CENTRE NATIONAL D'ETUDES SPATIALES

MUSCATE

Direction du Centre Spatial de Toulouse

Produits et Segments sol

Observation de la Terre et de son atmosphère

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TECHNICAL NOTE

SENTINEL-2A L2A PRODUCTS DESCRIPTION

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Technical note

SENTINEL-2A L2A Products description

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SUMMARY : This document describes the SENTINEL-2A Level 2A products generated by MUSCATE.

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GLOSSARY AND LIST OF TBC AND TBD ITEMS

EPSG	European Petroleum Survey Group
e.g.	Exempli gratia
TBD	To Be Defined
TBC	To Be Confirmed

List of TBC items

List of TBD items

1. INTRODUCTION

1.1. SCOPE OF THE DOCUMENT

The purpose of this technical note is to describe the format of SENTINEL-2 Level 2A products generated by MUSCATE.

It states in particular:

- the products definition (level, structure and naming conventions);
- the metadata format;
- the images format;
- the masks format;
- the geometrical convention;
- the quicklook format.

It also presents an example of a SENTINEL-2 L2A product.

1.2. FIELD OF APPLICATION

The field of application of this document concerns the activities for “Sentinel-2 Atmospheric Correction Algorithm Setup and Validation”.

2. PRODUCTS DEFINITION

2.1. PRODUCT LEVELS

Two different levels of product are handled in the field of “Sentinel-2 Atmospheric Correction Algorithm Setup and Validation”:

- L1C : orthorectified product in TOA (Top Of Atmosphere) reflectance,
- L2A : orthorectified product in ground reflectance

2.2. PRODUCT STRUCTURE

A **MUSCATE** « **user »** product is a repository, named according to MUSCATE nomenclature, which contains:

- A metadata file (public level)
- A quicklook file
- The image files of the product
- A sub-repository MASKS in which are gathered all the product masks in GeoTiff format.

Images and masks may be constituted of several bands. In addition the 8 coding bits of masks may be used independently to represent various physical values.

2.3. NAMING CONVENTIONS

2.3.1. Product naming

Product naming enables to identify easily the products.

The identification for a MUSCATE product is based on the following piece of information:

- Satellite-instrument-sensors
    - Which correspond to the content of the tags PLATFORM, INSTRUMENT and SPECTRAL_CONTENT in the metadata file, each content is separated by the “-“ symbol, special characters are deleted
- Date of acquisition
    - This corresponds to the content of the tag ACQUISITION_DATE in the metadata file, with the format YYYYMMDD-HHmmSS-sss, with YYYY year, MM month, DD day, HH hour over 24 hours, mm minuts, SS seconds and sss milliseconds
- Product level
    - This corresponds to the content of the tag PRODUCT_LEVEL in the metadata file

- A geolocation piece of information (geographical zone, tile, orbit number, …)
    - This corresponds to the content of the tag GEOGRAPHICAL_ZONE in the metadata file
- Metadata type of the product coded on one letter and indicating the product structure: C for complet, H for hybrid, D for distributed and user. In the field of “Sentinel-2 Atmospheric Correction Algorithm Setup and Validation” MUSCATE should only delivered type “D” for the metadata files.
    - This corresponds to the content of the tag METADATA_PROFILE in the metadata file

The product name is completed with:

- The product version (points are replaced by the “-“), prefixed by the letter V.
    - This corresponds to the content of the tag PRODUCT_VERSION in the metadata file.

The different pieces of information which constitute the product identification and name are separated by the “_” symbol. This symbol cannot be used inside a piece of information used for the product naming (if present, this symbol will be replaced by the “-” symbol).

For example:

- Product identification: SENTINEL2A_20091211-165909-000_L2A_T14SLE_C
- Product name: SENTINEL2A_20091211-165909-000_L2A_T14SLE_C_V1-0

2.3.2. Naming of the products files

Naming of the products files respects the following rules:

1) The repository which contains the product is named according to the rules describe in the chapter 2.3.1 Product naming
2) Each file of the product is named from this ID, by adding:

- A character “_”
- A trigram which specifies the content of the file:
    - MTD: metadata
    - QKL: quicklook
    - SRE: image in ground reflectance without the correction of slope effects
    - FRE: image in ground reflectance with the correction of slope effects
    - ATB: atmospheric and biophysical parameters with 2 bands :
        - 1st band: water vapor content (WVC) coded over 8 bits
        - 2st band: aerosol optical thickness (AOT) coded over 8 bits
    - SAT: saturation mask coded over 8 bits, 1 bit per spectral band (number of useful bits = number of spectral bands)
    - DFP (optional): defective pixels mask coded over 8 bits, 1 bit per spectral band (number of useful bits = number of spectral bands)
    - CLM: cloud mask computed by MACCS software, made of 1 band coded over 8 useful bits:
        - 1st bit (CM1): cloud_mask_all, result of a “logical OR” for all the cloud and shadow maks

        - 2nd bit (CM2): cloud_mask_all_cloud, result of a “logical OR” for all the cloud masks
        - 3rd bit (CM3): cloud_mask_refl, cloud mask identified by a reflectance threshold
        - 4th bit (CM4): cloud_mask_refl_var, cloud mask identified by a threshold on reflectance variance
        - 5th bit (CM5): cloud_mask_extension, cloud mask identified by the extension of cloud masks
        - 6th bit (CM7): cloud_mask_shadow, shadow mask of clouds inside the image
        - 7th bit (CM8): cloud_mask_sahdvar, shadow mask of clouds outside the image
        - 8th bit (CM9): cloud_mask_cirrus, cloud mask identified with the cirrus spectral band
    - MG2: geophysical mask of level 2, made of 1 band coded over 8 useful bits:
        - 1st bit (WTR): water mask
        - 2nd bit (CM2) : cloud_mask_all_cloud, result of a “logical OR” for all the cloud masks
        - 3rd bit (SNW): snow mask
        - 4th bit (logical OR between CM7 and CM8): shadow masks of clouds
        - 5th bit (SHD): topographical shadows mask
        - 6th bit (HID): hidden areas mask
        - 7th bit (STL): sun too low mask
        - 8th bit (TGS): tangent sun mask
    - EDG: edge mask coded over 8 bits, 1 useful bit
    - IAO: interpolated AOT pixels mask
- A symbol “_”
- An chain of characters indicating the subset of data addressed by the considered file. For example:
    - A unique spectral band: B2
    - A spectral band and a detector: B1-D02
    - A group of spectral bands: R1 (resolution 10m), R2 (resolution 20m)
    - All the spectral bands of the product: ALL
- A symbol “.”
- The extension in small characters indicating the file format (e.g. xml, jp2, tif, gml,…)

For example, for a product named SENTINEL2A_20091211-165909-000_L2A_T14SLE_C_V1-0, the metadata file is named: SENTINEL2A_20091211-165909-000_L2A_T14SLE_C_V1-0_MTD_ALL.xml.

3. METADATA FORMAT

The MUSCATE metadata file is an XML file which respects the XSD schema Muscate_Metadata.xsd.

Annex B of this document describes XSD schema Muscate_Metadata.xsd. The content of each tag is described through the XSD annotations.

MUSCATE metadata should indicate the physical signification of:

- Each bit of a mask,
- Each band of an image or a mask.

4. IMAGES FORMAT

Image files are in GeoTiff format. They also may be produced in JPEG2000 format.

An image file may contain several bands but all bands should be at the same spatial resolution.

5. MASKS FORMAT

Masks files are raster files in GeoTiff format.

A mask file may contain several bands but all bands should be at the same spatial resolution.

6. GEOMETRICAL CONVENTION

6.1. DEFINITION OF GEOMETRIC SETTING AND GEOREFERENCING

Geometric setting refers to the setting between all the images of a same product, which can be at different resolutions.

Figure 1 : Illustration of a centre-pixel geometric setting (left-hand side) and edge-pixel (right-hand side).

Georeferencing refers to the geographical location of the products in the images and in the metadata file.

6.2. GEOMETRIC SETTING

All MUSCATE products use the same geometric setting: edge-pixel convention.

6.3. GEOREFERENCING

6.3.1. Images

Georeferencing convention used in the images is described in the tag Raster_CS of the metadata file.

Image georeferencing should respect the conventions relative to each image format:

- GeoTiff: a centre-pixel georeferencing for non-orthorectifed products and an edge-pixel georeferencing for orthorectifed products
- JPEG2000: a centre-pixel georeferencing for all the products

6.3.2. Metadata

Georeferencing convention used in the MUSCATE metadata is described in the tag Metadata_CS of the metadata file.

Image geometric setting convention and metadata georeferencing convention are linked together:

- When a centre-pixel geometric setting is applied for images, a centre-pixel georeferencing is used in the metadata as the coordinates of the pixel centres of the 4 corners are the same in all images whatever their resolution
- When an edge-pixel geometric setting is applied for images, an edge-pixel georeferencing is used in the metadata as the footprint of all the images of a product are the same.

For all MUSCATE products, the centre-pixel convention is used.

7. QUICKLOOK FORMAT

Quicklook files are included in distributed MUSCATE products regarding the following rules. This chapter is only relative to quicklook files present inside the zip archive.

7.1. FORMAT

Quicklook files are in JPEG format.

7.2. BANDES

Spectral bands used to generate quicklook files are B4, B3 and B2 for SENTINEL-2.

7.3. DIMENSION

Quicklook files have a fixe dimension: 1000 x 1000 pixels.

Quicklook are generated in order to:

- Maximize space by respecting images proportion,
- Be centered.

8. EXAMPLE OF A SENTINEL-2 L2A PRODUCT

A L2A SENTINEL-2 product, with 4 spectral bands at a 10m resolution (R1 group) and 6 spectral bands at a 20m resolution (R2 group), distributed by MUSCATE contains:

- A metadata file (MTD)
- A quicklook file (QKL)
- 10 images in ground reflectance without correction of slope effects (SRE)
- 10 images in ground reflectance with correction of slope effects (FRE)
- 2 images of atmospheric and biophysical parameters (one image per resolution)
- 1 MASKS repository:
  - 2 cloud masks (CLM) (one mask per resolution)
  - 2 edge masks (EDG) (one mask per resolution)
  - 2 saturation masks (SAT) (one mask per resolution)
  - 2 geophysical mask of level 2 (MG2) (one mask per resolution)
  - 2 interpolated AOT pixel masks (IAO) (one mask per resolution)

		Number of files	Number of bands / file	Number of useful bits / band	Coding
IMAGES	**FRE**	10 (Number of spectral bands)	1	16	16 bits
	SRE	10 (Number of spectral bands)	1	16	16 bits
	ATB	2 (Number of spectral bands groups)	2	8	8 bits
MASKS	**CLM**	2 (Number of spectral bands groups)	1	8	8 bits
	EDG	2 (Number of spectral bands groups)	1	R=10m : 4 bit utiles R=20m : 6 bits utiles (Nombre de bandes spectrales dans le groupe considéré)	8 bits
	SAT	2 (Number of spectral bands groups)	1	R=10m : 4 useful bits R=20m : 6 useful bits (Number of spectral	8 bits

				bands in the considered resolution group)	
	MG2	2 (Number of spectral bands groups)	1	8	8 bits
	IAO	2 (Number of spectral bands groups)	1	1	8 bits

MUSCATE distributed product is a “zip” archive called <*IDENT*>.zip, with for example *IDENT* =SENTINEL2A_20160417-111159-116_L2A_T29SPR_D_V1.0:

- <IDENT> repository contains:
  - <*IDENT*>_MTD_ALL.xml
  - <*IDENT*>_QKL_ALL.jpg
  - <*IDENT*>_ATB_R1.tif
  - <*IDENT*>_ATB_R2.tif
  - <*IDENT*>_FRE_B2.tif
  - <*IDENT*>_FRE_B3.tif
  - <*IDENT*>_FRE_B4.tif
  - <*IDENT*>_FRE_B5.tif
  - <*IDENT*>_FRE_B6.tif
  - <*IDENT*>_FRE_B7.tif
  - <*IDENT*>_FRE_B8.tif
  - <*IDENT*>_FRE_B8A.tif
  - <*IDENT*>_FRE_B11.tif
  - <*IDENT*>_FRE_B12.tif
  - <*IDENT*>_SRE_B2.tif
  - <*IDENT*>_SRE_B3.tif
  - <*IDENT*>_SRE_B4.tif
  - <*IDENT*>_SRE_B5.tif
  - <*IDENT*>_SRE_B6.tif
  - <*IDENT*>_SRE_B7.tif
  - <*IDENT*>_SRE_B8.tif
  - <*IDENT*>_SRE_B8A.tif
  - <*IDENT*>_SRE_B11.tif
  - <*IDENT*>_SRE_B12.tif

- MASK sub-repository MASKS which contains:
  - <*IDENT*>_CLM_R1.tif
  - <*IDENT*>_CLM_R2.tif
  - <*IDENT*>_EDG_R1.tif
  - <*IDENT*>_EDG_R2.tif
  - <*IDENT*>_IAO_R1.tif
  - <*IDENT*>_IAO_R2.tif
  - <*IDENT*>_MG2_R1.tif
  - <*IDENT*>_MG2_R2.tif
  - <*IDENT*>_SAT_R1.tif
  - <*IDENT*>_SAT_R2.tif

ANNEX A : METADATA ORIGIN IN MUSCATE PRODUCTS

This annex details how are filled the tags in the MUSCATE metadata.

A.1. NOTES: RASTER_CS AND METADATA_CS

For the tags Raster_CS and Metadata_CS :

- If *_CS_TYPE tag equals CELL, then PIXEL_ORIGIN tag equals 0
- If *_CS_TYPE tag equals POINT, then PIXEL_ORIGIN tag equals 1

A.2. SENTINEL2 CORRESPONDANCES

MUSCATE	Origin	Notes
METADATA_FORMAT	Constant	
METADATA_FORMAT/version	Constant	
METADATA_PROFILE	Constant	
METADATA_INFORMATION	Constant	
IDENTIFIER	Generated according to the product format	
AUTHORITY	Constant	
PRODUCER	Constant	
PROJECT	Constant	
GEOGRAPHICAL_ZONE	Native « tile » metadata	Extract of TILE_ID (characters 50 to 55)
ORIGINAL_DATA_DIFFUSER	Native « tile » metadata	Extrait du TILE_ID (characters 21 to 24)
PRODUCT_ID	Generated according to the product format	
ACQUISITION_DATE	Native « datastrip » metadata	Native DATATAKE_SENSING_START tag
PRODUCTION_DATE	Generated	Date of production
PRODUCT_VERSION	Parameter	In command file

PRODUCT_LEVEL	Constant	L1C
PLATFORM	Native « datastrip » metadata	SPACECRAFT_NAME without "-"
ORBIT_NUMBER	Native « datastrip » metadata	Absolute orbit number extracted from the "datatakeIdentifier" tag of Datatake_Info (value which follows the 2nd « _ »)
UTC_Acquisition_Range/MEAN	Native « datastrip » metadata	Units: seconds Same value as ACQUISITION_DATE
Band_Global_List	Constant	
Band_Group_List	Constant	
QUICKLOOK	Constant / Generated	Used spectral bands are constant; path is generated according to the product format.
PRODUCT_DIRECTORY	Generated according to the product format	
GEO_TABLES	Constant	
HORIZONTAL_CS_TYPE	Native « general » metadata	
HORIZONTAL_CS_NAME	Generated from EPSG code (HORIZONTAL_CS_CODE)	Coherent with the native « tile » metadata value.
HORIZONTAL_CS_CODE	Native « tile » metadata	
Raster_CS	Native « general » metadata	
Metadata_CS	Constant	CELL and 0
LAT et LON des coins	Generated	Computed from X,Y and projection
X et Y des coins	Generated	Computed from ULX,ULY and (XDIM*NCOLS),(YDIM*NROWS) For the centre, average of the 4 corners

ULX et ULY	Native « tile » metadata	
XDIM et YDIM	Native « tile » metadata	
NROWS et NCOLS	Native « tile » metadata	
Sun_Angles	Native « tile » metadata	Units: degrees Mean_Sun_Angles/* tags
Mean_Viewing_Incidence_Angle	Native « tile » metadata	Units: degrees Mean_Viewing…/* tags
Sun_Angles_Grids	Native « tile » metadata	Sun_Angles_Grid tags
Viewing_Incidence_Angles_Grids	Native « tile » metadata	Reorganisation of native Viewing_Incidence_Angles_Grids tags
REFLECTANCE_QUANTIFICATION_VALUE	Native « general » metadata	
Nodata	Native « general » metadata	
Saturated	Native « general » metadata	
SOLAR_IRRADIANCE	Native « general » metadata	Units: W/m²/µm
PhysicalGain	Native « datastrip » metadata	
SPATIAL_RESOLUTION	Native « general » metadata	Units: meters (optional)
Wavelength min	Native « general » metadata	Units: meters (optional)
Wavelength max	Native « general » metadata	Units: meters (optional)
Wavelength central	Native « general » metadata	Units: meters (optional)
Spectral_Response/STEP	Native « general » metadata	Units: meters (optional)
Spectral_Response/VALUES	Native « general » metadata	Optional

ANNEX B MUSCATE_METADATA SCHEMA

Muscate_Metadata_S2ACA.html