AgRISTARS

SR-J2-C0653
JSC-18266

A Joint Program for Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing

Supporting Research

September 15, 1982

PROJECT IMPLEMENTATION PLAN FOR FISCAL YEAR 1983

Lyndon B. Johnson Space Center
Houston, Texas 77058

REVISIONS

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SUPPORTING RESEARCH

(SR)

PROJECT IMPLEMENTATION PLAN

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SUPPORTING RESEARCH

PROJECT IMPLEMENTATION PLAN

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DEFINITION OF ACRONYMS

AgRISTARS	Agriculture and Resource Inventory Surveys Through Aerospace Remote Sensing
AID	Agency for International Development
APEP	Advanced Proportion Estimation Procedure
CCB	Change Control Board
CCBD	Change Control Board Directive
CCT	Computer Compatible Tapes
DOMSAT	Domestic Satellite
DSAD	Data Systems and Analysis Directorate
EDC	EROS Data Center
FIREX	Free Flying Imaging Radar Experiment
FY	Fiscal Year
GSFC	Goddard Space Flight Center
JSC	Johnson Space Center
LACIE	Large Area Crop Inventory Experiment
MSS	Multispectral Scanner
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
P-1	Procedure 1-A Machine Classification Procedure for Landsat Analysis
P-1A	A Modified Procedure Developed After P-1
PIP	Project Implementation Plan
PCR	Project Change Request
PMT	Program Management Team
RBV	Return Beam Vidicon

R&D	Research and Development
SAR	Synthetic Aperture Radar
SR	Supporting Research
T&E	Test and Evaluation
TBD	To Be Determined
TM	Thematic Mapper
USDA	United States Department of Agriculture
USDC	United States Department of Commerce
USDI	United States Department of Interior

1. INTRODUCTION

This document is intended as an overview summary of the Supporting Research Project for FY83. A more detailed technical description of the SR project is to be found in the "Project Research Plan Document" (SR-J2-C0652, JSC-18247).

The Supporting Research (SR) project is conducting a program of research to: (1) advance the existing capability to utilize multispectral measurements collected from Earth-orbiting satellites to determine the type, condition, and maturity of natural and cultural vegetation and, 2) research and develop the use of computers, as well as to operate and maintain data systems, in support of the AgRISTARS research community.

Within these broad goals, the SR project is concentrating its research on monitoring critical attributes of cultural and natural vegetation and using this information to identify and inventory important cultural vegetation species on a global, regional, and local scale.

An automated information extraction research program will investigate automated approaches for vegetation identification and area estimation. It is designed to develop accurate and efficient procedures for vegetation proportion estimation. Accurate identification of key vegetation development stages and the assessment of the condition of the vegetation are expected to be important elements in the advanced vegetation proportion estimation research program. Research will be conducted into preprocessing procedures to support the above techniques. This includes research into image registration, atmospheric correction, and scene variability.

The feature identification research will 1) determine which biophysical characteristics of natural and cultural vegetation are best for differentiating and identifying vegetation type, stage of maturity, and condition of vegetation and 2) identify which features of current and future sensors are best for monitoring these biophysical characteristics. The feature identification research program is integrated with the automated information extraction research program and provides a number of important inputs to that program.

The outputs of this research are algorithms and knowledge relevant to mapping cultural vegetation type and condition using currently available sensors and to the future definition of the desirable characteristics of remote sensors, space platforms, and mission profiles involved in remote sensing of the Earth's renewable resources.

Examples of the results anticipated from the SR research program include:

- o More accurate and efficient procedures for estimating proportions of cultural and natural vegetation using direct proportion estimation techniques.
- o Highly automated procedures for differentiating and identifying vegetation types under normal and stress conditions throughout the growing season.
- o Stage of development models incorporating spectral data. Models will be used to accurately predict the effects of key agricultural and meteorological events on vegetation maturity rates and to support more accurate vegetation discrimination and yield estimates.
- o Procedures for the use of spectral and meteorological data to monitor important determinants of vegetation condition such as evapotranspiration and intercepted solar radiation.
- o A strong focused program of applied field research, including field data collection/analysis/simulation to investigate key issues related to vegetation identification, stage of development and condition monitoring.
- o Evaluation of various sensor types, such as TM, using simulation techniques, available radiation models, and active microwave data for cultural vegetation identification.

Some important cultural vegetation species to be investigated in this research are: a) wheat and small grains and their confusion crops, and b) corn and soybeans and their confusion crops.

The SR project will draw on results of other research wherever possible. The newly created Fundamental Research Program is of particular interest to SR and every attempt will be made to utilize its research findings.

1.1 PROJECT MANAGEMENT

Within the context of research and development, the SR project is designed to programmatic cost and schedule constraints. Project level changes to scope, schedule, and cost are controlled by the Program Management Team through established change control procedures. The AgRISTARS Program Management organizations relative to the SR Project are shown in Figure 1.

The Supporting Research Project reports on a periodic basis, including: 1) weekly activity reports, circulated to interested personnel including the NASA AgRISTARS Level 2 and project manager; 2) the Biweekly Status Reviews, held for the Supporting Research Manager and other interested AgRISTARS project managers; 3) the Monthly Highlights Report which is intended for AgRISTARS Level 1; 4) the Monthly Project Status Review held for the Level 2 NASA AgRISTARS Manager; 5) the Semi-Annual Project Review held for Level 1 and 2 agency managers; and 6) the Semi-Annual Project Report with a wide distribution within each agency participating in AgRISTARS. The schedule for these reports is shown in Figure 1a.

Research and Technology Support resources are divided into Research and Technology Support and Research and Technology Operations. Research and Technology Support provides the resources required to provide and maintain a ready baseline data processing capability to satisfy the continuing needs of the project. Research and Technology Operations are the resources required to provide specified services or products to meet the changing requirements of the projects.

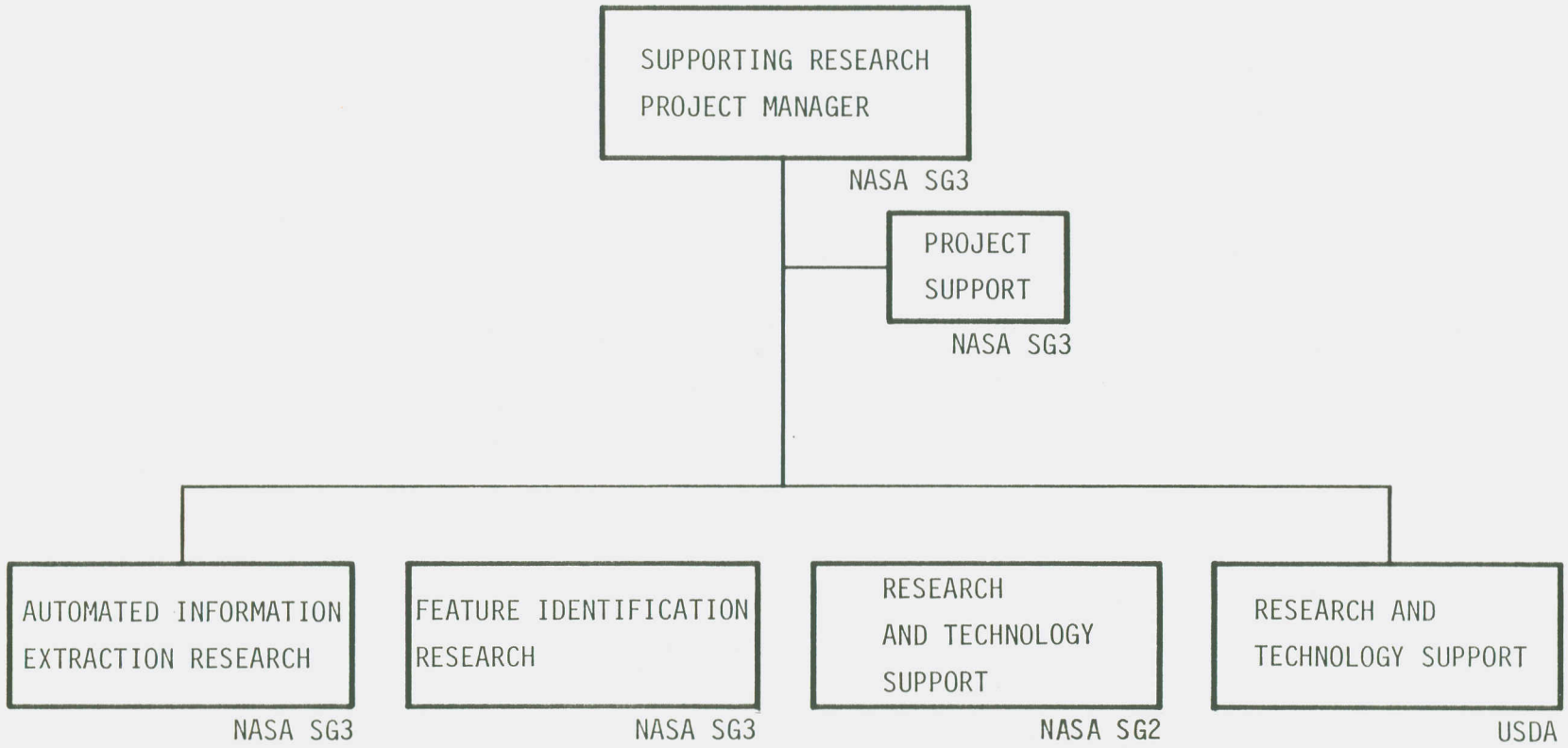
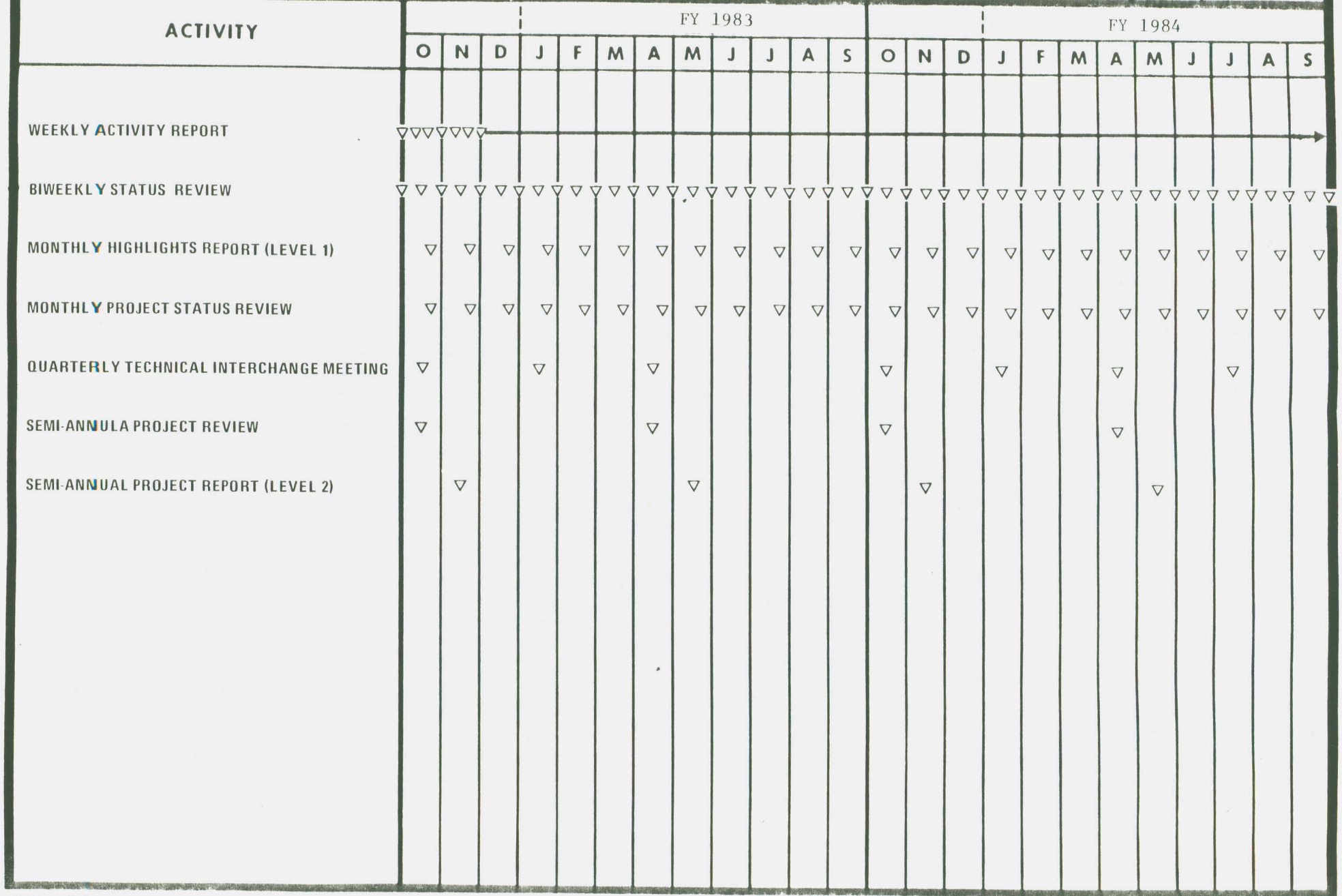

SUPPORTING RESEARCH
PROJECT MANAGER
NASA SG3
PROJECT
SUPPORT
NASA SG3
AUTOMATED INFORMATION
EXTRACTION RESEARCH
NASA SG3
FEATURE IDENTIFICATION
RESEARCH
NASA SG3
RESEARCH
AND TECHNOLOGY
SUPPORT
NASA SG2
RESEARCH AND
TECHNOLOGY SUPPORT
USDA

Figure 1

REPORTING ORG./ACTIVITY:	PROJECT MANAGEMENT	DATE	
		PAGE	1 OF 1



JSC Form 541 (Oct.) Jan.

Figure 1A

1.2 RESEARCH AND TECHNOLOGY SUPPORT

Research and Technology Support is a project element within the Supporting Research Project. Research and Technology Support is tasked to provide data processing capabilities and user services to satisfy the research, development, and techniques verification requirements of the AgRISTARS research community. This community is comprised of elements in NASA, USDA, NOAA, USDI, universities, and private industry.

These data processing services are provided to approved research projects whose participants perform research into methods of applying remotely sensed data for investigative purposes and conduct experiments in the practical application of new analysis techniques to interpret remotely sensed data.

1.2.1 DATA SYSTEMS COMPONENTS

The Data Systems element is comprised of four component parts: (1) Hardware, (2) Software, (3) Data Acquisition and Provisioning, and (4) Operations and Maintenance. This section discusses the capabilities provided by these four components.

1.2.2 DATA SYSTEMS HARDWARE

Data Systems hardware includes the Analysis Subsystem, Data Techniques Laboratory, and Cartographic Techniques Laboratory, which collectively make up the Earth Observations Data Laboratory System (EODLS). Functional responsibilities of this component include those tasks associated with the hardware system configuration, acquisition, integration and installation of vendor supplied equipment, and the engineering of special purpose equipment.

a) Analysis Subsystem

The Analysis Subsystem consists of a medium-scale, general purpose computer (AS-3000), associated communications equipment, and peripherals. This subsystem is available to experimenters primarily on a demand basis to conduct their research, and develop and evaluate new techniques. The Analysis Subsystem is linked to a user network of terminals and data bases

shown in Figure 1b. This communication link provides for a widely distributed application program and data base processing capabilities. These capabilities permit the sharing of data and processing capability by the various users.

b) Data Techniques Laboratory (DTL)

The Data Techniques Laboratory consists of two small scale processors (PDP 11/45) and associated peripherals. The two processors accommodate remote terminal access in a multi-user environment. One of these processors interfaces with the high density tape receiving and playback station, and is used primarily to extract Multi-Spectral Scanner (MSS) images from High Density Tapes (HDT). The Landsat MSS image status and tracking capability also resides on this processor.

The second PDP 11/45 is connected to the Image-100 display terminal. This configuration has the capability to display MSS images in several spectral bands and produce hardcopy color output on plate film or 35 mm format. Currently this system is used for Landsat reference image selection, registration accuracy evaluation, and as a check for ground data processing accuracy. It is being replaced with the newly installed image analysis station which has not only the capability to perform the above functions but more importantly serves as an intelligent work station for supporting interactive image analysis research.

c) Cartographic Techniques Laboratory (CTL)

The CTL has the precision cartographic and photogrammetric equipment necessary to plot field boundary overlays in support of Landsat image processing accuracy assessment. This laboratory provides digitized ground truth maps and registers them to aircraft and Landsat images.

1.2.3. DATA SYSTEMS SOFTWARE

The principal function of the Data Systems software component is the maintenance and update of computer operating systems and selected applications software. The operating systems are supplied by the hardware vendors, while the enhancement or maintenance of these systems are conducted in-house by Data Systems personnel. Principal software tasks are closely allied with the laboratory hardware as described below.

CURRENT AgRISTARS DATA SYSTEM

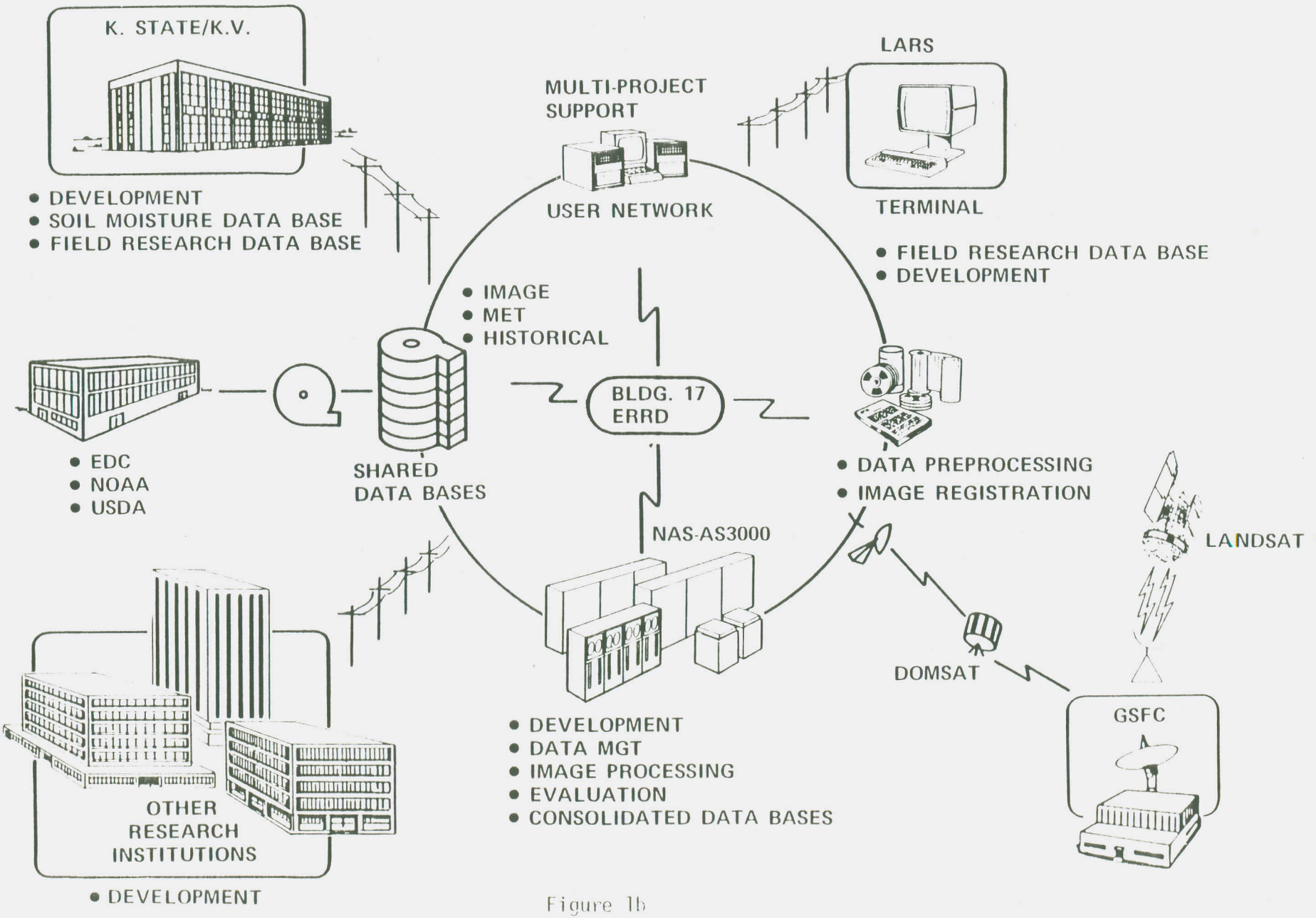


Figure 1b

Normally, users will develop their own applications computer programs with Data Systems consultation for interface to the operating system and associated utility programs. However, Data Systems also develops and implements selected application software.

Data Systems also provides general software services such as the extraction of image data from MSS scenes and the temporal registration of extracted images.

a) Analysis Subsystem Software

The AS-3000 Computer System provides multiple users with the capability of concurrent access to computer resources in a distributed network environment. In this environment, Data Systems provides software for the preprocessing of Landsat MSS image data. This software permits input of search areas, maintains reference image data bases, and performs temporal registration. Application programs developed by users provide for private (exclusive) and group (non-exclusive) data bases. These typically contain meteorological data, agricultural statistics, and temporally registered Landsat MSS image data, and experiment results, such as classification data, and soil and cloud statistics. Experimenters execute various application programs in the Analysis Subsystem to test different classification procedures, aggregation methods, and crop yield models. Accuracy assessment is performed by applications software which compares classification results to ground truth data.

b) Data Techniques Laboratory Software

Current operations include the registration of ground truth maps to aircraft and Landsat imagery and preprocessing Landsat imagery into "ready-for-analysis" data sets.

Other applications permit the display of multi-band images, and the manipulation of images for use in classification.

A Data Base Management System (DBMS) developed by Data Systems is supporting the above applications. The Data Acquisition and Provisioning element also uses this DBMS to perform ad hoc queries for the purpose of status reporting, magnetic tape management, production scheduling, and data base administration.

The status of all Landsat MSS processes, from HDT acquisition until data is made available to the researcher, is tracked and reported by the DTL.

c) Cartographic Techniques Laboratory (CTL)

The software applications available in the CTL are used to convert maps, charts, and ground truth information for input to the accuracy assessment registration process. Plotting software is also available to generate field boundary overlays at various map and image scales.

1.2.4 DATA ACQUISITION AND PROVISIONING

The Data Acquisition and Provisioning component includes those functions required to gather and integrate data requirements, order the data, receive and catalog data upon its acquisition, provide production control services for preprocessing and establish and maintain both electronic and physical data bases. This element provides data to experimenters, reports preprocessing status, and analyzes data anomalies, source schedules and problems.

1.2.5 OPERATIONS AND MAINTENANCE

Operations is responsible for operating the computer hardware and its associated gear to provide service to the experimenting user who depends on prompt access to his research application programs.

The responsibility of Hardware and Software Maintenance is to provide a readily available and fully operational data processing capability through periodic upkeep, preparation of procedures, and performance of operational readiness tests.

2. SUPPORTING RESEARCH PROJECT OBJECTIVES

This section summarizes both existing and planned Supporting Research activities for FY83 in the areas of automated information extraction research (Section 2.1), and feature identification research (Section 2.2). Plans for the research and technology support project element are discussed in Section 2.3.

2.1 AUTOMATED INFORMATION EXTRACTION RESEARCH

The objectives of the automated information extraction research are to develop automated approaches for vegetation identification, acreage estimation, image preprocessing, and image registration. The utility of present and future sensors (MSS, Thematic Mapper, and active microwave) in cultural vegetation identification will be researched.

The output of the automated information extraction effort will be automated, highly efficient, accurate, minimally biased procedures for identifying and inventorying cultural and native vegetation. Automated registration procedures with (±.2) sub-pixel registration accuracy will be developed. The desirable characteristics will be defined for future sensors used in airborne or spacecraft platforms for cultural vegetation identification.

The institutional efforts involved in accomplishing these efforts will consist of an in-house contractor and university researchers led by the NASA civil service staff at the Johnson Space Center. The groups are as shown below.

- o Vegetation Identification and Area Estimation Research
  - NASA JSC civil service staff
  - Lockheed
- o Preprocessing-Registration
  - NASA JSC civil service staff
  - Lockheed
  - Purdue LARS

- o Math/Statistics Research
  - Southern Methodist University

- o Radar Agriculture Research
  - NASA JSC civil service staff
  - Lockheed
  - University of Kansas

The Vegetation Identification and Area Estimation group will focus on automating procedures for identifying and inventorying vegetation using multispectral sensor data.

The Math/Statistics group will focus on generic research issues related to developing improved mathematical and statistical approaches to vegetation identification, acreage estimation, and feature identification.

The Preprocessing/Registration group will focus on improved preprocessing and automated registration procedures.

The Radar Agriculture group will focus understanding the utility of active microwave data in cultural vegetation identification.

The various parts of the automated information extraction research program will now be described in detail.

2.1.1 VEGETATION IDENTIFICATION AND AREA ESTIMATION RESEARCH

Research directed toward cultural vegetation identification and acreage estimation will be conducted at the field and multi-field level (sample unit). At this level a key objective is to develop a minimally biased acreage estimation procedure. Issues related to this objective are as follows:

1. Labeling Error - Spectral Confusion

   A proper balance is required between labeling procedures and machine proportion estimation procedures. Historically, labeling

procedures (whether manual or automatic) have generally been error prone and have generally introduced bias into the estimate. Approaches to crop estimation are required that provide improved labeling accuracy. In addition, machine proportion estimation procedures are required that are minimally biased even when coupled with a potentially biased labeling procedure.

2. Machine Processing Efficiency Improvement

The efficiency of the segment level proportion estimator requires improvement. Historically, the reduction in variance (or efficiency) achievable at the segment level has been directly related to the probability of error in the classification process and therefore bounded by it. The use of a direct estimator which does not require classification offers the possibility of significantly improved segment level efficiencies.

3. Mixture Pixels

Pixels which lie on the border between areas of different ground cover have been a continuing source of difficulty in performing segment level estimates. The spectral content of these pixels is not characteristic of major crop types and is often not even predictable to the misregistration errors. Methods of detecting boundary pixels and estimating the proportions of crops in these pixels need to be examined.

4. Feature Selection

The selection of features from the Landsat data which provide the largest cultural vegetation species separability and are predictable for the purposes of labeling is of critical importance in segment level estimation. In the past, Landsat channel values or linear transformations of these channel values have been used directly. There is now impressive evidence that features directly related to the crop growth history may be estimated from Landsat data. Such variables eliminate many extraneous sources of

variability and so enhance the spectral separability of crops. In addition, the typical values of such features may be estimated for a given cultural vegetation and region using ancillary meteorological and agronomic information. This allows the development of more accurate automated labeling. Research directed toward the definition, estimation, and prediction of appropriate features will substantially improve segment level crop identification and estimation.

5. Information Synthesis

Ancillary information such as agronomic and meteorological data must be combined with Landsat data in an appropriate way to obtain accurate, consistent, and efficient segment level acreage estimates. Ancillary information has always been useful to the human photo-interpreter in making judgments as to vegetation type, vegetation development stage, and vegetation condition. Now we must use such information as an aid in selecting appropriate features and in predicting the typical values of such features for a given cultural vegetation and region. The basic understanding and automated use of ancillary data provide the only efficient means available to adapt to the great variability in vegetation appearance and growth history in going from region to region and year to year.

Specific objectives related to segment level estimation during fiscal year 1983 are as follows:

- Testing in Argentina of an automated linear classifier developed and successfully tested in FY82 to separate corn, soybeans and other at harvest, on the basis of two key Landsat-derived biophysical features.
- Development of an automated linear classifier to separate corn, soybeans and other early in the season, on the basis of two key biophysical features derived from two early Landsat acquisitions.
- The mixture model to be used in the Advanced Proportion Estimation Procedure (APEP) will be defined in the first quarter of FY83 and tests on this model will be completed in the third quarter of FY83.

- o A research version of an automated labeling system employing ancillary agronomic and meteorological data and to be used with the distributions resulting from the mixture model will be complete in the second quarter of FY83. A test of this labeling system will be complete in the fourth quarter of FY83.
- o Techniques will be developed for identifying boundary pixels in the image. Procedures for estimating the proportions of cultural vegetation of interest in the class of boundary pixels will be developed in the third quarter of FY83.

2.1.2 MATHEMATICS/STATISTICS RESEARCH

The primary objective is to continue to assess research efforts of NASA and its contractors with regard to estimation efforts in support of the development of a foreign commodity production prediction capability and to organize and direct a Center of Excellence for Applied Mathematics and Statistics.

The functioning as a Center of Excellence in the area of Applied Mathematics and Statistics will entail:

a. Being fully knowledgeable of the AgRISTARS' objectives--particularly in regard to how they translate into the objectives and required developments in proportion estimation, labeling, crop growth stage estimation, crop condition monitoring, sampling and aggregation, experiment design, statistical testing and modeling.

b. A thorough assessment of the current mathematical and statistical approaches.

Specific objectives are to:

- o Investigate the theoretical and practical applicability of the current profile modeling techniques.
- o To determine whether or not the Ho-Kashyap (minimum distance) classifier can be modified to extract more information from the profile model features for purposes of crop separation.

- Determine whether there are other nonparametric linear or quadratic classifiers which might perform better than Ho-Kashyap.
- Critically examine techniques for estimating crop proportions using the mixture model.
- Critically examine the maximum likelihood estimators with respect to their robustness in the presence of data from mixtures of nonnormal densities.
- Examine alternative estimation techniques which are more robust and may be suitable for dealing with pure or mixed pixels.
- Evaluate the accessability of segment data and related software, and make suggestions for improvements.
- Investigate alternative generic proportion estimators which are capable of producing unbiased estimates of crop proportions and to investigate techniques for reducing the mean squared error of individual segment proportion estimators.
- Investigate the possibility of estimating several individual segment level proportions simultaneously using techniques like the James-Stein estimators for the purpose of getting improved individual segment proportion estimates.

2.1.3 PREPROCESSING - REGISTRATION

An objective of the SR research program is to conduct research into image preprocessing techniques to support pattern recognition research. Research will be conducted into image registration to: 1) improve the accuracy of Landsat MSS scene-to-scene (multitemporal) registration, 2) develop a capability to register TM aircraft to TM aircraft, and 3) develop the basis for registration of multisensor data sets together on a production basis. Multisensor image registration capabilities ideally would include 1) Landsat TM to MSS data, 2) radar to optoelectronics data, and 3) Landsat MSS data to maps.

In registration, the FY83 objectives are to:

- o Quantify the performance of the current MSS/MSS registration capabilities.
- o Improve the accuracy of current MSS to MSS registration capabilities.
- o Complete the development of a capability to refine aircraft Thematic Mapper for residual distortions. This capability would be used in generating simulated TM imagery.
- o Evalute the as-delivered TM registration.
- o Initiate research to support the development of a Thematic Mapper registration capability, as indicated necessary by the above study.
- o Continue research to support the development of a MSS to map registration capability.
- o Continue incorporation of improvements into the JSC MSS to MSS capability as the research program produces them.
- o Deliver an operational MSS to map registration capability.
- o Continue the development of a TM registration capability as defined by the evaluation of GSFC registration and AgRISTARS needs.

2.1.4 RADAR AGRICULTURE RESEARCH

Another objective of the SR research program is to conduct research focused on understanding the utility of active microwave data in cultural vegetation identification. The specific objectives of this research are: 1) to assess the utility of active microwave data in cultural vegetation with and without the aid of optical multispectral data, 2) to develop an understanding of the relationship between active microwave sensor parameters (wavelength, polarization combinations, and angle of observations) and crop discrimination, 3) to develop an understanding of the temporal patterns of the microwave backscattering coefficients of cultural vegetation over the season, 4) to develop procedures to use multichannel (multifrequency, multipolarization, and/or multiangle active microwave data to extract features (for single and multiple dates) useful in cultural vegetation identification, and 5) to define the desired characteristic of future active microwave sensor systems for use in airborne or spacecraft platforms for cultural vegetation identification.

In active microwave cultural vegetation classification research, the FY83 objectives are:

- o Continue the investigation of the use of long wavelength radar (L-band and C-band) for cultural vegetation identification.
- o Investigate the temporal behavior of radar backscattering from cultural vegetation through the season.
- o Determine the information content in Seasat synthetic aperture radar (SAR) and Shuttle Imaging Radar (SIR-A) relative to cultural vegetation identification.
- o Investigate the use of combined active microwave and optical data for cultural vegetation identification.

2.2 FEATURE IDENTIFICATION RESEARCH

The objectives of feature identification research are to (1) determine which biophysical characteristics of natural and cultural vegetation are best for differentiating and identifying vegetation type, stage of maturity, and condition of vegetation and (2) identify which features of current and future multispectral sensors and which mission characteristics are best for monitoring these biophysical characteristics.

The output of the feature identification effort will be the definition of improved spectral features for vegetation ID, improved approaches for estimating stage of maturity and improved vegetation condition monitoring models. Visible-Infrared (Vis-IR) bands available on current space-borne sensors as well as the Mid-IR, Thermal IR and Microwave bands to be flown on future missions will be investigated. The research will not only investigate future sensor requirements but will also examine future mission requirements such as satellite overpass frequency and time of overflight.

The institutional efforts involved in accomplishing these objectives will consist of two measurements and scene analysis groups each consisting of several universities led by two land grant institutions. A more generic scene analysis effort consisting of in-house contractor and university researchers will be led by the NASA civil service staff at the Johnson Space Center. These groups are as shown below:

- o Measurements and Scene Analysis--Winter and Spring crops
  - Kansas State University--Ed Kanemasu PI
    - South Dakota State
    - Cymmit, Mexico
    - Ag Canada, Lethbridge
- o Measurements and Scene Analysis--Summer Crops
  - Purdue LARS--Marvin Bauer PI
    - University of Nebraska

- o Scene Analysis--Generic Research
  - NASA JSC Civil Service Staff
    - Lockheed
    - Aster Consulting
    - Michigan State University
    - Texas A&M University
    - Pan American University
    - USDA-Texas Tech

The Measurements and Scene Analysis Groups will focus on collecting and maintaining a field research data base of spectral and agronomic data for key vegetation species. In addition, these groups will define which biophysical characteristics are best for species, maturity and condition identification as well as investigating the use of spectral data to improve the ability to estimate important condition influencing plant processes, such as evapotranspiration and photosynthesis.

The Scene Analysis Group led by JSC will concentrate on understanding how to improve techniques for spectrally observing the key vegetative characteristics suitable for species, maturity and condition identification. This group will be heavily involved in the use of existing canopy reflectance models, crop condition and stage models and temporal profile models to estimate Leaf Area Index and Solar Radiation Interception. The output of this as well as the other feature identification efforts will directly support the information extraction effort within the SR project.

2.2.1 VEGETATION GROWTH STAGE DEVELOPMENT

A key objective of this research program is the development and enhancement of cultural vegetation growth and phenology models. Models which estimate development stage cultural vegetation are needed for vegetation condition assessment, and for determining the effect of environmental and agronomic conditions on yield.

Currently, models exist which estimate growth stage and physical characteristics for a number of important cultural vegetation species. These models will be evaluated and refined using small plot field measurement data. In addition, studies will be performed to determine how remotely sensed spectral data can be used to make better estimates of vegetation growth and phenology.

The specific objectives for FY83 are to conduct research for selected species of cultural vegetation focused on:

- o Acquisition of field measurement data for testing of growth stage and development models for these cultural vegetation species.
- o Determination of key biophysical features which distinguish among key maturity stages.
- o Determination of how these key biophysical features can be observed from remotely sensed data.
- o Development of models for determining key biophysical features from remotely sensed data.
- o Initial study of the use of TM data as a source of spectral data.
- o Evaluation of TM data improvements over MSS for determination of key biophysical features.

2.2.2 VEGETATION CONDITION ASSESSMENT

A second key objective of the Feature Identificaiton research effort is the development of techniques for using remotely sensed spectral data to monitor evapotranspiration and photosynthesis key to cultural vegetation condition. Models are available which estimate the yield of a cultural vegetation based on certain key processes such as photosynthesis and evapotranspiration. If the observation of these key processes could be improved by using remotely sensed spectral data, it would be possible to obtain more detailed and accurate information concerning cultural vegetation condition and potential yield.

Investigations will be performed to determine the feasibility of using remotely sensed spectral data to improve estimates of these processes. In particular, spectral estimation of leaf area index to improve the estimates of evaportranspiration will be investigated as well as the estimation of solar radiation interception which is key to determining photosynthetic rate.

The specific objectives for FY83 are to conduct research for selected species of cultural vegetation focused on:

- o Determination of key biophysical descriptors of vegetation condition which may be observable using remotely sensed data.
- o Development of models for estimating these characteristics from remotely sensed data.
- o Development of models for the estimation of leaf area index using remotely sensed data.
- o Development of models for assessing cultural vegetation condition using remotely sensed data.
- o Determination of the effect of moisture stress on crop condition.
- o Evaluation and improvement to models for estimating leaf area index and moisture stress using remotely sensed data.
- o Development and evaluation of procedures for monitoring cultural vegetation condition using remotely sensed data.
- o Initial studies of the use of TM data to evaluate vegetation condition.

2.2.3 SCENE ANALYSIS GENERIC RESEARCH

This research activity will complement the crop specific measurements and scene analysis activities by focusing on the use of physical canopy reflectance models and temporal profile models to identify which spectrally based features are best for observing the key biophysical differences between different vegetation types, stages, and conditions. The measurements and scene analysis groups will focus on field data collection, empirical characterization of plant features and the spectral observation of plant processes, such as evapotranspiration and photosynthesis.

The scene analysis group will select and evaluate existing canopy reflectance models and use these models to identify the relationships between key biophysical properties such as leaf area index and spectral data in the VIS-IR, Mid and Thermal IR, as well as microwave regions. This group will identify where model improvements are needed and will, in general, look to NASA's fundamental research program for model improvements.

The scene analysis group will also develop and utilize temporal crop profile models to identify spectrally based features for observing key biophysical differences between vegetative type, stage, and condition. In addition, the group will combine crop growth and canopy reflectance models to further investigate the underlying functional form of temporal profile models and their dependence on weather induced stress.

The scene analysis group will use the empirical measurements data, as well as the canopy reflectance and temporal profile models to develop simulated digital image scenes for the purpose of better understanding mixed pixel effects, variability in planting date effects, meteorological effects, and atmospheric effects on the separability of vegetation types. The simulation capability will also be used to investigate improvements resulting from future sensors, such as the Thematic Mapper and radar.

The specific objectives for FY83 are:

- Models for estimating canopy reflectance from agronomic characteristics will be evaluated for use in the simulation capability and for determining how agronomic characteristics are manifested in remotely sensed spectral data, especially TM.
- Models will be developed to describe the spatial contribution to the spectral mixing of pixels due to atmospheric and sensor characteristics.

- On the basis of within field variability studies using Landsat (MSS and TM) and NS-001 spectral data, models will be developed for the within field variability.
- Using these physical models and spectral data, transformation will be investigated for reducing the number of channels and enhancing the information content of Thematic Mapper data.
- The physical models, along with plot level agronomic and spectral data, will be used to extract features from the spectral data which can be used to estimate various crop characteristics.
- Using field data, NS-001 spectral data, and TM data, studies will be performed on the information content in the mid and far IR data, and how these data can be used in conjunction with other spectral data.
- The effects of surface roughness and moisture on soil signatures for various types of soils will be determined.
- The effects of soil background on vegetation signatures will be determined.

2.3 RESEARCH AND TECHNOLOGY SUPPORT PROJECT OBJECTIVES

The fundamental capabilities and principal services provided by the Data Systems Branch to the Earth Resources remote sensing research community are described in planned Data System activities for FY82 and FY83. The following paragraphs address each of the four Data System components, the planned support activities for the new fiscal periods, and outline the Data Systems operating concept.

2.3.1 DATA SYSTEMS HARDWARE

Specific objectives for FY83 include the following:

- o Integrate and develop capabilities for the Image Analysis Station to expand Earth Observations ability to perform interactive image analysis.
- o Maintain a Production Film Converter (PFC) to provide a needed in-house capability to permit continuing and uninterrupted access to this service.
- o Expand the users research network (both local and off-site) to permit addition of new users as needed.
- o Continuation of the ongoing effort associated with providing data processing support to the remote sensing research community.

2.3.2 DATA SYSTEMS SOFTWARE

The general objectives of the Data Systems component include providing the capabilities to maintain existing software and to procure, develop, and integrate software changes to accommodate new equipment, software packages, and data products.

Specific objectives for FY83 include the following:

- o Maintain the existing software baseline configuration.
- o Enhance the Data Management System for control of research data bases.
- o Implement and integrate new software into the Image Analysis Station.
- o Implement and integrate modified PFC software with special emphasis on TM products.

- o Complete development of Landsat D software change requirements to accommodate:
  - Low volume Thematic Mapper image extraction and registration.
- o Upgrading TM capability to a level commensurate with anticipated GDFC output.
- o Develop additional enhancements to the research Data Base Management system.

2.3.3 DATA ACQUISITION AND PROVISIONING

The general objectives of this Data Systems component are to provide the capability to acquire, manage, and disseminate data in support of remote sensing research and perform data base system analysis and integration in support of this activity.

Specific objectives for FY83 include the following:

- o Extract U.S., Argentina and Australia, Landsat data.
- o Acquire from USDA, ground data over U.S. foreign similarity and research areas.
- o Acquire from Aircraft program aerial photography to support ground data collection over U.S. foreign similarity and research areas.

2.3.4 OPERATIONS AND MAINTENANCE

The general objectives of this Data Systems component are those required to maintain a readily available data processing capability within Data Systems and to provide products and user services to include the following:

- o Provide a data processing capability which is flexible and responsive to the requirements of the user community.
- o Provide data processing services and photogrammetric and cartographic support to the user community.
- o Provide facilities hardware maintenance within the Data Systems Laboratories.
- o Provide installation and integration support for new equipment.

3. SUMMARY OF AVAILABLE RESOURCES

AVAILABLE RESOURCES SUMMARY*

RESEARCH SUMMARY

RESOURCE	DOLLARS AND LOCATION											
	1983											
	NASA		USDA		NOAA		NASA		USDA		NOAA	
	$K	Location	$K	Location	$K	Location	$K	Location	$K	Location	$K	Location
In-House Civil Servant	--	NA										
In-House Support Contractor	1261	JSC	0050	JSC								
Contract with University												
	25	TAMU										
	770	LARS										
	350	KSU										
	110	SMU										
	50	LOS ALAMOS										
	85	U OF NEB.										
	170	U OF KAN.										
	25	PAN AM.U.										
	100	GISS										
	45	U OF MICH.										
	135	SUNY										
Contract- Private Indus.	80											

*Resources are for NASA, USDA, and NOAA. AID and USDI provide no resources accountable to SR.

Figure III-1

AVAILABLE RESOURCES SUMMARY*

RESEARCH SUMMARY (Cont'd)

RESOURCE	DOLLARS AND LOCATION											
	1983											
	NASA		USDA		NOAA		NASA		USDA		NOAA	
	$K	Location	$K	Location	$K	Location	$K	Location	$K	Location	$K	Location
Other	130	GSFC										
	100	ARC										
	18	USDA/ARS										
	45	TBD										
TOTAL	3499		0050									

*Resources are for NASA, USDA, and NOAA. AID and USDI provide no resources accountable to SR.

Figure III-2

AVAILABLE RESOURCES SUMMARY*

RESEARCH BASE OPERATIONS SUPPORT

RESOURCE	DOLLARS AND LOCATION											
	1983											
	NASA		USDA		NOAA		NASA		USDA		NOAA	
	$K	Location	$K	Location	$K	Location	$K	Location	$K	Location	$K	Location
In-House Civil Servant	-	NA										
In-House Support Contractor	200	JSC										
Contract with University	100 100	KSU LARS										
Other Gov't Organization												
Other	220 30 200	JSC-COD JSC-Data & Pub. LANDSAT DATA	500	AgSITES								
TOTAL	850		500									

*Resources are for NASA, USDA, and NOAA. AID and USDI provide no resources accountable to SR.

Figure III-3

AVAILABLE RESOURCES SUMMARY*

INSTITUTIONAL BASE

RESOURCE	DOLLARS AND LOCATION											
	1983											
	NASA		USDA		NOAA		NASA		USDA		NOAA	
	$K	Location	$K	Location	$K	Location	$K	Location	$K	Location	$K	Location
In-House Civil Servant	--	NA										
In-House Support Contractor	1363	JSC	50	JSC								
Contract with University												
Other Gov't Organization	111	GSFC										
Other	24 803	JSC-DSAD JSC-Equip. & Sup.										
TOTAL	2301		50									

*Resources are for NASA, USDA, and NOAA. AID and USDI provide no resources accountable to SR.

Figure III-4

4. SUMMARY OF TASKS TO BE COMPLETED

AND

FUNDING BY AGENCY*

*The following table lists NASA, NOAA, and USDA funding at task level. AID and USDI provide no accountable resources to the SR Project.

TASKS AND FUNDING BY AGENCY

PE	TASK NUMBER	TASK	FY 1983, $K					
			NASA	USDA	NOAA	NASA	USDA	NOAA
08		Support Data Systems						
	04	Research and Technology Base Operations Support	850	500				
		TOTAL	850	500				
10		Data Acquisition Handling						
	09	Institutional Base	2301	050				
22		Automated Information Extraction Research						
	01	Math/Statistics Research	110	---				
	02	Preprocessing - Registration Research	178	---				
	03	Vegetation Identification & Estimation Research	485	---				
	04	Radar Agriculture Research	210	---				
		TOTAL	983	---				
		- Continued --						

TASKS AND FUNDING BY AGENCY

PE	TASK NUMBER	TASK	FY 1983, $K					
			NASA	USDA	NOAA	NASA	USDA	NOAA
23		Feature Identification Research						
	01	Measurement and Scene Analysis Winter and Spring	407					
		Cultural Vegetation						
	02	Measurement and Scene Analysis Summer Cultural	805					
		Vegetation						
	03	Scene Analysis Generic Research	1074					
		TOTAL	2286					
24		Other NASA Center Research						
	01	Other NASA Center Support	230					
		TOTAL	230					
		GRAND TOTAL	6650	550				

5. DETAILED TASK DESCRIPTIONS

9/13/82

AgRISTARS FY83 PLAN

PROJECT: Supporting Research

PROJECT MANAGER: F. G. Hall

TASK AND/OR SUBTASK NO. AND TITLE	TASK DESCRIPTION	FUNDING BY AGENCY ($K) FY83		PERFORMING ORG./FUND AND LEAD PERSON	
04-08-04 R&T Base Operations Support	Support Building 17/JSC computer operation and data acquisition, preparation and management.	NASA/JSC	850	Data Systems Branch	
		USDA/JSC	500	Lockheed	200
				COD	220
				DATA/PUB	30
				USDA	500
				KSU	100
				LARS	100
				LANDSAT DATA	200
		Total	1350		1350
04-10-09 Institutional Base	Provide computer operations facilities, ground data processing facilities, and data provisioning facilities to the SR tasks.	NASA/JSC	2190	Data Systems Branch	
		NASA/GSFC	111	Lockheed	1262
		USDA/JSC	50	DSAD	24
				LAB/SUP	402
				CASPAN	101
				Data, Ops & Comm	156
				Equip. Lease	160
				Data Base Lease	85
				GSFC	111
				DOMSAT USDA	50
		Total	2351		2351

9/13/82

AgRISTARS FY83 PLAN

PROJECT: Supporting Research

PROJECT MANAGER: F. G. Hall

TASK AND/OR SUBTASK NO. AND TITLE	TASK DESCRIPTION	FUNDING BY AGENCY ($K) FY83		PERFORMING ORG./FUND AND LEAD PERSON	
INFORMATION EXTRACTION					
04-22-01 Math/Statistics Research	Applied math-stat research in support of Information Extraction and Feature Identification efforts. Error model development to support Proportion Estimation Sensitivity Analysis	NASA/JSC	110	R. Heydorn SMU	110
04-22-02 Preprocessing Registration Research	Improve Landsat MSS to MSS registration accuracy, develop TM simulator registration capability. Initiate Landsat TM registration studies.	NASA/JSC	178	R. Juday Lockheed LARS	128 50
		Total	178		178
04-22-03 Vegetation Identification and Estimation Research	Research, develop, and evaluate more accurate techniques for the estimation of small grains, corn, and soybeans proportions under normal and stress conditions.	NASA/JSC	485	R. Heydorn Lockheed	485
04-22-04 Radar Agriculture Research	Conduct research focused on understanding the utility of active microwave data on cultural vegetation identification.	NASA/JSC	210	J. Paris Lockheed U of K	40 170
		Total	210		210

AgRISTARS FY83 PLAN

PROJECT: Supporting Research

PROJECT MANAGER: F. G. Hall

TASK AND/OR SUBTASK NO. AND TITLE	TASK DESCRIPTION	FUNDING BY AGENCY ($K) FY83		PERFORMING ORG./FUND AND LEAD PERSON	
FEATURE IDENTIFICATION					
04-23-01 Measurements and Scene Analysis Winter and Spring Cultural Vegetation	Research, develop, and evaluate techniques in support of identification, state of development, and condition monitoring for Winter and Spring Cultural Vegetation.	NASA/JSC	407	D. Pitts	
				KSU	327
				K.A.R.E.	80
		Total	407		407
04-23-02 Measurements and Scene Analysis Summer Cultural Vegetation	Research, develop, and evaluate techniques in support of identification, state of development, and condition monitoring for Summer Cultural Vegetation.	NASA/JSC	805	D. Pitts	
				LARS	720
				NEB	85
		Total	805		805
04-23-03 Scene Analysis Generic Research	Address generic research issues raided by ERRD Automated Information Extraction research efforts related to feature identification and extraction techniques, condition monitoring techniques and crop stage of development estimation techniques.	NASA/JSC	1074	D. Pitts	
				Lockheed	608
				TAMU	25
				Pan Am U	25
				KSU	23
				U. of Mich.	45
				Soils	45
				GISS	100
				Los Alamos	50
				SUNY	135
				USDA/ARS	18
		Total	1074		1074

AgRISTARS FY83 PLAN

PROJECT: Supporting Research

PROJECT MANAGER: F. G. Hall

TASK AND/OR SUBTASK NO. AND TITLE	TASK DESCRIPTION	FUNDING BY AGENCY ($K) BY83		PERFORMING ORG./FUND AND LEAD PERSON
OTHER NASA CENTER RESEARCH				
04-24-01 Other NASA Center Support	Supporting research performed at other NASA Centers.	NASA/GSFC NASA/ARC	130 100	
		Total	230	

TOTAL NASA FUNDS	6650
TOTAL USDA FUNDS	550
	7200

AgRISTARS SHEET 1	PROJECT	DATE	WBS #	04	08	04	04	00
	SR	Sept. 15, 1982		PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Research and Technology Base Operations Support

(B) TECHNICAL OBJECTIVES AND SCOPE:

To provide an integrated research system that is user friendly, requires minimal training, and permits a widely dispersed set of users to be networked to the system for sharing of data, algorithms, etc. without interference to one another.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

- o Operate the Domsat/Landsat receiving station.
- o Operate the research computer system and its associated network.
- o Provide Landsat image preprocessing and registration coordination.
- o Compile digital ground data support products.
- o Operate the Supporting Field Research Data Collection and processing activity.

AgRISTARS SHEET 2

DATE:

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:
NASA/JSC
SG2/D. Hay

FY'33 WBS #

PROJ	PE	T#	TOW	RC	AR	$K	AFR	$K	PO	$K	BP (F)
04	08	04	04	00	12	0500	02	0500	01	0500	
					20	0850	02	0850	02	0200	
									05	0100	
									19	0100	
									01	0450	

(A) TASK TITLE:
Research and Technology Base Operations Support

(E) FUNDING REQUIREMENTS / FUNDING CODES

C = CIVIL SERVICE (IN-HOUSE)
S = SUPPORT CONTRACTOR
O = OTHER
U = UNIVERSITY
P = PRIVATE
T = TBD

(F) BENEFITING PROJ/IPA'S

FY 1982				FY 1983							
AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE
NASA				NASA	5.2	200	S	NASA			
					-	220	COD				
					-	10	DATA/EDC				
						20	PUB				
						100	KSU				
						100	LARS				
				USDA		500	0				
				NASA		200	NOAA*				

TECHNICAL APPROACH (CONTINUED)

*Landsat data purchase from NOAA.

– OUTPUT PRODUCTS
Preprocessed radiometer digital data
Data and publications
Photography
Computer results
Extracted Landsat digital products
Rectified ground data digital taper

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

ESPO 602-3

AgRISTARS SHEET 1	PROJECT	DATE	WBS #	04	10	09	04	00
	SR	Sept. 15, 1982		PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Institutional Base

(B) TECHNICAL OBJECTIVES AND SCOPE:

To provide data acquisition, processing, and archives to satisfy the research, development, and techniques verification requirements of the earth resources activity at the Johnson Space Center.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

Data Acquisition, Preprocessing, and Management

- Landsat Data
- Aircraft/Ground observed data
- Met and ancillary data
- Data Base Management Systems (DBMS) implementation/operation
- Research Library Facilities

Computer Facility

- New equipment engineering and implementation
- Systems software implementation and maintenance
- Computer and systems maintenance

Cartographic Facility

- Ground data digital rectification

Systems/Software Design

- Landsat D - TM and MSS upgrades
- DBMS enhancements

AgRISTARS SHEET 2

DATE: 9/15/82

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:

NASA/JSC
SG2/D. Hay

	PROJ	PE	T#	TOW	RC	AR	$K	AFR	$K	PO	$K	BP (F)
	04	10	09	04	00	20	2301	02 33	2190 0111	01 02 18 22	0827 1262 0101 0111	
FY'83 WBS #						12	0050	02	0050	02	0050	

(A) TASK TITLE:

Institutional Base

(E) FUNDING REQUIREMENTS / FUNDING CODES

C = CIVIL SERVICE (IN-HOUSE)
S = SUPPORT CONTRACTOR
O = OTHER
U = UNIVERSITY
P = PRIVATE
T = TBD

(F) BENEFITING PROJ/IPA'S

FY 1982				FY 1983							
AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE
NASA				NASA		1363	S	NASA		160	EQUIP/LEASE
						85	DBMS/LEASE				
						111(1)	GSFC				
						156	DATA OPS & COMM				
						24	DSAD				
						402	LAB/SUP				
				USDA(SRS)		50	S				

*

TECHNICAL APPROACH (CONTINUED)*

(1) DOMSAT/GHT related communications costs.

– OUTPUT PRODUCTS

CCT's and HDT's

*Additional 300k from USDA/FAS/CCAD for DOMSAT support.

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

ESPO 602-3

AgRISTARS SHEET 1	PROJECT	DATE	WBS #					
	SR	Sept. 15, 1982		04	22	01	01	00
				PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Math/Statistics Research

(B) TECHNICAL OBJECTIVES AND SCOPE:

The general objective of this task is to research and develop improved mathematical and statistical approaches in support of automated information extraction and feature identification efforts.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

A group of statisticians and mathematicians with experience in estimation theory, experiment design and other key discipline areas will:

- Continually review existing pattern recognition and scene radiation approaches, define required improvements, research, develop and implement the recommended improvements.
- Develop alternative methods for segment level generic proportion estimation. For example, develop the theory for parameter estimation for mixtures of distributions other than normals.
- Develop or modify techniques for statistical testing of labeling and proportion estimation techniques.
- Develop segment level error models relating performance on a per-pixel basis to segment level proportion estimation bias and variance.

AgRISTARS SHEET 2

DATE: 9/15/82

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:

NASA/JSC
SG3/R. Heydorn

FY'83 WBS #

04	22	01	01	00	20	0110	02	0110	72	0110	
PROJ	PE	T#	TOW	RC	AR	$K	AFR	$K	PO	$K	BP (F)

(A) TASK TITLE:

Math/Statistics Research

(E) FUNDING REQUIREMENTS / FUNDING CODES

C = CIVIL SERVICE (IN-HOUSE)
S = SUPPORT CONTRACTOR
O = OTHER
U = UNIVERSITY
P = PRIVATE
T = TBD

(F) BENEFITING PROJ/IPA'S

FY 1982				FY 1983							
AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE
NASA				NASA		110	SMU	NASA			

TECHNICAL APPROACH (CONTINUED)

– OUTPUT PRODUCTS

Reports describing recommendations, procedures, models, algorithms, and test results.

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

ESPO 602-3

AgRISTARS SHEET 1	PROJECT	DATE	WBS #	04	22	02	01	00
	SR	Sept. 15, 1982		PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Preprocessing - Registration Research

(B) TECHNICAL OBJECTIVES AND SCOPE:

General Objective:

To maintain an image to image registration capability on the JSC EODL system ($\pm$1 pixel accuracy) and conduct research to improve the efficiency of the system and in addition to achieve critically needed subpixel accuracy.

Specific Objectives:

1. Improve Landsat MSS to MSS registration accuracy of the JSC registration processor.
2. Develop techniques for Landsat MSS to RBV registration.
3. Review and recommend improvements to the existing JSC aircraft photography to Landsat MSS registration process.
4. Automate some of the critical manual operations that are performed in the JSC MSS to map rectification process.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

Research will be conducted on the existing JSC registration processor to improve various modules to achieve subpixel accuracies. Improvements will also be made to improve the efficiency of the registration system.

The approaches to satisfy the above objectives are respectively as follows:

1. Develop method for extracting image features which can be used for subpixel registration and develop image correlation methods using these features.
2. Develop methods similar to those discussed in item 1. for registering MSS to RBV data.
3. Develop a technical plan that recommends possible approaches that can be used to automate or otherwise improve the existing process. Implement the plan.
4. Proceed as in item 3. It is expected that methods will be recommended which can automatically find features in MSS images that can be matched to cartographic separation sheets.
5. Evaluate existing programs at other institutions to rectify aircraft scanner data to map and transfer a suitable approach to JSC.

AgRISTARS SHEET 2

DATE: 9/15/82

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:

NASA/JSC
SG3/R. Juday

	PROJ	PE	T#	TOW	RC	AR	$K	AFR	$K	PO	$K	BP (F)
FY'83 WBS #	04	22	02	01	00	20	0178	02	0178	02 05	0128 0050	

(A) TASK TITLE:

Preprocessing - Registration Research

(E) FUNDING REQUIREMENTS / FUNDING CODES

C = CIVIL SERVICE (IN-HOUSE)
S = SUPPORT CONTRACTOR
O = OTHER
U = UNIVERSITY
P = PRIVATE
T = TBD

(F) BENEFITING PROJ/IPA'S

FY 1982				FY 1983							
AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE
NASA				NASA		128	S	NASA			
						50	LARS				

TECHNICAL APPROACH (CONTINUED)

– OUTPUT PRODUCTS

- o An MSS to MSS subpixel registration processor.
- o Software modules which will improve JSC registration of MSS to other data sources (photographs and RBV) and our rectification capability.

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

ESPO 602-3

AgRISTARS SHEET 1	PROJECT	DATE	WBS #	04	22	03	01	00
	SR	Sept. 15, 1982		PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Vegetation Identification and Estimation Research

(B) TECHNICAL OBJECTIVES AND SCOPE:

To research, develop, and evaluate more efficient and more accurate techniques for the estimation of small grains, corn, and soybeans proportions under normal and stress conditions using Landsat (MSS and TM) and auxillary weather data.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

A multidisciplinary civil servant group, leading and working together with the support contractor, will develop approaches to improve the accuracy and efficiency of crop proportion estimation procedures. Part of the studies will be devoted to understanding the gains to be derived from the mixture model approach to proportion estimation. A more advanced integral form of the mixture model will also be developed. In addition methods of detecting boundary pixels and estimating crop proportions in this class of pixels will be developed. All of these efforts will lead to the formulation and development of the Advanced Proportion Estimation Procedure (APEP).

The main tasks are:

1. Evaluate the current version of the mixture model. This version assumes that the probability distribution function for the scene can be constructed of a finite sum of multivariate normal densities and that each of these densities can be uniquely associated with a cover type. This model will be tested with data derived from crop profile parameters. Possible transformat to enhance the normality of the data will be explored.
2. Examine the theoretical information content of several sets of features with respect to their ability to estimate crop proportions of interest.
3. Formulate the integral form of the mixture model. This model does not require that mixture components be multivariate to normal. Determine means for estimating the components of this model.

(Continued on next page).

AgRISTARS SHEET 2

DATE: 9/15/82

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:

NASA/JSC
SG3/R. Heydorn

	PROJ	PE	T#	TOW	RC	AR	$K	AFR	$K	PO	$K	BP (F)
FY'83 WBS #	04	22	03	01	00	20	0485	02	0485	02	0485	

(A) TASK TITLE:

Vegetation Identification and Research Estimation

(E) FUNDING REQUIREMENTS / FUNDING CODES

C = CIVIL SERVICE (IN-HOUSE)
S = SUPPORT CONTRACTOR
O = OTHER
U = UNIVERSITY
P = PRIVATE
T = TBD

(F) BENEFITING PROJ/IPA'S

FY 1982				FY 1983							
AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE
NASA				NASA		485	S	NASA			

TECHNICAL APPROACH (CONTINUED)

1. Develop and evaluate methods for detecting boundary pixels in an image and for estimating the proportions of crops of interest in this set of pixels.

5. Development and testing of an automated linear classifier to separate corn, soybeans and other at harvest, on the basis of two key Landsat-derived biophysical features.

6. Development of an automated linear classifier to separate corn, soybeans and other early in the season, on the basis of two key biophysical features derived from two early Landsat acquisitions.

– OUTPUT PRODUCTS

Research papers on results

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

AgRISTARS SHEET 1	PROJECT	DATE	WBS #	04	22	04	01	00
	SR	Sept. 15, 1982		PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Radar Agriculture Research

(B) TECHNICAL OBJECTIVES AND SCOPE:

The objective of the Radar Agriculture Research program is to conduct research focused on understanding the utility of active microwave data in optical sensor data (Visible-Near IR, Mid-IR and Thermal-IR bands) to identify cultural vegetation. The specific objectives of this research are to:

1) Assess the utility of active microwave data in cultural vegetation discrimination where combined with optical sensor data.

2) Develop an understanding of the relationship between active microwave sensor parameters (wavelength, polarization combinations, and angle of observations) and crop discrimination.

3) Develop an understanding of the temporal patterns of the microwave backscattering coefficients of cultural vegetations over the season.

4) Develop procedures to use multichannel (multifrequency, multipolarization, and/or multiangle) active microwave data to extract features (for single and multiple dates) useful in cultural vegetation identification, and

5) Define the desired characteristics of future active microwave sensor systems for use in airborne or spacecraft platforms for cultural vegetation identification.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

The objectives are to:

- Continue the investigation of the use of long wavelength radar (L-Band and C-Band) for cultural vegetation identification.
- Investigate the temporal behavior of radar backscattering from cultural vegetation through the season.
- Determine the information content in SEASAT synthetic aperture radar (SAR) data and Shuttle Imaging Radar (SIR-A) data relative to cultural vegetation identification.
- Investigate the use of combined active microwave and optical data for cultural vegetation identification.

AgRISTARS SHEET 2

DATE: 9/15/82

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:

NASA/JSC
SG3/J. Paris

FY'83 WBS #

04	22	04	01	00	20	0210	02	0210	02 11	0040 0170	
PROJ	PE	T#	TOW	RC	AR	$K	AFR	$K	PO	$K	BP (F)

(A) TASK TITLE:

Radar Agriculture Research

(E) FUNDING REQUIREMENTS / FUNDING CODES

C = CIVIL SERVICE (IN-HOUSE)
S = SUPPORT CONTRACTOR
O = OTHER
U = UNIVERSITY
P = PRIVATE
T = TBD

(F) BENEFITING PROJ/IPA'S

FY 1982				FY 1983							
AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE
NASA				NASA		40	S	NASA			
						170	UK				

TECHNICAL APPROACH (CONTINUED)

– OUTPUT PRODUCTS

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

ESPO 602-3

AgRISTARS SHEET 1	PROJECT	DATE	WBS #	04	23	01	01	00
	SR	Sept. 15, 1982		PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Measurements and Scene Analysis-Winter and Spring Cultural Vegetation

(B) TECHNICAL OBJECTIVES AND SCOPE:

To research, develop, and evaluate techniques in support of crop identification, crop state of development estimation and crop condition monitoring for Winter and Spring Cultural Vegetation and their important confusion crops.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

Kansas State University will direct a group of agronomists, crop physiologists, physicists, statisticans and other remote sensing researchers to design a field, aircraft, and Landsat-based research effort to develop the combined use of agronomic, meteorological and spectral data to identify crops, estimate their condition and stage development. Techniques developed at a plot and field level will be implemented and evaluated in the exploratory and pilot experiments in AgRISTARS.

Small Grains - Research activity will be concentrated in Crop Identification, Crop State of Development and Crop Condition. The technical approach in these areas will be as follows:

- o Crop Identification
  - + Define key distinguishing biophysical features for crop separability.
  - + Develop models relating spectral data to biophysical features.
  - + Define approaches for improving separation/identifying of small grains.
  - + Develop and implement procedures for crop identification.
  - + Adapt current small grains technology to TM.
- o Crop Stage of Development
  - + Define distinguishing biophysical features for crop stage identifiability.
  - + Develop observational models to relate biophysical features to spectral data.
  - + Develop agromet development models.
  - + Develop spectral/agromet models.
  - + Provide TM Spectral Inputs.

AgRISTARS SHEET 2

DATE: 9/15/82

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:

NASA/JSC
SG3/D. Pitts

	04	23	01	01	04	20	0407	02	0407	19 82	0327 0080	
	PROJ	PE	T#	TOW	RC	AR	$K	AFR	$K	PO	$K	BP (F)
FY'83 WBS #												

(A) TASK TITLE:

Measurements and Scene Analysis-Winter & Spring Cultural Vegetation

(E) FUNDING REQUIREMENTS / FUNDING CODES

C = CIVIL SERVICE (IN-HOUSE)
S = SUPPORT CONTRACTOR
O = OTHER
U = UNIVERSITY
P = PRIVATE
T = TBD

(F) BENEFITING PROJ/IPA'S

FY 1982				FY 1983							
AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE
NASA				NASA		327	KSU	NASA			
						80	P				

TECHNICAL APPROACH (CONTINUED)

– OUTPUT PRODUCTS

+ Determine key biophysical descriptors of crop condition which could be observed by remotely sensed data.
+ Determine how these characteristics can be observed using remotely sensed data.
+ Evaluate agromet models in assessing crop condition using remotely sensed data.

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

ESPO 602-3

AgRISTARS SHEET 1	PROJECT	DATE	WBS #					
	SR	Sept. 15, 1982		04	23	02	01	00
				PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Measurements and Scene Analysis-Summer Cultural Vegetation

(B) TECHNICAL OBJECTIVES AND SCOPE:

To research, develop, and evaluate techniques in support of crop identification, crop stage of development estimation and crop condition monitoring for Summer Cultural Vegetation and their important confusion crops.

To research techniques for image to image registration.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

LARS will lead a group of crop physiologists, and agronomists in a research effort to develop the combined use of agronomic, meteorological and spectral data to identify crops, estimate their condition and stage of development. Techniques developed at the plot and field level will be implemented and evaluated in crop agromet models as well as in the other elements within AgRISTARS.

The Summer Cultural Vegetation Measurements and Scene Analysis Research activity will be concentrated in Cultural Vegetation Identification, Cultural Vegetation Stage of Development and Cultural Vegetation Condition. The Technical approach in these area will be as follows:

- o Cultural Vegetation Identification
  - o Define key distinguishing biophysical features which permit vegetation type separability/identifiability
  - o Develop models relating spectral data to biophysical features
  - o Define approaches for improving separation/identification of vegetation types
  - o Develop TM understanding
- o Cultural Vegetation Stage of Development
  - o Define distinguishing biophysical features for vegetation stage identifiability
  - o Develop observational models to relate these biophysical features to spectral data

AgRISTARS SHEET 2

DATE: 9/15/82

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:

NASA/JSC
SG3/D. Pitts

FY'83 WBS #	04	23	02	01	00	20	0805	02	0805	05 56	0720 0085	
	PROJ	PE	T#	TOW	RC	AR	$K	AFR	$K	PO	$K	BP (F)

(A) TASK TITLE:

Measurements and Scene Analysis-Summer Cultural Vegetation

(E) FUNDING REQUIREMENTS / FUNDING CODES

C = CIVIL SERVICE (IN-HOUSE)
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(F) BENEFITING PROJ/IPA'S

FY 1982				FY 1983							
AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE	AGENCY	MYE	$K	CODE
NASA				NASA		720	LARS	NASA			
						85	NEB				

TECHNICAL APPROACH (CONTINUED)

- o Cultural Vegetation Stage of Development (Continued)
  - o Develop spectral/met models
  - o Provide spectral-met input to large area models
  - Provide TM spectral inputs
- o Cultural Vegetation Condition
  - o Determine key biophysical description of cultural vegetation condition which could be observed by remote sensing.
  - o Define biophysical-radiometric relationship
  - o Evaluate agromet models in assessing vegetation condition using remotely sensed data
  - o Provide TM inputs
- o Registration
  - o Evaluate image to image coorelation techniques.

-OUTPUT PRODUCTS

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

ESPO 602-3

AgRISTARS SHEET 1	PROJECT	DATE	WBS #	04	23	03	01	00
	SR	Sept. 15, 1982		PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Scene Analysis Generic Research

(B) TECHNICAL OBJECTIVES AND SCOPE:

The objective of the Scene Analysis Generic Research will be to address generic research issues raised by the ERRD Automated Information Extraction Research and the Measurements and Scene Analysis efforts relative to developing feature identification and extraction techniques, vegetation condition monitoring techniques, and vegetation stage of development estimation techniques.

Research will also be conducted into the effects of soil background on vegetation signatures. The utility of the Thematic Mapper sensor in vegetation identification and area estimation will be investigated.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

Feature Identification and Extraction Research

- Models for estimating canopy reflectance from agronomic characteristics will be evaluated for use in the simulation capability and for determining how agronomic characteristics are manifested in remotely sensed spectral data.
- Models will be developed to described the spatial contribution to the spectral mixing of pixels due to atmospheric and sensor characteristics.
- On the basis of within field variability studies using Landsat and NS-001 spectral data, models will be developed for the within field varability.
- Using these physical models and spectral data, transformations will be investigated for reducing the number of channels and enhancing the information content of thematic mapper data.
- The physical models, along with plot level agronomic and spectral data, will be used to extract features from the spectral data which can be used to estimate various crop characteristics.
- Using field data and NS-001 spectral data studies will be performed on the information content in the mid and far IR data, and how these data can be used in conjunction with other spectral data.

1074 02 0974 02 0608

AgRISTARS SHEET 2

DATE: Sept. 15, 1982

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:

NASA/JSC
SG3/D. Pitts

FY'83 WBS #	PROJ	PE	T#	TOW	RC	AR	$K	AFR	$K	PO	$K	BP (F)
	04	23	03	01	00	20				10	0025	
										19	0023	
										28	0018	
										62	0135	
										81	0025	
										80	0045	
										84	0050	
										99	0045	
								35	0100	01	0100	

(A) TASK TITLE:

Scene Analysis Generic Research

(E) FUNDING REQUIREMENTS / FUNDING CODES

C = CIVIL SERVICE (IN-HOUSE) S = SUPPORT CONTRACTOR O = OTHER U = UNIVERSITY P = PRIVATE T = TBD

(F) BENEFITING PROJ/IPA'S

FY 1983

AGENCY	MYE	$K	CODE
NASA			S
		608	LEMSCO
		0	CSU
		25	TAMU
		25	Pan Am
		23	KSU
		45	U of M

(CONT.)

AGENCY	MYE	$K	CODE
NASA		45	SOILS
		100	GISS
		135	SUNY
		18	USDA
U.		50	LOS ALAMOS

AGENCY	MYE	$K	CODE
NASA			

TECHNICAL APPROACH (CONTINUED)

USE OF CANOPY MODELS

A contractor will assume overall contract management as well as technical integrity of the use of crop canopy models to address critical AgRISTARS uses effort and will coordinate all activities, including data and data systems as well as reporting requirements and will organize and deliver to the NASA technical monitor reports as deemed necessary. The contractor will incorporate technical changes to the research plan as deemed necessary by the NASA technical monitor and will make provision for adding or deleting associate contractors where warranted by the revised plan of research. The contractor will provide a technical director and administrative staff to carry out the responsibilities described.

1. Develop a long range research plan (3-5 years).
2. Develop an implementation plan for FY83 modeling research. This plan must include a plan for interacting with the other AgRISTARS researchers.
3. Develop as a part of 1. and 2. a detailed set of data required to test cultural vegetation canopy models. This is to include but not be restricted to agronomy farm data, commercial field data with correlative spectral reflectance and emission, detailed measurements of physical properties of canopy components.
4. Implement research tasks for FY83 as per above plans.

(Continued on next page)

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

SCENE ANALYSIS GENERIC RESEARCH

RESEARCH TO BE CONDUCTED:

- TECHNICAL APPROACH (Continued)

  Soil Research

  1. Develop a comprehensive research plan (3-5 years)
  2. Investigate the effects of surface roughness and moisture on soil signautes for various types of soils.
  3. Investigate the effect of soil background on vegetation signatures.

  Thematic Mapper Research

  1. Develop preprocessing techniques for TM simulator data.
  2. Investigate the separability of crops in TM simulator data.

- OUTPUT PRODUCTS

  Research plans

  Research papers on results

AgRISTARS SHEET 1	PROJECT	DATE	WBS #	04	24	01	01	00
	SR	Sept. 15, 1982		PROJ.	PE	T#	TOW	RC

(A) TASK TITLE:

Other NASA Center Support

(B) TECHNICAL OBJECTIVES AND SCOPE:

ARC -

- o To integrate thermal data (remotely acquired) into yield estimation techniques.

GSFC -

- o Evaluate transformations of MSS data over several data sets and compare to the original Kauth-Thomas Transformation.
- o Evaluate asymptotic approximations to crop canopy models such as the Suits Model in order to study physical causes for spectral features.
- o Conduct and evaluate the results of a soybean water stress experiments.
- o Develop and evaluate a model to predict crop canopy temperature and the component part temperature.

(C) RESEARCH TO BE CONDUCTED:
– TECHNICAL APPROACH

ARC -

- o This subtask is to develop procedures for utilizing spacecraft thermal data for estimating crop yields. A joint program of research will be conducted by NASA/AMES and USDA/SEA (Dr. Ray Jackson and Dr. C. Aase) NASA will provide airborne multispectral scanner measurements and interpretations, and USDA will provide basic ground studies. NASA and USDA will each fund its portion of study.

GSFC -

- o Collect ground observations of green LAI for wheat and other ground data over a period of three growing seasons in Kansas concurrent with Landsat overpasses
- o Correct MSS for satellite calibrations and sun angle
- o Reject outliers
- o Partition data into 12 subsets according to LAI to reduce experimental uncertainty
- o Principal component analysis on subset MSS means
- o Compare characteristic vectors with Kauth's tasselled cap transformation
- o Relate "greenness" principal component to LAI
- o Repeat for data without sun angle and/or satellite calibration corrections
- o Derive a transformation of pure pixel Landsat MSS data that is related to green Leaf Area Index (LAI) for wheat
- o Evaluate the effect of the sun angle and satellite calibration corrections on the model

AgRISTARS SHEET 2

DATE: 9/15/82

(D) AGENCY - FAC./RESP. ORG./TASK LEADER:

NASA/JSC
F. Hall

	04	24	01	01	00	20	0230	14 33	0100 0130	01 01	0100 0130	
	PROJ	PE	T#	TOW	RC	AR	SK	AFR	SK	PO	SK	BP (F)
FY'83 WBS #												

(A) TASK TITLE:

Other NASA Center Support

(E) FUNDING REQUIREMENTS / FUNDING CODES

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(F) BENEFITING PROJ/IPA'S

FY 1982				FY 1983							
AGENCY	MYE	SK	CODE	AGENCY	MYE	SK	CODE	AGENCY	MYE	SK	CODE
NASA				NASA		100	ARC	NASA			
						130	GSFC				

TECHNICAL APPROACH (CONTINUED)

- o Six 15' x 20' plots will be planted to soybeans in 14" rows
- o Grow soybeans under normal conditions to full canopy
- o Create water stress conditions in three of six plots by
  - Withholding rain via use of shelters
  - Irrigating control plots
- o Measure spectral reflectance and canopy/scene variables on all plots twice daily (morning and afternoon) during periods of different crop conditions
- o Determine reflectance/canopy variable relationships for TM and MSS bands
- o Relate stress factors to spectral response
- o Identify spectral bands most sensitive to water stress
- o Develop a modified version of Jackson's (1979) row crop model
- o Validate and verify the model using field data collected on a cotton row crop in Phoenix, Arizona
- o Test various inversion schemes as reported by KIMIES (1981)

- OUTPUT PRODUCTS
  - o Procedures developed by this activity will be integrated into Landsat related work at JSC.

(G) TASK DATA REQUIREMENTS

☐ NONE
☐ SEE AgRISTARS (SHEET 4) FOR LEVEL 1 DATA SPECIFICATION.

6. REFERENCES

1. (Volume I): Preliminary Technical Program Plan, Agriculture and Resource Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS).

2. Volume II: Management/Organization Plan, Agriculture and Resource Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS) - USDA, NASA, USDC, USDI, AID - April 10, 1979.

3. VOLUME II: Management/Organization Plan, Appendix A, Change Control Plan for Level 2, Program Management Team (PMT), April 10, 1979.

4. VOLUME III: Preliminary Resources Program Plan, Agriculture and Resource Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS) - USDA, NASA, USDC, USDI, AID - April 10, 1979.

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas
77058

Dr. Charles Caudill

NASA

Reply to Attn of: SG3/82-243

September 15, 1982

TO: AgRISTARS Project Management Team

FROM: SG3/Manager, Supporting Research Project

SUBJECT: Transmittal of FY83 PIP

Attached, please find for your review a draft of the Supporting Research (SR) Project Implementation Plan (PIP) for FY83. In accordance with your instruction by memorandum of August 23, 1982, the FY83 SR PIP calls for FY83 NOA of $6.65M.* Of this, $3.269M is devoted to research, $850K to research and technology support ($200K of which is for purchase of Landsat data), $2.19M is to support such institutional facilities as DOMSAT and laboratory facilities that support not only SR but ITD, Early Warning, and the CCAD, $230K to other centers (GSFC, ARC), and $111K to DOMSAT costs.

SR tasks in FY83 are designed to continue on the very successful FY82 period which led to a major step toward a solution to one of the most important problems in the development of efficient crop identification procedures over large areas, the Signature Extension Problem. This progress is based on Temporal Profile Modeling, developed exclusively by the SR Project in FY80 and FY81. Using the Temporal Profile Modeling approach, a totally automated procedure for accurately identifying corn and soybeans near harvest was demonstrated in FY82 over the U.S. Corn Belt and Mississippi Delta for three crops years. This procedure achieved significantly higher accuracy for crop identification and proportion estimation than ever previously achieved, especially those with manual techniques which require hours of analyst time. Further, there is every reason to believe that this procedure can be cost-effectively implemented in an operational setting.

One important thrust in FY83 will be to test this procedure on Argentina corn and soybeans ground truth segments - preliminary indications are that the successful U.S. technique will, with only minor modifications, extend to the Argentina area. Another key effort is to extend this technique to early season while maintaining the high accuracies achieved near harvest. A third important area is to apply the Temporal Profile Technology to the identification/estimation of small grains, for which no automated technology has been successfully demonstrated.

*$245K of this is for continuing tasks deferred from FY82.

In addition to the crop identification problem, an equally important area of research in SR is the estimation of crop stage and condition. Again, Temporal Profile Technology has made possible a major breakthrough to a long standing problem, the accurate estimation of crop emergence date, critically needed to start agromet stage of maturity models. Research results to date indicate that the Temporal Profile Models can potentially be used to accurately estimate other key development stages such as floral initiation, heading, and senescence. Research to refine these techniques will continue in FY83. Several important results were achieved in FY82 in the use of spectral data to assess crop condition. In FY83 these results will be extended to develop techniques for estimating two of the most important determining factors in crop condition, Leaf Area Index and Solar Radiation Interception.

Finally, in the SR research, the improvement of Registration technology, essential to all the above efforts will continue. In the longer term research, the investigation of the microwave regions of the spectrum to help map the type, stage, and condition of crops and other vegetation will be pursued.

In addition, the SR project continues to fund Data Systems support and research to provide the computational research environment absolutely critical to a successful research program. The Data Systems effort provides Landsat, agricultural and meteorological data vital to research as well as rapid, easy access to these data by providing a comprehensive data base management system. In addition, the Data Systems support provides an extensive interactive computational environment not only to other AgRISTARS Projects within USDA and NASA but also networks these capacilities to the university community which supports AgRISTARS. This data system support permits the user community to have efficient access to a comprehensive set of research data and to share analysis capability. This support is particularly critical to the university community who have lost most of their own computational capability in the severe budget cuts of the past years.

The budget reductions of the past 2 years have reduced the SR effort to a minimal one for carrying out its assigned tasks in all of the critical areas described above. Unfortunately, other critical areas such as Thermal IR studies cannot be pursued at current budget levels. Further reductions would necessitate that some of the current research areas be dropped completely. A 20% reduction in the SR budget would result in the following.

PIP Task	Δ	Impact
04-08-04 R&T Base Ops. Spt.	141K	Eliminate film recorder - loss of precision digital image generation capability--also eliminate improvements in the TM image processing capability. System upgrades to accommodate increased GSFC tips thruput (July '83) postponed indefinitely.
04-22-02 Preprocessing and Registration	188K	No further improvements in registration - reduced accuracy in all critical multitemporal capabilities such as temporal based procedures
04-22-04 Radar Ag Research	210K	Elimination of all long-term radar ag research vital to improved crop ID and condition assessment
04-23-01 Measurements and scene analysis - winter and spring cultural vegetation	84K	Significant reduction in addressing problems in mapping of small grains
04-23-02 Measurements and scene analysis - summer cultural vegetation	170K	Significant reduction in mapping research for corn/soybeans
04-23-03 Scene analysis generic research	425K	Elimination of LEMSCO scene analysis research support to above areas
04-24-01 Other NASA Center rearch	63K	Significant reduction of research at other NASA Centers

Forrest G. Hall

Enclosure

AgRISTARS Project Management Team

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