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SINCLAIR WEEKS, Secretary
U.S. WEATHER BUREAU
F. W. REICHELDERFER, Chief

KEY TO METEOROLOGICAL RECORDS DOCUMENTATION NO. 3.12

HISTORY OF OBSERVATIONAL INSTRUCTIONS AS APPLIED TO THUNDERSTORMS

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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 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.

GENERAL PREFACE

This documentation has been prepared to illustrate changes to instructions that have occurred over the period of record 1891 to 1957. The history of changes is based upon instructions on USWB Forms 1001, 1130 Aer., and to the various WBAN-10 Forms. These instructions were found to be most nearly complete from a documentation viewpoint with respect to the history of observing thunderstorms. The "Original Monthly Record of Observations" Form 1001, has a period of record commencing with the beginning of Weather Bureau records in 1891 to 1948; the 1130 Aer., 1928-1944; followed by the current WBAN-10 series with their instructions published as a part of Circular N.

Instructions for observing and recording thunderstorms contained with Form 1001 were presented under the headings of Precipitation, Weather, and Footings and Summary through 1944. These same headings were continued in this summary both as a convenience and as a rapid reference to the original instructions.

On the following pages an attempt has been made to present a chronological sequence of significant changes that have occurred with respect to one element: Thunderstorms.

M. Baliles
Office of Climatology

PART I - HISTORY OF INSTRUCTIONS FOR RECORDING THUNDERSTORMS IN THE SYNOPTIC OBSERVATIONS

USWB FORM 1001

1891 - Weather:

When a thunderstorm is in progress, or threatening conditions exist over a station with no rain, state of weather will be recorded as "cloudy", with "threatening" written immediately after or indicated by International Symbol.

When a thunderstorm is prevailing at the moment of observation, or the rain is still falling, although neither thunder has been heard nor lightning seen for one hour previous to the observation, the International Symbol for thunderstorm will be entered after "State of Weather" and in the same column, and also once for the entire month as a reference mark on the margin.

1893 - Footings and Summary:

A day with thunderstorm is one on which thunder is distinctly heard at the station during the day whether or not lightning is seen or rain falls at the station.

Weather - Same as 1891

1904 - Precipitation:

When a thunderstorm occurs the international symbol for thunderstorm will be entered in the column for beginning of precipitation.

Weather:

When a thunderstorm is prevailing at the moment of observation, or the rain is still falling, although neither thunder has been heard nor lightning seen for one hour previous to the observation, the international symbol for thunderstorm will be entered after "State of Weather."

Footings and Summary:

A day with thunderstorm is one on which thunder is distinctly heard at the station whether or not lightning is seen or rain falls at the station.

1905 - Precipitation:

When a thunderstorm occurs the international symbol for thunderstorm will be entered on the right hand margin of page 8.

Weather:

Same as 1904.

Footings and Summary:

Same as 1904.

1906 - Precipitation

When a thunderstorm occurs the international symbol for thunderstorm  will be entered on the right-hand margin of page 8 on each day, midnight to midnight, standard of time in local use, on which thunder was heard.

Weather:

Same as 1904

1921 - Weather:

When a thunderstorm is prevailing at the moment of observation, or the rain is still falling, and thunder has been heard or lightning seen within the hour previous to the observation, the international symbol for thunderstorm will be entered after "State of Weather."

Precipitation:

Same as 1906.

Footings and Summary:

Same as 1904.

1936 - Precipitation

Beginning January 1, 1936, the following symbols for thunderstorms will be entered in the right hand margin of page 8, Form 1001; for a thunderstorm at the station (thunder, lightning, and rainfall), ⚡ ; for a thunderstorm heard or observed, but not actually occurring at the station (a distant thunderstorm), ⚡ ; for lightning observed, but thunder not heard (distant lightning), ↯

Weather:

Same as 1921.

Footings and Summary:

Same as 1904.

1938 - Footings and Summary:

A day with thunderstorm is one on which thunder is distinctly heard at the station, whether or not lightning is seen or rain falls at the station, or a thunderstorm heard or observed, but not actually occurring at the station (a distant thunderstorm).

Weather:

Same as 1921

Precipitation:

Same as 1936

1945-48 - Summary of Temperature and Precipitation:

Enter a thunderstorm symbol and/or a distant lightning symbol in the proper column when observed in the 24-hour period from midnight to midnight.

Meteorological Summary:

Thunderstorm - A day with a thunderstorm is one in which thunder is heard.

Distant Lightning:

A day with distant lightning is one on which lightning is seen, but no thunder is heard on account of distance. When distant lightning is observed and thunder is later heard from the same storm, it then becomes a "thunderstorm" and should not be listed as "Distant Lightning".

Form 1001 discontinued at the end of 1948.

USWB FORM 1001C - 733-1

1949 - Station Meteorological Summary:

Enter "T" for thunderstorm or "DL" for distant lightning when observed during the period from midnight to midnight. Do not enter more than one T or DL for a day. Enter DL only if thunder is not heard, except that if lightning occurs before midnight and thunder is heard after midnight, enter DL for the first day and T for the following. Similarly, if thunder occurs before midnight and lightning after midnight, enter T for the first day and DL for the following day. Enter both T and DL if lightning only is observed in one storm, and thunder is heard from another.

NOTE: Prior to 1893, it was the practice of the Weather Bureau to record a day with thunderstorms only if it was accompanied by rain. This was an interpretation on existing instructions. W. J. Humphrey's, Physics of the Air, 1940, Chapter XVII, has noted that this change in regulations was responsible for a phenomenal increase in the annual number of thunderstorms reported in the United States after 1893. Accepted tabulations of thunderstorm frequencies, such as W.H. Alexander's, Distribution of Thunderstorms in the United States., MWR 43, 52, and 63 rejected the earlier periods of record and even the decade of transition prior to 1904 for this reason.

PREFACE - PART II

While instructions for recording synoptic data have remained basically the same over a period of years, the same instructions were unsuited for airways observations. Accumulated experience and safety to air travel demanded a more specific type of observation based upon the needs of aviation.

As a means to accomplish the above and as an aid to the observer, new instructions were written, setting forth certain criteria and rules governing the taking of airways observations. These instructions were first published as "Instructions for Airways Observers", Circular N. 1928, by the United States Weather Bureau.

Thunderstorms were classified as to intensity and given a position of first importance in the General Conditions portion of the airways observation. Excerpts pertaining to the observation of thunderstorms will follow chronologically, again with the endeavor to present an orderly sequence of changes in instructions and procedures.

PART II - HISTORY OF INSTRUCTIONS FOR RECORDING OF THUNDERSTORMS FOR THE AIRWAYS OBSERVATION

FORM 1130 AER.

1928 - Circular N (1st Edition) Airway Observations:

Thunderstorms will be entered in the General Condition column giving direction of thunderstorm in reference to the station; i.e. thunderstorm to the N.W., thunderstorm at station, etc.

1932 - Circular N - Airway Observations:

(a) Lightning - Reported under "Remarks" together with its direction from the reporting station.

(b) Thunder - Reported under "Remarks" together with its direction from the reporting station.

(c) Thunderstorm - The presence of thunderstorms will be reported as a weather element and included in the General Conditions Column, when actually occurring at the station, or in such close proximity as to constitute a dominating element in the weather at that time; e.g. overcast, thunderstorm approaching from the west; overcast, violent thunderstorm, severe lightning, hail, and rain squalls.

When not falling in the foregoing classification; i.e., when observed at some distance or having passed over the station, and thus not constituting a dominating condition, they will be reported under "Remarks". For example: Thunderstorm in distant southwest; mild thunderstorm passed to north half hour ago.

(note): This is the first recognition of the thunderstorm as a weather element in the airways observation.

1935 - Circular N:

Thunderstorms shall be reported as the first element under "weather" when occurring at the station or in such close proximity thereto as to consitute a dominating element in the weather at the station at the time; otherwise they will be reported under "Remarks". If approaching the station, the direction from which it is approaching will be given under "Remarks" in all cases. A thunderstorm is considered to be in progress whenever lightning, if observed in close proximity to the station, or thunder, is heard.

Thunderstorms will be reported in the following three degrees:

(1) Mild Thunderstorm: When most of the lightning occurs within the cloud; the rainfall accompanying it is only light or moderate; no hail occurs; the wind occurring at the beginning of the storm, if any, does not exceed 25 to 30 miles an hour and is of short duration 3-5 minutes at most.

(2) Moderate Thunderstorm: When fairly frequent flashes of lightning occur between the cloud and ground, as well as cloud to cloud; loud peals of thunder occur; moderate to heavy rain occurs; an on-rush of wind may precede the storm, reaching velocities 40 MPH; light or moderate hail may occur; the storm is distinctly recognizable as well-developed.

(3) Severe Thunderstorms: When nearly incessant, sharp thunder and lightning occur; heavy rain occurs, possibly accompanied by moderate or heavy hail; wind preceding the storm may reach velocities in excess of 40 MPH and continues over a considerable time, as much as 15 minutes; a rapid drop in temperature, possibly as much as 20° in 5 minutes.

The "weather" element of the report is indicated, when appropriate, by the following symbols:

T Mild thunderstorm
T- Moderate Thunderstorm
T+ Severe Thunderstorm

Criteria for Special Observations: A thunderstorm not previously reported is observed or occurs, or one previously reported shows marked increase in intensity.

1939 - Circular N - Airways Observations: Rules for reporting thunderstorms: Any thunderstorm in progress at time of observation shall be reported as the first element under "weather" except when a tornado is also observable from or occurring at or near the station, in which case the tornado will be reported before any thunderstorm. A thunderstorm is considered to be "in progress at the time of observation," if thunder is heard or has been heard within 15 minutes preceding the time of that observation.

It is proper and desirable that under "Remarks" there shall appear information concerning the thunderstorm which will complete the word picture already partly drawn by the elements of ceiling, sky, visibility, etc., but such remarks shall be in addition and not in lieu of the report of thunderstorm under "weather". If the thunder is but slightly audible and the thunderstorm, therefore, fairly distant from the station, a remark, such as "Thunder distant southwest", should be made if the thunderstorm is marked by a limited area of dark clouds, rain curtains, and the lightning is near and sharp. This condition will be clear to the recipient of the report if the proper degree of severity is shown under "weather", and a remark such as "storm rapidly approaching station", is made.

If lightning is observed, but no thunder is heard, this condition does not constitute a "thunderstorm in progress" nor one within the range of the observation station. This condition may be described under "Remarks" but the distinction must be made that a thunderstorm requires that thunder be heard, and a lightning storm, or the mere observation of lightning, does not occasion other remarks than those concerned with lightning.

The direction of movement of thunderstorms is usually difficult to observe, and more difficult the nearer the storm. Unless the observer is confident that the direction of movement has been accurately determined by him, the reports of the thunderstorm should show, in remarks, the direction in which the heaviest thunder is heard, together with any appropriate remarks which will indicate the approach or retreat of the thunderstorms as to the station. Individual judgment and discretion by the observer will govern the use of the proper remarks. Such remarks as "Thunderstorm in N.W. apparently approaching and increasing in intensity."

To obviate the difficulty occasionally involved at times when an observer sees considerable lightning fairly near to this station but cannot hear thunder, the use of appropriate remarks is proper. Here the description of the storm should never be given to contain the word "thunder" or "thunderstorm" but such descriptive terms as "dark", "frequent lightning", "thunderheads with lightning", "lightning and rainfall in west", should be used in remarks, and covers the cases where the observer strongly suspects a thunderstorm but has not the required fact of hearing thunder to permit the reporting of a thunderstorm.

1939 - Circular N - Criteria for Special Observations: A thunderstorm not previously reported occurs, or one previously reported shows marked increase in intensity. Also, the cessation of a thunderstorm previously reported.

The reporting of the degree of intensity remains the same as in 1935.

1941 - Circular N - Rules of reporting thunderstorms: (primarily same as 1939).

The specifications of the degree of intensity were modified to the following - When a thunderstorm is in progress at the station and the intensity of the thunderstorm is less than that given for "heavy" thunderstorm: The following specifications are given as an aid in determining those thunderstorms which will be reported by the term "thunderstorm" or "T": (1) Occasional or fairly frequent flashes of lightning occur within the cloud, from cloud to cloud, or from cloud to ground; (2) weak to loud peals of thunder occur; (3) rainfall, if any, is light, moderate or possibly heavy; (4) hail, if any, is light or moderate; (5) the wind occurring in connection with the passage of the storm does not reach velocities in excess of 40 MPH; (6) temperature drop is not as great as in case of heavy thunderstorm.

Heavy Thunderstorm: (1) When nearly incessant sharp lightning occurs; (2) loud peals of almost continuous thunder occur; (3) heavy rain occurs; (4) hail, if any, if light, moderate, or heavy, (5) the wind occurring in connection with storm exceeds 40 MPH (6) rapid drop in temperature, possibly as much as 20° in 5 minutes.

1941 - Criteria for Special Observation: - Same as 1939

1945 - Form 1130A, WBAN 10A. - Instructions remain the same.

1947 - Circular N - 11th Amendment - Observations - Revised 1-1-47: "A thunderstorm is regarded as occurring at station when thunder is heard."

In addition, a clearer approach for both observing and defining the intensity of the thunderstorm was presented as follows -

Observation: Note the following -

1. Occurrence of thunder

2. Location of storm center with respect to station.

3. Direction toward which the storm is moving.

4. Whether lightning is occurring from cloud to cloud, cloud to ground, or within clouds.

5. Intensity of the storm.

Determination of Intensity: Classification of a thunderstorm as light, moderate, or heavy is based upon the appearance of the storm from the point of observation. The thunderstorm may be classified as light throughout its history as viewed from this point, or it may be classified during its passage by the station as light, moderate, heavy; and as it recedes, moderate, and light. Description of intensity will be based on the following guide.

Light Thunderstorm: Lightning occurs within the cloud and rainfall accompanying it is light or moderate. Small hail may also be observed. The thunder is not loud, and lightning occurs at intervals of a minute or more. The surface wind speed at the beginning of or during the storm does not exceed 30 MPH, and any sudden increase in speed is of short duration. The classification also applies to occasional peals of thunder during a general rain storm.

Moderate Thunderstorm: Loud peals of thunder occur at brief intervals and frequent flashes of lightning occur from cloud to ground, as well as from cloud to cloud; rain is moderate or heavy, and small hail is light or moderate. An on-rush of wind may reach speed of 40 MPH.

Heavy Thunderstorm: Sharp and pronounced thunder and lightning occur almost continuously. Heavy rain occurs, sometimes with hail. Wind may exceed 40 MPH. A rapid drop in temperature occurs, sometimes as much as 20°F in 5 minutes. Thunderstorms will be reported if 15 minutes or less have elapsed since thunder was last heard. Thunderstorms are reported as either heavy or moderate; that is, all thunderstorms not classified as heavy are reported as moderate. (when using the letter symbols, T, T +).

1949 Circular N - Identification Same as 1947

Intensity: Same as 1947

1949 - WBAN 10A-B: Enter appropriate symbol T, moderate; T+ heavy. Thunderstorms will be reported if 15 minutes or less have elapsed since thunder was last heard. Thunderstorms are reported as either heavy or moderate; that is, all thunderstorms not classified as heavy are reported as moderate.

WBAN-10B - (Col. 82-85): Enter times of beginnings and endings, to the nearest minute, of ~~thunderstorms, and changes~~ in intensity. Intervals of 15 minutes or less between the time of ending and recommencement need not be recorded unless occurring within one hour previous to the beginning of a 6 hourly observation, when all beginnings and endings will be recorded. This also applies to changes in intensity that do not last more than 15 minutes. When any phenomenon is occurring at midnight enter "cont" in column 84 for the day preceding midnight, and in column 83 for the day following midnight.

1955 - WBAN-10A - (Col. 13):

(a) Enter direction, if observable: (1) with respect to station (2) direction toward which storm is moving; e.g., T OVHD MOVG EWD or T SW MOVMT VRBL (omit remark concerning movement if movement unknown).

(b) Enter the time of beginning and ending, peak speed of gusts, and direction of movement; e.g., T+ B34E50 G45 MOVD N, in all observations until it has been transmitted in a record observation.

1957 (WBAN 10A - (Col 5): Enter appropriate symbol T, moderate; T+ heavy.

Col. 13: - Enter time of beginning of thunderstorm activity in all observations until appropriately transmitted.

WBAN - 10B - Climatological data. (Col 83-84): Enter, to the nearest minute: (1) Time of beginning and ending, and of changes in intensity. (2) Times of ending should be 15 minutes after last thunder.

1955 - Circular N - Identification: - A thunderstorm is regarded as occurring at the station when thunder has been heard within the previous 15 minutes. If overhead lightning or hail has occurred within the previous 15 minutes and the local noise level is such as might prevent hearing thunder, a thunderstorm will be regarded as occurring even though thunder was not heard.

1955 - Intensity: Remains the same as 1947.

1957 Revised Circular N - Criteria for Special Observation (airways) Change

No. 4, 1 /1/57: - Thunderstorm -

(1) Begins - A special observation is not required to report the beginning of a new thunderstorm if one is currently reported as in progress at the station.

(2) Increases in intensity.

(3) Ends (Special observation 15 minutes after thunder is last heard at station).

1957 - Identification:

(1) Thunder heard within past 15 minutes or,

(2) overhead lightning or hail observed within the past 15 minutes when the local noise level is such as might prevent hearing thunder.

1957 - Intensity: - Remains the same as 1947

HISTORY OF CIRCULAR N

1st ed., 1928	Instructions for Airway Observers, Circular N
2d ed., 1932	Instructions for Airway Observers, Circular N
3d ed., 1935	Instructions for Airway Meteorological Service Circular N.
4th ed., 1939	Instructions for Airway Meteorological Service, Circular N.
5th ed., 1941	Instructions for Airway Meteorological Service Circular N.
6th ed., January 1949	WBAN Manual of Surface Observations, Circular N
6th ed., revised June 1951	Manual of Surface Observations (WBAN), Circular N.
7th ed., January 1955	Manual of Surface Observations (WBAN), Circular N.