General comments:

This manuscript presents a novel UAV-GHG platform and its applications on characterizing and quantifying GHG emissions and fluxes for natural ecosystems over heterogeneous terrains. UAV-GHG flux measurement is an innovative topic, and the applied methodology is sound. This paper is well written, and the methodology is clearly presented. It consists of GHG sensors' lab tests including Allan deviation tests. However, how will the sensors perform against temperature changes and water vapor. These parameters would impact the analyzers' performance especially for the field applications. Please refer to Comment 5 and 6 on the laboratory tests. This study conducts demonstration flights in Jena comparing to EC tower measurements and comprehensive grid flights in Stordalen Mire (Arctic ecosystem).

This paper is highly suitable for AMT. I would recommend publication after consideration of the following comments and minor corrections.

Specific comments:

1. Section 3.1 Laboratory tests of gas analyzers would fit better to Section 2.1. Logically, the analyzers should be introduced first before describing the integrated UAV platform. Field site descriptions would be more suitable before the section flight strategies.

2. Section 2.2, how long is the inlet and what are the flow rates for both sensors? Is time synchronization considered for the system (GPS, CO2 and CH4 readings, etc.)?

3. Line 119, what data were pre-processed (from anemometer or GHG sensors)? And how the low-quality data were defined?

4. Line 148 with known CO2 and CH4 mole fractions here, could you track the criterion of these cylinders and provide information here? Please refer to Liu et al., (2022) Laboratory tests part as an example.

5. The long-term test conducted in the laboratory lasted for four hours with a linear drift for CO2. The CO2 sensor may be still warming-up for four hours. Are there any long-term tests over 24 hours performed? Calibration on the field was applied every 24 hours. How large are the sensor's drifts over 24h?

6. Laboratory tests, how was the sensors' performance against water vapor and temperature changes? The field campaign lasts for days, how large is the temperature difference and the humidity during the day? Will these changes during the day impact the sensors' performance?

7. Line 154-155, could you explain the numbers (380 ppm,460 ppm, etc.) chosen to filter the dataset?

8. Table 3 shows the estimated fluxes corresponding to large uncertainties. It would be nice to add a paragraph here to discuss how the large uncertainties were obtained. What are the sources attributed to the uncertainty? Any thoughts to improve the methodology to reduce the uncertainty? The instruments' noise can also impact on the flux error.

Technical corrections:

1. Line 167: Fig.5 shows before Fig.2 in the text. Please correct the order.

2. Line 182: Eq.10 should be replaced by Eq. 9.

3. Line 185: Eq.10 should be replaced by Eq. 9.

References:

Liu, Y., Paris, J.-D., Vrekoussis, M., Antoniou, P., Constantinides, C., Desservettaz, M., Keleshis, C., Laurent, O., Leonidou, A., Philippon, C., Vouterakos, P., Quéhé, P.-Y., Bousquet, P., and Sciare, J.: Improvements of a low-cost CO2 commercial nondispersive near-infrared (NDIR) sensor for unmanned aerial vehicle (UAV) atmospheric mapping applications, Atmos. Meas. Tech., 15, 4431–4442, https://doi.org/10.5194/amt-15-4431-2022, 2022.