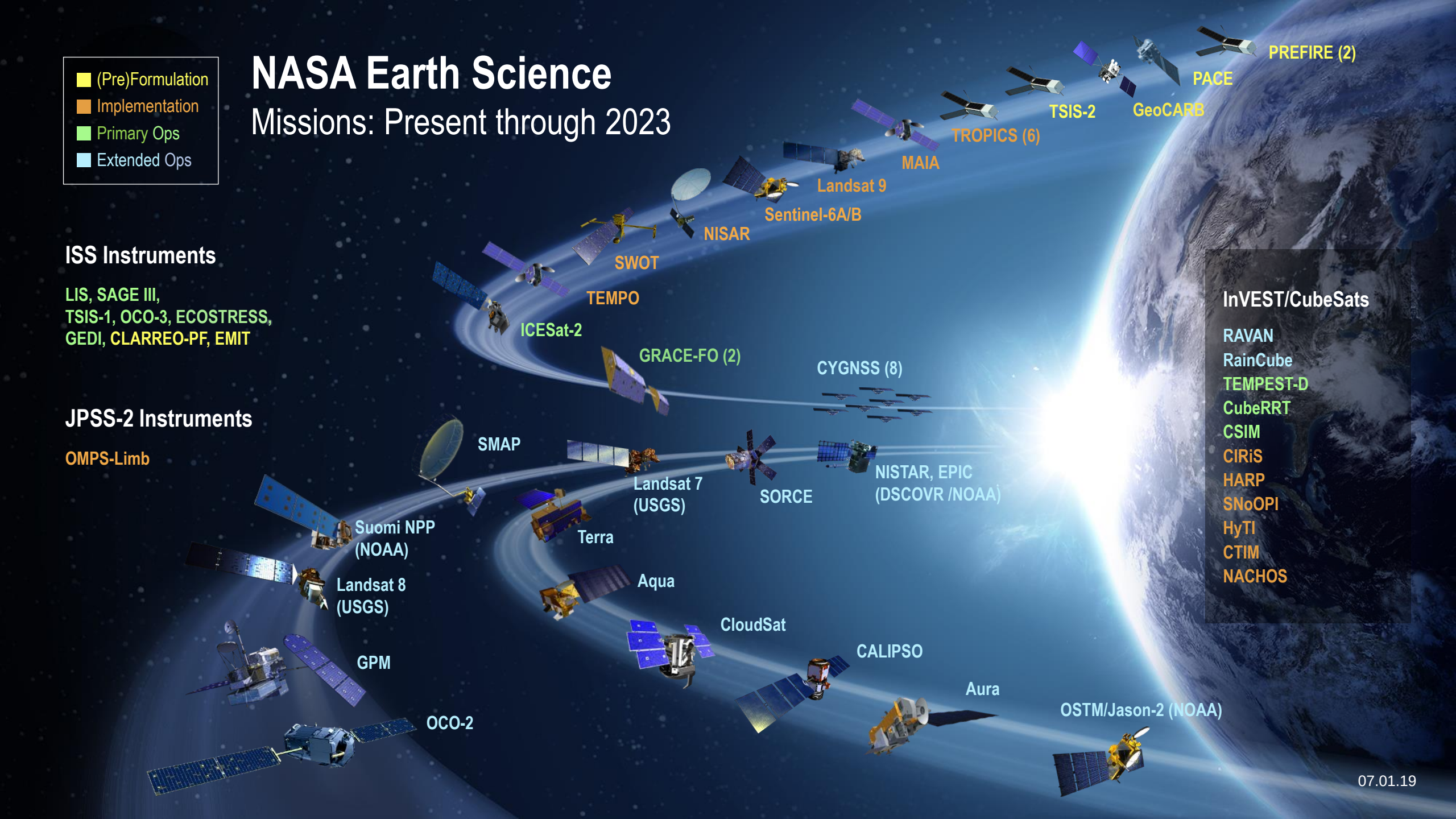
National Aeronautics and Space Administration

EXPLORE EARTH

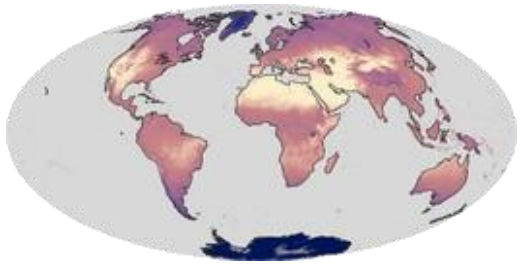
Bryan Duncan, PhD on behalf of
John Haynes, MS
Barry Lefer, PhD
Earth Science Division
Science Mission Directorate

Briefing to NACAA on NASA Health and Air Quality Applications

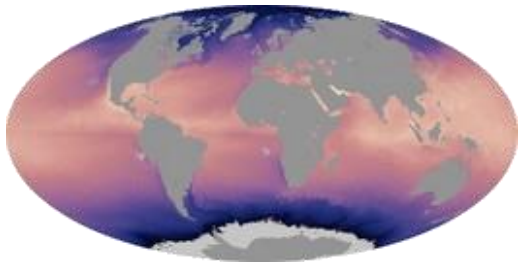
October 22, 2019


(Pre)Formulation
Implementation
Primary Ops
Extended Ops
NASA Earth Science
Missions: Present through 2023
ISS Instruments
LIS, SAGE III,
TSIS-1, OCO-3, ECOSTRESS,
GEDI, CLARREO-PF, EMIT
JPSS-2 Instruments
OMPS-Limb
PREFIRE (2)
PACE
GeoCARB
TSIS-2
TROPICS (6)
MAIA
Landsat 9
Sentinel-6A/B
NISAR
SWOT
TEMPO
ICESat-2
GRACE-FO (2)
CYGNSS (8)
SMAP
Landsat 7
(USGS)
SORCE
NISTAR, EPIC
(DSCOVR /NOAA)
Suomi NPP
(NOAA)
Terra
Aqua
Landsat 8
(USGS)
CloudSat
CALIPSO
GPM
Aura
OCO-2
OSTM/Jason-2 (NOAA)
InVEST/CubeSats
RAVAN
RainCube
TEMPEST-D
CubeRRT
CSIM
CIRiS
HARP
SNoOPI
HyTI
CTIM
NACHOS
07.01.19

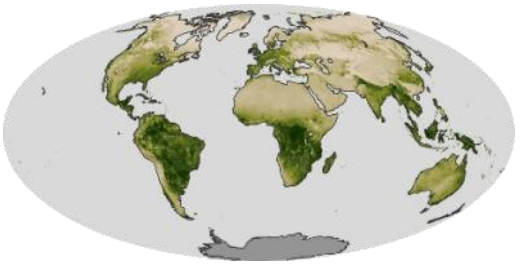
Some Types of Earth Observations . . .



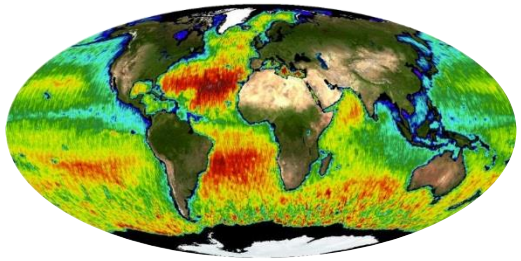
Land Temperature



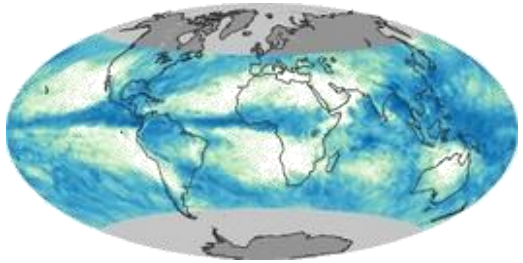
Sea Surface Temperature



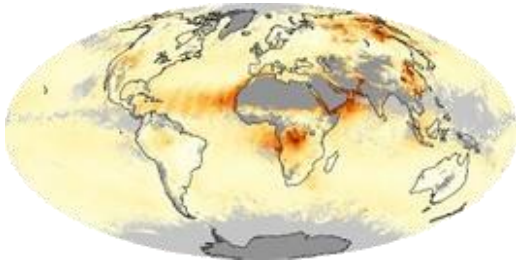
Vegetation



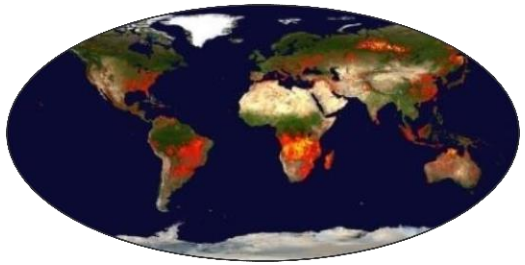
Sea Surface Salinity



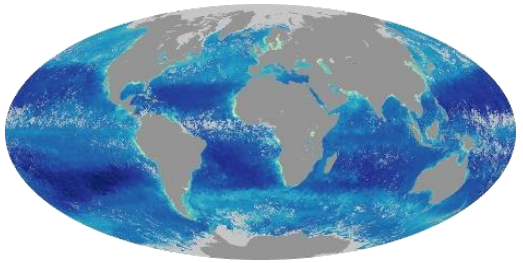
Total Rainfall



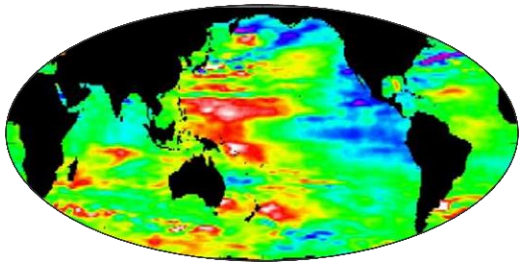
Aerosols



Fires & Thermal Anomalies



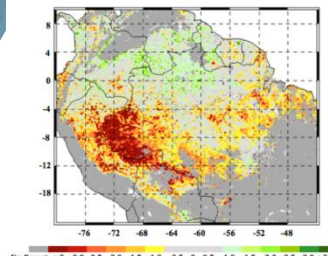
Chlorophyll

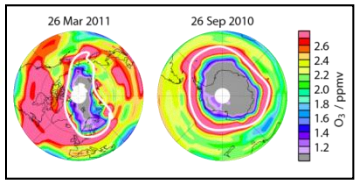


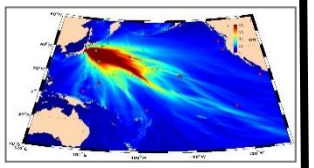
Sea Surface Height

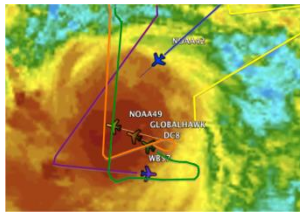
NASA's Earth Science Division

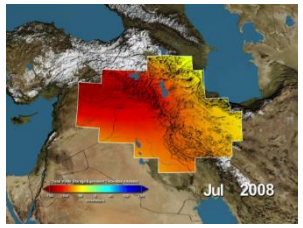
Research and Analysis

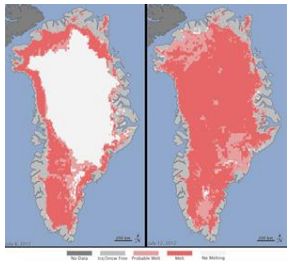




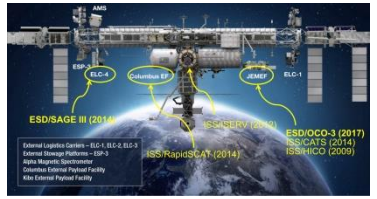




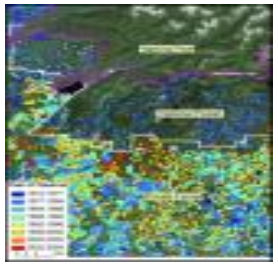


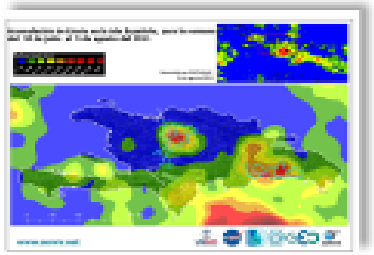


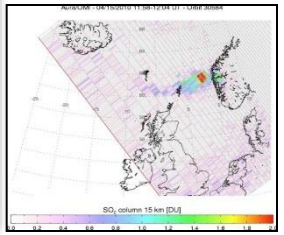
Flight

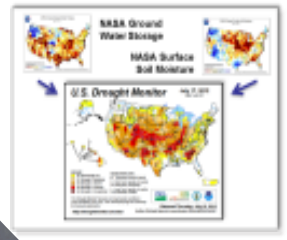


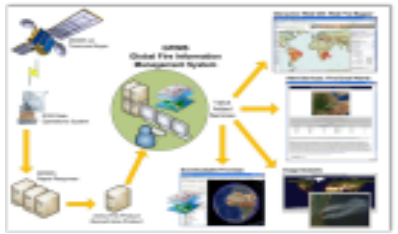
Applied Sciences

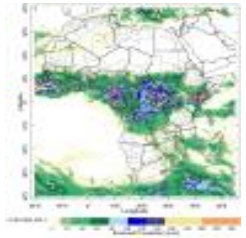




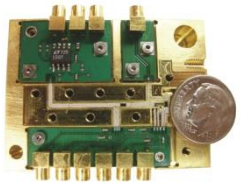


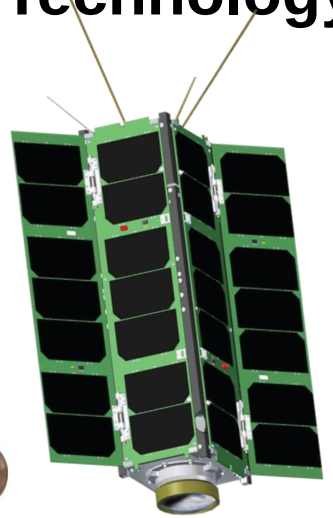


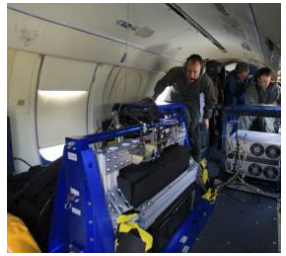


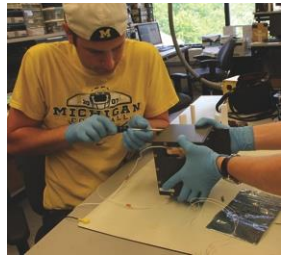


Technology









Applied Sciences Program

- *A little background*
- *Some examples*
- *HAQAST*
- *ARSET*

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

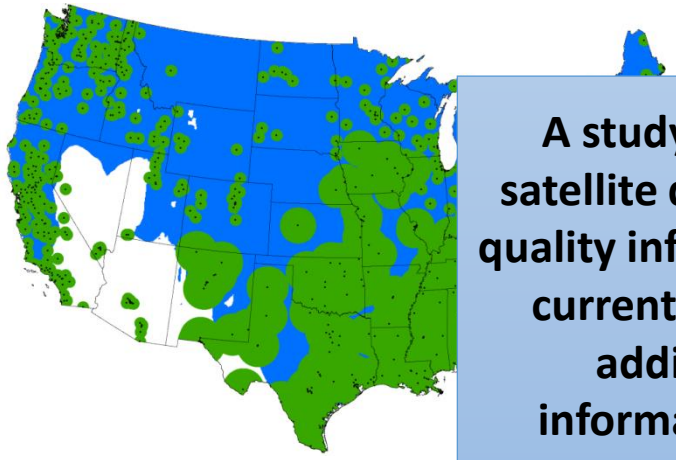
Climate & weather cross-cut all areas

Some Examples of Applying Satellite Data to AQ Applications

Improving Air Quality Maps with Satellite Data

PI: Phil Dickerson, EPA

GROUND-BASED + SATELLITE
COVERAGE OF AIR QUALITY

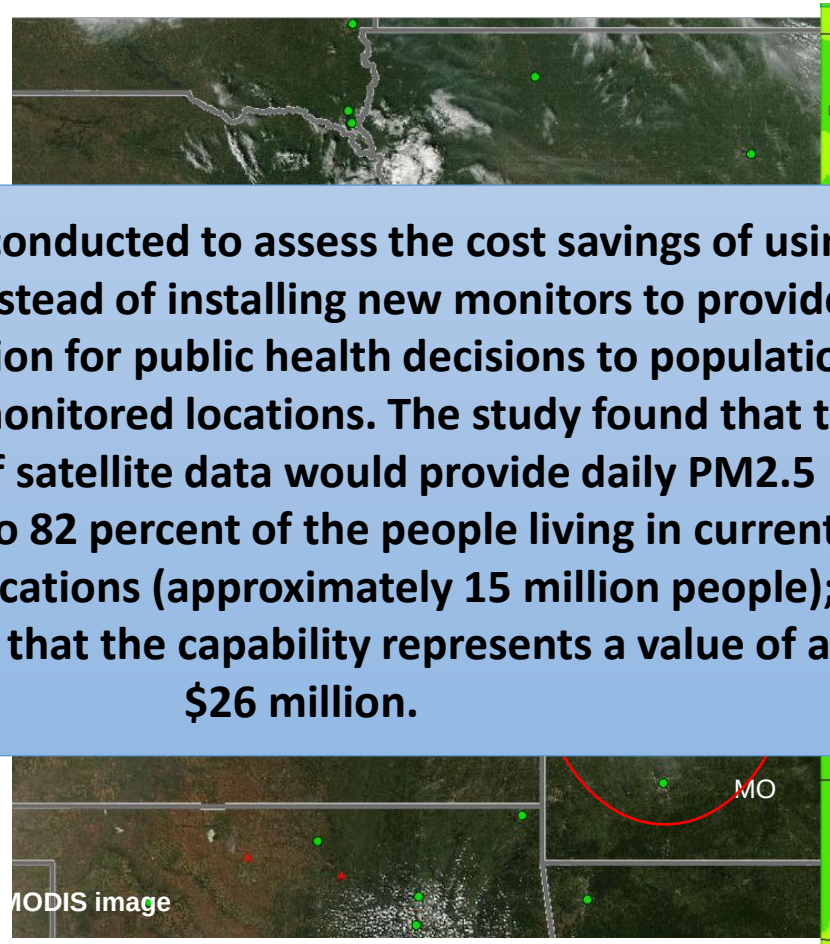


Green = ground-based PM
Blue = AirNow Satellite-ba
White = no coverage

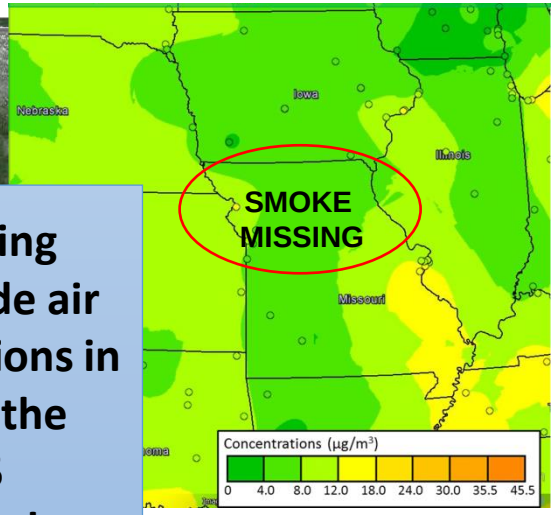
https://asdp.airnowtech.org/about.php

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.

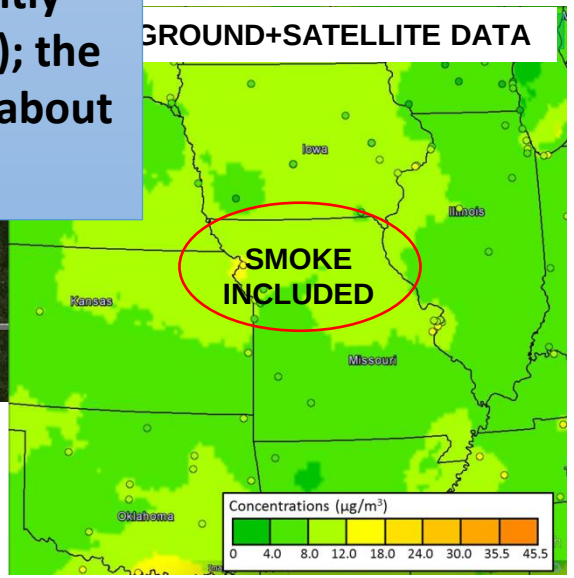
Northern Missouri fires - Sept. 4, 2013



PM2.5 FROM GROUND BASED DATA



GROUND+SATELLITE DATA

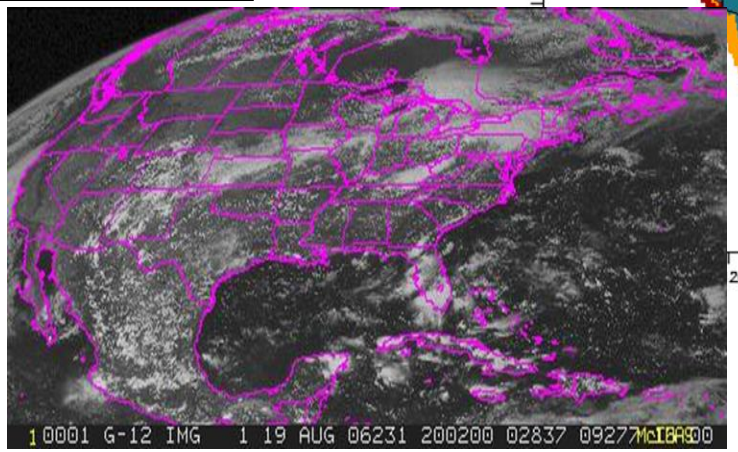


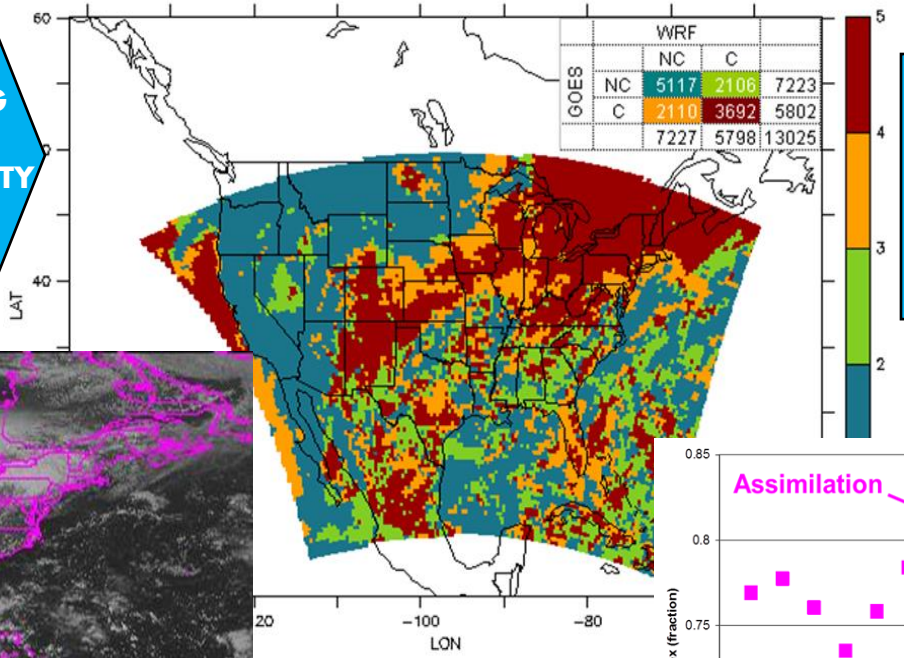
"This is the best tool I have seen so far that integrates satellite data with information from ground monitors."
Cassie McMahon, Minnesota Pollution Control Agency

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

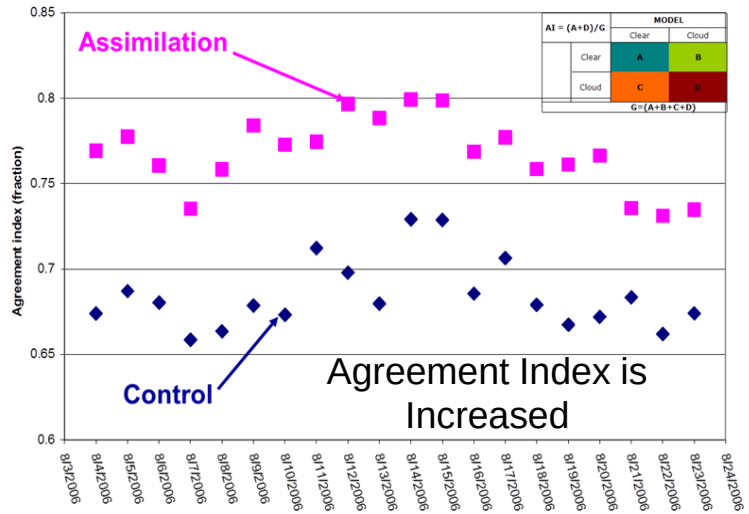
PI: Arastoo Pour Biazar, UAH

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



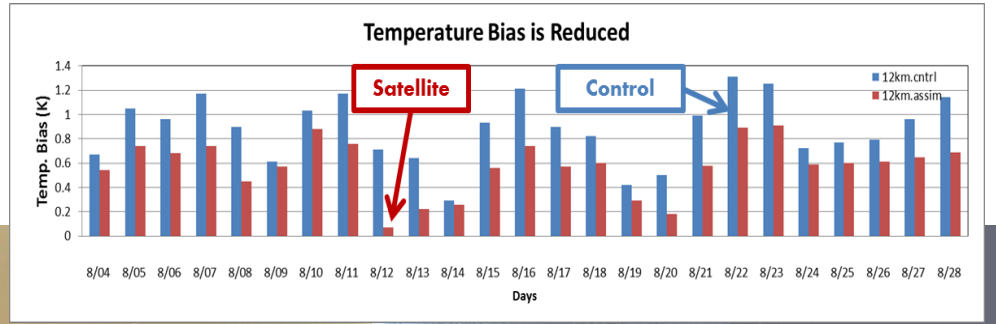


IMPROVED AIR QUALITY PLANNING AND REGULATORY DECISIONS



Agreement Index is Increased

- 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.

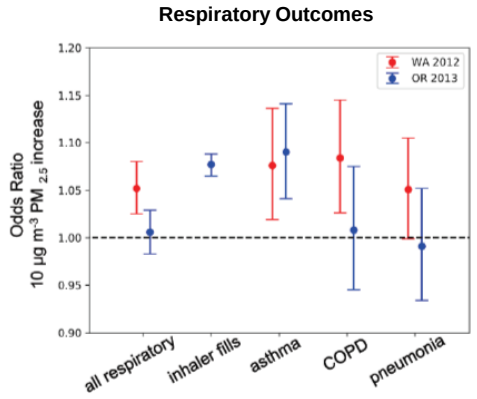


Smoke Health Impact Assessment (HIA) Forecaster

PI: Jeff Pierce (Colorado State University)

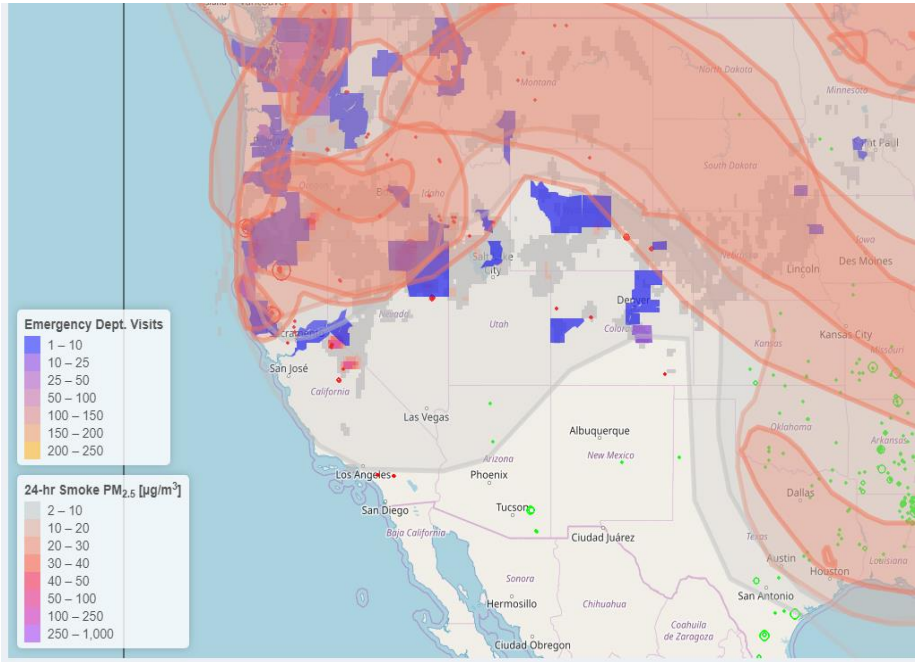
Background Research

- 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)

NASA's Health & AQ Applied Sciences Team (HAQAST)**

**Disclaimer:* HAQAST highlights shown in this presentation are weighted a bit heavily to Bryan Duncan's work since he's giving the presentation.

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)

Last Meeting: July 10-12, 2019, in Pasadena, CA
Stakeholder Webinars Planned for Winter 2019/2020
Joint Workshop Planned with EPA for May 2020

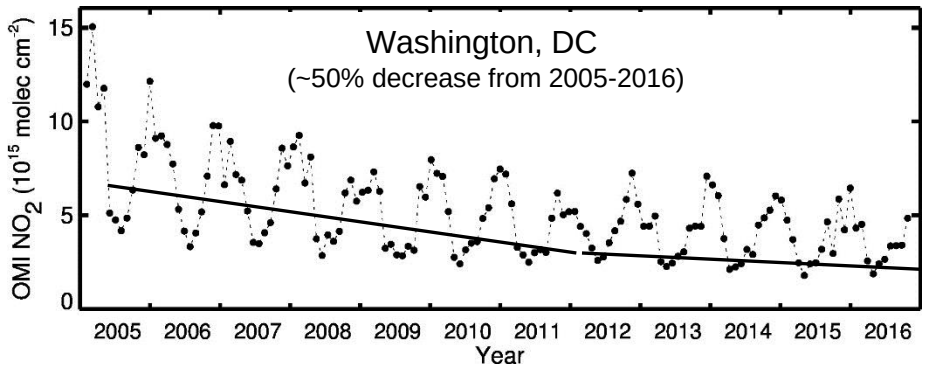
https://haqast.org

NASA *Aura* OMI Shows Air Quality Improved

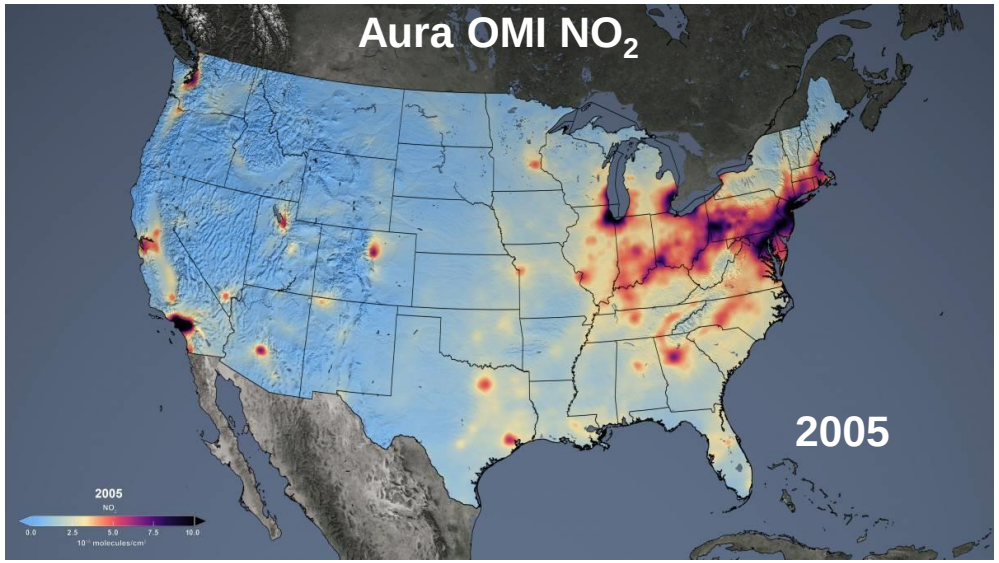
• Nitrogen dioxide (NO_2) is a pollutant that is unhealthy to breath and contributes to the formation of unhealthy levels of surface ozone pollution. It is primarily emitted from tailpipes and smokestacks.

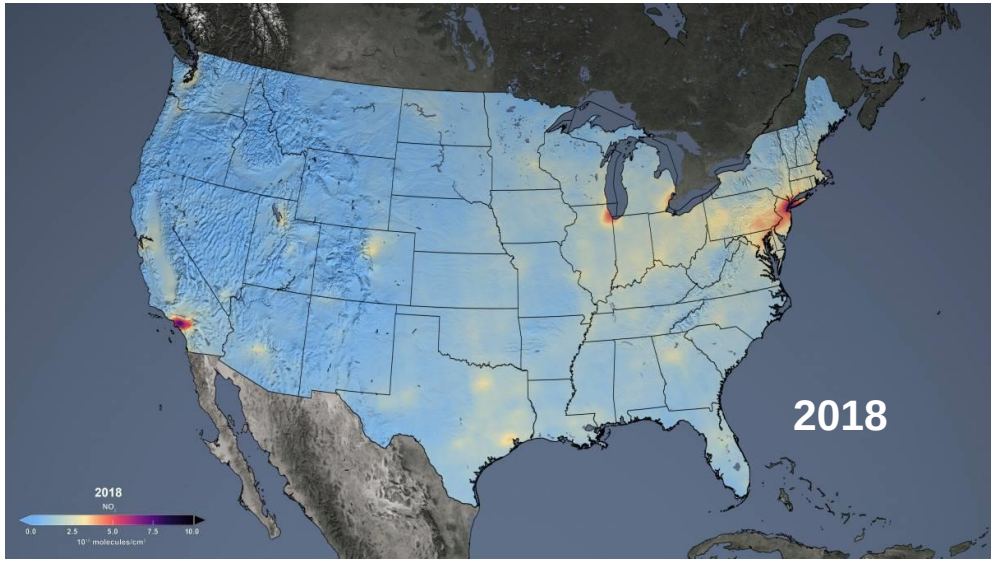
Earth observations such as these have been included in the EPA Air Trends Report since 2016 as part of the National Ambient Air Quality Standards (NAAQS) chapter.

occurred from 2005 to 2012, NO_2 levels have changed less between 2012 and 2016.



(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.

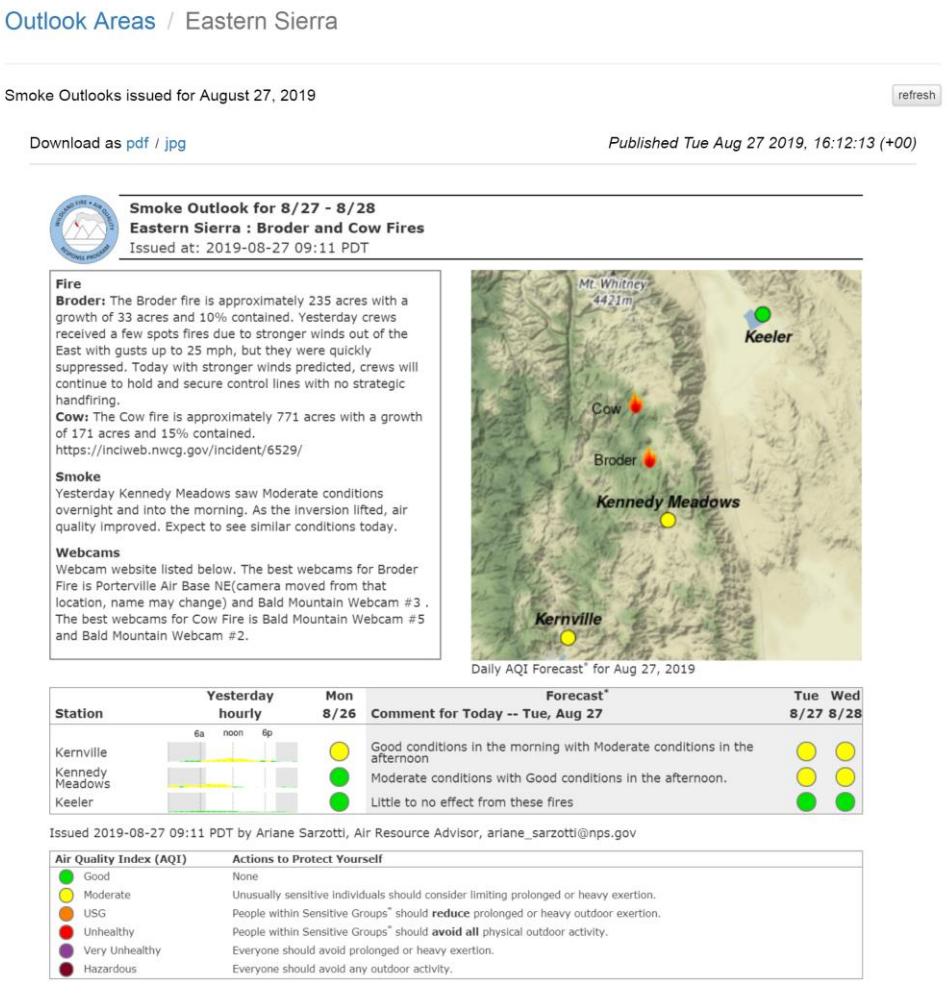
> *When smoke from wildfires blankets a region, people want to know: When will the smoke clear? Can my child play outside? Do we cancel the football game? NASA science is being used to support these important decisions affecting our daily life, health and safety.*

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



Outlook Areas / Eastern Sierra

Smoke Outlooks issued for August 27, 2019 refresh

Download as pdf / jpg *Published Tue Aug 27 2019, 16:12:13 (+00)*

Smoke Outlook for 8/27 - 8/28
Eastern Sierra : Broder and Cow Fires
Issued at: 2019-08-27 09:11 PDT

Fire
Broder: The Broder fire is approximately 235 acres with a growth of 33 acres and 10% contained. Yesterday crews received a few spots fires due to stronger winds out of the East with gusts up to 25 mph, but they were quickly suppressed. Today with stronger winds predicted, crews will continue to hold and secure control lines with no strategic handfiring.
Cow: The Cow fire is approximately 771 acres with a growth of 171 acres and 15% contained.
https://inciweb.nwcg.gov/incident/6529/

Smoke
Yesterday Kennedy Meadows saw Moderate conditions overnight and into the morning. As the inversion lifted, air quality improved. Expect to see similar conditions today.

Webcams
Webcam website listed below. The best webcams for Broder Fire is Porterville Air Base NE(camera moved from that location, name may change) and Bald Mountain Webcam #3 . The best webcams for Cow Fire is Bald Mountain Webcam #5 and Bald Mountain Webcam #2.

Daily AQI Forecast* for Aug 27, 2019

Station	Yesterday hourly (6a noon 6p)	Mon 8/26	Forecast* Comment for Today -- Tue, Aug 27	Tue 8/27	Wed 8/28
Kernville			Good conditions in the morning with Moderate conditions in the afternoon		
Kennedy Meadows			Moderate conditions with Good conditions in the afternoon.		
Keeler			Little to no effect from these fires		

Issued 2019-08-27 09:11 PDT by Ariane Sarzotti, Air Resource Advisor, ariane_sarzotti@nps.gov

Air Quality Index (AQI)	Actions to Protect Yourself
Good	None
Moderate	Unusually sensitive individuals should consider limiting prolonged or heavy exertion.
USG	People within Sensitive Groups* should **reduce** prolonged or heavy outdoor exertion.
Unhealthy	People within Sensitive Groups* should **avoid all** physical outdoor activity.
Very Unhealthy	Everyone should avoid prolonged or heavy exertion.
Hazardous	Everyone should avoid any outdoor activity.

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

Bryan Duncan (HAQAST)

•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).

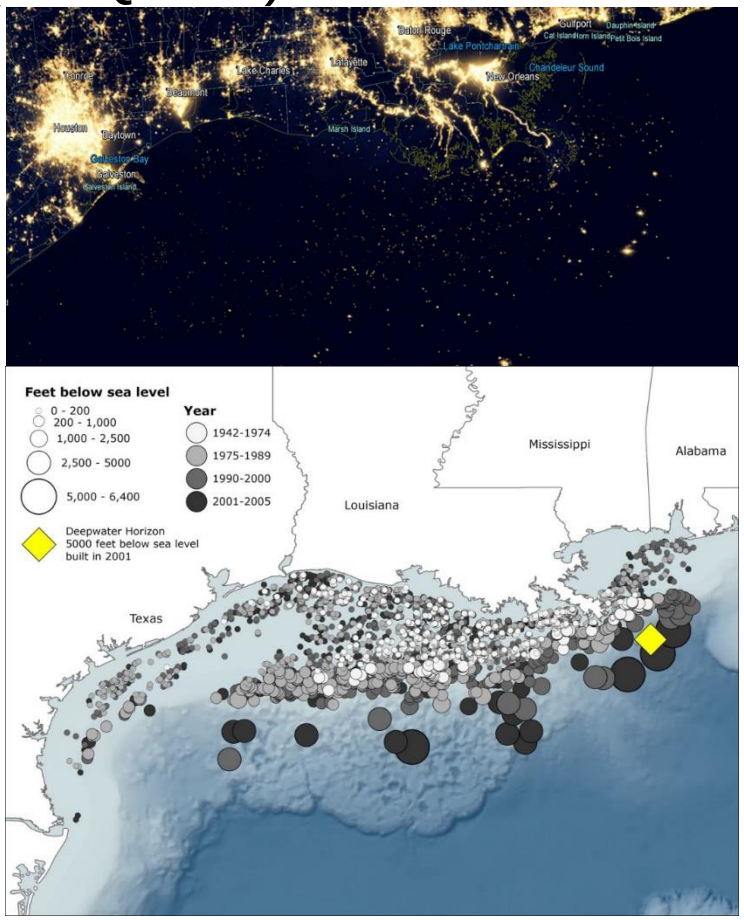
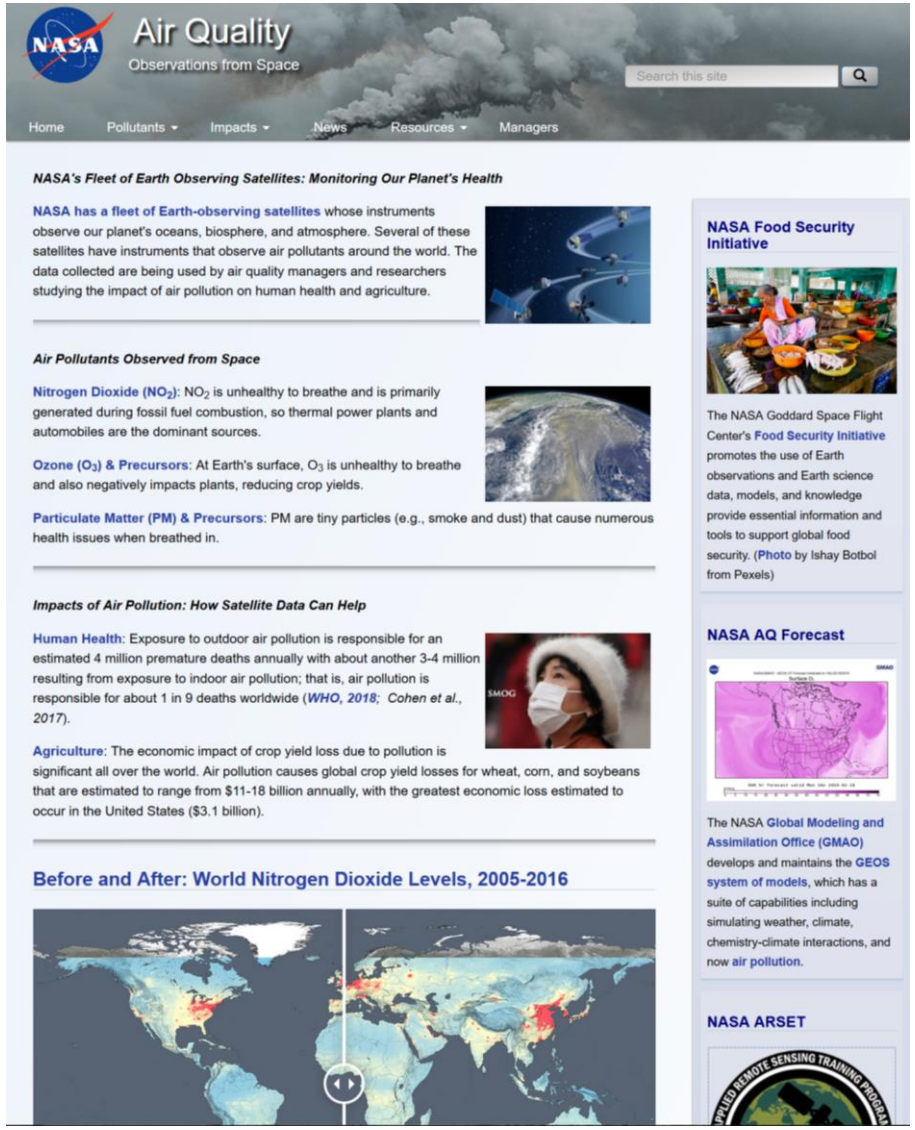


Figure. Suomi VIIRS "Lights at Night" data clearly show the locations of oil rigs and platforms

“Air Quality from Space” Website

POC: Bryan N. Duncan, NASA-GSFC



- General information on current observing capabilities
- Examples of how satellite data are being used by AQ community
- Free and publicly-available NASA resources listed, for example,
  - ARSET
  - HAQAST
- Images, factsheets, etc.

http://airquality.gsfc.nasa.gov/

NASA’s Applied Remote Sensing Training (ARSET)

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/

Research and Analysis

- Tropospheric Composition Program
  - *FIREX-AQ*

FIREX-AQ

Fire Influence on Regional to Global Environments and Air Quality

22 July – 5 September 2019
Boise, Idaho and Salina, Kansas

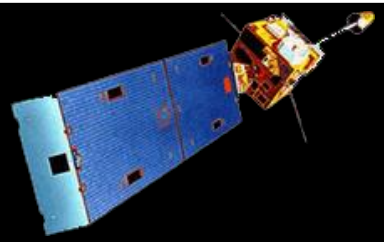
The motivation for this project is to improve the representation of fires in U.S. air quality forecast models so that the public is appropriately warned when poor air quality is likely.

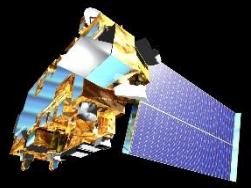
NASA Contacts: Jim Crawford, Jack Dibb, Barry Lefer
NOAA Contacts: Carsten Warneke, Joshua Schwarz, Tom Ryerson

FIREX-AQ Coordinated Activities 2018-2019

FIREX-AQ 2015-2019

- Multi-agency collaboration to study complex fire systems
- Requires multi-disciplinary effort





Satellites: Remote Sensing

Laboratory studies in 2016
Field Intensives 2018 and 2019

NOAA/NASA FIREX-AQ

Aircraft: Intermediate to Continental


NSF WECAN

CHEM Twin Otter

MET Twin Otter

Mobile Ground Sites: Local

JFSP Western Wildfire Campaign

NOAA/CU NightFOX

JFSP source fuel fire study 2019

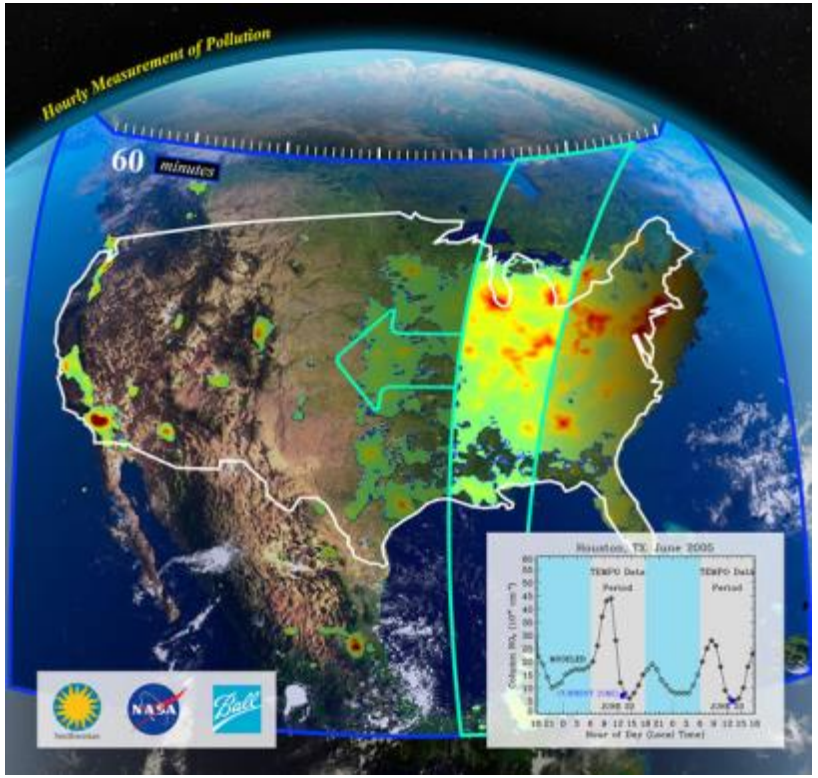
Upcoming Satellite Missions for Health & AQ Communities

Earth Venture Instrument-1:

Tropospheric Emissions: Monitoring of Pollution (TEMPO)

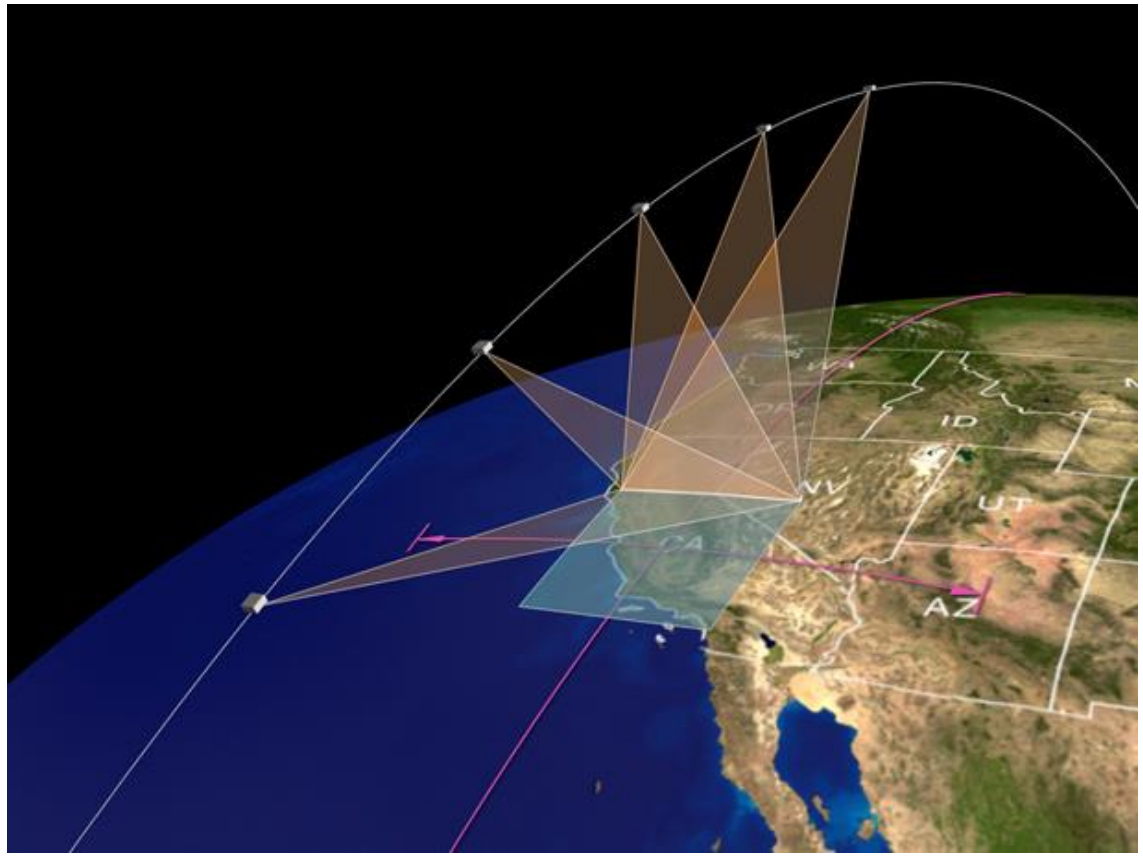
“Monitoring the air we breathe, hour by hour”

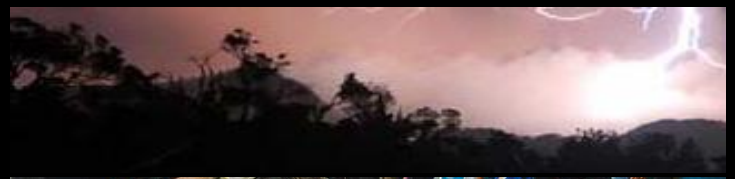
- ***TEMPO is a pathfinder to using hosted commercial payloads from GEO***
- Tropospheric pollution observations from Geostationary Orbit
  - Ozone, NO_2, and CH_2O.
- Forms a global Air Quality constellation in GEO with Copernicus Sentinel 4 and Korean GEMS.
- EPA and NOAA are part of the science team.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



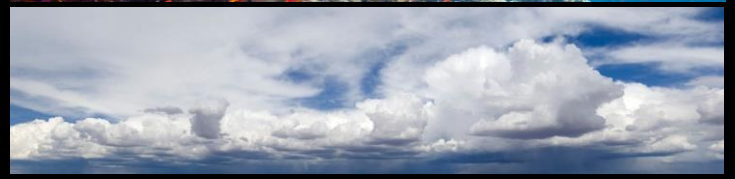
Earth Venture Instrument-3:
Multi-Angle Imager for Aerosols (MAIA)

- ***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.





National Aeronautics and
Space Administration



Questions:

John Haynes, Program Manager

Health & Air Quality Applications

NASA Headquarters / Earth Science

JHaynes@nasa.gov

http://AppliedSciences.NASA.gov