NASA Health and Air Quality
remote sensing for public health

Volume 38
January – March 2024

QUARTERLY HAQ PROJECT HIGHLIGHT:

SUPPORTING LOCAL GOVERNMENT DECISION-MAKING WITH A SUB-CITY SCALE AIR QUALITY FORECASTING SYSTEM USING DATA FUSION OF MODELS, SATELLITE, IN-SITU MEASUREMENTS, AND LOW-COST SENSORS

Supported through a 2021 HAQ grant, **K. Emma Knowland** and **Carl Malings (Morgan State University; NASA GSFC)** and **Nathan Pavlovic (Sonoma Technology, Inc.)** and their team are implementing new data fusion capabilities in a Google Earth Engine (GEE) tool in consultation with their stakeholders – Rio de Janeiro, Brazil; Dakar, Senegal; U.S. Environmental Protection Agency – to best address their needs for sub-city scale air quality forecasts. The data fusion tool combines a global model and satellite measurements with local ground-based observations and/or low-cost sensor data where available. A functioning prototype of the system was created by the Sonoma Technology team for nitrogen dioxide (NO_2) and fine particulate matter ($PM_{2.5}$) for the domains over Rio de Janeiro and Dakar.

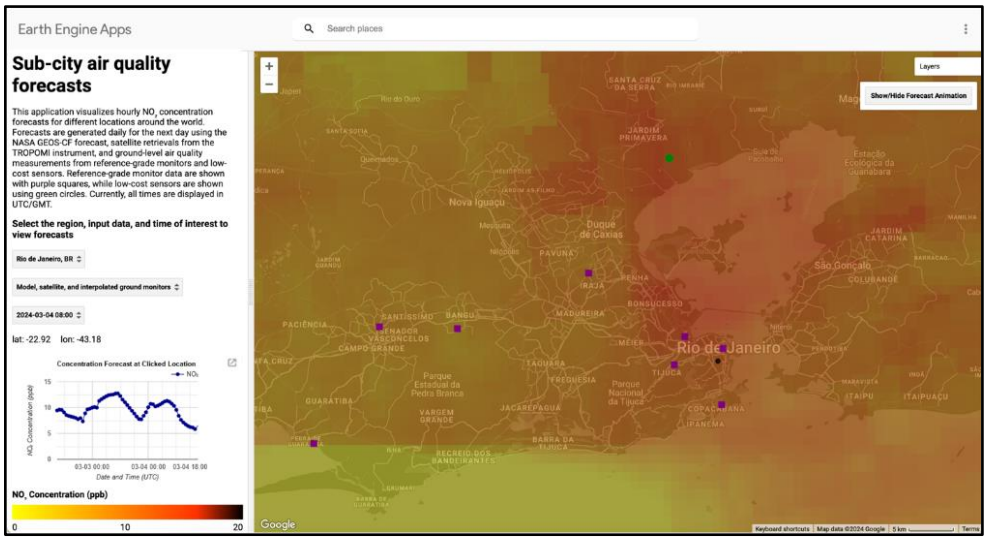

Figure 1. This prototype application displays sub-city air quality forecasts (NO_2) for the project partner (city of Rio de Janeiro, Brazil) to enable air quality managers to access and visualize estimates and forecasts of relevant air quality parameters. Purple squares indicate locations of regulatory grade monitors, and green circles represent low-cost sensors. Source: Figure reproduced from Malings et al., 2024.

ONE HEALTH AWARENESS MONTH

As January 2024 is recognized as U.S. National One Health Awareness Month, the HAQ and Communications **(Sofie Bates, NASA GSFC; Jocelyn Argueta, JPL)** Teams launched a social media campaign on January 24 (NASA Earth Facebook/X on NASA TEMPO/STAQS missions) and January 31 (NASA Earth Facebook/X on air quality challenges (including the Washington DC area) and the Earth Information Center.

Social media post on NASA Earth X

HEALTH AND AIR QUALITY APPLICATIONS
APPLIED SCIENCES PROGRAM

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Volume 38
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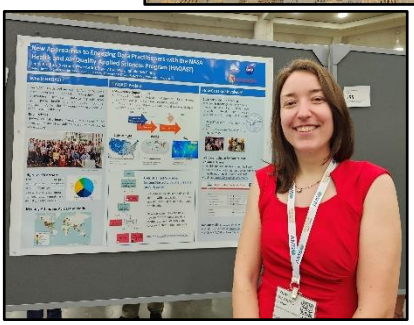
NASA HAQ TEAM HOSTS SCIENTIFIC SESSIONS AT AMS 2024

At the American Meteorological Society (AMS) 2024, the NASA HAQ team coordinated the scientific session under the topic, *Air Quality and Public Health Decisions with Earth Observations I - Federal Programs,* at the 15th Conference on Environment and Health. Moderated by **Helena Chapman (NASA HQ/BAH)** and **Jenny Bratburd (Univ. of Wisconsin-Madison),** this session included 6 oral topics and had over 92 attendees (82 in-person, 10 virtual). Also, **John Haynes** presented the talk, *Measuring Air Pollution from TEMPO*, and **H. Chapman** presented the topic, *Connecting Satellite Data to the One Health Approach*, at the NASA Hyperwall exhibit.

- ❑ NOAA Air Quality Program: National Air Quality Forecast Capability **(Youngsun Jung, NOAA)**
- ❑ Expanding Traditional Scientific Boundaries with Novel Earth Science Applications: An Overview of the NASA Health and Air Quality Program (**John Haynes, NASA HQ**)
- ❑ Capacity Building with NASA's Applied Remote Sensing Training Program **(Melanie Follette-Cook, NASA GSFC)**
- ❑ Using NASA Earth Observations to Improve Air Quality Decision-making Activity in Indian Subcontinent (**Rajesh Kumar, NCAR**)
- ❑ The NASA TEMPO Mission: Hourly Daytime Air Pollution Observations for Enhanced Health and Air Quality Applications (**Aaron Naeger, NASA MSFC**)
- ❑ Assessment of Air Quality and Empowerment of Knowledge in Schools across the Region of Rio Grande Valley **(Amit Raysoni, University of Texas Rio Grande Valley)**



AMS2024 presenters at the NASA HAQ session (Top), J. Bratburd presents her HAQAST poster (Left), and J. Haynes presents his Hyperwall talk. Credits: NASA

NASA INVESTIGATOR UPDATES

- ❑ **Helena Chapman (NASA HQ/BAH):** She presented a One Health flash talk, as part of the NASA Space Apps Collective Genius Collective Summit in March 2024.
- ❑ **Dan Goldberg (George Washington Univ.):** As lead of HAQAST Tiger Team on *Communicating the Uncertainties of Satellite-based NOx Emissions for Urban Planning*, they released a gridded ~1x1km monthly, seasonal, and annual satellite TROPOMI NO_2 data available for download on the NASA portal (May 2018-present) in March 2024.
- ❑ **John Haynes (NASA HQ), Dan Goldberg (George Washington Univ.),** and **Amber Soja (NASA LaRC):** They presented talks in the Heat, Dust, Smoke, Disease: What NASA Measures in Our Air session at NASA Meets South by Southwest in March 2024.
- ❑ **Tracey Holloway (Univ. of Wisconsin-Madison):** She presented a talk at the Western States Air Resources Council (WESTAR) 2024 National Exceptional Events Workshop in February 2024.
- ❑ **Yang Liu (Emory Univ):** He gave a talk in the CAFÉ Climate Health Data – Public Q&A at the 1st Annual CAFÉ Climate & Health Conference in February 2024.
- ❑ **Amber Soja (NASA LaRC):** HAQAST contributions by A. Soja, Emily Gargulinski, and Kellin Slater, were highlighted, as part of the Faces of Technology: Women of NASA 2024 series, to celebrate National Women's Day in March 2024.

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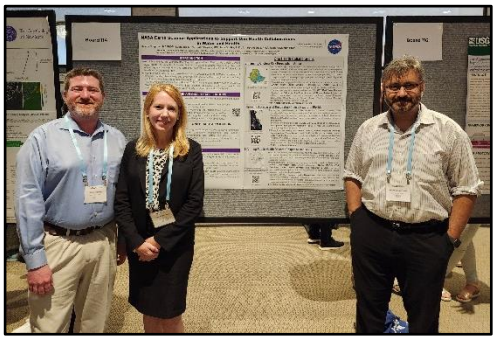
NASA HAQ TEAM PRESENTS AT AGU CHAPMAN CONFERENCE

In February 2024, as part of the AGU Chapman Conference on Remote Sensing of the Water Cycle in Honolulu, HI, **John Haynes (NASA HQ)** gave a scientific lecture entitled, *Connecting Earth Science to Decision Support: Contributions from the NASA Health and Air Quality Applications Program,* to over 200 attendees. **Helena Chapman (NASA HQ/BAH)** presented the poster entitled, *NASA Earth Science Applications to Support One Health Collaborations in Water and Health*. Also, they presented talks at the University of Hawaii at Manoa School of Nursing to over 100 nursing students.

J. Haynes presents his talk in the Health and Food Security session at the AGU Chapman Conference. Credit: H. Chapman



J. Haynes, H. Chapman, and A. Jutla in front of the HAQ poster at the AGU Chapman Conference (Left). HAQ team with Univ. of Hawaii faculty (Gary Glauberman, Michele Bray, and Holly Fontenot) (Middle). H. Chapman presents her talk at the Univ. of Hawaii (Right). Credit: NASA/G. Glauberman

NASA HAQ TEAM HOSTS SYMPOSIUM AT AMCA 2024

In March 2024, the HAQ team coordinated the *Using NASA Satellite Data to Enhance Understanding of Vector Habitats and Disease Transmission* Symposium at the American Mosquito Control Association (AMCA) Annual Conference in Dallas, TX. Moderated by **Helena Chapman (NASA HQ/BAH)**, researchers highlighted projects that incorporated satellite and other environmental datasets to forecast risk of vector-borne disease transmission (e.g. chikungunya, dengue, malaria) and enhanced community stakeholder engagement with researchers, to over 115 attendees. **H. Chapman** also presented the talk, *Satellite Data to Support Vector-Borne Disease Forecasting Tools* (in Spanish), as part of the Latin American Symposium, with 60 attendees. Notably, the HAQ and CDC Division of Vector-Borne Diseases teams connected during this event and identified synergies with vector-borne disease initiatives.

- ❑ Incorporating NASA Earth Science Applications to Monitor Infectious Disease Hotspots **(John Haynes, NASA HQ)**
- ❑ Climate Change and Vector-borne Diseases – A National and Global Perspective **(Ben Beard, CDC)**
- ❑ VectorSurv: Toward Web-based Forecasting of West Nile Virus Disease Risk **(Aynaz Lotfata, Univ. of California, Davis)**
- ❑ Designing a Global Surveillance and Forecasting System for Selected Vector-borne Diseases **(Assaf Anyamba, Oak Ridge National Laboratory)**

NASA HAQ session panelists at AMCA 2024. Credits: NASA

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GEO HEALTH COMMUNITY OF PRACTICE & REGIONAL NETWORKS

The Group on Earth Observations (GEO) Health Community of Practice (CoP) – led by **John Haynes (NASA HQ)** and **Juli Trtanj (NOAA)** – coordinates community teleconferences to leverage expertise across sectors and geographies and share Earth observation data and tools to support health decision-making. As each teleconference has engaged about 40 participants, new GEO Health CoP members have joined and presented their research applications to the wider community.

- **February 2024: Awa Babington-Ashaye (Space and Global Health Network & Univ. of Geneva)** described highlights of the UN/WHO International Conference on Space and Global Health from November 2023, **Stefano Ferretti (ESA)** shared updates on the ESA EO4Health User Forum from January 2024, and **Vincent Herbreteau (French National Research Institute for Sustainable Development, IRD)** presented the ClimHealth and ClimHealth–Leptospirosis Yangon (Lepto Yangon provides actionable and 5-day updates of the suitable environment for leptospirosis transmission to epidemiologists and hospitals in Yangon).
- **March 2024: Claire Quiner (RTI International)** presented the use of EO data to predict potential niche and drivers for outbreak occurrence of vaccinia virus, and **Karen Gruszynski (Lincoln Memorial Univ.)** described links between remote sensing data and animal pathogens and health.

In February 2024, the CoP leadership and work groups prepared a One Health white paper, upon request to the GEO Secretariat's Programme Board. Also, the USGEO Jazz Observatory website, which was launched for the GEO Week & Ministerial Summit 2023, included the Changing Cholera's Tune, Beating Back Vector-Borne Disease and Bad Bloom Vibes articles.

SUCCESSFUL PACE LAUNCH ON FEBRUARY 8

On February 8, at 1:33AM ET, the PACE (Plankton, Aerosol, Cloud, ocean Ecosystem) satellite was launched aboard a SpaceX Falcon 9 rocket from Space Launch Complex 40 at Cape Canaveral Space Force Station in FL. This instrument will study microscopic life in the oceans and microscopic particles in the atmosphere to investigate key mysteries of our planet's interconnected systems.

Credits: NASA

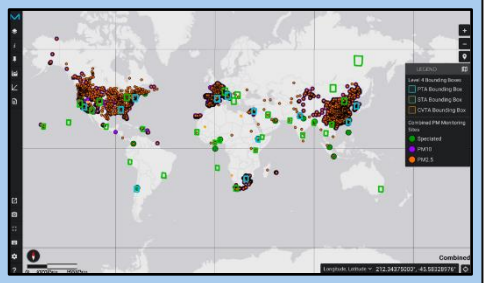
NASA HAQ TEAM CONTRIBUTES TO NATIONAL VECTOR-BORNE DISEASE STRATEGY

In February 2024, the U.S. Department of Health and Human Services released the National Public Health Strategy to Prevent and Control Vector-Borne Diseases in People, as the largest federal coordination on vector-borne disease prevention and control. Co-led by HHS/CDC and developed in collaboration with six federal departments (DHSS, DOD, USDA, EPA, DOI, DOC), it builds upon the *National Public Health Framework for the Prevention and Control of Vector-Borne Diseases in Humans* published in September 2020, as a component of the Kay Hagan Tick Act signed into law in December 2019.

MAIA TEAM OFFERS TRAININGS & VISUALIZATION TOOL

From January-March 2024, the MAIA team conducted three trainings and workshops to audiences. In January 2024, **David Diner** and **Sina Hasheminassab (NASA Jet Propulsion Laboratory)** gave a talk on MAIA and its surface monitoring activity to the U.S. Embassy in Ethiopia and representatives from other regional posts. In March 2024, **Amber Jenkins (NASA Jet Propulsion Laboratory)** and **S. Hasheminassab** delivered a virtual talk on MAIA, its air quality research, and application opportunities at a workshop focused on environmental issues in health security hosted by the U.S. State Department in Singapore. About 30 government officials (ministries of health, environment, finance, and natural resources) from 14 countries in Southeast Asia and the Pacific Islands attended. Also, **S. Hasheminassab** presented a poster at the UCAR Africa Initiative Workshop that focused on accelerating environmental sustainability solutions in Africa.

MAIA has developed a Geographic Information Visualization Tool (GIVT) to help partners, users, and stakeholders visualize the mission's target areas, ground-monitoring sites, and additional valuable geographic data. The next phase of the tool, soon to be launched, will reflect the operational status of the ground-based monitoring networks that MAIA has deployed to track PM, and help users to see dynamic monitoring of these data.



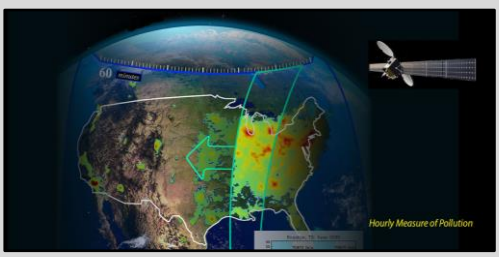
Screenshot of the Geographic Information Visualization Tool (GIVT)

TEMPO MISSION & EARLY ADOPTER PROGRAM ACTIVITIES

The TEMPO mission continues to operate successfully and efficiently with the upcoming public release of the level 2 and 3 trace gas data products (nitrogen dioxide, formaldehyde, total ozone, ozone profile), planned for May 2024. The team published the article titled, Delivering Revolutionary Satellite Data with NASA's Tropospheric Emissions: Monitoring of Pollution (TEMPO) Mission, in the Spring 2024 issue of *EM Plus* (A&WMA's quarterly publication).

Aaron Naeger (NASA MSFC) was invited to several application-focused meetings in February 2024:

- ❑ **4th NASA-VAAC (Volcanic Ash Advisory Center) Virtual Workshop**
- ❑ **U.S. Forest Service Webinar**: **A. Naeger** presented a mission status update with a special attention on TEMPO's capabilities to monitor smoke from wildland fires, which was attended by a diversity of forest service and air agency scientists.
- ❑ **Harnessing the Heartland Meeting** (Omaha, NE): **A. Naeger** discussed TEMPO's capabilities to enhance air quality and public health applications and demonstrated how to download preliminary TEMPO data products from Earthdata search.



TEMPO. Source: TEMPO website

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HAQ COMMUNITY ENGAGEMENT

HEALTH & AIR QUALITY

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

- ❑ **Walter Reed Army Institute of Research (WRAIR) One Health Branch:** J. Haynes and H. Chapman presented an overview of the HAQ focus area and selected HAQ projects in March 2024 (55 attendees).
- ❑ **George Washington Univ. (Virtual):** H. Chapman gave an invited lecture to the Risk Management and Communication course on One Health and selected projects using Earth observations for health applications in March 2024 (12 public health students).
- ❑ **ASIA-AQ (Airborne and Satellite Investigation of Asian AIr Quality):** L. Judd participated in the ASIA-AQ field campaign as the platform scientist for the G-III aircraft mapping air pollution. This work included collaborations with scientists in the Philippines, S. Korea, Thailand, and Taiwan.

LOOKING AHEAD

Meetings:

TRACER-SCOAPE Science Team Meeting
April 16-17, 2024
Houston, TX

World Medical Association Council Session
April 18-20, 2024
Seoul, Republic of Korea

HAQ Annual Team Meeting
April 23-24, 2024
Jackson, WY

MAIA Science Team Meeting
May 6-8, 2024
Pasadena, CA

American Thoracic Society International Conference
May 17-22, 2024
San Diego, CA

HAQAST Massachusetts
June 4-5, 2024
Cambridge, MA

Air & Waste Management Association's Annual Conference & Exposition
June 24-27, 2024
Calgary, Alberta, Canada

RECENT COMMUNICATIONS

NASA

- ❑ NASA Analysis Confirms 2023 as Warmest Year on Record (Roxana Bardan, NASA HQ)
- ❑ NASA Spinoff 2024
- ❑ Earth Science to Action

NASA Earth Action Program

- ❑ ARSET Online Resource Guide, 2015-2023
- ❑ NASA SERVIR Air Quality Explorer Gets an Upgrade Through Crowdsourcing (Trista Brophy Cerquera, Elissa Fielding, Shobhana Gupta, NASA HQ)

NASA Earth Observatory

- ❑ Five Factors to Explain the Record Heat in 2023 (Angela Colbert and Sally Younger, NASA JPL)

NASA Earth Data

- ❑ Earthaccess: Earth Science Data Simplified (Josh Blumenfeld)
- ❑ Applying Machine Learning to Harmful Algal Blooms (Josh Blumenfeld)

PUBLICATIONS

Evaluating the Spatial Patterns of U.S. Urban NOx Emissions using TROPOMI NO_2. *Remote Sensing of Environment*. **(D.L. Goldberg,** M. Tao, G.H. Kerr, S. Ma, **D.Q. Tong**, **A.M. Fiore**, A.F. Dickens, Z.E. Adelman, **S.C. Anenberg**)

Local Scale Air Quality Impacts in the Los Angeles Basin from Increased Port Activity during 2021 Supply Chain Disruptions. *Environmental Science: Atmospheres*. (T.N. Skipper…**A.G. Russell**)

Satellite Data for Environmental Justice: A Scoping Review of the Literature in the United States. *Environmental Research Letters*. (T. Kreutzer Sayyed…**A.J. Soja**, **S. Anenberg**, Y. Kuwayama)

Increasing Racial and Ethnic Disparities in Ambient Air Pollution-Attributable Morbidity and Mortality in the United States. *Environmental Health Perspectives*. (**G.H. Kerr**, A. van Donkelaar, **R.V. Martin…D.L. Goldberg**, **S.C. Anenberg**)

Public Health Benefits From Improved Identification of Severe Air Pollution Events With Geostationary Satellite Data. *Geohealth*. (K. O'Dell…**D.L. Goldberg**…**S.C. Anenberg**)

Who Is Affected by Saharan Dust in the Caribbean? A Spatial Analysis and Citizen's Perspective from Puerto Rico during the Godzilla Dust Event in June 2020. *Weather, Climate, and Society*. (M. Morales-Medina…**P. Méndez-Lázaro**)

Health-Damaging Climate Events Highlight the Need for Interdisciplinary, Engaged Research. *GeoHealth*. (J.D. Stowell, **S. Anenberg, B.F. Zaitchik, D.Q. Tong**, C.J. Howell, D.P. Stolle, **R.R. Colwell**, C. McEntee)

Tracking Progress Toward Urban Nature Targets Using Landcover and Vegetation Indices: A Global Study for the 96 C40 Cities. *GeoHealth*. (G.K. Martin…**S.C. Anenberg**)

Improvement of Surface PM2.5 Diurnal Variation Simulations in East Africa for the MAIA Satellite Mission. *ACS EST Air*. (C. Li, **J. Wang**…N. Janechek)

Elemental Characterization of Ambient Particulate Matter for a Globally Distributed Monitoring Network: Methodology and Implications. *ACS EST Air*. (X. Liu…**R.V. Martin**)

A MAIA-like Modeling Framework to Estimate PM2.5 Mass and Speciation Concentrations with Uncertainty. *Remote Sensing of Environment*. (Z. Jin…**Y. Liu**)

Public Health Data Applications Using the CDC Tracking Network: Augmenting Environmental Hazard Information With Lower-Latency NASA Data. *GeoHealth*. (H. Amos, N. Skaff, **S. Schollaert Uz**…A.K. Werner)

The Arbovirus Mapping and Prediction (ArboMAP) System for West Nile Vrus Forecasting. *JAMIA Open.* (D.M. Nekorchuk…**M.C. Wimberly**)

The Planetary Child Health & Enterics Observatory (Plan-EO): A Protocol for an Interdisciplinary Research Initiative and Web-based Dashboard for Mapping Enteric Infectious Diseases and their Risk Factors and Interventions in LMICs. *PLOS One*. (J.M. Colston…**B.F. Zaitchik**, V. Lakshmi, M.N. Kosek)

PAST

Airborne Field Campaign:

Airborne and Satellite Investigation of Asian AIr Quality) (various Asian Countries (ASIA-AQ)
January-April 2024

Meetings:

American Meteorological Society Annual Meeting
January 28 – February 1, 2024
Baltimore, MD

AGU Chapman Conference on Remote Sensing of the Water Cycle
February 13-16, 2024
Honolulu, HI

American Mosquito Control Association Annual Meeting
March 4-8, 2024
Dallas, TX