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REMOTE SENSING DATA MANAGEMENT FROM A USER'S VIEWPOINT

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16. Abstract

Incorporation of remote sensing data into a working data bank with diverse inputs and varying user requirements requires thorough management attention and adequate planning, in addition to technical competence. This paper describes the establishment and operation of an experimental data bank in conjunction with the National Marine Fisheries Service's Fisheries Engineering Laboratory's participation in the ERTS-1 Program. After a brief description of the flow of remotely sensed data into a system controlling all data, the established Data Management System is discussed - sources, organization, coordination, data bank operation, and user products.

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REMOTE SENSING DATA MANAGEMENT FROM A USER'S VIEWPOINT

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INTRODUCTION

The advent of satellite observation systems brought with it the capability to synoptically survey vast areas in unprecedented detail. Satellite weather coverage has become a routine daily occurrence. Use of satellite observations by urban planners, agriculturists, foresters, ecologists and environmentalists is gradually becoming a reality. The National Marine Fisheries Service (NMFS), and its constituent recreational and commercial fishermen and state regulatory agencies, have just begun to investigate the potential value of synoptic remote sensing surveys to achieve their goals and objectives.

The process from the acquisition of satellite data through decisive management action based on the observations, as shown in Fig. 1, is technically involved and requires a significant resource expenditure before it can become a routine occurrence. It is essential to understand the steps involved before addressing the requirements for successful data management.

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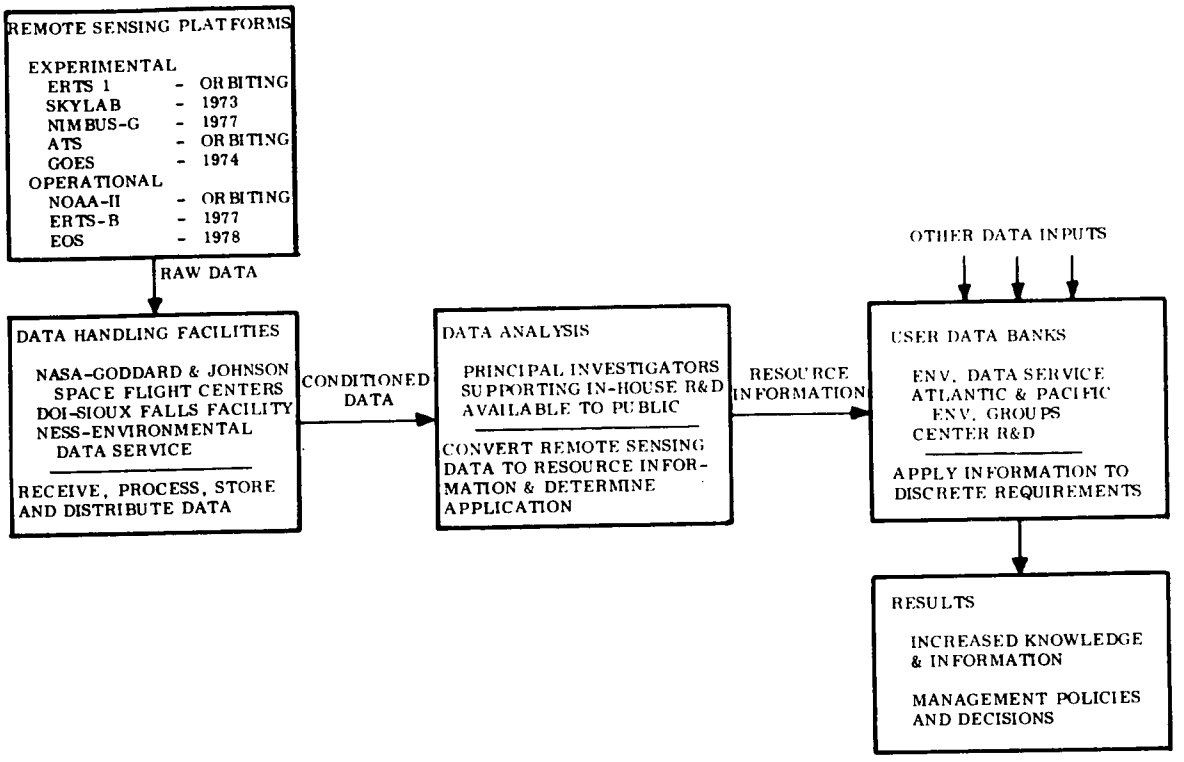

Figure 1. Flow of Remotely Sensed Data

REMOTE SENSING PLATFORMS

Aerospace remote sensing systems, or platforms, have been in the process of development for several years - some are operational while others are presently experimental. Advanced systems are on the drawing board. Generally each platform is designed to provide services to many diverse users. The same platform may acquire data for oceanographers, agronomists, urban planners and environmentalists.

Remotely sensed data requirements to support the management of living marine resources are similar to the data currently being acquired by conventional research ships and fishing vessels. Identified remote sensing requirements include water salinity and turbidity, indicators of basic oceanic productivity, current speed and direction, and high resolution photography. The satellite data are telemetered to ground stations from unmanned satellites, or acquired by man from aircraft and manned satellites.

DATA HANDLING FACILITIES

Ground data handling facilities include the NASA Data Processing facilities at the Goddard and Johnson Space Flight Centers; Department of Interior, Sioux Falls Facility; and NESS - Environmental Data System. A primary function of these facilities is to receive, process, store, and distribute copies of the data collected from the multispectral sensors and other acquisition systems. All remotely sensed data received are processed and archived for future use.

Telemetered signals are converted to formats suitable for analysis. Examples of the formats generated from these signals are high-quality film images, digitized data on computer-compatible magnetic tape, and Data Collecting System (DCS) information in the form of digitized data. Special processing equipment is required at the processing facility to correct for geometric and radiometric errors, to precision process film master images for selected map coordinates and precise annotation, and to develop computer-compatible tape records from selected processed images. The resulting conditioned data are then available to the user and to the general public.

DATA ANALYSIS

The next step in the process is the analysis of conditioned data to achieve the generalized objective of converting the remote sensing data to resource information. Presently this work is performed by Principal Investigators acting through various arrangements with NASA, and inhouse supporting research and development activities. Analysis of conditioned data is presently in a research mode and will be a continuing requirement throughout the operational life cycle of any remote sensing satellite or aircraft system.

It is during this vital step that the remote sensing data are investigated to develop possible applications. Interpretation and correlation studies are performed to determine what the data denote and how they can be used. Usable data formats are developed and analytical techniques are refined to facilitate routine use of the resource information. Through this function experimental satellites are evaluated to determine their; data acquisition characteristics, applicability to discrete data requirements, and potential applications to requirements identified in hypotheses and associated research.

USER DATA BANKS

Remote sensing data, in the form of resource information, are potential contributors to user data banks. Other data inputs include ground truth, sea truth, visual observations and laboratory results. When all the data are integrated, meaningful relationships can be established enabling synoptic monitoring and assessment of resources, and development of efficient resource management techniques.

User groups include the Environmental Data Service (EDS), Atlantic and Pacific Environmental Groups (AEG & PEG), and NMFS Centers. Center research and development tasks and operational surveys will also benefit from remote sensing data. Recent involvement in the NASA/ERTS-1 Program through the NMFS Fisheries Engineering Laboratory (FEL) Principal Investigator has provided the opportunity to evaluate and determine the data management requirements associated with integrating data from several sources.

NMFS-FEL DATA MANAGEMENT

Three principal organizations participated in the ERTS-1 Experiment conducted by FEL. They were: NASA's Earth Resources Laboratory (ERL) at the Mississippi Test Facility (MTF); the National Fish Meal and Oil Association (NFMOA) through its contractor EarthSat Corporation; and several NMFS laboratories. Each participating organizational element supplied data to a central data bank, and used the bank to satisfy their data requirements.

Three functional coordinators were assigned to assist the Principal Investigator in managing the flow of data generated throughout the experiment (Fig. 2). The responsibilities of each participating element of the three basic organizations involved in the experiment are also identified in Fig. 2.

Initially all requirements were identified to a Data Requirements Committee consisting of one representative from each principal organization (Fig. 3). Each requirement was evaluated to determine its applicability to the project objectives. If it was not within the predefined scope, it was returned to the requester. Each request was further reviewed to: Determine the acquisition, processing and analysis responsibilities; identify conflicting and redundant requirements; determine

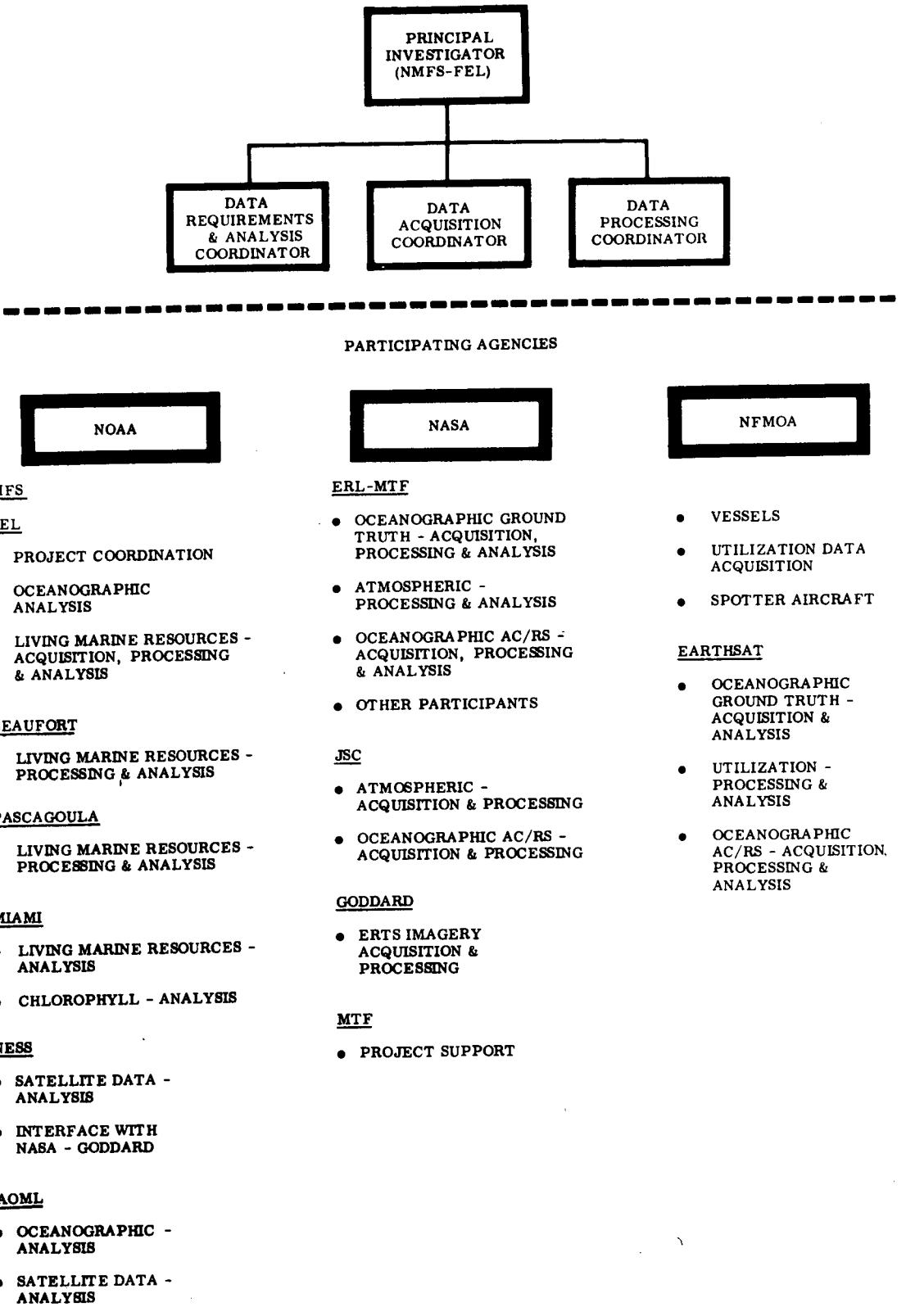

Figure 2. FEL ERTS-1 Experiment Organizational Responsibilities

schedule requirements; and establish priority, data control factors and responsibilities. The Data Requirements and Analysis Coordinator maintained the master listing of approved requirements.

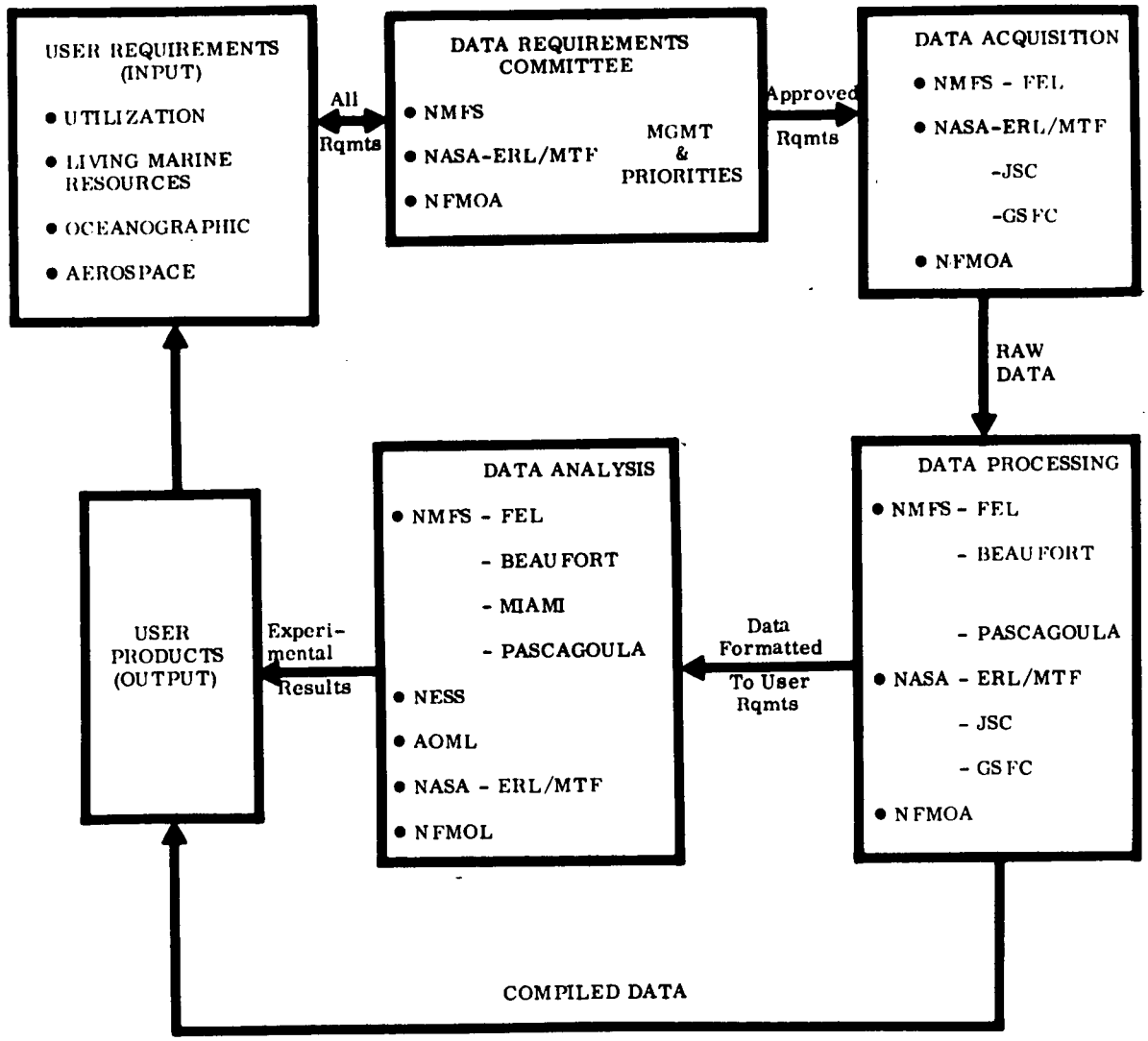

Figure 3. Data Management Flow

Approved data requirements were forwarded to the Data Acquisition Coordinator for dissemination to the agency with designated acquisition responsibility. The coordinator provided the applicable information, pertaining to the acquisition phase, identified during the review cycle. He also maintained continued surveillance to ensure performance, reliability and validity of the acquisition procedures and resultant data.

The Data Processing Coordinator was the focal point for all processing requirements and raw data were forwarded to him for transmittal to the responsible processing agency. The Coordinator's responsibilities included: Providing adequate information to the processing agency to ensure performance within the established constraints; monitoring activities to provide visibility for incoming raw data, processing tasks and analysis schedules; and assuring reproduction and other supporting functions are available as required.

Processed data were output in two forms. Some data were formatted in accordance with user requirements and forwarded to the Data Analysis Coordinator for dissemination; while other data were compiled, and forwarded directly to the user by the Data Processing Coordinator.

The Data Requirements and Analysis Coordinator monitors all analytical activities, and additionally has the responsibility for identifying and evaluating data requirements. Formatted data are forwarded to the responsible agency for analysis, and the Coordinator monitors the activities to ensure adherence to schedule constraints, identifies new/revised data requirements, and provides an interface with the users.

Certain data requirements were forwarded to responsible acquisition agencies who also had responsibility for processing and analysis. In these instances the data do not physically return to the data management flow until the analysis has been completed.

DATA MANAGEMENT SYSTEM

Digital data were supplied by each processing agency for input into the ERTS-1 Data Bank (Fig. 4). A supporting library was established to maintain and disseminate imagery. The data represent remotely sensed biological, environmental and meteorological parameters, surface vessel and aircraft observations, and analyses of physical and biological samples.

Software to establish, maintain, and utilize the ERTS-1 data (Fig. 5) consists of three main segments. The first segment was developed by FEL to reformat all incoming digital data for input to the information storage and retrieval segment. The second segment, which is an Environmental Information Retrieval (ENVIR) System developed for NASA by Gulf Universities Research Consortium, was used to build a compressed inverted binary bank. The system provides

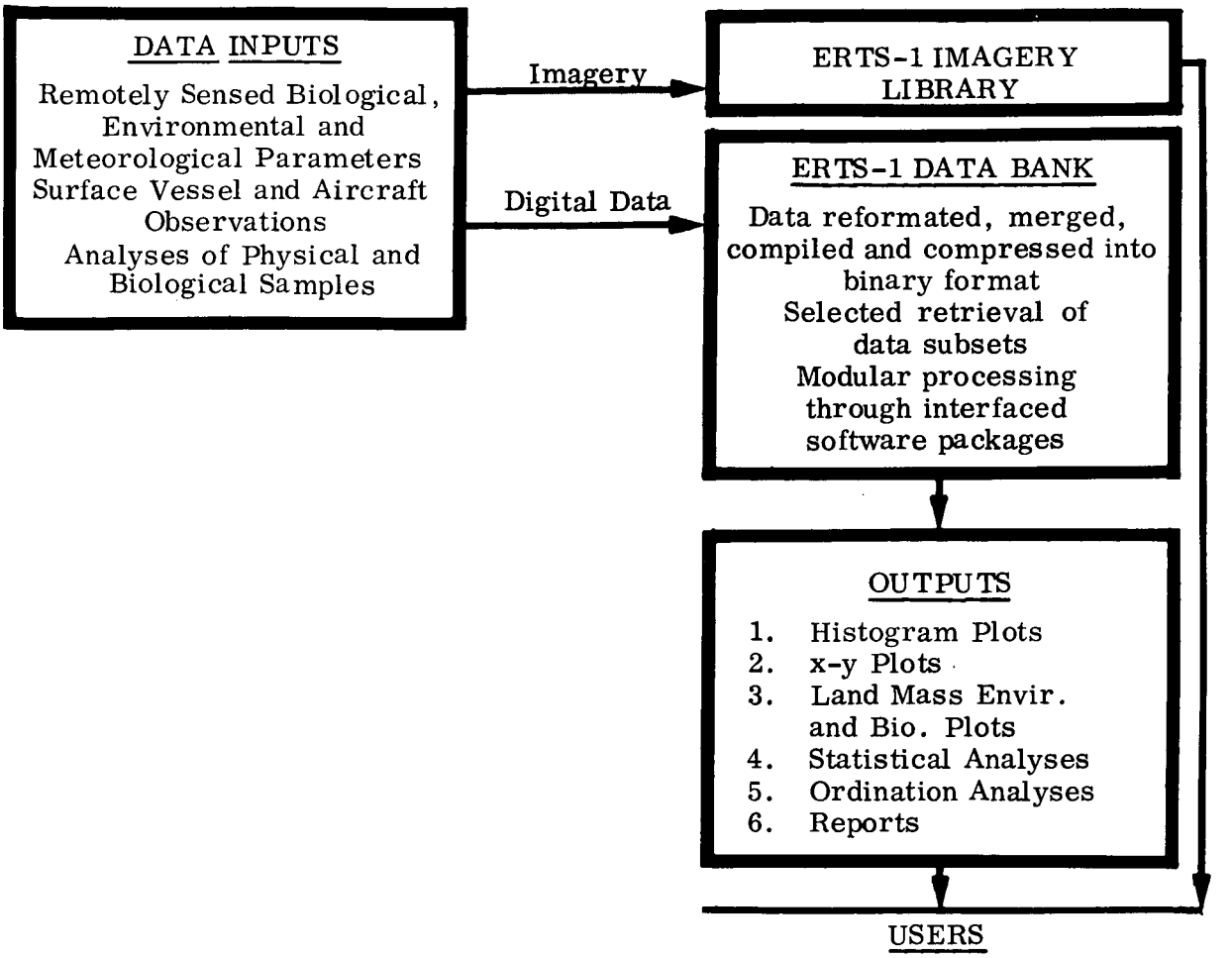

Figure 4. Establishment and Use of the ERTS-1 Data Bank

simple English language commands which enables the users to selectively retrieve information subsets from the inverted file, print the information, or store it on magnetic tape to be utilized by analysis programs. Information in the Data Bank satisfying the given search criteria can be located rapidly by mathematical calculation, rather than a sequential search. The last segment consists of several computer programs developed by FEL at MTF to analyze and display the selectively retrieved information subsets. The system provides software for statistical analyses, similarity/ordination analyses, mathematical computation, and graphical displays which include land mass plots along with contour and symbol plots, histogram plots and x-y plots.

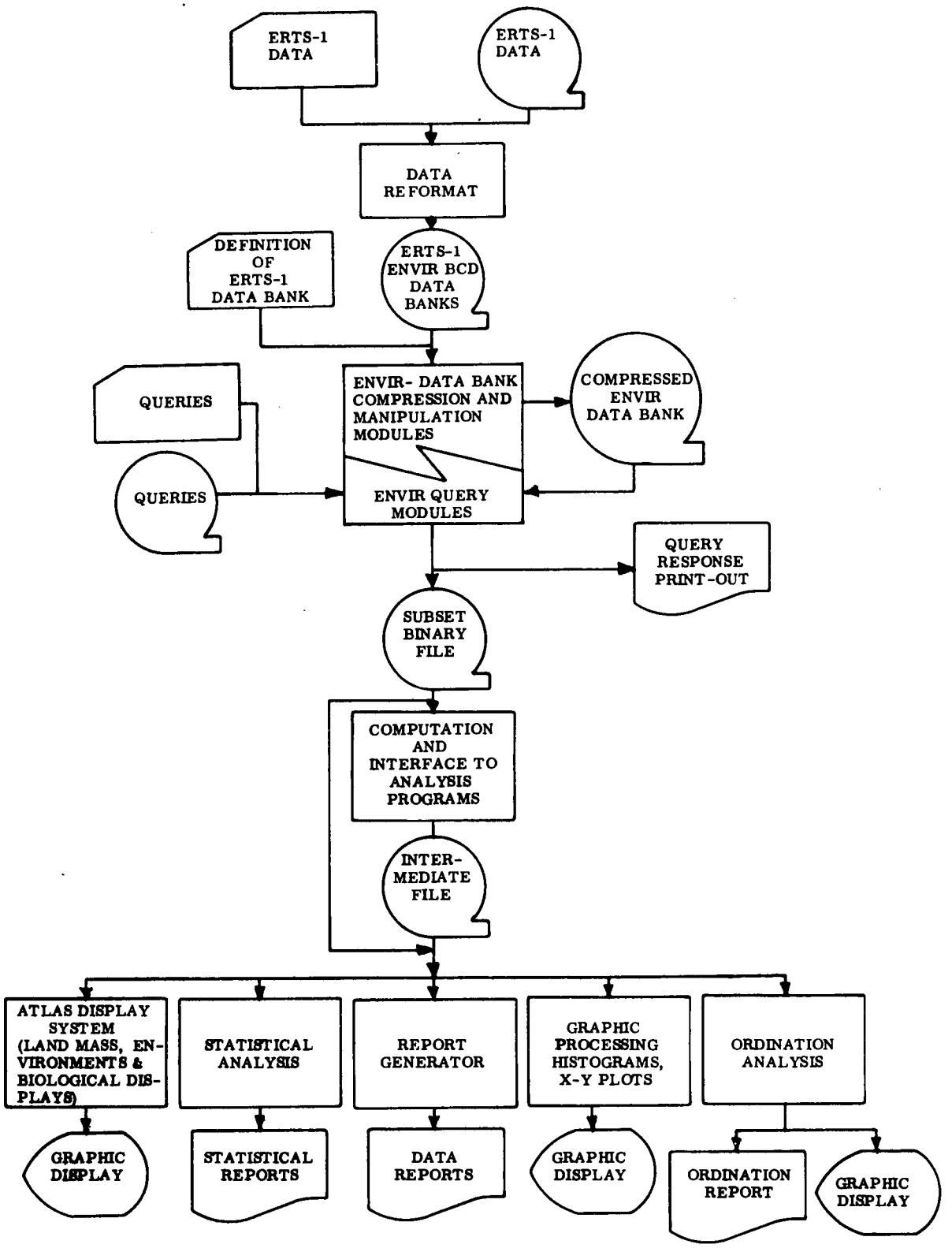

Figure 5. ERTS-1 Data Management Software System

CONCLUSION

The data management system was demonstrated to be effective in the performance of the NMFS-FEL ERTS-1 Experiment involving several input sources and varying user requirements. It will be further evaluated under similar conditions during FEL participation in the Skylab and ERTS-B experiments.

Agencies and organizations that are planning to incorporate remote sensing data into technical information systems will have to establish and maintain a remote sensing analysis entity as an integral part of the total management information system. At the present time there is little attention being given to this component of the system. Without the technical analysis component remote sensing data cannot be expected to make a significant contribution to the user.