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Towards a consistent approach of measuring and modelling CO_2 exchange with manual chambers

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Determining ecosystem CO_2 exchange with the manual closed chamber method has been applied in the past for e.g. plant, soil or treatment on a wide range of terrestrial ecosystems. Its major limitation is the discontinuous data acquisation challenging any gap-filling procedures. In addition, both data acquisition and gap-filling of closed chamber data have been carried out in different ways in the past. The reliability and comparability of the derived results from different closed chamber studies has therefore remained unclear. Hence, this study compares two different approaches of obtaining fluxes of gross primary production (GPP) either via sunrise to noon or via gradually-shaded mid-day measurements of transparent chamber fluxes (i.e. net ecosystem exchange, NEE) and opaque chamber fluxes (i.e., ecosystem respiration, R_{ECO}) on a field experiment plot in NE Germany cropped with a lucerne-clover-grass mix. Additionally, we compare three approaches of pooling R_{ECO} data for consecutive modelling of annual balances of NEE, i.e. campaign-wise (single measurement day R_{ECO} models), seasonal-wise (one R_{ECO} model for the entire study period), and cluster-wise (two R_{ECO} models representing low-/high-vegetation-stage data) modelling. The annual NEE balances of the sunrise to noon measurements are insensitive towards differing R_{ECO} modelling approaches (-101 to -131 g C m^{-2}), whereas the choice of modelling annual NEE balances with the shaded mid-day measurements must be taken carefully (-200 to 425 g C m^{-2}). In addition, the campaign-wise R_{ECO} modelling approach is very sensitive to daily data pooling (sunrise vs. mid-day) and only advisable when the diurnal variability of CO_2 fluxes and environmental parameters (i.e. photosynthetically active radiation, temperature) is sufficiently covered. The seasonal- and cluster-wise approaches lead to robust NEE balances with only little variation in terms of daily data collection. We therefore recommend sunrise to noon measurements and data pooling from adjacent measurement campaigns as long as pooling over e.g. harvest events and significant changes in plant development can be omitted. If, e.g. for extensive treatment comparisons, the sunrise to noon measurements are not feasible due to their higher workload, data pooling accounting for plant development is necessary.