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Interactive comment on "Eddy covariance for quantifying trace gas fluxes from soils" *by* W. Eugster and L. Merbold

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General comments

This manuscript presents a review of the eddy covariance (EC) technique directed at soil scientists. This is a challenging task and I appreciate the authors' effort to break down the complex theory of turbulence measurements to non-specialists. The paper is well written and clearly structured, so that I expect that the audience of this journal will benefit from this work. Such kind of manuscript may help to enhance the mutual understanding between scientists with different academic backgrounds in order to facilitate inter- and multi-disciplinary research, which is necessary to address today's environmental problems. Nevertheless, I would like to take the liberty of asking the

following three questions that came to my mind while reading this manuscript:

1.) What is the benefit of this manuscript compared to an existing text books on eddy covariance, such as that of Aubinet et al. (2012)?

2.) Is the presentation of the eddy covariance technique perhaps over-simplified?

3.) What if a soil scientist (or other non-specialist) reads this manuscript and believes this is sufficient to be able to conduct scientific-grade EC measurements?

To address the first question, the authors state that "these text books are either targeting atmospheric and fluid dynamic scientists or are strongly focusing on forest ecosystems". I cannot really agree with that. The text book of Aubinet et al. (2012) gives a broad overview of potential applications of the method. It does not only focus on forest ecosystems. There are separate chapters on applications of the EC method for forests, crops, grasslands, wetlands, lakes and urban areas of equal weight, and one of the authors is also a coauthor of the chapter on EC measurements over crops. So, I was surprised about this assessment. Nevertheless, one could argue that the manuscript at hand is much shorter and can be read much more conveniently than an entire text book, and so this manuscript could serve as a kind of appetizer that provides the reader with some sort of introduction into EC measurements for fluxes from soils. On this basis, the reader can then decide whether this method is of any further interest to him or her, and whether he or she wants to delve deeper into the matter. Admittedly, a potential entry barrier into the topic may well be reduced, which provides some justification for the relevance of this manuscript. In addition, chapter 4 can be probably be viewed as of the strongest asset of this manuscript. I find this general overview about experimental approaches and designs very good and useful, and this also goes beyond what can be found in the relevant text books.

The question remains however if the complex theory of turbulence measurements is perhaps presented in an over-simplified manner. There is a delicate balance between simplifying the theory so that potential novices in this field will not be deterred on the one hand, and emphasizing the complexity of the theory and the need for careful assessment of the underlying assumptions on the other hand. From my perspective, the authors did a very good job in finding this balance. However, it could be worthwhile mentioning a few more aspects and then refer to the literature for more detailed information. These are

- QA/QC : As mentioned in the manuscript, the applicability of the EC method to determine the ecosystem flux is based on a series of assumptions. Several quality tests have been published in the literature, and it is generally recognized as good scientific practice to use a set of such tests to assess the data quality (cf. Foken et al., 2012).

- Uncertainty quantification: Observational data can only be compared with model results in a meaningful way if an estimate of measurement error is available. This measurement error is highly variable in time and it depends on the turbulent exchange conditions. Again, several algorithms have been published on this topic in the literature and an overview can be found in the eddy covariance text book by Aubinet et al. (2012), section 7 (Richardson et al., 2012).

- Flux corrections: As mentioned above, the validity of some assumptions for EC measurements can be checked by certain test algorithms, but a slight violation of some other assumptions can actually be corrected for, e.g. misalignment of the sonic anemometer or high-frequency dampening of the concentration signal due to tube effects. One of the authors has done pioneering work in this field (Eugster and Senn, 1995). So, I am sure that the authors are aware of this. I feel this need for corrections should at least be mentioned in the text and then one could refer to the literature, e.g. the corresponding chapter in the Aubinet et al. text book (Foken et al., 2012)

Adding some remarks and references as suggested above will also help to avoid that a non-specialist in micrometeorology may believe that reading this manuscript is sufficient to operate his or her own eddy-covariance system. Moreover, the authors also state in the conclusions section that “the method is not yet at a level where the initi-

ated scientist can simply buy a system off the shelf, install it, and be happy the data streaming in”, and I completely agree with that.

Minor comments

P7,L16: What the authors describe by the term space-for-time substitution refers basically to the assumption of ergodicity. I think this concept might also be well known to scientists of other fields and it could add to the clarity of this paragraph if the authors just use this technical term.

P8,L4: The horizontal flux divergence term has already been dropped in the previous section. So, this paragraph is kind of redundant.

P9,L24: This statement is only true for the sensible heat flux. Other fluxes, such as those of latent heat or CO_2, usually do not exhibit a linear decrease with height (Huang et al., 2009). P16,L8: A few lines above, the authors write about two objectives, but only one objective is explicated. What is the second one?

P19,L13: The spatially explicit regionalization method by Metzger et al. (2013) is probably worth mentioning here as it overcomes the coarse spatial resolution problem that is otherwise typical for airborne flux measurements by combining wavelet analysis, footprint modeling and satellite remote sensing data.

P22,L14: In the context of EC in heterogeneous terrain, it could be useful to mention the possibility of checking the closure of the surface energy balance to get a first impression whether the flux measurements are meaningful or not.

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