EPA-660/2-75-018
JUNE 1975

Environmental Protection Technology Series

Use of Climatic Data in Design of Soils Treatment Systems

National Environmental Research Center
Office of Research and Development
U.S. Environmental Protection Agency
Corvallis, Oregon 97330

RESEARCH REPORTING SERIES

Research reports of the Office of Research and Development, U.S. Environmental Protection Agency, have been grouped into five series. These five broad categories were established to facilitate further development and application of environmental technology. Elimination of traditional grouping was consciously planned to foster technology transfer and a maximum interface in related fields. The five series are:

1. Environmental Health Effects Research
2. Environmental Protection Technology
3. Ecological Research
4. Environmental Monitoring
5. Socioeconomic Environmental Studies

This report has been assigned to the ENVIRONMENTAL PROTECTION TECHNOLOGY STUDIES series. This series describes research performed to develop and demonstrate instrumentation, equipment and methodology to repair or prevent environmental degradation from point and non-point sources of pollution. This work provides the new or improved technology required for the control and treatment of pollution sources to meet environmental quality standards.

EPA REVIEW NOTICE

This report has been reviewed by the Office of Research and Development, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

EPA-660/2-75-018
July 1975

USE OF CLIMATIC DATA IN DESIGN OF SOILS TREATMENT SYSTEMS

By

Dick M. Whiting
National Climatic Center
Environmental Data Service
National Oceanic and Atmospheric Administration
Asheville, North Carolina 28801

EPA-IAG-D4-F451
Program Element 1BB045
ROAP 21-ASH, Task 018

Project Officer

Richard E. Thomas
Robert S. Kerr Environmental Research Laboratory
National Environmental Research Center
P. O. Box 1198
Ada, Oklahoma 74820

NATIONAL ENVIRONMENTAL RESEARCH CENTER
OFFICE OF RESEARCH AND DEVELOPMENT
U. S. ENVIRONMENTAL PROTECTION AGENCY
CORVALLIS, OREGON 97330

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

ABSTRACT

Planners, designers and operators of land-based wastewater management systems need information about climatic influences on storage requirements. Parameters of special interest are discussed and two guidelines have been developed. The guideline referred to as the Freezing Index is recommended for stations whose average normal temperature during the coldest month is less than 32°F, while a study of days defined as either Favorable or Unfavorable is recommended for stations in the warmer climatic zones. The effect of a run of unfavorable days immediately following a cold period can also be determined by examining the daily listings.

A number of graphs, charts and maps are included to describe ways of presenting climatological data and to show the availability of summarized climatic elements. Air temperature, ground frost, evaporation, precipitation, snowfall, snow depth and wind direction and speed are discussed in relation to the possible effect of each on land application systems.

This report is submitted in fulfillment of Interagency Agreement EPA-IAG-D4-F451 by the National Climatic Center (NCC), Asheville, North Carolina. Work was completed on February 28, 1975.

TABLE OF CONTENTS

FIGURES

CONVERSION TABLES

BRITISH TO METRIC UNITS

Length:

1 inch (in.) = 25.4 millimeter (mm.)
= 2.54 centimeter (cm.)

1 foot (ft.) = 30.48 millimeter (mm.)
= 0.3048 centimeter (cm.)

1 yard (yd.) = 91.44 centimeter (cm.)
= 0.9144 meter (m.)

1 statute mile (stat. mi.) = 1609.344 m.
= 1.609344 kilometer (km.)

Speed:

1 mile per hour (mi. $hr.^{-1}$, mph) = 0.868391 knot (kt.)
= 0.44704 m. $sec.^{-1}$
= 0.609344 km. $hr.^{-1}$

Density, Specific Volume:

1 pound per cubic foot ($lb.ft.^{-3}$) = 0.0160185 grams per cubic centimeter ($g.cm^{-3}$)

Pressure:

1 standard atmosphere (14.7 lbs. $in.^{-2}$) = 760 millimeters of mercury (mm.Hg.)

1 millibar (mb.) = 0.750062 millimeters of mercury (mm.Hg.)

Temperature:

Celsius (C) = 5/9 (F-32) where F is temperature in degrees Fahrenheit

Absolute (A) or Kelvin (K) = C + 273.16

ACKNOWLEDGEMENTS

The leadership and assistance of Richard E. Thomas, Project Officer, Robert S. Kerr Environmental Research Laboratory and Frank T. Quinlan, Chief, Climatological Analysis Division, National Climatic Center, is gratefully acknowledged.

Previously published EPA reports containing results of investigations by Consultants Donald M. Parmalee, Dr. George Tchobanoglous, Dr. J. R. Mather, Charles E. Pound and Ronald W. Crites were referred to extensively in this report.

The cooperation of Wayne Tobiasson and Michael Bilello, U. S. Cold Regions Research and Engineering Laboratory and Mr. Douglas Griffes, Metcalf and Eddy, Inc. is acknowledged with thanks.

The author gratefully acknowledges the cooperation and support of the personnel in the several Divisions and Branches within the National Climatic Center who contributed to this report. Special thanks are extended to Mrs. June Radford and Mrs. Myra Ramsey for their contributions in typing and proof reading the report and to Miss Dorothy Goodman for preparing many of the graphs and charts.

SECTION I

CONCLUSIONS

The amount of wastewater storage required at a location because of climatic constraints can be estimated from analysis of weather station data with a program developed at the National Climatic Center. One feature of the program is an analysis of Favorable-Unfavorable days which shows the number of days during the winter season when operations will be restricted, based upon assigned thresholds for commonly measured weather parameters; a second feature is the Freezing Index which provides a measure of the intensity and duration of cold periods. When the index reaches 200 to 300 the ground is assumed to be frozen. The depth of frost penetration is not considered to be a critical factor in this program. Should it be necessary to estimate the depth of frost penetration, a graph is included for this purpose.

The lack of soil temperature data, the variability of winter temperatures from year to year and the differences in design and operating practices in the existing land application systems make it impracticable to accurately determine storage needs on the basis of available soil temperature data. An individual station analysis of climatic data can be extremely helpful in determining storage requirements once the limiting operating factors are defined.

SECTION II

RECOMMENDATIONS

Local decision making bodies should define acceptable climatic risks for the design of wastewater treatment plants. These criteria can then be used in the Freezing Index and Favorable-Unfavorable days program to determine the duration of non-operating conditions. It would be advantageous for climatologists to assist in the approximation of storage requirements.

It is recommended that the programs developed and discussed in this report be used as a test procedure to estimate storage needs with due consideration for the special operating practices designed for each installation. The climatological data should be applied only after decisions have been made as to the type of equipment, method of operation, expected volume, vegetation cover, loading rate, period of operation, etc.

SECTION III

INTRODUCTION

The application of wastewater effluents on the land is being practiced at several hundred sites throughout the United States.[31,35] These land utilization systems employ a multitude of land types and methods to dispose of different types of effluents with varying results. Representative information on the design, operation and performance of these systems can serve as a basis for defining good practice and determining the climatological constraints. Storage requirements must be accurately determined to avoid unplanned discharge of wastewater into streams and rivers due to under design or excessive costs due to over design. Climate constraints which prohibit irrigation are of special importance since they will help determine the long term storage needs.

The purpose of this report is to provide planners and designers of wastewater treatment systems with information about the type and availability of both raw and processed climatological data as well as possible methods of using these data as an aid for determining storage needs. This report describes two types of weather reporting stations, periods of record, elements reported, availability of digitized data (magnetic tape) and special programs developed by the National Climatic Center to provide summaries of selected climatological parameters for use in the decision making process.

In most land application operations, the vegetation cover is a major factor in the success of the system.[35] Both the rate of growth of vegetation and the rate of decomposition of organics in the effluent are regulated, in large part, by the energy available. Most places in the United States have sufficient energy for the development of a good ground cover of vegetation, although low levels of energy receipts in the winter in northern areas, with resulting low temperatures, will limit the rate of decomposition of any solids removed from the effluent.[30]

As stated in the CRREL Special Report No. 171,[34] "storage could be avoided if the land disposal site could function on a year-round basis; however, major risks to be considered prior to adopting year-round application include wintertime constraints on the movement of water, and wintertime response of the site ecosystem." The special report goes on to point out that winter time application can reduce the renovative capability of the site and inhibit the chemical reactions in the soil. For example,

some systems obtain nitrate removal by plants and micro-organisms in the ecosystem and since these are essentially dormant in winter, nitrate losses could be significant.

If land application in northern latitudes is planned only during the warmer months, the application period might vary from 20 to 40 weeks (March-November) depending on local conditions.[34] Storage and/or some other form of treatment will be necessary for the remainder of the year. Further restrictions might also be necessary during the warm months since spray irrigation should be avoided during periods of high winds and it may be desirable to cease all wastewater application during periods of intensive rainfall.

The three principal methods used in land application of wastewater are irrigation, overland flow and infiltration-percolation. According to an Environmental Protection Agency (EPA) publication[35] irrigation is the most reliable land application technique with respect to long term use and removal of pollutants from the wastewater, while overland flow and infiltration-percolation methods are feasible in many cases. The storage requirements estimated from climatic constraints may have to be supplemented depending on the date irrigation is required in the spring. Climate will affect irrigation and overland flow more than infiltration-percolation because the water needs of plants are affected by air temperature, humidity, solar radiation, and wind velocity.

Other disposal methods include subsurface leach fields, injection wells and evaporation ponds. EPA publications[31,35] refer to the importance of making a proper assessment of the type of system suitable for a given situation. The principal factors are classified as regulatory, economic and technical. The technical factors include the physical aspects of the land, underground formations, ground slope, wastewater characteristics and flow rates, climate and whether the flow remains constant throughout the year.

The extent to which weather affects the operation of a system depends on the type of system and equipment, as well as the volume of effluent. Some small systems are known to operate continuously during severe winters, while others utilize storage ponds capable of holding four to six months of effluent.[31] Obviously, climatic constraints to operation are quite variable and depend on the particular system and location. This demonstrates the fact that no hard and fast guidelines on climatic constraints can be established under all conditions.[31,35]

The following material concerning generalized climatic zones for the United States (Figure 1) was prepared for the Environmental Protection Technology Series 660/2-73-006 and published in August 1973.[35] The

map is a useful guide although detailed analysis of climatological data at the location under consideration is also recommended. In preparing the map, an effort was made to simplify distribution patterns; where possible, state boundaries were used for ease in setting zone boundaries even though climates seldom change at such political sub-divisions. The classification of mountainous areas should be adjusted according to elevation.

Zone A, which covers California except for the extreme southeastern part, delineates the unique Mediterranean climatic region with its marked seasonal pattern in precipitation. Average annual precipitation is about 15 to 25 inches confined generally to the six months from November to April; practically no precipitation falls in the other six months of the year. Temperatures are mild in winter and hot in summer so that adequate energy is available in almost all seasons for plant growth. Storage of the effluent due to freezing will not be necessary except at higher elevations, but may be desirable to maximize summer application rates or to make the addition of nutrients in wastewater correspond to crop requirements.

Zone B covers southwestern United States, an area of very hot, arid climates. Winter storage should not be a concern in most of the area although there will be a real problem due to the lack of sufficient moisture for vegetation growth in all seasons unless irrigation is available. There may also be problems of salt in the soil if brackish water is used in irrigation or constitutes a significant portion of the effluent.

Zone C covers primarily the states identified as the Mid and Deep South as well as the western portions of Washington and Oregon. In general, precipitation varies from 40 to 60 inches during the year, and average monthly temperatures range from the low 40's in winter to the low 80's in summer, except for part of the Washington-Oregon area which experiences mild summers and winters. Twelve-month operation of land application systems is possible from the standpoint of temperature. However, the well distributed and relatively high precipitation eliminates the need for extended periods of irrigation which are desirable from the standpoint of wastewater application.

The northern tier of states in Zone C and the states along the southern border of Zone D in the midwest represent areas that experience wide variations in weather from one winter season to the next. Fort Smith, Arkansas, for example, has a January normal temperature of 39.0°F, but recorded an average January temperature of 26.4°F in 1940. Dodge City, Kansas with a January normal of 30.8°F recorded a January average of 16.6°F that same year.

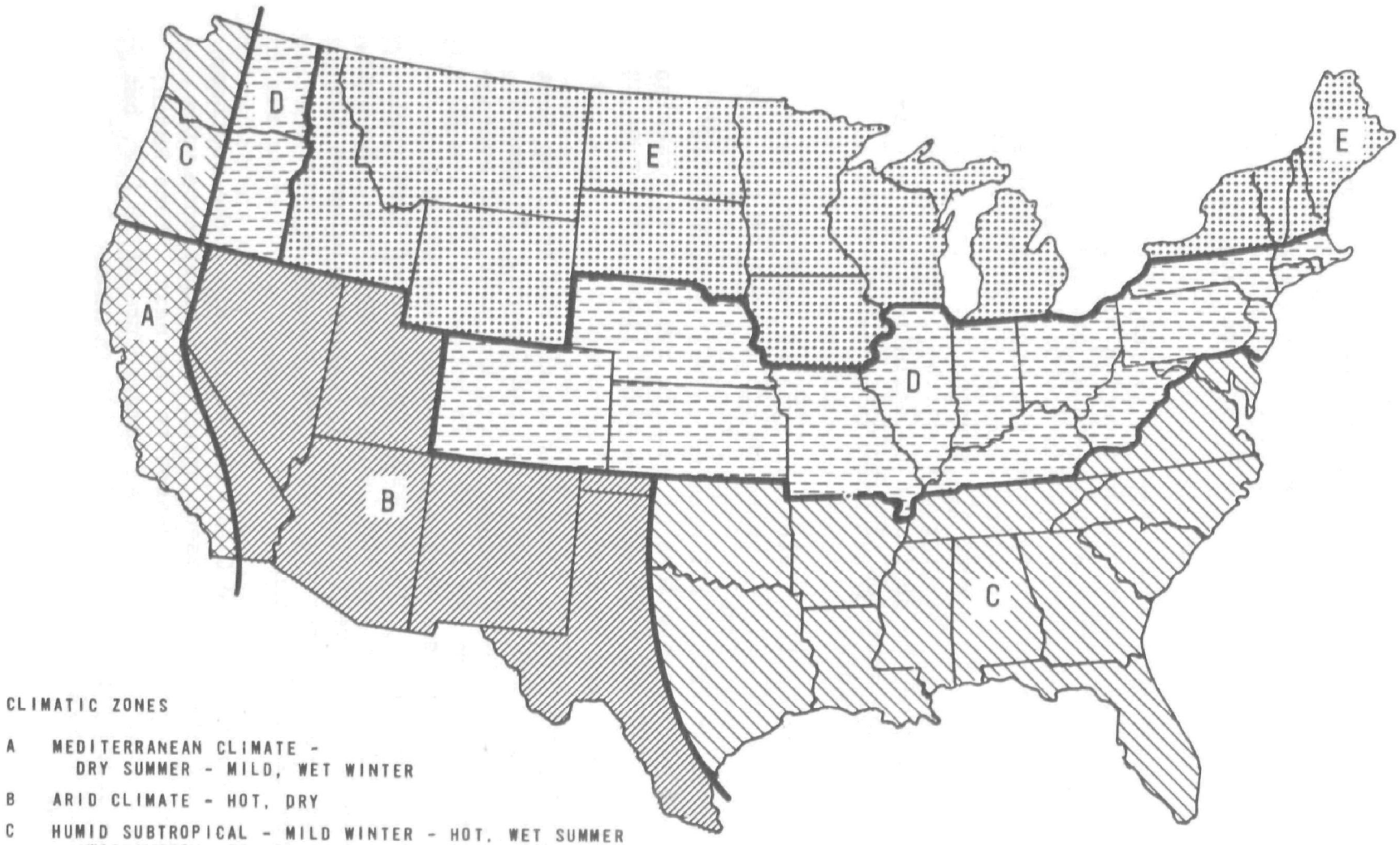


Fig. 1 Generalized climatic zones for land application

Zone D covers the middle tier of states running eastward from Colorado to southern New England and the eastern portions of Washington and Oregon. The climates are marked by moderately cold winters (average temperatures in the 20's), hot summers (average temperatures in the mid-70's), and precipitation well distributed through the year. Some irrigation might be needed in the western portion for vegetation development, but little would be needed in the east. Winter temperatures are cold enough so that effluent storage for several months or so may be necessary.

Zone E covers the northernmost tier of states. Very cold winters with warm summers and adequate moisture for vegetation exist. Winter operation of irrigation systems is quite limited because the low temperatures, with ice and snow, contribute to the storage of effluent for up to six months.

Evaluation of the effect of large land application systems on local climatic conditions is difficult because of the lack of observations. However, it is possible to draw certain conclusions on the basis of observations taken around reservoirs both before and after their establishment, from studies in the vicinity of large irrigation enterprises, and on the basis of various theoretical considerations.

According to Dr. J. R. Mather,[31] "the climatic changes that accompany irrigation enterprises are relatively local in extent. Air moving over an irrigated tract will rapidly pick up moisture and the air temperature will cool. Within the first few hundred feet in all but the most arid region, the air will have essentially reached equilibrium. Once the air has left the moist area, turbulent mixing will, within just a few miles, reduce its moisture content to its original low value and return the temperature to its value upwind of the irrigated tract."

It has been recommended that wastewaters with high temperatures be cooled prior to land application because of the adverse effect on both vegetation and soils.[31] Cooling ponds or lagoons used for this purpose might be a source of fog during the period from November through April in many parts of the country, especially in climatic Zones D and E.

SECTION IV

NETWORKS OF OBSERVING STATIONS

The National Weather Service and its Cooperative Networks collect a great deal of climatological data at thousands of locations. (See Appendix B.) The National Climatic Center publishes much of this information on a State basis by month, and annually. (See Appendix C.) Many of the original observations are digitized and retained on magnetic tape for rapid computer processing as the need arises. Single station summaries based on long periods provide a variety of detailed information about the climate of an area. The large number of programs developed at the National Climatic Center over the years provides a broad base of useful climatological information to all segments of the economy.

When the climatological material required can be clearly specified, it may be ordered and sent on an invoice. If, however, the needs are not clearly known, or cannot be adequately described in terms of available National Climatic Center programs, the services of a consultant to assist in developing the specifications and interpreting the results are recommended.

The analysis of climatological data can provide insight into the special problems of planning, design and location of land application systems. It can also be useful in studies relating to the growth and yield of plants. It is very important to establish which climatic parameters are essential to a specific problem, to process the data to obtain meaningful results and, most importantly, to correctly evaluate the results of such programs in terms of both cost and risk.

All climatological studies are limited by the type, amount and condition of the available observational data. The daily temperature, precipitation and snowfall data used in the program referred to in this report represent the best long term daily data available on a nationwide basis. Unfortunately, these observations contain only a few of the desired elements. Because climate cannot be described simply, or reduced to a single figure, decisions will most likely be based on probabilities after the planner has examined all available information.

The National Climatic Center's data base includes over 40,000 reels of magnetic tape. Observations are received from over 10,000 stations in the United States; however, there are differences in the type of elements reported and hours of observation. Some stations report on an hourly or three-hourly basis, while the majority of the stations report only the daily maximum and minimum temperatures and total precipitation. In any case, a survey can be made to select the weather station which has the appropriate data in digital form and is most representative of the selected site. Some of the elements, tabulations and programs described in the Appendices are discussed briefly in the following paragraphs.

SECTION V

SOIL TEMPERATURE

The EPA summary[35] recommends that climatic investigation be undertaken to define simultaneously surface soil and ambient air temperature for the United States. Such information would be useful in determining the annual period in which vegetation and active bacterial metabolism might be maintained by wastewater application. However, relatively few stations report soil temperatures on a regular basis. Unfortunately, neither the hours of observations, nor the depths at which the sensors are placed have been standardized. Because of this and the differences in soil types, ground cover, slope, etc., no attempt has been made to define simultaneous surface soil and ambient air temperature relationships. Figure 2 shows the relationship between the Freezing Index and freezing temperature penetration for various surface conditions for granular and fine grained soils. Other maps of interest are shown in the Appendices.

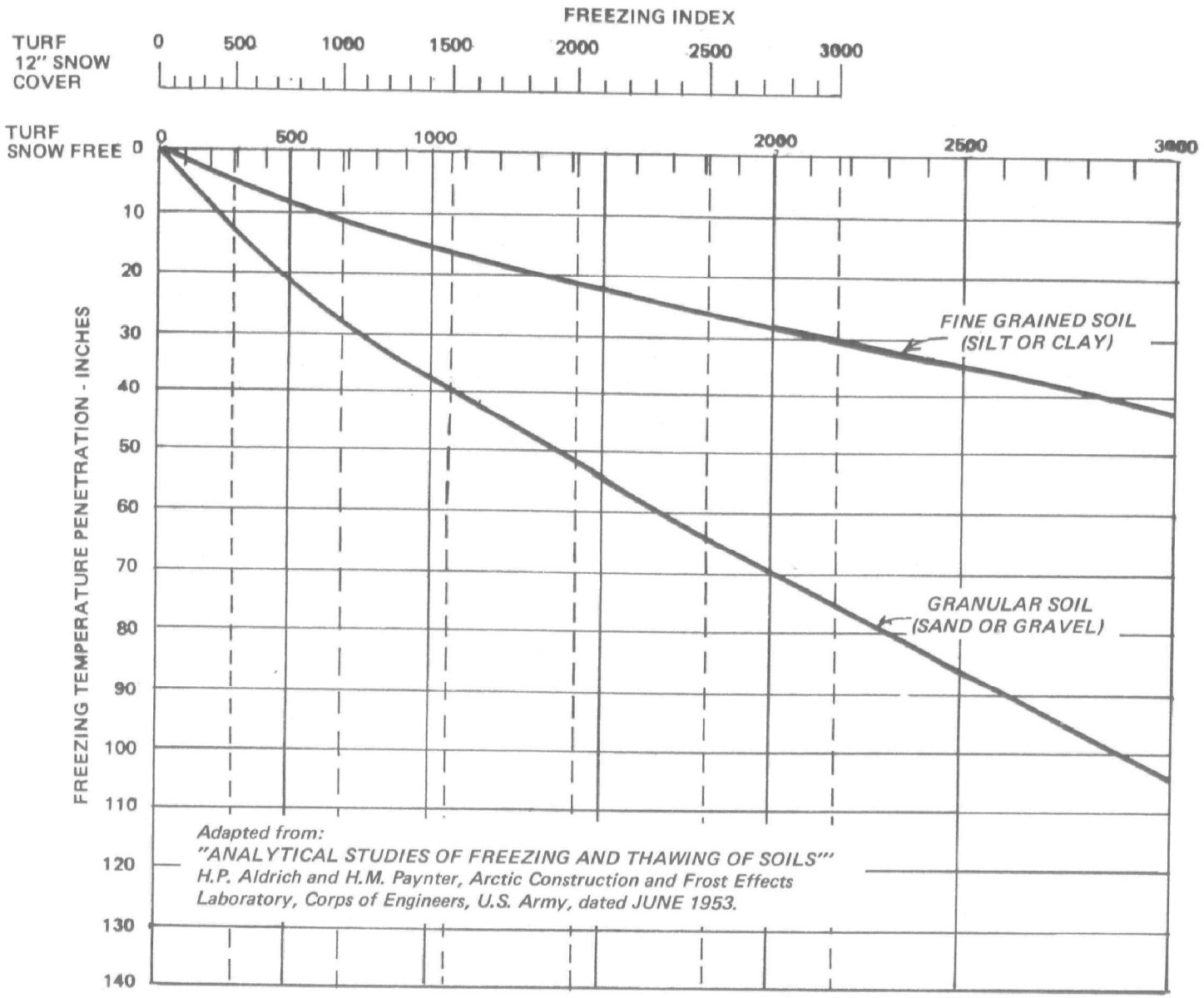


Fig. 2 Relationship between freezing index and freezing temperature penetration for various surface conditions for granular and fine-grained soils

SECTION VI

GROUND FROST

No article on this subject would be complete without making reference to the work of Jessberger.[19] This detailed and comprehensive volume of some 500 pages carries a bibliography of over 1300 references dealing with the freezing and thawing of soils, structure of water and ice, mechanical properties of ice, etc. Much of the text covers the underlying principles of the effects of frost on soil and the carrying capacity of roads in relation to frost. Other important investigations have been carried out by Aldrich and Paynter[1] in connection with frost penetration.

Jessberger states that "the frost depth beneath a covering free of snow and ice depends on the Frost Index (FI), the properties of the subjacent materials and the water conditions. The expected frost penetration can be approximately determined as a function of the accumulated cold in a freezing period." Much of the interest in Jessberger's study was in road building and the load capacity of roads; however, the fundamentals are of importance for land application of wastewater.

For the purpose of this report and the programs discussed, it is not necessary to determine the depth of the 32°F isotherm, but only to establish whether the ground is frozen. There is no question that such information may be critical at some installations when the applied effluent is considerably warmer than the ground. Investigation into such cases may be necessary at sites operating twelve months a year, but will necessarily be limited to those locations which record soil temperature measurements.

(NOTE: Figures 3 and 3a are included because they are the only known maps of average and extreme frost penetration for the United States. No background information is available concerning the source material, method of computation, or the document in which these maps were originally published. Caution is recommended in the use of these maps.)

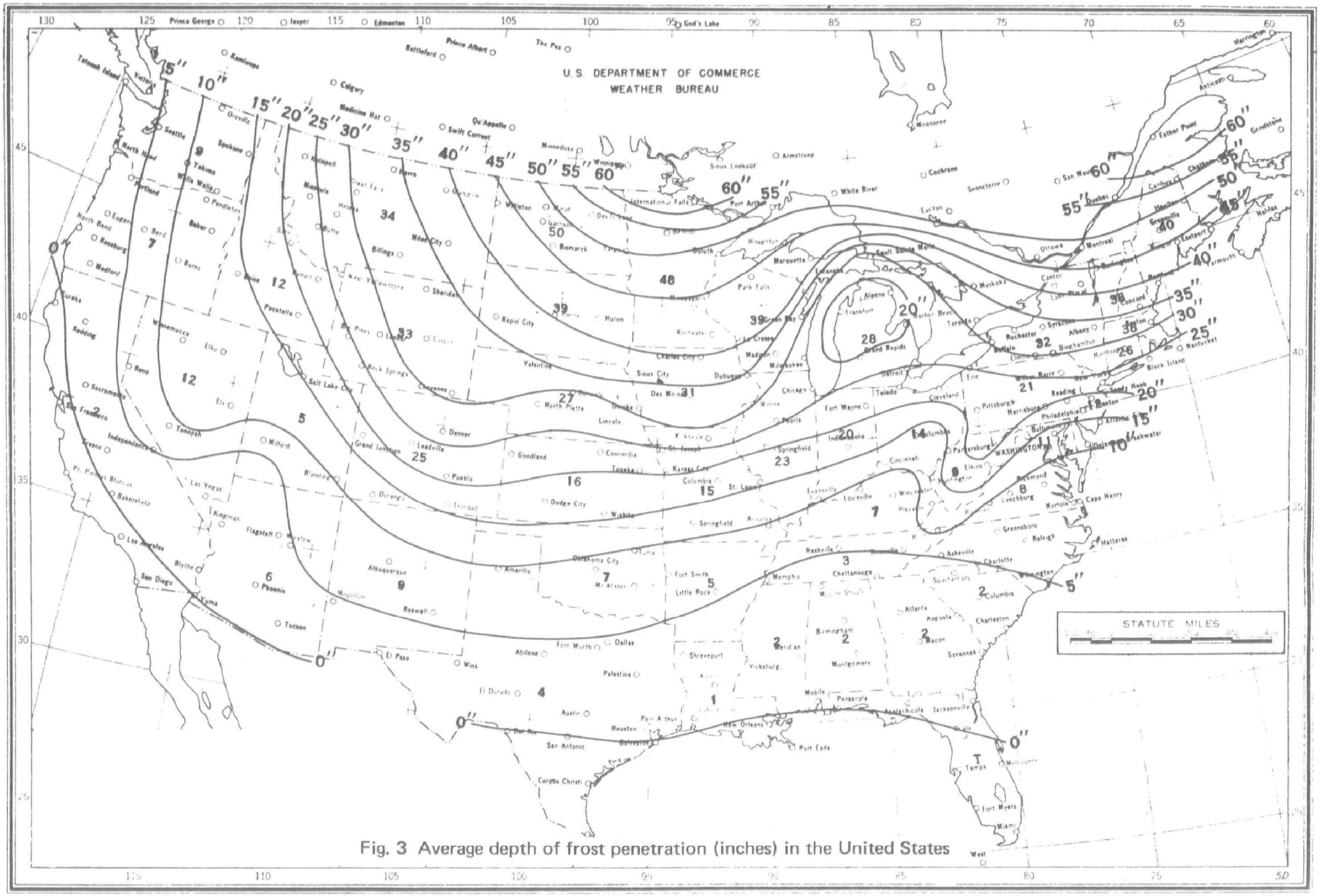


Fig. 3 Average depth of frost penetration (inches) in the United States

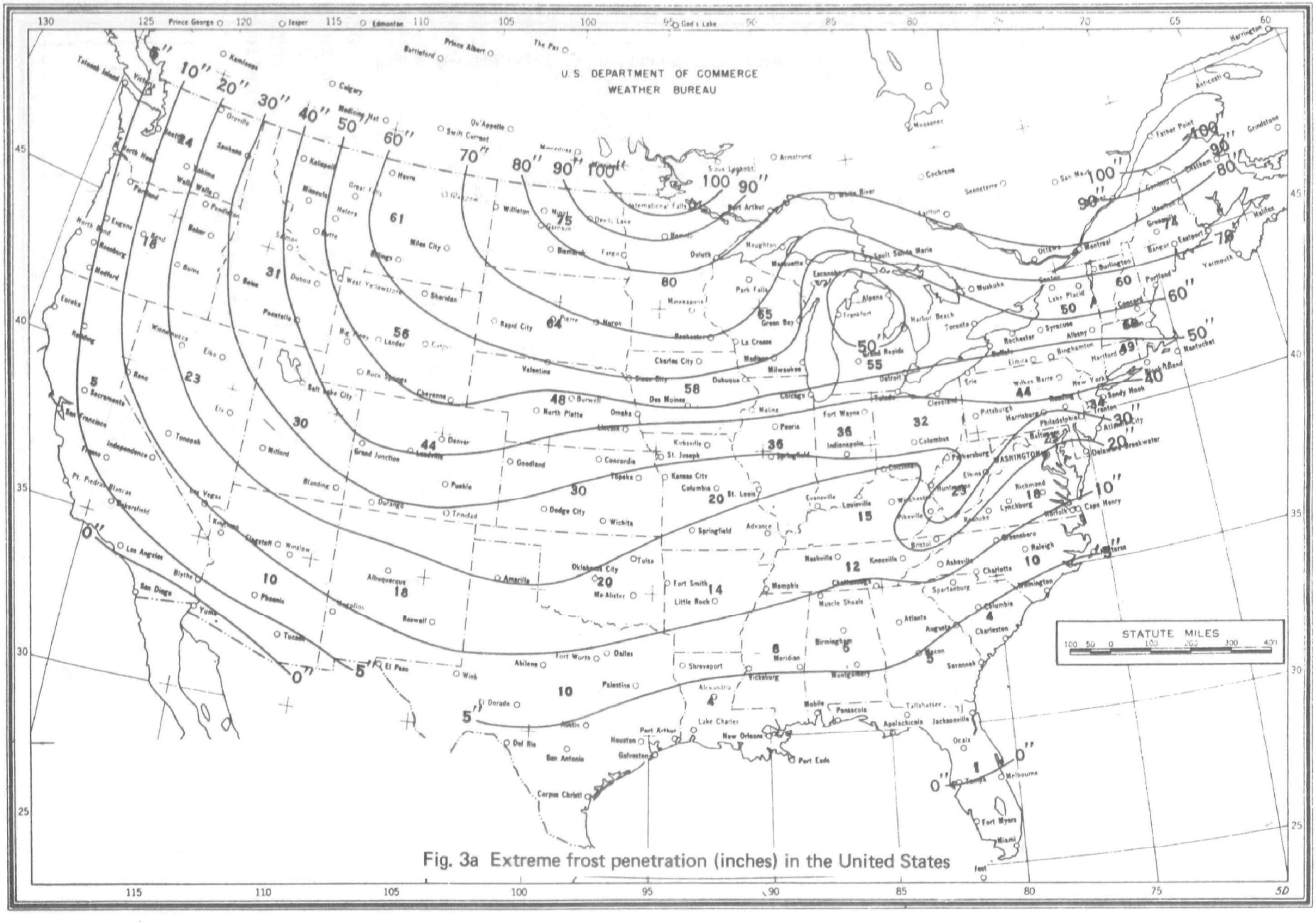


Fig. 3a Extreme frost penetration (inches) in the United States

SECTION VII

PRECIPITATION

The water balance is governed primarily by precipitation, evaporation and transpiration of the plant. The requirements of water are very different from one plant species to another as well as at different time periods throughout the year. There are times when too much water is as detrimental as is insufficient moisture at other times.[13]

Precipitation probabilities, frequency distributions and maps have been prepared which furnish useful information on a local, state and national level.[25,37] Many of the estimated probabilities are for one, two and three week periods, while others give values to be expected on a monthly basis. The week is the smallest unit of time used in these programs and a weekly total of one inch could have fallen in a 30-minute period, or gently over several days. These studies show the probability of receiving selected amounts of precipitation during a given period and location. Other studies give return periods for one to seven day rainfall amounts, while extreme rainfall values have been computed for many locations.

Although the state of the soil is not, strictly speaking, a climatic factor, it can be a definite constraint to the application of wastewater. Prolonged rainy spells can saturate the ground in some areas for up to several weeks. Storage will normally be adequate to handle such events if the rains occur during the summer or fall; however, a prolonged period of heavy rain immediately following the spring thaw could extend the run of unfavorable days and, therefore, increase the amount of storage needed.

It may be of interest to note that Holt, Missouri holds the world's record for the greatest 42 minute rainfall. On June 22, 1947, 12 inches of rain fell in that time period. Thrall, Texas holds the U. S. unofficial 12-hour rainfall record of 32 inches which fell on September 9, 1921. No one would be expected to design for such rare events as these and climatological information can be provided that will permit design of a system with an acceptable built-in risk factor. (See Appendix E.)

Precipitation frequency maps may be obtained from the Office of Hydrology, National Weather Service, National Oceanic and Atmopsheric Administration, Silver Spring, Maryland 20910.

SECTION VIII

EVAPORATION

Weather conditions which restrict operation of wastewater treatment plants have been defined elsewhere in this report. Storage of the effluent may be necessary for a period of from 10 to 180 days. The length of the storage period is usually greatest in the areas where evaporation is at a minimum (climatic zones D, E) and the least in areas of relatively high evaporation (climatic zones A, B, C). Although evaporation can be of primary importance during the time wastewater is being applied, it appears to be of limited importance in estimating storage requirements due to climatic constraints. The estimated capacity of reservoirs in zones D and E could not be reduced significantly because of loss through evaporation during the winter months. In zones A, B, and C storage due to climatic constraints will be needed for relatively short periods, perhaps 10 to 30 days. A detailed study of the expected loss through evaporation at those sites might reduce storage needs slightly.

Pan and lake evaporation values are available in a series of climatic maps of the United States.[17,23] The reliability of the maps is obviously poorer in the areas of high relief than in the plains region and the density of the observation network is an important factor in the series. In addition, the effect of topography has been considered only in a general way except where the data provided definite information. There is a considerable difference between the evaporation from a pan four feet in diameter and 10 inches deep and that from a large reservoir. Estimates indicate that evaporation from reservoirs averages about 30% less than that measured from Class A pans. (See Appendix F.)

This report is primarily concerned with estimating storage needed due to climatic constraints. An important related problem is one of storing wastewater during the off-season for irrigation during the growing season. In this case, the estimated water loss is an important factor in reservoir design.

SECTION IX

SNOWFALL

Snowfall distributions exhibit wide variation whether one considers a 24-hour period, a single storm, a calendar month, or an entire season (Figure 4). Extremes of seasonal snowfall (1930-1970) are listed below for a few selected stations to show this variation. Hartford, Connecticut recorded 83 inches during the 1966-67 season, but had only 15 inches during the 1936-37 season; while Sandburg, California had 101 inches during the 1943-44 season and only 2 inches during the 1934-35 season.

Maps and tables of monthly and seasonal snowfall have been prepared for most of the stations reporting this element. Generalized maps showing the greatest 24-hour snowfall and the greatest monthly snowfall of record are presented in Appendix G. Summaries are also available which give the greatest daily, monthly and annual snowfall. (See Appendix C.) The amounts shown in the examples may not agree due to the use of different periods of record.

	24 Hours	Single storm	Calendar month	Season
ALABAMA	19.2 Florence 12/31–1/1/64	19.5 Florence 12/31–1/1/64	24.0 Valley Head 1/40	25.0 Valley Head 1939–40
ALASKA	62.0 Thompson Pass 12/29/55	175.4 Thompson Pass 12/26–31/55	297.9 Thompson Pass 2/53	974.4 Thompson Pass 1952–53
ARIZONA	38.0 Heber R.S. 12/14/67	67.0 Heber R.S. 12/13–16/67	104.8 Flagstaff 1/49	226.7 Hawley Lake 1967–68
ARKANSAS	25.0 Corning 1/22/18	25.0 Corning 1/22/18	48.0 Calico Rock 1/18	61.0 Hardy 1917–18
CALIFORNIA	60.0 Giant Forest 1/18–19/33	149.0 Tahoe 1/11–17/52	390.0 Tamarack 1/11	884.0 Tamarack 1906–07
COLORADO	75.8 Silver Lake 4/14–15/21	141.0 Ruby 3/23–30/99	249.0 Ruby 3/99	779.0 Ruby 1896–97
CONNECTICUT	28.0 New Haven 3/12/88	50.0 Middletown 3/11–14/88	73.6 Norfolk 3/56	177.4 Norfolk 1955–56
DELAWARE	24.0 Milford 2/12–13/99 24.0 Dover 12/25–26/09	25.0 Milford 12/25–26/09	36.0 Milford 2/99	49.5 Wilmington 1957–58
LORIDA	4.0 Milton Exp. Stat. 3/6/54	4.0 Milton 3/6/54	4.0 Milton 3/54	4.0 Milton 1953–54
GEORGIA	19.3 Cedartown 3/2–3/42	19.3 Cedartown 3/2–3/42	26.5 Diamond 2/95	39.0 Diamond 1894–95
IDAHO	30.0 Pierce R.S. 12/28/68	60.0 Roland W. Portal 12/25–27/37	143.8 Burke 1/54	441.8 Roland W. Portal 1949–50
ILLINOIS	36.0 Astoria 2/27–28/00	37.8 Astoria 2/27–28/00	47.0 Astoria 2/00	77.0 Chicago 1969–70
INDIANA	20.0 Evansville 1/14/18 20.0 La Porte 2/12/44	37.0 LaPorte 2/14–19/58	59.8 La Porte 2/58	122.3 La Porte 1962–63
IOWA	21.0 Sibley 2/18/62	30.8 Rock Rapids 2/17–21/62	42.0 Osage, Northwood 3/15	90.4 Northwood 1908–09
KANSAS	26.0 Fort Scott 12/28–29/54	37.0 Olathe 3/23–24/12	55.9 Olathe 3/12	82.1 Olathe 1911–12
KENTUCKY	18.0 Bowling Green 3/9/60 18.0 Cecilia 11/2/66	27.0 Bowling Green 3/7–11/60	46.5 Benham 3/60	108.2 Benham 1959–60
LOUISIANA	24.0 Rayne 2/14–15/95	24.0 Rayne 2/14–15/95	24.0 Rayne 2/95	24.0 Rayne 1894–95
MAINE	35.0 Middle Dam 11/23/43	56.0 Long Falls Dam 2/24–28/69	88.3 Long Falls Dam 2/69	238.5 Long Falls Dam 1968–69
MARYLAND	31.0 Clear Spring 3/29/42	36.0 Edgemont 3/29–30/42	58.0 Oakland 1/95	174.9 Deer Park 1901–02
MASSACHUSETTS	28.2 Blue Hill 2/24–25/69	47.0 Peru 3/2–5/47	78.0 Monroe 2/93	162.0 Monroe 1892–93
MICHIGAN	27.0 Dunbar 3/29/47 27.0 Ishpemig 10/23/29	46.1 Calumet 1/15–20/50	115.3 Calumet 1/50	298.3 Herman 1968–69
MINNESOTA	28.0 Pigeon R. Bridge 4/4–5/33	35.2 Duluth 12/5–8/50	66.4 Collegeville 3/65	147.5 Pigeon R. Bridge 1936–37
MISSISSIPPI	18.0 Mt. Pleasant 12/23/63 18.0 Tunica 12/23/63	18.0 Mt. Pleasant 12/23/63 18.0 Tunica 12/23/63	23.0 Cleveland 1/66	25.2 Senatobia 1967–68
MISSOURI	27.6 Neosho 3/16–17/70	27.6 Neosho 3/16–17/70	47.5 Poplar Bluff 1/18	70.3 Maryville 1911–12
MONTANA	30.0 Summit 10/29/51	46.0 Summit 3/31–4/3/54	123.0 Summit 1/54	406.5 Kings Hill 1958–59
NEBRASKA	24.0 Hickman 2/11/65	41.0 Chadron 1/2–4/49	59.6 Chadron 1/49	104.9 Kimball 1958–59
NEVADA	25.0 Mt. Rose Resort 1/20/69	75.0 Mt. Rose Resort 1/18–22/69	124.0 Mt. Rose Resort 1/69	323.0 Mt. Rose Resort 1968–69
NEW HAMPSHIRE	56.0 Randolph 11/22–23/43	77.0 Pinkham Notch 2/24–28/69	130.0 Pinkham Notch 2/69†	323.0 Pinkham Notch 1968–69†
NEW JERSEY	29.7 Long Branch 12/26–27/47	34.0 Cape May 2/11–14/99	50.1 Freehold 12/80	108.1 Culvers Lake 1915–16
NEW MEXICO	30.0 Sandia Crest 12/29/58	40.0 Corona 12/14–16/59	144.0 Anchor Mine 3/12	483.0 Anchor Mine 1911–12
NEW YORK	45.0 Watertown 11/14–15/00	69.0 Watertown 1/18–22/40	120.0 Old Forge 3/71	375.0 Old Forge 1970–71
NORTH CAROLINA	31.0 Nashville 3/2/27	31.0 Nashville 3/2/27	56.5 Boone 3/60	100.7 Banner Elk 1959–60
NORTH DAKOTA	24.0 Lisbon 2/15/15 24.0 Berthold Agency 2/25/30	35.0 Lisbon 2/13–15/15	45.5 Tagus 4/70	99.9 Pembina 1906–07
OHIO	20.7 Youngstown 11/24–25/50	36.3 Steubenville 11/24–26/50	69.5 Chardon 12/62	161.5 Chardon 1959–60
OKLAHOMA	23.0 Buffalo 2/21/71	36.0 Buffalo 2/21–22/71	39.5 Buffalo 2/71	87.3 Beaver 1911–12
OREGON	37.0 Crater Lake 1/17/51	95.0 Crater Lake 1/15–19/51	256.0 Crater Lake 1/33	879.0 Crater Lake 1932–33
PENNSYLVANIA	38.0 Morgantown 3/20/58	50.0 Morgantown 3/19–21/58	86.0 Blue Knob 12/90	225.0 Blue Knob 1890–91
RHODE ISLAND	34.0 Foster 2/8–9/45	34.0 Foster 2/8–9/45	62.0 Foster 3/56	122.6 Foster 1947–48
SOUTH CAROLINA	21.8 Caesar's Head 2/16/69	28.9 Caesar's Head 2/15–16/29	33.9 Caesar's Head 2/69	60.3 Caesar's Head 1968–69
SOUTH DAKOTA	38.0 Dumont 3/27/50	60.0 Dumont 3/26–28/50	94.0 Dumont 3/50	222.7 Lead 1969–70
TENNESSEE	22.0 Morristown 3/9/60	28.0 Westbourne 2/19–21/60	39.0 Mountain City 3/60	75.5 Mountain City 1959–60
TEXAS	24.0 Plainview 2/3–4/56	33.0 Hale Center 2/2–5/56	36.0 Hale Center 2/56	65.0 Romero 1923–24
UTAH	35.0 Kanush 2/9/53	64.0 Alta 12/2–7/51	165.0 Alta 3/48	663.0 Alta 1951–52
VERMONT	33.0 St. Johnsbury 2/25/69	50.0 Readsboro 3/2–6/47	75.0 Waitsfield†	197.5 Waitsfield†
VIRGINIA	33.0 Big Meadows 3/6/62	42.0 Big Meadows 3/6–7/62	54.0 Warrenton 2/99	98.0 Mountain Lake 1913–14
WASHINGTON	52.0 Winthrop 1/21/35	129.0 Laconia 2/24–26/10	363.0 Paradise R.S. 1/25	1027.0 Paradise R.S. 1970–71
WEST VIRGINIA	34.0 Bayard 4/27–28/28	57.0 Pickens 11/23–30/50	97.0 Pickens 2/47	266.2 Pickens 1959–60
WISCONSIN	26.0 Neillsville 12/27/04	30.0 Racine 2/19–20/98	80.5 Gurney 12/68	230.0 Gurney 1968–69
WYOMING	34.0 Bechler River 1/28/33	52.0 Bechler River 1/15–19/37	188.5 Bechler River 1/33	491.6 Bechler River 1932–33

(Measurements are inches of snowfall)
† Figures have been exceeded at mountain top stations.

Source: Ludlum, D.M., "Weather Record Book - the Outstanding Events 1871-1970"

Fig. 4 Extremes of snowfall by states

SECTION X

SNOW DEPTH

Numerous studies have been made of the relationship between snow cover and frost penetration.[2,4,5,24,28,30] Crawford[14] states that on the average the frost depth is reduced about two feet for each foot of snow cover, while others report that snow reduced frost penetration by an amount equal to its depth. Baker[3] concludes that examination of the type of winter (snow depth and duration) with cumulative growing degree days proved to be a simple and effective means of predicting the maximum freezing depth. Baker also states, "the period when liquid water is restricted in movement through the soil is of obvious importance." This is defined as the period extending from the time when the temperature (at the 5 cm. depth) remained less than 32°F until the 32°F isotherm completely disappeared from the soil. The commencement date of this period was selected to ensure that water was in solid form and that soil was frozen sufficiently to serve as an effective barrier to surface water. The mean commencement date of this period at St. Paul, Minnesota was December 1 and the mean termination date was April 16. Thus, the mean duration was 136 days and over the eight years he examined ranged from 118 to 166 days. It is interesting to note that the Freezing Index program gives a mean of 124 days, while the value expected to be exceeded 10% of the time is 142 days.

Maps showing the depth of snow on the ground at 0700 EST each Monday during the winter months are published in the Weekly Weather and Crop Bulletin.[36] A map of the average annual number of days with snow cover one inch or more is presented in Figure 5. In addition, maps showing the maximum water equivalent, in inches, have been published in the U. S. Weather Bureau Technical Paper #50.[32] They show the maximum water equivalent for selected periods (i.e., March 1-15) expected to be equaled or exceeded once in two years, once in 25 years, etc. (selected probability levels). These can be useful in estimating soil moisture and stream flow in the Midwest during the spring months.

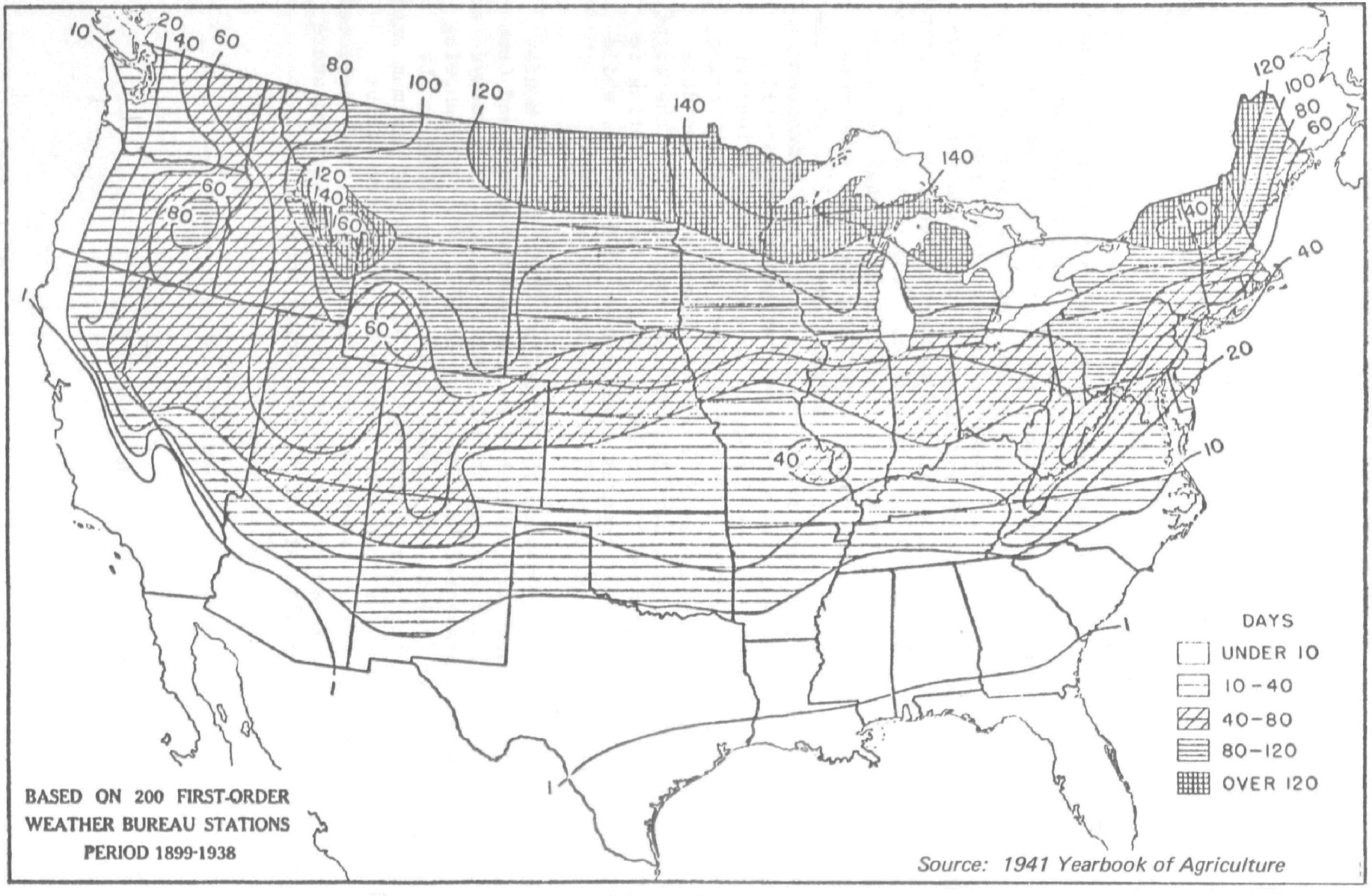


Fig. 5 Average annual number of days with snow cover 1.00 inch or more in depth

SECTION XI

WIND DIRECTION AND SPEED

Analysis of wind speed and wind direction can be provided in many ways as shown in Appendix I. Maps have been prepared which show the prevailing direction and speed on a monthly basis for the United States. While this information can be useful, the design engineer may be more interested in the occurrence of high wind speeds from certain sectors. In spray irrigation, for example, high winds might be acceptable only from a certain quadrant. In addition, the duration and frequency of such events may be of special interest. Processing the observed data can provide probabilities, or the likelihood of certain conditions occurring during those months when spraying is at a peak. The wind pattern is of particular interest [35] where municipal wastewater is applied by spraying and aerosol drift is a problem of significant concentration. In addition, prevailing wind direction, especially during the warm months, should be considered if odor is a problem.

Stations in the National Weather Service routinely report hourly wind direction and speed. Most of these stations also report the daily peak gust, along with its direction and time of occurrence. Special summaries can be prepared for those areas where more detailed wind information is available.

SECTION XII

AIR TEMPERATURE

Hourly and daily temperatures are recorded at most of the stations operated by the National Weather Service, while only daily measurements are taken at the cooperative stations. The mean of the daily maximum and minimum temperatures measured in a shelter about six feet above the ground is the average daily temperature. Although some stations compute daily averages for a 24-hour period ending at midnight and other stations use a different 24-hour period (8 a.m. to 8 a.m.), either type can be used in the programs discussed in this report.

Any combination of freezing air temperatures, frozen ground or the presence of snow and ice can result in ice formation from at least part of the applied liquid. A frozen surface reduces (or prevents) the infiltration of the effluent which leads to ponding and/or runoff which can cause severe erosion.[34]

A wide assortment of temperature summaries, maps,[16] etc., have been prepared as shown in Appendix J. Tables showing the average dates of the last freezing temperature in the spring and the first in the fall are available in several publications[18,36] and provide information on the length of the growing season.

SECTION XIII

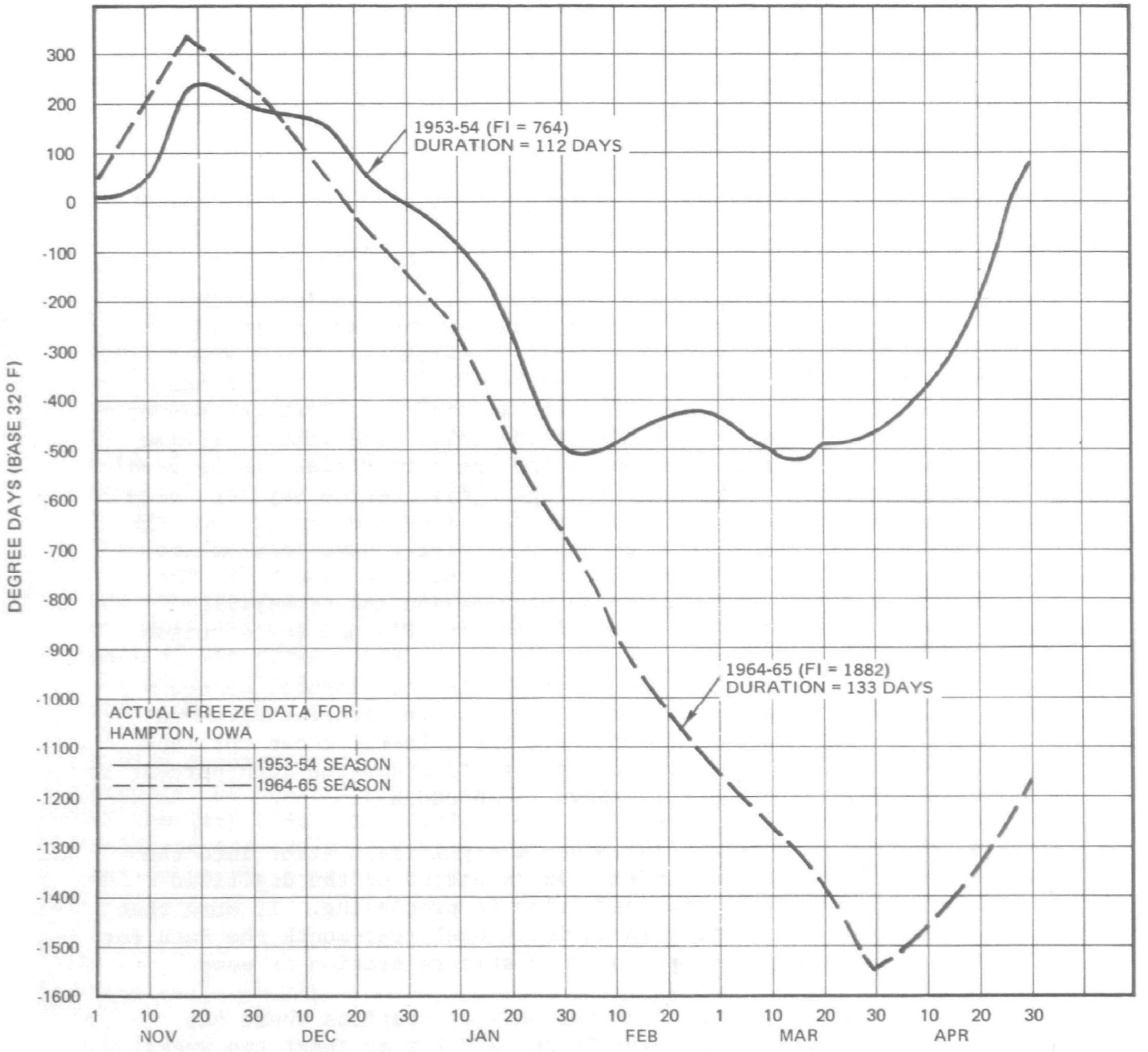
FREEZING DEGREE DAYS

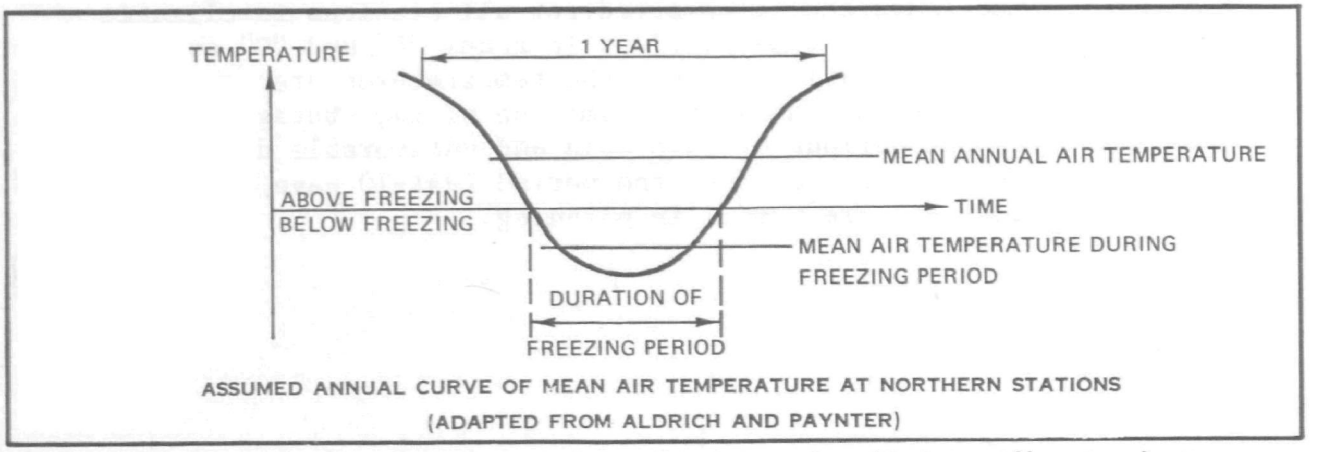
Degree Days are a measure of the departure of the average daily temperature from a standard. Freezing degree days are computed by subtracting 32°F from the average daily temperatures. They are positive when the average daily temperature is above 32°F and negative when below 32°F. Degree days accumulated over a winter season provide a measure of the intensity of the cold. The length of time between the onset of the cold period and the spring thaw can be used in estimating storage requirements (Figure 6). Degree day accumulations are obtained for each freezing season (November-April) and the Freezing Index is defined as the number of degree days between the highest and lowest point on a curve plotted against time.[4,26] The indexes are averaged over a 20 to 30 year period and probability tables can be prepared for both the intensity (FI) and the duration.

A map of mean air Freezing Index values in the continental United States is shown in Figure 7. Notice the expected general agreement with maps of daily average temperature, the climatic zones for land application, average depth of frost penetration and the 10th percentile minimum temperature for January shown in Appendix J.

Missing temperature data can introduce a significant error into the computation of the Freezing Index. An inventory of the digitized record for the station is examined prior to processing. If more than four days records are missing in an individual year-month the data for that station are not processed and a substitute station is used.

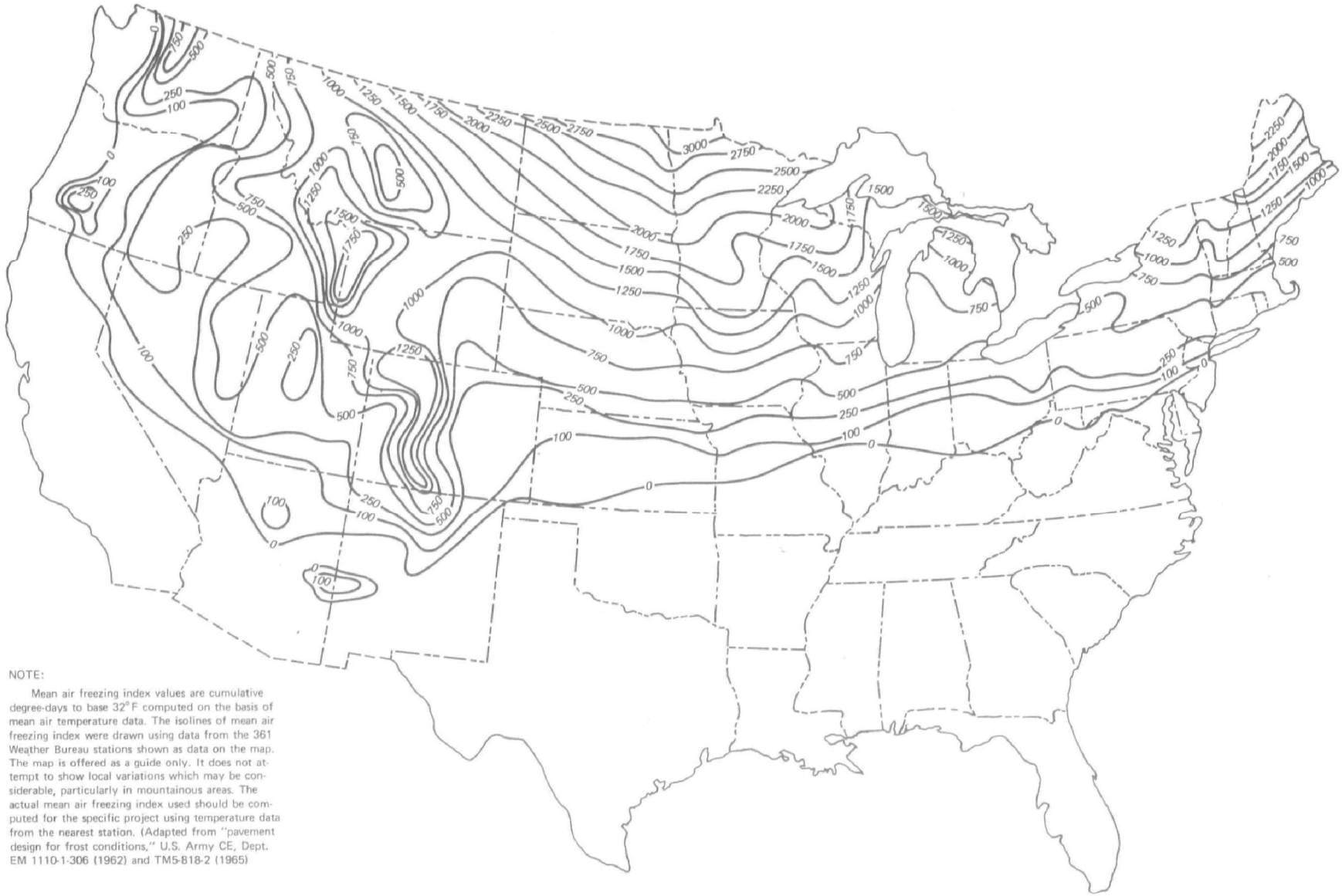
The Freezing Index should be computed only at stations where the average daily temperature remains below 32°F for at least two weeks. As a rule, the index can be computed for all stations in climatic zones "D" and "E"; for some stations in zones "B" and "C" and for most stations at high elevations. When the temperatures are not low enough to obtain the Freezing Index an estimation of the storage needs may be obtained from the periods of Favorable and Unfavorable days. Monthly normals of temperature based on the period 1941-70 have been published for each state [9] and are useful in planning.





ASSUMED ANNUAL CURVE OF MEAN AIR TEMPERATURE AT NORTHERN STATIONS
(ADAPTED FROM ALDRICH AND PAYNTER)

Fig. 6 Examples of the freeze index during a mild winter and a cold winter at Hampton, Iowa



NOTE:

Mean air freezing index values are cumulative degree-days to base 32° F computed on the basis of mean air temperature data. The isolines of mean air freezing index were drawn using data from the 361 Weather Bureau stations shown as data on the map. The map is offered as a guide only. It does not attempt to show local variations which may be considerable, particularly in mountainous areas. The actual mean air freezing index used should be computed for the specific project using temperature data from the nearest station. (Adapted from "pavement design for frost conditions," U.S. Army CE, Dept. EM 1110-1-306 (1962) and TM5-818-2 (1965)

Fig. 7 Distribution of mean air freezing index values in the continental United States

A special feature has been included in this program which permits greater flexibility in determining the duration of a "cold period" in the milder climates. The mild days occurring between cold spells can be considered as an extension of the cold spell. In addition, the intensity of the mild days (Positive Degree Days) is examined and the episode continued until either the duration, or the intensity reaches fixed threshold values. This feature can be seen in the listings (Figures 8, 9, 10, and 11) and is especially useful in areas where the mean temperature of the coldest month is between 28° and 34°F. A mean daily temperature of 33° and 34° may not be considered significant in breaking a cold spell if it persists for only a few days. Requesters have the option of setting a limit on the number of mild days as well as on the maximum number of degree days observed during this mild period. For example, if a cold period lasting twelve days was followed by three days when the positive cumulative degree days did not exceed 6 and low temperatures returned for an additional ten days, the total duration would be defined as 25 days.

An example is given in Figure 9 of a station in a mild climate where the greatest Freezing Index is not selected for a particular season. The modified threshold of 4 days, or 8 cumulative degree days has been used to continue cold spells which would otherwise be ended by a warm period. The cold period of greatest duration during the 1960-61 season ran 28 days (from December 8, 1960 to January 5, 1961) and had a Freezing Index of 171. A more intense (FI=266), but shorter (20 days) cold spell occurred between January 18 and February 7, 1961. The modified program is thereby designed to select the longest cold period rather than the one with the largest Freezing Index.

SECTION XIV

FAVORABLE AND UNFAVORABLE DAYS FOR OPERATION

The Freezing Index can be a useful guide in estimating storage requirements for stations in cold climates, but is not designed for locations where the average daily temperature remains above 32°F. For stations whose monthly normal temperature during January is around 30°F, an examination of the Favorable-Unfavorable days is more useful. The constraints to operation are assumed to be average daily temperature 32°F or less; snow depth 1.00 inch or more, or daily precipitation greater than 0.50 inch. These thresholds are flexible depending on the definition of non-operating conditions for the system being considered. The occurrence of fog or high winds might be a constraint for a short period, but neither is likely to be of significance except in isolated cases. Daily weather observations for a 20 to 30-year period are scanned by the computer and each day is classed as Favorable or Unfavorable according to the previously mentioned criteria. The number of days in sequence for each condition is printed each time the sequence is broken.

If a system is designed for twelve months operation, storage needs can be estimated by converting the number of Unfavorable days into days of storage. The estimated daily volume to be distributed is then reduced according to the number of Favorable days. This is necessary since, when irrigation begins, the current daily flow must be used as well as the stored volume. This cumulative cycle is continued through each winter season to determine the maximum number of days when storage is required based upon the assigned threshold criteria. The example in Figure 8 uses thresholds of (1.00) for an Unfavorable day and minus one-half (-0.50) for Favorable days. The greatest accumulated value is printed out at the end of each season and in Table 1 as MAX STOR. Examination of the frequency distribution of the length of runs of Favorable-Unfavorable periods is also recommended (Figures 8, 9, 10, and 11).

The marginal areas between distinct climatic zones present the greatest challenge in estimating the climatic constraints and the associated storage requirements. Over-estimating storage needs will result in excessive costs. If the estimated storage is insufficient, the operational problems are obvious. For such cases, the extreme conditions could be examined to discover their frequency and intensity as well as the ensuing consequences of such events.

The Favorable-Unfavorable day (FA-UNF) program has been used to process climatological data for a number of stations. Data for Pauls Valley, which lies in South Central Oklahoma, is an example of a location where the normal temperature for the coldest month is above 32°F and the FA-UNF portion of the program should be utilized. Although the maximum number of UNF days is given, the exact distribution of FA-UNF days is not obvious from the tables. Several runs of UNF (storage) days may be broken by short spells of FA (operating) days. In order to take into account those days when operation could take place, the following procedure was initiated. An assumed storage volume (1 unit) was assigned to each day defined as UNF. It was further assumed that during FA days of operation the system could disperse an amount equal to one and one-half units. Therefore, a one is added in the storage counter for each UNF day and a one-half is subtracted for each FA day. This cumulative count (MAX STOR) is continued through each individual season and the largest number is thus an estimate of the number of days storage would be required based upon the defined thresholds. At the end of each season and period of record these values are listed and percentiles are computed. This method of accounting results in a more reliable estimate of storage requirements than obtained from relying only on the maximum number of UNF days.

JOB NO. 14843

USE OF CLIMATIC DATA IN DESIGN OF SOILS TREATMENT SYSTEMS

Listing of Daily Weather Observations

PERIOD OF RECORD:

STA:	
YR:	49 = 1949, etc.
MO:	01 = Jan., etc.
DA:	01-31
MAX:	daily maximum temperature (°F)
MIN:	daily minimum temperature (°F)
MEAN:	daily mean temperature (°F)
SNOW DEPTH:	depth of snow on the ground at observation time. T = trace
PPPP:	total daily precipitation amount, inches and hundredths (T = trace)
FOG:	an "F" in this column means that fog occurred on the indicated date
DD:	daily degree days to base 32°F, computed by subtracting 32 from the daily mean temperature (DMT) i.e., DD = DMT - 32
CDD:	the cumulative degree days provide a measure of coldness. As the winter becomes colder the CDD's change from positive to negative (or decrease). The difference between the extreme values is a measure of the intensity of the cold period and is defined as the freeze index. The number of days between these points is the duration of the cold period. Tables of high to low freeze index and percentiles are furnished in Table 1. An option is available which provides for extension of cold periods through short (4 day) warm spells. In addition, the intensity of the warm period determined by the accumulated degree days may not exceed a selected base (currently set at 8).
FA:	favorable day of operation: Mean daily temperature is above 32°F, snow depth is less than 1 inch and total daily precipitation is less than 0.50 inch (all conditions must be met).
UNF:	unfavorable day of operation: Mean daily temperature is 32°F, or less, snow depth is 1", or more, and total daily precipitation is more than 0.49 inch (one or more conditions must be met). Thresholds may change from one station to the next.
DUR FA, UNF:	The numbers here indicate the length of runs (in days).
MAX STOR:	A value of one (1.00)is assigned to each day when storage is required (unfavorable), while a value of minus one-half (-0.50) is given to each day when the system could operate (favorable). These values are accumulated for each season with the counter reset to a minimum base of zero regardless of the number of favorable days in a sequence (Figure 9). The maximum values in this column are printed at the end of each season and in Table 1.

Table 1: A summary of the information obtained at the end each season which shows 10, 25, 50, 75 and 90 percentile values along with the average Freeze Index over the period.

Table 2: A distribution of the sequential sets of unfavorable-favorable days shown in the listings. For example, a run of 12 UNF days followed by a run of 20 FA days makes the set (12-20) and is counted in the third row down (11-15 UNF) and the fourth column (16-20 FA) from the left.

Fig. 8 Description of chronological listing shown in Fig. 9

USE OF CLIMATIC DATA IN DESIGN OF SOILS TREATMENT SYSTEMS 01/08/75

STA # 937210 BALTIMORE, MD (FRIENDSHIP AP) POR: 501101-720430

YR	MO	DA	MAX	MIN	MEAN	SNOW DPTH	PPPP	FOG	DD	CDD	FA	DUR FA	UNF	DUR UNF	MAX STOR
60	12	01	40	28	34				2	456	X				
60	12	02	43	22	33				1	457	X				
60	12	03	53	26	40				8	465	X				
60	12	04	58	23	41				9	474	X				
60	12	05	64	34	49				17	491	X				
60	12	06	65	30	48				16	507	X				
60	12	07	55	34	45				13	520	X				
60	12	08	42	27	35				3	523	X				
60	12	09	33	13	23				-9	514		38	X		1.0
60	12	10	49	12	31				-1	513			X		2.0
60	12	11	39	23	31		1.12	F	-1	512			X		3.0
60	12	12	24	14	19	12	.53	F	-13	499			X		4.0
60	12	13	19	8	14	9			-18	481			X		5.0
60	12	14	33	11	22	7			-10	471			X		6.0
60	12	15	33	9	21	6		F	-11	460			X		7.0
60	12	16	42	24	33	5	.01	F	1	461			X		8.0
60	12	17	37	14	26	5			-6	455			X		9.0
60	12	18	34	10	22	3			-10	445			X		10.0
60	12	19	38	8	23	2		F	-9	436			X		11.0
60	12	20	31	10	21	2			-11	425			X		12.0
60	12	21	37	21	29	2	.41	F	-3	422			X		13.0
60	12	22	21	4	13	2			-19	403			X		14.0
60	12	23	26	0	13	2			-19	384			X		15.0
60	12	24	24	11	18	2			-14	370			X		16.0
60	12	25	42	12	27	2			-5	365			X		17.0
60	12	26	50	16	33	2		F	1	366			X		18.0
60	12	27	44	22	33	1			1	367			X		19.0
60	12	28	26	15	21	1			-11	356			X		20.0
60	12	29	33	24	29	2	.84	F	-3	353			X		21.0
60	12	30	39	24	32			F	0	353			X		22.0
60	12	31	37	20	29	1	.01	F	-3	350			X		23.0

Fig. 9 Chronological listing of daily weather observations for Baltimore, Md. for Dec. 1960 with computed values

USE OF CLIMATIC DATA IN DESIGN OF SOILS TREATMENT SYSTEMS 01/08/75

STA # 937210 BALTIMORE, MD (FRIENDSHIP AP) POR: 501101-720430

HIGH TO LOW FREEZE INDEX

INDX	DATE BEGIN	DATE END	DUR	MAX FA	MAX UNF	MAX STOR
217	660107	660209	33	29	23	37.0
188	621208	630105	28	34	22	54.0
171	601208	610105	28	38	30	54.5
171	671222	680117	26	36	22	24.5
149	631213	640101	19	20	20	34.5
144	580207	580221	14	19	24	36.0
118	600229	600316	16	25	17	25.0
117	691231	700116	16	16	11	34.0
112	581205	581222	17	28	13	31.5
104	570110	570120	10	25	7	13.5
99	550126	550205	10	30	5	19.0
94	650110	650121	11	35	14	26.5
79	510129	510210	12	24	7	21.0
69	551209	551223	14	23	14	32.5
62	540110	540118	8	33	8	11.5
62	670216	670301	13	28	11	28.0
59	681229	690108	10	34	8	23.0
58	511212	511219	7	17	8	10.5
55	620206	620221	15	19	14	50.0
41	720203	720210	7	22	12	20.0
35	701224	710101	8	24	17	35.0
8	521226	521229	3	17	5	7.5

AVERAGE INDEX 101.

PERCENTILES			
10%	183	28	53.0
25%	145	17	35.2
50%	96	13	27.2
75%	59	9	19.7
90%	37	7	10.8

Fig. 10 Seasonal values of the freezing index, as indicated, with percentiles

USE OF CLIMATIC DATA IN DESIGN OF SOILS TREATMENT SYSTEMS 01/08/75

STA # 937210 BALTIMORE, MD (FRIENDSHIP AP) POR: 501101-720430

UNFAVORABLE DAYS OF OPERATION	FAVORABLE DAYS OF OPERATION																				
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	100+
1-5	246	72	39	18	7	3	4	1													
6-10	21	5																			
11-15	9			①																	
16-20	1	2																			
21-25	3	2																			
26-30	1																				
31-35																					
36-40																					
41-45																					
46-50																					
51-55																					
56-60																					
61-65																					
66-70																					
71-75																					
76-80																					
81-85																					
86-90																					
91-95																					
96-100																					
100+																					

Fig. 11 Distribution of sets of UNF-FA days of operation

SECTION XV

REFERENCES

1. Aldrich, H. P., Jr. and Paynter, H. M., "Depth of Penetration in Non-Uniform Soil," Special Report 104, U. S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire (October 1966). 11 p.

2. Atkinson, H. B. and Bay, E. E., "Some Factors Affecting Frost Penetration," Transactions, American Geophysical Union, Vol. 21, Part 3B, pp 935-947 (September 1940).

3. Baker, D. G., "Snow Cover and Winter Soil Temperatures at St. Paul, Minnesota," Water Resources Research Center, Minneapolis, Minnesota (June 1971). 16 p.

4. Bigelow, N., Jr., "Freezing Index Maps of Maine," Technical Paper 69-5R, Materials and Research Division, Maine State Highway Commission (September 1969). 20 p.

5. Boyd, D. W., "Normal Freezing and Thawing Degree Days for Canada (1931-1960)," Atmospheric Environment Service, Department of Environment, Downsview, Ontario, Canada (1973). 40 p.

6. "Climate and Man," Yearbook of Agriculture, U. S. Department of Agriculture, Washington, D. C. (1941). 1248 p.

7. "Climatic Atlas of the United States," U. S. Department of Commerce, Environmental Science Services Administration, Environmental Data Service, Washington, D. C. (June 1968). 80 p.

8. "Climatological Data, National Summary," U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, National Climatic Center, Asheville, North Carolina (1973). 114 p.

9. "Climatography of the U. S. No. 81, Monthly Normals of Temperature, Precipitation and Heating and Cooling Degree Days, 1941-70 (by State)," U. S. Department of Commerce, National Climatic Center, Asheville, North Carolina (August 1973). 250 p.

10. "Climatography of the United States, No. 82, Summary of Hourly Observations," U. S. Department of Commerce, U. S. Weather Bureau, Washington, D. C. (1963). 15 p.

11. "Climatography of the United States, No. 84, Daily Normals of Temperature and Heating and Cooling Degree Days, 1941-70," U. S. Department of Commerce, National Climatic Center, Asheville, North Carolina (September 1973). 650 p.

12. "Climatography of the United States, No. 85, Monthly Averages of Temperature and Precipitation for State Climatic Divisions 1941-70, U. S. Department of Commerce, National Climatic Center, Asheville, North Carolina (July 1973). 150 p.

13. "Compendium of Meteorology," edited by Thomas F. Malone, American Meteorological Society, Boston, Massachusetts (1951). 1334 p.

14. Crawford, C. B., "Construction on Permafrost," Division of Building Research, National Research Council, Ottawa, Canada.

15. Decker, W. L., "Periods with Temperatures Critical to Agriculture," North Central Regional Research Publication No. 174, University of Missouri Agricultural Experiment Station, Columbia, Missouri (1967). 76 p.

16. Doner, J. P., "A Predictive Study for Defining Limiting Temperatures and Their Application in Petroleum Product Specifications," U. S. Army, Mobility Equipment Research and Development Center, Coating and Chemical Laboratory, Aberdeen Proving Ground, Maryland (1972). 176 p.

17. "Extreme Maximum Values of Evaporation at Selected Stations in Eleven Western States and Texas," Bulletin 761, Washington Agriculture Experiment Station, College of Agriculture, Pullman, Washington (October 1972). 32 p.

18. "Freezing Temperature in Oklahoma," Oklahoma State University Extension Center, Stillwater, Oklahoma (undated). 23 p.

19. Jessberger, H. L., "Ground Frost: A Listing and Evaluation of More Recent Literature Dealing with the Effect of Frost on the Soil," U. S. Army Foreign Science and Technology Center, U. S. Army Material Command, Washington, D. C. (February 1970). 500 p.

20. "Local Climatological Data, Annual Summary with Comparative Data," U. S. Department of Commerce, National Climatic Center, Asheville, North Carolina (1973).

21. Ludlum, D. M., "Weather Record Book-The Outstanding Events 1871-1970," Weatherwise, Inc., Princeton, N. J. (1971). 98 p.

22. "Muskegon County Plan for Managing Wastewater," Bauer Engineering Co., Chicago, Illinois (1969).

23. "National Atlas of the United States," Hydrologic Services Division, U. S. Weather Bureau, Washington, D. C. (1966). 417 p.

24. "Pavement Design for Frost Conditions," U. S. Department of Commerce, Superintendent of Documents, Washington, D. C. (1962). 64 p.

25. "Precipiation Probabilities in the North Central States," Bulletin 753, Agricultural Experiment Station, University of Missouri, Columbia, Missouri (June 1960). 72 p.

26. "Prediction of Freezing Temperature Penetaration in New England," Miscellaneous Paper II, Arctic Construction and Frost Effects Laboratory, U. S. Army Corps of Engineers, Boston, Massachusetts (June 1955).

27. "Revised Uniform Summary of Surface Weather Observations, Part B," Unpublished Tabulations, U. S. Department of Commerce, National Climatic Center, Asheville, North Carolina (1973). 6 p.

28. Sanger, F. J., "Computations on Frost in the Ground," Journal of the New England Water Works Association, 80 (1): pp 47-67 (1966).

29. Sepp, E., "The Use of Sewage for Irrigation - A Literature Review," Bureau of Sanitary Engineering, Sacramento, California (1971).

30. "Soil Temperature and Ground Freezing," Bulletin 71, Proceedings of the Thirty-Second Annual Meeting of the Highway Research Board, Washington, D. C. (January 1953).

31. "Survey of Facilities Using Land Application of Wastewater, Report No. 430/9-73-006, U. S. Environmental Protection Agency, Washington, D. C. (July 1973). 377 p.

32. "Frequency of Maximum Water Equivalent of March Snow Cover in North Central United States," Technical Paper No. 50, U. S. Weather Bureau, Office of Hydrology, Cooperative Studies Section, Washington, D. C. (1964). 24 p.

33. "The National Climatic Center (NCC)," U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Washington, D. C. (1970). 34 p.

34. "Wastewater Management by Disposal on the Land," Special Report #171, U. S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire (May 1972). 183 p.

35. "Wastewater Treatment and Reuse by Land Application, Volumes I and II," Report No. 660/2-73-006 a and b, Environmental Protection Technology Series, Office of Research and Development, U. S. Environmental Protection Agency, Washington, D. C. (August 1973). 80 p. and 249 p.

36. "Weekly Weather and Crop Bulletin," U. S. Department of Commerce, U. S. Department of Agriculture, Agricultural Climatology Service Office, Washington, D. C. (1973). 14 p.

37. Wisner, W. M., "Rainfall Frequency Atlas for Missouri," University of Missouri Extension Division, Columbia, Missouri (1973). 32 p.

SECTION XVI

APPENDICES

A. INTRODUCTION TO APPENDICES

Examples are presented in the Appendices of some of the many types of published and unpublished summaries of climatological data which may be of interest to those planning Soil Treatment Systems. They have been prepared by a number of organizations and are shown primarily to provide information on the variety of material available. Many of the summaries were developed to fill a need in one particular discipline, e.g., engineering, aviation, agriculture, etc., but can be useful in others.

Special methods sometimes must be designed to fit the needs of a particular problem, as in the case of the Freeze Index and Unfavorable-Favorable Day programs. In all cases, the weather observations have been recorded by several networks to satisfy the public requirements by the most economical means. They occasionally may be less than ideal for answering a specific problem because of incomplete or broken periods of record. Careful examination of basic input data will be a guide as to the degree of confidence one might expect.

The NCC library participates in the Intra-library Loan System with the Library of Congress, universities and other State and Federal Agencies. Copies of all NCC produced computer tabulations of climatological data are indexed and filed for future use. A large part of the Center's holdings are available in the form of microfilm and/or magnetic tape and can also be furnished to users for the cost of duplication.

For easy reference the Appendices B-L are identified in the following pages in the lower right corner.

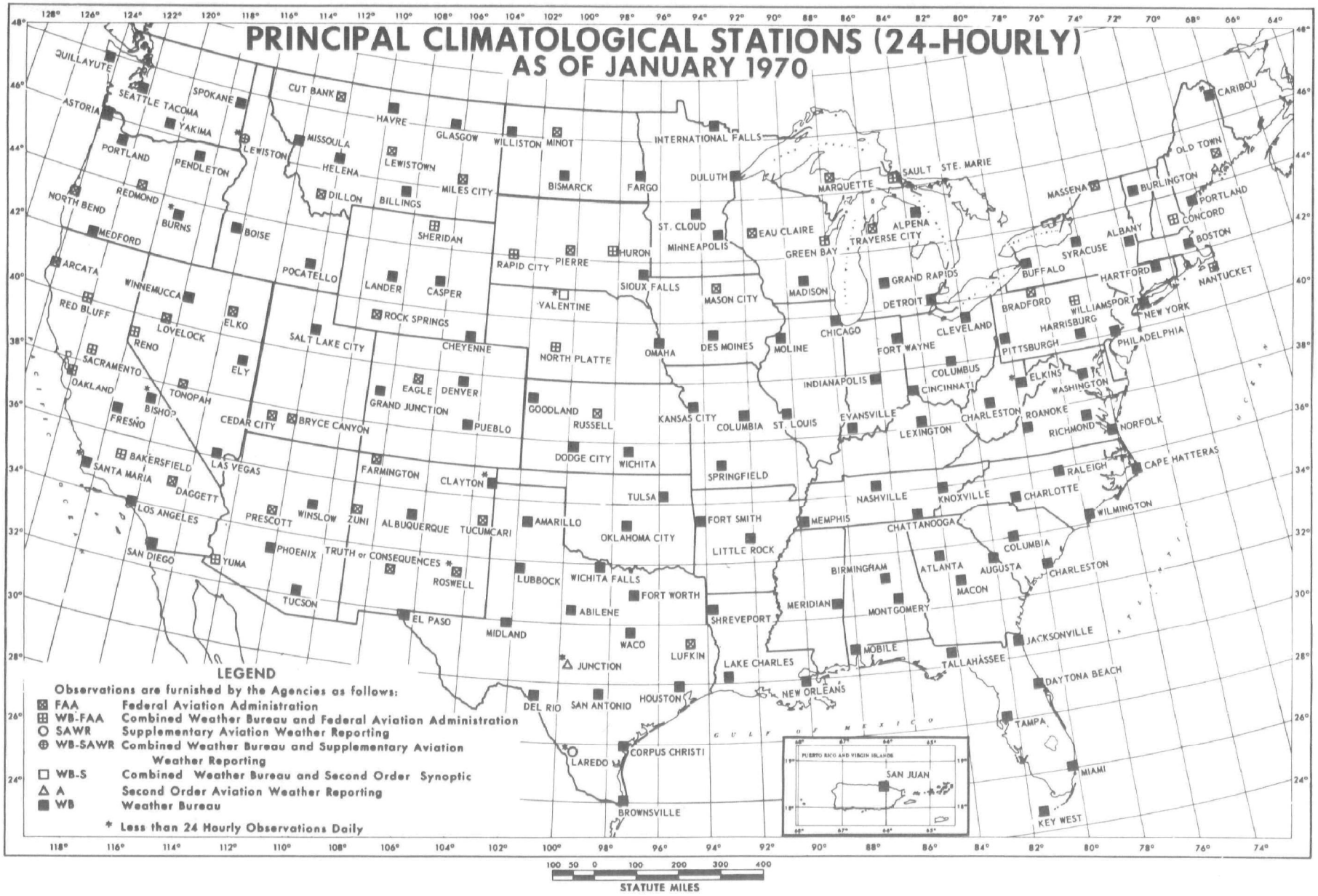


Fig. 1 Primary weather reporting network

LOCAL CLIMATOLOGICAL DATA

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA SERVICE

HILO, HAWAII
GENERAL LYMAN FIELD
JANUARY 1972

Latitude 19° 43' N Longitude 155° 04' W Elevation (ground) 27 ft. Standard time used: ALASKAN WBAN #21504

Date	Temperature °F: Maximum	Minimum	Average	Departure from normal	Average dew point	Degree days Base 65°: Heating	Cooling	Weather types on dates of occurrence (1 Fog, 2 Heavy fog x, 3 Thunderstorm, 4 Ice pellets, 5 Hail, 6 Glaze, 7 Duststorm, 8 Smoke, Haze, 9 Blowing snow)	Snow, ice pellets or ice on ground at 02AM In.	Precipitation: Water equivalent In.	Snow, ice pellets In.	Avg. station pressure In. Elev. 36 feet m.s.l.	Wind: Resultant direction	Resultant speed m.p.h.	Average speed m.p.h.	Fastest mile: Speed m.p.h.	Fastest mile: Direction	Sunshine: Hours and tenths	Sunshine: Percent of possible	Sky cover Tenths: Sunrise to sunset	Sky cover Tenths: Midnight to midnight	Date
1	80	60	70	-1	63	0	5	3	0	.01	0	29.84	16	4.6	6.0	14	E	6.3	58	4	5	1
2	81	61	71	0	64	0	6		0	.06	0	29.91	14	4.3	7.5	17	E	5.4	49	7	7	2
3	79	66	73	2	67	0	8		0	.47	0	29.99	10	3.3	6.2	14	E	2.1	19	7	9	3
4	77	61	69	-2	63	0	4		0	.01	0	29.96	14	1.1	4.9	8	SW	3.4	31	7	8	4
5	78	58	68	-3	58	0	3		0	0	0	29.88	21	2.1	6.6	8	NE	6.5	59	6	5	5
6	78	60	69	-2	60	0	4		0	.12	0	29.92	23	1.2	5.3	8	NE	2.6	24	7	8	6
7	70	62	66*	-5	64	0	1		0	2.36	0	29.99	24	4.4	5.2	12	SW	0.1	1	10	10	7
8	73	63	68	-3	64	0	3		0	.66	0	30.01	24	3.5	4.5	11	SW	0.1	0	10	10	8
9	77	57	67	-4	59	0	2		0	.05	0	29.97	33	.1	4.2	8	SW	5.3	48	7	6	9
10	78	60	69	-2	62	0	4		0	.08	0	29.93	31	.5	6.2	9	SW	6.4	58	6	7	10
11	77	57*	67	-4	59	0	2		0	0	0	29.91	15	.8	5.2	8	NE	7.1	65	4	4	11
12	80	59	70	-1	63	0	5		0	.04	0	29.95	13	.2	5.2	9	N	1.8	16	8	7	12
13	83*	63	73	2	68	0	8		0	.57	0	29.95	14	5.0	7.5	17	E	5.1	46	8	8	13
14	80	68	74	3	69	0	9		0	.03	0	29.96	15	6.6	8.1	17	E	3.0	27	7	8	14
15	81	70	76*	5	67	0	11		0	T	0	29.98	16	5.6	8.1	15	E	2.9	26	8	9	15
16	81	63	72	1	64	0	7		0	.01	0	30.00	16	5.5	7.6	14	E	2.6	24	7	7	16
17	78	61	70	-1	62	0	5		0	.01	0	30.02	17	.4	3.7	7	NE	1.5	13	9	7	17
18	79	61	70	-1	61	0	5		0	.06	0	30.04	15	1.0	5.0	10	NE	6.8	61	4	5	18
19	80	59	70	-1	60	0	5		0	.24	0	30.02	14	3.0	7.8	14	E	5.4	49	6	7	19
20	81	62	72	1	63	0	7		0	0	0	30.02	16	5.3	7.5	14	E	2.8	25	6	6	20
21	79	63	71	0	65	0	6		0	.27	0	30.00	10	4.2	7.1	15	E	1.2	10	8	8	21
22	74	65	70	-1	66	0	5		0	1.34	0	29.97	21	4.7	6.0	13	SW	0.0	0	10	10	22
23	80	64	72	1	65	0	7		0	T	0	29.85	14	9.4	10.4	19	SE	4.2	37	8	8	23
24	75	69	72	1	70	0	7		0	4.29	0	29.74	15	6.9	7.5	18	E	0.0	0	10	10	24
25	75	68	72	1	68	0	7		0	.10	0	29.79	01	4.8	6.0	10	N	0.0	0	10	10	25
26	78	62	70	-1	64	0	5		0	0	0	29.86	35	2.9	6.8	12	N	6.0	54	5	7	26
27	76	65	71	0	64	0	6		0	.01	0	29.85	36	6.5	7.9	18	NW	0.1	1	10	10	27
28	73	66	70	-1	63	0	5		0	T	0	29.84	33	4.8	6.3	10	NW	0.0	0	10	10	28
29	73	64	69	-2	63	0	4		0	.17	0	29.79	34	5.6	7.5	14	NW	0.0	0	10	10	29
30	77	59	68	-3	61	0	3		0	0	0	29.75	33	3.6	6.3	13	NW	4.3	38	8	8	30
31	77	60	69	-2	59	0	4		0	0	0	29.78	31	2.0	5.8	9	NW	1.5	13	9	9	31
	Sum 2408	Sum 1936				Total 0	Total 163			Total 10.96	Total 0	For the month: 29.92	15	1.2	6.4	19	SE	Total 96.5	% for 23	Sum 236	Sum 243	
	Avg. 77.7	Avg. 62.5	Avg. 70.1	Dep. -0.7	Avg. 63	Dep.	Dep.			Dep. -0.86						Date:		Possible	month	Avg. 7.0	Avg. 7.8	
																		343.9	27			

Number of days: Maximum Temp. ≤ 90°	≤ 32°	Minimum Temp. ≤ 32°	≤ 0°
0	0	0	0

Season to date: Total / Dep.

Number of days: Precipitation ≥ .01 inch 22; Snow, ice pellets ≥ 1.0 inch 0; Thunderstorms 1; Heavy fog X 0; Clear 0; Partly cloudy 13; Cloudy 16

Greatest in 24 hours and dates: Precipitation 4.32 24-25; Snow, ice pellets 0

Greatest depth on ground of snow, ice pellets or ice and date: 0

HOURLY PRECIPITATION (Water equivalent in inches)

Date	A. M. Hour ending at 1	2	3	4	5	6	7	8	9	10	11	12	P. M. Hour ending at 1	2	3	4	5	6	7	8	9	10	11	12	Date
1	.01																								1
2																					.02			.04	2
3	.21	.04					T				T	.02						.09	.02	T	.09	T	T		3
4						.01	T																		4
5																									5
6																			.06		T	T	.06	T	6
7				.14	.19	.17	.19	.16	T	.37	.03	.08	.08	.12	.14	.03	.05	T		.35	.13	.10	.01	.02	7
8	.09	.01	.29	.04		T	.09	.06	.01	T	.02	.03	.04	T	T	.01	.01	.01	.02	T	.03	T			8
9									.01	T											.03	.01	T		9
10		.01	.01		.02	T	.01	.01											T	.02					10
11																							T	.04	11
12																									12
13	T																					.02	.33	.22	13
14	T	.01								.02														T	14
15	T																								15
16			.01	T																					16
17							.01	T	T																17
18				T	T		.06	T																	18
19								T											.04	.11	.06	.03			19
20																									20
21				.03	T	.01	T	T		.03	.12	T	.01								.02	.01	.02	.02	21
22		.03	.25	.03	.17	.15	.09	T	T	T		.03	.02	.06	.04	.02	.39	.05	T	T	T	T	T	.01	22
23																		T	T	T	T	T	T		23
24	.04	.42	.26	.09	.03	.01	.06	.05	.02	.29	.28	.03	.14	.35	.46	.95	.52	.21	.01	.01	T	.01	.01	.04	24
25	.07	T											T	T						.01	T		.02	T	25
26																									26
27																					.01	T			27
28	T	T																	T	T					28
29																	.07	.06	.04	T	T				29
30																									30
31																									31

* Extreme temperatures for the month. May be the last of more than one occurrence.
– Below zero temperature or negative departure from normal.
≥ ≥ 70° at Alaskan stations.
+ Also on an earlier date, or dates.
X Heavy fog restricts visibility to ¼ mile or less.
T In the Hourly Precipitation table and in columns 9, 10, and 11 indicates an amount too small to measure.

The season for degree days begins with July for heating and with January for cooling.
Data in columns 6, 12, 13, 14, and 15 are based on 8 observations per day at 3-hour intervals.
Wind directions are those from which the wind blows. Resultant wind is the vector sum of wind directions and speeds divided by the number of observations. Figures for directions are tens of degrees from true North; i.e., 09 = East, 18 = South, 27 = West, 36 = North, and 00 = Calm. When directions are in tens of degrees in Col. 17, entries in Col. 16 are fastest observed 1-minute speeds. If the / appears in Col. 17, speeds are gusts.
Any errors detected will be corrected and changes in summary data will be annotated in the annual summary.

Subscription Price: Local Climatological Data $1.00 per year including annual summary if published. Single copy: 10 cents for monthly summary; 15 cents for annual summary. Checks or money orders should be made payable and remittances and correspondence should be sent to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

I certify that this is an official publication of the National Oceanic and Atmospheric Administration, and is compiled from records on file at the National Climatic Center, Asheville, North Carolina 28801.

William H. Haggard
Director, National Climatic Center

SUMMARY BY HOURS

Hour Local time	Sky cover Tenths	Station pressure In.	AVERAGES: Temperature Air °F	Wet bulb °F	Dew Pt. °F	Relative humidity %	Wind speed m.p.h.	Resultant wind: Direction	Speed m.p.h.
02	7	29.92	65	63	62	90	4.3	22	3.5
05	7	29.90	64	62	61	90	5.4	22	3.8
08	8	29.94	66	63	61	87	5.0	22	4.0
11	8	29.95	74	69	66	75	7.4	07	3.5
14	7	29.87	75	69	65	72	10.2	08	6.5
17	8	29.88	72	67	65	78	8.4	07	3.7
20	8	29.96	68	66	64	88	5.8	20	1.4
23	8	29.95	66	64	63	90	5.0	22	2.7

Fig. 2 Local climatological data (monthly) prepared for stations in the primary network

B

COLUMBIA, S.C. METEOROLOGICAL DATA FOR THE CURRENT YEAR

Station: COLUMBIA, SOUTH CAROLINA — COLUMBIA METROPOLITAN AIRPORT — Standard time used: EASTERN — Latitude: 33° 57' N — Longitude: 81° 07' W — Elevation (ground): 213 feet — Year: 1973

Month	Temperature: Averages: Daily maximum	Daily minimum	Monthly	Extremes: Highest	Date	Lowest	Date	Degree days (Base 65°): Heating	Cooling	Precipitation: Total	Greatest in 24 hrs.	Date	Snow, ice pellets: Total	Greatest in 24 hrs.	Date	Relative humidity (Local time): Hour 01	Hour 07	Hour 13	Hour 19	Wind &: Resultant: Direction	Speed	Average speed	Fastest mile: Speed	Direction	Date	Percent of possible sunshine	Average sky cover sunrise to sunset	Number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, ice pellets 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures: Maximum: 90° and above	32° and below	Minimum: 32° and below	0° and below	Average daily solar radiation - langleys
JAN	56.3	33.5	44.9	71	20+	18	14	618	0	5.25	1.94	7-8	2.2	2.2	7-8	78	79	52	65	31	1.8	7.3	18	30	15+	54	6.1	9	6	16	11	1	0	0	17	0			
FEB	57.4	30.6	44.0	71	2	5	12	583	0	5.75	2.47	1-2	16.0	15.7	9-10	72	80	46	55	32	2.5	7.8	25	01	10	30	5.6	12	3	13	8	2	1	0	17	0			
MAR	69.5	47.6	58.6	88	14	26	1	219	28	10.89	2.34	8	0.0	0.0		82	89	61	66	20	0.8	7.4	31	27	17	39	7.4	4	9	18	17	0	0	0	4	0			
APR	72.6	47.3	60.0	84	23+	30	12	179	33	4.47	2.49	7	0.0	0.0		74	80	45	49	24	3.5	8.8	30	28	10	70	5.6	12	6	12	6	0	2	0	3	0			
MAY	80.6	54.9	67.8	91	11	28	3	47	143	4.04	1.18	7-8	0.0	0.0		84	85	45	57	24	3.3	7.1	28	33	11	47	6.3	7	9	15	8	0	7	1	3	0			
JUN	86.8	67.6	77.2	93	17	57	1	0	375	14.81	5.44	15-16	0.0	0.0		89	91	62	73	11	1.0	6.0	29	19	15	57	7.3	6	4	20	14	0	14	4	6	0	0	0		
JUL	90.5	70.8	80.7	99	30	65	13	0	494	3.19	0.74	23	0.0	0.0		83	87	57	70	19	1.5	6.0	21	04	23	66	6.2	5	15	11	9	0	15	4	21	0	0	0		
AUG	90.4	70.7	80.6	96	11	63	21	0	490	8.92	2.71	1	0.0	0.0		91	93	59	73	22	0.4	5.8	25	33	20	57	6.5	8	11	14	14	0	10	7	18	0	0	0		
SEP	89.0	68.1	78.6	96	8	63	20+	0	413	4.47	1.45	9-10	0.0	0.0		89	93	56	77	98	1.6	5.8	21	07	26	64	5.3	8	17	5	7	0	7	3	14	0	0	0		
OCT	80.7	52.6	66.7	90	5+	35	18	57	116	0.71	0.52	28-29	0.0	0.0		91	90	45	73	36	1.4	5.0	18	23	28	67	3.9	18	3	10	4	0	3	0	2	0	0	0		
NOV	74.5	43.5	59.0	85	3	24	12	205	32	0.41	0.33	21	0.0	0.0		86	90	46	67	27	2.2	6.7	25	31	21	73	4.2	14	5	11	2	0	0	5	0	0	8	0		
DEC	62.2	36.7	49.5	81	31	18	22	477	6	6.66	1.78	8-9	T	T	17 +	80	89	58	71	27	1.8	7.6	22	28	10	61	5.5	11	8	12	12	0	2	2	0	0	13	0		
YEAR	75.9	52.0	64.0	99	JUL. 30	5	FEB. 12	2385	2130	67.57	5.44	JUN. 15-16	18.2	15.7	FEB. 9-10	83	87	53	67	26	0.9	6.8	31	27	MAR. 17	59	5.8	112	96	157	112	3	67	34	64	0	62	0		

NORMALS, MEANS, AND EXTREMES

Month	Temperature: Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal heating degree days (Base 65°)	Precipitation: Normal total	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, ice pellets: Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity (Local time): Hour 01	Hour 07	Hour 13	Hour 19	Wind &: Mean speed	Prevailing direction	Fastest mile: Speed	Direction	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, ice pellets 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures: Max.: 90° and above	32° and below	Min: 32° and below	0° and below	Average daily solar radiation - langleys
(a)	(b)	(b)	(b)	7		7		(b)	(b)	26		26		26		26	26		26		7	7	7	7	23	14	20	20		20	25	26	26	26	26	26	26	25	7	7	7	7	
J	56.9	33.9	45.4	79	1970	5	1970	608	3.46	7.02	1972	0.97	1949	2.82	1968	0.4	2.2	1973	2.2	1973	80	83	55	66	7.1	SW	46	28	1964	58	6.2	9	6	16	10	*	1	2	0	1	17	0	
F	59.7	35.5	47.6	81	1972	5	1973	493	3.67	8.68	1961	1.12	1950	3.69	1962	0.9	16.0	1973	15.7	1973	74	80	46	57	7.7	SW	40	20	1966+	39	5.9	9	6	13	10	*	1	2	0	*	17	0	
M	66.5	41.9	54.2	88	1973	20	1967	360	4.67	10.89	1973	1.25	1949	3.59	1960	0.2	3.2	1960	2.8	1960	74	83	48	54	8.4	SW	40	27	1954	64	5.7	10	8	13	11	*	3	2	0	*	7	0	
A	76.9	51.3	64.1	94	1970	29	1972	83	3.51	5.89	1938	0.91	1970	3.66	1956	0.0	0.0		0.0		77	84	45	50	8.5	SW	40	27	1961	68	5.3	11	8	11	8	0	0	1	0	0	0	0	
M	84.5	59.6	72.1	93	1970	36	1971	12	3.39	8.85	1967	0.29	1951	3.57	1967	0.0	0.0		0.0		84	88	49	61	7.1	SW	46	23	1958	65	5.5	10	10	11	9	0	0	1	0	0	0	0	
J	90.3	67.2	78.8	104	1970	46	1972	0	3.82	14.81	1973	1.26	1955	5.44	1973	0.0	0.0		0.0		88	90	54	64	6.8	SW	40	23	1957	64	5.8	8	12	10	9	0	0	2	0	0	0	0	
J	92.0	70.3	81.2	103	1970	59	1972+	0	5.65	13.87	1959	1.15	1957	5.81	1959	0.0	0.0		0.0		89	91	57	72	6.6	SW	40	35	1965	65	6.1	6	13	12	12	0	1	2	0	0	0	0	
A	91.0	69.4	80.2	106	1968	53	1969	0	5.63	16.72	1949	1.11	1968	7.66	1949	0.0	0.0		0.0		91	93	59	74	6.1	SW	44	16	1961	66	5.6	9	12	10	11	0	0	0	0	0	0	0	
S	85.4	63.3	74.5	97	1970	40	1967	0	4.32	8.78	1953	0.76	1958	6.23	1953	0.0	0.0		0.0		92	94	56	75	6.2	NE	38	11	1959	65	5.4	10	9	11	7	0	0	0	0	0	0	0	
O	77.1	51.3	64.2	90	1973+	29	1967	112	2.58	12.09	1959	T	1963	5.46	1964	0.0	0.0		0.0		89	92	54	76	6.2	NE	27	21	1968+	65	4.6	15	9	10	6	0	1	3	*	0	1	0	
N	66.9	40.6	53.8	85	1973	12	1970	341	2.34	7.20	1957	0.41	1973	2.30	1963	T	T	1968+	T	1968+	84	88	49	71	6.5	SW	35	35	1967	65	4.7	13	7	10	7	0	1	3	0	0	1	0	
D	57.8	34.1	46.0	83	1971	17	1972+	589	3.88	7.43	1953	0.32	1955	3.18	1970	0.4	9.1	1958	8.8	1958	80	85	55	71	6.7	WSW	30	29	1954	61	5.7	11	6	14	9	*	*	3	0	0	13	0	
YR	75.4	51.5	63.5	106	AUG. 1968	5	FEB. 1973+	2598	46.36	16.72	AUG. 1949	T	OCT. 1963	7.66	AUG. 1949	1.9	16.0	FEB. 1973	15.7	FEB. 1973	84	88	53	66	7.0	SW	60	27	MAR. 1954	64	5.5	121	103	141	110	1	54	27	65	1	85	0	

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 107 in June 1954+; lowest temperature -2 in February 1899.

(a) Length of record, years, based on January data. Other months may be for more or fewer years if there have been breaks in the record.
(b) Climatological normals (1941-1970).
* Less than one half.
\+ Also on earlier dates, months, or years.
T Trace, an amount too small to measure.
— Below zero temperatures are preceded by a minus sign.
‡ ≤ 70° at Alaskan stations.

The prevailing direction for wind in the Normals, Means, and Extremes table is from records through 1963.

Unless otherwise indicated, dimensional units used in this bulletin are: temperature in degrees F.; precipitation, including snowfall, in inches; wind movement in miles per hour; and relative humidity in percent. Heating degree day totals are the sums of negative departures of average daily temperatures from 65° F. Cooling degree day totals are the sums of positive departures of average daily temperatures from 65° F. Sleet was included in snowfall totals beginning with July 1948. The term "ice pellets" includes solid grains of ice (sleet) and particles consisting of snow pellets encased in a thin layer of ice. Heavy fog reduces visibility to 1/4 mile or less.

Sky cover is expressed in a range of 0 for no clouds or obscuring phenomena to 10 for complete sky cover. The number of clear days is based on average cloudiness 0-3, partly cloudy days 4-7, and cloudy days 8-10 tenths.

Solar radiation data are the averages of direct and diffuse radiation on a horizontal surface. The langley denotes one gram calorie per square centimeter.

& Figures instead of letters in a direction column indicate direction in tens of degrees from true North; i.e., 09 - East, 18 - South, 27 - West, 36 - North, and 00 - Calm. Resultant wind is the vector sum of wind directions and speeds divided by the number of observations. If figures appear in the direction column under "Fastest mile" the corresponding speeds are fastest observed 1-minute values.

SOURCE: Local Climatological Data, Annual Summary 1973

Fig. 3 Local climatological data (annual) prepared for stations in the primary network

COLUMBIA, S.C.

AVERAGE TEMPERATURE

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1934	49.1	41.7	53.0	63.9	69.7	80.3	82.7	80.7	77.0	64.6	56.7	45.6	63.8
#1935	47.0	47.9	61.4	65.3	72.2	80.0	80.4	80.0	74.1	64.9	57.2	39.4	63.9
#1936	43.0	44.7	58.6	60.6	73.8	79.2	82.4	81.0	77.0	67.2	53.2	49.4	64.2
1937	54.0	48.3	54.2	62.4	72.7	79.8	80.9	79.4	72.9	62.0	51.5	45.4	63.8
1938	46.6	54.0	61.6	64.0	73.4	76.9	79.3	82.4	75.4	64.9	57.4	47.4	65.2
1939	49.8	54.6	59.2	63.8	71.0	81.8	81.5	79.6	78.2	68.4	51.8	48.3	65.7
1940	35.3	46.8	59.0	61.5	69.4	79.4	80.8	79.6	75.8	65.3	54.4	51.0	62.5
1941	47.0	43.6	49.6	66.4	73.8	78.1	81.0	80.7	77.6	72.2	55.9	50.2	64.7
1942	46.4	43.6	56.2	65.9	72.3	80.1	83.0	79.2	76.2	66.1	57.4	45.9	64.4
1943	48.4	49.8	55.6	62.6	73.7	82.2	80.8	81.0	72.2	63.4	53.4	46.8	64.0
1944	46.6	52.8	54.7	63.0	74.6	81.8	78.9	78.6	76.3	64.8	53.8	42.6	64.1
1945	46.3	51.2	64.8	67.2	69.1	80.4	80.6	79.2	77.8	63.9	56.7	41.6	64.9
1946	48.0	50.8	61.8	64.8	71.2	78.6	79.7	78.6	74.4	65.4	60.2	51.8	65.4
#1947	51.2	42.6	47.4	66.4	72.6	78.0	78.0	80.4	76.0	68.2	51.1	45.7	63.2
1948	40.2	47.7	58.2	66.6	72.4	80.3	83.6	79.4	72.4	59.7	58.5	49.6	64.0
1949	55.1	54.1	55.4	61.9	72.7	79.2	83.2	79.8	72.9	68.7	52.6	48.6	65.4
1950	57.5	51.4	51.9	61.9	74.1	80.6	79.2	78.7	72.9	66.7	50.2	41.3	63.9
1951	45.8	48.2	55.3	61.9	70.3	80.0	81.4	82.2	75.5	67.7	49.9	49.4	64.0
1952	52.3	49.9	59.8	62.9	73.5	83.8	83.4	80.0	73.9	59.3	54.3	44.7	64.2
1953	49.7	49.6	56.0	62.2	77.3	80.2	82.0	80.2	74.6	65.2	52.4	46.4	64.6
1954	47.3	52.8	54.5	64.8	66.5	79.9	83.9	83.1	78.1	65.8	50.4	44.6	64.4
1955	43.9	49.0	57.9	67.0	74.1	74.8	82.6	82.4	76.1	62.4	52.6	43.9	63.9
1956	42.7	52.0	54.7	62.4	73.7	79.4	82.5	81.9	72.5	66.0	52.8	36.2	64.8
1957	47.9	55.1	59.5	65.8	72.4	79.2	81.1	79.1	76.3	60.0	55.7	47.7	64.5
1958	40.0	40.8	49.9	63.6	71.9	78.2	81.9	81.8	75.1	61.2	57.5	42.2	62.0
1959	44.6	50.1	53.0	63.6	73.6	78.3	80.3	81.7	74.2	66.4	53.5	47.1	64.0
1960	45.3	45.6	49.8	65.3	70.8	79.0	81.2	81.1	75.9	66.5	54.2	41.3	62.5
1961	41.3	50.1	58.1	58.4	68.9	77.1	81.2	78.8	76.2	61.9	58.7	47.0	63.1
1962	44.8	52.5	51.3	60.8	74.7	77.3	81.6	80.6	73.9	63.4	52.3	43.7	63.4
1963	41.3	42.0	59.0	65.3	70.9	77.5	79.9	81.7	72.3	64.3	54.3	39.6	62.4
1964	44.1	43.7	54.8	64.2	72.4	80.3	78.8	78.4	73.8	59.1	58.2	49.8	63.2
1965	45.7	48.9	52.2	65.1	76.1	75.5	79.9	80.5	75.4	62.8	54.7	47.3	63.6
#1966	40.3	46.9	51.8	63.1	70.2	75.0	81.6	79.2	73.8	62.8	53.4	45.7	62.0
1967	46.9	43.0	57.1	65.6	67.0	73.5	77.6	75.7	67.3	60.2	49.1	49.6	61.0
1968	41.1	40.1	54.8	63.8	69.6	77.9	80.5	82.9	72.4	64.0	53.6	42.7	62.0
1969	42.7	43.5	51.1	65.2	70.6	78.3	83.1	77.5	72.8	65.3	50.8	44.1	62.1
1970	38.3	47.5	57.1	67.6	73.0	78.8	83.4	81.3	78.6	64.7	50.7	50.1	64.3
1971	43.4	46.3	50.9	61.3	69.8	80.3	80.0	80.1	77.1	69.8	53.8	56.6	64.2
1972	50.9	45.7	59.9	63.1	68.4	73.9	79.2	79.1	75.2	62.7	53.5	51.3	63.1
1973	44.9	44.0	58.6	60.0	67.8	77.2	80.7	80.6	78.6	66.7	59.0	49.5	64.0
RECORD MEAN	46.3	48.0	55.1	63.4	71.8	78.5	80.8	79.9	75.1	64.5	54.3	47.3	63.8
MAX	56.2	58.4	66.0	74.9	83.1	89.2	90.7	89.6	85.0	75.6	65.5	57.3	74.3
MIN	36.4	37.9	44.1	51.9	60.5	67.8	70.8	70.1	65.2	53.3	43.1	37.2	53.2

HEATING DEGREE DAYS

COLUMBIA, SOUTH CAROLINA

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
#1934-35	0	0	0	76	270	602	560	498	177	130	15	0	2328
1935-36	0	0	4	85	265	790	681	588	222	174	0	0	2809
#1936-37	2	0	0	59	365	483	302	476	338	128	7	0	2160
1937-38	0	0	11	166	412	608	570	311	155	109	1	0	2343
1938-39	0	0	9	81	257	543	474	299	205	101	42	0	2007
1939-40	0	0	0	65	400	919	925	527	376	148	49	0	3009
1940-41	0	0	20	63	324	436	557	598	476	86	14	0	2544
1941-42	0	0	0	17	275	458	578	595	291	87	1	0	2302
1942-43	0	0	21	38	258	583	526	429	367	145	4	0	2379
1943-44	0	0	7	107	358	572	576	377	332	132	13	0	2474
1944-45	0	1	3	94	340	682	580	394	116	57	59	0	2326
1945-46	0	0	0	88	270	728	537	398	140	98	10	0	2269
#1946-47	0	0	1	64	170	409	431	630	548	42	33	1	2329
1947-48	0	0	32	31	419	599	762	509	252	56	4	0	2664
1948-49	0	0	6	185	223	481	312	313	345	141	7	0	2013
1949-50	0	0	17	20	372	516	253	383	420	184	2	0	2167
1950-51	0	0	22	35	455	725	585	469	313	133	10	0	2747
1951-52	0	0	2	47	460	492	390	444	348	124	14	0	2316
1952-53	0	0	0	209	315	620	467	423	282	137	0	0	2453
1953-54	0	0	0	72	375	569	543	352	352	63	69	0	2395
1954-55	0	0	0	137	438	630	647	444	261	47	1	0	2605
1955-56	0	0	0	131	380	648	683	370	333	154	9	0	2708
1956-57	0	0	23	45	372	263	531	283	350	102	91	0	2020
1957-58	0	0	20	160	287	526	766	671	463	113	19	0	3025
1958-59	0	0	3	148	249	702	630	412	370	93	5	0	2614
1959-60	0	0	1	98	350	630	603	557	695	84	38	0	2936
1960-61	0	0	0	85	317	728	728	412	238	227	15	3	2753
1961-62	0	0	7	123	272	550	620	360	430	183	0	0	2545
1962-63	0	0	14	112	378	653	726	641	208	86	41	0	2859
1963-64	0	0	14	70	311	779	840	612	325	112	17	0	2880
1964-65	0	0	3	204	216	473	592	466	398	93	0	0	2445
1965-66	0	0	2	138	303	543	759	502	408	128	19	1	2803
#1966-67	0	0	0	127	351	596	554	605	270	67	71	18	2851
1967-68	0	0	32	164	469	480	732	717	327	106	20	0	3047
1968-69	0	0	0	121	339	684	683	594	430	71	13	0	2935
1969-70	0	0	2	86	419	640	823	484	252	73	12	0	2791
1970-71	0	0	6	85	420	462	602	519	462	155	27	0	2738
1971-72	0	0	0	13	354	292	429	595	341	136	12	1	2183
1972-73	0	0	0	98	350	423	618	583	219	179	47	0	2517
1973-74	0	0	0	37	205	477							

TOTAL PRECIPITATION

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1934	1.10	3.77	3.16	2.81	3.61	3.30	4.27	3.69	1.97	2.60	3.18	2.29	35.75
#1935	0.77	1.37	2.47	2.30	2.46	2.06	7.89	10.26	5.65	0.54	2.80	2.80	41.77
#1936	5.96	4.30	5.36	10.76	0.06	1.85	7.10	9.82	2.09	4.72	2.58	4.62	58.92
1937	4.10	4.39	2.50	0.48	3.29	6.20	4.79	6.30	1.27	2.28	2.10	2.01	45.65
1938	1.17	0.49	1.09	7.34	4.21	6.63	7.91	0.91	3.03	1.30	2.44	2.46	38.98
1939	1.84	9.39	1.85	2.18	3.47	2.53	6.93	6.16	6.06	0.04	0.90	2.18	43.33
1940	2.49	2.89	3.01	2.09	1.90	4.21	1.44	5.18	1.18	0.68	4.42	1.32	30.79
1941	1.16	1.80	2.37	2.13	0.51	9.94	8.53	4.95	1.27	0.98	0.46	4.89	38.99
1942	2.20	2.94	6.12	2.75	4.57	4.67	7.24	4.68	2.66	1.01	2.25	4.14	45.23
1943	3.01	0.90	5.12	3.14	9.07	3.85	4.46	3.84	2.65	0.13	0.76	3.75	36.70
1944	2.68	4.44	6.90	4.29	1.76	4.03	8.54	1.82	3.42	2.39	1.29	0.91	43.09
1945	1.63	2.92	1.80	1.75	2.61	3.06	5.78	4.05	10.54	0.69	0.86	6.35	40.04
1946	1.96	2.56	2.81	3.71	3.39	0.71	4.20	2.74	1.36	4.62	1.67	0.47	30.20
#1947	3.87	0.77	5.24	5.61	2.87	4.38	5.31	3.96	9.07	3.37	7.95	4.06	60.44
1948	4.58	5.44	7.67	1.30	5.60	2.75	2.60	2.76	7.29	3.50	4.85	3.85	54.39
1949	0.97	6.38	1.25	5.81	2.34	1.70	5.36	10.72	2.63	2.38	1.01	1.62	47.87
1950	2.77	1.12	4.16	1.27	4.45	3.55	11.79	4.72	6.46	1.34	1.70	3.52	46.95
1951	1.50	1.42	6.85	4.87	0.29	4.79	8.16	1.27	4.70	0.67	2.31	3.76	38.59
1952	3.46	4.31	7.00	3.10	3.47	2.44	1.17	11.95	2.65	0.70	1.58	3.84	45.47
1953	1.98	5.35	3.70	3.41	3.49	6.46	4.25	6.81	8.78	0.82	1.28	7.43	53.46
1954	1.91	2.24	2.44	2.09	2.20	1.49	2.24	5.91	1.75	1.23	1.92	1.96	27.38
1955	4.80	2.17	2.00	4.01	3.00	1.26	2.95	4.79	1.38	2.55	2.13	0.32	31.46
1956	1.73	5.48	3.99	5.31	1.92	1.70	3.68	1.77	7.94	1.83	0.66	2.46	38.42
1957	2.48	1.30	4.39	2.25	6.71	1.86	1.15	4.12	6.74	1.80	7.20	2.44	42.64
1958	4.09	2.87	4.47	5.89	3.79	3.01	8.70	1.93	0.76	2.65	0.58	3.84	44.19
1959	2.94	4.99	6.28	2.84	3.79	2.67	13.87	4.52	7.12	12.09	0.67	2.	66.00
1960	7.15	5.93	6.17	3.91	1.47	2.37	4.79	5.52	3.94	1.17	0.68	2.	49.07
1961	2.93	8.68	5.75	3.52	2.98	1.95	5.70	14.94	1.46	0.82	1.01	3.21	54.95
1962	6.49	5.18	4.40	3.21	2.32	4.78	2.67	3.10	2.85	0.89	4.93	2.27	42.09
1963	5.38	3.94	3.28	4.18	2.67	4.84	2.68	1.91	3.98	T	4.30	5.05	42.11
1964	6.36	5.35	6.16	3.60	2.63	2.97	10.32	9.97	6.93	10.36	1.36	4.38	70.53
1965	1.48	9.35	7.68	3.99	1.46	8.20	4.35	9.39	5.99	2.34	1.77	0.64	52.55
1966	7.22	4.34	2.23	3.58	6.14	3.66	2.87	3.22	2.02	2.47	1.05	3.31	42.31
1967	2.79	4.36	3.08	3.72	8.85	4.18	7.27	11.16	2.38	0.62	3.71	2.59	56.71
1968	5.94	1.14	1.92	4.52	4.17	3.41	9.28	1.11	2.40	4.31	5.21	3.26	48.67
1969	2.64	3.03	5.16	4.57	3.28	4.70	4.31	2.93	3.17	1.17	1.29	4.31	40.67
1970	3.28	2.58	8.42	0.91	4.50	2.05	4.74	7.13	3.72	0.18	1.43	4.55	51.49
1971	4.55	5.28	9.53	4.31	2.71	7.46	11.13	10.68	5.03	3.44	2.35	2.90	69.32
1972	7.62	3.58	3.79	1.16	6.41	4.10	9.31	2.87	2.31	1.19	5.62	5.89	55.51
1973	5.25	5.75	10.86	4.47	4.04	14.81	3.19	6.92	4.47	0.71	0.41	6.66	67.57
RECORD MEAN	3.27	3.86	3.87	3.22	3.23	4.13	5.62	5.63	3.80	2.46	2.82	3.15	45.06

TOTAL SNOWFALL

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
#1934-35	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.0	0.0	0.0	0.0	T
#1935-36	0.0	0.0	0.0	0.0	0.0	4.4	6.2	1.1	T	0.0	0.0	0.0	11.7
1936-37	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	T
1937-38	0.0	0.0	0.0	0.0	T	0.0	T	T	T	0.0	0.0	0.0	T
1938-39	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T
1939-40	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	1.5
1940-41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.0	0.0	T
1941-42	0.0	0.0	0.0	0.0	0.0	T	T	T	0.0	0.0	0.0	0.0	T
1942-43	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	T	0.0	0.0	0.0	1.8
1943-44	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	1.3
1944-45	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	T
1945-46	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
#1946-47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1947-48	0.0	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.0	0.0	0.0	T
1948-49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1949-50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1950-51	0.0	0.0	0.0	0.0	T	T	0.0	T	0.0	0.0	0.0	0.0	T
1951-52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	T
1952-53	0.0	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.0	0.0	0.0	T
1953-54	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T
1954-55	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	1.7
1955-56	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	T	0.0	0.0	0.0	T
1956-57	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	T	0.0	0.0	0.0	T
1957-58	0.0	0.0	0.0	0.0	0.0	T	T	1.4	0.0	0.0	0.0	0.0	1.4
1958-59	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0	1.0	0.0	0.0	0.0	10.1
1959-60	0.0	0.0	0.0	0.0	0.0	T	T	T	3.2	0.0	0.0	0.0	3.2
1960-61	0.0	0.0	0.0	0.0	0.0	T	1.4	0.9	0.0	0.0	0.0	0.0	2.3
1961-62	0.0	0.0	0.0	0.0	0.0	0.0	T	T	T	0.0	0.0	0.0	T
1962-63	0.0	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.0	0.0	0.0	T
1963-64	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	0.0	T
1964-65	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	T	0.0	0.0	0.0	1.1
1965-66	0.0	0.0	0.0	0.0	0.0	0.0	1.0	T	0.0	0.0	0.0	0.0	1.0
1966-67	0.0	0.0	0.0	0.0	0.0	T	0.0	3.4	0.0	0.0	0.0	0.0	3.4
1967-68	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.0	0.0	0.0	0.0	0.0	2.7
1968-69	0.0	0.0	0.0	0.0	0.0	T	0.0	T	0.8	0.0	0.0	0.0	0.8
1969-70	0.0	0.0	0.0	0.0	0.0	T	1.8	T	0.0	0.0	0.0	0.0	1.8
1970-71	0.0	0.0	0.0	0.0	0.0	T	T	T	1.7	0.0	0.0	0.0	1.7
1971-72	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.8
1972-73	0.0	0.0	0.0	0.0	0.0	0.0	2.2	16.0	0.0	0.0	0.0	0.0	18.2
1973-74	0.0	0.0	0.0	0.0	0.0	T							

Record mean values above (not adjusted for instrument location changes listed in the Station Location table) are means for the period beginning in 1880.

# Indicates a break in the data sequence during the year, or season, due to a station move or relocation of instruments. See Station Location table. Data are from City Office locations through 2-14-47 and from Airport locations thereafter.

Fig. 4 Sequential tables in the local climatological data (annual)

B

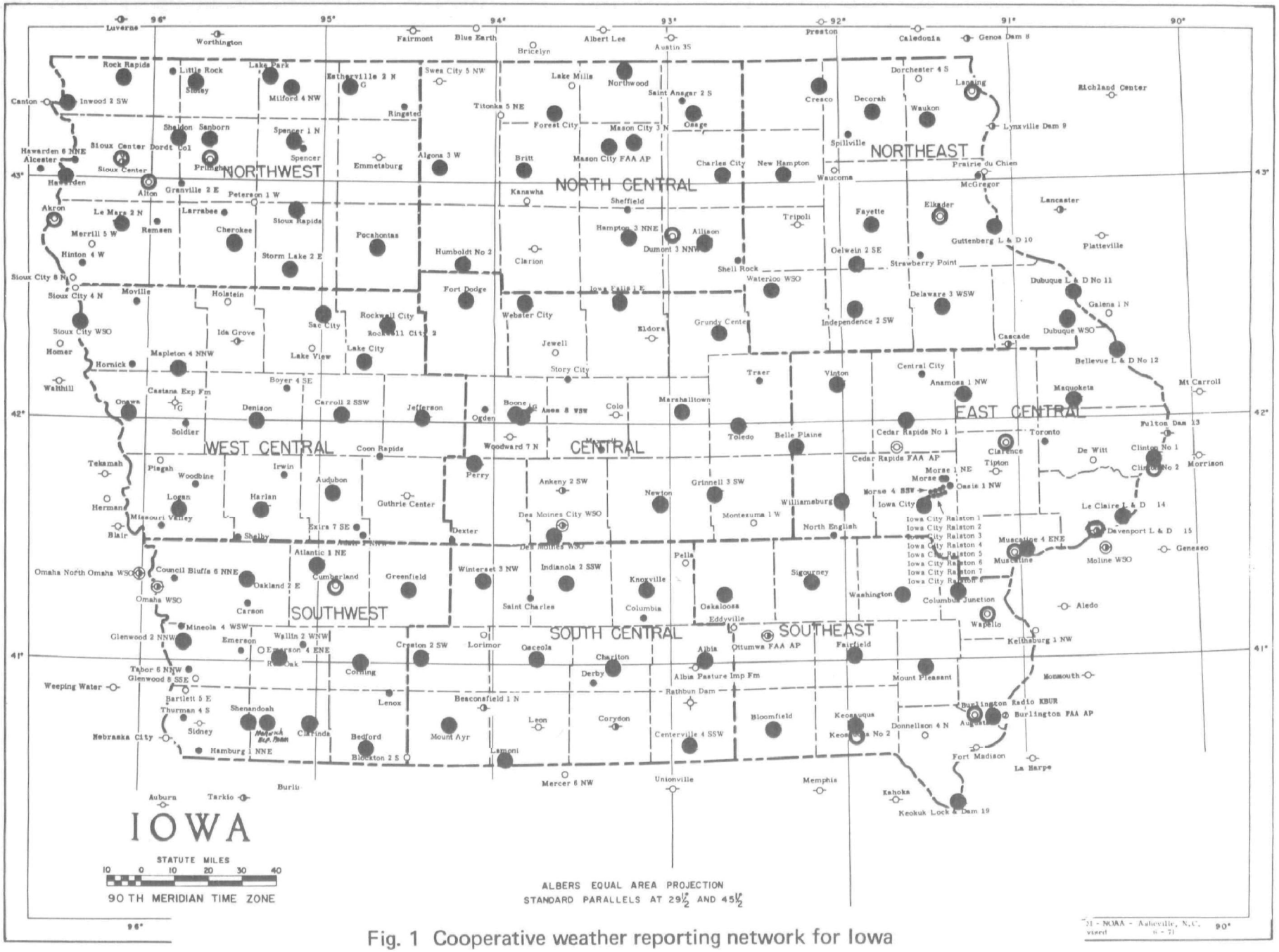


Fig. 1 Cooperative weather reporting network for Iowa

CLIMATOGRAPHY OF THE UNITED STATES NO. 20 - 26

CLIMATOLOGICAL SUMMARY

LATITUDE 39° 17' N
LONGITUDE 114° 51' W
ELEV. (GROUND) 6253

STATION Ely, Nevada
(Yelland Field)

MEANS AND EXTREMES FOR PERIOD 1938-1969

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days **	Precipitation Totals (inches): Mean	Greatest daily	Year	Snow, Sleet: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days. Precip. .10 inch or more	Temperatures Max. 90° and above	Max. 32° and below	Min. 32° and below	Min. 0° and below	Month
(a)	31	31	31	31		31		(b)	31	31		31	31		31		27	31	31	31	31	
Jan	37.8	9.1	23.5	68	1951	-27	1949	1308	.68	0.95	1952	8.9	24.8	1967	13.1	1943	2	0	9	30	7	Jan
Feb	40.8	13.9	27.4	66	1953	-25	1949	1075	.63	1.54	1969	7.1	19.9	1959	10.4	1956	2	0	6	27	5	Feb
Mar	46.8	19.1	33.0	73	1966	-13	1952	977	.85	0.86	1954	9.2	24.8	1958	10.6	1954	3	0	3	30	2	Mar
Apr	56.7	26.7	41.7	78	1962+	-5	1963	672	1.03	1.04	1947	5.8	24.5	1963	8.7	1964	4	0	*	24	*	Apr
May	66.6	33.9	50.3	87	1954+	7	1950	456	.92	1.42	1955	1.7	10.8	1964	7.2	1964	3	0	*	13	0	May
Jun	76.0	39.7	57.9	99	1954	19	1950	225	.92	1.50	1963	0.3	5.6	1939	5.6	1939	2	2	0	4	0	Jun
Jul	86.4	48.0	67.2	97	1960	30	1948	28	.58	1.22	1952	0.0	0.0		0.0		2	9	0	*	0	Jul
Aug	84.3	46.7	65.5	95	1962+	24	1960	43	.51	0.69	1957	0.0	0.0		0.0		2	5	0	1	0	Aug
Sep	76.0	37.7	56.9	93	1950	16	1965+	234	.69	1.25	1963	T	0.8	1958	0.8	1958	2	1	0	7	0	Sep
Oct	63.6	28.7	46.2	84	1967	8	1958+	592	.66	1.09	1968	1.7	7.8	1954	7.3	1954	2	0	*	22	0	Oct
Nov	49.2	18.8	34.0	71	1956+	-15	1964	939	.59	1.29	1960	4.6	15.3	1946	10.4	1967	2	0	3	28	1	Nov
Dec	41.0	12.6	26.8	67	1958	-22	1951	1184	.65	1.12	1966	7.3	22.3	1968	12.1	1967	2	0	6	30	4	Dec
Year	60.4	27.9	44.2	99	Jun 1954	-27	Jan 1949	7733	8.71	1.54	Feb 1969	46.0	24.8	Jan 1967+	13.1	Jan 1943	28	17	27	216	19	Year

(a) Average length of record, years.
(b) Climatological Standard Normals (1931-1960)
T Trace, an amount too small to measure.

** Base 65°F

\+ Also on earlier dates, months, or years.

* Less than one half.

CLIMATE OF ELY, NEVADA

Ely is located within and near the southern rim of the Great Basin. The weather station is near the center of Steptoe Valley, which is 5 miles wide at this point. The mountains of the Egan Range to the west and the Schell Creek Range to the east border the station. These ranges rise to an elevation of approximately 10,000 feet above sea level. These ranges also protect the valley from strong surface winds from the west and east, but enhance the drainage wind down the mountain slopes during the morning hours. The orientation of the mountains also influences the prevailing wind, which is from the south.

The neighboring terrain consists of alternate mountain ranges and sagebrush covered valleys. Principal cover of the mountains is juniper, pinion, and, at higher elevations, white fir and white pine.

The valley floor of this region is near 6,000 feet above sea level. This high elevation is conducive to sharp night time cooling, which not only produces pleasant summer nights, but also reduces the freeze free season to an average of 80 days. Minimum temperature of 32 degrees or lower has occurred every month of the year. Although the Ely weather station is only about 40 feet lower than McGill and about 5 miles to the north, its mean temperature averages about 3 degrees cooler than the temperature at McGill. Maximum temperatures during the summer months have never exceeded 99 degrees. With the low humidity, the high day temperatures are not uncomfortable. Relative humidity varies from about 20 percent in the afternoon of July to about 75 percent in the early winter mornings. The percent relative humidity for other periods of the day is listed in the table below.

MONTHLY AVERAGE PERCENT RELATIVE HUMIDITY FOR SELECTED TIMES OF DAY

TIME	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4 am	70	76	72	68	66	58	50	56	56	62	71	72
10 am	59	59	48	39	34	28	23	26	28	35	50	57
4 pm	55	52	40	34	30	24	21	23	23	28	45	54
10 pm	69	73	65	57	53	43	37	41	43	52	66	70

The warm moist southerly air flow from the Gulf of Mexico is prevalent over eastern Nevada for much of the summer. This moisture contributes to the production of an average of 32 thunderstorm days and 4 hail days making this the highest in the state.

Like much of Nevada, sunshine in Ely is abundant, averaging around 73 percent for the year and ranging from about 65 percent in the winter to near 80 percent for the summer. See the table below.

AVERAGE PERCENT POSSIBLE SUNSHINE

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
65	65	71	67	70	79	81	81	82	76	68	64	73

DATES OF LAST SPRING OCCURRENCE OF LOW TEMPERATURE (OR LOWER)

	Percent chance of later than indicated date								
Temp	90%	80%	70%	60%	50%	40%	30%	20%	10%
24°	4/20	4/27	5/03	5/08	5/12	5/16	5/21	5/27	6/04
28°	5/15	5/21	5/26	5/30	6/03	6/07	6/11	6/16	6/23
32°	6/05	6/09	6/12	6/15	6/17	6/19	6/22	6/25	6/29

DATES OF FIRST FALL OCCURRENCE OF LOW TEMPERATURE (OR LOWER)

	Percent chance of earlier than indicated date								
Temp	10%	20%	30%	40%	50%	60%	70%	80%	90%
24°	9/13	9/20	9/23	9/27	10/1	10/5	10/9	10/13	10/20
28°	9/03	9/08	9/11	9/14	9/17	9/20	9/23	9/26	10/01
32°	8/16	8/22	8/28	9/01	9/05	9/09	9/13	9/19	9/26

GROWING SEASON LENGTH (DAYS)

	Percent chance of longer than indicated length								
Temp	10%	20%	30%	40%	50%	60%	70%	80%	90%
24°	169	160	153	147	141	135	129	122	113
28°	129	121	115	110	105	100	95	89	81
32°	103	96	90	85	80	75	70	64	57

WIND SPEED AND DIRECTION

Month	Mean hourly Speed (mph)	Prevailing Direction	Fastest Speed (mph)	Fastest Direction	Year
Jan	10.8	S	66	SE	1952
Feb	10.8	S	56	S	1954
Mar	11.0	S	59	SE	1951
Apr	11.1	S	59	S	1968
May	10.8	S	74	S	1952
Jun	10.5	S	63	SW	1957
Jul	10.8	S	50	S	1954
Aug	10.8	S	57	E	1953
Sep	10.6	S	57	S	1950
Oct	10.5	S	65	S	1950
Nov	10.2	S	51	S	1954
Dec	10.2	S	61	SE	1952
Annual	10.7	S	74	S	May 1968

Clarence M. Sakamoto, ESSA State Climatologist
Richard O. Gifford, Associate Professor
Plant, Soil & Water Science Division
University of Nevada, Reno 89507
6/70

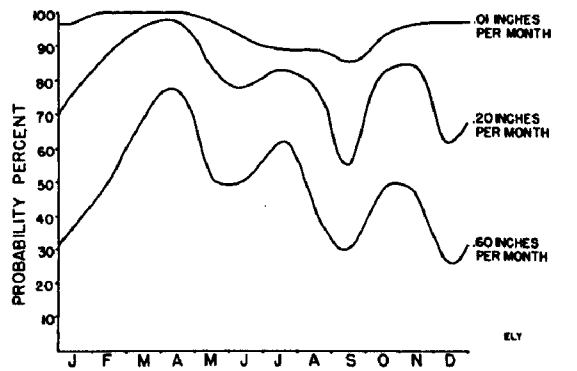
Fig. 2 Climatography of the United States No.20 prepared for stations in the cooperative network

Average Temperature (°F)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1938										44.8	28.6	27.3	
1939	21.1	14.7	34.5	45.8	51.8	57.4	67.4	66.3	57.1	44.4	37.7	34.0	44.4
1940	26.4	31.2	38.3	43.4	55.4	62.6	68.1	68.1	56.3	47.1	31.9	30.4	46.6
1941	27.2	34.7	36.2	36.2	51.4	55.8	65.1	63.0	51.1	41.8	34.6	28.6	43.8
1942	23.4	23.8	30.6	41.6	46.0	57.4	70.1	65.6	55.7	45.6	35.0	31.2	43.8
1943	25.3	28.8	36.8	48.1	49.8	54.6	66.6	65.8	59.3	46.8	36.2	27.1	45.4
1944	18.7	23.0	29.5	38.0	51.0	53.4	65.2	63.8	57.0	47.4	30.4	25.5	41.9
1945	25.6	29.0	27.6	37.4	49.0	53.4	67.2	65.3	55.0	48.0	32.6	24.6	42.9
1946	21.2	25.8	35.4	45.2	48.3	59.8	67.6	66.5	56.2	39.8	29.8	30.0	43.8
1947	20.0	34.8	37.6	41.2	53.5	55.8	67.3	65.5	58.4	48.3	29.0	24.8	44.7
1948	28.8	24.0	26.4	42.8	48.8	57.4	66.2	64.5	57.1	44.9	30.4	18.9	42.5
1949	5.8	15.0	31.8	46.0	50.0	57.6	66.3	64.5	59.0	43.0	41.4	23.4	42.0
1950	20.2	33.0	33.7	42.4	47.3	56.7	65.9	63.8	54.8	51.1	39.0	34.8	45.2
1951	25.3	29.3	32.3	43.5	50.3	56.8	67.3	64.8	57.6	43.0	31.8	18.4	43.4
1952	17.6	19.9	22.4	43.0	52.1	57.3	66.5	67.5	59.3	50.6	26.9	24.6	42.3
1953	33.5	30.7	35.1	39.8	42.7	57.5	69.1	65.2	59.7	45.9	37.9	24.1	45.1
1954	27.2	34.3	31.8	46.1	54.0	57.7	69.6	64.0	56.5	46.0	38.8	25.8	46.0
1955	14.6	17.9	31.4	39.3	47.8	57.6	65.2	67.7	56.8	47.3	31.6	28.6	42.2
1956	31.9	19.5	35.8	41.3	50.5	60.5	65.6	62.9	59.8	44.2	30.6	26.8	44.1
1957	18.7	34.3	35.9	41.0	47.5	60.0	67.0	66.5	56.4	43.5	29.1	30.6	44.2
1958	27.5	33.9	30.2	38.2	54.1	59.5	65.7	68.6	57.8	47.5	34.6	33.9	46.0
1959	28.8	26.0	35.6	44.8	47.4	63.3	69.4	65.5	53.5	46.1	34.4	25.9	45.0
1960	19.0	23.3	39.3	43.2	50.3	62.6	68.0	65.4	60.6	46.3	35.3	26.6	45.0
1961	27.0	31.7	34.0	41.4	50.2	62.4	68.4	66.1	52.6	43.4	30.5	25.1	44.4
1962	20.4	29.4	29.3	47.4	49.0	59.6	65.5	65.8	58.9	48.7	38.0	29.7	45.2
1963	22.9	36.8	32.3	36.1	54.3	53.7	66.5	65.3	59.8	50.7	43.3	27.6	45.0
1964	19.3	22.3	27.9	39.6	48.6	56.6	68.4	64.7	54.4	49.6	29.3	26.0	42.2
1965	29.4	27.8	32.4	41.9	45.9	55.2	65.5	63.6	50.5	49.2	37.6	24.5	43.6
1966	20.1	22.5	36.7	42.6	55.5	60.6	68.6	66.3	59.1	45.7	38.1	27.0	45.2
1967	26.2	28.4	38.4	34.7	49.2	54.6	68.1	68.1	57.9	47.7	37.6	17.6	44.1
1968	23.1	35.8	36.7	38.0	49.3	59.4	68.4	61.1	54.5	46.7	34.8	23.8	44.3
1969	31.2	25.9	26.2	43.2	56.9	57.4	68.5	69.6	60.7	40.4	35.1	29.8	45.4

Total Precipitation (inches)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1938											0.42	0.43	
1939	0.83	0.56	0.87	1.57	0.60	0.94	1.42	0.53	1.47	1.69	0.07	0.07	10.62
1940	0.95	1.12	0.51	1.76	0.07	0.70	0.03	0.05	2.07	1.06	0.19	0.15	8.66
1941	0.35	0.60	0.93	2.63	1.84	1.45	1.55	0.75	0.19	1.76	0.67	0.80	13.52
1942	0.63	0.27	1.03	0.59	0.69	T	0.15	0.17	T	0.40	0.61	0.06	4.60
1943	1.00	0.50	0.44	1.58	0.11	1.10	0.17	0.27	0.35	1.55	0.29	0.91	8.27
1944	0.53	0.56	0.99	1.16	0.52	1.15	T	T	0.11	0.43	1.60	0.44	7.49
1945	0.23	0.63	2.01	1.31	1.04	2.39	0.43	1.58	1.03	1.48	0.87	0.23	13.23
1946	0.62	0.08	1.22	0.97	1.21	T	1.18	0.54	0.01	1.46	1.60	0.67	9.56
1947	0.14	0.28	0.21	1.79	1.17	0.49	T	0.48	1.04	0.81	0.20	0.30	6.91
1948	T	0.89	0.87	0.62	T	0.92	T	0.26	0.26	0.47	0.10	0.92	5.31
1949	0.78	0.48	0.53	0.36	1.53	0.57	0.63	0.18	0.36	0.61	0.42	0.43	6.88
1950	0.45	0.13	0.88	0.16	0.87	0.04	0.87	0.06	0.98	0.63	0.54	0.42	6.03
1951	0.13	0.08	0.20	0.96	0.48	0.36	1.33	1.05	0.10	0.32	0.76	1.54	7.29
1952	1.92	0.87	2.40	1.77	0.36	0.51	1.51	0.19	0.03	0.00	0.43	0.99	10.98
1953	0.51	0.14	0.52	0.45	0.49	0.33	1.13	0.74	T	0.57	0.10	0.24	5.22
1954	0.94	0.54	1.37	0.54	0.28	0.19	0.32	0.05	1.48	0.47	1.12	0.59	7.89
1955	1.00	0.76	0.07	0.21	1.74	0.76	0.47	1.21	0.16	0.04	0.66	1.68	8.76
1956	0.99	0.94	0.34	0.63	1.61	0.38	0.18	T	0.65	0.54	0.04	0.06	6.36
1957	1.01	0.17	1.14	0.53	2.68	0.41	0.66	0.71	0.02	0.77	0.54	0.50	9.14
1958	0.53	1.08	2.25	0.69	0.38	0.35	0.12	0.49	0.79	T	0.53	0.17	7.58
1959	0.17	1.43	0.31	0.46	1.07	0.17	0.16	0.44	0.99	0.15	T	0.62	5.97
1960	0.80	0.70	.077	0.67	0.79	0.21	0.26	0.19	0.98	0.37	1.82	0.33	7.89
1961	0.15	0.36	1.21	0.80	0.64	0.56	0.64	1.14	0.41	0.52	0.36	0.48	7.27
1962	0.81	1.51	1.09	0.18	1.26	0.45	0.62	T	0.10	1.06	0.28	T	7.36
1963	0.11	0.49	0.84	2.12	0.40	3.53	0.01	0.29	2.18	0.37	0.60	0.20	11.14
1964	1.41	0.07	1.24	2.77	1.17	2.44	0.02	0.58	0.09	0.19	0.93	1.79	12.70
1965	0.46	0.64	0.46	0.74	0.54	1.25	1.12	1.52	1.56	0.27	0.93	1.28	10.77
1966	0.23	0.31	0.16	0.16	0.46	0.14	0.16	0.61	1.34	0.10	0.30	2.11	6.08
1967	1.86	0.10	0.37	1.38	3.05	2.83	0.84	0.41	2.23	0.13	0 84	0.69	14.73
1968	0.15	0.92	0.67	1.26	1.00	1.12	1.32	1.04	0.10	1.44	0.22	0.79	10.03
1969	1.24	2.19	0.41	0.98	0.28	2.80	0.55	0.34	0.37	0.91	0.79	0.59	11.45



PRECIPITATION PROBABILITY

The figure on the left represents the chance (percent probability of receiving at least the indicated amount (inch) of precipitation (liquid form) per month. To use the figure, determine your critical amount: 0.01, 0.20, or 0.60 inch per month. Locate the time period on the bottom scale; proceed up until the amount is intersected. Find the chance of receiving at least this amount on the left scale. For example, the chance of at least 0.20 inch per month in the middle of September is approximately 55 percent (the mid-month value is utilized).

STATION HISTORY

The first observation at the Ely weather station was taken on October 12, 1938. Original instrumentation consisted of wind instruments, thermometers, psychrometer, tipping bucket rain gage, weighing rain gage, 8-inch rain gage, and a pyronometer, located at 6262 feet. The equipment has been located at Yelland Field since 1938, with only one minor change. On September 8, 1961, the entire station was moved to the Yelland Field FAA - Weather Bureau Building, some 400 feet north northwest of the previous location. Area conditions were the same so that there was no change in exposure or elevation. All records are considered compatible. During the changeover, the wind equipment was moved 3,000 feet further north to the center of the airfield, and lowered from 46 feet to 20 feet above the ground. Also, the pyronometer was raised in elevation from 6262 feet to 6279 feet above mean sea level.

Fig. 3 Climatography of the United States No. 20, page 2

VIRGINIA

For hydrology, agriculture uses, energy supply, etc. it is sometimes necessary to use values averaged over an area of a state rather than a point (station). Each state is divided into divisions (up to 10) which represent, as nearly as possible, homogeneous climatic regimes. These divisions have been established to provide assistance to a variety of interests, and some areas (Rocky Mountain States, for example) may have rather extreme variations within a division. The data presented have many applications, but like all climatological products they must be used within the framework for which they were designed.

Fig. 1 Climatological divisions in Virginia

MONTHLY AND ANNUAL DIVISIONAL AVERAGES
TEMPERATURE (°F)

DIVISIONS — **VIRGINIA**

TIDEWATER 01	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1941	37.8	35.8	41.7	58.7	68.3	73.2	78.0	76.4	73.4	66.6	51.7	44.2	58.8
1942	36.8	36.9	48.7	58.4	69.1	75.5	79.6	75.6	72.1	61.5	52.0	38.4	58.7
1943	40.6	42.0	47.0	53.6	68.3	78.8	77.9	77.1	68.7	58.2	48.8	39.0	58.3
1944	39.3	40.9	45.6	55.9	70.8	76.1	77.7	75.6	72.0	59.5	48.7	37.1	58.3
1945	35.2	41.2	57.2	60.5	64.0	75.2	76.7	75.0	74.6	59.6	52.4	35.4	58.9
1946	40.0	42.9	54.4	57.0	66.1	72.7	75.5	73.2	70.5	62.0	54.3	44.9	59.5
1947	45.3	34.7	40.4	57.7	67.4	72.5	75.6	78.2	72.0	64.8	48.0	39.0	58.0
1948	32.8	40.5	51.4	57.4	66.3	74.3	78.4	76.2	70.3	57.6	55.4	44.0	58.7
1949	47.2	47.7	48.9	57.0	66.0	75.0	80.9	77.6	69.2	64.3	50.0	44.1	60.7
1950	51.0	42.6	45.9	54.6	64.8	73.8	77.0	75.1	69.8	62.1	49.3	37.5	58.6
1951	42.9	42.3	47.2	56.9	65.0	74.2	78.3	76.7	71.0	62.9	47.5	44.2	59.1
1952	43.9	42.7	47.2	59.1	66.2	78.0	80.2	77.1	70.8	56.7	50.8	41.1	59.5
1953	44.7	45.2	49.4	58.0	71.3	74.4	79.7	77.1	71.0	61.7	49.9	44.1	60.5
1954	40.1	46.2	48.7	61.3	63.9	74.9	77.8	77.3	73.8	63.8	47.6	39.6	59.6
1955	37.1	40.3	51.5	60.5	67.4	70.9	81.1	79.5	71.6	61.3	49.0	36.3	58.9
1956	36.7	44.5	47.3	55.7	65.0	74.7	77.9	76.5	69.6	62.3	50.1	50.2	59.2
1957	37.6	43.9	47.7	61.6	68.1	76.6	78.1	75.2	73.4	56.5	52.0	44.8	59.6
1958	35.6	35.0	43.1	57.3	66.1	71.4	80.5	76.9	69.6	60.0	53.4	35.0	57.0
1959	38.2	42.1	48.2	59.6	69.3	75.2	78.0	79.3	72.4	63.5	50.2	43.7	60.0
1960	40.9	40.9	37.2	61.8	65.3	74.3	76.5	78.4	71.5	60.6	51.4	35.5	57.9
1961	34.0	42.7	50.9	53.8	63.1	72.3	78.8	77.3	74.4	60.3	52.5	40.3	58.4
1962	38.4	39.9	44.8	57.0	68.9	73.3	75.1	75.6	68.4	61.9	48.0	36.6	57.3
1963	35.7	34.3	51.4	58.4	63.9	73.0	77.0	76.1	67.0	60.8	52.1	34.7	57.0
1964	40.4	39.2	49.3	55.7	66.7	74.3	77.1	74.5	70.3	56.3	53.4	44.7	58.5
1965	38.4	39.8	43.9	54.1	69.4	71.8	76.4	76.7	72.6	58.5	50.8	42.9	57.9
1966	34.9	38.1	48.0	54.2	64.2	72.4	78.4	76.1	69.5	58.7	50.6	40.2	57.1
1967	42.9	37.9	47.0	58.3	60.9	71.0	75.8	74.9	66.5	58.8	46.0	43.3	56.9
1968	34.8	34.5	49.7	56.3	64.1	74.3	78.0	78.9	70.2	62.1	52.3	39.1	57.9
1969	36.4	38.3	43.2	58.5	65.8	75.7	78.3	75.2	69.7	60.5	48.5	39.2	57.4
1970	32.5	39.8	44.0	56.2	67.8	74.5	76.9	77.4	74.2	63.1	51.1	42.6	58.3
NORMAL	39.1	40.4	47.4	57.5	66.5	74.1	77.9	76.6	71.0	60.9	50.6	40.7	58.6

EASTERN PIEDMONT 02	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1941	36.5	35.1	41.5	59.8	67.0	73.0	78.5	76.0	72.3	65.3	49.5	42.5	58.1
1942	36.5	36.1	48.7	58.9	68.6	75.2	78.5	74.5	70.2	59.6	49.5	36.6	57.7
1943	40.0	41.0	46.8	53.8	68.6	78.3	77.7	77.5	66.8	56.3	46.3	38.1	57.6

MONTHLY AND ANNUAL DIVISIONAL AVERAGES
PRECIPITATION (INCHES)

DIVISIONS — **VIRGINIA**

TIDEWATER 01	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1941	2.49	1.89	2.24	3.10	1.35	3.64	5.53	2.99	0.89	1.18	0.89	2.95	29.14
1942	2.90	1.64	5.49	0.65	1.79	3.38	4.69	8.67	4.57	6.28	1.12	3.36	44.54
1943	2.60	2.50	3.67	2.53	4.29	3.45	4.51	1.75	3.72	4.37	1.78	1.74	36.71
1944	3.76	4.91	5.98	3.55	1.17	1.74	4.31	4.31	5.93	2.79	3.78	2.24	44.47
1945	2.40	4.01	1.15	2.90	3.77	5.21	13.10	3.04	5.39	1.87	3.26	6.11	52.21
1946	2.43	2.91	2.28	3.08	6.98	4.08	4.55	5.20	3.32	2.41	2.37	1.75	41.36
1947	4.39	1.39	2.39	2.47	2.79	4.31	3.83	2.39	4.93	2.06	5.21	1.89	38.05
1948	3.96	2.90	3.30	4.59	6.55	3.57	3.97	6.73	3.04	2.83	6.37	4.72	52.53
1949	2.47	3.74	2.43	2.13	4.89	3.47	5.49	8.01	3.16	2.43	2.96	1.93	43.11
1950	2.24	1.59	3.25	1.87	3.52	2.11	7.84	4.23	4.50	1.83	1.79	2.43	37.20
1951	1.60	1.94	3.18	2.77	2.60	5.36	3.87	4.71	1.47	2.74	5.37	3.42	39.03
1952	5.41	4.00	4.68	3.55	3.06	2.83	3.52	5.24	2.55	2.22	5.20	3.18	44.94
1953	2.65	3.17	3.73	3.80	3.55	3.61	2.36	6.52	4.12	1.31	2.47	3.06	40.31
1954	4.86	1.79	3.75	2.60	5.08	1.19	4.12	4.24	2.07	2.54	2.04	3.01	37.29
1955	1.58	3.22	3.70	2.59	2.20	4.39	3.79	10.77	0.55	2.50	2.12	1.37	44.78
1956	2.24	4.40	3.15	3.26	3.01	2.76	7.47	3.98	4.11	6.29	2.56	3.29	46.52
1957	3.60	4.65	4.44	2.36	2.23	3.73	2.07	6.13	4.76	4.82	5.15	5.37	49.31
1958	3.71	3.71	5.77	4.26	5.90	5.11	4.49	9.46	0.94	4.50	2.17	3.84	53.86
1959	1.68	1.95	3.50	4.77	1.82	2.24	8.69	2.32	3.30	6.52	3.55	2.57	42.91
1960	2.96	4.19	2.85	2.48	5.71	3.08	6.67	6.11	7.20	3.58	1.12	2.39	48.34
1961	3.39	5.21	4.24	2.63	6.29	5.66	2.93	4.43	2.28	5.71	1.67	4.86	49.30
1962	5.16	3.34	4.18	4.16	2.65	5.37	5.39	3.26	3.80	2.06	5.76	3.16	48.27
1963	2.83	3.03	4.74	0.83	2.81	7.62	1.69	2.46	4.75	0.48	5.32	2.69	39.25
1964	4.11	4.89	2.60	3.34	1.55	2.98	4.40	5.08	6.74	4.72	1.74	3.48	45.63
1965	2.38	2.10	3.55	2.42	1.09	4.53	6.40	2.54	2.06	1.18	0.42	0.65	29.32
1966	4.27	3.65	1.62	2.04	4.58	3.63	3.34	3.85	4.78	2.36	1.04	3.03	38.19
1967	2.81	3.55	2.12	1.29	3.52	2.08	4.65	7.03	2.14	1.10	1.76	5.55	38.20
1968	2.85	0.97	4.32	2.40	3.15	3.72	4.60	3.01	1.90	2.82	3.48	2.61	35.63
1969	2.63	3.05	4.20	2.60	2.26	3.52	6.81	6.97	3.25	1.82	2.25	5.08	44.44
1970	2.09	3.24	4.04	3.51	2.23	3.20	5.83	2.48	2.17	1.63	3.49	2.78	36.69
NORMAL	3.08	3.12	3.54	2.82	3.41	3.70	5.02	4.95	3.68	2.97	2.94	3.15	42.38

EASTERN PIEDMONT 02	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1941	2.45	1.20	2.44	3.64	1.03	4.87	6.84	2.38	1.55	0.61	0.68	3.30	30.99
1942	3.24	1.66	4.65	0.68	2.71	4.64	5.87	8.05	4.14	6.13	1.73	3.69	47.19
1943	3.31	2.00	4.08	2.58	3.30	3.93	4.86	1.20	3.21	1.56	2.61	2.46	35.10
1944	2.61	4.82	0.36	3.80	2.24	1.61	5.34	4.34	8.56	2.44	2.98	2.58	47.68
1945	2.62	3.39	1.31	3.27	5.00	1.96	11.92	2.71	7.55	1.30	3.01	5.58	49.59
1946	2.51	2.94	3.12	3.18	6.87	3.55	5.91	3.06	3.37	2.44	1.90	2.34	41.20
1947	4.60	2.07	2.38	2.70	3.30	3.11	3.56	2.07	5.38	2.48	5.66	1.07	38.38

Fig. 2 Averages of temperature and monthly precipitation for state climatic division, 1941-70

D

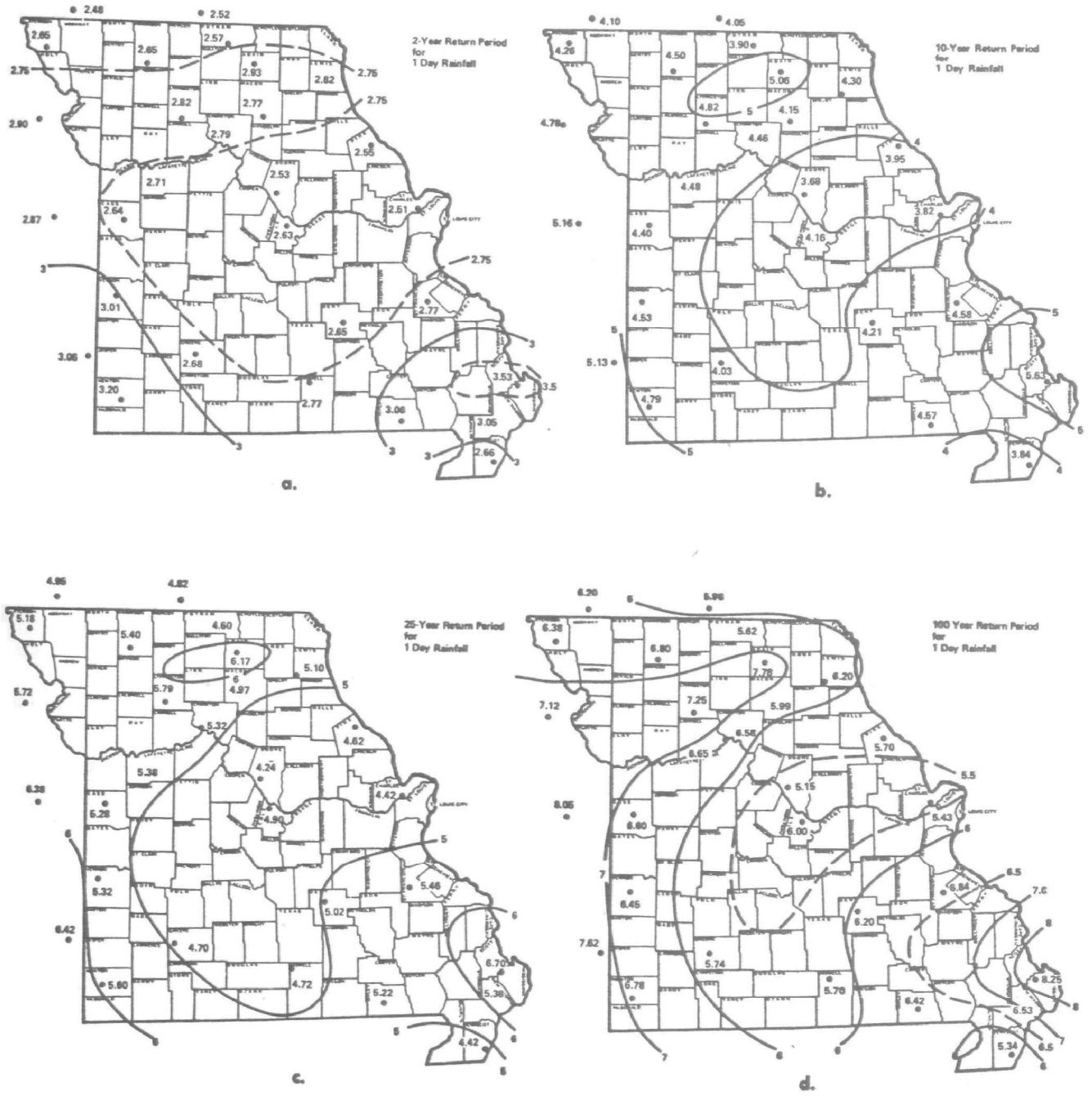
24160 STATION — WALLA WALLA WASHINGTON FAA STATION NAME — 49-65 YEARS

DAILY AMOUNTS

PERCENTAGE FREQUENCY OF PRECIPITATION (FROM DAILY OBSERVATIONS)

	AMOUNTS (INCHES)													PERCENT OF DAYS WITH MEASURABLE AMTS	TOTAL NO. OF OBS.	MONTHLY AMOUNTS (INCHES)		
PRECIP	NONE	TRACE	01	02-.05	06-.10	11-.25	26-.50	51-1.00	1.01-2.50	2.51-5.00	5.01-10.00	10.01-20.00	OVER 20.00			MEAN	GREATEST	LEAST
SNOWFALL	NONE	TRACE	0.1-0.4	0.5-1.4	1.5-2.4	2.5-3.4	3.5-4.4	4.5-6.4	6.5-10.4	10.5-15.4	15.5-25.4	25.5-50.4	OVER 50.4					
SNOW DEPTH	NONE	TRACE	1	2	3	4-6	7-12	13-24	25-36	37-48	49-60	61-120	OVER 120					
JAN	30.5	22.0	6.6	11.8	8.9	10.8	6.6	2.3	.4					47.4	527	2.20	5.25	.45
FEB	41.7	19.4	3.5	9.4	7.3	11.2	5.8	1.7						39.0	480	1.66	3.92	.41
MAR	50.1	13.7	2.8	9.7	5.5	10.6	6.6	.9						36.2	527	1.71	3.28	.42
APR	55.3	15.1	1.6	7.8	4.1	10.2	4.3	1.6						29.6	510	1.44	3.57	.15
MAY	60.0	14.2	3.0	4.7	3.2	7.4	4.4	2.5	.6					25.8	527	1.76	4.13	.40
JUN	67.6	12.0	1.6	6.5	3.3	4.3	2.5	1.6	.6					20.4	510	1.21	2.86	.27
JUL	86.1	6.6	1.1	1.9	1.3	1.3	1.1	.4						7.2	527	.35	2.12	.00
AUG	81.2	7.4	1.9	2.3	1.3	2.3	2.7	.6	.4					11.4	527	.71	2.70	.00
SEP	76.7	7.6	.6	4.9	2.4	4.5	1.6	1.6	.2					15.7	510	.89	2.85	.18
OCT	61.7	11.4	2.8	6.1	4.2	7.0	3.6	2.7	.6					26.9	527	1.79	4.42	.03
NOV	42.2	16.1	5.3	7.8	7.8	10.6	6.3	3.7	.2					41.8	510	2.28	4.14	.50
DEC	32.3	22.4	5.5	13.5	8.3	10.1	4.9	2.5	.6					45.4	527	2.14	4.69	.49
ANNUAL	57.2	14.0	3.0	7.2	4.8	7.5	4.2	1.8	.3					28.8	6209	18.15		

Fig. 1 Percentage frequency of daily amounts of precipitation



Maximum one-day rainfall amounts (inches) expected to occur with an average frequency of once in two years (a), once in 10 years (b), once in 25 years (c), and once in 100 years (d).

SOURCE: Rainfall frequency atlas for Missouri, Wisner, W.M., University of Missouri Extension Division, Columbia

Fig. 2 Maximum one-day rainfall amounts (2,10,25 and 100 year return periods) for Missouri

E

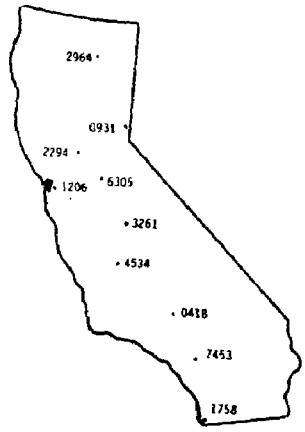
EXTREME MAXIMUM VALUES OF EVAPORATION AT SELECTED STATIONS

Evaporation extremes for consecutive day periods and frequencies of occurrence for stations in California adjusted to an irrigated environment and standard 4-ft USWB Class A pan

Station	Years of record	Adjust. factor	Occur. freq., years	Consecutive days in period: 1	2	3	4	5	7	9	11	15	20	25	30
				Evaporation amounts, inches of water depth											
Backus Ranch (04-0418)	23	.775	2	0.70	1.30	1.86	2.40	2.91	3.90	4.87	5.78	7.60	9.85	12.14	14.37
			5	0.79	1.46	2.11	2.69	3.26	4.34	5.40	6.40	8.42	10.82	13.24	15.74
			10	0.85	1.55	2.26	2.87	3.47	4.63	5.74	6.80	8.97	11.44	13.95	16.62
			20	0.91	1.64	2.40	3.04	3.67	4.88	6.06	7.17	9.46	12.00	14.59	17.42
Boca (04-0931)	22	.775	2	0.37	0.67	0.95	1.23	1.51	2.06	2.61	3.15	4.19	5.51	6.77	8.03
			5	0.46	0.73	1.02	1.31	1.60	2.17	2.74	3.32	4.45	5.84	7.17	8.53
			10	0.51	0.78	1.06	1.36	1.66	2.24	2.84	3.43	4.61	6.05	7.42	8.88
			20	0.56	0.81	1.11	1.41	1.71	2.30	2.91	3.53	4.76	6.23	7.65	9.15
Burlingame (04-1206)	16	.900	2	0.36	0.66	0.94	1.20	1.46	1.97	2.48	2.98	3.98	5.23	6.45	7.65
			5	0.44	0.77	1.09	1.35	1.63	2.18	2.74	3.29	4.36	5.74	7.11	8.44
			10	0.49	0.85	1.19	1.44	1.74	2.30	2.91	3.49	4.60	6.08	7.52	8.96
			20	0.53	0.92	1.27	1.53	1.84	2.43	3.06	3.67	4.82	6.37	7.91	9.41
Chula Vista (04-1758)	30	1.00	2	0.33	0.61	0.89	1.16	1.42	1.94	2.45	2.95	3.94	5.18	6.41	7.63
			5	0.40	0.69	0.96	1.24	1.51	2.04	2.57	3.08	4.12	5.44	6.74	8.01
			10	0.45	0.74	1.01	1.29	1.57	2.11	2.64	3.17	4.24	5.61	6.96	8.26
			20	0.50	0.79	1.06	1.34	1.63	2.17	2.72	3.26	4.36	5.77	7.18	8.50
Davis 2 WSW (04-2294)	30	.800	2	0.44	0.81	1.14	1.45	1.76	2.34	2.93	3.52	4.66	6.10	7.52	8.95
			5	0.51	0.94	1.30	1.64	1.98	2.62	3.24	3.90	5.13	6.69	8.24	9.77
			10	0.56	1.02	1.40	1.77	3.12	2.79	3.45	4.14	5.45	7.07	8.71	10.29
			20	0.60	1.10	1.50	1.89	2.27	2.96	3.65	4.38	5.74	7.45	9.18	10.81
Fall River Mills Intake (04-2964)	27	.775	2	0.39	0.73	1.05	1.36	1.67	2.30	2.92	3.53	4.74	6.24	7.72	9.15
			5	0.46	0.83	1.17	1.51	1.85	2.54	3.23	3.89	5.19	6.84	8.46	10.04
			10	0.50	0.90	1.26	1.61	1.97	2.69	3.43	4.12	5.49	7.23	8.94	10.60
			20	0.54	0.96	1.33	1.70	2.07	2.83	3.60	4.32	5.76	7.59	9.39	11.13
Friant Govt. Camp (04-3261)	20	.800	2	0.54	1.03	1.50	1.96	2.42	3.30	4.18	5.03	6.74	8.79	10.88	12.94
			5	0.61	1.13	1.63	2.14	2.64	3.58	4.52	5.46	7.30	9.54	11.75	13.99
			10	0.65	1.18	1.72	2.25	2.78	3.77	4.74	5.74	7.66	10.00	12.33	14.67
			20	0.69	1.24	1.80	2.35	2.93	3.95	4.96	6.02	8.02	10.49	12.89	15.33
Kettleman City (04-4534)	16	.775	2	0.61	1.09	1.55	2.00	2.44	3.29	4.18	5.03	6.73	8.87	10.90	12.94
			5	0.75	1.27	1.77	2.28	2.77	3.70	4.70	5.66	7.54	9.90	12.08	14.32
			10	0.84	1.40	1.92	2.46	2.98	3.95	5.05	6.06	8.06	10.56	12.83	15.21
			20	0.93	1.50	2.06	2.63	3.18	4.19	5.35	6.43	8.53	11.16	13.52	16.01
Oakdale Woodward Dam (04-6305)	15	.800	2	0.60	1.04	1.46	1.86	2.25	3.03	3.80	4.58	6.05	7.86	9.69	11.45
			5	0.72	1.19	1.65	2.07	2.51	3.38	4.23	5.12	6.70	8.66	10.66	12.62
			10	0.80	1.29	1.77	2.22	2.68	3.59	4.50	5.46	7.12	9.16	11.29	13.36
			20	0.87	1.38	1.88	2.34	2.84	3.80	4.75	5.78	7.50	9.66	11.86	14.05
Riverside Exp. Station (04-7473)	30	.800	2	0.34	0.63	0.90	1.18	1.44	1.94	2.45	2.93	3.91	5.11	6.30	7.50
			5	0.38	0.70	1.01	1.30	1.59	2.14	2.70	3.24	4.34	5.66	6.98	8.29
			10	0.42	0.74	1.07	1.38	1.69	2.27	2.88	3.43	4.61	6.02	7.43	8.80
			20	0.44	0.78	1.14	1.46	1.78	2.40	3.04	3.63	4.88	6.37	7.87	9.30

CALIFORNIA STATION DESCRIPTIONS

Index number	Station name	Normal precip., inches	Elev., feet	North latitude °	'	West longitude °	'
04-0418	Backus Ranch	6.51	2645	34	57	118	11
-0931	Boca	20.80	5575	39	23	120	06
-1206	Burlingame	18.89	10	37	35	122	21
-1758	Chula Vista	9.98	9	32	36	117	06
-2294	Davis 2 WSW	16.46	60	38	32	121	46
-2964	Fall River Mills Intake	18.48	3340	41	01	121	28
-3261	Friant Government Camp	13.72	410	36	59	119	43
-4534	Kettleman City	6.42	250	36	00	119	58
-6305	Oakdale Woodward Dam	13.56	215	37	52	120	52
-7473	Riverside Exp. Station	11.45	986	33	58	117	21



Washington Agricultural Experiment Station Bulletin 761

Fig. 1 Extreme maximum values of evaporation at selected stations

F

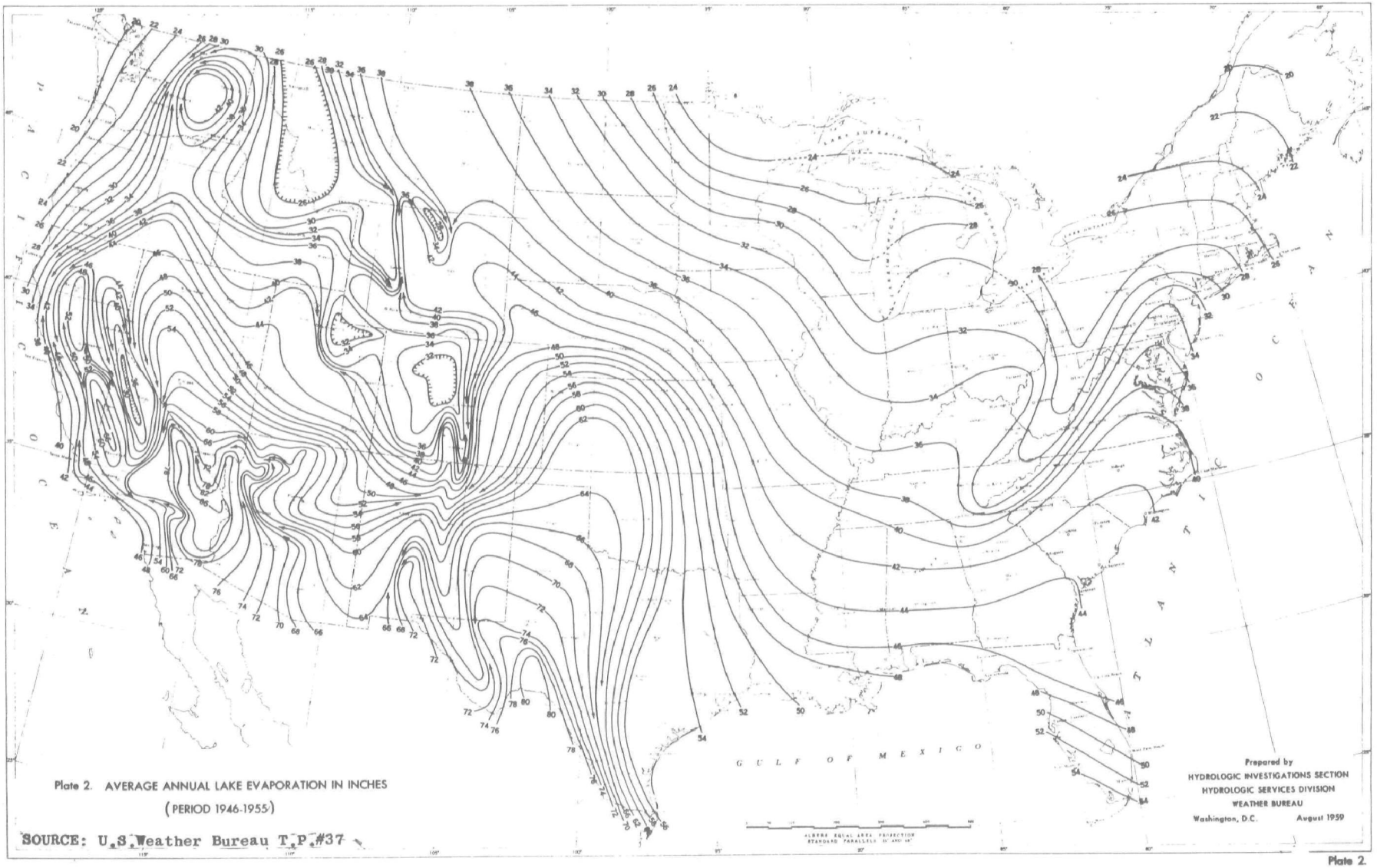
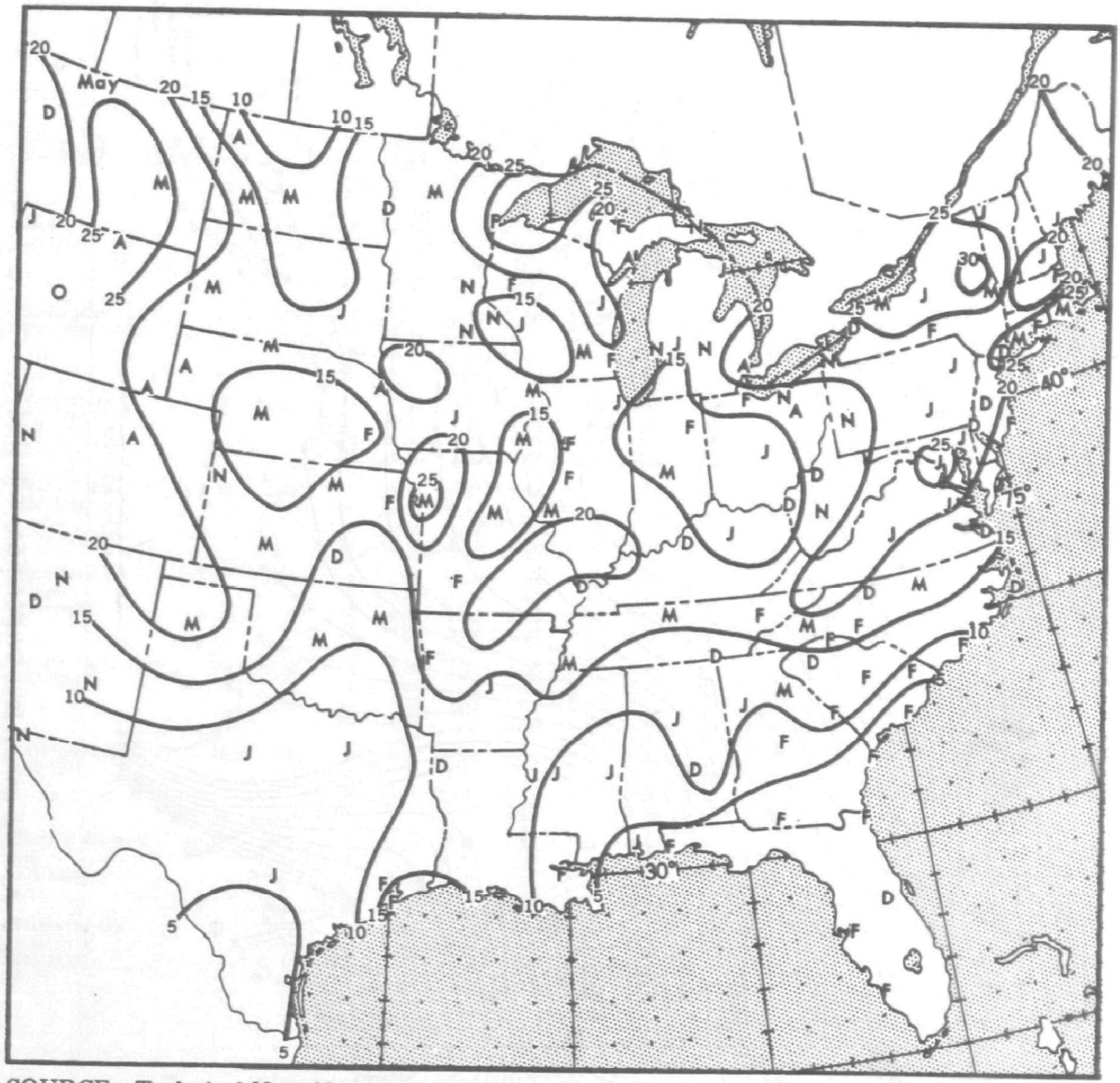
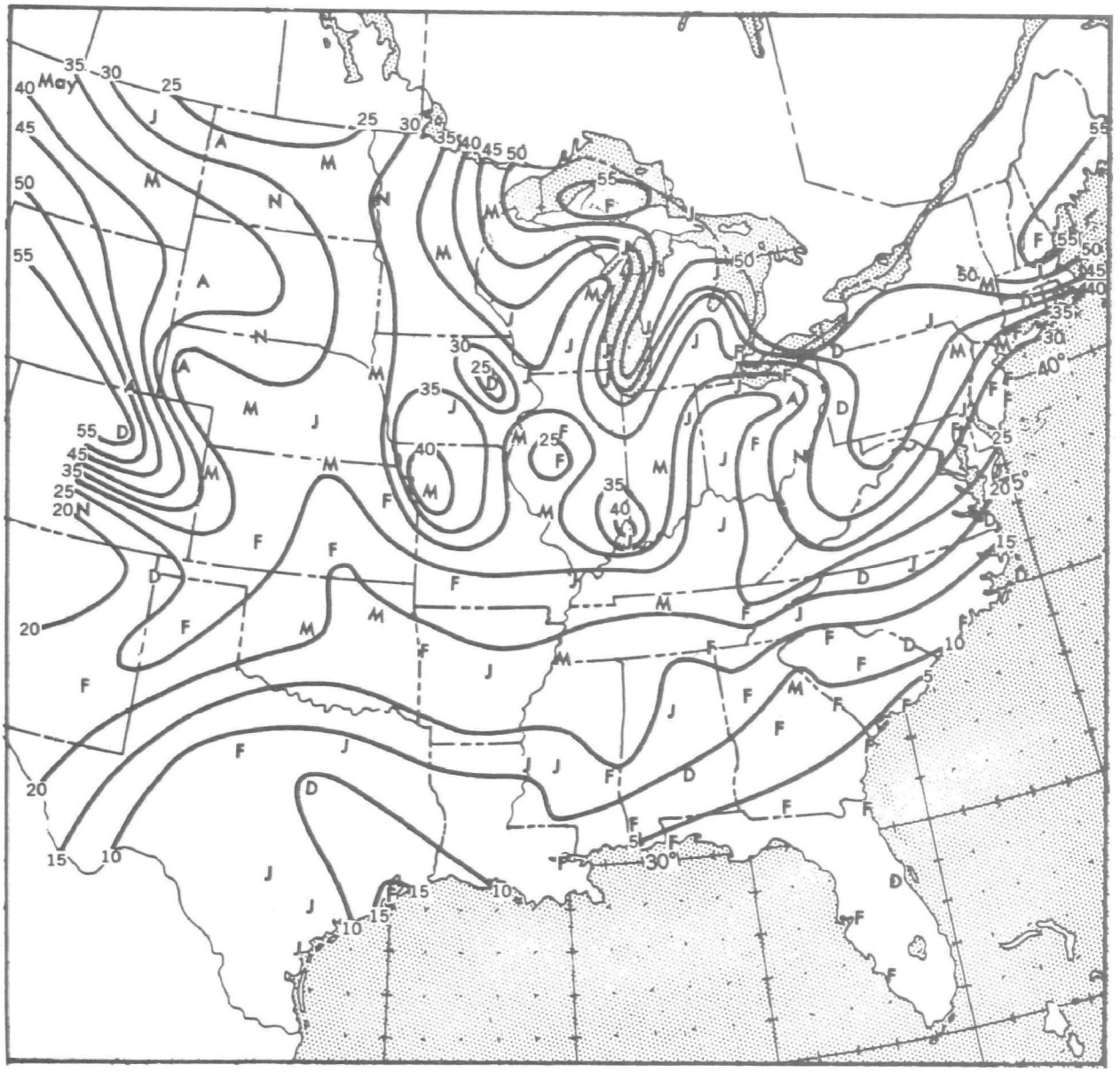


Fig. 2 Average annual lake evaporation, in inches



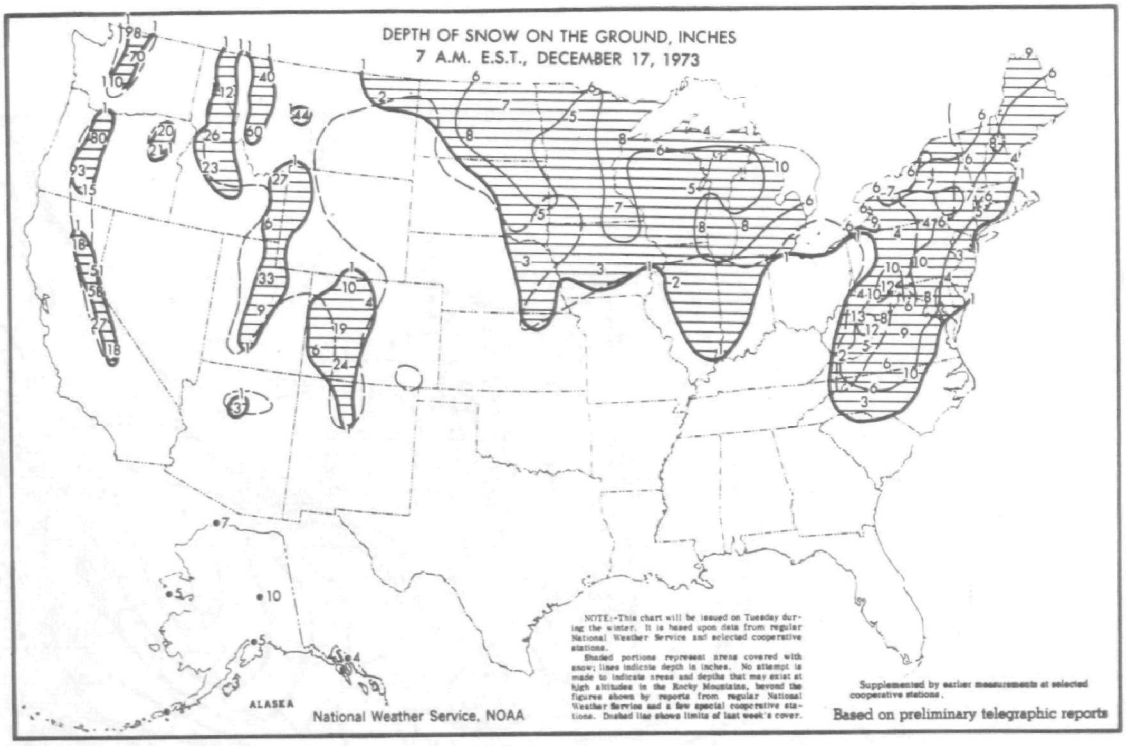
SOURCE: Technical Note No. 10, U.S. Weather Bureau 1962

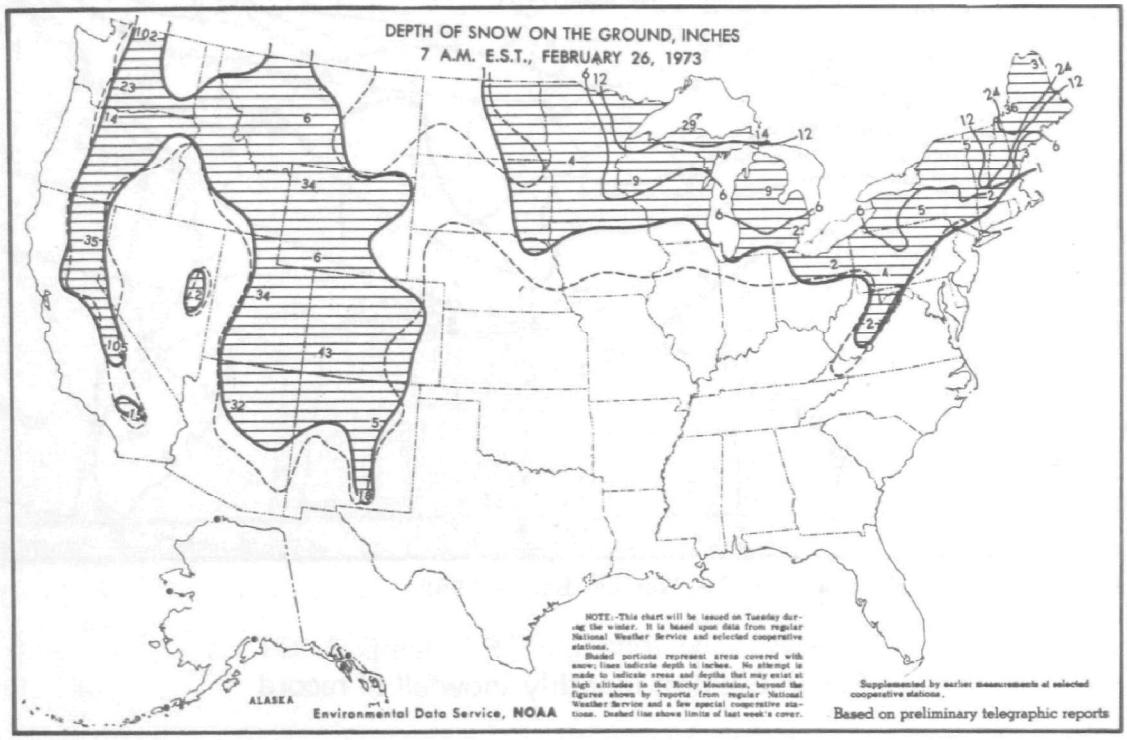
Fig. 1 Greatest 24 hour snowfall of record



SOURCE: Technical Note No. 10, U.S. Weather Bureau 1962

Fig. 2 Greatest monthly snowfall of record





SOURCE: **Weekly Weather and Crop Bulletin**

Fig. 1 Depth of snow on ground (inches) on Feb. 26 and Dec. 17, 1973

H

WIND DIRECTION VERSUS WIND SPEED

Station: 12834 Daytona Beach, Florida Hours: 24 observations per day Period: 1956-1963

Station Name/Number, Type of Run - Monthly, Seasonal or Annual and Period of Record. Month or Season: Data for individual months, or seasons, combined for the period of record. Annual: Total of all months combined. Tabulations prepared for stations reporting less than twenty-four observations per day will carry a special notation indicating the actual hours of observations.

SPEED GROUPS: Knots (knots)
MPH (miles per hour) ✓
MPS (meters per second)

A choice of units (as shown) is offered in the wind speeds. In general, no increase in cost will be incurred by altering class intervals, provided the number of classes shown is not exceeded.

MO: Month 01 = Jan., 02 = Feb., etc. where 12 = Dec.
AN = Annual
S1 = Season 1 (Dec., Jan., Feb.) S2 = Season 2 (Mar., Apr., May), etc.

Months selected for specific seasons may vary, but each season will be clearly defined in a separate document furnished with the tabulation.

CODE: No entry indicates that ALL weather conditions are included in the tabulation. When tabulations are prepared for selected weather conditions a series of special identification codes will be used and defined.

DIR: Wind Direction to 16 Compass Points and Calm.

The distribution represents mean conditions for the period specified. The direction is that from which the wind is blowing. Reporting practices vary somewhat among services and over different periods; however, it is common practice to prepare wind tabulations to 16 compass points and calm. The practice of reporting wind directions to 36 points began in January 1964. Tabulations can be prepared for stations and periods reporting to 36 points by using the conversion table shown below.

35,36,01 = N	08,09,10 = E	17,18,19 = S	26,27,28 = W
02,03 = NNE	11,12 = ESE	20,21 = SSW	29,30 = WNW
04,05 = NE	13,14 = SE	22,23 = SW	31,32 = NW
06,07 = ENE	15,16 = SSE	24,25 = WSW	33,34 = NNW

TOTAL: Total frequency by direction and by speed groups.

PERCENT: Total frequency by direction or speed group divided by the total number of observations for indicated period, rounded to tenths of percent. A percent shown as (.0) indicates an occurrence, but less than 0.05%.

AVG SPEED: Sum of speeds by direction divided by total number of observations in that direction category for tabulations prepared by computer. For those prepared by hand, an estimated value will be used based on the sums of the frequency times the cell mid-point for each class and divided by the total number of observations for that direction.

The usual input for this tabulation is the simultaneous observation of wind speed and direction recorded hourly, twenty-four times a day. Most wind tabulations on file contain a minimum of five years of record with 24 observations per day. Lesser observations are used pending the availability of data.

Fig. 1 Description of a wind direction vs. wind speed distribution

WIND DIRECTION VERSUS WIND SPEED

STATION NAME/NUMBER 12834 Daytona Beach, Florida HOURS 24 Observations per day PERIOD OF RECORD 1956-1963

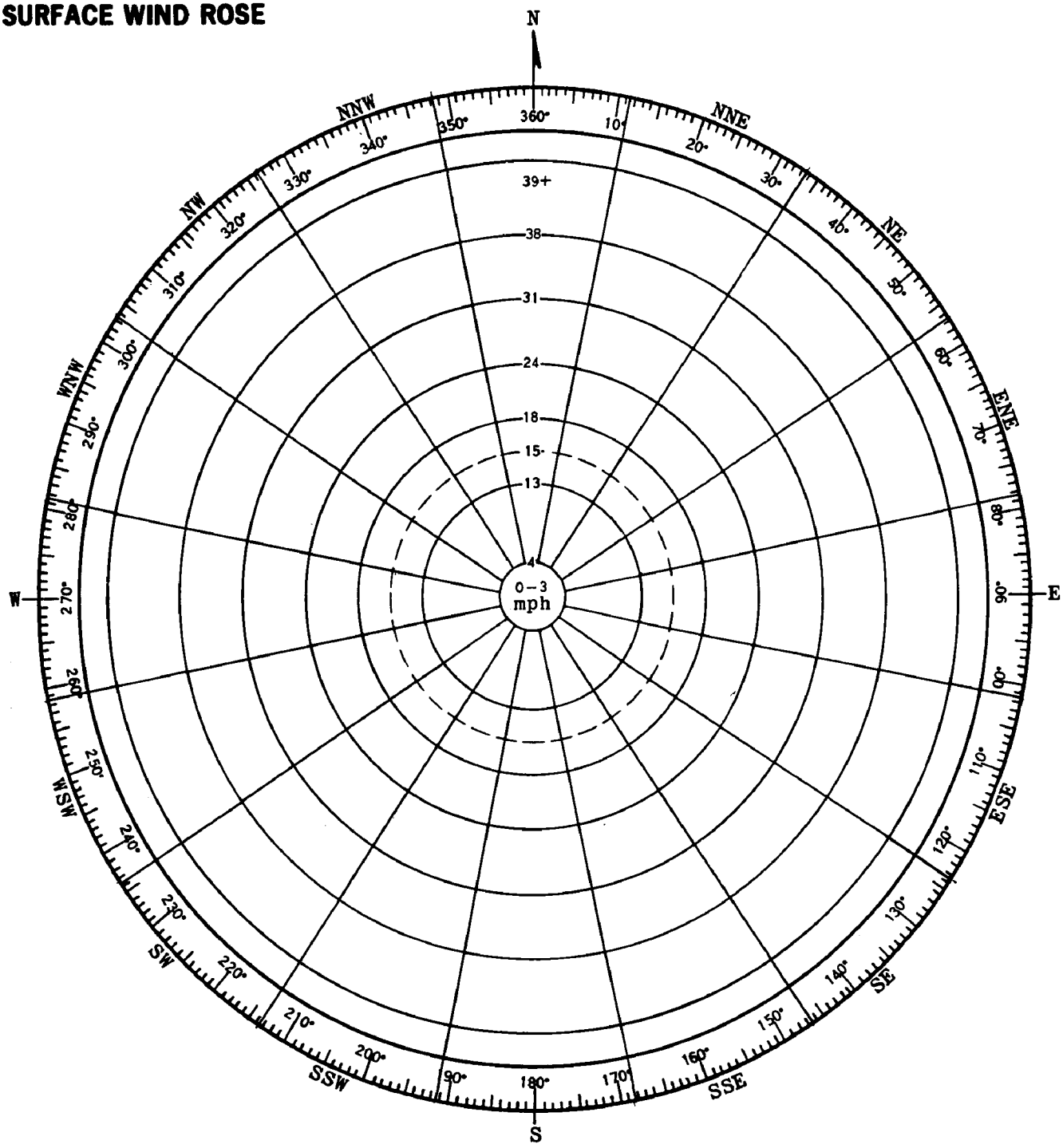
SPEED GROUPS IN M.P.H.

Mo	Code	Speed / Dir	0 — 3	4 — 7	8 — 12	13 — 18	19 — 24	25 — 31	32 — 38	39 — 46	47 & Gr.	Total	Percent	Avg Speed
01		N	28	84	151	165	53	19	2			502	8.4	12.6
		NNE	9	54	144	115	30	5				357	6.0	12.0
		NE	11	44	93	58	8					214	3.6	10.6
		ENE	11	29	78	41	8					167	2.8	10.5
		E	10	37	58	38	2					145	2.4	9.9
		ESE	7	30	56	51	8					154	2.6	11.3
		SE	16	53	51	41	13					174	2.9	10.2
		SSE	12	40	81	42	6					181	3.0	10.1
		S	23	61	84	50	14	5	1			238	4.0	10.4
		SSW	14	72	106	86	15					299	5.0	11.0
		SW	27	148	144	89	24	3				435	7.3	9.9
		WSW	23	121	133	89	27	1	1			455	7.6	10.3
		W	40	162	152	109	22	5	1	1		532	8.9	9.9
		WNW	28	145	205	120	16	3				517	8.7	9.9
		NW	43	285	248	128	17					721	12.1	9.0
		NNW	26	149	171	112	23	1				482	8.1	9.9
		Calm	378									378	6.4	
Total			706	1514	2055	1334	280	50	5	1		5951	100.0	9.7
Percent			11.9	25.4	34.5	22.4	4.8	.8	.1	.0			100.0	

USCOMM — NOAA — ASHEVILLE

Fig. 2 January wind distribution at Daytona Beach, Florida (1955-63)

SURFACE WIND ROSE



THE WIND ROSE IS A SCALED GRAPHICAL PRESENTATION OF SURFACE WIND DATA IN TERMS OF SPEED AND DIRECTION. THE RADIAL LINES OF THE DIAGRAM ARE POSITIONED SO THAT AREAS BETWEEN THEM ARE CENTERED ON THE DIRECTION FROM WHICH THE WINDS ARE REPORTED. THE CONCENTRIC CIRCLES REPRESENT LIMITS BETWEEN SPEED GROUPS SECTORS, I.E., 4, 13, 15, 18, 24, 31, 38, AND 39+ MILES PER HOUR. RADII FOR THESE GROUPS ARE ACCURATELY SCALED TO THE RESPECTIVE SPEEDS. THE SEGMENTS ENCLOSED BY RADIAL LINES AND CONCENTRIC CIRCLES ON THE DIAGRAM REPRESENT WIND SPEED-DIRECTION COMBINATIONS. THE DATA FROM A WIND SUMMARY ARE TRANSFERRED TO THE APPROPRIATE AREA ON THE DIAGRAM AS A PERCENTAGE OF THE TOTAL OBSERVATIONS EXAMINED.

Fig. 3 Surface wind rose diagram

SURFACE WINDS

(FROM DAILY OBSERVATIONS)

93837 JACKSONVILLE FLORIDA NAS 45-68

STATION STATION NAME YEARS

EXTREME VALUES: DAILY PEAK GUSTS IN KNOTS

MONTH / YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ALL MONTHS
45	WNW 34	SW 31	WSW 34	NNW 46	NE 42	WNW 59	W 38	WNW 42	N 67	NNE 39	NW 32	SW 42	N 67
46	SE 31	SW 54	WNW 44	N 32	SW 57	NW 32	N 39	N 39	NNE 32	E 54			
47									S 46	N 52	SW 33	N 26	
48	SW 35	NNE 32	W 55	SSW 38	WSW 57		S 38	N 40	NE 35		WSW 29	N 36	
49	NW 23	W 42	SSW 39	SSW 32	SW 34	NE 38	SSW 33	ESE 66	NE 30	NNE 27	WNW 30	N 38	ESE 66
50	NNE 27			NE 48	NNW 34	N 50	NE 59	S 35	ENE 36	NE 67		SE 25	
51	WNW 27	NW 38	W 35	WNW 36	WSW 40	NNW 38	NE 31	SSW 37	SSW 18				
52	NW 32	SW 35	SW 42	W 32	W 43		SE 39	SW 34					
53		S 55				S 29	SSW 39						
54				NW 41	WNW 45	W 46	WNW 46	S 47	E 34	NNE 31	N 38		
55													
56													
57													
58													
59													
60	ESE 32	SSW 49	WSW 40	WNW 38	W 32	WSW 44	SE 44	WSW 44	NE 56	S 33	NNW 23	NNE 31	NE 56
MEAN	33.7	40.1	39.8										54.3
S. D.	6.011	7.996	5.809										9.547
TOTAL OBS.	644	586	616										7546

Extreme Values - Peak Gusts: Derived from daily observations and presented by individual year and month for the entire period of record available. Speeds are presented in knots, while directions are given in 16 compass points from the beginning of record through 01/71, and in tens of degrees starting in Feb. 1971. When 90% or more of the daily observations of peak gust wind data are available for a month, the extreme is selected and printed. These values are then used to compute means and standard deviations for the entire period. Every month of a year must have valid observations present before the ALL MONTHS value is selected for that year. Means and standard deviations are computed when four or more values are present for any column. A supplementary list of Peak Gusts by year-month with <90% observations reported is also provided.

NOTE: According to Circular N specifications, "peak gust data are recorded only at stations with continuous instantaneous wind-speed recorders."

Fig. 4 Daily peak wind gusts (surface), by month and year

PERCENTILES OF MONTHLY MAXIMUM AND MINIMUM TEMPERATURES

WACO, TEXAS - CONNALLY AFB

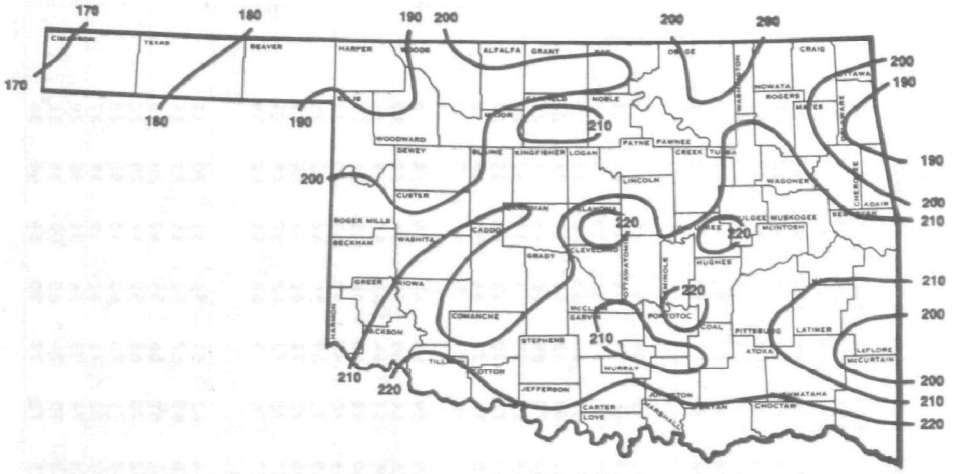
PERCENTILE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MAXIMUM												
100	84	90	93	98	99	102	109	107	105	96	89	85
99	80	86	88	91	95	100	104	106	103	95	86	80
97	78	80	85	89	93	99	102	104	99	92	84	78
95	77	78	84	88	93	98	101	103	97	91	83	76
90	73	75	81	85	91	96	100	102	96	90	80	73
85	71	74	79	84	90	96	99	101	95	89	78	71
80	69	72	78	83	89	95	99	100	95	87	76	69
75	67	70	76	83	89	94	98	99	94	86	75	68
50	58	62	69	78	85	92	96	96	90	80	68	60
MINIMUM												
0	9	7	22	33	43	54	66	59	49	35	20	13
1	11	21	25	36	46	58	67	62	54	37	26	16
3	15	23	29	39	51	62	68	66	56	42	28	21
5	18	25	30	41	52	63	69	67	57	44	31	24
10	23	28	33	44	56	65	71	69	60	46	34	27
15	26	31	35	46	58	67	72	70	62	48	35	30
20	29	32	38	48	60	68	72	71	64	50	38	31
25	30	34	39	49	61	68	73	72	65	51	39	33
50	36	40	46	57	65	71	75	75	70	58	46	39
3 HR MIN												
0	10	9	22	35	45	57	67	61	51	35	22	15
1	12	21	27	38	49	60	68	65	55	40	27	20
3	16	24	30	41	52	63	69	67	57	44	29	22
5	19	26	31	42	54	64	71	69	59	46	32	25
10	24	30	34	46	57	67	72	71	61	48	35	29
15	28	32	37	48	59	68	73	72	63	50	37	31
20	30	34	39	49	61	69	73	72	65	51	39	33
25	32	35	41	51	62	70	74	73	66	53	40	35
50	38	42	48	58	66	73	76	76	71	60	47	40
6 HR MIN												
0	13	10	23	36	47	58	69	63	54	36	26	17
1	14	21	28	40	52	62	70	67	57	42	29	21
3	18	26	31	43	54	64	72	70	59	46	31	24
5	20	28	33	45	56	66	72	71	61	48	34	27
10	25	31	36	48	59	69	74	72	64	50	37	30
15	30	34	39	50	62	70	74	73	66	52	39	33
20	31	35	41	52	63	71	75	74	67	53	41	35
25	33	37	43	53	64	72	76	75	68	55	43	36
50	40	44	50	60	68	75	78	78	73	62	50	42

WICHITA FALLS, TEXAS

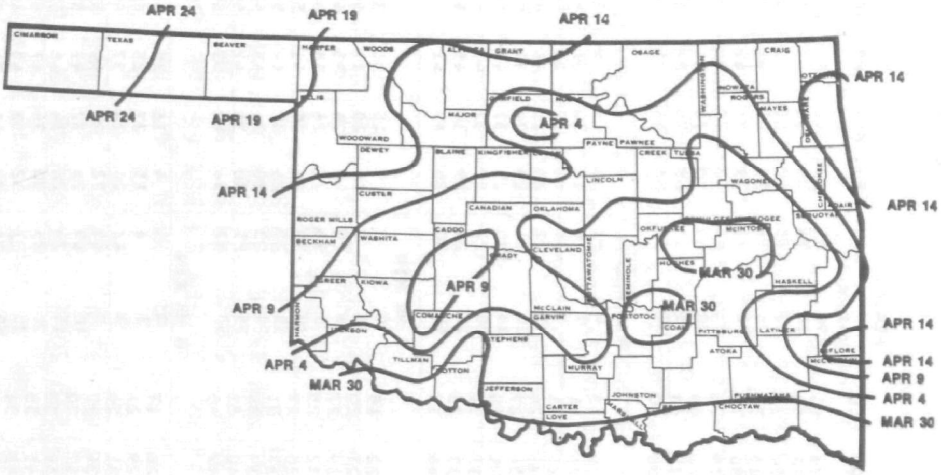
PERCENTILE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MAXIMUM												
100	85	87	92	98	101	108	109	111	106	100	87	87
99	78	85	90	95	99	104	107	107	104	96	83	81
97	75	82	87	92	97	102	105	106	101	94	82	75
95	74	80	85	91	95	101	104	104	100	93	81	72
90	71	73	81	88	93	99	102	103	98	90	78	69
85	68	72	79	86	91	98	101	102	96	88	75	66
80	65	70	76	84	90	97	100	101	95	86	73	64
75	63	68	74	82	89	96	99	100	94	85	72	62
50	54	58	66	75	84	92	96	97	89	78	63	55
MINIMUM												
0	-1	1	14	29	37	51	58	56	47	26	15	8
1	6	12	20	31	42	55	62	59	48	36	21	11
3	9	19	23	33	46	57	65	62	51	38	23	15
5	12	20	25	36	48	59	67	64	53	40	25	18
10	16	23	28	39	52	62	69	66	56	44	28	22
15	20	25	31	42	54	64	70	68	58	45	31	24
20	22	27	32	43	56	65	70	69	59	46	32	26
25	24	29	34	45	57	66	71	70	61	48	33	27
50	30	35	40	51	62	70	74	73	66	55	40	32
3 HR MIN												
0	3	3	15	30	39	53	59	58	48	29	18	9
1	7	14	20	33	44	56	64	60	50	36	22	12
3	10	19	24	35	47	59	67	64	53	40	25	16
5	13	21	26	38	50	60	68	66	54	42	26	19
10	18	24	29	41	53	63	70	68	57	45	30	23
15	22	26	32	44	56	65	71	69	59	46	32	25
20	23	28	34	45	57	66	72	71	61	48	34	27
25	25	30	35	47	59	67	73	72	62	50	35	29
50	32	36	42	53	64	72	76	75	68	56	42	34
6 HR MIN												
0	6	4	16	33	41	54	62	61	50	31	20	11
1	8	15	22	35	45	58	65	62	52	39	23	14
3	12	20	26	37	49	61	69	66	55	42	26	18
5	15	22	28	40	52	62	70	68	57	44	28	21
10	19	26	32	43	55	65	71	70	60	48	31	25
15	23	28	34	46	58	67	72	71	62	49	34	27
20	25	30	36	47	59	68	74	73	64	51	36	29
25	27	32	38	49	60	69	75	74	65	52	37	31
50	34	39	44	56	66	75	78	77	70	59	44	36

SOURCE: U.S. Army, Aberdeen Proving Grounds, MD. (J.P.Doner 1972)

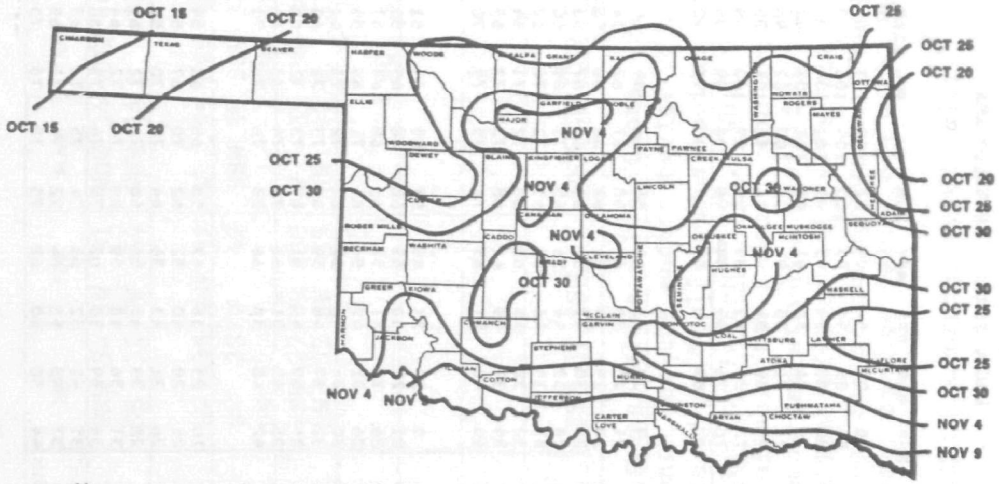
Fig. 1 Percentiles of monthly maximum and minimum temperatures (°F)



Mean length of freeze-free period (days) between last 32° (F.) temperature in Spring and first 32° (F.) temperature in Fall.



Mean occurrence date of last 32° (F.) temperature in Spring.



Mean occurrence date of first 32° (F.) temperature in Fall.

SOURCE:Freezing Temperatures in Oklahoma, OSU Ext. Center

Fig. 2 Freeze data for Oklahoma

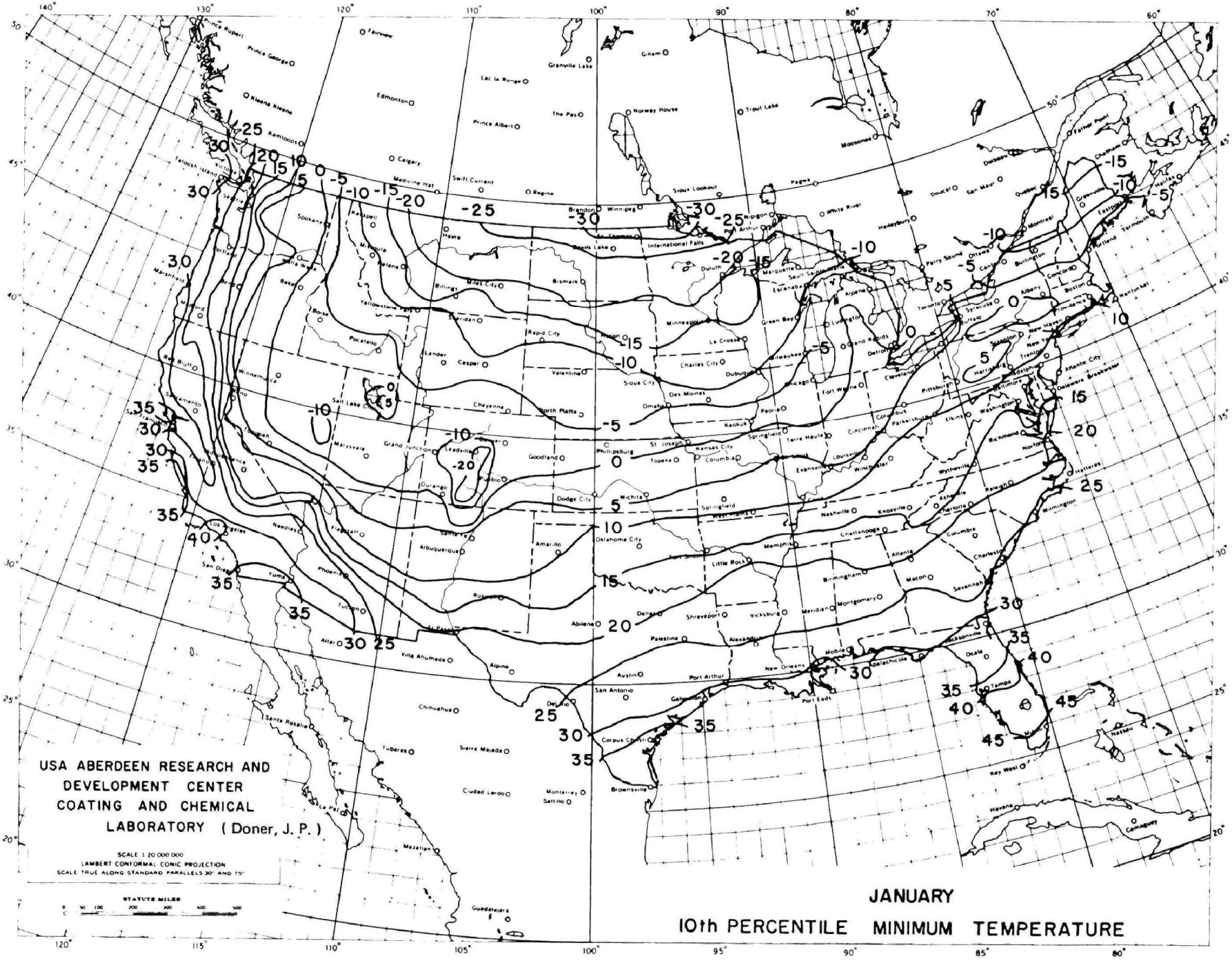


Fig. 3 Tenth percentile of minimum temperature for January

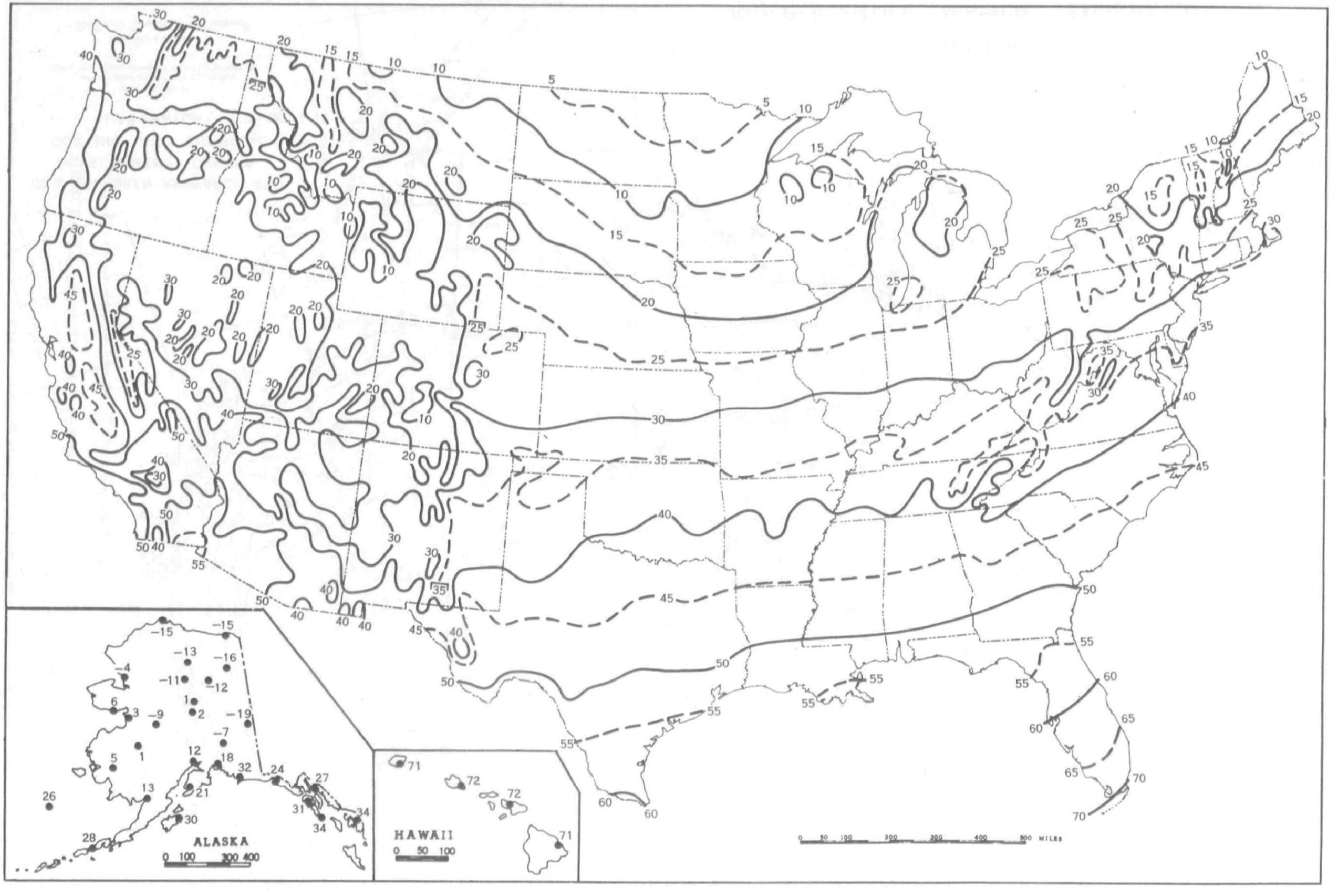
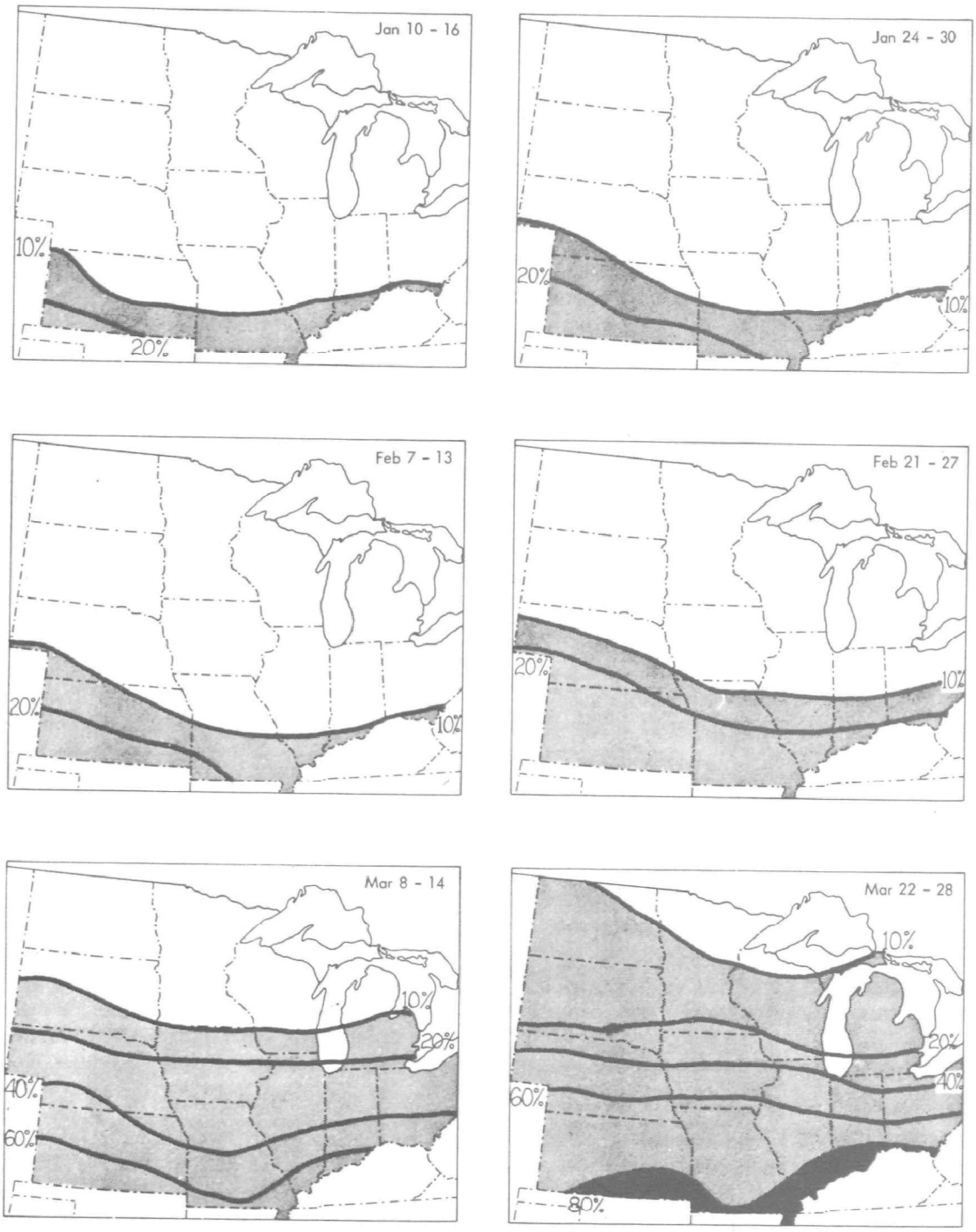


Fig.4 Normal daily average temperature (°F), 1941-70 - January



RUNS OF 15 OR MORE DAYS WITH MAXIMUM ABOVE 40F. EACH MAP PRESENTS THE PERCENTAGE OF YEARS HAVING SUCH PERIODS BEGIN DURING THE WEEK INDICATED.

Reprinted from " Periods with Temperatures Critical to Agriculture," Decker, W.L.

Fig. 5 Runs of 15 or more days with maximum temperature above 40 °F, by week

J

OKLAHOMA

PRECIPITATION NORMALS

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
FAIRVIEW	0.75	1.20	1.94	2.52	4.34	3.93	2.80	2.77	2.80	2.06	1.40	1.03	27.54
FANSHAWE	2.37	3.14	3.81	4.96	6.20	4.19	4.07	3.32	4.48	3.14	3.35	3.00	46.03
FARGO	0.51	0.99	1.23	1.85	3.65	3.37	2.58	2.39	1.85	2.18	0.89	0.72	22.31
FLASHMAN TOWER	3.41	4.18	4.47	5.79	6.62	4.37	4.12	4.43	4.75	4.02	3.81	3.71	53.68
FORT COBB	0.95	1.20	1.65	2.91	4.86	3.74	2.72	2.40	3.30	2.36	1.19	1.25	28.53
FORT SUPPLY DAM	0.49	1.04	1.24	1.74	3.49	3.21	2.76	2.53	2.00	1.93	0.84	0.70	21.97
FREDERICK	0.98	1.31	1.61	2.40	4.75	3.42	2.17	2.09	2.66	2.66	1.27	1.12	26.45
GAGE FAA AIRPORT	0.53	0.95	1.12	1.90	3.71	3.07	2.58	2.31	1.65	2.09	0.76	0.74	21.41
GARBER	0.80	1.09	1.77	3.10	4.56	4.49	3.38	3.07	3.77	2.58	1.52	1.25	31.38
GEARY	0.86	1.12	1.68	2.83	4.42	4.18	2.59	2.55	3.41	2.82	1.13	1.13	28.54

MEAN TEMPERATURE

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
ADA	40.9	45.5	51.9	62.9	69.9	77.9	82.6	82.2	74.6	64.8	52.4	43.5	62.4
ALTUS IRR. RESCH STN	40.0	44.6	51.4	63.3	71.5	80.3	84.3	83.6	75.6	64.8	51.6	42.8	62.8
ALVA	35.6	40.2	46.8	59.2	68.2	78.0	83.1	82.2	73.3	62.4	47.9	38.1	59.6
ANADARKO	38.6	43.6	50.5	62.3	70.0	78.4	82.9	82.5	74.3	63.6	50.5	41.7	61.6
ANTLERS 2 ENE	41.8	46.0	52.8	63.5	70.3	78.1	82.1	81.6	74.6	64.5	52.8	44.3	62.7
APACHE	39.2	43.9	50.7	62.2	69.8	78.2	82.8	82.7	74.8	63.9	51.0	42.1	61.8
ARDMORE	42.7	47.1	53.6	64.9	71.8	79.8	84.0	84.0	76.7	66.9	54.5	45.7	64.3
ARNETT	35.0	39.3	45.4	57.8	66.5	75.7	80.4	79.7	71.4	60.5	46.7	38.0	58.0
BARTLESVILLE 2 W	35.4	40.5	47.5	60.4	68.4	76.7	81.3	80.5	72.3	61.8	48.4	38.6	59.3
BEAVER 1 SW	34.4	39.0	45.2	57.5	66.8	76.2	81.1	80.1	71.6	59.9	45.5	36.7	57.8

NORMALS. A normal of a climatological element is the arithmetic mean for a specific period of record; it estimates the true mean of the element at the current exposure of the instrument measuring the element. The true mean is the mean of all possible observations (population) at the current exposure. It is from this population that future observations will come, not from values in the past record.

Normals for National Weather Service Offices and Principal Climatological Stations are computed by simply averaging the values from the 1941-1970 record, if no exposure changes have occurred at the station. Since it is not possible to maintain a multiple purpose network of meteorological stations without having some exposure changes, it is first necessary to identify periods of heterogeneity. After the periods have been determined, adjustments are applied to correct the heterogeneities in the record. This is done by comparing the record at the station for which the normal is desired to the record at a supplementary station with a homogeneous record. The difference method is used to adjust the monthly average maximum and minimum temperatures. The normal is the weighted average of the various partial means of the adjusted record.

Normals for Substations are computed somewhat differently than those for the National Weather Service First-Order stations. Monthly substation normals are the simple arithmetic averages of the monthly values of temperature for the period. The 1941-1970 normals were computed only for substations active during the entire period. No attempt was made to adjust for minor changes in location of the observing site, or for changes in the time of observation. Normals were not computed for substations which moved a significant distance during the 1941-1970 period, (more than 5 miles horizontally, or 100 feet vertically). Missing values in the data series were estimated up to a maximum of 18 consecutive temperature values. Annual substation heating and cooling degree day normals are the sums of the monthly values.

Fig. 1 Monthly normals (1941 - 70) are published by state

DAILY NORMALS OF TEMPERATURE AND HEATING AND COOLING DEGREE DAYS 1941-70

RICHMOND, VA BYRD FLD

DAY	JANUARY TEMPERATURE MAX	MIN	AVG	DEG DAY HDD	CDD	FEBRUARY TEMPERATURE MAX	MIN	AVG	DEG DAY HDD	CDD	MARCH TEMPERATURE MAX	MIN	AVG	DEG DAY HDD	CDD	APRIL TEMPERATURE MAX	MIN	AVG	DEG DAY HDD	CDD	MAY TEMPERATURE MAX	MIN	AVG	DEG DAY HDD	CDD	JUNE TEMPERATURE MAX	MIN	AVG	DEG DAY HDD	CDD	DAY
1	47	27	37	28	0	48	28	38	27	0	53	31	42	23	0	65	40	53	12	*	75	50	63	4	1	82	59	71	0	6	1
2	47	27	37	28	0	48	28	38	27	0	53	32	42	23	0	65	41	53	12	*	75	50	63	4	2	83	60	71	0	6	2
3	47	27	37	28	0	48	28	38	27	0	54	32	43	22	0	66	41	53	12	*	75	51	63	4	2	83	60	71	0	6	3
4	47	27	37	28	0	48	28	38	27	0	54	32	43	22	0	66	42	54	11	*	75	51	63	3	2	83	60	72	0	7	4
5	47	27	37	28	0	48	28	38	27	0	54	32	43	22	0	67	42	54	11	*	76	51	64	3	2	83	60	72	0	7	5
6	47	27	37	28	0	49	28	38	27	0	54	33	44	22	0	67	42	55	10	*	76	52	64	3	2	84	61	72	0	7	6
7	47	27	37	28	0	49	28	38	27	0	55	33	44	21	0	67	43	55	10	*	76	52	64	3	2	84	61	72	0	7	7
8	47	27	37	28	0	49	28	38	27	0	55	33	44	21	0	68	43	55	10	*	76	52	64	3	2	84	61	73	0	8	8
9	47	27	37	28	0	49	28	38	27	0	55	33	44	21	0	68	43	56	9	*	77	52	65	3	2	84	61	73	0	8	9
10	47	27	37	28	0	49	28	39	26	0	56	34	45	21	*	69	43	56	9	*	77	53	65	3	3	85	62	73	0	8	10
11	47	27	37	28	0	49	28	39	26	0	56	34	45	20	*	69	44	56	9	*	77	53	65	2	3	85	62	73	0	8	11
12	47	27	37	28	0	49	28	39	26	0	57	34	45	20	*	69	44	57	8	*	77	53	65	2	3	85	62	74	0	9	12
13	47	28	37	28	0	49	28	39	26	0	57	35	46	20	*	70	44	57	8	*	78	54	66	2	3	85	62	74	0	9	13
14	47	28	37	28	0	50	28	39	26	0	57	35	46	19	*	70	45	58	8	*	78	54	66	2	3	85	63	74	0	9	14
15	47	28	37	28	0	50	28	39	26	0	58	35	46	19	*	70	45	58	7	*	78	54	66	2	3	86	63	74	0	9	15
16	47	28	38	28	0	50	29	39	26	0	58	35	47	19	*	71	45	58	7	*	78	55	66	2	3	86	63	75	0	10	16
17	47	28	38	27	0	50	29	40	25	0	58	36	47	18	*	71	46	59	7	*	79	55	67	2	4	86	63	75	0	10	17
18	47	28	38	27	0	50	29	40	25	0	59	36	47	18	*	71	46	59	6	*	79	55	67	2	4	86	64	75	0	10	18
19	47	28	38	27	0	50	29	40	25	0	59	36	48	18	*	72	46	59	6	*	79	55	67	2	4	86	64	75	0	10	19
20	48	28	38	27	0	51	29	40	25	0	60	37	48	17	*	72	47	59	6	*	79	56	68	2	4	86	64	75	0	10	20
21	48	28	38	27	0	51	29	40	25	0	60	37	48	17	*	72	47	60	6	1	80	56	68	1	4	87	64	75	0	10	21
22	48	28	38	27	0	51	30	40	25	0	60	37	49	16	*	73	47	60	6	1	80	56	68	1	4	87	65	76	0	11	22
23	48	28	38	27	0	51	30	41	24	0	61	38	49	16	*	73	48	60	5	1	80	57	68	1	5	87	65	76	0	11	23
24	48	28	38	27	0	52	30	41	24	0	61	38	50	16	*	73	48	61	5	1	80	57	69	1	5	87	65	76	0	11	24
25	48	28	38	27	0	52	30	41	24	0	62	38	50	15	*	74	48	61	5	1	81	57	69	1	5	87	65	76	0	11	25
26	48	28	38	27	0	52	30	41	24	0	62	38	50	15	*	74	49	61	5	1	81	57	69	1	5	87	65	76	0	11	26
27	48	28	38	27	0	52	31	42	23	0	62	39	51	14	*	74	49	61	4	1	81	58	69	1	5	87	65	76	0	11	27
28	48	28	38	27	0	53	31	42	23	0	63	39	51	14	*	74	49	62	4	1	81	58	70	1	6	87	66	77	0	12	28
29	48	28	38	27	0						63	40	52	14	*	74	49	62	4	1	82	58	70	1	6	87	66	77	0	12	29
30	48	28	38	27	0						64	40	52	13	*	75	50	62	4	1	82	59	70	1	6	88	66	77	0	12	30
31	48	28	38	27	0						64	40	52	13	*						82	59	71	1	6						31

JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
MONTHLY NORMALS		MONTHLY NORMALS		MONTHLY NORMALS		MONTHLY NORMALS		MONTHLY NORMALS		MONTHLY NORMALS	
MAX	47.4	MAX	49.9	MAX	58.2	MAX	70.3	MAX	78.4	MAX	85.4
MIN	27.6	MIN	28.8	MIN	35.5	MIN	45.2	MIN	54.5	MIN	62.9
MEAN	37.5	MEAN	39.4	MEAN	46.9	MEAN	57.8	MEAN	66.5	MEAN	74.2
HEATING	853	HEATING	717	HEATING	569	HEATING	226	HEATING	64	HEATING	0
COOLING	0	COOLING	0	COOLING	8	COOLING	10	COOLING	111	COOLING	276

This publication presents daily temperature, and heating and cooling degree day normals for selected stations based on the 1941–70 record, adjusted to the present station location. The following elements are presented:

MAX = Maximum Temperature (°F)
MIN = Minimum " "
AVG = Average " "
HDD = Heating Degree Days (Standard Base of 65°F)
CDD = Cooling " " " " " "

The stations included in this publication are the National Weather Service Offices and Principal Climatological Stations included in Climatography of the United States No. 81 (1).

The daily values presented in these tables are not simple means of the observed daily values. They are interpolated from the much less variable monthly normals by use of the natural spline function as described by Greville (2). The procedure involved construction of a cumulative series of the monthly sums with the sum for each month being assigned to the last day of the month. The cumulative series was for an 18-month period (October, November, December, January, ... December, January, February, and March) so the interpolating function could adequately fit the end points of the annual series. This process was applied independently to all five elements. No normal values for February 29 are included here; in common practice the normal values for the 28th are used for the 29th in each leap year.

The monthly heating and cooling degree day normals (base 65°F) are derived from the monthly normal temperatures using the technique developed by Thom (3), (4). An asterisk (*) for a daily value indicates a daily normal of less than one degree day, but not equal to zero.

Additional information about the climate of the cities listed in this publication may be obtained from the National Climatic Center, Federal Building, Asheville, N. C. 28801.

References

1. Climatography of the United States No. 81, "Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1941-70."
2. Greville, T. N. E., "Spline Functions, Interpolation, and Numerical Quadrative," Mathematical Methods of Digital Computers, Volume 2 (edited by Ralson, A., and Wilf, H. S.). John Wiley and Sons, Inc., New York 1967.
3. Thom, H. C. S., "The Rational Relationship Between Heating Degree Days and Temperature," Monthly Weather Review, Volume 82 No. 1, January 1954.
4. Thom, H. C. S., "Normal Degree Days Above Any Base by the Universal Truncation Coefficient," Monthly Weather Review, Volume 94 No. 7, July 1966.

Fig. 2 Climatography of the United States # 84 daily normals of heating and cooling degree days 1941 - 70

K

CLIMATOGRAPHY OF THE UNITED STATES NO. 82 – 9

1951 - 1960

ATLANTA, GEORGIA
Municipal AP

FEBRUARY
6793 Obs.

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND DIR. / TEMP. (°F)	0-4 M.P.H.						5-14 M.P.H.						15-24 M.P.H.						25 M.P.H. AND OVER						TOTAL OBS.
75/ 79		1					2	2	4				1	5	7				2						23
70/ 74		6	1				19	20	4	1			3	8	21	5	3	1	4				1		99
65/ 69	2	9	6	1			26	32	27	15	4		22	19	29	6	29	22	6	5	3	2	3	3	275
60/ 64	8	17	8	9	10	10	29	56	49	41	33	60	19	43	51	19	20	49	6	2	1	2	4	2	546
55/ 59	9	17	18	9	14	51	42	120	97	68	69	210	14	72	38	18	22	71	1		1	2	2	1	967
50/ 54	5	30	36	19	30	71	22	152	166	98	62	164	18	86	64	25	26	64				2	2	2	1059
45/ 49	2	27	44	35	25	59	17	113	194	83	63	166	6	90	69	44	43	41		2	2	2	1	1	1090
40/ 44	7	23	56	28	12	38	9	79	173	112	95	156	8	92	54	56	24	64	1	6	2	1	1	1	1057
35/ 39	5	19	41	35	20	15	6	35	104	80	63	108	5	64	44	38	26	71	1	1		4	7	1	791
30/ 34		25	22	7	11	10	3	39	42	57	91	32	6	31	30	32	8	32		1		4	11	2	446
25/ 29		6	15	4	1		1	15	43	4	6		1	26	43	33	19	1	1	3		1	2		223
20/ 24			1					8	16	9	1		2	23	40	10	3		1	1	1	2			109
15/ 19			3					2	18	2				14	20	6			1	1	2	1			69
10/ 14								1	4	3	6			9	16	1									40
05/ 09									1					6	9										16
TOTAL	36	178	253	149	123	293	126	669	943	509	465	900	106	488	537	293	217	415	17	25	25	23	27	14	6792

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)								AV. SPEED
	0 - 3	4 - 7	8 - 12	13 - 18	19 - 24	25 - 31	32 - 38	39 - 46	47 OVER	TOTAL	
N	.2	.7	.4	.2	+					1.5	7.7
NNE	.1	.5	.5	.1	+					1.0	7.3
NE	.6	1.0	1.5	.6	+					3.8	8.5
ENE	.4	1.4	3.0	2.5	.6	+				8.0	11.5
E	.8	1.9	3.5	2.1	.5					8.7	10.3
ESE	.5	1.1	1.8	1.4	.1					5.0	10.1
SE	.6	1.1	2.0	.7	.2	+				4.7	9.1
SSE	.4	.7	1.3	.7	.2	.1				3.4	10.2
S	.6	1.2	1.5	1.2	.6	.1				5.2	10.8
SSW	.5	.6	.9	1.1	.4	.1	.1	+		3.6	13.3
SW	.7	1.1	2.0	2.1	.9	.2	.1	+		7.0	12.7
WSW	.2	.4	1.4	1.6	.4	+	.1	+		4.1	13.3
W	.3	.6	2.4	1.7	.6	.1	+			5.7	12.6
WNW	.2	.7	2.6	4.6	1.8	.5	.1	+		10.9	15.2
NW	.6	2.0	5.2	7.6	3.3	.4	.1			19.1	14.0
NNW	.3	.9	1.7	2.1	.6	.1	+			5.7	12.4
CALM	3.2									3.2	
TOTAL	9.9	15.4	31.5	30.3	10.3	1.6	.4	.1		100	11.8

C OCCURRENCES OF PRECIPITATION AMOUNTS:

INTENSITIES	FREQUENCY OF OCCURRENCE FOR EACH HOUR OF THE DAY																								NO. OF DAYS WITH
	A.M. HOUR ENDING AT												P.M. HOUR ENDING AT												
	1	2	3	4	5	6	7	8	9	10	11	NOON	1	2	3	4	5	6	7	8	9	10	11	MID.	
TRACE	21	29	23	30	30	28	25	26	36	41	39	27	24	26	27	22	23	22	21	25	21	24	30	24	40
.01 TO .04 IN.	8	11	11	7	7	10	11	6	4	7	5	8		5	1	8	5	6	6	5	7	7	5	4	7
.05 TO .09 IN.	16	9	17	11	20	18	21	18	12	14	10	10	19	13	11	12	8	11	12	11	8	9	10	19	23
.10 TO .24 IN.	4	6	2	5	4	7	5	8	8	2	4	5	3	4	10	2	3	3	2	3	3	5	7	4	27
.25 TO .49 IN.	1	1	2	4	5	1	1	2		1		2	2			1	1	1	1		4				15
.50 TO .99 IN.		1												2										1	13
1.00 TO 1.99 IN.																						1			13
2.00 IN. AND OVER																									1
TOTAL	50	53	55	57	66	64	63	60	60	65	58	52	48	50	49	45	40	43	42	44	43	46	52	52	145

D PERCENTAGE FREQUENCIES OF CEILING–VISIBILITY:

VISIBILITY (MILES)	CEILING (FEET)									TOT
	0	100-200	300-400	500-900	1000-1900	2000-2900	3000-4900	5000-9900	OVER 10000	
0 TO 1/8	.8	.4						+		1.2
3/16 TO 3/8	.3	.9	+					+	+	1.3
1/2 TO 3/4	.1	1.5	.1	.1	+			+		1.8
1 TO 21/2		2.1	1.6	.9	.3	.1	.1	.1	.3	5.7
3 TO 6		.4	1.5	2.6	1.3	.4	.6	.7	1.7	9.3
7 TO 15		+	.4	2.2	4.4	4.4	5.2	7.6	56.6	80.7
20 TO 30										
35 OR MORE										
TOTAL	1.1	5.4	4.0	5.6	6.0	5.0	5.9	8.5	58.5	100

E PERCENTAGE FREQUENCIES OF SKY COVER, WIND, AND RELATIVE HUMIDITY:

HOUR OF DAY	CLOUDS SCALE 0-10			WIND SPEED (M.P.H.)				RELATIVE HUMIDITY (%)					
	0-3	4-7	8-10	0-3	4-12	13-24	25-& OVER	0-29	30-49	50-69	70-79	80-89	90-100
00	41	10	49	11	57	32	+	+	13	27	23	14	24
01	44	7	49	14	50	34	2		10	28	20	17	25
02	42	8	49	13	52	34	1		8	27	19	19	27
03	41	8	51	13	49	36	1		6	27	18	20	28
04	39	10	51	13	47	38	1		5	24	19	17	34
05	39	9	52	15	50	35	+		4	24	17	19	36
06	38	8	54	13	52	34	1		4	22	17	18	39
07	33	13	55	17	47	35	1		4	20	19	19	38
08	31	8	61	14	46	39	1		5	25	15	18	37
09	29	11	60	12	42	44	2		11	28	14	18	29
10	31	7	62	8	41	49	1	1	21	28	12	14	24
11	30	14	56	7	40	49	3	4	25	29	12	11	19
12	30	15	55	9	36	52	4	8	32	23	12	7	17
13	30	13	57	6	33	58	3	10	37	22	10	6	16
14	30	13	57	5	37	53	5	16	36	21	8	6	13
15	29	13	58	6	37	52	5	16	38	22	7	5	14
16	31	13	55	5	39	52	4	19	34	22	6	7	12
17	30	14	56	6	40	51	3	16	35	23	6	6	14
18	34	12	54	7	54	37	2	8	36	25	8	8	15
19	37	11	52	8	61	29	2	4	33	29	11	7	17
20	39	11	49	9	57	33	1	1	28	31	19	7	19
21	41	10	49	9	58	32	1	1	22	31	17	10	19
22	41	10	49	10	55	34	1	+	18	33	18	11	20
23	41	7	52	10	57	31	2		17	29	21	12	21
AVG	35	11	54	10	47	41	2	4	20	26	14	12	23

Fig. 1 Climatography of the United States # 82 – a summary of ten years (1951 - 60) of hourly observations

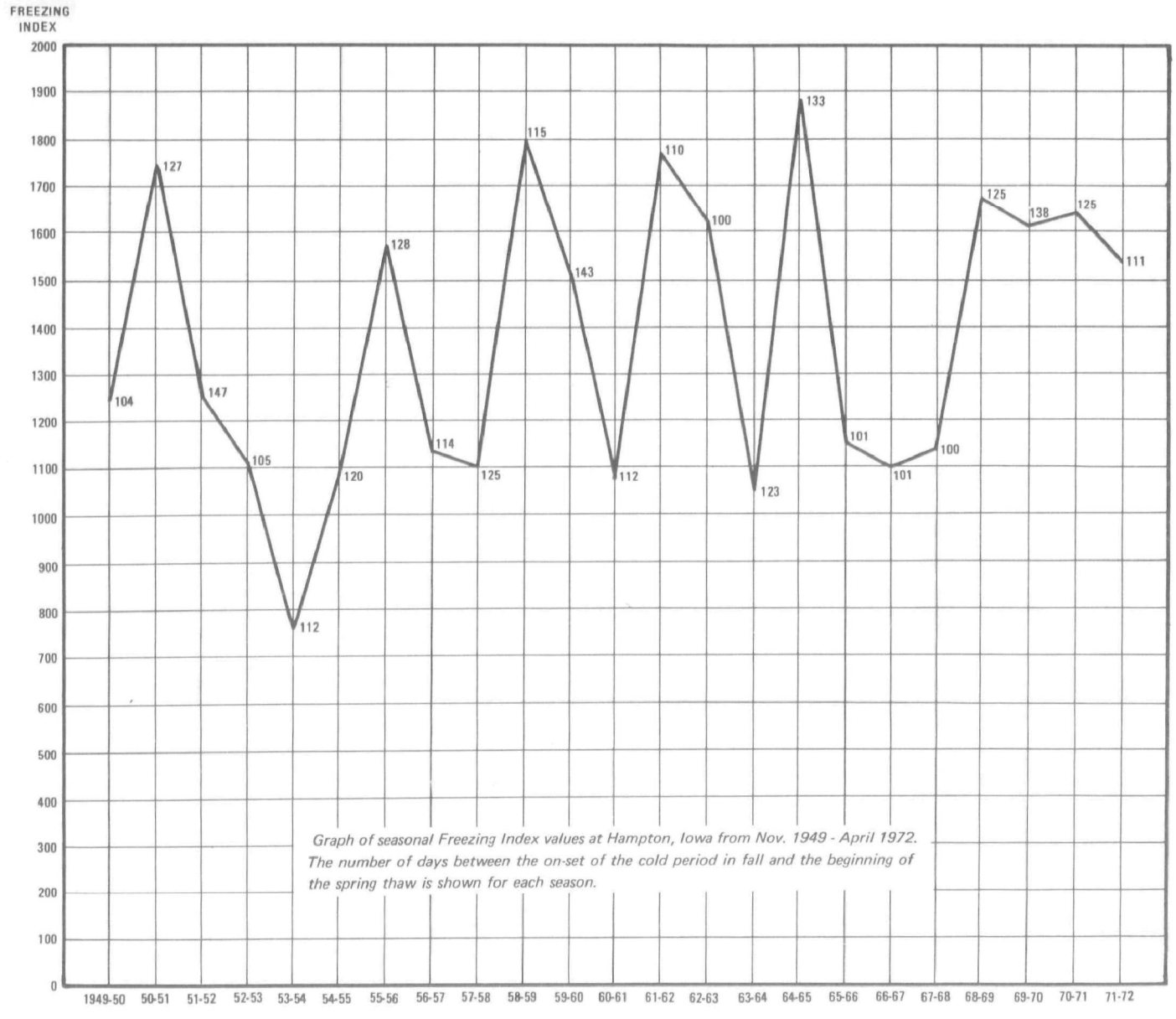


Fig. 2 Freeze indices and duration of cold periods at Hampton, Iowa for selected seasons

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-660/2-75-018		

4. TITLE AND SUBTITLE	5. REPORT DATE
USE OF CLIMATIC DATA IN DESIGN OF SOILS TREATMENT SYSTEMS	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Dick M. Whiting	
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Climatic Center (Asheville, NC) Environmental Data Service National Oceanic and Atmospheric Administration	10. PROGRAM ELEMENT NO. 1BB045 (ROAP 21-ASH, Task 18) 11. CONTRACT/GRANT NO. EPA-IAG-D4-F451
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Protection Agency, OR&D, NERC-Corvallis Robert S. Kerr Environmental Research Laboratory P. O. Box 1198 Ada, Oklahoma 74820	13. TYPE OF REPORT AND PERIOD COVERED Final (03/11/74 - 02/28/75) 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Planners, designers and operators of land-based wastewater management systems need information about climatic influences on the determination of storage requirements. Parameters of special interest are discussed and two guidelines have been developed. The guideline referred to as the freezing index is recommended for stations whose average normal temperature during the coldest month is less than 32°F, while a study of days defined as either favorable or unfavorable is recommended for stations in the warmer climatic zones. The effect of a run of unfavorable days immediately following a cold period can also be determined by examining the daily listings.

A number of graphs, charts and maps are included to describe ways of presenting climatological data and to show the availability of summarized climatic elements. Air temperature, ground frost, evaporation, precipitation, snowfall, snow depth and wind direction and speed are discussed in relation to the possible affect of each on land application systems.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Waste treatment Irrigation Design criteria Climatic changes	Soil treatment systems	Pri. 04/02 Sec. 02/03

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release unlimited	Unclassified	67
	20. SECURITY CLASS *(This page)*	22. PRICE
	Unclassified	

EPA Form 2220-1 (9-73)

☆ U. S. GOVERNMENT PRINTING OFFICE: 1975—698-780 /170 REGION 10