

## ***Interactive comment on “A high-altitude balloon platform for determining exchange of carbon dioxide over agricultural landscapes” by Angie Bouche et al.***

**Anonymous Referee #1**

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This paper presents an approach based on easily accessible 'weather' balloon launches with lightweight CO<sub>2</sub> sensors to determine surface fluxes of CO<sub>2</sub>. It is appropriate for AMT, and has particular relevance to engaging the public in making CO<sub>2</sub> flux measurements in appropriate regions. However, it needs some significant revisions before publication. Most notably, the computational approach that has been used to compute fluxes for each 100 m layer of atmosphere is not appropriate. The profiles should be integrated first and then the flux is computed from the difference. While it may work to compute the differences first and then integrate this can lead to spurious values due to how vertical mixing plays out between the two flights. The layer by layer values are not interpretable. Additional clarification is needed on details of the

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measurement methods.

Specific points to address are itemized here.

Page: 4 Line 105, here and throughout it would be more appropriate to refer to mixing ratio instead of concentration. The instrument is measuring CO<sub>2</sub> mixing ratio in micromole CO<sub>2</sub> per mole-of-air

Page: 5 Starting at line 151 You need to be specific about what the Licor measures. By specifying the unit as ppmv you imply that it is mole of CO<sub>2</sub> per mole of air. Is it dry air or ambient air with H<sub>2</sub>O included? However, the instrument signal is actually dependent on density - number of CO<sub>2</sub> molecules inside the cell and has to be converted to mole fraction by pressure correction internal to the analyzer. Is it pressure corrected? You need to explicitly discuss these details.

Page: 6 line 180; In the discussion about temperature I assume you are referring to the potential temperature, which would be the temperature if a parcel of air were brought to the pressure of reference height (surface). That's probably not far off, but you need to include some discussion of how much the actual temperature does deviate from the what you get from assuming constant potential temperature. The previous discussion about presence of mixed layer and noting that the mixed layer height increases over the day implies a deviation from constant potential temperature with height.

Line 190 It would be better to show the steps for equation 1 starting from the mass balance that relates the changes in the integral of CO<sub>2</sub> density to the sum of in and outgoing terms; flux at bottom, entrainment at top, difference in advection in and out. Then state that for cases where entrainment is small ( $dc/dz \sim 0$  at top of volume) and advection is small ( $dC/dx$  is small) you can get the surface flux from the change in CO<sub>2</sub> mass inside your volume. The equation should be applied to the integral NOT to individual layers because there is vertical mixing

Page: 7 line 207: You need to explain why it is necessary to generate a composite

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seasonal cycle of the eddy flux data rather than use the data as is for each year.

line 235: Usually the layer above the mixed layer is referred to as free troposphere.

Page: 8 Line 239 Clarify what you mean by the pressure values. Are you adjusting the partial pressure of CO<sub>2</sub> or the atmospheric pressure by 1%? I haven't seen any place where CO<sub>2</sub> partial pressure is actually used, so to mention it here causes confusion. Secondly, it would be more convincing to have some explanation of why the measurements shifted by 4 ppm.

line 253; Revisit the discussion about anomalously low NEE for 7/23/15 after recomputing using the difference of the integral and not doing the differences layer by layer. Then if you still think this point is anomalous, show the profile. Even if there is enhanced CO<sub>2</sub> in some layer the calculation still gives an estimate of surface flux, but it won't be NEE if the source of CO<sub>2</sub> is some combustion or anthropogenic source. It would still be NEE if the high CO<sub>2</sub> was from an unplanted field. Are there any large herds of livestock around? If that profile is judged to be anomalous it shouldn't be included at all, just say that there were more flights, but profiles with local influence were rejected.

line 263 With an unexplained instrument malfunction it might be more prudent to discard that data.

line 265: the NDVI trend is for a 16-day average while the NEE estimates are a snapshot for part of a single day. There are many reasons for CO<sub>2</sub> flux on a particular day to vary from the smoothed area average. Different flux footprints and hence mix of crop type or presence of bare fields on different days or clouds are just two causes that come to mind. Trying to interpret variations between the two years based on just a few observations in each year is too speculative and ought to be left out of the discussion.

Page: 9 line 277; averaging the whole annual NEE into 100 days of 12 hours ignores too much of the sharp seasonal pattern for crops. Comparing to the instantaneous flux

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values from Bondville tower is fine, but not averaging the annual NEE.

line 281; if you are going to include this data point but still call it anomalous you have to show its profile so the readers can make their own judgment of what is wrong with it. It isn't OK to talk about it and just claim that it has local source contamination.

Page: 13 This figure may not really be necessary. I don't think it adds very much to understanding the method. But if you keep it, I think it is not appropriate to compute the flux separately for each layer. As noted in comment about equation 1, there is vertical mixing so the differences between flight 1 and 2 at any specific layer are not simply related to the fluxes during the intervening time. The profiles must be integrated first and then take the difference to get the flux. I'm also not convinced that the ideal profile in lowest km would be constant. There is strong enhancement in early morning from the residual of respiration into the nocturnal layer and some change in concentration with height because mixing is not instantaneous so concentrations at higher position lag behind the concentration at the surface.

Page: 16 Figure 4 should not show flux per layer. Integrate the profile and take difference

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