7.7 CLIMATE DATABASE MODERNIZATION PROGRAM: PRE-20TH CENTURY TASK – KEY CLIMATE OBSERVATIONS RECORDED SINCE THE FOUNDING OF AMERICA, 1700'S – 1800'S

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1. INTRODUCTION

The U.S. Army forts recorded daily weather observations starting in the early 1800's. Many of these records continue into the mid-1800's. In the mid- to late 1800s, other volunteer observer networks were managed by the Smithsonian Institution and the U.S. Department of Agriculture. These station networks eventually evolved into the Weather Bureau's Cooperative Observer Network. The National Climatic Data Center (NCDC) holds these 1800's records on microfilm. As part of NCDC's Climate Database Modernization Program, these records have been scanned and indexed, and are available online to the research community. Researchers can request on-line access to particular data by following the procedures at: http://www.ncdc.noaa.gov/oa/climate/cdmp/wssrd.html.

Many of the daily records from these 1800's stations are being digitized. Approximately 160 priority stations (about 3 per state) have been selected for digitization, with more stations to be digitized as funding permits. Most of the data types recorded by the observers are being digitized. When completed, this digitized data set will allow for extension of the analysis of daily climate variables back into the 1800s and will provide a link between the more recent instrument records and paleoclimate records. Additional data sources are being located and added to this data periodically.

2. DEVELOPMENT OF STANDARD OBSERVING PRACTICES

Significant changes in instrumentation and observation practices occurred during the period covered by this data set. At the beginning of instrument observations, the temperature and other data types were observed several times a day, typically three, and occasionally up to six times a day at specified times ("at-hour" observations). Temperature was the most common data type observed in the early 1800's. Figure 1 shows a typical hand-drawn table of temperature, wind, and weather observations recorded by U.S. Army staff at Fort Armstrong (Rock Island), Illinois, in 1820.

Over time, additional instruments were added to weather stations, and more data types were recorded on standardized forms. By the mid-1800's, weather observations typically included precipitation, temperature, cloud cover and movement, wind direction and movement, barometric pressure, and dry- and wet-bulb temperatures, from which relative humidity was calculated. Figure 2a and 2b shows a typical standard printed form for volunteer observers to report weather observations to the Smithsonian Institution, with observations for Peoria, Illinois, in January, 1861. River gauge heights and surface water temperatures were also included in the standard set of data types observed for some stations in the 1880's.

With the development of the maximum/minimum thermometer, daily maximum and minimum temperature observations were added to the at-hour observations beginning in the 1870's. Eventually, the at-hour observations for temperatures were replaced by 24-hour observations, with few Cooperative Observer Network stations continuing at-hour observations after 1900.

The need for a more standard thermometer shelter was recognized in the mid-1800's. It took many years for a standard shelter to be developed and placed in use at all weather stations. In 1883, the Signal Office conducted a thermometer exposure survey of its weather stations, which is now preserved at the National Archives. The survey requested the observers to answer several questions in detail about the exact location of the thermometers and their surroundings. At this time, wood shelters were in use at some stations, although they were not of uniform construction (Chenoweth, 1993). Figure 3 shows a non-standard

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thermometer exposure typical for the time, with the thermometer attached to the back of a small wood building at the Signal Service station in Wellington, Kansas. Figure 4 shows a detailed sketch of a free-standing thermometer shelter at the Signal Service station in Fort Buford, Dakota Territory. The shelter is of wood construction, with a single-layer roof and blinds on the side, and open on the bottom, which is relatively close to the current standard. The sketch in Figure 5 shows the location of a free-standing thermometer shelter in the shade of a tree at the Signal Service station in Worthington, Indiana. The shelter is a small, shallow box, open in front, facing west, such that the sun may shine on the thermometers in the evening in the winter months. Figure 6 shows a building constructed specifically for the weather station in Peoria, Illinois, in 1906, with the thermometers located in a shelter near the building. By this time, most observing practices and instrumentation for daily weather stations had become standardized.

3. DATA AVAILABLE FOR DIGITIZATION

The approximately 160 priority stations include about three per state, for geographic coverage of the continental U.S. These stations include more than 50 with over 50 years of observations. Over 60 of the priority stations have at least 10 years of observations before 1850. Due to the large volume of data to be digitized for each station, about 20 stations will be completed during the first year of production digitization. As shown in Figure 7, these stations were selected for length and general coverage of the U.S.

Thirty-nine data types have been identified for digitization (Table 1). Many of these data types include observations for both 24-hour periods and periods less than 24 hours. For some stations, for example, the precipitation was recorded at three times per day. In all cases, the final digitized data set will include both 24-hour and less-than-24-hour observations, as recorded, to allow for the greatest research potential.

TABLE 1. Thirty-nine data types are to be digitzed from the 1800s daily weather observations.

Temperature: at-hour, maximum, minimum, daily mean, daily range, dry bulb, wet bulb, dew point, relative humidity.
Barometric Pressure: uncorrected, corrected for temperature, adjusted to sea level, temperature from attached thermometer.
Precipitation: total precipitation, melted snow, snowfall, snow depth, precipitation type (rain or snow), time of beginning, time of ending.
Wind: direction, velocity, force, maximum wind direction, maximum wind velocity, total wind movement.
Clouds: clearness of sky, cloud amount, type, direction, velocity.
State of the Weather.
Character of the Day.
River Gauge Height: gauge height, gauge height daily change.
Surface Water Temperature: surface air temperature, surface water temperature, bottom water temperature, depth to bottom.

5. METADATA

A comprehensive set of metadata is being developed to complement the data set. Some of the various standard forms used by the collecting organizations included a large variety of information about how the observations were made and recorded. Almost all forms and journals included the basic, necessary information about the station, including station name, latitude/longitude, elevation, and instruments in use. Some of the documents also included other, more detailed information, such as instrument make and model, barometer correction and other instrument adjustments, instrument exposure, and damage and replacement of instruments. Some standard forms have specific places for the observer to record this information, while in journals, the observers may have noted such information in the remarks.

A set of web-based metadata entry tools were developed specifically for this project, to manage the wide variety of information available while allowing for efficient entry of the metadata based on the manner in which it is presented on the forms. Since pulling up an image and becoming familiar with the information on it is relatively time-consuming, the metadata entry tools allow the keyers to systematically enter all information from the form. While looking at an image, the metadata keyers also enter information about each data element type recorded on the form. Preliminary keying of the daily data demonstrated that, since there are so many different forms used within this dataset, the greatest quality assurance challenge is to properly identify each data element type as it is keyed. In effect, the metadata keyers, who are trained meteorologists, produce a set of keying instructions for each image, which include the data element type list, for the daily data keyers, who are not trained meteorologists. The data element list is also used again in the quality assurance process after digitization of a station is completed.

4. DIGITIZATION AND QUALITY ASSURANCE

A series of quality control tests and procedures are being applied to the digitized data to assure the digitized data accurately represents the observations recorded on the original documents. The quality assurance includes double keying of the data to minimize keying errors and internal consistency checks and range checks on the monthly totals and means. The checks on the monthly totals and means help ensure that the data types are properly identified, particularly for temperature and precipitation. Internal consistency and extremes checks on individual values are also being applied to the data for each station. Suspect values will be flagged and will be retained in the data set.

Management of the various quality assurance tests is handled with a web-based tool to display values that fail the various tests and to record information about any corrections which are required. The tests must be applied sequentially to the data; for example, the data element types must be checked and any corrections made before internal consistency checks among the element types can be applied. In general, the issues with the quality of the daily data are more related to the observation techniques and general keying process, rather than to the keying of individual values. Double-keying minimizes keying errors in the individual values, while problems due to image quality, identification of observer habits, and non-standard observation practices remain challenges to identify.

6. ANALYSIS

Due to the changes in instrumentation and observation practices over time, as well as changes in the location of stations, it will not be possible to simply add the digitized data to the beginning of the more recent observations at the same stations. The metadata being digitized in this project will be useful for identifying the timing of potential changes in the daily data. The information gathered in a related pilot project funded through the Climate Database Modernization Program will also be helpful for analysis. In this project, detailed station history information for several stations with very long records is being gathered together, covering the beginning of record through the mid-1900's. The station histories may include records on everything from the precise siting of the instruments, with pictures, to the way of life and motivations of the observers.

Analysis will be necessary to determine the stability of changing observation techniques to a particular application. For example, Andsager and Angel (2000) examined biases between the 2 PM temperature and the daily maximum temperature to extend the analysis of heat wave days from about 1900 back to 1856 for several Illinois stations. The data may also be used in conjunction with proxy climate data; for example, Druckenbrod, et al. (2003) used tree-ring and meteorological diary reconstructions to examine the seasonality of precipitation from James Madison's era to the mid-1900's. When completed, the large number of data types included in this 1800's digitized data set will allow for extension of the analysis of a variety of daily climate variables back into the 1800's.

7. ACKNOWLEDGEMENTS

This project is funded through the Climate Database Modernization Program of the National Climatic Data Center. Any opinions, findings, and conclusions or recommendations expressed in this article are those of the authors and do not necessarily reflect the views of the National Climatic Data Center or the Illinois State Water Survey.

8. REFERENCES

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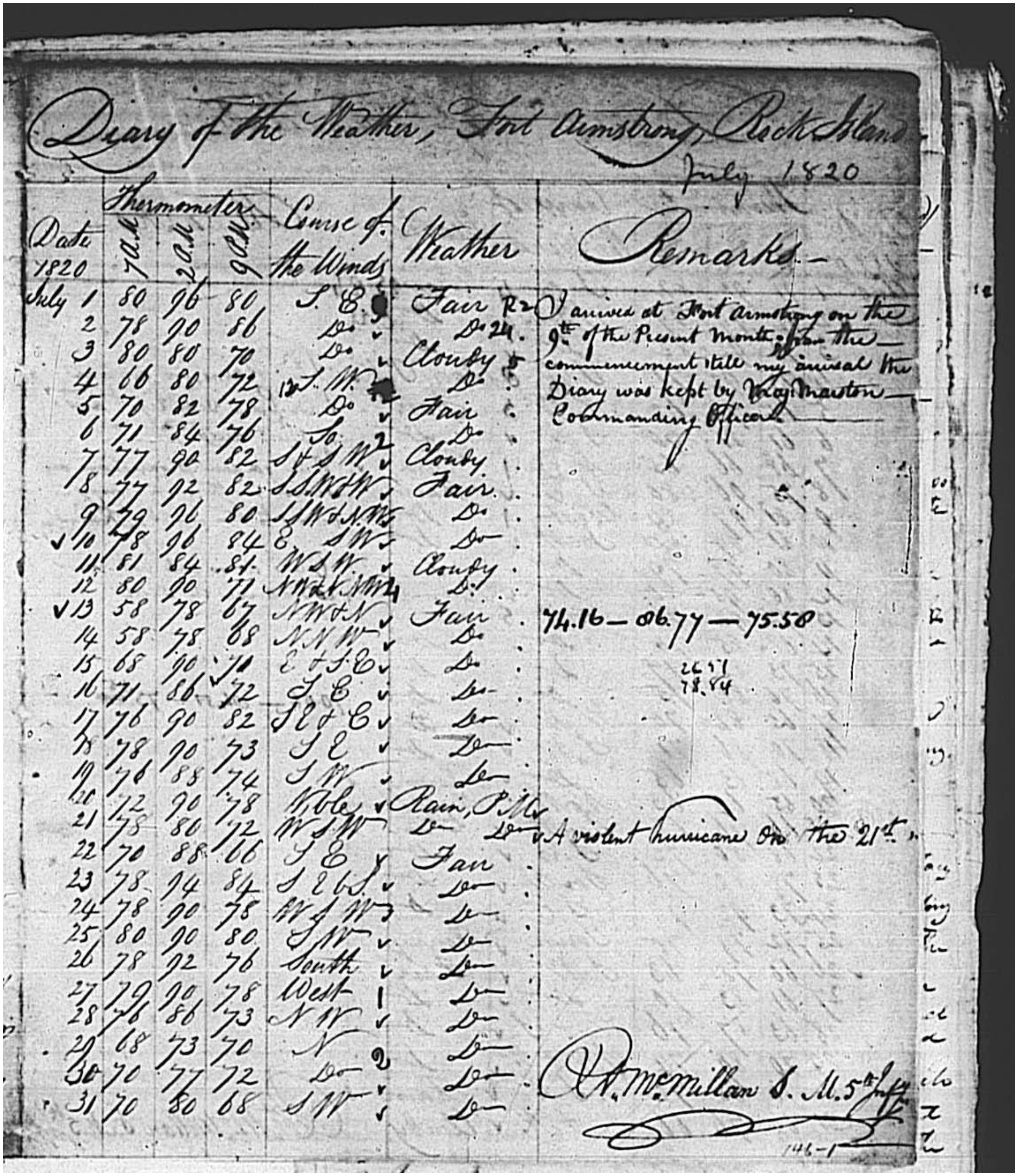
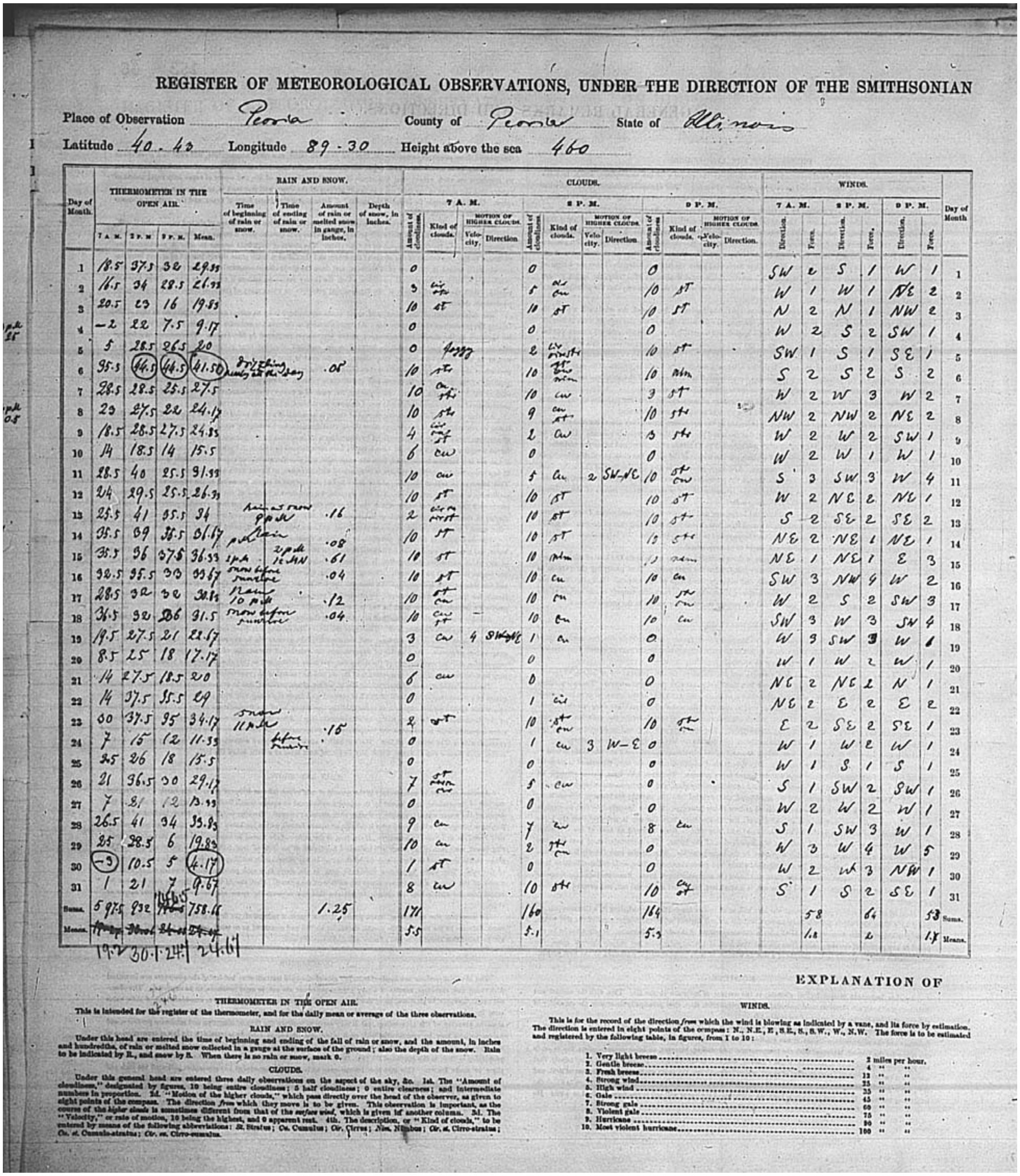


Diary of the Weather, Fort Armstrong, Rock Island
July 1820

Date 1820	Thermometer 7 A.M.	2 P.M.	9 P.M.	Course of the Winds	Weather	Remarks
July 1	80	96	80	S. E.	Fair	I arrived at Fort Armstrong on the 9th of the Present Month from the commencement still my arrival the Diary was kept by Maj. Marston Commanding Officer
2	78	90	86	Do	Do	
3	80	80	70	Do	Cloudy	
4	66	80	72	S. W.	Do	
5	70	82	78	Do	Fair	
6	71	84	76	So.	Do	
7	77	90	82	S & S W	Cloudy	
8	77	92	82	S S W & W	Fair	
9	79	96	80	S W & N W	Do	
10	78	96	84	E & S W	Do	
11	81	84	84	W S W	Cloudy	
12	80	90	71	N W & N W	Do	
13	58	78	67	N W & N	Fair	74.16 — 86.77 — 75.58
14	58	78	68	N N W	Do	
15	68	90	71	E & S E	Do	26.51 78.84
16	71	86	72	S E	Do	
17	76	90	82	S E & E	Do	
18	78	90	73	S E	Do	
19	76	88	74	S W	Do	
20	72	90	78	Noble	Rain, P.M.	
21	78	80	72	W S W	Do Do	A violent hurricane on the 21st.
22	70	88	66	S E	Fair	
23	78	94	84	S E b S	Do	
24	78	90	78	W S W	Do	
25	80	90	80	S W	Do	
26	78	92	76	South	Do	
27	79	90	78	West	Do	
28	76	86	73	N W	Do	
29	68	73	70	N	Do	
30	70	77	72	Do	Do	
31	70	80	68	S W	Do	R. A. McMillan S. M. 5th Infy

FIGURE 1. First month of record for Fort Armstrong (Rock Island), Illinois, in July, 1820. Common data types observed in the early 1800's included three times daily temperature, wind direction, and state of the weather. Also common were remarks, which for some observers were highly detailed.



REGISTER OF METEOROLOGICAL OBSERVATIONS, UNDER THE DIRECTION OF THE SMITHSONIAN

Place of Observation Peoria County of Peoria State of Illinois

Latitude 40.43 Longitude 89.30 Height above the sea 460

Day of Month	Thermometer 7 A.M.	Thermometer 2 P.M.	Thermometer 9 P.M.	Mean	Time of beginning of rain or snow	Time of ending of rain or snow	Amount of rain or melted snow in gauge, in inches	Depth of snow, in inches
1	18.5	37.5	32	29.33				
2	16.5	34	28.5	26.33				
3	20.5	23	16	19.83				
4	−2	22	7.5	9.17				
5	5	28.5	26.5	20				
6	35.5	44.5	44.5	41.50	Drizzling nearly all the day		.05	
7	28.5	28.5	25.5	27.5				
8	23	27.5	22	24.17				
9	18.5	28.5	27.5	24.83				
10	14	18.5	14	15.5				
11	28.5	40	25.5	31.33				
12	24	29.5	25.5	26.33				
13	25.5	41	35.5	34	Rain and snow 9 p.m.		.16	
14	35.5	39	35.5	31.67	p.m. Rain		.08	
15	35.5	36	37.5	36.33	1 p.m.	2 p.m. 12 MN	.61	
16	32.5	35.5	33	33.67	snow before sunrise		.04	
17	28.5	32	32	30.83	Rain 10 p.m.		.12	
18	36.5	32	26	31.5	snow before sunrise		.04	
19	19.5	27.5	21	22.67				
20	8.5	25	18	17.17				
21	14	27.5	18.5	20				
22	14	37.5	35.5	29				
23	30	37.5	35	34.17	snow 11 p.m.		.15	
24	7	15	12	11.33		before sunrise		
25	25	26	18	15.5				
26	21	36.5	30	29.17				
27	7	21	12	13.33				
28	26.5	41	34	33.83				
29	25	28.5	6	19.83				
30	−3	10.5	5	4.17				
31	1	21	7	9.67				
Sums	597.5	932	746.5	758.66			1.25	
Means	~~19.27~~ 19.2	~~30.06~~ 30.1	~~24.08~~ 24.1	~~24.47~~ 24.61				

Day of Month	7 A.M. Amount of cloudiness	Kind of clouds	Velocity	Direction	2 P.M. Amount of cloudiness	Kind of clouds	Velocity	Direction	9 P.M. Amount of cloudiness	Kind of clouds	Velocity	Direction
1	0				0				0			
2	3	cir st			5	cir cu			10	st		
3	10	st			10	st			10	st		
4	0				0				0			
5	0	foggy			2	cir cu st			10	st		
6	10	st			10	st nim			10	nim		
7	10	cu st			10	cu			3	st		
8	10	st			9	cu st			10	st		
9	4	cir st			2	cu			3	st		
10	6	cu			0				0			
11	10	cu			5	cu	2	SW–NE	10	st cu		
12	10	st			10	st			10	st		
13	2	cir cu st			10	st			10	st		
14	10	st			10	st			10	st		
15	10	st			10	nim			10	nim		
16	10	st			10	cu			10	cu		
17	10	st cu			10	cu			10	st cu		
18	10	cu st			10	cu			10	cu		
19	3	cu	4	SW–NE	1	cu			0			
20	0				0				0			
21	6	cu			0				0			
22	0				1	cir			0			
23	2	st			10	st cu			10	st cu		
24	0				1	cu	3	W–E	0			
25	0				0				0			
26	7	st cir cu			5	cu			0			
27	0				0				0			
28	9	cu			7	cu			8	cu		
29	10	cu			2	st cu			0			
30	1	st			0				0			
31	8	cu			10	st			10	cu st		
Sums	171				160				164			
Means	5.5				5.1				5.3			

Day of Month	Winds 7 A.M. Direction	Force	2 P.M. Direction	Force	9 P.M. Direction	Force
1	SW	2	S	1	W	1
2	W	1	W	1	NE	2
3	N	2	N	1	NW	2
4	W	2	S	2	SW	1
5	SW	1	S	1	SE	1
6	S	2	S	2	S	2
7	W	2	W	3	W	2
8	NW	2	NW	2	NE	2
9	W	2	W	2	SW	1
10	W	2	W	1	W	1
11	S	3	SW	3	W	4
12	W	2	NE	2	NE	1
13	S	2	SE	2	SE	2
14	NE	2	NE	1	NE	1
15	NE	1	NE	1	E	3
16	SW	3	NW	4	W	2
17	W	2	S	2	SW	3
18	SW	3	W	3	SW	4
19	W	3	SW	3	W	1
20	W	1	W	2	W	1
21	NE	2	NE	2	N	1
22	NE	2	E	2	E	2
23	E	2	SE	2	SE	1
24	W	1	W	2	W	1
25	W	1	S	1	S	1
26	S	1	SW	2	SW	1
27	W	2	W	2	W	1
28	S	1	SW	3	W	1
29	W	3	W	4	W	5
30	W	2	W	3	NW	1
31	S	1	S	2	SE	1
Sums		58		64		53
Means		1.8		2		1.7

EXPLANATION OF

THERMOMETER IN THE OPEN AIR.

This is intended for the register of the thermometer, and for the daily mean or average of the three observations.

RAIN AND SNOW.

Under this head are entered the time of beginning and ending of the fall of rain or snow, and the amount, in inches and hundredths, of rain or melted snow collected in a gauge at the surface of the ground; also the depth of the snow. Rain to be indicated by R., and snow by S. When there is no rain or snow, mark 0.

CLOUDS.

Under this general head are entered three daily observations on the aspect of the sky, &c. 1st. The "Amount of cloudiness," designated by figures, 10 being entire cloudiness; 5 half cloudiness; 0 entire clearness; and intermediate numbers in proportion. 2d. "Motion of the higher clouds," which pass directly over the head of the observer, as given to eight points of the compass. The direction *from* which they move is to be given. This observation is important, as the course of the higher clouds is sometimes different from that of the *surface wind*, which is given in another column. 3d. The "Velocity," or rate of motion, 10 being the highest, and 0 apparent rest. 4th. The description, or "Kind of clouds," to be entered by means of the following abbreviations: *St.* Stratus; *Cu.* Cumulus; *Cir.* Cirrus; *Nim.* Nimbus; *Cir. st.* Cirro-stratus; *Cu. st.* Cumulo-stratus; *Cir. cu.* Cirro-cumulus.

WINDS.

This is for the record of the direction *from* which the wind is blowing as indicated by a vane, and its force by estimation. The direction is entered in eight points of the compass: N., N.E., E., S.E., S., S.W., W., N.W. The force is to be estimated and registered by the following table, in figures, from 1 to 10:

1. Very light breeze .... 2 miles per hour.
2. Gentle breeze .... 4 "
3. Fresh breeze .... 12 "
4. Strong wind .... 25 "
5. High wind .... 35 "
6. Gale .... 45 "
7. Strong gale .... 60 "
8. Violent gale .... 75 "
9. Hurricane .... 90 "
10. Most violent hurricane .... 100 "

FIGURE 2a. Weather observations for Peoria, Illinois, for January, 1861, on the first of two pages of the standard form of the time for the volunteer observers reporting to the Smithsonian Institution. Common data types observed in the mid-1800's and recorded here include three times daily temperatures, precipitation, clouds, and wind.

INSTITUTION, ADOPTED BY THE COMMISSIONER OF PATENTS FOR HIS AGRICULTURAL REPORT. **(1)**

For the Month of January 1861

206 Name and address of Observer Frederick Brendel

Day of Month	Barometer 12: Observed Height 7 A.M.	2 P.M.	9 P.M.	Thermometer attached to Barometer 7 A.M.	2 P.M.	9 P.M.	Barometer height reduced to freezing point 7 A.M.	2 P.M.	9 P.M.	Mean
1	29.92	29.87	29.87	29	34	36	29.919	29.855	29.850	29.875
2	.79	73	80	37	39	44	29.768	29.702	29.759	29.743
3	82	78	83	38	39	38	29.795	29.752	29.805	29.784
4	88	92	93	32	33	32	29.871	29.908	29.921	29.900
5	91	87	86	28	30	34	29.911	29.866	29.845	29.874
6	635	52	42	37	41	45	29.613	29.487	29.377	29.492
7	60	68	78	45	45	43.5	29.556	29.636	29.740	29.644
8	82	81	80	41	41	42	29.787	29.777	29.764	29.776
9	70	625	54	38	40	41	29.675	29.595	29.507	29.592
10	74	82	80	35.5	38	38	29.722	29.795	29.775	29.764
11	48	43	70	35	38	38	29.463	29.405	29.675	29.514
12	73	78	85	39	40	41	29.702	29.750	29.817	29.756
13	80	69	66	40	41	44	29.770	29.657	29.616	29.681
14	60	56	60	43	45	46	29.562	29.516	29.554	29.544
15	50	36	21	45	46	46	29.456	29.315	29.165	29.312
16	20	38	70	46	45	46	29.155	29.337	29.654	29.982
17	77	78	69	43	44	44	29.732	29.739	29.649	29.707
18	20	29	50	42	43	43	29.165	29.252	29.562	29.326
19	64	70	80	41	42	41	29.607	29.664	29.767	29.679
20	77	83	90	35	37	38	29.753	29.808	29.875	29.812
21	90	92	30.03	32	36	37	29.891	29.900	30.007	29.933
22	30.00	95	29.90	35	37	41	29.982	29.928	29 867	29.926
23	29.79	66	60	40	44	45	29.760	29.619	29 556	29.645
24	58	62	78	41	42	38	29.547	29.584	29 755	29.629
25	77	74	80	30	33	36	29.766	29.728	29 780	29.758
26	70	65	64	34	38	41	29.685	29.625	29 607	29.639
27	70	74	79	39	40	39	29.672	29.710	29 762	29.715
28	54	45	55	35	37	41	29.523	29.428	29 517	29.489
29	68	70	89	40	46	41	29.650	29.654	29 857	29.720
30	30.035	30.030	30.00	31	31.5	32	30.028	30.022	29.991	30.013
31	29.88	29.76	29.55	27	30	34	29 884	29.756	29.535	29 725
Sums.							31×29 +28.370	31×29 +20.770	31×29 +28.911	31×29 +28.9[illegible]
Means.							29.690	29.670	29.708	21.329 29.689

Day of Month	Psychrometer, or Hygrometer: Dry Bulb 7 A.M.	2 P.M.	9 P.M.	Wet Bulb 7 A.M.	2 P.M.	9 P.M.	Force of 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.
1	18.5	37.5	32	17.5	34	30	.085	.150	.144	84.25	66.9	79.4
2	16.5	34	28.5	16.5	30	27.5	.092	121	139	100	61.7	88.5
3	20.5	23	16	20	22	16	102	107	090	92.6	86.4	100
4	−2	22	7.5	−2	21	7.5	039	101	060	100	86	100
5	5	28.5	26.5	5	26.5	26	055	120	.135	100	77.15	94
6	35.5	44.5	44.5	34.5	41	43	187	211	258	89.1	72	87.8
7	28.5	28.5	25.5	26.5	26.5	24	120	120	112	77.15	77.15	81.2
8	23	27.5	22	22	25.5	21	107	114	101	86.4	76.45	86
9	18.5	28.5	27.5	17.5	25	25.5	085	095	114	84.25	60.5	76.45
10	14	18.5	14	13	17.5	13	067	085	067	81.6	84.25	81.6
11	28.5	40	25.5	27.5	36.5	24	139	170	112	88.5	68.85	81.2
12	24	29.5	25.5	23	28.5	25	112	145	129	86.8	88.85	93.8
13	25.5	41	35.5	25	37	35	129	168	197	93.8	65.3	94.9
14	35.5	39	35.5	35.5	38.5	35.5	208	228	208	100	95.35	100
15	35.5	36	37.5	35.5	36	37.5	208	212	224	100	100	100
16	32.5	35.5	33	32	34	32	175	176	168	94.5	84.9	89.3
17	28.5	32	32	27	31	30	130	162	144	82.9	89.6	79.4
18	36.5	32	26	35.5	30	24	195	144	106	90.15	79.4	75.6
19	19.5	27.5	21	18.5	25.5	20.5	089	114	104	84.75	76.45	92.75
20	8.5	25	18	8.5	22	17.5	063	084	090	100	62.2	92
21	14	27.5	18.5	13.5	25	17.5	074	106	085	90.85	70.7	84.25
22	14	37.5	35.5	14	32	32	082	110	136	100	48.8	65.3
23	30	37.5	35	29	35	35	169	171	165	89	76.2	71.9
24	7	15	12	6.5	14	11	052	071	061	88.4	82.3	80.4
25	2.5	26	18	2.5	23	17	048	089	083	100	63.4	84
26	21	36.5	30	19.5	34	28.5	088	163	140	78.35	75.6	83.7
27	7	21	12	6.5	19	11	052	080	061	88.4	71.2	80.4
28	26.5	41	34	25	36.5	33	1181	158	175	81.8	61	89.5
29	25	28.5	6	22	26.5	5	089	120	043	63.4	77.1	76
30	−3	10.5	5	−3	9.5	4	038	056	042	100	79.4	75
31	1	21	7	1	19.5	5	045	088	032	100	78.35	53.8
Sums.	597.5	932	746.5	575	862	713.5	3.242	4.039	3.724	2707.71	2343.45	2617.95
Means.	19.27	30.06	24.08	18.55	27.8	23	.104	.130	.120	87	75	84

THE ABOVE COLUMNS.

29.689

BAROMETER.

Observed Height.—Under this head are entered the records of observations made on the barometer at three hours daily—7 a.m., 2 p.m., and 9 p.m.

Thermometer attached to Barometer.—Under this head are the records of the thermometer attached to the barometer, observations of which are necessary to correct the barometer for variations in height of the mercury on account of difference of temperature.

Barometer reduced to Freezing Point.—In this space are placed the figures which indicate the observations on the barometer reduced to the height of 32° Fahrenheit, by means of a table; and also the mean or average of the three reduced daily observations.

PSYCHROMETER, OR HYGROMETER.

Under this head are entered the records of the dry and wet-bulb thermometers, from which the "Force of Vapor" and "Relative Humidity" are obtained by means of tables.

FORCE OR PRESSURE OF VAPOR.

In this space are entered the numbers which indicate the inches of mercury of a barometer which the force of vapor of the atmosphere alone will sustain. The whole pressure of the atmosphere, as given under the head of "Barometer," is due, conjointly, to the weight of the air and the moisture which it contains. The figures under this table indicate the separate pressure of the moisture, and are obtained from the records of the wet and dry-bulb thermometers by means of a table based on experiment.

RELATIVE HUMIDITY, OR FRACTION OF SATURATION.

The quantity of water in a state of vapor which a given space can contain, depends on the temperature. When a given space has as much water as it can hold at a given temperature, it is said to be saturated with vapor. If the temperature be lowered, a portion of the vapor will be condensed into water, but the space will still be saturated. If the temperature be raised and no more vapor be admitted, the space will only be partially saturated. The numbers under the head of "Relative humidity" therefore denote the per-centage of saturation; full saturation being indicated by 1, and half saturation by 0.5. These figures are deduced from the corresponding forces of vapor by means of a table in the Smithsonian Collection.

[☞ SEE OTHER SIDE.]

Recd. Feb. 6. 1861. Entd.

FIGURE 2b. Second of two pages for weather observations for Peoria, Illinois, for January, 1861. Common data types recorded here include three-times-a-day information about pressure and relative humidity.

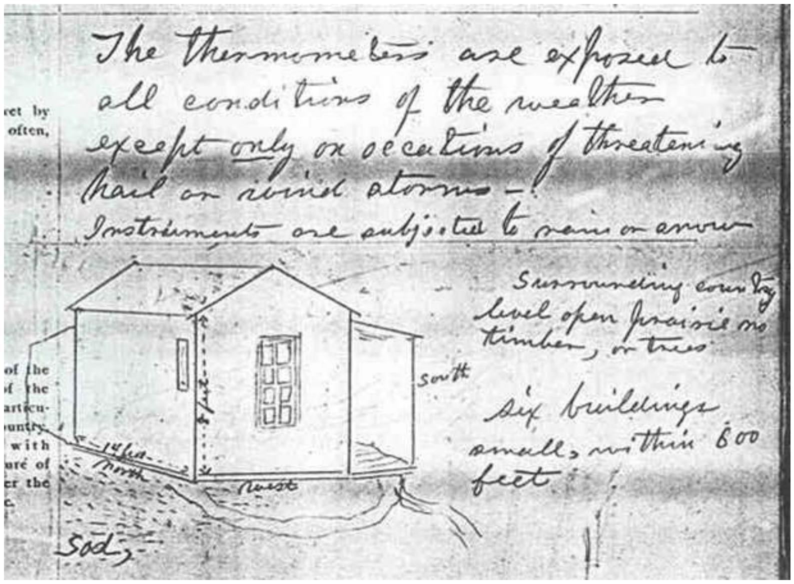


Figure 3. Stetch of thermometers attached to the back of a small wood building at the Signal Service station in Wellington, Kansas, in 1883 thermometer exposure survey. The text with the sketch describes the location and exposure of the thermometers as follows, "The thermometers are exposed to all conditions of the weather except <u>only</u> on occasions of threatening hail or wind storms – instruments are subjected to rain or snow. Surrounding country level open prairie, no timber, or trees. Six buildings small, within 600 feet." Note thermometers are attached to the north side of the building, over sod.

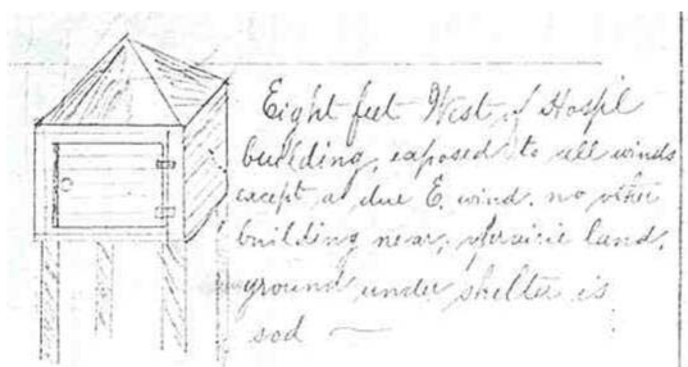


Figure 4. Sketch of free-standing thermometer shelter at the Signal Service station in Fort Buford, Dakota Territory, in 1883 thermometer exposure survey. The shelter is of wood construction, 2 ft by 3ft by 3 ft, with a single-layer roof and blinds on the side, and open on the bottom. The text with the sketch describes the location and exposure of the shelter as follows, "Eight feet west of Hospital building, exposed to all winds except a due E wind, no other building near, prairie land, ground under shelter is sod."

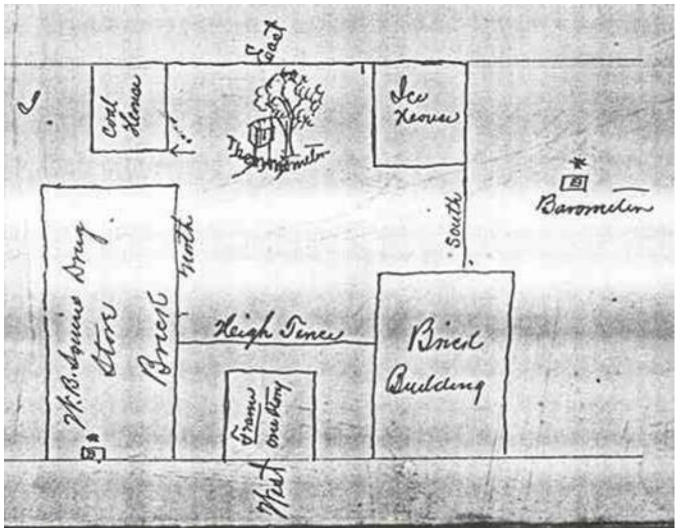


Figure 5. Sketch of free-standing thermometer shelter near a tree at the Signal Service station in Worthington, Indiana, in 1883 thermometer exposure survey. The shelter is a small, shallow box, open in front, three inches deep, and two feet long. The open side of the box faces west, and is always in the shade, except in the evening in November, December, and January. The shelter is between a coal house and an ice house in a yard behind the W. B. Squire Drug Store, a brick building. Another brick building and a frame building are also nearby. The barometer is located on the west wall inside the Drug Store.

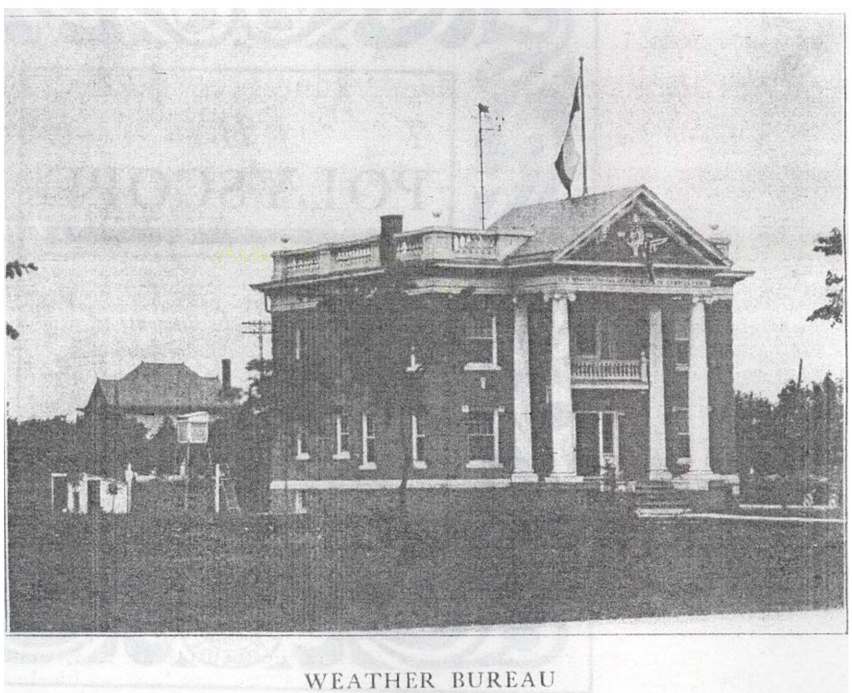


Figure 6. Photograph of the Weather Bureau observer's building on the campus of Bradley University in Peoria, Illinois, in 1906. The thermometer shelter is the small white box to the left of the building, in front of the building in the distance. There are stairs in front of the shelter for reaching the thermometers. The anemometer is located on the pole to the left in the picture, toward the center of the building's roof.

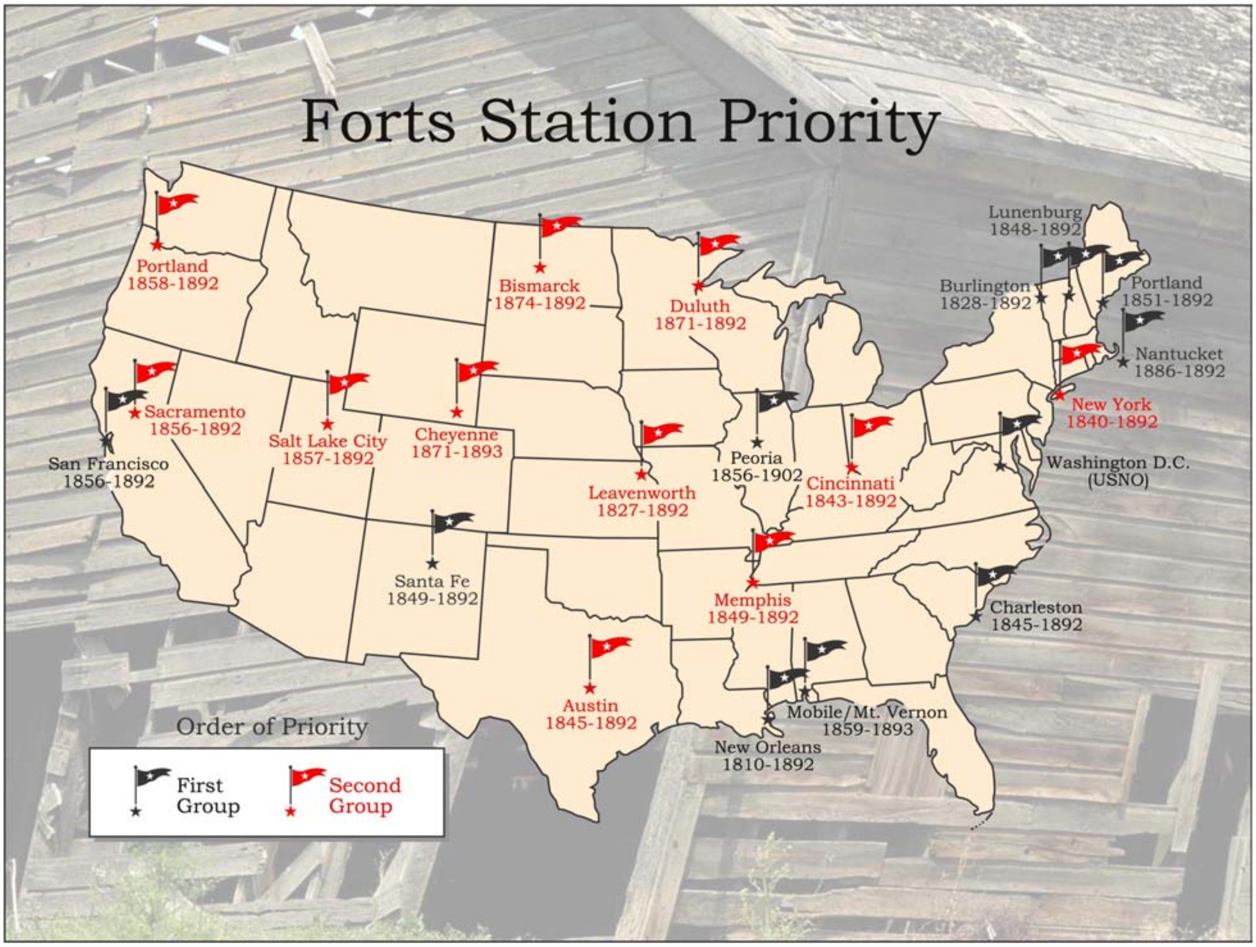


FIGURE 7. First-year priority stations to be digitized. These stations were selected for length and general coverage of the U.S.