January 29, 2025

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

Quantifying biases in TROPESS AIRS, CrIS, and joint AIRS+OMI tropospheric ozone products using ozonesondes

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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:

This paper provides a quantification of biases for three tropospheric ozone satellite products. The topic is appropriate for the TOAR-II Community Special Issue and the results are consistent with the results published so far in the Community Special Issue. However, there are a few items that should be addressed, as described below.

Please provide additional information regarding the selection of the ozonesonde stations used to evaluate the satellite products. The map of ozonesonde stations in the TOAR-Observations paper (Tarasick and Galbally et al., 2019) shows several current stations across East and Southeast Asia, but they are not shown in your Figure 2, which has no stations in Asia. These regions have been using ECC sondes since the late 1990s or early 2000s, and the Japanese stations go back several decades. In particular, the NASA SHADOZ program launches ozonesondes from Kuala Lumpur and Hanoi, and these locations show very strong ozone enhancements in the lower troposphere, with Hanoi having ozone levels similar to those above China (Gaudel et al., 2024). Another reason to focus on southeast Asia is because this is the only region on Earth where all of the satellite products from TOAR-I showed a positive ozone trend (see Figure 25 of Gaudel et al., 2018). Another important station is the JPL lidar at Table Mountain, north of the LA Basin. Since 2018 this site has been measuring tropospheric and stratospheric ozone profiles 5 times per week. As shown in the recent TOAR-II paper by Chang et al. (2024) high sampling frequency is required for accurate quantification of monthly means and long-term trends. While Table Mountain has only been measuring 5 times per week since 2018, it has been measuring 2-3 times per week since 2000, and therefore has a higher sampling frequency than most sites. Figure 1 (below) shows the long-term trend at Table Mountain (2000-2023) with a positive trend of 0.98 ± 0.93 ppbv per decade ($p=0.03$). I recommend that these stations be included in your analysis.

Additional discussion is required to fully describe the sampling frequency shown in Figure 2b. All of the ozonesonde stations listed here have a sampling rate of 4 profiles per month (or less) with the exception of Uccle, Hohenpeissenberg and Payerne, which launch 3 times per week. Despite the similar sampling rates, the number of data points per month, as reported in Figure 2b, varies greatly. Some of the high latitude sites have 10 or more data points per months, whereas I would expect a maximum of only 4 (because there are just 4 ozone profiles per month). I also don't understand how DeBilt (4 profiles per month) has 16 data points per month (CrIS), while Uccle (just down the road) launches 12 times per month and has fewer data points.

Figure 5 shows results for several latitude bands. Results in the 60S-30S latitude band seem to be based entirely on a single ozonesonde record, from Lauder, New Zealand. This is a very sparse time series with a sampling rate of only about 2 profiles per month. Given the challenges of detecting ozone trends with sparse data records (Chang et al., 2024), how can we have any confidence in the results from this particular latitude band?

Specific Comments:

Lines 17-19
Gaudel et al. (2018) is a paper that is now 7 years old and it is out of date regarding global tropospheric ozone trends. IPCC AR6 (see section 2.2.5.3 in Gulev et al., 2021) assessed the results from TOAR as well as papers published after the first phase of TOAR ended, and the consensus conclusion was that the global tropospheric ozone burden had generally increased (see section 2.2.5.3 in Gulev et al., 2021).

Table 1 needs to also include the satellite trends reported by two recent TOAR-II publications: Pope et al. (2023) and Froidevaux et al., 2025.

Line 137
The description of the ozonesonde method is not correct. The radiosonde measures pressure, temperature and relative humidity, while the actual ECC ozonesonde instrument simply measures the electrical current produced by the reaction of ozone in a potassium iodide solution. See Section 4.3 in Tarasick and Galbally et al., 2019. Also, ozonesondes typically reach altitudes above 30 km, so the lowest pressure that they reach is much lower than 80 hPa (as shown in your Figure S1). If I think back to the days when I launched ozonesondes, I believe they routinely reached pressures below 30 hPa.

Supplement, line 45
Here, do you mean to say that the sonde stopped measuring at low pressure (i.e. in the stratosphere) rather than at low altitude (i.e. the boundary layer)?

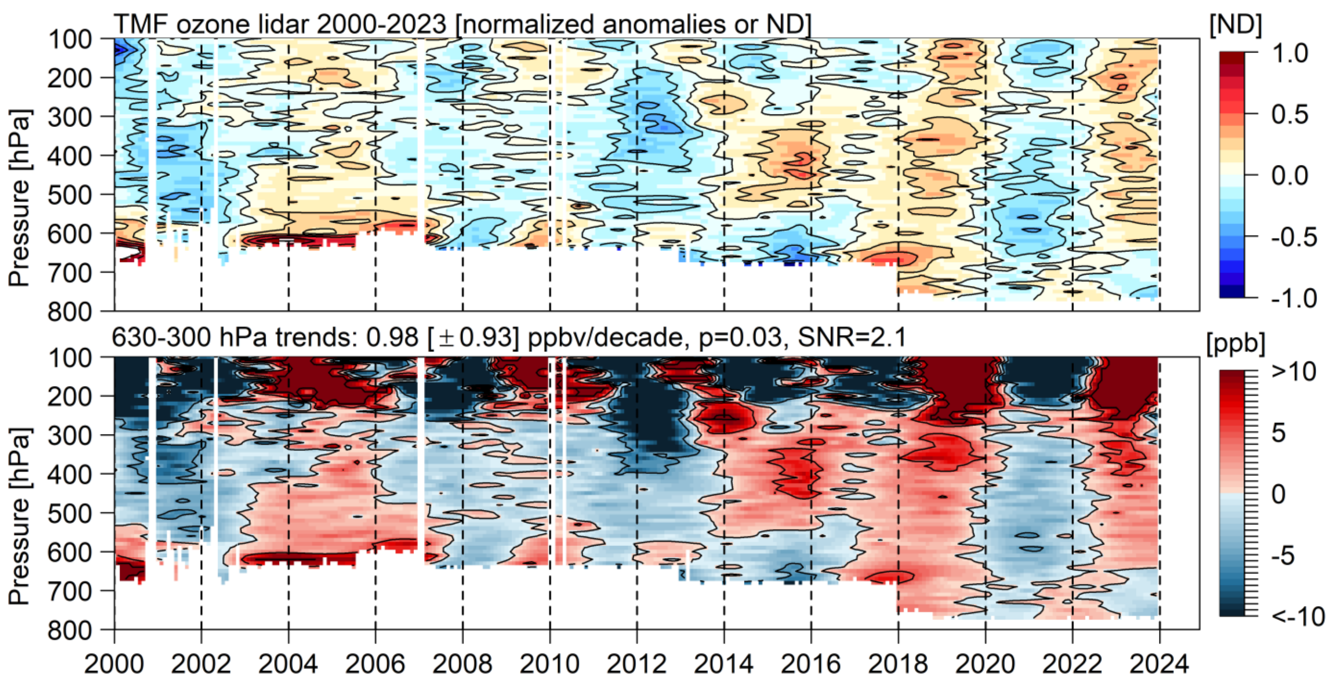

Figure 1. Ozone variability and trends based on the JPL Table Mountain lidar, following the methods show in Figure 3 in Chang et al. (2023). The mid-tropospheric 2000-2023 ozone trend is 0.98 ± 0.93 ppbv per decade (p=0.03).

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