Soil CO₂ efflux in a Congolese savannah: seasonal and interannual patterns, and comparison with eucalyptus 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)
Soil 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)

1.1. 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

\[
R = R_{sm} \left[ 1 - \exp(-a(SWC-SWC_0)) \right] \exp[b(Ts-28)] \times \left[ \frac{APAR}{APAR_{max}} \right]^{c} \quad (Eq1)
\]

\[
R = R_{sm} \left[ 1 - \exp(-a(SWC)) \right] \exp[b(Ts-28)] \quad (Eq2)
\]

\[
R_{sm} = \text{maximum soil respiration}, \quad SWC_0 = \text{minimum soil water content}, \quad APAR = \text{estimated from LAI and incident PAR}
\]

3. Model quality
Estimation of Fs on year 2009 using a model calibrated on data from previous years

Residual distribution

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