



Temporal and spatial variations of soil CO₂ flux over a soybean field in Nebraska

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Soil CO₂ flux (F_c) is the largest component of the ecosystem carbon balance. It is also an important piece of information in the study of soil carbon storage potential and soil carbon dynamics. F_c 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. To understand the temporal and spatial variations of F_c over an agricultural field, we used an automated soil CO₂ flux system (LI-8100/8150, LI-COR Biosciences, Lincoln, Nebraska, USA) to continuously measure the F_c at 16 different locations in a soybean field for two entire growing seasons in 2006 and 2007. The automated system is a nonsteady state closed-chamber system. Our results show that F_c varied from 0.4 to 8.0 micromol m⁻²s⁻¹ depending on the time of season, the soil temperature and the moisture content. 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 F_c responds to rain events differently depending on the amount of residual material at the soil surface. Manual measurements at weekly or longer time 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 as compared with continuous measurements. Biweekly or monthly measurements could have ±13%, ±25% errors, respectively. Our result strongly suggests that high spatial and temporal resolution data is essential in accurately estimating the total soil CO₂ flux and in understanding the soil carbon dynamics and how biological and environmental variables regulate the flux. Also some critical requirements in making chamber-based soil CO₂ flux will be discussed.