Comparing Three ecosystem CO_2 Flux Measurement Methods Across Spatial and Temporal Scales at a SMARTFARM Corn Production System in Illinois, USA

Comparing measurements of agroecosystem greenhouse gas (GHG) exchange at different scales is necessary for scaling synthesis and modeling validations. Eddy-covariance (EC) methods provide spatially and temporally continuous measures of ecosystem GHG exchange, such as net ecosystem exchange (NEE) of CO_2, but cannot further differentiate between component fluxes without additional measurements of autotrophic and heterotrophic fluxes. Meanwhile, automated or manual soil flux chambers may capture finer-scale changes in GHG emissions and flux-type partitioning of varying spatial and temporal resolutions. Past works sought to cross validate these methods to quantify agroecosystem CO_2 budgets, but to our knowledge no study has compare these three methods together within a single system. We measured CO_2 fluxes in a single maize field in central Illinois, through a novel “system of systems” approach that seeks to report highly accurate, field-scale GHG fluxes via multiple methods. For this, we measured NEE with EC, and belowground respiration at high temporal resolution with autochamber and at high spatial resolution with manual chambers. The mean CO_2 fluxes from high spatial (mean 0.69 ± SE 0.02 g m^{-2} h^{-1}) and high temporal (0.76 ± 0.06 g m^{-2} h^{-1}) resolution chambers from July-September 2021 aligned and were temporally correlated (R^2 = 0.67). As heterotrophic fluxes cannot be directly compared to NEE, we compared the EC June-September 2021 nighttime respiration rates (1.1 ± 0.03 g m^{-2} h^{-1}) to the autochamber measurements (0.70 ± 0.01 g m^{-2} h^{-1}). These two measures only partially aligned, likely because EC included both above and belowground respiration, whereas the autochambers only accounted for belowground respiration. Wintertime EC measures (0.30 ± 0.03 g m^{-2} h^{-1}) did not align with those of autochambers (0.70 ± 0.01g m^{-2} h^{-1}), which warrants further investigation. Overall, our findings contribute to synthesis between GHG estimations at different spatial and temporal scales that may improve the earth system models and climate projections.

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