MODIS LEVEL 1B PRODUCTS DATA DICTIONARY

Applicable to Level 1B code Version 6.1.14, file specifications Version 6.1.14.
(MODIS/Terra)
and to Level 1B code Version 6.1.17, file specifications Version 6.1.17 (MODIS/Aqua)

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Prepared by
Members of the MODIS Characterization Support Team
for
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
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Version	Written by:	Date
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	Approved by:	
	Dr. Vincent Salomonson MCST Project Manager	01/08/2003
	Dr. Jack Xiong MCST Project Scientist	02/27/2009
	Jack	08/08/2012

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SECTION 1 INTRODUCTION

Section 1.1 Document Identification

This document is the MODIS Level 1B Product Data Dictionary, MCST Document # MCM 02-2.3.1-PROC__LIBPDD-U-01-01070- REV D, MCST Internal Memorandum # M1055. New metadata included in this update are additionalattribute.10, parametervalue.10, additionalattribute.11, and parametervalue.11. The new global attributes identifier_product_doi and identifier_product_doi_authority were also added.

Section 1.2 Scope

This document provides information about the content of the Earth view (EV) output granules produced by the MODIS Level 1B software:

MODIS/Terra (PFM) data

MOD021KM	1km resolution data product, MODIS on the Terra satellite
MOD02HKM	500m resolution data product, MODIS on the Terra satellite
MOD02QKM	250m resolution data product, MODIS on the Terra satellite

MODIS/Aqua (FM1) data

MYD021KM	1km resolution data product, MODIS on the Aqua satellite
MYD02HKM	500m resolution data product, MODIS on the Aqua satellite
MYD02QKM	250m resolution data product, MODIS on the Aqua satellite

Additionally, many of the descriptions of metadata in this document also apply to the Level 1B OBC output granule.

Section 1.3 Purpose

The purpose of this Data Dictionary is to augment the MODIS Level 1B Product User's Guide ([8]), which provides a general understanding of the product format (HDF-EOS) and the scaling algorithms required for generating calibrated products. This data dictionary will allow users to understand the meaning and origin of the individual data items defined in the Level 1B product file specifications ([3], [4], [5], and [6]).

SECTION 2 DESCRIPTION OF DATA ITEMS

This section will describe items in the file specifications for the Level 1B (L1B) 250m, 500m and 1km granule Earth view (EV) products ([3], [4], and [5]). The organization of this section generally follows the organization in those file specifications. Specific subsections are:

Section 2.1 Global Metadata	(section I in EV file specifications)
Section 2.2 Instrument and Uncertainty Scientific Data Sets (SDSs)	(section II in EV file specifications)
Section 2.3 Band-Subsetting SDSs	(section III in EV file specifications)
Section 2.4 Geolocation SDSs	(section IV in EV file specifications)

Important acronyms for this section are (see Section SECTION 3 for a more comprehensive list):

Acronym	**Interpretation**
L1B code	same as MOD_PR02 (the major process in PGE02)
L1A code	same as MOD_PR01 (1st major process of PGE01)
geolocation code	same as MOD_PR03 (2nd major process of PGE01)
ECS	EOS Core System
LUT	Look-Up Table (an input value or array to the L1B code)
granule	one output product of specified time duration (5 minutes for MODIS)

MODIS/Terra	*MODIS/Aqua*	
MOD02xxx	MYD02xxx	L1B product short names
MOD01	MYD01	L1A product short name
MOD03	MYD03	Geolocation product short name

There are normally three L1A granules that are input to the L1B processing: "previous", "current" and "subsequent". These represent granules that are consecutive in time. The "current" L1A granule is the one whose boundaries correspond to the L1B granule data product boundaries. The purpose of using data from the "previous" and "subsequent" L1A granules is to allow the thermal calibration routines to process data near the edges of the current granule boundary. In the following descriptions, the term "L1A granule" will generally refer to the "current" granule. The terms "previous" and "subsequent" are used only if it is necessary to explicitly refer to those L1A input granules.

Note: MOD_PR02 may be run in operations without the previous and/or subsequent L1A granules as input if they are not available at execution time.

Section 2.1 Global Metadata

This section describes:

- ECS Standard Core Granule Metadata
- ECS Standard Archive Granule Metadata
- Level 1B Product Granule Metadata
- Level 1B QA Granule Metadata stored as global attributes
- Level 1B QA Granule Metadata stored as SDSs
- Level 1B HDF-EOS SWATH Metadata
- Level 1B Swath Metadata

Section 2.1.1 ECS Standard Core Granule Metadata

These data are stored in global attribute "CoreMetadata.0". When using SDP toolkit calls to extract the value of a parameter, note the following: a parameter data type of "INTEGER" is the same as a 32-bit integer. A parameter data type of "DOUBLE" is the same as a 64-bit float. A "STRING" data type may require different sizes of character buffers. The examples indicated below and information in reference ([12]) may help in estimating string buffers needed. Multi-valued parameters require appropriate arrays to be allocated.

Section 2.1.1.1 General Information

Name:	LOCALGRANULEID
Description:	Unique identifier of the L1B granule data product.
Data type:	STRING
Format:	MxD02zzz.Ayyyyddd.hhmm.vvv.yyyydddhhmmss.hdf, where: MxD02 represents a Terra (x = O) or Aqua (x = Y) L1B product zzz has value “QKM”, “HKM”, “1KM” or “OBC” **A** is a constant (there are no plans to use this letter for anything), yyyyddd.hhmm represents the four-digit year, three-digit day (001-366), hours and minutes for the start of the granule (UTC time), vvv is set dynamically to be the same value as VersionID, yyyydddhhmmss represents the four digit year, three-digit day (001-366), hours, minutes, and seconds of the time at which the granule was processed (UTC time). **hdf** represents an hdf file.
Example:	“MOD021KM.A1996218.1555.002.1998152115306.hdf”
Origin:	Generated internally within the L1B code.

Name:	PRODUCTIONDATETIME
Description:	The date and time a specific granule was produced by the L1B code.
Data type:	STRING
Example:	“1998-06-01T15:53:08.000Z”
Origin:	The SDP toolkit ([13]) generates this value automatically during execution of the L1B code.

Name: DAYNIGHTFLAG

Description: This attribute is used to identify if a granule was collected in Day mode (all individual scans are "Day"), night mode (all individual scans are "Night") or both (the granule contains a combination of day mode and night mode scans).

Data type: STRING

Values: “Day” or “Night” or “Both”

Origin: The value is copied from the ECS core metadata of the current L1A granule, where the name of the parameter is the same.

Name: REPROCESSINGACTUAL

Description: States what processing has been performed on this granule.

Data type: STRING

Example: “processed once”

Origin: The value is set from a run-time parameter in the Process Control File (PCF).

Name: REPROCESSINGPLANNED

Description: States what further processing may be performed on this granule.

Data type: STRING

Example: “no further update anticipated”

Origin: The value is set from a run-time parameter in the Process Control File (PCF).

Name:	SIZEMBECSDATAGRANULE
Description:	This attribute indicates the volume of data, in millions of bytes (not megabytes), contained in the granule.
Data type:	DOUBLE
Origin:	This value is neither set nor determined within the L1B code. After a granule is produced, an outside process may insert this value into the core metadata of the granule.

Section 2.1.1.2 Parameters ending in ".1"

Note: *the following parameters, with a ".1" at the end of the name, refer in general to the reflective solar bands, which are MODIS bands 1-19 and 26. However, the values are tailored to the particular L1B product. Within the L1B 250m product, the values pertain to MODIS bands 1 and 2. Within the 500m product, the values pertain to MODIS bands 3-7. Even though the 500m product contains bands 1 and 2 aggregated to 500m resolution, bands 1 and 2 are not included in the QA statistics of quantities such as percentage of missing data. Within either the 1km or OBC products, the values pertain to MODIS bands 8-19 and 26. Even though the 1km product contains bands 1 through 8, aggregated to appear at 1km resolution, the QA statistics only pertain to the native 1km resolution bands.*

Name:	AUTOMATICQUALITYFLAGEXPLANATION.1
Description:	A text explanation of the criteria used to generate the value of AUTOMATICQUALITYFLAG.1.
Data type:	STRING
Value:	"not being investigated"
Origin:	The above value is a defined constant within the L1B code. The value was chosen to represent the fact that there is currently no algorithm implemented within the L1B code for the value of AUTOMATICQUALITYFLAG.1.

Name: AUTOMATICQUALITYFLAG.1

Description: Indicates the results of QA performed on reflective bands data during product generation. Currently, there is no automatic QA algorithm implemented for reflective bands within the L1B code.

Data type: STRING

Value: “Suspect”

Origin The above value is a defined constant within the L1B code. The value was chosen from reference [12] as the most applicable value within the domain for this parameter.

Name: OPERATIONALQUALITYFLAGEXPLANATION.1

Description: A text explanation of the criteria used in setting the value of OPERATIONALQUALITYFLAG.1. This parameter is not required to appear in the core metadata and may be absent.

Data type: STRING

Origin: This value is neither set nor determined within the L1B code. After MOD_PR02 has completed execution, a process controlled by MODAPS (formerly by the DAAC) may insert this value into the granule metadata.

Name: OPERATIONALQUALITYFLAG.1

Description: A granule-level flag applying both generally to a granule and specifically to parameters at the granule level. The content of this parameter for reflective band data has not been defined. This parameter is not required to appear in the core metadata and may be absent.

Data type: STRING

Example: "Passed"

Origin: This value is neither set nor determined within the L1B code. After MOD_PR02 has completed execution, a process controlled by MODAPS (formerly by the DAAC) may insert this value into the granule metadata.

Name: SCIENCEQUALITYFLAGEXPLANATION.1

Description: A text explanation of the criteria used in setting the value of SCIENCEQUALITYFLAG.1. This parameter is not required to appear in the core metadata and may be absent.

Data type: STRING

Origin: No value is currently generated for this field.

Name: SCIENCEQUALITYFLAG.1

Description: Granule-level flag describing the science quality of reflective bands data within the granule.

Data type: STRING

Example: "Not Investigated"

Origin: The above value is set as within the MCF files and appears in the product as the default value. There is no accompanying default value in the SCIENCEQUALITYFLAGEXPLANATION.1 field.

Name: QAPERCENTMISSINGDATA.1

Description: Value indicating the percent of missing reflective Solar band data in the granule (see italicized note at beginning of Section 2.1.1.2). Pixels associated with scans that have no data or pixels having the DN value of –1 are missing pixels. Pixels associated with "Night" scans are included in the count of missing pixels. The one exception is for Band 26. The "EV_Band26" SDS is included as a separate SDS in the MxD021KM product and hence Band 26 pixels at night are not counted as missing because the data are present in the extra SDS.

Data type: INTEGER

Example: 0

Origin: This value is calculated within the L1B code.

Name:	QAPERCENTINTERPOLATEDDATA.1
Description:	Value indicating the percent of interpolated reflective band data in the granule.
Data type:	INTEGER
Value:	0
Origin:	This value is calculated within the Level 1B code. Starting with Collection 6, interpolated scaled integer (SI) values are no longer being calculated for non-functional detectors. Therefore, this value should always be 0 in Collection 6.

Name:	QAPERCENTOUTOFBOUNDSDATA.1
Description:	Value indicating the percent of reflective band data in the granule outside of acceptable limits (see italicized note at beginning of Section 2.1.1.2). The following are counted as out-of-bounds data: (1) saturated pixels, and (2) if the effective digital number (dn**) falls below the bottom end of the range for scaling to the product scaled integer. Saturation DN is determined from the LUT "DN_sat". The bottom end of the range of scaling is given by the LUT "dn_star_Min".
Data type:	INTEGER
Example:	0
Origin:	This value is calculated within the L1B code.

Name:	PARAMETERNAME.1
Description:	Name representing the parameter for which the above ".1" parameters pertain to.
Data type:	STRING
Value:	"EV_250_RefSB", "EV_500_RefSB" or “EV_1KM_RefSB”
Origin:	This value is determined within the L1B code. The value is dependent upon the output product being written (see italicized note at beginning of Section 2.1.1.2).

Section 2.1.1.3 Parameters ending in “.2

Note: *the following parameters, with a ".2" at the end of the name, refer in general to the thermal emissive bands, which are MODIS bands 20-25 and 27-36. These parameters appear only in the L1B 1km and OBC products. They do not appear in the L1B 250m or 500m products.*

Name: AUTOMATICQUALITYFLAGEXPLANATION.2

Description: A text explanation of the criteria used to generate the value of AUTOMATICQUALITYFLAG.2.

Data type: STRING

Value: “not being investigated”

Origin: The above value is a defined constant within the L1B code. The value was chosen to represent the fact that there is currently no algorithm implemented within the L1B code for the value of AUTOMATICQUALITYFLAG.2.

Name: AUTOMATICQUALITYFLAG.2

Description: Indicates the results of QA performed on emissive bands data during product generation. Currently, there is no automatic QA algorithm implemented for emissive bands within the L1B code.

Data type: STRING

Value: “Suspect”

Origin The above value is a defined constant within the L1B code. The value was chosen from reference [12] as the most applicable value within the domain for this parameter.

Name: OPERATIONALQUALITYFLAGEXPLANATION.2

Description: A text explanation of the criteria used in setting the value of OPERATIONALQUALITYFLAG.2. This parameter is not required to appear in the core metadata and may be absent.

Data type: STRING

Origin: This value is neither set nor determined within the L1B code. After MOD_PR02 has completed execution, a process controlled by MODAPS (formerly by the DAAC) may insert this value into the granule metadata.

Name: OPERATIONALQUALITYFLAG.2

Description: A granule-level flag applying both generally to a granule and specifically to parameters at the granule level. The actual content of this parameter for emissive band data has not been defined. This parameter is not required to appear in the core metadata and may be absent.

Data type: STRING

Example: "Passed"

Origin: This value is neither set nor determined within the L1B code. After MOD_PR02 has completed execution, a process controlled by MODAPS (formerly by the DAAC) may insert this value into the granule metadata.

Name: SCIENCEQUALITYFLAGEXPLANATION.2

Description: A text explanation of the criteria used in setting the value of SCIENCEQUALITYFLAG.2. This parameter is not required to appear in the core metadata and may be absent.

Data type: STRING

Origin: No value is currently generated for this field.

Name:	SCIENCEQUALITYFLAG.2
Description:	Granule-level flag describing the science quality of emissive bands data within the granule. This parameter is not required to appear in the core metadata and may be absent.
Data type:	STRING
Example:	"Not Investigated"
Origin:	The above value is set as within the MCF files and appears in the product as the default value. There is no accompanying default value in the SCIENCEQUALITYFLAGEXPLANATION.2 field.

Name:	QAPERCENTMISSINGDATA.2
Description:	Value indicating the percent of missing emissive band data in the granule. Pixels associated with scans that have no data or pixels having the DN value of –1 are missing pixels.
Data type:	INTEGER
Example:	0
Origin:	This value is calculated within the L1B code.

Name:	QAPERCENTINTERPOLATEDDATA.2
Description:	Value indicating the percent of interpolated emissive band data in the granule.
Data type:	INTEGER
Value:	0
Origin:	This value is calculated within the Level 1B code. Starting with Collection 6, interpolated scaled integer (SI) values are no longer being calculated for non-functional detectors. Therefore, this value should always be 0 in Collection 6.

Name:	QAPERCENTOUTOFBOUNDSDATA.2
Description:	Value indicating the percent of emissive band data in the granule outside of acceptable limits. The following are counted as out-of-bounds data: (1) if a raw digital number (DN) is the saturated value (4095) or (2) if the calibrated radiance falls below -NEdL (value input as a LUT to the L1B code).
Data type:	INTEGER
Example:	0
Origin:	This value is calculated within the L1B code.

Name:	PARAMETERNAME.2
Description:	Name representing emissive band data to which the above parameters with a ".2" pertain.
Data type:	STRING
Value:	“EV_1KM_Emissive”
Origin:	The above value is a defined constant within the L1B code.

Section 2.1.1.4 Other Core Granule Metadata

Note: *Each of the next four parameters will only appear one time in each L1B output product regardless of the fact that they have a ".1" at the end of each of their names.*

Name:	EQUATORCROSSINGDATE.1
Description:	The northward equator crossing date for the orbit during which granule data were collected.
Data type:	STRING
Example:	“1996-08-05”
Origin:	The value is copied from the ECS core metadata of the current L1A granule, where the name of the parameter is the same.

Name: EQUATORCROSSINGTIME.1

Description: The northward equator crossing time for the orbit during which granule data were collected.

Data type: STRING

Example: “15:55:45.854788”

Origin: The value is copied from the ECS core metadata of the geolocation input file, where the name of the parameter is the same.

Name: ORBITNUMBER.1

Description: Number of satellite orbit during which the granule data were collected.

Data type: INTEGER

Example: 88

Origin: The value is copied from the ECS core metadata of the geolocation input file, where the name of the parameter is the same.

Name: EQUATORCROSSINGLONGITUDE.1

Description: The northward equator crossing longitude for the orbit during which granule data were collected.

Data type: DOUBLE

Example: -73.021282

Origin: The value is copied from the ECS core metadata of the geolocation input file, where the name of the parameter is the same.

Name:	VERSIONID
Description:	Version ID of the data collection. The value of this field also appears in the "vvv" field of the LocalGranuleID.
Data type:	INTEGER
Example:	1
Origin:	This value is set in each metadata configuration file (MCF). When the SDP toolkit initializes the core metadata to be written to an output product, the value is automatically copied from the MCF file to the core metadata being written.

Name:	SHORTNAME
Description:	The short name associated with the L1B granule data product. For L1B, these will always begin with “MOD02” for Terra data and "MYD02" for Aqua data. “QKM” is added to distinguish the 250M data product, “HKM” is added to distinguish the 500M data product, “1KM” is added for the 1000M data product and "OBC" is added for the OBC file.
Data type:	STRING
Example:	“MOD021KM”
Origin:	This value is set in the appropriate metadata configuration file (MCF). There is a separate MCF file for each L1B product, including separate MCF files for Terra and Aqua processing. When the SDP toolkit initializes the core metadata to be written to an output product, the value is automatically copied from the MCF file to the core metadata being written.

Name: INPUTPOINTER

Description: This parameter contains the logical references to the input L1A granules and to the input lookup-table files. The logical reference to the geolocation file is not included here (it is placed in the ANCILLARYINPUTPOINTER.1 parameter). The Process Control File (PCF) contains the mapping of logical references to actual file names.

Data type: STRING (multiple values)

Example: (“UR_MOD01.A19972170835.001.1997217083500.hdf”,
“UR_MOD01.A19972170840.001.1997217084000.hdf”,
“UR_MOD01.A19972170845.001.1997217084500.hdf”,
“UR_Reflective_Lookup_Tables_file”, “UR_Emissive_Lookup_Tables_file”,
"UR_QA_Lookup_Tables_file”)

UR refers to “Universal Reference” which is an SDP Toolkit designation which signals that a file will be handled by a specific Toolkit function.

Origins: Logical references are read from the PCF file.

Note: The order of L1A file URs inside the value is: previous-current-following. If the previous or following L1A granule is missing, then that UR will also be missing from this value. To determine if a previous or following L1A granule is missing, examine bits 16 and 17 respectively of any record of the "Bit QA Flags" field of the "Level 1B Swath Metadata" Vdata (see **Table 2.1.4**).

Note: *Each of the next four parameters will only appear one time in each L1B output product regardless of the fact that they have a ".1" at the end of each of their names.*

Name: GRINGPOINTLONGITUDE.1

Description: Longitudes of a series of points connected by great-circle arcs that enclose the granule.

Data type: DOUBLE (four values)

Example: (-86.567558, -59.389000, -59.836601, -86.653564)

Origin: The value is copied from the ECS core metadata of the geolocation input file, where the name of the parameter is the same.

Name: GRINGPOINTLATITUDE.1

Description: Latitudes of a series of points connected by great-circle arcs that enclose the granule.

Data type: DOUBLE (four values)

Example: (41.644032, 37.729759, 36.824055, 40.686016)

Origin: The value is copied from the ECS core metadata of the geolocation input file, where the name of the parameter is the same.

Name: GRINGPOINTSEQUENCENO.1

Description: Sequence numbers corresponding to GRing latitudes and longitudes.

Data type: INTEGER (four values)

Example: (1, 2, 3, 4)

Origin: The value is copied from the ECS core metadata of the geolocation input file, where the name of the parameter is the same.

Name: EXCLUSIONGRINGFLAG.1

Description: Flag indicating whether points are on an inner (exclusion) G-ring.

Data type: STRING

Example: “N”

Origin: The value is copied from the ECS core metadata of the geolocation input file, where the name of the parameter is the same.

(**Note:** Every scan in a given granule has a start time that is greater than or equal to the beginning time of that granule’s temporal coverage, and less than the ending time of that coverage .)

Name: RANGEBEGINNINGDATE

Description: The UTC date when the temporal coverage period of this granule began.

Data type: STRING

Example: “1996-08-05”

Origin: The value is copied from the ECS core metadata of the current L1A granule, where the name of the parameter is the same.

Name: RANGEBEGINNINGTIME

Description: The UTC time when the temporal coverage period of this granule began.

Data type: STRING

Example: “15:55:45.854788”

Origin: The value is copied from the ECS core metadata of the current L1A granule, where the name of the parameter is the same.

Name: RANGEENDINGDATE

Description: The UTC date when the temporal coverage period of this granule ended.

Data type: STRING

Example: “1996-08-05”

Origin: The value is copied from the ECS core metadata of the current L1A granule, where the name of the parameter is the same.

Name: RANGEENDINGTIME

Description: The UTC time when the temporal coverage period of this granule ended.

Data type: STRING

Example: "15:56:00.626488"

Origin: The value is copied from the ECS core metadata of the current L1A granule, where the name of the parameter is the same.

Name: PGEVERSION

Description: Version number of PGE02, of which the L1B code (MOD_PR02) is the main processing element. The Level 1B code effectively treats this value as the version of the code itself.

Data type: STRING

Example: "4.0.5"

Origin: Written to the core metadata by the L1B code. The value comes from a macro (defined constant) within the L1B code.

Name: ANCILLARYINPUTPOINTER.1

Description: Logical reference to the geolocation (MOD_PR03) file used in L1B data processing.

Data type: STRING

Example: "UR_MOD03.A19972170840.001.1997217084000.hdf"

Origin: This value is read from the Process Control File (PCF) file which defines L1B inputs.

Name:	ANCILLARYINPUTTYPE.1
Description:	Describes that the ANCILLARYINPUTPOINTER.1 file name is a geolocation (MOD03 or MYD03) file.
Data type:	STRING
Value:	“Geolocation”
Origin:	The above name is a defined constant within the L1B code.

Name:	ADDITIONALATTRIBUTENAME.1
Description:	Name ascribed to parameter value 1, described below.
Data type:	STRING
Example:	“AveragedBlackBodyTemperature”
Origin:	The above value is a defined constant within the L1B code.

Name:	PARAMETERVALUE.1
Description:	Value of the average over all scans of the within-scan-average OBC blackbody (BB) temperature. The within-scan-average OBC blackbody temperature is the average of the temperatures of the 12 blackbody thermistors.
Data type:	STRING (the characters within the string define a floating point number)
Example:	“268.90” (units in Kelvin)
Origin:	Computed within the L1B code. Telemetry DNs, from the current L1A input granule, from each of the 12 BB thermistors (telemetry points TP_BB_TEMP01 through TP_BB_TEMP12), on each scan, are converted to temperatures using the formulas in [9] and then averaged. The overall average is then computed using the averages from each scan.

Name: ADDITIONALATTRIBUTENAME.2

Description: Name ascribed to parameter value 2, described below.

Data type: STRING

Value: “AveragedMirrorTemperature”

Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.2

Description: Value of the average over all scans of the within-scan-average mirror temperature. The within-scan-average mirror temperature is the average of the temperatures of both mirror sides.

Data type: STRING (the characters within the string define a floating point number)

Example: “250.27” (units in Kelvin)

Origin: Computed within the L1B code. Telemetry DNs, from the current L1A input granule, from each of the 2 mirror-side thermistors (telemetry points TP_SA_RCT1_MIRE and TP_SA_RCT2_MIRE), on each scan, are converted to temperatures using the formulas in [9] and then averaged. The overall overage is then computed using the averages from each scan.

Name: ADDITIONALATTRIBUTENAME.3

Description: Name ascribed to parameter value 3, described below.

Data type: STRING

Value: “AveragedFocalPlane1Temperature”

Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.3

Description: Value of the average over all scans of the in-scan-average of focal plane 1 (VIS) temperature.

Data type: STRING (the characters within the string define a floating point number)

Example: “361.42” (units in Kelvin)

Origin: Computed within the L1B code. Telemetry DNs, from the current L1A input granule, from telemetry point TA_AO_VIS_FPAE, on each scan, are converted to temperatures using the formulas in [9]. The overall overage is then computed using the averages from each scan.

Name: ADDITIONALATTRIBUTENAME.4

Description: Name ascribed to parameter value 4, described below.

Data type: STRING

Value: “AveragedFocalPlane2Temperature”

Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.4

Description: Value of the average over all scans of the in-scan-average of focal plane 2 (NIR) temperature.

Data type: STRING (the characters within the string define a floating point number)

Example: “363.21” (units in Kelvin)

Origin: Computed within the L1B code. Telemetry DNs, from the current L1A input granule, from telemetry point TA_AO_NIR_FPAE, on each scan, are converted to temperatures using the formulas in [9]. The overall overage is then computed using the averages from each scan.

Name: ADDITIONALATTRIBUTENAME.5

Description: Name ascribed to parameter value 5, described below.

Data type: STRING

Value: “AveragedFocalPlane3Temperature”

Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.5

Description: Value of the average over all scans of the within-scan-average of focal plane 3 (SMIR) temperature.

Data type: STRING (the characters within the string define a floating point number)

Example: “118.25” (units in Kelvin)

Origin: Computed within the L1B code. Telemetry DNs, from the current L1A input granule, from telemetry point TA_RC_SMIR_CFPAE, on each scan, are converted to temperatures using the formulas in [9]. The overall overage is then computed using the averages from each scan.

Name: ADDITIONALATTRIBUTENAME.6

Description: Name ascribed to parameter value 6, described below.

Data type: STRING

Value: “AveragedFocalPlane4Temperature”

Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.6

Description: Value of the average over all scans of the in-scan-average of focal plane 4 (LWIR) temperature.

Data type: STRING (the characters within the string define a floating point number)

Example: “85.94” (units in Kelvin)

Origin: Computed within the L1B code. Telemetry DNs, from the current L1A input granule, from telemetry point TA_RC_LWIR_CFPAE, on each scan, are converted to temperatures using the formulas in [9]. The overall overage is then computed using the averages from each scan.

Name: ADDITIONALATTRIBUTENAME.7

Description: Name ascribed to parameter value 7, described below.

Data type: STRING

Value: “CalibrationQuality”

Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.7

Description: Overall calibration quality of the granule. There is currently no algorithm implemented for this parameter.

Data type: STRING

Value: “marginal”

Origin: The above value is a defined constant within the L1B code.

Name: ADDITIONALATTRIBUTENAME.8

Description: Name ascribed to parameter value 8, described below.

Data type: STRING

Value: “MissionPhase”

Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.8

Description: Mission phase corresponding to the time period covered by this granule.

Data type: STRING

Example: “A&E”

Origin: This value comes from the LUT "mission_phase" in the QA lookup tables file.

Name: ADDITIONALATTRIBUTENAME.9

Description: Name ascribed to parameter value 9, described below.

Data type: STRING

Value: “NadirPointing”

Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.9

Description: Flag denoting if the orientation of the spacecraft is nadir-pointing. There is currently no algorithm implemented for defining any value other than "Y", which stands for "yes".

Data type: STRING

Value: “Y”

Origin: The above value is a defined constant within the L1B code.

Name: ADDITIONALATTRIBUTENAME.10
Description: Name ascribed to parameter value 10, described below.
Data type: STRING
Value: “identifier_product_doi”
Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.10
Description: Digital Object Identifier for MODIS L1B 1km, hkm, qkm, and OBC products.
Data type: STRING
Example: “10.5067/MODIS/MOD021KM.006”
Origin: This value is assigned by ESDIS to meet the ESDIS requirement for adding Digital Object Identifiers (DOI) to EOSDIS standard product metadata.

Name: ADDITIONALATTRIBUTENAME.11
Description: Name ascribed to parameter value 11, described below.
Data type: STRING
Value: “identifier_product_doi_authority”
Origin: The above name is a defined constant within the L1B code.

Name: PARAMETERVALUE.11
Description: The URL location defines the authoritative service for use with DOI values.
Data type: STRING
Example: “http://dx.doi.org”
Origin: This value is a defined constant within the L1B code.

Name: ASSOCIATEDPLATFORMSHORTNAME.1
Description: The short name assigned to the platform carrying the instrument.
Data type: STRING
Example: “Terra” or "Aqua"
Origin: The value appearing in each product is defined in the appropriate MCF file.

Name: ASSOCIATEDINSTRUMENTSHORTNAME.1
Description: The short name by which the instrument is known.
Data type: STRING
Value: “MODIS”
Origin: The value appearing in each product is defined in the appropriate MCF file.

Name: ASSOCIATEDSENSORSHORTNAME.1
Description: Defined sub-component of the instrument.
Data type: STRING
Value: “MODIS”
Origin: The value appearing in each product is defined in the appropriate MCF file.

Section 2.1.2 ECS Standard Archive Granule Metadata

These data are stored as global attribute "ArchiveMetadata.0".

Name:	ALGORITHMPACKAGEACCEPTANCEDATE
Description:	The date this algorithm package version successfully passed AI&T procedures and was accepted as an ECS standard algorithm.
Data type:	STRING
Example:	“1998-04-01”
Origin:	The L1B code reads this value from a LUT of the same name which resides in the QA lookup tables file.

Name:	ALGORITHMPACKAGEMATURITYCODE
Description:	This specifies the maturity of the algorithm package during the mission.
Data type:	STRING
Example:	“pre-launch”
Origin:	The L1B code reads this value from a LUT of the same name which resides in the QA lookup tables file.
Note:	The ECS "valids" for this field are (using reference [12]):
"pre-launch"	preflight development code
"PREL"	Preliminary: EOS platform is flying development code at best; frequently changing, not stable.
"OPL"	Operational: production code will change, but not frequently; preliminary validation has been done.
"stable"	code stable and has been fully validated
"final"	final version of code, mission over.

Name: ALGORITHMPACKAGENAME

Description: Algorithm package name

Data type: STRING

Value: “MODIS Level 1B Algorithm Package”

Origin: The above value is a defined constant within the L1B code.

Name: ALGORITHMPACKAGEVERSION

Description: The MCST version number of the Level 1B code and LUTs. This value is a four-digit version number, "A.B.C.D", where "A.B.C" matches the PGE version and D is an integer that is incremented for a LUT change only. Additionally, the string "_Terra" or "_Aqua" may be appended.

Data type: STRING

Example: “2.5.5.0_Terra”

Origin: The L1B code reads this value from the LUT "MCST_Version" which resides in each LUT file. All three LUT files must have the same value for the set of LUTs to be valid. See more explanation in [6].

Name: INSTRUMENTNAME

Description: The long name by which the instrument is known.

Data type: STRING

Value: “Moderate-Resolution Imaging SpectroRadiometer”

Origin: The above value is a defined constant within the L1B code.

Name: PROCESSINGCENTER

Description: Processing center where the product was generated.

Data type: STRING

Example: “GSFC”

Origin: The L1B code reads this value from the Process Control File.

Name: PROCESSINGENVIRONMENT

Description: A string describing the machine operating system and configuration used to produce the data.

Data type: STRING

Example: “IRIX64”

Origin: The L1B code constructs this value using the POSIX function “uname”. It duplicates the output of the UNIX command “uname –a”.

Name: EASTBOUNDINGCOORDINATE

Description: Easternmost longitude of the granule spatial coverage.

Data type: DOUBLE

Example: 40.000000 (value in degrees)

Origin: The value is copied from the ECS core metadata of the geolocation granule, where the name of the parameter is the same.

Name: WESTBOUNDINGCOORDINATE

Description: Westernmost longitude of the granule spatial coverage.

Data type: DOUBLE

Example: 15.000000 (value in degrees)

Origin: The value is copied from the ECS core metadata of the geolocation granule, where the name of the parameter is the same.

Name:	NORTHBOUNDINGCOORDINATE
Description:	Northernmost latitude of the granule spatial coverage.
Data type:	DOUBLE
Example:	25.000000 (value in degrees)
Origin:	The value is copied from the ECS core metadata of the geolocation granule, where the name of the parameter is the same.

Name:	SOUTHBOUNDINGCOORDINATE
Description:	Southernmost latitude of the granule spatial coverage.
Data type:	DOUBLE
Example:	10.000000 (value in degrees)
Origin:	The value is copied from the ECS core metadata of the geolocation granule, where the name of the parameter is the same.

Name:	DESCRREVISION
Description:	Version number of the ESDT descriptor.
Data type:	STRING
Example:	"1.0"
Origin:	Set within the MCF file. DESCRREVISION is used for configuration control of the ESDT ODL descriptor file. The attribute value is populated manually whenever any change (large or small) is made to the ESDT (descriptor). PGEs will not read or write this attribute.

Name:	PRODUCTIONHISTORY
Description:	The ProductionHistory is intended to capture version numbers of the products that are used as inputs to a given product. ProductionHistory is cumulative in that higher-level products show versions of all inputs down to the L1A data. Unlike input pointers, ProductionHistory does not point to specific granules, but instead shows only the versions of the input products. The PGE02 version shown in the PRODUCTIONHISTORY variable includes a fourth digit which signifies the LUT number associated to the product. This is similar to the metadata variable ALGORITHMPACKAGEVERSION except that the instrument platform designators "_Terra" and "_Aqua" were dropped for space considerations. Since Terra versions of Level 1B code always have an even third digit (e.g. V4.3.2) and Aqua versions have an odd third digit (*e.g.* V4.3.3), the instrument platform designation is implicit.
Data type:	STRING
Examples:	"PGE02:3.4.5.6;PGE01:3.5.8", "PGE02:3.4.5.6;PGE01:3.5.8:mod01;PGE01:2.3.4:mod03"
Origin:	Set within the Level 1B code. The PGE01 version numbers of the MOD01 and MOD03 input granules are read and if they are the same, only one PGE01 version is written (see Example 1); if they are different then both are written out with appropriate indications (see Example 2).

Section 2.1.3 Level 1B Product Granule Metadata

These data are stored as global attributes.

Name:	Number of Scans
Description:	The number of scans of data in the granule. This value is used to dimension many of the SDS and Vdata objects in the L1B output granules. A dimension name of "nscans" or "num_scans" refers to this value, which is typically 203 or 204. The maximum allowed value is 208.
HDF class:	File (global) attribute
Data type:	int32
Count:	1
Example:	203
Origin:	This value is copied from the global attribute of the same name in the current L1A granule.

Name:	Number of Day mode scans
Description:	Total number of Day mode scans
HDF class:	File (global) attribute
Data type:	int32
Count:	1
Example:	203
Origin:	This value is copied from the global attribute of the same name in the current L1A granule.

Name:	Number of Night mode scans
Description:	Total number of night mode scans
HDF class:	File (global) attribute
Data type:	int32
Count:	1
Example:	0
Origin:	This value is copied from the global attribute of the same name in the current L1A granule.

Name:	Incomplete Scans
Description:	This attribute contains the number of incomplete scans in the granule. An incomplete scan is declared if there are any missing packets for the scan. The number of missing packets in each scan is recorded in the "Scan quality array" SDS of the L1A file. The L1A code makes the determination of number of incomplete scans.
HDF class:	File (global) attribute
Data type:	int32
Count:	1
Example:	14
Origin:	This value is copied from the global attribute of the same name in the current L1A granule.

Name: Max Earth View Frames

Description: The maximum number of 1km-resolution Earth View frames over all scans of the current L1A granule. This value is not used to dimension any data objects in the L1B file. Rather, it is reported as information only.

HDF class: File (global) attribute

Data type: int32

Count: 1

Example: 1354

Origin: This value is copied from the global attribute "Max Earth Frames" in the current L1A granule.

Name: %Valid EV Observations

Description: Percentage of valid EV pixels in each of the MODIS bands. Band ordering implied in the array is 1, ...,12,13lo,13hi,14lo,14hi,15, ...,36.

HDF class: File (global) attribute

Data type: float32

Count: 38

Example: 98.2157, 87.1998, ...

Origin: Computed in the L1B code from the counts of total pixels available in each band and the total number of valid pixels in each band. The algorithm starts off assuming that all pixels are valid. The number of valid pixels is decreased by reflective band night mode pixels, pixels associated with scans having no data at all and pixels which cannot be calibrated (missing DN, dead detector, saturated DN, cannot compute zero point, cannot compute calibration coefficient, dn** falls below the bottom limit of the scaling range for reflective bands or if the radiance is below -NEdL for thermal bands).

Name:	%Saturated EV Observations
Description:	Percentage of EV pixels in each band which are determined to be saturated. Band ordering is identical to "%Valid EV Observations".
HDF class:	File (global) attribute
Data type:	float32
Count:	38
Example:	1.4, 0.2, ...
Origin:	Computed in the L1B code from the total number of saturated pixels per band determined in the emissive and reflective algorithms. A saturated pixel has a raw digital number of 4095, or values determined by off-line analysis for some reflective bands in which detectors are observed to saturate before their raw digital number can reach this value. For the reflective bands, these saturation levels are input to the code from the LUT "dn_sat_ev".

Name:	Electronics Redundancy Vector
Description:	Bit mask that indicates the state of many of the MODIS electronics subsystems. See the table of individual bits and associated telemetry fields in any of the L1B EV s.
HDF class:	File (global) attribute
Data type:	uint32
Count:	2 (two 32-bit words contain 64 available bits)
Example:	22401877, 1048
Origin:	The L1B code reads each associated telemetry point (an array of values, one per scan) from the current L1A granule. The value used for setting the associated bit is the last valid value of the array.
Note:	If there are no valid values for a telemetry field, then the most significant bit of the second word (which is an unused bit) is set to 1 as a flag to analysts. This does not identify which telemetry had no valid values, only that at least one of them had no valid values.

Name:	Electronics Configuration Change
Description:	Bit mask that indicates that a change occurred within the granule of any of the telemetry fields of the Electronics_Redundancy_Vector, described above (each bit: 1 = change, 0 = no change).
HDF class:	File (global) attribute
Data type:	uint32
Count:	2 (two 32-bit words contain 64 available bits)
Example:	0, 0
Origin:	The L1B code reads each associated telemetry point (an array of values, one per scan) from the current L1A granule. If there is a change in any of the valid values within the array, then the bit is set to 1. If the leading L1A granule is available and there is a change from the last valid value of the leading granule to any valid value of the current granule, the bit is also set to 1.

Note: If there are no valid values for a telemetry field, then the most significant bit of the second word (which is an unused bit) is set to 1 as a flag to analysts. This does not identify which telemetry had no valid values, only that at least one of them had no valid values.

Name:	Reflective LUT Serial Number and Date of Last Change
Description:	This value serves to identify the "science content" version of the reflective lookup tables. It is stored as a string and has the form: “Rvvv yyyy:MM:dd:hh:mm”, where “R” is for reflective, “vvv” is an integer version number that gets incremented and “yyyy:MM:dd:hh:mm” is the date and time of the last change to any LUT (see [6] for more details). Whether the Reflective LUT is changed or not, the serial number is updated for each new LUT submission. It is placed in each of the L1B Earth view products. Complete LUT histories may be found on the MCST Level 1B Product Information web page (http://mcst.gsfc.nasa.gov/l1b/product-information).
HDF class:	File (global) attribute
Data type:	char8
Count:	21
Example:	“R001 1998:01:28:12:00”
Origin:	The L1B code reads this value from a LUT in the reflective lookup tables file.

Name:	Emissive LUT Serial Number and Date of Last Change
Description:	This value serves to identify the "science content" version of the emissive lookup tables. It is stored as a string and has the form: “Evvv yyyy:MM:dd:hh:mm”, where “E” is for emissive, “vvv” is an integer version number that gets incremented and “yyyy:MM:dd:hh:mm” is the date and time of the last change to any LUT (see [6] for more details). Whether the Emissive LUT is changed or not, the serial number is updated for each new LUT submission. It is placed in each of the L1B Earth view products. Complete LUT histories may be found on the MCST Level 1B Product Information web page (http://mcst.gsfc.nasa.gov/l1b/product-information).
HDF class:	File (global) attribute
Data type:	char8
Count:	21
Example:	“E001 1998:01:28:12:00”
Origin:	The L1B code reads this value from a LUT in the emissive lookup tables file.

Name:	QA LUT Serial Number and Date of Last Change
Description:	This value serves to identify the "science content" version of the quality assurance (QA) lookup tables. It is stored as a string and has the form: “Qvvv yyyy:MM:dd:hh:mm”, where “Q” is for QA, “vvv” is an integer version number that gets incremented and “yyyy:MM:dd:hh:mm” is the date and time of the last change to any LUT (see [6] for more details). Whether the QA LUT is changed or not, the serial number is updated for each new LUT submission. It is placed in each of the L1B Earth view products. Complete LUT histories may be found on the MCST Level 1B Product Information web page (http://mcst.gsfc.nasa.gov/l1b/product-information).
HDF class:	File (global) attribute
Data type:	char8
Count:	21
Example:	“Q001 1998:01:28:12:00”
Origin:	The L1B code reads this value from a LUT in the QA lookup tables file.

Name:	Focal Plane Set Point State
Description:	The temperature-control state of the focal planes. 0=Running uncontrolled 1=Set Point is 83 deg 2=Set Point is 85 deg 3=Set Point is 88 deg
HDF class:	File (global) attribute
Data type:	int8
Count:	1
Example:	0
Origin:	The Focal Plane Set Point State is first determined for every scan. For each scan, if telemetry field CR_RC_LWHTR_ON = 0 and CR_RC_SMHTR_ON = 0, the Focal Plane Set Point State is 0. If CR_RC_CFPA_T1SET = 1 and CR_RC_CFPA_T3SET = 0, the Focal Plane Set Point State is 1. If CR_RC_CFPA_T1SET = 0 and CR_RC_CFPA_T3SET = 0, the Focal Plane Set Point State is 2. If CR_RC_CFPA_T1SET = 0 and CR_RC_CFPA_T3SET = 1, the Focal Plane Set Point State is 3. If every scan in the granule has the same Focal Plane Set Point State value, this field, the Focal Plane Set Point State for the granule, is set to that value. Otherwise, this field is set to 0.

Section 2.1.4 MODIS Level 1B QA Granule Metadata

Section 2.1.4.1 Level 1B QA Granule Metadata stored as global attributes

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Name:	Doors and Screens Configuration
Description:	Bit-wise fields denoting the state of the nadir aperture door (NAD), the space view door (SVD), the Solar diffuser door (SDD) and the Solar diffuser screen (SDS) on the first scan of the granule. The 4 most significant bits of the word are used in the order indicated above (NAD is the most significant bit). For the NAD, SVD and SDD, a value of 1 means open and 0 means closed. For the SDS, 1 means not screened and 0 means that the SD screen is in place.
HDF class:	File (global) attribute
Data type:	int8
Count:	1
Example:	2
Origin:	The state of each of the 4 doors on the first scan is read from the current L1A granule using the following telemetry fields: (1) nadir aperture door: CR_DR_NAD_OPEN; (2) space-view door: CR_DR_SVD_OPEN; (3) Solar diffuser door: CR_DR_SDD_OPEN; (4) Solar diffuser screen: CR_DR_SDS_OPEN.

Name: Reflective Bands With Bad Data

Description: Flag denoting the presence or absence of bad data in each reflective band. 1 indicates presence of any bad data and 0 indicates absence. The reflective bands are ordered: 1-12, 13lo, 13hi, 14lo, 14hi, 15-19, and 26.

HDF class: File (global) attribute

Data type: int8

Count: 22 (number of reflective bands)

Example: 1,0,0,1...

Origin: The value is set to 1 if any condition occurs that would cause a reflective band pixel to be considered invalid EXCEPT that the scan was a night scan. Otherwise it is set to 0. See comments in "%Valid EV Observations".

Name: Emissive Bands With Bad Data

Description: Flag denoting the presence or absence of bad data in all emissive bands. 1 indicates presence of bad data and 0 indicates absence. The emissive bands are ordered: 20-25, 27-36.

HDF class: File (global) attribute

Data type: int8

Count: 16 (number of emissive bands)

Example: 1,0,0,1...

Origin: The value is set to 1 if any condition occurs that would cause an emissive band pixel to be considered invalid. Otherwise it is set to 0. See comments in "%Valid EV Observations" for determining when a pixel is valid.

Note: *The next several attributes, with titles beginning "Noise in ", are designed to track the change in the noise of a temperature quantity during the life of the MODIS mission. Each of these represents the ratio of the variance in a given quantity relative to a pre-launch variance value. The variance is computed using valid values from all scans, although the actual number of unique values is generally much less than the number of scans due to the update rate of the telemetry. Values of this variance ratio in the range of [0-9] are scaled into an 8-bit unsigned integer, having possible values of [0-255]. Thus, a value of 255 for one of these attributes means that the variance is at least 9 times the pre-launch variance. This is the same as saying that the standard deviation is at least 3 times the pre-launch standard deviation. To recover the actual variance ratio, multiply a value in one of these attributes by the factor [9/255].*

Name:	Noise in Black Body Thermistors
Description:	The scaled variance ratio for the temperature in each of the 12 blackbody thermistors.
HDF class:	File (global) attribute
Data type:	uint8
Count:	12 (number of thermistors)
Example:	10, 12, 7, 15, ...
Origin:	Temperatures for the 12 BB thermistors are calculated using DNs from the telemetry points TP_BB_TEMP01 through TP_BB_TEMP12 and using the formulas in reference [14]. The pre-launch variances in BB temperatures come from the LUT "T_BB_Variance" in the QA lookup tables file.

Name: Noise in Average BB Temperature

Description: The scaled variance ratio for the average blackbody temperature.

HDF class: File (global) attribute

Data type: uint8

Count: 1

Example: 10

Origin: Temperatures for the 12 BB thermistors are calculated using DNs from the telemetry points TP_BB_TEMP01 through TP_BB_TEMP12 and using the formulas in reference [14]. The values for the 12 thermistors are averaged on each scan prior to accomplishing the variance calculation. The pre-launch variance in average BB temperature comes from the LUT "BB Average Temperature Variance" in the QA lookup tables file.

Name: Noise in LWIR FPA Temperature

Description: The scaled variance ratio for the temperature of the LWIR focal plane assembly (FPA).

HDF class: File (global) attribute

Data type: uint8

Count: 1

Example: 10

Origin: Temperatures for the LWIR FPA are calculated using the DNs from telemetry point TA_RC_LWIR_CFPAE and using the formulas in reference [9]. The pre-launch variance in LWIR FPA temperature comes from the LUT "LWIR FPA Temperature Variance" in the QA lookup tables file.

Name: Noise in MWIR FPA Temperature

Description: The scaled variance ratio for the temperature of the MWIR focal plane assembly (FPA).

HDF class: File (global) attribute

Data type: uint8

Count: 1

Example: 10

Origin: Temperatures for the MWIR FPA are calculated using the DNs from telemetry point TA_RC_SMIR_CFPAE and using the formulas in reference [9]. The pre-launch variance in MWIR FPA temperature comes from the LUT "MWIR FPA Temperature Variance" in the QA lookup tables file.

Name: Noise in Scan Mirror Thermistor #1

Description: The scaled variance ratio for the temperature of the scan mirror measured by thermistor 1.

HDF class: File (global) attribute

Data type: uint8

Count: 1

Example: 10

Origin: Temperatures for the scan mirror thermistor #1 are calculated using the DNs from telemetry point TP_SA_RCT1_MIRE and using the formulas in reference [9]. The pre-launch variance in scan mirror thermistor 1 temperature comes from the LUT "MirrorSide 1 Temperature Variance" in the QA lookup tables file.

Name:	Noise in Scan Mirror Thermistor #2
Description:	The scaled variance ratio for the temperature of the scan mirror measured by thermistor 2.
HDF class:	File (global) attribute
Data type:	uint8
Count:	1
Example:	10
Origin:	Temperatures for the scan mirror thermistor #2 are calculated using the DNs from telemetry point TP_SA_RCT2_MIRE and using the formulas in reference [9]. The pre-launch variance in scan mirror thermistor 2 temperatures comes from the LUT "MirrorSide 2 Temperature Variance" in the QA lookup tables file.

Name:	Noise in Scan Mirror Thermistor Average
Description:	The scaled variance ratio for the average temperature of the scan mirror.
HDF class:	File (global) attribute
Data type:	uint8
Count:	1
Example:	10
Origin:	Temperatures for the two sides of the scan mirror are calculated using the DNs from telemetry points TP_SA_RCT1_MIRE and TP_SA_RCT2_MIRE, respectively, and using the formulas in reference [9]. These values are averaged on a scan-by scan basis prior to computing variance. The pre-launch variance in average scan mirror temperature comes from the LUT "Mirror Average Temperature Variance" in the QA lookup tables file.

Name:	Noise in Instrument Temperature
Description:	The scaled variance ratio for the instrument temperature.
HDF class:	File (global) attribute
Data type:	uint8
Count:	1
Example:	10
Origin:	Instrument temperature on a scan-by-scan basis may be derived from a number of telemetry points or by a LUT. The algorithm is described in references [15] and [16]. The pre-launch variance in instrument temperature comes from the LUT "Instrument Temperature Variance" in the QA lookup tables file.

Name:	Noise in Cavity Temperature
Description:	The scaled variance ratio for the cavity temperature.
HDF class:	File (global) attribute
Data type:	uint8
Count:	1
Example:	10
Origin:	Cavity temperature on a scan-by-scan basis may be derived from a number of telemetry points or by a LUT. The algorithm is described in reference [16]. The pre-launch variance in cavity temperature comes from the LUT "Cavity Temperature Variance" in the QA lookup tables file.

Name: Noise in Temperature of NIR FPA

Description: The scaled variance ratio for the temperature of the NIR focal plane assembly (FPA).

HDF class: File (global) attribute

Data type: uint8

Count: 1

Example: 10

Origin: Temperatures for the NIR FPA are calculated using the DNs from telemetry point TA_AO_NIR_FPAE and using the formulas in reference [9]. The pre-launch variance in NIR FPA temperature comes from the LUT "NIR FPA base variance" in the QA lookup tables file.

Name: Noise in Temperature of VIS FPA

Description: The scaled variance ratio for the temperature of the VIS focal plane assembly (FPA).

HDF class: File (global) attribute

Data type: uint8

Count: 1

Example: 10

Origin: Temperatures for the VIS FPA are calculated using the DNs from telemetry point TA_AO_VIS_FPAE and using the formulas in reference [9]. The pre-launch variance in VIS FPA temperature comes from the LUT "visual FPA base variance" in the QA lookup tables file.

Name: Dead Detector List

Description: List of detectors identifying those which do not provide data of useful quality. EV pixels are not calibrated if the associated dead detector flag is set to 1.

HDF class: File (global) attribute

Data type: int8

Count: 490 (number of detectors: indexed by MODIS band and detector, with detector being the most rapidly varying index)

Example: 0,0,0,0,1,0,0... (1=dead or 0=not dead)

Origin: The values come from the dead-detector array index of the LUT "Detector Quality Flag Values" in the QA lookup tables file (see [6] and [2]).

Name: Noisy Detector List

Description: List of detectors, which are noisy, but data are assumed to be useful. These values are not used in processing. They are simply copied from the LUT for information purposes.

HDF class: File (global) attribute

Data type: int8

Count: 490 (number of detectors: indexed by band and detector, with detector being the most rapidly varying index)

Example: 1=True or 0=False

Origin: The values come from the noisy-detector array index of the LUT "Detector Quality Flag Values" in the QA lookup tables file ([6] and [2]).

Name: Noisy Subframe List

Description: List of subframes which are noisy, but data are assumed to be useful. These values are not used in processing. They are simply copied from the LUT for information purposes.

HDF class: File (global) attribute

Data type: int8

Count: 520 (number of subframes in 250m and 500m bands: indexed by MODIS band, detector, and subframe with subframe being the most rapidly varying index)

Example: 0,0,0,0,1,0,0… (1=noisy or 0= not noisy)

Origin: The values come from the noisy and dead subframe array index of the LUT "Detector Quality Flag2 Values" in the QA lookup tables file.

Name: Dead Subframe List

Description: List of subframes identifying those which do not provide data of useful quality. EV pixels are not calibrated if the associated dead subframe flag is set to 1.

HDF class: File (global) attribute

Data type: int8

Count: 520 (number of subframes in 250m and 500m bands: indexed by MODIS band, detector, and subframe with subframe being the most rapidly varying index)

Example: 0,0,0,0,1,0,0… (1=dead or 0= not dead)

Origin: The values come from the noisy and dead subframe array index of the LUT "Detector Quality Flag2 Values" in the QA lookup tables file.

Name:	Detector Quality Flag
Description:	Individual bits identify dead, noisy and other anomalous conditions associated with each detector ([6] and [2]).
HDF class:	File (global) attribute
Data type:	uint8
Count:	490 (number of detectors: indexed by band and detector, with detector being the most rapidly varying index)
Example:	0, 32, 0, 0, 1, 0, 0, 55, ...
Origin:	The values come from the noisy-detector array index of the LUT "Detector Quality Flag Values" in the QA lookup tables file ([6] and [2]). The values are then packed into the bit-wise flag. Tables Table 2.1.1 and Table 2.1.2 (from [2]) map the bits to specific meanings and criteria.

Table 2.1.1: Meaning of Each Bit in "Detector Quality Flag" for Reflective Bands

Bit	Meaning	Reflective Band Criteria
0 (LSB)	Noisy Detector	NedL @ Ltyp > 2 times mission spec
1	Non-Functional Detector	Non-responsive detector
2	Out-of-Family Gain	Gain deviates by > 10% from median gain
3	Dynamic Range	Saturates before mission spec Lmax
4	Detector DN saturates on calibration source	Expected DN saturates on illuminated, unscreened Solar Diffuser. (No RSB detectors on MODIS/TERRA (PFM) saturate on screened SD after 17 March 2000)
5	High calibration fit residuals	> 1% deviation from linear fit observed on pre-flight data within calibration range
6	Electrical or Optical Crosstalk	Residual Crosstalk observed on orbit
7 (MSB)	TBD	TBD

Table 2.1.2 Meaning of Each Bit in "Detector Quality Flag" for Emissive Bands

Bit	Meaning	Emissive Band Criteria
0 (LSB)	Noisy Detector	NedL @ Ltyp > 2 times mission spec
1	Non-Functional Detector	Non-responsive detector
2	Out-of-Family Gain	Gain deviates by > 10% from median gain for band 21 only; Criteria for other bands TBD
3	Dynamic Range	Saturates before mission spec Lmax
4	Detector DN saturates on calibration source	Expected DN saturates on blackbody when T_{BB} = 290 K.
5	High calibration fit residuals	> 1% deviation from linear fit (or quadratic where used) within calibration range
6	Electrical or Optical Crosstalk	Residual Crosstalk observed on orbit
7 (MSB)	TBD	TBD

Name:	Detector Quality Flag2
Description:	Individual bits identify noisy subframes associated with each detector ([6] and [2]).
HDF class:	File (global) attribute
Data type:	uint8
Count:	180 (number of detectors in 250m and 500m bands: indexed by band and detector, with detector being the most rapidly varying index)
Example:	0, 2, 0, 0, 1, 0, 0, 4, ...
Origin:	The values come from the noisy-detector array index of the LUT "Detector Quality Flag2 Values" in the QA lookup tables file ([6] and [2]). The values are then packed into the bit-wise flag. The bit 0-3, (0 is LSB) represents noisy subframe 1-4, and the bit 4-7 represents dead subframe.

Name:	Earth-Sun Distance
Description:	The Earth-Sun distance in AU at the middle time of the granule.
HDF class:	File (global) attribute
Data type:	float32
Count:	1
Example:	1.0045
Origin:	The value is calculated within Level 1B using the TAI time of the middle scan of the granule and the formulas in [1].

Name:	identifier_product_doi
Description:	The Digital Object Identifier for MODIS L1B products.
HDF class:	File (global) attribute
Data type:	Char8
Count:	26
Example:	“10.5067/MODIS/MOD021KM.006”
Origin:	This value is assigned by ESDIS to meet the ESDIS requirement for adding Digital Object Identifiers (DOI) to EOSDIS standard product metadata.

Name:	identifier_product_doi_authority
Description:	The URL location defines the authoritative service for use with DOI values.
HDF class:	File (global) attribute
Data type:	Char8
Count:	17
Example:	http://dx.doi.org
Origin:	This value is a defined constant within the L1B code.

Name:	Solar Irradiance on RSB Detectors over pi
Description:	Contains the Solar irradiance at 1 AU divided by π, weighted by a detector's relative spectral response (RSR), for each reflective detector.
HDF class:	File (global) attribute
Data type:	float32
Count:	330
Example:	511.459, 511.46, ...
Origin:	The values are read from a LUT in the Reflective LUT HDF file. These values were determined from pre-launch ground measurements and are not expected to change throughout the mission.

***Note:** The next set of attributes, down to "% EV Data Not Calibrated", provide an accounting of the percentages of Earth view pixels at the native resolution which could not be calibrated for some reason. There is a close correspondence of these attributes to the definitions of "unusable data values" for the scaled integer SDSs. However, there are some categories of unusable data values that are not tracked with an individual attribute. See Section 2.2.1, valid range description, in this data dictionary for a table of these values (Table 2.1.1) and a description of the order of precedence that is used for setting the unusable data values. The order of attributes in the description below generally reflects the order of precedence.*

Name:	% L1A EV All Scan Data are Missing
Description:	Identifies the percentage of completely missing scans in the granule. A completely missing scan is defined as a scan that has no valid scan data. Scaled integers will be set to 65535 for this case. (This category does not completely account for all values of 65535 – see the next attribute.)
HDF class:	File (global) attribute
Data type:	float32
Count:	1 (the same value applies to all detectors)
Example:	20.025
Origin:	The value is determined within Level 1B using the "Scan quality array" SDS, which is read from the current L1A granule. For a given scan, if element 1 (array index 0) is zero, then there are no valid scan data for that scan. Additionally, "split scans" are treated as missing and fall into this category.

Name: % L1A EV RSB DN Not in Day Mode

Description: This attribute identifies the percentage of data for each Reflective Solar Band detector that have scaled integers set to the fill value of 65535 due to MODIS not being in "day" mode. Thermal emissive band detectors will always have values of zero for this attribute. Completely missing scans, which also have the scaled integers set to 65535, do not count in this determination.

HDF class: File (global) attribute

Data type: float32

Count: 490 (total number of detectors)

Example: 10.523, 10.523, ...

Origin: The value is calculated within Level 1B by using the L1A granule SDS "Scan Type" to identify scans that are not in "Day" mode.

Name: % L1A EV DN Missing Within Scan

Description: This attribute identifies the percentage of data for each detector that have scaled integers set to the value of 65534 – due to L1A DN being missing (-1) within a scan. The cases of all scan data missing and MODIS not being in "Day" mode are not included in these percentages.

HDF class: File (global) attribute

Data type: float32

Count: 490 (total number of detectors)

Example: 10.523, 10.523, ...

Origin: The value is calculated within Level 1B by checking each Earth View DN for a -1 value.

Name:	% Dead Detector EV Data
Description:	This attribute identifies the percentage of data for each detector that have scaled integers set to the value of 65531 – due to the detector being classified as "dead".
HDF class:	File (global) attribute
Data type:	float32
Count:	490 (total number of detectors)
Example:	10.523, 10.523, ...
Origin:	A dead detector is determined within Level 1B by the second value of the "Detector Quality Flag" (see Table 2.1.2). The Detector Quality Flag comes from a LUT in the QA lookup tables file.

Name:	% Dead Subframe EV Data
Description:	This attribute identifies the percentage of data for each detector that have scaled integers set to the value of 65525 – due to the subframe associated with this detector being classified as "dead".
HDF class:	File (global) attribute
Data type:	float32
Count:	180 (total number of detectors)
Example:	10.523, 10.523, ...
Origin:	A dead subframe is determined within Level 1B by the "Detector Quality Flag2" The Detector Quality Flag2 comes from a LUT in the QA lookup tables file.

Name:	% Sector Rotation EV Data
Description:	This attribute identifies the percentage of data for each detector that have scaled integers set to the value of 65527 – due to the rotation of the Earth view sector from the nominal science collection position.
HDF class:	File (global) attribute
Data type:	float32
Count:	490 (total number of detectors)
Example:	10.523, 10.523, ...
Origin:	The amount of sector rotation on each scan is determined from the telemetry field CS_FR_ENC_DELTA.

Name:	% Saturated EV Data
Description:	This attribute identifies the percentage of data for each detector that have scaled integers set to the value of 65533 – due to the L1A Earth view DN being classified as saturated.
HDF class:	File (global) attribute
Data type:	float32
Count:	490 (total number of detectors)
Example:	10.523, 10.523, ...
Origin:	For thermal emissive bands, an Earth view sector DN is deemed saturated when its value is 4095. For reflective solar bands, a table of values is entered as a LUT in the reflective lookup tables file. The LUT currently has band, detector, subsample and mirror side dimensions. A DN value that equals or exceeds the appropriate value in the table is defined as saturated.

Name: % TEB EV Data With Moon in SVP

Description: This attribute is obsolete because there is now an algorithm within L1B to compute the average space-view (SV) DN when the moon is in the SV port. All elements will be set to zero.

HDF class: File (global) attribute

Data type: float32

Count: 490 (total number of detectors)

Example: 0, 0, 0

Origin: All elements will be set to zero.

Name: % EV Data Where Cannot Compute BG DN

Description: This attribute identifies the percentage of data for each detector that have scaled integers set to the value of 65532 – due to the inability to calculate a zero-point DN value (used in calibration of the data).

HDF class: File (global) attribute

Data type: float32

Count: 490 (total number of detectors)

Example: 10.523, 10.523, ...

Origin: For reflective bands, this situation could occur if both the space-view and blackbody DNs are all missing within a scan. For thermal emissive bands, this situation could occur if the space-view DNs are all missing within a scan or if an Ecal for one of the thermal bands is running (the space-view DNs are used to place the results of the Ecal test – rendering the space-view DNs unusable for calibration purposes).

Name: % RSB EV Data With dn** Below Scale

Description: This attribute identifies the percentage of data for each reflective Solar band detector that have scaled integers set to the value of 65530 – due to a calculated value of dn** being below the range for scaling dn** to the product scaled integer. For thermal band detectors, these values will always be set to zero.

HDF class: File (global) attribute

Data type: float32

Count: 490 (total number of detectors)

Example: 10.523, 10.523, ...

Origin: dn** is calculated within Level 1B as part of the process of calibrating reflective band Earth view data. The dynamic range of dn** that is used to scale a value to the product scaled integer range of 0-32767 is input to Level 1B through a LUT in the reflective lookup tables file.

Name: % EV Data Where Nadir Door Closed

Description: This attribute identifies the percentage of data for each detector that have scaled integers set to the values above 32767, up to the limit of 65500 – due to the nadir aperture door being closed.

HDF class: File (global) attribute

Data type: float32

Count: 490 (total number of detectors)

Example: 10.523, 10.523, ...

Origin: See Section 2.2.1 in the description of "valid_range", for a description of how the values are set if the nadir aperture door is closed.

Name: % EV Data Not Calibrated

Description: The values in this attribute represent total percentage of Earth view product scaled integer values above 32767 for each detector. These values include those categories of unusable data values that are not explicitly tracked (e.g., 65529) by individual attributes.

HDF class: File (global) attribute

Data type: float32

Count: 490 (total number of detectors)

Example: 10.523, 10.523, ...

Origin: Calculated within Level 1B by summing up preceding quantities appropriately as well as summing up cases where the scaled integers are set to unusable data values not represented in the foregoing attributes.

Name: Bit QA Flags Last Value

Description: The value for the last scan of the field "Bit QA Flags" in the Level 1B Swath Metadata Vdata (with one exception, described below). See **Table 2.1.4** for a description of the bits in the Bit QA Flags.

HDF class: File (global) attribute

Data type: uint32

Count: 1

Example: 32768

Origin: Calculated in the Level 1B code after the scan-by-scan values of the Bit QA Flags have been determined. For all bits except bit 11 (day mode bands at night flag), the value is that of the last scan. For bit 11, there must be at least 15 scans within the granule having a value of 1 in order to set the bit in this attribute to 1. The logic for bit 11 was devised to prevent "false positives" from appearing in the MCST QA database, which uses this attribute.

Name: Bit QA Flags Change

Description: A bit-by-bit determination if there were any changes within the granule for the Bit QA Flags. See **Table 2.1.4** for a description of the bits in the Bit QA Flags.

HDF class: File (global) attribute

Data type: uint32

Count: 1

Example: 64

Origin: Calculated within the Level 1B code, after the scan-by-scan values of the Bit QA Flags have been determined. For all bits except bit 11, any change within the granule will cause the appropriate bit to be set to 1. For bit 11, if bit 11 in the "Bit QA Flags Last Value" is set to 1, then bit 11 in this attribute is also set to 1. (See other comments above for "Bit QA Flags Last Value".)

Name: Granule Average QA Values

Description: These values are selected temperatures and voltages averaged over all scans of the granule.

HDF class: File (global) attribute

Data type: float32

Count: 50

Example: 290.004, 289.984, ...

Origin: Calculated within the Level 1B code from L1A telemetry data. The telemetry points and meaning for each value are given in **Table 2.1.3**.

Table 2.1.3: Telemetry Point Meanings

Telemetry Point	**Meaning**
TP_BB_TEMP01	BB Thermistor 1
TP_BB_TEMP02	BB Thermistor 2
TP_BB_TEMP03	BB Thermistor 3
TP_BB_TEMP04	BB Thermistor 4
TP_BB_TEMP05	BB Thermistor 5
TP_BB_TEMP06	BB Thermistor 6
TP_BB_TEMP07	BB Thermistor 7
TP_BB_TEMP08	BB Thermistor 8
TP_BB_TEMP09	BB Thermistor 9
TP_BB_TEMP10	BB Thermistor 10
TP_BB_TEMP11	BB Thermistor 11
TP_BB_TEMP12	BB Thermistor 12
TA_AO_VIS_FPAE	VIS Focal Plane
TA_AO_NIR_FPAE	NIR Focal Plane
TA_RC_SMIR_CFPAE	SMIR Focal plane Temp
TA_RC_LWIR_CFPAE	LWIR Focal plane Temp
TP_SA_RCT1_MIRE	Scan Mirror Temp 1
TP_SA_RCT2_MIRE	Scan Mirror Temp 2
TP_SA_A_MTR	Scan motor temperature A
TP_MF_CALBKHD_SR	Cal bulkhead below SRCA mount
TP_SR_SNOUT	SRCA Bulkhead Temp
TP_MF_Z_BKHD_BB	Mid zenith bulkhead near BB
TP_MF_CVR_OP_SR	cover opposite SRCA
TP_AO_SMIR_OBJ	SMIR Objective Lens Temp
TP_AO_LWIR_OBJ	LWIR Objective Lens Temp
TP_AO_SMIR_LENS	SMIR Eye Assy Temp
TP_AO_LWIR_LENS	LWIR Eye Assy Temp
TA_RC_CS	Cold stage Temp
TA_RC_CS_OG	Cold stage outgas Temp
TA_RC_IS	Intermediate Stage Temp
TA_RC_IS_OG	Intermediate Stage outgas Temp
TA_RC_OS_OG	Outer stage outgas Temp
VR_RC_LW_FPA_HTR	LWIR heater voltage

Name:	Noise in Thermal Detectors
Description:	A comparison of the noise in each thermal emissive band detector to a pre-launch value. The ratio of noise equivalent delta radiance (NedL) to the pre-launch value of NedL, for the range of values of [0-9], is scaled to an unsigned, 8-bit integer. Thus, a value of 255 means that the NedL is at least 9 times higher than the pre-launch value.
HDF class:	Scientific Data Set (SDS)
Data type:	uint8
Rank:	2
Dimensions:	[16][10] (16 thermal bands and 10 detectors, with detectors being the most rapidly varying index)
Example:	8, 6, 4, ...
Origin:	For each scan and detector, the signal to noise ratio (SNR) is computed as the mean blackbody (BB) dn divided by the standard deviation of the BB dn values (across the set of BB frames for the scan). The NedL is then computed as the BB radiance divided by the SNR. The NedL is averaged over all scans of each detector. The values of pre-launch NedL come from the LUT "NedL" in the QA lookup tables file.

Name: Change in relative responses of thermal detectors

Description: This value reflects the change in the linear calibration coefficient, b1, for each of the thermal band detectors. The ratio of b1 to a pre-launch value is computed and the value in the range of [0-9] is scaled to an unsigned 8-bit integer. Thus, a value of 255 means that the averaged b1 value is at least 9 times higher than the pre-launch value.

HDF class: Scientific Data Set (SDS)

Data type: uint8

Rank: 2

Dimensions: [16][10] (16 thermal bands and 10 detectors, with detectors being the most rapidly varying index)

Example: 10, 6, 8, ...

Origin: For each scan and detector, the linear calibration coefficient, b1, is computed and the average over scans is taken. The values of pre-launch linear calibration coefficient come from the LUT "a1" in the QA lookup tables file.

Name: DC Restore Change for Thermal Bands

Description: Identifies whether a change occurred during a scan in the DC Restore value of any thermal band detector (0 = no change, 1 = change).

HDF class: Scientific Data Set (SDS)

Data type: int8

Rank: 3

Dimensions: [nscans][16][10] (number of scans, 16 bands and 10 detectors, with detectors being the most rapidly varying index)

Example: 0, 0, 1

Origin: For every emissive detector, if its FPA DCR offset value in MODIS engineering group 1 packet 1 data field at this scan is different from that on the previous scan, this field is set to 1. Otherwise it is set to 0.

Name:	DC Restore Change for Reflective 250m Bands
Description:	Identifies if a change occurred during a scan in the DC Restore value of any 250m reflective band detector (0 = no change, 1 = change).
HDF class:	Scientific Data Set (SDS)
Data type:	int8
Rank:	3
Dimensions:	[nscans][2][40] (number of scans, 2 bands and 40 detectors, with detectors being the most rapidly varying index)
Example:	0, 0, 1...
Origin:	For every 250m reflective detector, if its FPA DCR offset value in MODIS engineering group 1 packet 1 data field at this scan is different from that on the previous scan, this field is set to 1. Otherwise it is set to 0.

Name:	DC Restore Change for Reflective 500m Bands
Description:	Identifies if a change occurred during a scan in the DC Restore value of any 500m reflective band detector (0 = no change, 1 = change).
HDF class:	Scientific Data Set (SDS)
Data type:	int8
Rank:	3
Dimensions:	[nscans][5][20] (number of scans, 5 bands and 20 detectors, with detectors being the most rapidly varying index)
Example:	0, 0, 1...
Origin:	For every 500m reflective detector, if its’ FPA DCR offset value in MODIS engineering group 1 packet 1 data field at this scan is different from that on the previous scan, this field is set to 1. Otherwise it is set to 0.

Name: DC Restore Change for Reflective 1km Bands

Description: Identifies if a change occurred during a scan in the DC Restore value of any 1km reflective band detector (0 = no change, 1 = change).

HDF class: Scientific Data Set (SDS)

Data type: int8

Rank: 3

Dimensions: [nscans][15][10] (number of scans, 15 bands and 10 detectors, with detectors being the most rapidly varying index)

Example: 0, 0, 1...

Origin: For every 1km reflective detector, if its FPA DCR offset value in MODIS engineering group 1 packet 1 data field at this scan is different from that on the previous scan, this field is set to 1. Otherwise it is set to 0.

Section 2.1.5 Level 1B HDF-EOS SWATH Metadata

```
|GROUP=SwathStructure                                                         |
| GROUP=SWATH_1                                                               |
|  SwathName="MODIS_SWATH_Type_L1B"                                           |
|GROUP=Dimension                                                              |

|      Object       DimensionName        Size                                 |
|   | Dimension_1 | "Band_250M"         | 2               |                   |
|   | Dimension_2 | "Band_500M"         | 5               |                   |
|   | Dimension_3 | "Band_1KM_RefSB"    | 15              |                   |
|   | Dimension_4 | "Band_1KM_Emissive" | 16              |                   |
|   | Dimension_5 | "10*nscans"         | 10*nscans       |                   |
|   | Dimension_6 | "Max_EV_frames"     | 1354            |                   |
|   | Dimension_7 | "2*nscans"          | 2*nscans        |                   |
|   | Dimension_8 | "1KM_geo_dim"       | 271             |                   |
|   +-------------+---------------------+-----------------+                   |
       Note: Dimension_8, "1KM_geo_dim", is computed as Max_EV_Frames/5+1
|                                                                             |
|   GROUP=Dimension--+---------------------+-----------------+--------+------+|
|   | Object      --+---------------------+-----------------+--------+------+|
|   | DimensionMap_1 | "2*n_geo_dim"       | "Max_EV_frames" |   2    |  5   ||
|   +----------------+---------------------+-----------------+--------+------+|
|                                          -+--------------------------------+|
|   |Object     |GeoFieldName| DataType     |--------------------------------+|
|   |GeoField_1 |"Latitude"  | DFNT_FLOAT32 |("2*nscans","1KM_geo_dim")      ||
|   |GeoField_2 |"Longitude" | DFNT_FLOAT32 |("2*nscans","1KM_geo_dim")      ||
|   +-----------+------------+--------------+--------------------------------+|
|                                                                 -----------+|
|   | Object      | DataFieldName        | DataType    | DimList   ---------+|
|   | DataField_1 | "EV_1KM_RefSB"       | DFNT_UINT16 |("Band_1KM_RefSB",  ||
|   |             |                      |             | "10*nscans",       ||
|   |             |                      |             | "Max_EV_frames")   ||
```

Figure 2.1.1: Excerpt from 1KM File Specifications for Swath Metadata

These are stored as global attribute "StructMetadata.0". However, this name is an internal structure for the HDF-EOS swaths and should not be needed by the user when using HDF-EOS functions. The file specifications give tables for the various groups in each product. Figure 2.1.1 above shows an excerpt from the 1km file specification. The "GROUP=Dimension" table associates names (specific strings) with actual dimensions present in the "GeoField" and "DataField" SDSs. The "GROUP=DimensionMap" creates a mapping that associates geolocation dimensions with data dimensions. The offsets and increments allow specific geolocation points to be aligned with the data points (used for visualization and geolocation subsetting). The "GROUP=GeoField" lists the geolocation latitude and longitude SDSs and the "DataField" group lists all instrument, uncertainty, samples used, other geolocation and band-subsetting SDSs. (***Note:*** the full "DataField" table from the 1km file specification is not shown in Figure 2.1.1. See Table 2.2.1, Table 2.3.1, Table 2.4.1, and Table 2.4.2 for summaries of this information.)

Section 2.1.6 Level 1B Swath Metadata

These data are stored as a single HDF Vdata table having the name "Level 1B Swath Metadata". There is one record per scan resulting in the number of records being equal to the number of scans as determined by the "Number of Scans" global attribute. NOTE: despite the name of this Vdata, there is no relationship with the HDFEOS Swath Type described in the preceding section (Section 2.1.5).

This section describes the fields of this Vdata. Note that the field "order" defines how many elements are within the field for a given record. The field orders are almost always 1, indicating one element per field per record. There is one exception to this -- the Scan type -- where there are four characters within the field.

Name:	Scan Number
Description:	The scan number within the granule. The values are in the set 1 through nscans, where nscans is the number of scans in the granule (value of attribute "Number of Scans").
HDF object:	Vdata field within the "Level 1B Swath Metadata" vdata.
Data type:	int32
Order:	1
Example:	1 to 204
Origin:	The L1B code creates the values for all records by means of a simple loop index. The result is that the scan number is exactly the same as the Vdata record number (i.e., this field does not provide any real information).

Name: Complete Scan Flag

Description: Denotes if the scan was complete (1=Complete,0=Incomplete)

HDF object: Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: int32

Order: 1

Example: 1

Origin: The L1B code uses the L1A SDS "Scan quality array" which contains the number of missing packets for all scans. If the number of missing packets for a scan is greater than zero, then a scan is denoted as incomplete (0). If there are no missing packets, then scan is complete (1).

Name: Scan Type

Description: Identifies a scan as being "Day", "Night" or "Other". When a scan is "Night", the 250m, 500m and 1km day bands data are not telemetered down from the spacecraft. A scan type of "Other" can arise if no data are present for a scan.

HDF object: Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: char8

Order: 4

Example: "D   " = day, "N   " = night, "O   " = other

Origin: The L1B code uses the data read from the L1A granule SDS "Scan Type". If the L1A scan type is "Day", then the value assigned is "D   " (three extra blank spaces). If the scan type is "Night", the value assigned is "N   ". If not any of the above, the value assigned it "O   ".

Name: Mirror Side

Description: The mirror side corresponding to the scan (0 or 1).

HDF object: Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: int32

Order: 1

Example: 0 or 1 (-1 is fill value)

Origin: The values come from the L1A SDS "Mirror side".

Name: EV Sector Start Time

Description: TAI time (number of seconds since 1/1/1993) for the beginning of the Earth view sector of the scan.

HDF object: Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: float64

Order: 1

Example: 144928505.511391

Origin: The values come from the L1A SDS "EV start time".

Name: EV_Frames

Description: Number of 1km-resolution Earth view frames (a fixed constant).

HDF object:Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: int32

Order: 1

Value: 1354 (constant)

Origin: Set as constant within the L1B code. This value does not provide any scan-to-scan information or any information about missing data.

Name: Nadir_Frame_Number

Description: The 1km-resolution frame that corresponds to the nadir frame assuming that the platform is in its nadir-stabilized orientation (a fixed constant).

HDF object:Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: int32

Order: 1

Value: 677 (constant)

Origin: Set as constant within the L1B code. There is no algorithm implemented in Level 1B to determine nadir frame number if the platform is maneuvering. Therefore, it would be more accurate to describe this as the center frame.

Name: Latitude of Nadir Frame

Description: The latitude of the nadir frame (above value) for the fifth detector in any 1km band for the scan.

HDF object:Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: float32

Order: 1

Example: -90.0 to 90.0 degrees

Origin: The L1B code reads the geolocation file SDS "Latitude” and extracts the appropriate value based on the 1km-resolution frame number 677.

Name: Longitude of Nadir Frame

Description: The longitude of the nadir frame for the fifth detector in any 1km band for the scan.

HDF object:Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: float32

Order: 1

Example: -180.0 to 180.0 degrees

Origin: The L1Bcode reads the geolocation file SDS "Longitude" and extracts the appropriate value based on the 1km-resolution frame number 677.

Name: Solar Azimuth of Nadir Frame

Description: The Solar azimuth angle of the nadir frame for the fifth detector for the scan.

HDF object:Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: float32

Order: 1

Example: -180.0 to 180.0 degrees

Origin: The L1B code reads the geolocation file SDS "SolarAzimuth" and extracts the appropriate value based on the 1km-resolution frame number 677.

Name: Solar Zenith of Nadir Frame

Description: The Solar zenith angle of the nadir frame for the fifth detector for the scan.

HDF object:Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: float32

Order: 1

Example: 0.0 to 180.0 degrees

Origin: The L1B code reads the geolocation file SDS "SolarZenith" and extracts the appropriate value based on the 1km-resolution frame number 677.

Name: No. OBC BB thermistor outliers

Description: When computing the within-scan average of the blackbody temperature (from up to 12 thermistor measurements), this value holds the number of values that were rejected by the outlier rejection algorithm. See origin, below.

HDF object:Vdata field within the "Level 1B Swath Metadata" vdata.

Data type: int32

Order: 1

Example: 0 to 12

Origin: On each scan, up to 12 temperatures of the black body are averaged to form a mean blackbody temperature for the scan. An outlier rejection algorithm is applied that rejects any temperature the lies outside of 3 standard deviations from the computed mean. Then, the mean is re-computed. A count is made of the number of outliers that were rejected. Not included are those thermistors that have been excluded by setting the appropriate weight value to zero. On each scan, temperatures for the 12 BB thermistors are calculated using DNs from the telemetry points TP_BB_TEMP01 through TP_BB_TEMP12 and using the formulas in reference [14]. The weight value that can include (by setting to 1.0) or exclude (by setting to 0.0) any of the 12 thermistors comes from the LUT "BB_Weight" which is contained in the emissive lookup tables file.

Name: Bit QA Flags

Description: **Table 2.1.4** gives the meaning of each bit in this 32-bit unsigned integer. Bit 0 is the least significant bit in the word.

Table 2.1.4: Bit QA Flags Descriptions

Bit QA Flags: Bit #	**Description (condition that causes bit to be set to 1)**
Bit 0	Moon within defined limits of SVP (the moon was found to be in the space-view keep-out box for at least one detector of at least one MODIS band on this scan)
Bit 1	Spacecraft Maneuver (at least one of the spacecraft yaw, pitch, or roll angles is greater than its threshold value as set in a QA LUT value) Prior to MOD_PR02 Versions 4.3.0/4.3.1, the value of the L1A telemetry field SS_FR_SCIABNORM determined this flag. The SS_FR_SCIABNORM indicator is flagged by Bit 26 in Versions 4.3.0/4.3.1 and higher.
Bit 2	Sector Rotation (the L1A telemetry field CS_FR_ENC_DELTA is not equal to zero for this scan)
Bit 3	Negative Radiance Beyond Noise Level (at least 1 thermal emissive band pixel has a radiance value less than –NEdL on this scan)
Bit 4	PC bands Ecal on (either L1A telemetry field CR_PCLWA_ECAL_ON or CR_PCLWB_ECAL_ON is 1 for this scan)
Bit 5	PV bands Ecal on (any of the following L1A telemetry fields is 1 for this scan: CR_PVVISA_ECAL_ON, CR_PVVISB_ECAL_ON, CR_PVNIRA_ECAL_ON, CR_PVNIRB_ECAL_ON, CR_PVSMA_ECAL_ON, CR_PVSMB_ECAL_ON, CR_PVLWA_ECAL_ON, CR_PVLWB_ECAL_ON)
Bit 6	SD Door Open (the L1A telemetry field CR_DR_SDD_OPEN is equal to 1 for this scan)

Bit QA Flags: Bit #	Description (condition that causes bit to be set to 1)
Bit 7	SD Screen Down (the L1A telemetry field CR_DR_SDS_OPEN is equal to 0 for this scan)
Bit 8	NAD closed (the value of CR_DR_NAD_OPEN is zero on this scan.)
Bit 9	SDSM On (either L1A telemetry field CR_SM_SDSM_A_ON or CR_SM_SDSM_B_ON is 1 for this scan)
Bit 10	Radiative cooler Heaters On (either L1A telemetry field CR_RC_CSHTR_ON or CR_RC_ISHTR_ON is 1 for this scan)
Bit 11	Day mode bands telemetered at night (an algorithm using the SD Sun azimuth and SD Sun zenith angles is used to flag situations where the Scan type is "Day" but the spacecraft is actually in spacecraft night. A value of 1 means that the above described situation is true.).
Bit 12	Linear Emissive Calibration -- this value is set to 0. This bit is effectively unused at the present time.
Bit 13	DC Restore Change (the FPA DCR offset value for any detector changed from the value of the last scan)
Bit 14	(unused)
Bit 15	BB Heater On (either heater A or B is on as read from L1A granule telemetry data)
Bit 16	Missing Previous Granule (Processing is occurring without the previous L1A granule. This is set from a granule level flag which is independent of scan).
Bit 17	Missing Subsequent Granule (Processing is occurring without the subsequent L1A granule. This is set from a granule level flag which is independent of scan).

<table>
<tr><th>Bit QA Flags: Bit #</th><th>Description (condition that causes bit to be set to 1)</th></tr>
<tr><td>Bits 18-19</td><td>SRCA calibration mode, determined from telemetry SS_CP_MACRO_ID. When a specific mode is identified, the corresponding value (0, 1 or 2) is set. Otherwise, the value 3 is set. (NOTE: bit 18 is the most significant bit of the pair, which is opposite of their order in the 32-bit word.)
<table>
<tr><td>Bit 18</td><td>Bit 19</td><td>Meaning</td></tr>
<tr><td>0</td><td>0</td><td>Radiometric (0)</td></tr>
<tr><td>0</td><td>1</td><td>Spatial (1)</td></tr>
<tr><td>1</td><td>0</td><td>Spectral (2)</td></tr>
<tr><td>1</td><td>1</td><td>Undetermined (3)</td></tr>
</table></td></tr>
<tr><td>Bit 20</td><td>Moon within the SV keep-out box for Reflective Solar bands (the moon was found to be in the space-view keep-out box for at least one detector of at least one reflective Solar band on this scan)</td></tr>
<tr><td>Bit 21</td><td>Moon within the SV keep-out box for Emissive bands (the moon was found to be in the space-view keep-out box for at least one detector of at least one thermal emissive band on this scan)</td></tr>
<tr><td>Bit 22</td><td>All space-view data bad for any Reflective Solar band (the algorithm could not compute a valid electronic background level from SV data for at least one detector of at least one reflective Solar band for this scan).</td></tr>
<tr><td>Bit 23</td><td>All blackbody data bad for any Reflective Solar band (the algorithm could not compute a valid electronic background level from BB data for at least one detector of at least reflective Solar band for this scan).</td></tr>
<tr><td>Bit 24</td><td>More than 5 scans were dropped between the previous granule and the granule being calibrated. As a result, the previous granule will not be used for emissive calibration.</td></tr>
</table>

Bit QA Flags: Bit #	**Description (condition that causes bit to be set to 1)**
Bit 25	More than 5 scans were dropped between the granule being calibrated and the subsequent granule. As a result, the subsequent granule will not be used for emissive calibration.
Bit 26	SCI_ABNORMAL flag (the L1A telemetry field SS_FR_SCIABNORM is equal to 0 for this scan). In versions of MOD_PR02 prior to V4.30/V4.3.1, Bit 1 was set in this manner.
27 … 31	Reserved for future use

HDF object:	Vdata field within the "Level 1B Swath Metadata" vdata.
Data type:	uint32
Order:	1
Origin:	See comments above for each bit.

Name:	Sector Rotation Angle
Description:	Angle from which the viewing sector is offset from its default value in normal operations.
HDF object:	Vdata field within the "Level 1B Swath Metadata" vdata.
Data type:	float32
Order:	1
Example:	0.0 to 360.0 degrees
Origin:	The L1A telemetry field CS_FR_ENC_DELTA gives a value in the range of [0 to 16383] roughly spanning 0 to 360 degrees.

Section 2.2 Instrument and Uncertainty SDSs

This section describes the instrument and uncertainty scientific data sets (SDSs) stored in the L1B Earth view (EV) granule output files. There are three categories:

- Scaled Integer SDS (Section 2.2.1)
- Uncertainty Index SDS (Section 2.2.2)
- Samples Used SDS (Section 2.2.3)

Table 2.2.1 summarizes the names of instrument and uncertainty SDSs by product location, type, and band grouping.

Table 2.2.1: Instrument and Uncertainty SDS summary

SDS Name	Product	Type	Bands
EV_250_RefSB	250m	Scaled Integer	250m Reflective
EV_250_RefSB_Uncert_Indexes	250m	Uncertainty Index	250m Reflective
EV_250_Aggr500_RefSB	500m	Scaled Integer	250m Reflective
EV_250_Aggr500_RefSB_Uncert_Indexes	500m	Uncertainty Index	250m Reflective
EV_250_Aggr500_RefSB_Samples_Used	500m	Samples Used	250m Reflective
EV_500_RefSB	500m	Scaled Integer	500m Reflective
EV_500_RefSB_Uncert_Indexes	500m	Uncertainty Index	500m Reflective
EV_250_Aggr1km_RefSB	1km	Scaled Integer	250m Reflective
EV_250_Aggr1km_RefSB_Uncert_Indexes	1km	Uncertainty Index	250m Reflective
EV_250_Aggr1km_RefSB_Samples_Used	1km	Samples Used	250m Reflective
EV_500_Aggr1km_RefSB	1km	Scaled Integer	500m Reflective
EV_500_Aggr1km_RefSB_Uncert_Indexes	1km	Uncertainty Index	500m Reflective
EV_500_Aggr1km_RefSB_Samples_Used	1km	Samples Used	500m Reflective
EV_1KM_RefSB	1km	Scaled Integer	1km Reflective
EV_1KM_RefSB_Uncert_Indexes	1km	Uncertainty Index	1km Reflective
EV_1KM_Emissive	1km	Scaled Integer	1km Emissive
EV_1KM_Emissive_Uncert_Indexes	1km	Uncertainty Index	1km Emissive

In Table 2.2.1, "Aggr500" in the name means that the data are aggregated to appear as if they were measured at 500m resolution. Similarly, "Aggr1km" means that the data are aggregated to appear as if they were measured at 1km resolution.

The band groupings for L1B EV products are given in Table 2.2.2.

Table 2.2.2: MODIS Band Groupings

MODIS Band Group	MODIS Band Numbers
250m-resolution Reflective Solar Bands	Bands 1,2
500m-resolution Reflective Solar Bands	Bands 3-7
1km-resolution Reflective Solar Bands	Bands 8-12, 13lo, 13hi, 14lo, 14hi, 15-19, 26
1km-resolution Thermal Emissive Bands	Bands 20-25, 27-36

Each type of SDS has associated metadata written as SDS attributes. These attributes provide the information needed to transform scaled integers to radiance values, reflectance values and counts, as appropriate, as well as information on units, valid ranges of data, and so forth.

Section 2.2.1 Scaled Integer Instrument SDSs and Attributes

Scaled Integer SDSs hold 16-bit unsigned integers which may be converted into useful scientific quantities such as radiance or reflectance. Each SDS contains attributes which are used to make these conversions. For the reflective Solar bands, the scaled integers represent scaled effective digital numbers generated using the following sequence (starting with the Level 1A digital number, DN):

1. Check DN for unusable data values (see the discussion below under the "valid_range" attribute description),
2. Form dn by subtracting the average electronic background DN level
3. Check for dn being saturated (see the discussion below under the "valid_range" attribute description),
4. Apply SWIR out-of-spectral-band correction to dn (if band 5, 6, 7, or 26).
5. Form dn* by applying temperature and RVS corrections.
6. Compute reflectance ($\rho \cos \theta$).
7. Convert reflectance to dn** by dividing by a band-dependent factor and detector normalization.
8. Convert dn** to the scaled integer.

For the thermal bands, the scaled integers represent scaled radiance values:

1. Check DN for unusable data values (see the discussion under the "valid_range" attribute description)
2. Form dn by subtracting the average electronic background DN level
3. Apply PC bands cross-talk correction to dn (if switch ON, apply to bands 32-36)
4. Compute radiance.

5. Convert radiance to the scaled integer.

For reflective solar bands, the following attributes are written for each scaled integer SDS:

- "units"
- "valid_range"
- "_FillValue"
- "long_name
- "band_names”
- "radiance_scales"
- "radiance_offsets"
- "radiance_units"
- "reflectance_scales"
- "reflectance_offsets"
- "reflectance_units"
- "corrected_counts_scales"
- "corrected_counts_offsets"
- "corrected_counts_units"

For thermal emissive bands, the following attributes are written for each scaled-integer SDS:

- "units"
- "valid_range"
- "_FillValue"
- "long_name”
- "band_names"
- "radiance_scales"
- "radiance_offsets"
- "radiance_units"

The following descriptions apply to both Reflective Solar bands and thermal emissive bands except where noted.

Name: units

Description: Description of the units of the data written into the SDS. Since the scaled integer value itself has no units, the value of this is "none".

HDF object: SDS attribute.

Data type: STRING

Count: 1

Value: “none”

Origin: The above value is set as a constant within the L1B code.

Name: valid_range

Description: This attribute defines the range of valid values of the scaled integer (SI) data (meaning that the pixel could be calibrated normally). See note below.

HDF object: SDS attribute.

Data type: UINT16

Count: 2

Values: 0, 32767

Origin: The above values are set as constants within the L1B code.

Note: The valid range is [0-32767], inclusive. Any value above 32767 represents unusable data. Table 2.2.3 shows the meaning of data values over 32767.

Table 2.2.3: Meaning of Data Values Outside of Valid Range

Data Value	Meaning
65535	Fill Value (includes reflective band data at night mode and completely missing L1A scans)
65534	L1A DN is missing within a scan
65533	Detector is saturated
65532	Cannot compute zero point DN, e.g., SV is saturated
65531	Detector is dead (see comments below)
65530	RSB dn** below the minimum of the scaling range
65529	TEB radiance or RSB dn** exceeds the maximum of the scaling range
65528	Aggregation algorithm failure
65527	Rotation of Earth view Sector from nominal science collection position
65526	Calibration coefficient b1 could not be computed
65525	Subframe is dead
65524	Both sides of the PCLW electronics on simultaneously
65501 - 65523	(reserved for future use)
65500	NAD closed upper limit

For native resolution data, the situations above are checked in the following order in the code. If more than one condition applies to a datum, the data value reflects only the condition which was encountered first, in this order:

1. Entire scans of L1A data are missing (same as Fill Value).
2. Reflective band data at night (same as Fill Value)
3. L1A DN is missing within a scan
4. Detector is dead
5. Rotation of Earth view Sector from nominal science collection position
6. Detector is saturated (DN)
7. Cannot compute zero point DN
8. Calibration coefficient b1 could not be computed (Emissive bands only)
9. Detector is saturated (dn for RSB only)
10. RSB dn** below bottom end of range for writing to scaled integer
11. TEB radiance or RSB dn** exceeds the maximum of the scaling range
12. Non-functional detectors (called "dead" detectors in the code) or subframes (called "dead" subframes in the code) are identified in the "Dead Detector List" or Dead

Subframe List. The value will be set at 65531 for dead detector or 65525 for dead subframe.

13. For the case of aggregation algorithm failure, the value 65528 is set if none of the native-resolution pixels which would be used for aggregation have a valid value.
14. For the case of nadir-aperture door (NAD) closed, the SI value will be set to a value greater than 32767 (denoting unusable data). First, if appropriate, a specific unusable data value above will be assigned. If one of the specific reasons does not apply, then the SI value will be calculated normally and then the most significant bit will be flipped, resulting in a value greater than 32767. If the resulting scaled integer value exceeds the value of NAD closed upper limit, the scaled integer value will be set to that limiting value.

Name: _FillValue

Description: The value used to fill any non-initialized values of the SDS. The following situations will cause this to occur:

- the entire scan is missing (number of data packets is zero),
- the scan type is not "Day",
- the scan is part of a "split scan" as determined by the code,
- an invalid value of "Scan quality array" was found on a scan.
- If a scan is not "Day", then the reflective solar bands, except for band 26, are not processed.

The scaled integers for those bands will then assume the value of this attribute.

HDF object: SDS attribute.

Data type: UINT16

Count: 1

Value: 65535

Origin: The above value is set as a constant within the L1B code.

Name:	long_name
Description:	The long or descriptive name of the SDS.
HDF object:	SDS attribute.
Data type:	STRING
Count:	1
Value:	(see file specifications for each SDS)
Origin:	The long name values are defined constants in the L1B code.

Name:	band_names
Description:	A description of the MODIS band numbers represented in the SDS.
HDF object:	SDS attribute.
Data type:	STRING
Count:	1
Value:	(see file specifications for each SDS)
Origin:	The band name values are defined constants in the L1B code.

Name: radiance_scales

Description: Scale factors to be used with the "radiance_offsets" attribute to scale the SDS integers to radiance values in the units identified in the radiance_units attribute. The formula to compute radiance is:

$$radiance = radiance\_scales_B\ (SI - radiance\_offsets_B)$$

where SI is the scaled integer and B is the band index.

Note: For reflective solar bands, radiance may also be computed directly from reflectance by using the global attributes “Earth-Sun Distance” and “Solar Irradiance on RSB Detectors over pi” (see above). To do so, compute reflectance using the reflectance scale and offset terms (see below):

$$reflectance = reflectance\_scale_B\ (SI - reflectance\_offset_B)$$

where SI = scaled integer and B is the band index. The derivation of radiance is then

$$radiance = [\ (E^{sun}_{B,D}/\pi)\ /\ d_{ES}^2\ ]\ *\ reflectance$$

where $(E^{sun}_{B,D}/\pi)$ is the detector-specific weighted Solar irradiance and d_{ES}^2 is the square of the Earth-Sun distance. This will result in the most accurate determination of radiance.

HDF object: SDS attribute.

Data type: float32

Count: # bands in the SDS

Origin: For reflective solar bands, the values of this attribute are determined by:

$$radiance\_scales_B = [\ (E^{sun}_B/\pi)\ /\ d_{ES}^2\ ]\ *\ reflectance\_scales_B$$

where (E^{sun}_B/π) is the average over all detectors of band B of the Solar irradiance at 1 AU weighted by the RSR of the detector divided by pi (see global attribute "Solar Irradiance on RSB Detectors over pi"), d_{ES} is the Earth-Sun distance in AU (see global attribute "Earth-Sun Distance") and the $reflectance\_scales_B$ is the scale factor to convert SI to reflectance for band B (see below in this section for how this is computed).

For thermal emissive bands, the values of this attribute are determined by:

$$radiance\_scales_B = (L_{max,B} - L_{min,B})\ /\ 32767$$

where the values of L_{min} and L_{max} come from emissive lookup tables.

Name:	radiance_offsets
Description:	Offsets to be used with the radiance_scales attribute when scaling the SDS scaled integers to radiance values. See other comments in the description for radiance_scales, above.
HDF object:	SDS attribute.
Data type:	float32
Count:	# bands in the SDS
Origin:	For a reflective solar band, the values are determined by:

$$\boldsymbol{radiance\_offsets_B = -\ 32767\ dn^{**}_{min,B}\ /\ (dn^{**}_{max,B} - dn^{**}_{min,B})}$$

where the values of $\boldsymbol{dn^{**}_{min}}$ and $\boldsymbol{dn^{**}_{max}}$ come from the reflective lookup tables.

For a thermal emissive band, the values are determined by:

$$\boldsymbol{radiance\_offsets_B = -\ 32767\ L_{min,B}\ /\ (L_{max,B} - L_{min,B})}$$

where the values of $\boldsymbol{L_{min}}$ and $\boldsymbol{L_{max}}$ come from emissive lookup tables.

Name:	radiance_units
Description:	The radiance units after scaling a scaled integer into radiance.
HDF object:	SDS attribute.
Data type:	STRING
Count:	1
Value:	“Watts/m^2/micrometer/steradian”
Origin:	The value is a constant within the L1B code.

Name: reflectance_scales

Description: Scale factors to be used with the "reflectance_offsets" attribute to scale the SDS scaled integers to reflectance values. The formula to compute reflectance is:

$$reflectance = reflectance\_scale_B \; (SI - reflectance\_offset_B),$$

where SI = scaled integer and B is the band index. This attribute does not exist for the emissive bands.

HDF object: SDS attribute.

Data type: float32

Count: # bands in the SDS

Origin: The values come from the formula:

$$reflectance\_scale_B = m1_{max,B} \; d_{ES}^2 (dn^{**}_{max,B} - dn^{**}_{min,B}) \,/\, 32767$$

where d_{ES}^2 is the Earth-Sun distance squared and $m1_{max,B}$ is the maximum value of $m1$ over band B. d_{ES} is computed within the L1B code. The values of $m1$, dn^{**}_{min} and dn^{**}_{max} come from reflective lookup tables.

Name: reflectance_offsets

Description: Offset values to be used with the reflectance_scale attribute when scaling the SDS integers to reflectance. This attribute does not exist for the emissive band SDSs.

HDF object: SDS attribute.

Data type: float32

Count: # bands in the SDS

Origin: The value comes from the formula:

$$reflectance\_offset_B = -\,32767 \; dn^{**}_{min,B} \,/\, (dn^{**}_{max,B} - dn^{**}_{min,B})$$

where the values of dn^{**}_{min} and dn^{**}_{max} come from reflective lookup tables.

Name: reflectance_units

Description: The reflectance units after scaling the SDS scaled integers into reflectance. This attribute does not exist for the emissive band SDSs.

HDF object: SDS attribute.

Data type: STRING

Count: 1

Value: “none”

Origin: The value is a constant within the L1B code.

Name: corrected_counts_scales

Description: Scaling factor used with the corrected_counts_offset attribute to scale the SDS integers to scaled, effective digital numbers (dn**). This attribute only applies to reflective solar bands.

HDF object: SDS attribute.

Data type: float32

Count: # bands inherent in the SDS

Origin: The value comes from the formula:

$$\mathit{corrected\_counts\_scale}_B = (dn^{**}_{max,B} - dn^{**}_{min,B}) / 32767$$

where the values of dn^{**}_{min} and dn^{**}_{max} come from reflective lookup tables.

Name:	corrected_counts_offsets
Description:	Offsets to be used with the corrected_counts_scale attribute to rescale the SDS integers to scaled, effective digital numbers (dn**). This attribute only applies to reflective solar bands.
HDF object:	SDS attribute.
Data type:	float32
Count:	# bands inherent in the SDS
Origin:	The value comes from the formula:

$$\boldsymbol{corrected\_counts\_offset_B = -\ 32767\ dn^{**}_{min,B} / (dn^{**}_{max,B} - dn^{**}_{min,B})}$$

where the values of $\boldsymbol{dn^{**}_{min}}$ and $\boldsymbol{dn^{**}_{max}}$ come from reflective lookup tables.

Name:	corrected_counts_units
Description:	The digital number units after rescaling the SDS scaled integers. This attribute only applies to reflective solar bands.
HDF object:	SDS attribute.
Data type:	STRING
Count:	1
Value:	“counts”
Origin:	The value is a constant within the L1B code.

Section 2.2.2 Uncertainty Index SDSs and Attributes

Uncertainty Index SDSs hold 8-bit unsigned integers. These contain scaled values of the percent uncertainties in the Earth view reflectance product of the Reflective Solar bands and for the Earth view radiance values of the thermal emissive bands. The uncertainty index is written into the first four (least significant) bits of the 8-bit unsigned integer (except for fill value, described below). This yields a range of [0 - 15]. Although the value 15 is described in the "valid_range" attribute to be in the valid range, it is technically not valid. If the computed index exceeds 15 or if the scaled integer is unusable, the L1B code sets the uncertainty index to 15. The four most significant bits of the SDS values have been reserved for the scene contrast scatter index (not implemented).

In the L1B code, the uncertainty index (UI) is computed from the percent uncertainty using the following formula:

$$UI = scaling\_factor_B * \ln (uncertainty\_in\_percent / specified\_uncertainty_B)$$

where "***ln***" is the natural logarithm. To recover the percent uncertainty from the uncertainty index, use:

$$uncertainty\_in\_percent = specified\_uncertainty_B * \exp (UI / scaling\_factor_B)$$

The scaling_factor and specified_uncertainty values come from band-dependent lookup tables ([6]). These values are also attached as attributes to each uncertainty index SDS (described later in this section). The attributes are provided for convenience to those downstream users who convert the uncertainty index to percent uncertainty, given that the values of scaling_factor and specified_uncertainty are subject to change.

Table 2.2.4 and Table 2.2.5 summarize the *current* values (as of 10/14/2002 through the date of this document) of specified_uncertainty and scaling_factor for the various MODIS bands and map uncertainty index (UI) to percent uncertainty.

Table 2.2.4: Current values of specified_uncertainty and scale_factor for MODIS/Terra (PFM) and MODIS/Aqua (FM1)

Bands	Specified_uncertainty	scale_factor
1-4, 8-19	1.5	7.0
5, 6, 7, 26	1.5	5.0
20	0.5625	5.0
21	2.5	4.0
22-25, 27-30, 33-36	0.5	4.0
31, 32	0.375	4.0

Table 2.2.5: Uncertainty Index (UI) mapped to uncertainty in percent

UI	Bands 1-4, 8-19	Bands 5, 6, 7, 26	Band 20	Band 21	Bands 22-25, 27-30, 33-36	Bands 31, 32
0	1.50	1.50	0.56	2.50	0.50	0.38
1	1.73	1.83	0.69	3.21	0.64	0.48
2	2.00	2.24	0.84	4.12	0.82	0.62
3	2.30	2.73	1.02	5.29	1.06	0.79
4	2.66	3.34	1.25	6.80	1.36	1.02
5	3.06	4.08	1.53	8.73	1.75	1.31
6	3.53	4.98	1.87	11.20	2.24	1.68
7	4.08	6.08	2.28	14.39	2.88	2.16
8	4.70	7.43	2.79	18.47	3.69	2.77
9	5.43	9.07	3.40	23.72	4.74	3.56
10	6.26	11.08	4.16	30.46	6.09	4.57
11	7.22	13.54	5.08	39.11	7.82	5.87
12	8.33	16.53	6.20	50.21	10.04	7.53
13	9.61	20.20	7.57	64.48	12.90	9.67
14	11.08	24.67	9.25	82.79	16.56	12.42
15	≥ 12.79	≥ 30.13	≥ 11.30	≥ 106.30	≥ 21.26	≥ 15.95

Associated with each uncertainty index SDS is the following set of attributes:

Name: long_name

Description: The long or descriptive name of the SDS.

HDF object: SDS attribute.

Data type: STRING

Count: 1

Value: (see appropriate value in the file specification)

Origin: The values are defined constants in the L1B code.

Name: units

Description: Description of the units of the SDS. Note that the uncertainty index itself does not have units.

HDF object: SDS attribute.

Data type: STRING

Count: 1

Value: “none”

Origin: The value is set from a defined constant in the L1B code.

Name: valid_range

Description: Range of normal values that the data in the SDS may assume (see comments at the top of this section). The reason that the range is [0-15] is that the uncertainty index is assumed to occupy only the 4 least significant bits of the unsigned 8-bit word. See other notes regarding "_FillValue", below.

HDF object: SDS attribute.

Data type: uint8

Count: 2

Value: 0, 15

Origin: These values are set from defined constants in the L1B code.

Name: _FillValue

Description: The value for all elements of the SDS that are not explicitly defined (written). The only time that this will happen in normal processing is for reflective band SDSs when the scan type is not "Day".

HDF object: SDS attribute.

Data type: uint8

Count: 1

Value: 255

Origin: This value is set from a defined constant within the L1B code.

Name: specified_uncertainty

Description: Values to use in converting uncertainty index to percent uncertainty (see formulae at the top of this section).

HDF object: SDS attribute.

Data type: float32

Count: (number of bands in the SDS)

Example: 1.5, ...

Origin: For reflective bands, they come from the LUT "RSB_specified_uncertainty" in the Reflective LUT HDF file. For emissive bands, they come from the LUT "TEB_specified_uncertainty" in the Emissive LUT HDF file.

Name: scaling_factor

Description: Values to use in converting uncertainty index to percent uncertainty (see formulae at the top of this section).

HDF object: SDS attribute.

Data type: float32

Count: (number of bands in the SDS)

Example: 7.0, ...

Origin: For reflective bands, they come from the LUT "RSB_UI_scaling_factor " in the Reflective LUT HDF file. For emissive bands, they come from the LUT "TEB_UI_scaling_factor " in the Emissive LUT HDF file.

Name: uncertainty_units

Description: Units of uncertainty after applying the specified uncertainty and scaling factor in the formulae described at the top of this section.

HDF object: SDS attribute.

Data type: STRING

Count: 1

Value: "percent"

Origin: A defined constant in the L1B code.

Section 2.2.3 “Samples Used” SDSs and Attributes

The "Samples Used" SDSs contain 8-bit signed integers which represent the number of samples used in aggregating a 250m or 500m band to a lower resolution. If a native-resolution pixel has been flagged as invalid (a value > 32767), then that pixel is not included in the aggregated value.

Associated with each Samples Used SDS is the following set of attributes:

Name: long_name
Description: The long or descriptive name of the SDS.
HDF object: SDS attribute.
Data type: STRING
Count: 1
Value: (see appropriate value in the file specification)
Origin: The values are set from defined constants within the L1B code.

Name: units
Description: Description of the units of the SDS. Since there are no units associated with "number of samples used", the value of this attribute is "none".
HDF object: SDS attribute.
Data type: STRING
Count: 1
Value: “none”
Origin: The value is set from a defined constant in the L1B code.

Name:	valid_range
Description:	Range of valid values that the data in the SDS may assume. The number of samples actually used in aggregation is usually the upper limit of the range indicated in this attribute. However, bad or missing data may result in fewer samples used.
HDF object:	SDS attribute.
Data type:	int8
Count:	2
Value:	0, 6 (when aggregating 250m bands to 500m data product) 0, 28 (when aggregating 250m bands to 1km data product) 0, 6 (when aggregating 500m bands to 1km data product)
Origin:	The values are set from defined constants in the L1B code.

Name:	_FillValue
Description:	The value for all elements of the SDS that are not explicitly defined (written). The only time that this will happen in normal processing is when the scan type is not "Day".
HDF object:	SDS attribute.
Data type:	int8
Count:	1
Value:	-1
Origin:	The value is set from a defined constant in the L1B code.

Section 2.3 Band-Subsetting SDSs

Table 2.3.1 summarizes the band-subsetting SDSs. The 250m product contains only the “Band_250M” SDS, the 500m product contains the “Band_250M” and “Band_500M” SDSs, and the 1KM product contains all four SDSs. There is a separate SDS for each of the entries in Table 2.3.1.

Name:	See Table 2.3.1 below.
Description:	Floating-point equivalents for the MODIS bands. For example, in the "Band_1KM_RefSB" SDS, band 13lo is represented as “13.0”, band 13hi is represented as “13.5”.
HDF class:	Scientific Data Set (SDS)
Data type:	float32
Count:	# of bands (see Table 2.3.1)
Value:	See Table 2.3.1.
Origin:	The values are set from defined constants in the L1B code.

Table 2.3.1: Band subsetting SDS summary (data type = float32)

SDS Name	# bands	Values
"Band_250M"	2	1, 2
"Band_500M"	5	3, 4, 5, 6, 7
"Band_1KM_RefSB"	15	8, 9, 10, 11, 12, 13, 13.5, 14, 14.5, 15, 16, 17, 18, 19, 26
"Band_1KM_Emissive"	16	20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36

Table 2.3.2 summarizes the long_name attribute for the band subsetting SDSs. The data type for this attribute is “STRING”.

Table 2.3.2: “long_name” attribute for Band subsetting SDS

SDS Name	Value
"Band_250M"	“250M Band Numbers for Subsetting”
"Band_500M"	“500M Band Numbers for Subsetting”
"Band_1KM_RefSB"	“1KM Reflective Solar Band Numbers for Subsetting”
"Band_1KM_Emissive"	“1KM Emissive Band Numbers for Subsetting”

Section 2.4 Geolocation SDSs

This section describes the Geolocation SDSs in the L1B granule products. The 1km granule contains information about the geodetic position (latitude, longitude, and height) and the Sun and satellite (“sensor”) bearings. The 250m and 500m data products contain only latitude and longitude information.

Section 2.4.1 Descriptions of Geolocation SDSs

Table 2.4.1 describes the Geolocation SDSs written to the 1KM granule product. Table 2.4.2 describes the SDSs written to the 250m and 500m products. The origin of all values is the geolocation file used as input to the L1B code. See the geolocation file specifications for the full details of these SDSs and their attributes.

Table 2.4.1: Summary of 1KM Geolocation SDSs

SDS name	Data Type	Dimensions
Latitude	float32	(2*nscans, Max_EV_frames/5+1)
Longitude	float32	(2*nscans, Max_EV_frames/5+1)
Height	int16	(2*nscans, Max_EV_frames/5+1)
SensorZenith	int16	(2*nscans, Max_EV_frames/5+1)
SensorAzimuth	int16	(2*nscans, Max_EV_frames/5+1)
Range	uint16	(2*nscans, Max_EV_frames/5+1)
SolarZenith	int16	(2*nscans, Max_EV_frames/5+1)
SolarAzimuth	int16	(2*nscans, Max_EV_frames/5+1)
gflags	uint8	(2*nscans, Max_EV_frames/5+1)

Table 2.4.2: Summary of 250m and 500m Geolocation SDSs

SDS name	Data Type	Dimensions
Latitude	float32	(10*nscans, Max_EV_frames)
Longitude	float32	(10*nscans, Max_EV_frames)

Descriptions of Geolocation SDSs:

Latitude: 32 bit signed floating point array containing the geodetic latitudes for the center of the corresponding 1km Earth View frames.

Longitude: 32 bit signed floating point array containing the geodetic longitudes for the center of the corresponding 1km Earth View frames.

Height: 16 bit signed integer array containing the geodetic heights above geoid for the center of the corresponding 1km Earth View frames.

SensorZenith: 16 bit signed integer array containing the sensor (spacecraft) zenith angles for the corresponding 1km Earth View frames.

SensorAzimuth: 16 bit signed integer array containing the sensor (spacecraft) azimuth angles for the corresponding 1km Earth View frames.

Range: 16 bit unsigned integer array containing the slant ranges (to spacecraft) for the corresponding 1km Earth View frames.

SolarZenith: 16 bit signed integer array containing the solar zenith angles for the corresponding 1km Earth View frames.

SolarAzimuth: 16 bit signed integer array containing the solar azimuth angles for the corresponding 1km Earth View frames.

gflags: 8 bit unsigned integer array containing the geolocation flag values (bit-wise settings) for the corresponding 1km Earth View frames. The individual bits are described in Table 2.4.4.

Section 2.4.2 Attributes for Geolocation SDSs (except "gflags")

The attributes for all of the geolocation SDSs are similar except for the gflags SDS (which will be described in the next subsection). Table 2.4.3 summarizes the values for the attributes of units, valid_range, _FillValue and scale_factor. The origin of the values of these attributes is the geolocation file data.

Table 2.4.3: Attribute Values for Geolocation SDSs (except gflags)

SDS name	**Units (STRING) Count = 1**	**valid_range (*) count = 2**	**_FillValue (*) count = 1**	**scale_factor (float64) count = 1**
Latitude	"degrees"	-90.0, 90.0	-999.9	**
Longitude	"degrees"	-180.0, 180.0	-999.9	**
Height	"meters"	-400, 10000	-32767	**
SensorZenith	"degrees"	0, 18000	-32767	0.01
SensorAzimuth	"degrees"	-18000, 18000	-32767	0.01
Range	"meters"	27000, 65535	0	25.0
SolarZenith	"degrees"	0, 18000	-32767	0.01
SolarAzimuth	"degrees"	-18000, 18000	-32767	0.01

* The data type for the corresponding SDS applies to the value.

** There is no scale factor attribute for this SDS.

Descriptions of Geolocation SDS attributes::

units: This specifies the units of the data, after data have been multiplied by the scale_factor.

valid_range: This specifies the range of valid numbers in the SDS, prior to multiplying by the scale_factor.

_FillValue: This specifies the value for missing or erroneous data.

scale_factor: All numbers in the SDS are multiplied by this value to obtain the units specified in the units attribute (latitude and longitude scale factors are 1.0 and do not have this attribute).

For each of the 1km product geolocation SDSs listed in Table 2.4.1, there are also line_number and frame_number attributes, summarized below.

Name:	line_numbers
Description:	This string is a description of which of the 10 detectors in a scan are mapped to the geolocation points stored in the geolocation SDSs. It is meant as an informative description only.
Data type:	STRING
Count:	1
Value:	“3, 8”
Origin:	The value is set from a defined constant in the L1B code.

Name:	frame_numbers
Description:	This string indicates which frame numbers in a scan are mapped to the geolocation points stored in the geolocation SDSs. It is meant as an informative description only.
Data type:	STRING
Count:	1
Value:	“3, 8, 13, ...”
Origin:	The value is set from a defined constant in the L1B code.

Section 2.4.3 Attributes for 1KM Geolocation "gflags" SDS

The "gflags" SDS is an 8-bit unsigned integer array containing the geolocation flag values (bit-wise settings) for the corresponding 1km Earth View frames. Table 2.4.4 summarizes the attributes of this SDS. The attributes which begin with “Bit” essentially summarize the meaning of the gflags bits (MSB = most significant bit).

Table 2.4.4: 1KM Geolocation SDS "gflags" bits

Name	**Type**	**Count**	**Value**
_FillValue	uint8	1	255
Bit 7 (MSB)	String	1	"1 = invalid input data"
Bit 6	String	1	"1 = no ellipsoidal intersection"
Bit 5	String	1	"1 = no valid terrain data"
Bit 4	String	1	"1 = DEM missing or of inferior quality"
Bit 3	String	1	"1 = invalid sensor range"

SECTION 3 ABBREVIATIONS AND ACRONYMS

(See also the Abbreviations and Acronyms in the Product User's Guide, reference [8])

DAAC	Distributed Data Active Archive Center
DN	Digital number -- upper case generally refers to uncorrected (raw) value as recorded by the MODIS instrument
dn	Digital Number -- lower case generally refers to DN corrected for the electronic background (zero point) DN value.
dn*	For reflective Solar bands, this is dn corrected for known instrument effects such as temperature effects and mirror side response *vs.* scan angle (RVS).
dn**	For reflective Solar bands, these are dn* values for a band placed on a common scale by accounting for detector variations of the calibration coefficients.
ECS	EOS Core System
EOS	Earth Observing System.
FPA	focal plane assembly
geolocation	The geolocation code (same as MOD_PR03) ingests a L1A granule and generates geolocation quantities (latitude, longitude, etc.) for the 5-minute granule.
GSFC	Goddard Space Flight Center
HDF	Hierarchical Data Format. The format was developed and is maintained by the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign
HDF-EOS	Hierarchical Data Format-Earth Observing System and the software library that will implement
L1A	Level 1A – the L1A code (same as MOD_PR01) unpacks the binary Level 0 data file, re-formats it into an HDF file, and generates a granule (file) size of approximately 5 minutes.
L1B	Level 1B – the L1B code (same as MOD_PR02) ingests the output of the L1A and geolocation codes to produce science data which can be scaled into useful scientific quantities (radiance, reflectance)
LUT	Look-Up Table. Generally an input value or array to the L1B code which resides in one of three files: (1) Emissive lookup tables file, Reflective lookup tables file, or QA lookup tables file.
LWIR	Long-Wave Infrared -- usually refers to MODIS bands 27-36.
MODAPS	MODIS Data Processing System
MODIS	Moderate Resolution Imaging Spectro-Radiometer
MOD_PR	MODIS Process -- leading part of the name of any major processing code in the MODIS data processing system (the L1A code is MOD_PR01, the L1B code is MOD_PR02, etc.)

MWIR	Medium-Wave infrared -- usually refers to MODIS bands 20, 21, 22, 23, 24, 25
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputing Applications
NEdL	Noise equivalent delta radiance
NIR	Near Infrared -- usually refers to the following MODIS bands: 1, 2, 13lo, 13hi, 14lo, 14hi, 15, 16, 17, 18, 19
OBC	On Board Calibrator -- usually one of the following: Solar diffuser (SD), spectro-radiometric calibration assembly (SRCA), blackbody (BB), space-view (SV).
PCF	Process Control File -- a necessary input for any process which utilizes the SDP toolkit. Contains the logical unit numbers (LUNs) and universal references (URs) for the input files, LUT files, and output files for the code being run as well as LUNs for other inputs and outputs.
PGE	Process Generation Executive -- Run by the MODIS Data Processing System (MODAPS) (formerly run by the DAAC), contains one or more processes generating the data products stored by MODAPS. PGE02 contains the L1B code.
QA	Quality Assurance
RSB	Reflective Solar Bands -- MODIS bands 1-12, 13lo, 13hi, 14lo, 14hi, 15-19, 26
SDP	Science Data Processing
SDS	Scientific Data Set. One of the basic HDF data types. Consists of a multi-dimensional array of numbers and various attributes associated with those numbers.
SMIR	Short and medium-wave infrared – generally refers to MODIS Bands 5,6, 7, 26 (SWIR bands) and Bands 20-25 (MWIR Bands).
SWIR	Short-wave infrared -- generally refers to MODIS bands 5,6,7 and 26
TBD	To Be Defined
TEB	Thermal Emissive Bands -- MODIS bands 20-25, 27-36
Vdata	One of the basic HDF data types. Equivalent to a data base having a set of records with each record having a common set of fields.
VIS	Visual – usually refers to the following MODIS bands: 3, 4, 8, 9, 10, 11, 12

SECTION 4 REFERENCES

(See also the references listed in the Product User's Guide, item [8] below.)

[1] Berriman, B., “Calculation of the Digital Signals Written to the Level 1B Data Products for the Reflective Solar Bands”, MCST Internal Memorandum # M0825, October 27, 1999.

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[3] “L1B 1km File Specification”, V5.0.4 (Terra) or V5.0.5 (Aqua), December 1, 2005. Latest releases are available on-line at http://mcst.gsfc.nasa.gov/l1b/documents.

[4] “L1B 250m File Specification”, V5.0.4 (Terra) or V5.0.5 (Aqua), December 1, 2005. Latest releases are available on-line at http://mcst.gsfc.nasa.gov/l1b/documents.

[5] “L1B 500m File Specification”, V5.0.4 (Terra) or V5.0.5 (Aqua), December 1, 2005. Latest releases are available on-line at http://mcst.gsfc.nasa.gov/l1b/documents.

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[7] MODIS Characterization Support Team, “MODIS LUT Information Guide For Level 1B”, REV B, MCST Internal Memorandum # M1056, June 22, 2012. Latest release is available on-line at http://mcst.gsfc.nasa.gov/l1b/documents.

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[11] “MODIS Level 1A Data Product Format”, Version 6.0.0, June 27, 2012 is available on-line at

https://modaps.nascom.nasa.gov:9500/software/ftp/filespec/collection6/Level1. You must first register at https://modaps.nascom.nasa.gov:9500/ to use that site.

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[15] Xiong, X., *et. al.*, "A Common Algorithm for Computing the Instrument Temperature in the L1B Code and New LUT Format", MCST Internal Memorandum # MO677, May 9, 1999.

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