APPENDIX B

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 United States participation in the World Weather Watch Program (WWWP). Until 1983, DOC published a separate report on WWWP plans. Beginning with the 1983 edition of the *Federal Plan for Meteorological Services and Supporting Research*, a section on the WWWP has been included, obviating the need for a separate report. The last segment of this narrative includes information on bilateral and regional international cooperative activities which are not under the WWWP.

GOALS AND ORGANIZATION

The WWWP goals are to extend the time, accuracy, range, and scope of weather prediction and to understand the physical basis of climate and climactic change. The WWWP is the core of WMO's programs and receives the highest budget priority. 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 a significant portion of the Earth's surface, especially over isolated areas including the oceans.

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, an integrated system can be developed to observe and collect comprehensive data about the atmosphere over the entire globe. This system is too complex and expensive 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 U.S. 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 181 Member States and 6 Member Territories, is an intergovernmental organization affiliated with the UN to facilitate international cooperation in the fields of meteorology, climate, and operational hydrology. The WMO responded to the UN request with the concept of the World Weather Watch Program (WWWP), 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 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 UN Conference on the Environment and Development. The WMO has established the concept of a Regional Basic Climate Network (RBCN); most observing stations would function as part of both the Regional Basic Synoptic Network (RBSN) and the RBCN.

The responsibilities of U.S. Federal agencies in the WWWP are as follows:

- Department of Commerce (DOC). Represents the U.S. at WMO and, through the National Oceanic and Atmospheric Administration (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. The U.S. is one of three (Russia; Australia) World Meteorological Centers, which includes World Data Centers and the principal telecommunication gateway for the WMO's Global Telecommunication System (GTS).
- Department of State (DOS). The DOS is the principal source for U.S. funds to the WMO. The DOS maintains relations with developing nations and, through NOAA and the WMO, assists developing nations through the Voluntary Cooperation Program to improve their national weather services. DOS also develops appropriate multilateral and bilateral arrangements to further international participation.
- National Science Foundation (NSF). Stimulates and supports basic and applied research by scientists primarily in academia on atmospheric and ocean circulation and models. 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 WWWP 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. DOD also operates a polar orbiting meteorological satellite program.

- Department of Transportation (DOT). Through the U.S. Coast Guard, provides personnel to support NOAA's National Data Buoy Center (NDBC) in developing, deploying, operating, and evaluating data buoy systems. DOT's Federal Aviation Administration's terminal aerodrome meteorological observations and air traffic telecommunication network provides an important source of data to the WWWP.
- National Aeronautics and Space Administration (NASA). Performs research, develops aerospace technology required for an effective global weather system, and provides data from R&D satellites to the WWWP. NASA launches for NOAA both polar orbiting and geostationary satellites.
- Department of the Interior (DOI). DOI's U.S. Geological Survey (USGS) is an important source of hydrologic data used in flood forecasting. The USGS, in addition to its advisory role on water issues in the WMO, will assume a greater functional role in the WMO's emerging water program.
- Department of Agriculture (USDA). USDA is a valuable resource for surface climatological meteorological data from cooperating observers. The department's World Climate Observing Board is responsible for monitoring the impact of climate and extreme weather on both the national and international commercial crops. USDA is in WMO technical commission work on agrometeorological issues.

THE WORLD WEATHER WATCH PROGRAM (WWWP).

The WWWP is an integrated Member-operated observing system linked by the GTS; it functions on three levels - global, regional, and national. The WWWP is divided into three essential elements that are closely linked and interdependent - the Global Data Processing System (GDPS), Global Telecommunication System (GTS), and the Global Observing System (GOS).

These elements are coordinated and closely integrated through three WWWP support functions: (1) the data management function coordinates, monitors, and manages the flow of data and products within the WWWP 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 WWWP components; and (3) the implementation and coordination function assures the timely completion of the WWWP implementation and effective support and maintenance of the WWWP system.

<u>Global Observing System</u>

The GOS is a coordinated observing system employing standardized techniques for making meteorological and marine surface observations on a worldwide scale. It is a composite system containing surface-based (national networks), airborne (civil aviation) and space-based (satellite) subsystems. The main elements of the network and airborne subsystems are:

- Regional Basic Synoptic Network (RBSN), staffed and automated, for both surface and upper-air observations.
- Fixed observing stations at sea, composed of fixed and anchored platform stations, and island and coastal stations.
- Mobile sea stations, including moving ships.
- Moored 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. Currently, the WWWP environmental observation satellite network includes five near-polar-orbiting satellites and six operational geostationary satellites as well as several research and development satellites. Operational meteorological satellites in polar orbits include the U.S. (POES; DMSP), Russia (METEOR-3) and China (Fengyun-1). Operational geostationary meteorological satellites include the U.S. (GOES), the European Union (METEOSAT), Japan (GMS-5/GOES-9), Russia (GOMS), China (Fengyun-2), and India (INSAT).

The National Oceanic and Atmospheric Administration (NOAA) manages a constellation of twelve polar orbiting meteorological spacecraft, including five military satellites, from the Satellite Operations Control Center (SOCC) in Suitland, Maryland. The POES spacecraft constellation includes two primary, one secondary, two standby and one non-operational spacecraft. These spacecraft are in circular orbits inclined at approximately 98 degrees (retrograde). The primary operational spacecraft, NOAA-16 and NOAA-17, are in sun-synchronous afternoon and morning orbits, respectively. One secondary spacecraft, NOAA-15, provides additional operational data. NOAA-12 and NOAA-14 are standby spacecraft supporting additional user data requirements. NOAA-N, the next POES originally slated for launch in September 2004, was seriously damaged in an accident at the Hughes satellite facility in Palo Alto, California.

Similar to the U.S. civilian POES program, the Defense Meteorological Satellite Program (DMSP) designs, launches, and maintains several near polar orbiting, sun synchronous satellites monitoring the meteorological, oceanographic, and solar-terrestrial physics environments. The visible and infrared sensors collect images of global cloud distribution across a 3,000-kilometer swath during both daytime and nighttime conditions. The current DMSP constellation consists of two primary, two secondary, and one backup operational spacecraft. The current primary operational NOAA polar-orbiting satellites are F-15 (launched in December 1999) and the F-14 (launched in April 1997).

Preparations continue by the Europeans for their assumption of NOAA's morning polar orbit mission starting with the launch of Metop-1 in 2005. This complements U.S. plans to merge NOAA's POES with the DMSP to form an integrated system called NPOESS (National Polar-orbiting Operational Environmental Satellite System) that is expected to fly at the end of this decade. NOAA, DOD, and NASA are working together to implement NPOESS in the context of 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. DOD has the lead responsibility for NPOESS acquisition, launch, and system integration. NOAA will facilitate the development and incorporation of new, cost-effective technologies to enhance the NPOESS capabilities.

The U.S. SOCC controls 7 Geostationary Orbit Environmental Satellites (GOES). GOES-12 (75 degrees West) was successfully launched on July 23, 2001. It carries a new instrument called the Solar X-ray Imager (SXI), which is capable of measuring and imaging the Sun in four X-ray energy bands. GOES-10 is the operational West Coast satellite at 135 degrees West. The GOES-11 spacecraft was successfully launched on May 3, 2000. In the event that GOES-10 or GOES-12 should fail, GOES-11 could be activated and be made operational within 48 hours. GOES 10 has been "inverted", i.e., 180 degrees from its normal relation to the Earth, in order to overcome a solar array drive problem. Launched in May 1995, GOES-9 is stationed over the western Pacific Ocean at 155 degrees East to provide operational data until Japan launches its MTSAT satellite, which will replace the GMS series. GOES-9 has limited capability due to attitude limitations and imager noise, but continues to provide useful data over the western Pacific as backup to Japan's failing GMS-5. GOES-7 is currently located over the Pacific to support data relay requirements for the University of Hawaii's Pan-Pacific Educational and Cultural Satellite (PEACESAT) Program, which includes the transmission of NOAA's Emergency Managers Weather Information Network (EMWIN) used throughout the Pacific.

Japan's Geostationary Meteorological Satellite (GMS-5) is being moved to a higher decommissioning orbit in preparation for the Multi-functional Telecommunication Satellite (MTSAT) scheduled for launch in 2004. India's National meteorological/ telecommunication Satellites (INSAT) are at 74 degrees East and 83 degrees East. EUMETSAT's METEOSATs 7 and 5 are at 0 degrees and 63 degrees East, respectively. China launched its first pre-operational geostationary environmental satellite FY-2A on June 10, 1997, and its second FY-2B in January, 2001. FY-2B is located at 105 degrees East and FY-2A was moved to the backup position at 85.6 degrees East.

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 U.S., through NOAA, develops information and products from these data for further distribution over the GTS

The WWWP has pursued a class of automated airborne reporting systems such as the Automated Meteorological Data and Reporting (AMDAR) systems. Over 3000 aircraft now provide reports of pressure, winds and temperature during flight. The amount of data from aircraft has increased dramatically during recent years - from 78,000 reports in 2000 to 140,000 reports in 2002. These systems are making a major contribution to the upper-air component of the GOS in regions where there is little or no radiosonde data. Global cooperation on AMDAR is facilitated by the WMO AMDAR Panel established in 1998 by a number of WMO Members operating or intending to operate AMDAR programs. Australia, Canada, China, EUMETNET, Japan, New Zealand, Republic of Korea, Russia and the U.S. have AMDAR programs. High priority regions include the Middle East (Saudi Arabia) and Africa (South Africa).

AMDAR was proposed for the First Global Atmospheric Research Program (GARP) Global Experiment (FGGE) in the 1970s. Two systems were developed, one using communications facilities available on the geostationary operational environmental satellite (GOES), and one using a standard aircraft VHF communication system (ACARS) which was developed in the U.S. and is rapidly gaining worldwide acceptance. The satellite system, Aircraft to Satellite Data Relay (ASDAR) was sponsored by a consortium of WMO Members and was developed into an operational system by 1991. ACARS-based systems require no additional specialized equipment to be fitted to the aircraft, whereas ASDAR uses a dedicated data processor and satellite transmitter. Experience with both systems has led to the conclusion that ACARS-based AMDAR systems are preferred, based on ease of implementation, worldwide applicability and overall cost. ASDAR operations reached a peak in the late 1990s with some 20 of 23 purchased systems still in service. It is anticipated these systems will continue to provide useful data. No further ASDAR developments are envisaged. Several new AMDAR systems are being developed using alternative methods for sensing and communications.

The U.S. AMDAR program, called Meteorological Data Communications and Reporting System (MDCRS), began in the early 1980's as a cooperative effort among ARINC, the NWS, and the FAA. Over 120,000 reports of wind and temperature are sent every day in the Binary Universal Form for Representation of Meteorological Data (BUFR) code. These MDCRS reports are provided by six airlines: Delta, Northwest, United, United Parcel Service (UPS), American Airlines and Federal Express (FedEx). Two additional MDCRS reporting elements continue under development: water vapor and turbulence. A new water vapor sensor, using diode laser technology, is being tested. The most recent humidity sensor was expected to be certified and the sensor would be fitted to UPS B757 aircraft.

A new turbulence algorithm, developed by the National Center for Atmospheric Research (NCAR) derives an objective, aircraft-independent measure of turbulence (eddy dissipation rate-EDR) from aircraft vertical acceleration. The EDR is included as part of the MDCRS data stream. The algorithm is currently installed on 90 United Airlines aircraft and will be installed on over 400 United, American, Delta, and Northwest aircraft.

GOS employs both marine and land surface-based observing systems. Approximately 11,000 stations on land take observations at least once every three hours and often hourly of thermodynamic and wind field parameters of the atmosphere. About 4,000 of the world's surface stations comprise the RBSN. Data from these stations are exchanged globally in real time. A subset of these surface stations are used in the Global Climate Observing System (GCOS) Surface Network (GSN). The U.S. operates 87 surface stations as part of the GCOS network. Many countries including the U.S. have available additional surface data from specialized meso-scale networks, such as Oklahoma's Mesonet, used for research, water management and transportation needs. The U.S. operates about 73 surface stations on the Antarctic continent. Twenty are U.S. government sponsored of which only 4 report regular observations. The other 53 sites are through university programs.

The lower atmosphere is vertically profiled using a land-based global array of about 900 upper-air stations which deploy at least once per day a balloon-borne radiosonde capable of providing in situ measurements of basic state parameters. Approximately 15 specially outfitted commercial ships provide upper-air observations over sparsely instrumented oceanic regions. The NWS operates 92 upper-air stations and support 15 additional sites in the Caribbean and Pacific. For all of the U.S. (including DOD and other agencies) it was reported to WMO a total of 132 sites. The U.S. has also implemented experimental or quasi-operational networks or single sites of ground-based Doppler radars called wind profilers to provide nearly continuous wind soundings. A network of 32 tropospheric wind profilers is being operated quasi-operationally at 404 MHZ primarily in the central part of the U.S.

Over the oceanic regions the GOS relies on ships, moored and drifting buoys, and stationary platforms - in addition to derived data from satellite observations. The Voluntary Observing Ship program (VOS) comprises some 7,000 commercial ships, of which 40 percent are at sea during any given period. About 750 drifting buoys provide 6,000 sea surface temperature and surface air pressure reports per day. Argo - A Global Array of Profiling Floats, plans to deploy and maintain a global array of around 3,000 autonomous profiling floats, which will automatically provide profiles of ocean temperature, salinity and ocean currents to depths of around 2000 meters. Each float reports via satellite every 10 days, and the data distributed in real time on the GTS. Since 1999, the U.S. has committed funds for 1,088 Argo floats and proposed funding for an additional 1,239 over the next 3 years. As of October 2003, about 921 Argo floats were in operation around the globe. It is expected that, once operational, Argo will become a component of the operational integrated ocean observing system.

To improve the methodology used in developing and deploying observing systems, NOAA, in 1997, established the North American Atmospheric Observing System (NAOS) program. The group has representatives from several Federal agencies along with representatives from Canada and Mexico. 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. Several projects of NAOS have been undertaken to assess the utility of the MDCRS data in numerical models, including the impact of replacing some numbers of radiosonde sites with MDCRS soundings, an assessment of forecaster use of MDCRS, and the impact on short-range forecasting.

Efforts are underway to design and implement a Global Observing Systems for Climate (GCOS), building upon the WWWP, 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 have been defined to provide basic global measurements for the GCOS. Links to existing organizational structures are being established and a high priority has been given to making observational enhancements. The GCOS Upper Air Network (GUAN) and the GCOS Surface Network (GSN) have been established. The U.S. has plans for providing funds to aid GCOS in developing countries. A Pacific Islands (PI) GCOS Implementation Plan has been prepared to establish a robust and sustainable climate observation and application system that meets the climate change and variability needs observations and application needs of Pacific Island nations, and the South Pacific region. The U.S. support for GCOS under the Climate Change Research Initiative (CCRI) has been programmed in to the base budget for NOAA's Climate Program Office for fiscal years 2004 and 2005.

Global Data Processing and Forecasting System (GDPFS)

The purpose of GDPFS is to make available all processed information required for both real-time and non-real-time applications. GDPFS 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 GDPFS products which allow all countries to benefit from their participation in the WWWP.

The GDPFS 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 GDPFS functions at the national level. In general, real-time functions of the system involve pre-processing 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 guidance products used for general short, medium, and long-range weather forecasts on a global scale. Melbourne specializes in forecast products for the Southern Hemisphere.

Regional Specialized Meteorological Centers (RSMCs) with geographical specialization: Algiers, Beijing, Bracknell, Brazilia, Buenos Aires, Cairo, Dakar, Darwin, Jeddah, Khabarovsk, Melbourne, Miami, Montreal, Moscow, Nairobi, New Delhi, Novosibirsk, Offenbach, Pretoria, Rome, Tashkent, Tokyo, Tunic/Casablanca, Washington and Wellington.

RSMCs with activity specialization for tropical cyclone forecasting: Miami - Hurricane Center, Nadi - Tropical Cyclone Center, New Delhi - Tropical Cyclone Center, Saint Denis, La ReUnion - Tropical Cyclone Center, Tokyo - Typhoon Center, Honolulu - Hurricane Center.

RSMSs for medium-range weather forecasting: European Center for Medium-Range Weather Forecast (ECMWF).

RSMSs for the provision of transport model products for environmental emergency responses: Beijing, Bracknell, Melbourne, Montreal, Obninsk, Tokyo, Toulouse, Washington.

Emerging Special Centers: African Center of Meteorological Applications for Development (ACMAD) - Niamey, Niger; ASEAN Specialized Meteorological Center (ASMC) - Singapore; Drought Monitoring Centers (DMCs) - Nairobi, Kenya - Harare, Zimbabwe; INPE - Sao Paulo, Brazil; National Center for Medium Range Weather Forecasting - New Delhi.

The regional centers at Bracknell, Honolulu, 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 International Civil Aviation Organization (ICAO) as World Area Forecast Centers (WAFC) and act as back-up for one another. The dissemination of aeronautical information via global satellite broadcast began in 1995 through the International Satellite Communication System (ISCS). The

U.S. provides the links to two of the three satellites specified in the system. The WAFS issue upper-wind and temperature forecasts with global coverage and forecasts of weather elements defined by ICAO as significant. The RAFC's were phased out in late 2002, at which time the WAFCs assumed their responsibilities.

The gradual implementation of the final phase of the WAFS has begun. The planned final phase call for the two WAFCs to 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 are developed through forecaster-initiated graphic interaction.

Global Telecommunication System

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 WWWP 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 inter-national organizations, and environmental programs as decided by the WMO 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 WWWP activities 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 weather facsimile (WEFAX) component of the geostationary satellites. The need to convert WEFAX to LRIT and APT to LRPT formats will have to be undertaken during the next decade.

Voluntary Cooperation Program (VCP)

From the beginning of WWWP, it was clear that all countries need better weather observations and improved communications systems. To help remedy deficiencies and to fully implement the WWWP, 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 WWWP 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 training fellowships in forecast preparation, technical aspects of the 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. The goal of VCP is to eliminate deficiencies in global observations and communications. The highest priority of the VCP is the implementation of the WWWP.

NOAA administers the program with funds from the DOS. Planned VCP Projects for 2004/5 calendar year include:

- Support of NWS training desks at the National Centers for Environmental Prediction (Camp Springs, Maryland) and the Pacific Region (Honolulu, Hawaii).
- Implementation of the WAFS-ISCS workstation in designated Caribbean and Central American countries.
- Support for the Ham Radio Operator projects in Africa and the Caribbean Amateur Radio Meteorological Emergency Network (Caribbean CARMEN).
- Implementation of the Eta PC-based mesoscale model in selected developing countries.
- Support of the Aircraft Meteorological Data Relay (AMDAR) Program.