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Atmospheric Measurement Techniques Discussions

Interactive comment on "Eddy-covariance data with low signal-to-noise ratio: time-lag determination, uncertainties and limit of detection" *by* B. Langford et al.

Anonymous Referee #1

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Langford et al. present a comprehensive evaluation of several key factors affecting flux estimate calculations from eddy covariance data with low signal-to-noise ratios. The authors focus on bias effects of different methods to determine the time lags between scalars, on methods to quantify the random instrument noise and the total random flux error, and on the bias effects of the peak width of the cross-covariance function. In addition, they exemplify their assessments by discussing uncertainties of real world flux data, and finally, give recommendations for good practice in collecting and processing eddy covariance data when sensors with a low signal-to-noise ratio are used.

The manuscript is well-structured and clearly written. The assessment of uncertain-

ties in eddy covariance flux estimates is an extremely important yet often neglected exercise. I particularly appreciate the comparison of numerically calculated random instrument errors with the analytical approximation given by Mauder et al. (2013), and the authors' attempt to give general recommendations for practical application of their conclusions. The manuscript is very instructive and covers its topic in depth. That said I recommend that some parts of the manuscript be revised to be more focused and easier to digest for all readers. I recommend publication of this manuscript in AMT after considering the following comments:

1) line 270/271: What is the reasoning behind your statement "... the standard deviation approach derives significantly smaller limits of detection, which we believe to be underestimates of the true uncertainty"? What makes you believe that these are underestimates?

2) line 324 and following lines: The passage about the sensitivity of the covariance and the distribution of the selected noise should be shortened and Figure 3 moved to the Supplemental Material. The reader should be informed about the main findings (similar frequency distributions and mean average flux close to zero) in the text. However, I was distracted by trying to understand Figure 3, which finally did not add much information. Also, the dashed lines in Figure 3B are not fully visible.

3) I suggest removing Figure 7 from the manuscript and adding one example of the disjunct eddy covariance exercise to Figure 6 in direct comparison with the standard eddy covariance result.

4) In Figure 8 (section 3.2.2) you discuss the influence of the peak width of the cross-covariance function on the relative flux error of artificially generated multifrequency signals. Could you expand a little bit on the discussion how the findings from these simulations can be transferred to real world data? Can the observed increase of the relative flux error with increasing FWHM be generalized, or might this be a peculiarity of the frequency distribution of the artificial signals? With respect to the caption of Figure

8, it suggests to me that the relationship between the average relative bias and the FWHM of the cross-covariance function peak is exponential. Is this really the case?

5) line 476 and following lines “The logarithmic relationship between turbulence and height ...”: Please explain your line of reasoning step by step. It is not obvious how this passage relates to the sentences before it. Also, the last sentence of this passage (“Nonetheless, during more unstable periods...”) needs more explanation and integration with the rest of this passage.

6) Section 3.3.1: I suggest moving Figure 10 to the Supplemental Material and to focus on Figure 9 in this section. Line 528 may be changed to “... can result in very unnatural bimodal flux distributions (see Supplemental Information).” In addition, I cannot follow the discussion of the Gaussian white noise flux data with respect to acetone and benzene. To me, the range of acetone and benzene fluxes in relation to the Gaussian white noise fluxes look very similar.

7) While Figure 12 is very illustrative, I found the discussion of down weighting of data points in the figure caption distracting. If there is no further discussion of this fit, I suggest removing these pieces of information altogether. Otherwise, the authors may add a brief discussion of the fit in the main text.

Technical comments:

lines 55 and 305: reference should read “Mauder et al. (2013)”

line 98: usage of "and or" seems awkward to me

line 135: reference should read “Mahrt, 1998”

lines 223 and following lines: I recommend moving the passage starting in line 232 "It should be noted that..." until line 236 "... would still be affected by such noise." to the end of line 222 before you start with the discussion of alternatives in the frequency domain.

line 244: add "Wienhold et al.," before "1995"

line 260: remove "(LoD"

lines 302 and 304: "epsilon" should be subscript

line 335: reference should read "Lenschow and Kristensen (1985)"

lines 373 and 417: "e.g." seems to be out of place

line 473: remove "maximum" after "FWHM"

line 477: "means" instead of "mean"

line 529: should read "to a certain extent"

line 570: for the acetone time series, refer specifically to "Fig. 9C"

line 595: replace "we have carefully examined the key factors" with "we have carefully examined several key factors"

line 633: Do you mean "adsorption" instead of "absorption"?

line 852, Figure 1: Why is the double-arrow, which indicates "Noise" in 1A going beyond the circle indicating AC(0)? According to lines 208/209, an estimate of random instrument noise is given by the difference between AC(0) and AC(1).

line 854: should read "through"

line 881, Figure 5: The units of the isoprene and acetone fluxes (top panels B and C) and the random instrument noise (lower panels B and C) should be the same for better comparison. What is the advantage of plotting the error contributions of instrument noise and variability in surface plots? I’d prefer a simple line plot.

line 885: add "into" between "can be divided" and "errors"

Figures 6, 7 and 10: For consistency with other figures and the manuscript text, use "PRES" instead of "FIXED" in the figure legends.

line 913, Figure 9D: The time axis of the lowest panel must be revised.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 2913, 2015.