Virginia.—The mean temperature was 68.8°, or 1.0° above normal; the highest was 102°, at Nottoway on the 10th, and the lowest, 26°, at Goshen on the 22d. The average precipitation was 1.01, or 3.46 below normal; the greatest monthly amount, 2.56, occurred at Salem, and the least, trace, at Farmville.—*E. A. Evans.*

Washington.—The mean temperature was 56.9°, or 0.3° below normal; the highest was 97°, at Centerville on the 21st, and the lowest, 24°, at Wenatchee Lake on the 28th. The average precipitation was 1.79, or 0.22 below normal; the greatest monthly amount, 7.90, occurred at Snohomish, and the least, 0.11, at Lakeside.—*G. N. Salisbury.*

West Virginia.—The mean temperature was 66.4°, or slightly above normal; the highest was 103°, at Hewett on the 15th and 16th, and the lowest, 27°, at White Sulphur Springs on the 17th. The average precipitation was 1.14, or greatly below normal; the greatest monthly amount, 4.00, occurred at Philippi, and the least, 0.02, at Green Sulphur Springs.—*H. L. Ball.*

Wisconsin.—The mean temperature was 65.5°, or 4.5° above normal; the highest was 97°, at Chilton, Sharon, and Whitemound on the 8th and at Delavan on the 10th, and the lowest, 22°, at Antigo and Barron on the 20th. The average precipitation was 2.28, or 0.78 below normal; the greatest monthly amount, 6.58, occurred at Prairie du Chien, and the least, 0.72, at Port Washington.—*W. M. Wilson.*

Wyoming.—The mean temperature was 61.1°, or 4.0° above normal; the highest was 99°, at Carbon on the 2d and at Fort Laramie on the 8th, and the lowest, 21°, at Fort Washakie on the 18th. The average precipitation was 0.38, or 0.67 below normal; the greatest monthly amount, 1.14, occurred at Fort Laramie, and the least, trace, at Wheatland.—*M. G. Renoe.*

RIVER AND FLOOD SERVICE.

By PARK MORRILL, Forecast Official, in charge of River and Flood Service.

The rivers have continued falling slowly and are now at about their annual ebb. As a rule, they are below their normal of lowest stage. Navigation is practically suspended except on the Mississippi below Cairo.

The highest and lowest water, mean stage, and monthly range at 113 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: Keokuk, 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.

The following résumé of river stages and conditions of navigation in the respective streams is compiled from reports by the officials of the Weather Bureau at various river stations and section centers:

Atlantic Coast Rivers. (Reported by A. F. Sims, Albany, N. Y.; E. R. Demain, Harrisburg, Pa.; E. A. Evans, Richmond, Va.; C. F. von Herrmann, Raleigh, N. C.; L. N. Jesunofsky, Charleston, S. C.; D. Fisher, Augusta, Ga.; and J. B. Marbury, Atlanta, Ga.)—During the first decade of September an abnormally low stage of water was maintained in the Hudson River. The water reached the lowest point for the season on the 7th. Usually the water is lowest in the months of July and August. The water has been so low that the steamer *Saratoga* of the Citizens' Line brought up mud on her huge paddles at every revolution. Light fog prevailed in the Hudson Valley on the 9th, and a dense fog on the 6th, and during the early morning hours on the 22d.

About the usual stages of water for the time of year obtained in the Susquehanna River and its tributaries. The average gauge readings of 14 reporting stations was 0.6 foot, the same as in 1896, although the average rainfall for 17 stations was only about 70 per cent of the amount registered during September, 1896. In the lower river, while low stages prevailed, the water did not fall so low as in last September. The average for the month at Harrisburg was 0.5 foot higher than during the corresponding period in 1896. Drought prevailed during the first half of the month and all streams fell slowly, but showers occurred in the basin from the 16th to the 22d and a general rain fell on the 23d and 24th, causing a rise of from 1 to 2 feet at most reporting stations, and the month closed with higher stages than ruled at the beginning of the month.

On the West Branch, at Sinnamahoning and Cedar Run, the water was below zero of the gauge during the entire month; at Cameron it ranged from —0.2 to 0.2; at Renovo the range was from zero to —0.5 from the 1st to the 24th, the river rising to a maximum of 2 feet on the 26th; at Lockhaven the water stood at zero from the 10th to the 19th, inclusive, and touched zero again on the 23d, the maximum reading for the month being 1 foot on the 26th; at other stations on the West Branch the gauge readings ranged from zero to 2.8 feet above. On the North Branch, at Wilkesbarre, the gauge readings ranged from zero to 1 foot below, and at East Bloomsburg a zero stage was maintained from the 1st to the 23d, when the river began to rise, the highest point touched being 2.5 feet on the 26th and 27th. The Juniata kept up well notwithstanding the deficiency in rainfall, the gauge readings ranging from 1.5 to 3.8 feet.

An unusually low stage of water prevailed in the James River, from the head of tidewater to its source, during the entire month. The month was largely deficient in rainfall, none of any consequence being reported, except about the 1st and 21st to 23d, when fairly good showers fell over the river basin. The proportion of this downfall which drained to the river was very small, owing to the dry condition of the ground, and hence but a slight passing change in the stage of the water occurred.

At Richmond the falls of the James present an unusual sight, the river bed being entirely uncovered in some places, and rocks never known before to be above the surface, are now high and dry. The water is the lowest on record at this point, and from reliable sources it is learned that it is lower than for many years, if not the lowest observed. The officials of the Chesapeake and Ohio Railway Company, which has maintained a system of gauges on the James River division of their line, state that the present stage of water is the lowest of which they have any record. This same state of affairs obtains in all the large streams in this portion of the State. The Rappahannock River is so low that the mills have been obliged to shut down, and on the line of the Richmond and Danville Railroad water has to be hauled from Richmond in tank cars to various points for use of the engines. Small creeks and branches, which are reported to have always furnished water heretofore, are now dry. The question of water is becoming a serious one for the agricultural communities of this section.

The month of September was characterized by the most severe drought in the history of North Carolina. The small amounts of precipitation occurring between the 17th and 23d were altogether insufficient to appreciably influence the stages of the rivers. The latter remained exceptionally low the entire month. During the second decade the lowest stages ever recorded were noted on the Cape Fear and Roanoke. On the Dan, at Clarksville, the river was 0.4 foot below the zero of the gauge from the 13th to the 17th, and at Fayetteville the Cape Fear diminished to 0.3 foot on the 17th. Many of the small streams in the upper country have become quite dry; wells are very low and many dry; stock has to be watered; navigation, except near the mouths of the Roanoke and Cape Fear, has been completely interrupted.

The freshet on the lower Edisto, at Jacksonboro, on September 27, continued to the 4th of October, when the water had receded sufficiently for the proper drainage of the rice lands. Much of the rice was overripe when the flood waters arrived, but by rapid harvesting, immediately after the freshet subsided, considerable was saved. The damage caused by the freshet was not so great as at first anticipated. A few of the rice planters escaped the high water entirely, as their crops were gathered two days before the rise occurred.

The general and heavy precipitation on the 21st and 22d affected the streams but slightly; other than this but little rainfall occurred over the drainage areas of the upper sections of the streams. The Great Pedee, from its mouth at Winyah Bay to Cheraw, was scarcely navigable during any day in the month. At Smiths Mills the gauge registered —1.6 foot on the 16th, 17th, and 18th, which was below the low water reading of October 22, 1895 (—0.4 foot). The latter was recorded at that time as being the lowest stage reached in thirty-eight years. Old river men connected with the steamboat interests for the past forty years state that they have never known the Great Pedee to become unnavigable for one entire month. This condition of affairs is rather unfortunate for the steamboat lines, as much cotton, rice, tar, rosin, turpentine, and other articles of merchandise, is awaiting transportation up and down these streams. There was also an unusual lack of steamboat water in the Little Pedee and Lumber rivers, navigation thereon having been impeded the entire month. The Waccamaw was at a fairly good stage up to Conway throughout the entire month, the traffic occasioned thereby having been quite brisk.

The Savannah fell to such a low stage during the first and second decades of the month that, for the greater portion of this period, navigation was wholly interrupted, several attempts having been made to run cargoes down the river, but even with the lightest of loads nothing was accomplished. The only rainfall worthy of note during September was that which occurred on the 22d and 23d, and though the fall was excessive over the central and lower portion of the Savannah

Valley, the amount of rainfall grew perceptibly smaller in advancing toward the upper basin; however, after the 22d regular schedules were resumed for the next five days, but after this further trouble was encountered and the boats were laid up again for want of sufficient water. But what was a serious loss to the boating interests proved to be a positive gain to the farmers in the lowlands, as one of the largest corn crops ever grown on these lands was harvested.

The month of September was abnormally dry, and little rain has fallen in the other drainage basins of Georgia, and as a consequence very low water has continued in the rivers during the month.

Mobile River and branches. (Reported by F. P. Chaffee, Montgomery, Ala., and W. M. Dudley, Mobile, Ala.)—Fairly good rains fell over the central portions of the watershed of the Alabama River during the middle of the month, but not enough to cause more than a very slight check in the fall of the rivers of this system, which have been either stationary or falling slowly during the entire month, at the close of which the lowest water of this season is noted. At Selma the stage was 2.0 feet below zero of gauge at the end of month, which is 0.1 foot lower than the lowest of last season. At other stations on the Alabama the stage is not quite as low as at the same season last year, but low enough to suspend steamboat traffic, except in the lower portions of the river.

The Tombigbee and its tributaries have been at very low stages during the entire month. There has been but little rain; that which occurred on the 13th and 14th was so light and of such short duration that it ran off rapidly. Owing to this lack of rainfall the fluctuations in the rivers have been very slight. The changes during the month have been downward; while the Tombigbee has been below the zero of the gauges during the entire month, the Warrior has been so since the 15th. There was some traffic on the Tombigbee and Alabama to the 13th, when the quarantine regulations stopped it, but it was resumed again toward the latter part of the month on authority of the State health officer, and boats were still running at the close of the month.

Ohio River and branches. (Reported by F. Ridgway, Pittsburg, Pa.; H. L. Ball, Parkersburg, W. Va.; S. S. Bassler, Cincinnati, Ohio; F. Burke, Louisville, Ky.; P. H. Smyth, Cairo, Ill.; L. M. Pindell, Chattanooga, Tenn.; and H. C. Bate, Nashville, Tenn.)—Navigation on the upper Ohio River has been suspended during the entire month, on account of low stages of water. The passenger and freight business of the packet lines plying the slack water of the lower Monongahela has been fair during the month.

The rainfall over West Virginia during the month of September was unusually light, and at no place did the amount reach the normal. A great many creeks and small tributaries were almost entirely dry by the end of the month and the rivers in the State were constantly at a low stage. Rains on the 21st and 24th resulted in a slight rise in the Ohio at Parkersburg, but no navigable stage of water was reached. Repairs on the locks along the Little Kanawha River were completed on the 16th, but the low stage would only allow the passage of one small packet, which made regular trips between Parkersburg and Palestine, a distance of 32 miles. Navigation on the Great Kanawha was open to the smaller packets.

A remarkable feature of the river at Cincinnati during the month of September was that there was not the slightest fluctuation in the stage, but a continuous and steady decline from the beginning to the end of the month, varied only by several short periods when it was at a stationary stage. The range for the month was 3.9 feet; the highest stage, 7.1, on the 1st, and the lowest, 3.2, from the 28th to the 30th.

The month opened with midsummer quiet on the river. Early morning fogs and menacing sandbars and snags made hazardous what little navigation there still was. The larger boats sought the banks and craft of lightest draught only were in service. Although freight offerings and passenger inquiries were more numerous than heretofore at this season of the year, the low and steadily declining stages of water prevented business on the river.

The water along shore is greenish and stagnant, an indication, according to old river men, of a long dry spell, which in this instance, at all events, has proved correct. Alarming reports were general concerning the continued drought and the dearth of water. At Ashland, Ky., wells dried up, and at Falmouth, Ky., the Licking River was dry, except for occasional stagnant pools. Pilots have been making trips in yawls to study and examine the condition of the river bed. Navigation is stopped to all up-river points, and only the lightest draught boats are running down stream.

At Louisville and Cairo the river fell steadily throughout the month. The stage of 3.7 feet at Cairo on the last day of the month is the lowest the river has been at this point since November, 1895.

The rainfall over the Tennessee system during the month was exceedingly light, and below the normal; the greatest amount, 2.07 inches, fell at Bluff City on the Holston River. No rain fell at Florence and Riverton. Navigation was closed to all boats during the month. The river was below the zero of the gauge from September 5 to 30 at Speers Ferry and Riverton, and from the 16th to 30th at Florence; at Kingston the river reached zero on the 11th and remained stationary during the rest of the month. The greatest change in the river at any station was a rise of 0.6 foot on the 5th at Clinton.

August closed with the Cumberland River low and falling steadily, and navigation closed above Nashville. Two feet is about the lowest stage that loaded boats can navigate the lower river, and the last boat left Nashville on the 4th for Paducah. The river rose slightly on the 17th, and on the next day a light boat left for the lower river to load and return with the first favorable stage of water. The month closed with the river very low and falling at all points.

Mississippi River and branches, except the Ohio. (Reported by P. F. Lyons, St. Paul, Minn.; M. J. Wright, Jr., La Crosse, Wis.; G. E. Hunt, Davenport, Iowa; F. Z. Gosewisch, Keokuk, Iowa; H. C. Frankenfield, St. Louis, Mo.; P. H. Smyth, Cairo, Ill.; S. C. Emery, Memphis, Tenn.; R. J. Hyatt, Vicksburg, Miss.; R. E. Kerkam, New Orleans, La.; P. Connor, Kansas City, Mo.; F. H. Clarke, Little Rock, Ark.; J. J. O'Donnell, Fort Smith, Ark.; and C. Davis, Shreveport, La.)—The extreme gauge readings for the Mississippi River at St. Paul during September were 4.5 and 5.5 feet. That is decidedly a better stage of water than can be shown for any other September since that of 1881, and with conditions such as have been usual since then, it would be considered very satisfactory; but the floods of last spring seem to have caused deposits in the bed of the river, and changes in the channel, and hence navigation has been impaired even with these favorable water stages. The steamer *Dubuque*, of the Diamond Jo Line, left on the 10th, for St. Louis, and with her departure came the close of navigation so far as regular freight and passenger traffic is concerned.

The comparatively steady and good stages of water noted must be partly due to the Government reservoirs at the headwaters of the Mississippi River, for the purpose of storing the surplus waters of spring. The rainfall of September, 1897, was considerably less than half the normal, and there was absolutely no rain during the last half of the month, and yet the river changed but little.

Good navigation was maintained at La Crosse during the month. The average stage of water at this point for the month was 4.0 feet, which is about 2.5 feet higher than the average for September, 1896. The month opened with a stage of 4.2 feet on the gauge and gradually declined until the 10th instant, when it reached a minimum stage of 3.4 feet. The river was stationary at the maximum stage of 4.3 feet for three days during the last decade of the month.

The stage of water at the various stations fluctuated in response to local rains, but these minor changes were of short duration. From La Crosse to Muscatine the river was a little lower, a fall of 0.7 foot at the last-named place, being the greatest monthly change. There has not been enough water for the larger steamboats, but the smaller local packets have experienced no trouble. Some rafting is still going on.

The tendency of the river at Keokuk has been to decline slowly during the month, and it is 0.9 foot lower at the close of the month than at the beginning. Still it is not low enough to interfere materially with the navigation of the regular channels, by light draught steamboats, except on the Des Moines rapids, which have not been navigable.

The rivers in the St. Louis district continued to fall during the month of September, reaching so low a stage about the middle of the month that navigation was totally suspended on the Missouri River, and was possible only for light draught boats on the Mississippi and Illinois rivers.

From St. Louis to Cairo the river fell slowly during most of the month. The low stage of the river is proving decidedly dangerous for navigation, several disasters having occurred during the month. The Anchor Line steamer *Belle Memphis*, estimated to have been worth between $50,000 and $60,000, was sunk just below Chester, Ill., on the 8th instant. She is supposed to have struck a sunken snag, which ripped through her bottom, and is reported a total wreck. On the 16th instant the Anchor Line steamer *Bluff City*, in backing off a reef near Avenue, Tenn., ran against the bank and demolished her wheel. On the 23d the Government steamer *Minnetonka*, a tender for the dredge boat fleet at work on the river below Cairo, struck what was supposed to be a sunken snag near Golddust, Tenn. No definite information could be obtained as to the extent of the damage, but it is reported to have been slight.

The month opened with a fair stage of water in the Mississippi from Cairo to Helena, but a steady fall continued up to the 28th, when it became stationary at 1.6 foot at Memphis, the total fall for the month being 4.1 feet. The average for the month was 4 feet below the normal September stage. It is estimated that there was only 5 feet of water from Cairo to Memphis at the close of the month, and most of the tributaries were so low that only the smallest boats could be operated.

The rivers between Memphis and Vicksburg were very low, and continued to fall during the month, as a rule. No precipitation of importance was reported, the only measurable amount being at Vicksburg, where 0.28 of an inch was recorded. Navigation was seriously interrupted not only by low water, but by stringent quarantine regulations, which forbade local traffic, owing to the prevalence of yellow fever in this section. Some few boats continued to run on the Mississippi between non-infected points in consequence of the restricted business. River interests have suffered considerably by the loss of trade, as a great deal of cotton is now ready for shipment.

The Mississippi, below Vicksburg, continued to decline gradually to the close of the month, except that at and below New Orleans the stage fluctuated, high winds on several occasions backing up the water

from the Gulf. The most marked occurrence of the sort was during the last three days of the month. The range of fluctuation did not exceed 2 feet at New Orleans during the entire month, while at Vicksburg the fall was 7 feet. Quarantine regulations in force during two-thirds of the month (from the 10th to the close) made all river traffic light, many places along the lower river refusing to allow steamboats from New Orleans to land.

The Arkansas River has maintained a very low stage throughout the month, being lower at Little Rock at the end of the month than it has been since December, 1887. The river declined slowly during the month, with only two slight rises, from the 11th to the 13th and from the 16th to the 17th. The range in depth of water was remarkably slight, being but 1.3 foot at Fort Smith, 1.7 foot at Dardanelle, and 1.9 foot at Little Rock. The river was too low for profitable navigation between Little Rock and Dardanelle during the entire month, none but the smallest steamboats being able to run. A navigable stage was maintained, however, from Pinebluff to the mouth.

Little rain fell during the month in the watershed of the Red River, and, as a result, the stream was characterized by very low stages. The upper Red had readings only a few feet above the zero of gauge, while at Shreveport stages below zero were recorded after the 7th. These conditions, together with the rigid quarantine rules in force, necessitated an entire suspension of navigation.

Rivers on the Pacific Coast. (Reported by W. H. Hammon, San Francisco, Cal.; J. A. Barwick, Sacramento, Cal.; and B. S. Pague, Portland, Oreg.)—The rivers have generally fallen slowly during the month. The Sacramento River at Sacramento ranged during the month of September between 8.7 and 8.3 feet, and has about reached its annual lowest point, unless the autumn rains hold off longer than usual, and in that case the river may fall several inches lower. Navigation was some time since obstructed by a sand bar forming about 2 miles below this city; before the commencement of building wing dams to increase the river's depth over the sand bar, the current of the stream, through some unknown cause, cut the sand away, and navigation is now and has been for the past three weeks unobstructed between this city and the mouth of the Sacramento River. Navigation above this city has also been good for the class of steamers that ply on that portion of the river between this city and the head of navigation, which for all practical purposes is Redbluff.

Navigation on the Columbia and Willamette was more difficult than usual, owing to the low stage of the water. During the month many large vessels come into Portland to load grain for England. They carry from 100,000 to 150,000 bushels of wheat each and go down the Willamette and Columbia rivers, drawing up to 23 feet of water. The *Glenlochy*, one of the largest steamships afloat, loaded with over 3,000,000 feet of lumber, left this port for Siberia. These items are given to show that a low stage of water in the river does not impede navigation to the sea.

Heights of rivers above zeros of gauges, September, 1897.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River.	*Miles*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
St. Paul, Minn.	1,967	14	5.5	17-19	4.5	1,2	4.9	1.0
Reeds Landing, Minn.	1,887	12	3.4	22,23	2.5	8,9	3.0	0.9
La Crosse, Wis.	1,822	10	4.3	24-26	3.4	10	4.0	0.9
North McGregor, Iowa	1,762	18	4.1	2	2.9	12	3.5	1.2
Dubuque, Iowa	1,702	15	4.7	2	2.9	13-15	3.5	1.8
Leclaire, Iowa	1,612	10	2.9	3-5	1.7	15-17	2.1	1.2
Davenport, Iowa	1,596	15	4.0	4	2.6	15-17	3.1	1.4
Keokuk, Iowa	1,466	14	3.0	6	1.6	20	2.2	1.4
Hannibal, Mo	1,405	17	3.8	1,7,8	2.5	19,20	3.1	1.3
Grafton, Ill	1,307	23	5.0	1	3.3	22	4.0	1.7
St. Louis, Mo.	1,264	30	6.8	1	3.9	22,23	4.9	2.9
Chester, Ill.	1,189	30	5.0	1	2.5	23,24	3.4	2.5
Cairo, Ill	1,073	40	9.0	1,2	3.7	30	5.6	5.3
Memphis, Tenn	843	33	5.7	1	1.6	27-30	3.2	4.1
Helena, Ark	767	44	8.6	1	1.2	30	4.4	7.4
Arkansas City, Ark.	635	42	8.9	1	0.1	30	3.9	8.8
Greenville, Miss	595	40	7.4	1	0.9	30	3.9	6.5
Vicksburg, Miss	474	41	8.6	1	1.0	30	4.5	7.6
New Orleans, La	108	16	6.0	12	2.5	28	3.8	3.5
Arkansas River.								
Fort Smith, Ark.	345	22	2.4	1	1.1	26-30	1.5	1.3
Dardanelle, Ark.	250	21	1.6	1	— 0.1	24,25; 28-30	0.3	1.7
Little Rock, Ark.	170	23	3.9	1	2.0	29,30	2.7	1.9
White River.								
Newport, Ark	150	22	0.9	1	0.2	25-30	0.5	0.7
Des Moines River.								
Des Moines, Iowa.	150	19	3.7	1	3.0	28-30	3.4	0.7
Illinois River.								
Peoria, Ill.	135	14	3.9	1-15; 17-25	3.7	29,30	3.9	0.2
Missouri River.								
Bismarck, N. Dak.	1,201	14	2.6	1	2.0	19-30	2.2	0.6
Pierre, S. Dak.	1,006	14	2.3	1	0.9	24-30	1.4	1.4
Sioux City, Iowa	676	19	7.0	1-6	5.3	30	6.2	1.7
Omaha, Nebr.	561	18	6.5	1,2	5.0	29,30	5.7	1.5
St. Joseph, Mo.	373	10	2.1	1	0.3	30	1.1	1.8
Kansas City, Mo.	280	21	6.8	1,2	5.0	18,20,22	5.5	1.8
Boonville, Mo.	191	20	7.5	1	4.7	30	6.1	2.8
Hermann, Mo.	95	21	1.6	1	— 0.8	30	0.1	2.4

Heights of rivers above 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.		
Ohio River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Pittsburg, Pa	966	22	6.5	26	5.2	12	5.7	1.3
Davis Island Dam, Pa.	960	25	3.0	26	1.5	16-20	2.1	1.5
Wheeling, W. Va.	875	36	3.0	1	0.9	19	1.8	2.1
Parkersburg, W. Va.	785	35	3.6	1-3	1.4	21-23,29	2.3	2.2
Point Pleasant, W. Va.	703	36	2.6	1	0.8	23-29	1.5	1.8
Catlettsburg, Ky	651	50	3.4	1	0.9	29,30	1.9	2.5
Portsmouth, Ohio	612	50	5.0	1	1.9	25-29	3.0	3.1
Cincinnati, Ohio	499	45	7.1	1	3.2	28-30	4.8	3.9
Louisville, Ky.	367	24	4.3	1	2.4	22-25	3.0	1.9
Evansville, Ind	184	30	6.1	1	1.0	30	2.9	5.1
Paducah, Ky.	47	40	3.7	1,2	0.2	30	1.6	3.5
Alleghany River.								
Warren, Pa	177	7	0.3	1-7	0.0	18-30	0.1	0.3
Oil City, Pa	123	13	0.7	1	0.2	23-27	0.4	0.5
Parkers Landing, Pa.	73	20	1.3	2	0.2	23-30	0.5	1.1
Freeport, Pa.	26	20	1.6	1,3,6	0.7	15,16,18	1.1	0.9
Conemaugh River.								
Johnstown, Pa.	64	7	2.2	25	0.6	10-12,16	1.0	1.6
Red Bank Creek.								
Brookville, Pa.	35	8	— 0.1	25-27	— 0.6	5-23	—0.5	0.5
Beaver River.								
Ellwood Junction, Pa.	10	14	— 0.1	2-4,7	— 0.5	29,30	—0.3	0.4
Cumberland River.								
Burnside, Ky	434	50	0.8	1,2	— 0.7	28-30	—0.1	1.5
Carthage, Tenn.	257	30	1.7	1	0.2	30	0.1	1.5
Nashville, Tenn	175	40	2.7	1	0.5	28-30	1.4	2.2
Great Kanawha River.								
Charleston, W. Va.	61	30	6.2	28	4.5	21	4.8	1.7
New River.								
Hinton, W. Va.	95	14	1.3	26	0.8	20-24	1.0	0.5
Licking River.								
Falmouth, Ky.	30	25	1.0	1-4	0.4	30-30	0.6	0.6
Miami River.								
Dayton, Ohio	69	18	1.6	16	0.8	28-30	1.1	0.8
Monongahela River.								
Weston, W. Va.	161	18	0.7	4	— 2.1	29,30	—1.4	2.8
Fairmont, W. Va.	119	25	0.0	1	— 0.7	13-21	—0.6	0.7
Greensboro, Pa.	81	18	7.3	1	5.8	29,30	6.4	1.5
Lock No. 4, Pa.	40	28	7.6	1-3	4.8	19	6.4	2.8
Cheat River.								
Rowlesburg, W. Va.	36	14	4.2	17	— 0.7	17	1.1	4.9
Youghiogheny River.								
Confluence, Pa.	59	10	0.5	24,25	— 0.1	14-23	0.1	0.6
West Newton, Pa.	15	25	0.6	27	— 0.1	16-20; 24-26	0.0	0.7
Muskingum River.								
Zanesville, Ohio	70	20	5.5	2,3	4.8	30	5.2	0.7
Tennessee River.								
Knoxville, Tenn.	614	29	1.3	1	0.2	30	0.8	1.1
Kingston, Tenn	534	25	0.5	1,2	0.0	11-30	0.1	0.5
Chattanooga, Tenn.	430	33	2.2	2	0.7	27-30	1.2	1.5
Bridgeport, Ala	390	24	0.8	1-3	0.0	24-30	0.3	0.8
Florence, Ala	220	16	0.9	1	— 0.3	22-29	0.1	1.2
Johnsonville, Tenn.	94	21	2.0	1	— 0.1	26-30	0.6	2.1
Clinch River.								
Speers Ferry, Va.	156	20	0.2	2	— 0.7	22,26,28	—0.4	0.9
Clinton, Tenn	46	25	4.2	6	2.0	28-30	2.9	2.2
Wabash River.								
Mount Carmel, Ill.	50	15	1.2	1	0.7	25-30	0.9	0.5
Red River.								
Arthur City, Tex.	688	27	5.6	25	3.3	7-9	4.2	2.3
Fulton, Ark	565	28	2.9	2	2.2	7-13; 26-29	2.5	0.7
Shreveport, La.	449	29	0.6	1	— 0.8	24-27	—0.4	1.4
Alexandria, La	139	33	— 0.6	1-3	— 2.3	30	—1.7	1.7
Atchafalaya Bayou.								
Melville, La	100*	31	9.2	1	2.4	28-30	5.3	6.8
Ouachita River.								
Camden, Ark.	340	39	3.2	1,2	2.5	22-30	2.7	0.7
Monroe, La	100	40	0.8	1	0.0	24-30	0.3	0.8
Yazoo River.								
Yazoo City, Miss.	80	25	— 1.0	1	— 2.6	25,29,30	—2.1	1.6
Chattahoochee River.								
Columbus, Ga.	140	20	0.9	10,11	— 0.9	19	0.1	1.8
Flint River.								
Albany, Ga.	80	20	2.2	1,4	1.1	27-29	1.6	1.1
Cape Fear River.								
Fayetteville, N. C.	100	38	4.6	2	0.3	17	1.4	4.3
Columbia River.								
Umatilla, Oreg	270	16	7.7	1	2.4	30	5.0	5.3
The Dalles, Oreg	166	40	11.5	1	4.5	30	7.5	7.0
Willamette River.								
Albany, Oreg	99	20	1.5	5-9	1.0	1,22-30	1.2	0.5
Portland, Oreg	10	15	5.9	1	1.6	20	3.5	4.3
Edisto River.								
Edisto, S. C	75	6	5.0	1,26-28	2.1	21	3.6	2.9
James River.								
Lynchburg, Va.	257	18	0.3	1	— 0.2	9-22; 27-30	—0.1	0.5
Richmond, Va.	110	12	0.4	4	— 0.4	8,9	—0.2	0.8
Alabama River.								
Montgomery, Ala.	265	35	0.7	1,2	— 1.3	28-30	—0.5	2.0
Selma, Ala.	212	35	0.6	1	— 2.0	28-30	—0.9	2.6
Coosa River.								
Gadsden, Ala	144	18	— 0.2	1-11	— 0.7	24-30	—0.4	0.5
Tombigbee River.								
Columbus, Miss.	285	33	— 2.4	1	— 3.5	22-25; 28-30	—3.1	1.1
Demopolis, Ala.	155	35	— 1.3	1	— 2.4	29,30	—2.1	1.1
Black Warrior River.								
Tuscaloosa, Ala.	90	38	1.0	2,3	— 1.5	29,30	—0.2	2.5
Pedee River.								
Cheraw, S. C.	145	27	1.7	1,4	0.4	17	0.9	1.3

Heights of rivers above 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.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Kingstree, S. C.	60	12	7.4	2	1.2	22-28	3.3	6.2
Lumber River.								
Fairbluff, N. C.	10	6	2.5	1	— 0.4	15-19	0.1	2.9
Lynch Creek.								
Effingham, S. C.	35	12	4.3	28	2.2	18	2.9	2.1
Potomac River.								
Harpers Ferry, W. Va.	170	16	0.7	1	0.0	7-19; 21-24	0.2	0.7
Roanoke River.								
Clarksville, Va.	155	12	0.4	27	— 0.4	13-17, 21	—0.1	0.8
Sacramento River.								
Redbluff, Cal.	241	23	0.7	2	0.0	18-30	0.1	0.7
Sacramento, Cal.	70	25	8.7	1-11	8.3	26-30	8.5	0.4
Santee River.								
St. Stephens, S. C.	50	12	5.1	27	— 1.4	18-22	1.0	6.5
Congaree River.								
Columbia, S. C.	37	15	2.0	23, 24	1.5	1-22; 25-30	1.5	0.5

Heights of rivers above 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.		
Wateree River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Camden, S. C.	45	24	5.0	1	1.7	18, 19	2.6	3.3
Savannah River.								
Augusta, Ga.	130	33	12.5	24	4.2	16, 18	5.7	8.3
Susquehanna River.								
Wilkesbarre, Pa.	178	14	1.0	28, 29	— 1.0	4-26	—0.7	2.0
Harrisburg, Pa.	70	17	2.2	29	0.5	15	1.0	1.7
Juniata River.								
Huntingdon, Pa.	80	24	3.8	24	2.8	1-23, 30	2.9	1.0
W. Br. of Susquehanna.								
Williamsport, Pa.	35	20	2.4	25	0.0	11, 12	0.7	2.4
Waccamaw River.								
Conway, S. C.	40	7	2.4	4	0.9	18	1.5	1.5

*Distance to Gulf of Mexico.

SPECIAL CONTRIBUTIONS.

THE HIGHEST KITE ASCENSIONS AT BLUE HILL.

By S. P. FERGUSSON (dated October 20, 1897).

On September 19, 1897, the kite meteorograph was raised to a height of 2,821 meters (9,255 feet) above the summit of the Hill, or 3,013 meters (9,885 feet) above sea level. The highest kite was 40 meters (131 feet) above the meteorograph, or 3,052 meters (10,016 feet) above sea level. The height reached by the meteorograph was 510 feet higher than that reached on October 8, 1896.

At the top of the line were two self-adjusting kites of the Hargrave pattern, having an area of 36 and 41 square feet. Five other kites of the same pattern, having an area of 22.9 square feet each, were respectively attached at the following distances from the top kites: 500, 1,500, 2,500, 3,500, and 5,000 meters. The length of the line employed was 6,300 meters, as shown by the register attached to the windlass. This register is made to indicate 1.5 per cent less line than is actually employed, in order to allow for sagging. The weight of the line was 59 pounds, and the pull, when 5,000 to 6,300 meters were out, varied between 104 and 152 pounds, the latter amount being about one-half of the breaking strain of the wire.

The instrument left ground at 0:01 p. m., and the highest point was reached at 4:17 p. m. At this time the angular altitude of the meteorograph (observed by means of a surveyor's transit) was 26.6°. At the windlass the angular altitude of the line was but little lower than that of the meteorograph. The work of reeling in the line began at 4:30 p. m., and the meteorograph reached the ground again at 6:40 p. m., having been in the air six hours and thirty-nine minutes, and during nearly five hours of this time, at a height of nearly 1 mile or more above sea level. There were stops of three to fifteen minutes after every 500 meters of line were let out or reeled in, and a stop of twenty minutes was made near the highest point.

The record obtained from the meteorograph is nearly complete, and is one of the smoothest that has been obtained. The record of relative humidity is incomplete at the highest point, and also a break of one hour's duration occurred in the record of height between 4 and 5 p. m. The record of temperature is complete.

The temperature at the highest point was 37.6° while at the Observatory it was 63°, the rate of fall being more rapid below the height of 2,000 meters above sea level than above it. The relative humidity rose rapidly until 700 meters was reached, then between 900 and 1,400 it fell lower than the humidity recorded at the Observatory. Between 1,450 and 1,900 meters the humidity was very high, and at 2,100 it fell again, afterward rising slightly at 2,200 meters and falling at 2,400 meters; above 2,500 meters it was very low, the trace going to 26 per cent and probably lower, the incompleteness of the record at the highest point rendering it impossible to determine the lowest reading. The wind at the ground was from the south and southwest during the entire flight, and varied in velocity from nearly 30 miles at noon to 20 miles an hour at 6 p. m. The direction of the wind gradually became westerly with increasing altitude, and above 2,000 meters it was almost exactly west.

On October 15, 1897, the meteorograph was raised to a height of 3,379 meters (11,086 feet) above the hill, or 3,571 meters (11,716 feet) above sea level. This height is 558 meters (1,831 feet) greater than that reached on September 19. The highest kite was 40 meters above the meteorograph, or 3,611 meters (11,847 feet) above sea level.

At the top of the line were a Lawson ribbed kite, having an area of 71 square feet, and an adjustable Hargrave kite, having an area of 36 square feet. Two other Hargrave kites, having an area of 22.9 square feet each, were respectively attached at distances of 2,000 and 3,500 meters from the top kites. The length of line employed was 6,300 meters, and the pull, when all the line was out, varied between 125 and 150 pounds. The instrument left ground at 3:48 p. m., and the highest point was reached at 6 p. m. The work of reeling in the line began at 6 p. m., and the instrument reached ground at 8:20 p. m.

The record obtained from the meteorograph is one of the best that has been secured, being complete, with very clear and smooth lines. (The meteorograph sheet is reproduced in facsimile as Chart VIII.)

The temperature at the highest point was 41°, and at the observatory it was 72°. An interesting feature of the flight was the passing of the meteorograph through the cumulus and alto-cumulus cloud levels, as shown by the increase, followed by decrease, of humidity at heights of 1,500 and 2,800 meters.

At the ground the wind direction was southwest during the entire flight, and the velocity varied between 13 and 22 miles an hour. Above the height of 1,000 meters the direction of the wind was northwest.

No mishap of any kind occurred during the experiments, the steam windlass reeling in the line easily and smoothly at a rate which was made to vary from 0.5 to 2.7 meters a second, according to the strain upon the line. The experiments were conducted under the direction of Mr. Rotch by Mr. Clayton, Mr. Sweetland, and the writer, and formed two of a series of high-level flights now being made with the aid of a grant of money from the Hodgkins fund held by the Smithsonian Institution.