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Interactive comment on "Seasonal and diurnal variation in CO fluxes from an agricultural bioenergy crop" *by* M. Pihlatie et al.

Anonymous Referee #2

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1 General comments

The manuscript of Pihlatie et al. on carbon monoxide (CO) flux measurements above an agricultural bioenergy crop (reed canary grass) represents an important study on the biosphere-atmosphere exchange of CO. While previous studies mainly focused on short term measurements of CO fluxes, the authors present the first eddy covariance measurements of CO fluxes over an entire growing season, making it a unique study. Like this, the authors can investigate the dependency of the CO flux on different environmental parameters such as irradiation, temperature, crop cover, fertilization status, etc.

Interestingly, the authors find that the reed canary grass ecosystem acted as a net source of CO at the beginning and a net sink during of the rest of the growing season. Also, they measured a strong diurnal cycle, as opposed to other previous studies over cropland, with mostly net emission during daytime and net uptake during night. In their study the authors correlate the net CO flux with environmental parameters to obtain an understanding on the controlling processes. As the nature of CO exchange is complex with many possible sinks and sources that have been observed in previous studies, this is challenging. As a consequence, the conclusions made on the underlying processes can often only remain assumptions, and therefore, the study provides only limited new insight into processes of CO exchange. As stated by the authors, further process related studies are necessary for future research.

The authors use state of the art measurement techniques for the quantification of CO fluxes and the fluxes were analyzed according to standard quality control procedures. Furthermore, the manuscript is clearly structured and well written. Due to the unique data set, I suggest the manuscript to be published in BG, after the more specific comments below have been addressed.

2 Specific comments

P. 3, L. 16-20: At which day was the crop cultivated? For completeness, I suggest to add this information to this short description of the growing season.

P. 4, L. 21-28: In this paragraph it is not clear that these are the same analyzers as used for the flux N_2O intercomparison in Rannik et al. (2015). It would be good to state this in this manuscript or move the above sentence "The comparison of four laser-based..." to the end of the paragraph.

P. 6, L. 4-7: Here it would be interesting to know, what the magnitude of the CO flux loss was, regarding the given response times of the EC systems. In context of the effect of the inlet lines, it would also be beneficial to mention their inner diameters in this section. According to Rannik et al. (2015) the reason for the larger response time of the system was caused by laminar flow due to a larger tubing diameter.

P. 6, L. 8-10: As stated here, more data had to be removed during daytime than during night-time. However, especially at night-time flux data has to be often rejected due to insufficiently developed turbulence. For this, a flux quality criterion using e.g. integral turbulence characteristics as suggested by Foken and Wichura (1996) is often applied. Also a test on stationarity, which was not applied for the N_2O fluxes in Rannik et al. (2015) for intercomparison reasons, might be important for CO.

P. 6, L. 22: The results chapter presents the measured CO flux and its correlation with various environmental parameters. In addition, I find it important to also present the CO mixing ratios as they can influence the CO flux significantly. Especially, the amount of CO uptake might be largely dependent on the available atmospheric CO. To rule out the effect of changing atmospheric CO levels on the CO flux when interpreting the results, CO mixing ratios should then also be included in the correlation analysis.

P. 6, L. 22: As it was mentioned in the method section, two different instruments for the CO flux measurements were used. However, in the result section the data from both analyzers is only shown as the cumulative flux in Figure 1f. If two independent analyzer are used, I would expect a paragraph or statement on the comparability of both measurements. This would give a better insight into the associated flux errors and would be also be valuable information for the CO flux community. Looking at the cumulative flux estimates, there seems to be a good agreement between days 205-270, while after that both fluxes seem to differ. Also, it should be stated in the manuscript that the presented fluxes (despite the green cumulative curve) are from the AR-CWQCL instrument while the LGR-CWQCL instrument was only operated from day 205.

P. 7, L. 19-21: As stated, the concept of the gross F_{CO} only holds if the CO uptake can be assumed to be constant over the entire diurnal cycle. However, especially turbulent

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transport and transport through the quasi-laminar boundary layer at the surface typically show distinct diurnal cycles with maxima during daytime. Hence, I would expect the CO uptake to increase during the day, unless the CO uptake is limited mainly by soil microbial consumption or transport in soil (then, the CO flux would also mainly be independent from above surface CO-concentrations, which would change during day). Is there more evidence that can support the assumption of a constant CO uptake? The authors note that there is evidence from previous studies that the temperature effect on microbial consumption can be assumed to be small. In my opinion it should also be shown that the CO uptake is mainly limited by soil microbial consumption or transport in soil for the assumption of a constant CO uptake to be valid. Otherwise, the diurnal variation in the aerodynamic and the quasi-laminar boundary layer resistances would have to be taken into account. In general, the use of a bi-directional exchange model would be useful to address the issue of flux partitioning and importance of soil uptake, although I understand that this is challenging given the lack of detailed process studies on CO exchange and might be the scope of future research.

P. 8, L. 8-16: What was the applied definition for daytime and night-time periods? This is valuable information, as the correlation values are often largely dependent on the variation of the used parameters, which are typically larger during daytime. In this context, it might be also valuable to mention if the flux error had an impact on the weak correlations found during night-time.

P. 9, L. 11-13: To correct for this bias, a gap-filling method can be applied for the calculation of cumulative CO fluxes.

P. 9, L. 14-15: As F_{CO} describes the net CO flux, one should differentiate here more explicitly between the emission component and uptake component of the flux. Otherwise the reader may assume you are referring to the net emission/uptake.

3 Technical comments

P. 3, L. 4: Write “reed canary grass” instead of “read canary grass”. Correct also on P. 13, L. 9 and 19, L. 1.

P. 3, L. 13: Omit space after “27°” or introduce after all units (°, ‘, “). Use same degree sign as used in L. 15.

P. 3, L. 17: Use superscript for “-1” in “ha-1”.

P. 4, L. 10: Shouldn’t it be “L=+-100 m” for the definition of the near-neutral range?

P. 4, L. 16: Insert space before “Considering”.

P. 4, L. 26: Write “LGR-CWQCL” instead of “LGRCW-QCL” as in the rest of the manuscript.

P. 6, L. 1: Do you intentionally differentiate between “co-variances” (here and L. 5) and “covariance”?

P. 6, L. 10: Write “daytime” instead of “day-time” as in the rest of the manuscript. Correct also on P. 7, L. 15 and on P. 9, L. 24.

P. 6, L. 27: I suggest using “over the 9-month measurement period” instead of “in the end of the 9-month measurement period” as the used expression could be misleading otherwise.

P. 7, L. 17: Use superscript in units.

Figures 2-5: Instead of using the day of year numbers, I suggest to use the introduced classification of S, ES, MS . . . in the subplot titles (or use both, DOY + the classification). This makes it easier to compare with Figure 1 and descriptions in the text.

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4 References

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