Response to review comments on MS# egusphere-2025-6197 by Wang et al.
(review query in black, response in blue)

Reviewer: 1

Comments:
1. Were all the flight measurement conducted on the same day? Sampling different atmospheres at different times of day for different cities in just one day could introduce variability due to changing atmospheric conditions. This may make it difficult to directly compare the measurements between cities and draw robust conclusions. Please clarify the timing of the flights and discuss how potential temporal differences were accounted for.

Yes, all the flight measurements were conducted on the same day. You are correct that this could confound the comparison between cities. The takeoff time from Beijing was 9:44 local time (Table 1), about 4 h after sunrise. The landing in Nanjing was 14:44 local time, when a fully convective boundary layer had developed. The returning flight took off from Nanjing at 18:31 local time and landed in Beijing at 22:17 local time; at these times, the stable stratification had already formed. Data during daytime and nighttime were analyzed separately to avoid direct cross-diurnal comparisons.

We noted that a high-pressure system prevailed over Eastern China during the observational day (Supplementary Figure S2). The variations in air trajectories between daytime and nighttime sampling were relatively small (Figure 9).

To further acknowledge the reviewer's point, we have added the following text to the Discussion (Section 3.1)

"We note that the profiles in Figure 5 were sampled at different times of the day. Some of the differences may have been caused by changing atmospheric conditions. The general inter-city patterns were unaffected because the temporal differences in the concentrations sampled at takeoff and at landing were smaller than the between-city differences."

2. Please define what is meant by "inversion jumps". It would be helpful to clarify how this inversion jump is identified in your observations and why it is significant. In addition, please expand on the importance of observing or measuring inversion jumps in the ABL and explain the implication of the inversion jumps observed in your results.

We now give a brief definition of inversion jumps as "differences in concentrations across the capping inversion at the top of the ABL", in the last paragraph of Introduction.

In Section 3.3, we described how these jump values were determined: "To determine the jump values, we calculated the average concentrations below 800 m for the midday observation and 500 m for the nighttime observation over Beijing, and below 1500 m for the mid-afternoon observation and 1000 m for the early evening

observation over Nanjing, to represent the concentrations in ABL…"

In Section 4.4, we provide a detailed discussion on the importance of measuring the inversion jumps and on the jump values we observed.

The jump values suggest that the simple slab ABL approximation is not suitable for the urban ABL (third paragraph in Section 4.3). This point is further highlighted in Section 5: "Our results suggest that the simple one-dimensional slab model of the convective ABL may be inadequate for describing GHG budgets in the urban environments. An alternative is the advection-entrainment-diffusion model described by Lee (2023; Chapter 12)."

3. Line 182: Please expand more on how the calculations were made.

In response, we have added the following text

"First, we calculated the total emission for each city and the corresponding total area within the city administrative boundary. The emission flux (mg $m^{-2}s^{-1}$) was then calculated as the ratio of the total emission to the total area."

4. Line 196: Please clarify what is meant by "south trip" and "north trip." Does this refer to latitudinal flight direction (north-to-south vs. south-to-north) or to flights conducted over southern vs. northern cities?

We now note: "… south trip (from Beijing to Nanjing) … north trip (from Nanjing to Beijing)…"

5. Line 269, 271: The figures referenced appear to be incorrect. Please verify the correct figure citation. Additionally, please clarify what is meant by the "horizontal spikes."

The referenced figures should be Figure 6(a) and Figure 6(d). Thank you for pointing out this error.

We have added the following text to describe "horizontal spikes"

"In the profile plot in Figure 6a, the data collected in the horizontal flights were collapsed to the same altitudes, giving the appearance of small horizontal spikes (with a spike length of about 3 ppm)."

6. Line 326: Please explain how the emission fluxes of the cities were calculated.

Please refer to response to Comment 3.

7. Figure 10: It would be helpful to include labels for the city names on the maps.

Done (This figure is now labeled as Figure 9).

Minor comments:

1. Line 110: The phrase "we wish" should be replaced with more appropriate wording.
We have changed to "we aim to".

2. Line 188: Please check spacing for "W m^{-2}in Beijing".
Corrected.

3. Line 192-193: Please check spacing for "m $s^{-1}$and".
Corrected.

4. Lines 191-194: Please revise sentence structure in this section to improve for clarity and readability.
Improved.

5. Line 226, 232: Please revise wording for "street-level concentrations." Are the authors referring to ground-based mobile measurements?
Yes. We have changed "street-level concentrations" to "ground-based concentrations" in the manuscript.

6. Line 256: Please revise sentence structure in this section to improve for clarity and readability.
Revised.

7. Line 317: "tips" seems to be a typo.
Corrected.