

**EROS DATA CENTER**  
**ANNUAL REPORT**

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**FISCAL YEAR 1990**

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**U.S. GEOLOGICAL SURVEY**  
**NATIONAL MAPPING DIVISION**

## FOREWORD

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The first aerial photograph was acquired from a stationary balloon over Paris in 1858 by Felix Nadar. Subsequent to Nadar's innovative enterprise, the evolution of imaging the earth's surface has advanced to include remote sensing applications for mapping, military intelligence, management of land resources, and for scientific studies of dynamic earth phenomena. From balloon platforms to space satellites, the technology of acquiring images of the earth's surface continues to provide growing challenges and opportunities in response to the increased demands for information about our global community. The EROS Data Center, as a research field center of the U.S. Geological Survey's National Mapping Division, is proud to play its part in this developing technology.

From its inception in 1971, the EROS Data Center has maintained an active commitment to providing remotely sensed land-surface data and technical assistance of the highest quality to National and international organizations for applications in the earth sciences. Technical support provided to the Department of State through the Agency for International Development (AID) to develop a famine early warning system for participating countries in Africa; digital data and photographic products prepared for the Department of Defense in support of Desert Shield operations and for counter-narcotics programs; and near real-time satellite data provided for several land management and regulatory agencies are a few of the activities supported by the Data Center this past year.

New research initiatives conducted by the EROS Data Center in support of the U.S. Global Change Program will significantly impact the future role of the Center and its ability to meet the growing needs of the scientific community. These initiatives include active participation in the National Mapping Division's Global Land Data Management and Research Programs, research to support the joint NASA/U.S. Geological Survey programs related to the Earth Observing System Data and Information System (EosDIS), modifications to the Data Center's facilities to accommodate future EOS data acquisition, archiving and dissemination activities, and the designation of the EROS Data Center as the United Nations Environmental Program/Global Resource Information Data Base (UNEP/GRID) North America Node.

To support these and several other major activities, the Center's team of highly skilled professional scientists and technicians, possessing a wide range of earth science and related disciplines, work diligently to maintain the EROS Data Center's high level of excellence for data management, product generation, computer systems development, and spatial data research as reflected in this report.

We are pleased to provide this annual report which summarizes the activities and accomplishments of the EROS Data Center for Fiscal Year 1990.

Allen H. Watkins  
Chief, EROS Data Center

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## **I. OVERVIEW**

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The Earth Resources Observation Systems (EROS) Data Center, located in Sioux Falls, SD, is a data management, systems development, and research field center of the U.S. Geological Survey's National Mapping Division. The Center was established in the early 1970's to receive, process, and distribute data from National Aeronautics and Space Administration (NASA) experimental Landsat satellites. The Center holds the world's largest collection of space and aircraft acquired imagery of the Earth. These holdings include over 2 million images acquired from satellites and over 8 million aerial photographs. The Center is also a major focal point for information concerning the holdings of foreign Landsat ground reception stations and data acquired by other countries' Earth observing satellites.

The central U.S. location provides the Center with a unique capability to receive real-time electronic signals from Earth orbiting satellites used for developing data sets of most of the North American continent.

The EROS Data Center (EDC) carries out a broad range of activities in the management of global Earth observations data, including the development and operation of advanced systems for receiving, processing, distributing, and applying land related Earth science, mapping, and other geographic data and information. These data support scientific studies, resource management, and environmental monitoring activities world-wide. The Center is a major supplier of analytical and other support services to Federal agencies involved in the application of these data to research programs.

To support the Data Center's mission, the facility houses one of the largest computer complexes in the Department of the Interior (DOI). In addition to computers to support scientific processing and analysis of data, over 100 locations in Federal, State, and commercial offices are linked to the Center for data inquiries. More than 60,000 inquiries and orders are received annually, resulting in the distribution of over 250,000 products to scientists and resource managers around the world.

The Center works closely with NASA, the National Oceanic and Atmospheric Administration (NOAA), Department of the Interior organizations, and other Federal agencies to develop advanced systems and techniques for applying Earth observations and other geographic information to Earth science problems.

The Center receives, processes, and carries out research on image data from the Advanced Very High Resolution Radiometers (AVHRR) on polar orbiting meteorological satellites and from the U.S. Landsat satellites. The Center uses these data and data from French, Japanese, Soviet, other foreign satellite systems to produce high quality image maps for a wide variety of scientific uses.

The Center uses these data and other Earth-science information to support a broad range of studies designed to improve our understanding of the mechanisms and processes leading to global environmental change. To support this research, the Center combines a multidisciplinary scientific staff in geology, hydrology, cartography, geography, agronomy, soils science, forestry, meteorology and climatology with engineering expertise in systems development, telecommunications, and the computer sciences.

Center activities include operation of the National Satellite Land Remote Sensing Data Archive, a legislatively mandated responsibility to maintain a high quality data base of space acquired

images of the earth suitable for use in future study of global change and related scientific programs, and the Federal Land Remote Sensing Research Program. This Program allows Federal agencies, universities, and other organizations to assign scientists and researchers to the Center on a full-time basis with complete access to analytical equipment, data, and research facilities of the Center.

Facilities at EROS include advanced data and information analysis laboratories, production data processing systems and digitizing capabilities, business and scientific systems, software development, geographic information systems development and implementation, and on-line computerized access to data directory, catalog, and inventory information about the Center holdings and the land data holdings of other facilities.

As a major participant in the U.S. Global Change Research Program, EROS provides data to scientists from around the world to improve understanding and ability to predict future change. The Center is also a key participant in NASA's 'Mission to Planet Earth' and plans to process and archive land related data from the NASA Earth Observing System polar platforms and sensors aboard the NASA Space Station in the mid-1990's.

The EROS Data Center operates field offices in Alaska and in North Africa to support resource and environmental studies in those regions.

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## II. RESEARCH AND DEVELOPMENT

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### Global Land Data Management and Research

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#### *Landsat Archive Maintenance and Conversion*

The Landsat archive, offering scientists the longest consistent and continuous record of the earth's surface, includes data stored on four different types of magnetic media, each degrading over time. A fraction of Landsat scenes have already been lost through media deterioration, and the data must be transferred to stable media as soon as possible to prevent further data loss. The highest priority task is to transcribe 150,000 Thematic Mapper (TM) scenes from 28-track high-density tapes (HDT) to a digital cassette tape media. Efforts in FY 1990 were directed toward preparing specifications for the TM Archive Conversion System. Contract award is scheduled for mid-1991, with conversion to take about 18-months. Selected conversion tasks will occur at EOSAT facilities in Lanham, Maryland, in order to use unique data recorders currently held by EOSAT.

Approximately 800,000 Landsat multispectral scanner (MSS) scenes exist. Roughly half, acquired after 1978, are stored on about 10,000 14-track HDT's. EDC owns the recorders required for transcription of these scenes. Software and some additional hardware will be procured under an option of the TM conversion contract. The conversion is scheduled to begin after the TM data are transcribed, and take about 12 months. The other half of the MSS scenes, acquired before 1978, are stored on wide-band video tapes (WBVT) that are usable only with obsolete instrumentation recorders of 1970 vintage. A contracted study will be initiated in 1992 to determine the feasibility and optimum approach of how to utilize the equipment to retrieve MSS data from WBVT, calculate orbital parameters, and produce a geo-corrected image product.

#### *Global Land Information System (GLIS)*

A key component of the National Mapping Division's (MND) contribution to the U.S. Global Change Research Program is the on-line global data directory, user guide, and inventory system called the Global Land Information System (GLIS), being developed at EDC. The system will provide research scientists with information about land data of use in global earth science and global change research programs, and facilitate access to these data. Functionally, the system will include a master directory of global land data sets and provide global change scientists on-line, interactive geographic and discipline-oriented data query and product request capabilities. The design for implementating the prototype was completed and released in June, following a series of design review meetings in April and May. The first phase for implementation is planned for October 1990. This initial implementation will also include on-line image data browsing capabilities for selected data sets. Figures 1 and 2 show some of the PC-based graphic capabilities included in the prototype beta-test version. The prototype will be accessed via wide-area networks, such as the NASA science Internet (NSI) and the National Science Foundation network (NSFnet), and low-speed telecommunications interfaces. A period of test, evaluation, and minor enhancement is planned for the November-March timeframe. Access to the prototype will be available to the global change research community in March 1991.

The sixth meeting of the Catalog Subgroup of the international Committee on Earth Observation Satellites (CEOS) Working Group on Data was held at the EROS Data Center on September 12-14, 1990. The Catalog Subgroup was initially formed in February 1988 to develop and promote a technical approach for achieving interoperability among international catalog systems. Current activities of the subgroup include the implementation of a prototype international directory and the development of Advanced Very High Resolution Radiometer (AVHRR) inventory exchange guidelines and standards. During the meeting at EDC, a demonstration of portions of the prototype Global Land Information System (GLIS) was given to the group. General comments were favorable with significant interest in future plans and possibilities for use of GLIS as an operational system.

#### *Global Data Set Development, Processing, and Distribution*

Another major contribution by NMD to the U.S. Global Change Research Program is the Global Data Set Development, Processing, and Distribution activity. This activity includes the development of prototype global and continental land data sets and techniques for their processing and distribution. Accomplishments for this fiscal year include:

##### Conterminous U.S. Land Cover Stratification

EDC staff developed and tested a strategy for large-area land cover stratification using NOAA 1-km AVHRR imagery and ancillary spatial data (digital elevation, climate, USGS land use/land cover, and ecological regions). The draft strategy involves digital classification of time series vegetation index data spanning 1990, then refinement of the preliminary classification using appropriate ancillary data with location-based logical rules to produce a land cover characteristics data base. The results include: (1) detailed image strata representing the basic land cover components; (2) descriptions of land cover/use composition for each image strata; (3) descriptive/quantitative image strata characteristics including vegetation type, albedo, vegetation index, and others; and (4) translation tables linking the image strata to common land cover classification schemes.

##### Prototype North America Greenness Image

The first greenness image of the North American continent was composited from NOAA-9 AVHRR 4-km data for the period of August 1-15, 1987. The data were selected from the archive of North American Global Area Coverage (GAC) data (1981 to 1989), recently acquired from Dr. Jim Tucker of National Aeronautics and Space Administration (NASA).

##### Experimental Albedo and Greenness Change Maps

Experimental maps were derived from AVHRR 1 km data of the conterminous U.S.: (1) directional albedo, (2) greenness change between two time periods, and (3) multi-temporal classification as a step towards land characterization. These maps were sent to several global change researchers for their evaluation and comment.

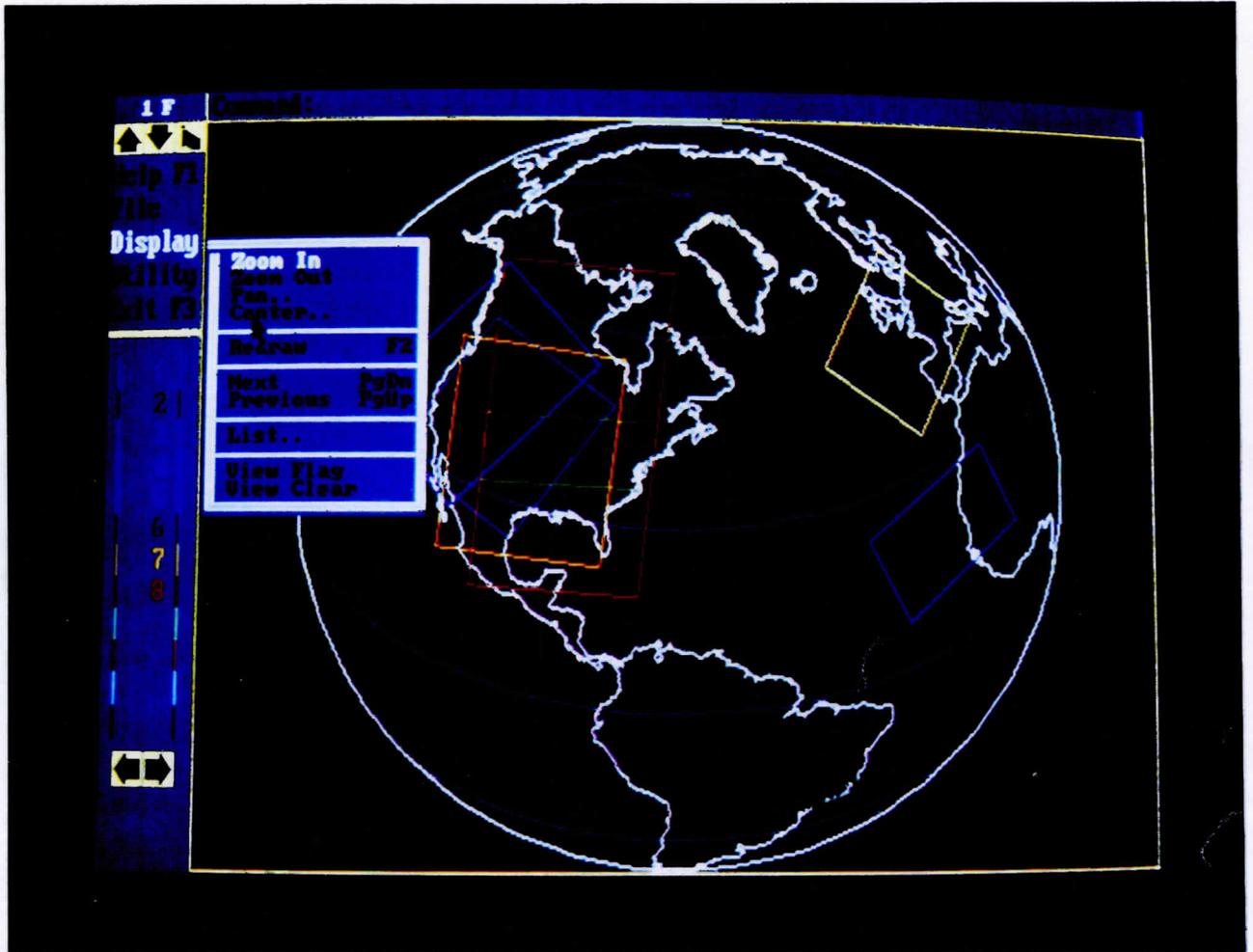


Figure 1 - A Graphic Presentation of an Interactive Search of the GLIS AVHRR Inventory Database

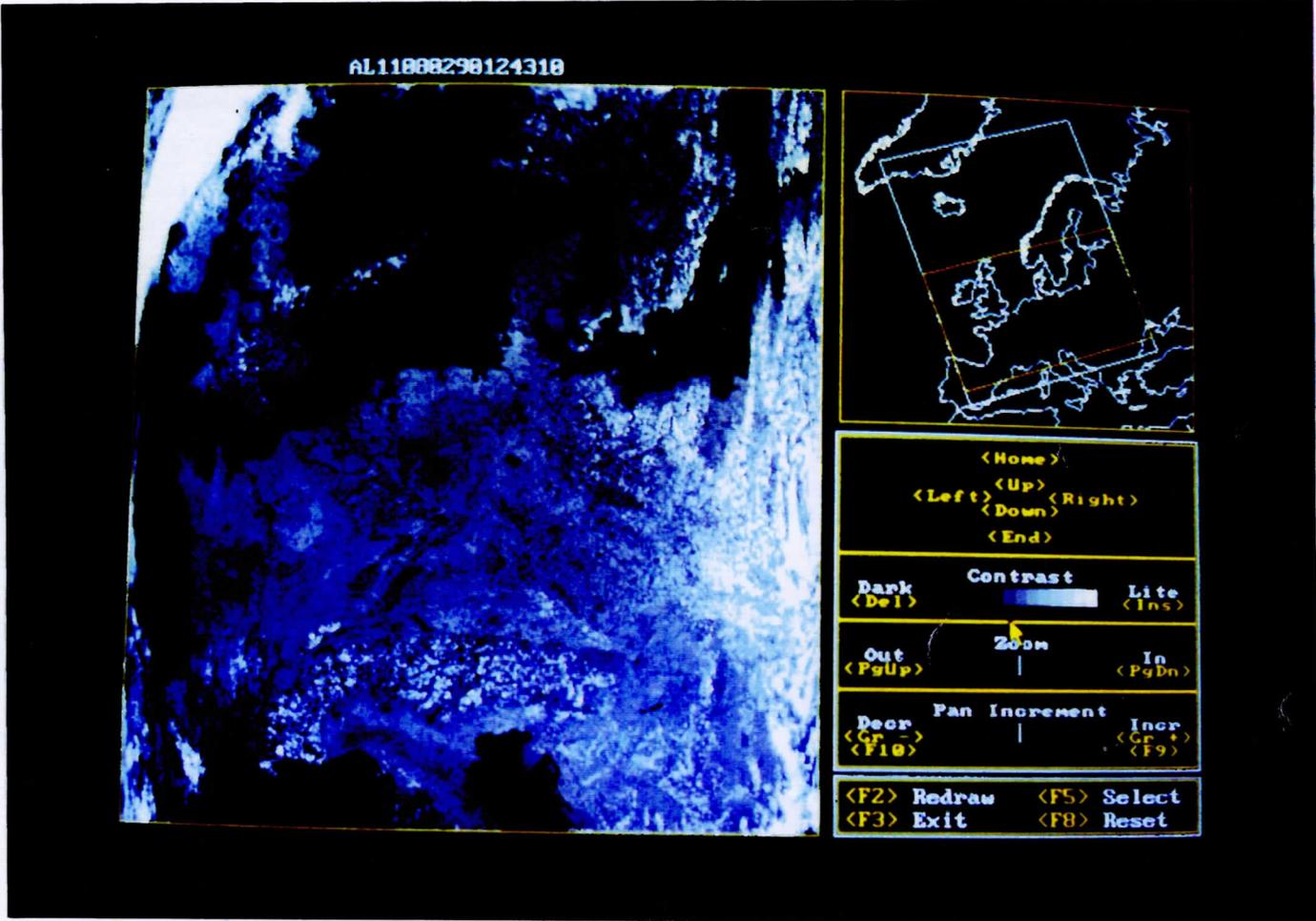


Figure 2 - Example of the GLIS Prototype AVHRR Image Data Browse Capability

### Large Area DED's

Existing smaller scale digital elevation data (DED) of North America were investigated, and the development of a plan for assembling a consistent DEM for the continent is underway. Figure 3 shows that compilation of complete topographic coverage will require contact with multiple national and international agencies with each data source representing potential differences in data composition, format, and consistency of available data.

### Global Vegetation Index (GVI) Data

EDC reprocessed experimental global greenness images from National Oceanic and Atmospheric Administration (NOAA) AVHRR 16-km GVI data to create a data set of calibrated greenness values. Images were produced for every bi-weekly period from April 1985 through 1989. Production continues for GVI data acquired in 1990. The images are being distributed to the NOAA National Climatic Data Center and the NOAA National Geophysical Data Center. The two NOAA centers and EDC are the distribution outlets to the research community.

### United Nations/Food and Agriculture Organization (UN/FAO) Forest Resources Assessment Project

UN/FAO requested that EDC cooperate in the development of a global Tropical Forest AVHRR 1-km data set. A quick review of the scope of this activity was made, and if the decision is made to proceed (dependent upon FAO funding availability), EDC will acquire, process, and distribute a consistent digital data product for the global tropical forest regions, and provide an archive for all source and processed data products.

### Converting Non-Digital Global Data to Digital Formats

In cooperation with the University of New Hampshire, global land cover maps produced by the Soviet Union were digitized. In cooperation with UN/FAO, the World Data Bank II cartographic data base was augmented with sub-national boundaries, to be used in their Forest Resources Assessment Project.

### Extraction of Surface Parameters from AVHRR Data

A methodology to extract land surface parameters from AVHRR data for use in global change models is under development with Dr. Michel Verstraete, University of Michigan, and Dr. Bernard Pinty, Universit e Blaise Pascal (France). A University of Michigan graduate student developed software at EDC which incorporates a bi-directional reflectance model and an AVHRR platform model to determine the reflectance characteristics of important biomes such as tropical rain forests and deserts. The cooperative research will continue into FY 1991.

### Meteorological Data Processing Capabilities

Meteorological data processing capabilities are being acquired from the Space Science and Engineering Center, University of Wisconsin. Measurement of atmospheric parameters, such as water vapor and aerosols, must be available in order to correct for atmospheric influences on satellite imagery.

### International Geosphere/Biosphere Programme (IGBP) Working Group on Data and Information Systems

An EDC scientist travelled to the Soviet Union in July to attend planning meetings for the IGBP Land Cover Change Pilot Study. The meetings were arranged and hosted by the Geophysical Committee of the Soviet Academy of Sciences for the purpose of proposing the joint Soviet and Mongolian region of the Ubsu-Nur Basin as a test site for the Land Cover Change Pilot Study. During the visit Soviet research reported on characteristics of the Ubsu-Nur region and hosted a field trip to the region. Participants drafted a report which summarized observations and recommended adoption of the test site by IGBP.

### *Land Characterization Research*

#### Baseline Studies for Monitoring Global Change in the Artic Environment

Staff at the Alaska Field Office (AFO) are establishing an environmental monitoring system in the Alaska arctic and sub-arctic, based on remotely sensed and other digital spatial earth science data bases. Several data layers were added to the Colville and Bonanza Creek study sites and additional study sites were identified, in collaboration with other agencies' global change programs. A paper on the project was presented at the International Conference on the Role of the Polar Regions in Global Climate Change held at the University of Alaska-Fairbanks during the week of June 11, 1990.

#### New Research Activities Addressing Global Change Research

Five new global change research proposals have been submitted to the National Mapping Division (NMD) Office of Research for approval: (1) Soil Interpretations for Global Change Modeling and Impact Assessment; (2) Integrating Simulation Modeling and Remote Sensing for Monitoring Primary Production; (3) Large Area Estimation of Evapotranspiration with Satellite Data for Global Change Investigations; (4) Development of a Statistical Overlay Method for Class Proportion Estimation over Large Forested Regions; and (5) Linkage of Socio-economic and Natural Resource Data for Predicting Land Surface Changes Influencing Global Climatic Change.

## **Earth Observing System Data and Information System Support**

### *Distributed Active Archive Center (DAAC) for Land Processes*

#### NASA and U.S. Geological Survey (USGS) Dignitaries at EDC

Dr. Lennard Fisk, NASA Associate Administrator for Space Science, and USGS Director Dallas Peck, visited the EDC in August to jointly announce the agreement between the USGS and NASA concerning the EOS Program and related USGS data management responsibilities. EDC has been designated as the site of the DAAC for land processes data, to provide land data management services necessary to support EOS. (Figure 4 illustrates the current distribution of DAAC facilities and their associated disciplines.) Other USGS officials visiting EDC were Doyle Frederick, USGS Associate Director, and Lowell Starr, Chief, NMD. Greg Hunolt, NASA EosDIS Program Manager, and Gail McConaughy, NASA EosDIS Version 0 System Manager, visited the Data Center in September to discuss the Data Center's Version 0 proposal and related activities.

#### EDC Facility Modification

Preparation of a facility modification bid package has begun. Figure 5 is a photograph of the architectural model of the EDC facility with the new addition. Members of the building expansion task force visited the Minnesota Supercomputer Center, the Los Alamos National Laboratory, the National Center for Atmospheric Research, and the San Diego Supercomputer Center to glean the latest concepts in supercomputer operations management, building design, mechanical support, and local-and wide-area networks. Per agreement with the EosDIS Project and NASA Headquarters, approximately \$700,000 will be made available in FY 1991 to engage an architectural & engineering (A&E) firm to prepare drawings and specifications required to proceed with contracting for major facility modifications. The design contract would be let in mid 1991, followed by a contract award for the actual facility modification in mid 1992. The planning date for beneficial occupancy is scheduled for early 1994.

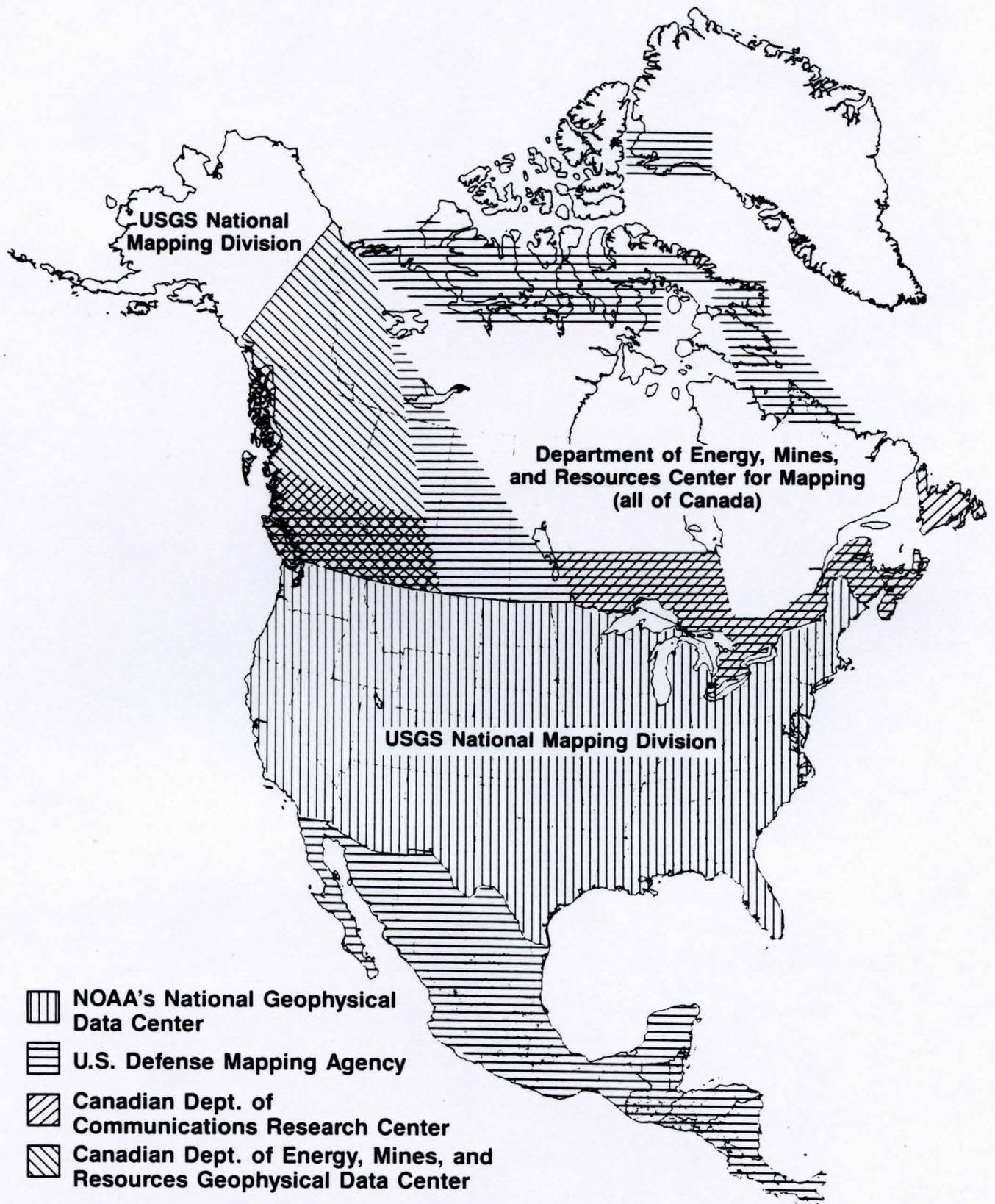


Figure 3 - North American Digital Topographic Data Sources

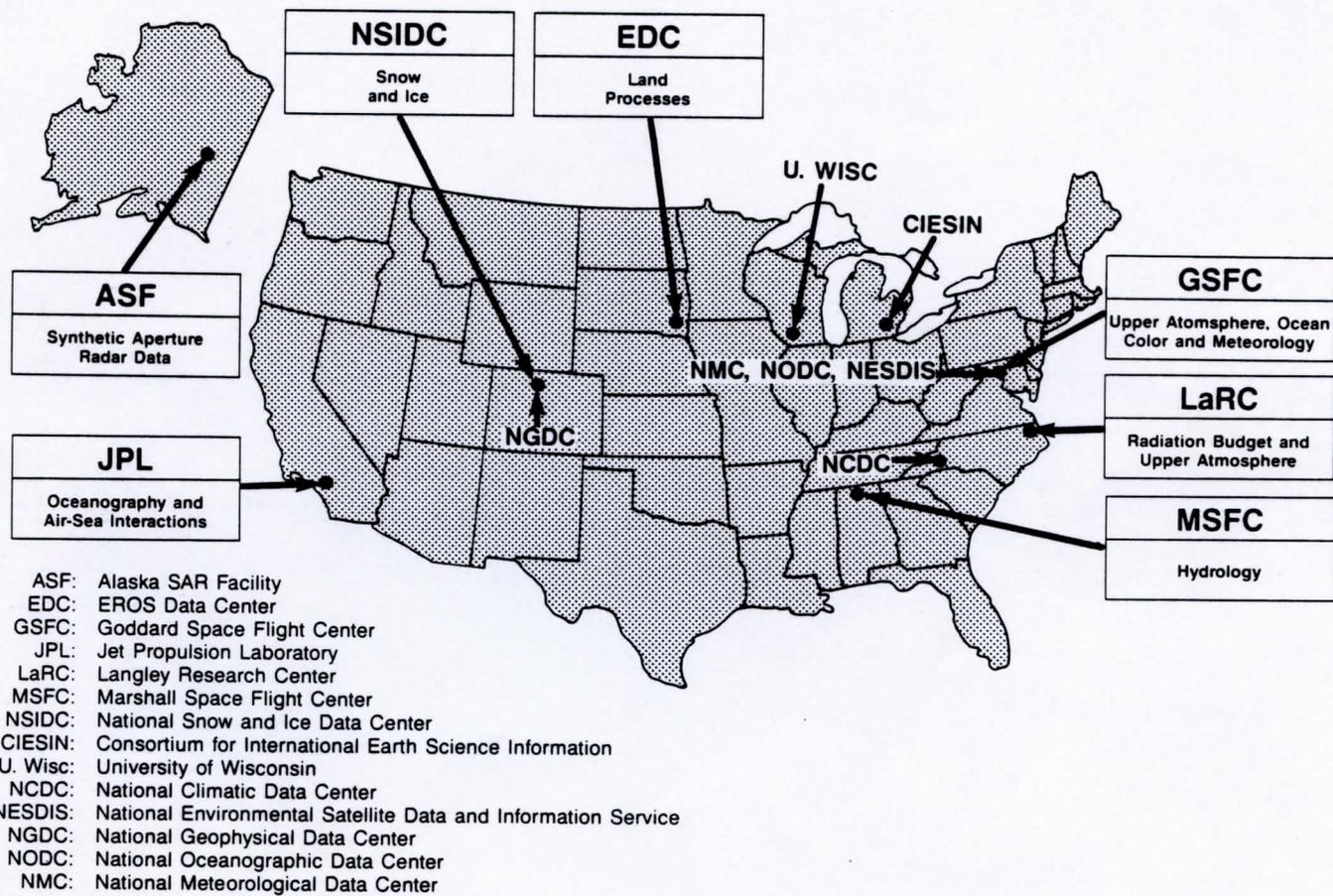


Figure 4 - EosDIS Distributed Active Archive Center Network

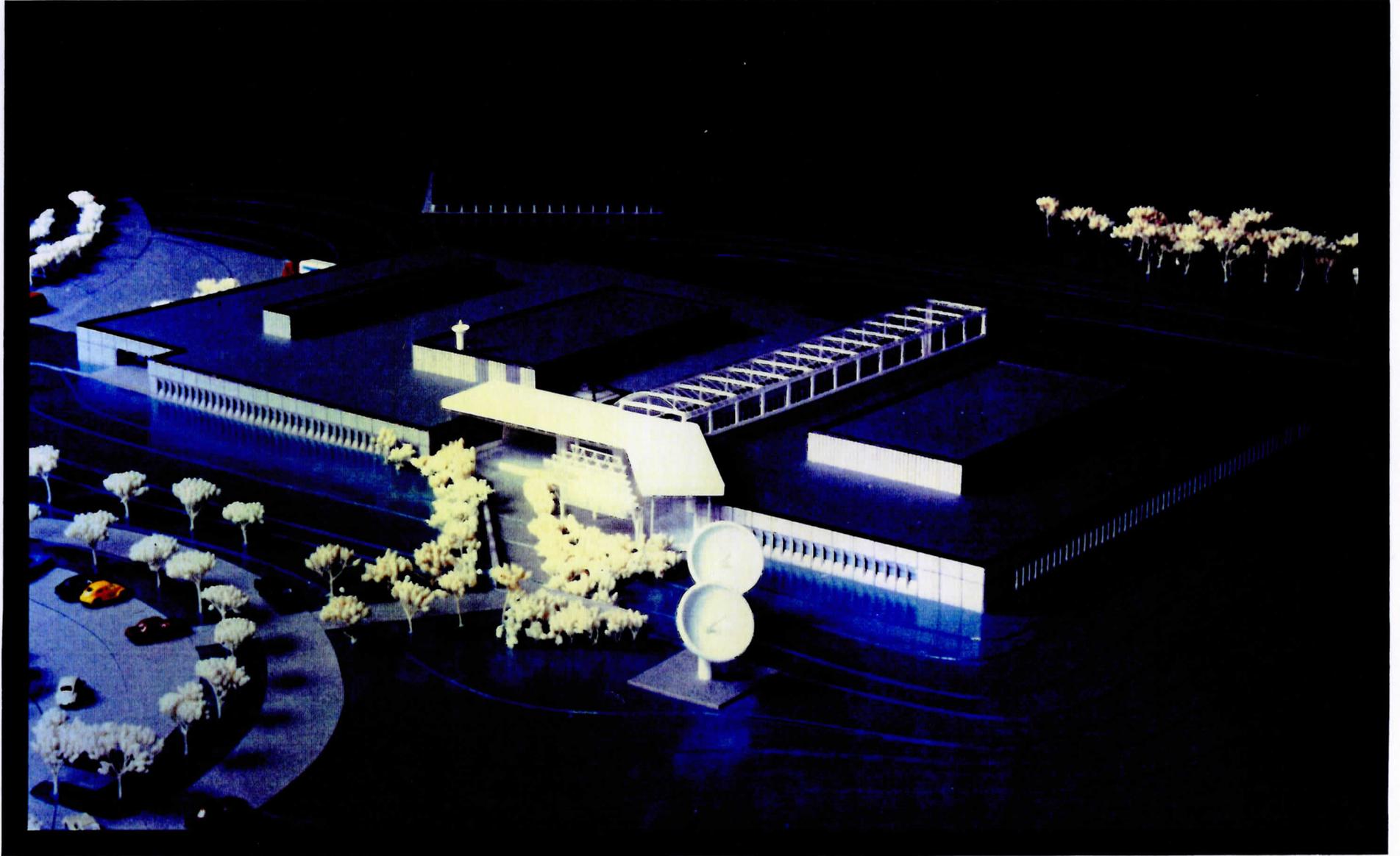


Figure 5 - Model of Future EDC Facility Addition

## *EosDIS Planning and Development*

### EosDIS Phase C/D Requirements/Specification Review

EDC staff participated in EosDIS technical reviews to define EosDIS requirements and functional specifications. Task teams addressed requirements for archiving the Level 0 data stream from each EOS sensor, distribution versus consolidation of the Information Management System (IMS), determination of levels of data browsing capability, and mechanics of incorporating science-developed software into the production data processing stream. The final requirements are the primary input to the technical specification for the key design/development contract for the build phase of EosDIS (referred to as the EosDIS Phase C/D Contract). Major system elements were identified, such as the IMS, the Product Generation System and the Data Archiving and Distribution System (DADS). Naming conventions were established, roles and responsibilities of the various DAAC's were defined, and the schedule for issuance of the Request for Proposal (RFP) and subsequent award of the Phase C/D contract was planned. A conceptual view of EOS and EosDIS is provided in Figure 6.

### Conceptual Design and Cost Review (CDCR) Meetings

Status and plans of specific EOS instruments were reviewed at CDCR meetings at the Goddard Space Flight Center (GSFC). Instruments included the Moderate Resolution Imaging Spectrometer (MODIS), the High Resolution Imaging Spectrometer (HIRIS) and the Atmospheric Infrared Sounder (AIRS). The Data Center will process, archive and distribute MODIS and HIRIS data, and will use the AIRS data to generate both MODIS and HIRIS products. EDC scientists also participated in several MODIS Science Team meetings in order to understand their requirements.

### Version 0 Project

The final proposal for early-EosDIS activities as presented by the EosDIS Version 0 Project was submitted to NASA. Proposed tasks are: (1) port the USGS land data directory, catalog and inventory system software to a prototype EosDIS-compatible computer platform, (2) experiment with processing and archiving several NASA airborne remote sensing data sets, which serve as pre-cursors to actual EOS sensor data sets, and (3) experiment with advanced levels of inter-operability between distributed information systems at various remote sites. EDC representatives attended the first EosDIS Version 0 system engineers meeting held at GSFC in August. Participants included representatives from the EosDIS Version 0 Project Office, the seven DAAC's and a number of the Affiliated Data Centers (ADC's). These meetings will be held quarterly throughout the multi-year Version 0 Project.

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## **Remote Sensing Research and Spatial Data Analysis Technical Development**

### *Automated Extraction of Hydrographic and Woodland Features in Alaska from Spot Digital Data*

Digital image processing techniques to extract hydrographic and woodland information in Alaska from SPOT digital data are being investigated. The objective is to demonstrate the capability to present the extracted data with sufficient detail and positional accuracy to meet National Map Accuracy Standards for Alaska 1:63,360 map products. A test site near Bethel, Alaska has been selected. Imagery of the area is being geometrically registered and the panchromatic and multispectral data are being merged prior to feature identification and extraction. The project will be completed in FY 1991.

### *Hyperspectral Data Visualization*

Development of visualization techniques for hyperspectral data analysis has begun with the selection of two sample data sets: (1) 208 spectral bands from the Airborne Visible Infrared Image Spectrometer (AVIRIS) data set of the Drum Mountains, Utah, and (2) the North American NDVI data set for the 1990 growing season. Preliminary investigations of volume rendering software at the GIS Laboratory in Reston have been conducted remotely. Visits were made to the Branch of Geophysics, Geologic Division, Denver, Colorado and the University of Colorado, Boulder, Colorado to investigate their visualization capabilities for AVIRIS data. Current work includes evaluating and implementing software from these two facilities, and more extensive use of the volume rendering software. The project will continue through 1991.

### *Development of Radar Data Processing Capabilities*

Formal NMD research project EDC 89-2 involves the development of a prototype radar geometric rectification capability, including capabilities for correcting terrain-induced geometric distortions and mosaicking. Existing software previously developed at the Jet Propulsion Laboratory (JPL) and another software package developed by the DMA have been installed at EDC and are being evaluated as possible prototype software systems. The JPL package has been successfully tested using Seasat data acquired over the Drum Mountains, Utah test site.

In a related activity, the French Space Agency (CNES) accepted a proposal from EDC to study the effect of various Digital Elevation Models (DEM's) on the geometric terrain correction of SAR data. CNES is providing SPOT-derived DEM's for comparison to the standard USGS 1:24,000-scale DEM for this purpose. These DEM's will be used to test the JPL and DMA software.

To further prepare EDC for future EOS radar data management activities, data from the JPL DC-8 polarimetric SAR system were acquired over the Drum Mountains, Utah as part of the JERS-1 Synthetic Aperture Radar simulation campaign. Experimentation with these data is sponsored by various Japanese agencies and is being supported by JPL and the Geosat Committee. The DC-8 system is an important precursor to the SIR-C and EOS SAR sensors. To extend the capabilities of radar processing software, EDC, JPL, and the University of Alaska, Fairbanks has submitted a proposal to NASA to modify the software to work for ERS-1 data.

### *Identification of Global and Continental Map Projects*

Briefings and meetings have been held to survey user needs and plans for displaying global and continental data sets. A key finding is that users need to statistically analyze large areas. Thus, the project is focusing on the evaluation of equal-area map projection, and their distortion characteristics. Distortions are being portrayed both graphically, using ellipses, and statistically, using standard deviations. A near-term goal is to depict how distortion patterns are affected when converting from one projection to another. The project will continue through FY 1991.

### *Relational Structures for Device Independent Map Composition and Design*

Work continued to define and implement a relational metafile to support integrated plotting of images and vector data on raster output devices. The structure of the relational metafile has been established and includes four sections: catalog, geometry, symbology, and map elements. The current implementation allows a plot of vector data to be made using a limited set of symbology. Immediate goals are to complete the prototype user interface, focusing on adding new symbology and map elements, and

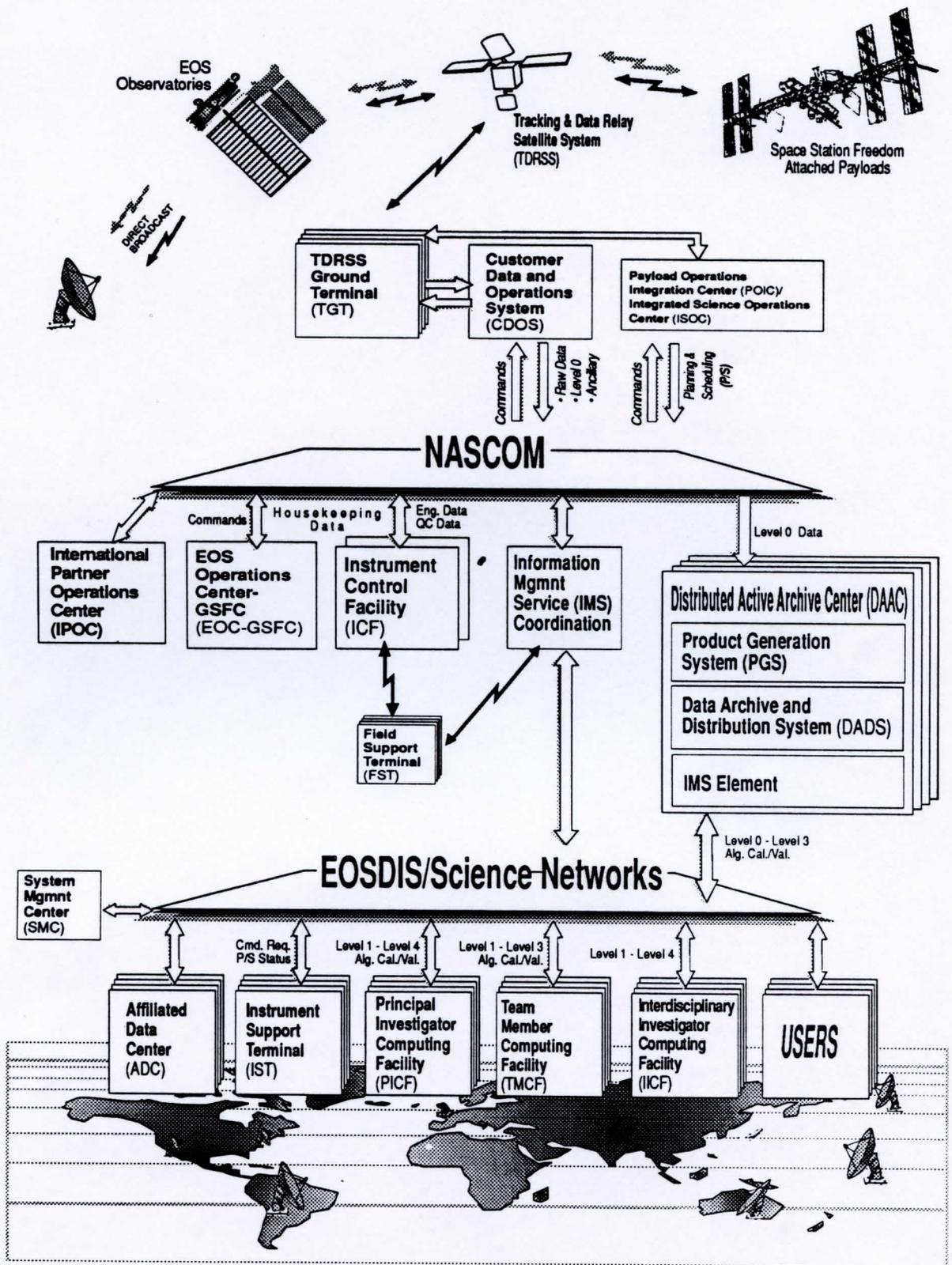


Figure 6 - EOS Conceptual Overview

investigating other devices and computers. Work will continue through FY 1991.

#### *Assessment of SPOT Stereoscopic Data and Potential Applications*

The final analysis of SPOT imagery is in progress on the InterMap Analytic stereoplotter with SPOT modeling software at Rocky Mountain Mapping Center (RMMC) in Denver. RMMC evaluated the geometric accuracy and is evaluating feature recognition potential of a stereo model of SPOT data acquired over Denver. EDC is awaiting confirmation from RMMC of the current status of this project.

#### *Nominal Filtering Research*

The research was completed and two papers were published: "A Region-Based Filtering Procedure to Simplify Classified Spectral Grid-Cell Data" and "Data Integration through Region-Based Nominal Filtering".

#### *Land Analysis System (LAS) Maintenance*

Accomplishments included porting and enhancement of LAS Version 4.1 modules to LAS 5.0; catalog manager tape archive and retrieve development and testing; implementation and testing of a LAS 5.0 interface to the IIS/IVAS, Raster Tech, and DeAnza displays; testing of GSFC delivered modules; and preparing the formal software release as well as finalizing, assembling, and distributing documentation.

Associated efforts included: meetings with the National Center for Geographic Information and Analysis (NGIA) and South Dakota State University (SDSU) to discuss algorithm development and implementation under LAS; providing assistance to Rick Guritz at the University of Alaska for tests on a Sun/IVAS hardware configuration; and developing additional applications. The staff also presented a paper on LAS 5.0 for the American Society of Photogrammetry and Remote Sensing (ASPRS) convention in Denver and was also involved with a presentation of a paper on TAE+ development at the TAE Users' Conference in League City, Texas. LAS 5.0 programs were also ported to the CONVEX, IBM RS6000, and Silicon Graphics hardware for benchmarking purposes.

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### **Agency for International Development Technical Assistance**

#### *Transfer of the Greenness Mapping Program to Africa*

Africa greenness mapping started at EDC in 1987 to support international efforts to control grasshopper and locust plagues through improved environmental monitoring, and is considered by the U.S. Agency for International Development (USAID) to be a highly successful regional project. The Africa greenness mapping efforts at EDC were transferred to the Agricultural-Hydrological-Meteorological (AGRHYMET) Data Center Program, headquartered in Niamey, Niger. Greenness map production went operational in May 1990. Greenness maps now are produced every 10 days for nine West African countries using NOAA AVHRR satellite data acquired in real-time by the AGRHYMET receiving station. The maps will continue to be used to monitor grasshopper and locust habitats, and for assessing cropland and rangeland vegetation conditions. International organizations, including the UN/FAO, have established agreements with AGRHYMET to purchase greenness maps for their monitoring needs.

### *Famine Early Warning System*

The Famine and Early Warning System (FEWS) was established under the sponsorship of the AID to provide timely information so that decision makers of African and donor governments can effectively implement famine prevention measures. The procedure is to target vulnerable populations and monitor their at-risk conditions. EDC staff assisted the FEWS project in defining and structuring a geographic information system approach which takes optimal advantage of existing data, including remote sensing. Data management procedures were developed which specify data archiving standards and analysis routines. A convergence of indicator approach was applied for data analysis. The system was structured to not only analyze data, but to effectively display and communicate the results in map form to decision makers of the host countries and international donor agencies.

### *AGRHYMET Program Support*

EDC continues to support contract staff at the AGRHYMET Regional Center (ARC) in Niamey, Niger. Staff tailored and installed applications software to produce vegetation index maps developed from NOAA AVHRR data. The NMD-developed systems were used operationally in 1990 by National AGRHYMET Center (NAC) staff in the nine NAC's to monitor the condition of national croplands and pastures. EDC staff designed and implemented procedures for assembling national historical climatological data and used to establish the relationship between current and historical rainfall amounts. Currently, EDC staff are developing a strategy to use GIS technology to improve drought monitoring and analysis throughout the AGRHYMET program. Ultimately, this will permit integrated analysis of all AGRHYMET spatial data.

### *Remote Sensing and Mapping for the Sudan Reforestation and Anti-Desertification Project*

Working the Sudan Survey Department, EDC staff prepared Landsat satellite image mosaics of the Sudan study area. These were used to design and publish a 1:250,000-scale satellite image base map and a 1:100,000 satellite image base map of the Kazgail area. The Sudan Forests National Corporation staff used the maps to prepare vegetation resources maps of these areas. This activity was supported by the U.S. Forest Service (USFS) who provided advisors to assist with data collection and tabulation. Locating field plots was accomplished using Global Positioning Systems and USFS staff provided instruction and support. EDC staff worked with USFS staff to create software to enter vegetation survey data into a DBASE matrix. From this matrix timber volume estimations were calculated, and stand and stock tables produced for the study area. The base maps were drawn and prepared for publication by the Eastern Mapping Division which printed 1,500 copies each of the four maps (1:250,000-scale Jebel Ed Dair Image Base Map and vegetation resources map; 1:100,000-scale Kazgail Image Base Map and vegetation resources map). All the above work, completed between October 18, 1990, and February 28, 1990, included the delivery of software, printed maps, a published handbook of 67 pages and a statistical summary of the sample survey of vegetation.

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## **Alaska Field Office (AFO) Activities**

### *Disaster Assessment Support in Alaska*

NMD expertise and information were used to help mitigate the effects of two recent,

large-scale environmental disasters in Alaska this past year: the eruption of Mount Redoubt and the Exxon Valdez Oil Spill in Prince William Sound. The November 15, 1990, eruption of Mount Redoubt disrupted air traffic and closed oil transport facilities in southcentral Alaska as ash clouds darkened the skies intermittently for a 5-month period. Flooding on the Drift River caused by snow and ice melting due to volcanic activity resulted in the closing of the Drift River Oil Terminal which is used as the storage and shipping for oil wells in Cook Inlet. During the eruption of Mount Redoubt, digital satellite data from NOAA's weather satellite was used to study the dispersion of ash following volcanic activity. Coastline data and DEM's were transferred to the University of Alaska's Geophysical Institute in Fairbanks where real-time monitoring was occurring with their quick-look system. Landsat data was registered with DEM data and computer-generated obliques were produced for the public.

The Valdez Oil Spill environmental disaster of March 17, 1990, in Prince William Sound stands as the largest offshore oil spill in North American history with cleanup efforts continuing into 1991. For the Valdez Oil Spill, the AFO served as the focal point for assembling digital data bases in support of the Oil Spill Damage Assessment Team established by Federal Law (CERCLA Act, 1980). Coastlines, Land Ownership Status maps, Environmental Sensitivity Index maps and documented oil impact information were integrated into a GIS data base. The data base was utilized for the production of integrated map products, reports, and for identifying study sites where damage assessment data was gathered by field parties. Long-term management and maintenance of the data base was turned over to the Alaska Department of Natural Resources to support cleanup and possible litigation.

#### *Wildfire Fuel Modeling Investigations*

The Alaska Department of Natural Resources, Division of Forestry and AFO are participating in a pilot research project to evaluate the utility of AVHRR for assessing vegetation greenness and relating it to fuel moisture conditions on the ground. Several dates of AVHRR imagery were acquired during the 1990 fire season over south-central Alaska. This information was correlated with fuel moisture data acquired on the same dates. A statistical evaluation of the data, which will take place later this fall, will be used to determine the level of effort to be placed into further investigations for the 1991 season.

#### *Cooperative U.S. Fish and Wildlife Service (USFWS) and AFO Research Activities*

The USFWS Region 8 Research Center defined a high-resolution landcover classification for Arctic National Wildlife Refuge (ANWR) based on classified TM and SPOT imagery, high- and low-altitude aerial photography, extensive field investigations, and integrated digital geobotanical data sets. AFO compiled digital high-resolution hydrography, hypsography and surficial geology data sets for the ANWR GIS, and provided copies to USFWS. The USFWS used the data to correlate the incidence of caribou calf mortality with topographic setting. The AFO investigated techniques for generating high-resolution DEM's based on the DLG hypsography data sets compiled for ANWR. The resultant DEM data will serve as a baseline data set for the USFWS research investigations.

#### *Chugach National Forest/AFO Cooperative GIS Development Project*

The AFO provided technical support to the Chugach National Forest in data base development, project planning, and the application of the ARC/INFO preprocessing system and its associated peripheral devices. Chugach National Forest currently has four persons located at the AFO on a regular basis, and is planning to add three more part-time persons in fiscal year (FY) 1991. They will be moving into additional office

space downstairs from AFO in early FY 1991.

#### *NOAA Oceans Assessment Division/AFO Cooperative GIS*

NOAA personnel used equipment at AFO to develop graphic materials for inclusion in a CD-ROM of historical fisheries information, including detailed utility and infrastructure data sets for the Duck Island and Prudhoe Bay areas. AFO staff provided technical assistance in process, macro, and program development.

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### **Department of Defense and Intelligence Technical Assistance**

#### *Desert Shield Assistance*

Since early August, EDC has provided numerous DoD agencies with digital data and photographic prints of areas in the Middle East. An overview product of the entire region was produced using AVHRR data acquired through the Domestic Communications Satellite System (DOMSAT) reception system. The final 40-inch products contained embedded World Data Bank II international boundaries for reference. A number of Landsat TM products were also generated. Most products were tape copies of information contained within the DoD multispectral image (MSI) library, Color FIRE transparencies, and 1:25,000-scale prints of full Landsat scenes.

#### *Image Product Development*

The EDC continues to work with DMA to develop techniques for producing digital map collars. This work was started last year with the production of two experimental image maps (Ft. Hood and Ft. Chaffee). Work continued this year for six additional fort areas on a lower priority basis. These products are to be produced completely within the digital domain which results in a digital file containing satellite, collar annotation, and UTM grid information.

The production of these fort maps generated interest within the Defense community which led to a cooperative agreement with DMA for production of 53 1:100,000-scale quadrangles in South America in early FY 1990, all Landsat TM data. An additional 17 quadrangles have just recently been completed and 33 are authorized and planned for completion during FY 1991. For more information on this see Satellite Image Mapping, Section IV a. of this report.

The large scale activities in South America have led to a number of activities with DMA. DMA installed additional equipment from an outside contractor (Intergraph) and modified existing equipment (VAX 11/785) for the purpose of producing a large volume of image maps. They requested LAS software which was installed on the modified VAX equipment and training was provided by EDC for two DMA staff to install and maintain the LAS software and an additional four DMA staff to produce image maps using the Large Area Mosaicking Software (LAMS) portion of LAS. In addition, there are two areas of research being pursued. First EDC is investigating techniques needed to extend control point information across multiple Landsat scenes and to quantify positional errors if the techniques are employed. Second, the volume of image maps makes it practical to pursue a digital interface with either in-house or contractor lithographic scanners. EDC is assisting the Office of Technical Management's Branch of Image Mapping to identify digital tape interface requirements and production specifications for a digital scanner interface.

EDC continues to implement new image processing techniques to assist in the image mapping and custom product generation activities. A contract with South Dakota State University (SDSU) has resulted in a preprocessing technique for deswathing Landsat TM data. The research conducted at SDSU developed a two-dimensional kernel to smooth a repetitive noise pattern. Further research into uses of adaptive filter techniques has led to the implementation of two adaptive filters for the removal of random noise in a digital image. The first removes random bit errors (pixels with no relation to the image). The second algorithm is an adaptive sigma filter which smooths noisy data (pixels related to the image but with an additive or multiplicative component of noise). The second algorithm is being tested on speckle noise found in radar images.

#### *Photogrammetric Modelling of SPOT Stereo Images*

In January 1989, Purdue University and NMD's Office of Research agreed to develop restitution capabilities for SPOT imagery and implement the capability on a digital photogrammetric workstation. All hardware components of the digital photogrammetric workstation were assembled at Purdue, and much of the software was written. In July 1990, EDC received and began running several of the completed software modules. With delivery of a stereoscopic display, currently scheduled for November 1990, EDC will be able to complete the workstation configuration and begin comprehensive evaluations of the system as well as support on-going system development. A follow-on proposal which addresses the generation of digital elevation data from digital stereoscopic imagery and the automated set-up of SPOT and digitized frame photography was submitted to the Division.

#### *USSR Greenness Mapping*

A greenness mapping project for the CIA has begun. Greenness maps derived from AVHRR data covering an area of Eastern Europe and Western Asia are being generated on a 10-day cycle for the 1990 growing season (April through August). Deliverables include digital information of the AVHRR original bands, Normalized Difference Vegetation Index (NDVI) data, satellite and solar zenith, azimuth bands, and statistics compiled on the basis of a specific grid reference system. Analog plots are also supplied at 1:5,000,000 and 1:20,000,000 scale. Following completion of the 1990 growing season, processing will begin on historical data sets in 1986, 1987, and 1988.

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#### **United Nations Environment Programme/Global Resource Information Database (UNEP/GRID) North America Node**

Negotiations between UNEP, USGS, and NASA to establish and operate a facility at EDC called GRID-Sioux Falls, are nearly complete. Concurrent evolution of the UNEP and USGS programs for the management of global scientific data and the development of the NASA EOS program have led to the decision by all three organizations to locate the North American facility of the GRID program at EDC. It will be managed by UNEP personnel with assistance from NASA. UNEP formally announced the establishment of GRID-Sioux Falls, which should begin operations later this calendar year. A draft agreement has been informally accepted by the agencies.

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### III. DATA PRODUCTION AND DISTRIBUTION ACTIVITIES

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#### National Mapping Program Support

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##### *Map Production Support*

##### Preparation for Sale 1:100,000-Scale Processing

Eighty-eight quads involving 10 project areas were completed in FY 1990, exceeding the annual production goal by 32 quads. Increased production rates resulted from software enhancements and workflow modifications.

##### Satellite Image Mapping

Eighty-four satellite image maps were produced in FY 1990 -- 70 of areas in South America for the Defense Mapping Agency (DMA), 3 of Indian Reservations for the Bureau of Indian Affairs (BIA), 7 of the U.S. Mexican border for the U.S. Army - Intelligence and Threat Analysis Center (ITAC), 2 for the Agency for International Development (AID), 1 for the National Park Service (NPS), and 1 for NMD. An additional 33 image maps of areas in Columbia were requested by the DMA for delivery by December 1990.

##### Alaska Interim Land Use and Land Cover

Preliminary land cover maps derived from Landsat data classifications were completed for the Anchorage, Seward, Tyonek, Talkeetna, and Talkeetna Mountains quads. The quads were field-checked this summer. Because of problems with the Array Processor of the Interactive Digital Image Manipulation System (IDIMS), the key raster image processing system at the Alaska Field Office, finalization of the land cover classification is scheduled for completion in early FY 1991.

##### *Mark II Support*

The Digital Line Graph (DLG-E) internal exchange data model, structure, and format were completed on schedule in January 1990. Phase 1 DLG-E prototyping activity was successfully completed in April 1990. The proposed second phase of DLG-E prototyping was superseded by an in-house rapid prototype software system design and development. The DLG-E rapid prototyping effort was initiated at a Divisionwide meeting held at Mid-Continent Mapping Center (MCMC) in August. System design and development is targeted for completion August 1991. EDC will provide the technical leadership in the transition of the DLG-E Processor from EDC to MCMC.

##### *Information Dissemination Services*

##### National Aerial Photography Program (NAPP) Activities

EDC duplicated and archived 33,000 frames of color-infrared NAPP film and 80,000 frames of black-and-white (B/W) photos from NAPP masters. Over 25,000 B/W and 400 color film diapositives for NMD's mapping program were produced in FY 1990. In addition, NAPP acquisition flight line plot maps were generated to assist the USGS contracting effort.

### Digital Image Production

A wide variety of digital image products were prepared for use in production and research projects throughout the Federal Government. Image data were acquired from Landsat, SPOT, and NOAA AVHRR sensors and were combined with Digital Elevation Model (DEM) and DLG data. The image products were used for crop production monitoring, land management planning, fire danger rating, forest fire damage assessment, and other purposes. Products varied from simple digital enhancements of satellite images to geometrically registered and color-corrected images with map collars, annotations, and registered line work depicting user-specified physical, political, or cartographic reference material.

### Civil Satellite Data Inquiry and Purchasing

Twenty-five Federal agencies have purchased nearly \$18 million worth of satellite data since October 1985, with over \$3 million of data purchased by 20 agencies in FY 1990. These purchases were based on agreements with EOSAT and the SPOT Image Corporation, the commercial operators of the Landsat and SPOT satellite systems. These agreements assist Federal agencies in obtaining civil satellite data products and services. The U.S. Geological Survey is currently negotiating a similar arrangement with Central Trading Systems, the commercial distributor of Soviet SOJUZKARTA data. EDC brokerage activities are funded via a five percent purchasing service fee on data procurements.

### Earth Science Information Network (ESIC) Support

Since DORRAN became operational in March 1989, EDC has been providing ESIC a system administration function and performing monthly accounting for each site. Assistance activities included coordination of network archiving activities, monitoring network message traffic, coordinating system administration, providing routine computer software and hardware support, and conducting routine end-of-month accounting.

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## **Satellite Data Operation**

### *Landsat Operations*

EDC received, processed, cataloged, and archived nearly 10,000 scenes of Landsat Multispectral Scanner (MSS) data and 300 scenes of Thematic Mapper data in FY 1990. At the end of FY 1990, the EDC archive held 927,500 Landsat scenes. Periodic updates were made to the EDC online catalog system which references the U.S. archive and the more than 1.8 million scenes held by the foreign Landsat stations in Argentina, Australia, Brazil, Canada, Italy, Japan, Spain, South Africa, and Sweden. Over 13,000 customer products were produced at EDC, resulting in revenue of \$9.4 million.

### *Advanced Very High Resolution Radiometer Data Acquisition, Processing, and Archiving*

Increased capability to receive world-wide coverage of AVHRR data was made possible by the installation of a communications satellite data reception station at EDC in May 1990. By mid-June, the system was fully operational, acquiring and processing 6 direct receive passes and 15 recorded passes daily. The parabolic antennae taps into the stream of foreign coverage received by receiving stations at Gilmore Creek, Alaska and Wallops Island, Virginia and related to the World Weather Building in Suiteland, Maryland. The data are decoded, converted to a digital signal, transferred to the processing computer, geodetically referenced on a DEC VAX minicomputer, and recorded on digital tape or film. The data reception station was funded by the Central

### Intelligence Agency.

A survey of facilities that receive real-time AVHRR data was conducted. Figure 7 represents the locations of known facilities and their receiving ranges. The figure illustrates the complexity of collecting complete global coverage and preparing a 1-km resolution data set of all land masses of the world. Only a portion of the facilities archive and distribute products in a manner that could contribute to compiling a global data set. Work will continue on a plan defining procedures for acquiring global coverage and establishing data exchange procedures.

### *Conterminous U.S. Greenness Mapping*

Production of bi-weekly greenness images for the Conterminous U.S. began on March 2, 1990. The images are composites of daily observations from the NOAA-11 AVHRR 1-km sensor. Prior to operational production in March, techniques for data calibration and atmospheric correction were investigated, and calibration refinements were made. A more accurate and efficient method to geometrically register multiple AVHRR scenes was developed and implemented. Statistical summaries, digital images, and paper maps of vegetation condition were produced and distributed in near real-time to the Bureau of Land Management (BLM), Forest Service (FS), National Park Service (NPS), Environmental Protection Agency (EPA), USDA, NASA, National Weather Service (NWS), National Oceanic and Atmospheric Administration, (NOAA) and USGS. The data are used in operational programs and basic research in wildland fire danger assessment, drought assessment, biomass production, and ecological assessment as it relates to global climate change. Data acquisition, archiving, and distribution will continue for alternate bi-weekly periods from November 1990 through February 1991; bi-weekly production will resume in May 1991. The 1990 set of bi-weekly greenness data will be available on Compact Disk Read Only Memory (CD-ROM) media in early FY 1991.

### *Data Archive Facilities*

EDC currently maintains 3,360 square feet of environmentally controlled film storage space onsite, and an additional 1,000 square feet offsite. EDC's onsite storage capacity is approximately 54,600 9-inch film rolls and the offsite capacity is about 20,000 9-inch rolls. Currently, both archives are at full capacity. Film has been routinely transferred offsite to accommodate the receipt of 1,500 to 2,000 rolls annually at EDC. Current archive holdings total 2.8 million Landsat image frames and 6.7 million aerial and space photographs. Additional offsite storage is being obtained. EDC maintains two digital tape archives. One is an environmentally controlled 4,400 square foot vault with a halon fire detection and suppression system. It houses 85,000 1/2-inch and 14,000 HDTs in space-saver movable shelving, and it has reached full capacity. The second tape archive is an environmentally controlled 8,000 square foot storage area protected with an overhead water sprinkler system. Stored on pallets are 26,000 high density and 4,000 1/2-inch tapes. This area is also used as an overflow for the main tape storage area.

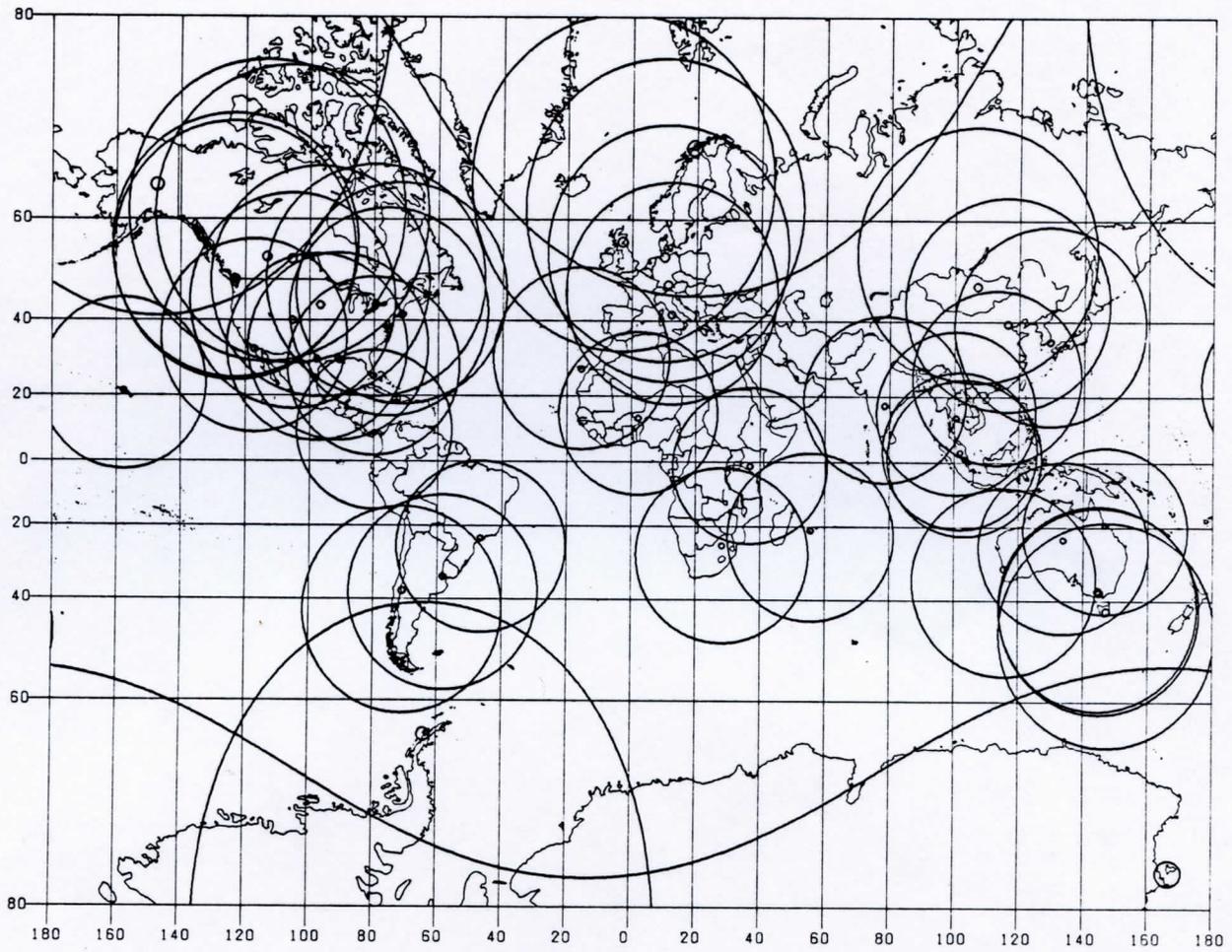


Figure 7 - AVHRR Reception Sites

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## IV. OTHER ACTIVITIES

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### International Space Year (ISY)

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EDC is involved in three ISY activities. First, the USGS, NOAA, and NASA will organize and conduct the ISY International Training Course in Sioux Falls, in September 1991. EDC has been working with the United National Committee on Peaceful Uses of Outer Space, who has responsibility for coordination and identification of attendees from developing countries.

Second, EDC prepared a proposal for a U.S. contribution to the ISY Land Cover Change Project. Discussions at the 3rd Space Agency Forum for the ISY (SAFISY) meeting in Kyoto, Japan, determined that the Project will be co-led by France, Australia, and the Soviet Union. The proposal, which focuses on development of land cover monitoring methodologies, will be presented at the first working group meeting of project participants scheduled to be held in Toulouse, France, in October/November 1990.

Third, EDC is contributing to the ISY Encyclopedia of Global Change Project. The goal of the project, headed by the Canadian Center for Remote Sensing, is to assemble regional and global data sets to reproduce and distribute on CD-ROM media. EDC is contributing selected North American 1-km greenness data sets and global greenness data sets derived from 16-km GVI data.

### Cooperative Work with Canadian Center for Remote Sensing (CCRS)

EDC staff traveled to the CCRS, Ottawa, Canada to discuss opportunities for cooperative work in global change data management. Tentative agreement was reached for development of an Annex to an existing MOU that addresses cooperative research, system networking, product development, and data base construction. CCRS staff has the initial action to draft the suggested Annex for USGS review and discussion.

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**V. STATISTICAL DATA**


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**Introduction**


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The following tables and graphs summarize the EROS Data Center's (EDC) data services activities for fiscal year 1990. Included is information on sales and distribution of products and services, revenue, customer profiles, and the current holdings of the EDC archives and databases.

Information on both USGS data distributed by EDC and those Landsat products and services that are produced or processed by EDC under its agreement with the National Oceanic and Atmospheric Administration (NOAA) and the Earth Observation Satellite Company (EOSAT) is also included.

**Overview**

In fiscal year 1990, EDC provided over 4 million dollars worth of USGS products and services and processed nearly 9.5 million dollars in Landsat transactions for a total in excess of 13 million dollars. More than 29,000 user inquiries were received during the year, 18,000 individual orders were filled.

FY 1990  
**Products and Services**

	USGS		LANDSAT	
	#	\$	#	\$
Photographic Products	164,424	2,655,285	2,087	366,995
Digital Products	9,743	579,235	6,752	5,072,380
Reference Aids	N/A	15,612	N/A	30,305
Digital Data Processing	536	632,338	N/A	N/A
Service Charges	N/A	N/A	3,107	173,400
Other	492	180,683	1,633	3,835,038*
<b>TOTAL</b>	<b>175,195</b>	<b>4,063,153</b>	<b>13,579</b>	<b>9,478,118</b>

\*Primarily products produced at EOSAT but billed by EDC.2

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**Tables and Graphs**


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- Section I. USGS Products and Services
- Section II. Landsat Products and Services
- Section III. EDC Archives and Databases

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**Section I: USGS Products and Services**

This section summarizes EDC activities dealing with the sale and distribution of USGS products, i.e., exclusive of those Landsat products produced by EDC under its agreement with NOAA and EOSAT.

In fiscal year 1990, EDC provided over 4 million dollars worth of USGS products and services. Of this total, 1.6 million dollars were direct repay sales and 1.1 million dollars were products and services provided through full repay EDC projects for a total amount of 2.7 million dollars in reimbursables. The remaining 1.3 million dollars were for products and services distributed to users within the USGS, including EDC, other National Mapping Division centers, and other divisions of the USGS.

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**Tables and Graphs**

- o Annual Sales Report
- o Product Profile - USGS Photographic Data
- o Customer Profile - Aerial Photographic Data



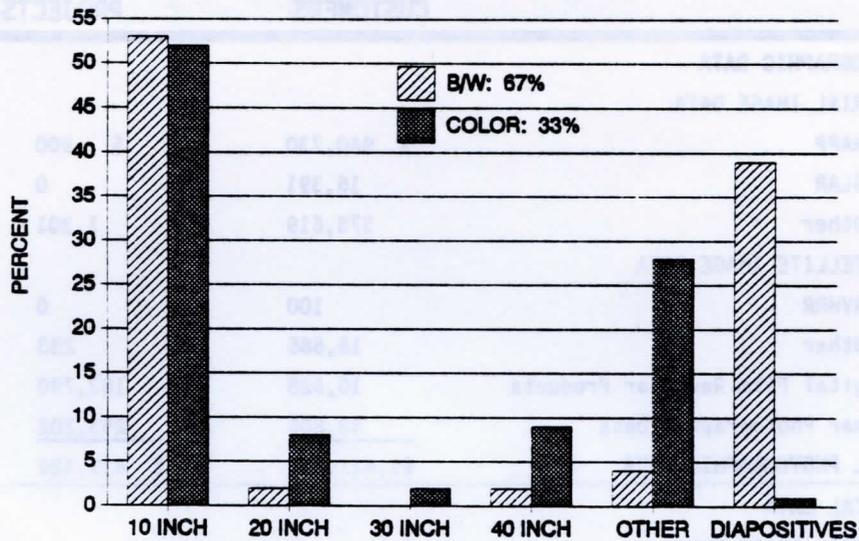
# ANNUAL SALES REPORT

FISCAL YEAR 1990

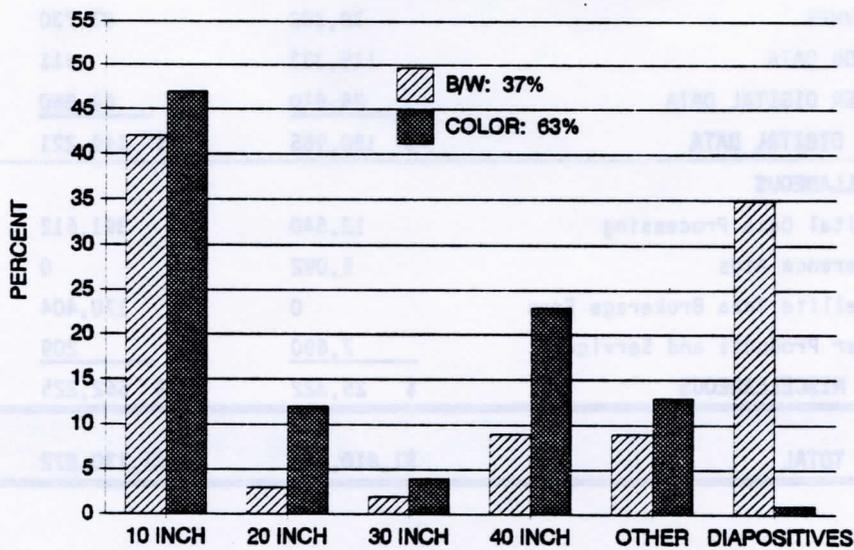
	DIRECT REPAY CUSTOMERS	EDC REPAY PROJECTS	USGS CUSTOMERS
<b>PHOTOGRAPHIC DATA</b>			
AERIAL IMAGE DATA			
NAPP	\$ 940,730	\$ 900	\$ 415,558
SLAR	16,391	0	27,138
Other	373,619	1,301	45,527
SATELLITE IMAGE DATA			
AVHRR	100	0	0
Other	16,685	233	531
Digital Film Recorder Products	10,628	163,790	191,490
Other Photographic Data	<u>53,805</u>	<u>253,202</u>	<u>143,657</u>
<b>TOTAL PHOTOGRAPHIC DATA</b>	<b>\$1,411,958</b>	<b>\$ 419,426</b>	<b>\$ 823,901</b>
<b>DIGITAL DATA</b>			
AERIAL IMAGE DATA			
SLAR	1,520	0	18,960
SATELLITE IMAGE DATA			
AVHRR	38,302	83,730	155,145
NDCDB DATA	115,333	611	7,129
OTHER DIGITAL DATA	<u>25,810</u>	<u>64,880</u>	<u>67,815</u>
<b>TOTAL DIGITAL DATA</b>	<b>\$ 180,965</b>	<b>\$ 149,221</b>	<b>\$ 249,049</b>
<b>MISCELLANEOUS</b>			
Digital Data Processing	12,540	391,612	228,186
Reference Aids	5,092	0	10,520
Satellite Data Brokerage Fees	0	170,404	0
Other Products and Services	<u>7,690</u>	<u>209</u>	<u>2,380</u>
<b>TOTAL MISCELLANEOUS</b>	<b>\$ 25,322</b>	<b>\$ 562,225</b>	<b>\$ 241,086</b>
<b>GRAND TOTAL</b>	<b>\$1,618,245</b>	<b>\$1,130,872</b>	<b>\$1,314,036</b>

# PRODUCT PROFILE USGS PHOTOGRAPHIC DATA FY 1990

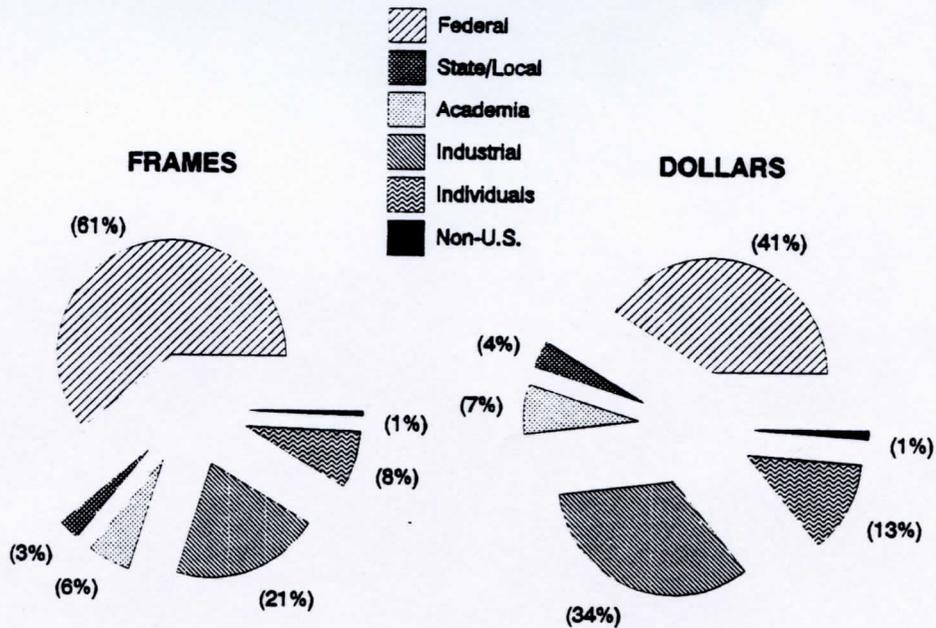
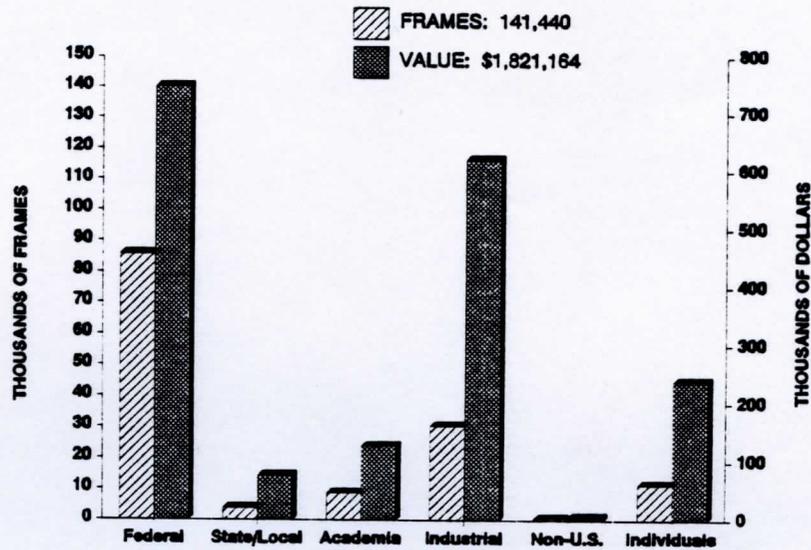
**TOTAL FRAMES: 165,000**



**TOTAL DATA VALUE: \$2,655,000**



# CUSTOMER PROFILE AERIAL PHOTOGRAPHIC DATA FY 1990



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**Section II: Landsat Products and Services**

This section summarizes EDC activities in support of the USGS agreement with NOAA and EOSAT for the production and distribution of Landsat products and services.

Landsat sales reported in this section refer only to data distributed by EDC, or distributed by EOSAT but billed through EDC. Some Landsat products that are both produced and billed directly by EOSAT do not appear in the following tables and graphs.

In fiscal year 1990, total revenue from Landsat products and services processed through EDC was about 9.5 million dollars. Of that amount, over 5 million dollars was for digital products and \$370,000 was for photographic products. A miscellaneous category, which consisted primarily of data produced and distributed by EOSAT but billed through EDC, accounted for over 3.7 million dollars.

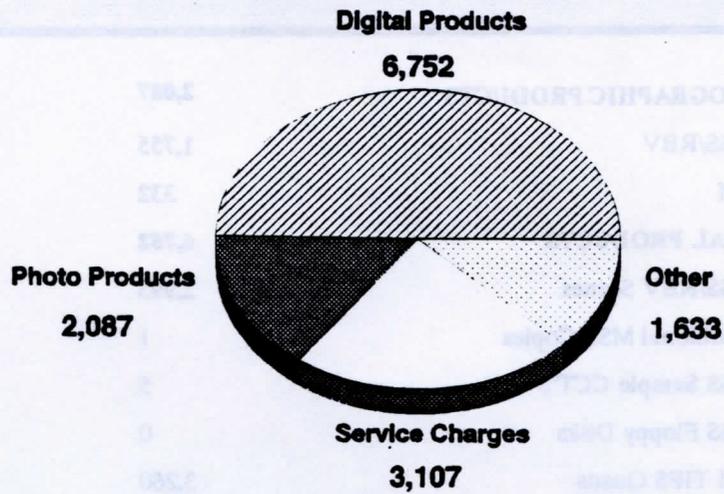
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**Tables and Graphs**

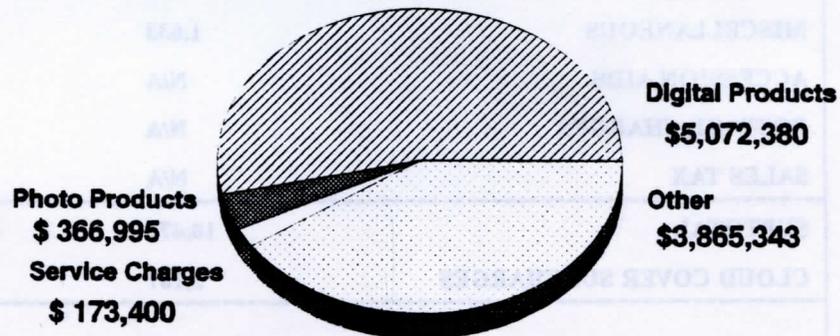
- o Landsat Transactions and Revenue
- o Landsat Product Summary
- o Customer Profile - Landsat Data
- o Product Profile - Landsat Photographic Data
- o Landsat Data Purchased for Federal Agencies by USGS via Brokerage Agreement with EOSAT

# LANDSAT TRANSACTIONS AND REVENUE FY 1990

**TOTAL TRANSACTIONS: 13,579**



**TOTAL REVENUE: \$9,478,118**





## LANDSAT PRODUCT SUMMARY

FISCAL YEAR 1990

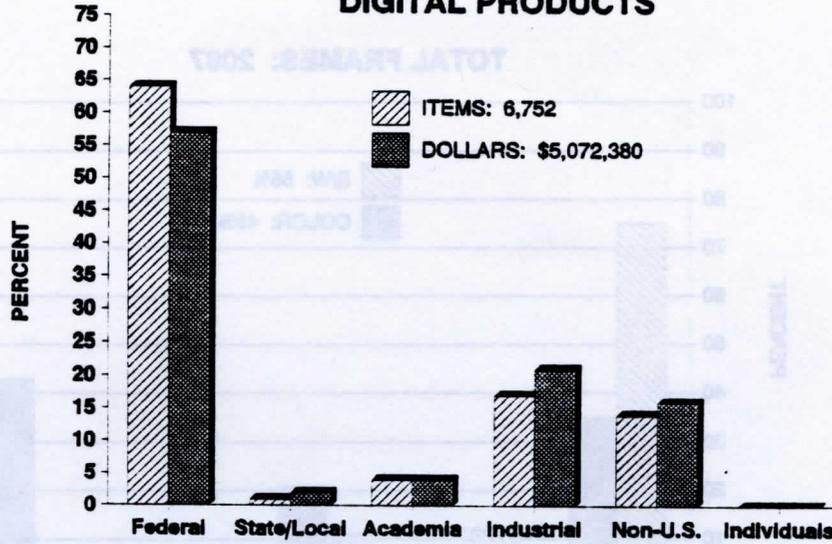
PRODUCTS/SERVICES/CHARGES	ITEMS	DOLLARS
<b>PHOTOGRAPHIC PRODUCTS</b>	<b>2,087</b>	<b>\$ 366,995</b>
MSS/RBV	1,755	243,805
TM	332	123,190
<b>DIGITAL PRODUCTS</b>	<b>6,752</b>	<b>5,072,380</b>
MSS/RBV Scenes	2,993	1,958,350
Additional MSS Copies	1	60
MSS Sample CCT'S	5	250
MSS Floppy Disks	0	0
TM TIPS Quads	3,260	3,047,300
Additional TM TIPS Copies	417	31,020
TM Scrounge Scenes	1	320
TM Sample CCT'S	-1	-200
TM Floppy Disks	76	35,280
<b>MISCELLANEOUS</b>	<b>1,633</b>	<b>3,736,553</b>
<b>ACCESSION AIDS</b>	<b>N/A</b>	<b>30,305</b>
<b>POSTAGE CHARGES</b>	<b>N/A</b>	<b>40,959</b>
<b>SALES TAX</b>	<b>N/A</b>	<b>57,526</b>
<b>SUBTOTAL</b>	<b>10,472</b>	<b>9,304,718</b>
<b>CLOUD COVER SURCHARGES</b>	<b>3,107</b>	<b>173,400</b>
<b>TOTAL LANDSAT REVENUE</b>	<b>13,579</b>	<b>\$9,478,118</b>

# CUSTOMER PROFILE

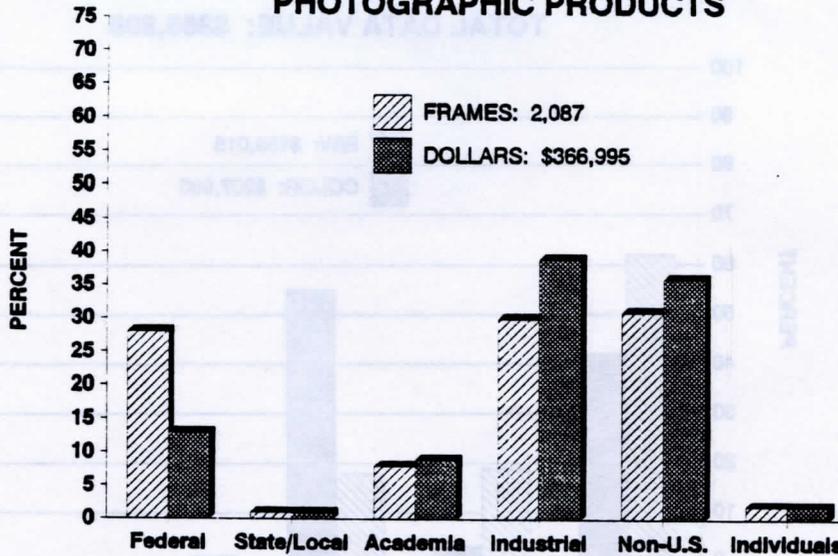
## LANDSAT DATA

FY 1990

### DIGITAL PRODUCTS



### PHOTOGRAPHIC PRODUCTS



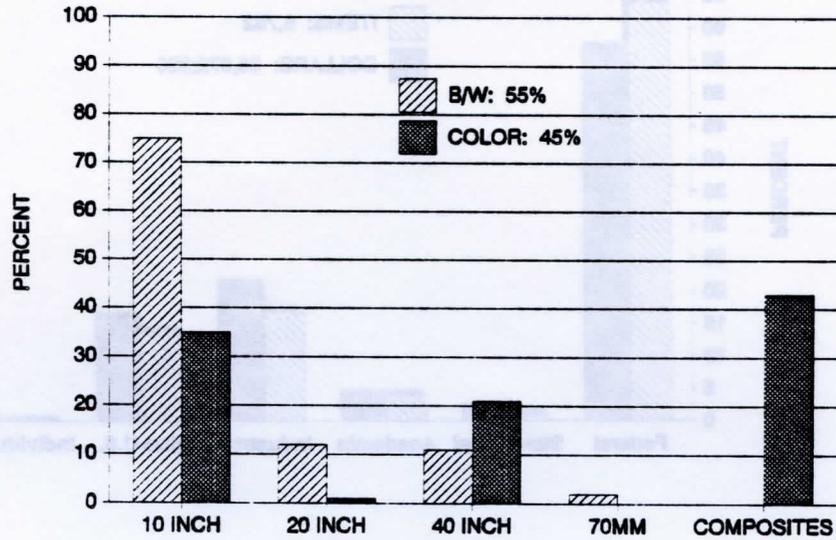
Note: Items and dollars include only those products produced and shipped from EDC.

# PRODUCT PROFILE

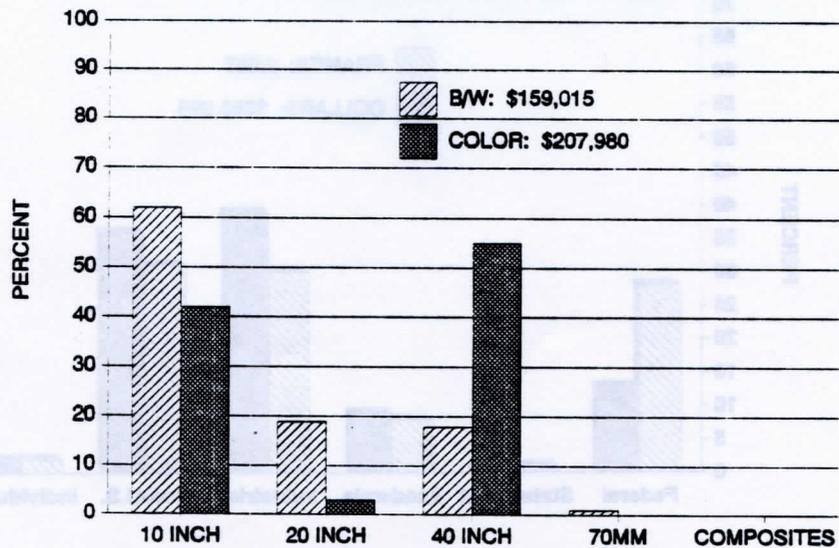
## LANDSAT PHOTOGRAPHIC DATA

### FY 1990

**TOTAL FRAMES: 2087**



**TOTAL DATA VALUE: \$366,995**





**LANDSAT DATA  
PURCHASED FOR FEDERAL AGENCIES BY USGS  
VIA BROKERAGE AGREEMENT WITH EOSAT  
FY 1990**

<b>BROKER</b>	<b>ITEMS</b>	<b>DOLLARS</b>
Ag	13	\$ 36,738
Ag/FAS/Foreign	1,742	662,405
Ag/FAS/Domestic	2,940	1,052,800
Ag/SCS	26	26,372
CIA	858	251,427
Commerce/NOAA/NESDIS	4	2,900
Defense	917	826,227
Interior/BIA	26	25,800
Interior/BLM	5	8,511
Interior/BR	17	29,268
Interior/NPS	1	3,969
Interior/Survey	134	115,548
Interior/Survey/GD	63	67,708
Interior/Survey/WRD	13	33,718
NASA/Ames	40	24,363
NASA/GSFC	30	14,973
NASA/GSFC - Science Office	64	54,579
NASA/Langley	80	115,988
NOAA	56	30,562
<b>TOTAL</b>	<b>7,029</b>	<b>\$3,383,856</b>

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**Section III: EDC Archives and Data Bases**

This section provides the status of data archives, both digital and photographic, that are maintained by EDC to preserve and reference remotely sensed, cartographic, or earth science data held by EDC. In addition, several data bases are maintained by EDC to reference or catalog data held elsewhere that is of interest to EDC customers.

As of the end of fiscal year 1990, EDC archived over 6.6 million frames of USGS photographic data and over 18,000 tapes containing USGS digital data. In addition, EDC archived 2.8 million frames of photographic Landsat data and 106,000 tapes of digital Landsat data. The International Landsat Data Base maintained by EDC for NOAA/EOSAT referenced over 1.9 million scenes of Landsat data held by foreign ground stations.

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**Tables**

- o USGS Photographic Data Archived at EDC
- o USGS Digital Data Archived at EDC
- o Landsat Data Archived at EDC
- o Landsat Data Referenced in EDC Data Base
- o Summary of Data Archived at EDC

# DATA ARCHIVE REPORT

FISCAL YEAR 1990

## USGS PHOTOGRAPHIC DATA ARCHIVED AT EDC

AERIAL PHOTOGRAPHY		
SOURCE	ROLLS	FRAMES
US Geological Survey	17,144	2,553,857
NAPP	5,493	890,389
Bur. of Land Management	625	124,992
Bur. of Reclamation	301	60,181
National Park Service	77	12,766
Bur. of Indian Affairs	37	7,421
TOTAL DEPT. OF INTERIOR	23,677	3,649,606
Army Map Service	1,680	213,873
US Air Force	3,377	329,710
US Navy	6,310	430,789
Corps of Engineers	83	22,931
TOTAL DEPT. OF DEFENSE	11,450	997,303
Ames Research Center	3,833	520,804
Johnson Space Center	7,622	1,009,791
Other	1,413	125,427
TOTAL NASA	12,868	1,656,022
OTHER SOURCE AGENCIES	1,750	279,502
<b>TOTAL AERIAL PHOTOGRAPHY</b>	<b>49,745</b>	<b>6,582,433</b>

SATELLITE PHOTOGRAPHY		
SOURCE	ROLLS	FRAMES
SKYLAB	634	44,845
APOLLO/GEMINI/APOLLO-SOJUZ	127	18,369
SHUTTLE (LFC 8 ROLLS)	638	63,150
<b>TOTAL SATELLITE PHOTOGRAPHY</b>	<b>1,399</b>	<b>126,364</b>



# DATA ARCHIVE REPORT

FISCAL YEAR 1990

## USGS DIGITAL DATA ARCHIVED AT EDC

FILM SOURCE	MAGNETIC TAPES
<b>AERIAL IMAGE DATA</b>	
NASA Data	
TMS 8-Channel Data	591
TMS 12-Channel Data	413
TIMS 6-Channel Data	161
M2S 11-Channel Data	77
AOCI 10-Channel Data	16
National Park Service	94
Side-Looking Airborne Radar (SLAR)	1,085
<b>TOTAL</b>	<b>2,437</b>
<b>SATELLITE IMAGE DATA</b>	
AVHRR	
EDC-HRPT Data	4,843
LAC Data Received via DOMSAT	6,230
LAC Data Received From Other Sources	57
Federally Owned Landsat Data (FOLD)	3,296
SPOT Data	270
Department of Defense MSI Data	326
<b>TOTAL</b>	<b>15,022</b>
<b>NDCDB DATA</b>	
Digital Elevation Model (DEM)	76
1:2 Million Digital Line Graph (DLG)	8
<b>TOTAL</b>	<b>84</b>
<b>EARTH SCIENCE DATA</b>	
National Uranium Resource Evaluation(NURE)	972
Geophysical Research Program	9
<b>TOTAL</b>	<b>981</b>
<b>TOTAL DIGITAL HOLDINGS</b>	<b>18,524</b>



# DATA ARCHIVE REPORT

FISCAL YEAR 1990

## LANDSAT DATA ARCHIVED AT EDC

PHOTOGRAPHIC DATA	ROLLS	FRAMES
MSS 70 MM Film, Landsat 1,2,3	7,708	1,342,187
MSS 9" B&W film	9,175	1,240,284
TM 9" B&W Film	2,968	177,118
MSS Color Composites	N/A	18,095
TM Color Composites	N/A	1,866
TOTAL	19,851	2,779,550
DIGITAL DATA	1/2" Mag. Tapes	HDT's
MSS	43,573	28,039
TM	34,568	
TOTAL	78,141	

## LANDSAT DATA REFERENCED IN EDC LANDSAT DATA BASE

LOCATION	SCENES
<b>DATA HELD IN U.S. BY EOSAT AND/OR EDC</b>	
MSS/RBV	765,563
TM	164,738
TOTAL	930,301
<b>DATA HELD BY FOREIGN GROUND STATIONS</b>	
Argentina	10,790
Australia	189,726
Brazil	85,889
Canada	508,847
Earthnet (Europe)	469,853
Italy	424,056
Japan	149,731
Pakistan	7,839
South Africa	59,279
Spain	19,990
TOTAL	1,926,000



# DATA ARCHIVE REPORT

FISCAL YEAR 1990

## SUMMARY OF DATA ARCHIVED AT EDC

PHOTOGRAPHIC DATA	FRAMES
AERIAL	6,582,433
SATELLITE	126,364
LANDSAT	<u>2,779,550</u>
TOTAL	9,488,347

DIGITAL DATA	MAGNETIC TAPES	HDT's
AERIAL IMAGE DATA	2,437	---
SATELLITE	15,022	---
NDCDB	84	---
EARTH SCIENCE DATA	981	---
LANDSAT	<u>78,141</u>	<u>28,039</u>
TOTAL	96,665	28,039

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