

Interactive comment on “Sudden changes in nitrogen dioxide emissions over Greece due to lockdown after the outbreak of COVID-19” by Maria-Elissavet Koukouli et al.

Anonymous Referee #1

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The work of Koukouli et al., provides an insight on the matter of reduction of NO₂ during the time of severe COVID-19 related measures at Greece, which is the most discussed topic among scientists this year. Data from TROPOMI and in situ measurements are used to compare the concentrations in March and April of 2019 and 2020. Also, a CTM is used to investigate the differences driven by meteorology during these periods. The subject is very important, and authors have used state of the art data to investigate it. However, I think that are some major improvements needed to be applied before publishing in ACP.

My major concern is the fact that only 2019 data are used to define the drop due to

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COVID-19 measures. Do we know that March and April 2019 are representative for the area? Can we eliminate the possibility of extreme high values during this period? TROPOMI NO₂ is not available from earlier periods, but there are retrievals from other satellites. The spatial resolution is poorer and some works have already pinpointed that there are hotspots that were ignored due to larger pixel size. Also, we should know what is the usual variability of NO₂ in the area. Are these drops something usual or it is something extremely rare? Hence, some work should be done in order to properly compare the absolute levels and provide to some reference values before defining the drop during the lockdown. Also, the same should be done with in-situ data (where available).

The other major concern is the meteorological variations and how they are used in the model. The CMT model is not described in detail. Reading paragraph 2.2 multiple times, it is not clear what are the inputs of the model, hence, it is impossible to interpret the results. Also, since the comparisons in the literature are show low correlation coefficient for this model, I think some comparison (for a non-lockdown period) should be presented. Figure 1 is not appropriate for understanding the credibility of the output. Additionally, any information on the variation of key parameters (mainly Boundary Layer, wind speed and Solar Irradiance) during the period would be very useful for understanding the conditions. What was the parameter that driven the theoretical increase in Patra (figure 5 upper plot). Keep in mind that the stricter lockdown period was April 2020, where the drops are lower (even increase is observed at Volos). Thus, the discussion about the meteorological conditions how they affected the NO₂ columnar retrievals should be deeper. There are number of findings that cannot be explained, hence question the validity of the approach. Both the approach and the results should be justified thoroughly.

Some specific comments: L58-61 I think here some details should be added about the monthly values, the seasonal cycle and the extreme values of this period. Since, these data are available, I would recommend a timeseries figure at least for Athens

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and Thessaloniki.

L102 Some literature should be provided about any possible biases among OMI and TROPOMI retrievals.

L119 It should be noted here, that a lot of industrial activities didn't stop during the lockdown or they were just slow downed. Thus, workers were moving to industrial areas and probably some behaviors could be explained by that (eg Elefsina from in situ measurements).

L.130 The way it is stated gives the impression that TROPOMI retrievals of NO₂ commence at August 2019. Please restate to be clear.

L143 ROCRV please explain the abbreviation

L145 This behavior should be considered more. Since during the drop of this period, NO₂ values became very similar to background ones, some noise could be added.

2.2 Is there any estimation on the diurnal cycle of NO₂ in the area? Is the overpass time of TROPOMI representative? This should also be discussed when selecting the output step of the CTM. Also, please provide details on the input of CTM as asked in general comments.

L208 State what this meteorology includes.

L211 This expectations should be justified properly.

L215 Are there any data or statistics of the clear days during 2020? Also, provide some some information of the actual number of days used (with qa>0.75) for monthly averages. How does cloudy days affect the photochemistry of NO₂?

L241 The fact that during the harsher lockdown, NO₂ decrease was not as high as in March (when 1/3 of the month was almost with normal activities) should be discussed. Could be a sampling issue?

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Figure 2 It seems that another NO₂ hotspot is located at western Macedonia, possibly in the coal mining and thermal factories area. Probably it would be interesting to focus also on that (probably compared with the statistics of energy demand provided in 1.2)

Table 2 I recommend to provide also the number of days used for each monthly average retrieval.

L 280-291 I suggest to focus more on these in-situ data. Plots from the supplement could be useful here. Also, it would be useful to calculate also the monthly mean with the days with TROPOMI retrievals in each case and compare directly the differences.

Figure 5 lower plot. These is the main conclusion of the work. Still, if the meteorology variations was properly subtracted, the results for Patra and Herakleion are unexplainable. Further investigation is needed on these cases. Any possibility of an artifact should be eliminated before considering as a valid conclusion. Again, sampling from satellite and meteorological inputs are the main sources of concern for these results.

L311 This is also a crucial finding about the naval activities. I would consider moving the figure to main manuscript instead of the supplement.

Figure 6. How these weeks were selected? Sampling reasons? Please explain explicit. Also, I suggest to use the in-situ data in order to validate the areas that have the larger differences.

Figure 6 Lower plot. Also, the last week have a high increase when subtracting meteorology. Although the end of the lockdown was announced, this is very strange. It could be explained with low values in 2019 (when this was orthodox easter week), but I think some investigation needed also for that.

Please also note the supplement to this comment:

<https://acp.copernicus.org/preprints/acp-2020-600/acp-2020-600-RC1-supplement.pdf>

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