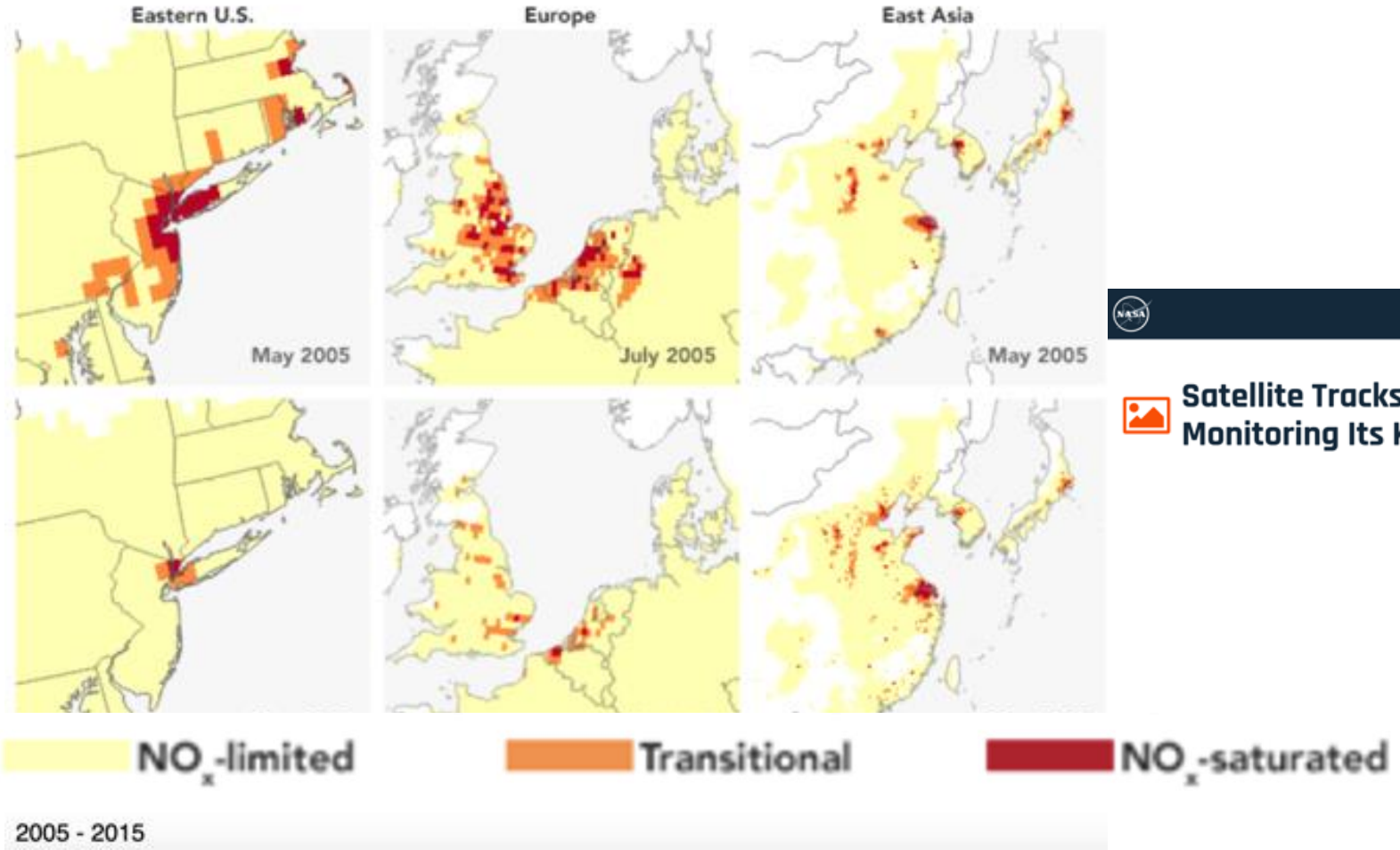
Broadening Access to Satellite Data

The NASA Health and Air Quality Applied Sciences Team (HAQAST)

Tracey Holloway, HAQAST Team Lead, University of Wisconsin—Madison



earth observatory

Satellite Tracks Ozone Pollution by Monitoring Its Key Ingredients

https://earthobservatory.nasa.gov/images/91234/satellite-tracks-ozone-pollution-by-monitoring-its-key-ingredients

Some theoretical results concerning O_3-NO_x-VOC chemistry and NO_x-VOC indicators

Sanford Sillman and Dongyang He
Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, Ann Arbor, Michigan, USA

Geophysical Research Letters / Volume 31, Issue 6

Atmospheric Science | Free Access

2002

Space-based diagnosis of surface ozone sensitivity to anthropogenic emissions

Randall V. Martin, Arlene M. Fiore, Aaron Van Donkelaar

First published: 24 March 2004

2004

Application of OMI observations to a space-based indicator of NO_x and VOC controls on surface ozone formation

Bryan N. Duncan [a], Yasuko Yoshida [a b], Jennifer R. Olson [c], Sanford Sillman [d], Randall V. Martin [e f], Lok Lamsal [e], Yongtao Hu [g], Kenneth E. Pickering [a], Christian Retscher [a b], Dale J. Allen [h], James H. Crawford [c]

2010

Integrating Satellite Data into Air Quality Management: Experience from Colorado

by Sarah Witman and Tracey Holloway, University of Wisconsin-Madison; and Patrick J. Reddy, Colorado Department of Public Health and Environment

Page 34

2014

Spatial and temporal variability of ozone sensitivity over China observed from the Ozone Monitoring Instrument

Xiaomeng Jin[1] and Tracey Holloway[1]

2015

Evaluating a Space-Based Indicator of Surface Ozone-NO_x-VOC Sensitivity Over Midlatitude Source Regions and Application to Decadal Trends

Xiaomeng Jin[1], Arlene M. Fiore[1], Lee T. Murray[2], Lukas C. Valin[3], Lok N. Lamsal[4,5], Bryan Duncan[4], K. Folkert Boersma[6,7], Isabelle De Smedt[8], Gonzalo Gonzalez Abad[9], Kelly Chance[9], and Gail S. Tonnesen[10]

2017

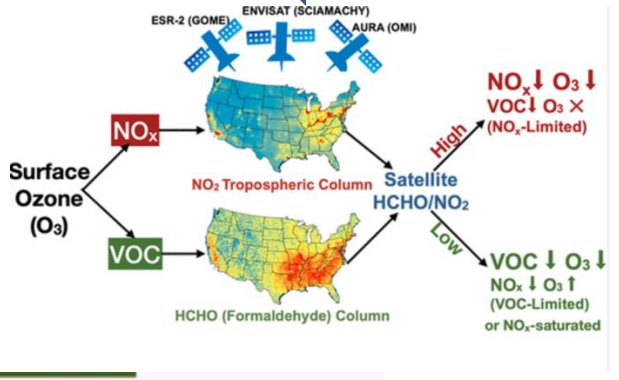
2020

RETURN TO ISSUE | < PREV **ARTICLE** NEXT >

Inferring Changes in Summertime Surface Ozone–NO_x–VOC Chemistry over U.S. Urban Areas from Two Decades of Satellite and Ground-Based Observations

Xiaomeng Jin*, Arlene Fiore, K. Folkert Boersma, Isabelle De Smedt, and Lukas Valin

Cite this: *Environ. Sci. Technol.* 2020, 54, 11, 6518–6529
Publication Date: April 29, 2020
https://doi.org/10.1021/acs.est.9b07785

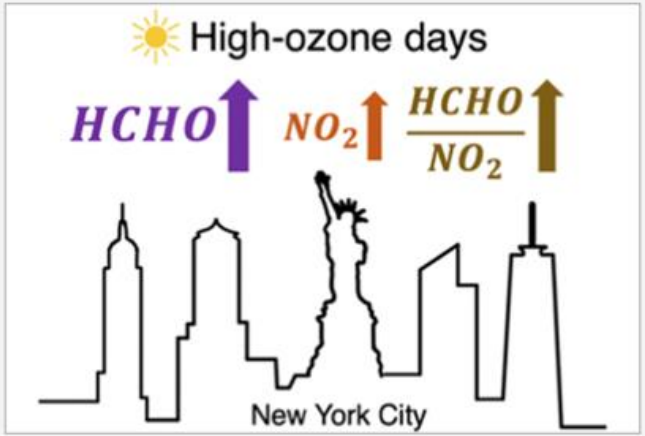


RETURN TO ISSUE | < PREV **ANTHROPOGENIC IMPACT...** NEXT >

Investigating Changes in Ozone Formation Chemistry during Summertime Pollution Events over the Northeastern United States

Madankui Tao*, Arlene M. Fiore, Xiaomeng Jin, Luke D. Schiferl, Róisín Commane, Laura M. Judd, Scott Janz, John T. Sullivan, Paul J. Miller, Alexandra Karambelas, Sharon Davis, Maria Tzortziou, Lukas Valin, Andrew Whitehill, Kevin Civerolo, and Yuhong Tian

Cite this: *Environ. Sci. Technol.* 2022, 56, 22, 15312–15327
Publication Date: October 11, 2022
https://doi.org/10.1021/acs.est.2c02972



2022

2023

Table 1: Overview of ease of use (green/E: easy, yellow/M: medium, red/D: difficult; based on author judgement for users without programming experience), analysis capabilities and datasets available relevant to ozone sensitivity analysis including temporal averaging, division across variables, and inclusion of TROPOMI data (green/Y: yes, red/N: no) of five satellite data visualization tools: NASA Worldview, NASA Giovanni, NASA Panoply, Google Earth Engine, and flexible data analysis software including Python, IDL, R, Matlab, and other related environments.

	Ease of Use	*Allows time averaging (2+ days)*	*Allows division among variables*	*Includes TROPOMI*
NASA Worldview	**E**	**N**	**N**	**N**
NASA Giovanni	**E**	**Y**	**N**	**N**
Panoply	**E**	**N**	**Y**	**Y**
Google Earth Engine	**M**	**Y**	**Y**	**Y**
Python, IDL, R, Matlab, etc.	**D**	**Y**	**Y**	**Y**

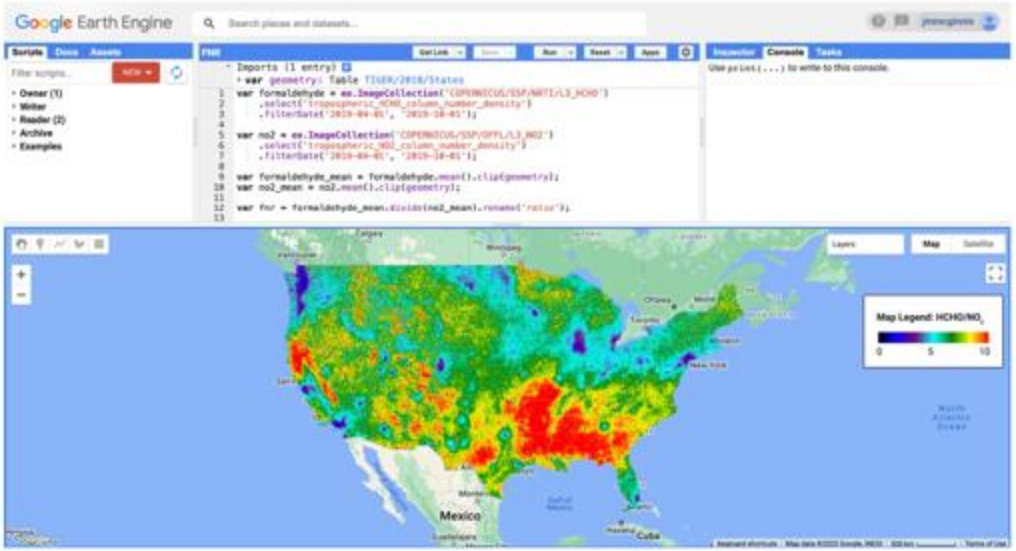
Satellite Data to Inform Ozone Sensitivity: A Practical Methodology Using Google Earth Engine

Authors: Jennifer McGinnis, Tracey Holloway, Jenny Bratburd, Madankui Tao, and Arlene Fiore

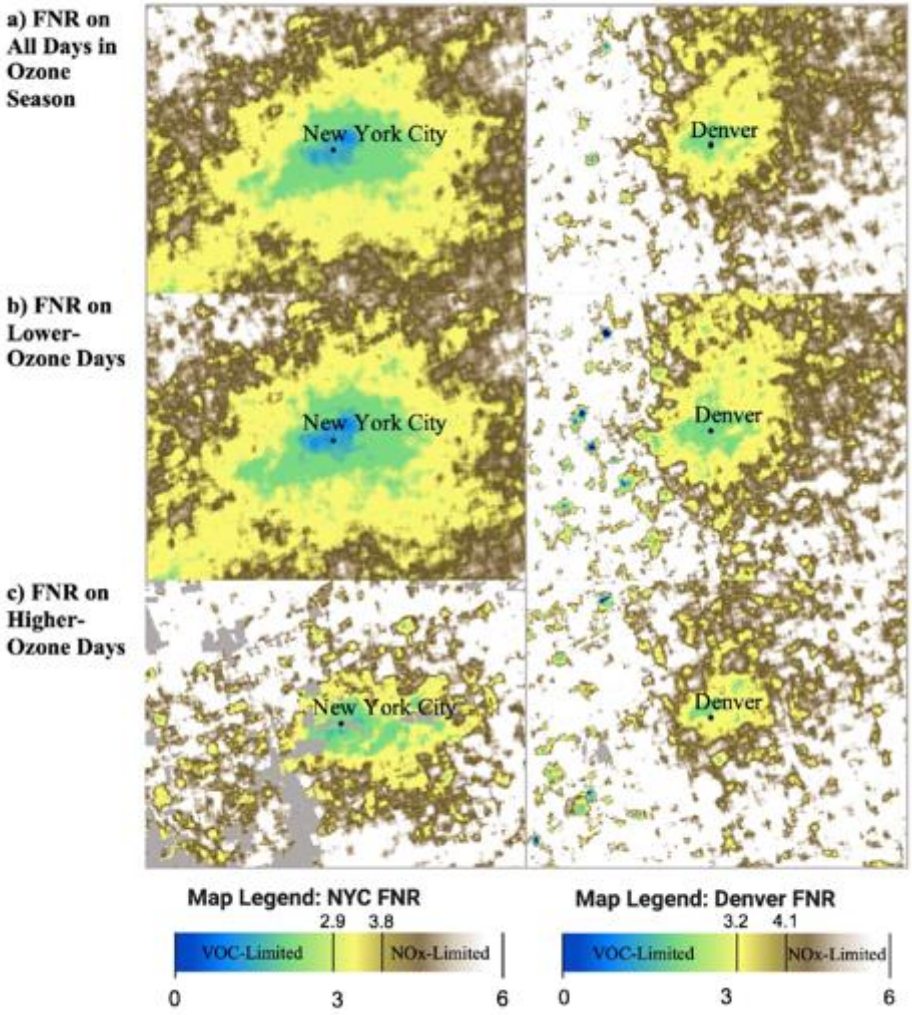
Accepted - EM for Special Issue on Ozone

Using Google Earth Engine to Evaluate Ozone Sensitivity

- Google Earth Engine offers the most user-friendly approach for analyzing the best-available global satellite data for HCHO and NO2 from TROPOMI
- Range of analyses useful in analyzing ozone sensitivities, including:
  - Plotting averages of consecutive or nonconsecutive dates
  - Calculating the product or ratio of variables



Screenshot of the doe editor available in Google Earth Engine with example code and imagery



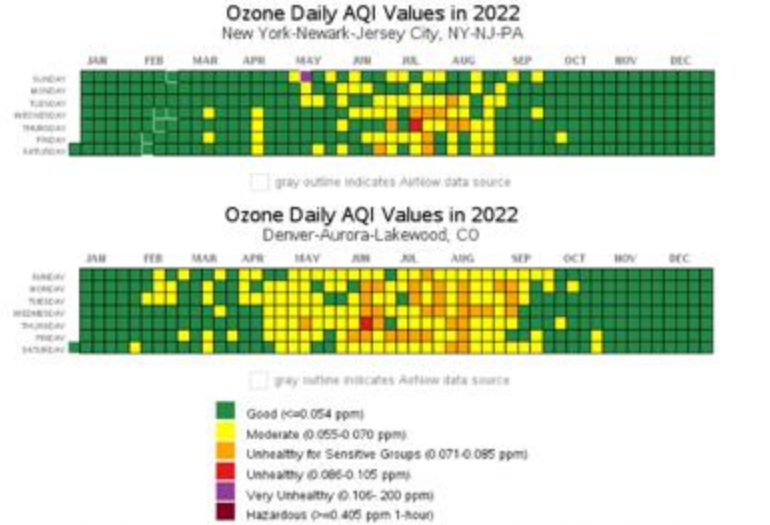
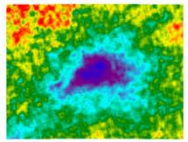
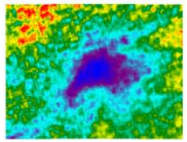
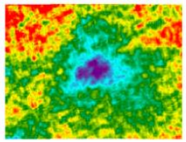
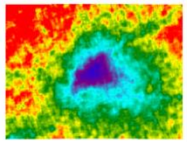
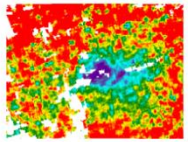
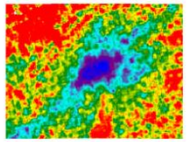
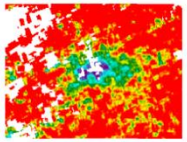
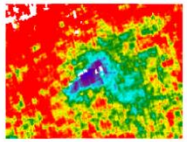
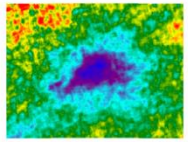
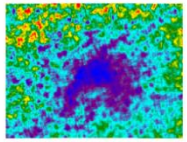
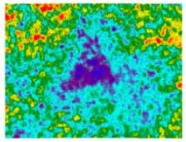
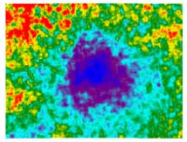


Figure 3: Daily ozone AQI values for 2022 from EPA Outdoor Air Quality Data Viz Tools, Single Year Tile Plot, for the New York City MSA (New York, NY; Newark, NJ; and Jersey City, PA; top) and the Denver MSA (Denver, Aurora, and Lakewood, CO; bottom). For this analysis, green/Good and yellow/Moderate are considered lower-ozone days; all day orange/Unhealthy for Sensitive Groups or higher (0.071 ppm or higher) are considered higher-ozone days.
Source: https://www.epa.gov/outdoor-air-quality-data/air-data-tile-plot

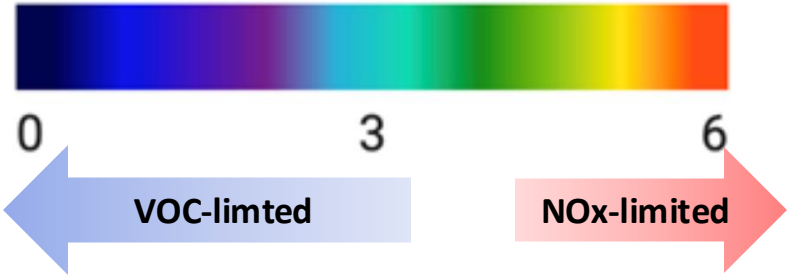
Figure 4: Because the quality assurance of NO_2 is more selective than that of HCHO, in some areas there are a different number of available days of NO_2 in comparison to HCHO. However, a mask was applied mask was applied to ensure at least 10 pixels of NO_2 data and HCHO data were temporally averaged before calculating the ratio. (a) FNR average of all days during the ozone season. Over New York City (left), 153 days were plotted (mean of 112 days of NO_2 and 127 days of HCHO available per pixel). Over Denver (right), 153 days were plotted (mean of 105 days of NO_2 and 109 days of HCHO available per pixel). (b) FNR on days categorized as lower-ozone days during the ozone season. Over New York City, 141 days were plotted (mean of 100 days of NO_2 and 114 days of HCHO available per pixel). Over Denver, 118 days were plotted (mean of 72 days of NO_2 and 76 days of HCHO available per pixel). (c) FNR on days categorized as higher-ozone days during the ozone season. Over New York City, 12 days were plotted (mean of 12 days of NO_2 and 12 days of HCHO available per pixel). Over Denver, 35 days were plotted (mean of 32 days of NO_2 and 32 days of HCHO available per pixel).

1. New York City, New York

Higher ozone days are more NOx-limited (all TROPOMI years)

	2022	2021	2020	2019
Average Summer				
Higher ozone days				
Lower ozone days				

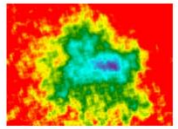
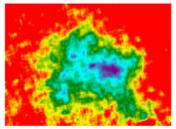
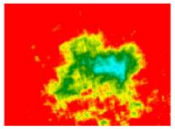
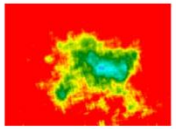
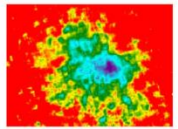
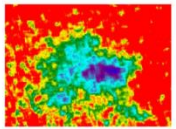
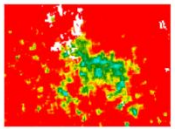
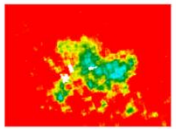
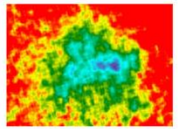
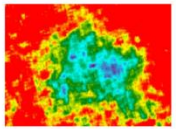
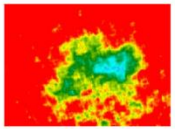
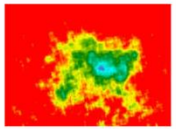
Map Legend: FNR



< 3.2 = VOC-limited
3.2 - 4.1 = Transitional
> 4.1 are NOx-limited
Thresholds from Jin et al. (2020)

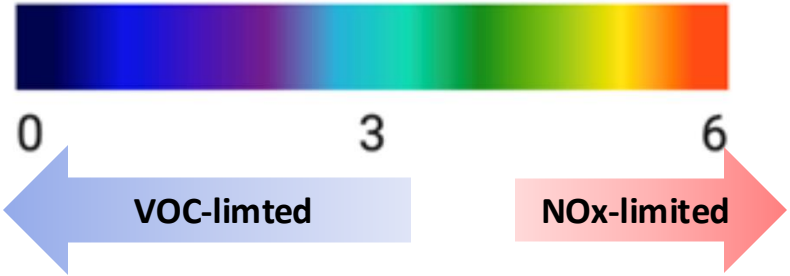
DRAFT from Raghad Bajouda via Google Earth

4. Houston, Texas

	2022	2021	2020	2019
Average Summer				
Higher ozone days				
Lower ozone days				

Higher ozone days can be more NOx-limited or more VOC-limited

Map Legend: FNR

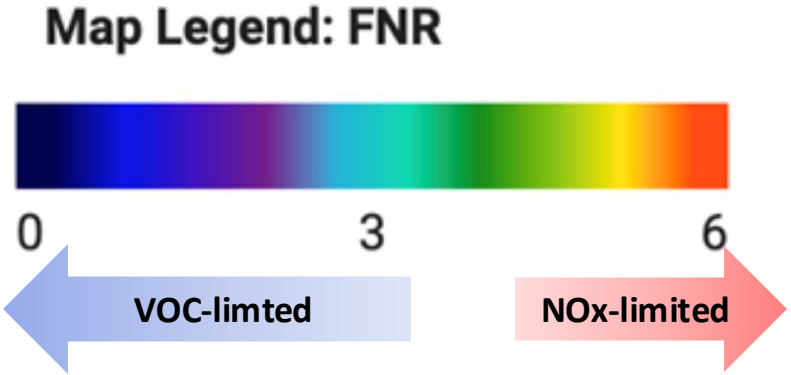


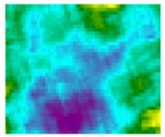
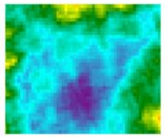
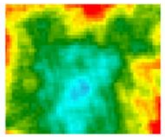
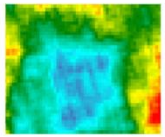
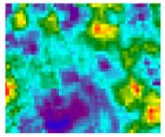
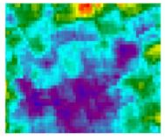
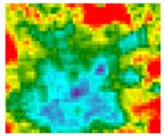
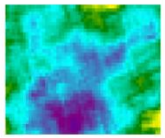
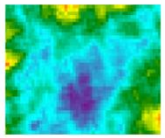
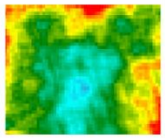
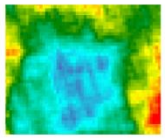
< 3.2 = VOC-limited
3.2 - 4.1 = Transitional
> 4.1 are NOx-limited
Thresholds from Jin et al. (2020)

DRAFT from Raghad Bajouda via Google Earth

24. Las Vegas, Nevada

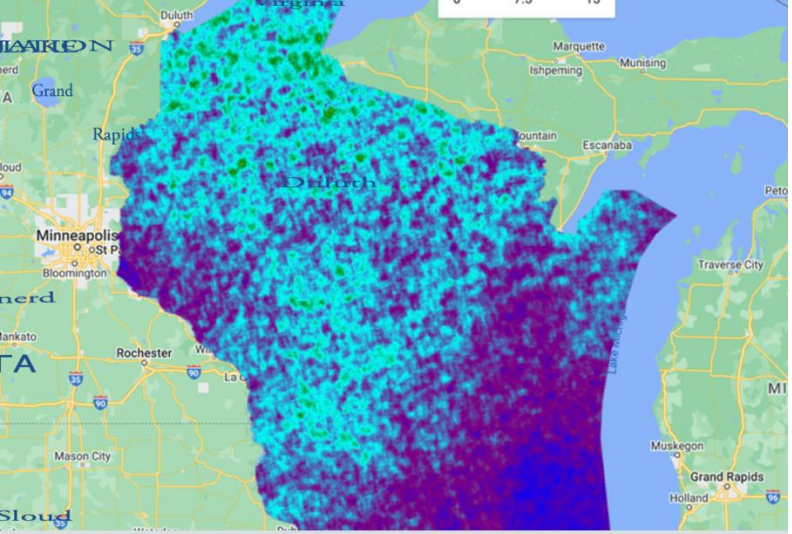
Higher ozone days are be more VOC-limited



	2022	2021	2020	2019
				
Average Summer				
Higher ozone days				**4 high days - not enough**
Lower ozone days				

< 3.2 = VOC-limited
3.2 - 4.1 = Transitional
> 4.1 are NOx-limited
Thresholds from Jin et al. (2020)

DRAFT from Raghad Bajouda via Google Earth



Plotting the Ratio of TROPOMI Formaldehyde and Nitrogen Dioxide Satellite Data: An Indicator of Ozone Sensitivity

User friendly tutorials using Google Earth Engine to plot the ratio of formaldehyde to nitrogen dioxide that can be used to assess ozone sensitivity.

Apr 20, 2023

Tutorial: Google Earth to calculate ozone indicator ratios in your city, state or region

https://hollowaygroup.org/tutorials

Jennifer McGinnis

	Ease of Use	*Allows time averaging (2+ days)*	*Allows division among variables*	*Includes TROPOMI*
NASA Worldview	E	N	N	N
NASA Giovanni	E	Y	N	N
Panoply	E	N	Y	Y
Google Earth Engine	M	Y	Y	Y
Python, IDL, R, Matlab, etc.		Y	Y	Y

Can this be M too??

Satellite Data to Inform Ozone Sensitivity: A Practical Methodology Using Google Earth Engine

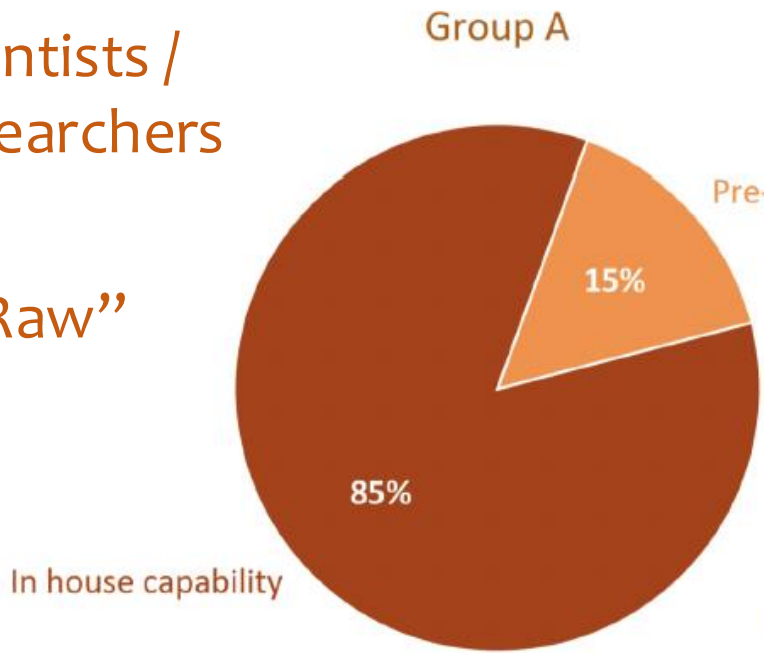
Authors: Jennifer McGinnis, Tracey Holloway, Jenny Bratburd, Madankui Tao, and Arlene Fiore

Accepted - EM for Special Issue on Ozone

Would a of service, (a) where you can download pre-processed, uniform datasets, be valuable to you, or is it preferred to (b) handle the original data and gain the full expertise and understanding in house?

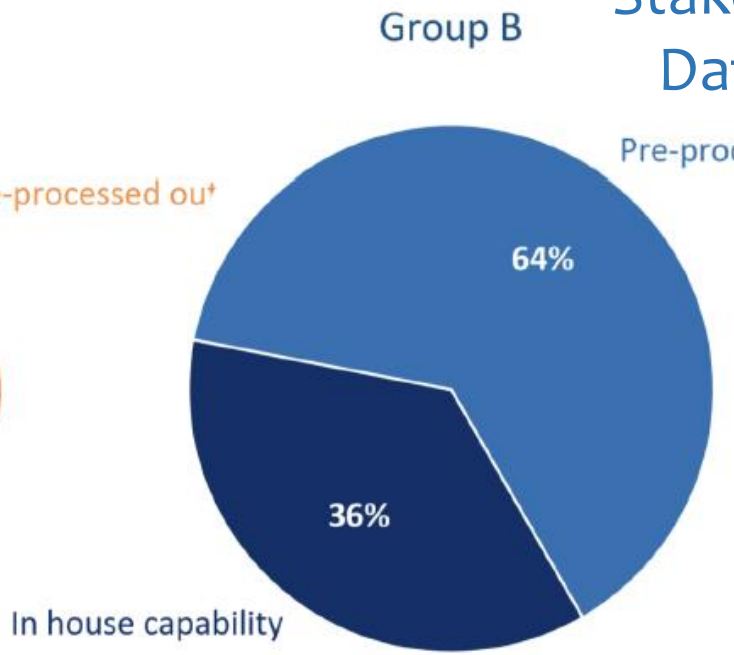
Scientists / Researchers

"Raw"

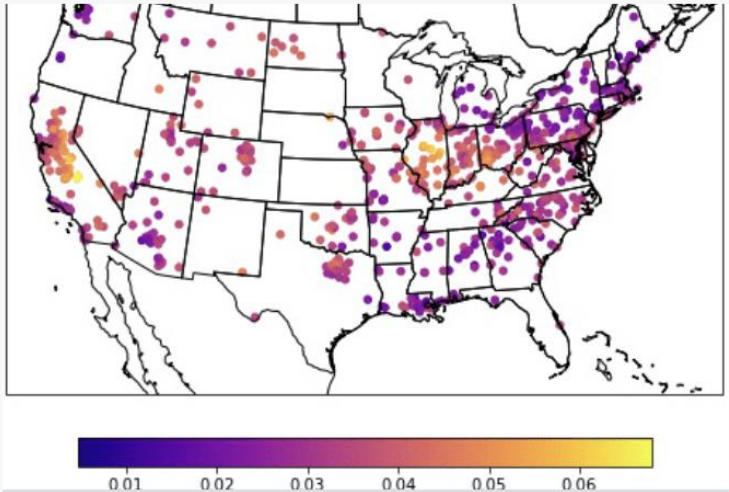


Stakeholders / Data Users

"Pre-processed



Dan Potts, Josh Vande Hey, and Emma Ferranti, Accepted, Environmental Science & Policy



Python Tutorials for Atmospheric and Geophysical Sciences

Designed for undergraduate and graduate students with no or minimal prior coding experience, these atmospheric and geophysical science Python tutorials are targeted toward students with an interest in air quality and the atmospheric sciences.

May 3, 2023

Tutorial: Learn to use Python in 8 user-friendly tutorials

https://hollowaygroup.org/tutorials

Tutorial 1 (intro):	94
Tutorial 2 (tables and lists):	74
Tutorial 3 (plotting):	53
Tutorial 4 (maps with Cartopy):	49
Tutorial 5 (functions/loops):	40
Tutorial 6 (netCDF and Xarray):	53
Tutorial 7 (plotting/selecting netCDF coords):	44
Tutorial 8 (remote data):	40

Alicia Hoffman and Gesangyangji


Kalaallit Nunaat
Ísland
Norge
Suomi / Finland
Sverige
Россия
Беларусь
Україна
Қазақстан
Монгол улс
România
Italia
España
Ελλάς
O'zbekiston
Türkmenistan
Algérie
الجزائر
Libya
ليبيا
Egypt
مصر
السعودية
Mauritania
موريتانيا
Mali
Niger
Centrafrique
Soomaaliya
الصومال
République démocratique du Congo
Tanzania
Angola
Mozambique
Namibia
South Africa
Malaysia
Papua Niugini
Australia
New Zealand
Aotearoa
Canada
México
Perú
Bolivia
Brasil
Paraguay / Paraguái
Chile
Argentina

LINKING AIR QUALITY WITH ENERGY & PUBLIC HEALTH

The Holloway Group Advances Air Quality Research To Inform Science And Policy. We Partner With Organizations To Ensure The Relevance Of Our Work To Real-World Needs.

hollowaygroup.org