This study targets an important question, what causes the ozone increase during lockdown despite substantial decrease in anthropogenic emissions? By applying some statistical approaches, the authors decouple the effects of changing meteorology and emission on ozone formation, and reported that changes in emissions causes a 5 ppb increase in ozone during the lockdown, where changes in meteorology conditions only increase ozone by 0.5 ppb. Further, it is shown that the ozone formation shifts from a VOC-limited regime before lockdown to the conjunction of NOx- and VOC-limited regime, which increase ozone formation. Overall, the scope of this study fits the journal. I recommend publication after major revisions.

Response: We thank the reviewer for the positive and constructive comments. Below is our point-by-point response to each comment, marked in blue. Changes made to the main text are presented in green.

Major Comments

Several statistical methods are applied in the study, but it is not clearly stated why they are selected? For example, why Sen's slope is used rather than a simple linear regression? There is a myriad of machine learning algorithms, so that the rationale behind each selection should be discussed. For example, Sen's slope is a robust slope and less susceptible to outliers. Further, current description of deweathered model lacks details. What does the model do? If I understand correctly, it takes several parameters as inputs and use random forest to predict O3 concentration, right?

Response: Thanks for the comment. The Sen's slope is selected since it is insensitive to outliers, and does not require a normal distribution of residuals. The deweathered model is used to remove the influence of meteorological conditions and obtain the hypothetical O_3 concentrations under the same "normalized weather condition", so that we can discuss whether the abnormal increase of O_3 is due to meteorological condition or changes in emissions. More details of the Sen's slope and deweathered model has been inserted into the

revised manuscript, please refer to Page 7, Line 158-177: The Sen's slope is selected since it is insensitive to outliers, and does not require a normal distribution of residuals.

Page 8, Line 158-177: The observed concentrations of O_3 could be influenced by meteorological conditions, emissions and/or chemistry. The emissions and chemistry are being treated together and separated from meteorology by the deweathered approach based on the random forest (RF). Hourly data of Unix date (number of seconds since 1970-01-01), Julian day, weekday, hour of day, wind speed (WS), wind direction (WD), temperature (T), relative humidity (RH), and pressure (P), which are available during the whole observation, were used for the deweathered calculation of O_3. The missing data was replaced by linear interpolation. Training of the models was conducted on 80% of the input data and the other 20% was withheld from training. To avoid the disadvantage of overfitting during the training of RF, a process called bagging (or bootstrap aggregation) was adopted. Bagging results in new, sampled set called out-of-bag (OOB) data. A decision tree is then grown on the OOB data. Therefore, all the decision trees are grown on different observations and avoid the overfitting (Grange and David, 2019). To determine the value of number of trees (ntree), number of samples (nsample), and the minimal node size, a series of random forests were performed under different choices of ntree, nsample, and minimal node size. Results suggest that the highest coefficient of determination (R^2, 0.84) was obtained when ntree, nsample and minimal node size was set as 300, 300, and 5, respectively (Table S1 and S2). More details of this model could be found in the study of Grange and David (2019). The uncertainty of the deweathered model is obtained by growing 50 random forest models with the hyperparameters described above, which is the same method as Grange and Carslaw (2019). The mean and standard error of the predicted O_3 concentrations is presented in Figure S1, and results of the model are stable during the 50 runs.

The interpretation of $O_{3,met}$ and $O_{3,emission}$ is confusing, partly because of lack of details in describing the stats methods. To the reader, the difference between observed O_3 and weather-normalized O_3 represents the influence of changing emission, as weather-normalized O_3 takes into account the variation in O_3. The difference in observed O_3 between different years does not represent the influence of emission, because the meteorology between different years is different. Such interpretation will fundamentally change the conclusion on this manuscript as well as the conclusions from the box model. Please clarify.

Response: Thanks for the comment. The difference between observed O_3 ($O_{3,\ Obs}$) and weather-normalized O_3 ($O_{3,\ Normal}$) represent the influence of meteorology, which is consistent with the definition in Li et al. (2021). The differences in $O_{3,Normal}$ among different years represent the influence of emissions, since the $O_{3,Normal}$ has already removed the influence of meteorological conditions. To avoid misunderstanding, relevant descriptions has been added in the revise manuscript. Please refer to Page 8, Line 177-181:

The differences in observed O_3 concentrations ($O_{3,Obs}$) and deweathered O_3 concentrations ($O_{3,Normal}$) were regarded as the concentrations contributed by meteorology ($O_{3,Met}$), which is consistent with the definition in Li et al. (2021). Correspondingly, the differences in $O_{3,Normal}$ concentrations in different periods represent the influence of emissions, since the $O_{3,Normal}$ has already removed the influence of meteorological conditions.

The discussions on ozone formation potential (OFP) can be reconstructed in a more meaningful way. Mainly, it should be clearly stated that OFP does not indicate O_3 concentration. With this premise, there is no need to discuss "consistency" or "inconsistency" between the two (Line 282). In other words, OFP is not helpful to answer the O3 question in the manuscript.

Response: We agree that OFP only gives the O_3 formation potential by the observed VOCs and it does not directly indicate O_3 concentration changes. But the discussion of OFP can be

a reference for the comparison of the reactivity of VOCs in each period. Therefore, we have revised the relevant description, please refer to Page 16, Line 304-310:

To compare the average reactivity of VOCs during different periods, we calculated the mean MIR, derived by dividing the total OFP by total VOC concentration, in each period. A higher MIR means stronger capability of VOCs to produce ozone. As shown in **Error! Reference source not found.**, the average MIR during Pre-lockdown, Full-lockdown, and Partial-lockdown period was 3.85, 3.53 and 3.68 (g O_3/g VOC), respectively. This result suggests that VOC species composition in Full-lockdown is more conductive to ozone formation than that in Pre-lockdown, and Partial-lockdown period.

The reliability of the box model results is compromised by the fact that the modeled O_3 during full lockdown (29 ppb) is lower than that during partial lockdown (32ppb), which contrasts the observation.

Response: We think there could be misunderstandings. According to the results of the box model and Figure 8 in the revised manuscript, the modeled daytime O_3 concentration during Full-lockdown (36.4 ppbv) is higher than that during Partial-lockdown (33.3 ppbv), which is consistent with the observation.

Minor Comments

Line 167 is a confusing sentence.

Response: The original sentence is confusing; hence we have revised:

It should be noted that the decreasing ratio of VOC/NO_x is around 1.75, suggesting that the lockdown policy has stronger influence on NO_x emissions than VOC emissions.

Line 257. “Vary”, not “varies”.

Response: Revised.

Line 281. It is “full-lockdown”, not “partial-lockdown”.

Response: Revised.

Line 299. What does “AOC” represent?

Response: AOC represents the atmospheric oxidation capability, and the relative description has already been declared in line 129: According to the definition of atmospheric oxidation capability (AOC)....