Thanks for your interesting work. I have a few questions and would greatly appreciate your assistance:

1. In the Introduction section's second and third paragraphs, I'm slightly confused by the mixed use of the terms "mixing depths" and "PBL depths". Are they referring to the same thing?

2. In lines 100-105, you mention that the native pixel resolution is 3.5x8 km² in Seoul. Could you please clarify what the native pixel resolution is outside of Seoul?

3. In Equation 1, is there a specific formula for AMF_G that depends on SZA and VZA?

4. In lines 119 to 121, would scattering weights also be dependent on altitude z?

5. In Section 2.2, could you possibly provide a bit more detail about the Beijing sites, similar to the descriptions you provided for the Seoul sites?

6. In lines 185 to 195, the location of the NO_2 plume is not clearly labelled on the figure. Could you please clarify this? Furthermore, while Figure 2 is quite informative, I believe it could be enhanced by adding a third column that shows the bias, calculated as the difference between the model and the observations. Would that be possible?

7. In lines 195 to 200, I noticed that measurements from the two Pandora sites were not aggregated for the GEOS-Chem grid, unlike what was done for the GEMS data. Could you please explain why this is the case? Alternatively, may you also compare the two Pandora sites to the non-aggregated GEMS data?

8. I'm trying to understand the methodology used to derive the net change of NO_2 from the net change of NO_x. Considering two time points $t1$ and $t2$, with corresponding column concentrations for NO$_2$ (denoted as NO_2^{t1} and NO_2^{t2}), NO_x (denoted as NO_x^{t1} and NO_x^{t2}), and their ratios (denoted as α^{t1} and α^{t2}), we can calculate the rate of change of NO_2 and NO_x as
$\frac{\partial NO_2}{\partial t}\Big|_{t=t2} = \frac{NO_2^{t2}-NO_2^{t1}}{t2-t1}$ and $\frac{\partial NO_x}{\partial t}\Big|_{t=t2} = \frac{NO_x^{t2}-NO_x^{t1}}{t2-t1}$, respectively. As far as I am concerned, we can only transform the former into something like
$\frac{\partial NO_2}{\partial t}\Big|_{t=t2} = \frac{\alpha^{t2}\times NO_x^{t2}-\alpha^{t1}\times NO_x^{t1}}{t2-t1}$, but this doesn't seem equal to
$\alpha^{t2}\times \frac{NO_x^{t2}-NO_x^{t1}}{t2-t1} = \alpha^{t2}\times \frac{\partial NO_x}{\partial t}$ unless we assume $\alpha^{t1}=\alpha^{t2}$. Is this assumption being made? Alternatively, can the GEOS-Chem model directly provide $\frac{\partial NO_2}{\partial t}$ and its individual components? I apologize if I've misunderstood any aspects of your methodology.

9. As you can derive the net change of NO$_2$ from the net change of NO$_x$, would it be more straightforward in Section 4 to directly analyse the individual

components of the net change of NO_2 rather than combining the net change of NO_x with NO_2/NO_x ratios to facilitate the analyses? Are you doing the latter way because the NO_2/NO_x ratios may have implications for something like O_3 entrainment. Nonetheless, I am assuming that both GEMS and GEOS-Chem can provide O_3.

10. In lines 249 and 250, why was the presence of the negative transport term linked to the upwind emissions being much lower?

11. In lines 250 to 255, it appears that you're discussing the variations of NO_2 alongside the variations of NO_x. Do you have evidence for the maximum concentration of OH at noon, or is this a generally accepted knowledge that's prescribed in the GEOS-Chem model?

12. In line 258, it appears that the discrepancy between the two Pandora sites is more clearly illustrated in Figure 3 rather than in Figure 2.

13. In lines 260 and 261, could you clarify what range is defined by the Pandora data? Additionally, could you explain how the diurnal variations observed by GEMS and simulated by GEOS-Chem agree within this defined range?

14. In lines 270 and 271, are you suggesting that if the transport term can be quantified by simple methods, satellite observations could directly indicate the role of emission and chemistry without the need for the GEOS-Chem model? However, the follow-on analysis in Figure 6 still have the transport term under different conditions. Similarly, in lines 293 and 294, are you suggesting that on a regional scale, the tranport term can be marginalized (minimized), leading us to interpret that satellite observations primarily reflect the contributions from emissions and chemistry? How would this statement apply to other regions and periods?

15. In lines 281 and 282, what is the source of the numerical relationship between wind speed and the ventilation time scale?

16. In Section 5, I'm curious whether the results for the SMA metropolitan area were obtained simply by averaging the results from the grids that belong to the SMA metropolitan area?

17. For Figures 4 — 7, the points on the lines in the first row correspond to exact hours (e.g., 8:00, 9:00, etc.), while the points on the lines in the second and third rows correspond to the half-hour marks (8:30, 9:30, etc.). Is this an intended behavior?