Temporal and Spatial Variations of Soil CO₂ Flux Over A Corn/Soybean Rotation Field In Nebraska

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INTRODUCTION

Soil CO₂ flux (FC) is usually the largest component of ecosystem respiration. It is also important for understanding soil carbon storage potential and soil carbon dynamics. FC has a strong temporal variation over the course of a day or a season because of changes in soil temperature, soil moisture, above-ground vegetation physiological activities, and other driving variables. It also shows a strong spatial variation because of high heterogeneity of soil properties in the field. Studies in literature on temporal variation are often limited to weekly, or even monthly measurements. Spatial variation studies are often limited to survey type measurements with one chamber. In this study, we present results that show FC temporal and spatial variations in an agricultural field. We used the LI-8100 Automated Soil CO₂ Flux System with LI-8150 Multiplexer (LI-COR Biosciences, Lincoln, Nebraska, USA) to continuously measure FC at 16 locations in the field over two complete growing seasons (2006 and 2007).

MATERIALS AND METHODS

Our field site was at the Agricultural Experimental Station at the University of Nebraska-Lincoln near Mead, NE. It was a rainy com-soybean rotation field (soybean in 2006 and corn in 2007). The multiplexing system we used in this study can sequentially measure soil CO₂ flux at 16 different locations and cover an area with a radius of 17 m. The system uses the non-steady state closed-chamber method. The flux is estimated using the initial slope of a fitted exponential curve at the ambient CO₂ concentration (see companion poster “Impact of Ambient Air CO₂ Concentration on Soil CO₂ Efflux” by McDermitt et al.). This is to minimize the impact of the altered CO₂ concentration gradient across the soil surface after the chamber is closed. Chambers were equipped with a newly-designed vent to ensure pressure equilibrium between the chamber and the outside air under both calm and windy conditions during the measurements. Even a small pressure difference can cause significant errors (Xu et al., 2006).

RESULTS

The coefficient of variation (CV = std dev / mean) shows large seasonal trends. Two phenomena are clear from the results:

a. Middle season has lower CV than that of early and late season, probably due to relatively uniform soil temperature from well-developed canopy and high rate of soil CO₂ flux.

b. Rain events greatly increase CV, see following explanation.

CONCLUSIONS

1. The Coefficient of Variation (CV) over the 16 locations was in the range of 20-60% for the major portion of the time. Rain events could increase CV to more than 100% because FC is enhanced due to the “Birch effect” (Birch, 1958; Xu et al., 2004). Suppressed FC was most likely due to an increase in resistance of gas transport in the soil surface layer after rain events.

2. Manual measurements at weekly or longer times intervals often fail to accurately estimate the total soil CO₂ flux. Our data show that weekly measurements could have ±5% error in total soil CO₂ flux estimation as compared with continuous measurements. Biweekly or monthly measurements could have ±13% or ±25% errors, respectively.

3. Our results show that high spatial and temporal resolution data are essential for accurately estimating total soil CO₂ flux, and for understanding soil carbon dynamics and how biological and environmental variables regulate the flux.

REFERENCES

