

were last noted off the New England coast, and the remaining nine over the Gulf of St. Lawrence or Newfoundland. The following high winds were reported on the evening of the 5th. As No. II passed across Ontario it caused a west wind of 64 miles an hour at Buffalo. On the morning of the 7th, as low No. III moved up the middle Atlantic coast, Block Island reported a northeast wind of 60 miles, and that same evening Eastport had northeast 60. On the morning of the 12th, as No. V moved to the upper Lake region, Chicago had 60 southwest. As low No. VI moved into Ontario, Buffalo had southwest 56. As low No. VII moved to the New England coast it caused the highest wind of the month, 72 miles from northwest at New York on the evening of the 19th, and the same station reported previously the same velocity and direction on the evening of the 29th as low No. X approached the Atlantic coast.

RIVERS AND FLOODS.

Nothing of importance in connection with river stages occurred during March, 1899, in that portion of the Mississippi River system north of Cairo. After the ice broke at Dubuque and south of Omaha during the second decade of the month there was a rapid rise in both the Mississippi and Missouri, due to comparatively heavy rains, but no high stages were reached except in the Illinois River. At Peoria the river was above the danger line of 14 feet from the 13th to the 28th, inclusive, reaching a stage of 15.1 feet on the 22d. At Beardstown stages above the danger line of 12 feet occurred during the entire month, with a maximum stage of 15.1 feet on various dates between the 6th and 14th.

East of Cairo the headwaters of the Ohio system rose rapidly from the 3d to the 6th, on account of heavy rains, particularly in West Virginia. At Charleston, W. Va., the Kanawha River rose 30.7 feet from the morning of the 4th to midnight of the 5th, reaching a stage on the latter date of 41.5 feet, 11.5 feet above the danger line, and with one exception the highest recorded stage. The highest previous stage was 46.9 feet, in September, 1861.

At Pittsburg there was a rise of 10 feet during the same time, a stage of 22.0 feet, just the danger line, having been reached. The crest of this rise reached Wheeling, W. Va., on the 7th and Parkersburg on the 8th. At Point Pleasant, W. Va., the rise from the Kanawha hastened the crest stage, and on the 7th there were 47.2 feet of water on the gauge, 8.2 feet above the danger line.

The necessary warnings were issued from Parkersburg on the 4th and 5th for the rises at Charleston and Point Pleasant. Commendatory notices of these warnings were received later, and the following extracts are taken from the special report of Mr. J. W. Crider, River Observer at Charleston, W. Va.:

This flood came upon us more suddenly than any previous one within my recollection. From a stage of 10.8 feet on the 4th, the river rose to 41.5 feet by midnight of the 5th. Special warnings from Hinton, W. Va., and information obtained by telephone from the United States Engineers as far above as Kanawha Falls prepared the people of this city, and by night of the 4th nearly all in the flooded district had removed to places of safety. On the morning of the 5th, when the gauge stood at 36.7 feet, I posted a notice that the river would continue to rise until it reached 41.3 feet. It did reach this stage, and exceeded it by 0.2 foot at midnight. Beyond the inconvenience and loss of time suffered by business interests, the damage was trifling. The fact that great loss did not occur can only be attributed to the timely warnings issued by the Weather Bureau. The smaller towns along the river did not fare so well. At Winifrede the dry docks and ten barges were swept away, and several coal tipples at other points were taken.

This rise also reached Catlettsburg, Ky., on the 7th, with a stage of 56.3 feet, 6.3 feet above the danger line, and Portsmouth, Ohio, with a stage of 55.8 feet, 5.8 feet above the dan-

ger line. Damage to the amount of \$1,000 was caused by the flood at the latter place. The Licking River was also in flood, reaching 27.7 feet at Falmouth, Ky., on the 5th, 2.7 feet above the danger line. The following history of this flood was furnished by Mr. S. S. Bassler, Official in Charge of the United States Weather Bureau Office at Cincinnati:

On Saturday, the 4th instant, the reports showed a tremendous rise in the Great Kanawha and other mountain streams, and the announcement was at once published and otherwise disseminated, that the storm then in progress was materially changing the river situation and that during Sunday and Monday the river would rise rapidly here with prospects of more water than we have had this winter.

On Sunday morning (5th) warning was issued that the river would exceed the danger line (50 feet) by Monday morning, equivalent to a rise of 6 feet. Railroad officials and merchants in the bottoms were notified as far as possible and all took prompt action. The danger line warning was telegraphed to Portsmouth, Ohio, and Catlettsburg, Ky., and warning sent to Louisville, Ky. Residents along the river bottoms were warned, through the police department, of a 50-foot stage by morning, and continued rising waters. By request I telegraphed the situation to the editor Daily Blade, Portsmouth, Ohio, giving him warning of stages above danger line from Point Pleasant down. Although it was Sunday the telephone was in constant use, and merchants first affected by the rising water were busy removing goods out of the cellars.

On Monday morning, March 6, the stage here was 50.3 feet and at Catlettsburg and Portsmouth it had passed the danger line. The forecast was issued as early as possible that the stage would reach 56 feet by Tuesday morning. Flood warnings were telegraphed to the mayors of Higginsport and Ripley, Ohio, Lawrenceburg and Vevay, Ind., and to the wharfmaster at Maysville, Ky. Long distance telephone and telegraphic communication was held with various points from Portsmouth, Ohio, to Lawrenceburg, Ind.

On Tuesday morning, March 7, the stage was 55.1 feet, the high winds and cold wave of Monday night undoubtedly preventing the forecast stage. Tuesday morning's forecast stated that the river would come to a stand by Wednesday morning and would not exceed 58 feet. This announcement from the Weather Bureau was a relief, and merchants whose property was not in danger at 58 feet refrained from incurring the expense of removing it.

On Wednesday morning, March 8, the river at Cincinnati was apparently on the stand at 57.2 feet and the forecast for the day was that the river was practically stationary and would remain so for several hours, possibly rising a tenth or two more, and then begin falling.

To save apparently unnecessary expense to the public the forecast limit of 58 feet was changed to 57.5 feet.

The observers at Louisville, Ky., and Cairo, Ill., were notified by telegraph, and the mayor of Lawrenceburg, Ind., by long distance telephone, of the river conditions here. Between 7 and 8 a. m. the stage rose to 57.3, where it remained until noon, when it fluctuated slightly until 4 p. m., when it had risen to 57.4 feet and there remained until 9 p. m., when it began slowly falling.

The singular fluctuation as recorded by the gauge a part of the day is believed to have been caused by the strong variable winds then prevailing.

The water at Cincinnati remained above the danger line (50 feet) from 6 a. m. of the 6th to 2 p. m. of the 11th.

By reason of the timely warnings, admitted on all sides, and the general readiness for the approach of high water, the loss here was unusually slight. The heaviest loss was to railroad and steamboat interests, and to the latter through inability to pass under the bridges, thereby losing trips.

At Catlettsburg the highest stage (56.3 feet) occurred at 4 a. m. of the 7th, when it was stationary for twelve and one half hours.

At Portsmouth the highest stage (55.8 feet) occurred at 6 a. m. of the 7th, when it was stationary for ten hours.

At Maysville the highest stage (54.1 feet) occurred during the afternoon of the 7th, when it was stationary about six hours.

At Cincinnati the highest stage (57.4 feet) occurred at 2 p. m. of the 8th, when it was stationary seven hours.

The crest reached Louisville on the 10th, with a stage of 52.8 feet, 4.8 feet above the danger line. At Evansville the danger line of 35 feet was reached on the 4th, and the crest stage of 42.7 feet on the 12th. Lowlands above and below the city were flooded, but the only annoying feature was the temporary inconvenience.

The Wabash River also contributed its full share to the general flood, reaching a stage of 18.6 feet at Mount Carmel, Ill., on the 7th, or 3.6 feet above the danger line, and remaining above this point until the 12th.

The flood also extended in a lesser degree to the Tennessee River and tributaries. At Clinton, Tenn., the Clinch River

was 1 foot above the danger line of 25 feet on the 7th of the month. The crest of the rise reached Chattanooga on the 8th, with a stage of 27.6 feet; Florence, Ala., on the 11th, with a stage of 15.1 feet; and Johnsonville, Tenn., on the 13th, with a stage of 24.5 feet, 3.5 feet above the danger line. At this latter place the river was above the danger line during the entire month.

The Cumberland River also made a considerable contribution to the volume of water in the Ohio. A stage of 56.5 feet, 6.5 feet above the danger line, was reached at Burnside, Ky., on the 5th; 39.0 feet, 9.0 feet above danger line, at Carthage, Tenn., on the 10th, and 39.0 feet, 1.0 foot below danger line, at Nashville on the 11th.

At Paducah, Ky., the Ohio passed the danger line of 40 feet on the 10th, but the full effect of the lower tributaries was not felt until the 15th, when a stage of 42.8 feet was recorded.

At Cairo the Ohio rose steadily during the entire month, but the crest of the rise from the upper river evidently passed on the 11th and 12th.

Another wave of much less intensity passed down the Ohio during the second decade of the month, reaching Pittsburg on the 21st, and Evansville on the 27th. This wave also extended in a much more pronounced form to the Tennessee and Cumberland rivers, and thereby prolonged the rise in the Lower Ohio until it was overtaken by the third rise of the month from the upper river, which was caused by the rains of the 28th and 29th. This latter rise began at Pittsburg on the 28th, and at Wheeling, Parkersburg, and Point Pleasant on the 29th. Owing to the increment received from the Kanawha, the rise at the latter place was more pronounced, and a stage of 40.5 feet, 1.5 foot above the danger line, was recorded. Below Point Pleasant the rise was still in progress at the close of the month.

The second rise shortly after the middle of the month caused a flood of somewhat alarming proportions in the Tennessee River, and very high stages were general. At Florence, Ala., the highest stage was 25.2 feet, 9.2 feet above danger line, and at Johnsonville, Tenn., 39.7 feet, 18.7 feet above danger line.

The following extracts relative to this flood were obtained from the special report of Mr. L. M. Pindell, Official in Charge, U. S. Weather Bureau Office, Chattanooga, Tenn.

As the month of March opened with a rising river, following closely upon the high water of February, river men feared a succession of rises during March, and it must be admitted that their fears materialized to a marked degree. During the 14th and 15th heavy rains, averaging 3 or 4 inches, fell over the entire Tennessee watershed, causing washouts and landslides on nearly all the railroads, flooding their yards, and washing away tracks and trestles. During the twenty-four hours ending at 8 p. m., March 15, the Hiwassee River rose 18.5 feet, the greatest twenty-four hour rise on record. At Chattanooga the river rose 10.9 feet, and a stage of 36 to 38 feet was forecast to occur by the night of the 16th. The surface water filled up all depressions and caused considerable trouble to the local transportation companies by flooding their tracks. Flood warnings were sent to all persons interested between Decatur, Ala., and Cairo, Ill., on the 16th. Special observations were called for and special bulletins issued. Information was also telephoned to all railroads and factories in the lowlands and flooded districts. The river began to fall on the night of the 17th, but on the 18th from 2 to 4 inches of rain again fell over the system, and a rapid rise once more set in over both the headwaters and the main stream. There was a repetition of the washouts, etc., of a few days previous, and damage amounting to \$15,000 was done to county bridges and roads alone.

On the 19th the following forecast was prepared and issued:

"Crest rise of 28 to 30 feet for Kingston, Tenn., in thirty-six hours; about a 30-foot stage at Bridgeport, Ala.; a 25-foot stage at Knoxville, Tenn., by night of 20th, and between 40 and 42 feet for Chattanooga by the night of the 21st."

Flood warnings were also sent to all interested parties as far as Cairo, and given the widest possible distribution. On the morning of the 20th Knoxville reported a rise of 10 feet, reaching 27.4. This indicated that the river at Chattanooga would reach 42 feet by the morning of the 22d. The forecast was prepared accordingly, and all persons interested were notified to move their goods. Persons moved out of their

houses on the 20th, but only when assured that the river would surely reach the 40-foot mark. All merchants and factories having goods under the 40-foot mark, moved them at once on advice from this office, and held goods at the 41-foot mark for further advice. Reports on the 21st indicated that the water would not rise above 40.5 feet, and information to this effect was received by the public with profound expressions of relief. Only on three days was the river free from driftwood, which for about two-thirds of the time, from the 1st to the 20th, was sufficiently heavy to impede navigation.

As far as can be ascertained the amount of property saved by removal as a result of the warnings given, was something over \$200,000, while the total amount of damage was not more than \$100.

Many communications testifying to the uniform timeliness, accuracy, and great value of the flood warnings were received, but lack of space forbids their reproduction here. The measure of success is dollars and cents, and the figures above given speak for themselves with convincing eloquence.

Stages above danger lines also occurred generally at this time in the Cumberland River, except at Nashville, but no damage resulted from the rise as far as can be learned.

From Cairo to New Orleans there was practically no interruption to the slow and steady advance of the waters, and the rise still continued at the end of the month. Danger lines were passed as follows: At Cairo on the 16th; Memphis on the 16th; Helena, Ark., on the 15th; Arkansas City, Ark., on the 16th, and Greenville, Miss., on the 30th. Below Greenville danger stages were not quite reached, but were indicated at the opening of April.

The Atchafalaya River remained high during the entire month, with a maximum stage of 32.2 feet, 1.2 feet above danger line, on the last day of the month.

The rivers of the Atlantic system remained comparatively quiet in the north, but were not so tractable in the south. From the operation of the same causes which produced the first flood in the Ohio system, the James River was also in flood on the 5th and 6th. A stage of 19 feet, 1 foot above the danger line, was reached at Lynchburg on the 5th, and a stage of 20.5 feet, 8.5 feet above the danger line, at Richmond on the 7th. The following account of the flood at the latter place is from the pen of Mr. E. A. Evans, Official in Charge, United States Weather Bureau Office, Richmond, Va.:

Showery weather had prevailed over the James River watershed on the night of the 3d and the day and night of the 4th, during which considerable rain was deposited, especially in the valley and Piedmont portions of the basin. The occurrence of these rains was well covered by the weather forecasts of the respective dates, and rising water was looked for by this office. The first telegram indicating that the precipitation was getting into the stream came from Buchanan at 9:55 a. m. of the 4th. The day, however, passed without further reports, but thunderstorms occurred on the night of the 4th, and on the morning of the 5th flood water was present in the upper courses of the river.

At 10:30 a. m., in consequence of information received from the special river stations at Columbia and Buchanan and from the official in charge at Lynchburg, a flood warning was issued and notification of same sent your office, as follows:

"Flood warnings issued for authorized points and locally. Twelve-foot stage indicated by 8 p. m. and higher later."

From this hour until the middle of the afternoon the office force was on duty, and as fast as information of the continued rising of the waters was received from Columbia, it was immediately sent out by telephone.

Along the wharves and the lower business streets every one was busy in preparation for the expected flood. In the warehouses large gangs of men were removing goods to upper stories and at the docks everything was being placed beyond reach of the water.

At 6:10 p. m. the last message from Columbia was received giving the gauge reading then as 29 feet, river rising. The height expected at Richmond had been increased to meet the continued rising at upper points, and when this message was received it was placed at 19 feet.

Telephone messages conveying this information were at once sent to all local interests, and later to the police station in the threatened district for distribution by policemen. This proved to be an excellent measure, and by its means many persons were warned who could not otherwise have been reached.

During the day personal inspection of the conditions along the river front were made by the official in charge and special readings of the gauge were made at 1 p. m., 7:2 feet, and 8:05 p. m., 11.0 feet.

Throughout the night the water rose slowly, but steadily, and on the morning of the 6th its height, as indicated by the Bureau gauge at the observation hour was 14.5 feet. At this hour the floors of the lower

or dock warehouses of all the water transportation companies were under water to a depth of several feet, and the river had risen into Main street between Richmond and Fulton (suburb) causing a cessation of street car traffic. It had also backed into some of the sewers, resulting in the flooding of cellars in a large part of the district lying between Fifteenth and Eighteenth streets.

Continued rising prevailed during the day. Special gauge readings were taken at 11:25 a. m., 15.9 feet; 2:45 p. m., 17.5 feet; 3:25 p. m., 17.8 feet; 5:20 p. m., 18.3 feet; and at 8:40 p. m., 19.6 feet.

Late in the afternoon the water had advanced into the city half way between Cary and Main streets, covering an area of about eight blocks, and was still rising. Cellars of stores and residence houses were full of water to the floors. Small boats were used for carrying people, and a general removal of goods and furniture to upper stories was going on in the inundated district and adjoining threatened streets. Throughout the rest of the afternoon and the night the river continued to rise, advancing into Main street and the old market, driving out the market-men, hucksters, and butchers and cutting off a considerable area of the lower city from street car communication by the Main street line, thus breaking their route at two separate points.

The maximum height of the water was attained at 12:10 p. m. of the 7th, after which it remained stationary a short while, beginning to recede at 2:25 p. m., when a special reading gave 19.7 feet. At this time the water was 2 feet deep on Main street near 17th street. The plant of the Trigg Shipbuilding Company, working on Government contracts for torpedo boats and destroyers, that of the Richmond Ice Company and Davenport and Morris Company, together with much city trackage of the Chesapeake and Ohio and Southern Railways were submerged to a depth of several feet. The city gas works was also in about 2 feet of water and had to suspend operations.

Altogether, all that portion of the city subject to overflow during high water was thoroughly inundated, and only timely warning, coupled with the slow rise of the river, prevented greater damage.

The records of this office, except during the recent ice gorge, do not show an equal volume of water, or such high gauge readings, since the Bureau gauge was erected.

The flood, however, is popularly said to be the greatest since 1889, which it about equals.

The quantity of water carried by the stream was certainly immense, as notwithstanding the fact that the channel was entirely free and unobstructed, water covered the banks over a major portion of the basin, and reached a height nearly equaling that recorded at the most critical period of the ice jam of February 18 last. Many outside points along the river were cut off from communication both by telegraph and rail, and the James River division of the Chesapeake and Ohio Railway suffered much damage from washouts.

The methods taken to warn our local interests were prompt and effective. The first telegram on Sunday morning came from Columbia, and was received at 8:47 a. m. Within fifteen minutes after its receipt it had been sent by telephone to all addresses on our flood warning list. The day being Sunday, it was somewhat difficult to reach several parties, but they all received it in ample time to make necessary preparations, so that, although the flood was of unusual magnitude, there was no instance of loss or damage, except minor or unavoidable casualties.

A noteworthy feature of the flood was the slowness with which its crest moved down. It is almost invariably the case that from ten to eighteen hours elapse between the highest reading at Columbia and at Richmond. In this instance it was considerably more. The only rational explanation apparent is that the flooding of the adjacent lowlands all along the river retarded the forward movement of the crest, or in other words its energy was expended in spreading out rather than moving forward.

If this reasoning be correct, it will have an important bearing in estimating the rate of flood travel and maximum gauge readings in future similar floods. The gauge readings here, as compared with the forecast of "a 12-foot stage at 8 p. m. and higher later," were: 8:05 p. m., 11.0 feet. The last warning, which was sent out at about this hour, forecasted a 19-foot stage for a maximum, and the maximum reached was 20.1 feet, or 1 foot difference in each case. Had full, reliable data for a similar flood been available, it is thought a still closer forecast could have been made.

The weather forecasts issued from your office prior to and during the flood were fully verified.

A minor flood occurred on the 20th and 21st, but it was well anticipated and passed off without damage of consequence.

The rivers of the Carolinas were high at various times during the month, corresponding to the dates of the floods in the Tennessee River. The necessary flood warnings were issued in ample time and were fully justified by the recorded stages of water. The following extract relative to the floods in South Carolina is taken from the report of Mr. L. N. Jesun-

ofsky, Official in Charge, United States Weather Bureau Office, Charleston, S. C.:

The volume of water which passed seaward during February was, on the whole, almost as great as the entire flow which passed by during the past two winters. The streams were generally above the danger points for greater periods than during any one month since the establishment of the river service in 1891. The flood waters kept the bottom lands well submerged, retarding spring plowing. But few casualties are reported other than the drowning of some cattle in the swamps. River men state that the freshets in February were the highest since the great "Sherman freshet," in January, 1865. There was a high freshet in 1867, but not equal to that of February, 1899. The flooding of the swamp lands enabled the lumber men to float the large collections of timber of the past three years. The lumber mills are running on full time and laying in large supplies.

Perhaps the greatest loss and inconvenience occasioned by the floods fall upon the rice planters on the lower streams, in the tide-water sections, where the freshet and tides have elevated the stream flow to such a height as to prevent the proper drainage of lands for plowing, thus retarding operations for over four weeks.

There was a great increase in traffic. Steamers made continuous trips on the Santee, Wateree, the Upper Pedee, and Little Pedee rivers. Drift was running heavily at Camden on the 6th, 7th, 17th, and 27th; at Cheraw and Columbia on the 6th and 7th, and light drift at Camden on the 8th and 18th.

The floods in the Alabama rivers passed off without reaching excessively high stages, and with little damage or inconvenience. The forecasts and warnings were timely and accurate, and were well heeded by those interested.

The rivers of the Pacific coast were quite high at times during the month, but no danger stages were recorded except at Eugene and Albany, Oreg., on the Willamette River. At the former place the river rose to 6.4 feet above the danger line of 10 feet on the 1st, and to 3.0 feet above the danger line of 20 feet at the latter on the 3d. The Sacramento River at Sacramento rose steadily during the month, and on the last day was within 0.9 foot of the danger line of 25 feet.

ICE IN RIVERS AND HARBORS.

Ice conditions changed materially after the close of February. The Mississippi remained frozen north of Dubuque during the entire month. At Dubuque it began to break up on the 11th, and by the end of the month the river was clear of ice below the bridge. It still held above, however.

The ice broke at LeClaire on the 13th; at Davenport on the 12th; at Muscatine, Iowa, on the 11th; at Keokuk on the 10th, and at Hannibal on the 2d. No floating ice was reported south of Keokuk after the 20th. At Cairo the last ice passed down the Mississippi on the 2d.

The Missouri was opened at Omaha by dynamite on the 25th, but the ice still held above the bridge. At Plattsmouth, Nebr., it broke away on the 10th, and moved out without causing any damage. There was floating ice at Kansas City until the 14th, but none after the 10th at Hermann, Mo.

The Des Moines River opened at Des Moines on the 11th. There were some attempts at navigation as far north as Davenport. The ferryboat at that place resumed trips on the 19th, and the first boat passed down through the draw on the 24th.

In the Hudson the gorges began to give way on the 14th; the first boat from below reached Albany on the 16th; floating ice until the 24th, and the first through boat from New York did not arrive until the 29th.

In the rivers of Pennsylvania there was practically no ice after the first week of the month.

The thickness of the ice in the various rivers for each week since December 5, 1898, is given in the following table. It will be noticed that there has been a marked decrease in the quantity since February 27, except in Minnesota and North Dakota. In the northern portions of these States there were from one to two inches more than at the close of February, south of La Crosse and Sioux City the ice has disappeared.

In the rivers of southern New England there was a loss of from 12 to 16 inches in the thickness of the ice.

Thickness of ice in rivers (in inches), winter of 1898-99.

Stations.	December.				January.					February.				March.			
	5.	12.	19.	30.	2.	9.	16.	23.	30.	6.	13.	20.	27.	6.	13.	20.	27.
Moorhead, Minn	13.5	15.0	18.0	20.0	24.0	26.0	26.0	26.0	28.0	32.0	33.0	43.0	42.0	42.0	42.0	44.0	44.0
St. Paul, Minn	10.0	14.0	16.0	18.0	22.0	23.5	22.5	22.5	24.5	28.0	30.0	25.0	23.0	30.0	30.0	30.0	24.0
La Crosse, Wis	6.5	*	13.0	14.0	15.0	20.0	22.0	19.0	26.0	27.0	32.0	22.0	20.0	16.0	20.0	19.0	12.0
Dubuque, Iowa	8.0	10.0	11.0	10.0	14.0	15.0	13.0	10.0	18.0	21.0	27.5	22.0	18.0	20.0	.....	.....	.....
Davenport, Iowa	.....	1.0	11.0	11.0	12.5	14.0	13.0	12.0	14.0	14.5	21.5	21.5	21.0	20.0	.....	.....	.....
Keokuk, Iowa	.....	7.0	8.5	10.0	14.0	18.0	12.0	11.0	13.0	15.0	26.0	15.0	10.0	10.0	.....	.....	.....
Hannibal, Mo	.....	7.0	9.0	6.0	*	11.0	.....	.....	5.0	11.0	16.0	10.0	9.0	.....	.....	.....	.....
Williston, N. Dak	12.0	12.0	12.0	12.0	16.0	18.0	20.0	20.0	21.0	32.0	32.0	32.0	32.0	30.0	30.0	30.0	30.0
Bismarck, N. Dak	10.0	16.0	18.0	18.0	20.0	20.0	24.0	24.0	*	27.0	34.0	30.0	30.0	30.0	20.0	20.0	24.0
Pierre, S. Dak	11.0	14.0	14.5	15.0	17.0	19.5	19.0	17.5	20.0	23.0	25.0	18.0	14.0	15.0	9.0	9.0	10.0
Yankton, S. Dak	8.0	11.5	15.5	15.5	16.0	16.0	16.0	16.0	18.5	21.5	26.0	25.0	25.0	24.0	20.5	17.0	14.5
Sioux City, Iowa	8.5	12.0	12.0	11.0	15.0	16.5	17.5	16.5	18.0	21.0	24.0	17.0	19.0	18.5	13.0	14.0	12.0
Omaha, Nebr	6.0	8.0	10.0	10.0	*	12.0	*	6.0	10.0	14.0	22.0	20.0	20.0	18.0	14.5	12.0	.....
Topeka, Kans	.....	2.5	3.0	2.5	4.0	.....	.....	.....	3.5	11.0	15.0	4.0	6.0	.....	.....	.....	.....
Kansas City, Mo	.....	.....	.....	.....	.....	.....	.....	.....	3.0	8.0	13.0	.....	.....	.....	.....	.....	.....
Wichita, Kans	.....	3.0	.....	.....	.....	.....	.....	.....	4.0	.....	.....	.....	.....	.....	.....	.....	.....
Pittsburg, Pa	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.4	.....	.....	.....	.....	.....	.....	.....
Parkersburg, W. Va	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.0	.....	.....	.....	.....	.....	.....	.....
Columbus, Ohio	.....	8.0	8.0	5.0	0.5	2.5	.....	.....	4.0	6.0	8.0	6.0	.....	.....	.....	.....	.....
Memphis, Tenn	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.5	1.0	.....	.....	.....	.....	.....	.....
Fort Smith, Ark	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.0	.....	.....	.....	.....	.....	.....	.....
Little Rock, Ark	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.0	.....	.....	.....	.....	.....	.....	.....
New Orleans, La	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.0	.....	.....	.....	.....	.....	.....	.....
Brattleboro, Vt	2.0	2.5	6.5	*	8.0	10.0	9.0	11.0	13.0	17.0	18.5	18.0	17.5	14.0	15.0	*	1.5
Concord, Mass	2.0	3.0	*	*	11.0	*	*	12.0	15.0	16.0	*	22.0	17.0	10.0	7.0	7.0	6.0
Albany, N. Y.	.....	.....	5.0	3.0	6.5	1.0	6.0	8.0	10.0	9.5	11.0	9.0	8.5	.....	.....	.....	.....
New Brunswick, N. J.	.....	.....	.....	.....	1.5	.....	.....	.....	.....	5.0	8.0	13.0	.....	.....	.....	.....	.....
Harrisburg, Pa	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.0	12.0	.....	.....	.....	.....	.....	.....
Lynchburg, Va	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.0	.....	.....	.....	.....	.....	.....	.....
Richmond, Va	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.0	2.0	.....	.....	.....	.....	.....	.....
Columbia, S. C	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.0	.....	.....	.....	.....	.....	.....	.....

* Missing.

The highest and lowest water, mean stage, and monthly range at 130 river stations are given in the accompanying table. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are: St. Louis, Cairo, Memphis, and Vicksburg, on the Mississippi; Cincinnati, 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.

Heights of rivers referred to zeros of gauges, March, 1899.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Mississippi River.</i>	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
St. Paul, Minn	1,957	14	Frozen					
Reads Landing, Minn	1,887	12	— 0.1	1-4, 12, 13	— 0.5	18-30	— 0.3	0.4
La Crosse, Wis	1,823	12	Frozen					
North McGregor, Iowa	1,762	18	7.6	10, 17	3.1	10	4.7	4.5
Dubuque, Iowa	1,702	15	8.0	14, 15	3.2	31	6.1	4.8
Leclaire, Iowa	1,612	10	4.0	14, 15, 19, 30	1.0	30, 31	2.9	3.0
Davenport, Iowa	1,596	15	6.8	20	2.5	31	4.8	4.3
Muscatine, Iowa	1,565	16	8.0	21	3.4	31	5.3	4.6
Galland, Iowa	1,475	8	4.8	19, 22	1.9	31	3.3	2.9
Keokuk, Iowa	1,466	14	8.5	19	3.0	30	5.8	5.5
Hannibal, Mo.	1,405	17	10.4	20	3.2	8, 9	6.5	7.2
Grafton, Ill	1,307	23	14.5	21, 22	8.0	3	10.6	6.5
St. Louis, Mo	1,264	30	19.8	22, 23	10.7	9, 10	14.5	9.1
Chester, Ill.	1,189	36	15.6	22, 23	8.1	10, 11	11.3	7.5
Memphis, Tenn	843	33	35.3	30, 31	22.0	1	23.1	13.3
Helena, Ark	767	42	45.5	31	28.8	1	40.9	16.7
Arkansas City, Ark	695	42	46.5	31	29.7	1	40.8	16.8
Greenville, Miss	595	42	40.1	30	24.8	1	34.5	15.3
Vicksburg, Miss	474	45	44.8	31	29.8	2	38.8	15.0
New Orleans, La	108	16	15.5	30, 31	11.2	7	13.7	4.3
<i>Missouri River.</i>								
Bismarck, N. Dak	1,301	14	10.9	22	4.6	1	7.9	6.8
Pierre, S. Dak	1,006	14	Frozen					
Sioux City, Iowa	676	19	Frozen					
Omaha, Nebr	561	18	*					
Plattsmouth, Nebr	533	17	6.7	14	4.0	27	5.3	2.7
St. Joseph, Mo	373	20	3.3	31	0.8	10	2.1	2.5
Kansas City, Mo	280	21	10.7	15	6.0	6	8.3	4.7
Boonville, Mo	191	20	11.9	19	6.8	6, 30	8.7	5.1
Hermann, Mo	95	24	12.9	20	7.2	29, 30	9.4	5.7
<i>Des Moines River.</i>								
Des Moines, Iowa	150	19	4.1	18	3.1	11, 12	3.7	1.0
<i>Illinois River.</i>								
Peoria, Ill	135	14	15.1	22	11.4	1	14.1	3.7
Beardstown, Ill	70	12	15.1	6, 10-14	12.8	1	14.7	2.3
<i>Osage River.</i>								
Bagnell, Mo	70	28	14.0	1	3.8	29	7.1	10.2
<i>Gasconade River.</i>								
Arlington, Mo	58	16	8.0	1	— 0.3	16, 17	0.7	3.8
<i>Youghiogheny River.</i>								
Confluence, Pa	59	10	8.5	5, 29	3.4	18	5.0	5.1
West Newton, Pa	15	23	11.5	29	2.6	18	4.7	8.9

Heights of rivers referred to zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Allegheny River.</i>	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
Warren, Pa	177	7	6.5	6	2.3	12, 13	3.7	4.2
Oil City, Pa	123	13	7.2	6	2.5	13	4.1	4.7
Parkers Landing, Pa	73	20	3.8	6	3.4	12	5.3	6.4
<i>Monongahela River.</i>								
Weston, W. Va	161	18	13.0	5	0.0	15-18	1.7	13.0
Fairmont, W. Va	119	25	16.0	29	1.7	18	5.2	14.3
Greensboro, Pa	81	18	22.0	6	8.5	18	11.2	13.5
Lock No. 4, Pa	40	28	25.9	6	8.9	18, 19	13.3	18.0
<i>Conenough River.</i>								
Johnstown, Pa	64	7	5.6	6	2.4	27	3.3	3.2
<i>Red Bank Creek.</i>								
Brookville, Pa	35	8	2.8	5	1.0	10-18	1.4	1.8
<i>Beaver River.</i>								
Ellwood Junction, Pa	10	14	3.3	5	1.4	17-19	2.0	1.9
<i>Great Kanawha River.</i>								
Charleston, W. Va	61	30	41.5	6	7.0	15, 16	13.6	34.5
<i>New River.</i>								
Hinton, W. Va	95	14	13.8	5	3.9	14, 15, 28	6.0	9.9
<i>Cheat River.</i>								
Rowlesburg, W. Va	36	14	10.0	5	3.5	19-15 (25-28)	4.3	6.5
<i>Ohio River.</i>								
Pittsburg, Pa	966	22	22.0	6	6.6	16-19	10.8	15.4
Davis Island Dam, Pa	960	25	17.9	30	8.2	17	11.4	9.7
Wheeling, W. Va	875	36	38.2	7	9.7	17	15.9	18.5
Parkersburg, W. Va	735	36	28.0	7	10.7	18	19.0	17.3
Point Pleasant, W. Va	703	39	47.2	7	15.5	17	27.8	31.7
Catlettsburg, Ky	651	50	56.3	7	20.0	17	34.6	36.3
Portsmouth, Ohio	612	50	55.8	7	21.2	17, 18	36.0	34.6
Cincinnati, Ohio	499	50	57.4	8	24.2	15	40.1	33.2
Louisville, Ky	367	28	32.8	10	9.9	16	18.6	22.9
Evansville, Ind	184	35	42.7	12	31.7	21	36.8	11.0
Paducah, Ky	47	40	43.6	31	33.4	1	40.7	10.2
Cairo, Ill								

Heights of rivers referred to zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Cumberland River—Con.	Miles. 257	Feet. 30	Feet. 39.0	10	Feet. 9.7	14	Feet. 26.3	29.3
Carthage, Tenn.	175	40	39.0	11	21.0	16	31.3	18.0
Nashville, Tenn.								
Arkansas River.								
Wichita, Kans.	730	10						
Webbers Falls, Ind. Ter.		23	9.5	1	3.0	31	4.6	6.5
Fort Smith, Ark.	345	22	11.5	1	4.1	14	6.0	7.4
Dardanelle, Ark.	250	21	11.0	2	3.4	17	6.0	7.6
Little Rock, Ark.	170	23	12.2	4	4.9	17, 18	7.9	7.3
White River.								
Newport, Ark.	150	26	16.8	1	9.4	17	12.9	7.4
Yazoo River.								
Yazoo City, Miss.	80	25	25.2	31	17.1	3-5	21.2	8.1
Red River.								
Arthur City, Tex.	688	27	6.1	22	4.3	7	4.7	1.8
Fulton, Ark.	565	28	9.3	4	3.8	18-20	5.5	5.5
Shreveport, La.	449	29	6.7	7	3.1	23, 24, 27, 31	4.3	3.6
Alexandria, La.	139	33	12.3	20	6.2	7, 14	8.5	6.1
Ouachita River.								
Camden, Ark.	340	39	18.6	2	7.3	30	11.3	11.3
Monroe, La.	100	40	29.2	24, 25	23.4	13	26.4	5.8
Atchafalaya Bayou.								
Melville, La.	100+	31	33.2	31	27.7	5, 6	30.1	4.5
Susquehanna River.								
Wilkesbarre, Pa.	178	14	14.0	6	4.7	31	8.7	9.3
Harrisburg, Pa.	70	17	13.0	7	5.8	12, 13	7.9	7.2
W. Br. of Susquehanna.								
Williamsport, Pa.	35	30	18.1	6	5.4	11	7.5	7.7
Juniata River.								
Huntingdon, Pa.	80	24						
Potomac River.								
Harpers Ferry, W. Va.	170	16	15.5	6	3.7	27	6.6	11.8
James River.								
Lynchburg, Va.	257	18	19.0	5	2.6	28	5.1	16.4
Richmond, Va.	110	12	20.5	7	1.9	29, 29	5.7	18.6
Roanoke River.								
Clarksville, Va.	155	12	17.0	21	3.6	14	7.1	13.4
Weldon, N. C.	90	27						
Cape Fear River.								
Fayetteville, N. C.	100	38	42.0	17	8.7	14	22.1	33.3
Lumber River.								
Fairbluff, N. C.	10	6	6.8	8.9	5.1	24-26	5.9	1.7
Edisto River.								
Edisto, S. C.	75	6	5.7	7	4.7	19	5.2	1.0
Pedee River.								
Cheraw, S. C.	145	27	32.7	22	7.0	14	19.7	25.7

Heights of rivers referred to zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Black River.	Miles. 60	Feet. 12	Feet. 10.0	1	Feet. 6.5	23-29	Feet. 7.1	Feet. 3.5
Kingstree, S. C.								
Lynch Creek.								
Effingham, S. C.	35	12	15.9	4	8.1	20	10.6	7.8
Santee River.								
St. Stephens, S. C.	50	12	12.2	8, 28	8.3	19	10.1	3.9
Congaree River.								
Columbia, S. C.	37	15	14.0	1	1.8	13, 14	8.3	12.2
Waterlee River.								
Camden, S. C.	45	24	28.5	21	7.4	14	18.2	21.1
Waccamaw River.								
Conway, S. C.	40	7	8.6	1-3	4.8	26, 27	6.7	3.8
Savannah River.								
Calhoun Falls, S. C.			13.6		16		3.9	12
Augusta, Ga.	130	32	28.5	1	11.0	15	16.0	17.5
Broad River.								
Carlton, Ga.			18.3		16		3.3	11-13
Flint River.								
Albany, Ga.	80	20	15.9	4, 5	7.8	15	11.2	8.1
Chatahochee River.								
West Point, Ga.	20	20	14.5	1	4.8	12	7.6	9.7
Eufaula, Ala.	90	30	29.0	1	8.0	14, 15	14.7	21.0
Coosa River.								
Rome, Ga.	225	30	29.2	17	4.5	13	9.9	24.7
Gadsden, Ala.	144	18	24.8	21	5.8	13	13.3	19.0
Alabama River.								
Montgomery, Ala.	265	35	25.2	2	9.8	13	24.2	25.4
Selma, Ala.	312	35	38.8	3	13.9	13	28.3	24.9
Tombigbee River.								
Columbus, Miss.	285	33	31.4	17	1.4	13	13.5	30.0
Demopolis, Ala.	155	35	59.3	24	19.9	13	43.4	39.4
Black Warrior River.								
Tuscaloosa, Ala.	90	38	60.3	17	10.0	13	30.1	50.3
Columbia River.								
Umatilla, Ore.	270	25	4.6	37-39	2.0	17, 18	8.0	2.6
The Dalles, Ore.	166	40	6.7	30	3.7	19	4.8	3.0
Willamette River.								
Albany, Ore.	99	20	23.0	3	7.5	31	10.6	15.5
Portland, Ore.	10	15	13.2	4	4.1	22	7.1	9.1
Sacramento River.								
Red Bluff, Cal.	241	23	20.4	25	2.3	1	7.0	18.1
Sacramento, Cal.	70	25	24.1	31	11.6	1	16.3	12.5

* Frozen until 25th. † Distance to Gulf of Mexico. † Record for 19 days.
 ‡ Record for 18 days. ‡ Record for 21 days. ‡ Record for 30 days. ‡ Record for 28 days. ‡ No gauge.

CLIMATE AND CROP SERVICE.

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

The following extracts relating to the general weather conditions in the several States and Territories are taken from the monthly reports of the respective sections of the Climate and Crop Service. The name of the section director is given after each summary.

Rainfall is expressed in inches.

Alabama.—The mean temperature was 55.6°, or 1.0° above normal; the highest was 91°, at Union on the 26th and at Pineapple on the 27th, and the lowest, 4°, at Decatur, Oneonta, and Valleyhead on the 7th. The average precipitation was 6.68, or 1.08 above normal; the greatest monthly amount, 15.80, occurred at Maplegrove, and the least, 1.79 at Clanton.—*F. P. Chaffee.*

Arizona.—The mean temperature was 54.4°, or 1.8° below normal; the highest was 94°, at Parker on the 7th and at Blaisdell on the 24th, and the lowest, 6°, at Flagstaff on the 14th. The average precipitation was 0.16, or 0.62 below normal; the greatest monthly amount, 1.16, occurred at Oracle, while none fell at a number of stations.—*W. G. Burns.*

Arkansas.—The mean temperature was 50.6°, or 0.4° below normal; the highest was 87°, at Prescott on the 22d, and the lowest, 1°, at Jonesboro and Pond on the 6th. The average precipitation was 2.97, or 2.21 below normal; the greatest monthly amount, 8.40, occurred at Osceola, and the least, 1.09, at Texarkana.—*E. B. Richards.*

California.—The mean temperature was 51.2°, or 1.0° below normal; the highest was 103°, at Elsinore on the 6th, and the lowest, 4° below zero, at Boca, on the 13th. The average precipitation was 6.10, or 3.13 above normal; the greatest monthly amount, 26.31, occurred at Bowmans Dam, while none fell at several stations.—*G. H. Willson.*

Colorado.—The mean temperature was 33.0°, or 1.5° below normal; the highest was 85°, at Lamar on the 8th and 24th, and the lowest, 25° below zero, at Moraine on the 27th. The average precipitation was 1.64, or 0.67 above normal; the greatest monthly amount, 16.59, occurred at Ruby, and the least, trace, at Saguache.—*F. H. Brandenburg.*

Florida.—The mean temperature was 66.3°, or nearly normal; the

highest was 93°, at Plant City on the 27th, and the lowest, 23°, at De Funiak Springs on the 8th. The average precipitation was 1.96, or about 1.00 below normal; the greatest monthly amount, 7.61, occurred at Wausau, and the least, 0.14, at Key West.—*A. J. Mitchell.*

Georgia.—The mean temperature was 55.1°, or 1.9° above normal; the highest was 92°, at Columbus on the 28th, and the lowest, 3° below zero, at Diamond on the 7th. The average precipitation was 4.81, or 1.85 below normal; the greatest monthly amount, 10.35, occurred at Ramsey, and the least, 1.00, at Brag.—*J. B. Marbury.*

Indiana.—The mean temperature was 37.3°, or 1.3° below normal; the highest was 76°, at Peru on the 11th, and the lowest, 3° below zero, at Rockville and Syracuse on the 7th. The average precipitation was 4.42, or 0.66 above normal; the greatest monthly amount, 7.83, occurred at Crawfordsville, and the least, 0.95, at Valparaiso.—*C. F. R. Wappenhans.*

Iowa.—The mean temperature was 23.0°, or about 10.0° below normal; the highest was 75°, at Mount Pleasant on the 10th and 11th, and the lowest, 16° below zero, at Charles City and Cresco on the 7th. The average precipitation was 1.62, or nearly normal; the greatest monthly amount, 5.90, occurred at Ridgeway, and the least, 0.37, at Monticello.—*J. R. Sage, Director; G. M. Chuppel, Assistant.*

Kansas.—The mean temperature was 37.3°, or 4.1° below normal; the highest was 87°, at Englewood on the 8th, and the lowest, 1° below zero, at Morantown on the 6th. The average precipitation was 1.90, or 0.26 above normal; the greatest monthly amount, 6.22, occurred at Centropolis, and the least, 0.20, at Winona.—*T. B. Jennings.*

Kentucky.—The mean temperature was 43.9° or 2.2° below normal; the highest was 80°, at Russellville on the 3d, and the lowest, 3° below zero, at Alpha on the 7th. The average precipitation was 8.10, or 2.14 above normal; the greatest monthly amount, 12.80, occurred at Mount Herman, and the least, 5.36, at Canton.—*H. B. Hersey.*

Louisiana.—The mean temperature was 61.3°, or 0.8° below normal; the highest was 91°, at Wallace on the 27th, and the lowest, 25°, at Plaquemine on the 6th, at Robeline on the 7th, and at Plain Dealing on 29th. The average precipitation was 3.02, or 1.80 below normal; the