CS SYSTÈMES D'INFORMATION

MACCS

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Département Images & Geo APPLICATIONS
Projet MACCS

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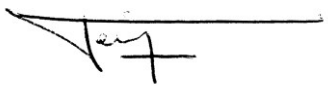
USER, INSTALLATION AND OPERATING MANUAL MACCS CHAINS

[MU]

Written by : FEUVRIER Thomas	CSSI/ESG/IGA	Date : 07/07/2015	
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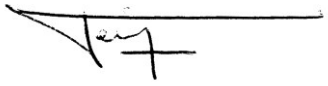
For application : FEUVRIER Thomas	CSSI/ESG/IGA	Date : 07/07/2015	

RESTRICTED TO MACCS

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USER, INSTALLATION AND OPERATING MANUAL
MACCS CHAINS
[MU]

AUTHOR(S) :

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SUMMARY : This is MACCS user, installation and operating manual in a stand-alone context.

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C:\Program Files\GDOC\gdoc\MODELES_GDOC\ModeleGDOCIndus_en.dot
Version GDOC : v4.3.0.0_TW05
Base projet :
D:\Users\folivie\Documents\Projets\Dprt_Application\MACCS\SVN\DocumentsProjet\BASE_GDOC_MACCS.mdb

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GLOSSARY AND LIST OF TBC AND TBD ITEMS

See [LD] document referenced by LAIG-LD-MAC-010-CS.

List of TBC items:

List of TBD items:

1. 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, **LAIG-DP-MAC-010-CS,** (in french).

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

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

[RD04]: MACCS 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

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

2. SYSTEM REQUIREMENTS

2.1. HOST PLATFORM

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

2.2. SPACE DISK REQUIREMENTS

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

- ✓ Input data volume: 4 Gb (1 Gb for GIPPs files and DTM and 3 Gb for the L1 image product),
- ✓ Output data volume: 4 Gb (L2 image product)
- ✓ Caching data directory volume: ~30 Gb

The caching directory named ".maccs-temporary-directory" is created in the output directory and is automatically deleted at the end of the processing.

This cleanup is configurable via a dedicated parameter in the "MACCSUserConfigSystem.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.

3. INSTALLATION MANUAL

This section describes the procedure to install MACCS software.

MACCS **installation** consists of two steps:

1. Installation of the COTS required to execute the scientific chains in the operational context (MACCS-Cots).
2. Installation of the scientific chains for operational context (MACCS).

3.1. USER ACCOUNT AND PERMISSION FOR INSTALLATION

The installation directory is configurable and can be defined during the install process.

By default, MACCS COTS and MACCS chain are installed in the directory "/opt".

For the installation of the COTS and the "tgz" MACCS package, it is mandatory to have the right of writing in the installation directory.

For the installation of the "rpm" MACCS package, connection as root is mandatory.

3.2. COTS INSTALLATION

3.2.1. COTS requirement

None.

3.2.2. List of the required COTS

The following COTS are required for MACCS execution:

- ✓ **Hdf4**
- ✓ **Expat**
- ✓ **LibXML2**
- ✓ **OpenJpeg**
- ✓ **Gdal**
- ✓ **InsightToolkit**
- ✓ **OrfeoToolbox**
- ✓ **Pugixml**

3.2.3. Package

The COTS listed in § 3.2.2 are delivered in the package:

maccs-cots-<Version>-<HostId>-<Mode>-<Compiler>.tar

The validity of this binary package could be checked with the following .sha256 file delivered:

maccs-cots-<Version>-<HostId>-<Mode>-<Compiler>.tar.sha256

Where <**Version**> is the version number of the COTS 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

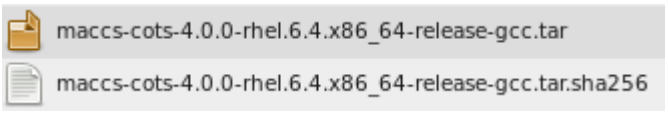
Z: third version digit, incremented to indicate patch version.

Where **<HostId>** is composed of the **name,** the **version** and the **type** (32 or 64 bits binary package) of the OS platform,

Where **<Mode>** is the compilation mode used to generate the package; being '**release'** or '**debug'**,

Where **<Compiler>** is the name of the program used to build the package; being '**gcc**' or '**icc**'.

Example: for the version 4.0.0 of the MACCS COTS, built on a RedHat Enterprise Linux Os Version 6.4 platform in 64 bits, in release mode with the gcc compiler the file is:



3.2.4. Package extraction

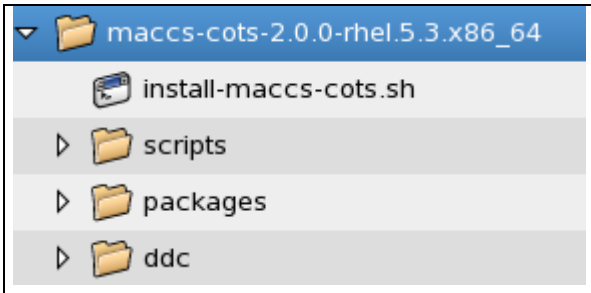
All the COTS provided in the file maccs-cots-<Version>-<HostId>-<Mode>-<Compiler>.tar are stored in the generation directory as follow:

```
$ cd < extraction directory >
$ tar xvf <media directory>/maccs-cots-<Version>-<HostId>-<Mode>-
<Compiler>.tar
```

Where:

- ✓ <media directory> is the complete path to maccs-cots-<Version>-<HostId>-<Mode>-<Compiler>.tar,
- ✓ <extraction directory> is the directory where the file in the .tar are extracted.

Thus, the extraction directory contains all the COTS listed in § 3.2.2 and the scripts to launch the installation, as showed in the following figure:



install-maccs-cots.sh : allows to launch the installation of the COTS required for the execution of the MACCS.

/scripts : scripts (intern) making easier the COTS installation

/packages : contains all the binaries required COTS

/ddc : constains the COTS ddc.

3.2.5. Required environment variables

None.

3.2.6. Package installation

The following command launches the installation of all the COTS listed in § 3.2.2 in the default '/opt' directory:

```
$ <extraction directory>/maccs-cots-<Version>-<HostId>-<Mode>-
<Compiler>/install-maccs-cots.sh
```

Then, during the installation, the operator shall follow the instructions, typing 'Y' or 'n' and pushing the Enter button or only pushing the Enter button when asked.

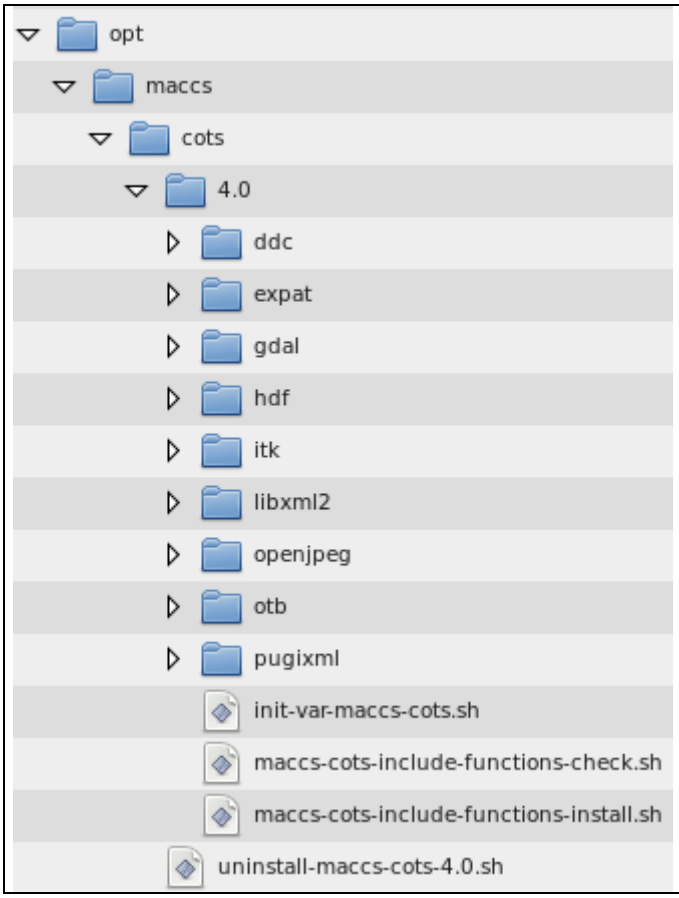
To show the options, launches the following command:

```
$ <extraction directory>/maccs-cots-<Version>-<HostId>-<Mode>-
<Compiler>/install-maccs-cots.sh --help
```

To install the COTS in a specific destination directory launches the following command:

```
 $<extraction                directory>/maccs-cots-<Version>-<HostId>-<Mode>-
<Compiler>/install-maccs-cots.sh --prefix <install directory>
```

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



/maccs : base directory for MACCS installation.

/cots : base directory where the COTS (other than RPM) are installed

/<Version> (ex: 4.0) : MACCS COTS version (two digits format).

/ddc : COTS ddc.

/expat : Expat library

/gdal : GDAL library

/hdf : HDF4 library

/itk : InsightToolkit library

/libxml2 : XML2 library

/openjpeg : OpenJpeg library

/otb : OrfeoToolbox library

/pugixml : Basic XML library (XPATH implementation)

init-var-maccs-cots.sh : call by the MACCS chain to set MACCS Cots environment variables.

maccs-cots-include-functions-check.sh : call by the MACCS chain installation step.maccs-cots-include-functions-install.sh : call by the MACCS chain installation step.

/uninstall-maccs-cots-<Version>.sh : script to uninstall the MACCS Cots.

Note: the version number inserted in the name of the installation directory is formatted with two first digits (the third digit is use for patch).

3.3. MACCS INSTALLATION

3.3.1. Requirement

Before MACCS installation:

- ✓ All the COTS shall be installed, as described in section 3.2.
- ✓ The following system packages, available in the RHEL distribution, shall be installed:
  - gd
  - libxslt (for the “xsltproc” application)

MACCS installation script (described in section 3.3.4) verifies that these prerequisites are correctly installed on the platform.

3.3.2. Package

MACCS is delivered in the package:

maccs-<Version>-<HostId>-<Mode>-<Compiler>.<TypePkg>.tar

The validity of this binary package could be checked with the following .sha256 file delivered:

maccs-<Version>-<HostId>-<Mode>-<Compiler>.<TypePkg>.tar.sha256

Where <**Version**> is the version number of the MACCS 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.

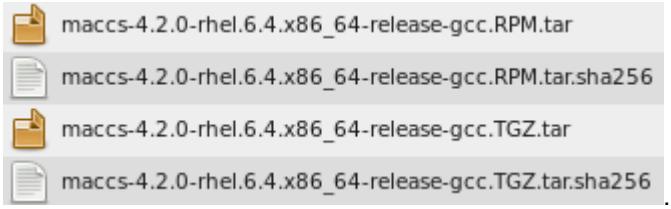
Where **<HostId>** is compose of the **name,** the **version** and the **type** (32 or 64 bits binary package) of the OS platform,

Where **<Mode>** is the compilation mode used to generate the package; being ‘**release’** or ‘**debug’**,

Where **<Compiler>** is the name of the program used to build the package; being ‘**gcc**’ or ‘**icc**’,

Where <**TypePkg**> is the type of package. Possible values are “TGZ” for a tarball package or “RPM” for linux rpm packages.

Example: For the version 4.2.0 of the MACCS, built on a RedHat Enterprise Linux Os Version 6.4 platform in 64 bits, in release mode with the gcc compiler, the TGZ and RPM files (with the .sha256 files) are:



3.3.3. Package extraction

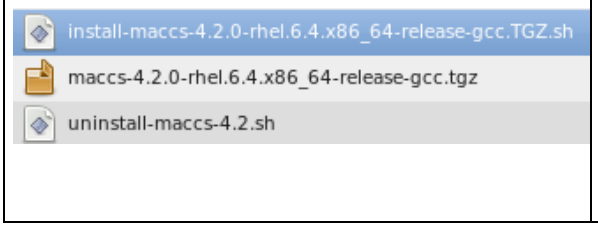
MACCS provided in the file maccs-<Version>.tar is stored in the generation directory as follow:

```
$ cd < extraction directory >
$ tar xvf <media directory>/maccs-<Version>-<HostId>-<Mode>-<Compiler>.<TypePkg>.tar
```

Where :

- ✓ <media directory> is the complete path to maccs-<Version>-<HostId>-<Mode>-<Compiler>.<TypePkg>.tar,
- ✓ <extraction directory> is the directory where the file in the .tar are extracted.

Thus, for the version 4.2.0 of the MACCS, built on a RedHat Enterprise Linux Os Version 6.4 platform in 64 bits, in release mode with gcc compiler for the TGZ package, the extraction directory contains the following files, as showed in the following figure:

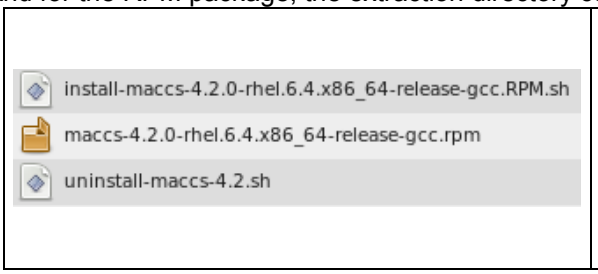


install-maccs-<Version>-<HostId>-<Mode>-<Compiler>.TGZ**.sh** : Generated script launched to install the chains. It detects the maccs tgz available in the script directory.

maccs-<Version>-<HostId>-<Mode>-<Compiler>.tgz: **maccs tgz chains binaries.**

uninstall-maccs-<Version>.sh : this script is installed (copied) in the installation directory (used for the uninstall macccs)

And for the RPM package, the extraction directory contains the following files, as showed in the following figure:



install-maccs-<Version>-<HostId>-<Mode>-<Compiler>.RPM**.sh** : Generated script launched to install the chains. It detects the maccs rpm available in the script directory.

maccs-<Version>-<HostId>-<Mode>-<Compiler>.rpm: **maccs rpm chains binaries.**

uninstall-maccs-<Version>.sh : this script is installed (copied) in the installation directory (used for the uninstall macccs)

3.3.4. Package installation

The following command launches MACCS installation:

```
$ <extraction directory>/install-maccs-<Version>-<HostId>-<Mode>-<Compiler>.<TypePkg>.sh
```

Where:

- ✓ <extraction directory> is the complete path where MACCS has been extracted.

Then, during the installation, the operator shall follow the instructions, typing 'Y' or 'n' and pushing the Enter button or only pushing the Enter button when asked.

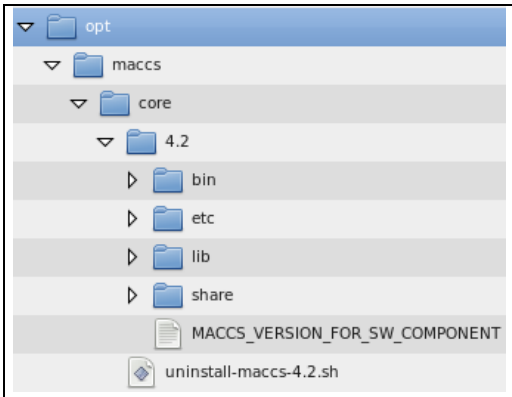
To show the options, launches the following command:

```
$ <extraction directory>/install-maccs-<Version>-<HostId>-<Mode>-<Compiler>.<TypePkg>.sh --help
```

To install MACCS in a specific destination directory, launches the following command:

```
$ <extraction directory>/install-maccs-<Version>-<HostId>-<Mode>-<Compiler>.<TypePkg>.sh --prefix <install directory>
```

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



/opt/maccs : MACCS base directory

/core : **MACCS** scientific chains 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 MACCS

/user: users configuration files

/lib : contains the library

/share : contains the resources files

/config : contains the internal configuration files for MACCS Administrator. Do not modify.

/ddc : ddc files for project management. . Do not modify.

/doc : copyright information

/examples : contains examples of GIPPs files

/schemas : contains all the ICD schemas used by the chains (EarthExplorer, Venus, Maccs, Senitnel2, etc…)

/MACCS_VERSIONS_FOR_SW_COMPONENT : show the version of MACCS, and MACCS Cots version

/uninstall-maccs-<Version>.sh : **script to uninstall the MACCS (version formatted with two digits).**

4. USER MANUAL

This chapter describes the user manual for the MACCS chains.

4.1. USER ACCOUNT AND PERMISSION

The use of MACCS doesn't require any specific permission, the user shall only have read and execution rights over the MACCS install directory (see § 3.3.4).

4.2. LAUNCHING MACCS PROCESSING

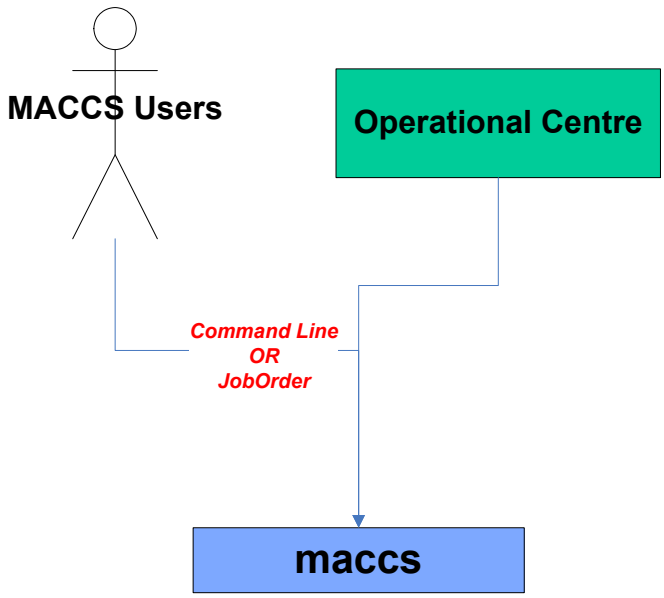


Figure 1: Illustration of using MACCS

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

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

```
$
$ /opt/maccs/core/<version>/bin/maccs  --jobOrder ./myJobOrder.xml
$
```

Figure 2: Example to execute MACCS with a JobOrder

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 MACCS.

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

- ✓ MACCS_L2_INIT_CHAIN
- ✓ MACCS_L2_NOMINAL_CHAIN
- ✓ MACCS_L2_BACKWARD_CHAIN
- ✓ MACCS_L3_CHAIN
- ✓ MACCS_L1_CHECKTOOL_CHAIN
- ✓ MACCS_L2_CHECKTOOL_CHAIN
- ✓ MACCS_L3_CHECKTOOL_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:

```
$
$ /opt/maccs/core/<version>/bin/maccs
$      --mode     L2INIT                    # Processing mode
$      --input    ./Input/Images            # Input data directory
$      --conf     ./Input/Conf              # User configuration files
directory$
$      --output   ./WorkingDir              # Output working directory
$
```

Figure 3: Example to execute MACCS with specifics options in command line

The user can obtain the help to launch MACCS processing launching the following command line:

```
$
$ /opt/maccs/core/<version>/bin/maccs --help
$
```

This command produces the helper lines detailed in Annex A

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

4.3. INTERFACES OF MACCS CHAINS

4.3.1. MACCS 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 might not have a good quality. In order to avoid this problem, the *backward mode* has been added in MACCS. This mode is used to improve the quality of the first level 2 product of a time series. The L1 products are first 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*.

MACCS allows seven different processing modes:

- Level-2 products generation:
  - Init Mode
  - Backward Mode
  - Nominal Mode
- Level-3 products generation:
- Checktool processing:
  - On Level-1 products
  - On Level-2 products
  - On Level-3 products

It is possible to activate automatically checktool processing after Level-2 or Level-3 production to have quality indications about the products generated. The generation of the quicklook is activated via the GIPP "…_GIP_CKQLTL_..." (Compute_QL= true/false) that defines also the bands that shall be included in the quicklook image; the generation of extracts activated via the GIPP "…_GIP_CKEXTL_..." (Compute_Extract_Points = true/false) that defines the bands and the points to extract.

4.3.2. Processing Interfaces

The following figures show MACCS 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.

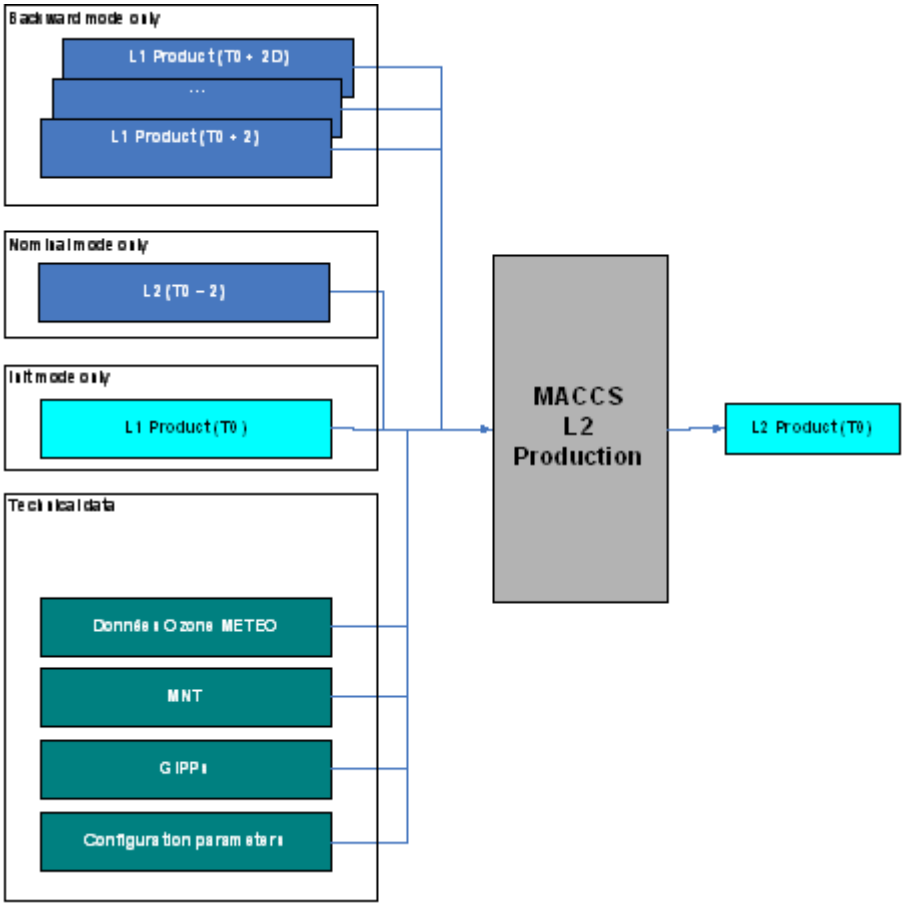


Figure 4: L2 processing data interface (Init, Nominal and Backward modes)

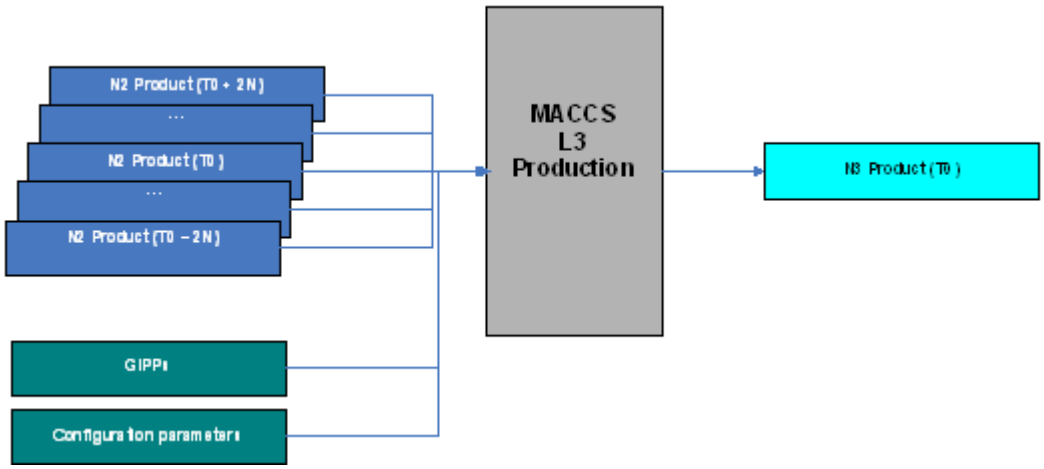


Figure 5: L3 processing data interface

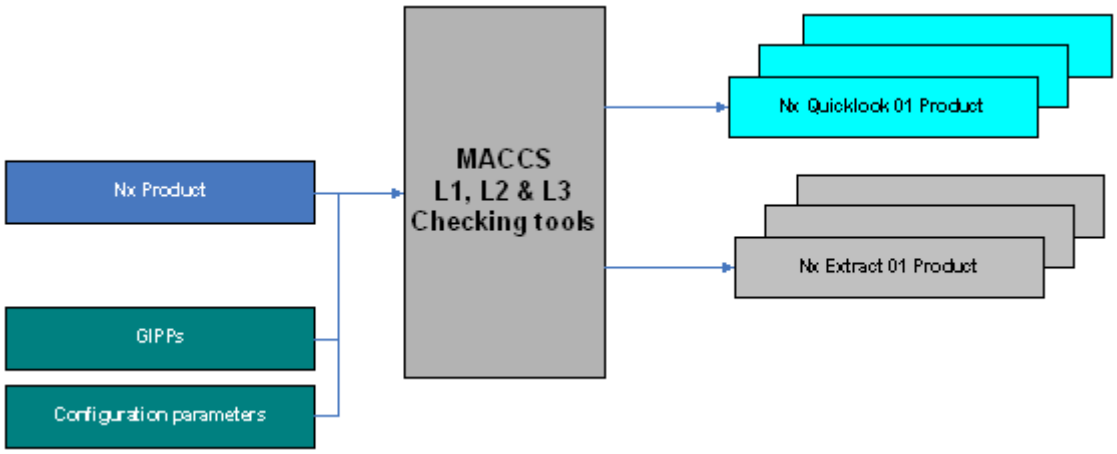


Figure 6: L1/L2/L3 checking tools processing data interface

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

- ✓ L1, L2, L3 image product (according to the processing mode),
- ✓ DTM data covering the tile (see section 4.6)
- ✓ Meteo data applicable for the acquisition date of EACH L1C product (see section 4.6)
- ✓ Production parameters: GIPP applicable for the acquisition date of EACH L1C product (see section 4.7)

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

- ✓ L2 or L3 Image product and/or quicklook and/or extracts (according to the processing mode)
- ✓ Production report file (named …__PMC_…)

Additional details on the Inputs and Outputs are provided in §0, 4.6 and4.7.

4.3.3. Operational Interfaces

MACCS respect the Interface detailed in [AD01].

Among these interfaces, there are:

- ✓ The « JobOrder »,
- ✓ The « Logging »,
- ✓ The « ExitCode »,
- ✓ The « ProductReport ».

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 § 5.

4.3.4. Revisit improvement via sensors mixing

The purpose of sensors combination is to improve the revisit over an area using data acquired by different sensors. Since the V4.1 of MACCS, it's possible to do it, under these conditions:

- ✓ 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 5.2.3),

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.

4.4. 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. This table summarizes the main options.

	Formosat ("proto" format)	Venμs	Landsat(5/7) ("proto" and "muscate" formats)	Sentinel2 (GPP and native formats)	Landsat8 ("proto", "muscate" and native formats)	Spot4 ("proto" format)
Stereoscopic cloud detection		X				
Water vapour determination		X		X		
Snow detection			X	X	X	X
Cirrus flag		X				
Cirrus mask				X	X	

Note: "proto" is the "muscate proto" format.

4.5. THE PRODUCTS

In Level-2 products:

- Water Vapour data are 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 consistently 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 11th date if the STO file contained yet 10 dates).

4.5.1. Venμs Image products

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

4.5.1.1. Level 1 product content

	Code	description	Res.	bands	Format Entête	Format Donnée	bits
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	-	-		-	-

Table 1: Level 1 Venμs Image product

The Venμs L1 product conforms to the VENμS ICD.

4.5.1.2. 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 and biophysical parameters			10	2	8	**8**	HDR	GEOTIFF
		VAP	Water vapour content							
		AOT	Aerosol optical thickness							
		LAI	Leaf Area channel							
		FAPAR	Fraction of absorbed Photosynth. Active radiation							
		FCOVER	Fraction of ground covered by vegetation							
		CHLLAI	Chlorophyll * LAI							
	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*		*2*	*2*			
			TAO	*AOT 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

Table 2: Level 2 Venμs Image 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.

4.5.1.3. Level 3 product content

	Code	description		Res.	bands	Format Entête	Format Donnée	bits
Public	-	Global description of the product		-	-		XML	-
	SRE	Surface reflectance without slope correction		10	12	HDR	GEOTIFF	16
	FRE	Surface reflectance with slope correction = « Flat reflectance »		10	12	HDR	GEOTIFF	16
	-	Quick look		100	3	HDR	JPEG	8
	MSK	Geophysical masks		10	4	HDR	GEOTIFF	16
		CLD	Cloud mask					
		CIR	Cirrus mask					
		WAT	Water mask					
		RAI	Rain mask					
	QLT	Quallity/Masks		10	2	HDR	GEOTIFF	16
		SAT	Saturated pixel mask					
		PXD	Pixel dates					
	BIO	LAI	Leaf Area channel					
		FAPAR	Fraction of absorbed Photosynth. Active radiation					
		FCOVER	Fraction of ground covered by vegetation					
		CHLLAI	Chlorophyll * LAI					

Table 3: Level 3 Venμs Image product

4.5.2. 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 the Sentinel 2A and Sentinel 2B products in nominal and backward modes. In the cloud and cloud shadow masks (detailed at § 4.5.1.2), the layer ALT (stereoscopic mask not available) is replaced by the cirrus mask:

	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 and biophysical 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*		*2*	*2*			
		(2 values)	*TAO*	*AOT 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*			
		(2 values)	*TAO*	*AOT 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
	CLA	Cloud altitude			240	1	16	**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 4: 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).

4.5.3. The Landsat L5/L7 Image products

4.5.3.1. Level 1 product content

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

The chain allows to mix Landsat 5 and Landsat 7 products in nominal and backward modes.

The directory of a LANDSAT 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		XML	GEOTIFF	16
		LANDSAT5		7			
		LANDSAT7		8			
MASK subdirectory							
	SAT	Saturated pixels mask	30			GEOTIFF	8
		LANDSAT5		7			
		LANDSAT7		8			

Table 5: Level 1 Landsat L5/L7 Image product

4.5.3.2. Level 2 product content

The structure of LANDSAT 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 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	6	16	**16**	HDR	GEOTIFF
	FRE	Surface reflectance with slope correction = « Flat reflectance »	30	6	16	**16**	HDR	GEOTIFF
	ATB	Atmospheric and biophysical parameters	30	2	8	**8**	HDR	GEOTIFF
		VAP Water vapour content						
		AOT Aerosol optical thickness						
		LAI Leaf Area channel						
		FAPAR Fraction of absorbed Photosynth. Active radiation						
		FCOVER Fraction of ground covered by vegetation						
		CHLLAI Chlorophyll * LAI						
	CLD	Cloud and cloud shadow mask	30	1	7	**8**	HDR	GEOTIFF
		(*) *ALL* *Summary Logical or of All cloud and shadow masks*		*7*	*7*			
		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*						
	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 mask*						
	QLT	Quality masks	30	3	6	**8**	HDR	GEOTIFF
		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*			
		TAO *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	7	**8**	HDR	GEOTIFF
	CLA	Cloud altitude	240	1	16	**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 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

Table 6: Level 2 Landsat L5/L7 Image product

4.5.4. The Landsat L8 Image products

4.5.4.1. 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

Table 7: Level 1 Landsat L8 Image product

4.5.4.2. 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 and biophysical parameters			30	2	8	**8**	HDR	GEOTIFF
		VAP	Water vapour content							
		AOT	Aerosol optical thickness							
		LAI	Leaf Area channel							
		FAPAR	Fraction of absorbed Photosynth. Active radiation							
		FCOVER	Fraction of ground covered by vegetation							
		CHLLAI	Chlorophyll * LAI							
	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*			
			TAO	*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
	CLA	Cloud altitude			240	1	16	**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 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

Table 8: Level 2 Landsat L8 Image product

4.5.5. The Spot4 Image products

4.5.5.1. Level 1 product content

The SPOT4 L1 product is conform to the specification contained in the document [RD04].

The directory of a SPOT4 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	20	4	XML	GEOTIFF	16
MASK subdirectory							
	SAT	Saturated pixels mask	20	4		GEOTIFF	8

Table 9: Level 1 Spot4 Image product

4.5.5.2. Level 2 product content

The structure of SPOT4 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 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			20	4	16	**16**	HDR	GEOTIFF
	FRE	Surface reflectance with slope correction = « Flat reflectance »			20	4	16	**16**	HDR	GEOTIFF
	ATB	Atmospheric and biophysical parameters			20	2	8	**8**	HDR	GEOTIFF
		VAP	Water vapour content							
		AOT	Aerosol optical thickness							
		LAI	Leaf Area channel							
		FAPAR	Fraction of absorbed Photosynth. Active radiation							
		FCOVER	Fraction of ground covered by vegetation							
		CHLLAI	Chlorophyll * LAI							
	CLD	Cloud and cloud shadow mask			20	1	7	**8**	HDR	GEOTIFF
		(*)	*ALL*	*Summary Logical or of All cloud and shadow masks*		*7*	*7*			
			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*						
	MSK	Geophysical masks			20	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			20	3	4	**8**	HDR	GEOTIFF
		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*		*2*	*2*			
			TAO	*AOT pixel mask (0 if computed, 1 if interpolated)*						
	-	Quick look			200	3	8	**8**	HDR	JPEG
Private	EEF	complete file containing private information			-	-	-	**-**		XML
	RTA	Composite TOA reflectances corrected from absorption			200	Nc[1]	16	**16**	HDR	GEOTIFF
	RTC	Composite channels for the "Top of canopy" (surface) reflectances			200	Nc	16	**16**	HDR	GEOTIFF
	RCR	Composite channels for surface Rayleigh corrected reflectances			200	Nc	16	**16**	HDR	GEOTIFF
	STO	Stack of surface rayleigh corrected reflectance images for 1 band (correl band)			200	N[2]	16	**16**	HDR	GEOTIFF
	PXD	Pixels dates of composite channels			200	1	16	**16**	HDR	GEOTIFF
	NDT	Composite no data mask			200	1	1	**8**	HDR	GEOTIFF
	CLD	Cloud and cloud shadow mask **(*)**			200	1	7	**8**	HDR	GEOTIFF
	CLA	Cloud altitude			200	1	16	**16**	HDR	GEOTIFF
	WAM	Water masks			200	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

Table 10: Level 2 Spot4 Image product

4.5.6. The Formosat2 Image products

4.5.6.1. Level 1 product content

The FORMSOAT2 L1 product is conform to the specification contained in the document [RD04].

The directory of a FORMOSAT2 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	8	4	XML	GEOTIFF	16
MASK subdirectory						
SAT	Saturated pixels mask	8	4		GEOTIFF	8

Table 11: Level 1 Formosat2 Image product

4.5.6.2. Level 2 product content

The structure of SPOT4 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 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			8	4	16	**16**	HDR	GEOTIFF
	FRE	Surface reflectance with slope correction = « Flat reflectance »			8	4	16	**16**	HDR	GEOTIFF
	ATB	Atmospheric and biophysical parameters			8	2	8	**8**	HDR	GEOTIFF
		VAP	Water vapour content							
		AOT	Aerosol optical thickness							
		LAI	Leaf Area channel							
		FAPAR	Fraction of absorbed Photosynth. Active radiation							
		FCOVER	Fraction of ground covered by vegetation							
		CHLLAI	Chlorophyll * LAI							
	CLD	Cloud and cloud shadow mask			8	1	7	**8**	HDR	GEOTIFF
		(*)	*ALL*	*Summary Logical or of All cloud and shadow masks*		*7*	*7*			
			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*						
	MSK	Geophysical masks			8	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			8	3	4	**8**	HDR	GEOTIFF
		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*		*2*	*2*			
			TAO	*AOT pixel mask (0 if computed, 1 if interpolated)*						
	-	Quick look			96	3	8	**8**	HDR	JPEG
Private	EEF	complete file containing private information			-	-	-	**-**		XML
	RTA	Composite TOA reflectances corrected from absorption			96	Nc[1]	16	**16**	HDR	GEOTIFF
	RTC	Composite channels for the "Top of canopy" (surface) reflectances			96	Nc	16	**16**	HDR	GEOTIFF
	RCR	Composite channels for surface Rayleigh corrected reflectances			96	Nc	16	**16**	HDR	GEOTIFF
	STO	Stack of surface rayleigh corrected reflectance images for 1 band (correl band)			96	N[2]	16	**16**	HDR	GEOTIFF
	PXD	Pixels dates of composite channels			96	1	16	**16**	HDR	GEOTIFF
	NDT	Composite no data mask			96	1	1	**8**	HDR	GEOTIFF
	CLD	Cloud and cloud shadow mask **(*)**			96	1	7	**8**	HDR	GEOTIFF
	CLA	Cloud altitude			96	1	16	**16**	HDR	GEOTIFF
	WAM	Water masks			96	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

Table 12: Level 2 Formosat2 Image product

4.5.6.3. Level 3 product content

	Code	description		Res.	bands	bits signif.	bits	Format Entête	Format Donnée
Public	-	Global description of the product		-	-		-		XML
	SRE	Surface reflectance without slope correction		8	4	10	16	HDR	GEOTIFF
	FRE	Surface reflectance with slope correction = « Flat reflectance »		8	4	10	16	HDR	GEOTIFF
	-	Quick look		96	3	8	8	HDR	JPEG
	MSK	Geophysical masks		8	4		16	HDR	GEOTIFF
		CLD	Cloud mask						
		CIR	Cirrus mask						
		WAT	Water mask						
		RAI	Rain mask						
	QLT	Quallity/Masks		8	2		16	HDR	GEOTIFF
		SAT	Saturated pixel mask						
		PXD	Pixel dates						
	BIO	LAI	Leaf Area channel						
		FAPAR	Fraction of absorbed Photosynth. Active radiation						
		FCOVER	Fraction of ground covered by vegetation						
		CHLLAI	Chlorophyll * LAI						

4.5.7. The Landsat L5/L7 “MUSCATE” Image products

The LANDSAT 5/7 L1 and L2 products are conforms with the specification contained in the document [RD05].

4.5.8. The Landsat L8 “MUSCATE” Image products

The LANDSAT 8 L1 and L2 products are conforms with the specification contained in the document [RD05].

4.5.9. The Landsat L8 “native” Image products

4.5.9.1. Level 1 product content

The LANDSAT 8 L1 products are conforms with the specification contained in the document [RD07].

4.5.9.2. 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 and biophysical parameters			30	2	8	**8**	HDR	GEOTIFF
		VAP	Water vapour content							
		AOT	Aerosol optical thickness							
		LAI	Leaf Area channel							
		FAPAR	Fraction of absorbed Photosynth. Active radiation							
		FCOVER	Fraction of ground covered by vegetation							
		CHLLAI	Chlorophyll * LAI							
	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*			
			TAO	*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
	CLA	Cloud altitude			240	1	16	**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 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

Table 13: Level 2 Landsat L8 Image product

4.5.10. The Sentinel2 “native” Image products

4.5.10.1. Level 1 product content

The Sentinel2 L1 products are conforms with the specification contained in the document [RD06].

4.5.10.2. Level 2 product content

This section details the content of Level 2 Sentinel 2 native product.

The chain allows to mix the Sentinel 2A and Sentinel 2B products in nominal and backward modes. In the cloud and cloud shadow masks (detailed at § 4.5.1.2), the layer ALT (stereoscopic mask not available) is replaced by the cirrus mask.:

	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 and biophysical 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*		*2*	*2*			
		(2 values)	*TAO*	*AOT 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*			
		(2 values)	*TAO*	*AOT 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
	CLA	Cloud altitude			240	1	16	**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 14: Level 2 Sentinel 2 Image product

4.6. AUXILIARY DATA OF MACCS

File	Comment
XXX_EXO_METDTA_XXX (HDR + DBL)	Archive that contains the ozone image. In the MACCSUserConfig_<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_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).

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:

$2.6867 \times 1020\ mol.m^{-2}$

$4.4615 \times 10\text{-}4\ mol.m^{-2}$

$2.1416 \times 10\text{-}5\ Kg[O3].m^{-2}$

$1\ Kg.m^{-2} = 46694$ 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 MACCS.
- ✓ 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.

4.7. GIPPS FILES OF MACCS

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

File	Comment
L2, L3 & Checking Tools	
XXX_GIP_L2COMM_XXX.EEF	Contains all the L2/L3 common parameters.
L2	
XXX_GIP_L2TOCR_XXX.HDR (+ .DBL)	Contains the LUT of Canopy reflectance.
XXX_GIP_L2DIRT_XXX.HDR (+ .DBL)	Contains the LUT of Direct Transmission.
XXX_GIP_L2DIFT_XXX.HDR (+ .DBL)	Contains the LUT of Diffuse Transmission.
XXX_GIP_L2ALBD_XXX.HDR (+ .DBL)	Contains the LUT of Atmospheric Albedo.
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.
L3	
XXX_GIP_L3COMM_XXX.EEF	Contains all the L3 common parameters.
Checking Tools	
XXX_CKQLTL_XXX.EEF	Contains quick look generation tool parameters.
XXX_CKEXTL_XXX.EEF	Contains extract generation tool 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

5. OPERATING MANUAL

This chapter describes the operating manual of MACCS.

5.1. MEMORY MANAGEMENT

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

The strip size is defined as the number of lines composing the strip and it is a parameter of the configuration file **MACCSUserConfig_<MISSION>.xml**.

It is then possible to raise or reduce the memory printfoot during MACCS execution by changing this parameter.

In addition, MACCS uses the GDAL library to read and write raster images. It’s in charge of users to adjust the GDAL configuration parameters in relation with the host machine characteristics.

For example, to manage the memory cache used by gdal, set the GDAL_CACHEMAX size, as follow:

```
$
$ export GDAL_CACHEMAX=512
$
```

Figure 7: Example to set the GDAL cache max size variable

Note: the memory cache size used by the MACCS application includes the GDAL memory cache size.

5.2. CONFIGURATION AND SETTING FILES

5.2.1. User configuration files

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

File	Comment
MACCSUserConfigSystem.xml (.xsd)	Contains all user configuration parameters (no Image parameters)
MACCSUserConfig_<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 MACCSUserConfigSystem.xml and each MACCSUserConfig_<MISSION>.xml are installed in the ““<installation-directory>/etc/conf/user” directory.

The “MACCSUserConfigSystem.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,
- ✓ 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 maccs 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 maccs 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 “MACCSUserConfig_<MISSION>.xml” contains for example the following parameters:

- ✓ Image division (strip) settings for each application of MACCS (L2INIT, L2NOMINAL, L2BACKWARD, L3 and CHECKTOOL),
- ✓ L2 coarse resolution set in the “L2CoarseResolution” field
- ✓ 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.

In “MACCSUserConfig_<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 availability of the 940 and 865 bands in the L1 product (for water vapor amount).

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

An example of the MACCSUserConfig_SENTINEL2.xml is given below with default values:

```
<Config  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"  xsi:schemaLocation="./MACCSUserConfig.xsd"
xmlns="http://maccs.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>
            <!-- 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>
            <!-- L2 coarse resolution in meter -->
            <L2CoarseResolution>240</L2CoarseResolution>
    </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>
<Config>
```

5.2.2. Administration configuration files

The following files are necessary to configure MACCS:

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

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

The MACCSAdminConfigSystem.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 white board filename used by the chain <WhiteBoardFilename>
- ✓ The option to measure the performance of the chain (time processing and memory footprint): <EnablePerformanceMeasureAlgorithms>

The MACCSAdmin_<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)

The following files are required to run MACCS:

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**.

5.2.3. 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 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 VENµS products) : <Refinement_Option>
- ✓ If the parameter "Use_Default_Constant_Ozone_Amount" is set to true in the MACCSUserConfig_<MISSION>.xml file, the parameter "Ozone_Amount_Default_Value" is read by the chain.
- ✓ 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" dose 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/cm² 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.

5.3. LOG MESSAGES

The log messages raised by MACCS 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),
- ✓ 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 vnsL2InitProcessing 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.

5.4. ERRORS MANAGEMENT

Error messages are sorted in 10 categories and each category has its specific code error.

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

Process	Category	General description and comment	Return code
PreProcessing		The error is raised by the "PreProcessing" process. In most cases, this error occurs when an input is missing or invalid. In this case, the operator has to control that the specific data of the jobOrder really exist in the work directory. In the other case, the operator has to refer to the project manager.	200
L2Init, L2Nominal, L2Backward, L3, Checktool (Scientific Processing)	***« Chain »*** ***(maccs)***	The error is raised at a high execution level, in the "ScientificProcessing" process (algorithmic chain processing). The error can be due to an incorrect input data (missing file in a input product for example, invalid JobOrder, etc.). Generally, this error is an user error.	135
	« Business » ***(maccs)***	The raised error comes from the algorithmic chain. If such an error occurs, it is highly probable that this error is an internal one (software anomaly). In this case, the operator has to refer to the project manager.	134
	« Data » ***(maccs)***	The raised error comes from the data access chain layer (read/write). Such an error occurs when an input data (or a data generated during the chain processing) doesn't comply its contents (missing or incomplete file, wrong format, etc.). In this case, the operator has to control that the data specified in the JobOrder are valid (see the product interfaces). In any case, the operator has to refer to the project manager.	133
	« OTB » ***(cots)***	Low layer error raised by the OTB/ITK library. In any case, the operator has to refer to the project manager to report the bug.	131
	« alloc » ***(cots)***	Memory allocation error (such as *bad_alloc*). It occurs when the system failed to reserve the memory needed by the chain processing. This low layer error is raised by the stlc++ base library. In this case, the operator has to refer to the project manager to report the bug.	130
	« std »	Low layer error (other than *bad_alloc*) raised by the stlc++ base library.	129

Process	Category	General description and comment	Return code
	(cots)	In this case, the operator has to refer to the project manager to report the bug.	
	« Unknown » (cots)	Non identified error (unlikely case). In this case, the operator has to refer to the project manager to report the bug.	128
PostProcessing		The error is raised by the “PostProcessing” process. There is two types of possible error: ○ The constituent XML file of a output product is not complying with the ICD XSD schema. ○ An error occurs during the generation of the .DBL (tar) archive of the final product. In both cases, it is an chain execution error that has to be reported to the project manager.	210
maccs		The error is raised by the “StandAlone” layer. It may be to an invalid JobOrder or to the “StandAlone” inability to detect the type of sensor (VENUS, SENTINEL2, etc). In this particular case, the error is an error in the settings of the MACCS execution. In any other case, the user has to refer to the project manager.	170

The error messages are compliant with the nomenclature described in the section [AD01].

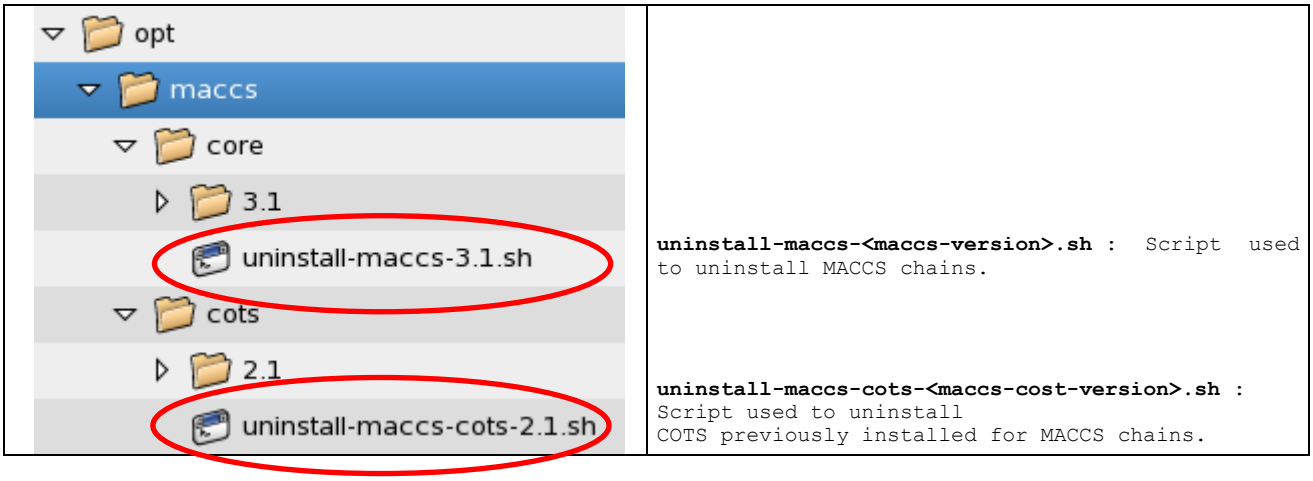
6. UNINSTALLATION OF MACCS

6.1. USER ACCOUNT AND PERMISSIONS

See section 3.1.

6.2. UNINSTALLATION ARBORESCENCE

The required files for the uninstallation of the chains in the context (scientific chains uninstallation) are the following (example with "/opt" installation directory):



The uninstallation consists of two steps:

1. uninstallation of MACCS
2. uninstallation of the COTS.

6.3. MACCS UNINSTALLATION

To uninstall the scientific chains, launch the following command and follow the instructions:

```
$ /opt/maccs/core/uninstall-maccs-<maccs-version>.sh
```

Note : After the scientific chains uninstallation, the chain specific COTS can also be uninstalled. For that, please refer to the following section (6.4).

6.4. UNINSTALLATION OF THE COTS USED BY MACCS

To uninstall the COTS used by the scientific chains, launch the following command and follow the instructions:

```
$ /opt/maccs/cots/uninstall-maccs-cots-<maccs-cots-version>.sh
```

ANNEX A : EXAMPLE OF THE COMMAND LINE HELP OF THE MACCS

For the version 4.1.0 of MACCS, the maccs –help produces the following helper lines

```
/opt/maccs/core/4.1/bin/maccs -help :

-------------------------------------------------------------------------------------------------------------------------------------------------------
./maccs [options]

    MACCS Chains

    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 L3 processor is used to merge L2 time series over short periods (~10 days)
   in order to remove cloudy regions and generate useful syntheses for
   downstream users
    The data and GIPPs files mandatory for MACCS are:
        - Common GIPPs files (for L2, L3 and Checktools processing):
            * GIP_CKEXTL
            * GIP_CKQLTL
        - For L2 processing:
            * GIP_L2COMM
            * GIP_L2DIRT
            * GIP_L2DIFT
            * GIP_L2SMAC
            * GIP_L2WATV
            * GIP_L2TOCR
            * GIP_L2ALBD
            * GIP_L2SITE
            * EXO_METDTA
            * AUX_REFDE2
      - For L3 processing:
            * GIP_L3COMM

    Processing description:
    -----------------------
    The maccs 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 checktool-processing treatment
            * Compute checktool on the outputs images products
        - 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 maccs processing.
                          -> use the '--jobOrder' option.
     2. Second user case: Use command line parameters to launch maccs processing
                          -> for example, use at least the '--mode' and '--input' options


 Usage : /MILO/thomas/MACCS/rhelw-6.4/opt/maccs/core/0.0/bin/maccs-processing
      [--help|-h]                                          :  Help
      [--version|-v]                                       :  Version
      [--jobOrder|-j]                                      :  Specify the JobOrder file (xml file)  (1 parameter)
```

```
       [--loglevel|-l]                                    :  Log level use and set to the JobOrder generated.
                                                             Possible values: 'INFO', 'PROGRESS', 'WARNING', 'DEBUG', 'ERROR'.
                                                             Default value: 'INFO'  (1 parameter)
       [--mode|-m]                                        :  Processing mode.
                                                             Possible values: 'L2INIT', 'L2NOMINAL', 'L2BACKWARD', 'L3', 'L1CHECKTOOL',
                                                             'L2CHECKTOOL', 'L3CHECKTOOL'. Default value: 'L2INIT'  (1 parameter)
       [--enableTest|-t]                                  :  Enable/Disable the field value 'Test' set in the JobOrder generated.
                                                             Possible values: 'true', 'false'. Default value: 'false'  (1 parameter)
       [--stylesheet|-s]                                  :  XML Stylesheet filename, used to overloads parameters in the XML configuration
                                                             files and GIPP files.
                                                             See the [MU] for an example of StyleSheet.  (1 parameter)
       [--admin-conf|-acs]                                :  Administration Configuration directory (contains for example the
                                                             MACCSAdminConfigSystem.xml)  (1 parameter)
       [--input|-i]                                       :  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 for the L3 mode.
                                                             Default value: '.'  (1 parameter)
       [--output|-o]                                      :  Output data directory (working directory). Default value: '.'  (1 parameter)
       [--conf|-ucs]                                      :  User Configuration directory (contains for example MACCSUserConfigSystem.xml)
                                                             (1 parameter)
       [--sensingTime|-s]                                 :  Start and Stop Sensing Time (two values). Mandatory for 'L3' mode, not used
                                                             for the others modes. Note: Time stamp in the format YYYYMMDD_HHMMSSuuuuuu.
                                                             ex: --sensingTime 20100824_105015000000 20100824_123030000000  (2 parameters)
       [--NbThreads]                                    :  UserConfigSystem overloads value for the parameter 'NbThreads'  (1 parameter)
       [--CheckXMLFilesWithSchema]                      :  UserConfigSystem overloads value for the parameter 'CheckXMLFilesWithSchema'
                                                             (1 parameter)
       [--CleanInputZipFiles]                           :  UserConfigSystem overloads value for the parameter 'CleanInputZipFiles'
                                                             (1 parameter)
       [--CleanFiles]                                   :  UserConfigSystem overloads value for the parameter 'CleanFiles'  (1 parameter)
       [--ZipFiles]                                     :  UserConfigSystem overloads value for the parameter 'ZipFiles'  (1 parameter)
       [--EnableCleaningCachingDirectoryBeforeProcessing]  :  UserConfigSystem overloads value for the parameter
                                                             'EnableCleaningCachingDirectoryBeforeProcessing'  (1 parameter)
       [--EnableCleaningCachingDirectoryAfterProcessing]   :  UserConfigSystem overloads value for the parameter
                                                             'EnableCleaningCachingDirectoryAfterProcessing'  (1 parameter)
       [--EnableCleaningTemporaryDirectory]             :  UserConfigSystem overloads value for the parameter
                                                             'EnableCleaningTemporaryDirectory'  (1 parameter)

-------------------------------------------------------------------------------------------------------------------------------------------------------------
```

ANNEX B EXAMPLE OF STYLESHEET

This is an example of a stylesheet. In this example, the 'NbThreads' and 'AOT_Method' parameters are overloaded with a new value:

```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
   <xsl:output method="xml" version="1.0" encoding="UTF-8" indent="yes" omit-xml-declaration="no" />
   <xsl:template match="Refining_Scenario">
      <Refining_Scenario xmlns="http://eop-cfi.esa.int/CFI">NONE</Refining_Scenario>
   </xsl:template>
   <xsl:template match="*">
      <xsl:choose>
         <xsl:when test="local-name(.)='AOT_Method'">
            <xsl:copy>
               <xsl:copy-of select="@*" />
               <xsl:value-of select="'SPECTROTEMPORAL'" />
            </xsl:copy>
         </xsl:when>
         <xsl:when test="local-name(.)='NbThreads'">
            <xsl:copy>
               <xsl:copy-of select="@*" />
               <xsl:value-of select="'8'" />
            </xsl:copy>
         </xsl:when>
         <xsl:otherwise>
            <xsl:copy>
              <xsl:for-each select="@*">
                <xsl:copy><xsl:value-of select="."/></xsl:copy>
              </xsl:for-each>
              <xsl:apply-templates select="node()"/>
            </xsl:copy>
         </xsl:otherwise>
      </xsl:choose>
   </xsl:template>
   <!-- Copy text, comments and PIs (xml-stylesheet, etc.) -->
   <xsl:template match="comment() | processing-instruction() | text()">
       <xsl:copy>
           <xsl:apply-templates />
       </xsl:copy>
   </xsl:template>
</xsl:stylesheet>
```

Note: set the stylesheet file with the --stylesheet command line option.

ANNEX C : EXAMPLE OF MACCS JOB ORDER FILE

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<Ipf_Job_Order xmlns:a="http://www.acsys.it/schemas/IPF" xmlns:xsi="http://www.w3.org/2000/10/XMLSchema-instance"
xsi:schemaLocation="http://www.acsys.it/schemas/VenusJobOrder.xsd">
 <Ipf_Conf>
  <Processor_Name>MACCS_L2_INIT_CHAIN</Processor_Name>
  <Version>01.00</Version>
  <Order_Type/>
  <Production_Request_Id/>
  <Stdout_Log_Level>INFO</Stdout_Log_Level>
  <Stderr_Log_Level>INFO</Stderr_Log_Level>
  <Test>false</Test>
  <Breakpoint_Enable>true</Breakpoint_Enable>
  <Acquisition_Station/>
  <Processing_Station/>
  <Config_Files/>
  <Sensing_Time>
   <Start>20000101_000000000000</Start>
   <Stop>20000102_000000000000</Stop>
  </Sensing_Time>
  <List_of_GIPP_Files/>
  </List_of_GIPP_Files>
 </Ipf_Conf>
 <List_of_Ipf_Procs>
  <Ipf_Proc>
   <Task_Name>L2_INIT_PROCESSING</Task_Name>
   <Task_Version>01.00</Task_Version>
   <Breakpoint>
    <List_of_Brk_Files count="0"/>
   </Breakpoint>
   <List_of_Inputs count="13">
    <Input>
     <File_Type>FSC_L1VALD</File_Type>
     <File_Name_Type>Physical</File_Name_Type>
     <List_of_File_Names count="1">
      <File_Name>./Sudouest_20060317_MS_fmsat_ortho_toa.hdr</File_Name>
     </List_of_File_Names>
     <List_of_Time_Intervals count="1">
      <Time_Interval>
       <Start/>
       <Stop/>
       <File_Name/>
      </Time_Interval>
     </List_of_Time_Intervals>
    </Input>
    <Input>
     <File_Type>GIP_CKEXTL</File_Type>
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