Manuel utilisateur MAJA

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MAJA Team

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GLOSSARY AND LIST OF TBC AND TBD ITEMS

CS Systèmes d'Information

Business Unit ESPACE
Département Payload Data & Applications
Image Processing

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USER, INSTALLATION AND OPERATING MANUAL FOR MAJA CHAINS [MU]

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CHAPTER

ONE

GLOSSARY AND LIST OF TBC AND TBD ITEMS

CR	Change Request

List of TBC items:

List of TBD items:

CHAPTER

TWO

REFERENCE AND APPLICABLE DOCUMENTS

Here below the list of reference and applicable documents for this manual:

[AD01] ESA Generic Processor Interfaces Guidelines, issue 1, revision 0 of 20/10/2006.

[RD01] Dossier de Performances, SETG**-DP-MAJA-010-CS,** (in french).

[RD02] Technical Note. Venus Ground Segment Interfaces file format specification, VE-NT-GSSM-196-CNES

[RD03] Technical Note Sentinel-2 MAJA Level-2A Product Format Specification, GS2-NT-GSL2-1320-CNES

[RD04] MAJA Level 1 and 2 products specification for FORMOSAT2, LANDSAT5, 7, 8 AND SPOT4 (“proto” format”, PSC-IF-411-0081-CNES

[RD05] Spécification de format des produits (format “muscate”),PSC-SL-411-0032-CG

[RD06] Sentinel-2 Products. Specification Document, S2-PDGS-TAS-DI-PSD, V12 and V14 (both products formats handled by MAJA software)

[RD07] Landsat8 (L8), Level 1 (L1) Data Format Control Book (DFCB),V8.0

CHAPTER

THREE

SYSTEM REQUIREMENTS

3.1 Host platform

MAJA software shall be installed, used and operated on a Linux platform; MAJA is available for all 5.x, 6.x and 7.x versions of the OS. Performance tests (cf. [RD02]) suggest to use a platform with at least 4 Gb of RAM.

3.2 Space disk requirements

Data volumes change considerably according to the mission (Formosat, Landsat, Venus or Sentinel-2) processed in MAJA execution.

Space disk dimensioning for the host platform has been performed considering the worst cases between all the figures observed with the data of the different spectral cameras.

At least the following space disk shall be available on the platform to run one single execution of MAJA:

- Input data volume: 4 GBytes (1 GBytes for GIPPs files and DTM and 3 GBytes for the L1 image product),
- Output data volume: 4 GBytes (L2 image product)
- Caching data directory volume: ~100 GBytes

  The caching directory is named ".maja-temporary-directory" and it is created in the output directory; by default, it is automatically deleted at the end of each successful processing.

  Cleanup options are configurable via dedicated parameters in the "MAJAUserConfigSystem.xml" configuration file (by default value is "enable").

  For investigation purposes, it is then possible to disable this cleanup and keep all the intermediary files (see *User configuration files*).

CHAPTER

FOUR

INSTALLATION MANUAL

This section describes the procedure to install MAJA software.

MAJA **installation** consists of one step:

1. Installation of the COTS and the scientific chains for operational context (MAJA).

4.1 User Account and permission for installation

The installation directory is configurable and must be defined during the install process. It is mandatory to have the right of writing in the installation directory.

4.2 MAJA installation

4.2.1 Requirement

A valid MAJA binary package

4.2.2 Description of the package delivered

MAJA is delivered as a .run package:

MAJA-<Version>.run

The validity of this binary package is checked automatically during installation.

Where **<Version>** is the version number of the MAJA configuration item given as **"X.Y.Z", being:**

X: first version digit , incremented for versions implementing major CR

Y: second version digit, incremented for versions implementing minor CR or correcting bugs

Z: third version digit, incremented to indicate patch version.

4.2.3 Package installation

To show install options, execute the following command:

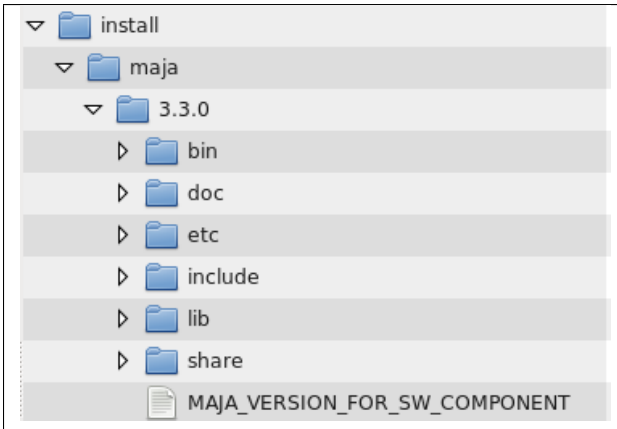
$ MAJA-<Version>.run –help

To install MAJA in a specific destination directory, execute the following command:

$ MAJA-<Version>.run –target <install directory>

4.2.4 Arborescence of the installation of MAJA

MAJA installation creates the following arborescence (example for "/opt" installation directory):



/<install_dir>/maja: MAJA base directory
/<Version>: contains the version <Version> of the scientific chains version <Version> (formatted with two digits) **/bin**: contains the executables and scripts
/etc: contains user data files
/conf: configuration files
/admin: admin configuration files, use only by the administrator of MAJA
/user: users configuration files
/lib: contains the library
/share: contains the resources files
/config: contains the internal configuration files for MAJA Administrator. Do not modify.
/ddc: ddc files for project management. . Do not modify.
/doc: copyright information
/schemas: contains all the ICD schemas used by the chains (EarthExplorer, Venus, Maja, Senitnel2, etc…)
/MAJA_VERSIONS_FOR_SW_COMPONENT: show the version of MAJA

CHAPTER

FIVE

USER MANUAL

This chapter describes the user manual for the MAJA chains.

5.1 User account and permission

The user needs at least read and execution rights within the MAJA install directory (see *Package installation*).

5.2 Launching MAJA processing

MAJA is launched in command line in two possible ways (example for "/opt" installation directory):

- Providing the JobOrder file as argument of the command line:

```
$ /<path to maja installation dir>/bin/maja --jobOrder
./myJobOrder.xml
```

The JobOrder file details the processing mode, the access path to all the inputs (images, GIPP, DTM, meteo data) and to the configuration files, the access path to the directory containing all the output produced by MAJA.

Note: the possible values for the <Processor_Name> node are:

- MAJA_L2_INIT_CHAIN
- MAJA_L2_NOMINAL_CHAIN
- MAJA_L2_BACKWARD_CHAIN

An example of Job Order file is provided in [AD01].

- Providing all the processing details (processing mode, input data directory, output directory, etc) as arguments of the command line:

```
$ /<path to maja installation dir>/bin/maja

$ --mode L2INIT # Processing mode

$ --input ./Input/Images # Input data directory

$ --conf ./Input/Conf # User configuration files directory$

$ --TileId "ID" # TileId, only necessary for PSD13 Sentinel2 products

$ --output ./WorkingDir # Output working directory
```

The user can obtain the help to launch MAJA processing executing the following command line:

```
$ /<path to maja installation dir>/maja --help
```

This command produces the helper lines detailed in Annex A

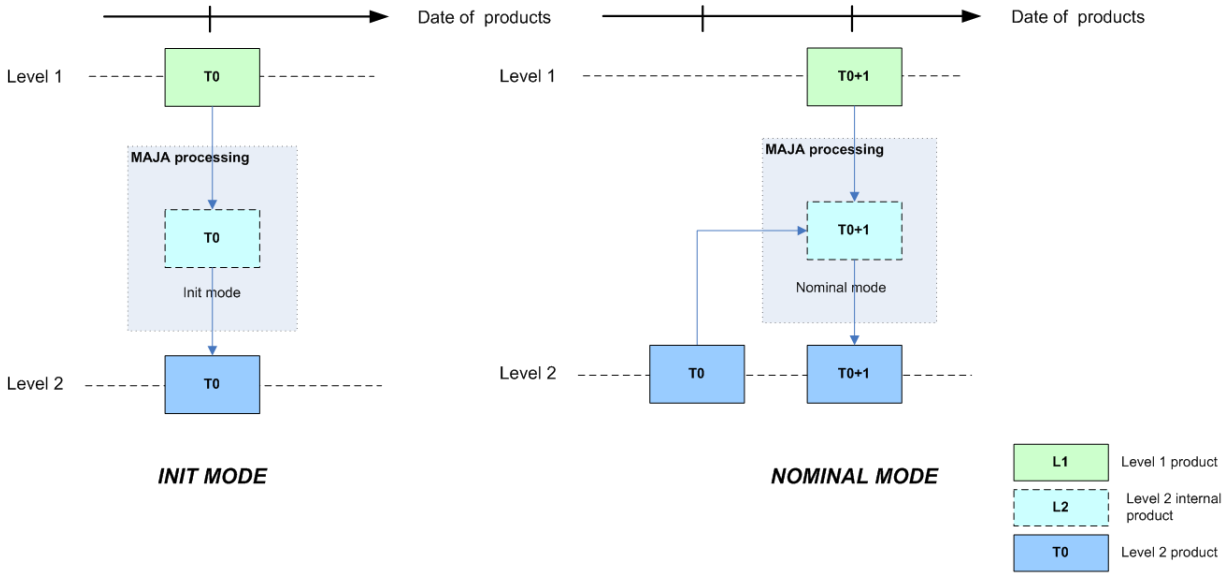
Additional details about the processing mode, the inputs expected by MAJA and the outputs produced are provided in the following paragraphs.

5.3 Interfaces of MAJA chains

5.3.1 MAJA Processing modes

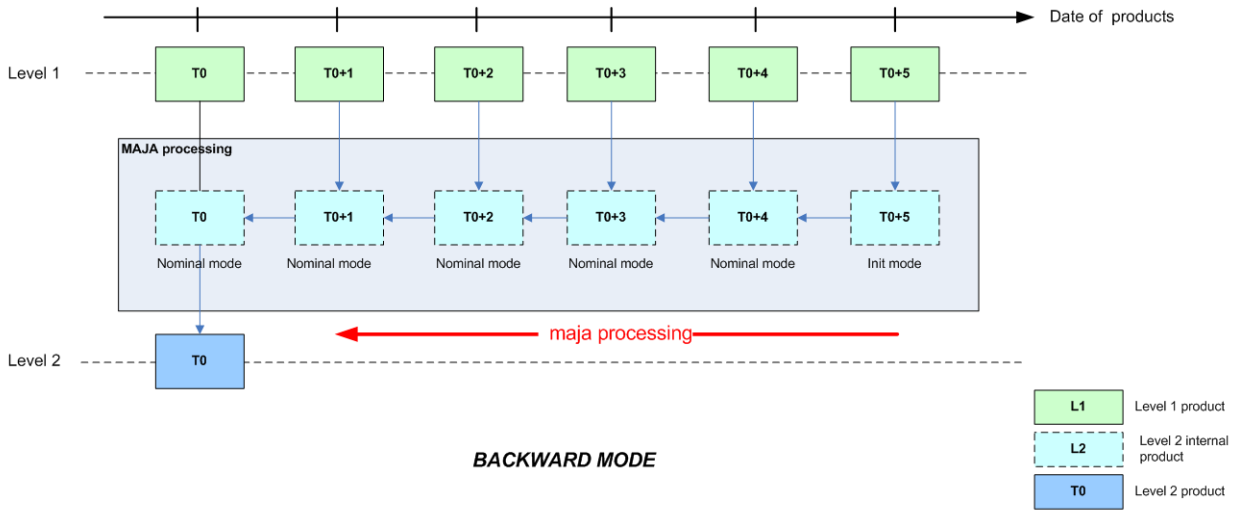
The level 2 chain implements successively several different algorithms such as atmospheric correction, cloud and snow detection or slope and environment correction in order to generate level 2 products. Some of those algorithms are multi temporal, therefore the chain uses level-2 product of date D-1 (the last available level 2 product) to generate the level 2 product of date D.

An initialization process for the first product of a time series has been developed (*Init mode*); in this mode the product is generated with a priori values and is just used to start a new time series. This first level 2 product of date D is then used to generate the product of date D+1 in *nominal mode* and so on for all the time series of level 1 products.



The level 2 product generated in init mode are usually of inferior quality. In order to avoid the former, the *backward mode* has been added in MAJA. This mode is used to improve the quality of the first level 2 product of a time series. The L1 products are processed from the youngest (date D+N) back to the oldest (date D).

In this mode the youngest L1 product (D+N) is processed in init mode. The older L1 products of the time series (D+i) are then processed in nominal mode using the level 2 product of date D+i+1 as input and so on backward to the oldest ones (D). The oldest level 2 product of date D is then used as input to reprocess all the products of the time series from the oldest to the youngest one in *nominal mode*.



MAJA allows seven different processing modes:

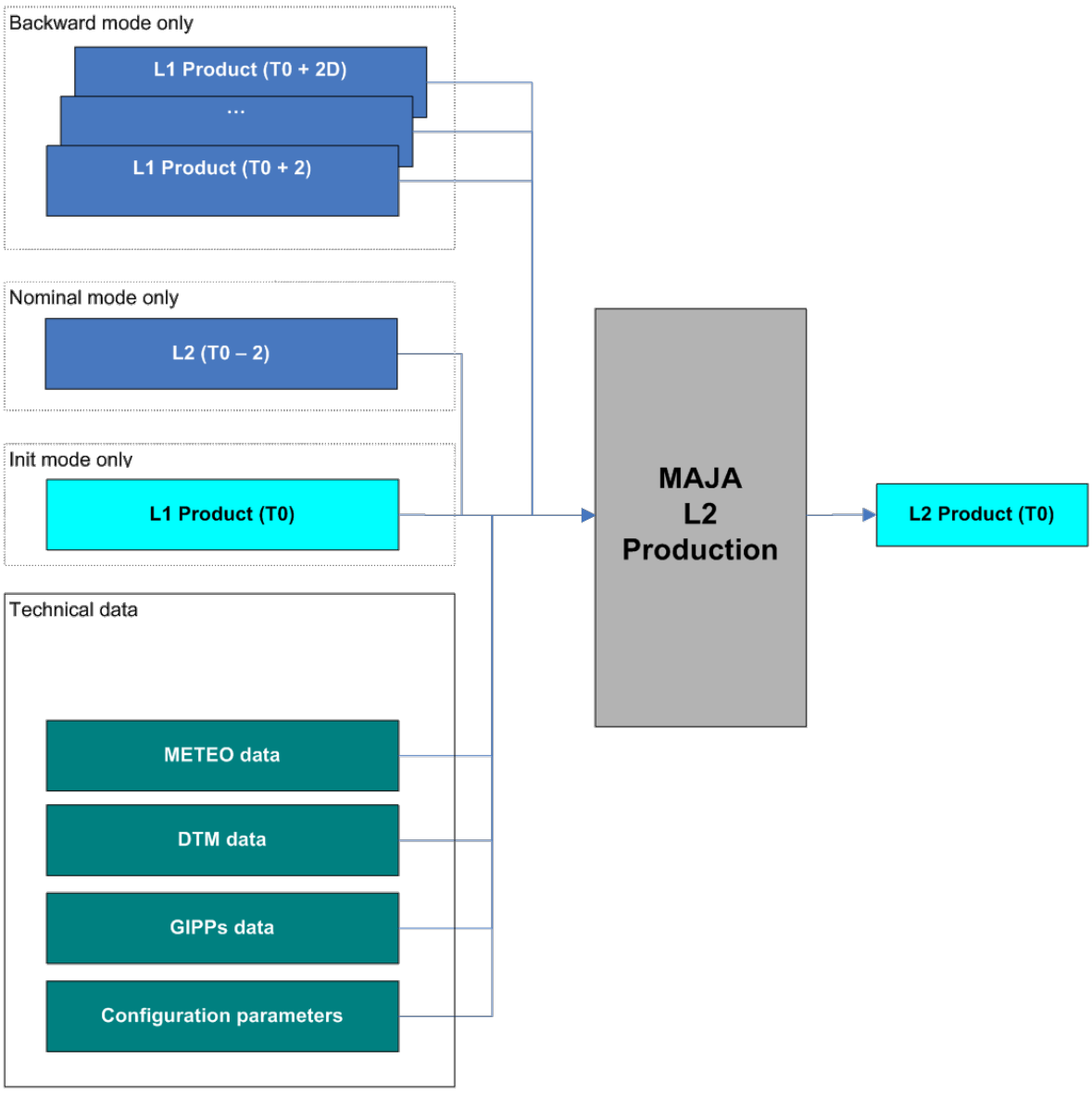
- Level-2 products generation:
  - Init Mode
  - Backward Mode
  - Nominal Mode

5.3.2 Processing Interfaces

The following figures show MAJA inputs and outputs for all the processing modes.

In particular, the input products for the Level-2 processing are:

- 1 Level-1 product for the Init Mode
- N Level-1 products for the Backward Mode
- 1 Level-1 product and 1 Level-2 product for the Nominal Mode.



When MAJA is launched, all the input data shall be available in the input directory:

- L1, L2 image product (according to the processing mode),
- DTM data covering the tile (see section *Auxiliary data of MAJA*)
- Meteo data applicable for the acquisition date of EACH L1C product (see section *Auxiliary data of MAJA*)
- Production parameters: GIPP applicable for the acquisition date of EACH L1C product (see section *GIPPs files of MAJA*)

  The output data generated by MAJA will all be in the specified output directory:

- L2 Image product and/or quicklook

  Additional details on the Inputs and Outputs are provided in *The products*, *Auxiliary data of MAJA* and *GIPPs files of MAJA*.

5.3.3 Operational Interfaces

MAJA respect the Interface detailed in [AD01].

Among these interfaces, there are:

- The « JobOrder »,
- The « Logging »,
- The « ExitCode »,

  The log messages are displayed in the standard output.

  The error messages are displayed in the standard error output.

  For additional details on these interfaces see *Operating manual* .

5.3.4 Revisit improvement via sensors mixing

MAJA offers the possibility of processing product time series acquired by different sensors in order to improve the revisit over an area; the following conditions shall be satisfied:

- The images to be processed shall have exactly the same footprint
- The images to be processed shall have the same pixel origin convention (center pixel or upper left corner),
- The coarse resolution chosen for the PRIVATE images of the L2 product and for the DEM low resolution images shall be identical for the two sensors,
- The bands selected for the multi-temporal processing and stored in the PRIVATE part of L2 product shall be the same for the two sensors (see section *GIPP configuration file (GIP_L2COMM)*),

Note that the bands used for multi-temporal are indicated in GIPP L2COMM and are used to detect the clouds, shadows, aerosols, etc. Then these data are used for atmospheric correction of all the bands to process.

5.4 The algorithms

Processing options are defined as a function of sensor in the chain. Depending on the spectral bands and stereoscopic capabilities of the satellite, some methods can or cannot be applied to the times series of the satellite. Table 1 summarizes the main options.

	Venus ("muscate" and native formats)	Sentinel2 ("muscate" and native formats)	Landsat8 ("muscate" and native formats)
Stereoscopic	X		
cloud detection			
Water vapour determination	X	X	
Snow detection		X	X
Cirrus flag	X		
Cirrus mask		X	X
Snow mask	X	X	X

5.5 The products

General information on Level-2 products

In Level-2 products:

- Water Vapour data is expressed in g/cm2
- Atmospheric Optical Thickness is dimensionless.

The Scale factors can be found in the main HDR in "Quantification_value" tags.

It should be noted that the LTC plan (Luts of Top Of Canopy reflectance) are not consistent in the output L2 product. It depends on the method used to estimate the aerosol optical thickness. If the processed method is multi spectral, only the current date is used and the LTC set in the composite products are not necessary. Therefore, a composite product generated with the multi spectral method could not be reused to process a L1 product with another method.

Some clarification should be made to the STO file stored in the private part of the L2 product. The "STO.DBL.DIR" file contains the TOA reflectance images after correction for absorbing atmospheric molecules for a given spectral band ("Correl_Band_Code" parameter set in the GIP_L2COMM file) and for a maximum number of dates ("Number_Of_Stack_Images" parameter set also in the GIP_L2COMM). In this file, the images are stacked as follows:

Band 1 = D (date of the current product)

Band 2 = D+1

Band 3 = D+2

...

Band 10 = D+9

In the "STO.HDR" file, the list of dates is stored in the "List_of_Bands" tag:

<Band sn="1">20130719</Band> => date D

<Band sn="2">20130703</Band> => date D+1

...

<Band sn="10">20130905</Band> => date D+9

Therefore the current date is added at the top of the stack (band 1), the other dates shift back and the oldest date stored in the STO file (which is the most recent date in backward mode) is removed (for instance the 11^{th} date if the STO file contained yet 10 dates).

Peculiarities on Level-2 products depending on the algorithms:

In line with Table 1, Level-2 products have slight differences due to slightly different algorithms applied to the input data:

- Venus Level-2 product is the only one providing the cloud altitude image because is the only sensor for which stereoscopy method in cloud masking can be applied;
- Cirrus mask is provided exclusively in Landsat8 and Sentinel-2 products
- Snow mask is provided Landsat 8, Sentinel-2 and Venus format products
- The quality mask indicating if water vapor mask has been estimated or interpolated is provided exclusively in Venus and Sentinel-2 products.

Validity of the Level-2 product:

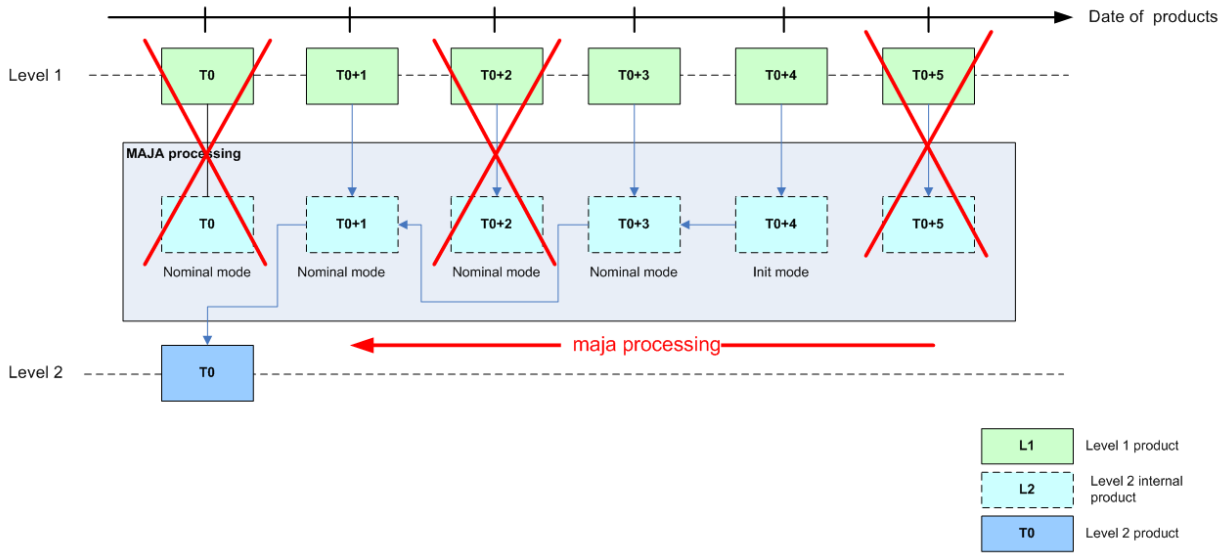
A Level-2 product is declared **valid** (flag L2VALD) when:

- The input Level-1 product is not too cloudy* and is not contains too many 'no_data' pixels**
- In nominal mode, the input Level-2 product is not too cloudy*,
- The output Level-2 product computed is not contains too many 'no_data' pixels

In the backward mode, the Level-2 product is declared valid if at least one of the Level-2 product of the series is determined as valid (the above conditions do not apply).

* A product is identified as too cloudy when the number of cloudy pixel is upper than the "Max_Cloud_Percentage" (parameter set in the GIP_L2COMM). Note that the 'no_data' pixels are excluded to compute this rate.

** A product contains too many 'no_data' pixels when the number 'no_data' pixels is upper than the "Max_No_Data_percentage" parameters (parameter set in the GIP_L2COMM).



In **backward** mode, MAJA:

1. **find the first valid L2 product (init mode)**: MAJA ingests the first T0+5 product, but it's detected as non valid (conditions of validity are described before) and it's excluded. The following T0+4 product is ingested and detected as valid,
2. **processes the series (nominal mode):** produces all previous intermediate L2 products, each non valid product are skipped. The T0+3 is computed, the T0+2 is ingested but excluded (non valid) and the T0+1 is computed,

3. **processes the final L2 product (nominal mode):** MAJA ingests the T0 product but it's detected as non valid and excluded. In this way, the latest final product computed in the series is the T0+1 and the date of this product is modified and set to T0.

5.5.1 Venus Image products

This section details the content of each Venus product (see [RD02]).

5.5.1.1 Level 1 product content

	Code	description	Res.	bands	Format		bits
					Entête	Donnée	
Public		Global description of the product	-	-		XML	-
	-	TOA reflectance and masks	5	15	HDR	GEOTIFF	16
		B1=>B12 TOA reflectance					
		SAT Saturated pixels mask					
		PIX aberrant pixels mask					
		CLD clouds mask					
	CLA	Cloud altitude	20	1	HDR	GEOTIFF	16
	SOL	Solar angles grid	100	8 (B05-10-07-06)	HDR	HDF	-
	VIE	Viewing angles grid	500	4 (3000-8000m)	HDR	HDF	-
	QLK	Quick look	100	3	HDR	JPEG	8
Private	EEF	complete file containing private information	-	-		-	-
	-	Geometrical model	-	-		-	-

The Venus L1 product conforms to the VENuS ICD.

5.5.1.2 Level 2 product content

	Code	description			Res. en m.	Nb. bands	bits signif.	bits write	Format Entête	Format Donnée
Public	-	Global description of the product								XML
	SRE	Surface reflectance without slope correction			10	12	16	16	HDR	GEOTIFF
	FRE	Surface reflectance with slope correction = « Flat reflectance »			10	12	16	16	HDR	GEOTIFF
	ATB	Atmospheric parameters			10	2	8	8	HDR	GEOTIFF
		VAP	Water vapour content							
		AOT	Aerosol optical thickness							
	CLD	Cloud and cloud shadow mask			10	1	8	8	HDR	GEOTIFF
		(*)	*ALL*	*Summary Logical or of All cloud and shadow masks*		*8*	*8*			
			ALL CLOUDS	*Logical or of All cloud masks*						
			SHADOWS	*Shadows mask from clouds within image*						
			SHADVAR	*Shadows mask from clouds outside image*						
			REFL	*Reflectance threshold*						
			REFL_VAR	*Reflectance variation threshold*						
			EXTENSION	*Extension of the cloud mask*						
			ALT	***Stereoscopic mask***						
	MSK	Geophysical masks			10	1	5	8	HDR	GEOTIFF
			WAT	*Water mask*		*5*	*5*			
			HID	*hidden surfaces*						
			SHD	*shadowed by topography mask*						
			STL	*sun too low flag*						
			TGS	*tangent sun flag*						
	QLT	Quality masks			10	3	12	16	HDR	GEOTIFF
		SAT	Saturation mask copied from L1 (12 useful values)				*12*			
		PIX	aberrant pixels channel copied from level 1 (12 useful values)				*12*			
		OTH	*EDG*	*Edge mask*		*3*	*3*			
			IAO	*AOT pixel mask (0 if computed, 1 if interpolated)*						
			IWC	***VAP pixel mask (0 if computed, 1 if interpolated)***						
	SOL	Solar angles grid (identical to L1 one at L2 scale)			-	-	32	32	HDR	HDF
	VIE	Viewing angles grid (identical to L1 one at L2 scale)			-	-	32	32	HDR	HDF
	-	Quick look			100	3	8	8	HDR	JPEG
Private	EEF	complete file containing private information			-	-	-	-		XML
	RTA	Composite TOA reflectances corrected from absorption			100	Nc[1]	16	16	HDR	GEOTIFF
	RTC	Composite channels for the "Top of canopy" (surface) reflectances			100	Nc	16	16	HDR	GEOTIFF
	RCR	Composite channels for surface Rayleigh corrected reflectances			100	Nc	16	16	HDR	GEOTIFF
	STO	Stack of surface rayleigh corrected reflectance images for 1 band (correl band)			100	N[2]	16	16	HDR	GEOTIFF
	PXD	Pixels dates of composite channels			100	1	16	16	HDR	GEOTIFF
	NDT	Composite no data mask			100	1	1	8	HDR	GEOTIFF
	CLD	Cloud and cloud shadow mask (*)			100	1	8	8	HDR	GEOTIFF
	CLA	Cloud altitude			100	1	16	16	HDR	GEOTIFF
	WAM	Water masks			100	3	16	16	HDR	GEOTIFF
		WAS	Water mask							
		PWA	Possible water mask (one bit for every one of the last 16 days)							
		TWA	Tested water mask (one bit for every one of the last 16 days)							
	LTC	Luts of Top Of Canopy reflectances for view and solar zenithal and azimutal angles fixed at the center of the image - 12 bands * 3D				Nc	16	16	HDR	DBL

1 : Nc = number of thematic bands used in the algorithms and defined in the GIPPs

2 : N = one band per date put in the composite product

The scale factors of each plan (SRE, FRE, ATB, etc.) are contained in the associated header (.HDR) (e.g. xml tags Reflectance_Quantification_Value or AOT_Quantification_Value). In order to optimize the size of the L2 product, some quality masks are concatenated in a unique file in which each bit is associated to a specific mask.

For instance, the cloud and cloud shadow mask at full resolution contains multiple binary masks for each pixel of the image. See the (*) in the previous Table for the description of the CLD bits.

For example, the value 19 (10011) means that the pixel is a cloudy pixel detected by the reflectance threshold algorithm.

5.5.2 Sentinel 2 Image products

The Sentinel2 L1 GPP product conforms with the GS2 ICD (see [RD03]). This section details the content of Level 2 Sentinel 2 product.

The chain allows to mix Sentinel 2A and Sentinel 2B products in nominal and backward modes.

	Code	description			Res. en m.	Nb bands	bits signif.	bits write	Format Entête	Format Donnée
Public	-	Global description of the product								XML
	SRE R1	Surface reflectance without slope correction			10	4	16	16	HDR	GEOTIFF
	SRE R2	Surface reflectance without slope correction			20	6	16	16	HDR	GEOTIFF
	FRE R1	Surface reflectance with slope correction = « Flat reflectance »			10	4	16	16	HDR	GEOTIFF
	FRE R2	Surface reflectance with slope correction = « Flat reflectance »			20	6	16	16	HDR	GEOTIFF
	ATB	Atmospheric parameters			10	2	8	8	HDR	GEOTIFF
	R1	VAP	Water vapour content							
		AOT	Aerosol optical thickness							
	ATB	Atmospheric and biophysical parameters			20	2	8	8	HDR	GEOTIFF
	R2	VAP	Water vapour content							
		AOT	Aerosol optical thickness							
	CLD R1	Cloud, cloud shadow and cirrus masks			10	1	8	8	HDR	GEOTIFF
		(*)	*ALL*	*Summary Logical or of All cloud and shadow masks*		8	8			
			ALL CLOUDS	*Logical or of All cloud masks*						
			SHADOWS	*Shadows mask from clouds within image*						
			SHADVAR	*Shadows mask from clouds outside image*						
			REFL	*Reflectance threshold*						
			REFL_VAR	*Reflectance variation threshold*						
			EXTENSION	*Extension of the cloud mask*						
			CIRRUS	***Cirrus mask***						
	CLD R2	Cloud, cloud shadow and cirrus masks			20	1	8	8	HDR	GEOTIFF
	MSK	Geophysical masks			10	1	6	8	HDR	GEOTIFF
	R1	(6 values)	*WAT*	*Water mask*		*6*	*6*			
			HID	*hidden surfaces*						
			SHD	*shadowed by topography mask*						
			STL	*sun too low flag*						
			TGS	*tangent sun flag*						
			SNW	***Snow***						
	MSK	Geophysical masks			20	1	6	8	HDR	GEOTIFF
	R2	(6 values)	*WAT*	*Water mask*		*6*	*6*			
			HID	*hidden surfaces*						
			SHD	*shadowed by topography mask*						
			STL	*sun too low flag*						
			TGS	*tangent sun flag*						
			SNW	***Snow***						
	QLT	Quality masks			10	3	4	8	HDR	GEOTIFF
	R1	SAT	Saturation mask copied from L1 (4 useful values)				*4*			
		PIX	aberrant pixels channel copied from level 1 (4 useful values)				*4*			
		OTH	*EDG*	*Edge mask*		*3*	*3*			
			IAO	*AOT pixel mask (0 if computed, 1 if interpolated)*						
			IWC	***VAP pixel mask (0 if computed, 1 if interpolated)***						
	QLT	Quality masks			20	3	6	8	HDR	GEOTIFF
	R2	SAT	Saturation mask copied from L1 (6 useful values)				*6*			
		PIX	aberrant pixels channel copied from level 1 (6 useful values)				*6*			
		OTH	*EDG*	*Edge mask*		*2*	*2*			
			IAO	*AOT pixel mask (0 if computed, 1 if interpolated)*						
			IWC	***VAP pixel mask (0 if computed, 1 if interpolated)***						
	-	Quick look			100	3	8	8	HDR	JPEG
Private	EEF	complete file containing private information			-	-	-	-		XML
	RTA	Composite TOA reflectances corrected from absorption			240	Nc[1]	16	16	HDR	GEOTIFF
	RTC	Composite channels for the "Top of canopy" (surface) reflectances			240	Nc	16	16	HDR	GEOTIFF
	RCR	Composite channels for surface Rayleigh corrected reflectances			240	Nc	16	16	HDR	GEOTIFF
	STO	Stack of surface rayleigh corrected reflectance images for 1 band (correl band)			240	N[2]	16	16	HDR	GEOTIFF
	PXD	Pixels dates of composite channels			240	1	16	16	HDR	GEOTIFF
	NDT	Composite no data mask			240	1	1	16	HDR	GEOTIFF
	CLD	Cloud and cloud shadow mask (*)			240	1	8	16	HDR	GEOTIFF
	WAM	Water masks			240	3	16	16	HDR	GEOTIFF
		WAS	Water mask							
		PWA	Possible water mask (one bit for every one of the last 16 days)							
		TWA	Tested water mask (one bit for every one of the last 16 days)							
	LTC	Luts of Top Of Canopy reflect. for view and solar zenithal and azimutal angles fixed at the center of image - 13 bands * 3D				Nc	16		HDR	DBL

1 : Nc = number of thematic bands used in the algorithms and defined in the GIPPs

2 : N = one band per date put in the composite product

Table 5: Level 2 Sentinel 2 Image product

A TIF file is created per data (SRE, FRE, ATB, . . .) and per resolution (10 and 20 meters).

The scale factors are provided in the global header of the level 2 product (e.g. in the <Reflectance_Quantification_Value> tag so BOA reflectance = X * 0.001).

5.5.3 The Landsat L8 Image products

5.5.3.1 Level 1 product content

The LANDSAT8 L1 product conforms with the specification contained in the document [RD04].

The directory of a LANDSAT8 L1 product contains an image header file and a geoTIF file but also a subdirectory MASK that contains the mask of saturated pixels.

Code	description	Res.	bands	Format		bits
				Entête	Donnée	
Product directory		-	-			-
TOA	TOA reflectance	30	10	XML	GEOTIFF	16
MASK subdirectory						
SAT	Saturated pixels mask	30	10		GEOTIFF	8

5.5.3.2 Level 2 product content

The structure of LANDSAT8 and VENUS level 2 products is nearly the same. The differences are found in the number of spectral bands and the resolution of images. The cirrus mask is added to the cloud mask. The level 2 product does not contain angle grids.

	Code	description			Res. en m.	Nb. bands	bits signif.	bits write	Format Entête	Format Donnée
Public	-	Global description of the product								XML
	SRE	Surface reflectance without slope correction			30	7	16	16	HDR	GEOTIFF
	FRE	Surface reflectance with slope correction = « Flat reflectance »			30	7	16	16	HDR	GEOTIFF
	ATB	Atmospheric parameters			30	2	8	8	HDR	GEOTIFF
		VAP	Water vapour content							
		AOT	Aerosol optical thickness							
	CLD	Cloud, cloud shadow and cirrus masks			30	1	8	8	HDR	GEOTIFF
		(*)	*ALL*	*Summary Logical or of All cloud and shadow masks*		*8*	*8*			
			ALL CLOUDS	*Logical or of All cloud masks*						
			SHADOWS	*Shadows mask from clouds within image*						
			SHADVAR	*Shadows mask from clouds outside image*						
			REFL	*Reflectance threshold*						
			REFL_VAR	*Reflectance variation threshold*						
			EXTENSION	*Extension of the cloud mask*						
			CIRRUS	***Cirrus mask***						
	MSK	Geophysical masks			30	1	6	8	HDR	GEOTIFF
			WAT	*Water mask*		*6*	*6*			
			HID	*hidden surfaces*						
			SHD	*shadowed by topography mask*						
			STL	*sun too low flag*						
			TGS	*tangent sun flag*						
			SNW	***Snow***						
	QLT	Quality masks			30	3	7	8	HDR	GEOTIFF
		SAT	Saturation mask copied from L1 (7 useful values)				*7*			
		PIX	aberrant pixels channel copied from level 1 (7 useful values)				*7*			
		OTH	*EDG*	*Edge mask*		*2*	*2*			
			IAO	*AOT pixel mask (0 if computed, 1 if interpolated)*						
	-	Quick look			240	3	8	8	HDR	JPEG
Private	EEF	complete file containing private information			-	-	-	-		XML
	RTA	Composite TOA reflectances corrected from absorption			240	Nc[1]	16	16	HDR	GEOTIFF
	RTC	Composite channels for the "Top of canopy" (surface) reflectances			240	Nc	16	16	HDR	GEOTIFF
	RCR	Composite channels for surface Rayleigh corrected reflectances			240	Nc	16	16	HDR	GEOTIFF
	STO	Stack of surface rayleigh corrected reflectance images for 1 band (correl band)			240	N[2]	16	16	HDR	GEOTIFF
	PXD	Pixels dates of composite channels			240	1	16	16	HDR	GEOTIFF
	NDT	Composite no data mask			240	1	1	8	HDR	GEOTIFF
	CLD	Cloud and cloud shadow mask **(*)**			240	1	8	8	HDR	GEOTIFF
	WAM	Water masks			240	3	16	16	HDR	GEOTIFF
		WAS	Water mask							
		PWA	Possible water mask (one bit for every one of the last 16 days)							
		TWA	Tested water mask (one bit for every one of the last 16 days)							
	LTC	Luts of Top Of Canopy reflectances for view and solar zenithal and azimutal angles fixed at the center of the image - 4 bands * 3D				Nc	16	16	HDR	DBL

1 : Nc = number of thematic bands used in the algorithms and defined in the GIPPs

2 : N = one band per date put in the composite product

5.5.4 The Landsat L8 “MUSCATE” Image products

The LANDSAT 8 L1 and L2 products conform with the specifications contained in the document [RD05].

5.5.5 The Landsat L8 “native” Image products

5.5.5.1 Landsat L8 level 1 product content

The LANDSAT 8 L1 products conform with the specifications contained in the document [RD07].

5.5.5.2 Landsat L8 level 2 product content

The structure of the level 2 products is described in the previous section *Landsat L8 level 1 product content*.

5.5.6 The Sentinel2 “native” Image products

5.5.6.1 Level 1 product content

The Sentinel2 L1 products conform with the specifications contained in the document [RD06].

5.5.6.2 Level 2 product content

The Level 2 Sentinel 2 native product is described in the previous section *Sentinel 2 Image products*.

5.5.7 The Sentinel2 “MUSCATE” Image products

The Sentinel2 L1 and L2 products conform with the specifications contained in the document [RD05].

5.5.8 The Venus “MUSCATE” Image products

The Venus L1 and L2 products conform with the specifications contained in the document [RD05].

5.6 Auxiliary data of MAJA

File	Comment
XXX_EXO_METDTA_XXX (HDR + DBL)	Archive that contains the ozone image. In the MAJAUserConfig_<MISSION>.xml, if the value of the "Use_Default_Constant_Ozone_Amount" field is false, the input data EXO_METDTA is mandatory. If it's true, the default constant ozone value used is the value set in "Atmospheric_Absorption_Correction/Ozone_Amount_Default_Value" field in the GIP_L2COMM file.
XXX_EXO_CAMS_XXX (HDR + DBL)	Archive that contains the CAMS data. In the GIP_L2COMM file, if the value of the "Use_Cams_Data" field is true, the input datas EXO_CAMS will be parsed to find suitable CAMS data for the product. If it is false or not suitable for the product the CONSTANT_Model from the GIPP L2COMM File will be used instead.
XXX_AUX_REFDE2_XXX (HDR + DBL)	DEM Archive that contains: • The altitude image: ALT • The altitude image at L2 coarse resolution: ALC • The aspect image at L2 resolution: ASP • The aspect image at L2 coarse resolution: ASC • The slope image at L2 resolution: SLP • The slope image at L2 coarse resolution: SLC • The water mask: MSK All these files have exactly the same footprint of the Level-1 product to process.

Please note the particular case of SENTINEL2 where the output Level 2 product contains two resolutions (R1 = 10m and R2= 20m) depending on the spectral band. In this case, the images of the altitude (ALT), the aspect (ASP) and the slope (SLP) are provided with the two resolutions R1 and R2 (e.g: _ALT_R1.tif and _ALT_R2.tif).

By default the constant model will be used for the various LUT (TOCR, ALBD, DIRT, DIFT). However these luts have been computed using an average model of atmosphere composition. In order to be more precise the CAMS data can be used to establish the exact proportions of each model according to the product localisation and time. To enable this you have to turn on the Use_Cams_Data field in the L2COMM Gipp and provide:

- At least one CAMS file (.HDR +.DBL) acquired in the range [Product_time – time_windows][Product_time+time_windows]. The time_windows is a parameter in the L2COMM GIPPP.
- LUTS for each selected model in the Model_List node of L2COMM : TOCR, DIRT, DIFT and ALBD. Please note that the TOCR luts for CAMS models have some information added in the HDR compared to a constant lut, see example provided in the install folder.

The current CAMS format provided by Copernicus contains data for Dust, Seasalt, Organic Matter, Black Carbon and Sulphate. Each model proportion is then associated with it's own lut to compute the final LUT used in the processing. If no suitable CAMS are found for a given product then the constant model will be used.The unit of the ozone content

is Kg.m^{-2} but to be conformed with SMAC and 6S this content is converted to cm.atm.m^{-2}. The conversion from kg.m^{-2} to cm.atm.m^{-2} is:

1 Dobson Unit (DU) is:

2.6867 x 1020 mol.m^{-2}

4.4615 x 10-4 mol.m^{-2}

2.1416 x 10-5 Kg[O3].m^{-2}

1 Kg.m^{-2} = 46694 Dobson

1 cm.atm.m^{-2} = 1000 dobson = 1 Jacobson

1 Kg.m^{-2} = 46.694 cm.atm.m^{-2}

If the meteo data is not available, a default value is set in the GIP_L2COMM file. Its unit is cm.atm.m^{-2}.

Generally, the ozone content varies between 250 and 480 Dobson (0,25 and 0,48 cm.atm.m^{-2}). By default the value is set to 0,3 cm.atm.m^{-2}.The meteo data are detected in the chain with their “EXO_METDTA” keyword. The “Mission” field set in the header (.HDR) of the meteo data is not used.

- In Init and Nominal modes, only one file is required in the input directory otherwise an error is raised. In those cases, the validity dates are not read by MAJA.
- In backward mode, one meteo data should be available for each processed L1 product. For each L1 product, the chain looks for the associated meteo data and checks if the product date is included in the validity “start” and “stop” dates of this meteo data.

5.7 GIPPs files of MAJA

The GIPP files used in MAJA are listed in the following table.

File	Comment
L2	
XXX_GIP_L2COMM_XXX.EEF	Contains all the L2/L3 common parameters.
XXX_GIP_L2TOCR_XXX.HDR (+ .DBL)	Contains the LUT of Canopy reflectance. One for the constant model in the L2COMM Gipp file and one for each CAMS model in the Model_List of L2COMM if this functionality is activated. In case of model LUT for CAMS usage some additional datas have to be put in the HDR like the extinctionCoeffs (see examples).
XXX_GIP_L2DIRT_XXX.HDR (+ .DBL)	Contains the LUT of Direct Transmission. One for the constant model in the L2COMM Gipp file and one for each CAMS model in the Model_List of L2COMM if this functionality is activated.
XXX_GIP_L2DIFT_XXX.HDR (+ .DBL)	Contains the LUT of Diffuse Transmission. One for the constant model in the L2COMM Gipp file and one for each CAMS model in the Model_List of L2COMM if this functionality is activated.
XXX_GIP_L2ALBD_XXX.HDR (+ .DBL)	Contains the LUT of Atmospheric Albedo. One for the constant model in the L2COMM Gipp file and one for each CAMS model in the Model_List of L2COMM if this functionality is activated.
XXX_GIP_L2WATV_XXX.HDR (+ .DBL)	Contains the LUT of Water Vapor.
XXX_GIP_L2SMAC_XXX.EEF	Contains the SMAC coefficients.
XXX_GIP_L2SITE_XXX_<SITE>.EEF	Contains the site parameters.

Notes:

- Parameter definitions are set as html comments in the xml file,
- The specific checking tools parameters are precisely described (as html comments) in the GIPPs “CKQLT” and “CKEXTL” xml files. To disable (or enable) the generation of the quicklooks, set the value of the field “Compute_QL” to false (or true) in the CKQLTL GIP file. In the same way, to disable (or enable) the generation of the extracts points, set the value of the field “Compute_Extract_Points” to false (or true) in the CKEXTL file,
- More instances examples of these files as installed in the “../share/examples” directory
- Contrary to the meteo data, the “Mission » field is read in the GIPPs in order to detect which GIPP is associated to the processed L1 product (because of the mixing of sensors). On the other hand, the validity dates are not considered

CHAPTER

SIX

OPERATING MANUAL

This chapter describes the operating manual of MAJA.

6.1 Memory management

MAJA processing can be performed on the whole image or by portions of image called “strip”.

The strip size is automatically computed by the OTB pipeline footprint computation using the RAM parameter, the image sizes and the pipeline complexity.

It is then possible to raise or reduce the memory printfoot during MAJA execution by changing this RAM parameter that can be found in the MAJAUserConfigSystem.xml configuration file (see *User configuration files*)

6.2 Configuration and setting files

6.2.1 User configuration files

The user parameters required by MAJA are gathered in the following configuration files:

File	Comment
MAJAUserConfigSystem.xml (.xsd)	Contains all user configuration parameters (no Image parameters)
MAJAUserConfig_<MISSION>.xml (.xsd)	Contains all <MISSION> user configuration parameters (no Image parameters)

Note:

- Parameter definitions are set as html comment in the xml file,
- The MAJAUserConfigSystem.xml and each MAJAUserConfig_<MISSION>.xml are installed in the ““<installation-directory>/etc/conf/user” directory.

  The “MAJAUserConfigSystem.xml” contains for example the following parameters that the user could be led to modify:
- Number of cores used for the execution (“NbThreads’ field). By default, the number of threads is set to 1,
- RAM maximum usage. By default, the RAM max is set to 8192,
- The notes (or comments) inserted in the “Note” field in the output header product,
- The field “EnableCleaningCachingDirectoryBeforeProcessing” is used to clean the caching directory at the beginning of the maja execution (the default value is false), Set to true in the relaunch case.

- The field “EnableCleaningCachingDirectoryAfterProcessing” is used to clean the caching directory at the end of the maja execution (the default value is true),
- The field “EnableCleaningTemporaryDirectory” is used to clean the temporary directory after processing (at the end of execution). Notice that this directory also contains the caching directory. If true, it cleans also this caching directory and therefore cancels the effect of the two previous options.
- The field “CheckXMLFilesWithSchema” is used to enable or disable checking of the interfaces (control of inputs and outputs data with schemas),
- The field “CleanInputZipFiles” is use to enable or disable cleaning the input product compressed (remove the .DBL files) after they have been uncompressed.
- The field “ZipFiles” is use to enable or disable the compression of the output product (creation of the .DBL file)
- The field “CleanFiles” is use to enable or disable cleaning the directory of the output product (.DBL.DIR directory),
- The field “EnableL2ResolutionProcessing” is use to enable or disable the generation of the output product at L2 resolution (the default value is true).

  The “MAJAUserConfig_<MISSION>.xml” contains for example the following parameters:

- The option parameter that defines if a default constant value is used to set the ozone content (“Use_Default_Constant_Ozone_Amount”).

  If the option is to use the default constant value, this value of ozone amount is available in the GIPP L2COMM. If the “ozone” option is set to false, the ozone content will be read in the meteo data.

  The field “WriteSRE” is used to enable or disable the generation of the SRE images at L2 resolution (the default value is true)

  In “MAJAUserConfig_<MISSION>.xml”, only the two previous options in Atmospheric_Absorption_Correction tag can be modified according to the availability of meteo data (for ozone amount) and the values of Water_Vapor_Band_Code and Water_Vapor_Reference_Band_Code bands code parameters in the GIP _L2COMM according to the L1 product (for water vapor amount).

  Default values are set for the other parameters and they should not be modified by the user.

  An example of the MAJAUserConfig_SENTINEL2.xml is given below with default values:

```
<Config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="./MAJAUserConfig.xsd" xmlns="http://maja.fr">

<Business>

<!-- Image divisions size (number of lines) -->

<ImageDivision method="strips">

<NbStrips>

<!-- Image divisions size (in number of lines) for the L2 Init
Processing -->

<L2InitProcessing>250</L2InitProcessing>
```

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```
<!-- Image divisions size (in number of lines) for the L2 Nominal
Processing -->

<L2NominalProcessing>100</L2NominalProcessing>

<!-- Image divisions size (in number of lines) L2 Backward Processing
-->

<L2BackwardProcessing>100</L2BackwardProcessing>

<!-- Image divisions size (in number of lines) L3 Processing -->

<L3Processing>200</L3Processing>

<!-- Image divisions size (in number of lines) Checktool -->

<ChecktoolProcessing>200</ChecktoolProcessing>

</NbStrips>

</ImageDivision>

<!-- Option to write or not write SRE images in the L2 product-->

<WriteSRE>true</WriteSRE>

</Business>

<Algorithms>

<GRID_Reference_Altitudes>

<!-- First reference altitude of solar grid (in meter) -->

<SOLH1>3000</SOLH1>

<!-- First reference altitude of solar direction (in meter) -->

<SOLHRef>4000</SOLHRef>

<!-- Reference altitude of viewing direction (in meter) -->

<VIEHRef>3000</VIEHRef>

</GRID_Reference_Altitudes>

<Atmospheric_Absorption_Correction>

<!-- Option to use default constant value available in GIPP instead
of meteorological data to determine the ozone amount -->

<Use_Default_Constant_Ozone_Amount>false</Use_Default_Constant_Ozone_Amount>

</Atmospheric_Absorption_Correction>

</Algorithms>
```

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```
<Config>
```

6.2.2 Administration configuration files

The following files are necessary to configure MAJA:

File	Comment
MAJAAdminConfigSystem.xml (.xsd)	Contains all administration configuration parameters (no Image parameters)
MAJAAdminConfig_<MISSION>.xml (.xsd)	Contains all <MISSION> configuration parameters

The MAJAAdminConfigSystem.xml file is installed in the "<installation-directory>/etc/conf/admin" directory.

The MAJAAdminConfigSystem.xml file defines few parameters as:

- The <System> field is used to set the name of the system. For example, set the name of the "operational centre" (VIP, SL2P, etc.). This value is inserted in all headers files of the L2 and L3 product in the field <Fixed_Header/Source/System>
- The tolerances' thresholds for footprint matching between the L1, L2, L2Coarse and DEM
- The option to measure the performance of the chain (time processing and memory footprint): <EnablePerformanceMeasureAlgorithms>

  The MAJAAdmin_<MISSION>.xml files defines few parameters as:

- The theoretical wavelength for each band: this values are used to set the theoretical wavelength in the composite XML headers in the L2 product (reflectances and LTC data)

  An example of the MAJAAdminConfig_SENTINEL2.xml is given below with default values:

```
<Config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="./
↪MAJAAdminConfig.xsd">
<Composite>
<!-- List of the bands with the theoretical wavelengths -->
<!-- Used for composite algorithms -->
<List_of_Band_Theoretical_Wavelength count="13">
<Band_Theoretical_Wavelength sk="B1" unit="nanometer">443</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B2" unit="nanometer">490</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B3" unit="nanometer">560</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B4" unit="nanometer">665</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B5" unit="nanometer">705</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B6" unit="nanometer">740</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B7" unit="nanometer">780</Band_Theoretical_
↪Wavelength>
```

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```
<Band_Theoretical_Wavelength sk="B8" unit="nanometer">840</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B8A" unit="nanometer">865</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B9" unit="nanometer">940</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B10" unit="nanometer">1380</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B11" unit="nanometer">1600</Band_Theoretical_
↪Wavelength>
<Band_Theoretical_Wavelength sk="B12" unit="nanometer">2200</Band_Theoretical_
↪Wavelength>
</List_of_Band_Theoretical_Wavelength>
</Composite>
</Config>
```

The following files are required to run MAJA:

File	Comment
A font file.	By default, the Font file used is the "Amble-Italic.ttf" true type file.

Warning: The /etc/conf directory contains the configuration files used by the chain and could be modified by users. **The /share/conf directory contains INTERNAL data used by the chain that should NOT be modified by users**.

6.2.3 GIPP configuration file (GIP_L2COMM)

The GIP_L2COMM is used to configure the different algorithms of the chain. One instance of this file is defined for each mission. Different kinds of parameters are set in this file. If an algorithm is never activated for a sensor (general configuration parameters §4.4), no parameter is defined in the GIP_L2COMM. Only parameters that modify the chain processing are detailed here after.

The file contains the following parameters defining processing options of the chain:

- The method used to estimate the aerosol optical thickness is set in the <AOT_Method> parameter. Values are: MULTITEMPORAL, MULTISPECTRAL or SPECTROTEMPORAL
- The model used to calculate the directional correction coefficients is set in the <DIRCOR_Model> parameter. Values are: Roy, Lut or None
- The implementation of environment correction is triggered via the <Env_Corr_Option> parameter
- The option to refine the cloud altitude instead of trust the stereoscopic altitude (available with VENuS products): <Refinement_Option>
- If the parameter "Use_Default_Constant_Ozone_Amount" is set to true in the MAJAUserConfig_<MISSION>.xml file, the parameter "Ozone_Amount_Default_Value" is read by the chain.
- The option to use or not the CAMS data "Use_Cams_Data" to activate the CAMS data search in order to enhance the quality of corrections. The list of models to use is given in the "List_Of_Models" node so as the "Time_Window_CAMS" validity period. If no valid data is found the "Constant_Model" is used to compute the athmospheric composition.
- For the water vapour amount, the parameter "Water_Amount_Default_Value":

  - **is always used for Formosat, Landsat 5, 7 and 8 or Spot4** (therefore the parameter "Use_Default_Constant_Water_Amount" does not exist in the GIP_L2COMM for those sensors),
  - **is optional for VENUS and Sentinel2. It is used if the** "Use_Default_Constant_Water_Amount" is set to true. In this case, the GIPP "GIP_L2WATV" is not mandatory in input. Otherwise, the water vapour content is interpolated within the LUT GIP_L2WATV using the ratio of the reflectance at 865 and 910 (or 940) nm.

It is important to note that this file contains especially the list of all the thematic bands used in the different algorithms of the chain. Only these bands are stored in the composite products contained in the private part of the L2 product (RTC, RTA, RCR and LTC files). Those thematic bands are set in different nodes of the GIPP file:

For the 'reflectance' files of the product (RTC, RTA and RCR):

- <Thematic_Definition> node:
- **Blue_Band_Code**
- **Red_Band_Code**
- **NIR_Band_Code**
- **SWIR1_Band_Code**
- <Cloud_Masking> node
- **Correl_Band_Code**
- **Shadow_Band_Code**
- <Rain_Flag> node:
- **Water_Band_Code**
- <AOT_Estimation> node
- **Dark_Band_Code**
- **Var_Band_Code**
- **MT_AOT_Band_Code**

For the 'LTC' file of the product:

- <AOT_Estimation> node
- **MT_AOT_Band_Code**

Attention: in the composite product (and LTC), the band is identified with the dedicated "theoretical wavelength" (and not the band code name).

This file contains also general parameters as:

- the no data value set in the output L2 product: <No_Data>
- the thematic band definition:
- bands used for all the algorithms: blue, green, red, NIR, SWIR bands,
- band used to generate the quicklook: blue, green, red bands
- the maximum percentage of cloudy or no data pixels for the product to be considered as valid
- The water vapor quantification value in g/cm^2 of the water vapor data (ATB file) in the <VAP_Quantification_Value> parameter and the no_data value of this image plan. Those values are also indicated in the header of the ATB file.

- The AOT quantification value (dimensionless values) and no data value (ATB file) in the <AOT_Quantification_Value> and <AOT_No_Data_Value> parameters. Those values are also indicated in the header of the ATB file.

6.3 Log messages

The log messages raised by MAJA are compliant (in terms of format) with the nomenclature described in the section 4.2 of the [AD01].

One log message consists of:

- The date,
- The machine name,
- The processor name (written in the JobOrder file),
- The processor version,
- The process identifier (PID),
- For Progress : Maximum RAM used during the processing, disk usage in working directory, time spend, cpu average load
- The type of message in increasing order of severity:
- [D] for Debug,
- [I] for Info,
- [P] for Progress,
- [W] for Warning,
- [E] for Error.
- The message itself.

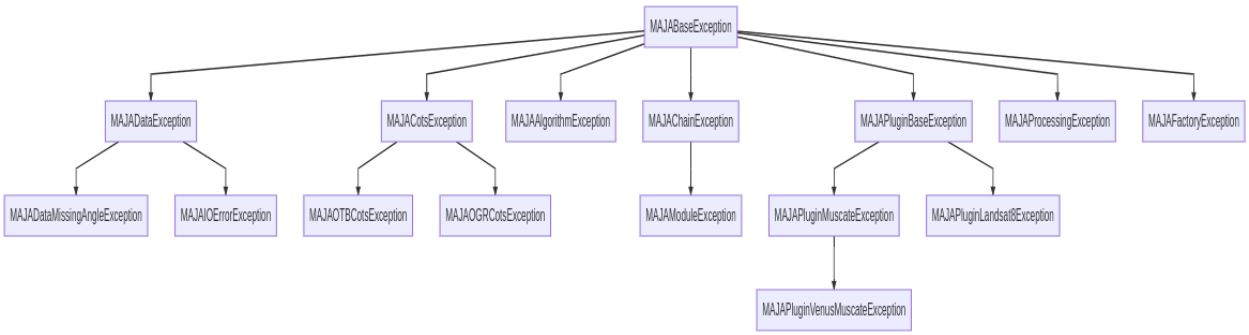
For example: *2011-03-02T17:03:44.518677 milo.si.c-s.fr maja-processing 01.00 [000000032108] [P] Starting L2Processor PreProcessing() ....*

The default log level is [I] ; in this case, all Info, Progress, Warning and Errors messages are displayed.

6.4 Errors management

Error messages are sorted in vaiours categories and each category has its specific code error.

Here is the structure of the Maja exceptions:



The following table gathered the errors that can occur according to each possible process.

Name	General description and comment	Return code
MAJABaseException	This error is the base of all exceptions. It should not be raised unless no cause is detected	136
MAJAProcessingException	General processing exception	135
MAJADataException	Error generated when a data is missing or corrupted	134
MAJADataMissingAngle	Error generated when a product has missing angles for some detectors (S2 for example)	133
MAJAIOException	Error generated when an I/O error occured on data	124
MAJACotsException	Error generated in case of error in a COTS sub code	132
MAJAOTBCotsException	Error generated in case of error in a OTB Cots sub code	131
MAJAOGRCotsException	Error generated in case of error in a OGR Cots sub code	130
MAJAAlgorithmException	Error generated in case of error in a Python maja algorithm	129
MAJAChainException	Error generated if an error occurs in a general chain code	128
MAJAFactoryException	Error generated if any of the factory fails to provide elements	128
MAJAModuleException	Error generated in case of error in a module	127
MAJAPluginBaseException	Error generated in the PluginBase code	126
MAJAPluginMuscateException	Error generated in the PluginMuscate code	126
MAJAPluginEarthExplorerException	Error generated in the EarthExplorer plugin code	126
MAJAPluginVenusMuscateException	Error generated in the VenusMuscate plugin	126
MAJAPluginSentinel2MuscateException	Error generated in the Sentinel2Muscate plugin	126
MAJAPluginLandsat8Exception	Error generated in the Landsat8 plugin	126
MAJAPluginSentinel2Exception	Error generated in the Sentinel2 Natif plugin	126
MAJAPluginVenusException	Error generated in the Venus plugin code	126
MAJANotImplementedException	Error when a function is not implemented	125

6.5 Example of the command line help of the maja

For the version 4.0 of MAJA, the maja –help produces the following helper lines

```
usage: maja.py [-h] [-j JOBORDER] [-l {INFO,PROGRESS,WARNING,DEBUG,ERROR}]
               [-m {L2INIT,L2NOMINAL,L2BACKWARD}] [-t]
               [--stylesheet STYLESHEET] [-acs ADMINCONF] [-i INPUT]
               [-o OUTPUT] [-w WORKINGDIR] [-p PLUGIN] [-ucs CONF]
               [--NbThreads NBTHREADS] [--CheckXMLFilesWithSchema]
               [--CleanInputZipFiles] [--CleanFiles] [--ZipFiles]
               [--EnableCleaningCachingDirectoryBeforeProcessing]
               [--EnableCleaningCachingDirectoryAfterProcessing]
               [--EnableCleaningTemporaryDirectory] [--TileId TILEID]
               [--perfos-log] [--perfos-report] [-v]
./maja [options]

         MAJA Chains
```

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```
        CNES All rights reserved. For more details, see Copyright.txt file.

        Description:

        ------------

        The L2 processor offers advanced atmospheric correction algorithms including

        water vapour and aerosol estimates based on multitemporal data analysis.

        It also provides cloud mask generation.

            - Cloud masking

                * Cloud detection

                * Shadow detection

           - Atmospheric correction

                * Gaseous absorption correction

                * Scattering correction

           - Environment and slope correction

                * Environment effects

                * Slope correction

           - Composite image update

        The data and GIPPs files mandatory for MAJA are:

            - For L2 processing:

                * GIP_L2COMM

                * GIP_L2DIRT

                * GIP_L2DIFT

                * GIP_L2SMAC

                * GIP_L2WATV

                * GIP_L2TOCR

                * GIP_L2ALBD

                * GIP_L2SITE

                * EXO_METDTA

                * AUX_REFDE2
```

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```
        Processing description:

        ------------------------

        The maja launches the following processes:

            - launches the pre-processing treatment

                * Uncompresses all data (DBL package files and BZ2 images files)

                * Check input data with the schemas

                * Deletes all tarballs (if option is enable in the Configuration␣
↪file)

                * Applies a specific stylesheet on GIPPs files

            - launches the scientific-processing treatment

                * Reads image products

                * Applies algorithms

                * Formats EE and writes datas

            - launches the post-processing treatment

                * Check output data with the schemas

                * Compress BZ2 all .TIF images data files

                * Generates the .DBL image product data (L2/L3)

         For more details, report to the SUM (Software User Manual, ref. LAIG-MU-MAC-
↪010-CS)

         Author: CS Systemes d'Information  (France)

         User cases:

         -----------

         1. First user case:  Use only a JobOrder file to launch maja processing.

                              -> use the '--jobOrder' option.

                              Note: the possible values for the <Processor_Name>␣
↪field are:

                                 * m_MAJA_L2_INIT_CHAIN

                                 * m_MAJA_L2_NOMINAL_CHAIN

                                 * m_MAJA_L2_BACKWARD_CHAIN

         2. Second user case: Use command line parameters to launch maja processing
```

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```
                              -> for example, use at least the '--mode' and '--input
↪' options




optional arguments:
  -h, --help            show this help message and exit
  -j JOBORDER, --jobOrder JOBORDER
                        Specify the JobOrder file (xml file)
  -l {INFO,PROGRESS,WARNING,DEBUG,ERROR}, --loglevel {INFO,PROGRESS,WARNING,DEBUG,
↪ERROR}
                        Log level use and set to the JobOrder generated.
  -m {L2INIT,L2NOMINAL,L2BACKWARD}, --mode {L2INIT,L2NOMINAL,L2BACKWARD}
                        Processing mode.
  -t, --enableTest      Enable/Disable the field value 'Test' set in the JobOrder␣
↪generated.
  --stylesheet STYLESHEET
                        XML Stylesheet filename, used to overloads parameters in the␣
↪XML configuration files and GIPP files. See the [MU] for an example of StyleSheet.
  -acs ADMINCONF, --adminconf ADMINCONF
                        Administration Configuration directory (contains for example␣
↪the MAJAAdminConfigSystem.xml)
  -i INPUT, --input INPUT
                        Input data directory: must be contain images, all GIPPs files,
↪ the DTM, etc.).
                                                The directory must be contain only␣
↪one L1 product for the 'L2INIT' mode, a list of L1 products
                                                for the 'L2BACKWARD' mode, one
                                                L1 product and one L2 product for the
↪'L2NOMINAL' mode and a list of L2 products

  -o OUTPUT, --output OUTPUT
                        Output data directory (product directory). Default value: '.'
  -w WORKINGDIR, --workingdir WORKINGDIR
                        Working directory (working 'temporary' directory). Default␣
↪value: the '--output parameter value'
  -p PLUGIN, --plugin PLUGIN
                        Output plugin to use to write L2 product. Available plugins :␣
↪SENTINEL2 , SENTINEL2_MUSCATE , VENUS_MUSCATE , LANDSAT8_MUSCATE. Default is to use␣
↪the MUSCATE version of the input L1 product plugin
  -ucs CONF, --conf CONF
                        User Configuration directory (contains for example␣
↪MAJAUserConfigSystem.xml)
  --NbThreads NBTHREADS
                        UserConfigSystem overloads value for the parameter 'NbThreads'
  --CheckXMLFilesWithSchema
                        UserConfigSystem overloads value for the parameter
↪'CheckXMLFilesWithSchema'
  --CleanInputZipFiles  UserConfigSystem overloads value for the parameter
↪'CleanInputZipFiles'
  --CleanFiles          UserConfigSystem overloads value for the parameter 'CleanFiles
↪'
  --ZipFiles            UserConfigSystem overloads value for the parameter 'ZipFiles'
  --EnableCleaningCachingDirectoryBeforeProcessing
                        UserConfigSystem overloads value for the parameter
↪'EnableCleaningCachingDirectoryBeforeProcessing'
```

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```
  --EnableCleaningCachingDirectoryAfterProcessing
                        UserConfigSystem overloads value for the parameter
↪'EnableCleaningCachingDirectoryAfterProcessing'
  --EnableCleaningTemporaryDirectory
                        UserConfigSystem overloads value for the parameter
↪'EnableCleaningTemporaryDirectory'
  --TileId TILEID       Set the Tile id of the Sentinel2 L1 product (Only necessary␣
↪for SENTINEL2 plug-in and only for the L1C product with PSD version < PSD 14)
  --perfos-log          Enable performance measurement in log
  --perfos-report       Enable synthesize performance measurement in log and xml file
  -v, --version         Display version information and exit
```

BIBLIOGRAPHY

[AD01] ESA Generic Processor Interfaces Guidelines, issue 1, revision 0 of 20/10/2006.

[RD01] Dossier de Performances, SETG**-DP-MAJA-010-CS,** (in french).

[RD02] Technical Note. Venus Ground Segment Interfaces file format specification, VE-NT-GSSM-196-CNES

[RD03] Technical Note Sentinel-2 MAJA Level-2A Product Format Specification, GS2-NT-GSL2-1320-CNES

[RD04] MAJA Level 1 and 2 products specification for FORMOSAT2, LANDSAT5, 7, 8 AND SPOT4 (“proto” format”, PSC-IF-411-0081-CNES

[RD05] Spécification de format des produits (format “muscate”),PSC-SL-411-0032-CG

[RD06] Sentinel-2 Products. Specification Document, S2-PDGS-TAS-DI-PSD, V12 and V14 (both products formats handled by MAJA software)

[RD07] Landsat8 (L8), Level 1 (L1) Data Format Control Book (DFCB),V8.0