APPENDIX E

WORLD WEATHER PROGRAM

The Department of Commerce (DOC) was designated by the President, following Senate Concurrent Resolution 67 (1968), to be the lead agency for coordinating U.S. participation in the World Weather Program (WWP). Previous to 1983, DOC published a separate report on WWP Plans. Beginning with the 1983 edition of the Federal Plan for Meteorological Services and Supporting Research, a section on the WWP has been included, obviating the need for a separate report. Included at the end of this appendix are bilateral and regional international cooperative activities not under the WWP. While not exhaustive, most government programs are included.

GOALS AND ORGANIZATION

The goals of the WWP are to extend the time, accuracy, range, and scope of weather prediction and to understand the physical basis of climate and climatic change. The ability of the U.S. and other nations to use their existing scientific capability to understand the climate and to increase their weather predicting skills is limited by the lack of global weather data. Available weather data are inadequately observed over 80 percent of the Earth's surface and mostly over the oceans; coverage over the remaining 20 percent is barely adequate.

Development of the technology and the systems to obtain these observations, especially over the oceans, presents formidable problems. With the use of satellites, aircraft, ships, radar, anchored and drifting buoys, and balloons, however, a system can be developed to observe and collect comprehensive daily data about the atmosphere over the entire globe. This system is too complex to be implemented by a single nation--a fact clearly recognized by the leaders of many nations whose international cooperation in meteorology has been a tradition for more than a century. In 1961, this continuing need for international cooperation prompted the President of the United States to propose to the United Nations (UN) the establishment of an international effort in weather prediction. The UN responded by calling upon the World Meteorological Organization (WMO) and the International Council of Scientific Unions (ICSU) to develop measures to improve weather forecasting capabilities and to advance the knowledge of the basic physical forces that determine climate.

The WMO, with 184 members, is a specialized agency created by the UN to facilitate international cooperation in the fields of meteorology and hydrology. The WMO responded to the UN request with the concept of the World Weather Watch (WWW), an operational system to bring the global atmosphere under improved surveillance and to provide for the rapid collection and exchange of weather data as well as for the dissemination of weather products from centralized processing centers.

More recently, the WMO, through its commission structure, is working towards the design and implementation of improved observations for a Global Climate Observing System (GCOS) through enhancements to the Global Observing System (GOS) and other appropriate measures. These efforts are expected to yield an enhanced GOS for both operational and research purposes and are part of the effort to strengthen the WMO's commitment to improve the understanding of climate and related environmental matters, as articulated by the Second World Climate Conference in 1990 and repeated at the United Nations Conference on the Environment and Development.

The responsibilities of U.S. federal agencies in the WWP are as follows:

» Department of Commerce (DOC). Represents the U.S. at WMO and, through NOAA, provides the focal point to coordinate our Nation's efforts in these international programs, implements those service improvements in the existing international weather system for which the U.S. accepts responsibility, and develops new technology.

» Department of State (DOS). Maintains relations with developing nations and, through the WMO, assists developing nations in improving their national weather services. DOS also develops appropriate multilateral and bilateral arrangements to further international participation.

» National Science Foundation (NSF). Stimulates and supports basic research by non-government scientists on atmospheric and ocean circulations and modeling. It also promotes the education and training of atmospheric and ocean scientists at universities.

» Department of Defense (DOD). Although the mission of DOD weather services is basically internal, the nature of DOD's operations is global. As such, the observation, telecommunications, and data-processing programs of the military weather services provide significant indirect support to the WWW through DOD's interface with NOAA's National Weather Service (NWS). Information from the research and development activities of these services is exchanged routinely with other similar national agencies and is often presented at national forums.

» Department of Transportation (DOT). Through the U.S. Coast Guard, provides personnel to support NOAA's National Data Buoy Center (NDBC) in developing, operating, and evaluating data buoy systems. Coast Guard cutters and aircraft provide operational support to deploy, service, and retrieve buoys built for test or operational purposes. DOT's observation and telecommunications programs also provide significant indirect support to the WWW through DOT's interaction with the NWS.

» National Aeronautics and Space Administration (NASA). Performs research and develops space technology required for an effective global weather system.

THE WORLD WEATHER WATCH

The World Weather Watch (WWW) is an integrated system which functions on three levels-- global, regional, and national. The WWW is divided into three essential elements that are closely linked and interdependent--the Global Observing System (GOS), Global Data Processing System (GDPS), and Global Telecommunication System (GTS).

These elements are coordinated and closely integrated through three WWW support functions: (1) The data management function coordinates, monitors, and manages the flow of data and products within the WWW system to assure their quality and timely delivery. It also includes the definition and use of code forms for data exchange; (2) The systems-support activity provides guidance, technical and scientific information, and training to those involved in the planning, development, and operation of WWW components. (3) The implementation coordination function assures the timely completion of the WWW implementation and effective support and maintenance of the WWW system.

Global Observing System (GOS)

The GOS is a coordinated system of methods, techniques, and facilities for making weather observations on a worldwide scale. It is a composite system containing surface-based and space-based (satellite) subsystems. The main elements of the surface-based subsystem are:

» Regional, basic-synoptic networks, manned and automated, for both surface and upper-air observations.

» Fixed sea stations, composed of ocean weather stations, fixed and anchored platform stations, and island and coastal stations.

» Mobile sea stations, including moving ships and drifting buoys.

» Aircraft meteorological stations, including automated aircraft reporting systems.

The space-based (satellite) subsystem provides vital support for meteorological and hydrological predictions and warnings. The use of satellites enables the routine collection of environmental observations from even the most remote locations. Two categories of satellites are used: those in polar orbits and those in geostationary orbits.

Presently, operational meteorological satellites in polar orbits are operated by Russia (the METEOR-3 series) and the United States. The United States operates the civilian NOAA POES (Polar-orbiting Operational Environmental Satellite) series along with the defense DMSP (Defense Meteorological Satellite Program) series of polar-orbiting spacecraft. NOAA currently launches satellites, alternately, into afternoon and morning orbits to maintain an uninterrupted stream of polar data. The current operational NOAA polar-orbiting satellites are NOAA-14 (launched in an afternoon orbit in December 1994) and NOAA-12 (launched in a morning orbit in May 1991). The current operational DMSP polar-orbiting satellites are F-12 (launched in August 1994) and F-13 (launched in March 1995).

Operational geostationary weather satellites are currently operated by Japan, India, Russia, EUMETSAT (Europe), and the United States. Japan's Geostationary Meteorological Satellite (GMS) is positioned at 140°E, India's Indian National Satellite (INSAT) is at 74°E, Russia's GOMS/Elektro #1 satellite is at 76° E (operational since June 1996), and EUMETSAT's METEOSAT is at 0°. The U.S. normally operates two Geostationary Operational Environmental Satellites (GOES)--one at 75°W and the other at 135°W. GOES-8, launched in April 1994, is operational at 75°W and GOES-9, launched in May 1995, is operational at 135°W.

To help ensure data continuity from geostationary orbit, NOAA has signed a long-term mutual back-up agreement with EUMETSAT.

In the future, NOAA's POES will be combined with the DMSP to form a converged system called NPOESS (National Polar-orbiting Operational Environmental Satellite System). NOAA, DOD, and NASA are working together to implement NPOESS and have created an Integrated Program Office (IPO). NOAA heads the IPO and is responsible for operating the NPOESS and for relations with national and international civilian users of the system. The DOD has the lead responsibility for NPOESS acquisitions, launch, and systems integration. NOAA will facilitate the development and incorporation of new, cost-effective technologies to enhance the NPOESS capabilities. Negotiations continue with the Europeans for their assumption of NOAA's morning polar orbit mission just after the turn of the century. This complements longstanding plans by NOAA and the meteorological operational satellites.

Broadcast of data from both the NOAA and GOES series of U.S. satellites is free, unrestricted, and does not require any prior notification. Data can be received directly by any properly-equipped ground station within the satellites' line-of-sight. The United States, through NOAA, develops information and products from these data for further distribution over the GTS.

The WWW is a flexible system which can be adapted to changing technology and operational conditions. The latest technological and scientific developments in observations, data processing, and telecommunications are under constant review with an eye towards improving the GOS, GDPS, and GTS.

Over the last few years, several systems intended to improve the operation of the GOS have continued to undergo development and deployment. Among these systems is the family of automated aircraft reporting systems known as the Automated Meteorological Data and Reporting (AMDAR) systems. This family of systems includes the Aircraft to Satellite Data Relay (ASDAR) System and the ARINC Communications Addressing and Reporting System (ACARS). ARINC is Aeronautical Radio Incorporated--a wholly owned subsidiary of the airlines.

To date, 23 ASDAR systems have been purchased. Nineteen have been installed aboard B-747 (14) and DC-10 (3), and B-767 (2) aircraft. Of these 19, there are 17 units flying operationally. Ten units are being flown aboard British Airways aircraft with the United Kingdom being the end owner of six of the units. The end ownership of three of the remaining four units rests with Switzerland. The Netherlands retains maintenance responsibility for the other unit. Three operational units are installed on KLM aircraft and currently reporting (one unit belongs to the U.S., the second unit had been previously flown on Continental Airlines, but is now being maintained by the U.S., and the third unit belongs to the Netherlands.) Two units are installed and operating on South African Airways aircraft (one unit being maintained by the Netherlands and the other by the UK). Of the two remaining operational units, one is installed and operating aboard an aircraft of Germany's Lufthansa Airlines, while the last unit is installed and operating aboard an aircraft of Saudi Arabia's Saudi Airlines. Finally, two units, provided by the UK to Mauritius, have recently been installed aboard B-767 aircraft of Air Mauritius. These two units are awaiting completion of certification by the Federal Aviation Administration prior to being placed into operation. Two of the remaining purchased units, one owned by Spain and the other by the UK, remain unallocated. However, current negotiations between Spain and Argentina are proceeding well for carriage of Spain's unit aboard an Aerolineas Argentinas aircraft. Lastly, two of the purchased units are maintained as operational spares to limit downtime resulting from unit failure. It has always been the intent to employ different airlines for ASDAR carriage in order to expand the overall geographic coverage of the operational ASDAR units.

A cooperative effort among ARINC, NWS, and the FAA is providing thousands of automated meteorological reports from ACARS-equipped aircraft flying over the U.S. The ARINC meteorological data collection and reporting system collects, organizes, and disseminates automated position/weather reports to the NWS. The standardized weather data is being sent to the NWS in the Binary Universal Form for the Representation of Meteorological Data (BUFR) code. Twelve thousand reports a day in varied formats and internal codes are received by ARINC and the quantity is expected to increase to 150,000 (mostly automated ACARS) reports by the late 1990's.

Large quantities of weather reports, particularly over oceanic and other data-sparse areas, will be realized via satellite communications and navigation systems. This source of data is of prime interest to the U.S. and other members of the International Civil Aviation Organization (ICAO) and the WMO's Automatic Aircraft Reporting study group. The group developed amendments to the ICAO Technical Regulations and made substantial progress toward standardizing meteorological down-link codes (automatic binary, automatic character, manual routine, and special air-reports).

In addition to these aircraft-based systems, other observation systems are being deployed to improve the GOS. For example, the Automated Shipboard Aerological Program (ASAP) has about 12 systems reporting regularly; one U.S. ASAP ship is now operating with a second expected in FY 1996. There has also been deployment of substantial numbers of drifting buoys. A number of nations including the U.S. are implementing test networks or single sites of ground-based Doppler radars called wind profilers to provide nearly continuous soundings of wind. During the past year, there were approximately 88 systems in use worldwide. A demonstration network of 29 wind profilers is being operated principally in the central part of the U.S. to assess the utility of the data in operational and research meteorological analysis and prediction. A report on the multiyear meteorological and engineering assessment was completed in November 1994. Data continues to be made available on the GTS to those countries requesting it.

To improve the methodology used in developing and deploying observing systems, NOAA is developing the North American Atmospheric Observing System (NAOS) program. NAOS objectives are to: (1) define a cost-effective, requirements-driven "best mix" of observing platforms and instruments and (2) reduce observing system risks and uncertainties. While the initial focus of the program will be to modernize the composite upper-air network, NAOS is expected to guide the resource-allocation process for most future observing systems developed and/or fielded by NOAA.

The concept of the Operational World Weather Watch Systems Evaluation (OWSE) has also been developed as a framework for regional implementation. The OWSE-Africa, which was created to evaluate the very extensive use of a geostationary meteorological satellite (operated by the European operational satellite consortium, EUMETSAT) to improve telecommunications and data availability in Africa, has been completed. It was designed to implement and test the data collection system for receipt of meteorological observations from various countries in Africa. Thus far, approximately 100 data collection platforms have been installed in Kenya, Ethiopia, Ghana, Sudan, Nigeria, Sierra Leone, Zaire, Egypt, Madagascar, St. Helena, Guinea, and Cape Verde. Evaluations have been carried out to gauge the improvement of observation receipt, and preliminary results show that high-receipt rates are achieved when systems are operating. Further, results indicate that high-receipt rates may be achieved for data originating in Africa, but infrastructure and maintenance issues remain for full operational deployment to be successful.

Efforts are underway to design and implement a GCOS, building upon the WWW, Global Atmospheric Watch, Integrated Global Ocean Services System, and other existing systems to further the knowledge and understanding of climate and the prediction of climate and climate change. Efforts to date have established planning groups to address needs and requirements for atmospheric, oceanic, and land-surface data. Upper-air and surface-observing networks are being defined to provide basic measurements for the GCOS. Links to existing organizational structures are being established, and a high priority has been given to making observational enhancements.

Global Data Processing System (GDPS)

The purpose of GDPS is to make available all processed information required for both real-time and non-real-time applications. GDPS provides products and processed information, based on recent advances in atmospheric science, using powerful numerical computer methods. Members have real-time, unrestricted access through the GTS to GDPS products which allow all countries to benefit from their participation in the WWW.

The GDPS is organized as a three-level system. It consists of World Meteorological Centers (WMC), Regional/Specialized Meteorological Centers (RSMC), and National Meteorological Centers (NMC). NMCs carry out GDPS functions at the national level. In general, real-time functions of the system involve preprocessing of data including real-time quality control, analysis, and prognosis, including derivation of appropriate meteorological parameters. The non-real-time functions include data collection and archival, and additional quality control, storage, and retrieval, to include cataloging observational data and processed information for operational and special applications and for research.

WMCs are located in Melbourne, Moscow, and Washington; they provide products used for general short, medium, and long-range weather forecasts on a global scale. Melbourne specializes in forecast products for the Southern Hemisphere.

The RSMCs with geographical specialization are located at Algiers, Algeria; Antananarivo, Malagasy; Beijing, China; Bracknell, United Kingdom; Brasilia, Brazil; Buenos Aires, Argentina; Cairo, Egypt; Dakar, Senegal; Darwin, Australia; Jeddah, Saudi Arabia; Khabarovsk, Russia; Lagos, Nigeria; Melbourne, Australia; Miami, Florida; Montreal, Canada; Moscow, Russia; Nairobi, Kenya; New Delhi, India; Novosibirsk, Russia; Offenbach, Germany; Rome, Italy; Tashkent, Uzbekistan; Tokyo, Japan; Tunis, Tunisia; Washington, D.C.; and Wellington, New Zealand.

RSMCs with activity specialization are found at The European Center for Medium Range Forecasts; Réunion Island (France); Toulouse, France; and Washington D.C.

The regional centers at Bracknell, Miami, Montreal, New Delhi, and Tokyo have dual geographical and activity specialization responsibilities. These centers provide regional products used for short and medium-range forecasting of small, mesoscale, and large scale meteorological systems by WMCs. Products of RSMCs can be used by members at the national level for further processing or interpretation to provide assistance or service to users.

In the World Area Forecast System (WAFS), two centers (Washington and London) are designated by the ICAO as World Area Forecast Centers (WAFC). They issue upper-wind and temperature forecasts with global coverage to associated Regional Area Forecast Centers (RAFC). The regional centers also prepare and distribute forecasts of weather elements defined by ICAO as significant weather.

In the planned implementation of the final phase, the two WAFCs would prepare and issue computer-based wind and temperature forecasts as they now do. In addition, those centers will automate all of the significant weather elements. While some of these elements are now prepared automatically, others will be realized in the near future through forecaster-initiated graphic interaction.

The dissemination of aeronautical information via global satellite broadcast began in 1995. The U.S. provides the links to two of the three satellites specified in the system.

Global Telecommunication System (GTS)

The GTS provides communication services for the collection, exchange, and distribution of observational data and processed information among the WMCs, RSMCs, and NMCs of the WWW to meet the member needs for real-time or quasi-real-time exchange of information for both operational and research purposes. The GTS also supports other WMO programs, joint programs with other international organizations, and environmental programs as decided by the WMO Congress and is organized on three levels:

» The Main Telecommunication Network (MTN).

» The Regional Meteorological Telecommunication Networks (RMTN).

» The National Meteorological Telecommunication Networks (NMTN).

The GTS is supported by the telecommunications functions of the WMCs, Regional Telecommunications Hubs (RTH), RSMCs, and NMCs.

The MTN links the WMCs at Melbourne, Moscow, and Washington with the RTHs at Algiers; Beijing; Bracknell; Brasilia; Buenos Aires; Cairo; Dakar; Jeddah; Maracay, Venezuela; Nairobi; New Delhi; Norrköping, Sweden; Offenbach; Prague; Rome; Sofia; Tokyo; Toulouse; and Wellington. It ensures the rapid and reliable exchange of observational data and processed information required by the members.

The RMTNs consist of an integrated system of links which interconnects RTHs, NMCs, and RSMCs to WMCs. The RMTNs provide for the collection of observational data and the selective distribution of meteorological information to member nations.

In summary, the GTS enables the NMCs to receive and distribute observational data and meteorological information to meet the requirements of members. Ongoing WWW activities for FY 1996-1997 include:

» GTS network redesign to take into consideration new technical opportunities, such as Internet-like services.

» Improvement of the capacity of MTN links and inclusion of graphics (e.g., Washington-Brasilia, Washington-Buenos Aires, Washington-Tokyo).

» Continued implementation of satellite-serviced data collection platforms to enhance the collection of meteorological data from upper-air and surface-observing sites.

» Continued implementation of satellite direct- readout stations that are compatible with polar-orbiting satellites and the WEFAX (weather facsimile) component of the geostationary satellites.

Voluntary Cooperation Program (VCP)

From the beginning of WWW, it was clear that all countries need better weather observations and improved communications systems. To help remedy deficiencies and to fully implement the WWW, the WMO established a Voluntary Assistance Program in 1967. The name of the program was changed to Voluntary Cooperation Program (VCP) in 1979.

The WMO-VCP helps the developing countries to implement the WWW program by providing equipment, services, and long-term and short-term study fellowships. Since the inception of the VCP, the U.S. has provided short-term fellowships in electronics, communications, operation and maintenance of weather data collection systems and electrolytic hydrogen generators, and tropical meteorology and river flood forecasting to students from more than 50 countries. Long-term fellowships, through which the students receive baccalaureate or advanced degrees, have been completed by candidates from over 48 countries. Highest priorities are given to those facilities needed to support the global aspects of WWW. The goal of VCP is to eliminate deficiencies in global observations and communications and to establish ground-readout stations for Automatic Picture Transmission (APT) reception so that the countries may benefit more fully from weather satellite services.

The DOS provides funding for VCP projects with NOAA administering and carrying out programs designed to aid meteorological/hydrological and climate projects in recipient countries. In FY 1996, DOS funding for WWW/VCP programs was cut to $1.3 million.

VCP Projects for FY 1996-1997 include:

» Implementation and updating of surface and upper-air observational programs in the tropics, the Southern Hemisphere, and Africa as resources and priorities permit.

» Support of WAFS implementation and utilization.

» Continued support for the implementation of VCP projects in Latin America and the Caribbean areas in support of the hurricane and tropical storm programs.

BILATERAL AND REGIONAL INTERNATIONAL COOPERATIVE PROGRAMS

United States - Peoples Republic of China (PRC) Protocol in the Field of Atmospheric Science and Technology

For more than 15 years, this protocol has covered a broad area of research and operational activities in the field of atmospheric science and technology. Program areas include the following:

» Climate Studies (which includes scientific experiments and research on monsoons and Tropical Ocean Global Atmosphere (TOGA)).

» Mesoscale Meteorology (which includes operational techniques for forecasting torrential rains).

» Training and Participation.

» Atmospheric Chemistry.

» Satellite Meteorology and Meteorological Satellites.

» Modernization Activities.

The cooperative activities between the U.S. and China under this program have decreased over the past 2 years. The main cooperative activity has been within the Training and Participation Program with a dozen Chinese scientists and trainees working at NOAA facilities for up to 18 months.

U.S.-Mexico Meteorological and Hydrologic Program

The U.S. and Mexico have signed a new cooperative agreement enhancing the scope of their cooperation in the fields of meteorology, hydrology, and climatology which began over 50 years ago. The new agreement facilitates the following activities:

» The establishment, operation, maintenance, and repair of meteorological and hydrologic observation systems in Mexico.

» The international dissemination of observations from these systems.

» The exchange of meteorological, hydrologic, and related data and products between the U.S. and Mexico.

» The cooperation necessary to assure prompt transmission through telecommunications networks of these data and products.

» The coordination and training related to the exchange of data and products between the National Meteorological Services of both countries.

Over the past few years, the Mexican Meteorological Service has undergone an impressive modernization effort, which included upgrading upper-air observation systems, installing Doppler weather radars, and establishing hundreds of automatic weather stations. This cooperative agreement will facilitate the exchange of data and information to the benefit of both countries.

Appendix D
Appendix F
Table of contents
Publications List
Home