MEGHA-TROPIQUES

PRODUCT DEFINITION DOCUMENT

Instantaneous non-precipitating conditions

Level 2 products

Relative Humidity profile

Derived from SAPHIR

SAPHIR-L2-RH

Version 1

Release 5

N° PDD-SAP-L2-RH_V1_R5

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1. Releases

Release N°	Publication date	Author	Brief description of the change
	September 2014	C. Dufour	1rst draft
R0	September 2014	R. Sivira	1rst release
R1	August 2015	C. Dufour	Add layers description
R2	October 2015	C. Dufour	Add L2B products description
R3	October 2015	C. Dufour	Layers description in L2 global attributes
R4	November 2015	C. Dufour	Syntax corrections
R5	January 2017	C. Dufour	New method for relative humidity profile retrieval

2. Product content

This document specifies the format of Megha-Tropiques level 2 (L2) products derived from the SAPHIR microwave radiometer. Those L2 products are instantaneous relative humidity profile products, on a pixel by pixel basis. For each pixel, relative humidity profile (on 6 layers) is given with its error estimation, over both land and ocean surfaces. The relative humidity retrieval algorithm used within the Megha-Tropiques framework is called ARPIA and is described in more details in RD1.

The L2 products are for the moment only derived from the SAPHIR L1A2 products. Three different level 1 products are proposed for the MEGHA-TROPIQUES data: 1A1, 1A2, 1A3. The 1A1 provide a "raw" set of calibrated and navigated brightness temperatures. The 1A2 and 1A3 are identical, with a re-mapping of all the channels to the position of the 89 GHz pixel centers. In the future ARPIA should work with SAPHIR and MADRAS 1A3 products together. More details on L1 definition and content can be found in RD2.

The L2A2 RH products are in the same observing geometry as the SAPHIR microwave measurements level 1A2. The L2 files have the same structure as the input L1A2 files: one file per orbit, one file for ascending and one for descending orbit. Information on housekeeping data are transferred from the L1A2 files to the L2 files (geolocation, time scan, navigation …).

3. Format of the SAPHIR RH L2 products

Currently, the Level 2 products are in the HDF4.2r10 format and contain datasets with gzip compression level of 5.

The file naming convention for the L2 Megha-Tropiques products is the following:

<INSTRUMENT>_<PRODUCT>_<DATATION>_<VERSION>.<EXT>

With:

- <INSTRUMENT> = "MT1"

- <PRODUCT> = <L2PRODUCT>-<L1PRODUCT>"
  - <L2PRODUCT> = Relative Humidity level 2 product familly : "L2-RH"
  - <L1PRODUCT> = SAPHIR Level 1 A2 origin
  Ex: "SAPSL1A2_X.YY" or "SAPOL1A2_X.YY"

- <DATATTION> = "YYYY-MM-DDThh-mm-ss"

Date of the first record (Year, Month, Day, hour, minute, second).
Ex: "2012-01-01T00-00-00"

- <VERSION> = “V<X-YY>”

Product version. Ex: “V1.05”

- <EXT> = “hdf”

HDF4 file suffix.

Example : “MT1_L2-RH-SAPOL1A2-1.05_2012-01-01T11-02-36_V1-00.hdf”

The Level-2 products structure is as follow and described in detail hereafter:

GLOBAL ATTRIBUTES	Global attributes outside datasets
GENERIC DATASET ATTRIBUTES	Generic attributes in all datasets
GEOLOCATION FIELDS	Datasets which are include in Vgroup: 'Geolocation_Fields'
DATA FIELDS	Datasets which are include in Vgroup: 'Data_Fields'

Dimensions used in dataset are:

- nscan = Number of scans
- npix = Number of pixel per scan
- nlayer = Number of profiling layers = 6

There are 6 layers for relative humidity defined by their heights as follows:

L1 : 100 hPa - 200 hPa
L2 : 250 hPa - 350 hPa
L3 : 400 hPa - 600 hPa
L4 : 650 hPa - 700 hPa
L5 : 750 hPa - 800 hPa
L6 : 850 hPa - 950 hPa

Table 1 : GLOBAL ATTRIBUTES		
Attribute Name	**Type**	**Notes**
File_Name	String	File name
ICARE_ID	String	File identifier in ICARE product database
Product_Description	String	Relative Humidity Profile and its conditional error PDF: The relative humidity profile retrieval algorithm coupled with the estimated standard deviation parameter of a Gaussian function describing the conditional error PDF are used within the Megha-Tropiques framework and is called ARPIA. See more details in Sivira et al. (2014) and R. Sivira (PhD these, 2013) respectively.
HDF_Version	String	Version of the HDF 4 library
Beginning_Acquisition_Date	String	Date of the first valid scan in the file. Format = YYYY-MM-DDThh-mm-ss For example : '2010-05-01T14:38:24'
End_Acquisition_Date	String	Date of the last pixel in the file. Format = YYYY-MM-DDThh-mm-ss For example : '2010-05-01T14:38:54'
North_Bounding_Latitude	Float 32	Latitude (in degrees) of the northernmost pixel.
South_Bounding_Latitude	Float 32	Latitude (in degrees) of the southernmost pixel.
West_Bounding_Longitude	Float 32	Longitude (in degrees) of the westernmost pixel.
East_Bounding_Longitude	Float 32	Longitude (in degrees) of the easternmost pixel.
Nadir_Pixel_Size	String	Resolution of relative humidity pixels : Same as SAPHIR.
Software_Version	String	Framework version (ICARE). For example : '2.3.6'
Product_Version	String	'VX-YY'. For example : 'V1-00'
Production_Center	String	Where the file is produced. For example : 'ICARE-CGTD'
Production_Date	String	Date of file creation. Format = YYYY/MM/DD hh:mm:ss For example : '2011/12/05 10:17:00'
Attributes_Info	String	'None'
Sensors	String	Satellite name / Sensor name : 'MT1/SAPHIR'
Input_Files	String	File name of the input L1 product
Ancillary_Files	String	Configuration file which contains GLM/GAM parameters. For example : 'CFGMODS_SAPHIR_V1-00.h5'
Mission	String	This attribute is set to : 'Megha-Tropiques'
Product_Name	String	This attribute is set to : 'SAPHIR-L2-RH'
Scientific_Software_Version	String	Software version of ARPIA. For example : '1.0'
Level1_Version	String	It's the 'ProcessorVersion' from the L1 input product.
Layers	String	'There are 6 layers for relative humidity defined by their pressure boundaries as follows: L1 = 100-200 hPa / L2 = 250-350 hPa / L3 = 400-600 hPa / L4 = 650-700 hPa / L5 = 750-800 hPa / L6 = 850-950 hPa'
GEO_AuxFile_Version	String	Version of auxiliary files used for L1 input product.
RAD_AuxFile_Version	String	Version of auxiliary files used for L1 input product.

Table 2 : GENERIC DATASET ATTRIBUTES		
Attribute Name	**Type**	**Notes**
long_name	String	Detailed name of the dataset.
units	String	Definition of the units. For example : '%'
format	String	Description of the data format. Format used are : '32-bit floating-point', '64-bit floating-point' and '16-bit integer'
HDF_Calibration_Equation	String	'physical_value = scale_factor*SDS_count + add_offset
Missing_Output	Variable	Value used to fill areas of an array not intended to contain either valid data or a fill value. Same type as dataset values. Int 32 => -9999
QA_SDS	String	This attribute is set to : 'None'
actual_range	Variable x2	Effective data range value for the file. Vector of two elements with same type as dataset values : Min, Max
Num_Fill	Int 32	Number of elements in dataset which stay at filling value
Num_Missing_Output	Int 32	Number of missing value
Num_Valid	Int 32	Number of values in dataset except missing or filling values.
Physical_Range	Float 64 x2	Physical data range value for the file. Vector of two elements : Min, Max
Comments	String	Dataset description
valid_range	Variable x2	Valid data range value for the file. Vector of two elements with same type as dataset values : Min, Max
_FillValue	Variable	Value used to fill empty locations in an SDS array. Same type as dataset values. Int 32 => -9999
scale_factor	Float 64	Value by which each array value is to be multiplied. This attribute is set to : 0.01
scale_factor_std_err	Float 64	Error introduced by scaling SDS array data This attribute is set to : 0.01
add_offset	Float 64	Value to which each array value is to be added This attribute is set to : 0.0
add_offset_std_err	Float 64	Error introduced by offsetting the SDS array data This attribute is set to : 0.0
calibrated_nt	Int 32	Data type of the calibrated data with HDF code.

Table 3 : GEOLOCATION FIELDS				
Variable	**Type**	**Units**	**Range**	**Dimensions**
UTC_Date_Scan	String			[nscan]
POSIX_Date_Scan	Float 64	second		[nscan]
Latitude	Float 32	Degrees	-90:90	[nscan, npix]
Longitude	Float 32	Degrees	-180:180	[nscan, npix]
Surface_flag	Int 16	none	0:2	[nscan, npix]
ClrPixel_flag	Int 16	none	0:1	[nscan, npix]
HONG_flag	Int 16	none	0:15	[nscan, npix]

Table 4 : GEOLOCATION FIELDS NOTES	
Variable	**Notes**
UTC_Date_Scan	Calendar date for each scan. Format = 'YYYY-MM-DDThh:mm:ss'
POSIX_Date_Scan	"Date of the scan: number of seconds that have elapsed since midnight Coordinated Universal Time (UTC), 1 January 1970"
Latitude	"Latitude of the pixel"
Longitude	"Longitude of the pixel"
Surface_flag	"Indicate the type of surface: 0->ocean; 1->land; 2->coast."
ClrPixel_flag	"Indicate if there are clouds: 0->clouds; 1->clear."
HONG_flag	“4 bits to indicate each result for HONG class tests : 0->Rainy Pixel; 1->Deep Convection; 2->Convective overshoot; 3->Low Rainy Pixel.”

Table 5 : DATA FIELDS				
Variable	**Type**	**Units**	**Range**	**Dimensions**
RH	Float 32	%	0:100	[nscan, npix, nlayer]
UNCERTAINTY	Float 32	%	0:100	[nscan, npix, nlayer]
MEDIAN	Float 32	%	0:100	[nscan, npix, nlayer]
Error_Standard_Deviation	Float 32	%	0:100	[nscan, npix, nlayer]
ALPHA	Float 32	none	0;+◎	[nscan, npix, nlayer]
BETA	Float 32	none	0;+◎	[nscan, npix, nlayer]
Quality_Index	Int 32	none		[nscan, npix]

Table 6 : DATA FIELDS NOTES	
Variable	**Notes**
RH	"Expected value for the relative humidity (RH) profile computed as an estimate of the Beta distribution by considering only clear sky conditions."
UNCERTAINTY	“Estimated uncertainty about the expected value: Half the difference between the third and the first quartile of the cumulative distribution function.”
MEDIAN	“Median of the distribution”
ALPHA	“Alpha parameter of the Beta distribution for RH”
BETA	“Beta parameter of the Beta distribution for RH”
Error_Standard_Deviation	"Standard deviation of the conditional error function: The standard deviation parameter for the beta distribution with RH as the expected value."
Quality_Index	"The Quality_Index is a 32 bits word where each bit as a significant value: 0) Coastal Profile (no guarantee in restitution); 1: Rainy pixel; 2-5): Rainy pixel details; 6) Empty; 7-24): 6 groups of 3 bits (one for each layer) related to 1: Very high relative humidity (over 97%); 2: Extrapolation outside the learning range; 3: Cloudy Layer; 25-31): L1 Quality Flags (Currently 0)."

4. Format of the SAPHIR RH L2B products

The format of the additional level 2B (L2B) products derived from the previous L2 RH products is described below. This L2B product is instantaneous but on a 1°x1° geographical grid. To compute the L2B product, all L2 RH pixels present in one L2B gridpoint are averaged weighted by uncertainty; the averaged RH calculation for one L2B cell is possible if the L2B grid cell is 75% covered by the L2 pixels.

Currently, the Level 2B products are in the NetCDF-3 format.

The file naming convention for the L2B Megha-Tropiques products is the same as the L2 files:

MT1_L2B-RH-<L1PRODUCT>_< YYYY-MM-DDThh-mm-ss >_V< X-XX >.nc

The Level-2B products structure is as follow and described in detail hereafter:

GLOBAL_ATTRIBUTES	File metadata
VARIABLES	All the variables

GLOBAL Attributes Notes	
File_Name	Name of the file.
Product_Description	Resumes the principle of the inversion algorithm
North_Bounding_Latitude	30
South_Bounding_Latitude	-30
West_Bounding_Longitude	0
East_Bounding_Longitude	360
Nadir_Pixel_Size	1.0 deg
Software_Version	Version of the complete framework algorithm
Product_Version	Version of the product (ex : VX.XX)
Production_Center	ICARE
Production_Date	Ex : 2013/07/27 20:55:56
Sensors	Sensor used for the inversion; here: MT/SAPHIR
Mission	Megha-Tropiques
Input_Files	Name of the L2 file used to compute the L2B file
Level1_file	Name of the L1 file used to compute the L2 file
NETCDF_Version	Netcdf version used to generate the file
Beginning_Acquisition_Date	Date UTC of the first pixel in the corresponding L2 file (YYYY-MM-DDTHH-MM-SS)
End_Acquisition_Date	Date UTC of the last pixel in corresponding the L2 file (YYYY-MM-DDTHH-MM-SS)
Product_Name	MT1_L2B-RH-[L1 VERSION NAME]
Icare_ID	ICARE internal identifier

Table 7 : L2B-RH Global Attributes notes

VARIABLES						
Parameter & Note	**Data Type**	**Units**	**Range**	**Fill Value**	**Missing Output**	**Size**
Time	Double	seconds	NA	NA	NA	[1]
Latitude	Float	Degrees_north	-29.5, 29.5	99999.f	999999.f	[60]
Longitude	Float	Degrees_east	0.5, 359.5	99999.f	999999.f	[360]
Layer	Int	NA	1,6	2147483647	-2147483648	[6]
Pixel_time	Double	seconds	NA	99999.f	999999.f	[1,60,360]*
RH	Float	%	0,100	99999.f	999999.f	[1,6,60,360]*
RH_Error_Standard_Deviation	Float	%	0,100	99999.f	999999.f	[1,6,60,360]*
RH_quality	Float	%	0,100	99999.f	999999.f	[1,6,60,360]*

* : first dimension : time dimension added = [1]

Table 8 : L2B-RH Variables

VARIABLE notes	
Time	Unlimited dimension. The time value is the first scan time expressed in “seconds since 2011-10-12 00:00:00.00".
Latitude	Latitude of each gridpoint of the 1°x1°grid. Latitude represents the center of gridpoint. A positive value means North.
Longitude	Longitude of each gridpoint, representing the center of gridpoint.
Layer	RH is determined for nlayers , where each layer corresponds to one of the 6 following channels: layer = 1: RH from 100 hPa to 200 hPa layer = 2: RH from 250 hPa to 350 hPa layer = 3: RH from 400 hPa to 600 hPa layer = 4: RH from 650 hPa to 700 hPa layer = 5: RH from 750 hPa to 800 hPa layer = 6: RH from 850 hPa to 950 hPa
Pixel_time	The mean time value of each gridpoint is computed by averaging the time value of all the instantaneous L2 pixels included in a gridpoint (Only first pass is considered). A L2 pixel (lat,long) is included in a gridpoint centered at (Latitude, Longitude) if its lat/long values are included in the range (Latitude/Longitude +/- 0.5°). The pixel time format is "seconds since 2011-10-12 00:00:00.000".
RH	The mean RH value of each gridpoint is computed by averaging all instantaneous L2 RH pixels included in a gridpoint weighted by their uncertainty.
RH_Error_Standard_Deviation	The error standard deviation of RH values included in each gridpoint weighted by their uncertainty.
RH_quality	Percentage of valid RH (QUALITY_FLAG) values within each 1°x1° gridpoint.

Table 9 : L2B-RH Variables notes

5. Reference Documents

Index	Title of document	Reference
RD1	A layer-averaged relative humidity profile retrieval for microwave observations: design and results for the Megha-Tropiques payload.	Sivira, R., Brogniez, H., Mallet, C., Oussar, Y., 2015. Atmos. Meas. Tech., 8, pp1055-1071.
RD2	Exploitation des mesures "vapeur d'eau" du satellite Megha-Tropiques pour l'élaboration d'un algorithme de restitution de profils associés aux fonctions de densité de probabilité de l'erreur conditionnelle.	R. Sivira, PhD these 2013, Université Pierre et Marie Curie.
RD3	Megha Tropiques L1 product definiton	2012_03_21_Level-1productdef_ED2rev8.pdf