

Interactive comment on “Estimating lockdown induced European NO₂ changes” by Jérôme Barré et al.

Anonymous Referee #2

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We would like to thank the reviewer for their comments that helped to improve the paper's quality. Please read our answers in italic fonts below.

This paper addresses the impact of the European 2020 Covid lockdown on NO₂ levels using satellite data, surface NO₂ data and model simulations. Because of the short TROPOMI satellite record the impact of meteorology is derived using a machine learning algorithm, which is also applied to the surface data. The large impact of meteorological differences between 2019 and 2020 is noted and this serves as a caveat to some previous simple presentations of the data during/after lockdown. The impact of lockdown is quantified for all large European cities by the 3 methods. These are important and useful results to publish, in a timely manner given the interest in the impact on the effects of lockdown. I only have minor comments and I think that the paper is publishable. My main comment is that the reader does not get a feel for the ML methodology and how well it works pictorially. Text refers to large outliers but it is important to show this to the reader (see my comment on Figure 5).

We have added an additional figure providing times series for 2019 and 2020 for Madrid, showing the performance of the machine learning model. We also have amended the text to include the figure description and discussion.

The paper is readable as is, but there is a very large number of minor grammatical errors which will need addressing. Maybe the ACP office will do that. I don't have time to go through them all, but I would point out that the typos start in affiliation 1 for the lead author (Forecasts not Forecast and Shinfield not Sinfield!). Not a good start. In fact the errors start in the paper title (which would need a hyphen: lockdown-induced).

The grammar has been revised

Other Specific Comments

Section 2.1 line 115. Give the local time of the TROPOMI observations in this section.

Done

Line 197. 'not expected'. Make it clear that this is not expected based on emissions. One could expect this if one understood the impact of meteorology.

The sentence has been clarified.

Line 225. 'Contrary to' change to 'In contrast to. . .'

Line 231. Table 1. Spell out the acronyms in the table headings.

As requested by the other reviewers, this table has been removed from the article.

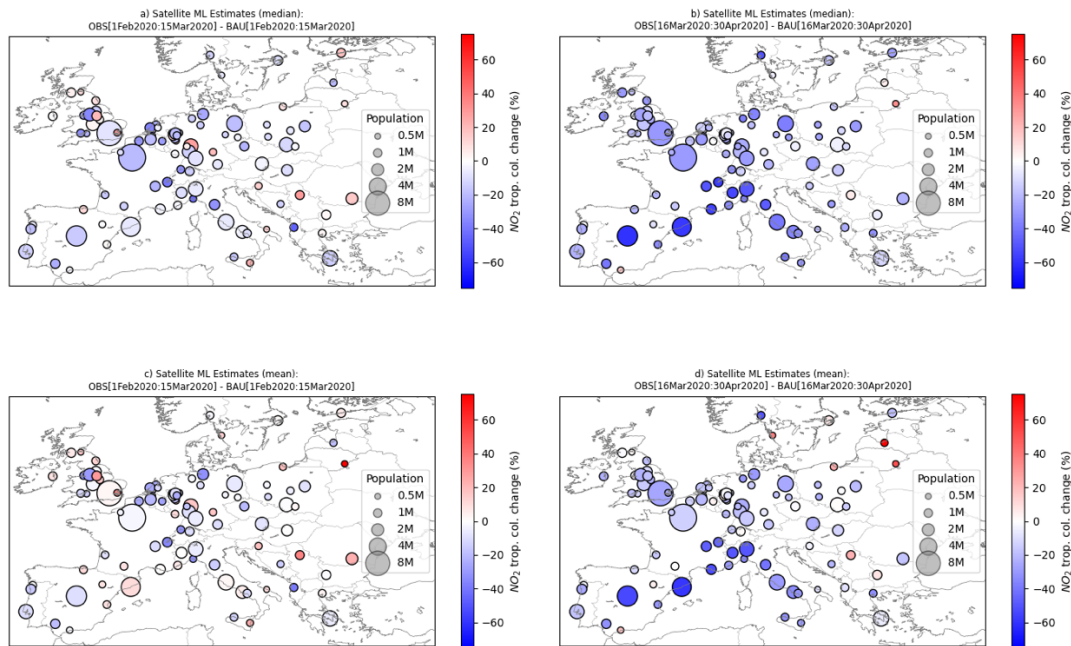
Line 239-240. Explain what is meant by 'overfitting', what the implications would be and how you know it is not occurring.

We have detailed the text accordingly.

Figure 5 shows median values and not the mean. How different would Figures 3 and 4 be if the median was used? This needs some more explanation and somehow the same methodology should be included in one of the cases. You could make Figure 5 into 4 panels and show both methods. It is important to show the limitations of the ML method and provide the equivalent results to the other methods.

For consistency we now have changed figure 3 and 4 with median estimates.

We provide here in the response the additional plots comparing the median vs mean on the satellite ML estimates. This provides a fairly similar overall picture. See below.



To prevent cluttering the paper and overwhelming the reader with lots of different statistics we prefer to keep the median estimates and not add the mean estimates. This is also justified by keeping consistency with the final figure that provide the equivalent of box plots based on the median and quartiles. Such estimates have also the advantage of being non-parametric displaying the variation in the statistical distributions without making underlying assumptions (i.e. gaussianity). We have now clarified the text accordingly.

Line 266. 'would be expected'. How large is the interannual variability on NO₂ emissions?

We have clarified the text accordingly. It is true that the trend in NO₂ reduction might influence the results as we only used 2019 to train the model.

Line 288. 'Contrary to' -> 'in contrast'.

Done

Line 294. Same comment as above on overfitting.

We now refer to the previous section in the text.

Line 312. What does 'marginal' mean here? Small? Better to say what the lifetime of NO₂ is and say that the impact is likely small.

We are assuming that the reviewer refers to line 309 instead of 312. We have clarified the statement accordingly.

Figure 6 caption. Say that these data are weather-normalized.

Done