CO_2 exchanged above a cultivated savanna in Sudanian region in northern part of Benin, West Africa

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Introduction

High uncertainties remain on Africa's terrestrial carbon budget, especially on African's savanna ecosystems.

Models simulating carbon dynamics need site level measurements for calibration and validation. With this goal, the AMMA and CarboAfrica projects had installed few flux towers in Africa, especially in Benin, in the West part of the continent.

Objectives of this study

→ to estimate the net ecosystem exchange of a Sub-Saharan Savanna in Western Africa.

→ to determine some mechanisms and factors that control the daytime and nighttime fluxes in the Savanna.

Methods

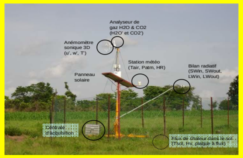
-Measurement period : Twenty-one (21) months between August 2007 and April 2009

-CO_2 and H_2O fluxes measured with the eddy covariance method.

-Micrometeorological measurements

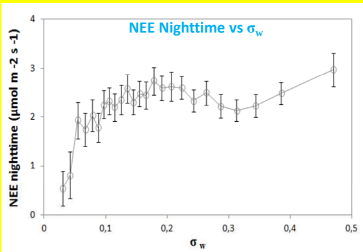
-Inventory of dominating species around the tower (about 1kmx1km).

- All data treated following the EUROFLUX methodology (Aubinet et *al.*, 2000).



-Night time CO2 flux correction : data selection criterion based on σ_w (Acevedo et *al.*, 2008).

- σ_w threshold : 0.12.



Results

Site description and meteorological conditions of Eddy covariance measurements

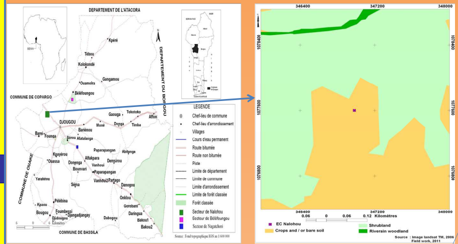


Figure 1. Site of Eddy Covariance and soil occupation about 1kmx1km

- Cultivated Savanna
- Nalohou village, Donga catchment, Northern part of Benin (450 km NW of Cotonou), West Africa (74°N, 1.60° E, 449 m asl)

- Site location : "*Northern savanna belt*".
- Vegetation : Woodland, Shrubland and crop.
- No Herbaceous in dry season (burned by farmers).
- Slope : 2%.
- Soil type : tropical ferruginous soil dominates.

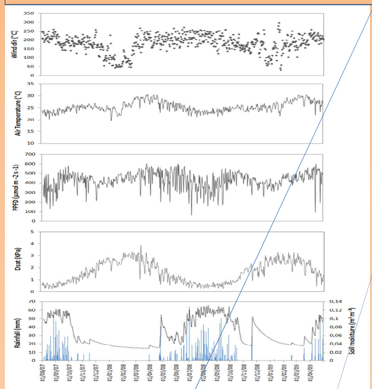
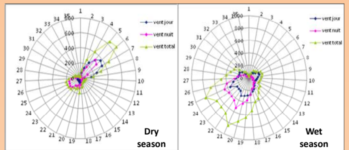


Figure 2. Mean daily meteorological conditions conditions

- Sudanian climate: One dry season (November to March) and one raining season (April to October)
- Mean annual rainfall : 1200 mm
- Mean annual temperature : 25.3 °C
- Mean daily wind speed : 0.53 m/s to 3.12 m/s
- Inter-tropical zone : 2 maxima et 2 minima PPFD
- After rain, rapid soil moisture decrease
- Winds: mainly SW in wet season, SW and NE in dry season.



CO_2 fluxes responses to PPFD

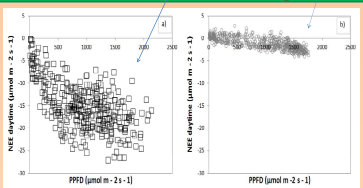


Figure 3. Response of net exchange ecosystem (NEE) to PPFD: a) rainy season (August 2008) and b) dry season (January 2008)

- Different responses according to the season
- Wet season: CO_2 assimilation increases with increasing PPFD following a typical curvilinear function; saturation for PPFD > 1000 µmol $m^{-2}s^{-1}$.
- Dry season: Very small response of CO_2 flux increases to PPFD due to the small amount of vegetation.

Nighttime CO_2 fluxes responses

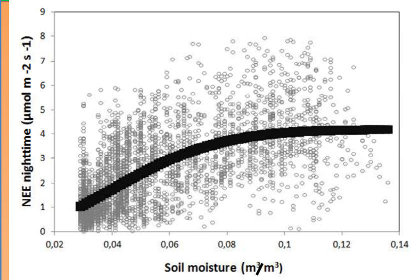


Figure 4. Response of Nighttime net exchange ecosystem to soil moisture during all period

- Below Sm = 0.1 m^3m^{-3}, respiration increases with increasing soil moisture.
- Above Sm = 0.1 m^3m^{-3}, the respiration response saturates.

•Proposed response curve:

$$TER = a\left(1 - exp\left(-b(Sm)^2\right)\right)$$

a=4.2 µmol m^{-2} s^{-1}, b=370, R^2= 0.47

No clear relation of residuals with either air or soil temperature was observed

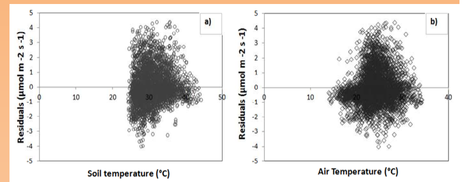


Figure 5. Evolution of residuals nighttime net exchange ecosystem (NEE): a) soil temperature and b) air temperature

Main features

❑**Response to PPFD**: Larger CO_2 assimilation (up to 25 µmol m^{-2} s^{-1}) in wet season due to the importance of vegetation. Practically no response to PPFD in dry season (reduced vegetation, stomatal limitation due to drought).

❑**Response to soil moisture**: Ecosystem respiration remains under the control of soil moisture below 0.1 m^3m^{-3}.

❑**Response to temperature**: No respiration response to temperature : masked by the response to soil moisture ? No respiration sensitivity in this temperature range ?

❑**To be continued ...**

Acknowledgements

This work was financed by "Agence Belge de Développement" (CTB) and l'"Association pour l'Agriculture et le Développement Durable" (A2D). We thank also members of AMMA-Benin project for supplying the Eddy covariance and complementary micrometeorological data set.