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FÉDÉRATION WALLONIE-BRUXELLES

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OUTDOOR MEASUREMENT OF CATTLE METHANE EMISSIONS USING THE EDDY-COVARIANCE TECHNIQUE IN COMBINATION WITH GEOLOCALIZATION DEVICES

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1. Objectives

- ❑ Calculate cattle methane emissions using geolocalization combined with a footprint model
- ❑ Determine methane daily emission pattern drivers
- ❑ Identify cattle methane emissions response to forage quality

2. Material and Methods

The eddy covariance method measures fluxes emitted upwind from the measurement site (footprint). If we want to calculate cattle emissions (moving sources), cattle positions on the field must be known at all time.

Site Description

Four measurement campaigns took place at the Dorinne Terrestrial Observatory on a 4.2 ha pasture grazed by Belgian Blue cattle (cow-calf operation system).

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

Each cow was equipped with a GPS (position) and accelerometer (behaviour) device

Measurements

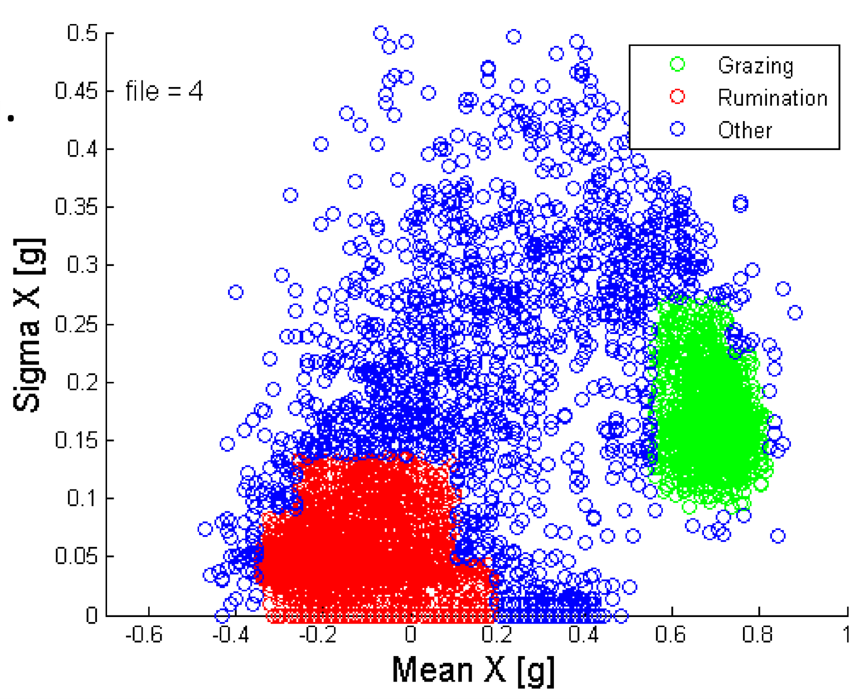
For each half hour we calculate a flux per Livestock Unit (LSU) using:

$$f = \frac{F_T}{\sum_i \sum_j n_{ij}\phi_{ij}}$$

Where f corresponds to a flux per LSU (nmol s^{-1} LSU^{-1}),
F_T is the half-hour measured flux (nmol m^{-2} s^{-1}),
n_{ij} the number of LSU in the cell ij (LSU) and
ϕ_{ij} is the footprint function in the cell ij (m^{-2}) calculated according to the model described by Kormann and Meixner *(2001)*.

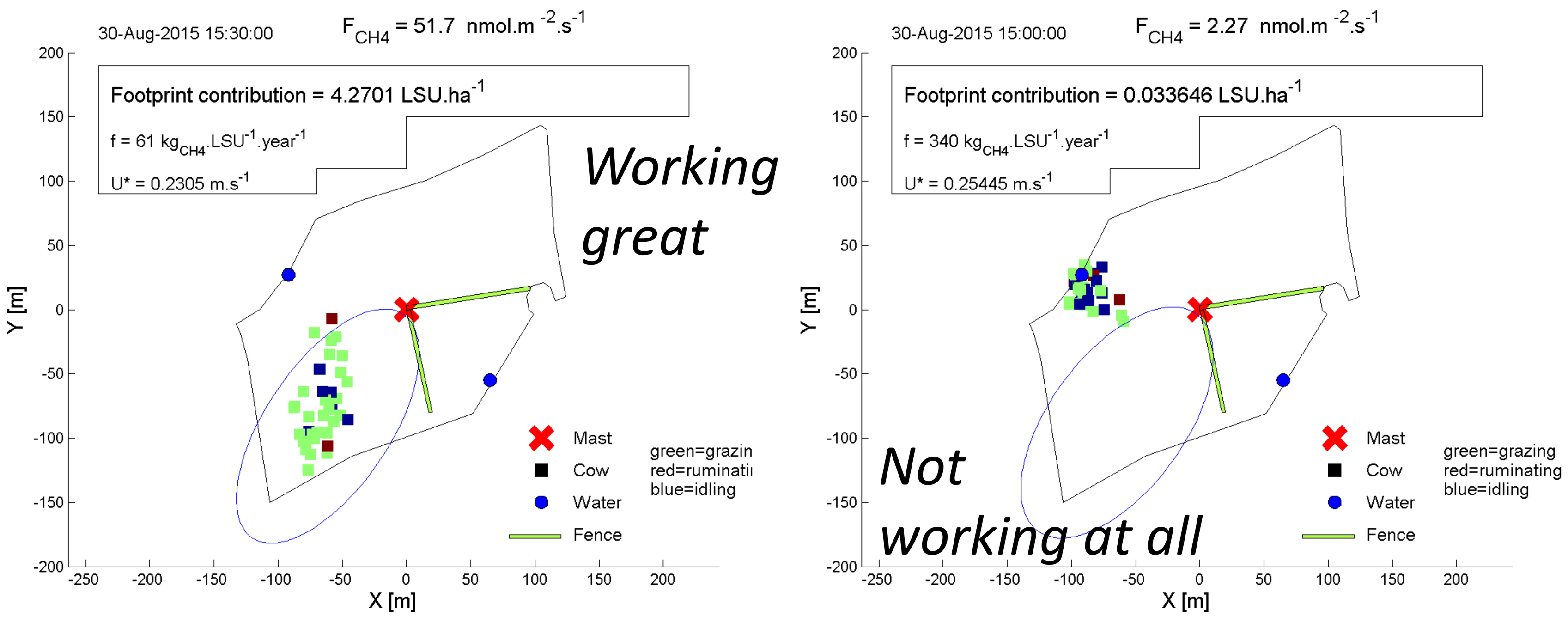
Cattle behaviour was derived from a 3 D accelerometer using the X-axis (aligned with the cow's axis of symmetry) signal mean and standard deviation.

Highest density zones correspond to grazing or rumination behaviours



3. Results

Half-hour results



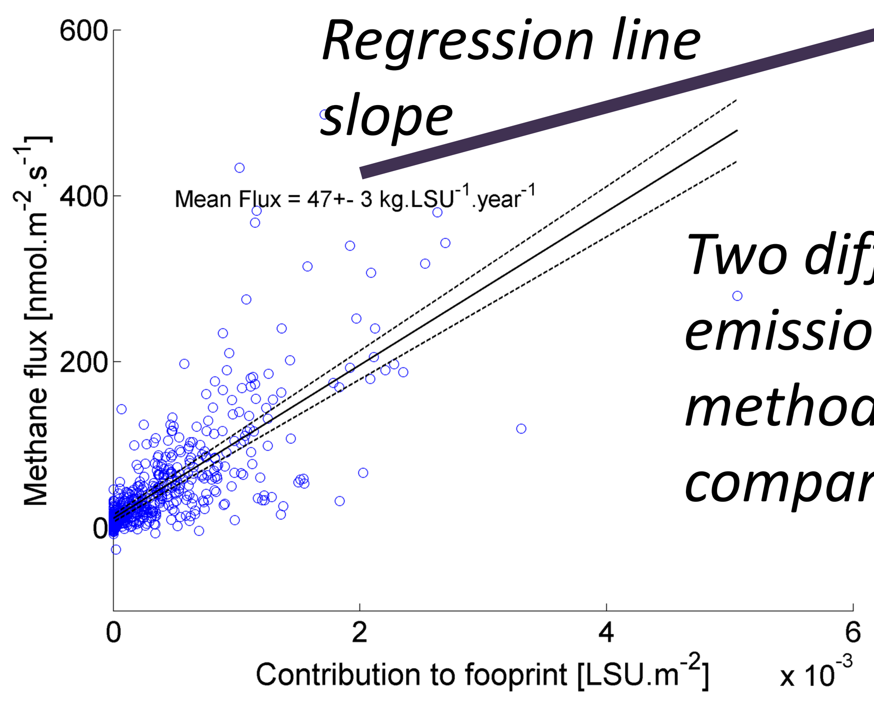
- ❑ Measured methane fluxes were related to cow positions in the footprint.
- ❑ Sufficient stocking density needed
- ❑ Footprint model needs to be improved

Methane flux per cow

- ❑ Methane fluxes per animal seem constant throughout the year except in autumn
- ❑ Forage quality is known to be lower during autumn

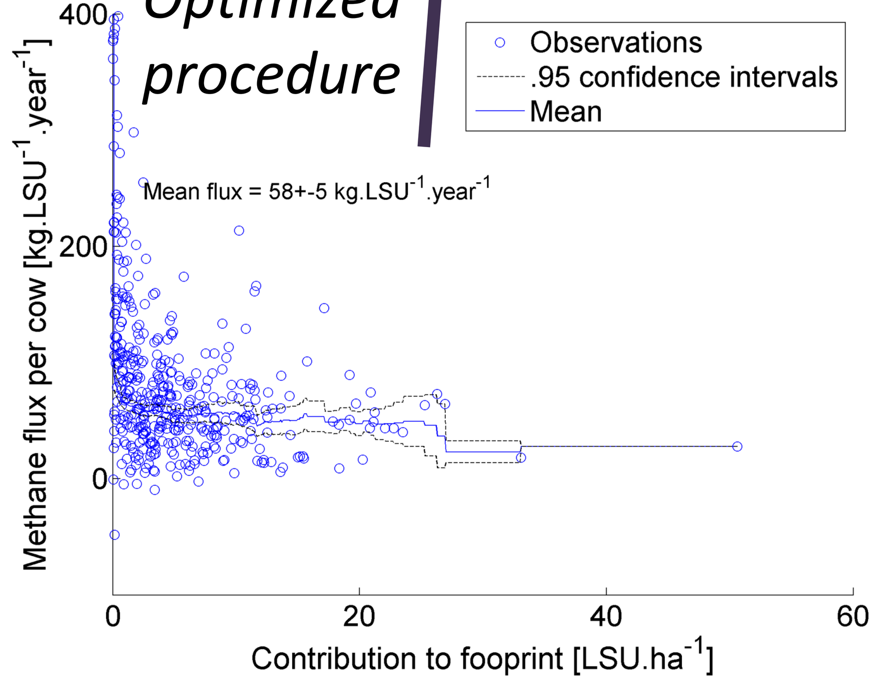
Campaign	Flux [kg CH_4 LSU^{-1} year^{-1}]	Flux [kg CH_4 LSU^{-1} year^{-1}]	Mean stocking density [LSU ha^{-1}]
Spring 2014	**47 ± 3**	**58 ± 5**	**6**
Spring 2015	**41 ± 8**	**54 ± 11**	**2.8**
Summer 2015	**54 ± 4**	**52 ± 7**	**3.8**
Autumn 2015	**96 ± 6**	**65 ± 7**	**1.9**

Regression line slope

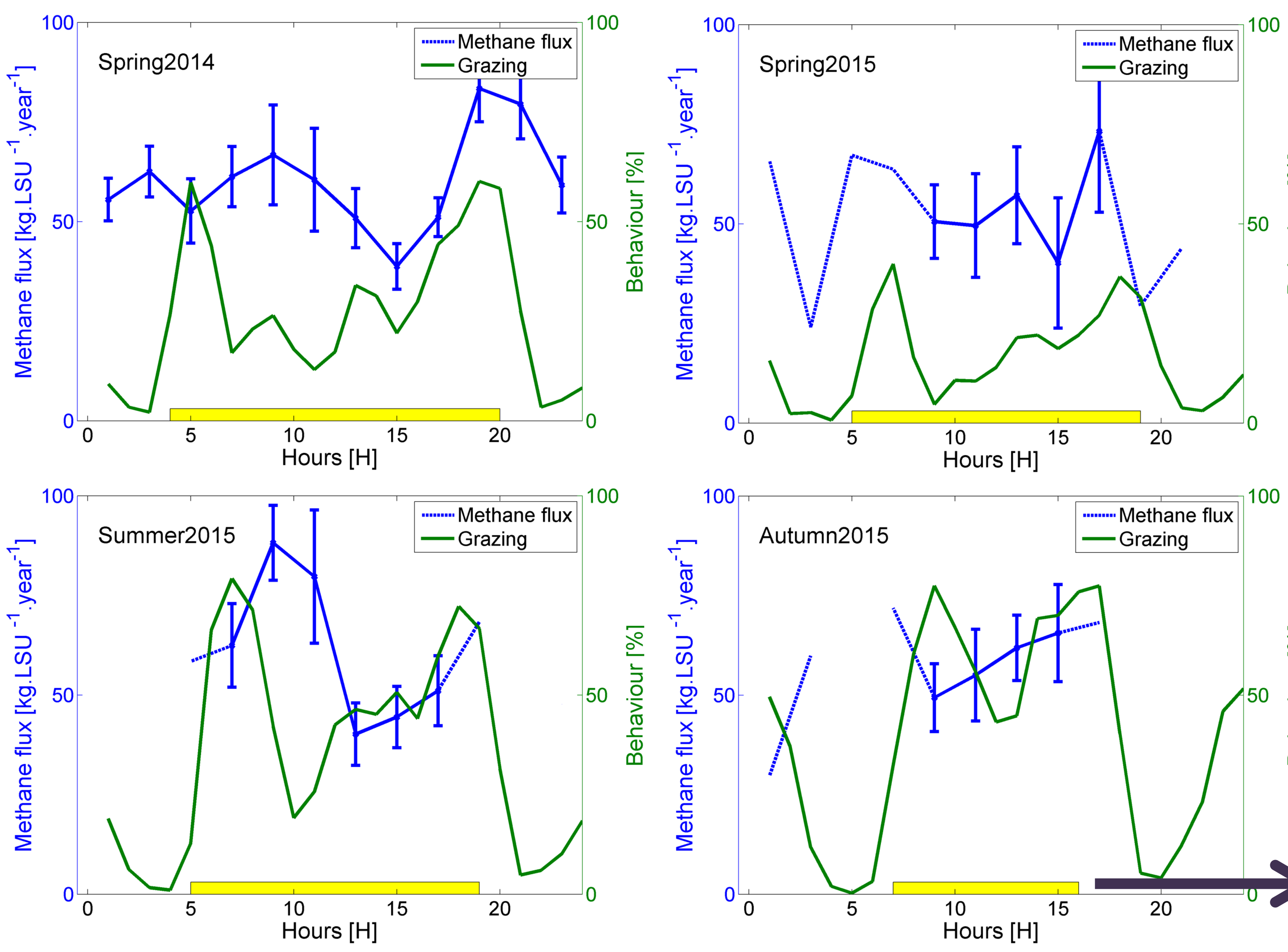


Two different cattle emission estimation methods were compared:

Optimized procedure



Daily evolutions



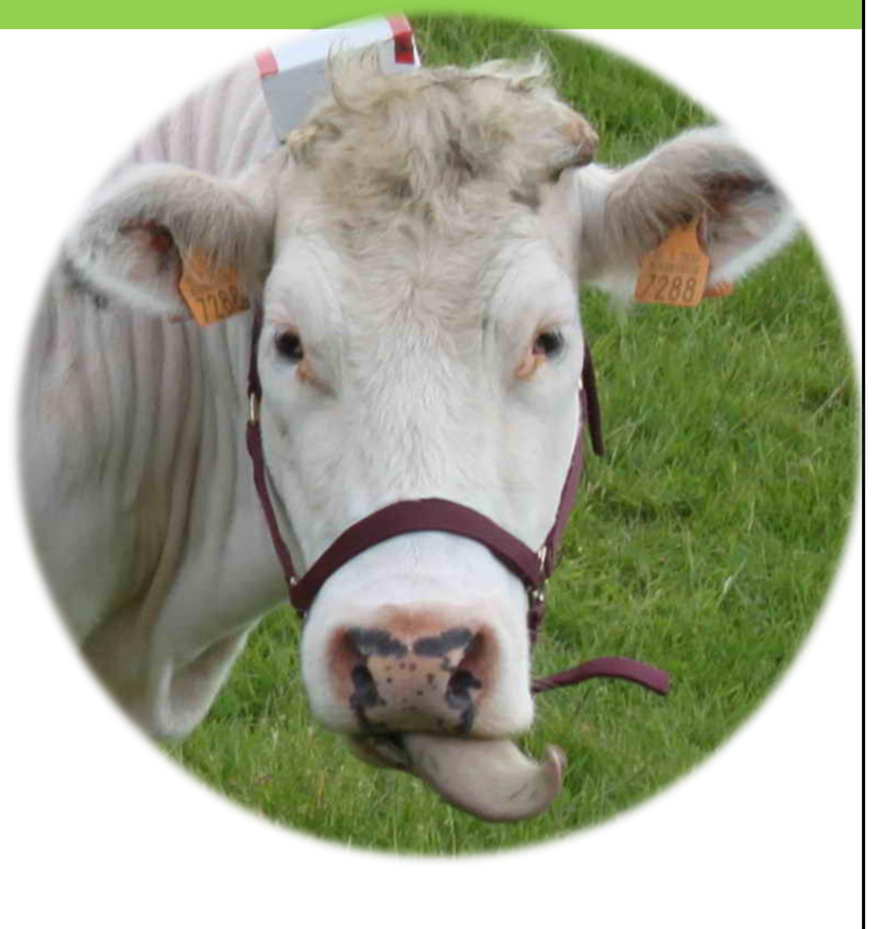
Daily behaviour and emissions per LSU evolution for all 4 periods

- ❑ Two grazing peaks were observed daily
- ❑ Emission peaks position throughout the day was regulated by photoperiod
- ❑ Grazing periods were associated with higher methane emission rates.

Photoperiod

4. Conclusions and perspectives

- ❑ Measured methane fluxes were correlated with the stocking density in the footprint
- ❑ We obtained a mean flux per cow between 52 and 65 kg CH_4 LSU^{-1} year^{-1} (against 57 kg CH_4 LSU^{-1} year^{-1} for IPCC tier 1 emission factor - IPCC, 2006)
- ❑ An obvious diurnal pattern can be found in cattle behaviour. The methane emission per cow seem to follow a similar pattern
- ❑ The footprint model will soon be validated/ improved through an artificial source experiment
- ❑ In the future, emissions could be linked to cattle behaviour and forage quality



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