Tropical Forests Carbon Dynamics using 10-y SPOT-VEGETATION Time Series and Land-Surface Modelling

The VEGECLIM Project

Inès Moreau, Pierre Defourny and Emmanuel Hanert*

Research Laboratory in Environmetrics and Geomatics - Earth and Life Institute (ELI) - Université catholique de Louvain (UCL)

1. Introduction

Vegetation is a major carbon sink and is as such a key component of the international response to climate change caused by the build-up of greenhouse gases in the atmosphere. However, anthropogenic disturbances like deforestation or fires are the primary mechanism that changes ecosystems from carbon sinks to sources, and are hardly included in the current carbon modelling approaches. Moreover, in tropical regions, the seasonal/interannual variability of carbon fluxes is still uncertain.

In the context of climate change and mitigation policies like "Reducing Emissions from Deforestation and Forest Degradation in Developing Countries" (REDD), it is particularly important to be able to quantify and forecast the vegetation dynamics and carbon fluxes in these regions.

Deforestation in tropical forests

2. Research objectives

The overall objectives of this research is to dynamically assimilate the land-surface characterization obtained from long SPOT-VEGETATION time series (figure 1 et 2) as well as in-situ carbon flux data (figure 5) into the ORCHIDEE global vegetation model (figure 6) in order to improve the forecast of the terrestrial carbon cycle in tropical regions.

More specifically, the optimized ORCHIDEE model coupled with a land-use and land-cover change model for Africa will allow us to determine quantitative estimates of the carbon stocks and fluxes in Central African forests under different climate change scenarios and anthropogenic forcings.

The challenge of this research is to bridge the gap between the land-cover and the land-surface model communities.

3. Research strategy

GLOBAL | **AMAZON BASIN** | **CONGO BASIN**

SPOT-VEGETATION 1 km time series 2000 - 2010

Figure 1. 10 years VEGETATION Composite

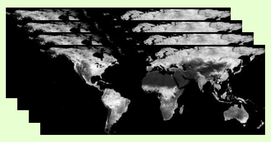


Figure 2. 10 days Composites NDVI –VEGETATION

→ Mean compositing algorithm providing smooth temporal profiles of spectral reflectance

Land-cover characterization - Plant Functional Type (PFT)

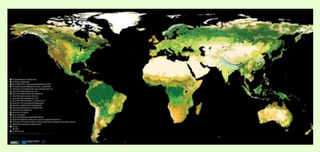
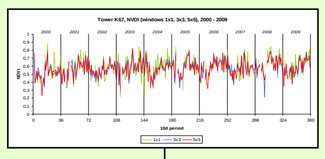


Figure 3. GlobCover classification module (Defourny et al., 2009)

→ First multi-year Land-cover map

→ LC translation into 13 PFT's thanks to LCCS

Vegetation temporal characterization



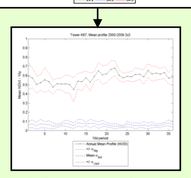


Figure 4. Phenology - Annual NDVI and mean NDVI 10-y

→ NDVI, NDWI, EVI, LAI, fAPAR per land-cover and per ecoregion

→ Vegetation foliage phenology reference data set

In-Situ carbon data

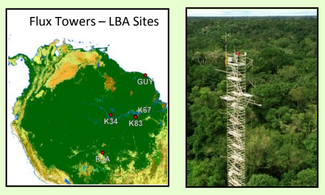


Figure 5. Flux Towers in Amazon Basin

→ Flux Tower measurements : Net Ecosystem Exchanges, Heterotrophic Respiration, LE

Assimilation

ORCHIDEE model

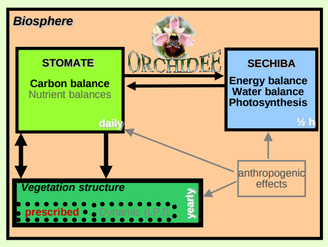


Figure 6. ORCHIDEE Model (Ciais et al., 2005)

→ Organizing Carbon and Hydrology In Dynamic EcosystEm

→ Global vegetation model wich simulate vegetation dynamics and carbon balance

Land-use land-cover change model

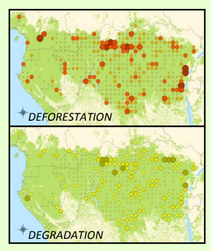


Figure 7. Deforestation and degradation in Central Africa (Duveiller et al., 2008)

→ Landsat images (30 m) + multivariate analysis identifying the driving forces

→ Spatially explicit deforestation/ degradation and socio-economic model (Cellular Automata)

In-Situ carbon data

→ No field data available !

Climate change scenarios

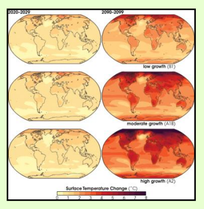


Figure 8. IPCC Fourth Assessment Report (2007)

→ Three different "future climate" IPCC scenarios considered as external forces

Optimization

Quantification and evolution of carbon fluxes and terrestrial carbon stock

→ Combine the large-scale vegetation dynamics with the effect of small-scale disturbances due to human activities

4. Results expected

- **1 km global multi-year land-cover map**
- **1 km global reference data set characterizing the spectral response to vegetation canopy seasonality of each representative land-cover**
- **Optimized ORCHIDEE Model for Amazon Basin and Congo Basin**
- **Land-use land-cover change model for Central Africa to predict deforestation and degradation according various scenarios**
- **Quantitative estimates of the carbon stocks and fluxes in Central African forests for the current situation and predictions under different scenarios for climate change and deforestation**

Contacts and partners

Website project : http://www.uclouvain.be/319155.html

Partners :

Université catholique de Louvain, Research Laboratory in Environmetrics and Geomatics

Ghent University, Laboratory of Plant Ecology

Laboratoire des Sciences du Climat et de l'Environnemement

*** Contact address:**
ines.moreau@uclouvain.be

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