IMPLEMENTING MULTI-SCALE AGRICULTURAL INDICATORS EXPLOITING SENTINELS

SERVICE SPECIFICATIONS

IMAGINES_RP1.2_SSD

ISSUE 2.00

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DOCUMENT RELEASE SHEET

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CHANGE RECORD

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	18.06.2013	All	First issue focusing on PROBA-V 300m products	I1.00
I1.00	23.09.2013	16, 21, 24	Update File naming (§3.1), User support (§3.6.3) and Product Sheet to be compliant with Global Land Service specifications	I1.10
I1.10	30.09.2013	16	Update the file naming convention to fit the recommendations of the Design Key Point review	I1.11
I1.11	17.11.2014	All	Update according to Issue dated on 12.08.2014 of Annex I	I2.00

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ACRONYMS AND DEFINITIONS

AL-BH : Hemispheric Albedo or Bi-Hemispheric reflectance or White-sky albedo

AL-DH : Directional Albedo or Directional-Hemispheric reflectance or Black-sky albedo

ATBD : Algorithmic Theoretical Basis Document

Attribute : A small dataset that can be used to describe a specific characteristic of the data stored in the same file.

CEOS/LPV : Land Product Validation group of Committee for Earth Observation Satellites

DataSet : A multi-dimensional array of data elements. A dataset can support several attributes.

EBF : Evergreen Broadleaf Forest

FAPAR : Fraction of Photosynthetically Active Radiation Absorbed by the vegetation

FAQ : Frequently Asked Questions

FCover : Fraction of green Vegetation Cover

FTP : File Transfer Protocol

gco : Defines basic types such as strings, integers, etc. Gco namespace is based on ISO 19118: http://www.isotc211.org/2005/gco

gmd : Basic geographic metadata, as designed in ISO 19115. This contains most of the XML elements used: http://www.isotc211.org/2005/gmd

GMES : Global Monitoring for Environment and Security (former name of Copernicus)

gml : Geography Markup Language, an XML variation for geographic applications, defined by OGC. ISO 19115 and 19139 use some elements from GML: http://www.opengis.net/gml

gmx : Extended geographic metadata. This is an extension of the gmd namespace, for instance for the definition of coordinate reference systems (crs). http://www.isotc211.org/2005/gmx

gsr : Definitions of spatial referencing, based on ISO 19111 and linked to GML. http://www.isotc211.org/2005/gsr

HDF : Hierarchical Data Format

HDF file : A container for storing datasets and attributes in Hierarchical Data Format.

ISO : International Standardization Organization

JECAM : Joint Experiment of Crop Assessment and Monitoring

LAI : Leaf Area Index

LDAS	: Land Data Assimilation system
OGC	: OpenGIS Consortium.
NRT	: Near Real Time
PUM	: Product User Manual
RMSE	: Root Mean Square Error
SMAC	: Simplified Model for Atmospheric Correction
TOA	: Top Of the Atmosphere
WGS	: World Geodetic System
XML	: Extensible Markup Language, an extension of the well-known HTML (Hypertext Markup Language), used in websites.

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1. BACKGROUND OF THE DOCUMENT

1.1. EXECUTIVE SUMMARY

The Copernicus program is the EU response to the increasing demand for reliable environmental data. The objective of the Copernicus Land Service is to continuously monitor and forecast the status of land territories and to supply reliable geo-information to decision makers, businesses and citizens to define environmental policies and take right actions. ImagineS intends to continue the innovation and development activities to support the operations of the Copernicus Global Land service, preparing the use of the new Earth Observation data, including Sentinels missions data, in an operational context. Moreover, ImagineS aims to favor the emergence of downstream activities dedicated to the monitoring of crop and fodder production, that are key for the implementation of the EU Common Agricultural Policy, of the food security policy, and could contribute to the Global Agricultural Geo-Monitoring Initiative (GEOGLAM) coordinated by the intergovernmental Group on Earth Observations (GEO).

The main objectives of IMAGINES are to (i) improve the retrieval of basic biophysical variables, mainly LAI, FAPAR and the surface albedo, identified as Terrestrial Essential Climate Variables, by merging the information coming from different sensors (PROBA-V and Landsat-8) in view to prepare the use of Sentinel missions data; (ii) develop qualified software able to process multi-sensor data at the global scale on a fully automatic basis; (iii) complement and contribute to the existing or future agricultural services by providing new data streams relying upon an original method to assess the above-ground biomass, based on the assimilation of satellite products in a Land Data Assimilation System (LDAS) in order to monitor the crop/fodder biomass production together with the carbon and water fluxes; (iv) demonstrate the added value of this contribution for a community of users acting at global, European, national, and regional scales.

To reach these objectives, ImagineS has collected the needs of a number of institutions worldwide involved in different applications related to agriculture, of the African community gathered in the MESA project, and of the Copernicus Global Land service which expects that the ImagineS medium resolution EO-derived products can be included into its portfolio to contribute to the its evolution. Based on the findings from this exercise, concrete technical product specifications have been elaborated building upon experiences from previous pre-operational and current operational Copernicus initiatives.

1.2. SCOPE AND OBJECTIVES

The Service Specifications Document contains all technical characteristics of the ImagineS products. A detailed sheet is provided for each product.

This issue focuses on the EO-derived 300m products.

1.3. CONTENT OF THE DOCUMENT

Chapter 2 recalls the ImagineS portfolio and the preliminary characteristics of the products.

Chapter 3 details the specifications of the products.

Chapter 4 compiles the product description sheets.

The Annex details the requirements of the production centre in terms of format and packaging of the final products.

1.4. RELATED DOCUMENTS

1.4.1. Inputs

Overview of former deliverables acting as inputs to this document.

Document ID	Descriptor
ImagineS_RP1.1_URD	Users Requirements Document
ImagineS_MIN_ABM1	Minutes of the first meeting of the Advisory Board

1.4.2. Output

Overview of other deliverables for which this document is an input:

Document ID	Descriptor
ImagineS_RP1.3	Users Assessment Reports
ImagineS_RP2.1	ATBD of LAI, FAPAR, FCover
ImagineS_RP2.2	ATBD of Albedo
ImagineS_RP3.1	ATBD of LDAS-derived biomass, carbon and water fluxes, and drought indicators
ImagineS_RP4.1	ATBD of crop maps
ImagineS_RP5.1	Technical Specifications or Detailed Processing Model
ImagineS_RP6.3	Product User Manuals

1.4.3. Global Land Service Documents

Document ID	Descriptor
GIOGL1_ServiceValidationPlan	Service Validation Plan of the Copernicus Global Land service
GIOGL1_QAR_GEOV3	Quality Assessment Report of GEOV3 products

1.4.4. External Reference Document

RD1: Appendix 1 “Product and Service Detailed technical requirements” to Annex II “Technical Specifications” to Framework Service Contract supporting the Global land Component of the GIO Land service – 2 Lots, Contract Notice N°. 2012/S 129-213277 of 7th July 2012.

RD2: GMES Space Component Data Access Portfolio: Data Warehouse 2011-2014 (ESA – GMES-PMAN-EOPG-TN-11-0006)

RD3: HDF5 File Format Specification Ref: http://www.hdfgroup.org/HDF5/doc/index.html

RD4: INSPIRE Metadata Implementing Rules: Technical Guidelines based on EN ISO 19115 and EN ISO 19119, MD_IR_and_ISO_20090218.pdf, 18/02/2009.

2. OVERVIEW OF IMAGINES PORTFOLIO

The ImagineS portfolio contains global and regional biophysical variables derived from multi-sensor satellite data, at different spatial resolutions, together with agricultural indicators, including the above-ground biomass, the carbon and water fluxes, and drought indices resulting from the assimilation of the EO-derived biophysical variables into the Land Data Assimilation System (LDAS) (Table 1).

ID	Name	EO sensor	Temporal resolution	Spatial resolution	Spatial coverage
01	LAI, FAPAR, FCover	PROBA-V	10 days	333 m	Global
02	Albedo	PROBA-V	10 days	333 m	Global
03	Biomass	N/A	10 days	16 km (8 km)	Global (Fr,Hu)
04	Drought indicators	N/A	10 days	16 km (8 km)	Global (Fr,Hu)
05	Carbon fluxes (GPP, RE, NEE) and evapotranspiration	N/A	10 days	16 km (8 km)	Global (Fr,Hu)
06	FAPAR per class	PROBA-V	10 days	333 m	Demo sites (25 km²)
08	FAPAR	Landsat-8 + PROBA-V	10 days	30 m	Demo sites
09	Above-ground biomass	N/A	10 days	local simulations	Demo sites
10	Crop map	S1 + Landsat-8 + PROBA-V	Continuous update [1]	30 m	Demo sites

Table 1: Detailed IMAGINES products. [1]: when a new acquisition is available.

To match the expectations of the Copernicus Global Land Service expressed during the Advisory Board Meeting [ImagineS_MIN_ABM1], ImagineS focuses its efforts on the LAI, FAPAR, FCover and Albedo (Table 1) derived from PROBA-V 333m resolution data. The production in near real time (NRT) of these 333m resolution products, at a frequency of 10 days, is carried out in the Copernicus Global Land Service, starting over Europe with a gradual extension to the whole globe. Meanwhile, IMAGINES will perform in parallel off-line production over the demonstration sites outside Europe. The demonstration of high resolution (30m) products (Landsat-8 + PROBA-V) will be done over some demonstration sites of cropland and grassland in contrasting climatic and environmental conditions (Table 2).

ID	Name	Description	Location
1	South-West, France	Flat cropland with a rotation of wheat, maize, sunflower. Some fields are irrigated.	43° 29' N, 1° 16' E
2	Hegyhatsal, Hungary	Flat cropland where small parcel-based agricultural management is typical of the whole country	46° 57' N, 16° 39' E
3	Las Tiesas Farm, Barrax, Spain	Flat cropland of 65% dry land (barley, wheat) and 35% irrigated crops with large pivots (onion, garlic, sugar beets, potatoes, maize, alfalfa, sunflower).	39° 02' N, 2° 04' W
4	Tula, Russia	Typical field size is near 100 hectares. Crop types are winter wheat, spring barley, potatoes, maize, rape seeds, and winter rye.	53° 05' N, 37° 14' E
5	Upper Tana Basin, Kenya	Small holder farms where grow tea, coffee, maize and vegetables	0° 55'N, 36° 47'E
6	Merguellil, Tunisia	Flat plain with fields of cereals, vegetables and olive trees, dry and irrigated	35° 45' N, 10° 5' E
7	Free State Province, South Africa	Agriculture and grasslands. Site located in the major grain producing province of South Africa.	28° 25' S 27°4' E
8	Greenbelt Farm, Ottawa, Canada	Agriculture in this region of eastern Canada mainly consists of corn, soybean and spring wheat annual crops adapted to short-season, perennial forage and livestock pasture.	45° 18' N, 75° 45' W
9	San Fernando, Chile	Flat cropland area covered by annual crops such as maize, wheat, alfalfa, sunflowers.	34° 42' S, 71° 0' W
10	25 de Mayo, La Pampa, Argentina	Semi-desertic area with irrigated alfafa pastures	37° 54' S, 67° 44' W
11	Yanco area, Murrumbidgee River catchment, Australia	A gently sloping area containing irrigated croplands and natural rangelands.	34° 45' S, 146° 04' E
12	Comunidad de regantes del Campo de Cartagena, Spain	50.000 ha irrigated crops with drip irrigation (vegetables and citrus trees)	37° 48' N, 1° 03' W
13	Cordoba, Spain	Flat cropland area	37° 48' N, 4° 44' W
14	Lambayeque, Peru	Flat cropland area monitored for drought and desertification analysis	6° 47' S, 79° 46' E
15	La Albufera, Spain	Rice fields	39° 16'N, 0° 19'W

ID	Name	Description	Location
16	Rosasco, Milan, Italy	Rice fields	45° 15'N, 8° 33'E
17	Pshenichne, Ukraine	Flat area with winter wheat, spring barley, maize, soy beans, winter rapeseed, sunflower, sugar beet, potatoes, winter rye and spring wheat	50° 4'N, 30° 6'E

Table 2: ImagineS demonstration sites characteristics

The demonstration of high resolution (30m) products (Landsat-8 + PROBA-V) will be done over some demonstration sites of cropland and grassland in contrasting climatic and environmental conditions.

France and Hungary are the main areas of interest as the regional LDAS can run at 8 km resolution over these countries.

The feasibility of the crop map merging Sentinel-1, Landsat-8 and PROBA-V will be demonstrated over two areas of about 300km x 300km around Tula (Russia) and in the Free State Province, South Africa. Both areas are demonstration sites of the JECAM initiative, developed in the framework of GEO Global Agricultural Monitoring, which enables to share experiment data on proposed sites where regularly field campaigns are organized.

3. SPECIFICATIONS OF EO-DERIVED 333M PRODUCTS

In a first step, ImagineS focuses on the development of 333m PROBA-V LAI/FAPAR/FCover and Albedo products. The processing line, set-up and tested by ImagineS, is delivered to the Copernicus Global Land service to be integrated into the production facility. **Consequently, the PROBA-V LAI/FAPAR/FCover and Albedo products are considered as Copernicus Global Land products and are compliant with the requirements of the service** [RD1]. These latter are translated by the production centre into specifications of output format, relevant for the development team. The main specifications are summarized below and the details are given in Annex.

3.1. FILE NAMING

The naming follows the standard of the Global Land service, a string of up to 255 characters made of 6 fields separated by single underscores with shape:

g2_BIOPAR_<Acronym>_<YYYYMMDDHHMM>_<AREA>_<SENSOR>_V<Major.Minor>

where

- <Acronym> is the short name of each product and variable. Here, Acronym = LAI, FAPAR, FCover, AL-DH for directional surface albedo, and AL-BH for hemispheric surface albedo. If necessary, the acronym may be composed from different parts as <Acronym-name[-ZZZ]> where:
  - Acronym-name: short name
  - [ZZZ]: reflects the mode of operation, in case multiple decadal updates are used to improve the reliability of real-time product:
    - RT0: Near Real Time product
    - RTn: Consolidated Real Time Product, where n equals the number of times the RT0 product was updated.
- <YYYYMMDDHHMM> gives the representative date of the file. YYYY, MM, DD, HH, and MM denote the year, the month, the day, the hour, and the minutes, respectively. For 10-daily products, ‘HHMM’ = ‘0000’.
- <AREA> gives the spatial coverage of the file (see 3.3).
- <SENSOR> gives the name of the sensor used to retrieve the product. Here, SENSOR = PROBAV
- <Major.Minor> gives the version number of the product. “Major” increases when the algorithm is updated. “Minor” increases when bugs are fixed or when processing lines are updated (metadata, color quicklook, etc...).

3.2. FORMAT

The Copernicus Global Land products are distributed in zip archives which contain the following files:

- A multi-band HDF-5 format datafile
- a xml file containing the metadata conform to INSPIRE2.1 (Annex). An xsl file allows displaying a friendly view of the metadata file.
- A quicklook in a coloured geo-tiff format (Annex). The quicklook sub-sampled to 25% in both horizontal and vertical direction for the variable layer.
- A text file containing the copyright of the product.

In case of LAI, FAPAR and FCover, the multi-band HDF-5 data file contains the following layers:

- LAI (or FAPAR, or FCOVER)
- QFLAG: quality flag
- NOBS: number of daily observations used in the compositing
- RMSE: root mean square error on LAI (or FAPAR or FCover) value compared to the daily estimates
- SEMI-PER-LEFT: length, in days, of the semi-period before the dekadal date of the compositing window
- SEMI-PER-RIGHT: length, in days, of the semi-period after the dekadal date of the compositing window.

In case of Broadband Surface Albedo products (AL-DH and AL-BH), the multi-band HDF-5 data file contains the following layers:

- AL-DH-VI (or AL-BH-VI): Broadband Directional Hemispheric (or Bi-Hemispheric) Reflectance over visible band [0.4, 0.7µm]
- AL-DH-VI-ERR (or AL-BH-VI-ERR): the error on the Broadband Directional Hemispheric (or on the Bi-Hemispheric) Reflectance over visible band
- AL-DH-NI (or AL-BH-NI): Broadband Directional Hemispheric (or Bi-Hemispheric) Reflectance over near infrared band [0.7-4µm]
- AL-DH-NI-ERR (or AL-BH-NI-ERR): the error on the Broadband Directional Hemispheric (or on the Bi-Hemispheric) Reflectance over near infrared band
- AL-DH-BB (or AL-BH-BB): Broadband Directional Hemispheric (or Bi-Hemispheric) Reflectances over total spectrum [0.3-4µm]
- AL-DH-BB-ERR (or AL-BH-BB-ERR): the error on the Directional Hemispheric (or Bi-Hemispheric) Reflectances over total spectrum
- QFLAG: the quality flag of the product
- Z-Age: the elapsed time since the latest clear day for which observation is used to calculate the albedo.

The HDF-5 format data file of the Spectral Surface albedo products (AL-DH and AL-BH) contains the values for each spectral bands of PROBA-V sensor (blue, red, near infra-red and shortwave infrared). It contains the QFLAG and the Z-Age as well.

Both the archives as well as the files within are compliant with the filename convention as described in the previous paragraph (§3.1).

3.3. SPATIAL COVERAGE AND PROJECTION INFORMATION

The Global Land service products cover the whole globe which is split into tiles of 10° x 10°, one file per tile. A dedicated typology has been defined to locate easily each tile when reading its name. The globe is divided in 36 tiles in longitude and 18 tiles in latitude according to Figure 1. The products are also provided by continents (grouping of a set of tiles) as defined in Figure 1 and named as Table 3.

The global window definition is aligned on the specifications of the PROBA-V data to be procured as part of the Data WareHouse programme [RD2]:

- Geographic projection: regular lat/lon grid “plate-carrée”
- Geodetical datum: WGS84
- Pixel size: 1/336° – accuracy: minimum 10 digits
- Coordinate position: pixel centre

In the first step, the LAI, FAPAR, FCover, and Albedo products cover only Europe defined by the EURO window (Table 3).

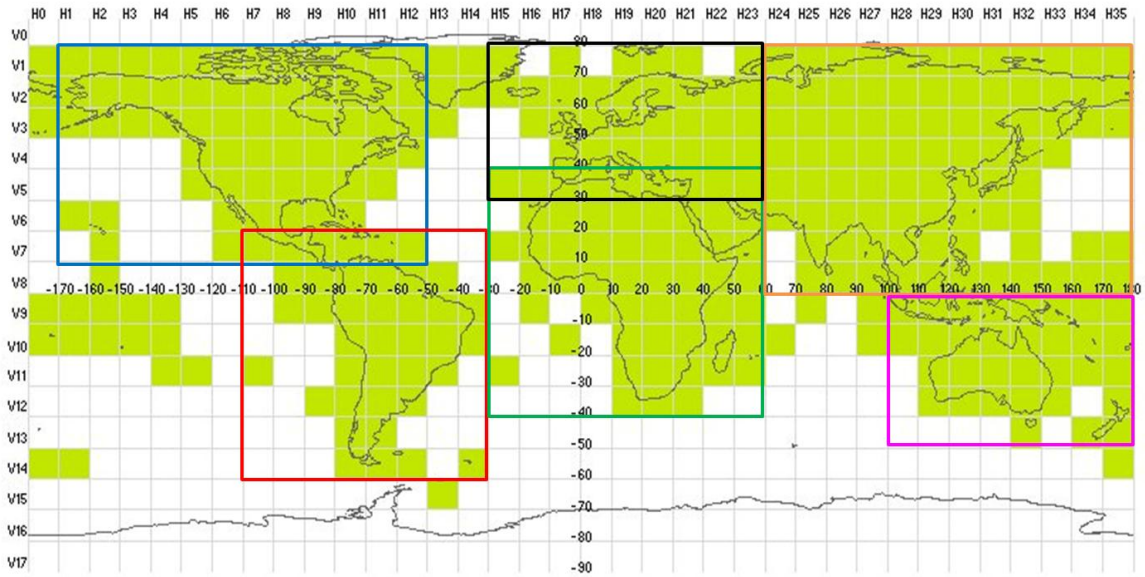


Figure 1: Tiling of global EO-derived products. Only green tiles are generated. Tiles are gathered into 6 continents

Short name	Continent
AFRI	Africa: 30°W – 60°E, 40°N – 40°S
ASIA	Asia: 60°E – 180°E, 80°N – 0°N
EURO	Europe: 30°W – 60°E, 80°N – 30°N
NOAM	North America: 170°W – 50°W, 80°N – 10°N
OCEA	Oceania: 100°E – 180°E, 0°S – 50°S
SOAM	South America: 110°W – 30°W, 20°N – 60°S

Table 3: Definition of the continents.

3.4. QUALITY INFORMATION

The quality information is contained in the QFLAGs as defined in the ATBDs [ImagineS_RP2.1].

3.5. METADATA

The metadata are dedicated to 3 particular use cases:

1. The catalogue web service for collection metadata
2. The catalogue web service for product metadata
3. To be delivered with products for users

For the use in the collection metadata catalogue web service, and in the product metadata catalogue web service, the metadata are presented in an XML file compliant with the INSPIRE2.1 guidelines. The XML file is associated with the .XSL template to make the metadata file friendly readable by users using viewing tools.

The details are given in Annex.

3.6. DISSEMINATION

As stated in introduction of this chapter, the 333m PROBA-V products developed in ImagineS are generated and distributed in the Copernicus Global Land Service. Consequently, this section reports information related to the Global Land Service.

3.6.1. Documentation

Each product is associated with 3 public documents:

1. The Algorithmic Theoretical Basis Document (ATBD) describing in details the retrieval methodology

2. The Product User Manual (PUM) recalling the main algorithmic principles, describing the product structure and format, and summarizing the result of the product validation
3. The Scientific Quality Assessment Report presenting the scientific quality assessment procedure, and the results of the exercise

The ATBD is generated in the ImagineS framework.

The Scientific Quality Assessment is performed during the demonstration production phase of the Global Land Service.

The PUM is initiated in ImagineS, with the sections related to the definition of the products, and finalized in the Global Land Service, with the information related to the production, dissemination and validation.

All documents are available through the ImagineS website (http://fp7-imagines.eu/documents/) and through the Global Land service web site (http://land.copernicus.eu/global/).

3.6.2. Delivery

The Copernicus Global Land products are delivered via two channels: the ftp associated to the Global Land service website (http://land.copernicus.vgt.vito.be/PDF/portal/Application.html#Home) and EUMETCast.

The products are accessible on the dissemination portal within 3 days after the acquisition of the latest input data. The ftp site is accessible 365 days/year, 7 days/week, 24 hours/day. The access to products is granted only after due registration. It is possible to subscribe to receive the NRT products as soon as they are generated.

Users in Africa and Americas can receive the NRT products via EUMETCast, the broadcast dissemination system of EUMETSAT.

3.6.3. User support

The support to users of Copernicus Global Land products is provided:

- by email: helpdesk@vgt.vito.be
- by telephone 5 days a week: +32 14 33 68 14 (8:00am – 4:00pm CET/CEST
- using a contact form on the page: http://land.copernicus.eu/global/contact

A web-based FAQ is maintained and fed with requests from users and corresponding answers: http://land.copernicus.eu/global/faq.

The ImagineS experts may be sought if necessary.

3.6.4. Tools

The Copernicus Global Land products are provided in HDF-5 format files which can be handled with the HDF5 library from http://www.hdfgroup.org. The library comes with useful tools that could be used to discover the organization and contents of the HDF-5 files. A java viewer tool called HDFView is more user friendly-oriented than the based-line commands.

The extraction of ROI, the mosaicking of tiles and the format conversion of Global Land service will be handled on the new dissemination data portal of the Copernicus Global Land service.

4. PRODUCT DESCRIPTION SHEETS

LAI, FAPAR, FCover (GEOV3) products	
Description	
Variable Definition	LAI is defined as half the developed area of photosynthetically active elements of the vegetation per unit horizontal ground area. FAPAR corresponds to the fraction of photosynthetically active radiation absorbed by the canopy. FCover is defined as the part of the unit ground covered by the green vegetation.
Products	Products generated in NRT, updated every 10 days Consolidated products generated with a delay of N decades, updated every 10 days. N is defined in the ATBD (ImagineS_RP2.1).
Input data (EO and ancillary)	Top of Atmosphere (TOA) daily synthesis (S1) from PROBA-V at 333m resolution. Meteo information: ozone content, water vapor content, atmospheric pressure corrected from the altitude.
Methodology	From the TOA S1 PROBA-V reflectances to the 10-daily LAI, FAPAR, FCover products, the algorithm is split into 2 major steps: 1. Step A: instantaneous daily estimates 2. Step B: compositing, smoothing, gap filling and projection Step A is made itself of 5 successive components: • Spectral correction to convert the PROBA-V TOA reflectances in SPOT/VGT reflectances. • Atmospheric correction using SMAC4.0 model to remove the effects of ozone, water vapor and atmospheric pressure. • First outlier rejection based on the PROBA-V S1 Status map to discard cloud/snow/water contaminated pixels, and on the definition domain of spectral reflectances. • Instantaneous estimates of each variable and its uncertainty using neural networks using as input the TOA S1 blue, red and NIR reflectances, the sun and viewing zenith angles, and the relative azimuth angle. • Outlier rejection based on the expected physical range, including tolerance values, of the variables. Step B discriminates the pixels in 2 classes (EBF-like and non EBF-like). For each class, the length of the compositing window, and the degree of the polynomials used to perform smoothing, gap filling and projection, are adjusted according to the number of available instantaneous estimates. Details are available in the ATBD [ImagineS_RP2.1]. For access, see

	Documentation below.
Spatio-temporal features	
Spatial coverage	Europe (30°W – 60°E, 80°N – 30°N) by continental tile or by 10° x 10° tiles
Projection / Geographic coordinate system	Regular latitude/longitude grid “plate-carrée” Geodetical datum: WGS84 Pixel size: 1/336° Coordinate position: pixel centre
Geometry accuracy	½ pixel
Temporal coverage	From November 2013 onwards
Temporal frequency	Every 10 days
Quality Information	
Indicators	Variable uncertainty. Algorithm metrics: number of valid input, length of compositing window, RMSE of final product Quality Flag. Details can be found in the ATBD [ImagineS_RP2.1].
Validation	Scientific quality assessment and quality monitoring are based upon the CEOS/LPV guidelines, focusing on 1) direct validation against ground measurements; 2) indirect validation including checking of spatio-temporal consistency of variables, and inter-comparison with similar EO products. Technical quality monitoring is performed at production centre by semi-automatic checks of product generation, archiving, and dissemination, and by visual inspection. Procedures are detailed into the Service Validation Plan of the Global Land Service [GIOGL1_ServiceValidationPlan]. The results of scientific quality assessment are available into the Scientific Quality Assessment report [GIOGL1_QAR_GEOV3].
Accuracy	Target: 0.5 for LAI < 1, 20% for LAI > 1; 0.05 for FAPAR and FCover < 0.2, 10% for FAPAR and FCover > 0.2. Actual values are in the Scientific Quality Assessment report.
Dissemination	
Format	Zip archives containing a multi-band HDF-5 format file, a xml file of metadata associated with an xsl file for displaying it in a friendly way, a quicklook, and a text file containing the copyright of the product.
Access	Free and open access by FTP via the Global Land Service website (http://land.copernicus.eu/global) after registration. Subscription is possible to get the NRT products as soon as they are generated.

Timeliness	NRT (no more than 3 days after the end of the synthesis period)
Documentation	The Product User Manual recalls the retrieval methodology, describes the technical characteristics of the products, and summarizes the scientific quality assessment results. The ATBD and the various validation reports are also public documents. They are available through the Global Land Service website (http://land.copernicus.eu/global) The ATBD and the PUM are also available on the ImagineS website (http://fp7-imagines.eu/documents/)
User support	By email: helpdesk@vgt.vito.be By telephone 5 days a week: +32 14 33 68 14 (8:00am – 4:00pm CET/CEST Using a contact form on the page: http://land.copernicus.eu/global/contact
Data Policy	See the metadata for credits. Free and open access compliant with the Copernicus data policy regulation in preparation.

ANNEX: FORMAT DEFINITION

The Copernicus Global Land products are based on HDF5 [RD3]. The metadata is written according to the INSPIRE guidelines [RD4].

FILE STRUCTURE

The Global Land products provided in the form of **ZIP archive** containing following files:

- 1 or more pixel data files (HDF);
- 0 or more status files (HDF);
- 1 quicklook image (TIFF6.0);
- 1 XML metadata file[1] (XML);
- 0 or more metadata translator files (XSLT)
- 1 Copyright Information file (ASCII)

The files in the archive are stored in a **subdirectory** that has the decade end date as name, followed by a second **subdirectory** that has the tile number as name, e.g. 20090621\H15V12 as shown in Figure 2.

Figure 2: Example of ZIP file structure

Each ZIP file contains a single product and the respective metadata although one product can be composed by more than one file.

HDF files

The HDF files in the Global Land processing chains have the following structure:

- A common set of attributes for all kind of data, containing general information about the data;
- One or more datasets for the parameter values.

[1] The XML metadata file is according an internationally standardized format [RD4].

In this context, a dataset is composed by a set of specific attributes and a space for the data. The datasets might have different dimensions and different number of bytes per pixel (1 or 2 bytes).

The set of general attributes to be part of all Global Land files, and their possible values, are described in Table 5. The common attributes for the datasets are described in Table 6. Other relevant information for the interpretation and visualization of the product and its images, such as the projection, geo-location and resolution information, is (also) stored in the XML product description file.

The HDF pixel data of HDF files are based on the Scientific Data Set (SDS) profile and contain the actual scientific data of the product, the pixel values for all pixels in a certain Area Of Interest (AOI). The data type used to store the pixel data depends on the type of data to store and can thus vary between products and even between HDF files in the same product. However, the following rules of thumb are always obeyed:

- The HDF pixel data files are in HDF5 format, and are created with and readable by version 5.1 or higher of the HDF library.
- The data type is as small (in number of bits) as possible to limit the size of the HDF files.
- Scaling and offset, together called encoding, can be applied to make conversion to a smaller data type possible.
- Data type, scaling & offset and other related information should be clearly documented as this is clearly vital information for users.
- The data type must be compatible with the HDF format (see §0).
- The Scientific Dataset (SDS) that holds the pixel values has the name of the layer or “PIXEL DATA”.

XML files

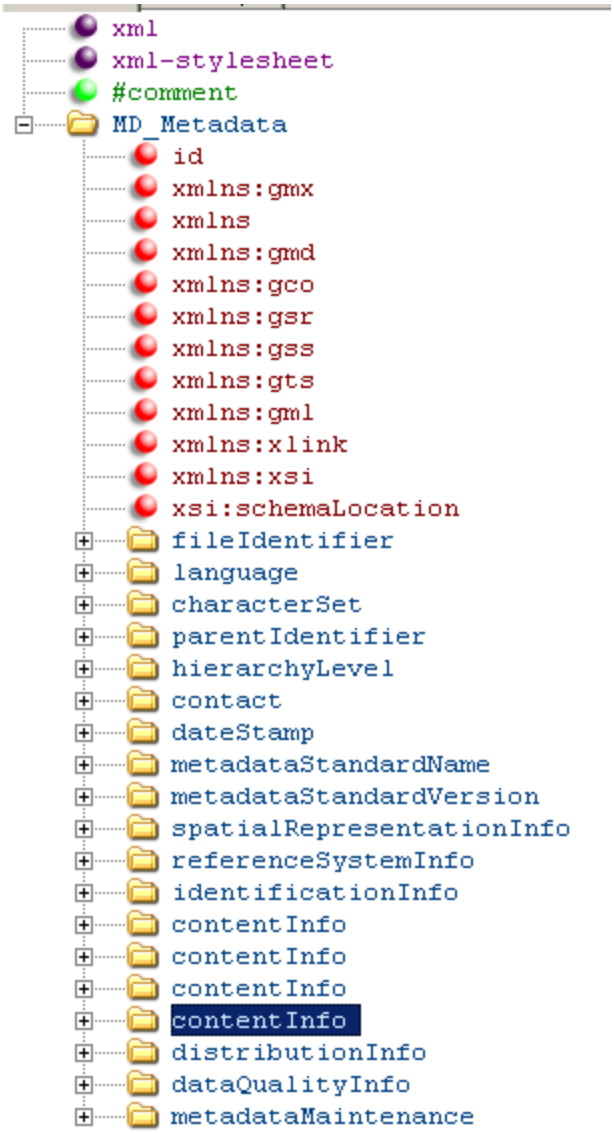
Additional metadata is presented in an XML file that can be easily viewed in a regular web browser using the XSL translator file (g2_BIOPAR_PROD-DESC.xsl). The viewer can easily be replaced by an own viewer by substituting the corresponding xsl tag in the xml file viewer with the name of another XSL translator file.

The product descriptions follow the international standards ISO 19115 (version 2003) and ISO 19139 (version 2005), that are defined by the International Standards Organization (ISO) and supported by the OpenGIS Consortium (OGC).

More precisely, ISO 19139 provides a set of XSD (XML Schema Definition) files, that were derived from the metadata structure designed in ISO 19115 and that contain the rules that the XML format must obey.

As defined in the ISO standards, a MD_MetaData element must be at the top level in the XML hierarchy and only 1 top-level element is allowed. The HDF files and the pixel data they contain are represented by separate ‘contentInfo’ elements in the XML structure.

E.g. for products that contain only two images and a quicklook, the XML structure can be summarized as follows:



The common attributes as presented in the XML file are described in Table 7.

QL files

The quick look images (xxx_QL_xxx) contain 8-bits per pixel color scale values and are provided in standard TIFF (True Image File Format). Such quick look files provide a first look at the datasets in the HDF files, and are not to be further processed or analyzed. The data in the TIFF quick look images could be ‘n’ times lower longitudinal and latitudinal resolution than the data in the HDF files.

TXT files

The copyright text file (g2_BIOPAR_RIG.txt) contains information and restrictions on the use of the product.

DATA TYPES

The data types to be used in HDF files are given in the table below.

Data Type	Data type description	HDF5 Predefined Data Type
Bool	8-bits, only contains 0 or 1	H5T_NATIVE_UCHAR
UInt8	Unsigned 8-bit integer	H5T_NATIVE_UCHAR
Int8	Signed 8-bit integer	H5T_NATIVE_CHAR
Char	8-bit unsigned character	H5T_NATIVE_UCHAR
UInt16	Unsigned 16-bit short integer	H5T_NATIVE_USHORT
Int16	Signed 16-bit short integer	H5T_NATIVE_SHORT
UInt32	Unsigned 32-bit long integer	H5T_NATIVE_UINT
Int32	Signed 32-bit long integer	H5T_NATIVE_INT
Float	Single precision floating point number (IEEE)	H5T_IEEE_F32BE
Double	Double precision floating point number (IEEE)	H5T_IEEE_F64LE
UInt64	Unsigned 64-bit long_long integer	H5T_NATIVE_LLONG
String<N>	Set of 8 bit characters	N* H5T_NATIVE_UCHAR
Array<N>	Set of ‘N’ datatypes	N* ‘datatype’

Table 4: Data types for HDF files

METADATA

Hereafter the following naming convention applies:

Attribute	Description	Data Type	Allowed Values
ARCHIVE_FACILITY	As part of product_contact: Institution archiving the data	String<5>	'VITO'
CENTRE	As part of product_contact: Institution generating the data	String<5>	'VITO'
ELLIPSOID_NAME	Reference to ellipse (sphere) used and hence it's axis parameters	String<6>	'WGS84'
GEODATE_NAME	Reference to geodetical datum used	String<6>	'WGS84'
LAT	North & South bound coordinates in degrees	Array[2] of Double	Depends on product
LONG	West & East bound coordinates in degrees	Array[2] of Double	Depends on product
IMAGE_ACQUISITION_TIME	Start date for composite image	String<14>	'YYYYMMDDhhmmss'
INSTRUMENT_ID	Instrument which acquired the data used to generate product	Array[10] of String<9>	{'PROBAV'}
NB_PARAMETERS	Number of datasets in file	Int32	Depends on product
NC	Maximum number of columns for all datasets in file	Uint32	3360 for 10°x10° tile
NL	Maximum number of lines for all datasets in file	UInt32	3360 for 10°x10° tile
OVERALL_QUALITY_FLAG	Overall quality flag for the product	String<3>	OK, NOK, PAR
PIXEL_SIZE	Spatial resolution: size of pixel	String<10>	Free text, e.g. '333m'
PRODUCT	Describes the acronym of the product (=Description)	String<79>	One of: 'LAI','FAPAR' …
PRODUCT_TIME	Nominal product time at which product is generated	String<14>	'YYYYMMDDhhmmss'
PRODUCT_ALGORITHM_VERSION	Product version of the processing line that generated the product	String<4>	e.g. 0.10
PROJECTION_NAME	Projection code to reference to actual projection parameters	String<15>	e.g. PlateCarree
REGION_NAME	Processed area name as ISO code	String<6>	e.g. BEL
SATELLITE	Platform identifier	Array[10] of String<9>	{PROBAV}
TIME_RANGE	Temporal resolution of product	String<20>	10-day, annual, none = unknown/irrelevant

Table 5: General attributes of Global Land products files. Mandatory fields are in bold.

Attribute	Description	Data Type	Value
CLASS	Dataset type	String<8>	'Data'
DATA_OFFSET	Number of leader bytes from beginning of file until the actual image data from dataset	UInt64	Depends on dataset
N_ LINES	Number of lines (fakeDim0)	UInt32	Depends on dataset
N_ COLS	Number of columns (fakeDim1)	UInt32	Depends on dataset
NB_BYTES	Number of bytes per pixel	UInt32	Depends on dataset
ORDER_BYTES	Byte order of platform generating product	Bool	0=HE, 1=LE
PRODUCT	Defines the name of the dataset. The size of the binary dataset can be calculated as: N_LINES*N_COLS*NR_BYTES	String<32>	Depends on dataset. One of: LAI; LAI-ERR, …
MAX_VALUE	Highest digital value of significant range	Int32	Depends on dataset
MIN_VALUE	Lowest digital value of significant range	Int32	Depends on dataset
MISSING_VALUE	Missing value	Int32	Depends on dataset
OFFSET	Offset of the scaling factor	Float	Depends on dataset
SCALING_FACTOR	Scaling factor for the parameter	Float	Depends on dataset
UNITS	Parameter Unities	String<32>	Free text

Table 6: Dataset attributes. Mandatory fields are in bold.

Attribute	Description	Element
ARCHIVE_ID	Unique identifier to the archived version of the product data	Gmd:identificationInfo: citation:identifier
CHECK_POINT	Earth location in the coordinate system defined by the Spatial Reference System (upper left corner points & pixel centered)	Gmd:spatialrepresentationInfo:cornerPoints Gmd:spatialrepresentationInfo:pointInPixel
DESCRIPTION	Description of the actual parameter	Gmd:contentinfo:attributeDescription
DISTRIB_CONTACT	Information related to the distribution of the product, such as the file format used (ZIP format of the product), the organization responsible for the distribution of the product, etc.	Gmd:distributorInfo
HIERARCHY	The scope of the metadata = dataset	Gmd:hierarchyLevel
IMAGE_ACQUISITION_TIME	Start date for temporal resolution of product	Gmd:identificationInfo: extent
INSTRUMENT_ID	Instrument which acquired the data used to generate the product	Gmd:identificationInfo: descriptiveKeywords "theme"

Attribute	Description	Element
KEYWORD	Information that can be used to identify the product or dataset	Gmd:identificationinfo: desriptiveKeywords Gmd:identificationinfo:t opicCategory
LANG	Language used = English	Gmd:language
LAT	Actual latitude	Gmd:identificationInfo: extent
LONG	Actual longitude	Gmd:identificationInfo: extent
META_CHARSET	CharacterSet used = UTF-8 (8-bits Unicode)	Gmd:characterset
META_CONTACT	Contact information, such as the name of the responsible organization, it's coordinates (postal address, phone number, e-mail address), specific contact instructions and a link to a relevant website.	Gmd:contact Gmd:metadataMainten ance
META_DATE	DateStamp, as part of MD_MetaData, is used to define the creation/revision date	Gmd:dateStamp
META_ID	Logical identifier (UUID) of a file, which can be random value or a reference to the filename.	Gmd:fileIdentifier
META_NAME	Name of the metadata standard, typically ISO 19139.	Gmd:metadataStandar dName
META_VERSION	Version number of the metadata standard = 2005	Gmd:metadataStandar dVersion
N_COLS	Number of columns (samples)	Gmd:spatialrepresentat ionInfo:axisDimension Properties
N_LINES	Number of lines (records)	Gmd:spatialrepresentat ionInfo:axisDimension Properties
PARENT_ID	Reference to the collection this product belongs to, referencing to 'series' uuid	Gmd:parentIdentifier
PIXEL_SIZE	Spatial resolution of the product	Gmd:identificationInfo: spatialResolution
PRODUCT	Descriptive information of the product; its purpose and credits	Gmd:identificationinfo: abstract Gmd:identificationInfo: purpose Gmd:identificationInfo: credit
PRODUCT_CONTA CT	Contact information, such as the name of the responsible organization, it's coordinates (postal address, phone number, e-mail address), specific contact instructions and a link to a relevant website. The role of the organization (owner, distributor, provider, etc.) is also indicated.	Gmd:identificationInfo: pointOfContact
PRODUCT_ACTUA L_SIZE	Actual size of the zip file, required for distribution	Gmd:distributionInfo:

Attribute	Description	Element
PRODUCT_TIME	Nominal time of the product time at which product is generated	Gmd:identificationInfo: citation
PRODUCT_VERSION	Version of the processing line (algorithm) that produces the product	Gmd:identificationInfo: citation:edition Gmd:identificationInfo: citation:editionDate
PROJECTION_NAME	Reference to the geographic system used (e.g. WGS1984)	Gmd:referenceSystemInfo
QUALITY_INFO	Quality indicators of the product	Gmd:dataQualityInfo:lineage
QUICKLOOK	Reference to any files that contain a thumbnail of or first quick loo k(filename, type and reduction parameter) at the dataset	Gmd:identificationInfo: graphicOverview
REGION_NAME	Processed area of interest	Gmd:identificationInfo: descriptiveKeywords “place”
RESOURCE_CONSTRAINT	Information to describe the usage constraints (useLimitation) and legal constraints (accessConstraints)	Gmd:identificationinfo:resourceConstraints
SATELLITE	Platform identifier of source of data.	Gmd:identificationInfo: descriptiveKeywords “theme”
TIME_RANGE	Temporal resolution of product	Gmd:identificationInfo: extent
VALUE_DISPLAY	The display value dimension is a subset of the significant value dimension and specifies the range of binary values that are typically displayed. Sequence identifier = “display”: :see VALUE_MIN, VALUE_MAX, VALUE_NR_BITS, VALUE_SCALE, VALUE_OFFSET	n.a.
VALUE_FLAG	Specific dimensions for special flag values. Such flag dimensions do not include a decode scale and offset, since flags should never be decoded, and the range of binary values (indicated by the minValue and maxValue elements) includes only 1 value. The descriptor of this dimension contains the meaning of the flag value. Sequence identifier = “flag”: see VALUE_MIN, VALUE_MAX, VALUE_NR_BITS	n.a.
VALUE: MAX_VALUE	Range of binary values for the parameter or flag	Gmd :contentInfo :dimension :maxValue
VALUE: MIN_VALUE	Range of binary values for the parameter or flag	Gmd :contentInfo :dimension :minValue
VALUE: MISSING_VALUE	Sequence identifier = “missing value” :see VALUE_MIN, VALUE_MAX, VALUE_NR_BITS	n.a.
VALUE_NR_BITS	Number of bits per pixel	Gmd:contentInfo:dimension:bitsperValue

Attribute	Description	Element
VALUE: OFFSET	Offset of the scaling factor. Physical value = (binary value * scale) + offset	Gmd:contentInfo:dimension:offset
VALUE_PHYSICAL	The physical value dimension describes the name, range and unit of the physical values that can be retrieved by decoding the significant binary values. Sequence identifier = “physical”: see VALUE_MIN, VALUE_MAX, VALUE_NR_BITS, VALUE_SCALE, VALUE_OFFSET	n.a.
VALUE: SCALING_FACTOR	Scaling factor for the parameter. Physical value = (binary value * scale) + offset	Gmd:contentInfo:dimension:scaleFactor
VALUE_SIGNIFICANT	The significant value dimension describes the range of binary values that can be decoded into physical values. This excludes any unused binary values or special flag values. Sequence identifier = “significant”::see VALUE_MIN, VALUE_MAX, VALUE_NR_BITS, VALUE_SCALE, VALUE_OFFSET	n.a.

Table 7: XML attributes according to ISO19115. Attributes shared within HDF are in bold.