

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

**Data Management System
(DMS)**

**Requirements Management Plan
Version 5**

for

TRMM, Terra, Aqua, and NPP

April 2012

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

Data Management System

Stakeholder-Commitment Sheet for the CERES Requirements Management Plan

This Stakeholder-Commitment Sheet is to demonstrate that the relevant stakeholders as identified in the CERES Data Management Plan are aware of and support the CERES processes described in the CERES Requirements Management Plan.

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Document Revision Record

The Document Revision Record contains information pertaining to approved document changes. The table lists the Version Number, the date of the last revision, a short description of the revision, and the revised sections. The document authors are listed on the cover.

Document Revision Record

Version Number	Date	Description of Revision	Section(s) Affected
V1	10/11/2005	<ul style="list-style-type: none"> • Initial version of CERES Requirements Management Plan. • Updated format to comply with standards. 	All All
V2	04/15/2006	<ul style="list-style-type: none"> • Updated Introduction and added References and Appendix A to conform to new plan standards. • Added information on stakeholders. • Tables to describe understanding requirements, bidirectional traceability. and identify inconsistencies were added. Changes were made to other tables. • Updated format to comply with standards. 	Sec. 1.0, References, & App. A Sec. 1.0 Sec. 2.0 All
V3	09/05/2006	<ul style="list-style-type: none"> • Incorporated changes from July 17, 2006 Peer Review. The minutes from the Peer Review are the official record of changes. • Table of Contents and List of Figures were updated and "s" added to "requirement." • Updated format to comply with standards. • Converted document from FrameMaker to Word. (04/22/2008) 	All TOC and LOF All All
V4	03/02/2009	<ul style="list-style-type: none"> • Removed references to SAIC or other specific contractor, except in the Document Revision Record where it will be maintained for the historical record. • Modified cover page to follow new standard. • Included updated Stakeholder-Commitment Sheet reflecting new staff. • Modified Preface to follow new standard. • Included new Acknowledgements page. • Modified Introduction to follow new standard. 	All Cover Page Stakeholder-Commitment Sheet Preface Acknowledgements page Introduction
V5	04/09/2012	<ul style="list-style-type: none"> • Clarified text as needed. • Changed references from DMT to CPOB. 	All All

Document Revision Record

Version Number	Date	Description of Revision	Section(s) Affected
V5 (Cont'd)	04/09/2012	<ul style="list-style-type: none"> • Reworded acceptance question to be answered in the affirmative. • Clarified addition of requirements to the log and SCCR. • Updated links in references. • Completed Annual Review. (04/19/2012) • Updated Cover. (04/19/2012) • Updated Introduction. (04/19/2012) • “Previously Reviewed 07/17/2006” was added to the Stakeholder-Commitment Sheet. (04/23/2012) 	Table 2-2 Sec. 3.0 References All Cover Page Introduction Stakeholder-Commitment Sheet

Preface

The CERES DMS supports the data processing needs of the CERES Science Team to increase understanding of the Earth's climate and radiant environment. The CERES DMT 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 ASDC, produces an extensive set of science data products. The DMS consists of 12 subsystems each of which contains one or more PGEs.

The purpose of the Requirements Management Plan is to provide specific guidance on the Requirements Management process in receiving, accepting, and implementing requirements for the development of CERES DM software that will be delivered to the Langley ASDC. The CERES Software Development Plan provides specific guidance and definition of the Software Development Process used by the CERES DMT.

The CERES Data Management Plan provides overall guidance to the CERES DMT.

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This document reflects the collaborative efforts of the CERES DMT (in conjunction, as appropriate, with the CERES Science Team). The primary contributors to this document are:

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1.0 Introduction

CERES is a key component of EOS and NPP. The first CERES instrument (PFM) flew on TRMM, four instruments are currently operating on the EOS Terra (FM1 and FM2) and Aqua (FM3 and FM4) platforms, and NPP (FM5) platform. CERES measures radiances in three broadband channels: a shortwave channel (0.3 - 5 μm), a total channel (0.3 - 200 μm), and an infrared window channel (8 - 12 μm). The last data processed from the PFM instrument aboard TRMM was March 2000; no additional data are expected. Until June 2005, one instrument on each EOS platform operated in a fixed azimuth scanning mode and the other operated in a rotating azimuth scanning mode; now all are typically operating in the fixed azimuth scanning mode. The NPP platform carries the FM5 instrument, which operates in the fixed azimuth scanning mode though it has the capability to operate in a rotating azimuth scanning mode.

CERES climate data records involve an unprecedented level of data fusion: CERES measurements are combined with imager data (e.g., MODIS on Terra and Aqua, VIIRS on NPP), 4-D weather assimilation data, microwave sea-ice observations, and measurements from five geostationary satellites to produce climate-quality radiative fluxes at the top-of-atmosphere, within the atmosphere and at the surface, together with the associated cloud and aerosol properties.

The CERES project management and implementation responsibility is at NASA Langley. The CERES Science Team is responsible for the instrument design and the derivation and validation of the scientific algorithms used to produce the data products distributed to the atmospheric sciences community. The CERES DMT is responsible for the development and maintenance of the software that implements the science team's algorithms in the production environment to produce CERES data products. The Langley ASDC is responsible for the production environment, data ingest, and the processing, archival, and distribution of the CERES data products.

The purpose of the CERES Requirements Management Plan is to provide specific guidance on the Requirements Management process in receiving, accepting, and implementing requirements for the development of CERES DM software that will be delivered to the Langley ASDC.

All acronyms used in this document are defined in [Appendix A](#). They are not defined in the text.

This document is organized as follows:

Section [1.0](#) - Introduction

Section [2.0](#) - CERES Requirements Management

Section [3.0](#) - Requirement Logs

[Appendix A](#) - Abbreviations and Acronyms

1.1 CERES Program Plan

All current software requirements must be traceable back to and within the scope of the Statement of Work as found in the CERES FM-5 Program Plan. (See Reference [1](#)). The CERES Program Plan is updated annually. For the specific SOW see the Program Plan, but a summary of the SOW from the Program Plan follows.

Statement of Work

SSAI will provide support for software design, development, implementation, testing, validation, configuration management, and documentation for processing and analyzing CERES data from multiple instruments, including both pre-launch testing and on-orbit operations. Subsystem's code, as directed by the respective Subsystem Working Group Chair, will accept inputs from the various satellite instruments to produce consistent CERES data products. Consistent with requirements and priorities established by the CERES Subsystem Working Group Chairpersons, SSAI will perform code development and maintenance for production and analysis codes. The operational code must execute correctly at both the Science Computing Facilities (SCF) and at the Atmospheric Science Data Center (ASDC). SSAI will support production code delivery to the ASDC for data product production in accordance with the CERES Code Delivery Process.

1.2 Algorithm Theoretical Basis Documents

The CERES Algorithm Theoretical Basis Documents (Reference 2) were written by the CERES Science Team WG to describe the scientific calculations to be implemented in the CERES DM software before the first instrument launch. From the ATBDs and other information provided by the DMT Lead a complete set (one for each CERES subsystem) of CERES Software Requirements Documents (Reference 3) were produced. The Software Requirements Documents served as a basis for the initial software design and guided the Release 1, the prelaunch version, subsystem development. Subsequent releases included updated algorithms and unique needs for each satellite are originated through the Science Team WG. Instead of updating the prelaunch ATBDs, descriptions of new algorithm are documented in peer review papers.

1.3 Organization

The key organizational elements that are involved in the CERES software development are the CERES Science Team and the CERES DMT. The CERES Science Team consists of NASA personnel, NASA contractors, and personnel from other federal government organizations, educational institutes, foreign governments, and industry. The Science Team, through various WG Chairs, is responsible for algorithms and CERES data product validation. The Science Team provides algorithm requirements or contributed code. The CERES DMT consists of NASA personnel and contractors and is responsible for the development of the operational CERES software which will be put in production at the ASDC. The NASA members of the DMT provide systems requirements regarding production environments, metadata, data product formats, and input data. They transmit requirements needed to perform production at the ASDC. The assignment of responsibility for each task identified in Section 2.0 of the Requirements Management Plan can be found in the CERES Requirement Responsibility Matrix shown in Table 1-1. Since science and system requirements flow from two different groups, the first task is broken into two for the matrix.

Table 1-1. CERES Requirement Responsibility Matrix

Task	Science Team	NASA DMT Lead	CERES Supervisor	Subsystem Team
Convey Science Requirements	P	S	S	S
Convey System Requirements	S	P	S	S
Obtain an Understanding of Requirements	S	S	S	P
Accept Requirements	S	S	S	P
Obtain Commitment to Requirements	P	P	P	P
Manage Requirements Changes	S	S	P	P
Maintain Bidirectional Traceability of Requirements	S	S	S	P
Identify Inconsistencies between Project Work and Requirements	P	P	S	P

Key: P – Primary
S - Secondary

2.0 CERES Requirements Management

The following tables describe the tasks associated with Requirements Management: demonstrate how requirements are conveyed and received by CERES DMT personnel, how understanding of the requirements is demonstrated, the acceptance criteria, and the feedback mechanism for confirming with the customer that the requirements have been received, understood, and the action that will be taken to implement the requirements. All requirements are entered into the subsystem Requirements Log located on the CERES Requirements Log Website at to http://ceres.larc.nasa.gov/requirements_logs.php (Reference 7) upon receipt and an SCCR (Reference 8) is created if one does not exist. The SCCR is updated before delivery to capture additional requirements received for that delivery.

Table 2-1. Convey Science and System Requirements

Conveyance Mechanism	Description
Face-to-Face Meetings	Many of the CERES software requirements and changes to those requirements are conveyed to the software development teams through various meetings. The CERES Science Team Meetings and associated WG sessions are formally documented in the CERES Science Team Meeting Minutes (Reference 4) and (Reference 5). Occasionally, the CERES PI will hold "local" but more formal meetings with the WG chairs and DMT staff. Some WG chairs have periodic meetings with their team. Members of the DMT staff attend meetings with their WG chair or other members of the CERES Science Team. Regular biweekly meetings of the CERES Production Oversight Board (minutes for these meetings are approved by the DMT Lead) (Reference 6). Requirements not documented in meeting minutes need to be acknowledged in an email to the PI, WG chair, or DMT lead or in action item logs.
Phone Calls	Phone calls are often made between Science Team or DMT Lead and members of the software development team, typically a subsystem lead, to discuss implementation of requirements or changes to them. Requirements received by this method are documented by an email to the conveyor.
Email	Requirements and changes to requirements also can come by Emails. This Email is the first level of documentation for the requirement.

Table 2-2. Obtain an Understanding of Requirements

Evaluation Criteria	Questions to Answer Affirmatively
Clearly Stated	Emails, meeting minutes, and personal notes should be reviewed to ensure that all relevant information has been documented. Is the request unambiguous? Was it stated as a needed capability as opposed to a software solution?
Complete	After having time to think about the requirement, have all your questions about the requirement been answered? Are the effects known on all other calculations or procedures impacted by the change? Do you know exactly what will need to be changed?
Consistent	Are the new requirements consistent with existing software requirements?
Implicit Assumptions	Have all implicit, not identified, requirements that need to be implemented in conjunction with this requirement been identified? Some implicit assumption might result in a new data set, additional error checking, or existing interface or data product being changed.
Appropriate	The requirement should be evaluated in terms of the overall and subsystem objectives. Is this subsystem the best place to implement the requirement?
Verifiable	Can a method to verify the requirement be determined? Are there answers to any question this process generates?
Restate	Can you describe the requirement in your own words? An email or document will be sent to the requirement conveyor and other impacted stakeholders stating the understanding of the requirement.

Table 2-3. Accept Requirements

Category	Acceptance Criteria
SOW	Proposed requirements or requirement changes must be within the scope of the SOW within the CERES Program Plans (see Reference 2 and 3).
Source	Software development requirements can be accepted only when received from or approved by one or more of the following and in accordance with the conveyance methods described in Table 2-1. a. the CERES Principal Investigator or a duly assigned representative, b. CERES Science Team WG Chairs or a duly assigned representative, c. the CERES DMT Lead or a duly assigned representative.
Schedule	Proposed requirements or requirement changes must be consistent with CERES DP schedule as maintained by CERES CM in the current CM schedule which is available through the CERES CM Website (Reference 8). The impact of proposed requirements or requirement changes that are NOT consistent with the DP schedule must be evaluated and the results of this evaluation must be provided to the conveyor of the requirement before it is accepted. The conveyor can defer a requirement to a latter delivery.
Other Resources	Proposed requirements or requirement changes must be consistent with personnel, computational, and other resources. The impact of proposed requirements or requirement changes that are NOT consistent with the necessary resources needed to satisfy the requirement must be evaluated and the results of this evaluation provided to the conveyor of the requirement before acceptance. The conveyor can request additional resources from the PI or defer a requirement to a latter delivery.

Table 2-3. Accept Requirements

Category	Acceptance Criteria
Targeted Software	Proposed requirements or requirement changes must be consistent with existing software that needs to implement it. If not, approval from the PI, WG Chairs, and DMT Lead will be needed before new software development is done.

Table 2-4. Obtain Commitment to Requirements

Method	Description
Email	As described in Table 2-1 , email is sent to the requirement conveyor to confirm the receipt of the requirement. In addition to confirming the receipt of the requirement, where appropriate, this or a different email may be sent to the requirement conveyor explaining the subsystem developer understanding and interpretation of the requirement Table 2-2 . The near-term and long-term implementation strategy for the requirement is also described, especially any impact to other efforts.
SCCR	A CERES SCCR is opened by the appropriate CERES subsystem lead when the software development team receives the first requirement. SCCRs are emailed to the entire CERES DMT and to the appropriate Science Team WG. The SCCR is discussed at a biweekly meeting of the CCB (Reference 9) during the CPOB meeting. The CCB chair approves or disapproves the SCCR. If necessary at the end of software development activity and before the resulting modified or new software is delivered to CM, the SCCR is updated to reflect in more detail the nature of the science changes, non-science changes, and parameter changes that actually resulted from implementing all accepted requirements and changes to the requirements.
Software	Members of the WG can obtain a copy of the completed software.
Test Results	The result from CM testing following the subsystem's specific Test Plan is recorded in the TRL.

Table 2-5. Response to Conveyor

Documents	Description
Email	Email is sent to the requirement conveyor to confirm receipt of the requirement, to verify the interpretation and understanding of the requirement, and to describe the near-term and long-term implementation strategy for the requirement.
SCCR	The requirement conveyor is on a distribution list that will receive an email message containing the complete SCCR when the pertinent SCCR is submitted. An Email is sent for subsequent updates to the SCCR. This keeps all parties advised of the implementation status of the requirement. Any stakeholder can view the SCCR through the CERES CM Website.
Requirements Log	All stakeholders have access to the CERES Requirements Log Website. Requirement providers should be able to confirm when the requirement they provided was received and accepted.

Table 2-6. Maintain Bidirectional Traceability of Requirements

Documents	Traceability
Requirements Log	The major requirement is identified in the subsystems Requirements Log with the subsystem and a single number. Sub-requirements that are derived from the major requirement are indicated with a decimal and number from the major requirement. The requirement is associated with a SCCR number in the Requirements Log.
SCCR	The SCCR will contain the requirement number for each change that is implemented. The SCCR will list addition, deletions, or changes of parameters.
Biweekly CPOB Meeting Status Reports	Updates provided to the DMT that are tied to requirements will have the requirement and SCCR number listed.
Prologues	The prologue in each module, function, or subroutine will identify the SCCR in the description of the change.
Program Plan	CERES is in the maintenance phase so most modifications do not require much time. The Program Plan provides system-level guidance and resource allocation.

Table 2-7. Identify Inconsistencies between Requirements

Methods	Comments
CPOB Meeting	During the biweekly CPOB meeting, the production priority, delivery schedule, work tasks, and SCCRs are discussed. This allows insight to those attending, representatives from the CERES DMT Lead, task management, each subsystem team, CM team, and ASDC, on current requirements. The representatives are encouraged to speak about impacts to their subsystem or production
SCCR Email	When an SCCR is created or updated, an auto generated email is sent to the Science WG Chair and DMT members. After reviewing the information, the recipients are encouraged to respond about any inconsistencies they identify.
Science Team Meetings (formal and informal)	The CERES PI and Science WG Chairs hold meetings that are attended by DMT members to determine impacts that changes in the CERES data products have on users and downstream subsystems.
Contract Program Manager	The contract Program Manager reviews the monthly report that includes information on SCCR status in the CM section. Subsystems will report progress on implementing requirements in their section. CERES Supervisor has regular meetings with the Program Manager to discuss progress and issues with the CERES DMT.
Science Testing	The Science WG Chairs review CERES data products while the requirements are implemented. Their approval is needed before the software can be delivered.
CM Testing	CM maintains the TRLs that record problems that occur during CM testing.

3.0 Requirements Logs

CERES software requirements are generally provided to specific CERES subsystem teams. A list of the CERES subsystem groupings for requirement purposes follows:

1. Instrument (Subsystem 1)
2. ERBE-like (Subsystems 2 and 3)
3. Clouds (Subsystems 4.1 through 4.4)
4. Inversion (Subsystem 4.5 and 4.6)
5. Instantaneous and Synoptic SARB (Subsystem 5 and 7.2)
6. TISA and Grid Averaging (Subsystem 6, 7, 8, 9 and 10)
7. GGEO (Subsystem 11)
8. MOA (Subsystem 12)

Requirements Logs are maintained by each CERES subsystem and contain the fields listed in the following table.

Table 3-1. Fields in a CERES Requirements Log

Field Number	Field Description
1	Requirement Number
2	Requirement
3	SCCR
4	Provider
5	Responsible Subsystem
6	Responsible Person
7	Method the new requirement was conveyed to the subsystem team
8	When was the new requirement received by the subsystem team
9	When was the new requirement accepted by the subsystem team
10	When was the requirement completed
11	The current status of the requirement

The procedure for updating a subsystem requirements log follows.

CERES Subsystem Lead

1. Retrieve the current version of the document from the CERES Requirements Log Web site (see Reference 7).
2. Make modifications to the document. A new requirement will also require a SCCR to be open. The first requirement defines the purpose of the delivery such as a new Edition or migration to different computer hardware. Subsequent sub-requirements providing details on specific changes such as a new algorithm for a specific parameter or production

system change are entered into the requirements' log under their "parent" requirement. Status of open requirements should be updated.

3. Email the document to the CERES Documentation Team.

CERES Documentation Team

1. Version control - confirm the baseline of the modified document is as expected
2. Review the document and ensure compliance with standards
3. Update the version number
4. Create PDF version
5. Post a copy of the revised Requirements Log on the CERES Requirements Log Website
6. Store a copy of the document into the CERES documentation repository
7. Replace the CERES Requirements Log Web link to the updated document

On a biweekly basis a request for input to the biweekly CPOB Meeting Status Report is sent to all subsystem team members. A reminder to update subsystem requirements logs is included with this request. Also, on a biweekly basis, the status of ongoing activities in support of recorded subsystem requirements is provided in the CPOBM status report.

References

1. NASA Task Order Plan No: A-041_Mod0 CY2 CERES FM-5.
2. CERES Algorithm Theoretical Basis Documents, <http://ceres.larc.nasa.gov/atbd.php>
3. CERES Software Requirement Documents, <http://ceres.larc.nasa.gov/srd.php>
4. CERES Science Team Meeting Minutes (2000 – 2003), <http://ceres.larc.nasa.gov/science-team-meetings.php>
5. CERES Science Team Meeting Minutes (2004 – present), <http://ceres.larc.nasa.gov/science-team-meetings2.php>
6. CERES Production Oversight Board Meeting Minutes, <http://ceres.larc.nasa.gov/cpob.php>
7. CERES Requirements Log Website, http://ceres.larc.nasa.gov/requirements_logs.php
8. CERES CM Website, <http://earth-www.larc.nasa.gov/cgi-bin/cgiwrap/cerescm/mysql/cerescm.pl>
9. CERES DMS Configuration Management Plan Version 7 for TRMM, Terra, and Aqua, March 2009, http://ceres.larc.nasa.gov/documents/DMP_Plans/pdfs/cm_plan_V7.pdf

Appendix A Abbreviations and Acronyms

ASDC	Atmospheric Sciences Data Center
ATBD	Algorithm Theoretical Basis Document
CCB	Configuration Control Board
CERES	Clouds and the Earth's Radiant Energy System
CM	Configuration Management
CPOB	CERES Production Oversight Board
CPOBM	CERES Production Oversight Board Meeting
DM	Data Management
DMP	Data Management Plan
DMS	Data Management System
DMT	Data Management Team
DP	Data Processing
EOS	Earth Observing System
ERBE	Earth Radiation Budget Experiment
GGEO	Gridded Geostationary Narrowband Radiances
MOA	Meteorological, Ozone, and Aerosol
NASA	National Aeronautics and Space Administration
NPP	National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project
PDF	Portable Document Format
PGE	Product Generation Executable
PI	Principle Investigator
SARB	Surface and Atmospheric Radiation Budget
SCCR	Software Configuration Change Request
SOW	Statement of Work
TISA	Time Interpolation Space Averaging
TRL	Test Result Log
TRMM	Tropical Rainfall Measuring Mission
WG	Working Group