

2,400 feet the thermometer read 60°, with a temperature of 85° at the earth's surface. The rate of fall in this case was about 10° per 1,000 feet, or more than three times the average rate.

The conclusion to be drawn from available data is that the stagnant atmospheric condition attending periods of excessive heat extends a mile, and probably two or three miles, or more, above the earth with temperature gradients about or greater than the average, and that heated periods are due to a slowing up of atmospheric movements over a large area and a gradual superheating by the sun's rays of the stagnated air mass. Observations show also, that the termination of a heated period is indicated about two days in advance by an acceleration of the upper air currents, by a sharp decrease in upper air temperatures and by an increase in the temperature gradient at elevations of 8,000 to 10,000 feet, or more, above the earth.

During a greater portion of the month high barometric pressure over high latitudes of the North Atlantic Ocean caused a flow of exceptionally cold northerly winds over the British Isles and adjacent portions of continental Europe. On the 18th pressure began to fall over Iceland and from the 20th to 25th an area of low barometer occupied the British Isles.

During the second decade of the month low pressure over Bering Sea and high pressure over the Hawaiian Islands apparently contributed to the warm period of the third decade over the United States, and a reversal of pressure distribution over the Pacific area during the third decade was followed over the United States by a change to cooler weather during the closing days of June and the early portion of July.

Based upon changes in Atlantic and Pacific pressures the following special forecast was issued Saturday, June 26:

The warm wave that has covered the country east of the Rocky Mountains during the past week will begin to moderate Monday and the week beginning the 28th will as a whole be cooler than the preceding week.

A gradual moderation in temperature began over the eastern portion of the country on June 29 and during the early days of July temperature fell below normal over eastern and northern districts with minimum readings close to the July record in the Middle Atlantic States.

#### BOSTON FORECAST DISTRICT.\*

[New England.]

The first half of the month was cool, and the latter half warm with excessive temperatures on several days. General rains fell on the 5-6th and 17-18th; during the balance of the month precipitation was in the form of irregularly distributed showers. No storm warnings were issued and no gales occurred on the coast.—*J. W. Smith, District Forecaster.*

#### NEW ORLEANS FORECAST DISTRICT.\*

[Louisiana, Arkansas, Oklahoma, and Texas.]

Abnormally warm weather prevailed during the greater portion of the month, and rainfall was unevenly distributed, being deficient in some localities and in excess in others. The only storm of the month appeared off the mouth of the Rio Grande River on the 30th, and northeast storm warnings were ordered for the Texas coast. The storm moved westward into Mexico and reports indicate that it was the most severe that has visited the section near the mouth of the Rio Grande in several years.—*I. M. Cline, District Forecaster.*

#### LOUISVILLE FORECAST DISTRICT.\*

[Kentucky and Tennessee.]

The periods 6-10th and the last eight or nine days of the month were unusually warm. About the middle of the month there were several cool waves of short duration. Rainfall was in excess in eastern Kentucky and central Tennessee, and was deficient in other portions of the two States. Thunderstorms were frequent and there was some minor damage from lightning and local squalls.—*F. J. Walz, District Forecaster.*

#### CHICAGO FORECAST DISTRICT.\*

[Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, and Montana.]

No storm warnings were issued for the upper Lakes. One frost warning and two advisory warnings were sent to the cranberry marshes of Wisconsin which enabled the growers to anticipate the occurrence of frost.—*H. J. Cox, Professor and District Forecaster.*

#### DENVER FORECAST DISTRICT.\*

[Colorado, Wyoming, Utah, Arizona, and New Mexico.]

Precipitation was deficient except on the middle-eastern slope, a feature of the month being the persistency of rainfall in southeastern Wyoming, where the amount was the greatest for June of record. Special warnings were issued for high water in the Grand, Colorado, Arkansas, and Rio Grande rivers. The freshets in these streams were due to melting snow and the fluctuations followed closely changes in temperature.—*F. H. Brandenburg, District Forecaster.*

#### SAN FRANCISCO FORECAST DISTRICT.†

[California and Nevada.]

The month was one of quiet weather. The first decade was cool and the second unusually cool. The third decade was warmer, and on the 23d temperature rose to 100° in the Santa Clara Valley, and to 94° in the San Francisco Bay cities. This was the warmest day recorded for four years. It is interesting to note that a dry period, extending about seventy-six days, was broken June 17 by light rains. Such rains are unusual in June. They were forecast with precision.—*A. G. McAdie, Professor and District Forecaster.*

The following letter from Professor McAdie calls attention to a warning given to a vessel that evidently was lost because the warning was not heeded:

SAN FRANCISCO, June 23, 1909.

I inclose a clipping relative to the British tugboat *Grayling* and the American steamer *President*, Captain Cousins, Master. I have verified the facts in the case as far as possible and interviewed the reporter who wrote the article and who spoke directly to Captain Cousins.

I would be glad if the Chief of Bureau would give publicity to this kindly act of Captain Cousins. There are few men in command of large passenger steamers (where the minutes count and where every ton of coal is checked) who would go out of their course to give warning to a smaller vessel. It was the action of a generous and humane man. May the time speedily come when all masters will feel it incumbent upon themselves to do all they can to be of service to others under such circumstances.

The following from the San Francisco Examiner of June 20, 1909, is referred to in the above quoted letter:

The British tug *Grayling*, which sailed from British Columbia for San Francisco on the way to Ancon, is given up as lost. She sailed on May 31 and should have reached port in three days. She had only eight tons of coal on board, which in ordinary weather would last four days. The last seen of her was when passing Cape Flattery on the Sound, when she passed out two miles ahead of the steamer *President*.

Captain Cousins of the *President* saw the danger the little vessel was in, and fearing she was not aware of an approaching storm, steered to the *Grayling* and hailed her. Cousins considered her situation so precarious that he went out of his way a mile to warn her.

When alongside the *Grayling* Cousins told the skipper of the latter that the Weather Bureau had predicted a violent storm. The warning was not acted upon, and as nothing has been heard from the *Grayling* since it is believed she foundered with all on board.

#### RIVERS AND FLOODS.

The Missouri River continued to rise during the first three weeks of the month, and stages slightly above the flood stage were reached between Blair, Nebr., and Boonville, Mo. Heavy rains in the Black Hills regions during the latter part of May and the first decade of June resulted in general floods in all the western tributaries in the State of South Dakota, and much damage was done to mines, irrigating plants, and crops. The

\* Morning forecasts made at district center; night forecasts made at Washington, D. C.

† Morning and night forecasts made at district center.

effects of these floods were felt in the Missouri River early in June, and more or less overflow occurred between Yankton, S. Dak., and the mouth of the Niobrara River. Considerable damage was done to hay and pasture lands in this section while in the Black Hills region the losses amounted to about \$500,000. Warnings to remove stock and portable property were issued in ample time.

Nothing of special interest occurred along the Mississippi River. The lower river remained quite high at stages a few feet below the flood stage, a rise from the Ohio and upper Mississippi rivers coming down before the flood waters of the previous month had passed out. In the Vicksburg, Miss., district crops to the value of \$150,000 and other property to the value of \$10,000 were destroyed.

The upper Mississippi River was slightly above the flood stage in the vicinity of Hannibal, Mo., on the 12th and 13th on account of heavy rains above, and was again rising rapidly at the end of the month under the influence of heavy rains and a decided rise over the watershed of the Des Moines River. The Illinois River was above the flood stage during much of the time, but there was no resulting damage of consequence.

Excellent boating stages prevailed along the Ohio River.

The heavy rains of the 2d and 3d over the South Atlantic States caused general floods in the rivers of the Carolinas, and warnings were issued on those days. Livestock, etc., to the value of about \$75,000 were saved, and crops to the value of

about \$25,000 were destroyed. The floods in the Tombigbee River and the rivers of central and southeastern Mississippi about the same time were noted in the MONTHLY WEATHER REVIEW for May, 1909.

The freshets in the Grand, the Colorado, the upper Arkansas, and the Rio Grande were fully covered by special warnings issued while the unmelted snows still covered the mountain slopes. The freshets were due to the melting snows, and the fluctuations, the greatest in many years, followed closely the changes in temperature.

The annual rise in the Columbia River reached its maximum at Portland, Oreg., on the Willamette River, on the 21st with a crest stage of 21.6 feet, 6.6 feet above the flood stage. A report on this rise will be made later.

The Sacramento River remained at moderate stages, while the San Joaquin was generally above flood stage, though only moderately so, and without unusual incident.

The highest and lowest water, mean stage, and monthly range at 215 river stations are given in Table IV. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—H. C. Frankenfield, Professor of Meteorology.

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

ANNUAL RISE OF THE COLUMBIA RIVER, 1909.

By E. A. BEALS, District Forecaster, Portland, Oreg.

The two principal features to be considered in connection with the annual rise of the Columbia River are the amount of snow in the mountains within the drainage area of that stream at the close of the cold season and the subsequent temperatures in relation to their effect upon the melting of this snow. Summer thundershowers also affect the behavior of the rise, but their importance is insignificant as compared with the other two factors. Reports received at the end of March from Weather Bureau sources showed that the snowfall at the headwaters of the Snake River was unusually heavy and well packed, and reports from the Canadian Meteorological Service and from the Weather Bureau showed the snowfall at the headwaters of the Columbia River to be heavier than last year and in some places to be above the average for a number of years. During the spring months the newspapers published, from time to time, items stating that the snow was very heavy in the mountains within the drainage area of the Columbia River.

The temperature and precipitation data for the northern Plateau as published in the MONTHLY WEATHER REVIEW reflect fairly well the conditions prevailing at higher elevations in the same localities, and as this district is largely within the Columbia River Basin, a table showing these data follows:

TABLE 1.—Temperature and precipitation of the northern Plateau during the cold season, 1908-9.

Month.	Temperature.		Precipitation.	
	Mean.	Departure.	Average.	Departure.
1908.				
November .....	42.0	+3.0	0.83	-0.55
December .....	30.4	-1.8	0.80	-0.90
1909.				
January .....	29.0	+0.3	2.72	+1.10
February .....	37.7	+5.6	1.90	+0.50
March .....	43.2	+3.0	1.01	-0.60
	36.5	+2.0	7.26	-0.45

The northern Plateau precipitation, as will be seen by the foregoing table, was 0.45 of an inch below normal and the tem-

perature was 2° above normal. The precipitation was heavier than usual in January and February and below normal during the other months when the precipitation was likely to be mostly in the form of snow. The backward spring kept the snow from melting in the mountains until very late in the season.

The reports of heavy snow in the mountains combined with the backwardness of the spring caused the people affected by the annual rise of the Columbia River to become unduly alarmed, and many irresponsible people made predictions that the rise this year would exceed that of all former years. Telegraphing of river reports to this office began on March 1 and they were continued until the latter part of June from nearly all the stations and from a few of the most important stations till the end of July.

The river did not begin to show any material rise until the third decade in June, but it was necessary to have the reports telegraphed in order to allay the alarm of the people living in the flooded areas, and who were expecting a big rise on account of the alarming reports that had been disseminated by the newspapers.

During the entire rise accurate forecasts of the height that the water would reach were issued from this office covering periods of from four to six days in advance of their appearance. At no time did the stage reached fall short of the stage forecast by more than a few tenths of a foot and the forecast for the crest of the flood was only two-tenths of a foot higher than the stage actually reached.

Table 2 shows the crest stages at all the river stations affected by the rise.

It will be noticed on the hydrograph, Fig. 1, that there were two crests at Portland, an unusual occurrence. For the purpose of comparison Table 3 presents the stages of all the recorded flood crests at Portland, Ore., due to the annual rise in the Columbia River.

After the first crest of 20.5 feet was reached on June 10 many people affected by the rise thought that this was the highest stage that would be reached, but all were told that the river might rise again and advised not to place their goods in jeopardy until they were assured that the danger had passed. This advice was well received and when the second rise oc-