Agreement of two Laser Methane Detectors with respiration chambers and in a dairy barn

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Laser Methane Detector (LMD)

- for detection of gas leaks
- wavelength specifically absorbed by methane (tunable diode laser absorption spectroscopy)
- mobile, portable, hand-held
- 2 data points/sec
- cumulative methane concentration along path in ppm-m
- data stored on smartphone

(Crowcon Detection Instruments Ltd.)
Our application of the LMD

Similar to Chagunda et al. (2009), Chagunda & Yan (2011), Grobler et al. (2014), Ricci et al. (2014), Pickering et al. (2015)
Questions

Can two LMDs be used in parallel when recording a large amount of data?

→ Agreement of two LMDs with each other in a closed room and under farm conditions

How accurate is this sensor?

→ Agreement of LMDs with sensor of respiration chamber
Experimental setup

- placed inside chamber
- measuring through portion of air near outlet tube

→ technical accuracy compared with sensor of respiration chamber

→ visual monitoring of cow activity to detect differences in methane concentration
Experimental setup

1. LMD
2. Laser path
3. Outlet tube
4. Air flow
5. Cow

chamber 1 and 2

chamber 3 and 4
Experimental setup

Simultaneous measurement at different locations for 10 min each:

- feeding table over straw bedding pointing to ceiling over slatted floor
- elevated CH$_4$ concentration, but no cow profile
Agreement of two LMD in a respiration chamber

\[ R^2 = 0.99 \]
\[ r = 0.99^{***} \]
\[ n = 27280 \]
Agreement of two LMD under farm conditions

\[ R^2 = 0.94 \]
\[ r = 0.97^{***} \]
\[ n = 4093 \]
Agreement of two LMD under farm conditions

→ good agreement under different conditions
→ in the barn probably influenced by environment
Agreement of LMD and respiration chamber

![Graph showing agreement between LMD and respiration chamber methane concentrations over time. The graph compares LMD1, LMD2, and chamber2 methane levels with time and LMD methane levels on the right axis.](image-url)
Agreement of LMD and respiration chamber

<table>
<thead>
<tr>
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<th>LMD</th>
<th>Chamber</th>
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<tbody>
<tr>
<td>mean (ppm)</td>
<td>613-1023</td>
<td>639-906</td>
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<tr>
<td>SD (ppm)</td>
<td>72-135</td>
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\[ r = 0.86 \text{ - } 0.98 \]

Chagunda and Yan (2011)
Agreement of LMD and respiration chamber

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\[
r = 0.86 - 0.98
\]

\(\Rightarrow\) agreement similar/better than in a study with previous model of LMD

Chagunda and Yan (2011)
Agreement of LMD and respiration chamber

For chamber 1 – LMD1, the correlation coefficient (r) is 0.00.

For chamber 2 – LMD1, the correlation coefficient (r) is 0.48.
Agreement of LMD and respiration chamber

→ at higher concentrations methods tend to drift apart, but cow profiles have usually much lower concentrations
Agreement of LMD and respiration chamber

→ both detect differences in methane concentration due to cow activity
Conclusion

- two LMD have good agreement and can be used in parallel
- LMD suitable to measure low physiological methane concentrations in air
- LMD can detect differences in cow activity in a respiration chamber
- its use to measure methane emissions from dairy cows should be further analyzed
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