TOAR-II Community Special Issue Guidelines

Approved by the TOAR-II Steering Committee, April 12, 2023

The *TOAR-II Community Special Issue* is an inter-journal special issue hosted by six Copernicus open-access, peer-reviewed journals (ACP [lead journal], ESSD, AMT, GMD, ASCMO and BG). The submission window is March 1, 2023 –April 30, 2024, and manuscripts may be submitted to any of the six participating journals. Submissions are expected from the TOAR-II Focus Working Groups, however participation with TOAR-II is not required; the only requirements are: 1) the submitted paper must address some aspect of tropospheric ozone and it must conform to the journal's submission guidelines; 2) the authors must inform Owen Cooper (TOAR Scientific Coordinator of the Community Special Issue; owen.r.cooper@noaa.gov) of the manuscript submission; and 3) as TOAR papers and the Copernicus journals focus on science and not policy, the submitted paper may be policy-relevant, but not policy-prescriptive. While authors have freedom regarding their preferred topic and analysis methods, 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.

1. Copyright and Open Data Policy

All manuscripts published with Copernicus journals are distributed under the Creative Commons Attribution 4.0 License. Authors retain the copyright of their manuscript and its final journal article. Further details are available on the ACP License and Copyright webpage.

TOAR and Copernicus journals are committed to open data practices and all submitted manuscripts will follow COPDESS (Coalition on Publishing Data in the Earth and Space Sciences) principles: http://www.copdess.org/statement-of-commitment/

Use of observations and metrics from the TOAR-II Database of Surface Observations must follow the TOAR Version 2 Data Use Policy. Further information on the TOAR Data Infrastructure, including User Guides and Technical Guides can be found here.

2. Association with TOAR

A paper accepted for publication within the *TOAR-II Community Special Issue* will be recognized by TOAR as a component of the peer-reviewed inter-journal special issue, but the TOAR Steering Committee will not endorse any paper as an official statement of TOAR, nor is there any guarantee that any conclusion of the paper will be accepted as a likely conclusion by the TOAR-II Assessment papers. For example, the conclusions of a paper published in the *TOAR-II Community Special Issue* may not be accepted by the TOAR-II assessment papers if evidence from other papers in the *TOAR-II Community*

Special Issue or the broader peer-reviewed literature support a different and more likely set of conclusions.

To avoid confusion with the final assessment papers, "TOAR" or "Tropospheric Ozone Assessment Report" may not appear in the title of the paper, nor should the paper claim to be an official TOAR publication. However, it is acceptable to refer to TOAR in the manuscript as, for example, "In the context of the Tropospheric Ozone Assessment Report (TOAR) Phase Two focus working group on XYZ, etc.".

3. Guidelines for Authorship

TOAR authorship qualifications must follow the guidelines set forth by the Copernicus journals. To ensure that the Copernicus authorship guidelines are followed, and to avoid assigning co-authorship to someone who may not want to be listed as an author, we recommend the following method for compiling the final author list: 1) create a list of "confirmed authors", listing the names of only those contributors who have explicitly stated that they would like to be listed as authors, and have also made a substantial contribution to the manuscript; 2) create a list of "potential authors", listing individuals who are expected to make a substantial contribution to the paper, or individuals who have not yet confirmed their participation as authors; 3) when a potential author demonstrates a contribution worthy of authorship (following the Copernicus guidelines) and when they request to be listed as an author, their name should be elevated from the "potential author" list to the "confirmed author" list. When the paper is submitted to the journal only the names in the confirmed author list should be attached to the submission.

4. Manuscript Style Guidelines

General manuscript preparation guidelines (e.g. figures, tables, abstract, references, supplementary material etc.) are available on the websites of the six journals hosting the *TOAR-II Community Special Issue*, and can be accessed through the hyper-links below:

Atmospheric Chemistry and Physics (ACP) *[lead journal]*

Atmospheric Measurement Techniques (AMT)

Geoscientific Model Development (GMD)

Advances in Statistical Climatology, Meteorology and Oceanography (ASCMO)

Earth System Science Data (ESSD)

Biogeosciences (BG)

The manuscript preparation guidelines provide links to scientific color maps (or color tables, or color palettes). Wide ranges of color palettes are also available from the National Center for Atmospheric Research (NCAR) and from the IPCC Visual Style Guide (pdf for direct download), which also provides excellent advice for designing effective figures and tables. Color palettes recommended by the TOAR-II Steering Committee for displaying TOAR ozone observations and trends are listed in Appendix II.

5. Guidance note on best statistical practices

The TOAR-II Statistics Focus Working Group has produced a *Guidance note on best statistical practices for TOAR analyses*, which can be downloaded from their webpage. The aim of the guidance note is to provide recommendations on best statistical practices and to ensure consistent communication of statistical uncertainty across TOAR publications. The scope includes calibrated language for the communication of uncertainty, approaches for reporting trends, a summary of statistical capabilities of commonly applied trend detection techniques, and a discussion of strengths and weaknesses of commonly used techniques.

6. Units and scales

TOAR uses specific units when describing ozone observations and levels of exposure. When referencing an ozone observation, which is measured from moist, ambient air, TOAR follows World Meteorological Organization guidelines (*Galbally et al*., 2013) and uses the mole fraction of ozone in air, expressed in SI units of nmol mol^{-1}. The same units are applied to any ozone statistic, such as median or 95^{th} percentile values. Ozone exposure metrics (e.g., 8-h daily maximum average ozone value) have typically been developed using the more ambiguous mixing ratio unit of parts per million (ppm) or parts per billion (ppb) which, in the case of ozone, refers to the number of ozone molecules per million or billion moist, ambient air molecules in a fixed volume. In this context, ppb is equivalent to nmol mol^{-1}. To maintain consistency with the ozone human health and vegetation research community, TOAR uses units of ppb when discussing ozone in terms of an exposure metric.

Comparisons regarding tropospheric column ozone (TCO) or partial tropospheric columns should follow the TOAR-II Guidelines for TCO and profile intercomparisons (pdf for download) developed by the HEGIFTOM Focus Working Group.

When reporting trends, authors may use the scale of their choice, but they should also report trends in units of nmol mol^{-1} per decade. Trends of tropospheric column or partial column should also be converted to layer-average values of nmol mol^{-1} per decade, allowing for IPCC-style comparisons of surface, free tropospheric and tropospheric column trends (see Figure 2.8 of *Gulev et al*., 2021; also shown in Appendix I below).

Preferred time scales for intercomparisons are as follows:

present day: averaged values across 2017-2021, with at least 3 out of 5 years of data (or three out of five seasons) available with data capture > 66%

21^{st} Century trends: time series beginning in the range 2000-2002 and ending in the range 2019-2021 (may include sites with data before 2000, but limit the analysis to 2000 and later)

trends since the late 20^{th} century: time series beginning in the range 1990-1999 and ending in the range 2019-2021 (for comparison to IPCC AR6 Figure 2.8; see Figure 2.8 of *Gulev et al*., 2021, also shown in Appendix I below)

long-term trends: time series beginning in the range 1970-1989 and ending in the range 2019-2021

short-term trends: time series beginning in the range 2010-2012 and ending in the range 2019-2021. Time series should be at least 10 years in length. Given the low signal-to-noise ratio of short time series, trend detection will be difficult and the uncertainty will be high. While trend analysis on the time-scale of a decade can be challenging, this option could be useful for studying ozone changes in regions with little data but with newly established monitoring sites.

Galbally, I. E., et al., 2013. Guidelines for Continuous Measurement of Ozone in the Troposphere, GAW Report No 209, Publication WMO-No. 1110, ISBN 978-92-63-11110-4, WMO, Geneva. https://library.wmo.int/index.php?lvl=notice_display&id=14537#.Y6IOTRXMLq4

Gulev, S.K., et al. (2021), Changing State of the Climate System. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 287–422, doi:10.1017/9781009157896.004, https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter02.pdf

7. Regional Definitions

A range of regional definitions are available for categorizing and analysing surface, free tropospheric, and tropospheric column ozone. Following are recommendations (and web links) for a range of TOAR-II focus areas:

Climate: IPCC AR6-WGI Reference Regions describes 58 land and oceanic regions for climate research. In addition, TOAR-II recommends the following latitude bands for broad zonal analyses:

Tropics: 20°S-20°N

Sub-tropics: 20°-30° N or S

Mid-latitudes: 30°-60° N or S

Polar: 60°-90° N or S

Health: Global Burden of Disease created seven super-regions based on two criteria: epidemiological similarity and geographic closeness. A map of the regions (and sub-regions) and a link to download a full list of countries and their corresponding regions can be found here.

Vegetation: The TOAR-Vegetation paper from the first phase of TOAR used 12 climate zones. Meta data associated with the ozone monitoring sites in the TOAR-II database indicate the climate zones for each site, as described in the TOAR Database paper (Schultz et al., 2017). The Global Gridded Crop Model Intercomparison (GCMI) Phase 3 is a composite product merging various observational data sources. It provides in each 0.5° land grid cell the planting day and maturity day for 18 different crops, separating rainfed and irrigated systems.

Geopolitical: The United Nations and the World Bank define a wide range of country groupings and classifications

Carbon Budget: Atmospheric Tracer Transport Model Intercomparison Project (TransCom)

Appendix 1: IPCC AR6 Tropospheric Ozone Trends

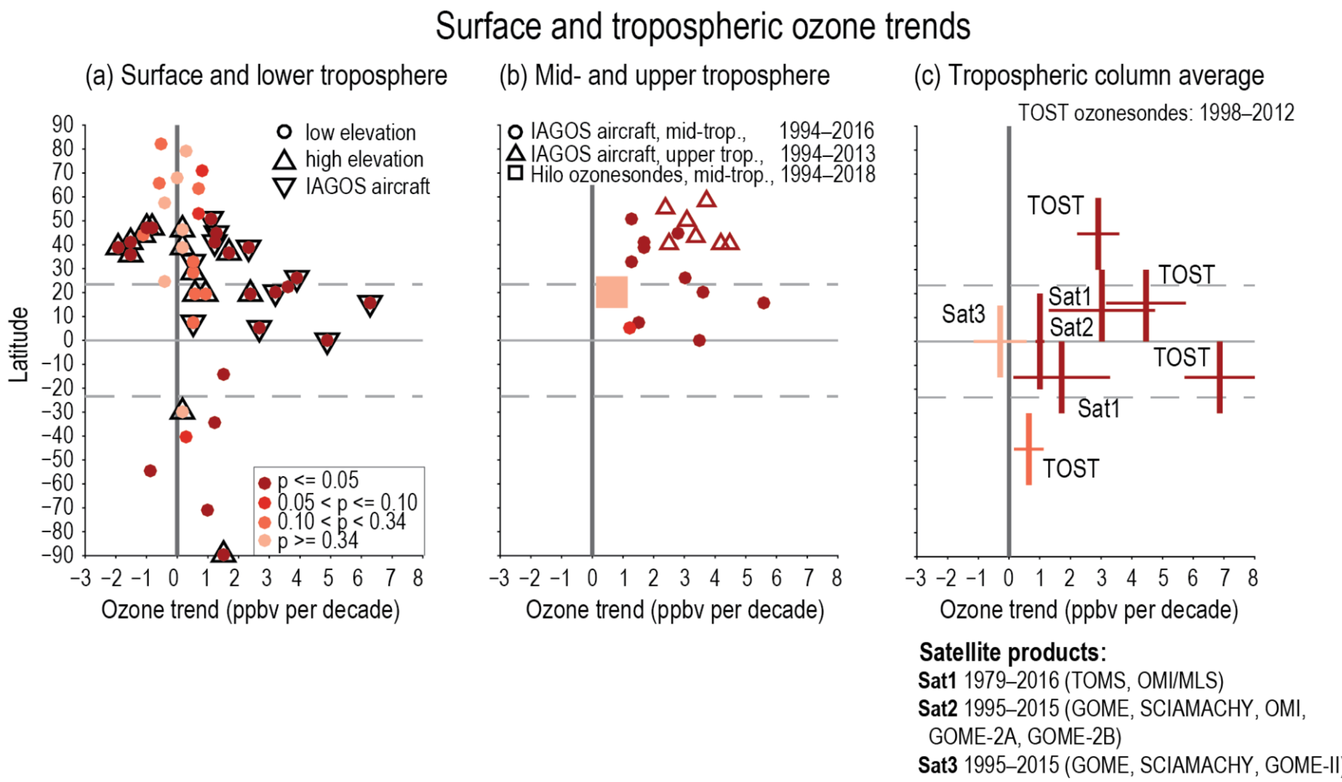

Figure 2.8 from IPCC AR6 WG I (*Gulev et al., 2021*)

Figure 2.8 | Surface and tropospheric ozone trends. (a) Decadal ozone trends by latitude at 28 remote surface sites and in the lower free troposphere (650 hPa, about 3.5 km) as measured by IAGOS aircraft above 11 regions. All trends are estimated for the time series up to the most recently available year, but begin in 1995 or 1994. Colours indicate significance (p-value) as denoted in the in-line key. See Figure 6.5 for a depiction of these trends globally. (b) Trends of ozone since 1994 as measured by IAGOS aircraft in 11 regions in the mid-troposphere (700–300 hPa; about 3–9 km) and upper troposphere (about 10–12 km), as measured by IAGOS aircraft and ozonesondes. (c) Trends of average tropospheric column ozone mixing ratios from the TOST composite ozonesonde product and three composite satellite products based on TOMS, OMI/MLS (Sat1), GOME, SCIAMACHY, OMI, GOME-2A, GOME-2B (Sat2), and GOME, SCIAMACHY, GOME-II (Sat3). Vertical bars indicate the latitude range of each product, while horizontal lines indicate the *very likely* uncertainty range. Further details on data sources and processing are available in the chapter data table (Table 2.SM.1).

Appendix II: TOAR-II Color Palettes

So that TOAR figures have a common look and feel across the *TOAR-II Community Special Issue*, TOAR has produced several color palettes. These colors, while taking advantage of most of the full color spectrum, avoid the commonly used "rainbow" palettes which are not ideal because: 1) they are problematic for people with red-green color blindness; 2) they can be visually overbearing; and 3) they can falsely exaggerate gradients (see examples in the IPCC Visual Style Guide). Following are the RGB values of the TOAR color palettes:

10 colors for plotting present-day ozone values

R	G	B		
0.2081	0.1663	0.5292	%%% dark blue	1
0.3961	0.3176	0.8000	%%% purple	2
0.0123	0.4213	0.8802	%%% blue	3
0.4941	0.7647	0.8980	%%% light blue	4
0.1157	0.7022	0.6843	%%% blue-green	5
0.5216	0.6980	0.1725	%%% muted green	6
0.9968	0.7513	0.2325	%%% yellow-orange	7
1.0000	0.4863	0.0000	%%% dark orange	8
0.8000	0.3176	0.3176	%%% light reddish brown	9
0.6980	0.1725	0.1725	%%% reddish brown	10

12 colors for plotting months

R	G	B		
0.3922	0.0000	0.5882	%%% purple	Jan
0.1529	0.1882	0.8431	%%% blue	Feb
0.3490	0.5529	0.9882	%%% light blue	Mar
0.5451	0.9373	0.8510	%%% aqua	Apr
0.3765	0.8118	0.5686	%%% blue green	May
0.1020	0.5961	0.3137	%%% dark green	Jun
0.5686	0.8118	0.3765	%%% light green	Jul
0.8510	0.9373	0.5451	%%% yellow green	Aug
0.9961	0.8784	0.5451	%%% light orange	Sep
0.9882	0.5529	0.3490	%%% salmon	Oct
0.8431	0.1882	0.1529	%%% muted red	Nov
0.5882	0.0000	0.3922	%%% burgundy	Dec

7 colors for plotting trend vectors by sign and p-value

R	G	B		
0	0	0.6000	%%%	dark blue, for negative trend values with p<=0.05
0.1176	0.3922	1.0000	%%%	medium blue, for negative trend values with 0.05<p<=0.10
0.4706	0.7373	1.0000	%%%	light blue, for negative trend values with 0.10<p<=0.33
0.6431	0.7569	0.4431	%%%	light olive green, for positive/negative values with p>0.33
1.0000	0.7294	0.4000	%%%	light orange, for positive trend values with 0.10<p<=0.33
1.0000	0.3922	0	%%%	orange, for positive trend values with 0.05<p<=0.10
0.6471	0	0.1294	%%%	dark red, for positive trend values with p<=0.05

12 colors for plotting global maps of satellite ozone data

R	G	B	
0.2081	0.1663	0.5292	%%% dark blue
0.1403	0.3147	0.8168	
0.0410	0.4502	0.8685	
0.0734	0.5410	0.8257	
0.0232	0.6407	0.7925	
0.1024	0.6984	0.6934	
0.3187	0.7395	0.5625	%%% green
0.5745	0.7484	0.4479	
0.7798	0.7361	0.3658	
0.9613	0.7281	0.2774	
0.9763	0.8328	0.1590	
0.9763	0.9831	0.0538	%%% yellow

11 colors for plotting trends or anomalies on maps (red being positive, blue being negative)
This is NCAR's CBR_coldhot palette:
http://www.ncl.ucar.edu/Document/Graphics/ColorTables/CBR_coldhot.shtml
To convert to decimal divide each value by 255

R	G	B	
5	48	97	
33	102	172	%%% dark blue
67	147	195	
146	197	222	
209	229	240	
247	247	247	%%% white
254	219	199	
244	165	130	
214	96	77	
178	24	43	
103	0	31	%%% dark red