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

Intercomparison of long-term ground-based measurements of tropospheric and stratospheric ozone at Lauder, New Zealand (45S)

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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:

This paper presents a thorough multi-instrument comparison of total column ozone, stratospheric ozone and tropospheric ozone above Lauder, New Zealand focusing on the period 2000-2022. My comments will focus on just the tropospheric portion of the analysis. While typical measurement uncertainties are considered, the issue of low sampling frequency also needs to be addressed. As described below, low sampling frequency is a major challenge to accurate trend quantification. However, because Lauder has high quality observations from several instruments this analysis provides an excellent opportunity to calculate the tropospheric ozone trend by merging all available data. The method of calculating ozone trends and anomalies based on the merging of data from nearby stations has been done several times before (Cooper et al., 2010; Tarasick et al., 2010; Gaudel et al., 2018; Steinbrecht et al., 2021; Chang et al., 2022), but this paper could produce the first (as far as I am aware) ozone trend analysis that merges three data sets at a single location. By merging the data sets and greatly increasing the sample size the authors may succeed in reducing the uncertainty on the long-term trend, which could serve as a model for future TOAR-II trend studies.

Between 1988 and 2020 five papers appeared in the peer-reviewed literature showing that a low sampling rate of just once per week (based on ozonesondes) either failed to produce an accurate monthly/seasonal mean (Logan 1999; Saunois et al., 2012), or failed to produce an accurate trend (Prinn, 1988; Cooper et al., 2010; Chang et al., 2020). While these papers have been around for a long time, the sampling issue is often overlooked. Chang et al. (2023) have written a new paper on ozone sampling rates and they offer some suggestions for improved trend detection when faced with low sampling rates (this paper will soon appear as a submission to the TOAR-II Special Issue). The simplest solution is to boost the sampling rate, and in the case of Björklund et al. (2023) that can be achieved by merging the ozonesonde, FTIR and Umkehr records at Lauder. According to Table 1 the merged data set could have more than 10 profiles per week, although probably only for the most recent years, as earlier years had gaps, and Figure 1 seems to indicate lower sampling rates before 2012. Table 5 shows that the individual trends from ozonesondes, Umkehr and FTIR have similar magnitudes but all have relatively wide 95% confidence intervals. A merged data set may produce a trend that is more accurate and with lower uncertainty. This finding would also be relevant to the first paper published in the TOAR-II Community Special Issue. Pope et al. (2023) developed a new satellite ozone product that indicates broad ozone increases across much of the globe from 1996 to 2017. The product shows a weak ozone increase above New Zealand, while the trend based on the sparse Lauder ozonesonde record shows no trend. Would a merged ozone time series based on ozonesondes, FTIR and Umkehr reconcile this discrepancy?

Comments regarding TOAR-II guidelines:

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, and tropopause definitions.

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”.
It would be helpful for TOAR-II if the submitted paper can describe the trend detection method that was applied (e.g. linear least squares, quantile regression, multiple linear regression), report all trends with 95% confidence intervals and p-values, and avoid using the expression, “statistically significant”. Based on the highly influential paper by Wasserstein et al. (2019), TOAR first abandoned the expression “statistically significant” with the *TOAR-Observations* paper (Tarasick and Galbally et al., 2019), and we now ask the author teams to describe their confidence in a trend using the calibrated language in the statistical guidelines. In addition, to facilitate trend comparisons across TOAR-II papers, trends should also be reported in units of nmol mol^{-1} per decade (it’s fine to also report trends in units of percent per decade, as currently shown in the submitted manuscript).

Additional Comments:

References to the WMO 2018 ozone assessment should be updated with the 2022 edition.

Reference to the National Research Council 1991 report needs to be updated with a modern review of the impact of ozone on human health.

When providing a summary of global tropospheric ozone trends, the TOAR paper by Gaudel et al. (2018) has been superseded by IPCC AR6, which assessed an increase of the tropospheric ozone burden since the 1990s in both the tropics and northern mid-latitudes (Gulev et al., 2021; Szopa et al., 2021).

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