

Main comments

1) My comment regarding the title was not addressed.

a) If I understand your study correctly, the changes in atmospheric composition you observed during the lockdown were largely due to different meteorological conditions (temperature, RH, air masses etc) that led to different O₃ concentrations whereas emission reductions (i.e. the lockdown measures) were only minor. At least that is how I interpret your text at multiple places throughout the manuscript, e.g. lines 76ff: Online observations, model simulations, and satellite measurements have pointed out that the appearance of haze events during the LCD **were mainly caused** by the unfavorable meteorological conditions....

l. 84ff: In order to understand the effect of the reduced anthropogenic emissions during the **LCD and different meteorological parameters....**

l. 182: 'The **more favorable atmospheric conditions** such as the higher temperature and stronger solar radiation during the LCD...'

l. 185: A recent study using the WRF–Chem model found that about 80% of the increased O₃ level in eastern China **was mainly due to meteorological changes,...**

b) What do you mean by 'contribution of photooxidation'? Are you referring to your (wrongly inferred – see my comment on Sections 3.3 and 3.4 below) difference in aqueous vs photochemical diacid formation? Also, you only use 'photooxidation' at one other place in the whole manuscript. Be consistent in terminology.

Please modify the title and abstract such that they properly reflect the content of the article.

2) The subsections of Section 3 still have very little connection to each other. Instead of being repetitive, previously identified findings should be used and referred to in the further discussion: what did you conclude on the formation processes of C₂ in Section 3.2, how are these conclusions corroborated (or contradicted) in Section 3.3, what additional insight is gained in Sections 3.3, 3.4 and 3.5 etc

3) The structure of Section 3 and some of the headings of the subsections add to the confusion:

3.1 Overview of observations

The header suggests that this section includes only observations. However, there is already a lot of discussion and interpretation (e.g. on reasons of different O₃ levels). This adds to later repetitiveness.

3.2 Molecular distributions of diacids and related species

The header should clarify that the discussion that follows relates to both periods i.e. before and during lockdown. In addition, the header does not fully describe the content of the section: You discuss potential formation pathways. In addition, you compare to previous studies – which is great; however, the header does not reflect the fact that you discuss data and place them in the context of previous studies.

3.3 Aqueous formation of SOA before the LCD

3.4 Enhanced photochemical formation of SOA during the LCD

Why suddenly switching from 'dicarboxylic acids' to SOA? The acids only constitute a small fraction of SOA? Also, distinguishing between 'aqueous formation' and 'photochemical formation' implies that the former is not photochemical. This is not correct.

3.5 Stable carbon isotopic compositions of diacids

In the heading you refer to diacids; however, in Table 3, there are also oxoacids.

4) Summary and conclusions

This last section is merely a summary of your results. However, conclusions are not given, e.g. How do your results compare with previous studies? What do your results mean for our understanding of the state and/or behaviour of the atmosphere?

Minor comments

I. 23: isn't 'clearer sky conditions' and 'haze events' a contradiction?

I. 218: the new sentence: 'Different secondary formation rates...' is very vague. 1) The list of parameters includes basically all potential reasons why formation pathways may change in a qualitative sense. 2) In light of the previous discussion (see my comment 1 above), a more quantitative statement should be given.

Are the reasons for the differences the emission reductions? If yes, then the lockdown measures are the reason for the differences.

If all changes are due to differences in meteorological conditions (RH, photochemical activity), then the fact that emissions were reduced during the lockdown are not the main reason for the observed differences. – In this case, the title of the study is misleading.

I. 179: The preceding lines say that high O₃ concentrations are caused by high NO_x concentrations. The sentence starting with 'Thus, ...' states the opposite. Be clear what you want to say here. I am not saying it is wrong but it is confusing.

I. 214: add 'more' (while these species are MORE stable in the absence of Fe) – all acids can be further oxidized by OH and by other oxidants

I. 250: '...because the hydroxylation of C₄ can be photodegraded into C₃ through the decarboxylation process' – Hydroxylation is the addition of an OH group to a molecule. I do not think that this is the mechanism here. Do you mean simply 'the photochemical degradation of C₄ leading to C₃...?'

I. 276: what does 'relative abundance' refer to here? total organic aerosol mass?

I. 280: 'heterogenous processes' usually refer to processes on interfaces. However, the oxidation of oxoacids into diacids can also occur in the aqueous bulk phase (e.g. several studies by B. Turpin's group, Carlton et al etc). – You correctly call it 'aqueous oxidation' in I. 284

I. 334: There is a lot of literature on discussions that Henry's law constants – that are usually defined for pure water – are not directly applicable for aerosol water (e.g., <https://doi.org/10.1021/es400083d>, <https://doi.org/10.1021/acs.est.5b02782> and references therein) .

I. 337 – 339: This needs more discussion: On the one hand you say that Gly and LWC correlate, i.e. LWC is proportional to Gly. In the next sentence you say that C₂/Gly is proportional to LWC, which would imply that LWC is proportional to 1/Gly – unless the increase in C₂ is significantly higher than that of Gly. Can this be shown based on the observations?

I. 339 – 341: I do not understand this sentence ('Such strong correlations...'. Please clarify.

I. 356ff: The sentence starting 'There, we conclude...' seems out of place because a lot of discussion actually comes after it.

Also the discussion should include the aspect that oxalic acid is not only formed more slowly at low pH but it is also oxidized more slowly at low pH.

I. 365: Why is this section entitled 'Enhanced photochemical formation of SOA during the LCD'? You only talk about dicarboxylic acids – which are, of course, a fraction of SOA but if you were to replace 'SOA' by 'dicarboxylic acid' here, it is basically the title of your paper. What is the purpose of this section, and what additional information does it provide as compared to the preceding ones? It seems very repetitive, and in parts even contradicting.

I. 376: The next on OH levels is very confusing. Here you say that differences in OH levels are mainly due to differences in NO₂. ... Whereas higher above, you said that differences in O₃ levels are largely due to meteorological conditions. It is well known that O₃ and OH are closely related in the atmosphere. What is the main message you can and want to give?

Are the meteorological conditions more /equally/less important than the emission reductions as you point out at several places throughout the manuscript (see 'Major comment') or is the difference in chemical composition of the atmosphere (e.g. reduced NO_x etc) the main reason for enhanced dicarboxylic acid concentrations?

I. 392: In your response to my previous round of reviews, you stated that O₃ is just a proxy for photochemical activity. The text here implies that O₃ was directly involved in the formation. Please be consistent.

I. 397: The sentence 'the increase in the temperature can accelerate the volatilization of C₂, leading to the drop of C₂ concentration in the aerosol phase' contradicts your earlier text (I. 216): 'Therefore, the loss of diacids and related compounds may be negligible when the temperature increases'

I. 445: But this statement 'These results imply that the effect of photochemical decomposition of higher diacid homologues on C₂ before the LCD was minor' is contradicting what you say in I. 404 " indicating that C₂ may be largely derived from the photochemical degradation of higher molecular weight homologues of diacids"

I. 465: 'each period suggests that C₂ in Jinan aerosols was mainly originated from aqueous oxidation of ωC₂' – above you say that the main source were larger acids.

I. 482: 'more clear sky conditions' implies higher visibility and less haze – however, in the beginning you state that during the lockdown enhanced haze formation was observed.

I. 495: In several sections before, you discuss the correlations of O₃, Gly, wC₂ and argue that they point to efficient aqueous phase processing. Please clarify how the classification of factor 3 connects to the previous sections.

Technical comments

I. 22: remove 'the' before 'more aged organic aerosols'

I. 27 ff: Correct as follows:

'Source apportionment using the molecular characteristics of organic compounds and positive matrix factorization (PMF) suggest...'

I. 41: 'marine area' sounds odd. Either 'marine regions' or 'marine air'

I. 48: Cloud observations are also field measurements. Better: 'field measurements in- and outside clouds...'

I. 54: replace 'proved' by 'proven'

I. 56: 'aqueous' misspelled

I. 66: replace 'photodegraded under the O₃ chemical pathway' by 'oxidized by O₃'

I. 170: Define PSCF

I. 173: either 'were reduced by' or 'decreased by'

I. 176: 'O₃ is produced...': This sentence repeats nearly verbatim the information just a couple of lines above. If there is no additional information, remove one of the sentences

I. 208: Arrhenius is misspelled

I. 315: You refer here to Section 3.3. but it is in Section 3.3.

I. 328: 'slope' misspelled

I. 348: Remove 'formation'

I. 382: 'Because OH· radical was unavailable in this work...' You mean 'Because measurements of the OH· radical were unavailable in this work...'

I. 385: 'significant escalation' is not the right term here.

I. 433: 'heaviest' does not seem the right word here. DO you mean 'highest'?