

## ***Interactive comment on “Ozone seasonal evolution and photochemical production regime in polluted troposphere in eastern China derived from high resolution FTS observations” by Youwen Sun et al.***

**Anonymous Referee #1**

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General comments :

The authors have used a new FTIR dataset to infer tropospheric ozone seasonal evolution and photochemical production regime at Hefei in China. Comparisons of the new dataset with OMI observations, and the GEOS-Chem and WRF-chem model data have shown good agreements. Back trajectories analyses have been used to attribute the contribution regions, and seasonal variabilities, to the high ozone levels observed at Hefei. The chemical sensitivity to ozone production has been studied at Hefei by using proxies such as CO and HCOH.

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Although the authors use a new dataset, the novelty of some results is hard to admit. For instance, it is presented the fact that tropospheric ozone column is higher in spring/summer as a key result, which is a known scientific idea (same for better agreements comparing smoothed profiles relative to unsmoothed profiles). A reorganization of the paper's structure is needed, with less focus on the know results and more thinking about what is the paper contribution to scientific progress. In addition, the goal of the comparisons of the new dataset with independent data (atmospheric models and satellite observations) is unclear, as well as the use of two different model (global and regional). The objectives of the paper should be clarified and listed in a concise way. The number of figures should be reduced to fit the main scientific results. Discussions about results, such as model and observations comparisons, are missing and would improve the scientific impact of the paper.

The thorough section describing the retrievals is well written and I would advise the authors to submit this paper to a more technical journal, such as Atmospheric Measurement Technique, if not addressing these comments.

Specific comments:

Concerning the structure of the paper, it needs to be reorganized with a shorter abstract focusing a key results, more detailed introduction about the proxies used to assess the chemical sensitivity to ozone production, more sub-sections and tables summarizing the results of the comparisons, less figures, and appropriate English language. Consistency is also needed across the paper: define acronyms once (NDACC has never been defined in the abstract but appears in the keyword section, same for HCOH and VOC in the abstract, ...) and use them along the manuscript (ozone or O<sub>3</sub> ?). Change old references with newest and avoid Wikipedia as a reference.

In the introduction section, more explanations about why using proxies such as CO and HCOH would help the reader understanding how to assess the chemical sensitivity to ozone production. In the retrieval strategy section, you mention a meteorological

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station onsite. Do you correct the NCEP profiles with these data? If yes, it should be clarified.

Define the use of the coincidence criteria when comparing to OMI (Why 3 hours and 0.7°?) and other independent data.

In section 5.1, it is mentioned a trend analysis on a 4-years timeseries. The word “trend” needs to be changed.

Are back trajectories used to investigate the regions of influence of high tropospheric ozone at Hefei? If yes, it needs to be clarified and better structured in a sub-section. The end of section 5.1 needs to be better structured to emphasis on the scientific conclusions.

Concerning the comparisons with models, you may want to clarify their use; it is unclear if it is to assess the new dataset quality or investigate the model performances to reproduce observations. Explain the scientific interest of comparing the FTIR dataset with a global and a regional model.

Discussions about results concerning comparisons between model/satellite and FTIR observations are missing and would raise the scientific level of the paper. Why is there a shift in the seasonal maximum in GEOS-Chem? Why do OMI and the FTS exhibit different seasonality? For WRF-Chem it is mentioned that the difference could be attributed to uncertainties in the input files, but what about the meteorological data, and/or the chemistry? This has to be further analyzed and explained.

Technical corrections :

- line 20 and 22 : define acronym CO, HCOH, and NO<sub>2</sub>
- line 26 : by “the” FTS
- line 27 : “occur” with no s
- line 32 and 33 : choose the precision, one or two decimal?

C3

- line 34 : by “atmospheric models” GEOS-Chem and WRF-Chem
- line 41-43 : rephrase the sentence
- line 45-50 : state that HCOH is a VOC and define VOC
- key words : NDACC never defined in the abstract
- line 55 : add a reference
- line 56 : add a reference
- line 53-71 : references are old
- line 75-77 : why so many references? Are they all relevant? You may use the most relevant one
- line 78-79 : define all chemical species
- line 84 : state the accuracy or use a reference
- line 87 : avoid Wikipedia as a scientific reference
- line 88 : first time ozone is written O<sub>3</sub>. Be consistent across the manuscript
- line 91 : “PM<sub>2.5</sub>”
- line 93 : “the” FTS
- line 96 : “Most NDACC sites”
- line 99 : Is the Hefei site a NDACC site? It is not clear here
- line 103 : add a reference for OMI
- line 105 : “the” site description
- line 107 : clarify the sentence “ozone related gases”
- line 114 : reference to Figure 1b

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- line 114-115 : rephrase
- line 117 : clarify why it is an important region
- line 118 : add a reference
- line 119-120 : rephrase
- line 121 : change “the same as” to “similar to”
- line 123-125 : rephrase
- line 125 : change “demonstrated” to “showed”
- line 126 : “typical observation day in August”
- line 139 : define MIR
- line 143 : “for O3 measurements”
- line 144 : are you certain filters are used to avoid detector non-linearity? What about signal to noise ratios?
- line 148 : clarify “ozone related gases”
- line 151 : how much is an adequate accuracy?
- line 152-155 : is this sentence misplaced ? If not explain why it “confirms”
- line 155 : delete “so”
- line 157 : delete “overpass”
- line 161 : add a reference to SFIT4
- line 195 : use mathematical equations
- line 230 : “Figures 4 and 5”
- line 252 : explain why two sets of models

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- line 282 : how much is 0.7° in kilometers at Hefei?
- line 307 : add the GEOS-Chem general reference
- line 320 : what is the nearest grid in kilometer?
- line 345 : add a general reference for WRF-Chem
- line 347 : “Liu et al. (2016)”
- line 348 : “20 x 20 km”
- line 382-383 : add a reference
- line 395 : delete “global”
- line 430 : “air pollution”
- line 430-432 : rephrase the sentence
- line 435 : state the percentage
- line 439 : “considering the fact”
- line 441 : “air pollution”
- line 454 : “Obvious”. Why it is obvious?
- line 465 : “not an emission pollutant” is not clear, rephrase
- line 466-467 : explain why the fact that it is complicated means that it shows regional representativeness?
- line 479 : “as a result”, explain further the link between the two sentences
- line 485 : stay at present
- line 497 : how much are a good and an adequate correlation?
- line 502 : “has taken”

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- line 505-513 : this could go to the introduction section
- line 525 : change “obtainment”
- line 554 : change “validate” since OMI, GEOS-Chem, and WRF-Chem, to my knowledge, have already been validated
- Figure 1 a : change to see star colors
- Figure 1 b : instead of showing SZA for 1 day, you may want to show the mean SZA for all the data involved in this study
- Figure 1 legend : is it relevant to point out the wetlands? Are the red hexagons SZA or azimuth angle?
- Figure 2 : cut altitude at 60 or 80 km
- Figure 3 : arrange the figure so that the text is readable and is not crossed by the lines. Figure 3 partial column averaging kernel of HCOH : explain what are the influences on retrieved column of a partial Avk of 12
- Figure 4 and 5 : cut at 60 or 80 km and combine them in one Figure
- Figure 6, 8, and 10 : insert the number of points included in the comparison and insert the standard deviation of the mean
- Figure 7 and 9 a : insert error bars
- Figure 7 b : shift text
- Figure 11 b : why showing both biased and unbiased data?
- Figure 12 b : reduce y-axis scale
- Figure 15 : maybe plot all the measurements involved instead of daily means?
- Figure 16 : reduce the size of the dots. Do you consider error bars to fit the data?

C7

- Figure 18 : all 3 panels should fit in one page. Do you account for uncertainties when fitting the data?  $R = 919$  with 8 points, are you certain it is a robust statistic?
- Table 1 : enlarge the first column to adjust the word “regularization”. O3668 with exponent and index

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