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

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1. Objectives

- Measurement of CH₄ fluxes over a grazed grassland in Belgium
- Identification of CH₄ fluxes drivers on a grazed grassland
- Evaluation of management practices impacts on CH₄ 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

- Non invasive
- Half hour measurement rate
- High temporal coverage
- Integration of all sources (including feces and soil exchanges)

Cons

- Meteorological conditions dependent
- 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 CH₄ and CO₂ fluxes using eddy covariance (Picarro G2311-i)
- 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 cattle 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: \( F_{CH4} = (7.9 \pm 0.5) \times S + 11.9 \pm 3.4 \times 10^{-3} \)

Daily cycle

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

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

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 CH₄ year⁻¹ LSU⁻¹ (against 57 kg CH₄ year⁻¹ LSU⁻¹ for IPCC tier 1 emission factor - IPCC, 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

4. Conclusions

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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