

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2020-1198

Anonymous Referee #1

Referee comment on "Investigations on the anthropogenic reversal of the natural ozone gradient between northern and southern midlatitudes" by David D. Parrish et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-1198-RC2>, 2021

This manuscript by Parrish *et al.* describes the analysis of trends in tropospheric ozone at mid-latitudes in both Northern and Southern Hemispheres over the last few decades, using the outputs from community efforts such as HTAP and TOAR. The manuscript is generally well written and presented, and provides a good account of the many factors affecting observed ozone concentrations, and of the challenges associated with modelling them. I have one major reservation on how the sites discussed are assumed to be representative of mid-latitudes for both hemispheres (see Major Comments below). There are also minor points (see below) that, once addressed, would make the text clearer. I recommend publication of this manuscript only once the comments below, especially the major ones, are suitably addressed.

Major Comments

My main reservation about the conclusions drawn by the authors of a reversal in the interhemispheric tropospheric ozone gradient in the pre-industrial era is that they mainly rely on the extrapolation of the fits to two series of observation from two background sites, one per hemisphere, and on the assumption that the polynomial fit derived from European monitoring sites (Fig. 2a) is representative of ozone trends for all NH mid-latitudes.

While the authors make a compelling case for their conclusions, for instance by showing how most European monitoring sites exhibit similar (relative) trends, it is also evident that some of the data shown in Fig. 2a (notably Arkona) exhibit deviations from the overall assumed trend. Furthermore, comparison with a non-European site (US Pacific MBL) shows potentially different temporal trends from its European counterparts (Fig 3). As the increase in tropospheric ozone in the NH is driven primarily by enhanced emissions of ozone precursors and nitrogen oxides (as the authors rightly point out), how do the authors justify assuming that these increases followed the same trend in Europe, North America and mid-latitude Asia throughout the time period considered here (1950-present)?

The authors convinced me that the sign of the ozone difference at Mace Head and Cape Grim (the two sites considered representative of their respective hemispheres) *might have been* reversed in the pre-industrial period for those two sites (or at least that their ratio might have converged to unity, as I have my reservations on the extrapolation of a 4th degree polynomial), however I'm not convinced that this can be extrapolated to all mid-latitudes based on these two sites alone. The authors point out that extrapolation to pre-1988 times (*i.e.*, before the Mace Head record started) is apparently confirmed by measurements (Fig. 3), but as the authors point out, 3 out of 4 are from NH sites of questionable reliability, and the remaining site exhibited large variations in Fig 2 (Arkona). Why not show more points from the Arkona time series in Fig. 3? And perhaps the polynomial fit to the Arkona time series? As for the SH, why was the Cape Point dataset not considered? It would be useful to include the Cape Point data series in Fig 3 as a term of comparison with the Cape Grim data, mirroring what the authors did for the NH data with Mace Head and the US Pacific MBL data.

I appreciate how some of the points raised here may be difficult to address due to the paucity of pre-1980 data, as the authors point out. However the paper would still make a valuable addition to the current literature on tropospheric ozone if the language in the discussion/conclusions section was adjusted to account for the sources of uncertainty in their analysis, as outlined below.

Line 20 (abstract): replace "likely" with "potentially"

Line 221: replace "were" with "may have been"

Line 226: replace "must necessarily have been" with "might have been"

Minor Comments

line 22: replace "natural" with "*pre-industrial*"

line 34: add "However, *tropospheric ozone*..."

line 47 (and again 53): I don't think "inconsistency" is the correct word in the context given. "*aspect*" would sound better in the paragraph in its current form. I'm assuming the authors think the findings of recent analyses (described in lines 47-55) are inconsistent with the NH always being thought of as the hemisphere with higher levels of pollutants? I would suggest either replacing "inconsistency" or revising the paragraph.

Line 51 – add “higher in the NH *than in the SH*”

Lines 145-150: Need to stress how this is strictly only valid across the temporal range for which measurements are available

Line 221: change to “Discussion *and Conclusions*”

Lines 222-226: You need to add the rate of increase in the SH for this sentence to make sense.

Figures 3 and 4: Can you crop the y axis as starting from 10 ppb?