HISTORY OF WEATHER OBSERVATIONS
MEMPHIS, TENNESSEE
1849 — 1948

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Prepared By
Glen Conner
9216 Holland Road
Scottsville, Kentucky

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ACKNOWLEDGEMENTS

The climate of Memphis was recorded by scores of people over more than one hundred years. There followed scores of people who later cleaned out their files but chose not to throw away those data, notes, photographs, and other materials we now find valuable. There are now scores of people who seek to preserve those documents and to identify their stations' histories. Among them at the National Weather Service's Memphis Office are Jim Belles, Joe Lowery, and Zwemer Ingam,

All of these people made this study possible and, to them, thank you.

Perhaps someone will read this study when it is a hundred years old. If so, to you, thanks for continuing the thread of interest in climate history.

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Glen Conner
Kentucky State Climatologist Emeritus

INTRODUCTION

Matthew Fontaine Maury has been credited as the discoverer of the Gulf Stream, proponent for the creation of a Naval Academy, and author of the first textbook on oceanography. To his long list of accomplishments, another can be added. There can be no doubt that two of his efforts gave rise to the beginning of weather observations in Memphis, Tennessee.

The first effort occurred when Maury became the Navy Department's Superintendent of the Depot of Charts and Instruments[1] in Washington, D. C. in 1842. There, he began a long-term effort to collect data from ships' logbooks on wind, weather, and ocean currents. He became an advocate for standardized weather observations both on land and on sea. He was the father of the Navy's climate network.

The second effort by Maury was to advocate a Navy Yard at Memphis. According to him, collection of data at Memphis would facilitate understanding of the winds along the Mississippi River and its tributaries and their currents and fluctuations in water level.

Both of those efforts were fruitful. Congress authorized a Navy Yard in Memphis in 1845 and Maury assured that weather observations would be taken there.

The Location

Memphis was an important location in many respects. The Mississippi River with its connections to the Missouri and Ohio Rivers provided routes of navigation to most of the country. The Missouri's drainage area explored by Rogers and Clark forty years earlier was still being explored and settled. The City was located about half way between the Great Lakes and the Gulf of Mexico, at a time when a canal connecting the Great Lakes with the Mississippi was being discussed. Memphis was set to become a major port for river traffic from those areas as well as traffic coming upstream from the port of New Orleans.

The Place

The Memphis Navy Yard was constructed on the banks of the Mississippi River at its confluence with the Wolf River. The original purpose of the Navy Yard was to outfit ships and to

[1] Later known as the Hydrographical Office

make cordage.[2] One justification for the Memphis location was its accessibility to the hemp producing areas that could supply the raw materials for the cordage.

The Navy Yard (Figure 1) had grown by the time the Gleason's Pictorial Drawing Room Companion featured it in their 1854 issue. It mentioned that among other attributes of Memphis were its "…salubrity of climate, fertility of soil, and beautiful forests of the best oak timber."

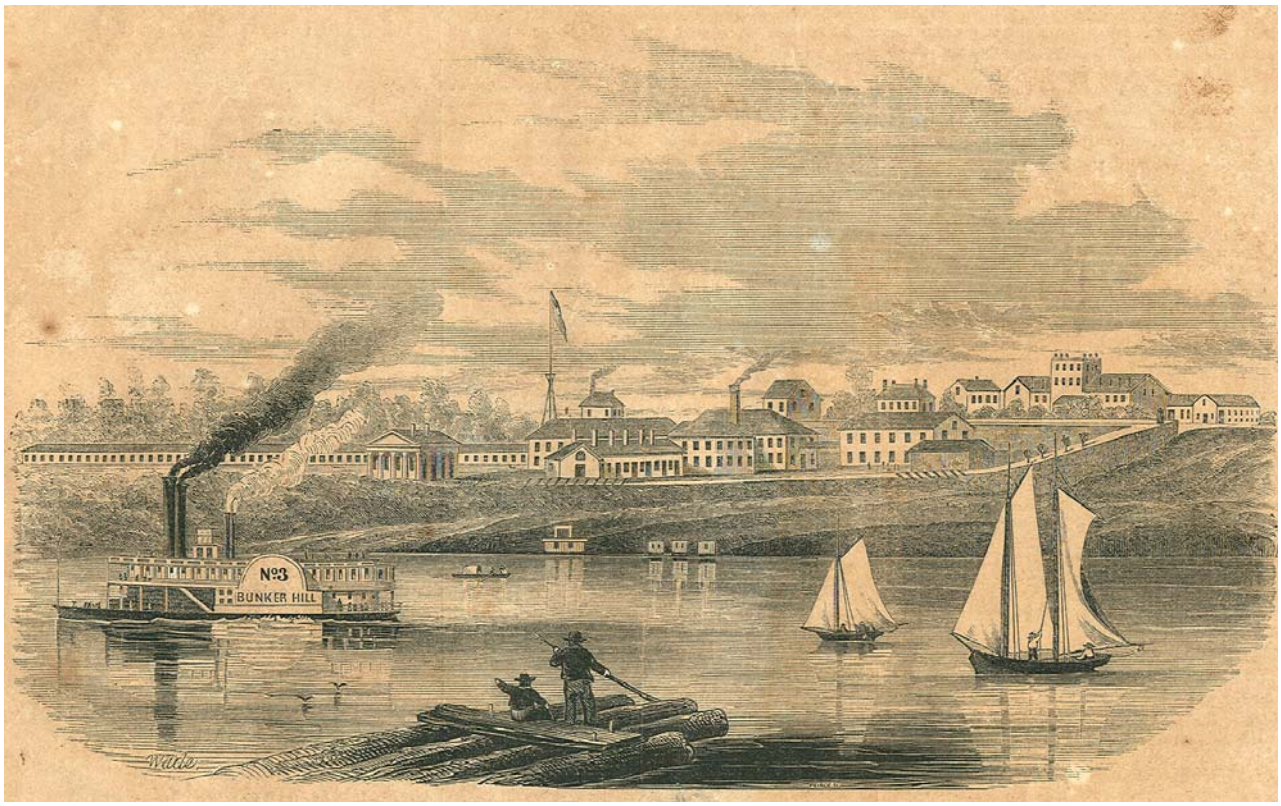


Figure 1. Memphis Navy Yard 1854 Viewed from the West
Source: Author's Copy of Gleason's Pictorial Drawing-Room Companion

The Gleason article referred to the illustration (Figure 1) when describing the Navy Yard.

> The illustration we have given of this navy yard, comprising the ropewalk[3]building —to be easily identified by its length, it being over one fourth of a mile long;—the commandant's house situated on the elevated ground, with its surrounding garden-spot handsomely adorned with choice shrubbery and beautiful walks; the office building on the lower yard, or battery, with its

[2] Ropes for the riggings of ships
[3] The Ropewalk was the building where strands of fibers were twisted around a central core to form a strand, rope, or cable for use as ship's riggings

imposing columns on every side; and other buildings near it, designed as mechanical shops, and indispensable to the purposes of the yard, makes up a picture of interesting details.

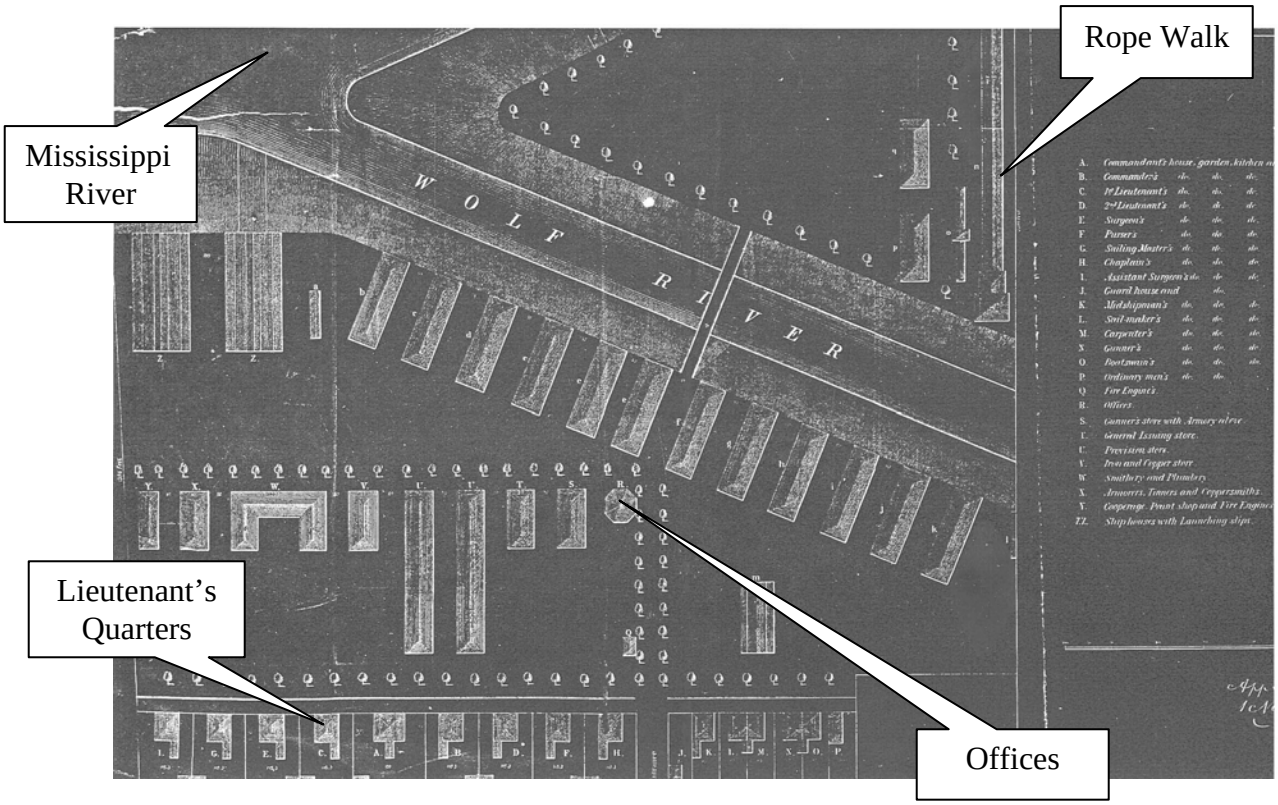


Figure 2. Plan of Memphis Navy Yard, 1844
Source: Memphis Central Library

The Record

The Memphis climate record began on 11 August 1849 when Lt. Robert A. Marr, Master of the U.S. Navy Yard in Memphis, submitted observations. It seems likely that the observation site would have been near the office building, the building with the columns in the left center of the illustration in Figure 1. However, it may also have been at the observer Lieutenant's House (Figure 2)

The first observations (Figure 3) were made by the watchmen who were under Lt. Marr's supervision. His observations were under the direction of Lt. Maury who had fathered the Navy Yard. Several years later, the Navy's role in weather observations was replaced by a succession of networks: from the Navy, through the Smithsonian Institution, the Army's Signal Service, and the Weather Bureau, to the National Weather Service. That succession through 156 years of

weather data collection and public service continues with Jim Belles and his staff at the National Weather Service Forecast Office in Memphis.

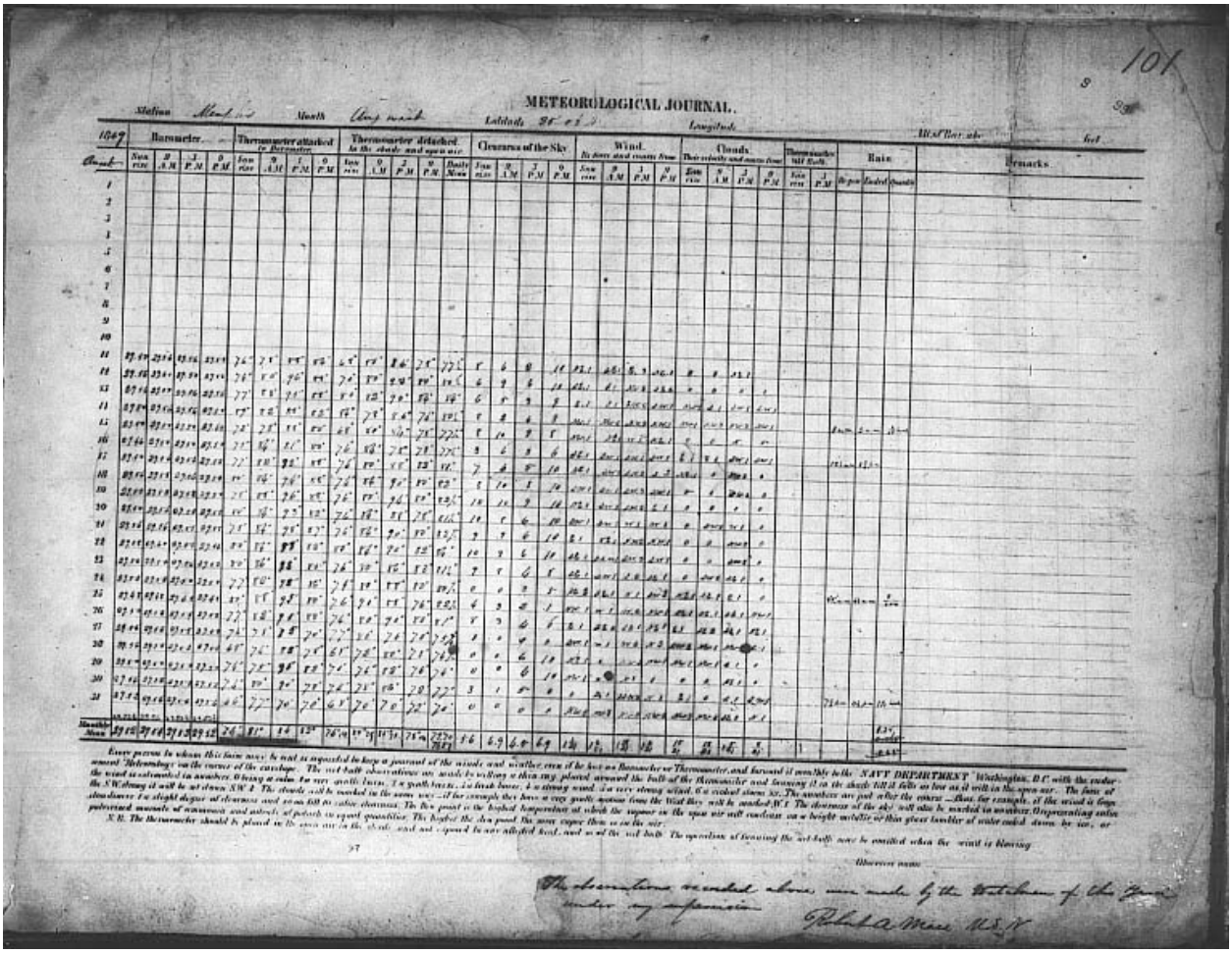


Figure 3. First Observations from Memphis, August 1849
Source: National Climatic Data Center

Goal of the Study

The goal of this study was to document the weather observational history of Memphis, Tennessee. The climatic data, and information from the observations made there, are readily available for the entire period of record. They may be accessed through the National Climatic Data Center, the Midwestern Regional Climate Center, and the State Climatologist of Tennessee. The challenge of this study was to identify Memphis' role in the development of a federal weather observational program and where it fit in the route that followed from the Navy's first efforts, through the Smithsonian Institution, the Signal Service Observer Sergeants, the Weather Bureau meteorologists, and the National Weather Service observational and forecast network of today.

LOCATION OF OBSERVATIONS

Latitude, Longitude, and Elevation

City Observation Sites

The observations at the Navy Yard began in 1849 and were located as 35˚ 08' N, 90˚ 06' W, at 262 feet above mean sea level (MSL) at Mobile Bay Alabama.

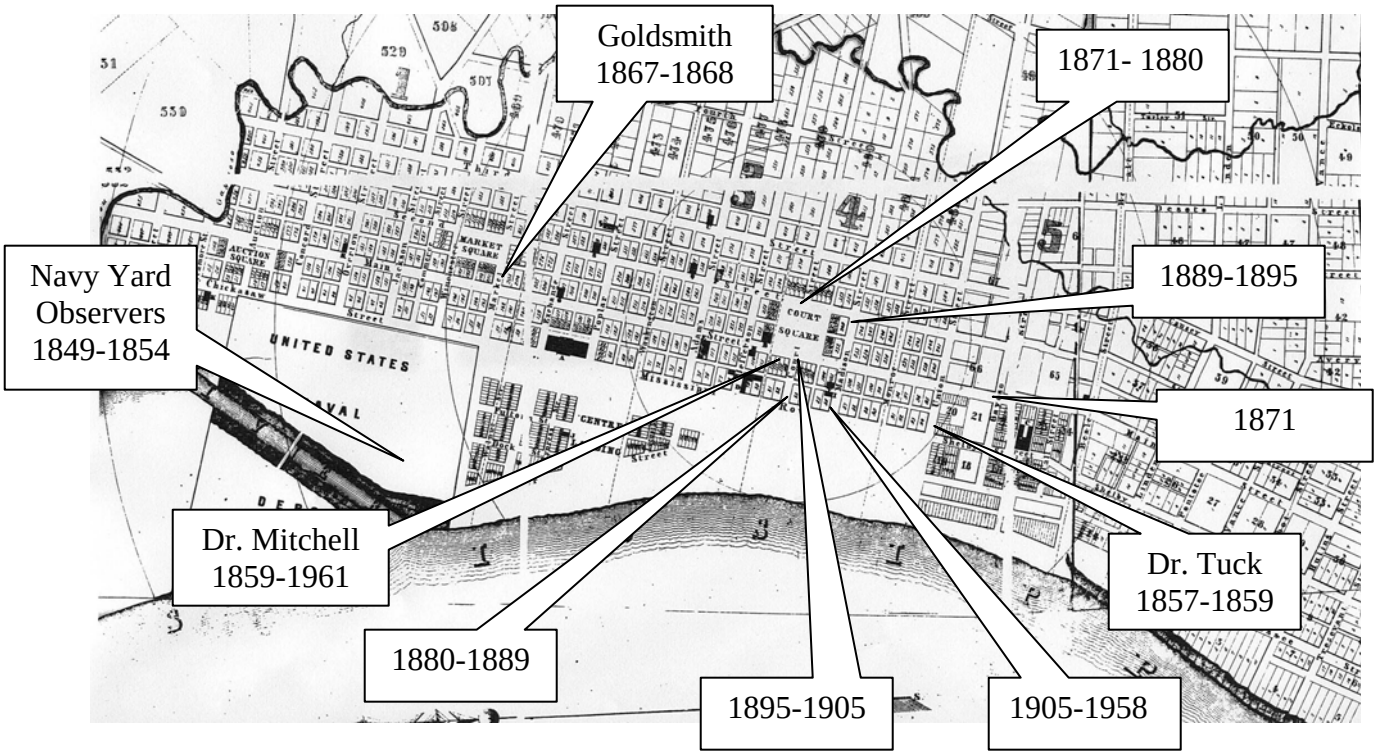


Figure 4. City of Memphis Observation Locations 1849—1958 on an 1850 Map
Source: Tod and Crider Map, Memphis Central Library

The Navy Yard closed in 1854 and the observations resumed three years later in September 1857. The new location was given as 35˚ 08' N and 90˚ W, at 262 feet MSL. That latitude and longitude indicate a move away from the Navy Yard area. The precise location of the observations between 1857 and 1871 are not known. The occupations of the observers lead to the conclusion that the sites were near the downtown locations (Figure 4) of their offices (Drs. Tuck and Mitchell) or homes (Goldsmith).

The first Signal Service office was established in the Jackson Block at Main and Gayoso Streets on 28 February 1871. The anemometer and rain gauge was on the roof and a window shelter was mounted in a north-facing window 48 feet above ground level (AGL).

On 10 October 1871, the office moved to the Irwin Block at 256 2nd Street (Figure 5) facing Court Square, the largest park in the city. It was just one block from the telegraph office. The office was on the third floor of a four-story building. The window shelter was mounted in a north-facing window that was 39 feet AGL (Figure 6).

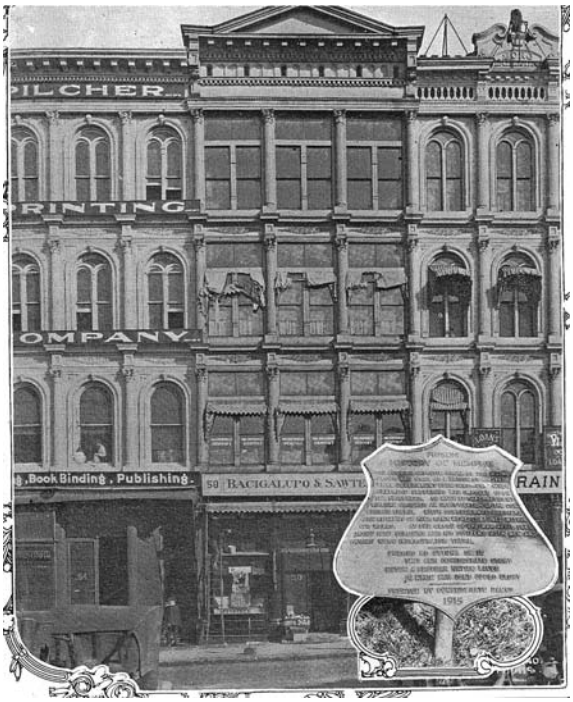


Figure 5. Irving Block
Source: Memphis Public Library

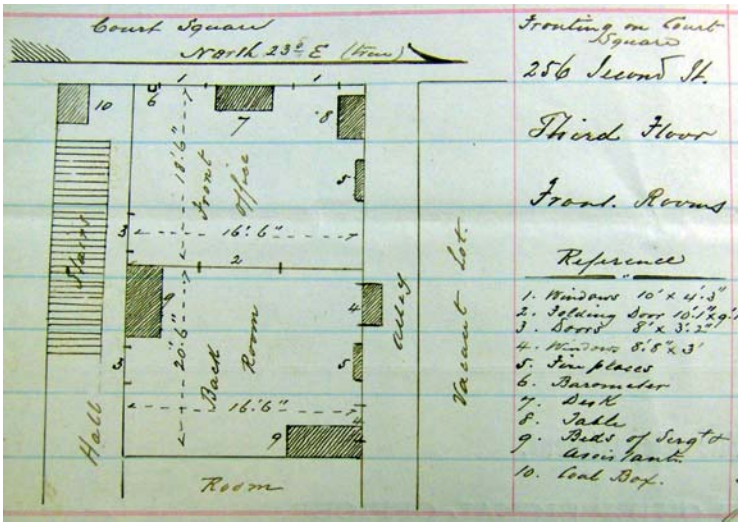


Figure 6. Office Layout 1871
Source: National Archives and Records Administration

In 1872, the layout of the roof (Figure 7) showed that the roof (the highest point within the city) was sloped slightly away from a ridge as indicated by the dashed line.

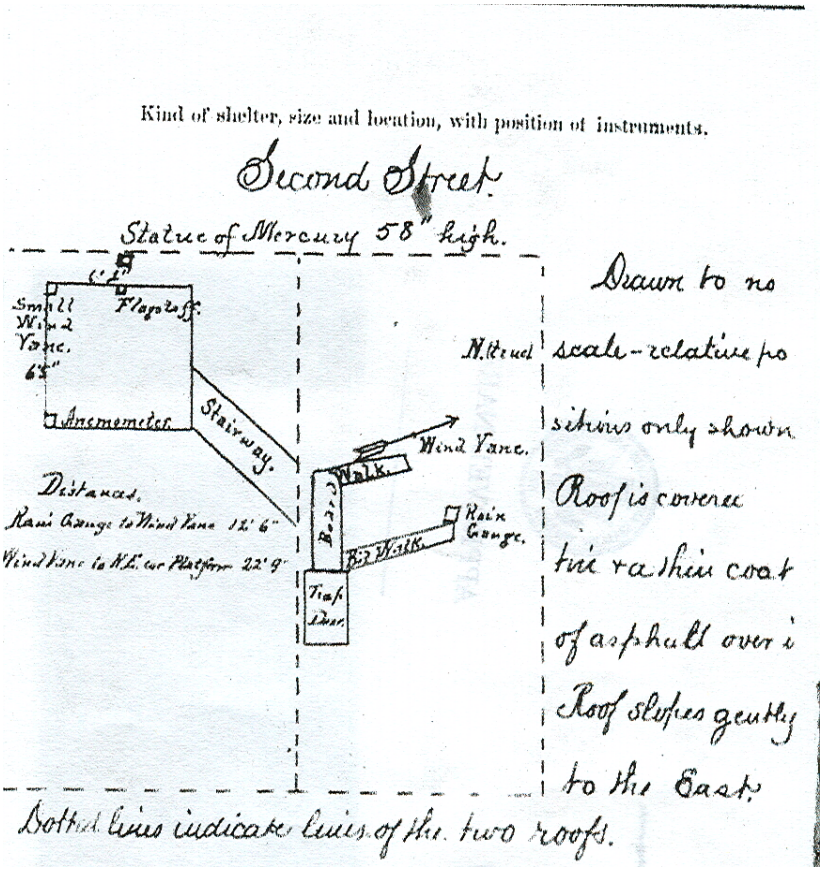


Figure 7. Roof Layout 1872
Source: National Archives and Records Administration

There was a move to within two blocks of the Mississippi River to the McClellan Building at 260 Front Street on 1 January 1880. There were comments in the June 1888 report that the office was located in the northeast corner of Front and Court Streets. The room where the observations were taken was on the fourth floor on the northeast corner. That building is not illustrated here.

The Cotton Exchange Building (Figure 8) at Madison and 2nd Streets was the next location. The Cotton Exchange Building was occupied on 2 January 1889. The building also held the Meteorological Board whose purpose was for coordination of weather information that impacted trade. The Signal Service offices were in rooms 32 and 33 on the 4th floor.

Figure 8. Cotton Exchange Building
Source: Memphis Public Library

On 1 July 1895, the Weather Bureau moved to the Porter Building (Figure 9) at Main and Court Streets. This was also called the Continental Bank Building and was located on the southeast corner of Court and Main Streets The weather offices occupied rooms 111, 112, and 113 on the 11th floor.

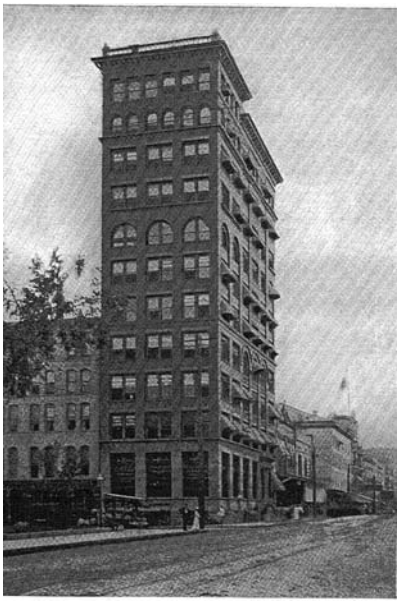


Figure 9. Porter Building
Source: Memphis Public Library

The move to the Post Office Building at Front and Madison occurred on 1 April 1905. That building was later called the Federal Building in some documents. The Post Office Building (Figure 10) was at 35˚ 09' N and 90˚ 03'. That latitude and longitude was the same as that given for all the other downtown locations. The layout of the office is shown in Figure 11.

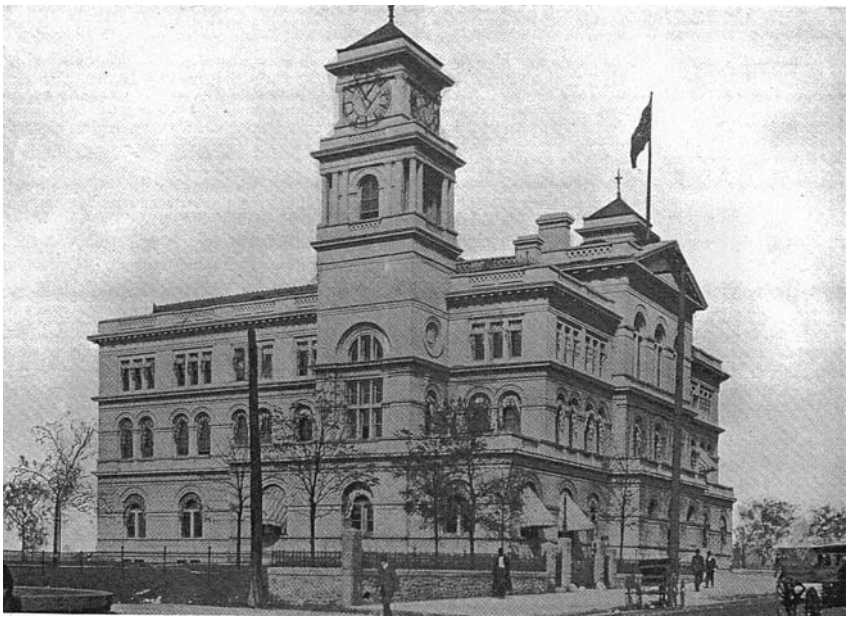


Figure 10. Post Office Building
Source: Memphis Public Library

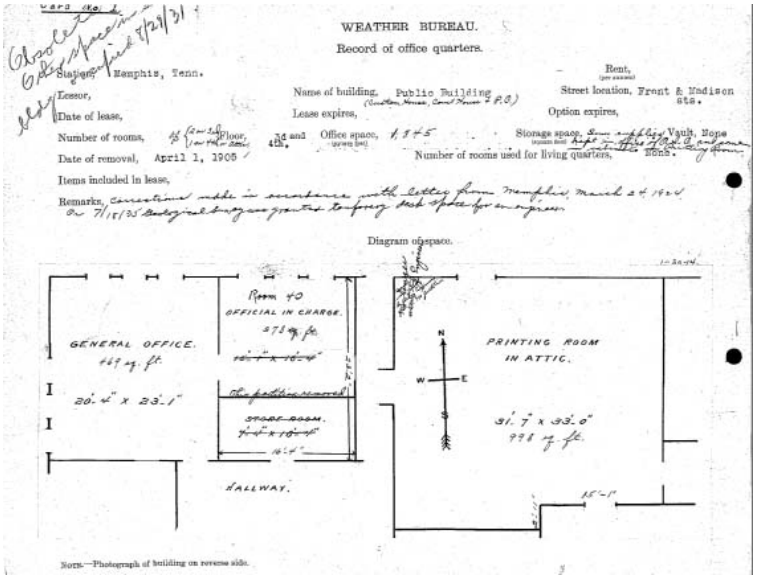


Figure 11. Office Layout 1935
Source: National Climatic Data Center

The roof of the Post Office Building is shown in Figure 12 as it looked in 1932.

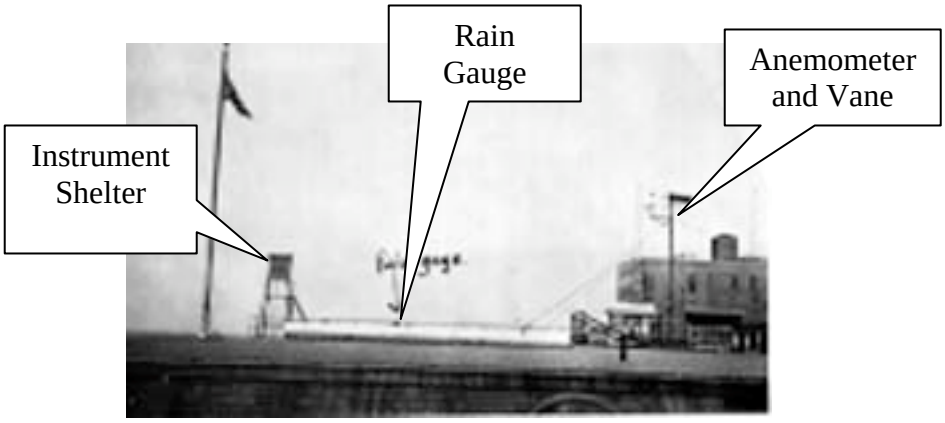


Figure 12. Roof Exposure in 1932
Source: National Climatic Data Center

The occupation of the Post Office Building continued for fifty-three years until 29 August 1958. However, as in most cities of the period, another observation site was opened at the airport. For the period 1931—1964, there were observations taken at both sites.

On 25 September 1964, the downtown site was closed. The equipment was relocated to a voluntary observer site.

Airport Observation Sites

The first observations at the airport were begun on 24 October 1931. The location was on the second floor of the Curtiss-Wright Hanger at 35˚ 03' N and 89˚ 59' W and at 263 feet MSL.

On 20 September 1932, the airport observation site was moved to the American Airways Hanger.

The airport observation site was moved to the Department of Commerce's Radio Building on 21 September 1936.

On 28 May 1938, the General Aviation Building, also called the Administration Building, (Figure 13) became the observation site.

Figure 13. Administration Building 1942
Source: National Climatic Data Center

The mosaic photograph in Figure 12 shows the Memphis Airport in 1939. The environment of the observation site can be seen very well.

Figure 14. Mosaic Photographs of the Memphis Airport 2 June 1939
Source: National Climatic Data Center

The photographs in Figures 15 and 16 depict the facilities at the airport in 1957. Although that date is beyond the end date of this study, they are included here because they probably represent how the facility looked in 1948 as well.

Figure 15. Administration Building and Instrument Shelter in August 1957
Source: National Climatic Data Center

The offices, labeled WB in Figure 15, are shown in Figure 16 from 1951.

Figure 16. Interior of Weather Bureau Office 1951
Source: National Climatic Data Center

Environment

The Navy Yard was adjacent to the Mississippi River on property that was bisected by the Wolf River. The observations were relatively near the rivers where all the Yard's buildings were located. However, the Navy Yard buildings occupied only a small part of the total area of 82 acres in the Navy Yard.

The downtown area of Memphis presented at least two potential impacts on the observations. First, there is the well-documented urban heat island that develops as a city grows. As the size of the city increases, the temperature increases. Second, because the observations were made on top of tall buildings, the wind speed increased.

The airport observational sites posed a different problem. The moved from the warmer inner city to the expansive airport area and would likely show a reduction in temperature and wind speed.

INSTRUMENTATION

The Memphis instrumentation record from its Climatological Record Books seem to be complete and probably are because there was a rather strict oversight of the disposition of thermometers that had been supplied to the station.

Thermometer

The thermometers were mounted in a window shelter in November 1871 at 38.9 feet AGL.

Dry bulb thermometers were used in the calculation of dew point and relative humidity.

In 1880, the thermometer was at 54’ 9” AGL. There was a note that in 1904 and part of 1905, smoke from a neighboring building would affect temperature when there was an east wind.

Neither dew point nor relative humidity can be observed directly. To calculate them, comparisons between a dry bulb and a wet bulb thermometer were made. The two thermometers were alike except that one had a “cotton sock” over its bulb. That sock was wetted and the evaporation cooled it. A table was consulted and, using the dry bulb’s temperature and the difference between it and the wet bulb’s temperature, the dew point and relative humidity could be determined.

Table 1. Dry Thermometers Used at Memphis

	In Use	
Number	**From**	**To**
221	Feb1871	May 1878
301	May 1878	Dec 1879
511	Dec 1879	Aug 1880
542	Aug 1880	May 1881
221	May 1881	Jan 1886
287	Jan 1886	Dec 1887
226	Dec 1887	Mar 1888
1862	Mar 1888	Jan 1889
1881	Jan 1889	Oct 1889
1619	Oct 1889	Nov 1889
2781	Nov 1889	Jul 1896
3810	Jul 1896	Mar 1900
3778	Mar 1900	Jul 1902
3815	Jul 1902	Dec 1912
6767	Dec 1911	Apr 1912
4304	Apr 1912	

Table 2. Wet Thermometers Used at Memphis

Number	In Use From	To
37	Feb 1871	May 1878
613	May 1878	Nov 1885
17	Nov 1885	Jan 1886
1635	Jan 1886	Jun 1886
2575	Jun 1888	May 1889
1798	May 1889	July 1895
3815	Jul 1895	Mar 1900
3790	Mar 1900	Jul 1905
4274	Jul 1905	Nov 1918
2911	Nov 1918	

The maximum and minimum thermometers in standard use by the Signal Service were the Green thermometers. One measured the maximum temperature, the other minimum temperature since the last time they were reset. They were attached to the crossbar inside the instrument shelter by means of a Townsend support. Figure 17 shows that configuration.

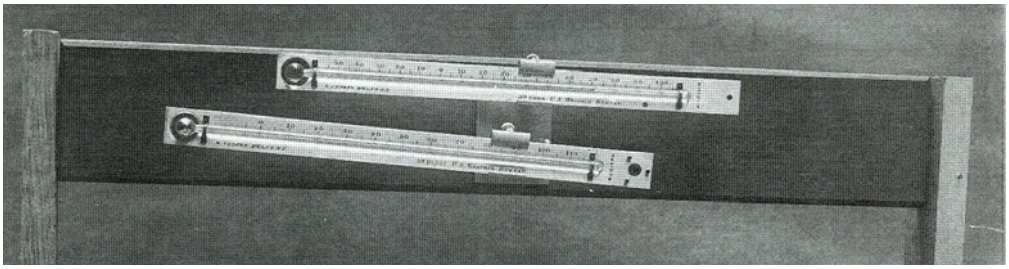
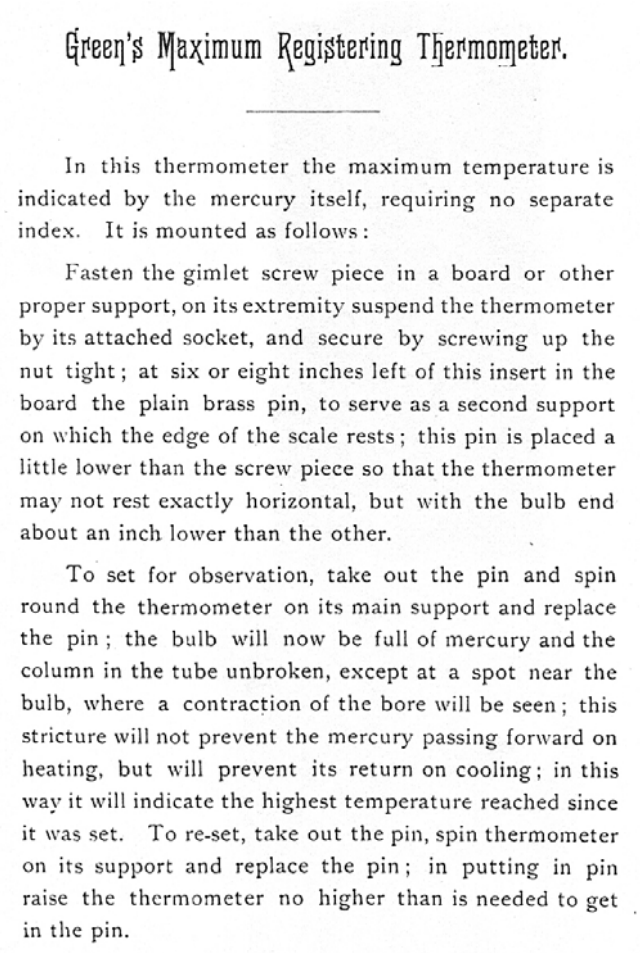


Figure 17. Green Maximum and Minimum Thermometers on a Townsend Mount
Source: National Archives and Records Administration

Table 3. Maximum Thermometers Used at Memphis

Number	In Use From	To
115	Feb1871	Apr 1876
231	Apr 1876	Jul 1879
299	Jul 1879	Mar 1885
115	Mar 1885	Nov 1885
1016	Nov 1885	Feb 1888
1798	Feb 1888	Jan 1890
4483	Jan 1890	Jan 1896
6486	Jan 1896	Aug 1904
8134	Aug 1904	Dec 1911
15864	Dec 1911	



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:

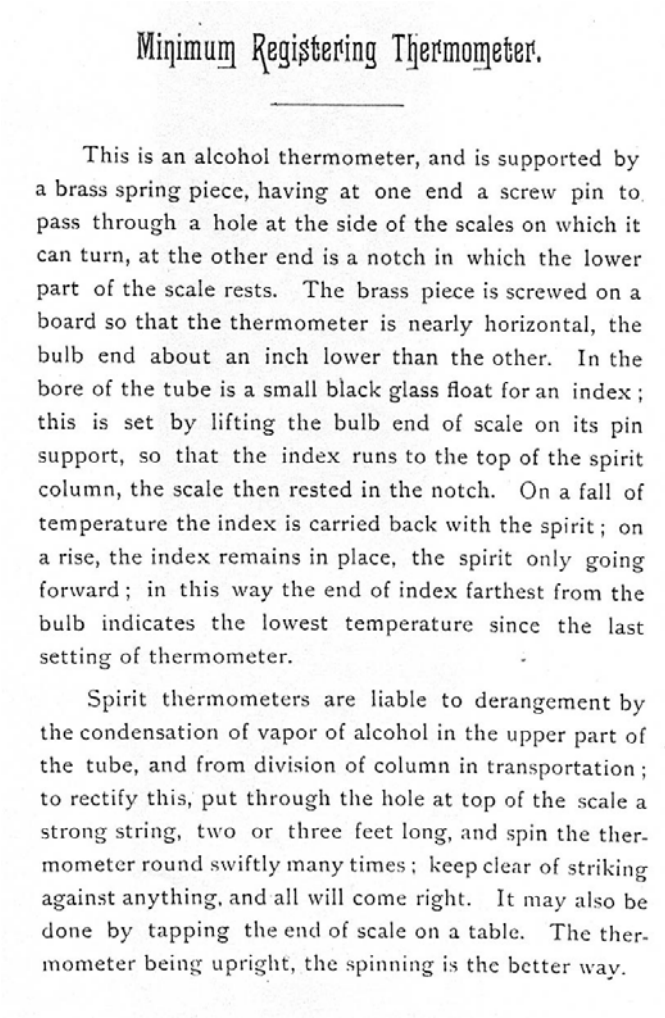
Fasten the gimlet screw piece in a board or other proper support, on its extremity suspend the thermometer by its attached socket, and secure by screwing up the nut tight; at six or eight inches left of this insert in the board the plain brass pin, to serve as a second support on which the edge of the 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 16. Instructions for Green's Maximum Thermometer
Source: Thermometer Record Cincinnati Observatory Sep 1 1882-June 30 1884

Table 4. Minimum Thermometers Used at Memphis

	In Use	
Number	**From**	**To**
94	Feb1875	Aug 1875
182	Aug 1875	Apr 1876
213	May 1876	Aug 1876
217	Aug 1876	Oct 1879
291	Oct 1879	Oct 1881
388	Oct 1881	Dec 1884
973	Dec 1884	Dec 1887
1589	Dec 1887	Dec 1899
5257	Jan 1900	Jun 1906
5489	Jul 1906	Jul 1909
8279	Jul 1909	Dec 1918
5891	Nov 1918	



Minimum Registering Thermometer.

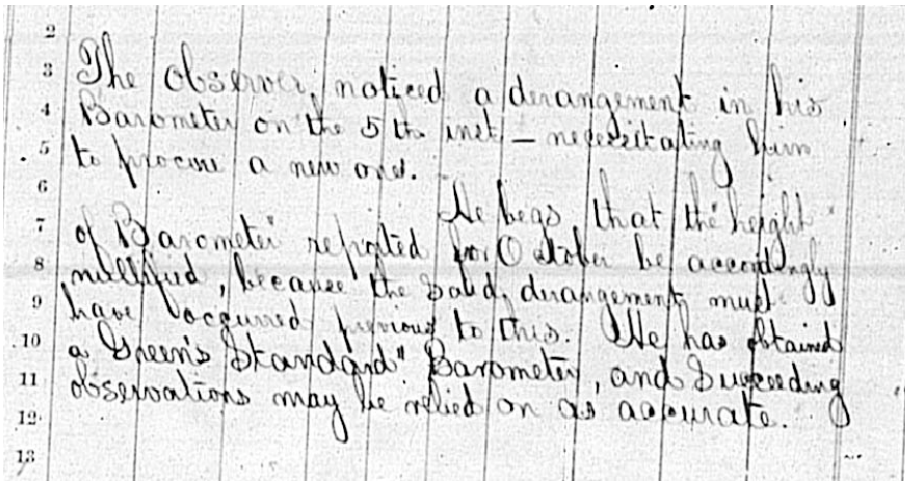
This is an alcohol thermometer, and is supported by a brass spring piece, having at one end a screw pin to pass through a hole at the side of the scales on which it can turn, at the other end is a notch in which the lower part of the scale rests. The brass piece is screwed on a board so that the thermometer 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 17. Instructions for Green's Minimum Thermometer
Source: Thermometer Record Cincinnati Observatory Sep 1 1882-June 30 1884

Barometer

The aneroid barometer used in September and October 1867 was replaced and the observer commented on the data for those two months (Figure 20).


The observer noticed a derangement in his Barometer on the 5th inst. — necessitating him to procure a new one.

He begs that the height of Barometer reported for October be accordingly multiplied, because the said derangement must have occurred previous to this. He has obtained a Green's Standard Barometer, and succeeding observations may be relied on as accurate.

Figure 20. Goldsmith's Barometer Comments, November 1867
Source: National Climatic Data Center

He mentioned on 20 November 1867 that he had borrowed a mercurial barometer to use until he received a Greene Standard barometer (Figure 21).

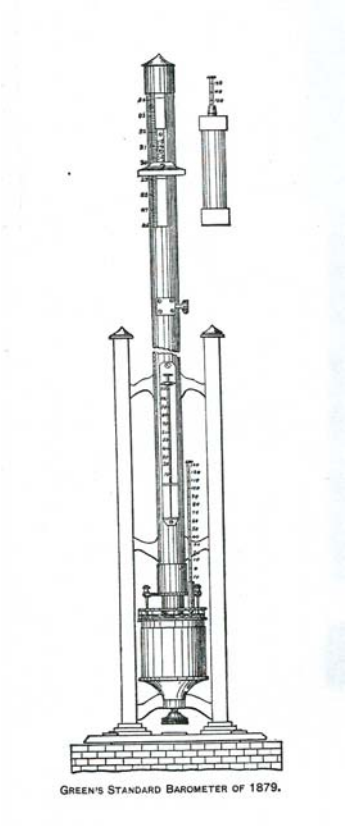


Figure 21. Green Standard Barometer 1879
Source: National Archives and Records Administration

In November 1871, the barometer was mounted at 37 feet AGL and 262 feet MSL. Its location can be seen in Figure 6 at the top left as #6 in the drawing. The inspection report of 1872 found it reading within 0.008 inch of the inspector's barometer.

The move in January 1880 placed the barometer at 310.84 feet MSL.

Table 5. Barometers Used at Memphis

	In Use	
Number	**From**	**To**
1782	Jan 1873	Aug 1878
1782	Aug 1878	Jun 1882
224	Jun 1880	Feb 1886
362	Feb 1886	Sep 1887
461	Sep 1887	Jan 1889
393	Jan 1889	Nov 1922
771	Nov 1922	

Triple Register

One of the primary instruments of the Weather Bureau was the Triple Register. It was installed in Memphis on 9 May 1890 and no doubt was the center of attention during tours. Figure 22 shows a similar one.

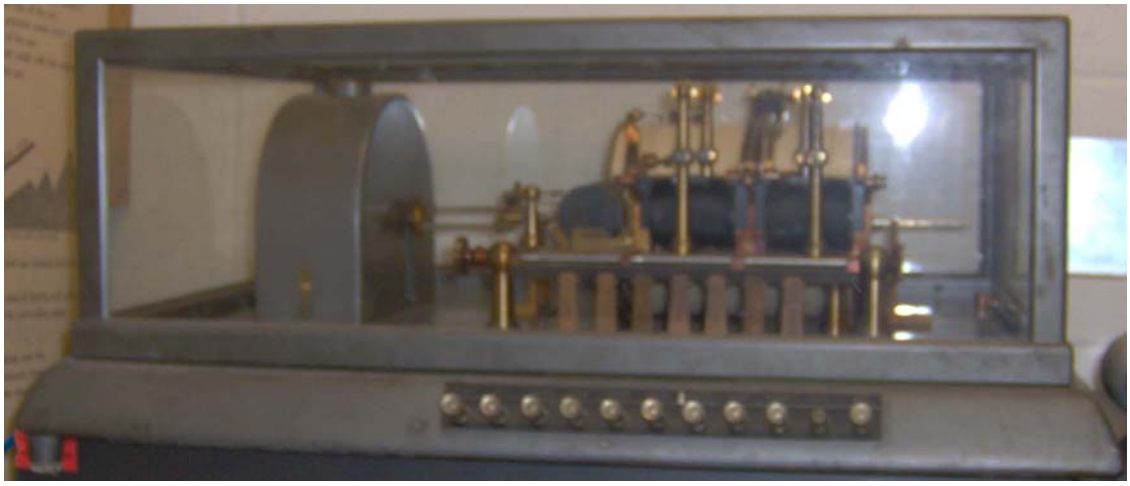


Figure 22. Triple Register, College Heights Weather Station Museum, Bowling Green, KY
Source: Author

The Triple Register was an electrical device that recorded three elements of the weather: the direction and velocity of the wind each minute, the amount of rainfall as it fell, and the accumulated hours and minutes of sunshine. The information was recorded by pens on graph paper wrapped around a drum that rotated once per week. The working parts of the Triple Register were made of brass and the unit was covered by a glass case to protect the device from dust. It was quite an impressive part of the meteorologist's equipment.

Wind was measured in two ways. A wind vane that was mounted on the roof determined the wind direction. It swiveled toward the direction from which the wind came. It can be seen in Figures 26. Also mounted on the roof were the anemometer cups (Figure 26). The wind rotated those cups that in turn rotated the shaft to which they were attached. Each time the shaft rotated 500 times, one mile was added to the "total miles run." That total was displayed on a dial like that shown in Figure 23. That is to say, the dial displayed the total number of miles of air that had passed since the anemometer dial was reset. Both the wind direction and the wind speed were electrically connected to the triple register were they were registered on the Triple Register's graph. The difference between the miles run dial and its earlier reading could be divided by the elapsed hours to determine the average wind speed for the period.

Figure 23. Total Miles Run Dial
Source: Author

A tipping bucket rain gauge was mounted on the roof. A funnel directed rainfall into a small "bucket" on one end of a seesaw like device. The seesaw tipped when the bucket filled with one hundredths of an inch of rain. The tipping emptied that bucket and placed the bucket at the other end of the seesaw under the funnel to be filled next. Each time the buckets tipped, an electrical signal marked another 0.01" of rain on the triple register.

The triple register also recorded sunshine. The sensor was a glass tube with a large bulb at either end (Figure 24). It was normally located on the roof. One end was clear, the other coated with lampblack. The tube was partially filled with mercury. In the middle of the tube were two wires. When exposed to sunshine, the lampblack would absorb solar radiation causing the mercury to expand and cover the ends of the two wires. The electrical circuit between the two wires would be completed. That connection would be recorded on the triple register until cooling (as the sunshine ended) caused the mercury to contract and uncover the two wire ends thus breaking the connection.

Figure 24. Sunshine Recorder, College Heights Weather Station Museum
Source: Author

Rain Gauge

From its first observations on 28 February 1871, the Signal Service rain gauges were mounted on the roofs of the buildings they occupied. This roof was covered with a thin coating of asphalt. The rain gauge was on a raised wooden platform about ten feet above the back of the main roof in 1871. It was at 66 feet AGL and in 1872 was 2” 3” feet above the roof. The 1872 position was rated fair by the inspector with the possibility that a high west wind would produce some eddies. The station observers recorded that there were not towers or other obstructions to significantly interfere.

Prior to 1889, the exposure of the rain gauges was on flat roofs without interference. On 10 February 1896, a new registering rain gauge put in use. It and the other rain gauges were considered to have good exposures although there were gables and walls that interfered and may have disturbed the wind somewhat. The rain gauge was at an elevation of 67.4 AGL. On 13 May 1897, a tipping bucket rain gauge #38 put into use.

There were rain gauges at each of the other observation sites but exposure wasn’t identified.

They weren't often replaced. For example, Figure 25 shows the rain gauges on the roof of the Post Office Building in 1932 (on the left) and the same gauges still in use in 1947 (on the right).

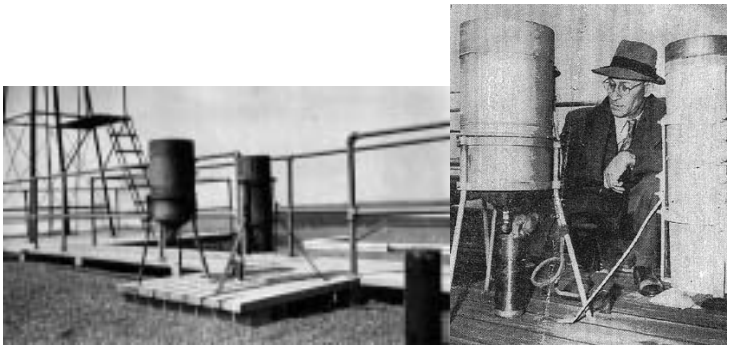


Figure 25. Rain Gauges 1932 on left and 1947 on the right with George Allmendinger Source : Memphis Commercial Appeal 4 January 1947

Anemometer

The anemometer was mounted on the roof in 1871 with the wind vane at 80.3 feet AGL In 1872, the anemometer was 6' 3" and the vane 22' 6" above the roof. Both could not have been located in a better position according to the inspectors.

After the move in January 1880, the anemometer was at 81.4 feet AGL.

The wind instruments on the roof of the Cotton Exchange Building from 31 January 1889 through 20 June 1895 were unaffected by the surrounding buildings. But, about 1 January 1895 an eleven-story building was constructed one block west of the station. The building affected slightly both wind direction and velocity readings.

On 30 June 1895, the wind vane on the Porter Building was 154 feet AGL with a free exposure. There were comments by the observer that the average daily velocity changed noticeably from the previous location.

The wind instruments were moved to the roof of the Post Office Building (Federal Building) on1 April 1905. The vane was 97 feet AGL.

In 1932, the wind vane (Figure 26) was mounted on the roof of the Customs House-Post Office Building.

Figure 26. Anemometer and Vane 1932
Source: National Climatic Data Center

Table 6. Anemometers Used at Memphis

	In Use	
Number	**From**	**To**
73	Feb1871	Apr 1876
194	Apr 1876	May 1882
224	May 1882	Dec1884
252	Dec 1884	Apr1885
445	Apr 1885	Aug1885
417	Aug 1885	Jan 1887
356	Jan 1887	Jan 1892
591	Jan 1892	Aug 1904
861	Aug 1904	May 1919
392	May 1919	Nov 1922
1245	Nov 1922	

Shelters

The standard window shelter was used in 1871 in a north-facing window of the Jackson Block.

In October 1871, it was moved to a north-facing window of the Irwin Block Building (Figure 27). Note that the drawing on the left is the view looking into the shelter. The one on the right is looking from above at the instrument mount.

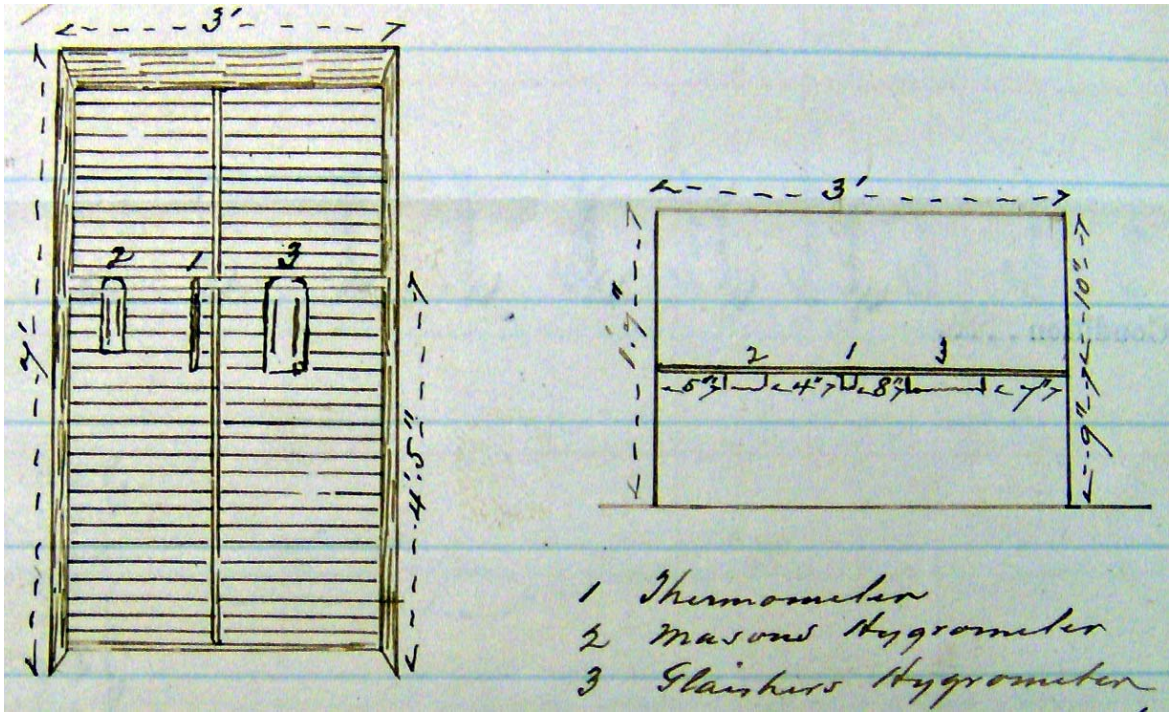


Figure 27 Window Shelter November 1871 with Instrument Locations
Source: National Archives and Records Administration

Note that within the shelter were a thermometer, a Mason's Hygrometer and a Glaisher's Hygrometer. The original shelter was made with closed sides and an open bottom. The Inspection Report of 1871 ordered that latticed sides be installed and that it be painted white. That had been done by the next month.

In March 1872, the window shelter (Figure 28) was described as "the Smithsonian Plan" facing north northeast. The shelter's dimensions were 3" 3" wide, 2' 6" deep, and 6' 10 high. The shelter roof sloped 10". The sides were latticed, the roof solid, and the floor open. The inspector noted that the board to which the instruments were attached was only one foot from the window pane and about one inch beyond the window sill. He recommended that the crossbar be moved to provide 18" of space between it and the windowpane to make it less liable to radiation from the room.

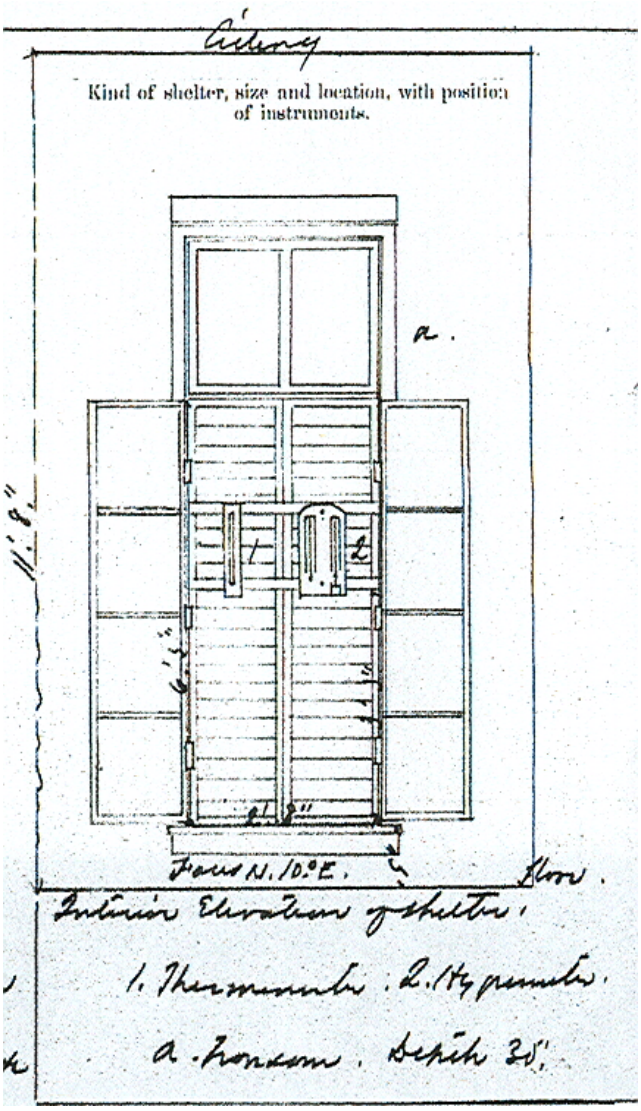


Figure 28. Window Shelter March 1872
Source: National Archives and Records Administration

The cross bar inside on which the instruments were mounted was 1.5 feet from the window.

In 1880, the window shelter was in a north-facing window on the third floor of the McClellan Building 53 feet AGL. On 1 November 1885, the shelter was moved to the roof of the same building 58 feet AGL.

The shelter was located on the roof of the Cotton Exchange Building on 31 January 1889 at 109 feet AGL.

On 1 July 1895, the observations were moved to the roof of the Porter Building, at 140 feet AGL and 10 feet above the roof.

In April 1905, the shelter was mounted on top of the roof of the Post Office (Federal Building) 76 feet AGL and 10 feet above the roof. The report of the elevation in included as Appendix 1.

In 1932, the shelter (Figure 29) was on the roof of the Customs House-Post Office Building. Note the steel supports and the ladder that the observer had to mount to read the instruments inside.

Figure 29. The Instrument Shelter in 1932
Source: National Climatic Data Center

The instrument shelter at the airport in 1942 was located adjacent to a paved area (Figure 28). Note the nearness of the paved area.

Figure 30. Instrument Shelter at the Airport in 1942
Source: National Climatic Data Center

THE OBSERVERS

Navy Observers 1849—1854

Members of the Navy stationed at the Memphis Navy Yard made the observations for the first six years of the Memphis climate record.

Lieutenant Robert A. Marr

The first observational form was dated August 1849 and was signed by Lieutenant Robert A. Marr, U.S. Navy. The form recorded only the weather conditions at Memphis but he also reported by separate means his observations of the flow of the Mississippi River. Both of these observations were reported to Lieutenant Maury in Washington. Maury had proposed a system of observations that could provide him with information by telegraph that could also be made available to the captains of steamers others who might be interested.

Lt. Marr continued the observations through August 1852. Both he and his successor wrote "Observations made by the watchman under my supervision."

Lieutenant Reuben Harris

Lieutenant Reuben Harris began making the observations in January 1850. He continued to do so for more than three years. He signed the forms as "Acting Master, USN."

The Memphis Appeal of 12 January 1853 reported that Lt. Harris was moving from the Navy Yard to Vicksburg at his own request due to ill health. The article praised him in a manner of speech common for the period.

> We feel safe in remarking that a truer, warmer hearted, and more intelligent gentleman, or a more chivalrous, high-toned, and gallant officer never trod the decks on a American man of war beneath the flashing folds of the Union Jack.

Another article on 15 March 1853 described his going away party in similarly glowing terms. Reuben Harris began using Smithsonian Institution forms in February 1853.

James Higgins

James Higgins, the Acting Master in the Master's Department at the U.S. Memphis Yard assumed the observation responsibility in February 1853. Charles H. Hays substituted for Higgins in August 1853.

Charles W. Wooley

Charles W. Wooley signed the Smithsonian Form for October 1853 as the "Passed Mid^{m}." A Passed Midshipman was one who had passed examinations for promotion to Lieutenant. Because of the number of officers was limited, long waits for promotion occurred. The Passed Midshipman rank was no longer needed when the rank of Ensign was created in 1862.

When the promotion delay was intolerably lengthy, some senior midshipmen would take a warrant as a master, Masters became commissioned officers in the U.S. Navy in 1837. From 1837 to 1862, Master was the lowest commissioned grade. It remained as the step between Ensign and Lieutenant until 1883 when it was renamed Lieutenant Junior Grade.

James Higgins

The observer changed to James Higgins in January 1854, back to Wooley in March, to Higgins in April, to Wooley in June, and back to Higgins in September. It was Higgins who made the last observations in October 1854. He made a note that the barometer and thermometer were transferred to the Navy Yard in New York.

The Memphis Navy Yard closed and there followed a gap in the climate record from October 1854 through August 1857.

The Smithsonian Institution Observers 1857—1871

The Smithsonian Institution's Climate Network grew rapidly under the leadership of Joseph Henry. In just two years, it had over 150 observers providing monthly report containing daily data. By 1860, there were over 500 stations reporting. The network grew rapidly because Henry obtained a list of people who were already observing weather. That list came from Professor James H. Coffin at Lafayette College in Pennsylvania who had been collecting weather reports from a large number of observers. The Smithsonian prepared circulars and sent them to those on Professor Coffin's list to solicit them to become members for their new network. As an observer of weather, it may be that Dr. Tuck in Memphis received one of those invitations. In any case, he agreed to submit reports to the Smithsonian and had been provided observation forms by them.

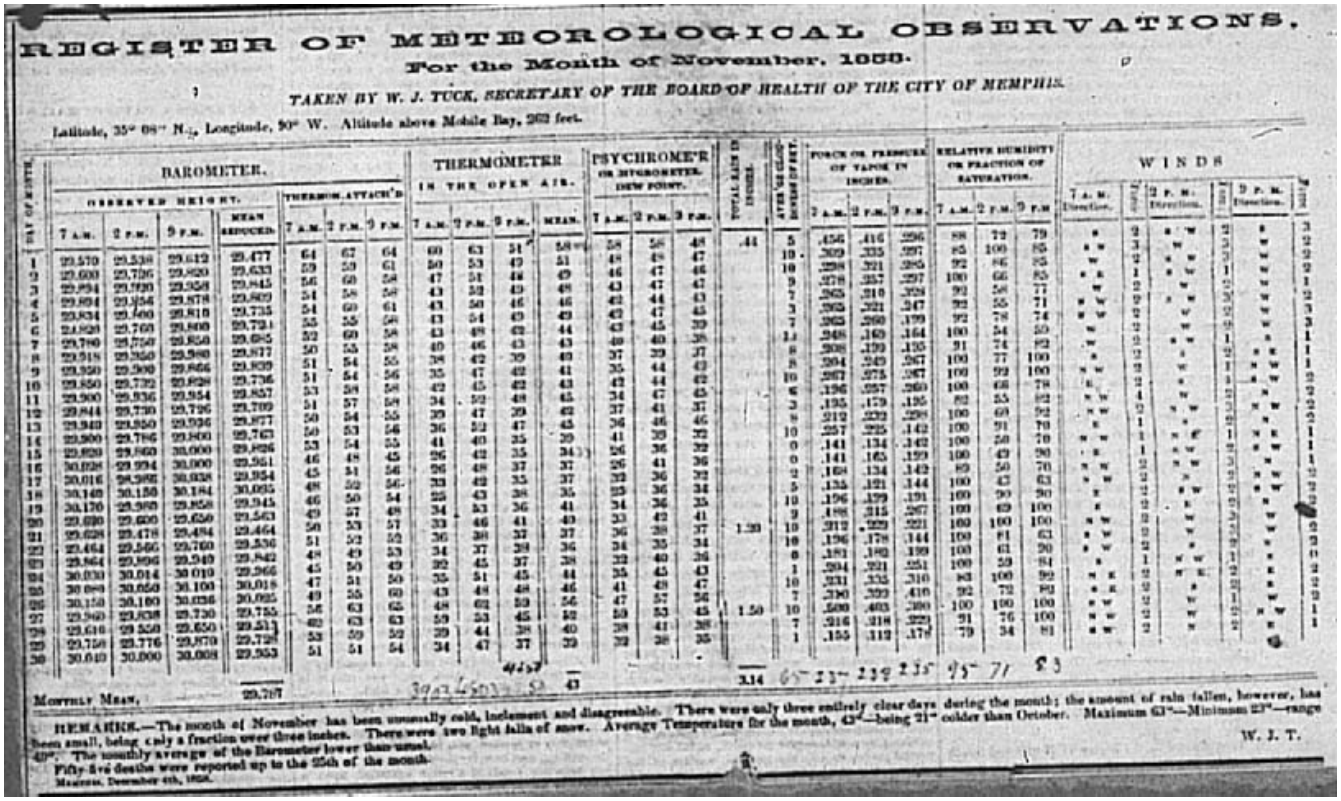
Surgeons in the U.S. Army had been recording weather observations since 1817 in an effort to determine the relationship between disease and climate. Civilian physicians had a similar interest and Dr. Tuck may have shared that motivation.

William J. Tuck, MD

Dr. William J. Tuck was a physician who graduated from University of Pennsylvania in 1838. He came to Memphis in 1842 and in 1852 became the Secretary of the Memphis Board of Health. Boards of Health were commonly interested in comparing the mortality data with climate data. The objective was to find a link between the cause of death and the climate, if such cause

and effect existed. He began reporting his observations to the Smithsonian in September 1857. The following year he was the Institutes of Medicine chair at the Memphis Medical College.

He provided his daily observations for a month to the newspapers in Memphis, usually shortly after the first of the month. Figure 31 is one such submission to the Enquirer.



REGISTER OF METEOROLOGICAL OBSERVATIONS.

For the Month of November, 1858.

TAKEN BY W. J. TUCK, SECRETARY OF THE BOARD OF HEALTH OF THE CITY OF MEMPHIS.

Latitude, 35° 08' N., Longitude, 90° W. Altitude above Mobile Bay, 262 feet.

DAY OF MONTH	BAROMETER. OBSERVED HEIGHT. 7 A.M.	2 P.M.	9 P.M.	MEAN REDUCED.	THERMOM. ATTACH'D. 7 A.M.	2 P.M.	9 P.M.	THERMOMETER IN THE OPEN AIR. 7 A.M.	2 P.M.	9 P.M.	MEAN.	PSYCHROME'R OR HYGROMETER. DEW POINT. 7 A.M.	2 P.M.	9 P.M.	TOTAL RAIN IN INCHES.	STATE OF WEATHER.	FORCE OR PRESSURE OF VAPOR IN INCHES. 7 A.M.	2 P.M.	9 P.M.	RELATIVE HUMIDITY OR FRACTION OF SATURATION. 7 A.M.	2 P.M.	9 P.M.	WINDS. 7 A.M. Direction.	Force.	2 P.M. Direction.	Force.	9 P.M. Direction.	Force.
1	29.570	29.536	29.612	29.477	64	67	64	60	63	51	58	58	56	48	.44	5	.456	.416	.396	88	72	79						
2	29.600	29.726	29.820	29.633	59	59	61	50	53	49	51	48	48	47		10	.369	.335	.297	85	100	85						
3	29.954	29.920	29.958	29.845	56	60	58	47	51	46	48	46	47	47		9	.328	.321	.295	92	86	85						
4	29.894	29.856	29.878	29.809	54	58	58	43	52	49	48	43	44	43		7	.278	.257	.297	100	66	85						
5	29.834	29.760	29.818	29.735	54	60	61	43	56	49	49	43	47	45		7	.265	.310	.328	92	58	77						
6	29.820	29.760	29.800	29.724	55	55	56	43	54	49	49	43	45	39		11	.302	.321	.247	92	55	71						
7	29.780	29.750	29.850	29.695	52	60	58	43	48	42	44	43	40	36		8	.248	.260	.199	92	78	74						
8	29.518	29.260	29.360	29.317	50	55	58	40	46	43	43	40	39	37		8	.208	.199	.135	91	74	92						
9	29.320	29.300	29.466	29.239	51	54	55	38	42	39	40	37	39	37		8	.204	.249	.267	100	77	100						
10	29.850	29.732	29.820	29.736	51	54	56	35	47	42	41	35	44	42		10	.267	.275	.267	100	92	100						
11	29.900	29.836	29.954	29.857	53	58	58	42	45	42	43	42	44	42		6	.196	.257	.260	100	68	78						
12	29.844	29.730	29.796	29.709	51	57	58	34	52	48	45	34	47	45		5	.195	.179	.195	82	55	82						
13	29.840	29.850	29.926	29.877	50	54	55	39	47	39	42	37	46	46		5	.212	.232	.208	100	69	92						
14	29.900	29.786	29.900	29.763	50	53	54	36	52	47	45	34	49	46		9	.257	.295	.142	100	91	79						
15	29.920	29.960	30.000	29.926	53	54	55	41	46	35	39	34	36	32		0	.141	.134	.142	100	58	79						
16	30.028	29.994	30.000	29.951	46	48	45	26	42	35	34	26	41	36		0	.141	.165	.159	100	49	90						
17	30.016	29.998	30.038	29.954	45	51	56	26	48	37	37	25	36	32		2	.164	.134	.142	85	56	70						
18	30.148	30.158	30.184	30.095	48	52	56	33	42	35	37	33	36	34		5	.135	.121	.144	100	67	83						
19	30.170	30.100	29.958	29.945	46	50	54	33	43	36	37	34	36	35		10	.196	.179	.191	100	90	90						
20	29.630	29.600	29.650	29.563	49	57	48	34	53	46	41	33	42	41		9	.188	.215	.267	100	69	100						
21	29.628	29.478	29.484	29.464	50	53	57	33	46	41	40	33	38	37	1.20	10	.212	.229	.221	100	100	100						
22	29.464	29.566	29.760	29.536	51	52	52	36	38	32	37	36	35	34		8	.196	.178	.144	100	81	63						
23	29.864	29.896	29.940	29.842	48	49	53	34	57	38	36	32	40	43		1	.204	.221	.251	100	59	90						
24	30.030	30.014	30.010	29.966	45	50	49	32	45	35	37	35	45	43		1	.231	.335	.310	83	100	92						
25	30.080	30.050	30.100	30.018	47	51	50	35	51	45	44	34	46	47		10	.300	.309	.410	92	72	92						
26	30.150	30.100	30.036	30.095	49	55	60	43	44	44	44	43	47	47		7	.500	.403	.380	100	100	100						
27	29.960	29.838	29.730	29.755	56	63	62	48	62	53	54	39	53	45	1.50	10	.216	.218	.229	91	76	100						
28	29.616	29.550	29.650	29.513	62	63	63	59	64	44	56	40	41	36		7	.155	.112	.178	79	34	81						
29	29.750	29.776	29.870	29.729	53	59	52	39	44	38	40	38	38	35		1												
30	30.040	30.000	30.008	29.953	51	51	54	34	47	37	39	32	36	35														
Monthly Mean.				29.767											3.14													

REMARKS.—The month of November has been unusually cold, inclement and disagreeable. There were only three entirely clear days during the month; the amount of rain fallen, however, has been small, being only a fraction over three inches. There were two light falls of snow. Average Temperature for the month, 43°—being 21° colder than October. Maximum 63°—Minimum 27°—range 49°. The monthly average of the Barometer lower than usual.

Fifty-five deaths were reported up to the 25th of the month.

Memphis, December 4th, 1858.

W. J. T.

Figure 31 . Dr. W. J. Tuck's Observations November 1858 for the Enquirer Newspaper Source; National Climatic Data Center

The reports that Dr. Tuck submitted were logged in a ledger type book at the Smithsonian Institution in Washington D. C. All the other Smithsonian observer's reports were similarly accounted. The log was by station and the entry for Memphis confirms that Dr. Tuck was the first entry for Memphis. That is assurance that he was their first observer in the City. The log contained an entry "(B. T. P. R.)." That means that he reported barometer, thermometer, psychrometer, and rainfall data. It had the station's latitude and longitude as reported by the observer. There was a entry that read "1859. 1,2,3,4,5,6,7,8,9,10,11,12." As each report was received its month was added to the line. In this case, it shows that Dr. Tuck's first report was for January 1859 and each following months' reports were received. Figure 30 is a copy of the Memphis portion of that ledger that reports Dr. Tuck's death and notes that his replacement was Dr. R. W. Mitchell.

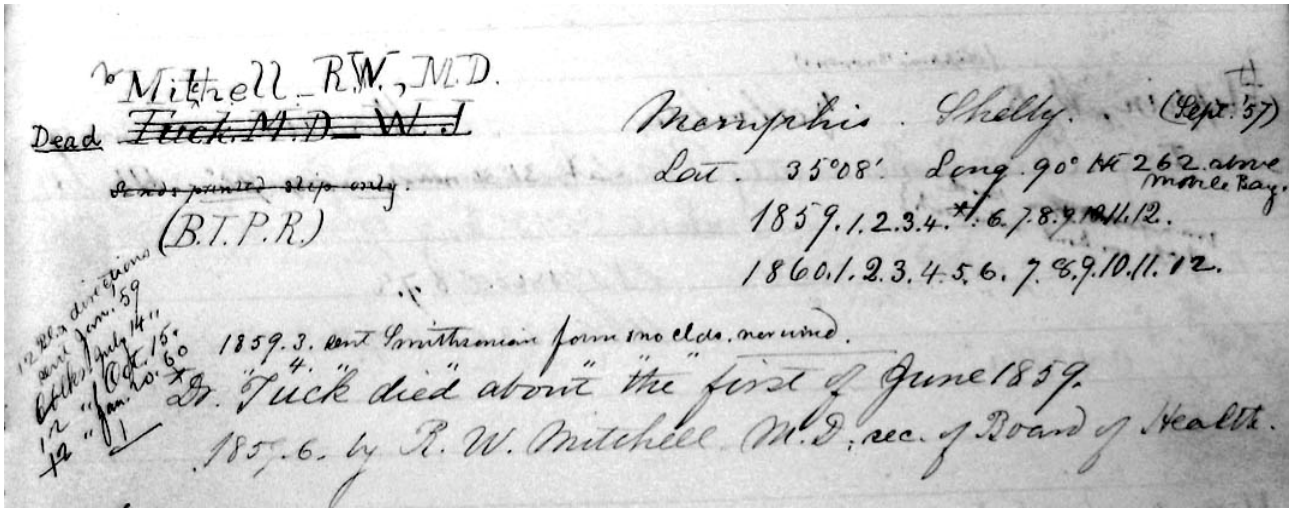


Figure 32. Notice of Dr William J. Tuck's Death
Source: Smithsonian Institution Archives

Note also in Figure 30 that the new reports were coming from Dr. R. W. Mitchell who was in the Memphis Board of Health.

The May report from Memphis was missing but the following month's report to the Smithsonian Institution contained a note from his successor, Dr. R. W. Mitchell. He too announced Dr. Tuck's death.

> Our former Secretary Dr. W. J. Tuck died about 1st of June last. Since that time, the observations have been noted without regard to condition of instrument which will account for the inaccuracy of the present report.

Robert W. Mitchell, MD

Dr. Robert Wood Mitchell began observations in June 1859. He received his medical degree from the University of Louisiana in 1856 and came to Memphis in 1857 where he worked in a hospital. He was elected Secretary of the local Board of Health and helped organize the City Hospital in 1860. The observations were missing for the year 1860, perhaps he was too busy with the new hospital responsibilities, but he resumed observations in January 1861.

Dr. Mitchell's last observations were in March 1861, just prior to the beginning of the Civil War. He served as a surgeon with the 15th Tennessee Volunteer Infantry (CSA) and served as a Surgeon of the Army of the Tennessee. He resumed his practice in Memphis in 1865 but did not resume his weather reports to the Smithsonian.

His public service did not end. He became a hero in a different kind of war—one that had a horrific number of deaths, but was different in that the enemy was unknown and unseen. It was the Yellow Fever epidemic and Dr. Mitchell (Figure 33) was on the front line again..

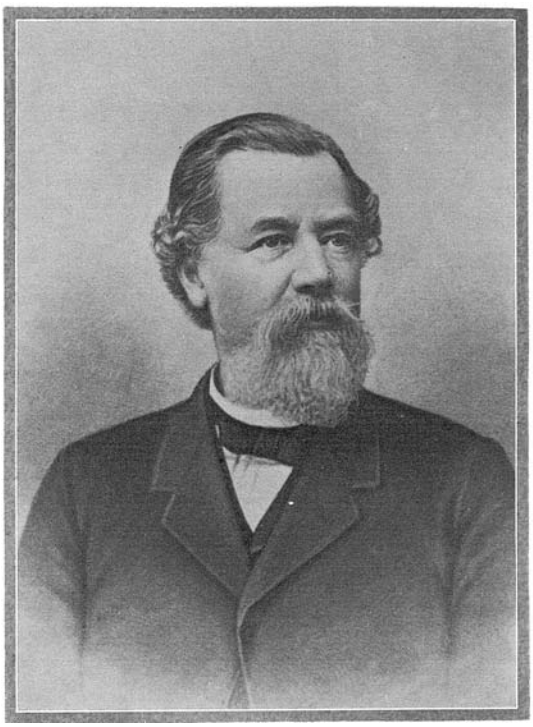


Figure 33. Dr. Robert Wood Mitchell
Source: Memphis Public Library

A yellow fever epidemic erupted in the south in the summer of 1878. Dr. Mitchell was by then the President of the Memphis Board of Health. He resigned in protest when the Memphis City Council refused a request for quarantine as yellow fever was detected in the Caribbean. Fifty-five cases were reported in Memphis on the 15th and 16th of August. Mass evacuations resulted from the panic. More than half of the City's population fled. Only 20,000 mostly poor people remained, 14,000 blacks and 6,000 whites. By the end of the epidemic in October, 17,000 of them had contracted yellow fever and 5,150 of them died. Many of those who evacuated did not return and it took more than ten years for the population to reach the level in was in 1878.

Dr. Mitchell was a member of the Board of Yellow Fever Experts and President Hayes appointed him in 1879 to the first National Board of Health. About twenty years later, the mosquito was identified as the culprit in yellow fever and its presence was very much related to weather and climate.

The 1900 census listed him as a physician living at 110 Adams Street in Memphis.

April 1861—Aug 1867

There were no official observers reporting for the period April 1861 through August 1867. The Civil War and the Reconstruction had taken its toll on the Smithsonian Institution's climate network in the south, Memphis included.

For some places in the south, the weather observer maintained the observations uninterrupted but did not send them to the Smithsonian Institution. One understands that, even if the observer wanted to, the mail service between their city and Washington D.C. was interrupted for five years. In Memphis, the observer had left his observation site to go to war.

Edward Goldsmith

Edward O. Goldsmith (Figure 34) began his Smithsonian Institution observations in September 1867. An article in the Memphis Commercial Appeal on 23 June 1935 described Edward Goldsmith as a weather hobbyist who had a barometer, thermometers, and an anemometer. He too supplied weather reports to the newspaper.[4] He was a partner in the E. O. Goldsmith & Company, a high-grade clothing store for men.

Many, perhaps most, Smithsonian observers had instruments and were making observations before joining the Smithsonian network. Typically, their interest in weather went beyond the scope of a hobby—avocation may have been a better term.

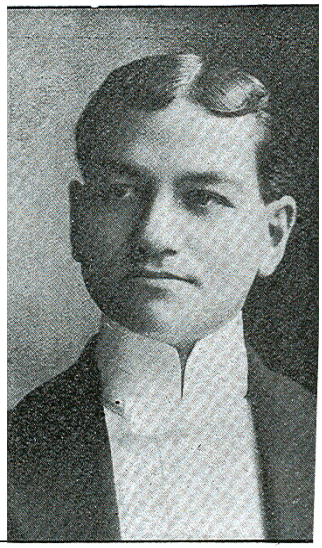


Figure 35. Edward O. Goldsmith
Source: Memphis Public Library

[4] The paper also received reports from a "Mr. Duggan" who was the telegraph operator at the Peabody.

James Nathan

James Nathan made the observations for August and September 1868. He remarked that the primary observer was absent from the city. Nathan (Figure 35) was a cashier at the Manhattan Savings Bank in Memphis. His relationship to Goldsmith is not known.

Figure 35. James Nathan
Source: Memphis Public Library

Edward O. Goldsmith

Edward O. Goldsmith resumed the observations in October. After four years of service, Goldsmith's last observations were submitted at the end of March 1870. The Smithsonian Institution's climate network was supplanted by the U.S. Army Signal Service.

The Signal Service Observers 1871—1890

The Signal Service was established in 1870 and soon opened their Meteorology School at Fort Whipple (now Ft. Myer) in Virginia to train Army Privates to become Observer Sergeants Those carefully chosen Privates could be promoted to Sergeant if they were considered to be capable of fulfilling the responsibilities of that rank. Those responsibilities were significant. The Meteorologist in Charge is the position now that the Observer Sergeants filled back then. The job then and now requires good public relations because the Observer Sergeants became well known members of their community.

The new Signal Service weather stations were located in major cities around the Country, cities that had railroads running through them. Memphis was such a city. They needed access to the telegraph lines along the railroads so that they could send weather reports and receive weather maps.

As the Signal Service grew, their responsibilities grew. They became highly visible and respected members of their community. Their published weather maps spurred a public interest in weather that has not waned since.

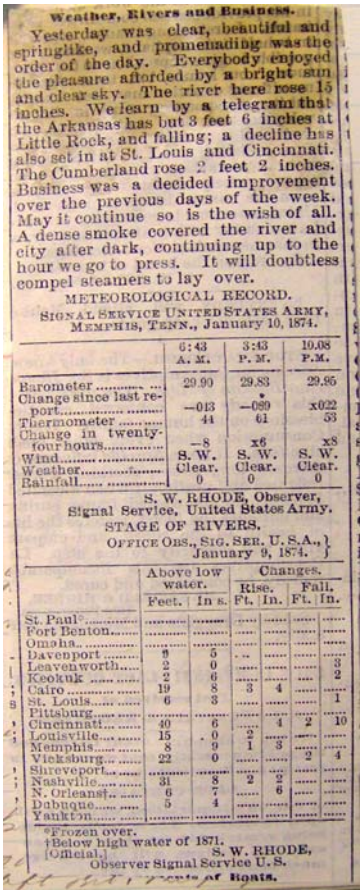
Thomas K. Brown, Sgt

Sgt. Thomas K. Brown was the first Signal Service Sergeant to arrive in Memphis according to the Memphis Climatological Record Book (See Appendix 2). It reported his arrival as being on 23 February 1871. It also reported that he made the first observations on 28 February 1871. His duties were not over because his public relations job had not yet begun. Those duties were prescribed in detail in the Instructions to Observers.

> An observer, upon opening a new station, will, as soon as practicable, put himself in communication with the board of trade, chamber of commerce, or board of underwriters, and such other bodies as may desire to co-operate with this office in its efforts to make the service locally, as well as generally useful. If meteorological committees have not been appointed by any or all of these bodies, their appointment should be urged as a matter of special importance, and the committees requested to place themselves in communication with the Chief Signal Officer. He will also communicate with such colleges, scientific associations and other institutions of learning as may be located at or near his station, and will explain to their officers and members the nature and object of his duties, and invite their co-operation. He must constantly bear in mind that he is expected to use every effort in his power to render his office of the greatest public utility.

S. W. Rhode, Sgt

Sergeant S. W. Rhode made the entries for November 1871. He also made them for almost three years with just one interruption (one hopes for a vacation) in 1873. Otherwise, the record of Memphis' weather was his during that period. He followed the Instructions to Observers and began providing weather information to the newspapers (Figure 36).



Weather, Rivers and Business.

Yesterday was clear, beautiful and springlike, and promenading was the order of the day. Everybody enjoyed the pleasure afforded by a bright sun and clear sky. The river here rose 15 inches. We learn by a telegram that the Arkansas has but 3 feet 6 inches at Little Rock, and falling; a decline has also set in at St. Louis and Cincinnati. The Cumberland rose 2 feet 2 inches. Business was a decided improvement over the previous days of the week. May it continue so is the wish of all. A dense smoke covered the river and city after dark, continuing up to the hour we go to press. It will doubtless compel steamers to lay over.

METEOROLOGICAL RECORD.

SIGNAL SERVICE UNITED STATES ARMY,
MEMPHIS, TENN., January 10, 1874.

	6:43 A. M.	3:43 P. M.	10.08 P.M.
Barometer	29.90	29.83	29.95
Change since last report	—013	—089	x022
Thermometer	44	61	53
Change in twenty-four hours	—8	x6	x8
Wind	S. W.	S. W.	S. W.
Weather	Clear.	Clear.	Clear.
Rainfall	0	0	0

S. W. RHODE, Observer,
Signal Service, United States Army.

STAGE OF RIVERS.

OFFICE OBS., SIG. SER. U. S. A., January 9, 1874.

	Above low water.		Changes.			
			Rise.		Fall.	
	Feet.	In s.	Ft.	In.	Ft.	In.
St. Paul*	.....	.....	.....	.....	.....	.....
Fort Benton	.....	.....	.....	.....	.....	.....
Omaha	.....	.....	.....	.....	.....	.....
Davenport	9	5	..	.....	.....	.....
Leavenworth	2	0	.....	.....	.....	3
Keokuk	2	6	.....	.....	.....	2
Cairo	19	8	3	4	.....	.....
St. Louis	6	3	.....	.....	.....	1
Pittsburg	.....	.....	.....	.....	.....	.....
Cincinnati	40	6	.....	4	2	10
Louisville	15	0	2	.....	.....	.....
Memphis	8	9	1	3	.....	.....
Vicksburg	22	0	.....	.....	2	4
Shreveport	.....	.....	.....	.....	.....	.....
Nashville	31	8	2	2	.....	.....
N. Orleans†	6	7	.....	6	.....	.....
Dubuque	5	4	.....	.....	.....	.....
Yankton	.....	.....	.....	.....	.....	.....

*Frozen over.
†Below high water of 1871.

S. W. RHODE,
[Official.] Observer Signal Service U. S.

Reports of Boats.

Figure 36. Sgt. Rhode's Weather News 1871 clipped from an Unknown Newspaper Source: National Archives and Records Administration

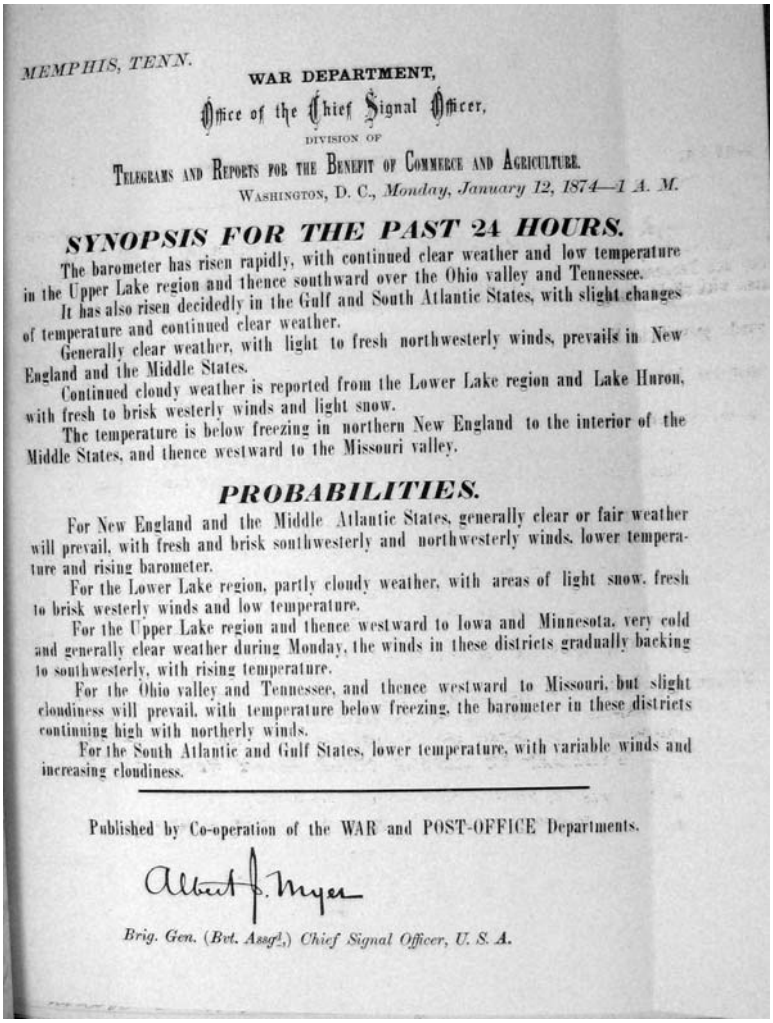
M. T. Downes

M. T. Downes made the observations as a substitute for Sgt Rhode in October 1873 only until when Sgt Rhode resumed the work.

S. W. Rhode, Sgt

By early January 1874, Sgt Rhode was provided two assistants; Pvt. Birt was an observer and Pvt Clemments was the printer. There was a Meteorological Committee formed within the Chamber of Commerce with a Mr. Temmes in charge.

One of the most popular products produced by the Signal Service was the forecast (Figure 37).



MEMPHIS, TENN.

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

WASHINGTON, D. C., *Monday, January 12, 1874—1 A. M.*

SYNOPSIS FOR THE PAST 24 HOURS.

The barometer has risen rapidly, with continued clear weather and low temperature in the Upper Lake region and thence southward over the Ohio valley and Tennessee.

It has also risen decidedly in the Gulf and South Atlantic States, with slight changes of temperature and continued clear weather.

Generally clear weather, with light to fresh northwesterly winds, prevails in New England and the Middle States.

Continued cloudy weather is reported from the Lower Lake region and Lake Huron, with fresh to brisk westerly winds and light snow.

The temperature is below freezing in northern New England to the interior of the Middle States, and thence westward to the Missouri valley.

PROBABILITIES.

For New England and the Middle Atlantic States, generally clear or fair weather will prevail, with fresh and brisk southwesterly and northwesterly winds, lower temperature and rising barometer.

For the Lower Lake region, partly cloudy weather, with areas of light snow, fresh to brisk westerly winds and low temperature.

For the Upper Lake region and thence westward to Iowa and Minnesota, very cold and generally clear weather during Monday, the winds in these districts gradually backing to southwesterly, with rising temperature.

For the Ohio valley and Tennessee, and thence westward to Missouri, but slight cloudiness will prevail, with temperature below freezing, the barometer in these districts continuing high with northerly winds.

For the South Atlantic and Gulf States, lower temperature, with variable winds and increasing cloudiness.

Published by Co-operation of the WAR and POST-OFFICE Departments.

Albert J. Myer

Brig. Gen. (Bvt. Asst.) Chief Signal Officer, U. S. A.

Figure 37. Forecast Dated 12 January 1874
Source: National Archives and Records Administration

Note that the forecast was called “Probabilities.” That term was associated with Cleveland Abbe who first prepared such things when he was in Cincinnati. At this time, he was in charge of the preparing this document in the Signal Service office in Washington and distributing it to the local Signal Service offices across the country. Note the “official” appearance of the document including the signature of the commander of the Signal Service.

There was criticism of the probabilities from no less than Commander M. F. Maury in 1871—the same Maury whose actions had caused weather observations to be started in Memphis.

> There is nothing in these “probabilities” that you can utilize. There is no reason why, with the means and appliances under the control of that office, you should not reasonably expect to have

> timely warning at least of certain great changes in the atmosphere that you can profit by. After a while, the information, as knowledge and experience increase, may be more specific; but as they are, these "probabilities" are so vague that ship masters and farmers who felt a lively interest in them at first are beginning to ask each other, "Cui bono?"
>
> Nevertheless, considering this office is new, it has made a good beginning. But the time is coming…when these probabilities should become "certainties."

It is clear from the popularity of the "probabilities" that the public did not share Maury's criticism. Cleveland Abbe first published his probabilities in Cincinnati in 1869 with his opinion.

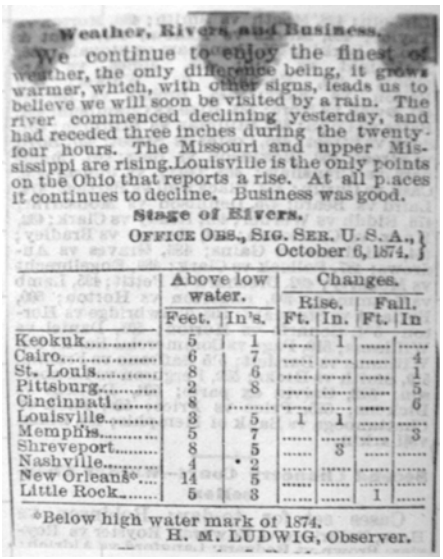
> I have started that which the country will not willingly let die.

And, we haven't let it die.

Sgt Rhode continued the observations in Memphis until he was transferred to have charge of the office in Milwaukee in September 1874.

H. M. Ludwig, Sgt

Sergeant H. M. Ludwig arrived as the new Observer Sergeant on 24 September 1874. He had been transferred from the Milwaukee office where he had been in charge. By July 1876, the Meteorological Committee had become part of the Cotton Exchange organization. Ludwig's news releases were actually climatological summaries (Figure 38) but interesting to the public nonetheless.



Weather, Rivers and Business.

We continue to enjoy the finest of weather, the only difference being, it grows warmer, which, with other signs, leads us to believe we will soon be visited by a rain. The river commenced declining yesterday, and had receded three inches during the twenty-four hours. The Missouri and upper Mississippi are rising. Louisville is the only points on the Ohio that reports a rise. At all places it continues to decline. Business was good.

Stage of Rivers.

OFFICE OBS., SIG. SER. U. S. A., October 6, 1874.

	Above low water.		Changes.			
			Rise.		Fall.	
	Feet.	In's.	Ft.	In.	Ft.	In
Keokuk	5	1	.....	1	.....	.....
Cairo	6	7	.....	.....	.....	4
St. Louis	8	6	.....	.....	.....	1
Pittsburg	2	8	.....	.....	.....	5
Cincinnati	8	.....	.....	.....	.....	6
Louisville	3	5	1	1	.....	.....
Memphis	5	7	.....	.....	.....	3
Shreveport	8	5	.....	3	.....	.....
Nashville	4	*2	.....	.....	.....	.....
New Orleans	14	5	.....	.....	.....	.....
Little Rock	5	3	.....	.....	1	.....

*Below high water mark of 1874.

H. M. LUDWIG, Observer.

Figure 38. Ludwig's News Release 1874
Source: National Archives and Records Administration

William M. Elroy, Sgt

Sergeant William M. Elroy was the new Observer Sergeant in July 1876. He was assisted by Pvt. Neal who had been trained as a meteorologist at Ft. Whipple in Virginia. It was Sgt Elroy's misfortune to be stationed in Memphis during the great Yellow Fever Epidemic of 1878. While most residents of Memphis evacuated, he stayed at his post. He made his last observations in August 1878 and died of yellow fever on 1 September 1878. One cannot help wondering if the ex-weather observer Dr. Mitchell treated him.

Pvt. Neal took charge and was lauded for his performance by an inspection that quickly followed. In the inspection report was recommended that he be promoted to Sergeant.

George H. Rohe, Sgt

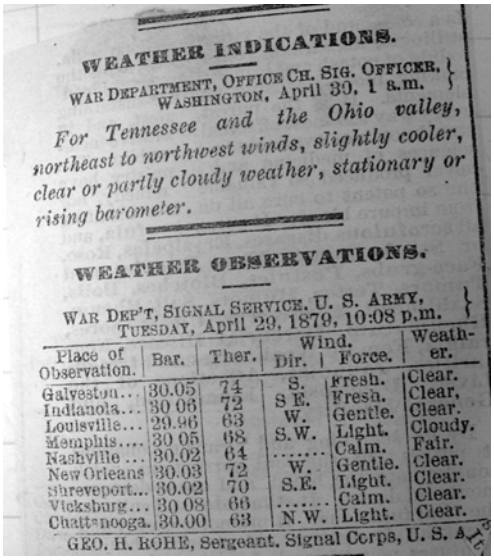
Sgt George H. Rohe signed as the observer after Sgt Elroy's death. He signed the forms in August, September, and October of 1878 but was then replaced by Pvt. Dabney.

R. J. Neal, Pvt

Pvt T. M. Neal made the observations in November and December 1878.

George H. Rohe, Sgt

Sgt George H. Rohe was officially in charge on his return on 24 January 1879. He, like most other Signal Service Observer Sergeants provided weather data to the Newspapers. The clipping in Figure 39 is an example.



WEATHER INDICATIONS.

WAR DEPARTMENT, OFFICE CH. SIG. OFFICER, WASHINGTON, April 30, 1 a.m.

For Tennessee and the Ohio valley, northeast to northwest winds, slightly cooler, clear or partly cloudy weather, stationary or rising barometer.

WEATHER OBSERVATIONS.

WAR DEP'T, SIGNAL SERVICE, U. S. ARMY, TUESDAY, April 29, 1879, 10:08 p.m.

Place of Observation.	Bar.	Ther.	Wind. Dir.	Wind. Force.	Weather.
Galveston...	30.05	74	S.	Fresh.	Clear.
Indianola...	30 06	72	S E.	Fresh.	Clear,
Louisville...	29.96	63	W.	Gentle.	Clear.
Memphis....	30 05	68	S.W.	Light.	Cloudy.
Nashville ...	30.02	64	.....	Calm.	Fair.
New Orleans	30.03	72	W.	Gentle.	Clear.
Shreveport...	30.02	70	S.E.	Light.	Clear.
Vicksburg...	30 08	66	.....	Calm.	Clear.
Chattanooga.	30.00	63	N.W.	Light.	Clear.

GEO. H. ROHE, Sergeant, Signal Corps, U. S. A.

Figure 39. Sgt Rohe's News Release 1879
Source: National Archives and Records Administration

R. J. Dabney, Sgt

Pvt. R. J. Dabney, who was an assistant to Sgt. Rohe, made the observations for September through December 1879 until Cpl. Flannery was assigned. Pvt. Dabney was a graduate of the meteorology school at Ft. Whipple in Virginia and had arrived on 13 December 1878.

David Thomas Flannery, Cpl

Corporal David Thomas Flannery was placed in charge on 6 January 1880. He was the official in charge for over eight years. Occasionally, he would be absent (perhaps on leave) and others would fill in. Pvt. Edward F. Brady substituted in October 1881 and Pvt. J. N. Ryker in May 1883,

David Thomas Flannery, Sgt

In June 1883, the newly promoted Sgt. Flannery was signing the observation forms. The Chairman of the Meteorological Committee in Memphis was D. P. Hadden in May 1885.

E. A. Evans, Sgt

Sgt E. A. Evans was listed at the official in charge during the inspections report dated 12 June 1888.

J. W. Byram, Sgt

Sgt J. W. Byram was in charge beginning in July 1889. He had two assistants, Privates Butler and Hill. Sgt. Byram was 29 years old when he departed Memphis.

Wilford M. Wilson, Cpl

Cpl Wilford M. Wilson reported for duty on 17 June 1890 to replace Sgt. Byram. Privates Butler and Hill were still assigned there.

William C. Butler, Pvt

Pvt. William E. Butler was placed in charge while Cpl. W. M. Wilson was on leave. Wilson retired but would return the next month as a civilian. Butler had attended the University of Mississippi. He was assisted by Judson S. Walker.

The Weather Bureau Observers 1891-1947

On 1 October 1890, Congress passed an act that transferred the weather service from the Signal Service to the Department of Agriculture. This was the result of the success of the "probabilities" and the desire to focus those forecasting skills to a practical application rather

than a generic and regionally oriented one. The decision had some immediate impacts. The Signal Service sites, located on the roofs of tall buildings in downtowns and collecting data from other tall buildings in other downtowns, would now become responsible for forecasts focused on agricultural operations. Almost immediately, voluntary observers from the countryside were recruited to provide observations of weather data that would make those forecasts possible. Times were changing!

The transition in purpose would take a while. To facilitate the transition, Congress allowed those individuals, who wished to do so, to transfer from the Army to the new Weather Bureau as civilian employees. Those, like Cpl. Wilson who could retire, did. They then returned to work as civilians in the Weather Bureau in the same facility performing the same job as when they were in the Signal Service.

Wilford M. Wilson

Mister Wilford M. Wilson was in charge again in January 1891, but this time as a civilian and the as the first Official in Charge of the Weather Bureau office in Memphis. The inspection during 13— 15 April 1893 found that Mr. Wilson and his staff were performing well. But, the inspector made special comments about a nineteen years old observer who had been assigned o Memphis recently. He was described as “one of the brightest young men I have found in the Service. In short, he is a model young man.” That individual was Edward H. Bowie (Figure 40) who would become the chief forecaster for the American Expeditionary Force in Europe during World War I and, years after that would become the Meteorologist in Charge in San Francisco.

Figure 40. Edward H. Bowie, about 1924, as Meteorologist in Charge San Francisco
Source: National Weather Service Forecast Office San Francisco

Samuel C. Emery

Samuel C. Emery was the Meteorologist in Charge at Memphis in March 1896 at 48 years of age.

Frederick W. Brist

Frederick W. Brist became the Meteorologist in Charge (MIC) in 1923. He maintained that position until his retirement in February 1944.

Berl L. Henry

Berl L. Henry was the temporary MIC for three months, February through April 1944.

George H. F. Allmendinger

George H. F. Allmendinger (Figure 23) was the temporary MIC from May through September 1944.

A. L. King

A. L. King took over as the Meteorologist in Charge in October 1944 and continued in that capacity through the end of the period considered in this study.

One other individual needs mention here. He is Cecil E. Carney (Figure 41) who became the MIC at the airport location on 26 February 1937.

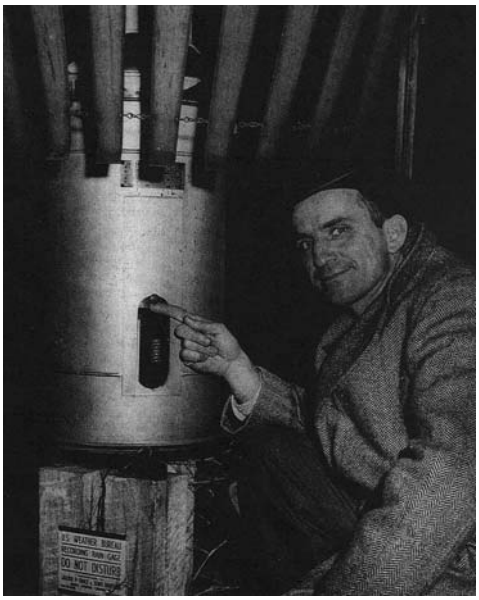


Figure 41. Cecil E. Carney, MIC Memphis Airport
Source: National Weather Service Office, Memphis

THE OBSERVATIONS

The Navy Department

The last pressure observations by the Navy were on 23 October 1854. There was a note under the barometer column that the "barometer packed for transfer to N. Yard N. York." On 28 October 1854, the last temperatures were recorded and under the temperature column was: "Ther packed for transfer to N Yard N York."

The Memphis Navy Yard had been envisioned as a rope walk to produce cordage made from American hemp. Federal funding was limited and in 1851 the Army Engineers inspection supported the rope walk goal but determined that the Navy Yard lacked essentials. Congressional support was lost and the Navy Yard operations ceased in 1854.

The weather observations had begun because of the Navy Yard's existence. They ended with the Navy Yard's demise.

There followed a three-year gap in the weather record.

The Smithsonian Years

The observations in Memphis resumed on 1 September 1857. The observer made entries on a Smithsonian Institution form and forwarded them to that organization.

The Smithsonian institution, headed by Joseph Henry, was created in 1846 and immediately began establishing a climate observation network. Henry envisioned three types of observers; those without instruments who would observe the sky, extent of clouds, wind, and beginning and ending time precipitation. A second group would do that too but would also be equipped with thermometers. The third group would be equipped with a complete set of instruments to observe temperature, precipitation, pressure, humidity, clouds, wind direction and wind speed. The new observer at Memphis fit into the latter category. His first report contained entries in all columns except winds. At 7 a.m., 2 p.m., and 9 p.m., he reported the barometric pressure in inches, the temperature from the thermometer attached to the barometer, the barometer reading reduced to the freezing point, the open air temperature, the dry and wet bulb temperatures, the precipitation amounts with starting and ending times, amount of sky coverage and type and velocity of clouds, the force of the pressure of vapor in inches, and the relative humidity in percent. In March 1858, wind data were added to the report

The Smithsonian became the weather data collection agency for the U.S. Department of Agriculture in 1847. By the time the Navy Yard at Memphis closed, the Smithsonian had observers reporting from thirty-one states and was receiving real time observations by telegraph from some of them. The Smithsonian received as many as half-a-million separate weather observations each year. It required up to fifteen people to make the necessary arithmetic calculations — human computers so to speak. In 1861, the Smithsonian published the first of a two-volume compilation of climatic data and storm observations for the years 1854 through 1859.

There are no records of observations between April 1861 and September 1867. The Civil War during the first part of this period disrupted weather records throughout the south. The first post-Civil War Smithsonian reports made in September-October 1867 in Memphis contained lengthy comments:

> The observer took no account of fractions in his thermometrical observations, owing to the absence of instructions to that effect. He was placed in receipt (by mail) of a pamphlet of instructions during the latter part of the month—too late to make any corrections or alterations. He has however perfected his arrangements for making future observations conform as strictly to requirements as possible. Future registry will therefore contain the state of therm. in tenths, as also the Barometer reduced to freez'g point. Below he appends the observed height of Barometer during the month thinking it might prove of some little value. He would only remark that his being an aneroid barometer, it will not be possible to record variations of less that hundredths of an in.

It is clear from these comments that the observer had not taken observations during the missing data period. He followed those comments with even more, including these:

> Extreme Fall of Rivers…. Owing to an unusually dry summer in the Mississippi Valley, the Rivers in this section have fallen to a very low stage. Said to be lower that at any time since 1856…

The observer understood the importance of the river to Memphis and its economy.

The Signal Service Years

On 9 February 1870, Congress directed the War Department to form a weather network and to make meteorological observations at the Army Posts in the United States. The Signal Service was formed for that effort because of their capability using their telegraph network. At 7:35 a.m. on November 1, 1870, its observers reported from twenty-four stations. Those observations were transmitted by telegraph to the central office in Washington, D.C. just eleven months after Congress authorized the network. The data were used to produce national weather maps.

The Smithsonian observer in Memphis submitted his last observations in March 1870. There was no indication that a nineteen month gap in the record would follow.

In fact, the Signal Service began observations in Memphis in February 1871 but the first record that has survived was submitted in November 1871. The cause of the gap between February and November remains unexplained.

The Signal Service soon took over all of the weather observation roles from the Smithsonian Institution. On 10 February 1874, the Chief Signal Officer, General Myer, sent a letter to all the ex-Smithsonian observers announcing that the Smithsonian observation network was no more. He invited them to become voluntary observers in the Signal Service network and told them that he would provide stamped envelopes in which to submit their monthly reports. Some did.

The Signal Service form used in the beginning contained much less data than the Smithsonian Institution's form had. In fact, the Signal Service form reported only the mean daily barometer reading in inches, the mean daily temperature in Fahrenheit rounded to the nearest whole degree, and the precipitation amount in inches and hundredths. There was a small remarks column with room for three or four words. At the bottom of the form were the prevailing wind direction and the total number of miles traveled by the wind for the month. The form was lacking any information about the station, its location, elevation, time of observation, or any other station history type information.

A new Form 22 was used in January 1873 for the first time in Memphis. It had columns for barometer and temperature entries at "a.m., p.m., and midnight." No provision was made for reporting precipitation. Use of the new and old form alternated until May 1873 when yet another Form 22 appeared. This one was like the previous revision except that there were three times daily "telegraphic observations" and columns for the "local observations." The local one only recorded the daily means of the barometer, thermometer, and humidity and the total rainfall.

The Weather Bureau Years

On 1 October 1890, Congress passed an act that transferred the weather service from the Signal Service to the Department of Agriculture. The number of weather stations included in that publication increased over subsequent months as the Weather Bureau increased the number of Cooperative Weather Observers. By 1891, the network of voluntary weather observers across the country had grown to 2,000 stations.

In 1904, the Memphis Weather Bureau office had grown in the service it was providing. They were distributing about 280 daily weather maps and about 350 forecast cards.

Forecast flags were being displayed on a tall staff on top of their eleven-story building. The forecast flags were displayed prominently so that citizens could see what weather conditions were forecast for that location. The use of the flags began shortly after the Weather Bureau took over from the Signal Service. Two versions of the flags were used. One displayed the precipitation forecast, the other temperature.

Square flags (Figure 42) gave the precipitation forecasts; white for fair, blue for rain or snow, and half white—half blue for showers. A pennant gave the temperature forecast by its position on the staff; warmer if above the precipitation flag, colder if below, and no change if it

wasn't displayed. A square white flag with a small black square in its center forecast a cold wave.[5]

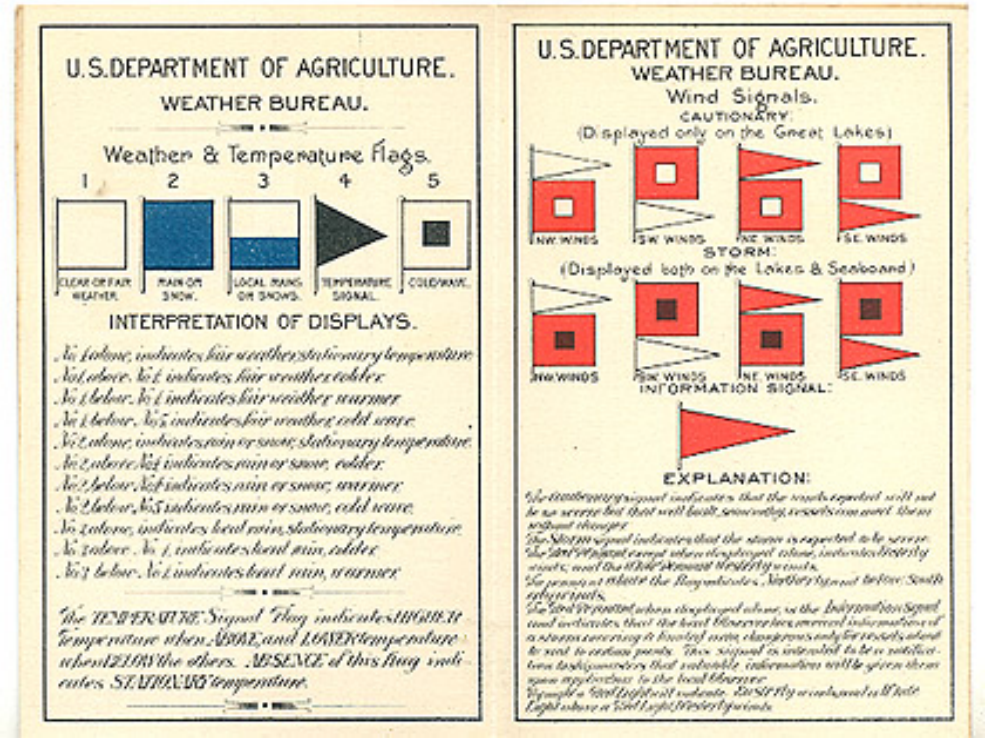


Figure 42. Weather and Temperature Forecast Flags
Source: World's Columbian Exposition Souvenir, 1893

Blackboard weather maps were being prepared daily at he Cotton Exchange and at the Merchants Exchange. The station was providing weather news to the newspapers on a regular basis. This innocuous contribution became the center of a small controversy. The Memphis Morning News began presenting the weather news using a drawing of a monkey placed at the head of the weather news column—for humor they said. Mr. Emery of the Weather Bureau in Memphis saw it differently. The Inspection Report of 25 January 1904 agreed.

> As will be seen in the enclosed clipping, it appears to be used to attract attention to what they have to say about their local political opponents. In a recent city election riots occurred and that is what is referred to in the enclosed clipping. The Managing Editor who has the entire authority in the matter, was requested

[5] Memphis did not display the wind signal flags shown in Figure 42 that were displayed in the area of the Great Lakes

by Mr. Emery some time since to not use the weather information in that way: He stated that it was not intended to reflect on the Weather Bureau in the least but continued to use it frequently.

OCTOBER 19, 1904.

RAIN TODAY, SAYS JO-JO.

"I mustn't forget. I can't forget!" cried Jo-Jo, wildly.

"Oh, forget it," advised the forecaster.

"I don't want to forget it. I'm trying to record all the records that are going to be broken during this meeting. Make the weather good, mister."

"Rain and colder."

Tennessee—Fair in east, rain and colder in west portion Wednesday; Thursday, rain and colder.

Mississippi—Rain and colder in west portion, fair in east portion Wednesday; Thursday, rain, colder in east portion; variable winds, becoming fresh south.

Arkansas—Rain and colder Wednesday; Thursday, fair.

Alabama—Rain and colder Wednesday; Thursday, fair.

Georgia—Fair in interior; rain on the coast Wednesday; Thursday, rain; brisk northeast winds on the coast.

South Carolina—Fair in interior, rain on the coast Wednesday; Thursday, rain; brisk north winds.

North Carolina—Increasing cloudiness Wednesday, with rain on the coast; Thursday, rain, northeast winds.

MEMPHIS METEOROLOGY, OCT. 18.

7 a.m.	52	11 a.m.	76	1 p.m.	80	5 p.m.	80
9 a.m.	65	12 m.	79	3 p.m.	81	7 p.m.	76

	1904	1903	1902	1901
Maximum	81	61	75	66
Minimum	52	41	58	46
Average	66	51	66	56

Precipitation .00
Wind direction, E. Highest 10 M
Sun rises, 6:10 a.m. Sets (p.m.) 5:20

S. C. EMERY, Local Forecaster.

Figure 43. The Monkey Cartoon
Source: Memphis Morning News, 19 October 1904

Beneath the monkey cartoon was a dialogue between the monkey Jo-Jo and the Forecaster. The forecasts and the climate summary followed. At the bottom, the Memphis forecaster's name, S. C. Emery, appeared. The inference was that he was the author of the entire column.

Other newspapers used a cartoon character similar to the one from Indianapolis in 1928 (Figure 44) but there was no inference that the forecaster may have drawn it.

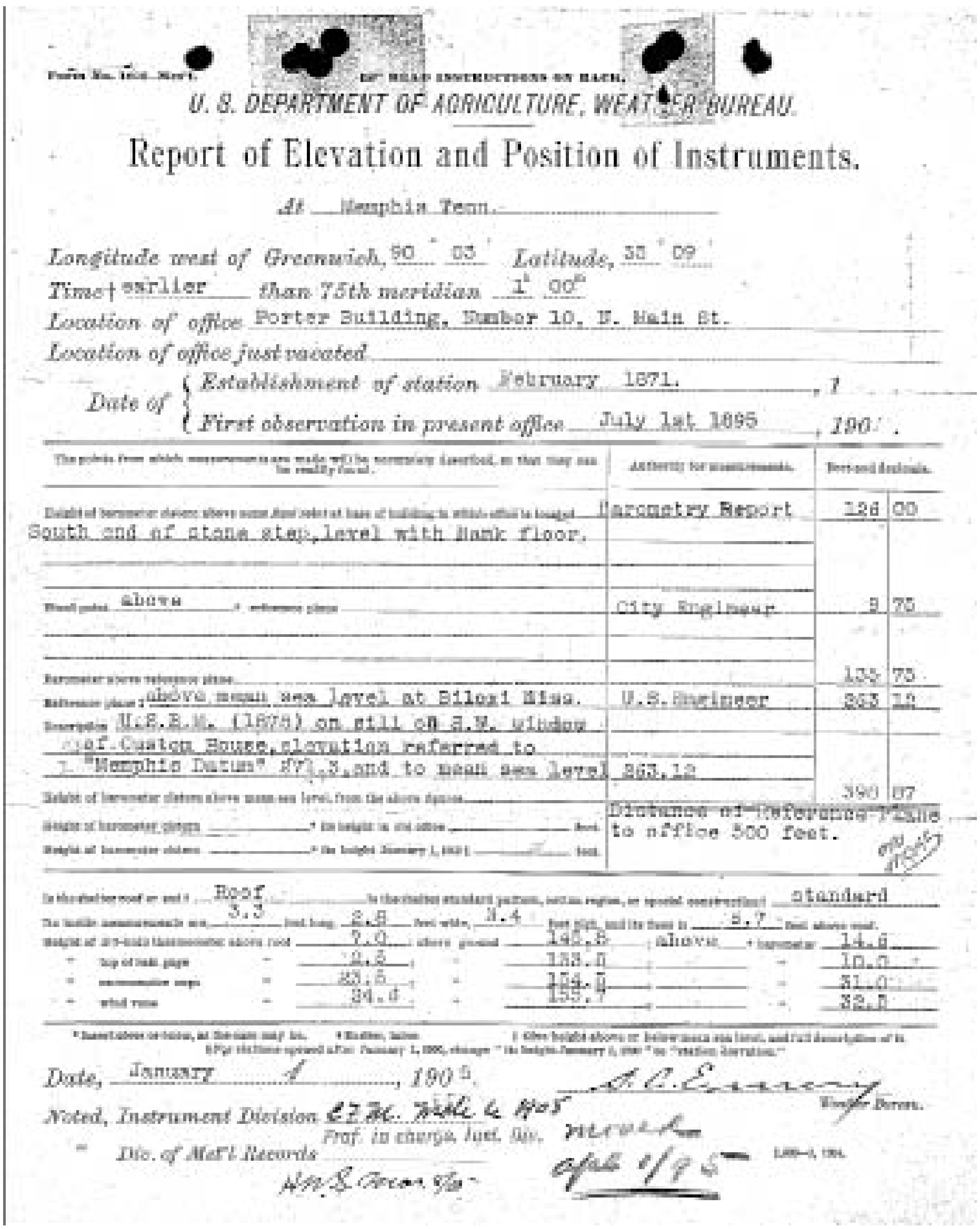
Figure 42. Weather Cartoon
Source: Indianapolis Telegram 21 February 1928

The Digital Record

The National Climatic Data Center is Asheville, North Carolina has digitized the observations from Memphis. To facilitate computer usage, the station was given the identifying number of 405947.

APPENDIX 1

Report of Elevation and Position of Instruments
Memphis
1905



U. S. DEPARTMENT OF AGRICULTURE, WEATHER BUREAU.

Report of Elevation and Position of Instruments.

At Memphis Tenn.

Longitude west of Greenwich, 90° 03' *Latitude,* 35° 09'

Time † earlier *than 75th meridian* 1h 00m

Location of office Porter Building, Number 10, N. Main St.

Location of office just vacated

Date of *Establishment of station* February 1871.

Date of *First observation in present office* July 1st 1895 , 190 .

	Authority for measurements.	Feet and decimals.	
South end of stone step, level with Bank floor.	Barometry Report	126	00
above	City Engineer	9	75
		135	75
above mean sea level at Biloxi Miss.	U.S. Engineer	263	12
U.S.B.M. (1878) on sill of S.W. window of Custom House, elevation referred to "Memphis Datum" 871.3, and to mean sea level	263.12		
		390	87
	Distance of Reference Plane to office 500 feet.		

Roof — standard

3.3 — 2.8 — 3.4 — 5.7

	above roof	above ground	above barometer
	7.0	145.8	14.6
	9.2	133.0	10.0
	23.5	154.0	31.0
	34.4	155.7	32.5

Date, January 4, 1905.

Noted, Instrument Division

Prof. in charge Inst. Div.

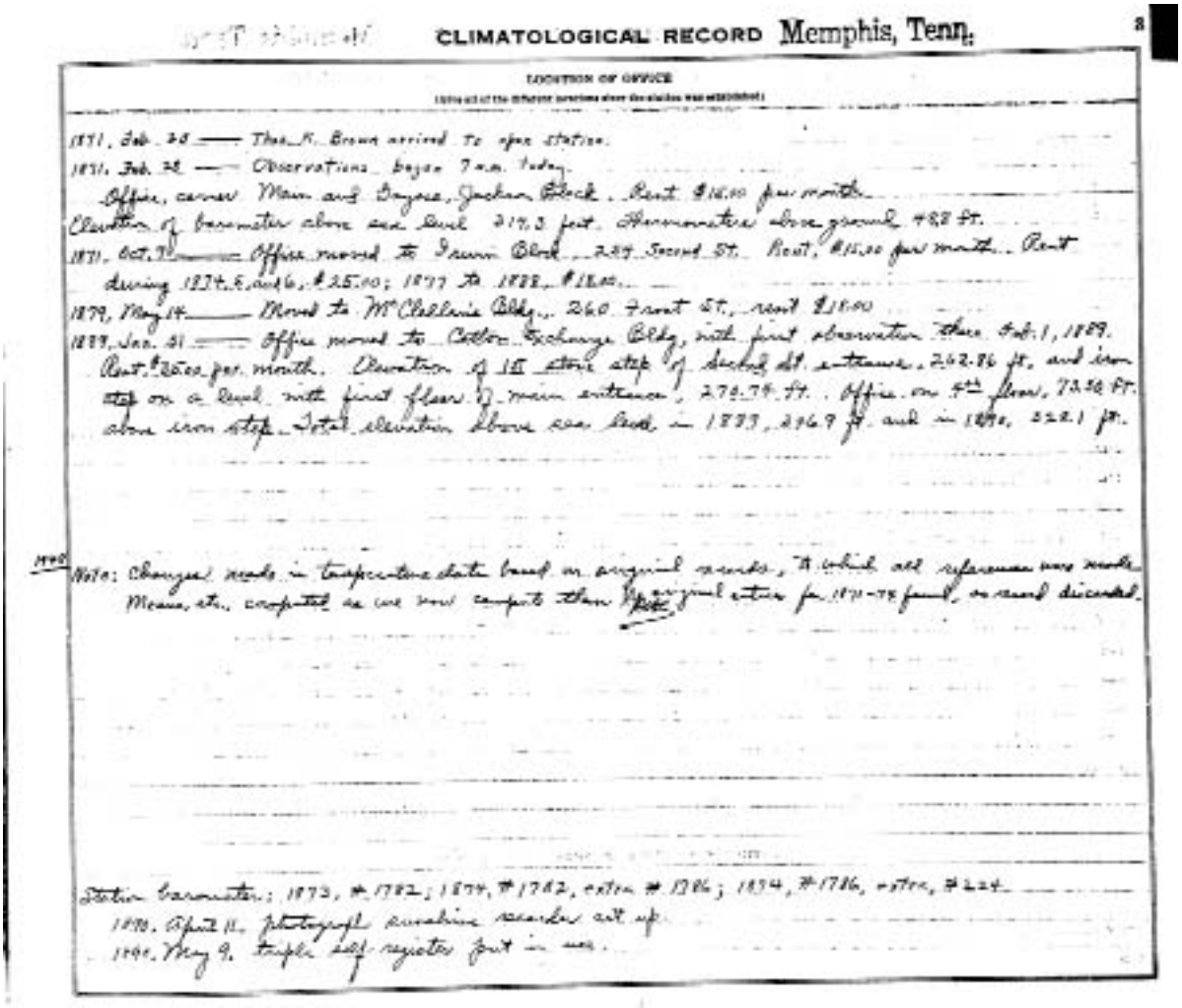
Div. of Met'l Records

Weather Bureau.

Source: National Climatic Data Center

APPENDIX 2

First Page Memphis Climatological Record Book



CLIMATOLOGICAL RECORD Memphis, Tenn. 3

LOCATION OF OFFICE

1871. Feb. 20 —— Thos. R. Brown arrived to open station.
1871. Feb. 28 —— Observations begun 7 a.m. today.
Office, corner Main and Bayou, Jackson Block. Rent $16.00 per month.
Elevation of barometer above sea level 219.3 feet. Above street above ground 48.8 ft.
1871. Oct. 7th —— Office moved to Irwin Block, 287 Second St. Rent, $15.00 per month. Rent during 1874, 5, and 6, $25.00; 1877 to 1882, $18.00.
1879, May 14 —— Moved to McClelvie Bldg., 260 Front St., rent $18.00
1889. Jan. 31 —— Office moved to Cotton Exchange Bldg, with first observation there Feb. 1, 1889. Rent $25.00 per month. Elevation of 18 stone step of ducking dr. entrance, 262.86 ft. and iron step on a level with floor of main entrance, 270.74 ft. Office on 4th floor, 72.50 ft. above iron step. Total elevation above sea level in 1873, 296.9 ft. and in 1890, 322.1 ft.

1905 Note: Changes made in temperature data based on original records, to which all references were made. Means, etc., computed as we now compute them. Original entries for 1871-78 found, as noted, discarded.

Station barometer: 1873, # 1782; 1874, # 1782, extra # 1786; 1884, # 1786, extra, # 224.
1890. April 11. Photographic recording records set up.
1891. May 9. Temple self registers put in use.

APPENDIX 3

Methodology

The primary sources of information for this study were the Memphis 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 Memphis, its history, and its people. The author visited and collected information from the holdings of the National Climatic Data Center at Asheville, North Carolina; the National Weather Service Office in Memphis, the Memphis Public Library, the Memphis Historical Society Library, the National Archives and Records Administration in College Park, Maryland, the Smithsonian Institution Archives in Washington D.C., the Western Kentucky University Library in Bowling Green, Kentucky; the LDS Family History Library in Salt Lake City, Utah; and the Tennessee State Library and Archives in Nashville, Tennessee.

The tertiary sources were reference materials that are available on-line. Among those were the metadata prepared by the National Weather Service Office in Memphis, the Midwestern Regional Climate Center, and the National Climatic Data Center. In addition, substation histories previously prepared were consulted. 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 the Memphis. 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 at Memphis, judge the trustworthiness of the observers who collected them, and determine the climatological significance of the whatever variability may be discerned.

BIBLIOGRAPHY

Adamiak, Stanley J.,, 2002. *A Naval Depot and Dockyard on the Western Waters*

Baker, Thomas H., 1968. *Yellowjack: The Yellow Fever Epidemic of 1878 in Memphis Tennessee.* Bulletin of the History of Medicine, Vol. 42, No. 3, May-Jun 1968

Bishop, Andrew N., 1980. *Memphis Historical Markers.* A. N. Bishop, Memphis, Tennessee

Bruesch, S. Rulin, 1979. *Yellow Fever in Tennessee in 1878.* Journal of the Tennessee Medical Association, Part 1, December 1978; Part 2, February 1979; Part 3, March 1979

Cook, James B., 1860. *Memphis and Its Environs 1860.* Monsarrat, Dupree and Company, Memphis, Tennessee

Council, R. Bruce, 1985. *Historical Documentation and Site Reconnaissance of the Memphis Navy Yard Archaeological Site, Memphis, Shelby County, Tennessee.* Jeffery L. Brown Institute of Archaeology, University of Tennessee, Chattanooga

Crawford, Charles W., 1993. *National Bank of Commerce.* National Bank of Commerce Bancorporation, Memphis, Tennessee

Davis, James D., 1873. *History of Memphis.* Hite, Crumpton and Kelly, Memphis, Tennessee

Elwood Cemetery, 1874. *History of the Cemetery with Biographical Sketches.* Boyce and Chapman Printers, Memphis, Tennessee

Faragher, Scott, 2000. Memphis in Vintage Post Cards. Acadia, Charleston, South Carolina

Findlay, Stephan M., 1980. *The Memphis Navy* Yard *1845-1854.* Thesis (M.A.) Memphis State University, Memphis Tennessee

Goodspeed Publishing, 1887. *The History of Tennessee.* The Goodspeed Publishing Company, Nashville, Tennessee

Halphin, T. L., 1868. *Memphis City Directory 1867-1868.* Bulletin Publishing Company, Memphis, Tennessee

Hughes, Patrick A./ 1970. *Century of Weather Service, A History of the Birth and Growth of the National Weather Service 1870-1970.* Gordon and Breach, Science Publishers, Inc., New York

Keating, J. M., 1888. *History of the City of Memphis, Vol I.* D. Mason and Company, Syracuse, New York

LaPointe, Patricia M., 1983 *The Disruptive Years, Memphis City Hospitals 1860-1867.* West Tennessee Historical Society's Papers #37, 1983:9-29. Memphis, Tennessee

Maury, Matthew F., 1855. *The Physical Geography of the Sea and Its Meteorology.* Republished in 2003 by John Leighly Editor, Dover Publications, Mineola, New York

Maury, Matthew F., 1871. *Address of Com M. F. Maury Before the Fair of the Agricultural and Mechanical Soc. of Memphis Tenn.* Delivered at the Fairgrounds Oct 17th 1871. Appeal Job Office, Memphis, Tennessee

Memphis Appeal, 1853. *Lieut. Reuben Harris, U.S.N.* 12 January 1853, page 2

Memphis Commercial Appeal, 1935. Article on Weather Reporting. 23 June 1935

Memphis Evening Scimitar, 1891. Sourvenir Edition of theMemphis Evening Scimitar, October 1891. A. Lesse & Company, Chicago

Memphis Morning News, 1904. *Rain Today Says JoJo.* 19 October 1904, Page 1

Miller, Eric R., 1931. *The Evolution of Meteorological Institutions in the United States.* Monthly Weather Review, Vol. 59, No. 1, January 1931

National Archives and Records Administration, 1735—1979. *Records of the Weather Bureau.* Records Group 27, Series 53, Station Inspection Reports, 1871—1930

National Archives and Records Administration, 1735—1979. *Records of the Weather Bureau.* Records Group 27, Series 55, Records Describing Weather Stations, 1883—1904. College Park, Maryland

National Archives and Records Administration, 1754—1971. *Records of the Hydrographic Office.* Records Group 37, Series 37.2, Hydrographic Records of the Bureau of Ordnance and Hydrography and the Bureau of Navigation Created Prior to the Establishment of the Hydrographic Office, letters sent to Navy Yards, 1842-1863, College Park, Maryland

National Archives and Records Administration, 1880-1950. *Still Pictures (General, Meteorological Instruments and Apparatus.* Records Group 27.10, Boxes 1 through 12. . College Park, Maryland

National Weather Service Forecast Office, 2005. *History of the National Weather Service in Memphis, Tennessee.*
http://www.srh.noaa.gov/meg/background.html
Last visited 4 October 2005

Potter, James D., 1878. *Governor James D. Potter Papers.* Tennessee State Library and Archives, Nashville, Tennessee. GP 24, Box 6, Folder 6, 1878. Reference to R. W. Mitchell, Medical Director, Yellow Fever Epidemic, Memphis Tennessee

Rives, Frank. 1998. *Joseph Henry, Father of the Weather Service. The Joseph Henry Papers* Project, History Division, Smithsonian Institution

Sanger, W. P. S., 1844. *Plan of the Navy Yard in the Harbor of Memphis.* Bureau of Yards and Docks, Washington D.C.

Signal Service, 1882. *Instructions for Voluntary Observers of the Signal Service United States Army.* Government Printing Office, Washington

Smithsonian Institution Annual Report. 1848 Mis. No. 48. Smithsonian Institution Archives, Washington, D.C.

Smithsonian Institution Archives, 1850-1870. *Meteorological Instruments Loaned.* Record Unit 60, Series 8, Box 19, Washington D.C.

Smithsonian Institution Archives, 1868 and after. *Records of Meteorological Observers.* Record Unit 60, Series 8, Box 19, Washington D.C.

Tanner and Halpin, 1859. *Memphis City Directory.* Hutton and Clark Publishers, Memphis, Tennessee

The Rise and Fall of the Memphis Naval Yard, 1844–1854. International Journal of Naval History, Vol 1, Issue 1 http://www.ijnhonline.org/volume1_number1_Apr02/article_adamiak_memphis_navyyard.doc.htm

Tod and Crider, 1850. *Map of the City of Memphis.* Milne and Bruder, Louisville, Kentucky

U. S. Congress, 1844. *Navy Yard and Depot at the City of Memphis, 1844.* House Committee on Naval Affairs, Washington D. C.

U.S. Navy, 1844. *Memphis Navy Yard Map 1844*. Chief of the Bureau of Yards and Docks, Department of the Navy, Memphis Tennessee

Vedder, O.F., 1888. *History of the City of Memphis, Shelby County, Tennessee, Vol. II.* D. Mason and Company Publishers, Syracuse, New York

Whitnah. Donald R. 1961. *A History of the United States Weather Bureau.* University of Illinois Press, Urbana, Illinois

Williamson, M. T., 1871. *Map of the City and Suburbs of Memphis.* Strobridge Lith and Company, Cincinnati, Ohio