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RE: Responses to reviewer's comments on manuscript gi-2022-1

Dr. Grimaldi, Associate Editor  
Geoscientific Instrumentation, Methods and Data Systems

Dear Dr. Grimaldi,

We have been really appreciated with reviewer #1's strong positive comments on the significance of this manuscript as a completion of systematic study of overall accuracies of field CO<sub>2</sub> and H<sub>2</sub>O data from infrared gas analyzers in both closed-path and open-path eddy covariance flux systems.

We are happy with thoroughly address the technical and editorial comments from reviewer #1 in the final revision while addressing upcoming comments from reviewer #2. Here, we are briefly responding the major and minor comments from reviewer #1 below.

#### **Major comments**

I have two open-path analyzers, i.e., EC150 and LI-COR 7500. In practice, when I perform a zero calibration, I always found a positive zero drift about 10  $\mu\text{mol mol}^{-1}$  for LI-COR 7500 at ambient temperature, slightly higher in the unit of  $\text{mg CO}_2 \text{ m}^{-3}$  and much higher than the upper of the values in the manuscript, but a much smaller accuracy due to gain drift when tubing the CO<sub>2</sub> span gas of 500- $\mu\text{mol mol}^{-1}$  after a zeroing operation. I speculate that this was caused a non-negligible housing CO<sub>2</sub>/H<sub>2</sub>O accumulation, although the chemicals in the internal cell needs no replacement of new ones, i.e., after a zero calibration the analyzer works well for months. This is the same for H<sub>2</sub>O density. Therefore, in practice, I recommend the author give a short discussion of the possibility of field drift of zero and gain using the big data of analyzer-supplier, for example, that from EC150 in the lab of CSI, in the 6.3 section. These data may be helpful for providing suggestions for new users.

#### **Response**

Yes, an individual infrared CO<sub>2</sub>-H<sub>2</sub>O gas analyzer may behaviors differently due to unexpected reasons. For this study, we must use the specifications of analyzers from their manufacturer. Our assessment must be based on the official specifications from manufacturer. We are not sure whether the data from field individual analyzers are valid because no benchmark data are available to assess the field data, which is the reason we assess the overall accuracies for field CO<sub>2</sub> and H<sub>2</sub>O data based on atmospheric physics and ecological background.

#### ***Minor comments***

1. Title: "CO<sub>2</sub>-H<sub>2</sub>O" (and in the text). I understand the authors wanted to identify both gas types using "-" from one of the two gas types using "/". In my opinion, however,

“CO<sub>2</sub>/H<sub>2</sub>O” may be better, just the same as they are in the profile system. The same for other parts of the manuscript.

**Response**

We also preferred “CO<sub>2</sub>/H<sub>2</sub>O”, but “CO<sub>2</sub>/H<sub>2</sub>O” means “CO<sub>2</sub> or H<sub>2</sub>O” and “CO<sub>2</sub>-H<sub>2</sub>O” means “CO<sub>2</sub> and H<sub>2</sub>O”. “CO<sub>2</sub>-H<sub>2</sub>O” is the editorial choice for this expression.

2. L24: For a background concentration of atmospheric CO<sub>2</sub>?

**Response**

The background concentration of atmospheric CO<sub>2</sub> is reported by Global Monitoring Laboratory and is used globally. The details about this background concentration are given in the paragraph of lines 95 to 100. In abstract, there is no room to describe what is a background concentration of atmospheric CO<sub>2</sub>.

3. L27-29: I recommend deleting “Under freezing conditions, an H<sub>2</sub>O span is both impractical and unnecessary, but the zero procedure becomes imperative to minimize H<sub>2</sub>O measurement uncertainty.”, because there was some overlap of this sentence with the next one “In cold/dry conditions, the zero procedure for H<sub>2</sub>O, along with CO<sub>2</sub>, is an operational and efficient option to ensure and improve H<sub>2</sub>O accuracy”.

**Response:**

We discuss two issues:

- a. H<sub>2</sub>O span

“Under freezing conditions, an H<sub>2</sub>O span is both impractical and unnecessary, but the zero procedure becomes imperative to minimize H<sub>2</sub>O measurement uncertainty.”

- b. H<sub>2</sub>O zero

“In cold/dry conditions, the zero procedure for H<sub>2</sub>O, along with CO<sub>2</sub>, is an operational and efficient option to ensure and improve H<sub>2</sub>O accuracy”.

Both sentences are not overlap each other

4. L36: delete “fluctuations”, for consistency with “3-D wind and sonic temperature”.

**Response:**

Yes, this word can be removed. It may be redundant although the word can reflect the nature of turbulence measurements.

5. L75: “CO<sub>2</sub>/H<sub>2</sub>O molar mixing ratio” or “CO<sub>2</sub>/H<sub>2</sub>O dry molar fraction” is better.

**Response:**

The former is more popularly use. CO<sub>2</sub>/H<sub>2</sub>O molar mixing ratio is used in manual of close-path eddy-covariance systems and in AmeriFlux variable names.

6. L108: “in practice”?

**Response:**

“In practice” can be used to replace “in applications”.

7. L170: Possibly, use “the analyzer often gradually reports that this zero ρCO<sub>2</sub> value, when exposed to a zero gas, is different from zero”.

**Response:**

This recommendation will be adopted in final revision.

8. L190: housing CO<sub>2</sub>/H<sub>2</sub>O accumulation.

Response

See response to minor comment 1.

9. L209: housing CO<sub>2</sub>/H<sub>2</sub>O accumulation.

Response

See response to minor comment 1.

10. L224: remove “calibration/”, “span” is clear enough.

Response

“Calibration” is a full process to construct the H<sub>2</sub>O and CO<sub>2</sub> working equations in production process. “Span” is a user operation to adjust H<sub>2</sub>O/CO<sub>2</sub> span coefficients. We clarified the difference in use of two terms in the manuscript. We will further check the clarity.

11. L233-234: “that is smaller in magnitude by at least two orders” may be more concise.

Response

Yes, the word of “reasonably” ahead of “smaller” can be removed.

12. L283: “microbial respiration” is more commonly used.

Response

The word of “microorganism” can be replaced with “microbial”.

13. Figure 2: For simplicity, I recommend using only absolute value of accuracy and relative accuracy.

Response

Accuracy is defined as a range. One positive value may mislead readers.

14. Table 2: These numbers are very detailed, and thus are somewhat a repeat of Figures 2 and 3. I recommend only show the temperature points in a coarse resolution, for example, -30, -20, -10, 0, 10, 20, 30, 40, 50 °C.

Response

Yes, in final revision, this table can be simplified as reviewer suggested.

Again, we really appreciate reviewer’s positive comments in the significance of our study.

Sincerely,

Ning Zheng, Ph.D.  
Application Scientist