

ACP Review

The Effects of the COVID-19 Lockdowns on the Composition of the Troposphere as Seen by IAGOS

Clark *et al*

MS No.: acp-2021-479

Summary

The authors use ozone, CO and meteorological measurements from the IAGOS dataset for Frankfurt airport to study the impact of COVID lockdowns on air quality. They compare measurements during spring 2020 (European COVID lockdown) to the previous 27 years of data (20 years for CO). They find surface level increases of ozone during the lockdown period driven by increases in nighttime ozone. The anomaly in ozone turns to a slight negative at higher altitudes.

The authors also find a reduction on CO at the surface and little to no reduction at higher altitudes which they attribute to incoming emissions from outside Europe. This hypothesis is strengthened by IASI CO retrievals of the same period.

General Comments

This is a decent study that fits well with other COVID air quality related publications. It is useful to have the view of the free troposphere as most publications focus on surface level impacts. The authors give a good overview of the current literature and highlight what extra information this study can give. I feel the following comments need to be addressed before publication.

As the ozone data for April 2020 is missing, is a comparison to the MAM climatology valid? Do you remove April from the previous years to take the climatology and if not, does it have an impact on the result?

I find the difference in time series and calculated climatology between ozone and CO leads to an incoherent picture. I would recommend using the same baseline years for both ozone and CO.

A measure of statistical significance is needed on the presented results. Without this, the arguments for why we are seeing the anomalies aren't as strong as they could be.

I am unsure if using the standard deviation as the definition for interannual variability in this case is the best way to present the results. Would the range or a percentile (e.g. 95th) be a more suitable parameter to use? If a month is one standard deviation from the mean there is still ~30% chance it would be completely expected. Showing if the lockdown period fell outside the 95th percentile for example would really highlight if it was an unusual year.

Some of the discussion points are mixed in with the results (e.g. the discussion about previous ozone events during heatwaves). This is ok to put the results into context but it leaves the final section of the paper more like a summary rather than a conclusion. I recommend moving some of these sections into the conclusion.

Section 2.2.2 discusses the drop in CO in the free troposphere and trying to relate that to the lockdowns but as far as I can see from figure 8 they were mostly well within the expected interannual variability. This doesn't appear to be mentioned and the results are presented in a way that suggests that the changes are abnormal. Clearly stating the anomalies are within the expected range is needed here.

Specific & Technical Comments

There are a number of occasions where there are double negatives (e.g. -XX% drop). Either say XX% drop or -XX% change (or something similar).

Throughout: There are a number inconsistencies with spaces between numbers and units which need to be fixed

Line 23: The Le Quere paper only focuses on CO₂, I would either add examples of AQ papers by for the atmospheric composition statement, or rewrite this sentence.

Line 79 & 232: should be 'balloon-borne ozonesondes'

Line 80: I think this should be 'reduction in surface emissions' not 'pollution'

Figure 1 & 8: I suggest changing the y axis to hPa and mark where your free troposphere definitions begin/end. This way the reader can more easily see which bit of the profile you are discussing.

Lines 156 & 157: Specify air traffic

Lines 156 – 159: is the 50% reduction in (air) traffic related to the the introduction of restriction measures (22nd March) or were there measures in place before this date that was reducing air traffic?

Line 212 & figure 5: 00:00-09:00/19:00-23:59 is confusing, I would either replace the slash with an ampersand or say '7 pm to 9 am'

Figure 4: What do the numbers on the secondary y-axis denote?

Line 245: This should be 'inflection' not 'inflexion'

Line 262: I would say 'As with ozone...' not 'As for ozone...'

Line 291: airports *than* might be though

Line 302/303: What do you mean you're ignoring fire or anthropogenic sources of CO? That doesn't leave much. Or do you mean you are not distinguishing between them and only looking at source regions? This needs to be clearer.

Line 305: there is reference to fig 13 before saying you're talking about figure 13.