climate change initiative

→ LAND COVER NEWSLETTER

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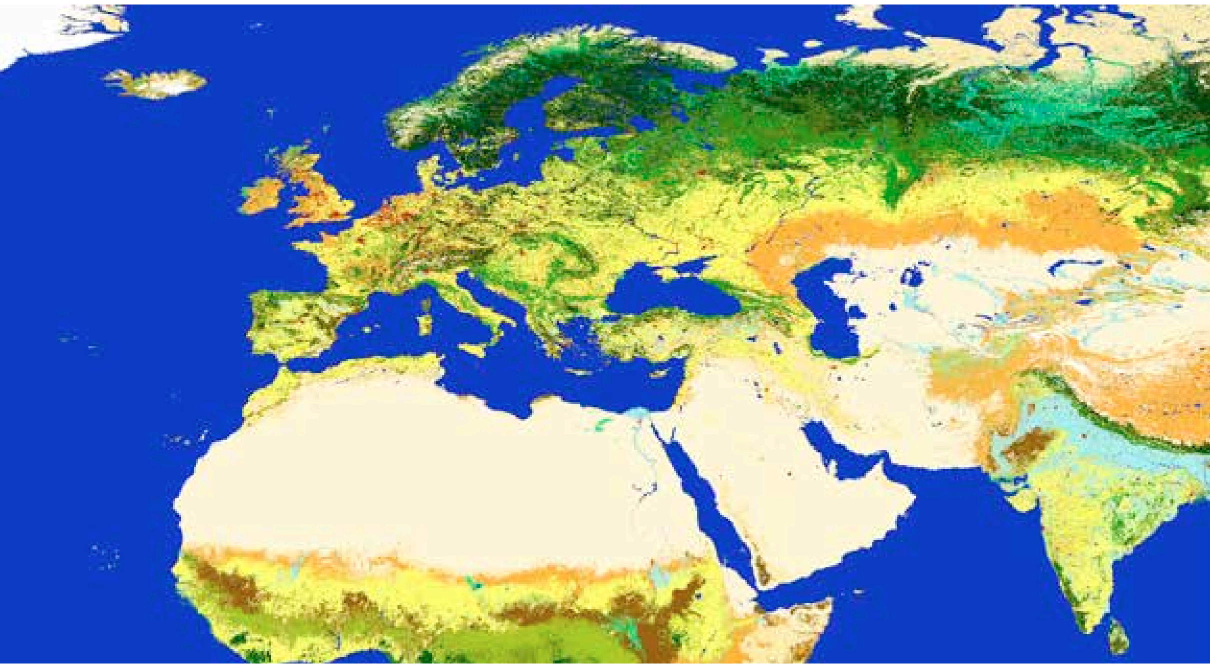

In this issue:

Strength and innovation of Land Cover CCI products

A series of 5 interoperable and consistent products were released in October 2014 to meet the climate modelling community needs for better land cover information. The next step is now to extend the timeline of the dataset to go back in the past to the 1980s-1990s and to cover the current years. In parallel, the project will also move to higher spatial resolution products based on the new ESA Sentinel-1 and Sentinel-2 sensors, to map the land surface and the water bodies at 10-20 meters.

The October 2014 dataset already includes:

(i) 3 global land cover maps at 300m corresponding to the 1998-2002, 2003-2007 and 2008-2012 epochs,

(ii) 3 global land cover seasonality products describing the vegetation greenness, the snow and the burned areas occurrence along the year,

(iii) A global map of open permanent water bodies at 300m,

(iv) The full archive (2003-2012) of MERIS time series processed in 7-day composites and,

(v) A user tool for re-projecting, re-sampling and converting the products into climate model inputs.

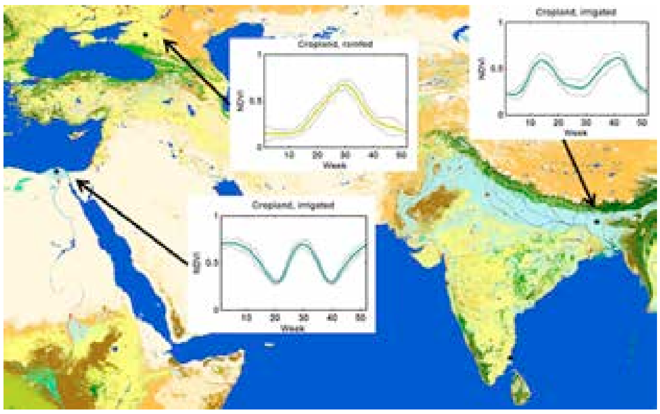

Figure 1: The Land Cover CCI package offers joint consistent static and dynamic information on land cover.

Global LC maps characterize these three areas as croplands and land surface seasonality products show the distinct number and timing of their crop cycles.

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How Land Cover maps impact climate change models

The three climate groups involved in the project are closely evaluating the impact of the uncertainty in Plant Functional Type (PFT) distributions on land surface models. It involves assessing uncertainty in the land cover to PFT cross-walking table, and uncertainty in the classification of land cover classes. The assessment will have a particular focus on the carbon, water and energy budgets. Current results are presented here but the process will extend in the next months and years with the aim of reaching a better understanding of the models' sensitivities to the input data.

The climate modelers at the Laboratoire des Sciences du Climat et de l'Environnement (LSCE, France) used the NDVI seasonality product to evaluate the leaf phenology (seasonal cycle of vegetation) before and after the ORCHIDEE Land Surface Model parameters had been calibrated with another satellite NDVI dataset. This allowed an independent validation of the results, which is crucial when attempting to use data to optimize a model. The main change in the model simulations after optimization was an earlier start to leaf fall (end of growing Season – EOS date) in the autumn across much of the Northern Hemisphere (compare for example Figure a– prior simulation and Figure b – posterior simulation after the optimization).

Comparing to the EOS dates calculated from the Land Cover CCI product (Figure 2d), we can verify that the optimization has been successful, as the posterior simulations match the LC CCI data much more closely than the prior. This demonstrates an alternative, and very beneficial, use of the NDVI seasonality product generated by the project.

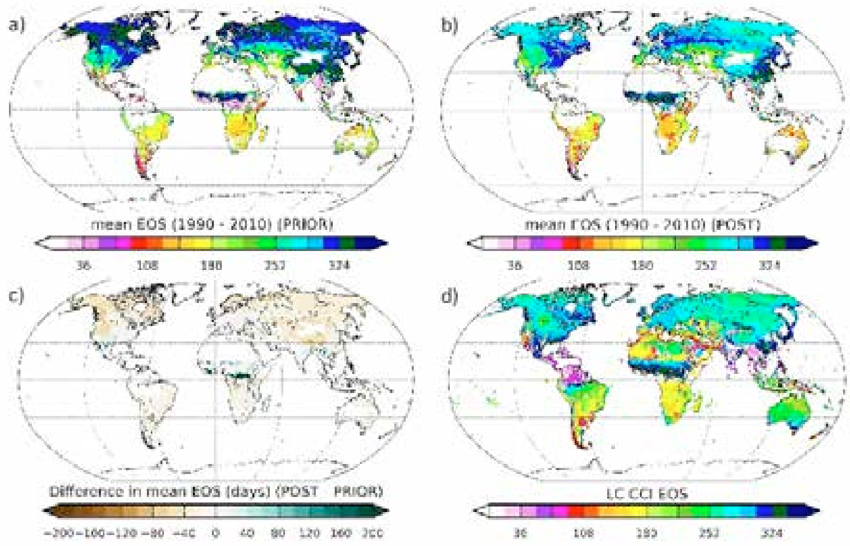

Figure 2: Global maps showing the modelled prior and posterior EOS dates (a, b) and their difference (c) compared to those derived from the LC CCI product (d) or the picture.

At the Max Planck Institute for Meteorogoly (MPI-M, Germany), the water body product is used as a prescribed boundary of wetland extends, but also for the evaluation of recently implemented wetland extent dynamics (WEED) scheme (Figure 3). It is shown that JSBACH wetlands are in the range of the uncertainty of various observations except in the equatorial zone. This result will facilitate further development and improvement of the WEED scheme.

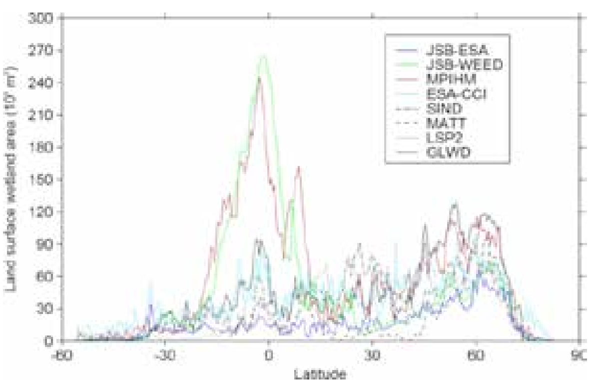

Figure 3: Zonal extension of wetlands for JSBACH with prescribed wetlands boundary (JSB-ESA) and wetland extent dynamics (JSB-WEED) in comparison to MPI hydrological model (MPIHM), WB product (ESA- CCI) and other observations (satellite derived inundation (SIND) by Prigent et al. (2001, 2007), wetland ecosystem map (MATT) by Matthews and Fung, (1987), land surface parameter 2 (LSP2) by Hagemann (2002) and global lake and wetland database (GLWD) by Lehner and Döll, (2004)).

At the Met Office Hadley Center (MOHC, United Kingdom), the Land Cover CCI has been used to improve the representation of land cover in the Unified Model. This has involved running simulations to test the impact of Land Cover CCI data on short time scale numerical weather prediction (NWP) model (Met Office Global Model), and longer term climate time scales (HadGEM3-AO).

Improvements in NWP simulations were found in 1.5m air temperature and relative humidity over northern hemisphere land and tropical land during June, July and August. In HadGEM3-AO climate simulations, improvements in 1.5m air temperature over northern high latitudes were found during spring. This was due to needleleaf tree cover in Land Cover CCI data replacing grass cover, which lead to faster snow melt, and more realistic spring air temperatures. Further improvements were potentially found in the gross primary production of vegetation in south eastern China, and in the dust aerosol load over many arid areas of the world.

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Evaluating the consistency between climatic models

Previously, the climate modellers started assessing the impact of the new land cover maps on their model. One finding of interest was that results between climate models were hard to compare as the reference maps used in control simulations were different between groups. As a result, the project will focus in the coming years on the best way to use consistent simulations across climate models.

Using the new land cover maps to generate new plant functional types mostly led to changes in the high latitudes and tropical regions, where changes from/to forest and bare soil, or from forest to agriculture, respectively have induced strong changes in the surface energy budget, hydrology and seasonal cycle of the vegetation, with concurrent impacts on the carbon cycle. For example, Figure 4 shows changes in mean annual surface albedo and land surface temperature in JULES, JSBACH and ORCHIDEE as a result of using Land Cover CCI in offline land surface simulations. Clearly, changes are not consistent across models, which is in part due to differences in the vegetation.

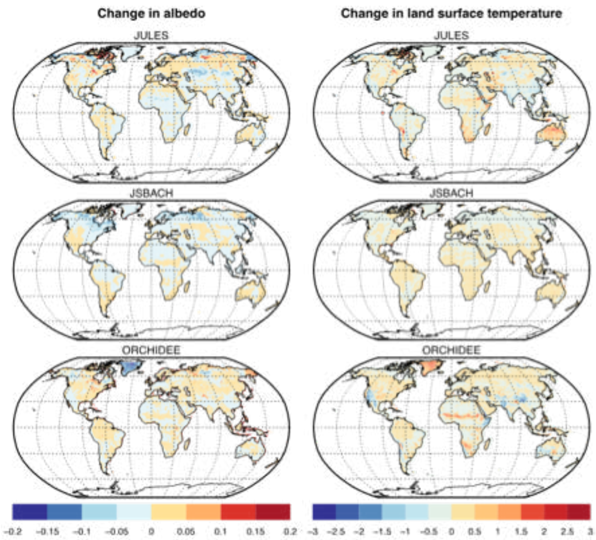

Figure 4: Absolute changes in albedo and land surface temperature (LC_CCI minus Reference simulation) for JULES, JSBACH and ORCHIDEE.

Sentinel-1 for an improved water bodies mapping

The project previously developed a new method to detect water bodies in different environments. The method relied on multi-temporal metrics based on multiple observations of the backscattered intensity by the Envisat Advanced Synthetic Aperture Radar (ASAR) instrument. Our challenge for the future will be to see the potential of Sentinel-1 data for improving the mapping of water bodies based on this method.

A quasi-global indicator of water bodies representative for the year 2010 was derived from ASAR images acquired in ScanSAR mode at spatial resolution of 150 m. Primarily over northern regions, the quality of the SAR-based detection of water bodies was superior to existing global products.

Now, one of the objectives is to demonstrate the capability of Sentinel-1 SAR data to improve the mapping of water bodies achieved with Envisat ASAR. The 30 m spatial resolution of the standard Interferometric Wide Swath Mode (IWS) and the dual-polarization capability shall be used for a more robust detection of water bodies and detailed delineation.

For this, the automated SAR processing and classification chain developed for multi-temporal ASAR data shall be adapted to ingest Sentinel-1 data and related metrics. Scandinavia has been selected as prototype region because of the availability of multi-temporal data already during the ramp-up phase of the Sentinel-1 mission.

Figure 5 shows a false color composite with a pixel spacing of 30 m combining the average HV-backscatter (red), the minimum HV-backscatter (green) and the temporal variability of the HH-backscatter (blue). Water bodies are clearly differentiated from other land surfaces thanks to the low average and minimum HV-backscatter, and the high temporal variability of the HH-backscatter. Currently, the signatures of multi-temporal metrics of the HV-backscatter are analyzed and the existing algorithm for water body detection developed in Land Cover CCI is being adapted accordingly.

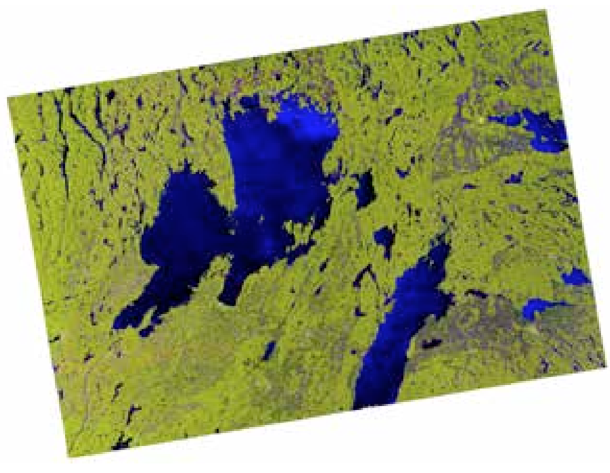

Figure 5: Sentinel-1 false color composite

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New re-processing of the Envisat MERIS archive

Last year, ESA provided a reprocessed MERIS FR dataset, which has been systematically processed for the first time applying a consistent radiometric, spectral and geometric calibration and consistent auxiliary dataset. After additional checks for corrupted inputs, the project has reprocessed this dataset to deliver new Surface Reflectance (SR) time series. This dataset will be released in Autumn 2015.

The SR products consist of a global time series covering the period 2003-2012. The spectral content encompasses the 13 surface reflectance channels and the spatial resolution is of 300 m and 1000 m for the full and reduced resolution datasets respectively. 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" and invalid pixels), atmospheric correction with aerosol retrieval and BRDF correction as well as compositing and mosaicing.

Significant improvements have been brought for the cloud detection, through the development of a new neuronal net and the adaption of particular features, e.g. the temporal-filtering feature.
The new obtained SR values will be compared again with in-situ data from CEOS LandNet sites and with SR products available from other sensors as well as with those from the previous 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.

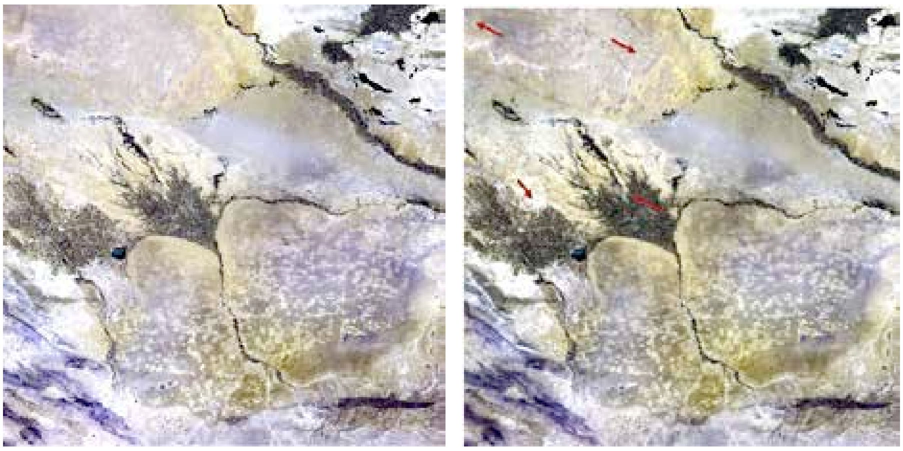


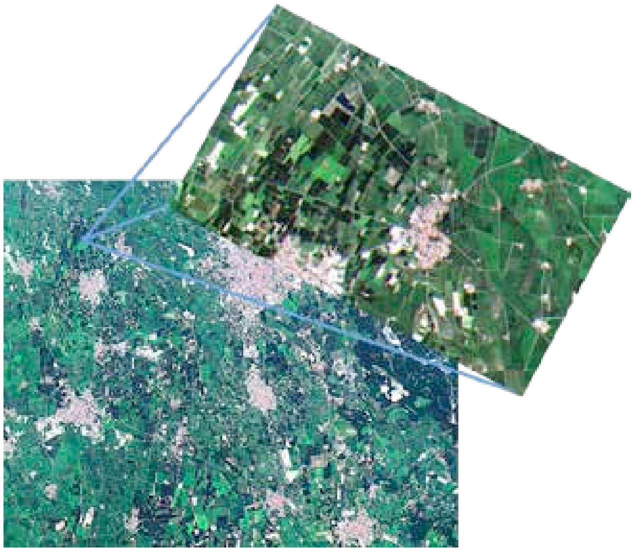
Figure 6: Different versions of 300-m spatial resolution 7-day surface reflectance composite and the result of the improved cloud screening can be observed at indicated locations.

Counting on Sentinel-2 to move to high resolution land cover mapping in Africa

In 2015-2016, the project will work on the generation of a 10-20m resolution land cover map over Africa using Sentinel-2 data.

Developed for Europe's Copernicus environmental monitoring programme and widely anticipated by the whole Earth Observation community, the Sentinel-2A satellite was launched with success on 23rd June, from Kourou, French Guiana, by a Vega rocket.

With its temporal revisit frequency of 5 days, its 13 spectral bands in the visible and infrared, its high spatial resoltution (10-20 meters) combined with its 290 km wide swath, Sentinel-2 will provide unprecedented views of Earth. Further, its compatibility to the Landsat missions will allow building on a long historic time series of observations.



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