NASA Health and Air Quality
remote sensing for public health

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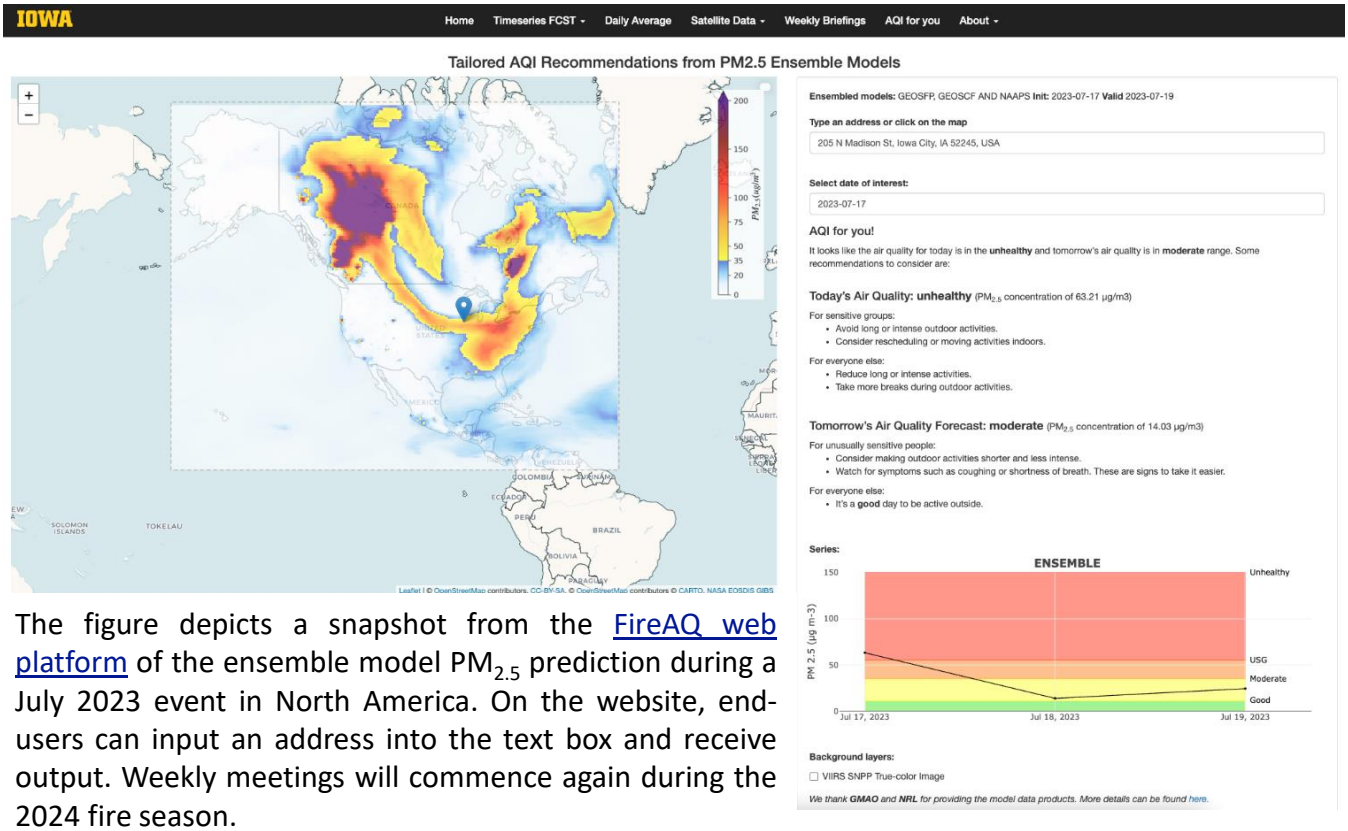
QUARTERLY HAQ PROJECT HIGHLIGHT:

REGIONAL AIR QUALITY AND PUBLIC HEALTH MANAGEMENT UNDER SMOKE CONDITIONS

Supported through a 2021 HAQ grant, **Jun Wang (Univ. of Iowa)** and his team are working to support decision-making activities of air quality and public health management agencies under smoke conditions. The project includes the development of an interactive, user-friendly FireAQ web platform. In July 2023, the FireAQ team began weekly briefings to provide a retrospective analysis of the previous week's air quality estimates due to smoke, discuss the current air quality forecast, and maintain engagement with community members. The first season of these meetings concluded in October 2023, with 47 members representing 21 different universities, 10 state agencies, and 7 federal organizations who subscribed to the weekly listserv. All past presentations, and forecast summaries, are archived and available on the website. In addition to subscribing to the listserv, the website hosts the option for users to search the AQ forecast by their address along with the respective EPA recommendations.



The figure depicts a snapshot from the FireAQ web platform of the ensemble model $PM_{2.5}$ prediction during a July 2023 event in North America. On the website, end-users can input an address into the text box and receive output. Weekly meetings will commence again during the 2024 fire season.

HEALTH AND AIR QUALITY APPLICATIONS
EARTH ACTION PROGRAM

JOHN HAYNES
PROGRAM MANAGER
HEADQUARTERS

HELENA CHAPMAN
ASSOCIATE
HEADQUARTERS/BAH

LAURA JUDD
ASSOCIATE
LANGLEY RESEARCH CENTER

Created by Helena Chapman, MD, PhD; please direct correspondence to helena.chapman@nasa.gov

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WELCOME TO NEW HAQ TEAM MEMBERS

Amber Jenkins, PhD
MAIA Mission Applications Lead
Jet Propulsion Laboratory

In August 2023, **Amber Jenkins (Jet Propulsion Laboratory)** joined the MAIA team as Mission Applications Lead. She is trained in applied science system engineering, stakeholder and decision-maker engagement, information architecture, project management, and science communications. In addition to her role on MAIA, she leads strategic initiatives for NASA's Western Water Applications Office and works with NOAA's Earth Prediction Innovation Center. Previously, Amber was manager of JPL's Climate Science Center, editor of NASA's Climate Change website, and founder of Nature Photonics magazine. She received first-class MSci and MA degrees in natural sciences from Cambridge University and a PhD in particle physics from Imperial College London. Her interests include impactful science, translating science into action for the benefit of society, and the power of storytelling.

Credits: A. Jenkins

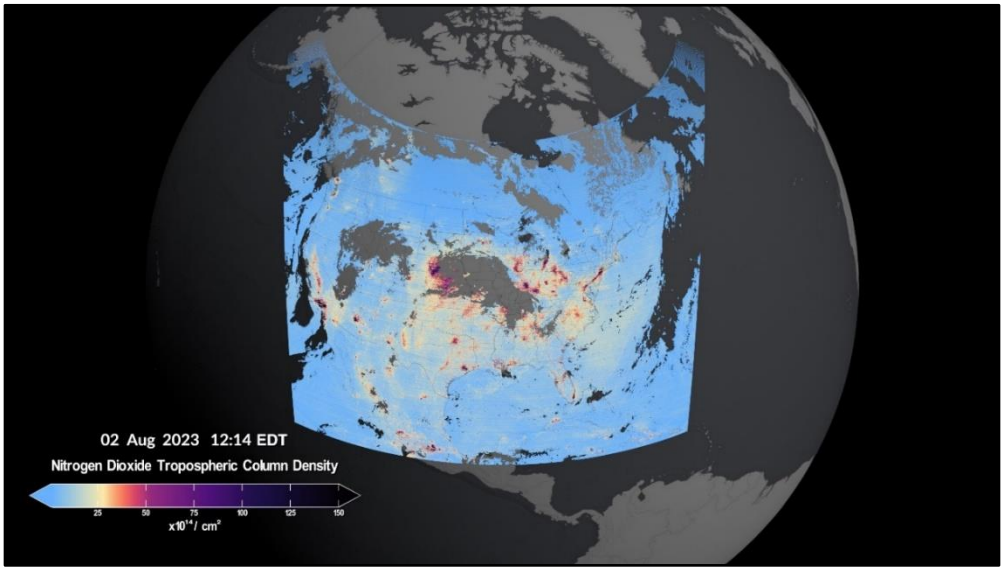
Shay Nair Sharma
HAQ Intern

In Summer 2023, **Shay Nair Sharma (Stanford Univ.)**, a third-year undergraduate student studying human biology, joined the HAQ team as the Summer Intern. Under the direct mentorship of **Helena Chapman (NASA HQ/BAH),** Shay did a retrospective analysis of 10 HAQ funded projects from the ROSES2013 solicitation. This included, (1) a comprehensive bibliographic review of teams' project, (2) designing a 14-question survey for research teams to complete, followed by (3) a subsequent 30-minute interview to learn about the project milestones and analysis on advances upon completion of the NASA funded project period. He also helped develop the HAQ focus area's programmatic strategic plan for interactions with schools of health sciences. With his participation in team meetings, Group on Earth Observations (GEO) Health Community of Practice semi-monthly telecons, and AmeriGEO Week proceedings – including **one poster presentation** and **one flash talk** – he recognized emerging global health risks, grasped the One Health concept, and understood the importance of bridging disciplines to minimize scientific knowledge gaps. His valuable contributions have helped our HAQ team better understand how original project milestones can expand beyond the anticipated timeline, increase scalability, and build end-user capabilities.

Credits: S. Sharma

TEMPO

In Summer 2023, the TEMPO mission successfully completed its First Light operations, highlighting First Earth imaging scans on August 2, with six daytime hourly scans across the TEMPO Field of Regard covering greater North America. Tropospheric NO_2 data retrieved from the First Earth imaging scans tracked NO_2 pollution (daylight hours) from a myriad of emission sources, including cities, traffic corridors, fires, and industrial complexes. TEMPO's successful commissioning phase concluded on October 18, with nominal operations on October 19.



TEMPO's first Earth image around midday on August 2, showing NO_2 over the field of regard. Credits: NASA Scientific Visualization Studio

To highlight TEMPO mission and Early Adopters program achievements, **Aaron Naeger (Univ. of Alabama in Huntsville)** presented at the Air Quality Assessment Division (AQAD) and Atmospheric and Environmental Systems Modeling Division (AESMD) technical meeting on July 20, the Association of Air Pollution Control Agencies (AAPCA) webinar on utilizing satellite data for air quality monitoring and modeling on August 22, and the 35th Annual Conference of the International Society of Environmental Epidemiology (ISEE 2023) from September 17-21 in Kaohsiung, Taiwan. More than 80 new users and stakeholders joined the TEMPO Early Adopters program by late September, with most new members from air regulatory agencies and health organizations.

NASA HAQ INVESTIGATOR AND TEAM UPDATES

- **Assaf Anyamba (Oak Ridge National Laboratory):** He was interviewed for *The Bulletin of Atomic Scientists* (El Niño increases global health threats that require a One Health response) in July 2023.
- **Helena Chapman (NASA HQ/BAH):** She served as a panelist for the NOAA One Health Summit in August 2023.
- **John Haynes (NASA HQ):** He served as a panelist on the ESIP Wildfires event in August 2023**.**
- **Tracey Holloway (Univ. of Wisconsin-Madison):** She was an invited guest on the Wisconsin Energy Institute podcast (Mountains and Molehills) and Well Wisconsin Radio (What can you do about climate change?) in August 2023.
- **Christopher Uejio (Florida State Univ.)**: He was an invited guest on the Science Friday podcast (Higher Temperatures Are Bad For the Body) in July 2023.

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A CLOSER LOOK AT THE 2023 HAQAST TIGER TEAMS

The NASA 2023 HAQAST Tiger Teams highlight short-term, high-impact, collaborative efforts between HAQAST members and stakeholders to identify and solve critical problems using NASA data and products. Learn more about the five selected projects:

Credits: NASA HAQAST

OIL AND GAS EMISSIONS

Industry, local decision-makers, community groups, and air quality experts study the effects of oil and gas emissions. **Ted Russell (Georgia Tech)** leads a team bringing satellite observations to support assessments of oil and gas emissions and exposures. The work leverages collaborative efforts with the Boston-based Health Effects Institute. Russell said, *"They are getting some tremendously rich ground-based observations at fine scales, and there's lots of opportunities to start bringing Earth systems observations and models to bear with a direct link to air quality policy and health."*

TAPPING INTO USING TEMPO

NASA's recently launched TEMPO satellite instrument will provide air quality monitoring hourly over northern America. A team led by **Arlene Fiore (Massachusetts Institute of Technology)** will allow health stakeholders to take full advantage of TEMPO data, with a focus on ozone. *"Part of why [surface ozone] is so challenging to control is because it's not emitted directly but forms through atmospheric chemistry,"* Fiore said.

MODELING AIR QUALITY

Brad Pierce (Univ. of Wisconsin-Madison) is leading a team that will test existing models as boundary conditions in higher resolution computer models used by air quality managers. Managers expressed their support for the project, commenting that the project promises to *"improve the reliability and validity of the modeling systems that we use to support air pollution policy and public health."*

ENVIRONMENTAL JUSTICE

Qian Xiao (Univ. of Texas Health Science Center at Houston) will continue to lead the ongoing Satellite Data for Environmental Justice team. It addresses needs of the environmental justice community and is part of NASA's Environmental Justice efforts. In the next iteration, the team is developing more training resources and dedicated support for community projects.

IMPROVING AIRNOW AND PUBLIC HEALTH SURVEILLANCE

NASA's contributions to the Environmental Protection Agency's AirNow dashboard continues. The 2023 effort expands on the work accomplished the 2021 Tiger Team, led by Pawan Gupta (NASA GSFC). Now led by **Yang Liu (Emory Univ.)**, the team aims to expand the use of these data to aid public health asthma surveillance networks.

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SYNERGISTIC TEMPO AIR QUALITY SCIENCE (STAQS)

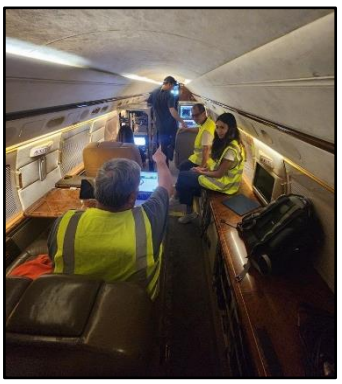
In Summer 2023, NASA conducted the Synergistic TEMPO Air Quality Science (STAQS) mission, which seeks to integrate TEMPO satellite observations with traditional air quality monitoring to improve understanding of air quality science and increase societal benefit. Led by **Laura Judd (NASA LaRC)** and **John Sullivan (NASA GSFC)**, the STAQS instrument team included NASA collaborative effort from Langley Research Center, Goddard Space Flight Center, Jet Propulsion Lab, Johnson Space Flight Center, and NASA HQ. The STAQS name describes the strength of its observing strategy of integrating observations from a stacked multiple perspective – ground-, aircraft-, and satellite-based – recognizing the strength of each point of view for collectively understanding the state of current air quality challenges.

Between late June and late August 2023, NASA flew over 270 flight hours between two aircraft integrated with remote sensing instrumentation to measure high resolution NO_2, formaldehyde, ozone, aerosols, and methane over Los Angeles, Chicago, New York City, and Toronto. Additionally, ground-based instrumentation from NASA TOLNet, NASA/ESA Pandonia Global Network, and AERONET were deployed in each domain. Ten flight days coincided with TEMPO observations and will help with validating TEMPO products as well as accelerating their use in understanding air quality challenges in these cities.

This successful campaign included key collaborations with the TEMPO team at Harvard-Smithsonian Astrophysical Observatory for planning coincident observations as well as tag-teamed flights with the NASA DC-8 as part of the NOAA Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) mission and numerous other AGES+ activities.

To learn more about this summer's activities, please review the NASA-led Mission to Map Air Pollution in 3D Over Megacities and A Tale of Three Pollutants NASA web features.

STAQS/AEROMMA teams on Media Day. Credits: NASA



Preflight activities on the NASA GV. Credits: NASA

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GEO HEALTH COMMUNITY OF PRACTICE HOLDS BIWEEKLY TELECONS

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 each meeting.

- July 2023: **Didier Davignon** and **Melissa MacDonald (Environment and Climate Change, Canada)** presented an update on wildland fire smoke forecasts and communication strategies on health impacts in Canada.
- August 2023: The *Special Edition: The Americas* telecon offered 16 flash talks on environmental health and emergencies, water resources, air quality, and data management and capacity building.

The **Small Work Groups** leads facilitated discussions with CoP members to provide technical knowledge on health-related project tasks. They regularly provide updates on Small Work Group activities to the CoP membership. To join one of the CoP Work Groups, please complete the form.

Heat-related Health Risks
Ben Zaitchik (Johns Hopkins Univ.)
Cascade Tuholske (Montana State Univ.)

Air Quality, Wildfires, and Respiratory Health
Carl Malings (NASA GSFC/Morgan State Univ.)
Nathan Pavlovic (Sonoma Technology)

Infectious Diseases
Antarpreet Jutla (Univ. of Florida)
Tatiana Loboda (Univ. of Maryland, College Park)

Food Security and Safety
Orhun Aydin (St. Louis Univ.)
Mahesh Jampani (International Water Management Institute)

Health Care Infrastructure
Andreas Skouloudis (iSteep.org)
Ajay K. Gupta (HSR.*health*)

USGEO ANNUAL WORKSHOP 2023

In August 2023, the two-day **2023 USGEO Annual Workshop** was held at NASA HQ in Washington DC. As part of the agenda, the GEO Health CoP team **(J. Haynes, J. Trtanj, H. Chapman)** presented in the *Nexus Area* and the *Future Strategy of GEO* sessions, highlighting key examples of how Earth observations can improve understanding of how changing Earth's systems influence public health. Discussions centered on how the new Post-2025 GEO Strategy can be implemented by the various thematic areas – including the GEO Health CoP. It was recognized that the GEO Health CoP currently exemplifies many aspects of the Post-2025 GEO Strategy and may serve as a model, as its One Health focus touches on using Earth observations to examine the complex global challenges related to human, animal, and environmental health.

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AMERIGEO WEEK 2023

In August 2023, the NASA HAQ Team participated in AmeriGEO Week 2023, hosted by the University of Costa Rica and the Costa Rica's Ministry of Environment and Energy in San Jose, Costa Rica. This event highlighted how Earth observations are contributing to AmeriGEO's five thematic priorities. The EO4Health team, together with the US Embassy of Costa Rica, supported three One Health activities, with more than 100 attendees at the scientific and side event sessions.

- **Scientific and Poster Sessions**: The *Connecting Earth and Health Science Communities through One Health Regional Partnerships* session – facilitated by **John Haynes (NASA HQ)**, **Juli Trtanj (NOAA)**, and **Helena Chapman (NASA HQ/BAH)** – focused on building valuable partnerships in the Americas region to assess air quality exposure in the Caribbean basin and Brazil, develop water-related and vector-borne early warning systems in Chile, Costa Rica, and Peru, and prepare climate, environment, and health tools for decision-making activities within the Americas region. To complement the scientific session, a total of 10 posters by GEO Health CoP members were presented during the hybrid break-out poster sessions.
- **Side Event**: The *Deep Dive on Using Earth Observations for Public Health Applications* session facilitated direct interactions with students and faculty of medical schools. Focusing on malaria and urban heat, 10 medical (IFMSA-Costa Rica/ACEM) and microbiology students from five institutions in Costa Rica presented clinical cases and helped moderate the discussion. Experts offered flash talks on vector-borne and water-related diseases, air quality, and urban heat, followed by a deep dive into malaria and urban heat mapping applications.
- **Capacity Building**: The two-day *Environmental-Epidemiological Models for Dengue Early Warning Training* – facilitated by **Hunter Jones (NOAA), Ximena Porcasi (CONAE),** and **Pablo Paccioretti (CONAE)** and supported by NOAA, US Department of State, and US Embassy of Costa Rica – aimed to build capacity in developing epidemiological models related to vector-borne disease transmission.

Also, the EO4Health team provided formal presentations on using Earth observations for public health applications to more than 100 medical and microbiology students and faculty at the University of Medical Sciences (UCIMED) in San José. We invite everyone to view the One Health sessions and other recorded sessions!

Facilitators and participants in the One Health side event (Left), and EO4Health team with Dr. Adrian Avendaño at the University of Medical Sciences (UCIMED) (Right). Credits: H. Chapman

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NASA CELEBRATES INTERNATIONAL DAY OF CLEAN AIR FOR BLUE SKIES

Each September, the International Day of Clean Air for blue skies 2023, recognized by the United Nations, aims to increase awareness about air quality. This year, the NASA HAQ and Communications Teams supported a social media campaign on NASA Earth (Facebook and Twitter on TEMPO) as well as NASA Atmosphere (Facebook and Twitter on HAQAST and TEMPO). Also, **John Haynes (NASA HQ)** was an invited panelist at the UNEP event held at the Walter Reed Community & Senior Center and Park in Arlington, VA.

Panelists at UNEP event. Credits: UNEP

LOOKING AHEAD

Meetings:

HAQAST Utah Meeting
October 19-20, 2023
Salta Lake City, UT

American Public Health Association Annual Meeting & Expo
November 12-15, 2023
Atlanta, GA

Primer Congreso Internacional Una Salud
November 21-24, 2023
Virtual for Santiago, Chile

American Geophysical Union Fall Meeting
December 11-15, 2022
San Francisco, CA

HAQ COMMUNITY ENGAGEMENT

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

- ❑ **Georgetown University:** J. Haynes and H. Chapman gave lectures on *Spatialization and Dynamics of Vector-borne Diseases: Advances in Remote Sensing*, as part of the Seminars on Global Infectious Diseases course (12 graduate students).
- ❑ **U.S. Department of State's International Visitors Leadership Program:** J. Haynes presented on using Earth observations to better forecast and understand risk from mosquito-borne diseases to participants from Southeast Asia.
- ❑ **George Washington University:** H. Chapman presented the talk, *Innovative Applications in Environmental Health: A Focus on One Health*, as part of the MPH@GW Discovery Series for Professional Enhancement Opportunities (90 public health students).

RECENT COMMUNICATIONS

NASA

- ❑ NASA Shares First Images from US Pollution-Monitoring Instrument (Karen Fox, Katherine Rohloff, Charles Hatfield, NASA)
- ❑ NASA and Google Team up to Better Track Local Air Pollution (Aries Keck, NASA)

NASA Earth Observatory

- ❑ Temperature Extremes 2023, Aerosol Optical Depth, Aerosol Size, and Clearer View of Great Lakes Air Quality

NASA Earth Action Program

- ❑ Looking to Solve Real-World Air Quality Issues (Jenny Bratburd, Univ. of Wisconsin-Madison)
- ❑ Air Quality Forecasts Get an Upgrade (Marissa Kunerth, IntelliBridge)
- ❑ Getting Satellite Data into the Hands of Park Rangers (Kaitlin Carpenter, IntelliBridge)

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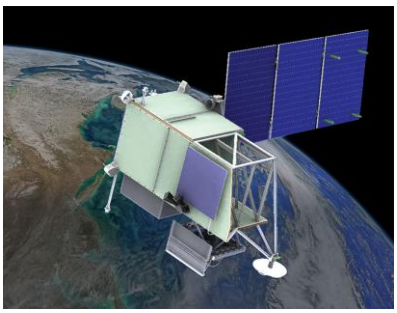
2023 PACE APPLICATIONS WORKSHOP

In September 2023, **Erin Urquhart Jephson (NASA GSFC/SSAI)** and **Natasha Sadoff (NASA GSFC/SSAI)** led the NASA PACE (Plankton, Aerosol, Cloud, ocean Ecosystem) Applications Workshop. The event focused on future uses of PACE satellite data, research, and applications to benefit society and support decision-making in the context of water resources, air quality and health, climate, disasters, and ecological forecasting. View the session recordings of the PACE Applications Workshop, and learn more about the PACE Community of Practice and Early Adopters program!



Credits: PACE webpage

PAST

ARSET Training:

Assessing the Impacts of Fires on Watershed Health
July 6-13, 2023

Satellite Data for Air Quality Environmental Justice and Equity Applications
August 23-September 6, 2023

Building Climate Risk Assessments from Local Vulnerability and Exposure
September 19-21, 2023

Meetings:

AmeriGEO Week
August 7-12, 2023
San José, Costa Rica

USGEO Annual Workshop
August 22-23, 2023
Washington, DC

PUBLICATIONS

Source Contributions to Fine Particulate Matter and Attributable Mortality in India and the Surrounding Region. *Environmental Science & Technology*. (D. Chatterjee…**R.V. Martin**)

Reversal of Trends in Global Fine Particulate Matter Air Pollution. *Nature Communications*. (C. Li…**S.C. Anenberg**, M. Brauer, **R.V. Martin)**

Association of Wildfire Exposure while Recovering from Lung Cancer Surgery with Overall Survival. *JAMA Oncology*. (D. Zhang…**Y. Liu**, L.M. Nogueira)

Anthropogenic Amplification of Biogenic Secondary Organic Aerosol Production. *Atmospheric Chemistry and Physics.* (Y. Zheng…**J. Mao**)

Artificial Light at Night and Social Vulnerability: An Environmental Justice Analysis in the U.S. 2012–2019. *Environment International*. (**Q. Xiao…J. Wang**, C. Bauer)