Proceedings of the Conference on Cooperative Climate S

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Rockville, MD
October, 1983

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Climate Program Office

Proceedings of the Conference on Cooperative Climate Services

Tallahassee, Florida
March 22-24, 1983

Compiled by
Howard L. Hill

Rockville, MD
October, 1983

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator

National Climate Program Office
Alan D. Hecht, Director

ACKNOWLEDGMENT

The Conference on Cooperative Climate Services was held at the Florida State Conference Center, Florida State University, Tallahassee, on March 22-24, 1983. Joan Rissinger of the Center, and Patricia Smith, F.S.U. Department of Meteorology, helped arrange the conference and following workshop. Their assistance is greatly appreciated.

Special appreciation is expressed to Professor Werner Baum of Florida State University for his assistance in arranging the conference and his continuing interest and efforts to improve the Nation's climate services.

National Climate Program Office staff who contributed to conference planning and arrangement include: Bernard Dethier and Howard Hill, conference program and attendance; Mason Charak, conference arrangements; and Wendy Graham, conference secretarial services. Howard Hill compiled the speeches for publication.

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CONFERENCE ON COOPERATIVE CLIMATE SERVICES

BACKGROUND AND RECOMMENDATIONS

Howard L. Hill
National Climate Program Office
Rockville, Maryland

The Conference on Cooperative Climate Services marks a turning point in the climate services element of the National Climate Program. An initial phase of the Intergovernmental Climate Program, which demonstrated climate services, is substantially completed. Emphasis has shifted to developing and testing institutional arrangements for a nationwide system of climate services.

The National Climate Program Act of 1978 was justified, in part, on the finding that "information regarding climate is not being fully disseminated or used." The Act mandated "management and active dissemination of climatological data, information and assessments" as an element of the Program, and it created the Intergovernmental Climate Program, consisting of Federal and State cooperative activities in climate studies and advisory services, as a nationwide, user-responsive effort to carry out the mandate.

The Climate Board of the National Academy of Sciences was influential in guiding early development of the Intergovernmental Climate Program (ICP) ("A Strategy for the National Climate Program" 1980). The Board recommended that the ICP be developed in phases, the first consisting of federally funded projects to demonstrate uses and benefits of local and regional climate services. Later phases included jointly funded Federal and State activities, and acceptance of State Climate Programs into the ICP. The concept of phased development was adopted in the Five-Year Plan but specific plans were confined to the first phase.

In 1980, the Climate Board created a Panel on Intergovernmental Climate Programs to document potential benefits from cooperative federal and state climate activities, and to develop strategy and recommend approaches for implementing intergovernmental climate activities. The Panel's report, "Meeting the Challenge of Climate" (1982) was an analysis of user needs and information system requirements to meet these needs. The Panel concluded that a coordinated nationwide system of federal, state and local climate services is needed, consisting of local experts from both the public and private sectors, a network of state and regional climate programs, and coordinated federal participation. The Panel recommended that the National Climate Program Office (NCPO) take a leadership role in development and support of a coordinated nationwide system of climate services involving both the public and private sectors.

It endorsed the original strategy (Climate Board, 1980) of a three-phase effort over 5 years. Other specific recommendations addressed to NCPO were:

- o Complete the exploratory phase in the next year or two.
- o Take the lead in initiating an equitable process for defining responsibilities for participation in a nationwide system of climate services on the part of local, private-, and public-sector experts, state and regional climate programs, and the federal government.
- o Take lead in coordinating federal agency participation in a nationwide system.
- o Incorporate state and regional climate programs into a nationwide system.

The decision to hold the Conference on Cooperative Climate Services, and goals set for the conference, were in direct response to the Panel's recommendations. The exploratory phase was substanially completed. During this phase (1980-1982) NCPO funded 14 intergovernmental projects in 11 states, including 2 regional projects, 8 projects in individual States, and 4 projects with private sector companies and associations. The projects were equally divided among demonstrations of climate information dissemination and applications, and studies leading to development of state and regional climate plans. Except for projects with the private sector, all projects were carried out by universities. Two projects, in Connecticut and Illinois, were carried out jointly with a state agency. Average funding per recipient organization was about $53,000. Nine projects were of one year duration; the other five were of 2 or 3 years duration.

Other considerations also entered into the decision to hold the conference. There was a need to determine if established information networks, such as those of the Cooperative Extension Service, could be a major means of delivering climate information and services. New approaches were needed for involving the private sector in providing climate services, and for applying advanced technology in data collection and communication.

The purpose of the conference was to evaluate options for public/private cooperation in providing regional, state and local climate services. A representative group of users and producers of climate services were invited to attend and participate in planning future program activities. Following the opening session, the conference was divided into sessions which addressed separate aspects of this goal:

Federal agency roles in providing climate services (NOAA and USDA)

Providing climate services (user needs and specialized climate services provided by the public and private sectors)

Regional and state climate centers (Northeast and North

Central regions, Connecticut, and Colorado), and survey of state climatologists.

Technology support for state and regional climate centers (examples from Nebraska, Florida, and USDA)

NOAA Adminstrator John Byrne spoke at a luncheon session. Congressman George E. Brown, Jr., was unable to attend the conference as planned but sent a message which was read at the luncheon. Their remarks are reported with others given at the opening session of the conference.

The final session was a workshop to discuss issues raised by the conference and to recommend approaches for improving climate services.

Workshop Summary

The starting point for the workshop was general agreement on the need for a coordinated nationwide system of climate services involving both the public and private sectors.

During general discussion a number of issues were identified and certain points of agreement were reached.

o The Federal government has major responsibilities for key elements of a national climate information system including data acquisition, quality control, publication and archiving of national climate data. The fulfillment of these responsibilities so as to maintain a stable, long-term data base is absolutely necessary for provision of reliable and credible climate services. The Federal government also should provide guidance to states on acquisition and quality control procedures for specialized data collected by the states.

o The National Climatic Data Center (NCDC) is a unique Federal resource with a vital role in climate services. NCDC's priorities and ways to improve its operations must be addressed when considering how to improve the Nation's climate services.

o The climate data inventory of the National Environmental Data Referral Service (NEDRES) of NOAA is a valuable addition to the Nation's climate services.

o The National Weather Service (NWS) and the National Environmental Satellite, Data and Information Service (NESDIS) need to be responsive to users' needs and determine the impact to users when they propose to change data acquisition, handling, or publication priorities.

o Existing information networks, particularly those of State Climatologists and the Cooperative Extension Service, should be utilized whenever possible to deliver climate services.

o Major opportunities exist and should be exploited for utilizing advanced technology to acquire and communicate climate data.

o The role of regional climate centers is to facilitate delivery of federal climate services to states, and to support rather than to compete with states in meeting their responsibility to disseminate climate information.

o The public and private sectors can have a complementary relationship in providing climate services. Opportunities for the private sector to market climate services will appear as more public agencies charge for providing services. The public sector is best able to demonstrate new applications of climate information while the private sector can meet the demand for tailored climate services that result from the demonstrations.

o Present obstacles to private sector participation in planning regional and state climate services might be lowered by fostering private sector leadership of seminars and fairs to develop markets for climate-related services.

o New approaches for public and private sector cooperation in providing climate services should be considered, such as not-for-profit organizations discussed in two talks given at the conference (Hauser, Martsolf).

o The distinction between weather and climate services is not clear-cut because users need information on a continuum from the past and present weather to forecasted conditions. Differences in agency missions and the uses they support are important and must be considered when planning regional, state, and local climate services.

Recommendations

The workshop conferees addressed a general recommendation to NOAA:

o In recognition of its responsibility to maintain the national climate data base, NOAA should make policy and program committments to assure continuity and adequate funding support for basic national acquisition networks (first and second order stations and cooperative observers), to maintain high standards for data quality, and to adopt advanced communication technology as required to improve the timeliness and accessibility of climate data by users.

The workshop conferees made the following recommendations for action:

1. NOAA should establish an advisory group to review and recommend user priorities for National Climatic Data Center

programs. NCDC/NESDIS should make its operational data managment plan available for the advisory group's use.

2. The NEDRES activity of NOAA (voluntary registration of data sources) should be strengthened, and expanded to include registration of climate information and services.

3. The interagency Climate Program Policy Board, or other body that it designates, should coordinate federal support and services provided to regional and state climate centers. This responsibility should include consulting with users and communicating their needs to federal agencies or, when more appropriate, referring them to regional or state centers where specific needs can be met.

4. USDA and NOAA should expand present cooperation in preparing and disseminating climate information products and services to users in both the public and private sectors.

5. States should take the initiative in forming regional climate centers to serve their needs, making maximum use of USDA and state agricultural experiment station research capabilities to develop climate information products, and of information networks of State Climatologists and the Cooperative Extension Service to disseminate weather and climate information and services.

6. Regional and state climate centers should actively explore ways to increase private sector participation in all phases of weather and climate services. Not-for-profit corporations, such as those formed in California and Florida to provide specialized weather services to agriculture, should be considered for wider application. Another approach that should be explored is private sector sponsorship and participation in climate service fairs and seminars directed to specific user groups, such as the construction industry, agribusiness, energy suppliers, public utilities, and recreation businesses.

7. Increased efforts should be made at the national, regional, and state levels to improve public understanding and strengthen support for providing climate services by such means as identifying areas of need and potential benefits from weather and climate services, demonstrating public and private sector partnership in providing climate services, and documenting expected costs and benefits of weather and climate services.

MEETING THE CHALLENGE OF CLIMATE SERVICE in the 1980's

by
Alan D. Hecht, Director
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Rockville, Maryland

The National Climate Program Act, enacted nearly five years ago, is a flagship to guide climate research and services. In five years the National Climate Program has navigated some rough water. However the river ahead is fast and straight and I expect the Program to move rapidly forward. The purpose of this conference is to address one aspect of the Program: meeting the Nation's growing needs for climate services. Our goal in bringing together a representative group of users and producers of climate service is to develop the framework for a nationwide system of climate services and to establish a consensus of how it should be done. We have structured this conference so as to learn what can be provided by the Federal government, States, and private sector toward better meeting the Nation's climate service needs. The Conference will review options for meeting these needs, and will be followed by a workshop to draft a plan of action to set goals and direction for the next decade.

Evolution of Climate Services in the U.S.

The system of collecting, archiving and disseminating climate data has grown steadily over the past 100 years. The network of cooperative observers, the main source of the Nation's climate data, has grown to over 11,000 observers from its beginning in the late 1800's. Data collected by the National Weather Service (NWS) from the cooperative network and other sources, including satellite data, are archived at the National Climate Data Center (NCDC) in Asheville, N.C. The NCDC began as the National Weather Records Center in 1951 and now serves approximately 75,000 customer requests per year. Today NCDC has access to over 75,000 magnetic tapes which contain digital climatic data.

Between 1954 and 1973, NOAA and its predecessor ESSA established the State Climatologist (SC) Program as a means of maintaining adequate climate data and information. During this period most states had Federally-employed state climatologists, many of whom were located at land grant colleges. The function of the state climatologists was to cooperate with local, State, and Federal agencies in providing climatological applications to meet specific needs. Following budget reductions in 1973, the SC Program was ended and States were left to assume this responsibility. State responses were uneven, but generally over the past 10 years state climate programs have been maintained. Some states have expanded their activities and serve the interest of their entire region. Currently there are only 3 states without a SC or acting SC.

Climate services, although rooted deeply in NOAA, also are intimately tied to USDA. Agriculture is one of the largest users of climate and weather information. Legislation enacted in 1870 established the United States Weather Bureau as part of the Army Signal Corps. In 1891, the Weather Bureau was moved to USDA where it remained until the early 1940's. USDA began the first effort in long range forecasting by establishing the first experimental climate forecast center at Massachusetts Institute of Technology in 1936. Now, two of USDA's Regional Research Committees, NC 94 and NE 135, have taken the lead in forming regional climate centers, a new institutional framework for data management, research and impact studies. The State Cooperative Extension Service in a number of states also is actively delivering weather and climate information to users in agricultural and in rural communities, and is utilizing weather and climate information in educational programs.

As the present climate information system has evolved, user demand has increased and the value to society of climate and weather information has become more apparent. Weather and climate data have become inseparable. A continuum of real time and historic data is needed by all users particularly in the realm of management planning and strategy decisions.

As the present climate information system has evolved, user demand has increased and the value to society of climate and weather information has become more apparent. Weather and climate data have become inseparable. A continuum of real time and historic data is needed by all users particularly in realm of management planning and strategy decisions.

Since the end of World War II, the private sector has become an important component of the climate service system. In this age of environmental concern and rapid expansion of technology, the scope and detail of weather and climate applications in all sectors of the economy and government operations have brought increasing demands for specialized serices extending beyond the traditional public service function of NOAA. There are now over 326 certified consulting meterologists nationwide and more than 100 consulting firms. A challenge to this conference is to devise practical and equitable ways to match private sector service capabilities with the growing demand for tailored weather and climate services -- keeping in mind that both individual and societal benefits result from some of these services.

A decade ago saw the start of technological innovations which ushered in new opportunities in data management and information flow that can revolutionize the entire climate network. Unfortunately the same era saw the end of the Federal support for the state climatologist program. The tenuous and fragile partnership between the federal, state, and private sector was ruptured in some states and severely strained in others. Now it is time to create a new partnership that applies technology improvements in meeting today's needs for climate information and service.

In many ways the existing climate data system is like a house built by three generations of carpenters who may have spoken the same language but seldom talked together. While the house stands it has weaknesses. Some of the plumbing doesn't work, the appliances are old, and the wiring is not up to present specifications. Yet the house has a strong foundation and has provided shelter for several generations of families.

Today the climate family is bigger than ever and is ready to put its house in order. This conference will help determine what renovations are to be made and what our house will look like ten years from now. This is not another conference to discuss weaknesses in the current system. The house is there for all to see. Rather this is the time to draw up plans to rebuild and to make committments for the future.

The National Climate Program--A Turning Point in Climate Services

In 1978 Congress enacted the National Climate Program -- a principal objective being improvement of climate services. While the NCP Act may be somewhat idealistic the Act itself has served to focus attention on the need to improve climate services. It has created a favorable environment in which to consider the future direction of climate services.

The Act mandates mechanisms for management and active dissemination of climate data and information. The framework for these mechanisms is the Intergovernmental Climate Program (ICP) carried out within the overall national program. We soon found that the intergovernmental program, as established by the Act, was too ambitious for the funds provided to implement it. Instead the NCPO began a phased approach for improving climate services with a series of demonstration projects aimed at showing new approaches and applications for climate system. The North Central and Northeast regional climate centers were begun in this phased approach. We are highly encouraged by early performance of these regional centers, and at this conference, we want to assess their value as the central component of a new approach to climate services.

A New Approach

The decision to hold this conference stems from our efforts to follow guidance provided by the National Academy of Sciences' Climate Board Panel on Intergovernmental Climate Programs in their recent report "Meeting the Challenge of Climate". NCPO's clear objective, as recommended by the panel, is to take a leadership role in the development and support of a coordinated nationwide system of climate services involving both the public and private sector to ensure effective and efficient delivery of climate services. What we seek are new institutional arrangements for cooperation between Federal and State Climatologists, industrial meteorologists, and private consultants, and better two way communication between users and producers of climate data.

The endurance of these new arrangements will depend heavily on responsiveness to users needs. Thus it is essential that attention to user needs be considered at all times, especially at the points where services are disseminated. Improvements in delivery and interaction with users might require, for instance, networks of experts at the local level. The State Cooperative Extension Services and Agricultural Experiment Stations provide models of how this can be done. An educational program for users, such as might be provided by county extension agents, could improve users' skills in applying climate and weather services and also become a channel for communicating their needs back to data collection and analysis activities of State and Federal agencies. We think that regional climate centers formed by two or more states could be very important in this two-way communication of climate services, on the one hand, and user feedback, on the other.

Federal, State and Private Sector Roles

Federal, State, private sector partnership must be based on clear understanding of roles and responsibilities. The Federal government has the major responsibility for collecting, processing, and archiving national climate and weather data. Many States collect data to supplement these data or to serve specific State needs. But the unique Federal responsibilities are to develop climate and weather data standards and quality control measures, and to operate national data collection networks. The interest of the Federal government in standards for collection and data quality control extends to international data exchanges. There also is a Federal responsibility to provide technological guidance for communicating climate information. Both NOAA and USDA have important investments in communication systems, but we recognize that communication technology is rapidly changing and becoming less costly and more available to all users.

The dissemination of climate information is the responsibility of Federal and State governments. Several states, including Colorado, Connecticut, Iowa, Illinois, and New York have taken a lead in providing expanded weather and climate information and services within the states. The two regional climate centers were formed in response to needs and common problems of several states in using climate information. Regional centers provide an infrastructure to coordinate climate studies, advisory services and data management activities. They fill a gap between data collectors and data users. An extension of this concept would be to develop a nationwide system of regional centers which would serve as focal points for interaction with the Federal government.

The private sector in this partnership provides the technical expertise for specialized needs not required by the general public. Agricultural production provides examples of the use of specialized climate services, such as local area climate alerts, and climate analyses useful for practices such as planting, aerial applications, pest management, irrigation scheduling, and others. Specialized service to municipalities, industry, transportation, utilities, and recreation are equally important.

A Federal, State, and private sector partnership based on this distribution of responsibilities can be the infrastructure for providing climate services over the next decade. It must, however, make use of technology improvements for collecting, processing and communicating data, and it must be responsive to user needs. The center of the partnership for delivering services is a regional center extablished for that purpose by one or more states. The advantage of operating fewer centers (compared to the more than 40 States now providing some climate services) is in more focused and economical delivery of climate information. Implied in the concept of regional centers is a strengthened dissemination of climate data and information.

Improving coordination among Federal agencies in meeting their responsibilities for providing climate services is a major challenge. We propose formation of a steering council by the interagency Climate Program Policy Board to monitor and coordinate development of a nationwide climate system. The steering council can be the focal point for user interaction and planning within the Federal Government. A unique feature of this steering council would be a responsibility to interact with users of climate services, and the regional centers.

During the course of this conference, I urge each of you to give careful thought to the implications and implementation of a new partnership in climate services. At the end of the conference, we will convene a workshop where we will begin to synthesize your advice and develop an operating plan. I look forward to hearing your views as we begin the important task of deciding how best to provide climate services to the Nation in the decade ahead.

MEETING THE CHALLENGE OF CLIMATE

Werner A. Baum

Chancellor Emeritus, University of Wisconsin-Milwaukee
Dean and Professor, Florida State University

My assignment was to talk about Meeting the Challenge of Climate [1] one of the direct antecedents--probably the major one--of this conference. Rather than addressing the report in a limited way, I would like to place it into a somewhat broader perspective: What has led to this particular conference at this particular time?

For me, at least, the story begins with World War II. The military, largely under the leadership of Dr. Woodrow C. Jacobs, undertook the first major effort in the United States in applied climatology. An enormous amount of work was done in the application of climatic information in such matters as equipment design, strategic planning, selection of alternate bombing targets, and a variety of other military problems. This effort eventually evolved into the current-day Air Force ETAC, which has certainly been a prime element in applied climatology in the United States.

That work led to a classic post-war publication by Dr. Jacobs.[2] He presented about half a dozen of the World War II case studies and showed how dramatically and effectively climatological information could be used in the solution of practical problems. There was widespread hope that this demonstration would lead to significant development in applied climatology in the American economy at large; but that hope was largely unrealized.

Actually, while private meteorology began to develop consequentially after World War II, the overwhelming emphasis was on the short-range weather forecast and its utility in economic operations. Applied climatology did not move very much. Along came the 1970's and the series of climatic episodes--in an environment of energy and food concerns--which we all remember: The Sahel desert affair, the serious drought in the western United States, and our extremely cold winters of 1976-77 and 1977-78. That series of episodes certainly was a major element in consideration and adoption of the National Climate Program Act. Natural events made it possible for interested individuals,

[1] Climate Board, National Research Council: Meeting the Challenge of Climate. National Academy Press, Washington, D.C., 1982, 66 pp.
[2] Jacobs, W.C.: Wartime developments in Applied Climatology. Volume 1, Number 1, Meteorological Monographs, American Meteorological Society, Boston, MA, 1947, 52 pp.

among whom Representative George Brown of California was a leader, to focus attention on the issue and to obtain some action.

That Act has a very important aspect which needs to be emphasized and re-emphasized. While the Act talks about research and our need to understand climatic behavior better--as well as about our obvious desire to develop the ability to forecast climate, if possible--the Act makes it clear that there is a great deal we already know about climate which ought to be applied for the benefit of the American economy to improve our productivity. We are not taking nearly full advantage of what we already know. In the Act, this was reflected by establishment of the then so-called Intergovernmental Climate Program.

The next thing which happened, and this has always struck me as kind of astounding, was that the Academy of Sciences' Climate Research Board (now the Board on Atmospheric Sciences and Climate) held two summer workshops in 1978 and 1979 at Woods Hole. In contrast to what one might expect to arise from an Academy group, the first and primary emphasis of the reports of those summer conferences--which subsequently formed the nucleus of the five-year plan for the National Climate Program--was on data management and service applications of what we already know. The primary emphasis was <u>not</u> on a better understanding of climate or the ability to forecast climate; they were there, of course, but they were not the points of major emphasis. I think it is most unusual for an Academy group to be so oriented as to give the primary emphasis to appropriate handling and application of existing knowledge. I think that is significant. I think it indicates the widespread recognition there is of the gap between what we do and what we could do.

So then, the five-year plan appeared and the National Climate Program was formally in action. Relatively soon it became clear that the Intergovernmental Climate Program, the applied activity, was not moving the way it should. There seemed to be a complex of reasons for this. Some reasons related to the experimental nature of the Act; this was well understood at the time the Act was written, Congressman Brown himself characterizing it as "an experiment in public administration." The first version was not ideal; the second, written a year later may not be either, but the first one certainly was not. Further, hard times had hit in the federal government, and the Office of Management and Budget saw the Intergovernmental Climate Program as something that might be a perpetual sink for money. Additionally, there were management problems in the National Climate Program Office. A host of factors came together and the program was rather stagnant, certainly not moving as much as many of us had hoped. That is when it was decided that perhaps it was time to create a panel of the Climate Board to look at what could be done to light a new fire under the service component of the National Climate Program. A panel was created with one other person now in this room as a member, namely Tom McKee of

Colorado. What we probably needed was another very severe winter with its economic repercusssions. Not being able to produce that, we surveyed the situation and finally concepetualized the document Meeting the Challenge of Climate.

The way we conceptualized it was: "Let's look at some success stories and some failures in the application of climatic information; let's see what we can learn as to what needs to be done in order to be successful, what the common threads are." So we contacted a large number of people, including many of you, and asked you to send in some of your success stories in dealing with climatological problems. We looked at failures such as the 1979 collapse of the Hood Canal Bridge, where Dick Reed[3] found that climatic information had not been appropriately utilized.

Several of the case studies we considered are recounted in Meeting the Challenge of Climate. Some common elements in the success stories become clear upon a little reflection. One common element certainly relates to the availability of data and their nature; that, however, is not our principal concern here. Another common element relates to the nature of climate services, which are in some respects quite different from the delivery of weather services. You can get a great deal of weather service out of a national meteorological center. Or you can get a great deal of weather service out of State College, Pennsylvania, over the radio even when you are in Dubuque, Iowa, and you think you are listening to somebody in Dubuque but you are really listening to somebody in State College. Meteorological services can be pretty effectively delivered in that fashion. Climatological services clearly can not. That led us to what I believe to be the single most important paragraph in Meeting the Challenge of Climate, taken from the Summary (page 1):

"Most applications of climate information are on a local or regional level, and a key role is played by experts experienced in local climate, data sources, user needs, and decision-making environments. Thus, decentralized climate services are essential to satisfy national needs, with both the public and private sectors playing important roles. Such services are best provided through a coordinated, nationwide system of federal, state, and local climate services, both public and private, that are made up of local experts, state and regional climate programs, and federal activities."

This paragraph is followed by the specific recommendation that "The National Climate Program Office should 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

[3]Reed, R.J. Destructive winds caused by an orographically induced mesocal cyclone. Bulletin of the American Metoerological Society, 1980, Volume 61, Pages 1346-1355.

regional climate programs and by encouraging the further development of such programs."

Happily the National Climate Program Office has taken this recommendation to heart and is, indeed, providing leadership in the development of a nationwide system for climate services. That is why we are here today.

I don't know how many other opportunities we may have simultaneously to improve the American economy by further application of climatic knowledge and to advance our own interests in terms of climatology. We all know the ETAC mechanism; that is, the more application there is, the more successful the applications are, the more demand there will be for services and the easier it will be to obtain the necessary support to do the research needed to improve the quality of these services. Thus we have a selfish interest, obviously, as well as the unselfish interest. There may not be many more opportunities; we clearly have one now.

I can not help but be delighted by the tenor which Alan Hecht has set for this conference. We now have some momentum and leadership. I hope we will capitalize on these and that the outcome will be a satisfying one for everybody.

Dr. JOHN V.BYRNE
REMARKS
COOPERATIVE CLIMATE SERVICES
CONFERENCE AND WORKSHOP
Florida State University
Tallahasee, Florida
March 22, 1982

Dr. Baum, Dr. Hecht, ladies and gentlemen:

It was with great pleasure that I accepted the invitation to come down here and talk with the participants in this conference. Certainly the public is paying increasing attention to climate these days. The great and often terrible weather events we have experienced in the last few years, plus the effects of volcanic eruptions, have raised many questions in people's minds -- most pointedly, is our climate in the process of major change?

And if so, which way is it going? Hotter? Colder? Wetter? Drier? I am sure that many of you have been quizzed by the press, not to mention your families and friends, with just such questions as these.

From my own standpoint as an oceanographer, I have been greatly intrigued by the increasing evidences of links between the oceans and the climate, and how each affects the other. The progress that has been made in adding to our understanding of these interrelationships is turning out to be most useful, as well as intellectually stimulating.

The ongoing events with the southern oscillation, and all the related phenomena -- El Nino, but out of season...alterations in the jet stream over North America...the consequent rainstorms in California...mild, wet weather on the east coast...changes in the ice pack in the Bering Sea, with possible effects on the King Crab fishery years hence...the huge die-off of birds on Easter Island, which was pointed to only last week by Ralph Schreiber of the Los Angeles Natural History Museum as an outgrowth of El Nino...all these apparent interrelationships are fascinating to me as a scientist, as well as being critically important to me in my role with the Federal Government.

The National Climate Program Act of 1978 addressed these kinds of concerns, and set in motion activities to help us better understand climate, and improve and make better use of the Nation's climate information resources. Specifically, Section 6 of the Act provided for intergovernmental climate programs, to consist of Federal and State cooperative activities in climate studies and advisory services.

And that, of course, is why you are here.

Writing in a NOAA publication a short time after passage of the Act, Congressman George Brown emphasized that the Act "initiates a process for evolving a workable program".

The responsibility of the Secretary of Commerce and the National Climate Program Office, he wrote, was to ensure that

Federal agencies, state and local governments, and private interests "perceive the climate program ... as a national partnership that uses the best talents and capabilities of all participants in both planning and execution."

Two years later the first National Climate Program was published, in accordance with the Act. It is worth while taking another look at the six activities that it described for the Intergovernmental Climate Program.

It was to assemble, analyze, and make available local climate data of high quality.

It was to inform sectors of the community about the importance of climatic impacts, the availability of data, and methods of analysis.

It was to assist states and local governments with climate-related issues.

It was to identify needs for research and services.

It was to focus and coordinate local and regional climate activities of various Federal agencies.

And finally, it was to exchange and guide studies of climate impacts, and demonstrate the value of climate services.

That's a tall order.

We now have several years experience with the first phase of the program, during which time it has indeed demonstrated how climate services can be provided and used. It has begun to serve its coordination functions.

This exploratory phase has also demonstrated, in my view, that the notion of a cooperative intergovernmental program was sound, and that the program has worked the way it was supposed to work.

During the initial phase, support was provided to several states, as well as to organizations in the private sector, to determine user needs for climate services and to look into, and experiment with, different ways to provide climate information and services.

Right here in Florida, the University used remotely sensed data to develop techniques for identifying "cold spots" -- areas that are cold often enough to be a problem to the citrus crop. This project is of obvious benefit, and is a good example of the creative work coming out of the program.

You will hear from Stan Changnon first thing this afternoon, and Boyd Pack a little later, so I won't belabor all the good things they have done with the regional climate centers at the Illinois State Water Survey and Cornell University. But I do want to mention these two projects in the context of the overall Federal-State program.

Illinois and Cornell undertook some activities in similar fashion, while handling other problems quite differently. They have provided highly useful services in two regions where the situations, and the needs, were quite different one from another.

The 12-state region served by the Illinois group was marked by active state climatological centers in each state. Some of the state centers are quite sophisticated, with interactive computer capability, others less so.

The purposes of the project were to improve the efficiency and effectiveness of these 12 centers, to provide a central point for communications and cooperation by Federal agencies, and to bring together the facilities and equipment needed for coordination of climate studies, advisory services, and data management activities.

The situation in the Northwest region was quite different. State climate centers didn't exist in many of the states, and the level of what we might call "climate awareness" was, in some areas, markedly less than elsewhere.

Basic tools had to be created. The Cornell group therefore put together publications of state and regional climate summaries and analyses, producing monthly publications for each state. It inventoried climate data sets, established key climate archives, and -- among other things -- surveyed users.

The survey turned up the fact that the largest fraction of users, 25% were Federal and state agencies, and the second largest, 14% were county extension agents. While these figures occasioned some surprise, it turns out that they are not far from the numbers in most areas of the country.

One of the states within the northeast region, one that did not have a state climate program, was Connecticut. Tommorrow morning Dr. David Miller will tell you how he got climate services started up in his state.

You will also hear from some states with very sophisticated statewide climate systems, such as Nebraska and Colorado.

The purpose of my mentioning these projects -- and there are many more -- is not to give the project directors their well-deserved kudos, but to emphasize the flexibility of approach and variety of projects that the intergovernmental climate program has made possible.

So the first phase of the program, as outlined in the National Climate Program published in 1980, has essentially been completed. Its purposes were to provide needed knowledge for the design of a national program, to provide models of climatological services at various levels, to identify the markets for the information, and to demonstrate that the intergovernmental process is appropriate and effective.

I think this phase has been very successful.

Now comes the next step. That is to begin a concerted effort to create a nationwide system of climate services capable of meeting our needs in the decade ahead.

The report of the National Academy of Sciences, Meeting the Challenge of Climate, put it this way:

"The National Climate Program Office should take the lead in initiating an equitable process for defining responsibilities for participation in a nationwide system of climate services on the part of local, private- and public-sector experts, state and regional climate programs, and the federal government."

This is what the Office now proposes to do, and this conference is a step in the process.

Emphasis is now shifting to supporting a smaller number of projects that will develop the framework and some components of operational climate service systems.

May I add that the inclusion of the private sector in the planning is both logical and welcome. The Academy report discussed the private sector role in providing climate service and those of us in Government should stay alert to the valuable contributions that the private sector can make. As you may know, we in NOAA are studying our own activities and programs in all areas, including weather and climate, to determine the most cost-effective ways to provide the services.

STATEMENT OF CONGRESSMAN GEORGE E. BROWN, JR.*

I was certainly honored to have been invited to speak today. I am sorry that legislative business has prevented me from attending the conference.

The subject of this conference is certainly timely and appropriate. The federal-state and public-private roles in many areas of government have been under considerable scrutiny, particularly in the last couple of years. I believe that the Climate Program can serve as a model for other government programs in which there is a leadership and coordinating role for the federal government to play, with appropriate involvement and support by state governments and the private sector.

As all of you are aware, NOAA's role in the National Weather Service and in remote sensing satellites has been the subject of great debate, and will continue to be for some time. Under the best of circumstances, complex systems developed by the government and supported by the government are difficult to "transfer." I am sure the Climate Program will benefit from such scrutiny but we need to be careful that the needs for which the program was set up are being met adequately.

The Climate program is unique in the large number of government agencies involved, the breadth of areas covered under the program, and the levels of government and private sector involvement required. I beleive the federal government has a key leadership role to play in the development and coordination of a nationwide climate service program. This is why I supported the National Climate Program in the first place. I will be interested in learning the recommendations of this conference with regard to other activities of the Climate Program Office.

Thank you again for inviting me to speak. I regret not being able to join you. Enjoy your lunch!

* Congressman Brown's message was read at the Conference

FEDERAL AGENCY ROLES IN PROVIDING CLIMATE SERVICES

Synopsis*

Two themes characterized this session: the opportunity provided by advancing technology for providing climate services at the federal and local (regional, state, and private sector) levels; and the need for two way communication between levels.

Margaret Courain (NOAA) reviewed present programs and plans for NESDIS and the Climate Analysis Center of NWS. Increasing emphasis is being placed on easy access to national data bases. CAC already allows users dial up access, and the National Climatic Data Center recently started a pilot project with a similar format. Such access is likely to expand in scope and sophistication in the next few years, implying a partnership between levels. They may require that formal agreements replace the present informal contacts. They will certainly require that local data bases become vital complements to the national archives, and that NEDRES (and its international counterpart, INFOCLIMA) be expanded and maintained as a reliable guide to data sources.

Joe Friday (NOAA) discussed plans for the cooperative climate network. The primary NWS mission is to protect lives and property. The secondary mission is to foster economic development. All observation and service programs must be justified in these mission terms. Consequently possible new programs for "non-standard" measurements, such as solar radiation, must have well articulated needs, well defined critical parameters, and a potential national benefit. However, needs can be identified and initiatives developed at the local as well as the national level. A specific example of a new initiative is ROSA, a system for the rapid collection of cooperative station data, meeting the NWS need for timely data from a network denser than that of the synoptic stations. The resulting information has many climatological applications and will be availabe to local users.

These presentations emphasized the connection between the federal government and "intermediate users" at the local level and the need for clarification of the roles of each. It was the unstated assumption that at the local level there are competent experts, such as those in the private sector or in the State Climatologist program, to provide the needed information to the final user.

Denzil Clegg (USDA) considered the information generation and dissemination system of agriculture, with emphasis on outreach to final users. The Extension Service, a federal, state, and county partnership, is highly decentralized, with county agents

* Reported by Peter Robinson, University of North Carolina

providing the main direct contact with the farming community. The increasing need for rapid information dissemination, particularly agricultural weather information, and the opportunity presented by computer technology, is forcing a reappraisal of the way the system works. Several new methods are being tested in various states, involving various mixes of federal, state and county inputs. Although the reappraisal may change the details of the system, the underpinning remains the same. The farmer's need is the prime consideration. This requires that information be generated and communicated through the various levels, that education be a continuous process, and that research be an integral part of the system. This well established system provided a ready made network of experts and an opportunity to be explored for providing climate services.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) PLAN FOR CLIMATE SERVICES IN THE 1980'S

Margaret E. Courain
Deputy Assistant Administrator
for Information Services
National Environmental Satellite, Data, and Information Service
National Oceanic and Atmospheric Administration

ABSTRACT

Major responsibility for weather and climate data and information is part of the mission as the National Oceanic and Atmospheric Administration. Three major meteorological mission areas logically follow from this responsibility: long and short range weather prediction from the National Weather Service (NWS); climate data, information and assessments from the National Environmental Satellite, Data, and Information Service (NESDIS), and new insights into the global processes that drive the entire climate system from our Office of Atmospheric Research. The National Climate Program Act of 1978 focused on climate issues and the need to more fully disseminate and use existing climate information. Our involvement in the five year plan shows our commitment to the same goals. To meet this commitment, we need a continued and expanding partnership with State Climatologists, Cooperative Weather Observers, other Federal agencies, universities, and the private sector. Exploring our nationwide capabilities together in this forum will assess our available resources to achieve one of our major goals of the 1980's: to improve regional, state, local, and Federal climate services by leading the development of distributed, cooperative automated national environmental data and information networks. Improved NOAA climate products planned for the 1980's from NESDIS are: (1) improved climate data bases through a Data Management and User Services System (DAMUS), (2) improved user access (i.e., Co-op Climate Monthly Update and Distributed Access System), (3) a National Environmental Data Referral Service (NEDRES), and (4) new indices/applications of climatology (i.e., Stress Index). From the NWS/Climate Analysis Center: (1) improved climate diagnostics, and (2) improved user access (i.e., a dial-up CAC Product Communication System).

Introduction

The timing of this meeting is excellent. From my perspective, it could not be better. One of our 1983 projects is an appraisal of the national oceanographic, geophysical and climate data and information networks as a part of our 10-year plan to take advantage of the state of technology to develop distributed, cooperative national environmental data and information networks with leadership in NOAA/NESDIS.

The computer climate is also right. Last Friday evening, I accepted an invitation to visit with friends who have their home computer system doing all manner of impressive tasks, from family finance to text processing, including a voice synthesizer. After hearing "Welcome Marjorie to your first home computer demonstration here," I settled down to an interesting display of information -- printed, charted and calculated. After we wound down, we talked about the rapid growth of interest by management people who traditionally have been unwilling to type on a terminal, but who now request their agencies and companies to buy equipment compatible with their home resources. They take their floppy disks in their attache cases and use them to work at home in the evening or on a trip.

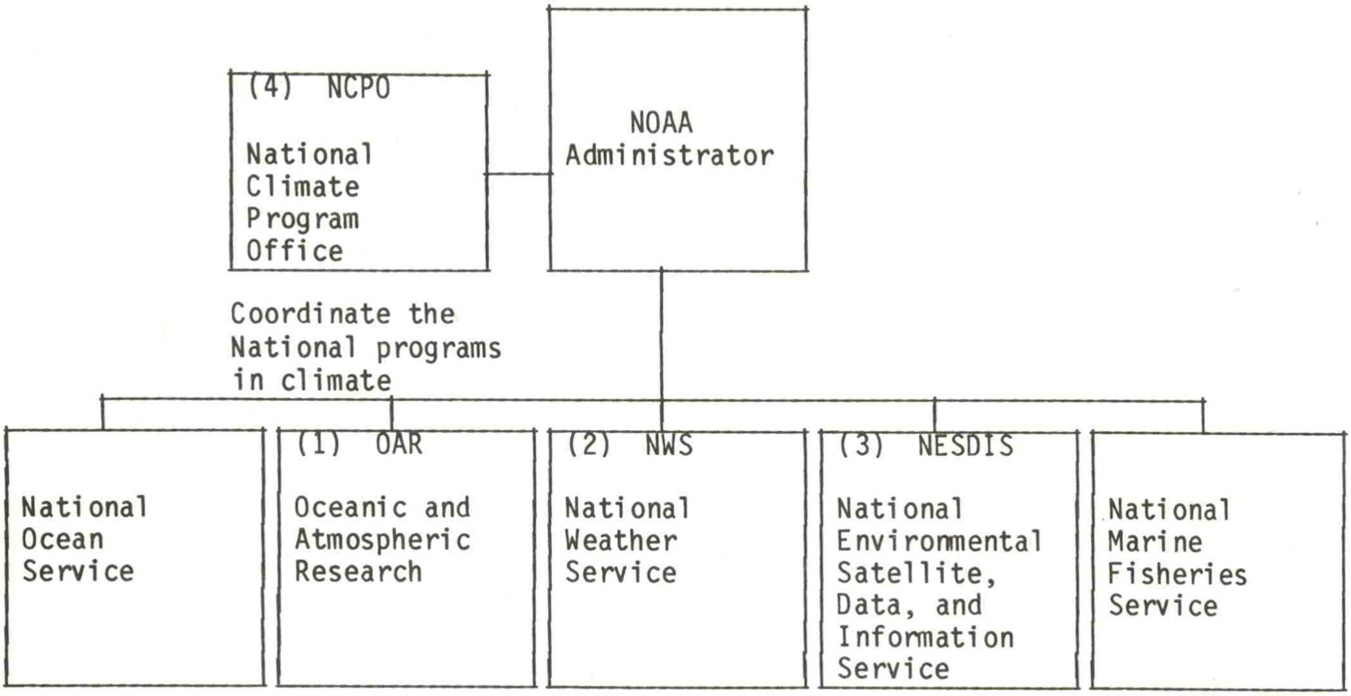
NOAA Climate Mission

NOAA's role as a Federal agency in providing climate services should be seen in the context of our mission.

Major responsibility for weather and climate data is part of our mission to effectively manage the oceanic and atmospheric resources of the United States.

Our responsibility then translates into a number of services which logically follow in the four NOAA components numbered in Figure 1 below.

Figure 1: FOUR NOAA COMPONENTS WITH CLIMATE MISSIONS AND ACTIVITIES



(1) OAR

To conduct research on causes of climate variability and change.

(2) NWS

To provide surface-based meteorological observations.

To produce short-range weather forecasts and long-range prediction.

To develop long-range weather forecasting techniques (which may contribute to climate prediction).

(3) NESDIS

To collect:
- Space-based observations

To produce:
- New applications of remotely sensed data
- Retrospective data management applications
- Short-term social and economic impacts of climatic episodes

To provide:
- Satellite data and imagery
- Climate data and information services
- Statistical applications
- Impact assessment
- Referral services

The National Climate Program Act of 1978

Passage of the National Climate Program Act in 1978 focused on climate issues and the need to more fully disseminate and use existing climate information. It provided the impetus to bring additional elements of NOAA and other agencies to participate in climate services. There since has been an increased use of NOAA resources to provide new and better services. To comply with PL 95-367, the Climate Analysis Center was formed in 1979 as a part of the National Weather Service.

NOAA Climate Services In The 1980's

Major improvements in the 1980's in the climate services of NESDIS and NWS will include:

- o Improved data management systems
- o Improved quality control techniques
- o Better climate data delivery systems
- o On-line access to data bases
- o Improved nationwide and global data exchange
- o New climate indices/applications
- o Increased use of local, state, and regional expertise in building our national networks
- o Further development of graphic communications capabilities
- o Production of the North American Climate Catalog as the first product of our NEDRES referral system

National Environmental Satellite, Data, and Information Service (NESDIS) Current Climate Services

NOAA/NESDIS has a major national responsibility for environmental data management (climatic, oceanographic, and geophysical). The December 9, 1971 NOAA policy statement says: "The Environmental Data Service has the NOAA program responsibility for the management of (1) environmental data for non-realtime application, both in NOAA itself and in the national and international user communities, once the realtime (example, forecasting) purposes for which the data are collected have been satisfied and (2) environmental science information, including its NOAA products."

Our National Climatic Data Center (NCDC), Asheville, North Carolina, (including its Satellite Data Services Division) is now the largest climatic data center in the world, processing millions of meteorological observations annually from the National Weather Service, our NESDIS Satellite Services, military services and international sources. NCDC makes data and related products available to a large and diverse user community. Over 80,000 subscribers regularly receive published data. It is the World Data Center-A and the national center in meteorology.

Our Assessment and Information Services Center (AISC), Washington, D.C., provides assistance to managers of critical national resources by assessing the impacts of climate variations on various sectors of our economy, providing periodic and special reports on climatic anomalies and developing economic climate indicators and indexes. A Consortium composed of economists and climatologists from NESDIS and the Universities of Oklahoma, Missouri, and Nebraska began work on this problem in 1979.

The goal of this effort is to quantify the economic impact of climate variations. Three economic sectors with known sensitivity to weather and climate were selected for the initial effort -- food production, energy use, and water management. Indexes which specify climatic impact on each of these sectors are being developed. These indexes will improve current economic models by explicitly incorporating accurate climate information.

NESDIS Improvements

(1) Improved climate data bases through a Data Management and User Services System (DAMUS) began in 1978. Figure 2 shows the structures of our consolidated, computer-stored data base of atmospheric, marine, solid earth, and solar observations which constitute a major national resource providing retrospective data for all types of users.

A major upgrade to the DAMUS Computer Facility is scheduled for completion in December 1983. This will enable NESDIS to provide users with improved, quality-assured data and information products and services and better access to the multidisciplinary environmental data base.

(2) Improved user access. The National Climatic Data Center (NCDC) has developed a Co-op Climate Monthly Update service for the State Climatologists whereby they are able to dial into a VAX 11/780 at NCDC and selectively obtain climatological data records for their use. This service will expedite the accessibility of this information for the selected data onto storage media, rather than having to enter the values from manuscripts. The data are available from four different climatic data files: (1) the Summary of the Day data, (2) the PRELIM data, (3) the Climatological Monthly data, and (4) the Local Climatological Data.

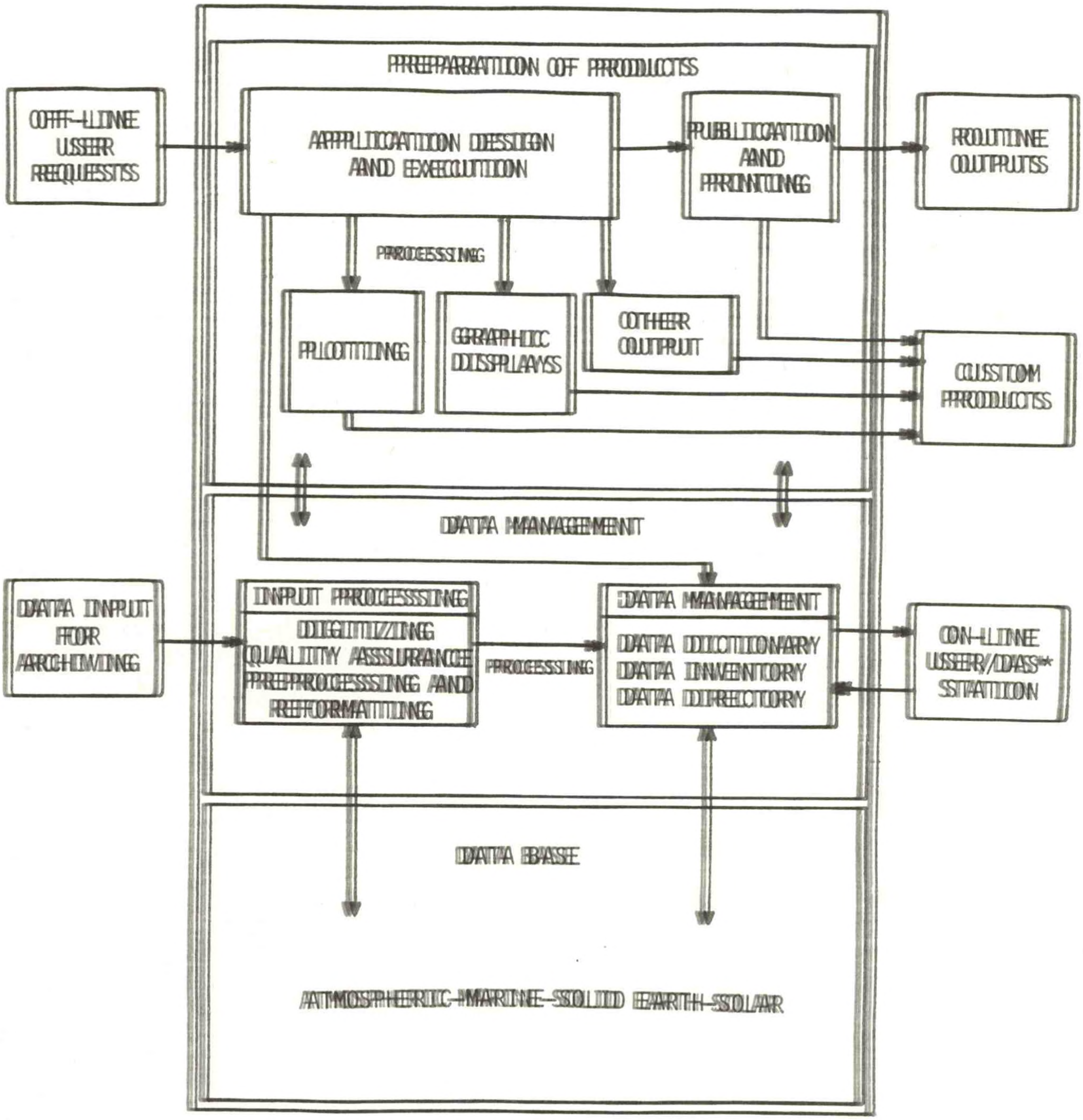
The Distributed Access System developed in our National Oceanographic Data Center was demonstrated last year and is being expanded this year. Using an Apple Computer, it requests data from the DAMUS host computer, receives the subset overnight and can utilize it, and display it, off-line. This is a prototype program to provide cheap user access to the data base by personal computer on a delayed basis during off-peak hours. See Figure 3 below.

(3) The National Environmental Data Referral Service (NEDRES) is being developed by NESDIS to locate and describe existing environmental data files maintained by Federal, state and local agencies; academic institutions; and the

Figure 2

NESDIS DATA MANAGEMENT and USER SERVICES SYSTEM

(DAMUS)

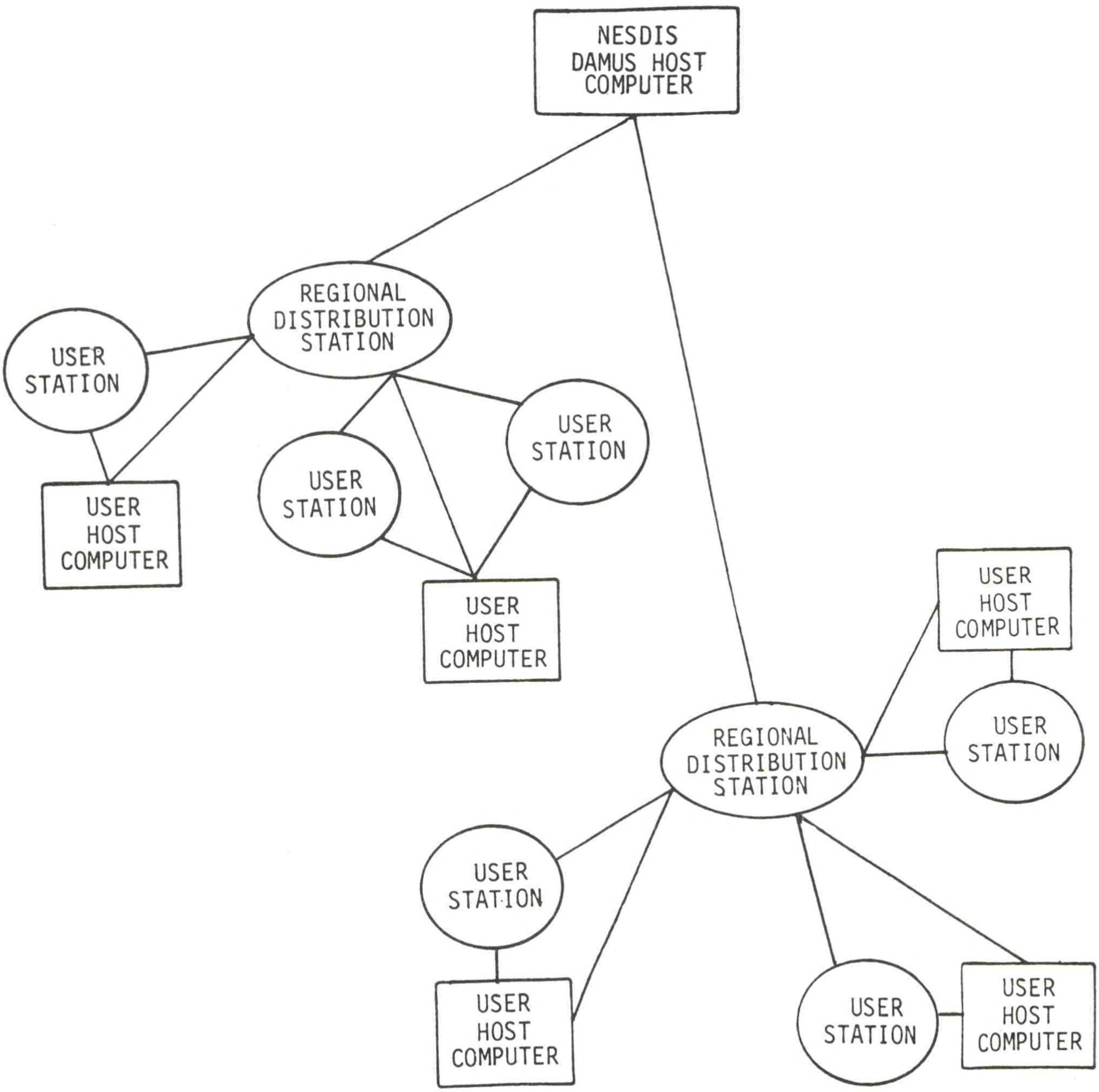


*SEE FIGURE 3

Figure 3

NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE

DAMUS DISTRIBUTED ACCESS SYSTEM CONCEPT (DAS)



private sector. Atmospheric, oceanic, and geophysical data are needed for application in energy, agriculture, housing, transportation, and natural resource management. Because the data produced by satellites, ships, weather stations, and even observers with backyard thermometers is accumulating at an unprecedented rate, finding the data can be costly, time-consuming, and frustrating.

The first priority of NEDRES has been to implement the National Climate Program Act requirement for active dissemination of existing climatological data. For the past six months numerous Federal, State, and local government and non-government organizations have been contributing climatological record descriptions. Gaining the cooperation of these data-holding organizations is a job that will require years of effort. Anyone representing any organization presently collecting data who would be interested in cooperating with NEDRES would be welcome to join us. We have taken the records and formulated a computer-searchable database which will be accessible to the public in October of this year. The first section of the North American Climate Catalog will be produced from the NEDRES database by January 1984. Yearly updates are planned as new datafile descriptions are added to the collection.

(4) NESDIS now is publishing a new "Weather Stress Index" (see Figure 4). This is based not only on high and low temperatures and wind velocity, but on where you live and what you're used to. For example, a humid, 92-degree day in Duluth this summer would very likely bring more grief to that northern Minnesota city than a comparable day in New Orleans. Conversely, a stiff wind on a 25-degree day in Houston produces more misery for Houstonians than the same wind and temperature combination in Bangor, Maine. This latest measurement of weather discomfort, or "misery" index, was developed by NESDIS/AISC scientists and Laurence S. Kalkstein, of the Center for Climatic Research at the University of Delaware, working under a NOAA research contract. The purpose of the contract is to assess the impact of weather and climate on a variety of human-related activities.

We now are talking to the Centers for Disease Control in Atlanta to evaluate death rates from heat-stroke. Also, the Bureau of Labor Statistics is interested in studying absenteeism in the construction industry during periods of severe weather.

National Weather Service Climate Services

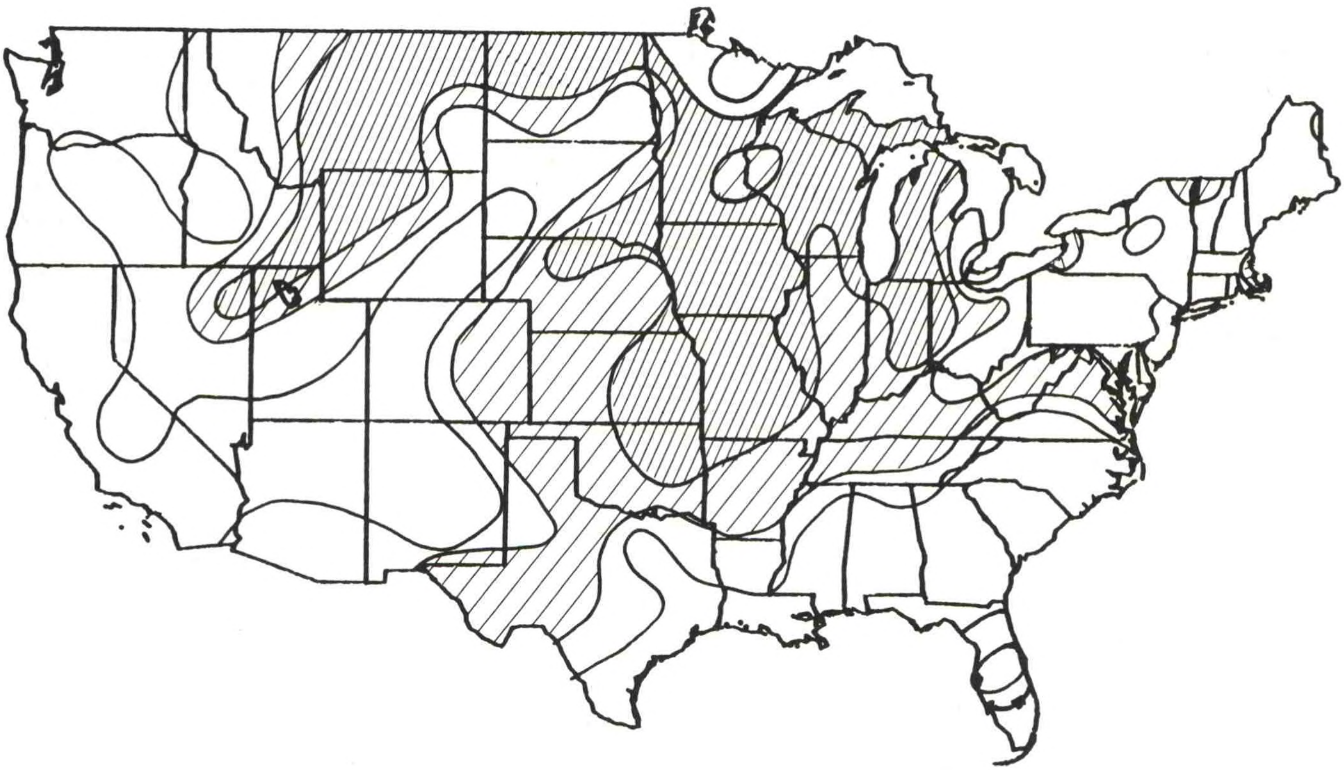
Data Acquisition The National Weather Service operates the national data acquisition and dissemination facilities for recent climatological data. The data from national and global networks and space based platforms are obtained over telecommunication systems, quality controlled and organized into files for user access. The surface meteorological data files are supplemented by a wide variety of related data such as marine meteorological and oceanographic observations, ice and snow cover, radiation budget and atmospheric general circulation data. A major new effort is underway to develop a national high density precipitation data base in real time by automating a complex of cooperative and hydrological networks.

Figure 4

AISC WEATHER STRESS INDEX

A Measure of Human Discomfort Relative to Local Climte

Current Week: July 27 – August 2, 1983



Index Values	Degree of Stress
0% - 74%	None
75% - 89%	Moderate
90% - 99%	Severe
99%	Extreme

Analysis and Information The national and global surface data are organized into a Climate Assessment Data Base. These data are routinely disseminated to users both in NOAA (e.g. NESDIS/AISC) and to other government agencies and other users. A program of current climate monitoring is undertaken through the NWS/Climate Analysis Center. The objective of the monitoring is to identify and monitor the development of climate anomalies. Special indices and analyses are generated and disseminated (e.g. Palmer Drought Index, Heat Wave Index, Crop Moisture Index, Heating/Cooling Degree Days, etc.). These specialized indices are tailored to applications in the agriculture, energy and water resources sector.

Prediction The NWS/Climate Analysis Center produces monthly and seasonal outlooks for the United States. The Outlooks are cast in a probability format and are available by subscription to the Monthly and Seasonal Weather Outlook publication. A research and development program is underway to improve the prediction capability.

NWS Improvements

Climate Diagnostics A research program designed to improve our understanding of the global climate system is a major objective of NWS. A current topic is the El Nino phenomena and its relation to global climate variations. The climate diagnostics studies utilize the CAC's Climate Diagnostics Data Base, a unique data file which includes global meteorological, oceanographic, and satellite derived data fields.

CAC Product Communication System The NWS/CAC has implemented a microcomputer dial-up facility to facilitate CAC data and product dissemination to users. Figure 5 illustrates schematically the system and its products. The purpose of the system is to provide access for any user to the current climate data products of the NWS/CAC.

Concluding Remarks

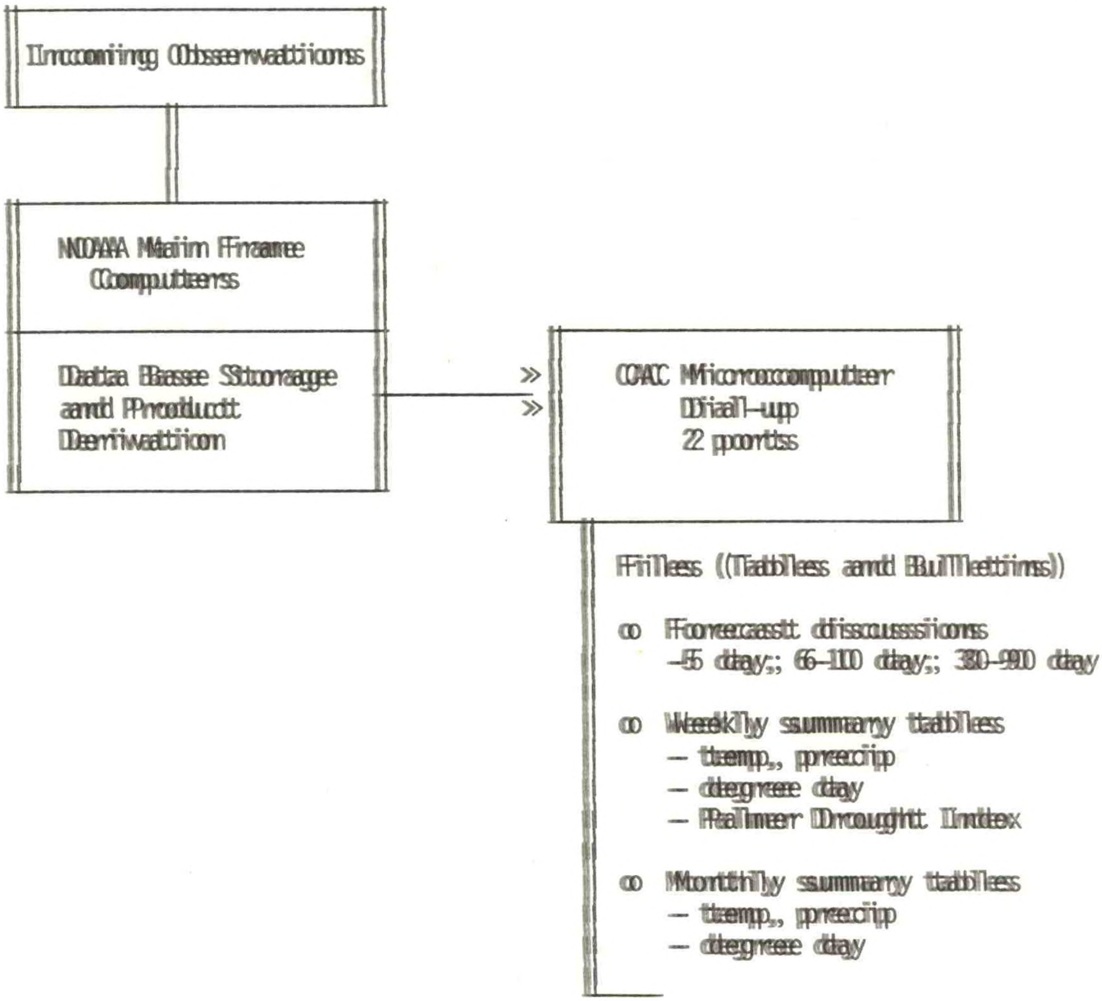
We have always supported the concept of partnerships as a way to provide more and improved climate services needed by the nation and the world.

EDIS was and NESDIS is a major advocate and supporter of the development of a state-funded State Climatologist Program. As of March, 1983, there are 47 states with active programs and negotiations are underway with the remaining states. The program is designed to expand NOAA's climatic data/information service capability to users at a local level.

In 1982, in my work on strategic and operational plans for our Climate Services Program, we sought the advice and discussion of some issues with Stan Changnon and his staff for insight into the value and workings of a regionalized climate service.

We also called upon Fred Nurnberger, President of AASC, to represent the climate services needs of the states of State Climatologists and for a reading

Figure 5: CAC Product Communications System



on the level of their computer resources nationwide. Fred will present the results of his survey in his paper, "Status of State Climate Programs."

The only way we can recognize the full potential of the existing systems and those developing with the technological improvements of the 1980's is to explore our nationwide capabilities together in workshops such as this one and escalate our continued cooperation. I look forward to listening to the other speakers as we fill in together the total picture of resources that can be brought to bear on the Nationwide Climate Data & Information network.

PLANS FOR THE COOPERATIVE CLIMATE NETWORK

Elbert W. Friday, Jr.
Deputy Director, National Weather Service

Real-time synoptic and aviation observations provide the backbone of the meteorological observations necessary for the general weather forecasting across the country. The density of such observations, however, is insufficient to provide all the data for agricultural, energy, hydrological, and climatological needs of this country. The National Weather Service (NWS) cooperative observer program is designed to overcome the data shortage.

The objective of the cooperative network is to provide temperature, precipitation, evaporation, and river stage data for climatic, hydrologic, agricultural, and local service programs.

The distinctive feature of this program is that observations are taken by lay persons who perform this service for little or no pay.

Use of the information is for basic data and/or reporting purposes. The data usually are provided through published records and are used in climatic studies, hydrologic design, and other planning.

Reports serve operational purposes and are transmitted in accordance with specific criteria to meet the needs of hydrologic forecasting, agricultural advisories, hurricane and severe storm warnings, control of hydrologic structures, crop summaries, etc.

Special cooperative projects are operated for other agencies to meet their particular needs when these are beyond those normally provided by NWS. A total of 51 cooperative network specialists, supported by reimbursable, state, and NWS funds, inspect and maintain a network of 11,590 substations.

The following table enumerates the types of cooperative stations within the network.

Table 1

FUNCTION	NUMBER
Temperature and precipitation	5,892
Precipitation only - daily	3,218
Precipitation only - storage	36
Hourly precipitation stations (Recording precipitation gages)	
Sponsored by NWS	2,943
Other government agencies	127
Associate stations	134
Substations equipped with both recording and nonrecording precipitation gages	1,930
Crop reporting stations	512
River and/or rainfall reporting stations	
River stage reports only	970
Rainfall reports only	3,497
River stage and rainfall reports	1025
Evaporation stations	434
Reference Climatological Stations	21
Automated Hydrologic Observing System (AHOS)	
AHOS/T (telephone)	447
AHOS/S (satellite)	61
Special reporting stations	213

(Table 1 continued)

FUNCTION	NUMBER
Substation data published	
Temperature and precipitation	8,374
Precipitation only	3,106
Evaporation	427
Soil temperature	277
Miscellaneous (snow density, special meteorological, etc.)	388

NWS is exploring ways of improving the cooperative observer program. The major improvement in the operational availability of the cooperative program data is taking place in the NWS Central Region under a project known as ROSA (Remote Observation System Automation).

Present collection, collation, and dissemination by NWS of these remote observations is overwhelmingly manual and subject to constricted pipelines and higher priority duties, especially under significant weather. Busy phones and busy people lead to unacceptable data losses, transcription errors, and frustrated cooperative observers.

An example of the present data flow at WSFO Minneapolis, Minnesota, is as follows:

1. 6AM Local (daily):
   20 outward calls to telemarks. Log data, format, transmit on AFOS, RAWARC.

   Time: 30-45 minutes

2. 7AM - 9AM Local (daily):
   25 - 40 hydrological observations called in via WATS and toll calls. Log, format, transmit on AFOS, RAWARC.

   Time: 25-40 minutes

3. 8AM (daily):
   Corps of Engineers calls with lock and dam readings for upper Mississippi and selected temperatures. Log, format, transmit on AFOS, RAWARC.

   Time: 15-25 minutes

4. 9AM (daily):
   Outward call to Central Wisconsin for data. Log, format, transmit.

   Time: 10-15 minutes

5. 9:30AM (daily):
   Second Corps of Engineers report.

   Time: 15 minutes

6. 10-11AM (Tuesday):
   Snow depth data incoming via WATS and toll. 20-40 observations. Collect, format, and transmit.

   Time: 30-50 minutes

7. 12 Noon (Sunday):
   Agricultural data. Incoming from 24-30 agricultural stations. Daily reports for the week. Collect and compute weekly averages for Monday Crop Bulletin.

   Time: 150 minutes

8. Six times daily:
   Contract A synoptic observation (BJI). Collect, type and transmit observations to WMSC.

NOTE: This work is usually performed by the radar operator, who is supposed to be maintaining "continuous surveillance" at a network radar.

ROSA is designed to streamline our data collection routine and provide better data quicker. A brief rundown will explain my optimism. Cooperative observers will enter their data on a specially designed pad, off line. They will be able to review their entries on an LCD display before storage in the pad. They can review the entire message by bringing it out of storage.

We propose the establishment of four locations in the central Region as data collection points. At each of these locations, there would be three inward WATS lines, in rotary. Hydrological, Substation, Agricultural, Contract A, and other data would flow into these locations using the WATS lines.

Figure 1 shows one possible configuration. The load at each place is about one-quarter of the regional load. In the event of problems at one location, ample back-up capability exists at the others for outage and busy lines. The configuration is designed such that data from meteorological events of importance flow in to different locations, i.e., adjacent states report to different locations.

Advantage is also taken of differing time zones, where possible. Full back-up capability is now in place and reporting schedules can be arranged such that overload is avoided. Table 2 summarizes things. Coded data of all kinds would be phoned into a suitable computer at each location, using touch-tone pads for data entry.

FIGURE 1

COLLECTION STRATEGIES

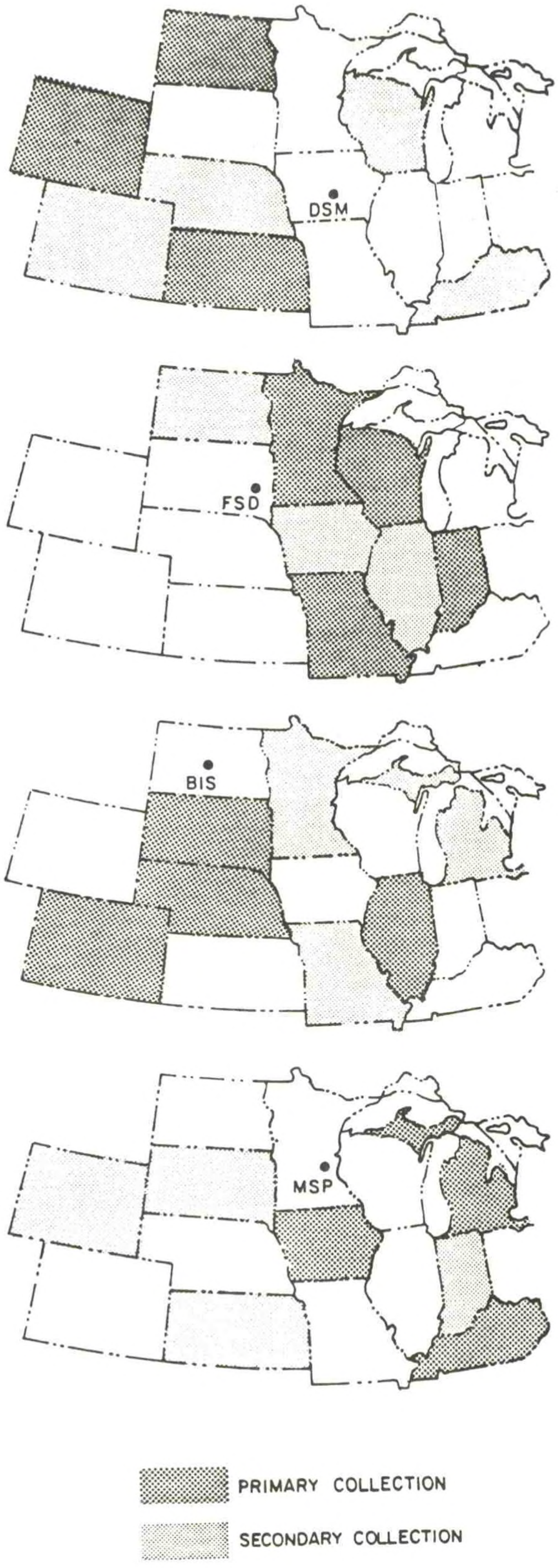


Table 2. Rosa Collection Strategy

Primary Collection - Dial-in Locations

Collection Point	States in Program	Number of Observers	Time Zone
Des Moines	WY	31	MST
	ND	162	CST-MST
	KS	375	CST-MST
		total 568	
Minneapolis	IA	286	CST
	KY	149	EST-CST
	MI	145	EST
		total 580	
Bismarck	NE	269	CST-MST
	SD	65	CST-MST
	IL	176	CST
	CO	116	MST
		total 626	
Sioux Falls	MN	128	CST
	WI	72	CST
	MO	234	EST
	IN	118	EST-CST
		total 552	

Back-up and Secondary Collection - Dial-in Locations

Collection Point	States in Program	Number of Observers	Time Zone
Des Moines	WI	72	CST
	KY	149	EST-CST
	CO	116	MST
	NE	269	CST-MST
		total 606	
Minneapolis	WY	31	MST
	SD	65	CST-MST
	KS	375	CST-MST
	IN	118	EST-CST
		total 589	
Bismarck	MN	128	CST
	MI	145	EST
	MO	234	CST
		total 507	
Sioux Falls	ND	162	CST-MST
	IA	286	CST
	IL	176	CST
		total 624	

Theoretical Dial-in Maximum Load

	DSM	MSP	BIS	FSD
Primary Load	568	580	626	552
Back-up Secondary Load	606	589	507	624
	1174	1169	1133	1176

We have simplified the codes as well. For example, magnitude errors will be reduced by the introduction of a decimal point in the observer's code. Negative temperatures will be entered with a minus sign. A temperature of 104.7° enters exactly that way -- no transposition, no dropping digits, etc.

The observers will dial the ROSA computer using toll free lines. Three lines in rotary at the computer end and a fast CPU assures quick access to the computer. When the computer signals an "OK tone," the observer will hit the send button and serial data will flow. The on-line process will take about 8 seconds. After receipt, the ROSA computer will collate the data under State headers and pass it through to AFOS. Once on AFOS, the data will appear at WSFO Indianapolis and pass to the S/140 computer at Lafayette.

The ROSA system will start collecting data later this year. Observers will be phased into the system through 1984 until 1550-2000 reporting locations in the 14-State Central Region are ROSA-ized. The first States to be completed around this time next year will likely be Missouri, Illinois, Minnesota, and Kansas.

Of particular interest to climatologists is the establishment, under ROSA, of a skeleton daily reporting network. NWS Central Region will be coordinating preferred locations with the RCCO in Illinois in the coming months.

DISSEMINATING WEATHER AND CLIMATE INFORMATION TO FARMERS AND RANCHERS

By
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INTRODUCTION

People who work in the areas of weather and climate every day are well aware of the potential benefits of these types of information to American agriculture. This awareness makes those of you here a distinguished, and a very limited group. As you probably know, this subject is not generally understood in Washington or many of the States, which probably indicates that you and we in Washington have a big job to do.

I believe this situation is a direct result of our failure to provide the correct educational atmosphere. In short, the subject has not been properly explained to those who make or influence decisions about where available resources are to go. Getting this information to those persons is a task we must complete. We have a difficult job ahead of us.

Generally speaking, those persons who received their training in agriculture have had limited exposure to weather and climate information or how it can be applied to production decisions. On the other hand, most meteorologists have little understanding about commercial agriculture. As a result we have people in two highly technical specialties that still need to communicate with each other.

NEEDS AND BENEFITS

Weather controls the development of almost everything in the biological sphere that encompasses production agriculture -- development of crops, weeds, insects, diseases -- in addition to the energy needs for many practices, irrigation water needs, and management of livestock. Therefore, when weather information is used to predict biological activity it is possible to make decisions that can improve production efficiency, or save the producer from certain losses. Such improvements can be translated into profits for the farmer or rancher.

When one looks at the potential applications of weather and climate information in commerical agriculture it is hard to understand why their adoption has not moved ahead more rapidly. The potential cost-benefit ratio is impressive -- even if we use today's technology. Just think if the research community gave these matters some more attention.

Researchers estimate that using local weather information in Extension's ongoing Integrated Pest Management programs can result in a reduction of pesticide needs of about 20 percent. This is a saving to producers' pesticide bills of more than a billion dollars each year.

Likewise, scientists of USDA's Agricultural Research Service have found that as much as one-fourth of the herbicides applied each year are ineffective because of poor timing with respect to weather and soil moisture conditions. In this area potential annual savings up to $2.5 billion are possible.

Irrigation work within one of our Land Grant Universities has produced some dramatic information. Using local weather information to drive models for irrigation scheduling can reduce irrigation water needs by about a third with accompanying reductions in pumping costs. That translates into $42 million annually in just that one state.

We in Washington get many requests for climatological information from people who are considering moving into new areas with hopes of beginning an agricultural business. A short time ago, interest was high in grapes for wine making. What kind of weather could be expectd in a certain county? How cold did it get in a "normal" winter? How often would they be faced with extremely cold weather that might kill the plants? Careful analysis of climatological data and comparison with crop requirements could save the prospective producer many problems.

RESEARCH

Weather and climate-based agricultural research can provide the building blocks with which Extension programs with farmers and ranchers are developed. The much needed knowledge developed within the State Experiment Stations, USDA's Agricultural Research Service, and the laboratories of the private sector, give us in Extension the information we need for our educational programs.

Scientists at a workshop pointed out that interdisciplinary research involving meteorologists and agricultural specialists will be required to make advances. Thus the scientific community appears to be in broad agreement on the main physical and biological factors controlling improvements in agricultural production. What is needed is a systematic, interdisciplinary approach toward overcoming limiting factors.

Agricultural producers are the ultimate adoptors of scientific products and techniques. They must integrate all the various factors into production systems for their individual operations. Research and Extension working together must hasten the process and reduce costs by taking the guesswork out of farming operations that are highly weather dependent.

EDUCATION

Often, when we speak of education, we speak about our efforts with agricultural producers. But, an effective weather-climate educational program must include some of the other decision-makers.

Among the decision makers that must be made fully aware of the benefits of such a program are government leaders in Washington. These are the people who decide where available funds and manpower will be placed. Because applying weather and climate information to the decision-making process in production agriculture is rather new, we must provide them with the tools they need before they can decide to support these efforts.

The next category that needs to be informed are the leaders within our Land-Grant system who face the same problems of conducting programs within the limits of available resources. They require a full understanding of the potential benefits of this work to their clientele. Only after they have this understanding will they positively influence the decision-making process effecting programs of instruction, research, and Extension.

The leaders in the private sector — farm equipment manufacturers, suppliers, bankers, and the others who interface with producers of agricultural products — must be given a full understanding of the benefits of weather and climate information. With understanding they will support you.

The political sphere in which we must all operate is a prime candidate for a comprehensive educational program. These leaders in all levels of government are doing their best to fully represent the wishes and needs of their constituents, but sometimes they do not have the information they need to carry out their responsibilities. Collectively, they are probably one of the most important links in the overall decision-making chain.

Last, and certainly the most important, is our ultimate audience — the American farmer and rancher — the one who has been providing us with an adequate supply of food, feed, fiber, and forest products. These producers will accept new technology that will reduce costs and risks. But, they must first learn about it and learn how to apply it to their own operations. We must use all available means to provide them with the necessary tools.

DELIVERY

Knowledge and information have little value until they are transferred to the user and applied by them. Much of this transfer over the past years was made through face-to-face work with individuals. Increased demand for such services has brought about new delivery methods utilizing what is often referred to as "high technology."

Time-share computer systems that had their beginning in the 1960s were the first applications of computer-based systems to deliver information. Within agriculture this technology gave the County Extension Agent ready access to a great volume of information available on a distant university campus. Among the best known of these is the AGNET system operated out of Nebraska. There are several others in operation in other states.

Videotex, a new arrival on the U.S. computer scene, is a government developed concept that was first tested in Kentucky and was generally known as the Green Thumb Project. This concept was developed expressly for getting weather and climate information directly to farmers. It get its information over standard telephone lines and displays it on the home television receiver. Phase II equipment, which industry developed based upon knowledge gained in Kentucky, is now available on the open market and is finding acceptance in the private sector. This concept uses batch dump techniques with short connect times that greatly reduce costs for both the users and providers of information. The first Extension system, ESTEL, is getting on line in Maryland.

Satellite technology promises to be a cost-effective method of transferring information between various segments of Extension. Other advances in technology will probably introduce new methods of getting the job done in future years.

Radio, television, voice telephone, and the printed media have been important media for getting Extension 's information to its clientele. These media will continue to be used for dissemination of information that does not require speed, graphics, availability on demand, and retention for more intensive study.

HOW TO DO IT

Although we have considerable knowledge upon which to base an Extension Agricultural Weather and Climate Program for producers, the long run success will depend upon a constant stream of research-based information that can be incorporated into this effort. We are counting on the research community -- federal, state, and private -- to provide the basis for up-to-date information for farmers and ranchers.

Experience shows that rural weather programs requires ready access to observations from the areas in which the crops are grown. We already have such networks operating in twelve states where volunteer observers are entering their data by Touch-Tone telephone directly into a central computer. These data are then instantly available to National Weather Service forecasters and to cooperating State Extension Services where they can be used to improve the climatological map and also provide inputs to predictive biological models. New technology promises to do this job faster and at even lower cost. The traditional mail collection of such information is just too slow for today's needs.

Our experience in North Carolina clearly demonstrates the need for an Extension Agricultural Weather and Climate office at each Land Grant University. The needs of agriculture show that we must consider weather and climate a continuum of information -- climatology to real-time weather to forecasts to climatological outlooks. This team effort can support both the Extension program for producers and the research community.

This team in each state would work closely with the agricultural subject matter specialists to help them make weather and climate information an integral part of both agricultural research and Extension programs with growers. Together, with full understanding of local conditions and needs they could provide meaningful, weather-based agricultural recommendations to farmers and ranchers.

As a representative of the Office of Management and Budget once said, "If this information is so badly needed by farmers, how are you going to get it to them when they need it?" The videotex concept was developed to meet these needs at a price farmers and ranchers could afford. Interest in this concept is growing, particularly in the private sector.

This brings us back to the beginning -- education. None of this information is going to be widely applied within the agricultural community without a comprehensive educational program. Those of you who are familiar with the subject will have to provide the leadership for the educational effort that must reach all segments of the society influencing agriculture -- from the decision-makers in Washington through all levels of the system including the farmers and ranchers who will apply it.

CONCLUSIONS

Within USDA, both Extension and research are deeply interested in providing the necessary weather and climate information for agriculture and others in the rural areas. We believe this information is necessary for helping farmers increase production efficiency and reduce production costs.

At this time complete weather and climate programs are not operational in any area of the country, but some States are doing a fine job on various parts of the overall program within the limits of resources available. But, considerable improvement is necessary.

To accomplish these goals we must continue our partnership with all branches of the federal government, the states, and the private sector. No one part of this team can do the job alone, but working together we can provide American agriculture with a service that is unmatched anywhere in the world.

PROVIDING CLIMATE SERVICES

Synopsis*

The speakers represented a cross section of public and commercial organizations that provide or sell climate information and services.

Stanley Changnon (Illinois State Water Survey and University of Illinois) summarized findings of a survey and workshop on agricultural uses of climate information. Some major uses are to plan farm and business operations, as input to crop yield models run by grain traders, and to monitor current season climate; but there also are impediments to the use of climate information:

- o Unsuitable delivery system.
- o Perceived complexity of using climate data.
- o No interest by prospective user, perhaps due to lack of credibility of the data.
- o Lack of information about data availability or data are not available in a useable form.

Richard Felch (Central Data Corporation) addressed private sector involvement in providing climate services and some of the problems that must be overcome. The respective responsibilities of the public and private sectors need to be defined more clearly. Obstacles faced by the private sector are:

- o Limited opportunity to help plan climate services.
- o Potential competition with the public sector.
- o Difficulty of producing marketable information due to poor or late access to critical data.

Successful involvement of the private sector requires that firms identify and develop tailored products, educate users about the value of climate information, and provide and sell climate services at reasonable cost.

Paul Janota (Environmental Research and Technology, Inc.,) addressed pragmatic aspects of providing climate services by the private sector.

- o Opportunties and investment required by small firms to produce climate services in competition with large firms.
- o Expected return on investment to develop climate products and markets.
- o Customer expectations for commercial climate services.
- o Potential liabilities assumed for climate services based on probabilities.
- o Protecting proprietary interests in climate data and products.

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*Reported by Richard E. Felch, Control Data Corporation

Ralph Neild (University of Nebraska - Lincoln) reported on a Nebraska extension activity, the Nebraska Agriculture Climate Situation Committee, that meets weekly during the growing season to analyze current weather and crop information and recommend appropriate action by farmers. The information is distributed on the same day to the media, and to county agents via electronic mail.

Rolland Hauser (California State University - Chico) discussed the NOWCAST system, a not-for-profit corporation developed at California State University which provides specialized weather and climate information to subscribers. Primary products are wind velocity and ventilation forecasts for controlled burning, and agricultural weather information and short term climate forecasts. Some large growers purchase site specific forecasts. New products are being developed to support irrigation and pest management.

Currently there are 116 subscribers with 88000 acres enrolled. The potential for expansion is great, probably to as many as 40 districts, each serving 100-500 subscribers. Fees charged to agricultural subscribers are 20¢ per acre per year with a minimum charge of $75 per year.

James Duncan (Florida Fruit and Vegetable Association) discussed needs of Florida growers for weather and climate information. Florida agriculture has been a stong supporter of activities in weather and climate will continue to be in the future. Mr. Duncan pointed out that there is a need to integrate weather and climate data with other information about agriculture and resources to produce an overall picture of the impact of weather and climate events.

In summary:

- The use of climate services is growing but the profitability of commercial climate services is still to be determined.
- New technologies for collecting, analyzing, and disseminating of climate information will help stimulate demand for climate information in near real-time, that is easily accessible and understood.
- Education programs are needed to help users overcome real and perceived problems in using climate services.
- An effective climate service does not have to be complex to be of value.
- There is growing support for national and regional programs in climate. The private sector is prepared to participate in such programs, but it also needs to be able to participate in planning the programs.

PRESENT AND POTENTIAL AGRICULTURAL USES OF CLIMATE INFORMATION: A STUDY OF AGRIBUSINESS USERS

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Illinois State Water Survey

INTRODUCTION

One of the more striking science policy developments of the past decade has been the formulation of large, ambitious, multifaceted "climate programs" at both the national and international levels. The U.S. National Climate Program (USNCP), for instance, was established by an Act of Congress (September 1978, PL 95-367) to "assist the Nation and the world to understand and respond to natural and man-induced climate processes and their implications" (Section 3), following legislative deliberations during 1975-78. It has three components (NOAA, 1980).

A Climate Impact Assessment effort is seeking to identify "procedures to evaluate climate's effects on society, the economy, and the environment in order to develop responses and strategies for dealing with climate fluctuations" (NOAA, 1980, p. E-4).

Climate System Research will attempt to increase the knowledge of global and regional climate and its variation by means of a range of empirical studies and analyses of the climate record, the development of climate simulation and prediction models, and the investigation of climate system processes (e.g., solar and terrestrial radiation, ocean heat storage and transport).

The *Data, Information, and Services* component is designed to provide accurate and timely data and information products, and be responsive to Government and private sector needs.

The relatively sudden emergence of climate programs from the situation in the late 1950's and 1960's where there was little interest in climate, its vagaries, or their effects, has been in response to both 1) the climate system providing an abundance of striking weather extremes and climatic fluctuations during the last 15 years, 2) and to the wide publicity given to the adverse socioeconomic effects of those episodes by the ever-increasing capabilities of the news media. In particular, the Sahel drought and consequent famine of the early 1970's force governmental and scientific communities, on an international level, to recognize that climate does vary on short time-scales and that such variations can have disastrous human consequences.

This new awareness has been increasingly reinforced as the 1970's and 1980's have progressed by other pronounced climatic fluctuations and their adverse impacts:

- the 1976 heatwave, drought, and water shortages in Western Europe;
- pronounced extremes in Indian monsoon rainfall and their associated flooding and famine;

- four recent very severe U.S. winters, including one whose excessive snowfall crippled the Chicago transportation system for many weeks;
- recurrent poor growing seasons in the Soviet Union;
- the 1980 central U.S. heatwave and drought that greatly reduced crop production.

For the U.S., the appreciation of climate's central role in human affairs was hastened by the serious economic repercussions of the 1972-73 and 1975 grain sales to the Soviet Union that were occasioned by that nation's aforementioned climate-induced crop failures.

The developing climate program has been conceived and designed to broadly benefit mankind by reducing the adverse socioeconomic consequences of climatic variability, rather than to foster narrow basic research. This is why they are dominated by the climate impact assessment, data acquisition and applications, and the provision of information and services. The climate system research included would very probably have been supported and pursued, for reasons of scientific curiosity, without the creation of the climate program. In fact, the existence of the elaborate, ambitious, and expensive climate program is based on the assumption that a substantial reduction of the unfavorable effects of climatic variability is attainable. Whether this is the case has never really been demonstrated, as is clearly acknowledged by the twin program objectives for the USNCP Climate Impact Assessment effort that were quoted above. There is no doubt that the second of these goals (the development of "responses and strategies for dealing with climatic fluctuations") will be much more difficult to achieve than its necessary forerunner (the identification of "procedures to evaluate climate's effects on society, the economy, and the environment").

We believe that the management strategies necessary to substantially reduce the unfavorable socioeconomic consequences of climatic variation are presently largely unknown. If this is correct, the climate program constitutes something of a risk. However, we believe that this risk is justified, and indeed that the emergence of the climate programs from the public interest generated by the recent climate vagaries and their impacts is a desirable development that offers considerable potential and challenge for both atmospheric and social scientists. Conversely an inadequate response to this situation will be to the considerable detriment of the atmospheric sciences' reputation among the wider scientific and governmental communities for its ability to "deliver." The fact that early optimism relating to weather modification and numerical weather prediction has so far not been anywhere near matched by actual achievement underlines the atmospheric sciences' need for the climate program to be at least modestly successful. In contrast, since social scientists did not initiate the climate programs, they presumably have little to lose (and much to gain) from their participation.

THE U.S. PRIVATE AGRICULTURAL SECTOR: BACKGROUND AND PRESENT INVESTIGATION

One of the better starting points for the investigation of the extent to which the adverse socioeconomic consequences of climatic variability could be reduced is the consideration of the world's most productive agricultural system - that of the U.S., and particularly its midwestern heart. This overwhelmingly private enterprise endeavor (save some Federal price-support and acreagerestriction programs) is endowed with highly fertile soil, generally abundant moisture, the finest available scientific and technological support in the fields of plant breeding, chemical development, pest management, and machinery design, and educated operators who function within the motivating (or perish!) environment of the "farm firm."

If the present level of use of climate data and information by this highly developed sector could be clearly established, and the benefits ascertained, this knowledge would provide incentives and guidelines for the adoption or increased utilization of such practices by less developed agricultural systems. In addition, the aforementioned attributes of the U.S. private agricultural sector suggest that it may possess the considerable structural and human flexibility that is necessary to provide an agricultural demonstration of the ultimate potential for improved management strategies to reduce the unfavorable socioeconomic effects of climatic variation.

It is therefore very surprising that this sector has been rather neglected in the development of the NCP. Several meetings in the past two years failed to obtain private agricultural representation. The agricultural perspectives/positions/interests at these gatherings were instead taken care of solely by government (Federal and State) and academic economists and scientists.

The research reported here was conceived as an attempt to commence the very necessary addressing of the agribusiness sector. It has four objectives:

(1) to determine the present level of use of climate data and information by the U.S. private agricultural sector,

(2) to identify the potential for a fuller use of such material in the future

(3) to assess the uncertainties involved, and

(4) to use the results of (1)—(3) to specify the research needed before the level of present use can be increased to the maximum that would seem to be possible.

The ultimate project goal is to develop a prioritized research strategy that would make this important sector less vulnerable to climatic fluctuations. The following components of the private agricultural sector have been considered — 1) rural insurance, 2) integrated pest management, 3) agricultural chemicals, 4) food canning, 5) seed production, 6) farming and farm management, 7) agricultural lending, 8) the brokerage industry, and 9) the grain trade. The study was supported by NSF, with funds from USDA, by funding from agribusinesses, and the State of Illinois.

Our data have been acquired in two distinct phases. In the first (Spring, 1982), responses to a detailed 10-page questionnaire survey were obtained by mail from 107 people involved in private agricultural concerns (generally 10-15 from each of the above categories) with locations as disparate as San Francisco (CA), Minneapolis (MN), St. Louis (MO), Greensboro (NC), and Midland (TX). The questionnaire focused strongly on the present use of climate data and information, with historical data, "year-to-date" accumulations, "now only" values, and climate prediction being treated separately. The assessment of the potential for a fuller utilization of such material in the future, along with the identification of the research needed before this potential can be realized, took place at a workshop held during August 1982. The primary workshop participants were 14 of the aforementioned questionnaire survey respondents (1-2 from each category); they were chosen from the 107 original respondents because the insight apparent in their replies suggested they were the best equipped to anticipate possible future developments. Several major agribusiness corporations were represented - Monsanto, Pioneer Seed, Control Data, E.F. Hutton, Continental Grain, Crop-Hail Insurance, and Stokely-Van Camp. Other workshop attendees included four representatives from Federal agencies (USDA, NSF, NCPO), and one from the Illinois Farm Bureau.

The remainder of this paper provides a *summary* of some of the apparently major findings of the foregoing research effort. We wish to stress that our analysis has not yet been completed, and that the following results should therefore be regarded as tentative. More detailed, quantitative, supported, and analytical treatments will become available later.

PRESENT USES OF CLIMATE DATA AND INFORMATION

Several major and somewhat overlapping categories of application of Climate Data and Information (CDAI) have emerged.

One is in the design and planning of ongoing and future operations. Here CDAI are used in the scheduling of field efforts (e.g., tillage, fertilizer application, spraying, planting, etc.) by farmers, seed producers, chemical companies, and food processing organizations, and also in the financial decisions made by many of the above activities and by loan companies. In the cases of the seed and food processing firms, the planning includes the selection of sites for contract production, while for the chemical companies CDAI are utilized to assess the likely behavior of their products in the actual environment.

A second type of use of CDAI is as input to the crop yield models that are run routinely during the growing season by grain and brokerage companies and their consultants. These models cover a wide range, and include those of the physiological/daily variety as well as the more traditional statistical/monthly ones. However, it appears that the meteorological input utilized by the former type for the growing period up to the time of the model run is interpolated to a much finer spatial resolution (e.g., down to the county-scale) than characterizes the actual data to which the modelers have access. This activity also makes some assumption about the climatic character of the rest of the growing season beyond the time of a given model run. The alternatives presently in use include the standard 30-year normal, some shorter-period normal (e.g., Lamb and Changnon, 1981), conditional probability predictions derived from the historical records (e.g., there is X% chance August will be Y because July was Z), and the more physically-based monthly and seasonal outlooks of the National Weather Service.

CDAI are also extensively used for the monitoring of inseason conditions by all of the components of the private agricultural sector considered. This monitoring permits the timely and productive adjustments to operating practices that are needed because of prior climatic developments, and also leads to revised estimations of both the procedures that should be used during the rest of the season and their likely outcomes (including yields). Particularly prominent in this regard are decisions relating to seed and chemical selection, integrated pest management, and herbicide application. Historical climatic data also yield a range of probability estimates (e.g., fall and spring frost dates, planting dates, yields) that are frequently used as background-type information.

As the foregoing discussion implies, the present application of CDAI within the private agricultural sector involves a relatively wide range of meteorological parameters. In the case of temperature, the use includes the entire historical data bank on both seasonal and monthly time-scales, daily values for the present season, temporal integrations of interpretive quantities derived from these daily data (e.g., growing degree days, heat units), and information on runs of daily extremes. Precipitation data are also utilized in broadly similar forms. Information on cloud amount/sunshine duration/solar irradiance is considered very useful for photosynthetic and soil moisture considerations, especially when extensive cloudiness persists during important crop growth periods. The latter conditions characterized the middle third of the 1982 growing season in the upper Midwest, and caused plant development there to lag considerably behind in the stage that was implied by the accumulated growing degree days. However, the much needed cloud/sunshine/radiation data are not readily available. The other parameters for which CDAI are presently being used include wind (relevant to insect pest problems), soil temperature (planting), soil moisture (crop maturation and nitrogen application), and frost occurrence (variety selection and overall scheduling).

<u>The most surprising of the foregoing results was the very high level of present use of CDAI by this important economic sector</u>, and especially its grain and brokerage companies and the strongly "controlled" seed and food canning industries. <u>This particularly applies to the "in season" utilization of "now only" (e.g., present soil moisture content) and "year/season to date</u>" (e.g., accumulated growing degree days) information, which evidently constitutes a large part of the total use. The latter is probably little recognized by the atmospheric science community. Furthermore, it appears that there has been a rapid growth of this type of use (and also others) in recent years. The probable contributing factors include the increased financial pressures on agribusiness, a perception that such use provides a company with an economic advantage over its competitors, the dramatic improvement in the sector's modeling and data/information management capabilities that has resulted from the greatly enhanced computer technology, and the financial consequences of the aforementioned 1972-73 and 1975 grain sales to the Soviet Union.

MAJOR IMPEDIMENTS TO A FULLER USE OF CLIMATE DATA AND INFORMATION

There is a wide range of reasons why CDAI are presently not used more extensively by the private agricultural sector.

In some cases the non-use is due to the <u>lack of an appropriate delivery system for data</u> that exists, is known to exist, and is desired. This particularly applies to the "now only" or "season-to-date" type information for which Section 3 noted a substantial need. In the absence of such material, the agribusiness community is forced to use field reports of climatic indicators, various other estimates, experience, and instinctive reactions.

<u>A second major impediment to a fuller use of CDAI is the perceived complexity of the problem of which climate is but one part</u>. There is wide recognition that the complex decision making and modeling processes characteristic of this sector

have other equally or more important inputs (e.g., economic, social, and political considerations) that are not easily quantified or whose dimensions are imperfectly known. In the face of this situation, there has been a tendency to see little dividend in the sophisticated use of climate data. This may be a product of the lack of understanding of the management techniques needed to ameliorate adverse climatic impacts, and the fact that the benefits to be obtained have not been adequately demonstrated.

There is also deliberate non-use of CDAI known to be available. Such material is either perceived to be of little use, or else its utility is thought to have not yet been demonstrated. In this regard, the monthly and seasonal climate predictions available at present from the National Weather Service and various consultants are not seen to be credible by a large majority of the people in this sector. The zero lead time, coarse spatial resolution, and open distribution (which gives no individual or company an "edge" over competitors) of the Weather Service's predictions further militates against their use.

The capability to fully exploit the existing CDAI is sometimes deficient. Such limitations can be either conceptual (the appropriate models do not exist or are thought not to exist) or physical (lack of the requisite organizational support, computational facilities, trained staff, financial resources). However, the growing trend towards the provision of electronically generated and transmitted information by some large organizations (e.g., grain and brokerage companies, and Farm Bureaus) should help overcome this impediment.

Other reasons for the present use of CDAI not equalling the maximum possible include simple unawareness of the material that is available, the nonexistence or inaccessibility of some highly desirable data (e.g., cloud/sunshine/radiation, soil temperature and moisture, wind, and growing degree days, as was discussed in Section 3), communication problems between scientists and lay users (e.g., the question of what probability predictions mean), the inappropriate formats of some of the present publications and data tapes, and the notion that the cost incurred in acquiring and processing data was not worth the resulting benefits (real or perceived).

CLIMATE PREDICTION NEEDS FOR THE FUTURE

One of the Workshop sessions focused exclusively on this topic because the achievement of a really *substantial* reduction of the adverse socioeconomic consequences of climatic variation would seem to require an effective use of skillful climate predictions. The potential benefits to be derived from a fuller utilization of other forms of CDAI are by comparison inherently more modest. The participants were charged with discussing climate prediction needs with respect to the following parameters — applications, lead times, desired length of forecast periods, weather elements needed, resolution (e.g., "above normal" or something more precise), accuracy, and skill. In general, they found this a rather difficult assignment, primarily because they had never before given the subject serious and rigorous consideration. This supports Lamb's (1981) contention that considerable research is needed to assess whether, where, how and what type of climate predictions could/should be used. The full dimensions of this problem are outlined in that publication.

However, three important (if rather general) conclusions did emerge. The first was that, for many agribusiness applications, a prediction of the likely general character of the late spring and summer conditions would be useful if it was made available during the preceding January-March period (certainly no later than April 10). For example, the forecasting of the late May and June climate with this lead time could potentially influence winter decisions on fertilizer use, pesticide and herbicide choices, and production/sales questions. The important meteorological parameters appear to be temperature, sunshine, and rainfall. Since the early-July through mid-August period is the most critical one for crop growth, a demonstrated capability to successfully anticipate its climatic character six months ahead would affect *all* decisions made during the intervening time. A particularly important issue in this regard is the likelihood of a July-August climatic extreme (e.g., the 1980 midwestern heatwave and drought).

The second important conclusion to emerge was that the private agricultural sector would welcome attempts to predict September and early October conditions with some lead time. It is particularly interested in the likelihood of the early frost that would damage crops, and also the extended wet and cool period that delays harvesting and thereby exposes the crop to a range of yield-reducing threats. It appears that "first frost" predictions would be needed by August 15 to influence late-season decisions; much longer lead times would be required before forecasts could be incorporated into the variety selection process that determines maturation time. Atmospheric scientists have probably underestimated this interest in the predictability of September-October conditions.

Finally, it appears that climate predictions may have to be highly skillful - like "correct" 70-80% of the time - before they are taken seriously by this sector. However, this rather negative attitude could well be the product of the lack of prior deep and rigorous consideration of the subject that was mentioned above. The Workshop participants readily agreed that considerable research and user education will be necessary before an individual company or farmer can properly assess the risks involved in using climate predictions, including those expressed in probabilistic terms.

CONCLUSION

There are three major inputs to productivity: raw materials, energy, and information. In the last 10 years the relative costs of raw materials and energy have risen greatly. This trend will continue. The cost of climate information has not risen, and in fact, it can be made more available and inexpensively in the future. Hence, the recent increases in usage of climate data/information we found by agribusinesses reflects the turn to information for economic gain. This need will likely continue.

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THE PRIVATE SECTOR ROLE
in
PROVIDING CLIMATE INFORMATION SERVICES
to
AGRICULTURE AND AGRIBUSINESS

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Minneapolis, Minnesota

INTRODUCTION

Agriculture has always been a major user of climatic information services. If we look back at development of the state climatologists program many years ago, the primary justification was the agricultural user. With the demise of that program in 1973, it was primarily the agricultural sector that came forward and attempted to restore that program. Many of the climatic events which lead to the development of the National Climate Program were agriculturally related. Therefore, it is a real pleasure for me to have this opportunity to discuss the climate information needs of agriculture and agribusiness and, in particular, to address how the private sector can play an important role for providing the required services.

The need for climatic information services has been met previously by a combination of public and private sector programs. In general, the agricultural producer needs have been met by various government programs at the national, regional or state level; the agricultural business complex has depended on the private sector. This is not unreasonable since the climate information services requirements of the farming community have been somewhat general, while the private sector has required more detail and tailored information. However, the information needs of the producer are becoming more stringent. While public sector programs will meet at least a part of these information needs, in general the role of the private sector will increase in all segments of the agricultural complex.

THE NEED FOR CLIMATE INFORMATION SERVICES

Why are climate services important to agriculture and agribusiness? It would be impossible to cover all of the potential needs for climate information services in this paper, but let us look at some basic needs for the agricultural producer and agribusiness.

The primary objective of the producer is to maximize his financial returns through effective management decisions that will optimize production levels while keeping costs at a minimum. Adequate climate information services can help him select the best crop or variety for a particular season, minimize his spray or fertilizer applications, design weather-sensitive facilities more effectively, and make adjustments in planting and harvesting schedules.

Four related objectives are: minimizing or optimizing the use of limited resources, minimize or eliminate potential environmental problems, improve his marketing programs, and finally, improved long-range planning. Obviously, many are inter-related, but each will be considered briefly.

Soil, water and energy all represent limited resources to the producer. He must use each to his maximum advantage while minimizing or optimizing their use. Is an irrigation really required at this time? What is the risk of erosion associated with a particular crop? What kinds of alternative crops can be considered?

Another need is to minimize or eliminate various environmental problems. This could be accomplished through the minimizing of runoff, better irrigation management, the elimination of unnecessary spraying, or adopting to cropping systems better suited for his conditions. Long-term records can be utilized in planning systems. Short-term climate information or forecasts can be used to determine current management steps that can or cannot be taken.

A fourth need is to provide him with the information required to do a better job of marketing his products. He can be the most efficient producer in his area, but without adequate marketing information which includes weather in the surrounding producing areas, he will not be able to survive economically. This information, along with various climatic scenarios, can be used to calculate yield potential, both locally and nationally.

A final need is for guidance in long-term planning. What are the climatic risks associated with various kinds of crop and livestock production systems? Is irrigation economically feasible for my farm? Do wind and solar conditions justify alternative energy methods? How large a tractor can I operate on my farm?

PRIMARY NEEDS FOR CLIMATE INFORMATION SERVICES
FOR
AGRICULTURE AND AGRIBUSINESS

AGRICULTURE

- OPTIMIZE PRODUCTION LEVELS
  - IMPROVED YIELD
  - DECREASED COSTS
- MINIMIZE/OPTIMIZE USE OF CRITICAL RESOURCES
- MINIMIZE/ELIMINATE ENVIRONMENTAL CONCERNS
- IMPROVED MARKETING STRATEGIES

AGRIBUSINESS

- SPECIFIC TO PARTICULAR ACTIVITIES
  - PRODUCT PERFORMANCE
  - PRODUCT DEMAND
  - MARKETING
  - TRANSPORTATION

For the agribusiness sector, the objectives really are tailored to their particular activities. In general, the objectives are to help them through better planning activities. A few brief example follow:

- PRODUCT PERFORMANCE

  Many of the seed varieties or chemicals perform within certain weather constraints. Through monitoring of climatic conditions it is possible to anticipate problems, change recommendations, or be able realistically to evaluate complaints.

- PRODUCT DEMAND

  The demand for fertilizers, chemicals, or even farm equipment changes with current weather condtions. A wet Spring encourages weed development and, thus, the demand for herbicides. Equipment may break down more frequently because of wetter soil conditions, i.e., harder to pull equipment, etc. A large crop will increase the demand for harvesting equipment, including storage. Production schedules, etc. can be adjusted in response to these conditions.

- MARKETING

  Farm prices are driven by the supply of or demand for the particular commodity. Knowledge of changes in supply can assist in evaluating potential prices. Large firms often have large staffs that monitor these conditions. Weather is a key element in these activities.

- TRANSPORTATION

  Monitoring of climatic information can assist in planning the availability and movement of products.

PRIVATE SECTOR CONSIDERATIONS

The private sector is both a user and provider of climate services. Private meteorologists and climatologists require information from various public programs. Often times, he supplements this basic information with data he has collected from other sources. This information could become a part of a larger regional, state or even national data base.

The private sector exists because it can provide more carefully tailored products to meet the special needs of the agricultural producer or the agribusiness concern. These needs are often very specialized. The benefits of these capabilities are also often very limited. Therefore, it would be very difficult for public programs to meet these needs. Through the proper analysis and interpretation of the climatic information, the private sector has added value to the basic data. It is this value-added characteristic which provides the margin financially to allow the private convern to exist.

The report by the National Academy of Sciences entitled, "Meeting The Challenge of Climate," outlines six requirements for climate services. The report indicates that, in general, the private sector role has been somewhat limited in meeting these six requirements. Again, it has been in those areas where the private sector can add value to the basic data that they have been actively involved. These requirements will be addressed in more detail shortly.

Another important consideration is that there is only a limited number of consultants who specialize in providing climate services. This seems almost to be a paradox in light of the many stated requirements and uses of climate information. The reason for this might be tied to the next consideration, which is related to the respective roles of the private and public sectors. In many cases, the private consultant must compete against public programs which are providing at least a portion of the information at little or no cost.

Finally, the "local expert" role that has been assigned to the private sector is both critical and limited. There is no doubt that the local expert is extremely important in climate programs, but the report implies that this is the primary role. In fact, the local experts can play a much broader role.

PRIVATE SECTOR CONSIDERATIONS

- PRIVATE SECTOR IS BOTH A USER AND A PROVIDER OF CLIMATE SERVICES.
- PRIVATE SECTOR CAN OFTEN PROVIDE MORE CAREFULLY TAILORED CLIMATE SERVICES TO MEET SPECIAL NEEDS.
- PRIVATE SECTOR ROLE IN MEETING SIX REQUIREMENTS HAS BEEN SOMEWHAT LIMITED.
  - TIED TO VALUE-ADDED ASPECTS.
- ONLY A LIMITED NUMBER OF CONSULTANTS WHO SPECIALIZE IN CLIMATE SERVICES.
- RESPECTIVE RESPONSIBILITIES AND AREAS OF ACTIVITY OF THE PRIVATE VS. PUBLIC SECTORS IS KEY.
- LOCAL EXPERT ROLE IS BOTH CRITICAL AND LIMITING.

USER NEEDS

The "Meeting the Challenge of Climate" report has also identified a series of user needs. Let us take a brief look at these needs relative to agriculture and agribusiness.

The first of these is the need for tailored probablistic climate information. This kind of information can be extremely important in the development of tactical or even strategic or long-term plans. The key is that such information is provided in a form that he can use effectively. Back in the late 1950's and early 1960's, an extensive series of publications were prepared by state climatologists and regional committees. These documents dealt with probabilities of precipitation and distribution of temperatures. Today, the majority of those reports collect dust. Most farmers cannot understand what is provided to them.

The second need identified was access to data. This has been a common problem for many years. Data from many climatological networks are not available for many weeks after the observations have been taken. As we move into a new era in climate services, it will be important that we have the ability to obtain data quickly. New communications, technologies hold the key to a successful access to data.

A third need identified was for usable measures of various climatic phenomena. Agriculture has been a key user of these kinds of measures. Simple concept of growing degree days or heat units is one such measure. The transformation of extensive temperature and precipitation data into a measure of soil water use, such as potential evapotranspiration, is another example.

A fourth need is for the observation of data critical to agriculture. Standard observation networks provide only temperature and precipitation. This is not adequate for many needs in agriculture. This problem will become more serious as we move into extensive programs in integrated pest management and water management.

Another serious need is for compatible climate data. It is important for agriculture that we be able to access data in reasonable forms. The proliferation of networks within the individual states represents a serious problem if this data is not readily exchanged. Common format, common methods of observation, and similar characteristics will be very important.

Another need is for adequate data coverage. Most observation networks are not adequate for agricultural purposes. We will hear a discussion later on in these meetings about the activity in the State of Nebraska to help overcome this deficiency.

A seventh need is for current climate information. This really has been alluded to in previous discussions. Data must be readily available shortly after the time of observation if we are going to be able to meet the needs of agriculture.

Finally, there is the question and issue of climate forecasts. Depending on who you talk to, the potential for the development and use of such forecasts ranges from some hope to a great deal of optimism. In many cases, if we go back to the first need for tailored, probablistic climate information, we can in fact make very useful climate forecasts.

USER NEEDS

- TAILORED PROBABILISTIC CLIMATE INFORMATION
- DATA ACCESS
- USABLE MEASURES OF CLIMATIC PHENOMENA
- NONSTANDARD CLIMATE DATA
- COMPATIBLE CLIMATE DATA
- ADEQUATE DATA COVERAGE
- CURRENT CLIMATE INFORMATION
- CLIMATE FORECASTS

FROM: MEETING THE CHALLENGE OF CLIMATE.

INFORMATION SYSTEM REQUIREMENTS

As mentioned earlier, the NAS report on "Meeting the Challenge of Climate" identified six requirements for a climate information system. Again, let us take a look at these requirements relative to the private sector and the agricultural community.

Briefly, these six requirements are for:

- Climate Monitoring
- Data Analysis and Quality Control
- Research and Innovation
- Coordination, Communication and Referral
- Dissemination and Education
- Maintenance of an Adequate System for Providing Climate Services

The issue of climate monitoring will increase in importance in the years ahead. When we look at broad phenomena such as drought or even flooding, heavy snowfall, it will be important to be able to anticipate or recognize when particular phenomenon are occurring. This also will become important with the renewed efforts in the area of water management and integrated pest management.

The issue of data analysis and quality control is also extremely important from the standpoint that you cannot generate any better information than your original data. By this I mean that if the initial data is inaccurate, the information derived from that data will also be inaccurate. Careful, quality control is the key to good data. Good quality control often requires two aspects. The first is the ability by machine to check for what are obvious errors. The second aspect is the review of such data by climatologists who can recognize, in even greater detail, when data are in error.

Another key point related to this is in formats and compatibility. A serious problem in the past has been the lack or the inability to quickly read tapes provided by organizations such as the National Climate Center.

In the area of research and innovation, they are talking about being able to tailor information and capabilities to the specific user's needs. Many times these are specialized or "non-standard". These often represent major challenges to the consultant. In addition, there is a need for an exchange of methods and innovations being developed in both the public and private sectors.

There are increasing efforts to improve the coordination, communication and referral between the public and private sectors. However, these need to be increased still further.

The education of the user on how to effectively utilize climatic information is critical to the success of both public and private sector programs. Whether dealing with a farmer or the CEO of a large firm, we must be able to show him how to use the services available.

Finally, there is a need for the maintenance of an adequate system for the collection, analysis and storage of data that are the basic input to a climate information service.

SUMMARY

- The agricultural production/agribusiness complex has always been a major user of climate services. Their needs for climatic information have been met by a combination of public and private sector services. The majority of the agricultural producer needs have been met by various government programs at the national, regional or state level, while the private sector climatologist has focused on the agribusiness complex.

- The private sector role in providing these services will expand in the future. Deterrents to the expansion of their activities are:

  - Lack of private sector involvement in the development of integrated programs at the national, regional, state and local levels.

  - Potential competition with public sector programs.

  - Inaccessibility to critical data, despite the growing demand for such data. This is a common problem for both the public and private climatologist. We are seeing a myriad of specialized networks being established within states or regions to ensure the rapid and accurate collection of data. A mechanism needs to be established to allow rapid exchange of such data.

- The role of the private sector, ultimately, will come down to their ability to provide value-added capabilities. Keys to their success will be their ability to:

  - Develop and deliver products specially tailored to the needs of their customers. Reliability will be as important, or more so, than absolute accuracy.

  - Educate their users on how climatic information can be used in the various decisions they must make, i.e., the private sector must understand its customers' problems.

  - Market their capabilities to the various components of the agricultural producer/agribusiness complex.

  - Utilize new technologies for both the collection and delivery of data and information.

- The private sector represents a significant source of both applications and experience (local experts) that must be utilized in a coordinated climate service program.

- The private sector serving agriculture is a potential paying customer for climatic data and information being generated by national, regional and state climate programs.
  - The private sector should be consulted in developing data collection, archiving, and quality control programs at all program levels.
  - The private sector will be able to provide better quality, more timely services is they are supported by a system responsive to their needs.

PRIVATE SECTOR CLIMATE SERVICES FOR
INDUSTRY AND COMMERCE

By Paul Janota, Ph.D.

Environmental Research and Technology, Inc.

My presentation today will briefly discuss the following points: the pragmatic aspects of climate as a business interest as seen through the eyes of a private sector individual who is also professionally interested in applied climatology, climate prediction, and weather forecasting; the capabilities in this area that are available from the private sector; some technologies which not only foster private sector involvement but also tend to demonstrate a trend for additional involvement as these technologies improve; restraints inherent in the viability of the climate business; and some elements from the climate community needed by the private sector. I will conclude my talk with two examples of projects which either depend on or influence our understanding of climate. These are large projects which involved substantial private sector investment, use public and private data sources and require public cooperation or support.

One other point to be made in introducing my topic today, is that at first I considered making a generic presentation about the private sector and climate steeped in philosophy and notions regarding the cooperation between the private and public sectors. However, the publications Managing Climatic Resources and Risks, and Meeting the Challenge of Climate from the NRC summarize so well the requirements and the principles of interaction among the different academic, public and private groups, that I have no need to go over that any more. Consequently, I feel that the path outlined in these NRC publications appears to be a reasonable one and that you might simply be interested in some of the actual reactions that private sector individuals have in this regard.

Now let me comment on the pragmatic aspects of climate as a business. Most private sector companies seriously engaged in the climate business are not large; there are probably only three or four private sector firms large enough to make substantial investments from their own resources or that can generate substantial capital for investment; therefore, one of the very real considerations is the investment risk: Is this a good business area; should we focus on climate as a business or should we merely react opportunistically to funded programs that involve climate? Making climate a business area as opposed to a target of opportunity is a fundamental choice, and generally when it is made a business area it involves investment. This is a real-world problem and we will return to it later when commenting on restraints. Another pragmatic issue is that of liability. The more a company becomes involved in weather and climate activities the more it becomes vulnerable to damage suits resulting from disputes involving the uncertainties and vagaries of natural phenomena. Smaller companies may have less of a problem because they may not be involved in high value projects and may not attract legal action due to their smaller assets. But larger corporate entities always have to seriously look at their liability. Climate forecasting, for example, is clearly an area in which potential liability issues are a concern. Data acquisition could be another risk area considering that data collected for a profit must be as valid and calibrated as other public sector data bases which are used for actually making meaningful decisions by clients. Private firms tend to be very concerned with maintaining their proprietary rights to data sets, applications models, market areas, etc. My company is gathering data for private use and is trying to make money in that process. At some point I may be asked to share that data with the general public; how is that point defined and how do I protect my proprietary interests? These are a few of the real factors that confront the private sector on almost a daily basis whenever we are serious about weather and climate as major lines of business.

Next, let me turn to some of the private sector capabilities. First, there are many consultants with legitimate credentials in climate. There are not enough of them but they are out there in the market place on government contract or performing studies for agriculture and industry, and there are some who are willing to take the risk of making climate forecasts for a fee. The fact is that these are viable business areas and the consultants and forecasters are making a contribution. The private sector provides technical services, operates and maintains data collection networks, manages centralized information services and sells or leases these resources on a subscription basis which cuts down the capital investment that some clients might otherwise have to make. We are also trading these technologies overseas. Companies are in the business of developing and producing instruments for measuring weather and climate data. I recently sent for instrument catalogs from 32 different instrument manufacturers, most of whom are in the United States, and I have been surprised at the innovation and variety on the market. Many private companies such as ours which have been in the air quality business for 12-14 years have large data sets which can often be of value to the climate community. For example, we specifically were involved in wind power studies and used data from meteorological sites that we operate for industrial clients. These clients were willing to supply additional data over and above the normal wind values from the National Weather Service and the FAA.

A great many new technologies available today support private involvement. Perhaps the biggest and most obvious revolution has been in the area of computers and the fact that we can now internet a variety of experts, data bases, and applications models through public data networks using microprocessors and the phone. Just about everybody in the business is going to have an Apple, or TI, or TRS/80, or you-name-it computer on their desk. With the addition of a modem and a storage disk they can be internetted. Distributed processing is here and is a revolution that puts more information at our fingertips than was ever before available at an affordable cost. People solve problems at their desks that required a large central processor a few years ago. Packages for statistical operations which permit the solution of complex statistical relationships or the fitting of curves to data sets are now office tasks and the answers are immediately available.

Telecommunications options are increasing also. A variety of data networks are appearing; remote data can be collected using satellites for communication; costs are going down; regulations regarding services are constantly under review. These revolutions are contributing to our ability to communicate and to work together as a team while separated in space. The increasing number of public and private data sets become data bases organized and managed using packaged software on local computers; interfaces are becoming standardized and we can share data in principle. Whether or not we can work out the administrative, political and financial issues is the question; technology is not the question. Increasingly, our knowledge of the market for climate-related products and services will come from the private sector. That is the name of the game in the private sector, marketing and understanding who will buy.

In spite of the capabilities and factors which favor private sector involvement, it is worth commenting on a few restraints to entering the market. The first is again the investment issue. Is this a good business area for investment of capital or am I better off going in some other direction? Resolving this question will also depend on one's natural professional inclination. A business is rarely a pure bottomline enterprise. Generally speaking there is a professional aspect; you are a meteorologist or climatologist because you want to be. A banker getting into the climate game does not make a whole lot of sense. There is an entrepreneurial aspect and one must analyze and balance the business and professional forces. If the business of marine or aviation forecasting is a better gamble than providing climate services in agriculture, then climate suffers. This decision is partly based on return on investment and partly on inclination and skills, but capital investment decisions create priorities and these are restraints. Another serious restraint is the fact that the weather and climatology business competes with public information sources that in many cases seem to be free or at least highly subsidized. Services provided by or supported by a university, the state, or federal government that disseminate enormous amounts of weather and climate information virtually free of charge using media such as radio and television wherein the cost per unit information is measured in pennies are formidable competitive obstacles to pure private sector involvement. True, private sector involvement can be at the wholesale level such as a weather and climate service provided on cable TV as opposed to the high science and technology services that professionals often prefer to provide. Such professionals may be driven from the private sector into a public sector or academic job if the drawing power of professional satisfaction is stronger than the "bottom line". This competitive aspect from the public sector looms very large and even though the trend is towards privatization, it is a real factor in investment decisions. The availability of expertise is still a restraint: How many private sector climatologists are there? Will the educational system and the market forces create enough high-value climatologists to fill the need? I believe we can use more mathematicians and statisticians who know how to solve problems probabilistically as well as economists and operations researchers who can perform risk analysis. Private climatologists must be able to market and interface with clients who have problems and to do what the client wants not the other way around.

Private sector services need a wide variety of input data as a basis for analysis and problem solving. There is conventional weather data that comes in over various weather circuits and the usual information from the National Climate Center. Everyone has an "oldboy" network of one form or another, a favorite university or a cooperative source in some state or private or public institution where data can be obtained in books and prepared reports. In order to optimize the search for data, the private sector needs a clearing house for quick reference. If I had a computerized capability to access this clearing house and give it a set of buzz words like: climate, state name, rainfall, dates, etc., and receive a list of public and private sources for analyzed information and/or raw data of a certain type so that I could quickly start researching my problem, this would be a very valuable resource. It is also a business area that the private sector could actually enter. Other private sector firms like Data Resources Inc. and Dunn & Bradstreet, have made their fortunes with economic or financial data. ERT is doing it with environmental regulations by setting up a computerized system that allows clients to access the state and federal environmental regulations sorted by the problem one is trying to solve. There is no technological reason why the private sector could not do this for climate-related information assuming it is worth the investment. The data must be timely; problems that are solved by private sector consultants generally start and stop within a month or two. If you cannot get the data quickly you are not in that business. Generally the timeliness factor for this kind of problem solving either means that you already own the data or you must have a source that can get it to you in a matter of days or at most weeks. Finally, there is always the price factor; this service may or may not be available at low cost, but it must be equitable. If one must go to a unique source for data, then it should be available to you at roughly the same price that it is available to others. In other words, here again is the problem of competition by "free" sources.

Now I will quickly discuss two current projects that may interest you and I have brought some material on them with me today. The first example is a Hydrological Information Service (HIS) operated by ERT. Today HIS is supporting the water allocation of the Arkansas River in the State of Colorado. There are 80 or so hydrological sites which report through the GOES satellite to ERT's earth station and data central in Massachusetts. Users in Colorado access the data via dial-up computer. We provide a value-added service in that we have discharge rates developed from rating curves as well as water stage height; we also have a number of nice data base features and display options available to the clients. This service originally started with federal R&D funds which ran out. The COMSAT/ERT family took over the project as an investment and offers it now as a subscription service. The principal clients of this service will be the State of Colorado as well as private clients such as canal companies. From the standpoint of climate, one impact of this system has been to generate data that has revised the hydro climatological knowledge about the behavior of the river hydraulics. New extremes of stage height and discharge have been detected, and the speed of the flood crest was revised by several hours. Data capture rates on this system are very high and it may be the best performing data collection system on the GOES satellite as far as we know.

The second example is an on-going activity that has not yet reached the project stage but it represents an ERT development of a concept for the management of small hydro-power dams on a river complex in a multi-state region. The client is a utility consortium. ERT went to the utility with the idea for managing their hydro-power network in a more efficient and optimum fashion using a model that was developed in our company; therefore, we generated the interest from a marketing standpoint and the utility is now seriously considering using this as a management system on their central computer. Climate information was invaluable in that all of the modeling activity was based on historical data which was available through the National Weather Service, the Corps of Engineers and the USCG plus data from instruments owned by the utility. These data enabled our analysts to develop the model which then supported our marketing activities. This example has a number or relevant characteristics: It is a regional activity; it involves private sector initiative; and it was dependent on private and public data bases for development. It may become a turnkey system for the client or perhaps it will be operated by ERT for a service fee. That is still in the future but it is an interesting case in which climate data played a key role. If the project goes ahead, it is likely that historical data will play a continuing role in updating and improving the system.

In closing, I would like to remind you that the descriptions of these two project examples are available if you want a copy. Thank you very much. Now I would like to try to answer your questions.

THE NEBRASKA AGRICULTURAL CLIMATE SITUATION COMMITTEE

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Abstract

The Nebraska Agricultural Climate Situation Committee consisting of an interdisciplinary group of extension specialists provide up-to-date information and advice on seasonal changes in crop/weather conditions. The committee meets each Monday during the growing season to review:

- Maps and tabular data developed from a computer program CIS - Crop Weather Information System, that is linked to automated weather stations and terminals in county agent offices.
- Entomology, plant pathology and agronomy surveys.
- Weekly weather and crop reports.
- Weather outlooks and probabilities.

Situation reports and advisories are released to newspapers, radio and T.V. stations and to county agents via electronic means.

The Nebraska Agricultural Climate Situation Committee

The Agricultural Climate Situation Committee was established in the spring of 1981 to provide up-to-date information and advice on current seasonal changes in climate as related to Nebraska's agricultural industry. The discussion to follow will show you why the committee was established, how it was formed and operates and examples of what type of information and advice it provides.

Why the committee was formed

Nebraska produces 1,000,000,000 bushel of grain, 7,000,000 tons of hay and 11,000,000 head of livestock annually with a total value of $6,000,000,000 Table 1). Agriculture is the largest industry in Nebraska.

Table 1. Nebraska Agriculture

	Production	Value
Grain	1,000,000,000 Bushel	$2,500,000,000
Hay	7,000,000 Tons	
Cattle and Pigs	11,000,000 Head	$3,500,000,000
		$6,000,000,000

The importance of weather to agricultural production and the economic well being of the state can readily be seen by comparing two adjacent years; 1973, a year with ample rainfall and 1974, a year of drought (Table 2). In 1973 Nebraska received 29.2 inches of precipitation. The corn yield averaged 93 bushel per acre and 554,600,000 bushel were produced. Only 15.8 inches of precipitation fell in 1974. The corn yield dropped to 68 bu. per acre and only 380,800,000 bu. were grown.

Table 2. Production related to weather

	1973	1974
Average Precipitation	29.2 In.	15.8 In.
Corn Yield	94 Bu.	68 Bu.
Corn Production	554,600,000 Bu.	380,800,000 Bu.

Following are some important considerations concerning weather and agriculture in Nebraska:

1. Precipitation and temperature decrease from east and west.

2. These patterns shift eastward or westward from season to season.

3. Eighty per cent of the precipitation occurs during the growing season as scattered and variable thunderstorms.

4. Cropping patterns are also complex.

5. Cropping systems are also complex in their effect on soil moisture supplies.

The effect of shifting precipitation patterns across the state can be seen in Table 3. Shown are the precipitation and yield of dryland and irrigated corn at different crop reporting districts in 1973 and 1974. In 1973, 39 inches of precipitation occurred in the east, 30.7 inches in central Nebraska and 20.5 inches in the west. Yield of dryland corn in these districts were 87, 61 and 31 bushel per acre. The dry weather shifted eastward in 1974 so that the eastern district received an amount only equal to that obtained in the west the previous year. Dryland corn yield in the east dropped 26 bushel per acre. As may be seen, irrigated corn yield are more stable.

Table 3. Corn production 1973 and 1974

	1973			1974		
	Precipitation	Corn Yield (Bu.)		Precipitation	Corn Yield (Bu.)	
	Inches	Dryland	Irrigated	Inches	Dryland	Irrigated
East	39.0	87	116	20.5	26	101
Central	30.7	61	100	16.5	26	106
West	20.5	31	93	11.9	30	88

The complex cropping patterns in Nebraska are shown in Figures 1-6. The darkened areas are the counties where 80% of the acreage of various crops are concentrated. For example, dryland corn and soybeans are primarily grown in the northeast while most irrigated corn is along the Platte River in central Nebraska and at the edge of the Sandhills. The wheat crop is produced along the southern part of Nebraska and at the edge of the Sandhills. The wheat crop is produced along the southern part of Nebraska next to Kansas and in the dry western part of the state. Wild hay comes from the Sandhills in north central Nebraska and sorghum is grown in the southeast where high temperature stress is more frequent than in other areas.

The effect of cropping system on moisture availability can be seen in Figure 7 and 8. These bar graphs show the amount of precipitation for a recharge period when no crop is grown and during the growing season. Under a continuous cropping system for wheat, eastern Nebraska receives twice as much precipitation as does the west,

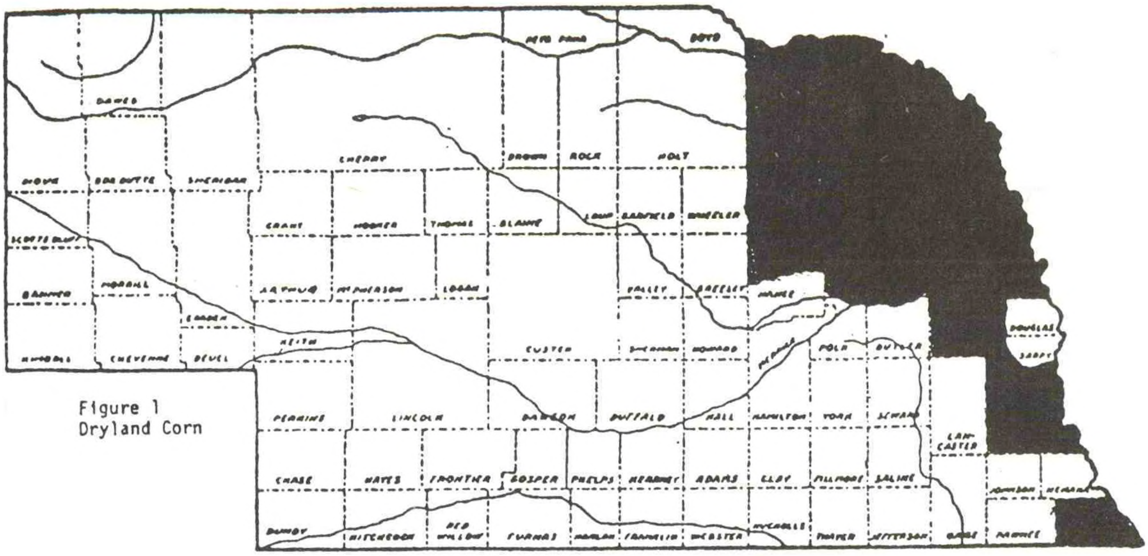


Figure 1
Dryland Corn

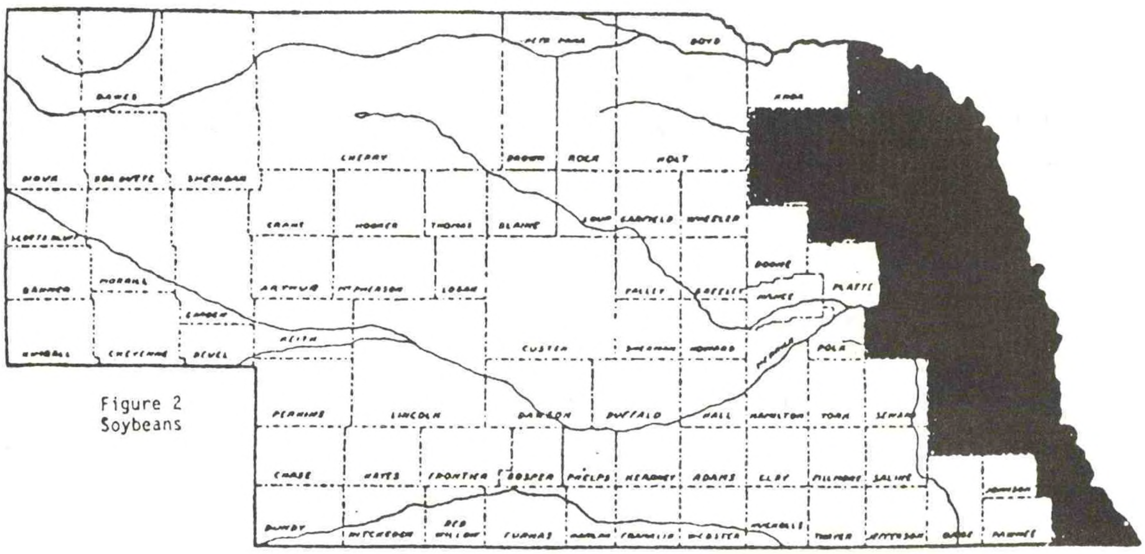


Figure 2
Soybeans

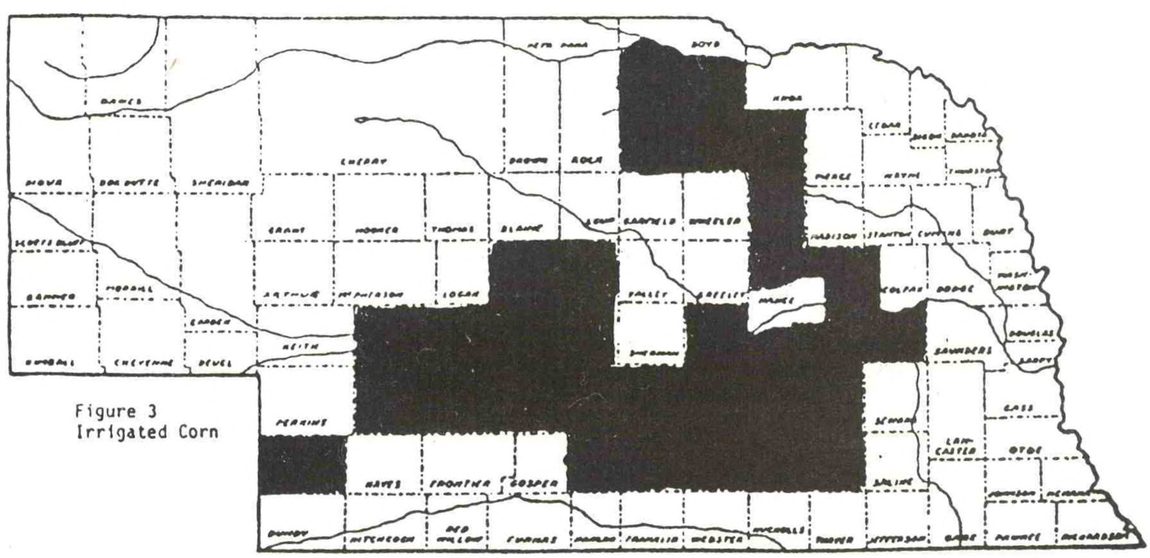


Figure 3
Irrigated Corn

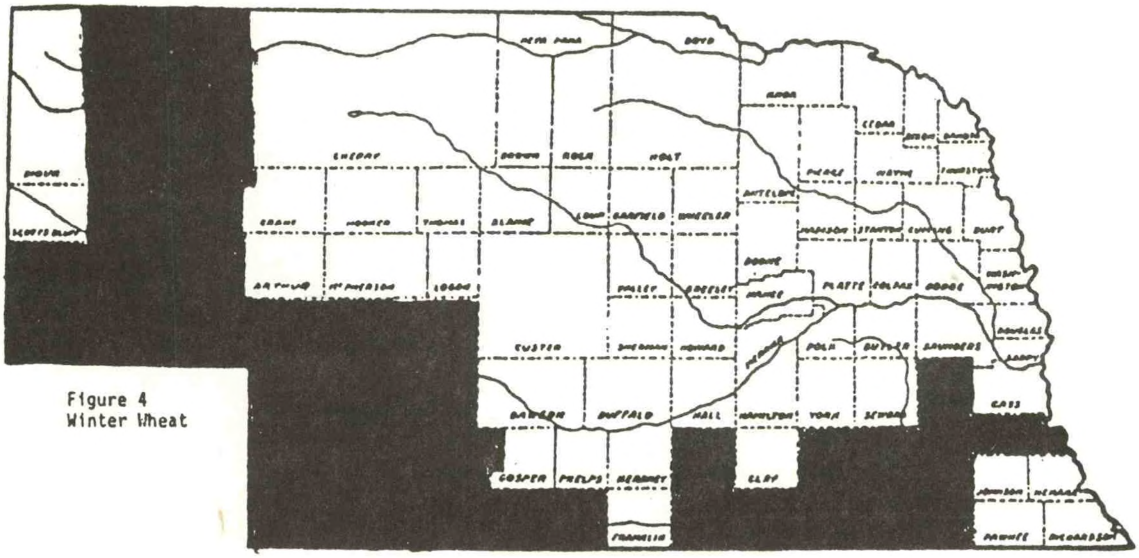


Figure 4
Winter Wheat

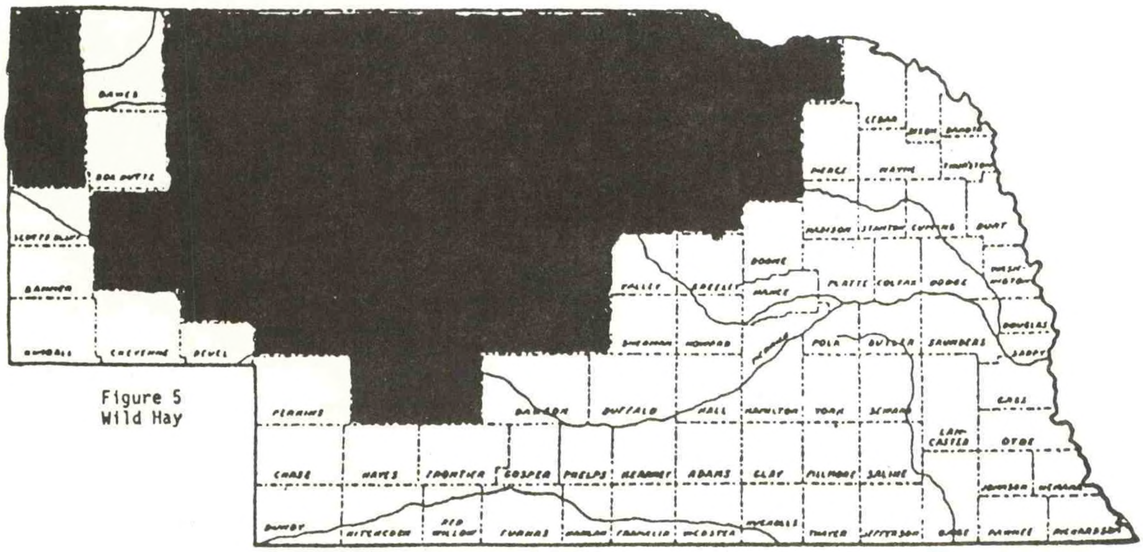


Figure 5
Wild Hay

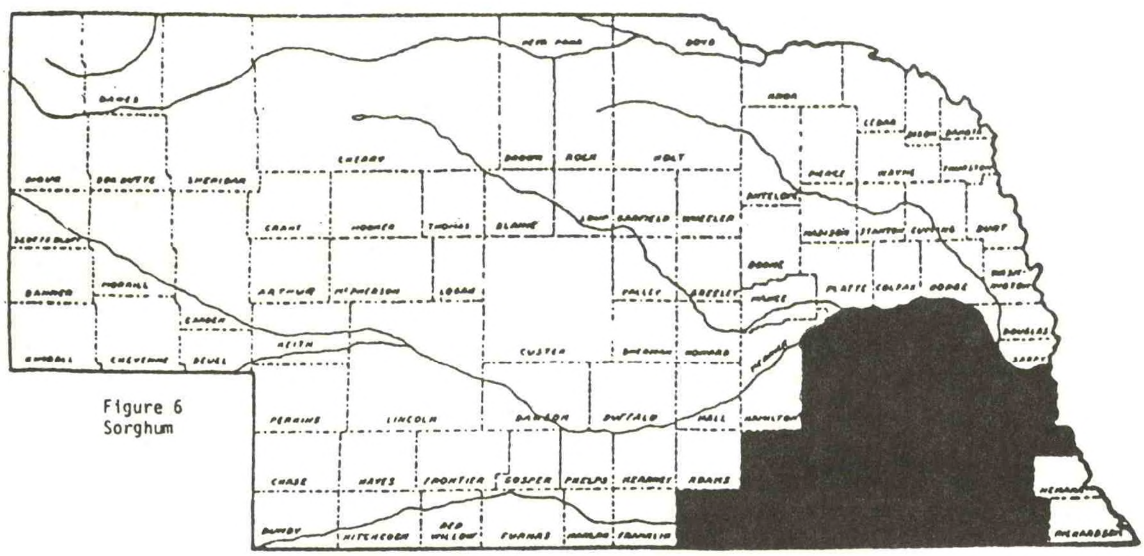


Figure 6
Sorghum

Figure 7. Precipitation Available for Winter Wheat in Different Cropping Systems

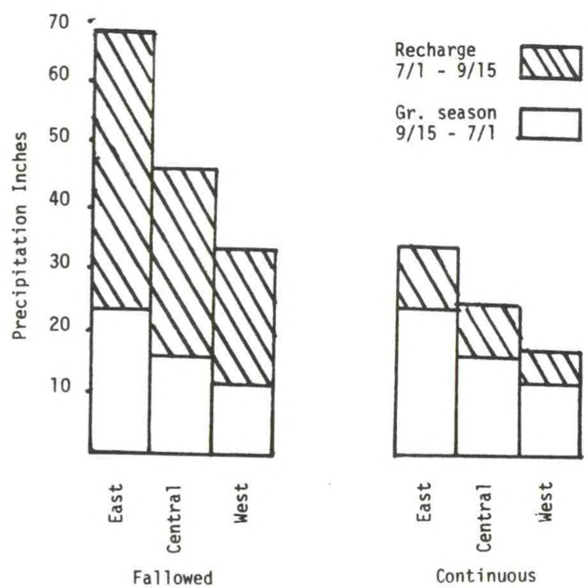


Figure 8. Precipiation Available for Corn in Different Cropping Systems

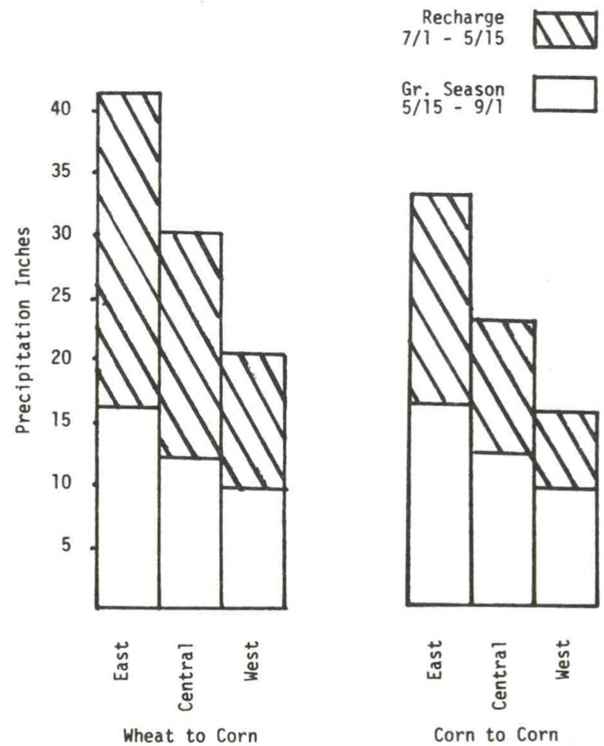


Figure 8. Precipiation Available for Corn in Different Cropping Systems

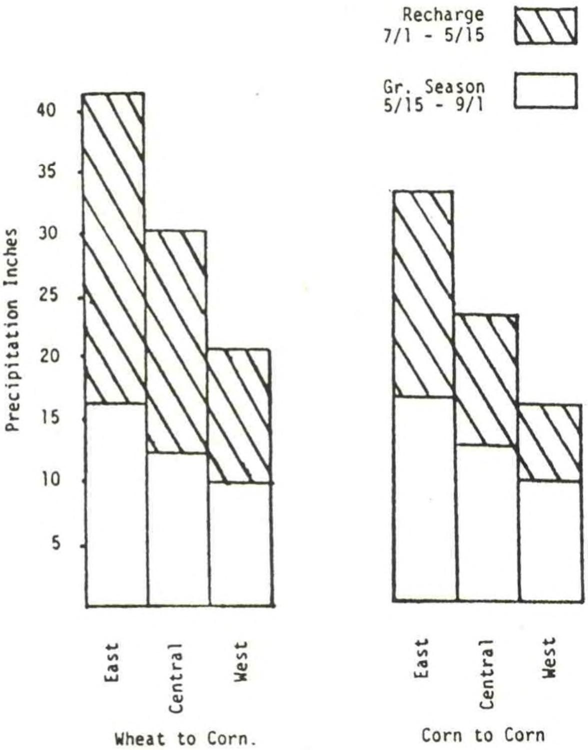
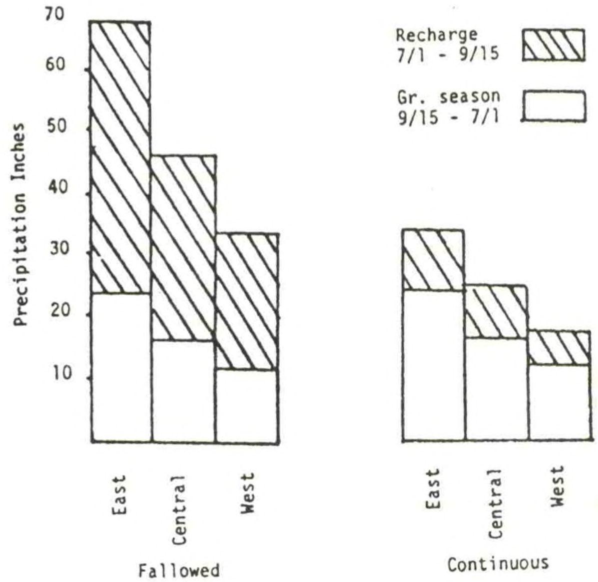


Figure 7. Precipitation Available for Winter Wheat in Different Cropping Systems



30 vs. 15 inches. If the field is fallowed 1 year as in the case in the west, the wheat crop there receives as much precipitation as in the east.

About half of the moisture available for dryland corn in eastern Nebraska is from the recharge period 9/1-5/15; the remaining half during the growing season. In the ecofallow system, an increasingly popular practice, in south central Nebraska, corn is planted in wheat stubble which has been left standing after harvest for 11 1/2 months to act as a surface mulch to intercept and hold moisture from rain and snow and prevent erosion. When this practice is used there is almost as much moisture available for row crops in central Nebraska as in a continuous system of row cropping as in the east.

I hope these tables and figures illustrate the importance of weather data for Nebraska's agriculture. Unfortunately, the state climate office which managed the network of cooperative volunteer observers that served agriculture so long was closed in 1973. In contrast with the synoptic stations at airports in larger cities, the cooperative stations in small rural communities were more representative of agriculture.

Following are some of the agencies that began to receive requests and attempted to answer requests for agricultural weather information:

National Weather Service Forecast Office

Crop-Livestock Reporting Service

Soil Conservation Service

Private commercial companies

Institute of Agriculture and National Resources of University of Nebraska

Calls were directed to:

Conservation and Survey Division

Agronomy Department

Agricultural Engineering Department

Horticulture Department

District Research/Extension Stations

Geography Department

None of these groups were sufficiently staffed and/or trained to provide the information needed and there was no well defined responsibility as to what or how information should be provided.

However, certain resources were available from which improved agricultural weather information could be provided. Following are some of the resources available in Nebraska and other states as well:

Current weather data networks
    Cooperative stations

. Synoptic stations
. Automated stations

Climatic data to develop daily weather normals and probabilities

Centralized state computer with terminals in county offices - AGNET

Agroclimatic parameters and models for computer software

Agricultural Extension Specialists

Information Dissemination System

How the system operates

Two systems, Irrigation Scheduling and the Agricultural Climate Situation Committee were formed to provide for the need for improved weather information for agriculture in Nebraska. The following discussion concerns the Agricultural Climate Situation Committee of the Agricultural Extension Service. It is composed of the following specialists:

Agronomists	Journalists
Animal Scientist	Plant Pathologist
Climatologists-Meteorologists	Rangeland Specialist
Entomologists	Soil Scientist
Forester	Weed Control Specialist
Horticulturalist	State-Federal Agricultural Statistician

The committee meets 1:00 P.M. each Monday during the growing season and reviews information showing crop-weather changes the previous week along with probabilities and future outlooks. Following are some of the information that is reviewed:

Current computer maps and tables from the computer program CIS-Crop Weather Information System

Weekly weather and crop reports

Entomology, pathology and agronomy surveys

Comments from district and county agents via electronic mail

Monthly and seasonal weather outlooks

The committee prepares a release of conditions and advisories to the press, radio tape, T.V. and back to county agents via electronic mail.

Information and advice provided

Following are excerpts from releases made during the 1982 season:

May 19, 1982

Because of wet weather and inability to plant, seven to ten percent of the seasons temperature has been lost and unavailable to corn. Thus, producers should begin to consider planting earlier-maturing (2450 GDD or 100-day) hybrids.

These hybrids could be a good risk if they are in the ground by May 30 for areas south of a line running from Blair to Columbus, through Grand Island to Trenton.

May 19, 1982
Wet weather has cultured tan spot and septoria leaf disease on wheat.

Some growers may want to consider fungicide application. Chemicals registered for this use are manzate 200 or dithane M-45.

It is recommended the fungicide be sprayed from aircraft at two pounds per acre in a minimum of 3 gallons of water. Applications should be seven days apart with the first going on in the early boot stage. It costs $9 to $10 per acre to apply the fungicide once.

June 7, 1982
Because of below-normal temperatures in May, crop progress has been delayed three to six days.

Because of the shortened growing season and shorter period for weed growth, rates of the grass herbicides, lasso and dual, can be cut back by 25 percent under most conditions.

July 6, 1982
Continued high moisture favors economic infestations of stable flies in feed lots and dairies.

Producers should consider harrowing or discing potential breeding areas to dry them out. Wet feed, hay, straw and strawy manure are all potential breeding areas for flies.

Reports of cattle deaths Saturday prompted the committee to remind cattlemen not to handle or treat cattle in any way when the temperature-humidity index is likely to be in the danger zone.

Cattle should be kept spread out, but shouldn't be handled in any other manner including dipping. Some reported deaths Saturday occurred after dipping.

July 26, 1982
Farmers who lost corn or soybeans to hail may choose to grow forage crops in the remaining season.

Corn ground treated with atrazine can be used to grow forage sorghum, sudan, or sorghum-sudan hybrids.

Soybean ground treated with treflan can be planted again to soybeans and harvested for hay or silage, or sunflowers could be grown for silage. Soybean land treated with sencor can not be safely planted to sunflowers.

Another alternative for farmers who have already signed up for the reduced acreage program for corn or soybeans is to comply with the August 15 participation deadline.

September 13, 1982
Seed wheat needs a resting period after harvest to break dormancy. Normally this is not a problem, but much of the seed wheat harvested

was late this year. Growers who already have planted may be anxious about germination.

Because of the wheat scab scare in eastern Nebraska earlier this summer, farmers are looking for other sources of wheat seed.

Farmers in eastern Nebraska who buy non-certified bin run seed from the western part of the state may be buying a long-term headache. Such seed is likely to contain jointed goat grass and wild buckwheat, two troublesome weeds, rarely found in eastern Nebraska.

In most of eastern Nebraska, moisture is favorable and there is no reason to plant before the recommended dates in the last week of September. There will be reduced incidence of insects, disease and weeds and the possible dormancy problem by delaying planting until the recommended time.

THE NOWCASTING, INC. APPROACH FOR PROVIDING AG WEATHER SERVICES IN CALIFORNIA

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Abstract. NOWCASTING, Inc., and its operational arm, Cal Ag Weather, are the result of a grass-roots effort among a group of Northern California farmers which began in 1979. The needs for ag weather and climate information and the economic setting which prompted the formation of a not-for-profit corporation are discussed. Attention is given to the users, fees, services, equipment, and communications which have translated NOWCASTING's private-sector philosophy into action. Plans for a State-wide ag-weather system are described. Areas for public-private cooperation are identified.

Introduction. Modern technologies and the economic realities of modern agriculture are combining to create opportunities for a new, localized level of climatological and meteorological services. The purpose of this paper is to describe briefly one of the types of public-private interaction and cooperation which we at NOWCASTING, Inc. believe is worth exploring seriously. At the request of the sponsors of this workshop, we also will present certain economic information.

The approach we have taken is firmly rooted in the soil of private-enterprise philosophy. Either we produce a product the value of which to the consumer is greater than its price, or we close our doors. Our actions are directed toward achieving self-support on this basis as rapidly as possible. Those who provide our financial support are in direct control of our policies and guide our operational procedures. While we deploy modern technologies and personnel quickly where demand provides the fiscal justification, we choose the least expensive management option whenever possible.

We tend to identify needs by questioning users directly and by showing them examples of weather and climate information packages. One result is that feedback from our consumers is direct and is acted on directly.

In what follows we briefly sketch our history, describe an initial economic setting, outline our current product lines, highlight the technical system, comment on our uses of both climate and real-time data interactions with other agencies, give some details about our current Ag Weather District subscribers and the fees they pay, and peer however dimly into the future.

Some History. NOWCASTING, Inc. and its operational arm, called Cal Ag Weather, have grown from work which began in January 1979. A group of northern California agricultural interests, mainly orchardists, decided that Federal budgets for ag weather services were very unlikely to increase. It was felt an increase by a factor of 3 to 10 times would be necessary if the Federal government were to provide the degree of "free" ag weather and climate support needed for survival during the economic, social, and political climate of the 1980's and 90's. Self-help at the grass-roots level was needed.

Our work began as a research and development project under the auspices of The University Foundation of California State University, Chico. On July 1, 1981, a new not-for-profit corporation was formed under Public Law 501(c)3 to perform educational and scientific functions related to this topic. In early 1982 a subsidiary, Cal Ag Weather, was created to deliver "ag-weather" services on a routine basis. NOWCASTING's Board of Directors, who are prominent California agribusinessmen, chose an organizational framework which was modeled after the California Farm Bureau Federation which, itself, is a not-for-profit organization. The author presents this paper as a representative of these California growers.

Our goal is to provide services year-round, and in a very site-specific and commodity-specific manner. We intend to supply complete, one-stop ag weather service wherever in California our services are desired. It is not our goal to replace or threaten in any way the extremely valuable, but more generalized, ag weather services provided in California by the National Weather Service. In fact, our "perfect world" would be one of intimate interaction between Cal Ag Weather employees and both NWS and Cooperative Extension Service field personnel at the local level. We remain ever hopeful that policy adjustments can be made at the middle- and upper-management levels of Federal and State agencies to permit an increasing degree of such cooperative efforts. We believe that California agriculture would benefit from this kind of public-private partnership.

Paying the Bills. The majority of our funding to date has been in the form of development grants and research contracts from some 45 organizations. These have included two Farm Bureau chapters, six county governments, three Universities, ten growers' associations and cooperatives, seven banks, two ag chemical companies, two State agencies, several prominent individual farmers, and the W.K. Kellogg Foundation. From 1979 through the first half of 1984, about $1.5 million dollars has been made available for our work.

The large-scale economic picture that we serve is based on an annual gross crop value in California of 10 to 15 billion dollars. Contributing to this figure are about 270 different crops of significant economic value, which are grown in a highly regulated environment. Much of this production is exported and serves to improve our nation's balance-of-payments situation. Conservatively speaking, at least 1 percent of California's production is affected by avoidable, adverse weather events. That's 100 to 150 million dollars. If the activities of Cal Ag Weather can mitigate 10% of this weather impact, then the value of our activities can be in the 10 to 15 million dollar range. In this setting, both our present annual budget of $500,000 for routine operations and our projected operating budget of $2 million have a sound cost-benefit foundation.

The funding question appears not to be "Is our work needed?" or "Is our work valuable?" or "Is our work being used?" The question is where to send the bill. We handle this question by letting those who are interested in paying the bill choose their own answers.

Products to Date. Our business plans are based on an orderly transition to self-support which depends on the success of three "products." First, we provide wind velocity and ventilation forecasts for 34 separate zones of the Sacramento Valley during October and November. These forecasts at the sub-county scale are delivered electronically *via* commercially available software. They are used by 10 County Air Pollution Control Officers to manage the smoke that results when the rice industry uses fire to dispose of straw and stubble, a practice which sanitizes their fields for the prevention of stem rot fungus diseases. (For more information, see Rutger and Brandon, 1981; Hauser, 1982a; Duckworth and Kinney, 1982; and Crowe and Kinney, 1983.) For this product, the education and acceptance phases of marketing are over. The product is successful. It is sold and paid for.

Our second product line is a year-round program of ag weather and short-term climate forecasts, which are delivered mainly by telephone either as voice recordings or during direct conversation between forecaster and farm manager. There are two different audiences for these very local, site-specific and operationally oriented forecasts. Large, diversified farming corporations tend to interact with the forecaster directly. The smaller growers are organizing themselves into units called Ag Weather Districts and make use of telephone voice recorders. We believe the larger farms will make increased use of electronic delivery soon; the smaller farms appear to be about two years further away from this point. In response to farmer requests, our recordings also deliver the latest available frost and agricultural advisory message prepared by National Weather Service personnel who work out of the Redding, California office.

These two product lines have produced 40% of our calendar year 1983 income to date. This is slightly ahead of our self-support schedule. However, the usual, considerable education and acceptance period associated with deriving income from individual subscriptions to cooperative efforts of this kind has not yet been overcome.

Finally, we are applying recent research results of the University of California's Cooperative Extension Service to create new products based on the cumulative effects (as the crop year progresses) of temperature, humidity, solar radiation and wind. We anticipate that growers will use these forecasts to help avoid costs during pest-management and irrigation activities. Our Board feels that this third product line is potentially the most important of our activities and is especially necessary because the University of California has announced its intention *not* to become a "weather service." California growers are perhaps fortunate, also, in the strength and vigor of the State's agricultural advisor industry with whom we are building an ever closer working relationship.

The Technical System. In support of these activities we operate a stand-alone McIDAS system, an electronic communications system which includes commercial software running in Apple II Plus microcomputers, three acoustic echosondes manufactured by Radian corporation, and an expanding network of remote automatic weather stations located in fields and orchards--currently numbering 15 Campbell Scientific units polled each hour by telephone. (For more information see Hilyard, 1977; Hauser et al., 1981; and Hauser, 1982b.)

We use the output of the National Climate Analysis Center and will receive, soon, time- and space-tapes of California climate data prepared for us by Amos Eddy of the Oklahoma Climate Survey. We will be working with the California State Climatologist in connection with data terminal access to the National Climate Center during summer of 1983. We also make use of ports on computers in both the National Weather Service's River Forecast office and the California Department of Forestry in Sacramento.

We believe that our use of the products of larger, more centralized computer systems operated at the State, regional (multi-state), and Federal levels will increase as additional electronic communications facilities become available there. We recognize a responsibility to share observations from growing regions where appropriate. We are willing to explore ways to place some of our information into these larger systems.

We have found it necessary, however, to have the local-level (sub-state) outlet as an essential part of the weather/climate information system to enhance our degree of contact with the agricultural user community. Finally, we continually review our product list and technical system against the private-sector criterion for viability: Do the users find that the value they assign to our information exceeds the price they must pay? The long-term answer, of course, will be found in their willingness to continue to pay our costs.

Some District Details. The fees paid by District subscribers are directly tied to the value of production. The group of District sponsors provides advice both on the design of the District's fee schedule and on the final unit (per acre) price. Most District subscribers are comfortable with production-related annual fees, because they feel that each subscriber should pay a fair share of the District's cost. We estimate a minimum program of District forecast-recording services costs at least $20,000 per year.

The two types of fee schedule are in operation now. Both result in annual fees which are subject to a minimum annual fee of $75 per subscriber. The first schedule is a flat 20¢ per acre per year. Thus, only productive acreages greater than 375 acres pay above the $75 minimum fee. The second schedule was proposed because of the sensitivity on the part of some farm operators who preferred not to reveal the exact number of acres they have in production. In this case, annual District fees are tied to acreage categories: 0-300 acres--$75; 301-700 acres--$100; 701-1200 acres--$150; 1201-2200 acres--$250; 2201-3200 acres--$300; and 3201+ acres--$350. Some single, very large diversified farming operations are considering forming one or more "Personal Districts."

Industrial and commercial subscriptions to minimum District services are available. The current schedule of annual fees is as follows: 1-5 employees--$75; 6-20 employees--$150; 21-75 employees--$250; 76-200 employees--$500; 201+ employees--$1,500.

The first Districts in Butte, Sutter and Yuba counties are in the formation process. The Butte effort began 1 September 1982 and the Yuba/Sutter campaign began 1 February 1983. None of the Districts is yet fully subscribed. As of 1 March 1983, there were 116 subscribers with 88,000 subscribed acres. The size distribution represented in this total is shown in Figure 1. Interest in the District concept has been forthcoming from individuals and organizations located throughout California.

Continued marketing effort has revealed that subscribers desire more than just a thrice-daily, geographically specific, telephone recorded forecast. There is additional value in site-specific products related to pest management, irrigation, disease control, the application and drift of agricultural chemicals, and quantification of the type of 3- to 10-day outlooks usually phrased using terms such as above and below "normal." Satellite images with interpretive markings are also of genuine interest.

We have found among the majority of our users little interest in, or appreciation of, fine distinctions between "weather" and "climate." In fact, our educational activities among farmers are advanced when we simply show examples, the forecast-period time-spans of which range widely from very short term through seasonal. Beyond ten days into the future, we draw entirely on National Weather Service products for these examples and we readily acknowledge this fact.

Another essential aspect of District success is our ability to provide a broad range of support services. Table 1 outlines these meteorological and climatological service categories. Both horizontal integration of the product line and vertical integration of available services are keys to achieving the forward progress we all seek, in our opinion.

The Future. In order to meet the needs of our users, we have found it essential to exercise a broad range of technical capabilities. Geostationary satellite images, available every half-hour in digital form for subsequent processing, pixel-by-pixel registration and high-resolution display, play a key role both in timing forecasts and in enabling fine-scale site prediction. Access to National Weather Service computer-forecast model outputs in digital form at speeds of 1200 bits per second or greater (asynchronous) is essential for positioning of synoptic-scale features out to 5 days. Hourly surface and twice-daily upper-air observations, again in digital form at medium or high speeds, must be input to fast and flexible analysis and display computer programs.

The ability to add dense, local observations at relevant agricultural sites to the National Weather Service skeleton observations is essential to maintain local-scale credibility. Access to a large and flexible, computer-compatible climate data base permits climate and anomaly mapping with a flexibility and level of detail which can respond quickly to a user's question. A broad range of out-communications options is necessary to make use of the communications systems already in routine use for serving the farming community. Finally, a very important item is an increasingly close working relationship between meteorologists and the knowledgeable agricultural experts located both in local Farm Advisors offices and in the agricultural advice industry.

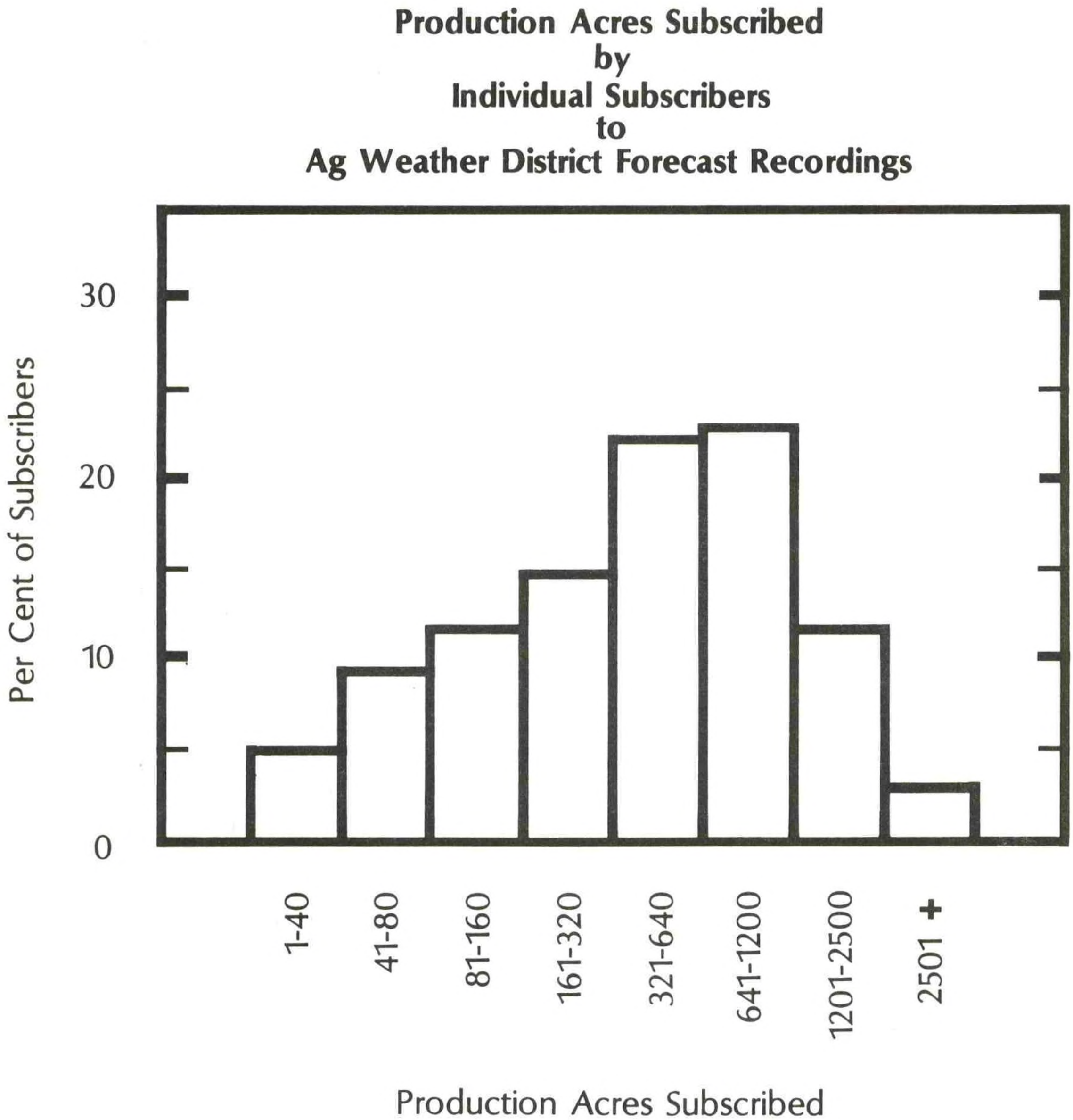
Production Acres Subscribed
by
Individual Subscribers
to
Ag Weather District Forecast Recordings
Per Cent of Subscribers
30
20
10
0
1-40
41-80
81-160
161-320
321-640
641-1200
1201-2500
2501 +
Production Acres Subscribed

Figure 1.

With such technical tools at hand, today's agricultural meteorologists can respond to the increasingly technical needs of farm managers for modern ag weather services. These considerations have led us to the ag weather and climate system concept outlined in Table 2. Centralized components are needed only for the larger and more expensive elements of the system: the direct digital acquisition of stretched VISSR geostationary images and their preprocessing for transmission to remote work stations; and the storage and preprocessing of computer-compatible climate data. Regional (multi-state) and national storehouses for climate data will undoubtedly prove useful. Similar storehouses for satellite images probably will not prove as useful, because of both the volatility and the volume of such data.

To bring the full benefit of modern ag weather technology to California growers, the major theme must be cooperation. The private-sector must be encouraged to provide the farm manager with weather and climate information that matches his window-of-opportunity for management action. The public-sector needs to encourage and nurture this private-sector development through its early stages. The agricultural end user is intrigued and willing to fund proven applications. Cooperation is particularly necessary to ensure compatability and open exchange, where appropriate, of the automatic weather station observations that are becoming increasingly common.

Cooperative efforts can bring economically important ag-weather and climate assistance to the two types of productive farming operations which are evolving in our nation at this time. The small farm which is operated by someone with a second source of income remains economically viable and deserves to be served. So does the larger farming operation, most of which are becoming larger.

NOWCASTING, Inc. is now investigating several public-private partnership options which, we hope, will lead to the system described in Table 2 One possible configuration consists of a central facility in Davis or Fresno with ten to fifteen ag meteorologist work stations at various locations in growing regions of the State. The possibility exists for appropriate use of the California State University microwave system now in the final planning stages and supported by U.S. Department of Commerce funding.

Conclusion. There is no technical reason to delay further our taking major steps into the ag-weather future. By working together and in close communication with the modern agriculturalist, much of a useful nature can be accomplished. Of course, a key to the success of any cooperative effort is the practical utility and user understanding achieved by the end products that result from technological opportunity. Perhaps one way we at NOWCASTING can help achieve advances in this important effort is to call attention to the two-day Conference on Weather Information Packages for Use in Agriculture, sponsored by the W.K. Kellogg Foundation and scheduled for May 1984 at California State University, Chico. We would be pleased to correspond with any parties interested in attending or participating in this workshop.

In any case, we believe the future of ag weather and climate services is exciting and pledge to work cooperatively with those who have shared their knowledge at this present Conference.

Table 1

Outline of Ag Weather District Service Categories

FIELD OPERATIONS
- Automatic Weather Stations
  - Siting & Installation
  - Maintenance & Repair
  - Automated Telephone Polling
- Special Equipment and Sensors
  - Acoustic Echosondes

DATA PROCESSING
- Input Message Handling
  - Broadcast & Interactive
- Interactive Data Manipulation
  - Merging Data from Many Sources
  - Error Checking
  - Analysis
  - Interpretation
  - Processing Raw Observations to Products for Application in Agriculture
  - Registration of Earth-Based Observations into Satellite Perspective
  - Complete Satellite Image Processing
- Real-Time Interaction with Historical Data
  - Full Cooperative Station Climate Histories
  - Real-Time Anomaly Updating
  - Local-Scale Climate Mapping
  - Archiving for McIDAS Analysis

FORECASTING
- Operational Focus
  - Weather Events
  - Fine-Scale Timing
  - Real-Time Updating
- Grower-Forecaster Interaction
  - Educational Materials
  - Involvement in Flow of Farm Management
  - Feedback and Advice
  - Agricultural Advisor Industry

DISSEMINATION
- Television
  - Full-Color Broadcast
  - Cable TV
  - Closed-Circuit TV
- Radio
  - Commercial Radio
  - Public Radio
  - Business Radio
- Telephone Line
  - Human Voice-Recorded Messages
  - Dial-up Line to Personal Computers

Table 2

Future Ag Weather System for California

Redundant Centralized GOES-West Acquisition and Processing

Automatic Weather Stations on Phone Lines or Radio

Microwave Communications to Work Stations

Microcomputer Remote Work Stations for Ag Meteorologists
- Image Display
- Satellite Reception of Real-Time "Public Service" Data
- Meteorological Data Processing
- Microclimate Data Processing
- Agricultural Data Processing

Climate Data Base Available for Computer Interrogation

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REPORT OF JAMES T. DUNCAN
EXECUTIVE VICE PRESIDENT & GENERAL MANAGER
FLORIDA FRUIT & VEGETABLE ASSOCIATION

One hundred and twenty miles of radishes -- this is what one large Florida farming operation harvests most every day from October to May. (That's a lot of burps!) Agriculture in Florida is big business.

Cash receipts from marketing Florida's agricultural products in 1981 totaled over $4 billion. Florida ranked 12th in the nation in total cash receipts from farm marketing. In 1981, Florida's cash receipts were:

Citrus - 31%	$1,240,000,000
Livestock and Products - 25%	1,000,000,000
Vegetables and Melons - 20%	800,000,000
Miscellaneous Crops - 13%	520,000,000
Field Crops - 11%	440,000,000

Florida's diverse agricultural industry is an important element in the State's overall economy with 39 percent of Florida's total land area devoted to farming operations.

If you couple all the related agri-business support dollars to the cash receipts dollars, you can clearly see that Florida has a multi-billion dollar farm economy, an economy that has all the signs of a healthy growth provided, of course, the weather continues to cooperate and behaves in its normal unpredictable manner.

Let's take a look at our state's farming seasons in relation to our weather and climate. Florida's geographical situation, surrounded on three sides by water, and having a very low elevation, makes for a warm-humid climate with a normally high rainfall. Of course, the climate has a decided influence on where, when, and how crops are produced in the fall, winter, and spring seasons. The hot and rainy (humid) months of July, August and September are devoted to land preparation and planting of crops for the fall shipping period. Summer rains are advantageous to the citrus crop and to recharge surface and groundwater reservoirs which will be tapped for crop irrigation during production months. This year we can add fall and winter rains to the recharge cycle. In layman's language, we are just about over recharged.

Climate, too, plays a big part in determining where in Florida particular crops are concentrated; for example, Citrus groves appear in 41 of 67 counties with the central counties devoted predominantly to citrus. In recent years, as the result of tree damaging freezes, new citrus acreage is moving southward. Actually, the citrus industry got its start much farther north, but cold weather has caused a continued trend toward warmer locations.

In vegetable crops, fall production begins in the central area and migrates southward in order for the tender crops to escape the possibility of cold weather in the months of December, January, and February. Then as the warm spring months approach, crop migration moves north again.

The needs for climate and weather data are as varied and diverse within Florida's fruit and vegetable industries as the industries themselves are varied and diverse. Each industry has its own production cycle and its own particular needs for information, as growers make decisions affecting the planting, culture and harvesting of crops; needs that are determined by type and variety of crop, geographical location, and other factors.

Thus a conference such as this is very timely. The opening sentence of Mr. Hecht's letter to me last December said; "We invite you to participate in a conference to evaluate options for public/private cooperation in providing regional, state and local climate services." Then, following a very interesting summary about recommendations provided by the NAS Climate Board's Panel on Intergovernmental Climate Programs in their recent report, entitled "Meeting the Challenge of Climate" and comments about what has been done already in connection with those suggestions, Mr. Hecht said; "We would like to hear from you on the climate and weather data and information needs of Florida fruit and vegetable growers. We would also be interested in the relative importance to agricultural users of real-time, near real-time and historic climate data and information." Then, he said, you have twenty minutes. I'm not sure to which of the three suggestions I should pay the most attention - I question that the three are compatible - so, I shall proceed on the basis that I was being given friendly advice about how to fulfill my obligations for this assignment, which literally interpreted means "do as you please."

So much has happened within the last couple of years affecting our weather reporting services. On the one hand, we talk about the fact that a good deal more needs to be done to achieve a nationwide system of climate services:

That NOAA's roles, capabilities, and plans for providing climate services must be understood as a first step in program coordination.

That the USDA role in education and delivery of climate services must be clarified.

That the potential and limitations of State Climatologists for providing climate services and the option of regional climate activities need to be evaluated.

And, that ways of integrating public and private climate services should be recommended.

On the other hand, I note from the Department of Commerce Budget recommendation for fiscal year 1984 that "The Agricultural weather, fruit frost, and aviation area forecast programs are proposed for termination, and the fire weather program is proposed for reduction." I suspect that this conference does not intend to deal with the political aspects of the situation, but I suggest that if that budget recommendation is approved by the Congress, that the purpose of this conference takes on an entirely new direction. I believe in being realistic. I will state publicly to this conference, Dr. Byrne, and Dr. Friday, that the Florida Fruit & Vegetable Association, and I am sure many other agricultural groups in Florida, will do everything possible to assure the continuation of the Agricultural Weather Forecast and Advisory Service at Ruskin, Florida, until we are convinced there is a better way to do the job.

I believe we have representatives from the Department of Commerce and from USDA at this conference. I would hope that people in both Commerce and USDA would do whatever they can to see that the kind of information the producer needs to enable him to be efficient and competitive in the marketplace is readily available at all times. It seems to me this is in the public interest as well as in the interest of agriculture. If that type of program is not to be continued, then I suggest the agenda of this conference should be changed to deal with just how this information is going to be available in the future.

Upon the presumption that agriculture's efforts to preserve the service will be successful and that we will have the support of Commerce and Agriculture in this endeavor, I will get on with my assignment. I must say however at this point I have some reservations about such support.

In Florida agriculture, we have several basic needs for climate and weather data and information.

In the interest of simplification for me in preparing this report, I shall integrate (if you please) comments concerning climate and weather data and information needs. I will leave it to the learned individuals in the field of weather to make whatever separations are considered necessary or desirable in the final analysis. When we talk about the weather on the farm, we tend to make it one subject and deal with all aspects as one subject.

First, let's deal with RAINFALL:

Today and every day the grower needs to know just as much as possible about rainfall yesterday, today and tomorrow. And, when I say grower, I mean the man and/or company who produces, markets and delivers. It is understood, of course, that in many instances this might constitute two or three or more distinct and separate operations.

Some of that need is climate data and some of it is weather information. We need to know the past rainfall record and variation in rainfall from dry to wet years. This we put in the crystal ball for long-range planning. For immediate use, we also need to know the evapotranspiration and evaporation possibilities of water from the fields; with this information and knowledge of how much it rained yesterday and how much is expected tomorrow, we can determine whether to irrigate and whether to send harvesting crews to the field. Historical information of this type is essential for decision making about whether an irrigation system is needed and if so the type that would be most efficient. Also, such data is important for determining the right variety to plant in terms of drought, hardiness and irrigation requirements. Actually, in day to day operations, it is a continuous consolidation of weather data and current weather information in the decision making process. Should we lower water tables in canals and fields? Should we irrigate? Should we make pesticide applications? Today, what to do about IPM (Integrated Pest Management) programs for disease and insect forecasting.

These comments, of course, point to just a few of the informational and historical data needs related to rainfall, but let us get on with some other weather subjects as they relate to Florida agriculture.

TEMPERATURE - High, low and average temperature both wet and dry bulb essential.

Also temperature information highly important in predictions of pest outbreaks under IPM programs.

PRODUCTION - Needed in scheduling planting and harvest. Days to harvest vary due to temperature. Planting, harvesting and handling timing and procedures will also be affected by temperature.

COLD PROTECTION - Cultivation, harvest and irrigation must be altered well in advance of frost or freeze. Duration of possible frost conditions as well as temperature low are needed. Cloud movement, wind or calms are also important in frost or freeze outlooks.

WIND - Velocity, duration and direction are needed. And in connection with IPM - needed for insect and disease movement locally and between areas. Application of pesticides must be altered due to coverage and drift.

PRODUCTION - Field preparation, planting, transplanting, are stopped and protection of young plants is essential in times of high winds. Winds can also scar fruit and desicate leaves, thus, precautions must be taken against this happening.

Rapid communication of the current temperature situation is needed when a freeze is likely, including projecting the low temperature and the number of hours it is liekly t be below freezing, below 28, 22, etc. Also, it is important to know long-range forecasts, as well as short-range, one to three days; with 8 or 10 hour forecasts very important when extremes are anticipated. Three-day forecasts allow enough time for extensive flooding; while eight hours help if heating, wind machines or undertree irrigation are to be used. Of course, following a freeze, it is nice to know how cold it got, particularly the number of chilling hours plants received in particular locations.

Also, in connection with temperature and wind information, we need current and historical information about frost probability because most Florida crops are susceptible to frost damage; and knowledge of inversions and winds are important, particularly during pesticide applications and at times of agricultural burnings.

We must deal, too, with:

DEW POINT AND DURATION OF WETNESS - Needed for both harvesting scheduling and disease control.

HUMIDITY INFORMATION - Needed for IPM work.

CATASTROPHIC EVENTS - Hurricane, storms, hail. No explanation needed.

I should add, too, a couple of points about which I know little but about which I have heard discussions.

(1) The availability of computer enhanced radar sweeps following fronts moving into an area; and

(2) A more defined area in Satellite Freeze Forecast Systems.

When we stop and make a careful or detailed search for information that the Florida farmer needs to operate successfully, it is difficult to find a stopping place. Someone handed me a memorandum that I thought pretty well summarized the situation. I would like to share it with you and give credit to whomever passed it to me; i.e. -

It says: "Examples of needs"

Under short range (1 to 3 days)

Accurate and timely freeze and frost warnings are needed to maximize the effectiveness of our cold protection systems and practices - both active and passive.

Precipitation and wind forecasts are essential to the success of our extensive spray programs.

In the intermediate range (3 to 10 days)

Need the best post freeze projections of weather (particularly temperature and precipitation) to efficiently manage replanting and/or salvage operations.

Need precipitation projections for effective soil fumigation programs.

In the long range (more than 10 days)

We need a blend of "climatological" probabilities and synoptic data to make judgments on such things as removal of banks from young trees.

Needed for late winter and early spring plantings of vegetable crops.

And, in speaking of not knowing where to stop, I should mention that nothing has been said about other kinds of information needs that come to mind like cloud location, lightning probability, growing degree days, etc.

And, why should we be so interested in the availability of this information? Simple, an ever increasing population in the United States and in the world must be fed and in this country as you know that population is almost totally dependent upon the American farmer to provide its daily bread.

The American farmer provides food for more people for less money by far than any other farmer in the world. Improvements in technology, know how and good ole American ingenuity under the "Free Enterprise System" has made this possible. We must not only protect but perpetuate that fact and one of the important elements to make this a reality in Florida agriculture is the continuation of good dependable and reliable weather data and information.

The Institute of Food and Agricultural Sciences (IFAS) at the University of Florida just recently completed an extensive study about "Florida Agriculture in the 80's" having to do with Florida agriculture in the next decade. I was fortunate to have had a part in some of the deliberations in the series of reports containing projections for the future of Florida agriculture. I am taking the liberty of quoting from a special report by the "Agriculture and the Florida Economy Committee" included in this IFAS study regarding the future of Florida agriculture:

> "The Development of Florida agriculture to its current level, did not occur by chance or because of any unique historical advantages. In fact, Florida agriculture developed in spite of enormous problems of soil fertility, pests and diseases. Overcoming these problems reflects on the ingenuity of Florida farmers and supporting research and technology. Continued growth in the future is likely to be at least as big a challenge as has growth in the past."

I believe this conference could be the vehicle that might make that challenge a little easier. Should we do any less?

REGIONAL AND STATE CLIMATE SERVICES

Synopsis*

Climate services are provided by the Federal Government, states, regional centers, and the private sector. The goal of this session was to review activities of two regional centers established by states with NCPO support, and two state centers. A survey of state climatologists was reported. These examples show that states are a vital part of national efforts to disseminate climate information.

John Vogel (Illinois State Water Survey) reported on climate activities in the North Central Region. The plan for a regional climate center was initiated from the North Central Regional Research Project, "Characterization of the Climate and Assessment of its Impact on Agriculture and other Renewable Resources " (NC-94). NC-94 is supported by USDA regional research funds and is conducted jointly with the State Agricultural Experiment Stations in the region. A Regional Climate Coordinating Office (RCCO), located at the Illinois State Water Survey, coordinates activities between the states and federal agencies including NOAA (NCPO,NESDIS, NWS), USDA, NSF, and DOE relative to data acquisition, advisory services, data archiving, and research. RCCO's activities have included preparation of a newsletter, visits to states, contacts with federal agencies, coordination of regional data collection, acting as a clearinghouse of information, and initiating proposals for regional research.

Boyd Pack and Thomas Schmidlin (Cornell University) reported on climate activities by the Northeast Regional Climate Office (NRCO) located at Cornell University. Like the north central activity, the regional effort was formed by state initiative with support from USDA-funded regional research, "Impact of Climate Variability on Agriculture (NE-135). The primary effort of NRCO is acquistion and dissemination of climate data and information. Most states in the region have no climate center and thus no mechanism to pass data and information from the federal level to the user. The establishment of NRCO provided the mechanism and reduced the workload on the National Climatic Data Center. Climate summaries for ME, NH, NY, and VT are prepared and disseminated monthly to over 3800 users. Participating states have a computer link to NRCO. Two answering telephones gave local and regional weather and climate information to 100,000 users last year. The program also is designed to provide information to state agencies and to inventory climate data sets.

Thomas McKee (Colorado State University) reported on the Colorado

* Reported by Thomas McKee, Colorado State University

program which has been active since 1973. Requests to the center have increased at the rate of 30% per year and currently number about 150 per month.

Some new uses of information include a solar radiation summary, a method to determine minimum design temperature, and the use of a high spatial resolution Palmer Drought Index in Colorado to monitor drought.

Conclusions based on 10 years' experience are:

- Demand for climate information continues to rise.
- A high quality data base is essential.
- Local climate expertise is essential.
- Computer technology will transform methods.
- Users should pay a portion of the cost.
- Cooperative observers are a success.
- A small fraction of climate information users receive most of the value.
- New uses of climate information can be developed through research.
- Close association of services and research is beneficial.

David Miller (University of Connecticut) reported on Connecticut's climate program which has been developed in the past five years. Climate is viewed as a natural resource, and the climate data base is integrated with other natural resource data. A survey was made to determine climate information use, user needs, data requirements, and costs and benefits of using climate information. One analysis concerning energy management indicated potential savings from using climate information in excess of $10 million.

A state climate plan has been formulated. Climate data will be maintained by the Connecticut Department of Environmental Protection. Service and research will be handled by the University of Connecticut Cooperative Extension Service. The plan also provides for an advisory committee to interact with the program.

Fred Nurnberger (President, American Association of State Climatologists) discussed results of a national survey of state climatologists which he conducted. The number of state climatologists has increased to 47. State programs vary greatly. Over 70 percent of the state climatologist are located at universities, and 20 percent are at a state agency. The majority say their program has grown some in the past 3 years, but 20 percent said they do not have an active program. Some expansion was reported to add computer equipment (12 states) or staff (10 states). But about half of the programs have one or less than one full time position, and only three states have more than three full time staff. A majority projected no changes in the next 1-3 years. They desire more interaction with the Federal Government.

GOALS AND EXPERIENCE IN REGIONAL CLIMATE COORDINATION: NORTH CENTRAL STATES

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INTRODUCTION

The Regional Climate Coordinating Office (RCCO) was formed in 1981 in Champaign, Illinois, funded by the National Climate Program Office and the State of Illinois, with the primary objectives of: 1) upgrading the climatic services within the North Central Region, and 2) demonstrating the feasibility of the regional approach for the provision of climate services. The plan for the RCCO was conceived by the North Central Regional Research Committee, or NC-94, in order to develop a regional intergovernmental climate program within an existing institutional framework that would include data management and impact studies for the 12-state region (Fig. 1).

PROJECT GOALS AND OBJECTIVES

The overall goal of the NC-94 Plan is to develop an infrastructure to coordinate climatic research studies, advisory services, and data management activities in several states. The key components of this plan are 1) 12 State Climate Centers and 2) the Regional Climate Coordinating Office.

The lines of communication among federal agencies, state climate centers, and users prior to the initiation of the NC-94 Climate Plan were not uniform (Fig. 2). Information flow from federal agencies to State Climate Centers was dependent upon the level of communications which had evolved between the State Climate Centers and federal agencies, and varied from inadequate communications to essentially full communications. The size of the state boxes (Fig. 2) represent the varied levels of support for State Climate Centers within the North Central states. The level of support for basic climatic services at some State Climate Centers is almost non-existent, others possess only a minimum of services, while others are able to maintain various research projects in addition to providing basic climatic services to users. An objective of the full implementation of the North Central Climate Plan is to provide a data and information communication system between federal, regional, and state agencies. The general flow of information from federal agencies and State Centers will be achieved through RCCO, as shown in Fig. 3. A second objective of the 4-year demonstration project is to bring all 12 State Climate Centers to some minimum level of support. The RCCO is the vehicle to provide guidance through which 1) the objectives of the NC-94 Climate Plan can be accomplished, 2) the communications between federal, regional, state, and private user groups can be encouraged and maintained, and 3) the coordination of regional goals, climatic data sets, and climatic impact research can be achieved.

Figure 1. Location of State Climate Centers in North Central States.

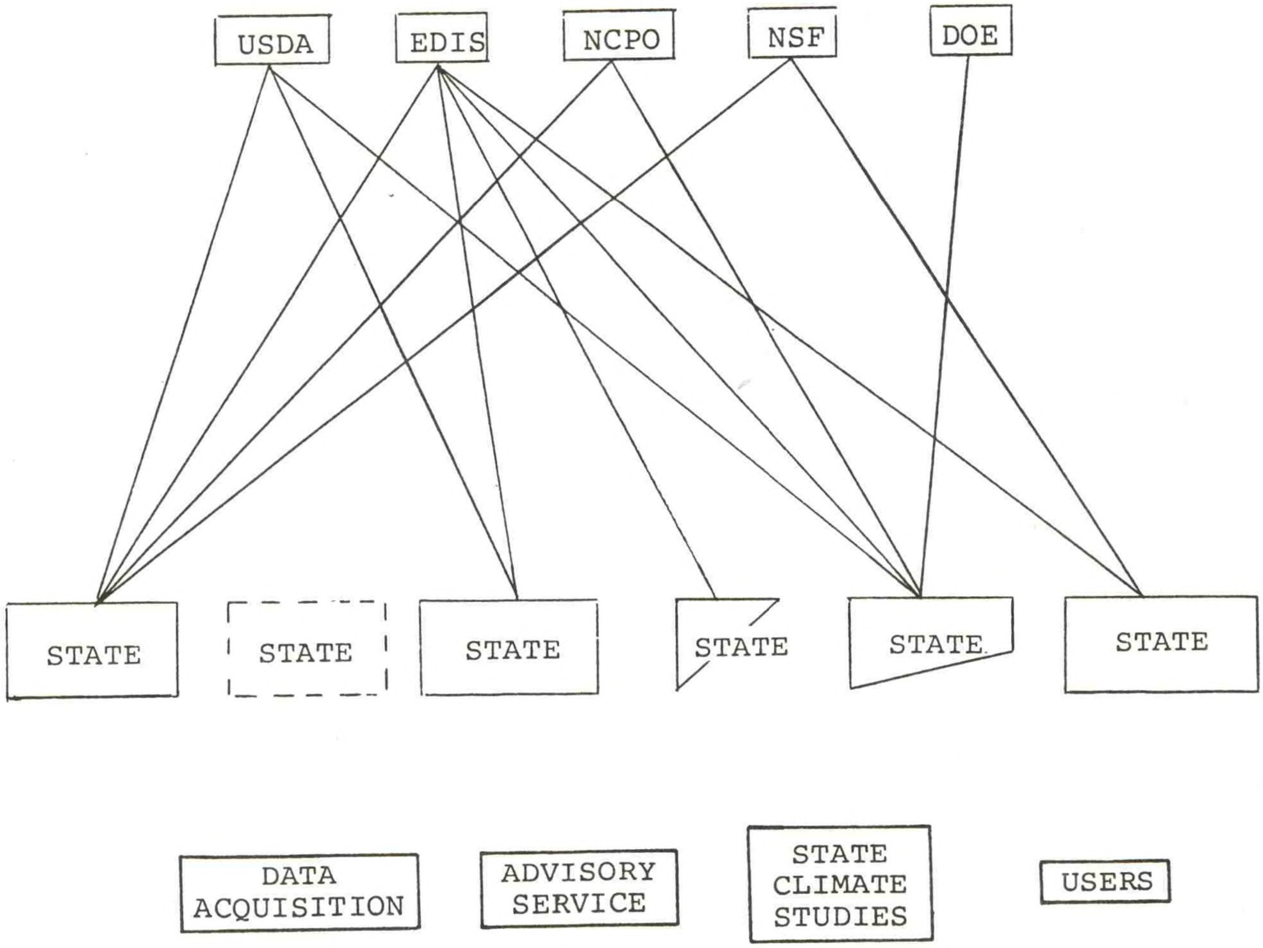

Figure 2. Lines of communication prior to NC-94 plan.

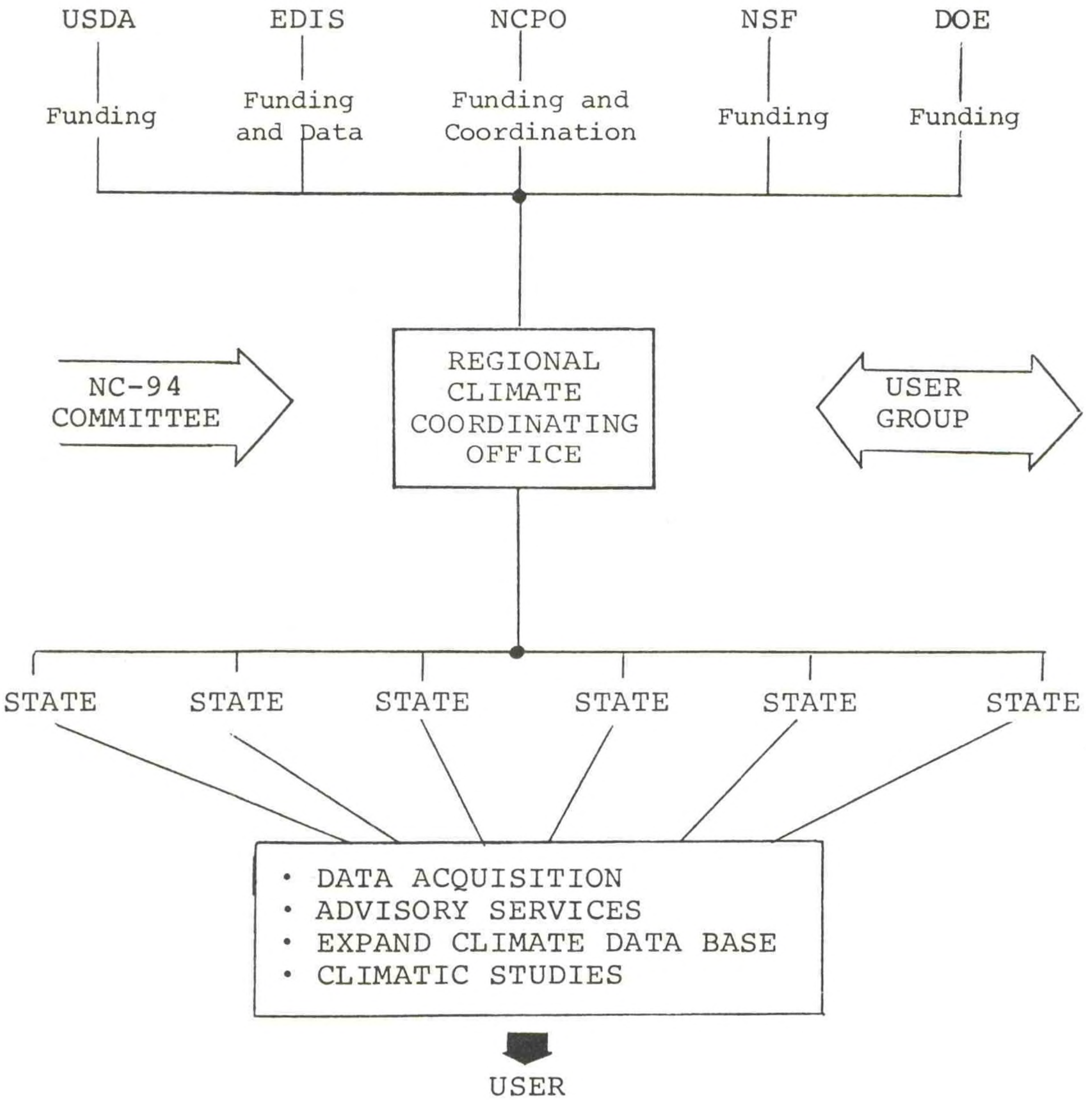

Figure 3. Lines of communication and structure of State Climate Centers at conclusion of NC-94 Climate Plan.

The State Climate Centers provide the foundation for the proposed regional program, and it is necessary for the State Climate Centers to achieve a minimum level of climatic services and research capabilities. The State Climate Centers are able to maintain close contact with the user groups within each state, and are aware of the specific needs for their areas so that their efforts can be focused for maximum local benefit. At the state level, the link between the users of the climatic data and information, and the NCPO will be the State Climate Centers. The main program components of each State Climate Center are: 1) advisory services; 2) acquisition of data; 3) expansion of climatic data bases for special studies and special needs; and 4) involvement in climatic impact research.

The primary purpose of the RCCO is 1) to improve the efficiency and effectiveness of the State Climate Centers and 2) to offer a means for all federal agencies involved in climate to have a convenient communications link with the states. This is accomplished with the RCCO: 1) overseeing and coordinating regional programs housed at State Climate Centers; 2) serving as a clearinghouse of information between State Climate Centers and other state and federal agencies; 3) administering federal funds allocated for regional activities; and 4) advising and assisting State Climate Centers and federal agencies. The RCCO performs the management roles for the regional research committee and remains accountable to NC-94. The major tasks or responsibilities of the RCCO are: 1) program management of projects and funds allocated from federal and other non-state sources for regional work; 2) management of regional climate data, special data networks, and the near real-time collection of climate data; 3) development, promotion, and coordination of regional climatic research and impact studies; and, 4) liaison with federal, state, regional, and private groups within and outside the North Central Region.

This paper will summarize the activities and accomplishments of the RCCO by reviewing some of our experiences within the four major tasks areas.

PROGRAM MANAGEMENT

Key components of the NC-94 climate plan are the optimization of climatic services, climatic data bases, and communications. Essential to all three of these components is the development of specific hardware to facilitate data management and data communication within the region. The Computer Communication Subcommittee of the NC-94 Committee developed criteria for microcomputers in State Climate Centers, which would have the ability to send, retrieve, or develop climatic information for use within State Climate Centers or for communicating between State Climate Centers. The RCCO developed a proposal utilizing the results of the Computer Communication Subcommittee, calling for specific hardware to be used in a common manner throughout the region. Since each State Climate Center would have common hardware, software packages developed at State Climate Centers could be readily exchanged. The proposal calls for a two-year development with the acquisition of 6 microcomputers in the first year and 6 more microcomputers in the second year. At the end of the two-year period it was envisioned that a regional system would have been established. The proposal, which was submitted to NESDIS, requests funds only for the acquisition of the basic hardware.

The 12 State Climate Centers were visited by RCCO staff to 1) become familiar with the personnel and facilities in each state; 2) promote state investments into climatic resources; and 3) identify the resources presently available. A summary of the resources available in each of the 12 states is available in the RCCO Annual Report (Vogel et al., 1982).

The State Climate Centers in all 12 states recognize a user need for near real-time climatic data to characterize present climatic conditions. As a result, a significant effort has been, and is being, devoted to the acquisition of climatic data in a timely fashion. In some states, special networks have been developed to transmit climatic data on call; in others data from cooperative observers are directly forwarded to the State Climate Center. In addition, each state has at least one climatic station to provide measurements of a variety of climatic parameters; such as, soil moisture, soil temperature, humidity, wind, evaporation, solar radiation and others. The augmentation of climatic data and the acquisition of near real-time data are all part of the NC-94 Climate Plan.

A primary goal of the NC-94 plan is to develop at least a minimal level of climatic services in each state. Representatives within each state have been working to upgrade their climatic services, and the RCCO has assisted these states in several ways. Usually, this takes the form of visiting key personnel within state government or administrative officials within universities, and providing information on the types and benefits of various climatic services to agriculture, state governmental agencies, businesses and individuals. In two states within the North Central Region, extension climatologist have been added to the staff of State Climate Centers within the last year and additional climatic services are now available. In a third state, a State Climate Plan was formulated, and approved by the state government, thus, accepting the responsibility for state-supported climatic efforts. It is hoped that this will eventually provide the impetus for obtaining state resources to support this State Climate Center.

DATA MANAGEMENT

A major aim of the NC-94 plan is to develop compatible formats to facilitate the exchange of historical and near real-time data. The National Weather Service Central Region Office is presently developing a system for the real-time acquisition of climatic data, and the RCCO has been working with Regional Office to ensure that data from this system will be compatible to computer systems in the North Central Region. The RCCO is also maintaining close contact with the National Climatic Data Center as they redesign the format for the historical data sets, and as they prepare to accelerate the data exchange between themselves and the states through the use of computer systems.

The RCCO is consulting with the National Weather Service to develop software to facilitate the exchange of data between State Climate Centers and federal agencies.

COORDINATION OF RESEARCH AND IMPACT STUDIES

Three regional research projects coordinated by RCCO are currently underway and two are in the planning stage. The three in progress include 1) determination of corrections to monthly mean, maximum and minimum temperature normals (1951-1980) for over 100 stations in the 12 states of the NC-94 region, 2) a regional study of contrail frequency over the 12 state region, and 3) a review of the anomalous weather during 1982-1983 winter over the 12 state region.

The corrections to the 1951-1980 normal temperatures come about because National Weather Service cooperative stations observe the previous 24-hr maximum and minimum temperature at various times of the day in accordance with their personal schedules. Research (Mitchell, 1958; Baker, 1975; and Dale and Schaal, 1977) shows that if maximum-minimum thermometers are read from about 0500 to 0700 local time, mean monthly minimum temperatures tend to be 1 to 2°F lower than those determined at 2400 hours. If the temperatures are observed from about 1500-1800 local time, the mean monthly maximum temperatures are elevated 1 or 2°F from those observed at 2400 local time. The magnitude of the correction is also a function of season of the year and locale. From temperature data observed each hour of the day, we will generate corrections by season and by location for the 12-state area and apply these corrections to the preliminary published 1951-1980 means.

At the October 1982 NC-94 meeting, the RCCO requested all NC-94 representatives to contact County Extension Agents in their states to entice their help in identifying a cadre of volunteer contrail observers, whose observations would help determine the areal extent and density of persistent contrails on any given day during the four seasons. The topic was discussed, and accepted. The NC-94 representatives asked their state Cooperative Extension Agents to disseminate this request to their County representatives. Thus far, responses from about 60 volunteer observers have been received in 6 of the 12 states, indicated on Fig. 4. The RCCO will contact each of the volunteers in mid-June, sending them an observation form with instructions, and return stamped envelope for their July observations. Observations will be taken again in October 1983, January and April 1984.

Because of the anomalous temperature and precipitation observed in significant portions of the NC-94 region during the past winter, RCCO contacted the State Climatologist in all 12 states to request a listing of preliminary mean monthly temperature, precipitation, and departures from the mean, for stations in their states. In addition, they will contact various state government agencies as well as private industry to assess the impact of the anomalous weather on fuel needs, reduced budget funds spent for snowfall removal, and an anticipated impact on agriculture during the coming growing season. The article will be written at the RCCO, submitted to each of the State Climatologists for review, and submitted to Monthly Weather Review.

In order to encourage cooperative regional research projects within NC-94, the RCCO submitted a proposal (Wendland, Changnon, Vogel, and Jones, 1983) entitled "Proposal to Convene a Workshop to Write Two Regional Agriculturally Oriented Research Proposals" to the North Central Computing Institute (NCCI) at the University

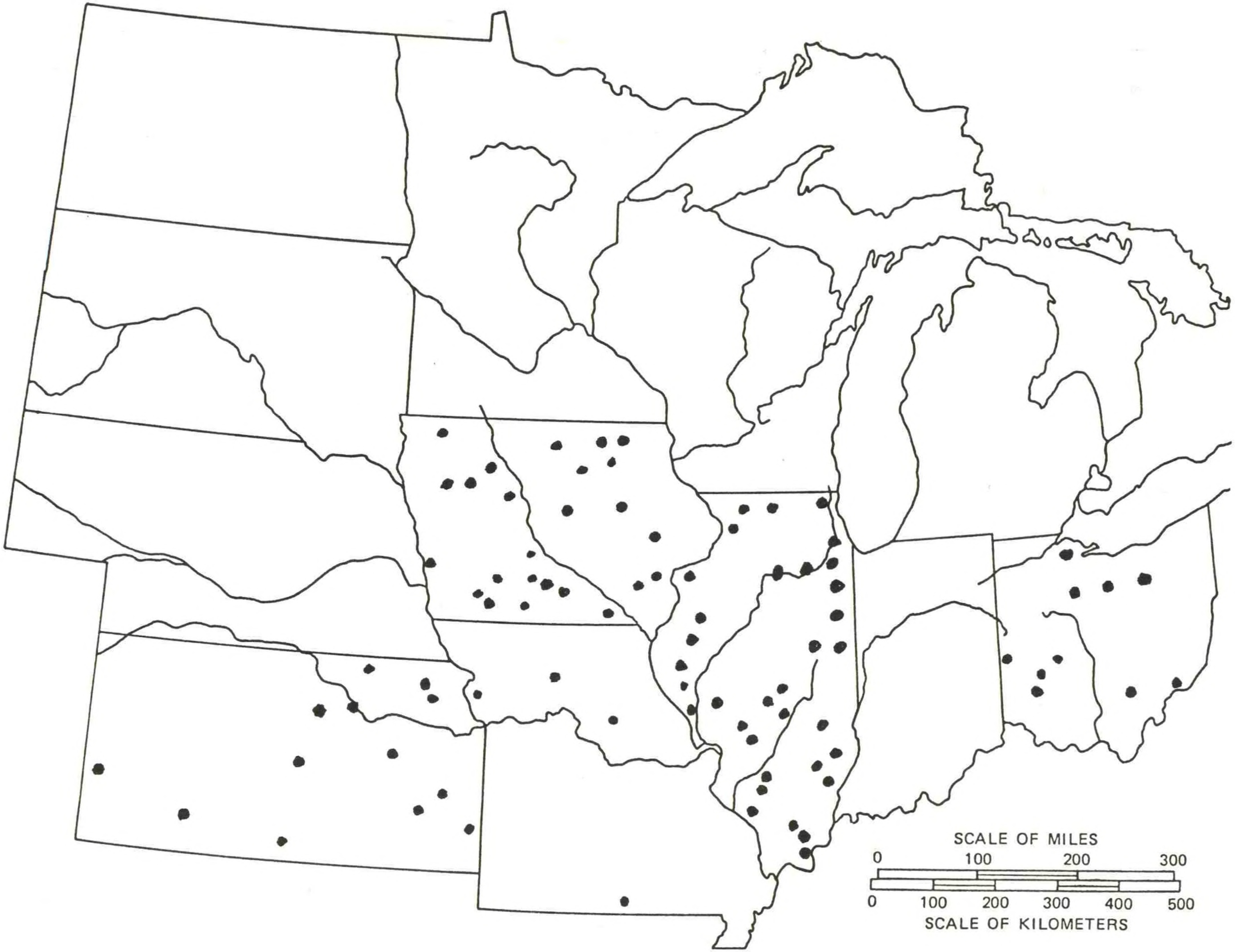

Figure 4. Locations where volunteers have been identified to participate in the contrail observing network (as of 15 March 1983).

of Wisconsin-Madison. NCCI encourages the development of regional data sets, and software development for regional agriculturally oriented research. The proposal to NCCI is to support travel and per diem for representatives of interested states within NC-94 to attend a 3-day meeting in late spring at a motel near O'Hare Airport, Chicago. RCCO has contacted and identified researchers from the 12 states who should attend. One and 1/2 days will be devoted to the preparation of a proposal to develop a regional soil moisture model, and another 1 1/2 days for a proposal to develop a regional integrated pest management model.

Interest in the regional soil moisture model has been expressed by IL, IN, IA, MI, MN, MO, NE, ND, OH, and SD. The objective of the research is to build a large data base including a diversity of climatic conditions and soil types with the intent of calculating soil moisture values for each of the above conditions under different precipitation and evaporation regimes. The outputs would be usable for irrigation advisories as well as for monitoring local water resources.

IL, IA, MI, MN, MO, ND, and OH have expressed interest in the development of a regional integrated pest management model. Again, a regional data base including climatic data and distributions and state of development of various pests will be incorporated into a regional model, which could be used for forecasting pest development and mitigation strategies to combat their impact on agriculture. Such advisories could be generated in one location to be disseminated to all interested states.

The two research proposals will be submitted to outside funding agencies and will be submitted during the present calendar year.

LIAISON BETWEEN STATE CLIMATE CENTERS AND OTHER AGENCIES

RCCO is the primary liaison between the State Climate Centers and federal, regional, and state agencies with climatic interests. An example of some of the agencies with whom we interact are: 1) the National Weather Service, Department of Energy, and Department of Agriculture on the federal level; 2) several North Central agricultural committees and the Office of Appropriate Technology on the regional level; and 3) various state Departments of Agriculture and Natural Resources and university officials on the state level.

During the first year of RCCO it was imperative that visibility be achieved with a variety of federal, state, and regional agencies. The visibility was obtained in a variety of ways. Initial contact was often made by telephone and followed by correspondence. In some instances it was necessary, after initial contact, to go to the agency or group of agencies and brief the group about the RCCO and the climate plan adopted by NC-94. In addition, a newsletter, RCCO News, was inaugerated and announcements of the formation of RCCO and the NC-94 plan were forwarded to various professional groups. These releases have resulted in a large number of additional contacts being made with individuals within groups wanting to know more about RCCO and the NC-94 Climate Plan.

CONCLUSION

In summary, the RCCO visited the 12 State Climate Centers in the North Central region; contacted and briefed 19 Federal agencies and their major divisions of; worked with or contacted 7 regional groups, both inside and outside the North Central region; and interacted with 3 State Climate Centers outside the North Central region. It has inaugerated 3 research projects involving some or all 12 states and is directing the preparation of 2 proposals to solicit outside funding for regional research projects which impact the agricultural community.

As a result of the contacts, RCCO has distributed various information to State Climate Centers from federal agencies. In addition, the close contact that RCCO maintains with the 12 State Climate Centers allows us to identify problems that develop, or could develop, at the State Climate Center level that could have regional or national implications. Thus, RCCO has become the focal point between the State Climate Centers and federal agencies, and can facilitate the communications between the two groups. The interaction that RCCO has had with federal agencies is greater than originally perceived.

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NORTHEAST REGIONAL CLIMATE PROGRAM

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BACKGROUND

The following is a brief statement concerning the past status of climate services in the Northeast and presents the rationale and need for a regional climate program in that region.

Prior to the abandonment of the Federal State Climatologists Program, one person was responsible for all State Climatologists' (SC) activities in Maine, Massachusetts, New Hampshire, and Vermont; one person for Connecticut and Rhode Island. New York was fortunate in having its own SC. In 1973 the SC program was eliminated. Although New York continued the program at a reduced level, the program essentially disappeared in the other states. Over the ensuing years the situation improved only slightly. New York had a state climatologist and had also employed the former federal SC on a 2/3 basis. Connecticut initiated a state climate program under a grant from NCPO (1980) and has designated a faculty member at the University of Connecticut as SC. Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont had no state climate program or SC. Although all of these states have a Governor's Representative to the National Climate Program Office (NCPO), New York is the only state with an approved state plan and a viable state program with responsibilities in Climate Information Services, Data Acquisition and Climate Effect studies and to cooperate in conducting regional studies.

In the 1950's and 1960's, the New York State College of Agriculture and Life Sciences (CALS), Cornell University, participated in a regional research effort entitled "The Climate of the Northeast". Due to the lack of climatologists at some of the participating Land-Grant Institutions, CALS was given the responsibility of working with the National Weather Records Center (NWRC) in assembling and analyzing the regional data base for the years 1926-1955. It became imperative that this data base be updated and expanded so that climate products could be produced and made available to all members of both public and private sectors involved with climate and weather related problems. (There are almost 30 million potential users of climate data and information in the northeast region of the United States.)

In order to achieve this, it was necessary to define the significance of the variations of weather and climate to the users' activities; to collect pertinent information; to analyze these data; and to provide climatic analyses and user-oriented formats suitable for practical applications.

After consulting with Directors of the Maine and Vermont Agriculture Experiment Stations and the respective governors' representatives, Maine and Vermont were chosen as cooperators in a project to demonstrate the need for and the feasibility of a regional climate center. Both states and New York have representatives on the Technical Committee of the regional and international program "Impact of Climate Variability on Agriculture " (NE-135) supported by USDA Federal Regional Research funds. The three states are active in the program as they have been active in the preceding regional research committees (NE-95, NE-69, NE-35). This past close cooperation between Maine, New York, and Vermont dates from 1956 and has resulted in a strong ongoing relationship in climatology.

PROJECT GOALS AND OBJECTIVE

The regional climate program is designed to demonstrate the need for and the feasibility of a regional climate office for the Northeast. The program is primarily service oriented to conform to the provisions of Section 6 of the National Climate Act.

The priorities of this multi-year regional climate program are ordered to achieve the maximum effectiveness of services within the limits of funding and integration with the National Climate Program. This project is conducted in part with funds provided by the National Oceanic and Atmospheric Administration, National Climate Program Office, and National Environmental Satellite and Data Information Service (NESDIS), Grant No. NA81AA-D00108, and in part by Federal Regional Research funds and contributed to regional project NE-135, "Impact of Climatic Variability on Agriculture".

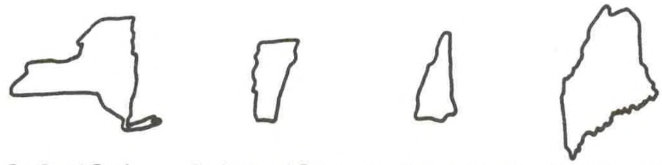
Objective: 1. To establish a Northeast Regional Climate Program with a regional climate office to:

- a) Coordinate and assist in the publication and dissemination of state and regional climate summaries and analyses,
- b) Supply guidance for developing approved state climate programs for Maine and Vermont,
- c) Supply regional climate data to Regional Research Committees working in the area of climate and agriculture and to act in an advisory capacity on the climate of the Northeast, and
- d) Inventory climatological data sets in the Northeast for inclusion into the National Environmental Data Referral Service (NEDRES) of NESDIS.

PROGRAM MANAGEMENT

The management of the overall program is performed by the Northeast Regional Climate Office (NRCO) at Cornell University. The Director of the program is also the state climatologist for New York and acting state climatologist for Maine and Vermont. The State Cooperative Extension Service in Maine and Vermont are active in the program (Figure 1). Dr. James Dill, Extension Pest Management Specialist, is in charge of the program in Maine and Dr. Leonard Perry, Extension Ornamental Horticulturist, directs the Vermont segment of the program. Dr. Robert Adams, Department of Geography, University of New Hampshire and State Climatologist is the cooperator from that state.

Support Personnel (FTE)



Personnel	NCPO	Dr. Boyd Pack Atm. Sci. Unit N.Y.	Dr. Leonard Perry Extension Spec. Vt.	Dr. Robert Adams Dept. Geography N.H.	Dr. James Dill Extension Spec. Me.
Scientists		0.70	0.10	0.10	0.10
System Analy.		0.75			
Lab. Tech.		0.50			
Res. Sup. Spec.	1.0				
Grad. Student	0.5	0.50			
Secretary	0.2	0.10	0.10	0.10	0.10

Fig. 1: Support personnel of the Northeast Regional Climate Program

The collection of data, generation of climate information, preparation, and printing of the monthly climate publications are performed by the regional climate office with additional input from the collaborators in Maine, New Hampshire, and Vermont. While the mailings to users in New Hampshire, New York and Vermont are handled by New York, the state extension service in Maine mails the Maine publication.

Personnel support is contributed by the State Agricultural Experiment Stations and the State Cooperative Extension Service in Maine, New York, and Vermont and by the University of New Hampshire.

DATA ACQUISITION

The flow of climatic data and information from the federal level to the ultimate user is shown in Figure 2.

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.

Real time data is being acquired through teletype drops of circuit GDE 090488604 (high speed FAA circuit from Kansas City) and circuit GTE 008196 (NOAA Weather Wire). Data and information from these circuits are held on-line in the computer for 48 hours.

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.

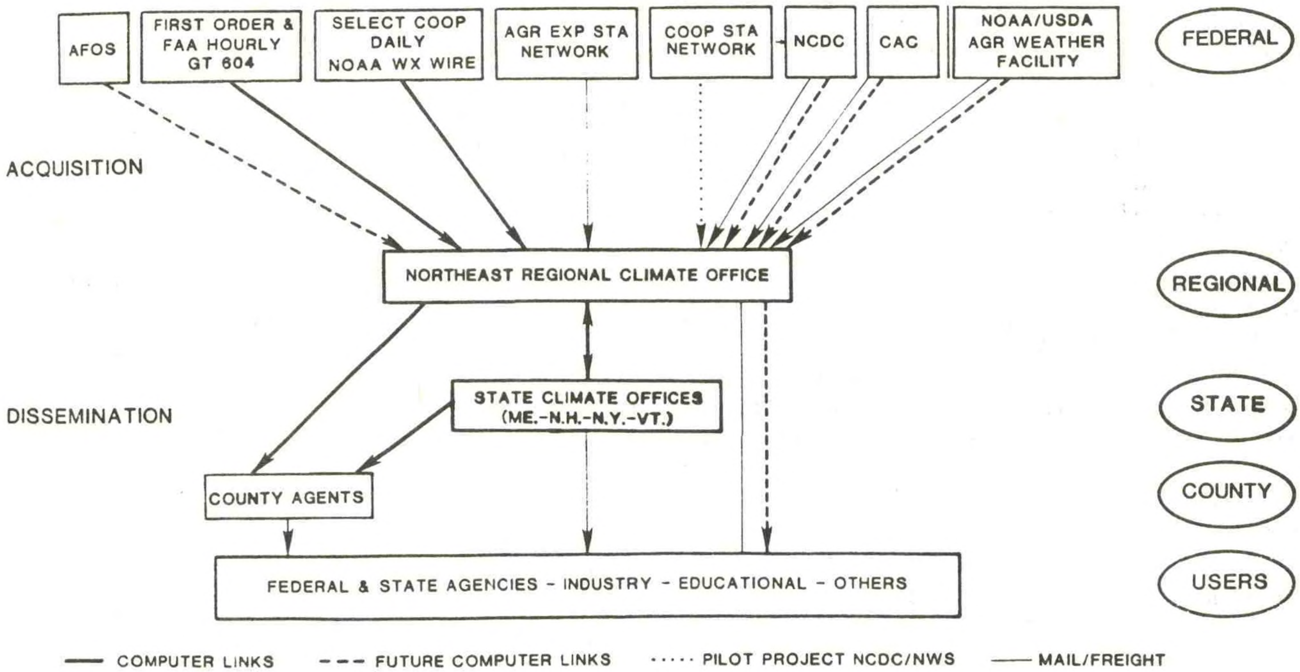


Fig. 2: Acquisition and Dissemination of Climatic Data and Information

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 the 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 (NWS). 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 and the method is now also being used in South Carolina.

The historical data base for New York and New England has been updated through 1981 using tapes supplied by the National Climatic Data Center (NCDC). These data were reformatted, examined for missing data and quality control, and became part of the data base maintained in the dedicated weather computer in the Northeast Regional Climate Office (NRCO).

NEDRES was developed by NESDIS to provide a means for anyone who needs environmental data to find out whether relevant data exist and, if so, where and how they may be obtained. The Northeast Regional Climate Program has agreed to participate in this project by conducting an inventory of the climatological data sets held in the Northeastern United States that are not already in the

National Climatic Data Center's archives. The area covered by this project includes all states north and east of Delaware, Maryland, West Virginia, and Pennsylvania.

The first phase of this project, which was completed December 31, 1982, covered the states of New York, Vermont, Maine, New Hampshire, and Connecticut. Approximately 2000 survey forms were sent to state agencies, cooperative extension agents, power companies, universities, and various other organizations and individuals. Over 200 replies were received. These responses, together with previously accumulated data, resulted in 180 stations and/or networks in the four states with a total of 475 observers being added to the inventory. 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.

A similar process will be carried out for the remaining states with the project slated to be completed this fall.

INFORMATION DISSEMINATION

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

Monthly mailings of the "Maine Climate", "New Hampshire Climate", "New York Climate", and "Vermont Climate" are sent to over 3800 users and include all county agents and appropriate state and federal agencies. The response to these monthly state publications has been enthusiastic with a continuous increase in the number distributed (Figure 3).

The dissemination of these climate series began in September 1981 for New York, April 1982 for Maine and Vermont, and September 1982 for New Hampshire.

These publications routinely include (a) the weather highlights for each state (NRCO), (b) drought severity maps (NOAA/USDA), (c) weekly weather highlights for the United States in map and text form, weekly climate descriptions, and agricultural weather highlights (NOAA/USDA joint Agricultural Weather Facility and Climate Analysis Center/CAC), (d) maps of temperature, precipitation and degree days (computer generated by NRCO), (e) monthly summarized station and division data (NRCO), (f) monthly and seasonal weather outlooks (CAC), (g) the normal climate for the coming month in descriptive and tabular form (NRCO), and (h) 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.

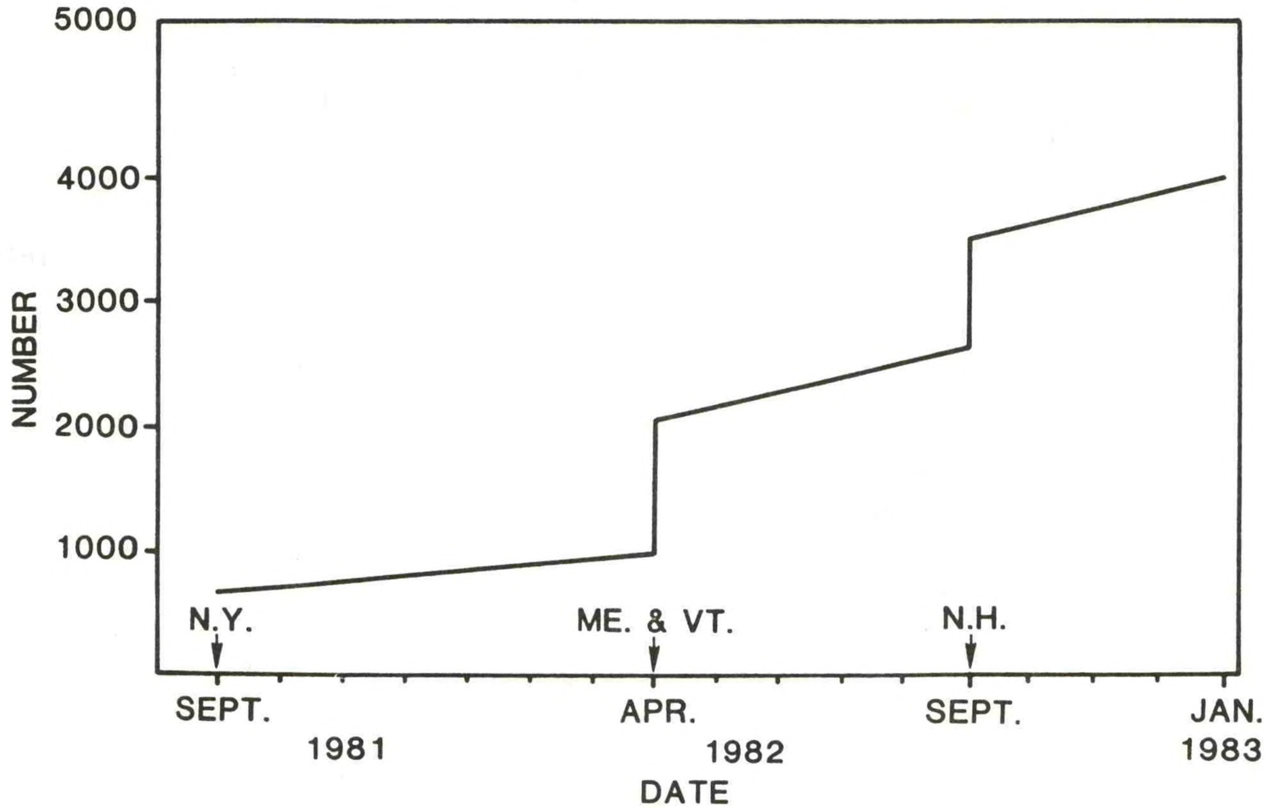


Fig. 3: Distribution Growth of Monthly Climate Summaries

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 (see Data Acquisition). Data bases not on-line can be sent upon prior request. Liaison was established with the Connecticut state climatologist and plans are progressing for linking his office to the NRCO computer.

The New York State Cooperative Extension Service subsidizes the maintenance of two answering telephones which give 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.

OTHER ACTIVITIES OF THE NORTHEAST REGIONAL CLIMATE OFFICE

Research

The Regional Research Committee NE-135, the New Jersey state climatologist and NRCO are cooperating on the publication of drought frequency by climatological divisions for the continental United States.

The Northeast Environmental Research Group (NERG) of the University of Maine and the NRCO are continuing their research on growing season information for the Northeast from the late 1700's to the present.

Frequencies of heavy snowfalls were determined for application to the planning and building trade.

Studies of the relationships between topography and temperature have generated two publications.

Training

NRCO personnel have participated in state extension workshops and training sessions for county agents.

Lectures on climate impacts have been given to various service organizations and to public school audiences.

Guidance

Working with NCDC, contact has been made with the Rhode Island State Experiment Station and with the University of West Virginia concerning the appointment of state climatologists for those states.

The NRCO has acted as spokesman with NCDC and NWS concerning data acquisitions for the northeast region.

International

NCPO scientists are collaborating with scientists at Laval University, Quebec and in the Atlantic Provinces, Canada on the impact of climate variability on agriculture (NE-135).

USEFULNESS OF PROGRAM

In August 1982, a preliminary survey was made of users of the monthly climate publication of the NRCO (Tables 1, 2, 3, and 4). State and federal agencies comprised 26% of the respondents followed by 14% for extension agents, 13% for business, and 12% for educational users. The greatest non-personal use was by agricultural interests (41%) followed by natural resource users (17%) and energy interests (13%).

USERS OF MONTHLY CLIMATE SUMMARIES

Respondent	%
Government agencies	26
County extension agents	14
Professional societies or businesses	13
Schools	12
Public libraries	3
Media	3
Other-private individuals, farmers	29

Table 1

USE OF MONTHLY CLIMATE SUMMARIES

Area of use	%
Agriculture	41
Natural Resources	17
Energy	13
Transportation	7
Recreation	6
Insurance	1
Other	15

Table 2

SAMPLE OF STATE AGENCIES RECEIVING MONTHLY CLIMATE SUMMARIES
from the
NORTHEAST REGIONAL CLIMATE PROGRAM

NEW YORK

- Department of Environmental Conservation
- State Psychiatric Hospitals
- Department of Water Resources
- Department of Transportation
- State Parks and Recreation
- Department of Public Services
- Department of Agriculture and Markets

VERMONT

- Department of Water Resources
- State Energy Office
- State Travel Division
- Natural Resources Council
- Department of Public Safety

MAINE

- State Forest Service
- Department of Agriculture
- Department of Marine Resources
- State Planning Office
- Department of Conservation
- Department of Energy Resources

NEW HAMPSHIRE

- State Fish Hatchery
- Fish and Game Department
- Water Resources Board
- State Parks Division

Table 3

SAMPLE OF FEDERAL AGENCIES RECEIVING MONTHLY CLIMATE SUMMARIES
from the
NORTHEAST REGIONAL CLIMATE PROGRAM

- U.S. Geological Survey
- U.S. Air Force Weather Squadron, Plattsburgh, NY
- U.S. Air Force Weather Office, Griffiss AFB
- Federal Aviation Administration
- Department of Education
- U.S. Army, Fort Drum
- St. Lawrence Seaway Development Commission
- U.S. Postal Service, Utica, NY
- Corps of Engineers
- USDA Forest Service
- Soil Conservation Service
- Brunswick (Maine) Naval Air Station
- Department of Transportation
- Fish and Wildlife Service
- USDA Animal and Plant Inspection
- National Park Service (Acadia National Park)

Table 4

CONCLUSIONS

A key factor in the Northeast Regional Climate Program is the acquisition and dissemination of climatic data and information. Figure 2 shows the flow from the federal level down through the regional, state and county level to the users. Since most of the states had no climate office there were no effective means by which data and information could pass from the federal level to the general user. The establishment of NRCO provided this mechanism, increased the user pool and decreased the request load upon NCDC.

The Northeast Regional Climate Program provides climate information, products and services to meet the needs of agriculture, commerce and industry effectively stimulating productivity, economic recovery, and growth of the region.

LESSONS FROM THE COLORADO CLIMATE CENTER

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Fort Collins, Colorado

INTRODUCTION

The program for disseminating climate information in Colorado has been active for nine years. We know a great deal about the users of climate information and the needs for climate information in the State. As a part of the program, several new uses of information have been developed. This presentation will summarize important aspects of the program in Colorado and draw a set of general conclusions for information dissemination.

Before examining climate information use in Colorado a brief review of Colorado is needed to place climate in perspective. Fig. 1 identifies three primary economic areas: agriculture, mining, and tourism. Water, a limiting resource in Colorado, is a part of all other topics and, hence, is also identified directly with these economic sectors. These four topics dominate Colorado and its relation to climate. A second important feature of Colorado is that a significant portion of the state is owned and managed by the federal government (USFS and USBLM).

The average depiction of climate is not adequate for needs in Colorado. Fig. 2 gives a more realistic view of climate elements and aspects that are needed for the intelligent use of information. People often think that only the average and extremes are available and don't think in terms of variability or events. Variability is most commonly displayed in terms of probability. Events are a significant aspect of climate for many applications.

INFORMATION USERS

Increasing demand for climatic data and information has been observed throughout the U.S. in recent years. Fig. 3 graphically shows the increases in requests received by the Colorado Climate Center (CCC) for climate information. The substantial increases averaging more than 30% per year are not simply the result of increased demand for climate information in Colorado. Increased visibility, effectiveness, and expanded data resources within the CCC have all contributed to this steady growth.

Major user groups in Colorado are listed in Table 1. Statistics for 1979, 1980 and 1981 are shown which reflect the relative percentages of direct requests for climatic information received from these user groups. Percentages vary somewhat from year to year, but the major user groups in Colorado have remained quite consistent. Each year, more than 80% of the total requests for climate information received by the CCC have come from these 7 user classes:

1. Consulting and engineering
2. Universities
3. Individuals
4. Federal government

are shown in map form in Fig. 4 showing a range of -14.4°C to -32.8°C of winter design temperatures across Colorado. Elevation is not the major factor influencing these temperatures (Fig. 5).

Solar radiation -- All available solar radiation data has been collected for Colorado, subjected to quality control, and published in one place. A total of 14 sites were included and nearly the same number eliminated. A map is given in Fig. 6 showing station locations. An example of the data appears in Fig. 7.

Palmer Drought Index (PI) -- Colorado has a need to monitor drought and available water in the state. A capability has now been developed to calculate the PI for 25 regions within Colorado instead of the 5 river basins used by the federal government. This allows much better resolution of drought identification in the state. A map of the areas is given in Fig. 8 with an example of the use of these higher resolution results in Fig. 9.

CONCLUSIONS

A series of conclusions seem appropriate from the CCC experience during the past 9 years.

- Demand for climate information continues to rise.
- High quality data base is essential (federal).
- Local climate expertise is essential.
- Computer technology will transform methods.
- Users should pay a portion of cost.
- Cooperative observers are a success.
- Small fraction of users have most value.
- New uses of information involve identification and research.
- Need systematic effort to develop new users.
- Close association of services and research are beneficial.

WATER

Precipitation Maximum -- Spring (Front Range)
-- Summer (Plains)
-- Late Summer-Fall (Southwest)
-- Winter (some Mountains)

Use -- River flow (winter snow)
-- Soil moisture
-- Reservoir
-- Wells

AGRICULTURE

Crops -- Dryland, Irrigated
Livestock -- Cattle, Pigs, Sheep, Feedlots
Timber

ENERGY

Coal -- Reclamation, hydrology
Oilshale -- Water available, air quality, reclamation, pipelines
Renewable -- Solar, wind, wood
Electricity -- Transmission lines, schedules
Consumption
Rate adjustments

TOURISM

Winter -- Ski, snowmobile
Summer -- Mountains, hike, camp, fish

Figure 1. Dominant climate-sensitive topics in Colorado.

	Precipitation, Temperature, Snow
AVERAGE --	Wind, Humidity, Pressure, Clouds
	Solar Radiation, Evaporation, Soil Temp, Soil Moisture

	Annually
VARIABILITY --	Monthly
	Daily
EXTREMES --	Hourly
	Minutes (PP)

EVENTS --	Flood, Drought, Hail, Tornado, Lightning, Wind, Cold, Heat, Blizzard, Snow

Figure 2. Elements and aspects of climatic descriptions.

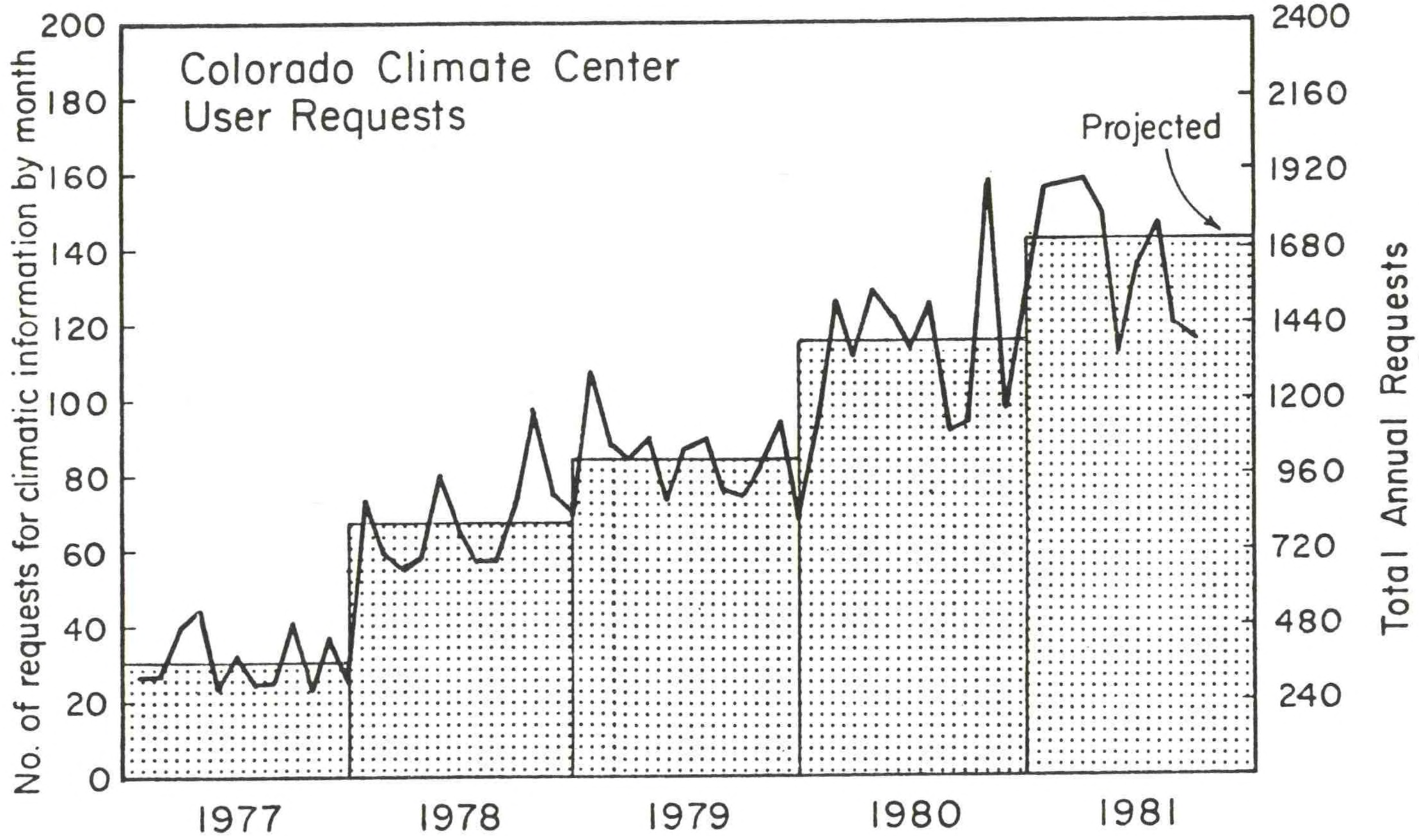


Figure 3. Number of requests for climatic data and information received by the Colorado Climate Center during the period 1977-1981.

Table 1. Users of climate information in Colorado. (Based on climate requests received at the Colorado Climate Center.)

User class	Percent of total requests 1979[1]	1980	1981[2]	All
Business and Industry				
Agri-business	1.4%	2.2%	2.2%	2.1%
Architecture	1.4	1.0	2.0	1.5
Attorneys	2.1	3.0	2.9	2.8
Construction	3.1	4.0	2.2	3.1
Consulting and Engineering	16.0	18.8	21.2	19.3
Health	0.0	0.1	0.2	0.1
Individuals	8.7	9.9	10.8	10.1
Insurance	1.7	2.2	1.7	1.9
Manufacturing	1.2	1.1	0.6	0.9
Marketing	1.0	1.0	1.4	1.2
Media	3.7	8.5	6.7	7.1
Recreation	0.2	0.3	0.3	0.3
Transportation	0.0	0.2	0.2	0.2
Utilities	4.4	4.7	6.6	5.4
Other	1.4	2.5	2.6	2.4
Public and Government				
Federal	10.8	10.6	10.1	10.4
State and Local	10.4	7.8	6.4	7.6
Universities	31.3	20.9	20.2	22.2
Schools	1.2	1.1	1.5	1.3
Libraries	0.0	0.1	0.2	0.1
Total percent	100.0%	100.0%	100.0%	100.0%
Total number	482	1,395	1,265	3,142

[1] - based on July-December [2] - based on January-September

5. Media
6. Utilities
7. State and Local government

Of these user categories, engineering and consulting firms, utilities, and individuals, have shown steady growth each year, both in terms of total number and in terms of percentages of all information requests. Government and university requests have been decreasing somewhat percentagewise, although the total number of requests from these groups continues to increase in Colorado. Media requests for information also take a large piece of the Colorado pie. All other categories ranging from agri-business to insurance claims and attorneys account for only a small percentage of the request load.

INFORMATION NEEDS

It is considerably more difficult to assess user needs than it is to simply identify users. Those of us who work regularly with users know that many of them are not knowledgeable about climate. They recognize that their task may be climate sensitive, but they may not know where to go from there. What users ask for, what they need, and what they receive are often not the same. Furthermore, despite having needs, many potential users do not seek information. Assessing user needs objectively requires an in-depth analysis of each problem. The CCC does not always have time to perform such analyses for each request as it comes to us. In fact, requests tend to be assessed in terms of what data or summaries already exist rather than in terms of what information would really be needed to best solve the problem.

The method chosen for assesssing user needs in Colorado involved several steps.

1. General objective inventory of information uses and applications.
2. Identification of special set of climate information users covering a variety of user classes.
3. Individualized phone interviews.
4. Interpretation of responses.

The first step was a part of the user identification effort. Beginning in July 1979, each time a request for climate information was received by the Colorado Climate Center as much information as possible was obtained from the requestor concerning how the climate information being requested was going to be used. Table 2 summarizes the data on information uses and applications.

More than 60 percent of the information requests applied to four broad topical areas -- energy, water resources, food, and land use. Energy-related applications accounted for more than 25 percent of the CCC's requests.

Specific types of information use in Colorado were fairly easy to determine. Seven categories of information use accounted for nearly all of the requests. At least one-third of all information requests were placed in the category "Operations and short-range planning." Examples in this category included such things as: 1) the need for temperature or heating degree day information to assess energy demand, and 2) frequency and probability of snowstorms to plan and budget urban snow removal.

Research was also a major type of information use (~22%) and included a broad spectrum of research topics. Most research-related requests came from university sources, and generally were applied to fields other than atmospheric science.

Many of the government-related requests fell in the category "Policy making and long-range planning." About nine percent of all requests were placed in this group including reservoir project studies, land valuation, and assessments of wind power potential.

The "Design" category included architectural and engineering questions. However, many requests from architects and engineers did not relate directly to design and were instead placed in either of the planning categories. Only 7% of all requests related directly to design questions.

The "Education" category included only those requests which were a part of the classroom education process on the elementary, secondary or collegiate level. About five percent of the Colorado requests were placed in this category.

"Documenting past record" relates to proving that a certain weather occurrence or climate anomaly occurred at a certain time. Legal and insurance related requests were generally the only ones which fell in this category which accounted for about 8% of all requests.

"General information" is the category into which a request was placed when someone "just wanted to know." Most media requests were placed here. This could also be considered educational except that it is not directly tied to the academic learning process. About 12% of all information requests were placed here.

Generally less than 3 percent of all requests for climatic information could not be placed legitimately into the 7 information-user categories.

This breakdown of information uses shown above suggests a strategy for assessing economic "value" of climate information. The use categories "Education" and "General Information" have obvious importance and value but do not lend themselves to analysis. The categories "Research" and "Policy making and long-range planning" make up nearly 30% of the Colorado requests. These uses are suited to hypothetical cost/benefit or other value analyses which could help determine long-term practicality of a proposed policy or climate sensitive plan. Where climate information is used to "document past records" affecting insurance and legal judgments, dollar values of insurance claims and awards stemming from lawsuits can be easily documented. The final two categories, "Design" and "Operations and short-range planning," are especially well suited to economic analyses. Comparisons can be made between activities which made use of new or existing climate information and those which did not.

NEW USES OF INFORMATION

Several new uses or application of climate information have evolved at the CCC during the past few years. A limited set of examples are given in this section.

Hourly temperature -- A method has been developed to generate minimum design temperatures (temperature threshold for 1% coldest hours during winter) from daily minimum temperatures. Hourly temperatures are available for less than 10 sites in Colorado while daily temperatures are available for over 100 sites. A few results

Table 2. Uses and applications of climatic data and information requested from the Colorado Climate Center.

	Percent of annual requests		
	1979[1]	1980	1981[2]
Type of information use			
Policy making and long-range planning	8.5%	7.4%	10.6%
Operations and short-range planning	32.8	36.6	33.9
Research	27.2	18.7	20.4
Design	6.8	5.7	9.0
Education	7.3	5.1	3.7
Documenting past record	7.9	8.7	6.2
General information	8.3	14.6	13.8
Other	1.2	3.2	2.4
Total percent	100.0%	100.0%	100.0%
Total number in sample	482	1,395	1,265
Application of information			
Energy consumption, conservation and development	27.2%	24.5%	28.1%
Water resources	18.0	13.8	15.7
Food and fiber	12.9	9.3	9.1
Land use	11.2	11.2	8.7
Other	30.7	41.1	38.4
Total percent	100.0%	100.0%	100.0%

[1] - based on July-December, [2] - based on January-September

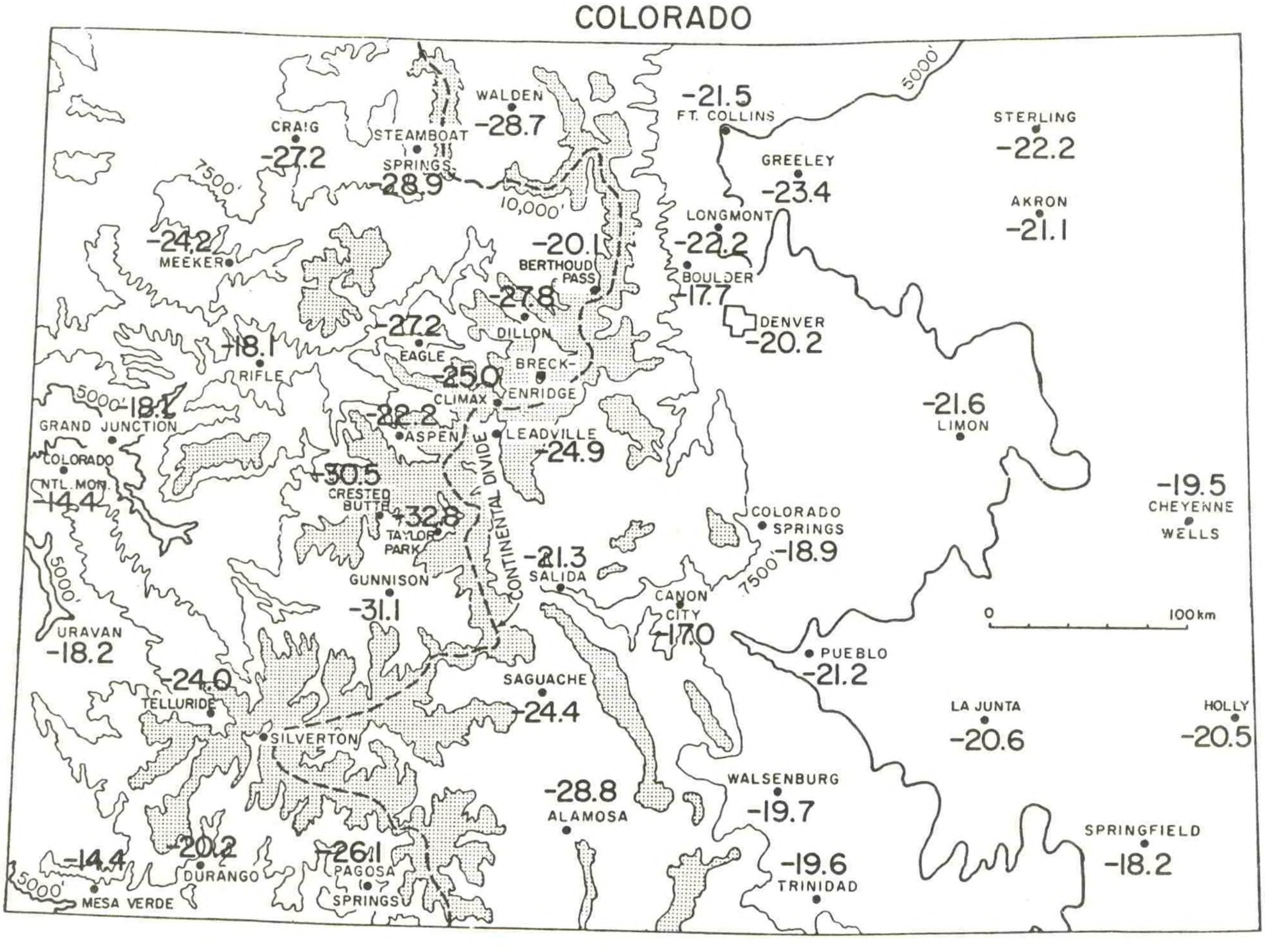


Figure 4. Winter design temperatures (°C) for selected Colorado stations.

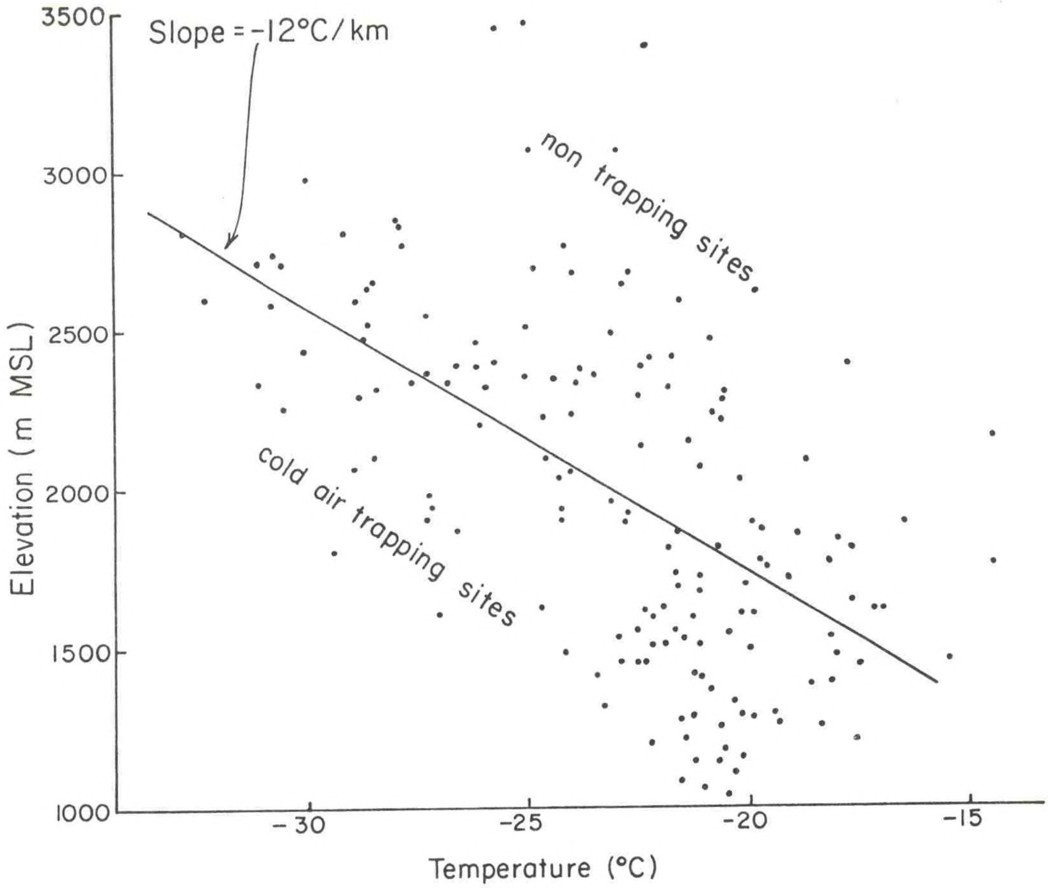


Figure 5. Winter design temperatures for many Colorado locations as a function of elevation.

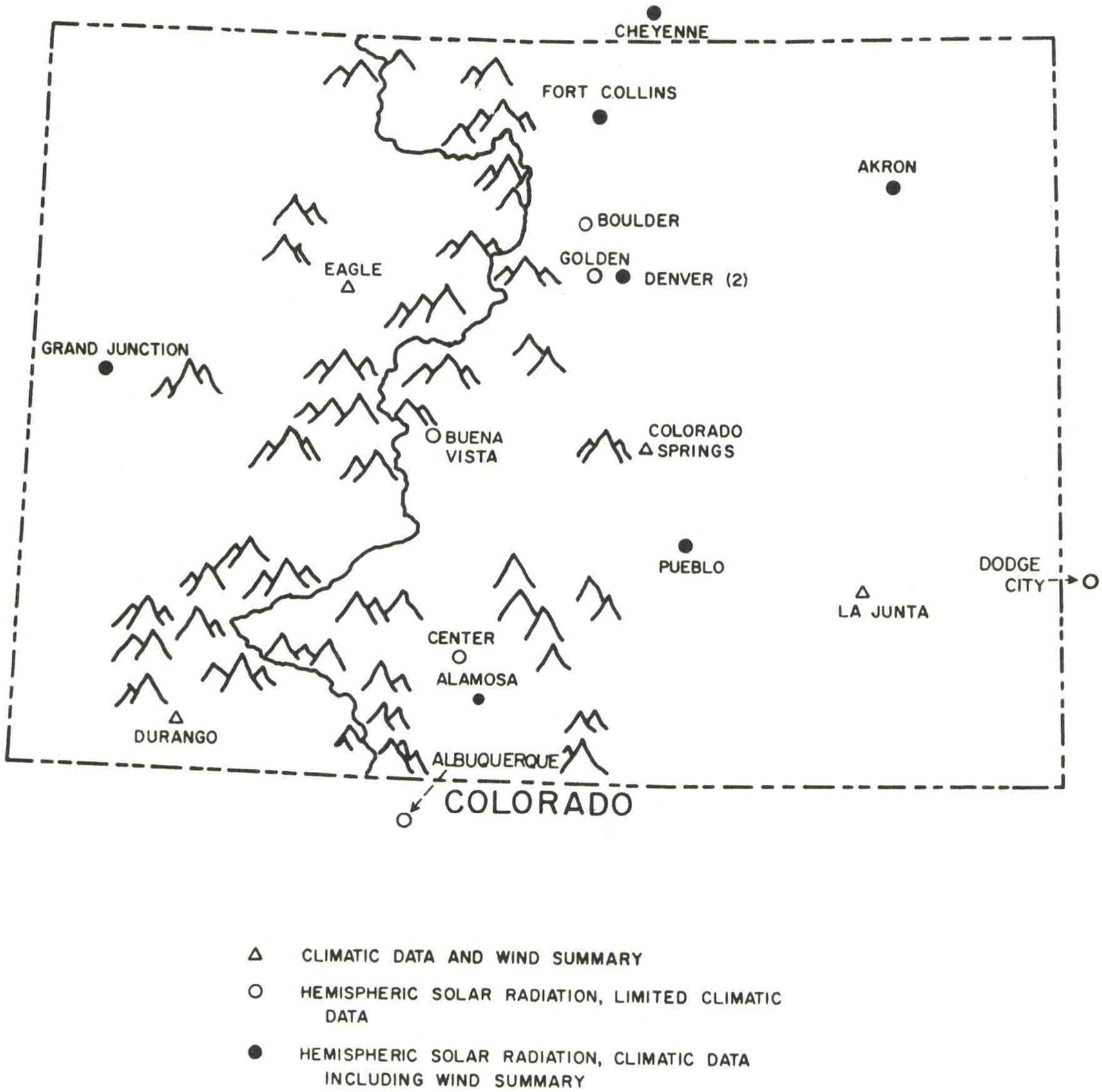


Figure 6. Locations of summarized solar radiation data for Colorado.

FORT COLLINS

ELEVATION 5279 FEET MSL   LATITUDE 40 DEG 35 MIN   LONGITUDE 105 DEG 8 MIN

SOURCE OF SOLAR RADIATION DATA -- COLORADO STATE UNIVERSITY, DEPARTMENT OF ATMOSPHERIC SCIENCE

INSTRUMENTATION -- EPPLEY PRECISION SPECTRAL PYRANOMETER

OBSERVED SOLAR RADIATION DATA -- AVERAGE DAILY TOTAL HEMISPHERIC RADIATION ON A HORIZONTAL SURFACE, MAY 1975-DECEMBER 1980.

TILTED SURFACE RADIATION DATA -- CALCULATED FROM THE OBSERVED HORIZONTAL DATA USING THE METHOD DEVISED BY LIU AND JORDAN (1960). VALID FOR SOUTH-FACING SURFACES. REFLECTIVITY = 0.2

CLIMATIC DATA -- ALL DATA COLLECTED AT COLORADO STATE UNIVERSITY MAIN CAMPUS WEATHER STATION. TEMPERATURE AND PRECIPITATION AVERAGES ARE FOR THE 1951-1980 PERIOD. DEGREE DAY AVERAGES BASED ON 1941-1970 DATA. MEAN WIND SPEED OBTAINED FROM 1893-1957 DATA. AVERAGE STATION PRESSURE AT ELEVATION 5004 FEET BASED ON 1887-1957 DATA.

SOLAR RADIATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	RECORD (YEARS)
* * * * * * * * * * * * * * * *														
HEMISPHERIC (MJ/SQM DAY)	8.69	11.39	16.64	19.56	20.98	25.01	23.30	20.58	18.04	13.79	9.12	7.65	16.23	6
HEMISPHERIC (BTU/SQFT DAY)	765	1003	1466	1723	1848	2203	2052	1813	1589	1215	803	674	1429	6
(HEMISPHERIC / ETR) RATIO	.57	.55	.60	.56	.52	.59	.57	.56	.60	.60	.55	.56	.57	
COMPUTED TILTED SURFACES (MJ/SQM DAY)														
LATITUDE - 15 DEG.	14.26	15.95	20.32	20.74	20.43	23.43	22.14	20.86	20.56	18.31	14.02	13.05		
LATITUDE	16.48	17.48	21.03	20.04	18.91	21.20	20.20	19.69	20.58	19.63	15.88	15.26		
LATITUDE + 15 DEG.	17.73	18.03	20.59	13.36	16.59	18.13	17.44	17.62	19.51	19.85	16.82	16.57		
VERTICAL	16.60	15.49	15.53	11.55	9.32	9.37	9.30	10.36	13.46	16.24	15.29	15.79		
CLIMATE														
* * * * * * * * * * * * * * * *														
EXTREME MAXIMUM TEMP. (DEG F)	68.0	75.0	80.0	84.0	90.0	102.0	102.0	99.0	95.0	87.0	77.0	73.0		30
AVERAGE MAXIMUM TEMP. (DEG F)	40.6	45.1	50.2	60.1	69.5	80.0	85.8	83.3	75.4	64.9	50.4	43.7		30
MEAN TEMP.	26.9	31.8	36.7	46.4	56.1	65.6	71.4	68.9	60.3	49.9	36.8	30.4	48.4	30
AVERAGE MINIMUM TEMP. (DEG F)	13.2	18.5	23.3	32.7	42.7	51.2	56.9	54.5	45.2	34.8	23.2	17.1		30
EXTREME MINIMUM TEMP. (DEG F)	-32.0	-41.0	-23.0	-8.0	25.0	33.0	40.0	39.0	21.0	8.0	-17.0	-18.0		30
DEGREE DAYS														
HEATING(65 DEG. BASE)	1184	960	918	558	297	101	7	12	175	477	834	1076	6599	30
COOLING(65 DEG. BASE)	0	0	0	0	5	80	187	133	25	0	0	0	430	30
PRECIPITATION (INCHES)	.42	.40	1.07	1.75	2.79	1.75	1.56	1.52	1.09	1.05	.62	.45	14.47	30
SNOWFALL (INCHES)	7.3	6.3	12.2	6.5	1.5	0.0	0.0	0.0	.6	2.9	6.9	6.7	50.9	30
AVERAGE WIND SPEED (MPH)	6.4	6.6	7.5	7.8	6.6	5.4	4.7	4.6	4.9	5.3	5.9	5.9	6.0	65
AVERAGE STATION PRESSURE (MB)	844.5	844.4	843.4	844.2	844.8	849.1	849.2	848.3	847.8	847.1	845.4	846.2	846.2	71

Figure 7. Example of published solar radiation data summary for Colorado.

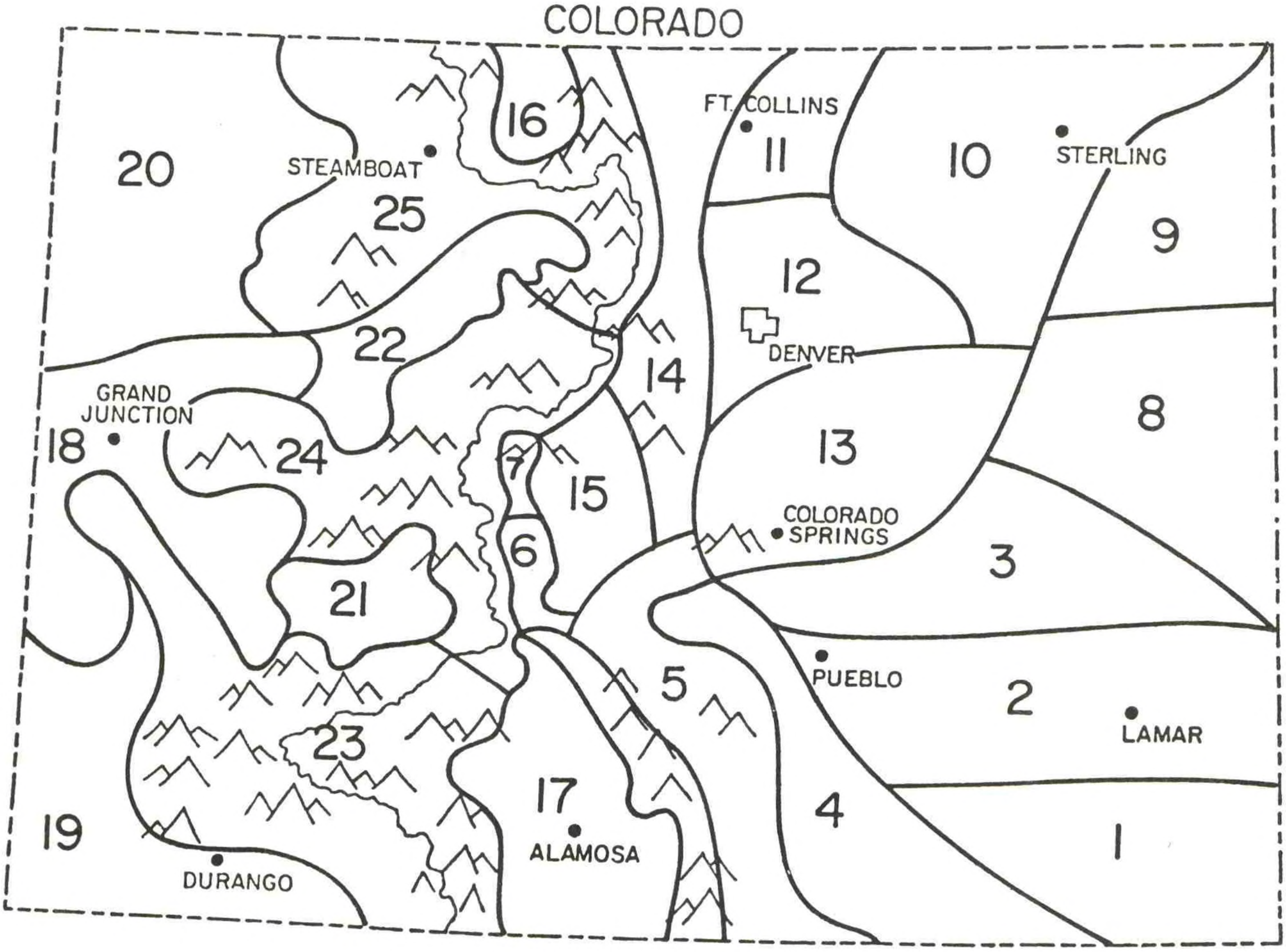


Figure 8. New climatic divisions for Colorado chosen for calculation of local Palmer Index values.

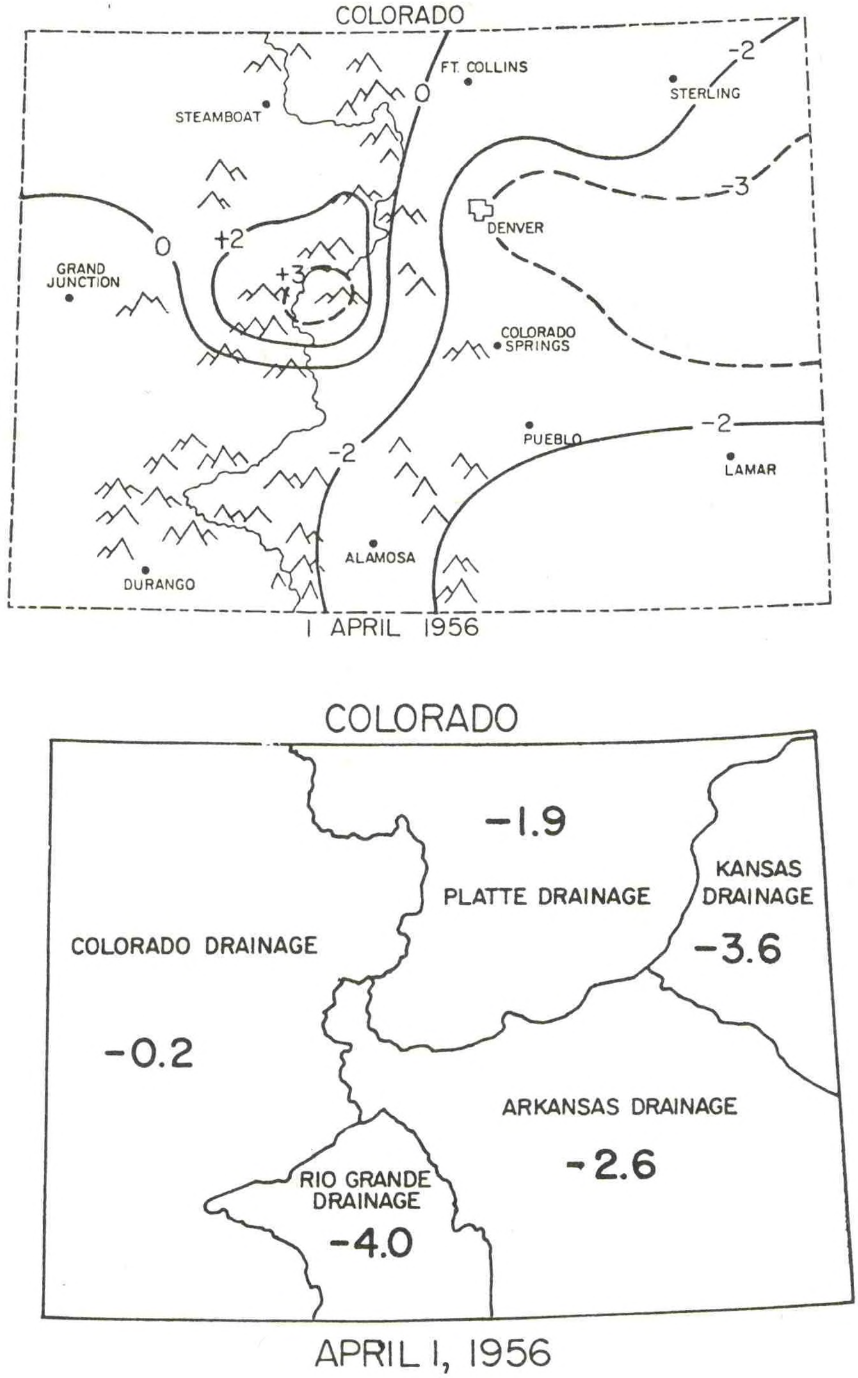
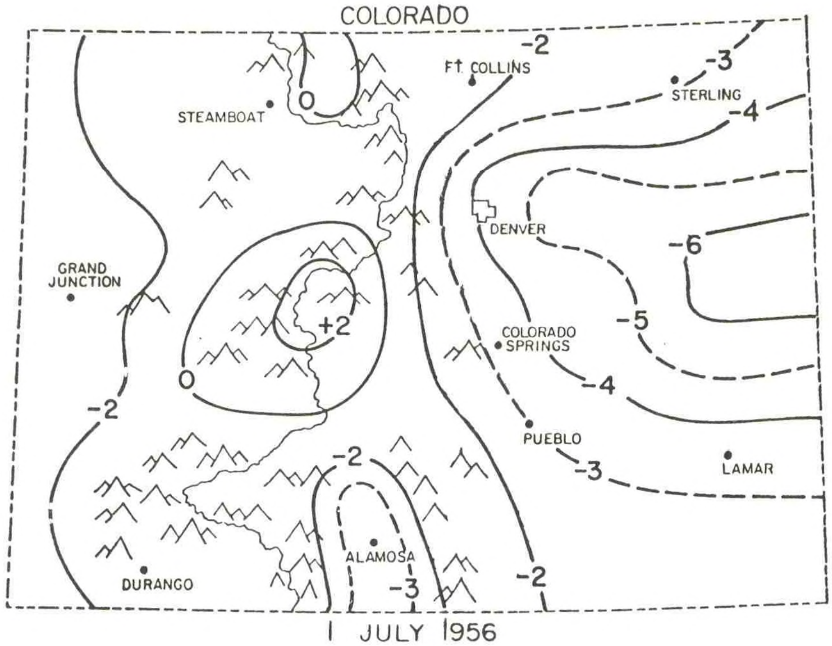


Figure 9. Palmer Index pattern for Colorado comparing results based on 25 new regions (top) with the 5 original divisions (bottom). Case study: 1956-1957.



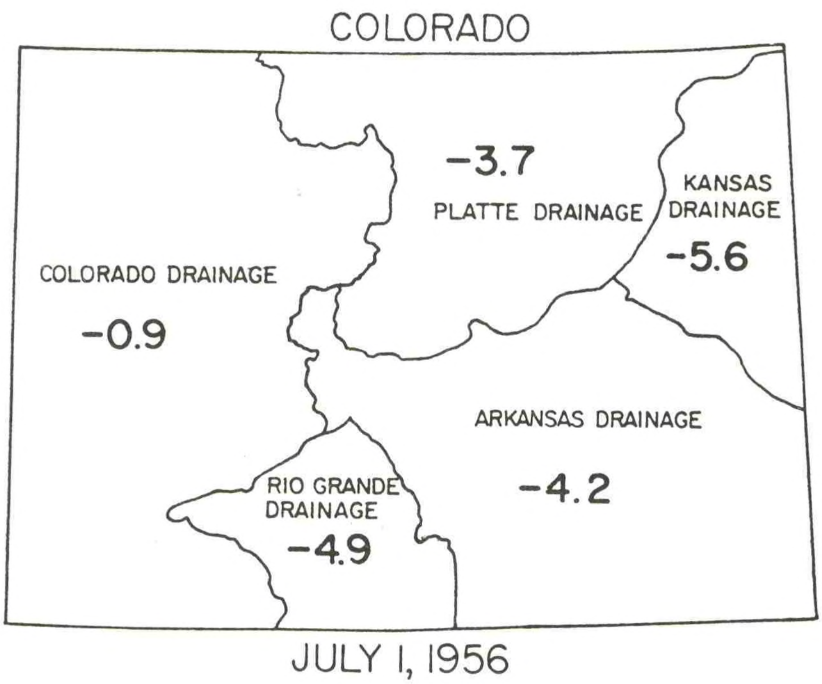
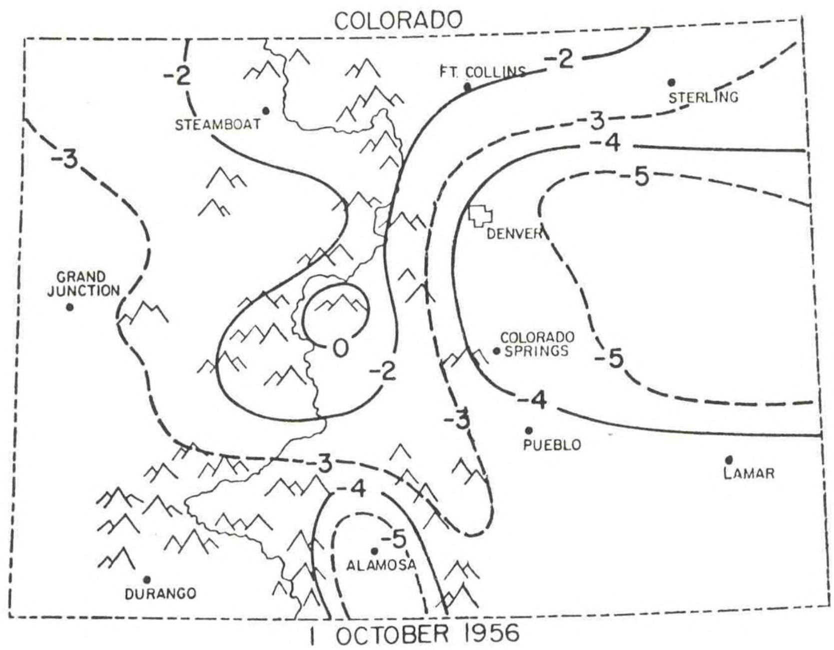


Figure 9. continued



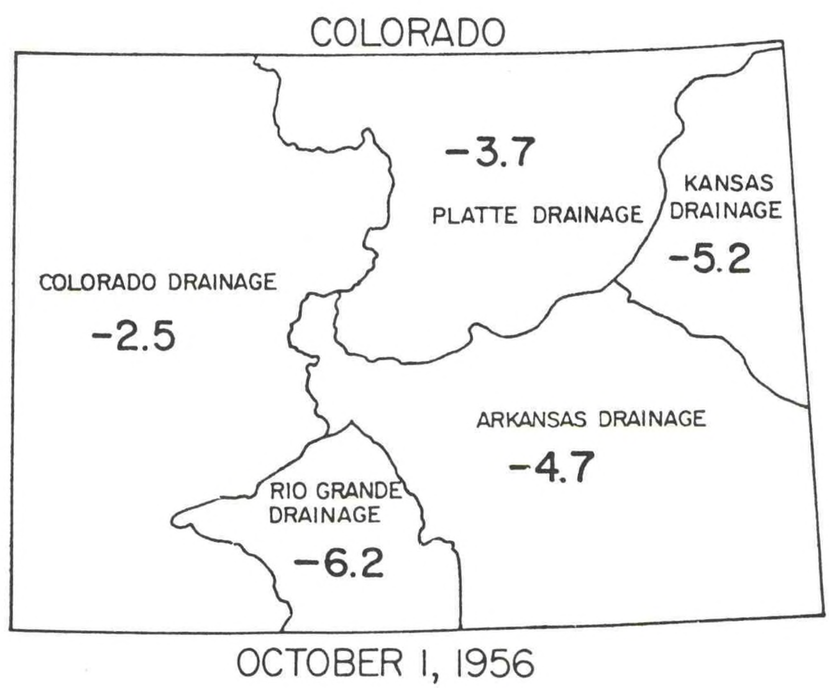
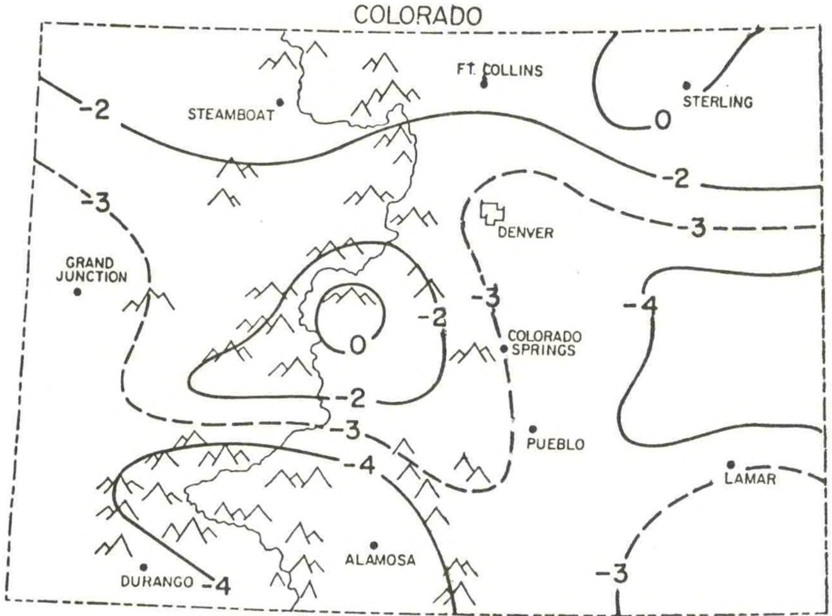


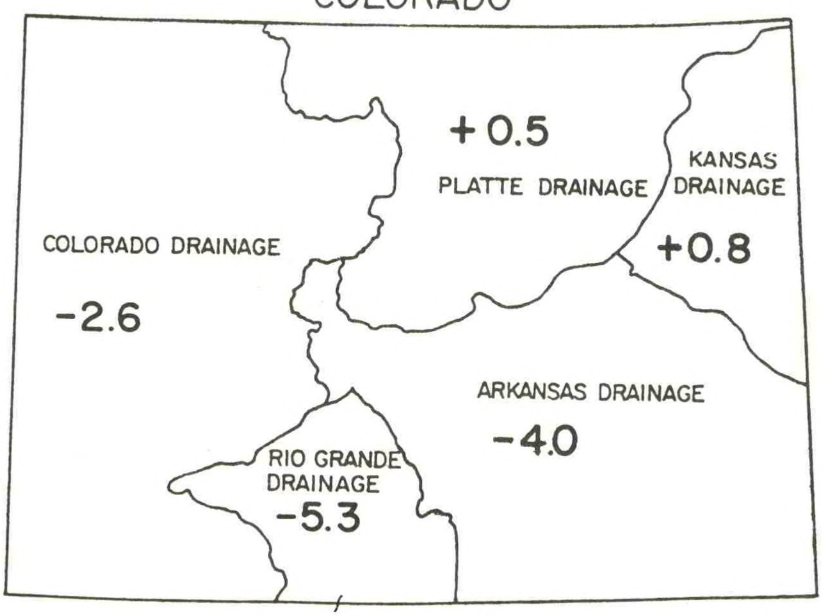
Figure 9. continued

COLORADO



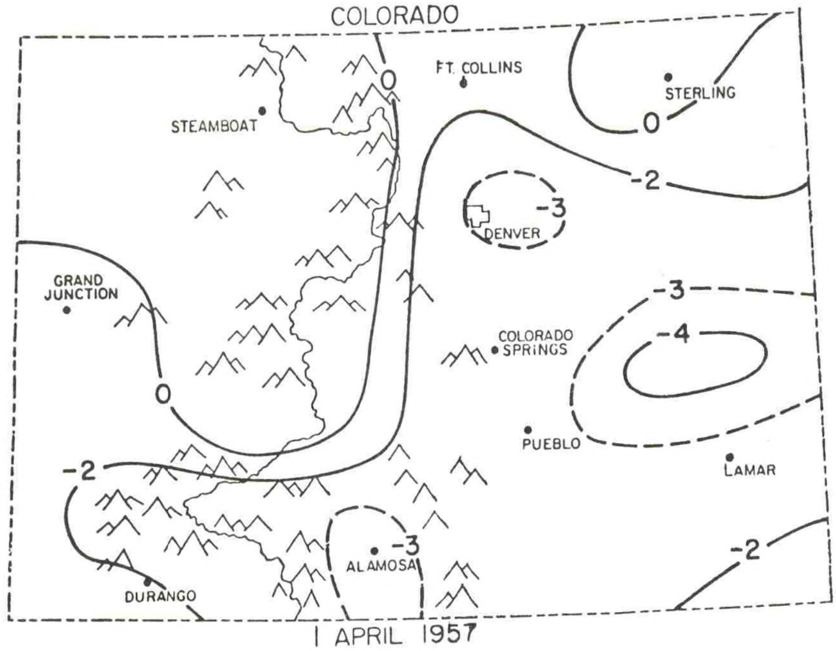
I JANUARY 1957

COLORADO



JANUARY I, 1957

Figure 9. continued



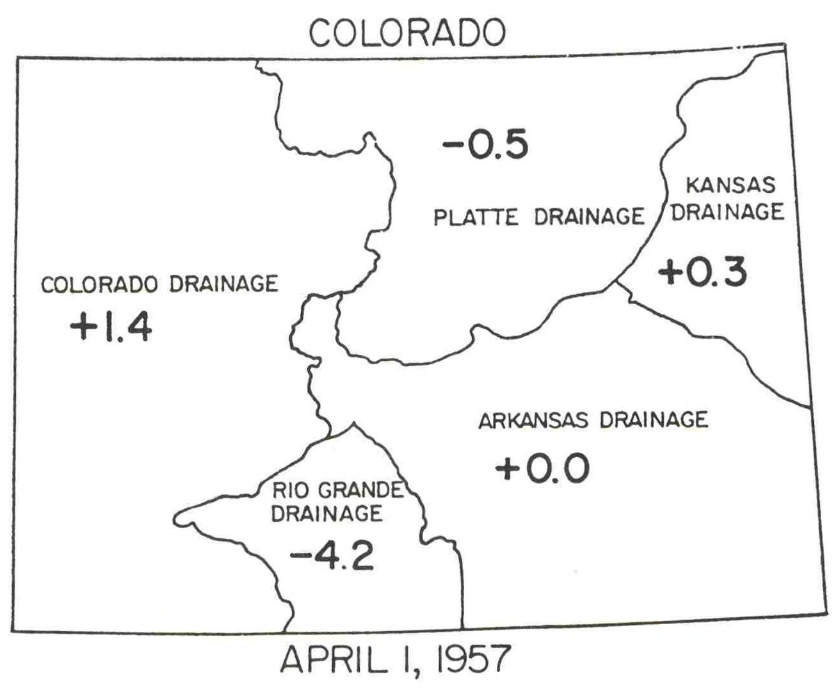


Figure 9. continued

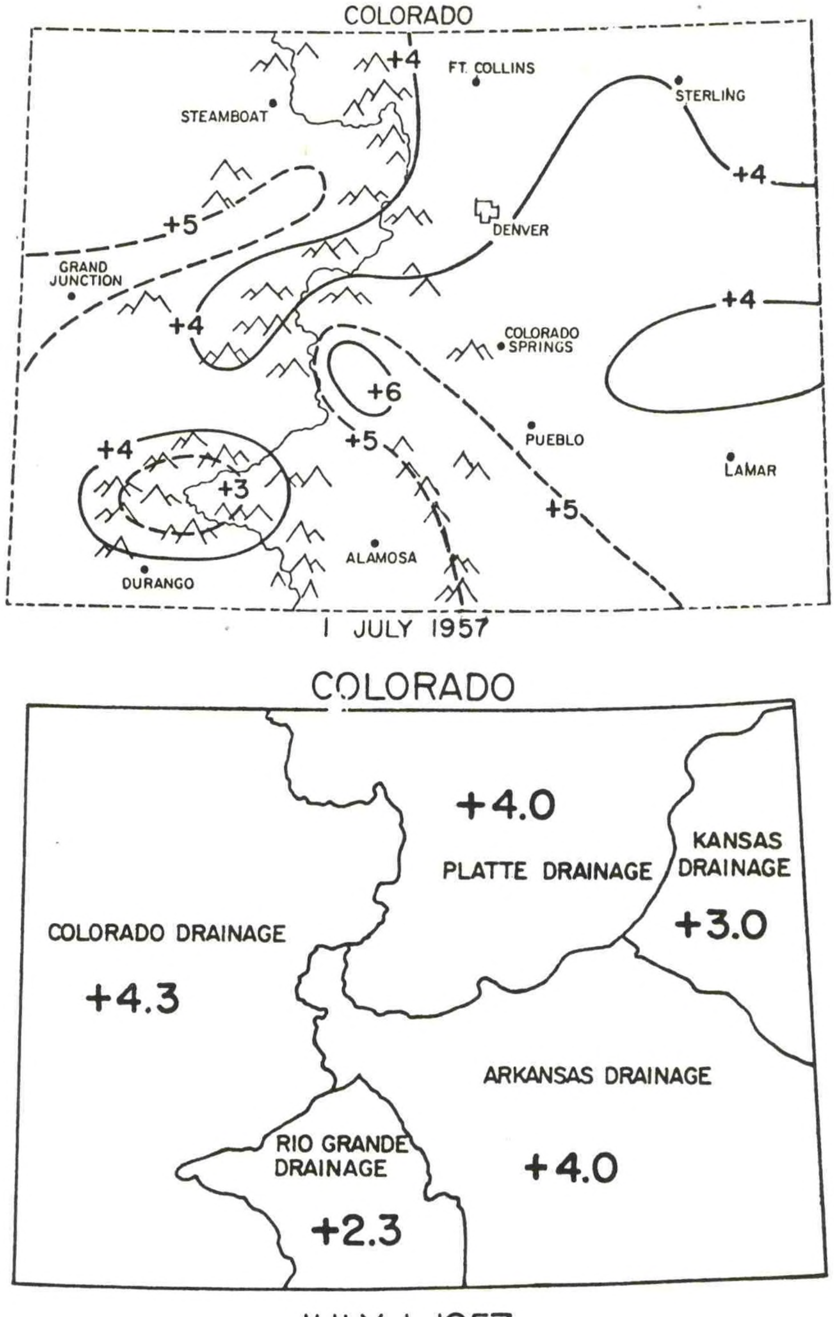


Figure 9. concluded.

INITIATING A STATE CLIMATE SERVICE IN CONNECTICUT

David R. Miller
State Climatologist
and
Hugo F. Thomas
Director, Natural Resources Center
Connecticut DEP

ABSTRACT

In Connecticut, our basic approach is to view climate as a natural resource which must be considered in an integrated manner with the rest of the natural resource system in an operational Connecticut Integrated Natural Resources Data Base and Information System (CINRIS). The Climate program was first initiated in 1979 to supply state of the art Atmospheric Resource inventory information into the system. The scale of the accompanying climate service program, was determined from three studies, a Climate Data Use and User's Survey, a Climate Data availability inventory and Cost/Benefit analysis. The program currently being instituted involves the cooperation of two inplace State agencies. The Natural Resources Center of the State Department of Environmental Protection will maintain the data base within the CINRIS. The Cooperative Extension Service (CES) of the University of Connecticut will conduct the information and education services relying heavily on electronics communication. Two general groups of users will be accommodated. One group will consist of sophisticated users such as consultant meteorologists, engineers, architects, and researchers, with their own analysis capabilities. The other group is made up of users who simply have a single request for information, analysis or a product. This group will be serviced through the hardware at the CES county offices. At the current levels of funding, implementation of the initial system should be completed in three years with some services available now.

THE CONNECTICUT CLIMATE PROGRAM

In Connecticut, our basic approach is to view climate as a natural resource which must be integrated with the rest of the natural resource system in decision-making processes. For the last decade we have been working toward an operational integrated natural resources data base and information system (CINRIS). The system now contains state of the art inventory information on Earth Materials, Land Surface, Water Resources, Atmospheric Resources, and Biological Resources. The primary purpose for developing the CINRIS is to ensure that information from these different resource inventories are available in compatible formats and registrations and that they can be used in an integrated manner in land use and environmental decision applications. Secondly, the system allows us to prioritize the needs for new and continuing resource inventories by highlighting the information missing in various applications. Thus we can better allocate and more efficiently use the tax dollars available for resource inventory.

Such a system must be capable of handling basic resource inventory data from both static resources, such as topography and soils, and from dynamic resources, such as climate and water. It must be able to take these inventory data, generally in map (static data) and statistical (dynamic data) formats, combine them and manipulate them both statistically and graphically. The resulting derived data can then be input to various simulation models for use in decision-making and management applications.

Figure 1 diagrams the information transfer pathways which will be involved in the Connecticut system. From the raw data inventories listed in the left hand column, data moves to the two basic computer data management systems in the data manipulation column. These are the widely used IBM SASS package and a powerful Map Analysis Package (MAP) developed by Tomlin (1983). These packages allow the data to be manipulated, summarized and reformatted, either as grid map information or as statistical information depending on the requirements of the next step - the resource systems simulation models.

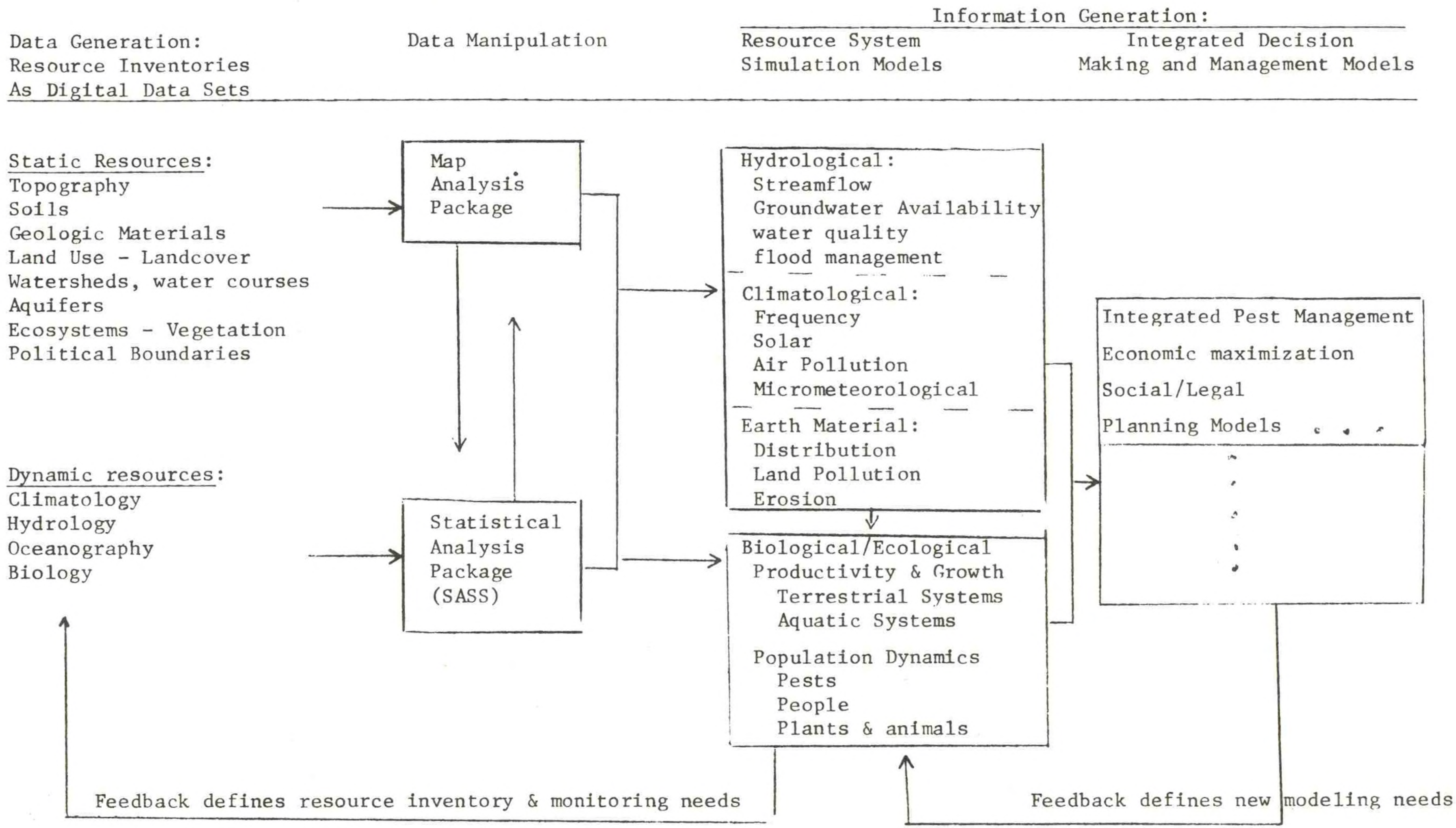
One of the most efficient ways to bring information from a number of sources together, integrate it, and apply it to resource management or allocation decision problems is by the use of simulation modeling. The scientific literature in each natural resource discipline contains models which simulate the dynamics, distribution, and characteristics of the resource system. The use of these models to predict optimum or worst-case conditions allows the decision makers to look at the long-term results of their decisions and update them continuously. The development of these models for general application has been slow because the data required to drive them are generally extensive and specific. Their development for use in Connecticut should be must faster with the availability of the CINRIS to provide compatible input data.

Output from the resource simulation models can be used in various economic and social decision-making models and processes. Feedback from the decision-making community and the initial results from these processes will define priorities for resource modeling efforts. It is important to acknowledge and maintain two way communication between data generators and decision makers since the resource models will assist the decision makers and the decision makers will help to define future resource inventory efforts.

Current Status of the CINRIS

We have extensive natural resource inventory information available for the state. All of the data bases are managed in the Natural Resources Center (NRC) of the state Department of Environmental Protection. Most of the static inventories are mapped on compatible scales and bases, where not, such as the detailed soil survey, they must be hand rectified to a planimetric base (or the photo quad or topographic quad) before they can be used numerically with the other resource data sets. Only hydrological and climatological dynamic resources have been monitored on a long-term, spatially adequate basis. These data are in compatible statistical formats.

Figure 1. The Connecticut Integrated Natural Resources Information System (CINRIS)



Transferring static data to MAP requires data in grid format. We plan to use one hectare grid throughout the state as the basic grid size. The U.S. Geological Survey GIRAS program package may be used to transfer polygon data from individual maps to the 1 ha grid format, but this is still being investigated. Tapes with topographic gridded data are already available, although not to be the vertical resolution desired. The remaining map information must be scanned or hand input into GIRAS or some similar package. Several federal resource agencies are initiating digital cartographic products on a routine basis (such as U.S. Geological Survey's Digital Line Graph program (DLG)).

The design and testing of the computerized data management system is presently underway. The first generation programs to transfer SASS data into MAP grid data (i.e., allocate point data spatially) have been written. Also, the algorithms to perform SASS analysis on the grid map data (i.e. spatial frequency analysis) are also operable. An example of this is given by Allen and Miller (1982).

The information generation or modeling portions of the system are presently operable only in a subjective mode. Data from the original inventories or output from the manipulation programs are now used directly in decision-making processes which are not computerized (i.e. the Connecticut Site Plan Review Procedures for Local Government Officials (Dickenson et al., 1982). A numerical hydrological model is currently being compiled for use with the system. Since this is the first generalized resource simulation model in the system, it will be tested on a small area before being made available for use throughout the state. The approximately 20 square mile Broad Brook watershed is being instrumented as a long-term monitoring site for testing this and other models within the system.

The Climate Program

Climate data has not been readily available in Connecticut due to the lack of an organized climate program on the state level. This has been a serious drawback to the establishment of a comprehensive CINRIS. Thus we initiated steps beginning in 1979 to establish a Climate data base for the state. The extent of any accompanying service program was not predetermined. A minimum data base was required to properly represent the atmospheric resource in the CINRIS. But the need for other public climate education and service programs in the state was unknown. Therefore several studies were conducted in the last two years to define needed service programs.

First a climate data use and users survey (Palley and Miller, 1981) was conducted. It defined categories of use and users and showed that the greatest use of climatic information in the state was for agriculture, energy and legal/investigational purposes. It identified the climatic parameters used, their frequency of use and the adequacy of available data. Surface temperature and precipitation were the most frequently used parameters. The survey also identified the users' current sources of data, primarily the National Weather Service (NWS), and summarized the needs expressed by users. The study showed a general lack of ability to use climate information in any but the most rudimentary way.

Secondly, the existing data bases were inventoried (Palley and Miller, 1982). One hundred and thirty-six weather observation sites in Connecticut were located and all the information available on each site was catalogued. This included parameters measured, length of record, recording method, frequency of observation, instruments used, calibration procedures, and location of instrumentation by geographical coordinates. The study showed good coverage of the state by various private and public weather stations but poor quality control and the lack of compatibility of data from different sources precluded adequate use of this information without extensive coordination.

The third study conducted was a cost/benefit analysis to determine the economic benefits of allocating scarce state resources to a climate program. A literature search revealed that little research has been documented on the costs and benefits of using improved climate information for purposes other than agricultural or aviational. Therefore, three user groups important to the economy of Connecticut, the insurance, the energy, and the water resources industries, were examined. Agriculture was not studied because extensive data is available elsewhere. The benefit analysis (Miller and Palley, 1983) has shown extensive monetary benefits, tens of millions of dollars per year in energy savings to the structure design industry and the operational managers of buildings from more accurate local climate data. The necessary accuracy can be achieved by extrapolating the existing weather station data rather than adding stations. The value of currently available data to the water supply and insurance industries in the state is very high. In fact, they could not operate without it. But we were not able to demonstrate any real marginal increases in monetary benefits from additional or more accurate climate data or information.

The information available from these three studies has encouraged us to initiate a state climate program within the two cooperating agencies, the Natural Resources Center (NRC) of the Connecticut Department of Environmental Protection and the Cooperative Extension Service (CES) of the University of Connecticut. Also, an independent advisory committee, consisting of representatives of scientific and user groups in the state has been formed to assist in the definition and prioritization of climate resource inventories, information programs, and climate effects studies.

Table I is an organization chart showing the agencies and groups involved and their specific responsibilities. In general, the NRC establishes and operates the data acquisition and analysis system and manages the data base with the CINRIS. The CES guides the development and delivery of information services to users in the state.

<u>The Role of the CES in the State Climate Program</u>

Table I lists the specific areas of responsibility of the CES in the program. The Connecticut CES county offices are in the process of obtaining hardware for electronic communications. These CES systems will be the primary method for climate data and information transmittal. Data analyses (i.e. output from integrated map analyses, conditional probability analyses, and graphic displays) will be made available throughout the state to users primarily through the extension offices. Interactive software is being developed to allow users throughout the state to obtain climatic data and information from the system over telephone line remote terminals and down loading microcomputers.

Two general groups of users will be accommodated. One group will consist of

TABLE I

CONNECTICUT CLIMATE PROGRAM

ORGANIZATIONS AND RESPONSIBILITIES

Natural Resources Center
Department of Environmental Protection
Coordination and Administration

NATURAL RESOURCES CENTER CONN. DEPT. OF ENVIRON. PROTEC.	THE UNIVERSITY OF CONNECTICUT COOPERATIVE EXTENSION SERVICE	CONNECTICUT CLIMATE ADVISORY COMM., NCR AND CES
Data Acquisition and Analysis:	Climate Information Services:	Climate Effects Studies:
Data Acquisition Federal networks, State observations, other in state, nearby states	User Contacts Identify users, establish Contacts, consult with users, prioritize needs	Scientific and Technical Quality Control and Monitoring Prioritize Studies Needs Key State Climate Sensitivities Agriculture, energy, water resources, other
Data Analysis Monitor daily quality, maintain data archive, state-wide awareness	Information Dissemination Respond to requests, publications, media, conferences and seminars, computer products, user education, referral	Special Problems Studies Examples: Excessive precipitation, drought indices environmental impacts
Data Resources Raw data, data summaries, NCC publications, State publications, library materials, input data to national networks.	Advice to Government Federal field offices, State and local	Local Impact Assessment Economic effects
	Information Development Effects studies, research results, quantify needs, develop climate products	Cooperate in Regional Assessment
	Evaluation of Benefit Case studies, user surveys	

sophisticated users such as engineers, architects, and researchers, with their own terminals and microcomputers. The other group will be made up of users who simply have a single request for information, analysis, or a product. This group will be serviced through the hardware at the CES county offices.

Manuals are being prepared for these two audiences on the access and use of the system. Demonstrations and training workshops will be held to teach the details of using the climate data with MAP and SASS. Training sessions will be held for the county extension staff on the access and use of the system. This will allow the county extension staff to service the more general audiences.

Depending on the financial resources available, complete implementation of the initial system should take from three to six years.

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Palley, P. A. and D. R. Miller. 1981. Climated Data Use and Users in Connecticut. Storrs Agriculture Expt. Sta. Research Rpt. 71. The University of Connecticut. 35 p.

Palley, P. A. and D. R. Miller. 1982. Climate Data Sources in Connecticut. Storrs Agriculture Experiment Sta. Bulletin 461, The University of Connecticut. 96 p.

Miller, D. R. and Palley, P. A. 1983. Some Economic Benefits of Climate. Data Services in Connecticut. Storrs Agr. Expt. Sta. (In preparation).

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STATUS OF STATE CLIMATE PROGRAMS

by

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President, American Association of State Climatologists

ABSTRACT

A survey questionnaire was sent to the 45 states with a designated state climate contact person. Information about the status of the climatological programs in their state was solicited and a response of 87% was obtained. Approximately 20% of the respondents indicated they had no state climate program. About 30% of the respondents reported total staffing of one or less full-time equated (FTE) positions. With respect to funding levels, 23% indicated no funding while an additional 48% are funded at $50,000 or less per year. The status is not expected to change significantly except in isolated cases because over 70% indicated no anticipated expansion in the next 1-3 years. Much more work and funding are needed to bring the nation up to a minimal level of regional, state, and local climate services.

Introduction:

Many worker-years of effort have been expended in recovery efforts since that fateful day nearly 10 years ago when the federally funded "state climate" programs were terminated. Many studies and reports have addressed the needs for climatic information and services. The National Climate Act became law and created the NCPO. Other reports and conferences have addressed the problems encountered in meeting the climatic needs.

Reports dealing specifically with State Climate (SC) Programs were prepared by Eddy (1980) and Changnon (1981). Eddy summarized the activities of the state climate programs. After developing an extensive questionnaire and repeated prodding, approximately 80% of the 33 states with designated State Climatologists (SCs) were included in his report.

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*State Climatologist for Michigan
Chief of the Climatology Division, Michigan Dept. of Agriculture
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Changnon gave a brief history of events of the SC programs including the formation of the American Association of State Climatologists (AASC). At the time of his report, 42 states had designated SCs.

Current Status:

The number of designated SCs has increased to 47, mainly through the efforts of William Bartlett, Special Projects Officer and State Climatologists' Liaison at the National Climatic Data Center (NCDC, formerly NCC), my predecessor presidents of AASC, and interested persons within the individual states. Work is continuing in the remaining two states, and perhaps by the August 1983 meeting of the AASC, they will also have designated SCs.

A look at just the numbers of designated SCs may lead us to the conclusion that "all is well." Not So!. Much has been accomplished, but a closer examination reveals just how superficial the numbers can be. Many states who have had "designated SCs" for several years still have not appropriated a single dollar toward climate efforts, while many other states have provided only very limited funding, minimal or no services are, therefore, available in these states. The magnitude of these problems will become evident as we examine the results of the recent survey.

Survey:

A 2-page questionnaire, Appendix A, was sent to all 45 designated state climate contacts of record as of January 1, 1983. Two additional states have designated SCs since that time. Associate members of AASC were also mailed copies.

Survey Result:

	Number	Percent
Total State Respondents	39	87.0
Associate Member Respondents	8	26.0

The modest return from the associate members was expected since:

1) many are affiliated with SC programs and would have no additional information; and

2) the questionnaire was designed for the SCs and, therefore, had many items that were not applicable to the associates.

The author is very appreciative of the effort and comments of those who responded. This is especially true of the great 87% response of the SCs.

In the statistics that follow, generally, only the responses from the SCs are included. However, if an associate member was the only respondent from an otherwise unrepresented state, i.e., one without a designated SC, his/her comments were included. This was done to clarify the issue at hand, i.e., what is the status of climate programs in the states?

Please keep in mind:

1) that rounding errors may preclude some of the percentages from totaling to exactly 100%; and

2) in some cases where multiple responses were included, the multiple response percentage is an overage.

Question: What is your primary affiliation?

Reply:

	Number	Percent
University	28	71.8
State Agency	8	20.5
Both	1	2.6
Other	2	5.3

From the comments and personal conversations, it was clear that many, if not all, active programs involve cooperation with the various state agencies and universities in their state or commonwealth. In fact, many, although funded primarily through a state agency, are cooperatively located at a university.

Question: Which of the following characterizations best describe the State Climate Program in your state during the past 3 years?

Reply:

	Number	Percent
No SC Program	8	20.5
Expanded	23	59.0
Unchanged	11	28.2
Contracted	2	5.3
Multiple Answers	-5	-12.8

Individual comments are included in the following summary:

Extension climatology has expanded at the expense of research.

University program remains unchanged while Water Resources supports the updating and augmentation of data files & generates finished climate products.

I have been recognized by state as SC but have zero funds. Have been working with the agricultural experiment station regional committee representative to analyze and publish some data.

SC office created by state law in 1979. SC not hired until 1982.

University approved Dept. of Meteorology & Physical Oceanography to represent state with respect to NCPO in 1978. However, it was stipulated that no new state dollars be assigned. Dept. does provide very limited services.

Outside support would be needed for development of a program.

State sponsored portion has not kept up with inflation. University & Agr. Experiment Station funds allow additional personnel & expanded program.

Non-funded limited part-time position. Maintained by personnel desiring to upgrade integrity of climate data within state.

No organized SC program. Working with Sec. of Agriculture to get some funding to provide climatic information to farmers.

Program to provide climatic information to all who pay for research.

Expansion has been due to a few contracts & more publicity. Dollars are very tough to come by now.

Grants & contract monies promised again. Grants now for 2 years.

Primary source of funding is the University with direct support from Agr. Experiment Station added in 1982.

Formal program into statutes in July 1981.
Program very limited until mid-1982.
Unchanged from very low level of funding.
In operation only 1 year.

As is clearly evident, over 20% of the "designated SCs" do not have a recognized program. On the positive side, nearly 60% of the respondents indicate some expansion during the past 3 years. Although it was not stated explicitly, it is assumed by the author that this is in real dollars and not just inflated dollars.

Question: If you indicated changes in the above question, what were the primary changes? e.g., operational funds, staffing, equipment as micro- or mini-computers, etc.

Reply: The comments in response to this question are given below. No clear concise summarization is practical except to say computer equipment lead the list with increased staffing a close second.

Computer equipment changes or equipment added (12)
Increased staffing (10)
Operational funds increased (4)
Volunteer, non-funded, more temporary help (4)
Soft funds expanded (2)
Volume of requests increased (2)
Facility changes (2)
Service to state government increased, public service activities greatly increased.
2-year cooperative agreement with USDA-Forestry, to provide computer-accessible climate data base.
Equipment more fully utilized, resources used to purchase better data files.
Hired full-time Assistant SC.
NCPO grant not continued second year.
Some contract support for air quality & water resources.
Assistance of personnel from Office of Grants & Contracts.
Funding to prepare studies & printing.
Only research for which user is willing to pay.
Program to charge to recover some costs.
Mini-grant from Water Resources Research Institute.
To cut storage costs -- using microfiche/film equipment.
Automatic data loggers.
Funds in July 1981 for avalanche/fire weather forecast center.
APPLE connects with NOAA weather wire.
Network increase.
Computer applications have increased with micro-computer to be added in 1983.
More time to applied climatology.
Initiation of prototype near real-time climate reporting network.

Question: Our current program has the following elements:
Staffing: FTE Permanent _______, FTE Temporary _______________
Budget: Gross fixed budget _____________,
Gross soft budget_______________.

Reply: This information is summarized in Figures 1 - 3.

From the total staffing (Figure 1), it can be seen that 7 (18%) have no staff and 12 (31%) have .1 to 1 FTE. Therefore, almost half, 49% have 1 or less staff members assigned to the program (Figure 2). This is very indicative of the part-time nature of many SCs and how their programs are operated.

Only 3 programs have a staffing of more than 5.0 FTE. These have 9, 11, & 15 respectively. Many states utilize student part-time workers through the universities and, therefore, have many individuals making up the FTE. In Michigan, for example, approximately 20 students make up 5 FTE at an average of about 10 hours/week.

From a budgetary point of view, approximately 23% have no SC funding! An additional 48% are funded at $50,000 or less. Six states, 17%, have budgets of $200,000 or more with two of these at about $500,000 or more. Four respondents with active programs did not indicate their funding levels. They are definitely not zero, but the exact categories into which they fall are not known by the author.

The cumulative percent of programs with total operating budgets of indicated levels is given in Figure 3. About 60% of the programs have $50,000 or less.

Question: What are your best estimates as to the trends in budget, staffing, and projects for the climate program in your state in the next 1-3 years?

Reply:

	Number	Percent
Expansion (including slight)	11	28.2
Unchanged	24	61.5
Reduction	2	5.1
Other	2	5.1

Less than 30% of the respondents expect any expansion to occur in the near future, with over 60% expecting no change.

The individual comments are as follows:

Funds are extremely scarce. Poor economic conditions. No growth for next few years (7)

Increased activities (3)

Study of future underway (2)

Depends on public response to pay for services (2)

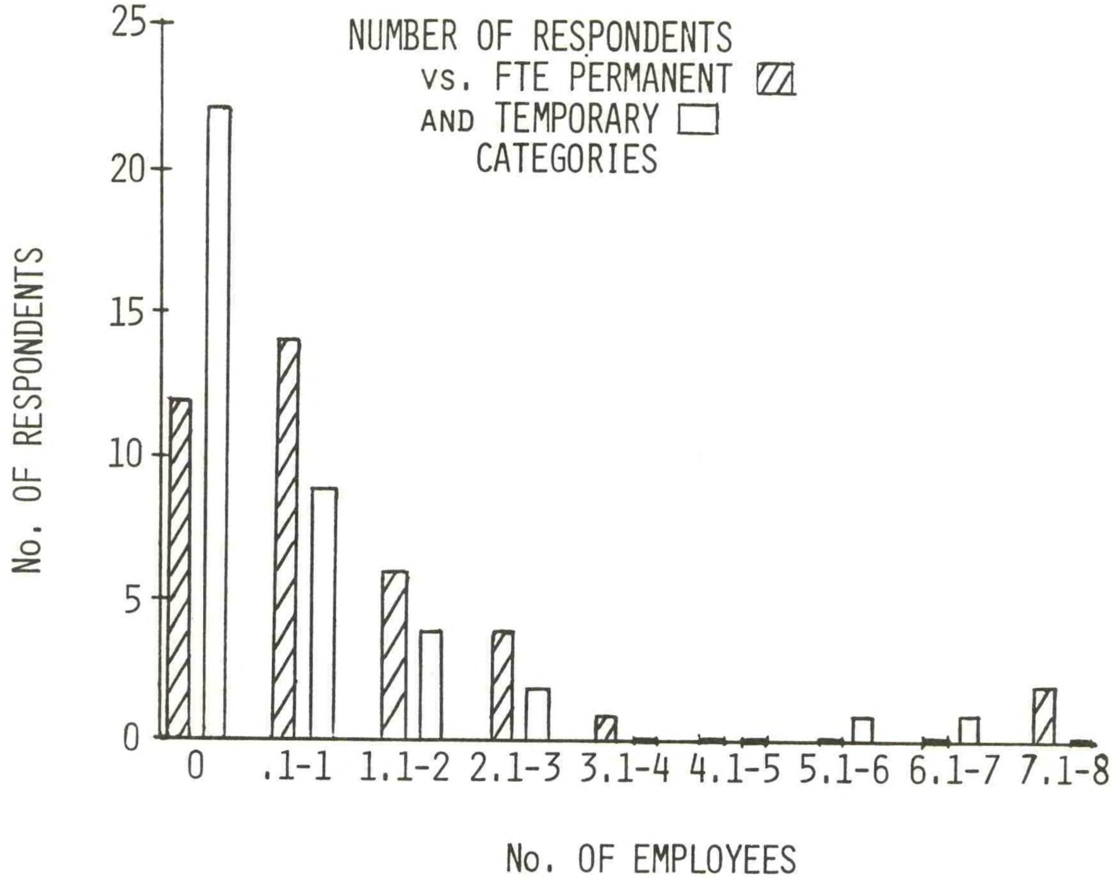
Moderate increase in funding (2)

More effort to publications and short courses, to cut costs & time of answering requests.

Increasing contract studies & agreements for air quality and water resources (state & USDA).

Goal is one new report each year.

FIGURE 1.


NUMBER OF RESPONDENTS
vs. FTE PERMANENT
AND TEMPORARY
CATEGORIES
No. OF RESPONDENTS
0
5
10
15
20
25
0
.1-1
1.1-2
2.1-3
3.1-4
4.1-5
5.1-6
6.1-7
7.1-8
No. OF EMPLOYEES

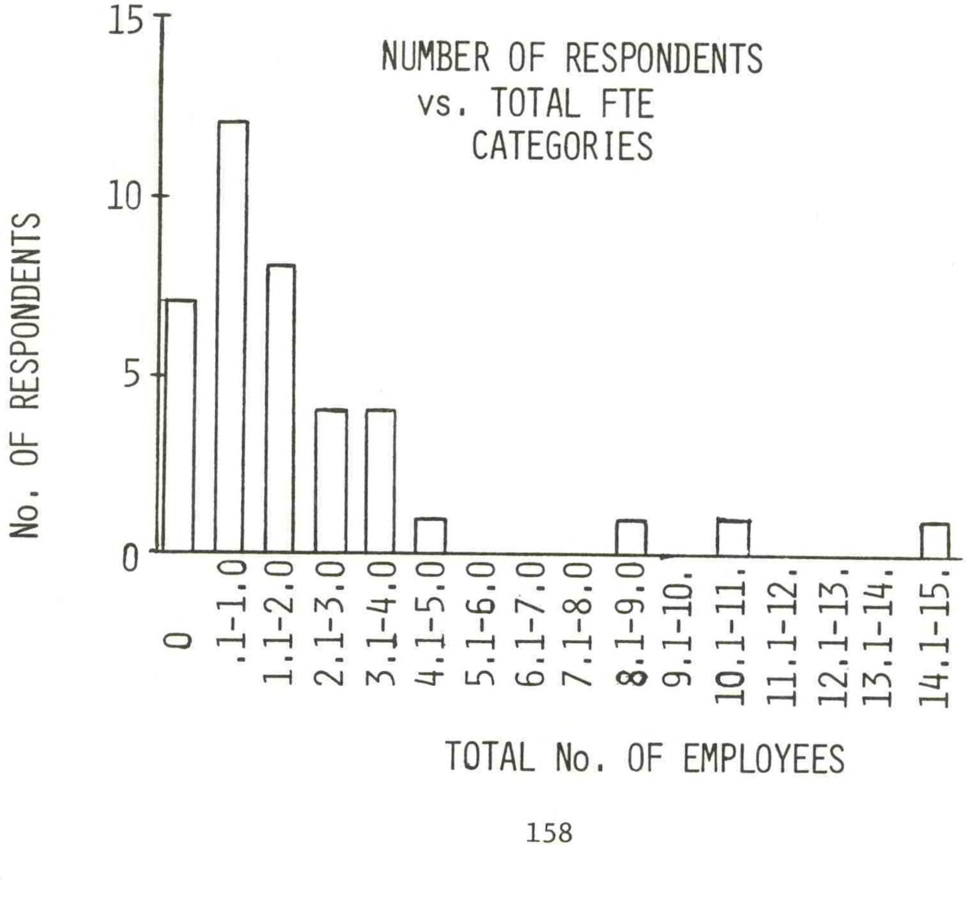

NUMBER OF RESPONDENTS
vs. TOTAL FTE
CATEGORIES
No. OF RESPONDENTS
0
5
10
15
0
.1-1.0
1.1-2.0
2.1-3.0
3.1-4.0
4.1-5.0
5.1-6.0
6.1-7.0
7.1-8.0
8.1-9.0
9.1-10.
10.1-11.
11.1-12.
12.1-13.
13.1-14.
14.1-15.
TOTAL No. OF EMPLOYEES

FIGURE 2.

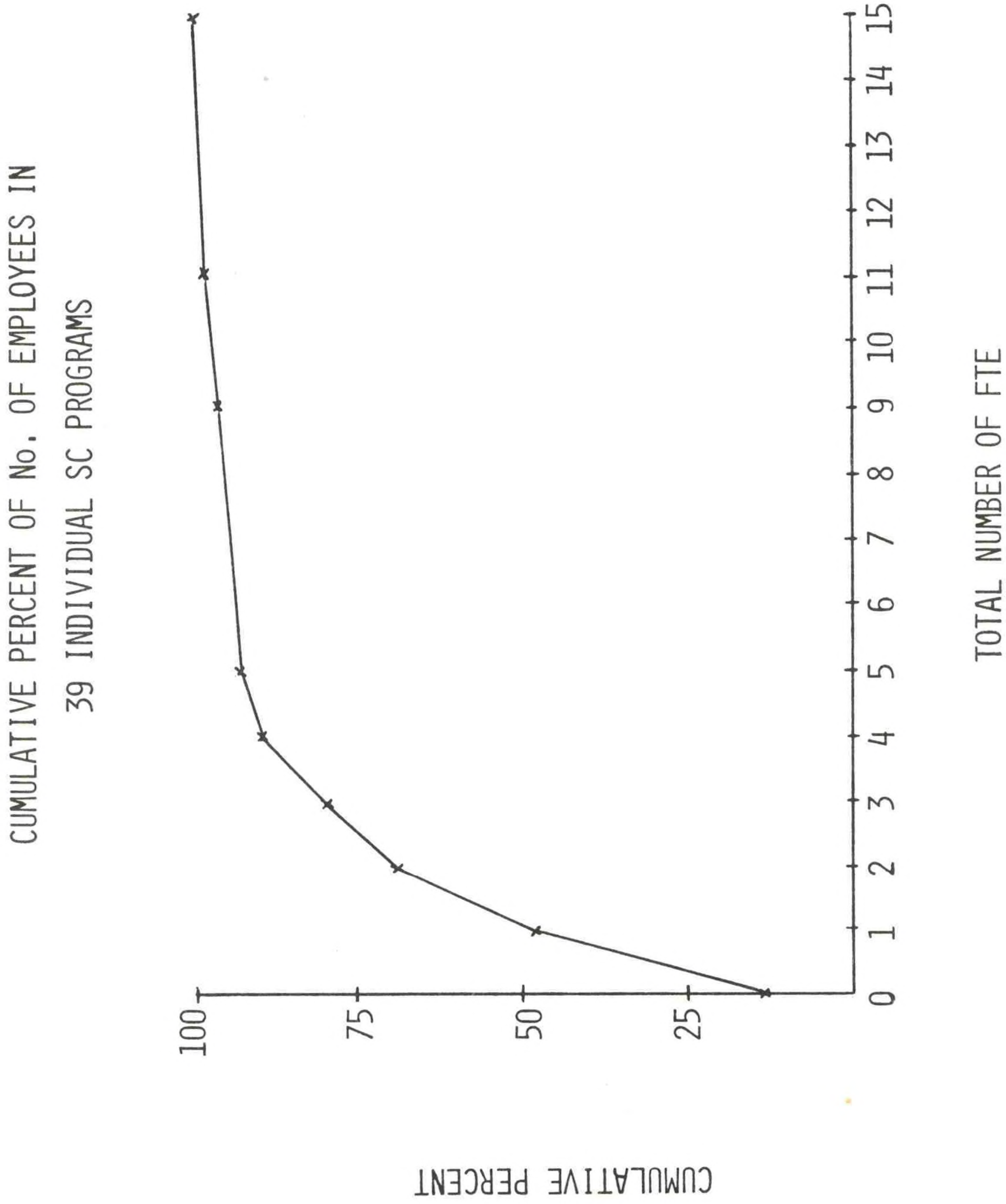
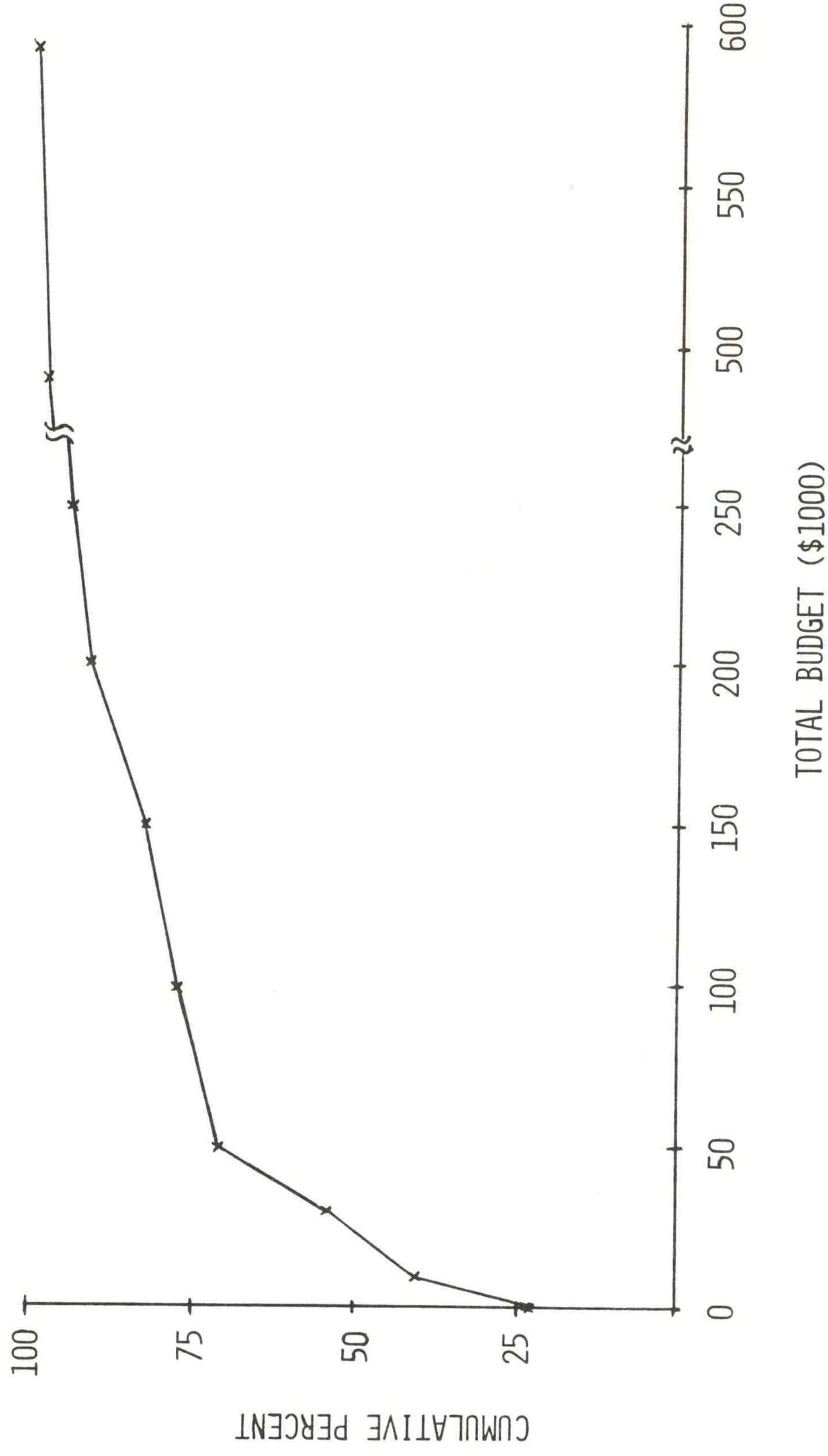

CUMULATIVE PERCENT OF No. OF EMPLOYEES IN
39 INDIVIDUAL SC PROGRAMS
CUMULATIVE PERCENT
100
75
50
25
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
TOTAL NUMBER OF FTE

FIGURE 3.

CUMULATIVE PERCENTAGE OF TOTAL BUDGET REPORTED
FOR 35 INDIVIDUAL SC PROGRAMS



60% chance of continuing at same level, 5% chance of increase, 35% chance of elimination.

Expect fixed budget to double in 3 years. Soft monies to substantially increasse.

Perhaps increase in staff.

Stable to modest expansion.

Real-time data-information system for selected users.

Unknown at this time.

Unchanged or contract slightly.

Budget and staff about the same.

Probably unchanged, perhaps 2 new positions.

Question: What are the major activities/projects being performed by your state climate center?

Reply: Comments about the major activities of the SC programs are given below. Many common activities are included; however, each state has its own specific areas to service. The author believes that many of the active SC programs are each involved in many of the following activities but did not list them independently. The number of individual citations has little relevance and is therefore, not a part of this list.

Dissemination of climate information & referral service.

Data collection & archival.

Climate atlas for state.

Support state agencies, county, & local governments.

Cooperation with NWS & federal agencies.

Preparing publications & climate summaries, some monthly climate information published.

Data computation, limited analysis & research, expansion of digital data bases.

Statewide severe weather preparedness.

Ice atlas for state waters.

Preparing climate information for state water atlas.

Precipitation & temperature study for patterns, trends, forecasts.

Solar analyses, loan of solar equipment from EPA, & Research Solar Radiation Climatology.

Avalanche/fire weather forecast.

Anemometer loan program.

Drought study, soil moisture, irrigation schedule.

Crop yield models.

Pest vs. climate.

Snowmelt.

Frost depth estimation.

Hydrologic modeling, flooding, water resources, agriculture.

Evaporation & transpiration.

Economic impact of climate, long-term climate trends.

Improved state climo-data base.

NEDRES inventory for NE U.S.

Data quality control, statistical summarization, news articles, state newsletter.

Set up new climate stations.

Coordinate state weather information services & atmospheric monitoring, air quality.

Operate network of automatic remote weather stations.

Initiation of a delivery system through cooperative extension service.

Climate monitoring.

Consultation.

Checking NCDC array with E-15s & adding comments for NWS/ Cooperative Program Manager's use in the solution of observer related problems.

Manage climate program.

Work on system to provide current data from substations.

Micro-processor/climate analysis for lesser-developed countries (WMO).

Use of D/RADEX data for small watershed management (NWS/OWRB).

R/RADEX data archival (NWS).

Research project on maritime climatology, 12-82/2-83, supported externally.

Question: To what kind of computer facilities do you have access, if any?

Reply:

	Total	None	%	Yes	%	# with 2 or more
Large Mainframe	37	2	5.4	35	94.6	2
Mini-computer	29	8	27.6	21	72.4	6
Micro-computer	31	7	22.6	24	77.4	5

A summarization of the computers in use is given in the following table:

Mainframe	#	%	Mini-	#	%	Micro-	#	%
IBM	14	38.9	DEC	13	52.0	APPLE	10	32.3
CDC	9	25.0	TI	2	8.0	IBM	6	19.4
AMDAHL	4	11.1	HP	1	4.0	HP	4	12.9
DEC	3	8.3	HARRIS	2	8.0	WANG	1	3.2
UNIVAC	3	8.3						
Others	3	8.3		7	28.0		8	25.8
						W.P.	2	6.5
	36	99.9		25	100.0		31	100.1

Individual comments were as follows:

Funds for CYBER limited to less than $500/year.

Harris & Xerox belong to university's Dept. of Meteorology.

All state climate data (1901-82) are on disk storage -- mainframe at Agriculture Data Network (ADN).

The company (I'm a full-time employee) allows me to use their extensive computer facilities.

Major data storage on magnetic tape at university computer. Access via CYBER.

Use departmental funds for processing as I am chairman.

PDP 11/70 is in-house & essentially free (university).

Use TNRIS data storage facilities.

Anticipate acquisition of terminal & limited access to a large mainframe computer about May 1983.

Office Information Systems - Campus-wide WANGNET being installed with word processing.

I have a data acquisition system for research purposes that is a micro-computer, also.

Data entry & off-line editing on TERAK -- development work continuing.

IBM personal computer expected to be installed June 1983.

Question: If you answered yes to items b and/or c in the above question, (mini- and/or micro-computers) do you use the following items?

Reply:

	Total	No	%	Yes	%
a. Floppy Diskettes	27	2	7.4	25	92.6
5 1/4"				16	64.0
8"				14	56.0
Both				6	24.0
No indication				1	4.0
b. Hard Disks	23	6	26.1	17	73.9
10 M byte or less				7	41.2
Between 10 & 100 M				5	29.4
Larger than 100 M				1	5.9
Not indicated				4	23.5
c. Digitizer	2	13	56.5	10	43.5
d. Graphics	26	6	23.1	20	76.9
e. Modem	27	2	7.4	25*	92.6

*The "yes" category contains one respondent who indicated a dedicated line without a modem.

The distribution on baud rates of the 25 with connections is:

Baud Rate	Number	Percent
300	17	68.0
1200	13	52.0
2400	2	8.0
9600	2	8.0
Missing	1	4.0
Multiple Rates	10	40.0

The author is not sure how many respondents answered sections b, c, & d with respect to ALL computers available instead of limiting it to the mini- & micro's as requested. It is suspected to be a substantial number. A few respondents indicated their answers were with reference to the mainframe.

Question: What is/are the operating system(s) you use and/or have the capability of using?

Reply: The responses were as follows:

APPLE: DOS, SOS, DOS 3.3
Burroughs: CANDE/MCP 3.3

CDC: SCOPE & CYBER record manager	
CDC - NOS	
CYBER 205	
Commodore: 2.0	
DEC: VAX, PDP11: UNIX	DEC 10: TOPS 10/TOPS 20
PDP 11/70	
HARRIS: VULCAN, 1600	
IBM PC: MS-DOS UCSD P-System	DOS 1.1
OS/VSI (batch)	3033: OS/MVS
PC/DOS	OS, TSO, CMS
MISCELLANEOUS SYSTEMS:	
AGNET	RSTS/E VERSION 7.2
CP/M, CP/M 2.0	XENIX
CMS	NEUROS
VMS	ZEROX - CP/M 2.2
EXEC 8	WYLBUR
UCSD - PASCAL on TERAK	SUPERWYLBUR
Series I-EDX Minicomputer	USPC
VS/DOS RSX 11m$_v$4	SAS

As is to be expected, the operating systems are even more varied than the computers since each may be configured differently.

As expected, categorization into mini- and micro-computers was variable since the demarcation between them is not clear cut. The author adjusted the few discrepancies into the categories indicated by the majority of the respondents with similar equipment.

Two active SC programs were reported to have no computer access, while 6 of the respondents without programs indicated computer access. The remaining 2 without a program did not answer the question.

Many additional general statistical, data management, and graphics packages that are oriented strictly to mainframe utilization were also reported but not included herein.

Question: Do you anticipate having in your office the capability to use digital data from NCDC via floppy diskettes if they were made available in the near future?

Reply:

Total	No	Percent	Yes	Percent	
39	7	18.0	32	82.0	
			21	65.6	Immediately
			3	9.4	3-6 Months
			3	9.4	6-12 Months
			3	9.4	1-2 Years
			2	6.3	More than 2 years

Nearly 2/3 of the affirmative respondents can utilize information via floppy diskettes immediately, with an additional 19% within the next year.

Question: Please make any additional comments that you would like to have passed along to the NCPO and conference attendees.

Reply: The edited comments of the respondents are given below.

If NCC tele-communications were compatible with LIBRARY, a computer system in all Land-grant schools, interactions between data-banks nationally and locally would be facilitated considerably.

Unfortunately, it seems that SC concerns have very low priority in NCPO regardless of what is said or written by them. When will the decision makers at NCPO recognize the vital importance of continuing and upgrading the observation network and quality control of the data? The stupid decision of abandoning the SC offices in 1973 must be overturned. Funding must come from the Feds. State funding will always be so heterogeneous that little can be done uniformly across the country without Federal support.

The continuing support from NCDC & NESDIS is gratefully appreciated. However, the continuing $500/SC service account is woefully inadequate during the times when the costs of a magnetic tape of digital data have more than tripled in 2 years ($80 each in 1980 to $265 in 1982).

We are concerned about the flimsy envelopes used to mail such products as CD's (several have torn apart in the mail), and the poor turn around time through NCDC for a request of digital Palmer Drought Indices.

I think NCPO has done a good job with the resources they have had. The fact that available funds fell short of grant requests should not produce criticism of NCPO. In this situation, NCPO has done a reasonable thing by trying to fund a few projects that would hopefully produce the type of success stories that Congress and others would buy. Whether this is a planned strategy or happened because there were too few funds to go around, I do not know. But, NCPO should be congratulated for their handling of the situation. I hope that the economy will allow reasonable and orderly growth of NCPO funds based on the success of projects supported to date.

The NCPO provided minimal funding during FY '82 for a project to develop a 'Concept for a Climate Information & Analysis Center for ....' This study identified over 40 agencies within the State that make, or would make, use of climate information, and established a definite need for improved climate products. Subsequently, a proposal was sent to NCPO (hurriedly, at their insistence) to establish a 'mini' climate center. Several state agencies had agreed to work with us on this project.

The proposal was rejected before the NCPO even had received our final report on the first year's study. After repeated contacts, the 'bottom line' became obvious - NCPO had essentially decided ahead of time which states were going to receive funding, and other proposals had little chance of acceptance.

My questions: Is this situation acceptable? Is the NCPO following the intent of the National Climate Program Act by funnelling additional monies to states with active and basically well-funded programs, while refusing funds to those states with weak or non-existent programs? It would appear that the latter group of states are the ones that require a boost, if the goal of having active programs in all states is to be realized.

Thank you for this opportunity to explain, in large measure, why my state will likely continue without a climate program.

In a follow-up telephone survey by Bob Muller, President Elect, AASC, SC/LA, it was determined that 14 states currently issue a regular monthly or quarterly publication concerning conditions within their state. The total is not complete due to inability to contact all SCs. However, it is believed to be accurate to within 2 or 3.

Summary & Conclusions:

Much progress has been made in recent years to provide the climatic information and services needed in the individual states and throughout the nation. A tremendous amount of work is still needed to bring many of the states up to a "minimal" level. This is crucial for the approximately 20% that have nothing! It is readily acknowledged that any active program could utilize additional staff and funding. Those most in need, however, are the nearly half which have a total staff of one or less FTE position and the nearly 60% which received annual funding of $50,000 or less.

Those states which have strong and growing programs (59% reported expansion during the last 3 years) must serve as role models and do everything they can to encourage the development of stronger programs in the other states. In this way, the total climatic program for the nation will be enhanced and all programs will benefit in the long term.

The rapid advances in computerization that have taken place in the past few years offer tremendous opportunities and challenges. The timeliness of collecting and editing data, summarization and special research projects can now become a reality instead of just a dream. The backbone of the whole process is the federal climatological data collection system. We cannot afford to allow the system to deteriorate or be dismantled without adequate replacements. Let's get on with the activities necessary to improve the whole system and implement the procedures necessary to meet the current and future regional, state, and local climatological needs.

References:

Changnon, Stanley A., Jr. "The American Association of State Climatologists", Bulletin of the American Meteorological Society, Vol. 62, No. 5, May 1981.

Eddy, Amos. "State Centered Climate Services". Prepared for the American Association of State Climatologists under contract by EDIS/NOAA NA80DA-C00007, August 1980.

APPENDIX A

AASC QUESTIONNAIRE
1983

1. I prefer the annual meeting at Asheville to be held:
   August 9-11, 1983________________
   August 2-4, 1983________________

2. What is your primary affiliation?
   ☐ University   College/Dept.________________________________
   ☐ State Agency   Dept. of____________________________________

3. Which of the following characterizations best describe the State Climate Program in your state during the past 3 years?
   ☐ We have no recognized State Climate Program
   ☐ It has expanded
   ☐ It has remained essentially unchanged
   ☐ It has contracted

   Comments:

4. If you indicated changes in #3 above, what were the primary changes? e.g., operational funds, staffing, equipment such as micro- or mini-computers, etc.

5. Our current program has the following elements:
   Staffing:
      FTE Permanent_____________
      FTE Temporary_____________

   Budget:
      Gross fixed budget_________
      Gross soft budget__________

6. What are your best estimates as to the trends in budget, staffing, and projects for the climate program in your state in the next 1-3 years?

7. What are the major activities/projects being performed by your state climate center?

8. To what kind of computer facilities do you have access, if any?
   a. Large mainframe
      ☐ None ☐ Yes, a(n)________________
   b. Mini-computer
      ☐ None ☐ Yes, a(n)________________
   c. Micro-computer
      ☐ None ☐ Yes, a(n)________________

   Comments:

9. If you answered yes to items b and/or c in #8 above, do you use the following items?
   a. Floppy Diskettes
      ☐ No ☐ Yes ☐ a 5¼"
      ☐ an 8"
   b. Hard Disk Drive
      ☐ No ☐ Yes, a ________ byte
   c. Digitizer
      ☐ No ☐ Yes
   d. Graphics Packages
      ☐ No ☐ Yes, ________________
   e. Modem between the micro/mini and a mainframe
      ☐ No ☐ Yes, at a ________ baud rate

10. What is/are the operating systems(s) you use and/or have the capability of using?

11. Do you anticipate having in your office the capability to use digital data from NCC via floppy diskettes if they were made available in the near future?
    ☐ No ☐ Yes, When? ☐ Immediately
    ☐ 3-6 months
    ☐ 6-12 months
    ☐ 1-2 years
    ☐ > 2 years

12. Please make any additional comments that you would like to have passed along to the NCPO and conference attendees. (Attach additional sheets if necessary).

TECHNOLOGY SUPPORT FOR STATE AND REGIONAL CLIMATE SERVICES

Synopsis*

Hightlights

o All Speakers focused on the need for timely and accurate data in an appropriate format to meet the users' needs.

o Use of ADP and other electronic communications capability will be a must to meet user demands for data and information.

o More data doesn't always ensure better decisions.

o All agreed that many observations never leave the observer's work area. How do we get these data into the current system for data collection? Are they compatible with existing network data? Are they needed to complement NWS data? What level of detail is needed at the Federal, regional and local level?

Kenneth Hubbard (University of Nebraska-Lincoln): The major effort (Nebraska project) is on data collection and management. Timely and accurate observations are now possible from remote ADP connnected sources. User access to data is accomplished with "user friendly software" i.e., one word commands. The communication-dissemination capability will be the major change in the next ten years. The conversion of data to information will and can take place on two levels: on site by decisionmakers for application of irrigation water or by multidiscipline teams when the impacts of a climate event are likely to cover a state or multistate region. In the latter case an advisory will be prepared with recommendations for appropriate action to be taken but it is up to the individual farmer to take the steps necessary to respond.

J.J. Stephens and colleagues (Florida State University): The Kindly Local Interaction Meteorological Access is ADP software that enables the users to acquire satellite data and other meteorological information via a set of simple commands. This data and information is provided to ensure information for real-time decision making and longer term planning. It expands data available to a regional or national basis, more in the nature of AFOS products but with selected historical data sets. Again the stress is on ease of access to data, timeliness, and accuracy to aid farmers and decisionmakers in solving today's operational needs.

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* Reported by Norton Strommen, U.S. Department of Agriculture

John Woeste (University of Florida) emphasized the role of ADP and the changing role of the extension service. This includes education and training for users of climate data and expands work in areas for livestock management and marine interests. The focus will be on increased profitability in the food and agriculture system. While the federal government will have a responsibility, the private sector will have an important role to play in evolving cooperative public and private climate data and information services.

J.David Martsolf (University of Florida): The Satellite Frost Forecast System provides essentially real-time thermal maps based on satellite readout. While the ADP is complex for handling large data, the final product can be acquired easily by the user for display on the TV screen or in hard copy. The ability to update at selected intervals allows the user to note changing patterns in a near real-time mode for use in operational decisions for fruit frost protection.

A larger system is developing as the Florida Agricultural Science and Technology System (FAST). FAST was established as a not-for-profit corporation in January 1983. It will supply products similar to those developed for SFFS but covering a broader range of weather and climate information needs. FAST is expected to assume much of the operational responsibility for products and services originally developed in SFFS.

Norton Strommen (U.S. Department of Agriculture): ADP and a dedicated data management capability are essential to handle large volumes of climate and weather data. The source of data is global; thus quality control is a continuing problem because the user has no direct contact with the observer. Selected historical data, both agronomic and meteorological, have been placed on disc files to provide ready access by the user. Known crop parameters, i.e., growing degree days, potential evapotranspiration, etc, are generated and stored using the current data flow from the WMO/Global Telecommunications system. A multidiscipline staff monitors global weather events and interprets the expected impact on major crops. But because many types of data and information are used, it is still the person in the loop who must select data used and determine how these will be integrated for qualitative and quantitative assessments. The Joint Agricultural Weather Facility is an outstanding example of cooperation between two Federal Departments. The basic meteorological data generated by the Department of Commerce is now used to enhance the agricultural assessment capability of the Department of Agriculture.

CLIMATE DATA COLLECTION AND MANAGEMENT:

THE NEBRASKA AUTOMATED WEATHER DATA NETWORK AND AGNET[1]

by

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Abstract

Using commercially available computers and weather stations, an Automated Weather Data Network (AWDN) was established in Nebraska. The AWDN was linked to a computer management tool for agriculture (AGNET) providing access to many users. Since June of 1981 the network has expanded from four to 17 stations. The AWDN data has been used in irrigation scheduling, evapotranspiration studies, agricultural weather advisories, national publications and in the news media. An irrigation scheduler may choose from the programs WEATHER, ET and IRRIGATE depending on the desired format and degree of computation to be accomplished on AGNET.

Introduction

Historically the collection of reliable weather data has been a time consuming and often tedious process. However, today's technology can revolutionize these practices. Up-to-date data can be collected from remote areas and, with models of physical processes related to agricultural operations and production, will serve as a guide to planning.

Advances in computer microelectronics and communication systems will present new challenges and opportunities to engineers and scientists. Scheduling on-farm activities, summarizing weather impacts in real time and projecting farm production based on the effects of weather are a few examples. The credit for advancement in weather data collection lies in part outside the field of meteorology. Technological advances in microengineering have decreased the cost and improved the performance of computer equipment (Branscomb, 1981), thus paving the way for current applications of weather data to many agricultural problems.

A system to automatically collect weather data has been developed by the University of Nebraska's Center for Agricultural Meteorology and Climatology (CAMaC). The system is designed to collect near-real time meteorological measurements from specially selected agricultural sites across the state.

The Nebraska Automated Weather Data Network (AWDN) uses telephone linkages for all communication beginning with the collection of remote weather data and culminating in the real-time dissemination of weather summaries to the user.

The applications of near-real time weather data have stimulated great interest in the AWDN. As a result, the number of weather stations in the network has increased from four to 17 in less than two years.

The challenge facing us today is to apply basic knowledge concerning the impacts of weather to various agricultural management situations by the development of appropriate software. This paper describes some of the progress to date at the University of Nebraska toward automated weather data collection, the application of weather data to real-time agricultural problems and procedures developed to disseminate results to users in a timely manner.

Automated Weather Date Network (AWDN)

The AWDN is composed of transmitting weather stations that are managed or controlled as a group by a communications computer. From a computer perspective, it is a set of microprocessors that are controlled by a minicomputer that in turn communicates with a mainframe computer to which other minicomputers and terminals have access. Each link in the chain is vital to the dissemination of data to users.

The microprocessor at each weather station serves as an on-site manager. A solid state memory stores instructions for on-site management of data as well as calibration constants for use in converting analog weather sensor input to digital (in the electronic sense) form during the processing of incoming weather signals. The instructions in use require that the microprocessor monitor signals from the sensors once each minute and from these values calculate hourly averages or totals. These hourly values are then stored in the memory of the station microprocessor. The current memory configuration and storage frequency results in a storage capacity corresponding to two full days of data.

Several sensors are monitored by each microprocessor. A cup anemometer and a wind vane measure wind speed and direction, respectively. The wind parameters collected are mean wind speed, mean wind vector magnitude, mean wind vector direction and standard deviation of direction. Air temperature is measured with a thermistor and relative humidity is measured with a temperature compensated electronic hygrometer. Global radiation is measured with a silicone pyranometer mounted on a horizontal surface. A shielded thermistor serves as a soil temperature probe. Each site is also equipped with a tipping bucket rain gauge for measuring precipitation. The tipping mechanism records each 0.04 inches of precipitation received.

Installing a weather station consists of erecting a 10 ft. tower. Weather sensors are then mounted upon or near the tower. Wind sensors are mounted atop the tower while temperature, humidity and radiation probes are attached at 5 ft. The soil probe is installed at a depth of 4 inches under bare soil (natural sod in rangeland locations) and the rain gauge is located within a few meters of the tower base.

A battery-powered telephone answer modem is installed inside a small weather-tight shelter along with the station microprocessor. A private telephone line is installed at the weather station and a lead wire connects the microprocessor to the telephone jack through the answer modem.

Stations are located as shown in Fig. 1. There are currently 17 stations in Nebraska each of which record weather data from seven sensors on an hourly basis. A minicomputer located at the Center for Agricultural Meteorology and Climatology (CAMaC) automatically controls communication with station microprocessors. Telephone calls are scheduled routinely at 3 a.m. to take advantage of the night-time telephone rates. This CAMaC computer also identifies those hours for which data should be transmitted and compares the signature for transmitted data strings with the signature prior to transmission (checksums) to insure reliability in transmission. The CAMaC computer also checks weather parameters against specified upper and lower bounds, flags any inconsistencies and stores the data for future use. After interrogating all weather stations, the CAMaC computer initiates a call to a mainframe computer.

The mainframe computer in this case houses a multi-user Agricultural Management Network (AGNET). Weather data are transferred to the mainframe computer, checked for transmission inconsistencies and stored in a master data file for AGNET use.

AGNET (Thompson, 1981) is designed to allow users with very little programming background to obtain the available computer answers. One word program names provide access to user friendly software. The user selects the options that are available in each program and obtains a printout of information pertaining to the problem under consideration. The AGNET system can be accessed by telephone communication from any terminal. A schematic of the AWDN and the linkages discussed above is shown in Fig. 2. It has been demonstrated that weather data can be collected with the AWDN in near-real time and with a high degree of reliability.

AWDN Operation

Unlike temporary stations established in the past by scheduling consultants, the automated weather stations are established at permanent agricultural sites and are maintained year round. Maintenance of the network includes the repair of non-functioning equipment, the calibration of sensors and the checking of data for quality.

Maintenance of a near-real time network is far easier than maintenance of a conventional network. One advantage is that the daily reporting of data to a central location allows personnel to review sensor output and the battery signal from each station. This task is simplified because the minicomputer flags and prints any data that deviates from expected values. This review is accomplished in a few minutes each morning and any problems can be dealt with swiftly.

Calibration is performed annually on selected AWDN sensors. The silicon pyranometer is calibrated against a precision spectral pyranometer. Wind sen-

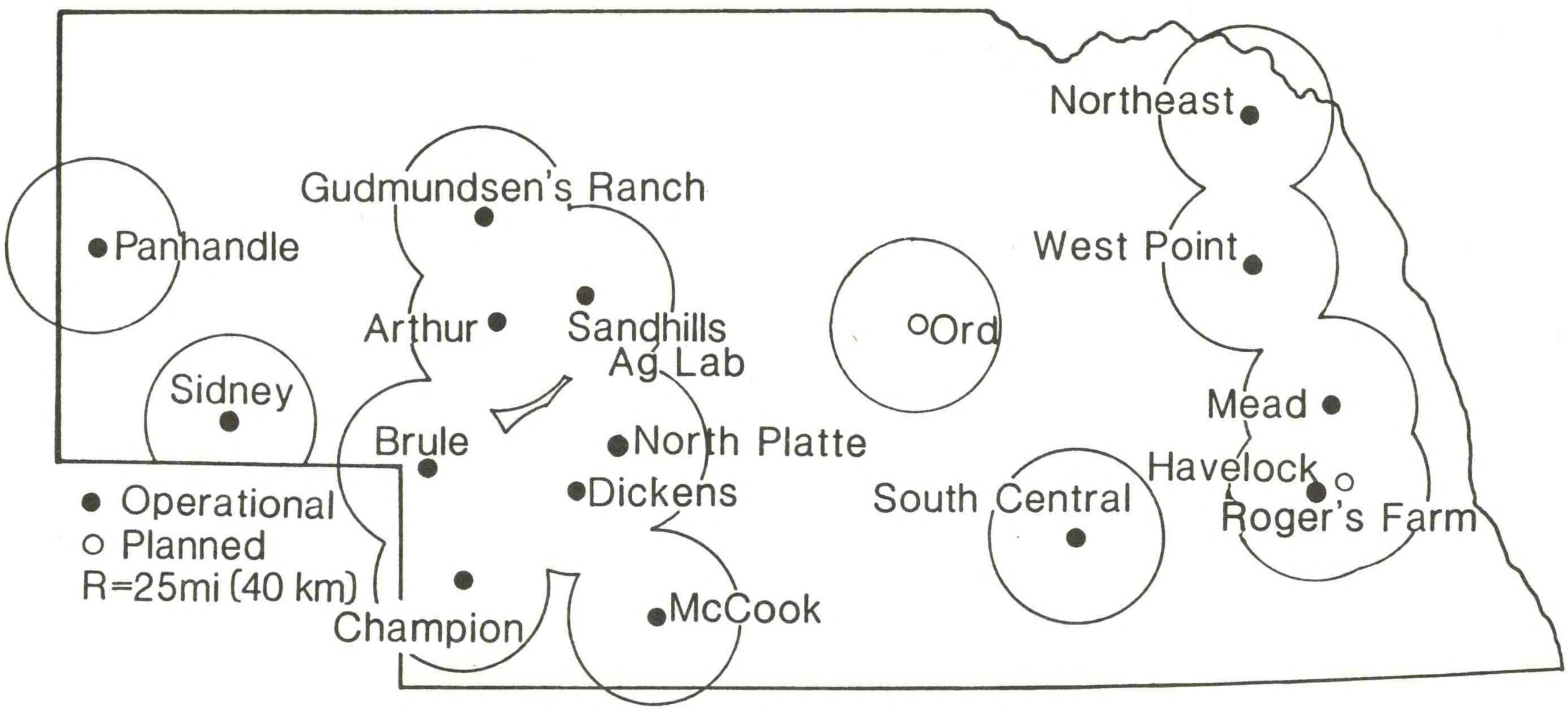

Fig. 1. Weather Station locations in the Automated Weather Data Network.

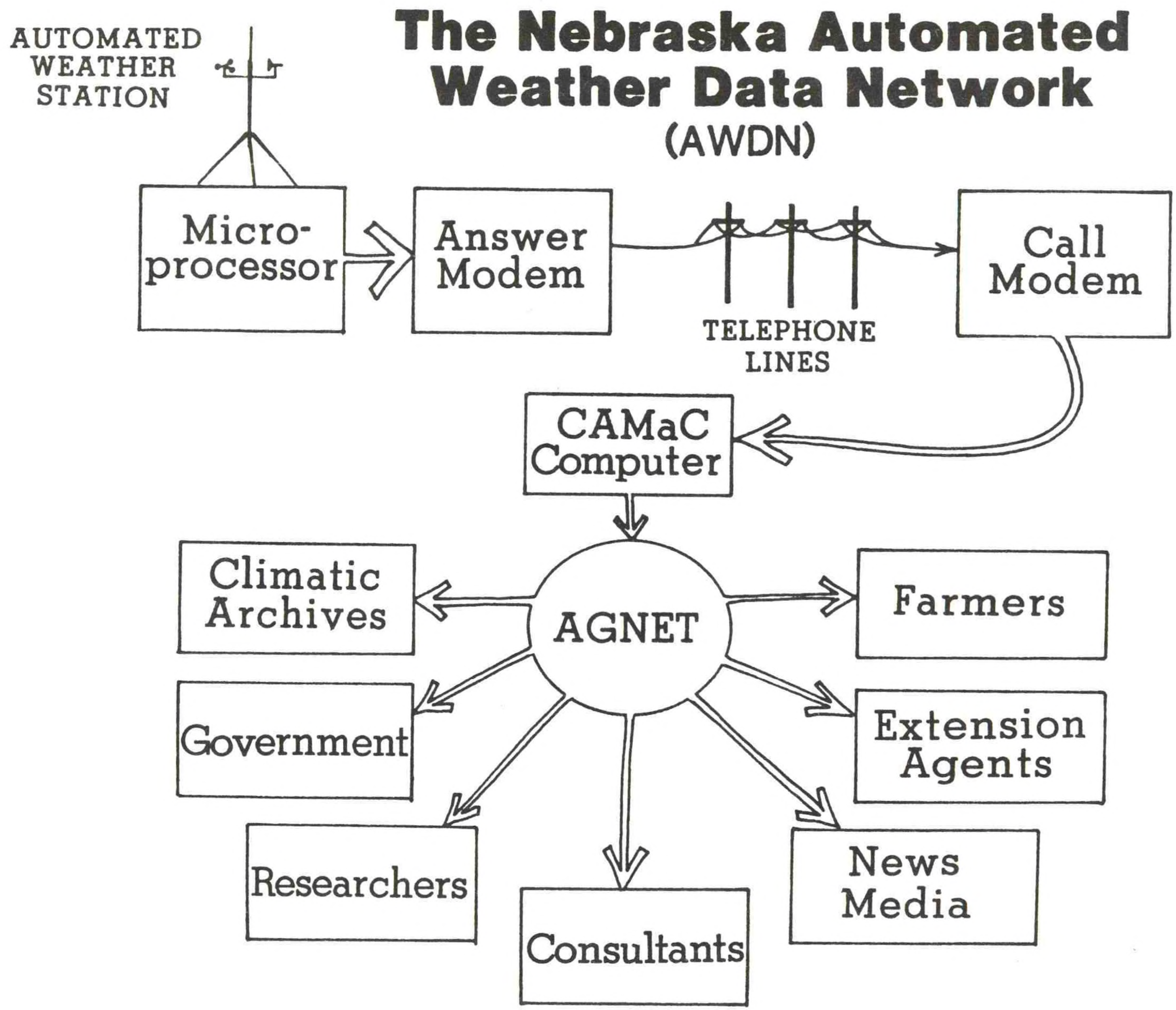

Fig. 2. The conversion of weather data into user information in the Automated Weather Data Network.

sors (anemometers) are calibrated in a wind tunnel. Temperature probes are calibrated against a thermocouple standard. The humidity transducer of the electronic hygrometer is replaced annually at the beginning of each growing season. Calibration is a critical part of a successful AWDN because poor data would likely lead to erroneous management decisions.

AWDN data is quality checked in several steps. First, the check of data signature before and after transmission assures valid data exchange. Second, the computer checks incoming parameters against reasonable upper and lower bounds and flags suspicious data for later review by CAMaC personnel. Third, the main frame computer is used to periodically compare nearby stations. Possible data errors are identified by plotting a scatter diagram for a station and its nearby neighboring station(s). Any points which fall beyond a reasonable range of scatter are checked for validity.

Missing or errant data are estimated in the following manner. A real-time data estimate is made by averaging surrounding stations for the same parameter. At a later time a more accurate estimate is obtained from linear interpolation of parameter differences in space and time. This method is far superior for periods of less than 24 hours and is used in all cases because of the smooth transition it provides from actual data to estimated data periods.

User Applications

A summary of AGNET programs which utilize weather or climate data is shown in Table 1. These programs provide the user with facts that can be applied to the management decisions such as: crop selection, water consumption by crops and crop development; livestock purchase, feeding and care; and grain drying. There are other applications where engineers and scientists could contribute to weather-based agricultural applications. For example, scheduling of fertilizer application as it relates to soil conditions could be related to existing weather because of the link between weather and soil moisture. The timing of pesticide control measures could also be guided by the prediction of pest development from weather data. An analysis of weather stress on crops could aid in crop yield forecasts. The possible AWDN applications are many and the literature abounds with weather-related studies. It seems reasonable to assume that other near-real time applications will be developed in the future.

Applications to Irrigation:

The use of near-real time weather data in irrigation scheduling will be used to illustrate weather data application to agricultural problems.

In the Great Plains region of the United States, the use of irrigation to stabilize food production and increase yields has risen at an exponential rate since the 1950's. In Nebraska about 7 million acres are now irrigated (Fischbach, 1981) and in 17 western states there are 50 million irrigated acres.

Many of the new irrigation systems are easily observable from an overflight of the plains states. Traveling by plane, an observer can see obvious patterns on the ground below due to the recent addition of sprinkler systems. The center-pivot system sprinkles water on a crop while slowly revolving about the center of the field and seemingly enclosing a perfect circle that is easily distinguished from rectangular shaped dryland fields, gravity irrigated fields or rangelands.

Irrigation costs can be reduced if scientific irrigation scheduling is used to manage sprinkler systems. Unwise irrigation pumping wastes fuel, degrades soil quality, overtaxes ground water and possibly degrades the quality of ground water and surface runoff. The monetary cost of excess irrigation is 50 to 100 percent higher than the cost of prudent irrigation using scientific scheduling methods. Immediate savings are realized by reducing the energy (diesel fuel, liquid petroleum gas, natural gas or electricity) used in pumping irrigation water.

Irrigation can be scheduled on a field-by-field basis if certain field specific information is available:

a) soil type, moisture-holding capacity and antecedent soil moisture content;

b) crop type, stage of development and water requirements by stage;

c) irrigation system, water application rate, efficiency, irrigation history and area involved;

d) total daily actual crop water use, probable evapotranspiration and precipitation;

e) timely weather forecast;

f) on-site rainfall.

The irrigation scheduler needs accurate weather data when reliable estimates of crop water use are part of his scheduling method. Since center-pivots require two to four days to complete a full rotation (130 to 160 acre field), weather changes must be anticipated to avoid watering into a rainy weather period and to allow time to apply water necessary to avoid crop stress.

The IRRIGATE program (Fischbach et al., 1980) is available on AGNET for managing field-specific information in various irrigation scheduling methods. The IRRIGATE program user can employ data from the AWDN to estimate ET by simply selecting the station closest to the point of interest. Precipitation is more variable, and a record should be kept of precipitation on individual fields.

The ET Program:

Near-real time weather data is used in the AGNET ET program to provide accurate estimates of d) above (the daily actual crop water use). An example of a user session on AGNET where crop water use is calculated is shown below:

```
•L AGN10318

ENTER PASSWORD:

XXXXXXX

LOG ON AT 15:42:54 CST THURSDAY 7/1/82

                              ****AGNET****

                     A MANAGEMENT TOOL FOR AGRICULTURE

                              Copyright 1982

R;

•ET

PROGRAM LAST UPDATE 6/18/82

WEATHER DATA UPDATED 6/30/82 11:00

ENTER DESIRED WEATHER LOCATION

•CHAMPION

                7/1/82  --ESTIMATED CROP WATER USE (inches)--

        EMERGENCE    LAST     LAST      6/30     NEXT      NEXT     METHOD
          DATE       WEEK    3 DAYS             3 DAYS     WEEK

ENTER CROP CODE, AND EMERGENCE DATA (M,D)

•6 5 10

CORN      5/10       1.97     0.72      0.21     0.60      1.96     B(7/1)

ENTER CROP CODE, AND EMERGENCE DATA (M,D)

•9 5 25

SORGHUM   5/25       1.09     0.43      0.13     0.39      0.37     B(7/1)

ENTER CROP CODE, AND EMERGENCE DATA (M,D)

•STOP

ENTER MONTH DAY YEAR (PRESS RETURN FOR TODAY'S DATE OR STOP)

•STOP

R;
```

•LOG

APPROXIMATE CHARGE $0.33

The user's responses are on those lines which begin with a decimal point. After the log on procedure, the ET program was selected and a number of responses were given to choose time period, crop and emergence date to be used.

The type of crop and the emergence date can be selected for any of the weather station locations. Evapotranspiration is then calculated using the Penman method (Penman, 1948). For corn planted on May 10th near Champion, the example shows the estimated weekly ET to be 1.97 inches for the week ending June 30. Daily ET for corn on June 30th was 0.21 inches compared to 0.13 inches for sorghum planted May 25th in the same area. The Blaney-Criddle ET (Blaney and Criddle, 1962) calculation is based on climatic data for the next three-day and the next week period. The projection serves as a guide to irrigation schedulers. The information generated by the ET program can be applied by an irrigation scheduler to calculate a soil water balance from which estimates of current soil moisture reserves and the next date to begin irrigation are obtained.

A private company in the McCook, Nebraska area is now using AWDN to schedule irrigation for more than 160,000 acres.

The WEATHER Program:

Near-real time weather data can be printed or listed by using the WEATHER program. An example of a daily listing is shown below for Champion, Nebraska. Logging on the AGNET system is accomplished in the same manner as was shown in the previous example (see ET program). The next step is to choose the WEATHER program.

R;

•WEATHER

WEATHER DATA LAST UPDATED 6/30/82 11:00

DO YOU WANT A DESCRIPTION? LAST UPDATED 7/14/81

•NO

ENTER:

STATION NUMBER	STARTING DATA MONTH	DAY	YEAR	NUMBER OF DAYS	HOURLY OR DAILY
•3	6	28	82	3	D

STATION 3   CHAMPION - IMPERIAL, NE

Date	Max (F)	Ave (F)	Min (F)	RH (%)	DEW P (F)	SOIL (F)	WIND RUN Miles/Day		RADIATION Lang Day	RAINFALL (Inches)
6/28	85.3	71.3	54.3	77	63.5	69.2	208	S	754.2	0.0
6/29	89.2	74.7	61.9	72	65.3	71.5	258	SE	718.3	0.59
6/30	74.7	67.9	63.5	88	64.1	70.7	267	E	597.2	0.0

•STOP

The WEATHER program would be used by anyone desiring actual weather data. This is the basic AWDN data that other programs use as input (see Table 2).

Costs and Benefits

The cost of setting up and operating a station can be accurately determined. The benefits, on the other hand, require a more detailed economic study than is currently available. Discussion of benefits will, therefore, be limited to the assumptions stated.

The costs of purchasing a weather station[1] complete with sensors, tower, microprocessor and modem is less than $4,500. The cost of the CAMaC minicomputer (IBM Series 1) used to control the AWDN is about $20,000. Software development costs are always considerable, and this is true for the AGNET system as well. Each AGNET program is, however, the responsibility of the program author. Thus, AGNET is a reasonable software resource for programmers and non-programmers alike. A powerful data file management tool has been developed for the weather data on AGNET (Thompson, 1982). Since this type of software is now in place, it should be considered a resource to later AGNET users.

The operational costs of the AWDN have been calculated and are shown on a per station basis in Table 2. These charges include maintenance of the minicomputer, AGNET transmission and storage charges, telephone service and long distance calls, and the repair and labor associated with maintenance of the weather station.

Potential AWDN benefits for irrigation scheduling are quite high. The use of scientific irrigation scheduling may result in one less irrigation cycle per year for each center pivot. The ratio of AWDN benefits within a 25 mile radius of an Automated Weather Station (AWS) to the cost of operating an AWS would then be calculated as follows:

---

[1] CR21 weather station manufactured by Campbell Scientific, Inc., Logan, Utah.

$$B/C = \text{BENEFIT/COST}$$

$$= \frac{\text{(STATEWIDE COST FOR ONE IRRIGATION CYCLE)} \quad \text{(FRACTION OF NEBRASKA CHARACTERIZED BY 1 AWS)}}{\text{(ANNUAL COST OF 1 AWS)}}$$

$$= \frac{\text{(CYCLE COST PER AREA)} \quad \text{(AREA USING CENTER PIVOTS)} \quad \dfrac{\text{(AREA SERVED BY 1 AWS)}}{\text{(AREA NEBRASKA)}}}{\text{(ANNUAL COST OF 1 AWS)}}$$

$$= \frac{(\$6/\text{acre}) \quad (2{,}705{,}776 \text{ acre}) \quad (\pi(25 \text{ mi})^2/76{,}483 \text{ mi}^2)}{\$1{,}680}$$

$$B/C \approx 250/1$$

There are many other benefits of the AWDN. The Agricultural Climate Situation Committee (a group of specialists of the Nebraska Cooperative Extension Service) meets on a weekly basis during the growing season to examine current weather-related agricultural problems. Data and information from the AWDN has been used in part by the committee to determine the nature and content of the advisory to be released to producers, media personnel, agencies and extension specialists.

The AWDN soil temperatures are also published in the springtime issues of the Weekly Weather and Crop Bulletin. AWDN soil temperatures provide better coverage for Nebraska than was previously available. More adequate coverage is likewise the case for winds, solar radiation and humidity.

Conclusion

It is now possible to automatically collect and disseminate surface weather data so that engineers and scientists can employ timely weather information. The Automated Weather Data Network (AWDN) provides a unique source of weather data for application to agriculture. It is a forerunner to new computer-aged data collection systems that will revolutionize the manner in which we manage agricultural operations. The AGNET connection makes the data readily accessible to a wide user audience.

The rapid growth in AWDN coverage and in weather data applications indicates a movement toward the solution of weather-related problems in near-real time. Scientists and engineers have shown marked interest in the network and will likely find many more applications for the available weather data.

Table 1. Those programs on AGNET that use weather data.

AGNET WEATHER PROGRAMS

NAME	FUNCTION
WEATHER	Lists hourly or daily weather parameters.
ET	Calculates Penman ET for various crops (uses Blaney-Criddle ET to project ahead).
IRRIGATE	An irrigation scheduling program used for training users in scientific irrigation practices.
CROPSTATUS	Estimates crop development, frost probability and harvest dates based upon actual weather to date and normal weather in the remaining season.
DRY	Calculates the energy requirements for drying grain to specified levels of moisture.
BEEF	Estimates livestock performance from the feed rations, weather and economic factors.
ANIMAL STRESS	Calculates heat stress on animals and the time in each category (i.e., alert, danger and emergency).
WINDCHILL	Calculates the wind chill on exposed flesh from wind speed and temperature.

Table 2. The monthly cost of operating an AWDN station.

AVERAGE OPERATION COST/STATION/MONTH

Computer Maintenance[2]	$	30
AGNET		20
Telephone Service[3]		15
Telephone (Long Distance)		15
Travel[2 & 3]		35
Labor and Repair		25
Total	$	140/Month
		$1,680/Year

[2]Cost decrease with added stations.

[3]These costs vary from site to site.

Acknowledgements

The author would like to acknowledge the support of the National Climate Program Office during the initiation and development of the AWDN through Cooperative Agreement No. NA80AA-H-00087. Acknowledgement is made to Dr. N. J. Rosenberg, the principal investigator for this research project, and to Mr. D. C. Nielsen, who served as weather network technician. Mr. James R. Hines, CAMaC systems analyst, developed the AWDN telecommunicatons software. Acknowledgement is also made for support provided by a grant from the University of Nebraska Foundation.

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KLIMA - A DUAL PURPOSE ARCHIVAL AND RETRIEVAL SYSTEM

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Introduction. Climate data archives of varying emphases and completeness abound.[1] Their accessibility varies similarly. The challenge is to make the data and an almost arbitrarily long list of derived products available to the consumer in an economical fashion.

The Florida State University development has been stimulated by our experience with the departmental McIDAS, developed by the University of Wisconsin, and by the presence in the department of the Florida State Climatologist. Certainly, the McIDAS success in bringing interactive color graphics to the display of atmospheric data suggested the pattern to be followed.

A need existed to bring interactive color graphics to a number of simultaneous users. The McIDAS system, supported by a Harris 100-level mainframe, has but a single user console. Also, there was a need to establish the means of delivering climate data to consumers throughout the state and region. The result is KLIMA, an evolving data archival and retrieval system design for both current and climatic data. The software development to this point has been based on a disk storage of only one-third of an 80-megabyte drive.

The acronym is for Kindly Local Interactive Meteorological Access. It is intended to emphasize that the system is an interactive, "user friendly" archive with both meteorological and climatic capabilities.

The McIDAS command structure permits plotting and analysis of current (or recent) airways and upper air data as ingested from the FAA 604 line with overlays of the same variable at another time or of a second variable, including derived quantities such as vorticity and divergence, thermodynamic diagrams and cross sections. A separate access, storage and retrieval system is already in place for this subset of McIDAS capability. In addition, a menu-driven climate data retrieval system is being added. The present, limited menu is described below. Enhancement of our storage capability will permit user-dictated expansions of the menu. In addition to plotted and contoured climatic fields, extremal mapping and various automatic tabular presentations now available, a user can expect to obtain frequency distributions, empirical probability distributions, time series analyses,

[1] A summary of these may be found in Eddy, A., 1980: Climatological Service Assisted by Computers, Oklahoma Climatological Survey Report for NOAA/EDIS, Contract NA80DA-C00007.

eigenfunctions, heating days, severe or extreme weather occurrences, etc., with simple commands. The system is structured to permit easy access, analysis and display of any distributed variable, whatever its character or source.

KLIMA characteristics include:

(1) Software that is nearly machine independent. All programming is modular and written in well documented, transportable FORTRAN 77. The system can be installed on nearly any mini- or midi-computer. Only the data gathering function is machine/source dependent.

(2) Modifications, deletions or additions to the software can be implemented with only a knowledge of FORTRAN 77 necessary.

(3) The climate archive structure can be used without alteration for any state or region.

(4) Any number of diverse data sources (PAM, radar, satellite) can be incorporated.

(5) A typical user station with interactive color graphics and hard copy can be inexpensive (well under $10 K) and can consist entirely of off-the-shelf hardware.

KLIMA - General Information. Schematic diagrams of the KLIMA structure are shown in Figures 1-3.

KLIMA is an ordered set of linked program modules that access data bases of historic and current weather information. The KLIMA design demonstrates a largely machine-independent weather information system that processes and archives a large data base for distribution to users with a wide range of informational, operational, educational and research needs.

Three different software systems were used as models for KLIMA:

(1) The NCAR (National Center for Atmospheric Research) graphics package for its example of a large software system that requires a minimum of machine-dependent routines for installation.

(2) The University of Wisconsin McIDAS system for its example of an interactive current weather system.

(3) The North Carolina State University HISARS (Hydrologic Information Storage and Retrieval System) package for its example of a computerized system for storage, retrieval and routine processing of historical climate information.

User interface module. All user interaction with KLIMA would be via a single command scanner. Upon receipt of a legal command, the scanner passes program control to the appropriate program module.

This control transfer could be done by program chaining, jumping to a subroutine, or overlay, depending upon the local site installation.

All program modules will have complete online help sections. That is, a full manual of KLIMA commands will be available online.

Local site modules. Modular construction facilitates installation of any subset of the KLIMA system. Local sites can tailor the KLIMA environment to their needs.

Graphics package. The basic software for plotting is the NCAR graphics package. NCAR provides versions of this code for almost every available mini and mainframe machine. It is implemented on a system by writing twelve short machine dependent routines and a "translator." The translator can be almost trivial for a vector-oriented device such as a Tektronics terminal or more complicated for a line printer/plotter. The translation to any graphics device would be handled internally by KLIMA. The user need only specify the device code to the system before initiating a plot. The user may change device codes as desired. In addition, there is a character graphics package available that would produce low resolution plots on a standard CRT, TTY, or line printer.

KLIMA data retrieval routines. This set of data base access program modules are used by all programs or program modules that require access to KLIMA data bases.

KLIMA data bases. KLIMA data bases are divided into three general categories:

(1) current weather
(2) historic climatic
(3) auxillary

Current weather data bases store the information extracted from the primary data sources. These sources may be either satellite-transmitted or land-based data lines. A representative data source is the FAA 604 line.

Transmissions from the 604 line are organized into logical groups called bulletins or catalogs. As the bulletins are received at a KLIMA site, KLIMA will either print, save, or discard them as directed by a site-defined parameter list. Bulletins to be saved as transmitted would be stored in a data base of packed text files for a length of time determined by the site-defined parameter list. Bulletins consisting of decodable data could be passed to decoder programs that would then store the decoded data in packed binary formats in a data base of the specific data type. The data in these data bases would be held for a length of time specified by the site-defined parameter list. Examples of decodable data are surface synoptic reports, surface hourly observations, upper air observations, and radar summaries.

In general, text data are bulletin ordered, then time ordered. Decoded data are time ordered, then station ordered. The data bases are ordered so as to allow efficient synoptically oriented accessing.

Historic climatic data bases would be station ordered, element ordered, then time ordered. Active states or regions would be determined by local KLIMA site personel and those data bases could be loaded from NCC tapes or other sources. A representative data source is the National Climate Center.

KLIMA would support hourly, daily and monthly observation reports from NCC. Although monthly summaries (formerly NCC TD9924) could be created from the daily summaries (formerly NCC TD9727) KLIMA would support both types with the view that some potential KLIMA sites would not have the online storage necessary to implement the daily summary observation data files. These data files could be automatically updated by the current data decoders.

Auxillary data bases may be site dependent. Examples are hurricane, WEFAX, radar, sodar (acoustical radar) and PAM data.

Ingestors and handlers. Data ingestors are defined to be machine dependent programs or program modules that obtain data from outside the machine independent environment of KLIMA. They should be as simple as possible. An example of an ingestor is a program that responds to a machine interrupt, reads data from an input port, and writes that data into a memory buffer or onto a secondary storage device.

Data handlers are defined as machine independent programs or program modules that read raw data produced by ingestors and convert the data to a form usable by the KLIMA system.

Automatic and manual update programs. Automatic update programs, when installed at a KLIMA site, would convert element data from the current data (time ordered) format into the historic data (station ordered) format. They would then update the historic climatic data bases with this information. These updates would later be replaced by the validated data tapes, when received, from NCC and other sources. Since some data will only be available in paper form, a set of update programs would handle keyed data updates. Maintenance programs would periodically reorganize the historic climatic data bases and recreate index files.

KLIMA Demonstration. A set of typical products is shown in figures 4-20. On line documentation is demonstrated by help instructions in figure 4, the list of commands in figure 5, the list of information files in figure 6, and an example of one page of an information file in figure 7. Current weather retrieval and listing is shown by a text listing of a Florida forecast in figure 8, a list of Service A hourly data for Florida in figure 9, and a radiosonde listing for Appalachicola, Florida in figure 10. Graphic display is demonstrated by a character graphics plot of weather symbols in figure 11, a plot of temperature alone in figure 12, a full station model plot with contour overlays in figure 13, a regional station model plot and contours in figure 14, a radiosonde station model plot with contours (vorticity, a derived quantity), a Stuve diagram for Appalachicola, Florida in figure 16, and a vertical cross-section from Bismarck, ND to Boothsville, LA showing potential temperatures and isotachs in figure 17. Display of Climatic data is quite similar to current data so only two examples are shown, a contour of lowest temperatures of the month in January 1976 and a four panel time series of selected parameters in figures 18 and 19. Finally the auxillary data base display of hurricane and tropical storm tracks is shown in figure 20.

Figure Captions

Figure 1.	KLIMA Site Structure
Figure 2.	Data Ingestors and Handlers
Figure 3.	Climatic Data Archiving
Figure 4.	KLIMA Help Instructions
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Figure 6.	List of Information Files
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Figure 11.	Character Graphics Display of Weather Symbols
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Figure 13a.	Service A Station Model Plot (Florida)
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14b.	Overlay of Pressure Contours
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Figure 16.	Stuve Diagram
Figure 17.	Vertical Cross Section
Figure 18.	Contours of Lowest Temperature for January 1976
Figure 19.	Time Series of Selected Climatic Parameters
Figure 20.	Plot of Hurricane Tracks (Auxillary Data Base)

KLIMA SITE STRUCTURE

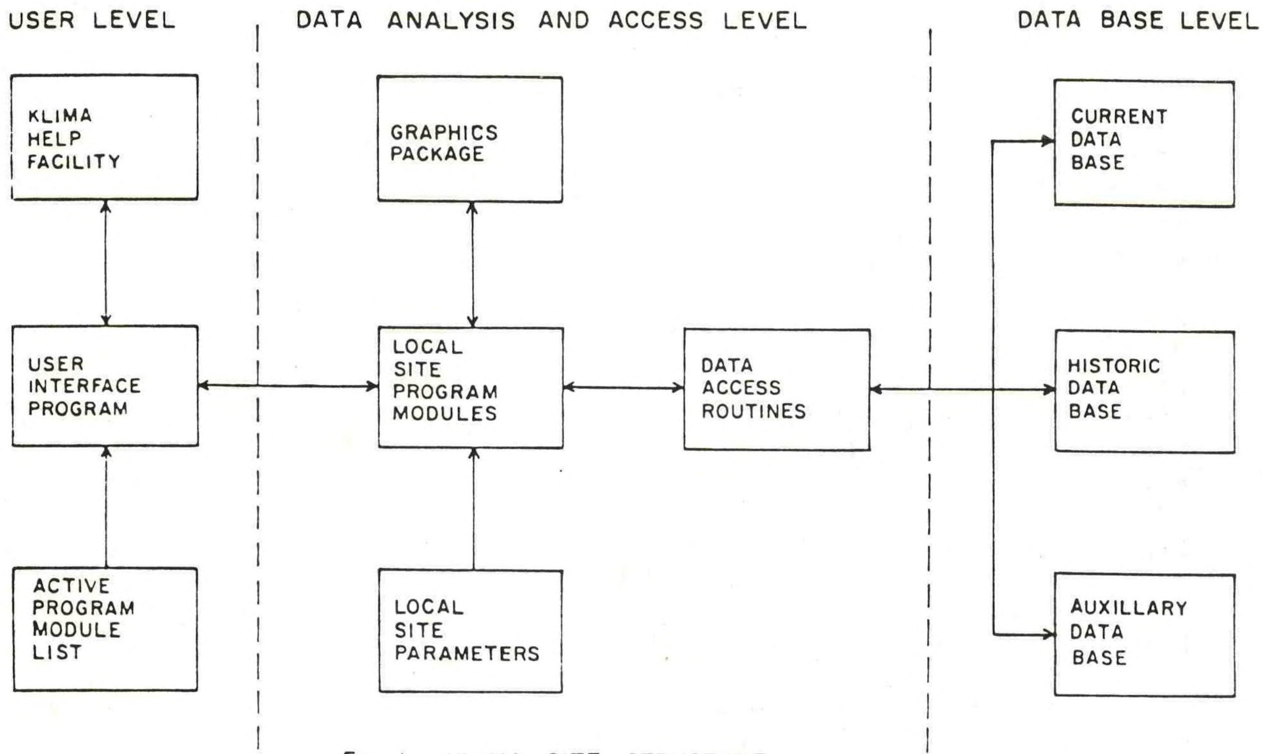


Fig. 1. KLIMA SITE STRUCTURE

INPUT TO CURRENT DATA BASE

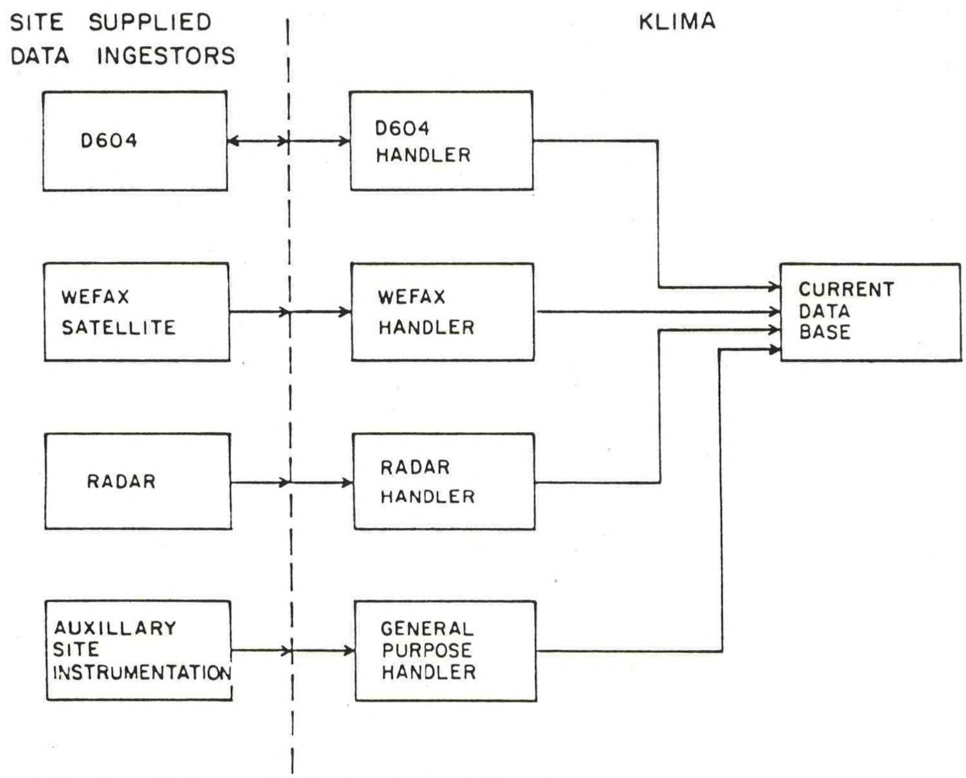


Fig. 2. DATA INGESTORS AND HANDLERS

CREATION AND MAINTENANCE OF HISTORIC DATA BASE

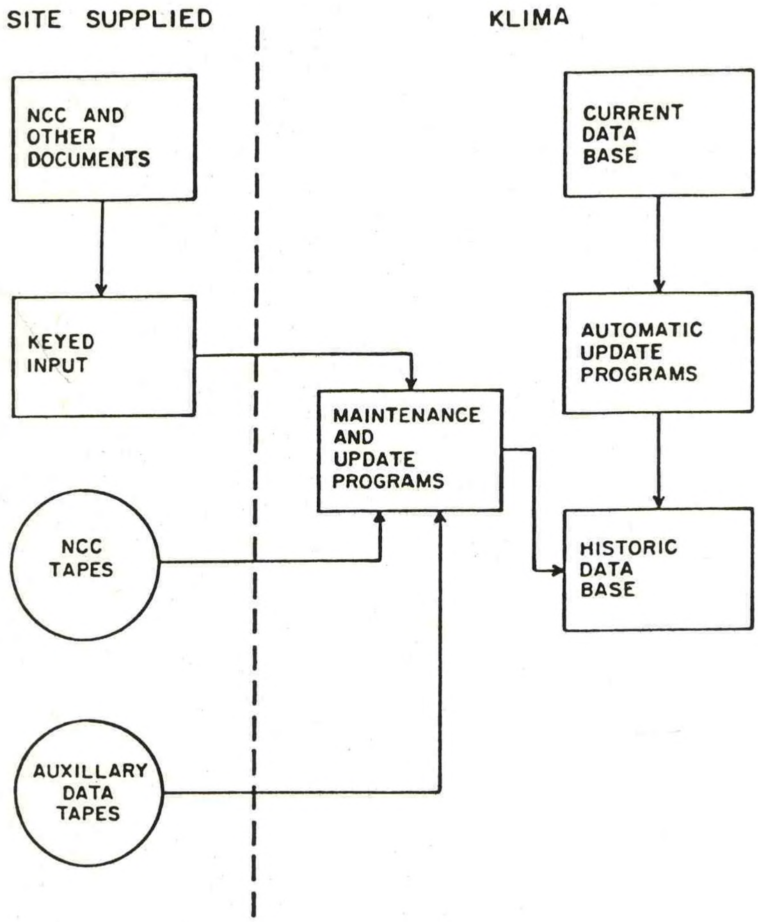


Fig. 3. CLIMATIC DATA ARCHIVING

FSU KLIMA HELP INSTRUCTIONS

THERE ARE TWO WAYS TO GET HELP FOR A COMMAND. WHEN IN THE COMMAND SECTION TYPE IN EITHER OF THE FOLLOWING FORMS:

HELP,*'NAME'
'NAME',HELP

'NAME' IS TO BE REPLACED BY A VALID KLIMA COMAND NAME.

THE INDEX CONTAINS A LIST OF VALID COMMANDS.

THE FIRST FORM WILL GIVE A DETAILED DESCRIPTION OF THE COMMAND AND HOW TO USE IT. THE SECOND WILL GIVE A SHORT SUMMARY OF THE COMMAND OPTIONS. IN ADDITION, THERE ARE SOME GENERAL INFORMATION FILES ON SUCH TOPICS AS COMMAND STRUCTURE, SHORTCUTS, GRIDS, ETC. TO SEE A LIST OF THESE TYPE -HELP,*INFO-. SEE SYSTEM PERSONNEL FOR PROBLEMS BEYOND THE HELP FACILITIES. EXAMPLES:

HELP,*ZI
YY,HELP
HELP,*COMMANDS

Fig. 4. KLIMA Help Instructions

THIS IS A LIST OF THE PROGRAMS AND COMMANDS AVAILABLE ON KLIMA

DD	DISK DUMP UTILITY
GG	SINGLE GRID UTILITY
GU	GRID FILE UTILITY
HELP	PROVIDES THE USER WITH A DESCRIPTION OF COMMANDS
XS	VERTICAL CROSS SECTIONS
YC	ANALYSIS AND CONTOUR OF N.A. RAOB DATA
YI	NORTH AMERICAN RAOB RETRIEVAL PROGRAM
YP	N.A. RAOB PLOTTER, TERMINAL AND LINE PRINTER
YS	STUVE DIAGRAM
YY	604 TEXT RETRIEVAL PROGRAM
ZC	GRID CONTOUR CALLING PROGRAM
ZI	SVC-A (HOURLIES) RETRIEVAL PROGRAM
ZJ	SETS DEFAULT PLOTTER AND SDS FILES
ZK	ANALYSIS AND CONTOUR OF SVC-A DATA
ZM	MAP DRAWING PROGRAM
ZP	SVC-A DATA PLOTTER, TERMINAL AND LINE PRINTER
ZS	WEATHER AND SYSTEM UTILITY PROGRAM
CC	CLIMATE CONTOUR PROGRAM
HP	EXPERIMENTAL
CI	CLIMATE DATA LISTER
CM	CLIMATE MAPS OF FLORIDA WITH VARIOUS DATA PLOTS
EX	EXTRACT DATA FROM THE CLIMATE DATABASE FILE
FD	TABLE OF FREEZE DAYS
HR	PLOTS OF HURRICANE TRACKS
HT	NEW PROGRAMS FOR HURRICANE TRACKS UNDER DEVELOPMENT
PT	PRECIPITATION TABLE
QU	STATION DATA QUERY ROUTINE
SH	PROVIDES A STATION HISTORY
TT	TEMPERATURE TABLE
ZZ	TO TOGGLE OUTPUT AREAS AND TO PRINT A FILE

Fig. 5. KLIMA Index

GENERAL INFORMATION FILES

NAME	CONTENTS
BULLETIN	FAA 604 CATALOG DESCRIPTIONS
COMMANDS	EXPLAINS KLIMA COMMAND STRUCTURE
GRIDS	GENERAL INFORMATION ABOUT GRIDS
HEADERS	FAA 604 HEADER ABBREVIATIONS
INFO	THIS FILE. A LIST OF GENERAL INFORMATION FILES
PLOTS	DESCRIPTIONS OF PLOT DEVICES
SHORTCUT	TRICKS TO REDUCE TYPING
SYSTINFO	GENERAL INFORMATION ON KLIMA

TYPE HELP,'NAME' TO LIST THE CONTENTS OF THESE FILES.

Fig. 6. List of Information Files

NUMBER	BULLETIN DESCRIPTION	
00200	SA	NEW ENGLAND
00201	SA	EASTERN STATES
00202	SA	MID-ATLANTIC STATES
00203	SA	SOUTHEASTERN STATES
00204	SA	GREAT LAKES STATES
00205	SA	OHIO VALLEY STATES
00206	SA	NORTHERN PLAINS STATES
00207	SA	GREAT PLAINS STATES
00208	SA	GULF COAST STATES
00209	SA	NORTHERN ROCKIES STATES
00210	SA	SOUTHWESTERN STATES
00211	SA	PACIFIC NORTHWEST STATES
00212	SA	PACIFIC STATES
00213	SA	WESTERN MILITARY BASES
00214	SA	EASTERN MILITARY BASES

Fig. 7. First page of Bulletin Descriptions

STATE FORECAST FOR ALABAMA AND NORTHWEST FLORIDA
NATIONAL WEATHER SERVICE BIRMINGHAM AL
410AM CST MON MAR 14 1983
ALABAMA
PARTLY CLOUDY AND MILD TODAY THROUGH TUESDAY. HIGHS TODAY AND
TUESDAY 66 TO 73. LOWS TONIGHT 43 TO 53.
NORTHWEST FLORIDA
PARTLY CLOUDY AND MILD TODAY THROUGH TUESDAY. A SLIGHT CHANCE OF
SHOWERS TODAY AND EARLY TONIGHT. HIGHS TODAY AND TUESDAY 67 TO
74.
LOWS TONIGHT 48 TO 53.

Fig. 8. Forecast text listing

FDHHMM	STN	T	TD	WIND	PRES	LO	MID	HI	VIS	WX
141300	CEW	8	6	0000	1013.4	0	2	3	7	
141300	JAX	6	3	2305	1013.8	0	0	1	3	F
141300	TLH	4	3	0000	1013.8	0	1	3	5	F
141300	PNS	11	7	0000	1013.4	0	2	2	7	
141300	GNV	5	5	0000	1014.5	0	1	0	0.5	F
141300	DAB	8	6	0000	1015.1	2	0	0	3	F
141300	MCO	10	9	0103	1014.8	1	1	2	4	GF
141300	MLB	12	11	0000	1015.1	1	1	0	5	F
141300	TPA	13	12	1306	1014.5	1	0	2	1.5	F
141300	VRB	12	9	0000	1015.1	2	0	2	2.5	F
141300	PTE	16	15	1408	1014.1	1	0	2	2.5	F
141300	SRQ	12	11	1003	1013.8	0	2	0	5	F
141300	PBI	12	11	1803	1015.8	2	0	2	5	K
141300	FMY	14	13	1303	1014.5	0	0	2	6	F
141300	FLL	13	13	0000	1014.8	1	1	1	7	
141300	MIA	14	12	0000	1015.5	0	1	3	6	H
141300	EYW	18	13	0507	1014.8	0	0	3	10	
141300	CTY	6	4	0901	1014.8	3	3	3		
141300	PFN	8	7	0000	1013.1	2	0	0	6	F
141300	AGR	12	11	0000	1014.8	2	2	0	4	F
141300	NPA	11	8	2808	1012.1	0	2	3	7	
141300	COF	13	10	0000	1015.5	0	2	2	8	
141300	HRT	9	6	1102	1013.4	0	3	0	6	F
141300	HST	14	11	0000	1015.5	0	1	3	5	F
141300	MCF	14	10	1203	1014.5	2	0	2	7	
141300	NIP	7	7	2207	1014.1	0	0	1	6	F
141300	NQX	18	15	0406	1014.5	0	1	3	7	
141300	NRB	8	5	2208	1013.8	0	0	1	5	F
141300	NSE	11	6	2003	1011.7	0	2	3	5	F
141300	NZC	8	7	2404	1014.5	0	0	1	2.5	GF
141300	PAM	9	7	0000	1013.8	0	2	2	6	F
141300	VPS	11	9	0000	1013.8	0	3	0	7	

Fig. 9. Service A listing for Florida

	72220	140000							
1012	12.8	4.8	230003	7	400	-27.7	-34.7	280018	7360
1000	11.8	3.8	240003	110	385	-29.8	-37.2	285017	7621
984	10.8	3.8	253003	245	338	-37.3	-46.0	280014	8536
977	10.8	3.5	260003	304	327	-39.3	-48.3	277015	8773
962	10.6	-.4	264003	433	309	-42.2	-76.6	270019	9146
951	11.8	-18.2	267003	529	300	-43.9		275021	9360
941	11.7	-18.3	270004	609	295	-44.5		275023	9451
908	11.0	-19.0	250004	914	250	-52.9		260020	10560
875	10.3	-19.7	250005	1219	245	-53.7		255020	10670
850	9.6	-20.4	245005	1463	235	-55.9		255026	10956
843	9.6	-20.4	245005	1524	213	-53.6		255042	11585
816	9.2	-20.8	255005	1801	200	-52.1		265046	11990
813	10.6	-19.4	256005	1832	176	-53.6		265042	12804
783	9.2	-20.8	275006	2134	160	-54.8		270050	13414
755	7.8	-22.2	285007	2439	150	-55.7		270042	13830
728	6.4	-23.6	285008	2743	119	-60.9		270028	15243
718	5.8	-24.2	285008	2856	103	-64.3		265034	16158
700	4.0	-26.0	285008	3064	100	-65.1		265034	16350
650	.1	-29.9	275010	3658	78	-67.1			17856
602	-3.9	-33.9	290011	4268	59	-63.5			19556
556	-8.0	-38.0	300009	4878	53	-65.5			22272
500	-13.7	-43.7	290011	5710	20	-53.1			26366
475	-17.0	-37.9	280013	6097	16	-46.5			27826
457	-19.5	-33.5	279014	6385	13	-47.1			29202
441	-21.3	-27.3	278015	6649	8	-32.9			32522
419	-24.5	-31.0	275018	7012					

Fig. 10. Upper Air Sounding for Appalachicola, FL (72220)

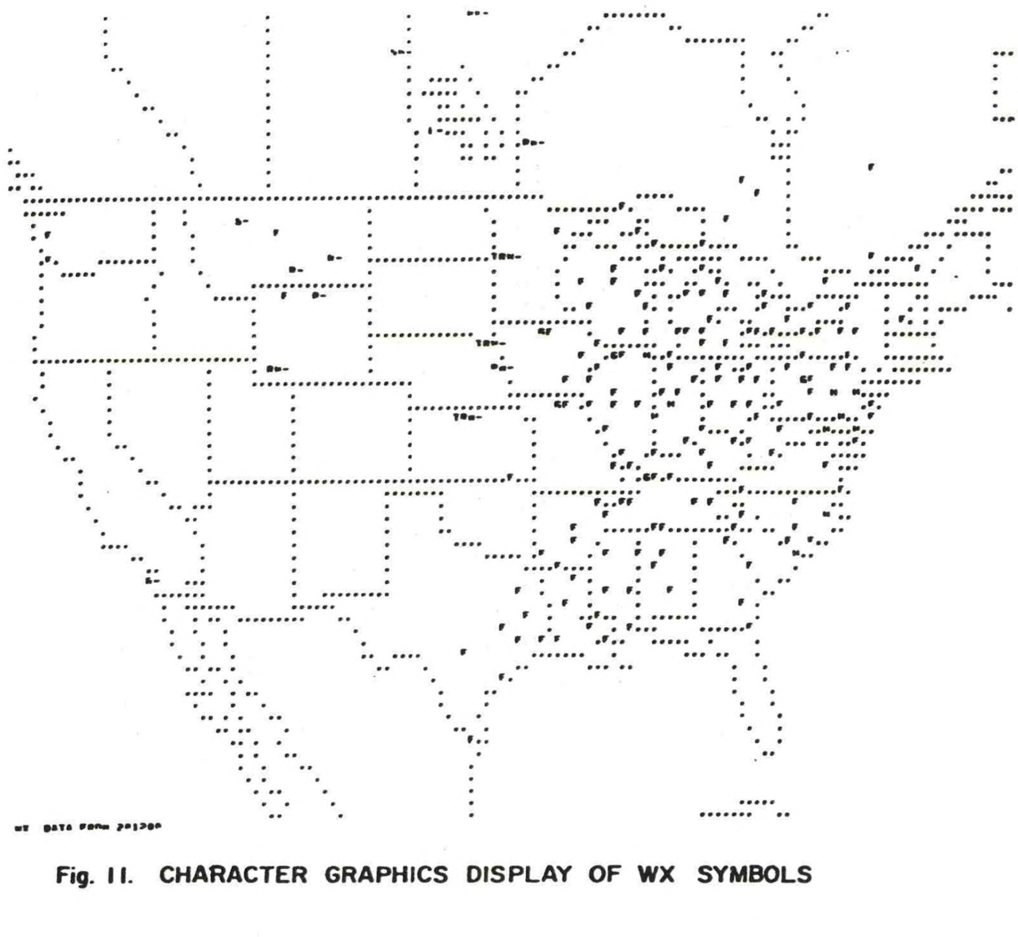


Fig. 11. CHARACTER GRAPHICS DISPLAY OF WX SYMBOLS

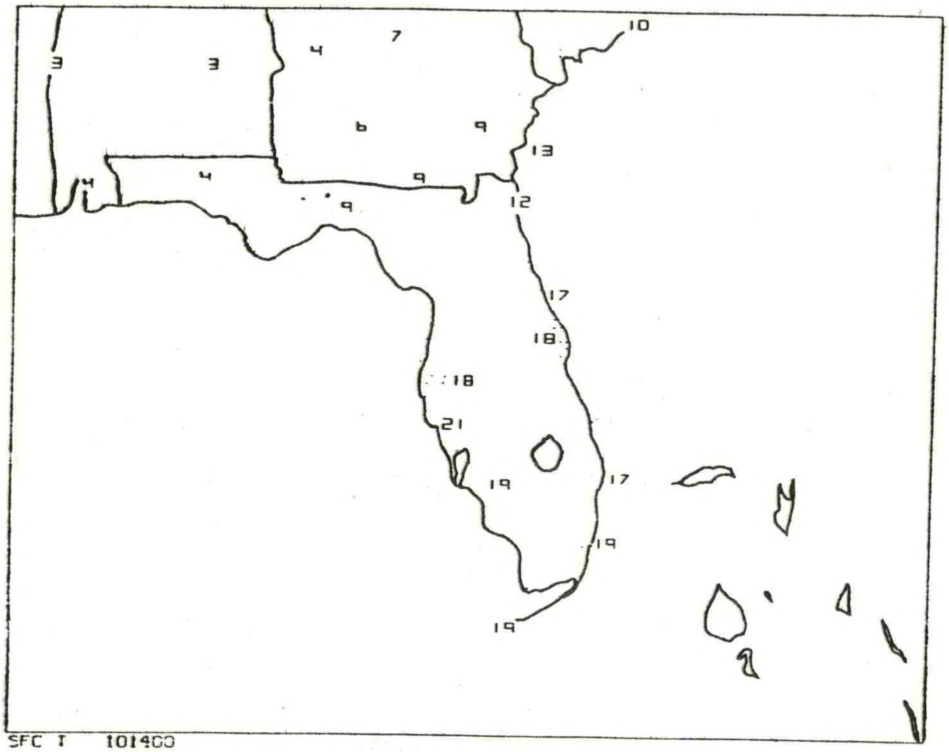


Fig. 12. PLOT OF SINGLE VARIABLE (TEMPERATURE)

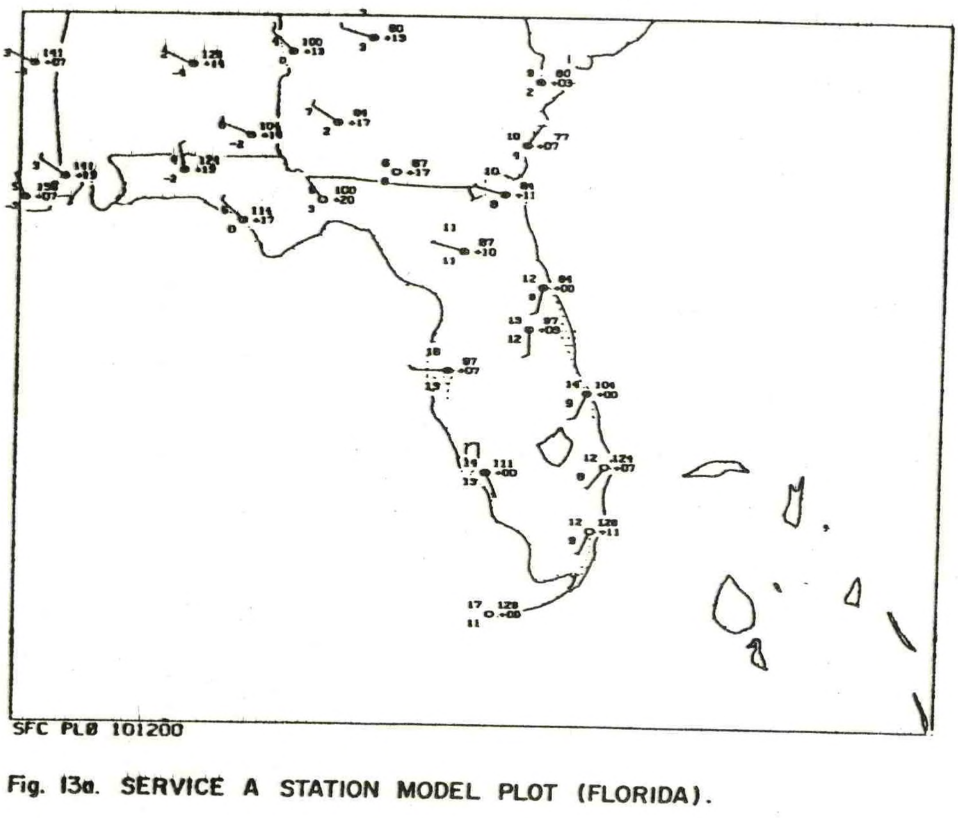


Fig. 13a. SERVICE A STATION MODEL PLOT (FLORIDA).

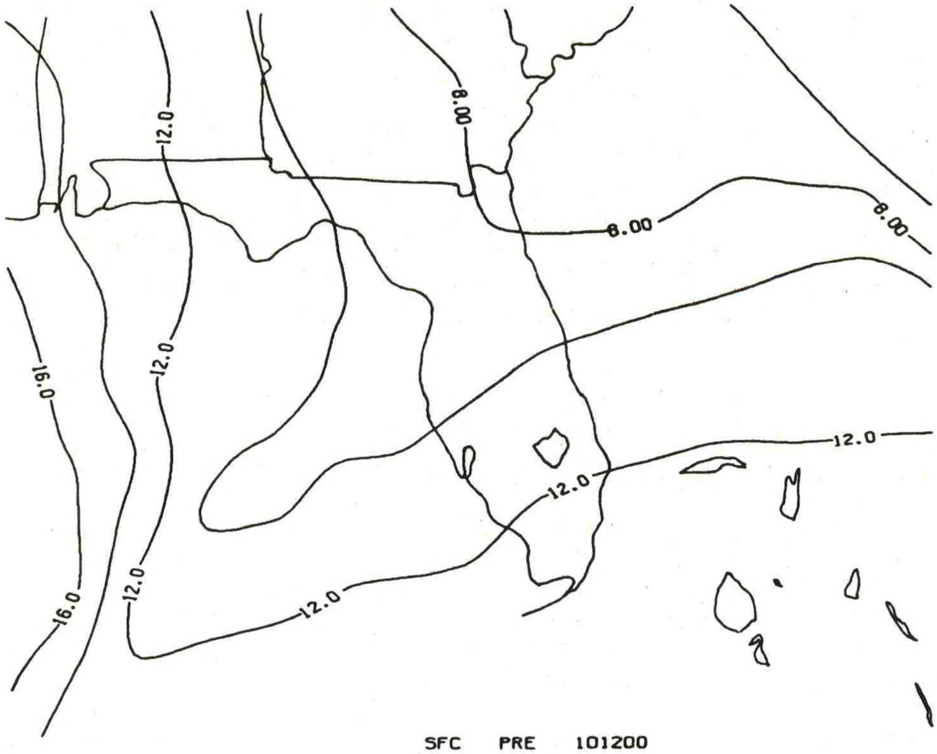


Fig. 13b. OVERLAY OF PRESSURE CONTOURS

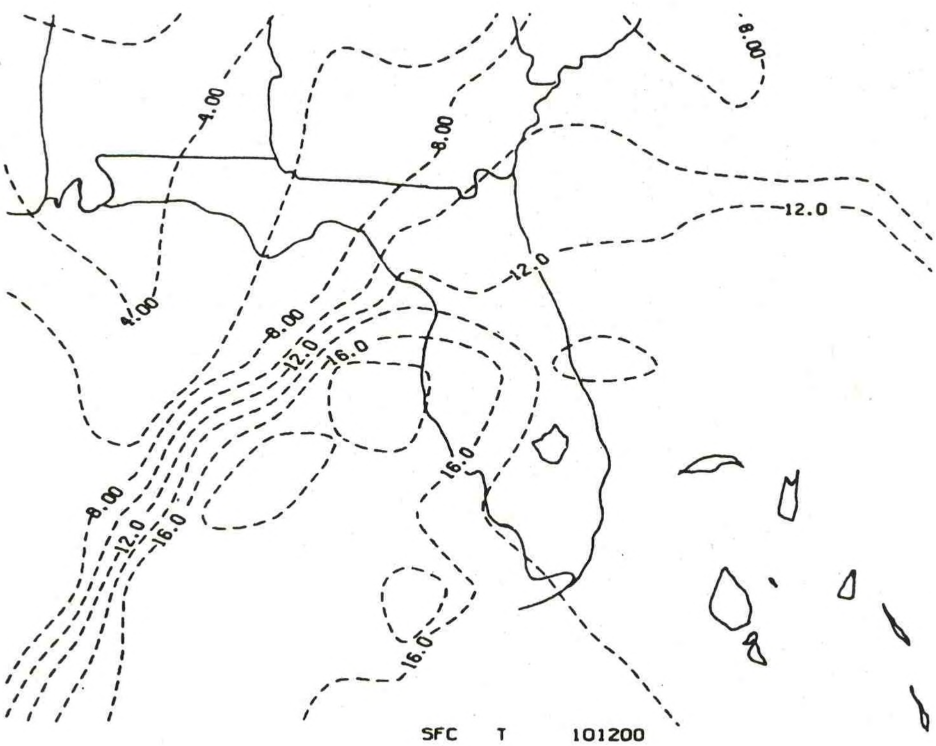
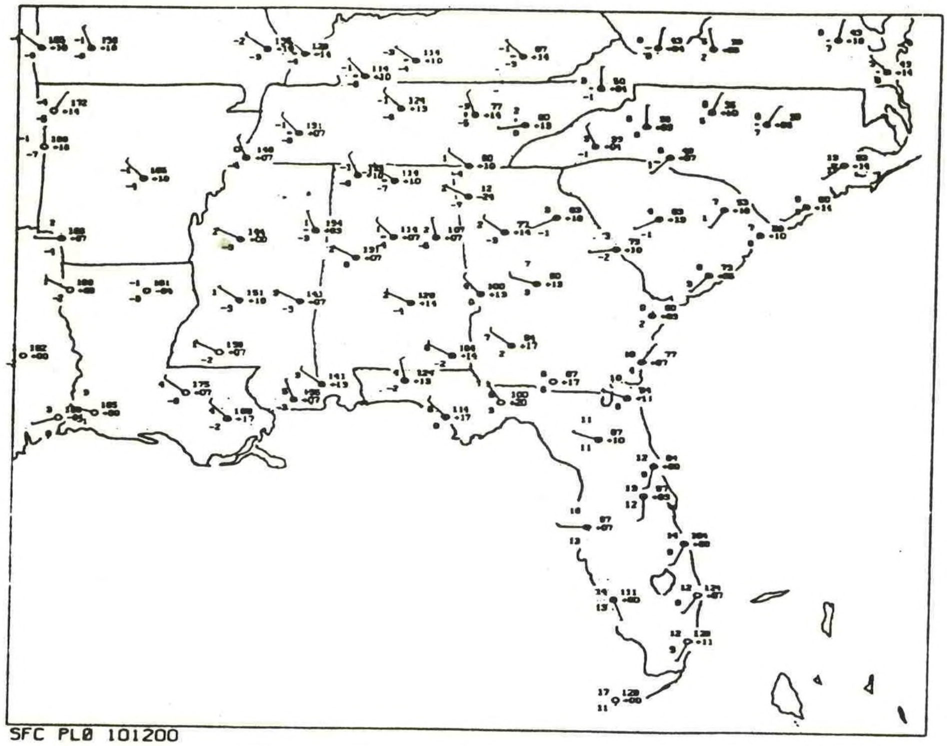
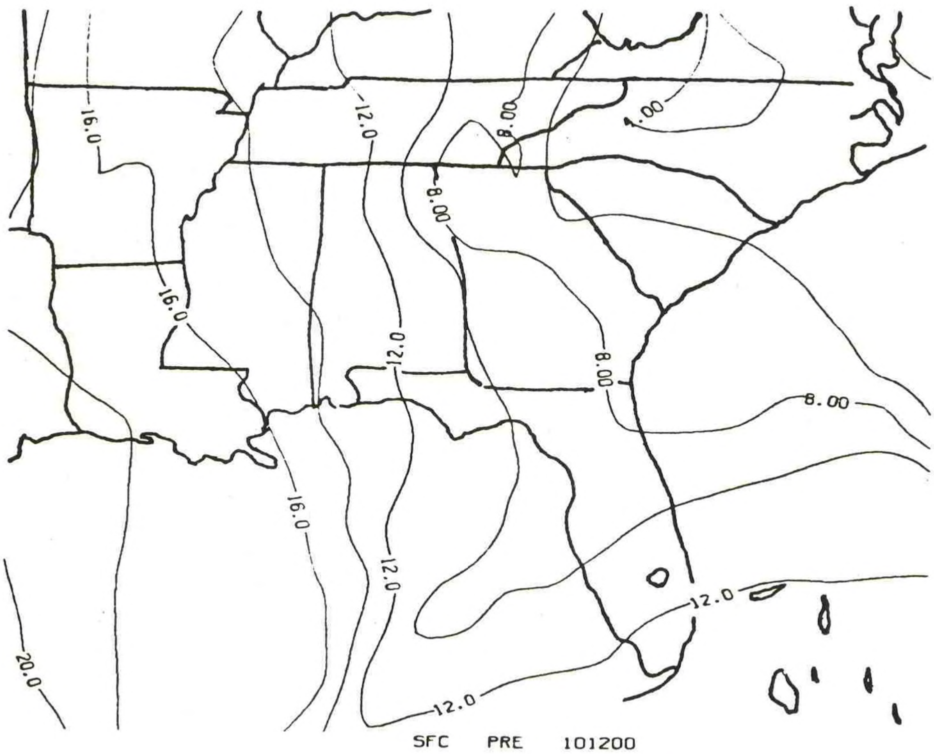


Fig. 13c. OVERLAY OF TEMPERATURE CONTOURS



SFC PLØ 101200

Fig. 14a. REGIONAL STATION MODEL PLOT



SFC PRE 101200

Fig. 14b. OVERLAY OF PRESSURE CONTOURS

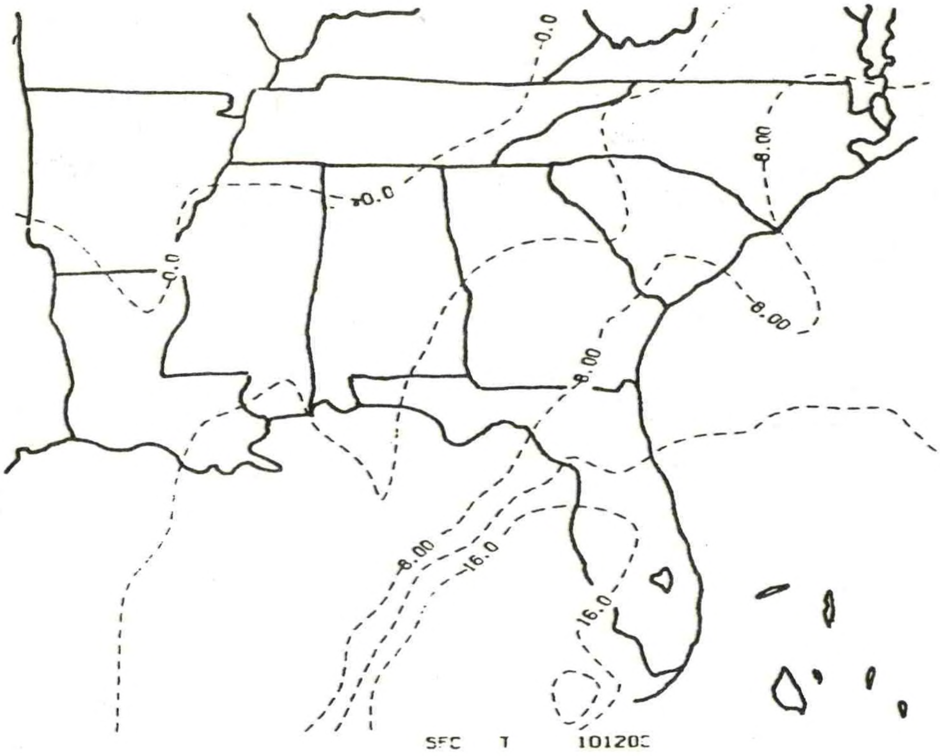


Fig. 14c. OVERLAY OF TEMPERATURE CONTOURS

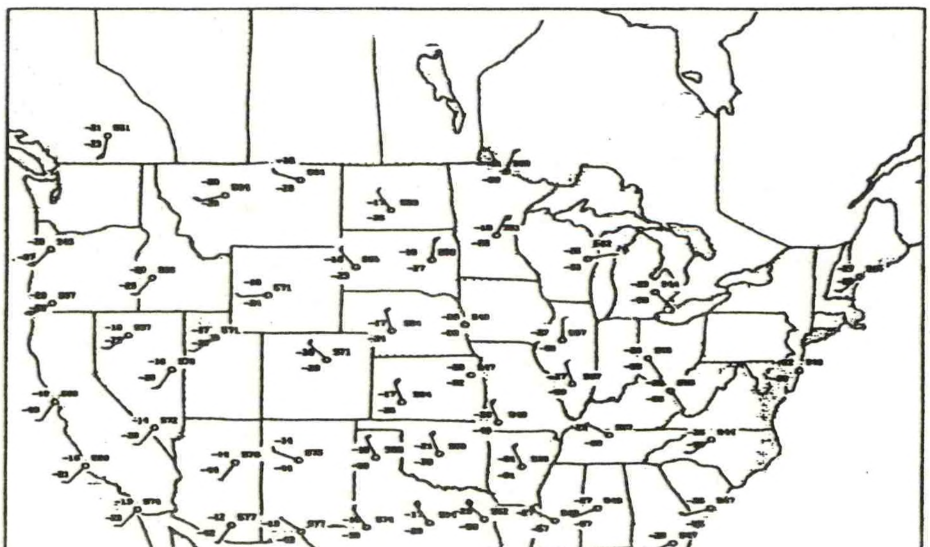


Fig. 15a. RADIOSONDE STATION MODEL PLOT

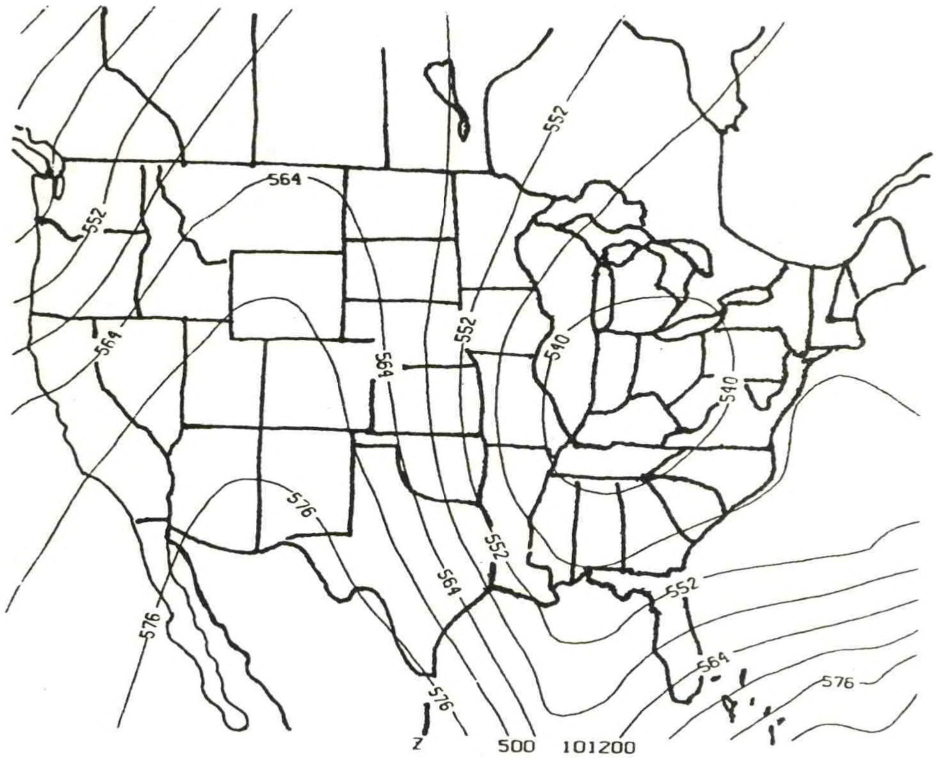


Fig. 15b. OVERLAY OF HEIGHT CONTOURS

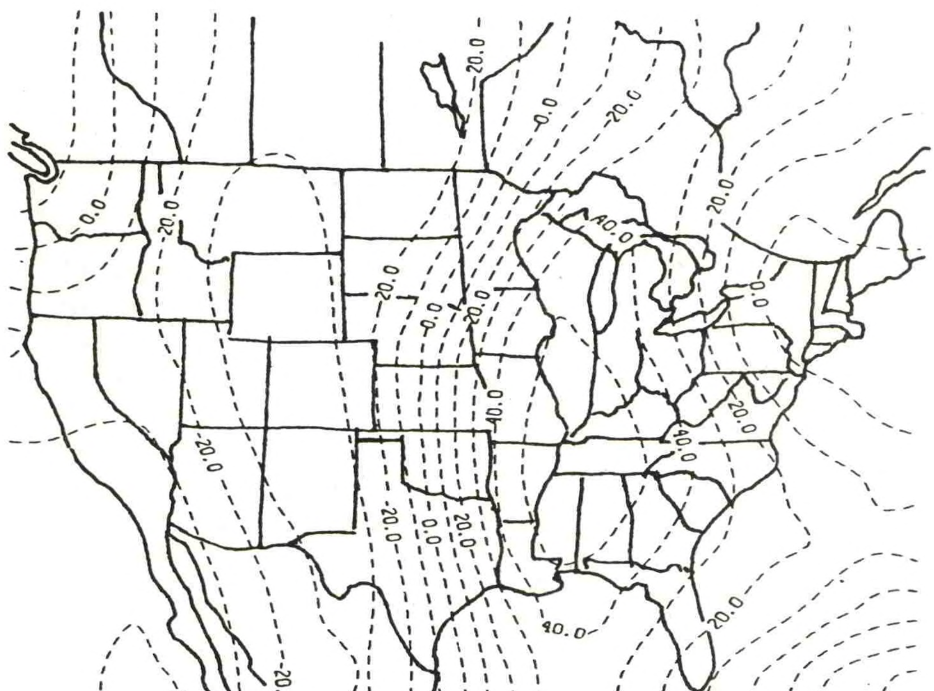


Fig. 15c. OVERLAY OF VORTICITY CONTOURS (DERIVED QUANTITY)

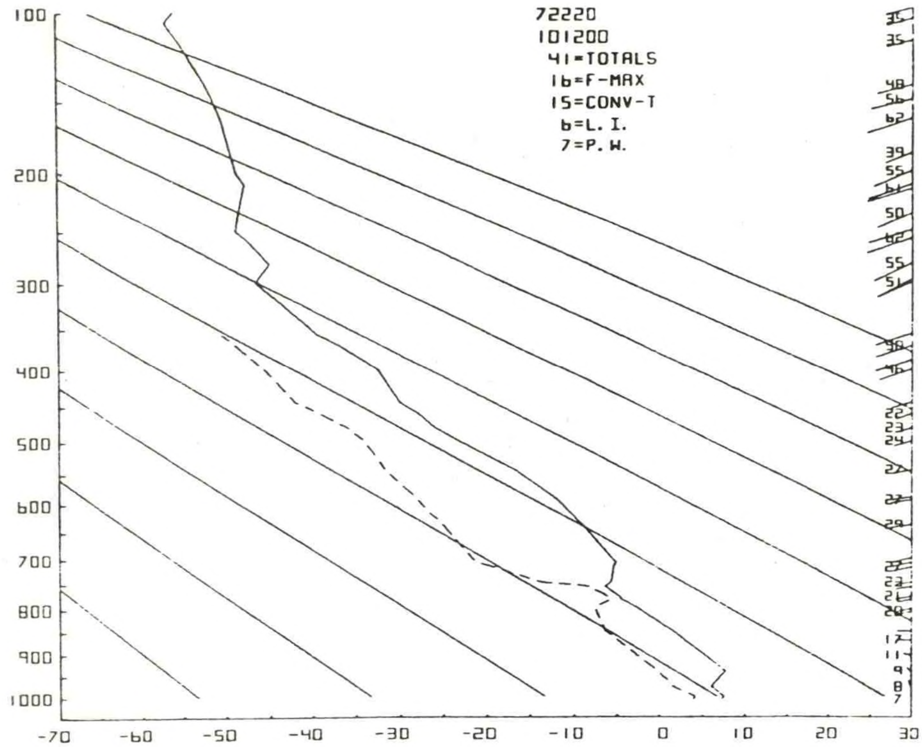


Fig. 16. STUVE DIAGRAM

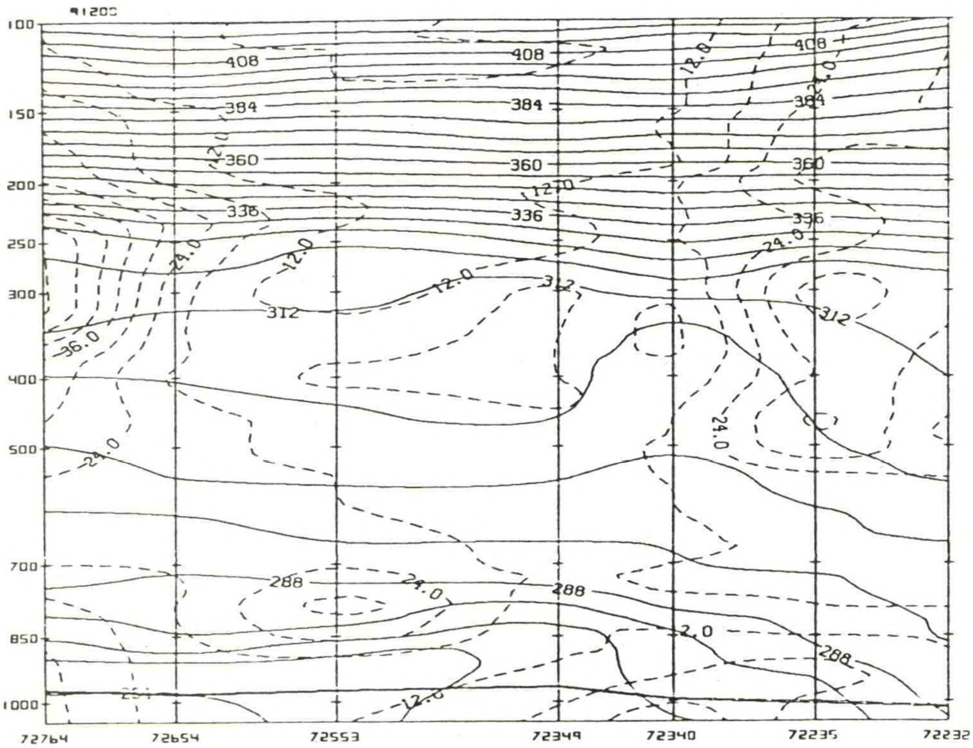


Fig. 17. VERTICAL CROSS SECTION

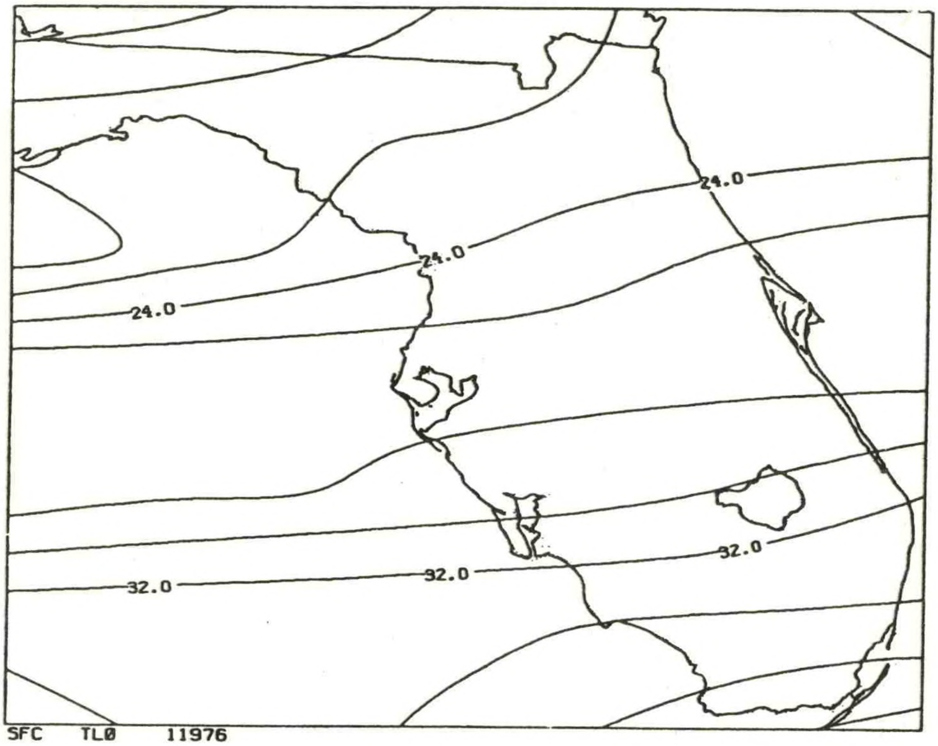


Fig. 18. CONTOURS OF LOWEST TEMPERATURE FOR JAN. 1976

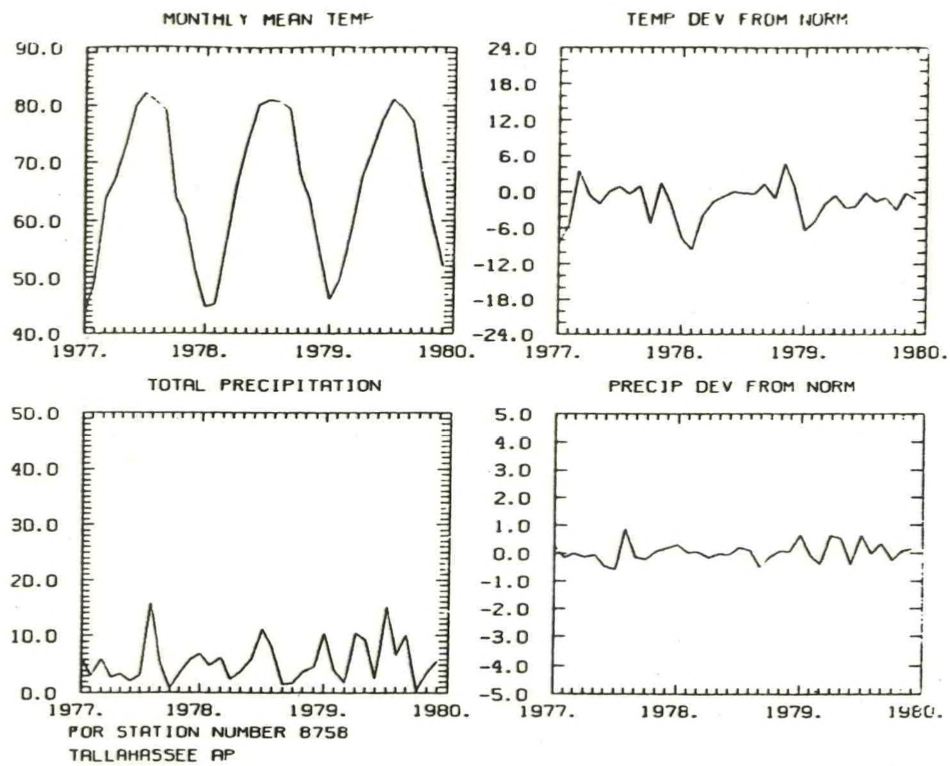


Fig. 19. TIME SERIES SELECTED CLIMATIC PARAMETERS

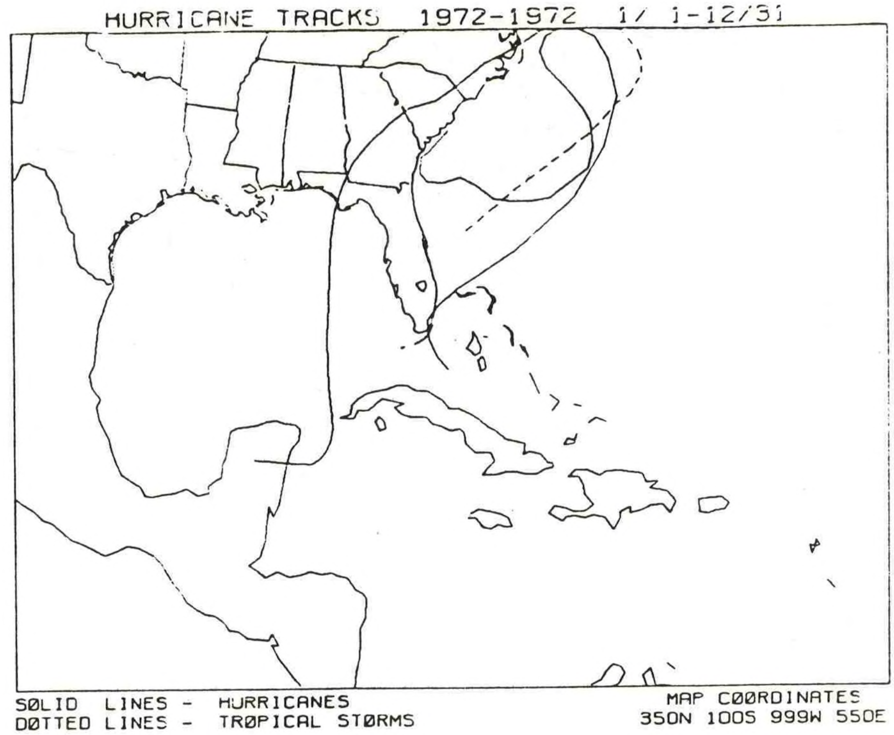


Fig. 20 PLOT OF HURRICANE TRACKS (AUXILLIARY DATA BASE)

ELECTRONIC COMMUNICATION BY STATE EXTENSION SERVICES

John T. Woeste
Dean for Extension
University of Florida

ABSTRACT

The capacity for communications of climate information within the states is expanding. The state extension services will be both users and providers of climate information. The user function will include both integration with other data, primarily biological data into production and management systems, as well as being the content for educational programs. Private groups will have an important place in the provider role. The opportunities offered through new acquisition and delivery technology will be best realized through cooperative public and private provider efforts.

I am pleased to be included in the discussion of future direction for climate programs. Climate and weather information are very important inputs to efficient crop and livestock management systems.

One case in point. There is increasing interest in growing tropical corn for increased feed grain and forage production in Florida. Identification of recommended planting dates for different areas of the state include consideration of the probable rain fall or moisture conditions for planting; the likely temperature, humidity and rain fall that effects the significant pest population during the growth cycle and of course the rain fall and humidity during the harvest cycle. Because of the variability in weather conditions during the year and the impact of those conditions on both the plant and the pests, climate information plays an important part in those decisions.

Assuming previous speakers have sighted other examples, I will move to the assigned topic. As I interpret the charge, I am to discuss the use and I assume potential for electronic communication of climate and weather information by the cooperative extension services. While I assume that most of the attention should be focused on utilization of information, I did want to mention data acquisition.

Increasingly, cooperative extension services and state experiment stations are using automated data recording technology to gather site specific information needed for crop production management. Such information is an essential input to models for irrigation scheduling, pest control and frost protection. Further, the existence of an information network could file such data and thus enhance over time the climatological data base.

Applications of electronic communication technology are slowly, but steadly, underway within the state cooperative extension services. Systems using various approaches include: 1) FACTS - Indiana 2) TELEPLAN - Michigan 3) COMNET- Michigan 4) PMEX - Michigan 5) AGNET - Nebraska and cooperating states 6) ESTEL - Maryland 7) CMN - Virginia, and 8) Greenthumb - Kentucky. The above are examples of early efforts that have been widely discussed and continue to develop. New systems underway include "Extend" in Minnesota, TELETEXT in Wisconsin and an array of others that are too young to have a catchy name. A recent survey of the state extension services on the investment in computer and communications equipment indicates that over half of the states are actively acquiring computer hardware for the county extension offices that will communicate directly with campus departments.

What about the future? Weather and climate information will have multiple uses. Extension will be both a user and a provider. The use as input to crop and livestock management models will experience the most rapid increase. It is also the area that will contribute the most to increased profitability in food and agriculture. Consequently, cooperative extension has a compelling interest in the acquisition, storage and retrieval of a wide array of weather and climate information.

Private organizations and groups will want similar information for decision making. In some cases, I foresee them acquiring it from the local extension office. At the same time I see a wide array of groups receiving climate information directly from the source and disseminating it directly to users of weather and climate information. This I believe is desirable.

Our emerging plan in Florida may be helpful as a model system. We plan to make the satellite weather information available to our county extension offices. I expect our county faculty to use that information in advising clientele on management, production and marketing decisions. I also expect, at least in the next couple of years, that the staff will provide training for clientele on interpretation and use of the information in decisionmaking.

At the same time, a private non-profit group recently organized to make computer services available to consumers. The group - FAST - Florida Agriculture Service and Technology, will make the satellite information as well as other available climate and weather information directly available on a user fee basis. They will of course provide other types of data bases, computer programs and information to subscribers on a fee bases. I am delighted with that decision since I feel we will need many such vehicles to deliver information and programs to users on a continuing cost effective service type basis.

As computer software becomes operational and data bases are established with operational management systems, we will make them available to private groups and organizations serving the food and agriculture industry for distribution. Our overriding objective is to help the consumer utilize information to improve their individual decision making and subsequently of course improve the profitability and productivity of the food and agricultural industry.

In summary, I foresee multiple channels of information flow. The developmental and educational roles of the state cooperative extension services can be best delineated by a statement from the recent publication "The Computer Management Program for Modern Agriculture" published by the Extension Committee on Organization and Policy, July 1982. They concluded their report with, "In summary, Extension's primary computer role should remain interpretive and educational. The private sector should be the primary provider of the service aspects of the application of the computer to the farm and rural sector - as it has in the business and urban sector".

The importance of the Extension role is reflected in the concluding paragraph of Appendix A of the same report. They point out "just having more information is not, of course, the answer to everyone's problems, but new action alternatives may come to light. Norman Cousins offered this philosophical and yet basically practical comment, saying that in a computerized age "their may be the tendency to confuse logic with values, and intelligence with insight." Those with the real need for better (and sometimes more) information must be ready to go through an 'educational' process of sorts. This may involve a shift in priorities, including how time is spent and specifically what types of information are critical to the management of their operation. Any change involves an element of risk, but as Peter Drucker (in managment science) counseled nearly 25 years ago: "...while it is futile to try to eliminate risk, and questionable to try to minimize it, it is essential that the risks taken be the right risks."

Thank you for the opportunity to visit with you. I look forward to discussions of future directions. Hopefully, my comments will be helpful in identifying alternatives for future actions.

FLORIDA FROST INFORMATION & DISSEMINATION SYSTEM[1]

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INTRODUCTION

The computer-controlled data acquisition, processing, and dissemination system that has recently been developed at the University of Florida is called the Satellite Frost Forecast System (SFFS). Most of the following discussion will concern SFFS but in light of a second generation system that is emerging from experiences with SFFS.

SFFS is a highly focused system. It has been created to fit a singular situation, frost. Color coded thermal maps are its primary products (see Fig. 1). Models provide forecasts of thermal maps that the satellite is expected to observe hours in the future.

Insights that have accrued through the experiments with SFFS provide a fertile environment in which to experiment with a larger system which has a much broader aim. Demands on SFFS for connecting ports provide convincing evidence that a larger system is required. A larger system is developing as the Florida Agricultural Science and Technology (FAST) system. In many ways SFFS is the model upon which FAST is developing. When FAST becomes operational, one of its initial tasks will be to assume the responsibilities that UF/IFAS has for SFFS operation, e.g. direct downlink of GOES and dissemination of products beyond the NWS forecasters. Consequently, it seems appropriate to discuss Florida's development of climate and weather information acquisition and dissemination in terms of what we have learned through SFFS, indicating how that experience will help build FAST.

THE SATELLITE FROST FORECAST SYSTEM

The first of two minicomputers that are the main components of the Satellite Frost Forecast System (SFFS) was delivered in July of 1977. SFFS has evolved appreciably since then (Woods, 1977; Sutherland and Bartholic, 1977; Bartholic and Sutherland, 1978; Woods, 1979; Sutherland, et al., 1979; Martsolf, 1979, 1980abcd; Gaby, 1980; Sutherland, 1980; Barnett, et al., 1980; Martsolf, 1980abcd, 1981abc, Gerber, 1981; Martsolf, 1982). SFFS has developed with support from

[1]Florida Agricultural Experiment Station Journal Series No. 4638. NASA Contracts, NAS10-9168 & NAS10-9892, are acknowledged.

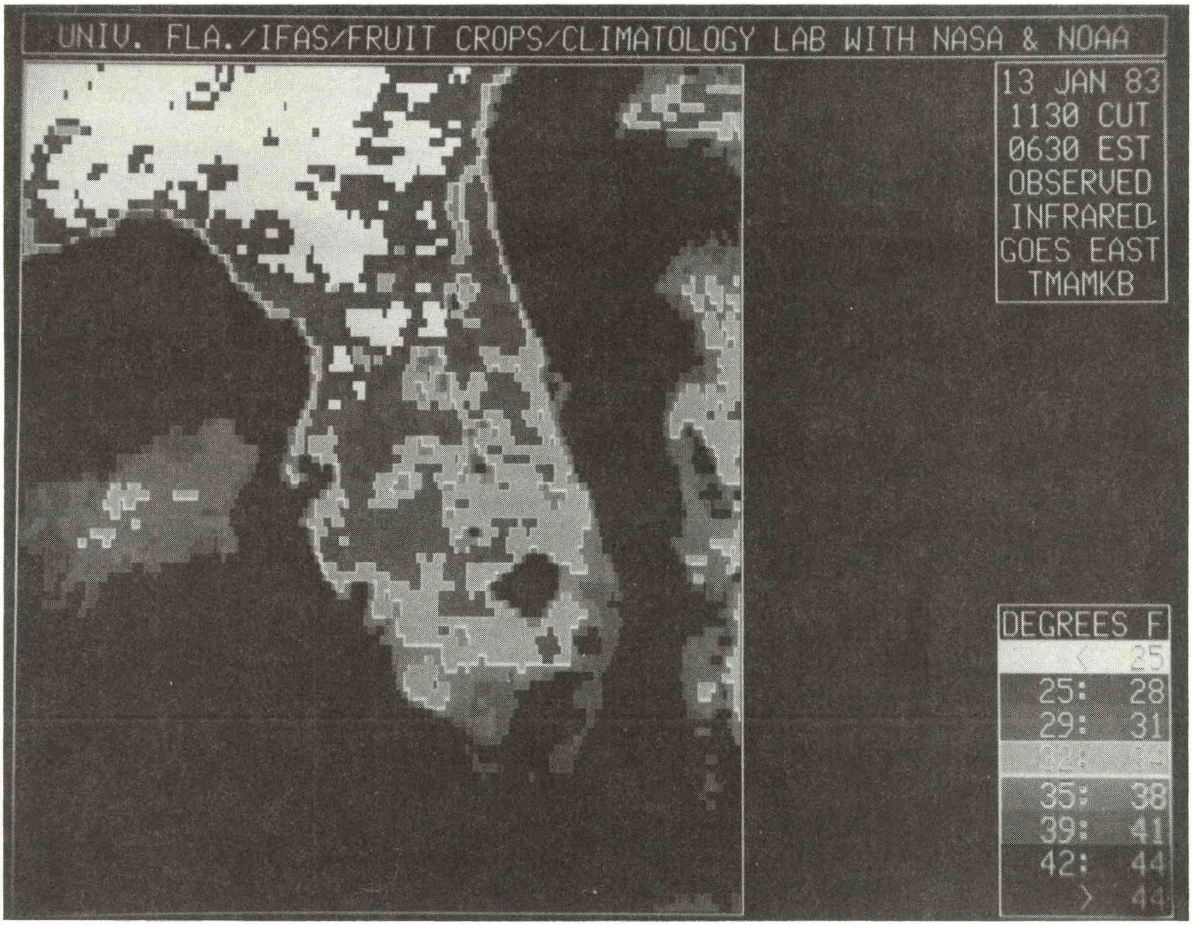

Fig. 1. Black and white rendition of the primary SFFS product. This is a photo of the television screen on which the color coded thermal maps are displayed for a typical but mild frost in 1983.

UF/IFAS and NASA (Contracts NAS10-9168 and NAS10-9892) and with the cooperation of NWS, over a period of almost 6 years. The last NASA contract for SFFS development has an end date of 31 March 1983. NOAA/NWS assumed responsibility for the SFFS operational computer system on December 1, 1982, and shares responsibility for the automated weather stations with UF/IFAS as of this March.

SFFS was originally conceived as not only a system with a very singular purpose but of stand-alone configuration (Fig. 2). The singular purpose broadened somewhat to include dissemination to growers through county extension agents as the hardware increased to include a development system and a direct downlink from the satellite. It simplifies the description to discuss SFFS as three systems:

1. the operational system
2. the developmental system
3. the integrated system

The operational system is located in Ruskin, Florida, where the Greater Tampa Bay NWS Forecast Office and radar are located. This is also the site of the Federal-State Frost Warning Service, a memorandum of understanding between NWS and UF/IFAS that has a history of more than 40 years of productive service to Florida agriculture and which has recently been updated to the Federal-State Agricultural Weather Service.

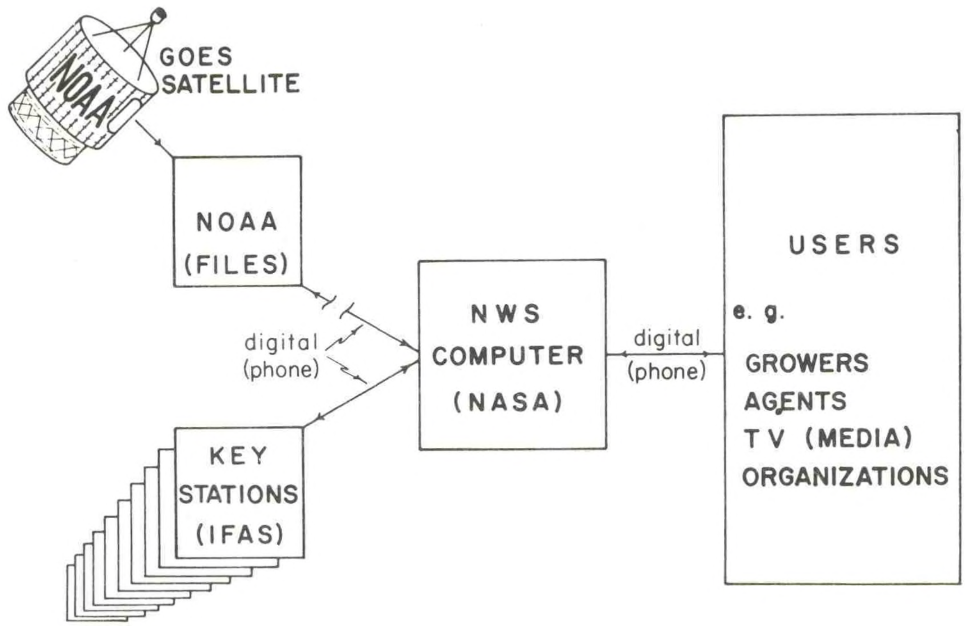

Fig. 2. Block diagram of SFFS as it was originally conceived and as the operational system had developed by the end of three years. SFFS acquired digital IR through NWS/Suitland, MD, once per hour, and surface observations from Key Stations by voice contact with volunteers by phone.

SFFS OPERATIONAL SYSTEM

Description

The stand alone operational system (Figure 3) is located in Ruskin Fl. at the NWS Forecast Office. Table 1 lists the equipment that acquires and processes the data, then displays these products for the meteorologists to use in making their frost forecasts.

Table 1. Components list of the Operational System of SFFS, Ruskin, Fl.

Item	Brief Description
Mini-computer	- Hewlett-Packard Model 2112A (21MX-M) w/448 Kbytes of memory.
Terminal	- HP Model 2645A CRT type w/16 Kbytes of memory and 112 Kbytes of storage on two integrated magnetic tape cassette drives.
Disc	- HP Model 7905A Hard Disc drive with a 15 Mbyte capacity.
Printer	- Texas Instruments Model 733A thermal type, 30 Char./sec. serves as a back-up to the CRT and as the system console.
Tape Drive	- HP Model 7970B magnetic tape drive, 45 in/sec., 800 B.P.I., stores 20 to 24 Mbytes on 2400 inch tape.
TV Monitor	- Conrac Model 5211, a 19 in. high quality RGB color display system. The system is capable of displaying 256 horizontal pixels and 240 vertical pixels in 8 colors.
Modems	- 9600 baud dedicated line to development system in Gainesville as a distributed system.
	- 1200 Baud full duplex, autodialing for acquisition of satellite data from Suitland, MD.
	- 300 Baud full duplex, autodialing for calling 10 automatic weather stations.
AFOS Link	- listen only link to the Automated Field Operations System Data General computer through which weather data and forecasts are acquired.

Data acquisition

Satellite data.

SFFS acquires data from two sources: 1) GOES-EAST and 2) 10 automated weather stations scattered over Peninsular Florida. The acquisition of satellite data from GOES-East may occur by either of two routes: 1) to Suitland, MD, by 1200 baud land line or 2) by 9600 baud dedicated line to the development system in Gainesville, Florida. The Suitland source provides a Florida sector of the infrared data once per hour. However, the source is experimental in an operational environment. The batch program that fills the Florida queue (a series of files avcailable to SFFS by phone) runs on a lower priority than most of the operational tasks with the result that the queue is filled on the average of 66% of the time and when it is filled the data averages several hours delay. The Gainesville source has been available since February 22, 1982. Since that date its reliability has been nearly perfect and the delay but a few minutes. The data is available every half hour and the sector may be easily changed.

Fig. 3. SFFS Operational System located in National Weather Service Forecast Office in Ruskin, FL. A TI printer/terminal and an HP CRT terminal are visible on left. The Conrac color monitor, HP 21MX M, extender and Vadic modem chassis occupy the left hand rack from top to bottom while a mag tape and 15 megabit disc occupy right hand rack.

Surface data.

SFFS acquires surface observations from 10 automated weather stations. Their locations are given in Table 2.

The automated weather station (AWS) is diagrammed in Figure 4.

Table 2. List of key stations serving SFFS, indicating their location and affiliation.

No.	Station	Location	Affiliation
1	Tallahassee	Airport	NWS
2	Jacksonville	Airport	NWS
3	Gainesville	Horticultural Unit 5 miles NW of Gainesville	IFAS/Fruit Crops
4	Tavares	Agr. Extension Center Rural, SW of Tavares	IFAS/Extension
5	Ruskin	Site of	NWS
6	Bartow	Ag. Extension Center	IFAS/Extension
7	West Palm Beach	Airport	NWS
8	Belleglade	Branch Experiment Station	IFAS/AEC
9	Immokalee	Branch Experiment Station	IFAS/AEC
10	Homestead	Branch Experiment Station	IFAS/AEC

The components of the AWS are listed in Table 3. Normally, the AWS´s are interrogated once per hour on frost nights beginning near sunset. The success rate is about 95% in acquiring data from these stations largely because the software has been refined to include numerous attempts for those stations that do not respond initially or send in data that is suspect. The extent to which the calling software will press the equipment to be successful in this acquisition process is controlled by the SFFS scheduling routines. Trial and error have been effective teachers. Refinements in the software have been checked against previous renditions to test improvement.

Initially these ground stations were manned by volunteers. There were a dozen key stations selected to represent peninsular Florida in locations in which volunteers read and reported the sensings. In the third frost season the 10 remaining stations were automated by the addition of microprocessors manufactured by Darcom.

Data Processing

Color coded thermal maps.

SFFS acquires data to process into products tailored to the needs of the user. The primary products of SFFS are a series of color-coded maps, often termed thermal maps, displayed on the Conrac color monitors located in Gainesville (the development system) and in Ruskin (the operational system). These products fall into two

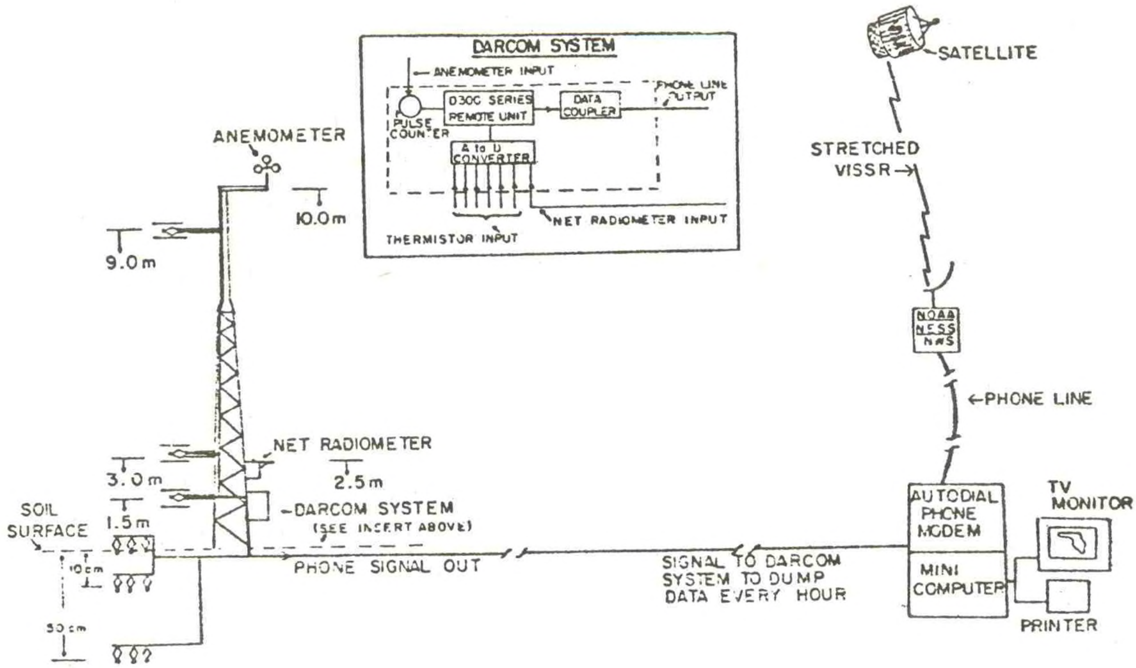

Fig. 4. Diagram of the automatic weather station and its relationship to the SFFS operational system.

categories: observed maps and predicted maps. A scheduling program provides the operator with an opportunity to exercise options by modifying instructions when initiating SFFS operation. Once started (scheduled) SFFS operates on previous instructions, unless there are changes. Normally, one observed map and three predicted maps are displayed as the generating programs complete their construction during each hour of the system's operation. The scheduling program looks in an answer file for its instructions concerning the options. For example, the rather broad range of temperatures from 13 degrees F to 50 degrees F is often chosen for the initial thermal map display to assure complete coverage of the data. The operator then has the opportunity to request the system to refine the temperature resolution of the display by requesting a narrower temperature range.

In addition to flexibility in the temperature range per color, the operator has options in the type of presentation, split screen permitting comparison of two thermal maps side by side, or the enlargement of a particular portion of the screen. With a little practice the user can slice the temperature range into appropriate increments that reveal isotherms near critical values for the forecast

Table 3. List of Components of each of 10 automated weather stations, part of SFFS

Item	Brief Description
Darcom	- Microprocessor based data acquisition system capable of responding to phone interrogation of its memory.
Air temp. sensors	- 3 ea at 1.5, 3.0 and 9.0 meters above the surface, shielded top and bottom from radiant exchange, aspirated by wind, for nocturnal use. Initially, the temperature sensors were thermocouples but now are thermistors.
Soil temp. sensors	- 3 ea at 0, 10 and 50 cm in depth; 3 series thermistors per sensor for better spatial integration.
Wind speed	- R. M. Young 3-cup light-chopper at 10m above the surface. A GE silicon/Darlington photo detector (type L-14-F1) and an IR emitter (Type LED-55B) have been substituted for better counting reliability.

or for plant damage.

Black and white symbols maps.

The big freeze of January 13-14, 1981, revealed that secondary products from the system were also in demand. Figure 5 is a copy of a printout of the so-called "symbols map." A translation table has been added that permits the user to translate the symbols in a particular area into temperatures. The map can be easily reproduced in quantity and many of these have been used by decision makers in the areas of crop transportation, processing, futures, etc. A detail that becomes apparent in viewing this map is that differentiation of temperatures ceases below 13.7 degrees F. This is an arbitrary limitation that results from the necessity of assigning a symbol set to temperature values in order to easily move them through the NOAA/NWS program and into the SFFS queue in Suitland. The raw data covers a much broader temperature range, i.e. -110 degees C to 568 degrees C. covered by 256 counts.

Automated weather station temperatures.

A secondary product of the system is the printout of the 1.5m air temperatures from the automated weather stations. These data are available faster than those from minimum-temperature thermograph networks. The product is easily reproduced and inexpensively duplicated for mass dissemination.

Predicted Thermal Maps

Two models operate in series to produce the predicted products. The first, known as P-model, is an energy budget model requiring as inputs data from the key stations and estimated or observed dew points from the SFFS operator. The P-model has been published (Sutherland, 1980) and discussed in the literature (Shaw, 1981; Sutherland, 1981). The "P" in P-model stands for predictive as well as physical. The model outputs 1.5m air-temperature forecasts for the remainder of the night, i.e. up to 7AM the following morning. These forecasts are printed out in tabular form along with the previously observed 1.5m air temperatures at the key station for the operators to view at the system printer. The forecasters use these as part of the input information they have available to make their frost warnings for various areas of the state.

The second model, called the S-model, requires the output of the P-model and the satellite data to produce forecasted satellite maps. The "S" stands for space, statistical and satellite. It must build a predicted satellite view, a thermal map, from the predicted temperature at 10 locations, into temperatures for each of the 8 km by 8 km pixels within the borders of the peninsula. A matrix of coefficients relates the predicted key station temperatures to pixels surrounding the key station. These coefficients primarily describe the distance between the key station and the pixel to be predicted but they are one of the ways that recall of the distribution of temperatures in past freezes can be available to the prediction process.

SFFS Development System

Early in the development of SFFS, IFAS procured a sister minicomputer system. This avoided the problems of moving the SFFS operational system back and forth between Ruskin and Gainesville and provided a back-up to the Ruskin system during the frost season. The development system has been kept as compatible as possible with the operational system so that software developed for one runs on the other. Table 4 lists the components of the development system.

Data Acquisition

The development system has the capability of acquiring the same data as the operational system but with some minor considerations.

1. The development system has a more difficult time acquiring AWS data because a recent change in telephone policy on the campus forced it into use of SunCom lines which are notoriously more noisy than regular voice grade lines.

2. The operational system acquires the AFOS data initially and only portions of it are linked through the distributed system 9600 Baud line to the development system.

3. The development system downlinks the satellite directly and

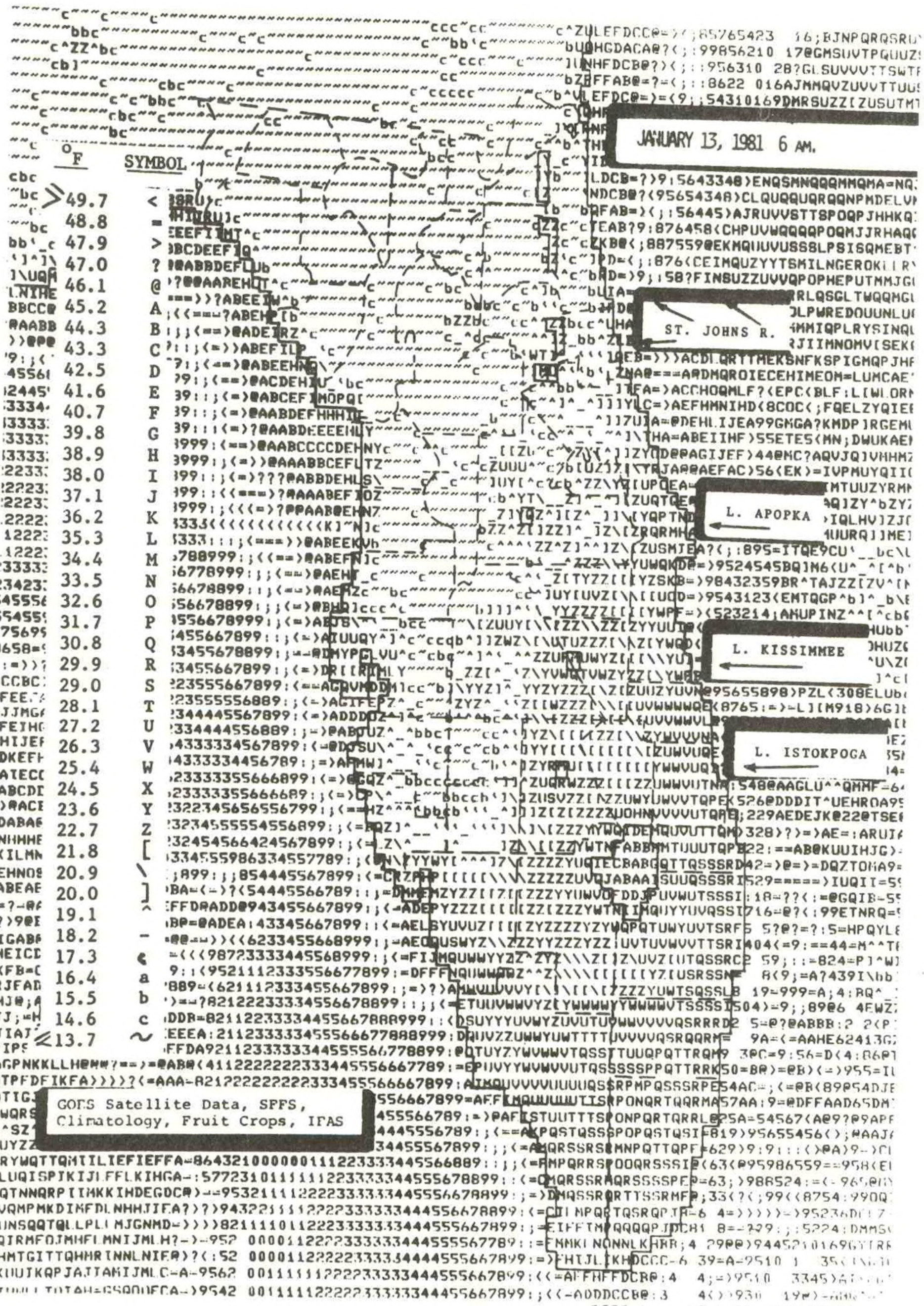

Fig. 5. January 13-14, 1981 Freeze, as diagrammed with a "Symbols" map. A translation table is superimposed.

has the capability of viewing much more of the hemisphere of data than can be shared with the operational system. However, the 9600 Baud line follows.

The antenna system became operational February 22, 1982. Since then Software has been developed to take advantage of the data being available on half-hour intervals versus hourly, of twice as many

Table 4. Components of the SFFS Development System, University of Florida, Gainesville, Florida.

Item	Brief Description
Mini-computer	- Hewlett-Packard Model 2113A (21MX-E) with 768 Kbytes of memory
Terminals	- 2 ea. HP Model 2645A w/16 Kbytes of self-contained memory. One terminal has a pair of integrated cassette magnetic tape drives, each with a capacity of 112 Kbytes of storage. - 3 ea HP Model 2621 w/4 Kbytes of memory. One of these contains an integral thermal printer.
System console	- Texas Instruments Model 733A thermal paper type printer.
Discs	- 3 ea. HP Model 7900A discs with 5 Mbyte per disc (2.5 Mbyte of which is removable. - 1 ea HP Model 7912P Winchester type disc with 67.5 Mbyte capacity.
Tape drive	- HP Model 7970B, 800 BPI, 20 to 24 Mbytes per 2400′ reel.
Printer	- HP Model 2635A medium duty impact matrix with approx. 180 characters per second speed. A keyboard permits use as a back-up terminal.
Television display	- Conrac Model RHM-19, 19 in. TV monitor from NASA, RGB, capable of displaying 786 horizontal pixels and 480 vertical pixels in 8 colors. An additional white over-lay channel is non-destructive to under-lain colors. This display system is an Intermedia model 4601. Additionally a Hewlett-Packard model 91200B system drives a Panasonic model CT-1910M monitor displaying 256 horizontal pixels and 240 vertical pixels. The HP system emulates the Ruskin display system.
Plotter	- HP Model 7210 single-pen with a resolution of 100 points per in.
Modems	- 1 ea. 9600 Baud dedicated line modem serving the other half of the distributed system link with the Ruskin machine, Paradyne model M96. - 1 ea. 300 Baud full duplex autodial modems integrated in a Vadic chassis. - 2 ea. 300 Baud full duplex answer-only modem in same chassis. - 1 ea. 1200 Baud full duplex autodial modem in same chassis. - 1 ea. 300/1200 Baud full duplex answer-only auto speed detection modem in same chassis.
Antenna interface	- HP 12566 data interface card and lab developed and installed hand-shaking signal producing circuits.

pixels of IR data, and of numerous sectors scattered over the hemispheric view of GOES-East. Before GOES-WEST failed the antenna was occasionally turned to receive Goes-West data from it. A second bit sync was added to the system to permit uisition. The data arrives from the antenna in binary whereas these data are encoded in the ASCII character set when communicated from Suitland. Having a 92 step range in the latter case versus a 256 step range in the

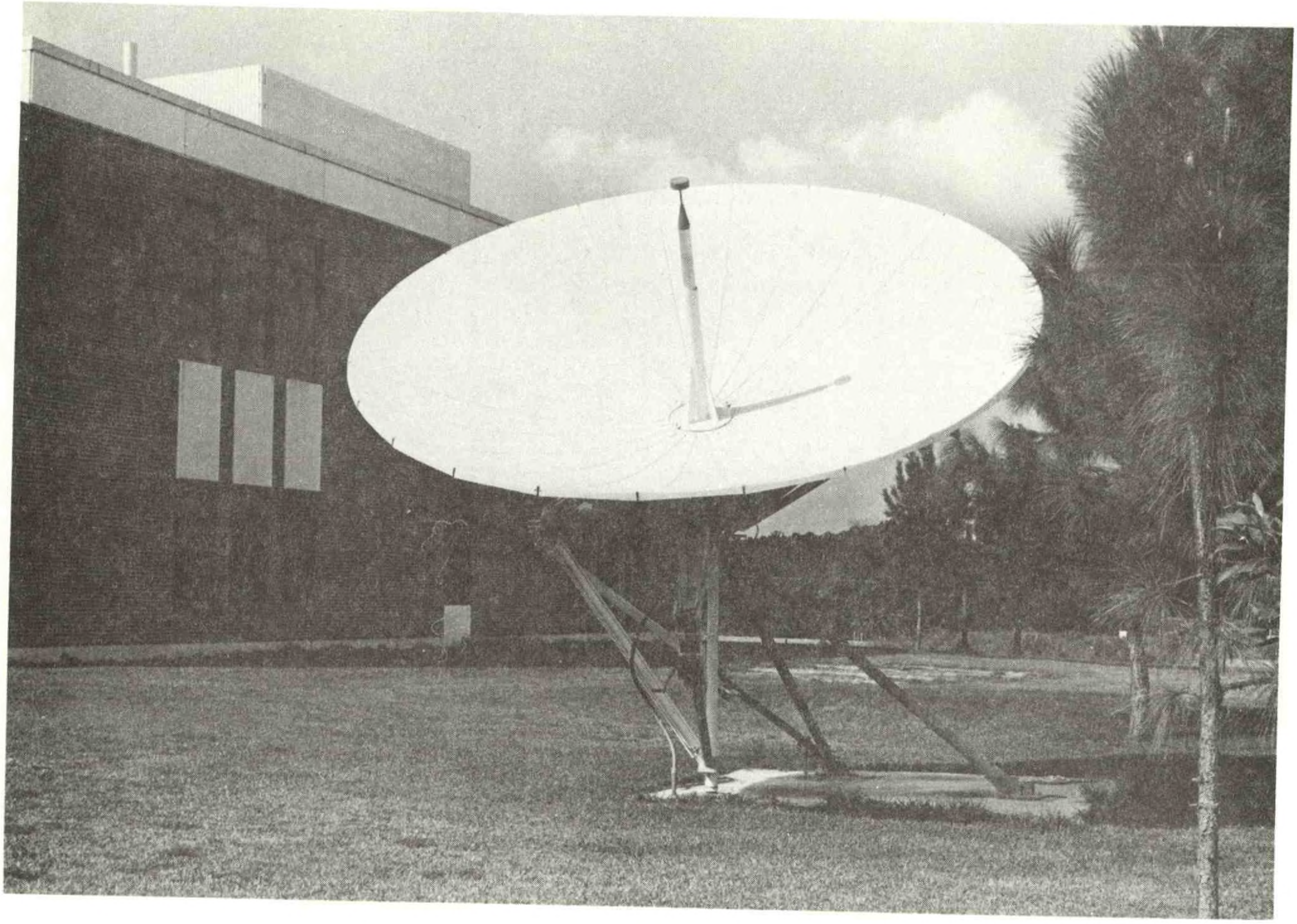

Fig. 6. SFFS direct downlink from GOES located just East of HS/PP Bldg. on the UF Campus in Gainesville, Florida.

original binary data causes truncation at some point. Thus the antenna cures a problem that has appeared in the cases of both the major freezes of ´81 and ´82 when temperatures fell below the lowest temperature encoded in the Suitland data, i.e. about 13 degrees F.

Product Dissemination

The primary user of SFFS output is the forecaster. The NOAA/NWS forecaster incorporates SFFS information into the frost warnings and communicates these to users through the normal communication channels that have developed over years of NWS service to its clientel.

Additional users of SFFS information include all other consumers showing interest in receiving the information. During the 80-81 frost season, two county extension offices (one in Polk County and the other in Lake County) received the thermal maps by an APPLE II

Table 5. List of components of the Direct Downlink Antenna System, a part of the SFFS Development System in Gainesville, Florida.

Item	Brief Descripiton
Antenna	- Scientific Atlanta 5 meter dish Model 3556-5 with AZ-EL adjustable mount assembly.
Feedhorn	- Band pass filter, isolator, low noise amplifier, dipole receptor, and 1/4 wave cavity.
Cable	- I.F. bandpass line amp, filter assembly, and power supply.
Down converter	- Oscillator, phase lock multiplier, filters, mixer, post amp, cable drivers, and power supply.
Demodulator	PSK Model 728.
Bit Stream Sync	- EMR Model 720 PCM & DECOM Systems Inc. Model 7136 PCM.
Sectorizer	- EMR Model 822 Frame synchronizer and Sectorizer, GOES PCM Simulator and bit error detector.

computer link with the Gainesville minicomputer. During the 81-82 frost season the number of agents linking to the system through the experimental APPLE network increased to ten. In the 82-83 season the IFAS Computer Network became the source of SFFS products for IFAS users, i.e. the county agents. The SFFS development system automatically loads the queues in the IFAS Computer System. APPLE III's, IBM PC's and Zenith Z-100's now have software that permits them to interrogate either the development system or the IFAS Computer System VAX for SFFS products but these programs do not have the automatic acquisition mode that characterizes the APPLE II software (see Fig. 7). Growers, media, processors, etc. are expected to arrange to connect with the county computers or terminals to view thermal maps, as well as to obtain other system products through the cooperative extension service. Table 6 lists the agricultural extension agents that are members of the experimental APPLE network.

FAST and the Future

FAST became tangible as a not-for-profit corporation with a non-faculty (UF) board of directors in January of this year. Dr. John F. Gerber is on temporary leave from his UF/IFAS duties to serve as the executive director of FAST. The author of this paper is the principal investigator of a contact between IFAS and FAST to transfer technology to FAST accrued through SFFS development by the Climatoloy Laboratory of the Fruit Crops Department and to develop

Fig. 7. Apple II Plus used as a SFFS terminal. Two disc drives, a clock, a software controlled modem, and a color monitor are needed for a complete system capable of automatic data acquisition, display and archival.

additional products from radar and AFOS sources.

FAST is leasing a Cyber 730 and space in a building in the new research park in Alachua, Fla., from the University of Florida Foundation (SHARE). It will supply products similar to those developed for SFFS but covering a broader spectrum of weather and climate information needs. FAST is expected to gradually assume much of the operational responsibility that the SFFS development system has accumulated and in the process acquire support for its services from members it serves. FAST is likely to develop color renditions of the following:

- thermal maps of GOES IR
- reflectance maps of GOES VIS
- summary maps of weather radar data
- composites of GOES and radar data
- lightning maps
- plotted severe weather advisories and other NWS forecasts.

Table 6. APPLE Network Listing, effective February of 1983, in approximately the order in which each joined the network.

County	City	Agent	Crop(s) Covered
Lake (& Orange)	Tavares	John Jackson (Francis Ferguson)	Citrus, ornamentals
Polk	Bartow	Tom Oswalt	Citrus
Dade	Homestead	Seymour Goldweber	Subtropicals, vegetables
St. Lucie	Ft. Pierce	Pete Spyke	Citrus, Ornamentals
Madison	Madison	Jacque Breman	Peaches
Brooks	Quitman, GA	Henry Carr	Peaches
Palm Beach	Palm Beach	Clayton Hutcheson	Citrus, vegetables, ornamentals
Collier	Naples	Reggie Brown	Citrus, IPM
Highlands	Sebring	Tim Hurner	Citrus
Manatee	Bradenton	Marlowe Iverson	Citrus, ornamentals
Indian River	Ft. Pierce	Brian Combs	Citrus
Lee	Punta Gorda	Susan Hedge	Citrus, ornamentals

Two Control Data Corporation software packages are expected to aid the development of these products, i.e. CDC/McIDAS and INTERSYS.

The characteristics of the system are primarily apparent to the end user as they are displayed on his system terminal. The new Zenith Z-100 dual-processor microcomputer is being programmed by members of the SFFS development team toward testing its ability to serve as one of many microcomputer systems with which the FAST system expects to be compatible. Sufficient development has occurred in this software that this microcomputer along with the more typical SFFS APPLE II Plus is demonstrated during the workshop in which this paper is presented.

One of the concepts that developed from experiences with SFFS operation which is expected to benefit the FAST system is the need to serve members as uniquely as possible with products tailored to their specific needs. The on-line storage capability of the Cyber 730 is expected to facilitate the handling of numerous unique account. Efforts will be made to accumulate and store information in the member's requests uniquely when their particular site, or the manner

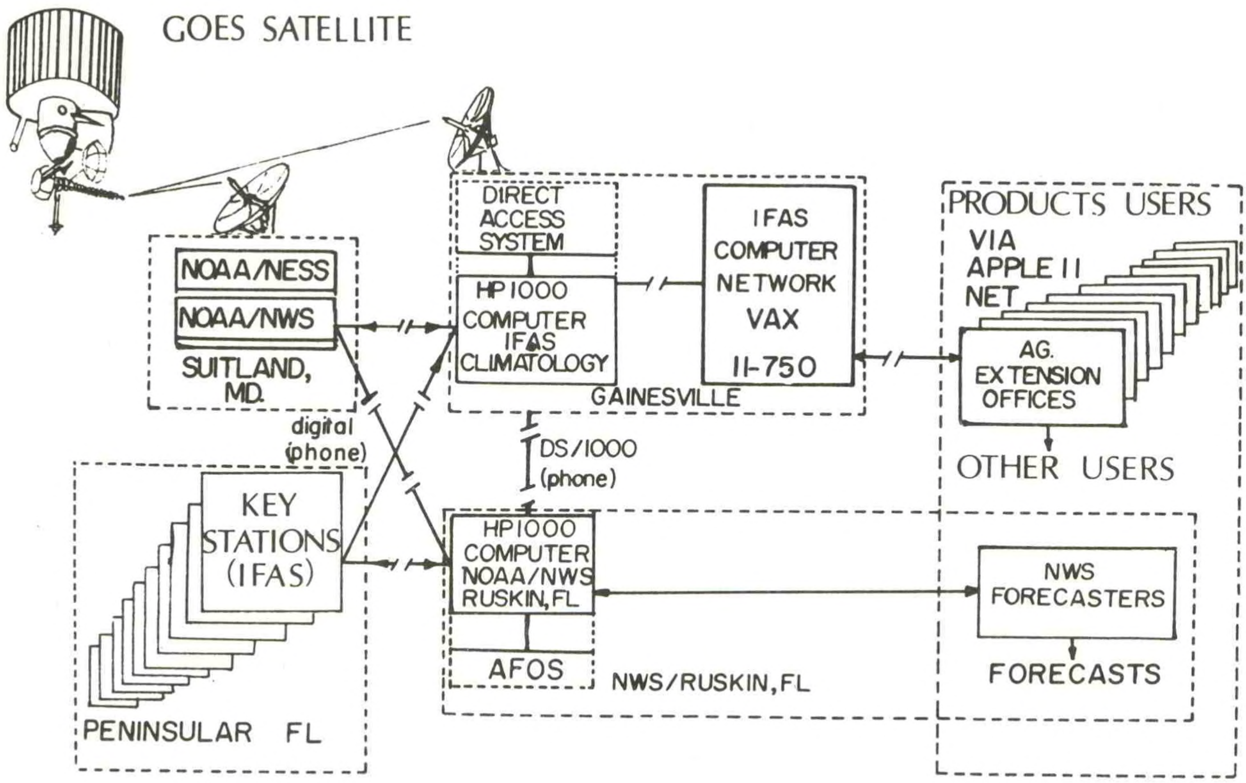

Fig. 8. Block diagram of the components of the Integrated SFFS System with the exception of the newest component FAST which may be placed above the the SFFS Antenna System (Direct Access System) and be interfaced initially with that antenna and to the development system (i.e. Climatology).

in which they have indicated they intend to use the information, warrants special processing of of their products.

ACKNOWLEDGEMENTS

Both IFAS/UF and NASA (Contracts NAS10-9168 and NAS10-9892) have funded SFFS development with NOAA/NWS cooperating. USDA/Extension has funded product dissemination to county extension offices through Grant 12-05-300-535. Prior to this grant for the dissemination effort, Dean John T. Woeste, who participated in this workshop, should be acknowledged for his special interest in and support of

the extension component of the effort. Dr. Jon F. Bartholic served as the principal investigator (PI) during the first 1.5 of the effort years before becoming an Assistant Director at Michigan State University, Agricultural Experiment Station. Dr. John F. Gerber is acknowledged for his service as interim PI for a period of approximately one year, in addition to service as IFAS Grants Office Director. Dr. Michael J. Burke, Chairman of Fruit Crops, Dr. Robert Sutherland, and Dr. Ellen Chen, both previously Post Doctorate Assistants on the SFFS project, and Mr. James G. Georg, Consultant Meteorologist,

have made special contributions to SFFS development. Dr. James M. Dodge, NASA/HQ, Mr. U. Reed Barnett, Jr., and Mr. Richard A. Withrow, both of NASA/KSC, have coordinated NASA's support to the development. Mr. Frederick C. Crosby of NOAA/NWS has coordinated NOAA's cooperation and provided operational testing of SFFS at the Ruskin WFO. Mr. Ferris G. Johnson, Jr. has coordinated the software development with recent programming support from Mr. Fred D. Stephens, Mr. Robert A. Dillon and Mr. G. Dana Shaw. Mr. Eugene H. Hannah and Mr. Michael P. Baker have developed the key station instrumentation and the latter has responsibility for the antenna system. Mr. Jon Boczkiewicz, a microcomputer specialist, and Mr. Paul H. Heinemann, a doctorate student, have aided dissemination, data acquisition, and modeling development. Mr. Richard E. Mueller has helped Mr. Hannah on a part time basis. Mrs. Alice E. Grimes continues her support in bookkeeping and procurement. Miss Kathleen M. Daniels, a part-time secretary, is responsible for the text processing that permitted the development system to output this report on one of its printers.

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Anonymous. 1982. Florida Grower and Rancher 95(4):Cover.

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Rapid Worldwide Agricultural Weather Assessments

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Introduction

The availability of food, or the lack of it, influences how world trade patterns occur. World trade in effect is the movement of food and fiber from regions of general surplus to regions of general and often presistent deficiencies. The United States is one of a very few countries which can consistently produce more than it consumes. Thus, the export of agricultural products is an extremely important component of the U.S. Agribusiness system. Agricultural exports have been a bright spot in our balance of payments, providing a surplus over imports of $21.3 billion versus a nonagricultural trade deficit of $63 billion in 1982.

To help identify potential agricultural markets, the U.S. Department of Agriculture (USDA) has developed a rapid worldwide monitoring and weather assessment capability. The Joint Agricultural Weather Facility (JAWF) has as one of its tasks the responsibilty to provide daily agricultural assessments, keeping the nation's planners and policymakers aware of potential markets developing around the world. A primary source of information is the standard meteorological data provided over the World Meteorological Organization, Global Telecommunication System (WMO/GTS) and available at JAWF.

JAWF, is a cooperative effort between the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and the World Agricultural Outlook Board (WAOB) of USDA. JAWF has two basic missions: publication of the Weekly Weather and Crop Bulletin (WWCB); and the monitoring and early-warning alert missions for weather events that may impact growing conditions and yield potential for all major crops and crop areas around the world. Along with the so-called major crops, JAWF also follows the lesser commodity crops and agriculture in many developing countries too, but to a less intense degree.

The National Weather Service (NWS) of NOAA provides meteorological expertise in numerical forecasting and satellite image interpretation from the Climate Analysis Center of the National Meteorological Center (NMC/CAC). NOAA/NWS provides the editor for the WWCB; currently, Don Haddock fills this post. The WWCB, published each Tuesday, contains a summary of the past week's world weather events and a qualitative assessment of the current weather's impact on crop conditions. USDA provides crop condition assessments for the WWCB in a joint effort, with USDA's Statistical Reporting Service (SRS) covering the domestic crops and the WAOB covering crops in the foreign countries. The inclusion of a foreign country section in the WWCB began in 1978. The bulletin is now in its 110th year of publication and demonstrates the importance placed on the strong relationship known to exist between USDA's planning efforts and weather-related impacts.

Monitoring Effort

While the WWCB work has been a long-standing endeavor, a less well-known but equally important aspect of the JAWF effort is the real-time or near-real-time monitoring of daily weather events around the globe leading to an early warning, qualitative assessment of the possible impacts on crop condition and yield potential. This work began in 1978 and is partly the outgrowth of a joint research effort between USDA, NOAA, and NASA called the Large Area Crop Inventory Experiment (LACIE). Thus, JAWF is providing a new and important source of timely information to keep USDA Secretary and other top officials informed about changing crop conditions. This information also is used in crop production deliberations leading to USDA's monthly World Crop Production and World Agricultural Suppy/Demand Estimates Reports.

These weather assessments are provided to USDA analysts in two ways. First, verbal weekly weather briefings are presented by the NOAA/NWS meteorologist with the USDA crop/weather analysts describing the likely crop response--current and cumulative--to the observed weather events. Second, the weekly written assessments are published in the WWCB to form a basis for future reference. The commodity analysts often interact with the meteorologist between briefings to clarify and/or evaluate conflicting statements from other information sources.

It is important to stress that the JAWF estimates are prepared using weather events as the driving mechanism in determining crop conditions and yield potential. This approach complements the various assessment techniques that have been USDA's primary approach to crop yield, area and production estimates for many years. The JAWF work does not in any way replace these long-standing techniques, but simply provides a systematic integration of timely weather data and weather-based assessments for the commodity analysts' use.

Data Management

The meteorological assessments require the use of both the historical data series and current data for monitoring and interpreting ongoing weather events. The historical agronomic data are equally important for determining technology levels, trends and changes in area and yields, and normal crop calendars. The historical data reside on a dedicated DEC/PDP 11 system within the WAOB. Software provides for a rapid retrieval and manipulation of the historical data. For example, temperature rankings for South Africa for January and February 1951 to 1983, are shown in Figure 1. Figure 2 shows the January and February precipitation rankings, 1951 to 1983.

Current meteorological data from the NMC/CAC are transferred to the dedicated WANG disc files. Software has been developed for calculations of current growing degree days (GDD) for several bases and potential evapotranspiration (PET) calculations. These are then transferred to the PDP systems for retention with the historical data files. Calculations are made for selected individual stations and by aggregates of 5-10 stations for designated crop regions.

NMC/CAC provides an operational quality control program for the incoming current data received over the WMO/GTS system. It is still necessary, however, to continue quality control on the derived data within the JAWF. Figure 3 illustrates the cumulative seasonal plots for PET, precipitation and normal. The basic Data Management Flow concept is depicted by Figure 4.

Assessments Techniques

The preparation of the JAWF assessments draws heavily on the analysts' ability to systematically integrate information obtained from analysis of the meteorological data and the agricultural information obtained from many ancillary sources.

The meteorological satellite imagery provide the starting point for the daily review of the global weather events. The JAWF daily discussions between the CAC meteorologists and the WAOB agrometeorologists is the starting point for an assessment. Meteorologists are alerted to the types of weather events that may help or hurt crops for each area of concern. Surface maps and forecast projections are then reviewed to determine if weather events can be expected to change. These daily discussions provide the basis for early warning alerts and/or updates to the USDA Secretary and his top staff.

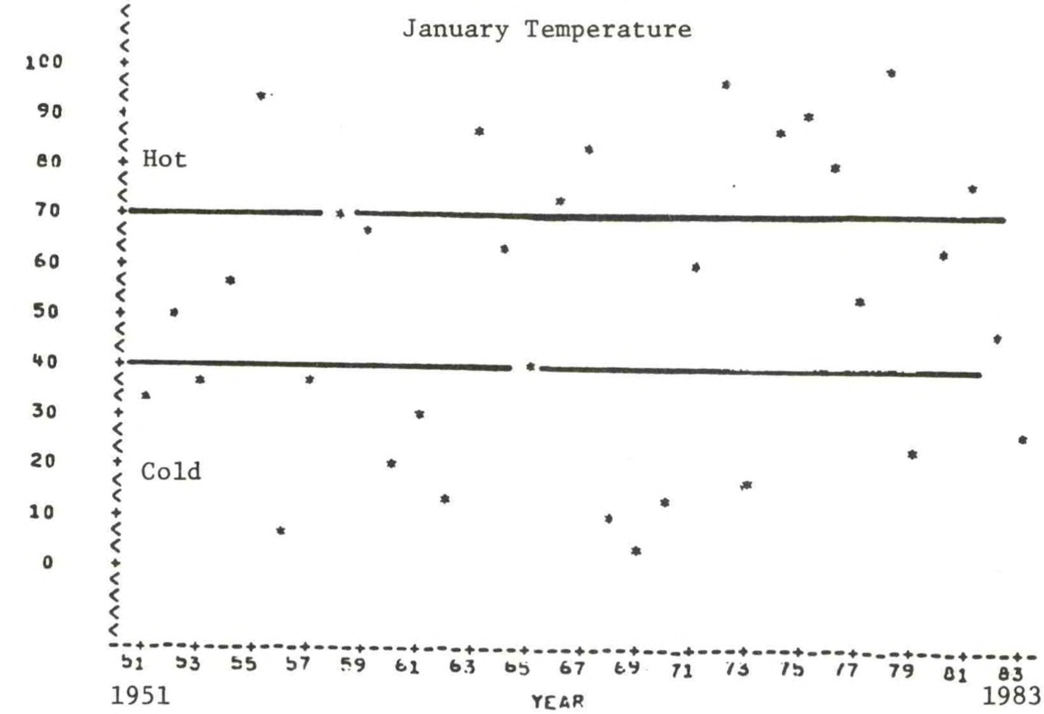
The final step is very critical--that is the ability to convert the data assembled into information that can be understood and used by the lay person, the non-meteorologist or agrometeorologist. Simple words and clear thoughts, well organized to portray the appropriate message will determine the success or failure of the agricultural weather assessments.

Summary

Basic meteorological data, when properly monitored to ensure high quality, can be converted into parameters that are related to crop responses. These parameters then can be correlated with the cumulative effect of the weather as the season unfolds,—through the various stages—planting, vegetative, flowering, grain filling and ripening. At each stage the weather parameters that can enhance or deteriorate potential crop yield are very different. Assessment personnel must further be able to integrate many non-meteorological pieces of information, then analyze and interpret these across time and space to complete the assessment.

Today, most crop assessment work can not be fully automated. It is the man in the loop that must convert the raw data into the information needed by the user. The user's needs vary immensely and thus, a single best approach to crop yield assessment work cannot be presented at this time. However, one of the most important requirements is the exchange of ideas and thoughts that must take place between different disciplines. Good assessments require a good working environment with multi-discipline teamwork. Without it, misleading or only partically accurate assessments are the most likely result.

Percentile Rank for Temperature by
Indicated Month and for South African
Maize Triangle



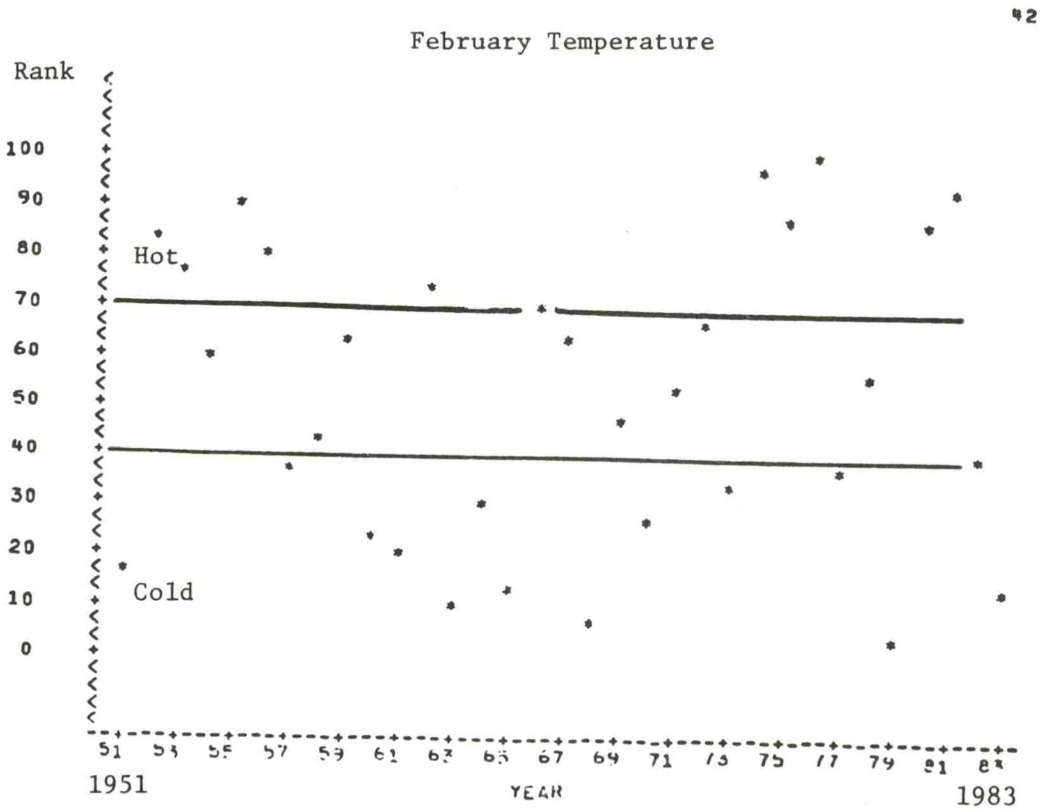
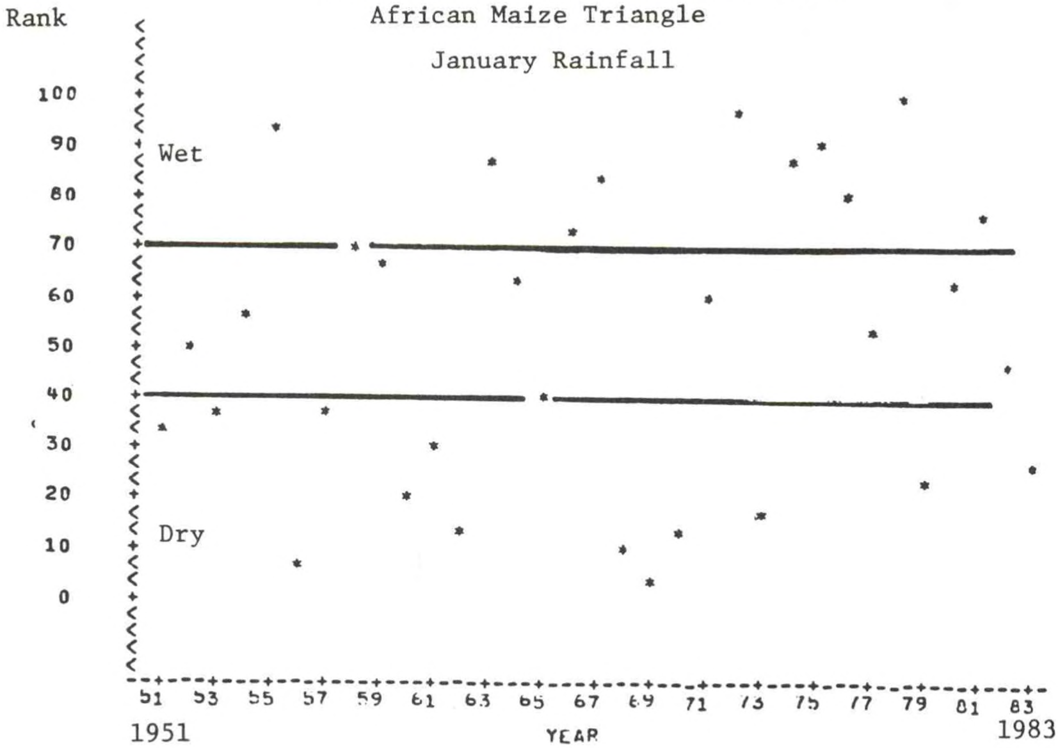


Figure 1

Percentile Rank for Precipitation by
Indicated Month and Year for South
African Maize Triangle



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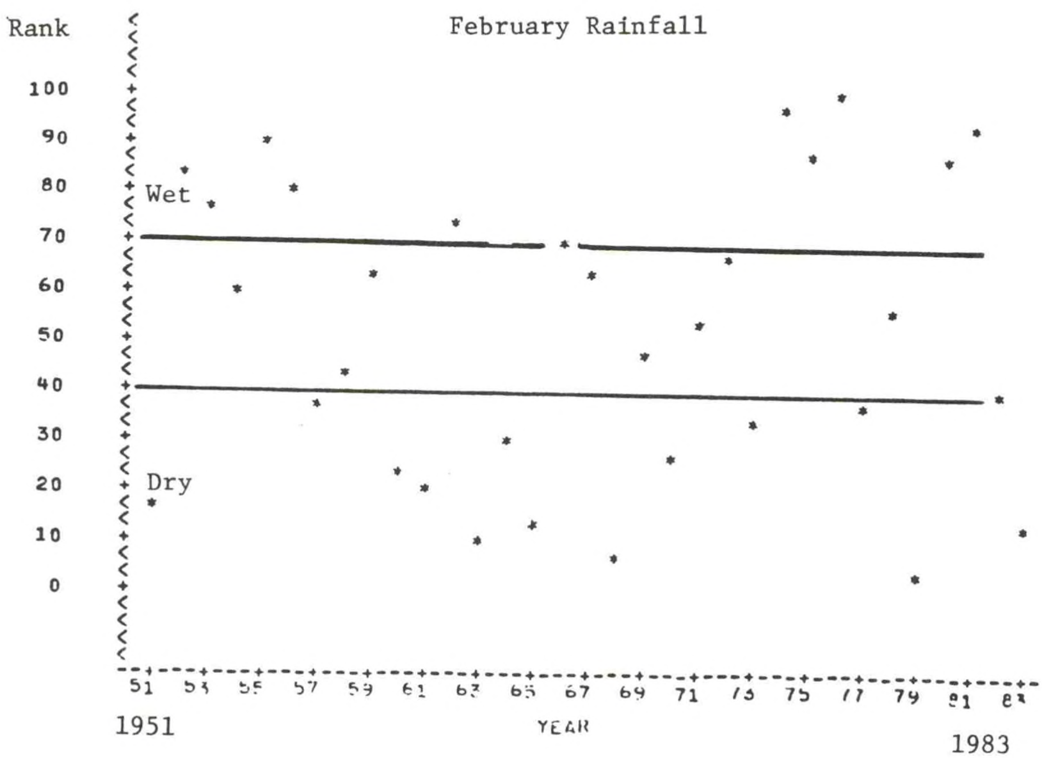

Figure 2

South Africa - West Transvaal corn area: Growing Season - Cumulative normal rainfall (Y) in millimeter; cumulative observed rainfall (Y1); crop potential evapotranspiration versus cumulative growing degree days (GDD) (Y2) and crop development stage.

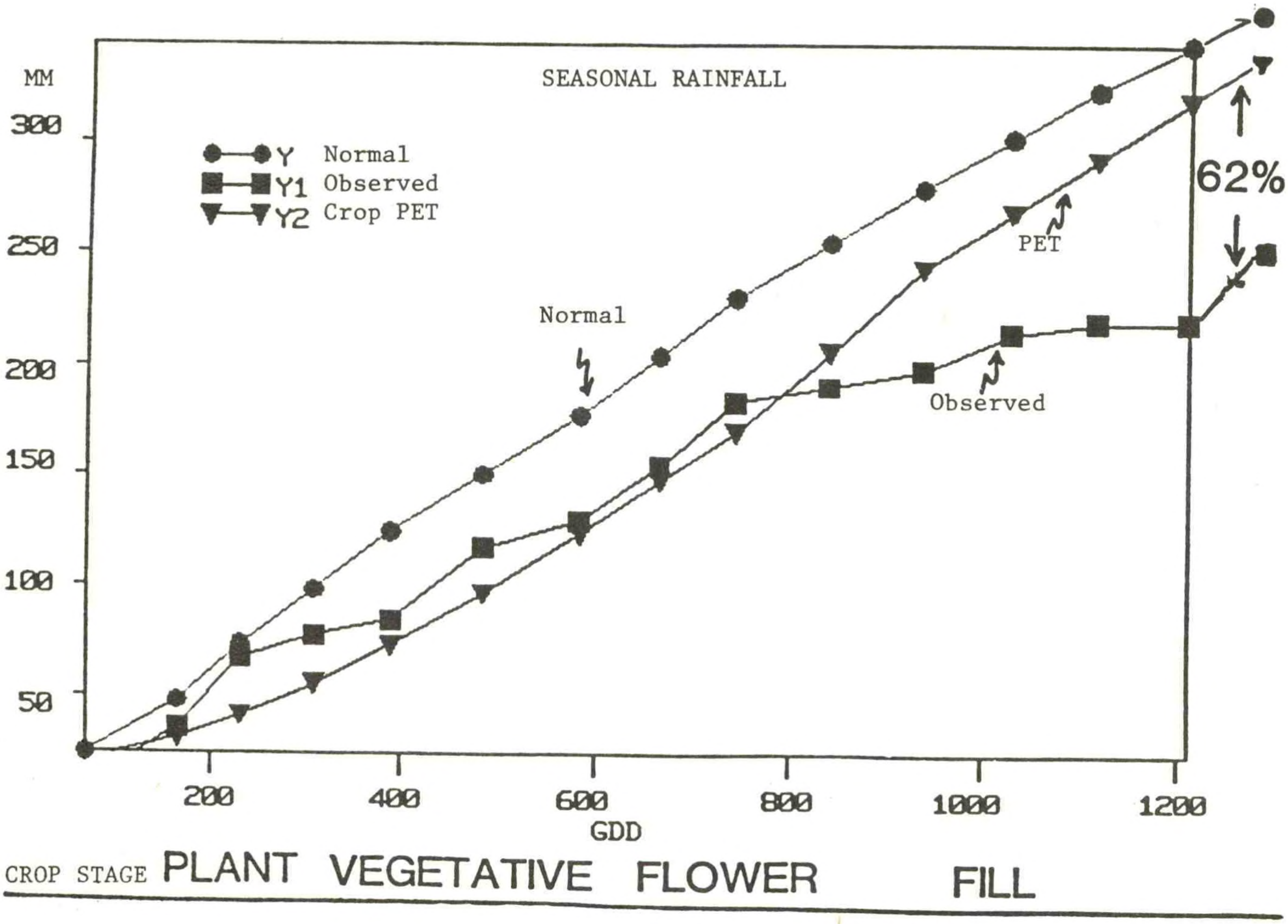

Figure 3

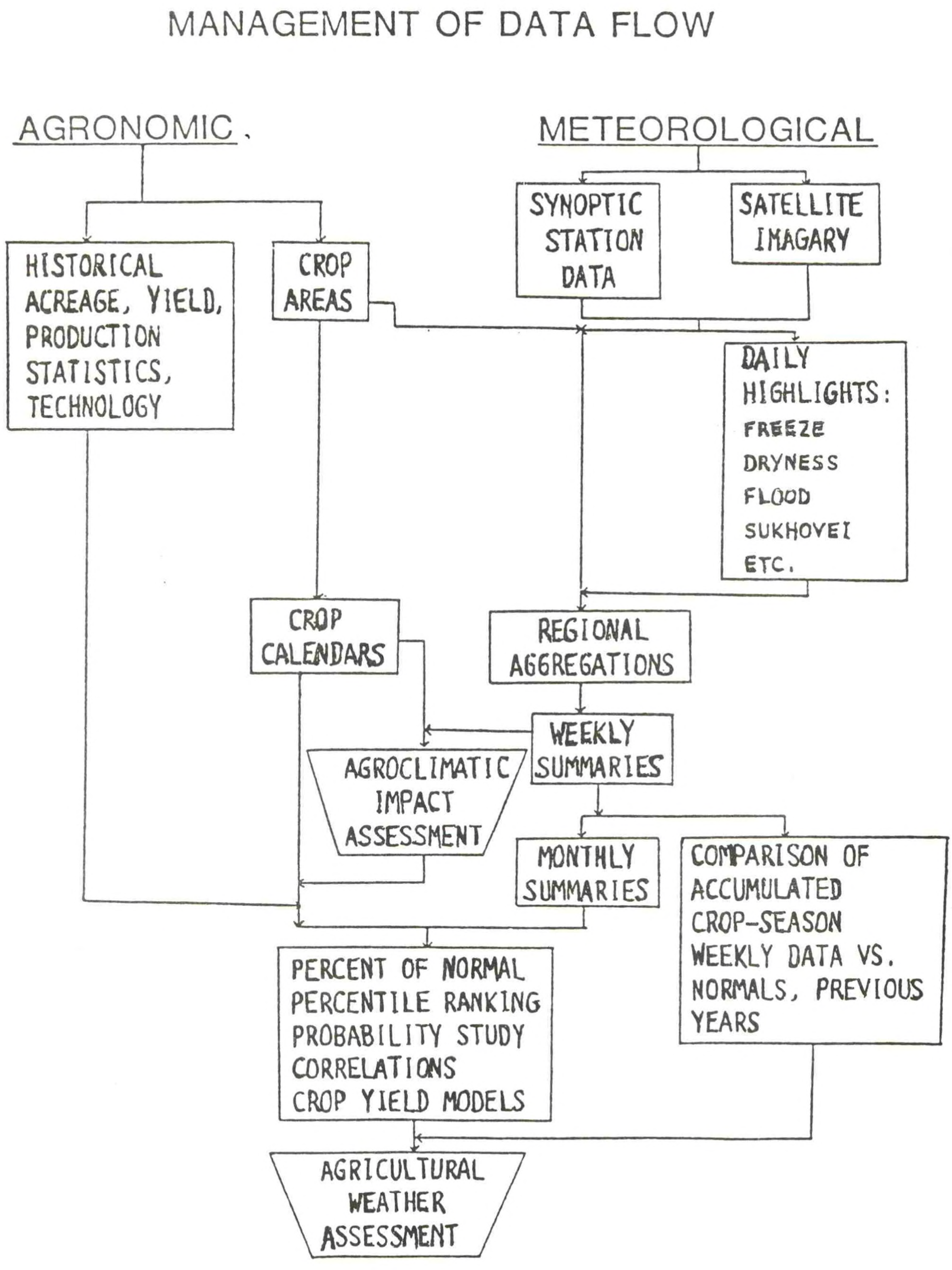
MANAGEMENT OF DATA FLOW
AGRONOMIC
METEOROLOGICAL
HISTORICAL ACREAGE, YIELD, PRODUCTION STATISTICS, TECHNOLOGY
CROP AREAS
SYNOPTIC STATION DATA
SATELLITE IMAGARY
DAILY HIGHLIGHTS: FREEZE DRYNESS FLOOD SUKHOVEI ETC.
CROP CALENDARS
REGIONAL AGGREGATIONS
WEEKLY SUMMARIES
AGROCLIMATIC IMPACT ASSESSMENT
MONTHLY SUMMARIES
COMPARISON OF ACCUMULATED CROP-SEASON WEEKLY DATA VS. NORMALS, PREVIOUS YEARS
PERCENT OF NORMAL PERCENTILE RANKING PROBABILITY STUDY CORRELATIONS CROP YIELD MODELS
AGRICULTURAL WEATHER ASSESSMENT

Figure 4

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Dr. Ralph Neild	Horticulture Department, University of Nebraska
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Mr. John C. Purvis	Water Resources Commission, State of South Carolina
Dr. James Rasmussen	Climate Analysis Center, National Weather Service
Mr. Kelly Redman	Dept. of Atmospheric Sciences, Oregon State University
Mrs. Vivian Rivera	Office of Management & Budget
Dr. Peter Robinson	Department of Geography, University of North Carolina
Dr. John Sandilands	The Canadian Climate Center, Atmospheric Environmental Service
Dr. Thomas Schmidlin	Agronomy Department, Cornell University
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☆U.S. GOVERNMENT PRINTING OFFICE: 1983-427-248