HAQAST 2019 Review

Prepared by

Tracey Holloway | HAQAST Team Lead | taholloway@wisc.edu

Daegan Miller | HAQAST Communications Lead | drmiller9@wisc.edu

Page Bazan | HAQAST Communications Specialist | pbazan@wsic.edu

September 11, 2019

haqast.org

What is "hay-kast"?

- Health and Air Quality Applied Sciences Team
- NASA-funded Applied Sciences Team
- ~~3~~ 4-year funded project (thru summer ~~'19~~ '20)
- 13 Members and 70+ co-investigators
- Mission: Connect NASA science with air quality and health applications
- ~ $15 Million Total Cost
- Three types of work:
  1. Outreach & engagement
  2. Tiger team projects (collaborative)
  3. Member projects

HAQAST Investigator Susan Anenberg (left), NASA HQ Program Manager John Haynes (middle), and HAQAST Communications Lead Daegan Miller (right) at HAQAST4 in Madison, WI

HAQAST: Who We Are

Tracey Holloway *Team Lead*, UW-Madison

Bryan Duncan NASA GSFC

Arlene Fiore Columbia University

Minghui Diao San Jose State University

Daven Henze University of Colorado, Boulder

Jeremy Hess University of Washington, Seattle

Yang Liu Emory University

Jessica Neu NASA Jet Propulsion Laboratory
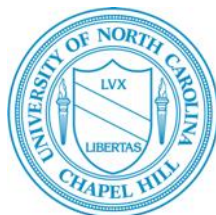
Susan O'Neill USDA Forest Service

Ted Russell Georgia Tech

Daniel Tong George Mason University

Jason West UNC-Chapel Hill

Mark Zondlo Princeton University

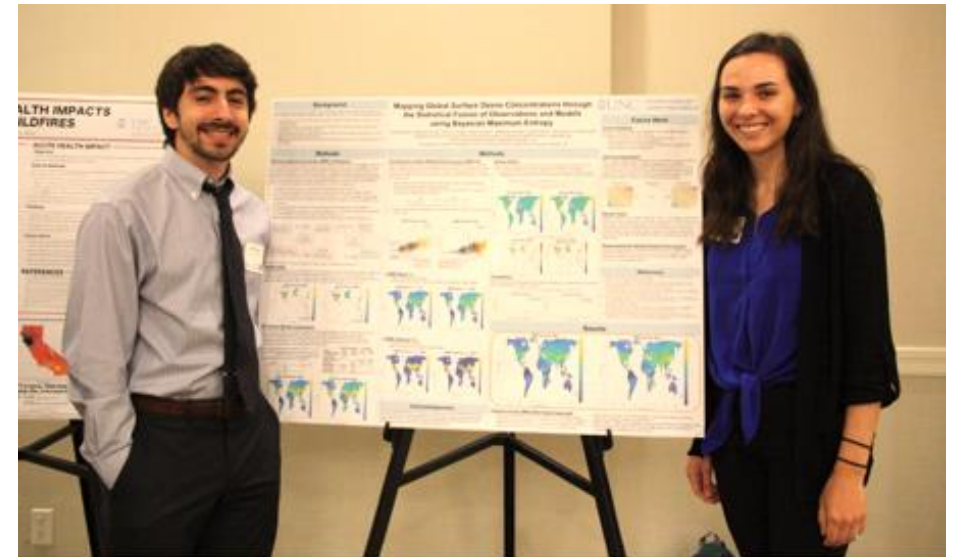# HAQAST: Who We Are

HAQAST Leadership Team

Tracey Holloway
HQAST Team Lead

Daegan Miller
HQAST Communications Lead

Page Bazan
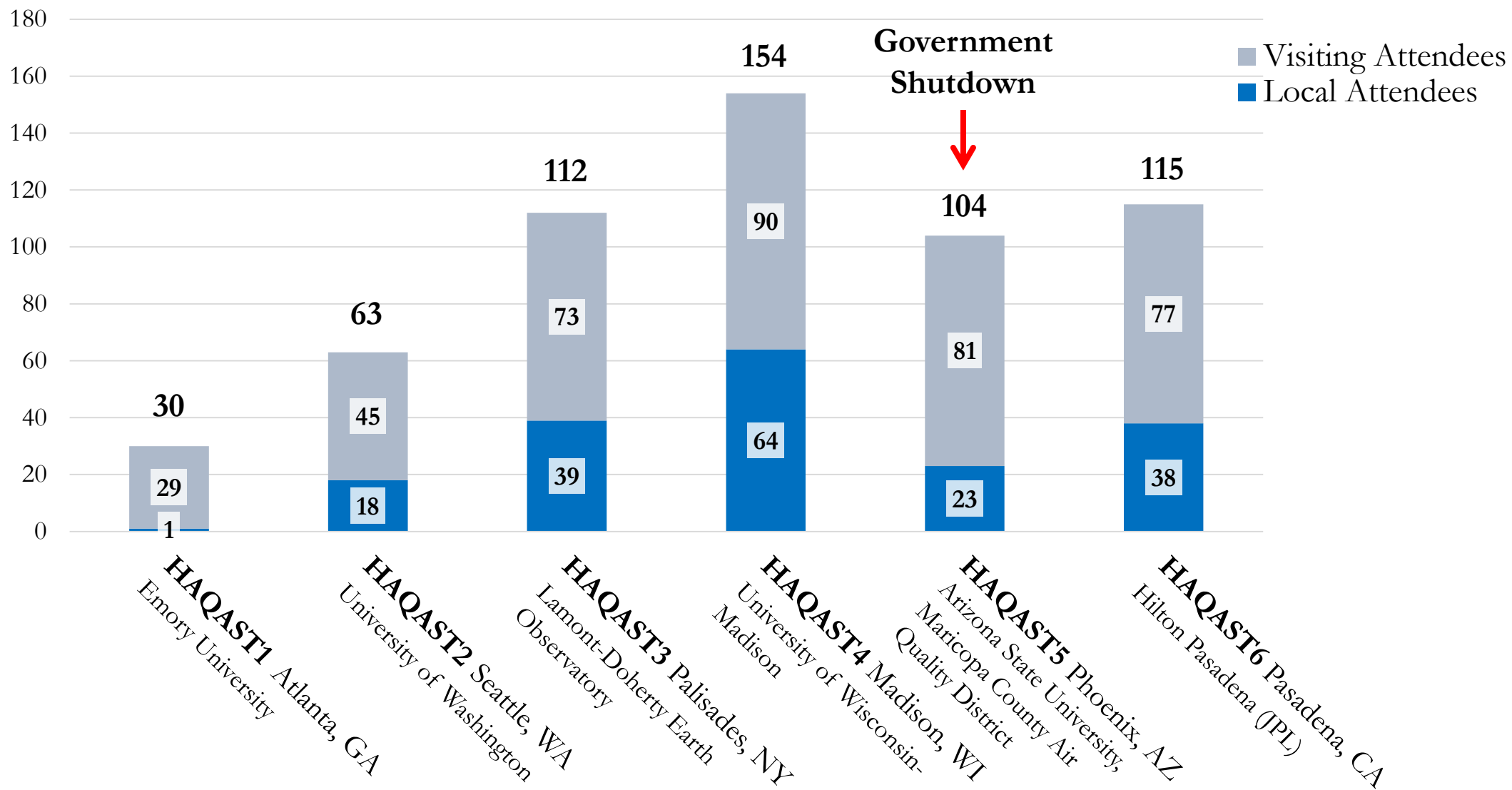HQAST Communications Specialist

HAQAST Meetings

HAQAST Meetings: In Person Attendance

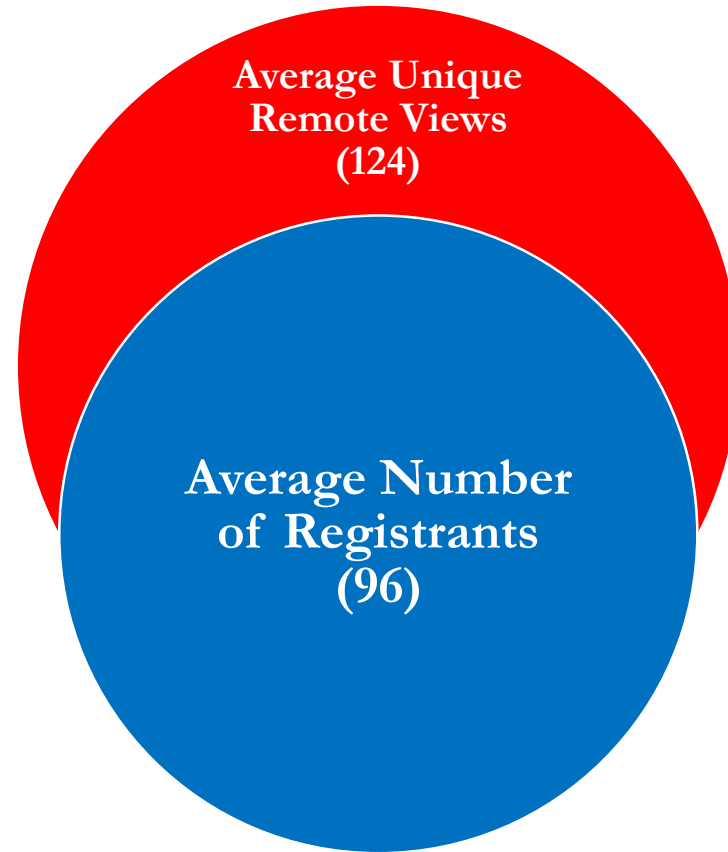## Local vs Visiting Registrants

Remote-Connect Option Significantly Increases HAQAST's Orbit

Offering an option to join the HAQAST conferences remotely **more than doubles** the average HAQAST conference audience size…

Average Unique Remote Views (124)

Average Number of Registrants (96)

… but the type of engagement is fundamentally different

HAQAST.org Promotes NASA Tools for Stakeholders

- Website (www.haqast.org) features NASA tools and data

- Tools section designed in consultation with ARSET

- Developed how-tos for two of the most useful tools for HAQAST stakeholders, Worldview and Giovanni; includes short video tutorials

Click on **Getting Started** for a brief primer to the benefits and limitations of satellite data.
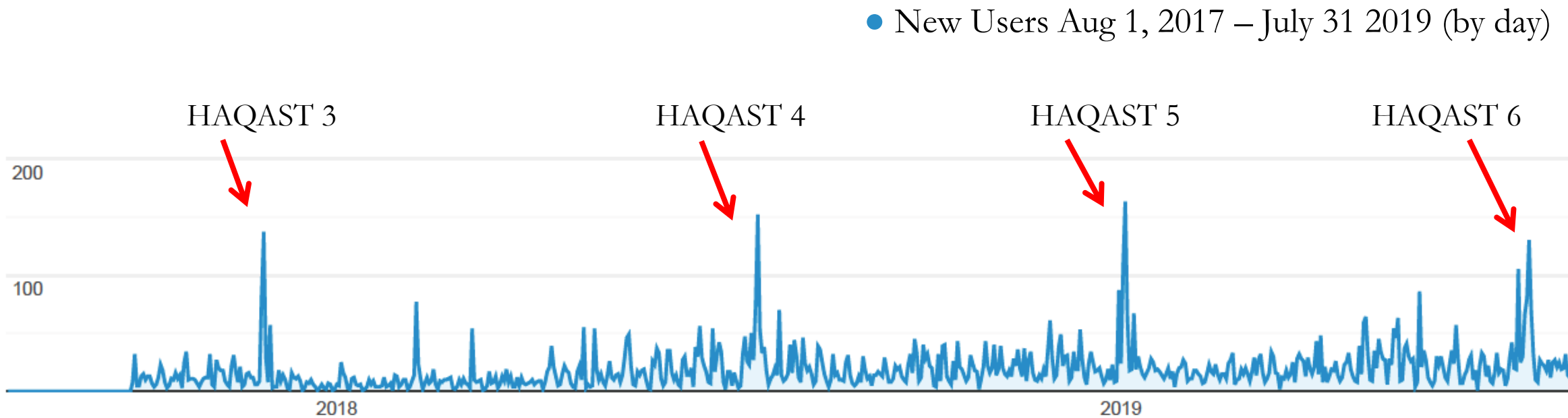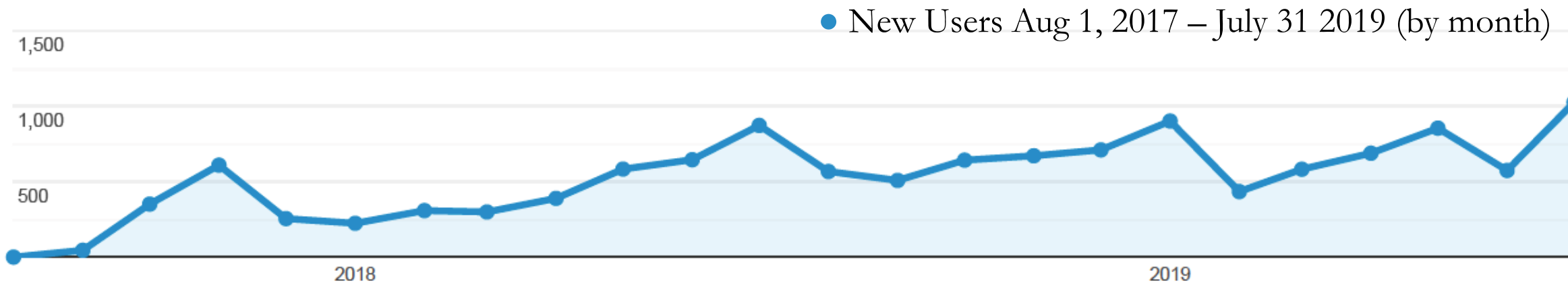
Clicking on the title takes you directly to the tool's NASA page.

Tutorials available (online, pdf, and video formats).
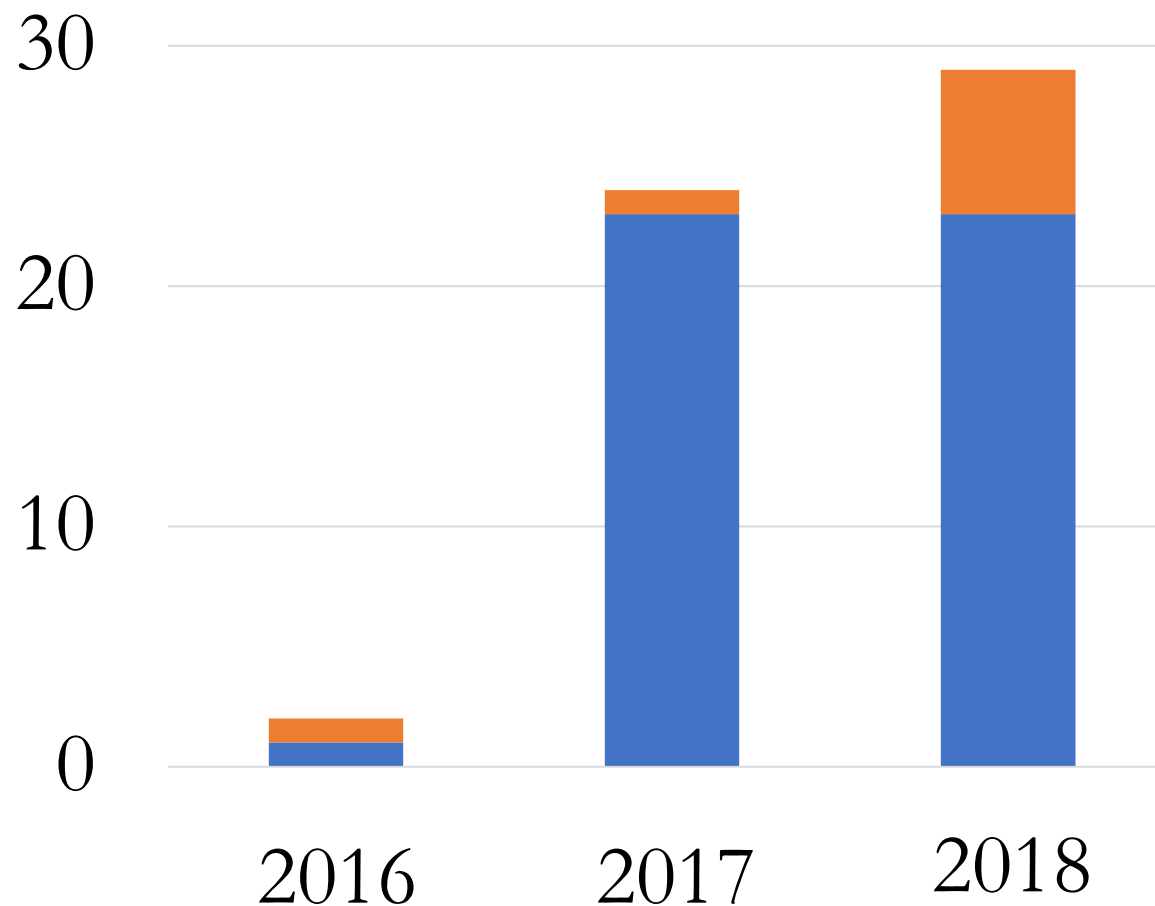
Very brief descriptions of each tool.

HAQST.org New Users

Collaborative Publications

Over 65 total papers
published to date

HAQAST publications by calendar year
Multiple PIs involved; **single PI involved**

Tiger Teams: A Competition for Ideas

- Assume that all HAQAST members will participate equally in the Tiger Team process

- Members and Co-I expertise could support many different projects

- After projects were selected, people are reallocated to contribute to selected teams

- In 2017, $1.5 Million allocated to support 4 Tiger Teams. Feedback from participants suggests that teams are successful and productive.

- In 2018, $1.6 Million allocated for 4 new Tiger Teams.

Haze Tiger Team leads Susan O'Neill (left) and Minghui Diao (right) with co-investigator Sean Raffuse (center) at HAQAST6. Image: Page Bazan

- **Led by Susan O'Neill:** assess the effects of wildfire smoke on the air quality and human health burden resulting from October 2017 California wildfires

- **Led by Arlene Fiore**: Supporting the use of satellite data in regional haze planning

- **Led by Jessica Neu:** improve the quantification of background O_3 in SIPs

- **Led by Susan Anenberg:** developing satellite-derived air pollution and climate indicators at the global scale

Susan O'Neill

Arlene Fiore

Jessica Neu

Susan Anenberg

Tiger Team: PIs O'Neill & Diao

Air Quality and Health Burden of 2017 Northern California Wildfires

http://bit.ly/haqasttiger

Overview

- Fire Emission Inventory (MODIS, VIIRS, GOES-16)

- Air Quality Modeling (WRF/CMAQ/Dispersion)

- Satellite Observations to Improve (Data Fusion) and Evaluate Model Predictions

- Health Impact Analysis

- Over 80 people involved from 30+ agencies

- Seven sub-teams

Outcomes

- Completed training video "The Basics of Satellite Data for Smoke and Fire".

- Demonstrated utility of GOES-16 fire detections as a data calculation stream. Extrapolating to 2018 – Camp Wildfire.

- Webpage – Communications, Data Hosting/Organization/Analyses

- 6 conference talks

- Draft paper outline

CMAQ 24hr Average PM25_FRM with AQS Observation
FIRE08_BlueSky_run2

October 09, 2017 00:00:00 UTC Min (140, 96) = 2., Max (36, 130) = 8816.

HAQAST
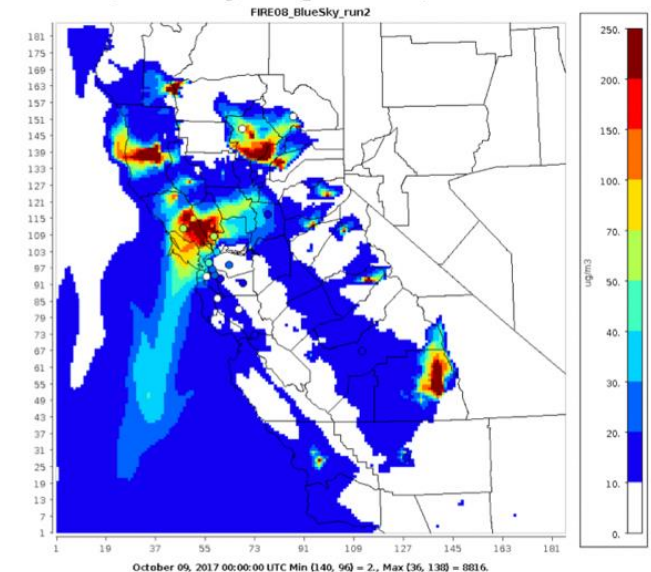
Supporting the Use of Satellite Data in Regional Haze Planning
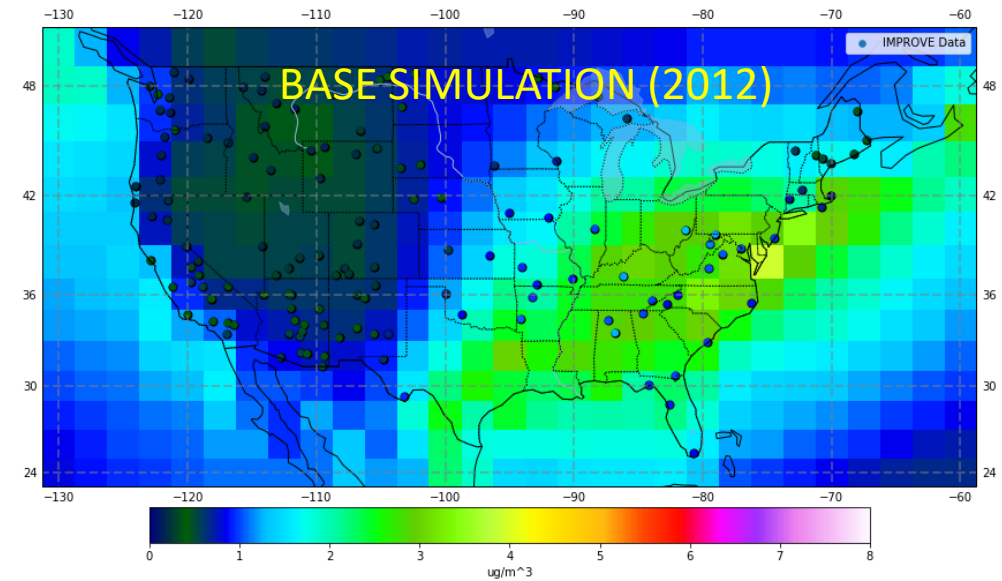
Overview

- Assist in the attribution of observed visibility-impairing PM to natural and anthropogenic sources

- Provide tangible, user-friendly examples of using satellite data for haze applications

Outcomes

- Communication: listening sessions with 5 stakeholder partner agencies; monthly calls with 10+ stakeholder agencies, meeting notes, compiled stakeholder needs

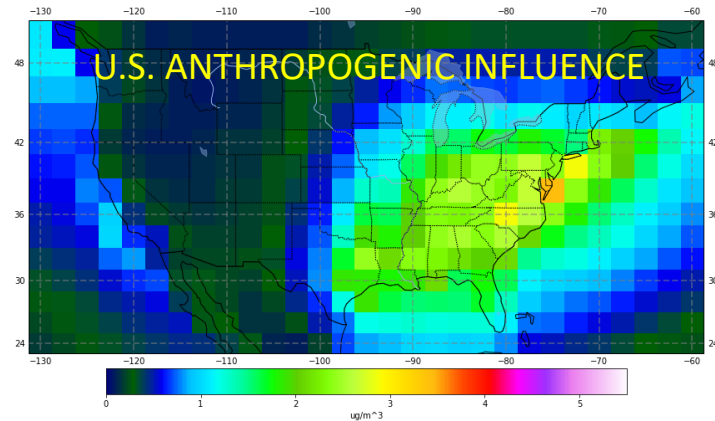- Sent analysis of model attribution at SW IMPROVE sites to stakeholder partners at TCEQ and EPA

GEOS-Chem Base Run-2012 Average SO4
BASE SIMULATION (2012)
IMPROVE Data

GEOS-Chem (USB - NAB) Run-2012 Average SO4
CANADA + MEXICO INFLUENCE
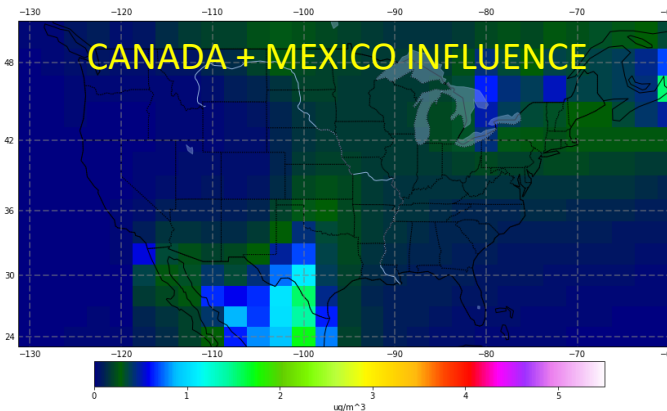
GEOS-Chem (Base - USB) Run-2012 Average SO4
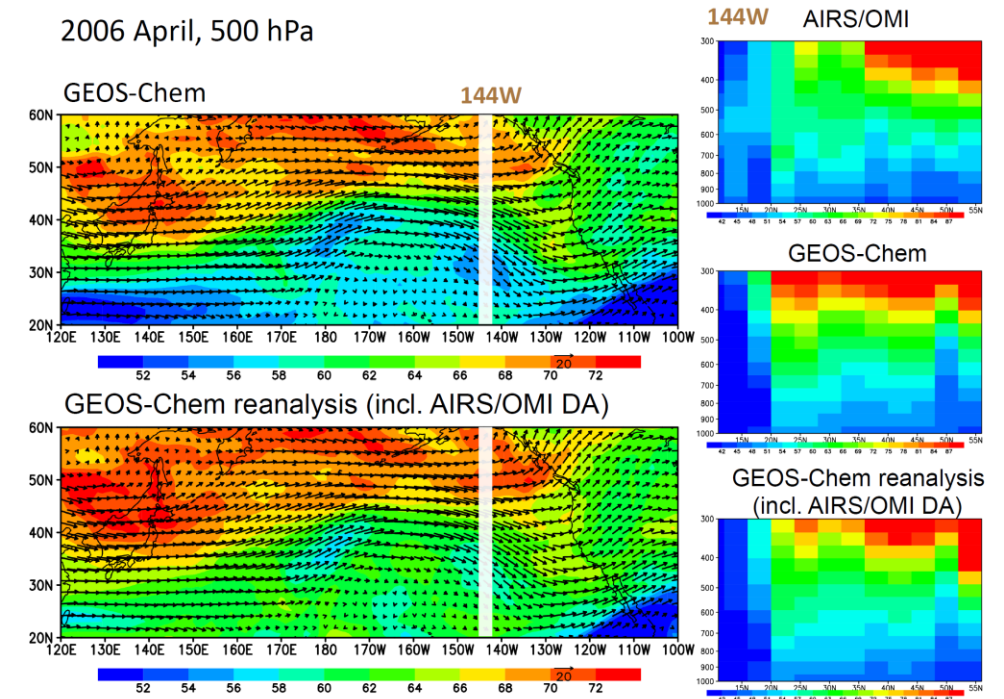U.S. ANTHROPOGENIC INFLUENCE

Using Satellite Data to Inform Background Ozone Estimates

Overview

- Provide a coordinated set of boundary conditions for ozone, background ozone, and natural ozone for 2016 from multiple global models that are evaluated with or informed by satellite data.

- Establish 'best practices' for evaluating the models used for boundary conditions with satellite ozone measurements, and for evaluating satellite-informed simulations with independent datasets.

Outcomes

- Have identified region and year for BC generation in concert with stakeholders.

- First set of BCs being generated from 3 different model versions.

- Protocols for evaluating BCs being established

- AIRS/OMI data along the Western boundary of CMAQ being processed for BC evaluation

2006 April, 500 hPa

GEOS-Chem   144W

GEOS-Chem reanalysis (incl. AIRS/OMI DA)

144W   AIRS/OMI

GEOS-Chem

GEOS-Chem reanalysis (incl. AIRS/OMI DA)

Tiger Team: PI Anenberg

Using Satellite Remote Sensing to Derive Global Climate and Air Indicators

Overview

- Transfer knowledge and global-scale datasets tracking indicators for ozone and NO_2 concentration, $PM_{2.5}$ and ozone disease burden in cities, and wildfire occurrence.

- Scope the potential for using satellite remote sensing to track global airborne dust storms and pollen season start date and duration.

May 9, 2019: Science to action roundtable

Outcomes

- Launched website www.haqastindicators.org, which hosts team updates and disseminates information on air quality and climate change topics.

- Two full-team telecons (third in Nov 2019), three investigator telecons, and May 2019 stakeholder meeting in DC.

- Liu shared global wildfire spot dataset with *Lancet Countdown* and will now be new climate indicator in their upcoming report.

- GWU published PM2.5 disease burdens for 250 cities worldwide in *Scientific Reports*. Results shared with C40 cities who will use them to provide info to mayors on cobenefits of city GHG mitigation. Results also on tiger team webpage.

- Global Burden of Disease Study partnering with GWU and NASA (Bryan Duncan and Lok Lamsal) to estimate global burden of NO_2 on asthma. Will be using the supplemental funding to complete this. Results from initial analysis published in *Lancet Planetary Health* on TT webpage.

- Made air pollution and health video for NASA Science on the Sphere which includes city air pollution disease burden estimates from Tiger Team.

**Common Themes
in PI Projects**

1. Developing user tools

2. Comparing satellite data
    with other forms of data

3. Data Fusion: combining
    satellite data with other
    forms of data

HAQAST Team Lead Tracey Holloway (left) with PIs
Arlene Fiore (middle) and Jason West (right)

Engaging LMIC Cities & Health Communities

- Kevin R. Cromar and Bryan N. Duncan have partnered with the NASA Global Modeling and Assimilation Office (GMAO) to entrain stakeholders (e.g., city governments) into GMAO's global air quality forecast system effort.

- Cromar, Duncan, and GMAO personnel are engaging city governments in low to middle income countries (LMIC) to:
  - communicate health risks of air pollution.
  - encourage health studies in these locations rather than only relying on concentration response functions from wealthier countries to assess risks and health impacts.

- This effort will not only benefit local residents, but also Americans living abroad in these areas.

Figure. Factsheet being distributed to world cities via c40 Cities, UNEP and WHO.

Predicting the Impacts of Prescribed Fires

- Georgia Tech has developed SIPFIS, a WebGIS-assisted online analysis tool that provides easy access to the predictions of prescribed fire impacts in southeastern USA (Hu et al., 2019, doi:10.3390/ijerph16111981).

- The air quality impacts are predicted daily using the HiRes-X forecasting system being developed as part of Georgia Tech's core NASA-HAQAST project.

- SIPFIS consists of a data-fetching component, a data-archiving component, and a data visualization and analysis component.

- Analyses include comparing the locations and areas of permitted burns to those of satellite-detected fires and prescribed burn forecasts.

- SIPFIS can be used in tasks such as checking community-level smoke exposures, screening for fire-related exceptional events, supporting analyses for air quality forecasts, and assessing the impacts of prescribed burns.
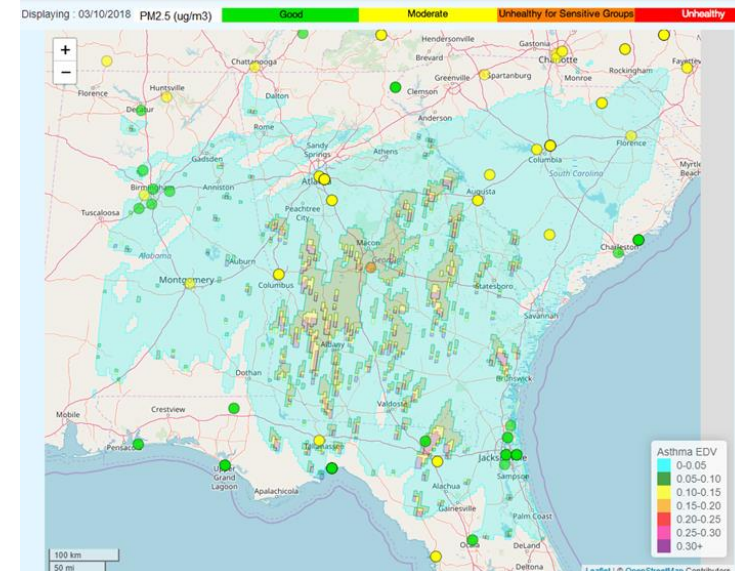
- SIPFIS expands prescribed fire impact information beyond just air quality impacts, by providing estimates of human exposure and health effects.
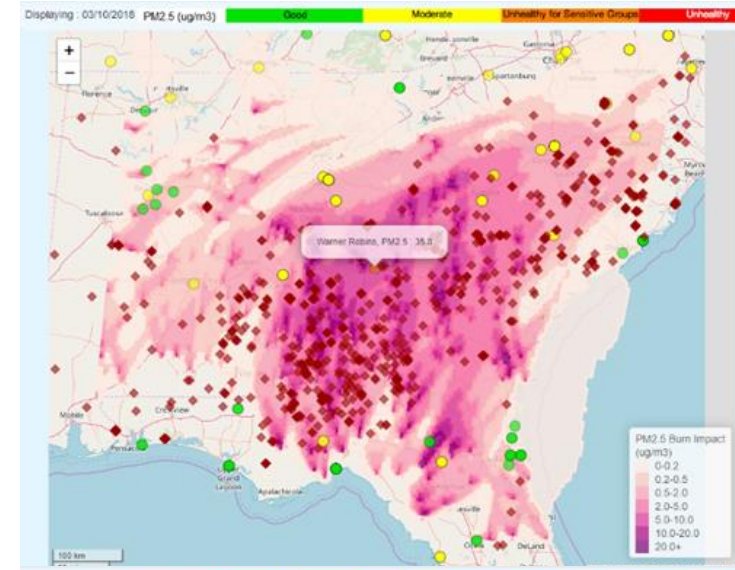
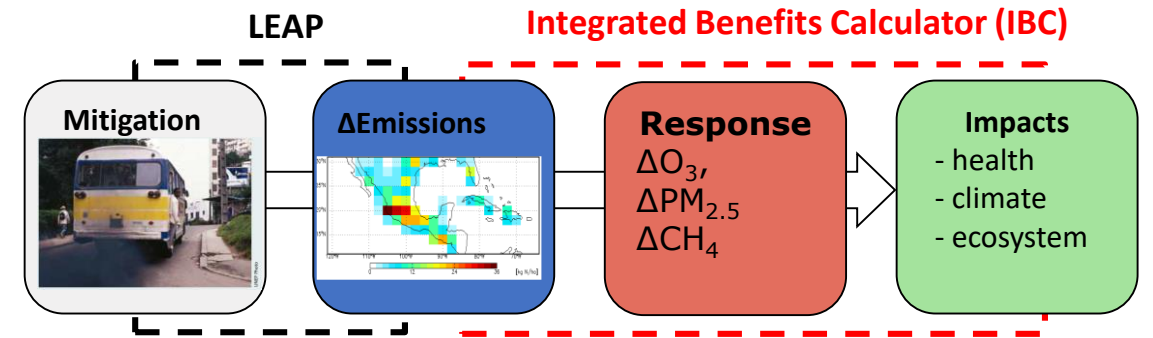Predictions of prescribed fire contribution to $PM_{2.5}$ levels for 3/10/2018

Increase in emergency department visits due to asthma for 3/10/2018

PI Project Updates: Henze

Use of satellite-informed PM$_{2.5}$ concentrations in an international integrated assessment tool (LEAP-IBC) for the CCAC
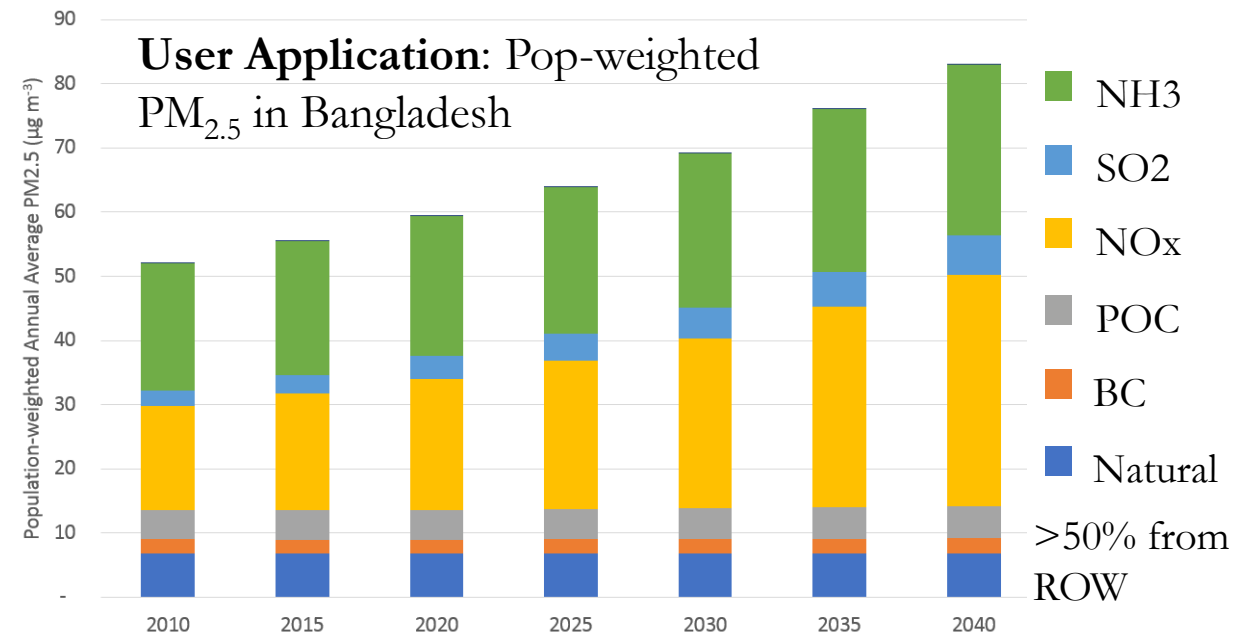
Climate and Clean Air Coalition (CCAC):

- Initiated in 2012, funding sources include US Department of State: now 61 countries, 71 NGOs, 93 actors

- Short Lived Climate Pollutant (SLCP) Supporting National Action Planning (SNAP) Toolkits – provide countries a means of evaluating the impacts of short-lived climate pollutants (emission reduction strategies)

Our project: Provide satellite-constrained estimates of PM$_{2.5}$ sources for the LEAP-IBC toolkit, now used in 25 CCAC member nations

CCAC
CLIMATE AND CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

ccacoalition.org

Integrated Benefits Calculator (IBC)

LEAP

Mitigation → ΔEmissions → Response ΔO$_3$, ΔPM$_{2.5}$, ΔCH$_4$ → Impacts - health - climate - ecosystem

GEOS-Chem adjoint, PM$_{2.5}$ from AOD-derived products (van Donkelaar et al., 2016)

User Application: Pop-weighted PM$_{2.5}$ in Bangladesh

- NH3
- SO2
- NOx
- POC
- BC
- Natural
- >50% from ROW

Satellite NH$_3$ for improving ground-based networks

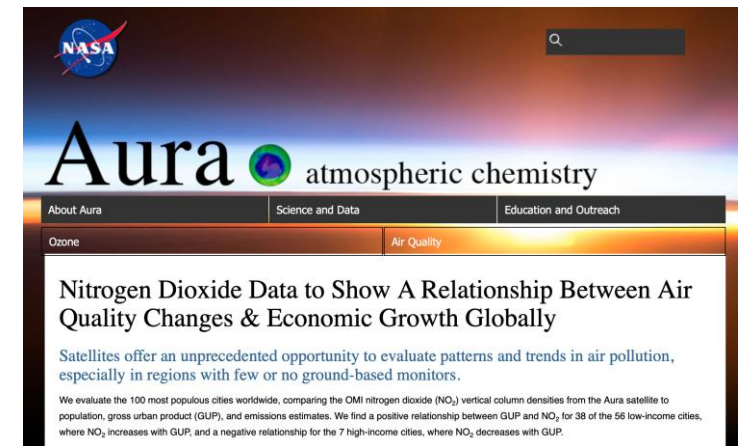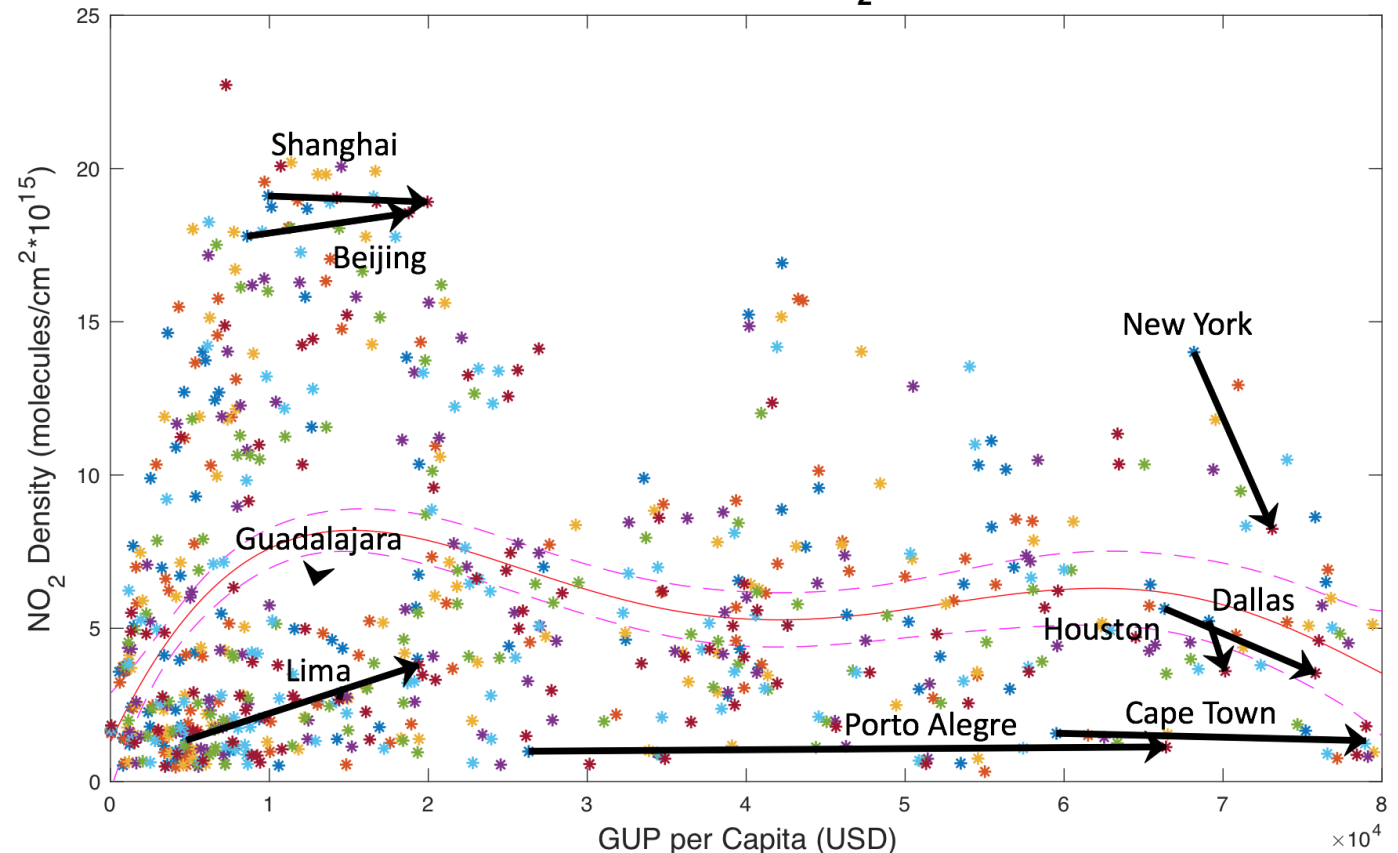IASI NH$_3$ oversampling method (Sun et al., *AMT*, 2018)
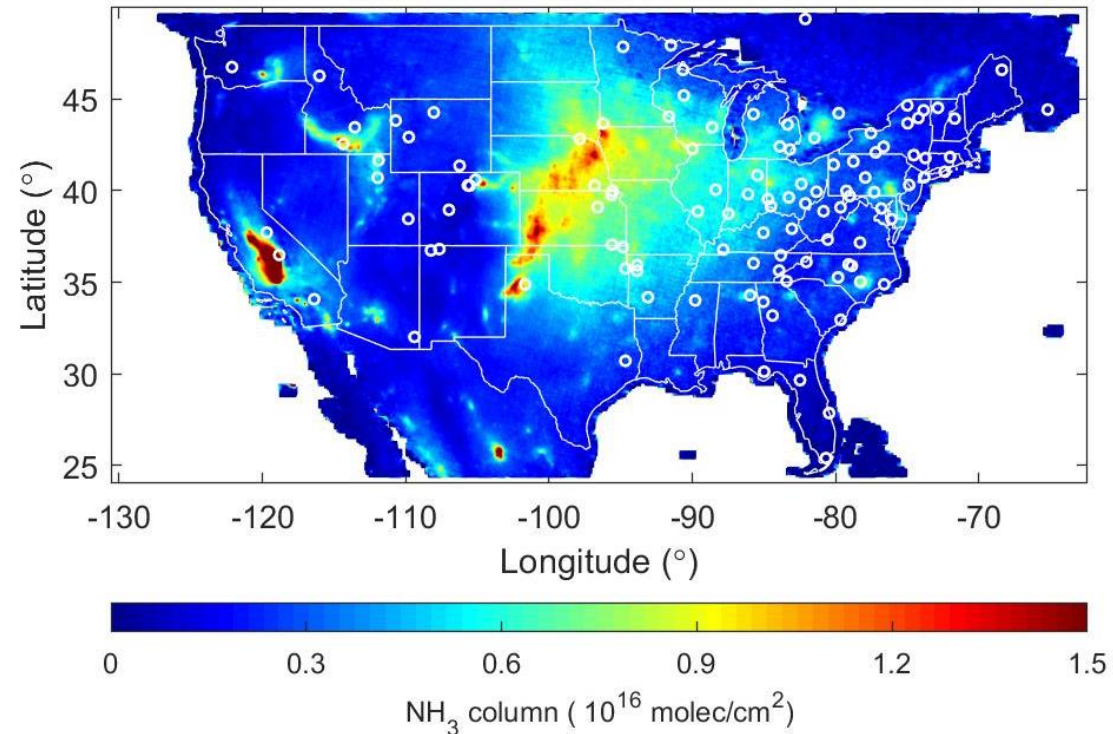
- High-resolution maps of IASI NH$_3$ at 2 km horizontal resolution (oversampling)

- Most AMoN sites located far away from the largest NH3 source regions

- Air and Waste Management Assoc. trade journal Environmental Monitor

- NASA Earth Observatory Image of the Day:
  - "The seasonal rhythms of ammonia" – Dec. 10, 2018

PI Project Updates: Holloway

New Applications for Satellite Data

- Connecting satellite data–especially for NO_2, HCHO, and AOD–with novel user applications in air management and health.

- In a 2018 study, we compared satellite-based NO_2 with per capita wealth in the 100 largest global cities. We see evidence for the "Kuznets Curve" where poorer cities get more polluted as the increase in wealth, and richer cities get cleaner.

- Other projects include:
  - Working with EPA to evaluate models with satellite HCHO data
  - Working with HAQAST colleagues to understand data fusion impacts on health estimates

Montgomery & Holloway, *JARS*, 2018

NASA — search

Aura ● atmospheric chemistry

| About Aura | Science and Data | Education and Outreach |
| Ozone | | Air Quality |

Nitrogen Dioxide Data to Show A Relationship Between Air Quality Changes & Economic Growth Globally

Satellites offer an unprecedented opportunity to evaluate patterns and trends in air pollution, especially in regions with few or no ground-based monitors.

We evaluate the 100 most populous cities worldwide, comparing the OMI nitrogen dioxide (NO_2) vertical column densities from the Aura satellite to population, gross urban product (GUP), and emissions estimates. We find a positive relationship between GUP and NO_2 for 38 of the 56 low-income cities, where NO_2 increases with GUP, and a negative relationship for the 7 high-income cities, where NO_2 decreases with GUP.


GUP per Capita vs. NO_2 Density

PI Project Updates: West

## Global Mapping of Surface Ozone Concentrations

- Our team estimated global surface ozone concentrations through a statistical fusion of global ozone measurements and models.

- Our first estimate was used in the Global Burden of Disease 2017 assessment, which estimated 470,000 deaths globally from ozone.

- We then improved this by
  - Estimating ozone each year from 1990 to 2017.
  - Adding recent ozone measurements from China.
  - Using the Bayesian Maximum Entropy method to merge multi-model ozone with observations in space and time.
  - Adding fine spatial structure (0.1 degrees) using the NASA GEOS-5 Nature Run.

- Our new estimates have been delivered for use in GBD2019.
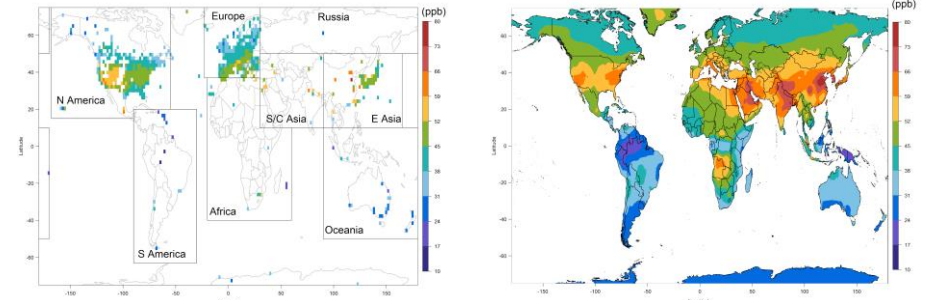
Fused ozone surface used in GBD 2017

MODIS Albedo-based Dust Map

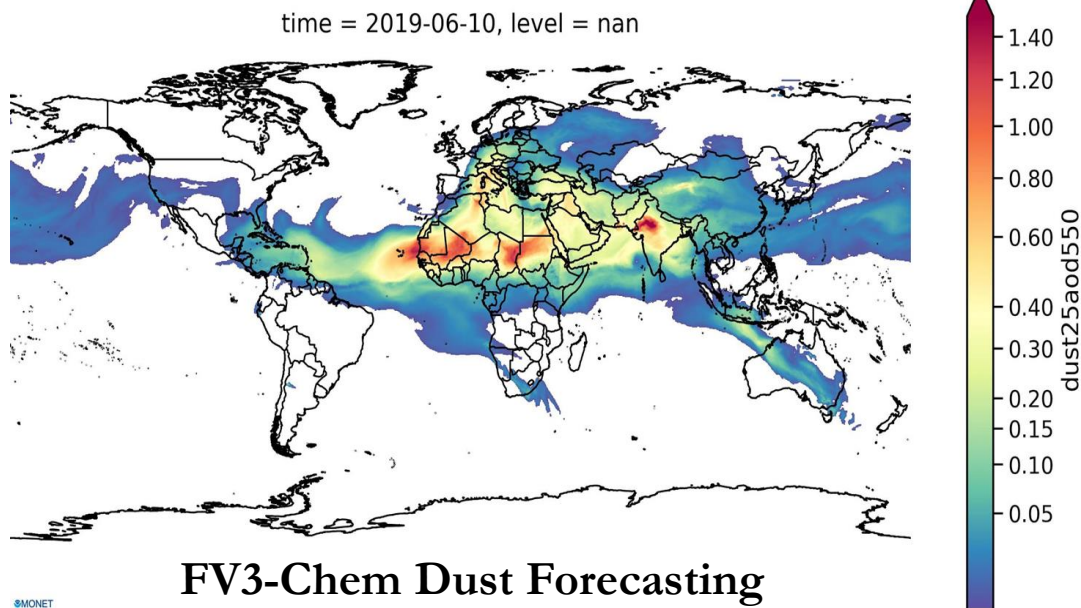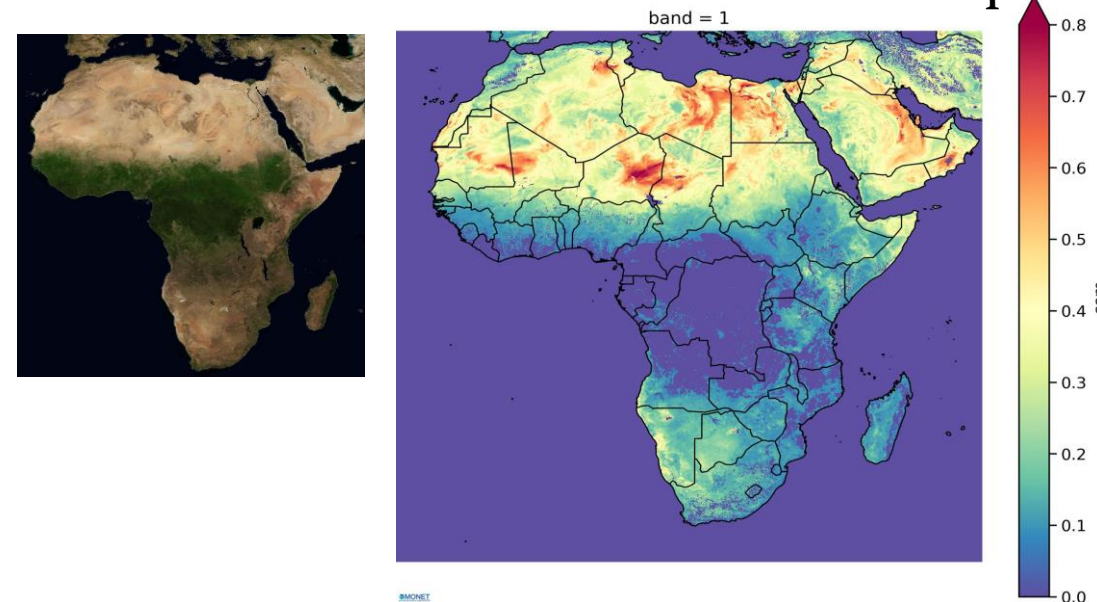**HAQAST**
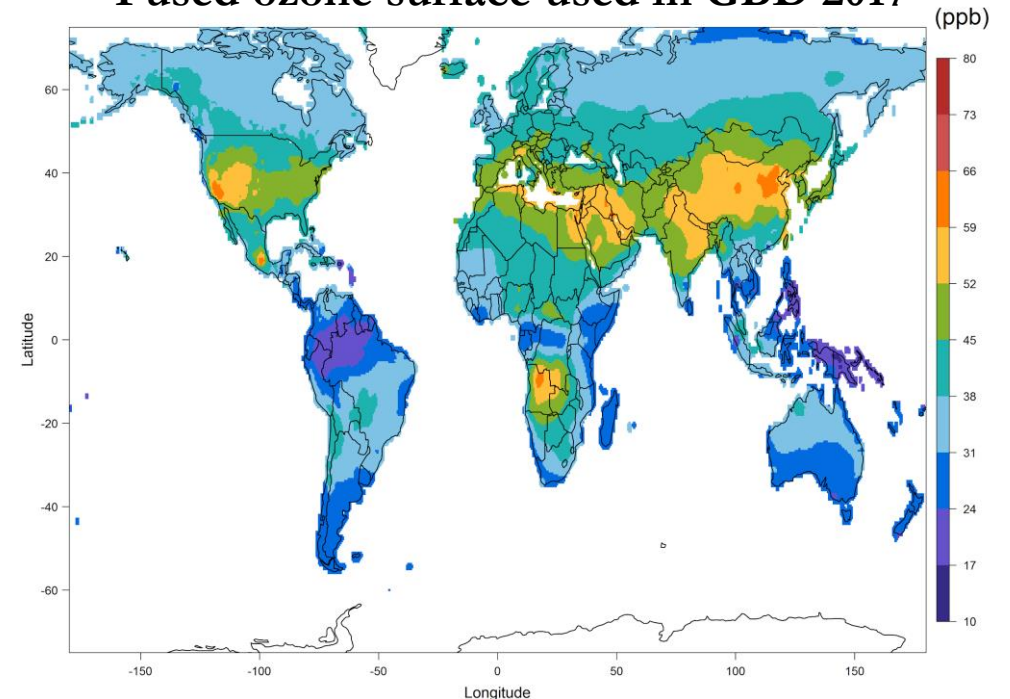
Satellite-aided Dust Forecasting

Goal:

Novel method to improve dust forecasting nationally and globally.

Satellite Products:

- MODIS/VIIRS Albedo;
- MODIS/VIIRS BRDF;
- MODIS/VIIRS AOD;

FV3-Chem Dust Forecasting
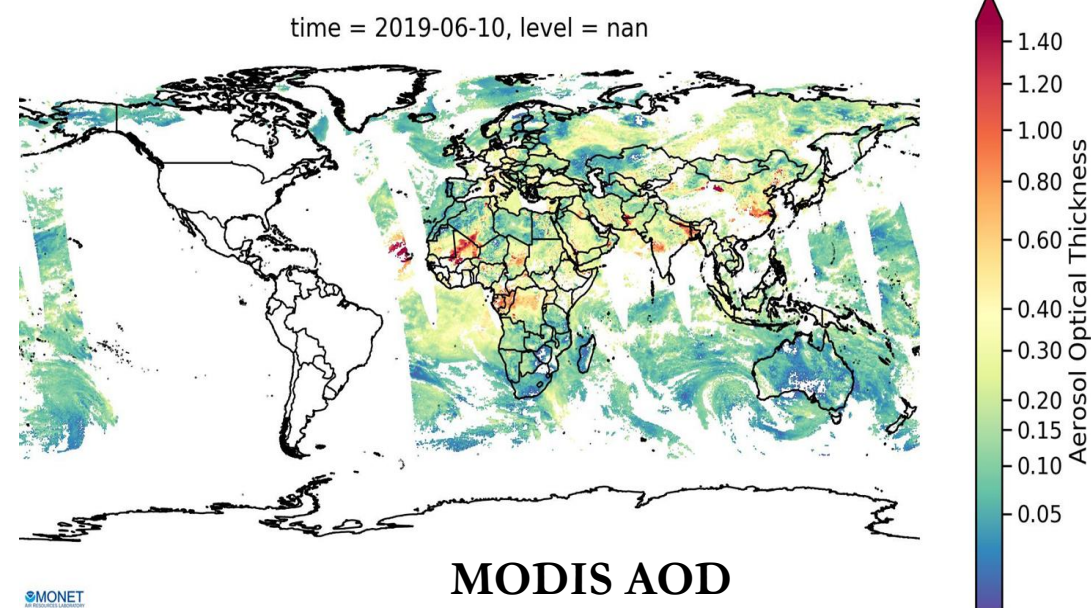
MODIS AOD

Image from
www.dustrisingfilm.com

Screenshot of Daniel Tong from the film. Credit: L. Schwartzman

- PI Daniel Tong featured in Lauren Schwartzman's critically acclaimed documentary film, Dust Rising.

- The film traces the effect of dust on human health and the environment.

- For screenings and to find out more, visit dustrisingfilm.com

HAQAST in the News: DustWatch App

- Smartphone app provides early warning notifications for dust storms

- Developed by a team of youth citizen scientists using NASA/NOAA data

- Also provides data on visibility, high wind conditions, air quality index (AQI), and dust concentration. Plus guides and educational materials.

- Featured in an article on NASA.gov, "Students Create App to Warn of Dangerous Dust Storms"

- Available for iOS. More info at: dustapp.org

The DustWatch team (left to right)
Alex Xie, Jeffrey Tong, Edgar
Nzokwe, Bill Tong, and Kevin Liu.
Image: Feng Zhang from NASA.gov
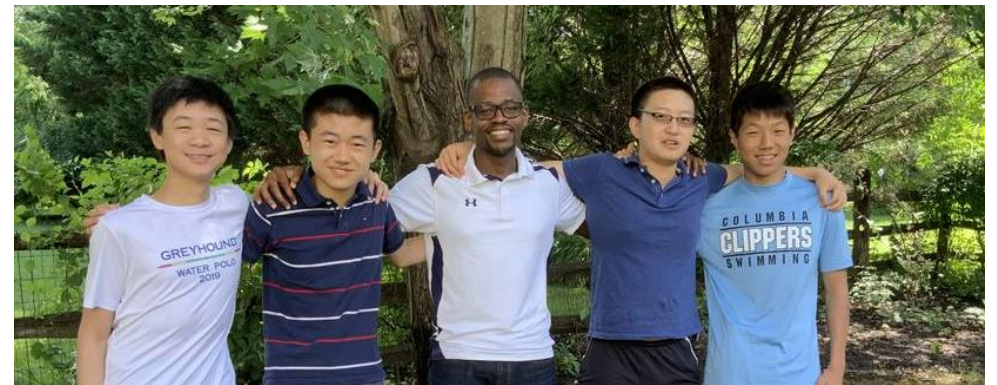
Thank You!

Visit HAQAST.org
- NASA data, tools & tutorials
- Info about and resources from our meetings
- Links to all our PIs' research and publications

Photo from HAQAST6 meeting in Pasadena, CA