Welcome to the

TOAR-II Quickstart Event

Agenda:

12:00-12:10 UTC	Welcome and introduction by the TOAR-II Co-chairs
12:10-12:30 UTC	Overview and brief highlights from TOAR I and introduction to TOAR II aims
12:30-12:50 UTC	Introduction to the expanded TOAR Database and data services
12:50-13:00 UTC	How to get involved: TOAR II Working Group concept
13:00-13:10 UTC	Presentation from the newly formed Satellite Ozone Working Group
13:10-13:30 UTC	Question & Answer session
13:30 UTC	Announcement of the TOAR-II Kick-off Workshop (early 2021) and Close

Owen Cooper on behalf of the TOAR-II Steering Committee

https://igacproject.org/activities/TOAR/TOAR-II

TOAR-II 2020-2024, Steering Committee

Owen Cooper (co-Chair), CIRES, U. of Colorado Boulder/NOAA CSL, USA owen.r.cooper@noaa.gov

Martin Schultz (co-Chair), Forschungszentrum Jülich, Germany m.schultz@fz-juelich.de

Lisa Emberson, University of York, UK l.emberson@york.ac.uk

Yugo Kanaya, Japan Agency for Marine-Earth Science and Tech. (JAMSTEC) yugo@jamstec.go.jp

Raeesa Moolla, University of the Witwatersrand, South Africa Raeesa.Moolla@wits.ac.za

Yinon Rudich, Weizmann Institute of Science, Israel yinon.rudich@weizmann.ac.il

Erika von Schneidemesser, Institute for Advanced Sustainability Studies, Potsdam, Germany evs@iass-potsdam.de

Rodrigo Seguel, Center for Climate and Resilience Research (CR)2, Universidad de Chile, Santiago, Chile rodrigoseguel@uchile.cl

Bärbel Sinha, Indian Institute of Science Education and Research, Mohali, India bsinha@iisermohali.ac.in

Helen Worden, National Center for Atmospheric Research, Boulder, USA hmw@ucar.edu

Lin Zhang, Peking University, Beijing, China zhanglg@pku.edu.cn

https://igacproject.org/activities/TOAR/TOAR-II

TOAR-II Stay up-to-date!

Please register for the TOAR-II email list here:

https://igacproject.org/activities/TOAR/TOAR-II

…or just google "TOAR-II email list"

140 scientists have registered so far

Emails will be infrequent and will only announce key TOAR-II activities

Achievements of TOAR-I and goals of TOAR-II

Owen R. Cooper
Senior Research Scientist, CIRES, University of Colorado Boulder
NOAA Chemical Sciences Laboratory, Boulder

on behalf of the TOAR-II Steering Committee

TOAR-II Quickstart Event

Held Worldwide in Virtual Format

September 16, 2020

TOAR-I 2014-2019

Mission:
To provide the research community with an up-to-date scientific assessment of tropospheric ozone's global distribution and trends from the surface to the tropopause.

Deliverables:

1) The first tropospheric ozone assessment report based on all available surface observations, the peer-reviewed literature and new analyses.
2) A database containing ozone exposure metrics at thousands of measurement sites around the world, freely accessible for research on the global-scale impact of ozone on climate, human health and crop/ecosystem productivity.

Stakeholders: WMO GAW, World Health Organization, NOAA, LRTAP Long-range Transboundary Air Pollution, Task Force on Hemispheric Transport of Air Pollution

IGAC International Global Atmospheric Chemistry

TOAR tropospheric ozone assessment report Phase II

https://igacproject.org/activities/TOAR/TOAR-II

TOAR-I 2014-2019

Funding and in-kind donations provided by:

IGAC — International Global Atmospheric Chemistry

NOAA — National Oceanic and Atmospheric Administration, U.S. Department of Commerce

JÜLICH Forschungszentrum

WMO

CIRES — Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder

AEMet — Agencia Estatal de Meteorología

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences

Nanjing University 1902

Environment and Climate Change Canada

TOAR tropospheric ozone assessment report Phase II

https://igacproject.org/activities/TOAR/TOAR-II

TOAR-I Accomplishments, 2014-2019

Nine highly-cited journal publications in Elementa

A database with easily accessible ozone metrics at 1000s of stations worldwide

A highly motivated community of > 240 scientists from over 35 countries

Uptake of TOAR results by other communities (e.g. WMO, GBD and IPCC)

TOAR-I publications in Elementa

https://
collections.elementascience.org/toar

ELEMENTA Science of the Anthropocene

Young, PJ, et al. 2018 Tropospheric Ozone Assessment Report: Assessment of global-scale model performance for global and regional ozone distributions, variability, and trends. Elem Sci Anth, 6: 10. DOI: https://doi.org/10.1525/elementa.265

REVIEW

Tropospheric Ozone Assessment Report: Assessment of global-scale model performance for global and regional ozone distributions, variability, and trends

P. J. Young, V. Naik, A. M. Fiore, A. Gaudel, J. Guo, M. Y. Lin, J. L. Neu, D. D. Parrish, H. E. Rieder, J. L. Schnell, S. Tilmes, O. Wild, L. Zhang, J. Ziemke, J. Brandt, A. Delcloo, R. M. Doherty, C. Geels, M. I. Hegglin, L. Hu, U. Im, R. Kumar, A. Luhar, L. Murray, D. Plummer, J. Rodriguez, A. Saiz-Lopez, M. G. Schultz, M. T. Woodhouse and G. Zeng

The goal of the Tropospheric Ozone Assessment Report (TOAR) is to provide the research community with an up-to-date scientific assessment of tropospheric ozone, from the surface to the tropopause. While a suite of observations provides significant information on the spatial and temporal distribution of tropospheric ozone, observational gaps make it necessary to use global atmospheric chemistry models to synthesize our understanding of the processes and variables that control tropospheric ozone abundance and its variability. Models facilitate the interpretation of the observations and allow us to make projections of future tropospheric ozone and trace gas distributions for different anthropogenic or natural perturbations. This paper assesses the skill of current-generation global atmospheric chemistry models in simulating the observed present-day tropospheric ozone distribution, variability, and trends.

ELEMENTA Science of the Anthropocene

Schultz, MG, et al 2017 Tropospheric Ozone Assessment Report: Database and metrics data of global surface ozone observations. Elem Sci Anth, 5: 58, DOI: https://doi.org/10.1525/elementa.244

RESEARCH ARTICLE

Tropospheric Ozone Assessment Report: Database and metrics data of global surface ozone observations

Martin G. Schultz[1,82], Sabine Schröder[1], Olga Lyapina[1], Owen R. Cooper[2,3], Ian Galbally[4], Irina Petropavlovskikh[2,3], Erika von Schneidemesser[5], Hiroshi Tanimoto[6], Yasin Elshorbany[7,8], Manish Naja[9], Rodrigo J. Seguel[10], Ute Dauert[11], Paul Eckhardt[12], Stefan Feigenspan[11], Markus Fiebig[12], Anne-Gunn Hjellbrekke[12], You-Deog Hong[13], Peter Christian Kjeld[14], Hiroshi Koide[15], Gary Lear[16], David Tarasick[17], Mikio Ueno[15], Markus Wallasch[18], Darrel Baumgardner[19], Ming-Tung Chuang[20], Robert Gillett[4], Meehye Lee[21], Suzie Molloy[4], Raeesa Moolla[22], Tao Wang[23], Katrina Sharps[24], Jose A. Adame[25], Gerard Ancellet[26], Francesco Apadula[27], Paulo Artaxo[28], Maria E. Barlasina[29], Magdalena Bogucka[30], Paolo Bonasoni[31], Limseok Chang[32], Aurelie Colomb[33], Emilio Cuevas-Agulló[34], Manuel Cupeiro[35], Anna Degorska[36], Aijun Ding[37], Marina Fröhlich[38], Marina Frolova[39], Harish Gadhavi[40], Francois Gheusi[41], Stefan Gilge[42,43], Margarita Y. Gonzalez[44], Valerie Gros[45], Samera H. Hamad[46], Detlev Helmig[47], Diamantino Henriques[48], Ove Hermansen[12], Robert Holla[42], Jacques Hueber[47], Ulas Im[49], Daniel A. Jaffe[50], Ninong Komala[51], Dagmar Kubistin[42], Ka-Se Lam[23], Tuomas Laurila[52], Haeyoung Lee[53], Ilan Levy[54], Claudio Mazzoleni[55], Lynn R. Mazzoleni[55], Audra McClure-Begley[2,3], Maznorizan Mohamad[56], Marijana Murovec[57], Monica Navarro-Comas[44], Florin Nicodim[58], David Parrish[2,3], Katie A. Read[59], Nick Reid[60], Ludwig Ries[61], Pallavi Saxena[62], James J. Schwab[63], Yvonne Scorgie[64], Irina Senik[65], Peter Simmonds[66], Vinayak Sinha[67], Andrey I. Skorokhod[68], Gerard Spain[69], Wolfgang Spangl[38], Ronald Spoor[70], Stephen R. Springston[71], Kelvyn Steer[72], Martin Steinbacher[73], Eka Suharguniyawan[74], Paul Torre[75], Thomas Trickl[76], Lin Weili[77], Rolf Weller[78], Xu Xiaobin[79], Likun Xue[80] and Ma Zhiqiang[81]

ELEMENTA Science of the Anthropocene

Lefohn, AS, et al. 2018 Tropospheric ozone assessment report: Global metrics for climate change, human health, and crop/ecosystem research. Elem Sci Anth, 6: 28. DOI: https://doi.org/10.1525/elementa.279

RESEARCH ARTICLE

Tropospheric ozone assessment report: Global ozone metrics for climate change, human health, and crop/ecosystem research

Allen S. Lefohn, Christopher S. Malley, Luther Smith, Benjamin Wells, Milan Hazucha, Heather Simon, Vaishali Naik, Gina Mills, Martin G. Schultz, Elena Paoletti, Alessandra De Marco, Xiaobin Xu, Li Zhang, Tao Wang, Howard S. Neufeld, Robert C. Musselman, David Tarasick, Michael Brauer, Zhaozhong Feng, Haoye Tang, Kazuhiko Kobayashi, Pierre Sicard, Sverre Solberg and Giacomo Gerosa

ELEMENTA Science of the Anthropocene

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

RESEARCH ARTICLE

Tropospheric Ozone Assessment Report: Present-day distribution and trends of tropospheric ozone relevant to climate and global atmospheric chemistry model evaluation

A. Gaudel[1,2], O. R. Cooper[1,2], G. Ancellet[3], B. Barret[4], A. Boynard[3,5], J. P. Burrows[6], C. Clerbaux[3], P.-F. Coheur[7], J. Cuesta[8], E. Cuevas[9], S. Doniki[7], G. Dufour[8], F. Ebojie[10], G. Foret[8], O. Garcia[11], M. J. Granados-Muñoz[12,13], J. W. Hannigan[14], F. Hase[15], B. Hassler[1,2,16], G. Huang[17], D. Hurtmans[7], D. Jaffe[18,19], N. Jones[20], P. Kalabokas[21], B. Kerridge[22], S. Kulawik[23,24], B. Latter[22], T. Leblanc[12], E. Le Flochmoën[4], W. Lin[25], J. Liu[26,27], X. Liu[17], E. Mahieu[27], A. McClure-Begley[1,2], J. L. Neu[23], M. Osman[29], M. Palm[6], H. Petetin[4], I. Petropavlovskikh[1,2], R. Querel[28], N. Rahpoe[23], A. Rozanov[23], M. G. Schultz[31,32], J. Schwab[33], R. Siddans[22], D. Smale[20], M. Steinbacher[34], H. Tanimoto[35], D. W. Tarasick[36], V. Thouret[4], A. M. Thompson[37], T. Trickl[38], E. Weatherhead[1,2], C. Wespes[39], H. M. Worden[40], C. Vigouroux[40], X. Xu[41], G. Zeng[30], J. Ziemke[42]

ELEMENTA Science of the Anthropocene

Tarasick, D, et al. 2019. Tropospheric Ozone Assessment Report: Tropospheric ozone from 1877 to 2016, observed levels, trends and uncertainties. Elem Sci Anth, 7: 39. DOI: https://doi.org/10.1525/elementa.376

REVIEW

Tropospheric Ozone Assessment Report: Tropospheric ozone from 1877 to 2016, observed levels, trends and uncertainties

David Tarasick, Ian E. Galbally, Owen R. Cooper, Martin G. Schultz, Gerard Ancellet, Thierry Leblanc, Timothy J. Wallington, Jerry Ziemke, Xiong L…, Martin Steinbacher, Johannes Staehelin, Corinne Vigouroux, James W. Hanniga…, Omaira García, Gilles Foret, Prodromos Zanis, Elizabeth Weatherhead, Irina Petropavlovski… …ohammed Osman, Jane Liu, Kai-Lan Chang, Au… …n, Maria Granados-Muñoz, Anne M. Thompson, … Juan Cuesta, Gaelle Dufour, Valerie Thouret, Birgit Hassler, … Thomas Trickl and Jessica L. Neu

ELEMENTA Science of the Anthropocene

Fleming, ZL, et al. 2018 Tropospheric Ozone Assessment Report: Present-day ozone distribution and trends relevant to human health. Elem Sci Anth, 6: 12. DOI: https://doi.org/10.1525/elementa.273

RESEARCH ARTICLE

Tropospheric Ozone Assessment Report: Present-day ozone distribution and trends relevant to human health

Zoë L. Fleming, Ruth M. Doherty, Erika von Schneidemesser, Christopher S. Malley, Owen R. Cooper, Joseph P. Pinto, Augustin Colette, Xiaobin Xu, David Simpson, Martin G. Schultz, Allen S. Lefohn, Samera Hamad, Raeesa Moolla, Sverre Solberg and Zhaozhong Feng

ELEMENTA Science of the Anthropocene

Mills, G, et al. 2018. Tropospheric Ozone Assessment Report: Present-day tropospheric ozone distribution and trends relevant to vegetation. Elem Sci Anth, 6: 47. DOI: https://doi.org/10.1525/elementa.302

RESEARCH ARTICLE

Tropospheric Ozone Assessment Report: Present-day tropospheric ozone distribution and trends relevant to vegetation

Gina Mills, Håkan Pleijel, Christopher S. Malley, Baerbel Sinha, Owen R. Cooper, Martin G. Schultz, Howard S. Neufeld, David Simpson, Katrina Sharps, Zhaozhong Feng, Giacomo Gerosa, Harry Harmens, Kazuhiko Kobayashi, Pallavi Saxena, Elena Paoletti, Vinayak Sinha and Xiaobin Xu

ELEMENTA Science of the Anthropocene

Chang, K-L, et al 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: https://doi.org/10.1525/elementa.243

RESEARCH ARTICLE

Regional trend analysis of surface ozone observations from monitoring networks in eastern North America, Europe and East Asia

Kai-Lan Chang, Irina Petropavlovskikh, Owen R. Cooper, Martin G. Schultz and Tao Wang

Surface ozone is a greenhouse gas and pollutant detrimental to human health and crop and ecosystem productivity. The Tropospheric Ozone Assessment Report (TOAR) is designed to provide the research community with an up-to-date observation-based overview of tropospheric ozone's global distribution and trends. The TOAR Surface Ozone Database contains ozone metrics at thousands of monitoring sites

ELEMENTA Science of the Anthropocene

Xu, X, et al. 2020. Long-term changes of regional ozone in China: implications for human health and ecosystem impacts. Elem Sci Anth, 8: 13. DOI: https://doi.org/10.1525/elementa.409

RESEARCH ARTICLE

Long-term changes of regional ozone in China: implications for human health and ecosystem impacts

Xiaobin Xu, Weili Lin, Wanyun Xu, Junli Jin, Ying Wang, Gen Zhang, Xiaochun Zhang, Zhiqiang Ma, Yuanzhen Dong, Qianli Ma, Dajiang Yu, Zou Li, Dingding Wang and Huarong Zhao

INTERNATIONAL GLOBAL ATMOSPHERIC CHEMISTRY IGAC

TOAR Tropospheric Ozone Assessment Report Phase II

TOAR-I publications are highly cited

According to Web of Science

Over 430 citations so far

Current rate is ~250 citations per year

1. Tropospheric Ozone Assessment Report: Present-day distribution and trends of tropospheric ozone relevant to climate and global atmospheric chemistry model evaluation
By: Gaudel, A.; Cooper, O. R.; Ancellet, G.; et al.
ELEMENTA-SCIENCE OF THE ANTHROPOCENE Volume: 6 Article Number: 39 Published: MAY 10 2018
Times Cited: 75 (from All Databases) — Highly Cited Paper

2. Tropospheric Ozone Assessment Report: Present-day tropospheric ozone distribution and trends relevant to vegetation
By: Mills, Gina; Pleijel, Hakan; Malley, Christopher S.; et al.
ELEMENTA-SCIENCE OF THE ANTHROPOCENE Volume: 6 Article Number: 47 Published: JUN 28 2018
Times Cited: 64 (from All Databases) — Highly Cited Paper

3. Tropospheric Ozone Assessment Report: Database and metrics data of global surface ozone observations
By: Schultz, Martin G.; Schroder, Sabine; Lyapina, Olga; et al.
ELEMENTA-SCIENCE OF THE ANTHROPOCENE Volume: 5 Article Number: 58 Published: OCT 18 2017
Times Cited: 64 (from All Databases)

4. Tropospheric ozone assessment report: Global ozone metrics for climate change, human health, and crop/ecosystem research
By: Lefohn, Allen S.; Malley, Christopher S.; Smith, Luther; et al.
ELEMENTA-SCIENCE OF THE ANTHROPOCENE Volume: 6 Article Number: 28 Published: APR 6 2018
Times Cited: 62 (from All Databases) — Highly Cited Paper

5. Tropospheric Ozone Assessment Report: Assessment of global-scale model performance for global and regional ozone distributions, variability, and trends
By: Young, P. J.; Naik, V.; Fiore, A. M.; et al.
ELEMENTA-SCIENCE OF THE ANTHROPOCENE Volume: 6 Article Number: 10 Published: JAN 31 2018
Times Cited: 59 (from All Databases) — Highly Cited Paper

6. Regional trend analysis of surface ozone observations from monitoring networks in eastern North America, Europe and East Asia
By: Chang, Kai-Lan; Petropavlovskikh, Irina; Cooper, Owen R.; et al.
ELEMENTA-SCIENCE OF THE ANTHROPOCENE Volume: 5 Article Number: 50 Published: SEP 7 2017
Times Cited: 52 (from All Databases)

7. Tropospheric Ozone Assessment Report: Present-day ozone distribution and trends relevant to human health
By: Fleming, Zoe L.; Doherty, Ruth M.; von Schneidemesser, Erika; et al.
ELEMENTA-SCIENCE OF THE ANTHROPOCENE Volume: 6 Article Number: 12 Published: FEB 5 2018
Times Cited: 48 (from All Databases)

8. Tropospheric Ozone Assessment Report: Tropospheric ozone from 1877 to 2016, observed levels, trends and uncertainties
By: Tarasick, David; Galbally, Ian E.; Cooper, Owen R.; et al.
ELEMENTA-SCIENCE OF THE ANTHROPOCENE Volume: 7 Article Number: 39 Published: OCT 11 2019
Times Cited: 10 (from All Databases)

9. Long-term changes of regional ozone in China: implications for human health and ecosystem impacts
By: Xu, Xiaobin; Lin, Weili; Xu, Wanyun; et al.
ELEMENTA-SCIENCE OF THE ANTHROPOCENE Volume: 8 Article Number: 13 Published: MAR 24 2020
Times Cited: 1 (from All Databases)

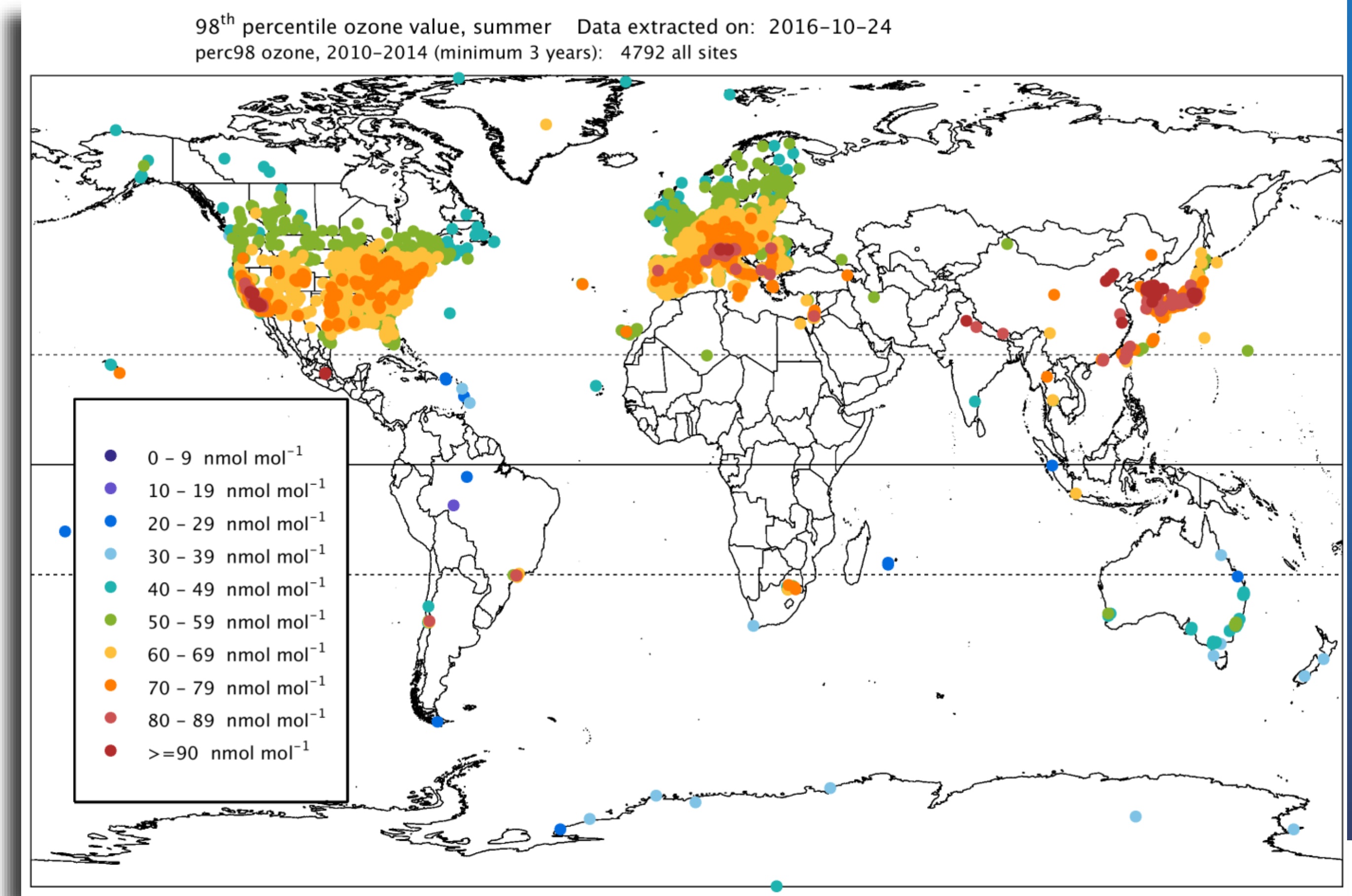
TOAR-I key results

The first global-scale view of all available surface ozone observations

98th percentile

5-year average (2010-2014)

summertime months: *April-Sept. in the N. Hemisphere, and Oct.-March in the S. Hemisphere*



Data available at:

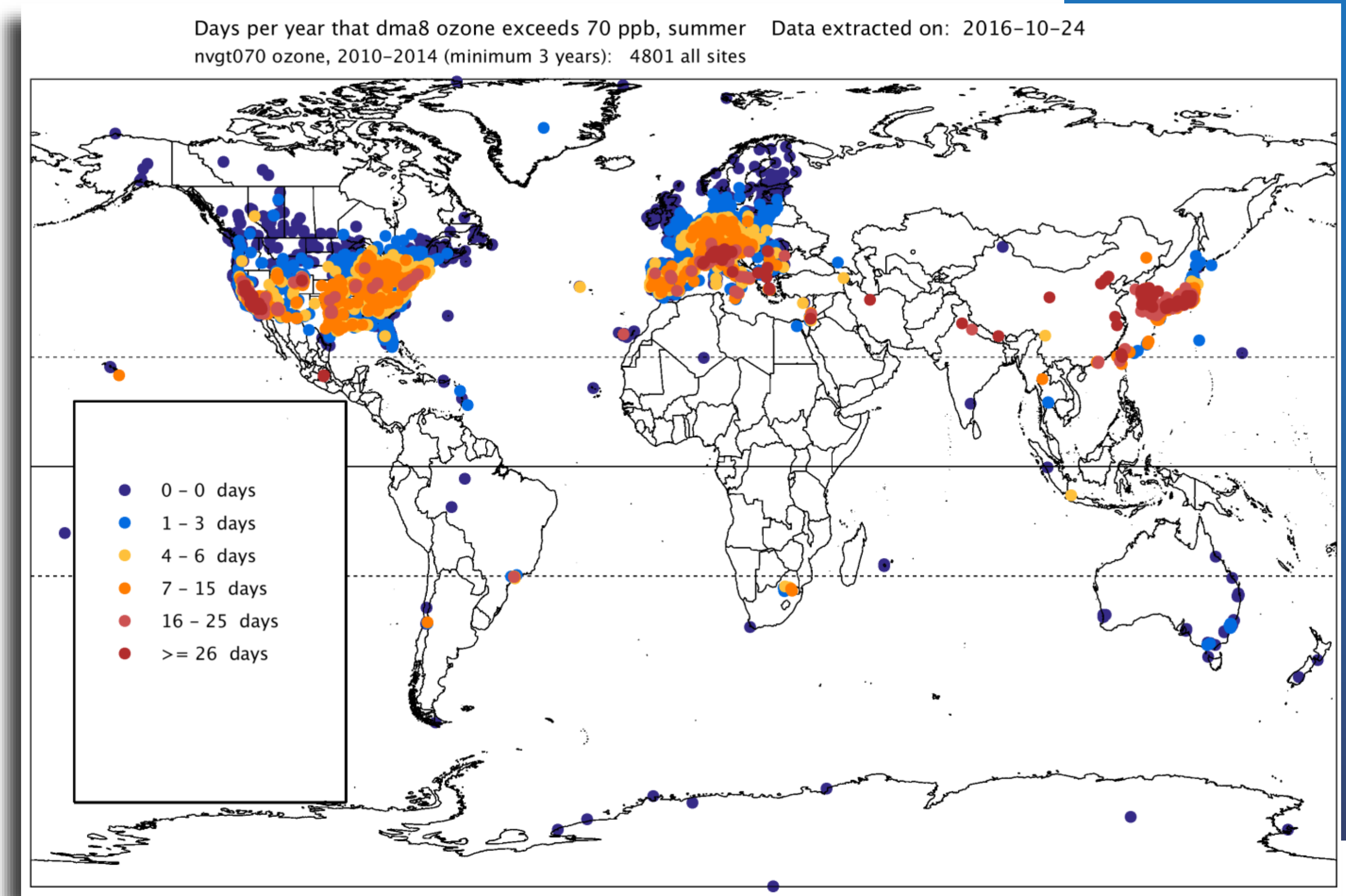
Schultz et al., Tropospheric Ozone Assessment Report, links to Global surface ozone datasets. PANGAEA, https://doi.org/10.1594/PANGAEA.876108

Owen Cooper on behalf of the TOAR-II Steering Committee
TOAR-II Quickstart Event, September 16, 2020

https://igacproject.org/activities/TOAR/TOAR-II

TOAR tropospheric ozone assessment report Phase II

TOAR-I key results



The first global-scale view of all available surface ozone observations

Number of days per year that ozone (max.daily 8-hr avg.) exceeds 70 ppb

5-year average (2010-2014)

summertime months: *April-Sept. in the N. Hemisphere, and Oct.-March in the S. Hemisphere*

See *TOAR-Health* for further details:

Fleming, Z. L., and R. M. Doherty et al. (2018), Tropospheric Ozone Assessment Report: Present-day ozone distribution and trends relevant to human health, Elem Sci Anth, 6(1):12, DOI:https://doi.org/10.1525/elementa.273

TOAR tropospheric ozone assessment report Phase II

https://igacproject.org/activities/TOAR/TOAR-II

TOAR-I key results

The first global-scale view of all available surface ozone observations

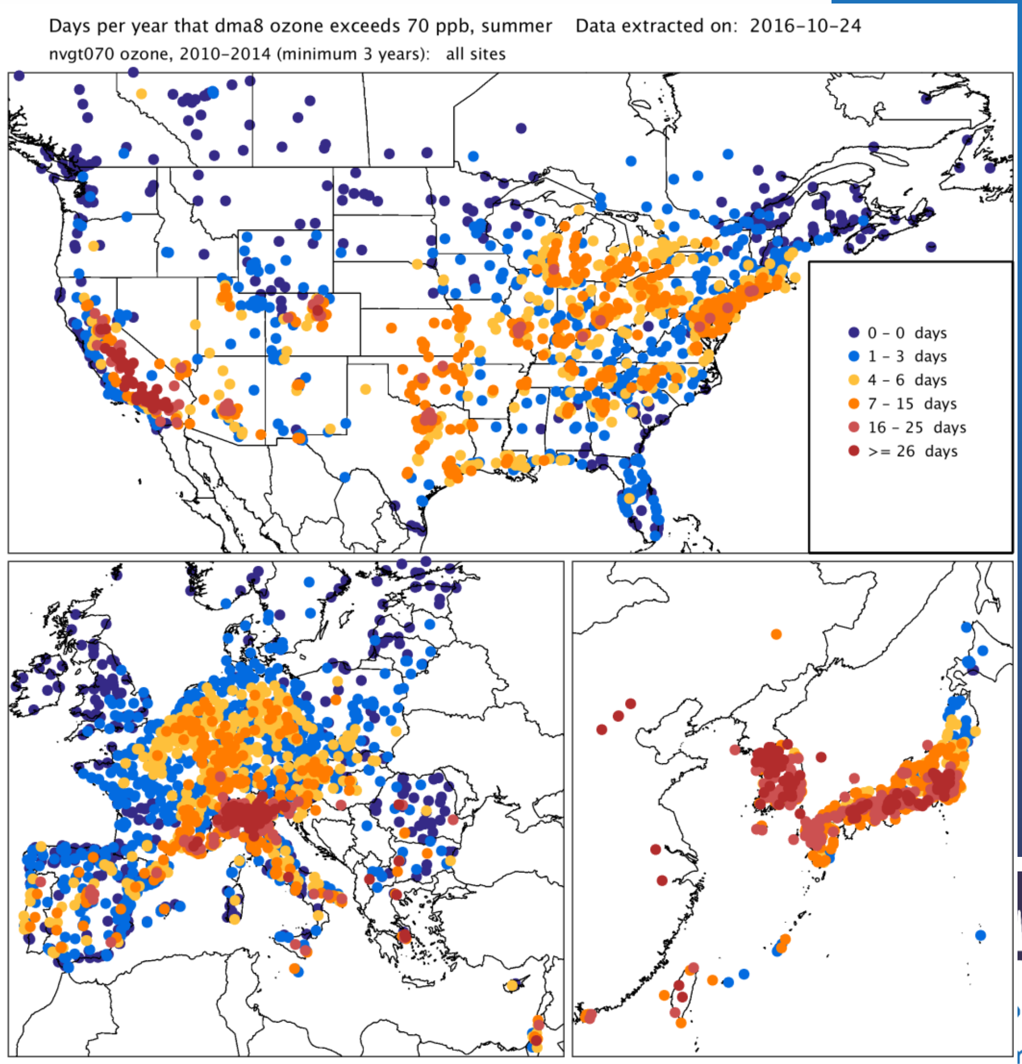
Number of days per year that ozone (max.daily 8-hr avg.) exceeds 70 ppb

5-year average (2010-2014)

summertime months: *April-Sept. in the N. Hemisphere, and Oct.-March in the S. Hemisphere*

See *TOAR-Health* for further details:

Fleming, Z. L., and R. M. Doherty et al. (2018), Tropospheric Ozone Assessment Report: Present-day ozone distribution and trends relevant to human health, Elem Sci Anth, 6(1):12, DOI:https://doi.org/10.1525/elementa.273



https://igacproject.org/activities/TOAR/TOAR-II

TOAR-I key results

The first global-scale view of all available surface ozone observations

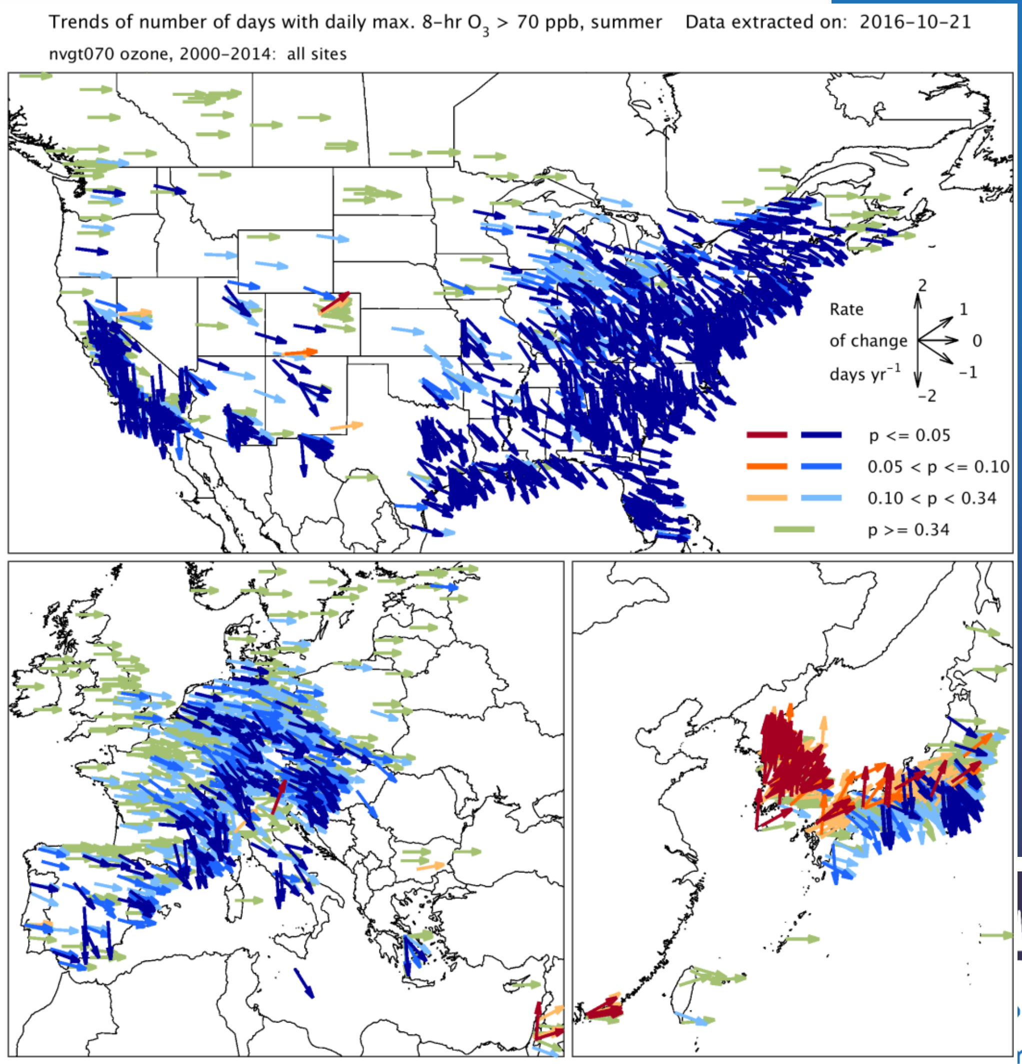
Number of days per year that ozone (max.daily 8-hr avg.) exceeds 70 ppb

Trends: 2000-2014

summertime months: *April-Sept. in the N. Hemisphere, and Oct.-March in the S. Hemisphere*

See *TOAR-Health* for further details:

Fleming, Z. L., and R. M. Doherty et al. (2018), Tropospheric Ozone Assessment Report: Present-day ozone distribution and trends relevant to human health, Elem Sci Anth, 6(1):12, DOI:https://doi.org/10.1525/elementa.273



Owen Cooper on behalf of the TOAR-II Steering Committee
TOAR-II Quickstart Event, September 16, 2020

https://igacproject.org/activities/TOAR/TOAR-II

TOAR-I key results

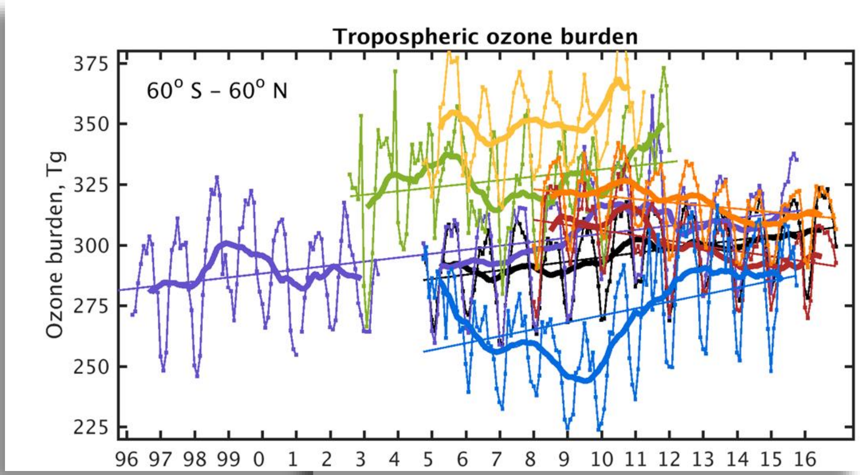
The first intercomparison of satellite ozone products

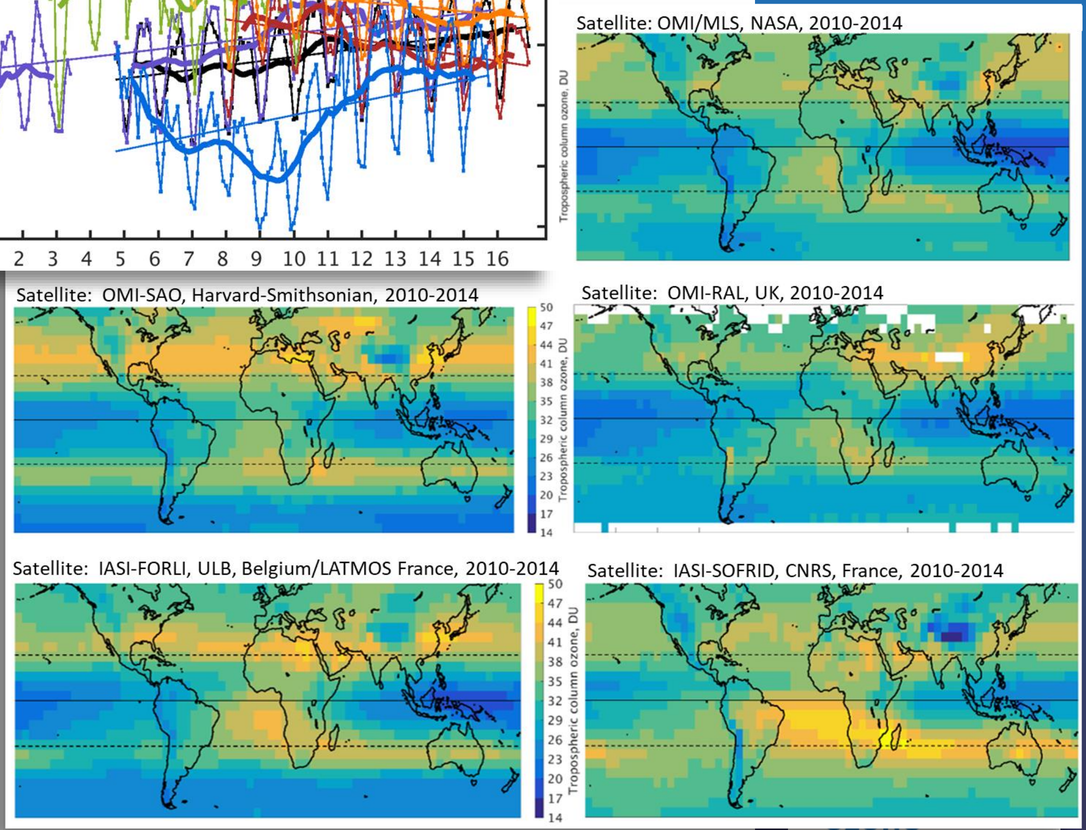
Satellite products generally agree regarding global ozone hotspots.

Satellites and IPCC models report similar values for the tropospheric ozone burden.

However, the satellites disagree regarding trends over the past decade (2008-2016).

Future TOAR work will reconcile the satellite ozone trends.





See *TOAR-Climate* for further details:

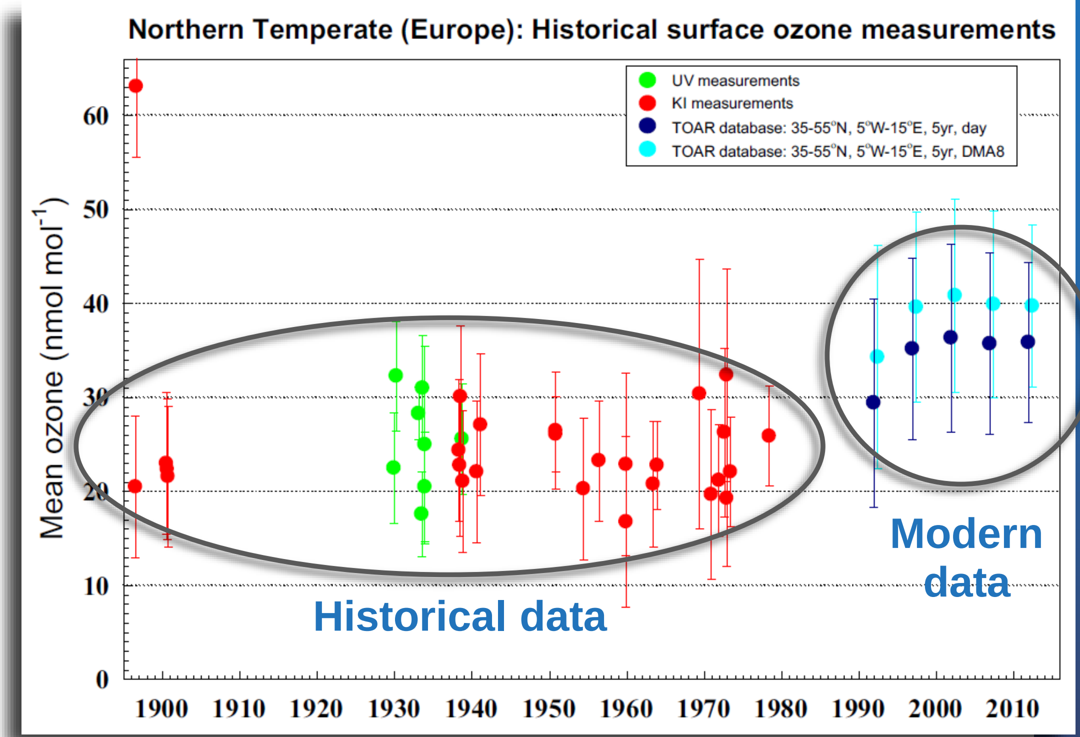
Gaudel, A., et al. (2018), Tropospheric Ozone Assessment Report: Present-day distribution and trends of tropospheric ozone relevant to climate and global atmospheric chemistry model evaluation, Elem Sci Anth, 6(1):39, DOI: https://doi.org/10.1525/elementa.291

https://igacproject.org/activities/TOAR/TOAR-II

TOAR-I key results

The most extensive evaluation of historical (pre-1975) ozone observations

Ozone has increased at northern mid-latitudes since the mid-20th century, in the range 30-70 %



See *TOAR-Observations* for further details:

Tarasick and Galbally et al. (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

TOAR tropospheric ozone assessment report Phase II

TOAR-I Fostering independent research

To date, 25 independent studies have utilized the TOAR database

WMO (World Meteorological Organization), *Scientific Assessment of Ozone Depletion: 2018*, Global Ozone Research and Monitoring Project–Report No. 58, 588 pp., Geneva, Switzerland, 2018

Blunden, J., D. S. Arndt, and G. Hartfield, Eds., 2018: State of the Climate in 2017. *Bull. Amer. Meteor. Soc.*, **99** (8), *Si*–S332,

Lu, X., et al. (2018), Severe surface ozone pollution in China: a global perspective, *Environ. Sci. Technol. Lett.* *5*, 8, 487-494.

Chang, K.-L., et al. (2019), A new method (M3Fusion v1) for combining observations and multiple model output for an improved estimate of the global surface ozone distribution, *Geosci. Model Dev., 12*, 955-978

Lu, X., et al. (2020), Rapid increases in warm-season surface ozone and resulting health impact over China since 2013, *Environ. Sci. Technol. Lett. 7*

Seltzer, K. M., et al. (2020), Magnitude, trends, and impacts of ambient long-term ozone exposure in the United States from 2000 to 2015, *Atmos. Chem. Phys., 20*, 1757–1775

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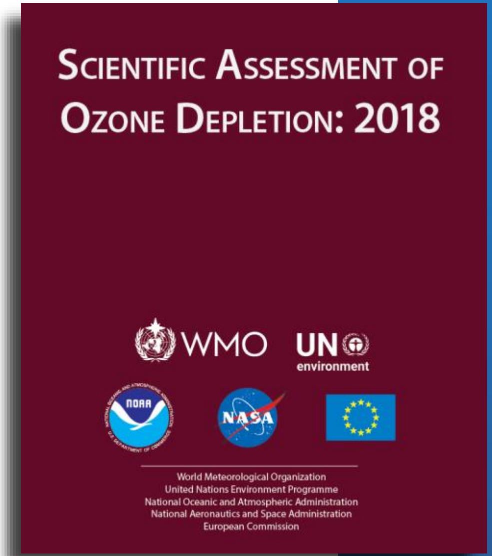
Lu, X., et al. (2018), Severe surface ozone pollution in China: a global perspective, *Environ. Sci. Technol. Lett. 5*, 8, 487-494.

Chang, K.-L., et al. (2019), A new method (M3Fusion v1) for combining observations and multiple model output for an improved estimate of the global surface ozone distribution, *Geosci. Model Dev., 12*, 955-978

Lu, X., et al. (2020), Rapid increases in warm-season surface ozone and resulting health impact over China since 2013, *Environ. Sci. Technol. Lett. 7*

Seltzer, K. M., et al. (2020), Magnitude, trends, and impacts of ambient long-term ozone exposure in the United States from 2000 to 2015, *Atmos. Chem. Phys., 20*, 1757–1775



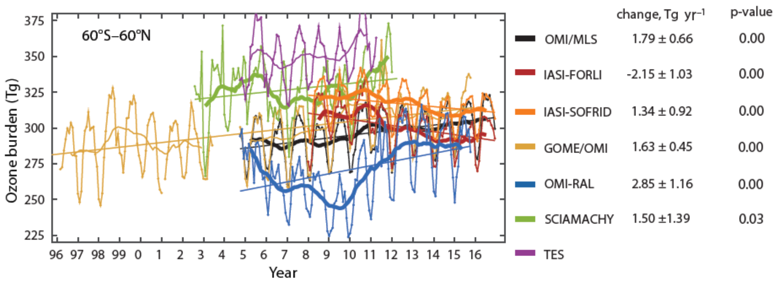


Figure 3-22. Time series of the tropospheric ozone burden, calculated from measured tropospheric ozone columns for seven satellite records. All instruments are nadir-viewing and have differing vertical sensitivities. The black line is the OMI/MLS tropospheric ozone residual product; the dark red and orange lines are IASI retrievals using the Fast Optimal Retrievals on Layers (FORLI) and SOftware for a Fast Retrieval (SOFRID) algorithms; respectively; the blue line is the OMI optimal estimation retrieval from Rutherford Appleton Laboratories (RAL); and the gold line is a combined GOME and OMI time series from Smithsonian Astrophysical Observatory. The green and purple lines are standard products from SCIAMACHY and TES, respectively. See Gaudel et al. (2018) and references therein. Adapted from Gaudel et al. (2018).

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WMO (World Meteorological Organization), *Scientific Assessment of Ozone Depletion: 2018*, Global Ozone Research and Monitoring Project–Report No. 58, 588 pp., Geneva, Switzerland, 2018

Blunden, J., D. S. Arndt, and G. Hartfield, Eds., 2018: State of the Climate in 2017. *Bull. Amer. Meteor. Soc.*, 99 (8), *Si*–S332,

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Seltzer, K. M., et al. (2020), Magnitude, trends, and impacts of ambient long-term ozone exposure in the United States from 2000 to 2015, *Atmos. Chem. Phys., 20*, 1757–1775

Owen Cooper on behalf of the TOAR-II Steering Committee
TOAR-II Quickstart Event, September 16, 2020

https://igacproject.org/activities/TOAR/TOAR-II

TOAR tropospheric ozone assessment report Phase II

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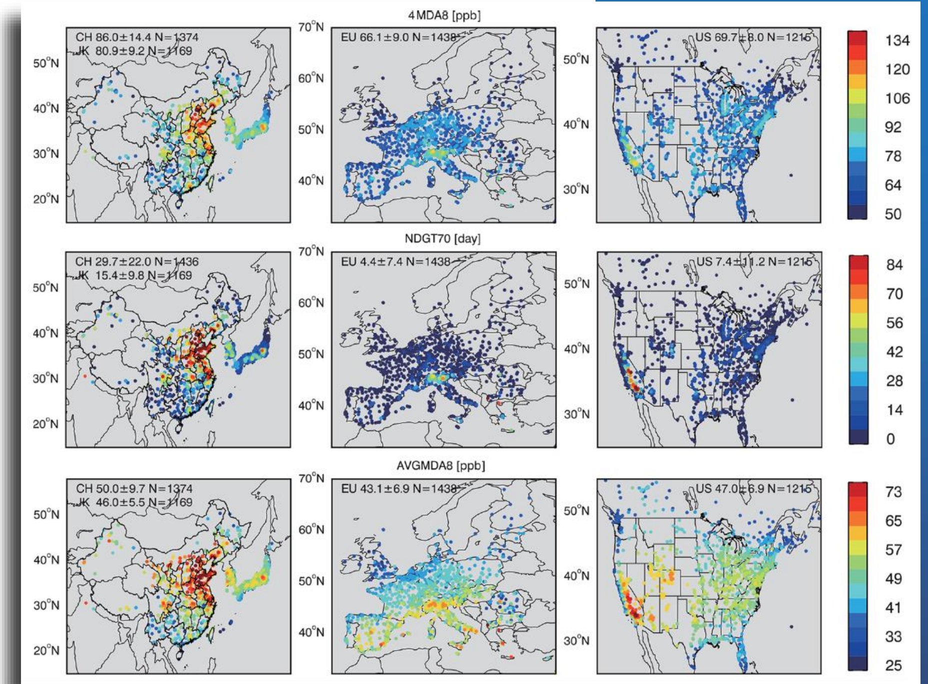

This paper confirmed that China is the global hotspot for surface ozone pollution

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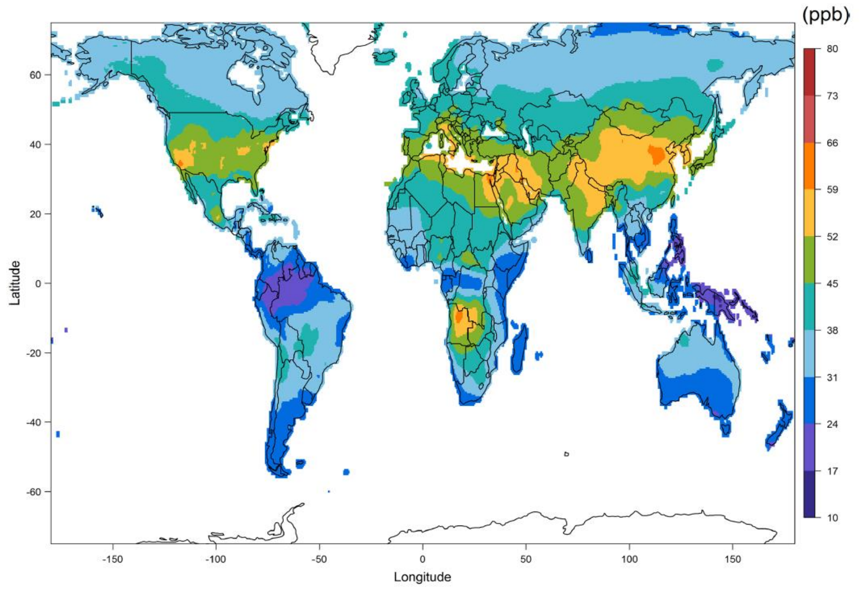

(a) Multi-model composite

This paper combined the TOAR data with 5 global models to produce a more accurate map of ozone exposure

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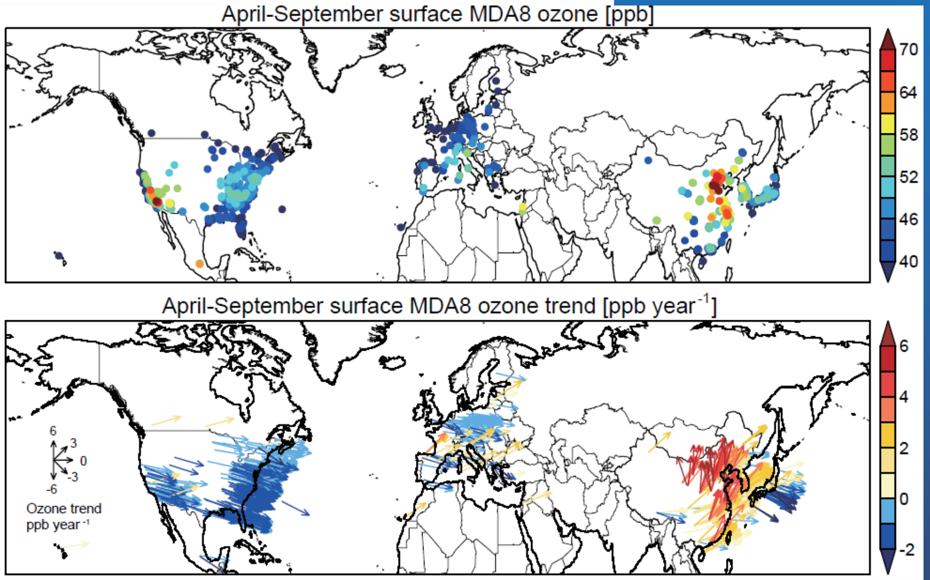

Since 2013 ozone has increased rapidly across China, despite emissions reductions.

https://igacproject.org/activities/TOAR/TOAR-II

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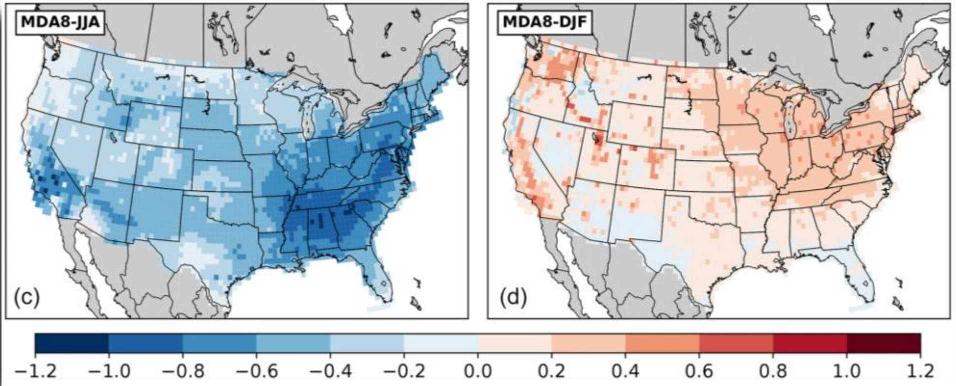

Trends (ppb per year) of MDA8 ozone (2000-2015) for summer (left) and winter (right).

Artificial neural networks were applied to the TOAR database to quantify human exposure to ozone across the USA.

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TOAR-II Goals for 2020-2024

1. **TOAR Ozone Data Portal**: Update the TOAR Surface Ozone Database with all recent ozone observations (through 2020); new sites and regions; ozone precursors and meteorological data. Develop methods for including historical data (pre-1975) and create links to repositories of free tropospheric observations.

…further details in the following presentation by Martin Schultz.

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3. **Outreach:** Involve scientists from the atmospheric sciences community, as well as statisticians and scientists who focus on broader issues of global change and sustainability, to identify outstanding science questions in relation to tropospheric ozone. Topics may include *impacts* of tropospheric ozone on climate, human health and vegetation, as well as urban-scale issues (in addition to regional/global scale).

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4. **Maximize exploitation of TOAR data**: 1) help scientists around the world, beyond the TOAR effort, to apply the database to new analyses; 2) explore new data science methods to improve the analysis of global ozone trends and their attribution.

TOAR-II Scientific Scope

An observation-based, up-to-date assessment of tropospheric ozone's distribution and trends on regional, hemispheric and global scales.

Observations include in situ measurements using modern quantitative methods *(e.g. UV-absorption instruments - surface and airborne),* wet chemical ozonesondes, and remote sensing methods from ground-based and space-based platforms *(e.g. lidar, UV-absorption, thermal-infrared)*

Historical data (pre-1975) may also be considered (see *TOAR-Observations*)

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TOAR-II will assess the physical science basis for tropospheric ozone's global distribution and trends *(similar to IPCC Working Group I)*

TOAR-II will also explore and quantify the impacts of tropospheric ozone on human health, crop and ecosystem productivity and climate change *(similar to IPCC Working Group II)*

As TOAR is a science effort, studies may be policy-relevant but not policy-prescriptive.

TOAR-II research will be guided by the community

TOAR-II findings will appear in two TOAR-II Special Issues of a peer-reviewed, open-access journal (*T.B.D.*)

TOAR tropospheric ozone assessment report Phase II

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1) a set of papers contributed to the TOAR-II Community Special Issue

- Paper topics are developed by the community through Focus Working Groups (described later in Helen Worden's presentation)
- These papers should contribute to TOAR-II objectives and support the final TOAR-II assessment
- Papers should make use of TOAR-II data resources

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- Papers should make use of TOAR-II data resources

2) an invited set of core papers comprising the assessment report

- Papers are developed by Assessment Working Groups
- At present, the only specified core papers are updates to *TOAR-Health, TOAR-Climate* and *TOAR-Vegetation*
- Additional core papers will be identified by the TOAR-II Steering Committee, based on input from the TOAR-II community

TOAR-II Status and roadmap

2020

Selection of new steering committee

Planning of objectives and roadmap

Development of enhanced data infrastructure

2021

First TOAR-II workshops

Formation of working groups (WGs)

Beginning of new data collection

Bring data infrastructure online

2022

WGs: Preparation of analyses and planning of manuscripts

Develop new metrics and populate database

2023

Finalize data

Perform new and updated analyses

Draft manuscripts, submit by Sept. 1

2024

Publication of TOAR-II

https://igacproject.org/activities/TOAR/TOAR-II

TOAR tropospheric ozone assessment report Phase II

Detailed information on TOAR-II scope and procedures can be found on the TOAR-II webpage:

https://igacproject.org/activities/TOAR/TOAR-II

Question and Answer Session

facilitated by:

Erika von Schneidemesser

Institute for Advanced Sustainability Studies, Potsdam, Germany

To sign up for the TOAR-II email list, or for more information on TOAR-II please visit our webpage:

https://igacproject.org/activities/TOAR/TOAR-II

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