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Earth Observing System



**Multi-angle
Imaging
Spectro-
Radiometer**

Data Product Specification for the MISR Level 2 Cloud Product

-Incorporating the Science Data Processing Interface Control Document

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To determine the latest released version of this document, consult the MISR web site
(<http://misr.jpl.nasa.gov>).

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Jet Propulsion Laboratory
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Which Product Versions Does this Document Cover?

Product Filename Prefix	Version Number in Filename	Brief Description
MISR_AM1_TC_CLOUD	F01_0001	L2 Cloud Heights and Motion



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1 INTRODUCTION

1.1 MISR LEVEL 2 CLOUD PRODUCT

The Multi-angle Imaging SpectroRadiometer (MISR) Level 2 Cloud Product provides the climate, modeling, and general atmospheric research communities a unique set of atmospheric parameters associated with the observation of cloud frequency, height, and motion. It contains gridded retrievals of cloud top height (CTH) and height-resolved cloud motion vectors (CMV) at 1.1 km and 17.6 km resolution respectively, in addition to retrievals of the *cross-track* component of cloud motion gridded at 1.1 km resolution. Retrievals are recorded across the 380 km MISR swath and distributed as a single HDF-EOS file for each orbit.

The purpose of this document is to describe the format of the MISR TC_CLOUD product. The full details of the other MISR standard products, as well as the ancillary datasets used in their generation, can be found in their respective MISR Data Product Specifications Documents (and for earlier versions of the products in the MISR Data Products Specifications Document, Rev S). Information concerning the MISR georegistration is contained in the MISR Science Data Product Guide.

1.2 MISR DATA PRODUCTS

The MISR project is a component of the Earth Observing System (EOS) Terra Mission and the EOS Data and Information System (EOSDIS), which are components of the National Aeronautics and Space Administration's (NASA) 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.

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 B, August 1996 (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 Cloud Algorithm Theoretical Basis, JPL D-73327, April 2012 (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).

APPLICABLE DOCUMENTS

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

2 MISR LEVEL 2 CLOUD DATA PRODUCT SPECIFICATION

2.1 MISR LEVEL 2 CLOUD PRODUCT GRANULE BRIEF DESCRIPTION

The MISR Cloud Product contains 17.6 km resolution cloud motion vectors (CMV), 1.1 km resolution cloud top heights (CTH), and 1.1 km *cross-track* cloud motion components (where along-track and cross-track motion refer to motion along, and transverse to, the trajectory of the Terra platform). Quality indicators and cloud masks associated with these retrievals are also provided.

Parameters provided at 1.1 km resolution are divided into two grids, *Stereo_1.1_km* and *Stereo_WithoutWindCorrection_1.1_km*. The *Stereo_WithoutWindCorrection_1.1_km* grid contains parameters retrieved under the assumption that features observed by MISR did not move in the *along-track* direction during the interval between MISR camera views. The *Stereo_1.1_km* grid parameters are similar to the *Stereo_WithoutWindCorrection_1.1_km* parameters, but use associated 17.6 km retrievals to correct for along-track feature motion. In the absence of a good quality CMV, the *Stereo_1.1_km* parameters are set to fill.

2.2 MISR LEVEL 2 CLOUD PRODUCT GRANULE COMPONENTS

Each granule of the MISR Cloud Product corresponds to one full orbit of data, consisting of observations made on the sunlit side of the Earth. The product is associated with one Earth Science Data Type (ESDT) that has a short name of MIL2TCSP. Each file uses the HDF-EOS Grid “stacked-block” format and contains HDF-EOS Grid structures, corresponding to parameters at 1.1 km and 17.6 km spatial resolution. The grid structures have x and y spatial dimensions, as well as a third dimension corresponding to the SOM block number. The x and y dimensions correspond to the number of 1.1 km by 1.1 km or 17.6 km by 17.6 km regions in the along-track (x) and cross-track (y) directions. For each Level 2 Cloud Product granule, the number of blocks in the grid structure corresponds exactly to the number and location of blocks in the Level 1B2 and the other Level 2 Product files for the same orbit. Also, the blocks that make up the Cloud Product files are a subset of the blocks that make up the Ancillary Geographic Product (AGP).



Table 1 - Level 2 CLOUD Product Files and Grid

ESDT (Shortname)	Local Granule ID ¹	Grid Structure Name
MIL2TCSP	MISR_AM1_TC_CLOUD_Pmmm_Onnnnnn_Fff_vvvv.hdf	Motion_17.6_km
		Stereo_WithoutWindCorrection_1.1_km
		Stereo_1.1_km

2.3 MISR LEVEL 2 CLOUD PRODUCT (MIL2TCSP)

2.3.1 File Metadata Description

Table 2 - File Metadata for Cloud Product

File Metadata Field Name	Definition	Data Type	Units	Valid Range
Path_number	Orbit path number	INT32	N/A	1-233
AGP_version_id	Version identifier for AGP	INT32	N/A	2
DID_version_id	Version Identifier for DID (DTED [Digital Terrain Elevation Dataset] Intermediate Dataset)	INT32	N/A	4
Number_blocks	Total number of blocks	INT32	N/A	1-180
Ocean_blocks_size	Dimension of ocean_blocks parameter	INT32	N/A	1-180
Ocean_blocks.count	Total number of blocks containing entirely ocean data	INT32	N/A	1-180
Ocean_blocks.numbers	List of block numbers containing entirely ocean data	180 x INT32	N/A	1-180
SOM_parameters.som_ellipsoid.a	Semimajor axis of Earth ellipsoid	FLOAT64	meters	WGS84 ellipsoid (6.3781370E+ 06)
SOM_parameters.som_ellipsoid.e2	Eccentricity of Earth ellipsoid squared	FLOAT64	N/A	WGS84 ellipsoid (6.6943480E-03)
SOM_parameters.som_orbit.aprime	Semimajor axis of Terra satellite orbit	FLOAT64	meters	1.0
SOM_parameters.som_orbit.eprime	Eccentricity of Terra satellite orbit	FLOAT64	N/A	1.0
SOM_parameters.som_orbit.gama	Longitude of Terra satellite perigee	FLOAT64	radians	1.0
SOM_parameters.som_orbit.nrev	Number of revolutions per ground track repeat cycle	INT32	N/A	233

¹ Where Pmmm corresponds to the orbital path number (001 to 233), Onnnnnn is the absolute orbit number, Fff is the file format version, and vvvv is the version number (relating to the reprocessing of a dataset with different software and/or ancillary inputs).

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SOM_parameters.som_orbit.ro	Radius of circular Terra satellite orbit	FLOAT64	meters	7.0780408E+06
SOM_parameters.som_orbit.i	Inclination of Terra satellite orbit	FLOAT64	radians	1.7157253
SOM_parameters.som_orbit.P2P1	Ratio of time of revolution over length of Earth rotation/orbit	FLOAT64	N/A	6.8666667E-02
SOM_parameters.som_orbit.lambda0	Geodetic longitude of ascending node	FLOAT64	radians	-2 π : 2 π
Origin_block.ulc.x	SOM X coordinate of the upper left corner of the first block	FLOAT64	meters	
Origin_block.ulc.y	SOM Y coordinate of the upper left corner of the first block	FLOAT64	meters	
Origin_block.lrc.x	SOM X coordinate of the lower right corner of the first block	FLOAT64	meters	
Origin_block.lrc.y	SOM Y coordinate of the lower right corner of the first block	FLOAT64	meters	
Start_block	The block number in the AGP which corresponds to the first block in this file containing valid data	INT32	N/A	1 - 180 Start_block < End block
End_block	The block number in the AGP which corresponds to the last block in this file containing valid data	INT32	N/A	1 - 180 Start_block < End block
Cam_mode	Indicates whether the data in this grid file was obtained in MISR global observing mode or local observing mode	INT32	N/A	0-1 1 = global 0 = local
Num_local_modes	The number of MISR local mode acquisitions contained in this file	INT32	N/A	0-6 0 if data is global mode
Local_mode_site_name	The geographical name of the first local mode site contained in this file	CHAR8	N/A	String up to 12 characters in length, excluding null
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. A value of -1.0 indicates that the orbit is likely poorly registered and that only cloud-top heights without wind correction are provided.	FLOAT32	N/A	-9999.0 = NoRetrieval -1.0 = Poor 0.0 = Nominal
Orbit_qa_winds	Indication of the overall quality of the orbit data based on the wind retrievals. A value of -1.0 indicates that the orbit is likely poorly registered and that only cloud-top heights without wind correction are provided.	FLOAT32	None	-9999.0 = NoRetrieval -1.0 = Poor 0.0 = Nominal

2.3.2 Per-grid Metadata Description

Table 3 - Per-grid Metadata for Cloud Product

Common Grid Metadata	Definition	Data Type	Valid Values
Block_size.resolution_x	Resolution of block x dimension in meters	INT32	1100, 17600
Block_size.resolution_y	Resolution of block y dimension in meters	INT32	1100, 17600
Block_size.size_x	Block x dimension	INT32	128, 8
Block_size.size_y	Block y dimension	INT32	512, 32
MISRReferenceCamera	Name of reference camera used in production of data contained in grid	CHAR8*2	One of Df,Cf,Bf,Af, An,Aa,Ba,Ca,Da
MISRCameras	Names of all cameras used in production of data contained in this grid	CHAR8*18	A subset of DfCfBfAfAnAaBaCaDa

2.3.3 Per-block Metadata Description

Table 4 - Per-block Metadata for Cloud Product

PerBlockMetadataCommon	Definition	Data Type	Valid Values
Block_number	Current block number	INT32	1-180
Ocean_flag	Flag signaling whether the block contains entirely ocean data	INT8	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	FLOAT64	
Block_coor_ulc_som_meter.y	Upper left corner SOM block y coordinate in meters	FLOAT64	
Block_coor_lrc_som_meter.x	Lower right corner SOM block x coordinate in meters	FLOAT64	
Block_coor_lrc_som_meter.y	Lower right corner SOM block y coordinate in meters	FLOAT64	
Data_flag	Flag signaling whether the block contains entirely fill data	INT8	0 = block contains entirely fill data 1 = block contains valid data

Common Per Block Metadata	Definition	Data Type	Valid Values
Geometric DQI	Geometric Data Quality Indicator for the An camera copied from the L1B2 Ellipsoid parameter file	FLOAT64	-1 to 1

PerBlockMetadataTime	Definition	Data Type	Valid Values
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. The time displayed is that of the nadir (An) camera. The times for the other cameras will differ by up to +/-3.5 minutes.	CHAR8*28	Null string = No Data

2.3.4 Grid Structure Descriptions

In order to reduce the size of the file, some fields that contain floating point data have been scaled to integers by specifying a *scale_factor* and an *add_offset*. The transformation back to floating point is accomplished by (a) multiplying by *scale_factor* and (b) adding *add_offset*, in this order, as shown in equation (1) below. Both the *scale_factor* and *add_offset* are stored as attributes attached to the field (SDS structure) in question and can be read with the HDF interface, but not HDF-EOS. In Table 6 the *scale_factor* and *add_offset* parameters are abbreviated as *SF* and *AO*.

$$f = (i * scale_factor) + add_offset \quad (1)$$

Floating point values, and some integer values, may take on a flag value, typically -9999.0, indicating no data. Missing integer data may be represented either by a value of 0 (for flag data) or -9999 (for measured data) or -128 (for measured byte integer data). The commonly used fill value for fields that have been scaled is -22222. The fill values and scaling information (where appropriate) are contained in field-level attributes in the HDF-EOS file. The locations that contain the fill value specified below should not be rescaled.

Table 5 - Cloud Product Field Dimension Descriptions

Dimension	Description	Valid Values
SOMBlockDim	<i>SOMBlockDim</i> is the number of SOM blocks in the file. The slowest-varying dimension is implicitly the SOM block dimension. It is not shown in the dimension list column below.	180
XDim	Number of lines in a block. The x dimension direction is identical to the standard SOM x dimension.	128 for 1.1 km parameters 8 for 17.6 km parameters
YDim	Number of samples in a block. The y dimension direction is identical to the standard SOM y dimension.	512 for 1.1 km parameters 32 for 17.6 km parameters

Table 6 - Cloud Product Grid Structure Descriptions

Field Name Parameter Description	Dimension List	Number Type	Units	Transformation	Flag Values
Motion_17.6_km (Spatial Resolution: 17.6 km x 17.6 km, XDim = 8, YDim = 32, SOMBlockDim = 180)					
CloudTopHeightOfMotion Height above the WGS84 ellipsoid of the retrieved cloud motion vector	XDim, YDim,	FLOAT32	m	None	No data=-9999.0
CloudMotionNorthward Northward component of cloud motion vector	XDim, YDim,	FLOAT32	m/s	None	No data=-9999.0
CloudMotionEastward Eastward component of cloud motion vector	XDim, YDim,	FLOAT32	m/s	None	No data=-9999.0
MotionDerivedCloudMask Indicator, with low or high confidence, of whether motion vector is associated with cloud or terrain	XDim, YDim,	INT8	None	None	0 = No Data, 1 = High Confidence Cloud, 2 = Low Confidence Cloud, 3 = Low Confidence Terrain, 4 = High Confidence Terrain
MotionQualityIndicator Quality flag corresponding to the cloud motion vector	XDim, YDim,	INT8	None	None	Range from 0 = Worst Quality 100=Best Quality No data=-128
Stereo_WithoutWindCorrection_1.1_km (Spatial Resolution: 1.1 km x 1.1 km, XDim = 128, YDim = 512, SOMBlockDim = 180)					
CloudTopHeight_WithoutWindCorrection Height above the WGS84 ellipsoid of the observed feature (without correction for along-track cloud motion)	XDim, YDim,	INT16	m	None	No data = -9999
CloudMotionCrossTrack_WithoutWindCorrection Cross-track cloud motion component	XDim, YDim,	INT16	m/s	SF = 1.0E-02 AO =0.0	No data = -22222
CloudMotionCrossTrackHeading_WithoutWindCorrection The heading (degrees East from North) of the cross-track cloud motion component	XDim, YDim,	INT16	degrees	SF = 1.0E-02 AO = 0.0	No data = -22222

StereoDerivedCloudMask_WithoutWindCorrection Indicator, with low or high confidence, of whether retrieved height (without wind correction) is associated with a cloud	XDim, YDim,	UINT8	None	None	0 =No Data, 1=High Confidence Cloud, 2=Low Confidence Cloud, 3=Low Confidence Near Surface, 4=High Confidence Near Surface
StereoQualityIndicator_WithoutWindCorrection Quality flag corresponding to the height and cross-track motion	XDim, YDim,	INT8	None	None	Range from 0 = Worst Quality 100=Best Quality No data=-128
Stereo_1.1_km (Spatial Resolution: 1.1 km x 1.1 km, XDim = 128, YDim = 512, SOMBlockDim = 180)					
CloudTopHeight Height above the WGS84 ellipsoid of the observed feature	XDim, YDim,	INT16	m	None	No data =-9999
CloudMotionCrossTrack Cross-track cloud motion component	XDim, YDim,	INT16	m/s	SF = 1.0E-02 AO =0.0	No data = -22222
CloudMotionCrossTrackHeading The heading (degrees East from North) of the cross-track cloud motion component	XDim, YDim	INT16	degrees	SF = 1.0E-02 AO = 0.0	No data = -22222
StereoDerivedCloudMask Indicator, with low or high confidence, of whether retrieved height is associated with a cloud	XDim, YDim	UINT8	None	None	0=No Data, 1=High Confidence Cloud, 2=Low Confidence Cloud, 3=Low Confidence Near Surface, 4=High Confidence Near Surface
StereoQualityIndicator Quality flag corresponding to the height and cross-track motion	XDim,YDim	INT8	None	None	Range from 0 = Worst Quality 100=Best Quality No data=-128

3 Appendix

Acronym List

AGP	Ancillary Geographic Product
CMV	Cloud Motion Vector
CTH.....	Cloud Top Height
DAAC	Distributed Active Archive Center
DID	DTED Intermediate Dataset
DTED	Digital Terrain Elevation Dataset
ECS	EOSDIS Core System (Data Production System at DAAC)
EOS.....	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
ESDT.....	Earth Science Data Type
HDF-EOS	Hierarchical Data Format for EOS
JPL	Jet Propulsion Laboratory
LaRC DAAC.....	NASA Langley Research Center DAAC
MISR.....	Multi-angle Imaging SpectroRadiometer
NASA.....	National Aeronautics and Space Administration
SCF	Science Computing Facility
SDP	Science Data Processing
SDS	Scientific Data Set
SOM.....	Space-Oblique Mercator
TAI	Temps Atomique International (International Atomic Time)
TC	Top-Of-Atmosphere and Cloud
TOA	Top-Of-Atmosphere
UTC	Coordinated Universal Time
WGS84.....	World Geodetic System 1984