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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "On the impact of future climate change on tropopause folds and tropospheric ozone" *by* Dimitris Akritidis et al.

Anonymous Referee #3

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General comments

This is an interesting and well-presented paper. My main concern is that like many of the past papers that discuss the influence of climate change (either past or future) on tropospheric ozone, it is difficult to separate out the individual effects of different processes. You appear to be assuming that all (or the vast majority) of your signal is just the combination of changes in STT, together with changes of anthropogenic emissions under RCP6.0. But what about changes in water vapour, and natural emissions from lightning NOx and BVOCs (etc.)? Most of these are barely discussed in the paper, but I think they must be simultaneously changing, and having potentially large effects. Some authors have attempted to separate out some of these processes in the past (e.g., Wild, 2007; Doherty et al.,2013), but this is not easy. This wider context needs to

be discussed to place some perspective on where changes in the STT rank compared to other climate change effects on ozone. If this can be included, and the points below, then I am happy to recommend publication in ACP.

Specific comments

P1

L4: Clarify the temporal and spatial context of the 3% increase (i.e. from (1970-99) to (2070-99); is it a global average number, or related to the model grid size?)

L8: maxima -> largest

L9: Highest background fold frequencies, or changes?

Abstract: How is the (likely) shortened lifetime of tropospheric ozone in future, due to higher levels of water vapour, and hence bigger flux through O(1D)+H2O, taken into account? Also what about changes in lightning NOx emissions (and BVOC emissions, and other climate dependent processes. . .) that may affect tropospheric O3? Introduction: This should also mention other climate-driven influences on tropospheric O3 – ie water vapour, lightning NOx, biogenic VOC emissions, etc.

P4

L1: Presumably the stratospheric ozone tracer ignores rapid cycling processes involving O3, ie.: O3 + NO -> NO2 + O2 NO2 + hv -> NO + O O2 + O -> O3 Which form a null cycle. But presumably it does include Ox (O3+NO2) loss processes that interact with this cycle, such as O(1D)+H2O and NO2 dry deposition?

P5

L7 in the Northern Hemisphere, not at the Northern Hemisphere (and several other similar instances). 'At' is appropriate for a specific site, whereas 'in' is more appropriate for a larger region. I don't think this is just my dubious grammar.

L22 Do you mean the hotspots in the REF distribution, or the changes?

L26 delete ‘a’

L27 It is a bit confusing that Figure 3 has colours for REF winds and contours for FUT-REF changes, whilst Figure 4 has contours for REF fold frequencies and colours for changes. I suggest all the figures follow a consistent format?

P6

L12 lower tropospheric ozone?

Section 3.2 What about lightning NOx? Does it change? And BVOCs?

Section 3.3 From your experiments it is not possible to separate the effects of stratospheric O3 recovery (due to ODS declines) and enhanced STE. Is that correct?

P7

L25 and l30 positively

Section 4: Should EM be EMME?

P18, Figure 4 caption: green not black. What are the units of fold frequency? “hatched with black circles” -> “indicated by black dots”.

References

Doherty, R. M., et al. (2013), Impacts of climate change on surface ozone and intercontinental ozone pollution: A multi-model study, J. Geophys. Res. Atmos., 118, doi:10.1002/jgrd.50266

Wild, O.: Modelling the global tropospheric ozone budget: exploring the variability in current models, Atmos. Chem. Phys., 7, 2643-2660, https://doi.org/10.5194/acp-7-2643-2007, 2007.

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