This paper is an extensive and intensive study of the NOx, VOC and O3 changes over Europe due to the Lockdown using WRF-CMAQ and TROPOMI data. In a sense, it is 2 papers combined into 1. The first part is the assimilation of satellite data to adjust emission inventories of NOx and VOC. The second part is a process analysis of ozone formation.

The paper seems rigorous and is well written, I am happy to recommend publication. Below are some minor comments that you may wish to consider.

We appreciate the time and thoughts this reviewer put into their review.

Minor Comments:

Table 2 and 3: Do you mean that these are the differences between 2019 and 2020 after assimilation?

These numbers are 2020 minus 2019 (in terms of 2020, it's normalized with respect to 2019) and yes, they are based on the inversion. We explicitly mentioned "top-down estimate" and "2020 with respect to 2019" in the caption.

The inconvenience of having so much material in a single paper is that the paper brushes over a fair amount of the information on the assimilation.

I think it would be good to show the emissions in the prior as well as the emissions in the 2019 posterior and the 2020 posterior.

We fully understand your concern. Emissions are usually a large source of error in CTMs. Because the accuracy of any experiment derived from models is subject to the errors of initial conditions (here emissions), we believe inversion/data assimilation procedures should be a prerequisite step in getting reasonable results from models.

To account for the reviewer's comment, we added both a priori and a posteriori of NOx and VOCs in the supplemental information and briefly mentioned them in the main text. We have decided to show these contour maps in the SI because we want to focus on the changes in emission happening during the pandemic.

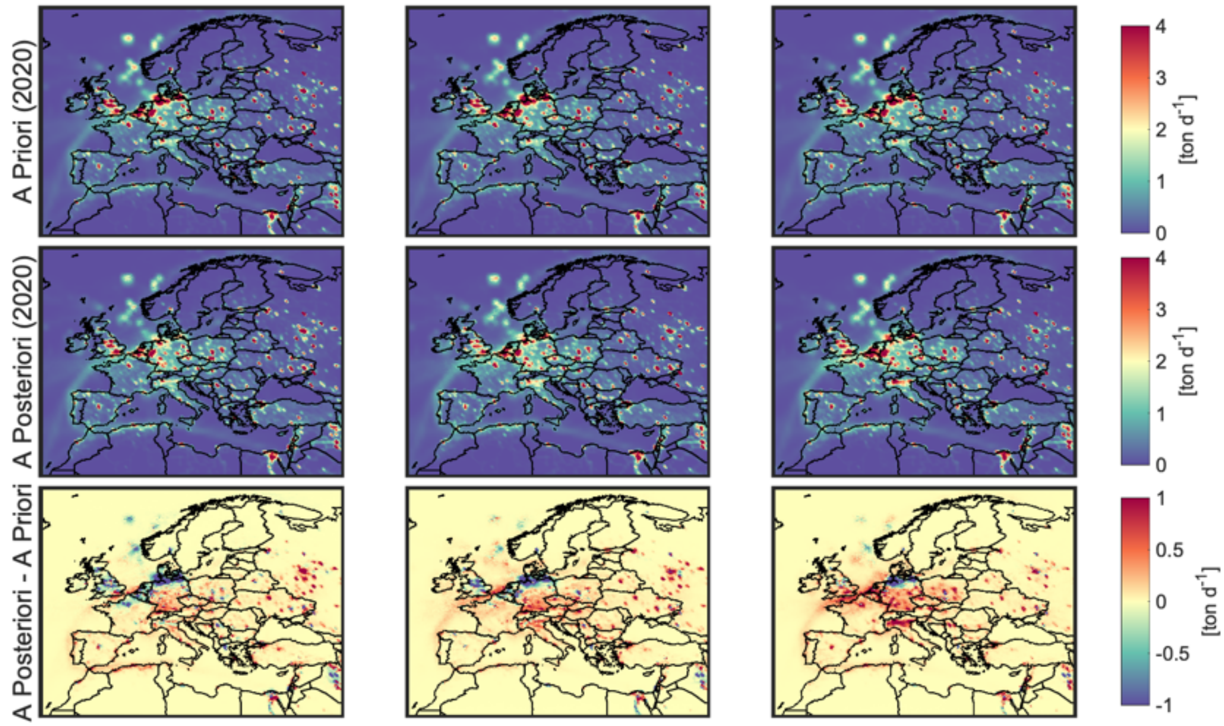

Figure S3. The a priori and the a postteriori of the total NOx emissions for the months of March (first column), April (second column), and May (last column) in 2020.

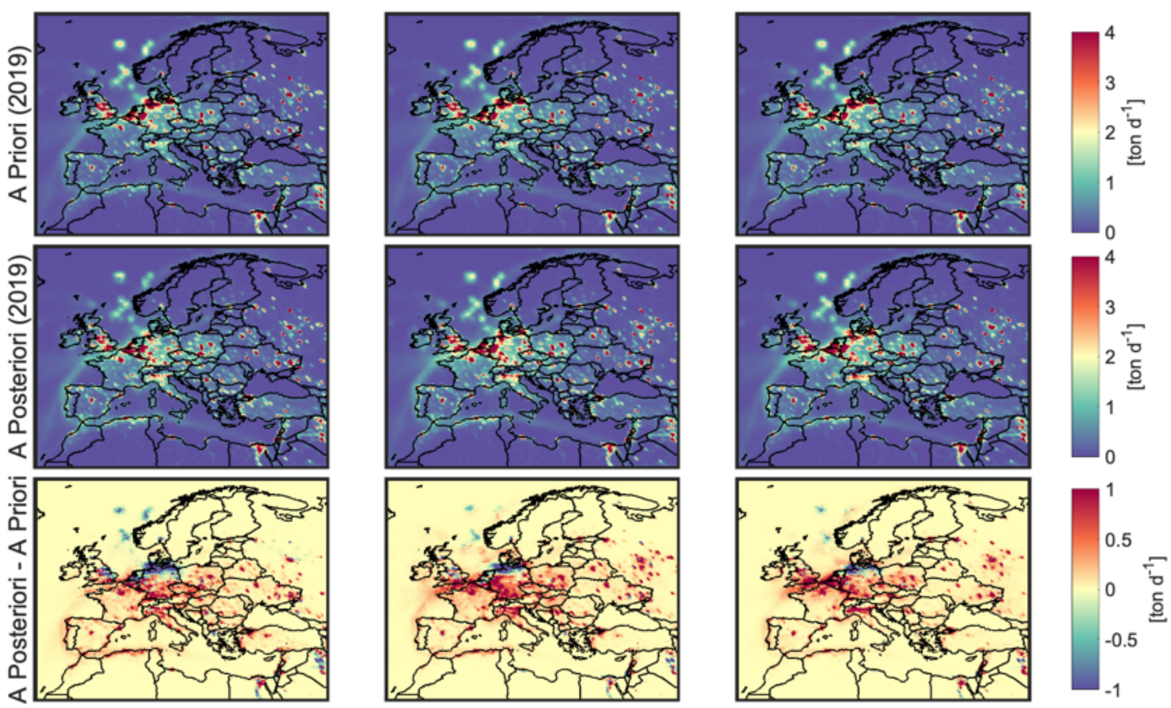

Figure S4. The a priori and the a postteriori of the total NOx emissions for the months of March (first column), April (second column), and May (last column) in 2019.

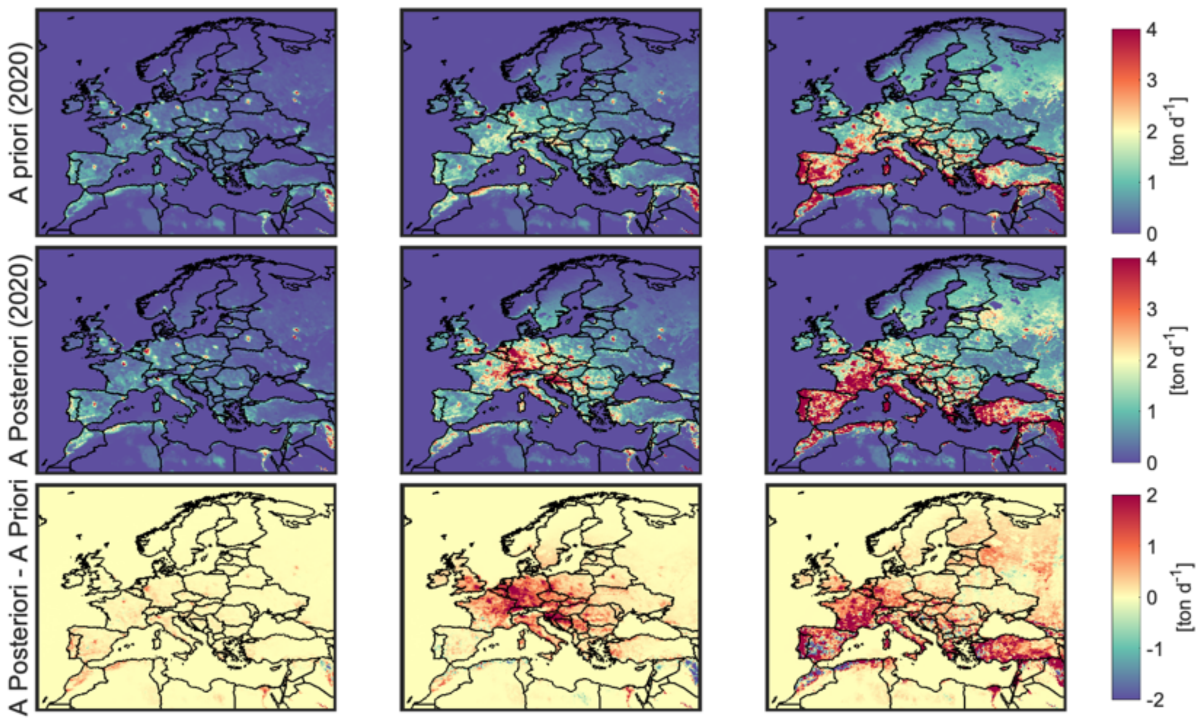

Figure S5. The a priori and the a postteriori of the total VOC emissions for the months of March (first column), April (second column), and May (last column) in 2020.

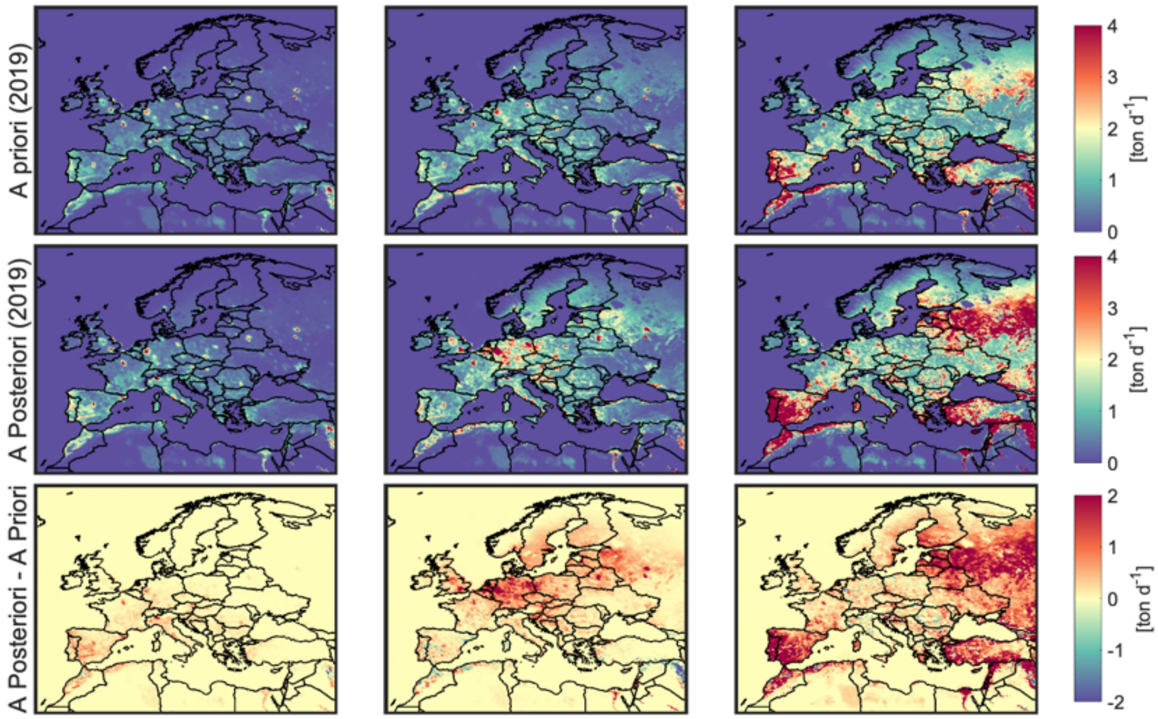

Figure S6. The a priori and the a postteriori of the total VOC emissions for the months of March (first column), April (second column), and May (last column) in 2019.

The caption should clarify that these are estimates based on inversions using TROPOMI (vs. estimates based on ratios of TROPOMI data,for example).

Thanks, we added:

In Figure 11: "Emissions used for these experiments are based on the top-down estimates**."**

In Figure 12: "the constrained emissions by the satellite data**"**

In Figure 13. "These outputs are based on the constrained model**"**

In Figure 14: "The constrained model by the satellite observations are used to derive these outputs**."**

In other captions, we had stated the inversion as either "top down" or "the constrained model"

Fig. 10: There is a big difference in ozone production rates in Eastern Europe between rural and urban areas. This is discussed in Section 3.4. Given the importance of the question of ozone sensitivity, would it be possible to provide average values of ozone changes for NW Europe,

Rural East Europe and Urban East Europe? This could be integrated into a discussion of NOX/VOC sensitivity.

Thanks, this comment is addressed by including a figure described in the next comment.

Fig. 10: It would be instructive to see the corresponding average MDA8 Ozone maps. We see many difference plots, but without seeing the actual average values that these are departures from, it is hard to get a sense of what is going on.

Thanks, we now have included the MDA8 maps. The description of the new result follows:

"We plot the simulated MDA8 surface ozone concentrations in April 2020 (lockdown), April 2019 (baseline), and their differences in Figure 9. Surface ozone concentrations show a strong latitudinal gradient with lower values in higher latitudes, underscoring the importance role of solar radiation in the formation of ozone. Meanwhile, the Mediterranean basin has always been prone to elevated concentrations of ozone resulting from different factors including calm weather, the transport from neighboring countries, atmospheric recirculation in coastal environments, and local emissions [Lelieveld et al., 2002]. While we observe a strong variability in the difference map, signaling various sources and sinks (discussed later), three distinctive features in 2020 in comparison to 2019 are evident: i) higher concentrations over the central Europe (up to 5 ppbv), ii) lower concentrations in eastern Europe (-2.67±1.65 ppbv) due to the 2019 biomass burning activities and larger snow cover fraction accelerating photolysis [e.g., Rappenglück et al., 2014], and iii) lower values in the Iberian Peninsula (-0.51±1.41 ppbv) [Ordóñez et al., 2020]."

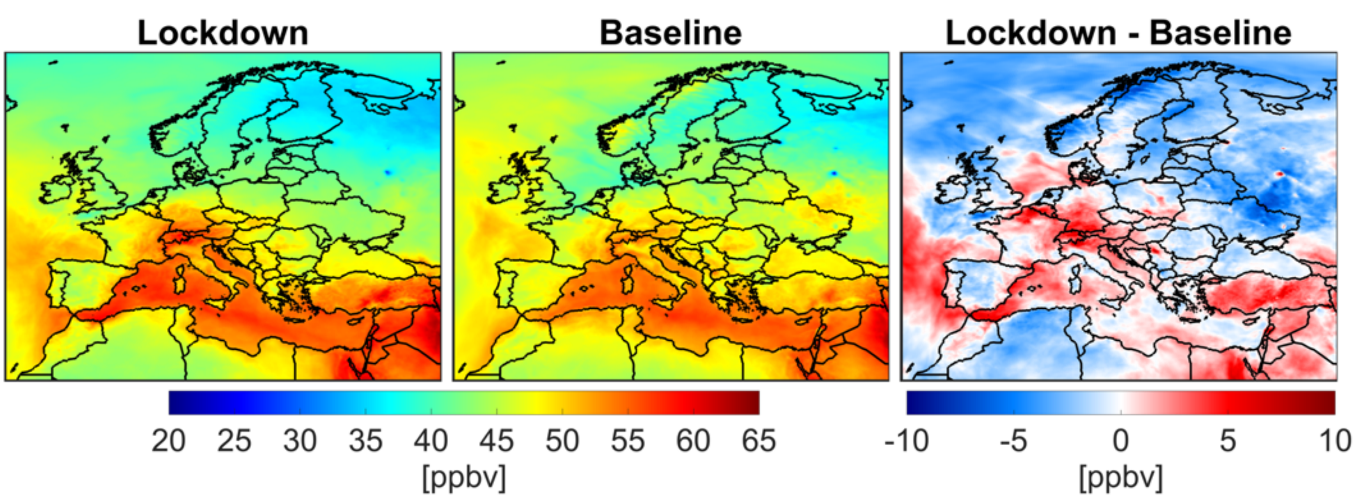

Figure 9. Simulated surface MDA8 ozone concentration using the constrained model in the month of April 2020 (lockdown), April 2019 (baseline), and their difference.

Technical Comments:

Fig. 3: "Estimate" not "Estmate"

Corrected.

Fig. 4: I think you mean Delta X = X_2020 – X_2019 – this is what you have in the text and elsewhere.

Corrected.

Fig. 5: Could zoom in on the area with data, which would make the figure more legible.

We want to be consistent throughout the paper about the location of case study.

Fig. 10: There is room to spell out Delta in the title. I think this would make it easier for the casual reader to follow, eg. Delta O3P = O3P_2020 - O3P_2019

Thanks, added.