January 19, 2025

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

Inter-comparison of tropospheric ozone column datasets from combined nadir and limb satellite observations

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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.

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".

General comments:

In the introduction it would be helpful to cite some of the key papers from the first phase of TOAR as they are highly relevant to the background information on the importance of ozone for health, vegetation and climate: Fleming and Doherty et al. (2018), Mills et al. (2018), Gaudel et al. (2018).

Line 152
Regarding the impact of the COVID economic downturn on tropospheric ozone, there is now a large body of evidence that there was a widespread decrease of ozone in the free troposphere, and also at rural surface sites, of northern mid-latitudes. In addition to the papers already cited in this paper, you can also include: Miyazaki et al., 2021 (who show ozone decreases observed by the CrIS satellite instrument); Chang et al., 2022 show decreases above Europe; Putero et al. 2023, show ozone decreases at high elevation sites (a TOAR-II paper); see also Elshorbany et al., 2024 (a TOAR-II paper).

It would be helpful to compare your findings to those of other papers in the TOAR-II Community Special Issue. In particular, two papers discuss satellite-detected ozone trends: Pope et al., 2023 and Froidevaux et al., 2025.

Line 209
The authors make very good use of the HEGIFTOM database, which is a major achievement of the TOAR-II effort. However, there are two key time series in the HEGIFOTM database that were not used, and I recommend that they be included. As shown by Chang et al. (2024), recently published in the TOAR-II Community Special Issue, highly accurate quantification of free tropospheric ozone above a given location requires 15-20 profiles per month. There are only two locations in the world where ozone is profiled at such a high frequency. 1) Since 1994, the IAGOS commercial aircraft program has profiled the atmosphere above Frankfurt, Germany multiple times per day, and therefore this location has the most accurate monthly mean ozone profiles (see Figure 1, below). The data are so frequent that they can be matched to the overpass times of the satellite instruments. While the profiles only extend from the surface to 12 km, this covers the full depth of the troposphere for most of the year (winter, spring and autumn). 2) The JPL Table Mountain lidar (north of Los Angeles) has been sampling at the rate of 20 times per month since 2018. As the lidar has to operate under clear-sky conditions, it is an ideal match for UV satellite instruments. As shown in Figure 2, the lidar shows a drop in ozone in 2020, so it is an excellent time series for evaluating the impact of the COVID-19 economic downturn.

Following the TOAR-II Recommendations for Statistical Analyses, all trends need to be reported with their 95% confidence intervals and *p*-values. In the current draft, Figure 8, Figure 10 and Figure S10, Figure S12 and Figure S15 do not report *p*-values, and they need to be added.

Specific comments

Line 92
Here the period for the SCIA+OMPS product is listed as 2002-3023, but in Table 1 it is listed as 2004-2023. Why the discrepancy?

Line 109
Figure 1: It's worth pointing out that the only place where all products seem to agree well is northern mid-latitudes (40-60 N) in summer. Do you have an explanation? Why is there no comparison for the 20-40 N latitude band?

Line 120
It's not clear how the data sets were de-biased. Please explain.

Figure 4 and Figure S3
Please check the labels on the x-axis. OMI-MLS has been previously reported as showing a drop in ozone in 2020, but these figure show the drop occurred in 2021. Also, the time series in these plots seems to start in January 2006, when the OMI-MLS data go back to late 2004. Something seems to be off.

Line 251
A paper submitted to the TOAR-II Community Special Issue (Lu et al., 2024) quantifies ozone trends across East and Southeast Asia using ozonesondes and IAGOS data, and they found increases above both regions.

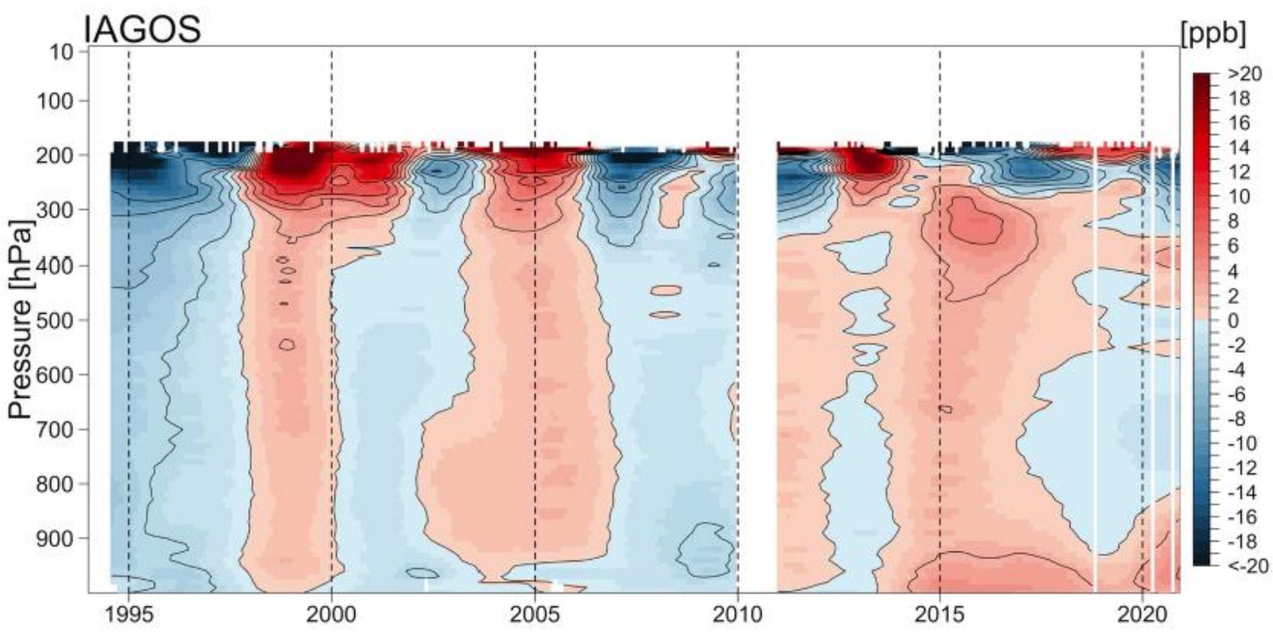

Figure 1. Ozone variability above Frankfurt, Germany, based on daily IAGOS commercial aircraft profiles, following the methods show in Figure 4 in Chang et al. (2022).

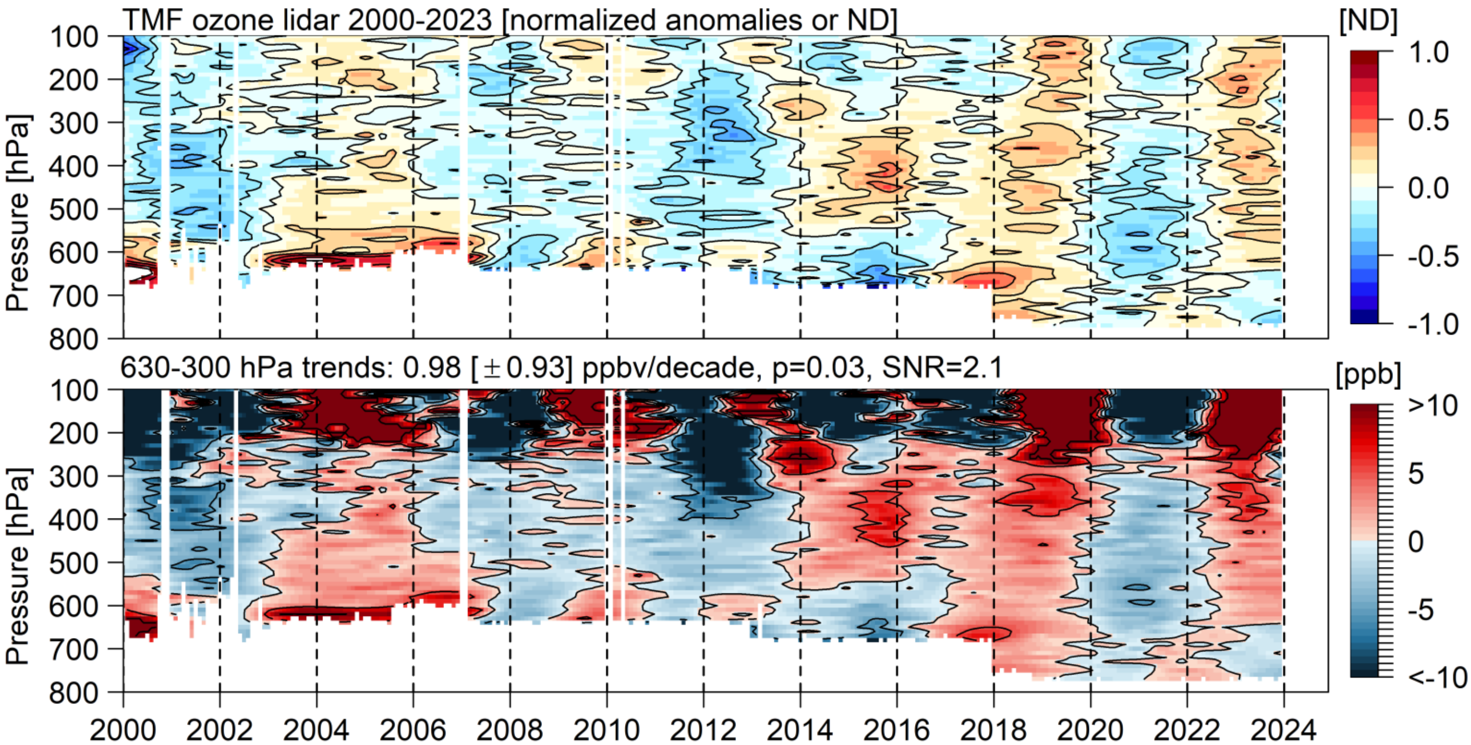

Figure 2. Ozone variability and trends based on the JPL Table Mountain lidar, following the methods show in Figure 3 in Chang et al. (2023). The mid-tropospheric 2000-2023 ozone trend is 0.98 ± 0.93 ppbv per decade (p=0.03).

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