Overview

This study showed how ozone formation sensitivity changes diurnally in urban areas using GEMS satellite data over China in the warm season from 2021-2023. It was found that NO_2 generally decreased throughout the day, and both HCHO and ozone increased. The diurnal variations of ozone formation are also affected by local meteorology that may enhance or inhibit the ozone formation reactions, leading to differences in different cities, suggesting the need for city- and time-specific emission controls.

This paper uses a novel dataset with the GEMS satellite data, and I recommend this manuscript for publication after the following revisions.

General Comments

1. The temporal extent of the study was not clearly defined in the text. Additionally, justifications for the temporal extent would be beneficial. For example, why was 2021-2023 used for the study, what is the definition of the warm season, and why was only the warm season investigated? References to the study period also seemed inconsistent throughout the text.

2. The use of TROPOMI data to compare to GEMS would be much more beneficial for the community if they were quantitatively and statistically compared. For example, Figure 5 shows that there are clear discrepancies between the two sensors for the NO_2 and HCHO products. Doing a statistical analysis to quantify the spatial agreement and differences between NO_2, HCHO, and FNRs would be more impactful. Additionally, the use of TROPOMI data should also be mentioned in Section 2 alongside the GEMS data.

3. Generally, all discussions of results could generally benefit from additional quantitative comparisons, especially including statistical support for the relationships between variables.

Specific Comments

1. Lines 44-46: In general, how were the ozone sensitivity classes defined for your study? This was not clearly discussed in the paper.

2. Lines 87-103: the literature discussed here shows how ozone sensitivity changes for spring, summer, and autumn, but not the winter, which would explain the full cycle of seasonal variations in ozone formation. How does ozone sensitivity change in the winter?

3. Line 163: is the purpose of Figure 1a-b just to show the first and last available scans for each day over the study area? Why is this important for the paper?

4. Line 168-169: what retrieval algorithms are used for the GEMS L2 HCHO and NO_2 products? A brief description of the retrieval algorithms used may be helpful for readers.

5. Lines 183-185: how were the gridded GEMS data compared to the point station data?

6. Lines 208-210: it is difficult to distinguish between which panels contain the HCHO and NO_2 data in Figure 2.

7. Lines 225-230: how do the meteorological variables vary spatially in the study region? Something similar to Figure 2 may be helpful for showing the spatiotemporal variations in meteorology. Additionally, are the temporal variations between the pollutants and meteorology correlated or statistically significant?

8. Line 287: which TROPOMI HCHO/NO_2 data were used and how different is the retrieval process compared to GEMS? The use of TROPOMI data was not mentioned in Section 2 (Data and Methods).

9. Lines 287-292: what is the statistical relationship between the NO_2, HCHO, and FNR values for GEMS and TROPOMI for your study? Including some quantitative and statistical parameters such as correlations and discrepancies should be included. Additionally, have discrepancies between the HCHO and NO_2 data products been previously discussed in the literature?

10. Lines 292-295: is there a change in ozone sensitivity regime for any locations between the GEMS and TROPOMI products? Additionally, both TROPOMI and GEMS have ozone profile products, making it possible to assess variations in tropospheric ozone. Are these trends in the FNR and observed surface ozone from the air quality monitoring network consistent with the satellite-retrieved tropospheric ozone?

11. Lines 321-322: what do the two black lines represent on Figure 4a-h? How were they determined? Based on the caption, it appears this is based on the LOESS analysis, but I am confused how this would produce two values.

12. Lines 380-382: what are these fractions of ozone formation regimes based on? Are the four cities being treated as a single point or several points within an area? How is this defined?

13. Lines 449-450: NO_x should also be mentioned here.

14. Line 452: was the data daily or hourly?

15. Lines 505-506: when and how was land use remote sensing data used?

Suggested Technical Corrections

1. Lines 251-257: should the chemical mechanism be discussed in the results? This seems like something that should be discussed in the introduction along with the literature.

2. Lines 277-279: this seems like an important result of the paper, but I did not understand exactly what was trying to be said here.

3. Lines 335-339: the discussion here was already presented on lines 279-283.

4. Lines 343-360: since there is a section specifically for comparing the four city clusters, should this part of the analysis be moved there?

5. Line 380: typo (“environmen” instead of environment).

6. Lines 428-429: this sentence does not make sense.

7. Line 460: type (“levles” instead of levels).

8. Line 470: ranges of numbers do not require brackets in the text.