

SWS Contract Report 356

**NORTH
CENTRAL
REGIONAL
CLIMATE
CENTER**

NCRCC

**Third Annual Report
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by

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Introduction

The North Central Regional Climate Coordinating Office (originally the Regional Climate Coordinating Office) located at the Illinois State Water Survey, Champaign, was established in September 1981 as part of a plan devised by the North Central Regional Research Committee, entitled "Development, Implementation, and Use of Weather and Climatic Information for Agriculture." This committee, identified as NC-94, developed a regional intergovernmental climate program within an existing institutional framework for the 12 state North Central Region. The overall goal of the NC-94 plan, entitled, "A regional intergovernmental climate plan for the North Central United States," was to develop an infrastructure to coordinate regional climate research, improve and coordinate climatic services and data management activities. The components of this plan are the 12 State Climate Centers of the North Central Region, and the Regional Climate Coordinating Office, now called the North Central Regional Climate Center (NCRCC). Funds needed to maintain the NCRCC are provided by the National Climate Program Office (NCPO) and the state of Illinois.

The purpose of the North Central Regional Climate Center is to improve the efficiency and effectiveness of climate information dissemination at the state and regional levels, oversee State Climate Center participation in regional climate research, serve as a clearinghouse of information between State Climate Centers and other groups (including federal agencies), and administer regional funds which may be made available for climatic studies. Each of these purposes has been pursued with varying degrees of success during the past 3 years.

As part of this 5-yr demonstration plan, the North Central Regional Climate Center is accountable to the NC-94 committee, specifically to its subcommittee which advises NCRCC staff relative to current activities and future plans. We meet with the NC-94 committee annually to present the annual report, and discuss plans for the immediate future. We meet with the advisory committee twice annually. In addition, the NCRCC has an external advisory committee, composed of three individuals from the private sector who deal with climatically-related problems in their profession.

During the first 3 1/2 yrs of this Center's operation, John L Vogel served as director, Stanley A Changnon Jr as the liaison with federal agencies, and Wayne M Wendland directed research. As of 1 September 1984, Wendland assumed the directorship and will continue with research activities, Vogel is primarily concerned with the transmission and archiving of climatic data, and Changnon will continue liaison with federal agencies with climatic interests.

Interstate dissemination of climatic data and information has significantly grown during the recent years, in part because of the advice and technical assistance given by NCRCC. The National Climatic Data Center (NCDC) now makes its monthly climatic summaries (Climatological Data) available on their computer, the data of which may be accessed by terminal and modem. Daily climatic data from the Midwest Agricultural Weather Service Center (MAWSC) at Purdue University are routinely obtained via computer-to-computer link via phone line by Illinois, Michigan, Minnesota, Missouri, Nebraska and Ohio. South Dakota and Kansas access these data through the Nebraska A6NET system. In addition, Illinois, Indiana, Nebraska and South Dakota routinely receive the climatic outlooks, Palmer Drought Index and soil moisture information from

the Climate Analysis Center (CAC) of National Weather Service. Michigan, Minnesota, Nebraska and Wisconsin routinely access CD information directly from the National Climatic Data Center (NCDC) computer via long distance phone line. These data are incorporated into state-operated climatic data and information systems for immediate use and further dissemination, and are used by various states in the analysis of the impact of anomalous temperature and precipitation on local agriculture and other climate-related economic enterprises.

A number of regional climate research studies were initiated and/or completed during the past 2 years. Two of these resulted in the publication of two papers in professional journals, and another study led to the preparation of a major research proposal. Each of these 3 studies required input from NC-94 representatives and State Climatologists (SCs) of each of the 12 North Central States. The studies were organized and directed by NCRCC. Another research project in progress is an analysis of 1951-80 normal monthly isotherms and isohyets over the Upper Midwest, accounting for biases introduced by different times of observation. This will lead to the publication of a Midwestern atlas of normals.

Since 6 State Climate Centers received new microcomputer systems within the past 12 months, computer-to-computer transmission of digital data via long distance phone line will increase as more experience and competency is gained. The engineer from NCRCC advised the Midwest Agricultural Weather Service Center (MAWSC) at Purdue as to certain hardware which would make their data more easily accessible, and built and installed the equipment at MAWSC. We have met with representatives from Missouri to aid them in developing a near real-time climatic data acquisition and dissemination system for Missouri.

The NCRCC serves as a clearing house of information both between states of the region and between those states and private and federal agencies. This service operates as needed, i.e., as states or outside agencies have a need for a specific database, they contact NCRCC which provides the data, or directs the requestor to an appropriate state agency.

Although NCRCC will administer funds made available for regional climatic studies, no such grant have yet been received. NCRCC has negotiated with the National Environmental Satellite Data and Information Service (NESDIS) to enable a representative of each of the North Central States to prepare a listing of climate observations maintained by private and public agencies in their state and provide this information of NESDIS. Although NESDIS is interested in initiating such a contract with the NCRCC, they have had insufficient funds to date to make such an allocation to the states of the North Central region.

A research proposal including contributions from each of the State Climatologists of the North Central Region has been prepared and submitted to the National Science Foundation for consideration. If this proposal is accepted and funded, each of the SCs will prepare a database for analyses, participate in the analysis under the direction of NCRCC, and receive financial support for those services.

The NCRCC continues to follow it's initial objectives, although each has evolved slightly differently in direction with time and experience. Most of the objectives have expanded in scope. The primary focus of the NCRCC is directed toward agricultural concerns because of the strong agricultural and agribusiness interests in each of the participating states. In addition, the objectives are directed toward energy, water resources, tourism, industrial

development, environmental issues, transportation, and construction interests.

The NC-94 regional committee has, and will continue to provide a strong leadership role in NCRCC. This is accomplished by means of their Oversight Committee consisting of three members. This committee will meet with the NCRCC staff twice a year beginning in 1985. Two meetings per year were suggested by the NC-94 Advisory Committee and supported by Director Roger L. Mitchell, Dean of the College of Agriculture, Agricultural Experiment Station, Columbia, MO.

2. Attainment of Objectives

As mentioned in the Introduction, the objectives of IMCRCC have been realized with varying degrees of success. It was initially hoped that research and service money might be obtained by NCRCC from the federal government and other agencies which would have helped support each of the regional State Climate Centers. This hope has not been fully realized for several reasons. Money for research and services has become more difficult to obtain during the last few years because of a larger number of researchers applying for money, and past inflation required that increased funds were required to merely maintain current research, and finally, funds for the improvement of state research facilities are generally perceived to be the responsibility of the supporting state agency. This condition permitted expansion of facilities only in instances where state money was available.

The following accomplishments, completed during the past 12 months, demonstrate the services and research focus of NCRCC, and give a measure of

its maturity.

A. Communications

Relative to maintaining communication and coordination between State Climate Centers, federal agencies and users (the first goal), the NCRCC continues to advise SCs and NC-94 representatives as to the availability of funding for specific research and service projects, administrative developments in climate agencies of the federal government, as well as developments within Climate Centers of other states. This is accomplished by letter and by phone calls. NCRCC staff met with SC's and NC-94 representatives at the annual American Association of State Climatologists meeting in August, and the NC-94 annual meeting in October 1984. During the coming year, we will investigate the possibility of using electronic mail and encourage computer-to-computer communication between SC's, and the NCRCC. NCRCC staff presented papers at the 3rd Applied Climatology Conference in November 1983, discussing various activities of the NCRCC. Dr. Bernhard Dethier, director of the Northeast Regional Climate Center, visited NCRCC in May 1984 to be briefed on its operation and to discuss issues of interest. We met with staff from the NWS Central Regional Headquarters in December 1983, and briefed them on the objectives and tasks of the NCRCC.

One of the primary objectives of the NCRCC is the coordination of regional center activities with federal agencies and federal staff members, primarily accomplished by Stanley Changnon. Principal interactions with federal agencies in 1984 were with NOAA and the Department of Agriculture. Discussions relating to the Regional Climate Center were held at the National Climate Program Office in February, June and October. The NOAA Administrator was

briefed about NCRCC in February, and NCRCC was discussed with members of the NOAA Policy and Planning staff in July. There were also interactions with NCPO staff and other federal representatives at two climate meetings during the year. These included the Climate Prediction Workshop sponsored by the American Meteorological Society on 5-6 September, and again when the Illinois Water Survey hosted the National Academy Panel on Climate Data in Champaign-Urbana on 1-2 November.

Staff members in the atmospheric sciences and engineering sciences of the National Science Foundation were briefed on NCRCC in February, April, and October. The staff of the Governor of Illinois housed in Washington was briefed on NCRCC in February, and certain Illinois and Iowa members of the House of Representatives were briefed about NCRCC in March 1984.

Discussions about implementation of a broader federal program of regional climate centers for state services were held on several different times with state representatives during the year. Discussions with state officials from Missouri, Connecticut, Iowa, Utah, North Dakota, and Nevada were conducted at a series of 8 different meetings during 1984. Furthermore, discussions were held at the annual meeting in August of the American Association of State Climatologists with various state climatologists relating to the federal program in the NCRCC.

Interactions with the Department of Agriculture involved two discussions with Dr. Norton Strommen, Chief Meteorologist of the World Agriculture Outlook Board, once in February and once in May. The Assistant Secretary of Agriculture for Science and Education, Dr. Orville Bentley, was briefed about NCRCC in June. Representatives of the Corps of Engineers from St. Louis and Louis-

ville, Kentucky were briefed about the NCRCC in June. Two representatives of the U. S. Geological Survey were briefed about NCRCC in July.

Dr. Bradley Schneller of the Canadian Ministry of Agriculture and Food visited NCRCC in October to study the organization of NCRCC, and the climate centers in the North Central Region. Dr. Colin Banfield of Memorial University, St. Johns, Newfoundland visited NCRCC in the fall to discuss the organization, and to view the Illinois Climate Center and other centers in the region. Canada anticipates establishing provincial (regional) climate centers, and Dr. Banfield is the representative from Newfoundland.

B. Research

The second major goal, to develop and launch one or more regional research projects, has been addressed and fulfilled with several projects. First, following the successful completion of an analysis of winter climate anomalies and their impact on snow removal, heating and energy costs relative to the mild 1983 winter (published in Bulletin, American Meteorological Society 64: 1346-1350), representatives of the State Climate Centers completed an analysis for the 1983 summer. This was a particularly interesting episode with considerably warmer than normal temperatures and relatively long periods without precipitation. The economic impact on agriculture, primarily within the cornbelt, and on electrical consumption was analyzed for all states of the region. This research project began during fall of 1983, resulted in a draft of the paper (prepared by the present NCRCC director) by the end of 1983. After review by each of the contributing authors, the revised version was submitted and appeared in Bulletin, American Meteorological Society (65: 1068-1072).

The preparation of regional maps showing mean monthly isotherms and isohyets for the 1951-80 period, corrected for time of observation biases continues. These data were more difficult to analyze than anticipated, primarily because of the unequal spatial location of stations taking observations at any one given time, and because many stations changed their time of observation at least once during the 30 year episode. Since the data are digitized, mean monthly temperatures from all stations have been plotted on one chart for each month. Several SCs have helped by providing advice on local conditions and stations. When completed, these maps will be assembled as an atlas, and a NCRCC publication.

After considerable discussion concerning a research topic for a regional project, a proposal was written by Wendland to reconstruct modal monthly synoptic patterns for the Upper Midwest for the past 80 to 100 years. This project will base its findings upon significant changes in the distribution of daily maximum temperatures, collated from about 10 stations in each of the 12 states. Using a technique discussed by Bryson (1966), these temperature data will be analyzed to demonstrate changes in the airmass frequency with time. This proposal has been submitted to the National Science Foundation for review and possible funding. A response is not anticipated until spring 1985.

Several researchers in this region, notably D. Baker, R. Dale, and L. Schaal (and others outside the region) have noted that mean monthly temperatures constructed from maximum/minimum thermometers read once per day differ from midnight-to-midnight observations by up to about 1.5C depending upon the time of observation. In general, once a day observations from times near 0700 local time underestimate the midnight-to-midnight mean by 0.5C whereas those made in late afternoon over-estimate the midnight to midnight mean by about

1C. During the past year, David Head, masters degree candidate in the University of Illinois Department of Geography completed an investigation of the spatial continuity of the time of observation biases. Sixteen years (1959-1964) of hourly data were acquired from 10 first order stations within the North Central Region from the SCs. This analysis indicated spatial continuity of the sign and magnitude of the biases over the entire area, with a slightly greater gradient exhibited in the north-south direction. This MS thesis was submitted to the University of Illinois Graduate School in January 1985 and will be duplicated and distributed to all SCs and NC-94 members within the region during early 1985 as a NCRCC publication.

The time of observation is being pursued on a larger spatial scale. The current director of NCRCC participated in the National Climate Data Center's exchange program during 1984, and was resident at the Center for 3 weeks. While there, he worked closely with Tom Karl to prepare a database of hourly temperatures from more than 70 stations within the United States from 1950-1964. These data will be analyzed to determine the time of observation bias for stations near sea level to altitudes of about 2,000m MSL. Because of the spatial continuity suggested by the study of Upper Midwestern data, we anticipate that an equation for the time of observation bias may be generated.

During the past year we negotiated an agreement with the National Environmental Satellite Data and Information Service, whereby SCs or NC-94 representatives from each of the Upper Midwest states would compile a list of routine climatological observations gathered over recent years by agencies other than federal and state government. NESDIS is charged with the responsibility of compiling such a list, and to act as a clearing house so that interested individuals may determine the availability of special climatological

observations by a request to NESDIS. Although an agreement was struck whereby NESDIS would provide a small amount of support to each state to compile these data, the necessary funding has not yet been made available to NESDIS, and therefore no allocation of funds nor work has been completed. We have continued contact with NESDIS, and will direct this operation when funding becomes available.

At the NC-94 annual meeting in October 1982, NCRCC proposed the establishment of a volunteer contrail observing network within the region. The Illinois State Water Survey has been operating such a network for about 2 years and was interested in expanding its area of observation. NC-94 representatives and SCs compiled names and addresses of experiment station directors and offices in each of the states, so that NCRCC could contact the directors and request that they disseminate the request for observers. A volunteer cadre of about 100 observers was established and observations were taken during 4 months of the recent year. These observations have been digitized and will be analyzed to determine areas of persistent contrails on specific days of each of the months.

C. Regional climate data system.

The third goal "...to implement and gain access to a regional real-time climatic data and information system" has been addressed in several ways. The National Weather Service Remote Observation System Automation (ROSA) will enable 8 to 10 cooperative stations per state to enter their daily observations on the AFOS system. The ROSA observers transmit their observations via touch tone pad to central computers which then access AFOS. At present, less than 10 stations are functioning in the region, but as this number increases we will

access these data from AFOS at the Midwest Agricultural Weather Service Center and make them available to the North Central States. Access by the states to the observations can be accomplished either from the Illinois Climate Assistance Service (a computer-based climatic data system), by telefax, by computer-to-computer link via telephone, or by mail, whichever system satisfies the time constraints of the requestor.

NCRCC is also investigating the possibility of initiating a regional scale computer-based, near real-time climatic data system, whereby daily observations of temperature and precipitation would be received from NWS Cooperative Observers via touch tone phone, and from the ROSA stations from Automation of Field Operations and Services (AFOS) system. The regional computer would generate a series of maps on a daily update basis, tables and narratives describing the climate to the present date. These products would be made available to State Climatologists and other authorized users so that they could assess the current or accumulated state of temperature and precipitation over any, or all, of the 12 states of the region. Such a system is particularly beneficial to State Climatologists in that it makes current temperature and precipitation data available within a few hours after the time of observation. Heretofore the SC had to wait one or more months to receive the carbon copy of the E-15 form (the monthly form on which the cooperative observer records daily observations) from NWS. Under a contract with the Climate Analysis Center, the National Climate Program Office, and the State of Illinois, the Illinois State Water Survey developed a near real-time climatic data acquisition and dissemination system, called the Climate Assistance Service (CLASS), that could serve as a model for a regional system.

Missouri (W. Decker, V. Jones & M. Fairchild) is planning to inaugurate a state-scale system similar to the Illinois CLASS. They would include data from Missouri Cooperative Stations for use in integrated pest management. They have consulted extensively with the NCRCC staff for a demonstration of the Illinois Climate Analysis System, and to discuss the possible transfer and adaptation of the Illinois system (hardware and software) to accommodate Missouri data and develop products.

John Vogel of NCRCC continues to participate in planning **with** the North Central Computer Institute (NCCI) of the University of Wisconsin-Madison relative to implementation of a regional climate data repository. A committee, with representatives from Kansas, Ohio, Nebraska, NCRCC, and NCCI, is writing a plan which could form the basis of such a system, including parameters which might be included, integration times prior to recording each of the parameters, potential funding mechanisms for the maintenance of the system, and a method whereby such a regional system could be chartered, developed, initiated, and funded. The appendix to this annual report contains a series of questions and answers devised by the committee which describe how the repository might function.

Another goal of NCRCC was entitled "to answer climatic inquiries, when possible, from users in those states unable to provide climatic services." NCRCC has made the availability of such limited service known to state climatologists within the region. The SCs have begun to recognize that some requests made to them could more easily be satisfied by NCRCC, and this service has increased. It will grow as funding permits. We are able to transfer data electronically, via phone line, by floppy disc, or by tape.

In September 1984, Wendland participated in the National Climatic Data Center's exchange program, and was introduced to a listing of early (pre-1900) meteorological observations compiled by the Smithsonian Institution, and held on microfilm at NCDC. The listing includes short- and long-duration diary and travel records, and standard observations (from 0700, 1400 and 2100 local time) which tend to continue for decades or more. Lists of the holdings were duplicated for all states of the North Central Region and distributed to SCs and NC-94 representatives. Although discontinuous, the earliest records generally begin in the 1840s and continue through the late 1800s.

During that same visit, it was determined that the daily digitized temperature and precipitation records of Illinois stations held by the Illinois State Water Survey were more complete than those held by NCDC. After consultation with William Brower of NCDC, Illinois prepared copies of their 1901-1983 records of Illinois cooperative stations and provided them to Mr. Brower.

The goal entitled "... to prepare guideline documents relating to stations, instruments, data collection and data quality" has long been discussed between members of NCRCC and individual SCs and NC-94 representatives. It is not possible to write one all-encompassing document which describes proper measurement of a meteorological or climatological parameter, particularly in instances when such measurements are under state jurisdiction, or directed by private enterprise, since these are typically inaugurated for specific purposes, e. g., to measure the wind stress on a given surface or to measure the temperature at a given height within the standing crop or forest, or to measure the solar radiation intensity on a given surface etc. Observations for such special purposes may require non-standard sensors, integration times and recording techniques. Since these conditions cannot be dictated by outside

agencies, only general statements of acceptable exposure sensor time constant, integration time etc. can be made. Discussions between NCRCC and a committee on NC-94, also charged with this responsibility, will be pursued.

Another goal of NCRCC was entitled "Provide computer expertise for the operation of the real-time data systems and assist the State Climate Centers to ensure computer compatibility." NCRCC has advised the Missouri State Climate Center relative to their establishment of a state operated climatic data acquisition and dissemination system (described above). We have provided guidance and advice to Dr. D. Clark, (Wisconsin SC) who is designing a near real-time data system. Hourly data from NWS First Order Stations in Wisconsin will be transmitted over the Wisconsin television network by a system akin to that used for closed-caption transmissions for the hearing impaired. Such data will be available to any receiver with an appropriate decoder.

3. Current State Activities

Illinois; Funding for climate service in Illinois has remained essentially constant from the previous year. The major innovation to the Illinois Climate Center is the initiation of operation of the Illinois Climate Assistance Service (CLASS). A micro computer at the Survey receives daily temperature and precipitation observations from 36 National Weather Service Cooperative Observers via touch tone phone, and reformats these observations into tables, maps and narratives which explain the current state of climate within the state. These data are currently available to about 300 users in and around Illinois. The system presents temperature and precipitation data for each of the last 14 days, compared to the same information for the last year and for the 30 year normals. In addition, data can be displayed on maps of Illinois

for the present, for the last 7 days, for the month to date, for last month etc. Degree days are calculated and summed to date, and data and information from the Climate Analysis Center (30- and 90-day outlooks, and Palmer Drought Index) *are* presented. We present soil moisture observations from the surface to 2 meters depth from 17 sites in Illinois updated bi-weekly during the growing season, and river gage heights, and depth to the water table at 17 stations, lake levels at 10 site, and peak river heights at 33 sites, all monitored by the Water Survey. CLASS gives the opportunity to keep current as to the present distribution of temperature and precipitation gathered from a 36-station array of observing sites (report by Wayne M Wendland, Illinois SC).

Indiana; Professor James Newman of Purdue University has been appointed Indiana State Climatologist. The budget realized no change since that of last year, although they have acquired a word processor. They have recently finished digitizing all Indiana Cooperative Data to update the database. They are in the process of writing several programs which will routinely summarize and analyze the recently accumulated observations. They are developing an energy-use assessment model for Indiana State Government, as a function of past and current climatic conditions. Preliminary tests of this model during the 1984 summer suggest that energy demand for corn drying for the 1984 harvest was about 2.5 times greater than that used in 1983. This was due to the end of the PIK program, the greater 1984 harvest, and because of the greater crop moisture content at time of harvest. (Report by Professor James Newman, Indiana SC).

Iowa: State support for the State Climatologist has remained constant. There are 3.1 full time equivalents working in the State Climatologist's office, with slightly more than 1 FTE funded by soft money resources. In the

last year, a new IBM PC-XT has been acquired. The staff of the Iowa Climate Center are currently digitizing the Iowa Cooperative data. The State Climatologist is continuing a hail study for NSF, analyzing hail occurrence data accumulated by the Crop Hail Insurance Actuarial Association. The State Climatologist is also continuing a study to define how climate statistics from different temporal episodes impact decisions-making. Using precipitation data from 1873 to 1984, he is identifying significant cycles and trends. Using precipitation reconstruction from tree-ring data, the precipitation time series has been extended back to AD 1680. This project is funded by the US Army Corps of Engineers. (Report by Dr. Paul Waite, Iowa SC).

Kansas: Although he receives no direct support for a state climatological program, Prof. L. Dean Bark acquired a micro-computer with a hard disc during the past year to help with managing the Kansas data and preparation of the monthly summaries (report by Prof. L. Dean Bark, Kansas SC).

Michigan; The Michigan program continues to be active. They have acquired a new microcomputer (containing a 10 megabyte hard disc and 396k storage). This system will be used in Michigan's continuing effort to identify incorrect and missing data in their cooperative archive. Dr. Fred Nurnberger was invited to testify at a meeting of the National Academy's Panel on Climatic Data. He described the needs for climatic data in Michigan, current research and service programs, and interactions between NCRCC and the Michigan Climate Center. (Report by Dr. Fred Nurnberger, Michigan SC).

Minnesota; The office of the Minnesota State Climatologist has acquired 2 IBM PC-XTs. These will be used to prepare data discs to be distributed to other offices interested in accumulating daily and mean monthly conditions for

the state. For example, the discs will be distributed to the Experiment Stations for subsequent distribution to county agricultural extension agents. Eight existing Campbell sensor-recorders at remote automatic recording sites will be upgraded to modem service by spring 1985, so that real-time data may be acquired at the State Climate Center. Jim Zandlo participated in NCDC's exchange program during September. He demonstrated several data analysis programs routinely used at the Minnesota State Climate Center. (report by Professor Earl Kuehnast, Minnesota SC and James Zandlo).

Missouri: Professor Wayne Decker and Dr. Vernon Jones (Assistant State Climatologist) are working on the development of a climate/integrated pest management model, and a near real-time data acquisition system to drive the model. They consulted with the staff of the Illinois State Water Survey and NCRCC to discuss the organization, use and attributes of Illinois CLASS, with the thought that Illinois CLASS might serve as a prototype for a similar system in Missouri. Dr. Jones participated in NCDC's exchange program during September 1984. He aided NCDC as to Missouri station histories. (report by Professor Wayne Decker, Missouri SC).

Nebraska: Funding has remained level for the Nebraska Climate Center, however new climatic products continue to evolve. They have developed a crop status model which became operational in April 1984. This routine calculates crop yields as a function of current climate, and anticipated conditions through the remainder of the growing season. There were about 13,000 requests for this information during 1984. They have also developed a model which generates conditional probability information for given conditions and specific time windows, and about 10 other models ranging from irrigation scheduling, and anticipated beef growth, to soil temperature. (report by Kenneth Hubbard,

Nebraska SC and Professor Ralph Nield).

North Dakota: Largely due to the efforts of the MIC of the Bismarck National Weather Service office, 25 NWS Cooperative Observers in North Dakota call their daily temperature and precipitation observations to the Bismarck office, where they are disseminated via the North Dakota Weather Wire. Long term records from 40 stations in North Dakota have been digitized by the State Climate Center to provide current statistics of daily temperature and precipitation, i.e., highest temperature ever, greatest 24 hour precipitation ever, etc. Such data are very helpful in evaluating the current conditions, and are of interest to the media. A microcomputer was recently secured for the North Dakota State Climatologist. (report by Professor John Enz, North Dakota SC).

Ohio: There is no specific state support for Prof John Rayner, SC in Ohio. He serves as the climatological archiver for the state. Dr. R. Bruce Curry, NC-94 representative from the Ohio Agricultural Research and Development Center at Wooster is able to support some of the services of a SC program, however, also receives no specific support for climatological services (report by Bruce Curry, NC-94 representative).

South Dakota: The South Dakota State Climate Center is cooperating with the Nebraska AGNET system in that 3 automatic recording stations have been established in southern South Dakota, and contribute data used in the preparation of irrigation advisories published on AGNET. Three more automatic stations are anticipated to be in operation within the next few months. The South Dakota State Climate Center has acquired 2 new microcomputers during the recent year, and is analyzing statewide precipitation from June 1984. The extent, magnitude and duration of flooding in South Dakota during that month

were extreme. The South Dakota study will determine recurrence frequencies for the precipitation rates which were observed during that month (report by William Lytle, South Dakota SC).

Wisconsin; Dr. Clark continues to digitize the Wisconsin Cooperative data, and to generate programs which analyze those data. The Climate Center enjoyed an increase of 1/2 FTE during the past year. Daily (hourly) data from state First Order Stations are available to the Center via the University of Wisconsin McIDAS system. Dr. Clark is developing a method whereby these data will be available to the state television network for dissemination. He also testified at the National Academy's Panel on Climate Data, held in Urbana in November. (report from Dr. Douglas Clark, Wisconsin SC).

4. Future Plans

With the advent of climate data acquisition and dissemination systems in some states of the North Central Region, there is strong support for, and sufficient experience to promote a regional climate data system. The advantages of a regional system are quite clear, in that near real-time data would be available to State Climatologists for their own as well as surrounding states. The benefits to commercial users are obvious. The advent of available ROSA data during 1985 suggests that the present is an appropriate time to establish a regional climate data acquisition system, since the 8 to 10 ROSA stations per state would provide a database. The ROSA observations are to be available on AFOS daily, and those data could be accessed from the AFOS station at the Midwest Agricultural Weather Service Center.

We will continue to pursue the development of a regional climate data acquisition and dissemination system, and to identify potential commercial users

in the states of the North Central Region. The latter list is important because support for the continued maintenance of such a system will clearly fall to the users. A series of workshops to identify potential users in the region is currently under study. A proposal to support three workshops in major cities of the Midwest has been submitted for review and possible funding.

The increase in the number of microcomputers in state climate centers also suggests that interest in exchange data will increase. The Regional Climate Center will serve as the focus for such diffusion of ideas, data, and programs. One problem in data transfer continues, i.e., different equipment used in many of the states. This therefore requires that software prepared in one state in a particular language will have to be recoded for use on other systems. We will investigate the possibility of such translation routines and act as a translator as funding permits, and as necessary.

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Appendix A

Some Questions and Answers about a
North Central Weather/Climate Data Repository

John Vogel, Dean Bark, Dave Brunkow,
Bruce Curry, and Thomas Thompson
20 August 1984

General Definition of Data Repository

The Climate/Weather Data Repository for the North Central Region has four main responsibilities. These responsibilities are:

- 1) to receive near real-time climate/weather data;
- 2) to transmit these data to users in near real-time;
- 3) to archive this data thereby building a historical data base; and
- 4) to make this historical data available for use by others.

The objective of these data collection activities is to make available near real-time (1 day to 1 week from the time of observation) weather/climate data for decision making in agriculture and other weather/climate dependent activities, and to provide a repository for quality climate data not being archived in other repositories.

The data shall consist of measurements from automatic networks funded and operated by various state agencies, or other groups, as well as any measurements from the National Weather Service primary and secondary networks that are available in near real time. The data flow will be implemented using computer-to-computer telecommunications between the data sources and the repository. As available, data will be obtained directly from National Weather Service ports. The transmission of the near real-time data base from the repository to users (individuals, private industry, or communication networks), should be accomplished using a telecommunications protocol which would accommodate the most simple terminal or microcomputer. The historical data from specialized networks, that are not being centrally archived, can be made available to the user either by computer-transmission or by the use of tape or disk, depending on the length and the amount of data required. Since the data is to be stored for historical purposes as well as near real-time purposes, it would be expected that copies of past years data from the special weather stations would be assimilated by the repository to define the historical records.

The near real-time data will be received on a daily basis, when available, from a variety of sources, and some initial quality control will be exercised by these sources and the data repository. However, the most recent climate data will not have undergone extensive quality control measures; i.e., the near real-time climate data will not be of the same quality as climate data that has undergone final quality control. As errors are discovered at

the data source or at the data repository, corrections or estimates will be made. Thus, with time the quality of the data will improve.

Real-time data, with a backlog of at least one year, will be available on line for users. The users may consist of individuals or groups requiring data for maintaining a state network. The data or products will be made available in a flexible format for the conveniences of the user. Historical data will be made available on disks, tapes, or hard copy depending upon the needs of the user. It is envisioned that historical data will be used by researchers, and the total data set need not be on line.

An advisory committee, consisting of one representative from each participating state in the region will be established to assist the Directory of the repository.

Beyond the basic definition and responsibilities of the data repository for the North Central Region, there are a number of questions that need to be resolved. These questions address many of the specific operations of the data center and the requirements that will be imposed upon this data repository when it is initiated. These various questions have been divided into five categories: 1) benefits; 2) operational; 3) quality control; 4) data transmission; and 5) funding. Specific questions within each of these categories will be addressed in the following.

Benefits

Question 1. What are the benefits derived by the state for participation with the data repository?

The states or the data collection points will be able to use the repository for quality control of near real-time and historical data. The repository will provide quality control of historical data sets, and will be able to develop procedures to more effectively compare, correct, and substitute invalid data for a larger region. Presently, the quality control of the specialized data sets is spotty, and a consistent quality control needs to be applied.

Many states do not have a specialized weather/climate network or the network does not have a sufficient density to represent adequately the spatial and temporal variations of various parameters. In addition, the data from these state networks are generally not readily available to more than a few users. The data repository will collect NWS and other daily data from various sources, and will make these data available to users. Thus, a minimum collection of daily data will be available for all states in the North Central Region.

States or collection points will be able to merge present resources at a central repository for the development of consistent quality control packages, data management, and data distribution. In addition, it is anticipated that there will be a movement toward standardization of instrumentation, instrument exposure, and weather/climate data.

Question 2. What are the benefits of a regional repository?

The data repository will be able to merge and provide data for use at the state or regional level in one convenient central location, and would allow all states to have a minimal data base. Procedures for quality control and data management could be developed at a central location and would be transferable to the state or local level. A central data repository would foster the faster development of special data networks. Also, the repository would be able to supply a consistent, quality-controlled set of climate/weather data for modelers and researchers.

Currently, the data from automated agricultural stations are not archived by the National Climatic Data Center (NCDC). If quality data from the region were available from a central repository, NCDC may be interested in obtaining the data.

Operational

Question 1. How are data transmitted from the collection points?

Most states will have a collection point (Figure 1) which will collect the data from individual stations, and then transmit the data to the data repository, but alternate arrangements between states or other groups can be made to transmit the data to the repository.

It will be the responsibility of the individual states to set up, maintain, and collect the data from their automated weather/climate stations.

Question 2. What types of equipment will be required to implement and maintain the repository?

The equipment required at the data repository will be dictated largely by the total function envisioned for the repository. If the user base is to be a wide range of agribusiness, farmers, states, and others, then the equipment required to run such a system will be expensive. However, if the users of this data repository are allocated to a relatively small group of individuals, then the types of equipment and communication devices required at the data

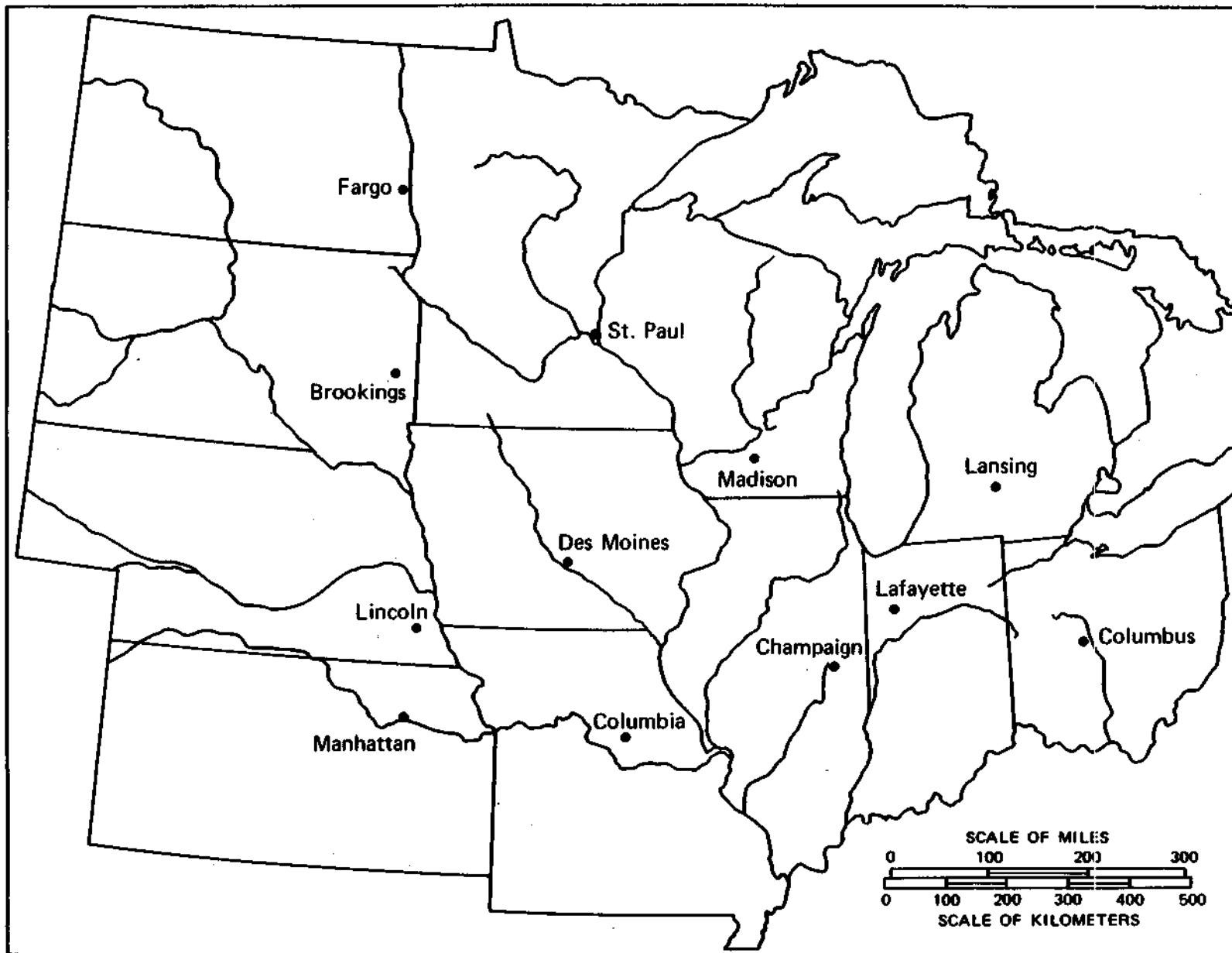


Figure 1. Location of State Climatologists

repository could be minimized. It is anticipated at this point that we are talking about a small to medium sized minicomputer, or purchasing time from a time-sharing computer.

Question 3. How is the transmission of data from the individual states to the repository implemented?

There are at least five potential options of transmitting data from the states or collection point to the repository. The selection of one of these depends upon the facilities and resources that would be available at each data collection source, and availability of personnel to develop specialized communications software. Table 1 provides some information about the transmission time required for data from one station with 10 parameters for one day using the various options indicated below.

- 1) The first possible mode would be to have computers communicate with each other through normal 1200 baud asynchronous modems, without any attempt at transmission error detection or correction. While this would be the lowest cost solution, it would have the greatest potential for error, and is therefore not recommended unless funding is severely limited.
- 2) One step beyond option 1 would be to add a error detection protocol which would automatically re-transmit records which were received incorrectly. This would be done by acquiring or developing software to support the protocol which could be run at each of the sites. This has the advantage of little or no additional hardware (assuming each site already has the capability for uploading data using a teletype (TTY) compatible protocol). However, the diversity of computer systems available at the various collection sources complicates the problem of developing software for a common protocol. This approach could also be used at 2400 baud at the expense of providing a modem (\$1000).
- 3) Asynchronous modems with built-in hardware error detection and correction could be used. This is perhaps the most attractive solution since the protocol is moved into a "black box" which can be driven by anything from the simplest micro-computer to a main-frame computer. This is a relatively new system, but several companies are offering such a product running at 1200 baud, and 2400 baud will be available soon. The 1200 baud version costs \$1000.
- 4) A synchronous communications protocol such as Bisync, could be installed at both the receiving and transmitting computers. Many computers from micros on up can support this protocol and emulate IBM 3780 remote job entry terminals. It is implemented using a commercially available software package and/or a specialized hardware package which is fitted to the computer. These packages would probably cost from \$1000 to \$3000. In addition, a modem to support such a system at 4800 baud would cost about \$1800. The advantage of this approach is that the time to transmit the data would be reduced. The disadvantages are a significantly higher

cost, and the possibility that some of the states may be using computer systems which do not support this protocol.

- 5) Telenet would be another option. This option would allow the data to be entered into the repository with one protocol, and to be transmitted by another. The user or a data supplier could call one number and telenet would connect to the data repository computer, and would provide any protocol conversion which might be required. The costs for this option are dependent upon the availability of Telenet. In some instances it may be cheaper, and in others it may be more expensive than other options.

Table 1. Estimated Transmission Time of Hourly Data from Collection Point to Repository.

Baud	Time
1200 (Asynchronous)	26.0 seconds
2400 (Asynchronous)	13.0 seconds
4800 (Synchronous)	5.5 seconds

- Assumptions: 1) 10 parameters at 10 characters each hour plus a daily summary (2600 characters)
 2) error detection protocol is used
 3) no errors detected

Question 4. Is a common format required?

A common format for transmission would make the reception of data at the repository convenient. However, as long as the format from each of the transmitting collection sources is known, the data can be properly converted to a common file format at the data repository. It does not appear that a common format for the transmission of the data from the data source to the data repository would be necessary.

Question 5. What is the format of data retrieval from the data repository?

A common set of subroutines will be used to retrieve data from the repository. Simple programs can then be used to call these retrieval subroutines and to obtain the results in a desired format. The data can then be transmitted to a receiving computer for additional analysis and/or distribution, or used to generate specialized reports for users.

Question 6. What provisions should be made for Hybrid or specialized data bases such as leaf wetness?

All climate/weather measurements or all measurements that could be attributed to climate or weather phenomenon should be considered legitimate data for this near real-time data base. Leaf wetness, which could be a combination of dew or trace rain events, is a good example. Soil moisture is another measurement that could be argued to be more of a hydrologic parameter. However, soil moisture measurements can be directly related to previous precipitation in most instances, and should and would be considered a very reasonable measurement for this data repository.

As much as possible, the repository will emphasize the necessity of data collection throughout the year. Some real-time applications require data only during segments of the growing season, while other applications require data during all seasons.

Question 7. Should a historical or station log be Maintained for each station?

The present location (latitude and longitude), elevation, types of instruments, the various station locations, and the starting and ending dates of various types of instruments, a change in any observational procedures, and other pertinent information should be maintained for each station that is considered part of the near real-time data base. Such information would especially be important for those stations which are run by state agencies or are not maintained by the National Weather Service. Without such information it becomes very hard to utilize the data in any historical manner, or to determine its use in the near real-time situation.

Question 8. Will different time zones be used in the data base?

Data will be stored in local standard time. Daylight savings time will not be used. The time zone will be stored as part of the station log. Whenever comparisons of hourly data across two time zones is needed, a one hour shift will be incorporated in the data comparison.

Question 9. What backup procedures should be used?

There are two issues to address with this question. The data will need to be recorded on backup tapes or other digital storage devices. In addition, concern must be expressed about 1) redundant equipment at the repository in case of a computer failure, or 2) the availability of the data from more than

one site. It is possible that eastern and western sites should be considered for the North Central Data Repository.

The repository should be backed up in some way. This might mean recording the data on backup tapes or disks as they arrive, or could mean an actual duplication of the repository. Requests for historical data are not likely to be seriously impacted by delays of several days, however, the delay in obtaining the data in the near real-time situation could be serious. Thus, there should either be a backup at the data repository or in another physical location.

Question 10. How often should the data be updated?

As much of the data as possible at the repository should be updated on daily basis, preferably early in the day. For the convenience and utility of the wide variety of potential users, the most current climate data should always be available.

Quality Control

Question 1. What type of quality control should be applied to real time and historical data?

The quality control applied to the real time data will only be done for obvious mistakes or missing data, and should be done automatically by software procedures. The user must recognize that real time climate/weather data will have more errors than historical data sets that have undergone extensive quality control.

The historical data set will have more quality control applied. A quality control procedure will be initiated, and as experience dictates there will be changes made. Whenever possible that quality control should be applied at the state level, rather than at the data repository level. This is especially true for special parameters. However, geographic comparisons between the measurements could be made at the data repository. Higher quality data will be substituted for any real-time measurements, such as data from cooperative observers, whenever it is available. It is anticipated that, in addition to developing methods for quality control of real and historical data, that cost comparisons will be made of the implementation of different levels of quality control.

Question 2. Should substitutions be made for missing data? If so, how?

Most real-time applications of data require a steady data stream. Thus, procedures must be initiated to estimate missing or invalid data. The data providers and the repository will have to work cooperatively to provide these data. It is proposed that a status code describing the data quality be established for all climatic measurements. This code would indicate whether the data is good, invalid, or estimated. Estimates for all invalid data will be available.

Question 3. Should the data be standardized to account for observations made at different times or different heights?

Maximum and minimum temperatures would be one of the major measurements affected by different observation times. It is possible that comparisons could be made with 24 hour maximum/minimum temperature observations made at first order or other cooperative stations, and that corrections to either morning, afternoon, or evening observations of maximum/minimum temperatures could be made. The representativeness of the values will vary depending upon the climatic parameter being measured. For example, point to point representativeness of precipitation on a daily basis is not good, but estimated monthly observations can be obtained with data from other stations.

Wind measurements, because of the availability of equipment and the different requirements for measurement will vary. A common reduction will have to be initiated which is a function of atmospheric stability and height. It will be necessary to standardize other climatic measurements as well. However, each set of climatic measurements will have to be evaluated, and substitutions will not be possible for all measurements.

Data Retrieval

Question 1. How should data be grouped for retrieval from the repository?

Each user will have individual needs. It is anticipated that the user will be able to define or alter their data information needs. The data transmission should attempt to incorporate maximum flexibility. Software will be made available to the users so that they can define their needs, and can expect to obtain those data when they request it.

Question 2. Should special products be developed or is the repository to function only as a dispenser of special data bases?

Initially, the repository would best function only as a dispenser of the special regional data base. However, it is anticipated that the data repository could eventually develop special regional information. The raw data from the data repository will be available to various state networks for distribution or to develop informational products.

Funding

Question 1. Are users to be charged? What about information providers?

In general, users of real-time information should be expected to pay for either the long distance phone call or for the privilege of using an 800 number. In addition, the user should also be expected to pay something for the data and information that will be provided. These charges should be reasonable and should be in an effort to recover costs, and not to be a money making proposition. The information provider is the back bone of the repository, and should be given some special privileges. It is anticipated that the collection point: 1) should be allowed to withdraw data equal to an amount commensurate with the amount of data and information that are provided to the repository; and 2) should not be made to pay for data they transferred to the repository. However, there should be a charging system whereby a person would be expected to pay for data taken from the repository in excess of some reasonable amount.

Users of the historical data base should anticipate paying for computer expenses, computer programming, the cost of tapes, floppys, or whatever method of transmission of the historical data base is used. As we enter into an information oriented society, the user should become more and more accustomed to paying for the privilege of using certain types of data.

Question 2. What level of financial support is needed for the establishment and maintenance of the repository?

The answer depends somewhat on the established scope and implementation plans for the repository. If the repository is established on a small or medium size minicomputer, the repository would best function only as a dispenser of the special regional data base. However, it is anticipated that the data repository could eventually develop special regional information. The raw data from the data repository will be available to various state networks for distribution or to develop informational products.

If the repository is established on a time share system, it may be advisable to immediately plan to use the system to generate and distribute specialized reports to the users. The marginal costs of generating the specialized reports would be small. The effectiveness and impact of the repository would best be served if specialized reports could be generated early in the life of the repository.

Question 3. Who is responsible for the establishment and maintenance of the specialised weather/climate networks?

This is a very broad question, and could be answered in a number of ways. It is possible that these networks may be maintained by the Agricultural Experiment Stations and/or agricultural extension groups within the states as several have been in the past.

Question 4. What is the source of funding for initiating and maintaining the data repository?