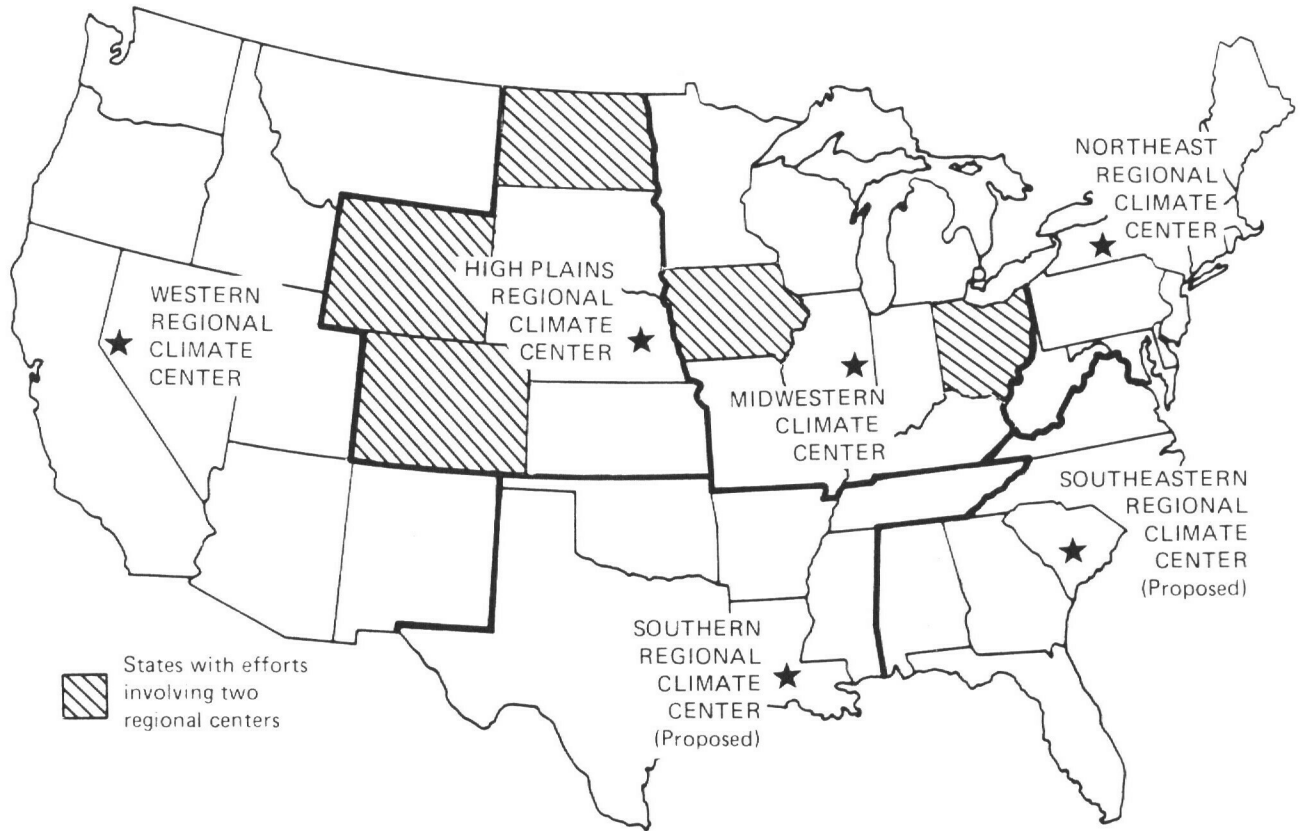


THE STATE CLIMATOLOGIST



VOLUME 12 NUMBER 1 SPRING 1988

PUBLISHED BIANNUALLY AT THE NATIONAL CLIMATIC DATA CENTER, ASHEVILLE, N.C.
IN COOPERATION WITH THE AMERICAN ASSOCIATION OF STATE CLIMATOLOGISTS

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
NATIONAL CLIMATIC DATA CENTER

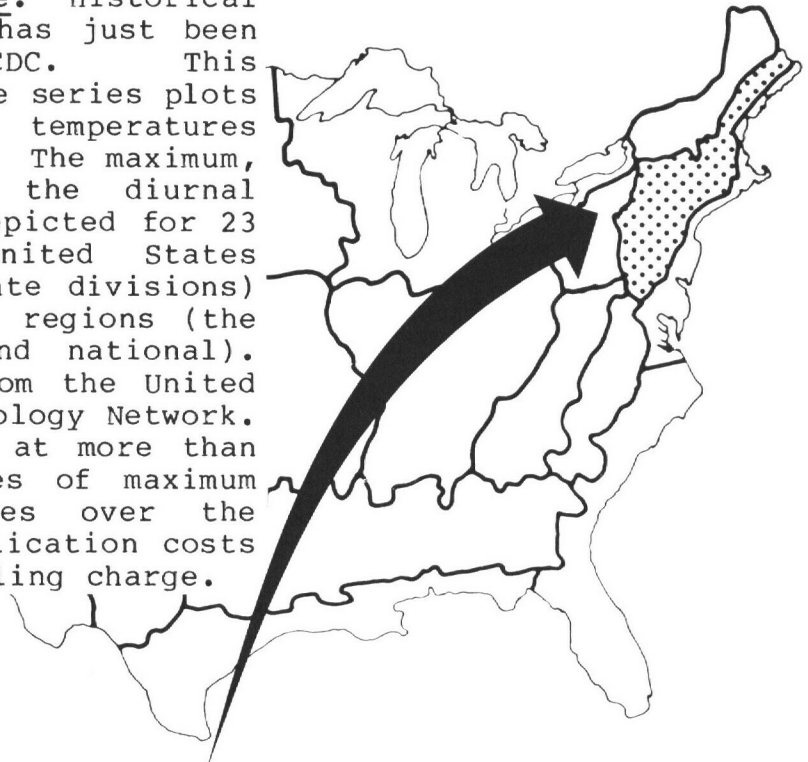
Editor's Note: This issue of **The State Climatologist** is devoted to the Regional Climate Center concept. Each Center, the Climate Analysis Center, the National Climate Program Office, and the NCDC, were asked to submit "their story." Therefore, what follows is a collection of individually written articles expressing the system as seen from their perspective. I would like to thank each author (and staff) for their efforts.

WRCC	-	Dick Reinhardt
HPRCC	-	Ken Hubbard
MCC	-	Peter Lamb
NERCC	-	Bernie Dethier/Keith Eggleston
SERCC	-	John Purvis
SRCC	-	Bob Muller
NCPO	-	Howard Hill
CAC	-	Jim Laver

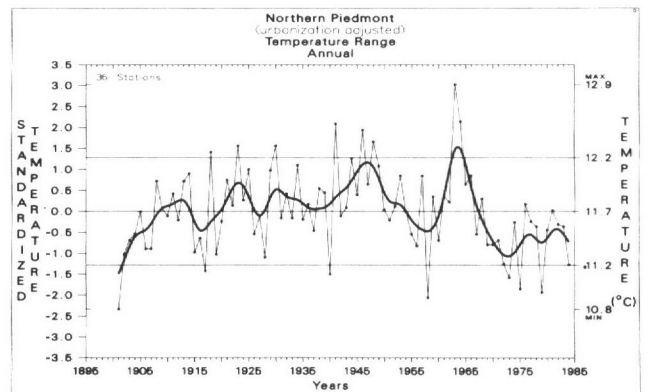
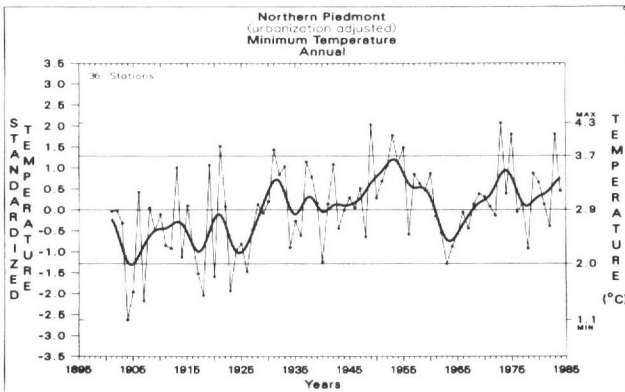
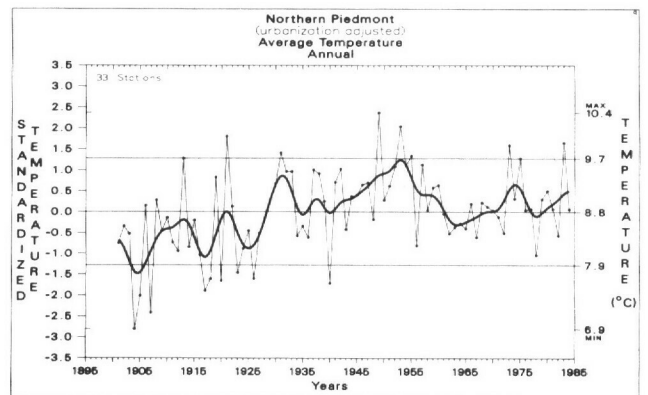
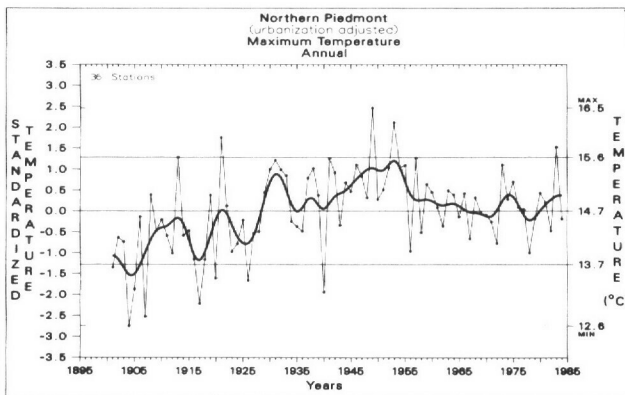
NCDC NEWS BRIEFS

- Frost/Freeze Publication. During the last month or two, NCDC distributed copies of the new Frost/Freeze Publication to the State Climatologists. Did anyone out there receive it? We have not heard a word of encouragement or disappointment. How about some feedback, folks?
- Cooperative Really Means Cooperative. The heart of the United States' climatological service is the 8,000-station Cooperative Station Network. This network is administered by the National Weather Service, and the observations are archived, quality controlled, and published by the NCDC. During the week of May 3, 1988, the NWS Regional Cooperative Program Managers met at NCDC to discuss the future of the network in a time of diminishing resources. Joining in the discussions were representatives from the Atmospheric Environment Service (AES)-Canada, the American Association of State Climatologists, and the Regional Climate Centers.

◦ Monitoring Climate Change. Historical Climatology Series 4-5 has just been released by the NCDC. This publication contains time series plots of seasonal and annual temperatures over the period 1901-84. The maximum, minimum, average, and the diurnal temperature range are depicted for 23 regions across the United States (aggregates of the climate divisions) as well as four broader regions (the west, central, east, and national). The data are derived from the United States Historical Climatology Network. This is the first look at more than eight decades of changes of maximum and minimum temperatures over the United States. The publication costs \$6.00, plus a \$5.00 handling charge.



Region: NORTHERN PIEDMONT



THE WESTERN REGIONAL CLIMATE CENTER

The Western Regional Climate Center (WRCC), located at the Atmospheric Sciences Center of the Desert Research Institute, Reno, Nevada, is one of four Regional Climate Centers now providing weather and climatic data to public and private users throughout the United States. The WRCC was created via federal support through the National Climate Program Office (National Atmospheric and Oceanic Administration) to provide regional data encompassing the states of Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah and Washington. The WRCC has also established working agreements with the States of Colorado and Wyoming, who are officially part of the High Plains Regional Climate Center. These states are cooperating with the WRCC's data validation program discussed below.

The regional centers are the result of a growing national and international awareness of the importance of climate and our lack of understanding of its variability and economic impact. They will improve the delivery of climatic data to its users and will provide the data management systems needed to facilitate the analysis of regional climate patterns and problems. Each center is designed to fulfill a service need by providing accurate data to private and public sector users. The WRCC will promote climate research within the western region and conduct a continuing program aimed at providing high quality information to all interested parties.

WRCC's program is designed to enhance and support the capabilities of the region's State Climatologists. The State Climatologists are an integral part of the WRCC and a communications network of microcomputers links each climatologist with the WRCC and one another. Another complementary mission of the Center is to maintain regional and national climatological data collections. The Center is thereby able to provide State Climatologists with ready access to data obtained from the national archive as well as supply the National Climatic Data Center (NCDC) in North Carolina with additional climatological information gathered by the various networks within each state. The Center has also entered into an agreement with the Forest Service and the Bureau of Land Management to archive and provide access to the remote automatic weather station (RAWS) data. This hourly data is downlinked to the Boise Interagency Fire Center from some 450 stations in the west.

Another important part of the WRCC's agenda is to identify users of western regional climatic data and to provide them with needed "products" in terms of user-specific analyses and computer programs. For example, to begin to meet the requirements of the many Federal Agencies that operate in the eleven western states, the WRCC has established the Climatic Data Service Facility. This Facility is based on a program, the Northwest Hydrologic

Information Management System, developed at the University of Idaho, by the Idaho State Climatologist, Dr. Myron Molnau. The program permits the generation of various statistical reports from the climatic database via submission of a batch job request from the user's terminal or computer. The report output can then be used as input to the requesting Agency's engineering models.

The key ingredient to the utility of this Facility is data that has been validated by the State Climatologist in each of the eleven western states. To this end, the WRCC has established a program with the National Climatic Data Center which provides each State Climatologist with funds to validate the daily observations obtained on a monthly basis from the national cooperative network. The validation is based on a program developed by the Oregon State Climatologist, Dr. Kelly Redmond. Work is also in progress to obtain funding for the validation of thirty years of historical data. Beyond the traditional users of climate information, the WRCC is working to expand the client base to new areas of the private sector including tourism, gaming, economic development and warehousing.

Future activities of the WRCC include: helping to expand the user base of the State Climatologist by developing computer software "products;" identifying additional private and public sector users with interstate needs; working with the National Climatic Data Center and the National Climate Analysis Center to implement national products (e.g. CLICOM, NCDC's computerized methodology for helping users of climatic data, and PMTD 1.1, a CAC program that provides probabilities for such parameters as heating or cooling degree days during the month ahead) on a regional level.

The Atmospheric Sciences Center:

The Desert Research Institute's Atmospheric Sciences Center has built an international reputation in the areas of atmospheric physics and weather modification. The excellent potential for applying weather modification techniques to increase winter mountain snowpack and spring run-off water is one of the Center's major research interests. Achievements in this area include new chemical analysis techniques to determine the efficiency and accuracy of cloud seeding.

Another major research initiative for the ASC is the development of comprehensive programs to study regional climate, both from an historical perspective and on shorter-time scales devoted to the trends and developments of the last few decades. The ASC also concentrates its efforts on weather prediction and the effects of weather modification programs on western climate. Research areas of special interest to the ASC include: (a) Great Basin satellite studies of snowpack, insolation and radiation balance; (b) study of physical mechanisms and cloud cover, season-to-season climate changes in the Great Basin; (c) effects of cloud condensation

nuclei on cloud microstructure; and (d) study of links between climate and human activities in the Lahontan Basin.

The Desert Research Institute (DRI):

The Desert Research Institute (DRI), one of the seven campuses within the University of Nevada System, is primarily engaged in full-time basic and applied research. The Institute was established by special act of the Nevada State Legislature in 1959 to conduct scientific research on topics of special relevance to Nevada and the Nation. DRI was activated in 1960 by a grant from the Max C. Fleischmann Foundation, which continued as a major private supporter until the foundation's dissolution in 1981. DRI's program originated around the general theme of arid land problems 28 years ago and has expanded to include five separate research centers: Atmospheric Sciences, Biological Sciences, Energy, and Environmental Engineering; Social Sciences; and Water Resources.

HIGH PLAINS CLIMATE CENTER

by

Kenneth G. Hubbard
Director

BACKGROUND

The High Plains Regional Climate Center is located at the University of Nebraska in Lincoln. The idea for a center was the outgrowth of demonstration projects undertaken by University of Nebraska faculty and sponsored within the framework of the National Climate Program. Between 1980 and 1986 several studies were carried out, including a study to demonstrate and evaluate the use of climate information in support of irrigation scheduling and other operations. These studies required near-real time climate data, so a network of five automated stations was created in 1981. The private sector, local and state governments, and the federal sector were quick to cooperate in this network as the benefits (ease of access, proper maintenance and centralized quality control) became apparent. Expansion of the near-real time climate network (50 stations, 1988) into other states followed. As the projects took on a multistate nature, the High Plains became heir to a "defacto" center that in many ways had grown from the grass roots up. The High Plains Regional Climate Center was formalized in 1987.

States that had been involved in the multistate weather monitoring activities were invited to help establish a regional climate center for the High Plains. A cooperative agreement was executed between Nebraska and each of the states as a means of recognizing both membership and common goals related to climate in the region. A constitution was prepared to clarify the operational procedures of the center. The members that make up the High Plains Climate Center are:

Colorado State University
Iowa State University
Kansas State University
North Dakota State University
South Dakota State University
University of Nebraska
University of Wyoming

Each member institution appoints one technical and one administrative representative who participate in center matters and make up the advisory committee. These representatives also

coordinate the proposed work plan from their state and handle subcontracts as needed. At the present time, about 50% of the funding for center projects comes from the states.

The climate center represents a new institution that can link the climate interests found in the federal, state and private sectors. As such, the climate center interacts with climatologists and those interested in climate. The work of CAC, NCDC and NWS plays an important role in this regard. Climatologists working for state institutions have interests in climate-related problems that often cross state lines. HPRCC can coordinate these problem solving efforts to avoid duplication of effort and to address studies larger than one state is able to sustain alone. Other aims of the center are the transfer of technology to the private sector and education through guidance furnished to the private sector on the availability of appropriate data sets and proper use of climate data.

OBJECTIVES AND ACTIVITIES

The mission of the High Plains Regional Climate Center includes the following objectives:

1. Carry out applied climate studies in the High Plains Region.
2. Develop improved climate products for use in the High Plains Region.
3. Provide climate services in the High Plains Region.

ACTIVITIES OF HPRCC

Four activities have been identified for the five year period 1987-1992. These are:

1. Development of a user-support group for automated weather station network managers.
2. Soil moisture and drought monitoring study.
3. Development of common data interfaces and efficient linkages between federal agencies and states in the High Plains Region.
4. Development of expert system software to perform routine activities in weather and climate information dissemination.

Space does not permit a full description of the activities underway, but the following is an attempt to characterize some

of the activities and give some highlights.

A user-support group was initiated to facilitate the exchange of information on the progress and problems associated with the rapid evolvement of automated weather networks. HPRCC has initiated a newsletter called TRIPOD that focuses on issues surrounding the automated collection and handling of data. A forum for interaction among network managers hopefully helps set the stage for voluntary acceptance of data collection standards. Adherence to standards on a minimum number of variables would greatly increase the future value of the climatological data now being collected.

Techniques to monitor soil moisture status across the region in near-real time are being developed. The approach is to use near-real time weather data as input to a general soil moisture simulation model. The soil characteristics, crop and variety can be changed from point to point, and the model represents such important physical processes as the movement of rainfall into the soil, movement of water through the soil, evaporation from the soil and crop surfaces, and phenological development of the crop. Soil moisture data is collected for all relevant crops for purposes of verifying the model. The High Plains are characterized by high climatic variability, and drought is a frequent and recurring problem. The use of models together with mapping tools will aid in early detection of problem areas and in a more quantitative approach to describing the climate impact on specific crops than has been available to date.

Development of efficient data-sharing linkages is important to the success of the National Climate Program. Data, in most cases, needs to be turned into information before it has value. The goal of realizing the value of climate information to our country can be realized if that information can be placed in the hands of those who can use the data in a decision-making situation. HPRCC is supporting the adoption of CLICOM in the region for the purpose of creating compatibility among climate sets in the region. Experiments with the use of optical computer data storage media are also underway to determine the applicability of this technology to climate data handling in the region. HPRCC is also examining the UNIDATA system as a source of near-real time visible and IR images for use in conjunction with surface climate data. The use of satellite communications to interrogate remote near-real time climate data stations has also been demonstrated at HPRCC.

The development of new climate products hinges on the success of climate studies and the transfer of research results into everyday use. New software is therefore needed to provide users with a friendly interface to the information contained in climate data. The approach to expert systems taken by HPRCC includes the basic ingredients necessary for providing accurate climatic assessments (data collection, quality control, data

archival, flexible algorithms, and usable graphics) as well as the rule based environment.

The High Plains Climate Center must also identify and make arrangements to archive special climate data sets that have been taken in the region but are not now stored at NCDC. This is becoming increasingly important with the advent of special climate data networks and the development of interdisciplinary data sets that include special climate measurements. The latter data set is very expensive to collect because it requires the use of resources from a number of disciplines. It is important to have a mechanism for permanently storing this type of data.

CONCLUSION

Much remains to be done in the federal, regional, state, and private sectors before the National Climate Program reaches full potential. The challenge to those of us in the climatological discipline is large but the tools to meet the challenge are increasingly powerful. State climatologists can provide a much needed state and local perspective on climate and climate-related problems. The climatology program in the federal government will continue to address issues of nationwide scale and national importance. Regional Centers provide a new and valuable link in the framework of the National Climate Program.

Midwestern Climate Center

A "missing link" in the delivery of climate information in the United States is being filled by a new institution for climate services. Federally funded regional climate centers are being established across the nation to collect and disseminate climate data and information, and to coordinate and conduct applied research.

The Midwestern Climate Center is located at the Illinois State Water Survey and serves a nine-state region. It is of significant benefit to Illinois and to each state in the region. Both climate and the demand for climate information are regional by nature. This Center will allow researchers to study climate impacts on this scale and to provide meaningful information for the region. In developing the Center's program, Water Survey staff will draw upon their experience in operating the North Central Regional Climate Center as a demonstration project. As part of this project, staff members developed the computerized Climate Assistance Service [CLASS] to provide near real-time climate information.

The Center will have three main components:

.. A data delivery system similar to CLASS but region-wide and more sophisticated is being developed to collect real-time weather data and provide climate information delivery to the users in the nine states in the region.

.. Relevant historical climatic data bases are being developed. These will be a mixture of existing data bases and new data bases designed to address specific problems.

.. Applied research will be conducted on diverse climatic issues. The research is being designed to define the key weather and climate factors that have impacts on agriculture, water resources, and the generation and consumption of energy. Research in the first years of the Center will primarily deal with agriculture and water resources. Energy applications will be phased in as the Center develops.

The research component is intended to lead to information products applicable to specific climate-related issues or problems.

The private agricultural sector is expected to be the primary user of the Midwestern Center. A comprehensive study of how and why this group uses climate information was made by the Water Survey five years ago and will be a foundation on which many of the services and products will be developed. To serve the needs of this diverse group of users of climate data and information, a new interactive computer system will be developed within the Center. This system, which has been named the **AGRIcultural CLIMate Service System [AGRICLIMSS]**, is being designed on the basis of the Water Survey's experience in developing and operating of the CLASS system. The Midwestern Climate Center is funded by the National Climate Program Office. Two advisory groups will provide guidance to the Center. One will be composed of representatives of climate-sensitive industries in the region. Officials of federal agencies concerned with regional climate issues will comprise the other advisory group. The groups will annually review the Center's plans, operations, and products and make recommendations based on the review.

The Midwestern Climate Center will provide six types of services to users in both the public and private sectors:

- .. Access to regional and perhaps national climate data bases.
- .. The provision, on a subscriber-pay basis, of near real-time climate data and information designed to serve the needs of users within the region.
- .. Expertise relating to climate data, climate information, and climate research.
- .. Funding and equipment to help develop compatible state weather station networks [particularly specialized ones, such as those collecting data important to agriculture], and to promote the exchange of data and cooperative research.
- .. Publications dealing with regional climate issues.
- .. Planning and coordination of regional and subregional research projects, of both basic and applied natures.

The Midwestern Climate Center will work closely with federal agencies concerned with climate issues, such as the National Oceanic and Atmospheric Administration, the U.S. Department of Agriculture, and the U.S. Environmental Protection Agency. The Center will provide assistance to federal agencies in ways similar to those provided on a regional and state basis, and will work with other federally-sponsored regional climate, weather, water, and agricultural centers.

The Center will work closely with the states and their climatologists in the region who wish to be cooperating members. The Center will establish computer-based systems called **CLICOM** in states throughout the region, and in turn, the cooperating states will provide climate data and information to the Center. The Center will also serve as a source of climatic expertise to the states and assist them in planning and conducting climatic research.

The Northeast Regional Climate Center (NRCC) at Cornell was established in September 1983 and is one of the keystones in constructing a nationwide system of climate services called for by the National Climate Program Act and responds to the recommendations of National Academy of Sciences Panel on Intergovernmental Programs and NCPO's Conference on Cooperative Climate Services (Tallahassee, FL, March 22-24, 1983).

NRCC has completed the first four years of operation. During this period NRCC personnel have provided (1) leadership and guidance in the area of climate to the governmental agencies, industries, and the private citizens of the northeastern United States. Work at the Center also included (2) research, development of climate products, and service activities.

The objectives of the NRCC are:

1. To promote and assist the formation of State Climate Programs,
2. To initiate and promote NRCC cooperation with Federal and State agencies and private sector organizations,
3. To provide standards and procedures for data collection, regional climate products and communications protocol,
4. To receive, archive, and disseminate Federal weather and climate data and specialized State data,
5. To provide limited climate data and information to users in states without services,
6. To conduct regional research on climate effects.

During these four years the Center has had many accomplishments which are listed below under the individual objectives.

1. To promote and assist the formation of State Climate Programs.

In consultation with the Directors of the Agricultural Experiment Station in Maine, Rhode Island, Vermont, and West Virginia scientists were identified as prospective state climatologists for these states. Formal agreements were drawn up between NCDC, NWS, and the states.

Computer terminals were installed in the climate offices of Maine and Vermont. This allows the state representative in those states to access the current data. Data bases not on-line can be sent upon prior request.

In states with no state climatologists (SC) or with limited resources for the SC, NRCC performed the role of SC or acted as the SC resource base.

2. To initiate and promote NRCC cooperation with Federal and State agencies and private sector organizations.

NRCC continued its cooperation with the City of Ithaca by maintaining a computer accessed automated weather station and processing the data. This activity is in conjunction with an environmental quality project.

Director of NRCC was one of the leading architects of a new regional research project entitled "Climate and Weather Data: Applications and Methods of Extrapolation". The proposed project is designed as a follow on to regional project NE-135 "Impact of Climatic Variability on Agriculture". It is inter-regional and inter-national in scope with participation from the states of CT, IN, ME, NJ, NY, RI, and VT and the Canadian Provinces of Ontario and Quebec.

The NRCC and Massachusetts State Climatologist, David M. Taylor, cooperatively prepare a narrative monthly weather summary for the NCDC publication Climatological Data - New England. NRCC personnel prepare a narrative summary for

Climatological Data - New York for NCDC publication.

Due to budget restrictions the Department of Interior/United States Geological Survey in New York discontinued the preparation and publishing of the New York Cooperative Snow Survey. After discussions with USGS the NRCC assumed the responsibility for data collection, writing, publishing, and distributing the survey. Twenty-nine federal, state, local, and Canadian agencies were among the subscribers. A user fee helped defray the cost.

Contact was made with the Atlantic Coast Observer Network (private sector group) and the center developed and provided an observer/station location map for the 107 observers in the 13 coastal states and the District of Columbia.

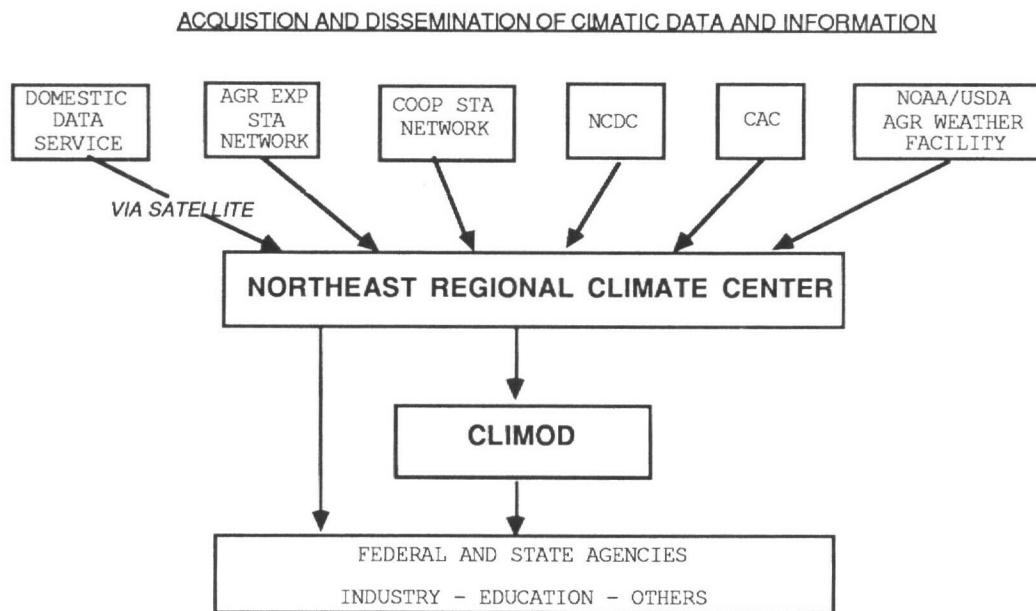
NRCC participated in Project Ezra, an IBM sponsored educational project. The sub-project is titled "Regional Climate Analysis for Teaching Grain Crops Management". All hardware was supplied to NRCC in return for \$10,000 worth of data and expertise.

3. To provide standards and procedures for data collection, regional climate products and communications protocol.

Climatological data sets held in the Northeast were inventoried for inclusion into the National Environmental Data Referral Service (NEDRES). Approximately 4000 survey forms were sent to various agencies, organizations, companies, and individuals who might have information pertaining to current and/or historical climatological data sets in the Northeastern United States. Approximately 600 responses to these inquiries were received. The parameters measured, type of instrumentation, period of record, availability of data, and other information were summarized for each of these stations and sent to NESDIS to be edited and input to their computer.

4. To receive, archive, and disseminate Federal weather and climate data and specialized State data.

The flow of climatic data and information from the federal level to the ultimate user is shown in the following figure:



A useful climatic data base should include real time, near-real time, and historical data. Therefore, it logically follows that a viable data base must be continuously

updated with data moving from the real time category through the near-real time into the historical category.

The real time data and the data from the cooperative networks are entered into the NRCO computer thereby adding more than 9,000 observations to the data base each month.

The acquisition of near-real time data is necessary if information is to be generated and disseminated in a time frame suitable for management planning and strategy decisions. The current time frame requires that data from the cooperative weather stations be entered into the NRCO computer within ten days following the observation month. The usual mail routing from the observer to the National Climatic Data Center (NCDC) for forwarding to NRCO resulted in an unacceptable delay. Therefore, a pilot study of a method to obtain these data in near-real time was initiated in the fall of 1981, with the cooperation of NCDC and the National Weather Service. The two objectives of this very successful pilot study were (1) to quickly provide data to NRCO and, (2) to determine the feasibility of extending this method of data acquisition by state climatologists nationwide. The change of the mailing routine has been widely accepted by the observers.

The historical data base for the region has been updated through 1986 using tapes supplied by the NCDC. These data were reformatted, examined for missing data and quality control, and became part of the database maintained in the dedicated weather computer in the NRCO.

Routine data and information are disseminated by monthly climate publications, computer hook-ups, and by phone answering services.

The monthly publications began in November 1981 for New York, April 1982 for Maine and Vermont, and September 1982 for New Hampshire. A subscription fee of \$9.00 per year was initiated in January 1984 for the monthly climate summaries. The user fee helps defray the cost of printing and covers the cost of first class mailing. Cooperating observers continue to receive a free copy. Subscriptions now total 740.

These publications routinely include (a) the weather highlights for each state (NRCC), (b) drought severity maps (NOAA/USDA), (c) maps of temperature, precipitation, and degree days (computer generated by NRCC), (d) monthly summarized station and division data (NRCC), (e) monthly and seasonal weather outlooks (CAC), (f) the normal climate for the coming month in descriptive and tabular form (NRCC), and (g) pertinent articles on climate and past weather events. Although CAC, NCDC, and the joint NOAA/USDA Agricultural Weather Facility routinely disseminate some of the above information, it is in publications with a limited clientele. Many users of climate information, particularly those outside the normal meteorological community, are unaware of the existence of this valuable information. The inclusion of this information in the monthly climate series greatly widens the audience, enhances the use of existing data and information, consolidates meaningful and pertinent data and information in one publication, and speeds its delivery to the users. A survey showed that less than 20% of the readers were aware of the existence of the Weekly Weather and Crop Bulletin (NOAA/USDA), the Climatological Data for states (NCDC), and Monthly and Seasonal Weather Outlooks (CAC).

Federal, state, and local governments continue to be major subscribers to monthly climate summaries of the NRCC. Fifty federal offices subscribe to the summaries while nearly 100 state and local government offices subscribe. Subscriptions from schools, colleges, and universities total 125 and 18 subscriptions come from media in the Northeast.

Climate Information for Management and Operational Decisions - (CLIMOD) a real-

time interactive data and information bank continues to provide services to users in the region. CLIMOD now delivers current data and forecasts for all of the U.S., weather advisories and outlooks and regional climate data. This interactive system can, upon demand, generate current weather maps, climate maps, electronic versions of the monthly climate summaries which including more than 1800 graphs of daily temperatures and precipitation, perform temperature conversions, compute sunrise and sunset times for any place on earth, compute dewpoints, and wind chill values.

Daily climate data for more than 30 years for 37 northeastern stations have been included in the CLIMOD computer system. A user can now generate more than 30 different types of tables and maps of these data.

Current users of CLIMOD include state climatologists, extension agents, universities, the media, integrated pest management programs, and ski area operators. Currently there are 94 users. There is no charge to use CLIMOD, but users must establish an account and pay for their own telephone calls. This real-time link enhances the delivery of useful information to users in the region.

The New York State Cooperative Extension Service subsidize the maintenance of NRCC's answering telephone which gives current, local, and regional weather information and forecasts. During the past year this system handled over 100,000 inquiries. In addition, over 800 telephone and letter requests for non-routine climate information for the region were answered last year.

Through a computer link NRCC supplies Cornell Info, a university wide computer information system, with daily forecasts. Since December 1985 the request for this forecast service averages 2000/month.

5. To provide limited climate data and information to users in states without services.

NRCC continued to answer requests for data from the states in the region as well as users in other parts of the country needing data from the northeast. A user fee was usually charged to help defray the cost of this service. Last year users included 8 Federal departments and agencies, 10 state and local agencies, and 8 educational institutions. Service was also provided at cost to numerous private sector users.

6. To conduct regional research on climate effects.

Research projects resulted in publications on the following topics: mean temperature on wet and dry days, freeze-thaw days, freeze hazard, freezing degree days, and a temperature climatology for New York State.

PRELIMINARY PROGRESS REPORT

SOUTHEASTERN REGIONAL CLIMATE CENTER

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THE NEED FOR A SOUTHEAST REGIONAL CLIMATE CENTER

The need for a regional center to serve the Southeastern states of Alabama, Florida, Georgia, North Carolina, South Carolina and Virginia has been quite evident for some time. These six states have many common ties. Each State has similar coastal weather problems and is vulnerable to damage from hurricanes as well as winter storms. Agriculture, although greatly diversified throughout this region, needs climate information for planning, cultivation of crops, and marketing. The operation of hydroelectrical facilities in one state is based partly on the rainfall within their basin, as well as on the rainfall of adjacent states.

The severe drought that affected the Southeastern U. S. during 1986 certainly brought the need for a regional climate center into focus. A center attuned to the relationship between the climate and the economy of the Southeast would have helped alert the six southeast states to the developing drought emergency and would have provided valuable climatological support for the mitigation of the severe conditions caused by the drought. This climate-caused event demonstrated the need for a central point that people within the region could query for climatological information. If there had been such a center, it would have helped water resource managers of the six southeast states to make their decisions on water use. Instead, there was little coordinate between the six states on drought response.

PROPOSED SOUTHEAST REGIONAL CLIMATE CENTER

A regional climate center serving the six southeast states has been proposed for implementation when funding permits.

The objectives of the Southeast Regional Climate Center (SERCC) are essentially threefold, including:

1. The SERCC will maintain a regional climatological data base, which will be coordinated with the data needs and requirements of the member states. The data base will be broad enough to meet the user's needs and structured so that it can be easily accessed and manipulated.

2. Another major objective of the Southeast Regional Climate Center is climatological research. The SERRC will coordinate and support applied climatological research dealing with climate related problems relevant to the region. A special effort will be made to ascertain climatological research needs of both the private and public sectors, as well as to gain funding for worthwhile climatological research projects.

Potential and important regional topics needing to be addressed are drought, rainfall and temperature variability, acid rain, and climate changes affecting sea level heights.

3. Regional Climatological services that cater to the full climatological service needs of the six southeast states, including:

Support to the various State Climatologist's Offices. This, in part, will be accomplished through coordinated use of CLICOM data management system throughout the region in order to have a common basis for processing and exchanging climate data.

Another important service aimed at the needs of the total climate user community will be the establishment of a near real-time regional, specialized climate data and information exchange network.

The SERCC will seek to improve the availability and exchange of relevant, timely, accurate climatological data for the mutual benefit of private and public sector users promoting public awareness regarding the availability of climate information and its varied uses through a quarterly newsletter and periodic symposiums.

The use of national standards for climate data observations and quality control for the non-federal, private sector will be encouraged and coordinated.

Climate data which are not currently archived within the region (i.e., unpublished data from NWS and other sources) will be sought and archived.

THE SOUTHERN REGIONAL CLIMATE CENTER
LOUISIANA STATE UNIVERSITY
Baton Rouge, Louisiana 70803

Robert A. Muller
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The proposed Southern Regional Climate Center (SRCC) will be located on the Baton Rouge campus of Louisiana State University, and it will serve the states of Arkansas, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas. The region includes much of the humid subtropical climate areas of the United States and some of the much drier subtropical steppes and deserts in Oklahoma and Texas. Much of the region is integrated by the overwhelming influences of the lower Mississippi River drainage network and proximity to the atmospheric influences of the Gulf of Mexico.

Over the last 10 years the region has been plagued by sequences of droughts, floods, Arctic outbreaks, and coastal hurricanes. There are many environmental and economic interrelationships with climate that need to be appreciated and understood, so that the impacts of climatic variability and even climatic change can be anticipated and possibly ameliorated. At this time there is little regional understanding of climatic variability and extreme events in terms of associated environmental and economic impacts. There is urgent need to coordinate all available information and studies within regional geographic frameworks.

A primary goal of the SRCC will be to work closely with the federal and state agencies and the private sector to integrate the near realtime collection, quality control, storage, and retrieval of climatic data from the first-order and cooperative stations of the National Weather Service, the FAA, the Air Force and Navy, as well as the other specialized climatic data sets in the region. The center would coordinate and encourage the operations of the individual State Climatology offices within the region, and interact with the large number of federal and state agencies that are in need of climatic data and interpretations of interrelationships with the environment and the economy.

The SRCC would initiate a pilot program of automated climate stations in each of the states, modified from the automated agroclimatic network that has been developed in Louisiana; the Louisiana network features readily available data, including solar radiation, in hourly and daily formats on a near realtime basis.

In addition to climate data services, the SRCC would also initiate and encourage informational services, studies, and research, on the properties of subtropical climates, the coastal climates along the Gulf of Mexico as well as climate over the Gulf of Mexico. Special attention will be focused on climatic variability in terms of synoptic climatology, flooding, droughts, irrigation and drainage, and the impacts of atmospheric transport potential on biological organisms and air quality.

There are, for example, urgent needs for understanding of some of the interactions and feedbacks of the Mississippi River

outflow to the northcentral Gulf and local interactions of energy and precipitation over the coastal wetlands, to safe environments for the offshore oil and gas extraction industry and for productive environments for the rich fisheries of Louisiana. Another example is the relationships of droughts and excessive rainfall events throughout the region to synoptic atmospheric patterns and the potential for integrated irrigation and drainage systems for agricultural production.

It is intended that the operating mode of the SRCC will be a spirit of cooperation and support for the various federal agencies within the meteorological and climatological families, the state climatologists, state agencies, and the private sector. Together we would hope to encourage a spirit of federal and state interaction to address the need for much improved monitoring of climate variability, increased understanding of climatic impacts, and development of more effective techniques for climatic amelioration.

The Evolution of Regional Climate Centers

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The concept of regional climate centers is expressed in legislation that established the National Climate Program. The National Climate Program Act (P.L. 95-367) and the House Conference Report on the Act explicitly identify regional activities as a component of the Program. Section 6 of the Act established "a program for Federal and State cooperative activities in climate studies and advisory services" and authorized the Secretary of Commerce "to make annual grants to any State or group of States...to conduct climate-related studies or provide climate-related services" (emphasis added). The intergovernmental program (also called the Federal-State program) was directed to include the following services and functions:

- (1) studies relating to and analysis of climatic effects on agricultural production, water resources, energy needs, and other critical sectors of the economy;
- (2) atmospheric data collection and monitoring on a statewide and regional basis;
- (3) advice to regional, State and local government agencies regarding climate-related issues;
- (4) information to users within the State regarding climate and climatic effects; and
- (5) information to the Secretary regarding the needs of persons within the State for climate-related services, information, and data.

The rationale for regional climate centers was expressed in the House Conference Report: "For certain purposes climate influences are best understood on a regional, as opposed to State basis. Similarly services and information dissemination needs could be common to groups of States within a given climatic zone, and then could be handled most efficiently on a regional basis. Wherever it appears that a program could not be organized on a State level the conferees urge the Secretary to provide incentives for regional organization of the intergovernmental program" (Conf. Report, p.15).

Amendments to the Act in 1986 repealed Section 6 and its authorization for Intergovernmental Climate Programs. Mechanisms for intergovernmental climate-related studies and services were and continue to be an element of the National Climate Program, however, and the services and functions listed above were made a

part of this element by the 1986 amendments. The amendments eliminated mandatory 50 percent state matching of intergovernmental grants and requirements (never implemented) for federal approval of state climate programs as a condition for receiving an intergovernmental climate program grant.

Early development of regional climate centers was influenced by several studies and recommendations of the National Academy of Sciences (NAS). The first study, "Meeting the Challenge of Climate" (NAS, 1982), reviewed needs for climate data and services, and recommended that the National Climate Program Office (NCPO) "take a leadership role in the development and support of a coordinated, nationwide system of climate services involving both the public and private sectors through collaboration with existing state and regional climate programs and by encouraging the further development of such programs." Later NAS studies endorsed the concept of a nationwide system of climate services based on federal, regional, and state cooperation and private sector participation in providing climate services (NAS, 1986a, 1986b).

The intergovernmental climate program was begun in 1980 as an exploratory program "to demonstrate the value of various modes of State/Federal cooperative climate activities and to illustrate and test the different institutional forms that they can take" (NOAA, 1980). During the exploratory phase (1980-1982), NCPO funded 14 projects in 11 states, including 2 regional projects (North Central and Northeast), 8 state projects, and 4 projects with private sector firms and non-profit associations. Except for the 4 projects in the private sector, all were carried out at universities. In two states, Connecticut and Illinois, projects were carried out jointly by a university and a state agency (NCPO, 1983).

During the exploratory state, it became apparent that funds would not be appropriated for grants to implement the intergovernmental program on the scale authorized by the Act. A new approach was needed to respond to Congressional concern that climate data were not being fully disseminated or used. What resulted were demonstrations of regional climate centers at the Illinois State Water Survey and Cornell University beginning in 1983. Later, a project at the University of Nebraska, begun as a demonstration of near real-time weather support for irrigation scheduling, was extended to adjoining states. The three centers continued as demonstration-scale activities until 1987, when a Congressional addition to NOAA's appropriation provided funds for a Midwest Climate Center in Illinois and a High Plains Regional Climate Center in Nebraska. A Western Regional Climate Center at the Desert Research Institute in Nevada had been similarly funded the year before, 1986, and funding for the Northeast Regional Climate Center at Cornell University in New York was added by Congress in 1988. Proposals have been submitted for regional climate centers in South Carolina and Louisiana. The suggested "service areas" of the six centers cover the 48 contiguous states (see figure).

The concept of regional climate centers is sound, based on their performance during the demonstration phase. Significant achievements during this phase include:

- o automated weather data collection and near real-time dissemination of climate data and information,
- o support for NOAA programs (National Environmental Data Referral Service--NEDRES, and river forecasting),
- o monitoring and assessment of user needs for climate services,
- o technical support for state climate programs,
- o development of state and regional climate data bases, and
- o research on regional climate-related problems.

Agreement has been reached that appropriate functions of regional climate centers are services, applied research, and data base development and management (Regional Climate Centers, 1987). A major challenge for the regional climate centers is to establish mutually beneficial cooperation with states for carrying out these functions. It is difficult to develop consistent and equitable regional programs given the diversity of state climate activities and varying level of state support. Regional climate centers have a responsibility to help where state programs end. How should regional resources be applied in states that provide little or no support to climate studies and services? What can be done to increase state support for climate programs? These questions are critical because state support for climate programs is vital to successful cooperation between regional climate centers and states.

Another challenge facing the regional centers is to help create an environment that will increase private sector involvement in providing climate services. Risk-bearing is an inherent part of profit-seeking, but the risk of an unreliable data source is one that the private sector is very reluctant to assume. This is recognized in plans for a nationwide system of climate services, discussed below. The private sector also is reluctant to try to market services and products in competition with the public sector. Some state climate centers have had to face this problem and regional climate centers need to be aware of it. Data base development and management, and applied climate research at regional and state climate centers underlie opportunities for the private sector to produce and market specialized climate products and service.

The most recent step in the evolution of regional climate centers is their integration into a nationwide system of climate services consisting of federal, state, and regional climate services, and services available from the private sector.

An example of integrated climate services is found in Nebraska. An automated weather data network started under a NCPO grant was expanded to a state-wide network by the State of Nebraska and is being used operationally to aid irrigation scheduling, among other things. During the growing season, daily evapotranspiration estimates derived from data collected by the network are widely disseminated by the Cooperative State Extension Services and agricultural consultants. The network includes some stations owned by USDA's Agricultural Research Service, and users of network data include the National Weather Service River Forecast Center in Kansas City.

The decision to plan an integrated, nationwide system was made by leaders of the National Climate Program Office, the National Climatic Data Center, and the Climate Analysis Center, all from NOAA, and the regional climate centers. The Department of Agriculture (USDA) has joined in writing the plan and other federal agencies may join later.

The plan builds on existing federal, state, and private sector capabilities to produce and deliver climate services to all areas and economic sectors of the United States. New institutional arrangements, including regional climate centers, and the use of advanced technology are components of system.

The plan is built around four goals (NCPO, 1988):

- o Data Management: data collection, quality control, and archiving,
- o Analysis: applied research and impact assessment, analysis of climate data trends, and development of value-added climate products,
- o Delivery: printed materials, electronic communication, and outreach activities,
- o Feedback: external interaction between users and suppliers of climate services and data, and internal interaction between analysts, processors, and collectors of climate data.

The plan defines roles and relationships for each of the participating organizations, and suggests where emphasis should be given in providing climate services. A draft of the plan has been prepared for agency review, after which it will be revised and published.

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THE CLIMATE ANALYSIS CENTER AND THE REGIONAL CLIMATE CENTERS

A major task of the Climatic Analysis Center (CAC) continues to be the derivation of climate assessment information using near-real-time climate oriented data. Especially important are assessments of climate conditions and anomalies related to impacts on agriculture, energy, and water resources. A steady increase in telephone, written and electronic requests for short term climate information over the past decade will no doubt continue, with special interest in regional climate conditions and impacts.

As a federal center, the CAC will focus on developing and communicating data and products useful for regional and state applications. The cooperative effort between CAC and the Regional Climate Centers (RCCs) will result in:

1. Exchange of real-time observational and climate assessment information on a regular basis.
2. Issuance of information on climate events at all levels.
3. Assessments of the impacts of climate events.
4. Definition of regional climate change and its implications.

Among the actions which the CAC plans to take to strengthen Federal and Regional cooperation are the following:

1. Develop a new National Climate Assessment Data Base (NCADB) suitable for national short-term (real-time) climate assessments using national, regional, state and special area surface observations and data summaries.
2. Cooperate in the development and improvement of observational data standards and quality control techniques that can be applied to these observations.
3. Develop new and enhance present national products for the most advantageous use by the RCCs.
4. Improve the availability and timeliness to users of real-time climate data and products, including graphical products and summary data sets.
5. Improve climate assessment procedures on an international, national, regional and local basis.

Several efforts are already underway which will enhance the CAC-RCC relationship. First, in FY89, the CAC expects to upgrade the hardware which supports the climate Dial-Up Service. The current system and its data sets are documented in Tables 1 and 2 respectively. Several RCCs and State Climatologists are among the several hundred users who routinely access the current system. The upgraded system will provide faster service, have more on-line disk space and will permit more flexible, interactive access to file protected data sets. Other features will include automatic adjustment to user based rates, improved user access statistics and the potential for linkage with more sophisticated communications techniques (e.g., other networks, satellite,

etc.). Second, the CAC has begun testing real-time access (computer to computer) with each of the existing RCCs. Nebraska's AGNET system and Illinois' CLASS system have already been explored and new tests will follow with new regional adaptations of these systems. Other projects are being pursued, such as the comparison of real-time data availability at CAC with data available to the planned Southern RCC (Louisiana) and with archive data at NCDC.

CAC will continue to focus attention on the common needs for climate analyses and assessments. Coordinated efforts, between federal and regional centers, will result in more cost effective current climate information services to decision makers at all levels. These efforts will also help point the way toward useful evaluations of climate and global change in the future.

TABLE 1. THE CAC PRODUCT COMMUNICATIONS SYSTEM

- 0 24-HOUR OPERATIONS
- 0 CONTINUOUS OPERATION SINCE JANUARY 1983
- 0 OVER 750 CURRENT CUSTOMERS
- 0 MORE THAN 70 DIFFERENT DATASETS OF INTEREST TO AGRICULTURAL, HYDROLOGIC, AND ENERGY ORIENTED USERS
- 0 NEAR REAL-TIME DATA SUMMARIES - WEEKLY AND MONTHLY DATA AVAILABLE WITHIN A FEW DAYS OF THE END OF THE PERIOD
- 0 DIAL-IN CAPABILITIES AT 300, 1200, AND 2400 BAUD
- 0 UP TO 10 SIMULTANEOUS USERS

TABLE 2. DATASETS CURRENTLY AVAILABLE ELECTRONICALLY FROM CAC

WEEKLY AND MONTHLY SUMMARIES FOR OVER 200 MAJOR U.S. CITIES OF:

WEEKLY, MONTHLY, SEASONAL, AND ANNUAL U.S. SIGNIFICANT CLIMATE EVENTS
WEEKLY SUMMARY OF INTERNATIONALLY SIGNIFICANT CLIMATE EVENTS
WEEKLY INTERNATIONAL WEATHER AND CROP HIGHLIGHTS AND SUMMARY
EL NINO/SOUTHERN OSCILLATION ADVISORIES AS APPROPRIATE

FORECAST DATA FOR:

5 DAY OUTLOOK
6 TO 10 DAY OUTLOOK
SEVEN DAY MAX-MIN TEMPERATURE
MONTHLY AND SEASONAL TEMPERATURE AND PRECIPITATION OUTLOOKS
WEEKLY AND MONTHLY HEATING OR COOLING DEGREE DAYS

GLOBAL DATABASE OF OVER 6000 STATIONS WORLD-WIDE CONTAINING WEEKLY AND MONTHLY
SUMMARIES ALONG WITH A DAILY DATABASE OF A ROTATING 14 DAYS OF DATA

WEEKLY AND MONTHLY LISTINGS OF TEMPERATURE AND PRECIPITATION FOR 175 FOREIGN
CITIES

WEEKLY AND MONTHLY HEATING AND COOLING DEGREE DAYS -
POPULATION WEIGHTED STATE, REGIONAL AND NATIONAL AVERAGES

WEEKLY PALMER DROUGHT INDEX DATA AND PROJECTED PALMER INDEXES ORGANIZED BY
SECTION OF THE U.S.

WEEKLY APPARENT TEMPERATURES AND WIND CHILL FOR THE U.S.

HIGH DENSITY PRECIPITATION DATA FOR PAST 8 WEEKS ACCESSIBLE BY STATE

RUDIMENTARY MAPS OF WEEKLY AND MONTHLY TEMPERATURE AND PRECIPITATION DATA, ALSO
MAPS OF 6 TO 10 DAY FORECAST BY CATEGORY

MONTHLY AND SEASONAL U.S. CLIMATE RANKINGS BY AREA

MONTHLY COMPARISON OF CURRENT MONTH'S TEMPERATURE AND PRECIPITATION TO RECORD

SEASONAL SUMMARIES OF TEMPERATURE AND PRECIPITATION FOR OVER 200 U.S. CITIES

PAST DATA OF THE PREVIOUS 3 WEEKS AND 3 MONTHS OF SELECTED DATA

THE EXTREME MAX AND MIN TEMPERATURE AND TOTAL PRECIPITATION FOR THE PAST 7 DAYS
THAT WAS FOUND IN OUR DATA BASE

NCDC AND REGIONAL CLIMATE CENTERS

Introduction

The National Climatic Data Center (NCDC) has, for over three decades, taken the lead in providing climatological services to the people of the United States. During this time NCDC has provided the long term stability and continuity on a national scale that is required of a national center. NCDC, nevertheless, has remained a flexible dynamic organization that is able to respond to the ever changing events and technologies that present themselves.

One such major change was the abolishing of the Federally sponsored State Climatologist program in 1973. NCDC responded to this major shift in emphasis by coordinating the establishment of state sponsored State Climatologists. This highly successful program now has 48 of the 50 states participating. The American Association of State Climatologists, with the active support of the NCDC, has also grown into a full fledged viable scientific organization.

The National Climate Program Act of 1978 also brought new challenges to the Federal climatological program. This new awareness of the importance of climatological data and information being delivered on an ever finer scale in a time frame approaching near-real time has brought about the concept of the Regional Climate Center (RCC). The RCC's have thus become the third party in the total climate services system.

The Relationship between NCDC and the Regional Climate Centers

Since the inception of the RCC's, the NCDC has played a major role in the development of the operational plans for the interactions between the State, Regional, and National Centers. NCDC is now actively involved in supporting the established RCC's as well as helping plan for the two remaining RCC's.

The major activities underway at this time include:

- ° Establishing standards for the exchange and storage of climate data

This activity has centered around the CLICOM system. This PC based "NCDC in a box" has been selected as the official data management system for the regional centers. NCDC developed the system and now maintains, installs, and provides training for the CLICOM system.

- ° Developing new techniques to ensure that the highest quality data are made available to the user

This activity is now underway with the Western RCC. Work has begun on the development of a system that will allow the State

Climatologists, through the Western RCC, to become involved in the quality control and validation of daily cooperative data within the framework of the NCDC processing system.

° **Speeding the delivery of data to the user**

This activity with the Northeastern RCC has been in existence for several years now. NCDC, in cooperation with the National Weather Service, has been supplying envelopes to the Regional Center for distribution to the individual cooperative observers. The observer is then able to mail a carbon of the observational form to the Regional Center, thus saving many weeks of waiting for the data to emerge from the national system.

° **Planning for future services**

This activity takes on two aspects, depending on the status of the Regional Center. For the centers still being planned, it means providing statistics and profiles on users of climate data within the respective regions. For the established centers, it means serving on advisory boards or otherwise offering advice on a variety of topics.

° **Providing data from the National networks**

This activity should help provide the Regional Centers with a baseline data set to which can be added locally and regionally observed data. The Western RCC has been provided the major climate data sets for their eleven-state area. These data will then be made available to local users and the State Climatologists.

° **Collaborating on development activities**

This activity has as a goal the development of many new application products and techniques. Efforts are now underway with the Midwestern Climate Center on several topics including a portion of a new Climate Atlas.

The Future

As the RCC's become active partners with the already established State and National centers, they will provide welcome help in servicing the growing needs of the user community. A lot of work is needed in the acquisition of local and regional climate data, maintaining and developing inventories and catalogs, and in the timely delivery of the required data and information. In addition, much remains to be done in describing regional scale climates. These efforts will require new techniques, new skills, and the use of the latest in technology. An exciting time lies ahead.

AND WHO SAID REGIONAL CLIMATOLOGY WAS A NEW IDEA?



STATE CLIMATOLOGISTS - CENTRAL REGION LINCOLN, NEBRASKA - NOVEMBER 20-22, 1968

1st row Gerry Barger - NCC, Washington, D.C.
Bill Demark - Illinois
Karl Johannessen - USWB, Washington, D.C.
Wayne Palmer - USWB, Washington, D.C.
2nd row Joe Berry - Colorado
Roy Fox - WSWB, Central Region, Director
Dick Myers - Nebraska
3rd row Earl Kuehnast - Minnesota
Al Joos - Central Regional Climatologist
Harold Harshbarger - NCC, Washington, D.C.
Norton Strommen - Michigan

4th row John Alyea - Wyoming
Hans Rosendal - Wisconsin
Paul Waite - Iowa
5th row Ray Jensen - North Dakota
Larry Schaal - Indiana
Walter Spuhler - South Dakota
Merle Brown - Kansas
6th row Jim McQuigg - Missouri
NCC-National Climate Center
USWB-U.S. Weather Bureau