JPL D-110697

Earth Observing System

Multi-angle
Imaging
Spectro-
Radiometer

Data Product Specification for MISR Level 1B2 Georectified Radiance Products

-Incorporating the Science Data Processing Interface Control Document

Veljko M. Jovanovic
Nick LaHaye
Sebastian Val
Kevin J. Mueller
Michael A. Bull
David J. Diner

Jet Propulsion Laboratory
California Institute of Technology

June 24, 2024

JPL D-110697

Multi-angle Imaging SpectroRadiometer (MISR)

Data Product Specification for MISR Level 1B2 Georectified Radiance Products

-Incorporating the Science Data Processing Interface Control Document

APPROVALS:

David J. Diner

MISR Principal Investigator

Earl Hansen

MISR Project Manager

Approval signatures are on file with the MISR Project.
To determine the latest released version of this document, consult the MISR web site (http://misr.jpl.nasa.gov).

Jet Propulsion Laboratory
California Institute of Technology

June 24, 2024

The research described in this publication was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Document Change Log

Revision	Date	Affected Portions and Description
	June 24, 2024	All, original release

Which Product Versions Does this Document Cover?

Product Filename Prefix	**Version Number in Filename**	**Brief Description**
MISR_AM1_GRP_ELLIPSOID_GM MISR_AM1_GRP_ELLIPSOID_LM MISR_AM1_GRP_TERRAIN_GM MISR_AM1_GRP_TERRAIN_LM MISR_AM1_GRP_ELLIPSOID_BR_GM	F04_0030	Level 1B2 Georectified Radiance

Table of Contents

1 INTRODUCTION

1.1 MISR LEVEL 1B2 GEORECTIFIED RADIANCE PRODUCTS

The Level 1B2 Georectified Radiance Product (GRP) consists of radiances observed by MISR from the National Aeronautics and Space Administration (NASA) Terra Earth Observing System (EOS) satellite, which has been operational since early 2000. These data are reported for each Terra orbit on a Space Oblique Mercator (SOM) reference grid, with a combination of 1.1 km × 1.1 km and 275 m x 275 m spatial sampling. Files are distributed in NetCDF-4 format, which is designed to be interoperable with HDF5

1.2 MISR DATA PRODUCTS

The MISR project is a component of the EOS Terra Mission and the EOS Data and Information System (EOSDIS), which are components of NASA's Earth Science Enterprise. An integral part of the MISR project is the Science Data Processing (SDP) of the observations coming from the MISR instrument on-board the EOS Terra satellite.

MISR SDP exists to produce science and supporting data products from MISR instrument data. All functions of the MISR SDP system are directed toward this goal. MISR SDP does not operate as an independent entity, but rather is linked to the functionality of the EOSDIS at the Langley Research Center (LaRC) Distributed Active Archive Center (DAAC). The EOSDIS Core System (ECS) ingest subsystem at the LaRC DAAC is the agent for receiving and organizing all of the input data needed by MISR SDP. These data are then made available to MISR SDP through the data server and staging facilities provided by ECS at the LaRC DAAC. After MISR standard data processing is complete, the standard output products are archived through the EOSDIS data server and made available to users through ECS client services.

The MISR Science Computing Facility (SCF) at the Jet Propulsion Laboratory (JPL) supports the development of MISR science algorithms and software, instrument calibration and performance assessment, as well as providing quality assessment and data validation services with respect to MISR SDP. The MISR SCF is used to produce software, supporting data, and coefficients that are required to operate MISR SDP software at the LaRC DAAC. Additional algorithm development, calibration, and validation support for the Aerosol product is provided by the Climate & Radiation Laboratory at the NASA Goddard Space Flight Center (GSFC).

MISR SDP depends upon the availability of MISR instrument data, internal data sets produced at the MISR SCF, and external data sets that are products of other EOS data processing systems.

1.3 CONTROLLING DOCUMENTS

1) MISR Data System Science Requirements, JPL D-11398, September 1996 (or latest version).
2) MISR Level 1 Radiance Scaling and Conditioning Algorithm Theoretical Basis, JPL D-11507,

Revision D, January 1999 (or latest version).

3) MISR Level 1 Georectification and Registration Algorithm Theoretical Basis, JPL D-11532, Revision D, November 1999 (or latest version).
4) MISR Level 1 Cloud Detection Algorithm Theoretical Basis, JPL D-13397, Revision A, November 1997 (or latest version).
5) MISR Level 1 In-flight Radiometric Calibration and Characterization Algorithm Theoretical Basis, JPL D-13398, June 1996 (or latest version).
6) MISR Level 1 Ancillary Geographic Product Algorithm Theoretical Basis, JPL D-13400, Revision B, March 1999 (or latest version).
7) MISR Level 2 Aerosol Retrieval Algorithm Theoretical Basis, JPL D-11400, Revision G, March 2008 (or latest version).
8) MISR Level 2 Ancillary Products and Datasets Algorithm Theoretical Basis, JPL D-13402, Revision A, December 1998 (or latest version).
9) MISR Science Data Product Guide, JPL D-73355, April 2012 (or latest version).
10) MISR Level 1 Georectification and Registration Algorithm Theoretical Basis – Modified Terra Orbit Addendum, JPL D-110698 Revision A, to be released 2024

1.4 APPLICABLE DOCUMENTS

11) SDP Toolkit Users Guide for the ECS Project, HAIS 194-809-SD4-001 (or latest version)

2 MISR LEVEL 1B2 GEORECTIFIED RADIANCE DATA PRODUCT SPECIFICATIONS

2.1 MISR LEVEL 1B2 GEORECTIFIED RADIANCE PRODUCT FILE NAMES

Four different MISR GRP L1B2 products are reported for science applications, each representing a distinct method of sampling and geometric corrections.

- Ellipsoid-projected top-of-atmosphere (TOA) radiance global mode (GM) parameters are resampled onto the reference ellipsoid without correction for topography using supplied spacecraft position and pointing. Prior to resampling, these global mode parameters are averaged onboard the spacecraft to 1.1 km x 1.1 km resolution for the off-nadir, non-red-band channels (i.e. the near-infrared, green, and blue bands).

- Ellipsoid-projected local mode (LM) TOA radiance is reported without averaging at 275 m x 275 m resolution in all channels over specific targets, called local mode sites.

- Terrain-projected TOA radiance global mode parameters have had a geometric correction applied that removes the errors of spacecraft position and pointing knowledge and errors due to topography. These parameters are then orthorectified on a reference ellipsoid at the surface. As with the ellipsoid-projected GM parameters, they are averaged to 1.1 km x 1.1 km resolution in the off-nadir, non-red-band channels.

- Terrain-projected local mode (LM) TOA radiance is reported at 275 m x 275 m resolution in all channels over local mode sites.

Additionally, browse images are provided for convenience

- Ellipsoid-projected GM red, green, and blue bands reported as a true-color image.

The above five products have respective file names summarized by Table 1. The global mode products are produced once per orbit for each of nine cameras. The resolution of band data reported as a function of camera is summarized by Table 2.

Table 1 – MISR Level 1B2 Georectified Radiance Product File Names

MISR Level 1B2 Georectified Radiance Product Granule Name[1]	ESDT Name
MISR_AM1_GRP_ELLIPSOID_GM_Pppp_Oooooo_cc_Fff_vvvv.nc	MI1B2E
MISR_AM1_GRP_ELLIPSOID_LM_Pppp_Oooooo_cc_Fff_vvvv.nc	MIB2LME
MISR_AM1_GRP_TERRAIN_GM_Pppp_Oooooo_cc_Fff_vvvv.nc	MI1B2T
MISR_AM1_GRP_TERRAIN_LM_Pppp_Oooooo_cc_Fff_vvvv.nc	MIB2LMT
MISR_AM1_GRP_ELLIPSOID_BR_GM_Pppp_Oooooo_cc_Fff_vvvv.jpg	MISBR

Table 2 – MISR Level 1B2 Global Mode Camera and Band Resolutions

Grid	DF	CF	BF	AF	AN	AA	BA	CA	DA
BlueBand	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km	275 m x 275 m	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km
GreenBand	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km	275 m x 275 m	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km
RedBand	275 m x 275 m	275 m x 275 m	275 m x 275 m	275 m x 275 m	275 m x 275 m	275 m x 275 m	275 m x 275 m	275 m x 275 m	275 m x 275 m
NIRBand	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km	275 m x 275 m	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km	1.1 km x 1.1 km

2.2 BRIEF SUMMARY OF GEORECTIFIED RADIANCE PRODUCT GENERATION

This section gives a brief summary of the approach used to generate MISR Level 1B2 Georectified Radiance products. Subsection 2.2.1 applies to the orbit parameters at launch that were maintained until September 2022, summarizing more detailed documentation found in the MISR Level 1 Georectification and Registration Algorithm Theoretical Basis [Controlling Document – 3]. Subsection 2.2.2 applies to orbits September of 2022 and later following the discontinuation of Terra maneuvers sustaining constant sun-synchronous equator-crossing time. Updates to processing supporting the new paradigm are detailed in the Modified Terra Orbit Addendum [Controlling Document – 10].

2.2.1 L1B2 processing for original Terra orbit (2000-2022)

MISR L1B2 processing is responsible for routinely georectifying and coregistering imagery in

[1] Where ppp is the three-digit path number (001 to 233), oooooo is the six-digit orbit number, cc is the two-letter camera designation, ff is the two-digit file format version (13 for this version), and vvvv is the four-digit version number (0023 for this version).

four bands from nine widely varying view angles. Processing prior to September 2022, comprised three components, (1) a pre-flight camera geometric model (CGM), (2) periodic generation of nominal projection parameters (PP) and reference orbit imagery (ROI) that facilitates per-orbit removal of navigation and attitude errors and handling of surface topography, and (3) production of L1B2 products that employ per-orbit navigation adjustments to meet georegistration and coregistration accuracy requirements. This methodology is detailed in the MISR Level 1 Georectification and Registration Algorithm Theoretical Basis [Controlling Document – 3]. Key components of this original methodology exploit the repeat cycle of the sun-synchronous EOS-AM platform maintained until late 2022. Specifically, the platform made a total of 233 revolutions, or orbits per one repeat cycle with each cycle lasting for 16 days. This repeat cycle enabled MISR observations and ancillary data to readily be projected onto a prescribed set of 233 Space-Oblique Mercator (SOM) map projection grids (i.e. paths). From September 2022 to end of project, MISR observations could no longer continue to be projected as before, requiring a new paradigm described below.

2.2.2 L1B2 processing for modified Terra orbit (2022-end)

Key L1B2 processing segments are presented in Figure 2-1 along with input data interfaces from four main sources.

Since the new processing paradigm continue to be orbit based one of the first steps is the determination of the SOM map projection grid that best fit dayside portion of the subsatellite track for newly incoming orbit data. Previously established 233 paths are not adequate for this purpose so a unique dynamic path is established based on as flown ephemeris data. This processing step also includes generation of as required SOM based surface related geographic parameters [Controlling Document -8] and results in Dynamic-path based Ancillary Geographic Product (DAGP) used as the input in subsequent processing steps.

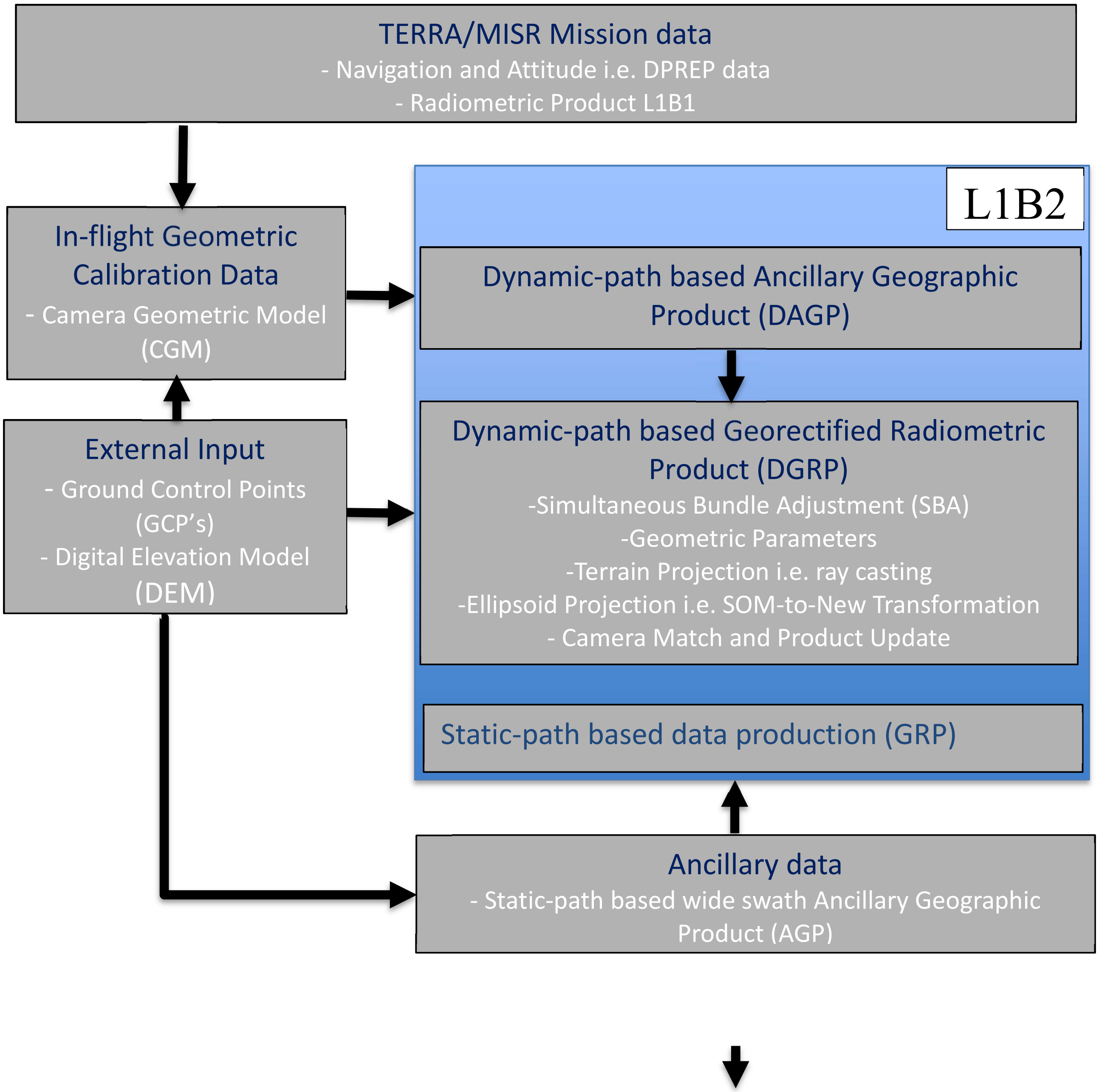

Figure 2-2: L1B2 Data Processing Segments and External Interfaces.

The objective of the next step is the improvement to the pointing accuracy by using Simultaneous Bundle Adjustment process. It is based on identification and matching of globally distributed Ground Control Points (GCPs) as well as tie points between nadir view camera and other cameras of interest. Such as measurements are used as input to optimization of the MISR pointing model where certain parameters are adjusted from its initial values.

At this point processing continues with three streams associated with three type of GRPs: 1) Geometric Parameters, 2) Terrain Projection, and 3) Ellipsoid Projection. While they share common inputs, these streams are independently executed on a camera by camera basis.

In the next step, intended to further improve co-registration accuracy, terrain projected image data from nadir camera is matched to other eight cameras. Matching results are statistically summarized into two dimensional offset corrections and applied to both terrain and ellipsoid projected radiance to produce final Dynamic-path based Georectified Radiance Product (DGRP).

The products generated up to this point i.e. DGRPs are not directly used as input to Level 2 processing or for public distribution. Instead, a transformation to align with the closest of 233 WRS-2 paths as well as translation into NetCDF4 format is done in Static-path based data production as the last step of the L1B2 processing.

2.3 DIFFERENCES BETWEEN GLOBAL MODE AND LOCAL MODE PROCESSING

2.3.1 Observational modes

There are two observational modes of the MISR instrument relevant to Level 1B2 algorithms and products: 1) Global Mode, and 2) Local Mode.

Global Mode refers to continuous operation with no limitation on swath length. Global coverage in a particular spectral band of one camera is provided by operating the corresponding signal chain continuously in a selected resolution mode. As designated, red band (670 nm) is acquired in high resolution in all nine cameras. Other three bands blue, green, and near-infrared (443, 555, and 865 nm respectively) are operated in 4x4 averaging mode. Table 2 in section 2.1 explicitly lists the Global Mode resolution of every camera and channel combination. Geospatially Global Mode data granule capture entire dayside portion of an orbit.

Local Mode data products of high-resolution images in all 4 bands for all 9 cameras will be produced for selected Earth targets. This is accomplished by inhibiting pixel averaging in all bands of each of the cameras in sequence, one at a time, beginning with the first camera to acquire the target and ending with the last camera to view the target. The instrument geometry limits the along-track length of Local Mode targets to about 300 km.

2.4 BROWSE IMAGE FILE CONTENT DESCRIPTION

The browse image is a standard JPEG with image size 2608 pixels × 23040 pixels. The JPEG dimensions correspond to SOM coordinate space at 1.1 km resolution with MISR observed red, green, and blue radiance scaled to produce a true-color composite. Block outlines and latitude and longitude descriptors are overlaid.

2.5 NetCDF FILE CONTENT DESCRIPTION

Content within each product file is organized as a hierarchy of groups, beginning with a top-level group, designated by the slash symbol (/). Each group can contain attributes, dimensions, fields, or other groups. Table 3 gives an overview of all groups with cross-references to subsequent tables describing the content of each group. Individual dimensions and fields can also contain attributes where applicable. The set of possible attributes for individual fields and dimensions is summarized in Table 17.

The GRP science content consists of radiance data found in top level groups, *Radiance_275_m* and *Radiance_1100_m*, and supporting geometric data found in top level group *GeometricParameters*. These groups define data on a single SOM projected coordinate space, containing the full MISR swath of data. The MISR swath itself occupies only a small portion of the coordinate space, with the data values outside the swath consisting of fill.

Table 3 – Overview of File Content

Group Name (parent group)	**Description**	**Applicable Cross-reference**
/	Top-level group, containing file attributes. *Note that early revisions of L1B2 products did not include CF attributes.*	Table 15 (MISR attributes) Table 16 (CF attributes)
Radiance_275_m *and/or* **Radiance_1100_m**	Contains radiances, grouped by available resolution. Products generated for the AN camera will have only the **Radiance_275_m** group. Other cameras will additionally have the **Radiance_1100_m** group. This top-level group contains per-band subgroups containing radiance fields.	Table 4 (resolution-specific attributes) Table 5 (resolution-specific dimensions) Table 6 (per-band attributes) Table 7 (per-band fields)
GeometricParameters	Contains sun-satellite viewing geometry used for each retrieval. Note that MISR reports zenith and azimuth geometry following the direction of photon travel, which may lead to unexpected results if not properly taken into account. See Figure 36 of controlling document [3] (JPL D-11532) for MISR definitions of sun and view angles.	Table 4 (resolution-specific attributes) Table 5 (resolution-specific dimensions) (resolution-specific dimensions) Table 8 (fields)
File_Metadata	Contains additional file-level metadata.	Table 14 (attributes)
Block_Metadata	Contains metadata dimensioned relative to the blocks of SOM coordinate space that MISR PGEs process data with respect to. Each block has dimensions 140 km × 1120 km. Block_Metadata is subdivided into common, time, radiance, and som-to-new transform related subgroups.	Table 9 (dimensions) Table 10 (common) Table 11 (time) Table 12 (radiance) Table 13 (som-to-new)
HDFEOS INFORMATION (/)	Contains ECS Inventory Metadata, used by the DAAC, for ingesting, cataloging, and searching data products.	

Table 4 – Resolution Specific Group Attributes

Attribute Name	**Definition**	**Data Type**	**Units**	**Valid Range**
origin_code pixel_reg_code projcode zonecode spherecode	HDF-EOS parameters defining gridding and projection in conjunction with attribute *projparm* defined below.	32-bit integer	n/a	n/a
projparm	SOM projection parameters represented as a 15-parameter array, compatible with the General Cartographic Transformation Package (GCTP), SOM A (code 22) format, detailed in the HDF-EOS User's Guide. Relevant parameters are: (1) Semi-major axis of ellipsoid (WGS84) (2) Eccentricity of ellipsoid squared (expressed as a negative value) (4) Inclination of orbit at ascending node (packed degrees minutes seconds (DMS) format) (5) Longitude of ascending orbit at equator (packed DMS format). See Table 15, SOM_parameters, λ_0 (9) Orbit period in minutes Parameters 3, 6 through 8, and 10 through 15 are ignored.	64-bit float	meters, degrees, minutes	(1) 6378137.0 meters (2) -0.006694348 (3) 0 (4) 98018013.75 (5) 0 to 360 degrees (6) 0 (7) 0 (8) 0 (9) 98.88 minutes (10) 0 (11) 0 (12) 0 or 180 (13) 0 (14) 0
SOM_map_minimum_corner.x SOM_map_maximum_corner.x SOM_map_minimum_corner.y SOM_map_maximum_corner.y	Coordinates representing the top left (minimum) and bottom right (maximum) corners of the SOM coordinate space on which data is reported.	64-bit float	meters	7460750 32804750 -1426150 1442650
block_min block_max	Minimum and maximum MISR block of SOM projection coordinate space. These values are always 1 and 180.	32-bit integer	n/a	1 180
block_size_in_lines block_size_in_samples	Dimensions of a MISR block in x- and y-coordinate space.	32-bit integer	pixels	128
resolution_in_meters	Resolution of this grid	32-bit integer	meters	275

Table 5 – Resolution Specific Dimensions

Dimension Name *[CF standard_name]*	**Description**	**Data Type**	**Units**	**Valid Range**
SOM_X_275 *<or>* **SOM_X_1100** *<or>* **SOM_X_17600** *[projection_x_coordinate]*	SOM projection X axis (along-track). Size of SOM_X_275 is 92160. Size of SOM_X_1100 is 23040. Size of SOM_X_17600 is 1440.	64-bit float	meters	Range is given by *SOM_map_minimum_corner.x* and *SOM_map_maximum_corner.x* attributes.
SOM_Y_275 *<or>* **SOM_Y_1100** *<or>* **SOM_Y_17600** *[projection_y_coordinate]*	SOM projection Y axis (across-track) Size of SOM_Y_275 is 10432. Size of SOM_Y_1100 is 2608. Size of SOM_Y_17600 is 163.	64-bit float	meters	Range is given by *SOM_map_minimum_corner.y* and *SOM_map_maximum_corner.y* attributes.

Table 6 – Radiance Band Group Attributes

Field Name *[CF standard_name]* Parameter Description	**Definition**	**Data Type**	**Units**	**Valid Range**
std_solar_wgted_height	$E_0^{std}(b)$[W m-2 μm-1], solar irradiances, standardized response weighted	64-bit float	m	n/a
SunDistanceAU	Approximate distance in astronomical units between the center of the earth and the center of the sun at the time MISR observes the first valid (non-fill) pixel in the swath. Replicated across bands for convenience; does not vary with band.	64-bit float	AU	n/a

Table 7 – Radiance Band Group Fields

Field Name *[CF standard_name]* Parameter Description	**Dimensions**	**Data Type**	**Units**	**Flag Values**
Radiance SOM projected top-of-atmosphere radiance.	[SOM_X_275, SOM_Y_275] <or> [SOM_X_1100, SOM_Y_1100]	16-bit unsigned integer	W m^{-2} sr^{-1} μm^{-1} (scaled)	16378 = Unseen by the camera, i.e., outside swath edges 16380 = Radiance unusable due to high RDQI
Quality_Flag Quality flag applicable to Radiance field (above).	[SOM_X_275, SOM_Y_275] <or> [SOM_X_1100, SOM_Y_1100]	8-bit unsigned integer	n/a	0 = Within specifications 1 = Reduced accuracy 2 = Not usable for science 3 = Unusable for any purpose 4 = Unseen by camera

Table 8 – GeometricParameters Fields

Field Name *[CF standard name]* Parameter description.	**Dimensions**	**Data Type**	**Units**	**Flag Values**
SolarZenith The angle of the sun relative to overhead (0°)	[SOM_X_17600, SOM_Y_17600]	32-bit float	angular degree	-111 = Fill above data -222 = Fill below data -333 = Fill IPI invalid -444 = Fill to side of data -555 = Fill not processed -999 = Fill IPI error
SolarAzimuth Angle measured clockwise relative to local north of the projection of the solar illumination vector onto a horizontal plane. The illumination vector points in the direction of photon travel, away from the Sun. The opposing vector, pointing *toward* the Sun, is given by [(Solar_Azimuth_Angle + 180°) modulo 360°]	[SOM_X_17600, SOM_Y_17600]	32-bit float	angular degree	-111 = Fill above data -222 = Fill below data -333 = Fill IPI invalid -444 = Fill to side of data -555 = Fill not processed -999 = Fill IPI error
BlueConversionFactor Factor by which the Blue Bidirectional Reflectance Factor (BRF) can be calculated. BlueConversionFactor = (π * SunDistanceAU^2) / (std_solar_wgted_height[Blue] * cos(SolarZenith)) BRF[Blue] = BlueConversionFactor * Radiance[Blue].	[SOM_X_17600, SOM_Y_17600]	32-bit float		-111 = Fill above data -222 = Fill below data -333 = Fill IPI invalid -444 = Fill to side of data -555 = Fill not processed -999 = Fill IPI error
GreenConversionFactor Factor by which the Green Bidirectional Reflectance Factor (BRF) can be calculated. GreenConversionFactor = (π * SunDistanceAU^2) / (green std_solar_wgted_height[Green] * cos(SolarZenith)) BRF[Green] = GreenConversionFactor * Green Radiance.	[SOM_X_17600, SOM_Y_17600]	32-bit float		-111 = Fill above data -222 = Fill below data -333 = Fill IPI invalid -444 = Fill to side of data -555 = Fill not processed -999 = Fill IPI error

RedConversionFactor Factor by which the Red Bidirectional Reflectance Factor (BRF) can be calculated. RedConversionFactor = (π * SunDistanceAU^2) / (red std_solar_wgted_height[Red] * cos(SolarZenith)) BRF[Red] = RedConversionFactor * Radiance[Red].	[SOM_X_17600, SOM_Y_17600]	32-bit float		-111 = Fill above data -222 = Fill below data -333 = Fill IPI invalid -444 = Fill to side of data -555 = Fill not processed -999 = Fill IPI error
NIRConversionFactor Factor by which the NIR Bidirectional Reflectance Factor (BRF) can be calculated. NIRConversionFactor = (π * SunDistanceAU^2) / (std_solar_wgted_height[NIR] * cos(SolarZenith)) BRF[NIR] = NIRConversionFactor * Radiance[NIR].	[SOM_X_17600, SOM_Y_17600]	32-bit float		-111 = Fill above data -222 = Fill below data -333 = Fill IPI invalid -444 = Fill to side of data -555 = Fill not processed -999 = Fill IPI error

Table 9 – Block_Metadata Dimensions

Dimension Name	Description	Data Type	Units	Valid Range
Block_Number *(Early revisions may have alternate or redundant name, Block_Dim)*	MISR block number	32-bit integer	n/a	1 to 180
Grid_Cell_Dim	Identifier for grid cells within which MISR SOM to NEW projection transform is defined.	32-bit integer	n/a	0 to 1
Coeff_Dim	Index of SOM to NEW transform coefficient		n/a	0 to 5
Band_Dim	Index of MISR band	32-bit integer	n/a	1 to 4 1 = Blue (446 nm) 2 = Green (558 nm) 3 = Red (672 nm) 4 = Near IR (867 nm)

Table 10 – PerBlockMetadataCommon

PerBlockMetadataCommon	Definition	Data Type	Valid Range
Ocean_flag	Flag signalling whether the block contains entirely ocean radiances	8-bit integer	0 = block has no ocean or is a mix of ocean and land 1 = block is entirely ocean
Block_coor_ulc_som_meter.x	Upper left corner SOM block x coordinate in meters	64-bit float	7460750
Block_coor_ulc_som_meter.y	Upper left corner SOM block y coordinate in meters	64-bit float	-1426150
Block_coor_lrc_som_meter.x	Lower right corner SOM block x coordinate in meters	64-bit float	32804750
Block_coor_lrc_som_meter.y	Lower right corner SOM block y coordinate in meters	64-bit float	1442650
Data_flag	Flag signalling whether the block contains entirely fill data	8-bit integer	0 = block contains entirely fill data 1 = block contains valid data

Table 11 – PerBlockMetadataTime

PerBlockMetadataTime	Definition	Data Type	Valid Range
BlockCenterTime	TAI time of the lower right pixel of the center four pixels in the current block, converted to UTC time, and displayed in CCSDS ASCII time code A format. Note: Uses a flag value of "0000-00-00T00:00:00.000000Z" to indicate blocks where data for the center of the block wasn't acquired (i.e., partial blocks at the start and end of the swath)	String (nominally 28 characters)	n/a

Table 12 – PerBlockMetadataRad

PerBlockMetadataRad	Definition	Data Type	Valid Range
number_transform	Number of transforms required for the block. If this number is two, then the following records occur twice.	32-bit integer	Terrain: always 0 Ellipsoid: 0, 1, or 2 *(0 outside data boundaries, 1 at edges, and 2 within)*
transform.ref_time	The time at which line 0 was acquired by the camera, adjusted for instrument corrections to this block.	string	n/a
transform.start_line	Defines the starting SOM boundary for which this transform applies relative to the first block in the entire swath.	32-bit integer	0 - 92159
transform.number_line	Defines the ending SOM boundary for which this transform applies.	32-bit integer	256 where transform is valid
transform.coeff_line[6]	The vector describing the line transform coefficients.	64-bit float	n/a
transform.coeff_samp[6]	The vector describing the sample transform coefficients.	64-bit float	n/a
transform.som_ctr.x	The x SOM coordinate of the center of the transform area, used in applying the transform.	64-bit float	0 - 92159
transform.som_ctr.y	The y SOM coordinate of the center of the transform area, used in applying the transform.	64-bit float	0 - 2047
transform.ipi_adj_sum	Not used.	64-bit float	n/a
GDQI	Geometric Data Quality Indicator	64-bit float	Terrain: -1.0 to 1.0 Ellipsoid: always 0.0

Table 13 – PerGridCellSomToNew

PerGridCellSomToNew	Definition	Data Type	Valid Range
grid_cell_index	Grid cell index	32-bit integer	0 - 1
band_index	Band index	32-bit integer	0 - 3
valid	Flag indicating if SOM-to-new transform is valid for this grid cell and band	INT8	0 - 1 0 = invalid 1 = valid
som_area.start_line	Start line of an SOM area, offset from the first line of block 1, in units of 275-meter pixels	32-bit integer	0 - 92159
som_area.start_sample	Start sample of an SOM area, offset from the leftmost (minimum SOM Y) pixel of the block containing the given range of line coordinates, in units of 275-meter pixels	32-bit integer	0 - 2047
som_area.number_line	Number of lines in an SOM area, in units of 275-meter pixels (range of line coordinates may not span more than one block)	32-bit integer	0, 256
som_area.number_sample	Number of samples in an SOM area, in units of 275-meter pixels	32-bit integer	0, 2048
transform.resolution.line	Line resolution of transform, in units of 275-meter pixels	32-bit integer	1, 4
transform.resolution.sample	Sample resolution of transform, in units of 275-meter pixels	32-bit integer	1, 4
transform.som_ctr.line	SOM center location (line) of the grid cell for which the transform applies, in units of 275-meter pixels	32-bit integer	0 - 92159
transform.som_ctr.sample	SOM center location (sample) of the grid cell for which the transform applies, in units of 275-meter pixels	32-bit integer	0 - 2047
transform.coeff_line	Transform coefficients (six total) used to compute native instrument line coordinate from SOM coordinates	64-bit float array	n/a
transform.coeff_sample	Transform coefficients (six total) used to compute native instrument sample coordinate from SOM coordinates	64-bit float array	n/a

Table 14 – File_Metadata attributes

Attribute Name	Definition	Data Type	Units	Valid Range
SOM_parameters.[*] (1) som_ellipsoid_a (2) som_ellipsoid_e2 (3) som_orbit.aprime (4) som_orbit.eprime (5) som_orbit.gama (6) som_orbit.nrev (7) som_orbit.ro (8) som_orbit.i (9) som_orbit.P2P1 (10) som_orbit.lambda0	SOM map projection parameters for X, Y gridded data in this file. Alternate format of the same information given in **Error! Reference source not found.**, GCTP projection parameters. (1) Semi-major axis of ellipsoid (WGS84) in meters (2) Eccentricity of ellipsoid squared (3) Not used (4) Not used (5) Not used (6) Number revolutions per ground track repeat cycle (7) Radius of circular orbit in meters (8) Orbit inclination in radians (9) Ratio of time of revolution per orbit to the length of Earth rotation (10) Longitude of ascending orbit at equator (λ_0), in radians, $\lambda_0 = \lambda_{ref} - \frac{2\pi}{233} \cdot path\_number$ $\lambda_{ref} = 129.3056 \cdot \frac{\pi}{180}$	64-bit float, 32-bit integer	meters, radians, n/a	(1) 6378137.0 meters (2) 0.006694348 (3) 1.0 (4) 1.0 (5) 1.0 (6) 233 (7) 7078040.8 meters (8) 1.715725326 radians (9) 0.068666667 0 to -2π radians
AGP_version_id	Version identifier for Ancillary Geographic Product (AGP)	32-bit integer	n/a	2
DEM_version_id	Version identifier for the Digital Terrain Elevation Dataset (DTED) Intermediate Dataset (DID)	32-bit integer	n/a	4
Number_blocks	Total number of blocks	32-bit integer	n/a	1 to 180
Ocean_blocks_size Ocean_blocks.count Ocean_blocks.numbers	List of MISR blocks containing only ocean surface type in the AGP	32-bit integer	n/a	1 to 180
Origin_block.ulc.x Origin_block.ulc.y Origin_block.lrc.x Origin_block.lrc.y	Upper left corner (ULC) and lower right corner (LRC) coordinates of SOM projection for X, Y gridded data of first block of data reported in file.	64-bit float	meters	ULC = (7460750, 245850) LRC = (7601550, 1372250)

Table 14 – File_Metadata attributes

Cam_mode	Indicates whether the data in this file was obtained in MISR global mode or local mode	32-bit integer	n/a	0 = local 1 = global
Num_local_modes	Number of MISR local mode acquisitions contained in this file	32-bit integer	n/a	0 to 6 0 if data is global mode
Local_mode_site_name	Geographical name of the first local mode site contained in this file (if applicable)	String	n/a	Empty string if global mode
Orbit_QA	Indication of the overall quality of the orbit data, based on analysis of quality flags in the spacecraft attitude and ephemeris data. Geolocation accuracy may be impaired for orbits with poor quality orbit data.	32-bit float	n/a	-9999.0 = No retrieval -1.0 = Poor 0.0 = Nominal

Table 15 – MISR Specific File Attributes

Attribute Name	Definition	Data Type	Units	Valid Range
Local_granule_id	The canonical file name for this granule	String	n/a	n/a
Path_number	Path number of the SOM projection for this Terra orbit	32-bit integer	n/a	1 to 233
Dynamic_path_number	Floating point path number of the best SOM projection to use with this orbit	64-bit float	n/a	0.0 to 233.0
Orbit	Terra orbit number		n/a	n/a
Camera	MISR camera	String	n/a	One of “DA”, “CA”, “BA”, “AA”, “AN”, “AF”, “BF”, “CF”, “DF”
Product_version	Version string of product	String	n/a	
Start_block End_block	MISR block numbers corresponding to the first and last blocks processed for this product	32-bit integer	n/a	1 to 180 (Start_block ≤ End_block)

Table 15 – MISR Specific File Attributes

Range_beginning_datetime Range_ending_datetime Production_datetime	Alternate source of the same named parameters in ECS inventory metadata. These are only provided for convenience of access to inventory metadata elements and should not be used as precise measurements relative to observations. See Time field (Table 7) for sources of time information.	String	n/a	time: ISO 8601 format, e.g. 2004-06-30T21:17:11.711120Z

Table 16 – NetCDF Climate and Forecast (CF) Standard File Attributes

Attribute Name	Value
title	MISR Level 1B2 Georectified Radiance <*ellipsoid-or-terrain*> Projected <*global-or-local*> Mode Product
institution	MISR Level 1B2 Georectified Radiance Products are produced by the MISR Science Team using processing and storage facilities of the NASA Langley Research Center DAAC.
source	Georectified radiances consist of native sensor measurements calibrated and projected onto the Ellipsoid or terrain surface.
history	<*date*> : Initial production using software version <*version tag*>, built <*build date*>, by <*user id*>. See also Software_version_information and Input_files.
references	Data Product Specifications and Algorithm Theoretical Basis Documents are available from the Langley Atmospheric Science Data Center at https://eosweb.larc.nasa.gov/project/misr/misr_table.
Conventions	CF-1.6

Table 17 – Common Attributes of Dimensions and Fields (Where Applicable)

Attribute Name	Description

coordinates	NetCDF CF standard attribute for specifying alternative sets of coordinate values. In this product, spatially gridded data is implicitly geolocated by the SOM X and Y coordinates of each grid cell. Latitude and Longitude fields serve as an alternative source of geolocation. The Time field serves as an alternative to the SOM X (along-track) coordinate. Example:
	
	`uint16 Aerosol_Optical_Depth(X, Y);`
	`    :coordinates = “Latitude Longitude Time”;`

calendar	CF standard attribute specifying reference calendar for time units. Value of “standard” specifies standard Gregorian/Julian calendar. Example:
	
	`double Time(X);`
	`  :calendar=”standard”`
	`  :units=”seconds since 2007-01-24T05:05:38.043934Z”`

units	CF standard attribute specifying units of measurement (e.g., meters, seconds). See calendar example, above.

long_name
comment
	CF standard attributes for specifying more descriptive information about a field.
	Example:
	
	`short Elevation(X, Y);`
	`    :standard_name=”surface_height_above_reference_ellipsoid”`
	`    :long_name=”Surface elevation”`
	`    :comment=”Reference ellipsoid is WGS84”`

flag_values,
flag_meanings
	CF standard attributes for assigning meanings to numeric values. Example:
	
	`int Camera_Dim(Camera_Dim);`
	`    :flag_values = 1, 2, 3, 4, 5, 6, 7, 8, 9`
	`    :flag_meanings = “D_forward C_forward B_forward A_forward A_nadir A_aftward B_aftward C_aftward D_aftward”`

standard_name	CF standard attribute for specifying the common name of a field. Example:
	
	`double X_Dim(X_Dim);`
	`    :axis=”X”`
	`    :long_name=” Space-oblique Mercator Along-Track”`
	`    :standard_name=”projection_x_coordinate”`
	`    :units=”meters”`

axis	CF standard attribute for specifying coordinate axis associated with a dimension. See standard_name example above.

<table>
<tr><td>scale_factor,
add_offset,
valid_range

(underflow)
(overflow)</td><td>CF standard attributes for packed data. To translate packed (integer) values to real (float) values:

float_value = integer_value * scale_factor + add_offset

The valid range of integer values for which the above formula holds is given by valid_range. Integer values outside the valid range should be interpreted as either fill values or flag values (if provided). Example:

<pre>uint16 View_Zenith_Angle(X, Y, Camera);
  :scale_factor = 0.1
  :add_offset = 0.0
  :valid_range = 0, 65532
  :flag_values = 65534, 65535
  :flag_meanings = “underflow, overflow”
  :_FillValue = 65533</pre>
Underflow and overflow flags indicate values outside the allowed range. For example, a view zenith angle of -0.5 cannot be numerically represented in the above example. Underflow represents values less than the minimum allowed. Overflow represents values greater than the maximum allowed.</td></tr>
<tr><td>_FillValue</td><td>CF standard attribute for specifying fill value.</td></tr>
</table>

3 Appendix

3.1 ACRONYM LIST

AGP......................Ancillary Geographic Product
ATBD...................Algorithm Theoretical Basis Document
AU........................Astronomical Unit
CF.........................Climate and Forecast
DAAC ....Distributed Active Archive Center
DID ....DTED Intermediate Dataset
DMS.....................Degrees Minutes Seconds
DTED...................Digital Terrain Elevation Dataset
ECS ....EOSDIS Core System
EOF ....Empirical Orthogonal Function
EOS ....Earth Observing System
EOSDIS................Earth Observing System Data and Information System
ESDT....................Earth Science Data Type
GCTP ....General Cartographic Transformation Package
GSFC....................Goddard Space Flight Center
HDF......................Hierarchical Data Format
HDF-EOS.............Hierarchical Data Format for EOS
IPI.........................Image Point Intersection
ISO ....International Organization for Standardization
JPL ....Jet Propulsion Laboratory
LaRC ....Langley Research Center
LUT ....Look Up Table
MISR....................Multi-angle Imaging SpectroRadiometer
NASA...................National Aeronautics and Space Administration
NetCDF ....Network Common Data Format
PGE ....Product Generation Executable
PP ....Projection Parameters
RCCT ....Radiometric Camera-by-camera Cloud mask Threshold
ROI.......................Reference Orbit Imagery
SCF ....Science Computing Facility
SDP ....Science Data Processing

SMART................Simulated MISR Ancillary Radiative Transfer
SOM.....................Space-Oblique Mercator
SSA ....Single Scattering Albedo
TASC ....Terrestrial Atmosphere and Surface Climatology
TOA ....Top-Of-Atmosphere
UTC......................Coordinated Universal Time
WGS84.................World Geodetic System 1984