

where the excess in rainfall was moderate, the State averages ranged from 6.79 inches for South Carolina, departure +2.94 inches, to 10.34 inches for the Mississippi area, departure +4.30 inches. The average for the entire district was 7.52 inches, which is 3.02 inches above the normal. The regions of greatest monthly rainfall were in southeastern Mississippi, central and northern Alabama, northeastern Georgia, and the adjoining portions of South Carolina, embracing the upper drainage areas of the Savannah, the Chattahoochee, the Alabama, and the Tombigbee Rivers. In the Mississippi area 16 places received over 10 inches, in Alabama 25 stations, and in Georgia 15. The rainfall was least near the coast and in Florida, where, in the southern portion, the amount received was less than 2 inches at several places. The maximum for the district was 14.56 inches at Laurel, Miss., followed by 14.22 inches at Porterville, Miss., and the least was 1.22 inches at Observation Island, Fla.

After a day or two of fair weather at the beginning of the month a long period of rainy weather occurred, lasting from the 3d to 16th, with snow and sleet from the 3d to 6th in Virginia and North Carolina, and very heavy local downpours of rain at a large number of stations throughout the district on the 5th-6th, 11th-12th, and 14th-15th. The heavy rains of the 14th-15th were especially noteworthy, 5 inches or more in 24 hours occurring at 15 stations, with the following maximum records: Salisbury, N. C., 6.23 inches; Santuc, S. C., 6.08; Elberton, Ga., 6.32; and Point Peter, Ga., 6.25. The following excessive amounts in brief intervals of time were registered: Pensacola, 3.30 inches in 1 hour 10 minutes, Atlanta 3.36 inches in 1 hour 37 minutes. Immediately after these storms a period of fine weather prevailed from the 17th to 21st, but general rains again fell from the 22d to 25th, and 28th to 30th, with excessive amounts on the 28th and 29th, especially in Georgia and Alabama.

The snowfall was heavy in Virginia and North Carolina, the State averages being respectively 10 and 5 inches, unmelted. The total fall exceeded 10 inches at 13 stations in Virginia and at 14 in North Carolina, with a maximum fall of 16 inches at Marion, N. C., of which 10 inches fell in 24 hours on the 5th-6th. This was the heaviest snowfall for March in the climatic history of North Carolina.

MISCELLANEOUS PHENOMENA.

The prevailing winds were from the northeast in all of the States bordering the Atlantic Ocean, from the north in Alabama and from the southeast in Mississippi. The wind movement was high even for March, the average hourly velocity exceeding 10 miles at Norfolk, Hatteras, Charleston, Atlanta, Savannah, Miami, and Pensacola; and there were many days with maximum velocities exceeding 40 miles an hour. The highest velocities were: Hatteras, 60 miles from the west on the 25th; Columbia, 57 miles southwest on the 15th; Savannah, 50 miles southeast on the 12th; and Pensacola, 62 miles northwest on the 11th, and 50 miles south on the 14th. The number of clear days ranged from 8 in Mississippi to 15 in Florida, the number of cloudy days from 7 in Florida to 17 in Mississippi; the average number of rainy days was 11.

SEVERE LOCAL STORMS.

The following brief descriptions of local storms have been furnished by the officials in charge of the stations named:

Pensacola, Fla.—(W. F. Reed, jr.)—A severe thunderstorm passed over Pensacola on the evening of March 11, 1912, traversing the city from northwest to southeast and causing much damage to buildings, fences, signs, roads, timber in booms, etc. Lightning began in the

northwest at 8 p. m.; the wind increased from 24 miles an hour from the southeast at 8.51 p. m. to 48 miles at 9 p. m.; south winds then prevailed until 9.14 p. m., when a sudden shift to northwest took place, the velocity increasing to 62 miles an hour, with a momentary gust at the rate of 100 miles an hour. The total damage is estimated at about \$5,000. Considerable property was saved by the warnings issued by the Weather Bureau.

Alabama (P. H. Smyth).—About 3 o'clock in the morning of March 15, 1912, a tornado developed about 2 miles northwest of Hartford, Geneva County, Ala., and moved northeastward into Henry County. The tornado passed over Wicksburg, Houston County, about 3 a. m., Jellico, Houston County, between 3 and 3.15 a. m., and Headland, Henry County, about 3.30 a. m.; it then seemed to have swerved to the right, passing south of Columbia, which is about 15 miles south by east of Headland, at 3.40 a. m. At Columbia it passed by the Central of Georgia Railroad depot, destroying the flues, and then moved across the Chattahoochee River into Georgia. Its path of greatest destruction varied in width from 100 to 400 yards. The trees on the north side and in the center of the path lie in all directions, while on the south side they were generally lying toward the northeast. The funnel-shaped cloud was seen by many persons. About 50 persons were more or less injured and 9 people were killed.

Much property was destroyed along the path of the storm. At Headland, where the greatest loss of life and property occurred, there were 5 deaths resulting from the storm, and about 26 persons injured; 32 buildings were demolished, at least half of these being totally destroyed; some live stock was killed. The total damage to property is estimated at nearly \$50,000.

Similar less destructive storms occurred at Farmville, Va., Cheraw, S. C., near Americus, Ga., and at many other places.

THE BREMO BLUFF TORNADO OF FEBRUARY 21, 1912.

By JAMES H. KIMBALL, Observer.

Tornadoes are of rare occurrence in Virginia, and a careful search through newspaper files and other records for a hundred years reveals but two storms that were unquestionably of that character. The local disturbance that crossed the James River just west of Bremono Bluff, a small village about 50 miles west of Richmond, Va., shortly after 8 p. m. on February 21, 1912, seems to have been a true tornado, as several observers state that the characteristic pendent-shaped tornado cloud was present. The evening weather map of February 21 showed the presence of a marked area of low barometer over northern Virginia with a pressure of 29 inches, and the storm evidently formed close to the trough of the main depression.

Mr. Plummer F. Jones, cooperative observer at Arvonnia, states that the storm originated about a mile southwest of New Canton, Buckingham County, moved due north across the James River, then curved toward the northeast and crossed the Bremono-Fork Union road about a mile and a half north of Bremono, where it was dissipated. The path of the storm was at first about one-quarter of a mile wide, but soon narrowed to about 200 yards. Within its path hundreds of trees, some of them from 2 to 3 feet in diameter, were blown down, some falling southwest to northeast, others southeast to northwest; in one portion of the path the uprooted trees fell in all directions, indicating the tremendous rotary force of the wind. The country is hilly and well wooded, and everything in the path of the storm was prostrated. A few persons sustained slight injuries.

THE FLOODS OF MARCH, 1912, IN THE SOUTH ATLANTIC AND EAST GULF STATES.

By C. F. VON HERBMAN, District Editor.

During March, 1912, destructive floods occurred in nearly all of the larger rivers that drain the eastern and southern slopes of the Appalachian Mountain system. Frequent rains during the early part of the month, accompanying the rapid succession of areas of low atmospheric pressure that moved from southwest to northeast over the district or near its northern borders,

caused a very full flow of the rivers, which was augmented by the local excessive rains of the 5th to 6th, and 11th to 12th. On the morning of March 14 a moderate disturbance was central over Oklahoma with a pressure of 29.64 inches at Oklahoma City, accompanied by a secondary depression over southern Texas. The main storm moved at a comparatively slow rate of speed to Ohio by the morning of the 15th, while the secondary moved over Georgia and the Carolinas, accompanied by severe local wind storms over an extended area. The rainfall during the afternoon and night of the 14th and early morning of the 15th over the districts from northern Georgia to western North Carolina, was largely the result of the forced ascent of moisture-laden air over the southern and southeastern slopes of the Blue Ridge Mountains, and the amounts received in the brief time of from 12 to 24 hours were unusually large, more than 15 places reporting over 5 inches in less than 24 hours. Considering the already swollen state of the rivers, the high level of the ground waters, the soggy condition of the almost entirely uncultivated soil, and the relative low temperatures that hindered evaporation, it is not surprising that the rivers throughout the district after the downpour of the 14th-15th experienced most destructive and dangerous rises. However, river forecast officials in the district were alert and in every case flood warnings were issued that unquestionably resulted in the saving of much valuable property. The floods were so extensive that a satisfactory general view can only be obtained by summarizing the main features in each river district.

Virginia—The James River (Mr. Edward A. Evans, section director).—The James River rose steadily during the afternoon and night of the 15th and throughout the 16th, the crest of the flood passing Richmond at 2 a. m. on the 17th, with a stage of 17.8 feet, which is 7.8 feet above the flood stage. During the night of the 16th the tracks of the Chesapeake & Ohio Railway, James River Division, were under water, and train service was suspended. Locally the first effect of the flood was to interrupt street car traffic between the city and Fulton, a suburb, and later the freight wharves of the steamboat companies were covered with water. The flooded area rapidly increased, covering a section of the city between Fifteenth and Eighteenth Streets and south of Cary Street to depths ranging from a few inches to 2 feet; by night the flooded area had advanced northward to Fulton Street, filling cellars of business and residence houses, covering the lower floors of buildings and putting business to a standstill. The river did not get within its banks again until the night of the 18th. Flood warnings were issued in ample time, and prompt action was taken to save movable property, and the subsequent loss, estimated at about \$50,000, was confined chiefly to material that could not be moved. Much damage resulted from the erosion of farm lands and deposits of sand and mud. Probably half a million dollars' worth of property was safeguarded by the warnings issued by the Weather Bureau.

North Carolina—The Roanoke and Cape Fear Rivers (C. H. Richardson, acting section director).—From reports received at 8 a. m. on the 15th, warnings were at once issued for decided floods in both the Cape Fear and the Roanoke Rivers, estimated stages of 45 feet being indicated at Weldon (flood stage 30 feet), and at Fayetteville (flood stage 38 feet). The run-off was very rapid, and crest stages were reached on the 18th, the Roanoke at Weldon attaining a maximum of 50.3 feet and the Cape Fear at Fayetteville, 50.1 feet.

The greatest damage was done by the flood in the upper portions of the watersheds. Many bridges were washed away or made unserviceable, and railroad traffic was practically suspended for several days. The flood was severe in Guilford County, and much damage to mill property occurred at Danville and Weldon. At Danville, Va., the river rose to a height of about 17 feet during the night of the 15th, exceeding the previous highest stage by 3.9 feet. The stage at Weldon has been surpassed but once, namely, in 1877, when the river is supposed to have risen to 60.3 feet. The estimated amount of damage by this flood is \$250,000. The warnings issued resulted in the saving of much valuable property.

South Carolina—The Pedee system (J. H. Scott, local forecaster, Charleston).—Excessive rains were reported over the drainage basin of the upper Pedee in North Carolina on the 15th and 16th, and the following warning was issued: "The most disastrous flood since August, 1908, is indicated in the upper Pedee River. Stage near or above 40 feet indicated at Cheraw within the next 24 to 36 hours." Subsequent

events fully justified the warnings. In a little more than 48 hours the river rose more than 26 feet to a maximum of 39.5 feet at 4 p. m. on March 17, or 12.5 feet above flood stage. This was decidedly the greatest flood on record with the single exception of the great flood of August, 1908, which exceeded the present flood by 4.8 feet on the Cheraw gauge. The river was above the flood stage at Cheraw for four days.

The damage resulting from this flood was immense. Farm lands suffered greatly from erosion in North Carolina and the northern portions of South Carolina. Numerous bridges were destroyed, and serious washouts occurred on several railroads, entailing heavy losses and deranging traffic for many days. The greatest damage of this nature apparently occurred in the vicinity of Winston-Salem, N. C., which was completely isolated. The Seaboard Air Line railway trestle across the Pedee at Robins Neck was saved by being weighed down with loaded cars. The estimated value of the property destroyed is \$235,000. Small grain that was housed or stacked in lowlands was removed upon receipt of the warnings; lumber companies moved their lumber and movable machinery to places of safety, secured logs, and weighed down trestles by loaded cars; cattle were driven out of the lowlands, and people dwelling on low ground moved their families and household goods to safer places. The rainfall over the Pedee basin in South Carolina was moderate, giving no indication of the impending flood, and it is probable that there would have been loss of life, as there certainly would have been much greater property loss, but for the warnings of the Weather Bureau, which were promptly and widely distributed by every available means. The money value of the property saved is estimated at \$100,000.

The Congaree, Wateree, and Santee Rivers (Harry O. Geren, section director, Columbia).—The early warnings issued on the morning of the 15th indicated floods in the rivers much above flood stages. As soon as complete reports were received from the several river and rainfall stations, forecasts for more definite stages were given wide distribution, the work being completed by 2 p. m. on the 15th. The stages attained were close to those predicted. The river at Columbia reached a maximum of 30.8 feet (flood stage 15 feet), at Camden, 36.1 feet (flood stage 24 feet), and at Rimini 27.7 feet (flood stage 12 feet). The warnings were received from one and a half to five days in advance of the crest stages.

It was decidedly the most destructive flood experienced since the memorable one of August, 1908. Reports received from the different communities affected indicate an approximate loss of \$896,000. This loss was almost entirely unpreventable, consisting mainly in the washing out of railroad trestles and tracks, damage to telegraph and telephone lines, and the destruction of dams and dykes. An estimate of the value of the property saved by the warnings is over \$210,000.

Georgia—The Savannah River (E. D. Emigh, local forecaster, Augusta).—At 10 a. m. March 15 the following warning was issued: "Rainfall reports from the Savannah watershed and an estimate of the rainfall likely to occur to-day indicate that the Savannah River will reach a stage of 32 to 34 feet at Augusta by Saturday morning." By nightfall the business houses in all portions of the city subject to inundation from the river were prepared for a river much higher than the stage predicted. During the night of the 15th the official in charge in company with the chief of police, Mr. George P. Elliott, and the commissioner of public works, Mr. Nisbet Wingfield, visited the city bridge, where it is customary for people to gather to watch the rise in the river, and various other points in the city, and the action of the river was closely watched and people reassured.

The river rose steadily to 30.5 feet, and subsequently continued to rise at the rate of about 6 inches per hour for several hours. At 2 a. m. of the 16th the stubbornness of the rise showed clearly that the original estimate would be exceeded; that the height reached in 1908, namely, 38.8 feet, could not possibly be expected, but that 36 feet would undoubtedly be reached. At 7 a. m. this was changed to 36.5 feet. At 9 p. m. of the 16th the following telegram was sent to the Chief of Weather Bureau:

"Nine p. m., river 36.8 feet and practically at a stand. Strong current through main streets since 3 p. m., but houses built well above water level and merchandise raised above floors of business houses where water entered. Large quantities of cotton moved out of flooded district on Friday, but some in warehouses damaged to unknown extent. No trains running. Mills and other industries suspended. Actual damage to property aside from deposits of mud in buildings not believed to be great."

Practically all damage to property by the flood waters was of a nature that could not have been avoided. A conservative estimate of the total loss is \$125,000, including damage to all kinds of property in the city and to the Charleston & Western Carolina Railway. The loss of property in the lowlands below Augusta is probably between \$125,000 and \$150,000.

The Ocmulgee and Oconee Rivers (W. A. Mitchell, local forecaster, Macon).—During the night of the 14th very heavy rains fell in the middle and upper portions of the basins of the Ocmulgee and Oconee Rivers in eastern Georgia, and the rivers rose very rapidly. At 7 a. m. of the 15th the Ocmulgee reached a stage of 16.7 feet at Macon, and the Oconee 18.7 feet at Milledgeville. Warnings were immediately issued

for flood stages and were distributed as widely as possible. On the morning of the 16th the crest of the flood in the Ocmulgee passed Macon with a stage of 22.7 feet, the highest stage since August, 1887, when the river reached 24 feet. The highest stage at Milledgeville was 33.8 on the 17th. Warnings were issued giving the probable time of arrival of the crest at various points in the lower valleys, and it is believed that much good was accomplished by the warnings.

The Chattahoochee and Flint Rivers (C. F. von Herrmann, section director, Atlanta, Ga.)—The remarkably heavy downpour of 5.52 inches in less than 12 hours during the afternoon and night of March 14 at Atlanta, and the reports of similar excessive rains received next morning from other stations in the upper watershed of the Chattahoochee and Flint Rivers in western Georgia, necessitated the issue of warnings for dangerous floods in these rivers as promptly as possible. Flood stages but slightly lower than the memorable floods of 1886 and 1908 were indicated at all points, and people were warned to remove their families, household goods, stock, and other movable property to places of safety. Special warnings were sent to West Point, Ga., where much damage would have been done in the business districts of the city by a stage of 24 feet or more, stating that a stage of 24 feet would not be reached and reassuring the public. The following river stages were predicted: In the Chattahoochee River, at West Point, slightly higher than 23, but not reaching 24 feet; at Eufaula, Ala., 45 feet; at Alaga, Ala., 38 feet. In the Flint River, at Montezuma, 22 feet; at Albany, 28 feet; at Bainbridge, 26 feet. The maximum stages attained were as follows: At West Point, 22.9 feet; at Eufaula, 48.3; at Alaga, 38.1; at Montezuma, 20.6; Albany, 26.2; and Bainbridge, 27 feet.

The flood was the worst since 1908; the warnings were fully justified, and the stages attained fairly close to those estimated. The actual loss of property at West Point was about \$3,000; at Columbus, \$10,000, and at all other points about \$50,000, which includes the destruction of bridges, damage to railroad tracks, loss of stock, etc. A conservative estimate of the value of the property saved by the warnings is about \$50,000.

Alabama—The Alabama River (P. H. Smyth, section director, Montgomery).—At 5 p. m. on March 14 special warnings were issued that the heavy rains then falling over the watershed would cause the Alabama River at Montgomery and Selma to rise rapidly during the night. On the morning of the 15th extremely heavy 24-hour rainfalls were reported at numerous points and pronounced rises in the rivers, amounting to 14 feet in 24 hours at Canton and 9 feet at Rome, Ga., 12 feet at Wetumpka, and 27 feet at Milstead, Ala., occurred. Forecasts were accordingly issued on the morning of the 15th that flood stages would be reached. At 4 p. m., March 16, warnings were issued that the crests would be approximately as follows: Rome, 27 feet (actually attained, 25.6 feet); Gadsden, 23 feet (maximum reached, 21.2 feet); Wetumpka, 45 feet (maximum, 44.8); Montgomery, 44 feet (attained, 44.9 feet); and Selma, 45 feet (maximum, 46.4). The highest stage ever recorded was reached at Milstead, namely, 48.2 feet.

The warnings were issued in ample time to enable those interested to take such precautions as were considered necessary. Stock valued at many thousands of dollars was driven to high land and saved. Quantities of sawed lumber were moved to safe places. Some stock was drowned, and considerable damage was done to fences, pastures, farm lands, etc. Similar floods occurred on March 29 to April 3 without much damage, although stages in excess of those reached during the middle of the month occurred at Resaca and Rome, Ga., and Gadsden and Lock No. 4, Ala.

At the end of March the flood in the Tombigbee River was still in progress and will be described in the April number of the Monthly Weather Review. The river at Demopolis, Ala., has remained above the flood stage

since February 26, and on March 31 reached a maximum stage of 51.1 feet (flood stage, 35 feet) and is still rising. The Black Warrior at Tuscaloosa reached a crest of 49.6 feet at 4 p. m., March 16 (flood stage, 43 feet), and a second crest of 54.7 feet on March 30.

The floods in the Pearl and Pascagoula Rivers of southeastern Mississippi were comparatively unimportant, but warnings were issued in ample time for people to remove stock and movable property to higher ground. There was some damage to lumber interests in the lower portion of both rivers.

The wide extent of the floods is sufficiently indicated by the following table, which will be found useful for immediate and future comparisons, giving the flood stages, maximum attained during March, 1912, and the highest stages previously recorded for the most important river stations in the district:

TABLE I.—Highest river stages in March, 1912, as compared with highest stages previously recorded.

[Arranged by river systems, the names of the tributary connections not being given.]

River system station.	Flood stage.	Highest in March, 1912.	Highest on record.	River system station.	Flood stage.	Highest in March, 1912.	Highest on record.
James:	Feet.	Feet.	Feet.	Altamaha—Cont'd.	Feet.	Feet.	Feet.
Buchanan, Va.	12	16.2	24.6	Dublin, Ga.	30	25.5	25.8
Lynchburg, Va.	20	14.0	29.0	Macon, Ga.	18	22.7	24.0
Columbia, Va.	18	27.7	40.0	Hawkinsville, Ga. . .	25	25.1	30.9
Richmond, Va.	10	17.8	23.2	Abbeville, Ga.	11	18.1	17.5
Roanoke:				Lumber City, Ga. . .	15	19.3	22.0
Randolph, Va.	28	30.6	25.7	Apalachicola:			
Danville, Va.	8	17.0	13.1	Woodbury, Ga.	10	13.1	14.0
Clarksville, Va.	12	17.0	27.0	Montezuma, Ga.	20	20.6	26.0
Weldon, N. C.	30	50.3	60.3	Albany, Ga.	20	26.2	32.4
Tar:				Norcross, Ga.	16	19.3	19.4
Rocky Mount, N. C. .	12	9.4	19.0	West Point, Ga.	20	22.9	25.6
Tarboro, N. C.	20	16.4	28.0	Eufaula, Ala.	40	48.3	56.0
Greenville, N. C. . .	13	13.5	22.3	Alaga, Ala.	30	38.1	38.2
Cape Fear:				Mobile:			
Moncure, N. C.	25	29.2	25.9	Canton, Ga.	20	17.0	23.0
Fayetteville, N. C. .	38	50.1	67.5	Resaca, Ga.	25	25.0	36.6
Pedee:				Rome, Ga.	30	28.2	40.3
Cheraw, S. C.	27	39.5	44.3	Gadsden, Ala.	22	23.9	36.7
Smiths Mills, S. C. .	16	17.1	24.0	Lock No. 4, Ala. . . .	17	18.5	22.7
Effingham, S. C. . .	12	13.5	20.0	Wetumpka, Ala. . . .	45	44.8	61.7
Kingstree, S. C. . .	12	10.5	14.5	Milstead, Ala. . . .	35	48.2	46.8
Santee:				Montgomery, Ala. . .	35	44.9	59.7
Mount Holly, N. C. .	15	21.5	23.0	Selma, Ala.	35	46.4	57.0
Catawba, S. C.	11	27.0	28.4	Tuscaloosa, Ala. . . .	43	54.7	65.0
Camden, S. C.	24	36.1	39.7	Columbus, Miss. . . .	33	21.0	42.0
Blairs, S. C.	14	32.0	31.1	Demopolis, Ala. . . .	35	51.1	68.7
Pelzer, S. C.	7	15.0	25.6	Pascagoula:			
Chappels, S. C.	14	28.5	34.7	Hattiesburg, Miss. . .	17	18.3	20.5
Columbia, S. C.	15	30.8	35.8	Enterprise, Miss. . .	18	27.1	36.0
Rimini, S. C.	12	27.7	33.8	Shubuta, Miss. . . .	25	32.0	45.0
Ferguson, S. C.	12	19.4	23.7	Merrill, Miss.	20	21.0	25.1
Savannah:				Pearl:			
Carlton, Ga.	11	29.2	29.0	Edinburg, Miss.	17	21.5	29.0
Calhoun Falls, S. C. .	15	18.9	28.2	Jackson, Miss.	20	27.1	36.0
Augusta, Ga.	32	36.8	38.8	Columbia, Miss.	18	23.1	27.6
Altamaha:							
Milledgeville, Ga. . .	25	33.8	33.2				