

UNITED STATES DEPARTMENT OF COMMERCE  
WEATHER BUREAU  
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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: Office of Climatology

SUBJECT: Climatological Service Memorandum No. 55

MEMO

GENERAL

1. TESTING CBM RECORDS FOR HOMOGENEITY. The following explanation of the procedure for testing the records from proposed bench mark stations for homogeneity was written in reply to a field inquiry. The body of the memorandum is repeated here (with some revisions) for general information:

(Climatological Service Memorandum No. 55)

The records for each tentatively selected Climatological Bench Mark Station will be tested for homogeneity by suitable comparison with the records for the stations surrounding the CBM candidate within a radius of approximately 50 miles. The planned procedure is generally as follows, subject to modification in particular regions where lack of data requires.

1. Monthly summary data (temperature and precipitation) are punched for period of record at the CBM-candidate station and at all other stations within some 50 miles of it which possess reasonably unbroken record and a minimum of site relocations.

2. Time-continuity and space-continuity arrays of summary data for the CBM candidate and so-called "satellite" stations are prepared which closely resemble the daily substation arrays used at the WRPCs. These arrays are used (a) to make a preliminary estimate as to the homogeneity of the CBM-candidate record, (b) to edit the summary card data, and (c) to facilitate interpolation of missing monthly data at all stations.

3. Statistical criteria of relative homogeneity are applied to the summary data (as parallel time series) by machine methods, and generally include the method of rank correlation, the "t"-test, and the Abbe Criterion (Conrad and Pollak, pages 227-232). Briefly, these criteria are applied as follows:

(a) Temperature

(i) Each segment (greater than 10 years in length) of each satellite record presumed to be homogeneous (e.g., the record between two known changes of site) is compared with the corresponding segment of record at the CBM station which may or may not include known

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discontinuities. A large number of such comparisons are then plotted together in such a manner as to bracket those portions of the CBM record which are not relatively homogeneous with a significantly large proportion of the comparable satellite records.

(ii) Regarding the portions of the CBM-candidate record which are thus deemed inhomogeneous, if any, a decision is made either to reject the CBM candidate as a member of the CBM network or to adjust its record such that relative homogeneity is statistically achieved. The second alternative is not considered, however, in any case where the period of CBM inhomogeneity postdates the most recent known change of station exposure.

(iii) Again by the use of suitable statistical tests, a final measure of the homogeneity of the CBM-candidate record, for the full length of record, is conducted by comparison with a temperature series of identical duration which is derived from cumulative year-to-year temperature differences averaged for all satellite records except the differences at particular stations and in particular years which embrace known changes in exposure or any other suspected discontinuity. If this test indicates homogeneity, the CBM candidate is unconditionally approved for inclusion in the CBM network.

#### (b) Precipitation

(i) Owing to the greater variability of precipitation in space and time compared with the variability of temperature, double-mass analysis is used instead of other statistical techniques to identify discontinuities in the CBM-candidate record, and is applied to the data by machine methods. The circumstances under which such analysis is used parallel those described in Paragraph (3) (a) (1) above.

(ii) Regarding the portions of the CBM-candidate record thus deemed inhomogeneous, if any, a decision to reject or adjust the record is made similarly as for temperature.

(iii) Suitable statistical tests are applied to the full length of record, using ratios appropriate to precipitation, to pass final judgment on the acceptability of the record for inclusion in the CBM network.

At the present time, summary card decks have been completed for a few CBM candidate stations and their satellites in the eastern U. S., and machine procedures for arraying the data and applying the statistical tests are being worked out. It is improbable that final selection of any CBM stations can be made for several months.

2. FORM OF SOIL MOISTURE DATA. (Reference item 6, page 9, CSM #54). There seems to be a need for further clarification of some of the concepts and terms concerning the soil moisture data. "Field capacity" (item (a) in the referenced CSM #54) refers to one of the so-called "soil constants". It is determined in a laboratory and is a measure of the total amount of

water which a given depth of a particular soil is able to retain after the excess water, the "gravitational water", has drained from it. This total amount of soil-held water is not all available for plant use. A portion of it is held so tightly by the soil that it cannot be used by plants. "Wilting Point", often called permanent wilting point, is another laboratory-determined soil constant which measures the amount of this tightly held unavailable soil moisture. The difference between field capacity and wilting point gives an indication of "available capacity"; i.e., the amount of water (in inches) that a given depth of a particular soil is able to supply to the roots of a growing plant.

Soil moisture measurements are generally obtained initially in terms of "percent of weight of dry soil". Such figures are more or less meaningless until one determines the "bulk density" of the soil in question and converts the measurements to a "percent by volume" basis. Only then can one obtain inches of water per unit depth of soil. This will then be a measure of "total moisture" which, in conjunction with a knowledge of the soil constants, enables one to make comparisons of the moisture situation in various soils.

For the purposes of the Crop Bulletin we will not be able to carry all this information. Instead we will use "available moisture" which is the difference between total moisture and wilting point, and "moisture deficit" which is the difference between field capacity and total moisture. These two figures contain all the pertinent information; the only item neglected being the amount of unavailable moisture--a measure of the soil moisture situation which is, in general, not particularly useful.

In some instances following heavy rain it will be found that the gravitational water had not all drained from some of the layers being sampled and the available moisture will be larger than the available capacity. In these cases the moisture deficit will be considered to be negative thus indicating the amount of gravitational water remaining in that layer. Similarly, following extended dry periods certain layers (generally those near the surface) will be found to have dried so much that they are drier than the wilting point. In such cases the moisture deficit will be greater than the available capacity and the available moisture will be considered to be negative thus indicating the amount of so-called "unavailable water" which must be added to that particular layer of soil in order to wet it to the point where moisture will begin to be available for plant growth.

For example, using the 12" to 24" layer at Ames:  
If the bulk density of the soil is 1.4-, and the field capacity on a dry weight basis is 21%, then field capacity in inches per foot is  $.21 \times 1.4 \times 12 = 3.5$ .

If the wilting point is 14% on a dry weight basis, then wilting point in inches per foot is  $.14 \times 1.4 \times 12 = 2.3$ .

The available capacity can then be computed as the difference between these two values or  $3.5 - 2.3 = 1.2$  inches per foot (in this layer).

If on a given date a gravimetric sample in this layer shows 19% moisture on a dry weight basis, then the soil has 3.2 inches of water per foot in this layer and the available moisture would be  $3.2 - 2.3 = 0.9$  inches per foot, and the moisture deficit would be  $1.2 - 0.9 = 0.3$  inches.

If, on the other hand, the weighed sample should show 23% moisture, the available moisture, 3.9 inches, exceeds the field capacity, 3.5 inches, and the deficit, -0.4 inches, is a measure of the amount of gravitational water present in that layer.

For additional information on the subject of soil moisture see the article, "How Water Acts in the Soil", by W. A. Mitcheltree in the April 25, 1955 issue of the Weekly Weather and Crop Bulletin National Summary.

3. NATIONAL INVENTORY OF SOIL AND WATER CONSERVATION NEEDS: The Department of Agriculture is undertaking a national survey of soil and water conservation needs. They have established a Departmental Committee to outline the general form of the program. Under the guidance of the Departmental Committee, state committees will be established in each state and they in turn will establish county committees which will make the actual surveys.

Several of the state committees have already met and in a number of cases State Climatologists or other Weather Bureau representatives have been invited to participate. In a recent meeting with members of the Departmental Committee, we were advised that they would likely continue to call upon Weather Bureau personnel for assistance and cooperation. No definite program of Weather Bureau participation has yet been established, but it appears likely that state weather records will be needed at some stage of the survey. State Climatologists or others who may be invited to these meetings should participate, whenever possible, as part of their normal functions. A copy of the United States Department of Agriculture Memorandum No. 1396 dated April 10, 1956, will be mailed to each State Climatologist for additional information regarding the general nature of the program.

4. AIDS FOR COMPUTING ESTIMATED DEGREE-DAY TOTALS. The following items are intended to facilitate computation of estimated degree-day totals from monthly mean temperature, according to the method of Thom embodied in our recently distributed degree-day nomograph.

(1) A work sheet (W.B. Form 920-16) has been printed for distribution to all State Climatologists. This can be used for the computation and convenient filing of degree-day estimates. Twenty copies of this work sheet are being mailed to each State Climatologist; additional copies may be requisitioned from the Regional Office as required.

(2) Following a suggestion by the State Climatologist, Oregon, each State Climatologist is encouraged to apply the following method of locating substations on the charts of "standard deviation of monthly

average temperature" required in deriving the degree-day estimates. Secure a small sheet of acetate and, in india ink, trace the outline of the particular state to the same scale as that of the National Atlas sheets. Also in ink, add a latitude-longitude grid, preferably having a one-degree interval or less. In order to keep these ink markings from rubbing off, cover the acetate with a second sheet and fasten the two together. A substation may then be located on the acetate with ink or grease pencil, and the whole used as an overlay on the atlas sheets of standard deviation of temperature. The standard deviation applying to the substation in question may then be interpolated to the nearest tenth of a degree for use in the nomograph.

(3) In using the degree-day nomograph, the values " $b-t_m$ " and " $\Delta$ " should both be determined to an accuracy of one-tenth of a degree.

It should be emphasized that this method produces an estimate of mean monthly degree days; it cannot be used to estimate degree day totals for a particular month in any one year (e.g. September, 1956).

5. REVIEW OF SUBSTATION HISTORY. Any errors found in the published substation histories, as for example when reviewing data punched by cooperators, should be called to Central Office attention.

6. SUBSTATION HISTORIES. A number of the printed substation histories have been distributed, others are now being published. Each State Climatologist Office is listed to receive 10 copies for his state, plus one copy for each of the other states. We feel that a user of data (in Bulletin W Supplement, Climatological Data, etc.) should know of the availability of the history and should be encouraged to consider the history before using the data.

Histories which have been printed, and their sale prices, follow:

Alabama	\$.35	New Mexico	\$.50
Arizona	.50	New York	.65
Arkansas	.45	North Carolina	.35
Colorado	.50	North Dakota	.25
Georgia	.35	Nebraska	.45
Illinois	.35	Ohio	.45
Iowa	.35	Oregon	.50
Kansas	.50	Oklahoma	.50
Kentucky	.30	South Dakota	.35
Louisiana	.35	Texas	1.00
Maryland & Delaware	.25	Utah	.45
Michigan	.35	Virginia	.35
Mississippi	.35	Washington	.50
Minnesota	.35	West Virginia	.35
Missouri	.45	Wisconsin	.35
Nevada	.30	South Carolina	.25
New England	.60	Montana	.50
New Jersey	.15	Wyoming	.40

7. METHODS OF STATEWIDE DISTRIBUTION OF CLIMATOLOGICAL INFORMATION OF INTEREST: We would like to hear of those occasions where some new method of distributing information of an agro-climatological nature is developed for state-wide distribution. The following item: from a report by the State Climatologist for Indiana shows the medium he used in disseminating important information on the normalcy of rainfall within his state:

"During the first few days of May there was some concern about the dryness in the state. A news release and tape recording went out to county agents, radio stations, and the press on the subject of normalcy of rainfall in the various parts of the state. This was done through Agricultural Information of Purdue University which has close contact with news distributing agencies in all parts of the state. At least three news releases were made this way during May. Two were taken from Indiana Weekly Weather and Crop Report."

8. RECORDS FROM NON-OFFICIAL NETWORKS. Occasionally we are asked if we want to get records from non-official networks, for example a dense micro-net set up for a special purpose.

While we may not want to collect and process such data on a current basis, we would like to have State Climatologists arrange for the eventual collection of these data for file at the NWRC. Such arrangements should be coordinated with this Office.

9. ACTIVITY REPORT AND TRAVEL. As a reminder, and because we still get travel reports on each trip from some State Climatologists we reproduce below our May 15, 1956 memorandum:

"From time to time each State Climatologist should make a report to this office of his non-routine activities, such as contacts with organizations interested in climatology, progress of the climatological program in the state, etc.

Where Area Climatologists' offices have been established a copy should go to the appropriate Area Climatologist.

These reports will preclude the necessity of individual travel reports to this office.

Official travel on regional travel orders need not be reported to the Central Office, but official travel on Central Office travel orders should be so reported. See paragraphs F-4502 and F-4503, Volume I of the Weather Bureau Manual.

A number of State Climatologists have arranged with the Regional Offices for a small quarterly travel allotment. We believe that such an arrangement is worthwhile where acceptable to the Regional Office involved."

10. SEVERE STORM DAMAGE ESTIMATES. Since the decision has been made to categorize storms as published in the Climatological Data National Summary

several queries have indicated a need for clarification of field requirements, Disaster insurance will require that some one agency be designated as a collector of damage figures. Until such time it is essential that we continue to obtain estimates of damage in dollars. These estimates should be noted on the severe storm reports but should not be used in the narrative summary for the State CDs.

11. NATIONAL WEEKLY WEATHER AND CROP BULLETIN. If any State Climatologist's office is not now receiving the national Weekly Weather and Crop Bulletin please advise us so that mailing list can be corrected. We want all State Climatologist offices to receive it.

12. CLIMATOLOGICAL SUMMARIES FOR SUBSTATIONS. Mr. Nathan Kronberg, State Climatologist for South Carolina has cooperated with the Citizens and Southern National Bank of Columbia in the production of an "Outline for a Community Industrial Survey". In this outline is a page discussion on preparation of substation summaries which is reproduced below. In addition, there is a page devoted to an outline of pertinent climatological data required in community planning. This is an excellent way to publicize the substation summary program.

"The Weather Bureau has been recently making a concerted effort to supply the smaller communities with more definitive climatological data. These summaries require concentrated labor which, for the most part, is supplied by the Weather Bureau. But occasionally help is needed from agencies in the community both for additional labor and additional expense. Usually a complete summary, because of improved techniques, can now be obtained at a cost of fifteen to twenty-five dollars. This cost includes labor and printing of 500 copies. Such summaries have now been completed for the following localities: Clemson College, Anderson, Greenwood, Newberry, Rock Hill, Aiken, Camden, Cheraw, Conway, Sumter, Georgetown, Caesar's Head, Orangeburg, Winnsboro and Kingstree. Other summaries are contemplated (and will be completed providing the necessary cooperation is forthcoming) for the following communities: Waterboro and Beaufort. In addition, permanent summaries are compiled for Columbia, Greenville, Asheville, Spartanburg, Charlotte, Florence, Wilmington, N. C., Charleston, Augusta and Savannah.

With the completion of the above two contemplated summaries, a comprehensive compilation of weather data will be available for all areas of South Carolina. This type of information is extremely valuable to manufacturers considering new plant locations and communities mentioned should lose no time in acquiring these summaries for inclusion in reports compiled for specific prospects. As the work involved takes at least two weeks, communities are warned that sufficient notice is required.

Because of the good coverage given by these reports, communities for which the complete reports are not available, can use the nearest available summary. If at any time there is doubt as to which report should be used, consult the U. S. Weather Bureau at Columbia, South Carolina. It must be made clear that the complete reports are available only where

co-operatives and observers have been located for at least ten years and where both temperature and rainfall observations have been made during that period.

A copy of the map showing the location of all recording stations in South Carolina and a copy of one of the completed summaries will be furnished to communities on request to the Industrial Development Department of the Citizens and Southern National Bank of South Carolina."

(Ed. note. Summaries have since been completed for Waterboro, Beaufort, and Chester.)

13. PAN WATER TEMPERATURES AT EVAPORATION STATIONS. A number of evaporation stations over the country have temperature equipment to measure the pan water temperature. The equipment, described in paragraph 4400 of Circular B, consists of either a maximum and minimum indicating or recording thermometer. Most of the new stations are so equipped. In order that these records may become generally available every effort should be made to publish them in accordance with existing instructions. (M.A.I. dated February 17, 1949. "Water Temperatures at Evaporation Stations.") A recap of these instructions follows.

At those stations equipped with water temperature recorders, check-reading of water temperature in the pan should be made periodically, using a Weather Bureau mercury-in-glass thermometer, or one of equivalent quality and which has been calibrated properly. The check-reading should be made within the shadow of the sun shield of the sensing element, and at the same depth. Checks should be made by the inspector at the time of visits to the station. If there is a variance of  $2^{\circ}$  or more in the recorder reading and the checking reading, the pen arm of the recorder should be adjusted to zero correction if practicable, and noted on the chart. Where appropriate, the observer may be instructed to make check-readings. It is important that comparison readings be made at the time of resumption of evaporation observations each year. Appropriate instructions will be included in the next revision of Circular B.

14. EXPERIMENT STATIONS AS POTENTIAL "A" NETWORK STATIONS: The Northwestern Area Climatologist has suggested that all Experiment Station substations be considered for inclusion in the climatological or "a" network.

Some of the points he makes are (a) that experiment stations are located in different climatic areas, (b) that experiment station people have shown the interest and need for weather records and in some cases already have the equipment, and (c) that research specialists working on cooperative punched card projects desire records from experiment forms.

We agree in considerable part with Mr. Magnuson. We believe it would be best, however, to work gradually (and on an individual basis) towards including experiment stations in the "a" network. We know of



some experiment stations that do not want to cooperate with us, do not furnish us data promptly, or that do not want us to make any corrections to observations made by them.

We want to review our networks (after all "a" networks have been approved) with the view of setting up a minimum number of key stations with the best possible exposure, and equipped with more than the standard substation instruments. (See the article "Station Networks to Sample the Climate" in the national Weekly Weather and Crop Bulletin, July 9, 1956.)

15. WEATHER BUREAU SEAL. Legislation was started in the last session of Congress to provide for a seal for various agencies in the Department of Commerce, including the Weather Bureau. It passed the Senate and was reported out in the House, but did not get called up before adjournment. This legislation will quite likely be re-introduced at the next session of Congress. If approved, this seal will simplify Central Office certification on records now requiring the seal of the Department of Commerce.

16. CASH AWARD. Mr. Albert A. Karpovich of the Office of Climatology has been given an Incentive Award of \$15 for a suggestion that upper air wind values in the C.D. National Summary and the Monthly Weather Review be shown in knots instead of in terms of the Beaufort scale. Adoption of this suggestion will make possible more accurate determination of mean upper air wind values, and will make presentations comparable to those in use by the NWAC, Extended Forecast Section, Historical Map Program and most foreign countries.

17. ACTIVITIES OF STATE CLIMATOLOGISTS.

(a) North Carolina: The bulletin "Weather and Climate in North Carolina" has been awarded the blue ribbon at the recent annual meeting of Agriculture College Editors at Pennsylvania State University.

(b) Florida: As a member of the Committee on Climatology and Meteorology of the Florida Water Resources Commission, Keith Butson, State Climatologist, prepared an interesting and enlightening summary of precipitation of Divisions of Florida for the period 1921-1955.

Monthly averages for each year for the new State Divisions were compared to the 1921-1955 average and median, and a tabulation prepared to show frequencies of months above and below the average and median. Wet and dry years over the respective Divisions were listed for handy reference. This sort of data is frequently requested and it is well to be prepared.

As averages are determined for the new state divisions, similar arrays would be useful for each State Climatologist. We have very little information available on variations of precipitation over homogeneous areas and this may very shortly become a pressing problem in connection with analysis of "drought periods", "flood periods" and jet stream fluctuations.

*H. E. Landsberg*

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Director, Office of Climatology

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