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Discerning the cows from the pasture when determining annual NEE and carbon budget

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The CO_2 exchange of ecosystems and the resulting annual net ecosystem exchange (NEE) and total carbon budget (soil carbon sequestration) is commonly investigated using the eddy covariance (EC) technique. For the carbon budget of managed ecosystems also the import and export of organic carbon has to be taken into account. Grazed pasture systems represent a special challenge because their respiration can considerably contribute to the measured CO_2 flux, but this contribution depends on the spatial distribution of the cows relative to the footprint and thus is variable in time. This has implications for the gap filling of CO_2 flux time series necessary to determine annual NEE.
In few existing studies two procedures have been suggested to determine the NEE of grazed pasture: (a) discarding all cases with cows in the footprint and gap-filling the remaining dataset; (b) treating the cow respiration as part of total ecosystem respiration and gap fill the entire flux dataset including cow contributions. Both approaches rely on idealized assumptions and have limitations.
In our study we evaluated and compared the two approaches (for the first time to our knowledge) for a grazed pasture in Switzerland. For this purpose, the grazing cows were equipped with GPS sensors to monitor their position relative to the flux footprint. We found that the resulting annual NEE strongly depends on the flux data selection (e.g. u* filtering) and the applied gap filling procedure. Using an optimized procedure, the annual NEE with approach (b) was several times larger than the result of approach (a), but the difference agreed fairly well with independent estimates of cow respiration. Necessary assumptions and requirements of the two approaches for the determination of the pasture carbon budget will be discussed.