Methane Emission Measurement from Beef Cattle Feedlot Using EC System.

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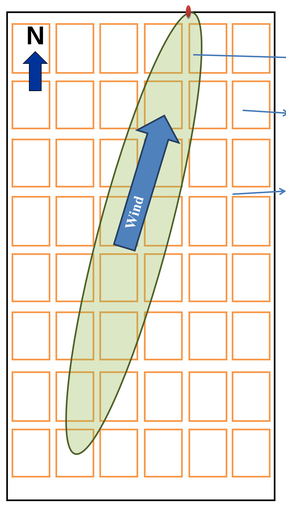
Introduction

Cattle feedlots in the US are one of the primary sources of methane. Measurements of methane emissions from these systems are challenging and still scarce. Accurate quantification of greenhouse gases are necessary to enhance our understanding of the factors controlling the magnitude and temporal dynamics of methane fluxes in these systems. The eddy covariance technique has been used in several sites around the world to measure gas and energy exchange between the land and the atmosphere, but only few studies have applied this technique to monitor gas emissions from confined animals operations. The objectives of this study are

1. to apply the eddy covariance technique to estimate methane emissions from a commercial beef cattle feedlot.
2. to investigate variables controlling the temporal dynamics of methane fluxes.

Site Description



- Feedlot location
  – Western Kansas
- No of cattle
  – 30,000
- Area of feedlot
  – 62 ha

Diagram of the feedlot showing location of tower and pens

Field measurement

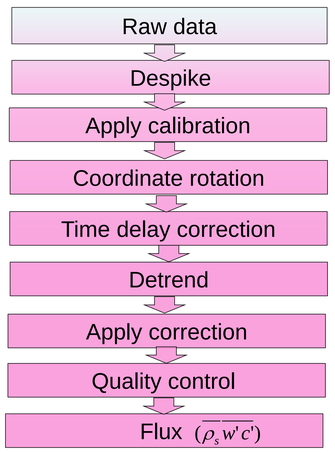
- Data were collected from August, 2013 to May, 2014.
- Concentrations of CO_2 and CH_4 gases were measured by open-path (LI-7500A, LI-COR Biosciences) and closed path gas analyzer (G1301-f, Picarro Inc., USA) respectively.
- Wind vectors and Temperature were measured with 3D sonic anemometer (CSAT3, Campbell Sci., Inc., USA)

Instruments

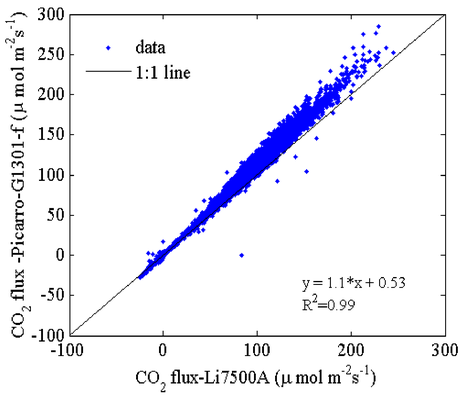
Instruments: Open-path, Closed-path, Data loggers, Sonic Anemometer (Campbell Scientific).

Data processing

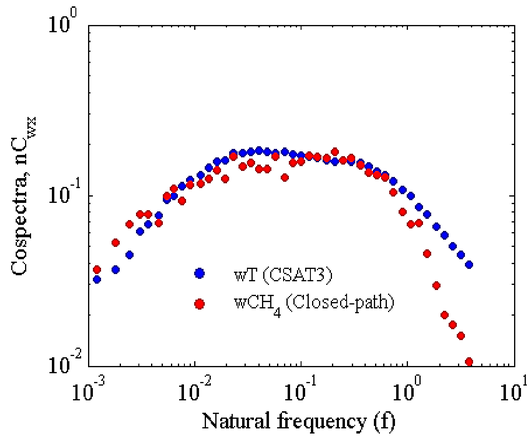
High frequency raw data were processed with Eddy pro software package (version 5.2, Licor- Biosciences) and Matlab (version 8.4, The Mathworks, Inc., Natick, MA). Following steps were followed:

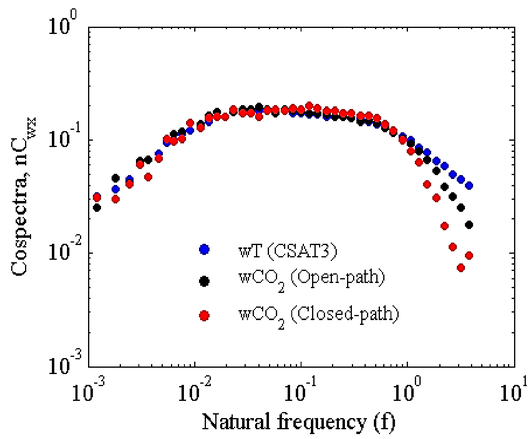


Results

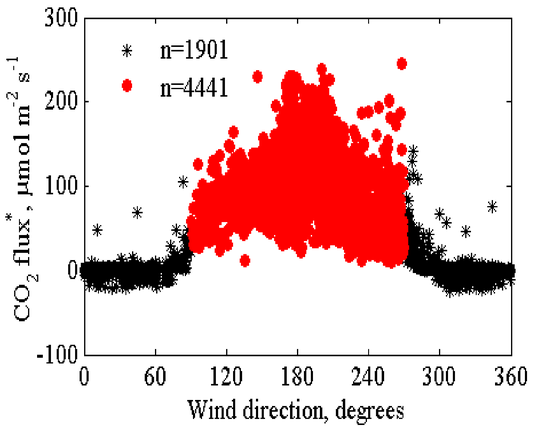


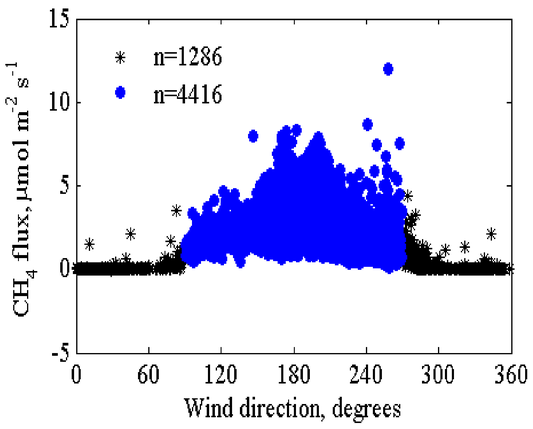
Comparison of CO_2 fluxes from closed path and open-path gas analyzers



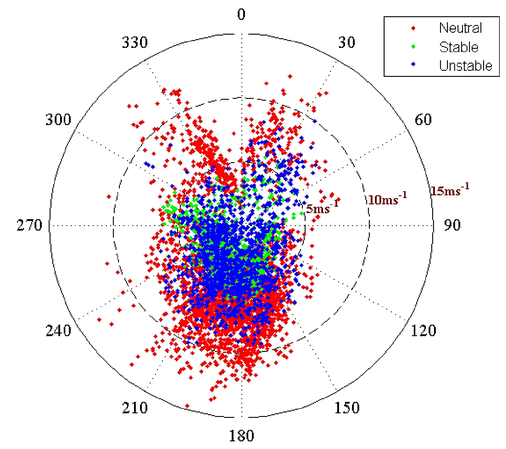


Ensemble average daytime cospectra. Data are from 10:00 to 14:00 LST.





Effect of wind direction on CO_2 and CH_4 flux measurements



Polar plots of wind direction versus atmospheric stability (|L| > 100 is neutral, 0 < L < 100 is stable, -100 < L< 0 is unstable), and wind speed (m/s)

Summary and Conclusion

- Fluxes calculated using the open-path sensor were slightly lower than the ones obtained using the closed-path analyzer.
- Frequency losses were observed in the close path-sensor, probably related to tube attenuation.
- The atmospheric conditions during the duration of study were most of the time near neutral and unstable as observed in previous study (Baum et al., 2008).
- The average fluxes were: 1 μmol m^{-2} s^{-1} (CH_4) and 100 μmol m^{-2} s^{-1} (CO_2). CO_2 fluxes were within the range reported by Baum et al.(2008).

Additional works

- Footprint analysis will be used to determine the contribution of source area to vertical flux.
- Ongoing image analyses will be used to evaluate the impact of the animal position to the CH_4 flux.

Bibliography

Baum, K. A., Ham, J. M., Brunsell, N. A., & Coyne, P. I. (2008). Surface boundary layer of cattle feedlots: Implications for air emissions measurement. *Agricultural and forest meteorology*, *148*(11), 1882-1893.

Detto, M., Verfaillie, J., Anderson, F., Xu, L., & Baldocchi, D. (2011). Comparing laser-based open-and closed-path gas analyzers to measure methane fluxes using the eddy covariance method. *Agricultural and Forest Meteorology*,*151*(10), 1312-1324.