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Detecting management and fertilization effects on the carbon balance of winter oilseed rape with manual closed chamber measurements: Can we outrange gap-filling uncertainty and spatiotemporal variability?

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Winter oilseed rape is the dominant biofuel crop in the young moraine landscape in North-Eastern Germany. However, studies on the effect of rapeseed cropping on net ecosystem exchange of CO_2 (NEE) and the soil carbon (SC) balance are scarce. SC balance estimates are usually derived from long-term soil sampling field trials where rapeseed is part of different crop rotations. The estimated annual differences linked to rapeseed cropping are rather small (varying between losses of 40 g C m^{-2} and gains of up to 100 g C m^{-2}). Testing management effects on the NEE and SC balance of cropping systems is best done by comparing plots with different treatments at the same site under the same climate. The soil sampling approach is in the need of field trials that run over decades, which has the disadvantage that management strategies of practical farming may have already changed when the results are derived. Continuous eddy covariance measurements of NEE would require large fields in flat terrain for each of the treatments, which is especially complicated in the heterogeneous landscapes of glacigenic origin of North-Eastern Germany. The common approach of using the chamber technique to derive NEE, however, is subject to the local soil and plant stand heterogeneities due to its tiny footprint. This technique might also disturb the ecosystem, the measurements are usually discontinuous requiring elaborate gap-filling techniques, and it has mostly been used on organic soils where large respiratory C losses occur. Therefore, our aim was to answer, if a combined approach of the eddy covariance and the chamber technique can detect the relatively small NEE and SC differences of rapeseed cropping on mineral soils within a shorter period of time than conventional soil sampling field trials can. We tested the new experimental design taking the advantages of both techniques into account: The eddy covariance tower measuring the NEE dynamics during the year; the chamber measurements to detect the flux differences between specific management practices - with additional chamber measurements installed close to the eddy tower as a reference linking the two techniques. In our experiment, we studied the effect of four different treatments of fertilization (mineral *versus* organic) and tillage (no-till *versus* mulch-till *versus* ploughing) on the NEE of rapeseed cropping for the climatic seasons 2013 to 2015. We compared the NEE of the treatments to the "background" NEE measured by the eddy covariance technique in the nearby reference field for the years 2013 and 2014. With this data, we estimated the uncertainty resulting from gap filling discontinuous chamber measurements and relate it to the observed effects of the four different treatments on the NEE. Here, we present first results on the applicability of the manual-chamber technique to derive the relatively small effects of rapeseed cropping on NEE and SC within a short period of three years of study.