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Potentials and challenges associated with automated closed dynamic chamber measurements of soil CO_2 fluxes

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Soil respiration fluxes are influenced by natural factors such as climate and soil type, but also by anthropogenic activities in managed ecosystems. As a result, soil CO_2 fluxes show a large intra- and interannual as well as intra- and intersite variability. Most of the available soil CO_2 flux data giving insights into this variability have been measured with manually closed static chambers, but technological advances in the past 15 years have also led to an increased use of automated closed chamber systems. The great advantage of automated chambers in comparison to manually operated chambers is the higher temporal resolution of the flux data. This is especially important if we want to better understand the effects of short-term events, e.g. fertilization or heavy rainfall, on soil CO_2 flux variability. However, the chamber method is an invasive measurement method which can potentially alter soil CO_2 fluxes and lead to biased measurement results. In the peer-reviewed literature, many papers compare the field performance and results of different closed static chamber designs, or compare manual chambers with automated chamber systems, to identify potential biases in CO_2 flux measurements, and thus help to reduce uncertainties in the flux data. However, inter-comparisons of different automated closed dynamic chamber systems are still lacking.

Here we are going to present a field comparison of the most-cited automated chamber system, the LI-8100A Automated Soil Flux System, with the also commercially available Greenhouse Gas Monitoring System AGPS. Both measurement systems were installed side by side at a recently harvested poplar bioenergy plantation (POPFULL, http://uahost.uantwerpen.be/popfull/) from April 2014 until August 2014. The plantation provided optimal comparison conditions with a bare field situation after the harvest and a regrowing canopy resulting in a broad variety of microclimates. Furthermore, the plantation was planted in a double-row system with the row width alternating between 1.50 m and 0.75 m, creating spatial differences in e.g. dry bulk density and soil organic carbon content. The soil CO_2 flux data sets were split into four subsets each characterized by different environmental conditions, thus presenting different challenges for the measurement equipment, namely 1) daytime, calm conditions, 2) daytime, windy conditions, 3) nighttime, calm conditions, and 4) nighttime, windy conditions. In parallel to the chamber measurements, soil CO_2 concentrations were manually measured in the topsoil. Soil CO_2 fluxes calculated from this dataset were used as a reference range of soil CO_2 fluxes at the field site.

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