Authors' response to referee comment amt-2018-460-RC1
(**referee comments in bold font** and author's reponse in normal font):

Interactive comment on "True eddy accumulation trace gas flux measurements: proof-of-concept" by Lukas Siebicke and Anas Emad

Anonymous Referee #2

The paper needs several clarifications with respect to the experimental setup, the performed calculation of TEA fluxes and some results given in Fig.12-16.

Page 3, Line 10: The paper is now presented by 2 authors.

AR: We have revised the text here and in other places throughout the manuscript to reflect the update of the list of authors (now two authors) as also noted by the second referee.

L 23: The paper is now presented by 2 authors. Please give the reference to such studies.

AR: Regarding the authors, the text has been revised (see also previous comment).
Regarding the references to „such studies": Mentioned studies have currently been published as conference contributions only but will be published later as peer-reviewed articles. In the current version of the manuscript commented by the referee, asking for references, we followed the explicit instructions given by the handling Editor, who asked us to remove any references to conference contributions (as can be seen in the online review process). Therefore we are unable to give further references to such studies. Instead we have updated the text to reflect this situation and mention the respective works as 'unpublished'.

P4: Fig.1: Please refer to section 1.1.3 Define DEA

AR: We have added to Fig.1 a reference to section 1.1.3 defining DEA as suggested.

L4: See page 3 Authors

AR: We have revised the text accordingly, see also comment above (Page 3, Line 10).

P6, L15: Please explain the meaning of noise in this context ?

AR: We clarified the meaning of noise in the revised manuscript. The revised text expresses the impact of scalar similarity and the dead-band on flux errors as simulated by Ruppert (2002).

P6, L27-28: β varies between max. 0.3 and about 0.8 in special conditions. Please explain "the order of magnitude lower accuracy" due to β approach.

AR: "The order of magnitude lower accuracy" was cited from the reference given (Foken 2008, on page 135 of the previous edition Foken 2003) and reference therein (Ruppert et al., 2002). The order of magnitude does not mean that the flux is uncertain due to the range of beta β but rather to the choice of β as either a constant or as a variable obtained from a proxy simulation. For the current manuscript the essential information is not the specific indication how much more uncertain the flux from a constant β would be but rather just the fact that a variable β is more appropriate as it reduces flux uncertainty. We have revised the text of the manuscript to express this.

P6, end: "aggressive use" ? noise ?

AR: The text of the revised manuscript has been rephrased and is now more specific.

P7, L11: noise in the flux ?
If somebody states a flux is uncertain, he must refer to the reference standard. What is the reference standard for

a flux ?

AR: The reference for the uncertainty of disjunctly sampled signals is the continously sampled signal (in this case of both the scalar and the vertical wind velocity, from which the fluxes are derived). We have revised the text of the manuscript to express this. Thanks for the indication that the reference should be stated explicitly.

P9,Items 1-3: Please add in the text or cite

AR: Regarding 1, we have added a reference to the relevant manuscript section, regarding 2 we have expressed the current status of the work and a reference to the literature, and regarding 3, we have added in the text a proposed correction approach.

P9-11: Please give a detailed description and diagram of the experimental setup of the TEA as it was used. For example, there is no information about i.e. the position of the flow controllers in the tubing, the pump, and no estimation of the influence i.e. of delays, stages of pressure drops and dead volumes. (Also section 3.2)

AR: We have followed the suggestion of the referee and included a detailed technical description of the system in an additional figure, i.e. Fig. 5 of the revised manuscript. The diagram of the experimental setup also includes the position of the flow controllers in the system, the tubing, the pumps, the delays, stages of pressure drops and dead volumes. The revised text also contains further details on the positioning of the air inlets relative to the sonic anemometer.

P14, L4: Please add the unpublished work in an appendix.
At the end of this section, please present exactly the method applied in the presented study.

AR: We have focused the text in the revised manuscript: now the principal idea of fitting a surface is mentioned directly insitu in the text and a reference to a related publication by Ross (2005) is given. An appendix presenting a new coordinate rotation method would be out of the scope of the current manuscript and in any case not appropriate as the manuscript does not use this method. The exact method used in the current study is presented in section 2.8.3 in the third paragraph, including citations.

Section 2.7: You have not shown any data about flow distortion for R3 and did not correct for any flow distortion. What is your estimated offset of R3 in w - axis ?

AR: Given the current data set it would be difficult to partition w residuals into (i) flow distortion, (ii) zero velocity offset, and (iii) non-zero mean vertical wind velocity during a given observation interval (such as the planar fit interval of one day). Therefore we estimate offset of the R3 related specifically to flow distortion by refering to a study by Loescher (2005), who found in a wind tunnel experiment that the vertical velocity bias of the R3 was 0.04 m s-1 at 0 m s-1 vertical wind velocity and -0.05 m s-1 at 0.3 m s-1 vertical wind velocity relative to a hotfilm reference.

P16, Eq.7,8: if mean w = 0 the $F_c = 0$?

The TEA relies on : $\sum w^+c^+ - \sum w^-c^- = \overline{w'c'}$.

Here it is replaced by eq.7 . Where is the difference to REA ?

AR: Please note that Eq. 7 of the original manuscript, which you reference, indicates to first take the absolute value of *w* and then apply the temporal mean, which is denoted by the overbar, which includes the absolute value! This means the order of the mathematical operations is important! We believe that the manuscript is already correct. To avoid further misinterpretation, we have included a sentence to explicitly alert the reader.
Regarding the difference of Eq. 7 to REA, we have clarified this in the revised manuscript through addition of the corresponding REA formula (see Eq. 10 of the revised manuscript).

In Fig.12 which w is used for TEA flux calculations?

AR: Note that the fluxes were calculated from $\overline{|w|}$ according to Eq. 7, i.e., not using updrafts or downdrafts separately, as shown in Fig. 12 in red and blue. We have added this note to the caption of Fig. 12 to be clear.

In Fig.15 and 16 you show that the wind vector seems to follow approximately the terrain. This is a nice example for along slope wind and should be also discussed with respect to influence of the rotation method.

AR: The influence of the rotation method on the along slope wind vector is discussed here: P32 L 22-24 in the original manuscript. In the revised manuscript we have added a further subfigure reference to the text. We also noticed that by mistake the regression lines were missing from Fig.14 Subfig. d). We have added the regression lines to the figure in the revised manuscript. The figure now clearly shows that the 7-day planar fit results in a vertical velocity independent of along-slope wind U, whereas the 1-day planar fit does not, biasing 30-min mean w by up to +- 0.02 ms-1. This addresses the referee's question on the influence of the rotation method.

References:

Foken, T.: Angewandte Meteorologie, Springer, pp. 298, 2003.

Foken, T. and Napo, C. J.: Micrometeorology, vol. 2, Springer, pp. 362, 2008.

Loescher, H. W., et al. Comparison of temperature and wind statistics in contrasting environments among different sonic anemometer–thermometers. *Agricultural and forest meteorology*, 2005, 133. Jg., Nr. 1-4, S. 119-139.

Ruppert, J, Wichura B, Delany AC, Foken T (2002) Eddy sampling methods, A comparison using simulation results, 15th Symp on Boundary Layer and Turbulence, Wageningen, 15-19 July 2002, Am. Meteorol. Soc., 27-30.