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KEY TO METEOROLOGICAL RECORDS DOCUMENTATION

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HISTORY OF OBSERVATIONAL
INSTRUCTIONS AS APPLIED TO
TEMPERATURE RECORDINGS



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PURPOSE

The Key to Meteorological Records Documentation Series has been established to provide guidance information to research personnel making use of climatological data.

Frequently users of such data have found it necessary to spend a great deal of time establishing whether the criteria for observing or computing various elements have changed over the period of record.

It is therefore hoped that the presentation of this series may not only conserve valuable time but may have a direct influence in improving the accuracy of research results.

PREFACE

Historical changes in corrections and procedures for recording temperatures as found in this annotation will apply only to the nonrecording liquid-in-glass instruments. All corrections are based upon scale error and have been obtained from various instructions issued by the Weather Bureau over a period of years. The changes are presented in sequence of their occurrence and identified by year of publication. Each section has been closed with a resume, briefly summing up past changes to date (1957).

No attempt is made to describe the specifications for the exposure of temperature sensing elements. The users of temperature data should examine the station record to determine changes in the exposure and environment of the thermoscreen which may have affected the readings. A paper describing the types of thermoscreens used, the characteristics and the history of use of each, is being planned. This paper will also give a history of the specifications for the exposure of thermoscreens.

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HISTORY OF TEMPERATURE CORRECTIONS

An early history of the thermometric standard, accepted by the Weather Bureau, was presented by Professor Cleveland Abbe in one of his papers on instrumental corrections. It seems fitting at this time to restate some of this history as a prelude to the instructions on thermometric recordings, issued by the Weather Bureau, over the past half century.

In the beginning (about 1881) the standard was the accepted air thermometer of constant volume and was identical within 0.02°C . or 0.05°F . with the standard of the International Bureau of Weights and Measures at Paris. The thermometers issued were carefully compared at each ten-degree point, with corrections determined to one tenth of a degree F. On January 1, 1888 it was decided in view of the fact that no thermometer was issued whose correction exceeded one-half of a degree, that scale corrections be neglected when they were 0.3 or less. However, Prof. Abbe noted that records he presented for 1891-92 had an uncertainty, due to scale errors that may be assumed as equal to the average amount of these neglected corrections plus the secular rise of the zero point, plus an additional uncertainty whenever the temperatures have exceeded or fallen below the range for which the thermometers had been accurately investigated; i.e., below -28° and 112° . Under the above system he computed a correction to be applied to cancel out the uncertainty due to scale error. These corrections were for the dry and wet bulbs ± 0.2 ; for the maximum thermometers ± 0.2 ; for the minimum thermometers $+ 0.4$; the plus correction for the minimum thermometer increases as the temperature falls, since the alcohol has less time to drain downwards.

At present all thermometers purchased by the Weather Bureau are inspected and tested to conformance specification against a "certified" thermometer issued by the National Bureau of Standards. These "certified" thermometers are used as the standard for determining scale corrections to thermometers received from the manufacturer.

Thermometers having an error greater than 0.3°F . above 0° and 0.5° below 0° for mercury-filled thermometers and 0.4°F . above 0° , 1.0° between 0° and -50° , 1.5° below -50° for spirit thermometers are not accepted by the Weather Bureau.

INSTRUMENTATION

Instruments in general use by the Weather Bureau for temperature purposes can be classified as follows:

Nonrecording:

1. Liquid in glass:

- a. Current temperature
- b. Psychrometer
- c. Maximum
- d. Minimum

2. Electrical resistance:

- a. Telethermoscope
- b. Telethermometer
- c. Telepsychrometer

Recording:

1. Thermograph
2. Telepsychrometer

INSTRUMENT CORRECTIONS

1894 - Instrumental corrections will not be applied to thermometer readings, except when they are ± 0.3 or more in the case of mercurial thermometers and ± 0.5 or more in the case of minimum or alcohol thermometers.

1905 - Instrumental corrections will not be applied to thermometer readings except when they are ± 0.3 or more in the case of mercurial thermometers and ± 0.5 or more in the case of minimum or alcohol thermometers, or at temperatures of 42° or lower; and when the wet thermometer

reads higher than the dry, then all corrections will be applied to the reading of the dry and wet-bulb thermometers.

1935 - Instrumental corrections will not be applied to thermometer readings except when they are ± 0.3 or more in the case of mercurial thermometers and ± 0.5 or more in the case of alcohol thermometers, except when the temperature is 32° or lower; and except when the wet thermometer reads higher than the dry, then all corrections will be applied to the readings of the dry and wet-bulb thermometers.

1939 - Instrumental corrections will not be applied to thermometer readings except when they are ± 0.3 or more in the case of mercurial thermometers; and ± 0.5 or more in the case of minimum or alcohol thermometers; except when the temperature is 42° lower; and except when the wet thermometer reads higher than the dry, then all corrections will be applied to the readings of the dry and wet-bulb thermometers.

1944 - Instrumental corrections will be applied to a thermometer reading whenever the indicated reading is above 42° and the instrument correction is ± 0.3 or more in the case of mercurial thermometers and ± 0.5 or more in the case of alcohol thermometers; whenever the temperature is below 42° ; and in all cases when the wet thermometer reads higher than the dry.

1949 - Corrections will be applied to all thermometer readings under conditions (1) and (2). An additional correction factor will be applied to all wet-bulb thermometer readings under conditions (3).

1. Whenever the temperature indicated by the thermometer is above 42° F. and the instrumental correction is $\pm 0.3^\circ$ F or more in the case of mercurial thermometers or $\pm 0.5^\circ$ F or more in the case of spirit-filled thermometers.

2. Whenever the temperature indicated by the thermometer is 42° F. or less.

3. Whenever the wet-bulb thermometer has an indicated reading higher than that of the dry bulb. If the reading of the wet-bulb thermometer, after the correction has been applied, remains higher than the dry-bulb reading, disregard it and use the dry-bulb value for both temperatures.

Resume:

The first mention of corrections to thermometers appears in the 1894 instructions. Corrections were to be applied to thermometer readings only when $\pm 0.3^\circ$ F or more. These corrections remained unchanged until 1905, when two additional cases where corrections should be applied were specified. These were:

*1. Whenever temperatures are 42° F. or lower.

2. Whenever the wet reads higher than the dry, in which case all corrections will be applied to the readings of the dry and wet thermometers. (In 1949 instructions stated that if the readings of the wet-bulb, after the correction has been applied, remains higher than the dry-bulb reading, it should be disregarded and the dry-bulb used for both temperatures).

These instructions remain in effect at the present time (1957).

INSTRUCTIONS FOR TIME OF READING OF MAXIMUM & MINIMUM TEMPERATURES

Instructions were first noted in 1897 pertaining to the recording of maximum and minimum temperatures as follows:

1897 - The maximum temperature for the day will be taken from the 8 p.m. observation except under the following conditions:

(1) The maximum recorded at 8 a.m. LST next day will be used when it is higher than the maximum at 8 p.m. and is believed to have occurred before midnight.

* From 1935 thru 1938 this value was set at 32° F. In 1939 it was changed back to 42° F. (Note: Corrections are not used by substation observers and may not have been applied by all first order stations.)

(2) Maximum recorded at the preceding 8 a.m. observation will be used when it is believed to have occurred after midnight, and is higher than any temperature recorded after 8 a.m. of that day.

(3) When the thermograph shows that the highest temperature during the day occurred between 8 p.m. and midnight and the temperature rose still higher after midnight, or when the thermograph shows that the maximum temperature for the day occurred between midnight and 8 a.m., and the temperature was still higher between 8 p.m. and midnight of the preceding day, the maximum for the day will be taken from the corrected thermograph reading with an explanatory note.

The minimum temperature will be taken from the 8 a.m. observation except under the following conditions:

(1) When the lower minimum is recorded at 8 p.m. it will be used.

(2) When the minimum recorded at the following 8 a.m. observation is lower than that recorded during the preceding day, and it is believed to have occurred before midnight, it will be used.

(3) When the minimum recorded at 8 a.m. of the current day is believed to have occurred before midnight, the minimum for the day will be taken from the 8 p.m. observation, unless example (2) requires it to be taken from the following 8 a.m. observation.

(4) From the corrected thermograph reading. When the minimum is from the thermograph it must not be lower than the reading of the minimum for the same period.

1904 - At stations without thermographs the maximum for the day will be taken from the 8 p.m. observation except when:

(1) The maximum at 8 a.m. next day will be used when it is higher than maximum at 8 p.m. and is believed to have occurred before midnight.

(2) The maximum recorded at the preceding 8 a.m. observation will be used when it is believed to have occurred after midnight and is higher than any temperature recorded after 8 a.m. of that day.

At stations having thermographs, maximum and minimum will be taken from the trace corrected at 8 a.m. and 8 p.m., at times of occurrence of daily extremes, and whenever other eye readings are made.

At stations without thermograph the minimum for the day will be taken from the 8 a.m. observation except:

(1) When a lower minimum is recorded at 8 p.m. it will be used.

(2) When the minimum recorded at the following 8 a.m. observation is lower than that recorded during the preceding day, and is believed to have occurred before midnight, it will be used.

(3) When the minimum recorded at 8 a.m. of the current day is believed to have occurred before midnight, the minimum temperature will be taken from the 8 p.m. observation unless example No. 2 requires it to be taken from the following 8 a.m. observation:

1906 - At stations having thermograph, the maximum and minimum temperatures will be taken from the thermograph trace sheets, corrected at the time of the a.m. and p.m. regular observations, at the times of occurrence of the temperatures registered by the maximum and minimum thermometers, and whenever other eye readings are made.

1907 - At stations without thermographs the maximum for the day will be taken from the p.m. observation except when (1) the maximum temperature recorded at the a.m. observation of the next day will be used when it is higher than the maximum at the p.m. observation, and is believed to have occurred before midnight.

(2) The maximum recorded at the preceding a.m. observation will be used when it is believed to have occurred after midnight, and is higher than any temperature recorded after the a.m. observation of that day.

The maximum of any day must be as high as the minimum of the preceding day. At stations having a thermograph, the maximum and minimum temperatures will be taken from the maximum and minimum readings except when the true maximum or minimum for the day, mid-mid, can not be thus obtained, in which event it will be obtained from the corrected thermograph trace.

1944 - The maximum and minimum temperature will be for the 24-hour period from mid-mid at stations equipped with recording instruments; otherwise from the 1:30 A to 1:30 EST observations. In the latter case appropriate reference notes should be entered.

1948 - Maximum and minimum temperature will be for the 24-hour period from midnight to midnight.

Daily entries should be for the period mid-mid LST except that where a midnight observation is not taken, and autographic equipment is not in use, enter a note in remarks to indicate the observational period (e.g., "temperature data for period 1630C to 1630C").

Resume:

In general the period used for maximum and minimum temperatures has been midnight-midnight, Local Standard Time.

At stations without thermographs, rather detailed instructions in the earlier years specified how to obtain readings on a midnight to midnight basis. In recent years these were modified to permit use of observational periods, with an explanatory reference note such as 1630C - 1630C".

Note: The foregoing does not apply to substations. At those stations thermometers were usually set at the time of the once daily climatological observations, either in the morning or in the evening.

INSTRUCTIONS ON READING OF THERMOMETERS TO TENTHS

1896 - All thermometers (except attached thermometers to the barometers) must be read, and readings recorded to the nearest tenth of a degree.

Note: No earlier instructions appeared, although in January 1891, original records for Block Island indicate that observations of dry, wet, maximum, and minimum temperatures were recorded to tenths.

1952 - Effective July 1, 1952 (Change No. 3 of Circular N) instructions were changed to provide that all thermometers be read to the nearest tenth, but that maximum and minimum readings would be recorded only to whole degrees.

Resume:

The earliest Weather Bureau instruction on this subject was in 1896 Instructions which stated all thermometers (except the attached thermometer to the barometer) must be read, and readings recorded to the nearest tenth of a degree.

This instruction continued unchanged until July 1, 1952 when it was changed to provided that all thermometers be read to the nearest tenth, but that maximum and minimum readings would be recorded only to whole degrees. This practice remains in effect at the present (1957).

Note: Thermometers at substations were read to whole numbers.

HISTORY OF INSTRUCTIONS FOR TIMES OF SETTING OF
MAXIMUM AND MINIMUM THERMOMETERS

1891 - The maximum thermometer will be set at 8 a.m.; the minimum at 8 p.m.

1897 - Maximum and minimum thermometers will be set both at 8 a.m. and 8 p.m. They will not be set when taking special observations.

1906 - Maximum and minimum thermometers will be set both at the a.m. and p.m. regular observations. They will not be set both at 8 a.m. and 8 p.m. They will not be set when taking special observations. They will not be set when taking special observations

1938 - Maximum and minimum thermometers will be set both at the a.m. and p.m. regular observations. They will not be set when taking special or 1:30 a.m. and p.m. observations.

Note: In 1939, instructions were amended by an item on page 156 of Topics for January 1939, to provide that they be set at 1:30 and 7:30 a.m. and p.m., effective March 1, 1939.

1944 - Maximum and minimum thermometers will be set only at 6-hourly observations.

Note: About July 1, 1948 instructions were changed to provide for setting at midnight observations as well as at 6 hourly.

1951 - Reset the maximum thermometer at each synoptic and midnight observation. Reset the minimum thermometer at each synoptic and midnight observation.

Resume:

From 1891 - 1896 the maximum thermometer was set at 8 a.m. and the minimum at 8 p.m. E.S.T.

From 1897 through 1937 instructions stated that maximum and minimum thermometers should be set at both the a.m. and p.m. observations; but not at special observations.

In 1938 instructions were not to set maximum and minimum thermometers at special or 1:30 a.m. and 1:30 p.m. E.S.T. observations.

Effective 1 March 1, 1939 instructions were changed to provide for setting of the thermometers at 1:30 and 7:30 a.m. and p.m. E.S.T. observations.

About July 1, 1948 instructions provided for setting at the midnight observation, as well as the six hourly, (1:30 and 7:30 a.m. and p.m. E.S.T.)

Thses instructions remain in effect at the present time (1957).