Fluxes of CO_2, CH_4 and N_2O in a short-rotation poplar plantation after conversion from agricultural land

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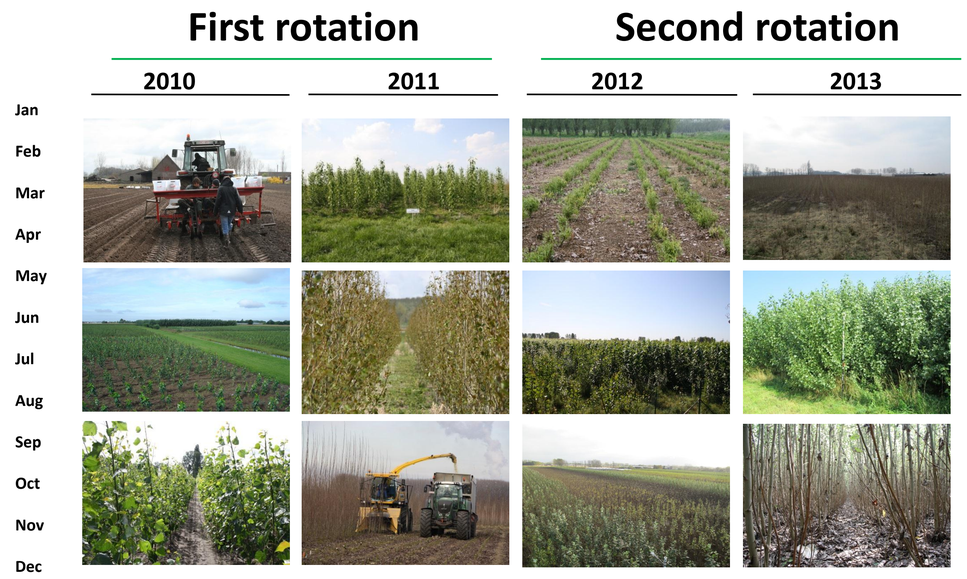
Introduction

Monitoring the exchange of greenhouse gases (GHG) between short-rotation coppice (SRC) plantations and the atmosphere is crucial to quantify their carbon sequestration potential.

We report on the greenhouse gas fluxes (CO_2, CH_4, and N_2O) measured using eddy covariance in a SRC poplar plantation located in Lochristi, Flanders (Belgium).

The site is a multi-clonal SRC planted in April, 2010 in a double row design with a density of 8000 plants ha^{-1}.

Fig. 1 Aerial view of the eddy covariance tower to monitor the GHG exchanges



Results

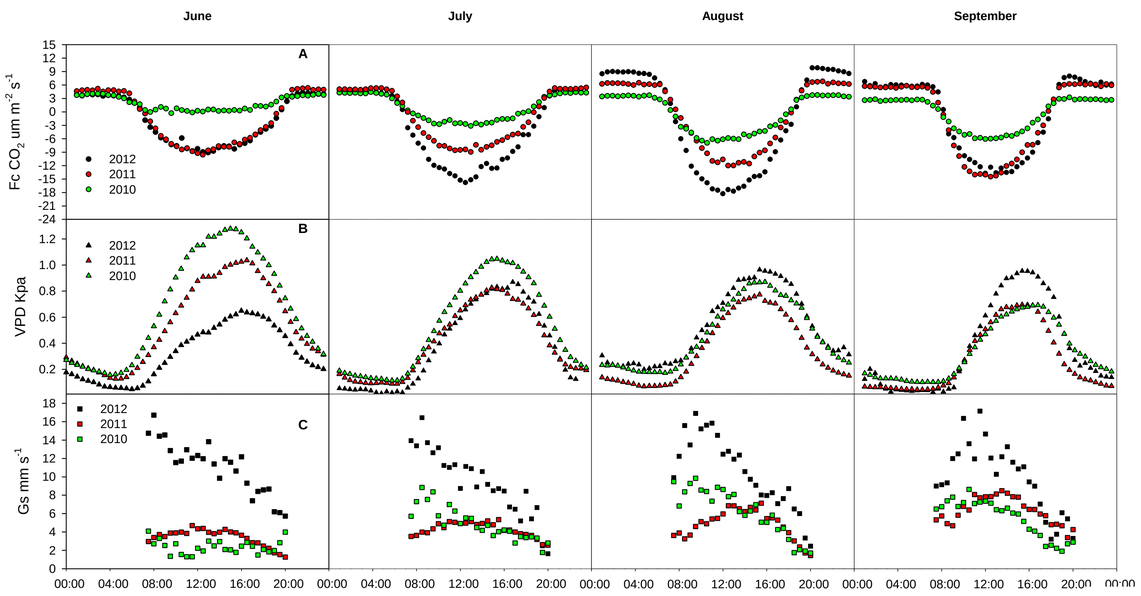


Fig. 2. Daily trend based on monthly averaged CO_2 fluxes (panel A) , VPD (panel B) and surface canopy conductance (panel C)

Over the three years we observed a constant increase of the daily CO_2 uptake particularly in July and August.

CO_2 uptake occurred mainly during the morning (panel A) with a maximum uptake around 12:00 (local standard time) in July and August.

The rapid decrease in the afternoon is mainly associated with a constant increase of the VPD until 16:00 (Fig. 3, panel B) and a decrease of the surface canopy conductance (panel C).

One-way ANOVA indicated that there was a significant difference of the surface canopy conductance values in 2012 as compared to 2010 and 2011 F (2,290) = 117 $p < 0.05$ while the difference was not significant between 2010 and 2011 ($p > 0.05$).

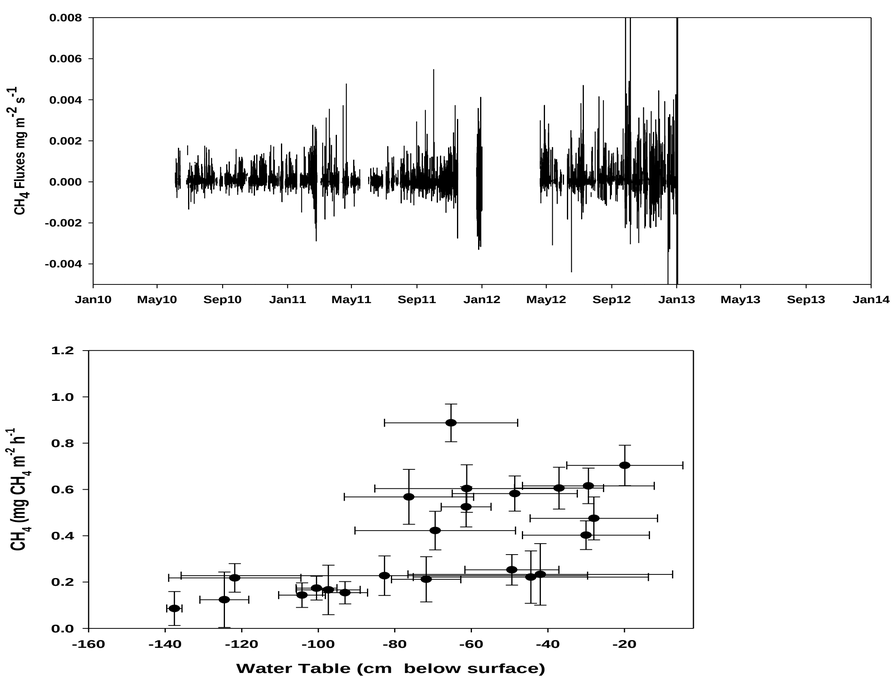


Fig. 4. Temporal dynamics of the half-hourly CH_4 fluxes (A) and relationship with water table depth (B): displayed are monthly averages and standard errors for the water table, and monthly averages and propagated errors for the CH_4 fluxes.

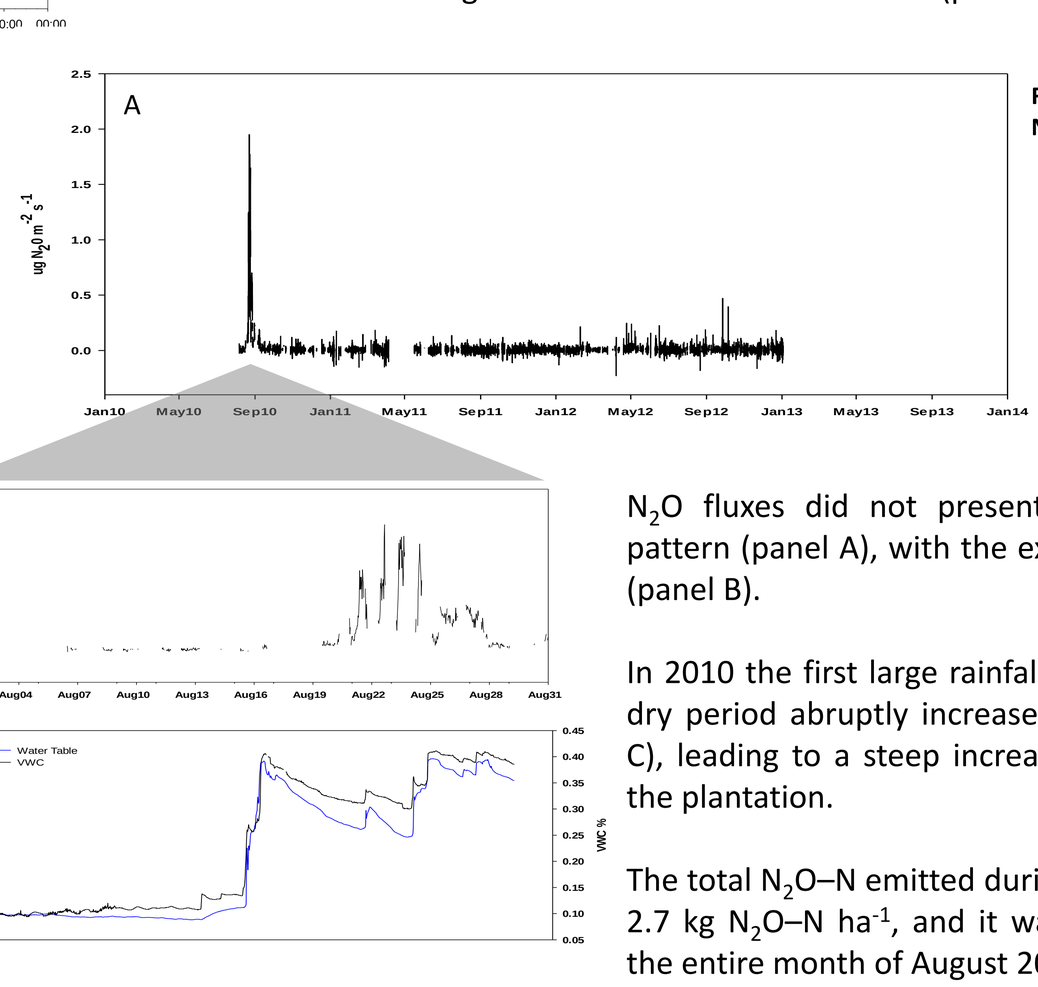


Fig. 3. Temporal dynamics of the N_2O emission.

N_2O fluxes did not present a well-defined diurnal pattern (panel A), with the exception of a few periods (panel B).

In 2010 the first large rainfall event after a prolonged dry period abruptly increased the water table (panel C), leading to a steep increase in N_2O emission from the plantation.

The total N_2O–N emitted during just a week was about 2.7 kg N_2O–N ha^{-1}, and it was 3.1 kg N_2O–N ha^{-1} for the entire month of August 2010

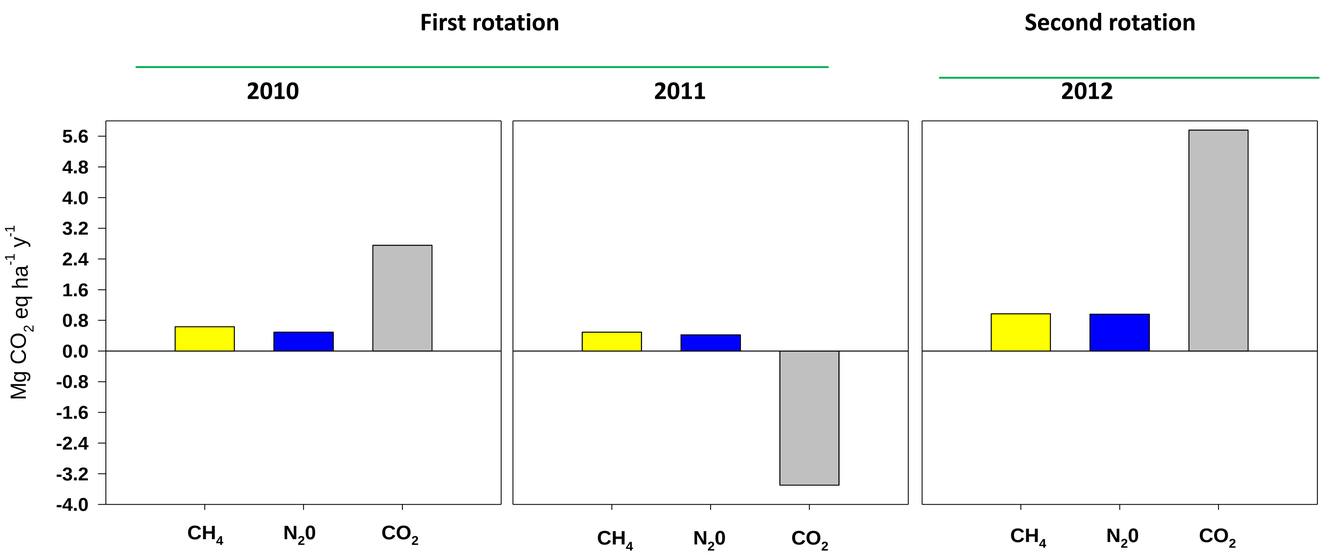


Fig. 5. Overall GHG balance during the 1st and 2nd year of the 1st rotation and first year of the 2nd rotation

Conclusions

- **GHG balance after the 1st rotation (and after the first year of the 2nd) appears to be a C source.**
- **No clear daily or seasonal dynamics were identified for CH_4 and N_20 fluxes.**
- **Next steps : (i) to quantify the C offset that can be achieved by producing 2nd generation biofuels heat and electricity; (ii) to quantify total energy and GHG balance of two entire rotations.**
- **Final objective of the project will be to provide practical recommendations to the policy makers on how to implement large-scale bioenergy poplar plantations.**

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