Temporal Variations in Greenhouse Gas Emissions from Dairy Cow Manure  
Pakorn Sutitarnnontr1 (pakorn@aggiemail.usu.edu), Rhonda Miller2, Markus Tuller3, and Scott B. Jones1

1. Department of Plants, Soils and Climate, Utah State University, Logan, Utah  
2. Agricultural Systems Technology and Education Department, Utah State University, Logan, Utah  
3. Department of Soil, Water, and Environmental Science, University of Arizona, Tucson, Arizona

Introduction
The implementation of air quality regulations for animal feeding operations (AFOs) increases the need for accurate determination of gas emission rates. However, there are no standardized methods for collection, measurement, and quantification of gas emissions from AFOs due to the difficulty of the measurement. Temporal variations complicate the determination of gas emissions from AFOs. The temporal variations in gas emissions primarily result from environmental variables (i.e., temperature, manure's moisture content, and porosity). Other factors influencing the temporal variations include variations of biochemical processes in manure and variations of gas transport mechanisms.

Focusing on diurnal and weekly variations, our research aims: (1) to characterize individual gas emission rates from manure as a function of temperature, moisture content, and time after excretion; (2) to investigate and determine the degree of temporal variability affected by these factors.

Experiment Design and Setup
Fresh dairy cow manure samples (left) were collected from the Caine Dairy Teaching and Research Center (Wellsville, Utah). The milking cows were mature Holsteins fed a standard total mixed ration (TMR) diet with an approximate crude protein content of 17%. The chamber was programmed to be closed for three minutes (one observation), with three observations performed in one hour. The Fourier Transform Infrared Spectrometers (FTIR) gas analyzer measures 15 different gases at low concentrations including CO₂, CO, CH₄, NH₃, N₂O, NOₓ, water vapor, and volatile organic compounds (VOCs).

Closed Dynamic Chamber
Methane (CH₄) flux data were collected on dairy cow manure in a greenhouse. Two observations are shown for demonstration purposes. For both observations, the observation length (time when the chamber is sealed against manure container) was three minutes. The first data point used in the analysis is collected after the chamber touches down (below).

Calculating gas flux ($J_g$) from measured data:

$$J_g = \frac{P \cdot V}{Ps \cdot R \cdot S \cdot (273.15 + T)} \cdot \frac{\partial C}{\partial t}$$

where $P$ is the measured ambient pressure, $V$ is the total system volume, $Ps$ is the standard pressure, $R$ is the gas constant, $S$ is surface area of the chamber over the emission source, $T$ is the temperature (°C), $C$ is the gas concentration, and $t$ is the observation time.

Results and Discussion
A. CO₂, CH₄, and NH₃ Fluxes

B. Temperatures and Relative Moisture Content

C. Comparison of CO₂ Fluxes between LI-COR 8100A and GASMET DX-4030

The temporal variation in gas emissions on the diurnal and weekly time scales shows a strong correlation to manure temperature and moisture content. However, under actual field conditions, abrupt increases in gas fluxes may occur in response to rainfall events. Hence, further investigation is necessary to determine the effect of rainfall events on the gas emission rates. In addition, CO₂ fluxes determined from using LI-COR 8100A and GASMET DX-4030 were in well agreement.

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