Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-1169-AC2, 2021

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mobile monitoring of urban air quality at high spatial resolution by low-cost sensors: Impacts of COVID-19 pandemic lockdown" *by* Shibao Wang et al.

Shibao Wang et al.

zhangyx@nju.edu.cn

Received and published: 24 January 2021

General Comments This paper presents a mobile monitoring study of CO, NO2, and O3 concentrations in a major urban area. The research in this paper is a solid scientific study that adds to the knowledge we have of the variability in air concentrations in large urban areas. Below I detail some specific comments that should be addressed by the authors as well as some technical corrections.

We thank the reviewer for this comment and the helpful suggestion. We have carefully addressed the reviewer's concerns. Please see below our replies. We hope he/she is satisfied with our answers and the new (figure) we provided.

Printer-friendly version

Discussion paper

Specific Comments

1- Lines 85-90: please provide detailed information on the machine learning algorithm used, including the equations used to calibrate the data, what is considered a "substantial deviation" from the national network measurements, how recalibration was conducted if there was a substantial deviation, and how many times recalibration was needed.

Re: The detailed information on the machine learning algorithm was added in line 101-105: "GBRT, an ensemble learning method, is a decision tree-based regression model that implements boosting to improve model performance using both parameter selection and k-fold cross validation. GBRT needs to be trained by a dataset with target labels (Yang et al., 2017). It takes input variables including raw signals of sensors, other air pollutants concentrations, temperature and humidity. The stationary instrument data are taken as training targets". Since we did not calculate the "substantial deviation" from the national network measurements, we deleted it in the revised manuscript.

2- Lines 91-99: explain why you are using a machine learning algorithm. My understanding from your paper is that Figure 2a shows actual measurements, while Figure 2b shows the machine learning air concentration estimates for the mobile sensors compared to actual measurements at the fixed site. The correlations in Figure 2a are much better than those in Figure 2b, which would suggest that there is no need to train an algorithm to develop better estimates of concentrations. Why can't you simply use the measurements from the low-cost sensors for your calibration/validation? Is it because the study data were collected throughout the city, and not just near fixed monitors? If so, perhaps you can do a second calibration using data near fixed monitors, without the machine learning algorithm.

Re: To clarify this, we added this sentence in line 90-94: "Different from traditional instruments, low-cost sensors have some limitations, such as dynamic boundaries, nonlinear response, signal drift, environmental dependencies and low selectivity, so it

is important that calibration procedures are applied with respect to these limitations (Maag et al, 2018). The sensors are usually trained with co-located data collected by reference methods before being deployed to actual measuring campaigns (Kaivonen and Ngai, 2020; Chatzidiakou et al., 2019; Bossche et al., 2015)". We added a sentence in line 98-100 to further clarify: "Comparing different calibration models, we found that machine learning algorithm can improve sensor/monitor agreement with reference monitors, and many previous studies have used this method (Qin et al., 2020; Esposito et al., 2018; Vito et al., 2018)." We also added a sentence in line 107-109: "The success of supervised model training with target labels (i.e. co-located with SORPES, Figure 2a) does not guarantee for its predicting power for conditions without labels (i.e. on road or co-located with SORPES but not feeding the station data to the algorithm, Figure 2b)".

3- Lines 128-130: this is a broad statement, and not true of all urban monitors. Can you provide citations to studies or reports that show that the stationary monitors do not have a significant impact from traffic emissions and are representative of urban background air quality?

Re: We clarified this by adding the following sentences in line 155-159: "Seven state-operated air quality observation stations in Nanjing are selected in our research, including Maigaoqiao, Caochangmen, Shanxi Road, Zhonghuamen, Ruijin Road, Xuanwu Lake, and Olympic Sports Center (Zhao et a., 2015; Zou et al., 2017), which are far away from major roads and large point sources, so they are usually used as regional backgrounds in different functional areas (Zou et al., 2017; An et al., 2015). For example, Zou et al. (2017) chose the Olympic Center station (G, Figure 1) to get the background characteristics of CO and NO2 in Nanjing".

4- Lines 205-206 and Table 1: explain how you are identifying the main source contributions to the hot spots. Is it based on nearby sources and wind direction? Do different sources have different fingerprints (i.e., different relative concentrations of the measured pollutants)? Are there other studies showing that these sources had significant

contributions at these locations?

Re: We clarify this in line 235-238: “To identify the main sources contributing to these hotspots, we use the different relative concentrations of the measured pollutants (Zhao et al., 2015). We also use field information around hotspots area, such as the existence of subway stations, construction sites, factories, and restaurants nearby”. Other studies had consistent results as stated in line 252-254: “Previous studies have also found that the air pollutants “hotspots” are associated with traffic-related emissions [e.g., heavy-duty diesel vehicles (Targino et al., 2016) and vehicle congestion (Gately et al., 2017)] and high-density urban areas (Li et al., 2018).”

5- Lines 334-335: do the observations at fixed monitors support the theory that increased temperature/insolation is the cause of higher O3 concentrations in P3 as compared to P1?

Re: Yes, they do. We added several references to support it in line 375: “. . .. . .(Xie et al., 2016; Fu et al., 2015; Reddy et al., 2010)”.

Technical Corrections

1- Figure 2: both the x- and y- labels on the regression plots are labeled “station.” Please change this to specify which station.

Re: The Figure has changed in the revised version. The x- and y- labels in Fig. 2a represents sensor-1 and sensor-2 respectively, while in Fig. 2b represents SORPES station and sensors data respectively.

2- Figure 5: the resolution isn’t good on this figure. Can you re-plot with better resolution? Also, the yellow/orange colors are hard to differentiate in Figure 5b.

Re: We replace it with a high-resolution image, which can be viewed by zooming in.

3- Line 334: ‘insulation’ should be changed to ‘insolation’

Re: We modified ‘insulation’ to ‘insolation’ in line 374.

4- Figure11: this figure is very hard to read. Can it be made a higher resolution or different color scheme?

Re: We have replaced it with a higher resolution image in revised version.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1169, 2020.

Printer-friendly version

Discussion paper