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

P. Dumortier, A.L.H. Andriamandrosio, M. Aubinet, Y. Beckers, J. Bindelle, L. Gourlez de la Motte, F. Lebeau and B. Heinesch

University of Liege, Gembloux Agro Bio Tech, TERRA, Exchanges Ecosystems - Atmosphere, Animal Science Axis, Precision Agriculture Axis, Belgium

1. Objectives
- Calculate cattle methane emissions using geolocalization combined with 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 upward 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 CH₄ and CO₂ 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:

\[ f = \sum \sum n_{ij} \phi_{ij} \]

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 \( \phi_{ij} \) is the footprint function in the cell \( ij \) (m²) 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.

<table>
<thead>
<tr>
<th>Campaign</th>
<th>Flux [kg CH₄ LSU⁻¹ year⁻¹]</th>
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<th>Mean stocking density [LSU ha⁻¹]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2014</td>
<td>47 ± 3</td>
<td>58 ± 5</td>
<td>6</td>
</tr>
<tr>
<td>Spring 2015</td>
<td>41 ± 8</td>
<td>54 ± 11</td>
<td>2.8</td>
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<tr>
<td>Summer 2015</td>
<td>54 ± 4</td>
<td>52 ± 7</td>
<td>3.8</td>
</tr>
<tr>
<td>Autumn 2015</td>
<td>96 ± 6</td>
<td>65 ± 7</td>
<td>1.9</td>
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</table>

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.

Regression line slope
- Two different cattle emission estimation methods were compared.

Daily evolutions
- Daily behaviour and emissions per LSU evolution for all 4 periods.

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 CH₄ LSU⁻¹ year⁻¹ (against 57 kg CH₄ 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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Contact: pierre.dumortier@ulg.ac.be