 1902, the river and flood service of the new Knoxville, Tenn., district was inaugurated with territory comprising the Holston and French Broad rivers and their tributaries. The special river stations of the district are located at Bluff City and Rogersville, Tenn., on the Holston River, and at Marshall, N. C., and Leadvale and Sinking Springs, Tenn., on the French Broad River. In addition to these, rainfall stations are also operated at Elizabethton, Greenville, and Newport, Tenn., and Mendota, Va.

The highest and lowest water, mean stage, and monthly range at 139 river stations are given in Table VII. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are: Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati, and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Forecast Official.*

CLIMATE AND CROP SERVICE.

By JAMES BERRY, Chief of Climate and Crop Service Division.

The following summaries relating to the general weather and crop conditions are furnished by the directors of the respective sections of the Climate and Crop Service of the Weather Bureau:

[Temperature is expressed in degrees Fahrenheit and precipitation in inches and hundredths.]

Alabama.—The mean temperature was 55.1°, or about normal; the highest was 82°, at Bermuda on the 25th, and the lowest, 17°, at Valley Head on the 18th. The average precipitation was 8.76, or 2.54 above normal; the greatest monthly amount, 14.14, occurred at Livingston, and the least, 5.31, at Thomasville.

Excessive rains and damaging floods; farm work very backward; corn land about one-third prepared, very little planted; only slight preparation for cotton.—*F. P. Chaffee.*

Arizona.—The mean temperature was 50.9°, or 4.7° below normal; the highest was 92°, at Parker on the 31st, and the lowest, 8° below zero, at Flagstaff on the 26th. The average precipitation was 0.59, or 0.32 below normal; the greatest monthly amount, 2.72, occurred at Flagstaff, while none fell at Fort Mohave.

The weather was characterized by high, drying winds, abnormally low temperature, and deficient rainfall. The mean temperature as compared

with the preceding three years was low, the deficiency ranging from 3° to 8°. Vegetation was not seriously injured in the lower agricultural valleys, but plant growth was arrested by the adverse conditions. Precipitation in the form of rain or snow was general during the last decade, and there was a marked increase in the water flow in the irrigating streams.—*Wm. G. Burns.*

Arkansas.—The mean temperature was 62.6°, or 1.3° above normal; the highest was 89°, at Texarkana on the 26th, and the lowest, 14°, at Dutton, Pond, Oregon, and Winslow on the 18th. The average precipitation was 5.34, or about normal; the greatest monthly amount, 9.37, occurred at Helena, and the least, 2.35, at La Crosse.

Cold, wet weather during the first half of the month was unfavorable for farming operations and work was greatly retarded; more favorable conditions prevailed during the last half of the month and work was pushed and advanced rapidly; the ground generally was in good condition for plowing and much had been done, though farming operations were generally about two weeks late. No corn or cotton had been planted. Early sown wheat and oats had improved, but the late sown were not doing so well, especially oats, many fields of which will be plowed up and the ground prepared for spring crops. Fruit trees had commenced to bud, and up to the close of the month had suffered no damage.—*Edward B. Richards.*