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The Federal Plan for Meteorological Services and Supporting Research

FISCAL YEAR 1983

FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES
AND SUPPORTING RESEARCH

FCM P1-1982

U.S. DEPARTMENT OF COMMERCE/National Oceanic and Atmospheric Administration

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator

The Federal Plan for Meteorological Services And Supporting Research

FISCAL YEAR 1983

MARCH 1982
WASHINGTON, D.C.

SILVER SPRING
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PREFACE

This Federal Plan is the eighteenth in a series of annual plans developed by the Federal Coordinator for Meteorological Services and Supporting Research. This Plan focuses on the measures being taken to protect weather-sensitive activities. Pursuant to Section 304, Public Law 87-843, it is published to provide the Congress and the Executive Branch with a coordinated, overall plan for Government meteorological services and for those research and development programs that directly support and improve meteorological services. The Plan covers the programs of all agencies for FY 1982 and FY 1983. Much of the FY 1983 activity is aimed at strengthening the basic meteorological system through advanced weather radar, larger and faster computers, better forecast models of the ocean and atmosphere, and preparedness of the public to respond to warnings.

Historically, the Federal Plan has provided a description of the various agency plans for improving these services. These features will continue in this issue of the Plan. Additionally, in response to growing interest and accelerated efforts to meet an expanding need, a special analysis and survey of numerical weather prediction is given in Section 1. Numerical weather prediction is at the core of the complex set of forecast services, and more accurate forecasts depend primarily on progress in numerical weather prediction.

The second section of this Plan highlights interagency cooperation that is essential to meet the needs for meteorological services. Section 3 contains a discussion of resource information and analysis. A special analysis of the National Climate Program is provided in Section 4. The appendices contain a compilation of agencies' weather activities and a list of acronyms.

The principal work of coordinating weather activities and of preparing and maintaining the Federal Plan is performed by the interagency committees shown on the inside front cover. These committees and their subcommittees conduct systematic, continuous reviews of basic and specialized meteorological requirements, services, and supporting research according to guidelines set forth in the Office of Management and Budget Circular A-62.

William S. Barney
Acting Federal Coordinator for
Meteorological Services and
Supporting Research

THE FEDERAL PLAN FOR METEOROLOGICAL SERVICES
AND SUPPORTING RESEARCH
FY 1983

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

SECTION 1

NUMERICAL WEATHER PREDICTION

Frederick G. Shuman*

INTRODUCTION

Weather services pervade virtually all activities of this nation and its people. There are few activities in the United States that are not to an important degree weather dependent. The diversity of weather services required is as great as the diversity of activities served, which include agriculture and animal husbandry, industry, transportation, military activities in peace and war, space activities, communications, energy, construction, fishing, water management, and sports and recreation. Because the atmosphere and hydrosphere strongly interact with each other, there can be no clear separation of service products concerning the atmosphere, oceans, seas, lakes, and rivers. Today's services are therefore based on a meld of meteorology, physical oceanography, and hydrology.

The bulk of weather information is provided by agencies of the U. S. Government, but there are many individuals and companies who contract to provide tailored information to private firms. Even for these private activities, however, virtually all of the basic information comes from U. S. Government agencies.

United States interests, civilian and military, are worldwide, and service offices and stations therefore exist not only in every state of the union but also in many foreign countries and aboard U.S. Navy ships at sea. These are the most direct points of contact for the user, and they provide most of the service. Their services, however, are based on round-the-clock information and guidance from three primary numerical prediction centers structured to serve the unique needs of their civil and military customers. These primary centers are the National Meteorological Center near Washington, D.C., the Air Force Global Weather Central near Omaha, NE, and the Fleet Numerical Oceanography Center in Monterey, CA. Each center is equipped with large computer systems for communications and data processing, and their varying services are based on automated numerical prediction models of the atmosphere and oceans. Although from a technical standpoint, the problem of forecasting the state of the ocean is closely related to forecasting the state of the atmosphere, I intend here to deal only with the latter.

HISTORY OF NUMERICAL WEATHER PREDICTION IN BRIEF

Numerical weather prediction is not merely weather forecasting by the numbers, nor is it the automation of processes previously done manually. Numerical weather prediction is the direct application to the weather forecast problem of the laws of classical physics which govern the evolution and behavior of the atmosphere. The physical laws were known a good century before they were

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*This is an invited article. Dr. Shuman recently retired after serving 40 years with the National Weather Service -- nearly 30 years of that time in numerical weather prediction.

directly applied to the weather forecasting problem. Their direct application seems the obvious approach to take; why was this approach not taken earlier?

There were a number of reasons, but sufficient was the overwhelming number of calculations that need to be done. Around the turn of the century, V. Bjerknes (1904) pointed out that future states of the atmosphere could be predicted in principle from an initial state. About two decades later L. F. Richardson (1922) actually attempted to carry out the calculations required for a three-hour forecast. He succeeded in getting a numerical result, but unfortunately it did not resemble the atmosphere in crucial respects. We now know the reason for his failure, but his result dampened enthusiasm among meteorologists for a direct dynamical and numerical approach for several decades.

Interest was revived in the 1940's when John Louis von Neumann organized a project at the Institute for Advanced Study in Princeton, NJ, to develop and build an electronic stored-program computer. Von Neumann identified weather forecasting as one of three problems suitable for investigation using the new computer. Within the Institute Electronic Computing Project, he organized the Meteorology Group under the leadership of the late Jule G. Charney.

Completion of the new computer was announced on June 10, 1952. It had the capability of performing about 10,000 instructions per second, a staggering speed at the time. This was the patriarch of modern computers, and its announcement ushered in the Computer Age. The modern computer turned out to be a revolutionary invention with profound effects on science and engineering, business, industry, communications, defense, and government generally. The world, for good or ill, would not be the same without it. An exotic example of its impact is on the space program which could not be carried on without the computer.

Computer technology itself has advanced at a breathtaking pace and continues to do so. Six generations of computers have been marketed during the thirty years since the announcement of von Neumann's computer, sometimes affectionately called the JOHNIAC, after von Neumann himself. The first generation could perform about 14,000 instructions per second, and could internally store the equivalent of 22,000 decimal digits. The most powerful sixth-generation computers commercially available today have both speeds and internal storage capabilities about 10,000 times greater than the first generation. On the average, this represents a growth in power of 36 percent compounded annually for 30 years. Each new generation has been four to ten times more powerful than its predecessor.

The computer at the Institute had been operating for several months before its official announcement in 1952. Even before it was ready for use, Charney's group had developed new approaches to the meteorological problem and had succeeded in a 24-hour integration of simplified atmospheric equations on the ENIAC at Aberdeen Proving Grounds, MD, (Charney, Fjortoft, and von Neumann, 1950). The ENIAC was a precursor to stored-program machinery, and the 24-hour prediction took 24 hours to run on it. This was an important result but not a demonstration of practicality. The same set of calculations, run later on the Institute machine, took only five minutes, demonstrating the practicality of numerical weather prediction.

The government weather services of the United States were quick to take advantage of the new science and technology. About three years after von Neumann's announcement, the U.S. Government had acquired a first-generation commercial computer and was producing numerical weather predictions on a daily schedule. Weather forecasting was thus for the first time placed on a firm scientific footing.

Numerical weather prediction developed and advanced in parallel with computer technology. Each new generation of computers that appeared was acquired for operational use as shown in Figure 1.1. The effect of improved computers, and advances in other science and technology related to numerical weather prediction, is clearly seen in Figure 1.2, which shows an upward trend in forecast skill for the past 25 years. Figure 1.2 is for forecasts issued from a weather central to practicing forecasters. Have improvements been passed on to the using public? Figure 1.3 is an example and is a clear indication that they have.

A "PREDICTION" OF THE FUTURE OF NUMERICAL WEATHER PREDICTION

Figures 1.1 and 1.2 taken together show that there has been an empirical relationship between computer power and prognostic skill. The accuracy and quality of central guidance at any given time, however, depend on a myriad of factors and not on a single factor such as availabale computer power. Below is a list of broad areas of science and technology, each essential to prognostic skill:

- o quality and density of observations in time and 3-dimensional space
- o communications that ensure timeliness of data acquisition, and product delivery
- o knowledge of atmospheric dynamics and physics
- o mathematical knowledge and know-how in numerical methods
- o computer power.

Finally, the practicing forecaster must have the understanding and experience to interpret the guidance and effectively to relay its benefits to the user. All of these factors have been improving since 1955 and promise to continue improving. Improvement in all areas is essential to continuing progress, although at any given time improvement in any one or a few should be expected to yield better forecasts or service or both.

Although increased computer power alone will generally not yield improved numerical predictions, it does tend to drive the other factors forward. Certainly it enables new approaches in research in meteorology and numerical methods. But it also stimulates development of not only new and better ways to observe the atmosphere, but also faster and more powerful ways to collect data and transmit results. To a large extent, not only does computer power drive the other factors forward, but also all the factors drive each other.

It would be interesting to relate the skill of numerical weather prediction to a measure of the state of its enabling science and technology. This, however, in the broadest sense is clearly impossible. For instance, how would we measure the state of knowledge? How would we mix the various factors to come up with a single measure? There is one factor, computer power, which is readily measurable and which fortunately is both a tool for the other factors and is woven into their fabric. It is perhaps better, as an index of the state of science and technology, than any other on the list.

The curves of Figures 1.1 and 1.2 are both more or less smooth. Therefore, if we eliminate the time variable, and simply consider forecast skill as a function of computer speed, it, too, will be more or less smooth. I will want to project such a curve in order to get some sense of what the future holds in store. To best do this, consideration should be given to the form that the curve should be expected to have.

To start, consider a hypothetical "perfect" computer. This computer does calculations instantaneously; its speed is infinite. Correspondingly "perfect" science and technology are also hypothesized. In this weather forecasters' heaven, forecasts are "perfect"; error vanishes. Such a mental exercise is not entirely fancy; it suggests that forecast error approaches zero asymptotically as computer power increases. To be more specific, I will adopt an exponential curve, relating forecast error to some function of computer speed:

$$\text{error} = ab^{f}$$

where "f" is the function of computer speed.

Now, what should be the form of "f"? Perhaps the most fundamental, although simple in principle, change that can be made in numerical weather prediction models is to increase their resolution. This has been done in the past, and certainly will have to be done repeatedly in the future in order to take advantage of improved science and technology.

At the same time, increased resolution is very expensive in terms of computer power. For example, if the resolution in one dimension is doubled, the number of calculations that must be done also doubles. Doubling the resolution in each of the two horizontal dimensions quadruples the number of calculations. The vertical dimension in our equations is to a degree dynamically degenerate, and resolution in that dimension can be expected not to be increased as fast as in the horizontal dimensions. I will ignore the vertical dimension for my rough purposes here. Resolution in time, however, cannot be ignored. For mathematical reasons, if resolution in the horizontal dimensions is doubled, then resolution in time must also be doubled. Thus, if the horizontal resolution is doubled, the number of calculations increases by a factor of eight.

I will take from this most expensive of expected changes, the form of "f":

$$f = s^{c}$$

where "s" is computer speed. Thus my *a priori* relation becomes

$$\text{error} = ab^{s^{c}}$$

If my arguments contain more than a modicum of truth, "c" should turn out to be reasonably close to 1/3, to accommodate increases in resolution. However, "c" should be somewhat smaller than 1/3 because other changes requiring some additional calculation have to be made to achieve progress.

I take five points from Figures 1.1 and 1.2:

Computer	Speed (MIPS)	s = Speed relative to IBM 360/195	Error
(Subjective)	0	0	0.61
IBM 704	0.047	1/255	0.48
IBM 7094	0.30	1/40	0.44
CDC 6600	2.	1/6	0.32
IBM 360/195	12.	1	0.22

Each of the values in the last column is taken from one of the horizontal bars in Figure 1.2. For a match to the CDC 6600 I chose to use the bar labelled "CDC 6600," for although that model version ran for several years on the IBM 360/195, it was designed for the CDC 6600, and represents our "ultimate" CDC 6600 model. That improvement could not have been made to models run on the IBM 7094 and earlier computers, and represents research driven by availability of the CDC 6600. I want my curve to represent what is achievable with given computer power.

First, I fitted the "subjective" data. Here I assumed zero computer speed. The human mind is capable of calculation, but its speed of calculation can hardly be compared to modern computers. The genius of the human mind lies in other endeavors. Thus a = 0.61. Next I fitted IBM 360/195 data, and for convenience used the IBM 360/195 speed as the unit of measure for speed (i.e., IBM 360/195-speed = 12 million instructions per second (MIPS) = 1 unit). Thus, b = 0.22/0.61 = 0.36. I then found that c = 0.28 gives a close fit to the other three pairs of data. I thus obtained

$$\text{error} = 0.61 \times 0.36^{s^{0.28}}$$

Figure 1.4 shows how closely this curve fits all the data. This is indeed a close fit, with root mean square error of fit of about 0.01.

One must, of course, be cautious in extrapolating data, but the fact that the curve of forecast skill (or error) vs. computer speed has followed so closely such a "law," for 25 years and five generations of computers gives us confidence that extrapolation of this curve is legitimate. As in all predictions, however, error of extrapolation grows with range from the known data, but since the known data include 2 to 3 orders of magnitude of computer speed, extrapolation should fit future experience quite well out to s = 10, 20, or so.

If we had used this procedure to predict what could be achieved with the IBM 360/195, we would have predicted an error level of 0.20, which agrees well with the actual to date of 0.22. This is about the only test of the methodology that can be made with so little data. The extrapolations in the range of 10 or so times the speed of the IBM 360/195 are not very sensitive to how the curve is fitted to the data. For example, if it is fitted to only the last three points, then a = 1.542, b = 0.143, and c = 0.119. This extrapolates to an error of 0.12 for s = 10. If it is not fitted to the first point, but instead it is assumed that error = 1 for zero computer speed, then a = 1, b = 0.22, and c = 0.143. This also extrapolates to an error of 0.12 for s = 10. The root mean square error of fit is about 0.02 in the latter case.

The extrapolated curve indicates that, given a computer 10 times faster than the IBM 360/195, error in the kind of product that Figure 1.2 represents should drop from 0.22 to about 0.09, roughly by 50 percent. Machinery of this class has been commercially available for several years, and has been in operational use at the European Centre for Medium-range Weather Forecasts (ECMWF) since late 1979. It is just now beginning to be acquired and used for operational numerical weather prediction in the United States, United Kingdom, and Canada.

There is no statistic available on ECMWF's performance comparable to that displayed in Figure 1.2. However, the World Meteorological Organization (Bengtsson and Lange, 1981) recently sponsored an intercomparison project among products of national meteorological centers in which ECMWF and the United States, as well as six other nations, cooperated. The ECMWF, by the way, was established and is operated by a consortium of Western European nations. The project was initiated by Finland. The Finnish Meteorological Institute took the responsibility for collecting and formatting the data, preparing data tapes and supervising the running of verification programs on ECMWF equipment.

The results for 1980, the first full year of ECMWF's operation, show them clearly superior to all. The root mean square error of ECMWF's 72 hour predictions in mid-atmosphere at 50 kPa was 46.8 m, compared to 53.1 m for the U. S. At 100 kPa, near sea level, the corresponding numbers were 39.1 m and 44.7 m. Thus, ECMWF achieved a 12 percent reduction in root mean square error over comparable U. S. guidance. The U. S., by the way, was second best at 100 kPa, and virtually tied for second with Canada (52.9 m) at 50 kPa.

ECMWF, because of its mission, has chosen to take advantage of the relatively great speed of its computer by running sophisticated atmospheric models out to 10 days. Therefore, ECMWF is more limited than other meteorological centers by the amount of calculation that can be done per forecast day. As a result, the horizontal resolution of ECMWF's model is no higher than that of short-range forecast models of many other centers. The improvement of 12 percent is probably due to a better data base, higher vertical resolution, and greater sophistication of their model's physics and of their analysis procedures. ECMWF waits as much as four hours longer for data receipt than most national centers, which results in an improvement independent of the power of their computer, but the other improvements are enabled by their computer's greater power.

Thus, while the 12 percent gain by ECMWF is encouraging, it should not be regarded as what can and will be achieved with sixth-generation computers, especially when applied to short-range forecasts. On the other hand, I judge my objective prediction of a 50 percent reduction to be optimistic, perhaps overly optimistic. Figures 1.4 shows that it took two generations of computers, after the IBM 7094, to halve that error statistic. Although the difference between a

12 percent and a 50 percent reduction in error is quite large, I believe that the best we can do at this time is to predict error reduction in that range. I personally believe that after several years of use of sixth-generation computers, the error reduction will be closer to 50 percent than to 12 percent.

I think it worth repeating here, that one cannot depend on increase in computer power alone for continuing progress in numerical weather prediction. But I also think that the close fit in Figure 1.4 demonstrates that computer speed is a good index of the state of the mix of science and technology relevant to numerical weather prediction.

CONCLUSION

What will reduction of error in central guidance mean in terms of user benefits? Forecasts made during ordinary run-of-the-mill weather are already remarkably good. Although improvements have been made, it is still the unusual event that is most difficult to predict. At the same time, because they are infrequent, these events have little impact on overall verification statistics.

Reduction of error statistics of central guidance products during the last decade has been, I believe, in large part due to our ability to better predict large-scale cyclones that are developing rapidly -- infrequent events that are associated with heavy snow and rainfall, high winds and seas, and blizzards. Indeed, for two decades great emphasis in applied research and development in numerical weather prediction has been given to such events and continues to be. It should be expected, with the more powerful computers now appearing in operational centers, and with further improvements in other relevant science and technology, that substantial progress will be made in predicting rapidly developing large-scale cyclones.

Hurricanes and typhoons, because they are smaller in scale than extratropical cyclones, are not handled well by operational models designed to predict over a continent, hemisphere, or the globe. Special models must be constructed to handle smaller scales. Such models have been run operationally since the mid-1970's. However, computers in current use cannot properly handle important detail within hurricanes and typhoons. For example, the highest winds in Atlantic hurricanes are 50 km or so from the center, which is roughly the same as the distance between grid points in tropical cyclone models at which such data are carried. Currently run models are therefore designed only to predict the tracks of hurricanes and typhoons.

Even a sixth-generation computer will not enable a straightforward increase of resolution adequately to describe the high-velocity inner vortex of hurricanes, although the greater detail that will be carried should result in improved tracking. On the other hand, "nesting" of a small, high-resolution grid around the core may succeed in the first numerical predictions of changes in intensity of hurricanes. Here again, however, more knowledge of the physics of hurricanes will be required. Increased resolution is not enough. Another limiting factor is the lack of detailed observations within and around the hurricane, but I believe improvements will be made in spite of this limitation.

Quantitative predictions of precipitation, in particular heavy snow and rainfall, are among the most difficult forecasts to make. Precipitation is the end result of a long chain of atmospheric processes, and errors in each link of the chain tend to multiply in quantitative precipitation forecasting. In cases of very large-scale steady precipitation, say covering most of the Midwest, forecast amounts are remarkably good. On smaller scales, however, precipitation amounts vary, and heavier accumulations tend to be arranged along axes that may be 1000 km long with cross-axis dimensions of 100 km or so. There is even much finer-grain detail within precipitation areas, down to 1 km or less, and with periods of a few minutes. Summer showers are good examples, but even what we ordinarily regard as large-scale precipitation has such fine-grained detail. Through use of weather radar, some success has been achieved in forecasting such detail for periods of an hour or so, but success on very fine scales for much longer periods is not in sight. Highly detailed predictions of precipitation amount are not required for them to be highly useful for some applications. Consider the problem of flash floods, for example. A watershed "integrates" rainfall into accumulated runoff and flood water; the detail of the rainfall pattern over the catchment matters little.

The problem of quantitative precipitation forecasting now appears ripe for attack. With the imminent operational availability of sixth-generation computers, the U. S. centers will be able adequately to describe in their models the scale on which much of the heavy precipitation falls. This will stimulate increased research efforts and, if the past is any guide, will result in greatly improved forecasts of sensible weather. Other areas that should benefit from our ability to go further into the "mesoscale" include prediction of more detail in the vertical temperature structure which affects such diverse applications as air pollution and radar propagation.

Benefits at the other end of the time and space scale should also be realized during the next decade. Numerical weather prediction was originally a method for short-range forecasting -- at best out to three days. The method now yields predictions with some skill out to six days, and four-day forecasts are as good as two-day forecasts were at the beginning. This trend is bound to continue; built into the method itself is the principle that as shorter range predictions improve, predictability is extended into longer ranges. By 1992, skillful forecasts with some skill in the fortnightly range could well be a reality.

Even if a 50 percent error reduction is not achieved in short-range circulation forecasts, we have these promising and important services to look forward to.

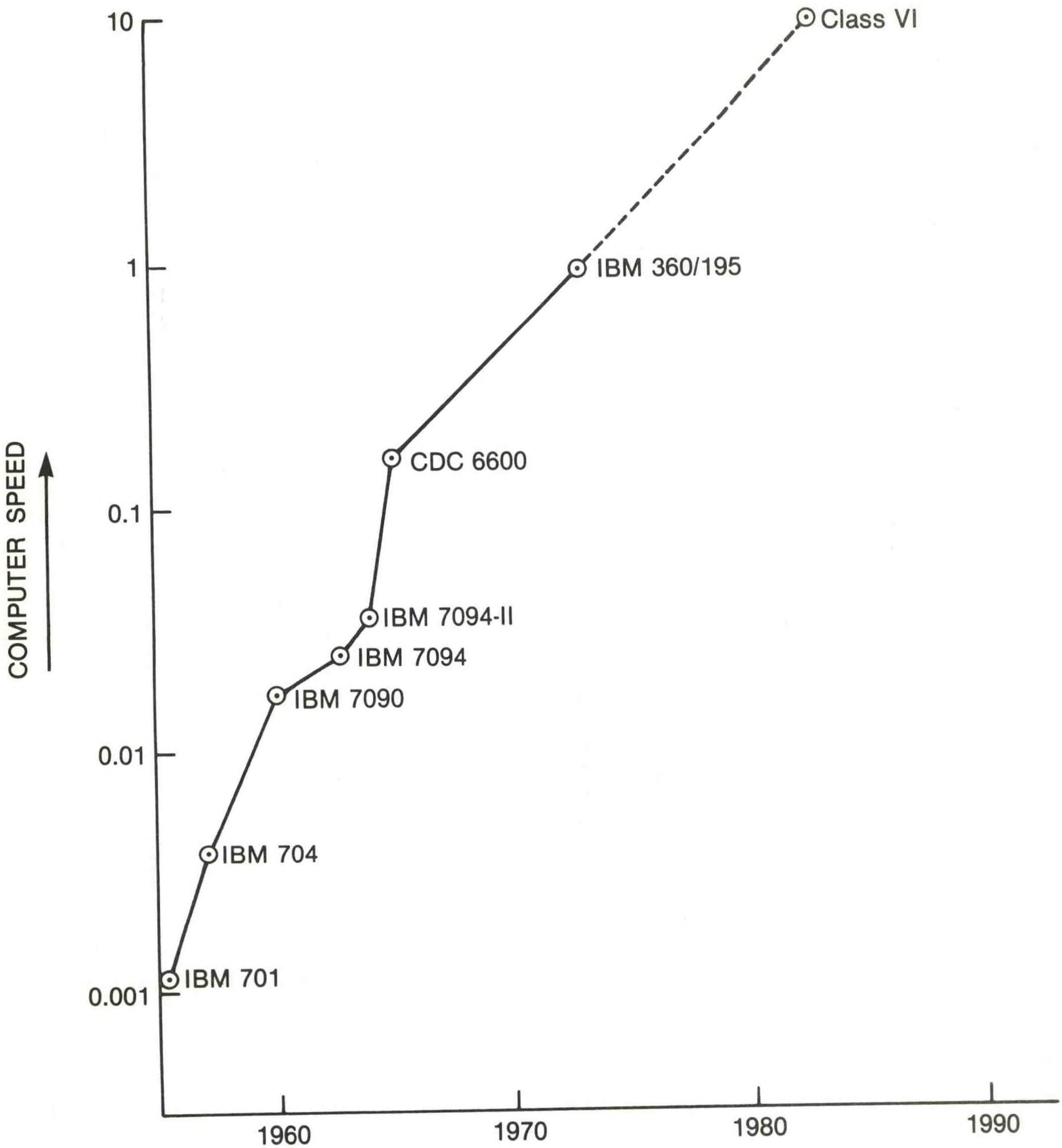

Figure 1.1 Speed of Operational Computers vs. Year of Acquisition

Operational computer speed, relative to the IBM 360/195, plotted against year of acquisition by the National Meteorological Center.

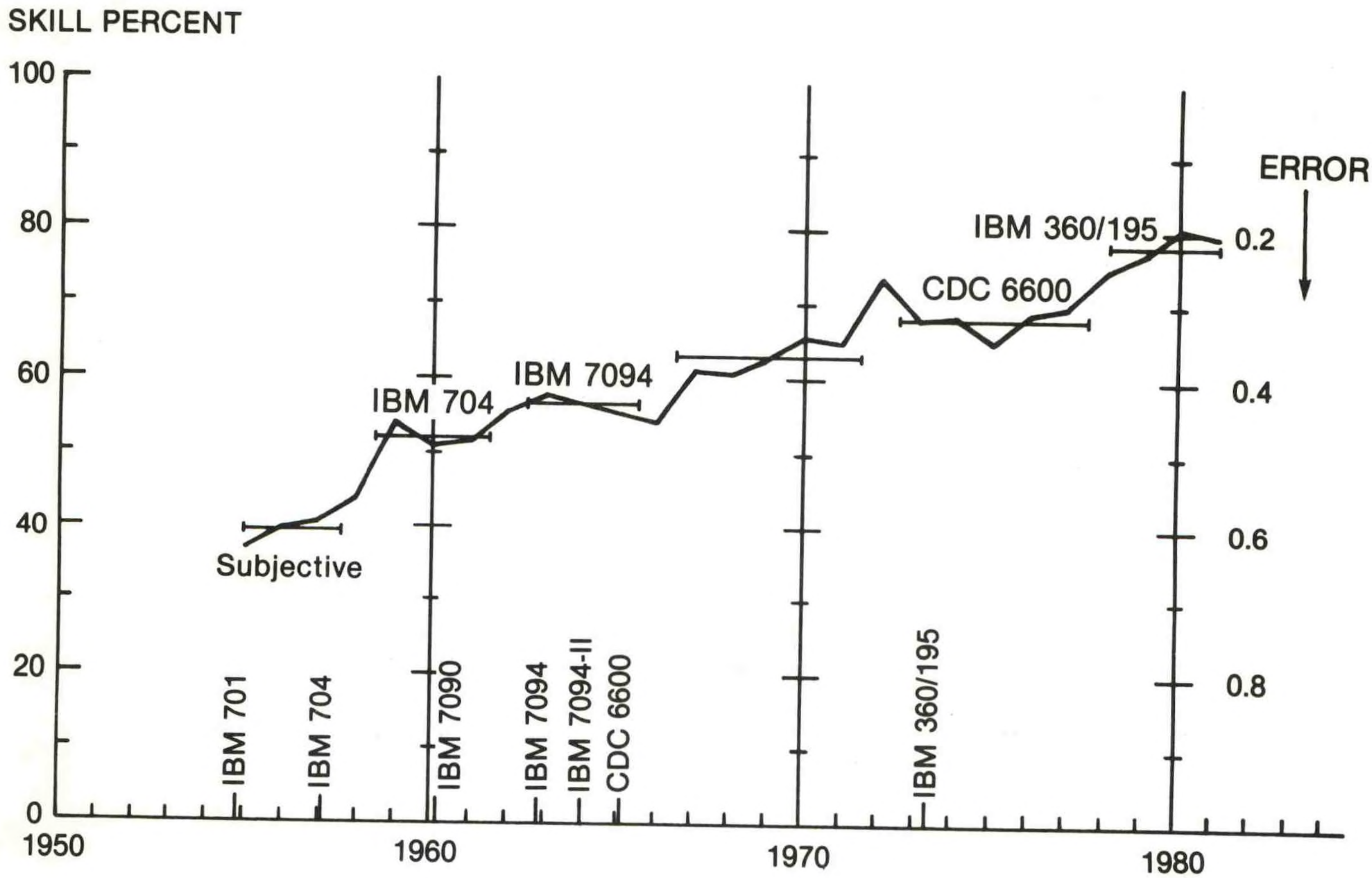

Figure 1.2 Increase of NMC Prediction Skills

Record of skill, averaged annually, of predictions of atmospheric circulation made by the National Meteorological Center. Specifically, the predictions are for 36 hours at 50 kPa (approximately 5.6 km high) over North America. The horizontal bars show averages for the years during which no major changes in models occurred. Data from the labelled bars were used in Figure 1.4. Data from the unlabelled bar represents a model designed for the CDC-6600, but they were not used in Figure 1.4, for reasons given in the text. The measure of skill is derived from the so-called S_1 score (Teweles and Wobus, 1954), which is a measure of normalized error in pressure gradients. A chart with an S_1 score of 20 is perfect for all practical purposes, and one with 70 is worthless. Skill (percent) is $2 \times (70 - S_1)$, which yields 0 for a worthless chart, and 100 for a practically perfect one. Error = $1 - (\text{skill} \div 100)$ is shown on the right.

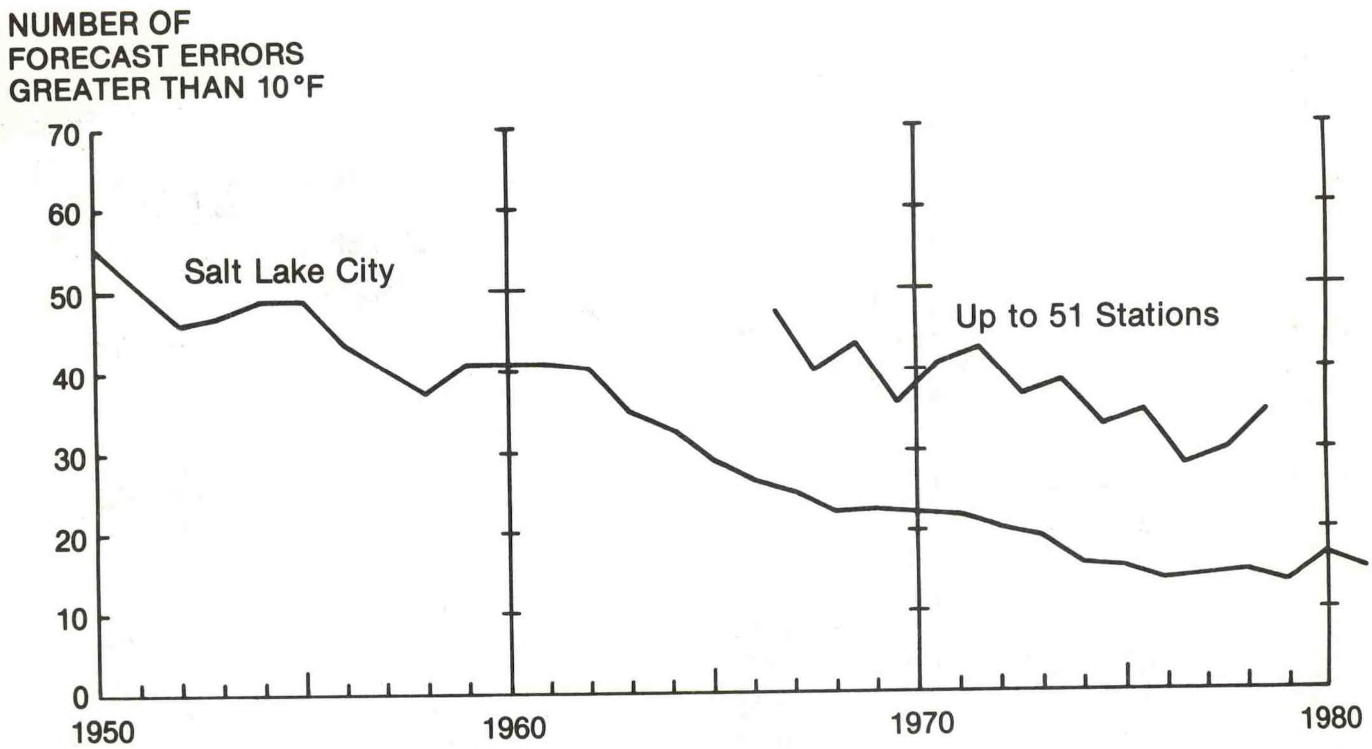

Figure 1.3 Decrease of Error in Temperature Forecast

Number of forecast temperature errors greater than 10^{o}F on an annual basis. Salt Lake City is the only station that has kept a consistent record of this for over 20 years, and its record is shown to illustrate improvements over a longer period. The shorter record is for forecasts local to WSFOs, which are scattered fairly uniformly about the country and is the average number per WSFO (National Weather Service Forecast Office). Both curves are for forecasts 36 to 48 hours in advance. The Salt Lake City record is for one forecast per day (365 each year). The shorter record is for two forecasts per day but only for the colder half of the year, October 1 to March 31. The difference in level of the two curves is largely due to two factors: (1) it is more difficult to forecast temperature in the colder seasons because temperature variations are larger, and (2) the variation of temperature over the Great Basin is smaller than elsewhere; for example, over the Great Plains. To remove large fluctuations that appear year-to-year in single-station records, data for Salt Lake City have been smoothed with weighting factors 1:2:4:2:1.

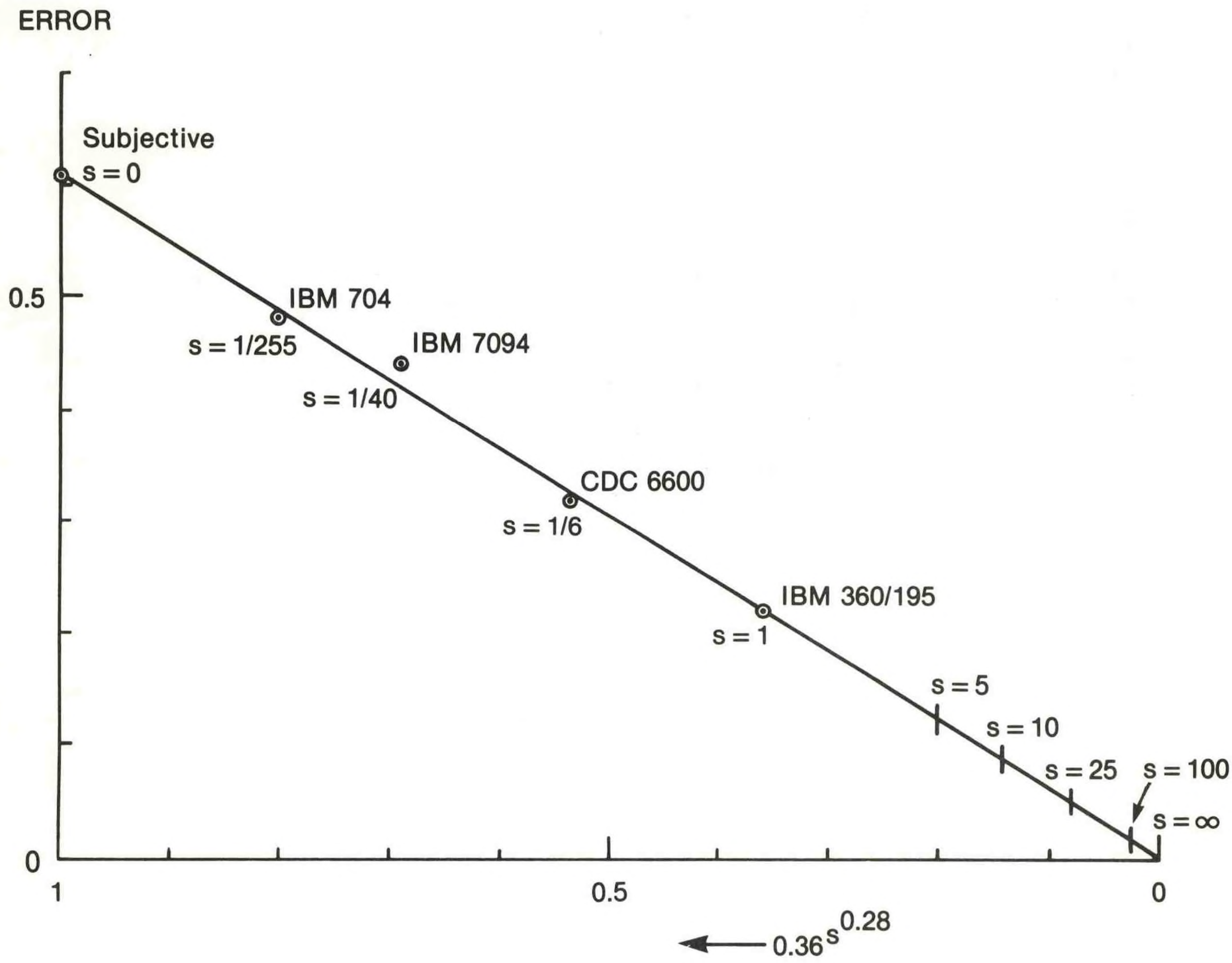

Figure 1.4 Error in Forecast Guidance Prodouct vs. a Function of Computer Speed

Error of the NMC 36-hour 50 kPa guidance product, plotted against a function of computer speed (s). The speed of the IBM 360/195 (12 MIPS) is taken as the unit of measure for "s." The five small circles are actual data. The straight line is the curve, error = ab^{s^c} where a = 0.61, b = 0.36, c = 0.28, which have been fitted to the data. Error = 1, represents a worthless product; error = 0, a virtually perfect one.

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SECTION 2

FEDERAL COORDINATION AND PLANNING

Recent events have stimulated renewed Federal interest in the coordination and strengthening of the overall Federal weather program which is carried out within many Federal agencies. In the review of the natural resources programs of the Federal Government, the President's Reorganization Project noted that some efficiencies and savings might result from the consolidation or integration of some weather programs. The General Accounting Office (GAO) report LCS-80-10, "The Federal Weather Program Must Have Stronger Central Direction," October 1979, urged more centralized planning and direction for Federal weather service activities. For the FY 1981 budget, the Office of Management and Budget (OMB) directed the Department of Commerce to undertake crosscutting reviews for selected weather programs in the FY 1981 budget in order to assure coordinated efforts among the agencies involved.

As a result of this increased interest, increased staff and other resources were provided to the Office of the Federal Coordinator. These increases in general were provided by the Federal agencies with major weather programs such as the Departments of Commerce (DOC), Transportation (DOT), and Defense (DOD). In addition to providing an ongoing focus for the coordination of interagency weather programs, the increased capability in the Office of the Federal Coordinator will be used to conduct studies and assessments that are responsive both to the needs of the Executive Branch and to the guidance from the Congress.

FEDERAL PLANS

The preparation of Federal plans is a major responsibility of the Federal Coordinator and requires extensive planning and coordination. Generally, Federal plans are prepared for each of the specialized meteorological services and for meteorological programs common to two or more agencies. In most cases, the preparation of Federal plans is facilitated by the existence of individual Agency plans for the service or program involved. The Federal Coordinator compiles input from the involved agencies and proposes a unified plan for consideration.

The Office of the Federal Coordinator published the following plans during FY 1982:

- Federal Plan for Meteorological Services and Supporting Research
- National Hurricane Operations Plan
- National Winter Storms Operations Plan
- National Severe Local Storms Operations Plan.

The Federal Plan for Meteorological Services and Supporting Research, as indicated in the Preface, is required by Section 304 of Public Law 87-843. In connection with the budget presentation for each fiscal year, the Congress is provided with a horizontal budget showing the totality of the programs for meteorology.

The National Hurricane Operations Plan, updated on an annual basis, presents procedures agreed upon by the U. S. Departments of Commerce, Defense, Transportation, and the Federal Emergency Management Agency (FEMA), for providing warning services on Atlantic and Pacific hurricanes. The service is an interdepartmental joint effort to provide the Nation and designated international recipients with environmental data, forecasts, and assessments concerning tropical and subtropical weather systems.

The National Severe Local Storms Operations Plan, updated annually, describes the responsibilities, roles, and procedures followed by the U.S. Departments of Commerce and Defense, the Federal Emergency Management Agency, and the Federal Aviation Administration (FAA), in observing, forecasting, and communicating information on severe local storms over the United States.

The National Winter Storms Operations Plan identifies agency responsibilities in acquiring weather information for use in predicting and providing adequate and timely warnings of severe and crippling winter storms along the east and Gulf coasts of the United States. Agencies involved are the U.S. Departments of Commerce, Defense, and Transportation. The annually updated Plan covers the period November 1 to April 15 each year since a relatively high incidence of winter storms is expected in that period.

OFFICE OF THE FEDERAL COORDINATOR (OFCM)

The mission of the OFCM is to act under the Federal Committee's direction in promoting coordination and cooperation among the various Federal weather agencies so that the best weather information is available to users at least cost. To discharge its mission, the OFCM obectives listed below are overlaid on the objectives of those agencies who provide the services and perform the research.

- o Review the set of Federal weather programs and total Federal requirements for weather services to:
  - Suggest additions or revisions to current or proposed programs.
  - Identify opportunities for improved efficiencies and reliability.
  - Identify opportunities for savings through coordinated actions or integrated programs.
- o Document agency programs and activities in a series of plans and reports that will form a reference to:
  - Enable agencies to revise or adjust their individual ongoing programs.
  - Provide a means for communicating new ideas and approaches to the solution of problems among agencies.

- o Provide analyses, summaries or evaluations of agency meteorological programs and plans to form factual bases to enable the Executive and Legislative branches to make appropriate decisions related to the allocation of funds.

- o Provide a structure and program to promote continuity in the development and coordination of plans and procedures for interagency meteorological service operations and supporting research activities.

These are the internal objectives of the OFCM as the operating arm of the Federal Coordinator for Meteorology and the Federal Committee for Meteorological Services and Supporting Research. The resulting analyses, evaluations and recommendations are subject to formal agency review and comment.

Based on current staffing, there are 96 professional staff-months available within the OFCM. Approximately one-half of these resources is required for the direct support of the Committee structure and preparation of recurring plans (National Operations Plans and the annual Federal Plan). The remaining is available for responding to special inquiries, investigations and studies.

The DOT, DOC and DOD each contribute approximately $250K per year to the operation of the OFCM. Of this sum, approximately $400K are available for contract services.

COORDINATION AND PLANNING ACTIVITIES

The activities of the OFCM are grouped into three categories: (1) Those associated with interagency coordination and planning; (2) examination of areas of functional similarity; and (3) those related to the identification and analysis of procedural issues.

- o Coordination and planning activities are those required to provide the systematic and continuing review required by Circular A-62. Individual tasks tend to be bounded and/or recurring on a regular basis.

- o Tasks concerning functional similarity are those follow-on tasks from the earlier reviews and surveys of the weather agencies, or from the agencies themselves, or which arise during the coordination planning activities. The tasks tend to deal with the means for producing and delivering weather services and with topics that bear on practices that will promote efficiencies within the individual systems.

- o Tasks in the procedural area tend to involve organizational planning and management issues.

The greatest portion of OFCM's efforts will be devoted to the coordination and planning tasks. The interdepartmental committee structure, established by the first OFCM staff and the member agencies, serves a spectrum of planning and coordination activities. The committees provide the forum where day-to-day, ongoing activities are coordinated, where changes to current programs are made known, and where future requirements for services or techniques are identified. In the near-time frame, the results are documented in operations plans, studies and proposals and in the more encompassing annual Federal Plan. The annual Federal Plan is submitted to the Congress, with the concurrence of the OMB, coincident with the submission of the President's budget. Midterm plans are brought together in the work of the subcommittees, for example, the recent documentation by the Subcommittee on Systems Development of the Automated Weather Information Systems planned by the agencies. The strategic planning of the agencies will be brought together in a long-range Federal Plan. During FY 1982-83, the major efforts of subcommittees and working groups will be concentrated in the areas and tasks described in the remainder of this section.

Next Generation Weather Radar (NEXRAD)

The Departments of Commerce (DOC), Defense (DOD), and Transportation (DOT) all require information concerning the location, intensity, and movement of hazardous weather activity to meet their mission responsibilities. A common need for a radar system with improved capabilities for detecting hazardous weather conditions has been stated by the three departments. In 1979, the Federal Committee for Meteorological Services and Supporting Research endorsed the establishment of a Joint System Program Office (JSPO) as a focal point for the NEXRAD program. At the end of Fiscal Year 1981, the staff included 10 persons from DOC, two from DOD, and two from DOT. As the exeuctive department is DOC, the NEXRAD JSPO is located within the National Oceanic and Atmospheric Administration's National Weather Service.

In January 1980, the Office of Management and Budget approved the Crosscut Analysis of Agency Proposals for NEXRAD, conducted by the Federal Coordinator, and authorized the participating agencies to proceed with the program through the system definition phase. The results of the crosscut analysis concluded that the fundamental technology to support NEXRAD has been developed, but that a substantial amount of work remains to transfer Doppler radar technology to operational use in the field. Early in the program, the decision was made to follow OMB Circular A-109, Major System Acquisition, for the acquisition and development of the NEXRAD system. The first key decision--approval by the Secretary of Commerce of the Mission Need Statement--was completed in August 1980.

To comply with Circular A-109, a Source Selection Evaluation Board (SSEB) was established in October 1980, to prepare and coordinate the approval of the Source Selection Plan and to evaluate all proposals for the first phase of the acquisition process, the System Definition Phase. The SSEB comprises individuals from each participating agency with various functional and technical backgrounds. The SSEB presents summary reports and briefings to the Source Selection Official, who will make the contract award decision in February 1982.

In January 1981, the Joint Operational Requirements were approved by the NEXRAD Program Council and the participating agencies. This document defined the operational requirements that needed to be addressed in preparing the NEXRAD Technical Requirements and the siting analysis. A preliminary siting analysis was completed in January 1982.

To support advanced development for the NEXRAD system, a Technical Advisory Committee was formed in July 1981 to review the research and development necessary to meet the composite needs of the user agencies and to make recommendations on new developments, adequacy of data and computer software, problems of transferring technology to industry, and operation of test facilities. An interim operational test facility was established in Norman, Oklahoma, in April 1981. This facility simulates a user environment, in order to test and to demonstrate automation techniques and product displays for Doppler radar. The test system will operate for extended periods to perfect operational procedures and to develop a data base.

An updated cost study provided an estimate for the total cost of an all-Doppler system. A preliminary Cost Benefit Study concluded that an all-Doppler radar network would have twice the net-present value of a non-Doppler network. These studies were completed in July 1981. The NEXRAD Program Council approved the NEXRAD Technical Requirements in November 1981 and the Research and Development Plan was approved in December 1981.

As a preliminary step to the contract award for the System Definition Phase, the JSPO staff conducted a briefing in April 1981 at the Department of Commerce to inform private industry of the background and mission of the NEXRAD program. This briefing gave the potential bidders an opportunity to ask questions about the program. A Request for Proposals (RFP) for the System Definition Phase was released to potential bidders on August 3, 1981; the RFPs were submitted to DOC on September 2, 1981. To clarify information on the preparation of the proposals, the JSPO staff held a preproposal conference in September 1981 for 80 industry representatives. The potential prime contractors have or can provide the capabilities needed to design, develop, and produce the full NEXRAD system. JSPO evaluated proposals for the System Definition Phase during October-December 1981. The contractors were selected for the System Definition Phase in February 1982. They will examine alternative designs to meet the stated operational requirements and will propose a specific design to be built and demonstrated during the validation phase.

Planned Activities for FY 1982:

o Post-award conference with contractors	March 1982
o Detailed site analysis to begin	March 1982
o Update of NEXRAD Technical Requirements due	June 1982
o Preliminary site surveys to begin	July 1982
o Final report for system definition phase due from contractor	August 1982

Automated Surface Observations

Beginning in FY 1982, the Federal Aviation Administration (FAA) plans to operationally demonstrate several commercially available automated surface weather observing and reporting systems at some airports. These systems will give the pilot, via radio, the wind direction and speed, altimeter setting, visibility, ceiling, and temperature. These systems are similar to the Automated Low-Cost Weather Observation System (ALWOS) at Dulles International Airport. This program will impact the Joint Automated Weather Observing System (JAWOS) Program. The FAA is coordinating this impact with the National Weather Service and the Department of Defense.

Automated Aircraft Reporting System

An experimental system called ASDAR (Aircraft to Satellite Data Relay), developed for the First Global Atmospheric Research Program Experiment (FGGE) held during 1978-1979, demonstrated the operational feasibility of automated aircraft reporting (AAR) of meteorological data. The objectives of FGGE were to extend the range, scope, and accuracy of weather forecasts, and to understand the physical basis of climatte and climate fluctuations. The objective of the ASDAR part of the experiment was to acquire good, reliable, and timely upper air data in sparse data areas to support the program.

In addition to ASDAR, which reports data through geosynchronous meteorological satellites, similar equipment was placed on 11 wide-body jets flying principally U.S. mainland routes. The purpose of this equipment was to test the feasibility of acquiring profile weather data during ascent and descent of aircraft at airports and the feasibility of using the existing VHF air-to-ground and ground-to-ground communications to relay the high volume of data to the major weather processing centers within the U. S.

ASDAR and the VHF system were so successful and beneficial to the major meteorological processing centers that the Working Group on Operational Processing Centers requested the Interdepartmental Committee on Meteorological Services and Supporting Research (ICMSSR) to keep the experimental flight hardware from being phased out, to develop a new generation of equipment suitable for commercial production, and to expand the operational use of the system. The NASA, DOT, DOD, and DOC members of ICMSSR contributed financially and provided other resources to keep the current flight hardware system operating, and to study and plan for the expansion of the system. Studies found:

- That calculations based on typical operating parameters and flight routes indicate that there is a potential for saving tens of thousands of dollars per wide-bodied aircraft per year (2-3% of fuel costs) by instituting automated aircraft reporting of flight winds and temperatures. These data would be fed into numerical models to reduce wind and temperature forecast errors. For example, if improved forecasts resulted in a one percent saving in annual fuel consumption for a L-1011 aircraft, a reduction in fuel costs of approximately $100,000 per aircraft per year would result.

- That AAR equipment on board an aircraft makes possible a number of valuable ancillary functions including real-time flight following and the transmission of distress messages over "Mayday" frequencies.

- That AAR could provide wind and temperature profiles during aircraft ascent and descent near airports to help define potentially hazardous wind shear and weather conditions.

- That AAR data over the U. S. could contribute to better meso- and synoptic-scale analysis and forecasting and could enhance the utility of satellite profile data by providing ground truth over both land and ocean areas.

The Ad Hoc Group on Automated Aircraft Reporting (AHG/AAR), established by the ICMSSR, is the major forum for exchanging ideas, for identifying problems and discussing alternative solutions, for being a catalyst to solve immediate problems requiring interagency coordination and participation, for making contributions to the studies, and for developing a program development plan for an automated aircraft reporting system which will meet national and international requirements. The AHG/AAR has been effective in discovering ways to provide a better system to meet the needs of the broad meteorological community as well as to enhance aviation operations and to develop a forum for more complete international participation in the program.

Planned Activities for FY 1982:

- o Prepare a program development plan.
- o Continue prototype hardware tests and evaluations.
- o Continue operations in both satellite and VHF modes with existing prototype hardware.
- o Complete development of detailed cost-benefit analyses and production specifications for operational hardware.
- o Prepare recommendations to improve the quality and timeliness of aviation products and services.
- o Contract for certification of a production model of the operational automated aircraft reporting system.

<u>Improved Weather Reconnaissance System</u>

Currently, the United States Air Force (USAF) has 20 aircraft whose mission is tactical military reconnaissance in support of DOD requirements and tropical cyclone and winter storm reconnaissance in support of joint DOD and DOC requirements. The National Oceanic and Atmospheric Administration (NOAA) reimburses the USAF for operational missions that support the National Hurricane Center (NHC) and the National Meteorological Center (NMC). The National Weather Service (NWS) has stated a need for high-precision reconnaissance data, especially during the 48-hour period prior to landfall. This cannot be met today because only the two NOAA research aircraft and one USAF aircraft have the instrumentation to provide the necessary information.

The Federal Coordinator for Meteorological Services and Supporting Research and the National Academy of Sciences have studied the forecasting problem and the need for aircraft data. They concluded that an improved reconnaissance capability is essential for current operational forecasting and to provide the data required for the 1980's and beyond for new meteorological models of the NMC.

In October 1975, OMB asked the DOC and DOD to coordinate the modernization of reconnaissance aircraft to arrange for joint funding. The initial and subsequent programs to meet these needs have not been included in the funding levels of either department. Consequently, the current operational aircraft instrumentation system is essentially the same as it was 15 years ago. It is manual and lacks the accuracy, reliability, and sampling frequency needed for new hurricane prediction models.

The USAF and NOAA are exploring another program to partially meet these weather reconnaissance needs. The system has been designed to consist of inertial navigation equipment, air-to-ground communications using satellites, data recorders, dropwindsonde equipment, and message composers. The data processing and communications of the program have been designated the Atmospheric Distributed Data System (ADDS).

During 1981, one USAF aircraft was instrumented with all the components of the ADDS equipment and is currently being evaluated with flight tests by the USAF. The preliminary report validates the ADDS concept and indicates that the system will satisfy most of the hurricane reconnaissance requirements for accurate high density data as well as DOD internal requirements.

Planned Activities for FY 1982:

- Continue tests of the equipment in the hurricane environment.
- Redesign the system installation to meet USAF as well as NOAA requirements.
- Equip one aircraft with the revised configuration for final evaluation.
- Purchase of follow-on equipment for the remaining reconnaissance aircraft (contingent on available funds).

Meteorological Planning for Emergencies

The ICMSSR established groups during FY 1981 to plan and coordinate meteorological support for emergency operations. The Task Group on Meteorological Plans for Radiological Emergency Responses drafted an interagency plan for such emergencies. This plan is being coordinated among Federal agencies and should become part of the Federal Emergency Management Agency (FEMA) Master Plan during FY 1982. Work on plans for other types of emergencies is in the early planning stages.

The Acting Federal Coordinator presented the keynote address at the Workshop on the Parameterization of Mixed Layer Diffusion held in Las Cruces, New Mexico, during October 1981. Several people who are members of Federal coordinating committees, including the DOD member of ICMSSR, participated in the Workshop which was sponsored by the U. S. Army Research Office and hosted by New Mexico State University. The Workshop addressed three basic subjects:

1. Identification of national needs related to the parameterization of mixed layer diffusion.

2. Assessment of current state-of-the-art pertaining to analysis of mixed layer diffussion.

3. Recommended actions to coordinate future cooperative R&D efforts.

The Workshop provided the Working Group on Radiological, Gaseous, and Particulate Transport Models of ICMSSR with a better understanding of the needs and coordination problems involved. The Workshop Steering Committee is preparing recommendations and a monograph.

Planned Activities for FY 1982:

- o Publish a plan for responding to radiological emergencies.
- o Draft plan for responding to emergencies other than radiological.
- o Consider and act upon recommendations received from the Workshop Steering Committee.

Automated Weather Information Systems

The principal systems under study are the Automation of Field Operations and Services (AFOS) of the National Weather Service, and the Naval Environmental Display Station (NEDS) of the Navy, the Automated Weather Distribution System (AWDS) of the Air Force, and the Flight Service Automation System (FSAS) of the Federal Aviation Administration. The NEDS is operational and has expanded in implementation. AFOS has passed a major operational test program and is expected to be operational in all conterminous regions by the end of FY 1982. Both FSAS and AWDS have progressed one step in the development cycle.

The Working Group on Automated Weather Information Systems (WG/AWIS) has continued its activity in developing means for conducting the planning and operations related to these systems. Two additional background reports have been prepared and are undergoing interagency coordination. These reports identify important areas for standardization, alternative considerations for management of the data bases, and the implications of variations in degrees of interoperability among the systems.

An informal working relationship was established with the National Bureau of Standards with the objective of developing a comprehensive approach to establishing integrated meteorological program standards.

A special Task Group on Communications, Interfaces and Data Exchange (TG/CIDE), established by WG/AWIS, has been developing a set of standards for "Weather Data Exchange Formats." The document, now in its third draft, covers an exhaustive variety of weather products and coding procedures.

Planned Activities for FY 1982:

- o Complete the document on Data Exchange Formats.
- o Recommend a definitive committee structure for coordinating both the development and operational aspects of current and future AWIS's.
- o Develop a definitive outline of required standards.
- o Continue the coordination of AWIS activities.

ACTIVITIES UNDER CONSIDERATION BY OFCM FOR FY 1983 AND BEYOND

There are a number of other Federal weather activity issues which should be addressed in FY 1983 and subsequent years. These are areas identified by one or more agencies as potential problems or where further analyses are required to develop and acquire information essential to future planning.

Improving Forecast of Icing Conditions for Aviation

The National Transportation Safety Board (NTSB) in Safety Report NTSB-SR-81-1 recommended that the OFCM develop icing instrumentation to collect icing data on a real-time basis and to develop techniques to forecast icing conditions. The ICMSSR requested the Subcommittee on Aviation Services (SC/AS) to consider the NTSB recommendations and to suggest a course of action. The SC/AS published a report FCM-R4 which concluded that further improvements in the forecasts of icing conditions are needed and proposed actions to be undertaken by the supporting agencies.

Long-Term Federal Plan

The OFCM staff-effort for FY 1983 will be directed toward drafting a strategic plan that projects agency plans and programs into the 1990's. The majority of the compilation will be carried out within the OFCM staff, possibly aided by contract assistance. Agencies have indicated they can provide input data, including some budgetary data for the first few years.

It is recognized that issues such as technological change, new requirements for services, financing of programs (including the consideration of user charges), and what the public sector could or should do will impact Federal weather programs. The initial attempt at compilation of the programs will recognize these realities and attempt to indicate the degree of uncertainty they introduce.

There is ongoing coordination of several major agency programs of the 1990's in the subcommittee structure (e.g., AFOS and AWDS), as well as in joint programs such as NEXRAD and JAWOS. The current status and projection into the future of these programs will be addressed and a description of how they mesh with future programs will be included. Such a discussion might well identify gaps in the plans of several agencies that require attention.

The OFCM envisions that an initial long-range plan, although modest in scale, will meet the minimum requirements of Circular A-62, provide a useful exchange of planning information among agencies, and form a basis for OMB's understanding of the future needs and directions of the weather services.

After meeting with those knowledgeable of the plans of the Air Weather Service, the Naval Oceanography Command, the Federal Aviation Administration and the National Weather Service, it was the consensus that a long-term Federal Plan could be assembled, and it could be completed without a long-term study and analysis. The format will be a subject of discussion at future meetings of agency planners.

The Plan will contain only those details needed to make it a useful document. It will be descriptive in nature and will emphasize the concepts of cooperation and coordination. It will be cast in terms of guidelines which serve as a conceptual framework for more detailed plans that more directly relate to the budget.

Procedural Issues

There were a number of issues identified in an earlier version of a long-range plan, some of which the agencies believe to be of sufficient importance to warrant the expenditure of resources. Other issues may be identified during ICMSSR or subcommittee deliberations; however, the OFCM considers the following to be of the highest priority for FY 1982:

- Reviewing the Federal Committee structure.
- Financing of joint programs (described below).
- Updating and extending the crosscut review of the automation of surface observations.
- Refining further the definition of roles and missions (described below).
- Continuing the coordination of the NEXRAD program through the NEXRAD Council.
- Role of the private sector.
- Centralization vs. decentralization of weather services.
- Definition of specialized and basic services.
- Technology assessment/transfer.
- The extent to which agency programs or functions may be interdependent.
- Skilled manpower training and availability.
- DOD weather support to the public sector.
- Coordination of field structure reorganization.

Joint Financing. The financing of joint programs is the most urgent issue. The triagency activity in NEXRAD is well along, and activity in automation of surface observations is in the start-up phase. In view of the vast differences among departments in procedures for funding R&D, logistics, and training, a study for the determination of optimum funding methods is essential if these programs are to realize the cost-benefits which are purported.

Update of Surface Observations. A brief update of the mutual crosscut was completed in January 1981. However, neither the initial crosscut nor the update included activities of agencies other than DOC, DOD and DOT. The OFCM will propose that the Interdepartmental Committee amplify the initial crosscut to include programs of the DOA, Forestry Service, Corps of Engineers, and others.

Update of Roles and Missions. The Roles and Missions study of FY 1980 minimally addressed agencies' roles and missions. OFCM plans to use its personnel to readdress the issue of who does what for whom and why in the broad context of national weather services. Such a task will take considerably longer than one year. However, with the multiplicity of agencies involved in the weather business to some degree, it is clear that there should be a document that more precisely defines the roles and missions of Governmental agencies involved in meteorological services and supporting research.

SECTION 3

RESOURCE INFORMATION AND ANALYSIS

This section summarizes the resources used by the Federal agencies to provide meteorological services and supporting research. The most significant changes in agency programs and the associated funding changes are also given in this section. The basic ongoing agency programs are presented in Appendix A to this plan. All fiscal data are current as of the end of January 1982. These data are subject to later changes; they do not have executive or legislative approval and do not constitute a commitment by the U. S. Government.

AGENCY OBLIGATIONS FOR METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH

The fiscal information in Table 3.1 is presented by agency for meteorological operations and supporting research and shows the FY 1982 planned funding level, the budget request for FY 1983 and the net differences. The agencies plan to spend approximately $1,056 million in FY 1982 and have requested $1,092 million for FY 1983. This represents a net increase of $36 million or approximately 3.4 percent.

Department of Agriculture (USDA)

There are slight increases in USDA meteorological operations and supporting research. The funding amounts shown reflect changes in categorization of some activities in the Department.

Department of Commerce (DOC)

The total National Oceanic and Atmospheric Administration (NOAA) FY 1983 requests is 0.8 percent lower than FY 1982 planned program. When inflation and pay increases are taken into account, this represents a moderate reduction in operational and supporting research programs. Nonetheless, the highest priority activities are being supported.

Under operations, Table 3.1 shows that the planned funding level for FY 1982 is $375.2M, a $16.5M reduction from the FY 1982 request of $391.7M that appeared in last year's Federal Plan. This decrease is largely due to reductions in the environmental satellite area. There was a slight increase in the supporting research costs over that shown last year.

Significant changes in NOAA's operations and supporting research from FY 1982 to FY 1983 are given below where changes are broken down according to the "activities" used in NOAA's budget. In FY 1983, NOAA plans to close 25 full-time Weather Service Offices (WSO's) and 20 part-time WSO's. These closures will impact a number of the budget activities discussed below -- Basic Environmental Services, Public Forecast and Warnings Services, and the Specialized Environmental Services. (Note: As this report goes to press, the proposal to close the 45 offices has been withdrawn. However, the impact on the distribution of resources, i.e., 163 positions and $2.862M, has not been determined.)

1. For its Basic Environmental Services activity, there will be a reduction of $3.8 million. This involves a reduction, from four to three, in

the number of National Weather Service regional headquarters in the conterminous U.S.; the WSO closures mentioned above; and a reduction of $1.0M in the NEXRAD Program.

2. In the Environmental Satellite Services activity, there will be a net increase of $10.8 million. This includes an increase of $35.5 million to complete preparation for GOES F launch; to continue instrument procurement and fabrication of GOES G, H and I; and to continue procurement of Delta launch services. This is offset by a decrease of $24.7 million by delaying the fabrication of NOAA H, I and J spacecraft.

3. A requested net increase of $3.3 million for Public Forecast and Warning Services will restore funding for full operations of the Automation of Field Operations and Services (AFOS) ($2.5 million) and implement the Satellite Weather Information System (SWIS) ($1.6 million). A decrease of $0.8 million in this activity is associated with the proposed WSO closures.

4. In the Specialized Environmental Services area, there will be an overall decrease of $28.8 million in FY 1983. Pending legislative authority, NOAA proposes to finance the aviation weather services from the Airport and Airway Trust Fund administered by the Federal Aviation Administration (FAA). The reduction of appropriated funds for aviation services comes to $26.7 million. The remaining $2.4 million decrease is due to eliminating the fruit frost and fire weather programs; reducing the agricultural programs; closing the 20 part-time WSO's; and deleting certain publications. An increase of $300K is to be applied to acid rain research.

5. Under Environmental Data and Information Services, there is a $1.5M decrease due to closing of the Environmental Sciences Information Center and a reduction in climate services.

6. A large number of small increases in the cost of many ongoing programs, i.e., "adjustments to base", account for about $16.7 million. These small increases arise from increased operational costs, e.g., communications, facilities and salaries; they do not involve changes in activities or systems.

Department of Defense (DOD)

A comparison between last fiscal year's Plan (Federal Plan FY82) and the present Plan shows a decrease in funding for the Department of Defense in FY 1982 ($429.3 million vs. $414.4 million). The budget reported in last year's Plan differed from the funds subsequently appropriated. Spending restrictions in many cases reduced the programmed expenditures below appropriations. From FY 1982 to FY 1983, the Department of Defense is requesting a net increase of $33.6 million for operational and supporting research costs. The significant program changes for FY 1982 and FY 1983 for the U.S. Air Force, Army and Navy are described below.

U. S. Air Force. In FY 1982, operational programs in the Air Force were reduced approximately $9.2 million. Of this amount, a $6.4 million reduction was due to costs no longer attributable to the Defense Meteorological Satellite program. Other miscellaneous reductions accounted for $2.8 million. In FY 1983, the U. S. Air Force is planning a net increase of $19.7 million for operational and supporting research costs:

TABLE 3.1
METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH, BY AGENCY
(Thousands of Dollars)

Agency	OPERATIONS			SUPPORTING RESEARCH			TOTAL		
	FY82	FY83	Net Difference	FY82	FY83	Net Difference	FY82	FY83	Net Difference
Agriculture	628	628	0	5,986	6,518	+ 532	6,614	7,146	+ 532
Commerce	375,201	369,686	- 5,515	42,984	45,210	+ 2,226	418,185	414,896	- 3,289
Defense	314,708	346,461	+ 31,753	99,658	101,504	+ 1,846	414,366	447,965	+ 33,599
Transportation/ Coast Guard	1,765	1,849	+ 84	-	-	-	1,765	1,849	+ 84
Transportation/ FAA	142,558	146,175	+ 3,617	3,221	3,179	- 42	145,779	149,354	3,575
EPA	500	500	0	7,000	5,700	- 1,300	7,500	6,200	- 1,300
NASA	829	946	+ 117	60,800	63,700	+ 2,900	61,629	64,646	+ 3,017
TOTAL	836,189	866,245	+ 30,056	219,649	225,811	+ 6,162	1,055,838	1,092,056	+ 36,218

1. For the observing category, the Air Force is planning a net increase of $7.9 million -- increases totaling $12.6 million for satellite operations, procurement of cloud height measurement equipment, and pay increases; with a decrease of $4.7 million for a reduction in procurement costs for surface observing equipment and termination of the rocketsonde and the FPS-77 weather radar modification programs.

2. For the analysis and forecasting category, the Air Force is planning a net increase of $10.9 million -- most of which will be for the Air Force Global Weather Center (AFGWC) operations.

3. For communications and dissemination to users, a net increase of $4.9 million is planned to cover pay increases.

4. For general agency support, an increase of $4.6 million is planned for pay increases, contractual services and training.

5. For supporting research programs, the Air Force is planning a net decrease of $8.4 million -- in the observation functional category there is a decrease of $8.9 million, and in the description and prediction functional category there is an increase of $0.5 million.

U. S. Army. In FY 1982, the procurement profile for replacement of upper air sounding equipment increased by $1.9 million over that reported in last year's Plan. The change in supporting research costs from FY 1982 to FY 1983 shows an increase of $7.7 million. This reflects increases of $5.0 million to convert to a civilian work force -- the hiring of 218 civilians and the release of 342 military spaces to the field Army; and $2.7 million for complete automation of research and development sites.

U. S. Navy. In FY 1982, there was a net increase of $4.0 million over the amount reported in the Plan for FY82. This reflects updated costs for personnel salaries, increased staffing at the Fleet Numerical Oceanography Center, and incidental costs for climatological services.

In FY 1983, the U. S. Navy is planning a net increase of $4.4 million for operational and supporting research costs:

1. For the observations, category there will be an increase of $2.7 million for procurement of surface, upper air and satellite equipment.

2. For the analysis and forecasting category, there is a reduction of $0.3 million due to completion of equipment for the Eastern and Western oceanography centers.

3. In the communications category, there is a reduction of $0.8 million for procurement of Naval Environmental Display Station (NEDS) equipment.

4. For general support, there will be an increase of $1.4 million primarily for costs associated with inflation and pay increases.

5. For supporting research programs, the U. S. Navy is also planning a net increase of $1.4 million.

Department of Energy (DOE)

The Department of Energy has discontinued reporting funding for meteorological programs due to the pending realignment of the agency. However, the estimated funding reported in last year's Plan for FY 1982 was $4.3 million.

Department of Transportation (DOT)

Program changes from FY 1982 to FY 1983 within DOT are presented for the Federal Aviation Administration (FAA) and the U. S. Coast Guard (USCG).

The FAA is planning a net increase of $3.6 million for FY 1983. In the observation functional category, there will be a reduction of $6.3 million as a result of savings in the weather radar displays and wind shear programs. For communications, there will be an increase of $2.8 million mostly due to higher personnel compensation costs. For dissemination to users, there will be an increase of $3.8 million due to the anticipated growth in pilot briefings and procurement of additional voice transmission equipment. Another $3.3 million increase will be needed for general support.

The USCG is planning a slight increase of $84 thousand. The USCG is estimating that approximately 300 ship-days will be required for providing towing and logistical services to the NOAA Data Buoy Office (NDBO). A small decrease in expenditures for light-station operations by replacement with automated navigational aids will help to offset the overall increased costs for FY 1983.

Environmental Protection Agency (EPA)

The Environmental Protection Agency is planning to complete its studies of prolonged elevated pollution and northeast oxidants episodes. This will permit a reduction of $1.3 million in FY 1983.

National Aeronautics and Space Administration (NASA)

From FY 1982 to FY 1983, the National Aeronautics and Space Administration is planning a net increase of $3.0 million primarily for supporting research.

AGENCY OPERATIONAL COSTS BY FUNCTION

Table 3.2 shows how the agencies plan to obligate their funds for the five major operational functions involved in meteorological service operations. Brief descriptions of the activities included in each of these major functions are provided below.

Observations. This function involves obtaining the data that underlie all weather forecasts and warnings. The observing function is divided into five program elements for planning and coordination: surface, upper air, weather reconnaissance, weather radar, and operational environmental satellite observing programs.

Analyses and Forecasts. This function involves centralized production of manual and computerized analyses of meteorological data as well as projections of the future states of the atmosphere and accompanying weather phenomena. This function is divided into three parts: analyses and forecasts on a global and hemispheric basis; products tailored for specific areas or user groups; and specific weather phenomena, such as hurricanes and severe thunderstorms.

Communications. This involves the movement of very large amounts of data and information from the observation sites to the processing centers and then disseminating products to users.

Dissemination to Users. This function represents the final step in preparing and delivering weather service products to the users. The field offices of DOC and DOD and the flight service stations of DOT are the principal program elements involved.

General Agency Support. This function involves the planning, training, maintenance, and management activities common to any large dispersed activity. The general support function is divided into internal suppport and planning, engineering and mission-related work, maintenance of equipment and facilities, training of personnel, and overall program management.

Table 3.2 shows that the agencies devote about 36 percent of their resources to observations on a sustaining basis. The principal changes year-to-year are associated with cyclic variations in satellite procurements and with costs for new equipment such as automatic weather observing stations and weather radars. Approximately 20 percent is devoted to analyses and forecasts where the major year-to-year changes are the result of replacing the computers that are the keystone of the operations. Communications costs, comprising about 11 percent of the total program, are usually stable year-to-year, reflecting the long-term nature of communications systems planning, engineering and operation. The dissemination to users function is also usually stable from year-to-year at about 17 percent because the field office structures are not subject to large changes. General agency support requiring the remaining 16 percent is subject to some significant year-to-year variations, especially in maintenance and training activities.

AGENCY SUPPORTING RESEARCH COSTS

Table 3.3 shows how the agencies plan to obligate their funds for supporting research in the four functional areas used for planning and coordinating programs.

The supporting research functions do not differ greatly from those discussed previously for operational programs. The observation and dissemination functions are identical and the "description and prediction" function equates to "analyses and forecasts". The research function of "systems and support" covers the development and engineering research work related to maintenance, training, and engineering operations.

Supporting research programs characteristically are stable year-to-year unless a major project is initiated or terminated by one or more of the agencies.

TABLE 3.2
AGENCY OPERATIONAL COSTS, BY FUNCTION
(Thousands of Dollars)

AGENCY	Observations		Analyses and Forecasts		Communications		Dissemination to Users		General Agency Support		Total	
	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83
Agriculture	225	225	53	45	-	-	350	358	-	-	628	628
Commerce	146,008	155,869	116,407	107,795	12,263	16,787	56,426	45,326	44,097	43,909	375,201	369,686
Defense	122,104	133,459	49,496	60,191	34,548	38,508	49,183	49,731	59,377	64,572	314,708	346,461
Transportation/ Coast Guard	490	472	-	-	244	236	54	54	977	1,087	1,765	1,849
Transportation/ FAA	28,159	21,766	-	-	39,209	42,005	44,134	47,952	31,056	34,452	142,558	146,175
EPA	-	-	500	500	-	-	-	-	-	-	500	500
NASA	235	259	157	219	78	83	-	-	359	385	829	946
TOTAL	297,221	312,050	166,613	168,750	86,342	97,619	150,147	143,421	135,866	144,405	836,189	866,245

TABLE 3.3
AGENCY SUPPORTING RESEARCH COSTS, BY FUNCTION
(Thousands of Dollars)

AGENCY	Observations		Description and Prediction		Dissemination		Systems and Support		Total	
	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83
Agriculture	-	-	1,800	2,100	286	300	3,900	4,118	5,986	6,518
Commerce	13,672	14,346	27,456	28,008	1,856	2,856	-	-	42,984	45,210
Defense	67,139	61,396	17,401	18,836	1,210	906	13,908	20,366	99,658	101,504
Transportation/ Coast Guard	- NOT APPLICABLE -									
Transportation/ FAA	527	530	62	75	154	250	2,478	2,324	3,221	3,179
EPA	-	-	7,000	5,700	-	-	-	-	7,000	5,700
NASA	44,825	45,575	15,750	17,975	-	-	225	150	60,800	63,700
TOTAL	126,163	121,847	69,469	72,694	3,506	4,312	20,511	26,958	219,649	225,811

METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH BY SERVICE

Table 3.4 shows how the agencies plan to obligate operational funds for basic and specialized meteorological services; Table 3.5 shows the corresponding data for supporting research. The tables show that the resources of the total Federal program are about evenly split between basic services and the specialized services. The definitions of specialized and basic services are provided below.

Specialized Services

For purposes of Federal planning and coordinating, Specialized Services are:

- Aviation Meteorological Services: Those services and facilities established to meet the requirements of general, commercial and military aviation. Civil programs are included that are directly related to services solely for civil and military programs in support of fixed and rotary wing aircraft and medium or long-range missile operations.

- Marine Meteorological Services: Those services and facilities established to meet the requirements of Commerce and Defense on the high seas, coastal and inland waters and for boating activities in coastal and inland waters. The civil programs which are directly related to services solely for marine uses and military programs supporting fleet, amphibious and sea-borne units (including carrier-based aviation and fleet missile systems) are included.

- Agriculture and Forestry Meteorological Services: Those services and facilities established to meet the requirements of the agricultural industries and Federal, State and local agencies charged with the protection and maintenance of the Nation's forests. The agricultural, large-area crop inventory programs and fruit-frost programs of the Department of Commerce are included.

- General Military Meteorological Service: Those services and facilities established to meet the requirements of military user commands and their component elements. Programs and services which are part of Basic, Aviation, Marine or Other Specialized Services are not included here.

- Other Specialized Meteorological Services: Those services and facilities established to meet requirements of user agencies or groups not included in the preceding categories, such as support to civil and military programs involving space operations and support to Federal, State and local governmental agencies responsible for dealing with urban air pollution. Department of Energy programs for these specialized meteorological services are included.

Basic Services

Basic services includes the programs and activities that do not fall under one of the specialized services identified above. In general, the products from basic services are not useful for the operational needs of users. Basic

TABLE 3.4
AGENCY OPERATIONAL COSTS, BY SERVICE
(Thousands of Dollars)

AGENCY	Basic		Aviation		Marine		Agriculture and Forestry		General Military		Other		Total	
	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83
Agriculture	-	-	-	-	-	-	628	628	-	-	-	-	628	628
Commerce	334,834	357,184	26,600	0	3,914	3,990	7,845	6,043	-	-	2,008	2,469	375,201	369,686
Defense	48,059	51,878	173,456	191,869	8,880	10,900	-	-	56,530	61,101	27,783	30,713	314,708	346,461
Transportation/ US Coast Guard	1,178	1,240	-	-	587	609	-	-	-	-	-	-	1,765	1,849
Transportation/ FAA	11,393	11,435	131,165	134,740	-	-	-	-	-	-	-	-	142,588	146,175
EPA	-	-	-	-	-	-	-	-	-	-	500	500	500	500
NASA	-	-	-	-	-	-	-	-	-	-	829	946	829	946
TOTAL	395,464	421,437	331,221	326,609	13,381	15,499	8,473	6,671	56,530	61,101	31,120	34,628	836,189	866,245

TABLE 3.5
AGENCY SUPPORTING RESEARCH, BY SERVICE
(Thousands of Dollars)

AGENCY	Basic		Aviation		Marine		Agriculture and Forestry		General Military		Other		Total	
	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83
Agriculture	-	-	-	-	-	-	5,986	6,518	-	-	-	-	5,986	6,518
Commerce	41,814	44,161	121	0	1,032	1,032	17	17	-	-	-	-	42,984	45,210
Defense	6,630	6,697	1,700	2,300	4,600	6,100	-	-	86,728	86,407	-	-	99,658	101,504
Transportation/ Coast Guard	- NOT APPLICABLE -													
Transportation/ FAA	-	-	3,221	3,179	-	-	-	-	-	-	-	-	3,221	3,179
EPA	-	-	-	-	-	-	-	-	-	-	7,000	5,700	7,000	5,700
NASA	60,800	63,700	-	-	-	-	-	-	-	-	-	-	60,800	63,700
TOTAL	109,244	114,558	5,042	5,479	5,632	7,132	6,003	6,535	86,728	86,407	7,000	5,700	219,649	225,811

services provides products that meet the common needs of all users and includes the products needed by the general public in their every day activities and for the protection of lives and property.

AGENCY PERSONNEL ENGAGED IN WEATHER OPERATIONS

Table 3.6 shows how agency staff resources are distributed among the five functions involved in weather operations. Overall, agency staff resources for FY 1983 total 18,192. This is a decrease of 258 from the 18,450 reported for FY 1982. This decrease is associated with the DOC closure of WSO's, reduction in staff for area forecasting, and adjustments in DOT's FSS operations. For FY 1983, it should be noted that 683 DOC positions that are associated with aviation weather services have been moved from the top Commerce line to the second Commerce line which gives the positions "funded by other agencies." This change arises from the NWS proposal to fund aviation weather services from the Airport and Airways Trust Fund administered by the FAA. This transfer involved 16, 322, and 345 positions respectively under Observations, Analyses and Forecasts, and Dissemination to Users. (See earlier discussion for DOC in the section on Agency Obligations.)

Among the functions, "Dissemination" requires approximately 28 percent of all staff resources. This reflects the large number of field offices operated by the Department of Commerce, Defense and Transportation, with many of these offices operating around-the-clock to serve the general public, military needs and the aviation industry.

The "Observations" function requires about 24 percent and "General Agency Support" accounts for about 16 percent of the staff resources for weather operations. Both are labor-intensive, particularly maintenance of increasingly sophisticated equipment and around-the-clock observations for forecasts, warnings and aircraft operations.

"Analyses and Forecasts" consume approximately 22 percent of the Federal staff resources for weather operations. This function, while requiring a substantial number of personnel, makes extensive use of computers and related automated processing systems to prepare a wide array of products employed by field offices to satisfy the needs of the public and specialized users of weather information. A significant portion of these staff resources are devoted to preparing and maintaining the computer programs necessary to produce new and more effective products.

The "Communications" function requires about 10 percent of the staff resources, the smallest percentage of any of the functions. This reflects the fact that communication has become less labor-intensive over the years as modern equipment came into use. It is important to note that the high percentage of the total Department of Transportation (Federal Aviation Administration) staff resources devoted to "Communications" is attributable to operations of major communications systems which support the other agencies as well as the FAA.

INTERAGENCY FUND TRANSFERS

Federal agencies transfer funds to other agencies to pay for services that the receiving agencies can perform more efficiently and effectively. Table 3.7 shows the interagency fund transfers for FY 1982. The total amount transferred

TABLE 3.6

AGENCY PERSONNEL ENGAGED IN WEATHER OPERATIONS, BY FUNCTION

AGENCY	Observations		Analyses and Forecasts		Communications		Dissemination to Users		General Agency Support		Total	
	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83	FY82	FY83
Agriculture	- NOT APPLICABLE -											
Commerce	***1,449	1,365	2,011	1,703	148	149	1,163	810	693	699	5,464	4,726
	# * -	16	153	380	-	-	-	345	-	-	153	741
Defense	2,448	2,465	1,627	1,604	815	817	2,522	2,490	2,015	2,049	9,427	9,425
	* -	-	14	12	5	4	-	-	5	4	24	20
Transportation/ Coast Guard	*** 36	35	-	-	18	17	4	4	49	54	107	110
	** -	-	-	-	-	-	-	-	14	14	14	14
Transportation/ FAA	362	316	-	-	847	851	1,334	1,246	688	718	3,231	3,131
EPA	-	-	13	13	-	-	-	-	-	-	13	13
NASA	*** 1	1	11	6	1	1	-	-	4	4	17	12
TOTAL	4,296	4,198	3,829	3,718	1,834	1,839	5,023	4,895	3,468	3,542	18,450	18,192

*Funded by other agencies

**Staff-years by others

***Staff-years

#See text for changes in Aviation Services

TABLE 3.7

INTERAGENCY FUND TRANSFERS FOR METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH, FY 1982

(Thousands of Dollars)

Agency			FY82 Funds	
Transferred from:	Transferred to:		Operations	Research
Commerce	USDA		70	-
	DOD		6,030	-
	DOT		678	-
	NASA		86,298	-
Defense	DOC		1,439	165
	DOE		-	130
	DOT		22	-
	NAS*		-	178
Transportation	DOC		17,433	467
NASA	DOC		230	75
	DOD		382	-
	NSF		-	35
EPA	DOC		-	2,800
DOE	DOC		2,240	-
		TOTAL	114,822	3,850

* National Academy of Sciences

is $114.8 million for operations and $3.9 million for supporting research. While specific amounts may vary from year-to-year, depending upon agency needs, the pattern shown in this table is essentially stable.

Department of Commerce. The Department of Defense will be reimbursed $6.0 million of which $5.8 million is for airborne weather reconnaissance of tropical cyclones and winter storms and $0.2 million for logistical support and upper air observations. The National Aeronautics and Space Administration will be reimbursed $86.3 million for costs related to procurement and launch of NOAA operational spacecraft.

Department of Defense. The Department of Commerce will be reimbursed a total of $1.6 million for data acquisition and archiving and support of the Office of the Federal Coordinator for Meteorology under the provisions of OMB Circular A-62.

Department of Transportation. The Department of Commerce will be reimbursed $17.9 million principally for meteorological support at Center Weather Service Units located with most Air Route Traffic Control Centers, research and development on meteorological equipment and prediction technology to support flight safety, and for support of the Office of the Federal Coordinator for Meteorology.

National Aeronautics and Space Administration. The Department of Defense will be reimbursed $382 thousand principally for meteorological support to the space-shuttle operations.

Environmental Protection Agency. Research and development support related primarily to air quality standards will require transfer of $2.8 million to the Department of Commerce.

Department of Energy. To support the Weather Service Support Office at the Nevada Nuclear Test Site, $2.24 million is transferred to the Department of Commerce.

LOCATIONS BY OBSERVING TYPE

Table 3.8 indicates that there are approximately 4,000 locations or platforms at which the Federal agencies make weather observations. About half of these are under the NWS Merchant Ship Cooperative Program. Included are NOAA's data buoy locations: Atlantic Ocean (5); Gulf of Mexico (3); Great Lakes (8); and Pacific Ocean (8). In addition, NOAA has placed observing equipment on 11 Department of Interior platforms (buoys or offshore platforms). NOAA also receives observational data from seven EXXON platforms in the Bering Sea. The status and capability of data buoys can be obtained from the Director, NOAA Data Buoy Office, NSTL Station, MS 39529.

TABLE 3.8
LOCATIONS BY OBSERVATION FUNCTION,
FISCAL YEARS 1982 and 1983

Observation Function	Agency	FY 1982	FY 1983
Surface (Land)	Commerce	407	369
	Commerce (Automatic)	121	121
	Defense (U.S.)	146	145
	Defense (Overseas)	82	82
	Transportation (FAA)	383	383
	Transportation (Coast Guard)	137	131
	NASA	1	1
Surface (Marine)	Commerce (MSCP) 1/	2,000	2,000
	Commerce (Buoys)	24	24
	Transportation (CG Ships) 2/	78	78
	Defense (Ships w/met personnel)	30	30
Upper Air (Rocket)	NASA	1	1
	Defense	6	1
Upper Air (Balloon)	Commerce (U.S.)	89	88
	Commerce (Overseas)	46	46
	Defense Fixed (U.S. & Overseas)	16	16
	Defense (Ships)	28	28
	Defense Mobile (U.S. & Overseas) 3/	36	36
	NASA (U.S.)	1	1
	Transportation (Coast Guard) 4/	19	19
Weather Radar	Commerce (U.S.)	127	128
	Commerce (At FAA Radars)	22	29
	Defense (U.S. & Overseas)	116	115
	Defense (Remote displays	28	28
Weather Reconnaissance	Defense (No. of aircraft)	20	20
	TOTAL	3,964	3,920

1/ Merchant Ship Cooperative Program.
2/ Reduced from 197 in FY81
3/ Includes 27 U.S. Army artillery met sections
4/ Inactive but available for use

SECTION 4

NATIONAL CLIMATE PROGRAM

SUMMARY

The National Climate Program FY 1983 budget requests by agency are shown in Table 4.1. Actual figures are shown for FY 1981 and planned figures for FY 1982. It should be cautioned that some adjustments are still being made to the FY 1982 figures (as agencies make internal allocations) and to the FY 1983 requests. These are, however, the best data available as of January 1982, having been checked through both the budgetary and programmatic channels.

The total of FY 1983 requests is slightly lower, in absolute terms, than the FY 1982 planned program. When inflation is taken into account, this represents a significant reduction in effort. The National Climate Program, just as with other Federal programs, has had to reduce the amount of effort from what had been planned earlier (e.g., the Five-Year Plan, November 1980). Nevertheless, the highest priority activities will be supported.

CROSSCUT REVIEW OF THE NATIONAL CLIMATE PROGRAM, FY 1983 BUDGET

Impact Assessment

FY 1983 funding requests by subprogram are shown in Table 4.2. Agency requests for Climate Impact Assessment will total \$20.4M, about the same level of effort as in FY 1982. The principal programs are in U.S. Department of Agriculture to determine the impacts of climate on food, fiber, and livestock production and in the Department of Energy (DOE) for studies associated with possible impacts of increased carbon dioxide (CO_2) levels in the atmosphere. The DOE effort is focussed on developing and assessing reliable information for the 1984 "Interim Assessment Report," a definitive statement up to that time, on the issues associated with increasing levels of atmospheric CO_2. DOE leads the multiagency effort in this area.

NOAA conducts studies of climate and fisheries productivity and of agricultural crop yield models. The Bureau of Reclamation of the Department of Interior (DOI) conducts studies of climatic impact on water resources management (watershed and river basin management and development, etc.) for the western United States which are large semi-arid regions.

Climate System Research

The FY 1983 total request for Climate System Research will be \$45.6M, a reduction of about \$4M from the FY 1982 level. The largest request is for the National Science Foundation which supports a broad program in just about all of the active areas of climate research (atmospheric and oceanic studies, earth sciences, paleoclimatology, etc.). Much of the NSF funding supports extramural academic research. NOAA's research is largely focussed on oceanic influences on important features of large scale climate. They are conducting two field programs (Equatorial Pacific Ocean Climate Studies and the Subtropical Atlantic Climate Studies). DOI maintains a modest paleoclimate research program to describe long term climate variations. DOE research is predominantly in support of the CO_2 program including studies of the global carbon cycle, improving climate models, and determining effects of increased CO_2 on vegetation. National Oceanic and Atmospheric Administration (NOAA), National Science Foundation (NSF), U.S. Department of Agriculture (USDA) and Department of Interior (DOI) have active research programs in support of the national program on CO_2 and climate.

Observations

The National Aeronautics and Space Administration (NASA) FY 1983 request for the observations subprogram is primarily to support the development of the satellite systems for the Earth Radiation Budget Experiment. This experiment will measure the incoming and outgoing (reflected and emitted) radiation in an attempt to relate variability in the radiation budget to variability in climate. Such measurements can only be carried out from space. NASA is also supporting the development of a satellite borne stratospheric monitoring sensor to give information on ozone levels and the ultraviolet spectrum of incoming solar radiation.

The NOAA request will mainly support the Geophysical Monitoring for Climatic Change (GMCC) program which includes ground-based measurement of ozone and CO_2, two key questions of very active interest. USDA measures snow pack, in order to forecast snow melt run-off for irrigation.

The NSF request includes about $4.2M for ship facilities and logistic support. The observations are primarily associated with large-scale oceanographic research programs such as Pacific Equation Ocean Dynamics (PEQUOD) and Seasonal Equatorial Atlantic Experiment (SEQUAL).

The declining levels of Interior's request reflect reductions in precipitation enhancement field programs.

Data Management

All of the agencies have data mangement responsibilities for the measurements they make. In addition, certain measurements taken for other purposes (e.g., weather) are retained for use in climate studies and applications. Thus, Table 4.2 includes data management funds for agencies which do not make direct climate observations.

NOAA has overall civil sector responsibility for providing climate information; thus, it has the largest program. Department of Defense also has a very large program but has grouped its funding under Information Services. The Department of Interior program is for the maintenance of a precipitation climatology partly related to its precipitation enhancement efforts.

Diagnosis and Projection

The NOAA request is to support its Climate Analysis Center which provides monthly and seasonal climate forecasts, maintains a climate diagnostic data base, conducts large scale climate diagnostic studies, and cooperates with USDA in operating the Joint Agricultural Weather Facility. The funds shown for USDA support snow melt run-off projections. NSF funds for diagnostic studies support climate prediction research and are reported in the Climate System Research category.

Information Service

These funds support the development and dissemination of climate information to end users -- primarily to the public but also to DOD field commanders and planners. DOD has lumped most of its requests for Data Management and Diagnosis and Projection into this category as the funds support facilities such as the U.S. Air Force (USAF) Environmental Technical Applications Center which manages the data, conducts engineering and applied climatological studies, and forwards the end information to the requester.

ASSESSMENT OF PRINCIPAL THRUSTS

The Five-Year Plan of the National Climate Program identifies six problem areas as being of the highest priority within this program. In several instances, work was underway in these areas before the National Climate Program came into being. Still, the Program has provided a framework for organizing and coordinating a multiagency, multidisciplinary attack on the problems. Table 4.3 shows the agency requests for activities in the six principal thrust problem areas.

The Department of Commerce (through NOAA) is the lead agency for the first two thrusts. The efforts to improve the generation and dissemination of climate data and information and to improve climate prediction are proceeding as operational, ongoing programs. However, NOAA has had to defer an important initiative ($0.47M) to improve the data base management system and to begin processing a backlog of data at the National Climatic Center (NCC). Further, the decrease of $1.3M in the NOAA-base program will cause a marked reduction in measurements and research on polar snow and ice fields which are felt to be important indicators of climatic variability. The decrease will also cause deferral of NOAA support for the International Satellite Cloud Climatology Project (ISCCP) scheduled to begin in 1983. This project is a lead activity of the World Climate Research program. Research on polar ice fields and on the influence of clouds are expected to make major contributions to improving climate prediction.

The Department of Energy leads the carbon dioxide program, and there is a notable multiagency contribution. There are also interagency transfers of fund (e.g., from DOE to USDA and NOAA) to utilize special skills. These transfers are not shown separately to avoid double counting. There is new program management in DOE and the programmatic emphasis will be on the physical science aspects of the CO_2 question with reduced effort on the social science aspects. The funding request reflects that new direction and choice of priorities.

In the climate and food thrust area, the Department of Interior (Bureau of Reclamation) is reducing activities in precipitation enhancement and the associated climate work (maintaining a precipitation climatology) is also being reduced.

NASA is the lead agency for the solar and earth radiation principal thrust and provides the bulk of the funding. In order to sustain the funding required for a viable program, NASA will focus almost all of its funding in this area and defer several important special studies (viz., air-sea interaction, hydrology, aerosol climatic effects, and polar ice).

The budget level for ocean heat flux research is about the same as in FY 1982 with NSF as the lead agency. Activities that do not fall into one of the "principal thrust" areas are included under "continuing program."

In summary, constrained funding for the National Climate Program, as part of the policy of curtailing the Federal budget, still provides for support of the highest priority portions of the program even though some important efforts have been reduced or deferred. In the context of the National Program, there is preliminary planning for an integrated approach to the question of climate monitoring for the detection of climatic variability and climate change. This is likely to involve climate diagnostic capabilities here and abroad, and it would build upon the findings of the First GARP Global Experiment. The World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) will meet next April to consider climate monitoring programs. The National Climate program expects to make recommendations for future monitoring efforts at the conference.

During mid-year 1982, however, the National Climate Program will formulate a revised Five-Year Plan which will reflect the experience and progress of the Program over the past three years. One of the issues to be addressed is the most appropriate and useful budget structure and process for communicating the contents and priorities of this program.

TABLE 4.1

CLIMATE FY 1983 BUDGET REQUESTS BY AGENCY

(Millions of Dollars)

	FY81 Actual	FY82 Planned	FY83 Request
USDA	17.4	17.0	18.2
DOC (NOAA)	25.2	26.0	24.7
DOD	9.4	10.4	11.8
DOE	12.2	13.5	9.1
DOI	6.5	4.8	3.9
NASA	30.9	33.3	32.7
NSF	32.1	35.3	37.8
TOTAL	133.7	140.3	138.2

TABLE 4.2

CLIMATE FY 1983 BUDGET REQUESTS BY SUBPROGRAMS AND AGENCY

(Millions of Dollars)

	FY81 Actual	FY82 Planned	FY83 Request
IMPACT ASSESSMENT			
Agriculture	12.7	12.8	13.5
Commerce (NOAA)	0.8	1.5	1.5
Defense	0.1	0.1	0.1
Energy	3.0	4.5	3.2
Interior	1.0	0.9	1.2
NASA	--	--	--
NSF	0.7	0.8	0.9
Sub-Total	(18.3)	(20.6)	(20.4)
CLIMATE SYSTEM RESEARCH			
Agriculture	--	--	--
Commerce (NOAA)	7.9	7.9	6.6
Defense	1.8	2.1	2.4
Energy	9.2	9.0	5.9
Interior	2.5	2.3	1.0
NASA	2.9	2.0	2.2
NSF	24.0	26.1	27.5
Sub-Total	(48.3)	(49.4)	(45.6)
OBSERVATIONS			
Agriculture	1.6	1.4	1.5
Commerce (NOAA)	4.9	5.0	5.0
Defense	--	--	--
Energy	--	--	--
Interior	--	--	--
NASA	26.9	30.5	29.7
NSF	6.6	7.5	8.5
Sub-Total	(40.0)	(44.4)	(44.7)

TABLE 4.2 - cont'd.

	FY81 Actual	FY82 Planned	FY83 Request
DATA MANAGEMENT			
Agriculture	0.5	0.4	0.5
Commerce	6.4	6.4	6.4
Defense	0.6	0.7	0.7
Energy	--	--	--
Interior	3.0	1.6	1.2
NASA	1.1	0.8	0.8
NSF	0.8	0.9	0.9
Sub-Total	(12.4)	(10.8)	(10.5)
DIAGNOSIS AND PROJECTION			
Agriculture	1.4	1.4	1.6
Commerce (NOAA)	2.2	2.2	2.2
Defense	--	--	--
Energy	--	--	--
Interior	--	--	--
NASA	--	--	--
NSF	--	--	--
Sub-Total	(3.6)	(3.6)	(3.8)
INFORMATION SERVICES			
Agriculture	1.1	1.0	1.1
Commerce (NOAA)	2.0	2.0	2.0
Defense	6.8	7.5	8.6
Energy	--	--	--
Interior	--	--	--
NASA	--	--	--
NSF	--	--	--
Sub-Total	(9.9)	(10.5)	(11.7)
NCPO	1.0	1.0	1.0
GRAND TOTALS	133.7	140.3	138.2

NOTES: A blank row means the Agency has no program in that area.

There may be slight discrepancies between Tables 4.1 and 4.2 due to "rounding off."

TABLE 4.3

AGENCY PLANNED CONTRIBUTIONS

TO THE CLIMATE PRINCIPAL THRUST AREAS, FY 1983

(Millions of Dollars)

	Generation & Dissem. Clim. Info	Climate Prediction	CO_2 & Clim.	Clim.& Food	Solar & Earth Radiation	Ocean Heat Flux	Continuing Program
Agriculture	...	...	...	*15.0	...	...	3.2
Commerce (NOAA)	* 8.4	*2.2	2.5	0.8	0.8	1.4	8.6
Defense	9.3	0.5	...	...	0.1	0.1	1.8
Energy	0.2	0.2	* 8.0	...	...	...	0.7
Interior	...	...	...	2.3	...	...	1.6
NASA	...	...	...	...	*32.5	...	0.2
NSF	...	1.5	5.9	0.6	2.6	*7.1	20.1
TOTALS	17.9	4.4	16.4	18.7	36.0	8.6	36.2

* Denotes lead agency.

APPENDIX A

COMPILATION OF STATEMENTS ON WEATHER PROGRAMS SUBMITTED TO THE OFFICE OF THE FEDERAL COORDINATOR BY THE AGENCIES

DEPARTMENT OF AGRICULTURE

The nation's food and forest resources are becoming increasingly important to our domestic and international economic situation. Food has recently taken on new dimensions in foreign affairs and national security. Weather and its effect on crop yields is one of the most important factors in the Nation's agricultural production. The USDA conducts supporting research that focuses on understanding the interactions of weather and climate with plants and animals. USDA also assists the Department of Commerce in determining farmers' needs for weather information and in disseminating such information to them. The Nation's forest resource must be managed for multiple use and must be protected from adverse impacts of fire, insects, disease, and pollution.

USDA conducts research that focuses on better management of the forest resource and the role weather plays in achieving those goals pursuant to its mission. USDA takes special fire weather observations and cooperates with the National Weather Service in providing fire and land management weather information to help manage the almost 181 million acres of national forest land.

The mission of the supporting research is to develop and disseminate information and techniques to ensure an abundance of high-quality agricultural commodities and products, while minimizing any adverse effects of agriculture on the environment. The research efforts of the Agricultural Research Service (ARS) relate directly to climatic effects and deal with developing technology and systems such as: 1) to manage precipitation and solar energy for optimum crop production; 2) to understand and manage water resources for agricultural use; 3) to understand the water-plant-atmosphere interactions; 4) to optimize the use of energy, water, and fertilizer; 5) to reduce plant and livestock losses from pests; 6) to improve techniques for irrigation and drainage; 7) to reduce plant and livestock stress from the environment; 8) to develop production, management, decision, and tactical models and systems to minimize the adverse effects of climate and weather; 9) to model the exchange between the atmosphere and gaseous compounds; and 10) to develop climate-related phenological crop models for the Great Plains.

Studies are being performed to determine the action of air pollutants on plants and methods of controlling the damage. The Cooperative State Research Service (CSRS) is cooperating with State and Federal agencies and universities to establish a nationwide program for monitoring deposits of atmospheric pollutants to determine their extent and effects on agriculture and natural ecosystems.

The Forest Service is continuing its program of meteorological supporting research, with emphasis on weather effects on forest fires and air quality. Research is pointed toward supporting Federal and other land managers by providing information on fire and smoke management, for prevention of significant deterioration of air quality and related values by studying the mechanisms by which mountainous terrain affects meteorological conditions.

Investigations carried out by the Statistical Reporting Service (SRS) will determine the potential effects of weather in crop production, both domestic and foreign. One aspect of these studies is the development of models relating various weather parameters to crop yields. Plant growth simulation models of weather-crop-yield interactions, together with other variables affecting crop yields, are constructed for use in short-run forecasting.

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

The National Oceanic and Atmospheric Administration (NOAA) is the principal meteorological agency of the Federal Government. By law, NOAA is responsible for reporting the weather of the United States and providing weather and flood forecasts and warnings to the general public, developing and furnishing specialized weather service for specific user groups, and recording the climate of the United States. This mission is carried out within NOAA by the National Weather Service (NWS), the National Earth Satellite Service (NESS), the Environmental Research Laboratories (ERL), and the Environmental Data and Information Service (EDIS).

NATIONAL WEATHER SERVICE

MISSION

The National Weather Service (NWS) has the principal responsibility for the plans and operations of the basic weather services and certain specific specialized services. The basic mission of NWS is to help ensure the safety and welfare of the general public with respect to the effects of weather and to further the conduct of governmental and commercial activities which are affected by weather.

In support of this mission, NWS:

- o Observes and reports the weather and the river and ocean conditions of the United States and its possessions.

- o Issues forecasts and warnings of weather, flood and ocean conditions.

- o Develops and operates national meteorological, hydrological, and oceanic service systems.
- o Performs applied meteorological research.
- o Assists in developing community preparedness programs for weather related natural disasters.
- o Participates in international meteorological activities, including exchange of data and forecasts.

ENABLING LEGISLATION

The basic enabling legislation and authority for weather services are listed below:

- o Organic Act of 1890 created the U. S. Weather Bureau.
- o Enabling Act of 1919 allowed U. S. Weather Bureau to enter into cooperative agreements for providing agriculture weather services.
- o Flood Control Act of 1938 authorized the establishment, operation, and maintenance of the Hydroclimatic Network by the Weather Bureau for Flood Control.
- o Federal Aviation Act of 1958 outlined duties of the Secretary of Commerce for provision of weather observations and services to aviation.
- o OMB Circular A-62 established criteria for Federal coordination of meteorological services and supporting research.

SERVICES

NWS provides two broad types of services, (1) real-time operation-oriented services and (2) technical, advisory and other supporting services relating to meteorological and hydrological considerations.

The three principal real-time operational services are (1) the measurement and description of the meteorological and hydrological conditions that prevail; (2) the prediction of the future state of these conditions; and, (3) the warnings of specific conditions that threaten life, property and the conduct of business.

To support the basic forecast and warning services, the weather observations include measurements of sky conditions, temperature, wind, precipitation, visibility, pressure, humidity, tides, currents, river stages, and solar radiation, as well as descriptions of severe weather events such as tornadoes, hurricanes, thunderstorms, blizzards, tsunamis, and general and flash floods.

To support the specialized services, additional measurements or observations are made where appropriate; e.g.,

- o Marine Weather: Coastal tides and currents, hazards to navigation on the high seas, conditions for pleasure boating, and ice and other factors affecting marine navigation.

- o Aviation Weather: Cloud ceilings and visibility, wind gusts and shears, and such significant enroute aviation hazards as aircraft icing and turbulence.

- o Agricultural Weather: Soil moisture and temperature, leaf wetness, and evaporation.

- o Fire Weather: Fuel moisture and local meteorological conditions affecting wildfire control.

- o Environmental Quality: Diffusion potential of the atmosphere and rivers.

The forecasting services involve the prediction of the future state of these same measurements for various time periods. The content of the forecasts is influenced by the interests and the requirements of the various groups of users. Forecasts are issued on a regular, recurring basis.

The warning services are keyed to the occurrence of specific events or conditions, critical to a broad or a specific set of interests. The familiar hurricane, tornado, flood, and winter storm warnings have broad impact on public and private operations. Other warnings involve critical interests to agriculture, forest protection, boating and aircraft operations. The warning services are provided at two levels of urgency, (1) the advice that conditions are favorable for the event or condition to occur and (2) the specific warning that it will occur,or is occurring.

The additional advisory and supporting services of the NWS include:

- o Disaster preparedness services.

- o Technical services for agriculture.

- o Assistance through the Voluntary Cooperation Program of the World Meteorological Organization (WMO).

- o International meteorological and hydrological advice and consultations.

- o Climatological services.

PRODUCTION AND DELIVERY OF SERVICES

The operational services of the NWS are provided by a tri-level field structure (Figure A.1). There are three national guidance centers, 52 Weather Service Forecast Offices and 13 River Forecast Centers that have regional responsibilities, for weather and hydrology services respectively, and more than

250 facilities that provide local services. These include:

- The National Meteorological Center (NMC) at Camp Springs, MD, makes large-scale forecasts and develops associated guidance material.
- The National Hurricane Center (NHC) at Miami, FL, and two regional centers at San Francisco, CA, and at Honolulu, HI, are concerned with specialized forecasts, warnings, and associated guidance for hurricanes and tropical storms.
- The National Severe Storms Forecast Center (NSSFC) at Kansas City, MO, is concerned with specialized forecasts and guidance for tornadoes and severe thunderstorms. NSSFC also provides aviation forecasts and advisories concerning severe convective activity.
- The 13 River Forecast Centers (RFC) produce specialized river and flood level forecasts and guidance material. Each RFC covers a major national watershed or portion thereof involving several states.
- The 52 Weather Service Forecast Offices (WSFO) prepare and issue medium- and small-scale forecasts, weather watches and warnings; they also acquire meteorological data. There is essentially one WSFO per State.
- The 199 local Weather Service Offices (WSO) issue small-scale forecasts, weather watches and warnings; they also acquire and generate meterological and hydrological data.
- There are 39 Weather Service Meteorological Observatories (WSMO), 11 Weather Service Contract Meteorological Observatories (WSCMO), and some 600 automated observing stations that acquire data.
- There are 54 of the 251 WSOs/WSFOs with designated Hydrologic Service Area responsibility that provide public hydrologic services.

BASIC FUNCTIONS

The basic functions of the weather services consist of weather observing (data acquisition), forecast and warning preparation (analysis, prediction and interpretation), and dissemination.

The information flows from many individual sources to central facilities for digestion and the preparation of guidance, then, flows back out for increasing levels of interpretation and tailoring to specific locations and/or applications (see Figure A.2). Figure A.3 illustrates the manner in which these functions are performed in the field operations structure.

The basic weather service relies on the cooperative efforts of several agencies of the U.S. Government and the weather services of foreign countries.

Figure A.4 illustrates the key interdependencies of these agencies.

DATA ACQUISITION

The production sequence begins with the acquisition of data on atmospheric, hydrological, and oceanographic conditions for the United States and large portions of the rest of the world. Most of the data are collected by the NWS, FAA, NESS, the Department of Defense, weather services of other nations, and cooperative observers (the latter including both land, oil platform, and shipborne cooperative observers). Some of the data also come from the Soil Conservation Service, the Forest Service, and the Geological Survey.

There are more than 1,000 principal surface observation points nationwide, with about 400 sites providing 24-hour service. Schedules at other sites are predicated on established needs; e.g., flight schedules. Most NWS observations are manually acquired although NWS is in the process of automating selected sites through its automated meteorological observing system. Elements observed include cloud cover, temperature, dew point, wind speed and direction, atmospheric pressure, and precipitation type and amount. These principal sites are augmented by 12,000 land-based cooperative observers, who report daily temperature and precipitation amounts.

Many of these field stations also send balloon-borne meteorological instruments aloft to measure temperature, moisture, pressure, and wind to 29 km above the surface. A few rocket soundings reach 100 km. There are 140 observation sites within the United States and its territories, the Caribbean, Mexico, and Central and South America. Most sites take two upper-air soundings per day at the standard analysis times of 0000 GMT and 1200 GMT. These soundings are augmented by weather observations from aircraft in flight and from satellites.

Specifically designed NWS weather radars monitor the location, extent, intensity, and movement of such severe or hazardous weather conditions as hurricanes, tornadoes, severe thunderstorms, and intense winter snowstorms. Weather radars also are capable of qualitative estimates of rainfall amount over specific watersheds to aid the forecasting of river floods and flash floods. About 123 weather radars are operated by NWS. These are augmented by about 90 weather radars operated by the Department of Defense. Of the NWS radars, 56 are staffed and operated continuously. NWS also makes observations from 22 FAA air traffic control radars in the mountainous regions of the west.

Polar-orbiting and geostationary environmental satellites collect large volumes of weather data in the visual and infrared spectrums by radiometry. NESS operated weather satellites "see" cloud cover, profile vertical temperature and humidity fields (soundings), measure sea surface temperature, portray sea ice coverage, and provide data from which frost conditions, cloud tops, and high altitude wind fields can be derived. They also collect and relay environmental data observed by remotely located sensing equipment.

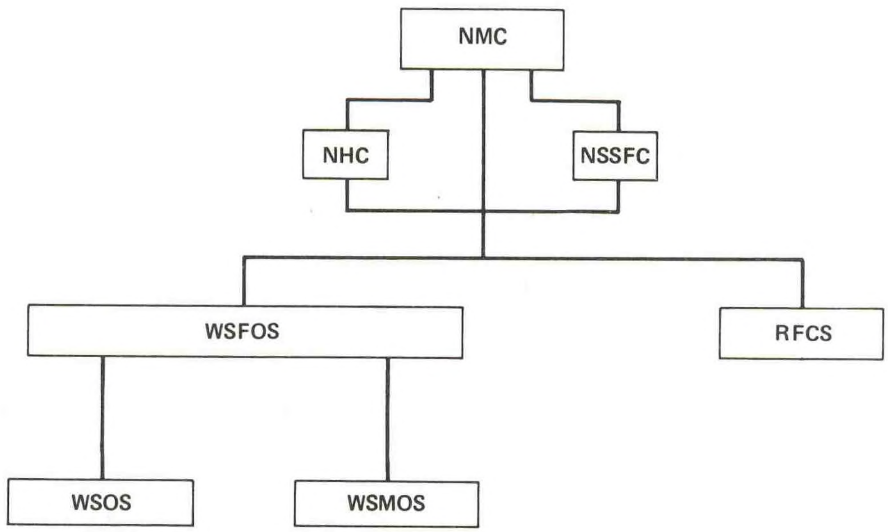


Figure A.1. NWS Field Structure for Technical Operations.

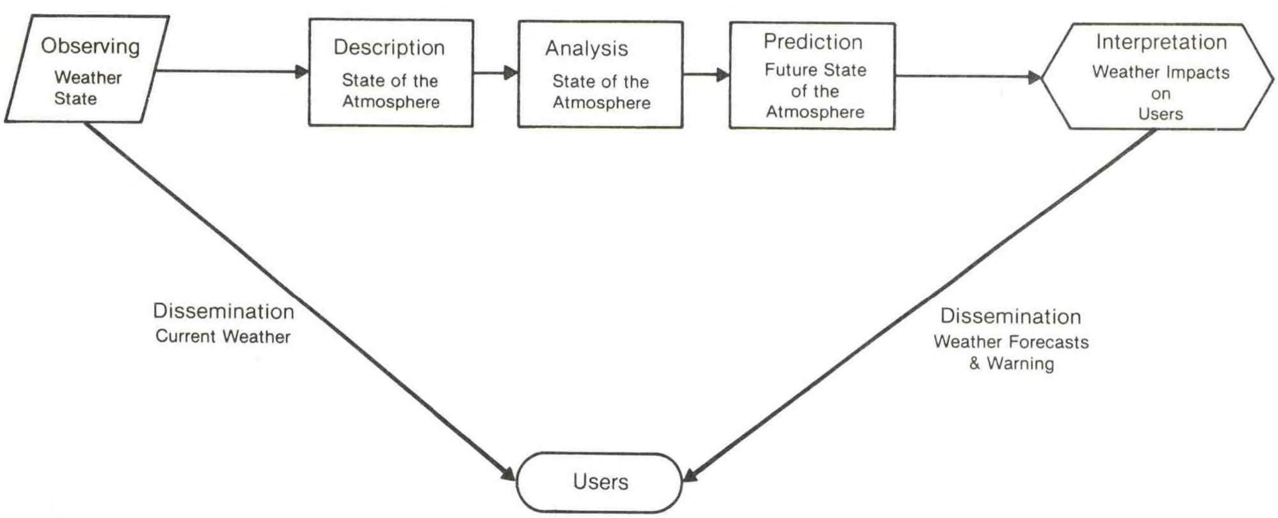
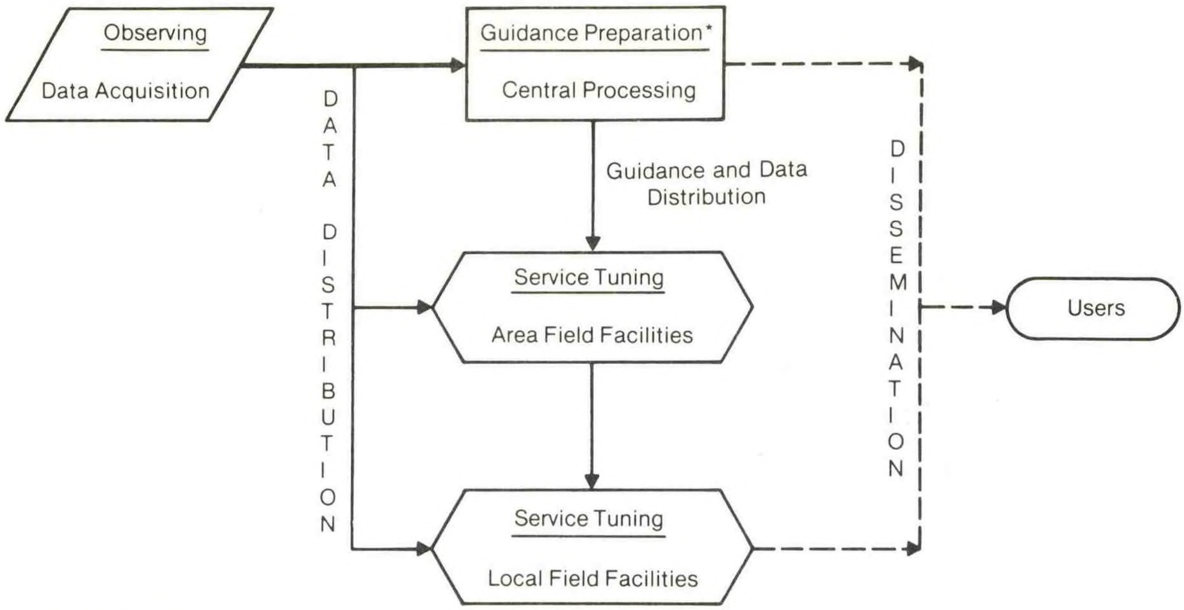


Figure A. 2. Weather Service Activities.



*Not Provided by FAA

Figure A.3. Levels of Weather Service Functions.

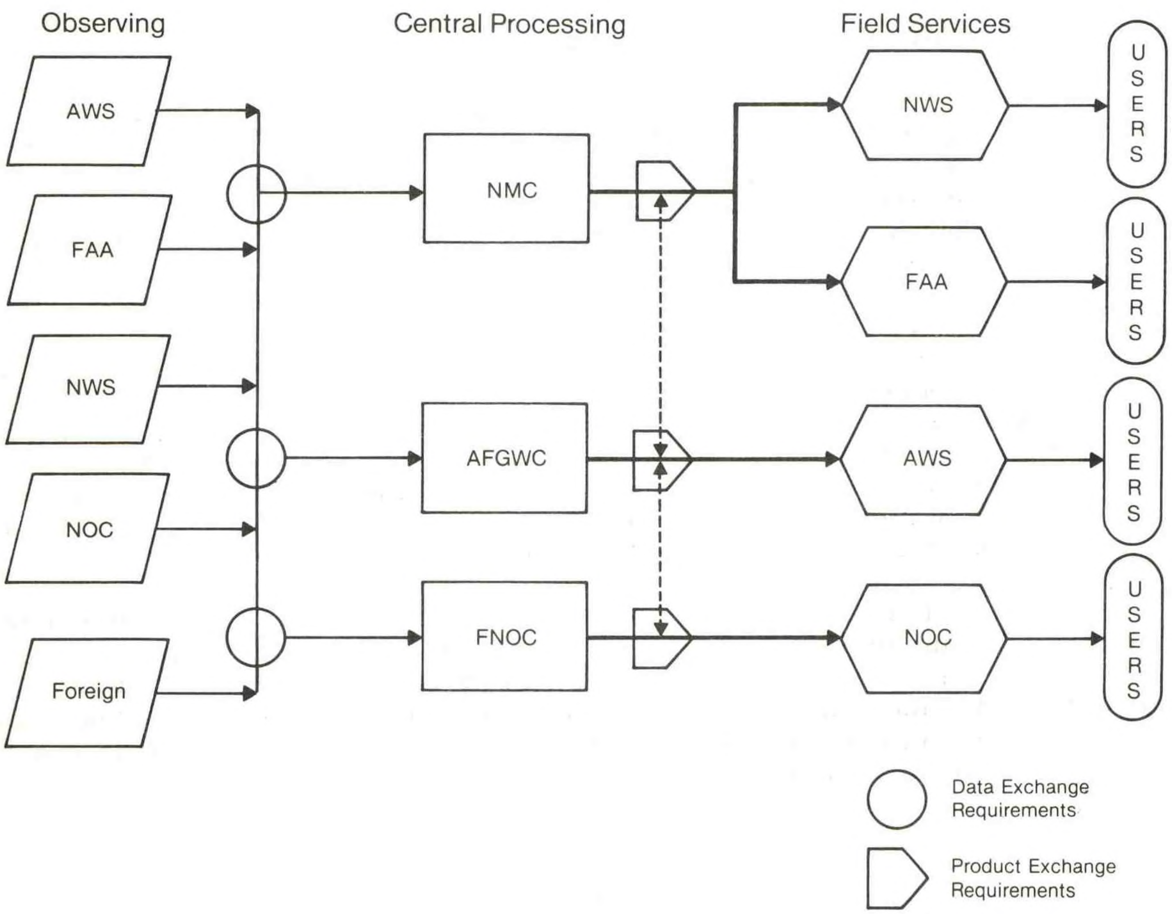


Figure A.4. Weather Service Interdependencies.

Hydrologic data are collected at about 8,000 river points nationwide. Measurements are made of river levels and precipitation amounts as input to prediction models that forecast river stages for 2,500 points. Some of these data are obtained automatically through NWS's Automated Hydrologic Observing System (AHOS).

NWS collects 90,000 to 95,000 marine surface weather observations monthly from cooperative weather observers aboard ships at sea worldwide. This is our international program participated in by 103 countries with a merchant marine. The U.S. Cooperative Ships Program is possibly the largest with over 2,000 ships in the program. There are 13 Port Meteorological Officers strategically located in U. S. ports to serve as liaison between NWS and the marine community.

Oceanographic data include "profiles" of deep ocean temperature and salinity, which are derived from bathythermographic measurements made by U.S. Department of Defense, U. S. research vessels and cooperating merchant marine ships. There are undersea measurements made at different depths. Sea-surface temperatures are observed and reported by NOAA data buoys and satellites, the U. S. Navy and American research vessels, as well as by ships-of-opportunity of many nations. Observations of tides, sea and swell are also observed and reported daily.

FORECAST PREPARATION

Once acquired, the data are transmitted to all NWS organizations that have pertinent forecasting responsibilities. The organizations then process and analyze the data and use the results to prepare their respective outputs. Such organizations include the WSFOs, and WSOs, as well as the large-scale and specialized weather forecasting organizations that have major responsibilities for preparing guidance material for the WSFOs and (through the WFSOs) for the WSOs.

Preeminent among these organizations is the National Meteorological Center (NMC), which in many respects is the key to NWS's analysis and forecast function. NMC has responsibility for developing coordinated large-scale forecasts and associated guidance material for the United States and much of the rest of the Northern Hemisphere, plus portions of the Southern Hemisphere. It produces a large number and variety of graphic products describing both current and forecast conditions throughout these areas.

Current condition depictions include 3-hourly and 6-hourly pressure analyses at the surface and 12-hourly analyses at about 1.5, 5.6, and 10.4 km above the surface. These products are produced by a mix of computerized numerical methods and human intervention to allow for subjective considerations. They give forecasters throughout the Nation a generalized, three-dimensional analysis of the current weather conditions.

Using information on current conditions as a starting point, NMC then uses objective numerical weather prediction programs (based principally upon various models of atmospheric dynamics and Model Output Statistics (MOS)) to predict future conditions of the Nation's weather for periods up to 10 days.

NMC transmits this information to forecasters throughout the Nation as guidance material for the preparation of specialized, medium-scale, and small-scale forecasts which become the final products issued to the using community. This information is distributed widely. NMC makes about 2,000 facsimile and teletypewriter transmissions daily to field forecasters. In addition, there are daily communications schedules for overseas users.

NMC's products are intended primarily to guide organizations responsible for specialized and medium-scale forecasts, and virtually all are made available to the public through these forecasts. A few products, however, are disseminated without change either directly by NMC or through other NWS organizations.

Specialized forecasting covers a less-than-national area, either a variable area determined by the current and future location of hurricanes, tornado systems or other specific phenomena or by a fixed area determined by river and stream drainage. Forecasts of NSSFC and NHC fall into the first category; those of the RFCs into the second. All, however, share two common characteristics, (1) they forecast only specific meteorological/hydrological phenomena and (2) their products represent important guidance to the WSFOs even though the products typically go to some users without change.

NSSFC prepares and issues tornado and severe thunderstorm "watches", which are then disseminated to the public in the threatened areas. A watch is a public-oriented statement which indicates that meteorological conditions are favorable for the development of severe thunderstorms or tornadoes. The watch statement may include advice as to what precautions should be taken by the public to protect itself from these hazards. As opposed to a watch, a warning of severe thunderstorms or tornadoes can be issued by any NWS field facility when a thunderstorm or tornado has been sighted.

NHC issues bulletins, watches, and warnings describing the current and future location, intensity, and movement of hurricanes, other tropical storms, and associated coastal tides. These bulletins are considered final products and are issued either directly or through the WSFOs to the public and other interested groups without modification.

Just as NHC and NSSFC analyze and forecast hurricanes and other severe disturbances, the RFCs develop specialized analyses and forecasts of river levels, stream flows, and flood stages to be expected in major national watersheds. They also develop runoff and snowmelt forecasts. RFC forecasts are normally disseminated to the public through the WSFOs without change.

Building primarily upon the material provided by NMC, the 52 WSFOs develop a large number of forecast products particularized in terms of area peculiarities and special user needs. These medium-scale forecasts often are issued directly to the public without further modification. A representative list of these products follows:

- o State forecasts cover general weather conditions out to five days. Information would include expected amount of sunshine or cloudiness, precipitation, diurnal temperature variations and wind conditions.

- Zone forecasts are similar in content to state forecasts but are further particularized to an area generally comprising several counties or parishes.

- Recreational forecasts are similar to zone forecasts but are limited to recreational zones, beaches and pleasure boating areas, skiing areas and so on.

- Agricultural forecasts reflect a further particularization of the weather elements included in a State forecast, to allow decision-making by farmers in terms of spraying crops, irrigating, harvesting and so on.

- Aviation forecasts again represent a further particularization of weather elements, so that the information applies to airport conditions and inflight weather.

- Marine forecasts focus on the coastal areas and high seas. They cover general weather conditions with specific emphasis on wind and wave conditions.

- Fire weather forecasts provide the weather elements for use in fire management planning, forest and rangeland management activities, and wildfire control. These specialized forecasts are often very localized, site-specific and time-specific in nature.

- Air pollution forecasts provide the necessary weather elements to express the atmosphere's ability to dilute and disperse pollutants as required for air quality management activities.

Small-scale forecasting involves the modification of medium-scale products so that they describe a specific locality, such as a city and its suburbs, an airport terminal, a national forest, a farming community, a local recreational area, a point-source polluting area, and space launch and recovery areas. This process considers two different sets of variables: (1) topographic and climatological peculiarities, and (2) unique parameterization of the basic weather elements to make them useful for specialized activities. Examples of the latter would be spraying information for crop protection or estimates of fuel moisture content of the debris covering a national forest.

Many small-scale public weather forecasts are made by meteorological technicians at the WSOs. These forecasts are frequently described as local adaptive forecasts; they are not original forecasts but rather an adaptation and localization of medium scale forecasts to meet local needs.

COMMUNICATIONS

In addition to the above discipline-oriented functions, there are substantial functions required to support the interchange of data and products within the service, the dissimination of the services to users, and the management and maintenance of operations.

The internal communications systems are in a transition stage. The use of most of the teletypewriter and facsimile circuits are being phased down, and the communication of both graphic and alphanumeric data is being concentrated on the Automation of Field Operations and Services (AFOS) system. AFOS will eventually replace the use of FAA-controlled circuits for internal NWS communications. AFOS consists of higher speed circuits (one for each NWS region) driven and interconnected by a Systems Monitoring and Coordination Center (SMCC); see Figure A.5.

External communications (i.e., communications to the non-NOAA users of information) involve a number of types of systems which are used to deliver weather services directly to the public, to private industry, and to other specialized groups via some intermediary organization. These include:

- Government-operated teletypewriter systems to commercial TV and radio stations; e.g., NOAA's Weather Wire Service.
- Direct radio broadcasts to the public through NOAA Weather Radio System.
- Heavy-duty automatic telephone answering devices which are operated by telephone companies and which, directly, give the public weather information furnished by NWS stations.
- Direct NWS-to-the-public telephones, including automatic answering devices at NWS field offices and personalized services.
- Special interfaces to the communications systems of the agencies; e.g., FAA networks, civil defense systems, and systems operated by private companies.

To a large extent, the success of the dissemination of services depends on the close cooperation among NWS, other government agencies and private enterprise. Service to the general public depends heavily on the news media. The NOAA Weather Wire Service, which is the chief interface to the media, is being driven by the AFOS system.

With the greater emphasis on the incorporation of high technology equipment in the observation of the atmosphere and in the communication and processing of weather information, more resources in terms of facilities, maintenance and training are devoted to the support of weather service operations. More of the training is concentrated on the operations and maintenance of automated data processing systems and on developing the ability to capitalize on the capability of the systems to improve the technical quality of the weather services.

TECHNICAL ASSISTANCE TO OTHER ORGANIZATIONS

Besides developing and issuing weather reports, NWS provides a number of other services that essentially involve technical assistance, advice and consultation:

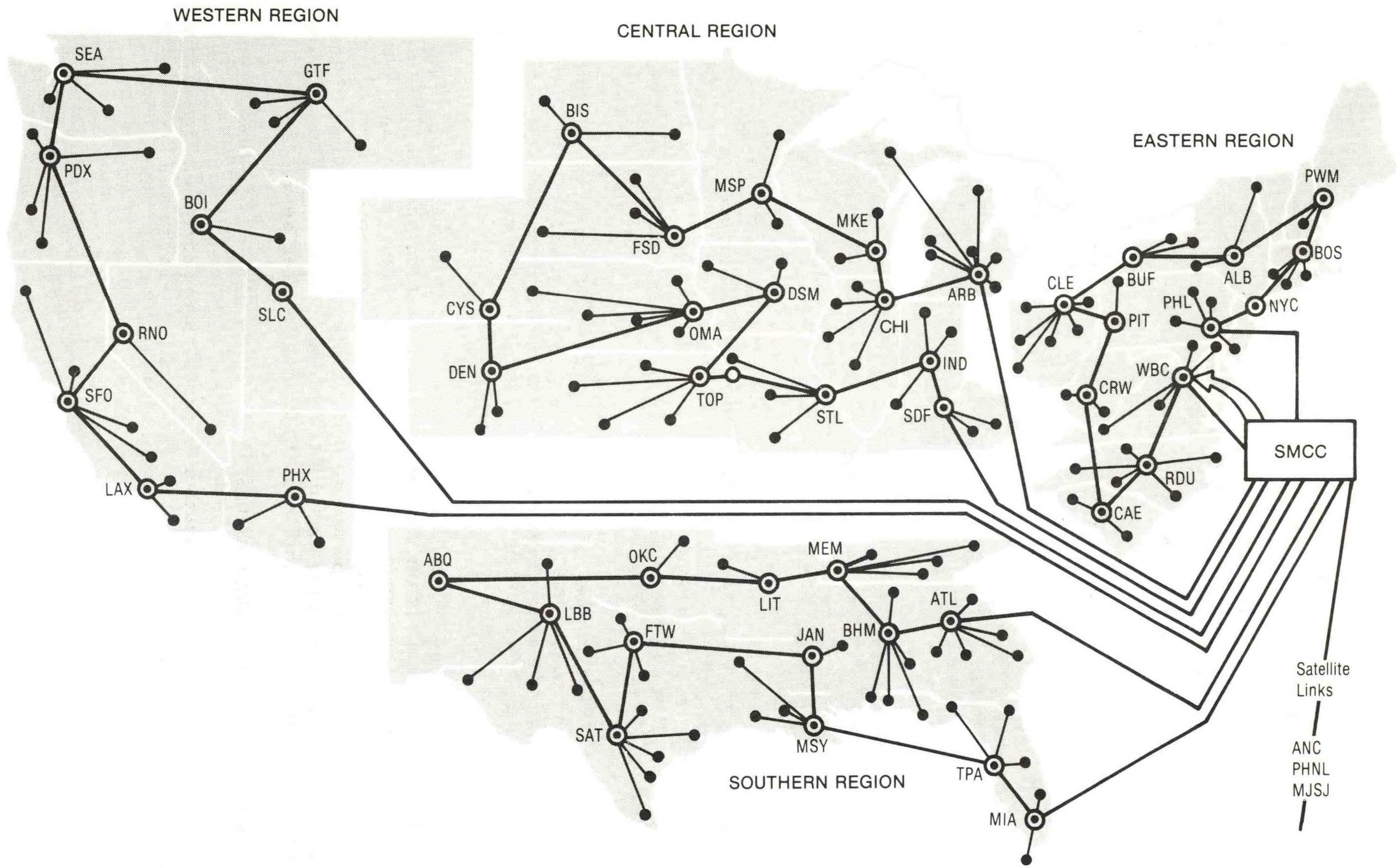


Figure A.5. AFOS Communications - Regional Loops.

Legend

⊙ WSFO

● WSO

- o Disaster preparedness assistance is designed to improve the response to forecasts and warnings by community officials and the public. It is carried out, within available resources, by WSOs and warning preparedness meteorologists assigned to WSFOs primarily in the eastern, midwestern and southern states. A Washington-based staff coordinates this program. The NWS effort is coordinated at all levels with the Federal Emergency Management Agency (FEMA) through a formal NOAA-FEMA Memorandum of Understanding.

- o Technical assistance to agriculture involve four Environmental Studies Service Centers (ESSC) in Texas, Mississippi, Alabama and Indiana. These ESSCs provide technical services, both, directly and through their respective land grant colleges.

- o The WSFOs and WSOs also provide direct technical assistance to Federal, State, and local governmental agencies, educational institutions, and the news media, as well as to the general public on a local basis.

- o Technical assistance to communities in developing local self-help flash flood warning systems, nationwide.

- o Technical assistance to Federal and State Forest and Land Management agencies is provided in the areas of training, observation, instrumentation, and site selection and in the evaluation of weather related developmental programs.

- o The Voluntary Cooperation Program provides meteorological assistance to less developed countries.

- o International meteorological and hydrologic advice, consultation, and assistance are avilable upon request.

- o NWS offices are involved in weather-related litigation activities and expert testimony.

- o Climate services are offered by the Climate Analysis Center of NMC, WSFO, WSO, RFC and ESSC, in addition to that provided by the Environmental Data Information Service (EDIS) of NOAA.

APPLIED RESEARCH AND DEVELOPMENT

To ensure that the quality of NWS forecasts and services continues to improve and is in line with current state-of-the-art, applied research and development is being carried on in a number of areas within NWS.

- o <u>Numerical Prediction</u>. Research and development is aimed at improving the day-to-day general forecast and warning services by placing the analysis and prediction system on a stronger scientific basis. Numerical prediction models that simulate atmospheric and hydrologic processes are constantly worked on and better computer techniques to solve the underlying equations are developed. Long-range prediction research is aimed at developing an improved capability to support operational planning.

- Forecasting Techniques Development. In the design, development, test and evaluation of improved objective forecasting techniques, special attention is focused on providing to field forecasters automated guidance forecasts of weather elements of immediate concern to the public and to users of specialized weather information, such as the aviation and agricultural communities.

- Short-term Climate Fluctuations. Research and development are aimed toward improving the accuracy, extent, information content and lead time of seasonal outlooks. Diagnostic studies are being conducted of short-term regional and global climate fluctuations.

- Hydrologic Models. Research efforts concentrate on the improvement of specific facets of the NWS River Forecast models using meteorological information and forecasts. Studies, augmented by research contracts, involve dam-break flood forecasting, snowmelt, mechanics of the rivers, data acquisition and analysis techniques, and procedures to update river forecasts.

- Equipment Development. NWS conducts research to devise and develop new and improved techniques for measuring weather elements. Meteorological instrumentation is being developed with a primary emphasis on automating the detection and dissemination of the data. Integration of automatic sensing equipment with AFOS will allow for computer controlled collection and processing of observational data. Test and evaluation of weather equiment are conducted at Sterling, VA. This facility, which has the capability to simulate a typical weather station, conducts tests of equipment and procedures under a wide range of environmental and operational conditions.

- Specific Products. NWS also conducts ad hoc research and development to improve quality and timeliness of forecasts and warnings issued to the public. Research and development are conducted in the Systems Development Office, the Hydrologic Research Laboratory, the Regional Offices, the National Hurricane Center, the National Severe Storms Forecast Center, NMC, River Forecast Centers, and many WSFOs to improve the forecasts of hurricanes, severe local storms, general weather, general flooding, flash floods and aviation weather conditions, using both dynamic and statistical techniques.

ENVIROMENTAL DATA AND INFORMATION SERVICE

Unless otherwise noted, Environmental Data and Information Service (EDIS) authority for its activities is contained in 15 USC 313, 49 USC 1463, and Department of Commerce Executive Order 25-5B. EDIS receives global meteorological and climatological data and information from other units of NOAA, other agencies, organizations, and individuals, both domestic and foreign, and incorporates them into the national environmental data base. The EDIS national data base defines and documents the physical environment and its processes. It is shared with the military for their use in national defense applications. EDIS also develops and carries out national programs required by legislation. Examples include the Principal Thrust of Generation and Dissemination of Climate Information in the National Climate Program. From the National data base, EDIS provides global data and information products and services to over 140,000 users in commerce, industry, agriculture, science, engineering, the general public, and Federal, state and local governments.

The EDIS National Climatic Center (NCC) is the custodian of U.S. weather records and is the largest climatic data center in the world. It also provides environmental satellite data to users. In addition, NCC houses World Data Center-A for Meteorology. NCC receives and processes over 30 million meteorological observations annually and disseminates data and summaries. Data are gathered from the National Weather Service, the National Earth Satellite Service, FAA, military services, and international sources. There are over 95,000 subscriptions to regularly published data and over 70,000 user requests are answered annually. General publications serve the needs of broad user audiences. Other data publications are designed to meet specific needs of large user groups. The latter include climatic publications prepared for the U.S. Navy.

DATA BASES

EDIS is responsible for maintaining, organizing and evaluating a large variety of data bases. The first thrust of the National Climate Program, and the highest priority, is to improve the generation and dissemination of climate information. NOAA has been designated the lead agency for the implementation of this thrust and has delegated this responsibility to EDIS. The first objective is to improve the quality and accessibility of existing climatic data. In this activity NCC will complete, compact, quality control, and enter into an automated data base selected sets of meteorological data. Initially, an intensive effort will be dedicated to processing the huge backlog of dispersed data files containing nearly two billion observations. High priority meteorological sets that will be processed include 300 U.S. hourly airway stations; 12,000 cooperative climatological stations; 800 million global marine weather observations; 3,000 U.S. hourly precipitation stations; 8,000 global synoptic stations; and, 5,500 global upper air stations.

The procurement by NCC of a Data Base Management System for Geostationary

Satellites by is underway. It will consist of a hardware/software configuration capable of (1) collecting full resolution Geostationary Orbiting Environmental Satellite (GOES) data on an archival medium and (2) searching and retrieving data from the archives, including the capability to produce imagery or digital products to meet user needs.

The National Oceanographic Data Center (NODC) is the world's largest repository of oceanographic data. Marine meteorological data are made available to users through its publication, Mariners Weather Log. The "Log" is sent to weather observers, the shipping industry, Navy, Coast Guard, fishermen, and private boatmen. It is the official record of weather and tropical cyclones over the world's oceans.

EDIS's National Geophysical and Solar-Terrestrial Data Center (NGSDC) provides archives and retrospective data and information services for the solid earth and near-space environments. Its archives include paleoclimatic data and space environmental data acquired by environmental satellites. The Center also prepares a consolidated list of solar flares, compiled from worldwide observatories.

The EDIS Reference Climatological Station (RCS) Program is managed by NCC and involves a network of 21 climatological stations serving as anchor points to stabilize the national network of principal and ordinary climatological stations. The latter stations suffer from changes in location, environment (natural and artificial) and exposure. Thus, continuity is interrupted and climatic changes can be estimated only by statistical techniques. The RCS anchor stations provide a "baseline" of climatological records, based on many years of observations in an undisturbed environment, thus providing a true measure of climatic trend. NCC furnishes technical leadership, monitors and funds the program. The National Weather Service operates the stations and furnishes inspection and maintenance service for the RCS stations.

APPLIED CLIMATOLOGY

Scientists of the Center for Environmental Assessment Services (CEAS) and the national data centers provide specialized data summaries, analyses and interpretations to meet national needs for climatic and marine environmental assessments. Specifically, CEAS provides products and assistance for projects dealing with the synthesis of atmospheric/oceanic baseline and engineering data and the assessment of social, economic and ecological impacts of climatic variations.

CEAS uses current and historical environmental data to provide assistance to managers of critical national resources by assessing impacts of climate variations on food, transportation, and energy resources. Impact assessment is accomplished by development and application of statistical and other numerical models; preparation of model inputs from current or historical data bases; and, tracking and verifying climatic anomalies on a global basis.

Agriculture

CEAS scientists are designing and delivering quality-controlled, standard-format, climatic data bases and are developing and testing a wide variety of weather/crop-yield models to support the Agricultural and Resource Inventory

Surveys through Aerospace Remote Sensing (AgRISTARS) program. This is a multi agency (USDA, NOAA, NASA, DOI, and US/AID) effort that aims at the improvement of USDA's global early warning and crop production estimation capabilities. Agriculture accounts for 16 percent of the U.S. gross national product (GNP) and is one of the three top sectors of export goods. Success in this project will allow the USDA to anticipate global food supplies and price fluctuations; thus, helping U.S. farmers and the national economy.

CEAS has developed climate/crop-yield models for major grain exporting countries. These models provide the USDA with information used in making decisions on grain export policies critical to the Nation's balance of payments. Assessment products and subsistence climate/crop-yield models have also been developed for 50 countries in Africa, 15 countries in Southern and Southeast Asia, and 15 countries in Central and South America. These are used by AID's Office for Foreign Disaster Assistance to verify claims for relief assistance and by foreign governments and international organizations to minimize the effects of grain production failures around the world.

Energy

NCC is working with other EDIS and NOAA components and the U.S. Department of Energy to quality control and validate solar radiation data taken in past years and to combine them with other meteorological data in a form most useful for solar energy applications. NCC can provide hourly solar radiation data or estimates for 241 locations in the United States. These data are used to determine the availability of solar energy for heating, cooling, and power generation systems. The Department of Energy (DOE) is using the reworked solar data to develop typical solar radiation values for selected U.S. cities.

About one-third of all the energy consumed in the United States is used to heat, cool, and operate homes, apartments, offices, and other buildings. It has been estimated that building-associated energy consumption could be reduced by up to 40 percent if climatic factors were included in the design, siting, and construction of buildings. NCC and the American Institute of Architects Research Corporation are cooperating in a pilot project to define the influence of climate on design criteria for residential housing. The goal is to provide specific guidance to engineers and architects, so that homes can be designed to be responsive to the climate and, thus, reduce fuel consumption. NCC also develops data products and services used by DOE to help homeowners and utility companies utilize wind energy and to guide the selection and evaluation of sites for current and future wind turbine development by DOE and NASA.

CEAS' energy-demand models currently provide DOE with state and regional estimates of natural gas usage, as well as expected demand for the next 30-to-90 days and for the heating and cooling seasons. These products were developed at the request of the Secretaries of Commerce and Energy. The estimates are being expanded to consider electricity and petroleum products. The DOE has requested that (1) assessment capabilities be extended to Europe, Canada, Australia and Japan and that (2) U.S. estimates be refined to the substate level.

Planning, site-selection, design, construction and operation of energy development facilities, such as drilling rigs on the Outer Contintinental Shelf, require assessments of interacting environmental elements; i.e., winds, visibility, air temperatures, atmospheric pressure, storms and storm surges.

CEAS has prepared such assessments for the Mid-Atlantic Bight, the Georges Bank and the California Outer Continental Shelf areas to support Department of the Interior (DOI) programs for the development of gas and oil resources. New synthetic fuels programs and stepped-up nuclear powerplant construction will generate an increasing demand for such products and services.

Military

The NCC data base is shared and/or accessed by the military services; and, NCC processes and archives data for, and provides tailored products and services to, the military. Because of the Administration's emphasis on strengthening defense capabilities, it is expected that DoD's demands for environmental data support will increase. The Navy, for example, projects an increase of more than 40 percent in their need for climatic data services over the next five years.

Bioclimatology

NCC answers hundreds of queries each year from patients and physicians concerning climate/health problems. Participants representing the medical community at an NCC-sponsored Workshop on Climate and Health agreed unanimously that NCC climatic data should be packaged in formats tailored to meet the needs of doctors, patients, and the research health community. The group also cited the need to relate weather and climatic events to cardiovascular disease, asthma and other allergenic ills, as well as to musculoskeletal, respiratory, neurologic and psychiatric problems. Since the Workshop, NCC has let contracts to several universities to define better the impact of weather and climate on health.

Publications

Under Code 10 USC 7393 and an Executive Order dated July 29, 1964, NCC furnishes meteorological data and analyses to be included in the Defense Mapping Agency Hydrographic Center's Pilot Charts and Sailing Directions Planning Guides.

NCC is providing state-funded state climatologists with data and publications. There are working agreements with 42 states and negotiations are underway with the remaining states. The activity is designed to expand NOAA's climatic data/information service capability to users at the local level; it provides a base to support the National Climate Program mandated by law.

EDIS's Marine Advisory Service is cooperating to produce a series of recreation weather brochures. These give weather information useful to vacationers. Brochures have been completed for Delaware, Rhode Island, coastal North Carolina, San Francisco Bay, Puerto Rico and Lake Erie.

NATIONAL EARTH SATELLITE SERVICE

Public Law 87-332 of September 30, 1961, provided the first appropriation for a national operational meteorological satellite system. This basic meteorological observing program consists of polar-orbiting and geostationary satellites. The U.S. Department of Commerce (DOC), through the National Earth Satellite Service (NESS), is the agency responsible for a national operational environmental satellite system. DOC is charged with operating and improving the system to meet the common requirements of the Federal agencies. The objectives of this operational system are to:

- Provide global imagery of the Earth and its environment on a regular basis, day and night, including direct readout to local ground stations within radio range of the satellite.

- Obtain quantitative environmental data on a global basis, such as temperature, moisture, winds, radiation flux, and solar energetic particle flux, for use in numerical analysis and prediction programs.

- Obtain near-continuous observations of the Earth and its environment, collect data from remote observing platforms (including automatic weather stations, balloons, aircraft, ships, buoys, and river and tidal stations) and broadcast weather data to remote locations.

- Improve monitoring and prediction of the atmospheric, oceanic, and space environments by developing applications of satellite information.

The operational satellite programs are directed toward satisfying the above objectives. The system also includes command and data acquisition stations; a satellite operations control center through which the satellites are controlled and data acquired; facilities for processing and analyzing satellite data and preparing products for distribution to the users; laboratories for developing new and improving existing applications of satellite data and conducting satellite instrument experiments; and programs for determining requirements of future operational satellite systems.

Satellite Field Services Stations (SFSS) have been established to analyze, interpret and distribute processed geostationary satellite products to regional National Weather Service offices and other Federal agencies. The products are also made available to private activities at their expense. SFSSs are located in Washington, D.C.; Miami, FL; Kansas City, MO; Honolulu, HI; San Francisco, CA; and Anchorage, AK. The Anchorage SFSS distributes data from both the polar-orbiting and geostationary systems. The San Francisco SFSS also has the capability of receiving data from the polar-orbiting satellites. A new SFSS was established at Slidell, LA, on August 24, 1981, to provide environmental support to the Gulf of Mexico.

POLAR ORBITING SYSTEMS

The NOAA system of environmental polar-orbiting satellites replaced the ITOS system on July 15, 1979. TIROS N, the NASA prototype, was launched by the Atlas launch vehicle on October 13, 1978; and, NOAA 6, the first NOAA-funded operational satellite of this series, was launched on June 27, 1979. On February 27, 1981, TIROS N became inoperative when its power supply failed, causing complete loss of altitude control. On June 23, 1981, NOAA 7 was successfully launched, and it became operational August 24, 1981. NOAA 6 and NOAA 7 are now the two polar-orbiting satellites.

NOAA-funded satellites retain the NOAA name and are numbered consecutively beginning with the number immediately following that last used in the ITOS series. These satellites focus on increasing the accuracy of weather forecasting by providing quantitative data required for improved numerical models. They carry advanced instruments to provide improved temperature soundings and microwave channels to facilitate sounding retrieval in cloudy areas. They also provide advanced multichannel images and carry a new data collection and platform location system. During the lifetime of the NOAA system, new instruments may be added or substituted for others. Therefore, the spacecraft are designed for a 25 percent growth capability in terms of weight, volume, power, command, and telemetry.

These spacecraft are five-sided, box-like structures that are 3.71 m long, 1.88 m in diameter, and 1,409 kg in weight, including expendables. This third-generation system consists of two satellites in orbit; therefore, there is no instrumental redundancy on either spacecraft. NOAA 6 and NOAA 7 operate in near-polar, sun-synchronous orbits of 810 and 850 km, respectively, and provide environmental observations of the entire earth four times each day. NOAA 6 crosses the Equator in a southward direction at 0730 local time and NOAA 7 crosses the Equator in a northward direction at 1430 local time. NOAA 7 orbits at a somewhat higher altitude to avoid extended periods of readout conflict. The orbital period of the satellites is 101.58 minutes which produces 14.2 orbits per day.

The NOAA system satellites carry four primary instrument systems. The Advanced Very High Resolution Radiometer (AVHRR) provides data for real-time transmission to both Automatic Picture Transmission (APT) and High Resolution Picture Transmission (HRPT) users and for storage on the spacecraft tape recorders for later playback. Thus, the AVHRR instrument improves satellite services in stored and direct readout radiometric data for day and night cloud cover, sea-surface temperatures, and snow mapping. The data from the AVHRR instrument on NOAA 7 are available in five operational modes. The AVHRR on NOAA 6 has only the first four modes listed below:

1. Direct readout to ground stations of the APT class worldwide, at 4-km resolution, of the visible and infrared data. Panoramic distortion is removed.

2. Direct readout to ground stations of the HRPT class worldwide, at 1.1-km resolution, of all spectral channels.

3. Global onboard recording of 4-km resolution data from all spectral channels. Global area coverage for commanded readout for

processing in the NOAA central computer facility at Suitland, MD.

4. Onboard recording of data from selected portions of each orbit at 1.1-km resolution of all spectral channels with local area coverage for central processing.

5. Onboard recording of data at 1.1-km resolution of all spectral channels to enhance sea surface temperature measurements in the tropics.

The TIROS Operational Vertical Sounder (TOVS) system combines data from several complementary sounding instruments on the spacecraft. These instruments are the High Resolution Infrared Sounder (HIRS/2), the Stratospheric Sounding Unit (SSU), and the Microwave Sounding Unit (MSU). The primary instrument providing tropospheric data, HIRS/2, is sensitive to energy from the visible to the carbon dioxide region of the infrared spectrum. This instrument is designed to provide data that permits calculation of temperature profiles from the surface to 10 mb, water vapor content at three levels of the atmosphere, and total ozone content. The SSU instrument, which is sensitive to energy in the carbon dioxide portion of the infrared spectrum, provides temperature information from the stratosphere. This instrument is provided by the Meteorological Office of the United Kingdom. The third instrument, the MSU, is sensitive to energy in the oxygen region of the microwave spectrum and will be used in conjunction with the two IR instruments. The microwave data permits computations to be made in the presence of clouds.

The Data Collection System (DCS) is provided by the Centre National d'Etudes Spatiales of France. The French call this the ARGOS Data Collection and Platform Location System. The ARGOS DCS provides a means to locate and collect data from fixed and moving platforms. It provides two new services not currently present in the geostationary satellite data collection system. First, it has the capability to determine platform location, using an inverse Doppler technique. Second, it is able to acquire data from any place in the world, but more particularly in the polar regions, beyond transmission range of the geostationary satellites.

The Space Environment Monitor (SEM) measures solar proton flux, alpha particle and electron flux density, and energy spectrum and total particulate energy distribution at spacecraft altitude. The three detectors included within this instrument are the Total Energy Detector, Medium Energy Proton and Electron Detector, and High Energy Proton and Alpha Detector. This instrument will augment the measurements currently being made by NOAA's geostationary satellites. The data from the SEM will be processed at Suitland, MD, and transmitted over a dedicated data link to NOAA's Space Environment Laboratory at Boulder, CO, within one hour of the spacecraft readout. The NOAA system data, along with the geostationary data, will be used to monitor the state of solar activity, which has a significant effect on terrestrial communications, electrical power distribution, and high-altitude aircraft flight.

The ground system, required to receive large volumes of digital data from NOAA satellites, consists of two major subsystems -- the Data Acquisition and Control Subsystem (DACS) and the Data Processing and Services Subsystem (DPSS). The DACS includes components at the Wallops Island, VA, and and Gilmore Creek, AK, Command and Data Acquisition (CDA) stations; the Satellite Operations Control Center (SOCC) at Suitland, MD,; the Western European Station at Lannion, France; and, the Satellite Field Services Station at San Francisco, CA. All the DPSS components are in the NOAA facility at Suitland.

DACS is used to command and control the spacecraft, monitor its health via housekeeping telemetry, and retrieve and transmit the spacecraft environmental data to the DPSS processing and data handling facility. The delivery of NOAA system data from the CDAs to Suitland is accomplished by using the RCA American Communications, Inc., commercial satellite communications network. This system, which includes Earth Stations at Suitland and Wallops Island, delivers the data to SOCC. These data are immediately passed on to the DPSS subsystem for initial processing.

During three sequential orbits and, occasionally, four on some days, the spacecraft is out of range of both NOAA CDA stations. To eliminate the resultant time delay in the receipt of the high-priority sounding data during the "blind" period, a Western European readout station was established at Lannion, France. This station acquires stored sounding data and transmits it to the United States via the eastern GOES satellite located at 75^{o} W.

The DPSS ingests the raw satellite data and preprocesses and stores them along with appended auxiliary information, such as Earth location and quality control parameters. DPSS consists of several unique segments of high-speed computers, intermediate disk storage units and a mass data storage system. Thus, all the data obtained from a single NOAA system spacecraft for a 24-hour period can be stored on a single tape.

GEOSTATIONARY SATELLITE PROGRAM

The geostationary satellite program began in 1966 as an operational experiment in which the imaging capability and weather broadcast system of the NASA Applications Technology Satellites 1 and 3 were used. This program became an operational reality following the launch of NASA's Synchronous Meteorological Satellites (SMS) 1 and 2 in 1974 and 1975. NASA released both SMS 1 and 2 to NESS for operational control and use following the initial checkout period. These satellites were the prototypes for NOAA's Geostationary Operational Environmental Satellites (GOES).

Since GOES 1 was launched on October 16, 1975, four more GOES satellites have been put into orbit. GOES 4, launched September 9, 1980, and GOES 5, launched May 22, 1981, are the current operational geostationary satellites. GOES 5 is located 35,000 km over the equator at 75^{o} W longitude and GOES 4, at 135^{o} W. SMS 1 was deactivated on January 29, 1981, and the remaining satellites are providing limited operational support for data collection and weather facsimile services. The eastern and western satellites provide repetitive viewing of the development and movement of destructive weather systems, such as thunderstorms, hurricanes, and major mid-latitude storms over much of North and South America and adjacent oceans.

The VISSR Atmospheric Sounder (VAS) is the principal instrument on GOES and is carried on the geostationary satellites starting with GOES 4. The VAS has both imaging and sounding capability. The VAS provides near-continuous cloud viewing with resolutions of 1, 2, 4 and 8 km in the visible wave lengths and 8 km in the infrared wavelength. Full Earth disc pictures are available at 30-minute intervals throughout the day and night; partial disc pictures can be obtained at more frequent intervals to meet special requirements such as viewing development and movement of severe storms. GOES 4 and GOES 5 have a dual research-operational mission. For the first time, the concept of obtaining atmospheric soundings from geostationary satellites will be tested. The additional capabilities of the VAS are the multispectral imaging -- VAS has 12 infrared channels whereas the VISSR has only one -- and the ability to derive temperature and moisture profiles. Additionally, the VAS can be programmed to select the area of interest, the data of interest, and the frequency of coverage. Sounding from a geostationary satellite affords several advantages over sounding from a polar-orbiting satellite. They are (1) constant surveillance, (2) constant viewing geometry, (3) better determination of temporal and spatial gradients, (4) easier comparison with radiosondes, and (5) synoptic large-area coverage. An experimental VAS data handling system has been built under the aegis of NASA's VAS Demonstration Program. This has resulted in a joint NOAA/NASA project called Centralized Storm Information System. Its future development and direction of operational meso-meteorological systems will be influenced by the outcome of the VAS experiment. The GOES satellites also carry a Data Collection System which is used to collect and relay environmental data observed by a variety of remotely located platforms, such as river and tide gages, seismometers, buoys, ships, and automatic weather stations. These satellites also broadcast environmental data to remote locations using the weather facsimile (WEFAX) system and collect data for warnings of solar activity using the Space Environment Monitor.

Table A-1 shows the launch schedule for polar orbiting and geostationary satellites by the Department of Commerce.

SATELLITE COMMUNICATIONS SYSTEM (SATCOM)

The NESS telecommunications system (SATCOM) is divided into two discrete subsystems, one serving the NOAA polar-orbiting satellites (NOAA) and the second serving the geostationary satellites (GOES) and the associated Satellite Field Services Stations (SFSSs). The major elements in the polar-orbiting satellite subsystem are the CDA stations at Wallops Island, VA, and Gilmore Creek, AK, and the Satellite Operations Control Center in Suitland, MD. The geostationary satellite subsystem connects the Wallops Island CDA station with the Central Data Distribution Facility (CDDF) at Camp Springs, MD.

The CDDF is connected, in turn, with the Gilmore Creek CDA station, with the seven SFSSs located in Washington, DC; Miami, FL; Kansas City, MO; San Francisco, CA; Anchorage, AK; Slidell, LA; and, Honolulu, HI; and, with the NWS San Juan, PR, WSFO. The Gilmore Creek CDA station also relays satellite data by land line and microwave circuits to the Anchorage SFSS and the NWS WSFOs at Anchorage, Fairbanks and Juneau, AK.

TABLE A.1

PROJECTED SATELLITE LAUNCH SCHEDULE

POLAR-ORBITING SYSTEM

Satellite Designator	Planned Launch Date*	Instruments for TIROS N Series
NOAA D	FY 1982	AVHRR - Advanced Very High Resolution Radiometer
NOAA E	FY 1983	TOVS - TIROS Operational Vertical Sounder
NOAA F	FY 1984	SEM - Space Environmental Monitor
NOAA G	FY 1985	DCPLS - Data Collection and Platform Location System
NOAA H	FY 1986	SBUV - Solar Backscatter Ultraviolet Instrument (starting with NOAA F)
NOAA I	FY 1987	SAR - Search and Rescue Instrument (starting with NOAA E)
NOAA J	FY 1988	ERBI - Earth Radiation Budget Instrument (starting with NOAA F)

GEOSTATIONARY SYSTEM

Satellite Designator	Planned Launch Date*	Instruments for GOES Series
GOES F	FY 1983	SEM - Space Environment Monitor
GOES G	FY 1985	DCS - Data Collection System
GOES H	FY 1986	VAS - VISSR Atmospheric Sounder
GOES I	FY 1988	

*Launch date depends on performance of prior spacecraft.

By the end of FY 1981, SATCOM consisted of the following links:

- The Wallops Island CDA station preprocesses and calibrates the "raw" GOES data. This data is re-transmitted to the satellite which transponds the data to the Federal Office Building #4 (FOB4) facility at Suitland, MD.

- Two full-duplex circuits for delivery of stretched VAS data from FOB4 to the World Weather Building (WWB) at Camp Springs, MD (1.75 Mbps), and one full duplex circuit for 1.5 Mbps digital data services between FOB4 and the CDDF.

- Two full-duplex, C-2 conditioned voice-grade satellite and terrestrial data circuits connecting CDDF with the Anchorage SFSS and the Gilmore Creek CDA station for facsimile.

- Twenty-six C-5 conditioned full-duplex circuits connect the computer facsimile outputs at the CDDF to the SFSSs. At the SFSSs, a total of about 250 "GOES-TAP" customer circuits relay the facsimile to nationwide locations. Several hundred other customers receive the facsimile over circuits that connect to the "GOES-TAP" customer circuits.

- One C-5 conditioned full-duplex circuit from the Suitland FOB4 computer to the Wallops Island CDA station to transmit WEFAX information.

- Two full-duplex, full-period voice-grade circuits conditioned for digital transmission from the Wallops Island CDA station to WWB for relay of GOES Data Collection System (DCS) information.

- Additional digitally conditioned circuits, dedicated and dial-up, for delivery of DCS information from WWB to a multitude of users.

- Two voice networks connecting all SFSSs, CDDF, FOB4 and Wallops Island CDA.

- One digitally conditioned voice-grade circuit between FOB4 and WWB for transmitting temperature sounding data used for interactive processing.

- One digitally conditioned voice-grade circuit for transmitting FAA Service "C" data to interactive computers in WWB.

- One C-2 conditioned circuit for transmitting radar data from Patuxent Naval Air Station, Patuxent River, MD, to WWB.

- Five C-5 conditioned voice-grade, full-period, full-duplex circuits from Wallops Island CDA to WWB (two circuits), Kansas City SFSS (two circuits), and Miami SFSS (one circuit) for transmitting full disc east and west GOES IR data.

- One C-2 conditioned circuit for the transmission of facsimile data to Owings Mills, MD, for the "AM Weather" television program.

- One C-2 conditioned circuit for the transmission of time code information from Goddard Space Flight Center to the CDDF.

- Four C-5 conditioned circuits for the transmission of polar-orbiter facsimile from FOB4 to the CDDF and GOES data in the opposite direction.

- GMS WEFAX is transmitted to the CDDF on the duplex side of a circuit to the Honolulu SFSS.

- Meteosat WEFAX is transmitted to the CDDF on the duplex side of a GOES-TAP circuit to the Goddard Space Flight Center.

- One 50-line multipoint voice coordination and monitoring network at Suitland for control and integration of launch activities.

- One 15-line multipoint voice coordination and monitoring network at Suitland for control and integration of launch activities.

- Two 100 WPM multipoint teletypewriter circuits connecting various elements of SATCOM.

- A direct alternate voice, data, or facsimile circuit between Washington, DC, and Moscow, USSR, for exchange of satellite information.

- Two 1.33 Mbps simplex satellite circuits for relay of NOAA system data from the two CDA stations to Suitland, MD, and to the RCA Ground Receiving Station at Offutt Air Force Base, Omaha, NE.

- Four alternate 9,600 Hz data/teletype and voice full duplex satellite and terrestrial circuits between the two CDA stations and Suitland, MD, to relay real-time NOAA system data, to transmit command and control functions to the NOAA spacecraft, and to provide alternate routing and backup for NOAA teletype and voice communications.

- Two full-duplex combination teletype and voice satellite and terrestrial circuits between the two CDA stations and Suitland, MD, for coordination of NOAA operations.

- Two simplex C-5 conditioned data facsimile circuits between the Wallops CDA station and Suitland, MD, for the relay of sectorized NOAA HRPT data.

- One simplex 48 kHz link from Wallops Island to Suitland shared with 36.2 kbps NOAA system Lannion (France) data to DOCC/DPSS and 43.7 4x4 IR GOES VAS data (IR with 4X4 mille resolution) to DPSS.

- One 9,600 bps full-duplex link between SOCC and NASCOM/GSFC for

NOAA system launch support and spacecraft anomaly investigation.

- One 7,200 bps simplex link from NASCOM/GSFC to SOCC for NOAA system launch support and spacecraft anomaly data separation.

- Four SCAMMA voice circuits between NASCOM/GSFC and SOCC for NOAA and GOES launch operations and spacecraft anomalies; also, used for spacecraft backup support operations.

RESEARCH PROGRAM FOR FY 1983

The NESS research programs in FY 1983 will be devoted to the development and improvement of quantitative data and products (from satellite observations) that are useful for national and international climate programs, agriculture, fisheries, energy, and other weather and land applications. With the addition of new sensors on board, both polar-orbiting and geosynchronous satellites, techniques will be developed to improve the algorithms to derive accurate temperature and moisture distributions that are essential for weather analysis and forecasting. Data received from the VAS instrument will be used in mesoscale meteorological studies and, in particular, to study the life cycle of severe storms over the United States. VAS data will be combined with other data received from the Prototype Regional Observing and Forecasting Service (PROFS) experiment to study the structure of short-lived weather phenomena.

Satellite data received from the operational and research satellites will be used to derive improved earth-atmosphere radiation budget parameters that are essential for the climate analysis, diagnostics, and monitoring (at the Climate Analysis Center). Since the national and international climate programs consider the earth-atmosphere radiation as the most important parameter needed in various activities, NESS will concentrate its efforts in this area and study the effects of clouds and their influence on the radiation budget.

In addition, NESS will focus on the improvement of sea surface temperature mapping for climate and other studies through the multispectral measurements and the development and testing of bio-optical techniques for NOAA-related fisheries application using data from the Coastal Zone color scanner on the Nimbus-7 satellite. Other application research areas involve improving techniques to estimate the wind speed and intensity of tropical storms using satellite visible and infrared observations; estimation of precipitation and solar insolation reaching the ground; and, other geographical, geological and hydrological parameters from operational and research spacecraft, including LANDSAT. All these application-oriented research efforts will make extensive use of interactive data processing and display systems.

ENVIRONMENTAL RESEARCH LABORATORIES

Environmental Research Laboratories (ERL) R&D programs related to basic meteorological services are oriented toward providing the understanding and developing the techniques and new technologies that will form the basis for future improvements in the nation's weather services. The responsibility for work on this important function encompasses the mission of several ERL laboratories.

Special emphasis will be placed on the improvement of severe weather forecasting. Severe weather is any major natural hazard such as flash floods, strong winds, thunderstorms (including tornadoes and hail), and heavy snowstorms. A number of ERL labs will be cooperating to meet this goal in FY83.

SEVERE WEATHER

The National Severe Storms Laboratory (NSSL) in Norman, OK, focuses its research studies on severe convective storms and their associated weather hazards such as hail, high winds, heavy rain, and turbulence. The parameters of storm development and intensification are being identified through the incorporation of observations from a dual Doppler radar system, a conventional weather radar, the tallest meteorologically instrumented tower in the U.S., an automated surface network, a system for locating lightning and identifying its characteristics, and from instrumented aircraft. NSSL is preparing a three-dimensional, time-dependent numerical model of convective weather which includes the ice phase and rudimentary electrical processes as a basic resource for relating thunderstorm data to natural processes of storm initiation and development. Computer facilities will be improved, in order to utilize Doppler radar observations for initialization of convective cloud models.

With the partial support and cooperation of the Federal Aviation Administration, the National Weather Service, the United States Air Force Air Weather Service, and the National Aeronautics and Space Administration, NSSL is continuing studies to develop radar data displays for interpretation in real time. These studies are based on demonstrated ability of pulsed Doppler radar to sense developing circulations 10-to-20 minutes prior to visual sighting of large tornadoes. Doppler radar can also sense turbulence and wind motion in optically clear air and can, thus, visualize fields of motion preceding cloud development. Funds permitting, the NSSL radars will be upgraded to develop operational techniques for use with the Next Generation Radar, as well as to extend their detection of winds in clear air.

Further development of unique lightning and electrical field sensors will be translated into improved identification and warning of lightning hazards, both to aviation and to the general public.

SHORT-RANGE FORECASTING

The Wave Propagation Laboratory will operate a network of three automatic tropospheric wind profiling radars surrounding the prototype PROFILER (an automatic, unmanned remote sensing system for the continuous vertical profiling of winds, temperature, and humidity, located at Denver, CO) during FY83. The primary research effort will be to develop and to test methods of using the continuously available profile information to improve short-term local weather forecasts. The data will be made available in real-time to the Prototype Regional Observing and Forecasting Service (PROFS) Program office and to the Denver Weather Service Forecast Office (WSFO).

The PROFS program objective to improve local weather services has been refined to include early technology transfers to National Weather Service (NWS) operations. PROFS has been charged with the establishment of a capability to acquire, to interactively manipulate, and to display conventional meteorological data, satellite and radar data, and data from local surface networks. The initial goal is to enhance NWS capability to provide severe weather and flash flood warning services. During FY81, PROFS established communications links for acquiring the necessary data for the Exploratory Development Facility (EDF) and has developed the hardware/software capability in EDF to manipulate, process and display these data. Based on subsystem capability testing performed in FY81, PROFS handed off an initial design for improved short-term, local weather services to NWS in FY82. More detailed systems testing, assessment and evaluation will be accomplished that will result in a major incremental system design transfer to NWS in FY83.

MESOMETEOROLOGY AND WEATHER MODIFICATION

The Mesometeorology Division of the Office of Weather Research and Modification (OWRM) develops techniques and technologies to improve short-term weather forecasts of significant weather events. Through detailed case studies and regional climatologies, OWRM scientists have developed diagnostic tools and aids to operational forecasting for severe thunderstorms, flash floods, convective storm complexes, downslope windstorms and for estimating rainfall from satellite digital infrared data. Pioneering advances in numerical modeling of local weather have included simulations of air flow, clouds, and precipitation in the Alsace region of France and in the Islands of Hawaii and the development of a realistic mesoscale convection model.

In FY83, OWRM plans to continue the transfer of knowledge about significant convective weather phenomena to NWS through courses at its training center; through visits and interactions with NWS centers, regional headquarters and field forecast offices; and, through cooperative projects. A study of the adaptability of the satellite precipitation estimation technique to winter cyclones undertaken in FY82 may find applilcation to operational problems as early as FY83. OWRM's numerical weather modeling plans for FY83 include the development of a comprehensive mesoscale model capable of handling such physics as surface radiation and energy budget, realistic convective parameterization, various types of complex terrain, warm and cold microphysics leading to precipitation, constituent conservation equations allowing applications to acid rain problems, and pollution and particulate transport. Improved and simplified numerical procedures will allow nesting the model in larger scales [e.g., Limited-area Fine Mesh (LFM)], adaptation to special local problems such as downslope wind prediction, and streamlining to fit into medium-sized computers for potential NWS operational applications.

The Weather Modification Program Office (WMPO) developed the Atmospheric Distributed Data System (ADDS). ADDS is an airborne data acquisition and display system. It accepts inputs from various meteorological sensors and aircraft systems, performs scaling and arithmetical calculations, and records and displays output parameters. Real time data are transmitted via satellite to the National Hurricane Center at Miami, FL.

HURRICANE RESEARCH

The National Hurricane Research Laboratory (NHRL), an element of the Atlantic Oceanographic and Meteorological Laboratories of ERL, does research directed at improved hurricane forecasts and warnings. The Laboratory's hurricane field program makes use of the highly instrumented Research Facilities Center (RFC) aircraft to acquire unique data sets that are analyzed to describe and understand the dynamics and energetics of the hurricane's inner intense core. NHRL also develops numerical hurricane models.

During 1981, research missions were flown in hurricanes FLOYD, GERT and IRENE. The main focus of these missions was to obtain data to further describe and understand hurricane rainbands (FLOYD and IRENE), the cloud physics of hurricane convective clouds (IRENE), and the long-term (up to 48 hours) natural variability of the hurricane's internal structure (GERT).

Analyses of data gathered in hurricanes DAVID (1979) and ALLEN (1980) have led to the proposal of an entirely new hypothesis for the temporal behavior of the mesoscale structure of mature hurricanes. During FY81 and FY82, modeling studies have been directed at immediate improvement of prediction models currently used by NWS and at the development of quasispectral techniques for substantially improving operational prediction models in the future.

In FY82, the hurricane field program will focus on gathering data by omega dropwindsondes to determine the synoptic-scale environmental flow on the periphery of mature hurricanes that are predicted to be within 48 hours of landfall on the United States mainland. The observations will be obtained in the middle and lower troposphere over normally data-void ocean areas at pressure levels that previous studies have shown to be important for determining storm tracks.

During FY83, tests of operational prediction models -- with and without the omega dropwindsonde data -- will help to assess the impact of the increased data coverage on the hurricane track forecasts. Analysis of data gathered during the hurricane seasons of 1978, 1979 and 1980 will continue in 1983, as will the development of new hurricane prediction models.

About one-half of the hurricane activities described above are funded through NOAA's Hurricane Strike Project.

NUMERICAL MODELING

The Geophysical Fluid Dynamics Laboratory at Princeton, NJ, does numerical modeling research of direct relevance to meteorological services. Three main activities are covered in this work. The first -- experimental prediction -- is the largest and has four goals:

1. To develop or improve atmospheric prediction models suitable for the time range from 5-to-30 days.

2. To identify important external forcing mechanisms and additional internal processes, which are required by models to simulate the evolution of macro-scale atmospheric disturbances over the range of several weeks to four months.

3. To search for a physically-based probabilistic approach for long-range simulation of atmospheric variation, given a suitable initial specification of the atmosphere, ocean, soil and snow-ice.

4. To study the mechanisms of particular atmospheric phenomena, such as tropospheric blocking, orographic cyclogenesis, tropical easterly waves, and sudden warming.

The second main activity is the study of hurricane dynamics, including the genesis, the development and decay of tropical depressions, and the study of small-scale features within hurricane systems.

A third area concerns mesoscale dynamics for which the goals are to:

1. Produce accurate numerical simulations of mesoscale processes, in order to understand what role synoptic scale parameters play in their generation and evolution.

2. Understand the internal gravity waves (generation, interaction and breakdown) that are strongly connected with the diffusive processes in the atmosphere and ocean.

DEPARTMENT OF DEFENSE

The Department of Defense (DoD) operates a military environmental service system to provide specialized worldwide meteorological and oceanographic prediction services in support of military forces. This service directly supports all phases of military operations, from strategic planning to tactical operations. The U. S. Navy's Naval Oceanography Command and the U. S. Air Force's Air Weather Service are the primary military performing agencies. The Army and the Marine Corps each have a small generic weather support capability, but depend upon the primary weather services for most support. The military weather services contribute to the national and international weather observing capability by making conventional observations on land and at sea where there is no other conventional weather observing capability and where the observations are most needed to meet military requirements. In addition, DOD maintains special observing capabilities such as the Defense Meteorological Satellite Program and aerial weather reconnaissance to meet unique military requirements. The reconnaisance program also serves national needs for data from tropical and coastal winter storms. Observational data are sent by military communications networks to military and civil facilities in the United States and overseas.

UNITED STATES ARMY

ORGANIZATIONAL ELEMENTS AND STRUCTURE

Environmental services personnel and other personnel concerned with meteorological activities and related equipment development and funding serve in the Department of Army staff sections of the Assistant Chief of Staff for Intelligence (ACSI), the Deputy Chief of Staff for Research and Development and Acquisition (DCSRDA), Deputy Chief of Staff, Operations and Plans (DCSOPS), and the Chief of Engineers (OCE). ACSI is the focal point for Army environmental services matters. DCSRDA and OCE are responsible for environmental research, development, test, and evaluation. DCSOPS arranges for allocation of communications frequencies for radiosonde, radar, and other electronic systems used by Army environmental services units. DCSRDA provides life cycle management of meteorological equipment. DCSOPS establishes priorities for meteorological equipment and systems development and procurement. OCE has responsibility for providing specialized river and flood forecasting services and hydrologic data for the U.S. Armed Forces.

The Army has 27 authorized artillery ballistic meteorological sections located throughout the world. Their primary function is to provide accurate environmental data for correction of artillery firing. In addition, data are provided to other elements of the Army for sound ranging and Chemical/Nuclear Defense operations, fallout forecasts, and the AWS units for synoptic purposes. The 201A warrant officers and 93F Ballistic observers are the artillery personnel used to accomplish these meteorological functions.

RESEARCH AND DEVELOPMENT OF METEOROLOGICAL TECHNIQUES AND EQUIPMENT

The primary mission of the Army, related to meteorology, is to maximize worldwide combat and strategic effectiveness by continually improving Army-required atmospheric related products. The Army role is defined in AR 115-10/AFR 105-3, 15 September 1980.

Army research emphasis today is being placed on atmospheric transmission problems associated with electro-optics, near millimeter waves, and high-energy laser weapons; on artillery and rocket ballistic problems; on the development of new equipment and systems for the field Army; on providing techniques and meteorological support for the research, development, and testing of materiel, systems, and equipment; and on making up-to-the-minute atmospheric information available at the corps or "mesoscale" level.

Battlefield Obscuration Effects

Obscuration at visible, infrared, and millimeter wavelengths experienced on the battlefield is produced by meteorological events such as fog, rain, and snow; smoke either deliberately employed or that associated with burning material, firing of weapons, and explosives; dust lofted by explosives, wind, or vehicular activity; and optical turbulence. The principle objective of the Army's battlefield obscuration effects program is to determine, understand, and quantify battlefield and natural atmospheric conditions and their frequency of occurrence which impact on current or future Army systems or sensors relying on electromagnetic radiation in the visible, infrared and millimeter wavelengths. Specific objectives include:

- Determine the effects of the realistic battlefield environment on the effectiveness of electro-optical (EO) systems.

- Establish methodology for relating measured meteorological parameters to atmospheric transmission of visible and infrared energy for Europe and other geographical areas of Army interest.

- Investigate propagation properties of dust and smoke aerosols.

- Improve aerosol measuring techniques.

- Determine the effects of vegetation on the generation and transport of battlefield dust and debris.

- Determine atmospheric effects on chemical munitions.

- Quantify through measurements and models the transfer of narrow band and broad band visible and infrared radiation through realistic battlefield type atmospheres including cold regions effects.

- Investigate atmospheric effects on directed beam propagation (high power microwaves, charged particle beams, and new laser devices).

- Develop and validate a library of models and user oriented computer codes capable of quantifying the obscuration effects of the battlefield environment including realistic terrain and vegetative conditions for electro-optical (EO) weapon systems.

- o Develop procedures and models for incorporation of battlefield obscuration into training simulators.

- o Quantitatively assess the atmospheric limitation of fielded, developmental, and conceptual Army Systems.

- o Develop from systems' specifications and mission profiles frequency-of-occurrence statistics for various levels of degradation as a function of geography and season.

- o Provide climatological data base and weather scenarios for specific areas of military interest as needed in the design, evaluation, and operations associated with electro-optical devices.

- o Develop and utilize mobile field units with state-of-the-art atmospheric sensors, aerosol samplers, transmission measurements, and data processing equipment for validating realistic battlefield models and assessing the impact of battlefield atmospheres on Army systems.

The Electro-Optical Systems Atmospheric Effects Library (EOSAEL) provides user-oriented models for quantifying the obscuration effects of the dirty battlefield. EOSAEL 80 was documented and distributed in FY81 to over 35 government organizations and contractors and NATO Panel IV.

The assessment of current high energy explosion dust cloud models was completed in FY81 and improved methodologies for dust cloud obscuration were incorporated into models for explosive and vehicular dust. Also developed were methods for evaluating obscuration effects of windblown dust and methods for relating measured meteorological factors to visible and infrared atmospheric transmission in Europe. FY81 also saw the construction and utilization of transmissometer systems using wide angle sources suitable for mounting on towers or elevated platforms.

Data from numerous field tests were assembled and analyzed in FY81. Tests included Meppen 80, in which low visibility slant path properties were correlated to optical and infrared transmission and meteorological conditions affecting Army electro-optical weapon systems; SNOW ONE, in which obscuration effects due to cold regions natural aerosols were addressed and optical properties of falling snow were related to meteorological parameters; and, Battlefield Induced Contaminants Test I (BICT I), which emphasized fire products and optical turbulence produced by fires. In addition, data were asembled and analyzed from SMOKE WEEK I, II, III; DUSTY INFRARED TESTS (DIRT) I, II, III; and, GRAF I, IIA, IIB. Preliminary results of DIRT III were published in FY81.

By developing models that consider the interactions of millimeter wave propagation with both natural obscurants such as rain, snow, etc., and with developmental multispectral obscurants, the interactions of millimeter wave energy propagation with battlefield atmospheric constituents can be determined and quantified. This particular research addresses special problems of millimeter wave systems acquiring targets under low visibility conditions. In FY81, near-millimeter wave calculations were compared with field snow measurements and laboratory rain measurements. Models were developed for rain extinction and backscatter and snow extinction.

The improvement of all-visibility target acquisition for such Army systems as the Abrams Tank, STARTLE, SADARM, Advanced Attack Helicopter, Millimeter Beamrider, and HELLFIRE is one goal of millimeter wave propagation research. Through this research, the Army will be able to identify and quantify atmospheric effects which impact on Army systems utilizing near millimeter wave (NMMW) and/or electro-optical (EO) sensors for acquisition, designation or tracking of targets. Atmospheric limitations to range and resolution capabilities of both active and passive NMMW Imagers will also be assessed.

Atmospheric Effects on High Energy Lasers

The U.S. Army Atmospheric Sciences Laboratory (ASL) has been designated lead laboratory for meteorological support to the DOD National High Energy Laser Test Range (NHELTR) at White Sands Missile Range, New Mexico, and has the responsibility for developing the meteorological support program for NHELTR.

In FY81, the analysis of High Energy Laser characterization data was completed at High Energy Laser Systems Test Facility (HELSTF) which is part of NHELTR. The HEL characterization data will be used by FALW (Forward Area Laser Weapon), Mid-Range Advanced Technology (MRAT), and SEA LITE. Optical turbulence associated with natural thermal plumes in the boundary layer were investigated at the HELSTF and the evaluation of remote sensors for optical turbulence and wind was completed.

The meteorological support program for NHELTR crosses the technical base and operational support lines. The technical base program addresses (a) development of specialized site peculiar measurement techniques and equipment; (b) establishment of optical turbulence, crosswind, gases, particulates and site peculiar micrometeorological data bases; and, (c) specialized data reduction and analysis techniques and development of operational techniques to characterize the atmosphere. The operational program (a) identifies operational support from scenarios provided by each service; (b) tailors support to the mission; (c) makes predictions of propagation conditions for tests; (d) provides real-time data in support of each mission; and, (e) provides post-test analysis.

Artillery Meteorology

The main thrust of this effort is to increase the effectiveness of artillery fire by reducing inaccuracies in artillery fire due to meteorological conditions and to reduce munition expenditures. This will be accomplished by the reduction of the meteorology portion of the artillery error budget through the development of improved sensing systems and improved techniques for data utilization and munition expenditures. Results of these efforts will be an overall increase in artillery effectiveness and lethality. Specific objectives include:

- Provide information on turbulence, shear, and wind profile structure.

- Improve long range artillery effectiveness by improving quality and extending the range of atmospheric measurements.

- o Provide the field artillery with a modernized meteorological message which is timely and effective.

- o Analyze tradeoffs between measurement errors, wind shear statistics, and zone structure for ballistic meteorological applications.

- o Develop mathematical models to predict target area meteorology.

In FY81, the development of improved meteorology through integration of merged meteorological messages, wind shear, and sounding frequencies provided improved first round hit capabilities for long range artillery. Errors introduced through lack of meteorological data above 20 km for the Multiple Launch Rocket System (MLRS) were determined in FY81. Exploratory hardware was also completed for an improved antenna which will improve low angle tracking which increases accuracy of wind data used in artillery meteorology.

A munition-expenditure model (KWIK) was completed and successfully tested in FY81. KWIK provides real-time estimates of smoke munition expenditures needed for field artillery. KWIK accounts for atmospheric transport, diffusion, humidity, visibility, and terrain effects on the effectiveness of smoke munitions.

Tactical Weather Intelligence

This program develops near real-time battlefield tactical weather intelligence and interpreted weather effects for the Army Commander. The main thrust is to provide the commander with details of the effects of weather on his operations and his systems, weapons or surveillance, on a scale which is meaningful to his operation and is in a format which can be quickly assimilated. This information will be provided through the use of battlefield automated processing, dissemination and display systems. These processes will utilize weather, dust, smoke models, displays, and include the effects of complex terrain. Specific objectives include:

- o Provide models and techniques for describing the transport and diffusion of chemicals, biological agents, and obscurants in complex terrain as influenced by vegetative growths and urban environments.

- o Provide models for the description of atmospheric water (clouds, precipitation, etc.) on tactical scales as it affects trafficability, mobility, and troop effectiveness.

- o Provide computer analyses and displays of weather effects on weapon systems and tactical operations.

- o Provide weather intelligence as a combat multiplier to tactical commanders.

In FY81, an obscuration model and smoke coverage displays were developed which provide analyses and displays of weather effects on weapon systems and tactical operations. An automated weather data base was also developed for use in determining sensitivity of operations and tactics to weather effects. FY81 also saw the development and preliminary validation of an interim probabilistic diffusion model and transport model. The finalized models will be used to describe the transport and diffusion of chemicals and biological agents.

Atmospheric Sensing

The main purpose of Army research involved in the sensing and probing of the atmosphere is to determine the atmospheric effects on the performance of battlefield systems. This includes existing, prototype and future weapon guidance systems, remote atmospheric sensing systems, and high energy laser (HEL) systems. Specific objectives of the program include:

- o Investigate the potential of advanced LIDAR and millimeter wave systems to determine values of atmospheric parameters required in Army atmospheric research projects and tactical applications.

- o Investigate the potential of millimeter wave and infrared radiometers to determine boundary level winds from the ground.

- o Investigate from space the rainfall rate, over surface areas of tactical importance.

- o Explore new techniques for measuring atmospheric parameters that critically affect the performance of Army weapons systems.

New atmospheric sensing techniques can increase the combat effectiveness of weapons and operations. The recent developments in remote sensing technology are being exploited to measure atmospheric parameters which reduce weapon system, effectiveness. For the first time, measurements can be used for direct fire weapons such as on the main battle tank. A prototype 10.6 micrometer crosswind sensor for tanks is being developed to correct wind aiming errors along a gun trajectory in combat engagements involving tanks. The sensor will be a subsystem of the tank fire control system and exploratory development was completed in FY81.

Army personnel, who will use future weapon systems such as COPPERHEAD, have no adequate means for objectively measuring ceiling and visibility. A hand-held ceiling-visibility sensor was developed to provide high-resolution ceiling and visibility information in a real-time mode and was based on the AN/GVS-5 laser rangefinder. The visioceilometer can be used at forward area aircraft landing sites, in support of EO precision guided munitions, and other tactical systems where cloud height and visibility must be quantified. In FY81, tests of the visioceilometer in a variety of weather conditions was conducted and improvements made in the analysis of lidar returns to allow more accurate measurements in smoke, dust, rain, and other aerosols.

New atmospheric sensing techniques and instrumentation have been developed for characterization of the National High Energy Laser Test Range (NHELTR) and for effective EO system operation. Short and long path scintillometers have been fielded to measure the path integrated optical turbulence. Fast response spatial temperature probes have been standardized for measurement of the microtemperature structure function. An optical technique using a star path analysis has been developed to measure the path integrated vertical modulation transfer function both night and day. Solar measurements of the optical spectrum using a Fourier Transform Spectrometer and controlled environmenetal measurements of the pressure and temperature dependence of the water vapor continuum absorption are used to characterize gaseous absorption for field operations. In situ, spectrophone systems have been developed to measure aerosol absorption/extinction. These state-of-the-art techniques and instrumentation have significantly improved predictive model capabilities for use in field testing of EO systems.

Tests in support of the High Energy Laser Systems Test Facility (HELSTF) and for EO atmospheric characterization field experiments required development of a remotely piloted, maneuverable, versatile and economical airborne instrumentation platform. Two remotely piloted maneuverable atmospheric probe (MAP) vehicles have been developed to gather microscale meteorological data; atmospheric composition; turbulence data; and dust cloud particulate size, number, density, and composition.

Meteorological Support Activities

Meteorological support to Army and DoD RDTE activities is provided through the combined efforts to both civilian and Army meteorologists, engineers, observers and technicians. The mission of providing timely and accurate atmospheric data is accomplished by the deployment of 12 permanent meteorological teams, 10 located in the contiguous states and one each in Alaska and the Republic of Panama. Support to other R&D efforts that cannot be conducted at one of the permanent locations is provided by quick reaction personnel on a temporary duty basis.

The measurements provided to the various users encompass the entire spectrum of atmospheric scales; i.e., micrometeorological measurements of mechanical and thermal turbulence in the surface boundary layer to macro-scale measurements of winds and thermodynamic parameters in the troposphere and stratosphere. Types of measurements include the more familiar ones of temperature, relative humidity, pressure, solar radiation, and winds to more sophisticated measurements of optical turbulence, EO measurements relating to "seeability" and remote measurements of pathwise integrated winds.

Support is provided to high priority projects sponsored by the Department of Army, DoD, and other government agencies. A partial list of projects supported during FY81 included Multiple Launch Rocket System (MLRS), ROLAND, STINGER, M-1 Tank, Advanced Attack Helicopter, COPPERHEAD, Global Positioning System, HEL, the Space Shuttle, and many major tests of various projectiles, fuzes and tubes. Other support includes environmental/exposure tests of system electronic components, clothing, personal equipment, weaponry, and various types of construction materials.

A major Army program of modernization continued on schedule with emphasis on software development and with complete automation of all sites scheduled for FY83. Primarily, emphasis is being placed on automation to be more responsive to the growing demand for real-time data and to enhance sophistication of development testing/operational testing (DT/OT) test requirements. In addition, automation will provide more timely and more accurate data and is more cost effective, because it is less labor intensive.

Other major efforts include the meteorological support provided to the

White Sands Missile Range, DoD, National High Energy Laser Test Range, and the design of remote vertical sounders, utilizing laser doppler velocimeters to measure winds in real-time from the surface to 3 km.

Army operations have always been affected by the atmosphere in which they must be accomplished but never so extensively or critically as today's operations using modern weapon systems. With emphasis on more sophisticated sensors, fire-control systems, and weather intelligence requiremnts, the annual research investment by the Army is of increasing importance and will provide the necessary products to cope with fluid battlefields on a worldwide basis.

UNITED STATES NAVY

OPERATIONAL PROGRAMS

Previous Federal Plans reported significant changes in the organization of the Naval Oceanography Command (NAVOCEANCOM), which forms a significant part of the Naval Oceanographic and Meteorological Support System (NOMSS). These changes were designed to provide optimum meteorological, oceanographic, mapping, charting and geodesy services to support the fleet and shore establishment.

During the period of this report, the new organization has functioned exceptionally well and has demonstrated the capability to meet Navy and, as appropriate, DOD's need for environmental support. Emphasis is now being placed on further improvements to programs involving training, services to aviation, the Naval Environmental Display Station (NEDS) and improved computer systems and weapons system support.

To satisfy requirements for analyzing and forecasting the air/ocean environment adequately, great emphasis is being placed on cross-training former meteorology and oceanography specialists. A Geophysics Technical Readiness Laboratory (GTRL) has been established to provide trained geophysics officers to become more aware of fleet operational needs which they support. This effort is ongoing. Also, greater attention is being given to ensure that the training of Aerographer's Mates (enlisted personnel) meet the increasingly sophisticated requirements of operational support.

The Navy's training program for both enlisted personnel and officers continues to place increasing emphasis on the total maritime environment of the world's oceans in which the fleet must operate. This interest reflects, in turn, the increasing sophistication of the Navy's ships; submarines and aircraft; their weapons and sensor systems; and command and control system; all of which are sensitive to the composite air-ocean environment.

An important program to improve services to Naval aviation is the Optimum Path Aircraft Routing System (OPARS). OPARS is a computer flight planning system developed and operated by the Fleet Numerical Oceanography Center (FLENUMOCEANCEN) to provide flight planning support to Naval aviation. It was designed specifically to support the Navy's mission of Anti-Submarine Warfare (ASW) and flights to and from ships operating at sea. OPARS provides for optimizing aircraft flight paths in the horizontal and vertical to achieve fuel efficiency and reduce enroute flight time. The system uses the Navy global environmental data base and supports all types of Navy aircraft.

NEDS units are operating and fulfilling expectations at the FLENUMOCEANCEN; the Naval Eastern, Western and Polar Oceanography Centers at Norfolk, VA, Pearl Harbor, HI, and Suitland, MD, respectively; the Naval Oceanography Command Centers at Rota, Spain, and Guam; and in the National Military Command Center in the Pentagon. Nine (9) smaller versions of the NEDS are planned for shore installations in Calendar Year 1982. Plans call for improved models of this series of NEDS to be installed at all NAVWEASERVCOM activities with forecast responsibilities. The primary function of the NEDS is transmission, receipt, storage, manipulation and display of graphic, alphanumeric and satellite data. NEDS capabilities include the multi-colored visual display of environmental parameters that significantly improve the ability to evaluate and forecast air-ocean environmental conditions of tactical significance to the operating forces. The NEDS is compatible with the Air Force automated COMEDS system, and efforts are being made to provide for compatibility with the National Weather Service (NWS) AFOS system. This compatibility will facilitate the existing exchange of data, products, services.

The Satellite Data Processing Center (SPC) is an operational computerized facility within the FLENUMOCEANCEN, Monterey, CA, designed to process data from the Department of Defense satellites and selected national environmental satellite systems to meet Navy requirements. Satellite information is invaluable for the analysis and forecasting of environmental conditions in data sparse ocean areas.

The primary computer system at the FLENUMOCEANCEN was upgraded during this period with the installation of a CDC CYBER computer system. This permits generation of the sophisticated air-ocean environmental products and tactical indices needed to support the increasingly complex fleet weapons and sensor systems.

The Naval Oceanographic and Meteorological Support System (NOMSS) is organized to provide global analysis and forecasting services and will be further described in the following paragraphs. The mission of the NOMSS, derived from Article 0316, Navy Regulations, 1973, is to ensure that Department of the Navy meteorological requirements and Department of Defense oceanographic requirements are met. Due to the nature of the Federal Plan, emphasis will be placed on meteorology even though in most cases it is difficult to separate meteorology from oceanography and the tactical orientation of most products. An equal simultaneous effort is being directed in oceanography.

NOMSS is primarily supported by activities and detachments assigned to the Naval Oceanography Command (NAVOCEANCOM). These activities are augmented by shipboard environmental units; geophysical (including enlisted meteorological) personnel assigned to various selected staffs, U.S. Marine Corps Aviation Weather Units, and environmental units assigned to test stations, ranges, and the Naval Support Force Antarctica. In addition, research, development, and logistics support is provided as appropriate, by the various Naval Systems Commands, Navy laboratories and the Navy Environmental Prediction Research Facility.

Shore field activities within the NAVOCEANCOM having, inter alia, meteorological responsibilities include the Fleet Numerical Oceanography Center (FLENUMOCEANCEN), three Naval Oceanography Centers, two Naval Oceanography Command Centers, seven Naval Oceanography Command Facilities, and 46 Naval Oceanography Command Detachments.

The FLENUMOCEANCEN Monterey, CA, is the master computer center of the NOMSS and is the hub of the Naval Environmental Data Network (NEDN). The NEDN is designed for product distribution. It is linked with the data collection networks of the U.S. Air Force and NOAA and receives world coverage of original data. From these data, basic and applied numerical (computer) products are generated by FLENUMOCEANCEN for use by NOMSS in producing specific support products and services.

The three Naval Oceanogrpahy Centers -- the Naval Western Oceanography Center (NAVWESTOCEANCEN) at Pearl Harbor, HI; the Naval Eastern Oceanography Center (NAVEASTOCEANCEN) at Norfolk, VA; and, the Naval Polar Oceanography Center (NAVPOLAROCEANCEAN) at Suitland, MD -- have been assigned broad geographical areas of responsibility for oceanographic and meteorological fleet support services and related matters. NAVWESTOCEANCEN is responsible for the Pacific and Indian Ocean areas; NAVEASTOCEANCEN, for the Atlantic and Mediterranean Sea areas; and, NAVPOLAROCEANCEAN, for the Arctic and Antarctic areas. They utilize basic and applied numerical products from the FLENUMOCEANCEN to provice environmental broadcasts and tailored support in response to specific requests from the operating forces. NAVPOLAROCEANCEN also supports and operates a Navy-NOAA Joint Ice Center which provides analyses and forecasts of sea ice conditions to the civilian community, as well as to DoD.

The two Naval Oceanography Command Centers (NAVOCEANCOMCENs) are located at Rota, Spain, and on the island of Guam. NAVOCEANCOMCEN Guam assists NAVWESTOCEANCEN in the provision of environmental services in the western Pacific and the Indian Ocean areas. NAVOCEANCOMCEN Rota assists NAVEASTOCEANCEN in the Mediterranean Sea area. Both centers utilize the basic and applied numerical products from the FLENUMOCEANCEN to provide fleet environmental braodcasts and tailored support in response to specific requests by the operating forces. NAVOCEANCOMCEN Guam has an additional responsibility for the operation of a "Joint Typhoon Warning Center" (with the Air Weather Service of the U.S. Air Force) and for the provision of topical warnings in the western Pacific and Indian Oceans.

Six Naval Oceanography Command Facilities (NAVOCEANCOMFAC) at Jacksonville, FL; San Diego, CA; Yokosuka, Japan; Cubi Point, Philippines; Bermuda; and Keflavik, Iceland, provide limited area local and aviation environmental forecast services. Primary forecast guidance is utilized by all facilities; the overseas units augment that data from other local sources. Four of these activities command assigned detachments. The seventh, NAVOCEANCOMFAC in Bay St. Louis, MS, is responsible for manpower management, Naval Reserve matters, and training.

There are 46 Naval Oceanography Command Detachments (NAVOCEANCOMDETs) mostly located at Naval Air Stations. Each is established under an Officer in Charge or Chief Petty Officer-in-Charge who reports to a designated shore/field activity. Most of these detachments are oriented to provide direct environmental support, including aviation and oceanographic services, within their local areas. Those within the contiguous states utilize the basic and applied numerical products from both the National Meteorological Center and the FLENUMOCEANCEN to provide aviation meteorological and oceanographic services; only products from the FLENUMOCEANCEN are utilized to provide such services by detachments overseas. Three of the detachments are oriented to provide specific technical support to the NOMSS. This includes such functions as coordination of the Navy's climatological program at the National Climatic Center and liaison and coordination at U.S. Air Force bases for the interservice exchange of data and products.

SUPPORTING RESEARCH AND DEVELOPMENT

The Navy's environmental research and devlopment effort consists of a highly integrated program of basic research and exploratory, advanced engineering, and operational development work areas. A brief description of each of the major projects is provided to indicate the scope of the Navy program to support fleet operations.

Meteorological Processes Research

The objective of this area of work is to improve the understanding of the atmospheric processes with primary consideration given to improvements in the accuracy of forecasts in the lowest layers of the atmosphere over the oceans. The research includes consideration of local and regional features, the fine scale structure of interactions, and the origin, distribution and chemistry of marine aerosols.

Studies of the physics of the lower atmosphere over the ocean include investigation of the temporal three-dimensional structure of the lower atmosphere by making measurements using fixed point remote sensors (lidars, radiometers, imaging systems) and direct sensors (knollenberg aerosols, spectrometers, air, dewpoint and sea surface temperature sensors, nephelometers) on airborne platforms. The measurements are being used to develop and/or improve models of the effect of atmospheric conditions on the performance of existing and planned electro-optical (EO) and electromagnetic systems. The role of aerosols and cloud condensation nuclei in haze and fog formation is also being investigated by both experimental and theoretical methods. Temporal and spatial variability of the temperature inversion in the lower atmosphere over the ocean is being investigated to determine its relationship to marine fog formation. Plans call for the evaluation of existing features of these models to construct an improved fog forecast model for ocean areas.

Meteorological Models, Prediction, and Instrumentation

The objectives of this work area are (1) the development of numerical techniques, models, and software for analysis and prediction of all scales of atmospheric phenomena for use at the Fleet Numerical Oceanography Center, (2) the development of synoptic and/or statistical weather forecast techniques for use by the fleet meteorologists primarily on-site, (3) the investigation and/or development of cost-effective technological options for obtaining accurate and timely measurements of the natural environment needed as inputs to assess and/or predict the performance of weapons system over the marine environments, and (4) the coordination with weapons system developments at concept phases to develop environmental support requirements.

The numerical modeling work provides the base for the operational systems to be tested and implemented under the Automated Environmental Prediction System (AEPS) program. The exploratory development includes several components: (1) nested regional model development, (2) tropical cyclone dynamic predictions, (3) data assimilation system development, (4) global atmospheric model development, (5) stratospheric global model development, (6) marine boundary layer model development, and (7) modeling of unique atmospheric parameters.

The synoptic and statistical work includes (1) tropical forecasting, (2) statistical tropical cyclone forecast aids, (3) short-range statistical forecasting, (4) marine fog forecasting, and (5), Model Output Statistics for forecasting air-ocean parameters.

The investigations of measurement technology include examination of existing, as well as newly developed, instrumentation for suitability of operation in existing and future fleet airborne and sea-based vehicles.

Atmospheric Remote Sensing and Data Applications

The objective of this area is to investigate the practicality of measuring ocean surface and subsurface temperatures remotely with a laser radar; to develop electro-optic mapping technology to meet naval requirements for tactical aerial environmental survey in coastal regions; to develop a shipboard day/night laser radar system capable of routinely measuring water vapor concentration, temperature, wind and sound transmission; and, to develop techniques to extract a number of environmental parameters from visual, IR and microwave satellite data.

The program in this area is approximately evenly divided between sensor design and development, and processing and display applications. The sensor work is divided into laser sensors for aircraft (50%), ships (25%), and microwave sensors for satellites (25%). The processing and display component of the project is evenly divided between central site techniques for extracting atmospheric temperature, moisture, winds, and sea surface temperature from satellite radiances and imagery, and remote site direct readout methods for interpreting satellite radiances and/or imagery in real time.

Tactical Environmental Support System (TESS)

The objective of the TESS program is to develop an automated, modular environmental support system which can accommodate the broad range of requirements and capabilities of various ship types, with or without embarked environmental specialists. The TESS will provide predictions/assessments of the performance of weapons systems as influenced by natural environmental conditions, provide on-scene environmental data for use in the exercise of command and control, and display information on automated interactive graphic and alphanumeric terminals. The concept is to use state-of-the-art technology to modernize the environmental support function on ships and at supporting land stations where it is now largely a manual function with considerable interpretation required to assess the environmental impacts on the weapons system performance.

The development plan for this program has been prepared and several Navy laboratories have been tasked to start the development of component parts of the system.

Remote Ocean Surface Measuring System (ROMS)

The objective of this program is to develop and demonstrate a capability for remotely measuring ocean surface characteristics within the accuracy limits defined by Navy operational requirements. The program will provide technology options to integrate oceanographic sensors into either existing or planned satellites.

It is planned to investigate active and passive microwave sensors aboard proven satellite platforms, new antenna technology, the space shuttle, launch and retrieval techniques, and use of communication satellite systems. The satellite system will provide all-weather and day/night observations of oceanographic parameters over regions inaccessible by any other means.

Automated Environmental Prediction Systems (AEPS)

Under the AEPS program, the development of an automated system to achieve a 1985 capability to provide essential environmental support to Navy Command and Control is continuing. This system is expected to expeditiously process and analyze meteorological/oceanographic data needed to describe air/ocean interactions in order to define environmental features affecting the Naval operating areas around the globe; to predict atmospheric and oceanographic conditions that affect Naval operations with the timeliness, accuracy, and scale necessary to meet command and control and weapons/sensor system requirements; and, to formulate, disseminate and display predicted weapons/sensor systems effectiveness indices and tactical decision aids based on predicted environmental conditions. Emphasis is on analysis and prediction improvements.

Some features of the AEPS development will be Model Output Statistics (MOS) of wind, cloud cover, ceiling and visibility; steering and wind distribution statistics in the FLENUMOCEANCEN tropical cyclone program; split-explicit tropical cyclone model; modified global prediction system for the FLENUMOCEANCEN upgraded computer; a 3-D mesoscale model; tropical cyclone strike probability; development of meteorological shipboard aids for use in tactical environmental support systems; Arctic Ice Dynamics Joint Experiment (AIDJEX), and Hibler Dynamic sea ice models for the FLENUMOCEANCEN systems; and, an Optimum Path Aircraft Routing System (OPARS).

Automated Environmental Prediction System II (AEPS II)

This project is developing an automated system to provide environmental predictions to Navy Command and Control and to the operating forces. Major emphasis is directed towards improvements in product dissemination, internal computer integrity, consolidation of communication functions and interfaces with users. The effort also implements, tests, and evaluates new models and techniques. Improvements and extensions will be made to the functional use of Optimum Path Aircraft Routing System (OPARS), Naval Environmental Ship Advisory Capability (NESAC) and data distributing. This includes a servicing capability for tactical aircraft and ships, as well as enhancements to the capabilities of implementing software routines for graphics display and user flexibility for products received from the Primary Environmental Prediction System at Monterey, CA. Effort will continue to provide the environmental data user with products tailored to specific user needs. R&D funding of this project ceases in FY 1983.

Meteorological Measuring System (MMS)

This system will correct an operational deficiency and develop an environmental measurement and display capability in support of Command and Control. MMS capability will enable (1) measurement of on-scene environmental parameters needed to assess/predict the effect of the environment on performance of weapon systems developed in TESS and needed to support airborne ASW, AEW and ESM missions; and (2), processing, communication, storage and display of environmental data, derived products and weapons systems performance parameters generated by AEPS. MMS includes E-2 Aircraft Microwave Refractometer (AMR); P-3/S-3 Aircraft Dropsonde; shipborne Mini-Refractionsonde (Minisonde); shipborne/airborne remote sensors; and, the family of Naval Environmental Display Stations (NEDS).

Satellite Data Processing Center (SPC)

This project will fulfill a requirement to receive and process data from Defense and National Satellite systems to alleviate global maritime data scarcity. During FY 1983, emphasis will be to complete development of software to receive and process data from the DMSP satellite, required by changes to sensors being flown. Additional development will be to ingest selected data from geostationary satellites, in order to utilize these data as an input to the data base residing in the SPC. This will provide wind data and an additional source of sea surface temperature. The Navy will continue development of display and dissemination procedures for fleet users. Methods of using GEOSAT altimeter data will continue to be developed and will be implemented into the Satellite Processing Center.

Navy Environmental Engineering Development Program

The environmental satellite acquisition and display system development (AN/SMQ-11) is being expanded to receive high resolution civil satellite data, in addition to the Defense Meteorological Satellite Program (DMSP) data.

A siting study, installation, and calibration test of the runway weather surveillance system, Surface Condition Analyzer (SCAN), was completed at NAS Pensacola, FL. This SCAN system is designed to measure critical water depths for predicting hydroplaning conditions on runways and it is being evaluated for Navy use.

A lightning position and tracking system (LPATS), installed at Naval Air Station Cecil Field, FL, is undergoing technical evaluation.

UNITED STATES AIR FORCE

METEOROLOGICAL SERVICES

The Air Weather Service (AWS) of the Military Airlift Command (MAC) is tasked by Air Force Regulation (AFR) 23-31 to provide environmental services to the United States Air Force and Army. Its primary mission is to support the Air Force and Army combat operations in wartime. During peacetime, AWS prepares for its wartime role by practicing special wartime support procedures and by providing or arranging daily staff and operational weather support to its military customers. AFR 23-31 also defines certain related environmental and scientific support requirements to other DoD and U.S. Government agencies. Collection, processing, and dissemination of atmosphic and space environmental data and weather modification are intrinsic to such support.

The Bureau of the Budget Circular A-62, 13 November 1963, divides meteorological services into two types, basic and specialized. Although involved in both services, AWS is strongly oriented toward specialized services.

The general functions involved in providing meteorological services include observing current weather, communicating weather data and information, preparing analyses and forecasts, issuing and disseminating warnings and forecasts, and archiving weather information for ready retrieval.

The first of these functions, observing, comprises four programs: Surface, upper air, radar, and meteorological satellites. Surface observations are taken by AWS personnel in support of analysis and forecasting, but primarily for other specialized applications. Observations at both Air Force and Army locations (fixed and tactical) are manually obtained, some atmospheric elements being sensed by instruments and some directly by the observer. The observations are made available locally and are collected by the Automated Weather Network (AWN), a high-speed communications network, for transmission to the Air Force Global Weather Central (AFGWC), as well as to other military and civil locations worldwide. In FY 1982, there are 107 AWS surface observing facilities or locations in the continental United States (CONUS) and 63 overseas.

Upper air observations provide the major input for numerical analysis and forecasting. Most of this information is obtained from U.S. civil and foreign sources, as well as rawinsonde (fixed and mobile) and rocketsonde facilities, operated by AWS. Additional upper air information from data-void areas is obtained from U.S. Air Force weather reconnaissance aircraft and in-flight pilot reports from both military and civil aircraft.

The Air Force performs aerial weather reconnaissance in support of U.S. military and national requirements. Thirteen WC-130 aircraft are provided by MAC's Aerospace Rescue and Recovery Service (ARRS) and seven by the Air Force Reserve (AFRES). Aerial reconnaissance weather officers and enlisted dropsonde operators are provided by AWS (for the ARRS aircraft) and the AFRES (for the AFRES aircraft).

The weather radar is a principal source of information for making short-term warnings of severe weather. AWS operates 92 weather radar sets (18 overseas). Two of the CONUS sets are a part of the U. S. basic weather radar network; 11 are used in a backup capacity. Eleven of the AWS weather radars are used to support the National Hurricane Operations Plan.

The final observing program is the meteorological satellite. The Defense Meteorological Satellite Program (DMSP) is an operational satellite system, managed by the Air Force for DoD, to support military requirements worldwide. The DMSP was designed and developed under a total system concept to provide the specialized meteorological data required by DoD. Sensors, communications, and ground processing facilities were developed to provide maximum responsiveness to the military decision-maker. The DMSP normally consists of two satellites in an approximately 830-km, sun-synchronous polar orbit with a period of 101 minutes. The DMSP provides visual and infrared (IR) images of the entire globe, plus temperatures and moisture soundings, auroral electron counts, and other specialized meteorological data to the AFGWC. It also supplies direct, real-time readout of regional cloud-cover information (visual and IR) to selected military terminals located around the world.

The present DMSP spacecraft series (Block 5D) uses an operational line-scan system (OLS). The OLS is a digital system designed to format and store visual and IR data. The visual sensors detect the brightness of reflected solar illumination from 0.4 to 1.1 micrometers. The IR sensors measure emitted radiation in the 8-to-13 micrometer spectral band. Beginning with the fourth Block 5D series spacecraft, the infrared spectral window was narrowed to 10.5 to 12.5 micrometers to reduce the amount of absorption by ozone and water vapor. The visual sensors were selected to optimize distinction among clouds, ground, and water. Electronic circuitry converts the sensed infrared energy directly into equivalent blackbody temperature, making temperature the displayed parameter. IR and visual imagery are obtained at near-constant cross-track resolutions of 0.5 km (fine data) and 2.8 km (smooth data). The Block 5D satellite incorporates selective redundancy and other reliability improvements to achieve longer operational life. It uses both stellar and inertial references, together with on-board processors, to maintain stability and pointing accuracy and is significantly better than earlier DMSP satellites.

The DMSP communications and ground processing systems are designed to produce usable products within five minutes after the data stream ends. The central processing facility at the AFGWC is linked to the DMSP command readout facilities via a real-time satellite link. High-quality imagery is displayed for manual use and can be input directly into the AFGWC computers. There, it is converted into cloud parameters and collated with conventional meteorological data to produce a comprehensive three-dimensional numerical cloud analysis. The Air Force system for direct, local readout of DMSP data is a self-contained, air-transportable unit, capable of worldwide deployment in a matter of hours.

The usefulness of these observations of meteorological elements depends on an effective communications network. The USAF global weather communications system provides for the collection of meteorological data (alphanumeric and pictorial), delivers these data to weather centrals and forecast facilities, and distributes centrally-produced products to the user. Conventional weather teletype networks; high-speed automated digital facilities; long-haul, point-to-point teletype data circuits; facsimile networks; and, radio and teletype intercept facilities constitute the Air Force Communications Command (AFCC) system.

The Automated Weather Network (AWN) is the backbone of military weather communications, using high-speed computers interconnected with 2400-4800 baud circuitry to deliver foreign and domestic weather data to designated users. Data-intercept sites in key overseas areas obtain foreign weather broadcasts for AWN delivery to the AFGWC. The USAF AWN also delivers these data to the Navy's Fleet Numerical Oceanography Center and to NOAA's National Meteorological Center. Overseas collection and dissemination teletype networks are driven by the AWN Automatic Digital Weather Switch (ADWS) computers. The CONUS ADWS at Carswell AFB, TX, drives the CONUS Meteorological Data System (COMEDS) and special teletype systems within the CONUS, an integral part of the weather collection and dissemination function. COMEDS serves as the prime communications system for the collection and dissemination of military Notice to Airmen (NOTAM) message traffic to all DOD users.

The Weather Facsimile Switching Center (WFSC) at Offutt AFB, NE, is the hub of the facsimile system, providing graphic and pictorial data to worldwide military users. WFSC drives the separate networks serving the CONUS, Europe and the Pacific, using computers to store and forward required products.

Data requirements of AWS units worldwide are met through a combination of routine data delivery and an Automatic Response-to-Query (ARQ) system to satisfy their needs for mission-essential, non-routine weather data.

In addition to communications responsibilities, AFCC maintains the AWS meteorological equipment. The command also maintains the Air Force facilities of the Defense Meteorological Satellite Program. Organizational maintenance is funded through the host base; intermediate maintenance is funded by AFCC.

Many analysis and forecast requirements for Air Force and Army customers are met by the AFGWC at Offutt AFB, NE. The AFGWC employs over 700 scientists and technicians (military and civilian) and uses five computer systems. The computer-based operation of AFGWC uses a build-and-apply concept. Worldwide weather data are relayed to AFGWC via the high-speed AWN and blended with civil and military meteorological satellite data to construct a real-time, integrated environmental data base. Scientific computer programs further digest the data to construct models of the atmosphere and forecast its future behavior. Final tailoring of the data is accomplished for application to the specific problem of the decision-maker.

The Federal Plan for Cooperative Backup Among Operational Processing Centers, designates AFGWC as backup for the NWS's AFOS system, NWS's facsimile network, NMC's computational center for aviation wind forecasts, and NWS's National Severe Storms Forecast Center (NSSFC).

The USAF Environmental Technical Applications Center (USAFETAC), Scott AFB, IL, provides environmental data to support the U.S. Air Force, U.S. Army, and other Government agency requirements for assessments of natural environmental effects on military plans, weapon systems, facilities, and intelligence activities. USAFETAC collects environmental data from its parent organization (AFGWC), then sorts, checks, and stores these data. USAFETAC operates a facility collocated with the National Climatic Center in Asheville, NC, for the exchange of climatic data with civil agencies. USAFETAC typically stores worldwide weather observations, surface weather analyses, upper atmosphere analyses, and unique three-dimensional cloud analyses extracted from meteorological satellite imagery. From these stored data, it provides standard climatological products such as atmospheric profiles, soil moisture assessments, and probabilties of cloud-free line-of-sight.

AWS contributes to the unique global needs of military aviation and makes its information available to civil aviation. It provides pre-mission briefings and air-ground radio services, tailoring its observations, forecasts, and warnings for unique military aircraft requirements.

An aspect of special emphasis in military weather support is the need to provide adequate decision-assistance to commanders and resource managers. To fulfill this requirement, designated AWS personnel serve as part of the working staff of supported Air Force and Army units. In this capacity, it identifies all weather-sensitive areas of the supported operation, monitors the weather service provided in these areas, and provides expert advice when weather threatens to restrict training or combat operations. This AWS effort helps ensure that Air Force and Army units are able to fulfill their missions in spite of adverse weather, and it results in efficient use of weather resources by gearing them to mission-essential support needs.

The Air Force and Army require worldwide meteorological services to support specific operational and planning activities. Military users require meteorological information directed to the needs of weapon systems being developed or used; command and control systems; Army firing units; research, development and evaluation; training and deployment of military forces; and contingency operations.

To provide these services, AWS maintains analysis and forecasting facilities in the United States and abroad, including the AFGWC in the U.S. and tactical forecast units in Europe and Alaska. Special centers, such as USAFETAC and the Joint Typhoon Warning Center on Guam, also fulfill unique military meteorological requirements. Similarly, AWS observing facilities obtain data in direct support of special military operations.

Aerial weather reconnaissance plays a vital role in specific military operations. Essential weather observations from tropical cyclones, along tactical deployment routes, from in-flight refueling areas and from missile and satellite recovery areas, are obtained by weather reconnaissance aircraft. In addition, these aircraft provide supplemental vertical soundings over data sparse ocean areas.

AWS, through AFGWC, directly supports DOD Special Strategic Programs, the National Command Authority, the National Military Command System, and the National Security Agency. Tailored environmental support products are disseminated to these customers worldwide.

In support of tactical military operations, AWS support is designed around three basic components: the Centralized Production Units (CPUs), Tactical Forecasts Units (TFUs), and Weather Teams (WETMs). The CPUs consist of the Air Force Global Weather Central (AFGWC), the United States Air Force Environmental Technical Applications Center (USAFETAC), the Automated Weather Network (AWN), and area Weather Support Units (WSUs). The CPUs provide direct, mission tailored support through designated communications circuitry, including the AWN, to TFUs and WETMs. The TFU represents a vital capability of the weather support force; it provides tailored weather service to in-theater decision-makers. These units provide forecast services and products for combat activities in a specific geographical area, tactical operation, or exercise, through relay of CPU products, tailoring of operational support products, and local generation of mission support products. WETMs are the basic units supporting customers in a tactical theater. They provide surface and upper air observations (often using tactical weather equipment such as the TMQ-22 and the Belt Weather Kit), briefings, and forecasting support. The Tactical Weather System (TWS), tactical weather radar (AN/TPS-68), and tactical meteorological satellite direct readout terminals (Mark IV) provide the means to acquire vital meteorological data within a theater. A broadcast system to link elements of the theater weather support force with the Defense Communications System is planned. Main components of the broadcast system will be reliable, secure, tactically deployable send and receive teletypes, receive facsimile sets, broadcast stations.

AWS integrates Army weather support into its overall support concept. AWS personnel are trained and oriented on applicable Army organizations, concepts of operations, and weather sensitivities required to satisfy Army environmental requirements. AWS support units are aligned and integrated with the Army intelligence organization. Support products are in a form which is directly usable and understandable by Army personnel, and are integrated into Army communications systems. Mobile and fixed meteorological equipment for use in Army support is programmed by AWS. In a tactical environment, direct forecast support is normally provided down to division level, to armored cavalry regiments, to separate brigade headquarters, and to special forces groups. Observer support is normally provided at these levels and at brigade levels within the division.

AWS provides meteorological support to the nation's space and missile programs. This includes a wide range of weather observing services at the Air Force Eastern Space and Missile Center and the Kennedy Space Center. AWS also provides the forecasting service for NASA's unmanned launches at the Kennedy Center.

AWS provides specialized meteorological services for the Air Force Western Space and Missile Center at Vandenberg AFB, CA, and the Pacific Missile Range which includes Pt. Mugu and San Nicholas Island, CA, and Barking Sands, HI. AWS also supports the White Sands Missile Range, NM, the Kwajalein Missile Range, and other DOD research and test facilities.

USAF and Army operational requirements for environmental support are the basis for all AWS actions to improve existing or acquire new capabilities. AWS assesses these requirements and attempts to satisfy them through either hardware acquisitions or technique development.

AWS plans to modernize its base-level weather support systems. This includes an Automated Weather Distribution System (AWDS) and an Advanced Weather Radar (AWR). Both AWDS and AWR have R&D funds budgeted during the period of this plan.

AWDS will perform two major functions, automated surface observing and data-handling. It will incorporate the latest state-of-the-art data processing, communications, and display technologies. The observing function will take, display, and transmit (long-line and locally) surface weather observations. The data-handling function will maximize forecaster capability. A modular design will permit AWDS to be operated in a fixed or mobile environment and minimize staffing requirements. Initial installation is planned for late 1986 with completion of overseas and tactical installations by 1990. AWDS will be able to receive information from the NWS systems and the Naval Oceanographic Command systems.

AWR is being procured under the auspices of the Next Generation Weather Radar (NEXRAD) Joint System Program Office. NEXRAD will be an automated, digitized, S-band Doppler system that will be jointly developed, procured, operated, and maintained by the DOD, NOAA, and FAA within the CONUS and by the USAF overseas. The system will be designed to incorporate the latest technological advances in Doppler radar, data processing, communications, and display. The CONUS NEXRAD network will satisfy weather radar requirements in support of the general public, the military, and the entire spectrum of the aviation community. Installation of the NEXRAD is planned between 1987 and 1990.

FY 1981 funds were approved to modify the current AWS AN/FPS-77 weather radars (to replace transmitter and receiver circuitry components). Varian Beverly was issued the contract in July 1981 and will begin delivery of modification kits in August 1982. Installation of the kits is scheduled to begin in October 1982 and continue through October 1983. This action is needed to ensure continued logistics and maintenance support of this radar until AWR is operational. The AN/TPS-68 tactical weather radar will be fielded in FY 1982 after shelter modifications and equipment testing is complete.

In the field of weather reconnaissance, AWS, through the Air Force Logistics Command (AFLC), has ongoing programs to upgrade current capabilities by improving system reliability and maintainability. An improved controller and universal counter replaced older unsuppportable components of the AN/AMQ-29 dropsonde recording system during FY 1982. An improved weather reconnaissance and dropwindsonde capability is being evaluated. The feasibility of using off-the-shelf equipment and in-house development of these capabilities is being considered in an attempt to minimize costs.

The Air Force is modifying airfield meteorological equipment to replace obsolete vacuum tube components with solid-state electronics. These actions will materially reduce logistics and maintenance costs and increase equipment in-commission time. A $1 million contract was awarded in July 1978 for 344 modification kits to convert inventory transmissometers (AN/GMQ-10) to solid state circuitry. Delivery to AWS field units is expected to be completed in FY 1981.

In the area of atmospheric pressure measurement, the USAF has converted from wide-bore, mercurial barometers to dead-weight piston gauges used as regional primary pressure standards. Funds were approved for FY81 to procure a digital barometer and altimeter setting indicator (DBASI). Tele-Signal Corporation was issued the contract in February 1981 and will begin delivery of instruments by October 1982 with installation continuing through FY 1984. The unit will be solid state, easily transportable, highly accurate, and mercury free. This will eliminate base weather station mercurial barometers and their hazard to health due to mercury contamination. Funds were approved for FY82 to procure replacement temperature/dewpoint and wind measuring equipment and to upgrade cloud-height measuring equipment indicators. Equipment delivery is scheduled for FY83 and FY84. Funds are programmed in FY83 to replace mobile cloud-height measuring equipment and to replace and expand the existing equipment for the worldwide ionosonde network.

A significant improvement in the interaction between forecaster and machine to provide accurate and comprehensive meteorological forecasts is the planned acquisition,beginning in FY 1983, of an Interactive Processing and Display System (IPADS) for use at the AFGWC. In March 1979, a contract was awarded for the acquisition of a Satellite Data Handling System (SDHS) with an option for the acquisition of IPADS. The two complementary systems will provide computer consoles to be used by AFGWC weather technicians to interact directly with the AFGWC computers, thereby eliminating most physical handling of hardcopy information (plotting, overlaying, tracing, posting, sorting, etc.). Meteorological satellite imagery will be electronically integrated with conventional meteorological data to construct weather products.

SUPPORTING RESEARCH

The overall objective of the Air Force meteorological research program is the development of techniques and equipment for observing and predicting meteorological conditions that affect military operations. Requirements for research and technology in meteorology are expressed in Air Force Technology Planning Objectives, Research Objectives, Technology Needs, Statements of Operational Needs, and Development Goals. In addition, the Air Weather Service provides guidance in the form of geophysical requirements and research objectives. The Air Force Geophysics Laboratory (AFGL) has the mission responsibility within the Air Force to conduct basic research and exploratory development in the environmental sciences, including meteorology. Its program places emphasis on global and mesoscale numerical weather prediction, groundbased and satellite remote sensing, climatological studies, boundary layer meteorology, cloud physics and battlefield weather measurement and forecasting. While predominantly conducted under contract, research and development for the Defense Meteorological Satellite Program is also performed.

In the area of global numerical weather prediction, an existing spectral model will be modified for use on AFGL computers. Auxiliary computer routines will be developed to emphasize the handling of cloud and moisture in the model. In mesoscale weather forecasting, radar, satellite and conventional weather data will be incorporated to develop models for the short range (0-6 hours) prediction of cloud ceiling and visibility. Also, two cloud forecast models will be developed for minicomputer cpplication. One will use satellite imagery data in conjunction with three-dimensional circulation and dynamic variables to account for large scale advection, development and decay. The second will focus on lower tropospheric cloud and moisture prediction and will be developed by studying the effects of moisture distribution on the model's time and space scales, in order to define cloud development/dissipation effects. Forecaster effectiveness in an automated operational environment, such as the Automated Weather Distribution System (AWDS), will be evaluated using AFGL's Man-Computer Interactive Data Access System (McIDAS). AFGL will continue to work with NOAA in the evaluation of its Prototype Regional Observing and Forecasting System (PROFS) as intensive mesoscale forecasting experiments are carried out using facilities and data sources tied to an elaborate minicomputer and interactive display system. These experiments will objectively evaluate forecaster performance, system effectiveness, human engineering factors, and dissemination options.

A carbon dioxide laser Doppler technique will be tested as a gound-based technique for the remote sensing of atmospheric winds in the vicinity of air terminals. Automated Doppler weather radar-based techniques will be developed for the detection of meteorological parameters that are precursors to severe storm phenomena such as gust fronts, low level shear, mesocyclones, tornadoes and stratiform winds. There is an urgent need to incorporate these techniques in the joint DoD, DOC and DOT Next Generation Weather Radar (NEXRAD) presently in design evaluation phase. Testing of a prototype tactical visibility meter suitable for bare-base airfield operations will be completed. Coherent polarization diversity weather radar techniques to derive hydrometer characteristics such as particle size distribution, orientation and thermo-dynamic phase will be tested. In support of satellite meteorological sensing, improved inversion algorithms will be developed to compute more accurate vertical temperature and water vapor profiles from satellite-measure radiance data at far infrared and microwave wavelengths. Cloud detection algorithms will be developed to enable the distinguishing of water clouds from ice clouds, cloud-covered areas from clear land, and oceans and snow cover.

In climatological technique development, atlases of wind extremes in the upper stratosphere and mesosphere, and of the differences in atmospheric structure between the northern and southern hemispheres between 30 and 100 km, will be developed. Revised models will be developed to provide information on mesoscale variations of ceiling and vertical cloud cover distribution over the globe. An atlas of monthly or seasonal one-minute rainfall rates over land areas of the Northern Hemisphere will be developed.

A new boundary layer meteorology program will be started in FY83 in which a series of experimental and theoretical studies will be conducted to define the atmospheric conditions which affect microwave propagation. A boundary layer prediction model will then be developed. A previously developed fog prediction model will be tested using data collected at the Otis Weather Test Facility and the model will be modified as appropriate. Techniques to predict the diffusion of hazardous gases during inadvertent propellant releases will also be investigated.

The AFGL cloud physics program will undergo considerable modification in FY83. Due to the loss of the C-130 aircraft to the AFGL program, emphasis will be on the development of smaller, light-weight instruments for potential small aircraft deployment. A prototype supersaturation sensor will be tested for potential use on an aircraft to study precipitation growth. A light-weight instrument for the accurate and direct in-flight measurement of hydrometer mass distribution and liquid water content will be developed. The major thrust of the cloud physics program will emphasize the development of computerized mathematical models for forecasting the microphysical structure of clouds and cloud systems, given macroscopic statements about the nature of the atmosphere.

The battlefield weather program will emphasize the development of low-cost expendable instrumentation for measuring humidity, visibility at visible and infrared wavelengths and the macroscopic characteristics of clouds and cloud systems (cloud cover amount, cloud tops and bases). Both unmanned recoverable and expendable alternatives will be investigated; e.g., remotely piloted vehicles, dropsondes, surface implants and satellites.

Regarding the Defense Meteorological Satellite Program in FY82, work will continue on development of the microwave imager and ground segment encryption. Work will also continue on a flight simulation system and upgrades to command, control, and telemetry systems. Systems engineering and analysis efforts necessary to support launch and on-orbit operations will be provided in both FY82 and FY83.

In FY83, work will begin on satellite development necessary for space shuttle compatibility and transition in the 1990 timeframe, as well as development of advanced technology sensors.

DEPARTMENT OF ENERGY

The Department of Energy (DOE) supports meteorlogical services at nine of its laboratories and at the Nevada Test Site. Services include climatological summaries, general weather forecasts, and items specifically in support of laboratory operations such as environmental monitoring, atmospheric sciences research, and hazardous material release assessments. The Weather Service Nuclear Support Office at the Nuclear Test Site provides continuing meteorological services required by the safety and technical programs associated with all forms of nuclear and non-nuclear experiments conducted at the test site and other locations.

DEPARTMENT OF INTERIOR

The principal meteorological activity of the Department of Interior (DOI) is the weather modification research program called Project Skywater, administered by the Bureau of Reclamation, dedicated to augmenting water resources in critical water problem areas of the West through the development and demonstration of a practical precipitation management technology. Other Bureau of Reclamation activities, including runoff forecasting, flood hydrology, irrigation projects, and reservoir operations, as well as projects related to the development of wind and solar energy resources, also require the collection and use of meteorological data.

The Water Resources Division of the Geological Survey collects precipitation and other climatological data for a number of projects concerning rainfall/runoff and other hydrologic processes. Precipitation and dryfall atmospheric deposition samples are collected in a number of studies for the determination of atmospheric contribution to the chemical constituent loads to runoff, and for defining the effect of atmospheric deposition on water quality and the acquatic environment. The Geological Survey provides lead agency coordination for the atmospheric deposition monitoring program of the Interagency Task Force on Acid Precipitation.

The Bureau of Land Management in DOI collects meteorological data from a system of remote automatic weather stations and operates a lightning detection system, containing wideband direction-finders that respond primarily to cloud-to-ground lightning, in its fire-management program.

DEPARTMENT OF STATE

The Department of State interests in meteorology are general but touch a number of areas. They involve the international aspects of food and feeding the world, disaster warnings and assistance, long-range concern with the socio-economic effects of climate change, World Meteorological Organization activities, international meteorological programs, and concern with some programs which start as operating programs but develop international interest and concern such as the possibility of seeding of storms in the Pacific.

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

RESPONSIBILITIES FOR AVIATION WEATHER

The Federal Aviation Administration (FAA) is responsible for the safety and separation of aircraft and the efficiency of flight operations. The adequacy of aviation weather information contributes significantly toward fulfilling these responsibilities. FAA makes recommendations to the U.S. Department of Commerce on civil aviation meteorological services, provides specialized equipment and surface observations at certain airfields, distributes weather data over civil communications systems, and provides the principal means for disseminating weather information to pilots.

Weather information for pilots is made available through Flight Service Stations, recorded messages broadcast over navigational aids, special weather broadcasts, and telephone answering systems. Air Route Traffic Control Centers now have weather service units manned by NWS meteorologists to assure that vital weather information is available to the controllers.

FAA maintains a continuing research program to improve aviation weather service to the National Airspace System and its users. FAA also engages in engineering efforts to improve weather observations and communications related to aviation.

The Aviation Weather Program is aimed at progressively improving the timeliness and accuracy of weather information provided to aircrews and to the Air Traffic Control (ATC) system so as to reduce the number of weather related accidents and incidents and to increase both system capacity and fuel savings by reducing weather related delays. Facets of the program are conducted in close cooperation with the National Weather Service (NWS). Wherever practical, the objectives of this program are accomplished by enhancing existing and planned air traffic control and flight service station system components and facilities for the collection, processing, and dissemination of significant weather information.

MAJOR PROGRAMS FOR AVIATION WEATHER

The program encompasses three major development areas: (1) Enhancements to the weather data bases of the air traffic control system to provide pilots and controllers with the capability for rapid access to hazardous and routine weather information; (2) developement of an improved national weather radar system for detecting hazardous weather phenomena through the applications of Doppler radar technology; and, (3) development of ground-based automated weather observation systems to provide observations at locations where needed; such as, airports with approved instrument approaches, heliports, and off-shore drilling platforms. The status and planned accomplishments of specific programs are given below.

Next Generation Weather Radar

The FAA continues to support development of the Next Generation Weather Radar (NEXRAD) with personnel and funding for the NEXRAD Joint System Program Office (JSPO). This support will assist the NEXRAD JSPO in the development of an integrated logistics plan, a personnel training program, and a systems development plan. FAA is participating jointly with the Department of Defense and the Department of Commerce in the development of a common use NEXRAD network to meet the common weather detection requirements of government and the public. In FY 1982, the initial phase of NEXRAD development continued with the multiple award of system design contracts and the completion of a cost benefit analysis of the NEXRAD requirements. In FY 1983, the development of NEXRAD will continue with the award of a single contract to validate the radar concepts developed in FY 1982.

In a NEXRAD-related but independent effort, the FAA will be testing optimum weather radar scan rate and signal processing algorithms at the National Severe Storms Laboratory (NSSL) in Norman, OK. In addition, at the FAA's Technical Center near Atlantic City, NJ, the assembly of a transportable weather radar test bed will be completed in FY 1982 for field test at selected airports.

Work on detection, tracing, and 0-30 minute prediction of convective cell movement and intensity will continue in FY 1982. Reflectivity and Doppler radar data collected at NSSL will provide independent data sets upon which prediction algorithms will be tested for accuracy and reliability.

NAS Weather Enhancements

National Airspace System (NAS) weather related enhancements include developing the capability for processing, distribution, and display of weather data to pilots, controllers, FSS specialists and meteorologists.

In FY 1982, work continues to improve the processing and distribution of weather data to pilots and controllers, including initiation of the development of a specification for automation of the Center Weather Service Unit (CWSU) work station using a Center Weather Processor (CWP).

In FY 1983, CWP/CWSU development will continue at the FAA's Technical Center with the testing and evaluation of the CWSU work station and continued development of specifications for subsequent FY 1984 procurement. Additionally, in FY 1983 testing of weather radar contours on the en route air traffic controllers Planned View Display (PVD) will continue at the FAA's Technical Center.

Cockpit Weather Displays

In FY 1981, Cockpit Weather Display flight tests were carried out in which the weather information was transmitted over the existing voice channels of two neighboring VOR (VHF Omnidirectional Range) stations. These tests showed that single pilots can operate and interpret the Cockpit Weather Display without degrading flight safety. In FY 1982, the objective is to demonstrate the system under thunderstorm conditions and in an area containing many VOR stations. In FY 1983 development and testing of the Cockpit Weather Display will result in specifications for ground equipment necessary to transmit radar data from a nationwide network of FAA VORs planned for implementation by 1985.

Joint Airport Weather Studies

The FAA, along with the National Science Foundation, the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administation, funded a full scale program -- the Joint Airport Weather Studies (JAWS) Program -- that began in the summer of 1981. The purpose of the program is to better understand the kinematics of thunderstorm outflows (winds and wind shear) and their effects on aircraft operations and traffic flow efficiencies. The information generated by this study will be utilized by the FAA for (a) improved warning of wind shear, (b) improved wind shear models for use in flight simulation, (c) expeditious dissemination of severe weather to pilots and air traffic controllers, (d) optimal placement of weather radars, and (e) hazardous weather tracking and prediction techniques associated with thunderstorms. Data obtained by aircraft, surface observations and weather radars obtained in FY 1982 will be analyzed in FY 1983 and FY 1984.

In FY 1983 analysis of JAWS data will continue with the results of aircraft probes into suspected convective areas related to hazards identified by Doppler radars. In addition, thunderstorm detection by a Lightning Tracking and Positioning System will be compared with the detection capability of weather radars.

Automation of Weather Observations

Work continues at the Transportation System Center (TSC) to upgrade the transmissometer/forward-scatter meter. The upgraded visibility measuring equipment will lead to the capability of making visible observations in Category IIIb weather conditions. Plans were formulated and candidate visibility sensors are scheduled to be installed for operational evaluation. In FY 1983, completion of the Category IIIb tests will lead to a specification of a hybrid transmissometer/forward scatter meter system which will be implemented at select major airports having Category IIIb approved landing aids.

Testing of an Automated Low Cost Weather Observation System (ALWOS) in the Gulf of Mexico was completed with the recommendation that the equipment be modified to cope with oil platform environments. Tests of a Lightning Position and Tracking System were concluded and the system was turned over to the FAA's Southwest Region for operational use in thunderstorm avoidance in the Gulf of Mexico and adjacent southwest states.

Beginning in FY 1982 ten, commercially available, trial, automated surface weather observing and reporting systems will be operationally tested and demonstrated at some airports. These systems will give the pilot, via radio, the wind direction and speed, altimeter setting, visibility, ceiling, and temperature. Implementation of approximately 1,200 of these systems is planned to begin in FY 1983.

The upgraded visibility sensor and cloud height indicator sensors will be evaluated in FY 1983 as modular components of the Automated Weather Observing System (AWOS). These sensors will be identified as candidates for replacement of AWOS obsolete components thereby increasing the dynamic range of those observational elements and reducing overall AWOS cost.

Flight Service Station Automation

FAA plans to automate 61 Flight Service Stations (FSSs) and ultimately consolidate the remaining FSSs into these 61 stations. Consolidation will be accomplished in several stages. After each automated FSS is operational, existing stations within its flight plan area are to be consolidated into the station only when (1) the quality of service provided by the automated station is equal or superior to the service available from the then-existing stations and (2) a consolidation plan has been developed that is tailored to the needs of the flight plan area.

The initial level of automation will be the Model 1 system which will consist of a computer that will be a subset of the final system design for the automated FSSs. Fourteen Model 1 computer systems will be installed at selected Air Route Traffic Control Centers (ARTCCs) which will drive remote alphanumeric terminals at 41 of the busiest FSSs. The Model 1 software will be a relatively simple version that will permit automatic file updating and retrieval, display of alphanumeric weather and aeronautical data, flight plan entry, and flight plan processing. Each computer system will have a dedicated data communications line from the FAA Weather Message Switching Center (WMSC) in Kansas City, MO, and the Automated Service B Data Interchange System (ASBDIS).

The upgraded or Model 2 automation system will provide full specialist automation capabilities. Twenty-three Model 2 computer systems will be installed to replace the Model 1 computer systems and drive the remoted specialist terminals at the 61 FSSs to be automated. The specialist terminals will display alphanumeric and graphic data to be furnished directly by two Aviation Weather Processors (AWPs). One AWP will be located at Salt Lake City, UT, and the other, at Atlanta, GA. The AWPs will interface with the WMSC for alphanumeric data and with NWS's National Distribution Circuit (NDC) for graphic weather products. Weather radar data will be received from selected NWS/FAA radars and stored in each computer system for instant retrieval. This will provide the necessary automation capacity to meet forecast service demands through 1995 for FSS specialist operating positions and for self-briefing access features for pilots throughout the country. Details are given in the Master Plan for Flight Service Station Automation Program, January 1978, and the Master Plan Addendum, March 1980.

Phase I of the FSS Automation Program was completed in FY 1981. A single contractor was selected to accomplish Phase II of the program which provides for the production/installation of the Models 1 and 2 computer systems, two AWPs and the development of long-term enhancements to the Model 2 system. Early in FY 1983, a production contract will be awarded for Model 2 system enhancements including a Package 1 - Voice Response System (VRS) and interfaces for user owned commercially available self-briefing terminals. In addition, transcribed weather broadcast route forecasts, local briefings, significant meteorological weather will be added to the Voice Response System (VRS) under operational test in the Washington, DC, and Columbus, OH, areas.

In FY 1982, five Model 1 computer systems are planned and 12 FSSs will receive remote alphanumeric terminals. Other major efforts in the FSS program are to develop techniques that will permit pilots to have direct access to the FSS automation data base. The approach is as follows:

- Continue development of computer-generated Voice Response System (VRS) capability.

- Develop automated flight plan filing capability via telephone with touchtone or voice inputs.

- Integrate voice response/flight plan filing and Pilot Automatic Telephone Weather Service (PATWAS) into a national system designed for pilot self-briefing.

- Develop the concept of pilot self-briefing via interactive coupling of user owned terminals with the FSS automation data base.

- Jointly develop, with NWS, new formats and techniques for generating, processing, and delivering aviation weather products to pilots for preflight and inflight applications.

Center Weather Service Unit (CWSU)

Each CWSU in the 20 ARTCCs within the 48 contiguous states and the one in Alaska are now staffed with four NWS meteorologists. They provide service to the center's air traffic controllers and to other FAA facilities for two 8-hour shifts per day. FAA reimburses the NWS for the salaries of the meteorologists, as well as providing staffing positions from its resources.

Low Level Wind Shear

The installation of the low level wind shear alerting system is continuing and will be completed at approximately 100 airports by the end of FY 1983. This system uses wind sensors (anemometers) near the approach and departure ends of the runway and compares the readings from these sensors with a centerfield wind sensor. When a wind shear is apparent from this comparison, the tower controller is alerted and the information is passed from the controller to the pilot approaching the airport or preparing for takeoff.

U.S. COAST GUARD

The U.S. Coast Guard is authorized by 14 USC 147 to cooperate with the National Oceanic and Atmospheric Administration (NOAA) in the observation and dissemination of weather information.

As part of its mission to support the Nation's weather program, the Coast Guard cooperates with the National Weather Service (NWS) in the collection of synoptic and other regularly scheduled observations from cutters and shore installations. Raw weather observations are transmitted via Coast Guard communications facilities to NWS forecast offices. Coast Guard communications stations also relay meteorological reports from coastal and high seas shipping to the NWS. These data are utilized by the NWS in producing their forecasts, which are then disseminated in part by the Coast Guard over Coast Guard radio facilities as part of the Marine Information Broadcasts. Additionally, data link and logistics support is provided for NWS automated sensors placed at Coast Guard stations.

Coast Guard personnel stationed at the NOAA Data Buoy Office (NDBO) at Bay St. Louis, MS, furnish technical support and liaison for the NOAA Data Buoy Project. Coast Guard vessels are employed to position, deploy and maintain NDBO environmental buoys, and communications facilities provide data relay functions.

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for working with state and local government agencies to ensure adequate air quality meteorological support programs. Applied research and operational meteorological support support to EPA is provided by the Meteorology Laboratory of NOAA's Air Resources Laboratories. Such operational support to the Office of Air and Waste Management, the EPA Regional Offices, and other EPA components includes review of the meteorological aspects of environmental impact statements, state implementation plans, application of dispersion models, and preparation of dispersion studies and evaluations.

RESEARCH PROGRAM FOR FISCAL YEAR 1983

EPA applied research is in the areas of air quality dispersion model development, evaluation, verification, and application, development and application of air pollution climatology, determination and description of pollutant effects on atmospheric parameters, and determination of meteorological effects on air quality. Dispersion models for inert and reactive pollutants are under development and evaluation on all temporal and spatial scales; e.g., urban and regional. Particular emphasis is being given to the development of a dispersion model for use in complex terrain; and photochemical air quality dispersion models on several scales utilizing data collected during earlier field programs. The data obtained from programs initiated in FY80-81 will be used to develop and evaluate models in the FY83 period. Planetary and urban boundary layer models are under development for use with air quality dispersion models. Examination of the relationship between meteorology and air quality continues with emphasis on ozone, sulfates, and other particulate matter. The effects of air pollutants on atmospheric parameters, such as visibility and acidic precipitation chemistry, are also under continuing investigation.

ENABLING LEGISLATION

- o Clean Air Amendments of 1970 - Sections 103, 110, 303, 313
- o Clean Air Amendments of 1977 - Sections 121, 126, 127, 128, 310

INTERAGENCY FUND TRANSFERS

Funds are transferred to the National Oceanic and Atmospheric Administration for the provision meteorological research and operational support of the agency's regulatory mission. Research activities define, describe and study the meteorological factors important to air pollution regulatory activities and the development of air quality standards and criteria. Air quality models are developed, evaluated, and validated for use by EPA in its regulatory and compliance activities. A users network for applied models of air pollution (UNAMAP), consisting of dispersion models either developed internally or by other groups and validated under the program, is maintained and continuously modified and expanded for use by the public and private sector. Direct operational support includes the review of the meteorological aspects of environmental impact statements, state implementation plans, and other compliance documentation; the application of dispersion models for control strategy evaluation; and the conduct of physical and mathematical dispersion studies for guideline and standard development, evaluation, and implementation.

FEDERAL EMERGENCY MANAGEMENT AGENCY

The Federal Emergency Management Agency (FEMA) was established in 1979, to merge closely allied Federal programs involved with preparedness, mitigation and response to national emergencies ranging from natural and man-made disasters to nuclear attack. FEMA replaces five former agencies, consolidating into a single structure a dozen different Federal emergency-related activities, including such functions as community-awareness programs for weather emergencies and coordination of all emergency warnings.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The goals of the NASA Weather and Climate Research Program are to observe and study the atmosphere and the Earth from the unique perspective of space, in order to increase our understanding of the atmosphere and to improve our ability to predict its future state. These goals are pursued through the development of remote sensors, space and ground data systems; techniques to process, interpret and verify satellite data; appropriate analytical procedures; and, advanced models to understand atmospheric behavior diagnostically and prognostically. Programmatically, these supporting research activities are managed under three elements:

- Development of space and ground systems for severe storm detection, monitoring, prodiction, and warning.
- Development of space and ground systems to improve our monitoring of global weather and our mid-range forecast capability (3-14 days).
- Investigation of the potential of space technology for monitoring and predicting climate variability.

In the study of severe storms, NASA uses spaceborne, airborne, and ground-based technology to obtain observations of severe storms in order to improve our understanding of the processes involved in severe storm generation and propagation. Data processing, analysis, interpretation, and modeling of these observations of thunderstorms and tropical storms are performed to improve prediction capability. This research also leads to the specification and development of new space capabilities for the detection and monitoring of severe weather.

The NASA-developed VISSR Atmospheric Sounder (VAS), now deployed on two Geosynchronous Operational Environmental Satellites, GOES-4 and GOES-5, is undergoing assessment to determine its value for severe storm observations. These instruments are providing temperature and moisture soundings in the vicinity of severe storms with unprecedented temporal and spatial sampling and are expected to have a significant positive impact on detecting and forecasting such phenomena.

NASA is continuing to support basic research on the time and space variability of lightning discharge rate. The work is intended to provide some understanding of a range of phenomena from global electrical behavior to the relationship with storm severity and tornado likelihood. The work includes obtaining an accurate climatology of lightning strike points for improved lightning protection. NASA has been exploring spaceborne techniques for the observation of the majority of discharges, day or night, from geosynchronous altitude (36,000 km). Currently, a comprehensive set of absolute intensity and spectral observations are being conducted from ground-based laboratories and the U-2 high-altitude aircraft flying above the storms; an experimental observing technique was successfully demonstrated on the Shuttle flight of November 1981. The most promising technique considered to date is a differencing optical array that should be able to detect flashes by observations each millisecond.

A joint NASA/NOAA project called the Centralized Storm Information System (CSIS) to aid in improved forecasting capability at the National Severe Storms Forecaster Center in Kansas City, MO, has now been partially installed. The system which provides all forms of currently available meteorological data directly to video consoles in the forecast office. Satellite, radar, surface, and upper air data are instantly accessible, along with NMC analyses, forecasts, and other forms of guidance. The data can be superimposed and interpreted using the same map areas and projections. Derived products can be superimposed on color-coded observations to provide a new dimension for the understanding of rapidly-developing weather situations.

The National Climate Program five-year plan was approve by the White House in 1978. NASA's basic role in this program emphasizes applications of space technology to improve our understanding of the physical processes and interactions which control the Earth's climate and is essential to the development of a national climate forecasting capability.

Four principal areas in which research is being conducted by NASA in support of the national program are

- Data Base Development. To demonstrate and facilitate the use of space-acquired global data sets for climate applications and studies.

- Special Studies. To conduct special studies to gain insight and understanding of the physical processes and connections between climate variables, to develop parameterizations for models, and to aid in future sensor development.

- Climate Modeling and Analysis. To develop climate modeling capabilities to guide the design of the observing system, to optimize the utilization of space-acquired data, to carry out studies of physical processes, and to help assess climate predictability.

- Climate Observing System. To develop a climate space-observing system, including operational system improvements and new instruments and research satellites as needed, as part of an integrated system composed of complementary and mutually supporting elements.

NASA has been assigned lead responsibility for the National Climate Program's principal thrust in Solar and Earth radiation. The Earth's radiation budget, which is the central element of this research, describes the energy balance which exists between the Sun, Earth, and space. It is the geographical and temporal imbalance in this key relationship which governs the state and changes of regional climate. Earth radiation budget data acquired by Nimbus research satellites, beginning in 1976, are currently being processed and merged into a global climate data set, to be augmented with data from the Earth Radiation Budget Experiment (ERBE) beginning in 1984. Monitoring of the solar irradiance is also being accomplished by sensors aboard Nimbus 7 and the Solar Maximum Mission (SMM). The total solar irradiance (often referred to as the solar constant) is the basic source of energy for driving the climate system. Climate model studies have shown that persistent variability in this quantity could have a major impact on climate.

NASA continues to supply NOAA with the TIROS-N series spacecraft (funded by NOAA) for operational meteorological deployment.

NASA continues to support the analysis of the data gathered during the GARP Global Weather Experiment. Emphasis will be placed on observations obtained from space with the interpretation and application of these data to the development of advanced techniques for modeling and prediction. An Applications Notice (AN) dealing with analysis of the FGGE data was released in June 1981. Over twenty proposals for research to this AN have been received. The investigations involve both NASA scientists and those from the external scientific community.

In order to facilitate the growing requirements for data analysis and modeling in the NASA atmospheric research programs, procurement of an advanced vector processor has been initiated. This computer, a Cyber 205, will be delivered to the Goddard Space Flight Center during the fourth quarter of FY82. This computer will increase the present NASA computing capability used for atmospheric research by a factor of ten.

NASA continues to support research and development activities to improve our remote sensing capabilities for possible future deployment on satellites. Studies involve remote sensing of atmospheric temperature, pressure, moisture, and winds using passive and active techniques. Worthy of mention are the successful flights of an airborne Doppler lidar wind measuring system during the summer of 1981. This system was flown aboard the NASA Convair 990 gathering data over an 8,000-km course. The winds were measured at horizontal ranges out to 20 km from the aircraft and delineated details, e.g., gust fronts, never before observed.

NUCLEAR REGULATORY COMMISSION

The Nuclear Regulatory Commission (NRC) licenses and regulates all nuclear facilities subject to the Atomic Energy Act of 1954, as amended. The licensing and operation of nuclear facilities require identification and evaluation of meteorological conditions that can affect the safe operation of the facility and that provide input to the assessment of the radiological impacts of any airborne releases from the facility.

Within the NRC, the Offices of Nuclear Reactor Regulation and Nuclear Material Safety and Safeguards review facility siting, design, construction, and operation. These reviews include consideration of meteorological factors. The Office of Inspection and Enforcement and the regional offices assure that conditions of NRC licenses are carried out and conducts NRC response to nuclear facility emergencies. The Office of Nuclear Regulatory Research develops regulations, guides, criteria, and other standards relating to the protection of public health and safety and the environment in the licensing of nuclear facilities. This Office also develops and conducts confirmatory research programs in support of activities of the other offices and in support of rule-making and standards activities.

There are several meteorological areas which will require major emphasis during FY 1982 and beyond and will involve the cooperative efforts of all of the NRC offices. Paleoclimatic site investigations of high-level radioactive waste depositories are being conducted, and meteorological criteria for siting of low-level radioactive waste depositories are being developed. Upgrading of the meteorological capabilities of the NRC and the operators of nuclear facilities are in process to cope with emergencies involving unplanned airborne releases of radioactive material from the facility. These meteorological capabilities include upgrading of meteorological programs at nuclear facility sites, development of assessment capabilities, and meteorological data and analysis transmission capabilities in real-time. Regulatory guides are being revised or are under development for nuclear facility design with respect to extreme meteorological events such as tornadoes, severe dust storms, lightning, extreme winds and temperatures, and snowloads. Major research efforts include prediction of atmospheric dispersion and diffusion around buildings.

APPENDIX B

ACRONYMS AND ABBREVIATIONS

AAR	Automated Aircraft Reporting
ADDS	Atmospheric Distributed Data System
ADWS	Automated Digital Weather Switch
AEPS	Automated Environmental Prediction System
AEW	Airborne Early Warning
AF	Air Force (USAF)
AFB	Air Force Base
AFCC	Air Force Communications Command
AFGL	Air Force Geophysical Laboratory
AFGWC	Air Force Global Weather Central
AFOS	Automation of Field Operations and Services
AFR	Air Force Regulations
AFRES	Air Force Reserve
AHOS	Automated Hydrologic Observing System
ALWOS	Automated Low Cost Weather Observation System
AMR	Aircraft Microwave Refractometer
AOIPS	Atmospheric and Oceanographic Information Processing System
APT	Automatic Picture Transmission
AR	Army Regulations
ARGOS	French Data Collection System
ARQ	Automatic Response to Query
ARRS	Aerospace Rescue and Recovery Service
ARTCC	Air Route Traffic Control Center
ASBDIS	Automated Service B Data Interchange System
ASDAR	Aircraft to Satellite Data Relay
ASW	Anti-Submarine Warfare
ATC	Air Traffic Control
AVHRR	Advanced Very High Resolution Radiometer
AWDS	Automated Weather Distribution System
AWES	Automated Weather System
AWIS	Automated Weather Information Systems
AWOS	Automated Weather Observing System
AWN	Automated Weather Network
AWP	Aviation Weather Processor
AWR	Advanced Weather Radar
AWS	Air Weather Service
CAC	Climate Analysis Center
CAT	Clear Air Turbulence
CDA	Command and Data Acquisition
CDAS	Command and Data Acquisition Station
CDDF	Central Data Distribution Facility
CEAS	Center for Environmental Assessment Services
COMEDS	Continental U.S. Meteorological Data System
COMNAVOCEANCOM	Commander Naval Oceanography Command
CONUS	Continental United States
COPPERHEAD	Artillery Projectile

CPU	Centralized Production Unit (USAF)
CWSU	Center Weather Service Unit (FAA)
DACS	Data Acquisition and Control Subsystem
DCPLS	Data Collection and Platform Location System
DCS	Data Collection System
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DOT	Department of Transportation
DPSS	Data Processing and Services Subsystem
EDIS	Environmental Data and Information Service
E/O	Electro-Optical
EOSAEL	Electro-Optical Systems Admospheric Effects Library
EPA	Environmental Protection Agency
ERBE	Earth Radiation Budget Experiment
ERBSS	Earth Radiation Budget Satellite System
ERL	Environmental Research Laboratories
ESM	Electronic Warfare Support Measures
ESSC	Environmental Studies Service Center
FAA	Federal Aviation Administration
FAMAS	Field Artillery Meteorological Acquisition System
FCMSSR	Federal Committee for Meteorological Services and Supporting Research
FEMA	Federal Emergency Management Agency
FLENUMOCEAN	The Fleet Numerical Oceanography Center
FNOC	Fleet Numerical Oceanography Cente
FSAS	Flight Service Automation System
FSS	Flight Service Station
FY	Fiscal Year
GAO	General Accounting Office
GARP	Global Atmospheric Research Program
GMT	Greenwich Mean Time
GOES	Geostationary Operational Environmental Satellite
HEL	High Energy Laser
HIRS/2	Modified High Resolution Infrared Sounder
HRPT	High Resolution Picture Transmission
HRWS	Helicopter Remote Wind Sensor
ICMSSR	Interdepartmental Committee for Meteorological Services and Supporting Research
IPADS	Interactive Processing and Display System
IR	Infrared
ITOS	Improved TIROS Operational Satellite
JAWOS	Joint Automated Weather Observing
JAWS	Joint Airport Weather Studies

JSPO	Joint System Program Office (NEXRAD)
KM (or km)	Kilometer
M	Million
MAC	Military Airlift Command
McIDAS	Man-computer Interactive Data Access System
MIPS	Million Instructions Per Second
MMS	Meteorological Measuring System
MOS	Model Output Statistics
MSU	Microwave Sounding Unit
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communication Center
NAVEASTOCEANCEN	Naval Eastern Oceanography Center, Norfolk, VA
NAVOCEANCOMCEN	Naval Oceanography Command Center
NAVOCEANCOMDET	Naval Oceanography Command Detachment
NAVOCEANCOMFAC	Naval Oceanography Command Facility
NAVOCEANO	Naval Oceanographic Office
NAVPOLAROCEANCEN	Naval Polar Oceanography Center, Suitland, MD
NAVWESTOCEANCEN	Naval Western Oceanography Center, Pearl Harbor, HI
NAWAS	National Warning System
NCC	National Climatic Center
NCPO	National Climate Program Office
NDBO	NOAA Data Buoy Office
NDC	National Distribution Circuit
NEDN	Naval Environmental Data Network
NEDS	Naval Environmental Display Station
NESS	National Earth Satellite Service
NEXRAD	Next Generation Radar Equipment
NHC	National Hurricane Center
NHELTR	National High Energy Laser Test Range
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NOMSS	Naval Oceanographic and Meteorological Support System
NOS	National Ocean Survey
NOTAM	Military Notice to Airmen
NRC	Nuclear Regulatory Commission
NSF	National Science Foundation
NSSFC	National Severe Storms Forecast Center
NSSL	National Severe Storms Laboratory
NTSB	National Transportation Safety Board
NWR	NOAA Weather Radio
NWS	National Weather Service
OFCM	Office of the Federal Coordinator for Meteorology
OLS	Operational Linescan Systems
OMB	Office of Management and Budget
OPARS	Optimum Path Aircraft Routing System
OWRM	Office of Weather Research and Modification
P-3	Four Engine Transport (Lockheed Orion)
PATWAS	Pilot Automatic Weather Answering Service

PROFS	Prototype Regional Observing and Forecasting System
R&D	Research and Development
RD/T&E	Research & Development, Test/Evaluation
RFC	River Forecast Center
ROMS	Remote Ocean Surface Measuring System
SATCOM	Satellite Communications System
SBUV	Solar Backscatter Ultraviolet Instrument
SCM	System Control and Monitor
SDHS	Satellite Data Handling System
SEL	Space Environment Laboratory
SEM	Space Environment Monitor
SFSS	Satellite Field Services Station
SMS	Synchronous Meteorological Satellite
SOCC	Satellite Operations Control Center
SPC	U.S. Navy Satellite Data Processing Center
SSU	Stratospheric Sounding Unit
TESS	Tactical Environmental Support System
TFU	Tactical Forecast Unit
TIROS	Television Infrared Observation Satellite
TMQ-22	Tactical Observing Kit (U.S. Air Force and Army)
TOVS	TIROS N Operational Vertical Sounder
USAF	United States Air Force
USAFETAC	USAF Environmental Technical Applications Center
USC	United States Code
USCG	United States Coast Guard
USDA	U.S. Department of Agriculture
USN	United States Navy
UV	Ultraviolet
VAS	VISSR Atmospheric Sounder (GOES D and subsequent spacecraft)
VHF	Very High Frequency
VHRR	Very High Resolution Radiometer
VISSR	Visible and Infrared Spin Scan Radiometer
VOR	Very High Frequency Omni Range
VRS	Voice Response System
VTPR	Vertical Temperature Profile Radiometer
WEFAX	Weather Facsimile
WETM	Weather Team
WFSC	Weather Facsimile Switching Center
WMO	World Meteorological Organization
WMSC	Weather Message Switching Center
WSCMO	Weather Service Contract Meteorological Office
WSFO	Weather Service Forecast Office
WSMO	Weather Service Meteorological Office
WSO	Weather Service Office
WWB	World Weather Building

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FEDERAL COMMITTEE FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (FCMSSR)

FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

INTERDEPARTMENTAL COMMITTEE FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (ICMSSR)

SUBCOMMITTEES

AVIATION SERVICES

SPACE ENVIRONMENT FORECASTING

SYSTEMS DEVELOPMENT

Working Groups

- o Automated Surface Observations
- o Automated Weather Information Systems
- o Radiological, Gaseous and Particulate Transport Models
- o Weather Radar Systems

OPERATIONAL ENVIRONMENTAL SATELLITES

BASIC SERVICES

Working Groups

- o Agricultural Meteorological Services
- o Cooperative Backup Among Operational Processing Centers
- o Dissemination of NMC Products
- o Hurricane Operations
- o Marine Environmental Predictions
- o Meteorological Codes
- o Metric Implementation
- o Operational Processing Centers
- o Severe Local Storms Operations
- o Surface Observations
- o Upper Air Observations
- o Weather Radar Observations
- o Winter Storms Operations
- o World Weather Program