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How accurate are gaseous C emission based estimates of the net ecosystem C balances?

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The accurate and precise quantification of an ecosystem′s carbon (C) balance is crucial for understanding not only the ecosystem functioning but also the global C cycle. However, often applied methods, based on measurements of the gaseous C exchange and systems C in- and outputs are prone to numerous errors and potential uncertainties. To date, validation studies using independent measures are scarce.
We present a pot experiment, which validates closed chamber based CO_2 emission estimates for Alfalfa (Medicago sativa L.) through closing the C balance. In a more detail, direct measurements of heterotrophic respiration (Rh) and net primary productivity (NPP; C fixed within living plant tissues) are used to cross-check the accuracy and precision of closed chamber based estimates of ecosystem respiration (Reco; sum of Rh and Ra), gross primary productivity (GPP; sum of NPP and Ra) and net ecosystem exchange (NEE; sum of Reco and GPP).Alfalfa was grown in 15 out of 18 pots (3 pots as control) under in-situ conditions. To minimize the influence of varying Rh on overall Reco and thus NEE, homogenized silicate without organic matter was used as a substrate. Gas exchange measurements from sunrise to midday using transparent (NEE) and opaque closed chambers (Reco) were conducted over a two month period once a week for each of the 18 pots. Plant height and growth was monitored throughout the study.
Our results showed a good overall agreement (R-squared: 0.91) between chamber based estimates of the net CO_2-C uptake by plants and measured C in living plant tissues, ranging from 37 g C m-2 to 187 g C m-2. In addition, chamber based estimates of GPP corresponded well with independently derived sums of NPP and Ra (difference between Reco and Rh). This indicates the general accuracy and precision of closed chamber based CO_2 emission estimates in a short-term, irrespective of their well-known methodical limitation, such as the low temporal measurement resolution.