

## ***Interactive comment on “The Utah urban carbon dioxide (UUCON) and Uintah Basin greenhouse gas networks: Instrumentation, data and measurement uncertainty” by Ryan Bares et al.***

### **Anonymous Referee #1**

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Review of Bares et al., "The Utah urban carbon dioxide (UUCON) and Uintah Basin greenhouse gas networks: Instrumentation, data and measurement uncertainty"

This manuscript is a well-written and organized description of two GHG measurement networks. Overall, most of my comments are extremely minor (wording/spelling/grammar), with only a few more substantial comments.

More substantial comments:

The methods and uncertainties seem sound. Two things could be improved: 1) the pump in the UUCON network is upstream of the analyzer, meaning that the sample (but not the cal gas) goes through the pump first. - the authors should test the output

of the pumps to ensure that Co<sub>2</sub> is not compromised or changed by the pump, or add some language addressing this issue. 2) The system does not dry the sample, so the authors should ensure that the water vapor correction is robust. Although they have done a very nice job explaining how it is applied for the Licor, they state that they do not think it is a large component of the uncertainty but they do not back that up. This should be done for both systems.

Specific comments:

L79. Restate what "These methods" refer to here

L115: IGRA should be IRGA

L118 - reword - what is continuously flowing (data? air?) and what is high-frequency? not the method.

L123 Again, what exactly is meant by "continuous" vs. "not continuous"? Are the 5 minute points not averages and the 10 second data are averages? Or is this just referring to the higher reporting frequency?

L126 I would not put quotes around contamination (not a term being defined here or special usage)

L146.  $\mu$ m is not the abbreviation for micrometer, the actual greek  $\mu$  should be used here

mole fraction should probably be used consistently throughout here rather than switching back and forth with concentration

L159 - I was interested in this pump so I looked it up and cannot find this one - can the authors check the number? The NMP850-KNDC (similar part) seems to be a diaphragm pump, not swinging piston. But perhaps the UMP is a piston? Here it would be desirable (as noted at the top of this review) to indicate whether this pump could affect CO<sub>2</sub> concentrations downstream.

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L175 L/minute is volume flow - specify standard liters per minute. I would guess at least some if not all the sites are at altitude, so this becomes more important.

L196 Division's (apostrophe)

L200+ I commend the authors on the careful accounting of their standards. It is a little disappointing to hear of drift in the tank of 0.5 ppm however, that seems quite high. (let alone the 1.5 ppm drift in one of the original tanks!).

What is the typical value of the target tank?

L217 subscript 2 in CO<sub>2</sub>.

L218-221 this paragraph is confusing and a little out of the blue? Is this round-robin between cities occurring or has already been done? (also conducted should be conducted). Or is this a recommendation?

L222, In the previous few paragraphs, the units have been  $\mu\text{mol mol}^{-1}$ , now switching to ppm - should be done at the top and defined once and be consistent

L226-228. How does this upper limit on the WMO scale affect the calibrations mentioned above which go up to 800 ppm?

L239 H<sub>2</sub>O mole fraction (in ppm), and missing "fraction" after "dry mole"

L254 including Foster et al.? Perhaps a few more words with the ref in parentheses?

L263 is the NOAA04 scale different from the WMO X2004A scale mentioned earlier for CH<sub>4</sub>?

L266 section 2.2.2 could be a bit longer - how are these corrections validated in the laboratory? A few more sentences would be useful on this important correction, including an estimate of the error on this (as mentioned below under the uncertainty analysis).

At the top of this section (L250) would be good to mention what gases are measured by the LGR.

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Figure 5. Caption is incorrect, as it states that the majority of the data is over 550 ppm, which is certainly not the case if the 95th percentile is 550 then only 5% of the data is above 550!

section 3.2: L 288-290 - clarify whether this is an issue in the Licor and LGR both or only Licor. Does the LGR control cavity pressure? Would the constantly flowing reference gas in the case of the Licor take care of this issue? (perhaps not).

L303: check consistency between British and American spelling of "vapor/vapour"

L305: is this now a mole fraction of H<sub>2</sub>O or something else (volume fraction, mass fraction? Mixing ratio often refers to mass ratio?)

Section 3.3 Please remind the reader that this is only being done for UUCON because the LGR is doing its own correction internally.

Fig. 7 caption wording: comma should be semicolon? (before flush periods). And here the target is referred to as the check tank, it might be more consistent to refer to it here as the target tank as was done earlier. Also, should say "calibrated", not post calibrated. Or perhaps "post-calibration".

L359: It has not been shown what typical uncertainty due to these might be for this system. Perhaps the authors could indicate what typical analyzer precision is during calibrations for the two instruments (I now see this information is already in Table 1, so you could just refer to this here). More difficult is the water vapor correction - are there any thoughts as to the possible error here, even if just a guess or based on a few tests mentioned earlier where the LGR correction was checked in the lab - what do those tests show? It would be good to be able to back this statement up, that these are likely small compared with the running uncertainty, even if just with some anecdotal information, without a formal estimate of their values.

L361: clarify that this is only available at the UUCON stations

L401. I would think this method would actually not be able to see a bias in the calibra-

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tion value of a given tank, it only can see whether the calibrations are noisy from day to day, because you are interpolating across calibration periods. For example, if one tank is always biased high due to a bias in the assigned value by the calibration lab, the slope has a bias all the time, and this would not be included in the virtual target method. Unless I am not understanding this right. If I am then it would be good to mention a case where this method does not capture the true full uncertainty that a true target would, or at least provide a sentence as to the limitations. Otherwise, this seems like a good method.

L408 typo: sites

L 409 - Is there an overall difference in the mean? i.e. Is UTGT larger than UpTGT on average? I would think so, but it would be nice to state the mean difference as well as the mean absolute difference here. I now see this in table 1 where it seems that at most sites where both were computed UTGT is greater, but not at all. this could be mentioned here, with a reference to the table.

Table 3: are these the mean uncertainties over some period of time? Please note in the caption.

L416: calibrated rather than post calibrated?

L424: ppm should be ppb for CH4 here.

L435. Is this proper ordering of sections? Data Availability before Conclusions

L454. Why does the UpTGT method likely overestimate uncertainty? There is no other indication of this anywhere in the text.

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