TOAR (Tropospheric Ozone Assessment Report) Steering Committee (past and present) comment on:

Opinion: Establishing a Science-into-Policy Process for Tropospheric Ozone Assessment
Richard G. Derwent, David D. Parrish and Ian C. Faloona
submitted to ACPD

The following is a joint statement from current and former members of the Tropospheric Ozone Assessment Report (TOAR) Steering Committee. The submitted manuscript proposes a science-into-policy process that would mis-interpret the findings from TOAR, and therefore we feel compelled to state our concerns regarding the scientific structure of the proposal.

- The submitted manuscript makes no mention of IPCC's well-known assessment of the co-benefits of greenhouse gas mitigation for air quality improvements, a concept that has been widely discussed by the atmospheric sciences community and by policy-makers for at least 10 years (e.g. see West et al., 2013; 391 citations according to Web of Science). As summarized by the recent Synthesis Report of IPCC AR6 (https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_LongerReport.pdf), existing and new policies to reduce greenhouse gas emissions will have the co-benefit of reducing ozone at the surface and in the free troposphere, especially due to methane mitigation (see also IPCC AR6 WG-III). This omission of IPCC findings is profound, and seriously undermines the suggested science to policy process. The authors also fail to discuss the inclusion of tropospheric ozone as a risk factor in recent Global Burden of Disease reports, which have brought tropospheric ozone into the public health community discourse (Murray et al. Lancet. 2020; 396: 1223-1249).

- The submitted manuscript calls for the development of a single ozone policy metric, "with full buy-in from the atmospheric science community". TOAR is a grassroots organization sustained by the atmospheric science community, and TOAR's great success is due to its popular and necessary use of multiple ozone metrics (for climate, health and vegetation impacts). Tropospheric ozone chemistry is extremely complicated, concentrations of ozone vary in space and on hourly timescales, and no single ozone metric can adequately gauge its impacts on diverse biological systems, or climate. The suggestion for a single ozone policy metric would not provide protection for the different receptors damaged by ozone which have very different exposure patterns, dose-response curves, and ozone damage thresholds. Rather than a new metric which would necessitate the development of a new set of exposure-response curves, ozone policy could be guided by the more consistent use of existing response curves to convert exposure or dose to easily understood impacts such as years of life lost (YLLs), years of life lived with disability (YLDs), and disability-adjusted life-years (DALYs), crop production losses (CPL) and economic cost losses (ECL).

- A foundation of this proposal is the authors' repeated claim that mid-latitude baseline ozone doubled from the 1950s to the early 2000s, but has since been steadily decreasing. This claim runs contrary to the findings of IPCC AR6 and other recent assessments of tropospheric ozone trends, including the analyses from TOAR (collectively cited over 1300 times), which do not support a steady decrease in tropospheric ozone across the mid-latitudes in recent decades (further details are provided below). This basic scientific error prevents us from having any confidence in the scientific structure of the proposed science-into-policy process.

- These authors call for the development of a simple, conceptual 'model' that would be used to understand the output of atmospheric chemistry models, guide research efforts and inform policy. They describe the attributes of the "model", which exactly match the attributes of a conceptual model that these same authors have proposed in a recent paper (Mims et al. 2022). While the authors do not cite their own work, we briefly discuss the weaknesses of the Mims et al. model below. In our expert opinion, output from modern atmospheric chemistry models can be effectively summarized for policy-makers, and there is no reasonable application for a simple, conceptual model that lacks basic atmospheric dynamics and is therefore unable to capture the temporal and spatial variability in column and ground level ozone, let alone allow for any attribution of ozone changes to driving forces. There may be important roles for simple models, but new models must be vetted among the community of scientists and demonstrate their value before they are used in a science-to-policy process.

While we agree that science must inform policy, we have no confidence in this particular proposal for a science-into-policy process, which seems to oversimplify the science and relevant metrics, while misinterpreting the science. TOAR follows the lead of other influential scientific processes like IPCC (which focuses on the science and summarizing that science for policymakers), to inform choices without prescribing policy. TOAR does so in part by including studies of impacts on health, crops, vegetation, and climate. TOAR will continue to work with IPCC, the Climate and Clean Air Coalition (CCAC, www.ccacoalition.org) and the Task Force on Hemispheric Transport of Air Pollution (TF HTAP) under the UNECE, as well as established regional organizations (for example, EMEP in Europe), to advise policy-makers to develop more effective approaches.

Signed:

TOAR-II co-chairs:

Dr. Martin G. Schultz, Jülich Supercomputing Centre, Forschungszentrum Jülich, Germany, TOAR co-chair 2014-present

Dr. Helen Worden, Atmospheric Chemistry Observations and Modeling Laboratory (ACOM), National Center for Atmospheric Research (NCAR), Boulder, CO, USA, TOAR-II co-chair 2022-present

Members of the TOAR steering committee (past and present):

Dr. Owen R. Cooper, CIRES University of Colorado Boulder/NOAA CSL, former TOAR co-Chair 2014-2022

Prof. Lisa Emberson, Environment & Geography Dept., University of York, York, U.K.

Prof. Mat Evans, Wolfson Atmospheric Chemistry Laboratories, Dept Chemistry, University of York, York, UK

Prof. Zhaozhong Feng, School of Applied Meteorology, Nanjing University of Information Science & Technology, Nanjing 210044, China

Dr. Jacek W. Kaminski, WxPrime Corporation, Toronto, Canada

Dr. Yugo Kanaya, Earth Surface System Research Center (ESS), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokohama, Kanagawa 2360001, Japan

Dr Raeesa Moolla, School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa

Dr. Manish Naja, Aryabhatta Research Institute of Observational Sciences (ARIES), Manora Peak, Nainital - 263 001, INDIA

Dr. Elena Paoletti IRET CNR via Madonna del Piano 10, 50019 Sesto Fiorentino, Italy

Dr. Gabriele Pfister, Senior Scientist, Atmospheric Chemistry Observations and Modeling Lab (ACOM), National Center for Atmospheric Research (NCAR), Boulder CO

Yinon Rudich, Department of Earth and Planetary Sciences, Weizmann Institute, Rehovot 76100, Israel

Dr. Rodrigo J. Seguel, Center for Climate and Resilience Research/Department of Geophysics, University of Chile

Dr. Baerbel Sinha, Department of Earth and Environmental Sciences, Indian Institute of Science Education and Research Mohali, India

Dr. David W. Tarasick, Environment and Climate Change Canada, 4905 Dufferin Street, Downsview, ON, M3H 5T4 Canada
Dr. Anne M. Thompson, Senior Scientist Emeritus, NASA/Goddard Space Flight Center, Greenbelt, MD 20771 USA; Senior Research Faculty, University of Maryland-Baltimore County, Baltimore MD 21228
Dr. Erika von Schneidemesser, Research Institute for Sustainability, Potsdam, Germany
Prof. J. Jason West, University of North Carolina at Chapel Hill
Prof. Lin Zhang, Department of Atmospheric and Oceanic Sciences, School of Physics, Peking University, Beijing 100871, China
----

Supporting information:

Simple conceptual 'model'

As stated above, the submitted manuscript calls for the development of a simple, conceptual 'model' that would be used to understand the output of atmospheric chemistry models, guide research efforts and inform policy. They describe the attributes of the "model", which exactly match the attributes of a conceptual model that these same authors have proposed in a recent paper (Mims et al. 2022). Even though the authors do not cite their own work, we briefly comment on this paper in order to point out the substantial shortcomings of a simple conceptual model. This particular conceptual model is similar to a simple 1970s box model that scientists had to build in the days before adequate computing power was available to run more complex models (e.g. Oeschger et al., 1975; Thompson and Schneider, 1979). It has no atmospheric dynamics and it assumes the mid-latitudes are isolated from the polar regions and the tropics; this is contrary to recent work, which shows that tropospheric ozone in the mid-latitudes is impacted by emissions and transport from the tropics, and this influence cannot be ignored (Zhang et al., 2016,2021; Gaudel et al., 2020). In contrast, modern atmospheric chemistry models can handle global and regional atmospheric dynamics, in addition to emissions and photochemistry. These models correctly reproduce the observed increase of the tropospheric ozone burden, and as shown by IPCC AR6 the output from these models can be effectively summarized to provide the answers to the questions from policy makers (see Chapters 6 and 7, and Box TS.7 in the Technical summary of AR6).

Baseline ozone trends:

As assessed by IPCC AR6 WG-I (Chapters 2 and 6), the annual State of the Climate Reports, the Tropospheric Ozone Assessment Report (Tarasick and Galbally et al., 2019), CMIP6 and the UNEP Scientific Assessment of Ozone Depletion 2022 (Chapter 3.3) the tropospheric ozone burden has continued to increase since the 1990s including at mid-latitudes; these same assessments found no convincing evidence that mid-latitude baseline ozone doubled from the 1950s to the early 2000s. These findings are corroborated by very recent studies published since the release of IPCC AR6 (Miyazaki et al., 2020; Christensen et al., 2022; Wang et al., 2022; Fiore et al., 2022; Chang et al., 2022). Contrary to the evidence, the authors of the submitted manuscript have claimed (since at least 2017) that baseline ozone has been consistently decreasing across northern mid-latitudes over the past two decades.
No independent study has been able to corroborate their claims, and these claims were not accepted by the assessment reports listed above.

References

Chang, K.-L., et al. (2022), Impact of the COVID-19 economic downturn on tropospheric ozone trends: an uncertainty weighted data synthesis for quantifying regional anomalies above western North America and Europe, *AGU Advances, 3*, e2021AV000542. https://doi.org/10.1029/2021AV000542

Christiansen, A., Mickley, L. J., Liu, J., Oman, L. D., and Hu, L.: Multidecadal increases in global tropospheric ozone derived from ozonesonde and surface site observations: can models reproduce ozone trends?, Atmos. Chem. Phys., 22, 14751–14782, https://doi.org/10.5194/acp-22-14751-2022, 2022.

Fiore, Arlene M., et al. (2022), Understanding recent tropospheric ozone trends in the context of large internal variability: A new perspective from chemistry-climate model ensembles, *Environmental Research: Climate, https://doi.org/10.1088/2752-5295/ac9cc2*

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(1):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

Mims, C.A., ***Parrish, D.D., Derwent, R.G***., Astaneh, M. and ***Faloona, I.C***., 2022. A conceptual model of northern midlatitude tropospheric ozone. *Environmental Science: Atmospheres*, *2*(6), pp.1303-1313.

Miyazaki, K., Bowman, K., Sekiya, T., Eskes, H., Boersma, F., Worden, H., Livesey, N., Payne, V.H., Sudo, K., Kanaya, Y. and Takigawa, M., 2020. Updated tropospheric chemistry reanalysis and emission estimates, TCR-2, for 2005–2018. *Earth System Science Data*, *12*(3), pp.2223-2259.

Oeschger, H., Siegenthaler, U., Schotterer, U. and Gugelmann, A., 1975. A box diffusion model to study the carbon dioxide exchange in nature. *Tellus*, *27*(2), pp.168-192.

Tarasick, D. W., I. E. Galbally, O. R. Cooper, M. G. Schultz, G. Ancellet, T. Leblanc, T. J. Wallington, J. Ziemke, X. Liu, M. Steinbacher, J. Staehelin, C. Vigouroux, J. W. Hannigan, O. García, G. Foret, P. Zanis, E. Weatherhead, I. Petropavlovskikh, H. Worden, M. Osman, J. Liu, K.-L. Chang, A. Gaudel, M. Lin, M. Granados-Muñoz, A. M. Thompson, S. J. Oltmans, J. Cuesta, G. Dufour, V. Thouret, B. Hassler, T. Trickl and J. L. Neu (2019), Tropospheric Ozone Assessment Report: Tropospheric ozone from 1877 to 2016, observed levels, trends and uncertainties. Elem Sci Anth, 7(1), DOI: http://doi.org/10.1525/elementa.376

Thompson, S.L. and Schneider, S.H., 1979. A seasonal zonal energy balance climate model with an interactive lower layer. *Journal of Geophysical Research: Oceans*, *84*(C5), pp.2401-2414.

Wang, H., Lu, X., Jacob, D. J., Cooper, O. R., Chang, K.-L., Li, K., Gao, M., Liu, Y., Sheng, B., Wu, K., Wu, T., Zhang, J., Sauvage, B., Nédélec, P., Blot, R., and Fan, S. (2022), Global tropospheric ozone trends, attributions, and radiative impacts in 1995–2017: an integrated analysis using aircraft (IAGOS) observations, ozonesonde, and multi-decadal chemical model simulations, Atmos. Chem. Phys., 22, 13753–13782, https://doi.org/10.5194/acp-22-13753-2022

West, J.J., Smith, S.J., Silva, R.A., Naik, V., Zhang, Y., Adelman, Z., Fry, M.M., Anenberg, S., Horowitz, L.W. and Lamarque, J.F., 2013. Co-benefits of mitigating global greenhouse gas emissions for future air quality and human health. *Nature climate change*, *3*(10), pp.885-889.

Zhang, Y., O. R. Cooper, A. Gaudel, A. M. Thompson, P. Nédélec, S.-Y. Ogino and J. J. West (2016), Tropospheric ozone change from 1980 to 2010 dominated by equatorward redistribution of emissions, Nature Geoscience, 9(12), p.875, doi: 10.1038/NGEO2827

Zhang, Y., West, J.J., Emmons, L.K., Flemming, J., Jonson, J.E., Lund, M.T., Sekiya, T., Sudo, K., Gaudel, A., Chang, K.L. and Nédélec, P., 2021. Contributions of world regions to the global tropospheric ozone burden change from 1980 to 2010. Geophysical Research Letters, 48(1), p.e2020GL089184.