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RATIONALE AND ROLE OF REGIONAL CLIMATE CENTERS IN THE UNITED STATES

by

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I. INTRODUCTION

Fundamental Activities: An Overview

Over the past 3 years two Regional Climate Centers have evolved as institutional innovations (Midwest and Northeast U.S.) to serve real and perceived regional needs for climate data and information. The objectives of the Centers include:

(1) to improve communications between federal agencies and State Climate Centers (SCO so as to enhance their disparate objectives;

(2) to guide State Climate Centers toward solutions of varied staffing, facilities, and institutional problems;

(3) to coordinate regional climate research projects; and

(4) to provide data and information to public and private users at the state and regional levels.

Communication activities have included the actual transfer of data, information, or advice from the State to the Regional Center or vice versa.

Some users desire climate data from networks other than those operated by the National Weather Service (NWS). Regional Centers are an appropriate agency for the archiving of non-NWS data, and can further serve as a central referral agency to provide information as to the availability of such data within a region.

Users of climate data and information (interpreted climate data) often require accessing this information for an area greater than one state. Therefore, the two Regional Climate Centers (RCC), cognizant of state data and climate, were organized where a group of states have common interests based on similar climate impacts including where common commercial and/or agricultural interests exist. Thus, the RCCs can understand the issues and can enhance the transfer of data and information between states, particularly when similar climate problems such as a drought, develop.

Regional climate research often involves studies of climate issues encompassing areas greater than one state. In these instances, a Regional Climate Center can and has offered guidance, data and information, and coordination to develop or enhance regional research studies.

Similarly, many services to in-state or regional-scale users (largely comprised of the energy, agricultural, water, and government sectors) are regional-scale. Hence, the services are most cost- and user-efficient when organized around a regional center which can provide the diverse expertise, data and information desired to resolve issues or make decisions wherein climate is a variable.

Climate data and information are usually desired for one of two time scales: anytime (i.e., "I am in no rush to see the data from the historical record"), or near real-time, (i.e., "my need is to see the current data at the present time"). If a facility exists, the Regional Climate Center allows access to data and information of either type, acquired by a simple contact from the user, rather than one to each state. Users primarily include climate-affected businesses, industries, state and local

governmental agencies, farmers, and the general public (i.e., people or agencies with climate-oriented problems or objectives). In areas without Regional Climate Centers, users currently can only acquire anytime climatic data, and this is sought from the State Climate Centers, (where they exist) private weather consultants, or the National Climate Data Center (NCDC). The value of historical (anytime) data at NCDC is established from the fact that paper and magnetic tape copies are requested, produced, and distributed for a fee.

Near real-time, regional-scale climatic data and information, are widely desired, but impossible to access in the U.S. on the space and time scales desired. Such data are now limited to that from NWS First Order and FAA stations, there being about ten such stations per state. Increased spatial density of data can be attained by use of the Cooperative Weather stations of NWS, and/or existing state weather networks, but these data are not available on a real-time regional basis. Nebraska and Illinois have established state-scale real-time climate data collection and delivery systems which have already demonstrated great utility in these states. Some other State Climate Centers receive data from the Cooperative network by weekly mail service (well before the reception from NCDC of the printed reports received months after their collection). However, the data are still received too late to serve most real-time needs, particularly because there is no delivery system available, other than the mail which adds days to the delivery.

The current and potential activities and data resources of a Regional Climate Center make it a logical interface between (1) the federal-state mix of established responsibilities for climate data collection, quality control, and archival, and (2) the public and private user sectors. The

private sector includes the direct user (e.g., a major grain corporation), and the consultant who interprets the climate data for a host of secondary users who have neither the expertise nor resources to hire expert staff. The public sector users include the direct user such as a state agency with expertise, and the State Climatologists, who serve diverse in-state needs, public and private.

To be effective in these diverse roles, Regional Climate Centers must be managed by experienced individuals sensitive to problems of data collection, quality control and archival; user services; and climate research. Familiarity with State Climate Centers and federal climate entities is important. An external advisory committee, composed of users from industry, education, and government, helps guide the activities of a Regional Climate Center so they will be meaningful and credible to the private and public users.

Current Regional Projects in the U.S.

Two Regional Climate Centers have been established with state funds and funds from the National Climate Program Office (NCPO). These are the Northeast Regional Climate Center (NERCC), and the North Central Regional Climate Center (NCRCC), each serving 12 states. Though currently funded at levels deemed only marginal, these two Centers, after 4 years of operation, have been able to: (1) identify users needing climatic data, information and assistance, (2) improve the distribution of climatic data and information, and (3) organize and direct regional climatic research projects.

Because of the limited funding, the NCRCC has only partially fulfilled the objectives of its original 5-year demonstration project, and it has relied on continuing supplementary support from the State of Illinois, its home. Indeed, although the NCRCC continues with the same number of staff assigned during the first year of operation (1981), support from NCPO now represents a smaller proportion of staff support than originally provided. To compensate, NCRCC has had to redirect some of its efforts, to ignore certain original objectives, and to somewhat alter course. Fortunately, user interactions and funding for a special Illinois-only climate delivery system have helped the Center identify a major need and a potential major function of Regional Centers; i.e., a *near real-time climate data delivery system.*

Regional Climate Centers and Climate Data

Climate data are routinely collected by the National Weather Service (NWS) from (1) First Order and FAA stations (about 500 in the U.S.) where hourly observations of most conditions are made, and (2) from the Cooperative weather stations (about 10,000 in the U.S.) where daily maximum and minimum temperatures, precipitation, snowfall, snowcover, and some peripheral daily weather data are recorded. Paper copies of both sets of observations are received by the National Climatic Data Center (NCDC) at each month's end. There, they are entered on tape and quality checked (for example, maximum greater than minimum temperature; values in agreement with adjacent stations; values evaluated within the variability of that station's climatic record, etc.). These quality-controlled records are then archived by NCDC, and are available usually 1 to 3 months after the end of the month.

Many states have now installed climatic stations in addition to those of NWS. These were often intended for special purposes, and/or to increase the data density. Some may be of intermittent tenure. Because many have been installed to serve special studies, the observations may not be compatible with NWS guidelines. Such data have not been received nor archived by NCDC in the past, and indeed, because of the often discontinuous nature in space and time of state/industrial data sets, they probably should not be held by NCDC. Nevertheless, these data often have great utility to local, state or regional problems. Thus far, the states have collected these observations, quality controlled them to varying degrees, and archived them in a myriad of varying locations.

Because of 1) the rapidly growing need for data/information in climate-related decision-making, 2) the growth of special climate data bases, and 3) the wide availability of micro-computers, there is now a need to standardize these special data to the degree possible, and more importantly, to make them available to the users who desire them on an anytime or a near real-time basis. Regional Climate Centers can serve (and to a limited degree, are serving) this purpose. Such a system is being studied at the North Central Regional Climate Center.

Types of Climatic Data and Information and their Applications

For the purposes of this report, climatic data and information belong to one of two broad categories: (1) anytime, and (2) near real-time data and information. Anytime data and information are those not needed for current conditions, but rather historical conditions. They are often used for designs or for some assessment of applications, i.e., information derived from many years of past climatic data. These products can provide

an estimate of the mean and variance characteristics of the atmospheric environment at a given location over a specified period of time, or what existed for a specific time (e.g., whether it was icy when someone fell on a given date in the past). Thus, anytime data are useful for these purposes today, next week or next year. These data must be and are quality controlled, and therefore are relatively error-free.

Real-time data, on the other hand, typically include historical, and must include very recent observations, generally made during the last few hours or days. These data are generally needed for current assessments and/or operational decisions (i.e., have there been sufficient heat units since May 1 to cause the cutworm to emerge so I can decide to spray?). The only real-time data now accessible across the nation are from the 250 First Order Stations in the U.S., and only through the limited-access Automation of Field Operations and Services (AFOS) ports of NWS. However, near real-time data from systems with more dense weather stations are being collected in a few states. These systems obtain daily data from special networks of state-supported stations and/or from NWS Cooperative stations. Near real-time climate data are not current observations in an operational sense, but are representative of the last 24 hours and/or a few days, and importantly the information that can be provided include comparisons of today's situation with conditions from last year and the long-term normals. Because of the speed with which these data and information are needed by the user, these data are typically not as quality controlled as anytime data (except for consistency).

II. UNIQUE CONTRIBUTIONS AND STRENGTHS OF REGIONAL CLIMATE CENTERS

Climatic Expertise of Regional Climate Centers

RCC staff assist both State Climatologists (SC) and private sector users about 1) the location of climatic data sets, and 2) appropriate analysis techniques for specific purposes. They also refer users to people or agencies with expertise within the area of interest. Therefore, RCC staff must be widely familiar with the region's climatic problems and with climatologists, the climate agencies in the federal and state governments, and with climate-effected private industry. This requires management capabilities and scientific credibility in the federal and state government sectors, the private sector, and with the scientific community.

Regional Climate Data and Information Dissemination Systems

Regional Climate Centers must provide near real-time climate data and information based on a thorough knowledge of the varying climates of the region and their effects on agriculture, energy, water resources and other key sectors. Virtually all the 12-states in the North Central Region, served by the NCRCC, already operate a near real-time climatic data collection system from at least a few observing sites. Their State Climate Centers (SCO receive various climate parameters by voice or computer transmission.

Real-time dissemination is another matter. In all states information dissemination occurs via phone or the media, but real-time dissemination to users via a terminal-and-modem system exists only in Illinois, Kansas, Michigan, Minnesota, Nebraska, South Dakota and Wisconsin. Indiana transmits data to the agricultural community by a fax system. At present,

these state-operated systems are heterogeneous, i.e., the data from one state are not necessarily compatible with those from other states. This refers particularly to parameters recorded, exposure of instruments, quality control, or dissemination methods. The near real-time data density varies greatly from one state to another.

Funds do not currently exist to develop a homogeneous regional delivery system. However, a Regional Climate Center could serve as the coordinator and operator of a regional system wherein the current climate conditions are available at a single source in a homogeneous mode.

In general, the Regional Climate Centers need not be a supplier of anytime (historic) climate data. These data can be procured from NCDC and it would be redundant to have these data for delivery at each RCC.

Regional Climate Research Studies

The NCRCC has initiated and coordinated regional research studies involving regional climatologists. These have focused on assessments of anomalous climate events, and on their general impacts on agriculture, energy use and transportation (Wendland et al., 1983, 1984). In addition, NCRCC recently analyzed 1951-1980 temperature and precipitation patterns of the region accounting for differences in the times of observations from site to site (Wendland et al., 1985). Time of observation corrections were obtained from another regional study coordinated by NCRCC (Head, 1985).

RCCs can initiate discussions of potential regional climate research projects, help collate the results, prepare proposals for funding, and help seek funding. Such efforts in the North Central Region have been successful. A regional research proposal is currently under study.

Regional Climate Centers Serving as a Climate Data Referral Service

The typically good communications between State Climatologists and other climatologists in the states (public and private), and between the State Climate Centers and the Regional Climate Center, enable the latter to serve as a climatic data referral service to potential regional and national users. Government and private interests often need climate data of spatial density greater than that available from NWS; or they need unusual climate data, but are unaware of the existence or location of such data in adjacent states. The Regional Climate Center can aid such a user by coordinating the information flow from their archive and that available from SCCs or other sources. Thus, the RCC can serve effectively as a referral service, or can forward the information or data to the user as available in the RCC.

III. USERS OF CLIMATE DATA AND INFORMATION

Extensive efforts have been made in certain states to analyze the climate user communities (Changnon, 1979; McKee and Doesken, 1983). From these analyses, and from three years of operation of the NCRCC, we have been able to identify a cross-section of the user community.

Anytime Data Users

Users of anytime climate data include: 1) those who routinely receive prepared mailings for general distribution (by subscription) from NCDC, the State Climate Center, or some other private users; and 2) those who request data or information for a specific purpose. In general, the make-up of these users closely parallels the economic interests of the area in question. The major climate-data clientele of State Climate Centers in the Midwest is associated with agriculture.

Several states have summarized users of *anytime* climatic data, as shown in Table 1. First, one must be aware that the categories were not commonly defined from state to state; i.e., they are not mutually exclusive. For example, government representatives, university staff and the media may request data and information for agricultural use. However, since some states categorized by user agency, and others by the use to which the data were applied, the results are not directly comparable. In the Illinois analysis (Changnon, 1979), the vast majority of users were classified as media, although they further distributed the data and information, and final users of these data represent several user categories as well as farmers and the general public.

Table 1. Users of anytime climate data at 5 state climate centers. Percentages shown do not necessarily total to 100% due to differences in category choices. (extracted from Wendland and Changnon, 1985).

	Arizona	Iowa	Oklahoma	Illinois	Colorado
Private Business	16	25	12	10	47
Farmers		25			
Coop County Extension Agents					
State Government Representatives	16	20	10	2	8
Federal Government Representatives			7		10
University Staff	26	10	28	12	22
Media			7	71	7
Individuals	30		19		10

Real-Time Climate Data Users

Near real-time climate data are only available nationwide from the First Order stations of NWS and the Climate Analysis Center (CAC) of NWS. A few State Climate Centers provide in-state data. Consequently, only a few analyses of the users of these data have as yet been performed.

The Center for Agricultural Meteorology and Climatology at the University of Nebraska-Lincoln has operated an on-line computer based system known as AGNET for several years. Support for the development of data in the Great Plains comes from NCPO. AGNET retrieves temperature, precipitation, soil temperature, wind, solar and humidity on a daily basis from 27 automatic recording stations in Nebraska, South Dakota and Colorado plus another 10 stations from Kansas. These data are used to drive several inter-active agricultural models and the products are then made available to the users of AGNET. Although AGNET is open to all users for a fee, it is clearly oriented to the agricultural market, with the system containing the climate parameters mentioned above, and models to help evaluate crop status, evapotranspiration, beefstock management, drying potential, and irrigation needs. In 1984, 15,170 accesses to AGENT were completed (11,933 in 1983). The users were composed of 50% County Extension Agents, 21% crop or livestock producers, 11% from agribusiness, and *5%* each from state and federal government agencies and agricultural consultants.

Table 2 shows the frequency of use by user category of the Illinois Climate Assistance Service (CLASS), a computer-based, climate data collection and delivery system which is maintained current on a daily basis. This system was developed with joint federal and state funds, and was operated in its first year (1984) to determine the use and value of

Table 2. Users of the Illinois Climate Assistance Service (CLASS) during 1984, the first year of a demonstration project.

Private Business	35%
Coop County Extension Agents	20%
Farmers	17%
State Government Agencies	12%
University Staff	11%
Federal Government Agencies	3%

climate data and information to *state governmental officials.* Thus, the users of CLASS were not an open-ended group. They were largely solicited, and therefore are not a representative sample of the total potential user community in Illinois. However, the current regular users of CLASS include several tens of users who have learned of the system by word of mouth, and been allowed to access it.

Since virtually all of the private business users were agri-businesses, CLASS users with an agricultural application totalled about 72% of this sector (Wendland and Changnon, 1985). During the first year of operation, the total number of regular users grew from an initial 30 to more than 2400. During the first 2 years of operation, the system was in use (on demand) about 10 hours per week by means of about 50 accesses per week. System use was directly related to times of stress; i.e., areal drought, extreme temperature and local flooding.

CLASS products include daily, weekly, monthly and seasonal temperature and precipitation assessments maintained current each day for 36 sites in Illinois. These data are presented in tabular or map format. In addition, secondary data; e.g., degree day data, 30- and 90-day outlooks (received from CAC), various pest advisories during the growing season, and Illinois water resources information are available.

The user response to this system has been very positive. Many Illinois users claim that a regionally-based system would be even more useful, since crop and climate anomalies and their interests do not respect political boundaries, and because such data and information are of obvious economic value. User testing suggests that the operation of an established <u>regional</u> system could be supported by user fees.

In 1982, the Illinois Water Survey (Lamb et al., 1984) directed a study of current and potential uses and needs of climate data in the agricultural community. Those assessed included agricultural finance companies, chemical manufacturers, food processors, grain traders, integrated pest management consultants, farm managers, insurance companies, seed producers, and farmers. One of the conclusions of that study was that climate data currently being observed, but not readily accessible, would be of great value, if available. Specifically, users expressed considerable interest in accessing the "current state of the climate", composed of data from a dense network of stations. Table 3 shows their needs for near real-time climate data and information. Table 3 reveals two key facts: 1) most agriculture users of climate products desire real-time information, and 2) that certain sectors are most vitally interested in near real-time information. According to this study (Lamb et al., 1984) about 40% of all agricultural users of climate data and information want, but do not currently use, near real-time data because either it is not available, or its delivery is too delayed to be useful. Products of agricultural interests most desired in real-time included temperature and precipitation for the past day, month, and season; storm information; and total degree days accumulated for the current season, all from measuring locations with 30 to 50 km separation. Climate data are available at this spatial scale from the NWS Cooperative stations, but generally are not available through any current dissemination systems. It can be accessed only as hard-copy, published at least 2 months after the fact from NCDC or State Climate Centers. A near real-time regional climate data and information dissemination system based on Cooperative station data input daily would alleviate this problem.

Table 3. Percent of respondents using climate information, who use this information in a quantitative way in their decision-making (Lamb et al., 1984).

	Historic Climate Data	Year-to-Date Accumulation, (near real-time)
Agricultural Chemical Manufacturer	40	50
Agricultural Finance Companies	17	17
Food Processing/Canning Industry	43	57
Grain Trade	26	21
Integrated Pest Management Consultant	58	70
Producers	33	43
Professional Farm Managers	27	18
Rural Insurance Industry	75	0
Seed Production Companies	40	40

Easterling (1985) polled subscribers to the Climate Analysis Center's semi-monthly publication entitled "Monthly and Seasonal Weather Outlook." He sought to determine who subscribes to the service (30- and 90-day outlooks), the users business activity, location, and the degree to which they quantitatively apply the information to decision-making. The list of subscribers is unsolicited, i.e., they request and pay for the service. Of the 321 who responded to the questionnaire, 1) 39? identified their activity as agriculture or agribusiness; 2) 17% were energy-related; and 3) 11% were government and education. The remainder of the categories each represented less than *5%* of the sample. Each of the respondents from these three main categories claimed a systematic use of weather and climate information in their decisions. It is worthwhile to note that the frequencies of these unsolicited users were similar to those frequencies found in the users of the Illinois Climate Assistance Service (Table 2).

IV. INSTITUTIONAL STRUCTURE AND ISSUES OF REGIONAL CENTERS

Criteria for Organization of a Region

Delineation of a region for a Regional Climate Center should be done according to a mix of factors. These could include consideration of (1) common climatic types, (2) common agricultural bases, (3) other common regional interests and needs for real-time climate data, (4) scale of the area, and (5) institutional considerations including support. RCCs can be developed from a data source of geographic standpoint. However, to provide useful near real-time data and information, and to organize research, the RCC must have expertise in the region's climate and its effects.

The Northeast Regional Climate Center includes Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia, a group of states that have historically been grouped by NWS, and U.S. Dept. of Agriculture projects including a committee of (university agriculture representatives). The mix of agriculture activities, and commercial and industrial interests gives the region some unity.

The North Central Regional Climate Center includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin. These 12 states experience a common interior continental climate, and a sizable portion of their economic income is from agriculture. They, too, have been associated with each other through an agricultural committee; i.e., NC-94.

Management and Funding of Regional Climate Centers

Since some uniformity must exist between regional centers due to data uniformity requirements, interaction of data exchange systems, and programmatic objectives, direction of Regional Climate Centers should originate at the federal level. If the direction of regional centers was given to some level other than national, the homogeneity and structure would be vastly diminished, removing most meaningful inter-regional interactions and services.

Within a region, there also must be a state and private sector (user) orientation. The needs for data and information products will vary between regions and must be made to suit major user needs. Furthermore, regional staff should be credible and particularly accountable to the state interests.

Hence we envision an institution wherein the RCC receives 1) input as to general management objectives and tasks from the federal government, and 2) guidance from regional-state users as to what special data to archive and what data/information products to provide.

Because Regional Centers must respond to the needs of the federal and state governments, as well as the private sector and individuals, the funding, too, must originate from these various sectors. We would suggest funding for the base RCC staff from federal sources; support for data bases from the states; and support for the climate delivery system (after installation) from user fees.

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