MODIS DATA STUDY

TEAM PRESENTATION

January 11, 1991

AGENDA

1. Action Items
2. A Brief Phone Conversation with Dr. Bob Evans Regarding Earth Shape Models
3. Issue for Clarification: Satellite Position Coordinates
4. A Description of the MODIS Level-1A Processing Software Design
5. Interface Description Between the MODIS Level-1A Processing and the External EOSDIS Entities
6. Form for Updating MODIS Data Requirements
7. Data Requirements for Menzel (Cloud Top Temperature, Cloud Top Pressure, Cloud Effective Emissivity, Cloud Type and Extent, Cloud Droplet Size, Atmospheric Stability, Total Precipitable Water, and Total Ozone)

ACTION ITEMS:

11/16/90 [Doug Hoyt]: Review MODIS Level-1 data flow diagrams and identify data items potentially provided by the MCST. Provide a list of instrument parameters required to Earth locate MODIS pixels (e.g. detector locations, electronic delays, mirror rotations, etc). STATUS: Presently available information insufficient to address item. Report due approximately one year from the assignment date. Open.

12/21/90 [Watson Gregg and Al McKay]: Combine Earth Model reports into single document. Pursue 2 additional questions: 1) how important is the geoid/spheroid difference over the oceans, and 2) how important is the difference over land, considering the types of DEM/DTM's likely to be used? Coordinate with Al Fleig to distribute report. STATUS: Report in this week's handout.

12/21/90 [Watson Gregg]: Make revisions of anchor point accuracies report. STATUS: Revised and delivered 01/04/91. Add typewritten figure/table legends. Revised and delivered 01/07/91.

12/21/90 [Daesoo Han]: Arrange a meeting (Preliminary Design Review) with appropriate EOSDIS civil service personnel to discuss the MODIS Level-1A data system design, including data processing services to be provided on each side of the EOSDIS/MODIS interface. STATUS: Meeting scheduled for January 18, 1991.

A Brief Phone Conversation with Dr. Bob Evans Regarding Earth Shape Models

In a phone conversation with Dr. Evans, I summarized the recently obtained information on the height offset between the ellipsoid and geoid Earth models (approximately 100 meters) and discussed the horizontal location offsets that result from the two models for MODIS observations at various scan angles and instrument tilts. I then asked Dr. Evans for his Earth model preference, considering that geolocation errors resulting from instrument attitude uncertainties will probably exceed any pixel location offsets attributable to the Earth shape model.

Dr. Evans felt that the effect of using the ellipsoid model would be to introduce additional inconsistency among nominally coregistered pixel observations obtained at different MODIS observation angles, and therefore, he prefers the geoid model. He expressed this preference even though location errors from other sources may exceed those due to the Earth model; his basic feeling was that use of a model other than a geoid would just introduce one more source of apparent randomness that would have to be removed in subsequent processing.

An attempt to pose the same question on Earth models to Dr. Chris Justice was unsuccessful. Dr. Justice is out of the office and is expected to return on Friday, January 10th.

Al McKay

ISSUE FOR CLARIFICATION:
SATELLITE POSITION COORDINATES

The recent minutes from the MODIS Technical Team Meeting, December 20, 1990 reported the following item:

"Location of Satellite and Sub-Satellite Point:

In response to a question from V. Salomonson, D. Han clarified that in the EOSDIS, satellite position will be available in Cartesian coordinates; whereas, and contrary to an earlier Data Study Team report, the subsatellite point on the ground will be available in geodetic latitude and longitude. V. Salomonson requested that a correction to the Data Study Team report be issued."

The wording in this statement is very unclear, and a clarification is desirable.

A Description of the MODIS Level-1A Processing Software Design

ABSTRACT: This document contains a description of the MODIS Level-1A processing system as designed using computer structured engineering methodologies. The design philosophies envisioned in this design are explained within. Also included as appendices are the software structure diagrams, a data dictionary, an internal granule structure description, an assumptions list, and references.

PURPOSE: The MODIS Level-1A processing software receives the MODIS instrument data as packets from external storage processes, verifies the packets and the data within the packets, and formats the MODIS data into the Level-1A data structure with headers and the associated MODIS metadata. This process does not recover the MODIS Level-0 data from the MODIS level-1A data. The data recovery function will be handled by a separate process to allow the Level-1A process to be modified at a later date without affecting the data recovery capability.

DISCLAIMER: This design is based upon the best information available for the current design of the EOSDIS system. The interactions between this process and the remaining EOSDIS processes are subject to change as the EOSDIS system design evolves. Interactions with other processes and the assumed functioning of those other processes are described as they are encountered in this description.

GENERAL DESCRIPTION: The processing of MODIS data into a Level-1A product is primarily a batch oriented process in which the packets of instrument data from the satellite and the ancillary data which are stored in an external (to this process) database manager are supplied on an as-requested basis. Upon the completion of the Level-1A processing, the data are returned to the database manager for dissemination to users and for retrieval by the follow-on processing programs. This MODIS process is required to handle several different modes of data in addition to external processing queries and internal data anomalies. These requirements add a layer of control functions to the basic data processing function.

This description of the MODIS Level-1A processor presents a narrative of the functions defined in the structured design charts. Further information on the specific contents of flow and control items, control transformations, and data processes is contained in the Data Dictionary.The document starts with a description of the processing control functions, next describes the initialization processes that are executed upon the first entry into the program, and then describes the various processes required to generate the MODIS Level-1A data products.

CONTROL FLOW DESCRIPTION: The execution of the MODIS Level-1A product generation program is initiated by the Schedule, Control, and Accounting (SCA) program within the EOSDIS. This external (to the MODIS Level-1A) process generates a starting message to the MODIS Level-1A program that contains all information necessary for the MODIS Level-1A program to determine the data types, sizes, instrument IDs, data set file names and

locations, processing mode (standard, quick-look, reprocessing), etc. As the processing progresses, the SCA can initiate an interrogation of the MODIS Level-1A process via another message. The MODIS processor then returns a message containing accounting information such as number of packets processed, spacecraft (S/C) start and stop times of those packets, percentage of granule completion, etc. This information can be used by the SCA to assign priorities of processing in the SCA response to Payload Operations and Science Members. The SCA can also send a termination message to the MODIS processing which will indicate either an immediate (do not save processed products) or a graceful (save products) termination. Upon normal completion of the processing, a termination message is sent to the SCA.

The MODIS level-1A processor will post an entry into the EOSDIS (or MODIS) Processing Log external entity. This allows a time based accounting of the processing events as they occur and can be used as a definitive audit trail to determine what has been processed and when.

During the processing of the MODIS instrument data, two types of control indications can be generated. These are labeled as events and alarms (problems). Events are non-catastrophic occurrences represented by anomalies between the telemetered data and MODIS Instrument Status database. Alarms are indications that signal the detection of a processing problem that could lead to the generation of invalid data. These control indicators are passed to the SCA for further action. Note that the EOSDIS Scheduler, not the MODIS process, makes the decision to abort this MODIS task if the problem is sufficiently severe. The guiding principle is that the MODIS processing will not be terminated internally.

INITIALIZATION DESCRIPTION: This process, executed once upon initiation of the processing task, first interrogates the external database entities to determine if the data sets required for the completion of this MODIS processing are available. Three data sets are required: the Level-0 Data Product with accounting and quality information (Level-0 Metadata), spacecraft ancillary data (ephemeris, attitude, and possibly other instrument science or engineering data), and the MODIS Instrument Status database. The Level-0 data and the spacecraft ancillary data are staged in the DADS after being received from the spacecraft via TDRSS, DOMSAT, and CDOS. The Modis Instrument Status is a flat file database derived from the instrument command history and can be maintained in the DADS or other location. The indication of data set availability is determined from a database index record rather than a reading of the data directly. If the data sets are not available, a problem initialization indication is sent to the control function to be passed to the SCA for resolution.

Next, the initialization determines the memory and disk allocation (sizes) necessary to contain the data store items. This is accomplished by performing operating system calls to allocate the necessary computer memory for this process and the necessary disk space for the granule backing store and the output metadata. The granule backing store area is converted to the actual granule upon completion of the MODIS processing. The data granule and metadata areas are preallocated and prefilled with data that represents an invalid condition. As the

packets are placed into the granule and the metadata is determined, these invalid conditions will be replaced with valid data. Granule and metadata initialization must be complete before the processing of MODIS data packets can begin.

DATA FLOW DESCRIPTION: Processing occurs in three stages: packet processing, scan cube processing, and granule processing. Packet processing verifies packet oriented data and places this data into a granule structure. For each part of a granule that represents a completed (filled) scan cube of data, several items that relate to the concept of a scan cube are generated and verified. This includes instrument housekeeping and scan cube header information. When all scan cubes of data have been filled, the granule is complete. The granule header is then generated and appended to the granule and the separate metadata product is derived.

The MODIS data processing requires that several modes of operation be accommodated. These include normal (standard) processing, quick-look data processing, and data reprocessing. Normal processing operates upon packets of data that are time ordered with duplicates removed and any missing packets artificially generated and filled with invalid data contents. Full accounting (Level-0 Metadata) is provided by CDOS. The quick-look Level-0 data may not be time ordered and may not have associated accounting data (Level-0 Metadata). In reprocessing mode, the processor receives a Level-1A data product consisting of an incomplete (invalid data indicators) granule and adds the missing packets of data to this granule to create an updated Level-1A product. Metadata is appended to the original metadata to represent this reprocessing. For each of the processing modes, differing packet parameters and ID locations are to be specified or determined before any packet processing can begin.

The MODIS Level-0 Data are requested from the DADS and is delivered in a packet format. After receiving a begin processing control indication, the data is requested from the DADS by a normal operating system file query. This implies a handshaking between the MODIS processor and the DADS with error detection processing. Delivered packets of data are verified using packet oriented sanity checks such as packet length, Cyclic Redundancy Check (CRC), packet ID, and other to be determined (TBD) checks. If any packet verification checks are not passed, a "problems, packet" indication is generated that is ultimately passed to the SCA process. This alarm message indicates that a potential catastrophe has occurred that affects the correct processing of the MODIS data. Following the packet checks, any instrument checks that are common to all packets are performed. An example would be an instrument "on" or correct instrument mode indication. An error in this data check will produce a "problem, instrument" alarm message. Finally, the current time (computer or external time base) is appended to each packet. This allows accounting to be performed following the "dynamic status request" inquiry from the SCA.

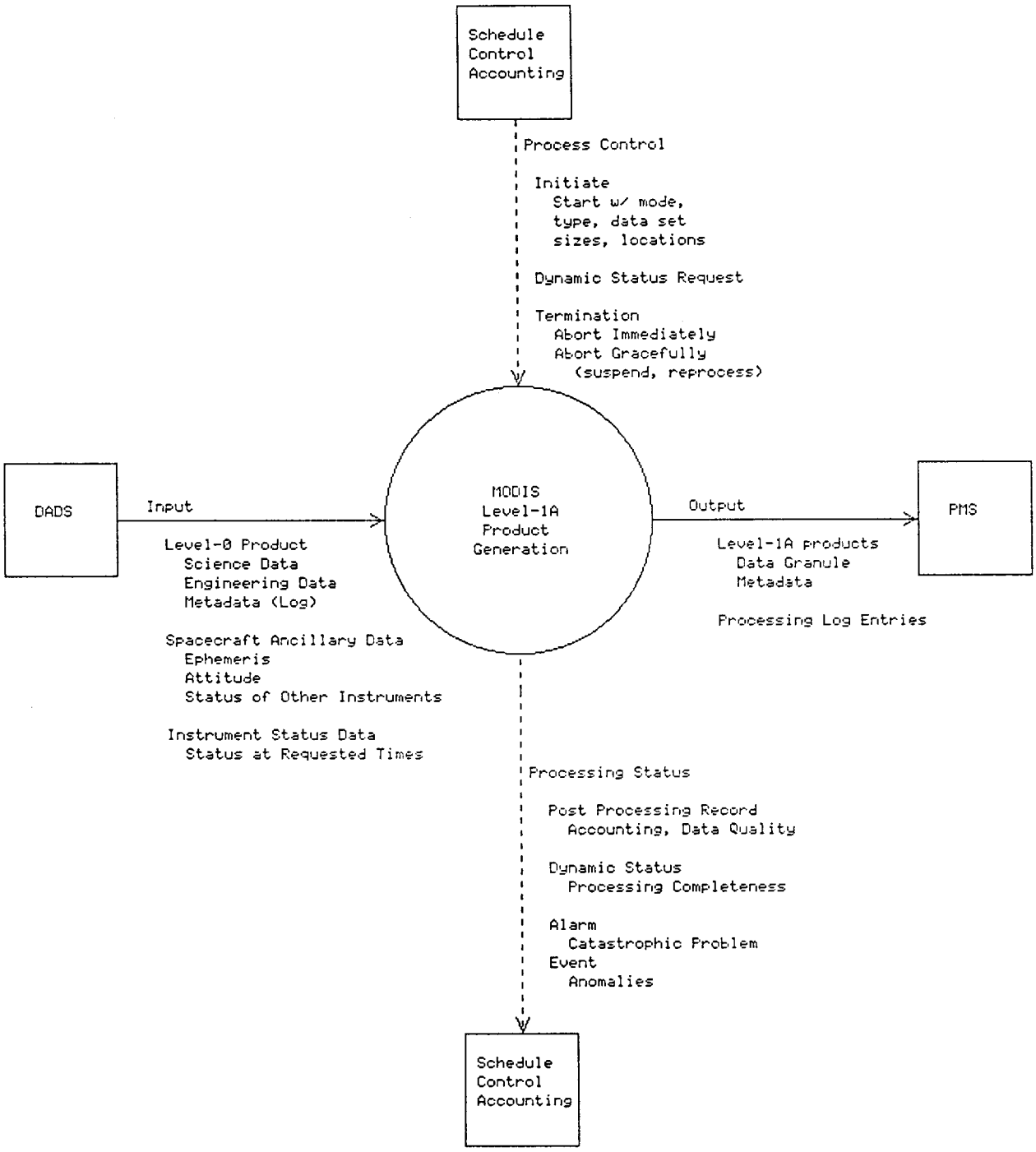
A valid packet of MODIS data, containing a scan cube counter and a subcube position indicator, is then placed in its proper logical location within the MODIS data granule. Performing a computer memory access to this logical location may require a logical to physical memory

translation using a simplified demand paging technique as outlined in the Granule Structure Description in the appendix. For each scan cube of data, a completeness indication matrix consisting of a binary array representation for each packet of subcube data and a counter of the number of packets received per scan cube will be maintained. This allows a quick determination of granule and/or scan cube completeness. Any byte alignment of the instrument science and engineering data (planned for the future) would be performed as the packet of data is placed into the granule structure.

Each completed scan cube of instrument data (corresponding to the concept of a single scan mirror rotation or sweep of the Earth), is checked for any instrument scan cube related items. These can include housekeeping analog information, boolean indicators, tilt position limits, instrument (not processing) modes, etc. Serious instrument problems, such as the inadvertent deployment of the diffuser plate, will generate a "problems, instrument" alarm message. In addition, the telemetered instrument data is compared with the Instrument Status database to determine any instrument anomalies and generate the corresponding event messages. Instrument status is appended to the scan cube along with the spacecraft ancillary (attitude and ephemeris) data. A scan cube header is derived and selected granule metadata items are updated to their current values.

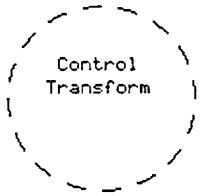
Upon completion of all scan cubes, the granule completeness indicator is generated. This will be performed using the packet per cube completeness indicators. If a granule of data is completed (filled), the process merely indicates that fact and allows further packets of data to be processed. The granule metadata is appended to the Level-0 Metadata to create the Level-1A Metadata product. The Level-1A Metadata and the Level-1A Data Granule are then passed, either as pointers to files or as actual data sets, to the Product Management Service (PMS) for further metadata processing before being placed into the DADS for archive and distribution.

Project : \ECPLUS\MODIS-1A\
Chart : context
Filename : context.trg
Modified : 01-10-1991

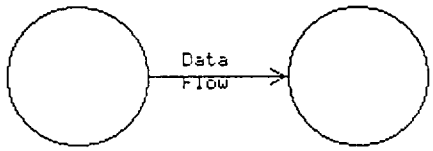


Project : \ECPLUS\MODIS-1A\
Chart : sample
Filename : sample.trg
Modified : 01-10-1991

A process that is not a part of this design. This requires an interface definition for data passing to/from this item.

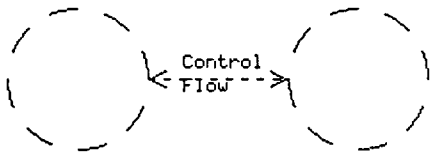


A process that receives or generates control functions. No data is required, but data may be generated.



A flow of data between Data Processes and/or Control Transforms. Data may flow in one or both directions.

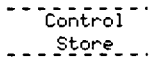
A process that utilizes generates data as oppose controlling a process.



A one or two way passing of control indicators.

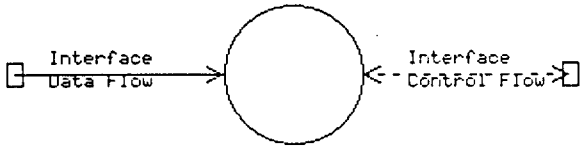
SYMBOL DEFINITIONS
for
Structure Charts

An area in which data is stored. May be in memory, disk, or other locations. May be paged between physical areas.



An area reserved for control parameters.

Split amd/or merge multiple data or control flows.

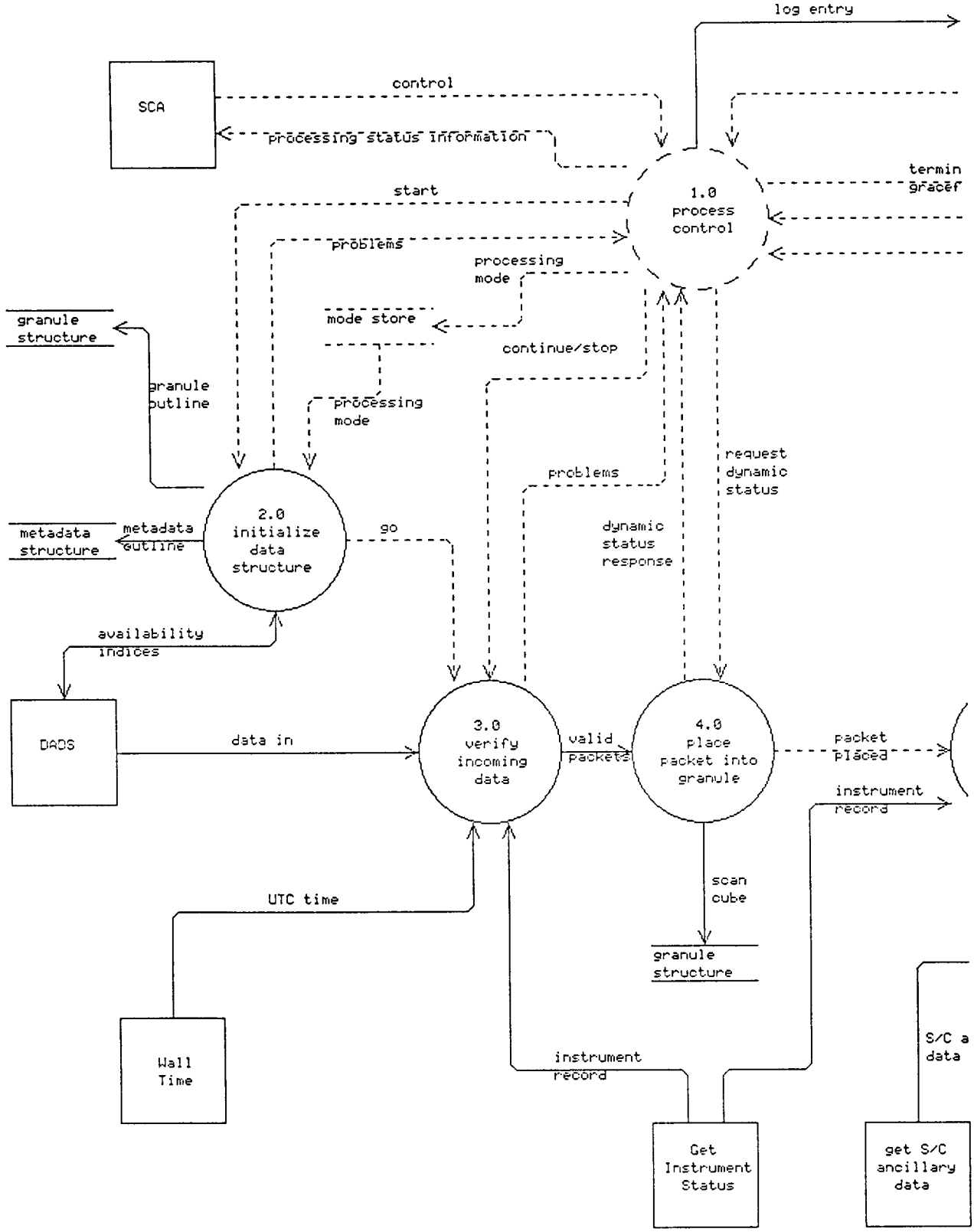


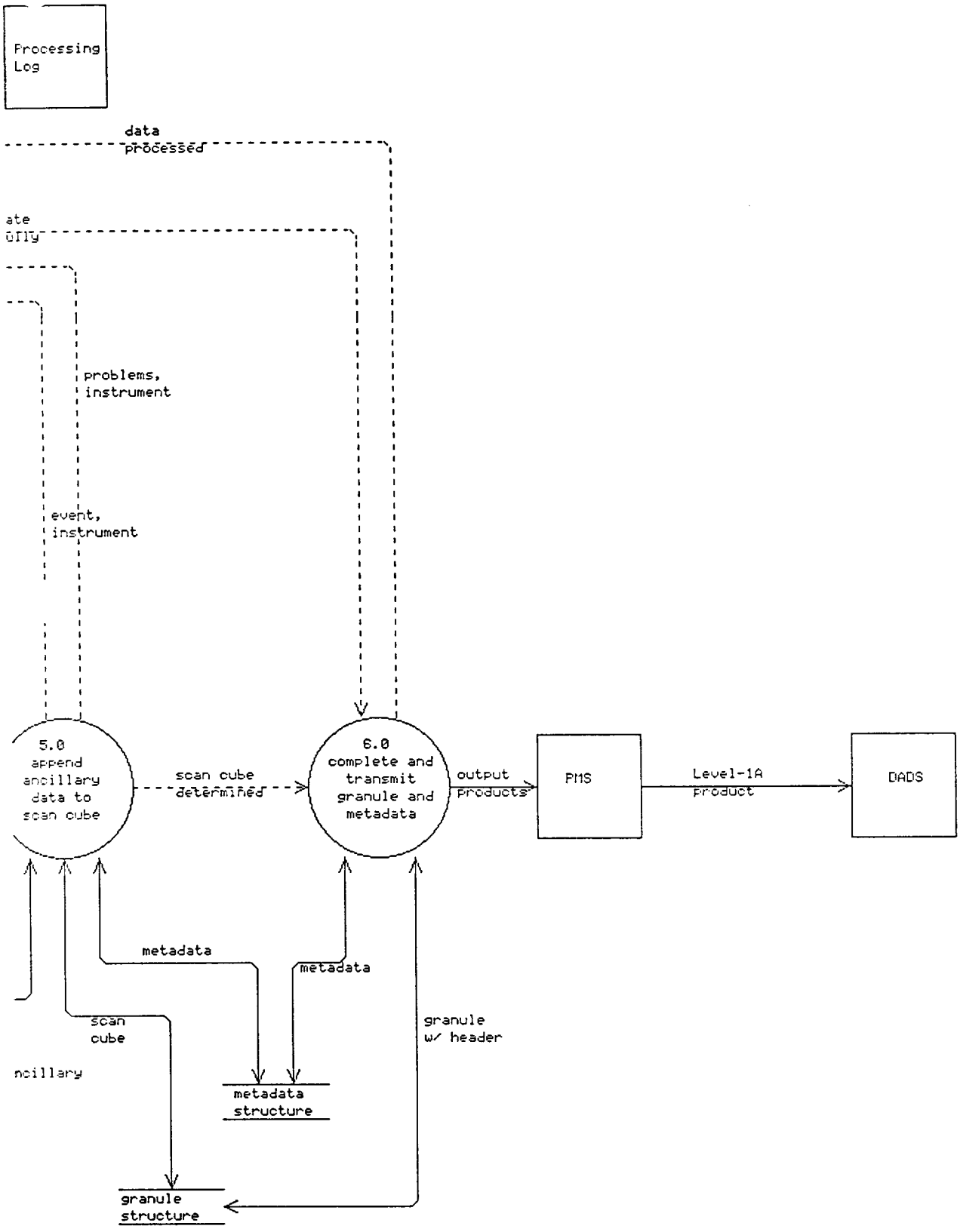
Upper Level Interface

Flow to/from an item that is defined on an upper level diagram.

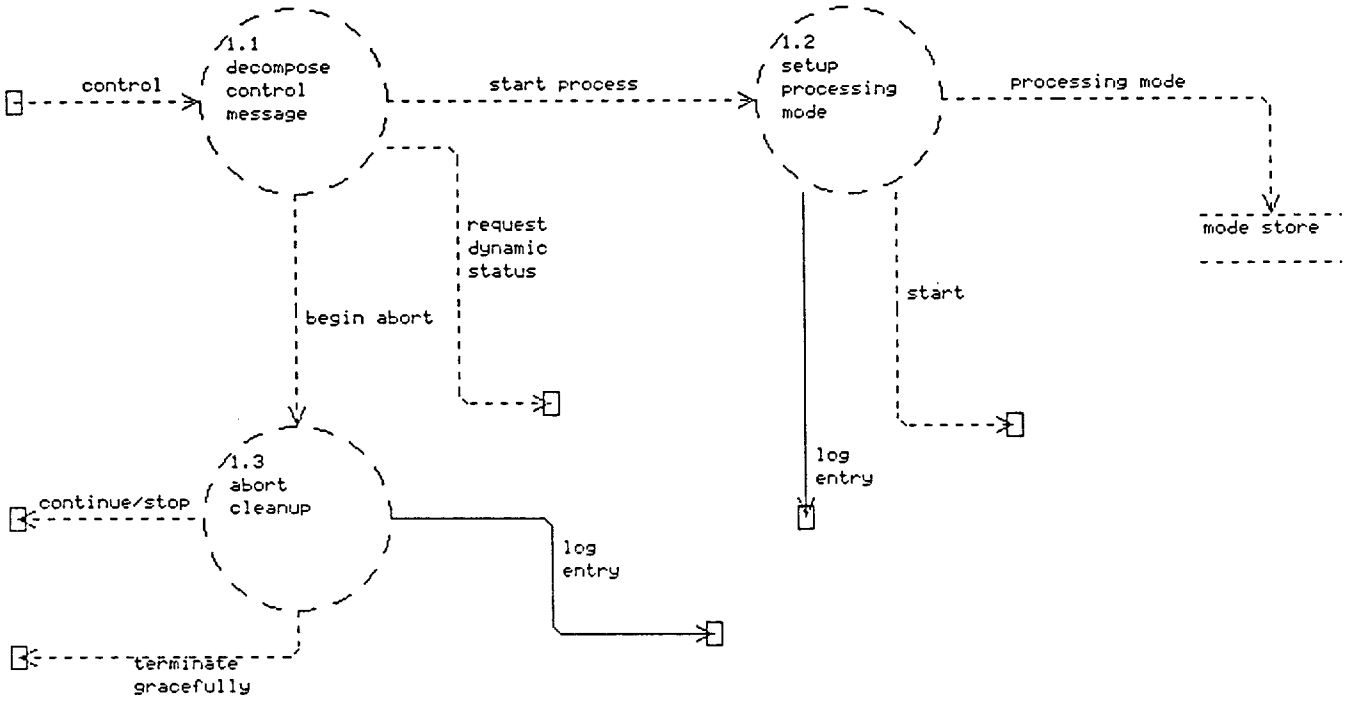
SYMBOL DEFINITIONS
for
Structure Charts

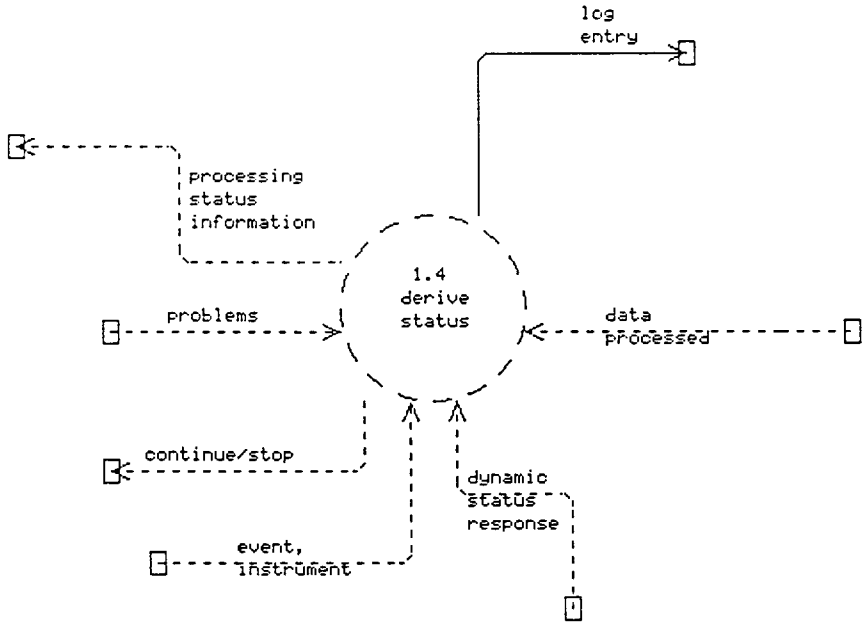
Project : \ECPLUS\MODIS-1A\
Chart : a
Filename : a.trg
Modified : 01-10-1991



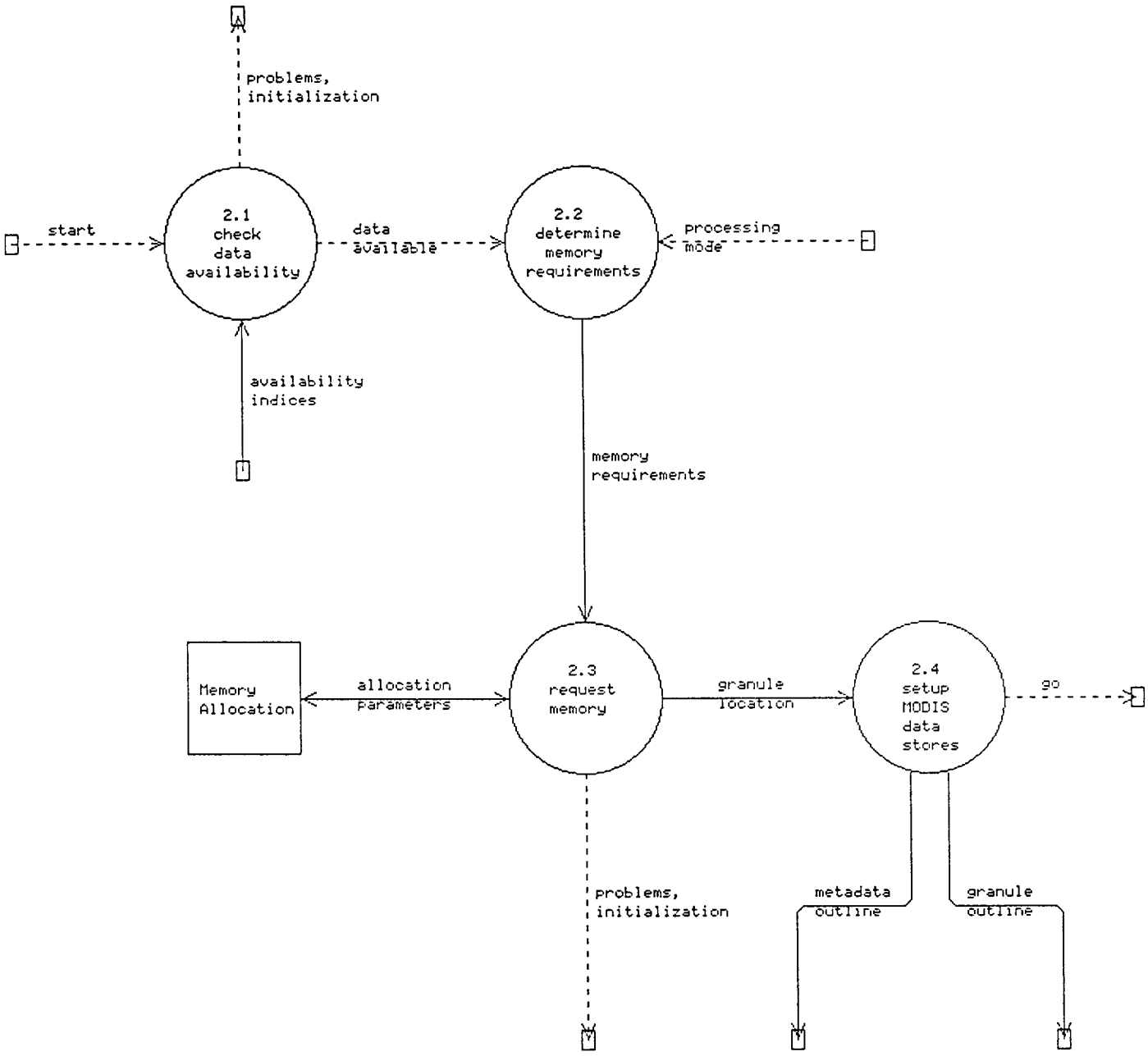

Processing Log
data processed
ate
Dlly
problems, instrument
event, instrument
5.0 append ancillary data to scan cube
scan cube determined
6.0 complete and transmit granule and metadata
output products
PMS
Level-1A product
DADS
metadata
metadata
scan cube
granule w/ header
ncillary
metadata structure
granule structure

Project : \ECPLUS\MODIS-1A\
Chart : b-1
Filename : b-1.trg
Modified : 01-10-1991

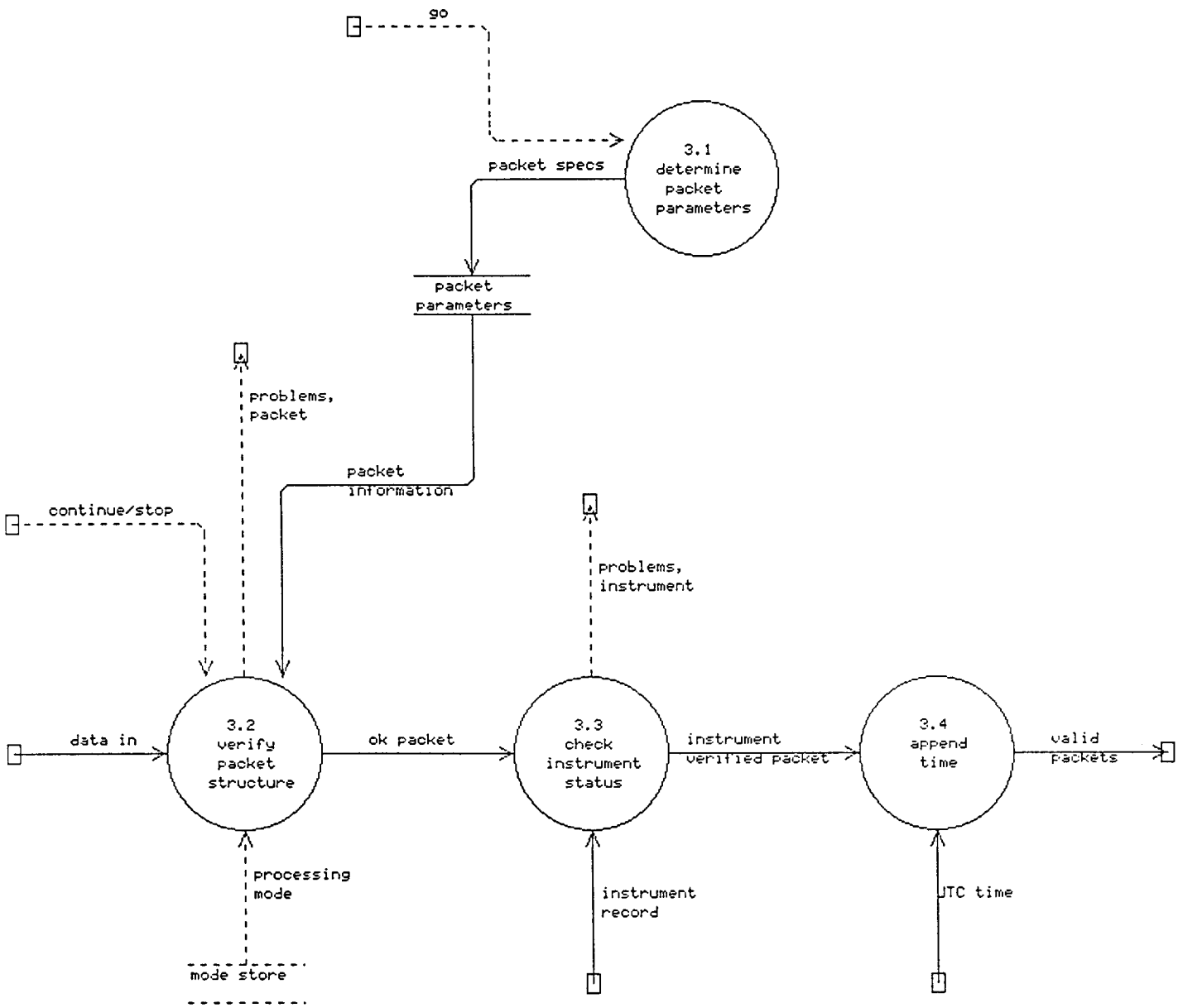




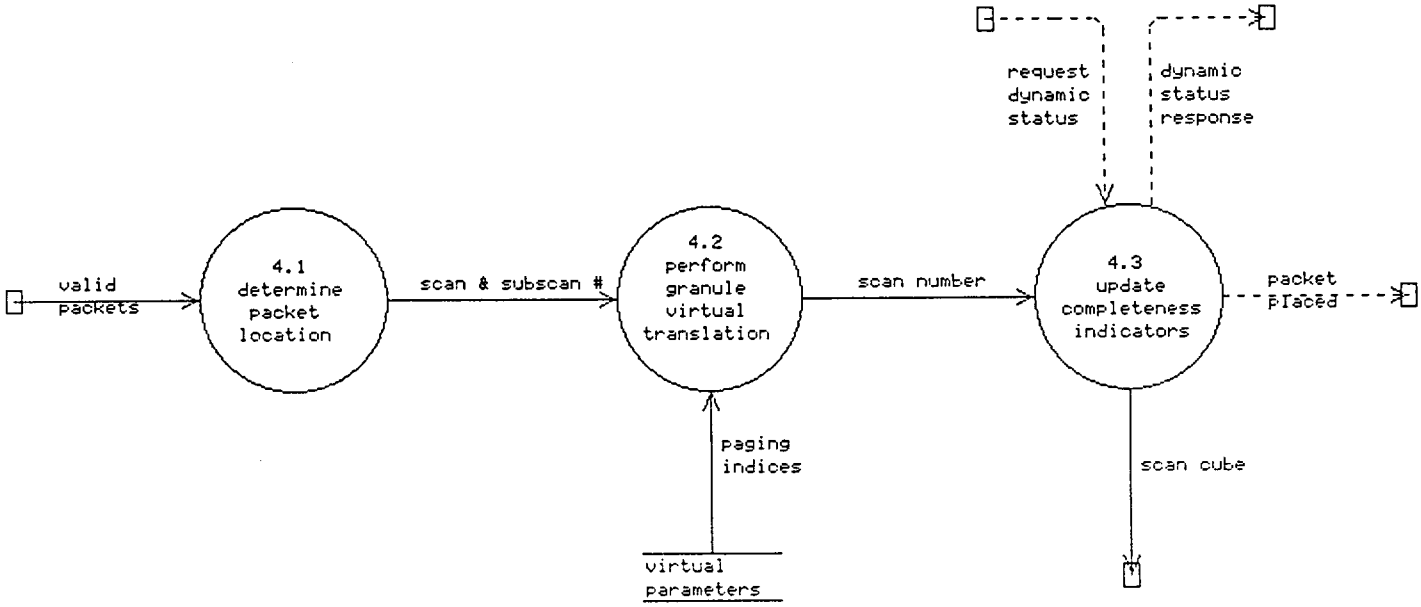
Project : \ECPLUS\MODIS-1A\
Chart : b-2
Filename : b-2.trg
Modified : 01-10-1991



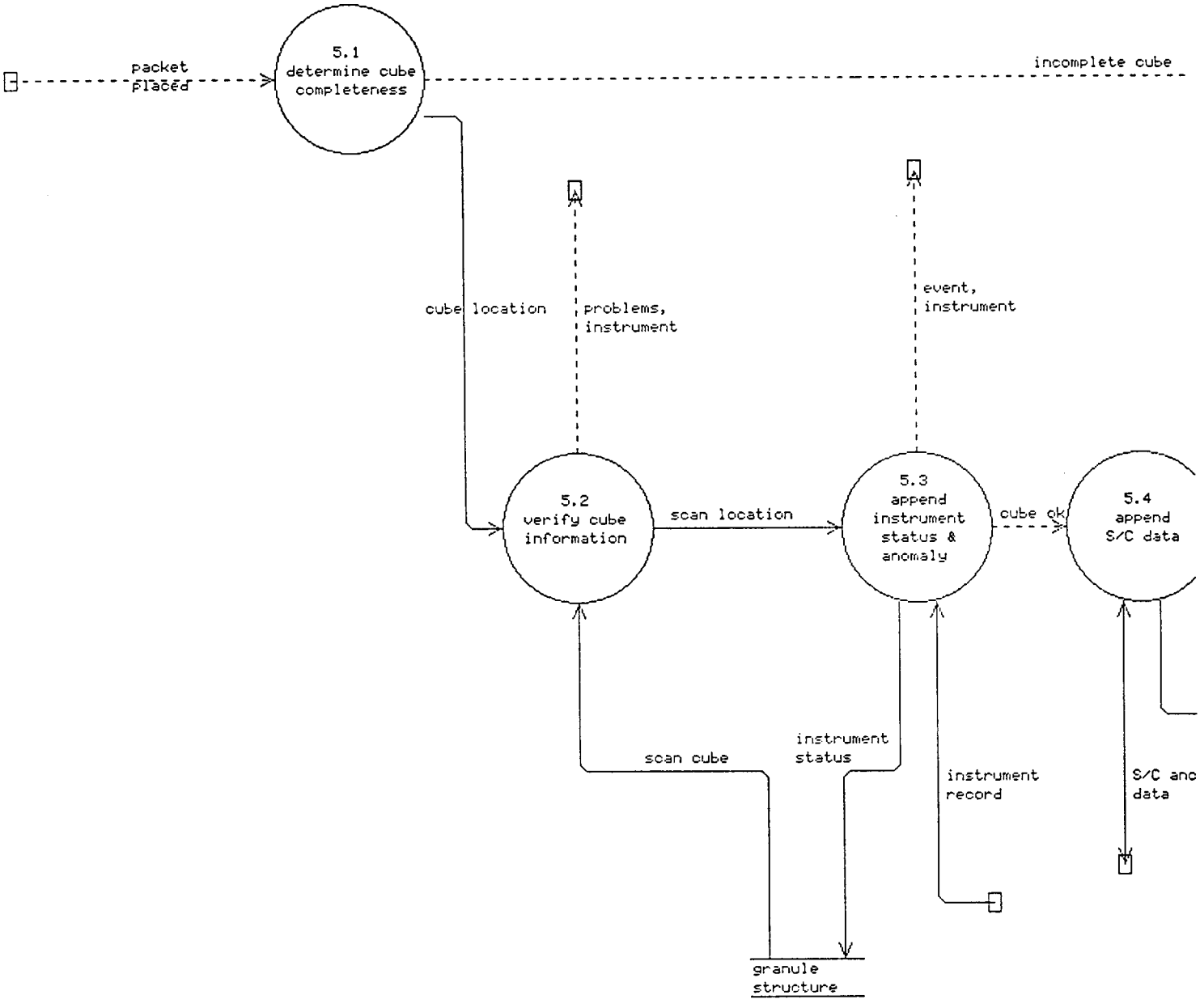
Project : \ECPLUS\MODIS-1A\
Chart : b-3
Filename : b-3.trg
Modified : 01-10-1991

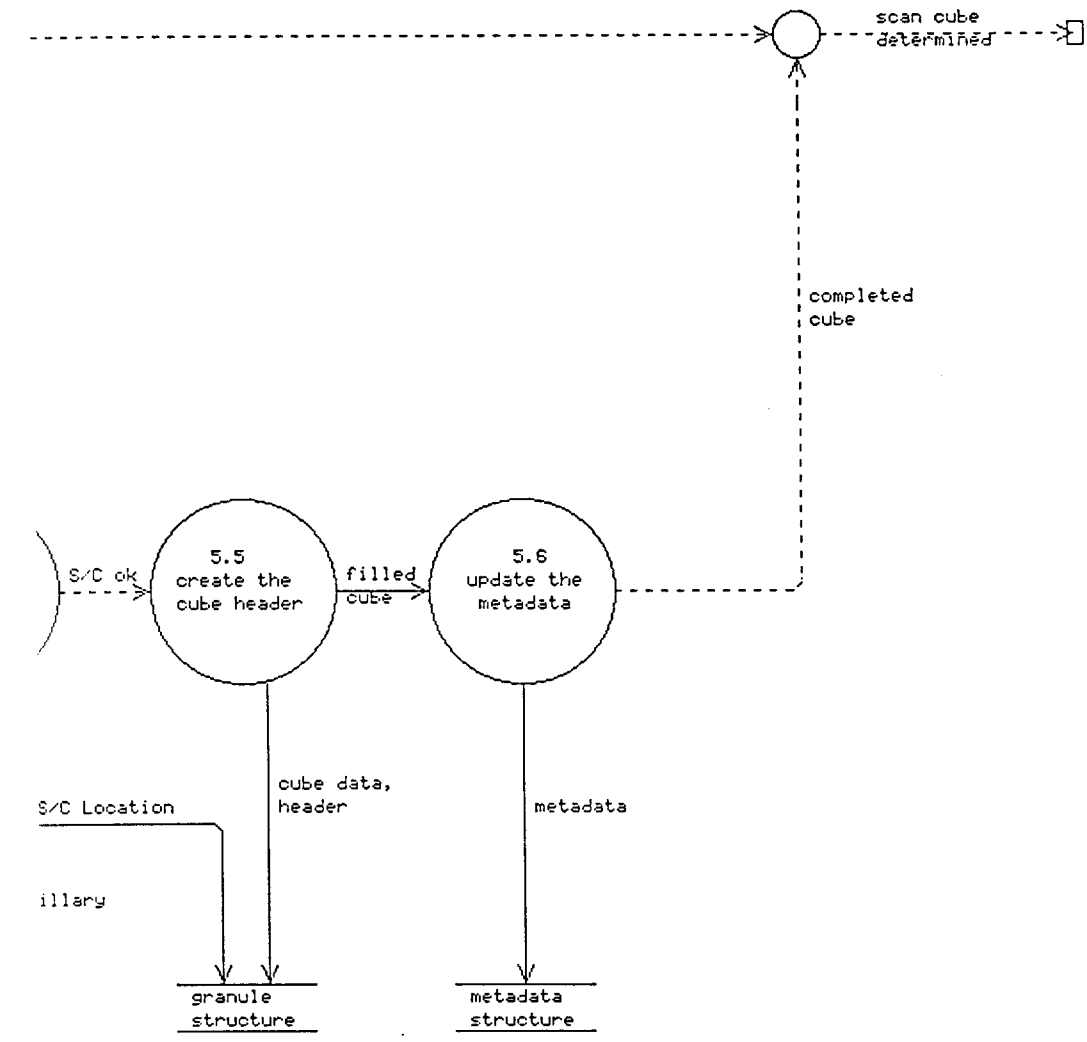


Project : \ECPLUS\MODIS-1A\
Chart : b-4
Filename : b-4.trg
Modified : 01-10-1991

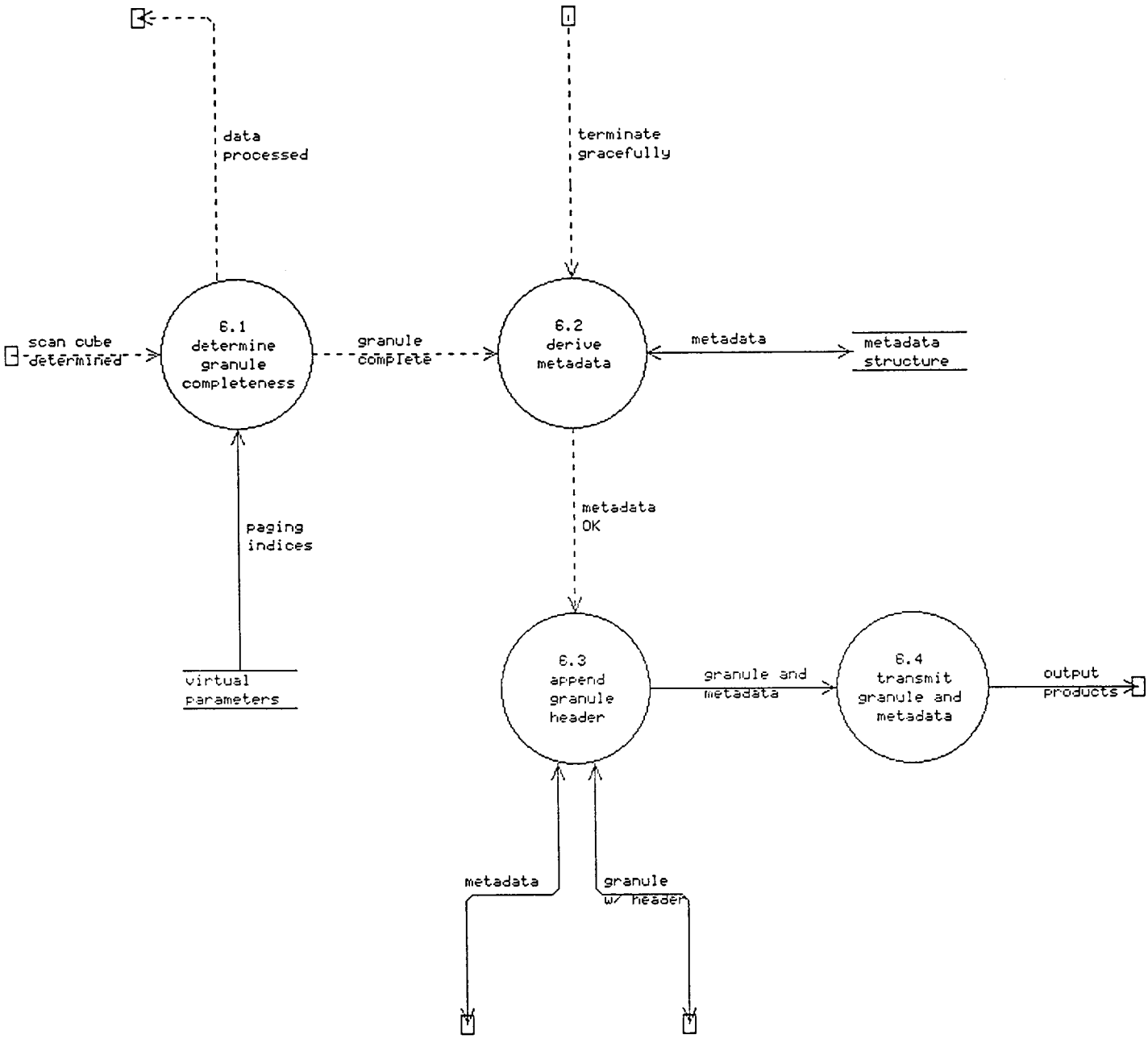


Project : \ECPLUS\MODIS-1A\
Chart : b-5
Filename : b-5.trg
Modified : 01-10-1991




scan cube
determined
completed
cube
S/C ok
5.5
create the
cube header
filled
cube
5.6
update the
metadata
cube data,
header
metadata
S/C Location
illary
granule
structure
metadata
structure

Project : \ECPLUS\MODIS-1A\
Chart : b-6
Filename : b-6.trg
Modified : 01-10-1991



Project : \ECPLUS\MODIS-1A\

Dictionary Entry Description Attribute Report for Object Type = All
(* indicates deleted DDE)

Object Identifier	Object Type	Description Attribute
Begin Abort	Control Flow	An indicator to begin an orderly abort of the processing. Files are not posted. Either a graceful termination or an immediate abort.
Completed Cube	Control Flow	All data necessary to complete a scan cube of information has been performed, and the granule has been updated. A message with the scan cube location description.
Continue/Stop	Control Flow	An indication to continue or stop processing data. Ask for the next packet, or stop asking for packets from the DADS.
Control	Control Flow	A message that informs the process which mode to operate in, to start, cancel, suspend, resume, to request and return status (dynamically or statically), and to request and verify the staging and/or destaging of data to/from the DADS.
Cube OK	Control Flow	An indication that the scan cube of data has completed instrument related anomaly processing.
Data Available	Control Flow	The data required to process this granule is available from the external databases.
Data Processed	Control Flow	An indication that the process is ready for the next packet. It will also contain an indicator of granule completeness and any error conditions.
Dynamic Status Request	Control Flow	A control item requesting that processing information be posted into a return message. See Dynamic Status Response.
Dynamic Status Response	Control Flow	An internal message that indicates the current status (accounting) of the data processing task.
Event, Instrument	Control Flow	An anomaly has been detected in any of: instrument status between instrument record log and telemetered data, or similiar non catastrophic problem. Does not require immediate attention.
Go	Control Flow	An indication that tells the processor that the store areas have been defined and that data processing can begin.
Granule Complete	Control Flow	An indication that a full granule of data is available and that metadata determination can begin.
Incomplete Cube	Control Flow	An indication that a scan cube has not been completed. More packet data are required.
Metadata OK	Control Flow	An indication that final granule metadata processing is complete.

Packet Placed	Control Flow	A packet (subcube) of data has been placed into the proper granule location in memory, paging if necessary.
Problems	Control Flow	This message can signal an end of data input, signal bad or inappropriate data, request an alarm generation, or other potentially catastrophic (probably stop processing) problem.
Problems, Initialization	Control Flow	A message indicating that a potentially catastropic problem has been detected, such as not enough store space to process the data. This is an alarm, not an event.
Problems, Instrument	Control Flow	An instrument serious discrepancy has occurred (i.e. turned off). This is an alarm, not an event.
Problems, Packet	Control Flow	An alarm message: the process has encountered the last packet, or has encountered a bad/illegal packet.
Process Control	Control Flow	A message from the SCA consisting of: initiate process w/ mode - quick-look, standard, reprocessing dynamic status request; suspend operations; terminate process - now or gracefully.
Processing Mode	Control Flow	A message containing the mode of processing to be performed. (e.g. standard processing, reprocessing, quick-look.)
Processing Status	Control Flow	A message to the SCA containing: dynamic status response; post processing record; alarm/event with anomalies, faults, and exceptions.
Processing Status Information	Control Flow	Information regarding the fault conditions and processing performance of this processor. Status or completion information from the MODIS process to the SCA. May be abnormal, dynamic, or normal termination messages.
S/C OK	Control Flow	An indication that the space craft ephemeris and attitude data have been appended to the proper scan cube structure.
Scan Cube Determined	Control Flow	All tests for a completed scan cube have been performed, no judgement is made of the results of these tests.
Start	Control Flow	Starts the process with initialization parameters from which the store sizes can be calculated.
Start Process	Control Flow	The result of an "initiate processing" message type being passed to the MODIS processor from the SCA.
Terminate Gracefully	Control Flow	An indicator that instructs the process to finalize any remaining products, clean up and return data stores to the operating system, and post/close any files used.
Mode Store	Control Store	A store containing all information necessary to determine the scope of processing to be performed. I.e. begin and end time, # of packets, mode, etc
Abort Cleanup	Control Transform	Processes the termination messages into

		the proper flow control items. This can be a graceful or abort-now condition. Posts an entry to the Processing Log.
Decompose Control Message	Control Transform	Parses the incoming message to determine message type and where to send it.
Derive Status	Control Transform	Handle problem and event messages as well as termination messages, post the system processing log message and pass a message to the EOSDIS SCA processor.
Process Control	Control Transform	Handles the control functions of the processor. Interfaces with the context environment via the EOSDIS SCA process.
Setup Processing Mode	Control Transform	Derives the mode parameters, posts an entry to the system processing log, and starts the show.
Allocation Parameters	Data Flow	A request to the operating system for storage allocation, and a response with the parameters, or an error indication.
Availability Indices	Data Flow	An enquiry to, and a response from the external databases with a map of the data set sizes and completeness that is used to determne if the MODIS level-1A processing can be performed.
Cube Data, Header	Data Flow	The scan cube (not structure) header information for this completed cube of MODIS data (including selected metadata items) to be placed into the granule structure.
Cube Location	Data Flow	The memory location of the completed scan cube. This cube must be in memory, not in the disk backing store.
Data In	Data Flow	Level-0 data or quick-look data in packet (subcube) form.
Filled Cube	Data Flow	A scan cube of data has been filled with all data from the satellite, including the cube header. Metadata and scan cube completeness indicators to follow.
Granule Outline	Data Flow	Addresses, sizes, and types of the MODIS granule store area. This includes disk and memory areas. The store area values are initially defined with invalid data.
Granule and Metadata	Data Flow	A flag indicating that all granule processing has been performed and this granule can be transmitted (actual or pointer) to the PMS.
Granule w/Header	Data Flow	All granule header information including most or all metadata items.
Input	Data Flow	Includes all of: Level 0 data w/science, engineering, & audit trail; Spacecraft ancillary w/ audit; Quick-look data; Locally maintained databases w/ browse criteria; Metadata w/ anomaly & audit trail.
Instrument Record	Data Flow	The current state of the MODIS instrument at the specified time. This is an integration of all previous status commands, not a history of status events.
Instrument Status	Data Flow	MODIS instrument information derived in combination with the telemetered and the Instrument Log information. This may

		include status as well as characterization parameters.
Instrument Verified Packet	Data Flow	A flag indicating that an OK packet with time tag added and instrument status has been processed.
Level-1A Product	Data Flow	MODIS level-1A product, verified by PMS (IMS) which are then passed to the DADS for dissemination.
Log Entry	Data Flow	A record to be posted in the EOSDIS (or other) master processing log. This leaves an audit trail in the legal sense.
Memory Requirements	Data Flow	The derived size of the level-1A storage area needed to process this granule of data.
Metadata	Data Flow	Information derived from data sets that provides an understanding of the content or utility of that data set.
Metadata Outline	Data Flow	Addresses, sizes, and types of the metadata store allocation. This sets up the metadata memory area and initializes that area with predefined values representing invalid data.
OK Packet	Data Flow	A flag indicating that a correct packet has been obtained.
Output	Data Flow	Consists of: Level-1A data product w/ header, data,DQ information; Processing Log; Metadata w/ audit trail; Browse data; Quick-look product.
C t Products	Data Flow	MODIS level-1A data product consisting of metadata, and the level-1A data granule. This can be standard, quick-look, or reprocessed products.
Packet Information	Data Flow	size, ID location, etc. of packet structure parameters. To be used to verify that the correct packets have been received from the DADS.
Packet Specifications	Data Flow	Packet parameters to be used for verification of the packet integrity (not instrument data).
Paging Indices	Data Flow	Internal pointers and flags that are used to manage the virtual to/from physical addressing of the MODIS granule structure.
S/C Ancillary Data	Data Flow	Spacecraft ephemeris and attitude data obtained from a database within the EOSDIS system.
S/C Platform Location	Data Flow	
Scan Cube	Data Flow	Data (science and engineering) in a scan cube format with ancillary data appended. Scanning parameters are TBD.
Scan Location	Data Flow	An indication that the instrument data within a scan cube has been processed and that additional scan items need further processing.
S Number	Data Flow	The number of the scan cube and location that the current packet belongs in.
Scan and Subscan Number	Data Flow	The scan cube number and packet subscan number which determines the location of this packet in the level-1A structure.
UTC Time	Data Flow	EOSDIS universal time. Similar to GMT.

		Used to time stamp processor log entries and data packets (for inclusion in the data cube).
Valid Packets	Data Flow	Packets of subcube data that have passed packet, not data, sanity checks such as instrument ID, packet size, etc.
Append Granule Header	Data Process	Append this granule (not scan cube) header to the granule product. This will include most or all of the values from the metadata as well as other information.
Append Instrument St. & Anomaly	Data Process	Determine any instrument based information (characterization) and post any status or derived items into the granule.
Append S/C Data	Data Process	Append platform ephemeris and attitude information to the scan cube. This represents the S/C data in the neighborhood of the scan cube time, not at the scan cube time.
Append Time	Data Process	Append current EOSDIS UTC time to the packet. This allows for an audit trail and an indication of packet time locality for future processing refinement.
Append to Scan Cube	Data Process	Test for a completely filled scan cube of data, append instrument and S/C data to the scan cube, create the scan cube header, and update selected metadata values.
Check Data Availability	Data Process	Perform a verification that the data (MODIS instrument, S/C ancillary, and Instrument Log) required to complete the granule is available to this MODIS level-1A processor.
Check Instrument Status	Data Process	Examine the instrument bits for ON/OFF, state, other instrument sanity checks.
Complete and Transmit G & M	Data Process	Perform final accounting at the granule level, fill in remaining metadata items, determine and apply the granule header, and deallocate memory and disc stores.
Create the Cube Header	Data Process	Determine all the items to be placed in the header of a scan cube. This includes the completness indicators.
Derive Metadata	Data Process	Determine all the remaining metadata values to be placed into the metadata store. If CDOS supplies a management information record (MIR) or a post event record (PER), then it will be appended to the MODIS metadata product.
Determine Cube Completeness	Data Process	Check completeness flags to see if this scan cube has all its data. A preliminary accounting of the number of subscans placed in this cube will speed up this process.
Determine Granule Completeness	Data Process	Determine if the entire data set granule has been filled. If so, indicate a desire to terminate, but allow further packets to be processed. This allows duplicate packets to be handled and accounted.

Determine Memory Requirements	Data Process	Calculate the memory and backing store size requirements as a function of the requested input data set size, mode, or other parameters.
[mine Packet Location	Data Process	Extract the scan cube number and subscan packet number from the packet.
Determine Packet Parameters	Data Process	Set up and fill the store area with the parameters necessary to verify the packet integrity. These are derived from SCA information.
Initialize Data Structure	Data Process	Setup the memory areas (both memory and disc) for the output products (data set granule and metadata).
MODIS-1A Product Generation	Data Process	The process that generates level-1A data from level-0 data packets. This includes headers, status, data quality, and metadata.
Perform Granule Virtual Xlation	Data Process	Determine if the scan cube location for this packet is currently in memory. If not, perform the physical/virtual memory mapping with scan cube posting if required.
Place Packet into Granule	Data Process	Checks instrument status indicators, appends S/C platform ephemeris and attitude, updates packet accounting, optionally byte aligns data.
Request Memory	Data Process	Ask the operating system for system resources to allow processing of this data set. This includes processor and disk memories.
Setup MODIS Data Stores	Data Process	Determine and initialize all level-1A stores - either in memory or on disk as needed.
Transmit Granule and Data	Data Process	Pass either the data products (meta and granule) or pointers to the products to the external EOSDIS PMS processor for ultimate inclusion in the DADS after IMS validation input.
Update Completeness Indicators	Data Process	Set the bit for this packet location in the scan cube that indicates that these data have been found. If a dynamic status has been requested, generate a response accounting message.
Update the Metadata	Data Process	Make any of the necessary metadata items current. An update process.
Verify Cube Information	Data Process	Perform a verification of data unique to the concept of a scan cube. This may be expanded to include noise analysis, A/D conversion verification, data orthogonality, etc.
Verify Incoming Data	Data Process	Perform sanity checks on the raw packets for packet integrity and instrument preliminary condition, and append a time stamp.
Verify Packet Structure	Data Process	Check for correct packet size, ID, CRC, and other sanity checks. Instrument data is not included here.
Granule Structure	Data Store	The storage area for the data set granule consisting of multiple scan cubes, multiple scan cube header, and a granule header. A scan cube consists of

		instrument science and engineering data.
Metadata Structure	Data Store	The storage area for the MODIS Level-1A metadata values.
Packet Parameters	Data Store	Specifiers of the packet size, ID, etc.
Virtual Parameters	Data Store	An internal store used to keep track of all counters and flags associated with the concept of a virtual demand paged storage allocation. This allows user defined page sizes which are each expected to be several MegaBytes in length.
DADS	External Entity	Data Archive and Distribution System. The database manager for input and output data.
Get Instrument Status	External Entity	The find current-instrument-status process. This is not a history of status events, but access to a flat file database of status versus time.
Get S/C Ancillary Data	External Entity	A separate process that returns platform ephemeris and attitude data in the neighborhood of the requested time.
Memory Allocation	External Entity	An operating system memory (and disk) allocation routine. A process requests storage allocation and the system returns error or location parameters.
PMS	External Entity	Product Management System - Performs data management of processed data, adds further DQ infomation before passing the data to the DADS.
Processing Log	External Entity	Log of processing status records, time sequential events. This is not the current status but a time based history of status events.
SCA	External Entity	Schedule, Control, Accounting. An EOSDIS process to perform scheduling of Product Generation System (PGS) programs.
Wall Time	External Entity	An EDSDIS or operating system service that returns the current time (=GMT).
a	trg	The first, upper (A) level of the MODIS level-1A structured diagrams. See also: the Context diagram. This is the beginning of the structured design Behavioral Model.
b-1	trg	The second (B) level diagram for the MODIS level-1A control functions.
b-2	trg	The second (B) level diagram for the MODIS level-1A initialization process.
b-3	trg	The second (B) level diagram for the MODIS level-1A incoming packet verification process.
b-4	trg	The second (B) level diagram for the MODIS level-1A packet placing process.
b-5	trg	The second (B) level diagram for the MODIS level-1A scan cube processor.
b-7	trg	The second (B) level diagram for the MODIS level-1A granule processor.
context	trg	The context diagram for the MODIS level-1A data processor. This is the structured design Environmental Model.
sample	trg	
Flag	doc	An internal process variable or external

		operating system semaphore indicating an alert to another process.
Granule	doc	A convenient quantity of data with defin ed boundaries. This may be an orbit, scan cube, or other quantuum of data.
Indication	doc	A generic term for either a flag or a message. The type of indication (flag, semiphore, or message) is to be determined when the design is further advanced towards completion.
Message	doc	A buffer with information for another process (or subprocess). It may contain control information or data. The message is usually sent without waiting for an acknowledgement and initiates an external (to this process) action.
Packet	doc	A quantity of data that has no well defined boundaries other than size. The packet has data with appended header or data quality indicators such as frame syncs, CRCs, and/or Reed-Solomon error detection/correction.
Scan Cube	doc	A set of MODIS instrument data that corresponds to a sweep of the instrument mirror or other scanning device. A scan cube has three dimensions: along track, across track, and depth of wavelength or frequency.
Subcube	doc	A subset of a scan cube. The scan cube may be decomposed into packets, scan lines, bands, etc. The subcube is an element of the composite scan cube.

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121 Data Dictionary Entries Printed.

This is the ASSUMPTIONS list for
the MODIS-1A Processing System Design

The MODIS level-1A processing program will not be required to convert the level-1A data back to the original level-0 data products. This function will be handled by a separate program. The separation of these two tasks allows one program to be modified or updated without disturbing the integrity of the other program. This reversability of the data processing task allows a permanent archive of the level-1A data product with metadata in place of an archive of the level-0 data product. Duplicate data packets and illegal (non-MODIS) packets labeled as MODIS packets would not be able to be regenerated. The MODIS processing program will, however, generate processing anomality messages that will contain these illegal packets of data.

A packet of MODIS data will not be spread across more than one scan cube. This implies that the scan cube boundaries coincide with the packet boundaries. Any concept of a subcube will also be on scan cube boundaries.

A packet of data will contain a sequence count that increments for each scan cube interval, and a packet count that starts at 0 at the beginning of each scan cube and increments until the end of the scan cube. This will be used to re-order the packets that may have been scrambled in the TDRSS and/or CDOS packet transmission store and forwarding system.

The instrument state that determines characterization quantities can not be determined until the entire cube of data has been received.

Spacecraft platform ephemeris and attitude data will be processed externally to the MODIS-1A processing. This is an item that is common to all instrument processing, not just the MODIS instrument. This ephemeris and attitude data is appended to the level-1A data set as a convience to later processing and is not needed at the time of level-1A processing. As this spacecraft information is transmitted in a separate packet format within a separate data stream from any instrument data, it can be eliminated from the MODIS level-1A processing program and only used in the MODIS level-1B processing when the ground anchor points are derived.

The information given by the Instrument Status enternal entity is derived from the contents of an instrument data store that contains the "Instrument Status Information" as defined in the context diagram. This methodology needs to be further defined at a later time. A separate process could be written that generates a time based, flat file database with instrument status at selected discrete times, derived from the instrumnet command log entries.

The system needs to potentially respond to several packet and/or information sources. These include scheduling messages, EOF with accounting packets, normal MODIS packets (in several sub forms such as calibration, diffuser, normal, etc), quick look packets, instrument mode designation packets (tilt angle verification, etc).

The concept of a granule of data is a logical division of the instrument data for science and data processing purposes and contains multiple whole scan cubes of data. This is similiar to an orbit or a scene of data.

Interface Descriptions between the MODIS Level-1A Processing and the External EOSDIS Entities

INTRODUCTION: This document describes the data interfaces between the MODIS Level-1A processor and the entities that are external to this process, but are contained within the EOSDIS computer system. This is a preliminary document and subject to change as the various processes described within are further defined and implemented.

From SCA to MODIS Level-1A Process

The Scheduling, Control, and Accounting (SCA) external entity is the master controller of the various EOSDIS Product Generation Systems (PGS), of which the MODIS Level-1A is a component. This SCA function controls the MODIS data processor by three methods: Initiation, Dynamic Status Request, and Termination. These controls are implemented as messages to the MODIS processor.

INITIATION: This is a message that the MODIS processor obtains from the operating system before performing any further actions. The message contains information indicating the type of data to be processed (standard, quick-look, or reprocessing mode), the quantity of data to be produced (output granule size), possibly the packet parameters and instrument IDs, and a file name (or other indicator) indicating the location of the MODIS Level-0 Data with its associated ancillary data (either as a metadata file or special record with the Level-0 Data).

DYNAMIC STATUS REQUEST: This is a message generated by the SCA and posted to the operating system. It is treated as a flag indicating that a Dynamic Status Response message is to be generated. The MODIS processor looks for the presense of this request message at selected points in the data flow processing by interrogating the operating system. If a message is present, a return message is generated. The request message can be generalized (enhanced) by adding parameters that indicate the format or content of the MODIS processor generated response message.

TERMINATION: This is an asynchronous message generated by the SCA that tells the MODIS processor to perform a termination or processing. The contents of this message indicate an abort termination of a graceful termination. The MODIS processor returns a post-processing message indicating that the requested termination has been performed. The MODIS process can then be removed from memory or restarted as necessary.

To SCA from MODIS Level-1A Process

The MODIS processing program can generate four types of messages to the SCA. These consist of the Post Processing and the Dynamic Status Response messages that have been solicited by the SCA, and the Alarm and

Event unsolicited messages.

POST PROCESSING: This is the final accounting message to the SCA that indicates the termination status of the MODIS Level-1A process. It is posted to the operating system for retrieval by the SCA upon MODIS termination. The accounting message contains the file name (location) of the output data granule and metadata products, an indication of the quality of the processing (criteria to be determined), and an indication of the quantity (size) of the data produced.

DYNAMIC STATUS RESPONSE: This response message to a Dynamic Status Request message contains the information necessary for the SCA to determine the processing completion. This includes the number of expected and already processed packets, an estimate of the percentage of data processing completion, and an indication of the quantity of data product produced up to this time. An indication of data quality may also be included.

ALARM: This is an unsolicited message from the MODIS processing program to the SCA indicating that a serious problem has occurred within the MODIS processor. The contents of this message indicate the nature and severity of the problem. The message is expected to have indicator flags (predefined error values) as well as a character based message for operator display.

EVENT: This is another form of an unsolicited message from the MODIS processor to the SCA. This message contains indicator flags for predetermined anomalies and a character based message, but it is expected to be passed to the instrument investigators for evaluation instead of the SCA. This message does not indicate a serious problem with the processing.

DADS

This external process handles the data archiving and distribution system (DADS) functions. The MODIS Level-1A program will, using the file name indicated in the SCA start message, ask for the MODIS Level-0 Data from the DADS using a normal operating system, file based, data access query. This will include an indication of the validity of the file record transfer with any error conditions. This is a synchronous transfer using operating system supplied handshaking.

PMS

This EOSDIS processing Product Management Service (PMS) function will accept the MODIS Level-1A Data products consisting of the MODIS instrument science and engineering data in MODIS Level-1A Granule format and the MODIS Level-1A Metadata. This external entity will in turn interrogate the Information Management System (IMS) for additional metadata items before transmitting the data products to the DADS for archive and distribution. If this data is to be passed from the MODIS processor as file names (pointers), then these file names will be transmitted to the SCA in a termination message and posted in a message

to the PMS processor. This is the recommended approach. If the data is passed directly to a concurrent PMS program, then the data records will be transmitted using a handshaking protocol between the PMS and MODIS programs.

Get S/C Ancillary Data

This is an EOSDIS function that will be required for all instruments. The format of the request to this process will indicate the items of interest to the calling process. For the MODIS Level-1A process as a minimum, this includes the spacecraft (S/C) ephemeris and attitude information consisting of the ten time-based S/C packets of ephemeris and attitude information localized to the MODIS scan cube time. In addition, there may be a requirement for other instrument scan positions as these scan positions can be coupled to the MODIS instrument pointing determination via the spacecraft platform dynamics. This S/C Ancillary Data is appended to the Level-1A product as a convenience to the MODIS Level-1B processing program which will perform the ground location determination of the pixels in the MODIS instrument scan.

Get Instrument Status

This is a MODIS unique external process that is used to maintain a database (flat file format) of current instrument status versus time. The status data are derived from the instrument command log and are used for comparison with the telemetered data. This process is called with a specified time value, and the process returns the total current instrument status at that specified time. The time can be in a compacted format as well as the instrument status. The status items are to be defined upon completion of the instrument design.

Processing Log

This process accepts a message with a formatted time stamp and posts this message into a processing accounting log that can be either unique to a program, instrument, or the entire EOSDIS system. The purpose of this entity is to allow other programs and databases to determine when processing has been started, stopped, suspended, or otherwise managed. This log is used to prove that the MODIS processor has performed certain tasks and when those tasks were initiated and completed.

Memory Allocation

This entity accepts requests from the MODIS processor for computer memory resources, both disk based and memory based. A request for disk based memory will include the size of the disk area requested. The external process will return the file name (implying the location) or and error indication. As some operating systems will not preallocate disk space, the MODIS program will guarantee this preallocation by filling the disk space with the invalid data qualifiers as described in the Structured Design documents. A request for computer memory will

contain the size of the memory required, with this external entity returning the local addresses or an error condition.

Wall Time

This item returns the current time when requested. The time returned to the calling program is in a compacted format such as milliseconds from the beginning of 1990 (or similiar) and is used for internal accounting purposes. This time is further formatted to allow the time stamping of entries in the Processing Log.

MODIS Team Member Proposal
Data Requirements Form

Investigator:

Output Product(s):
Resolution (Time):

(Space):

Domain (Space):

At/Post-Launch:

MODIS-N/T:

Input Data:

Spectral Bands Required:

Resolution (Time):

(Space):

Ancillary Data Required (Type and Source):

Pre-Launch: Size (Mbytes):

Post-Launch: Size (Mbytes):

Algorithm Complexity (floating point operations/scan):

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan):

Look-Up Tables Required:

Size (Mbytes):

Lines of Code:

Language Expected:

Accessory Output Products (e.g., field experiment data):

Pre-Launch: Size (Mbytes):

Post-Launch: Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required:

MODIS Team Member Proposal
Data Requirements Form

Investigator: Menzel

Output Product(s): Cloud top temperature, cloud top pressure

Resolution (Time): Every 3rd day; 2 times daily; daily/monthly

(Space): 50 km; 5 km; 1° x 1°

Domain (Space): Global

At/Post-Launch: At launch

MODIS-N/T: N

Input Data: MODIS Level-1B

Spectral Bands Required: Band 31 (11.03 μm), Band 33 (13.3 μm)

Resolution (Time): Full

(Space): Full

Ancillary Data Required (Type and Source):

Pre-Launch: **Size (Mbytes):**

Post-Launch: NMC 6 hourly forecasts (18 levels) **Size (Mbytes):**
Surface observing network conventional reports (hourly)
HIRS, AVHRR, LAWS (validation only)

Algorithm Complexity (floating point operations/scan):

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan):

Look-Up Tables Required:

Size (Mbytes):

Lines of Code:

Language Expected: FORTRAN

Accessory Output Products (e.g., field experiment data):

Pre-Launch: Size (Mbytes):

Post-Launch: Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required:

MODIS Team Member Proposal
Data Requirements Form

Investigator: Menzel

Output Product(s): Cloud effective emissivity

Resolution (Time): Every 3rd day; 2 times daily; daily/monthly

(Space): 50 km; 5 km; 1° x 1°

Domain (Space): Global

At/Post-Launch: At launch

MODIS-N/T: N

Input Data: MODIS Level-1B

Spectral Bands Required: Band 31 (11.03 μm), Band 33 (13.3 μm)

Resolution (Time): Full

(Space): Full

Ancillary Data Required (Type and Source):

Pre-Launch: **Size (Mbytes):**

Post-Launch: NMC 6 hourly forecasts (18 levels)
Surface observing network conventional reports (hourly)
Size (Mbytes):

Algorithm Complexity (floating point operations/scan):

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan):

Look-Up Tables Required:

Size (Mbytes):

Lines of Code:

Language Expected: FORTRAN

Accessory Output Products (e.g., field experiment data):

Pre-Launch: Size (Mbytes):

Post-Launch: Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required:

MODIS Team Member Proposal
Data Requirements Form

Investigator: Menzel

Output Product(s): Cloud type, extent

Resolution (Time): monthly

(Space): 50 km

Domain (Space): Global

At/Post-Launch: At launch

MODIS-N/T: N

Input Data: MODIS Level-1B

Spectral Bands Required:

Resolution (Time):

(Space):

Ancillary Data Required (Type and Source):

Pre-Launch: **Size (Mbytes):**

Post-Launch: NMC 6 hourly forecasts (18 levels) **Size (Mbytes):**
Surface observing network conventional reports (hourly)

Algorithm Complexity (floating point operations/scan):

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan):

Look-Up Tables Required:

Size (Mbytes):

Lines of Code:

Language Expected: FORTRAN

Accessory Output Products (e.g., field experiment data):

Pre-Launch: Size (Mbytes):

Post-Launch: Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required:

MODIS Team Member Proposal
Data Requirements Form

Investigator: Menzel

Output Product(s): Cloud droplet size (particle radius)

Resolution (Time): Every 3rd day; 2 times daily; daily/monthly

(Space): 50 km; 5 km; 1° x 1°

Domain (Space): Global

At/Post-Launch: Post launch

MODIS-N/T: N

Input Data: MODIS Level-1B

Spectral Bands Required: Band 16 (8.65 μm), Band 31 (11.03 μm), Band 33 (13.3 μm)

Resolution (Time): Full

(Space): Full

Ancillary Data Required (Type and Source):

Pre-Launch: **Size (Mbytes):**

Post-Launch: **Size (Mbytes):**

Algorithm Complexity (floating point operations/scan):

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan):

Look-Up Tables Required:

Size (Mbytes):

Lines of Code:

Language Expected: FORTRAN

Accessory Output Products (e.g., field experiment data):

Pre-Launch: Size (Mbytes):

Post-Launch: Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required:

MODIS Team Member Proposal
Data Requirements Form

Investigator: Menzel

Output Product(s): Atmospheric stability, total preciptitable water, ozone

Resolution (Time): 2 times daily; daily/monthly

(Space): 5 km; 0.5° x 0.5°

Domain (Space): Global

At/Post-Launch: At launch

MODIS-N/T: N

Input Data: MODIS Level-1B

Spectral Bands Required: IR bands

Resolution (Time): Full

(Space): Full

Ancillary Data Required (Type and Source):

Pre-Launch: **Size (Mbytes):**

Post-Launch: NMC 6 hourly forecasts (18 levels) **Size (Mbytes):**
Surface observing network conventional reports (hourly)
Surface observations, GOES I/M, AMSU, HIRS, AIRS (validation only)

Algorithm Complexity (floating point operations/scan):

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan):

Look-Up Tables Required:

Size (Mbytes):

Lines of Code:

Language Expected: FORTRAN

Accessory Output Products (e.g., field experiment data):

Pre-Launch: Size (Mbytes):

Post-Launch: Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required: