WEATHER IN CINCINNATI, OHIO, FOR 130 YEARS.

By W. C. DEVEREAUX, Meteorologist.

[Dated Weather Bureau, Cincinnati, Ohio.]

The first permanent settlement in the State of Ohio was made at Marietta in the spring of 1788, and during the fall of the same year three settlements were started at and in the vicinity of what is now the city of Cincinnati. These settlements were first called Columbia, Losantiville and North (or Great) Bend. The name Losantiville was changed to Cincinnati by Gov. St. Clair on January 1, 1790; Columbia was annexed to Cincinnati several years later; and North Bend is a separate town a few miles below the city.

In the year 1815, Dr. Daniel Drake published his book entitled a "Picture of Cincinnati," and nearly one half of this excellent volume of 251 pages is devoted to "Observations on the weather, the earthquakes, the aurora borealis and the southwest wind."

The daily observations summarized in Drake's book cover a period of eight years from 1806 to 1813, inclusive, and occasional observations are given for the period from 1789 to 1805. The thermometers used were "made in London and known to be correct by being subjected to the proper experimental examination." They were hung in contact with wood on the north side of the house, under shelter, and read before sunrise and at or a little after 2 p. m.

Up to 1815 the greatest degree of cold ever observed at this place was 18° below zero on January 8, 1797, as recorded in the manuscript of Gov. Sargent. During eight years the thermometer fell below zero on an average of two times each year and rose to 90° or higher fourteen times each year. The average annual temperature was 54° and the annual rainfall was about 36 inches, although "the amount had not been accurately determined." That these figures are unusually reliable is shown by comparison with 48 years record by the Weather Bureau ending with the year 1918, when the average temperature was found to be 55° and the rainfall 38 inches. In this connection it is interesting to note that Drake said in 1815, when Cincinnati was about 25 years old, "that our climate has undergone a change is the opinion of many people."

Drake states the the amount of snow which fell each winter averaged about 18 inches, and the usual fall for each storm was not more than 4 inches, except in one storm when about 10 inches fell. The ground seldom remained covered with snow longer than two or three days. Frosts, probably light, were reported as late as the first week in May, and the earliest frost in the fall occurred during the last week in September, but on the last day of August in 1789, "the Indian corn in the northern part of Kentucky was killed by frost." The Ohio River at Cincinnati was "blocked up" with ice every fifth year on an average. The new town was flooded in 1793 and again in December, 1808.

Drake found from six years observation that the wind at Cincinnati was southwest about 30 per cent of the time, and that all the severe winds were from the southwest or northwest. The most destructive windstorm was that of May 28, 1809, when several buildings were demolished, and "the tornado ascended the hill to the northeast of the town, forming a track through the forest, which remained visible more than a year," but the inhabitants escaped injury. On the 20th of April, 1814, "a tornado laid waste a strip of country between this town and Chillicothe, and another of great violence was experienced 60 miles south in the State of Kentucky." A brilliant aurora borealis occurred on Sunday, April 17, 1814, and according to the description by Drake, it was quite similar to the one observed at Cincinnati, on March 7, 1918. Another one, but less brilliant, occurred on September 11, 1814, and Drake states that these two are perhaps the only unequivocal instances of the aurora borealis observed in the Miami country since its settlement and up to 1814.

According to Drake's records, earthquakes were very frequent for the two years beginning in December, 1811; there were distinct shocks on 27 days in 1812 and some of these were quite severe. As far as known this record of earthquake intensity has never been equaled during any other year in the past 130 years.

Unfortunately the detailed weather records for the period from 1814 to 1834 have not been preserved, if any were kept. The newspapers and other publications of the time gave only casual mention of the weather, and did not publish, as far as known, complete weather data. A record of the temperature for that period was made at College Hill, which is now a suburb of Cincinnati; and the mean annual temperatures were later published in Smithsonian Contributions to Knowledge. These temperatures are shown in the accompanying table and the record is continued until 1848 for comparative purposes. It will be seen that the temperature at College Hill averaged 1.5° lower than that for the lower sections of the city. The maximum and minimum temperatures each year are not available for College Hill, but the highest and lowest temperatures for Marietta, Ohio, for the period of 1818 to 1834 are published in Hildreth's Pioneer History, and these are given in the table. These give a rough estimate of the extreme temperatures at Cincinnati, as the difference in the temperature between the two places seldom exceeds 5° and is usually not more than 2° or 3°.

From miscellaneous sources it is learned that the weather between 1814 and 1834 was of about the ordinary type, with the following exceptions: The months of February and March in 1815 were unusually mild with heavy rains in March, which were followed by a flood in April. The year 1816 was remarkably dry and cold, but the following year was prolific in both heavy rains and high waters. The months of February, 1818, and January, 1821, are described as very cold. Very heavy rains set in in December, 1827, which resulted in a flood in January, 1828, when the river reached a crest stage of 58 feet, probably on the 11th. The rains continued generally heavy during the first half of 1828. The winter months of 1831 were extremely cold and the average temperature for the whole year is the lowest on record, the average at College Hill being 48°, which is 2.4° lower than the record made in 1917, at the Abbe Meteorological Observatory in Clifton, a short distance from College Hill. December, 1831, was described as the coldest December "within the memory of the oldest inhabitants," and it was probably the coldest one since Cincinnati was founded, with the possible exception of December, 1917. At Portsmouth, Ohio, the average temperature for December, 1831, was 22.9°, or 2.7° lower than for the same month 1917, and the temperature at Portsmouth averages about 1° higher in December than at Cincinnati. The "great freshet" of 1832 was preceded by a long spell of unusually severe winter weather with heavy snow, broken by a thaw late

in January. The river reached a crest stage of 64.2 feet on February 19, and this was the highest stage which had occurred during the past 40 years.

Complete weather observations were begun in 1835, in the lower portion of the city, by Dr. Joseph Ray, then professor of mathematics at Woodward College, afterwards Woodward High School. These observations were continued at the same location by Dr. Ray with the assistance of a few others until 1855, when the work was turned over to Prof. Harper. The daily observations for 1837 were published in the Western Academican and the monthly summaries for the period from 1835 to 1850 were published in "Cincinnati in 1851" by Charles Cist. In a special article on "Meteorology" by Dr. Ray, in Cist's "Cincinnati in 1841", the general weather conditions are summarized as follows: "The climate of Cincinnati and vicinity is such as might be expected in its appropriate latitude. It differs from the same parallel at the Atlantic only in being rather more variable in the range of the thermometer, and in the greater frequency of rain in the winter months. Indeed, a fall of many degrees in the thermometer in the course of but a few hours is not uncommon in this city at any period of the year. The cold weather in winter is of intensity equal to that of the east, and perhaps the north, but severe frosts are less frequent in their occurrence, and of briefer existence. Snow rarely lies long enough to furnish sleighing, and the constant alternation of freezing and thawing renders the traveling through unpaved streets in the winter season very unpleasant."

In Februray, 1835, the temperature was 17° below zero and that record was not equalled again until February, 1899. March, 1836, was very cold with temperautre 4° below zero, which exceeds by 5° all low records for March. In April, 1837, 6 inches of snow fell on the 4th and the hilltops were again covered with snow on the 23d. A period of eight very wet years began in 1843 with a total precipitation of 51.25 inches, reached a maximum of 65.18 inches in 1847, and ended with 54.76 inches in 1850. The amount for June, 1845, was 11.50 inches and has been exceeded only once in any month, and the annual amount for 1847 is much the largest on record. The precipitation during this year was so large that the question has been considered as to whether Dr. Ray's rain gage was of standard type and properly exposed, and possibly some allowance must be made for the methods used in securing the records; however, 1847 must have been a very wet year as the river was high, reaching a crest stage of 63.6 feet, and there was 20.6 inches of snow in December. The daily papers in January, 1848, mentioned the fine "old fashioned" sleighing which was being enjoyed at that time, but the same paper a few days later stated that the sleighing had been ruined by a warm rain. There was 10.33 inches of rain and snow in December that year. The snowfall during the winter of 1849–50 reached the remarkable total of 50 inches, which exceeds by 10 inches the amount for any other year.

In the year 1855 Prof. Geo. W. Harper took over the work of making the weather observations and continued the same until 1902. The instruments remained at the Woodward High School until August, 1859, when they were moved to Prof. Harper's residence on Gilbert Avenue, Walnut Hills, near the northwest corner of Eden Park. These records were made for the Smithsonian Institution and only abstracts were retained by Prof. Harper, consisting of monthly data for temperature, pressure, wind direction, and weather, daily data for rainfall and snowfall, and meteorological notes, all of which have recently been turned over to the Weather Bureau. Precipitation records were kept also by R. C. and J. H. Phillipps and F. W. Hurtt from 1855 to 1870, and the monthly and annual amounts have been taken from the Smithsonian publications.

The winter of 1855–56 was the "longest and most severe within the memory of the oldest inhabitants." Near zero weather prevailed for about two months, the lowest being 2° below in December, 14° below in January, with 21° below to the north of the city, and 13° below in February. The Miami River at Hamilton, Ohio, was frozen over on November 4 and remained so until the night of February 22, and the Ohio at Cincinnati was frozen over from January 15 to February 2, it being an "everyday sight to see four-horse teams" crossing on the ice. The following winter was also cold, but the months of December, 1857, and January, 1858, were warm, the lowest temperature in December being 25° and the lowest in January 28°, while the mean for January, 42.5°, is the highest on record for that month. Heavy rains fell the following month, causing a flood of 55.3 feet on February 23. On May 21, 1860, a severe "hurricane" passed over the city, destroying thousands of dollars' worth of property and several lives. It lasted for over a half hour.

In the spring of 1861, frost and ice formed as late as May 2, and there were severe thunderstorms with heavy falls of hail on May 27, June 21, and July 1 and 12, followed, on August 21, by an extraordinary rainfall of 3.35 inches in two hours. In 1862 there was a violent windstorm on February 19, a destructive tornado on May 21 "before day," several severe thunderstorms during the summer months, a bright aurora borealis, and a great range in temperature in October, the highest being 91° on the 8th and the lowest 27° on the 26th.

In the "great snowstorm" of January 15, 1863, 20 inches of snow fell in about 24 hours, and during the "cold New Year's" in 1864 the temperature averaged 10° below zero for the day. February was also cold in 1864, with 5° below zero, and a heavy snowstorm occurred that year on May 11, the snowfall being 1 inch and the temperature 33°. Heavy snow fell in December, 1864, and there was deep snow on the ground during January and the first part of February, and heavy rains fell in March and again in July, causing a high river until the middle of August, with flood stages of 56.2 feet on March 8 and 51.2 feet on May 14. In 1866 there was a light frost as late as May 14, and the whole summer was very cool and wet. The rainfall for September that year was 10.88 inches, which is the third largest monthly amount on record, and for the three months of June, July, and August, the total amount was 26.24 inches, which exceeds all other periods of three months since the records began in 1835.

During the night of June 18–19, 1868, there was an excessive rainfall of 4.50 inches. A moderately heavy snowstorm occurred on October 19, 1869. In 1870 the river reached a crest stage of 55.2 feet on January 19; on June 29 there was an excessive rainfall of 2 inches in 30 minutes; and the months of August and September were very dry.

In 1868, Mr. Frank A. Armstrong, manager of the Western Union Telegraph Co., began the issue of a crude "weather report," showing the weather at about a dozen places. Early in 1869 Prof. Cleveland Abbe, Director of the Astronomical Observatory at Cincinnati, became an interested observer of these maps, and with the assistance of the chamber of commerce, he began the preparation of complete weather maps in the fall of that year. These maps contained reports from about twenty stations to-

gether with a summary of the general weather conditions and local forecasts, and were continued until Prof. Abbe was called to Washington to take charge of the forecast work in the Weather Bureau, which was established as a part of the Signal Corps of the Army, in 1870.

The Weather Bureau opened an office in the old Pike's Opera House, at the corner of Fourth and Vine Streets, on October 12, 1870. Observations were made at that point until March 1, 1885, when the office was moved to the Federal Building at the corner of Fifth and Walnut Streets, where the observations have been continued to date. Prof. Harper continued his observations on Walnut Hills for several years, and the highest and lowest temperatures are given in the table each year from 1871 to 1884 for both Walnut Hills and the lower section of the city to show the variation between the two points. The maximum temperature was highest in some years on the hilltops and other years in the valley, but the minimum temperature was nearly always lowest on the hilltops, the greatest difference being 10° in 1884, when 20° below was recorded on Walnut Hills and only 10° below at the Government building.

In 1871, a heavy frost on April 23 injured fruit trees and a light frost occurred on May 10. The summer of 1874 was extremely warm; the maximum temperature of 103° in July has been exceeded only twice in Cincinnati during the past 91 years, and the average temperature for June, 79.8°, has never been exceeded. The winter of 1874–75 was very severe, and the river was twice blocked by ice and once frozen over. By the middle of February over 5,000 families were deprived of water due to the bursting of many leading water mains by freezing. The month of March, 1875, was remarkable for the great and frequent changes in temperature, and the frequent snows, rains, and thunderstorms. A violent sleet storm occurred on March 3 between 1 a. m. and 8:30 a. m. and four days later, on the 7th, 6 inches of snow fell during the afternoon. On the last day of that year the temperature rose to 72°.

The following year, 1876 (Centennial year), was as remarkable in its weather as in other ways. The year opened with warm, pleasant weather, followed by heavy rains in January; very changeable weather during the spring months; hot, oppressive weather during the summer with an unprecedented hot spell of three days in July; frequent thunderstorms in August, and extremely cold weather in December, when the Miami Canal and ponds froze over on the 2d, the temperature fell to 6° below zero on the 9th, the Ohio gorged on the 10th, with people crossing on the ice by the 19th and heavy loads crossing in safety during the last week of the year. The ice finally went out on January 14, 1877, at a river stage of 32 feet, involving great loss to the river interests.

There was a heavy frost on May 2, 1877, and a very light frost was observed September 19 the same year. The winter of 1878–79 was very cold with temperatures from 1° to 5° below zero in December and from 10° to 16° below in January. The river was gorged with ice from December 25 to January 13 and nearly full of floating ice until February 22, and the snowfall was heavy for the winter with a fall of 4 inches on February 17. The rainfall for August in 1879, 11.72 inches, is the greatest amount ever measured in one month at Cincinnati, and the total amount for 1880, 54.67 inches, is the largest annual amount since 1847. On the 14th of June, 1880, a terrific storm occurred when 2.30 inches of rain fell in two and one-half hours. The following November was the coldest on record. The temperature on the morning of the 19th was 5° above zero at the Federal Building, where a dense fog prevailed, but on the hilltops, where the weather was clear, it was 12° below zero, and on the 27th the canal was frozen to a depth of 5 inches.

The period of three months, beginning with July and ending with September in 1881, is the longest period of intense heat on record for this city. In July the temperature was above 100° on four consecutive days, the maximum of 103.5° and the mean of 81.6° have been exceeded only once in the past 91 years, and the means for August and September have never been exceeded in the corresponding months. In 1882 the river reached a crest stage of 58.6 feet on February 21, which was the highest since 1849; snow fell on April 10, and three light frosts occurred in May, the last on the 23d.

Beginning with August, 1879, and ending with May, 1884, was a period of nearly five years of great rains. The annual amount each year was from 10 to 16 inches above the normal, and during that time 5 of the 12 months recorded the greatest amount on record, for the respective months. These years of great rains culminated in the great floods of 1883 and 1884. In the flood of 1883 the river reached a crest stage of 66.3 feet on February 15, which was the highest stage ever known up to that time, but this record did not stand long, as one year later, lacking one day, viz February 14, 1884, the river reached the extreme stage of 71.1 feet, which has never been exceeded. The last flood was preceded by heavy snows in December and January. In December 10 inches of snow fell between noon of the 22d and noon of the 23d and the snowfall for the month amounted to 17.5 inches followed by 9.8 inches of snow in January. On January 5 the temperature at the Federal Building was 10° below zero, while Prof. Harper's thermometer on Walnut Hills registered 20° below—the lowest on record for this city. Moderately heavy ice formed in the river, but the river did not freeze over, due to the comparatively high stage and to the fact that the weather during January was not extremely cold except from the 4th to the 7th. The extreme high water in February was due to the heavy rains, melting snow, and high temperature during the first half of that month. The rainfall at Cincinnati from February 4 to 13 was 6.82 inches, and this amount has seldom been exceeded during a whole winter month, and the temperature during that time varied between 40° and 67°. The temperature fell to 20° on the 14th, and the flood and cold weather caused intense and widespread suffering, besides the enormous property loss.

For several years following the "great flood" the weather was nearly normal, with mild winters and moderately warm summers and generally free from severe storms. The winter of 1892–93 was unusually cold, and the river was frozen or full of floating ice during the entire month of January. In 1895 the temperature fell to 12° below zero on February 12, and rose to 84° on March 29, both being near the extreme records for the months.

The year of 1897 was characterized by heavy rains and high water. On February 26 the river reached a crest stage of 61.2 feet. A few days later an excessive rain of 4.97 inches fell in about 16 hours, on March 4–5, and this amount has never been exceeded at Cincinnati for the same length of time, and the total amount for that month, 9.89 inches, has never been exceeded in February, March or April. Following this excessive rain on March 4–5, the river rose rapidly again but just reached the flood stage of 50 feet. On May 2, 1.5 inches of snow fell. The rains were especially heavy also in the months

of July and November, 1897, and continued heavy during the first three months of 1898, resulting in another flood with a crest stage of 61.4 feet on March 29.

The year of 1899 was one of extremes in temperature; the lowest in February, −17°, is the lowest ever recorded by the Weather Bureau for any day, and the highest for September, 99°, is the highest on record for that month. The average temperature for the week of February 8 to 14 was zero, and the minimum temperatures were as follows: −1° on the 8th, −17° on the 9th, −12° on the 10th, −3° on the 11th, −6° on the 12th, −11° on the 13th and 0° on the 14tn. The temperature was below zero for fifty consecutive hours and the highest during the five days was 8° above zero. There was considerable ice in the river during February, but no gorge formed. On March 8 the river reached a crest stage of 57.4 feet. During the following summer the temperature was above 90° on 32 days during June, July, August and September and the year ended with a temperature of 2° above zero on December 31.

The year 1900 passed without unusual features, but the year 1901 was very hot and exceedingly dry, especially from August to November. In April the river reached a crest stage of 59.7 feet on the 27th, but this flood was due to heavy rains above, as the amount for April at Cincinnati was less than 2 inches, and the total rainfall for the year was only 17.99 inches, which is considerably less than in any other year. July, 1901, was the warmest month on record, and neither the extreme of 105.2° on the 22d, nor the mean for the month, of 82.4°, has been exceeded in any month. During this month the temperature was 100°, or higher, on four days, and above 90° on 23 days. December of that year was almost as cold as July was warm, and the minimum of 7° below zero on December 15 had been exceeded only once in December, previous to 1917.

An extraordinarily heavy and excessive downpour of rain occurred near noon of May 20, 1902, when 2.28 inches feel in 30 minutes, which exceeds by 60 per cent the next heaviest rain for the same length of time made by an automatic recording gage.

The years from 1903 to 1906 were nearly normal. Heavy rains in January, 1907, caused a flood of 65.2 feet on the 21st of that month, and on March 12–13 of the same year 5.85 inches of rain fell in 31 hours, the greatest amount within 24 hours being 5.22 inches. This amount has never been exceeded for 24 hours, but the rate for 16 hours was exceeded in the storm of March 4–5, 1897, and the rate for 30 minutes was exceeded on July 7, 1912. In the second large flood of 1907, the river reached a crest of 62.1 feet on March 18.

The summer of 1908 was very warm with 42 days on which the temperature was above 90°, but no extreme high temperatures were recorded, and the rainfall of 0.62 inches between August 18 and November 9 is the smallest on record for such a long period. Heavy snow fell during the night of December 24, 1909, and this was followed by several more heavy falls during January and February, 1910, the amount being greatest on February 17, when 10.8 inches fell in 24 hours. The snowfall for that winter was 40.4 inches, which is the greatest amount recorded since 1850. On October 5 and 6, 1910, 4.30 inches of rain fell within 24 hours. The year 1911 was mild during the winter months and warm during spring and summer with frequent thunderstorms. This is the only year on record when the temperature did not fall below 10°, and it was below 20° on only 9 days during the entire year. The first month of the following year was quite the opposite, when for a period of 13 days from January 4 to the 16 inclusive, the temperature averaged 10° and the lowest was 9° below zero. February was also cold with temperature 7° below zero. There were several severe thunderstorms during the summer of 1912, the more destructive ones occurring on May 5, June 16 and 21, July 17 and August 28.

The year 1913 was characterized by high temperatures, excessive rainfall, two great floods, and an unprecedented rapid rise in the river during the first half of the year. The months of January and March were especially warm and a maximum temperature of 76.7° on the 14th of the latter month was the highest ever recorded between January 1 and March 15. Rains were unusually heavy in January and March with total amounts of 9.02 and 9.09 inches, respectively. The flood of January was more than ordinarily high, reacning a crest of 62.2 feet on the 14th, and then followed the great flood in the latter part of March, when the river reached a crest of 70 feet on April 1. While this flood was 1.1 feet lower at Cincinnati than the flood of 1884, due to the absence of secondary rises in the local tributaries just before the crest was reached, still in all other respects the flood of 1913 was the greatest ever known in the Ohio Valley. The rise of 21 feet in 24 hours in the river has never been exceeded at Cincinnati.

The unusual features of the year 1914 were the heavy snowfall of 21.4 inches in February, which has been exceeded only by the 23.5 inches in January, 1863; and the hot, dry summer, with a record temperature of 100° for June, followed by 103° for July. The summer of 1915 was generally cool and wet, both the average temperature for August, 68.6°, and the lowest, 43.1°, being the lowest on record for that month. On July 7 a very destructive storm passed over the city, when the wind reached an extreme velocity of 62 miles per hour, accompanied by a torrential rainfall. This storm approached the city from west-southwest, and struck the business section of the city at 9:29 p. m. and during the next minute the wind blew at the rate of 62 miles per hour and rain fell at the rate of 6.24 inches per hour, resulting in the loss of about 40 lives and more than a million dollars worth of property.

The year 1916 averaged nearly normal in both temperature and precipitation, but the weather was quite changeable during the entire year, with both unseasonably warm and cold days during the winter months, and a very cool June followed by hot dry weather in July and most of August. The weather continued nearly normal during the entire winter of 1916–17, except for five days early in February, when the temperature was below zero each day, the lowest being 9° below on the 5th. On March 11, 1917, a well-defined and destructive tornado developed over the eastern portion of the city, and moved slightly north of east across the southern portion of Hyde Park, the path of greatest destruction being about three-fourths of a mile long and varying from 50 feet to 300 feet in width. Fortunately, only three people were killed but 90 houses were totally or partially destroyed and the property loss was large. During the night of September 7–8, 1917, an excessive rain fell which was very heavy at Fernbank Dam, in the lower portion of the city. At that place 5.83 inches was measured in the Government gage, all of which fell in 11 hours. This considerably exceeds the record of 5.22 inches within 24 hours in March, 1907, and the fall of 4.97 inches within 16 hours in March, 1897. The summer and fall of 1917 were cool with mean temperatures below the normal every month and the means for May and October were the lowest on record for these months. The cold increased in intensity as the season advanced

and reached the maximum intensity in the severe cold winter of 1917–18, which exceeded all previous records for length of cold period and for extremes in December and January. The severe cold weather began on December 7, 1917, and continued with very little interruption until February 6, 1918. During this period the temperature was below zero on 17 days and near zero on several other days. The mean temperature for December, 22.3°; the minimum for December, −13°; the mean for January, 16.3°; and the minimum for January, −16°, were all considerably below previous records. The snowfall during this winter was very heavy, with a fall of 12 inches on December 8, a total fall of 36.5 inches during December and January, and an average depth on the ground of 13.5 inches on January 22. Great ice gorges formed in the river during the cold weather, which caused two great backwater floods with crest stages of 61.2 feet on February 1 and 61.8 feet on February 12, on which latter date the great gorge at Sugar Creek Bend finally broke. Nothing on record for December compares with the cold December of 1917. During that month the temperature was below zero on 9 days while for the preceding 50 years it had been below zero for a total of only 17 days, the greatest number in any one year being 4 days in 1901 with a minimum of −7°. December of 1831 may have been about as cold as December, 1917, but we do not have sufficient data to make a reliable comparison.

In January, 1918, the minimum temperature was not much lower than had been recorded in January during other years and not even as low as the −18° reported on January 8, 1797, but the average for the month in 1918 was 16.0° below the normal and 5° below the average for the cold Januarys of 1893 and 1857. On the whole the winter of 1917–18 was the longest and coldest on record, although the cold was not quite so intense during any week as it was during the cold week of February, 1899. The early spring months of 1918 were generally warm followed by a very cool July with a record low temperature of 51° on the 22d, followed in turn by a record high temperature in August of 102° at the Federal Building and then a change to the coolest September on record. The winter of 1918–19 in contrast with the preceding one generally, was mild and pleasant with only 1.6 inches of snow.

THE ABBE METEOROLOGICAL OBSERVATORY.

Since April 1, 1915, the Weather Bureau has been making complete records at both the Federal Building in the lower portion of the city and at the Abbe Meteorological Observatory, on Lafayette Circle, Clifton, on the hilltops, and the records at both locations are given in the table for comparative purposes. On an average the temperature is 2.0° lower, and the maximum and minimum each day from 1° to 4° lower at the Observatory than at the Federal Building. Under the most favorable conditions during a cold period when the wind is very light and fog or local smoke fills the valley, the temperature will fall 6°, 7° or even 8° lower at the Observatory than at the Federal Building, and during a warm day with bright sunshine and very little wind the temperature will occasionally be 6° or 8° higher at the Federal Building than at the Observatory, but these extreme variations seldom happen. The wind direction and velocity vary considerably at the two locations due partly to the topography of the region and partly to the exposure of the wind instruments.

The precipitation thus far has averaged nearly the same at the two locations. As will be seen by the table the precipitation for 1916 was 3.58 inches more at the Observatory than at the Federal Building, but during the two following years the amounts were somewhat larger at the Federal Building. On several days during the past three years more rain has fallen at one location than at the other but the difference is partly compensated by the end of the month and nearly disappears by the end of the year.

AVERAGE WEATHER CONDITIONS.

The weather conditions mentioned in the above notes are principally the abnormal features and severe storms during the past 130 years. The following is a brief description of the usual weather of Cincinnati, year after year.

Winter on the average begins about the 15th of December and lasts until the 15th of March. During the first half of December the minimum temperature is frequently below freezing but the maximum temperature rises to about 45°. About the 15th of that month the first cold spell usually occurs and there are, occasionally, fairly good snow storms. The first cold spell lasts only two or three days and the temperatures are more moderate again with very little snow between December 20 and Christmas, but the temperature falls more rapidly during the last week of December and continues to fall slowly during January. The wind is seldom strong enough in Cincinnati to be troublesome at any time during the year, and is generally sufficient to produce a gentle movement of the atmosphere and prevent the formation of stagnant pockets of very hot or very cold air; however, there is a moderate increase in wind velocity during the winter from 7.7 miles per hour in the middle of December to 8.7 miles at the end of February. The precipitation does not change much in amount during the winter months, averaging about 0.11 or 0.12 inch a day, or near 3.50 inches a month, with a slightly larger amount during the first three weeks of February. The winter rains sometimes are moderately heavy and continue for two or three days or longer, but very seldom are excessive for a short period of time, there having been only five winter (December, January, and February) storms during the last 20 years, when the rainfall was excessive. In March the rains are more frequently excessive than during the preceding three months and the greatest amount on record for 24 hours, 5.22 inches, fell on March 12–13, 1907. When the precipitation is in the form of snow, most of it falls in January and February with a slight tendency to a maximum about the second week of January; however, the snow seldom remains on the ground more than a few days before it is melted by a rise in temperature, or rain. Thunderstorms are almost unknown during the last half of December and the first half of January, but do occur occasionally late in January and more frequently in February. Although the temperature falls slowly during January, there is frequently a mild period about the third week of that month, followed by falling temperature again late in the month, and the coldest part of the year is the first few days in February, when the average daily minimum reaches the lowest point, 18.5°, on February 2, and the average daily maximum the lowest point, 34.2°, on the 5th. After the first week in February the average temperature rises steadily and rapidly, the rise in the first two weeks being as great as the fall during the preceding six weeks, and by the end of February the winter is frequently over, except for an occasional cold, stormy day during the first half of March.

Spring weather on the average begins about the 15th of March and continues until the middle of June. The average minimum temperature at the beginning of spring

is very near the freezing point and in many years it will not fall to that point again, although killing frosts quite frequently occur in April, the average date of the last killing frost being April 14. The temperature rise during the latter part of March and during April is the most rapid for the year, and by the end of April it ranges from 47° to 68°, and by the 15th of June from 62° to 82°. The amount of precipitation during the spring continues about the same as during the winter, although there is a slight increase in the last half of March and a slight decrease in April. Thunderstorms occasionally occur in April, but very seldom is the rain excessive. However, in May the thunderstorms occur quite frequently and excessive rains fall on an average of one each May. There is a decided increase in rainfall late in May and the first half of June, the average amount on the 12th of June being 0.16 inch, the largest of any day in the year. The wind velocity continues moderately strong during March, but begins to decrease late in that month and decreases quite rapidly through April and May, the average velocity in June being only 6 miles per hour.

Summer weather usually begins about the middle of June and continues to the middle of September. The maximum temperature averages above 80° during the entire summer, the highest being 86.7° on July 15, and at this time the minimum temperature averages 66°. Temperatures above 90° frequently occur in July and August, and occasionally the temperature goes above 100°, but the periods of extreme heat are usually short, lasting from three to five days. June has a slightly greater rainfall than any other month, the average being 3.82 inches, while the remaining months of the summer have about 3.4 inches each. Thunderstorms are quite frequent in June, with an average of 7 and also averaging 6 in each of the months of July and August. Excessive rains are most frequent in August, although the number does not greatly exceed that for May, June, or July, and a large proportion of the excessive rains of the year occur in these four months. Droughts are not of frequent occurrence, but when one does come it generally begins late in July or in August and continues into September or October. Dense fogs very seldom occur in the summer, only two having been recorded in July in the past 36 years and very few in the other summer months. The average wind velocity continues below 6 miles per hour all summer, with occasional high winds attending thundersqualls, and the direction is variable as during the other seasons of the year.

Fall may be said to extend from the middle of September to the middle of December. During this season there is an unsteady though general decrease in the temperature, a rapid decrease in the number of thunderstorms, and a gradual decrease in the rainfall until the middle of October, followed by a sharp increase in November. The average daily rainfall in the middle of October is only 0.05 inch, or one-third of the average for the middle of June, but by the third week in November the average has increased to 0.14 inch. Fogs are more numerous during October than any other month in the year, but severe storms seldom occur in the fall. Light frosts occasionally form in September and the average date of the first killing frost is October 25. The minimum temperature averages below freezing after November 23, but the weather usually contiunes mild until the middle of December. On the whole, fall is the most pleasant season of the year in Cincinnati.

Tables of comparative weather data for Cincinnati, Ohio.

Observers.	Place of observation.	Year.	Temperature. Mean.	Maximum.	Date.	Minimum.	Date.	Precipitation. Total.	Days.	Snowfall.[1]	Miscellaneous notes.
Mansfield and Drake.	Near the Ohio River.	1792				− 7	Jan. 23				Winter severe; snowfall during January, 24 inches.
		1793									Town flooded; highest river stage 57 feet.
		1794-5									Winters mild.
		1796				−14	Dec. —				Winter severe; Ohio River frozen; frost May 24.
		1797				−18	Jan. 8				Very cold winter; Ohio River frozen entire length.
		1799		103	June 20						Winter severe.
		1800-1802									Winters mild.
		1803-1805									Winters severe.
		1806	54.1	94		9					Winter mild.
		1807	54.4	95		−11					Winter severe; tornado on May 28.
		1808	56.4	98		− 4					Winter severe; high river late in December.
		1809	54.4	94		− 2					Light frost Aug. 9; tornadoes on May 28.
		1810	52.3	91		− 7					Winter mild.
		1811	56.6	96		− 8					Strong earthquake December 16.
		1812	52.6	96		− 5					Earthquakes on 27 dates.
		1813	52.8	97		−10					Earthquake 2 dates; *destructive hailstorm May 4.*
Prof. R. S. Bosworth and others.	(Mean temperature) College Hill, (maximum and minimum) Marietta, Ohio.	1814	52.0								Winter mild.
		1815	51.7								Flood in river; highest stage 62 feet, in April.
		1816	51.0								Winter mild; summer dry and cool.
		1817	50.4								Heavy rains; high river in June and November.
		1818	50.4	(99)		(−22)					Heavy snow and very cold in February.
		1819	53.7	(90)		(13)					Winter cold; summer hot.
		1820	52.1	(90)		(0)					Cool year; normal rain and snow.
		1821	51.0	(90)		(−20)					Very cold in January.
		1822	52.2	(86)		(−2)					Winter mild; heavy rains in November.
		1823	51.7			(−7)					Winter cold; summer wet.
		1824	52.5	(94)		(14)					Winter mild and summer warm.
		1825	53.6	(94)		(−6)					Winter mild except for short cold periods.
		1826	53.1	(95)		(−1)					Temperature and precipitation about normal.
		1827	52.9	(95)		(−2)					Heavy rains in December.
		1828	54:0	(94)		(10)					Warm winter, "torrents" of rain and great freshets in January.
		1829	50.8	(92)		(2)					Winter mild except in February.
		1830	53.5	(94)		(−5)					Winter cold; summer hot.
		1831	48.0	(90)		(−10)					January, February, and December very cold.
		1832	51.8	(92)		(−9)					Winter cold; flood Feb. 19, stage 64.2 feet.
		1833	52.5	(95)		(6)					Normal temperature and rainfall.
		1834	52.6	(95)		(0)					Killing frost May 16.

[1] Snowfall for winter ending in year recorded.

Tables of comparative weather data for Cincinnati, Ohio—Continued.

Observers.	Place of observation.	Year.	Temperature. Mean.		Maximum.	Date.	Minimum.	Date.	Precipitation. Total.	Days.	Snowfall.	Miscellaneous notes.
Prof. Ray and others.	Woodward College, Woodward and Sycamore streets, (mean temperature) also at College Hill.	1835	49.2	50.9	95	June 13	−17	Feb. 8	52.15	.....	.....	Winter mild, except part of February.
		1836	49.0	51.2	99	July 23	− 7	Feb. 3	57.39	.....	.....	Wet summer and cold fall.
		1837	50.3	53.0	96	July 15	5	Jan. 3	42.71	.....	.....	6 inches of snow Apr. 4.
		1838	49.5	51.8	100	Aug. 9	−10	Feb. 22	39.45	.....	.....	16.12 inches rain in May and June.
		1839	52.8	54.1	96	July 25	2	Mar. 4	30.02	.....	.....	Dry autumn.
		1840	52.3	53.4	96	July 12	− 1	Jan. 19	47.34	.....	13.3	Warm and wet, February to July.
		1841	52.0	53.9	99	June 12	− 7	Jan. 18	41.05	.....	24.4	Warm summer.
		1842	52.7	53.5	95	June 22	− 5	Feb. 17	41.29	.....	8.8	Zero temperature in December.
		1843	48.8	51.4	98	July 27	− 2	Feb. 7	51.25	.....	28.3	Heavy snows and rains.
		1844	53.0	54.4	94	July 6	− 1	Jan. 29	43.04	.....	10.3	Mild winter and warm summer.
		1845	52.6	53.1	95	July 21	− 6	Dec. 20	46.38	.....	9.0	Rainfall during June 11.50 inches.
		1846	54.0	54.9	96	July 10	0	Feb. 26	53.52	.....	23.6	Warm, dry fall with low river.
		1847	52.0	52.6	92	July 18	− 3	Jan. 8	65.18	.....	28.1	Rainfall, July 8.25 inches, October 9.57 inches, December 8.15 inches.
		1848	52.6	54.0	92	Aug. 14	− 4	Jan. 10	50.58	.....	30.1	"Old fashioned" sleighing in January.
		1849	.....	53.6	92	July 13	2	Dec. 31	52.97	.....	13.9	Heavy rains in July; 18 inches snow in December.
		1850	.....	54.1	96	July 6	0	Feb. 4	54.76	.....	50.0	10 inches snow in January and 19 inches in February.
		1851	.....	54.9	98	July —	− 4	Dec. —	31.70	.....	.....	Dry January; hot summer.
		1852	.....	54.2	98	July —	−12	Jan. —	54.06	.....	.....	Cold January; heavy rains in December.
		1853	.....	54.1	98	June —	2	Feb. —	41.23	.....	.....	An average year.
		1854	.....	56.2	99	Sept. —	5	Jan. —	50.77	.....	.....	High temperature; heavy rains in March.
	Woodward College.	1855	.....	55.1	95	July 20	− 2	Dec. 26	49.40	.....	.....	Very cold in November and December.
		1856	.....	52.8	101	July 17	−14	Jan. 9	25.49	.....	15.8	River frozen Jan. 15 to Feb. 2.
		1857	.....	53.4	95	July 25	−10	Jan. 21	35.25	.....	8.9	Cold January and November; warm December.
		1858	.....	57.2	94	June 29	1	Feb. 23	49.11	104	14.8	Warm January; lowest 28°.
		1859	.....	56.3	101	July 17	− 3	Dec. 8	45.11	102	9.4	Wet spring; rainfall in April 7.53 inches.
Prof. Harper and R. C. Phillips.	Walnut Hills near Eden Park.	1860	.....	56.1	96	July —	− 4	Jan. —	35.17	92	20.3	May 21, severe storm, "hurricane."
		1861	.....	55.9	100	Aug. —	7	Jan. —	43.08	113	8.6	Aug. 21, 3.35 inches rainfall in 2 hours.
		1862	.....	56.3	98	Sept. —	1	Feb. —	38.14	95	18.5	May 21, violent tornado.
		1863	.....	55.4	96	July —	7	Feb. —	40.05	110	39.7	Snowfall in January, 23.5 inches.
		1864	.....	53.9	99	July —	−12	Jan. 1	33.32	115	21.3	May 11, violent snowstorm.
		1865	.....	56.4	98	July —	3	Jan. —	43.98	110	26.2	July 24, severe tornado.
		1866	.....	54.8	92	July —	− 6	Feb. —	49.86	107	5.4	10.88 inches rain in September.
		1867	.....	55.8	95	July —	− 2	Feb. —	30.15	99	21.6	Heavy snows in March, 4.8 inches.
		1868	.....	54.3	99	July —	0	Jan. —	41.60	105	24.2	Heavy snows Apr. 7–9, 3.2 inches.
		1869	.....	55.4	96	Aug. —	5	Mar. —	39.18	98	23.2	Coldest March on record.
		1870	.....	55.8	96	July —	− 8	Dec. 24	27.88	94	19.0	June 29, 2 inches of rain in 30 minutes.
Weather Bureau and Harper.	Pike's Opera House and Walnut Hill.	1871	.....	55.9	96	97 July 9	− 5	0 Dec. 21	32.08	82	12.8	2 inches of rain, 1 hour, Aug. 11.
		1872	.....	54.1	96	96 Aug. 25	− 5	− 8 Dec. 22	34.89	114	19.8	Temperature below zero 3 days in Dec.
		1873	.....	55.1	94	95 June 23	− 1	1 Jan. 30	41.38	145	15.8	Low temperature for March, 1° on the 4th.
		1874	.....	57.0	100	103 July 7	2	6 Jan. 15	37.61	116	18.6	Very warm, temperature above 90° on 47 days.
		1875	.....	53.0	93	96 July 17	−10	− 7 Jan. 10	42.58	148	19.3	Violent sleet storm Mar. 3.
		1876	.....	55.4	98	96 July 18	−10	− 6 Dec. 9	52.62	156	13.0	9.49 inches rain and snow in January.
		1877	.....	56.4	98	92 July 5	− 7	− 4 Jan. 9	34.65	130	17.7	1.33 inches rain in 15 minutes June 25.
		1878	.....	57.0	98	96 July 17	− 6	− 1 Dec. 24	41.62	160	14.4	River rose 20.7 feet in 24 hours Sept. 15.
		1879	.....	56.2	99	98 July 16	−16	−10 Jan. 3	51.60	137	37.5	11.72 inches of rain in August.
		1880	.....	56.9	96	96 July 13	−12	− 5 Dec. 29	54.67	134	10.4	Very cold Nov. 19.
		1881	.....	57.9	103	104 July 10	− 1	2 Jan. 1	47.24	148	39.8	Temperature 101° Aug. 12.
		1882	.....	57.3	95	96 June 25	− 5	1 Dec. 8	52.12	152	16.2	10 inches of snow Jan. 4.
		1883	.....	55.8	96	94 July 22	1	6 Jan. 22	52.35	146	3.6	Crest of flood 66.3 feet, Feb. 15.
		1884	.....	56.3	98	93 June 22	−20	−10 Jan. 5	39.28	151	29.7	Highest river on record, 71.1 feet Feb. 14.
United States Weather Bureau.	United States custom-house and postoffice, Fifth and Walnut Streets.	1885	.....	51.7	.....	97 July 20	.....	−10 Feb. 11	33.94	141	27.3	Lowest average temperature, Feb. and Mar.
		1886	.....	53.0	.....	95 July 29	.....	−12 Jan. 12	31.35	137	21.1	Temperature −3° Dec. 3.
		1887	.....	55.3	.....	101 July 18	.....	− 5 Jan. 3	35.08	127	6.8	Killing frost Apr. 19.
		1888	.....	53.8	.....	97 Aug. 3	.....	6 Feb. 27	34.88	130	10.9	Killing frost Sept. 30.
		1889	.....	54.8	.....	92 July 9	.....	6 Feb. 23	30.92	117	3.3	Driest August on record, 0.26 inch of rain.
		1890	.....	56.4	.....	96 June 28	.....	7 Mar. 6	47.70	162	7.4	Warm winter.
		1891	.....	54.7	.....	92 Aug. 9	.....	4 Feb. 4	38.44	138	16.0	Coolest July on record.
		1892	.....	53.3	.....	98 July 24	.....	2 Dec. 27	31.95	135	15.7	"Old fashioned" white Christmas.
		1893	.....	53.7	.....	95 July 30	.....	−11 Jan. 15	44.00	141	29.8	Ohio frozen; first time since 1881.
		1894	.....	56.1	.....	96 Aug. 9	.....	− 4 Jan. 25	26.59	124	18.9	Rain in July, 0.13 inch; dryest month on record.
		1895	.....	53.6	.....	97 June 3	.....	−12 Feb. 8	29.33	110	36.0	3.57 inches rain in 24 hours Jan. 6–7.
		1896	.....	55.6	.....	96 Aug. 6	.....	− 2 Feb. 20	34.48	127	29.3	Maximum wind, 50 miles, Aug. 1.
		1897	.....	55.3	.....	98 July 4	.....	−10 Jan. 25	43.89	121	13.8	Crest stage of flood, 61.2 feet, Feb. 26.
		1898	.....	55.9	.....	98 July 3	.....	1 Feb. 3	38.97	133	13.0	Crest stage of flood, 61.4 feet, Mar. 29.
		1899	.....	55.0	.....	99 Sept. 6	.....	−17 Feb. 9	34.69	125	24.9	Record temperature for Sept., 99°.
		1900	.....	56.0	.....	97 Sept. 10	.....	− 5 Feb. 25	27.78	119	9.7	Thunderstorms on 15 days in August.
		1901	.....	54.0	.....	105 July 22	.....	− 7 Dec. 15	17.99	111	9.3	Driest year on record.
		1902	.....	54.7	.....	96 July 17	.....	0 Feb. 3	37.30	125	17.7	2.26 inches of rain in 1 hour May 20.
		1903	.....	54.3	.....	96 July 10	.....	− 1 Feb. 17	34.69	133	17.9	Heavy thunder squals July 21.
		1904	.....	53.2	.....	94 July 17	.....	0 Feb. 16	29.54	111	15.0	Very little rain July and August.
		1905	.....	54.2	.....	94 June 19	.....	− 5 Feb. 13	38.69	127	22.9	Violent thunderstorms May 11.
		1906	.....	55.4	.....	94 June 29	.....	0 Feb. 6	40.83	147	29.2	Record temperature for January, 75°.
		1907	.....	54.2	.....	95 July 6	.....	4 Jan. 26	44.56	142	15.8	Crest stage of flood, 65.2 feet, Mar. 19.
		1908	.....	56.6	.....	98 Aug. 16	.....	3 Feb. 2	27.29	113	9.7	Drought from Aug. 18 to Nov. 9.
		1909	.....	54.9	.....	95 Aug. 28	.....	− 3 Dec. 30	37.43	130	14.3	Light frost May 11.
		1910	.....	54.4	.....	95 June 19	.....	1 Feb. 19	34.42	107	40.4	20.6 inches of snow in February.
		1911	.....	56.7	.....	102 July 4	.....	10 Jan. 4	45.05	140	20.7	Record temperature for May, 95°, on the 27th.
		1912	.....	53.7	.....	96 July 24	.....	− 9 Jan. 7	38.61	131	25.5	Very cold Jan. 4 to 13.
		1913	.....	57.0	.....	101 July 30	.....	6 Feb. 6	42.15	130	9.6	Great floods, crest 70 feet, on Apr. 1.
		1914	.....	55.4	.....	103 July 12	.....	− 3 Dec. 15	32.78	108	28.6	21.4 inches of snow in February.
		1915	.....	53.7	.....	95 July 31	.....	2 Jan. 24	41.30	136	20.4	Destructive cyclone July 7.
		1916	.....	55.5	.....	99 July 27	.....	0 Jan. 17	34.66	129	19.8	Hot wave and drought July and August.
		1917	.....	52.4	.....	95 Aug. 1	.....	−10 Dec. 11	36.07	122	25.4	Great ice gorge, began Dec. 11.
		1918	.....	55.4	.....	102 Aug. 6	.....	−13 Jan. 12	41.10	111	37.7	Two floods, 61.2 and 61.8 feet; gorge broke Feb. 12.
		1916	53.5	.....	98	..... July 28	— 4	..... Jan. 17	38.14	136	26.7	4.5 inches snow, Apr. 8–9.
		1917	50.4	.....	94	..... July 31	−13	..... Dec. 11	35.32	129	27.6	Lowest temperature on record for December.
		1918	53.6	.....	101	..... Aug. 6	−16	..... Jan. 12	40.88	131	38.0	Lowest temperature for January since 1797.

*A Abbe Meteorological Observatory, La Fayette Circle, Clifton; last three years.

NOTE.—Temperatures, (mean, maximum and minimum) first columns for hilltops, second columns for lower part of city.