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MEMORANDUM

TO: Area and State Climatologists, Substation Inspectors, Field Aides, WRPCs, River District Offices, and Area Engineers. (With copies to Regional Offices for information.)

FROM: Climatological Services Division

SUBJECT: Climatological Service Memorandum No. 49

MEMO

GENERAL

1. DEPARTMENTAL INTEREST IN THE SUBSTATION SUMMARY PROGRAM:

(CLIMATOLOGICAL SERVICE MEMORANDUM NO. 49)

The Department of Commerce, through their Office of Field Services, has opened a fertile field for development of the substation summary program. Through their 33 field offices, they point out the program's advantages and explain its cooperative production aspects for transmittal to the more than 900 Chambers of Commerce, Manufacturers' Associations, and similar business groups associated with the Department as Cooperative Offices. A large number of these Cooperative Offices are located at places for which adequate data are available for summaries.

Personnel of Commerce's Field Offices will, in most cases, visit the nearest State Climatologist to obtain a complete picture of the project. A number of these contacts have already been reported by State Climatologists. Direct contacts by the Cooperative Office (Chambers of Commerce, etc.) with State Climatologists have also been made as a result of the Department's cooperation.

This plan is being tried first in only those states in which full-time State Climatologists are located. This "sampling" will determine, so far as Commerce is concerned, whether the plan will be sponsored later in other areas.

The State Climatologist for South Carolina has introduced something new in the way of obtaining cooperation in the publication of substation summaries. One Chamber of Commerce in his state, while very much interested in a summary for their locality, could not financially support its preparation and publication for the present. The State Climatologist, together with the manager of the local Commerce Field Office, came up with a plan whereby two or more Chambers in different localities could pool their efforts by employing someone in Columbia, S. to do the necessary work needed to prepare summaries for each of them.

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The advantages of this plan are (a) work could be expedited and done more efficiently and at less expense to the cooperators, and (b) the State Climatologist must train and supervise only one person to prepare a number of summaries.

Perhaps this plan may work out in other states.

2. TORNADO DATA FOR ARKANSAS: Mr. Asp, Climatologist for Arkansas, has assembled data on tornadoes for his State. This is a valuable reference in the Office of the State Climatologist. Mr. Asp has gathered data from many published sources and combined them into a loose-leaf folder to which he can add data for each year. The introductory pages of his collection, which give a good resume of data sources and qualifying statements, have been reproduced below.

Such tabulations, although routine in nature, will provide valuable source material for future reference. Statistics on blizzards, glaze, snow storms, and other types of severe weather are scattered and difficult to assemble. Better account of such events should be kept in the future.

TORNADOES IN ARKANSAS

The tabulation on the following pages lists, as far as possible, a record of all tornadoes reported from 1823 to date in Arkansas. It includes data from previous tabulations of information on tornadoes, as well as material from monthly and annual issues of Weather Bureau publications, articles published about tornadoes in the State, and newspaper and Weather Bureau files and clippings. These sources are listed below.

It is recognized that the tabulation does not represent a record of all tornadoes that have occurred. Many tornadoes, especially in earlier years, were not observed, or were not reported. The apparent increase in the number of tornadoes reported in more recent years can be explained by the increase in population, improved communications, and better facilities for the reporting of tornadoes. Property losses listed are based on values estimated and at prices prevailing at the time of occurrence.

It is also possible that a small number of those listed were straight-line windstorms rather than tornadoes, although in all cases they were classified as tornadoes by meteorologists at the time reported.

The listing is as complete as possible from data available at Little Rock. It also covers a longer period of time than by most studies for other sections of the country. Therefore, for comparative purposes, reference should be made to other sources of national scope such as Weather Bureau Technical Paper No. 20 — "Tornado Occurrences in the United States".

Sources of information for each tornado listed are shown by reference in "Remarks", and are as follows:

1. Climatological Data, Arkansas Section— reference to this publication for the month or year of occurrence is indicated in "Remarks" as CD.
2. Monthly Weather Review — reference to severe storm data for the month of occurrence is indicated by the letters MWR.
3. United States Meteorological Yearbook, and in earlier years Report of the Chief of the Weather Bureau — reference to storm data for the year of occurrence is indicated by - YRBK.
4. Climatological Data, National Summary — reference, Nat'l CD.
5. "Tornado Occurrences in the United States", Climatological Services Division, Weather Bureau Technical Manual No. 20, Table 1.
6. Report of Chief Signal Officer, for the years 1880, 1881, and 1883.
7. "Tornadoes in Arkansas, 1879-1926", Harvey S. Cole; Monthly Weather Review, April, 1927, 55: 176-182. Referred to in "Remarks" as COLE.
8. "State Tornado Charts - Arkansas", J. P. Finley; American Meteorological Journal, Nov. 1889; VII: 318-321. Referred to in "Remarks" as FINLEY.
9. "Tornadoes, 1889-1896", Alfred J. Henry; Report of the Chief of the Weather Bureau, 1895-1896; pp. xxiii-xl. Referred to in "Remarks" as HENRY.
10. Newspaper accounts of tornadoes from clippings on file at Little Rock, as well as newspaper files of the Arkansas Democrat and Arkansas Gazette. Referred to in "Remarks" as "Clip".
1819-1879
11. "Weather and Crops in Arkansas", W. C. Hickman, Monthly Weather Review, August 1920, 48: 447-451.
12. "Some Longer Tornado Paths in Arkansas About a Century Ago", M. O. Asp, Monthly Weather Review, June 1955; 83:117-118.
13. "Character of 600 Tornadoes", J. P. Finley, Professional Papers of the Signal Service, No. VII.

14. "Tornado Studies for 1884", J. P. Finley, Professional Papers of the Signal Service, No. XVI.
 15. Observations Forms WB 1001 and WB 1014 for Little Rock, Arkansas—for dates when tornadoes occurred in Little Rock and vicinity.
 16. "Tornadoes in Tennessee, Mississippi, and Arkansas", S. C. Emery, Monthly Weather Review, Nov. 1900; XXVIII:449-501.
 17. "Tornadoes of April 15, 1921 in Arkansas and Texas", W. G. Hickman, Monthly Weather Review, April 1921; 49:194-197.
 18. "Tornadoes in Arkansas in March 1927", W. C. Hickman, Monthly Weather Review, March 1927; 55:133.
 19. "Observing a Tornado's Life", T.G. Shipman, Monthly Weather Review, April 1927; 55:183-184.
 20. "Tornadoes in Arkansas, April 1929", H. S. Cole, Monthly Weather Review, April 1929; 57:155-156.
 21. "Tornado May 1, 1929 at Fort Smith, Ark.", Truman G. Shipman, Monthly Weather Review, May 1929; 57:207-288.
 22. Special reports and severe storm data on file at Weather Bureau Airport Station, Little Rock, Arkansas.
3. SOIL TEMPERATURE: Soil temperature data are important in describing the climate of an area. The Weather Bureau, although frequently asked to provide such data, does not have available a satisfactory listing of either existing data or data sources. It is known that data have been and/or are currently being collected by other organizations. Some of these historical data have been published. This Division is considering a program to collect, and perhaps publish, unpublished historical and current soil temperature data from as many reliable sources as possible to supplement the data now published in some states' Monthly Climatological Data.

All State Climatologists are requested to determine what type, quantity and reliability of soil temperature data are available for their respective states. Also please determine if the existing historical and current data are published, if publication is planned and, if not, whether the data can be obtained by the Weather Bureau for possible publication. Likely data sources are Agricultural Experiment Stations, Agricultural Colleges, Federal and State Agencies and, in some cases, Water Works organizations.

After State Climatologists have determined what data are available, a report to this Division through the appropriate Area Climatologist's

Office will be appreciated. Any available publications containing soil temperature data should be attached to the report. If at all feasible, we would like to receive the report by the end of the current calendar year.

4. REQUESTS FOR CURRENT OBSERVATIONAL DATA: All Weather Bureau offices placing requests for copies of Climatological data in the custody of the WRPCs should keep the fact in mind that WRPCs are staffed to perform a strictly recurring type of operation. WRPCs can make occasional photo copies in form of contact prints. However, no full-time personnel have been assigned to operate this equipment. Such requests, will, therefore, have to be handled so that work schedules at the WRPCs will not be delayed. Where a request involves the preparation of a large number of copies it should be addressed to the Climatological Division instead with an indication of its urgency.

5. RELIEF FOR STATE CLIMATOLOGISTS: We do not anticipate any problem in connection with leave for full-time State Climatologists located at an office where other professional meteorologists are assigned. Those climatologists who are on duty alone or with a clerical assistant should be guided by the following:
 - a. The office should not be unattended for long periods of time. Extended absences should be covered by a relief climatologist. The Division should be advised as far in advance as possible of extended scheduled absences, so a relief climatologist can be detailed. Notification of extended emergency absences should be made promptly by wire.
 - b. Absences for shorter periods (whether official or unofficial) should be covered to the extent that phone calls are answered, and visitors are received. All meteorologists interested in serving a relief detail as a State Climatologist should advise us.

6. HISTORICAL CHANGES IN INSTRUCTIONS FOR RECORDING SNOWFALL AND SNOW ON GROUND: Changing instructions over the years have not always contributed most effectively to the climatological value of our records of the fall of frozen precipitation (unmelted) and its depth on the ground. Climatologists and other users, not properly informed of the various interpretations to be placed on entries of these data, have frequently been confused in interpreting the records.

A preliminary examination of changing instructions for recording these data on Forms 1001 (1893-1948) and Forms 1001C (1949-present) at first-order stations indicates:

- a. From 1893 through 1908 the snowfall (unmelted) column included sleet when it occurred with snow, but no provision was made for recording occurrences of sleet alone. 1909-1939 "snowfall" and "hail and sleet" were recorded in separate

columns. 1940-1945, the only recording column was headed "snowfall" which probably was meant to include sleet, but instructions did not say so. 1946-1948, instructions required entry of sleet in the "snowfall" column, not to be included in the monthly totals. Beginning with 1949 this column, with the totals, included sleet and hail.

- b. From 1893 through 1908 the column containing "snow on ground" data included sleet when it occurred with snow, explained by a marginal note showing that entry included sleet; no provision was made for recording sleet only. 1909-1943, this column contained hail, sleet and snow. 1944-1948, it included snow, sleet and ice (no mention of hail). Beginning with 1949 it included snow, sleet, hail and ice.

The inclusion of hail in present columns headed "snow, sleet, hail" and "on the ground" columns in Weather Bureau forms and publications has resulted in much confusion. Plans are under way to eliminate "hail" in these columns. Since this change will necessitate extensive revision of forms and formats they cannot be implemented before the beginning of the 1956-1957 snow season. Headings of columns affected, or entries therein, should not be changed until complete instructions in the matter are issued to the field.

As a point of information we are now engaged in the preparation of a complete history of Weather Bureau instructions covering the recording of all meteorological elements.

7. CLIMATOLOGICAL SERVICES OF THE U. S. WEATHER BUREAU: A pamphlet describing the organization and activities of the Climatological Services Division is now being sent to the printers. As soon as copies become available each State Climatologist will receive a copy for his information. The pamphlet is an outgrowth of the spring meeting of the Advisory Committee on Climatology.
8. FREEZE MAPS FOR LOUISIANA: Periodically our attention is called to presentations of climatological data which in themselves tell more than many words about cooperation with other agencies within a particular state. Under separate cover each State Climatologist will receive copies of charts showing first and last dates of 32° in Louisiana. The excellent printing job resulting from coordinated efforts, and the attention to detail of topography within the state of Louisiana in drawing the maps are worthy of consideration for programs of data presentation in other states.
9. STANDARD DEVIATION OF MONTHLY TEMPERATURES: The first complete set of climatological data to be included in the National Atlas has been printed and are being distributed to each State Climatologist. Practical application of the charts is described in an article entitled, "The Rational Relationship between Heating Degree Days and Temperature"

by H. C. S. Thom in Monthly Weather Review for January 1954.

10. EDUCATIONAL BACKGROUND OF STATE AND AREA CLIMATOLOGISTS: A recent survey of the number of semester credit hours in meteorology and related subjects that have been earned by full-time State and Area Climatologists shows the following average:

Meteorology, including climatology	32
Physics	16
Mathematics	24
Engineering	8
Statistics	6

Although averages are sometimes misleading, this might serve as a first approximation of a desirable "educational profile" of our professional personnel serving in these capacities.

11. SUBSTATION DEPARTURES FROM NORMAL: Effective with the January 1956 issue of Climatological Data a new determination of "departures" will be published in Table 2 of the monthly C. D.'s. The WRPC's have been instructed as follows:

"1. For those states where Bulletin W Supplement data have not been tabulated, existing normals should be used. The heading in Table 2 should be changed to read "Departure from long-term mean". A reference note should indicate, where known, the method used to obtain long-term means for all stations except full-time Weather Bureau stations. This note should be omitted where the method is not known.

"2. For all states except those in 1 above, the long-term mean will be the average of the monthly values for the period 1931 through 1955, and departures will not be published for shorter records. The column heading in Table 2 of C. D. will be changed to read "Departure from long-term mean", and the following should be included in the reference notes: "Long-term means for all stations except full-time Weather Bureau stations are based on the period 1931-1955".

"3. The following reference note should be carried in all C. D.'s (except the National Summary): "Long-term means for full-time stations (those shown in the Station Index as 'U. S. Weather Bureau') are based on the period 1921-1950, adjusted to represent observations taken at the present location".

"4. As additional states are completed for Bulletin W Supplement, 25-year means for the period 1931-1955 will be computed as outlined above for substations. These new values should then be placed in use at the beginning of the following calendar year.

"5. When 1960 data become available, the 5-year period 1955-1960 will be included and the long-term means will then be based on the 1931-1960 period and designated as normals. This will then be the same period as that to be used for full-time station normals. These values would continue to be used until 1970 data become available.

"6. The NWRC should furnish each WRPC, as soon as possible, period summary cards for the 1931-1954 period for January. This is for all stations with full record for the 1931-1954 period in those states where Bulletin W. Supplement data have been checked. WRPC's should include 1955 data and compute new means for use in getting departures from long-term means. Long-term means for February and later months should follow in sufficient time to be of use at the WRPC's."

To qualify as "full record" all months must be complete. We realize that this requirement will reduce the number of stations for which long term means will be computed, but we feel that it is essential for purposes of comparability that only complete records be used.

Where records are complete for the period except for a few months missing precipitation totals, it is desirable to bring them to "full record" status by interpolating the missing totals according to standard procedures in order to complete the record for the period. WRPC's are encouraged to do this (or to arrange with State Climatologists to have them do it).

12. DATA REQUIRED TO DESCRIBE THE CLIMATE OF THE UNITED STATES, ITS TERRITORIES AND ITS POSSESSIONS: The Weather Bureau is by statute required to "record" the Climate of the United States. Other governmental agencies are also interested in climatology. In particular the Weather Services of the military departments have their own particular requirements. Recently an agreement has been reached on an interpretation of what data should be available to fulfill the statutory responsibilities of the Bureau in this respect. This interpretation is outlined in the following document.

THE PROBLEM

1. To describe the Weather Bureau's basic responsibility for maintaining and operating a program adequate to establish and record the climatic conditions of the United States, its territories and its possessions. By so doing it will become possible to designate the climatological functions for which responsibility is vested in the Weather Bureau and for which the Department of Defense will not need to plan.

FACTS BEARING ON THE PROBLEM

2. The basic legislation which established the U. S. Weather Bureau in 1890 carried with it the above basic responsibility. In the light of increasing knowledge and new developments, the concept of climate and the ways to describe it also change.

3. The Military Services are faced continuously with problems requiring use of climatological data; delineation of Weather Bureau activities in line with its basic responsibilities will aid in establishing the extent of special climatological functions needed by the Military Services for their own purposes that will not duplicate Weather Bureau functions.

DISCUSSION

4. At one time it was probably sufficient to know, from the climatological standpoint, that some areas were warmer than other areas; that one locality received a greater amount of precipitation than another, or that large areas are virtual deserts while others have a climate sufficient to sustain almost all types of vegetation. However, as the economy expanded more specific climatological information became desirable; e.g. length of growing season and distribution of rainfall became important to agriculture in all areas; likewise industry found an increasing need for special climatological information concerning all potential industrial areas. This trend toward more refinement has accelerated in recent years such that modern agriculture and industry frequently require documentation of climate in its most minute detail in three dimensions. Such complete detail if it were to be applied generally throughout all areas would be far beyond the scope that any one federal agency could justifiably continue as a contribution to the national economy.

5. It is necessary then that the Weather Bureau assume its obligation to document the climate generally and at the same time provide a mechanism by which the more detailed micro-climatological observational data may be integrated with large scale phenomena and thus extended in application.

RECOMMENDATIONS

6. That the record of the general climate of the United States be based upon climatological observations from four minimum networks containing stations sufficient to obtain adequate sampling as follows:

- a. A minimum network of approximately 50 stations for the purpose of documenting the long period trends in climate. See Fig. 6 of "Climatological Ser. of U.S. Weather Bur." in Item 7, this CSM.
- b. A minimum network of approximately 200 first-order climatological stations for the purpose of documenting the complete and detailed changes in all meteorological parameters observed. See Fig. 5, "Climatological Services of the Weather Bureau".
- c. A minimum network of approximately 5000 stations and substations (one station to approximately 600 square miles) to provide the salient features of the large scale distribution of

the physical and chemical properties and processes of the atmosphere. See Fig. 4 in "Climatological Services of the Weather Bureau". (This is a sample map which shows the network of climatological substation and first-order climatological station relationship for the State of Kansas.)

d. A minimum of 120 upper air stations for the purpose of obtaining vertical sampling of winds, temperature, moisture and pressure. See Fig. 8, "Climatological Ser. of the Weather Bureau."

7. That observations from other Weather Bureau stations as well as other civil and military stations will supplement these primary networks for special consideration, e.g. (1) the study of terrain influences, (2) the study of the thermal balance of the atmosphere and earth surface, (3) design of materiel, (4) location and operation of facilities, (5) planning of operations for detailed agricultural, commercial, industrial and military activities, etc.

8. That detailed maps of the networks for the United States, possessions and territories will be distributed to all agencies as they become available.

9. That stations in the minimum networks referred to in paragraph 6 observe and record the following as required by WMO agreement:

a. Bench-Mark Stations (at least one observation per day and recording equipment when the stations are finally established).

- (1) Extreme temperatures
- (2) Amount of Precipitation and snow on ground
- (3) Wind
- (4) Weather
- (5) Duration of Sunshine and/or Radiation
- (6) Temperature and Humidity
- (7) Soil Temperatures at Various Depths
- (8) Soil Moisture or Water Content at Various Depths

b. First-Order Climatological Stations (Hourly observations and/or recordings)

- (1) Extreme Temperatures
- (2) Amount of Precipitation
- (3) Wind
- (4) Weather
- (5) Duration of Sunshine and/or Radiation
- (6) Atmospheric Pressure
- (7) Amount of Cloud
- (8) Type of Cloud
- (9) Temperature and Humidity
- (10) Other items in Synoptic Observation

c. Climatological Substations (One or more observations per day)

- (1) Extreme Temperatures
- (2) Amount of Precipitation
- (3) Wind (at selected stations)
- (4) Weather
- (5) Temperature and Humidity (Or some measure of moisture content at selected stations)

d. Upper Air Stations (Two or more observations per day)

- (1) Atmospheric Pressure
- (2) Air Temperature
- (3) Humidity
- (4) Wind

10. That since the Weather Bureau's obligation to the general public and the World Meteorological Organization may require changes in the program stated under 6 and 7, above, the Weather Bureau retain full authority to modify its program to fulfill future obligations. Whenever any significant changes either in network or observational program occur, information concerning the changes will be furnished to interested military and civilian agencies.



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Climatological Services Division

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