Dear referee,

Thank you for your comments and suggestions. We carefully addressed them one by one as shown below. Hope you find our revisions useful. Thank you again.

Regards,

YIM, Hung-Lam Steve, Ph.D.

Associate Professor, Asian School of the Environment
Associate Professor, Lee Kong Chian School of Medicine
Principal Investigator, Earth Observatory of Singapore
Nanyang Technological University (NTU), Singapore

Email: steve.yim@ntu.edu.sg
ASE@NTU: https://www.ntu.edu.sg/ase/aboutus/staff-directory/staff-details/yim-hung-lam-steve
Address: Block N2-01C-44, Asian School of the Environment, Nanyang Technological University, 50 Nanyang Avenue, Singapore, 639798

#Referee 2

The author employs a land-use regression (LUR) approach in developing an integrated model framework to estimate the annual average exposures of four primary PM10 chemical species and four criteria air pollutants—PM10, PM2.5, NO2, and O3—within the context of a typical high-rise and high-density Asian city, namely Hong Kong, China. The methodology leverages annual concentrations of these air pollutants as captured by monitoring stations in Hong Kong. However, it appears there are only sixteen data points available for analysis, and in certain cases, even less for some pollutants.
Here are some significant queries I would like the author to address:
The choice of 2017 as the year of interest is based on the completeness of data. Nevertheless, how is this year relevant to the epidemiological data that the author plans to investigate further? The applicability of the annual model to current epidemiological studies seems somewhat limited. Given the study's title, could the author shed more light on this concern?

Response: Our models are particularly useful for cross-sectional health studies. It is because our model can provide multiple air pollutants over space at high spatial resolution that monitoring stations cannot provide. For long-term exposure, multiple models can be established for other years. This study demonstrated the development of an integrated model framework using the data in 2017 that is the year our research team collected health data in a Hong Kong cohort. In the revised manuscript, we added content on the applicability of exposure models (Line 281-288).

Line 281-288: The development and applicability of exposure models depends on the focus of the air pollution epidemiological studies, which either focus on long-term or short-term or even acute exposure. To the best of our knowledge, the annual or long-term LUR exposure models have been widely adopted in providing long-term exposure estimates for health studies. Meanwhile, considering the requirement for high spatial-resolution and short-term acute *exposure assessment, it is recommended that more studies are conducted to establish high spatiotemporal-resolution exposure models when detailed measurement data are available. Indeed, several recent studies have explored the possibility of estimating high spatiotemporal-resolution air pollution exposure models using the spatiotemporal statistical modelling approach (Lu et al., 2020; Masiol et al., 2018).*

The author refers to the work as an "integrated model framework". However, I can only discern individual LUR models designated for each pollutant. Could the author elaborate on how the integration of this model framework was accomplished?

Response: This work provided an integrated model framework to simulate multiple air pollutants based on one set of input data. It should be noted that the PM and GAS modules that are consisted of multiple LUR models require different type and number of predictive variables. The integrated model framework handles the input data required for the PM and GAS modules and provides the results of eight air pollutants. It is therefore considered an integrated model framework.

In the revised manuscript, we added the description on the integration of the PM and GAS modules (Line 76-82).

Line 76-82: The PM and GAS modules were separated because the measurement and LUR modelling of PM species and gaseous pollutants are largely different in terms of measurement techniques, the number of required measurement sites, and selected predictor variables, etc. In the present study, the PM module includes the LUR models for different sizes of PM and its chemical components, whereas the GAS module includes the LUR models for two typical gaseous pollutants of NO_2 *and* O_3*. The included air pollutants vary depending on the data availability when the proposed integrated model framework is applied in other cities.*

The models were specifically developed for "high-density cities". Still, it appears that there is a mismatch between the sparse density of monitoring stations and the actual population density. Could the author provide further clarification on this discrepancy?

Response: This is an important point. The city has a high population density but monitoring stations are sparse. The discrepancy clearly highlighted the need to develop a LUR model for high-density cities. In addition to number of stations, LUR model development also requires the diversity of monitoring stations. So, this work aimed at developing an integrated model framework based on the data collected at the sparse monitoring stations for high-density cities. In the revised manuscript, we added the general diverse and representative distribution of the included monitoring stations (Line 100-102).

Line 100-102: These AQMSs are generally diverse and representative, ranging from rural stations under a limited influence of anthropogenic emissions to traffic stations near the major roads in Hong Kong.

Overall, it appears that the number of data points presents a significant limitation in this study. Would the author consider adopting a spatio-temporal model to incorporate a larger data set with finer temporal resolution?

Response: Similar to other LUR model studies, one limitation is typically the limited number of stations. To determine whether the limitation is significant or not cannot be based on the number alone. Instead, it should base on detailed evaluations as we did in this work. We have proved that our models had promising performance and are capable of reflecting the air quality characteristics of the city. Therefore, our models as considered as sufficient for the scope of this paper. Certainly, it would be a good idea for a further study if there are data at a finer temporal resolution. Thank you for your suggestion.