The comments of "Observation of GHG vertical profile in the boundary layer of the Mount Qomolangma region using a multirotor UAV" by Zhou et al (ID: egusphere-2024-3478).

Thank you very much for taking the time to review this manuscript, your constructive contribution helped to improve the quality of the paper in both sciences and writing, making it more valuable, and easy understood for the readers. Please find the detailed responses below and the corresponding revisions in track changes in the revised version of this manuscript.

The ***black italic*** texts are comments of the reviewer, and ***red italic*** texts are responses.

Greenhouse gases such as CO2 and CH4 are thought to be the primary human activities contribute to the current global warming, therefore many efforts, such as ground-based and space-based measurements along as the flux modelling, have been done to figure out the amount of such contributes. Those measurements focused on the column integrated amount, not the vertical profiles. Based on sampling method and UAV, the authors provided a simple and economic method for vertical profile of four GHG species (CO2, CH4, N2O, and SF6) in remote and inaccessible Tibetan area. CO distribution of but less measurements. The work is exciting and encouraging for the research of "Carbon" source and sink, and introduces an automatic low-cost and user-friendly multi-altitude atmospheric sampling device that can be mounted on small and medium-sized unmanned aerial vehicles, balloons, and other flight platforms to collect air samples at multiple altitudes. A five-day continuous observation campaign was conducted at Mount Cho Oyu Basecamp and Mount Qomolangma Station to analyze and explore the vertical distribution characteristics of four greenhouse gases. These measurements are critical for elucidating their sources and sinks, transport pathways, and influence on Earth's radiative balance, as well as for enhancing predictive capabilities for climate change. Overall, the article is well-structured, provides valuable insights, and language well-written. Further clarification can be made in some areas before published, and specific comments are as follows.

Comments: *The innovative aspects of the study can be more explicitly emphasized. Additionally, the structure of the article should be introduced at the end of the introduction.*

Response: *We agree with the reviewer that the innovative aspects of our study could be more explicitly emphasized. In the revised manuscript, we have expanded the introduction to highlight the novelty of using a multirotor UAV for vertical profiling of GHGs in such a remote and challenging environment. We have emphasized the development of the sampling system and its potential applicability to other remote regions.*

Following the reviewer's suggestion, we have added a brief overview of the manuscript structure at the end of the introduction. This provides readers with a clear roadmap for the study.

Comments: *What impact does the change in BLH have on the vertical distribution and concentration of greenhouse gases?*

Response: *Thanks for the comment. We had 12 flights during three-day experiments from 01 to 03 Oct., 2023, the observed variations suggest that the weaker uplifting of BLH has very inconspicuous effect on the mixing ratio of GHGs. On 04 Oct., the BLH is notably lower than that of the adjacent days(Figure S1), and higher CH4 mixing ratio was observed(see Figure S2) in the afternoon of that day, this may attribute to local livestock or meadow emissions and the lower BLH.*

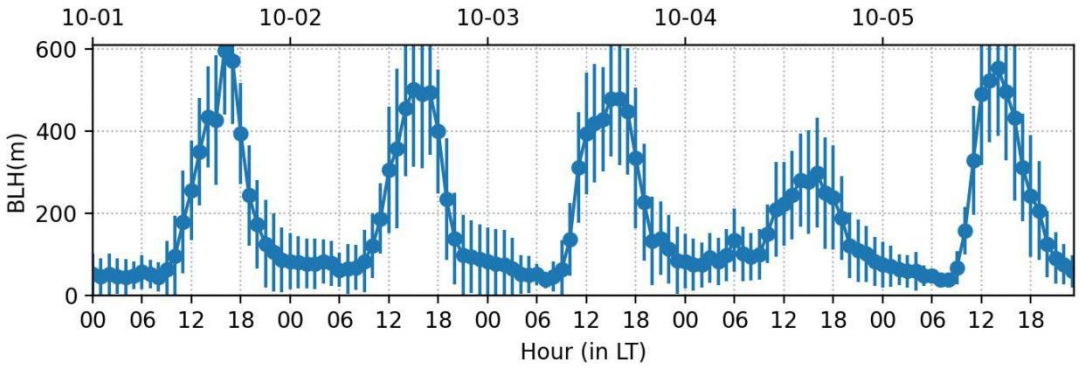

Figure S1. Variation of BLH with time

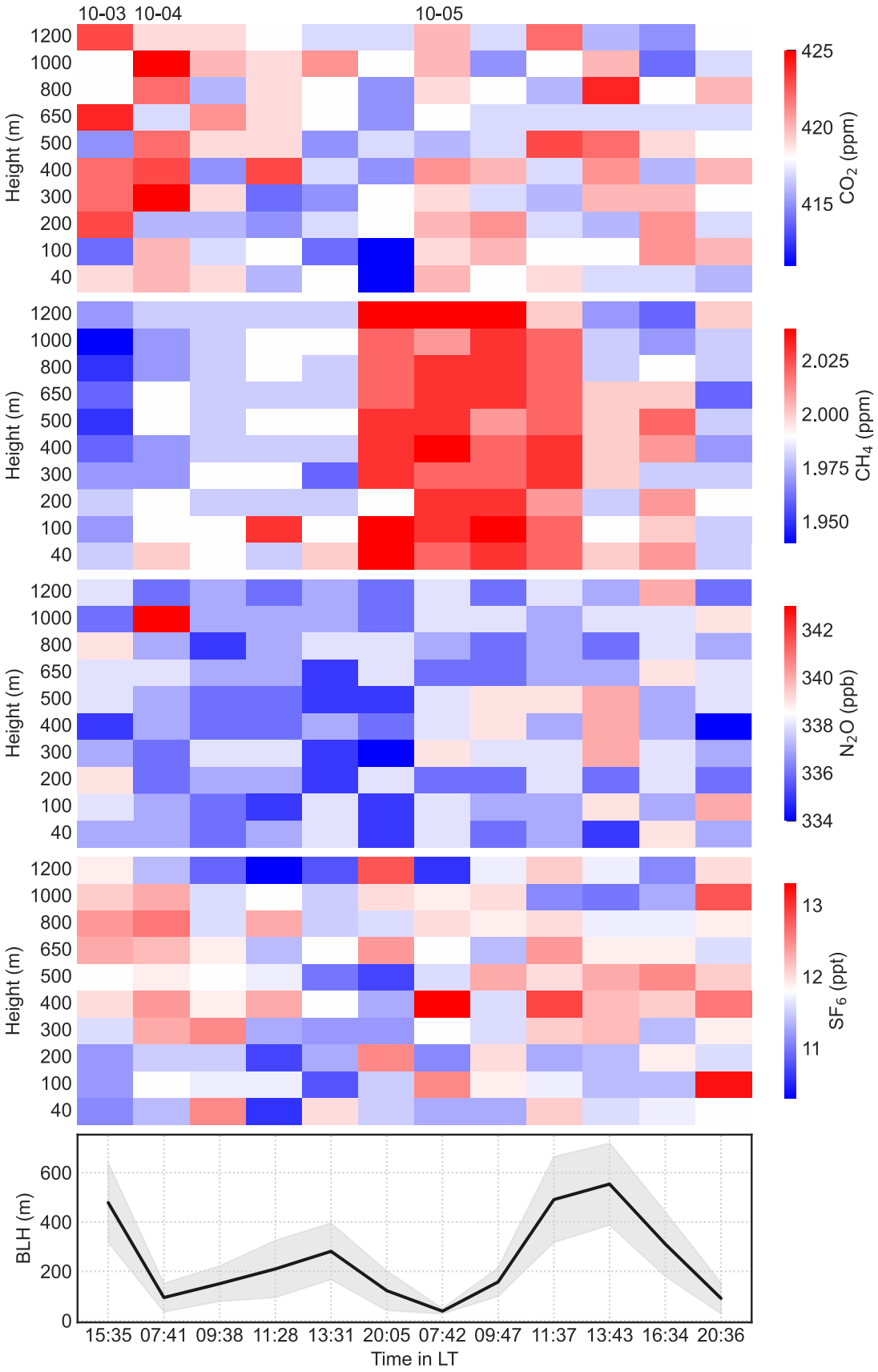

Figure S2. A heatmap BLH and mixing ratios of greenhouse gases.

Comments: *Does the vertical distribution of greenhouse gas concentrations change due to potential long-range transport?*

Response: *Thank you for your thoughtful question regarding the potential impact of long-range transport on the vertical distribution of greenhouse gas (GHG) concentrations.*

Due to short term (five days) flight, we focused on capturing the local vertical profiles of GHGs at the Mount Qomolangma and Cho Oyu basecamp. The measurements were designed to reflect the local atmospheric conditions, with an emphasis on understanding the distribution of GHGs in the boundary layer over this brief period. This limited temporal scope reduces the likelihood of significant influence from long-range transport, as GHG concentrations at these sites are more likely to be shaped by local sources and meteorological conditions than by distant emissions.

We added a sentence in Line 163 to clarify:

'The temporal scope of the measurements, although informative, constrains the degree to which long-range transport may have affected the observed trends.'

Comments: *"Figure 5. Same as Figure 5…" confusing.*
Response: *Thanks for the comment, this kind of typo errors from has been corrected in the revised manuscript.*

Comments: *"The conclusions of the article need further in-depth discussion.*
Response: *We added more sentences for the impact of BLH on GHG profiles, and the applicability of this sampling device are also discussed.*

Comments: *The text in figures is relatively small and needs to be improved.*
Response: *All figures have been reformatted to ensure readability in print and digital formats. Especially in the text-heavy Figures 1 and 2, we have simplified the text and increased the font size.*

Comments: *Line 13-20: Reference support required.*
Response: *Thanks for the comment. References and descriptions related to these references have been added to support the statements:*

'Contemporary global warming...since the Industrial Revolution.'(Masson-Delmotte et al., 2019; Friedlingstein et al., 2023).
'Variations in emissions from natural and anthropogenic sources and atmospheric circulation patterns result in significant differences in greenhouse gas concentrations at different altitudes. '(Ren et al., 2011; Xie et al., 2013; Carnell and Senior, 1998)

Comments: *Line 65: give the full name of iMET XQ2 and its main parameters*
Response: *Thanks for the comment. We added sentences related iMET XQ2:*
'iMET XQ2 is the second-generation sensor manufactured by the International Met Systems, it is designed for UAV deployment, with a 5-hour rechargeable lithium battery and 15 hours long of

data storage. It works for relative humidity of 0-100%, for temperature between -90°C and +50°C, pressure between 10 and 1200 hPa, it also provide GPS information such as time, longitude, latitude and altitude.'

Comments: *Line 77: Eq(1)： iMET XQ2 should also provide height information, say GPS height, please provide the comparison of the two data.*
Response: *Thanks for the comment. A comparison between GPS height and our calculation is presented. The difference is minimal.*

Comments: *Line 80: please explain "Just go"*
Response: *Thanks for the comments. We want to say this device is easy to set up and portable to be taken for field measurements. We have replaced this word and rewritten the sentences in the revised manuscript.*

Comments: *Line 83: "1300 a.g.l." should be "1300m above ground"??*
Response: *Thanks for the comment. "1300 a.g.l." has been revised to "1300 m above ground level" for consistency and clarity.*

Comments: *Line 87: it's better to change section 2.3 "Lab analysis" to "air sample analysis"*
Response: *Thanks for the comment. Section 2.3 has been renamed from "Lab analysis" to "Air sample analysis" as suggested.*

Comments: *Line 158: CMU or MCU?*
Response: *Thanks for the comment. Yes, it is corrected to "MCU" in the manuscript.*

Comments: *Line 163: what's "GPS profile"?*
Response: *Thanks for the comment. 'GPS profiles' should be corrected by 'potential temperature and relative humidity profiles calculated by iMET XQ2'. However, we have deleted Figure 6-7 and relative texts (Line 163-165) for consistency.*

The following papers are referred to and added to the list of section References.

REFERENCES

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Ren, W., Tian, H., Xu, X., Liu, M., Lu, C., Chen, G., Melillo, J., Reilly, J., and Liu, J.: Spatial and temporal patterns of CO2 and CH4 fluxes in China's croplands in response to multifactor environmental changes, Tellus B: Chemical and Physical Meteorology, 63, 222-240, 2011.

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