Detecting small scale spatial heterogeneity and short-term temporal variability of CO2 flux dynamics in agricultural used landscapes using a robotic chamber system

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Improved agricultural practices sequestering additional atmospheric C within the soil are considered as one of the potential solution for mitigating global climate change. However, agricultural used landscapes are complex and their capacity to sequester additional atmospheric C might differ substantially in time and space. Hence, accurate and precise information on the complex spatio-temporal CO₂ flux pattern is needed to evaluate the effects/benefits of new agricultural practices aiming towards increasing soil organic carbon.

To date, different approaches are used to measure and quantify CO₂ flux dynamics of agricultural landscapes, such as e.g. eddy covariance, as well as manual and automatic chamber systems. However, all these methods fail to some extend in either accounting for small scale spatial heterogeneity (eddy covariance and automatic chambers) or short-term temporal variability (manual chambers). Although, automatic chambers are in principle capable to detect small-scale spatial differences of CO₂ flux dynamics in a sufficient temporal resolution, these systems are usually limited to only a few spatial repetitions which is not sufficient to represent small scale soil heterogeneity such as present within the widespread hummocky ground moraine landscape of NE-Germany.

To overcome these challenges, we developed a novel robotic chamber system allowing to detect small-scale spatial heterogeneity and short-term temporal variability of CO₂ (as well as CH₄ and N₂O) flux dynamics for a range of different fertilization and tillage management practices. The system is equipped with two canopy chambers, CR6 data logger, CDM-A116 analog multiplexer and multiple sensors to measure plant activity/biomass development in parallel. The measurements of the gaseous C exchange is performed by moving the system along the tracks with each chamber along one half of the gantry crane. Thus, each chamber measures 18 plots, out of 36 plots (2x3m; 12 per soil type) established in the study area.

Here, we present first CO₂ flux measurement results (spring barley; 3 different soil types) using this novel system, to prove its overall accuracy and precision. Our results show clear small-scale/within field spatial pattern and short-term temporal dynamics regarding measured ecosystem respiration, net ecosystem exchange as well as derived gross primary productivity.