Response to Reviewer's Comments

We would like to thank the reviewer for his/her detailed and kind technical corrections and comments about our manuscript. Our responses and corrections we made to our manuscript are thoroughly described below in point-by-point (blue sentences), while the reviewer's corrections/comments are listed in black color.

Introduction

L37: "Behaviors related to …" sounds odd and is too vague. In addition, atmospheric gases and GHG are produced and consumed in the soil by plant roots or microorganisms. I suggest: "Atmospheric gases and GHG are produced or consumed in the soil by belowground plant biomass or soil microorganisms with production and consumption rates being affected by environmental ….."

- We changed "(line 37) Behaviors related to …" (new line 43) to "Atmospheric gases and GHG are produced or consumed in the soil by belowground plant biomass or soil microorganisms with production and consumption rates being affected by environmental …." as suggested.

L42: "soil gases are expected to vary" not sure how a gas can vary. Maybe "… and therefore, production and consumption rates and, thus, their concentration is expected to vary on a similar time scale"

- We changed "(line 42) soil gases are expected to vary" to "(new line 47)… and therefore, production and consumption rates and, thus, their concentration is expected to vary on a similar time scale" as suggested.

L52: , and there? does not seem …

- We changed "(line 52), and they does not seem ..." to "(new line 57), and there does not seem …".

L101: "detectioFcampan" is a typo I guess

- Yes, it is a typo. We changed "(line 101) hybrid ion detectioFcampan" to "(new line 107) hybrid ion detection and signal".

Materials and Methods

L147: I suggest adding "Though determination of Oxygen concentration would be more accurate using O_2^+ detection, Oxygen was detected … ". Then the audience more easily understands that

you sacrificed Oxygen precision for the benefit of CH_4 and N_2O precision and that the system can be optimized with regard to oxygen precision.

- We added the sentence "Though determination of Oxygen concentration would be more accurate using O_2^+ detection, Oxygen was detected …" in new line 153 as suggested.

L183: Please also add units for C and t.

- We added units for C and t as "(ppbv-N_2O, ppmv-CH_4, or ppmv-CO_2 h^{-1})" in new line 190.

Equation 3 brackets are arbitrary.

- The Brackets was deleted in Equation3 (new line 200).

L205: The MDF / MQF section is still confusing, and I still don't get why so many simulations are required to calculate MQF. The standard error of the regression slope is the square root of the ratio between error variance and the sum of squares for the independent variable (in this case time). Using the square root of your instrument precision as error variance should result in a very similar value.

- Minimum detectable flux (MDF) is derived from the analytical precision of the gas measurement technique and widely used as a performance metrics of flux measurement with flux chamber system [*e.g.*, Christiansen *et al.*, 2015, Nickerson, N., 2016 Courtois *et al.* 2019]. In our field observation, we applied a linear regression analysis for nine consecutive gas measurements to determine the rate of gas change during flux chamber closed. When we examined the data processing, we found that the quality of the linear regression analysis was quite poor even when determined flux values were above MDF. We found that the MDF is not a proper gauge to judge whether the flux data is reliable enough or not for further scientific discussion. The reason seemed that detection limits of our MS-based gas measurement were similar order of magnitude to the atmospheric concentrations of targeted gas species, which is not the case for cavity-ring down spectroscopic technique. Therefore, in order to have proper quality metrics for our quantitative flux determination, we newly defined the MQF (minimum quantifiable flux).

  But there was one big problem. In the field measurements, it is almost impossible to know the "*true* flux" which is necessary to evaluate the quality of our flux measurement. We thus conducted a model simulation to determined MQF in our flux measurement as described in this paper.

- We added the sentence, "(new line 212) However, we found that the MDF was not proper metrics for our flux measurement and thus defined new metrics, minimum quantitative flux (MQF), for better assessment of the reliability. Since flux is the rate of increase or decrease

in the gas concentration of interest in the closed chamber, we determine the flux by applying linear regression to every set of the nine consecutive gas concentration measurements in the closed chamber period over 20 min. We noticed that the quality of the linear regression analysis was quite poor even when the flux values were above MDF and the determined flux values were not reliable enough for further scientific discussion. We thus additionally evaluated the MQFs for each gas species to examine quantitatively reliable fluxes in our study."

Results

L262: $A_{a,i}$ was defined earlier as measurement accuracy. I guess you also mean measurement accuracy with frequency here. Please correct.

- We changed "(line 262) ...the measurements to obtain frequency $A_{a,i}$. The $A_{a,i}$ obtained from the atmospheric air measurements were ±22 ppbv for N_2O; ±102 ppbv, CH_4; ±8.1 ppmv, CO_2; and ±0.38 vol%, O_2." to " (new line 272) ...the measurements to obtain $A_{a,i}$. The $A_{a,i}$ obtained from the atmospheric air measurements were 22 ppbv for N_2O; 102 ppbv, CH_4; 8.1 ppmv, CO_2; and 0.38 vol%, O_2.".

L320: 2 should be in superscript

- Changed to "(line 320) R_2" to "R^2" in new line 329.

Figure 11 caption: MQF instead of QMF

- Changed "QMF" to "MQF" in Figure 11 caption.