Dear Editor,

We have now addressed all comments reviewers raised.

Referee:

I appreciate the effort made by the authors to address the comments, which they mostly did. I have only two comments regarding the revised version.

We are thankful for the valuable comments from the reviewer.

1. Please clarify what has changed in the revised Figure 2 compared to the previous version. What do the authors mean with the term “testing samples”? What is the size of it? Why don’t they include the whole year (or they do)? COVID-19 restriction measures began (roughly) at late January and early February. I suggest including (like Figure 2) two testing samples as different colors. As PRE COVID-19 period all samples from January 2020 and as COVID-19 period February to December 2020 samples. This might depict the effect of COVID-19 in XGBoost model performance. I understand that this might be out of the scope of the study, but this can be included as Supplement to better assess the COVID-19 effect.

Figure 2 originally used the data from the entire period to do frequency analysis. However, the current version only includes the results from the testing data.

We thank the reviewer for their comments on our wording. We have modified the corresponding content in the manuscript. Additionally, to avoid misunderstanding regarding the testing data period, we have updated the caption in Figure 2 by removing "2020" and using the unified “testing data”.

Line 197-200: “For the machine learning process, data from 2013 to 2019 were used for training the XGBoost models, while the 8613 data points measured from January 1 to December 31, 2020, were used for model testing (Fig. S2). Note that the 2020 analysis results may contain some uncertainties due to the impact of COVID-19.”

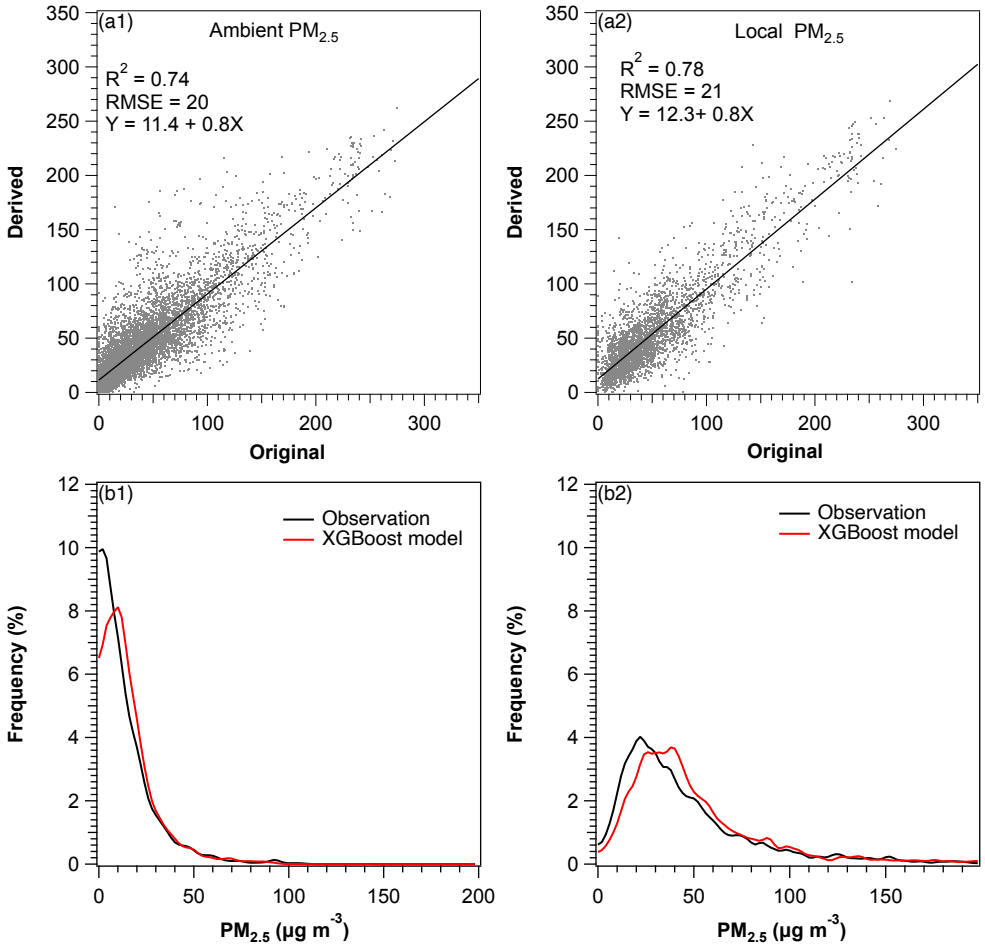

Fig. 2. Comparison of XGBoost model estimates and observations for (a1) ambient $PM_{2.5}$ and (a2) local $PM_{2.5}$ using testing data. Frequency distributions of $PM_{2.5}$ observations (black lines) and XGBoost model predictions (red lines) for (b1) ambient $PM_{2.5}$ and (b2) local $PM_{2.5}$ using testing data.

We have added the following figure to the revised manuscript's supplementary material:

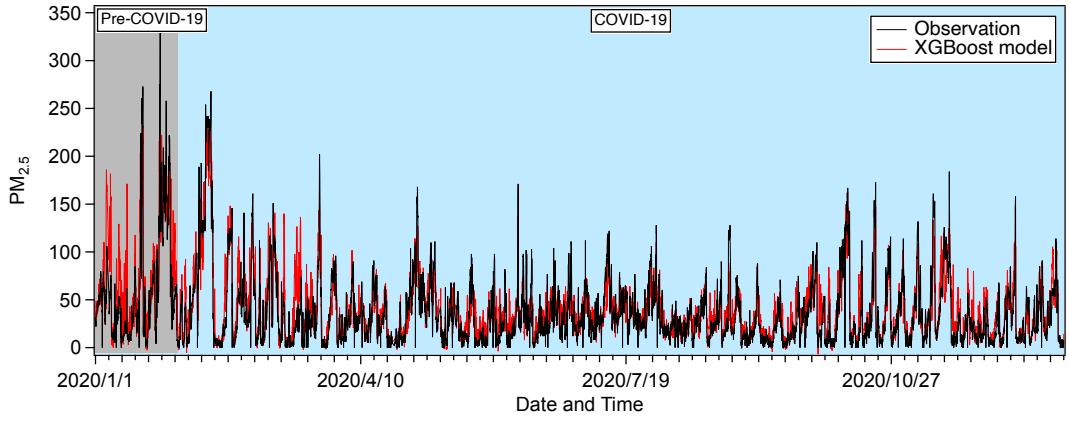

Fig. S2. Temporal evolution of $PM_{2.5}$ observations (black lines) and XGBoost model predictions (red lines) using testing data. The grey and blue shades represent the periods pre-COVID-19 and during COVID-19, respectively.

2. In accordance with the new discussion included "This may be attributed to the significant reduction in human activities during the COVID-19 lock-down periods, which led to a decrease in actual PM2.5 levels." a phrase for the fact that COVID-19 restriction measures might have contributed to the reduced PM2.5 levels of 2020 should be included in the Abstract and the Conclusions as well.

3. We thank reviewer to point this out. These are now added in the revision:

Line 43-46: "The COVID-19 restrictions might have reduced $PM_{2.5}$ concentrations in 2020. From 2013 to 2020, local emissions were the main contributors to pollution events in Beijing. The Action Plan has more effectively reduced pollution caused by regional transport, particularly during autumn and winter."

Line 349-353: "These clean air masses from different directions exhibited similar seasonal variations in their ability to reduce ambient pollution in Beijing, with a stronger reduction effect in winter and a weaker reduction effect in summer. In addition to clean air masses, COVID-19 restrictions might have contributed to the reduction of $PM_{2.5}$ in 2020."