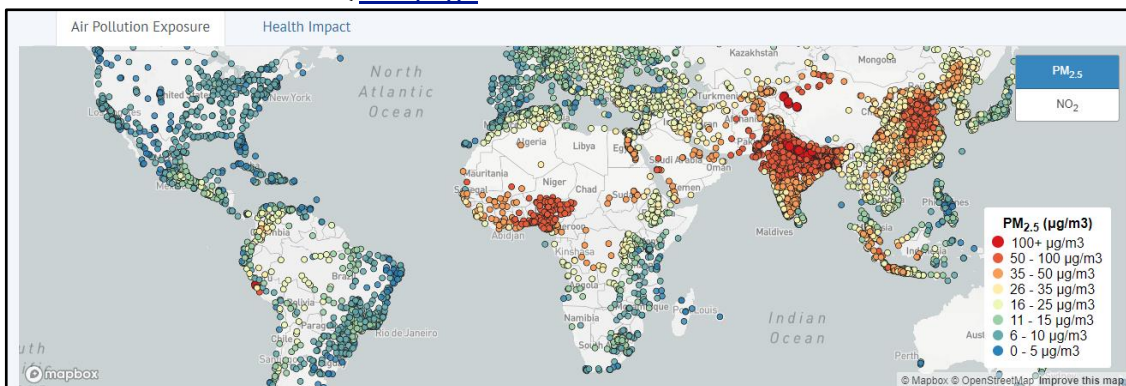


QUARTERLY HAQ PROJECT HIGHLIGHT: IMPROVING AIR QUALITY AND PUBLIC HEALTH IN MEGACITIES

Supported through a 2017 HAQ grant, **Susan Anenberg (George Washington Univ.)** and her team estimated air pollution and associated disease burden for ~13,000 cities worldwide from 2000 to 2019. They developed gridded concentration estimates that use satellite and model data with NASA support. These include PM_{2.5} concentrations using MODIS, MISR, and SeaWiFS aerosol optical depth data (from Randall Martin's group at Washington Univ. in St. Louis), NO₂ concentrations using OMI data (with Andy Larkin and Perry Hystad from Oregon State Univ.), and ozone concentrations using chemical transport models (from Jason West's group at Univ. of North Carolina). The [State of Global Air](#) initiative at the Health Effects Institute published a report and interactive website on [Air Quality and Health in Cities](#) using these estimates, led by Pallavi Pant, a [NASA HAQAST Ambassador](#). The team also works with the Environmental Defense Fund, C40 Cities, Stockholm Environment Institute, Vital Strategies, and the Climate and Clean Air Coalition. The full dataset can be downloaded and visualized at the UrbanAQ [webpage](#).



Population-weighted annual average pollutant concentrations and associated health burdens in cities in 2019 (showing PM_{2.5}). Source: [Health Effects Institute](#), 2022

NASA CELEBRATES ONE HEALTH DAY 2022

On One Health Day 2022, the NASA HAQ and Communications Teams prepared social media communications (NASA Earth [Facebook](#) and [Twitter](#)). This campaign promoted [NASA Data Pathfinders](#) and highlighted two public health projects that integrate Earth observation data into public health applications – [examining the health effects of urban air pollution](#) and [forecasting West Nile virus in South Dakota](#). These projects demonstrate that multidisciplinary collaborations with scientists and community stakeholders are fundamental to inform public health decision-making. This marks the [sixth annual participation](#) of Applied Sciences in One Health Day, highlighting NASA's role in connecting human, animal, and environmental health.



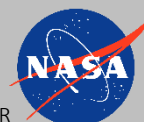
Credits: NASA

HEALTH AND AIR QUALITY APPLICATIONS APPLIED SCIENCES PROGRAM

JOHN HAYNES
PROGRAM MANAGER
HEADQUARTERS

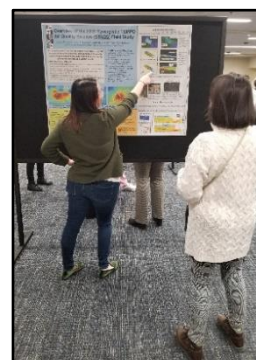
HELENA CHAPMAN
ASSOCIATE
HEADQUARTERS/BAH

LAURA JUDD
ASSOCIATE
LANGLEY RESEARCH CENTER



NASA HAQAST WISCONSIN MEETING

In October 2022, the NASA Health and Air Quality Applied Sciences Team ([HAQAST](#)) meeting engaged stakeholders on uses of Earth science information for environmental health and air quality. Held in Madison, this event addressed urban and rural air quality, dust and wildfire smoke emissions, health impacts of heat and artificial lights at night, climate risks, and community partnerships and environmental justice topics. The event occurred in conjunction with the National Association of Clean Air Agencies 2022 Fall Meeting, helping to advance understanding of using satellite data for new applications related to air pollution and health. Overall, this HAQAST meeting engaged 350 people – 125 in-person and 225 virtually – with 14 poster presentations. To learn more, please view the [HAQAST Wisconsin proceedings](#) and [Faces of Technology](#) (Emily Gargulinski) on the impact of small agricultural and range fires.



HAQAST crossover session with NACAA (left). L. Judd presents her poster on the STAQS Field Study (right). Credits: NASA

NASA HAQAST LEAD ELECTED TO NATIONAL ACADEMY OF MEDICINE

In October 2022, the NASA Health and Air Quality Applied Sciences Team (HAQAST) Lead **Tracey Holloway (Univ. of Wisconsin-Madison)** was elected as a member of the [National Academy of Medicine](#). This honor recognizes her interdisciplinary approach to air quality, climate science, and public health over the past 20 years. Using satellites and ground-based sensors to model air quality and its effects on public health, her research aims to examine the impact of harmful emissions on health as well as health benefits of energy production and policy changes. Since 2016, Tracey Holloway has led the NASA HAQAST Team, which helps end-user communities use and apply air quality data to solve real-world health challenges. **John Haynes (NASA HQ)** said, “Dr. Holloway’s election to this prestigious body not only recognizes her consummate work over the past two decades, but also illuminates the necessity of Earth observations for air quality and environmental health applications.”



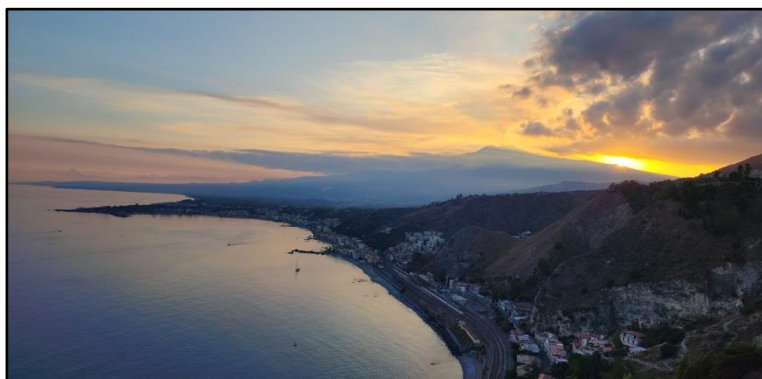
Credits: T. Holloway

NASA HAQ INVESTIGATOR UPDATE

- ❑ **Susan Anenberg (George Washington Univ.):** She presented the virtual talk, *Satellite Data and Atmospheric Modeling for Environmental Justice*, for the Association of Environmental and Resource Economists in October 2022.

HAQ CELEBRATES 5 YEARS OF TROPOMI

October 2022 marked the five-year anniversary of the launch of Copernicus Sentinel-5p TROPOMI Mission. In this time, the revolutionary data delivered by this instrument have revealed air pollution at unseen scales from satellites before. To mark the achievement, ESA, the European Commission, the Netherlands Space Office, industry, data users, and scientists met in Taormina, Sicily. Representing the HAQ team, **Dan Goldberg (George Washington Univ.)** shared the talk, *Policy and Health Relevant Application of TROPOMI NO₂ in the United States*, and **Laura Judd (NASA LaRC)** presented the topic, *Updated Assessment of TROPOMI NO₂ and HCHO Columns using Airborne Spectrometers during the MOOSE and TRACER-AQ Field Campaigns*. Presentations are available on the [conference webpage](#).



View of Sicily (left). D. Goldberg presents his conference talk (right). Credits: L. Judd

TEMPO EARLY ADOPTERS ACTIVITIES

In October 2022, a [TEMPO Mission](#) overview was provided as part of the recent ARSET Training on [Accessing and Analyzing Air Quality Data from Geostationary Satellites](#), with over 700 participants. Participants demonstrated a high-level of interest in the upcoming geostationary air quality observations from TEMPO (current launch date in April 2023), as expressed by the number of questions and discussion on the suite of data products planned for the mission.

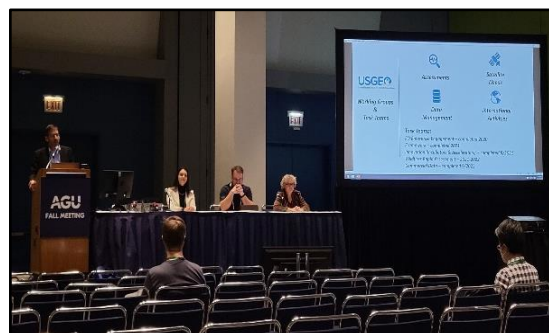
In November 2022, the TEMPO Mission and [Early Adopters Program](#) were represented at the Stakeholder Summit hosted by the NASA Short-term Prediction Research and Transition ([SPoRT](#)) Center. A TEMPO Mission overview was presented at the event, followed by a TEMPO air quality breakout session with approximately 25 participants including representatives from local and state air quality agencies. Additionally, the TEMPO mission was also a key discussion topic at the NASA Volcanic Ash Advisory Center (VAAC) Workshop, where VAACs discussed the critical role that TEMPO SO₂, bromine (BrO), and aerosol products could play in their operations. Notably, at both events, user needs in the context of TEMPO data were assessed during breakout sessions, including the importance of optimal data latency of two hours less for their air quality and disaster response operations, respectively.



TEMPO. Source: [TEMPO website](#)

NASA HAQ TEAM HOSTS SCIENTIFIC SESSIONS AT AGU 2022

At the American Geophysical Union (AGU) Fall Meeting 2022, the NASA HAQ team coordinated an oral and poster session, *Decision Support Applications for Public Health Surveillance*, in Chicago, IL. Moderated by **Helena Chapman (NASA HQ/BAH)** and **Laura Judd (NASA LaRC)**, over 60 attendees participated in the oral session, which included talks on modelling and citizen science applications for mosquito control, thermal mapping for urban malaria transmission, flood-related health outcomes, air quality dashboards, and dust forecasting in the western United States. The HAQ poster session had 11 posters, including the topic, *Innovative Earth Science Applications to Support Public Health Surveillance*. **J. Haynes** presented the NASA Hyperwall talk, *Accelerating Air Quality Solutions through Earth Observations*, and **H. Chapman** co-organized two oral GeoHealth sessions.



L. Friedl presents at the USGEO Town Hall.
Credits: H. Chapman



AGU2022 panelists for the HAQ panel session (left) and poster session (right). Credits: NASA

NASA HAQ TEAM PRESENTS AT APHA 2022

In November 2022, **Helena Chapman (NASA HQ/BAH)** and **Laura Judd (NASA LaRC)** convened the *How Satellite Data Support Public Health Data Science* symposium at the American Public Health Association (APHA) Annual Meeting & Expo 2022 in Boston, MA. Over 35 people heard **John Haynes (NASA HQ)** and PIs describe the integration of satellite- and ground-based data to improve surveillance of enteric diseases across eight geographic regions; the development of early warning systems for cholera in Africa; an assessment of the impact of malaria control programs in Peru; and improvements in air quality observations addressing health and air pollution inequities. **H. Chapman** also energized over 50 health educators in their One Health activities with the talk, *The Power of NASA Data and Visualizations*, for the Public Health Education and Health Promotion section.



APHA2022 panelists at the HAQ panel session. Credits: NASA

GEO HEALTH COMMUNITY OF PRACTICE HOLDS BIWEEKLY TELECONS AND ANNUAL MEETING



The Group on Earth Observations (GEO) [Health Community of Practice](#) (CoP) – led by **John Haynes (NASA HQ)** and **Juli Trtanj (NOAA)** – continues to coordinate community teleconferences that leverage expertise and share Earth observation data and tools to support health decision-making. On average, 40 attendees participate in each telecon. Below is a synopsis of these meetings.

❑ **November 2022:** The EO4Health team moderated an open discussion about the AfriGEO Symposium, GEO Week 2022, and GEO efforts to explore heat-health topics. Thilanka Munasinghe and Ajeet Parmar (Rensselaer Polytechnic Institute) and Assaf Anyamba (ORNL) described the semester project on understanding real-world rice production yield, as part of the RPI-NASA Student Engagement collaboration.

The **Small Work Groups** leads – Heat (Ben Zaitchik, Johns Hopkins Univ.; Cascade Tuholske, Montana State Univ.); Infectious Diseases (Antar Jutla, Univ. of Florida); Food Security and Safety (Dorian Janney, NASA GSFC/GPM); Air Quality (Eric Klos, DailyBreath; Pawan Gupta, USRA/NASA MSFC); and Health Care Infrastructure (John Balbus, NIEHS; Andreas Skouloudis, iSteep.org) – continue to leverage expertise with CoP members to provide scientific and technical knowledge on selected health-related topics for specific project tasks.

In December 2022, the GEO Health CoP held the [CoP Annual Meeting 2022](#), with an agenda (see Figure) that provided an opportunity for 80 CoP members to describe ongoing research

- ❑ **International Updates:** GEO Secretariat (Wenbo Chu), PAHO (Juan Castillo)
- ❑ **Focus on Infectious Diseases:** Antar Jutla and Moiz Usmani (Univ. of Florida), Darren Lumbroso (HR Wallingford), Moara Rodgers (Louisiana State Univ./A&M College), Assaf Anyamba (ORNL), William Pan (Duke Univ.)
- ❑ **Focus on Air Quality and Health Care Infrastructure:** Eric Klos (DailyBreath), Andreas Skouloudis (iSteep.org), Carl Malings (NASA GSFC/Morgan State Univ.), Rajesh Kumar (UCAR)
- ❑ **Focus on Heat and Food Security:** Cascade Tuholske (Montana State Univ.), H. Chapman (NASA HQ/BAH)
- ❑ **Regional Focus:** Phoebe Oduor (AfriGEO), Lara Congiu (European Commission), Haris Kontoes (National Observatory of Athens), Virginia Burkett (AmeriGEO)

observations to enhance health decision-making and priority focus areas that advance CoP goals and Work Group activities. Also, at AGU2022, the GEO Health CoP held two networking receptions, where 30 CoP members connected in-person and shared ongoing work.

GEO WEEK 2022



In November 2022, the EO4Health team co-convoked the *Earth Observation and Health: Early Warning Systems and beyond!* session with the European Commission and GEO DRR-WG as a side event at [GEO Week 2022](#) in Accra, Ghana. The event highlighted how Earth observations can offer valuable insight for health decision-making, both through the GEO Work Programme 2023-2025 and the Road to GEO Post 2025. Also, CoP members participated as panelists in two [AfriGEO Symposium](#) sessions: **Antar Jutla (Univ. of Florida)** with cholera forecasting in Africa in the Resilient and Sustainable Communities session, and **Emma Knowland** and **Carl Malings (NASA GSFC/Morgan State Univ.)** with air quality forecasting in Senegal in the Sustainable Urban Development session.

HAQ COMMUNITY ENGAGEMENT

The NASA HAQ team (**Helena Chapman, NASA HQ/BAH** and **Laura Judd, NASA LaRC**) presented webinars that introduced the HAQ program and key examples of using Earth observations for public health applications.

- ❑ **2022 ICESat-2 Atmospheric Applications Focus Session:** L. Judd presented an overview of the HAQ focus area in November 2022.
- ❑ **FDA Center for Veterinary Medicine One Health Day Virtual conference:** H. Chapman presented an overview on the HAQ program and using Earth observations to enhance health decision-making in November 2022.
- ❑ **Esri (Chile):** H. Chapman served as a panelist on the *Geography and Health: The Power of GIS in Landscape Analysis* webinar, as part of Esri Chile's World GIS Day activities (in Spanish) in November 2022.
- ❑ **[NASA Ella Es Astronauta](#) program (Colombia):** H. Chapman shared congratulatory words to 100 girls graduating from this NASA/Houston program in December 2022.

LOOKING AHEAD

ARSET Trainings:

[Connecting Citizen Science with Remote Sensing](#)

January 24-31, 2023

Meetings:

[American Meteorological Society Annual Meeting](#)

January 8-12, 2023

[American Mosquito Control Association Annual Meeting](#)

February 27 – March 3, 2023
Reno, NV

[American Thoracic Society International Conference](#)

May 19-24, 2023
Washington, DC

[Air & Waste Management Association's Annual Conference & Exposition 2022](#)

June 5-8, 2023
Orlando, FL

RECENT COMMUNICATIONS

NASA

- ❑ **[NASA Launches International Mission to Survey Earth's Water](#)** (Tylar Green, Jane Lee, Andrew Wang, Leejay Lockhart, Laura Aguiar, NASA)

NASA Climate

- ❑ **[5 Things to Know About How SWOT Will Look at the World's Water](#)**

NASA Applied Sciences Program

- ❑ **[Watching Wildfire Smoke Impacts for Healthier Communities](#)** (Marissa Kunerth, IntelliBridge)
- ❑ **[Tracking Saharan Dust to Safeguard Public Health](#)** (Marissa Kunerth, IntelliBridge)
- ❑ **[NASA Earth Science in Action Comic Strip Contest Winners Announced](#)** (Marissa Kunerth, IntelliBridge)
- ❑ **[NASA Partnership Launches Groundbreaking New Global Flood Early Warning Technology](#)** (Jacob Reed and Christian Thomas, NASA Disasters)

NASA Earth Observatory

- ❑ **[Smoky Skies in Northern India](#)** (Adam Voiland, NASA Earth Observatory)
- ❑ **[Fuel Regulation Reduced Air Pollution from Shipping](#)** (Sally Younger, NASA Earth Science News)

LAUNCH OF SWOT

The Surface Water and Ocean Topography ([SWOT](#)) mission – a partnership between NASA and the French space agency Centre National d'Etudes Spatiales (CNES), including contributions from the Canadian Space Agency and the UK Space Agency – was successfully [launched](#) from Vandenberg Space Force Base on December 16, 2022. This [mission](#) represents the first global survey of Earth's surface water, observe ocean surface topography, and measure temporal changes to [water bodies](#).



Credit: CNES

PAST

ARSET Training:

[Accessing and Analyzing Air Quality Data from Geostationary Satellites](#)

October 11-25, 2022

[Climate Change Monitoring and Impacts Assessment using NASA Earth Observations](#)

October 24, 2022

Meetings:

[HAQAST Wisconsin](#)

October 20-21, 2022

Madison, WI

[GEO Week 2022](#)

October 31 – November 4, 2022

Accra, Ghana

[American Public Health Association Annual Meeting & Expo](#)

November 5-8, 2022

Boston, MA

FDA Center for Veterinary Medicine One Health Day Virtual conference

November 15, 2022

[American Geophysical Union Fall Meeting](#)

December 12-16, 2022

Chicago, IL

PUBLICATIONS

[Global trends in ozone concentration and attributable mortality for urban, peri-urban, and rural areas between 2000 and 2019: a modelling study.](#) *Lancet Planetary Health*. (D.A Malashock, M.N. Delang, J.S. Becker, M.L. Serre, **J.J. West**, K-L Chang, O.R. Cooper, **S.C. Anenberg**)

[Disparities in air pollutants across racial, ethnic, and poverty groups at US public schools.](#) *GeoHealth*. (M.J. Cheeseman, B. Ford, **S.C. Anenberg**, M.J. Cooper, E.V. Fischer, M.S. Hammer, **S. Magzamen**, **R.V. Martin**, A. van Donkelaar, J. Volckens, **J.R. Pierce**)

[Neighborhood emission mapping operation \(NEMO\): a 1-km anthropogenic emission dataset in the United States.](#) *Scientific Data*. (S. Ma, **D. Tong**)

[Outside in: the relationship between indoor and outdoor particulate air quality during wildfire smoke events in western US cities.](#) *Environmental Research Health*. (K. O'Dell, B. Ford, J. Burkhardt, S. Magzamen, **S.C. Anenberg**, J. Bayham, E.V. Fischer, **J.R. Pierce**)

[A geoHealth call to action: moving beyond identifying environmental injustices to co-creating solutions.](#) *GeoHealth*. (A. Hoffman-Hall, M.E. Gorris, **S. Anenberg**...**B.F. Zaitchik**)

[The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels.](#) *Lancet*. (M. Romanello...**J.J. Hess**...**P. Kinney**...**Y. Liu**...et al)

[The 2022 Report of The Lancet Countdown on Health and Climate Change: compounding health crises.](#) *Lancet*. (M. Romanello...**J. Hess**...**P. Kinney**...**Y. Liu**...et al)

[Hourly and daily PM2.5 estimations using MERRA-2: a machine learning approach.](#) *Earth and Space Science*. (A. Sayeed, P. Lin, **P. Gupta**, et al)

[Satellite data applications for sustainable energy transitions.](#) *Frontiers in Sustainability*. (M.R. Edwards, **T. Holloway**, **R.B. Pierce**, L. Blank, M. Broddle, E. Choi, **B.N. Duncan**, et al)