We sincerely thank Referee#2 for the improvement suggestions. Below is a detailed answer to each comment which was raised. Changed made to the manuscript are reported in red hereafter.

Major comments:

The impacts of lockdown on aerosol chemistry were evaluated using Analog Application for Air Quality (A3Q) approach. Please give a detail discussion on the reliability and uncertainty (or limitation) of the method. I suppose that the method of comparing with reference period could be moved to the supplementary material because the focus should be on A3Q.

We added a further discussion on A3Q in the conclusion, as follows:

"The A^{3}Q method provided satisfactory results over a business-as-usual period, which ensures a robust characterization of concentration changes in the Paris region during lockdown. Yet, A^{3}Q requires a 9+ long term dataset, otherwise results can rapidly suffer from shortfall of representativeness. Also the analogy needs to be carefully inspected, notably in terms of local meteorology. Indeed, the first synoptic layer appears to be not quite enough to capture all the specificity of the sampling site."

Given the comments of Reviewer #1, we would like to keep in the main text some discussion about reference periods. But we tried to be a bit more concise.

Please elaborate how to calculate the absolute and relative changes of aerosol and gaseous species due to lockdown.

We added the equations in the main text for clarity.

The Aerosol Chemical Speciation Monitor (ACSM) were used to measure aerosol composition. Since there are two versions of ACSMs nowadays, i.e., quadruple and Time-of-Flight ACSM, the author should clarify this in the Method. A composition dependent CE or a constant CE is used in this study?

We clarified this in the text

For Sec. 2.2, the POA-constrained PMF (or ME-2) was performed on OA matrix to resolve three OA factors (i.e., HOA, BBOA, OOA) during January-May 2020. The source apportionment results during June 2011- March 2018 were obtained from previous studies. It

is unclear whether similar PMF method and OA components were used between the two periods. Please specify it.

Indeed, the harmonization of PMF analysis between both studies was not described. Both used the a-value approach (Canonaco et al., 2015), with 2 constrained factors, HOA and BBOA. Same Reference spectra were used, and the used a-values were in the same order of magnitude. As a result, the ouput profiles are very consistent, with slope and regression coefficients higher than 0.9 (see below). We added these pieces of information in the text accordingly :

"Results obtained here enrich the existing timeseries (Zhang et al., 2019) from June 2011 to March 2018.(where MO-OOA and LO-OOA were summed as OOA). Both PMF outputs were obtained with the same reference profiles of HOA and BBOA (Fröhlich et al., 2015), and similar a values for HOA and BBOA were used (on average 0.26 and 0.32 for HOA and BBOA, respectively; 0.21 and 0.22 in Zhang et al., 2019). As a result, HOA and BBOA profiles are very consistent, with slope and r^2 higher than 0.9."

The elemental ratio and oxidation degree of SOA were calculated using I-A method. Which fragments or m/z were used for O:C and H/C calculation? Considering that ACSM detect species with unit mass resolution, I am afraid that the absolute values of element ratios were questionable to some extent.

For OSc_{SOA}, we used the m/z presented in Canagaratna et al. (2015), i.e. m/z 29, 43 and 44. Given the unit mass resolution of the ACSM, the calculation has higher uncertainty, and the absolute values are indeed questionable. That is why we don't discuss absolute values, but only variations of values, as currently stated in the manuscript. We made it clearer in the text:

"From there, $O:C_{SOA}$, $H:C_{SOA}$ and OSc_{SOA} were calculated from the Improved Aiken (Aiken et al., 2008) equations provided in Canagaratna et al. (2014), using m/z 29, 43 and 44. Given the unit mass resolution of the instrument, it is important to underline that these equations provide only qualitative information for ACSM data. Absolute values, most probably associated with significant uncertainties will therefore not be discussed here. Nevertheless, it is sufficient to characterize a change, since they are uniformly applied throughout the dataset."

Figure 3, the scatter plots of simulated versus observed species contain two markers, i.e., small dots and six solid dots. Please explain it in the figure caption.

We clarified the caption

Compared to the secondary inorganic aerosol, both POA factors and OOA showed much lower R during the evaluation period (Table 4). Did this mean that the organics might not be well reproduced by this model? If this, the quantification of OA changes during 2020 lockdown might also be affected.

For the evaluation period, HOA and OOA have a R value of 0.65 and 0.63, respectively. It is indeed lower than the value of 0.90 found for NO_x, but in the same order of magnitude for OM (0.69), NO_3 (0.71) or SO_4 (0.70). BBOA has however a lower correlation coefficient (0.45).

The lower performances of OA factors may be related to the absence of 2019 data. Then, fewer analog days may lead to higher dispersion and uncertainty. However, they are associated with satisfactory Mean Bias, Normalized MB and FAC2 values. Moreover, HOA and BBOA are consistent with other tracers (eg BCff and BCwb respectively).

That is why we believe that the quantification of OA changes during 2020 lockdown is robust.

We added some lines on BBOA in the text as follows:

"The lower performance of BBOA in terms of co-variations may be related to the absence of 2019 data, where fewer analog days could lead to higher dispersion, but also to the fickleness of the wood-burning source. Still, as presented in the Results section, BBOA variations are consistent with BC_{wb}."

The time periods used for calculation and discussion were a bit confused. In line 205-210, the author said that "the study period covers 92 days from March 1st –May 31st 2020". However, January-February 2020 was chosen for model performance evaluation. Why only January-February 2020 was used? Which period was referred to as "lockdown" through the study? Please declare it in the Method.

Indeed, that sentence in line 205-210 was confusing. We removed it.

The lockdown period (LP2020) is already defined in the introduction. The Reviewer questions our 2-month evaluation period, being too short, but it is not clear why it would be so. In Grange et al. (2020), the evaluation period was 15 days (February 14th to March 1st). Petetin et al. (2020) used the 2.5 monthes before lockdown to evaluate their approach. This is reminded in the text as follows:

"Furthermore, the performance of the analog methodology has been evaluated on a business-as-usual period, from January 1st, 2020 to March 1st, 2020, similarly to the work of Petetin et al. (2020) and Grange et al. (2020)"

It is not clear which evaluation period would be sufficient for the Reviewer.

In line 390-400, is there other evidence that NO3 formed from long-range transportation?

SO_4 concentrations in Paris region have already been proven to be mainly related to long range transport (eg Favez et al., 2021). The cluster analysis presented in Figure S3b also supports this finding. We emphasized this in the text:

"On specific days, positive peaks of ΔNO_3 are concomitant to higher SO_4 concentrations (Fig. 9). Since SO_4 has been previously found to be mainly advected in Northern France (eg Favez et al., 2021), also supported by the cluster analysis in Fig. S3b, this means that nitrate was in these cases mainly advected from long-range transport, despite a decrease of NO_x."

The total changes of NO3 can be quantitatively apportioned into regional decrease and advected contribution? Please elaborate the estimation method.

Yes, this is part of the assumption. We detailed a bit more the estimation as follows:

Given the NO_x/NO_3 relationship (Fig. 8a), and hypothesizing that a decrease of locally-formed NO_3 is always associated to a decrease of NO_x concentration at the measurement site, long-range transported NO_3 can be assumed to overcompensate the regional decrease (eq. 4).

$$\Delta NO_3^{total} = \Delta NO_3^{advected} + \Delta NO_3^{local} \quad \text{equation 4}$$

Where ΔNO_3^{total} is the daily concentration change at t_i, calculated from A^3Q. ΔNO_3^{local} is calculated from the relationship with ΔNO_x (Figure 8).

For instance, on March 28th and April 19th, the total ΔNO_3 respectively of 11.7 and 6.7 $\mu g/m^3$ could be apportioned into a regional decrease of -5.5 and -3.7 $\mu g/m^3$, with an advected contribution of 17.2 and 10.4 $\mu g/m^3$, respectively. This result would need to be further investigated and confirmed from eg Chemistry Transport Model simulations, but still underlines the deleterious impact of long-range transport.

Minor comments:

Please define BCff and BCwb when first mentioned.

Now defined when first mentioned.

The table caption should be placed on the top to table instead of the bottom.

We changed this in the text.

Although this is not a final publication version of ACP, the author should carefully check the output styles of the references as ACP recommended. For example, complete and abbreviated journal names

The bibliography has been re-build using harmonized information.

The abstract could be more simplified, particularly for the descriptions before A3Q method.

The beginning of the abstract now reads as follows:

"Since early 2020, the COVID-19 pandemic has led to lockdowns at national scales. These lockdowns resulted in large cuts of atmospheric pollutant emissions, notably related to the vehicular traffic source, especially during Spring 2020. As a result, air quality changed in manners that are still currently under investigation. The robust quantitative assessment of the impact of lockdown measures on ambient concentrations is however hindered by weather variability. In order to circumvent this difficulty, an innovative methodology has been developed. The Analog Application for Air Quality (A3Q) method is based on the comparison of each day of lockdown to a group of analog days having similar meteorological conditions. "