Carbon balance of a grazed pasture and its response to grazing management

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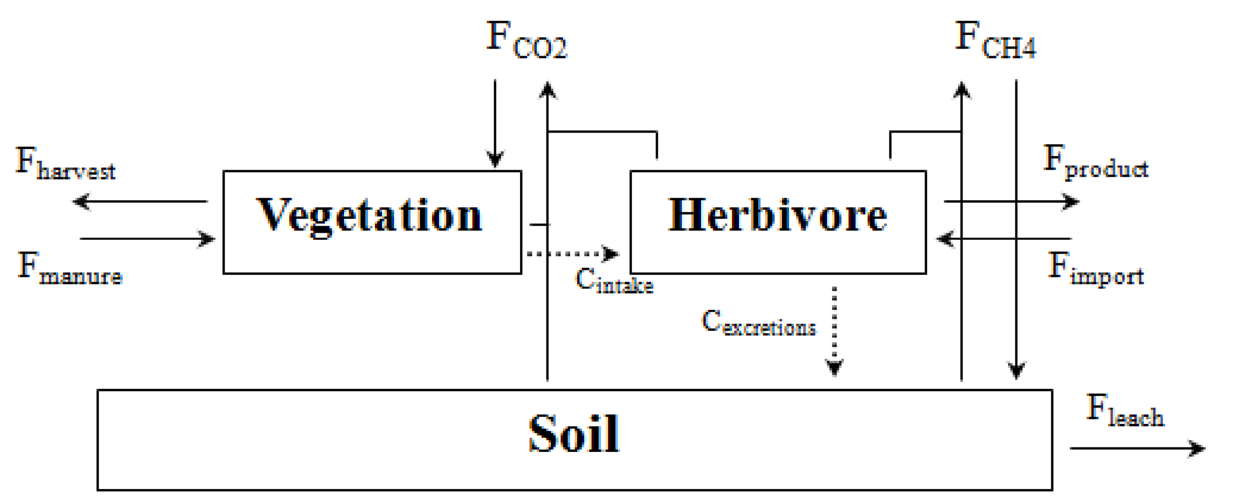
Carbon budget of the pasture

Jérôme et al. submitted to AFM

Theory and methods

$$NBP = F_{CO2} + F_{CH4\text{-}C} + F_{manure} + F_{import} + F_{harvest} + F_{product} + F_{leach}$$

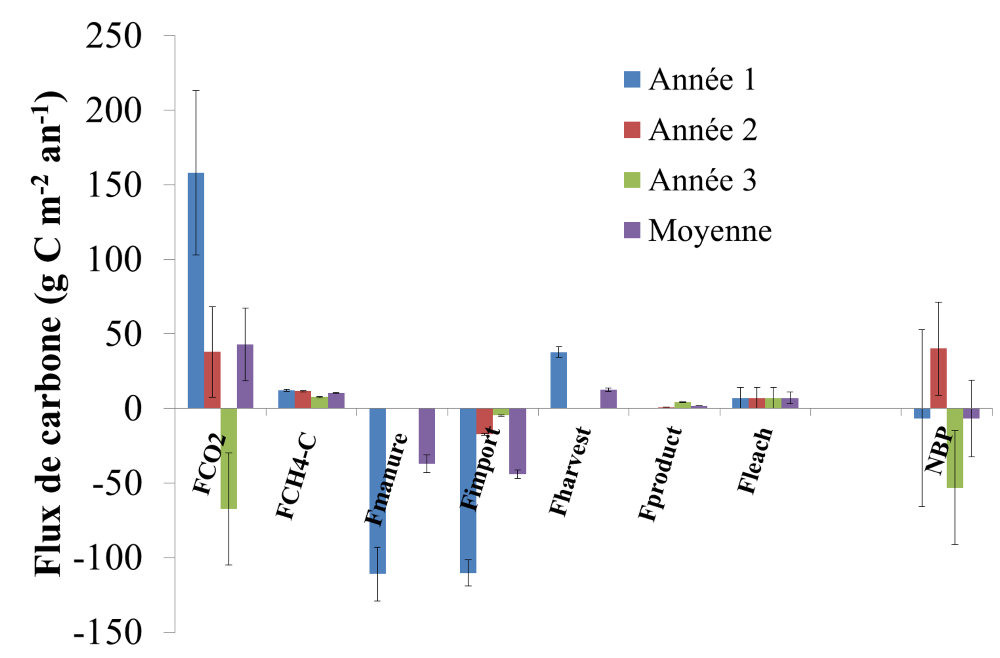
C balance of a grassland grazed by cattle



- F_{CO2}: Eddy covariance
- $F_{CH4\text{-}C}$: Based on dry matter intake
- F_{manure}:
- F_{import}: } m× $C_{content}$
- $F_{harvest}$: $C_{content}.(m_{beforeharvest}-m_{afterharvest})$
- F_{leach}: 7 ± 7gCm^{-2}y^{-1} (Schultze et al., 2009)
- $F_{product}$: $C_{intake}+F_{import}+F_{CH4\text{-}C}+C_{resp}+C_{excretions}$

A three year budget was implemented for a 4.2 ha pasture located in Wallonia (Dorinne Terrestrial Observatory, DTO)

Results



3 year carbon balance of the pasture including vertical (Eddy covariance) and horizontal (alternative techniques) fluxes. Data set covers 3 years from may 2010 to may 2013.

- Mean NEE= +43±24 gCm^{-2}yr^{-1}
- Mean NBP=+7±26 gCm-2yr-1
- The DTO site is C neutral
- Main driving variables :
  - organic fertilization
  - feed supplement
  - climate (direct and indirect, through management)
- At daily and seasonal scale, grazing impact on CO_2 fluxes blurred by climate response

⇒ Necessity to better highlight them

Direct and indirect grazing impact on C_{O2} fluxes

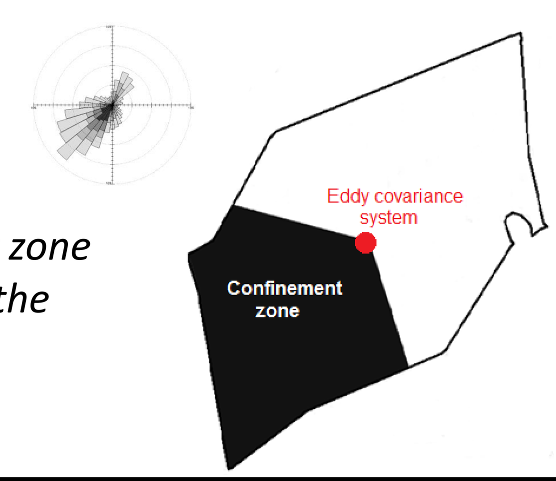
Published : Jérôme et al. (AEE 194, 7-16, 2014)

Study of direct impact by cattle confinement experiments

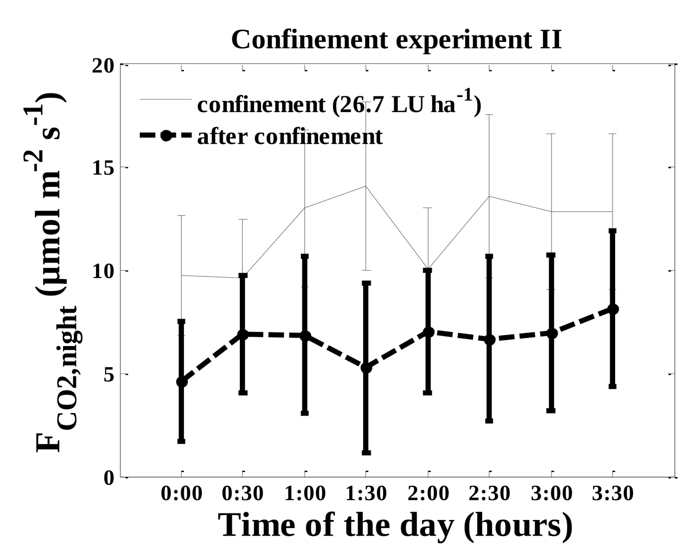
- Cattle confinement (26 LU ha^{-1}) during one day.
- No cattle before and after confinement.
- F_{CO2} comparison before, during and after confinement.
- Investigation of the flux difference

⇒ cattle respiration.

Confinement zone is located in the main wind direction

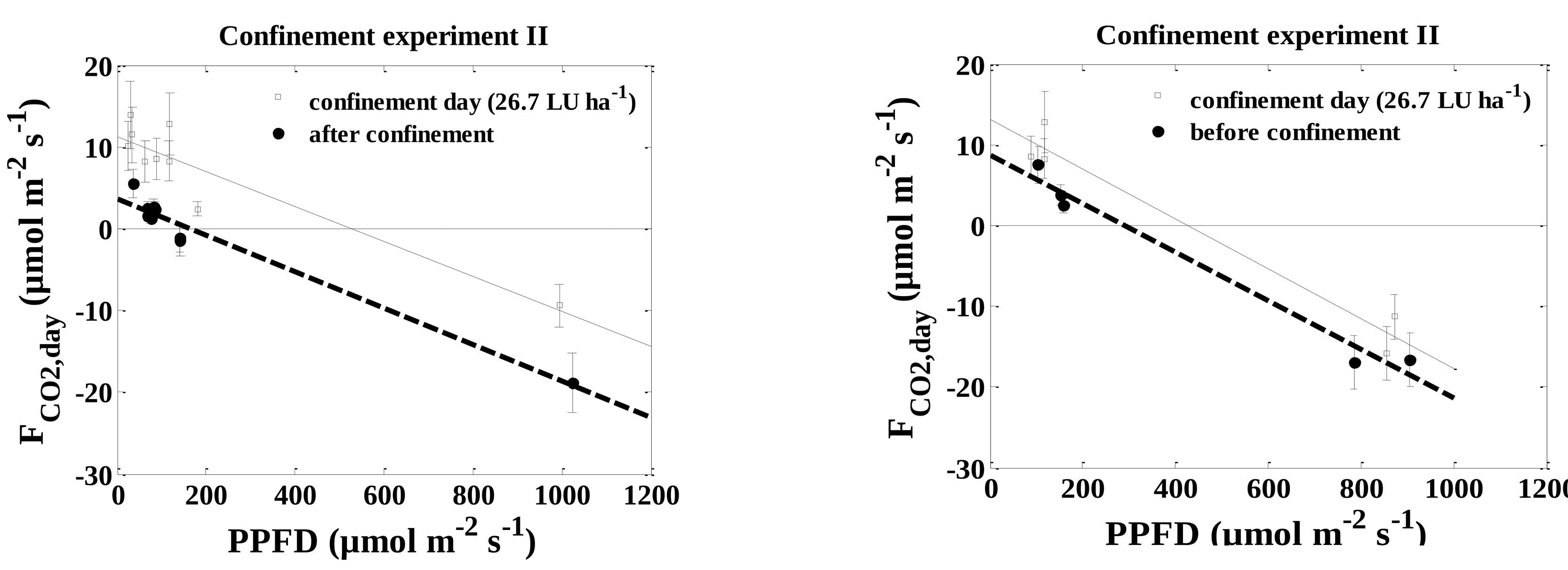


Results



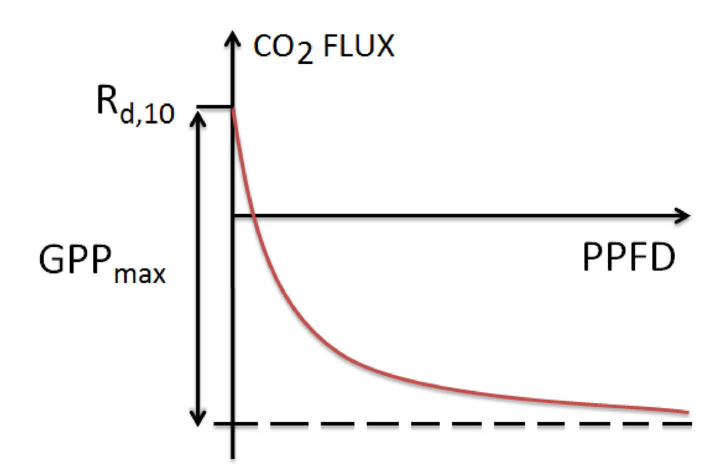
Nighttime CO_2 flux evolution during and after confinement

- Night F_{CO2}, larger during confinement than before or after.
- Day F_{CO2}, more positive (less negative) during confinement than before or after.
- On this basis, cattle respiration estimated to 2.59 ± 0.58 kg C LU^{-1}d^{-1} (8% of TER in at DTO)



Daytime F_{CO2} response to PPFD during and after (left) or before (right) confinement.

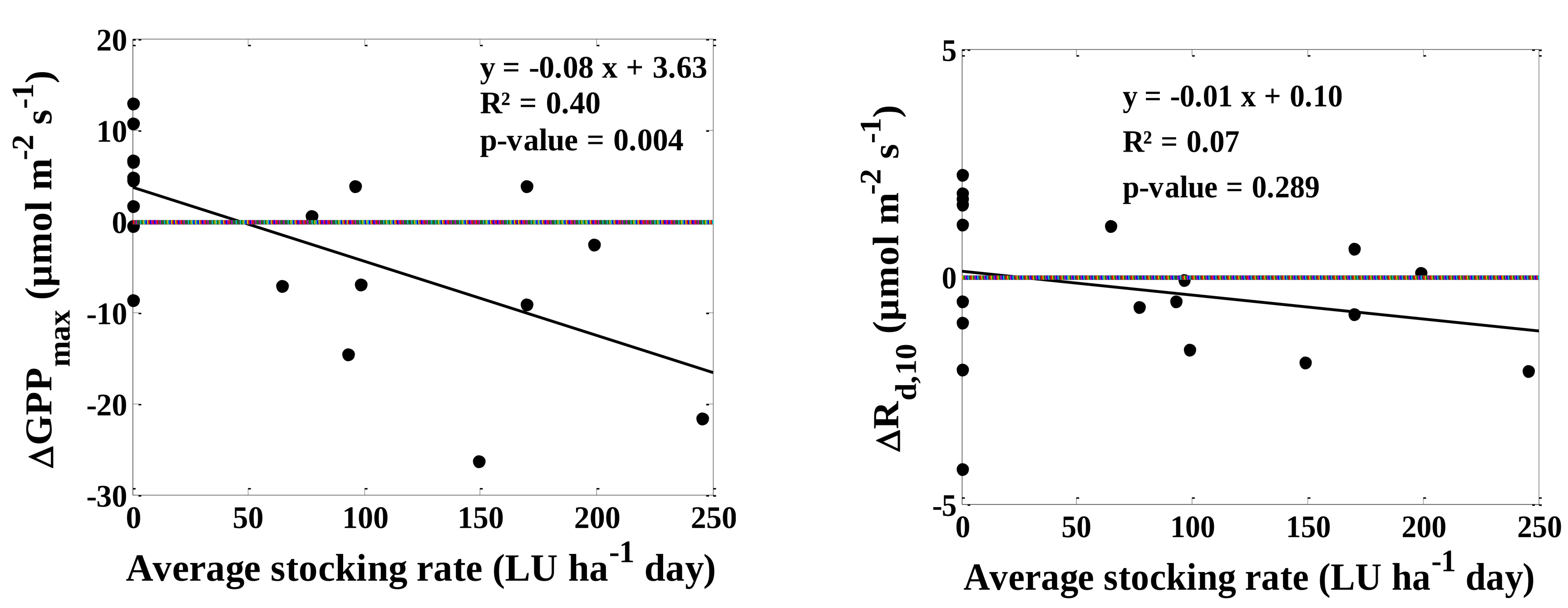
Study of indirect impact by light curve response analysis



Flux – PPFD relation and related R_{d10} and GPP_{max} parameters

- Flux – PPFD regressions fit on 5-day periods.
- GPP_{max} and $R_{d,10}$ decuced from regression.
- Parameter difference (ΔGPP_{max} , $\Delta R_{d,10}$) calculated between periods before and after a grazing period.
- Analysis of relationship between ΔGPP_{max} , $\Delta R_{d,10}$ and animal stocking rate during the grazing period.

Results



Response of ΔGPP_{max} and ΔR_{d10} to average stocking rate. One point corresponds to one grazing period (typically 10 – 30 days). Data set covers two years of measurements at DTO.

- ΔGPP_{max} is negatively correlated to stocking rate : defoliation by grazing affects pasture photosynthetic capacity.
- No significant correlation between $\Delta R_{d,10}$ and stocking rate : probably due to a combination of conflicting processes (autotrophic respiration decrease, heterotrophic respiration increase due to feaces, ….).

Research Highlights

- **This pasture is about C neutral (behaves as a source on the two first years and as a sink on the third year).**
- **Management practices, sometimes dictated by climatic conditions, are the main factors influencing the pasture C balance.**
- **GPP_{max} was significantly reduced with grazing intensity because of aboveground biomass reduction due to defoliation.**
- **R_{d10} was not significantly modified by grazing, probably because of conflicting processes.**
- **Confinement experiments allows cattle respiration estimation : it amounts to 2.59 ± 0.58 kg C LU^{-1}d^{-1} which represents 8% of TER.**

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