November 4, 2024

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

Large Reductions in Satellite-Derived and Modelled European Lower Tropospheric Ozone During and After the COVID-19 Pandemic (2020–2022)

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Discussion started Sep. 20, 2024
Discussion closes Nov. 5, 2024

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:

A new paper published in the *TOAR-II Community Special Issue* is highly relevant to this study as it shows that the decrease of ozone observed in the free troposphere during 2020 also extended to the surface, as observed at high elevation monitoring sites in North America and Europe (Putero et al., 2023).

An additional relevant study: Every year the *State of the Climate* reports provide updates on the global distribution and trends of greenhouse gases, including tropospheric ozone. The most recent report (Dunn et al., 2024) reports the latest findings based on NASA's OMI/MLS tropospheric ozone product (see Figure 2.66 on page S95). The data show an increase of the tropospheric ozone burden (60° S – 60° N) from 2004 to 2019, followed by a drop in ozone in 2020 and a levelling off through 2023.

Lines 76-78
The authors cite a paper that claims that free tropospheric ozone is decreasing all across northern mid-latitudes, but no other study has been able to replicate those results. In contrast, plenty of studies have conducted in-depth analysis of ozone observations in the free troposphere, and do not find a decrease of ozone. IPCC AR6 (Gulev et al., 2021; Szopa et al., 2021) concluded that free tropospheric ozone has increased since the mid-1990s based, in part, on IAGOS observations in the free troposphere (Gaudel et al., 2020). And follow-up studies have shown that ozone increased in the free troposphere from the mid-1990s to 2019 above Europe and western North America, with a decrease of ozone in 2020 due to the COVID-19 pandemic (Chang et al., 2022, 2023). These in situ observations fit with the decrease of ozone in 2020 and 2021, as observed by several satellite products (Ziemke et al., 2022; Dunn et al., 2024). Another recent study, submitted to the TOAR-II Community Special Issue, uses the ECHAM6-HAMMOZ global atmospheric chemistry model to show that ozone generally increased across the northern hemisphere from 2004 to 2019, in agreement with the OMI/MLS satellite product (see Figure 4 of Fadnavis et al., 2024). A NASA study reached similar conclusions (Liu et al., 2022).

Minor Comments

line 50
missing the word "of"?

line 293
missing the word "ozone"

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