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Multiangle SpectroPolarimetric Imager

Data Product Specification for the AirMSPI Level 1B2 Products

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Airborne Multiangle SpectroPolarimetric Imager (AirMSPI)

Data Product Specification for the AirMSPI Level 1B2 Products

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

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Document Change Log

Revision	Date	Affected Portions and Description
	27 April 2013	Original release

Which Product Versions Does this Document Cover?

Product Filename Prefix	Version Number in Filename	Brief Description
AirMSPI_ER2_tttt_GRP_ELLIPSOID	V001	L1B2 Ellipsoid-Projected Georectified Radiance and Polarimetry Data
AirMSPI_ER2_tttt_GRP_TERRAIN	V001	L1B2 Terrain-Projected Georectified Radiance and Polarimetry Data

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TABLE OF CONTENTS

1 INTRODUCTION 5

1.1 AIRMSPI L1B2 PRODUCTS 5
1.2 AIRMSPI DATA PRODUCTS 5
1.3 CONTROLLING DOCUMENTS 5
1.4 RELATED DOCUMENTS 5

2 AIRMSPI LEVEL 1B2 DATA PRODUCT SPECIFICATION 6

2.1 AIRMSPI LEVEL 1B2 PRODUCT GRANULE BRIEF DESCRIPTION 6
2.2 AIRMSPI LEVEL 1B2 PRODUCT GRANULE COMPONENTS 6
2.3 AIRMSPI LEVEL 1B2 PRODUCT 7
2.3.1 Collection Metadata Description 7
2.3.2 Granule Metadata Description (.met File) 8
2.3.3 HDF-EOS-5 Format Description 9

3 APPENDIX 13

ACRONYM LIST 13

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1 INTRODUCTION

1.1 AirMSPI L1B2 PRODUCTS

The Airborne Multiangle SpectroPolarimetric Imager (AirMSPI) Level 1B2 Products contain radiometric and polarimetric observations of clouds, aerosols, and the surface of the Earth made from the National Aeronautics and Space Administration's (NASA) ER-2 high altitude research aircraft. The AirMSPI instrument acquires data using one of two possible modes, step-and-stare and sweep. Step-and-stare data are gridded with 10 m spatial sampling, with one file provided for each view angle. Sweep data are gridded with 25 m spatial sampling. Files are distributed in HDF-EOS-5 format.

The purpose of this document is to describe the format of the AirMSPI L1B2 products.

1.2 AirMSPI DATA PRODUCTS

The MISR Science Computing Facility (SCF) at the Jet Propulsion Laboratory (JPL) supports the development of AirMSPI science algorithms and software, instrument calibration and performance assessment, as well as providing quality assessment and data validation services with respect to AirMSPI Science Data Processing (SDP). The MISR SCF is used to perform the standard processing of the AirMSPI data. After AirMSPI data processing is complete, the standard output products are archived and made available to users via the Langley Research Center (LaRC) Atmospheric Science Data Center (ASDC) client services.
http://eosweb.larc.nasa.gov/project/airmspi/airmspi_table

1.3 CONTROLLING DOCUMENTS

1) Multiangle Spectropolarimetric Imager (MSPI) Algorithm Theoretical Basis Document Rev. B Draft, November 2009 (or latest version).

1.4 RELATED DOCUMENTS

1) AirMSPI Data Quality Statement. April 2013 (or latest version).
2) User Guide for the AirMSPI Level 1B2 Products, JPL D-78962, April 2013 (or latest version).

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2 AirMSPI LEVEL 1B2 DATA PRODUCT SPECIFICATION

2.1 AirMSPI LEVEL 1B2 PRODUCT GRANULE BRIEF DESCRIPTION

The AirMSPI L1B2 Product contains radiance information in eight spectral bands (335, 380, 445, 470, 555, 660, 865, and 935 nm) as well as polarimetic information in three of these bands (470, 660, 865 nm). Quality indicators, solar and view geometry, and temporal information associated with the acquired imagery are provided, as well as geolocation (latitude and longitude) information.

2.2 AirMSPI LEVEL 1B2 PRODUCT GRANULE COMPONENTS

Each granule of the AirMSPI L1B2 Product corresponds to a single data acquisition, a single stare in a step-and-stare sequence or a single sweep (forward or aftward). Each file uses the HDF-5 General Cartographic Transformation Package (GCTP) Universal Transverse Mercator (UTM) grid format at either 10 m (step-and-stare) or 25 m (sweep) spatial sampling.

Table 1 – L1B2 Product Files and Grid

COLLECTION **(Shortname)**	**Local Granule ID**[1]
AirMSPI_PODEX_GRP_Data	AirMSPI_ER2_ttttt_GRP_ELLIPSOID_yyyymmdd_hhmmssZ_aaa[A,N,F]_Fff_Vvvv.hdf
AirMSPI_JUNE252013_GRP_Data	AirMSPI_ER2_ttttt_GRP_TERRAIN_yyyymmdd_hhmmssZ_aaa[A,N,F]_Fff_Vvvv.hdf
AirMSPI_SEAC4RS_GRP_Data	AirMSPI_ER2_ttttt_GRP_ELLIPSOID_yyyymmdd_hhmmssZ_SWP[A,F]_Fff_Vvvv.hdf

1 Where ttttt corresponds to the target name, yyyy is the year, mm is the month, dd is the day, hh is the hour, mm is the minute, ss is the second in UTC of the central observation, aaa is the angle (reported to the nearest tenth of a degree x 10), Fff is the file format version, and Vvvv is the version number.

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2.3 AirMSPI LEVEL 1B2 PRODUCT

2.3.1 Collection Metadata Description

Table 2 - File Metadata

File Metadata Field Name	Definition	Example Contents
Dataset	Name of dataset	AirMSPI_PODEX_Terrain-projected_Georegistered_Radiance_Data
Shortname	Collection Shortname	AirMSPI_PODEX_GRP_Data
Description	Description of file contents	AirMSPI terrain-projected georegistered radiance product
Longname	Longer description of file contents	AirMSPI terrain-projected georegistered radiance product acquired during the NASA PODEX flight campaign Jan-Feb 2013
Daynite	Specifies daytime or nighttime acquisition	Day
Visible	Visibility of the data	LWorld
Project	Project name	AirMSPI
Level	Processing level	1
Timers	Time	Variable
Spatialres	Spatial extent of the data contained in the file	Swath about 15km by 10km
Global	Global data	D
Fmt	Data format	HDFEOS-5
Source	Platform used for data acquisition	Aircraft, NASA ER-2
Sensor	Name of sensor	AirMSPI Instrument
Parameter	List of parameters	"Radiance, Infrared radiance, Visible Radiance, Ultraviolet Radiance, DOLP, AOLP"
MaxLat	Maximum geographic latitude (degrees N)	40.0
MinLat	Minimum geographic latitude (degrees N)	28.0
MaxLon	Maximum geographic longitude (degrees E)	-114.0
MinLon	Minimum geographic longitude (degrees E)	-130.0
MaxAltitude	Maximum altitude (ASL)	20 km
MinAltitude	Minimum altitude (ASL)	0
Strtdata	Campaign start date (mm/dd/yyyy)	01/14/2013
Enddate	Campaign end date (mm/dd/yyyy)	02/15/2013
Spatialrep	Spatial representation of data	Cartesian

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2.3.2 Granule Metadata Description (.met File)

Table 3 – Metadata (.met)

Field Name	Definition	Example Contents
DatasetName	Name of dataset	AirMSPI_PODEX_Ellipsoid-projected_Georegistered_Radiance_Data
GranuleName	Name of specific data granule	AirMSPI_ER2_LaJolla_GRP_ELLIPSOID_20130114_210928Z_000N_F01_V001.hdf
StartDate	UTC date at start of data acquisition for this granule	2013-01-14
StartTime	UTC time at start of data acquisition for this granule	21:09:03.998155Z
EndDate	UTC date at end of data acquisition of this granule	2013-01-14
EndTime	UTC time at end of data acquisition for this granule	21:09:53.104617Z
MaxLat	Maximum geographic latitude of data in this granule (degrees N)	32.995331
MaxLon	Maximum geographic longitude of data in this granule (degrees E)	-117.154437
MinLat	Minimum geographic latitude of data in this granule (degrees N)	32.670981
MinLon	Minimum geographic longitude of data in this granule (degrees E)	-117.538629
FlightHeadingAzimuth	Mean aircraft heading for data in this granule (degrees relative to N)	242.2
GranuleSize	Size of data granule	373008183
Processing Date-Time	UTC date and time of data processing	2013-04-09T04:13:57Z
VersionID	Product version number	001
Browse	Indicates existence of .jpeg browse product	Y
Browsjpeg	Filename of .jpeg browse product	AirMSPI_ER2_LaJolla_GRP_ELLIPSOID_20130114_210928Z_000N_F01_V001.jpg
jpegsize	Size of .jpg browse product (bytes)	491658
Resolution	Pixel resolution of data in granule	10.0 meters
TargetType	Text description of target type for this granule	Coastline
GeolocationStage	Level of geolocation processing for this granule	Indirect
GeoPolygon	Latitude/longitude coordinate pairs describing location of data within granule	((32.889052,-117.307633),(32.888995,-117.307610),⋯)

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2.3.3 HDF-EOS-5 Format Description

HDF-EOS-5 files are organized in the manner of groups and subgroups. The tables below describe the content of an AirMSPI HDF-EOS-5 file in a manner consistent with this organization.

Table 4 – Top Level Contents

Field Name	Description
HDFEOS	Contains the primary data contents of the file
HDFEOS INFORMATION	Contains ancillary information (metadata) about the file

Table 5 – HDFEOS Contents

Field Name	Description
ADDITIONAL	Contains additional information useful to users of the L1B2 data products
GRIDS	Contains the gridded HDF-EOS data

Table 6 – HDFEOS/ADDITIONAL Contents

Field Name	Description
FILE_ATTRIBUTES	Contains additional information useful to users of the L1B2 data products

Table 7 – HDFEOS/ADDITIONAL/FILE_ATTRIBUTES Contents

Field Name	Description
Band Table	Provides the band number (1-8), the associated wavelength, the in-band solar irradiance at 1 astronomical unit (AU), and the grid name.

Table 8 – HDFEOS/ADDITIONAL/FILE_ATTRIBUTES Attributes Contents

Field Name	Description
Acquisition end time	UTC date and time of end of data acquisition
Acquisition start time	UTC date and time of start of data acquisition
Aircraft heading (degrees)	Mean aircraft heading during data acquisition (relative to North)
BRF equation	Equation used to convert radiances to bidirectional reflectance factors BRF = Radiance x π x sun_distance^2 x (1/solar_irradiance) x (1/cos(sun_zenith))
Epoch (UTC)	UTC time used as the reference epoch for this data granule
Geolocation stage	Level of geolocation processing for this granule
Gimbal angle average (degrees)	Average gimbal angle for this data granule

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Gimbal angle maximum (degrees)	Maximum gimbal angle for this data granule
Gimbal angle minimum (degrees)	Minimum gimbal angle for this data granule
Gimbal scan direction	Direction of gimbal scan (forward or aftward)
Lower left latitude	Geographic latitude of data in the lower left corner of the granule (degrees N)
Lower left longitude	Geographic longitude of data in lower left corner of the granule (degrees E)
Lower right latitude	Geographic latitude of data in the lower right corner of the granule (degrees N)
Lower right longitude	Geographic longitude of data in the lower right corner of the granule (degrees E)
Production time	UTC date and time of product generation
Radiance units	Units of radiance data reported in the product ($Wsr^{-1}m^{-2}nm^{-1}$)
Resolution	Pixel resolution of data in product (m)
Sun distance	Earth-Sun distance for use in calculation of BRF (AU)
Target type	Text description of target type for this granule
Upper left latitude	Geographic latitude of data in the upper left corner of the granule (degrees N)
Upper left longitude	Geographic longitude of data in upper left corner of the granule (degrees E)
Upper right latitude	Geographic latitude of data in the upper right corner of the granule (degrees N)
Upper right longitude	Geographic longitude of data in the upper right corner of the granule (degrees E)
[config]	Configuration parameters used in data processing
[history]	Processing history information
[input]	Input information used in data processing
granule_id	ID name for this data granule

Table 9 – HDFEOS/GRIDS Contents

Field Name	Description
355nm_band	Parameters associated with the 355 nm (UV) spectral band.
380nm_band	Parameters associated with the 380 nm (UV) spectral band.
445nm_band	Parameters associated with the 445 nm (VIS) spectral band.
470nm_band	Parameters associated with the 470 nm (VIS) polarized spectral band.
555nm_band	Parameters associated with the 555 nm (VIS) spectral band.
660nm_band	Parameters associated with the 660 nm (VIS) polarized spectral band.
865nm_band	Parameters associated with the 865 nm (NIR) polarized spectral band.
935nm_band	Parameters associated with the 935 nm (NIR) spectral band.
Ancillary	Ancillary geographic information.

Note: Each Field at the HDFEOS/GRIDS level contains its own *Data Fields* Subdirectory described below

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Table 10 – HDFEOS/GRIDS/Data Fields Contents for Unpolarized Spectral Bands

Field Name Parameter Description	Dimension List	Number Type	Units	Flag Values
Step-and-stare (Spatial Sampling: 10 m x 10 m, XDim = 3584, YDim = 3584) **Sweep (Spatial Sampling: 25 m x 25 m, XDim = 3584/4608, YDim = 2048)**				
I Radiance	XDim, YDim	FLOAT32	W/m^2-sr-nm	FillValue =-999.0
I.mask Indicates locations with valid data	XDim, YDim	INT32	None	0 = Not valid 1 = Valid
RDQI Radiometric Data Quality Indicator	XDim, YDim	FLOAT32	None	0 = Within specifications 1 = Reduced accuracy 2 = Not usable for science 3 = Unusable for any purpose
Sun_azimuth Azimuth angle of the sun relative to North (0°)	XDim, YDim	FLOAT32	Degrees	FillValue = -999.0
Sun_zenith Solar zenith angle relative to overhead sun (0°)	XDim, YDim	FLOAT32	Degrees	FillValue = -999.0
Time_in_seconds_from_epoch Time in seconds from the epoch	XDim, YDim	FLOAT64	Seconds	FillValue = -999.0
View_azimuth Azimuth angle of the camera relative to North (0°)	XDim, YDim	FLOAT32	Degrees	FillValue = -999.0
View_zenith View zenith angle relative to nadir (0°)	XDim, YDim	FLOAT32	Degrees	FillValue = -999.0

Table 11 – Additional HDFEOS/GRIDS/Data Fields Contents for Polarized Spectral Bands

Field Name Parameter Description	Dimension List	Number Type	Units	Flag Values
Step-and-stare (Spatial Resolution: 10 m x 10 m, XDim = 3584, YDim = 3584) **Sweep (Spatial Resolution: 25 m x 25 m, XDim = 3584/4608, YDim = 2048)**				
AOLP_meridian Angle of linear polarization (AOLP) relative to the meridian plane	XDim, YDim	FLOAT32	Degrees	FillValue =-999.0
AOLP_scatter AOLP relative to the scattering plane	XDim, YDim	FLOAT32	Degrees	FillValue = -999.0
DOLP Degree of linear polarization	XDim, YDim	FLOAT32	None (Range 0.0 – 1.0)	FillValue = -999.0
Q.mask Indicates locations with valid Q data	XDim, YDim	INT32	None	0 = Not valid 1 = Valid
Q_meridian	XDim,	FLOAT32	W/m^2-sr-nm	FillValue = -999.0

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Q Stokes parameter relative to the meridian plane	YDim			
Q_scatter Q Stokes parameter relative to the scattering plane	XDim, YDim	FLOAT32	W/m^2-sr-nm	FillValue = -999.0
U.mask Indicates locations with valid U data	XDim, YDim	INT32	None	0 = Not valid 1 = Valid
U_meridian U Stokes parameter relative to the meridian plane	XDim, YDim	FLOAT32	W/m^2-sr-nm	FillValue = -999.0
U_scatter U Stokes parameter relative to the scattering plane	XDim, YDim	FLOAT32	W/m^2-sr-nm	FillValue = -999.0

Table 12 – HDFEOS/GRIDS/Data Fields Contents for Ancillary Data

Field Name Parameter Description	Dimension List	Number Type	Units	Flag Values
Step-and-stare (Spatial Resolution: 10 m x 10 m, XDim = 3584, YDim = 3584) **Sweep (Spatial Resolution: 25 m x 25 m, XDim = 3584/4608, YDim = 2048)**				
Latitude Geographic Latitude	XDim, YDim	FLOAT64	Degrees North	FillValue =-999.0
Longitude Geographic Longitude	XDim, YDim	FLOAT64	Degrees East	FillValue = -999.0

Table 13 – HDFEOS INFORMATION Contents

Field Name	**Description**
StructMetadata.0	Structural metadata for the file. This is ancillary information regarding the HDF-EOS contents of the grids within the file, including field names, dimensions, and data types, in a human readable format.

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3 Appendix

Acronym List

AirMSPI.....Airborne Multiangle SpectroPolarimetric Imager
AOLP ..... Angle of Linear Polarization
ASDC.....Atmospheric Science Data Center
ASL ..... Above Sea Level
AU..... Astronomical Unit
BRF ..... Bidirectional Reflectance Factor
DOLP ..... Degree of Linear Polarization
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
GCTP ..... General Cartographic Transformation Package
HDF-EOS ..... Hierarchical Data Format for EOS
JPL ..... Jet Propulsion Laboratory
LaRC ..... Langley Research Center (NASA)
MISR..... Multi-angle Imaging SpectroRadiometer
NASA..... National Aeronautics and Space Administration
NIR..... Near Infrared
SCF ..... Science Computing Facility
SDP ..... Science Data Processing
UTC ..... Coordinated Universal Time
UTM ..... Universal Transverse Mercator
UV ..... Ultraviolet
VIS ..... Visible

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