Nineteenth-Century Temperature Record at Fort Howard, Green Bay, Wisconsin

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Abstract. Fort Howard (located near the present site of Green Bay, Wisconsin) was one of several nineteenth-century army posts in the Old Northwest that participated in the nation’s first weather observing network. From late 1821 through mid-1841, and from late 1849 to mid-1852, medical personnel at the fort maintained a nearly continuous log of daily weather conditions. A comparison of monthly and annual mean temperatures suggests that recent months and years in Green Bay were generally cooler than the 1820s and 1830s at Fort Howard. However, several factors may affect the validity of this comparison. Specifically, concern surrounds the accuracy, exposure, and location of the Fort Howard thermometer, differences in methods of computation of mean temperatures, and the reliability of Fort Howard’s weather observers. Of these, instrument exposure is probably the most troublesome factor for it appears likely that at times Fort Howard’s thermometer was exposed to direct sunlight. Such instrument exposure would invalidate comparisons with the modern temperature record.

Fort Howard, located near the present site of downtown Green Bay, Wisconsin, was a member station of the nation’s first weather observing network. In the early to mid-1800s army medical personnel stationed at the fort dutifully maintained a log of daily weather conditions, providing us with a fascinating glimpse of climate for a period when such information was sparse throughout much of the North American interior. Comparison of the Fort Howard temperature record with the modern temperature record at Green Bay suggests that the recent era was somewhat cooler than the earlier era. The principal objective of this study is to assess the validity of that comparison. While there is little reason to question the reliability of Fort Howard’s weather observers or the accuracy of the thermometer in use, differences in weather observing practices between then and now pose more serious problems. Of these, differences in instrument exposure appear to be most significant and may well invalidate any comparison between temperatures at Fort Howard and Green Bay.

The Surgeon General’s Weather Network

Because the War of 1812 with the British revealed weaknesses within the medical service of the United States Army, the newly appointed Surgeon General, James Tilton, M.D., set about in 1813 to reorganize the service by drawing up a new set of duties and regulations for all army medical personnel. As part of that reorganization, on 2 May 1814, Tilton issued an order that, in retrospect, marked the first step in the eventual
establishment of a national network of weather observing stations (Hagarty 1962). Tilton directed the army medical corp to maintain a diary of weather conditions at army posts with responsibility for weather observations falling to the post's chief medical officer or surgeon. Tilton's objective was to learn more about the climate encountered by troops in the then sparsely populated interior of the continent. He also wanted to assess the relationship between weather and health for it was a popular notion at the time that weather and climate were important factors in the onset of disease.¹

It took time for Tilton's order to be implemented. The War of 1812 was still raging, and weather instruments had to be acquired and distributed along with directions for proper use. Benjamin Waterhouse, M.D., surgeon at Cambridge, Massachusetts, was the first to submit weather data (for March, 1816). By 1818, reports of weather observations at several army posts began trickling into the Surgeon General's office, and under the direction of Tilton's successor, Joseph Lovell, M.D., the data were compiled, summarized, and eventually published (Lawson 1840). For this reason Lovell rather than Tilton is sometimes credited with being the founder of the government's system of weather observation (Landsberg 1964).

At first, a thermometer and wind vane were the only weather instruments in use at the army posts. The chief medical officer or his assistant read the thermometer daily at 7 A.M., 2 P.M. and 9 P.M. (local sun time), and noted the day's prevailing wind direction and weather conditions. In a column labeled “remarks,” comments were entered concerning the health of the troops, phenological events, and any extreme or unusual weather. In 1836, many posts (including Fort Howard) were supplied with rain gages (DeWitt-type) along with very precise instructions on the proper siting and use of the instrument. Rainfall or melted snowfall was measured in inches (to 0.01 in.) at the end of each precipitation. Also beginning in 1836, prevailing wind direction and weather conditions were recorded for both morning and afternoon.

In 1842, the Army Medical Board, in consultation with some of the era's leading scientists, selected and issued new weather instruments along with revised and somewhat more sophisticated observation procedures (Mower 1844). These new procedures were adopted widely in January 1843 (1849 at Fort Howard), and except for observation times the instructions are similar to those issued to today's cooperative weather observers. Temperature, cloud cover (in tenths), and wind direction were recorded four times daily: at sunrise, 9 A.M., 3 P.M., and 9 P.M. The wet bulb thermometer was read at sunrise and 3 P.M., and at some army posts barometer readings also were recorded. Later, in 1855 the Surgeon General's Office shifted observation hours back to 7 A.M./2 P.M./9 P.M., convinced that these observation times gave a better estimate of daily mean temperature.

Medical personnel entered weather data in a journal each day, and quarterly summaries (January-March, April-June, July-September, and October-December) were prepared and then forwarded to the Army Medical Department in Washington, D.C. Tabulations of weather data from all army posts were later published as a series of Meteorological Registers (Lawson 1840, 1851, 1855).

By 1838, 16 army posts had compiled at least 10 complete—albeit not always successive—years of weather data. In ensuing years the number of military weather observing stations climbed steadily,

¹ Bates and Fuller (1986) point out that in wartime, even as late as World War I, more soldiers died from non-combat causes (disease, primarily) than from battle.
reaching 60 by 1843, and by the close of the Civil War, weather records had been assembled for varying periods at 143 locations. By the 1870s the Surgeon General’s weather network and those operated by the Smithsonian Institution and the U.S. Army Corps of Engineers were merged gradually into a single weather observation network within the Army Signal Corps. Eventually, this new network evolved into the present National Weather Service (Hughes 1980).

**Evaluating the Fort Howard Temperature Record**

Fort Howard’s weather record was among the earliest and most continuous in the Old Northwest (Table 1). The fort was one of several established just after the War of 1812, primarily to assert U.S. authority over the fur trade that had been long controlled by the British (Kellogg 1934). Fort Howard was erected in 1816-1817 on the low, swampy west bank of the Fox River very near the river’s mouth at Green Bay (Fig. 1). Earlier the same site was occupied by the French fort, St. François (1717-1760), and the British post, Fort Edward Augustus (1761-1763). Sometime in early 1820, troops were removed from the fort and temporarily garrisoned at Camp Smith, about 6 km up the Fox River. But by late 1821, Fort Howard was again reoccupied. Weather observations began 8 August 1821 and continued until 30 June 1841 when the garrison was withdrawn to Florida for service in the Seminole War and later to Texas to serve in the war with Mexico. With the end of hostilities in 1848, troops returned to Fort Howard, and weather observations resumed for a brief period. Weather records are continuous from 1 October 1849 through 31 May 1852, just prior to final troop withdrawal and abandonment of the fort on 8 June 1852.  

The Fort Howard weather record is likely the only weather data available for the early to mid-nineteenth century in the Green Bay area. Between 1852 and the beginning of U.S. Weather Bureau observations in the city on 1 September 1886, only sketchy weather data exist for Green Bay. How reliable then is the Fort Howard weather record, and is it reasonable to

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2 In 1863, the federal government ordered the sale of the Fort Howard military reservation. Although the fort was subsequently razed, several of the buildings remained in use for many decades. Today, visitors to Green Bay’s Heritage Hill State Park can view the original Fort Howard hospital (1834-1851) and reconstructed Surgeon’s Quarters (1834-1851). The buildings are situated on a hillside overlooking the Fox River about 6 km upriver of the original site of the fort.

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Table 1. Location and period of record of weather stations in the Old Northwest operated by the U.S. Army Medical Department

<table>
<thead>
<tr>
<th>Army Post</th>
<th>Present Name</th>
<th>Period of Record*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort Armstrong</td>
<td>Rock Island, Illinois</td>
<td>1824-1835</td>
</tr>
<tr>
<td>Fort Atkinson</td>
<td>Fort Atkinson, Iowa</td>
<td>1842-1846</td>
</tr>
<tr>
<td>Fort Brady</td>
<td>Sault Ste. Marie, Michigan</td>
<td>1823-1825, 1827-1828, 1830-1842 +</td>
</tr>
<tr>
<td>Council Bluffs</td>
<td>Omaha, Nebraska</td>
<td>1820-1825</td>
</tr>
<tr>
<td>Fort Crawford</td>
<td>Prairie du Chien, Wisconsin</td>
<td>1822, 1824-1825, 1829-1845</td>
</tr>
<tr>
<td>Fort Dearborn</td>
<td>Chicago, Illinois</td>
<td>1832-1836</td>
</tr>
<tr>
<td>Fort Howard</td>
<td>Green Bay, Wisconsin</td>
<td>1821-1841, 1849-1852</td>
</tr>
<tr>
<td>Fort Mackinac</td>
<td>Mackinac Island, Michigan</td>
<td>1826, 1831-1836, 1842 +</td>
</tr>
<tr>
<td>Fort Snelling</td>
<td>St. Paul, Minnesota</td>
<td>1819-1855</td>
</tr>
<tr>
<td>Fort Winnebago</td>
<td>Portage, Wisconsin</td>
<td>1829-1845</td>
</tr>
</tbody>
</table>

* Not necessarily complete years of data
Sources: Lawson, 1840, 1851; Miller, 1927
Fig. 1. Fort Howard was located near the mouth of the Fox River at Green Bay. When this map was published in 1833, army medical personnel at the fort had compiled almost 12 years of daily weather data. (North America Sheet V: The Northwest and Michigan Territories, 1833, Society for the Diffusion of Useful Knowledge. From the American Geographical Society Collection, University of Wisconsin-Milwaukee.)

draw comparisons between it and the modern climatic record of Green Bay?
This question is posed because of today's concern over the future course of climate and how variations in climate might affect society, a concern that has sent climatologists in search of an understanding of both how and why climate varies. Perhaps the most direct approach to determining this is to scrutinize closely the record of past climate because, after all, what has happened climatically can happen again. Unfortunately, in most places a reliable instrument-based record of past climate is limited to a little more than 100 years, and such record lengths simply may not encompass the full range of possible climatic variations. The lengthier and more detailed the view of the climatic past, the more data are available to aid in understanding how climate has varied and how it might vary in the future. The potential value, then, of the Fort Howard and other nineteenth-century weather records is evident.
Among the weather elements that constitute the Fort Howard weather record, temperature is the most convenient and perhaps most useful for drawing comparisons between the climate then and now. Except for the 1841-1849 hiatus when the fort was unoccupied, the pub-
lished Fort Howard temperature record is remarkably complete through the cumulative 22 years and 7 months of weather observations. Only five days within this period (27–31 December 1832) are missing temperature data. Focusing on the first episode of weather observations and eliminating 1832 as well as the incomplete years of 1821 and 1841, there are 18 years (1822–1831 and 1833–1840) for which monthly and annual mean temperature data are available for comparison with the modern National Weather Service temperature record at Green Bay. That comparison is made for a recent 18-year period (1968–1985) in Figure 2 and suggests that, except for autumn (September, October, and November) and April, recent years have been cooler than the 1820s and 1830s. Particularly anomalous is January with a temperature difference of − 5.9 °F. But just how realistic is this comparison? Several considerations bear on the integrity of the Fort Howard temperature record and hence, the validity of its comparison to modern climatic data. These considerations are (1) the accuracy, exposure, and location of the thermometer, (2) the method of computation of mean temperatures, and (3) the reliability of the weather observers.

Although we have no direct information on the thermometer at Fort Howard, we do have a description of the thermometer at Fort Snelling, a contemporary of Fort Howard, located near St. Paul, Minnesota. According to Ludlow (1968), William H. Keating, an explorer who
visited Fort Snelling in 1823, described the thermometer as "a glass tube attached to a brass plate, on which the graduation was marked" and which was made by "a Mr. Fisher of Philadelphia who sustains a high reputation as a manufacturer of that instrument." D. J. Warner, Curator of the History of Physical Sciences, The National Museum of American History, Smithsonian Institution, advises us (personal communication, 1986) that the Philadelphia city directories from 1793 to 1814 list Martin Fisher (1766–1826) as a thermometer maker. In 1816, he was joined by his son, Joseph Fisher (ca. 1795–1864), who continued the business until 1853. According to Warner, Fisher thermometers were "well regarded" although currently there are none in the museum’s collection.

It is reasonable to assume that at least during the 1820s and 1830s, the Army Medical Department supplied all army posts with the same model thermometer, that is, a Fisher thermometer. If this assumption is correct and if Fisher’s reputation as an instrument maker is justified, then we can also assume that Fort Howard’s thermometer was accurate. Resting on such indirect evidence, however, this assumption is necessarily tentative.

Since August 1949 official National Weather Service instruments for Green Bay have been located at Austin Straubel Airport. (Previously, they were at downtown sites.) The airport is situated in a rural area of gently rolling terrain about 10 km southwest of the Fort Howard site. All other factors being equal, the airport’s

Fig. 3. The waters of Green Bay likely moderated temperatures at Fort Howard on those days when regional winds were light or calm. But the Bay’s moderating influence probably had little effect on monthly and annual mean temperatures. (Lithograph courtesy of the State Historical Society of Wisconsin.)
higher elevation (208 meters above mean sea level) versus that of Fort Howard (178 meters above mean sea level) coupled with the airport’s greater distance from the moderating influence of the waters of Green Bay would favor a more continental climate at the airport (Fig. 3). (The more continental the climate, the greater is the contrast between summer and winter.) However, based on a comparison of contemporary temperature observations at the airport and at a site near the bay shore (the University of Wisconsin-Green Bay campus), the difference in continentality is insignificant in the time frame of months and years. On days when regional winds are light or calm, winter mornings typically are several degrees colder, and summer afternoons are a few degrees warmer at the airport. Nonetheless, there are only slight differences in monthly and annual mean temperatures. Since national weather observation practices were standardized in 1873 (year of the founding of the International Meteorological Organization, predecessor of the World Meteorological Organization), monthly mean temperatures have been computed by averaging daily mean temperatures, which in turn are derived by simply taking one-half the sum of the 24-hour maximum temperature and minimum temperature. However, thermometers that register maximum and minimum temperatures and that can be reset once every 24 hours were not in use by the Army Medical Department’s weather network (Forry 1842). At army posts, monthly mean temperatures were computed by averaging the mean temperatures obtained for each of the daily observations.

An estimate of the maximum error introduced by differences in the two averaging methods is based on a study by Baker (1975). Analyzing modern climatic data from St. Paul, Minnesota, Baker found that varying the time of day when the maximum/minimum thermometer is read and reset (that is, the observation hour) influences the daily mean temperature and hence, the monthly and annual mean temperatures as well. He noted variations of up to 1.7°F in annual mean temperature and up to 2.3°F in monthly mean temperature depending upon the specific hour of observation. Because observation hours at army posts were selected to catch the usual times of the day’s lowest temperature (near sunrise) and highest temperature (early afternoon), it appears likely that the actual error arising from the army’s averaging method would be less than that reported in Baker’s study. Indeed, it is likely that the two averaging methods do not produce statistically significant differences in computations of monthly and annual mean temperatures. This same conclusion was also reached by Wahl (1968) and Thaler (1979) in their respective analyses of the Fort Winnebago (near Portage, Wisconsin) and West Point (New York) nineteenth-century temperature records.

Any question regarding the reliability of Fort Howard’s weather observers is probably unwarranted. Although the army’s weather observers were not professional meteorologists, the Medical Department supplied them with very detailed instructions on how to take and record weather observations. There were great demands on the time and energy of medical personnel at Fort Howard (and other posts as well) because they were the only physicians within hundreds of kilometers and they tended to the medical needs of the nearby civilian population as well as those of the garrison (Kellogg 1934). It is therefore all the more extraordinary that they carried out their weather observing duties with skill and dedication as is evident from even a cursory examination of the original journals (The National Archives 1952). Of the 10 weather observers who served at Fort Howard between 1822
and 1840, some of course were more diligent than others in their contribution to the "remarks" section of the journal. William Beaumont, M.D. who served from July 1826 to March 1828, was particularly conscientious and often made very detailed notes on weather and health.

Hence, it is reasonable to assume that the Fort Howard weather observers and thermometer were reliable and that the slightly less continentality of the Fort Howard site and the difference in averaging methods would contribute only minor errors to any comparison between Fort Howard and Green Bay temperature records. A much more serious question concerns the exposure of the Fort Howard thermometer.

Instrument Exposure Problem

Today, National Weather Service instruments are housed in a standard white louvered shelter that provides adequate ventilation and protects weather instruments from exposure to precipitation and direct sunlight. Widespread use of instrument shelters dates only to the 1870s even at official meteorological stations. However, thermometers were usually suspended unprotected just outside a window—and not always a north-facing window. An earlier custom of mounting a

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1 Middleton (1966) reports that in North America the earliest account of a sheltered thermometer was at the Toronto Magnetic and Meteorological Observatory in 1841. The thermometer was in a louvered shelter mounted on the Observatory's north wall.
Fig. 5. Comparison of monthly and annual mean temperatures in °F for 1951–1980 at Portage and Green Bay. As expected, Green Bay is a colder locality than Portage.

thermometer indoors in an unheated room had been largely abandoned by the mid-1700s (Middleton 1966). Hence, based on the common practice of the day, chances are that the Fort Howard thermometer was outdoors and unsheltered (Miller 1931).

Studies of nineteenth-century weather records from Fort Winnebago, West Point, and Fort Snelling indicate that at times (diurnally and seasonally) thermometers were exposed to direct sunlight (Wahl 1968; Thaler 1979; Baker et al. 1985). This might well have been the case also at Fort Howard. Such exposure would introduce a major systematic error into the temperature record. Further complicating matters, however, is the possibility of undocumented changes in the exposure of the thermometer during the period of record.

Under ideal circumstances there would be other weather records from nearby localities covering the same period that could be used to corroborate the Fort Howard temperature record. Unfortunately, the nearest contemporary army post keeping weather records was Fort Winnebago, located about 150 km to the southwest of Fort Howard. For six complete years of available records (1835–1840) that overlap, Fort Howard was considerably warmer than Fort Winnebago—especially in winter (Fig. 4). However, a

* Because variations in climate are geographically nonuniform in both direction and magnitude, the farther apart two weather stations are situated the less meaningful is a comparison of their records.
comparison of modern climatic data from Green Bay and Portage indicates that Fort Howard should have been colder than Fort Winnebago (Fig. 5).

Going even farther afield (about 390 km west of Fort Howard), the Fort Snelling temperature record also suggests that temperature readings at Fort Howard were anomalously high. Baker et al. (1985), having the benefit of overlapping temperature records from nearby localities, were able to correct the Fort Snelling record for instrument exposure problems, and they produced a reasonably homogeneous temperature series for St. Paul for 1820–1982. A comparison of monthly and annual mean temperatures at Fort Snelling for 1822–1831 and 1833–1840 with that at St. Paul for 1968–1985 is shown as Figure 6. January is the only month that is cooler in the modern record. A comparison of Figure 6 for St. Paul/Fort Snelling with Figure 2 for Green Bay/Fort Howard supports the conclusion that temperature reports for Fort Howard were too high.

**Conclusion**

Of the many factors that could impinge on the integrity of the Fort Howard temperature record, improper instrument exposure may be the most significant. In fact, improper instrument exposure may well invalidate any comparison between Fort Howard’s temperature record and the modern temperature record at Green Bay. The value of the Fort Howard temperature record then is that it provides in-
sight on nineteenth-century weather observation practices and serves as a warning that early temperature records should be interpreted with caution. On the other hand, the Fort Howard weather logs include data other than temperature that may be useful in comparing the climate of then and now. Specifically, a comparison of the frequency of various weather types (e.g., snowfalls) might be a fruitful investigation.

Acknowledgments

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Works Cited


