Land Cover CCI

PRODUCT USER GUIDE

VERSION 2

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Document Change Record

VERSION	DATE	DESCRIPTION	APPROVED
1.0	2012-09-10	First version of the PUG1	
1.1	2012-12-03	Updated version of PUGv1 to be aligned with products V1.0	
2.0	2013-05-19	Updated version, which is aligned with Epoch1 v1.1, Epoch2 v1.0 and Epoch3 v1.0	
2.1	2013-11-28	Updated version according to the final LC products of phase I	
2.2	2014-06-13	Draft version for products delivery	
2.3	2014-07-03	Updated version for products delivery	
2.4	2014-09-02	Final version for products delivery	

From version 1.0 to version 1.1

RID	SECTION	COMMENTS
PM8_7	4.2.2	Updated legend to be in line with the LC products V1.0
PM8_7	5.2.1	Naming convention of the LC Map V1.0 updated
PUG1/1.	2	The reference to the products of the project described in the document has been included
PUG1/2.		Accepted, empty rows has been deleted
PUG1/3.		An example of a 7-day composite has been included
PUG1/4.		If we want to be in line with the LC product delivered in V1.0, this RGB triple should remain as it is. None the less, this RID should be and will be taken into account for version V1.1

PUG1/5.		The legend has been updated to be aligned with the LC map V1.0 in terms of RGB colours and regional classes that are present in the product.
PUG1/6.		Corrected
PUG1/7.		The description of the quality flags will be updated in the PUGv1_v1.1 when the LC map and conditions will contain the quality flags
PUG1/8.	5	The spatial resolution of both condition products has been included in the text.
PUG1/9.		Phrase 'old 04,18' has been deleted.
PUG1/10.		Description of uncertainty has been included
PUG1/11.	7.3	Please mention here that the pixel value represents the LC class, according to Table 4-1.
PUG1/12.		Phrase updated. Reference to regional subsets was also removed
PUG1/13.	7.3	Typo has been corrected
PUG1/14.	7	Available software tools for decoding and interpreting the data have been described
PUG1/15.	7.3	Update of section w.r.t. the current status

From version 1.1 to version 2.0

RID	SECTION	COMMENTS
	All	Update of document w.r.t. the current status

From version 2.0 to version 2.1

RID	SECTION	COMMENTS
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From version 2.1 to version 2.2

RID	SECTION	COMMENTS
Progress	All	Restructuration of the document to include the map of open and permanent water bodies and to put the netcdf info as appendices

From version 2.2 to version 2.3

RID	SECTION	COMMENTS
FR-02	Figure 4-2	Typo and date corrected according to proposed solution
FR-03	Page 31, 32	Ref', 'Issue' and 'Date' corrected
FR-04	Page 34 / Table 4-7	Product name changed into ESACCI-LC-L4-LCCS-Map-300m-P5Y-YYYY-v1.0_qualityflag1.nc/tif
FR-05	Page 34 / Table 4-7	Product name changed into ESACCI-LC-L4-LCCS-Map-300m-P5Y-YYYY-v1.0_qualityflag2.nc/tif
FR-06	Page 34 / Table 4-7	Product name changed into ESACCI-LC-L4-LCCS-Map-300m-P5Y-YYYY-v1.0_qualityflag3.nc/tif
FR-07	Page 34 /	Product name changed into ESACCI-LC-L4-LCCS-Map-300m-P5Y-YYYY-

	Table 4-7	v1.0_qualityflag4.nc/tif
FR-08	Page 55 / Table 6-3	Naming convention of table 6-3 modified according to the naming convention of the FTP
FR-09	Page 67 / Section 9	Terms of use defined
FR-10	Page 68	Change made
FR-11	Page 70 / APPENDIX B	Updated
Progress	-	Insertion of section 5.2
Progress	-	Insertion of section 5.3
Progress	7.4	Updated according to current status

From version 2.3 to version 2.4

RID	SECTION	COMMENTS
Progress	5 and 6	Minor updates, mainly typo

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1 INTRODUCTION

1.1 Scope

This document is the Product User Guide (PUG) for the Land Cover (LC) project of the Climate Change Initiative (CCI) led by the European Space Agency (ESA). It is the reference product description, which describes the products' data format, filenames, metadata, and their contents, with the aim to enable users to work with the CCI Land Cover (CCI-LC) products.

Note that this document reflects the current state of the project and is therefore likely to change in upcoming versions.

1.2 CCI Land Cover project

The ESA CCI programme aims at realizing the full potential of the long-term global Earth Observation archives as a significant and timely contribution to the Essential Climate Variables (ECV) databases required by United Nations Framework Convention on Climate Change (UNFCCC). All products will be assessed against requirements from the Global Climate Observing System (GCOS) for ECV and the Climate Modelling Community (CMC), represented within the CCI program by the Climate Modelling User Group (CMUG).

More specifically, the project aimed at:

- defining the detailed specifications of a global land cover product matching the GCOS requirements achievable on a regular basis using the current EO systems and building on the United Nations (UN) Food and Agriculture Organization (FAO) Land Cover Classification System (LCCS) for the sake of compatibility with other land cover products;
- engaging with key climate and carbon modelling users to ensure that the CCI-LC products meet the requirements for a range of model communities and for application of existing and future modelling approaches;
- selecting and/or developing the best practice algorithms and methods to pre-process the various data types according to the state-of-the-art as well as the most efficient strategy to discriminate and map the land cover in a consistent way over time at global scale;
- estimating the accuracy of the derived land cover information through a widely accepted and independent validation process and to quantitatively assess its relevance and usefulness for different climate models;
- designing the operational system required to implement the proposed approach for sustainable production of the land cover information.

1.2.1 Users requirements

During the first three months of the CCI-LC project, a user requirement analysis was conducted to derive the specifications for a new global LC product to address the needs of key-users from the CMC. This user assessment was built upon the general guidance from the GCOS and its related panel activities and has provided the next step to further derive more detailed characteristics and foundations to observe LC as an ECV [RD-1].

As part of this analysis, a user consultation mechanism was set-up to actively involve different climate modelling groups by setting out surveys. These climate users' surveys focused on three major ways land cover observations are used in climate models:

1) as proxy for several land surface parameters assigned based on Plant Functional Types (PFTs);
2) as proxy for (tracking) human activities, i.e. land use affecting land cover;
3) as datasets for validation of model outcomes (i.e. time series) or to study feedback effects.

The evolution of requirements for these aspects from current models to future new modelling approaches was specifically taken into account. In addition, the broad LC data user community, represented by users of the ESA-GlobCover products [RD-2] [RD-3] [RD-4], was also surveyed.

Next to the surveys, requirements from the GCOS Implementation Plan 2004 and 2010 [RD-5] [RD-6] and associated strategic Earth Observation (EO) documents for land cover (Global Terrestrial Observing System (GTOS), Integrated Global Observations for Land (IGOL), Integrated Global Carbon Observation (IGCO), CMUG in [RD-7] [RD-8] [RD-9]) were considered and integrated. Finally, a detailed literature review was carried out with special attention to innovative concepts and approaches to better reflect land dynamics in the next generation climate models.

The outcome of the user requirements assessment published in [RD-10] has shown that although the range of requirements coming from the CMC is broad, there was a good match among the requirements coming from different user groups and the broader requirements derived from GCOS, CMUG and other relevant international panels.

The findings of the User Requirement (UR) analysis highlight that:

- **UR1**: There is a need for both stable land cover data and a dynamic component in the form of time-series and changes in land cover;
- **UR2**: Consistency among the different model parameters is often more important than accuracy of individual datasets, and it is important to understand the relationship between land cover classifiers with the parameters and the relative importance of different land cover classes;
- **UR3**: Providing information on natural versus anthropogenic vegetation (disturbed fraction), tracking human activities and defining history of disturbance is of increasing relevance; in particular for land use affecting land cover with most details needed to focus areas with large anthropogenic effects;
- **UR4**: Land cover products should provide flexibility to serve different scales and purposes both in terms of spatial and temporal resolution;
- **UR5**: The relative importance of different class accuracies varies significantly depending on which surface parameter is estimated and the need for stability in accuracy should be reflected in implementing a multi-date accuracy assessment;
- **UR6**: Future requirements for temporal resolution refer to intra-annual and monthly dynamics of land cover including also remote sensing time series signals;
- **UR7**: More than 90% of the general land cover users find the UN-LCCS a suitable approach for thematic characterization; and this approach is also quite compatible with the PFT concept of many models;

- **UR8**: The quality of land cover products need to be transparent by using quality flags and controls, and including information on the probability for the land cover class or anticipated second class or even the probability distribution function for each class (coming from the classification algorithm).

1.2.2 Revisited land cover concept

Considering the importance of land cover as an input in climate modelling, the development of a new global LC database was initiated in the context of this project. The specifications of the new LC product are based on an in-depth user requirement analysis conducted during the 6 first months of the project. It aimed at defining the EO data needs of the climate and global LC research communities.

This analysis revealed first the need to consider LC data under 2 aspects: ***stable*** in the form of land cover map and and ***dynamic*** in the form of time series. In addition, the LC products should provide ***flexibility*** to serve different scales and purposes in terms of spatial and temporal resolutions. Their quality should also be transparent by using ***quality flags*** and controls.

From a remote sensing point of view, these requirements – and the first one in particular – led in turn in rethinking the whole LC concept into ***LC state*** and ***LC condition*** components. The LC state concept refers to the set of LC features remaining stable over time which define the LC independently of any sources of temporary or natural variability. It is agreed that the LC state is well described using the UN-LCCS, which is also quite compatible with the PFT concept of many models. The LC condition concept relates directly to the temporary or natural variability of LC features that can induce some variation in land surface over time without changing the LC in its essence. This LC condition is typically driven by biogeophysical processes. It encompasses different observable variables such as the green vegetation phenology, snow coverage, open water presence, and burned areas occurrence, etc.

According to the user requirements, the LC products generated in this project had to reach a spatial resolution of 300m or coarser and a frequency at which the production of a stable LC map is feasible (which has been set to 5 years), with a one-year-long time series for each LC-condition. In addition, each product should be delivered along with a set of flags which document their quality.

1.2.3 Project outputs

The overall objective of the first phase (2011-2013) of the CCI-LC project was to deliver, in a consistent way over years and from various EO instruments, global LC products matching the needs of key users belonging to the CMC. More precisely, the final products of the CCI-LC project consisted in global LC databases made of ***LC state products*** for three epochs – centered around 2000, 2005 and 2010 – and of ***LC condition products***. The surface reflectance (SR) time series which served as input for generating the global land cover databases were also delivered as CCI-LC products. As a result of the successful round robin process, a global Water Bodies (WB) product derived from the Envisat Advanced Synthetic Aperture Radar (ASAR) archives was also generated as a CCI-LC product. All products include metadata and documentation. They are summarized in Table 1-1.

Table 1-1: Summary of the CCI-LC Phase I outputs.

Product	Coverage		Resolution		Sensor	Projection	Format
	Spatial	Temporal	Spatial	Temporal			
SR time series	Global	2003-2012	300m	7-day	MERIS FR	WGS 84	NetCDF
			1000m		MERIS RR		
LC map 2010 epoch	Global	2008-2012	300m	5-year	MERIS FR/RR	WGS 84	NetCDF & GeoTiff
LC map	Global	2003-2007	300m	5-year	MERIS	WGS 84	NetCDF &

2005 epoch					FR/RR		GeoTiff
LC map 2000 epoch	Global	1998-2002	300m	5-year	MERIS FR/RR; SPOT-VGT	WGS 84	NetCDF & GeoTiff
NDVI LC condition	Global	1999-2012	1000m	7-day	SPOT-VGT	WGS 84	NetCDF & GeoTiff
Snow LC condition	Global	2000-2012	500m	7-day	MOD10A2	WGS 84	NetCDF & GeoTiff
Burned Areas LC condition	Global	2000-2012	500m	7-day	MCD64A1	WGS 84	NetCDF & GeoTiff
Water Bodies product	Global	2005-2010	300m	5-year	ASAR WSM	WGS 84	NetCDF & GeoTiff

1.3 Structure of the document

After this introduction, the document is divided into 8 sections that are shortly described below:

- Section 2 briefly recapitulates the CCI-LC processing chain;
- Section 3 describes the MERIS SR time series;
- Section 4 presents the land cover maps (i.e. LC state products) and the associated validation;
- Section 5 characterizes the land cover condition products;
- Section 6 focuses on the water bodies product and its validation;
- Section 7 presents the CCI-LC user tool that can be used to visualize and aggregate the products;
- Section 8 explains how to access the CCI-LC products;
- Section 9 gives the terms of use of the CCI-LC products.

Appendix A and B list the symbols/acronyms and the reference documents, respectively. Technical specifications on the netcdf format are summarized in Appendix C for all the products: attributes and structure of the product files, dimensions, flags, or metadata. Appendix D provides instructions to install and use the aggregation tool presented in section 7.3.

2 PROCESSING CHAIN

As just mentioned, the CCI-LC Phase 1 delivered global LC databases made of LC state products for three epochs and of LC condition products, the MERIS FR and RR time series which served as input for generating the global land cover maps and a global WB product derived from the Envisat ASAR archives. To do so, the processing has been organized in four distinct modules. As a thorough description of the CCI-LC processing chain is out of the scope of this document, only an overview of the processing chain is presented in this section (Figure 2-1). More details can be found in the Algorithm Theoretical Basis Document [AD-7].

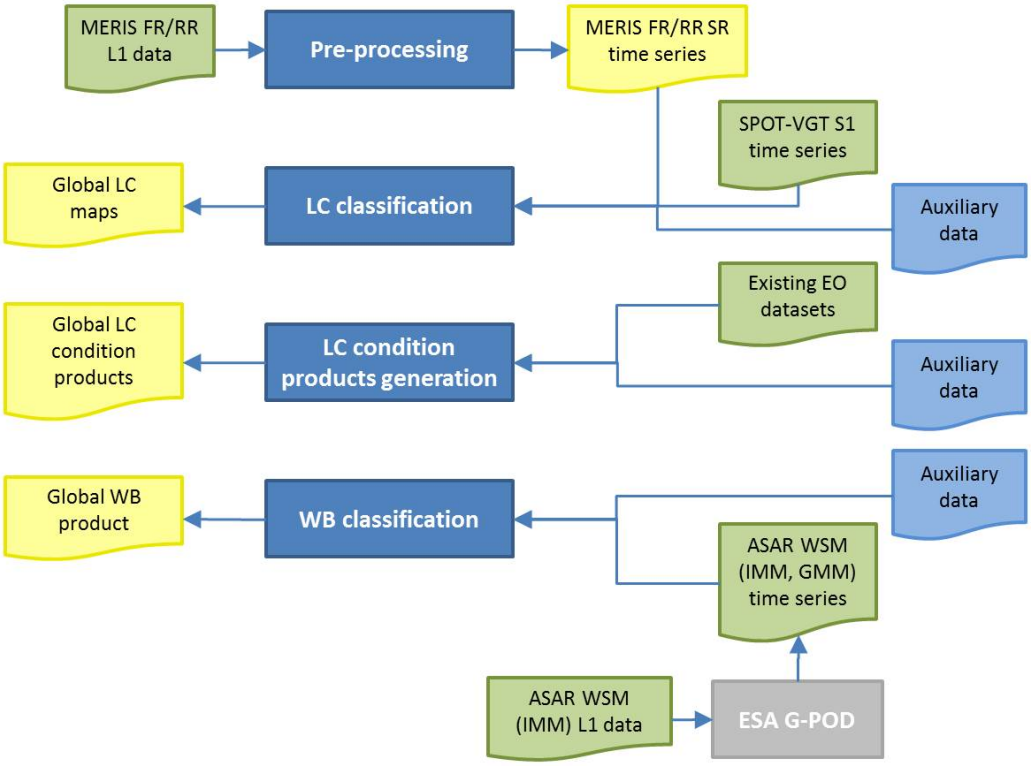


Figure 2-1 : Flowchart of the CCI-LC processing chains.

3 SURFACE REFLECTANCE PRODUCTS

3.1 Products description

The SR products delivered by the CCI-LC project consist in MERIS global SR composite time series covering the period 2003-2012 that are the input for the classification algorithms. The pre-processing module was developed by Brockmann-Consult (BC), capitalizing on the GlobCover and GlobAlbedo projects. The spectral content encompasses 13 of 15 MERIS spectral channels – bands 11 and 15 being removed – (Table 3-1) and the spatial resolution is of 300m for the Full Resolution (FR) and 1000m from the Reduced Resolution (RR).

Table 3-1: MERIS spectral channels.

Band number	Band centre (nm)	Band width (nm)	Use
1	412.5	10	Yellow substance and detrital pigments
2	442.5	10	Chlorophyll absorption maximum
3	490	10	Chlorophyll and other pigments
4	510	10	Suspended sediment, red tides
5	560	10	Chlorophyll absorption minimum
6	620	10	Suspended sediment
7	665	10	Chlorophyll absorption and fluorescence reference
8	681.25	7.5	Chlorophyll fluorescence peak
9	705	10	Fluorescence reference, atmospheric corrections
11	760.625	3.75	O2 R-branch absorption band
10	753.75	7.5	Vegetation, cloud
12	775	15	Atmosphere corrections
13	865	20	Vegetation, water vapour reference
14	885	10	Atmosphere corrections
15	900	10	Water vapour, land

The time series are made of temporal syntheses obtained over a 7-day compositing period. The exact schema for the 7-day periods is to start at January 1 and go on 7-day by 7-day periods until the end of the year. In this way, it should be noted that the last period of December comprises 8 days. As for leap years, the 7-day period including February 29 comprises 8 days. There are separate time series for MERIS FR and MERIS RR.

In order to simplify the handling and analysis of 300m spatial resolution global datasets, the MERIS SR time series are being delivered in tiles. Global products are subdivided into 72 x 36 tiles (Figure 3-1) following the tiling system already used in the GlobCover project [RD-3] [RD-4]. Tiles are 5 degrees by 5 degrees. The tile coordinate system starts at (0,0) (85N180W) (horizontal tile number, vertical tile number) in the upper left corner and proceeds right (horizontal) and downward (vertical). The tile in the bottom right corner is (71, 35) (90S175E). A tile is physically represented by a single file whose file name also indicates the tile south-west corner (see section 3.2 for a complete description of the naming convention). In addition, tiles having no land contribution are not delivered.

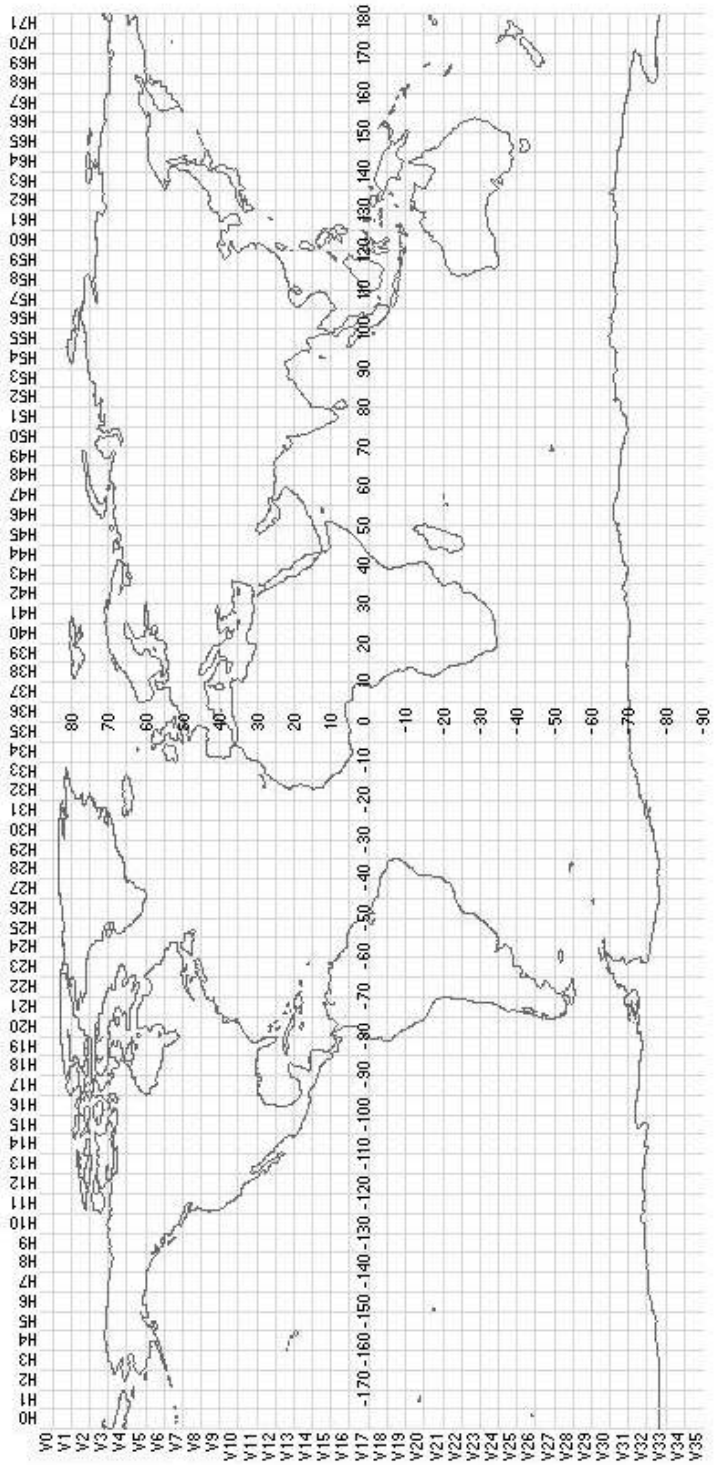


Figure 3-1: Description of the tiling system used for the SR products (from [RD-3] and [RD-4]).

The following figure (Figure 3-2) shows the individual RGB image of tile h37v12 of CCI-LC MERIS FR SR 7-day composite from 2005-07-02 at 300m spatial resolution.

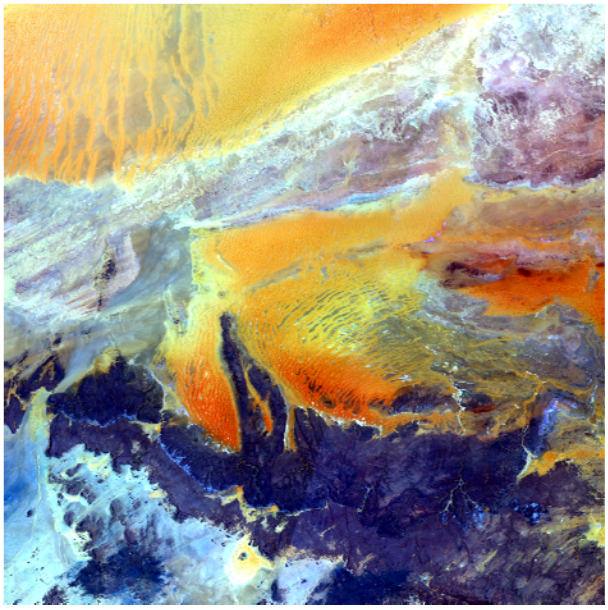


Figure 3-2: Example of CCI-LC SR 7-day composite, at 300m spatial resolution and tile v12h37 - ESACCI-LC-L3-SR-MERIS-300m-P7D-h37v12-20050702-v1.0.nc (RGB with channels 7, 5, 2).

Two examples of the global RGB image of CCI-LC MERIS FR SR 7-day composite are illustrated in Figure 3-3 (2009-04-02) and Figure 3-4 (2003-01-15). The different coverage of the Earth is clearly visible and is mainly influenced by the different number of available input daily data.

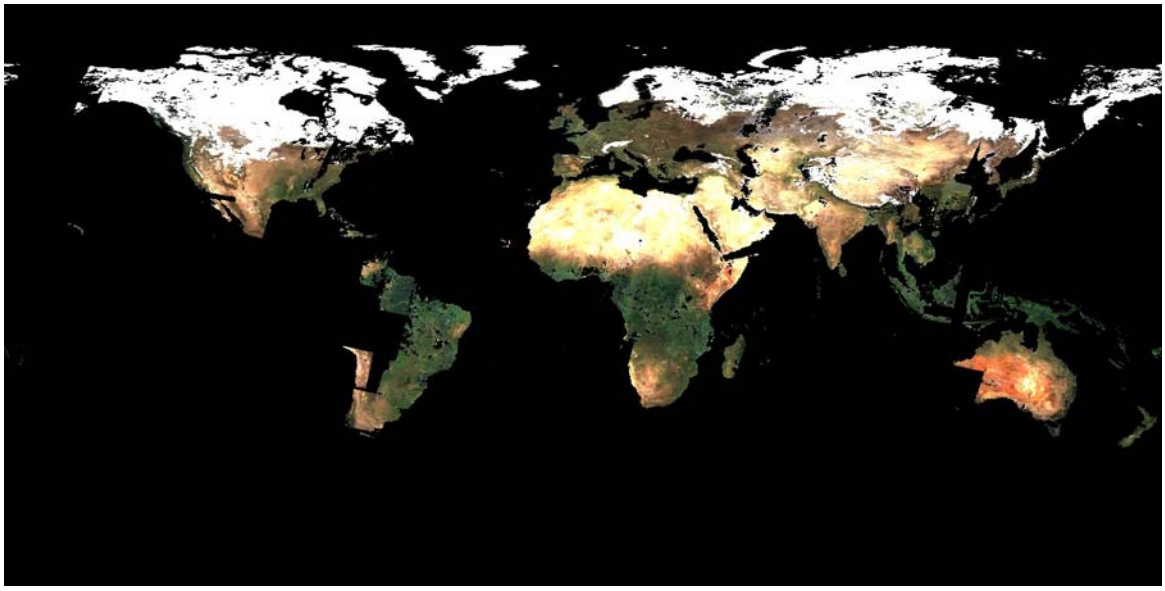


Figure 3-3: The CCI-LC Global Surface reflectance FR 7-day composite from the 2009-04-02 through 2009-04-08 at 300m spatial resolution (RGB with channels 7, 5, 3).

Figure 3-4: The CCI-LC Global Surface reflectance FR 7-day composite from the 2003-01-15 through 2003-01-21 at 300m spatial resolution (RGB with channels 7, 5, 3).

The Figure 3-5 shows the average of all FR 7-day composites related to the 2010 epoch (i.e. the 5 years from 2008 to 2012) at 300m spatial resolution.

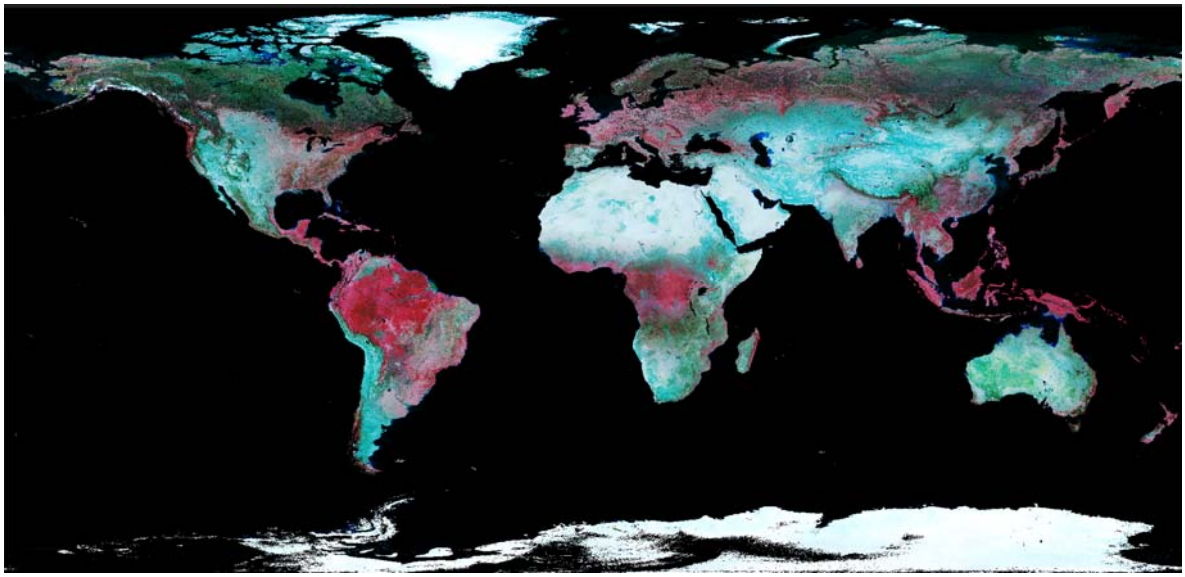


Figure 3-5: The CCI-LC Global Surface reflectance FR composite from all SR 7-day composite from the 2010 epoch (2008-2012), at 300m spatial resolution (RGB with channels 14, 7, 5).

3.2 Products format

- **Naming convention**

The file name convention of the global SR composite time series delivered by the CCI-LC project is the following:

File name = <id>-v<version>.nc

where <id> = <type>-<tile>-<start time>

where <type> = <project>[-<level>]-<code>-<sensor>-<spatres>-<tempres>

The dash "-" is the separator between name components. The filename convention obeys NetCDF CF by using the postfix ".nc". The different name components are defined in Table 3-2

Table 3-2: Components that make the name of the SR products delivered by the CCI-LC project.

Field	Signification	Value
project	Project Acronym	ESACCI-LC (constant)
level	Processing level	L3 (constant)
code	Product code identifier for CCI-LC products	SR (constant)
sensor	Mission, platform and sensor identifier	MERIS (constant but could be updated if other sensors are used to generate SR products - see Section 3)
spatres	Spatial resolution	300m (or 1000m - see Section 3)
tempres	Compositing period	P7D (constant)
tile	Tile of the Plate Carree grid (see Figure 3-1)	Tile name in format hXXvYY where XX is the column and YY is the row e.g. " h71v27" - tile in column 71 and row 27 of the Plate Carree grid (see Figure 3-1)
start time	Start time of the interval mentioned in the field "period"	"yyyyMMdd" where: "yyyy" is the start year of the composite "MM" is the start month of the composite "dd" is the start day of the composite
version	Incremental that follows the successive revisions of the CCI-LC Processing lines	Version of product, preferably major.minor , optionally with processing centre [a-zA-Z0-9._]

An example file name of the first 7-day SR composite for the year 2008 located at the tile h40v13 would be: "ESACCI-LC-L3-SR-MERIS-300m-P7D-h40v13-20080326-v1.0.nc"

- **Processing Level**

Level 3 (i.e. "data or retrieved environmental variables which have been derived from level 1 or 2 products and which have been spatially and/or temporally resampled" [RD-11])

- **Units**

Top of Canopy Reflectance values (no unit, provided as a fraction) coded in 16-bits

- **Spatial Extent**

All the terrestrial zones of the earth between the parallels 90°N and 60°S. The SR products are provided in tiles as defined in Section 3.1.

- **Spatial resolution**

300m

- **Temporal resolution**

7 day

- **Product layers**

The CCI-LC global 7-day SR products description is based on the structure of the NetCDF files. The global attributes of the composites are described in the Appendix C.

- **Projection**

The projection is a Plate Carree with a geographic Lat/Long representation based on the WGS84 ellipsoid. The Coordinate Reference System (CRS) used for the global LC products is a geographic coordinate system (GCS) based on the World Geodetic System 84 (WGS84) reference ellipsoid and using a Plate Carree projection.

The projection makes use of an equatorial radius (also called semi-major axis) of 6378.14 km and of a polar radius (also called semi-minor axis) of 6356.76 km. The inverse flattening parameter is of 298.26 m. The coordinates are specified in decimal degrees. A complete description of the CRS is given in Figure 3-6 as an ISO 19111 WKT representation.

```
GEOGCS["GCS_WGS_1984",
    DATUM["D_WGS_1984",
        SPHEROID["WGS_1984",6378137.0,298.257223563]],
    PRIMEM["Greenwich",0.0],
    UNIT["Degree",0.0174532925199433],
AUTHORITY["EPSG",4326]]
```

Figure 3-6: Description of the coordinate reference system defining the global LC products.

- **Format**

All the SR time series are delivered in NetCDF-4 format using the "classic model" of NetCDF with compression. The file specification follows CF conventions [RD-12].

- **Metadata**

The metadata for the SR products is provided as global attributes in the NetCDF file. It follows the CCI guidelines [RD-13].

- **Estimated size**

The size of a global 7-day 300-m MERIS FR SR composite is estimated at ~70 GB (compressed) and the size of the one tile is estimated at ~0.3 GB (compressed).

4 LAND COVER MAPS

4.1 Products description

The CCI-LC project delivers global LC maps at 300m spatial resolution for three 5-year epochs centred on the years 2010 (2008-2012), 2005 (2003-2007) and 2000 (1998-2002).

The methodological challenge was to produce, in a repeatable way, global land cover maps at 300m spatial resolution. The classification module was developed by UCL-Geomatics. It capitalized on the GlobCover unsupervised classification chain, which combined both the spectral and temporal richness of the MERIS FR time series. This GlobCover chain was improved by adding machine learning classification steps and developing a multiple-year strategy. Finally, it was designed to be globally consistent while regionally-tuned.

The LC maps were made with a dominance of MERIS FR imagery. MERIS RR dataset was also used to compensate for a lack of MERIS FR acquisitions in some areas and observations acquired by the SPOT Vegetation (SPOT-VGT) were used to extent the temporal coverage of the project over the years 1998-2002.

The classification module of the CCI-LC processing chain first transformed the 7-day MERIS FR and RR multispectral 5*5° tiles produced by the pre-processing module into meaningful global and stable land cover maps. Based on the entire 2003-2012 MERIS FR and RR archive, a 10-year 2003-2012 global land cover map was generated. This 10-year global land cover map served as baseline to derive the 2010, 2005 and 2000 maps using back- and up-dating techniques based on SPOT-VGT time series. This process is summarized in Table 4-1.

Table 4-1: CCI land cover map specifications.

CCI land cover map	Reference period	Spatial coverage and resolution	Data source
10-year LC map	2003-2012	Global / 300m	Envisat MERIS FR & RR time series
LC map from 2010	2008-2012	Global / 300m	MERIS 10-year LC map as baseline SPOT-VGT time series for updating
LC map from 2005	2003-2007	Global / 300m	MERIS 10-year LC map as baseline SPOT-VGT time series for back- and up-dating
LC map from 2000	1998-2002	Global / 300m	MERIS 10-year LC map as baseline SPOT-VGT time series for backdating

The typology has been defined using the UN-LCCS with the view to be as much as possible compatible with the GLC2000, GlobCover 2005 and 2009 products. In addition, the UN-LCCS has been found quite compatible with the PFTs by the climate modellers involved in the user requirements analysis [AD-1].

The UN-LCCS defines LC classes using a set of classifiers. The system was designed as a hierarchical classification, which allows adjusting the thematic detail of the legend to the amount of information available to describe each land cover class, whilst following a standardised classification approach. The CCI maps were designed to be globally consistent. Therefore, their “level 1” legend was determined by the level of information that was available and that made sense at the scale of the entire world. This “level 1” legend is the one expressed by ten values in Table 4-2 (i.e. class values of 10, 20, 30, etc.). The land cover maps were also described by a more detailed legend, called “level 2” which corresponds to the non-ten values in Table 4-2 (i.e. class values of 11, 12, 61, 62, etc.). This “level 2” legend made use of more accurate and regional information where available. It shall be noted that the regional classes are not present all over the world since they were not properly discriminated at the global scale.

Table 4-2: Legend of the global LC maps, based on LCCS.

Value	Label	Color
0	No Data	
10	Cropland, rainfed	
11	Herbaceous cover	
12	Tree or shrub cover	
20	Cropland, irrigated or post-flooding	
30	Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)	
40	Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)	
50	Tree cover, broadleaved, evergreen, closed to open (>15%)	
60	Tree cover, broadleaved, deciduous, closed to open (>15%)	
61	Tree cover, broadleaved, deciduous, closed (>40%)	
62	Tree cover, broadleaved, deciduous, open (15-40%)	
70	Tree cover, needleleaved, evergreen, closed to open (>15%)	
71	Tree cover, needleleaved, evergreen, closed (>40%)	
72	Tree cover, needleleaved, evergreen, open (15-40%)	
80	Tree cover, needleleaved, deciduous, closed to open (>15%)	
81	Tree cover, needleleaved, deciduous, closed (>40%)	
82	Tree cover, needleleaved, deciduous, open (15-40%)	
90	Tree cover, mixed leaf type (broadleaved and needleleaved)	
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	
120	Shrubland	
121	Evergreen shrubland	
122	Deciduous shrubland	
130	Grassland	
140	Lichens and mosses	
150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	
152	Sparse shrub (<15%)	
153	Sparse herbaceous cover (<15%)	
160	Tree cover, flooded, fresh or brakish water	
170	Tree cover, flooded, saline water	
180	Shrub or herbaceous cover, flooded, fresh/saline/brakish water	
190	Urban areas	
200	Bare areas	
201	Consolidated bare areas	
202	Unconsolidated bare areas	
210	Water bodies	
220	Permanent snow and ice	

Among these LC classes, four were largely identified thanks to external dataset: the “tree cover, flooded, saline water” class which is based on the global mangrove atlas [RD-14], the “urban areas” which have been extracted from the reference dataset [AD-6], the “water bodies” which have been inherited from the CCI-LC WB product [AD-12] and the “snow and ice” class which comes from the Randolf Glaciers Inventory [RD-15] (to which the CCI-Glaciers project is a main contributor).

Figure 4-1 presents the global LC map from the 2010 epoch and Figure 4-2 shows the classification obtained over the 3 epochs in the Amazon region.

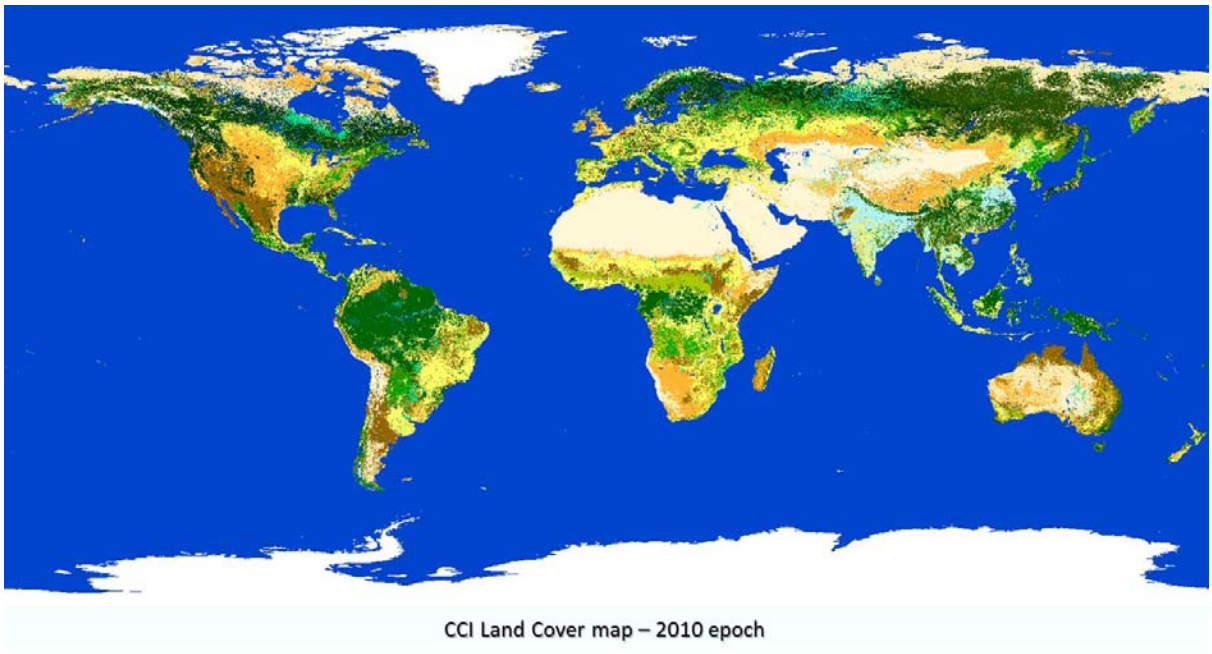


Figure 4-1: The CCI global LC map from the 2010 epoch (2008-2012), at 300m spatial resolution.

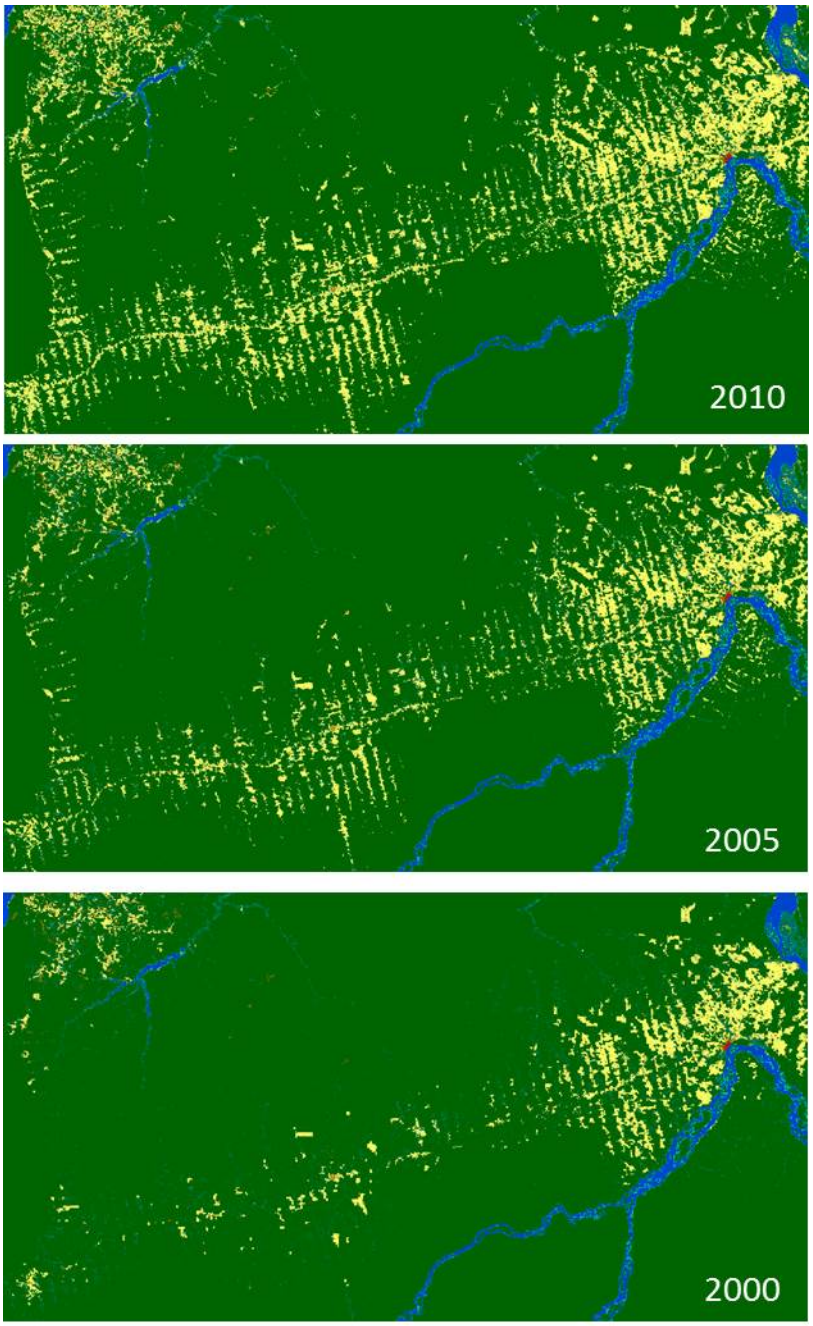


Figure 4-2: The CCI global land cover map from the 2010 epoch (2008-2012) on the top, from the 2005 epoch (2003-2007) at center and from the 2000 epoch (1998-2002) on the bottom, over the Amazon.

The following figures present the products (mainly the 2010 as it is the most recent one and as only the forest classes may differ in the other epochs), through snapshots and visual comparison with reference datasets in various regions of the world. The GlobCover product was particularly used in this comparison, in order to show the accomplished progress.

The high level of thematic detail is illustrated in Figure 4-3, Figure 4-4 and Figure 4-5. In addition, Figure 4-3 and Figure 4-4 show the good agreement between the CCI-LC map and the reference made of high spatial resolution dataset (20 m in Europe with the Corine map and 30 m in US with the NLCD). It can also

be noted that the amount of mosaic classes (which was a critical issue of the GlobCover products) has significantly been limited.

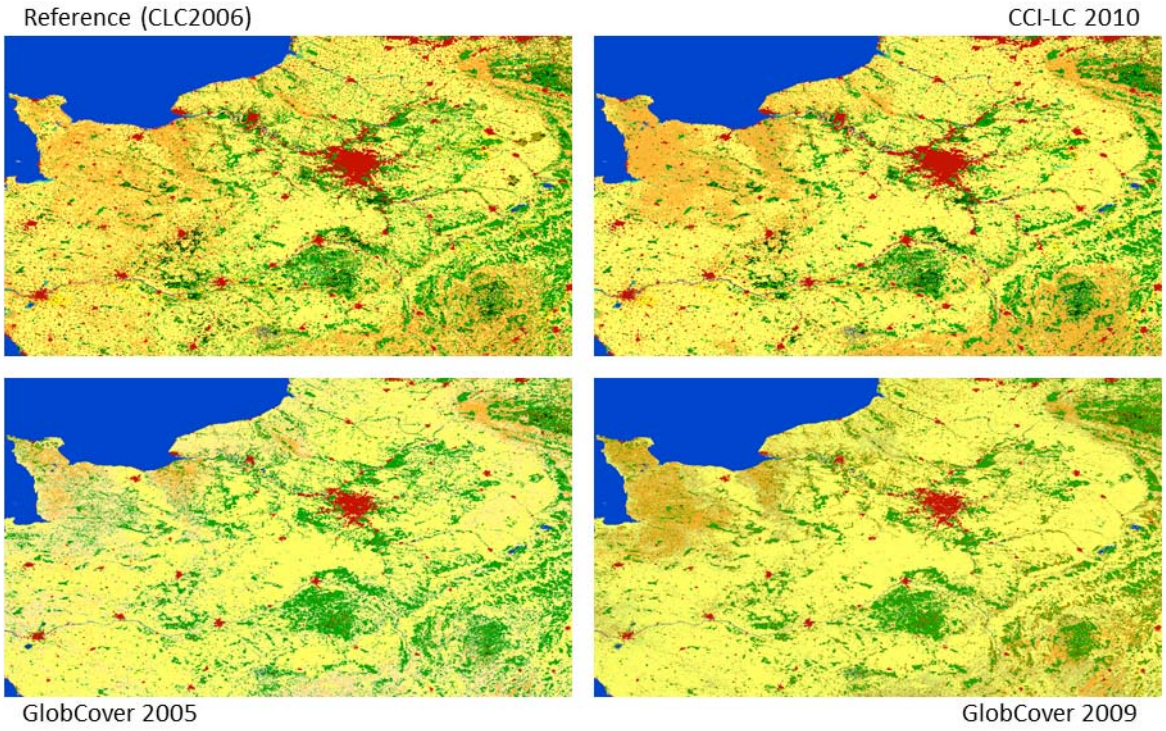


Figure 4-3: Comparison, over Europe, of the CCI-LC for the 2010 epoch (top right) with the reference dataset used in the classification made of Corine 2006 (top left) and the GlobCover 2005 and 2009 products (bottom left and right respectively).

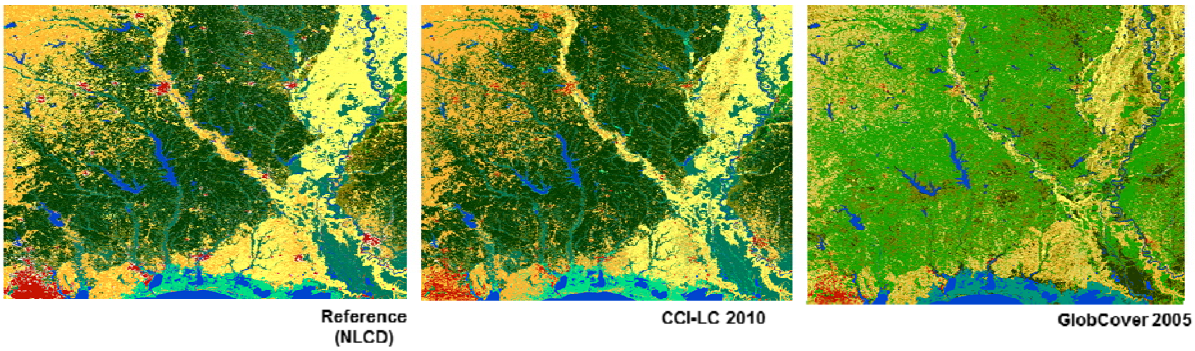


Figure 4-4: Comparison, in Florida (US), of the CCI-LC for the 2010 epoch (center) with the reference dataset used in the classification made of the US-NLCD (left) and the GlobCover 2005 product (right).

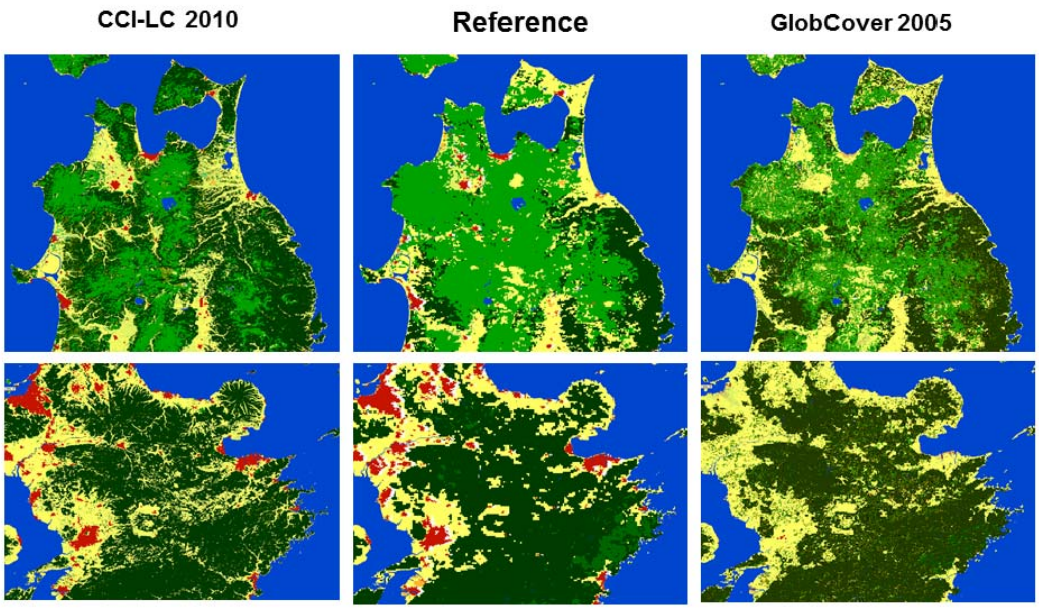


Figure 4-5: Comparison, in Japan, of the CCI-LC for the 2010 epoch (left) with the reference dataset used in the classification made of GLC2000 (center) and the GlobCover 2005 product (right).

The mapping of the deforestation in tropical basins looks quite good when overlying the map with Google Earth (Figure 4-6).

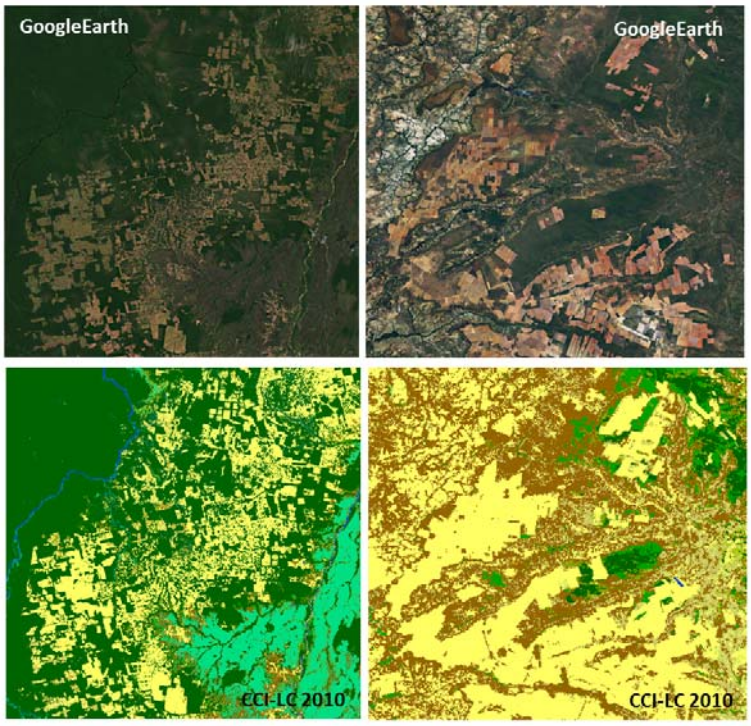


Figure 4-6: Illustration of the deforestation mapping in the CCI-LC 2010 map, with zooms in Central America.

The LC maps are delivered in the NetCDF-4 format, i.e. the "classic model" of NetCDF since most tools can handle them. The file specification follows CF conventions [RD-12]. Global LC products are also delivered in the GeoTiff format for specific users of the land cover community. A complete description of the products format can be found in Section 4.3.

In addition, the project also delivers a user tool along with the land cover product, which allows users to aggregate the LC map to the spatial resolution which is suitable for their models. This tool is described in detail in Section 7.3.

4.2 Products validation

A critical step in the acceptance of the LC maps by the user communities is providing confidence in their quality through validation against independent data such as ground-based reference measurements or alternate estimates from other projects and sensors.

The main objective of the validation is to allow a potential user determining the “map’s fitness for use” for his / her application. There are several definitions of validation available from various agencies, and it was agreed that the Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation (CEOS-WGCV) definition would be adopted within the CCI program:

> *“The process of assessing, by independent means, the quality of the data products derived from the system outputs”.*

The validation process independence has been ensured (i) using validation datasets that were not used during the production of the LC maps and (ii) being carried out by external parties, i.e. by staff not involved in the production of the LC maps.

4.2.1 Methodology

The validation process included three different steps: elaborating the sampling strategy, collecting reference data sources and assessing the products accuracy.

4.2.1.1 Sampling strategy

The sampling used in the CCI-LC project relied on the systematic sampling of the TREES dataset combined with a two-stage stratified clustered sampling, since it is generally recognized as the most efficient sampling strategy [RD-16]. This stratified random sampling allowed selecting the ***Primary Sampling Units*** (PSUs). In order to be consistent with the previous exercises, 2600 PSUs were selected (Figure 4-7).

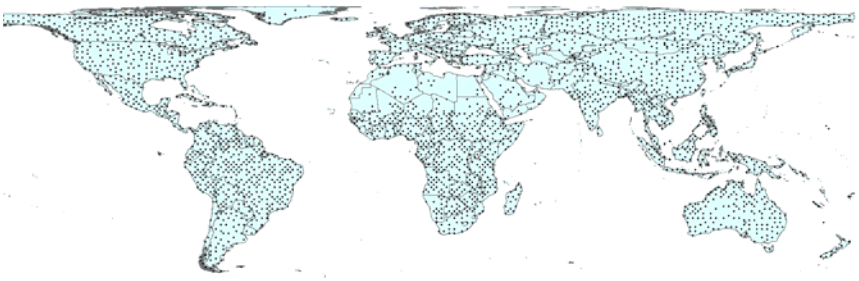


Figure 4-7: Selected sample frame displaying the 2600 PSUs

A 20-km × 20-km box was defined around each PSU and Secondary Sampling Units (SSUs), which correspond to the actual “sample plots”, were then selected by systematically distributing them within these

boxes. 5 SSUs were located at the center of each 20-km × 20-km box and at a distance of 4-km × 4-km from the center of each box (Figure 4-8).

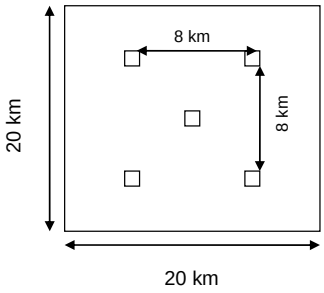


Figure 4-8: Selection of SSUs within a PSU

While the Minimum Mapping Unit (MMU) of the CCI global LC maps is the 300m spatial resolution pixel (i.e. 9 hectares), the observational unit (corresponding to the validation unit) gives more weight to the neighborhood of the pixel and is thus defined as a window of 3 × 3 pixels at 300-m × 300-m spatial resolution (i.e. 81 hectares).

4.2.1.2 Reference dataset collection

For global land cover products (such as the CCI-LC maps), collecting "ground truth" information is too costly. However, surrogate to "ground truth" can be obtained from existing reference data sources interpreted by experts.

The following reference data sources were made available for interpretation by experts:

- High and very high spatial resolution imagery: Google Earth/Virtual Earth imagery + 1 Landsat TM or ETM+ image over each epoch obtained from the Global Land Survey (GLS) dataset from 2000, 2005 and 2010;
- Multi-temporal Normalized Difference Vegetation Index (NDVI) profiles derived from SPOT-VGT time series: aggregated NDVI profiles built from 10 years of SPOT-VGT daily top of canopy SR syntheses (S1 products) + yearly NDVI profiles for the years 2000/2005/2010;
- Google Earth facilities.

These reference data sources were interpreted by an international network of experts in a standardized manner. The experts' network involved in this project is presented in Table 4-3. Selecting appropriate experts is a key element of the validation process. The selection / involvement of experts were based on the following criteria:

- Recognized expertise on land cover over large areas;
- Familiarity with interpretation of remote sensing imagery;
- Commitment to perform the interpretation;
- Complementarities with the other experts.

Table 4-3: Name and affiliation of the international land cover experts involved in the CCI-LC project.

Region	Experts	Institution
Africa	Kibambe Jean-Paul	Université catholique de Louvain
	Nonguierma André	Centre Agrhymet – Niger / Economic Commission of Africa
Russia	Bartalev Slava	Institute for Environment and Sustainability – Joint Research Centre
	Krankina Olga	Oregon State University
Asia	Heinimann Andreas	National Centre of Competence in Research North-South Centre for Development and Environment (CDE)
	Kuang Wenhui	Institute of Geographical Sciences and Natural Resources Research – Chinese Academy of Sciences
	Miettinen Juka	Institute for Environment and Sustainability – Joint Research Centre
	Rasi Ratislav	Institute for Environment and Sustainability – Joint Research Centre
	Stibig Hans-Jürgen	Institute for Environment and Sustainability – Joint Research Centre
North and Central America	Colditz René	Comision Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO) – Mexico
	Giri Chandra	United States Geological Servey – EROS Data Center
	Latifovic Rasim	Canada Centre for Remote Sensing – Ottawa – Canada
South America	di Bella Carlos	Instituto Nacional de Tecnología Agropecuaria – Argentina
	Gond Valéry	CIRAD-Guyane – Université Laval
	Shimabukuo Yosio	INPE
Australia	Cacetta Peter	Commonwealth Scientific and Industrial Research Organisation – Australia

A total of 4 workshops of one week was organised at UCL-Geomatics' premises in Louvain-la-Neuve (Belgium) and 1 workshop was held at the Joint Research Centre (JRC) premises. All necessary datasets and infrastructure (hardware / software) was put at the disposal of the experts in order to comply with the requirements of the project.

The experts were asked to interpret each SSU over the three epochs through a sequential procedure. First, they were invited to interpret the 2010 epoch, based on very high spatial resolution data available from Google Satellite/Virtual Earth. The interpretation was helped through the application of an a priori segmentation and a land cover class had to be assigned to each object. Second, the change in LC between epochs was determined at the SSU scale, using the 3 Landsat TM or ETM+ images obtained from the GLS datasets. For each diagnostic (2010 interpretation and LC change between epochs), the experts had to provide their level of confidence.

A new validation tool was developed for hosting this interpretation process, based on the experience gained during the previous validation exercises of the GLC2000 and GlobCover projects. The validation tool provides an online interface available to the expert on reception of the URL. Figure 4-9 presents this interface, highlighting different functionalities.

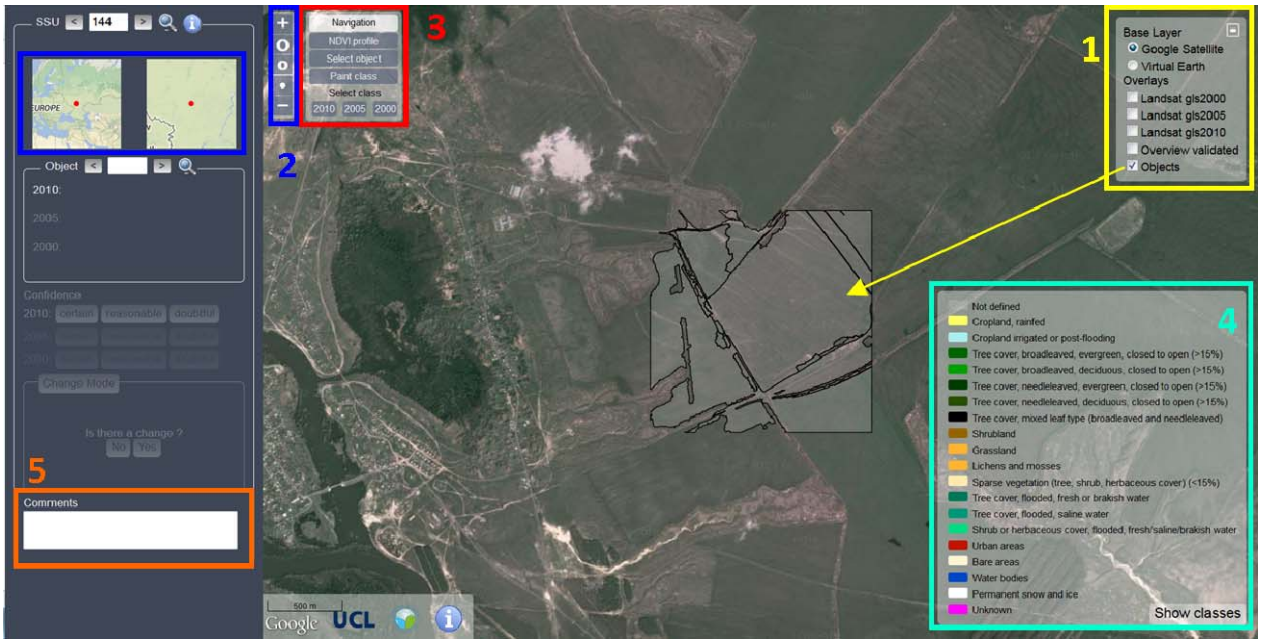


Figure 4-9: Main page of the validation tool, with the following functionalities: 1) Layer box to display different layouts; 2) Zooming functionalities; 3) Tools box to activate navigation, display NDVI profile, select objects or assign a LC class; 4) Legend description; 5) Comments box to include free text that should help understanding the labelling choices.

4.2.2 Validation results

At the end of the CCI-LC project Phase 1, most of the world was covered by interpreted samples except Europe where the validation is still in progress. For this reason, it has been decided to use - as a preliminary validation process - the GlobCover 2009 validation dataset to assess the accuracy of the CCI-LC map for the 2010 epoch. When the CCI-LC validation dataset will be ready, a new accuracy assessment will be carried out over the three epochs and this report will be updated. An exhaustive description of the GlobCover 2009 validation methodology and result can be found in [RD-4].

The contingency matrix was built by comparing the CCI-LC map with the validation dataset. Like in the GlobCover validation exercises [RD-3] [RD-4], the overall accuracy was not only calculated based on the diagonal cells of the matrix but also accounted for other cells which mark agreement between the product and the validation dataset.

Table 4-4 presents a first contingency matrix calculated by comparing the CCI-LC product for the 2010 epoch with the “certain” and “heterogeneous” points GlobCover 2009 validation dataset. A second contingency matrix is derived using only the “homogeneous” points of the GlobCover 2009 validation set. It is presented in Table 4-5. These two matrices indicate that the accuracy level is found to be 70.8% in the first case and 74.4% in the second case.

Table 4-4: Adjusted contingency matrix that considers the CCI-LC 2010 map and the "certain" and "heterogeneous" points of the GlobCover 2009 validation dataset. Green cells mark diagonal cells while yellow cells represent other samples that also mark a clear agreement between the product and the reference.

		REFERENCE: GLOBCOVER 2009 VALIDATION DATASET																							
		10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**	**210**	**220**	**SUM**	**User Acc. (%)**
PRODUCT: CCI-LC 2010 MAP	**10**	350	44	0	0	6	1	1	0	7	0	0	14	24	0	2	0	0	3	7	3	0	0	462	85
	20	5	17	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	25	88
	30	19	5	8	0	6	3	0	0	0	0	0	0	4	0	1	0	0	0	1	0	0	0	47	68
	40	9	2	0	9	7	2	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	32	63
	50	9	0	0	0	253	1	1	0	17	0	0	1	1	0	0	1	0	0	0	0	1	0	285	95
	60	9	1	0	0	24	68	3	3	41	0	0	24	7	0	0	0	0	1	0	0	1	0	182	60
	70	4	0	0	0	2	3	68	3	55	0	0	11	8	7	2	0	0	4	0	6	2	2	177	69
	80	0	0	0	0	1	3	2	31	2	0	0	1	0	2	1	0	0	0	0	0	0	0	43	77
	90	0	0	0	0	0	8	6	2	13	0	0	1	0	0	0	0	0	0	0	1	0	0	31	42
	100	3	0	0	0	1	1	0	2	2	6	0	4	1	2	0	0	0	1	0	1	0	1	25	64
	110	0	0	0	0	0	0	0	0	0	0	2	5	5	0	0	0	0	2	0	0	0	0	14	50
	120	28	0	0	0	6	4	1	0	6	0	0	116	24	0	7	0	0	2	0	6	0	1	201	58
	130	34	4	0	0	0	7	0	1	2	0	0	32	86	0	14	0	0	4	6	25	0	1	216	40
	140	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	5	60
	150	4	1	0	0	0	1	3	3	2	0	0	6	30	19	38	0	0	4	1	28	3	5	148	26
	160	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	12	33
	170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	1	0	0	0	0	8	75
	180	1	2	0	0	0	0	1	0	1	0	0	1	2	3	1	0	0	13	0	2	3	0	30	43
	190	3	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	28	0	0	0	33	85
	200	0	1	0	0	0	0	0	0	1	0	0	1	2	2	6	0	0	0	1	169	0	3	186	91
	210	2	1	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	2	2	101	0	112	90
	220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	32	34	94
	SUM	480	79	8	9	312	104	86	45	153	6	2	217	198	38	72	6	7	35	47	247	112	45	***2308***	
	Prod. Acc (%)	78	84	100	100	84	68	79	73	85	100	100	55	47	8	53	67	86	37	60	68	90	71		***70.8%***

Table 4-5: Adjusted contingency matrix that considers the CCI-LC 2010 map and the "certain" and "homogeneous" points of the GlobCover 2009 validation dataset. Green cells mark diagonal cells while yellow cells represent other samples that also mark a clear agreement between the product and the reference.

		REFERENCE: GLOBCOVER 2009 VALIDATION DATASET																						
		10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**	**210**	**220**	**SUM**	**User Acc. (%)**
PRODUCT: CCI-LC 2010 MAP	**10**	246	23	0	0	3	1	0	0	1	0	0	9	14	0	1	0	0	2	4	0	0	0	304	88
	20	4	8	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	13	92
	30	14	2	0	0	5	3	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	27	59
	40	7	2	0	0	5	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	18	44
	50	3	0	0	0	220	1	1	0	9	0	0	0	0	0	0	1	0	0	0	0	0	0	235	97
	60	5	0	0	0	21	44	2	2	24	0	0	16	4	0	0	0	0	0	0	0	0	0	118	58
	70	1	0	0	0	1	2	35	2	29	0	0	4	4	0	0	0	0	2	0	1	0	1	82	78
	80	0	0	0	0	1	1	0	11	1	0	0	1	0	1	0	0	0	0	0	0	0	0	16	75
	90	0	0	0	0	0	4	2	1	7	0	0	1	0	0	0	0	0	0	0	1	0	0	16	44
	100	2	0	0	0	1	0	0	1	1	0	0	3	0	0	0	0	0	0	0	1	0	0	9	67
	110	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	2	0	0	0	0	8	38
	120	16	0	0	0	5	2	1	0	2	0	0	79	13	0	7	0	0	2	0	4	0	1	132	60
	130	24	3	0	0	0	5	0	0	1	0	0	25	41	0	11	0	0	3	4	3	0	0	120	34
	140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0
	150	2	0	0	0	0	1	0	1	0	0	0	5	13	5	11	0	0	1	1	13	2	2	57	19
	160	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	10	40
	170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	1	0	0	0	0	7	71
	180	1	2	0	0	0	0	0	0	0	0	0	1	2	2	1	0	0	6	0	0	1	0	16	38
	190	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	20	85
	200	0	1	0	0	0	0	0	0	1	0	0	1	1	2	6	0	0	0	1	139	0	3	155	90
	210	2	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	2	80	0	89	90
	220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	28	30	93
	SUM	329	43	0	0	266	66	41	18	78	0	0	148	99	10	38	6	6	19	30	168	84	35	***1484***	
	Prod. Acc (%)	80	77	N/A	N/A	85	68	85	67	91	N/A	N/A	55	46	0	29	67	83	32	57	83	95	80		***74.4%***

These figures were derived with equal weighting for each of the stratified randomly sampled reference points. It means that classes that cover only small surfaces are overrepresented in the sample set and classes that cover large surfaces may have been underrepresented in the set. According to the CEOS recommendations, to account for the stratification, the overall accuracy values were weighted by the area proportions of various land cover classes. The surfaces of the various land cover classes were determined based on the CCI-LC 2010 product itself, projected in an equal area projection. Using the 2308 certain and homogeneous points, the weighted-area overall accuracy figure of the CCI-LC map is of 74.1%, while with the 1484 certain and homogeneous points, it is of 73.2%.

Attention should also be paid to the producers and users accuracy value, which give more information about the accuracy of the different thematic classes. Classes like “Bare Areas”, “Broadleaved Evergreen Forest”, “Water” and “Snow and Ice” were found quite accurately mapped, which is surely not surprisingly, as these classes are homogeneous, unambiguous and recognisable. What was more unexpected - and therefore a quite good result - was the high accuracy associated with the cropland and forest classes. On the other hand, classes such as shrubland, grassland, sparse vegetation and wetlands can be affected by errors.

Finally, it shall be mentioned that the quality of the map varies according to the region of interest. Looking at the number of valid observations available over a region (information which is provided as a quality flag) gives a first indication about the input data quality and the expected classification reliability.

4.3 Products format

- ### Naming Convention

The file name convention of the global LC maps delivered by the CCI-LC project is the following:

File name = <id>-v<version>.nc/tif

where <id> = <project>-<level>-<var>-<code>-<sres>-<tres>-<epoch>

The dash "-" is the separator between name components. The filename convention obeys NetCDF CF by using the postfix ".nc" and can be written as a GeoTiff file using the extension “.tif”. The different name components are defined in Table 4-6.

Table 4-6. Components that make the name of the LC maps delivered by the CCI-LC project.

Field	Signification	Value
project	Project acronym	ESACCI-LC (constant)
level	Processing level	L4 (constant)
var	Unit of the LC product	LCCS (constant)
code	Product code identifier for CCI-LC products	Map (constant)
sres	Spatial resolution	300m (constant but could be updated if other sensors are used to generate SR products – see section 4.1)
tres	Temporal resolution	P5Y (constant but could updated if shorter or longer intervals are processed)
epoch	Centre year of the epoch of the product	2000, 2005 or 2010
version	Incremental that follows the successive revisions of the CCI-LC Processing lines	Version of product revision, preferably major.minor, optionally with processing centre [a-zA-Z0-9._]*

An example file name of the LC map from 2010 would be: “ESACCI-LC-L4-LCCS-Map-300m-P5Y-2010-v1.0.nc/tif ».

- **Processing Level**

Level 4 (i.e. “variables that are not directly measured by the instruments, but are derived from these measurements” [RD-11])

- **Units**

Each pixel value corresponds to the label of a land cover class defined using UN-LCCS classifiers (see Table 4-2 in section 4.1).

- **Spatial Extent**

All terrestrial zones of the Earth between the parallels 90°N and 90°S.

- **Spatial Resolution**

300m

- **Temporal resolution**

1 product over a 5-year epoch

- **Product layers**

The land cover map is delivered along with 4 quality flags which document the reliability of the classification (Table 4-7).

Table 4-7: Quality flags of the LC maps.

Name in product	Data Type	Description
ESACCI-LC-L4-LCCS-Map-300m-P5Y-YYYY-v1.0_qualityflag1.nc/tif	byte	Indicates if the pixel has been processed (1) or not (0) 0 - pixel not processed 1 - pixel processed
ESACCI-LC-L4-LCCS-Map-300m-P5Y-YYYY-v1.0_qualityflag2.nc/tif	byte	Indicates the pixel status as defined by the pre-processing: 1 - Pixel flagged as “clear land” 2 - Pixel flagged as “clear water” 3 - Pixel flagged as “clear snow and ice” 4 - Pixel flagged as “cloud” 5 - Pixel flagged as “cloud shadow”
ESACCI-LC-L4-LCCS-Map-300m-P5Y-YYYY-v1.0_qualityflag3.nc/tif	short	Indicates the number of valid observations available to derive the classification
ESACCI-LC-L4-LCCS-Map-300m-P5Y-YYYY-v1.0_qualityflag4.nc/tif	byte	Provides a level of confidence in the product (ranging from 0 to 100)

The CCI-LC global land cover products description is based on the structure of the NetCDF files. The global attributes of the land cover maps are described in the Appendix C.

- **Projection**

The projection is a Plate Carree with a geographic Lat/Long representation based on the WGS84 ellipsoid (see section 3.2 for a complete description).

- **Format**

The three LC maps are delivered in NetCDF-4 format using the "classic model" of NetCDF with compression. The file specification follows CF conventions [RD-12]. Products are also delivered in the GeoTiff format for specific users of the land cover community.

- **Metadata**

The metadata for the LC maps are provided as global attributes in the NetCDF file. It follows the CCI guidelines [RD-13]. As for the GeoTiff files, the metadata are included in the GeoTiff raster.

- **Estimated size**

The size of the global land cover maps is around 260 MB. The size of the quality flags varies between 80MB and 2GB. These estimations take an internal LZW compression into account.

5 LAND COVER CONDITION PRODUCTS

5.1 Products description

To meet the climate modeling community needs and describe the natural variability of the land surface, three climatological variables, also named “LC conditions”, have been produced: the NDVI, the Burned Areas (BA) and the Snow.

On a per pixel basis, these climatological variables reflect, along the year, the average trajectory and the inter-annual variability of a land surface feature over the 1998-2012 period. They are built from existing long-term global datasets with high temporal frequency and moderate spatial resolution (500m-1km). They result from a compilation of 13 years of 7-day instantaneous observations into 1 temporarily aggregated profile depicting, along the year, the reference behaviour for the vegetation greenness, snow and BA.

The climatological dataset include various series of measurements, delivered in time series of 52 files (1file per 7-day time interval). The NDVI climatological variable includes the mean, standard deviation, the number of valid and cloud-free weekly composites and the pixel status (e.g. land, water, etc.) while both the BA and snow climatological datasets comprise the number of valid and cloud-free weekly composites and the percentage of the BA and snow occurrence, respectively. Table 5-1 summarizes their main characteristics.

Table 5-1: Main characteristics of the LC condition products.

Climatological dataset	Measurements	Data sources	Spatial coverage and resolution	Temporal coverage	Temporal resolution	Total Data Volume
NDVI	- Mean - Standard deviation - Number of valid weekly composites - Status	14 years of daily S1 SPOT-VGT surface reflectance time series	Global 1000m	1999-2012	Weekly	~ 30GB
Burned Areas	- Percentage of occurrence - Number of valid weekly composites	13 years of MCD64A1	Global 500m	2000-2012	Weekly	~ 5GB
Snow	- Percentage of occurrence - Number of valid weekly composites	13 years of MOD10A2	Global 500m	2000-2012	Weekly	~ 8GB

5.1.1 NDVI condition product

The NDVI condition product describes globally the yearly reference dynamic of the vegetation greenness characterizing the 1999-2012 period. It is therefore a valuable reference dataset for phenology studies and phenological metrics extraction at global scale [RD-17]. It is built from 14 years of SPOT-VGT daily top of canopy SR syntheses (S1 products) and of related quality flags.

It comprises 4 measurements in total. The annual behaviour of the vegetation is characterised by two time series of 7-day composites, corresponding first to the NDVI smoothed average and second to the inter-annual variability over the aggregation period (14 years). In addition, 2 quality flags are provided at the pixel-level: the number of valid and cloud-free weekly composites used to generate the NDVI average and the status qualifying the pixel. These items are described thoroughly in Section 5.4.1.

The average component of the resulting NDVI condition is illustrated for the 4 seasons of the year in Figure 5-1. As it can be seen, the product clearly captures the spatial pattern of many land features, including the ones situated in the cloudiest regions of the world like the equatorial areas.

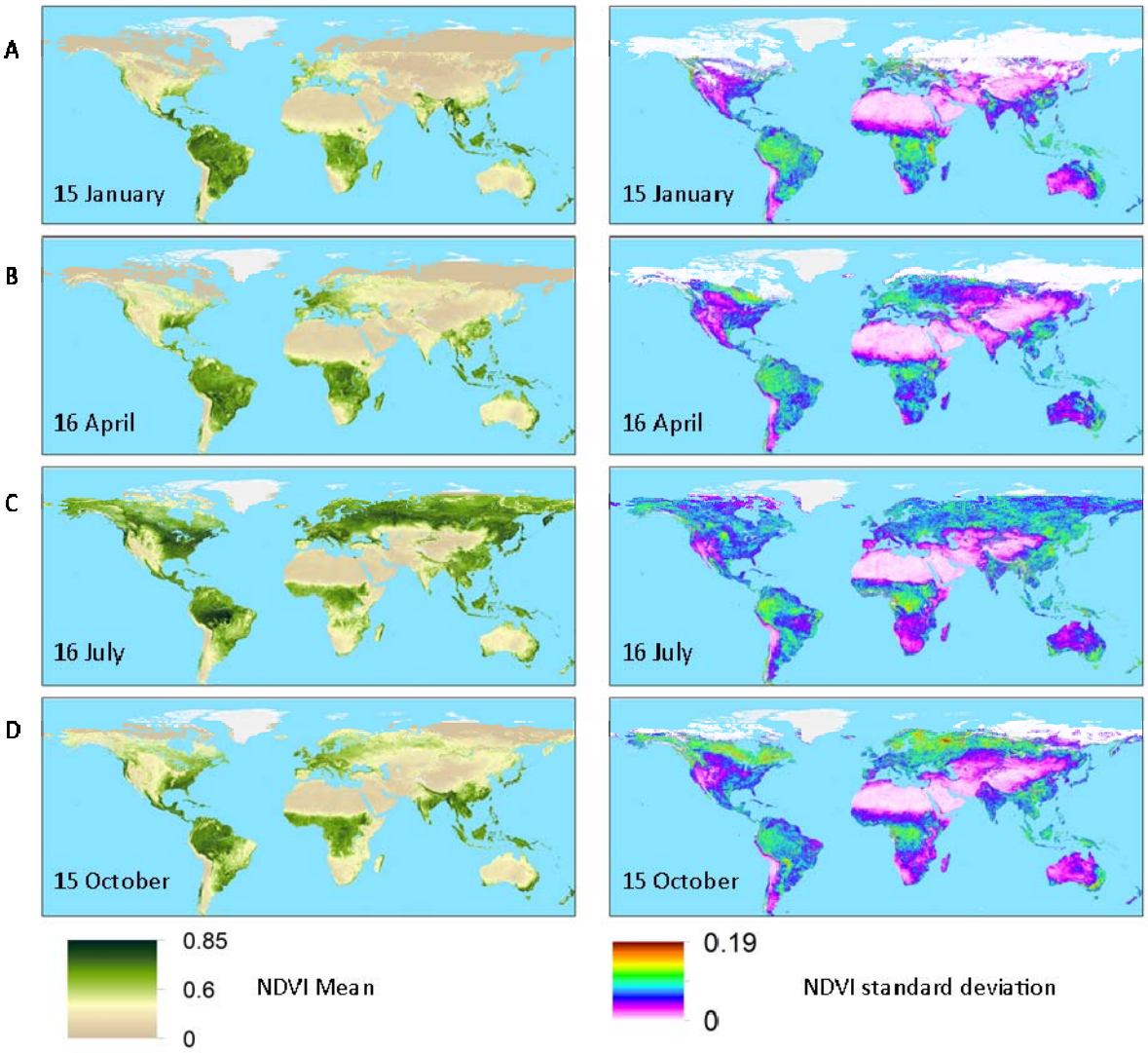


Figure 5-1: Average (left) and standard deviation (right) components of the NDVI Condition Product at 4 weeks of the year. The dates indicated in Figure A, B, C and D correspond to starting day of the 7-day composite period. White colour situated in high latitudes corresponds to NaN values [RD-17].

The SPOT-VGT 1-km spatial resolution associated with a high geometric accuracy allows producing meaningful profiles, even in highly fragmented areas such as in Africa (Figure 5-2). The 3 NDVI condition profiles, extracted on (i) a mosaic class of different cropland areas, (ii) a mosaic class of tree and shrub cover types and (iii) a land cover class made of broadleaved deciduous trees, demonstrate the spatial consistency of the product and its capacity to depict the intra-annual variability of the vegetation greenness.

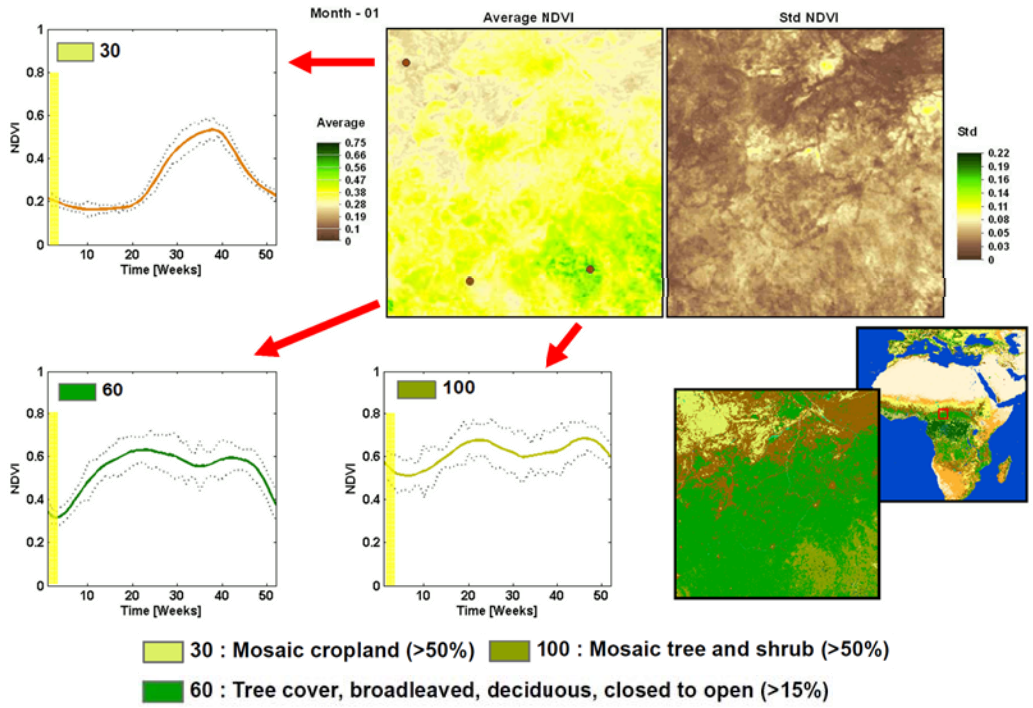


Figure 5-2: Detailed spatial example of NDVI condition profiles - average (plain line) and standard deviation (dotted line) - extracted in the region of Central Africa. The profiles are extracted from 3 pixels belonging to 3 classes of the 2010 LC state map product. The variety of the dynamic of vegetation is clearly captured.

5.1.2 BA condition product

The BA condition product presents the frequency at which burned areas have been detected along the year on a given pixel, based on observations of the 2000-2012 period. It provides the percentage of BA occurrence with a 7-day temporal resolution and depicts the seasonal dynamic of the fire impact on the surface. The BA input data are currently derived from the MODIS Direct Broadcast Monthly Burned Area Product (MCD64A1) [RD-18] being part of the Global Fire Emissions Database version 3 (GFED.v3) products [RD-19]. Its spatial resolution is 500m. As soon as available, this input data could be replaced by the Level 3 CCI-Fire disturbance product generated by the ESA CCI Fire project [RD-20]. It is important to mention that such a condition product is built on BA/fire time series but does not substitute these time series as the condition product only aims to provide an average behaviour and not the fire activity from one year to another.

The BA condition product is made of two layers. The first one represents the percentage of BA occurrence, on a 7-day basis, calculated as the sum of BA detections over the number of years in the aggregation period (currently 13 years – 2000 to 2012). It is expressed between 0 and 100. The second layer gives, on a 7-day basis, the number of valid and cloud-free weekly composites contributing to each 7-day period. It stands for a quality indicator of the occurrence values and is expressed between 0 and 13.

Figure 5-3 globally shows the percentage of BA occurrence characterizing the 7-day period from January the 1st to January the 7th.

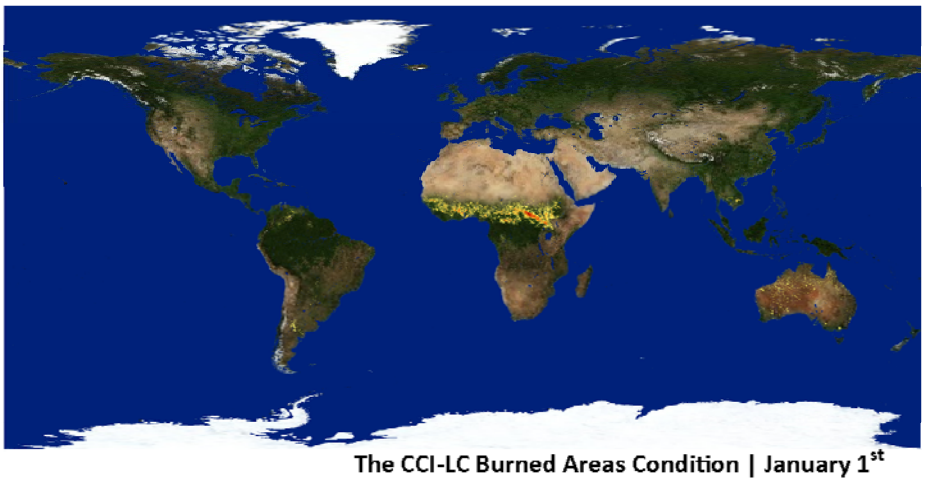


Figure 5-3: Illustration of the global BA occurrence for the 1st week of January (1-7 January). Each coloured dot represents a percentage of burned areas occurrence different from 0.

Figure 5-4 illustrates spatially (left) the percentage of burned areas occurrence for the 1st week of January in comparison with the NDVI condition for a zone of Central Africa. The temporal evolution of both variables (right) are presented for two pixels originating from the shrubland and tree cover broadleaved deciduous LC classes defined by the LC state maps centered on the 2010 epoch. The consistency in timing between both conditions is clearly highlighted.

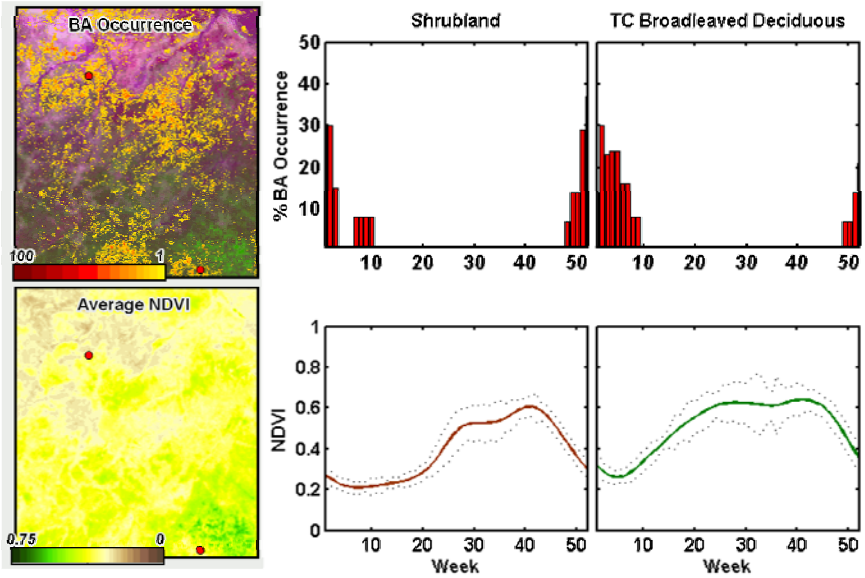


Figure 5-4: Spatial example of burned areas occurrence (top-left) and NDVI average (bottom-left) products characterizing the reference behaviour of the 1st week of January. The yearly discrete occurrence profiles illustrate the BA behaviour for two pixels originating from the Shrubland (top-left pixel) and tree cover broadleaved deciduous (bottom-right pixel) LC classes extracted in Central Africa. They are compared to the reference average (plain line) and standard deviation (dotted line) of the NDVI condition.

5.1.3 Snow condition product

The snow condition product presents the proportion of snow occurrence detected, along the year based on observations over the 2000-2012 period. It provides the seasonal dynamic behaviour of snow coverage with a 7-day temporal resolution.

The snow input data originates from the “MODIS/Terra Snow Cover 8d L3 Global 500m SIN Grid" product (MOD10A2) [RD-21]. Data are available freely from 2000 at global scale. All products come in tiles of 1200*1200 km and share the same technical properties: a sinusoidal projection and HDF format.

The condition product is made of two series of layers. The first one represents the percentage of snow occurrence, on a 7-day basis, calculated as the sum of detections over the number of valid and cloud-free years in the aggregation period (maximum 13 years – 2000 to 2012). It is expressed between 0 and 100. The second layer gives, on a 7-day basis, the number of valid and cloud-free weekly composites contributing to each 7-day period. It stands for a quality indicator of the occurrence values and is expressed between 0 and 13.

Figure 5-5 shows the snow condition product for the first week of January and Figure 5-6 gives a closer illustration of the same 7d composite for a region of the Western Europe centred on France.

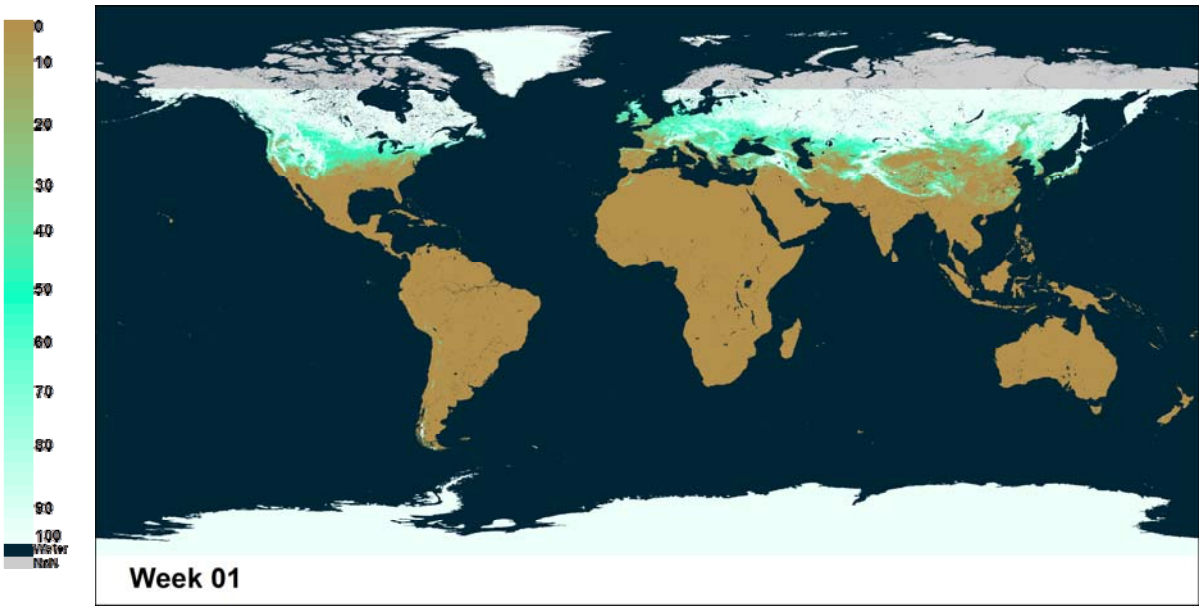


Figure 5-5: Global percentage of snow occurrence of the 1st week of January. Optical data are no longer available at latitudes above 68°N due to the absence of solar illumination (grey pixels).

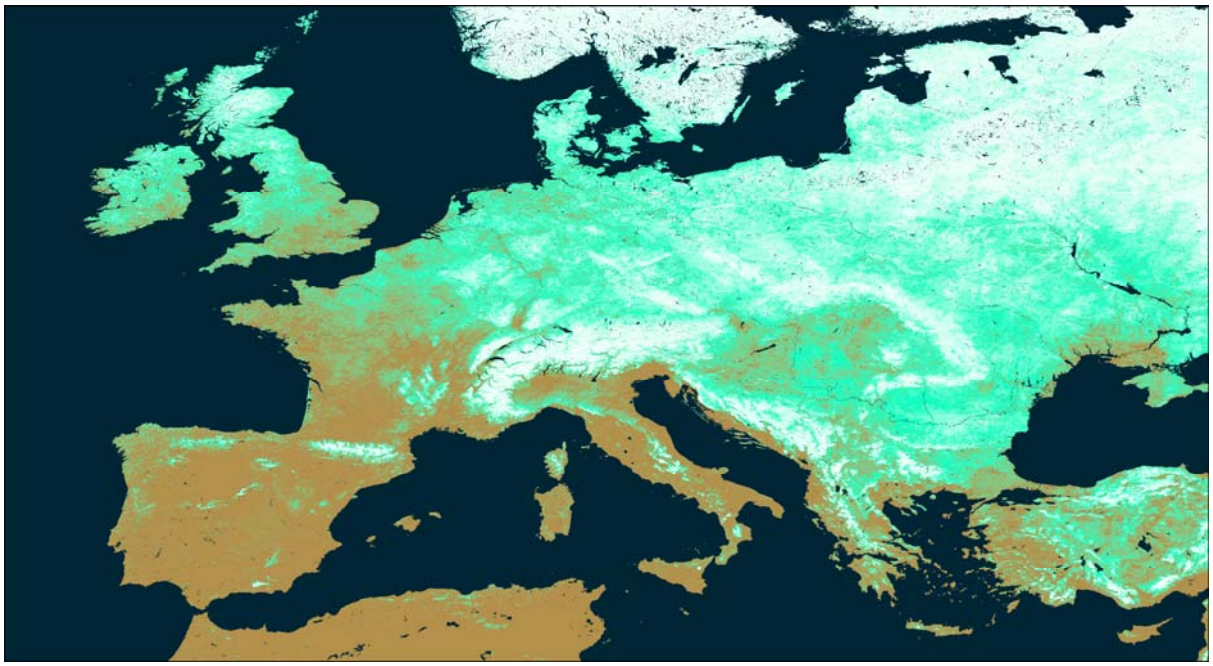


Figure 5-6: Detail of the percentage of snow occurrence of the 1st week of January over Western Europe. The legend is identical as in Figure 5-5.

5.2 Compliance between LC-condition products

As the condition products are built from various independent data sources, attention was paid to ensure compliance in terms of spatial coverage, coastline delineation and presence of glaciers.

The spatial coverage was forced to true global for all condition products and LC maps so that the extent is identical for all CCI-LC products.

Standardized coastline delineation was ensured by superimposing the CCI-LC WB product. The percentages of BA and snow occurrences were forced to 0 under the water mask while the status of the NDVI condition was set to water (value 2). The value of the NDVI itself was set to NoData.

Finally, the glaciers from the Randolph Glacier Inventory [RD-15] and the Antarctic coastline from the Scientific Committee on Antarctic Research Antarctic Digital Database [RD-25] were used to set the percentage of BA occurrence to zero, the percentage of snow occurrence to 100%, the status of the NDVI to “filled ice” (value 5) and the value of the NDVI itself to NoData.

5.3 Products evaluation

The potentialities for the NDVI condition were highlighted in the contexts of cropland diversity (intensity of agricultural practices, crop cycles), thematically close land cover classes diversity (bare areas, grassland and shrubland), vegetation seasonalities and leaf types. Similarly, the use of the snow and BA condition products enables the enrichment of the land surface description, thanks to their ability to discriminate various fire and snow regimes.

An analysis of discrepancy was carried out between pairs of condition products: BA against snow, BA against NDVI and snow against NDVI. It showed that, although based on independent sensors, various spatio-temporal resolutions and algorithms, in all cases, few discrepancies were observed on

average: less than 1% of the burned surface, 2% of the burned surface and 3% of the snow covered surface for the respective above-mentioned 3 pairs. These products can therefore be used together to further describe the land surface in a consistent manner and there is no known evidence against using them in climate modelling.

Yet, it shall be mentioned that the reliability of the products is spatially variable and dependant on the number of valid and cloud-free weekly composites which is to be used as a quality indicator. The lowest numbers of valid and cloud-free observations are found over the western coast of central Africa and extreme latitudes.

One of the drawbacks with using optical time series for global mapping is the inconsistency of the valid coverage along the year. Data are missing over high latitudes during winter time when there is no solar illumination.

The lack of validation and uncertainty estimates is also a limitation.

5.4 Products format

5.4.1 NDVI condition

- **Science dataset**

The global NDVI condition characterizing the 1999-2012 epoch includes 4 series of measurements distributed in the form of 52* 7-day layers for a total compressed data volume of 30 GB. Two of the series represent variables describing the yearly reference dynamic of the vegetation greenness and its inter-annual variation: the smoothed averaged NDVI and the standard deviation. The other two layers are the number of valid and cloud-free weekly composites and the status of the pixel. Each layer has a spatial resolution of 1km and a LAT/LONG WGS84 projection (see section 3.2 for a complete description). Table 5-2 summarizes the description of each 52* 7-day layers in terms of variable description, valid values range, scaling factor, NaN value and pixel depth.

Table 5-2: The description of the 4 series layers included in the global NDVI condition product.

NDVI Condition Series	Description	Valid values Range	Scaling Factor	NaN value	Pixel depth
AggMean	Smoothed NDVI values corresponding to the averaged NDVI over the 1999-2012 period. It gives the yearly reference dynamic of the vegetation greenness at a 7-day frequency.	[-10000 to 10000]	0.0001	32767	Int16
Std	Standard deviation of the averaged NDVI over the 1999-2012 period. It represents the inter-annual variability of the average NDVI for each 7-day period.	[0 to 10000]	0.0001	32767	Int16
NYearObs	Number of valid and cloud-free weekly composites contributing to each 7-day period of the AggMean and Std series. It is a quality indicator of the average and std estimates.	[0 to 14]	None	None	Int16
Status	Status of the pixel; 0: invalid, 1 : land , 2 : water , 3 : snow, 4 : cloud , 5 : filled ice	[0 to 5]	None	0	Int16

- ## Naming convention

All files are delivered at the global extent in GTiff and netcdf format. The file name convention of the global LC condition products is as generic as possible. All condition products follow this structure:

File name = ESACCI-<CCI Project>-<Processing Level>-<Data Type>-<Product String>[-<Additional Segregator>]- <IndicativeDate>[<Indicative Time>]-v<File version>.tif/nc

The dash "-" is the separator between name components. They are defined in Table 5-3.

Table 5-3: Naming convention in the NDVI condition filenames.

Field	Signification	Value
project	Project Acronym	ESACCI-LC (constant)
level	Processing level	L4 (constant)
Data type	Data identifier for the LC conditions	NDVI-Cond
Product String	Product identifier for CCI-LC products	AggMean, Std, Status, NYearObs
spat res	Spatial resolution	1000m
Period+temporal res.	Multi-year period of the product defined by the number of years + Temporal resolution of the product	P14Y7D
epoch	Multi-year epoch of the product, defined by the start and end years	[YYYY-YYYY] where the two "YYYY" are the first year and the last year of the period. This field is 1999-2012 for the NDVI Condition product.
date	Start date of the compositing period	[yyyymmdd] where "yyyy" is the starting year of the epoch, "mm" is the month and "dd" is the day
version	Incremental that follows the successive revisions of the CCI-LC Processing lines	Version of product, major-minor

An example file name of the global LC condition product related to the 1999-2012 NDVI standard deviation variable between the 1st to 7th January would be: "ESACCI-LC-L4-NDVI-Cond-Std-1000m-P14Y7D-1999-2012-19990101-v2.0.tif".

- ## Metadata

The following attributes are included in all 4 series of products (AggOcc, Std, NYearObs and Status). Fields named "Files", "Data set", "Description", "Scaling factor" and "Valid values range" vary according to the layer of interest. The following metadata concerning the NDVI status layer is proposed as an example.

```
Driver: GTiff/GeoTIFF
Files: ESACCI-LC-L4-NDVI-Cond-Status-1000m-P14Y7D-1999-2012-19990709-v2.0.tif
Size is 40320, 20160
Coordinate System is:
GEOGCS["WGS 84",
    DATUM["WGS_1984",
        SPHEROID["WGS 84",6378137,298.257223563,
            AUTHORITY["EPSG","7030"]],
```

```
        AUTHORITY["EPSG","6326"]],
    PRIMEM["Greenwich",0],
    UNIT["degree",0.0174532925199433],
    AUTHORITY["EPSG","4326"]]
Origin = (-180.000000000000000,90.000000000000000)
Pixel Size = (0.008928571400000,-0.008928571400000)
Metadata:
   Compositing period =7 days
   Copyright =ESA / ESA CCI Land Cover Project, led by UCL-Geomatics (Belgium)
   Data Set =Normalized Vegetation Index (NDVI) - Status
   Description =Status of the pixel; 1 : land , 2 : water , 3 : snow, 4 : cloud , 5
: filled ice
   NaN value =0
   Scaling Factor       =none
   Sensor =SPOT-VEGETATION
   Temporal coverage =1999 - 2012
   Valid values range =1 to 5
  AREA_OR_POINT=Area
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  (-180.0000000,  90.0000000) (180d 0' 0.00"W, 90d 0' 0.00"N)
Lower Left  (-180.0000000, -89.9999994) (180d 0' 0.00"W, 90d 0' 0.00"S)
Upper Right ( 179.9999988,  90.0000000) (180d 0' 0.00"E, 90d 0' 0.00"N)
Lower Right ( 179.9999988, -89.9999994) (180d 0' 0.00"E, 90d 0' 0.00"S)
Center      (  -0.0000006,   0.0000003) (  0d 0' 0.00"W,  0d 0' 0.00"N)
Band 1 Block=256x256 Type=Int16, ColorInterp=Gray
```

5.4.2 BA condition

The global BA condition characterizing the 2000-2012 epoch includes 2 series of 52* 7-day layers for a compressed volume of 5 GB. The first series represents the yearly reference behaviour of the burned areas occurrence. The second series corresponds, on a 7-day basis, to the number of valid and cloud-free weekly composites contributing to each 7-day period. Each layer has a spatial resolution of 500m and a LAT/LONG WGS84 projection (see section 3.2 for a complete description).

- **Science data sets**

Table 5-4 gives a description summary of each 52* 7-day layers in terms of variable description, valid values range, scaling factor, NaN value and pixel depth.

Table 5-4: The description of the 2 series layers included in the global BA condition product.

BA Condition Series	Description	Valid values Range	Scaling Factor	NaN value	Pixel depth
AggOcc	Percentage of burned areas occurrence as detected over the 2000-2012 period on a 7-day basis. This describes the reference behaviour of the burned areas dynamic at a 7-day frequency.	[0 to 100]	None	255	Byte
NYearObs	Number of valid and cloud-free weekly composites contributing to each 7-day period of the AggOcc series. It is a quality indicator of the occurrence values.	[0 to 13]	None	255	Byte

- **Naming convention**

All files are delivered at the global extent in GTiff and netcdf format. The file name convention of the global LC condition products is as generic as possible. All condition products follow this structure:

File name = ESACCI-<CCI Project>-<Processing Level>-<Data Type>-<Product String>[-<Additional Segregator>]- <IndicativeDate>[<Indicative Time>]-v<File version>.tif/nc

The dash "-" is the separator between name components. They are defined in Table 5-5.

Table 5-5: Naming convention in the BA condition filenames.

Field	Signification	Value
project	Project Acronym	ESACCI-LC (constant)
level	Processing level	L4 (constant)
Data type	Data identifier for the LC conditions	BA-Cond
Product String	Product identifier for CCI-LC products	AggOcc, NYearObs
spat res	Spatial resolution	500m
Period + temporal res.	Multi-year period of the product defined by the number of years + Temporal resolution of the product	P13Y7D
epoch	Multi-year epoch of the product, defined by the start and end years	[YYYY-YYYY] where the two “YYYY” are the first year and the last year of the period. This field is 2000-2012 for this product.
date	Start date of the compositing period	[yyyymmdd] where “yyyy” is the starting year of the epoch, “mm” is the month and “dd” is the day
version	Incremental that follows the successive revisions of the CCI-LC Processing lines	Version of product, major-minor

An example file name of the global LC condition product related to the 2000-2012 BA aggregated occurrence variable for the last week of the year would be: “ESACCI-LC-L4-BA-Cond-AggOcc-500m-P13Y7D-2000-2012-20000101-v2.0.tif”.

- **Metadata**

The following attributes are included in all 2 series of products (AggOcc and NYearObs). Fields named “Files”, “Data set”, “Description”, “Scaling factor” and “Valid values range” vary according to

the layer of interest. The following metadata concerning the BA AggOcc layer is proposed as an example.

```
Driver: GTiff/GeoTIFF
Files: ESACCI-LC-L4-BA-Cond-AggOcc-500m-P13Y7D-2000-2012-20000226-v2.0.tif
Size is 86400, 43200
Coordinate System is:
GEOGCS["WGS 84",
    DATUM["WGS_1984",
        SPHEROID["WGS 84",6378137,298.257223563,
            AUTHORITY["EPSG","7030"]],
        AUTHORITY["EPSG","6326"]],
    PRIMEM["Greenwich",0],
    UNIT["degree",0.0174532925199433],
    AUTHORITY["EPSG","4326"]]
Origin = (-180.000000000000000,90.000000000000000)
Pixel Size = (0.004166666666555,-0.004166666666555)
Metadata:
   Compositing period =7 days
   Copyright =ESA / ESA CCI Land Cover Project, led by UCL-Geomatics (Belgium)
   Data Set =BA - AggOcc
   Description =Proportion of Burned Areas occurrence, in percent, derived over
multiple years on a 7-day basis
   NaN value (Water) =254
   NaN value =255
   Scaling Factor =none
   Sensor =MODIS
   Temporal coverage =2000 - 2012
   Temporal resolution =7 days
   Valid values range =0 to 100
  AREA_OR_POINT=Area
  Preprocessing =monthly product week extraction/ Post-processing: smoothing based
on 4 weeks
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  (-180.0000000,  90.0000000) (180d 0' 0.00"W, 90d 0' 0.00"N)
```

```
Lower Left  (-180.0000000, -90.0000000) (180d 0' 0.00"W, 90d 0' 0.00"S)
Upper Right ( 180.0000000,  90.0000000) (180d 0' 0.00"E, 90d 0' 0.00"N)
Lower Right ( 180.0000000, -90.0000000) (180d 0' 0.00"E, 90d 0' 0.00"S)
Center      (  -0.0000000,   0.0000000) (  0d 0' 0.00"W,  0d 0' 0.00"N)
Band 1 Block=256x256 Type=Byte, ColorInterp=Gray
```

5.4.3 Snow condition

The global snow condition characterizing the 2000-2012 epoch includes 2 series of 52* 7-day layers for a compressed data volume of 8 GB. The first series represents the yearly reference percentage of snow occurrence. The second series corresponds, on a 7-day basis, to the number of valid and cloud-free weekly composites. Each layer has a spatial resolution of 500m and a LAT/LONG WGS84 projection (see section 3.2 for a complete description).

- **Science data set**

Table 5-6 gives a description summary of each 52* 7-day layers in terms of variable description, valid values range, scaling factor, NaN value and pixel depth.

Table 5-6: Description of the 2 series layers included in the global snow condition product.

Snow Condition Series	Description	Valid values Range	Scaling Factor	NaN value	Pixel depth
AggOcc	Proportion of snow occurrence as detected over the 2000-2012 period on a 7-day basis (ranging from 0 to 100). This describes the yearly reference dynamic of the snow coverage at a 7-day frequency	[0 to 100]	None	255	Byte
NYearObs	Number of valid and cloud-free weekly composites contributing to each 7-day period of the AggOcc series. This is a quality indicator of the occurrence values	[0 to 13]	None	255	Byte

- **Naming convention**

All files are delivered at the global extent in GTiff and netcdf format. The file name convention of the global LC condition products is as generic as possible. All condition products follow this structure:

File name = ESACCI-<CCI Project>-<Processing Level>-<Data Type>-<Product String>[-<Additional Segregator>]- <IndicativeDate>[<Indicative Time>]-v<File version>.tif/nc

The dash "-" is the separator between name components. They are defined in Table 5-7.

Table 5-7: Naming convention in the snow condition filenames.

Field	Signification	Value
project	Project Acronym	ESACCI-LC (constant)
level	Processing level	L4 (constant)
Data type	Data identifier for the LC conditions	Snow-Cond
Product String	Product identifier for CCI-LC products	AggOcc, NYearObs

spat res	Spatial resolution	500m
Period+temporal res.	Multi-year period of the product defined by the number of years + Temporal resolution of the product	P13Y7D
epoch	Multi-year epoch of the product, defined by the start and end years	[YYYY-YYYY] where the two "YYYY" are the first year and the last year of the period. This field is 2000-2012 for this product.
date	Start date of the compositing period	[yyyymmdd] where "yyyy" is the starting year of the epoch, "mm" is the month and "dd" is the day
version	Incremental that follows the successive revisions of the CCI-LC Processing lines	Version of product, major-minor

An example file name of the global LC condition product related to the 2000-2012 Snow aggregated occurrence variable for the last week of the year would be: "ESACCI-LC-L4-Snow-Cond-AggOcc-500m-P13Y7D-2000-2012-20000101-v2.0.tif".

- **Metadata**

The following attributes are included in all 2 series of products (AggOcc and NYearObs). Fields named "Files", "Data set", "Description", "Scaling factor" and "Valid values range" vary according to the layer of interest. The following metadata concerning the snow NYearObs layer is proposed as an example.

```
Driver: GTiff/GeoTIFF
Files: ESACCI-LC-L4-Snow-Cond-NYearObs-500m-P13Y7D-2000-2012-20001224-v2.0.tif
Size is 86400, 43200
Coordinate System is:
GEOGCS["WGS 84",
    DATUM["WGS_1984",
        SPHEROID["WGS 84",6378137,298.257223563,
            AUTHORITY["EPSG","7030"]],
        AUTHORITY["EPSG","6326"]],
    PRIMEM["Greenwich",0],
    UNIT["degree",0.0174532925199433],
    AUTHORITY["EPSG","4326"]]
Origin = (-180.000000000000000,90.000000000000000)
Pixel Size = (0.004166666666555,-0.004166666666555)
Metadata:
   Compositing period =7 days
   Copyright =ESA / ESA CCI Land Cover Project, led by UCL-Geomatics (Belgium)
   Data Set =Snow - NYearObs
   Description =Number of valid year observations contributing to the Snow
Condition product
   NaN value =255
```

```
   Scaling Factor =none
   Sensor =MODIS
   Temporal coverage =2000 - 2012
   Valid values range =0 to 13
  AREA_OR_POINT=Area
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  (-180.0000000,  90.0000000) (180d 0' 0.00"W, 90d 0' 0.00"N)
Lower Left  (-180.0000000, -90.0000000) (180d 0' 0.00"W, 90d 0' 0.00"S)
Upper Right ( 180.0000000,  90.0000000) (180d 0' 0.00"E, 90d 0' 0.00"N)
Lower Right ( 180.0000000, -90.0000000) (180d 0' 0.00"E, 90d 0' 0.00"S)
Center      (  -0.0000000,   0.0000000) (  0d 0' 0.00"W,  0d 0' 0.00"N)
Band 1 Block=256x256 Type=Byte, ColorInterp=Gray
```

6 WATER BODIES PRODUCT

6.1 Product description

The CCI-LC WB gives the repartition of open and permanent water bodies (inland water and oceans) at 300m spatial resolution and at global scale. It is the result of a land/water classification based on Synthetic Aperture Radar (SAR) data, combined with the Shuttle Radar Topography Mission (SRTM) Water Body data (SWBD) and MERIS data.

The land/water classification is derived from multi-temporal metrics based on time series of the backscattered intensity recorded by the ASAR instrument onboard the ENVISAT satellite between 2005 and 2010 (occasionally up to 2012 to avoid data voids). The main source of ASAR imagery is the Wide Swath Mode (WSM) at 150m spatial resolution. As the quantity of WSM was insufficient in some places, imagery in Image Mode Medium (IMM) at 75m and Global Monitoring Mode (GMM) at 500m was used in complement. The methodology to build the CCI-LC WB is fully described in [AD-12].

Figure 6-1 and Figure 6-2 illustrate the CCI-LC WB product at global and regional scales, respectively.

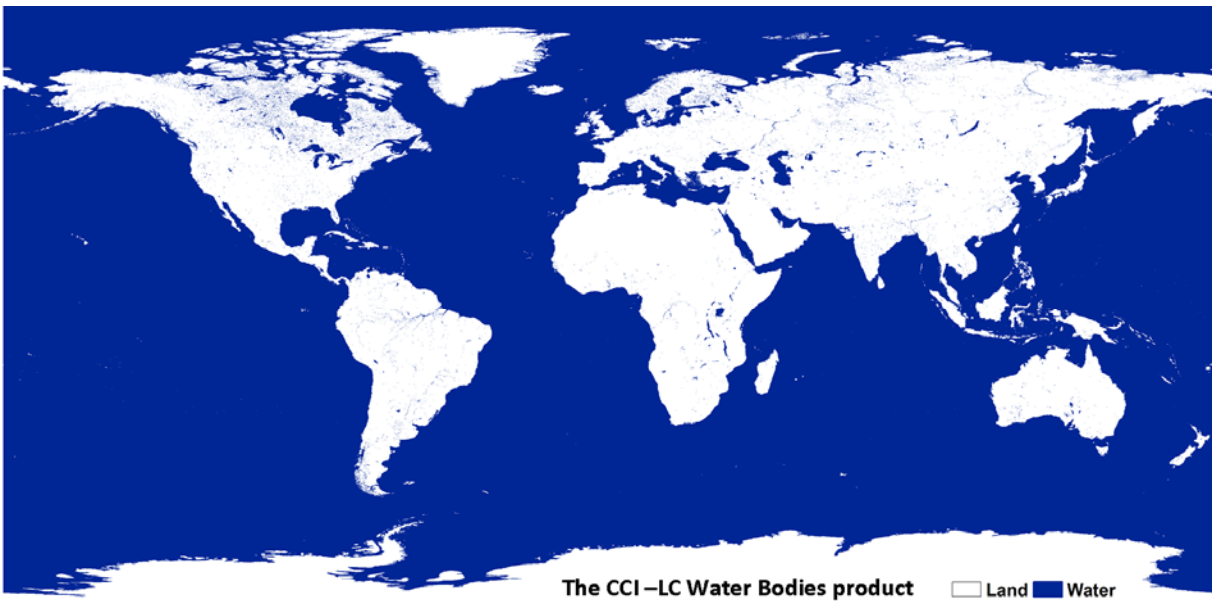


Figure 6-1: Illustration of the CCI-LC Water Bodies product.

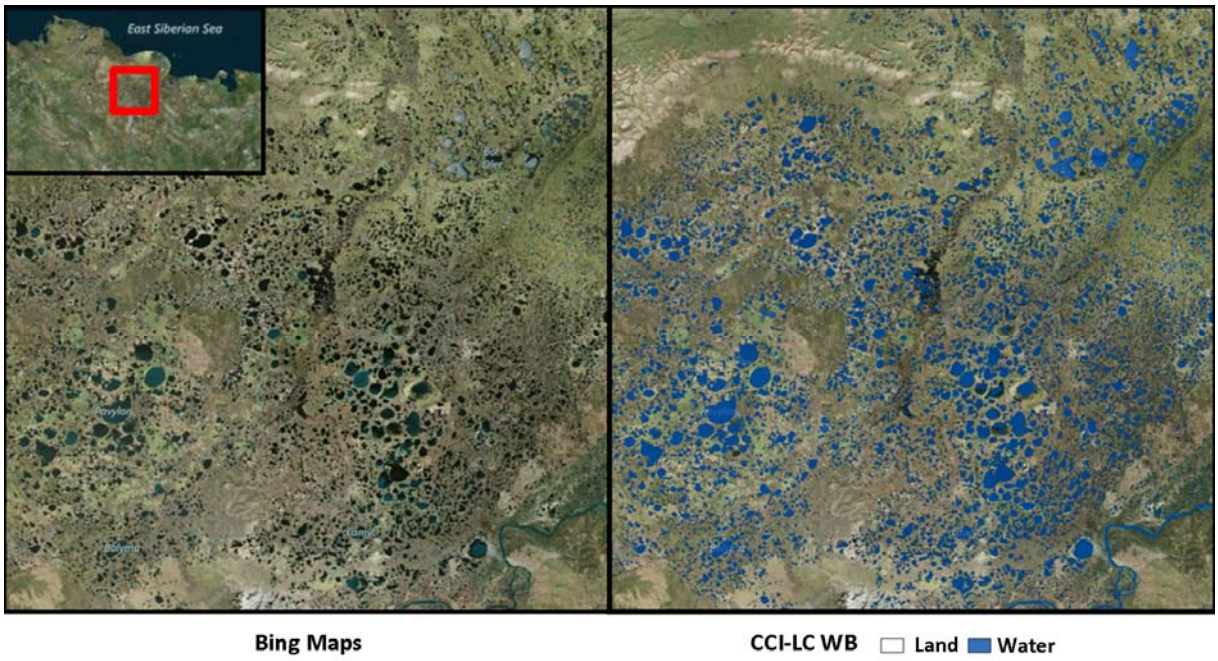


Figure 6-2: The high density of SAR data (> 60°N) used in the CCI-LC Water Bodies allows classifying water bodies with high quality as shown by this example over a regional subset in Russia.

6.2 Algorithm and product evaluation

6.2.1 Methodology

A specific analysis has been carried out to evaluate the performance of the developed classification algorithm and hence, the quality of the product. Yet, this analysis cannot be considered as a validation stricto sensus since it gave more emphasis on areas that are known to be difficult to map.

The methodology includes three different steps: elaborating the sampling strategy, building a reference database and assessing the product accuracy.

6.2.1.1 Sampling strategy

Large parts of the Earth's surface are either large permanent water bodies (oceans, large lakes) or land areas where water bodies are absent. The water classification algorithm gives correct and unambiguous results in those areas, which would therefore lead to a very high overall accuracy. As the objective of this validation scheme was to evaluate the performances of the water bodies product in areas where errors are most expected (shorelines, sand dunes, ice-covered regions, etc.), a stratified random sampling is used.

2300 points were randomly selected according to 3 criteria: (i) vicinity of land/water borders according to the GlobCover 2009 [RD-4] and MODIS Water Mask product (MOD44W) [RD-22], (ii) equal intervals of 45 degrees of latitude and (iii) desert or inland ice-covered regions. Figure 6-3 illustrates the spatial repartition of the 2300 points resulting from this stratified random sampling. The detailed description of the sampling methodology is described in [AD-14].

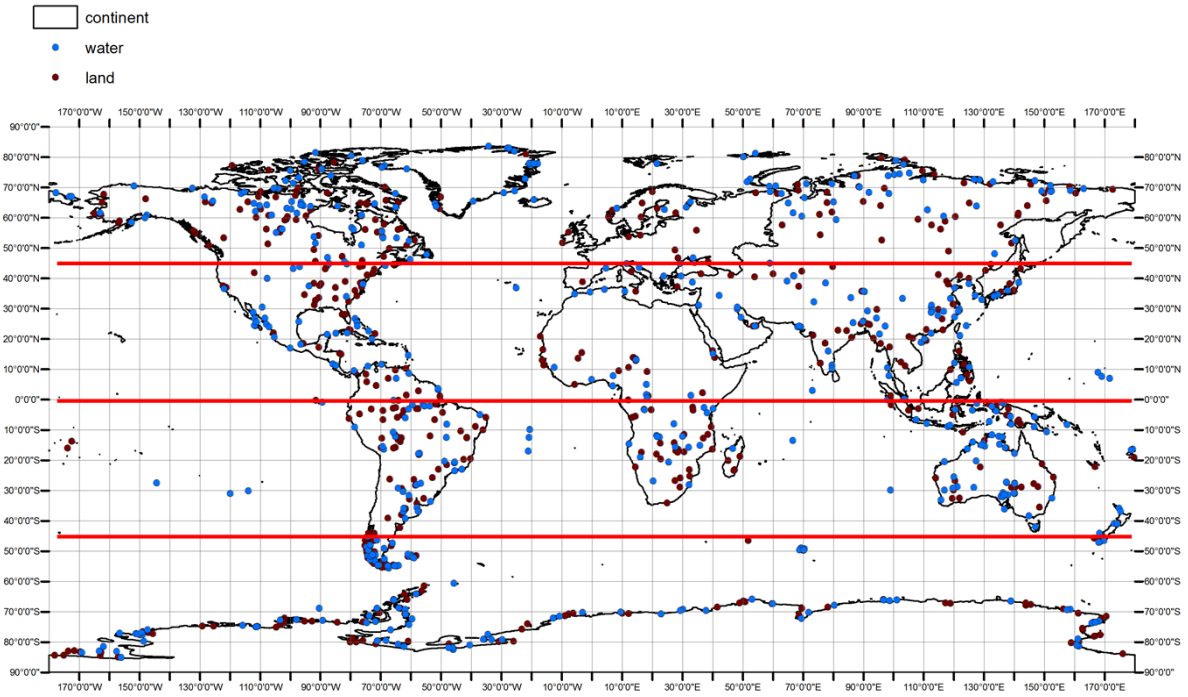


Figure 6-3: Final set of point locations: the red lines indicate the subdivision in 4 zones according to latitude.

6.2.1.2 Reference dataset collection

Based on the location of the selected sampling points, polygons corresponding to the 300m footprint of the CCI-LC WB product were generated. These polygons footprints were overlaid over the high resolution satellite data of Google Earth and labelled as “land”, “water” or “unknown” after interpretation of the imagery. Google Earth allowed a rapid access to recent remote sensing images with high zooming capabilities. In addition, the expert could also support his work using any additional sources of information such as the historic toolbar, pictures or so. The timescale option permitted reinforcing the capacity to evaluate the permanency of the observed water bodies. Indications on the permanency and the date of detection were also recorded in the database. Figure 6-4 shows an example of the interface used to evaluate the footprint label.

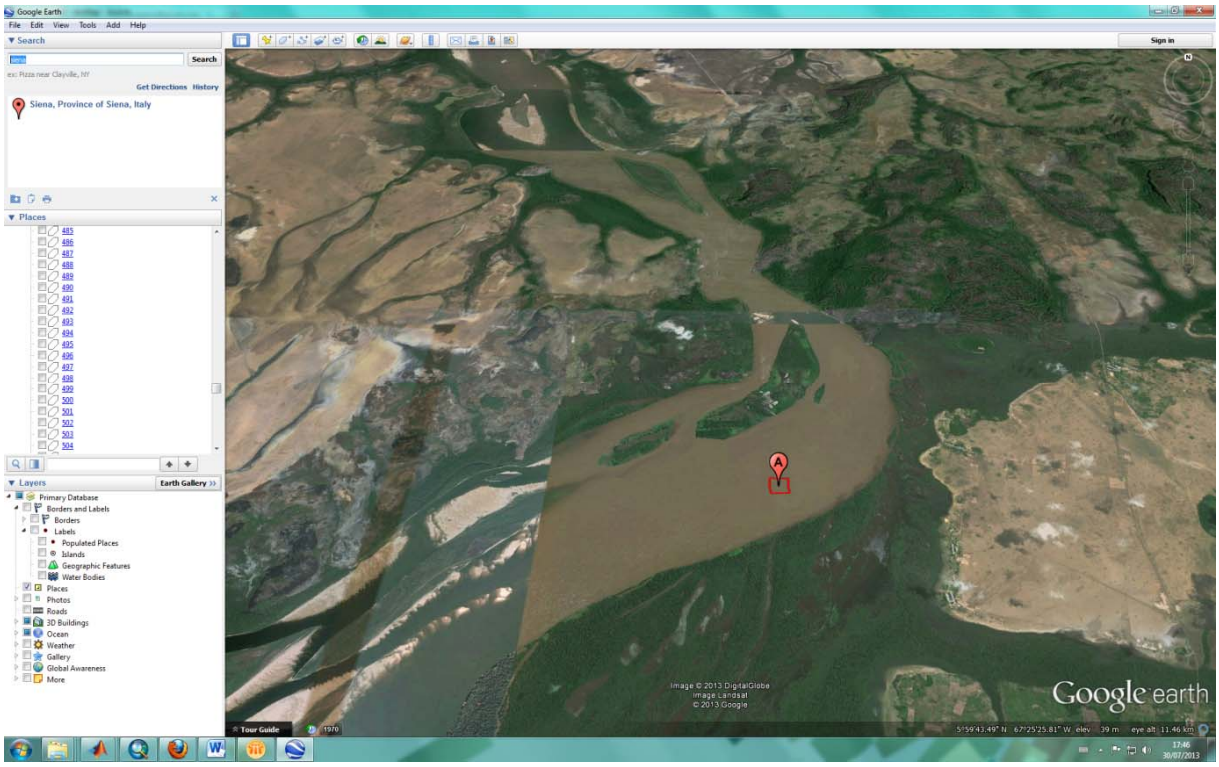


Figure 6-4: Example of the construction of the reference dataset collection. Polygons corresponding to footprints of the CCI-LC WB product are overlaid in Google Earth and labelled as "land", "water" or "unknown" according to visual interpretation of the high resolution imagery.

6.2.2 Results

From the 2300 footprints of the reference database, 811 were removed for the following reasons: the footprints location fell in unprocessed areas of the WB product or in areas were manual refinements were applied; when the footprints could not been interpreted in Google Earth. The reference data set, including the remaining 1844 footprints, was then compared to the CCI-LC WB product in order to build a confusion matrix.

The overall, the producer's and user's accuracies are presented in Table 6-1. All figures show high accuracies and the overall accuracy reaches 96%. Under-detection of water is more frequent than over-detection.

Table 6-1: Contingency matrix built on the comparison between the reference dataset of 1844 footprints and the CCI-LC WB product.

		REFERENCE DATASET			
		NO WATER	WATER	SUM	USER ACCURACY
CCI-LC WB PRODUCT	NO WATER	1089	66	1155	94%
	WATER	12	677	689	98%
	SUM	1101	743	1844	
	PRODUCER ACCURACY	99%	91 %		96 %

6.3 Product format

- **Science dataset**

The product consists of 3 layers: the classification between permanent water and land, the number of WSM + IMM observations and the number of GMM. Each layer has a LAT/LONG WGS84 projection. Table 6-2 gives a summary of the layers currently included in the CCI-LC WB product in terms of variable description, valid values range, units, fill value and pixel depth.

Table 6-2: The description of the layers included in the CCI-LC WB product.

Layer Names	Description	Valid values Range	Units	Fill value	Pixel depth
Map	Land/permanent water classification at 300m spatial resolution. Legend : 1-Land, 2-Water	[1 to 2]	None	None	Byte
NObsImsWS	Number of observations originating from the ASAR WSM + IMM imagery	[0 to 65535]	None	65535	Int16
NObsImsGM	Number of observations originating from the ASAR global monitoring mode imagery	[0 to 65535]	None	65535	Int16

- **Naming convention**

All layers are delivered at the global extent in GTiff format. The file name convention is as generic as possible and follows this structure:

File name = <type>-v<revision>.(tif/netcdf) **where <type>** =

<project>-<level>-<code>-<var>-<spat res>- <period+ temporal res.>-< epoch>

The dash "-" is the separator between name components. They are defined in Table 6-3.

Table 6-3: Naming convention in the CCI-LC WB dataset.

Field	Signification	Value
project	Project Acronym	ESACCI-LC (constant)
level	Processing level	L4 (constant)
code	Product code identifier for CCI-LC products	WB (constant)
var	Variable code identifier for the LC conditions	Variable name of the product. It could be: Map or NObsImsWS or NObsImsGM
spat res	Spatial resolution	300m
period+ temporal res.	Multi-year period of the product defined by the number of years + Temporal resolution of the product	P6Y
epoch	Multi-year epoch of the product, defined by the start and end years	[YYYY-YYYY] where the two “YYYY” are the first year and the last year of the period. This field is 2005-2010 for this product.
version	Incremental that follows the successive revisions of the CCI-LC Processing lines	Version of product, preferably major-minor , optionally with processing centre [a-zA-Z0-9._]*

An example file name of the number of valid observations in global monitoring mode is: ESACCI-LC-L4-WB-NObsImsGM-300m-P6Y-2005-2010-v2.0.tif

- **Metadata**

The following attributes are included in the layers of the product. The metadata of the WB-Map layer is proposed as an example.

```
Driver: GTiff/GeoTIFF
Size is 129600, 64800
Coordinate System is:
GEOGCS["WGS 84",
    DATUM["WGS_1984",
        SPHEROID["WGS 84",6378137,298.257223563,
            AUTHORITY["EPSG","7030"]],
        AUTHORITY["EPSG","6326"]],
    PRIMEM["Greenwich",0],
    UNIT["degree",0.0174532925199433],
    AUTHORITY["EPSG","4326"]]
Origin = (-180.000000000000000,90.000000000000000)
Pixel Size = (0.002777777700000,-0.002777777700000)
Metadata:
  AREA_OR_POINT=Area
  Copyright =ESA / ESA CCI Land Cover Project, led by UCL-Geomatics (Belgium)
  Dataset =Global Water Body Data Set from ENVISAT ASAR Data
  Description =Water classification; 1: Other , 2: Water
  Scaling Factor =none
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  (-180.0000000,  90.0000000) (180d 0' 0.00"W, 90d 0' 0.00"N)
Lower Left  (-180.0000000, -89.9999950) (180d 0' 0.00"W, 89d59'59.98"S)
Upper Right ( 179.9999899,  90.0000000) (179d59'59.96"E, 90d 0' 0.00"N)
Lower Right ( 179.9999899, -89.9999950) (179d59'59.96"E, 89d59'59.98"S)
Center      (  -0.0000050,   0.0000025) (  0d 0' 0.02"W,  0d 0' 0.01"N)
Band 1 Block=256x256 Type=Byte, ColorInterp=Gray
```

7 SOFTWARE TOOLS

A set of tools to browse and view the content of the CCI-LC products are available.

7.1 Software tools for viewing and using the CCI-LC SR 7-day composite products

7.1.1 BEAM

Since the CCI-LC SR 7-day products are in NetCDF format, these products can be opened with all NetCDF compatible software packages. We particularly recommend using the BEAM toolbox, which is specifically developed by ESA for the exploitation of EO data products. BEAM, for example, features the interpretation of flag-codings, provides image interpretation information, handles missing data gracefully and allows band arithmetic using a fast expression language.

BEAM is the Basic European Remote Sensing Satellite (ERS) & Envisat (Advanced) Along Track Scanning Radiometer ((A)ATSR) and MERIS Toolbox and is a collection of executable tools and an Application Programming Interface (API) which have been developed to facilitate the use, viewing and processing of data of various sensors. Furthermore, BEAM is open source and freely available from http://earth.esa.int/beam.

Regarding the CCI-LC products, BEAM could for example be used to:

- view the images and metadata;
- create regional subsets;
- investigate the products by creating statistics, histograms, and scatter plots;
- perform image analysis (e.g. clustering);
- validate data by comparison with in-situ or any other kind of reference data.

The components of the BEAM software are the following ones:

- VISAT - An intuitive desktop application to be used for visualization, analysis and processing of remote sensing raster data. Figure 7-1 gives an impression of how VISAT looks and feels like;
- A set of scientific tools running either from the command line or invoked by VISAT, also entirely written in Java;
- A rich Java API for the development of new remote sensing applications and BEAM extension plug-ins.

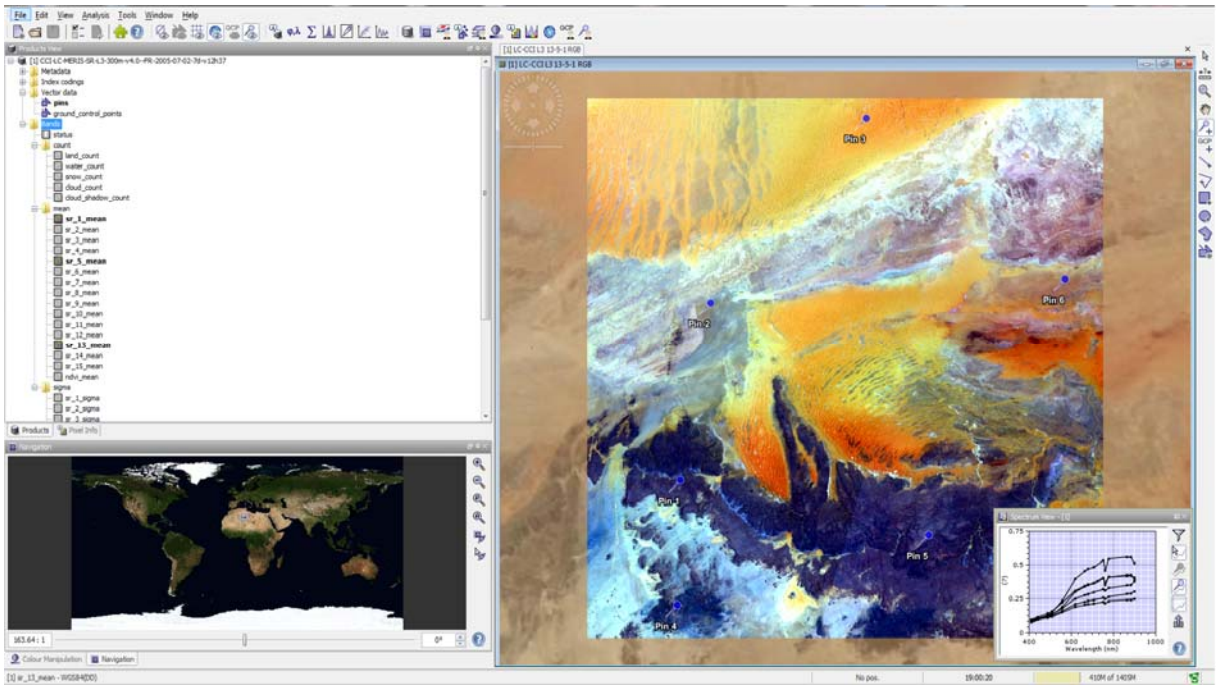


Figure 7-1: Screenshot of VISAT

7.1.2 Panoply

The Panoply data viewer provided by for free (available at http://www.giss.nasa.gov/tools/panoply/) can also be used. It is illustrated at Figure 7-2.

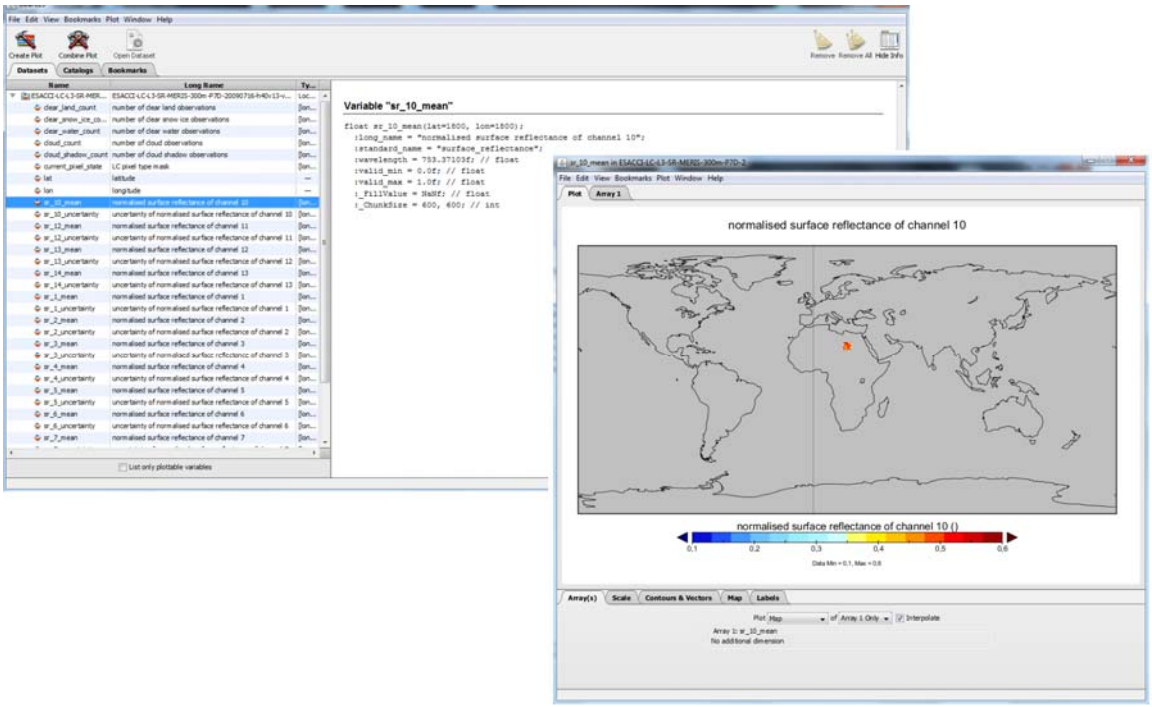


Figure 7-2: Screenshot of Panoply

7.2 Software tools for the CCI-LC map and condition products

The CCI-LC map and conditions product are delivered both in the NetCDF and GeoTiff formats.

The GeoTiff format is supported by many softwares such as ArcGIS, Erdas and ENVI. These softwares can be used simply to visualize the data or to cross LC information with other spatial sources (vector or raster layers), extract temporal series on the condition products, compute statistics, etc.

Several Open Source softwares also support the GeoTiff format, such as the Geospatial Data Abstraction Library (GDAL [RD-23]) and the Geographic Resources Analysis Support System (GRASS GIS [RD-24]).

GDAL is a library for reading and writing raster geospatial data formats. It is built with a variety of useful command-line utilities for data translation and processing. This software allows easy access to the metadata and statistics of the files via the gdalinfo command. Regional subsets can also be created with the gdal_translate function.

GRASS GIS is a free Geographic Information System (GIS) software used for geospatial data management and analysis, image processing, graphics/maps production, spatial modeling, and visualization.

7.3 CCI-LC user tool

The LC map and conditions products are delivered at spatial resolution of 300m (LC maps), 1km (NDVI condition product) and 500m (BA and snow condition product), all as global files in a Plate Carree projection. However, climate models may need products associated with a coarser spatial resolution, over specific areas (e.g. for regional climate models) and/or in another projection. In order to face the variety of requirements, the CCI-LC project has developed a tool that allows users to adjust these three parameters of the LC products in a way which is suitable to their model.

The climate users of the CCI-LC project have established a minimum list of possibilities in terms of spatial resolution and projection that the tool shall - and does - offer. They are presented in Table 7-1.

Table 7-1: Minimum set of projections and spatial resolutions that need to be included in the re-projection, aggregation and subset tool developed by the CCI-LC project

Parameter that can be adjusted	Possibilities offered by the tool
Regional subset ID	Predefined regional subset
	Free specification of regional subset (4 corner coordinates)
Spatial resolution	Original resolution
	0.25 degree
	0.5 degree
	1 degree
	1.875 degree
Projection	Original projection (Plate-Carree)
	Gaussian grid
Conversion of CCI-LC classes to PFT	CCI-LC standard cross table
	User defined cross table

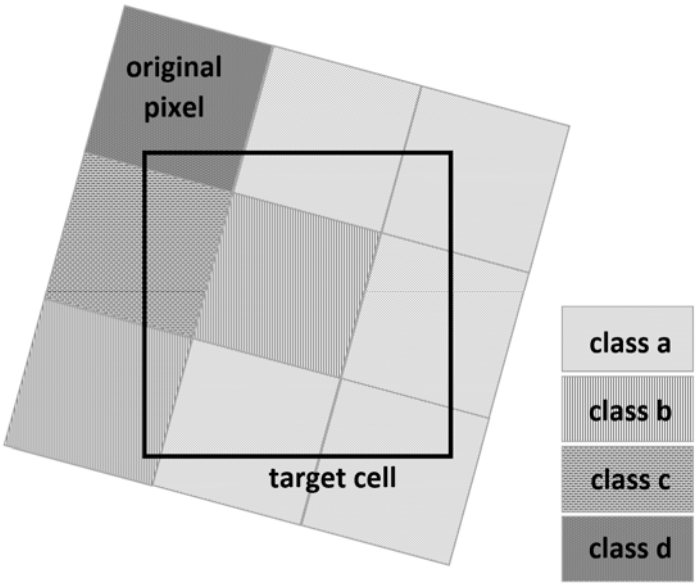
In case of re-projection and aggregation of the CCI-LC products the applied resampling algorithms are different depending on the type of product and on the included bands and are described in the following.

Re-sampling algorithm for the CCI-LC MAP products

The aggregated CCI-LC map product includes following bands: the fractional area of each CCI-LC class, the majority classes and the fractional area of each PFT as well as the accuracy. The majority class n is defined as the CCI-LC class which has the rank n of sorted list of CCI-LC class by fractional area in the target cell (see also Figure 7-3). The number of majority classes is a parameter which can be defined by user. The rules for the resampling are specified in consultation with the users. So each original pixel contributes to the target cell according to its area percentage but the value of a pixel will only consider if the flag -processed flag- has the status processed and the flag -current_pixel_state- has the status clear land, water or snow and ice. Then the accuracy is calculated by the median of the values of the band -algorithmic_confidence_level-.

Re-sampling algorithm for the CCI-LC condition product

In case of the aggregation of the NDVI CCI-LC condition product the mean of NDVI and the sum over all valid NDVI observations are included in the aggregated product. On the other hand, the aggregated burned areas or snow CCI-LC condition product contains 3 different bands: the proportion of area (in %) concerned by a burned area or snow, the average frequency of the burned areas or snow detected over the aggregated zone and the sum over all valid observations of burned areas or snow area. The rules for the resampling are also specified in consultation with the users. As well as for the CCI-LC map products each original pixel contributes to the target cell according to its area percentage but the value of a pixel will only consider if the flag -current_pixel_state- has a dedicated status w.r.t. the type of condition product.



	Area	Majority class
class a	~ 8/16	1
class b	~ 5/16	2
class c	~ 2/16	3
class d	~ 1/16	4

Figure 7-3: Visualization of the pixel aggregation from the spatial resolution of original LC-CCI Map product into the user defined spatial resolution of the aggregated LC-CCI Map product

Furthermore, it is very important that the modellers can use the aggregation tool to apply the conversion from the LC legend to their user-specific PFT list in order to deliver an appropriate PFT product. The conversion of CCI-LC classes to PFT is based on a look-up table, which has been confirmed by the climate modellers and is shown in Table 7-2. The users have the possibility to define their own look-up tables.

ID	CCI LC map description	Tree				Shrub				Grass		Non-vegetated				
		Broadleaf Evergreen	Broadleaf Deciduous	Needleleaf Evergreen	Needleleaf Deciduous	Broadleaf Evergreen	Broadleaf Deciduous	Needleleaf Evergreen	Needleleaf Deciduous	Natural Grass	Managed Grass	Bare soil	Water	Snow/Ice	No data	Total %
0	No data														100	100
10	Cropland, rainfed										100					100
11	Herbaceous cover										100					100
12	Tree or shrub cover										100					100
20	Cropland, irrigated or post-flooding										100					100
30	Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)	5	5			5	5	5		15	60					100
40	Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)	5	5			7.5	10	7.5		25	40					100
50	Tree cover, broadleaved, evergreen, closed to open (>15%)	90				5	5									100
60	Tree cover, broadleaved, deciduous, closed to open (>15%)		70				15			15						100
61	Tree cover, broadleaved, deciduous, closed (>40%)		70				15			15						100
62	Tree cover, broadleaved, deciduous, open (15-40%)		30				25			35		10				100
70	Tree cover, needleleaved, evergreen, closed to open (>15%)			70		5	5	5		15						100
71	Tree cover, needleleaved, evergreen, closed (>40%)			70		5	5	5		15						100
72	Tree cover, needleleaved, evergreen, open (15-40%)			15	15		5	5		30		30				100
80	Tree cover, needleleaved, deciduous, closed to open (>15%)				70				15	15						100
81	Tree cover, needleleaved, deciduous, closed (>40%)				70				15	15						100
82	Tree cover, needleleaved, deciduous, open (15-40%)				30				25	35		10				100
90	Tree cover, mixed leaf type (broadleaved and needleleaved)		30	20	10	5	5	5		15		10				100
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	10	20	5	5	5	10	5		40						100
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	5	10	5		5	10	5		60						100
120	Shrubland					20	20	20		20		20				100
121	Shrubland evergreen					30		30		20		20				100
122	Shrubland deciduous						60			20		20				100
130	Grassland									60		40				100
140	Lichens and mosses									60		40				100
150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	1	3	1		1	3	1		5		85				100
151	Sparse tree (<15%)	2	6	2						5		85				100
152	Sparse shrub (<15%)					2	6	2		5		85				100
153	Sparse herbaceous cover (<15%)									15		85				100
160	Tree cover, flooded, fresh or brakish water	30	30							20			20			100
170	Tree cover, flooded, saline water	60				20							20			100
180	Shrub or herbaceous cover, flooded, fresh/saline/brakish water		5	10			10	5		40			30			100
190	Urban areas		2.5	2.5						15		75	5			100
200	Bare areas											100				100
201	Consolidated bare areas											100				100
202	Unconsolidated bare areas											100				100
210	Water bodies												100			100
220	Permanent snow and ice													100		100

Table 7-2: Look-up table - conversion of CCI-LC classes to PFT

Figure 7-4 gives an example of the global land cover map aggregated at a cell size of 9.8km and the pixel value represents the majority class 1 w.r.t. the LC class, according to Table 4-2.

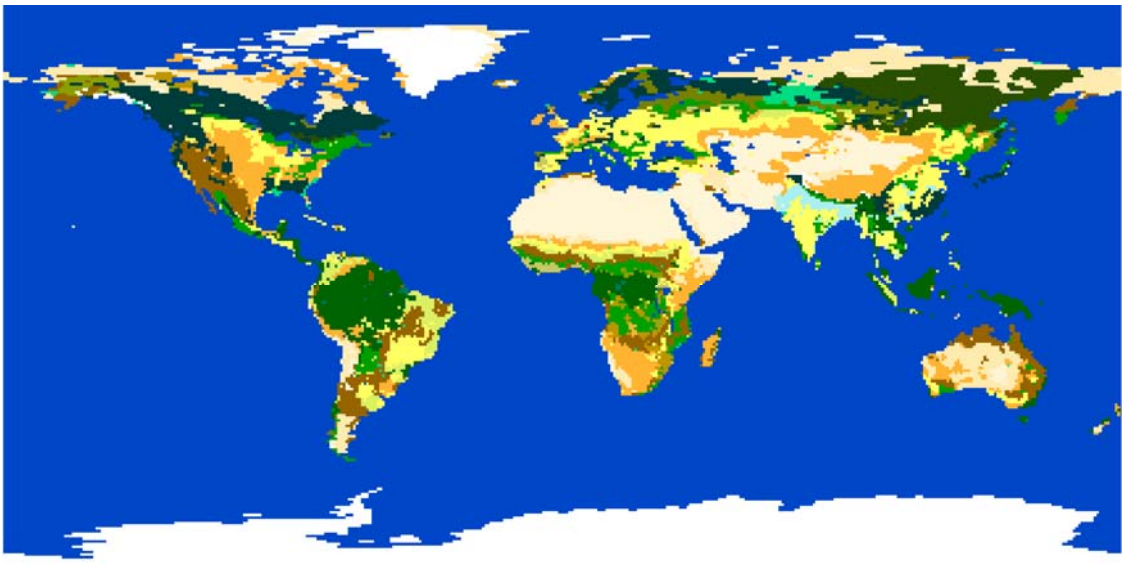


Figure 7-4: Example of an aggregated global land cover map V1 obtained with the aggregation tool. Its pixel size is 9.8 km, the majority class is 1, the pixel value represents the LC class according to Table 7-2

Figure 7-5 shows an example of the global land cover map aggregated at a cell size of 9.8km and the pixel value represents the area of the LC class 130 - grassland. Figure 7-6 gives an example of the global land cover map aggregated at a cell size of 9.8km and the pixel value represents the area of the PFT – natural grass.

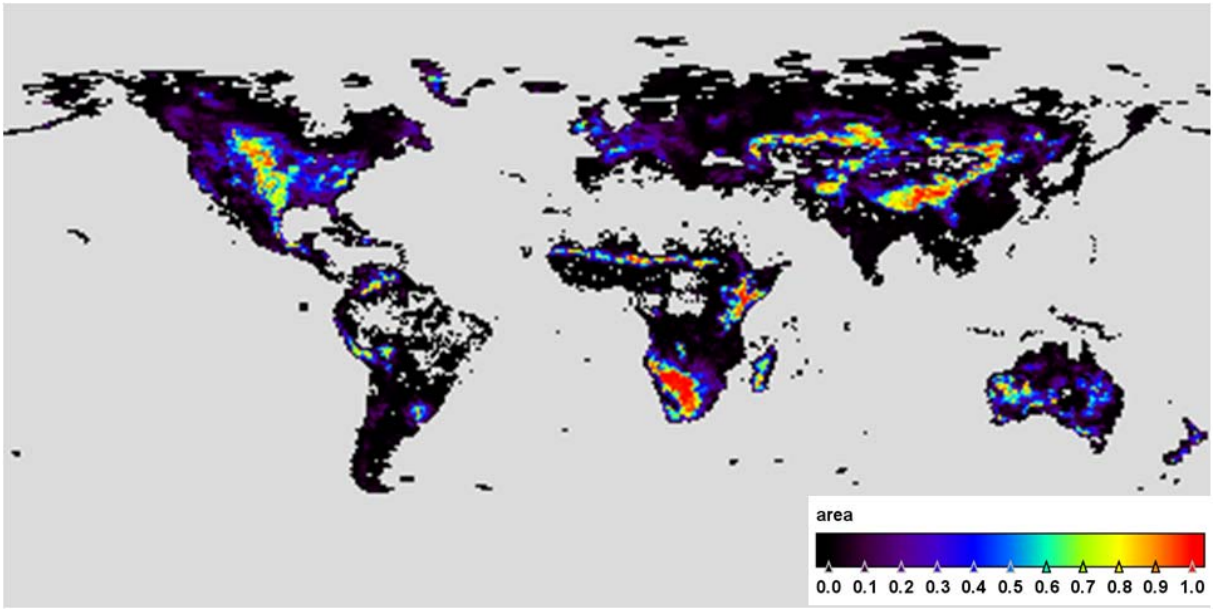


Figure 7-5: Example of an aggregated CCI Global Land Cover Map V1 obtained with the aggregation tool. Its pixel size is 9.8 km, area of CCI-LC class – 130 – grassland

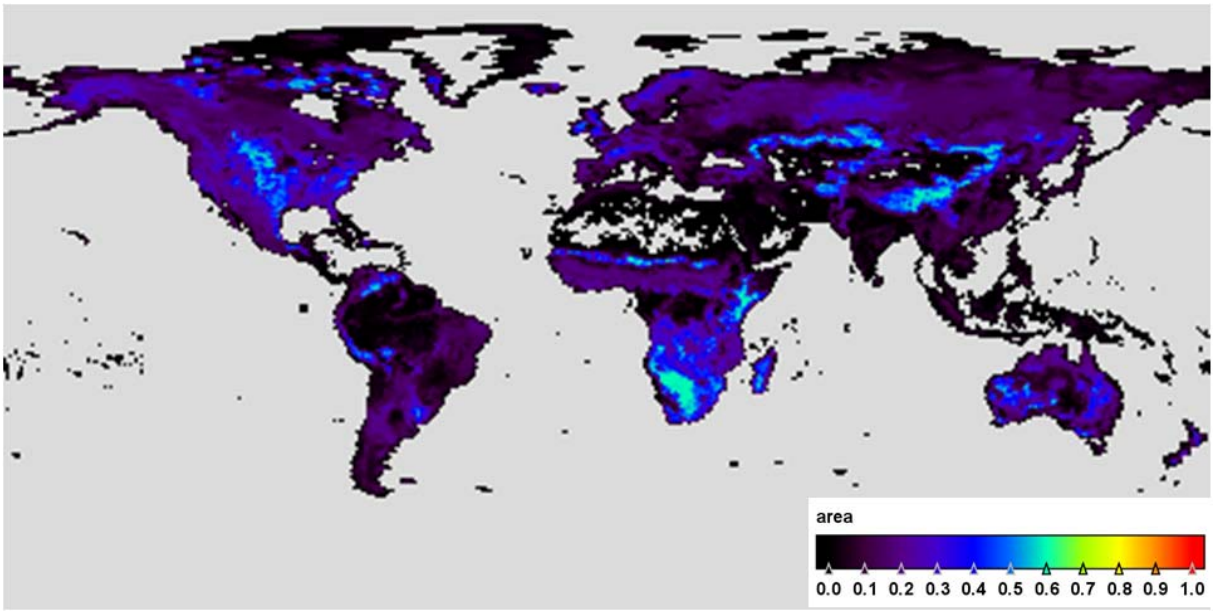


Figure 7-6: Example of an aggregated CCI Global Land Cover Map V1 obtained with the aggregation tool. Its pixel size is 9.8 km, area of CCI-LC PFT – natural grass

The instruction manual of the aggregation tool can be found in the Appendix D of this document.

7.4 Software tools for CCI-LC dataset visualisation

Considering the heavy download related to the full CCI-LC products dataset, a web interface was developed to mainly visualise data. It is accessible at the following address:

http://maps.elie.ucl.ac.be/CCI/viewer/index.html. Figure 7-7 illustrates the home page of the visualisation interface.

It includes two main compartments: the map environment (right) and the information panel (left). The information panel includes the description of the LC-Map legend (1) and the functionality to download pdf documents describing the products: this actual product user guide, summary user guides for the CCI-LC Maps and Conditions and the CCI-LC Maps legend (2).

The "+ O -" button (3) can be used to adapt the zoom, such as the mouse wheel and to set the visualization extent to global. By default, the base layer displayed in the map environment corresponds to the CCI-LC Map 2010 but it can be changed by selecting one of the products available in (4): a 10-year global MERIS surface reflectance product composite, the CCI-LC Maps from the 1998-2002, 2003-2008 or 2009-20012 epochs and the water bodies product.

The base layer is interactive (5). A left click, anywhere on the layer, highlights the LC-Map label of the selected pixel in the legend description of the left panel. A right click activates the display of the CCI-LC condition profiles for the NDVI, burned areas and the snow reference behaviours.

Finally, the download data button (6) redirects the user to a new web page where some of the products are available for download:

- The CCI-LC maps for three epochs and their corresponding quality flags (see Table 4-7);
- The SAR WB layer from the WB product (see Table 6-2);
- The profiles of the NDVI, burned areas and the snow condition products can be extracted according to LAT/LONG coordinates or simply downloaded;
- The user tool.

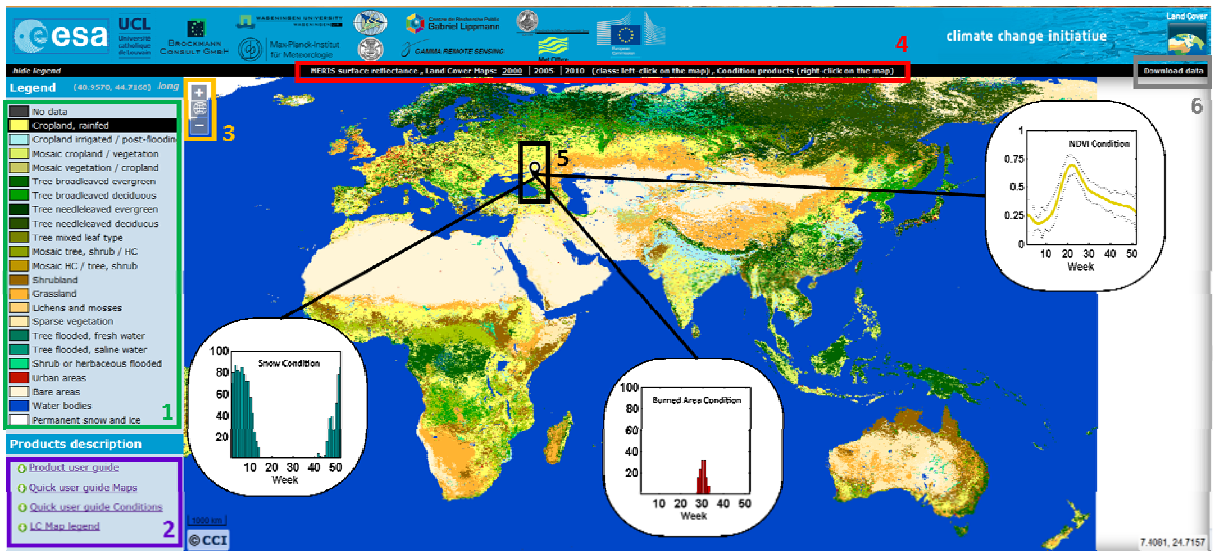


Figure 7-7: Main page of the validation CCI-LC products visualisation tool, with the following functionalities: 1) LC-Maps legend description; 2) download of documents describing the CCI-LC products; 3) Tools box to control the zooms (+ and -) or to set the view to the global extend (O); 4) products available for visualization; 5) a right click on the map activates the apparition of the condition profiles (NDVI, snow and burned areas) and highlights the LC-Map label on the left panel; 6) redirection to data download web page;

8 DATA ACCESS

This section is dedicated to explain how to obtain data processed by the CCI-LC project.

In accordance with the user requirements [AD-1] [AD-2], the set of products will be delivered through ftp. The ftp hosting still needs to be decided.

9 TERMS OF USE

This section explains how data processed by the CCI-LC processing chain can be used. Please read carefully.

For the time being, the data delivered in the CCI-LC database are the following ones:

- MERIS FR and RR time series version 1.0;
- LC map 2010 version 1.4;
- LC maps 2005 and 2000 version 1.3
- NDVI - BA - Snow condition products version 2.0;
- WB product version 2.0.

This CCI-LC database has been processed by the CCI-LC consortium led by UCL-Geomatics (Belgium). They are made available to the public by ESA and the consortium. You may use one or several CCI-LC products land cover map for educational and/or scientific purposes, without any fee on the condition that you credit the ESA Climate Change Initiative and in particular its Land Cover project as the source of the CCI-LC database:

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APPENDIX A – SYMBOLS AND ACRONYMS

(A)ATSR : (Advanced) Along Track Scanning Radiometer
API : Application Programming Interface
ASAR : Advanced Synthetic Aperture Radar
ATBD : Algorithm Theoretical Basis Document
BA : Burned area
BC : Brockmann Consult
CCI : Climate Change Initiative
CCI-LC : Climate Change Initiative – Land Cover
CEOS : Committee on Earth Observation Satellites
CEOS-WGCV : Committee on Earth Observing Satellites Working Group on Calibration and Validation
CMC : Climate Modelling Community
CMUG : Climate Modelling User Group
CRS : Coordinate Reference System
ECV : Essential Climate Variables
ENVISAT : ESA Environmental Satellite
EO : Earth Observation
ERS : European Remote Sensing Satellite
ESA : European Space Agency
FAO : Food and Agriculture Organization
FR : Full Resolution
GCOS : Global Climate Observing System
GCS : Geographic Coordinate System
GDAL : Geospatial Data Abstraction Library
GFED : Global Fire Emissions Database
GIS : Geographic Information System
GlobCover : ESA DUE project (http://due.esrin.esa.int/globcover/)
GLS : Global Land Survey
GMM : Global Monitoring Mode
GRASS : Geographic Resources Analysis Support System
GTOS : Global Terrestrial Observing System
IGCO : Integrated Global Carbon Observation
IGOL : Integrated Global Observations for Land
IMM : Image Mode Medium
JRC : Joint Research Center

L1, L2	: Level 1, Level 2
LC	: Land Cover
LCCS	: Land Cover Classification System
MCD64A1	: MODIS Direct Broadcast Monthly Burned Area Product
MERIS	: Medium Resolution Imaging Spectrometer
MMU	: Minimum Mapping Unit
MOD10A2	: MODIS/Terra Snow Cover 8d L3 Global 500m SIN Grid product
NDVI	: Normalized Difference Vegetation Index
PFT	: Plant Function Type
PSD	: Product Specification Document
PSU	: Primary Sampling Units
PUG	: Product User Guide
PVASR	: Product Validation and Algorithm Selection Report
PVP	: Product Validation Plan
RGB	: Red-Green-Blue
RR	: Reduced Resolution
SAR	: Synthetic Aperture Radar
SDR	: Surface Directional Reflectance
SPOT	: Satellite Pour l'Observation de la Terre
SPOT-VGT	: SPOT-VEGETATION
SR	: Surface Reflectance
SRTM	: Shuttle Radar Topography Mission
SSU	: Secondary Sampling Unit
SWBD	: SRTM Water Body Dataset
UCL	: Université catholique de Louvain
UN	: United Nations
UNFCCC	: United Nations Framework Convention on Climate Change
UR	: User Requirement
WB	: Water Bodies
WGS84	: World Geodetic System 84
WSM	: Wide Swath Mode

APPENDIX B – REFERENCE DOCUMENTS

Applicable documents

ID	Title	Issue	Date
[AD-1]	CCI-LC URD Phase I. Land Cover Climate Change Initiative - User Requirements Document (URD)	V2 -2.2	23/02/2011
[AD-2]	CCI-LC PSD Phase I. Land Cover Climate Change Initiative - Product Specification Documents	V1- 1.11	03/07/2014
[AD-3]	CCI-LC DARD Phase I. Land Cover Climate Change Initiative - Data Access Requirements Document	V1- 1.9	06/06/2012
[AD-4]	CCI-LC PVP Phase I. Land Cover Climate Change Initiative - Product Validation Plan	V1- 1.3	04/07/2011
[AD-5]	CCI-LC PVASR Phase I. Land Cover Climate Change Initiative - Product Validation and Algorithm Selection. (ESA)	v2-2.0	12/12/2012
[AD-6]	CCI-LC IODD Phase I. Land Cover Climate Change Initiative - Input Output Data Definition	V2-2.2	21-05-2013
[AD-7]	CCI-LC ATBD Phase I. Land Cover Climate Change Initiative - Algorithm Theoretical Basis Document (ESA).	v2-2.2	23/05/2013
[AD-8]	CCI-LC DPM Phase I. Land Cover Climate Change Initiative - Detailed Processing Models.	V2-2.2	2013-05-24
[AD-9]	CCI-LC SRD Phase I. Land Cover Climate Change Initiative - System Requirements Document	V1- 1.1	18.01.2012
[AD-10]	CCI-LC SSD Phase I. Land Cover Climate Change Initiative - System Specifications Document	V1- 1.0	11.12.2012
[AD-11]	CCI-LC PUG LC products Phase I. Land Cover Climate Change Initiative – Product User Guide Version 2	V2 – 2.0	2013-05-19
[AD-12]	CCI-LC PUG WB product Phase I. Land Cover Climate Change Initiative – SAR Water Bodies User Guide version 1	V1- 1.0	2013-05-22
[AD-13]	CCI-LC SVR Phase I. Land Cover Climate Change Initiative – System Verification Report	V1- 1.1	2012-12-11
[AD-14]	CCI-LC project - Production of a reference dataset for the validation of the Water bodies product (D3 of CCN4)	1.0	07.08.2013

Reference documents

ID	Title	Issue	Date
[RD-1]	Herold M., Woodcock C., Wulder M., Arino O., Achard F., Hansen M., Olsson H., Schmulllius C., Brady M., Di Gregorio A., Latham J. and Sessa R., 2009, GTOS ECV T9: Land Cover - Assessment of the status of the development of standards for the Terrestrial Essential Climate Variables	16	21.05.2009
[RD-2]	Arino O., Bicheron P., Achard F., Latham J., Witt R., Weber J.L. et al. 2008. Globcover: the most detailed portrait of Earth. ESA Bulletin 136		2008

ID	Title	Issue	Date
[RD-3]	Bicheron, P., Defourny, P., Brockmann, C., Schouten, L., Vancutsem, C., Huc, M., Bontemps, S., Leroy, M., Achard, F., Herold, M., Ranera, F., Arino, O. GlobCover: products description and validation report, ESA GlobCover project. Available at: http://due.esrin.esa.int/globcover/	2.0	05.09.2008
[RD-4]	Bontemps, S., Defourny, P., Van Bogaert, E., Kalogirou, V. and Arino, O., GlobCover 2009 - Products Description and Validation Report (2010). Available at: http://due.esrin.esa.int/globcover/		2010
[RD-5]	GCOS, 2004, Implementation plan for the Global Observing System for Climate in Support of the UNFCCC, World Meteorological Institute. Available at: http://www.wmo.int/pages/prog/gcos/Publications/gcos-92_GIP.pdf		2004
[RD-6]	GCOS, 2010, Implementation plan for the Global Observing System for Climate in Support of the UNFCCC, August 2010 (update), World Meteorological Organisation. Available at: http://www.wmo.int/pages/prog/gcos/Publications/gcos-138.pdf		2010
[RD-7]	Townshend J. R., Latham J., Arino O., Balstad R., Belward A., Conant R., Elvidge C., Feuquay J., El Hadani D., Herold M., Janetos A., Justice C.O., Liu J., Loveland T., Nachtergaele F., Ojima,D., Maiden M., Palazzo F., Schmullius C., Sessa R., Singh A., Tschirley J. and Yahamoto H., 2008, Integrated Global Observations of teh Land: an IGOS-P theme. IGOL Report No. 8, GTOS, 54. Available at: http://www.fao.org/docrep/011/i0536e/i0536e00.htm		2008
[RD-8]	Ciais P. and Moore B., 2004, Integrated Global Carbon Observation (IGCO) Implementation Plan, IGOS theme report. Available at: http://www.igospartners.org/Carbon.htm		2004
[RD-9]	CMUG, 2010, Requirement Baseline Document MOHC, MPI-M, ECMWF, MétéoFrance		2010
[RD-10]	Bontemps, S., Herold, M., Kooistra, L., van Groenestijn, A., Hartley, A., Arino, O., Moreau, I., and Defourny, P. (2012). Revisiting land cover observations to address the needs of the climate modelling community. Biogeosciences, 9, 2145-2157, doi:10.5194/bgd-9-2145-2012		2012
[RD-11]	Committee on Earth Observation Satellites, 2008, Working Group on Information Systems and Services - Interoperability Handbook, February 2008 Issue 1.1. Available at: http://www.eohandbook.com/	1.1	2008
[RD-12]	NetCDF Climate and Forecast (CF) Metadata Conventions,	1.5	25.10.2010
[RD-13]	Bennett, V, Guidelines for Data Producers - Climate Change Initiative Phase 1, CCI-PRGM-EOPS-TN-11-0003	2.1	20.03.2012
[RD-14]	Global Mangrove Atlas. Available at: http://geodata.grid.unep.ch/results.php		
[RD-15]	Randolph Inventory Glaciers. Available at: http://www.glims.org/RGI/		

ID	Title	Issue	Date
[RD-16]	Strahler A., Boschetti L., Foody G. M., Fiedl M. A., Hansen M. C., Herold M., Mayaux P., Morisette J. T., Stehman S. V., and Woodcock C. (2006). Global Land Cover Validation: Recommendations for Evaluation and Accuracy Assessment Of Global Land Cover Maps, Report of CEOS-WGCV		2006
[RD-17]	Verhegghen A., Bontemps S. and Defourny, P., 2014. Global land-surface phenology reference dataset from 13 years NDVI and EVI SPOT VEGETATION time series analysis. International Journal of Remote Sensing, 35, 7, 2440-2471.		2014
[RD-18]	Giglio, L., Loboda, T., Roy, D.P., Quayle, B. and Justice, C.O., 2009. An active-fire based burned area mapping algorithm for the MODIS sensor. Remote Sensing of Environment, 113(2): 408-420.		2009
[RD-19]	Giglio, L., Randerson, J.T., van der Werf, G.R., Kasibhatla, P.S., Collatz, G.J., Morton, D.C. and DeFries, R.S., 2010. Assessing variability and long-term trends in burned area by merging multiple satellite fire products. Biogeosciences, 7(3): 1171-1186.		2010
[RD-20]	Chuvieco, E., Calado, T. and Oliva, P., 2011. ESA CCI ECV Fire Disturbance (fire_cci) Product Specification Document (PSD). Fire_cci_Ph1_UAH_D1_2_PSD_v2_0.	2.0	2011
[RD-21]	Riggs, G.A., Hall, D.K. and Salomonson, V.V., 2006. MODIS Snow Products, User Guide to Collection 5.		2006
[RD-22]	Carroll, M., Dimiceli, C., Townshend, J.R., Noojipady, P. and Sohlberg, R.A., 2009, UMD Global 250 meter Land Water Mask User Guide.		2009
[RD-23]	The Geospatial Data Abstraction Library website : http://www.gdal.org/		
[RD-24]	The Geographic Resources Analysis Support System (GRASS GIS) website : http://grass.osgeo.org/		
[RD-255]	http://www.add.scar.org/index.jsp		

APPENDIX C – NETCDF ATTRIBUTES

- **Surface reflectance product**

The CCI-LC global 7-day SR products description is based on the structure of the NetCDF files. The global attributes of the composites are described in Table 1.

Table 1: Global attributes of the global 7-day SR products delivered by the CCI-LC project, according to the structure of the NetCDF files.

Attribute Name	Format	Value	Description
title		ESACCI-LC-L3-SR-MERIS-300m-P7D-h40v13-20080326-v1.0	Product identifier (see "naming convention" here above)
summary		This dataset contains a tile of a Level-3 7-day global surface reflectance composite from satellite observations placed onto a regular grid.	
project		Climate Change Initiative - European Space Agency	
references		http://www.esa-landcover-cci.org/	References that describe the data or methods used to produce it.
institution		Brockmann Consult GmbH	Where the data has been produced
contact		info@brockmann-consult.de	
source		MERIS FR L1b	Method of production of the original data
history		amorgos-4.0 lc-sdr-2.0 lc-sr-2.0	List of applications that have modified the original data, with time stamp, processor and parameters
comment			Miscellaneous information about the data or method used to produce it
Conventions		CF-1.6	Name of the conventions followed
standard_name_ vocabulary		NetCDF Climate and Forecast (CF) Standard Names version 18	
keywords		satellite,observation,reflectance	
keywords_ vocabulary		NASA Global Change Master Directory (GCMD) Science Keywords	

Attribute Name	Format	Value	Description
license		ESA CCI Data Policy: free and open access	
naming_authority		org.esa-cci	
cdm_data_type		grid	
platform		e.g "ENVISAT"	
sensor		e.g "MERIS"	
type		sr- 300m-7d	Product type
id		e.g "ESACCI-LC-L3-SR-MERIS-300m-P7D-h40v13-20080326-v1.0"	
tracking_id		e.g "2521cb70-348f-4676-9d7c-c0311a8118ac"	
tile	hXXvYY	e.g. " h71v27"	Example for the tile in row 27 and column 71 of the Plate Carree grid (see Figure 3-1)
product_version	major.minor	e.g " 1.0"	Product revision (see here above)
date_created	yyyy-MM-dd'T'HH:mm:ss'Z'	e.g " 20130424T124732Z"	Creation time of product
creator_name		Brockmann Consult	
creator_url		http://www.brockmann-consult.de/	
creator_email		info@brockmann-consult.de	
time_coverage_start	yyyy-MM-dd'T'HH:mm:ss'Z'	e.g" 20080326T000000Z"	Start of aggregation period e.g. 2009-01-01T00:00:00Z
time_coverage_end	yyyy-MM-dd'T'HH:mm:ss'Z'	e.g" 20080402T000000Z"	End of aggregation period e.g. 2009-01-11T00:00:00Z
time_coverage_duration	0 ... 1382400	P7D	aggregation period
time_coverage_resolution		P7D	
geospatial_lat_min	-90.0 ... 90.0		South border of the bounding box
geospatial_lat_max	-90.0 ... 90.0		North border of the bounding box
geospatial_lon_min	-180.0 ... 180.0		West border of the bounding box
geospatial_lon_max	-180.0 ... 180.0		East border of the bounding box
spatial_resolution		300	Resolution of the product in meters
geospatial_lat_units		degrees_north	
geospatial_lat_ resolution		e.g " 0.002778 "	
geospatial_lon_units		degrees_east	
geospatial_lon_		e.g " 0.002778 "	

Attribute Name	Format	Value	Description
resolution			
TileSize		600:600	

The global 7-day SR NetCDF file for a tile has two dimensions that define the spatial raster, as described in Table 2.

Table 2: Information related to the spatial dimension of the global SR products delivered by the CCI-LC project

Dimension	Value	Description
lat	1800	Dimension that distinguishes different lines
lon	1800	Dimension that distinguishes different columns

The variables and variables' attributes of the global 7-day SR NetCDF file are presented in Table 3.

Table 3: Variables and variables' attributes of the global 7-day SR products delivered by the CCI-LC project, according to the structure of the NetCDF files.

Variable	Attribute	Format	Value	Description
crs		int	0	Coordinate reference system attribute container
	wkt		GEOGCS["WGS84(DD)" DATUM["WGS84", SPHEROID["WGS84", 6378137.0, 298.257223563]], PRIMEM["Greenwich", 0.0], UNIT["degree", 0.017453292519943295], AXIS["Geodetic longitude", EAST], AXIS["Geodetic latitude", NORTH]]	
	i2m		0.002777777777777778,0.0,0.0,-0.002777777777777778,20.0,25.0	
lon		float (lon)	-180.0 .. 180.0	Longitude coordinate of pixel column
	standard_name		longitude	
	long_name		longitude coordinate	
	units		degrees east	
	valid_min		-180.0	
	valid_max		180.0	
lat		float (lat)	-90.0 .. 90.0	Latitude coordinate of pixel row
	standard_name		latitude	
	long_name		latitude coordinate	
	units		degrees north	
	valid_min		-90.0	
	valid_max		90.0	

Variable	Attribute	Format	Value	Description
sr_<n>_mean n = 1 .. 10, 12 .. 14 (MERIS) n=B0,B2, B3, MIR (SPOT-VGT)		float (lat,lon)		Mean of SR values of channel <n>1
	long_name		normalised (averaged) surface reflectance of channel n	
	standard_name		surface_bidirec-tional_reflectance	
	wavelength_nm		MERIS: 412.5, 442.5, 490, 510, 560, 620, 665, 681.25, 708.75, 753.75, 778.75, 865, 885, SPOT-VGT: 450, 645, 835, 1665	Centre wavelength of channel
	valid_min		0	
	valid_max		1	
	_FillValue		NaN	
	ancillary_variab-les		sr_n_uncertainty current_pixel_state clear_land_count clear_water_count clear_snow_ice_count cloud_count cloud_shadow_count	
sr_<n>_uncertainity n = 1 .. 10, 12 .. 14 (MERIS) n=B0,B2, B3, MIR (SPOT-VGT)		float (lat,lon)		uncertainity of normalized surface reflectance values of channel n
	long_name		uncertainity of normalized surface reflectance values of channel n	
	standard_name		surface_bidirec-tional_reflectance standard_error	
	wavelength_nm		see above	Centre wavelength of channel
	valid_min		0.0	
	valid_max		0.5	
	_FillValue		NaN	
vegetation index_mean		float (lat,lon)		Mean of vegetation index, e.g. NDVI
	long_name		mean of vegetation index	
	standard_name		normalized_difference_ vegetation_index	
	valid_min		-1	
	valid_max		+1	
	_FillValue		NaN	

[1] valid for current pixel_state 1 or 3

Variable	Attribute	Format	Value	Description
	ancillary_variab-les		current_pixel_state clear_land_count clear_water_count clear_snow_ice_count cloud_count cloud_shadow_count	
clear_land_ count		short (lat,lon)		Number of contributing observations over clear sky land in aggregation period
	long_name		Number of contributing of observations over clear sky land	
	standard_name		surface_bidirectional_ reflectance number_of_observations	
	valid_min		0	
	valid_max		150	
	_FillValue		-1	
clear_water_ count		short (lat,lon)		Number of observations with water coverage in aggregation period
	long_name		number of clear_water observations	
	standard_name		surface_bidirectional_ reflectance number_of_observations	
	valid_min		0	
	valid_max		150	
	_FillValue		-1	
clear_snow_ ice_count		short (lat,lon)		Number of contributing observations with snow and ice coverage in aggregation period
	long_name		number of clear_snow_ice observations	
	standard_name		surface_bidirectional_ reflectance number_of_observations	
	valid_min		0	
	valid_max		150	
	_FillValue		-1	
cloud_count		short (lat,lon)		Number of observations with cloud coverage in aggregation period
	long_name		number of cloud observations	

Variable	Attribute	Format	Value	Description
	standard_name		surface_bidirectional_ reflectance number_of_observations	
	valid_min		0	
	valid_max		150	
	_FillValue		-1	
cloud_shadow_count		short (lat,lon)		Number of observations with cloud shadow coverage in aggregation period
	long_name		number of cloud_shadow observations	
	standard_name		surface_bidirectional_ reflectance number_of_observations	
	valid_min		0	
	valid_max		150	
	_FillValue		-1	
current_pixel_state		byte (lat,lon)		Status of surface associated with the surface reflectance in the aggregation period: "invalid" = 0 "clear_land " = 1 "clear_water" = 2 "clear_snow_ice" = 3 "cloud" = 4 "cloud_shadow"=5
	long_name		LC pixel type mask	
	standard_name		surface_bidirectional_ reflectance status_flag	
	flag_values		0 ... 5	
	flag_meanings		invalid clear_land clear_water clear_snow_ice cloud cloud_shadow	
	valid_min		0	
	valid_max		5	
	_FillValue		-1	

- **Land cover products**

The CCI-LC global land cover products description is based on the structure of the NetCDF files. The global attributes of the land cover maps are described in Table 4.

Table 4: Global attributes of the global LC maps delivered by the CCI-LC project, according to the structure of the NetCDF files

Attribute Name	Format	Value	Description
title		ESACCI-LC-L4-LCCS-Map-300m-P5Y-01-2010-v1.0.nc/tif	Product identifier (see "naming convention" above)
summary		This dataset contains a global land cover map obtained from surface reflectance composites, placed onto a regular grid.	
project		Climate Change Initiative - European Space Agency	
references		http://www.esa-landcover-cci.org/	References that describe the data or methods used to produce it.
institution		UCL	Where the data has been produced
contact		Pierre.Defourny@uclouvain.be	
source		MERIS FR L1B, MERIS RR L1B, SPOT-VGT S1	Source of the original data
history		lc-mosaic-1.1 lc-compositing-1.0 lc-stratification-1.0 lc-classification-1.0 lc-labeling-1.0	List of applications that have modified the surface reflectance composites, with time stamp, processor and parameters
comment			Miscellaneous information about the data or method used to produce it
Conventions		CF-1.6	Name of the conventions followed
type		LCMap-300m	Product type
date_created	yyyy-MM-dd'T'HH:mm:ss'Z'	e.g " 20130424T124732Z"	Creation time of product
creator_name		UCL-Geomatics	
creator_url		http://www.uclouvain.be/elie.html	
creator_email		Pierre.Defourny@uclouvain.be	
epoch	YYYY	[YYYY] where the two "YYYY" are the middle year of the epoch	Multi-year epoch of the product, defined by the middle year
geospatial_lat_min	-90.0 ... 90.0		South border of the bounding box
geospatial_lat_max	-90.0 ... 90.0		North border of the bounding box
geospatial_lon_min	-180.0 ... 180.0		West border of the bounding box
geospatial_lon_max	-180.0 ... 180.0		East border of the

Attribute Name	Format	Value	Description
			bounding box
geospatial_lat_min	-90.0 ... 90.0		South border of the bounding box
geospatial_lat_units		degrees_north	
geospatial_lat_ resolution		e.g " 0.002778 "	
geospatial_lon_units		degrees_east	

The variables and variables' attributes of the global 7-day SR NetCDF file are presented in Table 5.

Table 5: Variables and variables' attributes of the global LC maps delivered by the CCI-LC project, according to the structure of the NetCDF files

Variable	Attribute	Format	Value	Description
crs		int		Coordinate reference system attribute container
	grid_mapping_name		Plate Carree	
	semi_major_axis		6378137.0	
	inverse_flattening		298.257223563	
	false_easting		0.0	
	false_northing		0.0	
	longitude_of_central_meridian		0.0	
	scale_factor_at_central_meridian		1.0	
time		double(time)		Start time of the multi-year period
	standard_name		time	
	long_name		multi-year period	
	units		year	
lon		double (lon)	-180.0 .. 180.0	Longitude coordinate of image column
	standard_name		longitude	
	long_name		WGS84 longitude coordinate	
	units		degrees east	
	valid_min		-180.0	
	valid_max		180.0	
lat		double (lat)	-90.0 .. 90.0	Latitude coordinate of image row
	standard_name		latitude	

Variable	Attribute	Format	Value	Description
	long_name		WGS84 latitude coordinate	
	units		degrees north	
	valid_min		-90.0	
	valid_max		90.0	
lc_classif_lcss		byte (lat,lon)		LC classification in LCCS
	standard_name		land cover	
	long_name		LC class defined in LCCS	
	vocabulary		UN-LCCS 2005	
	valid_min		1	
	valid_max		240	
	_FillValue		0b	
lc_quality_flag_1		byte (lat,lon)		LC map quality flag 1: pixel processed or not
	standard_name		land_cover status_flag	
	long_name		LC map processed area flag	
	valid_min		0	
	valid_max		1	
	_FillValue		-1b	
lc_quality_flag_2		byte (lat,lon)		LC map quality flag 2: pixel status
	standard_name		land_cover status_flag	
	long_name		LC map area type mask	
	valid_min		0	
	valid_max		5	
	_FillValue		-1b	
lc_quality_flag_3		short(lat,long)		LC map quality flag 3: number of valid observations
	standard_name		land_cover number_of_observations	
	long_name		number of valid observations	
	valid_min		0	
	valid_max		32767	
	_FillValue		-1s	

Variable	Attribute	Format	Value	Description
	_FillValue		-1b	
	scale_factor		0.01f	
lc_quality_flag_4		byte(lat,long)		LC map quality flag 4: LC map confidence level
	standard_name		land_cover confidence_level	
	long_name		LC map confidence level based on product validation	
	valid_min		0	
	valid_max		100	
	_FillValue		-1b	

APPENDIX D – INSTRUCTION MANUAL OF THE AGGREGATION TOOL

CCI-LC User Tools
~~~~~~~~~~~~~~~~~~
Version: 3.0
Release: 2013/05/15

Summary
~~~~~~~~
This set of tools (conversion tool, aggregation tool, subset tool) prepares data for model computation.

General Note
~~~~~~~~~~~~~
The target files are always written in NetCDF-4 (enhanced model) file format.
If the NetCDF-4 Classic file format is needed the standard nccopy tool can be used for conversion.

Installation
~~~~~~~~~~~~~
1) Unzip the zip-file in a directory of your choice.
2) Inside the unzipped directory you can find a folder which is named 'bin'.
   Inside you can find the windows and unix start scripts for the LCCCI tools.

Execution
~~~~~~~~~~
All start scripts are available in windows and unix versions.
Use the scripts in the same manner.

Conversion Tool Usage (converts Tiff to NetCDF-4 files)
~~~~~~~~~~~~~~~~~~~~~~~~~~
convert.sh <pathToMapTifFile|pathToConditionTifFile>

In case of a LCCCI Map file the corresponding flag files must be in the same directory as the Map file.
They are automatically detected and added to the output NetCDF-4 file.
If a condition product shall be converted the AggMean tif file must be provided as source. All the associated variables (AggMean, Std, Status and NYearObs) are considered and integrated into the output NetCDF-4 file if they reside in the same folder as the source tif file.

Aggregation Tool Usage
~~~~~~~~~~~~~~~~~~~~~~
aggregation.sh -PgridName=<name> -PnumRows=<integer>
-PoutputLCCSClasses=<boolean> -PnumMajorityClasses=<integer>
-PoutputPFTClasses=<boolean> -PuserPFTConversionTable=<filePath>
-PtargetDir=<dirPath> <sourceFilePath>

Parameter Description:
-PgridName=<name>
Specifies the target grid of the resulting product. For example a regular gaussian grid.
Valid Parameters are: GEOGRAPHIC_LAT_LON and REGULAR_GAUSSIAN_GRID
This is a mandatory parameter.
-PnumRows=<integer>
Specifies the number of rows for the specified grid.
Default ist 2160 rows. A grid with the default number of rows leads to a resolution of
~~~~~~~~~~~~~~~~~~~~~~

~9.8km/pixel in the target product.
For a REGULAR_GAUSSIAN_GRID onyl the following values are valid:
32, 48, 80, 128, 160, 200, 256, 320, 400, 512, 640

-PoutputLCCSClasses=<boolean>
Specifies whether the LCCS classes shall be added to the output. This parameter can be omitted. The default is true.

-PnumMajorityClasses=<integer>
Specifies the number of majority classes in the output. This parameter can be omitted, in this case the default (5) is used. A value of 1 will produce an output with just the majority class.

-PoutputPFTClasses=<boolean>
Specifies if a conversion to PFT classes shall be performed and the result added to the output. This parameter can be omitted. The default is true.

-PuserPFTConversionTable=<filePath>
Specifies the path to a user defined PFT conversion table. If not given the default LCCCI conversion table will be used. For a description of the file format see further down.

-PtargetDir=<dirPath>
Specifies the directory where the target will be written. It is written as NetCDF-4 file.
If already a file with the same name/path exists, it will be overwritten.
(see "Output File Naming Convention")

<sourceFilePath>
Is the path to the source NetCDF-4 file.

A real example might look like the following:

```
aggregation.sh -PgridName=REGULAR_GAUSSIAN_GRID -PnumRows=320 -PoutputLCCSClasses=false
               -PnumMajorityClasses=3
               -PtargetDir="/data/LCCCI/output/" "/data/LCCCI/ESACCI-LC-L4-LCCS-Map-300m-P5Y-2010-v2.nc"
```

The PFT (Plant Functional Type) conversion table

The file starts with a table header. Each column of the header defines one PFT.
The subsequent rows, one for each LCCS class, define the conversion from corresponding class to the PFTs.
Columns are separated with the pipe ('|') symbol and the column header names are used as band names.

Subset Tool Usage

```
subset.sh -PpredefinedRegion=<regionName> <sourceFilePath>
      or
subset.sh -Pnorth=<degree> -Peast=<degree> -Psouth=<degree> -Pwest=<degree> <sourceFilePath>
```

-PpredefinedRegion=<regionName>
Specifies one of the available predefined regions.
Valid Values are: NORTH_AMERICA, CENTRAL_AMERICA, SOUTH_AMERICA,
WESTERN_EUROPE_AND_MEDITERRANEAN_BASIS,
ASIA, AFRICA, SOUTH_EAST_ASIA, AUSTRALIA_AND_NEW_ZEALAND, GREENLAND

-Pnorth=<degree>
Specifies north bound of the regional subset.

-Peast=<degree>
Specifies east bound of the regional subset.

-Psouth=<degree>
Specifies south bound of the regional subset.

-Pwest=<degree>
Specifies west bound of the regional subset.

-PtargetDir=<dirPath>
Specifies the directory where the target will be written. It is written as NetCDF-4 file.
If already a file with the same name/path exists, it will be overwritten.
(see "Output File Naming Convention")

<sourceFilePath>
The source file to create a regional subset from.

In order to create a regional subset of a map, condition or aggregated product the subset

tool can be used. As parameter either one of the predefined regions can be selected or the outer bounds of the desired region can be specified. The target file is written into the directory of the source file.

Output File Naming Convention

Conversion Tool Output:

Map Product: ESACCI-LC-L4-LCCS-Map-{sRes}m-P{tRes}Y-{epoch}-v{versNr}.nc

Condition Product: ESACCI-LC-L4-{condition}-Cond-{sRes}m-P{tRes}D-{startY}-{endY}-{weekNr}-v{versNr}.nc

Split Points:

Map Product: ESACCI-LC-L4-LCCS-Map-{sRes}m-P{tRes}Y-{epoch}-v{versNr}.nc
^
|--- Split Position

Condition Product: ESACCI-LC-L4-{condition}-Cond-{sRes}m-P{tRes}D-{startY}-{endY}-{weekNr}-v{versNr}.nc
^
|--- Split Position

Examples Map Result:

Aggregation:

Input : ESACCI-LC-L4-LCCS-Map-300m-P5Y-2006-v4.nc

Output : ESACCI-LC-L4-LCCS-Map-300m-P5Y-aggregated-0.083333Deg-2006-v4.nc

Subset:

Input : ESACCI-LC-L4-LCCS-Map-300m-P5Y-aggregated-0.083333Deg-2006-v4.nc

Output : ESACCI-LC-L4-LCCS-Map-300m-P5Y-aggregated-0.083333Deg-EUROPE-2006-v4.nc
Output : ESACCI-LC-L4-LCCS-Map-300m-P5Y-aggregated-0.083333Deg-ASIA-2006-v4.nc
Output : ESACCI-LC-L4-LCCS-Map-300m-P5Y-aggregated-0.083333Deg-USER_REGION-2006-v4.nc

Examples Condition Result:

Subset:

Input : ESACCI-LC-L4-NDVI-Cond-300m-P7D-2001-2009-0101-v4.nc

Output : ESACCI-LC-L4-NDVI-Cond-300m-P7D-EUROPE-2001-2009-0101-v4.nc
Output : ESACCI-LC-L4-NDVI-Cond-300m-P7D-ASIA-2001-2009-0101-v4.nc
Output : ESACCI-LC-L4-NDVI-Cond-300m-P7D-USER_REGION-2001-2009-0101-v4.nc