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Land Cover CCI Newsletter

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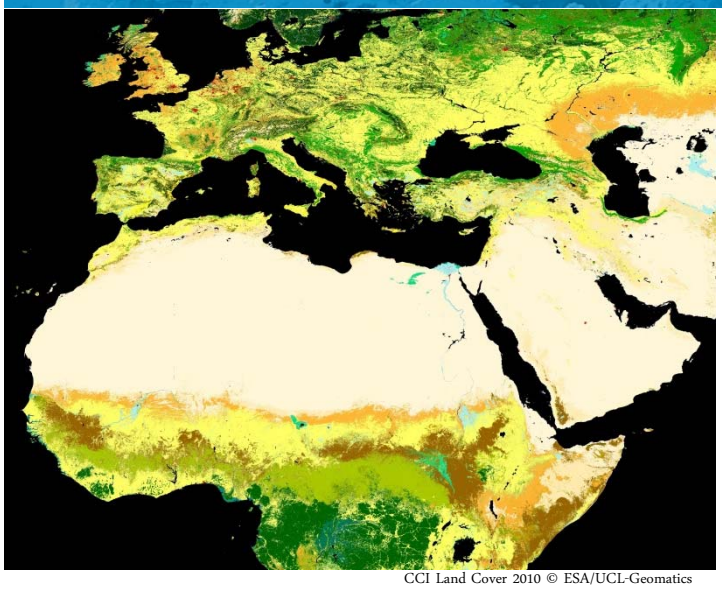

CCI Land Cover 2010 © ESA/UCL-Geomatics

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Internal release of the CCI Land Cover products

The CCI Land Cover (LC) team has successfully released its 4 key products to its climate modelers: a time series of 3 global LC maps representative for the 2000, 2005 and 2010 epochs; 3 global LC condition products on the Normalized Vegetation Index, the snow and the burnt areas; the surface reflectance time series for the whole MERIS archive made of 7-day composites and a SAR-based global water bodies product.

Land cover is referred to as one of the most obvious and commonly used indicators for land surface and the associated human induced or naturally occurring processes.

The users' requirements analysis (http://www.esa-landcover-cci.org/?q=documents#) highlighted the expectations of the climate communities for an improved land cover product which would include both stable and dynamic components. A revisited LC concept was therefore introduced, which distinguished the **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 United Nations Land Cover Classification System (UN-LCCS), which is also quite compatible with the Plant Functional Types (PFT) concept of many models. The **LC condition** concept directly relates 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. It is typically driven by biogeophysical processes. It encompasses different observable variables such as the green vegetation phenology, snow coverage, open water presence, burnt areas occurrence, etc.

The LC state component was described from multi-year observation dataset to reduce the sensitivity of the classification methods to the date(s) of observation. Conversely, the instantaneous observations of the LC condition were considered within the perspective of a time cycle (typically a year) precisely in order to reflect the above-mentioned temporary conditions.

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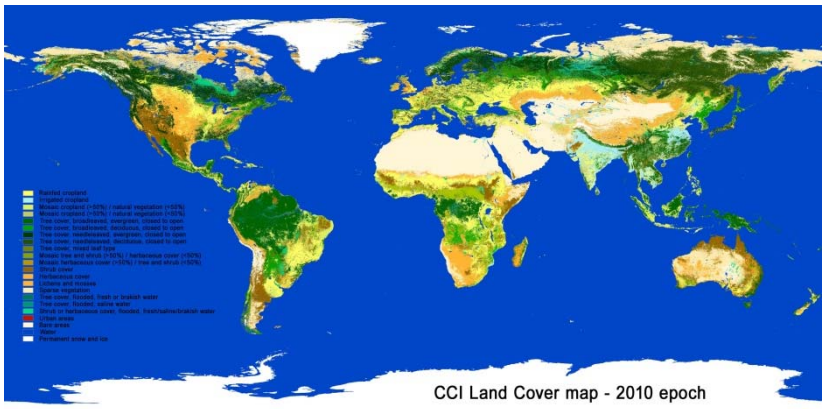
3 global LC maps for the 2000, 2005 and 2010 epochs



The CCI LC team is proud to announce that it has successfully produced and internally released its 3-epoch series of global land cover maps at 300m spatial resolution, where each epoch covers a 5-year period (2008-2012, 2003-2007, 1998-2002).

These maps were produced using a multi-year and multi-sensor strategy in order to make use of all suitable data and maximize product accuracy. The entire 2003-2012 MERIS Full and Reduced Resolution (FR and RR) archive was used as input by UCL-Geomatics to generate a 10-year 2003-2012 global land cover map. This 10-year product has then served as baseline to derive the 2010, 2005 and 2000 maps using back-dating techniques with MERIS and SPOT-Vegetation time series specific to each epoch.

In order to meet the user requirement set in this project, the map proposes a legend based on the UN Land Cover Classification System (LCCS) with the view to be as much as possible compatible with the GLC2000, GlobCover 2005 and 2009 products. The level of thematic details was found to be improved with respect to previous global LC products. Each map is characterized by a set of quality flags.

The map was delivered with a tool for sub-setting, re-projecting and re-sampling the products in a way which is suitable to each climate model. This tool also allows converting the LCCS legend to user-specific PFTs.

Zoom on deforestation patterns in the Amazon basin (left: CCI LC 2010 map, right: Google Earth imagery)

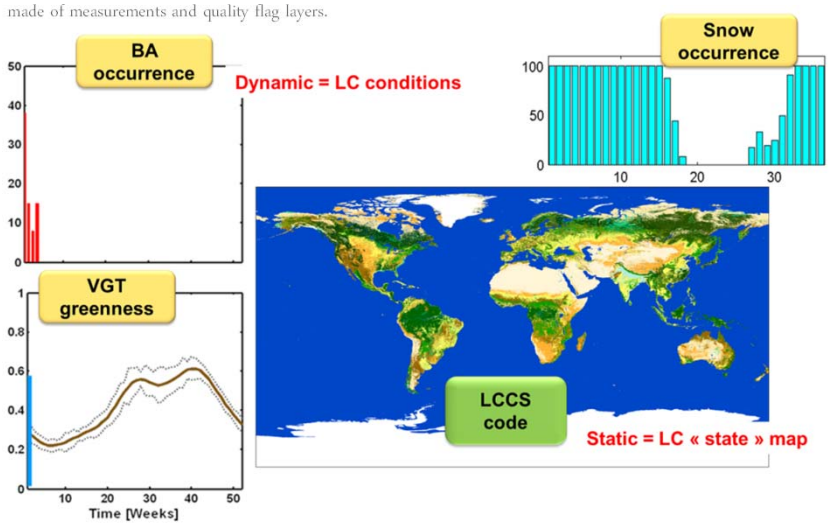
3 global LC condition products: the Normalized Vegetation Index, the snow and the burnt areas

As already mentioned, the LC condition products describe the dynamic aspect of the LC. In May 2013, the CCI LC project delivered 3 global LC-condition products: the Normalized Vegetation Index (NDVI), snow and burnt areas (BA) condition products. A water condition will be processed in a next stage of the project.

On a per pixel basis, these LC condition products reflect, along the year, the average trajectory (or behaviour) and the intra-annual variability of a land surface feature over the 1998-2012 period. They are expressed as 7-day time profiles of the mean and standard deviation for continuous variables (NDVI) or as temporal series of occurrence probabilities for discrete variables (snow, BA and water). These products are complementary to the three CCI global maps products characterizing the same period.

They are built from existing global datasets which beneficiate from high temporal frequency and long-term dataset.

The NDVI product is built from the SPOT-Vegetation (1km spatial resolution) time series over the 1999-2011 period. The BA product covers the 1998-2012 period with data originating from theMODIS Direct Broadcast Monthly Burned Area Product (MCD64A1 – 500m spatial resolution) being part of the Global Fire Emissions Database version 3 (GFED.v3) products. The Snow product is built from the MODIS/Terra Snow Cover 8d L3 Global 500m SIN Grid"product (MOD10A2 – 500m spatial resolution). Each LC condition product is delivered in 52 files (1 file per 7-day time interval) and each file made of measurements and quality flag layers.



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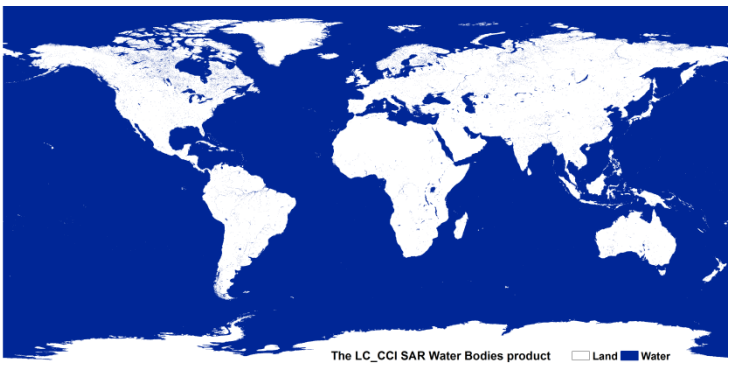
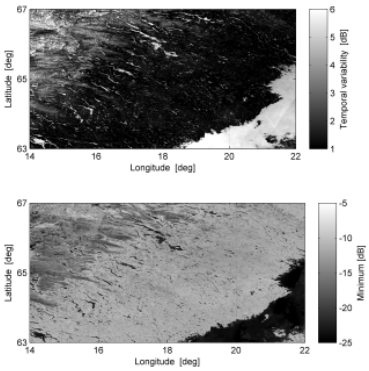
Global SAR-based Water Bodies product

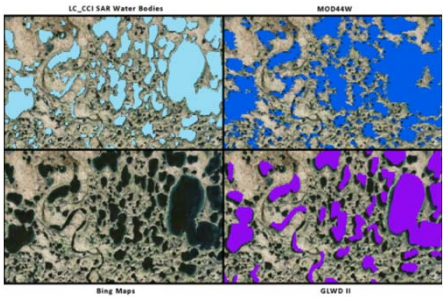
In an attempt to improve characterization of inland water bodies in global LC products, a SAR-based approach has been implemented. Multi-temporal acquisitions of Envisat ASAR Wide Swath Mode with local gap fillers based on Image Mode and Global Monitoring Mode from the years 2005 to 2010 have been used to generate a single epoch map of permanent open water bodies at 300 m. Starting from multi-temporal SAR metrics (temporal variability and minimum of a SAR backscatter time series), a simple thresholding algorithm has been applied to provide a first map of potential water bodies. The land/water classification has been enhanced by adapting the mapping algorithm to local environmental conditions, land cover types and amount of SAR data available. The refined product was generated at the resolution of the ASAR data. i.e., 150 m. The LC_CCI SAR WB product was finally obtained after consolidation of the refined product to remote local artefacts, fill classification voids and aggregate to 300 m.





Images of the SAR backscatter temporal variability and minimum backscatter. Water bodies correspond to area with the highest variability and the lowest minimum.

Verification of the LC_CCI SAR WB product revealed an outstanding quality above 60°N and satisfactory classification elsewhere.
Details of water body datasets for Eskimo Lakes, northwest Canada: the LC_CCI SAR WB, Global MODIS Water Mask (MOD44W), Bing Maps and Global Lakes and Wetlands Database (GLWD).

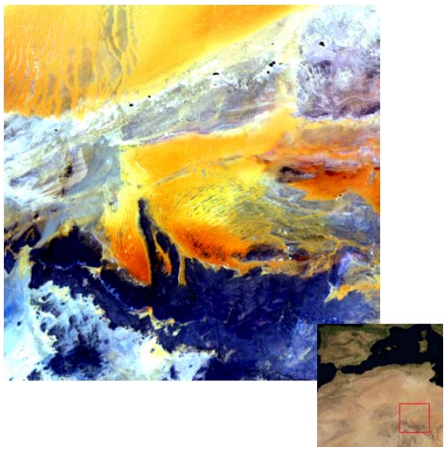


MERIS surface reflectance time series

The surface reflectance (SR) products consist of MERIS global time series covering the 2003-2012 period . The spectral content encompasses the 13 surface reflectance channels – the atmospheric bands 11 and 15 being removed – and the spatial resolution is of 300 m for FR and 1000 m from the RR. The time series are made of temporal syntheses obtained over a 7-day compositing period. In order to simplify the handling and analysis of global datasets, the MERIS SR time series are delivered in 5°x5° tiles.

Quality control of input products: The MERIS dataset is very valuable and the use of the full mission dataset in the CCI-LC project in a consistent manner is a major effort. It requires advanced techniques for the development of specific quality checks related to the input data.

Pre-processing: The pre-processing chain generates global SR time series by a series of pre-processing steps, including radiometric corrections, geometric correction, pixel identification, atmospheric correction with aerosol retrieval, BRDF corrections as well as compositing and mosaicking. Three intermediate products, which are considered as critical for the error budget, are quality controlled: the classes resulting from the pixel identification, the surface directional reflectance products and the global surface reflectance composite time series. The quality of each global multispectral SR composite is described, on a per-pixel basis, by a set of flags and values: uncertainties for each spectral band, current status of surface, uncertainties for each spectral band, number of observations with clear sky land coverage, water coverage, clear sky snow and ice coverage, cloudy coverage and cloud shadow coverage for each pixel. The uncertainties of the surface directional reflectance value is calculated from the contributions of each error source, assuming a negligible correlation between the different error sources. The obtained values are compared with in-situ data from CEOS LandNet sites and with reflectance products available from other sensors and other projects. Besides assessing the quality of individual composites, the quality of the global SR time series is also documented, with the aim of quantifying their discrimination potential.



RBG of 7-day surface reflectance composite, at 300m spatial resolution and tile h37v12 (ESACCI-LC-L3-SR-MERIS-300m-P7D-h37v12-20070702-v1.0)

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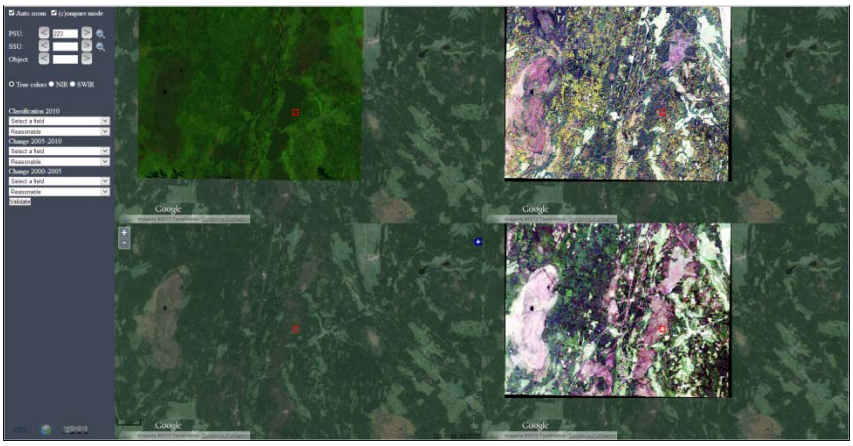
International effort to build a validation database for global LC maps

In order to produce the reference dataset required for the validation phase of the global LC maps, remote sensing specialists with international land cover expertise will contribute to the interpretation of high and very high resolution imagery.

For this purpose, the experts will be provided with a specifically developed graphical interface to interpret satellite imagery over the sampling unit. The interface combines satellite imagery and ancillary information, such as Google Earth imagery, a 3-date (2000, 2005 and 2010) time series of Landsat scenes and multi-temporal NDVI profiles (to display seasonal variations of vegetation).

The international effort has started in June, with the venue of the first experts at UCL premises. It is planned to last all summer, with the aim of building a reference database of around 5000 sample sites. This database will then be compared to the CCI LC maps to derive accuracy figures. A number of different user perspectives can be envisaged for land cover (e.g. carbon content and net primary productivity) for the use of the products into different climate models. For each of these potential uses, a matrix of similarity between classes will be constructed to derive specific accuracies.



Climate modellers assessment

Land cover is a key component in terrestrial carbon cycle modelling and determines land surface properties that determine carbon, water and energy exchange with the atmosphere. The ORCHIDEE dynamic global vegetation modelling team at Le Laboratoire des Sciences du Climat et l'Environnement (LSCE) has recently included ESA's CCI Land Cover product for global offline and online (i.e., coupled land-atmosphere) simulations. For both types of ORCHIDEE simulations, the 2010 land cover epoch was converted to 12 plant functional types (PFT) and merged with Koeppen-Geiger climate zones linking with biome specific parameters for structural and physiological PFT traits.

An initial assessment of the global offline simulations, run with the WATCH WFDEI climate forcing from 1979-2009, shows an improvement in modeled aboveground biomass stocks. Most recent forest inventory estimates of total woody biomass are around 363 ±28 Pg C. With the new LC_CCI product, we find a 56 Pg C reduction in total biomass simulated by ORCHIDEE, from 688 to 632 PgC (Figure). Much of the reduction in biomass came from improvements in mapping, tropical land cover where recent land-use transitions due to deforestation processes were included in the LC_CCI dataset but not in the original ORCHIDEE land cover dataset. The remaining positive bias in aboveground biomass simulated by ORCHIDEE can now be improved by focusing on parameters related to productivity and carbon turnover.

Model benchmarking will continue for carbon and water fluxes, using independent datasets from satellites or ground observations, to evaluate model improvement with the LC_CCI land cover product. In addition to the offline and online simulations, improvements in cross-model performance using the JSBACH (Max Planck Institute for Meteorology, Germany) and JULES (MET Office, United Kingdom) carbon cycle models will be considered in the coming months