Comments by Owen R. Cooper (TOAR Scientific Coordinator of the Community Special Issue) on:

Quantifying the tropospheric ozone radiative effect and its temporal evolution in the satellite-era

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This review is by Owen Cooper, TOAR Scientific Coordinator of the TOAR-II Community Special Issue. I, or a member of the TOAR-II Steering Committee, will post comments on all papers submitted to the TOAR-II Community Special Issue, which is an inter-journal special issue accommodating submissions to six Copernicus journals: ACP (lead journal), AMT, GMD, ESSD, ASCMO and BG. The primary purpose of these reviews is to identify any discrepancies across the TOAR-II submissions, and to allow the author teams time to address the discrepancies. Additional comments may be included with the reviews. While O. Cooper and members of the TOAR Steering Committee may post open comments on papers submitted to the TOAR-II Community Special Issue, they are not involved with the decision to accept or reject a paper for publication, which is entirely handled by the journal's editorial team.

General Comments:

TOAR-II has produced two guidance documents to help authors develop their manuscripts so that results can be consistently compared across the wide range of studies that will be written for the TOAR-II Community Special Issue. Both guidance documents can be found on the TOAR-II webpage: https://igacproject.org/activities/TOAR/TOAR-II

The TOAR-II Community Special Issue Guidelines: In the spirit of collaboration and to allow TOAR-II findings to be directly comparable across publications, the TOAR-II Steering Committee has issued this set of guidelines regarding style, units, plotting scales, regional and tropospheric column comparisons, tropopause definitions and best statistical practices.

The TOAR-II Recommendations for Statistical Analyses: The aim of this guidance note is to provide recommendations on best statistical practices and to ensure consistent communication of statistical analysis and associated uncertainty across TOAR publications. The scope includes approaches for reporting trends, a discussion of strengths and weaknesses of commonly used techniques, and calibrated language for the communication of uncertainty. Table 3 of the TOAR-II statistical guidelines provides calibrated language for describing trends and uncertainty, similar to the approach of IPCC, which allows trends to be discussed without having to use the problematic expression, "statistically significant".

Several of the authors on this paper have another paper under review with the TOAR-II Community Special Issue which reports the long term (1996-2017) ozone trends across the globe based on a composite satellite product (Pope et al., 2023a). The lower-mid tropospheric column (surface to 450 hPa) ozone increases reported by this analysis are quite strong and in some latitude bands greatly exceed the observed increases reported by IPCC AR6 (Gulev et al., 2021). Below I have inserted a comparison between the Pope et al. 2023a ozone trends (ppbv decade^{-1}) and the trends reported by IPCC AR6. In their reply to the referees the authors of Pope et al. (2023a) stated that they are confident in their reported positive trends and that they believe that the ozone decreases reported by IASI ozone products during the first phase of the Tropospheric Ozone Assessment Report (e.g. Gaudel et al., 2018) are not reliable. Based on studies that have appeared since the first phase of TOAR and based on the assessment by IPCC AR6, which have shown that tropospheric ozone has increased during the first part of the 21st century (Skeie et al., 2020; Szopa et al., 2021; Griffiths et al. 2021; Fiore et al., 2022; Wang et al., 2022; Liu et al., 2022), I agree that the tropospheric ozone burden has continued to increase. After the publication of Gaudel et al. (2018), Boynard et al. (2018) conducted a careful evaluation of the IASI ozone product and concluded that "The observed negative drifts of the IASI-A TROPO O3 product (8% – 16% decade^{-1}) over the 2008–2017 period might be taken into consideration when deriving trends from this product and this time period."
It's not clear if this new study has applied a bias correction to the IASI data to correct for the negative drift. If a bias correction has been applied, how does the corrected IASI record over 2008-2017 compare to the Pope et al. 2023a composite trend over the same period? If a bias correction has not been applied, then this study needs to discuss the impact of the negative drift on their analysis, and the authors also need to reconcile the IASI decreasing trend with the strong increasing trend reported by Pope et al. 2023a.

There are many instances in the paper in which ozone changes over 2008-2017 are referred to as long-term. Typically, long-term ozone changes are thought of in terms of two or more decades. To draw a distinction between this study (2008-2017) and studies that examine multi-decadal ozone trends, it would be helpful if the authors refer to their time period as decadal, rather than long-term.

Line 35
The abstract states that the tropospheric ozone radiative contribution to climate has remained stable with time, but these two processes are acting on very different time scales. Climate change is the response to radiative forcing, which can take decades to play out. While the analysis finds that ozone's radiative effect was constant over 10 years, there was no analysis to quantify the climate response to this period of stagnation, compared to a period in which ozone increased. While the authors can argue that radiative forcing did not increase, they provided no analysis of the climate response.

Line 37
I don't think it can be stated that emissions had a limited impact on TO3RE. Presumably the model shows that ozone increased due to emissions increases over the period 2008-2017. Therefore, in the absence of meteorological variability, emissions would have caused an increase of TO3RE. I think this statement needs to be rephrased to say that meteorological changes masked the expected increase in TO3RE due to emissions increases. It would also be helpful if a figure can be added to show the changes in ozone from year to year when meteorology is fixed to 2008.

The paper would benefit from a discussion of the reasons why changing meteorology reduced TO3RE. Is it due to changes in clouds, or to the redistribution of ozone in the atmosphere? For example, as TO3RE peaks in the upper troposphere in the sub-tropics, it seems reasonable that if ozone in the UT of the sub-tropics was pushed poleward, and/or downward, then a reduction of TO3RE would follow.

Minor Comments:

Lines 58-61
When reviewing the impacts of ozone on health, vegetation and climate you could also cite the key TOAR papers (Fleming and Doherty et al., 2018; Mills et al., 2018, Gaudel et al., 2018). References to IPCC should be updated to AR6, e.g. Forster et al., 2021; Gulev et al., 2021; Szopa et al., 2021.

Line 212
Bethan et al. (1996) is a fine paper, but when referencing the WMO tropopause the original WMO document should be cited.

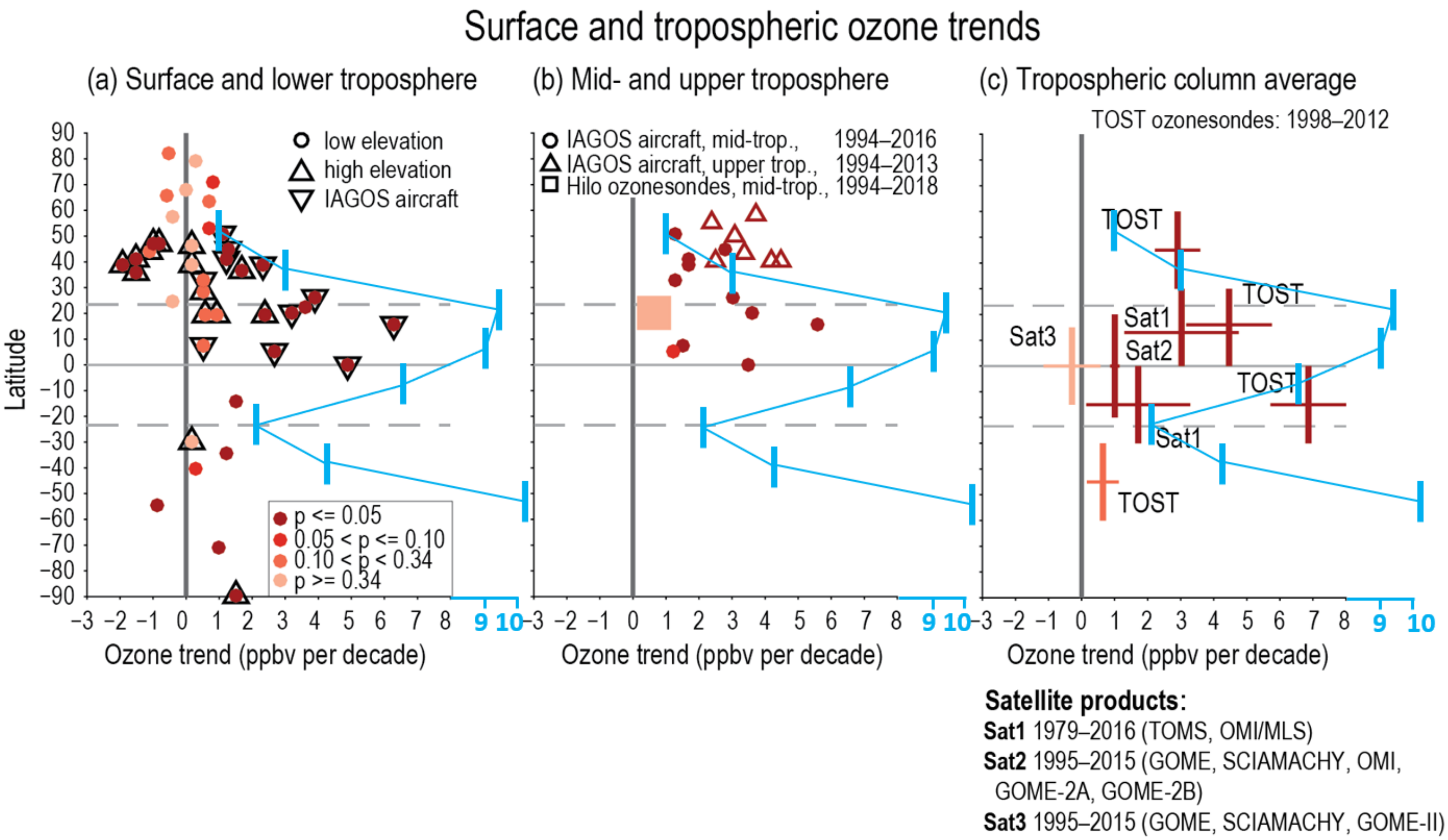

Figure 2.8 from IPCC AR6 WG-I: Surface and tropospheric ozone trends. (a) Decadal ozone trends by latitude at 28 remote surface sites and in the lower free troposphere (650 hPa, about 3.5 km) as measured by IAGOS aircraft above 11 regions. All trends are estimated for the time series up to the most recently available year, but begin in 1995 or 1994. Colours indicate significance (p-value) as denoted in the in-line key. See Figure 6.5 for a depiction of these trends globally. (b) Trends of ozone since 1994 as measured by IAGOS aircraft in 11 regions in the mid-troposphere (700–300 hPa; about 3–9 km) and upper troposphere (about 10–12 km), as measured by IAGOS aircraft and ozonesondes. (c) Trends of average tropospheric column ozone mixing ratios from the TOST composite ozonesonde product and three composite satellite products based on TOMS, OMI/MLS (Sat1), GOME, SCIAMACHY, OMI, GOME-2A, GOME-2B (Sat2), and GOME, SCIAMACHY, GOME-II (Sat3). Vertical bars indicate the latitude range of each product, while horizontal lines indicate the *very likely* uncertainty range. Further details on data sources and processing are available in the chapter data table (Table 2.SM.1). **Data in light blue added by O. R. Cooper, based on the recent findings by Pope et al., 2023a (manuscript under review). The Pope et al. (2023a) results apply to the lower-mid troposphere (surface to 450 hPa), and therefore this layer does not exactly match the layers in panels a, b and c.**

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