Clouds and the Earth's Radiant Energy System (CERES)

Data Management System

Interface Requirements Document

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Preface

The Clouds and the Earth's Radiant Energy System (CERES) Data Management System supports the data processing needs of the CERES Science Team research to increase understanding of the Earth's climate and radiant environment. The CERES Data Management Team works with the CERES Science Team to develop the software necessary to support the science algorithms. This software, being developed to operate at the Langley Distributed Active Archive Center, produces an extensive set of science data products.

The Data Management System consists of 12 subsystems; each subsystem represents a stand-alone executable program. Each subsystem executes when all of its required input data sets are available and produces one or more archival science products.

The documentation for each subsystem describes the software design at various significant milestones and includes items such as Software Requirements Documents, Data Products Catalogs, Software Design Documents, Software Test Plans, and User's Guides.

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1.0 Introduction

The Clouds and the Earth's Radiant Energy System (CERES) is a key component of the Earth Observing System (EOS). The CERES instruments are improved models of the Earth Radiation Budget Experiment (ERBE) scanner instruments, which operated from 1984 through 1990 on the National Aeronautics and Space Administration's (NASA) Earth Radiation Budget Satellite (ERBS) and on the National Oceanic and Atmospheric Administration's (NOAA) operational weather satellites NOAA-9 and NOAA-10. The strategy of flying instruments on Sun-synchronous, polar orbiting satellites, such as NOAA-9 and NOAA-10, simultaneously with instruments on satellites that have precessing orbits in lower inclinations, such as ERBS, was successfully developed in ERBE to reduce time sampling errors. CERES will continue that strategy by flying instruments on the polar orbiting EOS platforms simultaneously with an instrument on the Tropical Rainfall Measuring Mission (TRMM) spacecraft, which has an orbital inclination of 35 degrees. In addition, to reduce the uncertainty in data interpretation and to improve the consistency between the cloud parameters and the radiation fields, CERES will include cloud imager data and other atmospheric parameters. The first CERES instrument is scheduled to be launched on the TRMM spacecraft in 1997. Additional CERES instruments will fly on the EOS-AM platforms, the first of which is scheduled for launch in 1998, and on the EOS-PM platforms, the first of which is scheduled for launch in 2000.

1.1 Purpose of Document

One purpose of this Interface Requirements Document (IRD) is to describe data required by the CERES Data Management System (DMS) from external sources. It describes the technical and logistical requirements for the data and gives an overview of the organizations which contribute to the generation of the raw data and the specific data products required. This IRD is the definitive document for interface requirements by the CERES DMS for input data from external sources and is the basis for specifying interfaces for these data.

The secondary purpose of this IRD is to provide an overview of the relationship of the CERES DMS to components of the Langley Research Center (LaRC) Distributed Active Archive Center (DAAC). The interfaces between the CERES DMS and the LaRC DAAC components provide for exchange of archival and nonarchival data between the CERES DMS and the following components: Data Archival and Distribution System (DADS), Planning and Data Processing System (PDPS), Information Management System (IMS), and Nonarchival Storage System (NSS). The IRD is the definitive document for the archival and non-archival data interface requirements between the CERES DMS and the LaRC DAAC.

1.2 Document Organization

Section 1 Introduction - Describes purpose and organization of document

Section 2 Overview - Gives an overview of contributing facilities, interfaces between the LaRC DAAC and sources of external data, and interfaces between the CERES DMS and components of the LaRC DAAC.

Section 3 Interface Specifications - Describes details of interfaces for data from external sources required by the CERES DMS and describes internal interfaces for the exchange of input and output data between the CERES DMS and components of the LaRC DAAC.

1.3 Document Status and Schedule

The September 1994 Version 0 release is a draft of Sections 1.0 through 3.2. The remaining Sections (3.3 - 3.8) will be completed after the Release 1 software requirements phase, which is scheduled to be completed in October 1994.

2.0 Overview

2.1 Introduction

The CERES Data Management System (DMS) is a multiple-module software system which executes within the LaRC DAAC to produce CERES science data products. The system requires data from sources whose origins are external to the LaRC DAAC as well as data which are normally produced by the DAAC and are resident there. Figure 2-1 illustrates the interfaces for the three categories of external input data required by the CERES DMS, (1) - CERES instrument and spacecraft ancillary data (2) - archival ancillary science data and (3) - nonarchival ancillary data. Figure 2-1 also illustrates interfaces for exchange of data between the CERES DMS and components within the LaRC DAAC. Archival data of external and internal origin are stored in the Data Archival and Distribution System (DADS) from where the data are accessed by the CERES DMS. Likewise, non-archival data of external and internal origin are stored in the non-archival data storage system of the DAAC and are accessed by the CERES DMS through different interfaces.

The CERES DMS can access most archival data from the DADS using standard toolkit software provided by EOS. It can also access some of the nonarchival data through standard toolkit software. However, the CERES DMS will be required to access some of these input data through software tools developed specifically for the CERES DMS by the CERES Project. Reference 1 lists and describes the standard software tools provided by EOS to access archival data.

2.2 Relevant Organizations

Several organizations and facilities contribute to the acquisition of the raw CERES instrument data and to the processing of these data into products required by the CERES DMS. Others, including communication networks, contribute to the transmission and delivery of the required data. The following is a brief description of contributing organizations and facilities.

2.2.1 CERES Project Teams

Three CERES Project Teams contribute to the development of the design and operation of the CERES instruments and to the handling and processing of the CERES data. These teams coordinate among themselves and TRW, the prime contractor, to develop and build the CERES instruments and to insure that the instruments produce the raw data required for CERES science data processing. The teams contribute to the development of the CERES DMS and define input data required to process the raw CERES data and produce science data products.

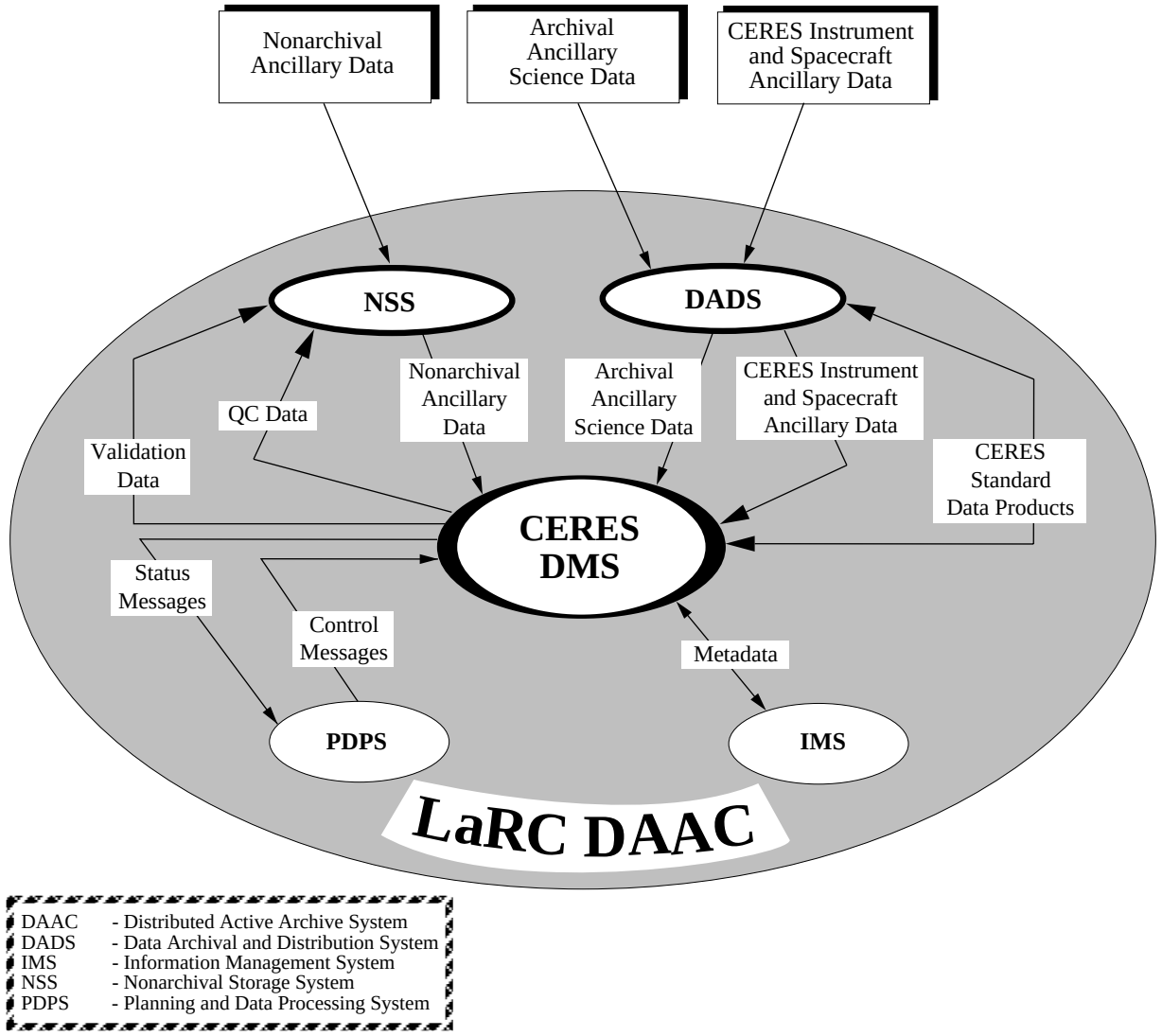


Figure 2-1. Interfaces for Data Required by CERES Data Management System

2.2.1.1 CERES Instrument Development Team

The CERES Instrument Development Team oversees the design and development of the CERES instrument by the prime contractor. Reference 2 describes the primary requirements for the design and development of the CERES instrument and is the major guideline for that purpose. The Instrument Development Team coordinates planning for CERES instrument ground testing and for operating and monitoring CERES instruments aboard the TRMM, EOS-AM, and EOS-PM spacecraft. It performs these tasks in cooperation with the CERES Science and Data Management Teams.

2.2.1.2 CERES Science Team

The CERES Science Team works closely with the Instrument Development Team to insure that the design of the CERES instrument meets the CERES science requirements. It works with the Instrument Development and Data Management Teams to plan operational scenarios for normal science operations and for operations required to calibrate and evaluate the instruments. It specifies algorithms and processing tools for science processing, and it works with the CERES Data Management Team to integrate these into the CERES DMS. Reference 3 describes the theoretical basis for the development of CERES science algorithms. The Science Team also specifies the contents of the CERES output science data products.

2.2.1.3 CERES Data Management Team

The CERES Data Management Team provides inputs to the Instrument Development and Science Teams on the data and instrument operational requirements for CERES science processing. It helps develop plans for operating and monitoring the instruments. It integrates science algorithms into the Data Management System and works with the Science Team to develop a comprehensive CERES DMS compatible with science objectives of the CERES Project and EOS Program. Reference 4 describes the plan for how the CERES data will be managed.

2.2.2 External Organizations

2.2.2.1 EOS Data and Information System

The EOS Data and Information System (EOSDIS) is the data and information system for the EOS Program and provides the space and ground measurement systems to acquire and process the data required to understand global climate change. EOS will launch a series of spacecraft with multiple science instruments over a period of several years beginning in 1998. However, the first EOS instruments, CERES and the Lightning Imaging Sensor (LIS), will be launched on the TRMM spacecraft in 1997.

The EOSDIS ground system consists of the flight operations segment, science data processing segment, and communication and system management segment. The science data processing segment provides the processing, storage, and distribution of the science data. The communication

and system management segment provides the communication network services for inter-connections among EOSDIS facilities. The LaRC DAAC (see Figure 2-1), part of the science data processing segment, is the EOSDIS element which will produce, store, and distribute CERES science data products.

2.2.2.2 Mission Operations Centers

The TRMM Mission Operations Center (MOC) and the EOS Operations Center (EOC) are the focal points for the on-orbit operations of the TRMM and EOS spacecraft, respectively, and for operation of the instruments aboard the spacecraft. The Flight Teams at these centers perform all routine tasks required to operate and monitor the CERES instruments. In addition, instrument support terminals at LaRC permit LaRC/CERES personnel to monitor the housekeeping data from the CERES instruments to receive planning aids and operational reports from the operation centers and to submit data requests to the centers.

Selected LaRC CERES personnel will be able to submit requests for expedited production and/or quick-look sets of CERES Level-0 data directly to the mission operation centers. The operation centers will coordinate the requests for and delivery of the data with the Level-0 data processing facilities, the Sensor Data Processing Facility (SDPF) and the EOS Data and Operations System (EDOS). The mission operation centers will also provide LaRC with mission planning aids and operational reports required to plan instrument operations. Reference 5 describes how the CERES instruments aboard the TRMM spacecraft will be operated and monitored and describes the interaction between the TRMM Mission Operations Center and LaRC/CERES Project personnel. Reference 6 describes how the CERES instruments aboard the EOS-AM spacecraft will be operated and monitored and describes the interaction between the EOC and LaRC/CERES Project personnel.

2.2.2.3 Tracking and Data Relay Satellite System

The Tracking and Data Relay Satellite System (TDRSS) provides two-way data transfer between the ground and NASA Earth-orbiting spacecraft. TDRSS will support the TRMM, EOS-AM, and EOS-PM spacecraft. TDRSS is comprised of two communication relay satellites in geostationary orbits at longitudes near the east and west coasts of the continental United States and a ground station at White Sands, New Mexico. Real-time and onboard recorded data are relayed to ground stations at White Sands during periods of communication contact called TDRSS Services Sessions (TSS's) or real-time contacts.

2.2.2.4 NASA Communications

The NASA Communication (Nascom) network operates under the NASA Communications Division at Goddard Space Flight Center (GSFC). The network provides for relay of raw data generated onboard the TRMM and EOS spacecraft from the TDRSS ground stations to the ground processing facilities, SPDF and EDOS. Nascom also provides the communication lines which transmit the CERES Level-0 data sets from the SDPF and EDOS to the LaRC DAAC.

2.2.2.5 Sensor Data Processing Facility

The SDPF is an institutional facility which operates under the Information Processing Division at GSFC to process raw data from orbiting spacecraft. The SDPF includes the Packet Processor (Pacor) II Data Capture Facility, which processes Consultative Committee for Space Data Systems (CCSDS) packets from instruments aboard the TRMM spacecraft and produces and distributes Level-0 data products. The process sorts the raw data streams, first by the Application Packet Identifier (APID) and second, by the data packet counter; both of these parameters are included in the primary headers of the CCSDS packets. The SDPF produces and distributes two primary types of Level-0 data sets: Production Data Sets (PDS's) and Quick-look Data Sets (QDS's).

The SDPF generates Production Data Sets and Quick-look Data Sets in accordance with instructions agreed to by the SDPF and its customers. It routes the data sets to the appropriate destinations via procedures agreed to by the SDPF and its customers. Level-0 data sets produced by the SDPF include accounting information about the quality and quantity of the data packets in the sets. Reference 7 provides additional details on the processing and distribution services provided by the SDPF.

Production Data Sets produced by the SDPF consist of all packets with a specified APID for a specified period of up to 24 hours. The packets in the data sets are in chronological order with redundant packets deleted. A PDS is normally ready for distribution to the customer within 48 hours after the last packet in the set is received at the SDPF.

A Quick-look Data Set produced by the SDPF consists of all packets received at the SDPF during a TSS which have a specified APID. A QDS is normally ready for distribution much sooner than a 24-hour PDS.

2.2.2.6 EOS Data and Operations System

The EDOS is a dedicated EOS facility at Fairmont, West Virginia, which processes raw data from instruments aboard the EOS spacecraft to produce and distribute Level-0 data sets. The process sorts the raw data streams, first by the APID and second, by the data packet counter; both of these parameters are included in the primary headers of the CCSDS packets.

EDOS generates customer data sets in accordance with instructions agreed to by EDOS and its customers. It also routes the data sets to the appropriate destinations via transmission protocol and procedures agreed to by EDOS and its customers. These instructions are included in the interface control documents which specify the interfaces between EDOS and the Level-0 data customers. All Level-0 data sets include accounting information about the quality and quantity of the data packets in the sets. Reference 8 provides additional information on the processing and distribution services provided by EDOS.

Production data sets produced by EDOS consist of all packets with a specified APID that covers a specified period of up to 24 hours. The packets in the data sets are arranged in chronological order with redundant packets deleted. A 24-hour PDS is normally ready for delivery to customers within 24 hours after receipt of the last packet in the data set from the TDRSS Ground Station. Delays

for PDS delivery are dependent on the time span of the PDS and the 24-hour delivery time may be reduced for PDSs with shorter time periods.

It is the understanding of the CERES Project that the quick-look data services described in Reference 8 may be reduced and/or modified as a result of an ongoing review by the EOS Project. In particular, we anticipate that the commitment to deliver quick-look data sets within about 2 hours will not be met.

2.3 Overview of Interface Requirements

2.3.1 Data from External Sources

The CERES DMS requires three major categories of input data from external sources (see Figure 2-1). The raw data required to produce these data products are acquired or have their origin outside the LaRC DAAC. However, many of the archival data products are generated at the LaRC DAAC or one of the other EOSDIS DAACs. This section presents an overview of the interface requirements for each of the three categories of external data input, and Section 3.0 describes the interface requirements for these data in more detail.

2.3.1.1 CERES Instrument and Spacecraft Ancillary Data

Raw instrument data are generated by the CERES instruments on the TRMM, EOS-AM, and EOS-PM spacecraft, and each spacecraft generates a set of orbit ephemeris and spacecraft ancillary data. Section 3.1 describes the science requirements for the raw CERES instrument and spacecraft ancillary data. It also describes the requirements for the instruments to assemble the data into CCSDS packets for transmission aboard the spacecraft and to the ground stations.

Figure 2-2 illustrates the flow of raw data from the platforms to the ground processing facilities. SDPF and EDOS capture, store, and perform delayed processing on the raw data to generate the Level-0 data sets required by the CERES DMS. Section 3.1 describes the requirements for the interfaces between the LaRC DAAC and the SDPF and EDOS for CERES Level-0 data from the TRMM and EOS spacecraft, respectively.

2.3.1.2 Archival Ancillary Science Data

The CERES DMS requires as input, several science data products which are not produced by the CERES DMS. Most of the raw data for these ancillary data products are acquired by instruments on Earth-orbiting spacecraft, and many of these spacecraft are operated by the EOS, TRMM, and other NASA Earth-science missions. Therefore, some of the data products required are generated within EOSDIS as standard archival products. In addition, some of the raw data are acquired and processed by other agencies such as NOAA and the United States Geological Survey (USGS).

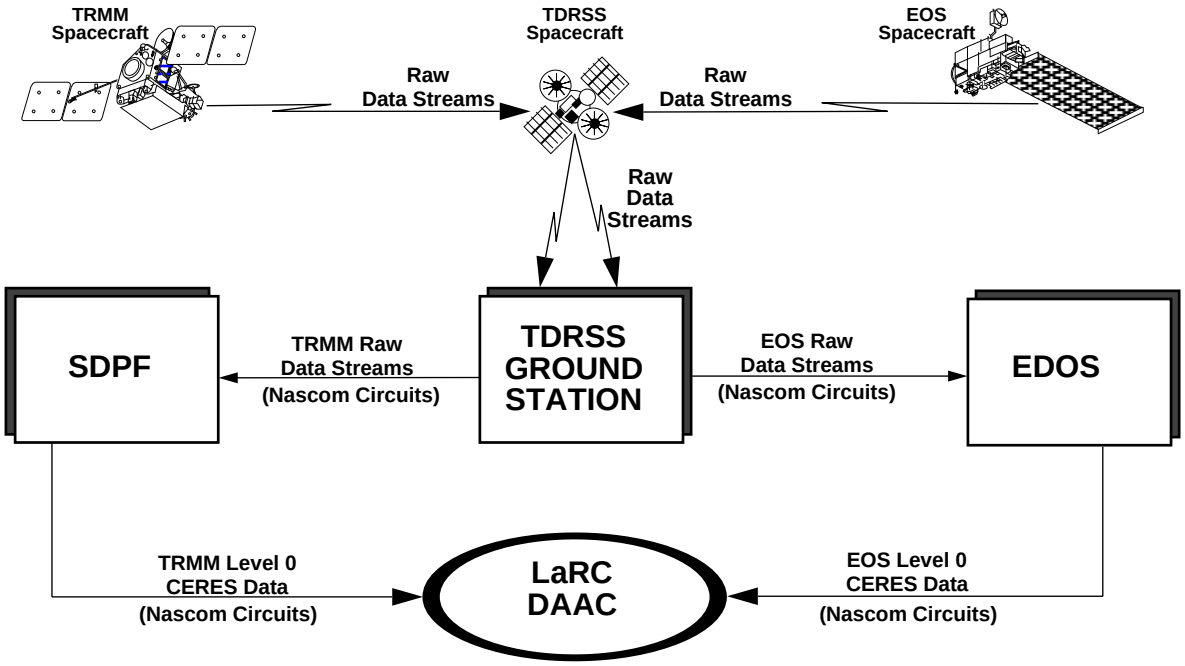


Figure 2-2. Flow of Instrument and Spacecraft Ancillary Data from TRMM and EOS Spacecraft

Section 3.2 describes detailed interface requirements for the archival ancillary science data products. Seventeen different types of data products are identified as requirements by the CERES DMS. A primary data source is identified for each data type, and at least one secondary (backup) data source is identified for most data types. Data sets from each source are evaluated in terms of several technical and procedural factors.

2.3.1.3 Nonarchival Ancillary Data

The CERES Science and Data Management Teams prepare ancillary data sets, such as Angular Directional Models (ADMs), calibration coefficients, radiation transfer models, and other processing parameters, off-line. These data are submitted to the LaRC DAAC NSS for storage and access by the CERES DMS. Section 3.3 will, in a later release, list each nonarchival data file, a description, its size, and its life cycle.

2.3.2 Interfaces Between CERES DMS and LaRC DAAC

2.3.2.1 Standard Data Products

Section 3.4 contains a high-level summary of the standard data products, which are Level-1 through Level-3 products produced and used by the DMS. The products are produced by one

subsystem within the DMS and used as input to a subsequent subsystem. This section is not included in this release.

2.3.2.2 Metadata

The CERES DMS is required to produce metadata for each data product in terms of its quality and content. Metadata is an interface between the DMS and the IMS. The specific metadata attributes and all CERES metadata files are discussed in Section 3.5, which is not included in this release.

2.3.2.3 Status Messages and Control Messages

The messages are communication mechanisms between the CERES DMS and the PDPS. Subsystem-specific messages are specified in Section 3.6, which is not included in this release.

2.3.2.4 QC Data

Section 3.7 lists each quality control report and plot produced by each subsystem, along with a short description of the file content, the producing subsystem, the frequency, and its size. Section 3.7 is not included in this release.

2.3.2.5 Validation Data

Section 3.8 summarizes the validation files that some of the subsystems produce. A summary table includes the producing subsystem, file life span, frequency, and size. Section 3.8 is not included in this release.

3.0 Data Requirements and Interface Specifications

3.1 CERES Instrument and Spacecraft Ancillary Data

3.1.1 Introduction

CERES instrument and spacecraft ancillary data are the primary data required by the CERES DMS to produce science data products. This section discusses the interface requirements for the instrument and spacecraft ancillary data, which are required specifically as inputs by the Geolocate and Calibrate Earth Radiances Subsystem (also known as Instrument Processing Subsystem). The Instrument Processing Subsystem is the front-end subsystem of the DMS, and its purpose is to process instrument and platform ancillary data and to apply calibration equations to produce Earth-located radiances. Reference 9 describes the software requirements for the Instrument Processing Subsystem.

Table 3.1-1 lists six Level-0 data streams: one set of TRMM spacecraft ancillary data and five sets of instrument data. The raw CERES instrument data are produced by five CERES instruments on three different spacecraft: One instrument on TRMM, two on the first EOS-AM, and two on the first EOS-PM spacecraft. Table 3.1-1 also lists the sources of the data and the ground facilities which process the raw data and provide Level-0 CERES instrument data to the LaRC DAAC.

Each of the three spacecraft produces a set of ancillary data required for science data processing which consists of spacecraft orbit and solar ephemeris data and spacecraft engineering data. The ancillary data from each spacecraft will be provided by the EOSDIS to the LaRC DAAC, together with the necessary software tools to access the data and to perform routine ephemeris and spacecraft engineering data calculations. The ancillary data will also be available by alternate means, except for the EOS-PM platform. The TRMM Project provides spacecraft ancillary data from the TRMM spacecraft in a separate Level-0 data set. Table 3.1-1 lists this data set as "EPH_ANC." The CERES DMS expects to use the ephemeris and ancillary data provided by EOSDIS.

Sections 3.1.2.1 and 3.1.2.2 describe the general requirements for the raw instrument and platform ancillary data, respectively. Section 3.1.2.3 describes, very briefly, how the raw data packets flow from the spacecraft to the ground processing facilities where they are captured and processed to produce Level-0 data sets. Finally, Section 3.1.2.4 describes the requirements for the interfaces between the ground-based Level-0 data processing facilities and the LaRC DAAC for producing and transmitting the Level-0 data sets.

3.1.2 Interface Requirements

3.1.2.1 Requirements for Raw CERES Instrument Data

General: Reference 2 describes the requirements for the raw science and engineering data which the CERES instruments must produce to meet the CERES science requirements. Reference 10 lists the data which the CERES instruments are designed to generate to meet the requirements in

Table 3.1-1. Level-0 Data Streams Required by CERES

ACRONYM	DATA DESCRIPTION	SOURCE
INSTR_TRMM	TRMM Data Packets Consisting of CERES Instrument Data (Production and Quick-look)	TRMM/SDPF
EPH_ANC	TRMM Packets Consisting of TRMM/SDPF Platform Ancillary Data (Production)	TRMM/SDPF
INSTR_EOS_AMF	EOS-AM Data Packets Consisting Of CERES Instrument and Platform Ancillary Data (Production and Quick-look*)	EOS-AM/EDOS
INSTR_EOS_AMA	EOS-AM Data Packets Consisting Of CERES Instrument and Platform Ancillary Data (Production and Quick-look*)	EOS-AM/EDOS
INSTR_EOS_PMF	EOS-PM Data Packets Consisting Of CERES Instrument and Platform Ancillary Data (Production and Quick-look)	EOS-PM/EDOS
INSTR_EOS_PMA	EOS-PM Data Packets Consisting Of CERES Instrument and Platform Ancillary Data (Production and Quick-look)	EOS-PM/EDOS

Note: EOS-AM-F is "fore", or forward instrument, on EOS-AM spacecraft.
EOS-AM-A is "aft", or rearward instrument, on EOS-AM spacecraft.
EOS-PM-F is "fore", or forward instrument, on EOS-PM spacecraft.
EOS-PM-A is "aft", or rearward instrument, on EOS-PM spacecraft.

*Quick-look data services for the EOS-AM spacecraft are currently under review.

Reference 2. The development of the instrument is the responsibility of the instrument contractor, TRW, but is coordinated among the CERES Science Team, Data Management Team, and Instrument Development Team.

During normal science operations, the CERES instrument output must contain all measurements required to calculate Earth radiances and to evaluate the operational status and performance of the instruments. The instrumenst must also generate measurements for their own calibration, as well as measurements required for diagnostics and instrument performance evaluation.

The TRMM and EOS Projects require a CERES instrument to assemble science data into source data packets compatible with the Path Packet Service described in Reference 11, Section 2.3.3. The CCSDS Path Protocol Data unit is the Version-1 CCSDS Packet, defined in Reference 12. Packets generated by instruments on each spacecraft are required to have a secondary header which contains a CCSDS time code. The general content and format of the different CCSDS time codes are described in Reference 13. Mission-specific applications of the CCSDS standards are discussed later in this section.

The CERES instruments will generate science data with three different application identifiers: Science APID for archival science data, Calibration APID for solar calibration data, and Diagnostic APID for diagnostic data. Table 3.1-2 lists the APID numbers assigned to the CERES instruments to be launched aboard the TRMM and EOS-AM spacecraft. The APID numbers for the CERES instruments on the EOS-PM spacecraft have not been selected and assigned at this time (see Table 3.1-2).

Table 3.1-2. APID Numbers for CERES Instrument on TRMM, EOS-AM, and EOS-PM Spacecraft

APID NUMBER					
Name/Inst	TRMM	EOS-AM-F	EOS-AM-A	EOS-PM-F	EOS-PM-A
Science	54	131	167	Not assigned	Not Assigned
Calibration	55	132	168	Not assigned	Not Assigned
Diagnostic	56	133	169	Not assigned	Not Assigned

Note: EOS-AM-F is "fore", or forward instrument, on EOS-AM spacecraft.
EOS-AM-A is "aft", or rearward instrument, on EOS-AM spacecraft.

CERES instruments will generate data in four different output formats: one for science and calibration data and three for diagnostic data. In each of the three diagnostic formats, a different set of diagnostic data replaces the radiometric and gimbal position data output in the science data format.

TRMM Spacecraft: Reference 14 lists the measurements in the science data packets generated by the instrument on the TRMM spacecraft; Reference 15 describes the format of these data within the source fields of the CCSDS data packets.

Reference 16 is the controlling document between the CERES and TRMM Projects for mission-specific data assembly requirements. CCSDS data packets generated on the TRMM spacecraft are required to contain a 64-bit secondary header which contains a reference time (Section 8.3.2 of Reference 16). The time is represented in the CCSDS Unsegmented Time Code option described in Section 2.2 of Reference 13. The code is not Universal Time Code (UTC)-based. A correction factor to correlate the time with Universal Time is contained in the Universal Time Correlation Factor (UTCF) which is included in the TRMM ancillary data packets. The time code does not include the optional P-field for explicit specification of the epoch, nor does Reference 16 specify an epoch. Therefore, it is assumed that the epoch is January 1, 1958, the default value specified in Reference 13.

EOS-AM Spacecraft: In addition to the science and engineering data, the CERES instruments onboard the EOS-AM spacecraft collect the standard set of spacecraft ancillary data generated by the spacecraft flight data system and include it in the CERES science data packets. This data set includes orbit and solar ephemeris data and a limited set of spacecraft housekeeping measurements. Except for the addition of ancillary data, the content and format of the science data in the source field of the packets generated onboard the EOS-AM spacecraft are identical to those generated on the TRMM spacecraft (see References 14 and 15).

Reference 17 is the controlling document between the EOS-AM Project and the CERES Project for EOS-AM mission-specific CCSDS data packet assembly requirements. The CCSDS packets

generated on the EOS-AM spacecraft are required to contain a 72-bit secondary header (see Figure 6-6 of Reference 17). The first bit of first octet is "0" to denote a non-CCSDS secondary header, and the first bit of the ninth octet can be set to "1" by the instrument to denote that the packet is to be processed as quick-look data. The last 7 bits of the ninth octet are undefined.

The time is contained in the 63 least-significant bits of the secondary header. The time code is the CCSDS Day Segmented Time Code option described in Section 2.3 of Reference 13. This is a UTC-based time code. The time code as specified in Reference 17 does not include the optional P-field for explicit specification of the epoch, nor does Reference 17 otherwise specify an epoch. Therefore, it is assumed that the epoch is January 1, 1958, the default value specified in Reference 13.

EOS-PM Spacecraft: The content and format of the science data in the source fields of the packets generated onboard the EOS-PM spacecraft are identical to those generated on the TRMM spacecraft (see References 14 and 15).

Reference 18 is the controlling document between the EOS-PM Project and the CERES Project for EOS-PM mission-specific CCSDS data packet assembly requirements. The CCSDS packets generated on the EOS-PM spacecraft are required to contain a 72-bit (9 octets) secondary header (Figure 6-4 of Reference 18). The first bit of the first octet is "0" to denote a non-CCSDS secondary header, and the second bit can be set to "1" by the spacecraft to denote that the packet is to be processed as quick-look data. The remaining 6 bits of the first octet are not defined.

The time is contained in the second through ninth octets of the secondary header. The code is not Universal Time Code (UTC)-based. The second and third octets contain the P-field for the time code, and the third through ninth octets contain the time (T-field). The seven least-significant bits of the P-field contain the data to correlate the time in the T-field to UT. The epoch is specified as January 1, 1958, in paragraph 6.5.7.2.3 of Reference 18.

3.1.2.2 Spacecraft Ancillary Data

General: The CERES DMS requires platform orbit and solar ephemeris data in the Earth-centered Celestial Coordinate Frame to calculate the Earth locations of the sources of the CERES instrument radiance measurements and to make ancillary geometry calculations. The CERES DMS also requires spacecraft parameters sufficient to determine the attitude status and operational modes of the spacecraft. Each of the three spacecraft generates a set of orbit and solar ephemeris data and spacecraft engineering data. These data will be made available to the CERES DMS at the LaRC DAAC by EOSDIS. Reference 1 describes the software tools for the access and use of these data. Alternate access of ancillary data from the TRMM and EOS-AM spacecraft are discussed below.

TRMM Spacecraft: A set of spacecraft ancillary data will be generated and formatted into separate CCSDS packets by the TRMM spacecraft. Reference 16 documents the content and structure of the TRMM ancillary data packets. The set includes orbit ephemeris data in the Celestial Coordinate Frame and attitude data, as well as a limited set of spacecraft engineering data. The engineering data include a parameter to denote the orientation (+X axis/-X axis forward) of the TRMM spacecraft during normal operation. The ancillary data packets will be processed into Level-0 data sets by the SDPF and transmitted to the LaRC DAAC.

EOS-AM Spacecraft: A set of spacecraft ancillary data generated by the EOS-AM flight data system are collected by the CERES instrument and included in the CERES science data packets generated by the instruments aboard the EOS-AM spacecraft. The data set includes spacecraft orbit and solar ephemeris data in the Celestial Coordinate Frame, attitude data, and some spacecraft engineering data. The data set is listed and described in Reference 17.

EOS-PM Spacecraft: There are no current plans to include an ancillary data set in the CERES science data packets. Therefore, there is currently no access to spacecraft ancillary data from the EOS-PM spacecraft except that provided to the LaRC DAAC by EOSDIS.

3.1.2.3 Flow of Data from Spacecraft to the SDPF and EDOS

The spacecraft data systems integrate the CERES science and platform ancillary data packets discussed above with all packets from other instruments and the spacecraft and transfer the resulting data streams to on-board storage devices. The data systems recall the stored data packets during TDRSS Service Sessions and transmit them to the SDPF and EDOS through the network illustrated in Figure 2-2. The SDPF and EDOS capture and store the data for later recall and processing into Level-0 data sets.

3.1.2.4 Level-0 Interface Requirements

Section 2.0 of this document describes the general services provided by the SDPF and EDOS in processing raw data into Level-0 data sets. This section describes specific requirements by the CERES DMS for these Level-0 facilities to process raw CERES instrument and spacecraft ancillary data into Level-0 data sets for delivery to the LaRC DAAC.

3.1.2.4.1 Level-0 CERES Instrument Data

General: The CERES Project plans to process its Level-0 science data in 24-hour segments (Midnight to midnight, Universal time). Therefore, it would be convenient to have the SDPF and EDOS create 24-hour production data sets of CERES instrument data. However, the CERES DMS software will have the capability to process production data sets with shorter time periods than 24 hours. A production data set of CERES instrument data shall consist of all packets with the same CERES instrument APID with times that fall within the specified period of a production data set. A Level-0 data set shall be created for each APID during a production data period in which at least one packet bearing the APID is received. The first packet in the set shall be the first valid packet with a time after the beginning of the data period, and the final packet shall be the last valid packet with a time before the end of the data period. Timing ambiguities among packets in production data sets shall be resolved by using the time code in the secondary headers of the packets. The Level-0 facilities shall append quality and quantity accounting information to each PDS.

More specific requirements for Level-0 data sets are described below for each of the three spacecraft. Table 3.1-3 lists the 31 Level-0 data sets required by the CERES DMS. The data sets are defined by a decomposition of the six data streams of Table 3.1-1. Three PDSs (one for each

APID) and three QDSs (one for each APID) are defined for each of the five instruments for a total of 30 instrument data sets. The Level-0 data set of TRMM spacecraft ancillary data, "EPH-ANC," is the thirty-first data set in Table 3.1-3.

TRMM Spacecraft: An Interface Control Document (ICD) between the SDPF and the TRMM Project will be the controlling document which specifies the interface for CERES Level-0 instrument and platform ancillary data from the TRMM spacecraft. The ICD will specify the implementation of the data interface requirements described in this document. The ICD will specify protocols for the LaRC DAAC to request Level-0 data and for transmission of Level-0 data sets to the LaRC DAAC. The ICD is the responsibility of the Mission Operations and Data Systems Directorate at GSFC and will be prepared by personnel from the Pacor II Data Capture Facility. The CERES Project participates in reviews of the ICD during its development.

A PDS shall be ready for delivery to the LaRC DAAC within 48 hours after receipt of the last packet for the period, and the SDPF shall attempt to transmit the data set to the LaRC DAAC upon completion. A PDS of CERES instrument data from the TRMM spacecraft shall have a data period of 24 hours (Midnight to midnight, UT).

The CERES Project shall have a standing request with the SDPF for QDS for each of its APIDs for all periods covering instrument calibrations. Calibrations will normally be performed about once every two weeks. Calibrations will be performed more frequently during orbit check out and during other special events. The CERES Project also requires the capability to submit special requests for quick-look data from time-to-time, during special events such as microprocessor loads and dumps, and diagnostic evaluations. In addition, CERES needs the capability to submit special requests for quick-look data for up to 2 hours after the completion of a TSS.

Table 3.1-3. Level-0 Data Sets Required by CERES from the TRMM, EOS-AM, and EOS-PM Spacecraft

	SOURCE		
PACKET TYPE	TRMM/SDPF	EOS-A/EDOS	EOS-P/EDOS
Production Science Data	INSTR_TRMM_PDS_Sci	INSTR_EOS_A_F_PDS_Sci INSTR_EOS_A_A_PDS_Sci	INSTR_EOS_P_F_PDS_Sci INSTR_EOS_P_A_PDS_Sci
Production Calibration Data	INSTR_TRMM_PDS_Cal	INSTR_EOS_A_F_PDS_Cal INSTR_EOS_A_A_PDS_Cal	INSTR_EOS_P_F_PDS_Cal INSTR_EOS_P_A_PDS_Cal
Production Diagnostic Data	INSTR_TRMM_PDS_Diag	INSTR_EOS_A_F_PDS_Diag INSTR_EOS_A_A_PDS_Diag	INSTR_EOS_P_F_PDS_Diag INSTR_EOS_P_A_PDS_Diag
Quick-look Science Data	INSTR_TRMM_QLD_Sci	INSTR_EOS_A_F_QLD_Sci* INSTR_EOS_A_A_QLD_Sci*	INSTR_EOS_P_F_QLD_Sci INSTR_EOS_P_A_QLD_Sci
Quick-look Calibration Data	INSTR_TRMM_QLD_Cal	INSTR_EOS_A_F_QLD_Cal* INSTR_EOS_A_A_QLD_Cal*	INSTR_EOS_P_F_QLD_Cal INSTR_EOS_P_A_QLD_Cal
Quick-look Diagnostic Data	INSTR_TRMM_QLD_Diag	INSTR_EOS_A_F_QLD_Diag* INSTR_EOS_A_A-QLD_Diag*	INSTR_EOS_P_F_QLD_Diag INSTR_EOS_P_A_QLD_Diag
Ancillary Data	EPH_ANC		

The data sets for the EOS AM and PM spacecraft are labelled for the fore and aft instruments.

*Quick-look data services for the EOS-AM spacecraft are currently under review.

Quick-look Data Sets for the same instrument (different APIDs) during a TSS shall be formatted into a single quick-look data file for transmission to the LaRC DAAC. These files shall contain, as a minimum, the accounting information listed in Table 3.1-4. A quick-look data file from the SDPF shall be ready for delivery to the LaRC DAAC within approximately 6 hours after receipt of the last packet in the TDRSS Service Session.

Table 3.1-4. Accounting Information Required for Files Containing More than One Quick-look Data Set

Quick-look Data Identifier (QL/Not QL Flag)
Number and APID of separate quick-look data sets in file
Time of first packet of first QDS in file
Time of last packet of last QDS in file

EOS-AM Spacecraft: An ICD between EDOS and the EOS-AM Project is the controlling document which specifies the interfaces for CERES Level-0 instrument and platform ancillary data from the EOS-AM spacecraft. The ICD will specify the implementation of the data interface requirements described in this document. The ICD will specify protocols for the LaRC DAAC to request Level-0 data and for transmission of Level-0 data sets to the LaRC DAAC. The ICD is the responsibility of the EOS Project and will be prepared by personnel of EDOS. The CERES Project participates in reviews of the ICD during its development.

A PDS of CERES instrument data from the EOS-AM spacecraft shall have a data period of 24 hours. A PDS shall be ready for delivery to the LaRC DAAC within TBD hours after receipt of the last packet for the period, and the EDOS shall attempt to transmit the data set to the LaRC DAAC upon completion.

CERES requires expedited science data sets for each of its APIDs within 6 hours after the TDRSS service session containing the data required. If the service is available, CERES plans to set the quick-look data flag in the CCSDS packets to identify data for expedited processing. Expedited data sets are required routinely during periods of internal and solar calibrations, which will be about every two weeks. Expedited data sets are also required from time-to-time during special events such as microprocessor loads and dumps and diagnostic evaluation of instrument performance.

EOS-PM Spacecraft: The ICD responsibilities are the same as those specified above for EOS-AM spacecraft. Level-0 data requirements are essentially the same as those described for data from the EOS-AM spacecraft.

3.1.2.4.2 Level-0 TRMM Spacecraft Ancillary Data.

Production sets of Level-0 TRMM spacecraft ancillary data shall be provided by the SDPF to the LaRC DAAC as files that cover the periods of playback data received during a TSS. The SDPF shall append quality and quantity accounting information to each PDS of ancillary data. The procedure for transmitting these files to the LaRC DAAC shall be the same as that described in Section 3.1.2.4.1 for transmitting CERES instrument PDSs to the LaRC DAAC.

3.2 Archival Ancillary Data Products

3.2.1 Overview

This section discusses external ancillary data products which are used in processing CERES data. These data are obtained from a variety of sources such as satellites, ground measurement stations, radiosonde networks, and aircraft. The data are acquired at times and locations that will not necessarily be directly or immediately compatible with the corresponding CERES radiometric data. These products can be static in nature, such as digital elevation data, or they can be dynamic in nature, such as humidity, which varies in space and time. It is necessary to describe various attributes for each of the seventeen external ancillary data products, i.e. factors that are both technical and procedural in nature. This information is presented in the following sections in the form of charts and narrative descriptions of the data. More detailed information of the data can be found in the CERES Data Products Catalog, Reference 14.

3.2.2 Interface Requirements

3.2.2.1 Specific Data Elements

There are seventeen external ancillary data products that are to be used in the overall processing and analysis of CERES data. They consist of meteorological, geophysical, and radiometric data obtained at different times by sensors operated by many agencies for a variety of diverse applications. Of considerable importance, therefore, is the specification of the data source as well as the frequency for the collection of a data set. Table 3.2-1 presents the seventeen data products and those factors that are indicative of data volume and frequency of collection.

3.2.2.2 Accession of Ancillary Data Products

The ancillary data products needed for CERES processing are acquired from diverse organizations over an extended period of time and for a variety of applications. Some of the products, such as digital elevation data for terrain, are quite stable in time; whereas other data, such as snow cover, have a time period measured in days, weeks, or possibly months. On the other hand, the more ephemeral meteorological data such as temperature, humidity, and cloud cover change in a matter of minutes. Thus, it is necessary to have specific references to all these data products in such a manner that subsequent mathematical analysis can produce a consistent overall data set for processing the CERES radiometric data. Some data are collected at locations on the Earth's surface quite distant from one another, whereas in other areas the density of collection is high (e.g. in heavily populated areas). Thus, it will be necessary to have algorithms which take into consideration the relative density of the data for the purposes of regridding to conform to the standard CERES requirements. In addition, provision should also be made for the specification of accuracy or precision associated with the interpolated data points. The same argument holds for the temporal aspect of the data products. Some data are collected on a time scale of minutes whereas other data are collected on a scale of days or weeks.

Table 3.2-1. External Ancillary Data Products

DATA NAME	DATA DESCRIPTION	FREQ	SIZE MB	MONTHLY SIZE MB
MWP	Microwave Liquid Water Path	6/Day	150	4650
APD	Aerosol (Column)	1/Day	TBD	TBD
APD	Aerosol (Thin Strat.)	1/Month	TBD	TBD
OPD	Ozone (Stratospheric)	1/Week	TBD	TBD
OPD	Ozone (Column)	1/Day	TBD	TBD
MWH	Microwave Humidity	6/Day	TBD	TBD
GAP	3-D Meteorological Data	4/Day	TBD	TBD
GAP	Land Surface Temperature	4/Day	TBD	TBD
GAP	Sea Surface Temperature	1/Day	TBD	TBD
MODIS_CID	MODIS Cloud Imager Data	1/Day	59784	1853304
VIRS_CID	VIRS Cloud Imager Data	1/Day	1706	52898
SURFMAP(DEM)	Surface Digital Elevation Map	1/Mission	16.6	17
SURFMAP(H2O)	Water Conditions	1/Month	16.6	17
SURFMAP(SNOW)	Snow Map	1/Week	16.6	72
SURFMAP(ICE)	Ice Map	1/Week	16.6	72
SURFMAP(VEGE)	Vegetation Map	1/Week	16.6	72
GEO	ISCCP Radiances	8/Day	3.8	942

Table 3.2-1 describes the availability of the data for processing (frequency) and the size (MB) of each product. All of these possible mismatches of ancillary data products in time and space need to be considered when developing algorithms for the final production of a coherent data set for incorporation into the processing system for the analysis of CERES data. As a result of the highly interdisciplinary nature of the data required for this effort, it is important that specific interagency agreements be implemented for the production of consistent ancillary data sets.

The Product Generation System (PGS)Toolkit shall provide the tools and means to access the seventeen ancillary data products from external sources as described in detail in the PGS Toolkit Requirements Specification for the EOSDIS Core System (ECS) Project document (Reference 1). In addition, it will provide some static data sets as well.

3.2.2.3 Data Schedule

Tables 3.2-2 through 3.2-18 illustrate the schedule for acquisition of the external ancillary data products by various sensors and/or organizational units through the year 2002. At the top of each chart we indicate the standard schedule for the TRMM and EOS missions for the CERES sensors. The lower portion indicates the corresponding schedule for the ancillary products. A primary data source is identified for each product. A secondary data source is listed for key parameters in the event that the primary data set is not available.

Table 3.2-2. MWP: Microwave Water Path

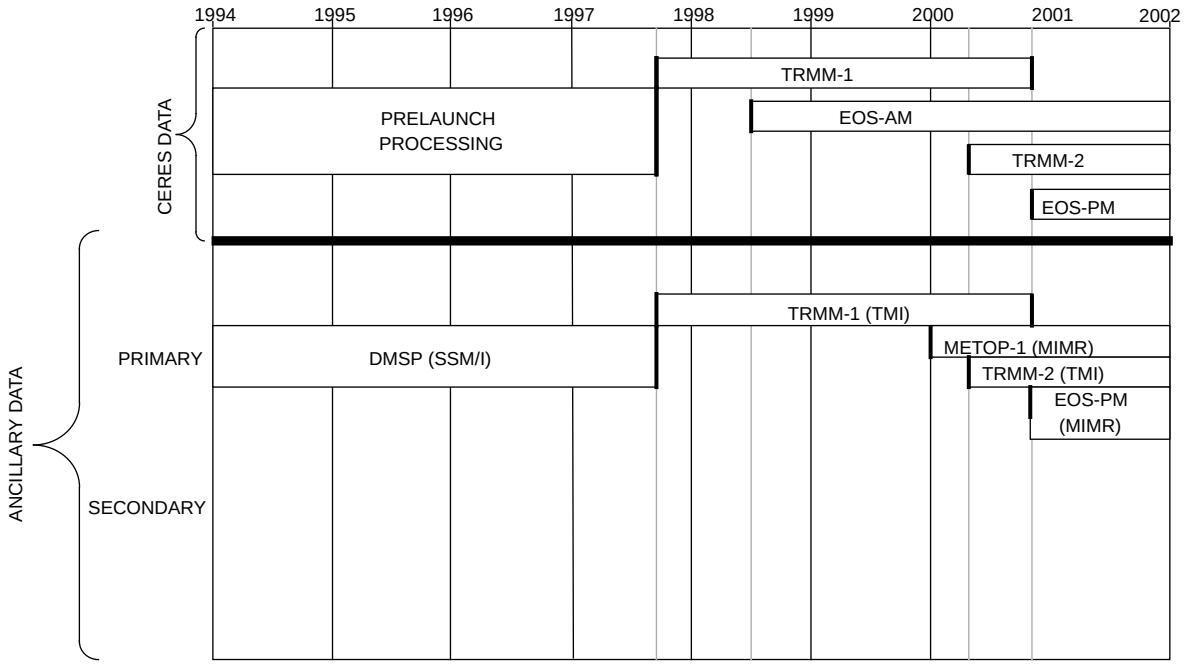


Table 3.2-3. APD: Aerosol (Column)

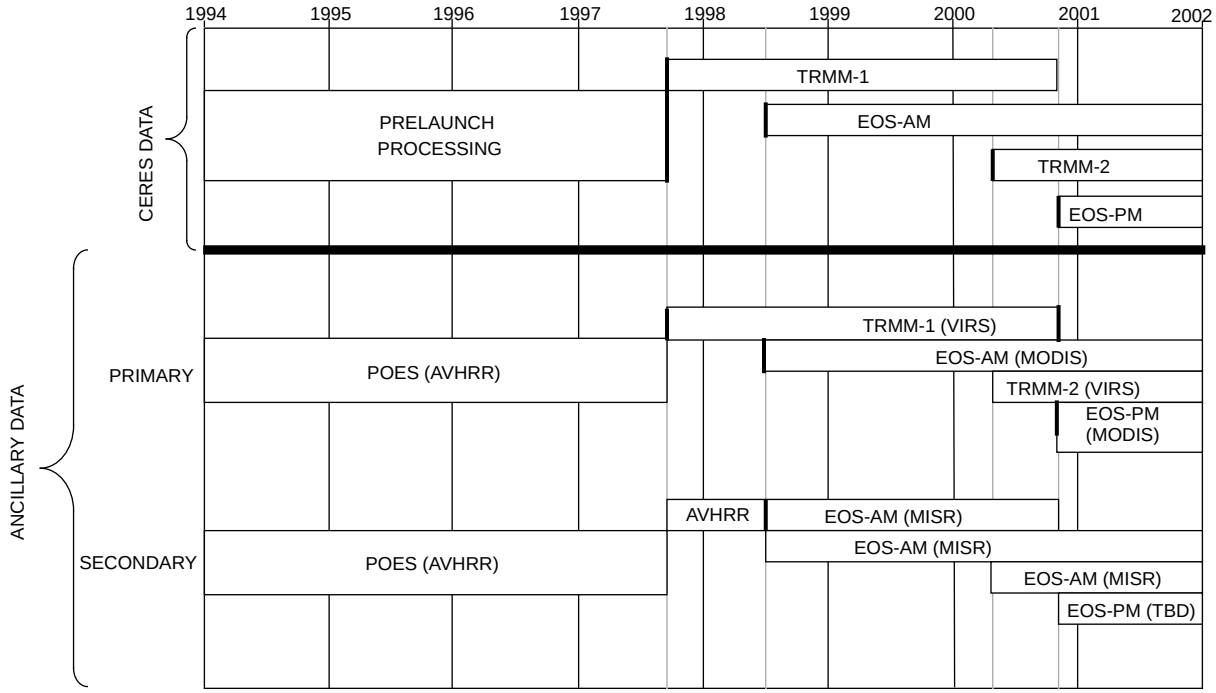


Table 3.2-4. APD: Aerosol (Thin Stratospheric)

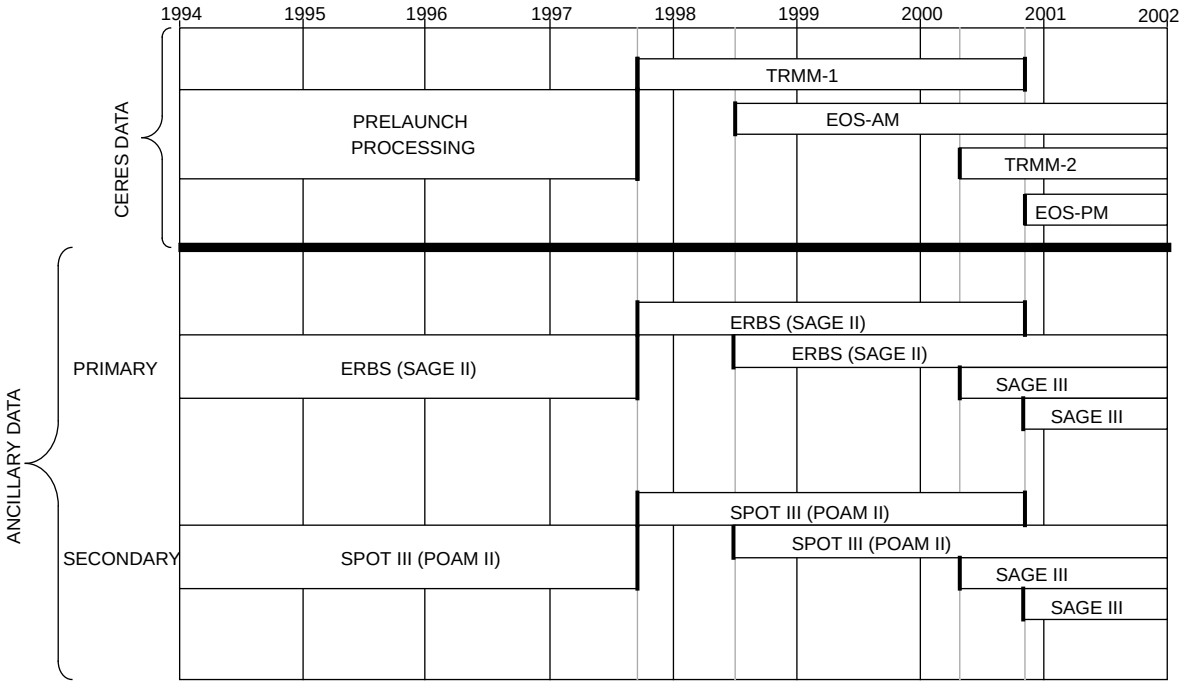


Table 3.2-5. OPD: Ozone (Stratospheric)

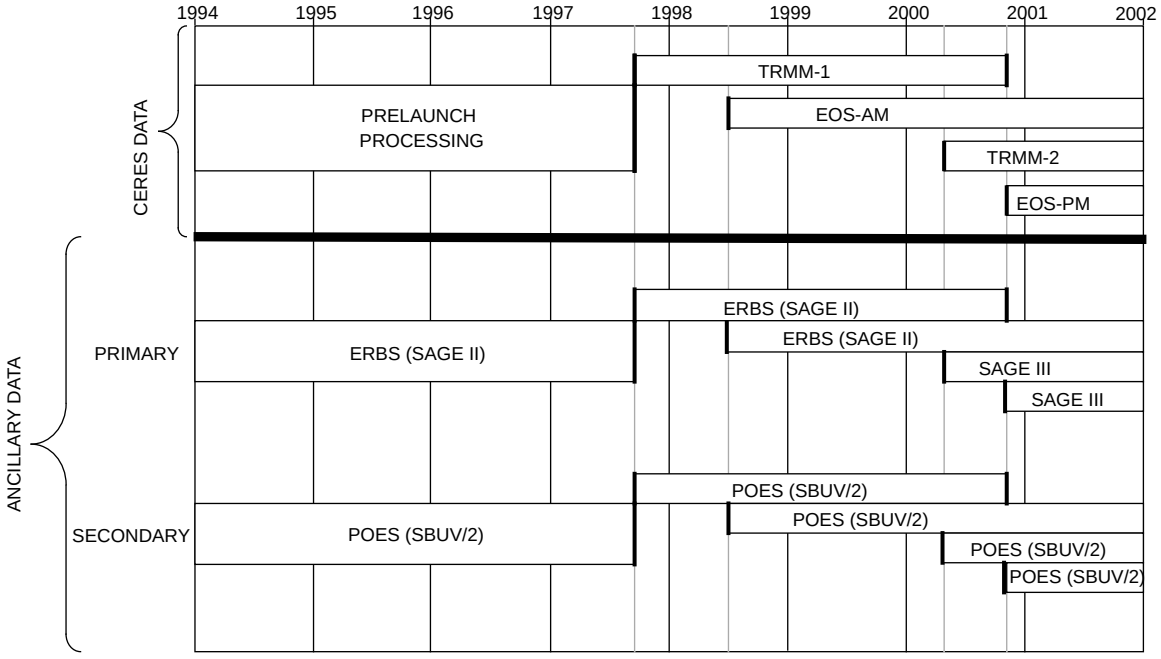


Table 3.2-6. OPD: Ozone (Column)

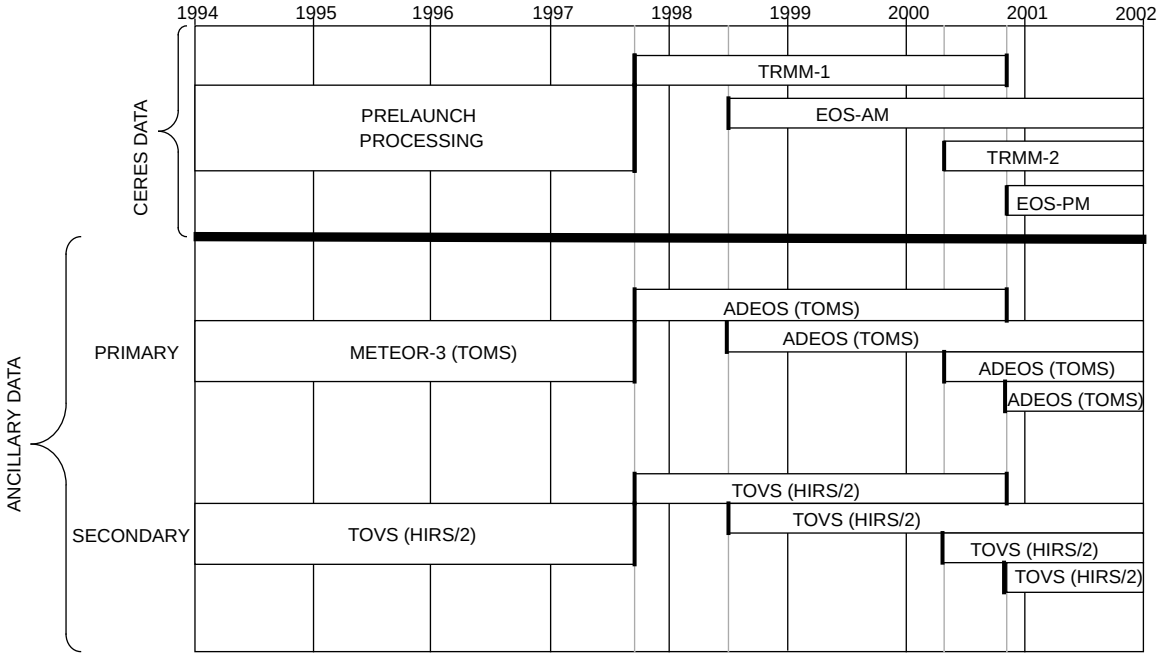


Table 3.2-7. MWH: Microwave Humidity

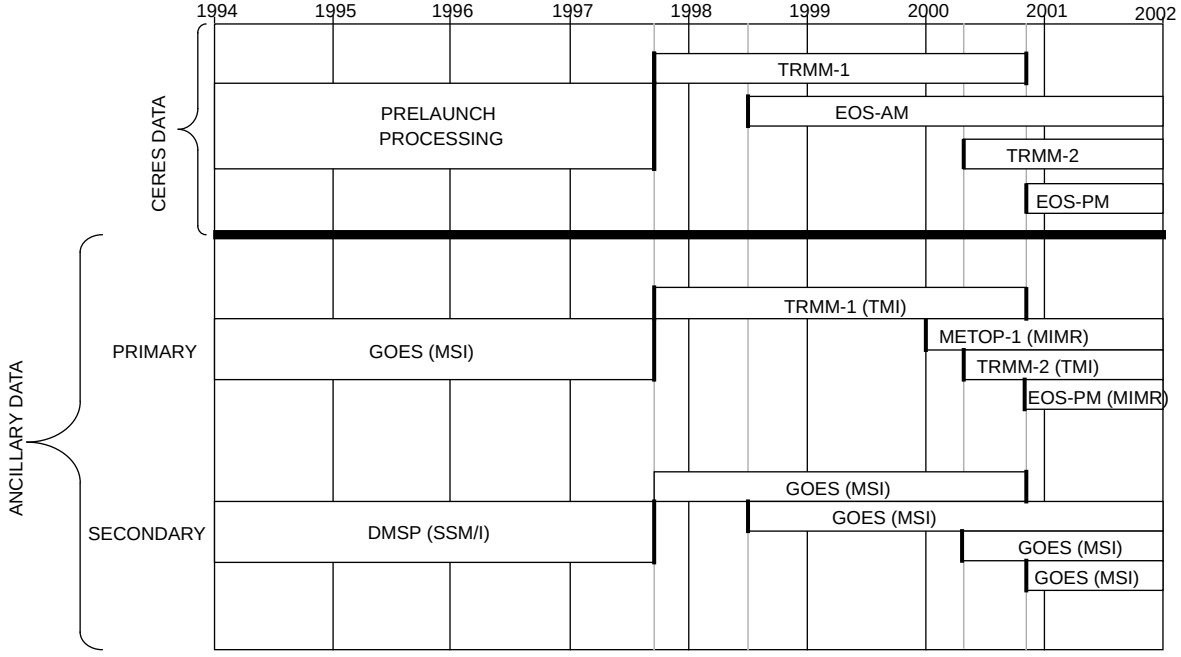


Table 3.2-8. GAP: 3-D Meteorological Data

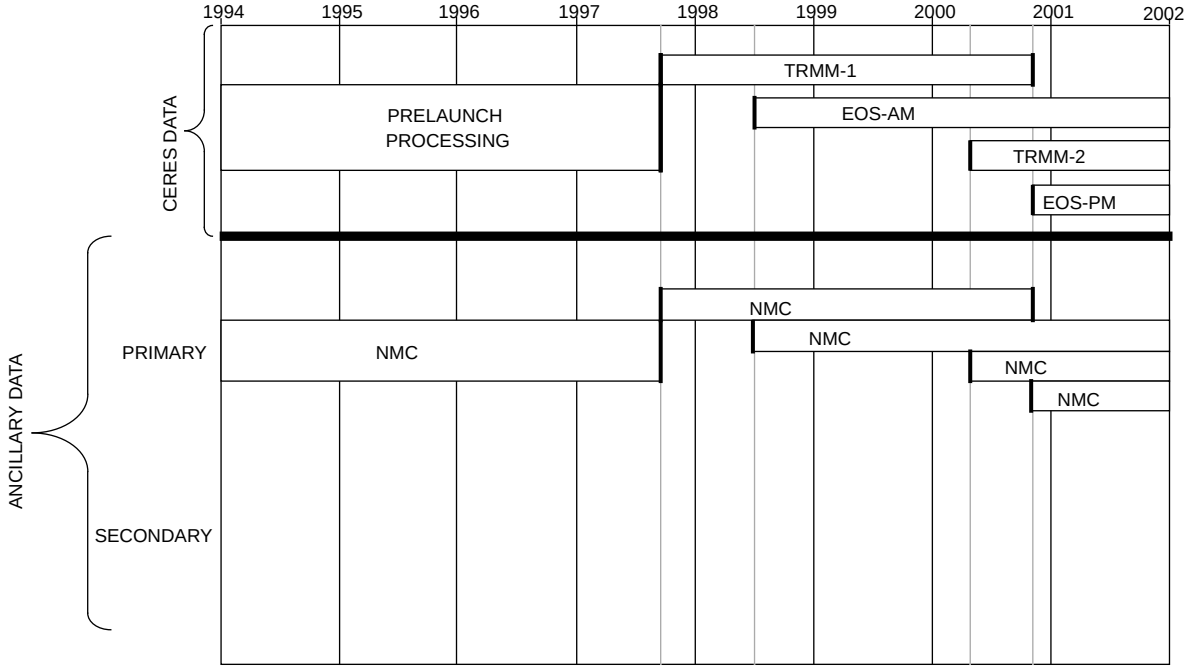


Table 3.2-9. GAP: Land Surface Temperature

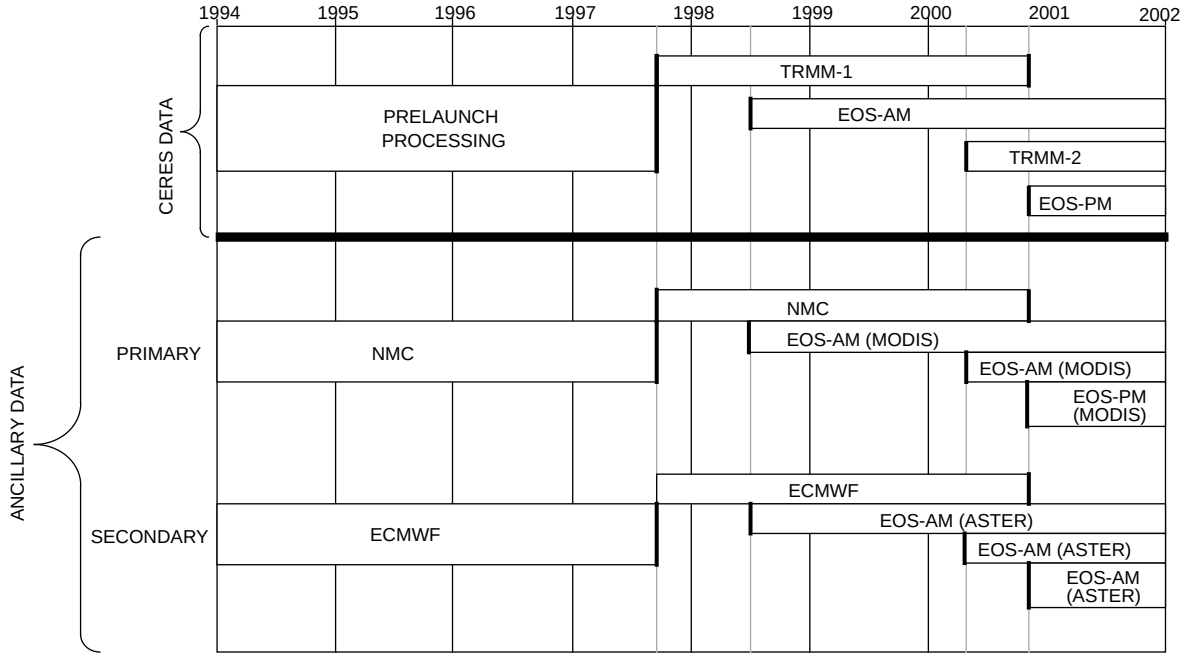


Table 3.2-10. GAP: Sea Surface Temperature

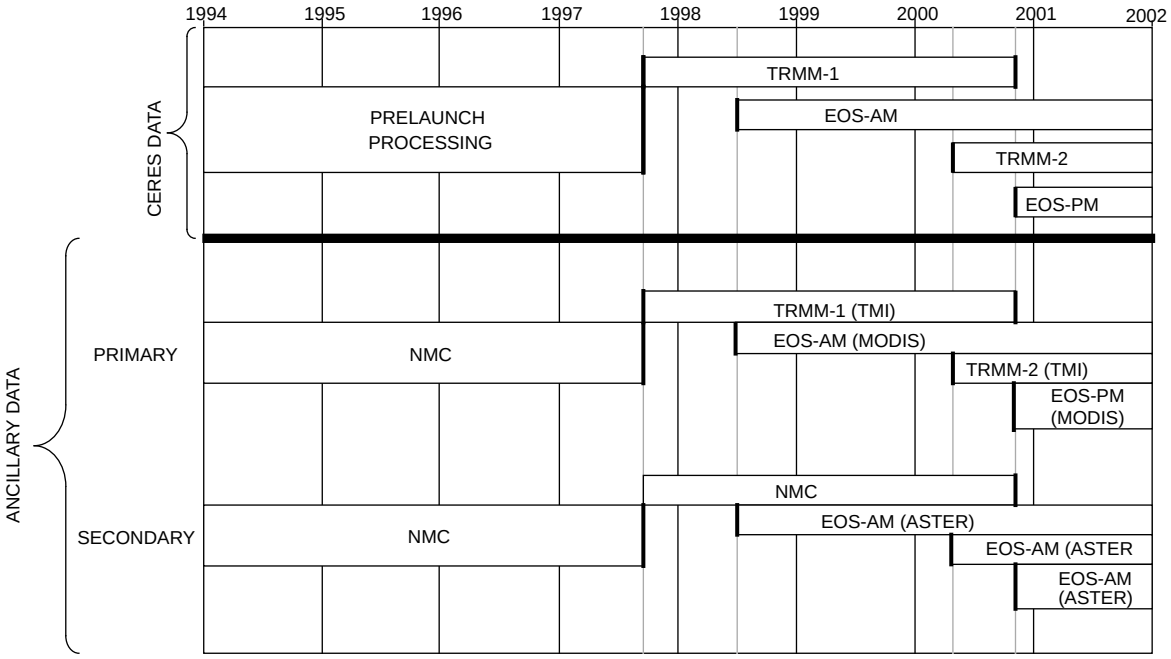


Table 3.2-11. MODIS CID: Cloud Imager Data

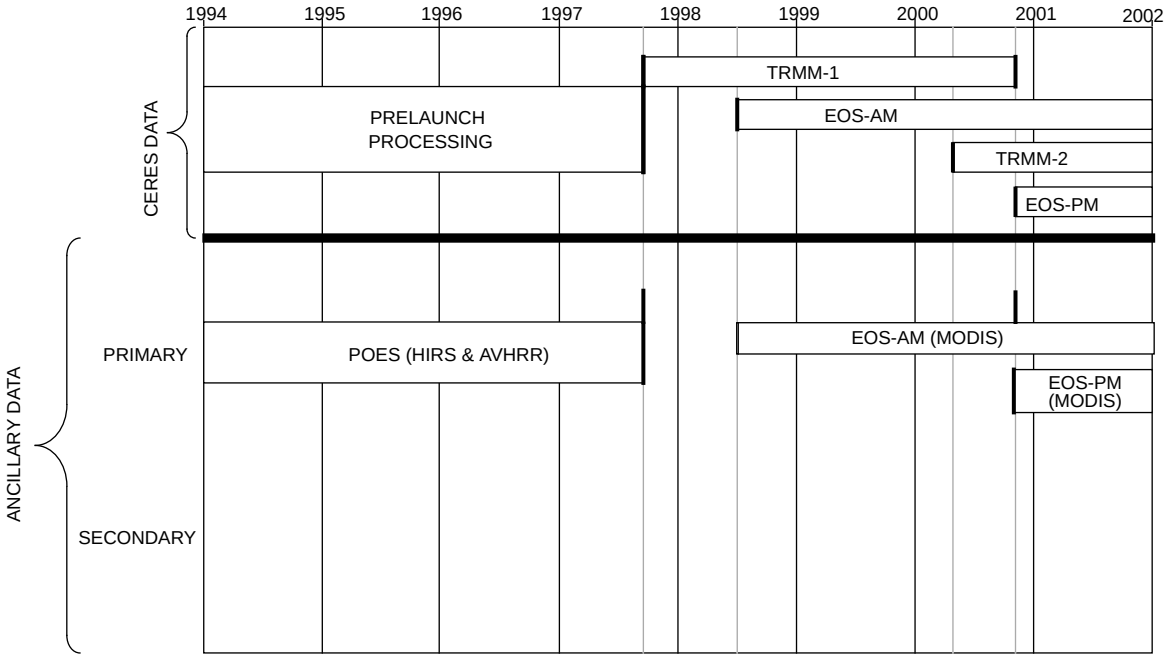


Table 3.2-12. VIRS CID: Cloud Imager Data

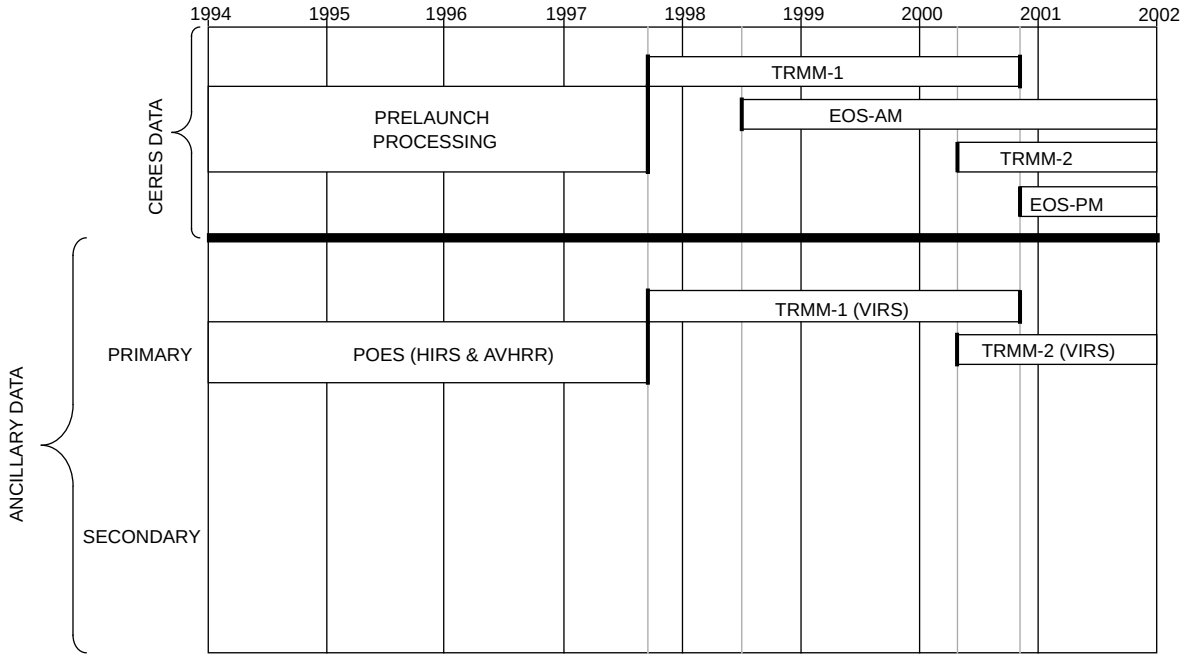


Table 3.2-13. Surfmap (DEM): Digital Elevation Map

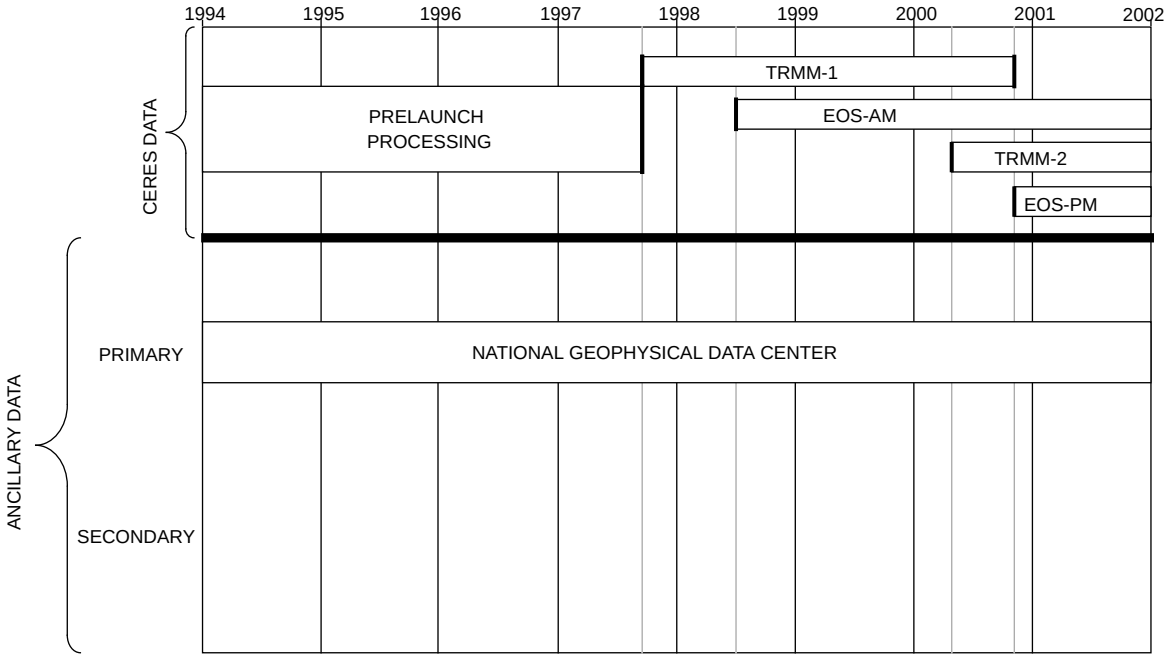


Table 3.2-14. Surfmap (H_2O): Water Conditions

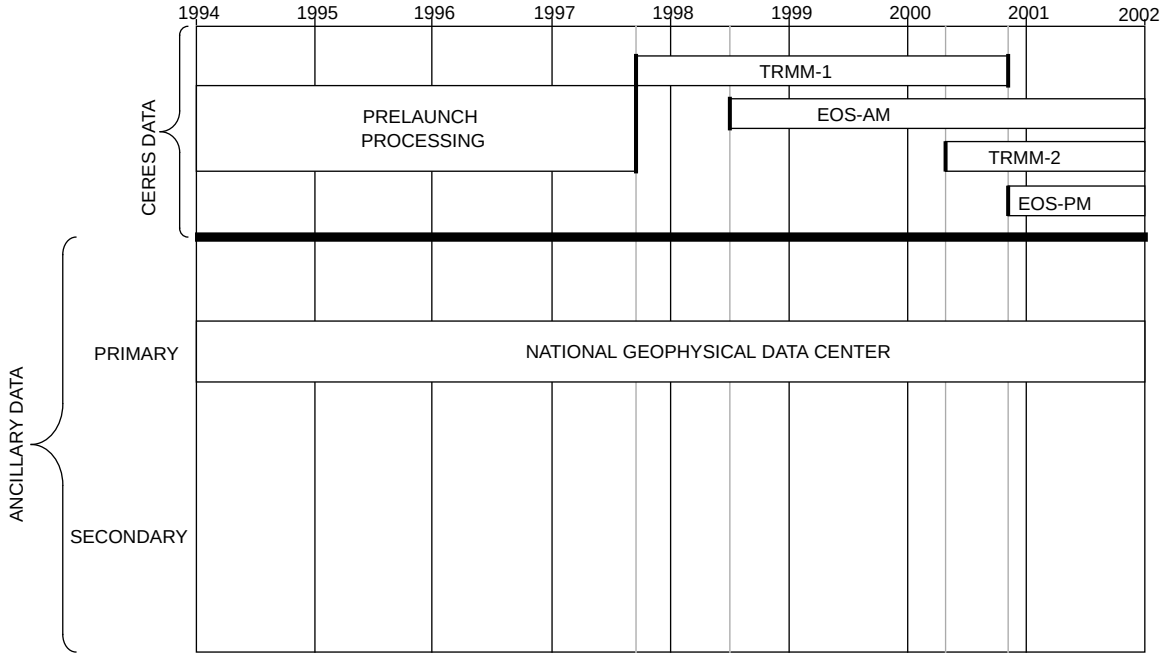


Table 3.2-15. Surfmap (Snow): Snow

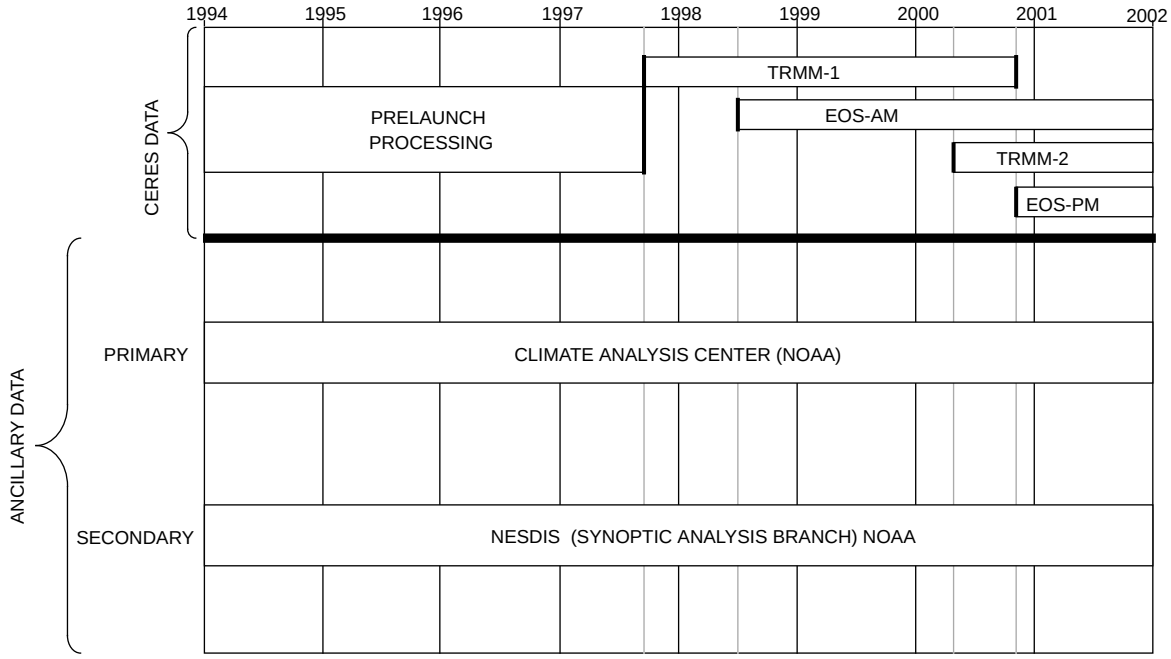


Table 3.2-16. Surfmap (Ice): Ice

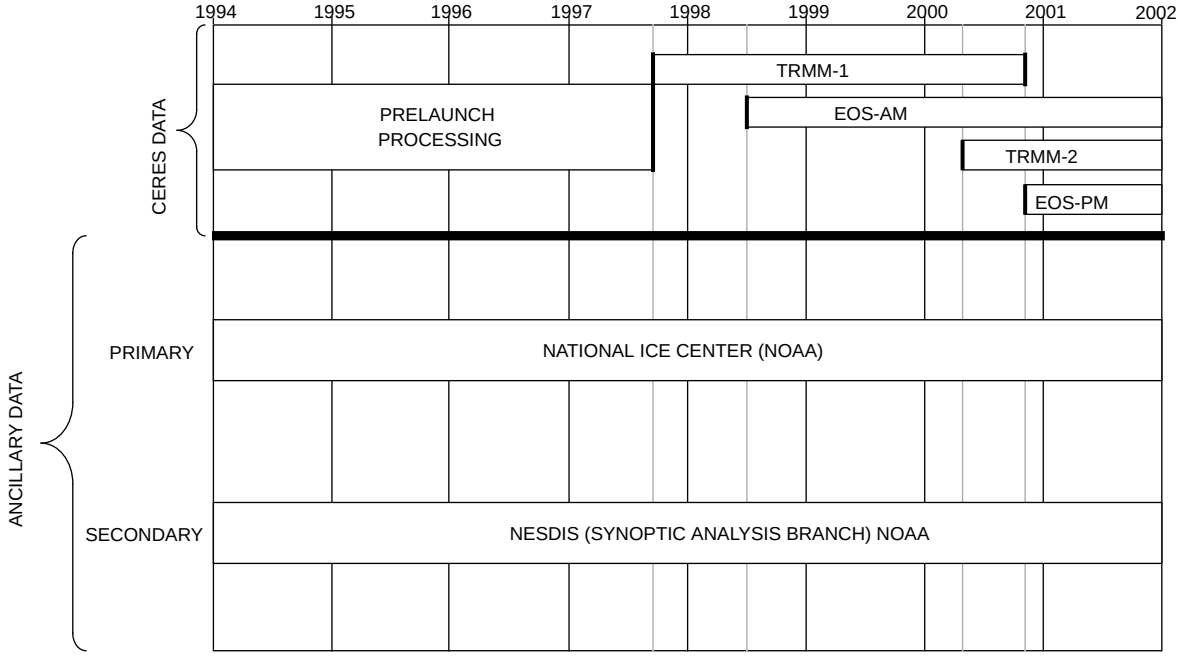


Table 3.2-17. Surfmap (VEGE): Vegetation

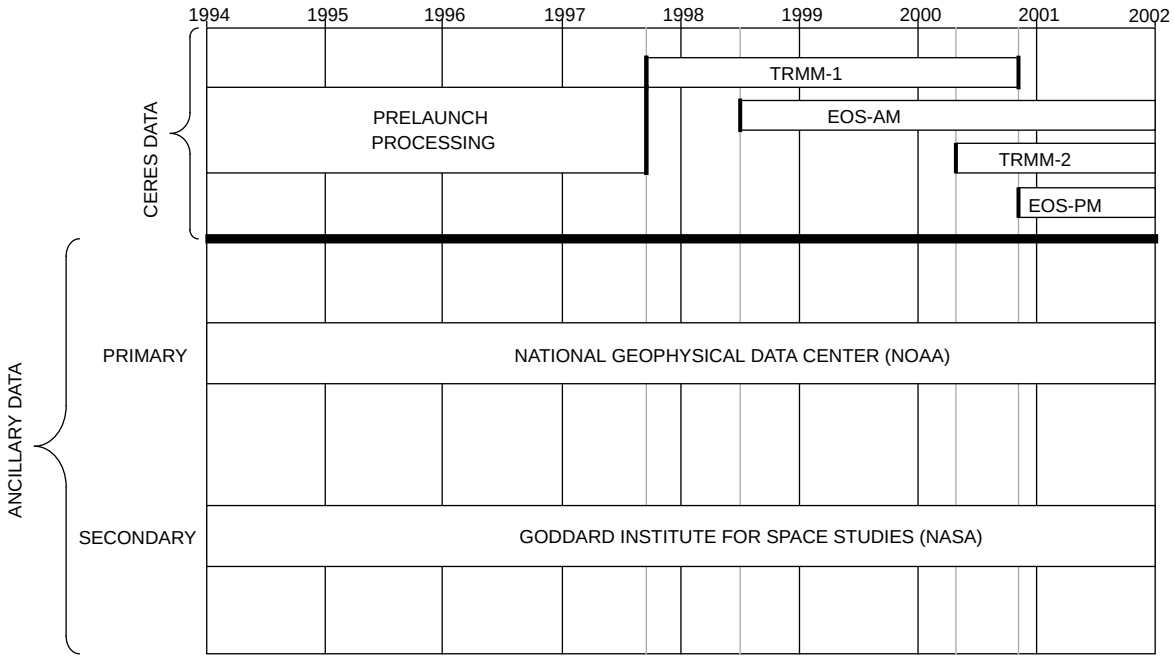
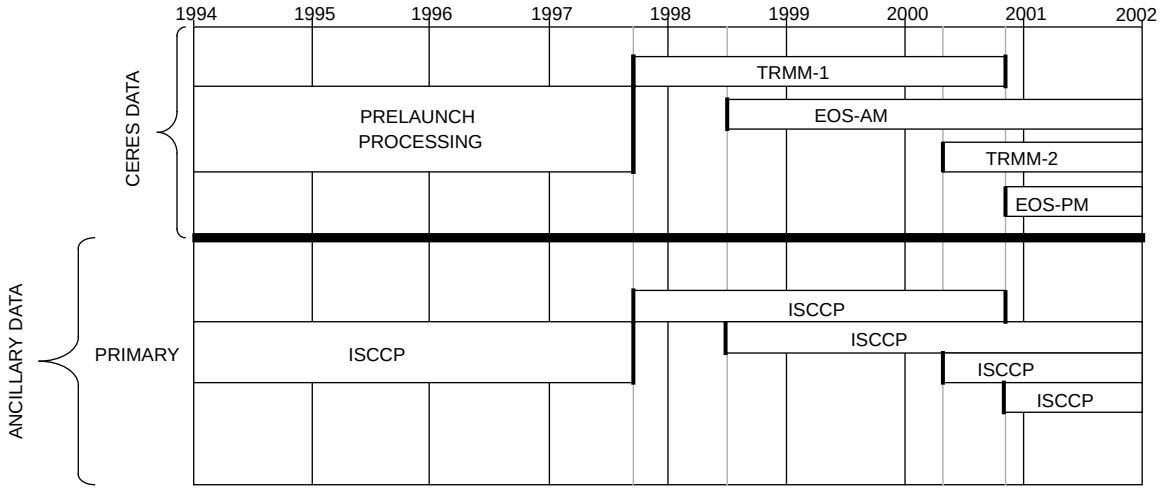


Table 3.2-18. GEO: ISCCP Radiances



3.2.3 Detailed Data Requirements

In this section each of the seventeen external ancillary data products are described in detail in the form of matrices with fifteen technical factors and fourteen procedural factors. For most products a primary and a secondary source are indicated. The primary source is preferred, but if it becomes unavailable one can use the secondary source. However, all of the Toolkit calls and procedures should apply equally to the secondary as well as the primary data. In the tables that follow, N/A indicates that a particular factor does not apply and TBD means that it is to be determined. The latter especially, applies to the DAAC-delivered items and source delivery times because the architecture is still being developed. Table 3.2-19 provides a detailed explanation of the factors for each of the seventeen external ancillary data products. Tables 3.2-20 through 3.2-36 include detailed information on twenty-nine factors for each of the seventeen data products.

Table 3.2-19. Explanation of Ancillary Data Product Factors (Sheet 1 of 2)

FACTOR	DEFINITION
Instrument	Acronym or name of instrument used to collect these data
Platform/experiment	Acronym or name of the platform or the experiment on which the instrument is used
Units	Scientific or engineering units (e.g., w-m^{-2}, g-kg^{-1}, km)
Horizontal resolution	Spatial resolution (degrees, km) in the horizontal plane
Vertical resolution	Spatial resolution (m, km) in the vertical direction
Number of vertical levels	Number of data levels from the Earth's surface to the TOA
Altitudes/pressure levels	Altitudes (m, km)/ pressure levels (hPa) above Earth's surface that correspond to the vertical levels
Spectral range	Spectral range (e.g., micrometers) for which this data product is applicable

Table 3.2-19. Explanation of Ancillary Data Product Factors (Sheet 2 of 2)

FACTOR	DEFINITION
Spectral values (resolution)	Actual values and resolution (micrometers or GHz) of the sensors for which these data apply
Absolute accuracy of data	Absolute accuracy (e.g, Kelvin, percent)
Relative accuracy of data	Precision (e.g., Kelvin, percent)
Data attainability level	Overall assessment of attainability of these data for processing (L-low, M-medium, H-high)
Importance level of data	Overall assessment of the importance of this product (L-low, M-medium, H-high)
Maximum spatial difference between ancillary & CERES data	Maximum distance on Earth's surface between this data product and CERES data
Maximum time difference between ancillary & CERES data	Maximum time difference between this data product and CERES data at the same position
Data collection mode	Method of data collection (e.g., satellite, radiosonde, aircraft, ground sensor)
Data set availability	Number of data sets per unit time available for processing (e.g., 2/day, 1/month)
Data level for processing	Level description (e.g., 1, 1b, 2, 3)
Time sequencing units	Standard for time reckoning (e.g., Julian days, Universal time)
Time data needed after launch	Specification of time (e.g., ASAP, 1 day, 3 weeks) data are needed after launch
Organizational source of data	Name or acronym of organization for data (e.g., LaRC-DAAC, NOAA-NMC, NOAA-NESDIS)
Data source contact	Names, addresses, phone numbers, e-mail, etc. of the key points of contact for data
Contact for receipt of data	Names, addresses, phone numbers, e-mail, etc. of the key points of contact for receipt of data
Form of source data	Source medium (e.g., CD-ROM, magnetic tape, diskettes)
Source data delivery mode	Mode of data transfer (e.g. electronic)
Source delivery time	Time for data to be delivered by a specific mode (e.g., 30 seconds, 2 hours, 5 days)
Backlog time for data	Time for data to be available in the system for processing
Replacement time for lost data	Length of time to replace these data (e.g., 1 hour, 7 days, 3 months)
Pre-launch data sets	Specification of data or program that are needed prior to launch

3.2.3.1 MWP: Microwave Water Path

The microwave water path will be measured using the 19.35 GHz and 37.0 GHz channels of the TRMM Microwave Imager (TMI) sensor aboard the TRMM-1 spacecraft which is to be launched in August, 1997. Also, the Multifrequency Imaging Microwave Radiometer (MIMR) scheduled for launch aboard the EOS-AM1 satellite METOP-1 of the European Space Agency in 2000 will have similar channels for the measurement of liquid water path. It should be noted that TRMM will have a predominantly equatorial orbit with an inclination angle of 35 degrees and an altitude of 350 kilometers. Because of the swath width the effective angle will be about 38 degrees, but, nevertheless, this could limit the global coverage of this product. Measurement of the liquid water path will only be available over the oceans. Prelaunch data sets will be available using the ER-2 aircraft (References 19, 20, 21).

Table 3.2-20. MWP Microwave Water Path

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	TMI MIMR	N/A	Data collection mode	Satellite	N/A
Platform/experiment	TRMM-1 METOP-1	N/A	Data set availability	2 - 6/day	N/A
Units	$kg\text{-}m^{-2}$	N/A	Data level for processing	2	N/A
Horizontal resolution	30 km	N/A	Time sequencing units	TBD	N/A
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	N/A
Number of vertical levels	N/A	N/A	Organizational source of data	DAAC MSFC	N/A
Altitudes/pressure levels	N/A	N/A	Data source contact	Bob Trapnell NASA-MSFC Huntsville, AL (205) 544-6329	N/A
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	N/A
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	N/A
Absolute accuracy of data	10%	N/A	Source data delivery mode	Electronic	N/A
Relative accuracy of data	10%	N/A	Source delivery time	5 - 7 Days	N/A
Data attainability level (L,M,H)	H	N/A	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	M	N/A	Replacement time for lost data	1 - Day	N/A
Max. spatial diff. between ancillary & CERES data	10 km	N/A	Prelaunch data sets	ER-2 aircraft	N/A
Max. time diff. between ancillary & CERES data	10 min	N/A			

3.2.3.2 APD: Aerosol (Column)

The Visible Infrared Scanner (VIRS) on the TRMM-1 platform and the Moderate-Resolution Imaging Spectroradiometer (MODIS) on the EOS-AM series of satellites will be used to estimate the vertical column aerosol optical thickness of the entire atmosphere. The wavelengths for which these optical thicknesses will be determined are those of the VIRS and MODIS sensors. Since optical depth and optical thickness are not official products of TRMM, the reliability of this product is in question for TRMM. MODIS will, however, be able to provide the aerosol optical thickness. The Advanced Very High Resolution Radiometer (AVHRR) on NOAA's Polar Orbiting Environmental Satellite (POES) will also be used to acquire aerosol data. Prelaunch data sets will be obtained using the AVHRR data (References 19, 20, 21, 22, 23) and UARS data.

Table 3.2-21. APD: Aerosol (Column)

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	VIRS MODIS	AVHRR MISR	Data collection mode	Satellite	Satellite
Platform/experiment	TRMM-1 EOS-AM	POES EOS-AM	Data set availability	1/day	1/day
Units	None	None	Data level for processing	1B	1B
Horizontal resolution	1.25°Eqa	1.25° Eqa	Time sequencing units	TBD	TBD
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	ASAP
Number of vertical levels	N/A	N/A	Organizational source of data	LaRC DAAC	NOAA DAAC
Altitudes/pressure levels	N/A	N/A	Data source contact	Sue Sorlie (804) 864-8660	George Murphy (301) 763-8115
Spectral range	TBD	TBD	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	TBD	TBD	Form of source data	TBD	TBD
Absolute accuracy of data	10%	10%	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	10%	10%	Source delivery time	5 - 7 Days	5 - 7 Days
Data attainability level (L,M,H)	H	H	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	M	M	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	TBD	TBD	Prelaunch data sets	POES (AVHRR) UARS (HALOE)	POES (AVHRR) UARS (CLAES)
Max. time diff. between ancillary & CERES data	TBD	TBD			

Eqa = equal area

3.2.3.3 APD: Aerosol (Thin Stratospheric)

The Stratospheric Aerosol and Gas Experiment (SAGE) II instrument will measure the thin stratospheric aerosol optical depth. However, it is expected that this instrument may be inoperable soon. A secondary source will be the Polar Ozone and Aerosol Experiment (POAM) II, a sensor that was launched in September 1993 by the Naval Research Laboratory (NRL). It is similar to SAGE in that it is a solar occultation device. It is in a sun-synchronous orbit at an altitude of 833 km with a period of 101.5 minutes and with an inclination angle of 98.7˚. In addition, in October, 1996 NRL plans to launch the Orbiting Ozone and Aerosol Measurement (OOAM) instrument with an inclination angle between 57˚ and 65˚. Another instrument would be the Improved Limb Atmospheric Sounder (ILAS), an infrared occultation device with one visible band from 0.753 μm - 0.781 μm and two infrared bands at 6.21 - 11.77 μm and 5.99 - 6.78 μm. The resolution is about 4 kilometers in the vertical direction. This instrument will be flown on the Japanese satellite Advanced Earth Observing System (ADEOS) in 1996 with a possible follow-on in 1999. Another alternative is the Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (SCIAMACHY), a device that will have several spectral bands from the ultraviolet to the near infrared. This instrument is to be launched aboard the Polar-Orbit Earth Observation Mission (POEM) Environmental Satellite (ENVISAT) in mid 1998 with a possible follow-on in 2003. Also, a SAGE III instrument will be available in 2000. Prelaunch data sets will be obtained using the current data from SAGE II (Reference 21) and UARS.

Table 3.2-22. APD: Aerosol (Thin Stratospheric)

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	SAGE II	POAM II	Data collection mode	Satellite	Satellite
Platform/experiment	ERBS	SPOT III	Data set availability	1/month	1/month
Units	None	None	Data level for processing	1B	1B
Horizontal resolution	1.25° Eqa	1.25° Eqa	Time sequencing units	TBD	TBD
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	ASAP
Number of vertical levels	N/A	N/A	Organizational source of data	LaRC DAAC	NRL Remote Sensing Division
Altitudes/pressure levels	N/A	N/A	Data source contact	Sue Sorlie (804) 864-8660	Richard Bevilacqua (202) 767-0768
Spectral range	TBD	TBD	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	TBD	TBD	Form of source data	TBD	TBD
Absolute accuracy of data	10%	10%	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	10%	10%	Source delivery time	5 - 7 Days	5 - 7 Days
Data attainability level (L,M,H)	H	H	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	M	M	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	TBD	TBD	Prelaunch data sets	SAGE II UARS (HALOE)	SAGE II UARS (CLAES)
Max. time diff. between ancillary & CERES data	TBD	TBD			

3.2.3.4 OPD: Ozone (Stratospheric)

The Stratospheric Aerosol and Gas Experiment (SAGE) II will be used to measure the stratospheric ozone content. The SAGE II instrument is on a platform which has an inclination angle of 57 degrees, but because of the limb scanning geometry, it can measure ozone profiles to 80 degrees. One possible problem is that SAGE II is nearing the end of its useful lifetime. An alternative source of data will be available from the Solar Backscatter Ultraviolet (SBUV/2) instrument aboard the NOAA Polar-Orbiting Operational Environmental Satellite (POES). It is a 12-channel device which operates on the day-side of the orbit. Future SBUV/2 instruments will be flown on other POES, and a SAGE III instrument will be available in 2000. Prelaunch data will be available from current SAGE II and the SBUV/2 instruments (References 21, 22, 24).

Table 3.2-23. OPD: Ozone (Stratospheric)

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	SAGE II	SBUV/2	Data collection mode	Satellite	Satellite
Platform/experiment	ERBS	POES	Data set availability	1/week	1/week
Units	TBD	TBD	Data level for processing	1B	1B
Horizontal resolution	1.25° Eqa	1.25° Eqa	Time sequencing units	TBD	TBD
Vertical resolution	TBD	TBD	Time data needed after launch	ASAP	ASAP
Number of vertical levels	5	5	Organizational source of data	LaRC DAAC	NOAA DAAC
Altitudes/pressure levels	TBD	TBD	Data source contact	Sue Sorlie NASA-LaRC Hampton, VA (804) 864-8656	George Murphy Camp Springs, MD (301) 763-8115
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	TBD
Absolute accuracy of data	5%	5%	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	2%	2%	Source delivery time	5 - 7 Days	5 - 7 Days
Data attainability level (L,M,H)	H	H	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	M	M	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	TBD	TBD	Prelaunch data sets	SAGE II	POES (SBUV/2)
Max. time diff. between ancillary & CERES data	TBD	TBD			

3.2.3.5 OPD: Ozone (Column)

It is desirable to have the total column ozone for the entire atmosphere. This can be obtained from the Total Ozone Mapping Spectrometer (TOMS) on the Nimbus 7 satellite which has provided meaningful ozone data. This satellite is in a south-north sun synchronous polar orbit such that it is always close to local noon/midnight every 24 hours. Total column ozone is inferred from the differential absorption of scattered sunlight in the ultraviolet and was measured in a 50 km square field-of-view of the instrument. There were about 200,000 ozone measurements every day and these have been averaged into grid cells 1 degree in latitude by 1.25 degrees in longitude. The new total ozone data now come from the Russian satellite Meteor-3/TOMS which was launched in 1991 and is still operating. It is not sun-synchronous but it has an inclination angle of 82.5° and complete global measurements are made of ozone except when the orbit is near the day-night terminator. Other satellites, such as the EP/TOMS, an Earth probe, is to be launched in July 1994 and the ADEOS/TOMS, a Japanese satellite, is to be launched in February 1996. In addition, the High Resolution Infrared Radiation Sounder (HIRS/2), as part of the suite of sensors for the NOAA TIROS Operational Vertical Sounder (TOVS) with a resolution of 1.25 degrees and an IFOV at nadir of 17.4 km, will measure the total ozone with an accuracy of 15 percent (tropical) and 50 percent (polar). Prelaunch data will be available from current TOMS and/or HIRS/2 instruments (Reference 21).

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Table 3.2-24. OPD: Ozone (Column)

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	TOMS	HIRS/2	Data collection mode	Satellite	Satellite
Platform/experiment	Meteor-3	TOVS	Data set availability	1/day	1/day
Units	TBD	TBD	Data level for processing	1B	1B
Horizontal resolution	1.25° Eqa	1.25° Eqa	Time sequencing units	TBD	TBD
Vertical resolution	TBD	TBD	Time data needed after launch	ASAP	ASAP
Number of vertical levels	(column)	(column)	Organizational source of data	LaRC DAAC	NOAA DAAC
Altitudes/pressure levels	TBD	TBD	Data source contact	Sue Sorlie (804) 864-8656	George Murphy (301) 763-8115
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	TBD
Absolute accuracy of data	5%	5%	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	2%	2%	Source delivery time	5 - 7 Days	5 - 7 Days
Data attainability level (L,M,H)	TBD	TBD	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	M	M	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	TBD	TBD	Prelaunch data sets	TOMS	TOVS (HIRS/2)
Max. time diff. between ancillary & CERES data	TBD	TBD			

3.2.3.6 MWH: Microwave Humidity

Humidity will be measured using the 21.3 GHz channel of the TRMM Microwave Imager (TMI) aboard the TRMM-1 spacecraft, which is to be launched in August 1997. The TMI sensor measures precipitable water over the oceans only. In addition, the Multifrequency Imaging Microwave Radiometer (MIMR) aboard the European Satellite (METOP-1) will also measure the humidity. This instrument is to be launched in early 2000. As an alternative source of data, the MSI instrument aboard the NOAA Geostationary Operational Environmental Satellite (GOES) will be available for the measurement of humidity. It is a satellite that measures precipitable water over the oceans only. For prelaunch data sets, one can use the existing GOES data or similar data from the Special Sensor Microwave/Imager (SSM/I) in the Defense Meteorological Satellite Program (DMSP) (References 19, 20, 21, 23, 25).

Table 3.2-25. MWH: Microwave Humidity

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	TMI MIMR	MSI	Data collection mode	Satellite	Satellite
Platform/experiment	TRMM-1 METOP-1	GOES	Data set availability	2-6/day	2-6/day
Units	$g\text{-}kg^{-1}$	$g\text{-}kg^{-1}$	Data level for processing	1B	1B
Horizontal resolution	1.25° Eqa	1.25° Eqa	Time sequencing units	TBD	TBD
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	ASAP
Number of vertical levels	N/A	N/A	Organizational source of data	GSFC DAAC	NOAA DAAC
Altitudes/pressure levels	N/A	N/A	Data source contact	JIm McManus (301) 286-4589	George Murphy (301) 763-8115
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	TBD
Absolute accuracy of data	5%	5%	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	5%	5%	Source delivery time	5 - 7 Days	5 - 7 Days
Data attainability level (L,M,H)	H	H	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	M	M	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	TBD	TBD	Prelaunch data sets	GOES (MSI)	DMSP (SSM/I)
Max. time diff. between ancillary & CERES data	TBD	TBD			

3.2.3.7 GAP: (3-D Meteorological Data)

The Gridded Analysis Product (GAP) for three-dimensional meteorological data refers to the standard meteorological data products of geopotential (G), wind speed (W), water vapor (WV), and temperature (T) in the atmosphere. These data can be obtained from NOAA's National Meteorological Center (NMC). The actual measurements are taken from a worldwide network of many instruments deployed on radiosondes, aircraft, ships, buoys, ground stations, and from satellites (into the National Environmental Satellite Data Information Center, or NESDIS). NMC then uses a forecast model to produce gridded values globally. Data generally come into the system four times per day and there is a two to three hour lag for processing. This means that there is about an eight hour lag for forecasts. Uncertainties or weights associated with the data points are not available. NMC grid size is 2.5˚ equal angle so that preprocessing will be necessary (References 26, 27).

Table 3.2-26. GAP: (3-D Meteorological Data)

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	Many	N/A	Data collection mode	Satellites Aircraft Radiosonde Ground Stations (ships; etc.)	N/A
Platform/experiment	Many	N/A	Data set availability	4/day	N/A
Units	G: km W: m/s WV: ppmv T: K	N/A	Data level for processing	2	N/A
Horizontal resolution	1.25 Eqa	N/A	Time sequencing units	TBD	N/A
Vertical resolution	TBD	N/A	Time data needed after launch	ASAP	N/A
Number of vertical levels	$\bar{>}$ 38	N/A	Organizational source of data	NMC DAAC	N/A
Altitudes/pressure levels	$\bar{>}$ 38	N/A	Data source contact	George Murphy (301) 763-8115	N/A
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	N/A
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	N/A
Absolute accuracy of data	G: 10% W: 10% WV: 10% T: 1 K	N/A	Source data delivery mode	Electronic	N/A
Relative accuracy of data	G: 10% W: 10% WV: 10% T: 1 K	N/A	Source delivery time	5 - 7 Days	N/A
Data attainability level (L,M,H)	TBD	N/A	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	H	N/A	Replacement time for lost data	1-Day	N/A
Max. spatial diff. between ancillary & CERES data	TBD	N/A	Prelaunch data sets	NMC	N/A
Max. time diff. between ancillary & CERES data	TBD	N/A			

3.2.3.8 GAP: (Land Surface Temperature)

The Gridded Analysis Product (GAP) land surface temperature can be obtained from NOAA's National Meteorological Center (NMC), which uses a surface model for estimates. The Moderate-Resolution Imaging Spectroradiometer (MODIS) on both the EOS-AM and EOS-PM series will measure the surface temperature with a 1-kilometer spatial resolution, day and night, with an absolute accuracy of 0.2 K for oceans and 1 K for land. As a secondary source of data, the European Centre for Medium-Range Weather Forecasts (ECMWF) has products similar to those of the NMC. A possible difficulty, however, is in the differences among the various processing methods used by another agency. In addition, the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), on the EOS-AM1 series to be launched in mid 1998, will measure the surface radiative (brightness) temperature and multispectral data from which the surface kinetic temperature and spectral emissivity can be derived (References 21, 28).

Table 3.2-27. GAP: Land Surface Temperature

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	Many MODIS	Many ASTER	Data collection mode	Satellites Aircraft Ground stations etc.	Satellites Aircraft Ground stations etc.
Platform/experiment	Many EOS-AM	Many EOS-AM	Data set availability	4/day	4/day
Units	K	K	Data level for processing	2	2
Horizontal resolution	1.25° Eqa	1.25° Eqa	Time sequencing units	TBD	TBD
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	TBD
Number of vertical levels	N/A	N/A	Organizational source of data	NMC DAAC	ECMWF DAAC
Altitudes/pressure levels	N/A	N/A	Data source contact	George Murphy (301) 763-8115	TBD
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	TBD
Absolute accuracy of data	1 K	1 K	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	1 K	1 K	Source delivery time	5 - 7 Days	5 - 7 Days
Data attainability level (L,M,H)	H	H	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	H	H	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	TBD	TBD	Prelaunch data sets	NMC	ECMWF
Max. time diff. between ancillary & CERES data	TBD	TBD			

3.2.3.9 GAP: (Sea Surface Temperature)

The Gridded Analysis Product (GAP), sea surface temperature can be obtained using the TRMM-Microwave Imager but the procedure is "experimental" and it will not be evaluated for at least two years after data acquisition. Sea surface temperature is not a primary product of the Visible Infrared Scanner (VIRS) on TRMM but it can be calculated using an algorithm from NOAA's National Meteorological Center (NMC). The algorithm is similar to that of the AVHRR algorithm. In addition, the Moderate-Resolution Imaging Spectroradiometer (MODIS) on both the EOS-AM and EOS-PM series will measure the sea surface temperature with a 1-kilometer resolution, day and night, with an absolute accuracy of 0.2 K. Secondary sources are NMC and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on the EOS-AM1 series to be launched in mid 1998. One can use the NMC data for prelaunch data sets (Reference 21).

Table 3.2-28. GAP: Sea Surface Temperature

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	TMI MODIS	Many ASTER	Data collection mode	Satellites Aircraft Radiosonde (ships, etc.)	Satellites Aircraft Radiosonde (ships, etc.)
Platform/experiment	TRMM-1 EOS-AM	Many EOS-AM	Data set availability	1/day	1/day
Units	K	K	Data level for processing	2	2
Horizontal resolution	1.25° Eqa	1.25° Eqa	Time sequencing units	TBD	TBD
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	ASAP
Number of vertical levels	N/A	N/A	Organizational source of data	NMC DAAC	NMC DAAC
Altitudes/pressure levels	N/A	N/A	Data source contact	George Murphy (301) 763-8115	George Murphy (301) 763-8115
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	TBD
Absolute accuracy of data	1 K	1 K	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	1 K	1 K	Source delivery time	5 - 7 Days	5 - 7 Days
Data attainability level (L,M,H)	H	H	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	H	H	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	TBD	TBD	Prelaunch data sets	DAAC	NMC DAAC
Max. time diff. between ancillary & CERES data	TBD	TBD			

3.2.3.10 MODIS CID: Cloud Imager Data

The Moderate-Resolution Imaging Spectroradiometer (MODIS) is a medium-resolution cross-track scanning radiometer to be launched on the EOS-AM and EOS-PM series of satellites in 1998 and 2000 respectively. Thus, the cloud image data obtained with this instrument will be contemporaneous with the corresponding CERES data. The instrument has 36 discrete spectral bands between 0.4 and 15.0 micrometers wavelength and a spatial resolution of 250 m, 500 m, and 1 km at nadir. For CERES, however, only 11 bands will be used for clouds (these specific bands are listed in the CERES Data Products Catalog, Reference 14). There will be continuous global coverage every 1 to 2 days. The spatial resolution for cloud cover is 250 meters by day and 1000 meters by night. Prelaunch data sets will be obtained from data acquired by the HIRS and AVHRR sensors aboard the NOAA Polar Orbiting Environmental Satellite (POES) (References 21, 29).

Table 3.2-29. MODIS CID: Cloud Imager Data

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	MODIS	N/A	Data collection mode	Satellite	N/A
Platform/experiment	EOS-AM; EOS-PM	N/A	Data set availability	1/day	N/A
Units	wm^{-2}-sr^{-1}–μm^{-1}	N/A	Data level for processing	1B	N/A
Horizontal resolution	0.25 km-1km	N/A	Time sequencing units	TBD	N/A
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	N/A
Number of vertical levels	N/A	N/A	Organizational source of data	GSFC-DAAC	N/A
Altitudes/pressure levels	N/A	N/A	Data source contact	Jim McManus (301) 286-4589	N/A
Spectral range	0.4 μm-15 μm	N/A	Contact for receipt of data	LaRC DAAC	N/A
Spectral values (resolution)	36 bands	N/A	Form of source data	TBD	N/A
Absolute accuracy of data	Solar: 5% IR: 0.5 K	N/A	Source data delivery mode	Electronic	N/A
Relative accuracy of data	Solar: 1% IR: 0.1 K	N/A	Source delivery time	ASAP	N/A
Data attainability level (L,M,H)	H	N/A	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	H	N/A	Replacement time for lost data	ASAP	N/A
Max. spatial diff. between ancillary & CERES data	N/A	N/A	Prelaunch data sets	HIRS AVHRR	N/A
Max. time diff. between ancillary & CERES data	N/A	N/A			

3.2.3.11 VIRS CID: Cloud Imager Data

The Visible Infrared Scanner (VIRS) is a sensor to be flown on the TRMM-1 spacecraft in August, 1997. It has one visible channel at a center wavelength of 0.63 μm and four infrared channels with center wavelengths of 1.60 μm, 3.75 μm, 10.80 μm, and 12.00 μm respectively. The spectral resolution varies from 0.06 μm to 1 μm. It will be at an altitude of 350 kilometers and will have a 720 kilometer swath width and a ground spatial resolution of 2.11 kilometers (in track). The visible channels will be turned off at night. The VIRS sensor has the advantage that it is on the same platform as the CERES sensor and will, therefore, be able to locate clouds that are contemporaneous with the CERES radiances. Prelaunch data sets will be obtained from data by the HIRS and AVHRR sensors aboard the NOAA Polar Orbiting Environmental Satellite (POES) (References 19, 20, 23).

Table 3.2-30. VIRS CID: Cloud Imager Data

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	VIRS	N/A	Data collection mode	Satellite	N/A
Platform/experiment	TRMM-1	N/A	Data set availability	1/day	N/A
Units	wm^{-2}-sr^{-1}-μm^{-1}	N/A	Data level for processing	1B	N/A
Horizontal resolution	0.25 km-2 km	N/A	Time sequencing units	TBD	N/A
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	N/A
Number of vertical levels	N/A	N/A	Organizational source of data	TSDIS	N/A
Altitudes/pressure levels	N/A	N/A	Data source contact	Erich Stocker GSFC Greenbelt, MD (301) 286-2153	N/A
Spectral range	0.63 μm-12 μm	N/A	Contact for receipt of data	LaRC DAAC	N/A
Spectral values (resolution)	5 bands	N/A	Form of source data	TBD	N/A
Absolute accuracy of data	Solar: 5% IR: 0.5 K	N/A	Source data delivery mode	Electronic	N/A
Relative accuracy of data	Solar: 1% IR: 0.1 K	N/A	Source delivery time	ASAP	N/A
Data attainability level (L,M,H)	H	N/A	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	H	N/A	Replacement time for lost data	ASAP	N/A
Max. spatial diff. between ancillary & CERES data	N/A	N/A	Prelaunch data sets	HIRS AVHRR	N/A
Max. time diff. between ancillary & CERES data	N/A	N/A			

3.2.3.12 SURFMAP(DEM): Digital Elevation Map

A number of sources exist for elevation data. The Digital Chart of the World (DCW) is a comprehensive 1:1,000,000-scale vector data base of the world. These data are available on CD-ROMs from USGS Map Sales at the Denver Federal Center in Boulder, Colorado. The preferred data, however, are available in the ETOPO5 set which consists of 5-minute gridded elevations/bathymetry for the world. These data, acquired originally from the Defense Mapping Agency, can be obtained from the National Geophysical Data Center (NGDC) in Boulder, Colorado, on a CD-ROM called "Terrain-Base." Dean Gesch at the National Center for Atmospheric Research said that they have 30-inch (1-km) data sets for Africa and North and South America, and they expect to have these data for Europe and Asia in about a year. Ten-minute gridded data from the Fleet Numerical Oceanography Center are also available from NGDC, but the quality of these data is considered to be low.

Table 3.2-31. SURFMAP (DEM): Digital Elevation Map

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	N/A	N/A	Data collection mode	Static	N/A
Platform/experiment	N/A	N/A	Data set availability	1/mission	N/A
Units	meters	N/A	Data level for processing	2	N/A
Horizontal resolution	10 km Eqa	N/A	Time sequencing units	N/A	N/A
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	N/A
Number of vertical levels	N/A	N/A	Organizational source of data	NOAA Code E/GC1 325 Broadway Boulder, CO 80303 (303) 497-6338	N/A
Altitudes/pressure levels	N/A	N/A	Data source contact	John Kineman (303) 497-6900	N/A
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	N/A
Spectral values (resolution)	N/A	N/A	Form of source data		N/A
Absolute accuracy of data	200 m	N/A	Source data delivery mode	Electronic	N/A
Relative accuracy of data	200 m	N/A	Source delivery time	Instantaneous	N/A
Data attainability level (L,M,H)	TBD	N/A	Backlog time for data	ASAP	N/A
Importance level of data (L,M,H)	H	N/A	Replacement time for lost data	Instantaneous	N/A
Max. spatial diff. between ancillary & CERES data	H	N/A	Prelaunch data sets	NGDC	N/A
Max. time diff. between ancillary & CERES data	TBD	N/A			N/A

3.2.3.13 SURFMAP(H_2O): Water Conditions

Water data include the calm ocean water and the specific areas of whitecaps on the ocean or large lakes. There is a distinct difference between the reflectance of calm water and the whitecaps and it is important to have data on these areas of large water bodies. A number of sensors in the EOS program will be able to provide information on water properties such as salinity, surface temperature, wind speed, and reflectance. In particular, MIMR will provide information on sea surface temperature and wind speed and MODIS will produce ocean color, i.e. ocean-leaving spectral radiance within 5 percent and sea surface temperature with an absolute accuracy of 1 K. In addition, insofar as a global map of general areal features is concerned one can obtain calm water-whitecap data using existing Landsat imagery. Although such data are not contemporaneous with CERES data, certain area patterns and relative percentages may be discerned. Another factor to be considered is the occurrence of land areas which are temporarily flooded over extensive regions such as in the Mississippi basin, the Nile region, or in the Mekong delta. Even though such areas are classified by certain land features, this classification will have to be modified depending upon hydrological cycles or severe weather conditions (Reference 21). Data from NGDC originally came from FNMOC and are a static data set available on CD-ROM.

Table 3.2-32. SURFMAP (H_2O): Water Conditions

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	N/A	N/A	Data collection mode	Satellite	N/A
Platform/experiment	N/A	N/A	Data set availability	1-Day	N/A
Units	%	N/A	Data level for processing	2	N/A
Horizontal resolution	10 km Eqa	N/A	Time sequencing units	TBD	N/A
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	N/A
Number of vertical levels	N/A	N/A	Organizational source of data	NOAA NGDC*	N/A
Altitudes/pressure levels	N/A	N/A	Data source contact	John Kinaman (303) 497-6900	N/A
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	N/A
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	N/A
Absolute accuracy of data	200 m	N/A	Source data delivery mode	Electronic	N/A
Relative accuracy of data	200 m	N/A	Source delivery time	5 - 7 Days	N/A
Data attainability level (L,M,H)	H	N/A	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	H	N/A	Replacement time for lost data	1-Day	N/A
Max. spatial diff. between ancillary & CERES data	N/A	N/A	Prelaunch data sets		N/A
Max. time diff. between ancillary & CERES data	N/A	N/A			N/A

*Code E/GC1, 325 Broadway, Boulder, CO 80303

3.2.3.14 SURFMAP(SNOW): Snow

NOAA's Advanced Very High Resolution Radiometer (AVHRR) sensor determines snow cover every week. These data are for the northern hemisphere only and are digitized on a polar stereographic 1˚ x 1˚ grid. Data are also produced on a 2.5˚ x 2.5˚ grid by the National Meteorological Center (NMC) and the Climate Analysis Center; these data can be accessed on-line as frequently as four times per day. Also, the Synoptic Analysis Center at the National Environmental Satellite Data Information Center (NESDIS) produces weekly snow data from the visible channels of the GMS, GOES, and Meteosat satellites. At the present time, a hand analysis is done, but eventually they will update their data three times per week. For prelaunch data sets, one can use the data from these centers (References 30, 31, 32).

Table 3.2-33. SURFMAP (SNOW): Snow

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	N/A	N/A	Data collection mode	Satellite	Satellite
Platform/experiment	N/A	N/A	Data set availability	1/week	1/week
Units	%	%	Data level for processing	2	2
Horizontal resolution	10 km Eqa	10 km Eqa	Time sequencing units	TBD	TBD
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	TBD
Number of vertical levels	N/A	N/A	Organizational source of data	NMC CAC Camp Springs, MD	NOAA (NESDIS) Synoptic Analysis Branch
Altitudes/pressure levels	N/A	N/A	Data source contact	Don Garrett (301) 763-8227	James Lynch (301) 763-8444
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	TBD
Absolute accuracy of data	10%	10%	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	5%	5%	Source delivery time	5 - 7 Days	5 - 7 Days
Data attainability level (L,M,H)	TBD	TBD	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	TBD	TBD	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	N/A	N/A	Prelaunch data sets	NMC Climate Analysis Center	NOAA (NESDIS) Synoptic Analysis Center
Max. time diff. between ancillary & CERES data	N/A	N/A			

3.2.3.15 SURFMAP(ICE): Ice

Sea ice data can be obtained from the National Ice Center. The data are actually acquired from the DMSP, NOAA, and other satellites with a spatial resolution of 15 nautical miles and are updated once per week. The data are coverage only, not temperatures or emissivities. In addition, the National Snow and Ice Center at the University of Colorado archives ice concentration data (percent) for the polar regions. This comes from the SSM/I sensor on the DMSP and is available on CD ROM. These data, however, are **not** in real time, but, rather are at least one year old. For prelaunch data, one can utilize these data centers (Reference 32).

Table 3.2-34. SURFMAP (ICE): Ice

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	N/A	N/A	Data collection mode	Satellite	Satellite
Platform/experiment	N/A	N/A	Data set availability	1/week	1/week
Units	%	%	Data level for processing	2	2
Horizontal resolution	10 km Eqa	10 km Eqa	Time sequencing units	TBD	TBD
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	TBD
Number of vertical levels	N/A	N/A	Organizational source of data	National Ice Center (NOAA)*	NOAA (NESDIS)**
Altitudes/pressure levels	N/A	N/A	Data source contact	Cheryl Bertoia (301) 763-7154	James Lynch (301) 763-8444
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	TBD
Absolute accuracy of data	10%	10%	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	5%	5%	Source delivery time	5 7 Days	5 - 7 Days
Data attainability level (L,M,H)	TBD	TBD	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	TBD	TBD	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	N/A	N/A	Prelaunch data sets	National Ice Center (NOAA)	NOAA (NESDIS)**
Max. time diff. between ancillary & CERES data	N/A	N/A			

*4251Suitland Rd., FOB 4, Washington, DC 20395
**Synoptic Analysis Branch, Camp springs, MD

3.2.3.16 SURFMAP(VEGE): Vegetation

Vegetation data can be obtained from NOAA's National Geophysical Data Center (NGDC) in Boulder, Colorado. There exists an Ecosystems Data Base on CD ROM (Olsen data base) with a 1˚ x 1˚ grid and possibly a 10' x 10' grid. This set is a composite of surface and satellite data and is updated once per year. Also, the Goddard Institute of Space Studies (GISS) has a global data base (1˚ x 1˚) grid of land use (percent cultivated and six categories), visible albedo for the four seasons and 178 vegetation types. This set makes use of ground data; there are no satellite data in the set; therefore, it is a static data set. In addition, NOAA's Climate Analysis Center (CAC) produces global maps of the Normalized Difference Vegetation Index (NDVI) at 16 kilometer resolution which is updated every week. These data, obtained from NOAA's AVHRR sensor, consist of vegetative data from 55˚ S to 75˚ N. Data are archived at the EROS Data Center (EDC) in Sioux Falls, South Dakota. Prelaunch data sets can be obtained from these centers (References 33, 34, 35).

Table 3.2-35. SURFMAP (VEGE): Vegetation

TECHNICAL FACTORS	PRIMARY	SECONDARY	PROCEDURAL FACTORS	PRIMARY	SECONDARY
Instrument	N/A	N/A	Data collection mode	Satellite; Surface	Satellite; Surface
Platform/experiment	N/A	N/A	Data set availability	1/week	1/week
Units	%	%	Data level for processing	2	2
Horizontal resolution	10 km Eqa	10 km Eqa	Time sequencing units	TBD	TBD
Vertical resolution	N/A	N/A	Time data needed after launch	ASAP	TBD
Number of vertical levels	N/A	N/A	Organizational source of data	NOAA NGDC*	NASA GISS
Altitudes/pressure levels	N/A	N/A	Data source contact	John Kinaman (303) 497-6900	Elaine Matthews GISS**
Spectral range	N/A	N/A	Contact for receipt of data	LaRC DAAC	LaRC DAAC
Spectral values (resolution)	N/A	N/A	Form of source data	TBD	TBD
Absolute accuracy of data	10%	10%	Source data delivery mode	Electronic	Electronic
Relative accuracy of data	5%	5%	Source delivery time	5 - 7 Days	5 - 7 Days
Data attainability level (L,M,H)	H	H	Backlog time for data	N/A	N/A
Importance level of data (L,M,H)	H	H	Replacement time for lost data	1-Day	1-Day
Max. spatial diff. between ancillary & CERES data	N/A	N/A	Prelaunch data sets	NOAA NGDC*	NASA GISS
Max. time diff. between ancillary & CERES data	N/A	N/A			

*Code E/GC1, 325 Broadway, Boulder, CO 80303
**2880 Broadway, New York, NY 10025, (212) 678-5628

3.2.3.17 GEO: ISCCP Radiances

The International Satellite Cloud Climatology Project (ISCCP) began in July 1983 as part of the World Climate Research Program. Visible and infrared images are obtained from an international network of operational geostationary and polar orbiting meteorological satellites (GOES-E, GOES-W, METEOSAT, GMS, and NOAA/ TIROS-N). These data have been routinely processed to develop a global data set of calibrated radiances and derived cloud parameters for climate research. There are some concerns about the availability and suitability of the ISCCP data. If the DX product is to be used, then there will almost certainly be a delay in obtaining the data since ISCCP will have to calculate the cloud parameters. The B3 may be more readily available on a real-time basis, but this data set has some disadvantages; the Langley DAAC is not scheduled to receive this produc,t and the B3 data contain no cloud information. In addition to the time constraints on the receiving of data, there is also the problem of data gaps in the ISCCP products. The Indian satellite (INSAT) data are often not available, which creates a lack of data over about 20% of the globe. Also, some ISCCP products do not include SW data for solar zenith angles greater than 72.5˚. This restriction severely limits the effectiveness of using these data in the SW averaging process. This problem can be alleviated if the radiances are still available even if ISCCP cloud parameters cannot be produced. Another concern is the possibility of inconsistencies between ISCCP and CERES cloud information. There will be differences in cloud properties derived by any two experiments. The main question is whether the improvements in the knowledge of meteorological changes between CERES observations provided by ISCCP are greater than inaccuracies produced by using CERES information whenever there is a nearby observation. The results of the simulations suggest, however, that the use of ISCCP cloud information does aid in the interpolation process. Currently, there is no adopted method for producing total sky/surface longwave (LW) flux from top-of-the-atmosphere (TOA) flux. It is expected that a method will be available by the time of Release 1. Any atmospheric parameters necessary for this parameterization will have to be available from either the MOA atmospheric data set or from a combination of CERES and ISCCP cloud properties. The regressions that are to be used to produce broadband simulated fluxes from the narrowband measurements will have to be derived. A global regression fit may be used initially. The effects of regional variations in these regressions can be minimized by the normalization of this time series to the CERES measurements. If this regression proves to be too coarse, then regional or climate-regime specific fits may be required each month using coincident CERES and geostationary data (References 36, 37).

Table 3.2-36. GEO: ISCCP Radiances (Sheet 1 of 2)

TECHNICAL FACTORS	PRIMARY	PROCEDURAL FACTORS	PRIMARY
Instrument	VISSR	Data collection mode	Satellite
Platform/experiment	GOES; GMS; METEO-SAT; INSAT; NOAA polar orbiters	Data set availability	8/day
Units	$w\text{-}m^{-2}$ - sr^{-1}	Data level for processing	1B
Horizontal resolution	30 km	Time sequencing units	UT
Vertical resolution	N/A	Time data needed after launch	ASAP
Number of vertical levels	N/A	Organizational source of data	LaRC-DAAC
Altitudes/pressure levels	N/A	Data source contact	Bill Rossow NASA-GISS 2880 Broadway New York, NY 10025
Spectral range	0.5 μm - 12 μm	Contact for receipt of data	TBD
Spectral values (resolution)	ISCCP values	Form of source data	DAAC files
Absolute accuracy of data	ISCCP values	Source data delivery mode	Electronic
Relative accuracy of data	ISCCP values	Source delivery time	ASAP

Table 3.2-36. GEO: ISCCP Radiances (Sheet 2 of 2)

TECHNICAL FACTORS	PRIMARY	PROCEDURAL FACTORS	PRIMARY
Data confidence level (L,M,H)	H	Backlog time for data	1 month
Importance level of data (L,M,H)	H	Replacement time for lost data	Immediately
Max. spatial diff. between ancillary & CERES data	N/A	Prelaunch data sets	N/A
Max. time diff. between ancillary & CERES data	N/A		

3.2.4 Format Requirements

3.2.4.1 Particular Formats

Many of the data products needed, such as meteorological and surface data, are to be in a 1.25 equal area grid. Other data products, such as cloud imagery, are to be given at specific spatial resolutions. The vertical profile data are to be at specified levels in the atmosphere. The Surfmap data products will have to be placed in a geographic information system so that the fractional coverage of each species (i.e. snow, grassland, deciduous forest, etc.) can easily be categorized. Once each of these species is identified, a vector array of geophysical and/or optical properties can be mapped onto the geographic system to enable investigators to obtain surface albedo, surface emissivity, and other quantities in the proper grid. Besides digitized data for each of the products, it is desirable to have surface maps or imagery for a quick-look analysis of the data. This is especially true for the more variable products such as snow cover, hydrological maps of water bodies, and certain forms of vegetation

3.2.4.2 Preprocessing of Data

Data from the National Oceanic and Atmospheric Administration (NOAA), the Naval Research Laboratory (NRL), the U.S. Geological Survey (USGS), and other agencies will be formatted in a form that is different from that which is required by the CERES processing groups. Thus, agreements will have to be made so that the external ancillary data can be preprocessed and reformatted into a form that is compatible with the CERES requirements. Which specific organizations will be involved on these tasks is to be determined.

3.2.5 ICD Responsibilities

The ICD for all the EOS missions are yet to be determined, but TRMM-related data products will be processed through GSFC and TSDIS. Lead responsible groups for this are the TRMM Project Office and EOSDIS, with Earth Science and MSFC providing support and review functions (Reference 16).

The following sections are not in this version of this document. They will be included in a later release.

3.3 Nonarchival Ancillary Data

3.4 Standard Data Products

3.5 Metadata

3.6 Status Messages and Control Messages

3.7 QC Data

3.8 Validation Data

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Appendix A

Abbreviations and Acronyms

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Abbreviations and Acronyms

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ADEOS	Advanced Earth Observing System
APD	Aerosol Profile Data
APID	Application Packet Identifier
ASAP	As Soon as Possible
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR	Advanced Very High Resolution Radiometer
BDS	Bidirectional Scan
CAC	Climate Analysis Center
CCSDS	Consultative Committee for Space Data Systems
CERES	Clouds and Earth's Radiant Energy System
CID	Cloud Imager Data
CLAES	Cryogenic Limb Array Etalon Spectrometer
DAAC	Distributed Active Archive Center
DADS	Data Archive and Distribution System
DCW	Digital Chart of the World
DDF	Data Distribution Facility
DEM	Digital Elevation Map
DMA	Defense Mapping Agency
DMS	Data Management System
DMSP	Defense Meteorological Satellite Program
DPF	Data Processing Facility
DRL	Document Requirements List
ECMWF	European Centre for Medium-Range Weather Forecasts
ECS	EOSDIS Core System
EDC	EROS Data Center
EDOS	EOS Data and Operations System
ENVISAT	Environmental Satellite
EOC	EOS Operations Center
EOS	Earth Observing System
EOS-AM	EOS Morning Crossing (Ascending) Mission
EOS-PM	EOS Afternoon Crossing (Descending) Mission
EOSDIS	Earth Observing System Data and Information System
EP	Earth Probe
Eqa	Equal area
ERBE	Earth Radiation Budget Experiment
ERBS	Earth Radiation Budget Satellite
EROS	Earth Resources Observation System
FNMOC	Fleet Numerical Meteorological Oceanographic Center
G	Geopotential
GAP	Gridded Analysis Product
GEO	Geosynchronous Orbit
GEWEX	Global Energy and Water Cycle Experiment
GIRD	General Interface Requirements Document

GISS	Goddard Institute for Space Studies
GMS	Geostationary Meteorological Satellite
GOES	Geostationary Operational Environmental Satellite
GSFC	Goddard Space Flight Center
HALOE	Halogen Occultation Experiment
HIRS	High-Resolution Infrared Sounder
ICD	Interface Control Document
IES	Instrument Earth Scans
ILAS	Improved Limb Atmospheric Sounder
IMS	Information Management System
INSAT	Indian Satellite
IR	Infrared
IRD	Interface Requirements Document
ISCCP	International Satellite Cloud Climatology Project
LaRC	Langley Research Center
LIS	Lightning Imaging Sensor
LW	longwave
METEOSAT	Meteorological Operational Satellite (European)
METOP	Meteorological Operational Satellite
MSFC	Marshall Space Flight Center
MIMR	Multifrequency Imaging Microwave Radiometer
MISR	Multi-angle Imaging Spectroradiometer
MOA	Meteorological, Ozone, and Aerosol
MOC	Mission Operations Center
MODIS	Moderate-Resolution Imaging Spectroradiometer
MSI	Multispectral Imaging
MWH	Microwave Humidity
MWP	Microwave Water Path
NASA	National Aeronautics and Space Administration
Nascom	NASA Communication
NASDA	National Space Development Agency (Japan)
NCDC	National Climatic Data Center
NDVI	Normalized Difference Vegetation Index
NESDIS	National Environmental Satellite, Data, and Information Service
NGDC	National Geophysical Data Center
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NRL	Naval Research Laboratory
NSS	Nonarchival Storage System
OOAM	Orbiting Ozone and Aerosol Measurement
OPD	Ozone Profile Data
Pacor	Packet Processor
PDS	Production Dataset
PDPS	Planning and Data Processing System
PGS	Product Generation System
POAM	Polar Ozone and Aerosol Experiment

POEM	Polar-Orbit Earth Observation Mission
POES	Polar-Orbiting Operational Environmental Satellite
PR	Precipitation Radar
QC	Quality Control
QDS	Quick-look Data Set
SAGE	Stratospheric Aerosol and Gas Experiment
SAT	Satellite
SBUV/2	Solar Backscatter Ultraviolet/Version 2
SCF	Science Computing Facility
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Cartography
SDPF	Sensor Data Processing Facility
SOCC	Science and Operations Control Center
SOHO	Solar Heliospheric Observatory
SPOT	Systeme pour l'observation de la Terre
SSM/I	Special Sensor Microwave/Imager
SURFMAP	Surface Map
SW	Shortwave
T	Temperature
TBD	To Be Determined
TDRSS	Tracking and Data Relay Satellite System
TIROS-N	Television Infrared Observing Satellite
TMI	TRMM Microwave Imager
TOA	Top-of-the-atmosphere
TOMS	Total Ozone Mapping Spectrometer
TOVS	TIROS Operational Vertical Sounder
TRMM	Tropical Rainfall Measuring Mission
TSDIS	TRMM Science Data and Information System
TSS	TDRSS Service Session
UARS	Upper Atmosphere Research Satellite
USGS	U.S. Geological Survey
UT	Universal Time
VIRS	Visible Infrared Scanner
VISSR	Visible, Infrared Spin-Scan Radiometer
W	Wind Speed
WV	Water Vapor