GEO-XO Atmospheric Composition: Capabilities and Applications

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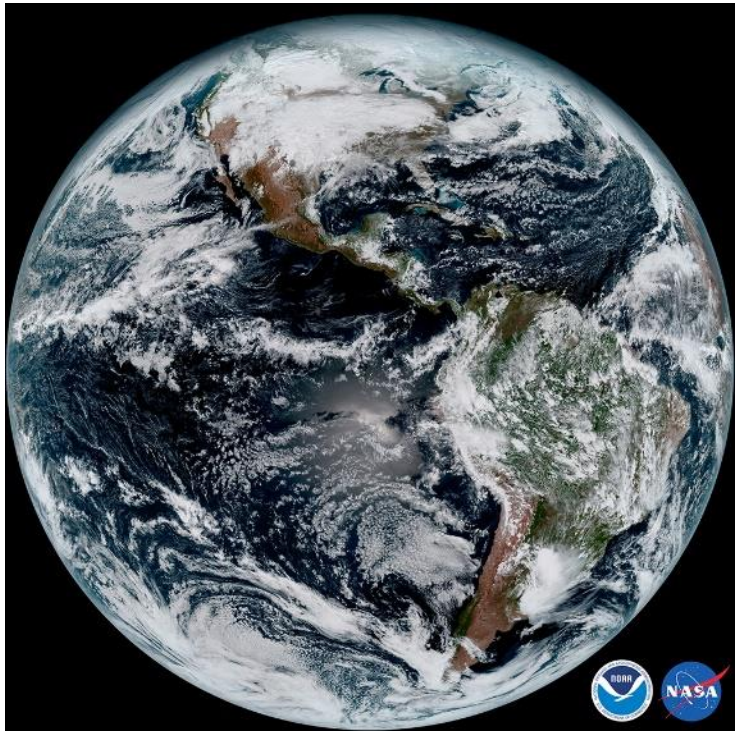
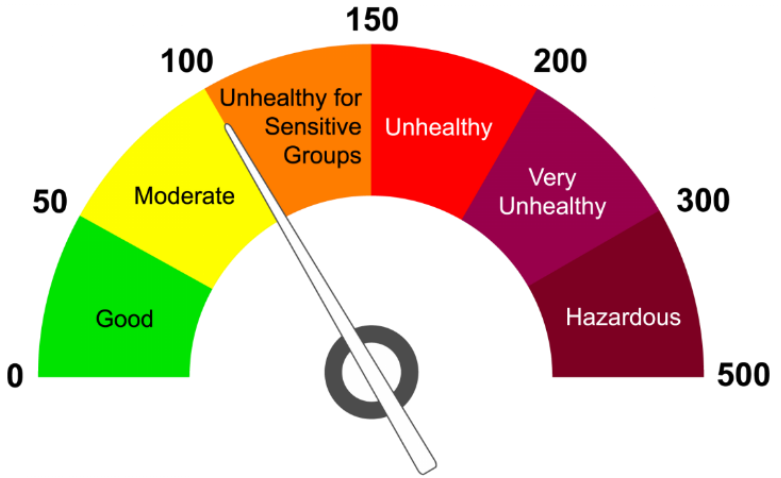
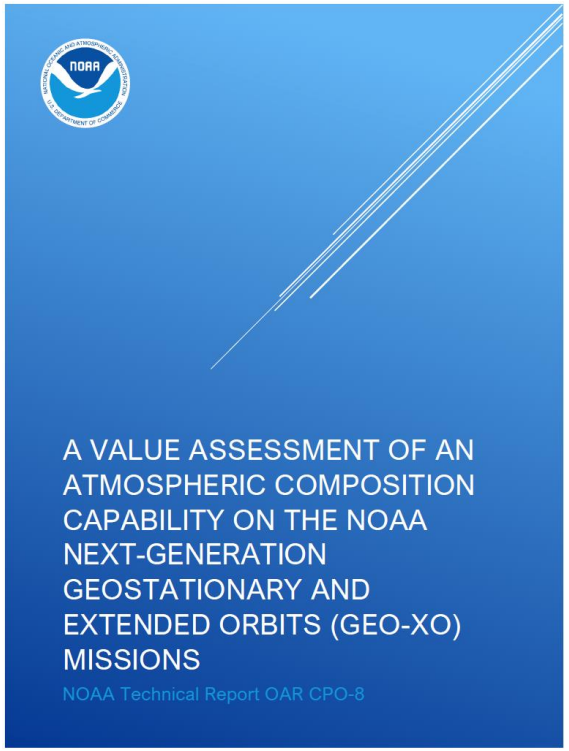




GEO-XO Atmospheric Composition Value Assessment

In 2020, an expert team **assessed the value of geostationary atmospheric composition** (AC) observations for **NOAA's science and operational application areas**, as part of the agency's mission to protect lives and property. **The proposed GEO-XO AC capability addresses the report's recommendations.**



https://doi.org/10.25923/1s4s-t405

NOAA's Atmospheric Composition Applications

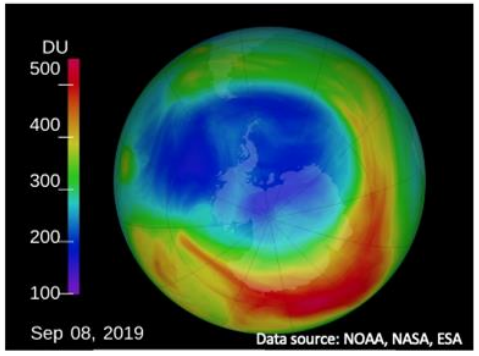
Air Quality

Wildfires

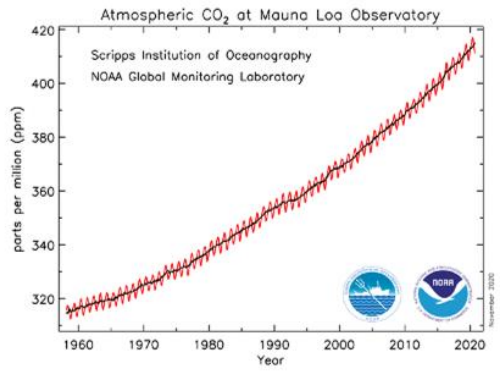
Hazards

Weather and Climate

Stratospheric Ozone



Greenhouse Gases

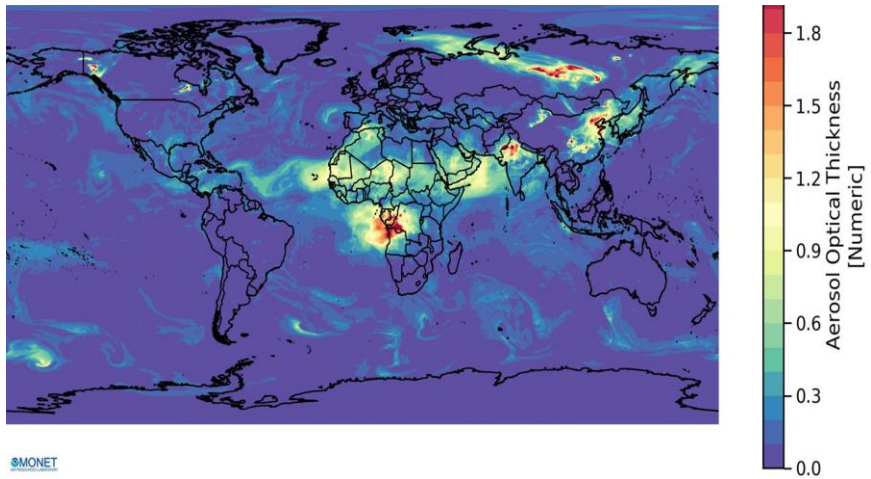


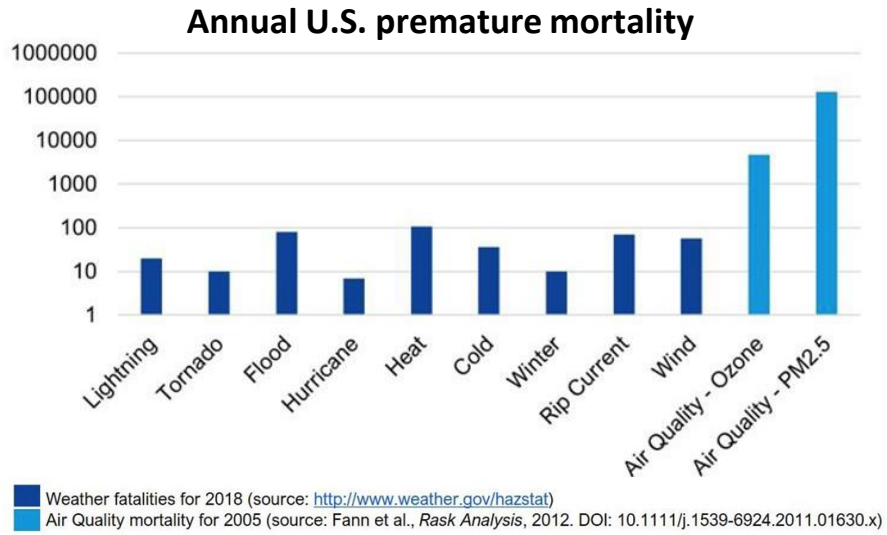
Atmospheric Composition: Critical to NOAA's Mission

NOAA has numerous mandates to observe and predict Atmospheric Composition.

Innovations in Atmospheric Composition observations and process understanding improve NOAA's operational predictions.

GEFS v12 Aerosol, operational September 2020





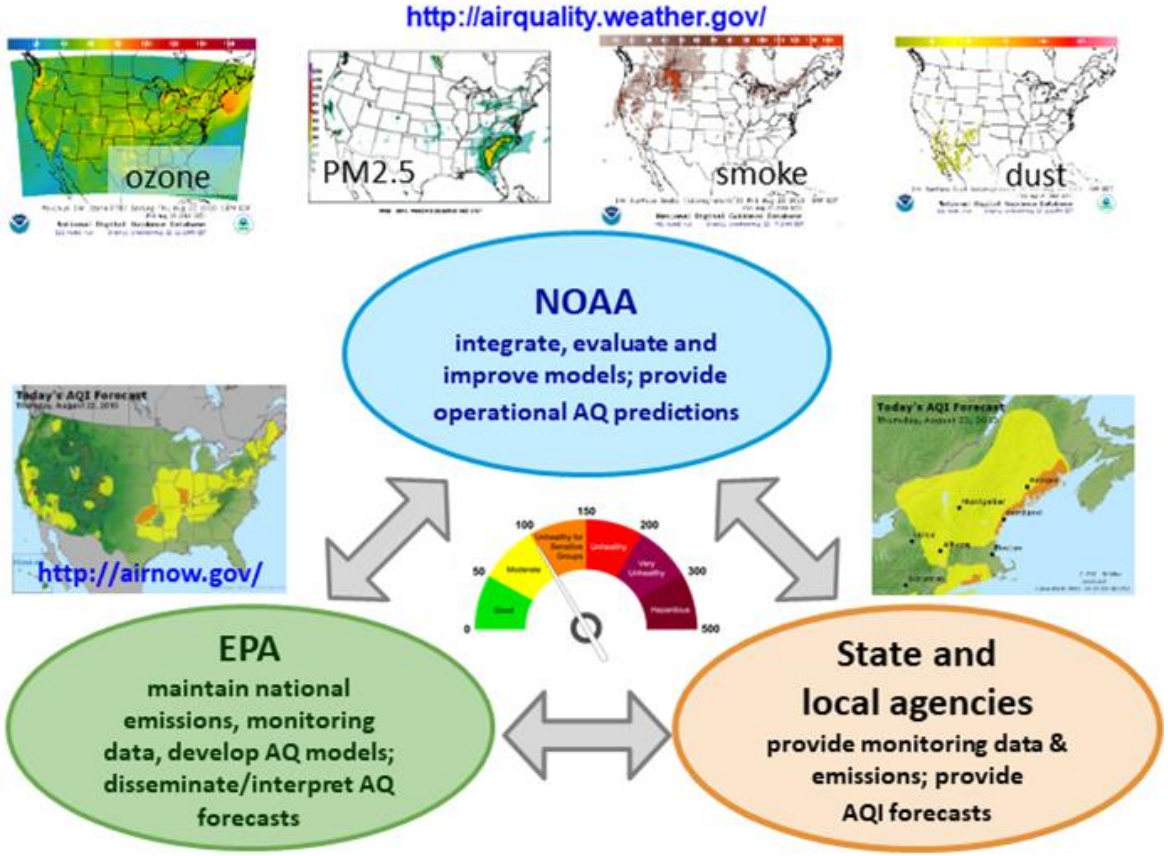
Poor air quality is responsible for many more U.S. deaths annually than all extreme weather events combined.

NOAA's Atmospheric Composition capabilities will be critical as we face increasingly complex and interconnected impacts from climate change and its consequences for the environment and our society.

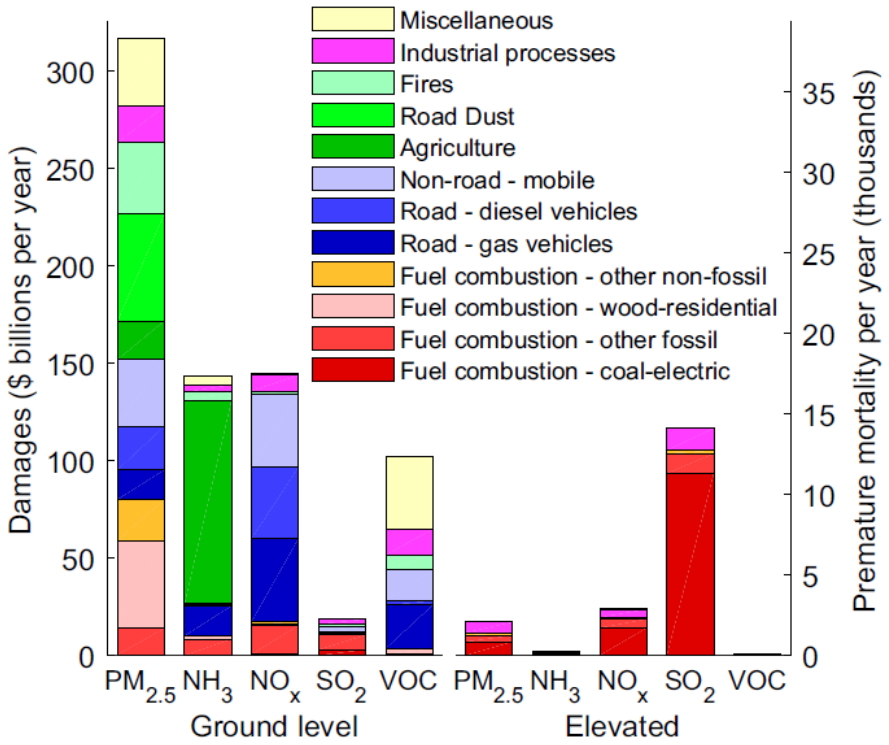
Value of NOAA's Air Quality Forecasting Capability

NOAA's **National Air Quality Forecasting Capability** provides guidance for the U.S. EPA and state and local agencies that are responsible for monitoring air pollutant levels and disseminating air pollution alerts.

Air pollution alerts help those in vulnerable groups to change their behavior, reducing their exposure and resulting in lower costs and reduced premature mortality.



U.S. Damages in Deaths and Dollars from Air Pollutants by Source



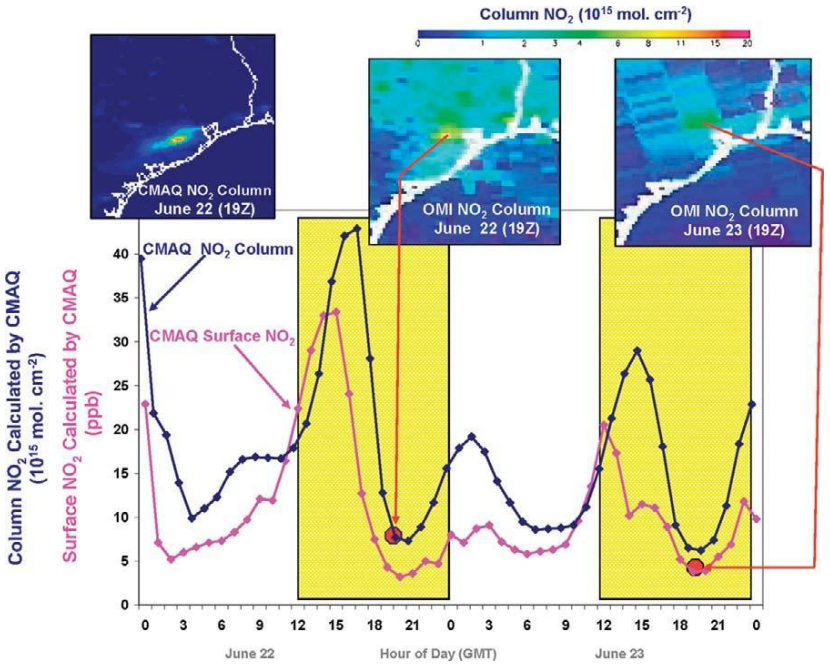
Goodkind et al., Proc. Natl. Acad. Sci., 2019

Costs associated with air pollution:

- Acute and chronic exposure
- Premature mortality
- Increased health care
- Lost economic productivity
- Environmental injustice

In the United States annually, air pollution results in **100,000+ premature deaths** and nearly **$1T in damages.**

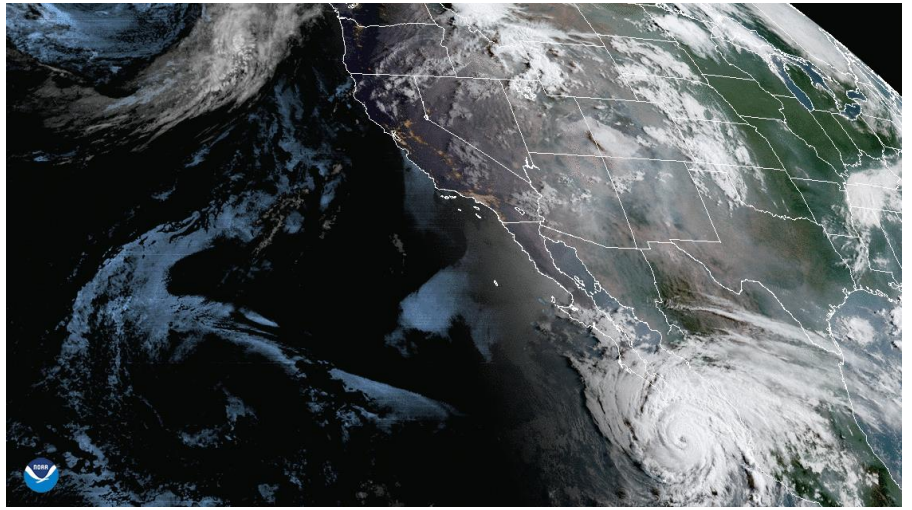
Advantages of GEO AC Observations



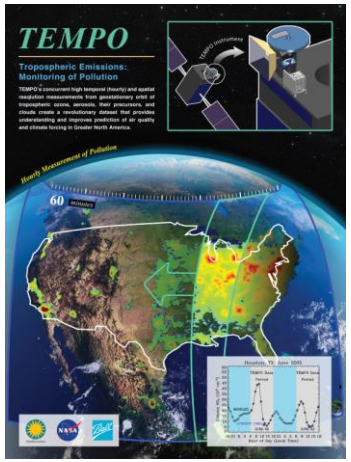
Fishman et al., BAMS, 2008

GEO Atmospheric Composition data will be indispensable to NOAA's future air quality, wildfire, and hazards observation and prediction efforts:

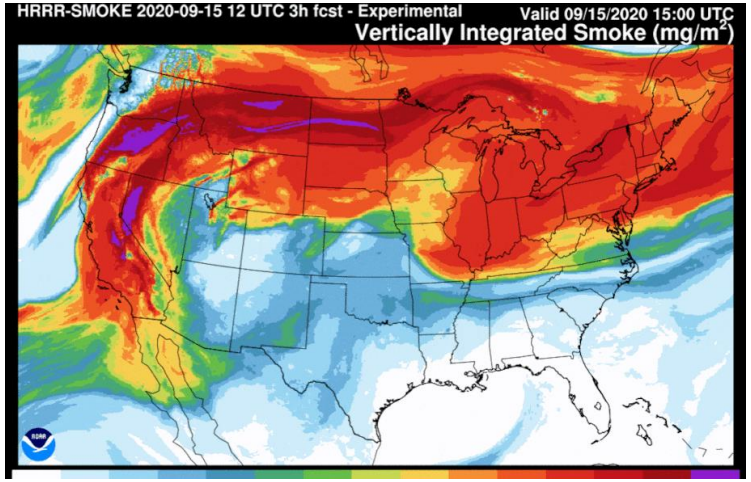
- Monitoring hourly variations
- Detecting episodic events
- Selecting cloud-free conditions



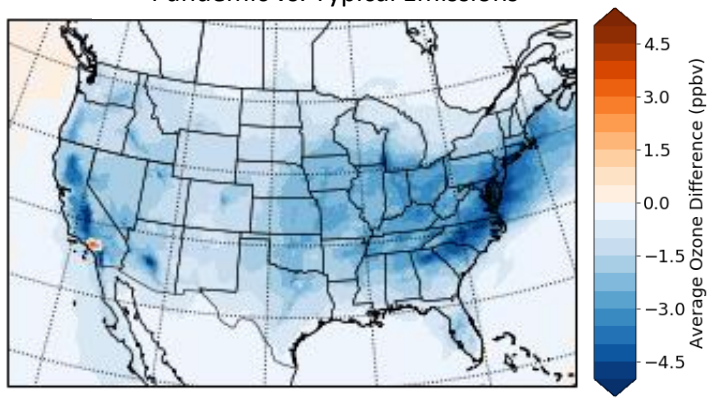
Once TEMPO data are available, NOAA's forecasting systems will become reliant on these data and will improve accordingly.



NASA's TEMPO Atmospheric Composition instrument will provide geostationary data over CONUS for research applications after it launches in 2022.

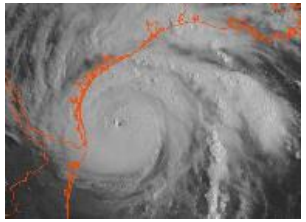


Change in Near-Surface Ozone, Pandemic vs. Typical Emissions

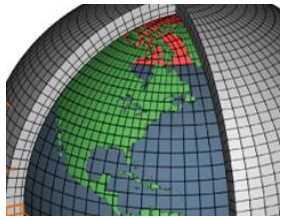


Atmospheric Composition: A Multi-Instrument Synergy

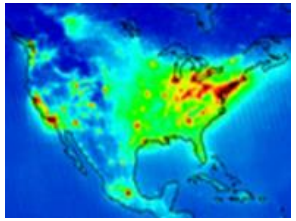
Vis/Near-IR Imagery



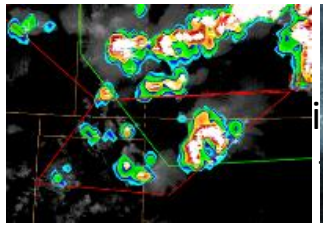
IR Sounding



Atmos. Composition

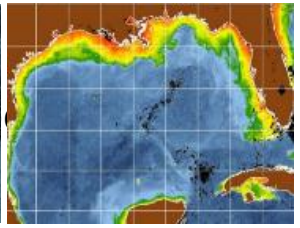


Lightning Mapping



Day/Night Imagery

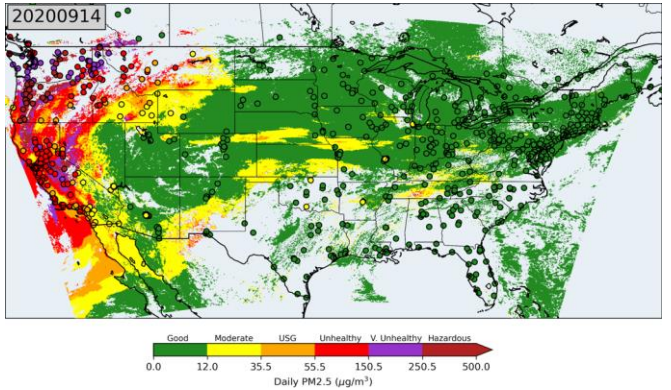
Ocean Color



Vis/IR Imager (GXI)

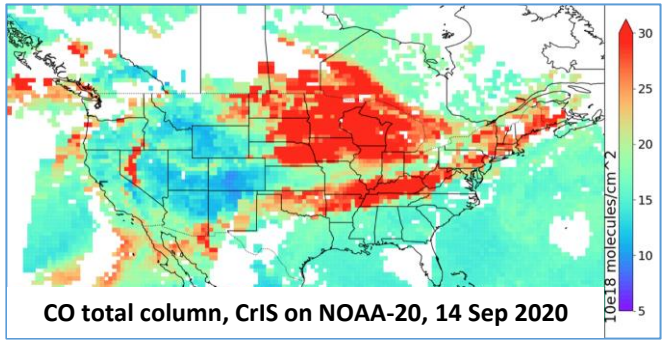
- Fire detection
- Fire radiative power
- Aerosol type
- Aerosol optical depth
- Aerosol concentration

PM2.5 derived from VIIRS AOD



IR Sounder (GXS)

- Ozone
- Methane
- Carbon monoxide
- Carbon dioxide
- Ammonia

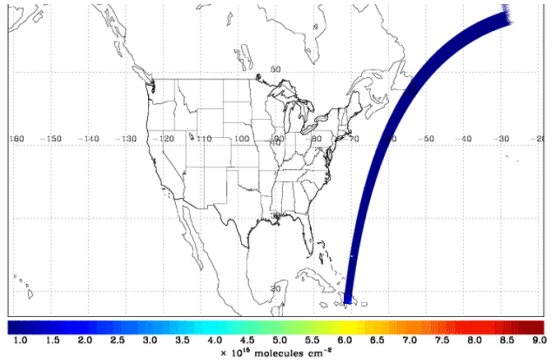


CO total column, CrIS on NOAA-20, 14 Sep 2020

UV/Vis Spectrometer (ACX)

- Ozone
- Nitrogen dioxide
- Sulfur dioxide
- Formaldehyde
- Aerosol layer height

OMI NO_2 over TEMPO field of regard

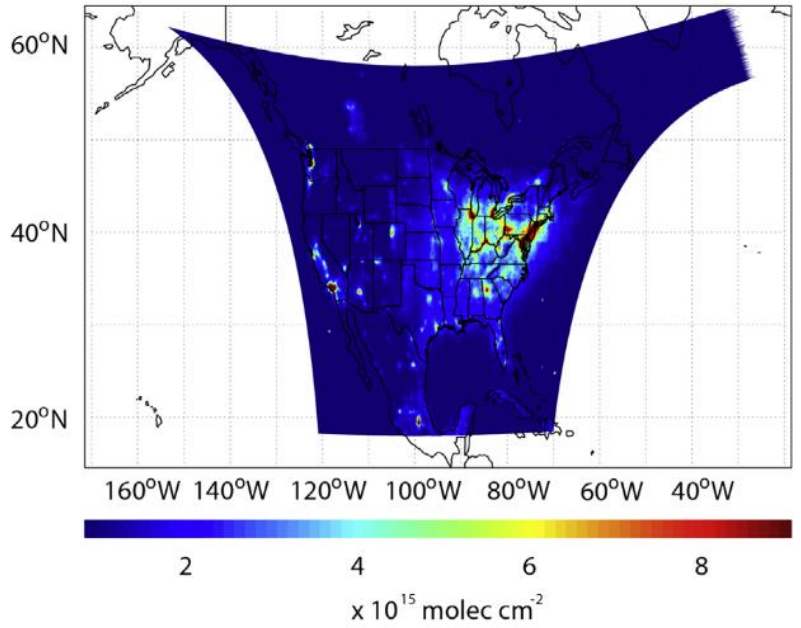


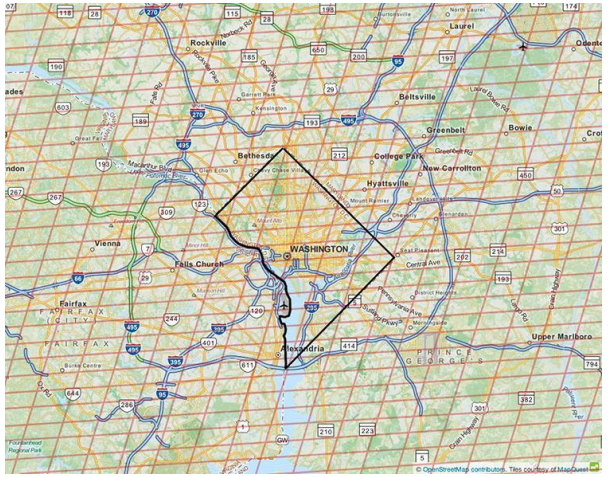
Potential GEO-XO ACX Attributes

(Preliminary, pending program approval)

Attribute	Proposed Quantity	Motivation
Coverage	CONUS, southern Canada, northern Mexico and Caribbean	Hourly inputs to national air quality, hazard and fire forecasting capabilities and warnings.
Spatial Resolution	8x3 km^2 @ nadir	Resolve sources, including cities, highway corridors, airports, oil/gas fields, large point sources like fires and power plants.
Temporal Resolution	60 min	Capture diurnal variations in emissions and photochemistry. Detect episodic events like fires and volcanoes. Select for cloud-free conditions. Capture peak pollution exposure during rush hour traffic and industrial activity.
Spectral Coverage / Resolution	UV: 300-500 nm Vis: 540-740 nm Both @ 0.6 nm	UV: ozone, nitrogen dioxide, formaldehyde, sulfur dioxide, absorption aerosol optical depth. Vis: cloud/aerosol layer height, PBL ozone, vegetation. High resolution critical for spectral fingerprinting.

OMI NO_2 sampled over TEMPO field of regard





Example TEMPO pixels over the Washington DC region

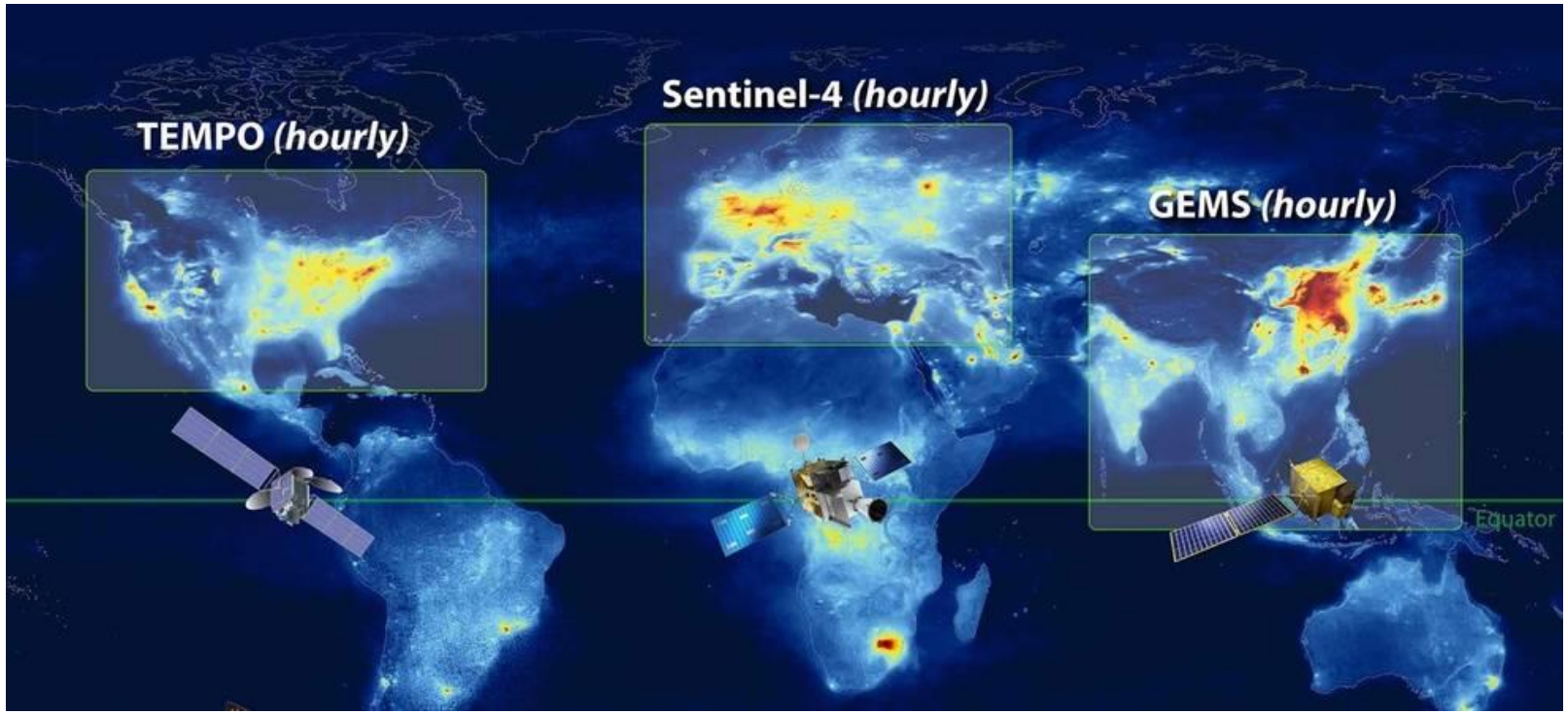
GEO-XO ACX: NOAA's Contribution to Geo-Ring

After its launch, TEMPO will be one component of a global Geostationary Atmospheric Composition constellation, the Geo-Ring.

South Korea has already launched, and the European Union will soon launch, their own GEO Atmospheric Composition instruments.

TEMPO is a pathfinder research instrument.

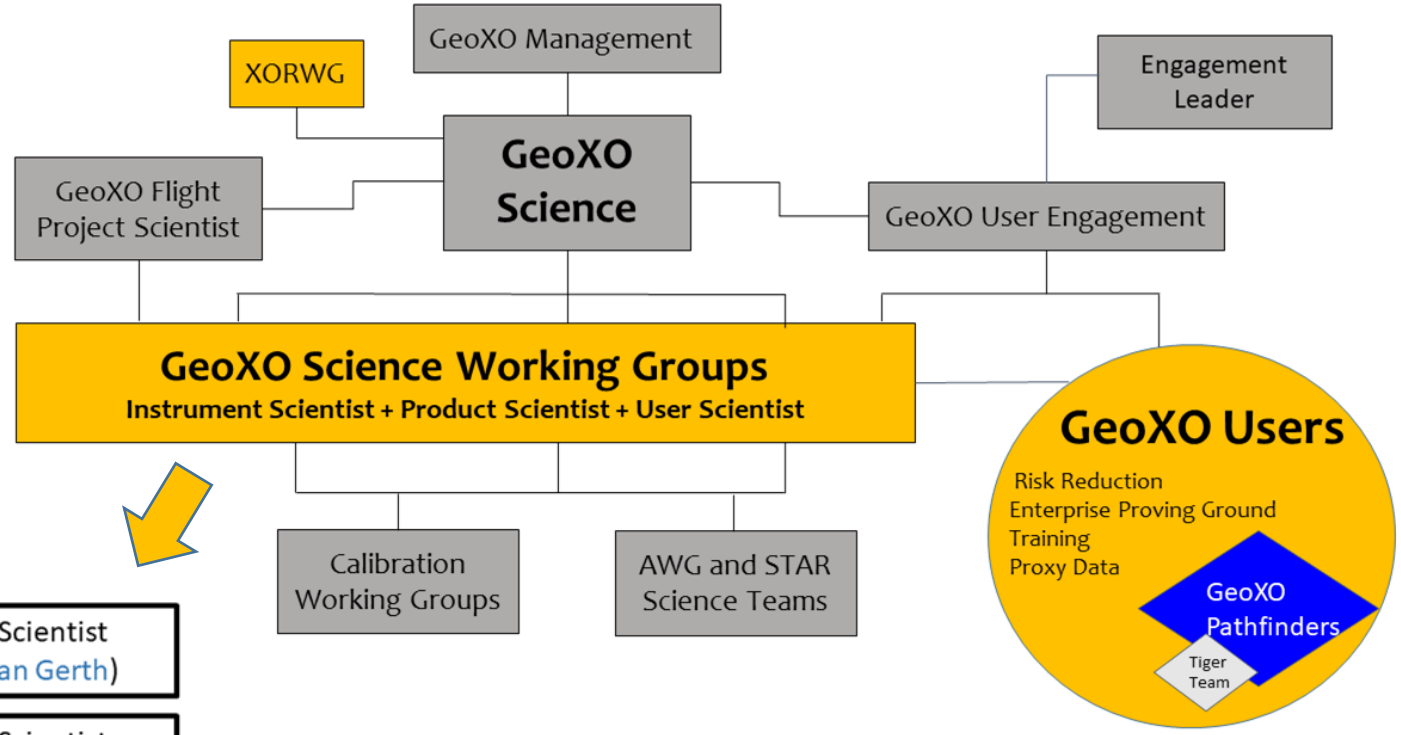
NASA has no planned follow-on to TEMPO.



Europe and South Korea are planning to operationalize their GEO Atmospheric Composition capabilities.

GEO-XO represents the Research-to-Operations transition for the US GEO Atmospheric Composition capability.

GEO-XO Science Working Groups



GXI	Instrument Scientist (Dan Lindsey)	Product Scientist (Dan Lindsey)	User Scientist (Jordan Gerth)
LMX	Instrument Scientist (TBD)	Product Scientist (Scott Rudlosky)	User Scientist (Brian Gockel)
GXS	Instrument Scientist (Dave Johnson)	Product Scientist (Tim Schmit)	User Scientist (Jim Yoe)
ACX	Instrument Scientist (Joanne Joiner)	Product Scientist (Shobha Kondragunta)	User Scientist (Greg Frost)
OCX	Instrument Scientist (Antonio Mannino)	Product Scientist (M. Wang/V. Lance)	User Scientist (Mike Ford)

ACX teams will be formed by invitation

NWS, NESDIS, Other NOAA, NASA

THE NESDIS PATHFINDERS

The early adopters of future satellite observations

The NESDIS PATHFINDERS PROGRAM includes people and organizations that volunteer their time to demonstrate *how* the use of satellite data can improve our daily lives. GEO-XO is the first NOAA mission to integrate the new Pathfinder Program into their mission development.

GEO-XO Pathfinders are the early adopters of future geostationary data. They will work in collaboration with the mission teams during the pre-launch phases to prepare and be the first to *use* GEO-XO data after launch.

GEO-XO Pathfinders realize benefits for themselves while also enhancing the the knowledge of how satellite data impacts society.

GEO-XO is Recruiting Pathfinders
How does your work impact society?

Example of Pathfinder Focus Areas

Emergency Response


Whale Migration


Wildfire Detection


Urban Air Quality

What Pathfinders Gain

- Direct interaction with the mission science teams for communicating impacts of the product will be used in areas of societal interest.
- Perspective into new mission product design
- Access to mission scientists for communicating improvements to future products
- Opportunities for training and early release data for optimal readiness

How Pathfinders Contribute

- Broader understanding of evolving needs in society
- Influential feedback on product uses and real-world decisions.
- More efficient ways of designing and delivering products to different user communities.
- Collaboration with local, national and international organizations

For more information on the Pathfinder program please email vanessa.escobar@noaa.gov