HISTORY OF WEATHER OBSERVATIONS
CINCINNATI, OHIO
1789 - 1947

December 2004

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This report was prepared for the Midwestern Regional Climate Center under the auspices of the Climate Database Modernization Program, NOAA's National Climatic Data Center, Asheville, North Carolina

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INTRODUCTION

The Location

In 1804, C. F. Volney published a book about his travels in the United States. He wrote that people in Cincinnati and other locations said that the climate was changing. These people reported that here were "longer summers, later autumns, and also later harvests; shorter winters, snows less deep and of shorter duration, but cold not less intense" and that the change was "not gradual and progressive, but as rapid and almost sudden, in proportion to the extent to which the land is cleared." Now two hundred years later, we are concerned that global climate is changing and voice concern that tropical deforestation may be contributing to it.

Weather observations apparently began before Losantivlle, as it was called in 1790, had its name changed to Cincinnati, and while it was still located in what was then called the Old Northwest. Remarkably, climate was also the purpose of those early data collections. Dr. Daniel Drake published the first climatology of Ohio in his 1815 book. He summarized observations made from 1789 through 1813. In it, he described the temperature, precipitation, and other elements that were characteristic of Cincinnati's climate. The reasons for his observations may have been his concern about the relationship between weather and disease. He published his "Notices of Cincinnati, its Topography, Climate, and Diseases" in 1810. There may have been another motivation. He wrote that in the opinion of many people "our climate has undergone a change." Perhaps he shared that opinion and was concerned about whether or not it was in fact changing.

Figure 1. Dr. Daniel Drake, an early weather observer in Cincinnati
Source: Pioneer Life in Kentucky 1785-1800, Daniel Drake M.D.

Dr. Drake established his medical practice in Cincinnati and, more notably, later founded the Medical Departments in the Cincinnati College, Miami University, and the Medical College of Ohio,

The earliest official effort to observe the weather was initiated by the United States Army. In 1818, Joseph Lovell as Surgeon General of the United States Army ordered each Army Post's Surgeon to keep a diary of the weather. According to Humphrey, he gave them great latitude on what to report.

> Every physician who makes a science of his profession or arrives at eminence in it will keep a journal of this nature, as the influence of weather and climate upon diseases, especially epidemics, is perfectly well known. From the circumstances of the soldier, their effects upon diseases of the army are peculiarly interesting as by proper management, they may in a great measure be obviated. To this end every surgeon should be furnished with a good thermometer, and, in addition to a diary of the weather, should note everything relative to the topography of his station, the climate, complaints prevalent in the vicinity, etc., that may tend to discover the causes of diseases, to the promotion of health, and the improvement of medical science.

As part of that effort, the Post Surgeon at Newport Barracks, Kentucky across the river from Cincinnati began weather observations on 1 July 1825. That Post was established after the disestablishment of Fort Washington in Cincinnati a few years earlier. Observations continued at Newport Barracks until 1894 when it too was disestablished.

Cincinnati grew as the westward migration continued. The migration came by water from the areas upstream along the Ohio River. From the south, settlers came overland on the old Wilderness Road that terminated in Newport, Kentucky across the Ohio River from Cincinnati along the banks of the Licking River. Among them were some people who brought thermometers with them.

Using their own instruments, independent observations like those of Dr. Drake were made in Cincinnati and at several other places including College Hill, Mount Auburn, Cheviot, Cummingsville, and Jacksonburg. The number of observers increased after an Act of Congress on August 10, 1846 created the Smithsonian Institute under terms of the will of James Smithson of London. Those terms were for it to increase and diffuse knowledge among men. It was and is a research organization. Within a year after their creation, they developed a climate network. They invited experienced weather observers to join their network and provide monthly reports to them. The observers at Woodward High School in Cincinnati were some of those who joined the systematic effort to collect climate information. Seven years later, the network had observers reporting from Ohio and from each of the other thirty states. By 1860, it had over 600 observer stations and the Smithsonian Institute had supplanted the Army Surgeon General's network as the primary climatic data collection agency for the United States.

Cincinnati weather observations were trend setting in other ways too. In particular, they gained national attention from the weather observations that were made at the Cincinnati Astronomical Observatory. Cleveland Abbe was the Director of the Observatory and he published temperature readings in the local newspapers.

> The importance of anticipating the changes in the weather, especially storms or droughts, was alluded to in my report of June 1868. The subject having been brought myself to the attention of the Chamber of Commerce of this city, that body, in June last, authorized me to organize a system of daily weather reports and storm predictions. Experienced observers at distant points offered their gratuitous cooperation. The Western Union Telegraph Company offered the use of their line at a nominal price. The bulletin began to be issued September 1, in manuscript form, for the special use of the Chamber of Commerce, and began to be printed a week later as an independent publication.

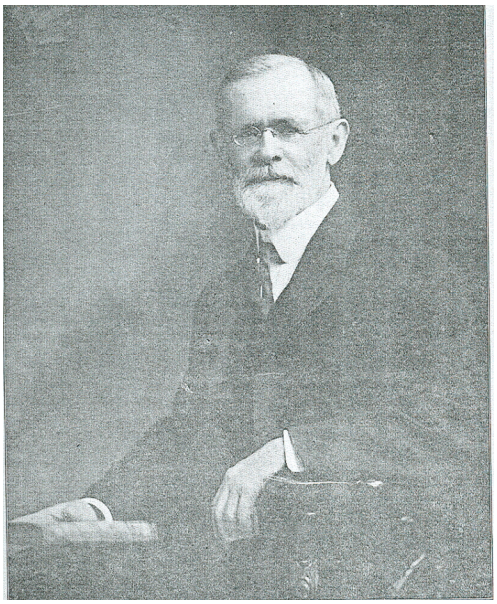


Figure 2. Cleveland Abbe, the Father of the U.S. Weather Bureau
Source: A Climatological History of Ohio, William Henry Alexander

The notion of daily weather information in the newspaper caught on rapidly. Subsequently, he used information received by telegraph to produce weather maps and forecasts, all made possible by that new technology of his day. In 1869, he began publishing weather maps with data from about twenty stations plotted on them. He knew the importance of what he had done as this quote from Humphrey's work shows.

> I have started that which the country will not willingly let die.

Cleveland Abbe got the Chamber of Commerce to support the publication of these maps but they only provided support for three months. In June 1870, he had convinced the Western Union Telegraph Company to provide support.

Cleveland Abbe's work was so admired that he was called to Washington D.C. in 1870. There he eventually created the Weather Bureau within the U.S. Army's Signal Service, a move that incorporated the Army's extensive telegraph network into an organization of weather observers. He thus began the lineage that was the predecessor of the current National Weather Service.

The new Signal Corps' Weather Service made observations in Cincinnati beginning in 1870. They continued until the Weather Bureau was transferred to the U. S. Department of Agriculture in 1891. They in turn were transferred to the National Weather Service under the Department of Commerce in 1947. In 1992, the observation responsibility was moved to the Cincinnati-Northern Kentucky Airport.

This study of the history of weather observations in Cincinnati traces the production of the climate record over more than two hundred years. It identifies the observers, their instrumentation, and their locations within the Cincinnati area.

Goal of the Study

The goal of this study is to document the primary weather observational history in the Cincinnati, Ohio area that was part of the path to the current National Weather Service's observing program. Climatic data from stations in the Cincinnati area that made weather observations throughout the period of record are readily available from the National Climatic Data Center, the Midwestern Regional Climate Center, and the State Climatologist of Ohio. The station's history since 1947 is well documented and also available through easily obtainable climatic records. The challenge of this study was to identify Cincinnati's role in the development of the formal weather observational program and where it fit in the route from the Army surgeons, through the Smithsonian Observers, the Signal Service Observer Sergeants, the Weather Bureau meteorologists, to the National Weather Service observational network of today. Therefore, the focus of this study is on the period before 1948, the generally accepted start of the modern era of the documentation of weather observations.

LOCATIONS OF OBSERVATIONS

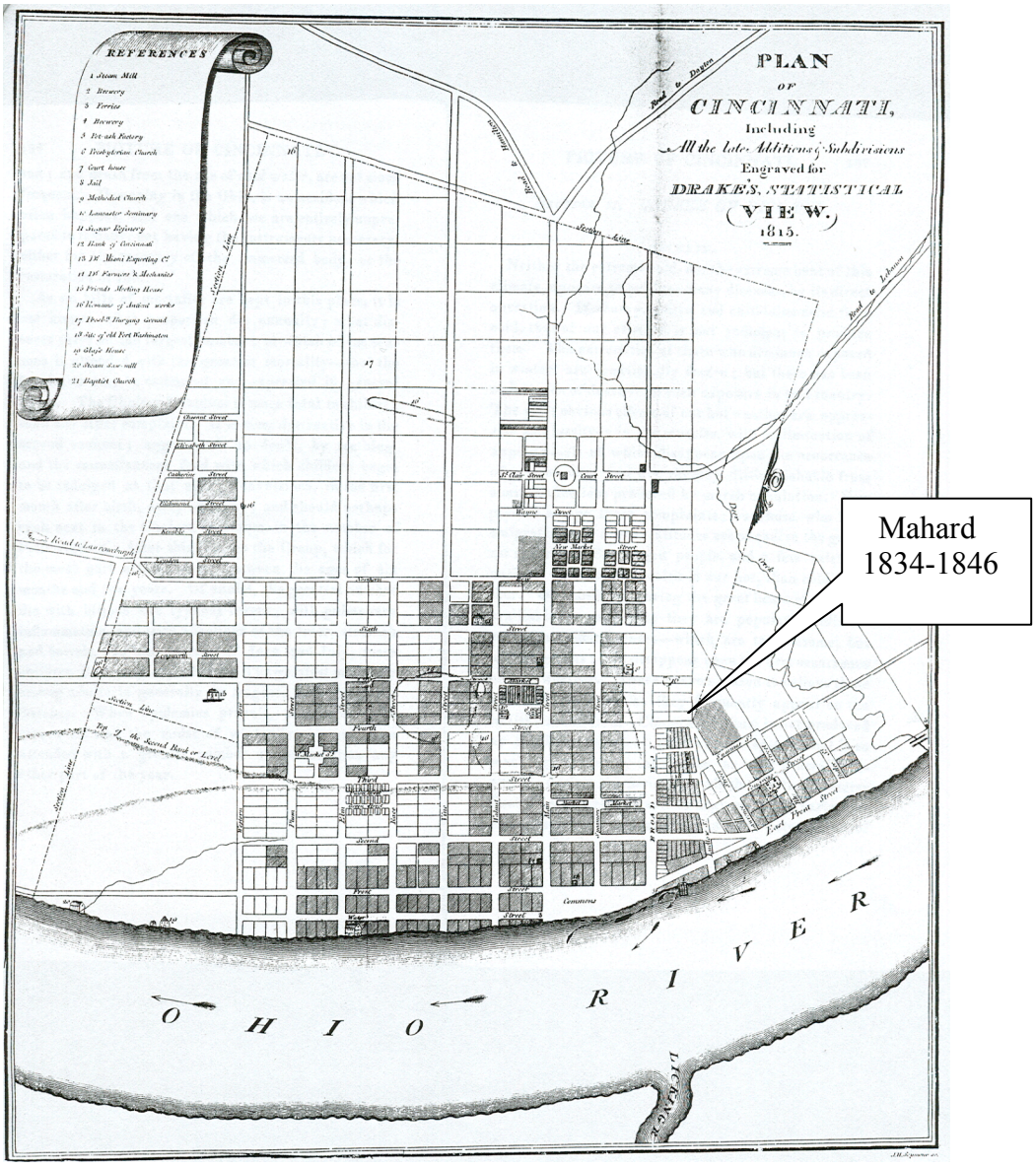


Figure 3. Approximate Location of John Mahard's Observations, Cincinnati, 1815
Source: Base Map from Natural and Statistical View or Picture of Cincinnati, Dr. Daniel Drake.

One of the earliest weather records in Cincinnati was that recorded by John Mahard. He came to Cincinnati in the summer of 1798. There he lived at the corner of Spring Street and the Corporation line when he started his weather diary in March 1834. That location now would be on 5th Street about halfway between Broadway and Lawrence.

Dr. Drake's early observations may have been made at his home (Figure 4) in Cincinnati. His home was the third house from the left in the depiction from 1837.

Figure 4 . Dr. Daniel Drake's Home in 1837.
Source: Cincinnati: The Queen City Vol. I, Charles Frederic Goss

In 1850 his home was located at what is now 124 West Fourth Street (Figure 5).

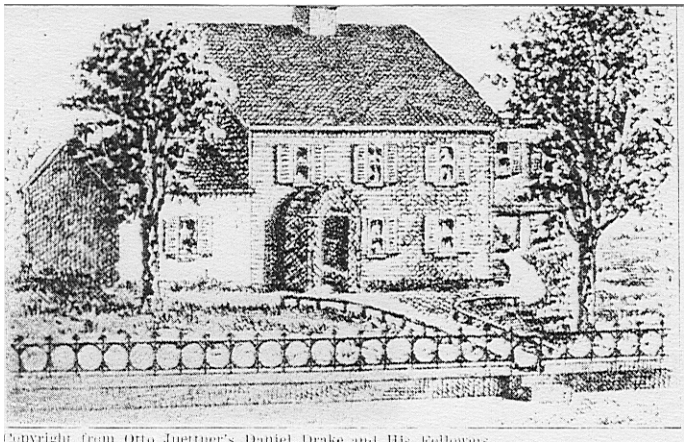


Figure 5. Dr. Daniel Drake's Home in 1850
Source: Cincinnati: The Queen City Vol. I, Charles Frederic Goss

M.G. Williams' observations in 1843 were made at 39˚ 06' north latitude and 84˚ 37' west longitude. He was the first of a long line of observers at Woodward High School (Figure 6.)

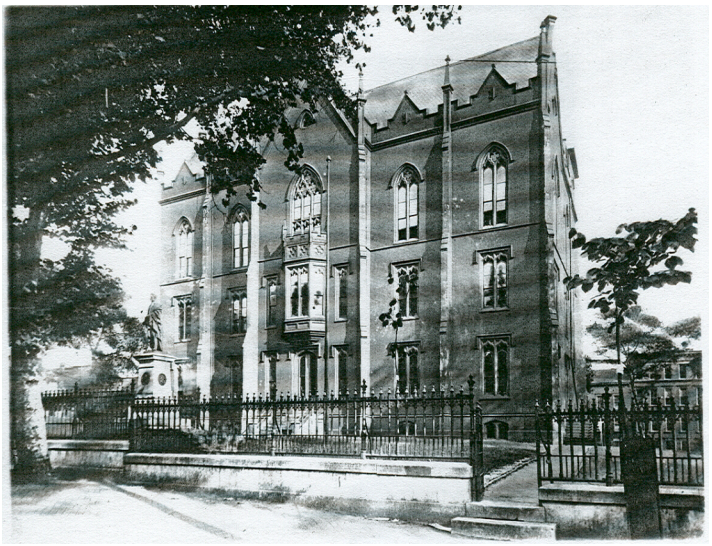


Figure 6. Old Woodward High School, 1855-1906
Source: Cincinnati Historical Society

For many years, there were newspaper reports from Cincinnati's Woodward High School (February 23, 1869 for example) made by George W. Harper who was its principal from 1865-1900. That location of Woodward High School was at 39˚ 06' north latitude and 84˚ 27' west longitude at 305 feet above the low water mark of the Ohio River.

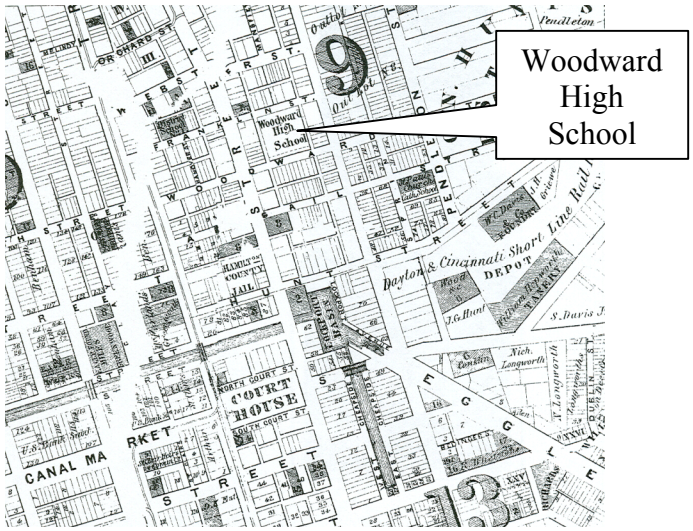


Figure 7. Woodward High School Location
Source: Map of Cincinnati 1868, R. C. Phillips

Devereaux reported that Professor Harper moved the instruments from Woodward High School in August 1859 to his home on Gilbert Avenue. Walnut Hills, near the northwest corner

of Eden Park. If so, he made no change in the latitude, longitude, and elevation in his reports and continued to use the name Woodward High School

Several locations are known because Cleveland Abbe, who would become the father of the Weather Bureau, pasted newspaper clippings onto over 400 pages of one of his old books. These clippings were from a variety of papers Cincinnati and other cities. Many of the clippings were the "Weather Bulletin of the Cincinnati Observatory, Showing the State of the Weather at Points North, West and South of Cincinnati" from his own observatory. The Abbe Observatory was at 206 Lafayette Circle about four miles north of the Federal Building at 39˚ 09.4' north latitude and 84˚ 30.9' west longitude at 761 feet MSL.

The Cincinnati Daily Enquirer published weather reports from several independent observers. Professor Abbe clipped them as well. Among them were clippings of an "Abstract of Meteorological Observations for Cincinnati, Latitude 39 Degrees 6 Minutes North, Longitude 84 degrees 27 Minutes West" by Thomas Winter (December 1859 for example). There were meteorological observations made by Henry Ware, Optician, at Nos. 5 and 7, West Fourth Street in Cincinnati (August 1869 for example). There were clippings of weather information provided by R. C. Phillips (28 July 1865 for example). He was the author of the map in Figure 7 in this study as well. His observations were made at 39˚ 06' north latitude and 84˚ 28 ' west longitude at 84 feet above the low water mark on the Ohio River and 540 feet mean sea level. There were clippings of weather observations from D. Lapham, a civil engineer in Cincinnati (April 1834 for example). There were clippings from reports from Charles M. Buchanan from College Hill for the week beginning Saturday 8 December 1860 and another from Prof. J. H. Wilson from College Hill.

Figure 8. Pike's Opera House, before 1903
Source: Cincinnati Historical Society

The first Signal Service office was opened in Cincinnati on 1 November 1870. According to the Annual Report to the Chief of Signal Service in 1871, its location was the Pike's Opera House Building (Figure 8). This building was close to the telegraph and the newspaper offices.

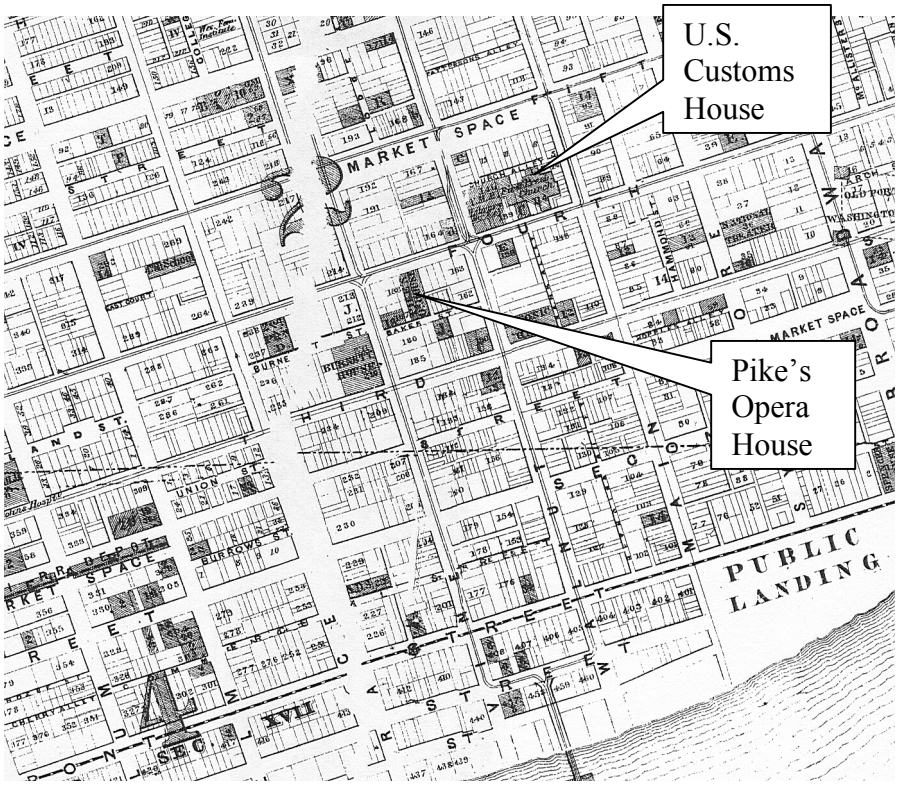


Figure 9. Signal Service Offices In the Pike Opera House and Customs House
Source: Map of Cincinnati, R. C. Phillips

The Signal Service data were published as early as June 1871 in Cincinnati newspapers. In the 1 February 1875 edition, their address was listed as Room 25 in Pike's Opera House building at the corner of Fourth and Vine Streets (Figure 9). The location was given as 39˚ 06' north latitude, 81˚ 30' west longitude, at an elevation of 656 feet.

They moved in March 1885 to Room number 1 on the Fourth Floor of the U.S. Customs House, Federal Building on Fifth between Main and Walnut Streets (Figure 9). The observational equipment was located on the roof of that building. They remained at that location until 1936.

Between 17 November 1936 and 15 January 1939, the Weather Bureau relocated to the Faller Building on the northeast corner of 8th and Walnut Streets. They occupied this building while the new Federal Building was being built. It was at 38˚ 06' north latitude, 84˚ 41' west longitude, with the thermometers at an elevation of 558 feet MSL. Instrumentation was on the building's roof.

When the Federal Building was completed, they moved into it. It occupied the entire block on Fifth between Main and Walnut Streets. The latitude and longitude were unchanged but the elevation changed to 553 feet MSL. The office was on the fourth floor but the observations were taken on the roof. The observations at the Federal Building continued until 1971.

The observations remained there even when a new aviation related operation was begun at the new Cincinnati and Northern Kentucky Airport that was built in Erlanger, Kentucky on 1 January 1947.

The Cincinnati Astronomical Observatory had an observation site that years later became known as Cincinnati Abbe Weather Service Office (Figure 10). It was located at 39˚ 09' north latitude and 84˚ 31' west longitude from 1893 to 1983 at 760 feet MSL.

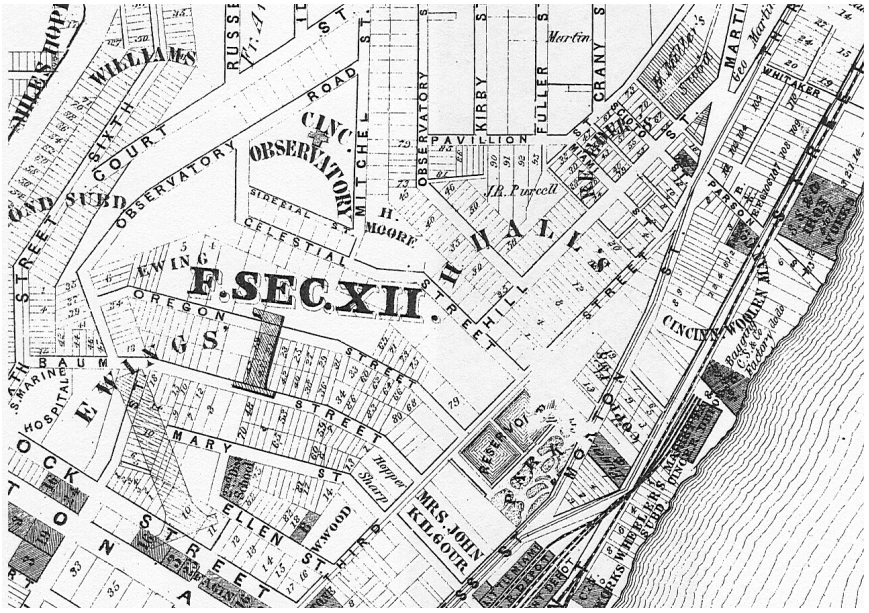


Figure 10. Cincinnati Astronomical Observatory
Source: Map of Cincinnati 1868, R. C. Phillips

The Abbe Observatory was the only weather station that was named for a person. The building served as the home of the senior meteorologist in 1943. The Weather Bureau assigned the operation of the weather observations to the University of Cincinnati on 19 May 1965.

An additional Weather Bureau observational site began on 1 January 1947 at the new Cincinnati and Northern Kentucky Airport that was built in Erlanger, Kentucky. Observations from that site continue to the present.

INSTRUMENTATION

The earliest observations that were summarized in Dr. Daniel Drake's 1815 book used thermometers made in London and hung on the north side of the house, under shelter, and read before sunrise and about 2 p.m. in the afternoon. He observed the wind direction and measured rainfall and snowfall. Little else is known about the Dr. Drake's instrumentation.

The Army Surgeon General's Form 3 used in 1843 had instructions for the observations at the bottom of the form.

> The wet bulb is ascertained by pulling a thin wet rag round the bulb of the thermometer and swinging it in the shade till it falls as low as it will in open air. The force of the wind is estimated in numbers 0 being calm, 1 a very gentle breeze, 3 a fresh breeze,4 a strong wind, 5 a very strong wind, 6 a violent storm, &c. The numbers are put just after the course thus, if the wind for example is from the S. W. strong it will be set down S.W. 4. The clouds will be marked in the same way, if for example they have a very gentle motion from the West they will be marked W. 1. The clearness of the sky will also be marked in numbers, 0 representing entire cloudiness, 1 a slight degree of clearness and so on till 10, entire clearness. The dew-point is the highest temperature at which the vapour in the open air will condense on a bright metallic or thin glass tumbler of water cooled down by ice, or pulverize muriate of ammonia and nitrate of potash in equal quantities. The dew-point when it is not very low, may also be obtained nearly by dividing 103 times the difference between the temperature of the air and the wet-bulb temperature, by the wet-bulb temperature, and subtracting the quotient from the temperature of the air; the remainder will be the dew-point. The higher the dew-point, the more water vapor there is in the air.

In 1869, Cleveland Abbe's instructions to his weather reporters were published in the Cincinnati Daily Gazette (Figure 11). He suggested that they use a barometer like those of James Green of New York City that had an attached thermometer. He suggested that the dry and wet bulb thermometers be hung in the shade. The wet bulb thermometer should be moistened with pure water and should hang near the maximum and minimum thermometers. The temperature readings were to be made in tenths of a degree with "vulgar fractions being studiously avoided." Wind direction was to be reported in the sixteen cardinal directions as was the direction of the movement of the clouds. Rain measurements were to be made twice per day in inches and tenths.

Instructions for Observers Reporting to the Daily Weather Bulletin of the Cincinnati Observatory.

In order to secure uniformity among the observers who have kindly volunteered their services in connection with the Daily Weather Bulletin, published by the Cincinnati Observatory, the following instructions are offered, and conformity therewith respectfully requested:

In general, all details are to be made to conform to the instructions issued by the Smithsonian Institute, or by the Patent Office, or by the Surgeon General of the Army, or by the Western Meteorological Association, or by this Observatory, to the observers corresponding with these respective institutions. Of these the following is a synopsis:

1. The barometer should be of the pattern made by James Green, of New York city, having an attached thermometer and brass scale.

2. The thermometer for the temperature of the air should, if possible, be by the same maker; hung in a shaded spot, not too cool, and read from a distance of two feet. The covering of the wet bulb should be renewed at regular intervals, and should be moistened with pure water. The maximum and minimum thermometers should be placed near by the wet and dry bulbs. All four instruments should be read and recorded to the [illegible] of a degree, vulgar fractions being studiously avoided.

3. The winds should be observed from a point not affected by local eddies. The directions of the winds are—North, North North East, North East, East North East, East, East South East, South East, South South East, South, South South West, South West, West South West, West, West North West, North West, North North West. The force of the wind is indicated by the following terms or numbers:

0. Calm.	3. Fresh Breeze.	6. Gale.
1. Light Breeze.	4. Strong Wind.	7. Strong Gale.
2. Gentle Breeze.	5. High Wind	8. Violent Gale.
	9. Hurricane.	

The amount of cloudiness [illegible] each layer in degrees, when the upper layer is much hidden i. e., in tenths. by the lower one, considerable care will be necessary in order to arrive at a proper conclusion; when wholly hidden, then a dash is to be entered in the columns [illegible]. The direction from which the clouds of each layer, respectively, are coming is to be carefully and independently noted. The angular velocity is to be estimated as the clouds pass over or near the zenith, and to be expressed as so many degrees in one minute of time. It will be convenient for the observer, standing on the ground, to have in his zenith a standard rod fixed horizontally to the house, or to a post, whose length shall at that distance represent five or ten degrees. A cloud passing over the angle of five degrees in thirty seconds would have an angular velocity of ten degrees in one minute, and a corresponding entry should be made in column V.

5. The color of the sky, when visible, is to be noted, as Dark Blue, Light Blue, Grayish, or Hazy—the latter applying specially to the Indian Summer haze.

6. The rain should be caught in an ordinary rain gauge, and its depth measured in inches and tenths. These observations are to be made twice per day, and entered in the column for rain fall. The last of the three columns headed Rain refers to the condition of things at the moment of taking the observation, and should be filled up by the following nomenclature: Clear, Cloudy, Threatening, Rainy, Showery, Drizzling, Partial Rain, Interrupted Rain, Continued Rain, Heavy Rain, Sleet, Hail, Snow, Thunder Storm, Tornado, Clearing Off. The time at which the rain begins and ends is to be entered in the first and second columns. The heading of the third column is to be filled out by the observer, to accord with the Cincinnati time, at which the observations are daily made.

Figure 11. Instructions for Observers Reporting to the Daily Weather Bulletin of the Cincinnati Observatory
Source: Clipping from the Cincinnati Gazette, in Klein's Past and Present

At the Abbe Observatory, the observations were taken from the site shown in Figure 12. The photograph is looking southwest from the observatory.

Figure 12. The Instrument Shelter at the Abbe Observatory, 1942
Source: National Climatic Data Center's Records from Abbe Observatory

The 1871 Annual Report of the Chief of the Signal Corps described the equipment used at Cincinnati.

> The high parapet by which the flat roof of the building is surrounded has rendered the construction of a platform necessary in order to get the proper exposure for the vane, anemometer, and rain gauge. The agent of the building has declined to allow the large wind vane to be erected without consulting the owners, so that at the present the small one only is used. The instrument shelter is of the standard pattern.

In the 1874 version of that Annual Report, it was noted that the equipment included two standard barometers, two standard thermometers, one standard maximum thermometer, one standard minimum thermometer, one standard hygrometer, one standard anemometer, one self-register for anemometer, one standard rain gauge, and one standard wind vane.

According to Grice, The Report of the Chief Signal Officer in 1877-1878 described the duties of the enlisted men at the weather offices manned by Signal Service personnel:

> ...they are required to take, put in cipher, and furnish, to be telegraphed tri-daily on each day, at different fixed times, the results of observations made at those times, and embracing, in each case, the readings of the barometer, the thermometer, the wind-velocity and direction, the rain-gauge, the relative humidity, the character, quantity and movement of upper and lower clouds, and the condition of the weather. These observations are taken at such hours, at the different stations, as to provide the three simultaneous observations, taken daily at three fixed moments of physical time (7:35 a.m., 4:35 p.m., and 11 p.m. Washington mean time) throughout the whole extent of the territory of the United States... Three other observations to be taken at the local times, 7 a.m., 2 p.m., and 9 p.m., are also taken and recorded at each station. A seventh and especial observation is taken and recorded at noon on each day. If at this observation such instrumental changes are noted as to cause anxiety, the fact is to be telegraphed to the central office at Washington.
>
> An eighth observation is required to be taken at the exact hour of sunset at each location. This observation, embracing the appearance of the western sky, the direction of the wind, the amount of cloudiness, the readings of the barometer, thermometer, and hydrometer, and amount of rain-fall since last preceding report, is reported with the midnight report**…**

Pasted into the inside covers of a ledger book containing 1884 observations at the Cincinnati Observatory were description of the Green maximum and minimum thermometers commonly used during the period.

Green's Maximum Registering Thermometer.

In this thermometer the maximum temperature is indicated by the mercury itself, requiring no separate index. It is mounted as follows:

Fasten the gimlet screw piece in a board or other proper support, on its extremity suspend the thermometer by its attached socket, and secure by screwing up the nut tight; at six or eight inches left of this insert in the board the plain brass pin, to serve as a second support on which the edge of the scale rests; this pin is placed a little lower than the screw piece so that the thermometer may not rest exactly horizontal, but with the bulb end about an inch lower than the other.

To set for observation, take out the pin and spin round the thermometer on its main support and replace the pin; the bulb will now be full of mercury and the column in the tube unbroken, except at a spot near the bulb, where a contraction of the bore will be seen; this stricture will not prevent the mercury passing forward on heating, but will prevent its return on cooling; in this way it will indicate the highest temperature reached since it was set. To re-set, take out the pin, spin thermometer on its support and replace the pin; in putting in pin raise the thermometer no higher than is needed to get in the pin.

Figure 13a. Instructions for Green's Maximum Thermometer
Source: Thermometer Record Cincinnati Observatory Sep 1 1882-June 30 1884

Minimum Registering Thermometer.

This is an alcohol thermometer, and is supported by a brass spring piece, having at one end a screw pin to pass through a hole at the side of the scales on which it can turn, at the other end is a notch in which the lower part of the scale rests. The brass piece is screwed on a board so that the thermometer is nearly horizontal, the bulb end about an inch lower than the other. In the bore of the tube is a small black glass float for an index; this is set by lifting the bulb end of scale on its pin support, so that the index runs to the top of the spirit column, the scale then rested in the notch. On a fall of temperature the index is carried back with the spirit; on a rise, the index remains in place, the spirit only going forward; in this way the end of index farthest from the bulb indicates the lowest temperature since the last setting of thermometer.

Spirit thermometers are liable to derangement by the condensation of vapor of alcohol in the upper part of the tube, and from division of column in transportation; to rectify this, put through the hole at top of the scale a strong string, two or three feet long, and spin the thermometer round swiftly many times; keep clear of striking against anything, and all will come right. It may also be done by tapping the end of scale on a table. The thermometer being upright, the spinning is the better way.

Figure 13b. Instructions for Green's Minimum Thermometer
Source: Thermometer Record Cincinnati Observatory Sep 1 1882-June 30 1884

Sgt. Bassler provided a footnote about the two instruments shown in Figure 14 that identify two purveyors of such meteorological measurement devices.

> I take pleasure in recommending to persons desiring to procure reliable instruments at reasonable prices, either Mr. Ferd. Warner, 41 West Fifth Street (Fountain Square) Cincinnati, Ohio or Mr. C. G. Boerner, Vevay, Ind. Mr. Wagner has always on hand a complete stock of meteorological instruments, as well as

mathematical and optical goods. Mr. Boerner[1] is a long established house of the highest reputation. Correspondence with, or a personal visit to either may be of advantage to the intending purchaser of meteorological instruments.

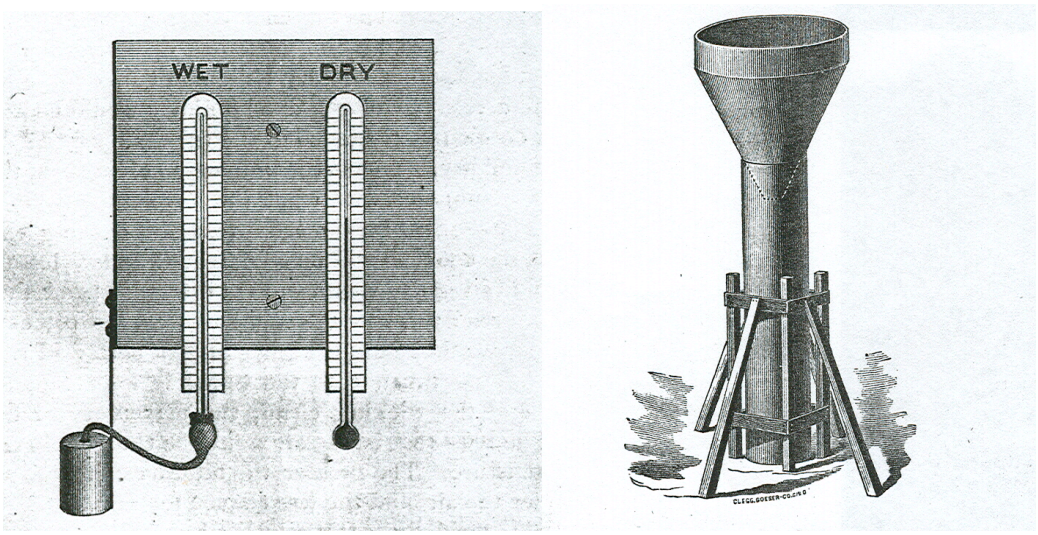


Figure 14. Hygrometer and Rain Gauge for Sale circa 1883
Source: The Weather, a Practical Guide, Bassler

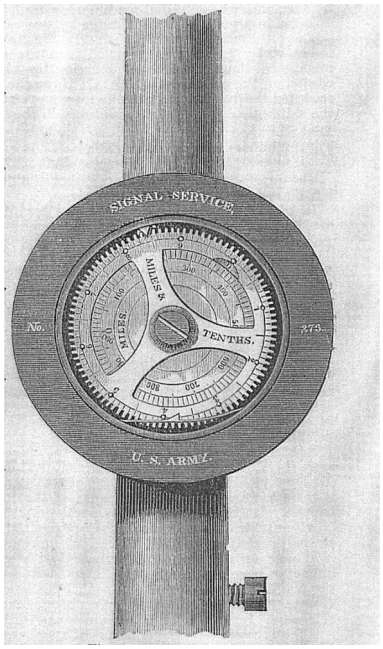


Figure 15. Anemometer circa 1880
Source: Instructions to Observers of the Signal Service, 1881.

[1] Charles G. Boerner was the Smithsonian observer at Vevay, Indiana

The U.S. Signal Service instrumentation included equipment on the roof of their building. There were a weather vane and an anemometer. The anemometer (like that in Figure 15) recorded the miles run of the wind, that is to say the miles of air that passed the station. There were wet bulb, dry bulb, maximum, and minimum thermometers. They began using a psychrometer on 1 August 1886. They used a mercury barometer to measure atmospheric pressure and a rain gauge to ascertain precipitation amounts.

Breakage of thermometers was not uncommon, particularly the maximum thermometer and the psychrometer's wet bulb thermometer. Both these required spinning or twirling to reset them and thus the opportunity to break them.

The Weather Bureau office in Cincinnati took over from the Signal Service. When the site was moved to the U.S. Customs Building, it had a complete set of observational equipment including thermometers both wet and dry bulb, maximum and minimum thermometers, psychrometer, wind vane and anemometer, standard rain gauge, and a tipping bucket rain gauge. A weighing rain gauge was added in January 1942.

THE OBSERVERS

The Independent Observers
1790-1846

In the Introduction to this study, the early observations of Dr. Daniel Drake were mentioned. His summarized data are most helpful to climatologists because of their continuity but he did not make the first weather observations in Cincinnati. Observers at Fort Washington, Ohio get that honor. The fort (Figure 16) was constructed in 1789 as one of the forts established for protection of the early settlers in the Old Northwest. Eleven months of their data have survived from 1790-1791. Those data are preserved at the Clements Library at the University of Michigan at Ann Arbor.

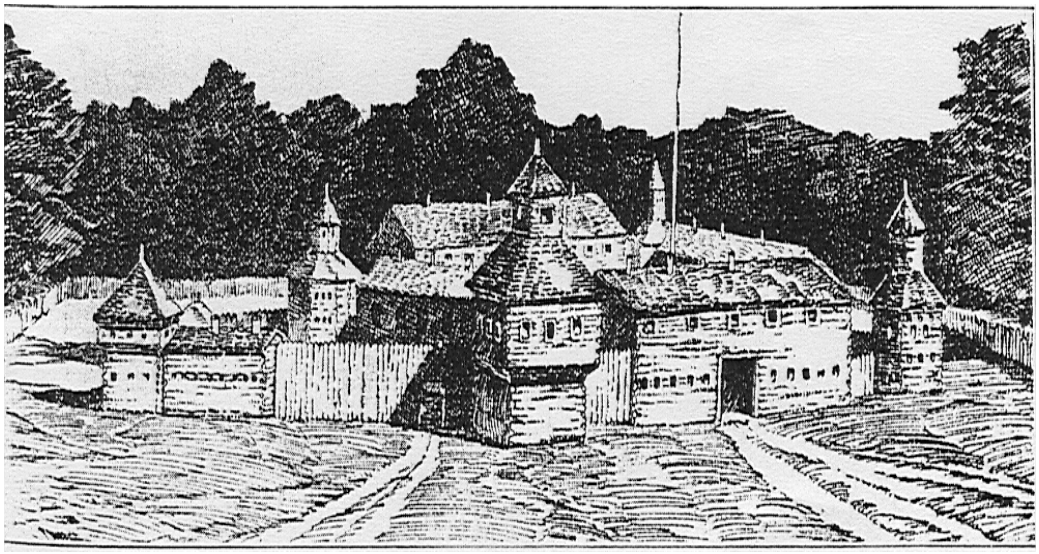


Figure 16. Fort Washington Ohio.
Source: Charles Frederic Gott, Cincinnati: The Queen City

The earliest extended daily observations from the Cincinnati area that were found during this study were from Hamilton, Ohio, about twenty miles north of the city (Figure 17). The observer's name is unknown but the four-month record from January 1824 through April 1824 makes us appreciate the effort required to record these data and makes us wonder about the motivation. They are included here for that reason.

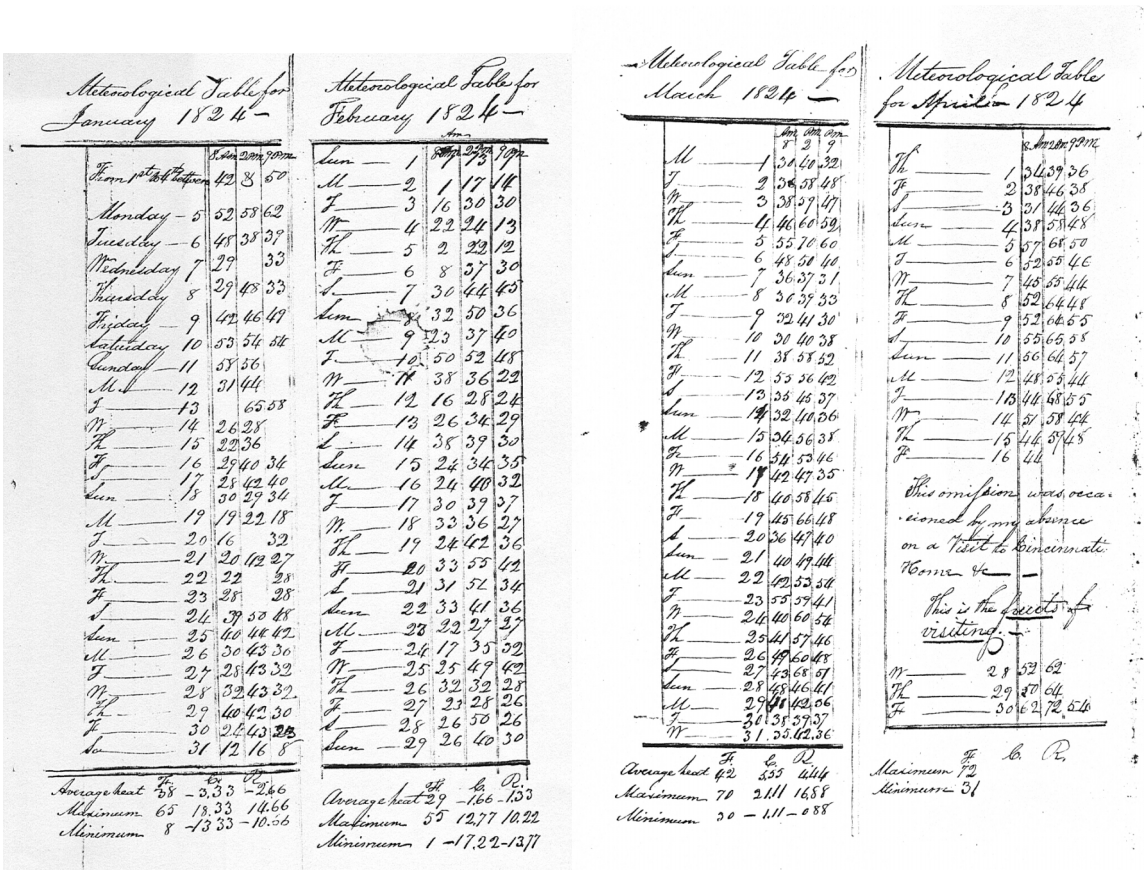
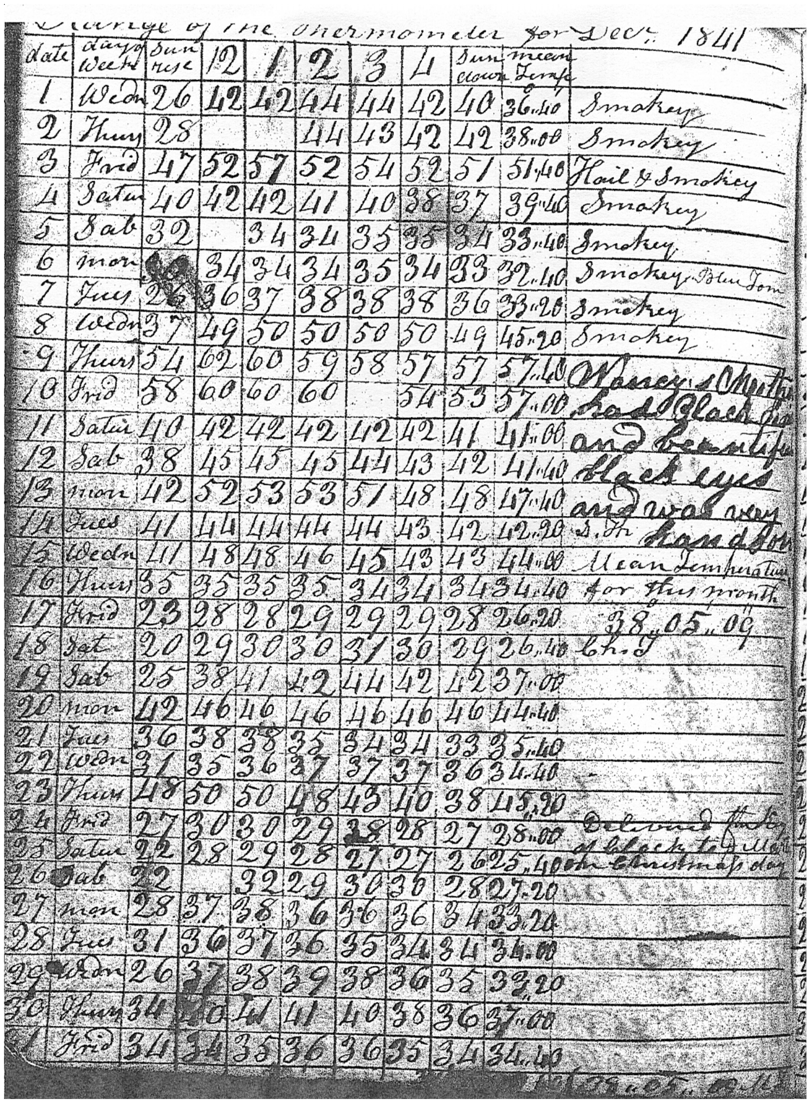


Figure 17. Daily Temperature January – April 1824, Hamilton, Ohio
Source: Blegen Library, University of Cincinnati

Another of the early observers was John Mahard. Early in the spring of 1798, he and Samuel B. Walker walked the only trail over the mountains from Loudentown, Pennsylvania westward to Pittsburgh, a distance of about 150 miles. There they secured work on a flatboat to pay for their passage from there to Cincinnati. John Mahard's occupation in Cincinnati is not known but he was commissioned Justice of the Peace in Cincinnati on 24 April 1809. What is known is that he started a daily weather diary (Figure 18) in March 1834.



Range of the Thermometer for Decr 1841

date	day of Week	Sun rise	12	1	2	3	4	Sun down	mean Temp	
1	Wedn	26	42	42	44	44	42	40	36„40	Smokey
2	Thurs	28			44	43	42	42	38„00	Smokey
3	Frid	47	52	57	52	54	52	51	51„40	Hail & Smokey
4	Satur	40	42	42	41	40	38	37	39„40	Smokey
5	Sab	32		34	34	35	35	34	33„40	Smokey
6	mon	[illegible]	34	34	34	35	34	33	32„40	Smokey Blue Tom
7	Tues	26	36	37	38	38	38	36	33„20	Smokey
8	Wedn	37	49	50	50	50	50	49	45„20	Smokey
9	Thurs	54	62	60	59	58	57	57	57„40	Nancy's Mother
10	Frid	58	60	60	60		54	53	57„00	had black [illegible]
11	Satur	40	42	42	42	42	42	41	41„00	and beautiful
12	Sab	38	45	45	45	44	43	42	41„40	black eyes
13	mon	42	52	53	53	51	48	48	47„40	and was very
14	Tues	41	44	44	44	44	43	42	42„20	[illegible] handsome
15	Wedn	41	48	48	46	45	43	43	44„00	Mean Temperature
16	Thurs	35	35	35	35	34	34	34	34„40	for this month
17	Frid	23	28	28	29	29	29	28	26„20	38„05„09
18	Sat	20	29	30	30	31	30	29	26„40	Ch. J
19	Sab	25	38	41	42	44	42	42	37„00	
20	mon	42	46	46	46	46	46	46	44„40	
21	Tues	36	38	38	35	34	34	33	35„40	
22	Wedn	31	35	36	37	37	37	36	34„40	
23	Thurs	48	50	50	48	43	40	38	45„20	
24	Frid	27	30	30	29	28	28	27	28„00	Delivered [illegible]
25	Satur	22	28	29	28	27	27	26	25„40	of black [illegible] on Christmas day
26	Sab	22		32	29	30	30	28	27„20	
27	mon	28	37	38	36	36	36	34	33„20	
28	Tues	31	36	37	36	35	34	34	34„00	
29	Wedn	26	37	38	39	38	36	35	33„20	
30	Thurs	34	40	41	41	40	38	36	37„00	
31	Frid	34	34	35	36	36	35	34	34„40	

[illegible] 38„05„[illegible]

Figure 18. John Mahard's Observations during December 1841
Source: Library of Cincinnati and Hamilton County Ohio

He observed and recorded the temperature at sunrise for four months. In July, he revised his form and thereafter provided columns for observations at sunrise, noon, 1 p.m., 2 p.m., 3 p.m., 4 p.m., and sunset. There was a column for the mean daily temperature. At the end of the month, he entered the monthly mean temperature. He illustrated his method of calculating the means on the January 1842 page. Another column provided space for remarks. In that column, he noted the occurrence of rain, snow, ice, thunderstorms, sky conditions, or other weather events. The depth of water in his well was a frequent entry and as were his crop informational notes.

The last entry in his book was on Tuesday, 16 July 1846 at noon with no indication of why it was the last. There are enough blank pages left in the diary to have recorded another fourteen months. One is made to wonder, with deep regret, why he stopped.

Charles Gist included meteorological data from 1835 through 1840 in his book about Cincinnati in 1841. He attributed the data to Woodward College located at 35˚ 5' north latitude and 84˚ 22' west longitude. This college eventually became Woodward High School and those records have survived. He said that the data observations were made at 5 a.m., 2 p.m., and 9 p.m.

Army Surgeon General Years
1843-1844

In April 1843, M.G. Williams submitted his first monthly report of daily readings on the Army Surgeon General's Form 3. He was the first Secretary of the Cincinnati Astronomical Society. In August 1844 he submitted his final form. He wrote

> Prof. Espy,
> This is the last tables which I send for Cincinnati; my residence is now in Dayton, O, where you will hereafter please address me. My moving will make some interruption in my record. I shall resume the regular entries on the first of October, if not before. Dr. Ray, of Cin. will probably furnish you with a table for Cin., I believe he has made an arrangement of occupy the same space in publishing his observation in the Cin. Chronicle which I did. Dayton will an important point for you as there is no regular record that I can hear of in this section.
>
> Yours very respectfully,
> M. G. Williams

The note was addressed to Professor James Pollard Espy who was the Meteorologist for the War Department to whom Mr. Williams sent his reports. The reference to Dr. Ray was to Joseph Ray, first Principal of Woodward High School in Cincinnati. Mr. Williams kept his promise and his records from Dayton are preserved beginning in February 1845.

Mr. Williams was also interested in the aurora borealis. He created a journal of observations of that phenomenon. The journal was begun in 1836 and continued until the book was filled in July 1873. Included in each account of an aurora was the barometric pressure, temperature, and sky conditions. Those observations were made from Springfield, Cincinnati, Dayton, and Urbana, Ohio.

The Smithsonian Years
1855 -1875

Mr. Williams was correct that Dr. Joseph Ray (Figure 19) Principal of Woodward High School would assure that the weather observations would continue. Francis W. Hurtt submitted

the first observations from Woodward High School to the Smithsonian Institution from Cincinnati during January and February 1855.

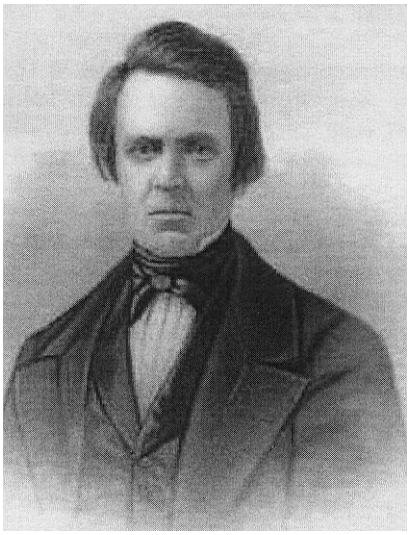


Figure 19. Dr. Joseph Ray, First Principal of Woodward High School.

Dr. Ray was sometimes called the "McGuffey of Mathematics," The reference is to another of the early professors at Woodward, William H. McGuffey, who became famous as the author of Eclectic Readers. Woodward also had students who became famous. Among them was President William Howard Taft.

Woodward High School had been incorporated in 1830 and opened the following year. The Cincinnati Enquirer reported that the school was "in the midst of the country" at the corner of what is now the streets of Broadway and Woodward. Although a private school, it admitted without fee some honor students who were considered the brainiest in the public schools.

George W. Harper became the third observer at Woodward in February 1856. Ten years later in 1865, he as selected as the fifth principal of the School. Even with that new responsibility, he continued to make the weather observations until April 1886. Some of his weather reports from Woodward High School were routinely published in the Cincinnati Enquirer. For more than fifteen years Woodward High School contributed to the body of climatological knowledge until the Smithsonian Institute relinquished the data collection network to the Signal Service. After that, according to Devereaux, Woodward High School continued to record the weather until 1902. However, Alexander combined and published an almost complete monthly data set of Woodward High School and the Weather Bureau for the period from 1835 through 1921. It ended just before his book was published. In that data set, Woodward data end in 1873. Those combined monthly data are included here as Appendix III.

An interesting although unrelated event from this era, may have caused a surge in interest in weather. Thaddeus Lowe went aloft in a balloon in April 1861 to make weather observations in the Cincinnati area. He may have learned more than he anticipated as the winds carried him to South Carolina. He was captured and held for a short period as a Union spy. He later was placed in charge of the U.S. Army Balloon Corps.

There was another contributor of weather observations to the Smithsonian Institute in addition to Woodward High School. He was R. C. Phillips. The first reference to him was in January 1859. That report, and most of those that followed, were signed by J. Howard Phillips for R. C. Phillips. In some years they are listed as co-observers. The location was farther west from the Woodward High School by one minute of longitude.

In addition to the full complement of instrumental readings by Mr. Phillips in his first report, there were two ground water temperature readings at the bottom of the form. One was a reading of 49˚ Fahrenheit from 40 feet deep in a well on a hill north of the city. The other was 50˚ at a spring 250 feet above the low water mark of the Ohio River. The temperature of ground water mimics the mean annual temperature of its area. That is about 54˚ mean in modern times.

In April 1862, R. C. Phillips himself authored the reports. He was a civil engineer by profession and was the author of several maps used in this study, for example Figure 10. His business address was at the northeast corner of Eighth and Central Avenue in Cincinnati. In September 1868, he listed his location as the Southeast corner of Laurel and John Streets on his observation form. The latest extant report from him was in March 1872. Although not a part of the continuum that led to the National Weather Service, his thirteen years of observations form a firm basis for understanding Cincinnati's climate history.

The Signal Service Years
1871-1890

The Signal Service took over the weather observation role from the Smithsonian Institution in 1870 with twenty-four reporting stations. In Cincinnati, the first Sergeant was assigned in 1871 and the earliest of the extant reports from the Signal Service were sent in March 1872. The Signal Service was part of the continuum that began with Woodward High School. Shortly the Signal Service started, the observers at Woodward High School ceased sending their reports to the Smithsonian.

By 1878, the total number of Signal Service reporting locations had increased to seventy-eight nationwide. Three times each day (usually 7:35 a.m., 4:35 p.m., and 11:35 p.m.), each station telegraphed their observations to Washington, D.C. These observations consisted of:

Barometric pressure and its change since the last report.
Temperature and its 24-hour change.
Relative humidity.
Wind velocity.
Pressure of the wind in pounds per square foot.

Amount of clouds.
State of the weather.

From the beginning, the station at Cincinnati received daily reports from fifty-three other stations. These data were used to prepare issued eleven daily bulletins and to furnish tables of weather data to five daily newspapers, several libraries, the Chamber of Commerce, and the Board of Trade. The daily newspapers published the daily weather reports with attribution to the Signal Service.

The Observer Sergeants as they were called, were required to improve themselves and were liable at any time after one year's service to be called before a board for their second regular examination. To facilitate the study toward that end, the office was provided with Guyot's Meteorological Tables, Buchan's Handy-book of Meteorology, Loomis" Treatise on Meteorology, Manual of Signals, and the Smithsonian Directions for Meteorological Observations.

Sgt. F. H. Fletcher established the first Signal Service observer's office in Cincinnati. The first entry in the Journal kept from 1870 to 1872 was made on 1 November 1870.

> Rented room No. 64 Pikes Opera House, on 4th between Walnut and Vine Streets, for the purpose of taking meteorological observations for the government under the direction and control of the War Department. Commenced operations under peculiar circumstances – I forgot to get a key to the main hall door, and when I came on the morning of the 1st to take the observations, I found I could not get in, so I had to wait for the Janitor, and it made me late at the telegraph office with my first report.

He was replaced seven months later in 1872 by his assistant, Sgt. Francis B. Lloyde. Sgt. James H. Garrard was then assigned to be the second man in the office. During Sgt Lloyde's time in charge, a printing press was provided to the office. That provided the capability for the distribution of eleven daily weather maps. Monthly climatic summaries were also prepared. The importance of these weather products to the local economic community was recognized by the appointment of a Meteorological Committee within both the Chamber of Commerce and the Board of Trade.

Sgt E. B. Maynard assumed the observation duties in Cincinnati in 1872. His observations were telegraphed to Washington, D.C. where a daily map was prepared. Figure 20 is one of those maps that included information that he provided. The Signal Service Office's printing press in Cincinnati was used to produce this map.

The printing process was described by in the Washington D.C. section of the 1871 Annual Report.

> An ordinary "proof press" is used, with a bed plate, in which square holes are made, coinciding with the stations on the map, in

> which are placed the symbol type to designate the weather and direction of the wind. The arrows for showing the direction of the wind are diagonal on some of the type and cross-wise on the rest, making them available for pointing in eight different directions, and fitting so closely in the holes as to prevent their pulling out by the ink-roller; close to each of these holes is cut a slot in which is set the figure types showing in regular order, first, the height of the thermometer, next, the barometer, and lastly, the velocity of the wind. These are printed in red ink on the black base chart of the United States, the contrast in color rendering them clearly perceptible; at the same time is set up and printed in the southwest corner of the map, a table showing opposite the name of each station the change of barometer in the last eight hours, change of thermometer in the last twenty-four hours, relative humidity of the atmosphere, and the amount of rain-fall in the last twenty-four hours. Adjoining this table is also printed at the same time the "synopsis for past twenty-four hours" and the "probabilities", making a completed meteorological record of the day.

Note that this weather map had plotted temperature, barometric pressure, wind speed in miles per hour, and wind direction. Plots were printed (not handwritten) for forty-seven stations all but six of which were east of the Mississippi. In the lower left corner were the "Probabilities" as issued by the Office of the Chief Signal Officer, Washington D.C. at 11 a.m. on 9 January 1873. The forecast for the Cincinnati area was:

> From Florida and South Atlantic Coast to Ohio Valley northerly to westerly winds, lower temperature, and clear weather.

Also on the map was Sgt. Maynard's "Daily Report" for the twenty-four hours ending at 3 p.m. January 8, 1873. It included the rising or falling of the river. There were no fronts or highs/lows on these early maps.

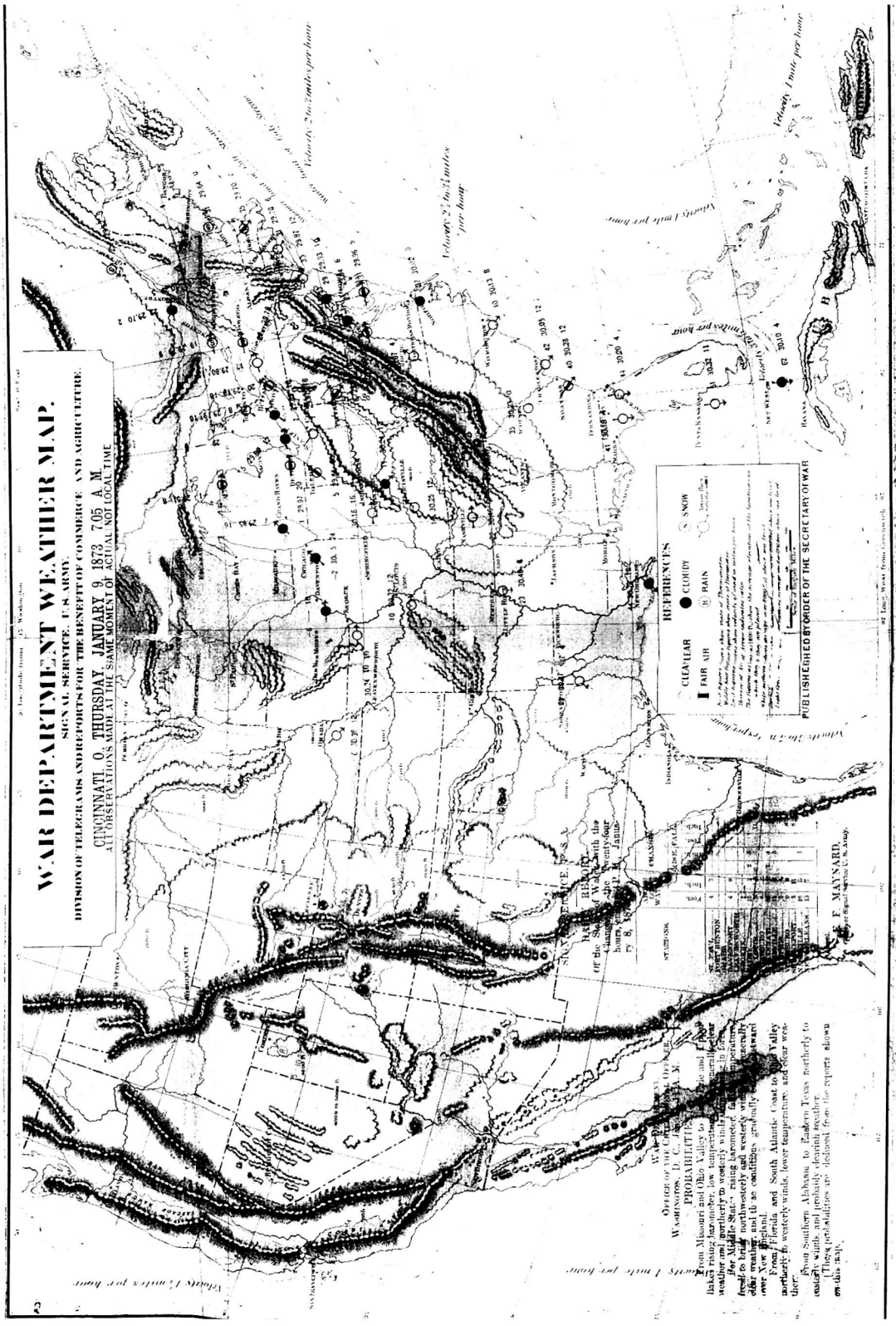


Figure 20. War Department Weather Map January 9, 1872, 7:05 a.m.
Source: Cincinnati Historical Society Library

Sgt J. H. Shields, Sgt. Theodore Wosher Jr, and Sgt. E. H. Singleton made some of the observations before Sgt. Simon S. Bassler was placed in charge in 1874 and served until 1877.

Sgt. Bassler entered the school at Fort Whipple, Virginia to train as a Sergeant Observer on 10 July 1873. There is a reference in Goodwin's study to a "school of instruction" located at Fort Whipple (later renamed Fort Myer) in Virginia. General Myer, Chief Signal Officer after the Civil War created that weather school in 1870. It provided a trained Private who replaced Sgt Garrard when he was transferred. The school trained the observers to be in both weather observation and in telegraphy. The simultaneous transmission of weather observations from the observers to Fort Whipple permitted the evolution of daily weather maps.

He was very active in the public service role. He was cited in the 1874 Annual Report of the Chief of the Signal Service for that role. An extract of his report for the July through December 1874 period was published in the Chief's Report.

> The river reports have been of unusual interest to our steamboat men, coal dealers, and other merchants interested in the river trade. The information they give has, in no few instances, led to important results, and been of great value to the public, and more especially to those directly engaged in the river trade. To know the stages of water in the rivers throughout the country is an aid to business transactions connected with the river that is of incalculable value. The steamboat men, as they become more acquainted with our bench marks, pay more attention to these reports, and make good use of the valuable information they give, and though the stations from which reports are received are not as numerous as desired, yet it is hoped they will gradually be established at every point where the information they give can be made of interest to the public. The weather reports are of great value to the pork and provision packers of this city, they being governed in a great measure by the favorable indications of the reports. They carefully consult them daily and also interview the sergeant in charge. The medical fraternity also make constant use of the reports, and in some instances regulate their mode of treatment by the changes in the meteorological conditions of the atmosphere. The study of our reports opens to them a field for exploration, one which has already rendered some valuable information, and promises to add more. Searching out and defining the relations existing between atmospheric conditions and contagious diseases are some of the advantages these reports afford the medical profession, while there are others that might be enumerated. The board of health have deemed it of special importance to show the meteorological condition of the atmosphere in connection with their weekly reports, and have published full local reports regularly, in connection with their weekly mortuary report, the data for which have been furnished from this office.

The Chief Signal Officer added these comments.

> The daily reports received here are printed in excellent form by the leading daily newspapers, which give a large amount of space to the

> data furnished from the signal-office, and in many ways manifest a lively and gratifying interest in the service.

Among other achievements, Sgt. Bassler published two documents. One was a book "The Weather, a Practical Guide to its Changes, showing Signal Service System and How to Foretell Local Weather" that he published in 1883. The book is a short hard cover text on meteorology for use by the readers of the Commercial Gazette newspaper in Cincinnati. It discussed these topics.

> Importance of Weather Knowledge, Weather Prophets, Signal Service System, Weather Signs, Weather Keys, The Dew Point, High and Low Barometer, Storms, Tornadoes, A Storm's Progress Illustrated, and Signal Service reports and the Foretelling of Weather.

He included sequences of daily weather maps to illustrate the progress of storms. He also noted that the signal service system is used in Great Britain and other European countries. He wrote this about the U.S. system.

> These observations are made several times each day, are promptly reported by telegraph to the central office in Washington, and there projected upon a map of the country, which then shows at a glance the distribution of sunshine and cloudiness, of warm and cold, and fair and foul weather at the time…. Our present weather science dates from the time of making simultaneous observations at numerous and widely scattered places and the use of the telegraph in transmitting the results.

With some pride, he wrote that, "The only reliable, as it is the only reasonable, system of forecasting the weather, is that of our Signal Service."

In 1886, he published "The Weather Chart with Explanation of Weather Prediction." It was a twenty-three paged pamphlet published by the Cincinnati Commercial Gazette. It sold for ten cents and was a condensed explanation for the Weather Maps that were published in the newspaper each day.

There were a number of Observer Sergeants who recorded observations between 1877 and 1890. They were: Sgt Nelson Gorom 1877-1878, Pvt Charles N. Kitchel 1879, Sgt R. B. Watkins 1880-1881, Pvt Joseph F. Harrold 1882, and Sergeants S. Dunnly, L. Dunne, and E. G. Johnson in 1883.

Sergeants L. Dunne was the observer during 1884-1885. In January 1885, the observation record's column headings of "Washington Time" were lined through and "75° W" substituted. In the margin above, was this entry, "Lat 39° 6' N Long 84° 26' W of Greenwich." This was no doubt in response to the institution of Standard Time Zones with 75° west longitude being the center meridian of the Eastern Standard Time Zone.

H. Jenkins 1886, D. T. Flannery 1889, and G.N. Salisbury 1890 followed as observers.

Not everyone shared the Observer Sergeants' enthusiasm for the weather mission. The famous Civil War General William Tecumseh Sherman was one of those detractors. According to Goodwin's study, he thought that the Observer Sergeants were

> …. No more soldiers than the men of the Smithsonian Institute. They are making scientific observations of the weather, of great interest to navigators and the country at large. But what does a soldier care about the weather? Whether good or bad, he must take it as it comes.

It isn't surprising that the Army's responsibility for weather observations was transferred to the new Weather Bureau that was created within the Department of Agriculture on 1 October 1890.

The Weather Bureau Years
1891-1947

The conversion from the Signal Service to the Weather Bureau in Cincinnati appears to have been finalized with the July 1891 report. The previous month's report was signed by H. Jenkins of the Signal Service. In July, he lined through the printed "Observer, Signal Service" and wrote underneath "Local Forecast Official In Charge." In November, he only lined through "Signal Service" and made no other substitution. In December, he added "In Charge." The apparent uncertainty about the title was solved with the February 1892 form that had "Observer, Weather Bureau" printed at the end of the signature line.

Mr. Jenkins continued as the observer through October although M. E. Blystone filled in as observer in September. In November 1892, S. S. Bassler resumed the observer duties after an absence of fifteen years.

According to Brown, the Weather Bureau was located on the fourth floor of the Federal Building. They were open to the public from 9 a.m. to 5 p.m. and invited visitors to come to see the weather instruments in use. Clearly, the longstanding attitude toward public relations was being continued.

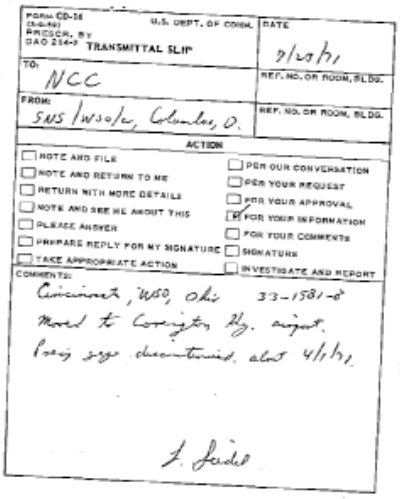
The End of Cincinnati's Federal Weather Observations

The Weather Bureau was transferred to the Department of Commerce in 1940 and the emphasis for weather collection shifted to that required for aviation weather forecasting. That change in purpose led to moves of the old Weather Bureau Offices. On 12 March 1947, a new Weather Bureau station was established about thirteen miles across the Ohio River at the Kenton County Airport in Kentucky. The station was later renamed Greater Cincinnati Airport after the airline operations were transferred from Luken Airport in Cincinnati to the new airport in Erlanger, Kentucky. The new location was in the Administration Building whose location was corrected to be 39˚ 03.5' north and 84˚ 39.8' west at an elevation of 869 feet. Upper air data were

collected using the roof as the Pilot Balloon launch site. The cotton region shelter and other instruments were on the roof as well. In 1967, the Weather Bureau was renamed the National Weather Service.

The observations at the Federal Building in Cincinnati continued until 1971 when the Weather Service Office was moved to the Greater Cincinnati Airport. That ended the one hundred years of the Signal Service, Weather Bureau, and the National Weather Service observations for Cincinnati. The location of the National Weather Service was renamed on 1 January 1992 from the Greater Cincinnati International Airport to the Cincinnati-Northern Kentucky International Airport.

Twenty-three years later on 17 February 1994, the National Weather Service Office personnel moved from the Cincinnati-Northern Kentucky International Airport to Wilmington, Ohio.


FORM CD-14 (3-6-90) PRESCR. BY DAO 214-2 U.S. DEPT. OF COMM.

TRANSMITTAL SLIP

DATE 9/20/71

TO: NCC

REF. NO. OR ROOM, BLDG.

FROM: SAIS/WSO/Lr, Columbus, O.

REF. NO. OR ROOM, BLDG.

ACTION

- NOTE AND FILE
- NOTE AND RETURN TO ME
- RETURN WITH MORE DETAILS
- NOTE AND SEE ME ABOUT THIS
- PLEASE ANSWER
- PREPARE REPLY FOR MY SIGNATURE
- TAKE APPROPRIATE ACTION
- PER OUR CONVERSATION
- PER YOUR REQUEST
- FOR YOUR APPROVAL
- FOR YOUR INFORMATION
- FOR YOUR COMMENTS
- SIGNATURE
- INVESTIGATE AND REPORT

COMMENTS:

Cincinnati, WSO, Ohio 33-1581-0
Moved to Covington, Ky. airport.
Precip. segment discontinued, abt 4/1/71.

L. Seidel

Figure 21. The Note Announcing the Move From Cincinnati
Source: National Climatic Data Center

Thereafter, the weather observations at the airport were made by Automated Surface Observation System equipment.

For digital data, the National Climatic Data Center assigned the station number 331581 with the name Cincinnati WSO City. That number includes the period from the Signal Service, Weather Bureau, and Weather Service continuum.

The Cincinnati Abbe Observatory station number is 331561.

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APPENDIX 1

METHODOLOGY

The primary sources of information for this study were the Cincinnati and Hamilton County observers' daily weather records themselves. Copies of their monthly reports and the data digitized from those reports were available from the Midwestern Regional Climate Center in Champaign, Illinois, or the National Climatic Data Center in Asheville, North Carolina. The monthly reports can be considered original sources because they were written by the observers and not altered by subsequent readers.

There were a variety of secondary sources that held information about Cincinnati, its history, and its people. The author visited and collected information from the holdings of the Kentucky Climate Center and the Kentucky Library at Western Kentucky University in Bowling Green, Kentucky; the National Climatic Data Center at Asheville, North Carolina; the Cincinnati Public Library, the Cincinnati Historical Society Library, and the University of Cincinnati Archives; the Kenton County Public Library in Covington, Kentucky; the Filson Historical Society in Louisville, Kentucky; and the LDS Family History Library in Salt Lake City, Utah. The National Weather Service Office in Wilmington, Ohio, especially Sam McNeal, was most helpful.

The tertiary sources were reference materials that are available on-line. Among those were the metadata prepared by the Office of the State Climatologist of Ohio, Midwestern Regional Climate Center, the National Climatic Data Center substation histories, and the Office of Medical History in the Office of the Surgeon General, U.S. Army. Two genealogical research sources, Ancestry.com and Genealogy.com were used to provide some of the personal information about the observers. For location analysis, the interactive maps available from TopoZone.com were used.

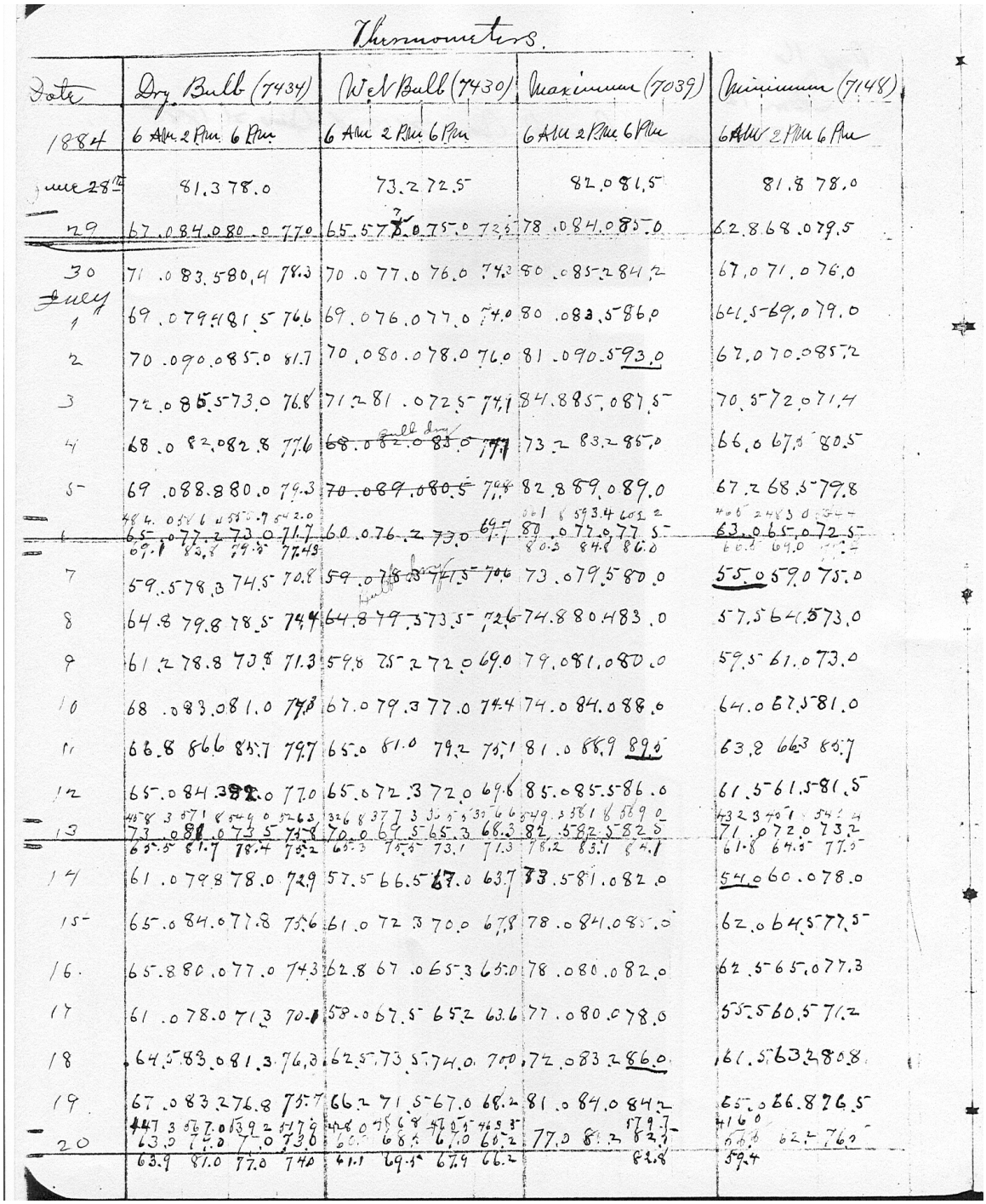
There was an attempt to glean information from all these sources that would allow a glimpse into the lives of the observers, the location of the observation site, and the historical environment that produced the climatic history of Cincinnati, Ohio. Maps, drawings, and photographs were included when appropriate to illustrate the information.

Throughout the research for and preparation of this study, the objective was to produce a document that future studies can use to evaluate the validity of the data that were collected here, judge the trustworthiness of the observers who collected them, and determine the climatological significance of the whatever variability may be discerned.

APPENDIX 2

Observations from the Cincinnati Observatory
28 June 1884 – 20 July 1884

Page 1



Thermometers.

Date 1884	Dry Bulb (7434) 6 AM.	2 PM.	6 PM.	Wet Bulb (7430) 6 AM.	2 PM.	6 PM.	Maximum (7039) 6 AM.	2 PM.	6 PM.	Minimum (7148) 6 AM.	2 PM.	6 PM.
June 28th	81.3	78.0		73.2	72.5		82.0	81.5		81.8	78.0	
29	67.0	84.0	80.0	77.0	65.5	77.0	75.0	72.5	78.0	84.0	85.0	62.8	68.0	79.5
30	71.0	83.5	80.4	78.3	70.0	77.0	76.0	74.2	80.0	85.2	84.2	67.0	71.0	76.0
July 1	69.0	79.4	81.5	76.6	69.0	76.0	77.0	74.0	80.0	83.5	86.0	64.5	69.0	79.0
2	70.0	90.0	85.0	81.7	70.0	80.0	78.0	76.0	81.0	90.5	93.0	67.0	70.0	85.2
3	72.0	85.5	73.0	76.8	71.2	81.0	72.5	74.1	84.8	85.0	87.5	70.5	72.0	71.4
4	68.0	82.0	82.8	77.6	~~68.0~~	~~82.0~~	~~83.0~~	~~77.1~~	73.2	83.2	85.0	66.0	67.8	80.5
5	69.0	88.8	80.0	79.3	~~70.0~~	~~89.0~~	~~80.5~~	~~77.8~~	82.8	89.0	89.0	67.2	68.5	79.8
6	65.0	77.2	73.0	71.7	60.0	76.2	73.0	69.5	80.0	77.5		63.0	65.0	72.5
7	59.5	78.3	74.5	70.8	59.0	78.3	74.5	70.6	73.0	79.5	80.0	55.0	59.0	75.0
8	64.8	79.8	78.5	74.4	64.8	79.3	73.5	72.6	74.8	80.4	83.0	57.5	64.5	73.0
9	61.2	78.8	73.8	71.3	59.8	75.2	72.0	69.0	79.0	81.0	80.0	59.5	61.0	73.0
10	68.0	83.0	81.0	74.8	67.0	79.3	77.0	74.4	74.0	84.0	88.0	64.0	67.5	81.0
11	66.8	86.6	85.7	79.7	65.0	81.0	79.2	75.1	81.0	88.9	89.0	63.8	66.3	85.7
12	65.0	84.3	82.0	77.0	65.0	72.3	72.0	69.6	85.0	85.5	86.0	61.5	61.5	81.5
13	73.0	88.0	73.5	74.8	70.0	67.5	65.3	68.3	82.5	82.5	82.5	71.0	72.0	73.2
14	61.0	79.8	78.0	72.9	57.5	66.5	67.0	63.7	83.5	81.0	82.0	54.0	60.0	78.0
15	65.0	84.0	77.8	75.6	61.0	72.3	70.0	67.8	78.0	84.0	85.0	62.0	64.5	77.5
16	65.8	80.0	77.0	74.3	62.8	67.0	65.3	65.0	78.0	80.0	82.0	62.5	65.0	77.3
17	61.0	78.0	71.3	70.1	58.0	67.5	65.2	63.6	77.0	80.0	78.0	55.5	60.5	71.2
18	64.5	83.0	81.3	76.3	62.5	73.5	74.0	70.0	72.0	83.2	86.0	61.5	63.2	80.8
19	67.0	83.2	76.8	75.7	66.2	71.5	67.0	68.2	81.0	84.0	84.2	65.0	66.8	76.5
20	63.0	77.0	73.0	73.0	60.2	68.5	66.0	60.2	77.0	82.2	82.8	59.4	62.2	76.0
	63.9	81.0	77.0	74.0	61.1	69.5	67.9	66.2						

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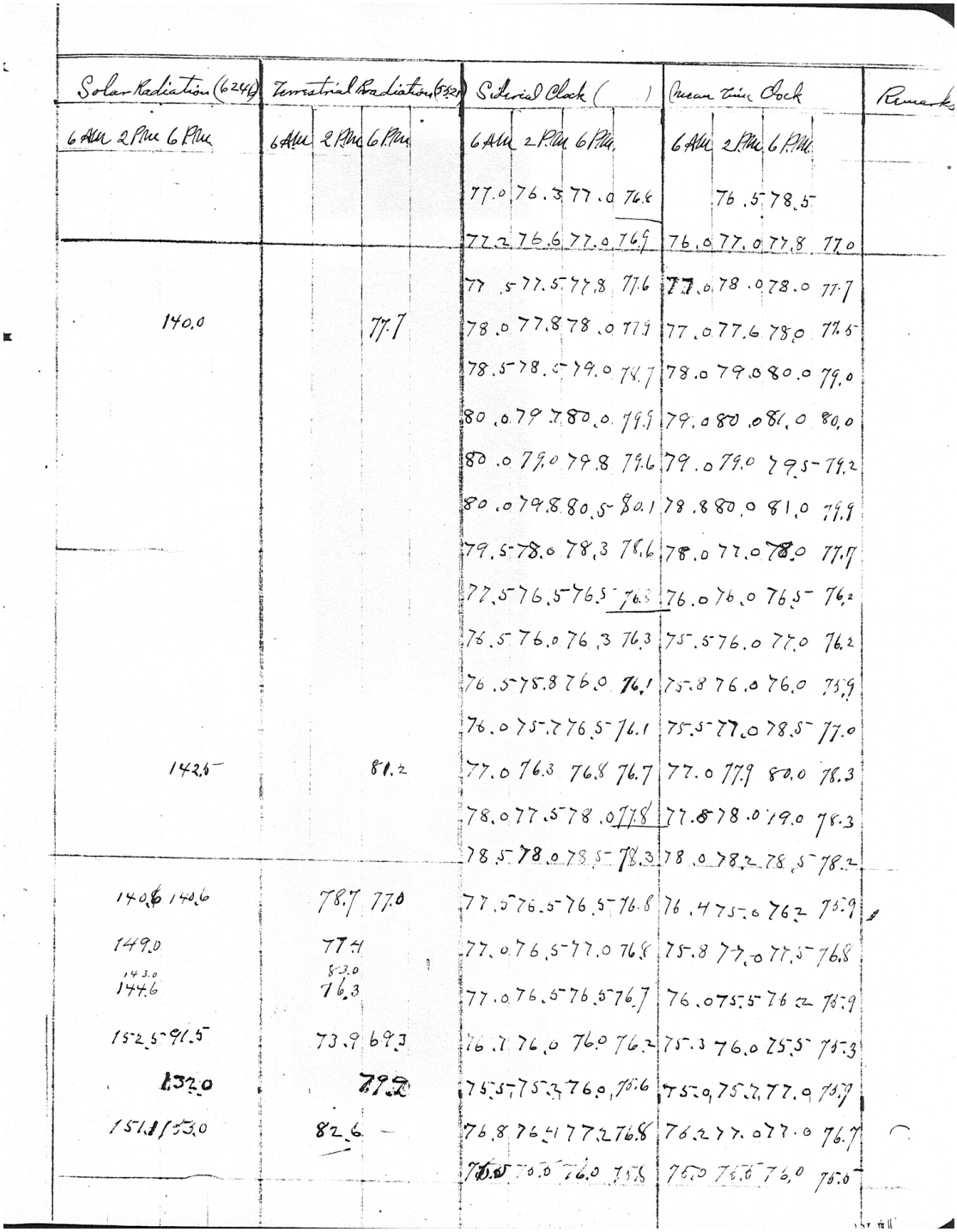
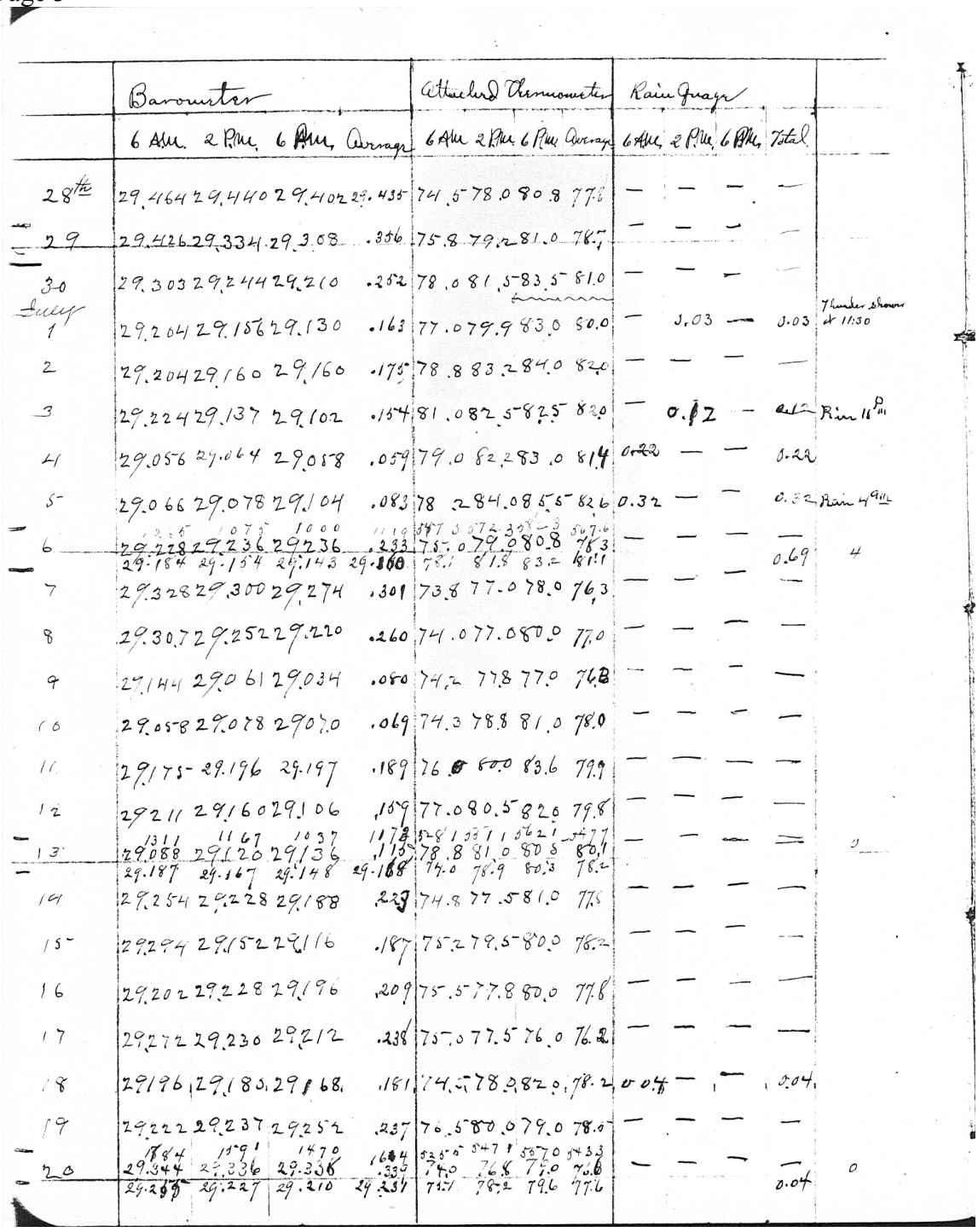


Solar Radiation (6244)			Terrestrial Radiation (6320)			Sidereal Clock ( )			Mean Time Clock			Remarks
6 AM	2 PM	6 PM	6 AM	2 PM	6 PM	6 AM	2 PM	6 PM	6 AM	2 PM	6 PM	
						77.0	76.3	77.0 76.8		76.5	78.5	
						77.2	76.6	77.0 76.9	76.0	77.0	77.8 77.0	
						77.5	77.5	77.8 77.6	77.0	78.0	78.0 77.7	
140.0					77.7	78.0	77.8	78.0 77.9	77.0	77.6	78.0 77.6	
						78.5	78.5	79.0 78.7	78.0	79.0	80.0 79.0	
						80.0	79.7	80.0 79.9	79.0	80.0	81.0 80.0	
						80.0	79.0	79.8 79.6	79.0	79.0	79.5 79.2	
						80.0	79.8	80.5 80.1	78.8	80.0	81.0 79.9	
						79.5	78.0	78.3 78.6	78.0	77.0	78.0 77.7	
						77.5	76.5	76.5 76.8	76.0	76.0	76.5 76.2	
						76.5	76.0	76.3 76.3	75.5	76.0	77.0 76.2	
						76.5	75.8	76.0 76.1	75.8	76.0	76.0 75.9	
						76.0	75.7	76.5 76.1	75.5	77.0	78.5 77.0	
142.5					81.2	77.0	76.3	76.8 76.7	77.0	77.9	80.0 78.3	
						78.0	77.5	78.0 77.8	77.8	78.0	79.0 78.3	
						78.5	78.0	78.5 78.3	78.0	78.2	78.5 78.2	
140.6	140.6			78.7	77.0	77.5	76.5	76.5 76.8	76.4	75.0	76.2 75.9	
149.0				77.4		77.0	76.5	77.0 76.8	75.8	77.0	77.5 76.8	
143.0 144.6				83.0 76.3		77.0	76.5	76.5 76.7	76.0	75.5	76.2 75.9	
152.5	91.5			73.9	69.3	76.1	76.0	76.0 76.2	75.3	76.0	75.5 75.3	
132.0				79.2		75.5	75.3	76.0 75.6	75.0	75.2	77.0 75.7	
151.1	153.0			82.6		76.8	76.4	77.2 76.8	76.2	77.0	77.0 76.7	
						75.5	75.0	76.0 75.5	75.0	76.0	76.0 75.6	

Page 3



	Barometer				Attached Thermometer				Rain Gauge				
	6 AM.	2 PM.	6 PM.	Average	6 AM.	2 PM.	6 PM.	Average	6 AM.	2 PM.	6 PM.	Total	
28th	29.416	29.414	29.402	29.435	74.5	78.0	80.8	77.8	—	—	—	—	
29	29.426	29.334	29.308	.356	75.8	79.2	81.0	78.7	—	—	—	—	
30	29.303	29.244	29.210	.252	78.0	81.5	83.5	81.0	—	—	—	—	
July 1	29.204	29.156	29.130	.163	77.0	79.9	83.0	80.0	—	0.03	—	0.03	Thunder shower at 11:30
2	29.204	29.160	29.160	.175	78.8	83.2	84.0	82.0	—	—	—	—	
3	29.224	29.137	29.102	.154	81.0	82.5	82.5	82.0	—	0.12	—	0.12	Rain 11 PM
4	29.056	29.064	29.058	.059	79.0	82.2	83.0	81.4	0.22	—	—	0.22	
5	29.066	29.078	29.104	.083	78.2	84.0	85.5	82.6	0.32	—	—	0.32	Rain 4 PM
6	29.228	29.236	29.236	.233	78.0	79.0	80.8	78.3	—	—	—	—	
	29.184	29.154	29.143	29.160	78.1	81.8	83.2	81.1				0.69	4
7	29.328	29.300	29.274	.301	73.8	77.0	78.0	76.3	—	—	—	—	
8	29.307	29.252	29.220	.260	74.0	77.0	80.0	77.0	—	—	—	—	
9	29.144	29.061	29.034	.080	74.2	77.8	77.0	76.3	—	—	—	—	
10	29.058	29.078	29.070	.069	74.3	78.8	81.0	78.0	—	—	—	—	
11	29.175	29.196	29.197	.189	76.0	80.0	83.6	79.9	—	—	—	—	
12	29.211	29.160	29.106	.159	77.0	80.5	82.6	79.8	—	—	—	—	
13	29.088	29.120	29.136	.115	78.8	81.0	80.5	80.1	—	—	—	—	0
	29.187	29.167	29.148	29.168	79.0	78.9	80.3	78.2					
14	29.254	29.228	29.188	.237	74.8	77.5	81.0	77.8	—	—	—	—	
15	29.294	29.252	29.216	.187	75.2	79.5	80.0	78.2	—	—	—	—	
16	29.202	29.228	29.196	.209	75.5	77.8	80.0	77.8	—	—	—	—	
17	29.272	29.230	29.212	.238	75.0	77.5	76.0	76.2	—	—	—	—	
18	29.196	29.180	29.168	.181	74.5	78.2	82.0	78.2	0.04	—	—	0.04	
19	29.222	29.237	29.252	.237	76.5	80.0	79.0	78.0	—	—	—	—	
20	29.344	29.336	29.306	.336	74.0	76.8	77.0	75.6	—	—	—	—	0
	29.289	29.227	29.210	29.231	75.1	78.2	79.6	77.6				0.04	

Observations from the Cincinnati Observatory
28 June 1884 – 20 July 1884

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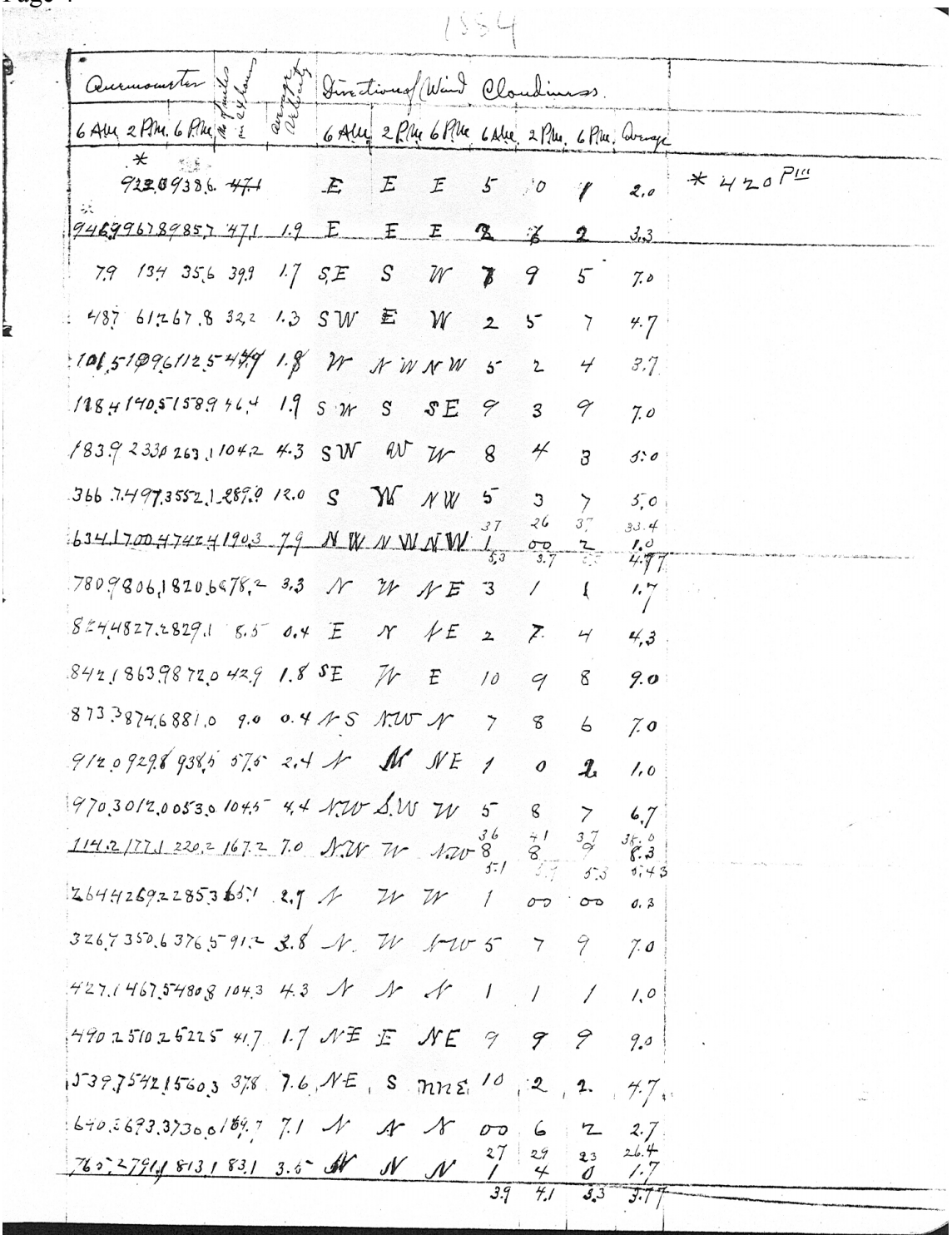

Source: Original manuscript in the Cincinnati Observatory Collection, UA-79-43, University Archives & Rare Books Department, University of Cincinnati, Cincinnati, Ohio. Box 16, Item Number 13, Thermometer Record June 28-1884-June 21 1885

APPENDIX 3

Woodward High School – Weather Bureau Meteorological Record
1835-1921

Page 1

6. CINCINNATI: D. (WOODWARD HIGH SCHOOL)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1835	34.6	24.5	40.1	50.5	65.3	71.2	71.7	69.1	59.1	55.8	43.3	31.4	51.4
1836	30.6	28.8	36.1	55.6	65.8	70.4	75.8	71.6	69.3	46.2	38.7	30.6	51.6
1837	30.1	36.6	41.8	48.3	62.5	70.1	75.3	72.4	64.9	55.8	48.1	35.5	53.4
1838	36.4	20.9	48.4	50.5	56.7	73.1	79.2	77.7	66.3	50.6	39.0	28.2	52.2
1839	38.0	37.0	44.9	60.2	66.0	69.5	76.2	73.5	61.1	60.3	37.3	30.6	54.6
1840	25.7	42.0	47.7	57.4	63.2	70.8	75.4	74.7	61.8	54.3	40.9	32.4	53.9
1841	32.0	32.5	44.7	51.2	62.1	75.1	79.1	76.4	67.8	51.2	44.2	36.3	54.4
1842	36.7	36.4	52.4	57.7	60.8	69.0	75.6	71.4	66.6	52.2	35.1	33.8	54.0
1843	35.8	26.6	28.8	51.3	62.8	70.4	73.8	70.3	69.3	47.7	40.6	36.2	51.1
1844	31.7	37.4	44.4	64.1	66.8	71.6	78.5	72.6	65.7	49.5	44.2	36.3	55.2
1845	37.9	40.1	44.5	59.9	61.6	72.6	73.4	73.0	64.1	50.2	40.3	24.8	53.5
1846	35.2	31.5	44.2	57.1	67.0	68.2	75.9	76.4	70.7	52.8	45.7	39.8	55.4
1847	30.8	36.8	40.2	55.7	62.7	69.2	74.4	70.5	64.1	53.2	44.9	34.3	53.1
1848	36.7	36.9	42.3	53.7	66.5	71.8	73.8	74.6	62.2	54.0	39.8	41.1	54.4
1849	32.3	32.2	46.5	52.6	63.9	73.9	73.7	73.5	65.3	53.3	49.9	31.6	54.1
1850	36.6	35.6	41.2	49.0	58.9	73.3	81.6	78.3	66.0	53.4	46.4	34.6	54.6
1851	36.1	42.4	46.4	52.0	65.8	71.3	79.1	76.5	69.4	53.7	40.9	30.3	55.3
1852	27.3	36.9	46.2	50.7	64.7	68.9	80.1	75.1	65.1	60.2	41.4	39.9	54.7
1853	34.5	35.6	42.2	54.4	63.4	75.6	75.6	76.2	66.9	50.1	47.6	32.7	54.6
1854	32.5	39.2	46.8	53.9	64.7	72.2	81.5	79.8	73.2	58.9	41.3	35.2	56.6
1855	33.6	27.9	.....	.....	.....	.....	.....	.....	.....	*53.3	*47.7	*34.7	.....
1856	21.9	28.0	34.6	60.0	67.3	78.0	82.3	74.3	67.9	58.5	43.4	29.9	53.8
1857	21.4	45.6	40.4	45.0	61.1	71.4	77.8	76.5	71.6	54.7	40.5	39.9	53.8
1858	41.0	29.3	43.2	55.9	63.2	75.6	81.6	80.0	71.4	61.9	42.5	45.1	57.6
1859	36.3	40.8	52.2	53.8	70.5	73.0	80.0	75.4	67.6	53.3	48.3	28.8	56.7
1860	36.9	38.3	48.2	57.8	69.8	74.2	78.2	77.5	67.4	59.4	43.5	33.5	57.0
1861	35.9	41.9	45.2	57.3	61.8	74.9	73.3	75.5	69.6	58.4	45.6	41.3	56.7
1862	36.3	35.8	44.4	55.0	64.9	71.6	78.7	78.0	73.1	59.3	46.1	41.3	57.0
1863	.....	38.6	42.7	55.0	69.6	71.3	77.3	76.3	66.8	53.0	47.2	40.6	.....
1864	32.4	38.2	42.9	.....	.....	73.7	79.6	75.6	68.3	54.2	47.0	35.7	.....
1865	29.0	38.8	49.9	58.4	65.2	77.5	77.0	76.3	76.8	58.1	46.3	40.6	57.8
1866	35.8	36.4	44.2	61.4	64.4	74.6	79.8	72.8	66.9	59.8	48.2	34.6	56.6
1867	27.8	44.4	40.5	58.6	61.0	76.9	79.2	81.5	74.4	60.4	50.5	37.8	57.8
1868	31.6	35.5	51.3	53.9	65.5	75.5	85.1	75.7	67.7	56.6	46.4	33.0	56.5
1869	40.6	41.6	39.8	56.3	66.8	75.4	81.4	82.4	71.4	49.6	41.6	38.4	57.3
1870	35.7	33.2	39.0	55.2	69.9	76.0	82.1	78.0	72.8	58.4	44.1	30.8	56.4
1871	34.5	36.6	49.2	58.9	67.1	74.2	75.3	76.4	64.2	57.4	41.6	29.7	55.6
1872	28.2	32.3	33.9	57.8	68.7	76.7	.....	77.6	66.6	53.3	36.0	25.4	.....
1873	27.1	31.3	37.2	51.2	62.0	76.9	75.3	74.8	65.8	50.2	36.6	31.1	51.0
Mean:	33.1	35.5	43.4	55.1	64.6	73.0	77.7	78.1	67.6	54.7	43.4	34.5	55.1

7. CINCINNATI: E. (U. S. WEATHER BUREAU)

1872	.....	.....	.....	.....	63.9	74.6	79.6	78.6	69.4	56.6	39.8	28.4	.....
1873	29.7	35.6	41.6	53.7	66.0	77.8	77.6	76.4	67.8	53.4	40.8	40.9	55.1
1874	37.6	38.4	44.2	47.8	67.2	79.8	79.0	77.0	71.6	56.4	45.2	40.0	57.0
1875	26.0	26.4	40.2	51.3	64.3	73.0	77.5	71.7	65.1	53.1	43.6	43.4	53.0
1876	42.3	39.6	40.2	54.0	67.0	75.2	79.8	77.2	67.6	52.5	44.2	25.0	55.4
1877	30.8	41.4	39.4	55.0	61.8	73.5	77.6	75.4	68.8	59.6	45.9	47.6	56.4
1878	36.0	40.8	51.4	60.0	63.0	69.8	81.8	77.9	68.2	56.6	47.4	31.0	57.0
1879	30.4	33.6	45.5	53.3	67.0	72.8	81.0	72.8	63.6	64.8	48.2	41.6	56.2
1880	48.7	43.0	45.4	57.8	70.0	74.6	76.8	76.6	67.4	55.2	37.2	30.0	56.9
1881	28.8	36.0	41.5	51.0	70.6	73.4	81.6	80.1	76.4	63.2	47.7	44.4	57.9
1882	37.6	46.3	49.4	55.4	61.2	73.4	75.0	75.0	69.0	62.6	46.6	35.7	57.3
1883	32.0	39.2	41.2	55.7	63.0	74.0	77.0	73.3	66.8	59.2	48.8	39.4	55.8
1884	26.4	41.9	45.4	53.1	64.5	75.0	76.7	75.2	74.1	61.9	45.0	36.2	56.3
1885	26.0	23.4	34.8	53.6	62.0	70.4	78.0	73.0	66.4	53.0	44.2	35.3	51.7
1886	25.9	30.1	42.9	55.8	65.6	70.4	75.2	74.6	69.2	56.9	41.7	27.8	53.0
1887	29.8	40.6	41.4	53.0	69.0	73.7	81.1	75.7	68.2	53.3	43.5	34.4	55.3
1888	29.2	35.0	38.7	54.8	63.2	73.8	77.1	74.2	64.8	52.0	46.4	37.0	53.8
1889	37.2	30.3	45.8	54.4	62.8	69.6	75.5	72.3	66.2	51.6	43.1	48.2	54.8
1890	41.5	43.1	39.7	55.8	63.8	77.8	77.0	72.6	65.8	56.5	47.8	35.8	56.4
1891	36.2	40.0	37.9	56.0	59.6	74.2	71.4	72.3	70.0	54.6	42.6	42.0	54.7

Source: A Climatological History of Ohio, Alexander

Woodward High School Meteorological Record
1835-1921

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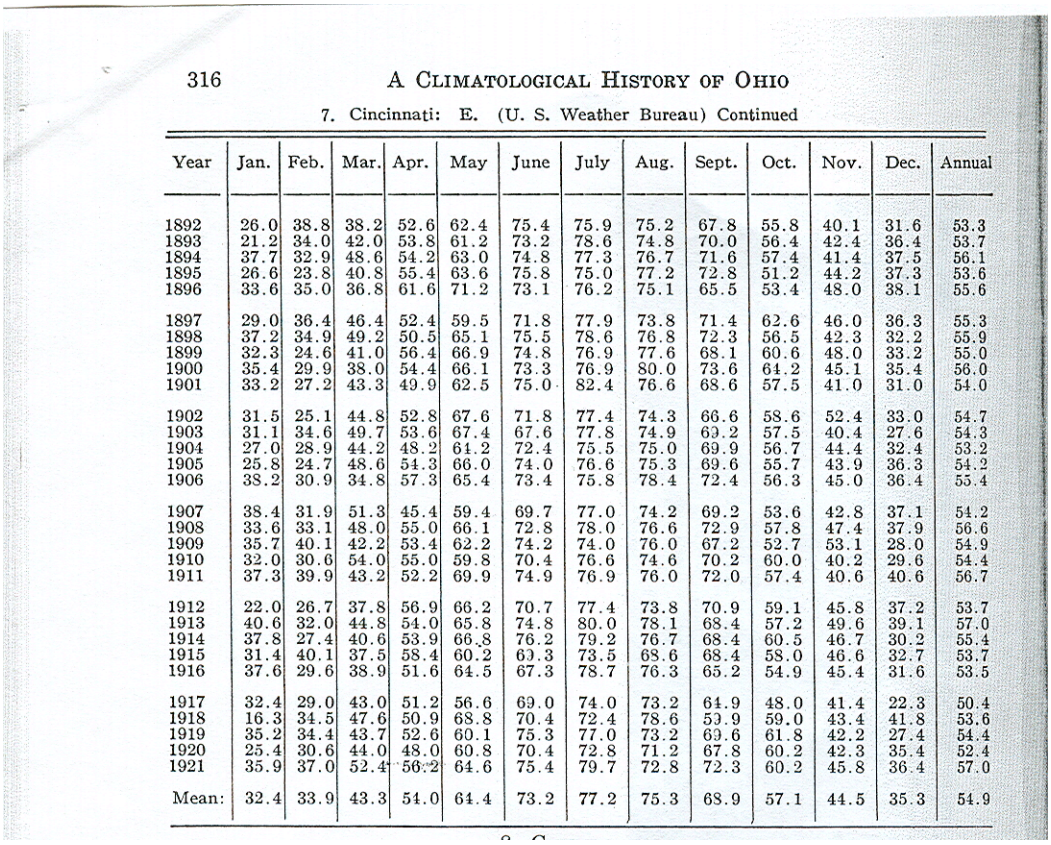

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7. Cincinnati: E. (U. S. Weather Bureau) Continued

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	26.0	38.8	38.2	52.6	62.4	75.4	75.9	75.2	67.8	55.8	40.1	31.6	53.3
1893	21.2	34.0	42.0	53.8	61.2	73.2	78.6	74.8	70.0	56.4	42.4	36.4	53.7
1894	37.7	32.9	48.6	54.2	63.0	74.8	77.3	76.7	71.6	57.4	41.4	37.5	56.1
1895	26.6	23.8	40.8	55.4	63.6	75.8	75.0	77.2	72.8	51.2	44.2	37.3	53.6
1896	33.6	35.0	36.8	61.6	71.2	73.1	76.2	75.1	65.5	53.4	48.0	38.1	55.6
1897	29.0	36.4	46.4	52.4	59.5	71.8	77.9	73.8	71.4	62.6	46.0	36.3	55.3
1898	37.2	34.9	49.2	50.5	65.1	75.5	78.6	76.8	72.3	56.5	42.3	32.2	55.9
1899	32.3	24.6	41.0	56.4	66.9	74.8	76.9	77.6	68.1	60.6	48.0	33.2	55.0
1900	35.4	29.9	38.0	54.4	66.1	73.3	76.9	80.0	73.6	64.2	45.1	35.4	56.0
1901	33.2	27.2	43.3	49.9	62.5	75.0	82.4	76.6	68.6	57.5	41.0	31.0	54.0
1902	31.5	25.1	44.8	52.8	67.6	71.8	77.4	74.3	66.6	58.6	52.4	33.0	54.7
1903	31.1	34.6	49.7	53.6	67.4	67.6	77.8	74.9	69.2	57.5	40.4	27.6	54.3
1904	27.0	28.9	44.2	48.2	61.2	72.4	75.5	75.0	69.9	56.7	44.4	32.4	53.2
1905	25.8	24.7	48.6	54.3	66.0	74.0	76.6	75.3	69.6	55.7	43.9	36.3	54.2
1906	38.2	30.9	34.8	57.3	65.4	73.4	75.8	78.4	72.4	56.3	45.0	36.4	55.4
1907	38.4	31.9	51.3	45.4	59.4	69.7	77.0	74.2	69.2	53.6	42.8	37.1	54.2
1908	33.6	33.1	48.0	55.0	66.1	72.8	78.0	76.6	72.9	57.8	47.4	37.9	56.6
1909	35.7	40.1	42.2	53.4	62.2	74.2	74.0	76.0	67.2	52.7	53.1	28.0	54.9
1910	32.0	30.6	54.0	55.0	59.8	70.4	76.6	74.6	70.2	60.0	40.2	29.6	54.4
1911	37.3	39.9	43.2	52.2	69.9	74.9	76.9	76.0	72.0	57.4	40.6	40.6	56.7
1912	22.0	26.7	37.8	56.9	66.2	70.7	77.4	73.8	70.9	59.1	45.8	37.2	53.7
1913	40.6	32.0	44.8	54.0	65.8	74.8	80.0	78.1	68.4	57.2	49.6	39.1	57.0
1914	37.8	27.4	40.6	53.9	66.8	76.2	79.2	76.7	68.4	60.5	46.7	30.2	55.4
1915	31.4	40.1	37.5	58.4	60.2	69.3	73.5	68.6	68.4	58.0	46.6	32.7	53.7
1916	37.6	29.6	38.9	51.6	64.5	67.3	78.7	76.3	65.2	54.9	45.4	31.6	53.5
1917	32.4	29.0	43.0	51.2	56.6	69.0	74.0	73.2	64.9	48.0	41.4	22.3	50.4
1918	16.3	34.5	47.6	50.9	68.8	70.4	72.4	78.6	69.9	59.0	43.4	41.8	53.6
1919	35.2	34.4	43.7	52.6	60.1	75.3	77.0	73.2	69.6	61.8	42.2	27.4	54.4
1920	25.4	30.6	44.0	48.0	60.8	70.4	72.8	71.2	67.8	60.2	42.3	35.4	52.4
1921	35.9	37.0	52.4	56.2	64.6	75.4	79.7	72.8	72.3	60.2	45.8	36.4	57.0
Mean:	32.4	33.9	43.3	54.0	64.4	73.2	77.2	75.3	68.9	57.1	44.5	35.3	54.9

Source: A Climatological History of Ohio, Alexander