# CARBOAFRICA

**Quantification, understanding and prediction of carbon cycle and other GHG gases in Sub Saharan Africa**

4-Monthly NewsLetter — No. 3: October 2007


## CONTENTS



## EDITORIAL

*Dear reader,*

*This third issue of the CarboAfrica Newsletter intends to take stock of the first year of activities. One year has been passed since the project start and many things have been done, but many others have still to be done! All the preparatory works are almost finished, and the project is now in the full operational phase: instrumentation setting, data gathering, database development, fields campaigns, fields and laboratory experiments, models development, papers preparation, training courses, communication strategy and capacity development.*
*We expect that the second year of the project will produce the first important results that will be the base for a successful project completion during the third year.*
*Thanks to everyone is working on or supporting CarboAfrica!*

The CarboAfrica Secretariat

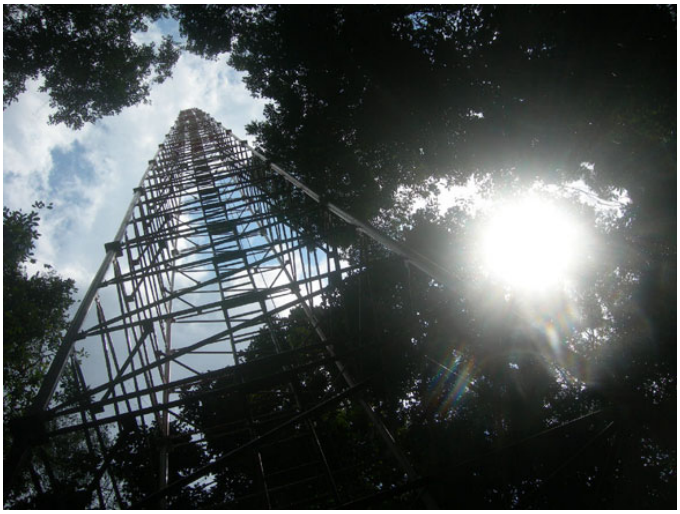
# CarboAfrica: a Year of Activities (01/10/2006 - 30/09/2007)

### *Summary Description of Project objectives*

The overarching goal of CARBOAFRICA is to set up a first attempt of a greenhouse gases (GHGs) fluxes monitoring network of Africa, in order to quantify, understand and predict, by a multidisciplinary integrated approach, GHGs emissions in Sub-Saharan Africa and its associated spatial and temporal variability.
Specific objectives are:
*Objective 1*: Consolidate and expand terrestrial carbon and other GHG fluxes monitoring network of Sub-Saharan Africa
*Objective 2*: Provide an analysis of the requirements in order to establish a terrestrial GHG monitoring system for Sub-Saharan Africa
*Objective 3*: Understand quantify and predict the GHG budget of Sub-Saharan Africa and its associated spatial and temporal variability
*Objective 4*: Assess the current land use change and evaluate the potential for carbon sequestration in Sub-Saharan Africa in the context - inter alia - of the Kyoto Protocol.
*Objective 5*: Maximise the outreach of the project through the communication and capacity building activities dedicated in particular to African institutions and stakeholders.

### *Work Performed and Results Achieved*

We believe that all the above mentioned objectives has been met, at least for the part relevant to the 1st year.
First year activities have been dedicated mainly to coordination, including the consolidation and the improvement of the African network for the monitoring of carbon and other GHGs balances (Objectives 1 & 2).
Probably the main achievement has been the construction (to be completed) of the first Eddy Covariance Flux Tower in an African (Ghana) evergreen tropical forest (Figure 1, 2 and 3). This new site will produce essential information on the African global role in the climate system (Objective 1 & 3).
All the data gathered by the network (previously and during the first year) have been collected in the project database, and processed with the same standardised method (Objective 3).



Figures 1, 2 and 3: the flux tower in the evergreen tropical forest inside the Ankasa Conservation Area (Ghana).

Many field campaigns (Figure 4) have been conducted in key regions for biomass and other ecological parameters (photosynthesis, respiration, LAI, soil characteristics) in order to have direct *in situ* measurements to support the flux estimations and the remote sensing observations (Objectives 1, 2 & 3). Satellite images have been used to be correlated with ground data and try to produce a remote estimation of aboveground carbon stock (Objectives 2 & 3).

Figure 4: an example of field works: soil sampling in Congo.

The study of the fire role in the African GHG emissions (Objective 3) has started through the mapping of the burned areas and the development of a method to estimate the GHG emission from fire. In particular an innovative "fire experiment" has been conducted using a new approach that integrates different techniques.

The modelling activities (Objectives 2 and 3) have started with the development of the CAMIC protocol (CarboAfrica Model InterComparison) that provides the baseline data set of modeled seasonal and interannual variability and associated climate sensitivity of ecosystem-atmosphere $CO_2$ and water exchange. This data set will represent the knowledge 'prior-to-CARBOAFRICA-data ingestion' about carbon and water cycles as implemented in the participating models, and will help to identify areas and conditions with large uncertainties and can serve as a reference for various follow on modelling work (e.g. effects of including dynamic vegetation and land-use change, fire emissions, and using different climate data, improvements via data assimilation of ecosystem level data) (Figure 5).

In regards to the socio-economic applications of carbon studies, the work to estimate the baseline for the reduction of emission from avoided deforestation and forest degradation has already started together with Afforestation and Reforestation (A/R)

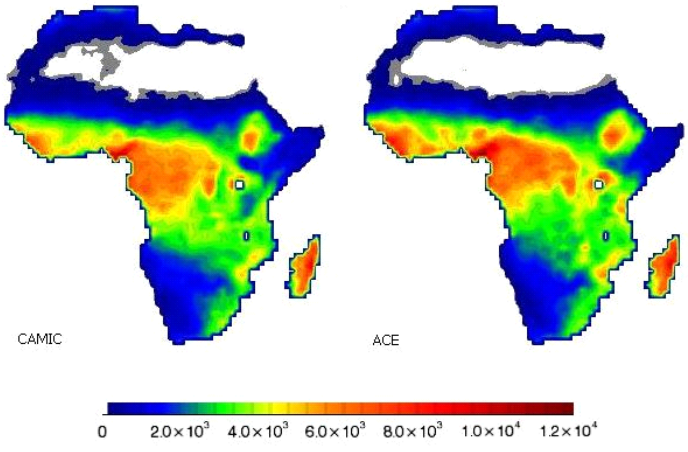



Figure 5: An example of the application of different models.

activities under the frame of the Kyoto Protocol (Objective 4). A global literature review of the current standard methodologies for C, water and nutrient has been carried out to develop a forest biomass database for sub-Saharan Africa, and establish protocols for field activities.
The dissemination and communication activities (Objective 5) have been started also before the official project start, through the development of the project website (http://www.carboafrica.net/) and others tools such as the list server, the 4-monthly newsletter, the brochures and leaflets produced, the networking activities and the development of an agreed communication strategy. All these activities are dedicated in particular to African institutions and stakeholders, in order to raise awareness on the project and to maximise the exploitation of the project's achievements, promoting also the integration of the environmental dimension in the social and economic context (Objective 5).

### *CarboAfrica 1st Annual Meeting*
### *South Africa, 25-26/08/2007*
### *Short report*

On 25-26 August 2007 the CarboAfrica consortium met in the Kruger National Park (South Africa) to present and discuss the activities carried out in the first year of the project and plan the next steps (Figure 6).
More than 40 people, of which 6 from Europe and 9 from Africa, attended the meeting. Each partner (through the presentation of WP leaders and intervention of people directly involved in the activities) presented a communication showing the progress in the practical effectiveness of the activities under his/her responsibility and the first data and results obtained. The compliance with the milestones and the deliverables was showed and the next steps presented and planned.
The project achievements and the respect of the work plan for the first year were evaluated, and any problem and the related possible solutions were discussed.
The future new partner (CESBIO, France) was presented. It will act (together with the participant N.6 CEH, UK) as representative of the AMMA (African Monsoon Multidisciplinary Analysis) EU project. A list of the field stations (in Benin, Mali, and Niger) belonging to the AMMA community that will provide data to CarboAfrica was confirmed. An agreement between the 2 projects was signed.
The instructions for the preparation of the periodic reports requested by the European Commission by the end of the first year were presented.
The advisory board was introduced and the chair and the third and last member were appointed. It is Mr Mamadou Khouma, of the United Nation Development Program (UNDP). The advisory board has produced a report on the project evaluation with comments and suggestions on the project development.
External participants representing initiatives relevant to CarboAfrica were invited to contribute to a specific session on possible cooperation. The foundations for concrete cooperation were laid.
The work was divided into 2 working groups according the 2 main cross cutting topics of the project: Eddy, Leaf and Soil (WG1), and Models and fires (WG2). Details on the next activities to be carried out and the respective deadlines were defined in the Working Groups (e.g. final list of field site and the deadline for data submission; guidelines for soil and GHG measurements; ancillary data and soil parameters to be measured; vegetation types and land cover to be used; variables needed to drive and evaluate models). Details about how to organize the training activities (workshop, seminars, training course) were also discussed.

Figure 6: the 1st CarboAfrica Annual Meeting, South Africa, 25-26/08/2007.

### *International Symposium on*
### *"Carbon-Climate-Human Interactions in Africa"*
### *South Africa, 23-25/08/07*

An international network of carbon cycle researchers, including the CarboAfrica consortium, met 23-25 August 2007 in the Kruger National Park, South Africa to explore the need for increased research capacity to both understand and manage the carbon cycle in Africa, and its interactions with climate change and human activity.
A joint project of the Global Carbon Project (www.globalcarbonproject.org) and the EU project CarboAfrica, this symposium presented the latest research results on African urban and regional carbon exchanges and management. Fundamental scientific evidence was discussed regarding bio-energy production, ocean and freshwater carbon transport and the significant drivers of human caused carbon emissions including fossil fuel emissions, land use changes and fires.
"Better understanding of the interaction of carbon and climate in Africa is needed to effectively manage carbon and biodiversity, mitigate carbon emissions and adapt to global environmental change." said Dr Josep Canadell, Executive Director of the Global Carbon Project.
Dr Guy Midgley, a scientist with the Global Change Research Group at the South African National Biodiversity Institute and co-organiser of the symposium said "With unavoidable regional warming, adaptation is going to become a key skill supporting sustainable development. Our understanding of adaptation to climate change, its limits, barriers and costs, remains

inadequate. We need answers to these questions sooner rather than later."

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Meeting website: www.globalcarbonproject.org/meetings/africa.htm

## *The CarboAfrica Fire Experiment*

In August 2007 a unique and important fire experiment was conducted by CarboAfrica personnel in collaboration with scientists from Kruger National Park (South Africa). The experiment was a collaboration between the University of Leicester, King's College London, CSIR and University of Tuscia. Four plots were burned in the Kruger National Park as part of the controlled burning program of the park (www.sanparks.org). The fires were observed thought different techniques from remote platforms (helicopter and satellite) and at ground level (with the instruments arranged along the perimeter of the plot and oriented downwind) (Figures 7, 8, 9 and 10).

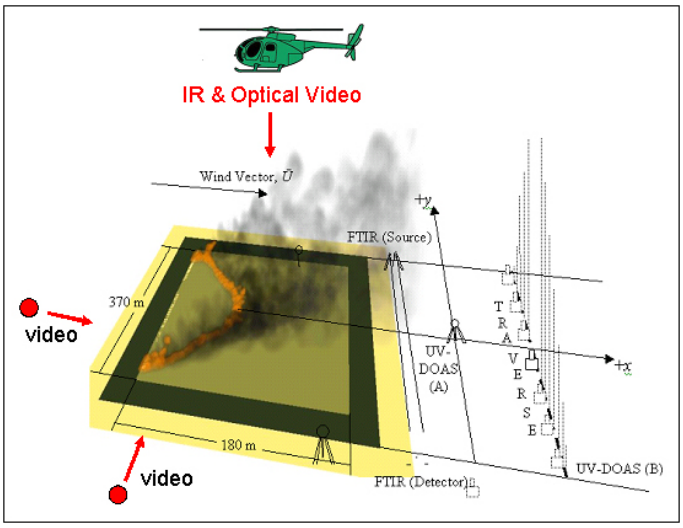


Figure 7: the different integrated approach of the fire experiment: aerial and ground measurements with different techniques.

The main objective of the experiment was to collect measurements of the trace gases emitted during the burning of vegetation, the fire spread, the Fire Radiative Energy (FRE), the smoke and fine particles production and the fuel consumption, contributing to the 'improvement and validation of estimates of greenhouse gas (GHG) and carbon (C) emissions from landscape fires in Africa using current state-of science remote sensing and modeling techniques'.

The experiment used a series of 7 ha experimental burns already planned within Kruger Park to inter-compare a variety of methods for deriving fuel consumption and carbon emissions from fires, including the fire radiative power technique and other remote sensing methods. Another aim was to obtain matched airborne and spaceborne fire radiative power observations of the same fire, so as to test the efficacy of the measurements made from orbiting satellites.

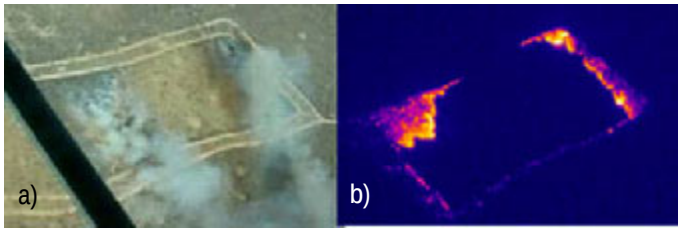


Figure 8: aerial optical video (a) and aerial thermal video (b) of the burning of one plot in the Kruger National Park during the fire experiment.

The experimental burning plots in Kruger were initiated in 1954, and one of only a few ongoing long-term fire ecology research projects in Africa. As part of the WP4 experiment, four plots were burned in the southwest area of Kruger park, the burns were part of a prescribed burning plan undertaken every year, in part to investigate the effect of differing fire frequencies on vegetation and soils.

A series of approaches were used to collect measurements related to the following parameters: trace gas concentrations, wind speed vertical profile, fire rate of spread, fire radiative power, rate of smoke production and total fuel consumption. The fires were observed at ground level and from remote platforms (overhead helicopter and satellite). This variety of techniques provided independent observations of the fire components which will improve our knowledge about the chemical and physical processes characterizing the burning activity, the relation between the Fire Radiative Energy (FRE) and the fuel consumption, the rate of spread of fire and the smoke production. To our knowledge, this is the first time that a UV-DOAS, FTIR and thermal imaging approach has been simultaneously deployed to derive independent measures of fuel consumption, building on the work of direct fuel consumption/FRP comparisons originally presented in Wooster *et al*. (2005).

Figure 9: the different sensors utilised during the fire experiment, in order to measure the gas emissions, the fire spread, the fire radiative energy, the fuel consumption, and the smoke and the particles production, and estimate the burnt biomass.

This experiments builds significantly on that approach by (i) deploying trace gas measuring devices for an independent measure of the flux of trace gases (including carbonaceous gases) from the fire, and (ii) by targeting a fire whose significant size (7 ha) and fuel characteristics are much more representative of the natural system.
The fires were timed to coincide with overpasses of the TERRA and AQUA MODIS sensors, in order to obtain simultaneous FRP measurements from both the helicopter-borne IR camera and the MODIS instrument. This is certainly the first time that this has been accomplished for an African savannah fire, and probably the first time anywhere (no publication of such an experiment exists to our knowledge). The key point here is to examine the FRP measurements made simultaneously by the helicopter-based instrument (relatively close at a few hundred m above the fire) and by the satellite-based instrument (~ 800 km above the Earth). These matchups will allow qualification of the effect of the intervening atmosphere and differing spatial resolution of the observations to be accurately assessed, in a way that has hitherto not been possible.
A field survey of existing (large-scale) burned areas inside the park was recorded using a GPS. This information will be valuable for the satellite analysis because it can be used as a training set for the classification of burned areas from the AATSR satellite data, and/or as a validation tool or the burned area product.


Figure 10: the burnt plot before (a) and after (b) the fire.

Direct measurements of emission fluxes: to the best of our knowledge, this was the first attempt to measure directly the emission fluxes of $CO_2$, $H_2O$ and particulate matter deriving from biomass burning, and the EOLO system applied in this experiment [Fratini *et al*., 2007] is among the first instruments specifically designed to measure fluxes of fine particles in the 0.3-7.0 μm optical range by means of the EC technique. For the fast acquisition of $CO_2$ and $H_2O$ concentration data, a Li- 7500 (Licor, Lincoln, Nebraska, USA) open path infrared gas analyzer was used. Size-segregated concentration data of particles in the optical range 0.26-7.00 μm were acquired by EOLO. A WindMaster Pro (Gill, Lymington, Hampshire, UK) sonic anemometer was used for 3D wind and sonic temperature data. Data from the three sensors were collected and stored by a unique PC, and fluxes are calculated in post-processing. Finally, particle samples were collected on filters (one filter per plot), to assess their optical and chemical properties.
The fire experiment was conducted in close collaboration with Dr. Navashni Govender and her staff (ca. 15) from the scientific service of Kruger National Park.

## *A Safari in the Kruger National Park (South Africa)*

People who participated in the above mentioned experiments and meetings in the Kruger Park has had the unique chance to experience a wonderful safari in the protected area with the greatest diversity of wildlife in Africa (www.krugerpark.co.za). Enjoy the photos below (thanks to Dario Papale).

# Related Links

ACE – African Carbon Exchange (ACE) Project
http://www.nrel.colostate.edu/projects/ace

AfDevInfo - African Development Information Services
www.afdevinfo.com/htmlreports/newsletter_7.aspx

AMMA - African Monsoon Multidisciplinary Analysis
http://amma.mediasfrance.org

CARBOEUROPE (Integrated Project CarboEurope-IP, Assessment of the European Terrestrial Carbon Balance)
http://www.carboeurope.org

Climate Change and Africa
www.climate.org/CI/africa.shtml

EO-LANDEG (Earth Observation initiative in a former homeland of South Africa in support of EU activities in land degradation and integrated catchments management)
http://www.eolandeg.com

ESASTAP - European South Africa Science and Technology Advancement Programme
http://www.esastap.org.za/esastap/home/index.php

European Commission - Evaluating protected areas in Africa
www-tem.jrc.it/PA/index.html

FIRMS - Fire Information for Resource Management System
http://maps.geog.umd.edu/firms

FLUXNET (Integrating Worldwide $CO_2$ Flux Measurements)
http://www.fluxnet.ornl.gov/fluxnet/index.cfm

GCP - Global Carbon Project
http://www.globalcarbonproject.org

ILEAPS - Integrated Land Ecosystem-Atmosphere Processes Study
http://www.atm.helsinki.fi/ILEAPS/

Marien Ngouabi University - University of Brazzaville, Congo
http://www.univ-mngb.net/

NEPAD - New Partnership for Africa's Development
http://www.nepad.org/

ROSELT - Réseau d'Observatoires de Surveillance Ecologique à Long Terme
mdweb.roselt-oss.org/index.php?la=eng

SAFARI 2000 Project
daac.ornl.gov/S2K/safari.html

TCO - Terrestrial Carbon Observation
http://www.fao.org/gtos/TCO.html

TroFCCA - Tropical Forest and Climate Change Adaptation
http://www.cifor.cgiar.org/trofcca

# Carboafrica Bibliographic Archive

CarboAfrica aims to create an archive of a comprehensive bibliography of papers related to Africa, carbon cycle, GHG and Climate Change. Therefore, please send to CarboAfrica@fao.org any document, publication, and presentation relevant to the topics mentioned above and CarboAfrica in particular. Then we will put them in the website http://www.carboafrica.net as downloadable documents, or just as references. In any case please let us know if there are any intellectual property rights and/or citation rules to be respected.

## CarboAfrica NewsLetter N. 3

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*Please circulate this issue to any interested people and ask them to join the CarboAfrica list server, in order to be informed on important incoming events and receive project news, documents and the periodic 4-monthly newsletters.*

http://www.carboafrica.net/listserver_en.asp