climate change initiative

→ LAND COVER NEWSLETTER

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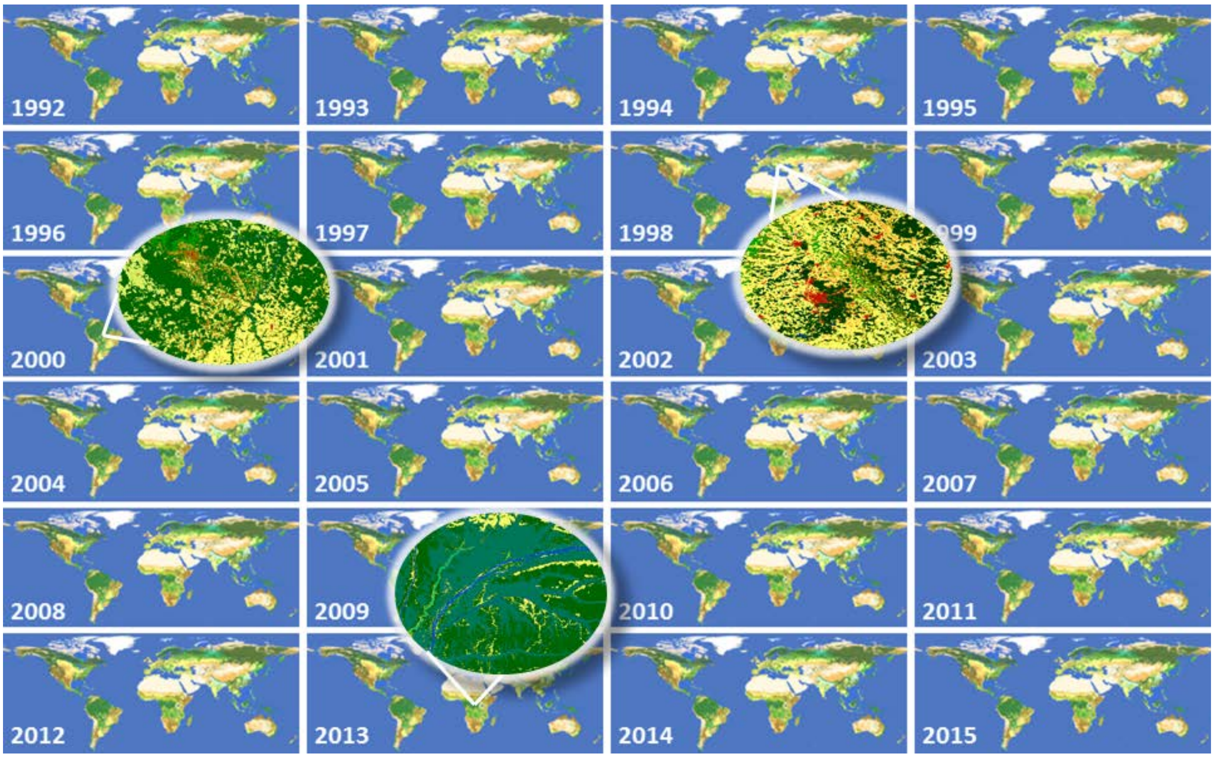

In this issue:

Release of a 1992-2015 time series of annual global land cover maps at 300 m

The CCI Land Cover team is pleased to announce the official release of the **first time series of annual global Land Cover maps at 300 m spanning a 24-year period, from 1992 to 2015**. These 24 global land cover maps were made consistent thanks to the decoupling of land cover mapping and land cover change detection. This innovative effort was supported by state-of-the-art reprocessing of the full archives of 5 different satellite missions providing daily observation of the Earth, including NOAA-AVHRR HRPT, SPOT-Vegetation, ENVISAT-MERIS FR and RR, ENVISAT-ASAR, and PROBA-V for the most recent years.

The European Space Agency launched its Climate Change Initiative (CCI) to provide an adequate response for long-term satellite-based products for climate.

The Land Cover component was addressed by a partnership of eleven European research labs led by UCLouvain, Belgium.

The ambition was to revisit all algorithms required for the generation of successive global land cover products that are consistent over time as required by the Global Climate Observing System.

After 6 years of research, the CCI Land Cover consortium is releasing the very first multi-mission annual time series from 1992 to 2015 providing the land cover for each 300x300 meters pixel of the whole terrestrial surface of the Earth. This achievement was highlighted at the WorldCover conference organised by ESA last March. The 24 annual global land cover maps can be interactively visualized and downloaded on the CCI Land Cover viewer http://maps.elie.ucl.ac.be/CCI/viewer.

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A typology of 22 land cover classes was defined based on the UN Land Cover Classification System and its classifiers to support the further conversion into Plant Functional Types distribution required by the Earth System Models.

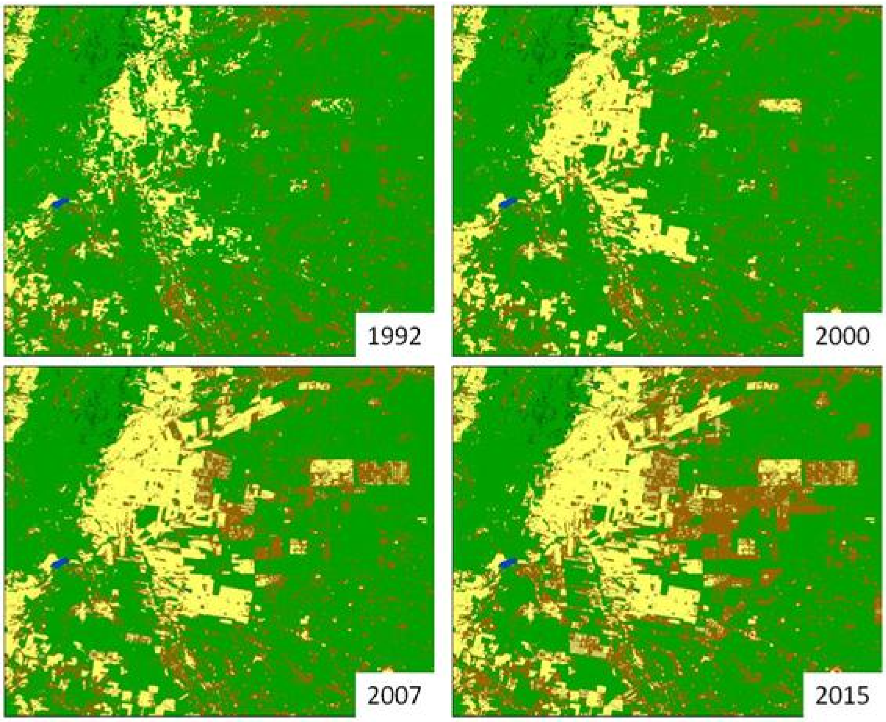
These land cover products rely on the state-of-art reprocessing of five very different satellite missions. The ENVISAT-MERIS Full and Reduced resolution reflectance recorded from 2003 to 2012 is the key data source for land cover discrimination thanks to its 15 spectral bands at 300 m resolution. The NOAA-AVHRR HRPT dataset recorded at 1 km allowed covering the period from 1992 to 1999. This 1992 dataset corresponds to the very first year of daily global observation at 1 km which has been archived thanks to the IGBP initiative.

The temporal consistency in the land cover time series was achieved thanks to an innovative approach consisting in decoupling land cover mapping and change detection.

The classification process applies machine learning and unsupervised algorithms on the whole MERIS FR 300 m resolution archive using most of the MERIS bands to establish a land cover baseline.

The land cover change detection makes use of the AVHRR dataset mentioned above, along with the SPOT-Vegetation time series spanning from 1998 to 2012 and the PROBA-V from 2013 to 2015. Based on similar classification algorithms, annual global land cover maps are produced at 1km resolution from these dataset to serve as input to the change detection algorithm.

The temporal trajectory of each 1-km pixel was systematically analysed to depict the main land cover change for a simplified typology matching the IPCC classes. This innovative change detection method was found quite reliable for the SPOT-Vegetation and PROBA-V missions thanks to their excellent temporal co-registration.



Extracts of the annual land cover maps for 1992, 2000, 2007 and 2015 (Argentina)

In contrast, the poorer radiometric and geometric quality of AVHRR HRPT time series only allowed detecting major changes in contrasted landscapes. As a last step, the change detected at 1 km was disaggregated at 300 m according to the 300 m data availability.

Such an approach avoids independent classification from year to year, thus ensuring temporal and spatial consistency between successive maps.

The inland open waterbodies and the coastline delineation rely on the ENVISAT-ASAR archive processing to derive a water indicator, which was compiled with several other sources of relevant information. This open waterbodies component can be downloaded separately as a 150-m water-no water mask for the global scale including the Polar Regions.

The urban class of these land cover maps is based on the combination of the Global Urban Footprint from DLR (~12m) released in 2016 and the 38m Global Human Settlement Layer from JRC, consolidated with the surface reflectance analysis at 300m with MERIS and PROBA-V. The urban dynamics are therefore depicted at a much better resolution than the 1 km.

This dataset is delivered along with an aggregation tool, enabling re-projection and re-sampling as well as the translation from land cover classes into Plant Functional Types.

In order to further improve this unique dataset made available and to be extended soon to the most recent years, any feedback is very welcome and can be sent to contact@esa-landcover-cci.org .

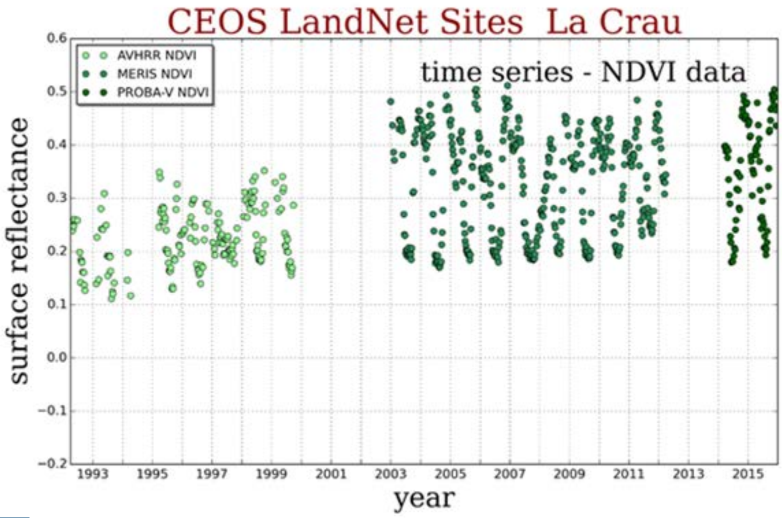
SURFACE REFLECTANCE TIME SERIES 1992-2015

The Surface Reflectance (SR) products consist of a global time series covering the period 1992-2015 based on AVHRR, MERIS and PROBA-V sensor data.

The spectral content encompasses the surface reflectance in the sensor channels and the spatial resolution is 300/1000 m as provided by the sensors. The time series are made of temporal syntheses obtained over a 7-day compositing period. The quality of each global composite is described by a set of quality flags and the uncertainties for each spectral band on a per-pixel basis.

The pre-processing chain developed to generate the products includes radiometric correction, geometric correction, pixel identification (i.e. attribution of a status to each pixel, being "land", "water", "snow", "cloud/cloud shadow" or invalid pixels), atmospheric correction with aerosol retrieval and BRDF correction as well as compositing and mosaicing.

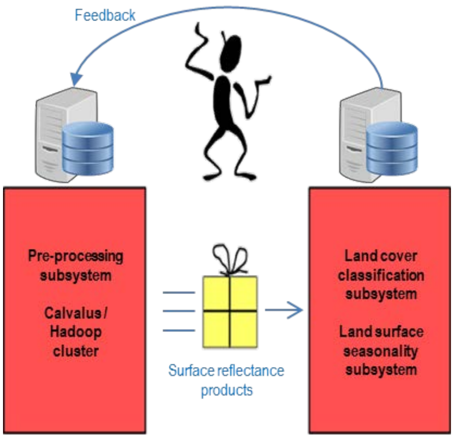
The obtained SR values have been compared with in-situ data from CEOS LandNet sites and with SR products available from other sensors as well as with those from the previous processing version. Besides assessing the quality of individual composites, the quality of the global SR time series will be documented again, with the aim of quantifying its discrimination potential.



Intercomparison between NDVI time series from AVHRR, MERIS FR, PROBA-V sensor data over the CEOS LandNet site La Crau - 1992-2015 without spectral adaptation

CCI Land Cover PROCESSING SYSTEM

The CCI Land Cover processing system is a distributed system with subsystems for pre-processing and for land cover classification located at the sites of the respective partners, i.e. close to the experts.



The pre-processing system is optimised for the large amount of input data. It processes e.g. the full mission MERIS FR and RR dataset to a global 10 years Surface Reflectance time series and into seasonal composites in about 1.5 months on a 90 nodes/368 cores/1000 TB Hadoop cluster using Calvalus for production control of more than 1.000.000 tasks and the management of data processors and versions.
SR products have been transferred to the classification subsystem by offline data transfer because this still provides the best bandwidth for the 60 TB of overall data to be exchanged.

The main effort in the classification chain is not so much the amount of data but rather the computational power needed. It is provided by a multi-core cluster optimised for concurrent computation.

CCI Land Cover processing is not a linear exercise. Small cycles and repetitions within a subsystem have improved the products due to updated processor versions and data quality checks. Also large cycles after analysis of the timeline have led to repetitions, e.g. for the optimal selection of cloud detection algorithms.

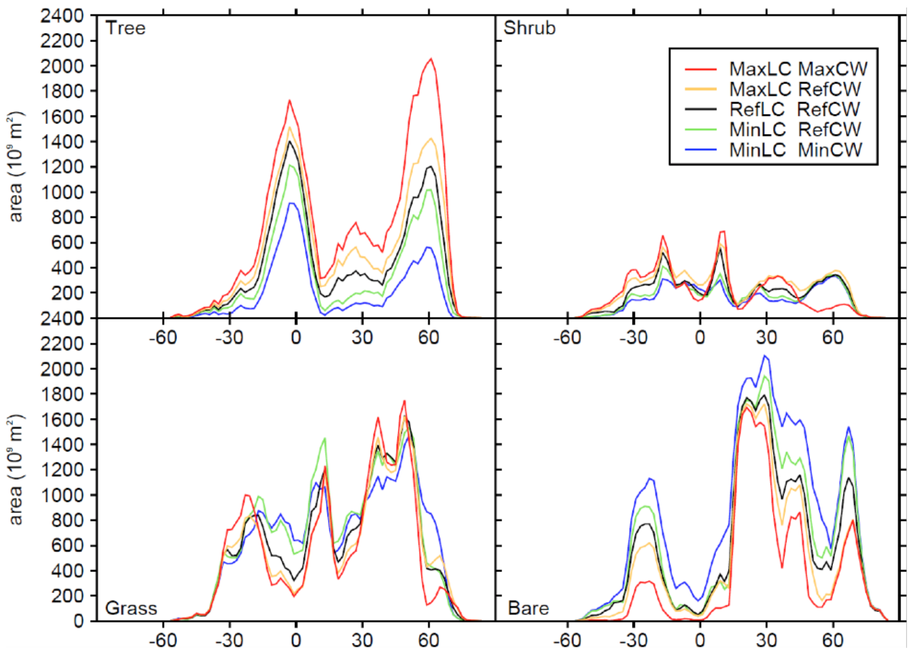
Uncertainty in Plant Functional Type distributions and its impact on land surface models

The spatial distribution and fractional cover of plant functional types (PFTs) is a key uncertainty in land surface models (LSMs) that is closely linked to uncertainties in global carbon, hydrology and energy budgets.

The Climate Modelling Group (CMG) of the CCI Land Cover component has assessed the range of PFT uncertainty derived from land cover maps on simulations of land surface fluxes using 3 leading LSMs (JSBACH, JULES and ORCHIDEE). PFT maps used in LSMs can be derived from a land cover (LC) class map and cross-walking (CW) table that allocates the fraction of each PFT that occurs within each LC class. CMG evaluated the impact of uncertainty due to both LC classification algorithms, and CW procedure, on energy, moisture and carbon fluxes in LSMs.

The impact of PFT uncertainty was examined on 3 key variables in the carbon, water and energy cycles (gross primary production (GPP), evapo-transpiration (ET), and albedo), for 3 LSMs (JSBACH, JULES and ORCHIDEE) at global scale.

Results showed a greater uncertainty in PFT fraction due to CW as opposed to LC uncertainty, for all three variables. CW uncertainty in tree fraction was found to be particularly important in the northern boreal forests for simulated LSM albedo.
Uncertainty in the balance between grass and bare soil fraction in arid parts of Africa, central Asia, and central Australia was also found to influence albedo and ET in all models. Each model had a different sensitivity to PFT uncertainty, for example, GPP in JSBACH was found to have a much higher sensitivity to PFT uncertainty in the tropics than JULES and ORCHIDEE, whereas the inverse was true for ET.



The latitudinal distribution of uncertainty in the area covered by the major vegetation types (tree, shrub and grass) and bare soil. Vegetation areas (y-axis) were calculated using area-weighting for each latitudinal zone with a spatial resolution of 2° latitude

These results show that future efforts in land cover mapping should be focused on reducing CW uncertainty through better understanding of the fractional cover of PFTs within a land cover class. Efforts to reduce LC uncertainty should particularly be focused on more accurate mapping of grass and bare soil fractions in arid areas. In the context of Land Surface Models, these results demonstrate that prescribed vegetation distribution in models is a key source of uncertainty that is comparable to the spread between models for key model state variables.

Visualize and download the CCI Land Cover Climate Research Data Package online

http://maps.elie.ucl.ac.be/CCI/viewer

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www.esa-landcover-cci.org

For more information on the project, please write to: contact@esa-landcover-cci.org