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Comment on acp-2021-786

Anonymous Referee #2

Referee comment on "Changes in anthropogenic precursor emissions drive shifts in the ozone seasonal cycle throughout the northern midlatitude troposphere" by Henry Bowman et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-786-RC2, 2021

Bowman et al. present a comprehensive analysis of changes in the ozone seasonal cycle across the northern hemisphere. The manuscript is generally well prepared and fits the scope of ACP. I suggest some revisions and adjustments to the presentation of the methods and results before consideration for publication in ACP by the Editor. Specific comments are given below:

General Comments:

Section 1: Several studies (e.g. Clifton et al., 2014; Schnell et al., 2016; Jaidan et al. 2018; Rieder et al., 2018) have reported on potential future changes in the ozone seasonal cycle due to changes in emissions/climate. Some reference to these findings should be made either in the introduction or in the conclusion section, especially given the concluding remarks in L620ff.

Section 2.1: This section is important to the manuscript as it details the statistical treatment of the data sets. I think however, it could be presented in more concise form, e.g. keep the fundamental equations and narrative in the main manuscript and move other parts to the supplement.

Section 2.4: Why do the authors limit the observational data to 2016/17? or if already shorter than available data is used do not align it to the same time frame of the historical ESM simulations?

Section 3.2: provides a comparison of the preindustrial seasonal cycle as derived from different ESMs, the authors however do not provide any insights (or hypotheses)

regarding the drivers of differences among ESMS and which estimates might be more reliable (e.g. overall amplitude differences of factor ~3, the differences in North American and European FT sites)

Section 3.3: I am not convinced that fitting Eq (5) to the comparatively short observational time series adds all that much besides maybe for the European Alpine and HP data sets.

Section 3.4: Figure 8 and the text surrounding need some clarifications/modifications. It is not entirely clear what we learn from the width of the Gaussian in panels (c) and (d).

Discussion and Conclusions:

i) I would like the authors to address the spread among models a bit more in this section. While overall the models agree on the timing of the shifts in the amplitude and phase of the seasonal cycle the authors highlight substantial variability across models and sampled locations which remains widely unaddressed.

ii) The authors hypothesize that the main driver of changes in the seasonal cycle are changes in anthropogenic precursor emissions. Testing this hypothesis for other regions, with different emission patterns, in the NH (e.g. Asia) or SH would make an interesting addition to the manuscript.

Minor Comments:
Table 1: Jungfraujoch should be specified as surface site, as far as I am aware ozone sondes are in Switzerland only launched in Payerne

Table 1: provide Trinidad Head and 200km West of Trinidad Head as last entries to separate observations from the additional model grid cell analyzed.

L104: typo Reider àRieder

L 273: typo Zugspitse à Zugspitze

L 278: I assume this refers to Parrish et al. (2014, 2020), but it is not entirely clear which "studies of western European baseline ozone concentrations" are refereed to.

Table 2: does not add to much in the main body of the manuscript, add to supplemental material

Figures: throughout: when showing model data add “simulated”

Figures: not all homogeneously labeled, compare e.g. order Fig. 6 and Fig. 8

Fig. 2: legend should show “red” not “yellow” color.

Figs. 5 and 6: I suggest moving the legends indicating model color coding outside the plotting frame for readability, do so also in the supplement

Figure 8: align sub panels, panels (f) and (e) are shifted compared to (a)-(d).

Figure 9: maybe color code model results based on colors chosen in Figs. 4,5,6

References:

Clifton et al., 2014 https://doi.org/10.1002/2014gl061378

Jaidan et al., 2018 https://doi.org/10.5194/acp-18-9351-2018

Rieder et al., 2018 https://doi.org/10.1016/j.atmosenv.2018.07.042

Schnell et al., 2016 https://doi.org/10.1002/2016GL068060