Using Satellite Data: Where to Start?

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

Tracey Holloway, Team Lead & Jenny Bratburd, Outreach Coordinator

University of Wisconsin—Madison

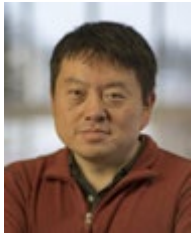
What is “hay-kast”?

- Health and Air Quality Applied Sciences Team
- 4 year initiative through January 2025
- 14 Members and 60+ co-investigators
- Mission: Connect NASA science with air quality and health applications
- Four types of work:
  - Member projects
  - Tiger team projects (collaborative)
  - Rapid Response (emergent/immediate)
  - Outreach, engagement









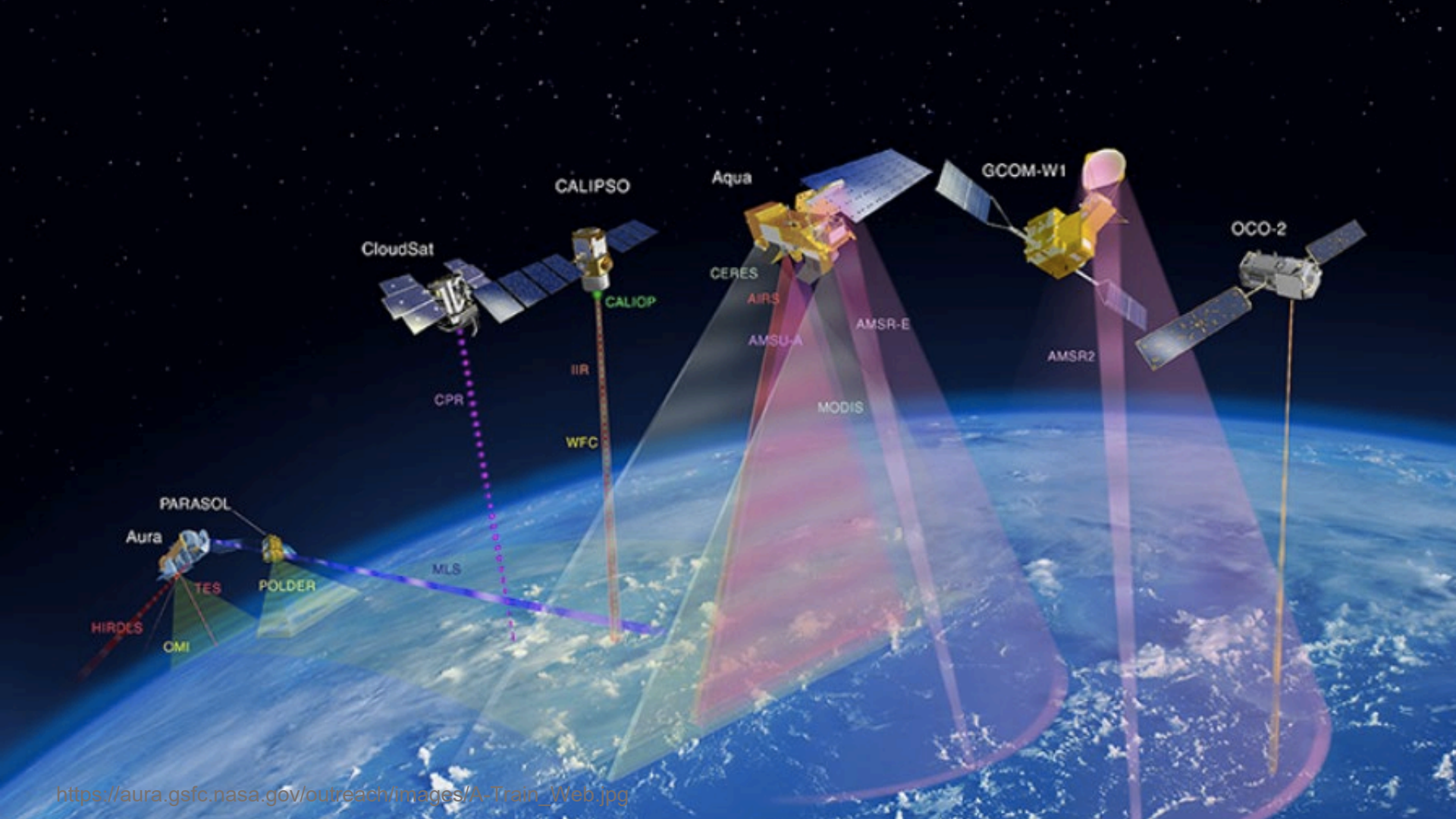




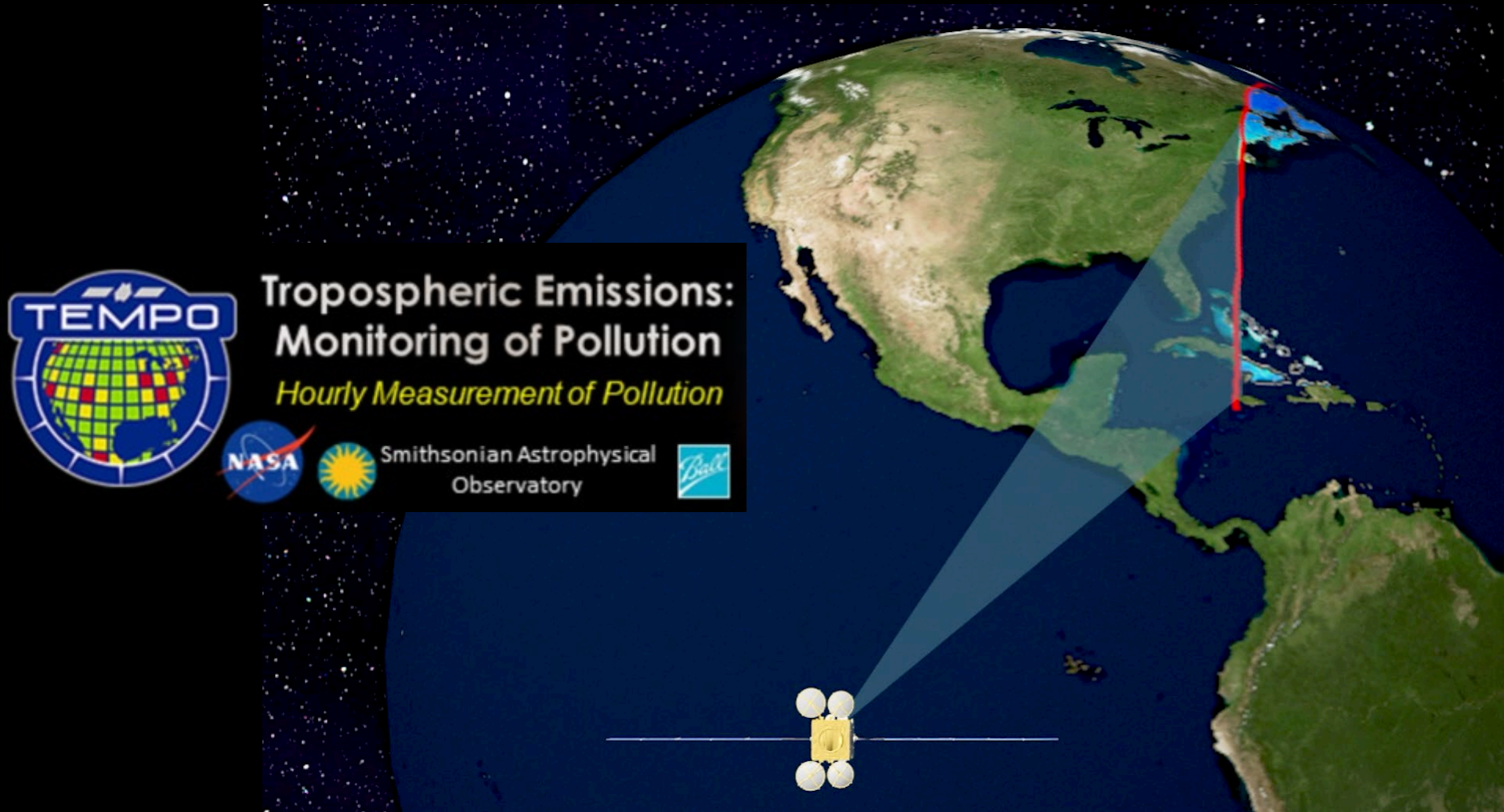

14 NASA Health and Air Quality Applied Sciences Team Members (HAQAST)

Tracey Holloway (Team Lead, UW-Madison)
Susan Anenberg (George Washington University)
Bryan Duncan (NASA GSFC)
Arlene Fiore (Massachusetts Institute of Technology)
Pawan Gupta (NASA GSFC)
Yang Liu (Emory University)
Jingqiu Mao (University of Alaska, Fairbanks)
Randall Martin (Washington University)
Ted Russell (Georgia Tech)
Jeffrey Pierce (Colorado State University)
Amber Soja (National Institute of Aerospace)
Daniel Tong (George Mason University)
Christopher Uejio (Florida State University)
Qian Xiao (University of Texas Health Science Center at Houston)

haqast.org



https://aura.gsfc.nasa.gov/outreach/images/A-Train_Web.jpg


TEMPO
Tropospheric Emissions:
Monitoring of Pollution
Hourly Measurement of Pollution
NASA
Smithsonian Astrophysical
Observatory
Ball

Scientists / Researchers

Group A
Academia/University
Research institute
Private enterprise
Government advisory group

Stakeholders / Data Users

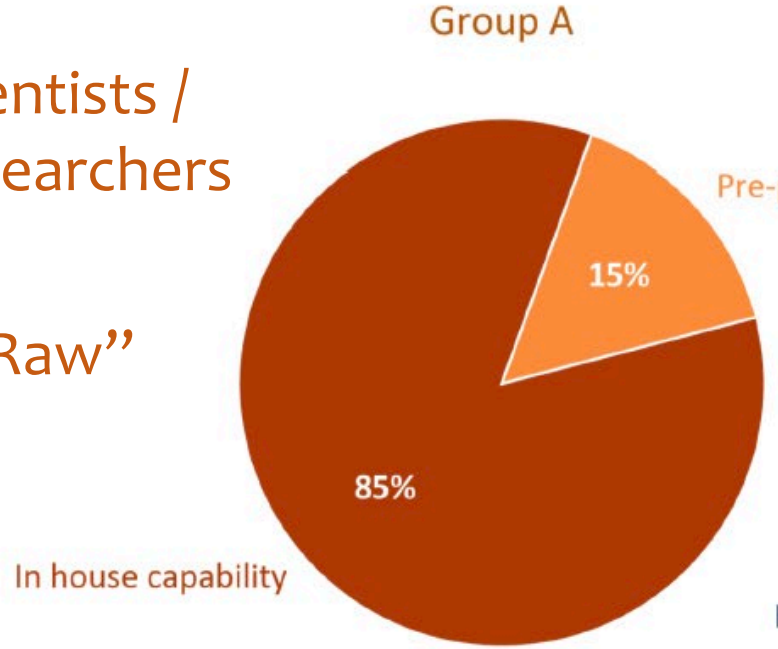
Group B
Government regulatory body
Local authority
Air quality consultancy
Research institute/Government lab
Public health

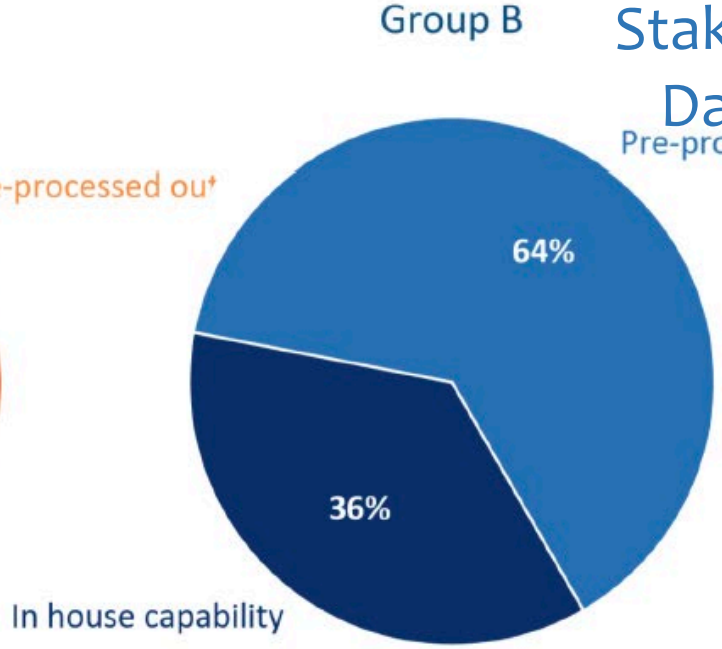
Daniel A. Potts, Emma J.S. Ferranti, Joshua D. Vande Hey, Investigating the barriers and pathways to implementing satellite data into air quality monitoring, regulation and policy design in the United Kingdom, Environmental Science & Policy, Volume 151, 2024.

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"



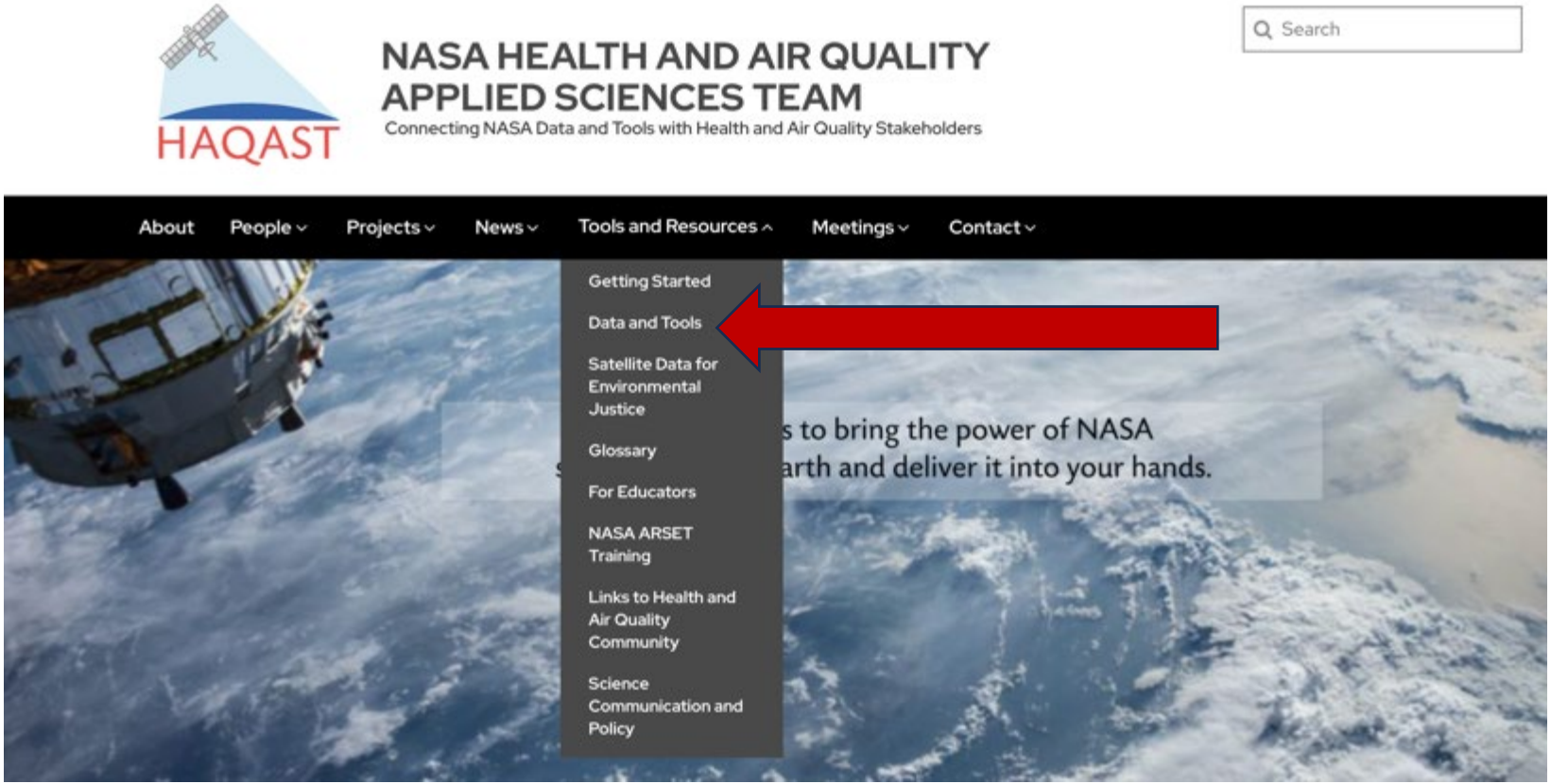


Stakeholders / Data Users

"Pre-processed

Daniel A. Potts, Emma J.S. Ferranti, Joshua D. Vande Hey, Investigating the barriers and pathways to implementing satellite data into air quality monitoring, regulation and policy design in the United Kingdom, Environmental Science & Policy, Volume 151, 2024.

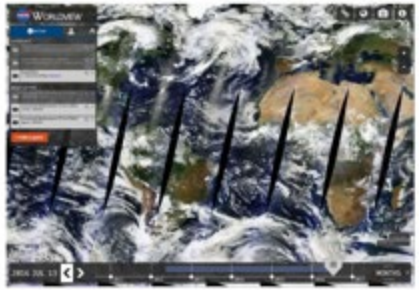
haqast.org


HAQAST
NASA HEALTH AND AIR QUALITY APPLIED SCIENCES TEAM
Connecting NASA Data and Tools with Health and Air Quality Stakeholders
Search
About
People
Projects
News
Tools and Resources
Meetings
Contact
Getting Started
Data and Tools
Satellite Data for Environmental Justice
Glossary
For Educators
NASA ARSET Training
Links to Health and Air Quality Community
Science Communication and Policy
s to bring the power of NASA
arth and deliver it into your hands.

Data and Tools

NASA's data and tools are free to the public. On this page, you can find:

- Links to available NASA data and tools
- Other free data and toolsets
- Tutorials to get you started



For more general resources that may be of interest, please visit our links page.

And if you are brand-new to working with satellite data, please visit our Getting Started page, which will orient you to the uses, as well as the limits of satellite data.

Flowchart of Resources and Data Products

The Flowchart of Resources and Data Products for Health and Air Quality Applications with an Emphasis on Satellite Data is intended to be a resource for users that are interested in using satellite data but are new to the data products and their capabilities. This document contains a flowchart that will guide users from a general question or need to a specific resource. For brevity this document focuses on the United States, but this resource will be extended to provide data products for global applications. Access it here.

HAQAST

HAQAST Ambassadors

Zach Adelman (Lake Michigan Air Directors Consortium)
Temilayo Adeyeye (New York State Department of Health)
Doug Boyer (Texas Commission on Environmental Air Quality)
Kelly Crawford (US Department of Energy)
Michael Geigert (Connecticut Department of Energy and Environmental Protection)
Barron H. Henderson (US EPA)
Tabassum Z Insaf (New York State Department of Health)
Alex Karambelas (NESCAUM)
Byeong-Uk Kim (Georgia Environmental Protection Division)
Maeve MacMurdo (Cleveland Clinic)
Magdalene McCarty Sanders (Earth Stewards)
Steve Moran (Google)
Amirhosein Mousavi (Waste Management)
Leticia Nogueira (American Cancer Society)
Pallavi Pant (Health Effects Institute)
Allison Patton (Health Effects Institute)
Patrick Reddy (Independent, formerly CDPHE)
Eric Stevens (National Park Service)
Mary Tran (US Department of State)
Mary Uhl (WESTAR)

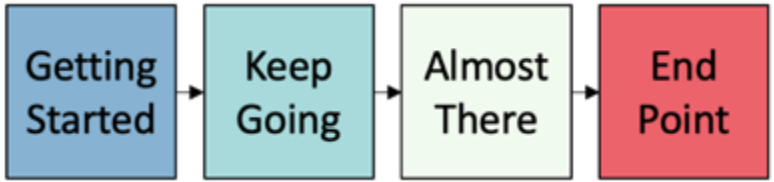
Flowchart of Resources and Data Products for Health and Air Quality Applications with an Emphasis on Satellite Data

Jennifer McGinnis
Tracey Holloway
Jenny Bratburd

Nelson Institute Center for Sustainability and the Global Environment
University of Wisconsin-Madison
Madison, WI 53726

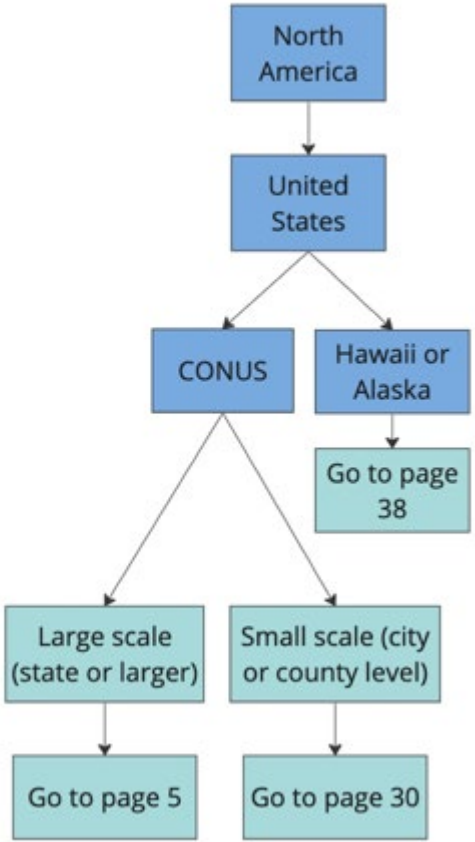
Flowchart of Satellite Data Resources for Health and Air Quality Applications

- Goal: Guide users from a general question to a specific resource
- Current Platform: 54-page clickable document
- End Points: HAQAST tutorials, ARSET tutorials, websites, and publications

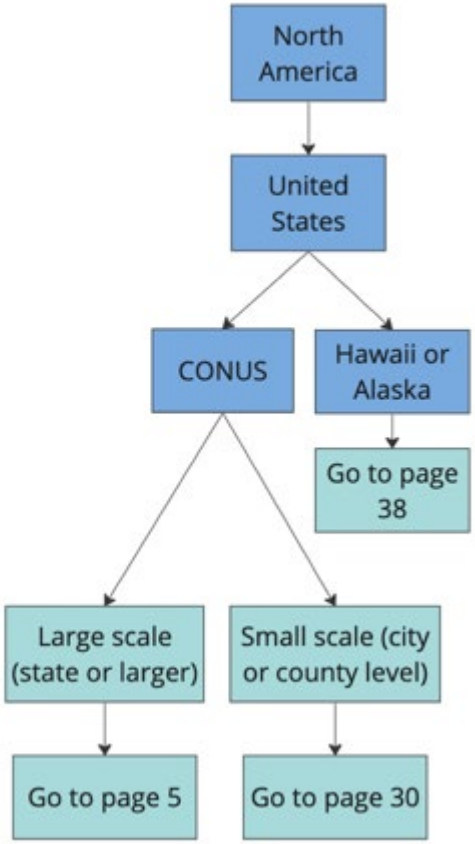


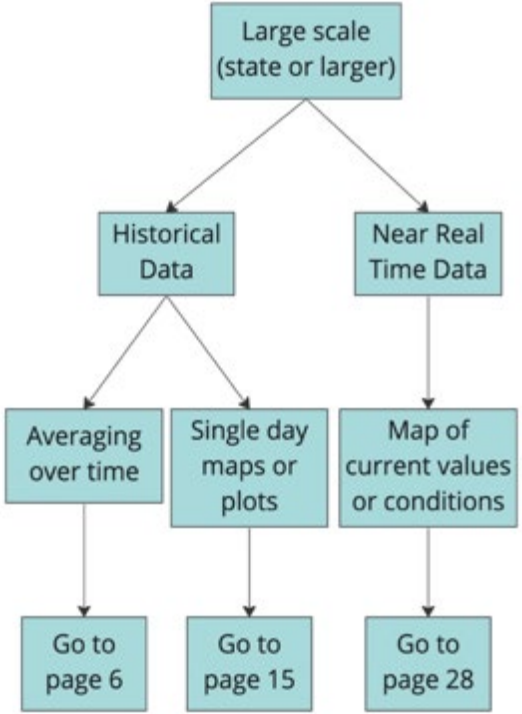
Jennifer McGinnis, Tracey Holloway, and Jenny Bratburd

Flowchart

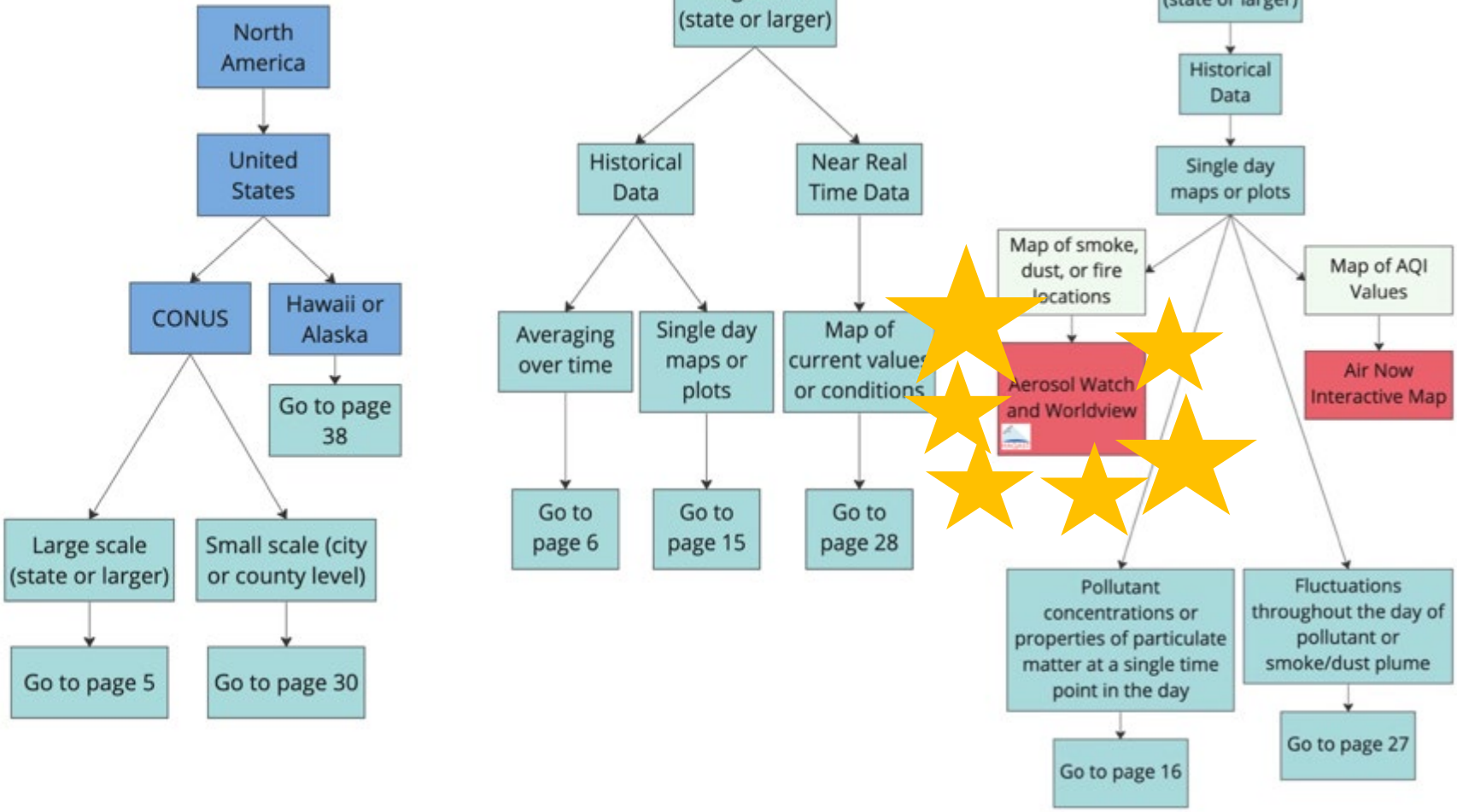

North America
United States
CONUS
Hawaii or Alaska
Go to page 38
Large scale (state or larger)
Small scale (city or county level)
Go to page 5
Go to page 30

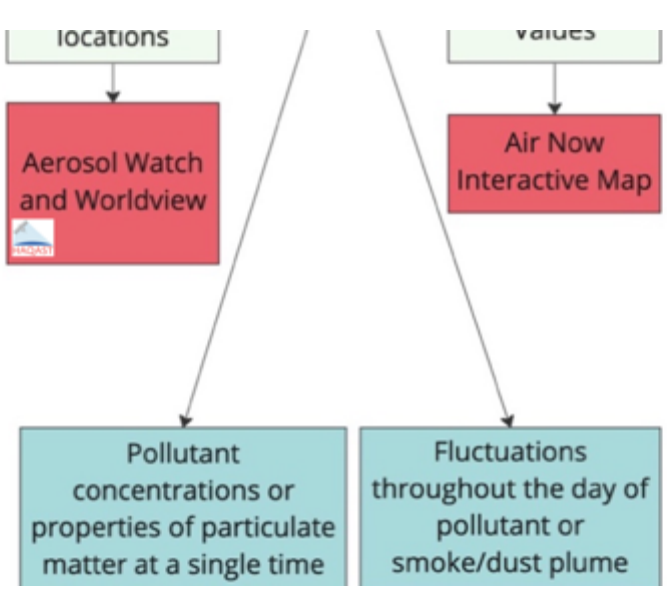
Flowchart


North America
United States
CONUS
Hawaii or Alaska
Go to page 38
Large scale (state or larger)
Small scale (city or county level)
Go to page 5
Go to page 30


Large scale (state or larger)
Historical Data
Near Real Time Data
Averaging over time
Single day maps or plots
Map of current values or conditions
Go to page 6
Go to page 15
Go to page 28

Flowchart


North America
United States
CONUS
Hawaii or Alaska
Go to page 38
Large scale (state or larger)
Small scale (city or county level)
Go to page 5
Go to page 30
Large scale (state or larger)
Historical Data
Near Real Time Data
Averaging over time
Single day maps or plots
Map of current values or conditions
Go to page 6
Go to page 15
Go to page 28
Large scale (state or larger)
Historical Data
Single day maps or plots
Map of smoke, dust, or fire locations
Map of AQI Values
Aerosol Watch and Worldview
Air Now Interactive Map
Pollutant concentrations or properties of particulate matter at a single time point in the day
Fluctuations throughout the day of pollutant or smoke/dust plume
Go to page 16
Go to page 27



- If the user determines they would like a map showing smoke, dust, or fire locations, they will be guided to Aerosol Watch[18] and NASA Worldview.[19] Aerosol Watch is a web-based platform where the user can map satellite imagery and the smoke or dust mask for the day of interest. NASA Worldview is a web-based platform that can show satellite detections of fires for any day the user chooses. Additionally, there is a tutorial for Worldview on the HAQAST website. For this tutorial see (1) on page 53.

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[18] Aerosol Watch - https://www.star.nesdis.noaa.gov/smcd/spb/aq/AerosolWatch/
[19] NASA Worldview - https://worldview.earthdata.nasa.gov/
[20] Air Now Interactive Map - https://gispub.epa.gov/airnow/

Tutorials and Suggested Readings

1) https://haqast.org/data-and-tools/

Tutorials

NASA Worldview

NASA Worldview is the best starting point for users new to satellite data and is freely available online. Worldview provides the capability to interactively browse global, full-resolution satellite imagery and then download the underlying data. Most of the 400+ available products are updated within three hours of observation.

In addition to this short video tutorial you, can view a NASA webinar here, and a written tutorial (you can find a downloadable pdf here).

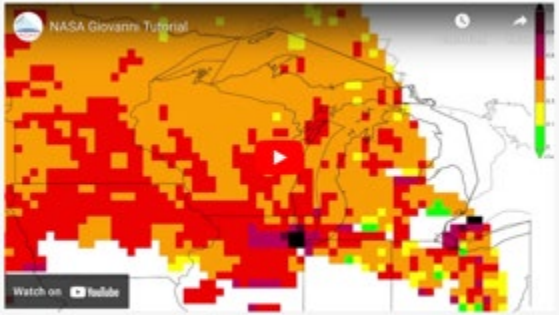
The Basics of Satellite Data for Smoke and Fire

HAQAST Outreach Manager Dr. Daegan Miller shares how you can begin using satellite data to analyze smoke from wildfire events. There are two parts to this tutorial. The image referenced at the end of the second video can be found here. Please visit the US Forest Service's AirFire Research Team at Airfire.org for more information.

NASA GIOVANNI

Along with Worldview, members of the health and air quality community will find Giovanni extremely helpful. Giovanni is a web-based interface that allows users to interactively analyze gridded data online without having to download anything. It is a flexible platform that allows a user to average data over time, create a range of plot types and formats, compare variables, and graphically display information. You can also download plot source files in netCDF format.

Here's a written version of the tutorial (you can find a downloadable pdf here).



NASA Worldview for Fire

This tutorial, led by HAQAST Outreach Manager Dr. Daegan Miller, applies NASA's Worldview for wildfire and smoke observations. Please visit the US Forest Service's AirFire Research Team at Airfire.org for more information.

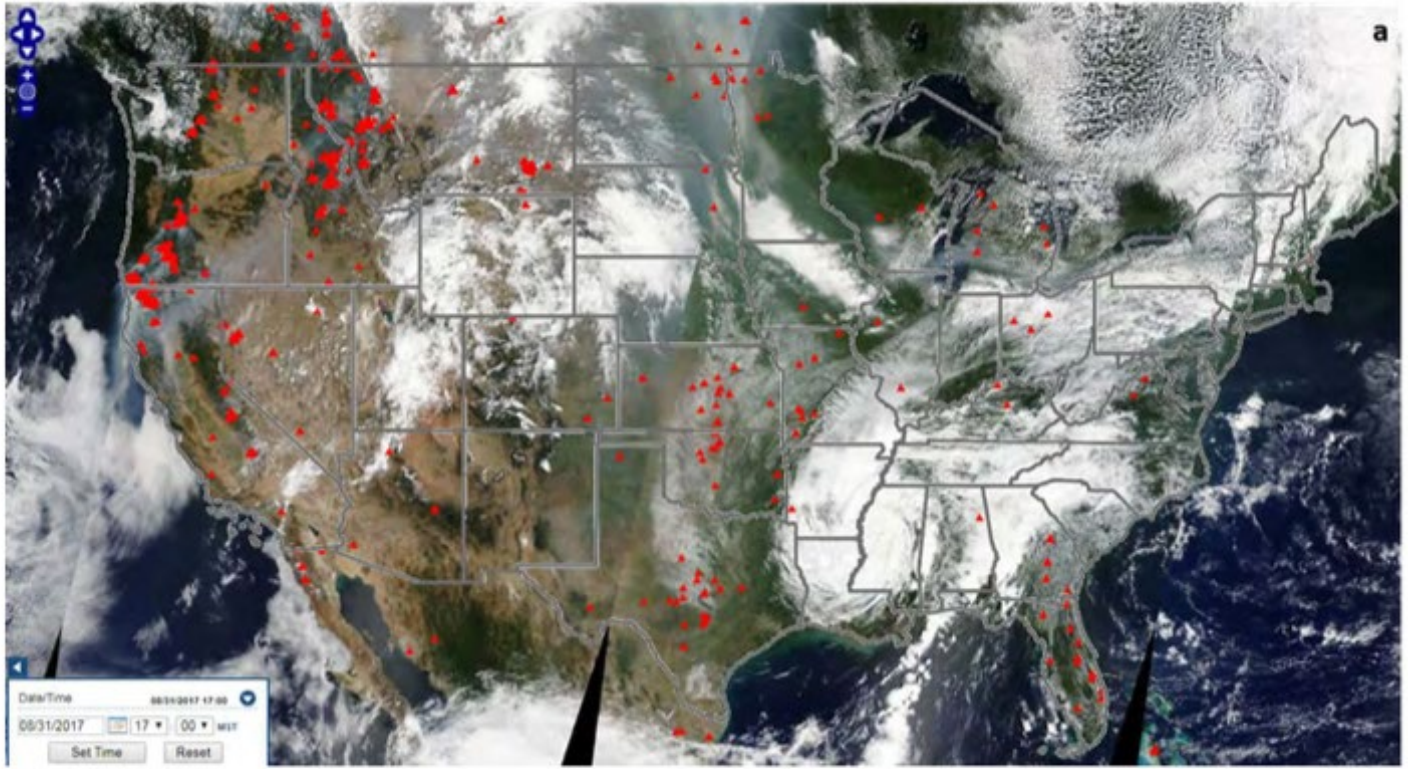
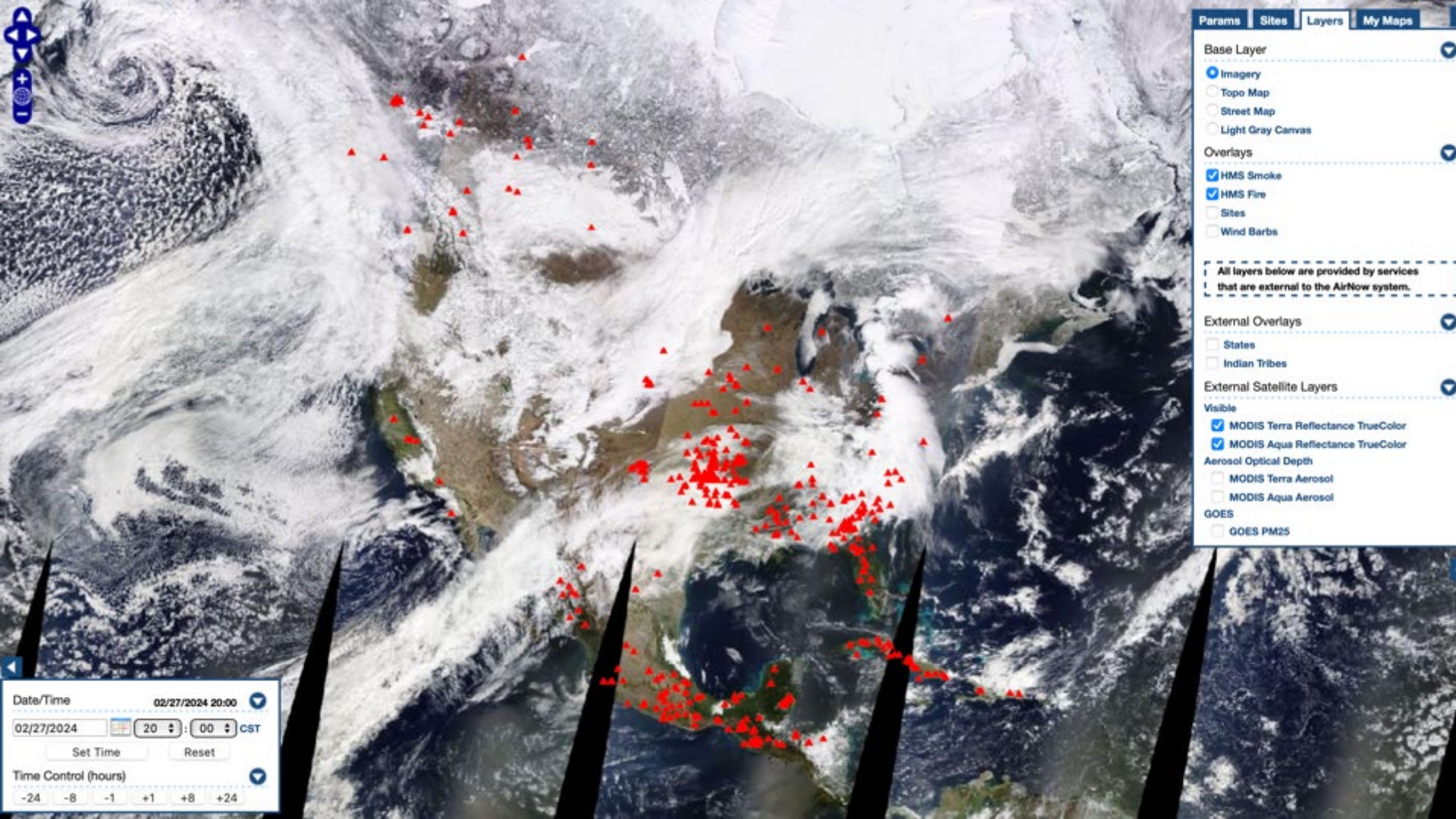


Figure 11a: MODIS Terra True Color satellite image with HMS Fire detection at 5:00 PM MST on August 31, 2017. (source: https://airnowtech.org/navigator)

From Colorado Wildfire Ozone EED for September 2017


Params
Sites
Layers
My Maps
Base Layer
Imagery
Topo Map
Street Map
Light Gray Canvas
Overlays
HMS Smoke
HMS Fire
Sites
Wind Barbs
All layers below are provided by services that are external to the AirNow system.
External Overlays
States
Indian Tribes
External Satellite Layers
Visible
MODIS Terra Reflectance TrueColor
MODIS Aqua Reflectance TrueColor
Aerosol Optical Depth
MODIS Terra Aerosol
MODIS Aqua Aerosol
GOES
GOES PM25
Date/Time
02/27/2024 20:00
02/27/2024
20
00
CST
Set Time
Reset
Time Control (hours)
-24
-8
-1
+1
+8
+24

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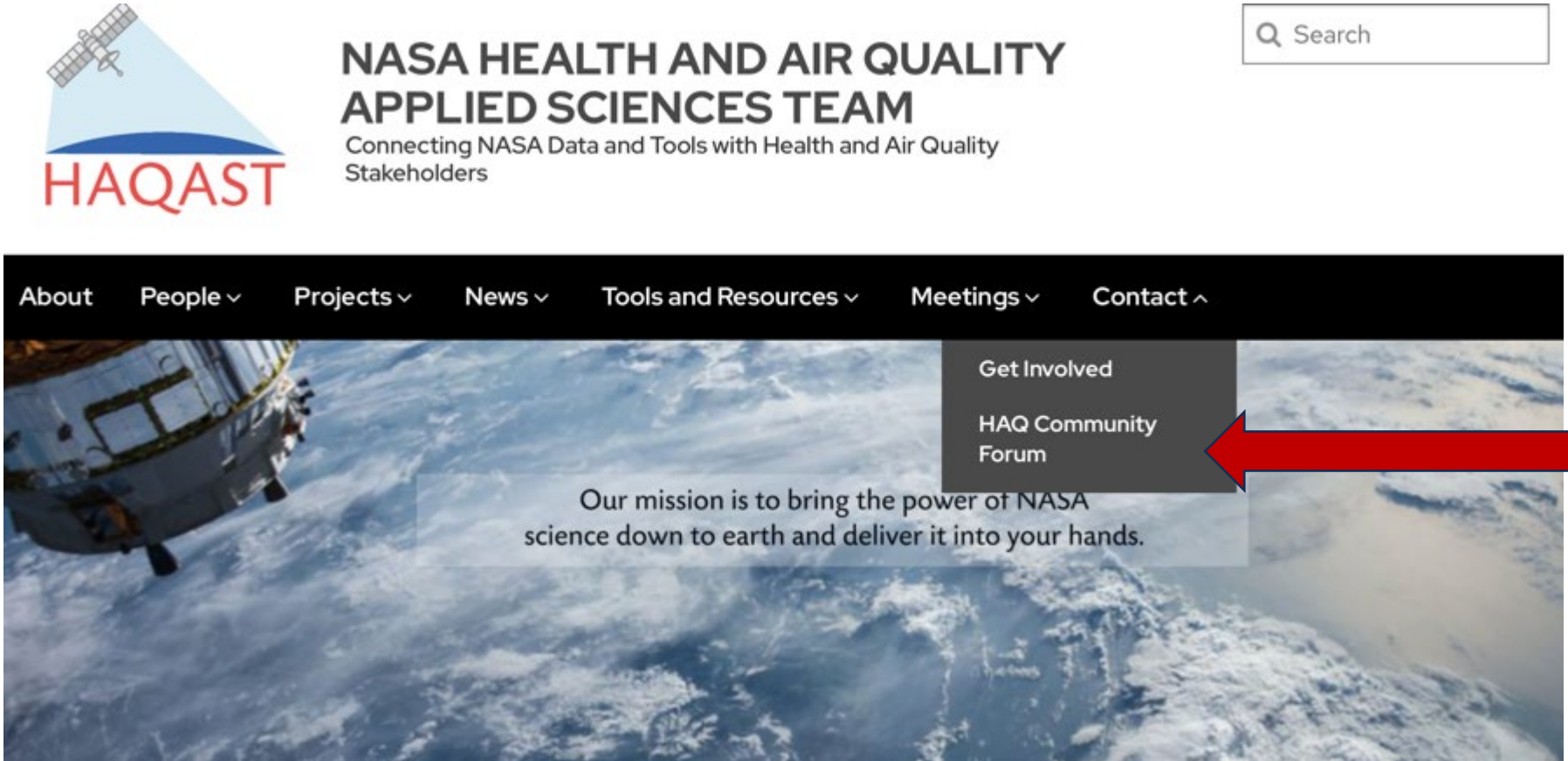
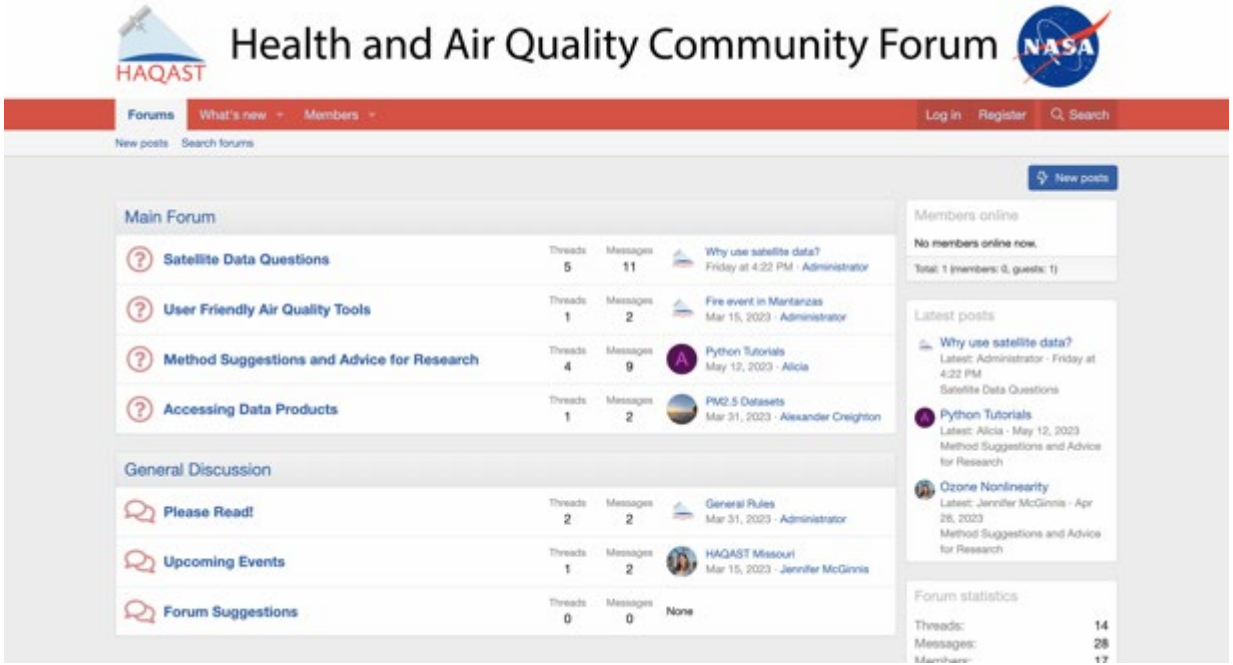
Getting Started Is Easy



Health and Air Quality Community Forum



- Browse already asked questions
- Create a profile to post a question or answer a question
- All levels of expertise are welcome!

https://haq.community.forum/

Jennifer McGinnis, Jenny Bratburd, and Community!!

https://www.earthdata.nasa.gov

SEARCH BY TITLE

exceptional event

LANGUAGE

- Any -

APPLY

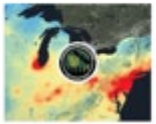
HEALTH & AIR QUALITY

ARSET - Satellite Data for Air Quality Environmental Justice and Equity Applications

TRAINING TYPE: Online Instructor Led

LEVEL: Intermediate

DATE: August 23, 2023 - September 06, 2023



HEALTH & AIR QUALITY

ARSET - NASA Air Quality-Focused Remote Sensing for EPA Applications

TRAINING TYPE: In-Person Training

LEVEL: Advanced

DATE: March 21, 2023 - March 23, 2023

HEALTH & AIR QUALITY

ARSET - Accessing and Analyzing Air Quality Data from Geostationary Satellites

TRAINING TYPE: Online Instructor Led

LEVEL: Intermediate

HEALTH & AIR QUALITY

ARSET - Tools for Analyzing NASA Air Quality Model Output

TRAINING TYPE: Online Instructor Led

LEVEL: Advanced

DATE: February 22, 2022 - March 01, 2022

HEALTH & AIR QUALITY

ARSET - Introduction and Access to Global Air Quality Forecasting Data and Tools

TRAINING TYPE: Online Instructor Led

LEVEL: Advanced

DATE: September 13, 2021 - September 30, 2021

WILDFIRES, CLIMATE, DISASTERS, ECOLOGICAL CONSERVATION, HEALTH & AIR QUALITY

ARSET - Observaciones de Satélites y Herramientas para el Riesgo, Detección y Análisis de Incendios

TRAINING TYPE: Online Instructor Led

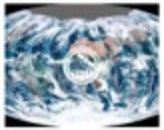
WILDFIRES, CLIMATE, DISASTERS, ECOLOGICAL CONSERVATION, HEALTH & AIR QUALITY

ARSET - Satellite Observations and Tools for Fire Risk, Detection, and Analysis

TRAINING TYPE: Online Instructor Led

LEVEL: Intermediate

DATE: May 11, 2021 - May 27, 2021



HEALTH & AIR QUALITY

ARSET - MODIS to VIIRS Transition for Air Quality Applications

TRAINING TYPE: Online Instructor Led

LEVEL: Advanced

DATE: October 22, 2020

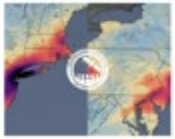
HEALTH & AIR QUALITY

ARSET - Un Vistazo a Cómo la NASA Mide la Contaminación del Aire

TRAINING TYPE: Online Instructor Led

LEVEL: Introductory

DATE: May 26, 2020 - May 28, 2020



HEALTH & AIR QUALITY

ARSET - An Inside Look at How NASA Measures Air Pollution

TRAINING TYPE: Online Instructor Led

LEVEL: Introductory

DATE: May 26, 2020 - May 28, 2020

HEALTH & AIR QUALITY

ARSET - Fundamentals of Satellite Remote Sensing for Health Monitoring

TRAINING TYPE: Online Instructor Led

LEVEL: Introductory

DATE: June 02, 2016 - June 30, 2016

HEALTH & AIR QUALITY

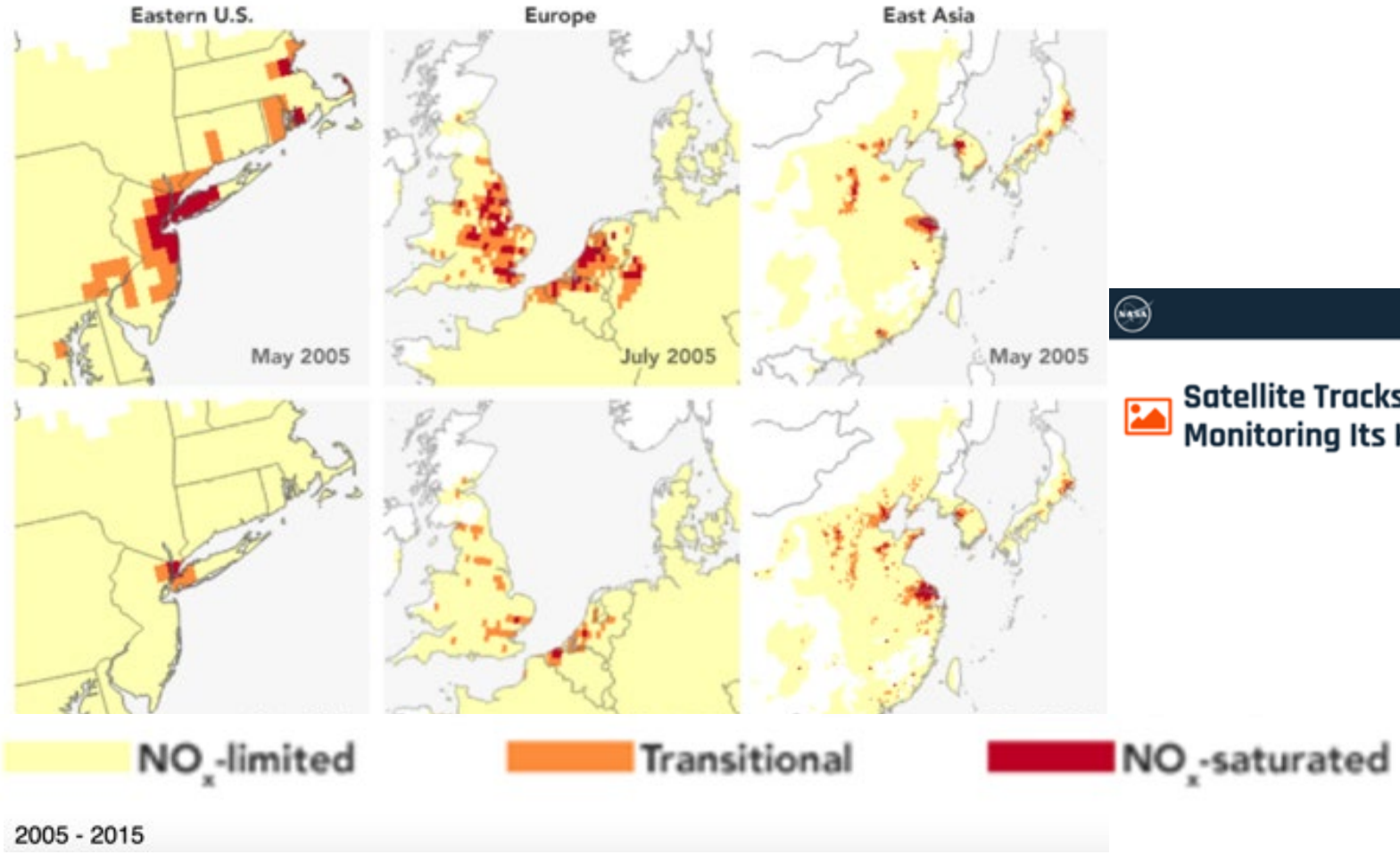
ARSET - Satellite Remote Sensing of Particulate Matter Air Quality

TRAINING TYPE: In-Person Training

LEVEL: Advanced

DATE: October 01, 2015 - October 22, 2015

https://appliedsciences.nasa.gov/what-we-do/capacity-building/arset



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

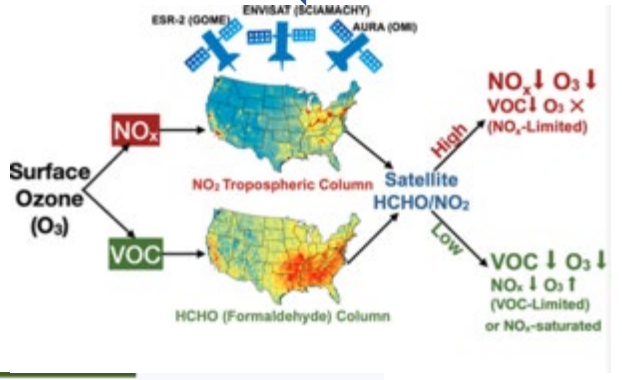
2020

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

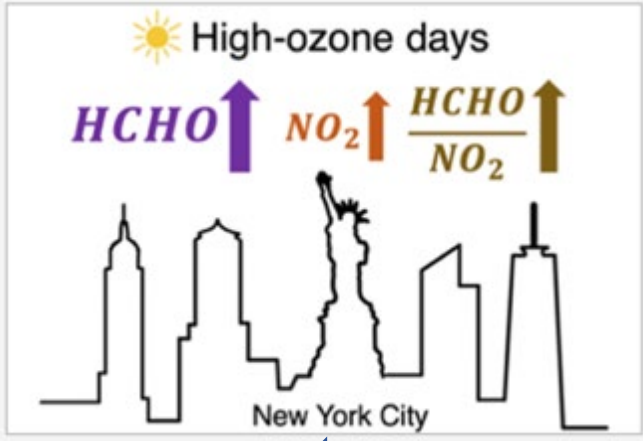


RETURN TO ISSUE | < PREV **ANTHROPOGENIC IMPACT...** NEXT >

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

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.

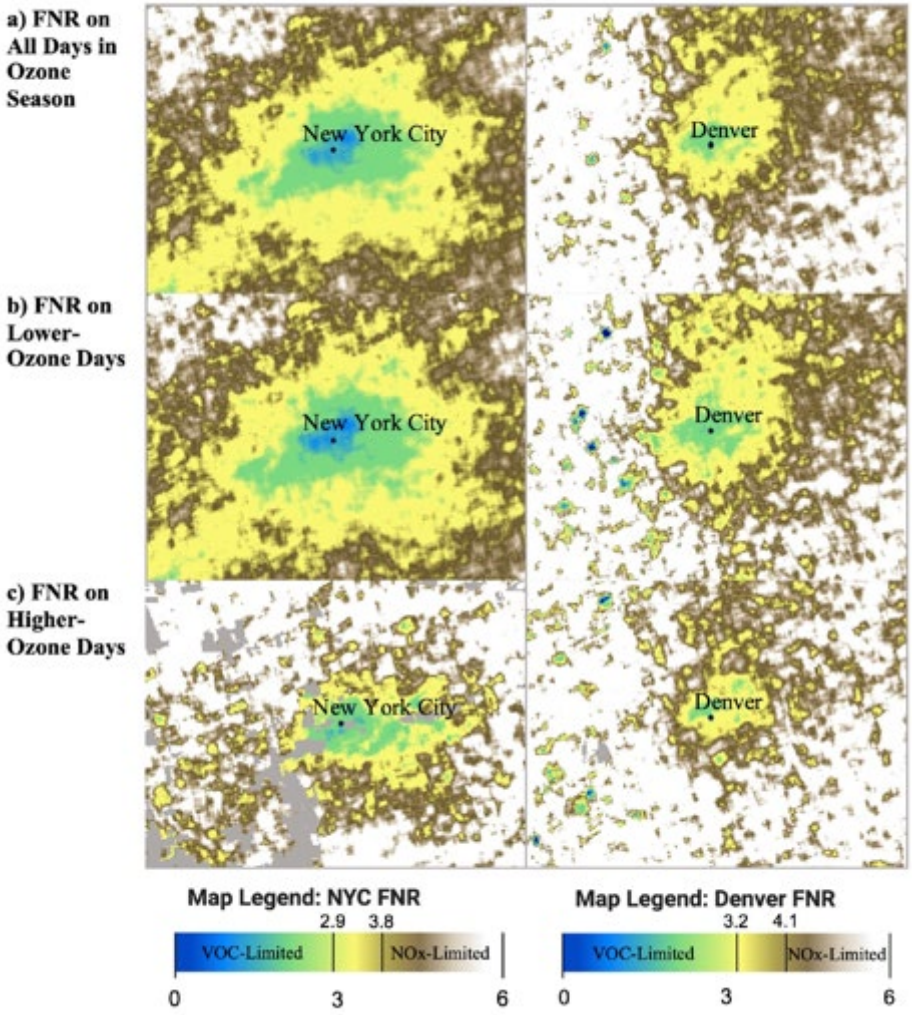
	Ease of Use	*Allows time averaging (2+ days)*	*Allows division among variables*	*Includes TROPOMI*
NASA Worldview	E	N	N	N
NASA Giovanni	E	Y	N	N
Panoply	E	N	Y	Y
Google Earth Engine	M	Y	Y	Y
Python, IDL, R, Matlab, etc.	D	Y	Y	Y

Satellite Data to Inform Ozone Sensitivity:

A Practical Methodology Using Google Earth Engine

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

Evaluating ozone sensitivity to emissions of its precursor gases with satellite data has evolved into a cutting-edge and increasingly popular application of remote sensing for health and air quality. Google Earth Engine offers a practical, user-friendly platform to support this analysis anywhere in the world using data from the TROPOMI instrument.



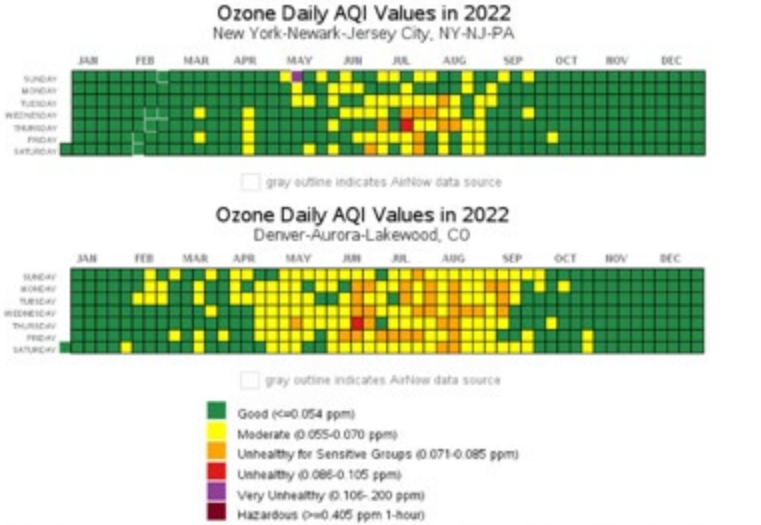
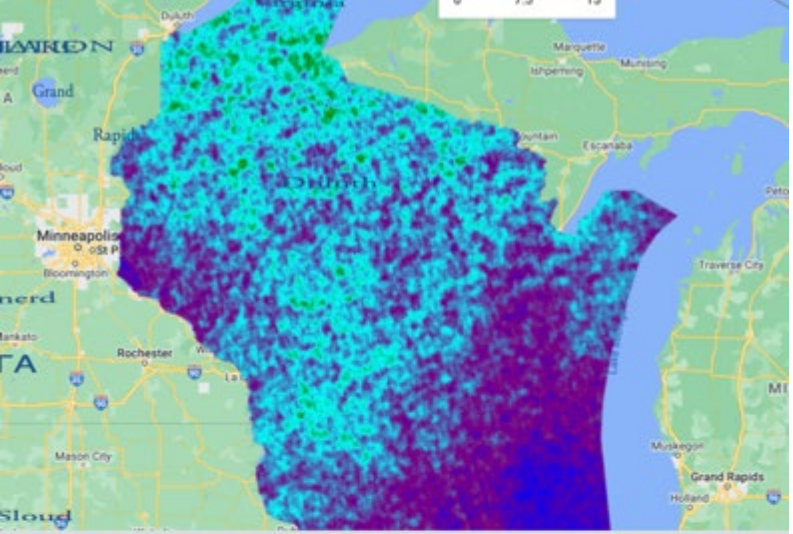


Figure 3: Daily ozone AQI values for 2022 from EPA Outdoor Air Quality Data Viz Tools, Single Year Tile Plot, for the New York City MSA (New York, NY; Newark, NJ; and Jersey City, PA; top) and the Denver MSA (Denver, Aurora, and Lakewood, CO; bottom). For this analysis, green/Good and yellow/Moderate 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).



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

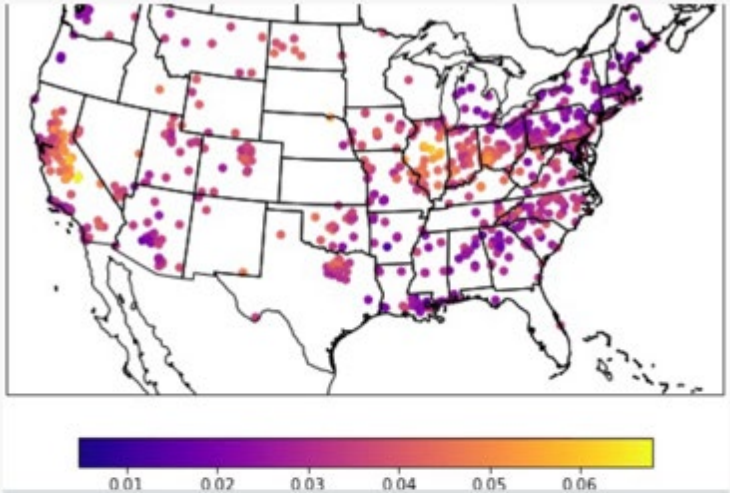
	Ease of Use	*Allows time averaging (2+ days)*	*Allows division among variables*	*Includes TROPOMI*
NASA Worldview	**E**	**N**	**N**	**N**
NASA Giovanni	**E**	**Y**	**N**	**N**
Panoply	**E**	**N**	**Y**	**Y**
Google Earth Engine	**M**	**Y**	**Y**	**Y**
Python, IDL, R, Matlab, etc.	**M**	**Y**	**Y**	**Y**

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



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

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Alicia Hoffman and Gesangyangji

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HAQAST Massachusetts

- June 4 - 5, 2024 in Boston/Cambridge
- Public, hybrid meeting
- Dialogue with stakeholders & scientists