MODIS SCIENCE DATA SUPPORT TEAM PRESENTATION

October 25, 1991

AGENDA

1. Action Items
2. MODIS Airborne Simulator (MAS)
3. MODIS SDST Project Plan
4. NetCDF Schedule and Status
5. Science Computing Facility Plan

ACTION ITEMS:

08/30/91 [Lloyd Carpenter and Team]: Draft a schedule of work for the next 12 months. Include primary events and milestones, documents to be produced, software development, MAS support, etc. (A new draft is included in the handout.) STATUS: Open. Due date 09/27/91.

10/04/91 [Phil Ardanuy and Team]: Prepare questions for the project to characterize the spacecraft position and attitude knowledge and the MODIS pointing knowledge in a way that will facilitate the evaluation of methods such as image registration to meet the science team requirements for earth location. (Previous contributions are to be formalized in a letter to the project.) STATUS: Open. Due date 10/18/91.

10/04/91 [Tom Goff]: Examine and describe the Miami DSP navigation scheme in relation to MODIS navigation. Status: Open. Due date 11/15/91.

10/04/91 [Tom Goff]: Contact Angel Li (currently at GSFC) to ask questions regarding the DSP. Status: Open. Due date 10/18/91.

Progress on MAS Level-1B processing system development

Progress up to 24 October 1991

(1) MAS software development

A complete MAMS flight track has now been calibrated, geolocated, and written in netCDF on the LTP VAX. The flight track is the third in the test data set provided by Wisconsin, and contains the test data region examined during the software development. The netCDF file contains all the Level-1B data for 1938 scan lines, and is 37,230,254 bytes in length.

The software is now ready to handle data processing from complete MAS flight missions. It is expected that changes and updates will be made to the software as time goes on, and more experience is gained in processing the MAS Level-1A product.

Data from a MAS test flight should be available next week (10/29) and will be processed to determine software compatibility.

(2) MAS instrument development and FIRE deployment

I called Jeff Myers at Ames and discussed prospects for obtaining MAS test data. They currently plan to fly the MAS on a test mission on Monday 10/28. Jeff will arrange to have a section of the MAS test data (straight line flight track) shipped to us within a couple of days of the flight.

I also asked Jeff about plans for data distribution during FIRE. He said that they plan to FedEx the "Level-0" data from Houston back to Ames during the field campaign, and process and distribute the Level-1A from Ames within 2-3 days. They are very keen to provide rapid turn-around. We are currently the only group he has on his distribution list for MAS FIRE data, however it is expected that Wisconsin will also be requesting data.

Another issue raised was the determination of spectral responses for the MAS thermal infrared channels. Jeff reported that while Daedalus is under contract to provide this data, it has not been forthcoming yet. He does have information on "half-power points" for the infrared channels, which he will send to me with the test data next week. In the event that we do not have spectral response functions in time to process MAS FIRE data, it is possible to simulate spectral response functions using a Gaussian or similar curve. The MAS Level-1B processing software is set up to handle any supplied spectral response data file for a given spectral band.

(3) MAS GSFC investigator computing platforms.

In order to complete our knowledge of GSFC investigator computing platforms, I spoke to Eric Vermote, who works for Chris Justice.

Chris Justice
Processing system - Hewlett Packard 720, Silicon Graphics Iris
Display system - Silicon Graphics Iris

Mike King
Processing system - IBM 3090 mainframe, MVS operating system
Display system - Apple Macintosh, and possibly Silicon Graphics Iris

Yoram Kaufman
Processing system - Cray, Unicos operating system (possibly IBM 3090)
Display system - Silicon Graphics Iris

Date: 10/24/91
Each Symbol = 2 Days

MAS Level-1B Processing System
MAS01

≡ Planned
■ Actual
* Completed
M Milestone

MAS Level-1B Processing System Development at GSFC

1991
JUN JLY AUG SEP OCT NOV DEC
30.....15.....29.....12.....26.....09.....23.....07.....21.....04.....18.....02.....16.....30

Task	Resource/Status		Date
Write MAS Level-1B in netCDF (TEG)			09/20
	LG	C	09/13
Update MAS code as need arises			10/22
	LG	I	10/22
Test netCDF read/write to tape			10/21
	LG	I	10/21
Test netCDF data transfer by FTP			10/21
	LG	I	10/21
Produce data product spec. V1.0			10/21
	LG	I	10/21
Process MAS test flight data			10/29
	LG		
Travel to Houston for MAS/FIRE			11/12
	LG		
First possible MAS FIRE flight			11/13
	LG		
Process MAS data from FIRE			11/18
	LG		
Demonstrate MAS viewing on LTP IRIS			11/25
	LG		
Distribute FIRE data to users			12/01
	LG		12/01

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MODIS Science Data Support Team (SDST)

Project Plan

Version 0

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1. Summary

This project plan documents the support to be provided by the MODIS Science Data Support Team (SDST) to the MODIS Science Team and the Team Leader within the context of the EOS objectives, the MODIS objectives, and within the EOSDIS structure. The SDST provides support for the development of a science data processing system for the MODIS instruments and science algorithms. This entails identification of data requirements, operational scenarios, instrument data rates, duty cycles for observations, science data products, data volumes, and processing algorithms and requirements. Specific areas of support are identified in section 4, Technical Plan.

2. Objectives

2.1 EOS Objectives (from the EOS Reference Handbook)

EOS is a science mission whose goal is to advance the understanding of the entire Earth system on the global scale through developing a deeper understanding of the components of that system, the interactions among them, and how the Earth system is changing. The EOS mission will create an integrated scientific observing system that will enable multidisciplinary study of the Earth including the atmosphere, oceans, land surface, polar regions, and solid Earth. In order to quantify changes in the Earth system, EOS will be a long-term mission providing systematic, continuing observations from low Earth orbit.

More specific mission objectives are:

(1) To develop a comprehensive data and information system including a data retrieval and processing system to serve the needs of scientists performing an integrated multidisciplinary study of planet Earth.

(2) To acquire and assemble a global data base emphasizing remote sensing measurements from space over a decade or more to enable definitive and conclusive studies of aspects of Earth system science including:

- The global distribution of energy input to and energy output from the Earth;
- The structure, state variables, composition, and dynamics of the atmosphere from the ground to the mesopause;
- The physical and biological structure, state, composition, and dynamics of the land surface, including terrestrial and inland water ecosystems;
- The rates, important sources and sinks, and key components and processes of the Earth's biogeochemical cycles;
- The circulation, surface temperature, wind stress and sea state, and the biological activity of the oceans;

- The extent, type, state, elevation, roughness, and dynamics of glaciers, ice sheets, snow, and sea ice and the liquid water equivalent of snow;
- The global rates, amounts, and distribution of precipitation;
- The dynamic motions of the Earth as a whole, including both rotational dynamics and the kinematic motions of the tectonic plates.

2.2 EOSDIS Objectives (from the EOS Reference Handbook)

The EOS Data and Information System (EOSDIS) will provide access to data from the EOS instruments and to the scientific results of research using these data. The EOSDIS is to be a complete research information system that incorporates traditional mission data system facilities, but includes on-line electronic access to EOS data for all Earth science researchers.

Key functional objectives for the overall EOSDIS system include:

- Providing a unified and simplified means for obtaining Earth science data
- Providing prompt access to all levels of data and documentation concerning the processing algorithms and validation of the data, and to data sets and documentation that result from research and analyses conducted using the data provided by EOS
- Enabling a distributed community of Earth scientists to interact with data sources and mission operations from their own labs
- Providing a retrieval system and science user interface that is responsive to user needs
- Providing a capability for evolution and growth and for adaptation to new sources of data and new data system technologies.

2.3 MODIS Objectives (from the MODIS Conceptual Design and Cost Review (CDCR))

The overall MODIS objective is to make long term observations for improved understanding of the global dynamics and processes occurring on the surface of the earth and in the lower atmosphere (including surface-atmosphere interactions) through exploiting the visible and infrared spectrum and observation resolutions of 1-2 days and 214-856 meters.

The land objective is to collect data for studies of the spatial and temporal variability in land surface properties (e.g., vegetation cover and phenology, snow and ice, radiative properties including radiation balance) with emphasis on problems such as desertification, regional vegetation stress due to acid rain or drought, and succession or change in vegetation species due to deforestation and anthropogenic effects.

The ocean objective is to collect data for studies of the spatial and temporal variability of ocean surface properties (e.g., photosynthetic pigments, sea surface temperature, flow visualization, attenuation coefficients and sea ice) with special emphasis on ocean primary productivity.

The atmosphere objective is to collect data for studies of tropospheric dynamics, climatology and chemistry as obtained through observations of cloud characteristics (height, type, albedo, etc.) aerosols, water vapor, and temperature (including surface temperature.

The MODIS-N measurement objectives include surface temperature (land and ocean), ocean color (sediment, phytoplankton), global vegetation maps, global change (deforestation and desertification), cloud characteristics, aerosol concentrations and properties, temperature and moisture soundings, snow and ice cover characteristics, and ocean currents.

The MODIS-T measurement objectives include chlorophyll concentration, primary productivity, sediment transport, standing water, wetland extent, vegetation properties, hemispherical albedo, bidirectional reflectance, cloud properties, and aerosol radiance.

2.4 MODIS Science Data Support Team (SDST) Objectives

The MODIS SDST objectives are to support the MODIS Science Team Leader and Team Members in developing, implementing, integrating, testing and documenting MODIS data processing software, in obtaining required ancillary data, and in satisfactorily completing MODIS processing to meet the scientific goals of the EOS effort.

3. Related Activities

3.1 Other EOS Instruments

Many of the EOS investigations will make use of data from more than one EOS instrument. In particular, many of the higher level MODIS algorithms and products will depend upon data from other EOS instruments. The MODIS SDST will be involved in the development, porting, testing, maintenance and evolution of these algorithms.

3.2 EOSDIS

Nearly all of the MODIS SDST activities will require coordination and interfacing with the EOSDIS Project to carry out the production processing, archival, and distribution of MODIS data products.

3.3 MODIS Characterization Support Team (MCST)

The MODIS Characterization Support Team (MCST) is primarily responsible for the characterization and calibration of the MODIS instruments. The calibration algorithms and parameters defined by the MCST will be incorporated into the MODIS Level-1B processing by the MODIS SDST. Extensive coordination between the two groups will be required, both prelaunch and postlaunch.

4. Technical Plan

During the pre-launch period, there are four major areas of support to the MODIS Team Members which are the responsibility of the MODIS Science Team Leader. The MODIS SDST will assist in:

(1) developing software that no team member will develop, such as utilities, Level-1, etc.;

(2) developing software when Team Members request;

(3) integrating, rehosting, unit testing, system testing and documenting the software; and

(4) delivering the software to EOSDIS.

Specific MODIS SDST activities may include the following:

(1) on-going collection and refinement of evolving science requirements,

(2) the revision and extension of previously-defined operations concepts and scenarios,

(3) the identification and development of derived data system requirements,

(4) the tracking of ancillary data requirements and availability,

(5) the review and update of data system size requirements,

(6) support for the MODIS Airborne Simulator (MAS) experiments,

(7) support for MODIS data simulation activities,

(8) coordination of Team Member/Team Leader interactions,

(9) coordination of Team Member/EOSDIS interactions, and

(10) the monitoring of MODIS interactions with external data services and agencies that could potentially affect the quality of MODIS data products,

(11) Development of a MODIS Software and Data Management Plan,

(12) Development of a MODIS Science Computing Facility Plan for the MODIS Team Leader Computing Facility (TLCF).

4.1 MODIS Software Development

4.1.1 Team Leader Algorithm Development

The MODIS SDST will support the Team Leader in developing algorithms not within the specific research interests of any MODIS Science Team Member, including the Earth location part of Level-1 processing, utilities, data quality assessment, direct readout, and near-real-time processing. The fundamental algorithms to generate the required radiances from instrument digital counts will likely be provided by the instrument manufacturers and Science Team Members, but may need to be adapted to the EOSDIS processing environment. Also, on-going maintenance and improvement of algorithms will certainly be required.

4.1.2 Tools and Utilities

The MODIS SDST will develop utility algorithms that will support Team Members in the development of software to run in a production environment, and will integrate the software as it is delivered to the Team Leader. The MODIS SDST will provide appropriate documentation for the use of the algorithms. Quality controls and quality assessments in algorithms not directly developed or supported by any Science Team Member may be defined either by an interested Science Team Member or the algorithm developer.

4.1.3 Team Member Algorithm Support

To the extent desired by members of the MODIS Science Team, the MODIS SDST will assist MODIS Science Team Members in the coding of algorithms, debugging, software integration, software optimization, testing, quality control, and documentation. The MODIS SDST will integrate the software developed by Team Members and the SDST under the TLCF environment, test the integrated software package, and deliver it to the EOSDIS.

Required documentation not provided by MODIS Science Team Members will be prepared by the MODIS SDST. Examples of needed documentation include technical code descriptions and user's and operator guides and training manuals.

In the post-launch time period, SDST support services will be expanded to include special activities relating to field experiment support, near-real-time processing, and reprocessing. Also, as time passes and the interests of Science Team Members evolve, the MODIS SDST may assume an increasingly important role in maintaining MODIS data products and supporting the development of new products.

4.1.4 Approach

The MODIS SDST will support the development of algorithms. This activity will include assembling the required data sets, developing specific algorithms that fall outside of the research interests of MODIS Science Team Members, supporting the development of data products required by other investigators, supporting and coordinating algorithm development by the MODIS Science Team Members, and developing utility algorithms. In addition to Level-1 processing and utility algorithms development, the MODIS SDST may be involved in supporting quality assessment techniques, development of data products required by the interdisciplinary teams and coordination of algorithm development.

4.1.4.1 Assemble Required Data Sets

Both simulated and other similar instrument data will be used for algorithm development and testing. The MODIS SDST will support the collection and make available any required data that EOSDIS cannot provide. The MODIS SDST will assist in assembling the required data and act as a central clearing house. The SDST will support the Team Members in selecting and using archived data, and managing and distributing simulated MODIS data.

4.1.4.2 Quality Assessment Techniques

The MODIS SDST will be concerned with the development and integration of algorithm quality controls. As the primary custodian and overseer of MODIS data production capacity, the MODIS SDST will provide a monitoring and feedback function for quality control and quality assessment procedures. Also, the SDST may serve as a communications facilitator among Science Team Members and between Team Members and the EOSDIS when common data quality interests and concerns are identified.

4.1.4.3 Support the Development of Data Products Required by Other Investigators

The members of the other Facility Instrument teams, the PI Instrument teams, and the Interdisciplinary Investigation teams will also have requirements for MODIS data products that should be met. These requirements will include accuracy, resolution, timeliness, completeness, and additional data products not proposed by the MODIS Science Team members. EOS interdisciplinary investigators have identified a substantial number of potential MODIS data needs that do not match the research interests of any MODIS Science Team Member. The MODIS SDST will assist in providing the required products.

4.1.4.4 Support Team Leader in Coordinating Algorithm Development

The MODIS SDST will support the MODIS Science Team Leader in coordinating Team Member algorithm development. This function will primarily be accomplished by the MODIS SDST acting as an information center. The MODIS SDST will maintain a data base describing the status of the team members' responsibilities and will advise the Team Leader of overlapping, conflicting, or incomplete efforts or responsibilities.

4.1.4.5 Integration and Testing

The MODIS SDST will assist the members of the MODIS Science Team in developing an integrated set of modules generating standard products on the TLCF. The SDST will support the Science Team members, as required, on any or all of the steps in this process (including coding of algorithms, debugging, porting to the TLCF, integration, optimization, testing, and quality control) which ends with an integrated set of modules generating standard products on the TLCF.

4.1.4.6 Utility Algorithms

The MODIS SDST will support the Team Leader to develop utility algorithms for MODIS data processing concerns that fall outside the specific research interests of MODIS Science Team Members. The functions and roles of the utility algorithms will be defined and reviewed by the entire MODIS Science Team. Some examples of utility algorithms include I/O and the processing shell, Earth location, topographic correction, cloud identification, cloud and snow/ice discrimination, atmospheric correction, orbital coverage simulation, time and space averaging and rectifying/overlaying, and display and processing.

The MODIS SDST would be assigned the task of integrating those utility algorithms already developed in whole or in part by the MODIS Science Team Members, and developing, coding and testing new utility algorithms specified as useful by the Science Team Members and the Team Leader. Documentation and maintenance of the utility algorithms would be a responsibility of the SDST.

Identification of sources of ancillary data required for utility algorithms, and commonality of utilities among disciplines would be a function of the MODIS SDST in the generation and integration of utility algorithms into the processing system. Utility algorithms are a major processing component in progressing from Level-0 to Level-1 data products, and utility algorithms may be required at higher data product levels (e.g. for spatial and/or temporal compositing or averaging of data products at different scales).

4.1.4.7 Configuration Control Software

It is anticipated that MODIS geophysical data processing requirements will grow at an annual rate of 40%. This projected growth requires that a flexible control program, or shell, be developed which allows the incorporation of new data products without disruption of on-going processing. The changes must be transparent to the users. The configuration control software may be viewed as a main driver program which calls various subroutines developed by the Science Team. Using ERBE as an example, 30,000 lines of job control language were required (6% of the total LOC). MODIS will have a similar or larger requirement which will fall upon the SDST.

Included in the configuration control software will be software for reprocessing, for field experiment support, for near-real-time processing, and for algorithm changes and upgrades.

4.1.4.8 Software Modification and Maintenance

As the interests of Science Team Members evolve, the MODIS SDST may assume an important role in maintaining existing MODIS data products and developing new ones. Changes in hardware of the data system may also result in software maintenance activities. In brief, the SDST will support algorithm reviews and upgrades, support continuing algorithm development and product validation, and implement new and revised algorithms as directed by the Science Team.

4.1.4.9 Field Experiment and Near-Real-Time Processing Support

The MODIS SDST will support the implementation of special processing requirements in support of field experiments. The SDST may assist in custom configuring the MODIS processing system to accommodate these requirements, which may involve unusual data paths, algorithms, and timeliness.

4.1.4.10 Special Software Development

In the post-launch environment, the MODIS SDST can be viewed as a resource within MODIS to develop codes that require certain special computing tasks. For example, there is a requirement that MODIS data be accessible to Geographic Information Systems (GIS). For a GIS, these tasks may be as simple as assuring the MODIS data products are in GIS and EOSDIS compatible formats. Alternatively, it may require the development of a GIS dedicated to using MODIS data products. Additional software development requirements may be for the support of field experiments, special I/O subroutines, planning and scheduling/orbital coverage simulation software, and the database management activities within DADS. If the satellite scheduling priorities are determined with the aid of an artificial intelligence program, the SDST could develop this code.

4.1.4.11 Special Analyses Support

Non-routine operations such as the support of field experiments, the analysis of new instrument anomalies, or the testing of the integration of new algorithms in the existing TLCF code may all require special analyses. The MODIS SDST would be expected to have the personnel and expertise to aid the science team members in the code development required for these special analyses.

4.1.4.12 A Complete MODIS System Simulation

To support the integration, testing, and optimization of software to generate MODIS data products prior to launch, the MODIS SDST will support the MODIS Science Team in the generation of a realistic and comprehensive simulated MODIS data set.

The MODIS SDST will support the formulation of a coordinated Earth definition, where the physics must include a radiatively consistent treatment of the effects of each of the proposed core products. The geophysical parameter data requirements will flow from the Earth description, and will include fields of clouds fraction, ozone, surface pressure and wind speed, vegetation, and surface temperature to name just a few. Global, multi-day (e.g., full 16-day orbital repeat period) domains for the summer and winter seasons will be considered.

It is envisioned that three increasingly complete implementations of MODIS at-launch product generation code prototypes be made. These would be delivered to EOSDIS three, two, and one years prior to launch. The implemented code, the processing capacity of EOSDIS, and even the robustness of the retrieval algorithms (i.e., the capability for exception handling) will be exercised through application of the simulated MODIS data. For each pass, the simulated MODIS data will be made incrementally more comprehensive and realistic. Given an adequate description of the characteristics of the Earth, the MODIS instrument, and the EOS platform, successful operation of the MODIS at-launch processing software on the final simulated data set will provide the MODIS and EOS science communities with the closest possible approach to a guarantee of standard data product generation shortly after launch.

4.2 MODIS Team Leader Computing Facility (TLCF)

The MODIS Team Leader Computing Facility (TLCF) work area involves the development of functional, operational and performance requirements, operations concept, science scenarios and preliminary design for the TLCF.

The TLCF must support pre and post launch algorithm development, integration, testing, validation, modification and evolution. It must also provide computing resources for the MODIS Team Leader and Goddard Team Members, and it will provide support for quality control and test of the MODIS products. Special products for the Team Leader and some of the Goddard team members, will be generated on the TLCF.

To meet these requirements, the TLCF must be capable of processing MODIS data at twice the full rate, and it must have total storage adequate to hold the data from one orbit per week for a ten year period (of the order of 2 Terabytes). The requirements for communications, displays, I/O, etc. will be based on a more complete definition of the TLCF operating environment.

The requirements will be refined, and the MODIS science scenarios and TLCF operations concepts will be developed and used as the basis for the preliminary design.

4.3 Support for MODIS Airborne Simulator (MAS) Experiments

An upgrade to 50 channels will be made on the MAS next year. Processing code (currently at Version 1.x stage) must be upgraded to Version 2.x. We will also continue to modify and update code as required or requested after feedback from the Science Team, King and Menzel. For field experiments, it is valuable to have someone in the field, (or in close contact with those in the field) to keep tabs on data quality, instrument problems or failures, visible calibration, etc. This is especially important in early test stages. Support may also be required in flight planning; e.g. weather conditions at the site. If ground or in-situ data is taken in conjunction with MAS overflights, we may act as a central distributor. Registration of MAS imagery may require investigation. Integration of MAS processing into the V0 DAAC must also be investigated.

4.4 MODIS Image Registration

A survey will be made to identify the significant questions and issues associated with MODIS image-to-map registration (registering MODIS images to Ground Control Points (GCP)) for more precise earth location. In addition, image-to-image registration will also be considered for the purpose of providing a good basis for examining changes over time in the recorded sensor data. A plan for MODIS image registration will be developed and circulated to the science team for comments and modification.

Efforts to build an automatic image registration system for MODIS will take into account the lessons learned in the extensive work that has already been done with images from Landsat, AVHRR, and other systems. As a first step, discussions are being held with many persons who have experience in image registration from GSFC, JPL, CSC (EOSAT), and EDC. The discussions with EDC relate primarily to experiences with Advanced Very High Resolution Radiometer (AVHRR) image registration over the United States.

The basic plan for MODIS image registration is to provide improved image location information for each scene over land areas. This information will be included in the MODIS Level-1B data product. Several steps are involved in preparing for this task.

Identify promising techniques and algorithms. The Fast Fourier Transform (FFT) was applied successfully to Landsat 1, 2 and 3 images. Precise registration was achieved with edge detection methods on Landsat 4 and 5 data. A method which offers the best possibility of providing a fully automatic process (or nearly so) would be very desirable for use with MODIS images. The adopted technique, or algorithm, must provide for identification and work-around or rejection of problem scenes without human intervention. The algorithm must be suitable for production processing.

Identify tasks involved in selecting a good set of GCPs. This will involve the identification of 100-meter to 500-meter feature types with well defined edges. Existing sets of GCPs will be examined for their suitability in the MODIS application. Dependence on frequency bands, gain, radiance range, seasonal variations, atmospheric conditions, spatial resolution, etc. will influence the usefulness of different types of features. Geographical areas where additional work is needed will be identified.

Test various candidate algorithms using real data (AVHRR or MAS).

Identify the computer resources required to do production image registration.

5. Management Plan

5.1 Organization

5.2 Project Management

~~5.3 Data Management Plan~~

5.4 Team Member Communications

6. End Items

6.1 Science Computing Facility (SCF)(MODIS Team Leader Computing Facility (TLCF)) Plan

The MODIS SDST will prepare a Science Computing Facility (MODIS Team Leader Computing Facility (TLCF)) Plan that summarizes the computing needs for the investigations and the approach to meet those needs. The plan will include schedules for the purchase of equipment and software, facilities and services to be provided, and the networking requirements within the Team and to the EOS community. The SCF procurements will satisfy the standards defined by team consensus. They will be based on recommendations provided by the Ground Systems and Operations (GS&O) Project.

6.2 Software and Data Management Plan

The MODIS SDST will prepare a Software and Data Management Plan that further defines:

a. The nature of the algorithms to be produced in the course of the investigation.

b. The input data required for MODIS investigations.

c. The output products to be produced, including standard, browse, quicklook, and special products. For each product the level, volume, required output media, and format of the output data will be specified. A schedule for the production of these output products will be provided showing a commitment to timely provision of data sets. The approach for using standard data formats for products will be discussed.

d. A schedule for the development and validation of the science data processing software required for the MODIS investigations, including the versions 1, 2, and 3 to be developed prior to launch.

e. The approach to satisfying software development standards. The focus of these standards will be to enable the development of portable and maintainable software.

f. The approach to integration and testing of the Team Member software prior to its delivery to the EOSDIS.

g. The approach to software test and verification to be used at the EOSDIS.

h. Requirements for EOSDIS support during integration, test, and checkout of MODIS.

i. Estimates of the amount of EOSDIS computing resources to be used for producing standard products and the nature and frequency of reprocessing.

j. Special requirements for data receipt, transmission, or expedited processing in support of evaluation of the health, safety and operation on MODIS. This will include a description of the nature, volume, and time critically of receipt for housekeeping and scientific data

k. Special requirements for data receipt, transmission, or expedited processing for special field experiments needed to support algorithm development and validation of output products.

l. The approach to validation of output products using EOSDIS facilities.

m. The approach to post-launch software maintenance.

The MODIS Data Management Plan will describe the manner in which the MODIS instrument data will be acquired, calibrated, validated, earth located, processed, archived and distributed to the science users, within the EOSDIS data management structure. The end-to-end data flow from its origin at the MODIS instrument to the science product archival and distribution will be described in the EOSDIS context.

The computer resources and software tools required for algorithm development, data processing, and generation of special products will be identified. A configuration management system will be provided for the protection and assurance of operational software and data products.

The collection and management of ancillary data and data from external sources will be described as they relate to the processing and production of MODIS products. The manner in which reference data for ground control points, digital elevation and terrain models, atmospheric models, coastline definitions, etc. will be collected and integrated into the system will be specified.

Consideration will be given to the processing and management of quick look data for field experiments, targets of opportunity and special investigations. A plan will be provided for the generation and delivery of metadata and browse products.

The responsibilities of the MODIS Science Data Support Team will be identified in terms of data product requirements, operational scenarios, algorithm integration and testing, design and implementation of the operational processing system, data product validation, integration of computer resources, and development of documentation during the definition, prelaunch and postlaunch phases.

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7. Procurement Approach
7.1 Acquisitions

8. Schedules
7.1 Project Phasing
7.2 Project Schedule
7.3 Contingencies

9. Resources Plan
8.1 Budget Requirements
8.2 Manpower Requirements

10. Reviews
9.1 Management Reviews
9.2 Technical Reviews
9.3 Operational Readiness Reviews

11. Safety, Reliability and Quality Assurance@

11. References

12. Acronyms

Tom Goff's Status
for
24 October, 1991

TGoff on GSFC mail, or teg@LTPIRIS2.GSFC.NASA.GOV

* The first version of the C program that creates the MAS data set in NetCDF format on the LTP VAX has been completed. The data content has been verified with both a known validation data set and a sample MAMS data set.

  - This program will be enhanced in the future to include attribute specifications for all variables and band specifiers for each channel that will include center wavelength and band width parameters.

  - The NetCDF data set size is slightly smaller than an equivalent non-formatted data set. The incremental time to transform the data into NetCDF format is approximately 20 minutes for a 2000 line flight track.

* Several utility programs are well underway on the VAX. These include programs that will synopsize the NetCDF MAS data contents, write flat file data sets of subsampled MAS data for examination as browse examples (on PC's or other), and a program to convert NetCDF to the native EASI/PACE data format. The EASI/PACE program will become a part of the EASI/PACE menu system on the LTP SGI IRIS computer.

  - These programs take approximately 10 minutes to produce a subsampled data set.

* Further information derived from a conversation with Mike King's programmer:

  - They use the IBM 3081 for radiative transfer models that create data sets that are transfered to an Apple Macintosh computer via FTP. All programming is performed in FORTRAN. The Mac has a 600 MByte disc and they use the SpyGlass imaging package.

  - It appears that the Mac would be a more appropriate platform to place any NetCDF to native file format conversion programs. Given access to a Mac with programming developement capabilities, we should develope programs (or port the VAX programs) that read in NetCDF MAS data to the Mac. These programs are written in C.

Development Plan and Schedule
for the
MODIS Team Leader Science Computing Facility Plan

Objective. The goal of this effort is to develop a Science Computing Facility (SCF) Plan for the MODIS Team Leader as required in paragraph 3.4 of the MODIS Team Leader Statement of Work (May 21, 1991):

> *"The Team Leader will prepare a SCF Plan that summarizes the computing needs for the investigations and the approach to meet those needs. The plan should state costs and schedules for the purchase of equipment and software, facilities and services to be provided by others (whether on-site or off-site, or whether at no cost or on a cost-reimbursable basis), and the networking requirements for both in-house (within the team) and to the rest of the EOS community. To maximize cross-development capabilities with the EOSDIS, SCF procurements should satisfy the standards defined by team consensus and be based on recommendations provided by the GS&O Project."*

Approach. The envisioned effort begins with an information gathering phase consisting of documentation reviews and personal interviews. The documentation reviews need to include all approved EOSDIS, MODIS, and other EOS instrument documents that define or discuss SCF functions and requirements. The interview phase of the effort should include key EOSDIS, MODIS, and other EOS instrument personnel who are active in developing or defining SCF requirements. Summary reports will be generated as information is gathered. This phase of the effort has already begun.

Computing needs at the Team Leader SCF will evolve as the system is implemented and the evolution of requirements must be analyzed in the plan. The software environment at the Team Leader SCF will affect software transport to and from the Team Leader SCF and will require special investigation. Interim reports addressing these and other special topics will be generated as they are needed during the effort.

Schedule. Since team member algorithms will be integrated and tested on the Team Leader SCF, decisions affecting the Team Leader SCF will impact all members of the Science Team. The Team Leader SCF plan will need careful scrutiny by the Team Leader and the Science Team. Although a draft version of the document is not required by EOSDIS before June, 1992, and the final version is not required until June, 1993, this document proposes the delivery of a "strawman" Team Leader SCF Plan on January 3, 1992. This schedule should maintain momentum in the effort and will allow time for thorough review. A production schedule for the SCF Plan is presented in Table 1.

TABLE 1

Task Completion Schedule
for the
MODIS Team Leader Science Computing Facility Plan

Completion Date	Task
October 25	Report on ECS RFP review and Rich Bredeson interview
November 8	Complete document and interview reports
November 15	Analyze schedule and requirements evolution
November 22	Quantify hardware requirements
December 6	Specify communications requirements
December 13	Analyze software requirements
December 20	Propose alternatives and develop cost information
January 3	Deliver "strawman" report

Excerpts From the ECS Specification Relating to SCF Functions

Science Computing Facilities (SCFs), located at science investigator facilities, will be used to develop and maintain algorithms, produce data sets, validate data, and analyze and synthesize EOS and other data to expand knowledge about the Earth System and its components. The ECS will provide toolkits for use by scientists at the SCFs.

The SDPS interfaces with the SCFs to perform data quality assessment, to receive updated algorithms and coordinate their test and integration into the production environment, and to exchange special and standard products.

The PGS supports the integration of new and updated science algorithms into the production environment through an interactive link to the scientists located at the SCFs. The SCFs transmit new or revised algorithms along with associated documentation and test data to the PGS. Test products generated by the candidate algorithms are sent to the SCF. Reviews of the test products are sent to the PGS. The PGS also sends requests for scientists to assess the data quality of its products and receives the resulting quality assessments.

Algorithm Updates are delivered to the PGS's integration and test environment by scientists at an SCF. They represent changes to existing production algorithms, or a new algorithm to produce a new Standard Product. Algorithm updates include the source code for the candidate algorithm, its associated documentation, and a job step control skeleton. The source code will be compiled to form an executable program suite as part of the integration and test process. The job step control skeleton contains instructions that control the sequence of execution of, and the interchange of data between programs from the executable program suite. Test data sets and calibration data should also be included.

The DAAC interfaces with the SCF for algorithm development, product documentation, metadata generation, and special data products generation.

An interface between each DADS and SCF shall provide for an exchange of documents, special data products, metadata, correlative data, calibration data, ancillary data, and algorithms. Standard Products will be distributed to SCF for QA or analysis purposes.

SPECIAL PRODUCT (L1-4) is the set of special science data products consisting of L1A, L1B, L2, L3, and L4 which are produced at the SCFs. These shall be archived at the DADS and distributed to authorized requestors.

An Interview with Rich Bredeson

On October 24th I contacted Rich Bredeson to obtain SOW information relating to the Science Computing Facility Plan and to obtain a list of SCF contacts for other EOS instruments (MISR, AIRS, CERES, ASTER, SAGE). As the conversation developed, we discussed several other issues relating to SCF requirements.

The ECS toolkit provided by the ECS contractor will play a crucial role in isolating SCF software from the specific requirements of the SCF operating system and hardware and will facilitate software transport among EOSDIS elements. With the proper toolkit, the operating environment and hardware at the Team Leader SCF will perhaps not need to match the environment and hardware used in the production environment.

The Integration and Test environment included in the ECS is intended primarily for use by ECS developers. Integration and testing of MODIS software components will need to be done on MODIS specific facilities (the Team Leader SCF).