National Aeronautics and Space Administration

NASA

EXPLORE EARTH

John Haynes, MS
Applied Sciences Program
Earth Science Division

HAQAST and Beyond: The View from NASA HQ

February 18, 2020

NASA EARTH FLEET

OPERATING & FUTURE THROUGH 2023

LANDSAT-9
SWOT
SENTINEL-6 Michael Freilich/B
TROPICS (6)
GEOCARB
NISAR
MAIA
TSIS-2
TEMPO
PREFIRE (2)
PACE
GLIMR
ICESAT-2
GRACE-FO (2)
CYGNSS (8)
NISTAR, EPIC (DSCOVR/NOAA)
SORCE
CLOUDSAT
TERRA
AQUA
AURA
CALIPSO
GPM
LANDSAT 7 (USGS)
LANDSAT 8 (USGS)
OCO-2
SMAP
SUOMI NPP (NOAA)

ISS INSTRUMENTS

EMIT
CLARREO-PF
GEDI
SAGE III
OCO-3
TSIS-1
ECOSTRESS
LIS

JPSS-2, 3 & 4 INSTRUMENTS

OMPS-Limb

INVEST/CUBESATS

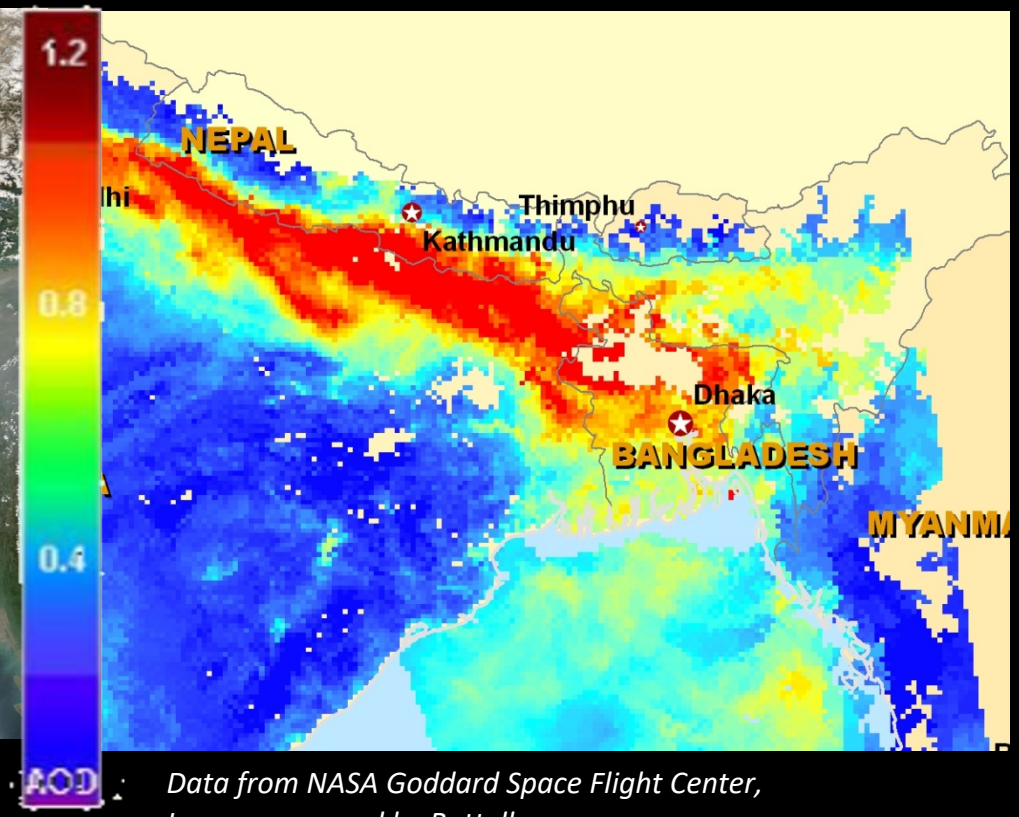
RAVAN
RainCube
CSIM
CubeRRT
TEMPEST-D
CIRiS
HARP
CTIM
HyTI
SNoOPI
NACHOS

(PRE) FORMULATION
IMPLEMENTATON
PRIMARY OPS
EXTENDED OPS

02.04.20

Earth Observations of Environmental Conditions

Image from NASA Earth Observatory



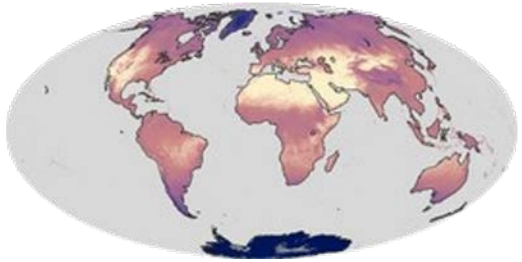
Data from NASA Goddard Space Flight Center, Image processed by Battelle

True Color

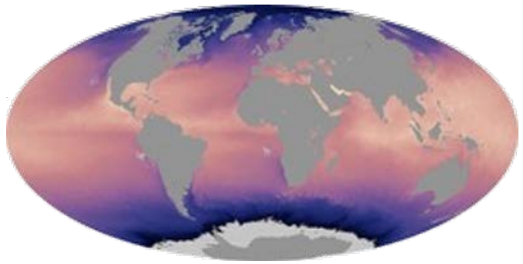
Aerosols & Particulates

Northern India, Nepal, and Bangladesh

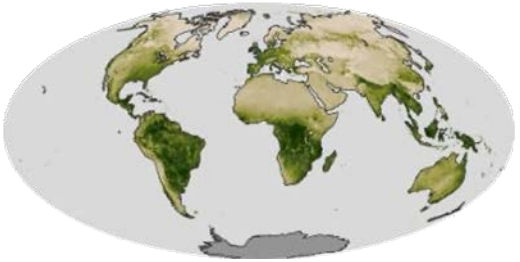
Some Types of Earth Observations . . .



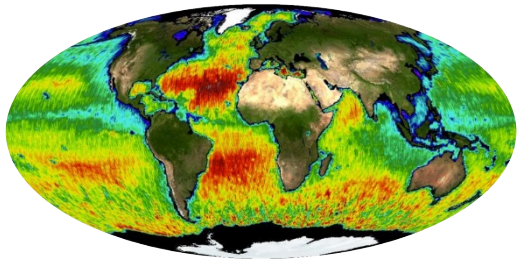
Land Temperature



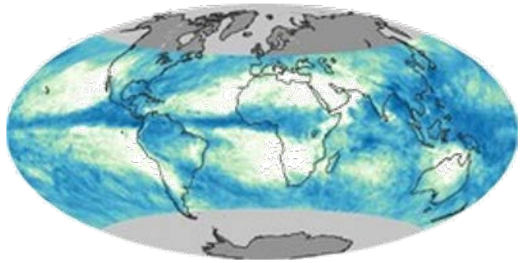
Sea Surface Temperature



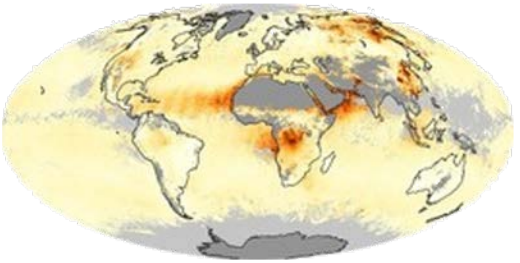
Vegetation



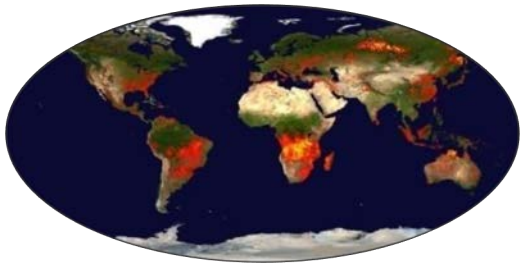
Sea Surface Salinity



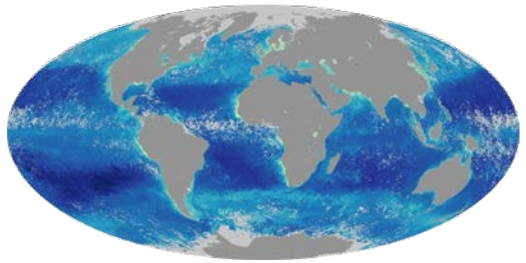
Total Rainfall



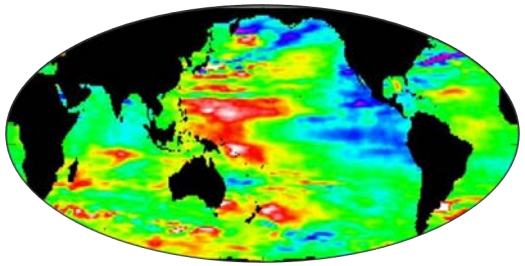
Aerosols



Fires & Thermal Anomalies



Chlorophyll



Sea Surface Height

NASA Applied Sciences Program

Discovering and demonstrating innovative and practical uses of Earth observations in organizations' policy, business, and management decisions.

http://AppliedSciences.NASA.gov

Applications
Prove-out, develop, and transition applications ideas for sustained uses of Earth obs. in decision making.

Capacity Building
Build skills and capabilities in US and developing countries to access Earth observations to benefit society.

Mission Planning
Identify applications early in mission lifecycle and integrate end-user needs in mission design and development.

Applications Areas

Areas of Applications Emphasis

Health & Air Quality

Water Resources

Ecological Forecasting

Disasters

Agriculture / Food Security

Support opportunities in additional areas

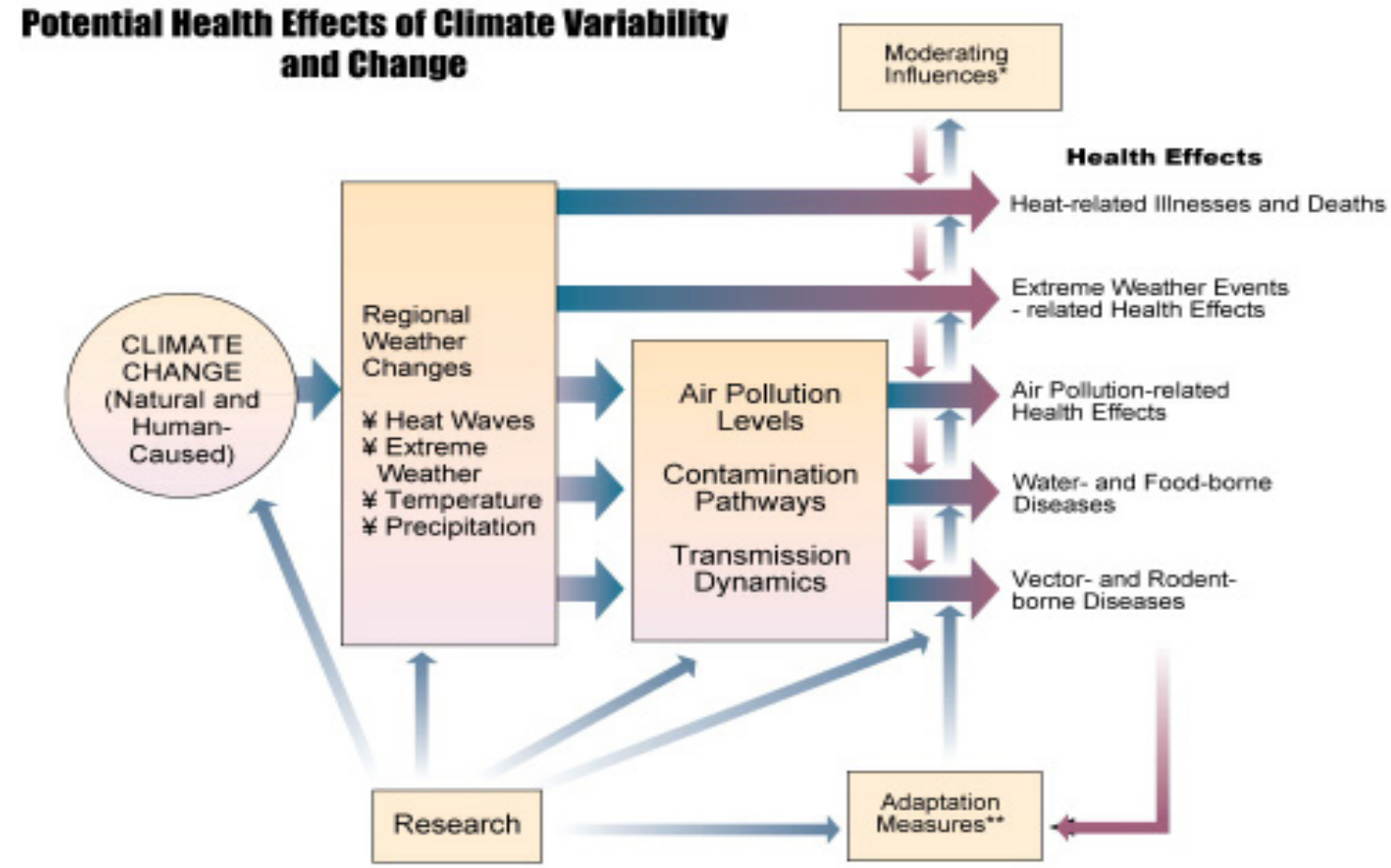
Energy

Urban Development

Transportation / Infrastructure

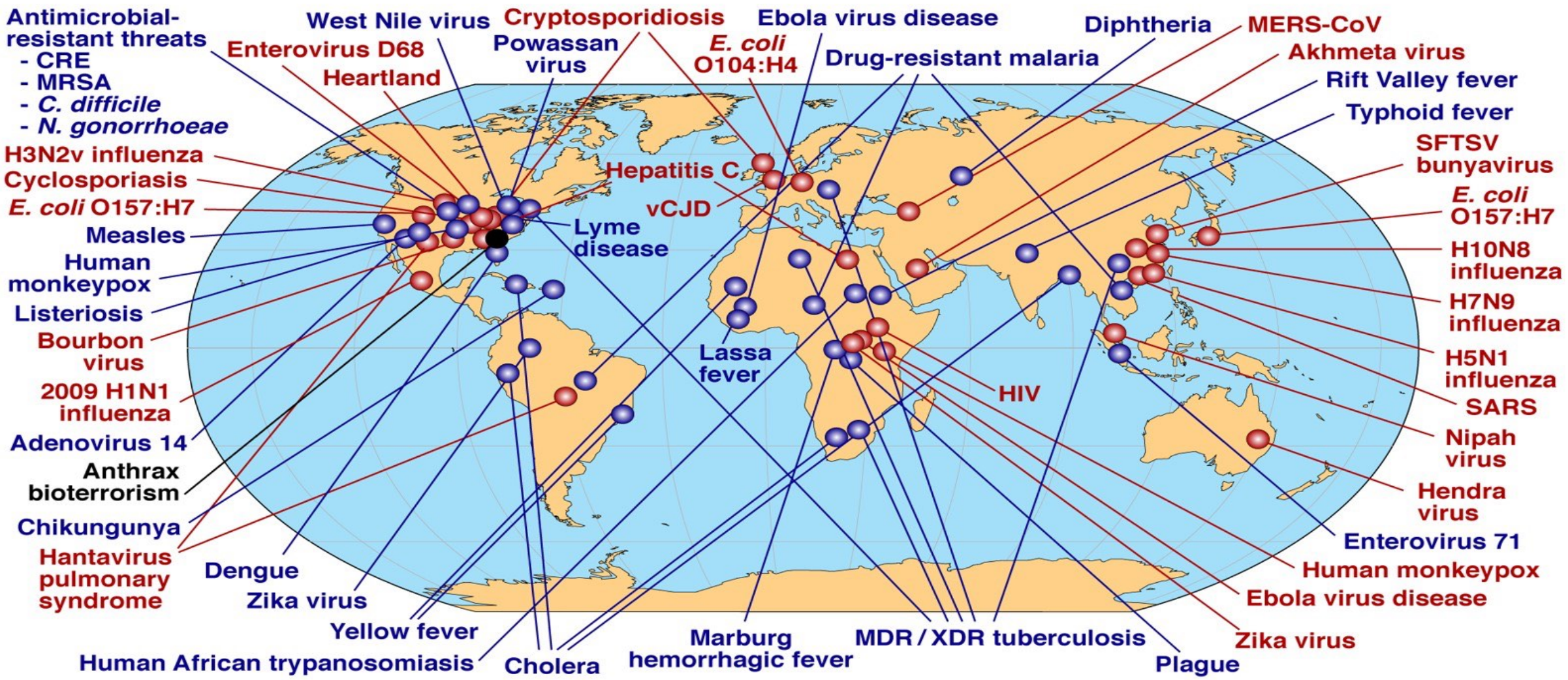
Climate & weather cross-cut all areas

Why Health & Air Quality?



Source: GEO, 2003

Global Examples of Emerging and Re-Emerging Infectious Diseases



Credit: NIAID, September 2017

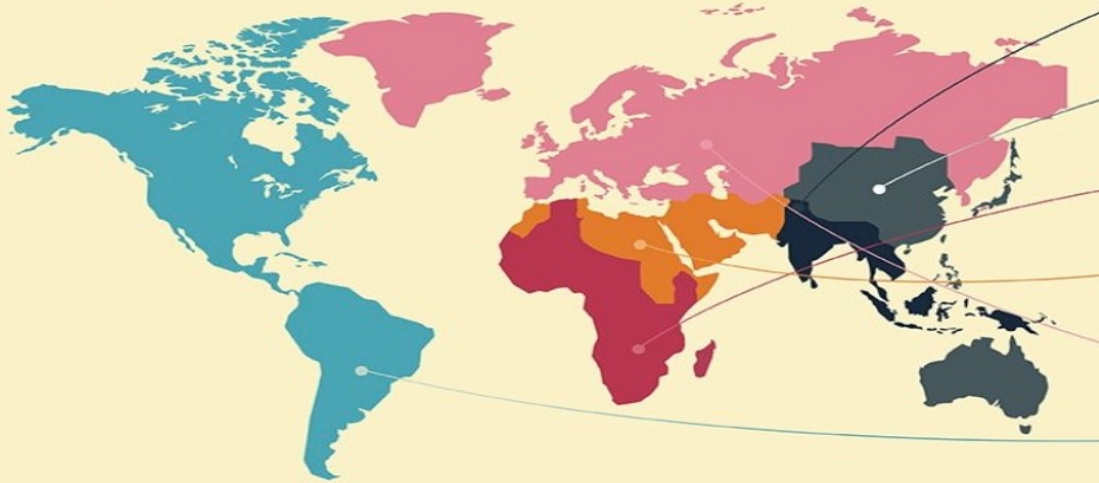
AIR POLLUTION – THE SILENT KILLER

Every year, around **7 MILLION DEATHS** are due to exposure from both outdoor and household air pollution.

Air pollution is a major environmental risk to health. By reducing air pollution levels, countries can reduce:

- **Stroke**
- **Heart disease**
- **Lung cancer, and both chronic and acute respiratory diseases, including asthma**

REGIONAL ESTIMATES ACCORDING TO WHO REGIONAL GROUPINGS:



- **Over 2 million** in South-East Asia Region
- **Over 2 million** in Western Pacific Region
- **Nearly 1 million** in Africa Region
- **About 500 000** deaths in Eastern Mediterranean Region
- **About 500 000** deaths in European Region
- **More than 300 000** in the Region of the Americas

CLEAN AIR FOR HEALTH #AirPollution World Health Organization

Health & Air Quality

Objectives:

- NASA's Health & Air Quality Applications Area supports the use of Earth observations in air quality management and public health, particularly regarding **infectious disease and environmental health** issues.

- The area addresses issues of toxic and pathogenic exposure and health-related hazards and their effects for risk characterization and mitigation.

- The area promotes uses of Earth observing data and models regarding **implementation of air quality standards, policy, and regulations** for economic and human welfare.

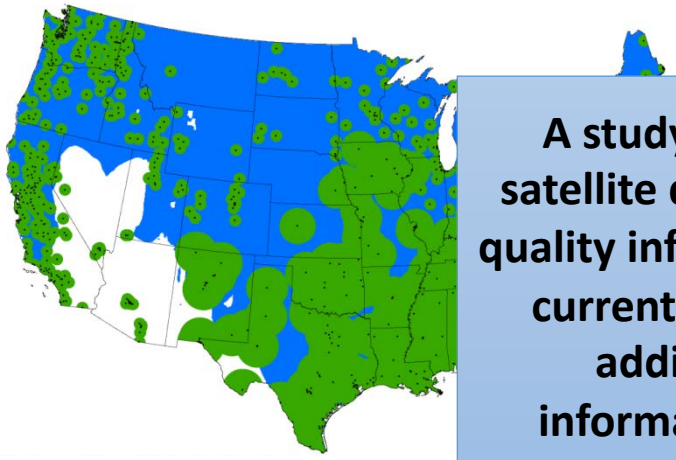
- The Health & Air Quality Applications Area also addresses **effects of climate change on public health and air quality** to support managers and policy makers in their planning and preparations.

Major Partners include International (e.g., GEO, WHO, UNICEF, PAHO), Federal (e.g., CDC, EPA, NIH, NOAA), State (e.g., South Dakota, California, Texas), and Private sectors (AER, Inc.).

Improving Air Quality Maps with Satellite Data

PI: Phil Dickerson, EPA

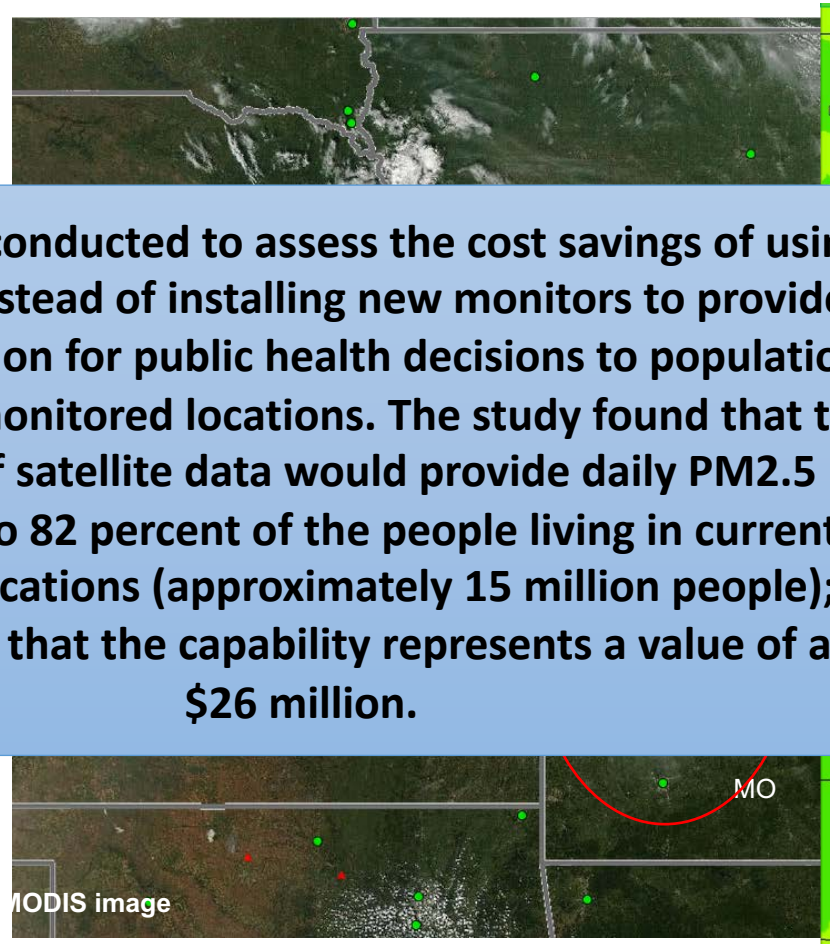
GROUND-BASED + SATELLITE COVERAGE OF AIR QUALITY



Green = ground-based PM
Blue = AirNow Satellite-ba
White = no coverage

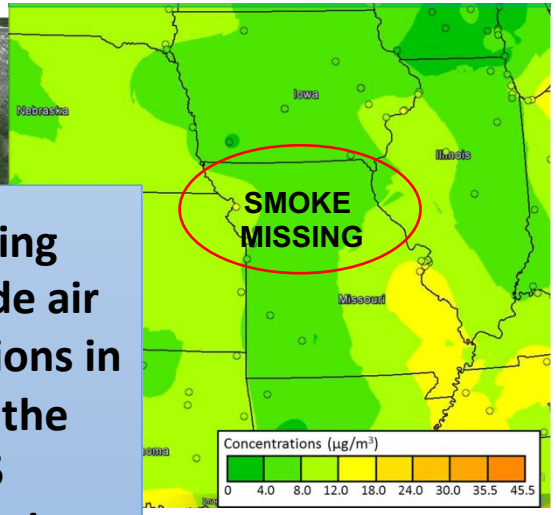
https://asdp.airnowtech.org/about.php

Northern Missouri fires - Sept. 4, 2013

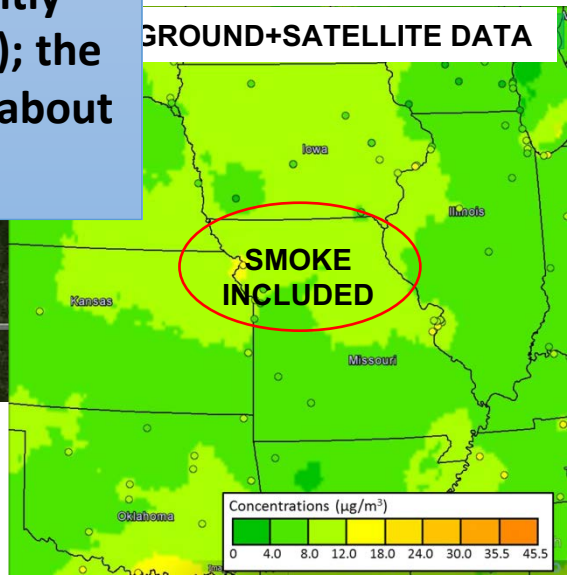


A study was conducted to assess the cost savings of using satellite data instead of installing new monitors to provide air quality information for public health decisions to populations in currently unmonitored locations. The study found that the addition of satellite data would provide daily PM2.5 information to 82 percent of the people living in currently unmonitored locations (approximately 15 million people); the study estimated that the capability represents a value of about $26 million.

PM2.5 FROM GROUND BASED DATA



GROUND+SATELLITE DATA



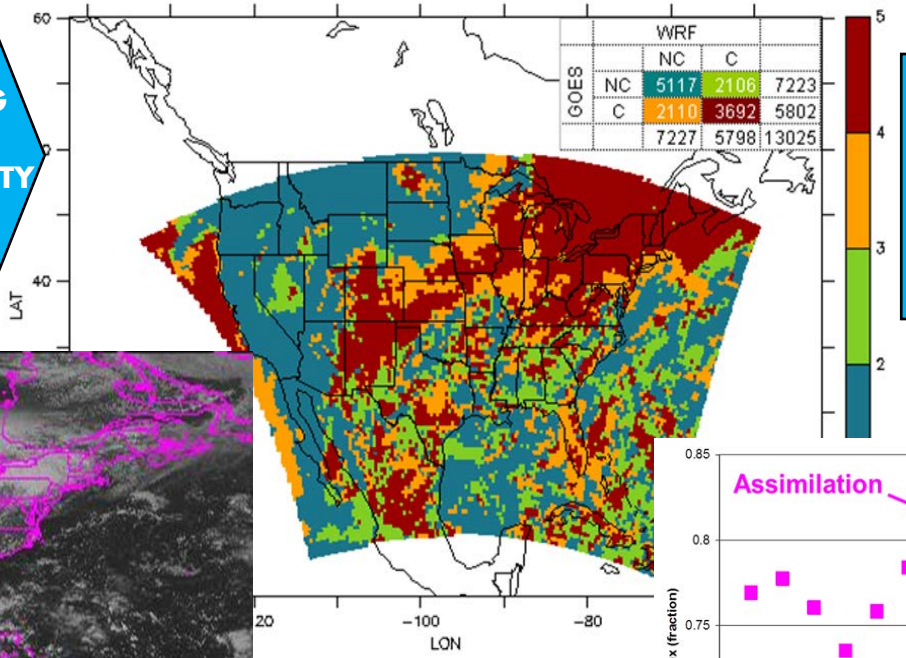
"This is the best tool I have seen so far that integrates satellite data with information from ground monitors."

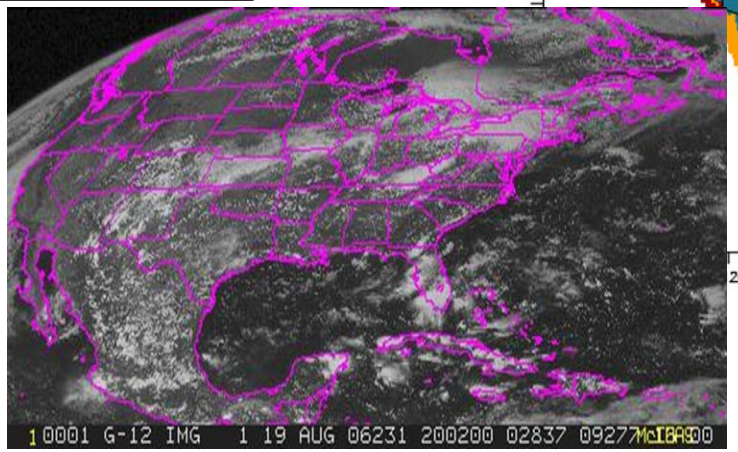
Cassie McMahon, Minnesota Pollution Control Agency

Incorporating Space-borne Measurements to Improve Air Quality Decision Support Systems for Texas

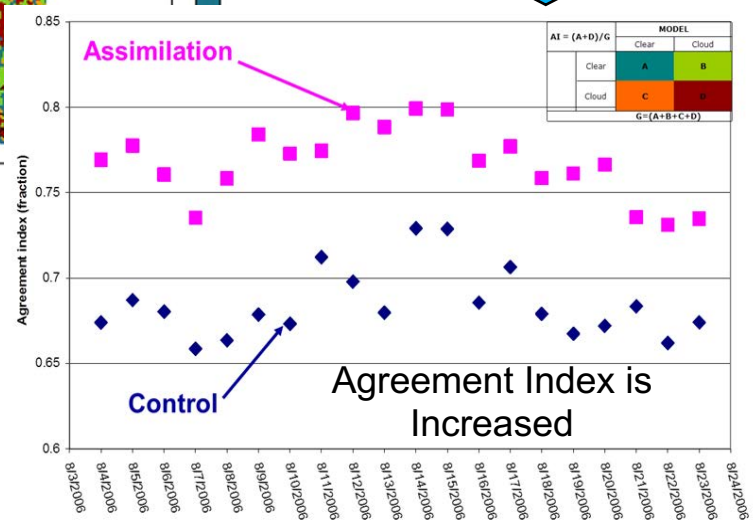
PI: Arastoo Pour Biazar, UAH

CLOUD LOCATIONS & TIMING FROM SATELLITE INGESTED INTO THE AIR QUALITY MODEL USED TO PLAN ACCEPTABLE EMISSIONS

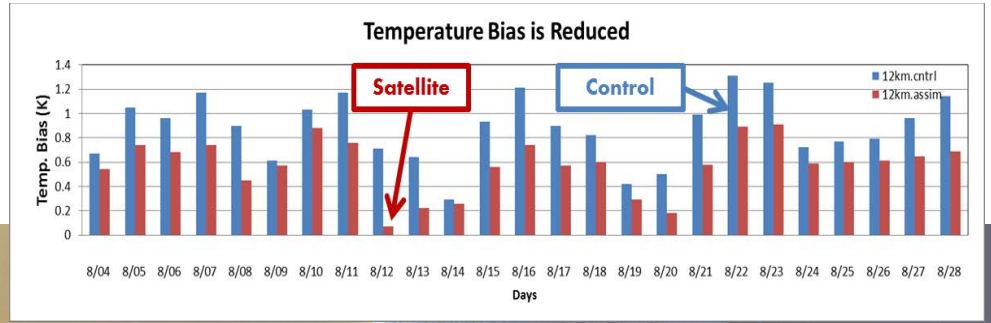




IMPROVED AIR QUALITY PLANNING AND REGULATORY DECISIONS



- The temporal and spatial location of clouds have a large impact on the projected air quality given a set of emissions. This tool is designed to provide accurate cloud information.
- Texas Commission for Environmental Quality (TCEQ) used this tool in their latest State Implementation Plans (SIPs)
- The State of Texas contributed an additional $500k in funding to NASA Applied Sciences.

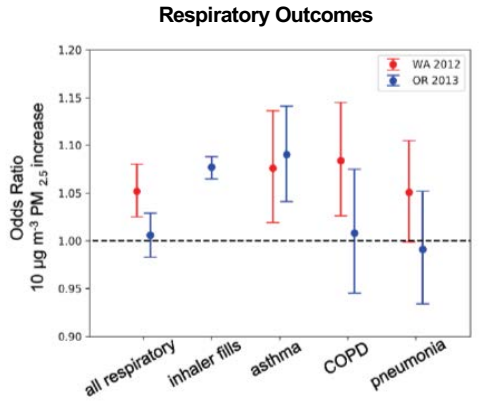


Smoke Health Impact Assessment (HIA) Forecaster

PI: Jeff Pierce (Colorado State University)

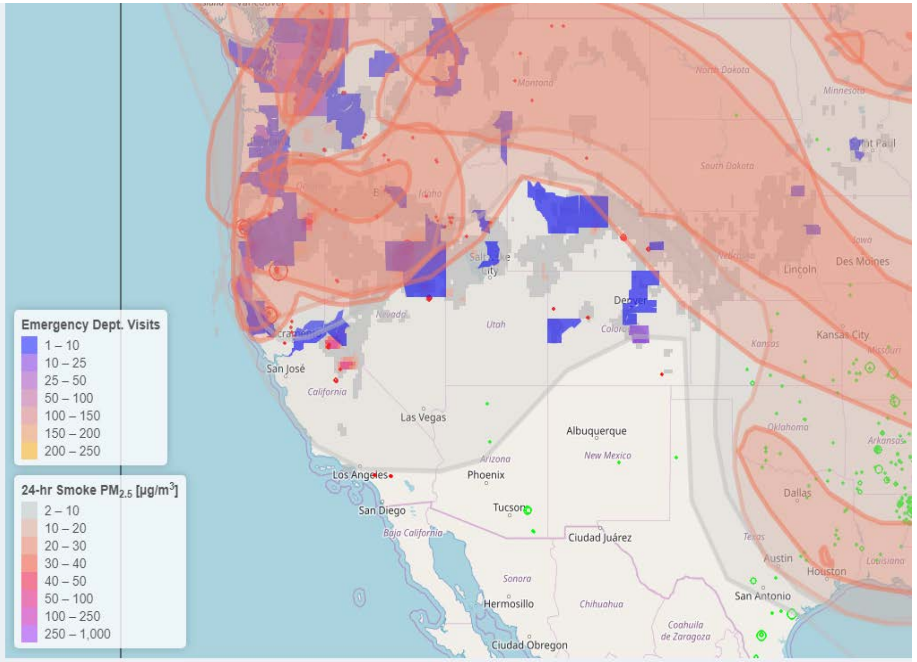
Background Research

- Used NASA MODIS Aerosol Optical Depth (AOD), surface measurements, and model concentrations to estimate smoke exposure for past fires



- Combined with health data to determine associated health effects of smoke exposure

Product: https://rgan.atmos.colostate.edu/smoke_forecaster/



- Apply those health associations to smoke forecasts to forecast health impacts of smoke exposure
- Allows communities and health providers to understand potential health risks and prepare for burden on health resources during smoke events

Ongoing Product Development

- Communications researchers at CSU are testing the usefulness and messaging of this product with the Colorado Department of Public Health and the Environment (CDPHE)

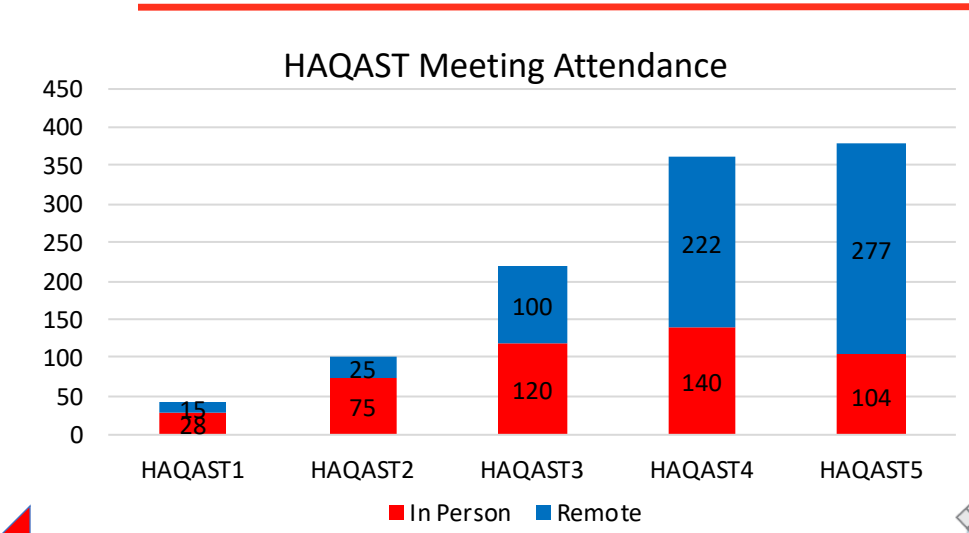
Health and Air Quality Applied Sciences Team (HAQAST)

Connecting NASA Data and Tools with Health and Air Quality Stakeholders

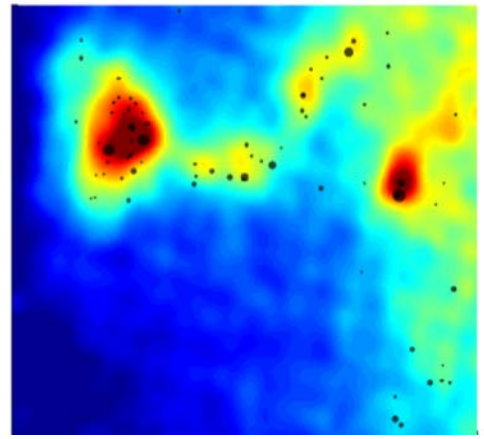
Tracey Holloway - Team Lead (University of Wisconsin-Madison)
Bryan Duncan (NASA Goddard Space Flight Center)
Arlene Fiore (Columbia University)
Minghui Diao (San Jose St. University)
Daven Henze (University of Colorado, Boulder)
Jeremy Hess (University of Washington, Seattle)
Yang Liu (Emory University)
Jessica Neu (NASA Jet Propulsion Laboratory)
Susan O'Neill (USDA Forest Service)
Ted Russell (Georgia Tech)
Daniel Tong (George Mason University)
Jason West (University of North Carolina, Chapel Hill)
Mark Zondlo (Princeton University)

Stakeholder Webinars Starting on Feb. 18, 2020
Joint Workshop Planned with EPA for June 2020
Final Showcase: July 21-22, 2020 in Washington, DC
https://haqast.org

How HAQAST Works



Direct collaboration



PI Zondlo works with Colorado to map ammonia from large farms

How we support novice users

How we support advanced users

HAQAST

Guide to Using Satellite Images in Support of Exceptional Event Demonstrations

PI Fiore and team created three technical guidance documents for policy use.

>60 papers published

Broad dissemination

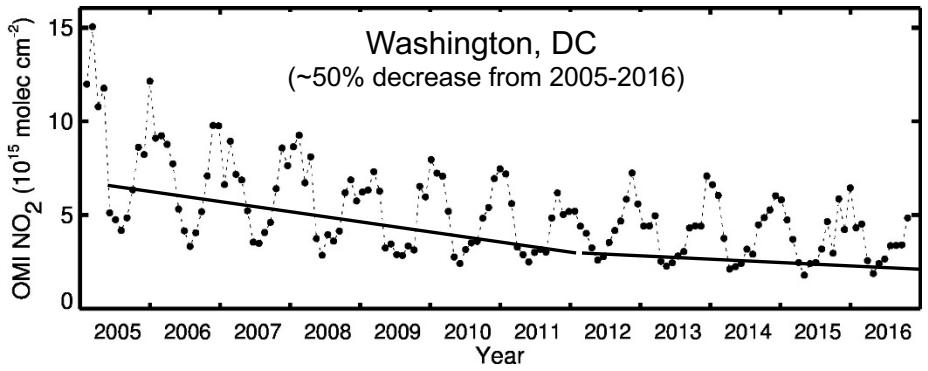
NASA *Aura* OMI Shows Air Quality Improved

• Nitrogen dioxide (NO_2) is a pollutant that is unhealthy to breath and contributes to the formation of unhealthy levels of surface ozone pollution. It is primarily emitted from tailpipes and smokestacks.

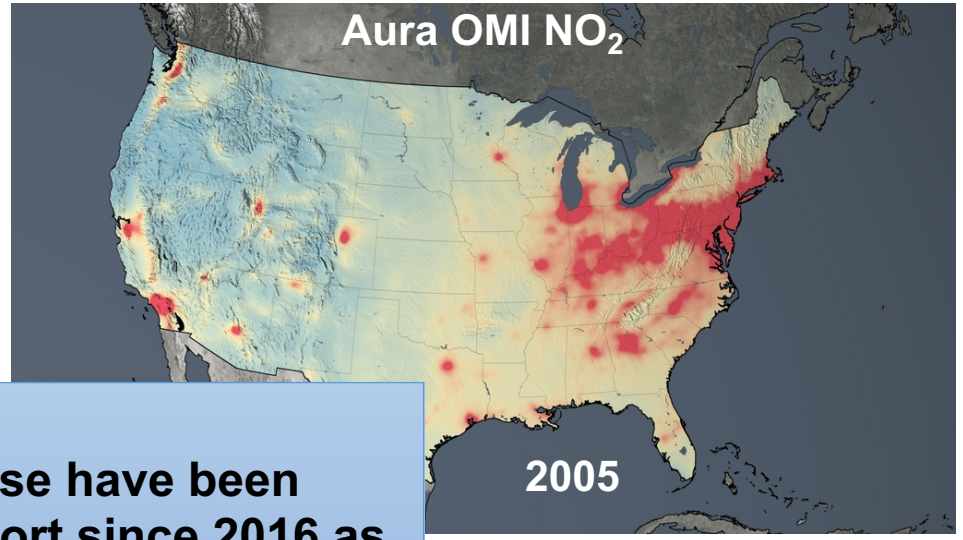
• Aura Ozone Monitoring Instrument (OMI) NO_2 data sho
of the U.S. fro
due to toughe

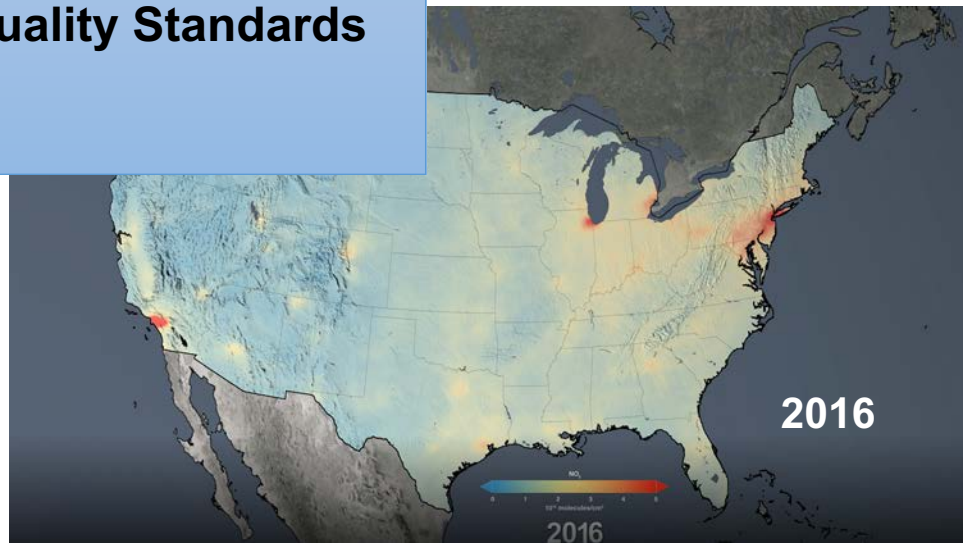
• While OMI d
occurred from
changed less

Earth observations such as these have been included in the EPA Air Trends Report since 2016 as part of the National Ambient Air Quality Standards (NAAQS) chapter.



(above) Monthly-average OMI NO_2 data for the Washington DC Metro area (source: https://airquality.gsfc.nasa.gov)





(above) Annual-average OMI NO_2 data for the U.S. (source: https://svs.gsfc.nasa.gov/12094)

Facilitating the Integration and Adoption of Satellite Products for Decision Support during Wildland Fire Smoke Episodes:

Susan O'Neill (USFS)

NASA remotely-sensed products help inform the public about smoke impacts from wildfires.

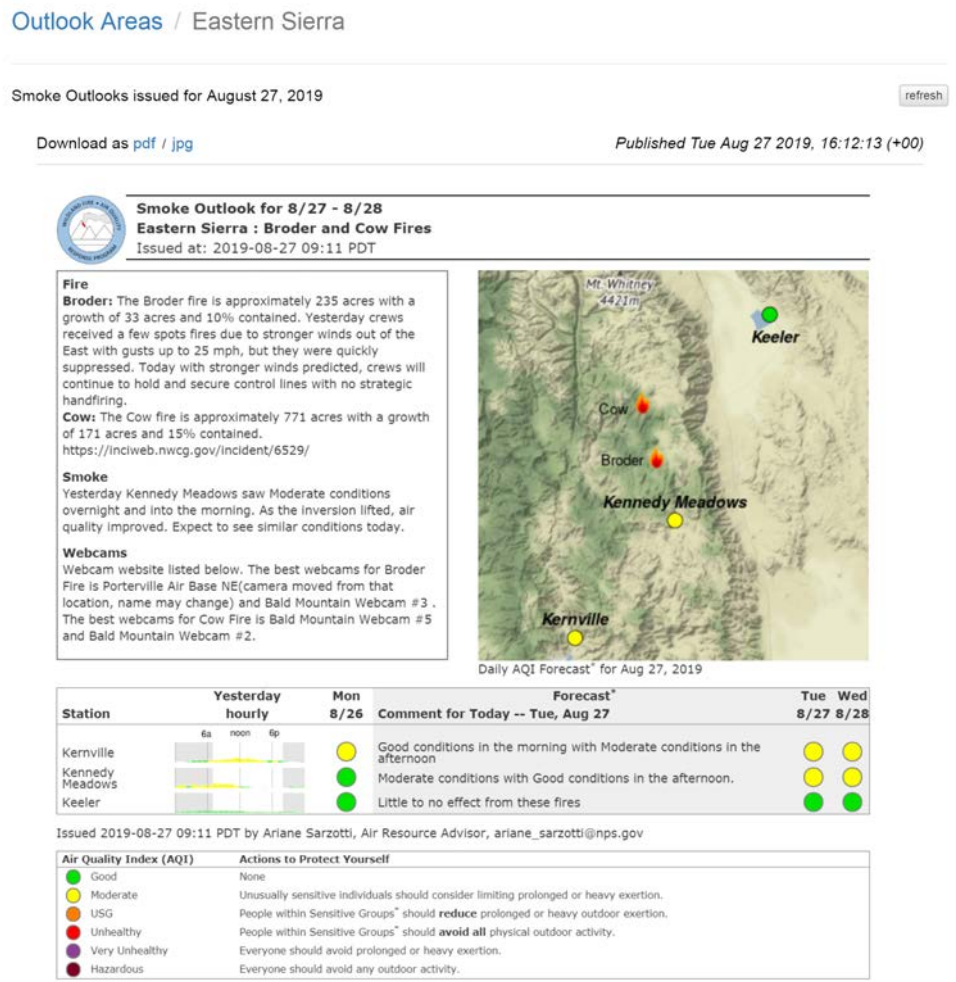
> *When smoke from wildfires blankets a region, people want to know: When will the smoke clear? Can my child play outside? Do we cancel the football game? NASA science is being used to support these important decisions affecting our daily life, health and safety.*

How: Including remotely-sensed data/products in tools/information used by smoke forecasters deployed with Incident Management Teams and Health/AQ Agencies.

- Smoke Outlooks (One-page smoke forecasts): https://wildlandfiresmoke.net/outlooks/
- Smoke Forecasting System Improvements (MODIS, VIIRS, GOES, CALIPSO, MISR, TROPOMI)
- Web-tool: GOES-16 fire detection viewer, custom time profile generator and smoke modeling

Training

- Online video "The Basics of Satellite Data For Smoke and Fire"
- In-class: Annual Land Manager Smoke Trainings, Annual Air Resource Advisor Training



Collaboration with the Wildland Fire Air Quality Response Program (WFAQRP), University of Washington, UC Davis, National Park Service, University of Wisconsin, NOAA, NASA Disasters Team, and Mazama Science.

HAQAST Observing AQ over the Gulf Of Mexico

- HAQAST members Bryan Duncan and Anne Thompson (GSFC) are partnering with the Bureau of Ocean Energy Management (BOEM) to evaluate the current capabilities of satellite data for air quality monitoring and emissions validation over the Gulf of Mexico.
- This project is a feasibility study to identify NASA resources for BOEM to aid in monitoring the impact of offshore pollution on inland communities. BOEM is co-funding this study.
- Two main project parts:
  1) Evaluation of NASA datasets for monitoring offshore air pollutants.
  2) Field campaign coordinated to measure surface to validate the satellite data (Summer 2019).

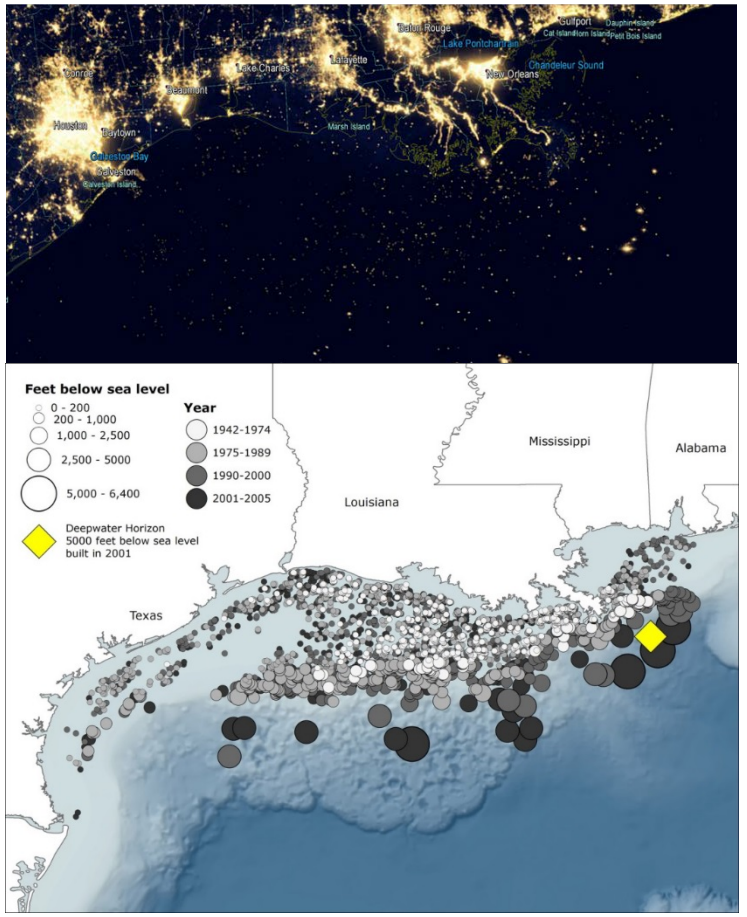
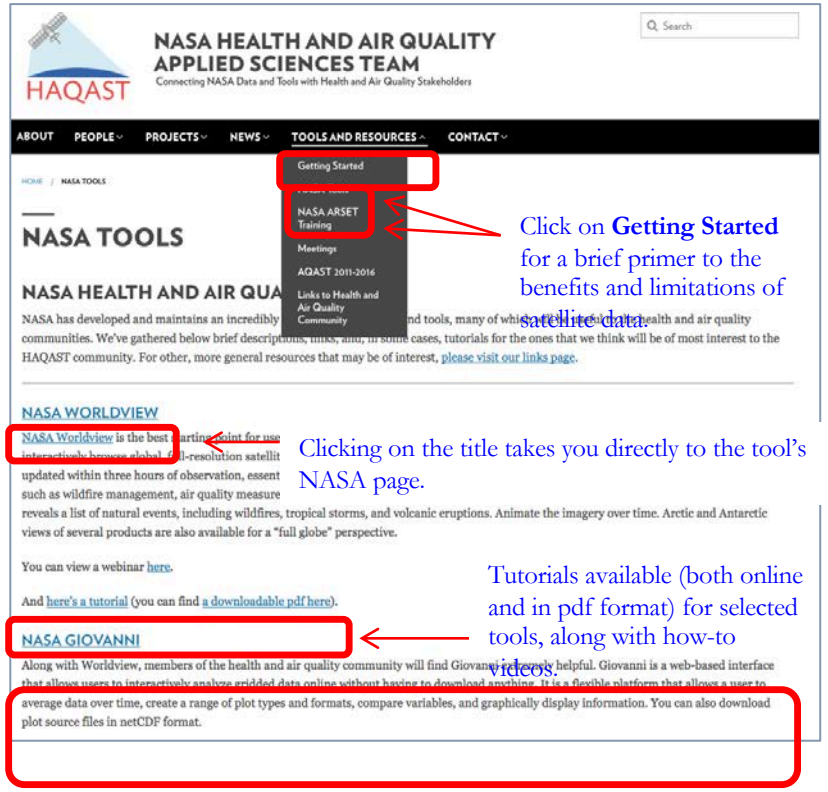


Figure. Suomi VIIRS "Lights at Night" data clearly show the locations of oil rigs and platforms

HAQAST Builds Portal to Promote NASA Tools for Stakeholders

- HAQAST has redesigned the website (www.haqast.org) to feature NASA tools and data.
- Tools section designed in consultation with ARSET (http://arset.gsfc.nasa.gov**).**
- Developed how-tos for two of the most useful tools for HAQAST stakeholders: Worldview and Giovanni; includes short videos.
- Website is live now!



What is next for HAQAST?

- NASA is re-competing HAQAST for an additional four year term through a NASA ROSES 2020 solicitation (NNH20ZDA001N-HAQ / ROSES 2020 Element A.38).
- Notices of Intent requested by April 17, 2020.
- Proposals due on May 29, 2020.
- Estimated 12-15 awards with a budget of $2M per year (does not include Tiger Team funds).
- Awards to begin in October 2020.
- For additional details visit: https://nspires.nasaprs.com/external/solicitations/summary!init.do?solId={CD3B3963-DF05-9EDB-4588-E12D86656CB0}&path=open

Applied Remote Sensing Training Program (ARSET)

POC: Ana. I. Prados, NASA-GSFC

Objectives

- Provide end-users with **professional technical workshops**
- Build long-term partnerships with communities and institutions in the public and private sectors.

Online and hands-on courses

- **Who:** policy makers, environmental managers, modelers and other professionals in the public and private sectors.

  Where: U.S and internationally
- **When**: throughout the year. Check websites.
- Do NOT require prior remote- sensing background.
- Presentations and hands-on guided computer exercises on how to access, interpret and use NASA satellite images for decision-support.

NASA ARSET Training for California Air Resources Board, Sacramento, CA

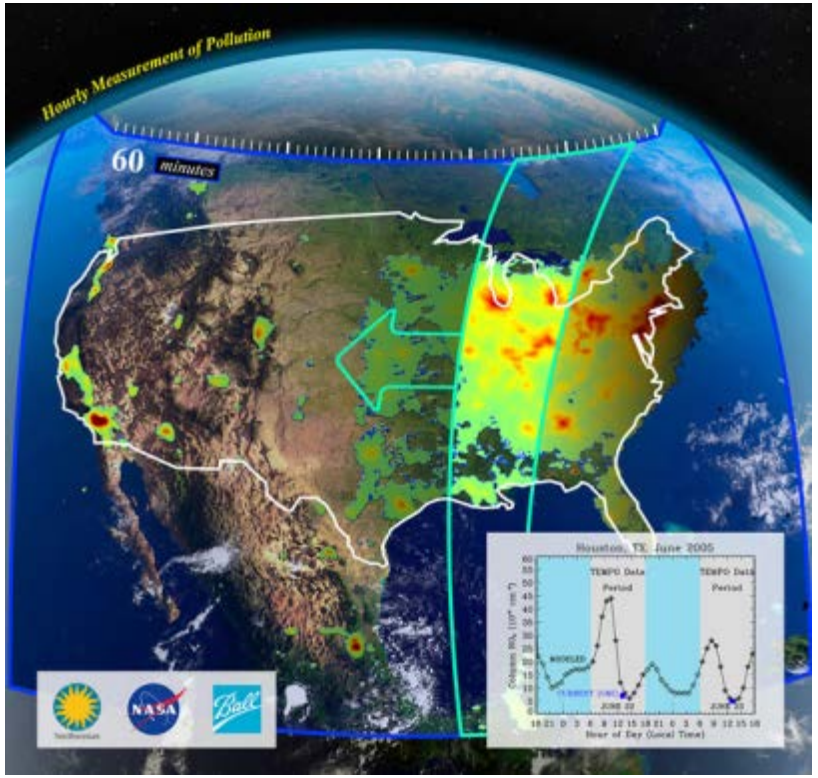
http://arset.gsfc.nasa.gov/

Earth Venture Instrument-1:

Tropospheric Emissions: Monitoring of Pollution (TEMPO)

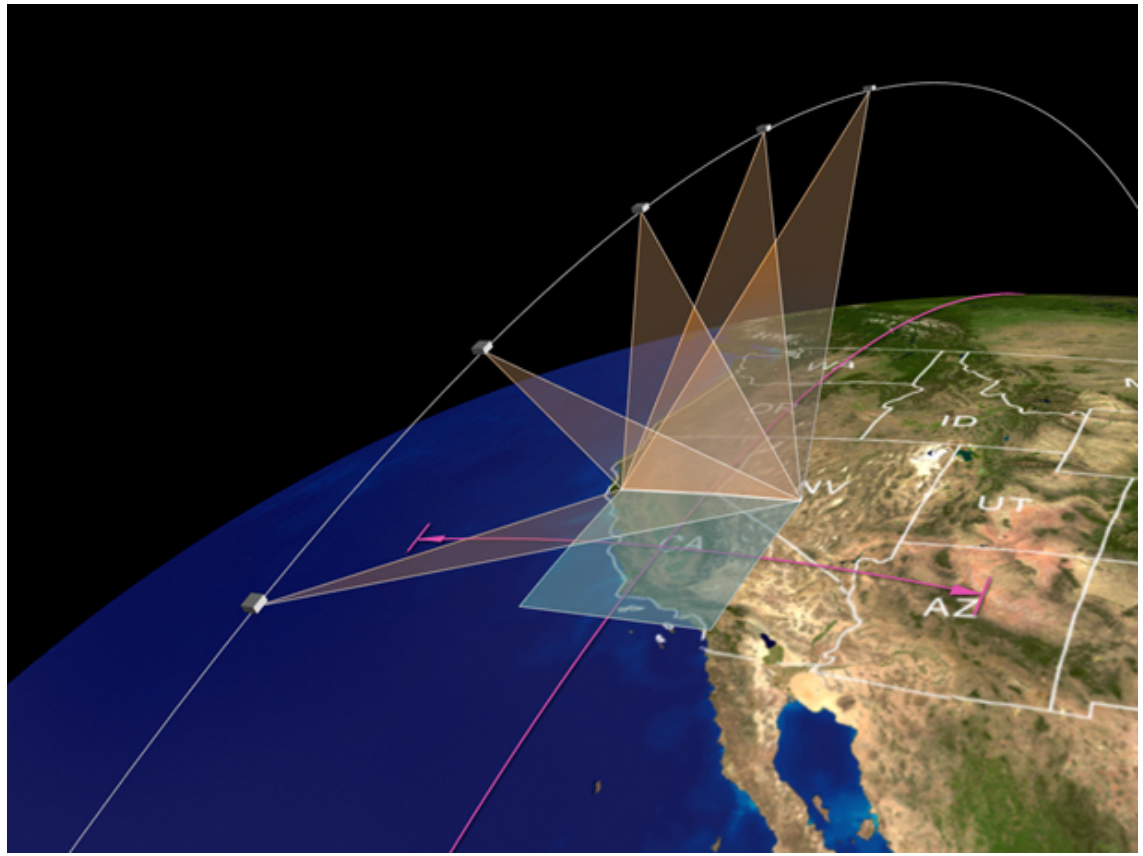
"Monitoring the air we breathe, hour by hour"

- ***TEMPO is a pathfinder to using hosted commercial payloads from GEO***
- Tropospheric pollution observations from Geostationary Orbit
  - Ozone, NO_2, and CH_2O.
- Forms a global Air Quality constellation in GEO with Copernicus Sentinel 4 and Korean GEMS.
- EPA and NOAA are part of the science team.
- Instrument delivered in 2018; Launch 2022

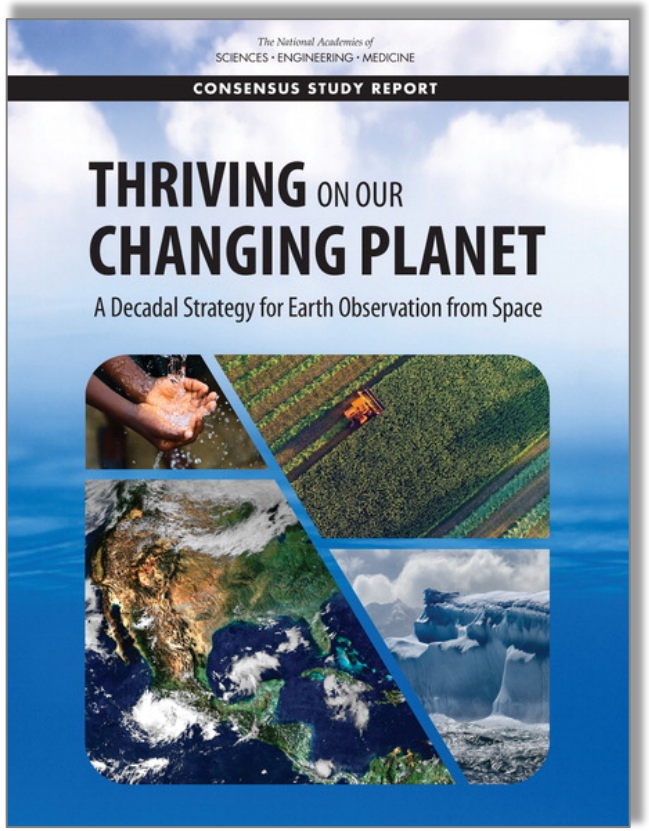


Earth Venture Instrument-3:
Multi-Angle Imager for Aerosols (MAIA)

- ***MAIA represents the first time NASA has partnered with epidemiologists and health organizations to use space-based data to study human health and improve lives.***
- **Objective**: Assess linkages between different airborne particulate matter (PM) types and adverse birth outcomes, cardiovascular and respiratory disease, and premature deaths.
- **Instrument:** Multi-angle spectropolarimetric imaging instrument for operation in a sun-synchronous Earth orbit to measure the particle types, sizes, concentrations, and geolocation of atmospheric aerosols.
- Launch expected in 2022.



2017-2027 Decadal Survey for Earth Science and Applications from Space



- Science and Applications Priorities for Air Quality:
  - Determine the effects of key boundary layer (BL) processes on air quality forecasts;
  - Reducing uncertainty of vertically resolved tropospheric fields of speciated PM, O_3, and $NO_{2.;}$
  - Characterize long-term trends and variations in global, vertically resolved speciated PM, O_3, and NO_2;
  - Characterize tropospheric O_3 variations and impacts on surface air quality and background levels.

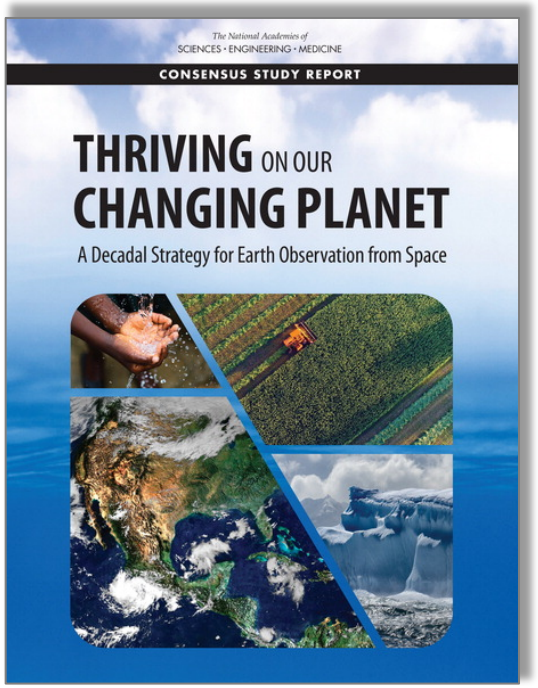
- Boundary layer processes are critical to air quality forecasts, as this is where people live and breathe.

- The upcoming launch of TEMPO and its Korean (GEMS) and European (Copernicus-Sentinel-4) constellation partners will allow unprecedented high temporal and spatial resolution measurements of tropospheric ozone, aerosols, and their precursors, to create a revolutionary dataset that will help address these priorities.

2017-2027 Decadal Survey for Earth Science and Applications from Space

Primary Air Quality Designated Observable:

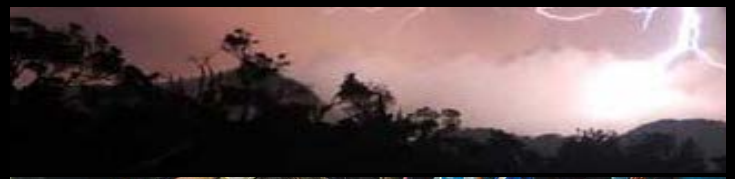
Aerosol Cloud Convection and Precipitation (A-CCP)



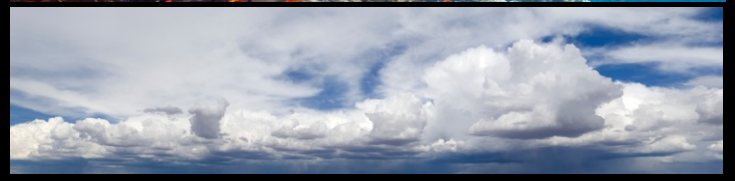
- NASA Applied Sciences is engaging the user community for feedback on potential A-CCP architectures and their corresponding geophysical variables, starting with most experienced users and then gradually including less experienced users.

- In July 2019, the U. of Maryland hosted a Weather Forecasting and Air Quality workshop that brought together operational representatives from US agencies (NOAA, NRL, AFWA, EPA) and international partners (JMA, ECMWF, UK Met Office, EC) to discuss the potential for A-CCP geophysical variables to be assimilated into their operational modeling frameworks.

https://science.nasa.gov/earth-science/decadal-surveys



National Aeronautics and
Space Administration



Questions:

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Health & Air Quality Applications

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http://AppliedSciences.NASA.gov