Review of manuscript bg-2020-445 by Vogl et al.

The authors present an evaluation of four different REA β-factor estimation approaches. They evaluate the four approaches for the H_2O flux at three different sites with very different vegetation cover (forest, meadow, gravel). The comparison of the different approaches and the different sites are the main advantage of the study. Specifically, the performance of the β_w approach is included (which is rarely reported in the literature) and for the proxy β approach, the use of an overall constant β value is compared to a half-hourly adjusted value. A main result of the study is that the use of a constant β value per site (or individual β_w values, which show a quasi-constant behavior) is superior to the use of half-hourly determined proxy β values.

However, the evaluation of REA approaches is less comprehensive than declared in the objectives. Only one scalar (H_2O / latent heat) is used for the approach validation, and only one scalar (T) is used as proxy. Moreover, the manuscript suffers from a number of additional shortcomings that need some substantial improvements before publication. They are listed in the following comments.

Important: The line numbering of the manuscript is erroneous (non-sequential) on most pages, which made the review somewhat cumbersome. I use the true text line numbers in the following comments (not the ones indicated in the manuscript).

MAJOR COMMENTS

1) Only the performance of the REA approaches for the H_2O flux is tested in the present study. This is done after an initial deadband optimization (using the reference EC dataset) for the same test scalar. This leads to a certain lack of independence in the method validation. Although the CO_2 flux and its correlation with the other scalar fluxes is introduced in Sections 3 and 4.1, the REA evaluations for the CO2 flux are unfortunately not presented. Alternatively CO_2 could have served as second proxy scalar option beside the temperature T (at least for some sites) as indicated in Section 2.3.
The authors should more prominently (in abstract and objectives) declare that they are evaluating the REA approaches only for H_2O fluxes. In addition they need to discuss better, whether and why they assume that the results also apply to other scalars, despite a sometimes low scalar correlation as exhibited in Fig. 3.

2) I find it a bit misleading to use the index "0" for the β factor of the proxy scalar approach. Obviously (see scalar correlation analysis) it matters, which scalar is used as proxy. Therefore, it would be more informative and more consistent to use the scalar specific index "T" or "wT" for the proxy scalar approaches here.

3) The presentation of the β_w approach in Section 2.2 is a bit confusing in my view. It is not clear what the use of Eq. 5 is for a REA application. The factor "m" is a purely theoretical quantity that has no use for practical REA applications. Therefore the practical β_w approach evaluated in the present study should be clearly separated from theoretical considerations.
In addition, the alternating use of "β" and "β_w" in this section is confusing. E.g. it is argued (P5, L5) that "the c'-w' correlation also affects β_w". But this is contradicting the definition of β_w (Eq. 4) purely depending on the w-distribution.

4) How can it be that the zero deadband calculations result in RMSE of about 20 mmol m^{-2} s^{-1} for the forest site in Figs. 5 and 6, when the fluxes themselves are only between 0 and 4 mmol m^{-2} s^{-1} (Fig. 2) and the flux ratios in the left panels are close to 1? This seems very unplausible and needs a detailed explanation.

5) The resulting $\beta_{0,const}$ values and the average β_w values for the three different sites should be listed in a Table, so that other researchers can compare them to their own results.

6) For Figure 10 and 11 it is not indicated, which data are displayed. Are these all (valid) data for all three sites or only data from one site? This needs to be clearly stated in the Figure caption.

7) I have some problems when comparing the β_w results displayed in Fig. 10 (right panel) and Fig. 11. The zero deadband results in Fig. 11 show a considerable variation with the kurtosis and that the kurtosis systematically depends on stability. In contrast the β_w results in Fig. 10 show practically no variation, neither with stability nor within the bins.

MINOR COMMENTS

P1, L15-16: It is not clear, which β approach this sentence is related to.

P2, L2-5: Both sentences are formulated in a misleading way.
First sentence: the detection limit of the instrument does not limit the REA fluxes directly but the quality/uncertainty of the REA fluxes. Change e.g. to "...when the uncertainty of the REA flux quantification is not limited by ...". Second sentence: change to: "For REA sampling differences close to the instruments detection limit ..."

P6, Fig. 1: Please check if the position of the grey points in the right panel is correct. According to Eq. 4 and a β_w value of about 0.6, the normalized vertical distance of the two grey points ($=\Delta w/\sigma_w$) should be about 1.6, but in the figure this distance is much less than 1. Maybe the x- and y-axis need to be exchanged...?

P8, Table 1: The units for the roughness length are probably [cm], not [m]. Only indicate two significant digits in the roughness length values, because their accuracy is not so high.
Please also include the average canopy heights and the EC measurement heights in the table (better than scattered in the text). This would be advantageous for the reader.

P9, L17: The formulation "...resulting in a total measurement height ..." is not logical (what results in what?). Please rephrase.

P9, last line: Correct to: "A diel course is still observed, but the flux is constantly directed ..."

P10, L18: What do you mean with "perturbation time scale"

P10, L25: Explain the "additional hard thresholding".

P11, Line 1-2: I do not understand what "force it through zero" means here.

P11, Line 5: I do not understand why the slope m had to be computed in the present study. It is not necessary for the β_w calculation according to Eq. 4. Moreover, the w'-c' statistics are not available in a real REA application (see also comment 3 above).

P20 Fig. 11 middle and right panel: The symbol colors hardly distinguishable. Removing the black frame of the symbols may be helpful.

P21, L7-10 ("The tested REA models .... along with the main results of this study.") This part should be omitted from the Conclusions because it is pure repetition.

Figures 5-8: Indicate the units of the RMSE in the right panels.

Table 2: In the second lowest row, "r_{xx}" presumably should be replaced by "r_{xy}"