Soil CO2 efflux in a Congolese savannah: seasonal and interannual patterns, and comparison with eucalypt plantations

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Introduction

Evaluation of the impacts of land use change on the potential for carbon sequestration.

→ Congo : afforestation of savannah by industrial plantation of eucalyptus

Soil CO2 efflux (Fs) : large component of ecosystem respiration with a high spatial and temporal variability.

→ Need to evaluate environmental controls on Fs to understand C cycling and sequestration in soils

Objectives : analyse of seasonal and inter-annual variations of Fs in a savannah and comparison with eucalyptus plantation.

Study site (Tchizalamou, N-NE Pointe Noire)

Savannah dominated by Loudetia Simplex, burned every year

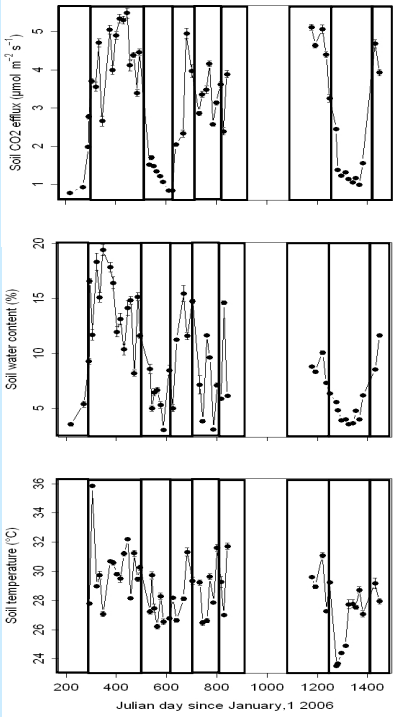
Deep sandy soil (arenosol)

Mean annual precipitation : 1600 mm

Mean annual air humidity and air temperature : 88% and 24°C

1. Seasonal and interannual pattern

(2006 September, 2009 December)



→ **High temporal variability of Fs**

2. Model

soil respiration (Fs) as a function of soil water content (SWC), soil temperature (Ts) and absorbed photosynthetically active radiation (APAR) **: Comparison savannah - eucalyptus**

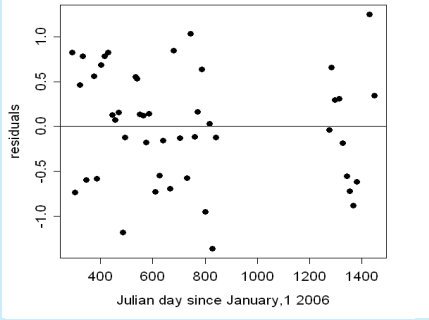
	Savannah			Eucalyptus		
	Q10	R^2	RMSE	Q10	R^2	RMSE
$R = Rsm\,[1-exp(-a(SWC-SWC_0))]$ *(Eq1)*		0.42	1.16		0.72-0.89	0.17-0.48
$R = Rsm\,[1-exp(-a(SWC-SWC_0))]exp[b(Ts-28)]$ *(Eq2)*	2.04	0.55	1.02			
$R = Rsm\,[1-exp(-a(SWC))]exp[b(Ts-28)] * [(APAR/APARmax)^c$ *(Eq3)*	1.62	0.82	0.65			

Rsm = maximum soil respiration, SWC_0 = minimum soil water content, APAR estimated from LAI and incident PAR

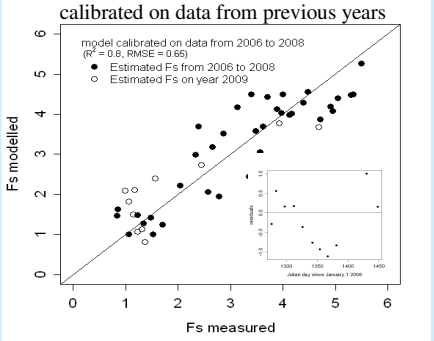
→ **Importance of carbon allocation to roots and autotrophic component compared to eucalyptus plantation**

3. Model quality

Residual distribution



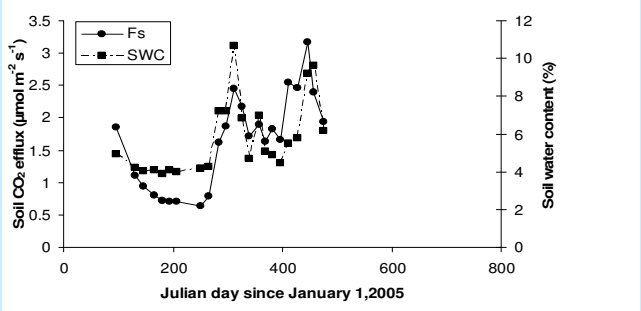
Estimation of Fs on year 2009 using a model calibrated on data from previous years

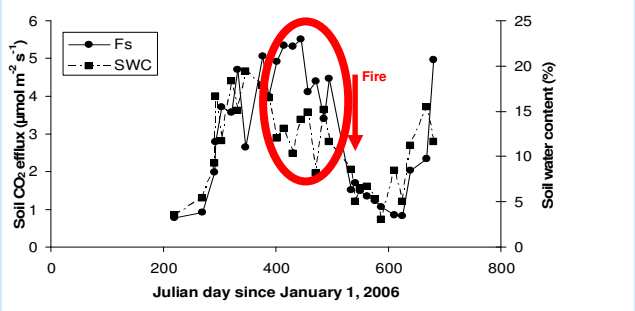


→ **Predictive model** :

Model able to predict rather accurately Fs using data on SWC, Ts, LAI and incident PAR (APAR)

4. Comparison savannah – eucalyptus plantation





	Cumulated soil C efflux (gC m^{-2})
Savannah (year 2007)	1195
Eucalyptus plantation	465-744

→ **Fs remains high despite decline in SWC at the end of the wet season**

Higher cumulated Fs in savannah

↳ Could be explain by the **large carbon allocation belowground** at the end of the wet season

Conclusion

Accuracy of the model is improved by adding APAR variable compared with the model using only SWC.

→ **Explained by the large carbon allocation belowground at the end of the wet season in savannah compared to eucalyptus plantation.**

→ **Results suggest strong coupling between Fs and GPP**