Authors' responses to Referee #2.

Reviewer's comments are in black text and authors' responses are in blue text.

Anonymous Referee #2

This study presents a multi-pollutant hourly gridded vehicle emission inventory over Delhi, with a bottom-up methodology. Hourly congestion data from TomTom were used to account for hourly changes in the speed. The traffic flow was derived from speed based on fitting formula established by the previous research. The percentage share of vehicle technical parameters (vehicle type, fuel used, emission standards, etc.) was provided by survey reports or previous study in Delhi. Emission factors were calculated by COPRET-5. This paper is well-written and presents results that would be interesting to the air quality modeling community or policy makers. However, I have several concerns that the authors should consider when revising the manuscript, as listed below. I recommend this work to be published after the following comments are adequately addressed.

We thank the referee #2 for taking time to review the manuscript. We appreciate the positive feedback and valuable concerns/comments that have helped to improve the manuscript.

Particular Comments:

1. Section 2.1.1., Values in Table S2 were different from those given in Malik et al., 2021. This would lead to huge deviations in subsequent calculations. What are the reasons for this revision?

The road links used in this study are classified into five road classes (RClass1 to RClass5) based on the width of the road as per TRIPP report (Malik et al., 2018). Speed–volume relationship for different road classes in Delhi reported by Malik et al. (2021) are given for different lanes (1 lane, 2 lanes, 3 lanes and >4 lanes). In order to harmonize the road classes, we use RClass1 for 1 lane, RClass2 for 2 lanes, RClass3 for 3 lanes, and RClass 4 and RClass 5 for >4 lanes. We selected the parameters of the road classes that have high numbers of sample points and higher R^2 corresponding to each road class. For eg, for RClass3, we considered the 3 lanes having higher R^2. The values of the corresponding parameters are listed in Table S2. We do, however, acknowledge that the table contained one typo that has now been corrected. The above explanation is now added in the manuscript section 2.1.1 (226 -231).

2. Line 218-220, How to correct the speed and traffic volume, all roads or some specific roads?

The hourly traffic volume and speed for each road link was estimated using the methodology described in section 2.1.1. The hourly congested speed has been calculated using equation 2 and the hourly traffic has been calculated using equation 3 for different types of road classes. This results in activity data as per road classes. As we have TRIPP traffic data (8am to 2pm) for each road link, we corrected the traffic and speed data for each road link by taking the ratio of estimated and TRIPP traffic data during 8 am to 2 pm to match the observed traffic keeping the hourly variation intact at the time of bias correction. The difference between the observed and corrected estimated hourly traffic (8 am - 2 pm) at 72 locations is shown in Fig. S3. The estimated and measured traffic have a correlation of 0.99 and the difference (estimated - measured) varies from -0.6% to 2.6%.

3. Whether the vehicular share (%) was constant for the specific road throughout the day? It was not reasonable. And, this directly determined the result of vehicular volume and emission share (section3.1 and section 3.6).

The vehicle shares of cars, buses, 2W, 3W, LCV and HCV is varying for each hour as well as each road of Delhi. Fig. 1 (b) below (also shown in Figure S1) shows the estimated hourly mean vehicle share over Delhi which is changing. The passenger vehicles namely 2W, 3W and cars have a large share during activity hours (08:00 to 20:00) whereas the night-time traffic is dominated by commercial vehicles due to the restriction of movement of freight vehicles during the peak traffic hours and ban of HCVs during daytime leading to increases share during night hours (23:00 to 5:00).

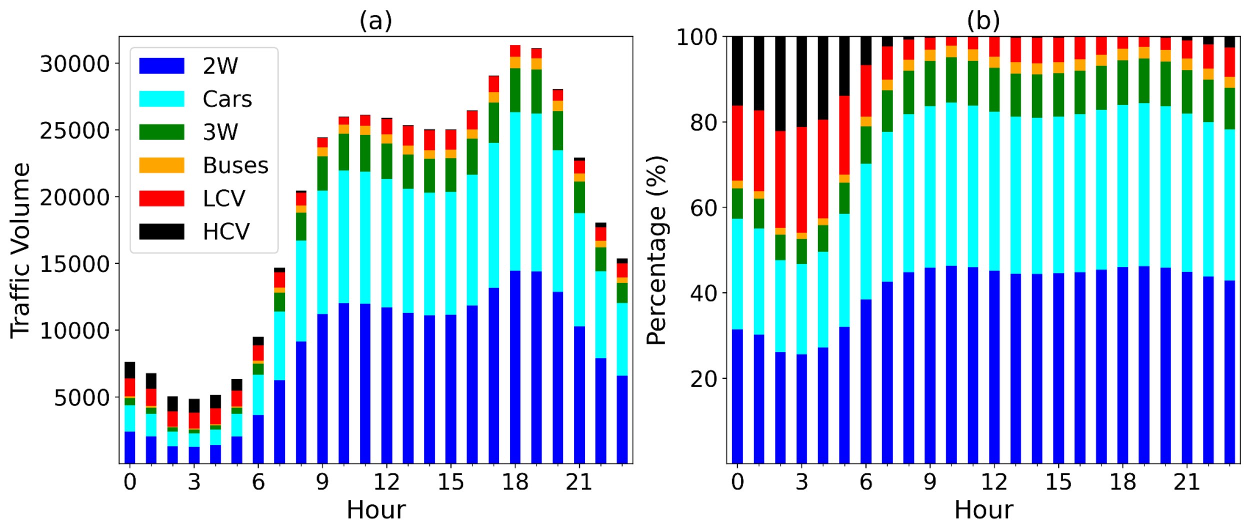

Figure 1. The stacked percentage bar plot showing the estimated hourly mean traffic composition over Delhi.

4. Table S4, all 3W vehicles were Euro 4 ?

We have performed this study for the year 2018. As per the official data, 99.8% (~100%) of the 3W (other than electric) were Euro 4. Therefore, we considered all 3W as Euro 4 using CNG fuel as CNG is mandatory in Delhi (Hakkim et al., 2022) so all the 3W are CNG (Sahu et al., 2011; Dhyani and Sharma 2017).

5. Section 3.3 and 3.4, The authors seem to assume that as long as the road types are the same, the relationship between speed and vehicle flow are the same too. The resulting

spatial distribution may have large errors. Authors should consider making some corrections.

Yes, we use the same speed-volume relationship for the same type of the road, however we further correct the traffic and speed for each road link based on the TRIPP data. This means although the traffic or speed variation for the same type of road is similar, they differ in terms of the traffic composition, count and average speed. We have shown the traffic and speed variations across different road classes as a box plot, shown in Fig. 2 of response (Fig. S5 in supplementary material). While the speed and traffic is highest for RClass5 and lowest for RClass1, a large variation in traffic and speed can be seen with a road class. These variations bring the spatial heterogeneity in emissions (Fig. 3 of the manuscript) due the heterogeneity in traffic and speed across roads of Delhi which reflects in the spatial emission analysis (Section 3.3). For eg. daytime average speed across all roads in Inner Delhi is 29 km/h which is lower than the daytime average speed of 32 km/h in outer Delhi. Moreover the emission flux over inner Delhi is higher as compared to outer Delhi indicating spatial variations driven by traffic and speed variation.

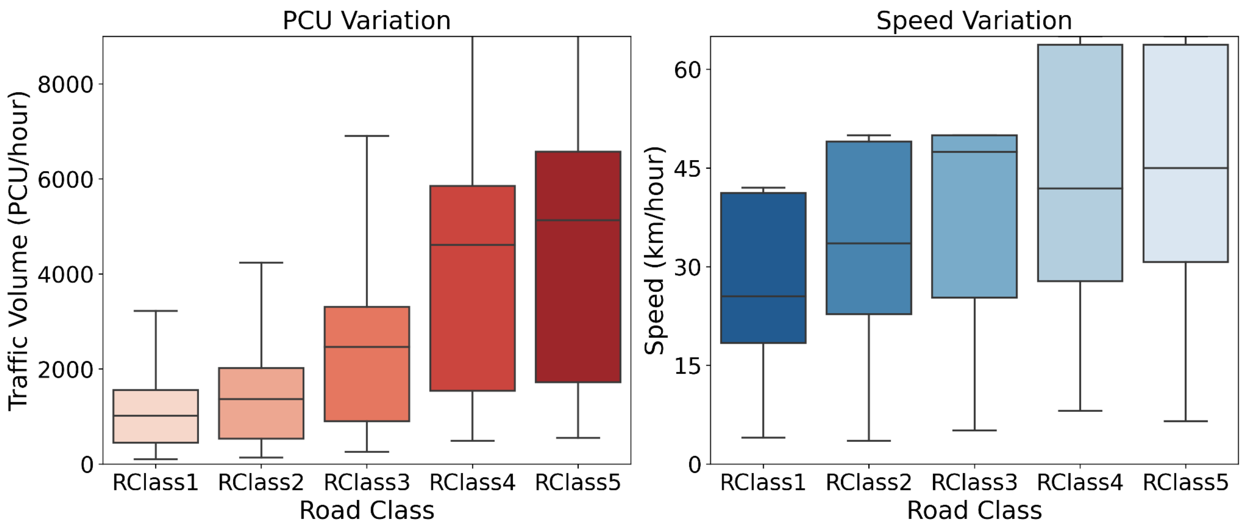

Figure 2. Boxplot for the PCU and speed variation across all road classes.

Reference

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