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Geoscientific Instrumentation Methods and Data Systems Discussions

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Interactive comment

# *Interactive comment on* "Using near-surface atmospheric measurements as a proxy for quantifying field-scale soil gas flux" *by* Andrew Barkwith et al.

**Anonymous Referee #1**

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General comments. This is a very short (too short?) but interesting paper in the scope of GI. It presents a method based on the theoretical principles of flux measurements at the soil/atmosphere interface coupled with data acquisitions based on the principles of an Eddy Covariance system. In general, micrometeorological systems are operated at a fixed location, at some meters above the ground, to get information on gas emissions over a long period. Information is thus mostly dependent from wind direction among other variables. Here, the authors use the basics of EC but operated from a mobile platform on which gas sensors are mounted to allow gas monitoring at 10 cm above the ground. The flux is derived from these gas concentrations measurements by using the Ideal Gas Law and by discretizing the air layer into virtual boxes opened at top and



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bottom, the vertical flow rate inside the box being determined using the anemometer from the EC system. This is an interesting approach, which is believed to benefit from a quite high rate of geographical coverage and from good location and description of gas emissions. Nevertheless, some important information is lacking in the manuscript; some comments are given below.

Specific comments. Introduction section: the authors compare the labor intensive ground-based method (flux measurements), the EC approach and airborne/space measurements (costly). Nowadays, there are several research institutes/companies worldwide developing drone-based solutions, using commercial or homemade sensor technologies, including open-path lasers, directed lasers, IR sensors... Some developments about this approach are welcome in the introduction, because, depending on the topography/vegetation, drone flights can also be operated at short distances from the ground, offering a geographical coverage rate far higher than the one reached by systems operated at walking speed. The reference Feitz et al. (2018) is mentioned but not as a basis of comparison e.g. for evaluating positive aspects and drawbacks. As noticed by the authors, there are some assumptions in the proposed approach. One of these assumptions is the absence of horizontal wind at land surface or at list little horizontal wind flow. More developments on this point are required to assess the potential use of the proposed method, and also on the related parameters such as soil roughness (e.g. Giannico et al., 2018. Contributions of landscape heterogeneity within the footprint of eddy-covariance towers to flux measurements. https://doi.org/10.1016/j.agrformet.2018.06.004). First, literature data are welcomed to evaluate the soundness of this major hypothesis. Second, data related to the acquisitions performed in Italy and UK have to be presented: there is no Figure showing the wind conditions during acquisitions and this information is lacking. This may partly explain some of the differences reported in Figure 1 (Italian site) and probably some of the differences observed at the UK site (data not shown but this can be deduced from Figure 3). On the contrary, are there some information on the diurnal variability of CO2 emissions at the UK site that can explain, at least partly, the poor agreement between chamber measurements and measurements using the authors' approach (chamber data were probably acquired over a longer period than the other data)? Do the authors think the "open-field scale" approach can be used with a sufficient degree of confidence at the UK site or would they prefer using the chamber measurements? Back on the "absence of horizontal wind" assumption: the authors mention potential applications of their method, including leakage detection. What about leakage detection when there is little to no vegetation on the ground (the CO2FieldLab experiment is mentioned in the references)? Does the assumption seem realistic in that case? What about using such a method in desert environments? The authors also mention the Weyburn case: what could be the influence of frozen conditions on wind conditions close to ground surface? The acquisitions were performed with a sensor mounted at 10 cm from ground surface: if the vegetation is higher than 10 cm and not grazed or mown (spring/summer conditions), how can be the method adapted? A picture showing/describing the "open-field scale" system in field-use conditions is lacking. It is always informative to have such Figure. Technical approach: it would have been interesting to compare with a third approach, intrinsically related to the "open-field scale" approach: the "traditional" EC monitoring. Why has this not been performed? It would have given interesting information on the benefits of the "open-field scale" approach, e.g.: is the "open-field scale" approach offering the same smoothing of anomalies than the EC approach, or does it give a better rendering? On the discrepancies between chamber data and "open-field scale" approach (especially for the UK site): a Figure comparing the results of the two methods is missing and this is needed; Figure 3 is not sufficient because we only see a point cloud. There is nearly no discussion on the differences between the two approaches for the UK site (only line 159). There is a lack of comparison with literature data, even if the "open-field scale" approach is not described in there because of its novelty. For example, what can be the differences with the use of vehicle-mounted (or walking use) of open-path lasers without quantifying the vertical wind flows? Because the "open-field scale" approach, like the EC approach, is supposed to give smoothed information on extreme values, what is the monitoring approach suggested by the authors in case there is a need to quantify these very high values. Use of "open-field scale" approach first and then perform chamber measurements, e.g. as suggested by Eugster and Merbold, 2015 (Eddy covariance for quantifying trace gas fluxes from soils. SOIL 1, 187–205. https://doi.org/10.5194/soil-1-187-2015)?

Technical corrections: none (well written)

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