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# GLOBCOVER

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## Products Description Manual



	Function	Name	Signature	Date
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## Acronyms

AD	: Applicable Document
AOT	: Aerosol Optical Thickness
ATBD	: Algorithm Theoretical Basis Document
BEAM	: Basic ERS & Envisat (A)ATSR and Meris Toolbox ( <a href="http://envisat.esa.int/services/beam/">http://envisat.esa.int/services/beam/</a> )
BRR	: Bottom Rayleigh Reflectance
AR	: Acceptance Review
CCN	: Contract Change Notice
CNES	: Centre National d'Etudes Spatiales (French space agency)
CYCLOPES	: FP5 project (contract n° EVG1-CT-2002-00076), Carbon cYcle and Change in Land Observational Products from an Ensemble of Satellites
DDF	: Design Definition File
DDV	: Dense Dark Vegetation
DJF	: Design Justification File
DEM	: Digital Elevation Model
DUE	: Data User Element
ENVISAT	: ESA Environmental Satellite
ESA	: European Space Agency
ESRIN	: European Space Research Institute
FR	: Full Resolution
FS	: Full Swath
GLOBCOVER	: ESA DUE ( <a href="http://dup.esrin.esa.it/invitations.asp">http://dup.esrin.esa.it/invitations.asp</a> )
GMES	: Global Monitoring for the Environment and Security
LCCS	: Land Cover Classification System
MERIS	: Medium Resolution Imaging Spectrometer Instrument ( <a href="http://envisat.esa.int">http://envisat.esa.int</a> )
MODIS	: Moderate Resolution Imaging Spectroradiometer ( <a href="http://modis.gsfc.nasa.gov/MODIS/">http://modis.gsfc.nasa.gov/MODIS/</a> )
POSTEL	: Pôle d'Observation des Surfaces Terrestres aux Echelles Larges ( <a href="http://medias.obs-mip.fr/postel/">http://medias.obs-mip.fr/postel/</a> )
RR	: Reduced Resolution
SMAC	: Simplified Method for the Atmospheric Correction of satellite measurements in the solar spectrum
SoW	: Statement Of Work document
TS	: Technical Specification
TOA	: Top Of Atmosphere
TOC	: Top Of Canopy
VEGETATION	: CNES Earth's observation sensor onboard SPOT-4
WBS	: Work Breakdown Structure

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## ***References***

### **Applicable Documents**


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[AP-3] Hagolle O. , A. Lobo P. Maisongrande, F. Cabot, B. Duchemin, A. de Pereyra, 2004 “Quality assessment and improvement of temporally composited products of remotely sensed imagery by combination of VEGETATION 1 and 2 images”, *Rem. Sen. Env.*, 94, 172-186.

[AP-4] GLOBCOVER, Globcover Products Description Validation Report I2.1, December 2008



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# 1. Products summary

## 1.1. General content

The GlobCover version 2.2 (V2.2) products consist of 4 products types generated over the period between December 2004 and June 2006 referring to [AP-1]:

- **GlobCover Bimonthly MERIS FR mosaics:**  
The 10 products computed every two months that provide for each spectral band the average surface reflectance calculated from all valid observations of this 2 months period. Products cover the periods: Dec 2004, Jan-Feb 2005, Mar-Apr 2005, May-June 2005, Jul-Aug 2005, Sept-Oct 2005, Nov-Dec 2005, Jan-Feb 2006, Mar-Apr 2006, May-June 2006.
- **GlobCover Annual MERIS FR mosaic:**  
1 product per year computed by averaging the surface reflectance values of the bimonthly products generated over the year 2005.  
The product covers the period: January 2005-December 2005
- **GlobCover Land Cover:**  
1 product derived by an automatic and regionally-tuned classification of a time series of MERIS FR mosaics. Its 22 land cover global classes are defined with the UN Land Cover Classification System (LCCS).  
The product covers the period: December 2004-June 2006
- **Regional Globcover Land Cover**  
11 products derived by the same automatic and regionally-tuned classification of a MERIS FR time series. However, the land cover typology has been extended to 51 possible land cover classes consistently discriminated only at the continental scale.  
The product covers the period: December 2004-June 2006

Each mosaic product is available in the Hierarchical Data Format-EOS2 (HDF) and is organised on a 5° by 5° tiling without any overlap. The entire Earth is therefore covered by 2592 tiles (72 horizontal tiles x 36 vertical tiles). Only tiles including land cover are processed, which reduces the number of available tiles. The Figure 1 gives the geographical repartition of tiles over the world for the Plate-Carrée projection. The global and regional Globcover Land Cover V2.2 products (Figure 2) are delivered in GeoTIFF format and stored in a zip archived enriched with additional files.

The following Table 1 summarizes the memory requirements for each of the products regarding the size of single tiles and the complete products.

Globcover Product Type	Total Size unzipped (Gb)	Comment
2004 Bimonth 6	140.0	1000 tiles * 140 Mbytes each (1800 x 1800 x 43 bytes)
2005 Bimonth 1	171.7	1227 tiles
2005 Bimonth 2	166.1	1187 tiles
2005 Bimonth 3	157.6	1126 tiles
2005 Bimonth 4	156.5	1118 tiles
2005 Bimonth 5	195.0	1393 tiles

2005 Bimonth 6	161.7	1155 tiles
2006 Bimonth 1	165.2	1180 tiles
2006 Bimonth 2	159.8	1142 tiles
2006 Bimonth 3	149.9	1071 tiles
Annual MERIS FR mosaic	237.3	1695 tiles
<b>Total</b>	<b>1860.8</b>	<b>Total products size for 19 months</b>

**Table 1 : Estimated size of the GlobCover bimonthly mosaics**

<b>Globcover Land Cover Products archive</b>	<b>Total Size</b>
Globcover_V2.2_Global.zip	255 Mb
Globcover_V2.2_NorthAmerica.zip	157 Mb
Globcover_V2.2_CentralAmerica.zip	10 Mb
Globcover_V2.2_SouthAmerica.zip	78 Mb
Globcover_V2.2_WesternEurope.zip	70 Mb
Globcover_V2.2_EasternEurope.zip	167 Mb
Globcover_V2.2_NorthAfrica.zip	74 Mb
Globcover_V2.2_Africa.zip	131 Mb
Globcover_V2.2_CentralAsia.zip	150 Mb
Globcover_V2.2_SEAsia.zip	39 Mb
Globcover_V2.2_Australia.zip	31 Mb
Globcover_V2.2_Greenland.zip	6 Mb
<b>Total</b>	<b>App. 1168 Mb</b>

**Table 2 : Estimated size of the Globcover Land Cover archive**

## 1.2. Data Source

The GlobCover products are based on ENVISAT's Medium Resolution Imaging Spectrometer (MERIS) Level 1B data acquired in Full Resolution mode with a spatial resolution of 300 meters. For the generation of the Level 1B data, the raw data acquisitions have been resampled on a path-oriented grid, with pixel values having been calibrated to match the Top Of Atmosphere (TOA) radiance.

Further information about the ENVISAT MERIS Mission is available at the MERIS home page [ENVISAT MERIS Mission \(http://envisat.esa.int/object/index.cfm?fobjectid=1665\)](http://envisat.esa.int/object/index.cfm?fobjectid=1665)

## 1.3. Data access

The Globcover products are available through two access points:

- ESA GCAT web site (<http://www.esa.int/dua/ionia/globcover>).
- POSTEL web site (<http://postel.mediasfrance.org>)

## 2. Products nomenclature

### 2.1. File Name Nomenclature

The bimonthly and annual Globcover MERIS FR mosaics follow the nomenclature:

GLOBCOVER-L3\_MOSAIC\_[YYYY]\_V[M].[m]\_[LENGTH]\_[DD]\_H[XX]V[YY].hdf

Field	Signification	Value
GLOBCOVER	Project Acronym	GLOBCOVER
L3	Temporal synthesis	L3 for the GlobCover MERIS FR mosaic (see section 2.3 for a description of algorithms)
YYYY	Year of mosaic	2005 or 2006  In case of annual or demonstration mosaic over two successive years [YYYY1][MM1]-[YYYY2][MM1]: <ul style="list-style-type: none"> <li>- start of the synthesis [YYYY1][MM1]</li> <li>- end of the synthesis [YYYY2][MM2]</li> </ul>
V[M][m]	Version of [M]ajor revision product number, [m] minor revision product number	Incremental that follows the successive revisions of the Globcover Processing lines
LENGTH	Frequency of the temporal synthesis	BIMONTH for bimonthly synthesis using as input a period of 2 months of MERIS FR products.  ANNUAL for an annual synthesis using as input a period of 12 months of MERIS FR products
DD	Figure describing the composite number	Number identifying the time period of the bimonthly MERIS FR composite (1-6): <ul style="list-style-type: none"> <li>1: Jan-Feb</li> <li>2: Mar-Apr</li> <li>3: May-Jun</li> <li>4: Jul-Aug</li> <li>5: Sep-Oct</li> <li>6: Nov-Dec</li> </ul> In case of annual MERIS FR synthesis, this field does not exist
XX	Horizontal tile number	From 0 to 71 (see Figure 1)
YY	Vertical tile number	From 0 to 35 (see Figure 1)

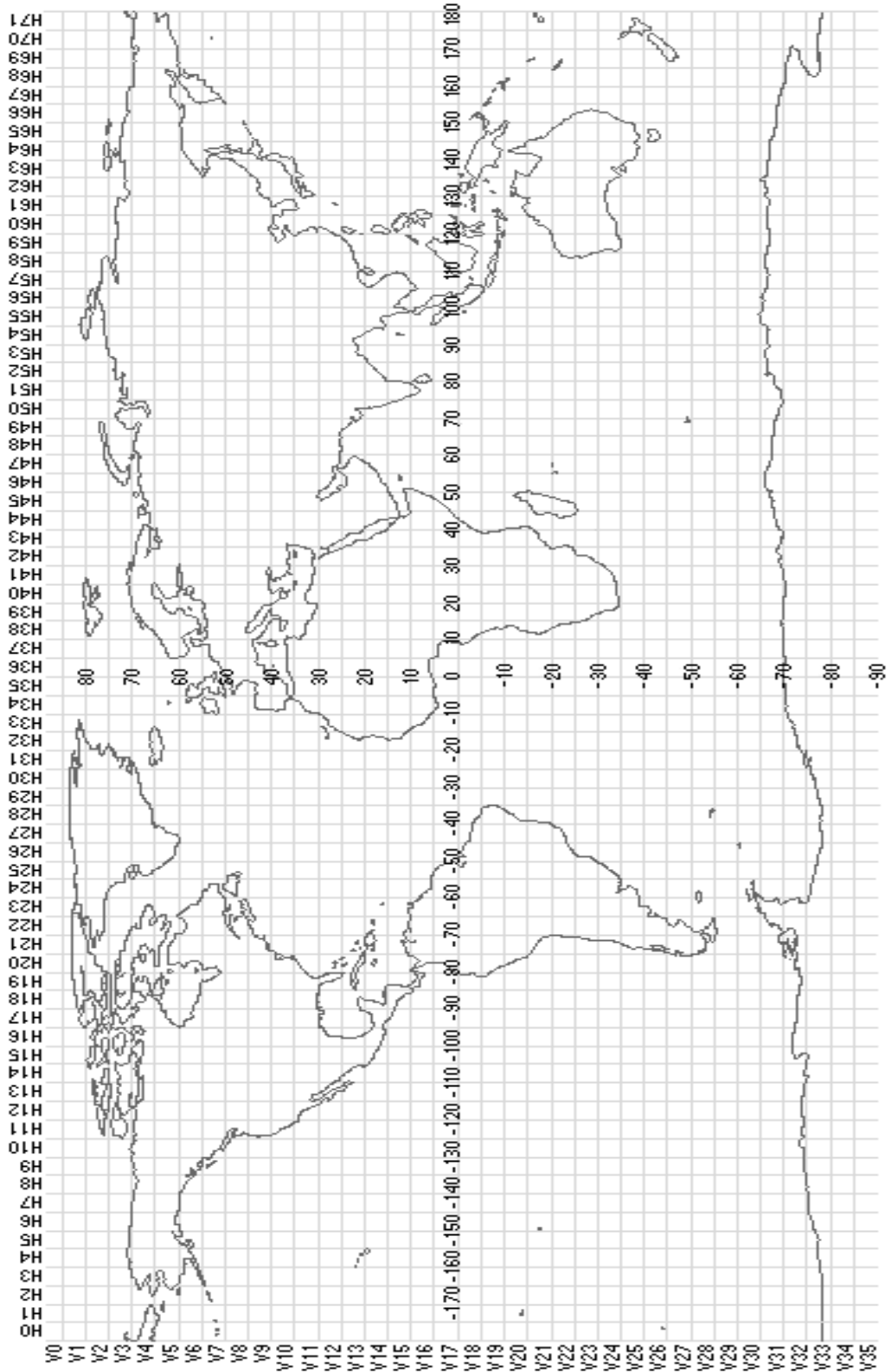


Figure 1 Scheme of the GlobCover tiles location



The Globcover Land Cover products have the nomenclature:

[Zone\_id]\_GLOBCOVER\_[Y<sub>s</sub>Y<sub>s</sub>Y<sub>s</sub>Y<sub>s</sub>M<sub>s</sub>M<sub>s</sub>]-[Y<sub>e</sub>Y<sub>e</sub>Y<sub>e</sub>Y<sub>e</sub>M<sub>e</sub>M<sub>e</sub>]\_V[M].[m].\_[Zone].zip

Field	Signification	Value
Zone_id	Identifier for an easy location of regional products	[0..11]. No value in case of global product
GLOBCOVER	Project Acronym	GLOBCOVER
Y <sub>s</sub> Y <sub>s</sub> Y <sub>s</sub> Y <sub>s</sub> M <sub>s</sub> M <sub>s</sub>	Start Year (Y <sub>s</sub> Y <sub>s</sub> Y <sub>s</sub> Y <sub>s</sub> ) and start month (M <sub>s</sub> M <sub>s</sub> ) of mosaic	2004-12
Y <sub>e</sub> Y <sub>e</sub> Y <sub>e</sub> Y <sub>e</sub> M <sub>e</sub> M <sub>e</sub>	End Year (Y <sub>e</sub> Y <sub>e</sub> Y <sub>e</sub> Y <sub>e</sub> ) and end month (M <sub>e</sub> M <sub>e</sub> ) of mosaic	2006-06
V[M][m]	Version of [M]ajor revision product number, [m] minor revision	Incremental following the successive revision according deliveries
Zone	Zone indicates the spatial extension of the Land Cover map	Zone = Global for the map at global scale. For the other 11 regional maps, zone = North_America; Central_America; South_America; Western_America; EasternEurope; NortAfrica; Africa; CentralAsia; SEAsia; Australia; Greenland



Figure 2 Windows for the regional Land Cover products

## 2.2. Geographic Location information

### 2.2.1. General case

The table list the parameters used for the projection processing.


Field	Description
Projection	plate-carrée,
Reference ellipsoid	WGS 84 ( $R_e$ = Equatorial Radius=6378,14km; $R_p$ = Polar Radius=6356,76 km)
Angular pixel resolution	$Res_{deg} = 1/360$ degree
Kilometric pixel resolution	<p>height: <math>h</math> [km]= <math>r \times 2\pi / 360 \times Res_{deg}</math>  width : <math>w</math> [km]=<math>R_e \times \cos(lat) \times 2\pi / 360 \times Res_{deg}</math></p> <p>with <math>r = \frac{R_e \cdot R_p}{\sqrt{R_e^2 \cdot \sin^2(\theta_c) + R_p^2 \cdot \cos^2(\theta_c)}}</math></p> <p>and <math>\tan(\theta_c) = (1 - f)^2 \cdot \tan(lat)</math></p> <p>and <math>f = (R_e - R_p) / R_e</math></p> <p>(<math>h</math> is variable between <math>2\pi / 360 \times R_e \times Res_{deg}</math> at the Equator and <math>2\pi / 360 \times R_p \times Res_{deg}</math> at the Pole)</p>
Tile Upper Left pixel location	<p>Tiles <math>H\{h\}V\{v\}</math> with <math>H\{h\}</math>: <math>h \in [0 ; 71]</math> and <math>V\{v\}</math> <math>v \in [0; 35]</math></p> <p>Upper Left pixel longitude: <math>-180^\circ + h \times 5^\circ</math> E</p> <p>Upper Left pixel latitude : <math>90^\circ - v \times 5^\circ</math> N</p>
Tile angular size	$5^\circ \times 5^\circ$
Tile size in pixels	1800 x 1800
Tile Upper Left corner of Upper Left pixel	<p>Upper Left corner of Upper Left pixel longitude:  <math>-180^\circ + h \times 5^\circ - 0.5 \times Res_{deg}</math> E</p> <p>Upper Left pixel of Upper Left pixel latitude :  <math>90^\circ - v \times 5^\circ + 0.5 \times Res_{deg}</math> ° N</p>

### 2.2.2. Case of Land Cover and Mosaics Version 2

The following fields applied on metadata of Land Cover and Mosaics version 2.

Field	Description
Projection	plate-carrée with a geographic Lat/Lon representation (GCTP_GEO)
Reference ellipsoid	WGS 84 (R= Spherical Radius= Equatorial Radius= $R_e$ = 6378,14km)
Pixel resolution	1/360
UpperLeftPointMtrs (degree)	Array that contains the location of <u>the upper left corner of the upper</u>



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	<u>left pixel</u> of the tile. As the projection is Geographic LatLon (GCTP_GEO), the coordinates are specified in degrees/minutes/seconds (DDMMSS.SSS) in the associated HDF-EOS2 metadata
LowerRightMtrs (degree)	Array that contains the location of the lower right corner of the lower right pixel of the tile. As the projection is Geographic LatLon (GCTP_GEO), the coordinates are specified in degrees/minutes/seconds (DDMMSS.SSS) in the associated HDF-EOS2 metadata

### 2.2.2.1. Caveat for the Land Cover and Mosaics version 2

Problems have been encountered to correctly read the geolocation information associated in the metadata using common tools such as GDAL. For example, GDALinfo may give the following information:

Coordinate System is:

```
GEOGCS["Unknown datum based upon the Clarke 1866 ellipsoid",
  DATUM["Not specified (based on Clarke 1866 spheroid)",
    SPHEROID["Clarke 1866",6378206.4,294.9786982139006,
      AUTHORITY["EPSG","7008"]]],
  PRIMEM["Greenwich",0],
  UNIT["degree",0.0174532925199433]]
```

This problem is directly linked to the HDF-EOS2 library. The processing line uses this library at the products writing. Even if the ellipsoid reference is WGS84, it does not write the projection information (and for the Geographic Lat/Lon, it does not take into account the radius). It is clearly mentioned page 2-124 of the 'HDF-EOS Library Users Guide for the EMD project. Volume 2; function reference guide' with the phrase 'Finally, we define a Geographic projection. In this case, neither the zone code, sphere code nor the projection parameters are used'. A possibility would be to force it, but in reality, it would not change anything. When using GDAL (that also uses HDF-EOS2 library), this information is not read, therefore the spheroid reference code is put at a null value which is by default 'Clarke 1866' (see page 1-8 of the 'HDF-EOS Library').

The UNIT is really 'degree' and the value obtained with GDAL is not the resolution but the conversion from radian to degree.

Another limitation of this library concerns also the metadata 'UpperLeftPointMrtrs'. It is specified in DDMMSS but the metadata name is '...Mrtrs' (meter).

## 2.3. Algorithmic Description

Level processing steps	Algorithmic description
<u>L0-&gt;L1:</u> Geometrical correction	<p>Two tools were used to perform this module. The first one called AMORGOS provided by ESA and developed by ACRI gives the geographical location and altitude for every pixel in the unprojected grid image. Software inputs are the MERIS FRS data, restituted attitude files and operational or precise orbit files. DEM used for orthorectification is based on the ACE Digital Elevation Model and is called Getasse 30. The projection is performed by a projection tool developed by POSTEL/MEDIAS-France.</p> <p>The relative validation was performed over 5 sites located at various latitudes for all the seasons during the year 2005. We obtained 146 MERIS couples. For the absolute validation, we only focused on two particular sites over Madagascar and Spain in summer using orthorectified Landsat images. We obtained in the case of absolute geolocation and relative geolocation respectively a RMSE of 51.6m and an absolute geolocation of 77.1m</p>
<u>L1-&gt;L2:</u> Atmospheric correction	<p>A first conversion is applied on L1b radiance previously corrected from the smile effect to obtain top of atmosphere reflectances. Then a neural network based on MOMO simulations is applied with several inputs. One of them is the aerosol content which was taken from LARS_RR_L3 monthly products for V2.2. Ozone is derived from ECMWF data present in MERIS auxiliary data, O<sub>2</sub> and H<sub>2</sub>O are derived from particular spectral bands plus polynomial coefficients from LUTs delivered by ESA [AP-2].</p>
<u>L1-&gt;L2:</u> Cloud and snow detection	<p>Two methods are used. The first one relies on a neural network derived from MOMO model. Two output states are possible (clear or cloud). The second one is called 'blue band' and uses different thresholds in various spectral bands. 4 states may be detected: clear, cloud (thin/dense), snow. The final cloud mask merges both results excluding snow and clear.</p> <p>The Cloud Top Height is estimated for a better determination of shadows. The snow reflectance is kept at its TOA level.</p> <p>These results have been validated through one month of Météo-France synoptic data over Europe and Africa and a cloud Toolbox designed by CNES and Noveltis.</p>

<u>L1-&gt;L2</u> : Cloud and shadow spatial extension	<p>As a cloudy pixel is detected in version 2.2, all the pixels over a 7 x 7 square are fixed to 'suspect'.</p> <p>The cloudy pixels are not spatially extended over snowy pixels</p>
<u>L1-&gt;L2</u> : Land Water reclassification	<p>Lakes present at global scale are derived from a flag of L1b data. A Land/Water-Water/Land reclassification is performed to reclassify pixels detected as land in water or detected as water in flooded or land using 2 spectral thresholds at 665 nm and 865 nm for pixels higher than -50 meters.</p>
<u>L2-&gt;L3</u> : Compositing	<p>A mean is firstly processed over a period of reference. This period is 2 months for the bimonthly mosaics. An iterative procedure [AP-3] is then applied for detecting 'valid' surface reflectances. Finally, a mean is applied over the 'valid' surface spectral reflectances at several temporal frequencies according the products type. The 'suspect' pixel are not taken into account in the compositing</p>
<u>L2-&gt;L3</u> : Status	<p>During the synthesis period:</p> <p>The status '<u>Land</u>' indicates if the pixel has at least one clear observation over land. A surface reflectance mosaic is processed</p> <p>The status '<u>Flooded</u>' indicates if the pixel has a majority of flooded observations during the compositing period and no '<u>Land</u>' status is detected within. A surface reflectance is processed</p> <p>The status '<u>Suspect</u>' indicates if the pixel has a majority of shadow or cloud edge during the compositing period. No surface reflectance is processed</p> <p>The status '<u>Cloud</u>' indicates if the pixel has a majority of clouds during the compositing period. No surface reflectance is processed</p> <p>The status '<u>Water</u>' indicates if the pixel is a lake or not during the compositing period. No surface reflectance is processed. <i>NB. The 'Water' status is also applied to ocean</i></p> <p>The status '<u>Snow</u>' indicates if the pixel has a majority of snowy observations during the compositing period. No surface reflectance is processed but TOA reflectance are kept in the final product</p> <p>The status '<u>Invalid</u>' is applied when a majority of observations are flagged as invalid in the L1b original mask or set up to invalid during the L1-&gt; L2 modules. No surface reflectance is processed</p>
<u>L3-&gt;L4 Auxiliary data for classification</u>	<p>The stratification is made up of 22 strata determined through ecoclimatological and remote sensing criteria.</p>
<u>L3-&gt; L4 Classification-Step 0</u>	<p>This step detects permanent snow areas through the use of annual synthesis.</p>
<u>L3-&gt;L4 Classification Step 1a</u>	<p>In each ROI (Region of Interest) of each stratum, the step 1a is an unsupervised spectral classification to identify land cover classes that are not well represented in the strata. It allows up to 10 classes at maximum for each ROI.</p>

<u>L3-&gt;L4 Classification Step 1b</u>	In each MASK area including the previous ROI, the step 1b is a supervised spectral classification using previous results from step 1a
<u>L3-&gt;L4 Classification Step 1c</u>	The step 1c is an unsupervised spectral classification of non classified pixels.
<u>L3-&gt;L4 Classification Step 2</u>	The step 2 is a per pixel spectral and temporal characterization where neo channels are generated. These neo channels ( <i>ie</i> spectral and/or temporal parameters) are then averaged for each land cover objects of step 1c
<u>L3-&gt;L4 Classification Step 3</u>	The step 3 is an unsupervised classification for the neo channels produced in step 2.
<u>L3-&gt;L4 Classification Step 4 and 5</u>	In step 4, the results of the step 3 are merged with the land cover classes coming from step 1 and step 0. The step 5 transforms the unlabelled classes into land cover classes described with the reference land cover maps labels using decision rules.  Gaps in the produced land cover are filled with the reference land cover. The 'flooded forest' not easily detectable with MERIS spectral channels are also forced with the reference land cover map.
<u>L3-&gt;L4 Classification: post processing</u>	The SRTM Water Bodies Dataset (SWBD) – 30 m spatial resolution is used according to a decision rule. If (no water in Globcover) and (water in SWDB), we force the pixel value to class value 210 'Water bodies'. If (water in Globcover) and (no water in SWBD), we force the pixel value to class value 254.

## 3. Product Specifications

### 3.1. Globcover MERIS FR Mosaics: product Content

All Globcover mosaics products are available in the Hierarchical Data Format-EOS 2 (HDF). Detailed information on the HDF file format is available on the HDF Group web site at <http://hdf.ncsa.uiuc.edu>

The Status Map flag indicating the status of each pixel in the composites takes into account the following parameters

<i>Parameter</i>	<i>Description</i>	<i>Intent (IN, OUT)</i>	<i>Physical Unit</i>	<i>Range</i>
L1b.land_ocean	L1b land flag <b>'Land'=1 or 'Water'=0</b>	IN	None	[0 ... 1]
land_flag	Land Flag from Land Water reclassification. <b>'Flooded'=0 or 'Land'=1</b>	IN	None	[0 ... 1]
cloud_flag	Cloud flag computed in Cloud processing	IN	None	[0 ... 1]
cloud_shadow	cloud shadow flag from this module	IN	None	[0 ... 1]
cloud_edge_flag	cloud edge computed in cloud processing	IN	None	[0 ... 1]
snow_flag	snow flag computed in cloud processing	IN	None	[0 ... 1]
SM	Flag indicating the status of each pixel	OUT	None	[0 ... 6]

The data layers of the bimonthly and annual Globcover MERIS FR mosaics are described hereafter

<i>Parameter</i>	<i>Description</i>	<i>Type</i>	<i>Precision</i>	<i>Range</i>
SM	Status map containing 0: LAND: no (cloud, shadow, cloud edge) AND land flag 1: FLOODED: L1b_landocean AND no land flag and no (cloud, cloud, cloud edge) 2: SUSPECT: Cloud shadow or cloud edge 3 : CLOUD: cloud flag 4: WATER: Not L1b_landocean AND no land flag 5 : SNOW : snow flag 6 : INVALID	UINT	None	[0 6]

NMOD	Number of valid observations in the temporal synthesis. 'Valid' means that the observation has the same status as that given in the status map.	BYTE	1	[0 255] 0 in case of snow
NDVI	Normalized Difference Vegetation Index		2.5*10e-3	[-1 1]
<i>For each spectral band n</i>				
MEAN_n	Normalized reflectance <i>n=1 for the first MERIS band at 412 nm, n=2 for the second MERIS band at 443 nm.</i>		5*10 <sup>e-4</sup>	[0 1]
ERR_n	Sum of absolute deviation between measured and modeled reflectances divided by the number of valid reflectances for band n		1/500	[0 0.5]

Only 13 bands of the initial 15 MERIS bands are processed. The band 11 (O<sub>2</sub> absorption band) and 15 (water vapour absorption band) are used for the processing but not delivered due to a too strong atmospheric contamination.

The current attributes present in the product are described hereafter:

<u>Attribute Name</u>	<u>Description</u>	<u>Type</u>	<u>Default Value</u>
Product start date	Date and hour of the first acquisition	String (YYYY/MM/DD HH:MM:SS)	
Product end date	Date and hour of the last acquisition	String (YYYY/MM/DD HH:MM:SS)	
Satellite name	Name of the platform	String	ENVISAT
Instrument type	Type of the sensor	String	MERIS
Instrument version	Version of the sensor	String	1

Each field has a scale and offset attribute recorded to compute the physical value from the recorded FD value:

<u>Attribute Name</u>	<u>Description</u>	<u>Default Value</u>
Scale MEAN_λ	Scale factor for the level 3 spectra reflectance in band λ	2000
Offset MEAN_λ	Offset for the level 3 spectral reflectance in band λ	0
Scale ERR_λ	Scale factor the error in the level 3 spectral reflectance	500
Offset ERR_λ	Offset for the error in the level 3 spectral reflectance in band λ	0



Scale NDVI	Scale factor for the level 3 NDVI	250
Offset NDVI	Offset for the level 3 NDVI	25
Scale NMOD	Scale factor for the NMOD parameter	1
Offset NMOD	Offset for the NMOD parameter	0

The physical value  $FD_{phys}$  is given by the following formula:

$$FD_{phys} = (FD - Offset_{FD}) / Scale_{FD}$$

### 3.2. Globcover Land Cover : product content

All Globcover Land Cover products are available in a zip archive. 12 archives are distributed: one for the Global Land Cover product and 11 for the regional Land Cover products.

#### 3.2.1. Global land cover product

For the Global Land Cover products, two single files are delivered (CLA) and (CLA\_QL) in Geo-tiff format. They cover the whole globe. Their descriptions are given hereafter.


<i>Parameter</i>	<i>Description</i>	<i>Type</i>	<i>Precision</i>	<i>Range</i>
CLA	The class value corresponding to the associated legend	BYTE	None	[0 230]. 230 for No Data

<i>Parameter</i>	<i>Description</i>	<i>Type</i>	<i>Precision</i>	<i>Range</i>
CLA_QL	Quality flag indicating if the pixel has been classified from: <ul style="list-style-type: none"> <li>- the MERIS FR temporal series (0)</li> <li>- the reference land cover (1)</li> </ul> applicable for gaps present in the MERIS FR temporal series	BYTE	None	[0;1]

In addition, other files are available in the archive:

- an Excel file named "Globcover\_Legend.xls". Its description is given hereafter:

<i>Field</i>	<i>Signification</i>	<i>Value</i>
Value	This field indicates the ID value for the considered class (global or regional according to sheet's number)	[0 230]
Label	This field describes the thematic content for the considered class	String
Color Red	This field indicates the Red color code	[0 255]
Color Green	This field indicates the Green color code	[0 255]
Color Blue	This field indicates the Blue color code	[0 255]

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- a quicklook of the Globcover global land cover map, named “Globcover\_Preview.gif”.
- Globcover Global color map in ArcInfo, ArcView, and Envi format.

### 3.2.2. Regional Land Cover products

Each regional land cover map is provided associated with the global (or level 1) and the regional (or level 2) legends (cf. section 4.2 of Globcover\_Product\_Description\_Validation\_Report\_I2.1). Two raster files are therefore available for each regional map, according to the detail of the legend.

Each regional map is available through the download of a zip file named “GLOBCOVER\_200412\_200606\_V2.2\_Region.zip”. This zip file contains:

- The full resolution data with the global (or level 1) legend in a single-band GEO-TIFF format. The file is named “GLOBCOVER\_200412\_200606\_V2.2\_Region\_Glob.tif”. A .tif.vat.dbf file stores the attributes table of the raster.
- The full resolution data with the regional (or level 2) legend in a single-band GEO-TIFF format. The file is named “GLOBCOVER\_200412\_200606\_V2.2\_Region\_Reg.tif”. A .tif.vat.dbf file stores the attributes table of the raster.
- The global and regional legends of the regional land cover map into an excel file named “Region\_Legend.xls” have the same structure as before. In this file, the ID values of the GEO-TIFF raster are linked with the land cover labels. As for the regional legend, the global class to which each regional class belongs is also indicated (in the field “Global class”). The RGB codes associated with each Globcover land cover classes are also provided.
- A quicklook of the Globcover regional land cover map, named “Region\_Preview.gif”.
- Globcover Regional and Global color maps in ArcInfo, ArcView, and Envi format.

A complete description of global and regional Globcover legends as well as their links to LCCS classifiers is given in Appendix I, II. A complete description of the LCCS may be found at <http://www.africover.org/LCCS.htm> or in [AP-4].

### 3.2.3. Reference Land Cover maps

The reference land cover map is based on the following dataset:

- The Global Land Cover 2000 over the world (<http://www-gvm.jrc.it/glc2000/>)
- The Corine Land Cover map based on the analysis of Landsat images acquired in 2000 (EEA)
- The Africover map over 10 countries of Africa (FAO, <http://www.africover.org/>)
- The National Land Cover Database (NLCD) for United States (USGS)
- The National Land Cover map supported by the Chinese Academy of Sciences based on the analysis of Landsat 5 and 7 images acquired in 1999 and 2000
- The Australia Land Use map (Australian Government)
- The land use classification of the agricultural areas of Argentina (Facultad de Agronomía, Universidad de Buenos Aires)
- The Democratic Republic of Congo map (UCL-Geomatics, 2006)
- A Land Cover map based on MODIS 250 m images for Canada
- The land cover database of Burkina-Faso (BDOT project, IGN France International)
- The land cover classification of Mexico (Giri and Jenkins, 2005)
- A Land Cover map based on the analysis of Landsat images for Cambodia



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## 4. Data Policy

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## Appendix I – Global and regional Globcover legends

Global Globcover legend (level 1)	Regional Globcover legend (level 2)	Value
Post-flooding or irrigated croplands (or aquatic)		11
	Post-flooding or irrigated shrub or tree crops	12
	Post-flooding or irrigated herbaceous crops	13
Rainfed croplands		14
	Rainfed herbaceous crops	15
	Rainfed shrub or tree crops (cash crops, vineyards, olive tree, orchards...)	16
Mosaic cropland (50-70%) / vegetation (20-50%)		20
	Mosaic cropland (50-70%) / grassland or shrubland (20-50%)	21
	Mosaic cropland (50-70%) / forest (20-50%)	22
Mosaic vegetation (50-70%) / cropland (20-50%)		30
	Mosaic grassland or shrubland (50-70%) / cropland (20-50%)	31
	Mosaic forest (50-70%) / cropland (20-50%)	32
Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (> 5m)		40
	Closed (>40%) broadleaved evergreen and/or semi-deciduous forest (>5m)	41
	Open (15-40%) broadleaved semi-deciduous and/or evergreen forest with emergents (>5m)	42
Closed (>40%) broadleaved deciduous forest (>5m)		50
Open (15-40%) broadleaved deciduous forest/woodland (>5m)		60
Closed (>40%) needleleaved evergreen forest (>5m)		70
Open (15-40%) needleleaved deciduous or evergreen forest (>5m)		90
	Open (15-40%) needleleaved deciduous forest (>5m)	91
	Open (15-40%) needleleaved evergreen forest (>5m)	92
Closed to open (>15%) mixed broadleaved and needleleaved forest (>5m)		100
	Closed (>40%) mixed broadleaved and needleleaved forest (>5m)	101
	Open (15-40%) mixed broadleaved and needleleaved forest (>5m)	102
Mosaic forest or shrubland (50-70%) / grassland		110

(20-50%)		
Mosaic grassland (50-70%) / forest or shrubland (20-50%)		120
Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)		130
	Closed to open (>15%) broadleaved or needleleaved evergreen shrubland (<5m)	131
	Closed to open (>15%) broadleaved evergreen shrubland (<5m)	132
	Closed to open (>15%) needleleaved evergreen shrubland (<5m)	133
	Closed to open (>15%) broadleaved deciduous shrubland (<5m)	134
	Closed (>40%) broadleaved deciduous shrubland (<5m)	135
	Open (15-40%) broadleaved deciduous shrubland (<5m)	136
Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses)		140
	Closed (>40%) grassland	141
	Closed (>40%) grassland with sparse (<15%) trees or shrubs	142
	Open (15-40%) grassland	143
	Open (15-40%) grassland with sparse (<15%) trees or shrubs	144
	Lichens or mosses	145
Sparse (<15%) vegetation		150
	Sparse (<15%) grassland	151
	Sparse (<15%) shrubland	152
	Sparse (<15%) trees	153
Closed to open (>15%) broadleaved forest regularly flooded (semi-permanently or temporarily) - Fresh or brackish water		160
	Closed to open broadleaved forest on (semi-) permanently flooded land - Fresh water	161
	Closed to open broadleaved forest on temporarily flooded land - Fresh water	162
Closed (>40%) broadleaved forest or shrubland permanently flooded - Saline or brackish water		170
Closed to open (>15%) grassland or woody vegetation on regularly flooded or waterlogged soil - Fresh, brackish or saline water		180

	Closed to open (>15%) woody vegetation on regularly flooded or waterlogged soil - Fresh or brackish water	181
	Closed to open (>15%) woody vegetation on temporarily flooded land	182
	Closed to open (>15%) woody vegetation on permanently flooded land	183
	Closed to open (>15%) woody vegetation on waterlogged soil	184
	Closed to open (>15%) grassland on regularly flooded or waterlogged soil - Fresh or brackish water	185
	Closed to open (>15%) grassland on temporarily flooded land	186
	Closed to open (>15%) grassland on permanently flooded land	187
	Closed to open (>15%) grassland on waterlogged soil	188
Artificial surfaces and associated areas (Urban areas >50%)		190
Bare areas		200
	Consolidated bare areas (hardpans, gravels, bare rock, stones, boulders)	201
	Non-consolidated bare areas (sandy desert)	202
	Salt hardpans	203
Water bodies		210
Permanent snow and ice		220

## Appendix II – LCCS & the Globcover legend

Value	Global Globcover legend (level 1)	LCCS Label	LCCS Entry
11	Post-flooding or irrigated croplands (or aquatic)	Irrigated tree crops // Irrigated shrub crops // Irrigated herbaceous crops // Post-flooding cultivation of herbaceous crops	<b>Cultivated Terrestrial Areas and Managed Lands</b> <b>A11</b>
12	Post-flooding or irrigated shrub or tree crops	Irrigated tree crops // Irrigated shrub crops	
13	Post-flooding or irrigated herbaceous crops	Irrigated herbaceous crops // Post-flooding cultivation of herbaceous crops	
14	Rainfed croplands	Rainfed shrub crops // Rainfed tree crops // Rainfed herbaceous crops	
15	Rainfed herbaceous crops	Rainfed herbaceous crops	
16	Rainfed shrub or tree crops (cash crops, vineyards, olive tree, orchards...)	Rainfed tree Crops // Rainfed shrub crops	
20	Mosaic cropland (50-70%) / vegetation (20-50%)	Cultivated and managed terrestrial areas / Natural and semi-natural primarily terrestrial vegetation	
21	Mosaic cropland (50-70%) / grassland or shrubland (20-50%)	Cultivated and managed terrestrial areas / Closed to open shrubland (thicket) // Herbaceous closed to open vegetation	
22	Mosaic cropland (50-70%) / forest (20-50%)	Cultivated and managed terrestrial areas / Closed to open trees	
30	Mosaic vegetation (50-70%) / cropland (20-50%)	Natural and semi-natural primarily terrestrial vegetation / Cultivated and managed terrestrial areas	
31	Mosaic grassland or shrubland (50-70%) / cropland (20-50%)	Closed to open shrubland (thicket) // Herbaceous closed to open vegetation / Cultivated and managed terrestrial areas	
32	Mosaic forest (50-70%) / cropland (20-50%)	Closed to open trees / Cultivated and managed terrestrial areas	
40	Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (> 5m)	Broadleaved evergreen closed to open trees // Semi-deciduous closed to open trees	
41	Closed (>40%) broadleaved evergreen and/or semi-deciduous forest (>5m)	Broadleaved evergreen closed to open (100-40%) trees // Semi-deciduous closed to open (100-40%) trees	
42	Open (15-40%) broadleaved semi-deciduous and/or evergreen forest with emergents (>5m)	Broadleaved evergreen (40-(20-10)%) woodland with emergents // Semi-deciduous (40-(20-10)%) woodland with emergents	
50	Closed (>40%) broadleaved deciduous forest (>5m)	Broadleaved deciduous closed to open (100-40%) trees	
60	Open (15-40%) broadleaved deciduous forest/woodland (>5m)	Broadleaved deciduous (40-(20-10)%) woodland	
70	Closed (>40%) needleleaved evergreen	Needleleaved evergreen closed to open	

	forest (>5m)	(100-40%) trees	
90	Open (15-40%) needleleaved deciduous or evergreen forest (>5m)	Needleleaved evergreen (40-(20-10)% woodland // Needleleaved deciduous (40-(20-10)% woodland	
91	Open (15-40%) needleleaved deciduous forest (>5m)	Needleleaved deciduous (40-(20-10)% woodland	
92	Open (15-40%) needleleaved evergreen forest (>5m)	Needleleaved evergreen (40-(20-10)% woodland	
100	Closed to open (>15%) mixed broadleaved and needleleaved forest (>5m)	Broadleaved closed to open trees / Needleleaved closed to open trees	
101	Closed (>40%) mixed broadleaved and needleleaved forest (>5m)	Broadleaved closed to open (100-40%) trees / Needleleaved closed to open (100-40%) trees	
102	Open (15-40%) mixed broadleaved and needleleaved forest (>5m)	Broadleaved (40-(20-10)% woodland / Needleleaved (40-(20-10)% woodland	
110	Mosaic forest or shrubland (50-70%) / grassland (20-50%)	Closed to open trees / Closed to open shrubland (thicket) // Herbaceous closed to open vegetation	
120	Mosaic grassland (50-70%) / forest or shrubland (20-50%)	Closed to open shrubland (thicket) // Herbaceous closed to open vegetation / Closed to open trees	
130	Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)	Broadleaved closed to open shrubland (thicket)	
131	Closed to open (>15%) broadleaved or needleleaved evergreen shrubland (<5m)	Broadleaved evergreen closed to open thicket // Needleleaved evergreen closed to open thicket	
134	Closed to open (>15%) broadleaved deciduous shrubland (<5m)	Broadleaved deciduous closed to open thicket	
140	Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses)	Herbaceous closed to very open vegetation // Closed to open lichens/mosses	<b>A12</b> Natural and Semi-natural Terrestrial Vegetation – Herbaceous
141	Closed (>40%) grassland	Herbaceous closed to open vegetation	
143	Open (15-40%) grassland	Herbaceous open (40-(20-10)% vegetation	
145	Lichens or mosses	Closed to open lichens/mosses	<b>A12</b> Natural and Semi-natural Terrestrial Vegetation
150	Sparse (<15%) vegetation	Sparse trees // Herbaceous sparse vegetation // Sparse shrubs	
151	Sparse (<15%) grassland	Herbaceous sparse vegetation	
152	Sparse (<15%) shrubland	Sparse shrubs	
153	Sparse (<15%) trees	Sparse trees	<b>A2+</b> Natural and Seminal Aquatic Vegetation
160	Closed to open (>15%) broadleaved forest regularly flooded (semi-permanently or temporarily) - Fresh or brackish water	Closed to open (100-40%) broadleaved trees on temporarily flooded land, water quality: fresh water // Closed to open (100-40%) broadleaved trees on permanently flooded land, water quality: fresh water	



161	Closed to open broadleaved forest on (semi-)permanently flooded land - Fresh water	Closed to open (100-40%) semi-deciduous woodland on permanently flooded land, water quality: fresh water	
162	Closed to open broadleaved forest on temporarily flooded land - Fresh water	Closed to open (100-40%) semi-deciduous woodland on temporarily flooded land, water quality: fresh water	
170	Closed (>40%) broadleaved forest or shrubland permanently flooded - Saline or brackish water	Closed to open (100-40%) broadleaved trees on permanently flooded land (with daily variations), water quality: saline water // Closed to open (100-40%) broadleaved trees on permanently flooded land (with daily variations), water quality: brackish water // Closed to open (100-40%) semi-deciduous shrubland on permanently flooded land (with daily variations), water quality: saline water // Closed to open (100-40%) semi-deciduous shrubland on permanently flooded land (with daily variations), water quality: brackish water	
180	Closed to open (>15%) grassland or woody vegetation on regularly flooded or waterlogged soil - Fresh, brackish or saline water	Closed to open shrubs // Closed to open herbaceous vegetation	
185	Closed to open (>15%) grassland on regularly flooded or waterlogged soil - Fresh or brackish water	Closed to open herbaceous vegetation on permanently flooded land // Closed to open herbaceous vegetation on temporarily flooded land // Closed to open herbaceous vegetation on waterlogged soil	
190	Artificial surfaces and associated areas (Urban areas >50%)	Artificial surfaces and associated areas	<b>B15</b> Artificial Surfaces
200	Bare areas	Bare areas	<b>B16</b> Bare Areas
201	Consolidated bare areas (hardpans, gravels, bare rock, stones, boulders)	Consolidated materials	
202	Non-consolidated bare areas (sandy desert)	Unconsolidated materials	
203	Salt hardpans	Hardpans Soils: subsurface: solonetz	
210	Water bodies	Natural water bodies // Artificial water bodies	<b>B28</b> Inland Waterbodies, snow and ice
220	Permanent snow and ice	Artificial perennial snow // Artificial perennial ice // Perennial snow // Perennial ice	