Spatial Variability of Soil CO₂ Flux in a Cornfield

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INTRODUCTION

Although soil respiration is a significant component of the carbon balance for an ecosystem, the environmental (soil moisture, rain event, temperature, etc.) and biological (photosynthesis, LAI, etc.) controls regulating soil respiration remain poorly understood. This limits our ability to understand the carbon budget at the ecosystem level, making it difficult to predict the impact of climate change on soil respiration and its feedback. One of the major reasons for this poor understanding is that there is a lack of continuous long-term soil respiration data at a very high spatial and temporal scale, due to unreliable, robust and reliable automated soil respiration instruments. To meet this need, LL-COR is developing a new automated multiplexing system, the LI-8100M, for obtaining high spatial and temporal resolution of soil CO₂ flux for FCO2 information. The system has the capability to sample FCO2 at up to 16 locations. In this paper we:

1. Discuss the number of measurements required in order to have reliable mean fluxes based on the spatial variability of FCO2

MATERIALS & METHODS

1. Multiplexing System Overview

The automated multiplexing system can sequentially measure soil CO₂ flux at up to 16 locations (Fig. 1), and cover an area with a radius of 17 m. One full cycle of 16 measurements can be finished in one hour. The LI-8100M can operate at ambient temperatures from -20°C to 45°C. The system has Wi-Fi capability that allows for wireless communications can be finished in one hour. The LI-8100M can operate at ambient temperatures in the underestimation was in the range of 10-40%, suggesting a strong suppression of gas diffusion to evaluate the impact of altered chamber headspace CO2 concentration on estimated FCO2. They found that the chamber-induced perturbation of the CO₂ gradient could result in substantial underestimation of FCO2 (6 to 34% for a 30-min measurement).

2. Temporal and Spatial Variation of FCO2 for a Cornfield

An automated-16-chamber multiplexing system was deployed in September 2005 in a dryland cornfield at the Agricultural Experiment Station, University of Nebraska-Lincoln, near Mead, NE, for about 2 months. The cornfield was at the end of a growing season. To study the spatial variability of FCO2 in the field, 8 chambers were installed between rows and 8 chambers within rows. From the two-week experiment (Fig. 5), we show that FCO2 varied during the course of the experiment than that between rows seemed more stable over the course of the experiment than that from within rows. In addition, we did not see any significant differences in CV from within row and between rows.

REFERENCES


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From information of CV, we can determine the samples needed for reliable site mean flux values. For a population with normal distribution, there is a 95% probability that the true mean of the entire population lies within the range of

When CV in the sample mean and s is the sample size. Generally, we wish to keep 1 CV ≤ μ

For example, if the CV of a field is 10%, 4 measurements at different locations are needed in order to have a sample mean deviation not more than 10% from population mean. If CV of a field is 20%, then 16 measurements are needed.

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Figure 1: 16-chamber multiplexing system control box. The top two panels show one side of the control box with 8 gas ports and a soil CO2 flux chamber.

Figure 2: LI-8100 approach to measure the FCO2 at ambient CO2 concentration. In this example the measurement was for 2 min with a dead band of 30 s. This example shows that FCO2 calculated from the linear fit underestimated the flux by 15.3% as compared with that from the exponential fit.

Figure 3: Comparison of underestimation of FCO2 when using linear fit for the heavy clay soil and a light sandy soil. The dataset for heavy clay soil was from the Agricultural Experiment Station, University of Nebraska-Lincoln, near Mead, NE, for about 2 months. The cornfield was at the end of a growing season. To study the spatial variability of FCO2 in the field, 8 chambers were installed between rows and 8 chambers within rows. From the two-week experiment (Fig. 5), we show that FCO2 varied during the course of the experiment than that between rows seemed more stable over the course of the experiment than that from within rows. In addition, we did not see any significant differences in CV from within row and between rows.

Figure 4: Longer measurement periods can further underestimate the soil CO2 flux when using a linear fit. Data shown are time series of chamber CO2 concentration and percentage of flux decrease for a 20-min measurement period. Data were obtained with the LI-8100 Automated Soil Flux System at LCOR.

Figure 5: Temporal and Spatial Variation of FCO2 for a Cornfield

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