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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Changes in satellite retrievals of atmospheric composition over eastern China during the 2020 COVID-19 lockdowns" *by* Robert D. Field et al.

Anonymous Referee #2

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This article presents an analysis of atmospheric composition changes due to COVID-19-related measures, based on observations from satellites. The methodology adopted in several recent studies for assessing COVID-19 impacts relied on comparisons of pollutants abundances during the lock-downs to the their levels in previous years during the same period of the year. The quantification of lock-down effects is uncertain for several reasons, including natural variability and the long-term trends in anthropogenic emissions. The main point of this paper is that those long-term decreasing trends in emissions explain a great deal of the observed decreases in the abundances of major pollutants like CO, NO_2 and aerosols. The paper provides "best estimates" of the COVID-related change in CO, SO_2, NO_2 columns and aerosol optical depths (AOD)

when taking the long-term trends into account. Accounting for the trends is found to have a huge impact on the inferred Covid-related changes. NO_2 is the only compound displaying a significant drop, and it is found to be much lower (17%) than the decrease estimated when ignoring the trend effect.

Major comments:

Although it is of course correct that the long-term trends should ideally be taken into account in order to quantify COVID-related changes, the methodology used here for subtracting the long-term trends is fundamentally flawed. A linear trend is assumed and calculated based on a "background period" defined as the period during which the trend was strongest, based on the r^2 value. The flaw is particularly evident in the case of SO_2 over East central China: as stated in lines 262-263, the "expected 2020 value" (i.e. the value extrapolated based on a linear trend applied to SO_2 data between 2012 and 2019) is negative (-0.06 DU). How can we consider a negative column as an acceptable expected value? This cannot be done. The negative linear trend cannot be extrapolated beyond 2019, because SO_2 columns have become so low, and cannot decrease much anymore. It's not just for SO_2. For AOD as well, there is a clear flattening of the observed decrease in the later years: as seen by Figure 5, the observed AOD values in 2018-2019 are higher than the linear regression, whereas they are lower than the regression in 2015-2017. This is very clear indication of a flattening. For NO_2 as well, the data are lower than the linear fit in 2014-2016, while they are (mostly) higher in 2017-2019. Again, the flattening is evident, and the regression is inappropriate. The choice of the background period based on the r^2 value is misguided. Of course, due to natural interannual variability, the r^2 of linear fits based on the later years (e.g. 2015-2019) will be higher than the ones adopted here; but it does not imply that they are less appropriate for extrapolation to 2020. Unfortunately, the 95% confidence interval of the trend (Figure 6) is very wide for a start year of 2015: for NO_2 and AOD, the range almost spans a zero trend. It would be interesting to see the results for a starting year of 2016. Based on Figure 5, the NO_2 and AOD trend

would become close to negligible.

There is another issue of some importance, the definition of the lock-down period. As seen on Figures 3 and 4, the lockdown was much more strict in February than during the rest of the period considered here (January 23 - April 8). In order to separate the effects of the lockdown from other effects, why wouldn't you focus the study on the month of February? Judging from Figure 3, this would make a lot of sense, at least for CO and NO_2.

Based on the above, I cannot recommend the paper for publication in ACP. I have serious doubts that the main shortcoming can be remedied. The subtraction of the trend will be always very uncertain, and is very likely a lesser issue than the natural interannual variability related to meteorology.

Minor (language) comments

- lines 66-69: unclear, please rephrase

- l. 72-73: the grammar is incorrect

- l. 133-134: "Systematic errors... have an uncertainty of 20%": rephrase

- l. 170: "higher-quality retrievals": defined how?

- l. 187: "depended on how"

- l. 220: "The main features of the SO_2": poor expression, be more specific

- l. 230: "but against a noisy background": unclear

- l. 239: "than in 2019"

- l. 243: "the distribution of daily CO..." : this is not what the figures shows. What we see is the evolution of averaged CO etc. abundances over 2005-2020

- l. 247: whisker

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