Yearly follow-up of methane turbulent exchange over an intensively grazed grassland in Belgium

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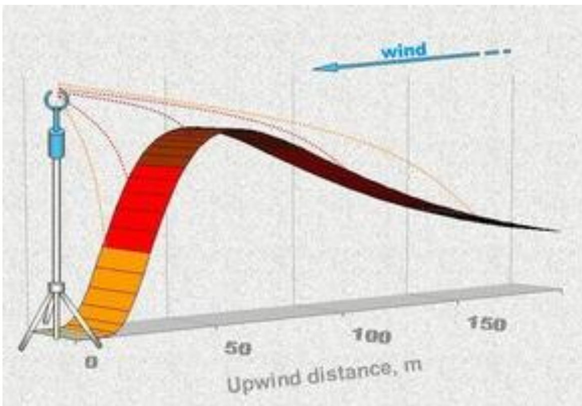
1. Objectives

- ❑ Measurement of CH_4 fluxes over a grazed grassland in Belgium
- ❑ Identification of CH_4 fluxes drivers on a grazed grassland
- ❑ Evaluation of management practices impacts on CH_4 fluxes

2. Material and Methods



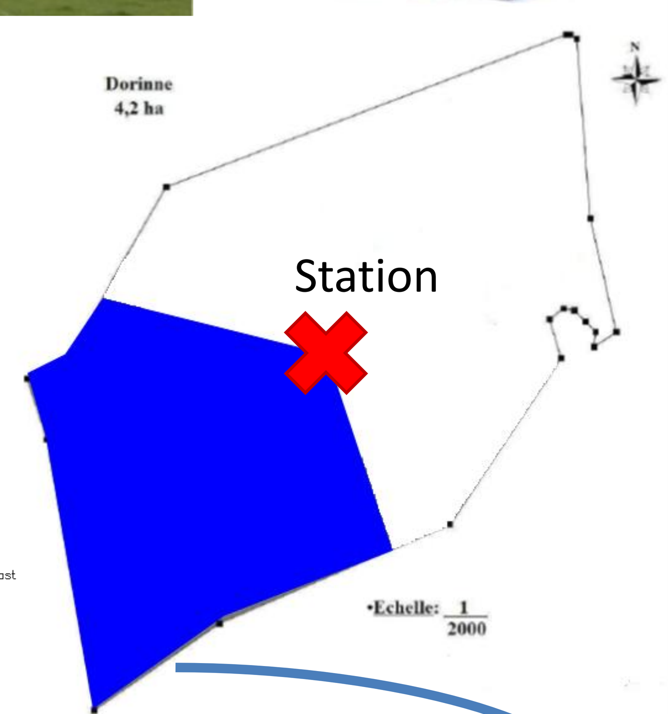
The eddy covariance method continuously measure fluxes in a zone situated upwind from the measurement site. The size of the measurement zone is determined by micro-meteorological conditions.

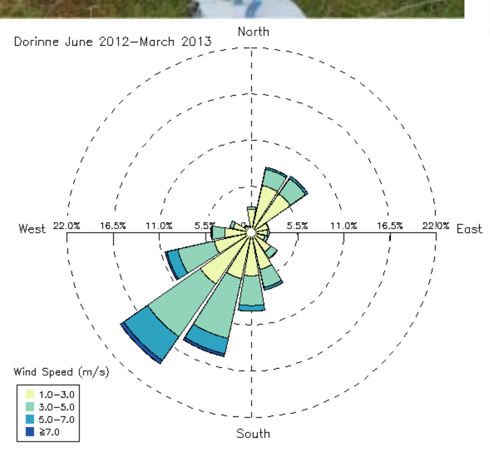
The eddy covariance technique is complementary to classic measurements like enclosure techniques or enteric tracer ratio techniques.

Pros	Cons
• Non invasive • Half hour measurement rate • High temporal coverage • Integration of all sources (including feces and soil exchanges)	• Meteorological conditions dependant •Variable measurement area

Our site is an intensively pastured grassland of 4.2 ha managed according to the regional usual practices. It is part of a cow-calf operation system which raises Belgian blue beef. Cattle density varies throughout the year and up to 30 cows graze simultaneously on the grassland.

- *Measurement of CH_4 and CO_2 fluxes using eddy covariance (Picarro G2311-f)*
- *Measurement of micro-meteorological variables*

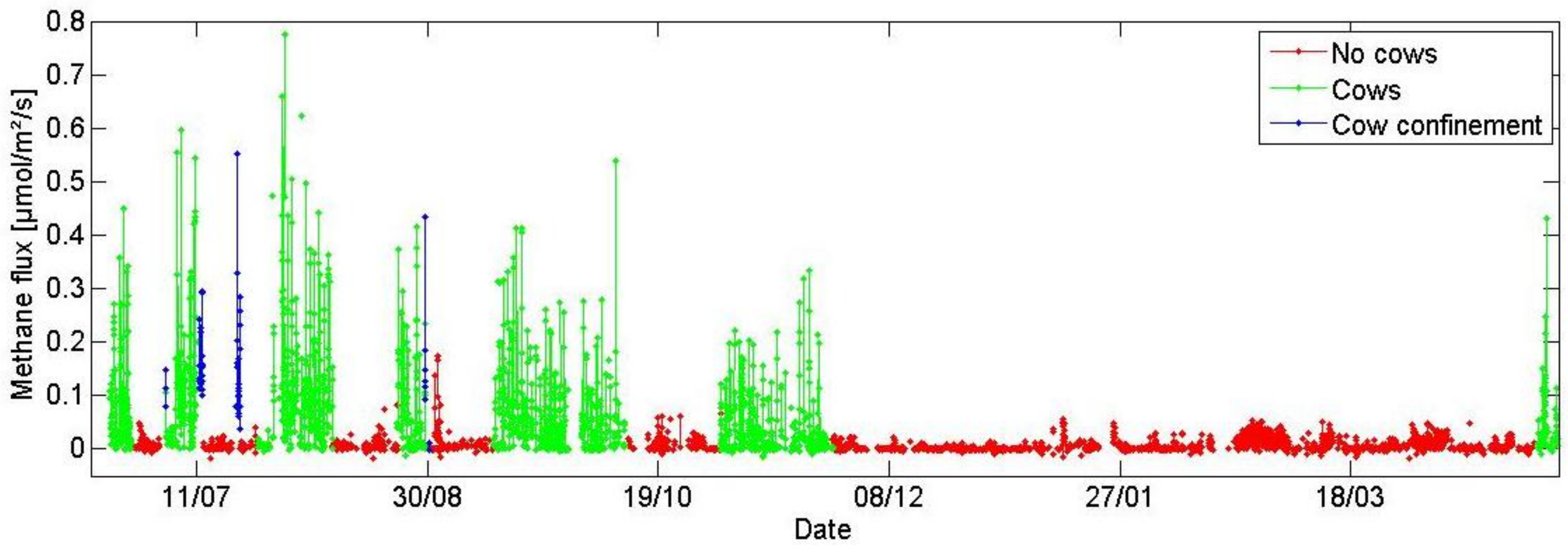




During confinement events, cows were confined in a smaller zone upwind from the measurement site (blue zone in the above figure) in order to achieve higher stocking rates.

3. Results

Right: Methane flux against time on our site for 3 different configurations

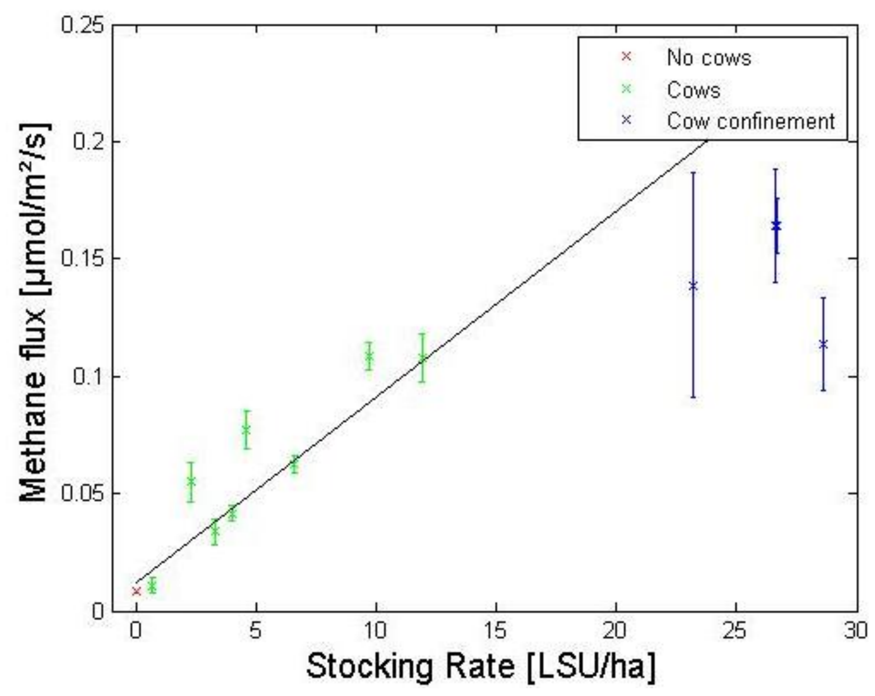


Fluxes

Methane emissions were measured during cattle presence as well as during cattle absence.

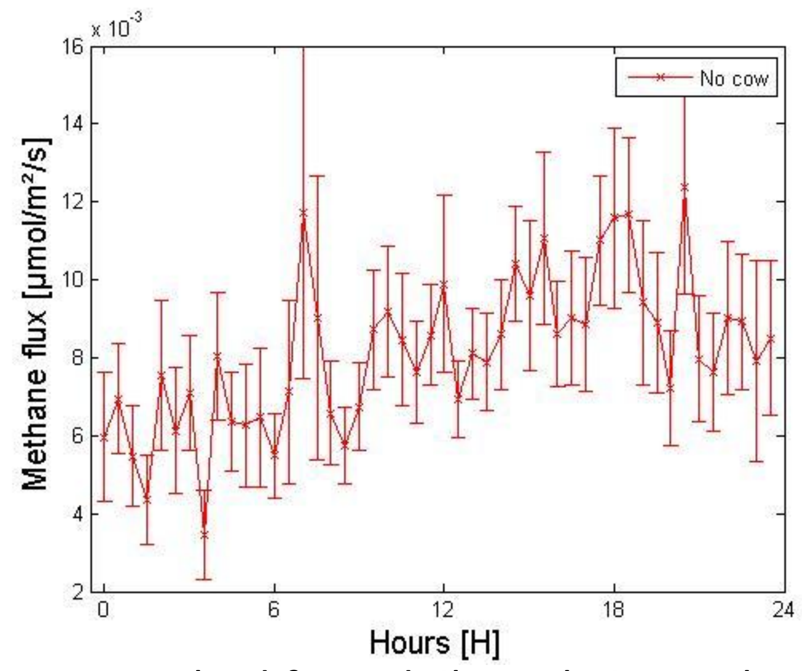
❑ Fluxes during cattle absence were commonly found to range between 0 and 0.05 µmol m^{-2} s^{-1} and were only exceptionally negative

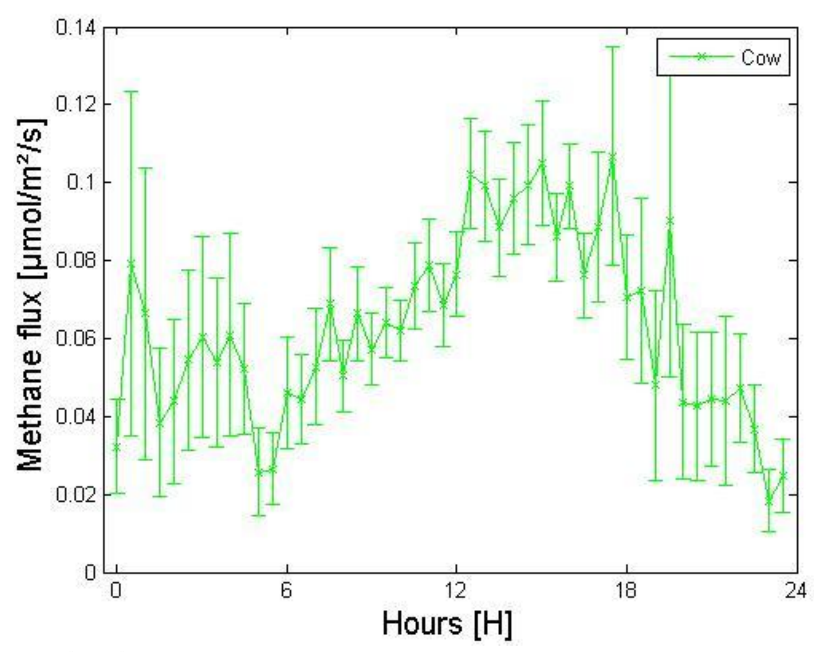
❑ When cattle was present on the grassland, emissions were much higher and were strongly linked to stocking rate with a regression curve corresponding to the equation: F_{CH4}=[7.9 (±0.5) x SR + 11.9 (±3.4)] x 10^{-3}



Up: Impact of stocking rate on methane fluxes with standard errors.

Daily cycle





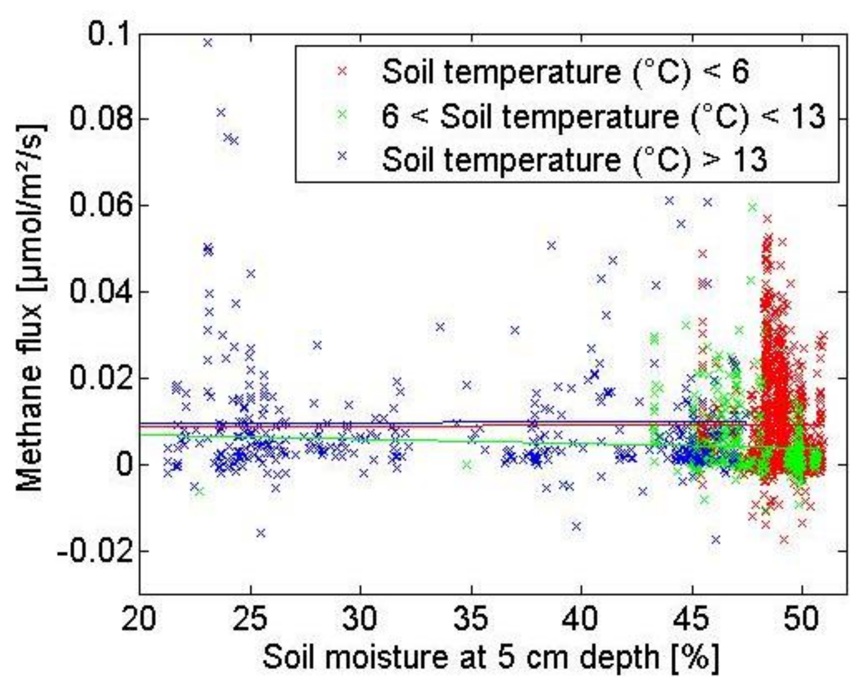
Left: daily evolution of methane fluxes during cattle presence or absence with standard errors.

We searched for a daily cycle in methane emissions.

❑ When no cows were present on the grassland, no clear daily cycle could be observed

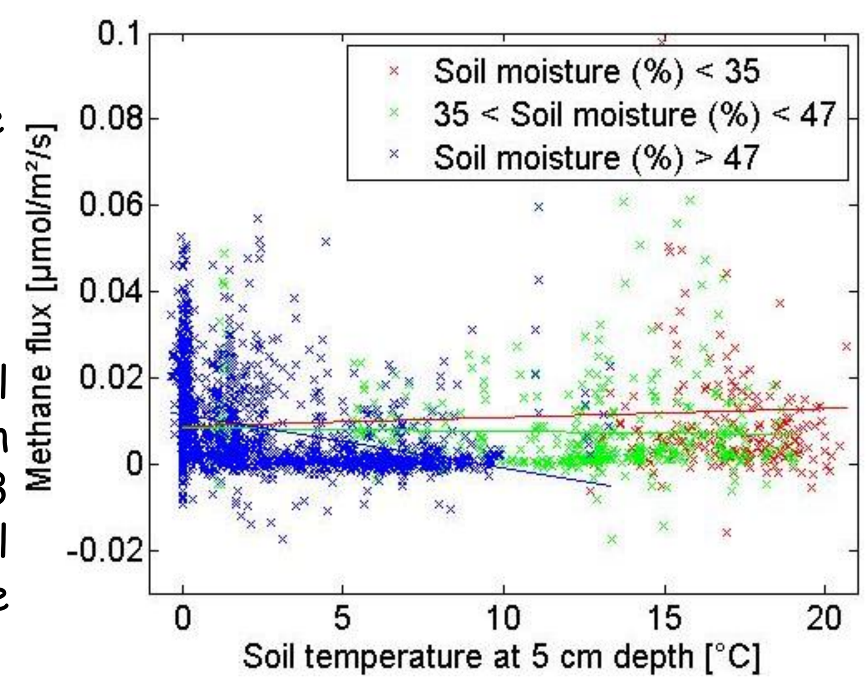
❑ When cows were present on the grassland, we clearly observed that emissions were low in the early morning, increased during day and reached a peak in the afternoon before decreasing in the evening. However, a second emission activity may occur between 1 am and 4 am

Environmental drivers



Left: Impact of volumetric soil moisture on methane fluxes for 3 categories of soil temperature

Right: Impact of soil temperature on methane fluxes for 3 categories of soil moisture



When no cows were present on the grassland, a relation between CH_4 fluxes and environmental drivers was investigated. We plotted CH_4 fluxes according to two environmental drivers; soil temperature at 5 cm depth (°C) and soil moisture at 5 cm depth (% volume). As both drivers are correlated, we divided each dataset in 3 categories according to the value of the other driver

❑ No significant relation was found between methane fluxes and environmental drivers

❑ Soil volumetric moisture is generally found between 43 and 52%

4. Conclusions

❑ Very reliable analyzer leading to a high data coverage of about 90.2 % of the measurement period

❑ Methane emissions correlated with cattle stocking rate with a slope of 39.8 ± 2.5 kg CH_4 $year^{-1}$ LSU^{-1} (against 57 kg CH_4 $year^{-1}$ LSU^{-1} for IPCC tier 1 emission factor - IPCCC, 2006. Guideline for National Greenhouse Gas Inventories)

❑ No net methane sink has been observed. The pasture behaves as a methane emitter, even in the absence of cows.

❑ In the absence of cows, no obvious relation can be established between methane emissions and soil temperature

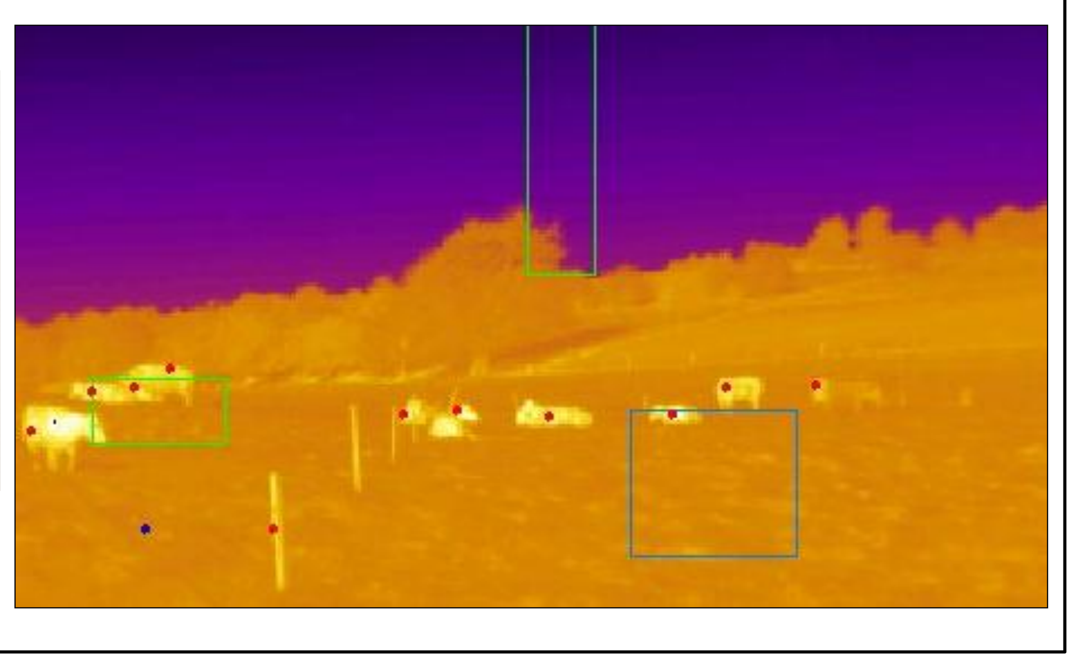
❑ During grazing periods fluxes are highly variable. This phenomena could be due to cow digestion rhythm and cow movements in and out the measurement footprint zone. Cattle geo-localization is needed to disentangle these two potential causes

5. Perspectives

Further developments are ongoing in order to automatically count the number of animals present in the measurement footprint. Two cattle geo-localization systems are currently under development:

❑ Home-made GPS devices fixed on cows will measure a position every 5 minutes and will have an autonomy of several weeks. GPS measurements are interesting but difficult to implement for long durations because of the high level of maintenance work required

❑ A thermal camera will allow detection of cow presence around the measurement site day and night without much maintenance work. The camera orientation will be automatically controlled by a pan-tilt unit in order to always face the flux footprint zone



Up: Home-made GPS device

Right: thermal infra-red image from the pasture