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Comment on gi-2022-1

Anonymous Referee #1

Referee comment on "Accuracies of field CO_2–H_2O data from open-path eddy-covariance flux systems: assessment based on atmospheric physics and biological environment" by Xinhua Zhou et al., Geosci. Instrum. Method. Data Syst. Discuss., https://doi.org/10.5194/gi-2022-1-RC1, 2022

General comments

This study focuses on a practical subject needed to quantify the overall accuracy of CO2/H2O measurements from open-path eddy-covariance (OPEC) systems. While I am analyzing my data, I always concern the overall accuracy in CO2 measurements from my infrared gas analyzers in OPEC systems, but the method how to estimate the overall accuracy were unavailable from published literature. Indeed, this manuscript along with Zhou et al (2021) is the completion of systematic study on the overall accuracy of CO_2/H_2O measurements from EC systems.

The OPEC is more popular than CPEC because of, for example, their lower power consumption and maintain demanding, in the flux community. What is estimable is that the authors showed the accuracies of CO_2/H_2O densities based on biologically meaningful data in the field and solid physical principles. Clearly, this study provided valuable results for scientists like me to reference. The analysis methodology based on atmospheric physics and ecosystem background is truly innovative and the equation development is logical in theory and practical in applications. Although the authors only used an old version of OPEC, equations (14) and (22) were easily used to calculate the accuracies of CO_2/H_2O densities for other types of open-path analyzers, e.g., IRGASON and LI-COR 7500 series; and having potentials in applications to analyzers for other gas species like CH_4 and N_2O in the areas of geosciences. Additionally, the structure was well organized and the writing was also easily to understand. Therefore, I would highly recommend this manuscript to be accepted for publication on Geoscientific Instrumentation, Methods and Data Systems after a minor revision.

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 μmol mol^{-1} for LI-COR 7500 at ambient temperature, slightly higher in the unit of mg CO_2 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_2 span gas of 500-μmol mol^{-1} after a zeroing operation. I speculate that this was caused a non-negligible housing CO_2/H_2O 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_2O 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.

Minor comments

- Title: "CO_2-H_2O" (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_2/H_2O" may be better, just the same as they are in the profile system. The same for other parts of the manuscript.
- L24: For a background concentration of atmospheric CO_2?
- L27-29: I recommend deleting "Under freezing conditions, an H_2O span is both impractical and unnecessary, but the zero procedure becomes imperative to minimize H_2O measurement uncertainty.", because there was some overlap of this sentence with the next one "In cold/dry conditions, the zero procedure for H_2O, along with CO_2, is an operational and efficient option to ensure and improve H_2O accuracy".
- L36: delete "fluctuations", for consistency with "3-D wind and sonic temperature".
- L75: "CO_2/H_2O molar mixing ratio" or "CO_2/H_2O dry molar fraction" is better.
- L108: "in practice"?
- L170: Possibly, use "the analyzer often gradually reports that this zero ρCO_2 value, when exposed to a zero gas, is different from zero".
- 8. L190: housing CO2/H2O accumulation.
- L209: housing CO2/H2O accumulation.
- L224: remove "calibration/", "span" is clear enough.
- L233-234: "that is smaller in magnitude by at least two orders" may be more concise.
- L283: "microbial respiration" is more commonly used.
- Figure 2: For simplicity, I recommend using only absolute value of accuracy and relative accuracy.
- 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.