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

Seasonal, regional and vertical characteristics of high carbon monoxide plumes along with their associated ozone anomalies as seen by IAGOS between 2002 and 2019

Lebourgeois, T., B. Sauvage, P. Wolff, B. Josse, V. Marécal, Y. Bennouna, R. Blot, D. Boulanger, H. Clark, J-M Cousin, P. Nedelec, and V. Thouret (2024),

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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".

Major Comments:

This manuscript provides a detailed analysis of the observed carbon monoxide mixing ratios above several regions sampled by the IAGOS program, and their associated emissions source regions. I find the analysis to be scientifically sound and the conclusions are consistent with the other papers submitted so far to the TOAR-II Community Special Issue. However, to increase this papers relevance to the TOAR-II effort I would like to recommend four areas for further analysis and discussion:

1) There are some previous TOAR papers and other peer-reviewed studies that are relevant to this work and they should be cited (see papers referenced below).

2) This study touches on two important topics that have received little attention in the peer-reviewed literature, and the authors have an excellent opportunity to expand upon these topics. Specifically, these topics are the exceptionally high ozone mixing ratios in the UT above Siberia, and the high ozone levels in the lower, mid- and upper troposphere above the Middle East. Figure 5 (top left panel) of Gaudel et al. (2018) shows that the highest ozone values in the upper troposphere in June-July-August are found above Siberia. Figure 3c of Gaudel et al. (2020) shows that the ozone above the Middle East is even greater than ozone above China. These two regions have received relatively little attention in the peer-reviewed literature (an exception is Li et al., 2001). It would be helpful if these two regions can be given greater attention and highlighted in the abstract and conclusions as regions with exceptionally high ozone. Please elaborate on the potential contribution of biomass burning and anthropogenic emissions to the observed high ozone levels. The authors mention a potential contribution of the Asian summer monsoon to the high ozone levels above Siberia (i.e. the monsoon transports pollution from South and East Asia to Siberia). This is an excellent hypothesis and I think it should receive further attention.

3) Previous studies (Nowak et al., 2004, Figure 3; Cooper et al., 2002, Figure 8) have shown that scatter plots of ozone vs. CO are an effective way to highlight air pollution episodes and stratospheric intrusions (or air in the UTLS that is of stratospheric origin). These types of plots would be helpful for this study. For example, on line 277 the authors speculate that some of the high ozone values may be due to stratospheric influence. A scatter plot ozone vs CO could indicate instances of stratospheric intrusions.

4) Many of the study regions have well known trends in ozone and CO since 2000, but these trends are not addressed. The plots of average ozone and CO can therefore be misleading for certain regions. For example, during summertime, lower tropospheric ozone has decreased strongly in eastern North America since 2000, while it has increased in wintertime (see Figures 14 and 15 of Gaudel et al.; also see Chang et al., 2017). Lower tropospheric ozone has also increased in East Asia (Lu et al., 2018; Kim et al., 2023). Globally, CO has decreased since the 1990s. For example, trends of global CO levels can be found at the bottom of this webpage maintained by the NOAA Global Monitoring Laboratory: https://gml.noaa.gov/ccgg/figures/ (The figure called co_tr_global.pdf shows a decrease of CO since the year 2000). Also, extreme CO air pollution events have decreased across the USA since 2000: https://www.epa.gov/air-trends/carbon-monoxide-trends
Because ozone and CO have changed in many regions since the year 2000 it would be helpful to compare regions using data from the most recent years, when possible, rather than using 20-year averages.

Minor Comments:

The paper contains many grammatical errors that should be corrected. A co-author with excellent English skills should carefully proofread the entire text.

Line 191
In addition to increased CO emissions in winter, there is also a well-known increase in CO lifetime in winter (due to less ozone and OH), which also explains the higher wintertime concentrations (Novelli et al., 1998).

Discussion of transport processes impacting India should reference previous work on this topic, e.g. Lal et al. 2014; Lawrence and Lelieveld, 2010; Lelieveld et al., 2001.

References:

Chang, K-L, I. Petropavlovskikh, O. R. Cooper, M. G. Schultz and T. Wang (2017), Regional trend analysis of surface ozone observations from monitoring networks in eastern North America, Europe and East Asia, *Elem Sci Anth., 5:50*, DOI: http://doi.org/10.1525/elementa.243

Cooper, O. R., J. L. Moody, D. D. Parrish, M. Trainer, T. B. Ryerson, J. S. Holloway, G. Hübler, F. C. Fehsenfeld, and M. J. Evans (2002), Trace gas composition of midlatitude cyclones over the western North Atlantic Ocean: A conceptual model, *J. Geophys. Res., 107*(D7), 4056, doi:10.1029/2001JD000901.

Gaudel, A, et al. 2018. Tropospheric Ozone Assessment Report: Present-day distribution and trends of tropospheric ozone relevant to climate and global atmospheric chemistry model evaluation. Elem Sci Anth, 6: 39. DOI: https://doi.org/10.1525/elementa.291

Gaudel, A., O. R. Cooper, K.-L. Chang, I. Bourgeois, J. R. Ziemke, S. A. Strode, L. D. Oman, P. Sellitto, P. Nédélec, R. Blot, V. Thouret, C. Granier (2020), Aircraft observations since the 1990s reveal increases of tropospheric ozone at multiple locations across the Northern Hemisphere. Sci. Adv. 6, eaba8272, DOI: 10.1126/sciadv.aba8272

Kim, S.-W., Kim, K.-M., Jeong, Y., Seo, S., Park, Y., and Kim, J.: Changes in surface ozone in South Korea on diurnal to decadal timescales for the period of 2001–2021, Atmos. Chem. Phys., 23, 12867–12886, https://doi.org/10.5194/acp-23-12867-2023, 2023.

Lal, S., S. Venkataramani, N. Chandra, O. R. Cooper, J. Brioude, and M. Naja (2014), Transport effects on the vertical distribution of tropospheric ozone over western India, J. Geophys. Res. Atmos., 119, doi:10.1002/2014JD021854.

Lawrence, M. G. and Lelieveld, J.: Atmospheric pollutant outflow from southern Asia: a review, Atmos. Chem. Phys., 10, 11017–11096, https://doi.org/10.5194/acp-10-11017-2010, 2010.
Lelieveld, et al. (2001), The Indian Ocean experiment: widespread air pollution from South and Southeast Asia, Science, 291, DOI: 10.1126/science.1057103

Li, Q, et al. 2001. A tropospheric ozone maximum over the Middle East. Geophysical Research Letters 28: 3235–3238. DOI: https://doi.org/10.1029/2001GL013134

Lu, X., J. Hong, L. Zhang, O. R. Cooper, M. G. Schultz, X. Xu, T. Wang, M. Gao, Y. Zhao, Y. Zhang (2018), Severe surface ozone pollution in China: a global perspective, Environ. Sci. Technol. Lett. 5, 487-494.

Novelli, P. C., K. A. Masarie, and P. M. Lang (1998), Distributions and recent changes of carbon monoxide in the lower troposphere, J. Geophys. Res., 103(D15), 19015–19033, doi:10.1029/98JD01366.

Nowak, J. B., et al. (2004), Gas-phase chemical characteristics of Asian emission plumes observed during ITCT 2K2 over the eastern North Pacific Ocean, J. Geophys. Res., 109, D23S19, doi:10.1029/2003JD004488.