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NOAA CLIMATE
SERVICES PLAN

CLIMATE ANALYSIS CENTER
NATIONAL CLIMATIC DATA CENTER
REGIONAL CLIMATE CENTERS

OUR MISSION IS TO PROVIDE INFORMATION
TO DECISION AND POLICY MAKERS

"....the unlimited climatic resources of the United States still await exploration and exploitation; they wait to be tapped. They promise full returns by better adjustment of our homes and health, our agriculture and technology, to the atmospheric environment.

Helmut Landsberg

AUGUST 1990

NCDC



**NOAA CLIMATE
SERVICES PLAN**

**CLIMATE ANALYSIS CENTER
NATIONAL CLIMATE DATA CENTER
REGIONAL CLIMATE CENTERS**

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NOAA CLIMATE SERVICES PLAN

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I. INTRODUCTION

A. Rationale for Plan

For the past two decades it has been widely recognized that the Nation's climate service activities were not functioning well and were poorly organized. In 1978, a major motivation for the National Climate Program Act (Public Law 95-367) was to improve dissemination and use of climate information. Congress found that information regarding climate was not being fully disseminated or used, and Federal efforts have given insufficient attention to assessing and applying this information. The Program mandated "systems for management and active dissemination of climatological data, information, and assessments". Since 1978 there have been several calls for an organized climate service system to improve the situation.

The concept of a nationwide climate service system emerged from recommendations by an National Research Council (NRC) Panel (National Research Council, 1984) and from a National Climate Program Office (NCPO) Conference on Climate Services (Department of Commerce, 1983). The NRC Panel concluded that "a coordinated, nationwide system of federal, state, and local, public and private, climate services is needed" and "that a major role in a nationwide system of climate services must be played by federal agencies". The Panel further stated that "In particular, NOAA occupies a key federal position". The Conference on Cooperative Climate Services noted that 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 National Climate Program Five-Year Plan, 1989-1993 (NCPO, 1989) includes the following major objectives and recommendations:

- To create an integrated climate information system permitting easy access to the data specifying the climate system and the factors having influence on climate.
- To provide climate data products and services aimed at wide-spread utilization of climate information.
- In close cooperation with the World Climate Data Programme, improve access to data representing the individual components of the climate system and the factors having influence on climate.
- Establish a cooperative international analysis and research program designed to reach a scientific consensus with regard to the observed global climate trend as represented by such parameters as the surface air temperature, precipitation, and the mean sea level.
- To increase the understanding of the processes having influence on climate, and to develop more realistic methods for their parameterization.

- To develop a hierarchy of numerical climate models capable of simulating and predicting climate on time scales ranging from one month to decades or longer.

The Five-Year Plan states that collecting, archiving, and disseminating primary atmospheric and oceanic observations is an important public responsibility and largely rests with the federal government.

In 1989, the National Climate Program Office distributed a draft Nationwide Climate Services and Applied Climatology Plan that recommended significant planned actions that would be accomplished by the National Climatic Data Center, the Climate Analysis Center and the Regional Climate Centers. The plan was never implemented in NOAA.

Recognizing the need for a coherent and coordinated climate services program, NOAA has established a strategic objective to "build a climate services program based on near-real-time climate monitoring, diagnostics, prediction, and the distribution of climate products and information". (NOAA Annual Operating Plan, FY1990). To meet this objective, the first meeting of the Climate Troika (May 22-23, 1990 in Asheville, NC) directed that a NOAA Plan for Climate Services be prepared, defining the vision of an ambitious program and identifying the mission and responsibilities of the components.

B. Climate Services

Climate Services is the acquisition, archiving, indexing, retrieval, quality assessment, evaluation, synthesis, interpretation, and dissemination of climatic data and information. In essence, it is the system by which we acquire, archive, and analyze climate data for research regarding the state of the climate system, the impact of climate and climatic change on society, and for decision-makers at all levels of the economic and political system. A key element of the service is the synthesis of the climatic data into information. Climate services include the following:

- Ensure the nation's climate data requirements are met, including the integrity of the data.
- Collect, quality control, archive, and disseminate climate data.
- Interpret and translate climate data into information for policy-makers and decision-makers in the nation's economic sectors.
 - Includes implementation of the National Climate Information System (NCIS). (See Appendix B)
- Census of climate.
- Applied research to support climate information services.
- Maintaining a continuous watch on short-term climate fluctuations, and trends, diagnose and predict them.
 - Includes implementation of the Global Climate Perspectives System (GCPS). (See Appendix C)

- Medium- and long-range predictions of climate anomalies/and trends.
- Interpretation of observed and predicted anomalies and trends for policy- and decision-makers.

C. NOAA Roles

Because of NOAA's unique history regarding the provision of weather and climate services and its statutory requirements regarding climate and information, a coherent, coordinated, and well managed NOAA climate services program is the only way to fulfill adequately NOAA's responsibilities.

Department of Commerce Department Organization Order (DOO 25-5, dated March 3, 1989) states that NOAA shall:

- Manage receipt, processing, archiving, dissemination, publication, and application of climatological, geophysical, oceanographic, and environmental data.
- Encourage international cooperation and participation in NOAA's environmental satellite and data archiving programs.
- Determine requirements and develop long-range plans for satellite-based earth remote sensing systems and for data management.
- Provide weather forecasts, hydrological and climate data products and warnings of severe weather to government, industry, and the general public.
- Analyze and project short-term climate fluctuations on a regional and worldwide basis.
- Identify significant climate anomalies and provide current information on them to users coping with associated climate problems such as energy, food supply, water resources, and health.
- Perform research and development to improve its meteorological, oceanographic, and climate products.

The DOO also states that the NOAA weather services system shall consist of monitoring and predicting the state of the atmospheric and hydrologic environment.

D. Goals and Objectives

The goal of a climate services program in NOAA will be to provide to a broad and diverse audience, timely and high quality climate data; and to pursue research to generate information on the current and near-future states of the climate including the impacts of climate on the environment and economy of the nation.

The dimensions of a climate services program in NOAA that will appropriately address this goal leads to the identification of several specific objectives.

- Responsive to the user community and the public sector, private sector, and research sector.
- Provide timely, reliable, and consistent information on the state of the atmosphere for use in research, management, and public policy making decisions.
- Improve the economic productivity, efficiency, and cost effectiveness of U.S. agriculture, commerce, and industry through enhanced use of climate information.
- Describe the climate of the United States.
- Monitor the fluctuations and trends in climate over the globe.
- Be a clearinghouse of sources of the nation's climate data, and ensure the integrity and accessibility of climate data of NOAA.
- Perform predictions of the state of the climate system.
- Improve the management of natural resources through improved use of climate data and information.
- Assess the impact of climate including its fluctuations and trends on physical systems and society including research to define climate impacts.
- Perform climate diagnostics research to improve capabilities of understanding and predicting on the short-term the climate system.
- To preserve the climate records of the country.

The future holds major challenges and great opportunities for a strong climate services program. As we enter the 1990s, the nation faces ever more limited natural resources, greater environmental stress, and major financial problems. As a result, the nation needs to find ways to increase productivity and manage natural resources in a more efficient, lower cost mode than ever before. There is great potential for gaining these advantages in the weather sensitive sectors of the nation by having a well functioning climate services system. For example, large agricultural subsidies exist and are of great concern, and part of this federal assistance goes to address production uncertainties due to seasonal and annual weather aberrations. Better climate information, more timely and with greater predictive accuracy, from a climate services program will, over time, remove some of the uncertainties and dependence on federal subsidies in both the agricultural and water management sectors.

A broad goal for an improved climate services system with extensive user interfaces and a strong information transfer program, is to achieve the economic and environmental benefits that can result from use of climate data and information. Congress, in enacting the National Climate Program in 1978, recognized this opportunity. Now, in 1990, with growing fiscal problems and environmental stress, the wise use of enhanced climate information provides one relatively inexpensive means to make better decisions and thus help maintain and increase the economic competitiveness of the U.S.

II. Existing Problems and Issues

A. Collection of Quality Climatic Data

The "Climate Networks" of the United States and the data they produce are largely for the purposes of weather analysis and forecasting. These networks, for climatic purposes, are beset by an ever growing set of problems, largely deriving from a series of management decisions made over the past 15 years. After the termination of the State Climatologist Program in 1973 and the closing of the Office of Climatology, agency attention to the climate networks and their data has greatly lessened. Budget cuts in recent years have reduced field and office personnel, and have limited equipment development, station maintenance and station replacement.

The problems are numerous. Servicing of the cooperative observer network is now so infrequent that there has been a major increase in missing data, and volunteer weather observers have quit and replacements are not found for months, if at all. Many cooperative weather stations, the backbone of the temperature and precipitation network of the nation have been closed. Many first-order stations with quality records of all weather elements dating since the early 1890s have been closed (Walla Walla, Red Bluff, Atlantic City, Haver, Cairo, etc.). The number of cooperative weather stations measuring precipitation has declined from 8,700 in 1967 to less than 7,000 by 1989. In the last three years, 50 of the 1,200 "historical climatology network" volunteer stations, those identified years ago as key long term sites, have terminated operation without any effort to reestablish them.

New instruments developed to record rainfall and to record maximum and minimum temperatures have frequently malfunctioned causing enormous losses of data. Assessment of the new system adopted for measuring high and low temperatures reveals that since 1983, 1,830 of the 2,840 systems installed have failed, leading to large amounts of missing temperature data. Forty percent of the hourly rainfall data has been lost by poor raingage performance. Inconsistent observation times due to lack of standards creates incompatible data for studying climate trends and changes.

Twenty years ago NOAA established a "climate benchmark network," 20 stations carefully selected at remote sites and well instrumented. Lack of attention to this network has caused two stations to close and the data from many of the others has become suspect.

Further, means of transmitting these data that are the core of the climate system have not improved. Most data are in paper form and are handled through routine mails. In the central region, the National Weather Service has established a computer-based system for rapid daily movement of extensive weather data for ready access, but this remains the only quality data transmission system in operation. Ironically, at a time of great national and international concern with climate, NOAA's networks collecting critical climatic variables have declined in number and quality, and amount of missing data has increased dramatically.

B. Collection of Critical Climate Variables

The historical climate data base has largely derived from observational networks and systems which were established for other purposes, notably the support of weather analysis and forecasting activities and hydrologic monitoring and forecasting. This "poor cousin" role for climate data is incompatible with the high priority the nation now places on the problems of climate variability and climate change. Thus steps need to be taken to support, in their own right, the climate data systems and networks.

Climate involves the entire earth system - ocean, atmosphere, the land surface, and the interlacing biogeochemical cycles. There has been a tendency to place a lower priority set on the acquisition and assemble of data that are not a part of the land surface standard weather observations network. A case in point is the surface marine observations obtained from transient merchant ships. There is no effective substitute for these data - they are essentially the only information for describing past surface climate variability over more than two-thirds of the earth's surface. Because of the low priority and associated inadequate procedures of the past, this data set has many problems. These include poor documentation, errors in the data and difficulty in identifying duplicate observations. Only during the past decade has action been taken to effectively merge the inhomogeneous national collections of ship observations into a coherent global data set. Even so, this work is done on an "ad hoc" basis, with marginal support, and not all the potentially available historical data has been assembled.

The data from the land surface climatological network are the backbone of the historical data base used for making judgments regarding the nature of regional climate variability and the evidence for climate change. It is a multi-purpose network, marginally financed by a variety of user agencies and groups, with different objectives and priorities. The U.S. climatological network has been largely maintained by non-professional voluntary observers. Support of the network has been increasingly difficult to maintain in the face of requests for financial support for new and expensive climate data acquisition systems which may supplement but in no way replace these data.

With the increasing concern and emphasis on environmental problems and climate change, there is an ever increasing need for the routine monitoring and archiving data for a much wider variety of climate system parameters than has

been the case in the past. Considering the problems which have developed with the more conventional climate data change networks and collections, bases, it seems imperative that steps be taken as soon as possible to assure the integrity, continuity, and availability of the climate data base.

C. Data Management and Quality Control

The management of climate data has become increasingly complex as new automated high volume observing systems replace traditional manual systems. First, these new systems have necessitated a change in the concept of processing data for the climate data base. New automated observing systems have made it possible to effectively quality control data for random errors on site, leaving the more complex quality control to identify systematic errors and biases to the NCDC. Second, the data from the new systems must be integrated with the historical data, and third, the requirements for accurate homogeneous long series data sets on a national, regional and global scale is placing an additional demand on data management and user services that may require the reprocessing of entire long-series data bases.

The subject of climate data management is currently being addressed within the draft Program Development Plan for NOAA's Earth System Data and Information Management Program and will not be addressed directly in the Climate Services Plan. There will be a need to ensure that the two plans are coordinated before implementation.

D. Access to Archived Climate Data and Information

Assessments of climate users over the last ten years revealed the extensive needs, and yet limited availability of "near real-time climate data and information." This form of climate information are values from extensive climate networks updated daily or weekly. These data, with limited quality control, are made available along with historical data to users over computer-based systems and various computer type linkages. Technology has made it possible, and at relatively low cost, to combine yesterday's weather data with climate data of past days, weeks, months, years, and decades to form a variety of products for operational decisions and assessments of anomalous climate events. A vast amount of climate information such as year-to-date summaries of growing degree days, heating degree days, soil moisture conditions, crop yield models, and basin runoff models can be quickly determined and provided. However, very little progress has been made in implementing such systems, both for collection and transmitting the data, and developing the systems needed. Two regional climate centers have developed prototype systems, and the Climate Analysis Center provides near real-time information based on limited stations throughout the nation. However, much more needs to be done to establish a nationwide system with sufficiently dense data, user-oriented products, and easy and relatively inexpensive access.

The NOAA goal of accessibility of reliable data and information to the scientific community, the government and the private sector is being addressed in the draft Program Development Plan for NOAA's Earth System Data and Information Management Program. If this plan is not adopted, the Climate Services Plan will have to be modified to address this subject.

E. Lack of Interface With Users of Climate Data and Information

NOAA's approach to the large and diverse community of users of climate data in the public and private sectors has been reactive and generally only partly responsive. Weather data, edited and archived, typically took three months to become available in the national archives for user access. For many years the user community has been complaining of the lack of timeliness of data and information but little has been done. Facilities allowing easy and rapid access to climate data are inadequate and antiquated. In general, the system is geared to provision of data to a user community which has not real urgency. Even there, however, inventory reveals that more than 100,000 requests for historical data at NCDC go unanswered because of a lack of personnel to answer telephone calls and handle customers.

Most climate products (publications) generated as climate information are simple listings of historical daily, monthly, and annual values with period of record extremes and averages. There has been no publication of a U.S. Climate Atlas since 1960. There is little user assistance at the state level except in those states with viable state climatologist programs (state funded). At the local level, meteorologists at first order stations provide as time permits, the public with climate information they have time for and understanding of.

The problem of understanding and addressing user needs is partly due to lack of knowledge of how climate-impacted sectors obtain and use climate data and information. A few recent studies of agribusiness have revealed that the low use of climate data related to a lack of knowledge as to where to obtain data, questionable data, and the fact that the data available does not address many needs of the industry. Limited user assessments also revealed that some of what was needed was available, but not in a timely mode. A lack of research to define the climate-effect relationships has limited knowledge of what types of products need to be presented beyond simple climate statistics. User analyses have also shown a great willingness to use climate probabilistic information for decision making relating to future events, but there is a lack of this type of information in readily available formats. Better understanding of the user is essential to improved services.

F. Differences in the Research Community

Broadly speaking, there appears to be a tendency for climate research activities to be polarized around two separate communities. We will refer to these two communities as the "big science" and "applied climatology" communities. Each community has developed its own conceptual framework and priorities during the past quarter-century, and the interface between the two communities has not always been smooth. A lack of common goals and interests has too often resulted in poor communications and competition rather than cooperation.

"Big science" climate research had its ancestry in GARP and the WCRP, and is now largely under the umbrella of Global Climate Change. It is globally oriented, with a strong emphasis on climate dynamics, physical/numerical models and prediction. "Applied climatology" had its ancestry in the old USWB Office of Climatology, then the Environmental Data and Information Service (the EDIS that was later merged with NESS to form NESDIS), and most recently under the

umbrella of the NCP Act. Activities of this community are regionally oriented, and oriented toward empirical/statistical analysis and models, and socio-economic application and impact assessment.

We believe that it is correct to say that the applied climatology community has emphasized the value of current climate information and associated climate impact over climate prediction at its current level of skill. Thus, there seems to be a feeling in this community of being more closely related to current "practical" climate services, while the big science community is more focused on future possibilities. A comprehensive and effective NOAA Climate Services Program must both support and be supported by both research communities. For this to happen, the interface between the two must be strengthened, or better yet, disappear entirely.

Like all idealizations, this division is far from clear cut. In particular there are elements in NOAA such as the CAC with a foot in each community. These

units can serve as bridges and linchpins in the development of the smooth interface needed for an integrated and comprehensive NOAA Climate Services Program.

Close links are required between the "big science" and the service elements of NOAA in the planning, implementation and evolution of climate research programs. Current examples are the TOGA Program, and the emerging international GEWEX Continental Project (GCP) and the NOAA Global Precipitation Project (GPP) now being developed under the Global Change umbrella.

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G. Management Problems

1) Key components of NOAA's current climate services program are not integrated into a coherent/coordinated program and are managed by disparate organizations with a wide range of missions, goals, objectives, and problems:

- Observations required to describe the climate of the United States are specified by the National Weather Service whose requirements are dominated by operational concerns.

- The observation network is operated and maintained by the National Weather Service.

- Climate predictions are performed by the Climate Analysis Center.

- Climate anomaly detection is performed by the Climate Analysis Center, the National Climatic Data Center and the Regional Climate Centers using observations collected for operational programs.

- Climate data quality control, archiving, and dissemination is performed by the National Climatic Data Center and the Regional

Climate Centers with some front-end quality control being performed by the NWS.

- Some climate data dissemination performed by the NWS.
- Climate information is provided by the National Climatic Data Center, Climate Analysis Center, Office of Climatic and Atmospheric Research, Office of Hydrology... and the Regional Climate Centers.
- Coordination of the Regional Climate Centers and the National Climate program has been under the direction of the National Climate Program Office.
- Climate research is directed by ERL.
- New program development plan for NOAA's Earth System Data and Information Management Program specifies that the Office of the Chief Scientist will manage the program.

In summary, the best that can be said is that there is no unified planned system.

- 2) Key components of the current NOAA climate services system are attached to NOAA line components where they are viewed to be distractions rather than an integral part of NOAA's mission.
- 3) While the overall responsibility for basic climate research is in the Office of Climate and Atmospheric Research, it is not clear where the ultimate responsibility for climate services and related research lies, how NOAA determines that its responsibilities are being met, or to what extent gaps and overlaps exist.
- 4) An organized climate services plan has not been developed since 1974 when NOAA published the Federal Plan for National Climatic Services (FCM 74-1, dated January 1974). Thus, there has not been any discussion of what needs to be done in climate services and what is the cost.

H. Inadequate Funding

Underlying many of the above problems has been a lack of funds to sustain and maintain the climate data collection, to enhance climate measurements of new atmospheric variables, to adequately quality control, to archive data, and to provide means adequate to access climatic data and information. A recent assessment (MacDonald, 1989) revealed that to properly collect data from the cooperative observer network, to reestablish the national benchmark network, and to provide a computer based system for rapidly gathering daily precipitation, daily data from cooperative observer stations across the nation would require an additional \$5 million expenditure. This analysis assessed the roles of the Regional Climate Centers in providing climate services and revealed a need for \$3.8 million for these centers to perform the services needed. A computer-based

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communication system linking the Regional Climate Centers, NCDC, CAC does not exist and will require \$1.5 million to be installed and brought to operational status. Enhancement of the facilities needed at CAC and NCDC to bring them to state-of-the-technology or climate data archival and access is assessed at \$4.8 million.

NOAA's climate services system, ranging from data collection through quality control, archival, and access, is under funded by \$15 to \$20 million. Furthermore, there needs to be greater attention to product development and user interfaces. This will include applied research involving study of climate effects to help guide product development. These new efforts will cost roughly \$8 to \$10 million per year.

III. PROPOSAL FOR AN OFFICE OF CLIMATE SERVICES

In the late 1970's, at the time of the passage of the National Climate Program Act, NOAA management realized that a consolidation of climate services would enhance the agency's ability to provide climate information and other services to the nation. Accordingly, the Climate Analysis Center was formed by assembling groups whose activities has previously been spread between EDIS, NESS, and NWS. In addition, a number of new CAC positions were earmarked for expansion of climate prediction and diagnostic activities. This action in 1979 was an incomplete move in the right direction, and well short of the comprehensive climate centers subsequently formed in Canada and Australia. We believe the time is overdue to complete the consolidation of climate services begun with the formation of the CAC, and propose the establishment within NOAA of an Office of Climate Services. Our reasoning derives from the belief that NOAA needs a "National Climate Service" analogous to but distinct from its NWS and NOS.

In terms of generic activities, there are many similarities between a National Climate Service and a National Weather Service. Both are focused on day-to-day service activities, and require a basic data and communications infrastructure and strong interfaces with the public and with research groups. Both carry on the degree of applied "mission-oriented" research needed for technology transfer and the direct support of their service activities. Neither is directly involved in basic research, except in a strong support role.

In the past, many have viewed climate services as simply a part of weather services. If this view were ever valid, it certainly is not valid today. The objectives, products, activities and approaches of the two services differ in fundamental respects. Weather is a highly perishable commodity, and yesterday's weather and forecast is normally of little interest. The emphasis in a weather service is on real time monitoring and short range, categorical forecasts. Prediction is at the heart of weather services, so much so that the dissemination of information on the current weather has come to be called "nowcasting".

The improvement of weather forecasts and real time monitoring of weather is of primary interest to the weather service. Continuity and homogeneity of the observational record and analyses is of secondary interest to their primary mission. They are primarily a provider rather than a user of climate information.

Modern climate services must deal with diverse aspects of the climate system, and thus has evolved into far more than the description and prediction of "the expectation of weather". Since it depends in a fundamental way on the ability to define departures from some sort of base period statistic, and deals with longer time scales than day-to-day weather changes, the homogeneity and continuity of the climate data base is of fundamental importance. This places requirements of operational weather activities.

With this background in mind, we visualize an Office of Climate Services which would have overall responsibility for the climate services program of the agency. It would have both management and staff responsibilities. The staff activities would include activities aimed at strengthening the interface with state/regional organizations and with the science/research community, as well as international activities pertinent to the maintenance and improvement of climate services. The office would seek guidance from three advisory groups, one dealing with the external public and private user community, another dealing with the external scientific community, and a third an internal NOAA advisory group.

We visualize four operating divisions of the climate services organization: (1) Data and Information Centers, (2) Operations and Services, (3) Product and Technique Development, and (4) Climate Data Collection.

The existing core for this organization consists of the CAC, NCDC, and possibly all or parts of some of the other data centers. It may also include other NOAA elements which may be suited for the organization. It would also be necessary to augment existing activities, primarily in the areas of Product and Technique Development and Collection of Climate data, as noted below.

Anticipated activities are as follows:

A. DATA AND INFORMATION CENTERS

- data archiving
- data retrieval
- clearing house for guidance on climate data/information data not maintained by NOAA.
- data documentation/quality assessment
- data set rehabilitation
- development/updating of benchmark data sets
- development/updating of consolidated data sets (example: consolidated ocean/atmosphere data set (COADS)).
- development of data/information transfer linkages with other service elements.

B. OPERATIONS AND SERVICES

- near real time diagnostics and prediction
- impact assessment (limits to be carefully defined)
- regional "value added" data/information through regional climatic centers
- development of real time computational/data links.

C. PRODUCT AND TECHNIQUE DEVELOPMENT

- mission oriented research and development
- technology transfer of research results (both NOAA and external)
- development of improved user interface (public/private, intra-NOAA, interagency)
- support and monitoring of extramural mission-oriented research

D. CLIMATE DATA COLLECTION

- This represents a new activity whose mission is to assure acquisition of the data required to satisfy the climate services responsibilities of NOAA. It will be concerned with:
 - the establishment and maintenance of climatological data networks
 - the quality assurance, continuity and homogeneity of remotely sensed climate data
 - global data acquisition

IV. IMPLEMENTATION AND ELEMENTS OF NOAA'S CLIMATE SERVICES PROGRAM

A. MAJOR ENTITIES

1. Office of Climate Services

The Office of Climate Services would have overall responsibility for the climate services program of the agency. It would have both management and staff responsibilities. The staff activities would include activities aimed at strengthening the interface with state/regional organizations and with the science/research community, as well as international activities pertinent to the maintenance and improvement of climate services. The office would seek guidance from three advisory groups, one dealing with the external public and private user community, another dealing with the external scientific community, and a third in an internal NOAA advisory group.

The existing core for this organization consists of the CAC, NCDC, RCCs, and parts of some NWS cooperative network activities. It may also include other NOAA elements which may be suited for the organization. It would also be necessary to augment existing activities, primarily in the areas of product and technique development and collection of climate data, as noted below.

2. National Climatic Data Center

The National Climatic Data Center has the principal responsibility to manage the national climatological data program, to include data and information services. To meet the responsibility, the Center:

- Performs all data management functions regarding data acquisition, archiving, retrieval, indexing quality assessments, evaluations, synthesis, dissemination, and publication of data from global and national observation networks that have enduring value to the Nation and are sufficient to describe the climate;
- As a designated agency Federal Records Center, operates the Center for NOAA for processing, storage, and servicing of retrospective meteorological records;
- Prepares and provides special products and services to users as required as a basis for regulatory standards and policy decisions;
- Develops and maintains national and global data bases for analyses of long-term climate trends and for monitoring global change;
- Describes the climate of the United States;
- Provides facilities, data processing support, data exchange, and expertise, as required, to meet U.S. commitments to foreign nations, international organizations, and to the World Meteorological Organization's programs. In this capacity, NCDC operates the World Data Center-A for Meteorology under the auspices of the International Committee of Scientific Unions.

The modernization of observing networks with the use of new technology and the increased concern on global climate change throughout the world have increased the challenge of managing climate data and serving the research community. To meet this challenge, NCDC will be focusing on the development and implementation of new data processing systems to adapt for the processing of data from the use of new technologies in observing meteorological variables; and to prepare and structure baseline data sets to meet the national needs for monitoring climate change.

3. The Climate Analysis Center

The Climate Analysis Center (CAC) formed within the National Meteorological Center, constitutes a major new element of the NOAA Climate Program. It's mission is to maintain a continuous watch on short-term climate fluctuations and to diagnose and predict them. These efforts are designed to assist agencies both

inside and outside the Federal Government in coping with such climate-related problems as food supply, energy allocation, and water resources.

The CAC consists of three Branches: (1) the Analysis and Information Branch which collects and analyzes data to depict the current state of global and regional climate. It includes the Agricultural Weather Section, which constitutes NOAA's contribution to the Joint Agricultural Weather Facility located at the Department of Agriculture; (2) The Diagnostics Branch which performs studies of recent climate fluctuations and climatic processes to achieve improved understanding of the behavior of the climate system with the ultimate goal of improving prediction; and (3) The Prediction Branch which makes and verifies monthly and seasonal forecasts, and undertakes research and development work to improve and extend the range of predictions of climate fluctuations.

The CAC supports research and development studies in climate diagnosis and prediction at universities, private research organizations, and other government agencies. CAC also sponsors an annual Climate Diagnostics Workshop, usually in cooperation with a university climate research group. At each Workshop, the past year's climate fluctuations over the globe are analyzed and new developments in analytic and predictive techniques are discussed.

4. Regional Climate Centers

Regional Climate Centers are to be maintained at six cooperating institutions throughout the nation to serve the regional needs for data management, climate services, and applied research of the National Climate Services of NOAA. The objectives of the Regional Climate Centers are to perform information and educational services, conduct applied climate research, maintain and manage data bases, and to communicate with user communities. These centers serve at the interface between the collection and archival of climate data, and the users of these data and derived information. The centers have widely diverse interactions with the states in their regions, with private companies, with federal agencies having offices in the region, and with the other elements of the climate services program.

Within the information-educational services, specific activities include the preparation of publications including those with other elements of the program, issuance of monthly summaries on key climatic conditions and impacts, conduct of workshops and conferences on regional climate issues, provision of constantly updated climate data and information geared to regional issues, and the expertise to respond to diverse requests for information on climate.

The centers encourage and perform applied climate research that focuses on regional issues and climate impacts, climate change and climatic fluctuations that have regional relevance, and on special climate anomalies such as drought. The regional centers are to acquire, develop, and manage specialized, high quality historical data sets of NOAA and other federal agencies. They also serve as a clearinghouse for other state and federal climatic data sets, and provide data in uniform formats useable for all other climate centers in the system. Central to their role in the NCS, the regional centers provide expertise to perform the above functions, to work closely with state and federal agencies, to work with the private sector, and to establish and utilize advisory bodies from

the region. The regional centers are networked to all other NOAA climate centers through a NSFNET to facilitate the rapid movement of large volumes of climate data and information.

5. Office of Product Development

A central objective of the National Climate Services is to perform services that include products that are state-of-the-science and user oriented. The objective of this office, which represents a new activity for NOAA, is to provide for technology transfer of climate information and outreach to the user community.

To improve services and product development, this office will pursue activities under three major functional areas: a) user liaison; b) product assessment; and c) research and development. Activities under user liaison are to focus on both the public and private sectors. This effort embraces a user interface through the regional climate centers, and interacts with state climatologists and the private sector entities that provide climate information. One of three advisory panels that will advise and interact with the National Climate Services Program will specifically address the needs of this office, that being the Panel of External Users. This panel will be drawn from both the public and private sectors with the express purpose of reviewing NCS products, commenting on NCS programs, improving means to interact with the user community.

Product assessment will involve measurement of usage of existing products. In-depth assessments of product requirements will be conducted. Interactions with the atmospheric sciences community will be used to assess the adequacy of climate data and its accessibility to them.

The third function will be to design and conduct research, both internal and external, to better understand the effects of climate on natural systems and on the economy of the United States. It will be important initially to assess the applied climate research efforts of NOAA and other federal agencies in developing a research plan and detecting areas that need research attention. The primary benefit of this research program will be to develop new assessment methods and devise new climate products of the NCS.

6. Office of Climate Data Collection

This office is a new institution. The objective of this office is to ensure data, adequate to describe the climate of the United States, are collected. It will incorporate elements of the National Weather Service and activities at the NWS regional offices that relate to certain field activities such as the cooperative observer network, plus the NCDC benchmark network. In the past, most data collected and used for climate studies have been driven by 19th Century concepts of climate (precipitation and temperature measurements) and by 20th Century needs for data for aviation and weather forecasting. This office addresses the broader needs of defining the climate of the nation on the types of measurements of conditions currently being observed and not observed in the United States.

The activities of the Office of Climate Data Collection will fall in three general functional areas: a) existing networks and systems used to collect weather data used in climatic studies; b) the needs for new types of data coming on line or not being measured; and c) methods of transmitting raw data. Particular attention will be given to the collection of data in the cooperative observer network of the country to stabilize the number of stations, instrumentation, and field maintenance of the network. The climatic benchmark network will be rehabilitated and operated through NWS field offices. Other existing networks such as the upper air network and recording raingage network will be assessed as to climatic data requirements. Particular attention is to be given to satellite data for its applications to meet climate needs. This office has the responsibility for reporting these needs to other elements of NOAA.

The advent of the new weather service with new instruments including sophisticated radars offers an opportunity and requirement to decide how these data from these systems will be best utilized for the needs of climate measurement. This office is to assess these data systems and provide guidance to NWS and NOAA on these issues. Furthermore, this office will work with the scientific community to assess the needs for measurement of climatic atmospheric conditions currently being poorly measured in space and time, or not measured at all. This office will work closely with the external research panel, to be established under the NCS program.

A third functional activity relates to assessing means of transmitting "weather data" to regional and national archives to serve climatic purposes. The great needs for near real time climate information impact the process of data transmission. This activity will be addressed through interactions with NWS and the NOAA advisory panel, to be established to serve NCS. It is very important that the atmospheric sciences community, and in particular the Global Climate Change program, have close interactions with this office to provide guidance and information about the existing networks, about data needs, existing networks, and new data collection systems. The external research panel and NOAA advisory panels will both be heavily involved in providing guidance to the activities of this office.

B. Institutional Structure and Program Management

The National Climatic Services (NCS) will be established within the National Oceanic and Atmospheric Administration. The NCS will link domestic producers and users of climate services through data management, analysis and delivery. The NCS will incorporate internal (NOAA), and external feedback groups to keep the system responsive to the needs and opportunities for services.

There will be established within the National Weather Service, a National Climate Service. The Director of the National Climate Service will serve under the direction of the Director of the National Weather Service. The NCS Director will direct, monitor, and set priorities for programs and budgets for all program elements of the NCS. The NCS Director will ensure close cooperation of the NCS with other elements of NOAA and federal agencies heavily dependent on climate data including the USDA, USGS, DOE and EPA.

Two advisory groups consisting of (a) external users from the public and private sector of climate data and information, and (b) members of the atmospheric sciences community including basic and applied research will be established to provide guidance to the NCS. The NCS will also have a NOAA group composed of leaders from each major administrative office.

The National Climate Service shall consist of six major elements/offices as follows:

1. The Office of Climatic Services to direct and administer the NCS and to handle various staff functions including international issues.
2. The National Climatic Data Center
3. Climate Analysis Center
4. Regional Climate Centers (contract funded at state/university institutions).
5. The Office of Product Development
6. The Office of Climate Data Collection

All program elements will:

1. Interact as appropriate with local, state, and federal agencies and private sectors entities that use and/or generate climate data and information.
2. Maintain a nationwide system for the high-speed transmission of large volumes of climate data and information.
3. Utilize uniform formats for the storage and retrieval of selected climatic data sets.
4. Establish and maintain oversight panels that advise, review, and assess the program's performance.

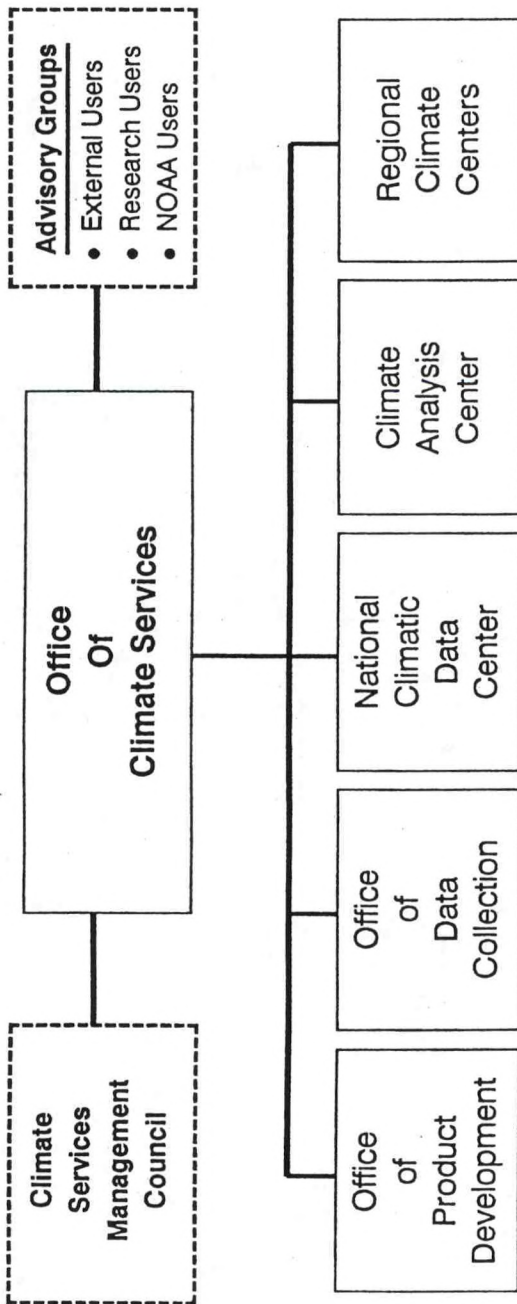
C. Budget

Office of Climate Services	\$1,000,000
NCDC	\$15,000,000
Climate Analysis Center	\$9,000,000
Regional Climate Center	\$4,000,000
Office of Product Development and Research	\$4,000,000
Office of Climate Data Collection	<u>\$9,000,000</u>
TOTAL	\$42,000,000

D. Authorization

(To be considered.)

NOAA CLIMATE SERVICE



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APPENDIX A

NOAA CLIMATE SERVICES PLAN

RECOMMENDATIONS REGARDING CLIMATE SERVICES

This appendix contains excerpts from a series of recommendations made over the past decade regarding climate information and services. The one theme pervading all of these workshop and panel recommendations is that there is an urgent need for a nationwide integrated climate services system. This key recommendation has never been implemented within NOAA which is the major player in climate services in the United States. As a result, the nationwide climate services system has never been implemented.

National Climate Program:
Five Year Plan 1989-1993

Major objectives for the next five-year period are:

- a) To create an integrated climate information system permitting an easy access to the data specifying the climate system and the factors having influence on climate.
- b) To provide climate data products and services aimed at a wide-spread utilization of climate information.
- c) To reconstruct past climates and to detect any changes in the current state of the climate system.
- d) In close cooperation with the World Climate Data Programme, improve access to data representing the individual components of the climate system and the factors having influence on climate.
- e) Develop improved methods of extracting information on climate parameters from operational satellite sensors, and programs for calibrating and validation in order to ensure consistency in long-term research data sets.
- f) Recompute the analyses of data obtained during the First GARP Global Experiment (FGGE) 1978-1979.
- g) Encourage the private sector to develop climate products, and to increase the level of awareness of the availability of climate information and products.
- h) Conduct a numerical experimentation program involving long-term integration of global atmospheric models in order to determine the feasibility of predicting certain large-scale features of the atmospheric circulation beyond the range of deterministic prediction.
- i) Routine production of experimental monthly climate forecasts for diagnostic studies.

National Climate Program:
Five-Year Plan 1989-1993
U.S. Department of Commerce
December 1988

The National Climate Program:
Early Achievements and Future Directions

Excerpts pertinent to climate services:

- An organized system of climate services must be set in place, supported and maintained. It is especially crucial that the governmental components of this system be structured in an efficient and straightforward manner and that their roles and responsibilities be well defined.
- NOAA should act quickly to modernize its capability to manage the national climate data resources by providing sufficient support to do the following:
 - a) Perform research and development of new technologies for collecting, validating, storing, retrieving, and communicating data.
 - b) Develop clear standards for data collection, quality control, archiving, and dissemination.
 - c) Ensure the continuity of key climate networks, including the cooperative observers, surface synoptic stations (including marine), and the solar radiation sites.
 - d) Develop adequate automated data processing and communication networks to meet user service requirements.
- Data management issues requiring attention include the following:
 - a) Timely release of data collected at public expense after the use for its collection is met.
 - b) Easy access, by other users and researchers, to data used in preparing climate products and reports for public dissemination.
 - c) Data management to handle increased data loads.
 - d) New instrumentation requires adequate documentation, calibration, and possible changes of quality control procedures.
- A new climatic atlas is needed to provide a comprehensive updated climatology of the United States, and as a related effort to the World Climate Impacts Program. The atlas would emphasize climate-society interactions and provide practical information needed for planning by federal, state, and local agencies and for commercial and business uses. The atlas should be developed in coordination with the 1990 census and should have the same population reference base.
- Studies of the utility of climate predictions should be undertaken.

- Empirical studies of the impacts of actually experienced climatic variations should be expanded; scenarios of likely future climate changes should be incorporated into long-term water resource and environmental planning.

The National Climate Program:
Early Achievements and Future Directions
Report of the Woodshole Workshop, July 15-19, 1985
National Research Council
National Academy Press, 1986

Atmospheric Climate Data - Problems and Promises

1. The federal government should clearly articulate an integrated national policy covering its obligations and limitations in:
 - a) The observation and monitoring of the weather and climate.
 - b) The collection, processing, and management of weather and climate data.
 - c) The retention and archiving of climate data.
 - d) The provision of weather and climate information and services.
2. The federal government should recognize the users' need for a continuum in the management of weather and climate data, NOAA should therefore reassess its existing institutional arrangements with the objective of improving the coordination of weather and climate data archives.
3. NOAA should establish a central data officer for weather and climate data with a clear mandate, broad authority, and sufficient resources to:
 - a) Conduct systematic and impartial studies of requirements for weather and climate data and of new techniques for efficiently meeting these requirements.
 - b) Coordinate planning for new weather and climate data management, communication, and dissemination systems throughout NOAA.
 - c) Develop clear standards for data collection and instrumentation, consistent and efficient quality control and cost effective data archiving and dissemination for basic observations, derived parameters, gridded data, and special purpose data sets such as those obtained in field experiments.
 - d) Ensure the continuity, careful management, and coordination of key climate networks, data bases, and publications, including the cooperative and baseline observing networks.
 - e) Act as coordinator and arbiter in decisions concerning resource allocation, technological modernization, and data preservation, both within NOAA and in cooperation with other agencies, and serve as a focal point for coordination with the World Weather Watch program of the World Meteorological Organization.
4. The federal government should increase active promotion of the application of weather and climate data in both the public and private sectors, including continued documentation and demonstration of the broad utility and value of such data.

Proceedings of the Conference on Cooperative Climate Service

Recommendations

The workshop conferees addressed a general recommendation to NOAA:

In recognition of its responsibility to maintain the national climate data base, NOAA should make policy and program commitments 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 Climate Data Center programs. NCDC/NESDIS should make its operational data management 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.

Proceedings of the Conference on

Cooperative Climate Services:

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

Rockville, MD October 1983

Meeting the Challenge of Climate

1. As part of the second phase of its five-year program, 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 local, private-, and public-sector experts, state and regional programs and the federal government.

2. The National Climate Program Office should take the lead in coordinating federal-agency participation in the climate-services system and in federal-cooperative efforts.

3. In the third phase of its five-year program the National Climate Program Office should focus on incorporation of state and regional climate programs into the nationwide climate services system.

(Note: The primary incentive for participation should be the benefits that state or regional climate programs would derive from an active and effective system of climate services.)

Meeting the Challenge of Climate
Panel on Intergovernmental Climate Programs
National Research Council
National Academy Press, 1982

Managing Climatic Resources and Risks

1. An interagency coordinating group led by the National Climate Program Office (NCPO) of the National Oceanic and Atmospheric Administration should survey the organizations that gather, process, and/or disseminate climate data and information and establish clear assignments concerning which organizations should be responsible for particular kinds of services.
2. An interagency coordinating group led by the National Climate Program Office should survey and evaluate the use of climate data and information by federal agencies.
(Note: The purpose is to examine the current and potential uses of climate information in terms of specific requirements, costs, and benefits in order to gain knowledge about how climate information is being, or could be, used. The federal government is the largest single user of climate information.)
3. The National Climate Program Office and other federal agencies should expand and strengthen networks of local experts and improve representation of user interests throughout the climate-information system.
4. The National Climate Program Office and other federal agencies should initiate a variety of educational activities to increase awareness and understanding of climate information.
5. The National Climate Program Office and Other federal agencies should sponsor studies of costs and benefits of climate data and information.
6. An interagency coordinating group led by the National Climate Program Office should take the lead in developing and coordinating guidelines for collecting, analyzing, and storing climate data.
7. An interagency coordinating group led by the National Climate Program Office should take the lead in developing and coordinating guidelines for presenting and disseminating climate information.
8. Continued efforts should be devoted to improve the timeliness of climate information.
9. Application of new analysis and management techniques to climatic resources and risks should be accelerated.

Managing Climatic Resources and Risks
Panel on the Effective Use of
Climatic Data in Decision Making
National Research Council
National Academy Press, 1981

APPENDIX B
NOAA CLIMATE SERVICES PLAN
A PLAN FOR A NATIONAL CLIMATE INFORMATION SYSTEM

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INTRODUCTION

Climate variability and long term climate change are important factors in the economic and social well being of the United States. Public concerns about global climate change, rising sea level, changes in the frequency of hurricanes, severe winters or record hot summers emphasize that climate is a natural hazard. But climate is also a major natural resource and knowledge of its variability has become an important factor in resource planning, economic development, and human adaptability.

The National Oceanographic and Atmospheric Administration has the responsibility to describe and monitor the climate of the United States and to promote the use of climate information to increase the economic productivity of the United States. Toward this end, NOAA, the National Climate Program Office, and an advisory group of industry, university and private sector contributors propose the development of a major new National Climate Information System (NCIS). The system will describe the climate of the United States, demonstrate the value of climate information for decision making, and initiate a process that would stimulate economic productivity of the United States. The NCIS is conceived as a national product tied closely to the census of 1990. It will be designed to benefit industry, decision makers, educators, researchers, and students and will be organized as a cooperative project between government, industry, and educators.

What is proposed is an innovative and dynamic climate information system, including an atlas series and information disks and software for personal computers that is unlike anything now available. The rapid changes in computer technology and the wide availability of personal computers, point in the direction of a "living atlas" like system. The provision of information products on computer media for interactive use; their tailoring to match specific needs, coupled with routine revision will provide a much needed service and provide a stimulus to all segments of the economy. Much greater amounts of information will be accessed, providing greater detail and greater relevance to decision making than was previously possible. This dynamic approach opens to Americans the vast, relatively unused potential of climate knowledge at a time when it is urgently needed to serve changing social, economic and environmental needs.

A series of Atlas volumes also will be a central aspect of the NCIS. Published atlas volumes designed with wide appeal and user-oriented products will be essential to help focus general user interest, particularly for those without computers, and to gain support for the total concept; books are still an essential entity in developing human resources. Volume 1, the CLIMATE OF NORTH AMERICA: INFORMATION FOR POLICY, PLANNING AND DECISION MAKING, will break new ground in information theory, public dissemination of climate information, and in building bridges with the private sector in advancing the better use of climate information. The other atlas volumes will focus on various sectors of the United States economy (agriculture, energy, water resources, etc.). These will be designed and implemented so that joint federal and industry support can be obtained.

This is a bold, innovative, international and exciting new project. A planning group is now prepared to organize and implement this program.

RATIONALE

NOAA has the responsibility and mission to define the climate of the United States and to make this information accessible to the public and private sector. What is proposed is an innovative climate information system unlike anything now available that will contribute greatly to the economy. The combined printed and digital products of the NCIS will become user friendly documents and tools for accessing and using new information and products. In one creative step NOAA will break new ground in promoting economic productivity, will enhance public awareness of climate information and will develop new tools for education. The Atlas, conceived as a cooperative project with industry and educators, will build new and permanent bridges with various sectors of industry and will broadly meet several of NOAA's key missions (see Table 1).

NOAA, as a lead agency in climate information, needs to assess how its vast data files can best be used to serve society. Information that cannot be accessed in timely fashion or be delivered in a form suitable for use, is of very limited utility. On the other hand, information that is closely tied to the current and future trends of society becomes a living resource. Climate information can be made a living resource; the proposed system will achieve that status by demonstrating its values and by providing new means by which society can access and interact with this information.

DIMENSIONS

The concept of a new and different means for providing climate information to the nation was developed at a meeting in July 1985 organized by the National Academy of Sciences to review the progress and future directions of the National Climate Program. This effort convened 90 leaders in the atmospheric sciences plus state and federal agency representatives and policy makers in the United States.

One of the major recommendations was that the U.S. develop a new form of climate atlas "emphasizing climate-society interactions", seen as much more useful material to government and industry than has been provided in climate atlases published over the past 100 years (National Academy of Sciences, 1985).

As a result of this scientific consensus, coupled with awareness that most citizens lack access to relevant climate impacts information, discussions proceeded inside NOAA and amongst interested scientific and industrial groups over the past 12 months.

Table 1. How the National Climate Information System
Addresses NOAA Missions.

- promoting economic efficiency and productivity by increasing industrial access to climate information.
- making optimum use of over 100 years of climate information in a form suitable for use by the private sector and other Federal agencies.
- providing information required for formulation and implementation of national policies and statutes.
- promoting the development of new climate and climate-dependent products and stimulating markets for the private sector.
- providing a basis for assessing the impact of population changes (1990 census) on climate sensitive economic and social indices.
- establishing a totally new concept of information exchange and filling a gap in access to existing climate information.
- addressing the long-term climate variability and change of the U.S. as a baseline against which to measure potential human impact on climate.
- providing information needed for the rational management of natural resources.
- providing a valuable contribution to the international community.
- demonstrating NOAA leadership in climate services in the United States.
- aiding in the national effort to enhance science education.

This led to the establishment of an ad hoc planning group of experts, and a meeting was conducted at the University of Illinois in October 1986. This 12-person select group (see Appendix) examined the rationale for an atlas-like system, considered its potential dimensions, and developed an implementation plan for a multi-year, climate information system. This document constitutes an initial plan of action that, along with a brochure, should provide sufficient information to allow informed decisions on launching the proposed "National Climate Information System" (NCIS).

Theme

There are twin themes. One theme of the NCIS is that "climate is a national resource and a risk". The information to be presented will demonstrate the linkages between climate, man, and the biosphere. The second theme is that "economic and social well being can be achieved by better information and informed awareness related to the nation's climate".

Concepts

The NCIS planning group identified 12 concepts that address these themes. These encompass the planning and implementation of the System.

- The materials selected would have a futuristic focus with selections based on future trends of North American society (population shifts, aging, more leisure time, etc.). Further, information would be presented, in part, in a time adaptable manner, allowing a change of materials presented over time to address society's ever changing needs for information.
- The system would address a broad audience including a new audience of millions of Americans currently without access to the types of climate information presented; to students from the lower grades through college level; and to specialists from the sectors of our economy effected by climate.
- Information would be delivered in multiple and highly varying formats to address this diverse audience and to allow for myriads of ways to access information including: publications (atlases), floppy disks and software ready for personal computers, magnetic tapes and floppy disks for various larger computers, video tapes, microfiche, and hard copy.
- The system would be the first of a kind for delivering climate information, it is best described as an innovative new means using new technologies to present different types of information based on 100 years of quality climatic data now available in North America.
- The information system, in part, would be a living information resource allowing periodic computer updating of the tapes and disks, and the selection of new climate information as needed.
- Its objectives would be to illustrate how climate conditions, including their variations, impact on man, human activities and the natural environment, and to provide guidance to optimize management and gain economic benefit. Great progress has been made in recent years in identifying the complexity of climate impacts providing an opportunity to be selective in use of remedial measures and policies for the mitigation of hazards and optimization of opportunities provided by climate.
- The system would be developed, and its atlas publications issued, at a time to be commemorative, in line with the 1990 census and the centennial of climate services corresponding to the transfer of the Weather Service into the Department of Agriculture (1891 to 1991).
- The presentation of climate information in a myriad of formats will serve a vast need to improve science education in our grade schools, high schools, and colleges. Atmospheric information is one of the high interest science areas providing outstanding opportunities to understand and apply the principles of physics and chemistry.

- The envisaged system and products will encompass North America, Canada and Mexico will be invited to participate in its development. Since the proposed atlases focus on the United States, these other nations probably will want to produce other atlases at their cost, tailored to their national interests. That would be greatly facilitated by the proposed continental approach to analysis and system development. The project publications and the atlases in particular, will be of enormous value to the World Meteorological Organization and its member nations, illustrating new types of climate information to present for better management of resources around the world.
- Multi-million dollar funding will be required for such an extensive innovative system; partnerships involving the federal government, private industry, and private foundations are seen as providing the support.
- The federal government must take the lead and have the central responsibility for the system: climate information is used to set standards, to establish national and state regulations, and to serve as the basis of legal decisions; actions requiring government-issued data and information.
- NOAA is recommended as the lead agency since the envisioned system and its purpose are under NOAA's mandate.

Products

The products will be published, computer based, or in visual formats, but all would be assembled around topical issues. Where pertinent, the information will be presented regionally based on economic, social, and environmental coherence.

Climate impacts also relate to temporal and spatial variations of weather conditions; hence a product theme will be to present material focused on the temporal behavior of various weather conditions and their spatial variability.

Publications. A central product of the NCIS will be an atlas series. Volume 1 with the proposed title of "Climate of North America: Information for Policy, Planning and Decision Making" would be generic, presenting a myriad of climate information that is important across many sectors and activities. It's production is seen as the responsibility of NOAA in coordination with other Federal agencies and advisory groups. The objectives of this volume would be:

- to provide a definitive basis for evaluating the implications of climate change and variations including those resulting from human activity on social and economic issues over the next decades; and
- to provide a basis for the rational exploration of the nation's climate in support of national goals and generally enhanced productivity.

Other atlas volumes would each feature the theme of "Climate Resources and Risks" as relevant to 1) agriculture, 2) energy, 3) water resources, 4) human

health and resources, 5) transportation, 6) structural design, construction and operations, 7) commercial and industrial planning and operations, and 8) recreation. Each of these specialty volumes will be designed by climate impact specialists and funded by interested agencies, foundations and firms that have direct and specific interest in their themes. It is likely that they will differ greatly in how they are assembled and what is presented since they are to be user-oriented and user friendly.

Computer-Based Climate Information. Presentation of climate information, both in a generic sense and by specialty areas, such as planned for the atlases in computer formats, offers two great advantages that past climate information publications could not address. First, computer-based information allows for presentation and hence availability of much more extensive relevant climate information than could ever be presented in atlases, thus allowing specialty audiences much greater access to extensive information. For example, one computer disk (and related software) could provide climate information about severe local storms -- in essence presenting hundreds of graphs, tables, and related texts about tornadoes, hurricanes, hailstorms, flash floods, etc.

The other very major advantage of the computer-based information portion of NCIS is that it allows updating; many publications become outdated before they reach the users. Routine updating of the computer information is recommended as a means to keep the NCIS current and a "living climate information resource".

The planning committee is convinced that the computer-based information products will be used extensively by a wide audience. Hence the information and programs should be designed to be utilized on a broad spectrum of personal computers, as well as on micro and macro computer systems used for sophisticated research, decision analyses, and corporate management.

Visual Aids. Other NCIS products will be made available on video tapes, movies, and microfiche as means to visually access and study climate information. The potential uses of video-taped climate information in the classroom is very great; thus visual aids will help fulfill the educational needs.

Volume One: The Climate of North America: Information for Policy, Planning, and Decision Making

This volume is recommended as the first of the NCIS atlases. It will be a showpiece, featuring 150 to 250 product pages. A typical 2-page spread will have maps and/or graphs on one page with text and explanations of how the information is utilized on the other page. Illustrative case studies of use of information in decision making and management will be included. The materials selected for Volume One will have broad relevance. For example, information on extreme rainfall rates which affect agriculture, water resources, transportation, and other major sectors would be one candidate for inclusion in Volume One.

The proposed contents of Volume One are presented below:

I. Climate as a Resource for the Nation's Economy:

- II. Climate in the Nation's Future: long-term climatic trends, the need for benchmark, climate and societal projections to the year 2000 and possible socio-economic implications (e.g., due to urbanization).
- III. Coping with Climate: the climate system and elements, their temporal and spatial variations, topographic effects, climate extremes (point and area), climate scenarios and impacts, measurement, information, information sources.
- IV. The Social and Legal Dimensions of Climate: building codes, federal statutes, state laws.
- V. Climate and Risks: to energy, to health, affects on population growth and movement, risks to agriculture, coastal conditions, and water resources.
- VI. Appendix: description of the NCIS, the organization of its products, and description of the available computer disks and software related to Volume One.

Requirements

The interdisciplinary nature of NCIS requires a wide variety of design skills; the development and realignment of existing climate data bases; applied research to define certain impacts; the development of software needed with the disks; and diverse technical and scientific expertise. Involvement of specialists in climate and climate impacts is essential. The participation of several federal agencies and private entities is essential to ensure adequate funding, planning, and conduct of the NCIS.

A living information system with annually updated computer-based products, will require a long-term commitment by NOAA to sustain this effort for periodic updating and maintenance of the NCIS. As in all complex, multi-party endeavors, strong leadership with committed support are the key elements. These issues are addressed more fully in the next section on implementation.

IMPLEMENTATION

The significant scope of such an innovative climate information system will require five years to implement. A target of 1991 for the completion of the atlas volumes is realistic. This "living" system will extend beyond 5 years as updated computed-based information continues to be generated. The 5-year target is to complete the initial first round of all products including the atlas volumes.

This effort will involve participation of diverse groups, many individuals, and several federal agencies needed to plan and to ensure that state of the science and the latest, most meaningful information is developed and presented. Data bases and software must be developed. Such an effort requires leadership and a supporting organization.

NOAA should take the lead in this new national effort in view of its basic mandate. Support for NCIS must be garnered from diverse sources---private firms, federal agencies, foreign countries, and private foundations; this too takes organization and commitment. NOAA should provide the focused leadership for this effort.

Implementation requires a structure with NOAA leadership and staffing for the National Climate Information System (NCIS); an interagency committee; an external advisory/action committee; and a series of advisory committees in the climate-impact specialty areas. These specialist committees will be needed to guide the careful selection of the materials to be presented relating to climate effects on agriculture, water resources, energy, and the other sectors.

Implementation of NCIS can be thought of in five broad phases:

- initial planning and assessment of the value of NCIS;
- decision to launch NCIS;
- comprehensive planning and the gathering of support;
- design and development of products;
- updating and maintenance of NCIS.

The first steps of the implementation plan consists of 1) the development of this initial plan; 2) the development of an illustrative brochure; 3) the limited discussions with potential constituents and influential supporters. These should be accomplished in early 1987, and presented at that time to NOAA/DOC leadership.

If a decision to proceed to accomplish NCIS is made, a 5-year plan of action is envisioned. Initial activities that largely follow in a sequential order include:

- The establishment of a NCIS office inside NOAA with a leader and staffing (this could be done largely externally) and funding by NOAA.
- Development of an external advisory committee and an interagency committee.
- The development of a detailed plan of action for the NCIS with specific annual milestones done in concert with representatives of federal agencies, the private sector and foundations, and NOAA leadership.
- Initial design and preparation of Volume One on the Climate of North America.

These and other envisioned activities over the 1987-1991 period are represented in a schedule depicted in the Appendix. Such a schedule offers annual milestones needed to monitor progress.

The ensuing implementation effort includes three major activities, largely performed in parallel. The first of these is the planning and organizational effort required to provide the diverse expertise needed for NCIS funding. Involvement of potentially interested and affected entities, be they federal agencies or private companies, will be essential. They and the representatives of their sectors are needed to provide the expertise to select the types of information needed in the specific impacted sectors of agriculture, energy, water resources, etc.

The second major activity will be a marketing effort. The potential of the atlas and the computer information products to serve the needs of the impacted sectors will require a well organized and extensive series of interactions with potentially interested parties including federal agencies, commercial and business interests affected by climate, and by private foundations whose goals fit portions of those of the NCIS.

In parallel, a third major activity of the implementation effort will be a research and development effort. This includes the studies needed to define and select the information to best describe climate impacts, some of which is not available. Development efforts will be needed to assemble climate data sets and to develop software packages to serve the needs of varied users. This effort will require diverse expertise including cartographers, computer programmers, managers of geographical information systems, climatologists, economists, geographers, etc.