

Interactive comment on “Analysis of spatial and temporal patterns of on-road NO₂ concentrations in Hong Kong” by Ying Zhu et al.

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We thank reviewer #1 for the referee for the constructive comments. These comments are helpful for improving our manuscript. We understand that the comments are positive on the scientific content of the manuscript while appropriate revisions and clarifications are necessary. We have addressed the reviewer's comments on a point to point basis as below for consideration.

The manuscript 'Analysis of spatial and temporal patterns of on-road NO₂ concentrations in Hong Kong' presents an investigation of the spatial and temporal variability of street level NO₂ concentrations in Hong Kong. Two on road measurement campaigns were performed in 2010 and 2017 which combined both remote sensing LP-DOAS and

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mobile in-situ CE-DOAS measurements. As the measurements were taken at different time under different conditions, the authors put a big effort on filtering and normalizing the data in order to make these data sets comparable. Details of the filtering and normalizing procedure are presented. The filtered data were used to analyze the long term trend as well as the temporal and spatial characteristic of NO₂. The authors also show some interesting characteristics, e.g., enhancement of NO₂ levels around shopping area during weekends and increase of NO₂ around metro stations. The manuscript is in general well written and the topic is of interest of the general audiences of "Atmospheric Measurement Techniques". However, some clarifications are necessary. I suggest this manuscript for publication after a minor revision.

Specific comment:

As the measurement campaign were only performed in 2010 and 2017 each for a week. Although the authors have put a lot of effort in filtering and normalizing the data, it is difficult to say the measurements are representative for the general condition. I understood that it is difficult to have longer term measurements, but the authors should at least clarify that it is only a short term measurement and avoid using the term 'representative'. In addition, the measurement campaigns were performed in different seasons of the year and the meteorological conditions could be quite different. Is there any good reason?

Response: The measurement campaigns took place in different years and months and each for around one week time (10 days in Dec. 2010 and 8 days in Mar. 2017). It is very difficult to have regular measurements to derive annual average map. Therefore, we put a lot of effort on filtering and normalizing the data to get a better overview. In the revised manuscript, we rephased the term 'representative' to avoid confusion.

Regarding to the measurement campaign in different seasons, we tried to organize the campaigns in the similar time of year, but due to certain limitations, we can only measure in these two time frames. The two measurement campaigns were performed in

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winter (December) and early spring (March). We have analyzed the meteorological parameters including temperature, humidity, wind speed and wind direction taken during the two measurement campaigns. The results show that the meteorological conditions are quite similar during the two campaigns. We have supplemented the information in the revised manuscript (page 12, line 24-26).

Section 3.2.1: The authors present an example of the NO₂ level under congestion condition and concluded that to filter data take 8 s after the vehicle speed below 5 km/h. The lag time shown in this case is the combination of accumulation of NO₂ in ambient plus the lag time of the instrument. The lag time of the instrument is fixed and can be measured, while the time of accumulation of NO₂ varies. Clarification is necessary.

Response: A clarification is added to the revised manuscript (page 8, line 1-2).

Figure 4 caption: Change 'during stops due to traffic congestion' to 'during traffic congestion'.

Response: The caption is revised according to the reviewer's suggestion (page 8).

Section 3.3: Deriving long term trend from 2 weeks of measurements is not very convincing. The authors should state clearly the purpose of comparing these short term measurements. The analysis of EPD and LP-DOAS data is variable though.

Response: The purposes of comparing these short term measurements are (1) to illustrate the differences between on-road mobile and road side stationary measurements and (2) to examine the consistency of the long term trend of road side NO₂ derived from stationary measurements. We have supplemented the information in the revised manuscripts (page 9, line 16 to page 12, line 2).

Figure 6: This plot contains a lot of information already. However, I still would like to know whether it is possible to compare the EPD data measured at the same time when the CE-DOAS was passing by and how's the correlation in between? The labels in the plots should be larger. The date in the title of each plot is redundant, please remove

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them.

Response: Our measurements only have few overpasses with the EPD stations during the campaigns. As a result, there are only few data points for comparison. Therefore, investigating the correlation for such a small dataset might not be statistically significant. We have revised Figure 6 according to reviewer comments (page 10).

Figure 8: How does the average map calculated for each year? Does it correct for the diurnal effect? Since the authors described the measurements were taken during the different time of the day which contains the morning and evening rush hours and non-rush-hour at noon, it may lead to a bias in averaging all measurements.

Response: The measurements were taken with a fixed schedule during morning rush hours, noontime and evening rush hours. We weighted the morning, noontime and evening measurements equally in the averaging process. Therefore, we do not correct for diurnal pattern of NO₂. As both the measurements in 2010 and 2017 are processed with the same procedure, it is unlikely to have a bias when comparing the two datasets. We have supplemented a brief description of the averaging procedure in the figure caption (page 13).

Figure 11: NO₂ concentration measured by the 7 EPD stations are shown on the map as well. But the authors don't describe any results such as the difference between EPD measurements and the coinciding closest on-road measurements, and the NO₂ average changes in these 2 years of EPD stations.

Response: The EPD measurements shown on the maps are used to illustrate the consistency of the on road and stationary measurements. We have supplemented a brief discussion regarding the on road and stationary measurements (page 11, line 5-9 and page 17, line 21). As we have discussed before, there are only few coinciding CE-DOAS and EPD measurement data. Looking into this small dataset might not be able to derive statistical significant conclusion.

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Page 5 line 28: 'a equilibrium state' to 'an equilibrium state'.

Response: We have removed the sentence according to comment from reviewer #2.

Page 12 line 2- 3: Explain why >1 ppb is significant. I suppose this is related to the detection limit of the instrument. Please specify it in the methodology section.

Response: The detection limit of the instrument is now included in the methodology section of the revised manuscript (page 4, line 7).

Page 15 line 10: 'primary NO is could be. . .' is grammatically incorrect. Please revise.

Response: The grammatically mistake has been corrected (page 15, line 26).

Page 17 line 3: If the traffic load is mostly constant in commercial areas which include most shopping malls on Sunday, why the differential map shows the decrease of NO₂ around shopping malls? A better description is necessary.

Response: Although the traffic load is mostly constant, the parking spaces are limited in these shopping areas and results in low speed cruising and traffic congestion around these major shopping areas during weekend, which lead to higher emission of NO_x. This explanation is written on page 19, line 7-10.

Page 18 line 14 and 15: Same as before, explain why >1 ppb is significant.

Response: The detection limit of the instrument is now included in the methodology section of the revised manuscript (page 4, line 7).

Page 20 line 20: I couldn't see the causal relationship between the increase amount of private cars and public transport usage with the significant increase of weekend drivers in Hong Kong. The authors should describe it better.

Response: Both number of private car and public transport usage increase in the past few years implied that the usage per private car is greatly reduced. The decrease of private car usage is mainly due to the reduction for daily commute using private cars,

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which is coherent with the increase of public transport usage. As a result most of the private cars are mainly used during weekends. We have supplemented the explanation in the revised manuscript (page 19, line 3-5).

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