Point-by-point Responses to Anonymous Referee #1 for #amt-2020-302 R3

Authors used regular fonts for Referee #1 comments and used blue fonts for author's response and red fonts for changes in our R3 revision. We followed referee's all comments and suggestions. Authors appreciate Editor and the Referee that allowed us to improve our revision.

Anonymous Referee #1

Major comments :

1. The authors ignore the suggestion to discuss transducer shadow effect (which could be introduced in the paragraph L100, and elsewhere). Doing so will heighten a sense of the work's relevance and move it from an instrument comparison to a flux comparison. Take some of the response from L967+ and put it into the text.

Response: Thank you. Accordingly we moved our R2 point-by-point response to the revised manuscript around L100 as below:

"It should be noted that transducer shadowing effects were heavily investigated during early sonic anemometer development in the 1980s and 1990s. The optimum geometry design minimizes shadowing effects (air flow distortion dynamics and line/path integration) for the sonic anemometer's geometry (e.g., a 120-degree orthogonal geometry) but this …"

2. The authors should comment on potential impact on CO2 flux via the WPL correction if not the CO2 flux differences themselves. This is an important implication of this work

Response: Please allow us to explain the reason that we haven't discussed H_2O WPL correction in our second revision (R2). This is because WPL correction for H_2O flux is dependent upon covariance components (i.e., $\overline{w'\rho'_v}$ and $\overline{w'T'}$) but not upon the mean component of $\overline{\rho_v}$ and $\bar{T}$. The $\overline{w'\rho'_v}$ was well explained by the co-spectral analysis shown in Fig. 6. Also the $\overline{w'T'}$ was calculated from sonic CSAT3 that is independent from IRGAs. Both $\overline{\rho_v}$ and $\bar{T}$ in the WPL correction are taken from the slow sensor HMP155. The bias or the drift of H_2O density from the fast sensor (IRGA) doesn't affect the water vapor flux. The HMP155 (or early version HMP45) sensors are stable and sufficiently accurate for mean water vapor density and mean air temperature. The WPL corrections [see below two equations for H_2O flux (F_v) and CO_2 flux (F_c)] were coded in our site's datalogger or eddy covariance software tool that we developed or Eddy-Pro tool by LI-COR. Two equations for WPL corrections for H_2O and CO_2 flux in open-path system are:

$$F_v = (1+\mu\sigma)\cdot\left(\overline{w'\rho'_v} + \overline{\rho_v}\cdot\frac{\overline{w'T'}}{\bar{T}}\right)$$

$$F_c = \overline{w'\rho_c'} + \mu \cdot \frac{\overline{\rho_c}}{\overline{\rho_a}} \cdot \overline{w'\rho_v'} + (1 + \mu\sigma) \cdot \overline{\rho_c} \cdot \frac{\overline{w'T'}}{\overline{T}}$$

Unlike H_2O WPL corrections, therefore, CO_2 WPL corrections additionally require stable and accurate mean terms $\overline{\rho_c}$ (note all $\overline{T}$, $\overline{\rho_v}$, and $\overline{\rho_a}$ are determined by slow sensor HMP155). This is why high-quality CO_2 flux monitoring usually requires a weekly or biweekly on-site CO_2 calibration due to CO_2 density drifts (or offsets).

Therefore, authors agreed to comment on CO_2 WPL corrections in our R3 manuscript. We added below at the beginning of subsection '**4.2 Water vapor flux error**' around L470 as:

"The water vapor flux is generally not affected by three IRGA's drifts (or biases) of water vapor density. The WPL corrections for water vapor flux is dependent upon the covariance terms but not upon mean water vapor densities from three IRGAs because the mean water vapor density is determined by the slow response sensors of the HMP155. However, notice that the CO_2 flux is certainly affected by IRGA's CO_2 drifts because WPL correction for CO_2 flux requires the mean CO_2 density from IRGA measurements."

3. The authors do not sufficiently highlight their assumptions around rmsd, which are that (1) they implicitly consider the 7500RS as the "good value" and deviation from it as "Bad" even though the article also highlights periods where the 7500RS seems to suffer measurement drift in comparison to the other sensor types (L301). It's better to be clearer that there is no gold-standard and you are assessing differences among sensors and not differences from a standard.

Response: We agreed that there is no gold-standard and we used the LI7500RS in figure 4 as a reference for this study's assessment only because it is the newest sensor, not because it was assumed to be the best. In fact, we found that the oldest, LI7500 IRGA performed best for our study.

We modified one sentence to clarify as below in section 2.2:

"In one case, when evaluating sensor drift, the reference is the average of three IRGAs or three EC systems, and in another case, for instrument intercomparison, the reference is the latest sensor, LI7500RS."

4. The reference to upper and lower values is still unclear (L186-8) and feels heuristic or arbitrary.

Response: Thank you for your insight. Please allow us to explain this range. They were determined by +/- 3.5 standard deviations in raw data for water vapor density. The 2 g H_2O m^{-3} (equals to 111 mmol H_2O m^{-3} or 2.7 mmol mol^{-1}) is the lower bound (-3.5 standard deviations) during the growing season at Bushland, Texas. The 30 g H_2O m^{-3} equivalent to 1,666 mmol m^{-3} or 42 mmol H_2O mol^{-1} water vapor density as an upper bound (+3.5 standard deviations). In Eddy-Pro software, the despiking thresholds for both water vapor and CO_2 are +/- 3.5 standard

deviations of a moving window (usually a 5-minute window or 1/6 of flux averaging period with half window overlapped). See Table 1 below:

Table 1. Plausibility range for spike detection for each sensitive variable.

Variable	Plausibility Range
u, *v*	window mean ±3.5 st. dev.
w	window mean ±5.0 st. dev.
CO_2, H_2O	window mean ±3.5 st. dev.
CH_4, N_2O	window mean ±8.0 st. dev.
Temperatures, Pressures	window mean ±3.5 st. dev.

(adapted from https://www.licor.com/env/support/EddyPro/topics/despiking-raw-statistical-screening.html).

Authors thus revised the sentence in R3 as,

"Both upper and lower bounds were estimated by using ±3.5 standard deviations of a 5-minute moving window with half window overlapped in water vapor density time series in Bushland, Texas."

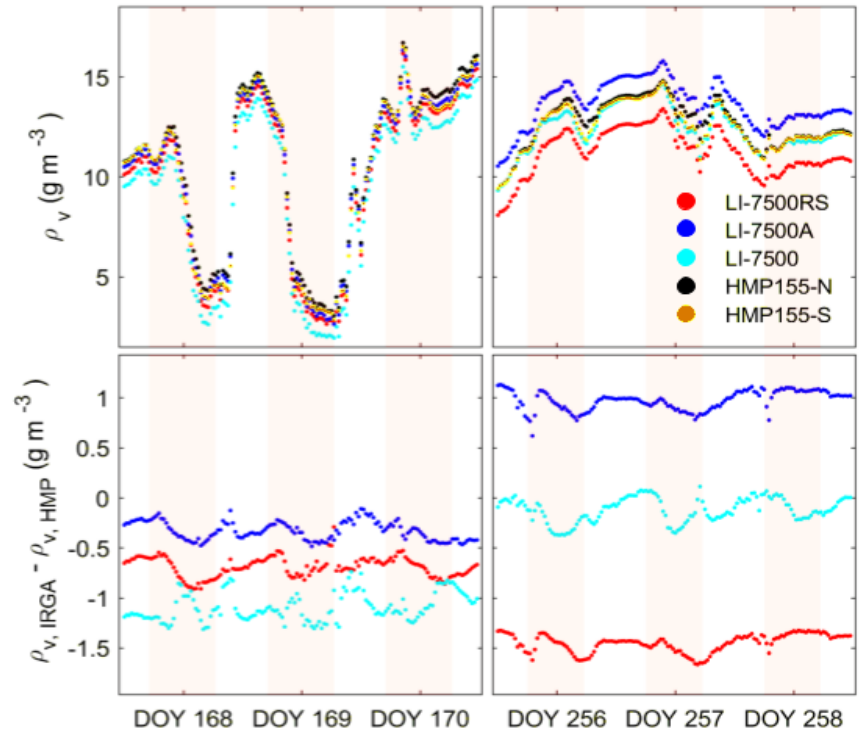
5. The description of advection can still be made clearer, and also its effect on the energy balance closure.

Response: We agreed. We enhanced the advection description by adding one sentence around L203 which is below:

"Such advected air, usually dry and warm, flowing from adjacent areas to irrigated crop fields is typically the driving force of enhanced daytime latent heat fluxes especially during the afternoon, which may not be fully captured by EC systems and thereby causing reduced energy balance closure."

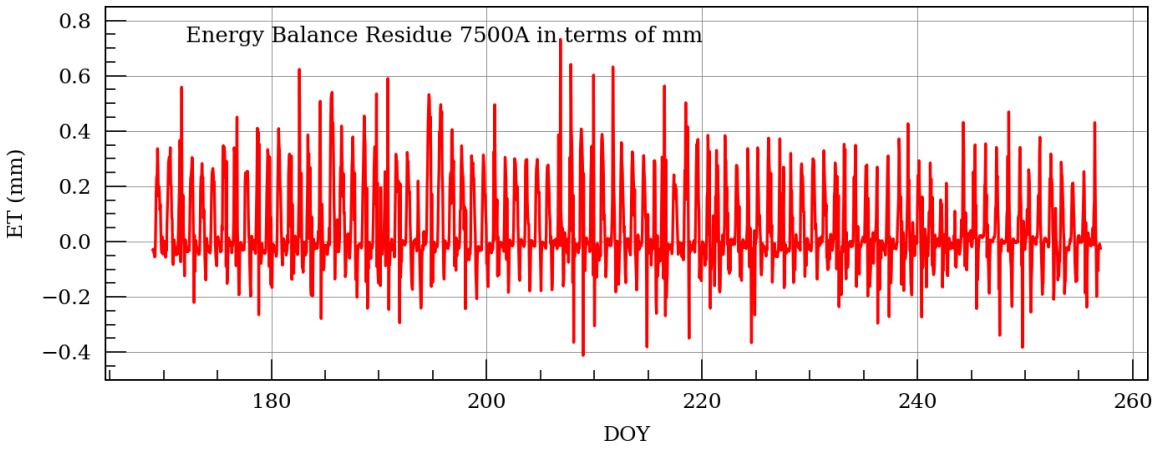
6. Fig 2 could be improved by increasing the marker size in the legend; the points there are too small for me to detect the difference in blues and greens. (particularly Li-7500 and HMP155S)

Response: Thanks for this good suggestion to improve readability. Legend marker size has been increased and the green is now dark orange to improve contrast. The updated figure is shown below:



7. R1 MC2 the energy balance term discussion (L992-7) is not clear and could be still added to Fig 7. It won't confuse the reader to have additional, helpful information there. (see also the point made in response to R1MC3)

Response: We agree that additional information would be helpful to link the daily ET to the larger energy balance picture. Here is the energy balance residue from 7500A IRGA.



We added this energy balance residue term in Figure 7. The new Figure 7 is below,

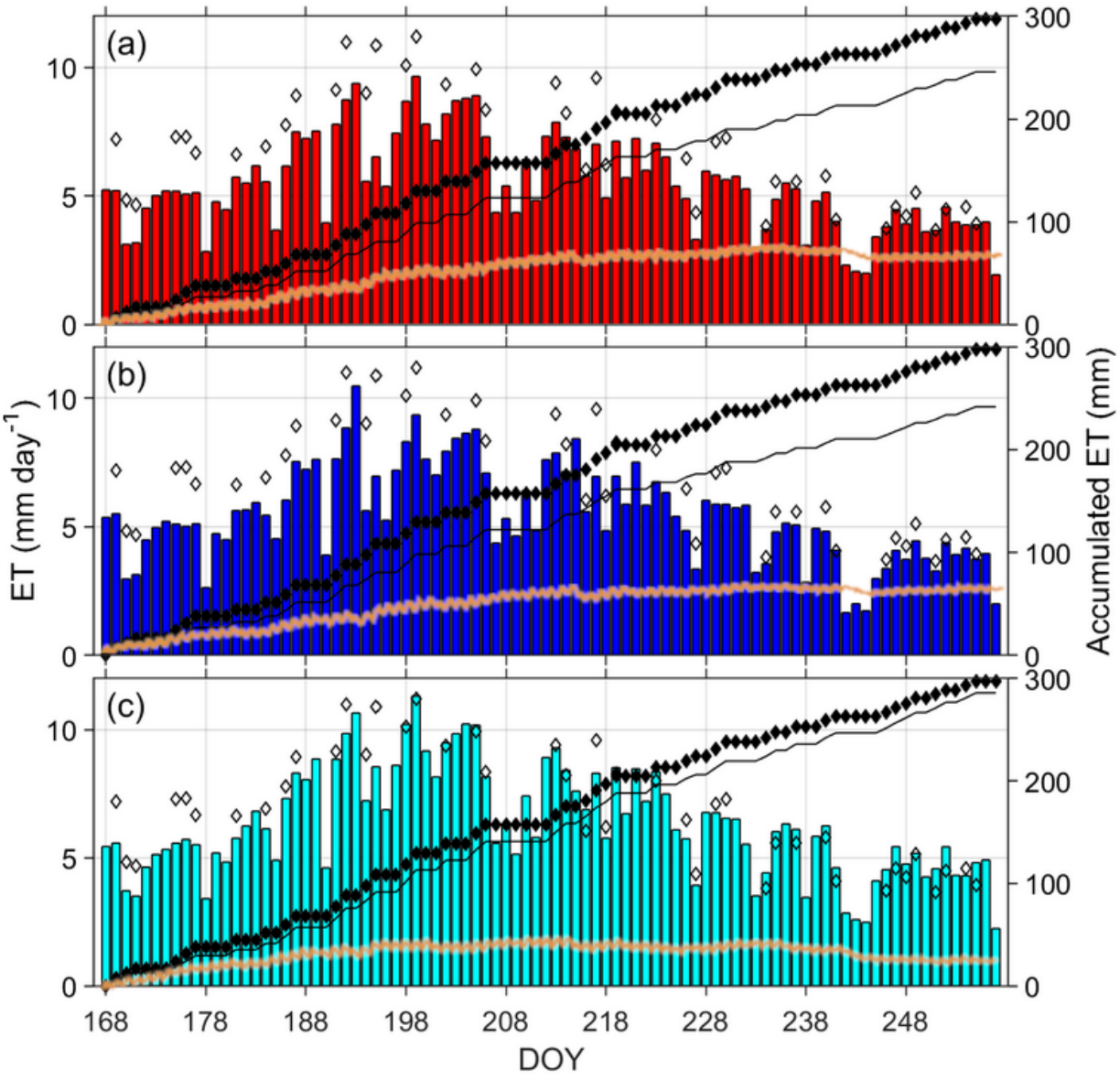


Figure 7. Daily ET determined with (a) LI-7500RS (red), (b) LI-7500A (blue), and (c) LI-7500 (cyan). The daily lysimeter ET is displayed by open diamond markers. Accumulated lysimeter ET is shown with solid diamonds, accumulated eddy covariance ET measurements with solid lines. Accumulated daily residual energy is shown in orange circles. Final accumulated energy balance residuals, computed by subtracting eddy covariance ET from the other major energy balance terms (R_n-H-G) of each day, for these EC systems (mm): 66.6, 63.3, and 20.0.

8. R1MC5 state explicitly that there is the potential appearance of a conflict of interest but it was managed by the means described in the response (L1020).

Response: We believe that is common for scientists at Li-COR, Campbell Scientific, and similar engineering companies to participate in collaborative research.

We inserted a sentence in our acknowledgements:

"It is not our intention to favor any particular instrument and authors only present evidence-based scientific results. There were no financial implications for this study - LI-COR did not fund or incentivize anything related to our findings."

9. R1 minor comment 2, "following rainfall events" – I disagree that this duration should not be quantified. Add "for periods from one to a few days" or something similar.

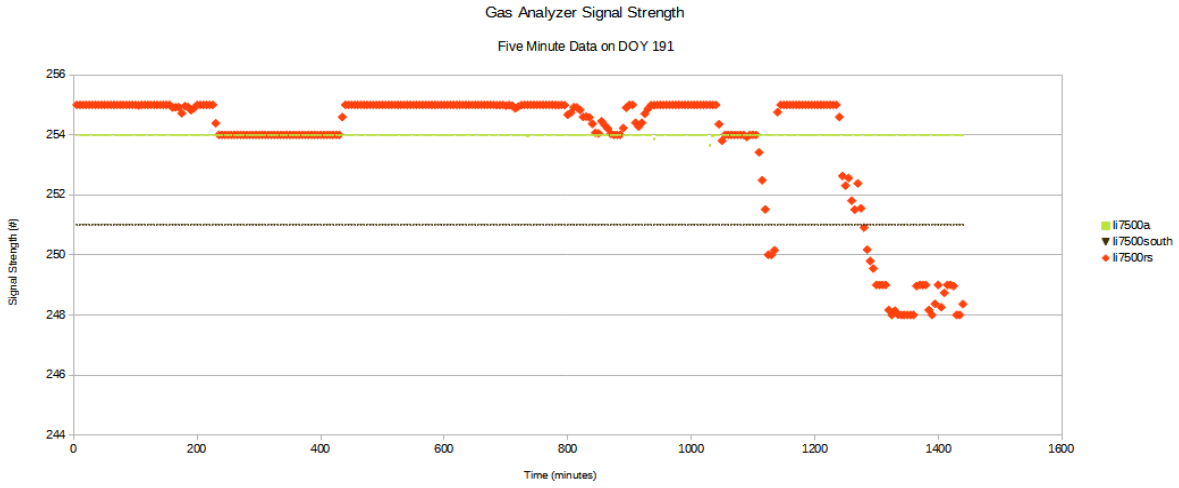
Response: Yes, we agree with you. It certainly can be quantified. We added "for a period from one to a few days'.

Minor comments :
1. L20 this suggestion was intended to then remove the words "water vapor density fluctuations" from L22, please don't repeat this phrase.

Response: This suggestion makes sense and we have removed the phrase.

2. L309-310 did they see loss in signal strength (RSSI or ADC) during this period?

Response: RSSI is for 7700. All 7500 are ADC, in which the first 4 bits represent the signal strength. Yes, we did see loss in ADC for the LI-7500RS (see below).



3. L375 add apostrophe-s after IRGA

Response: Added s (IRGAs).

4. L445 the transition from general results to one specific half hour seems abrupt. Perhaps adding "for example" and improving the transition would be helpful.

Response: Good suggestion. We have connected this sentence better to the previous one.

5. L448 and 449 shift case from singular (was) to plural (were). Pick one and re-write

Response: Both are now “were”.

6. L467 “exactly” is too precise. Rephrase.

Response: Changed to “behavior resembles”.

--- The End of point-by-point response for referee #1