

NOAA's Contribution to the Geo-Ring: The New Geostationary Extended Observations (GeoXO) Atmospheric Composition Capability

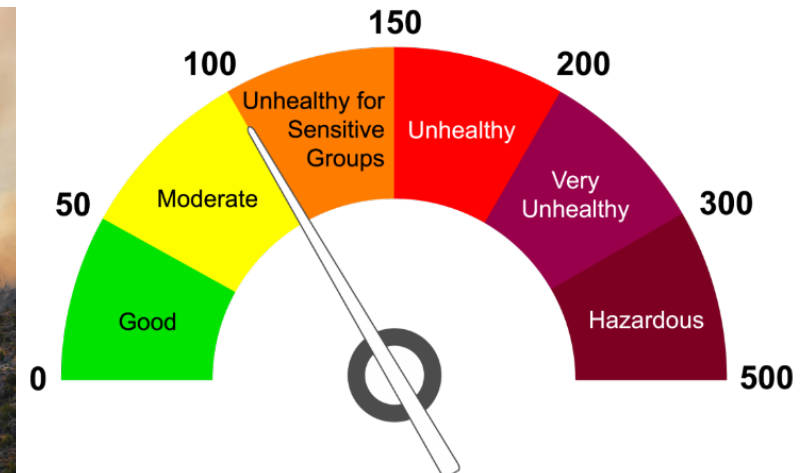
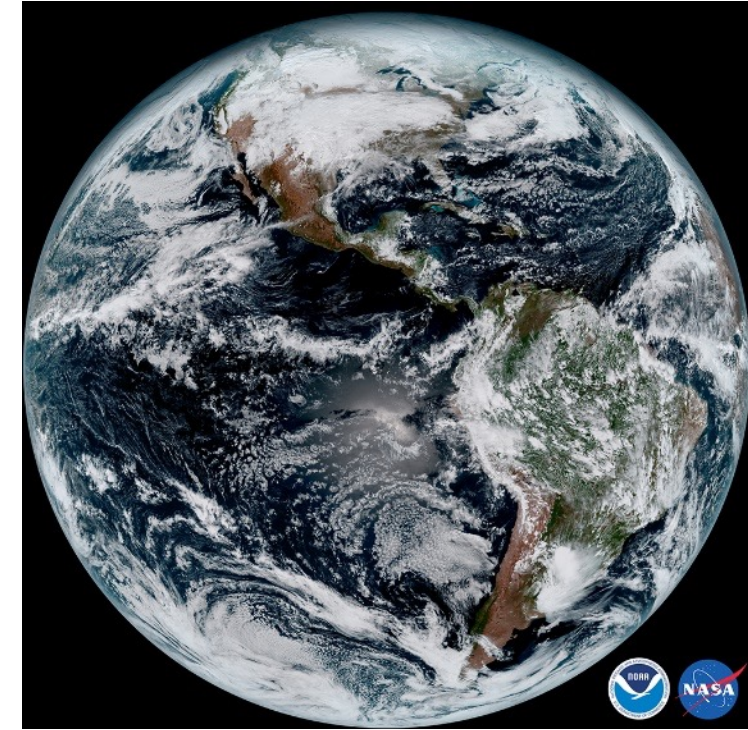
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Vanessa Escobar², and Pam Sullivan²

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²NOAA National Environmental Satellite, Data, and Information Service

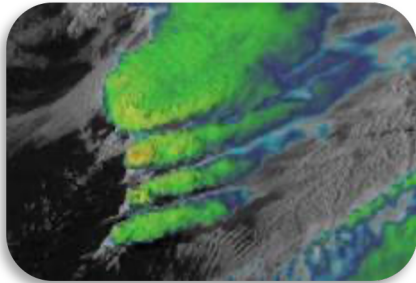
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NOAA's Highest Priority Geostationary Observations

Ongoing Needs: Imagery and Lightning data are essential for short-range forecasting, monitoring hazardous environmental conditions, and issuing severe weather watches and warnings



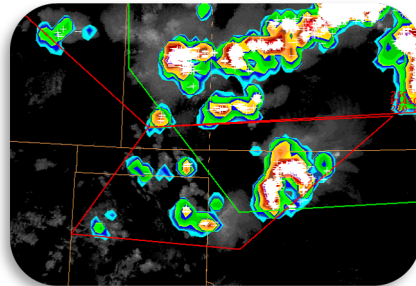
Severe Storms



Wildfire Detection



Hurricane Tracking

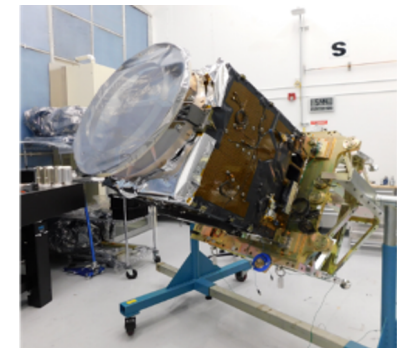


Lightning

Emerging Needs: Users expect NOAA to make operational observations that are currently planned by NASA and international agencies:

- **Hyperspectral IR Sounder** for numerical weather prediction and local nowcasting
- **Ocean Color Instrument** for monitoring dynamic coast/ocean features, ecosystem change, coastal/inland water quality, and natural and anthropogenic hazards
- **Atmospheric Composition Instrument** for monitoring air quality and the linkage between air quality, weather, and climate

*NASA TEMPO
Atmospheric
Composition
Instrument,
Launch 2022*

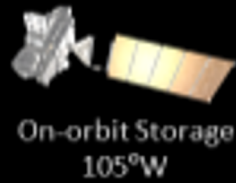


Recommended GEO-XO Constellation

(Preliminary, pending program approval)



GEO-West
Vis/IR Imager
Lightning Mapper
Ocean Color
Space Wx Suite*



GEO-Central
Hyperspectral IR Sounder
Atmospheric Composition
Partner Payload

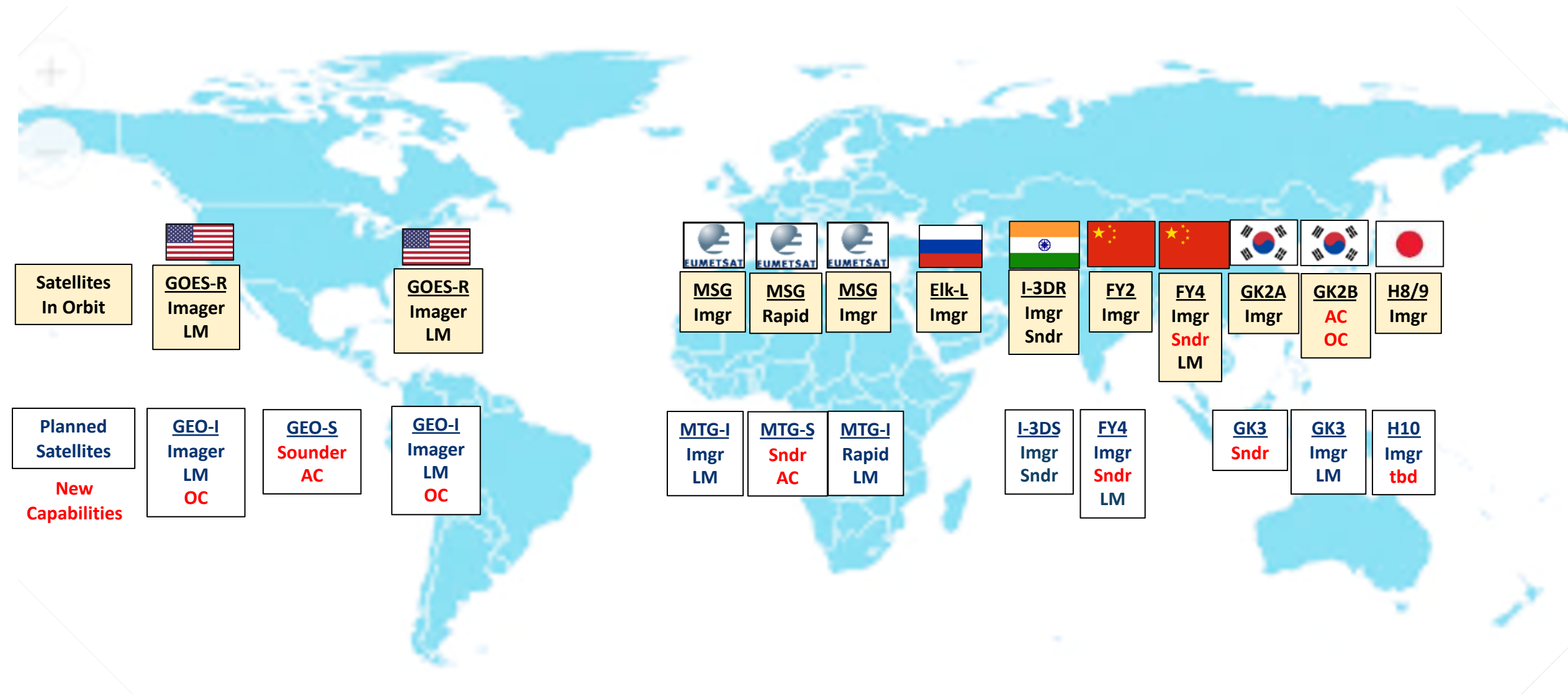


GEO-East
Vis/IR Imager
Lightning Mapper
Ocean Color
Space Wx Suite*



**Solar and In-Situ
instruments provided by
Space Weather Program
under separate initiative*

U.S. in the GEO Ring of Meteorological Satellites



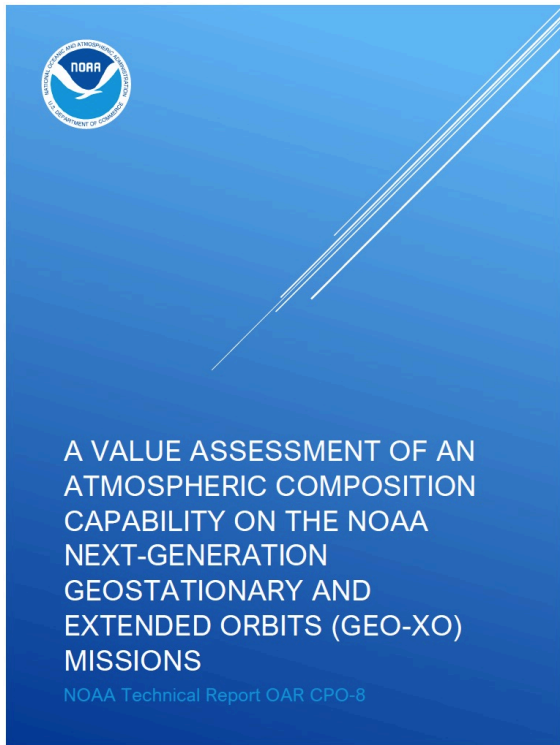
GEO-XO Next Steps

GEO-XO Formulation Event/Activity	Timeframe	Note
Imager Phase A Study Contracts Awarded	April 2021	2 Contracts
Mission Concept Review	June 2021	
NOAA-NASA Key Decision Point A	July 2021	
DOC Milestone 1 Review (DOC DepSec Approval)	Sept 2021	Program Initiation
Remaining Phase A Contracts Awarded	1QFY22	Up to 3 per Instr. Type
System Requirements Review	2QFY22	Requirements Baselined
Implementation Phase Acquisition Strategy Meeting	2QFY22	
Update Program Cost Estimate and Perform ICE	2QFY22	
DOC Milestone 2 Review (DOC DepSec Approval)	3QFY22	Program Approval
Report of Readiness to Congress	3QFY23	
Implementation Phase Contracts Awarded	3QFY23+	

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.**

NOAA's Atmospheric Composition Applications



Air Quality



Wildfires



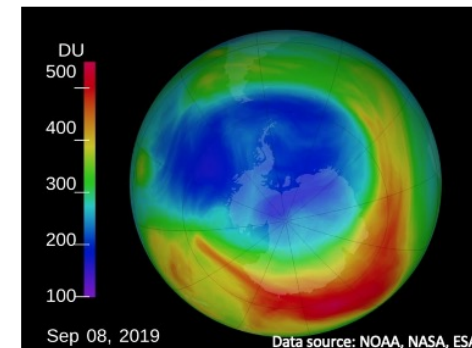
Hazards



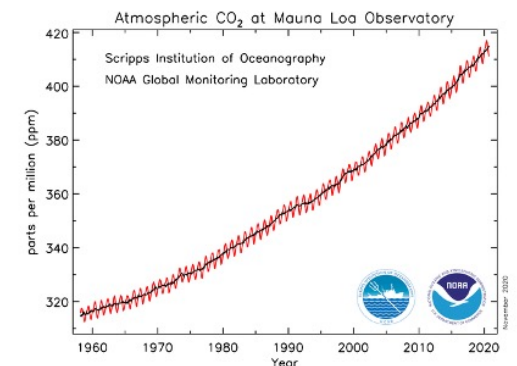
Weather and Climate



Stratospheric Ozone



Greenhouse Gases



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

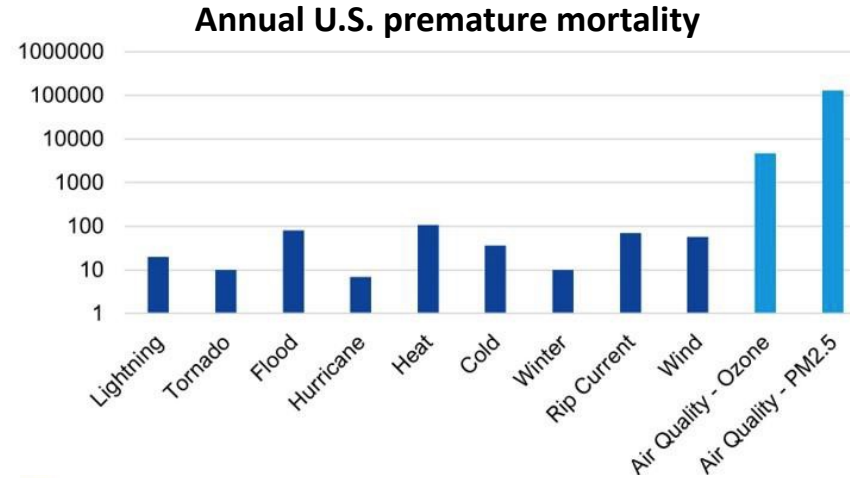
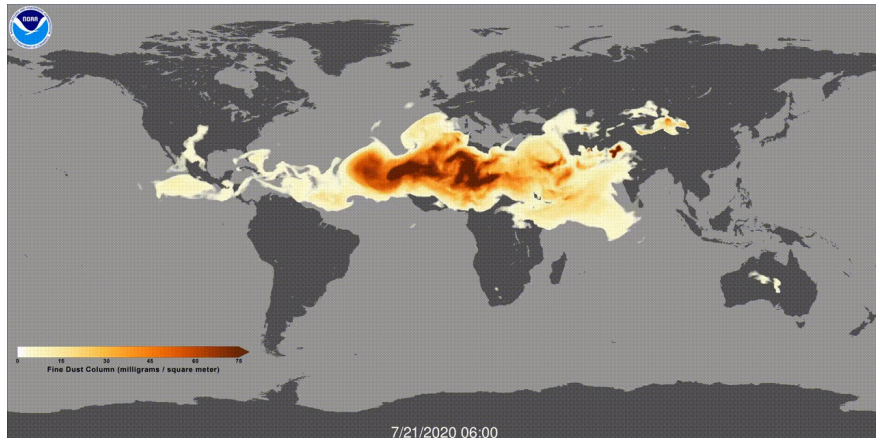
Atmospheric Composition: Critical to NOAA's Mission

NOAA has numerous mandates to observe and predict Atmospheric Composition.



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

GEFSv12-Aerosol Model, operational at NWS since Sept 2020



Weather fatalities for 2018 (source: <http://www.weather.gov/hazstat>)
Air Quality mortality for 2005 (source: Fann et al., *Risk Analysis*, 2012. DOI: 10.1111/j.1539-6924.2011.01630.x)

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

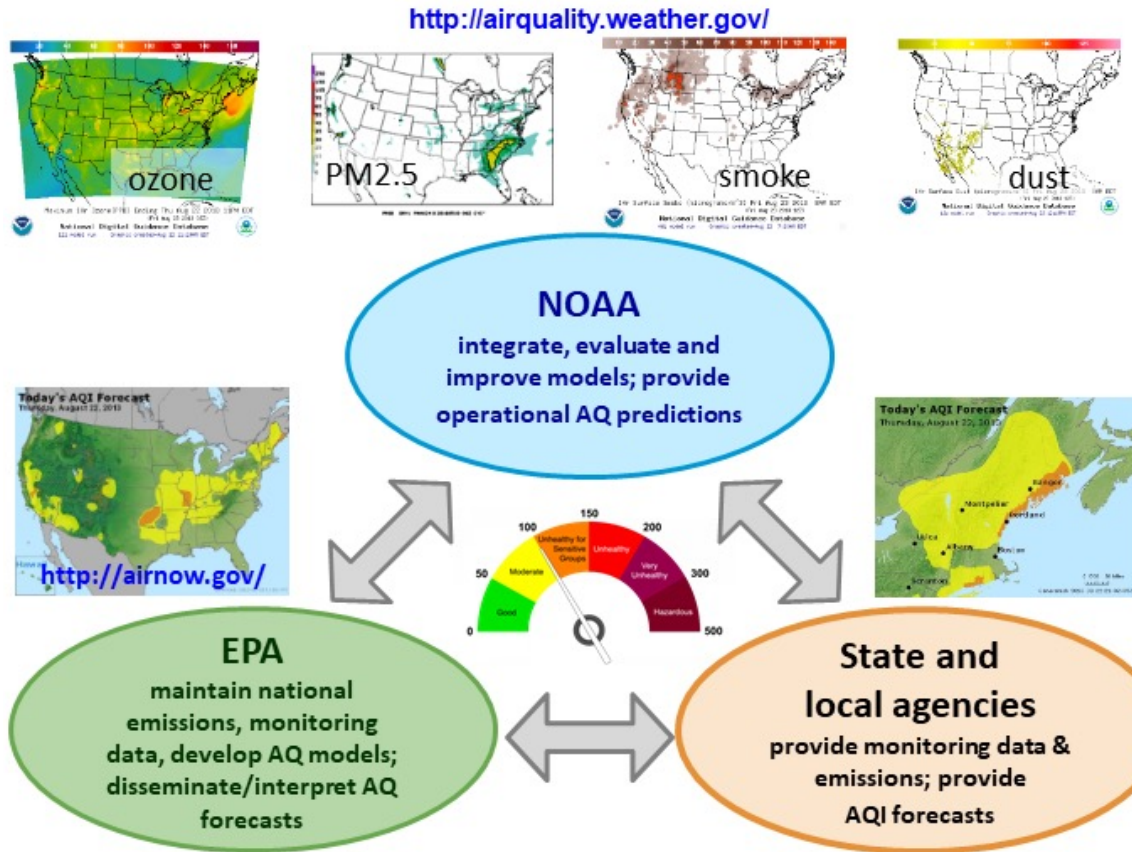
NOAA's Atmospheric Composition capabilities will be critical as we face increasingly complex and interconnected impacts from climate change and its consequences for the environment and our society.



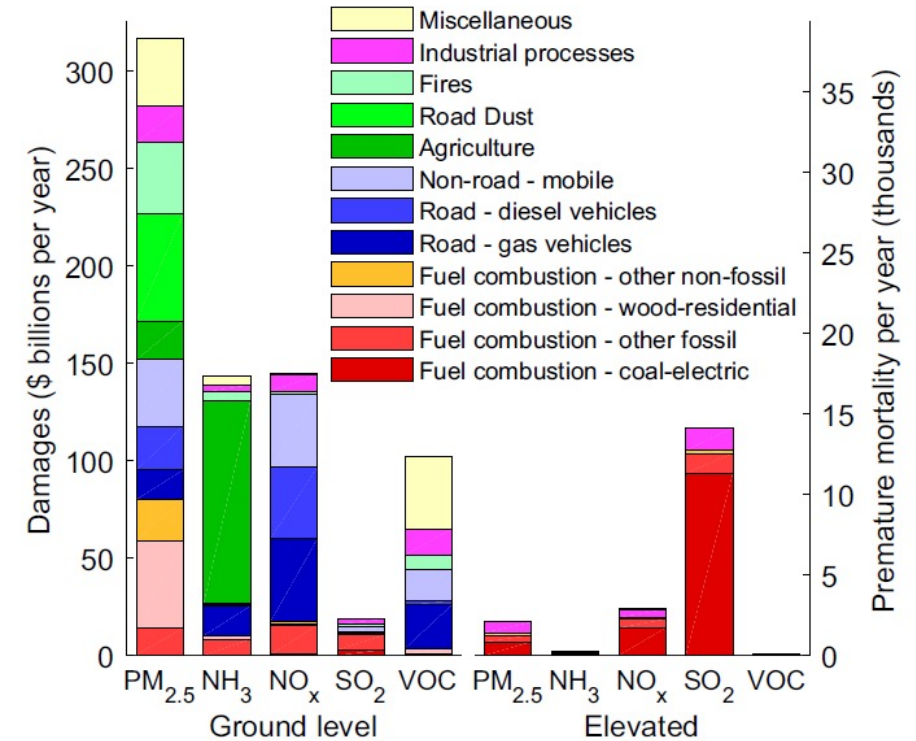
Value of NOAA's Air Quality Forecasting Capability

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**.

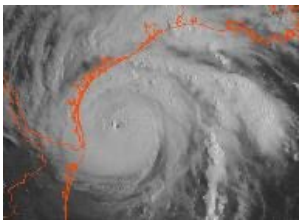
Atmospheric Composition: A Multi-Instrument Synergy

Recommended GEO-XO Constellation

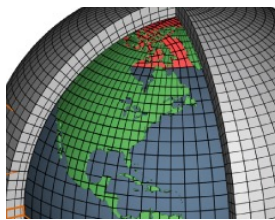
(Preliminary, pending program approval)



Vis/Near-IR Imagery



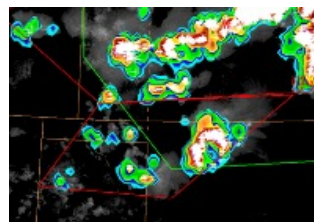
IR Sounding



Atmos. Composition



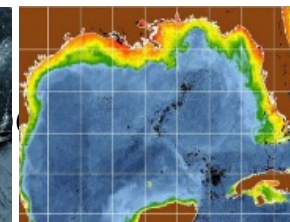
Lightning Mapping



Day/Night Imagery



Ocean Color



Vis/IR Imager (GXI)

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

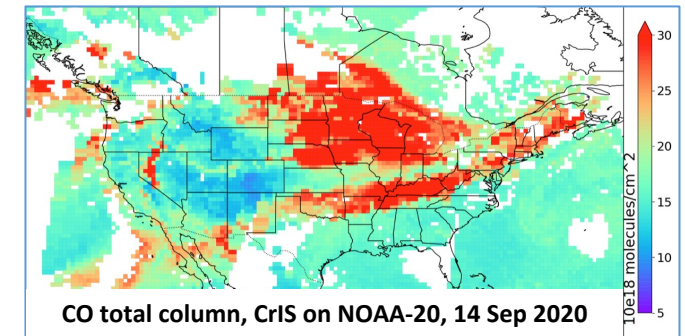
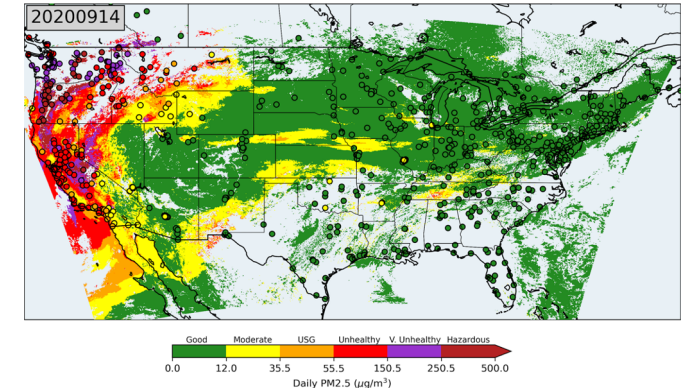
IR Sounder (GXS)

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

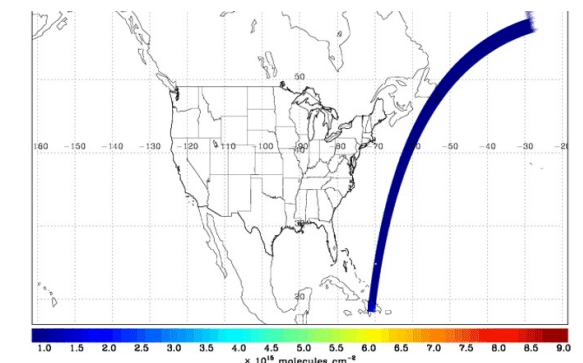
UV/Vis Spectrometer (ACX) (TEMPO analog)

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

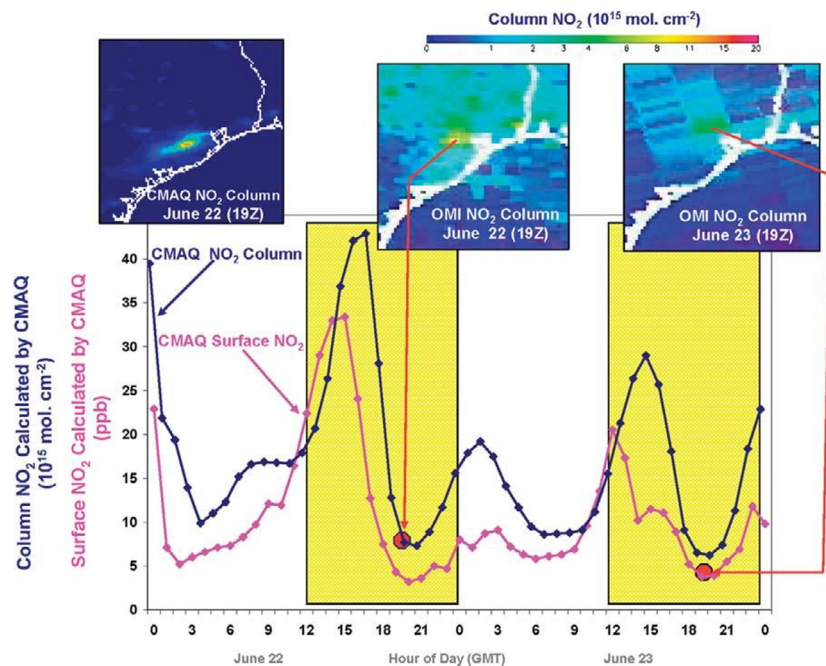
PM2.5 derived from VIIRS AOD



OMI NO₂ over TEMPO field of regard



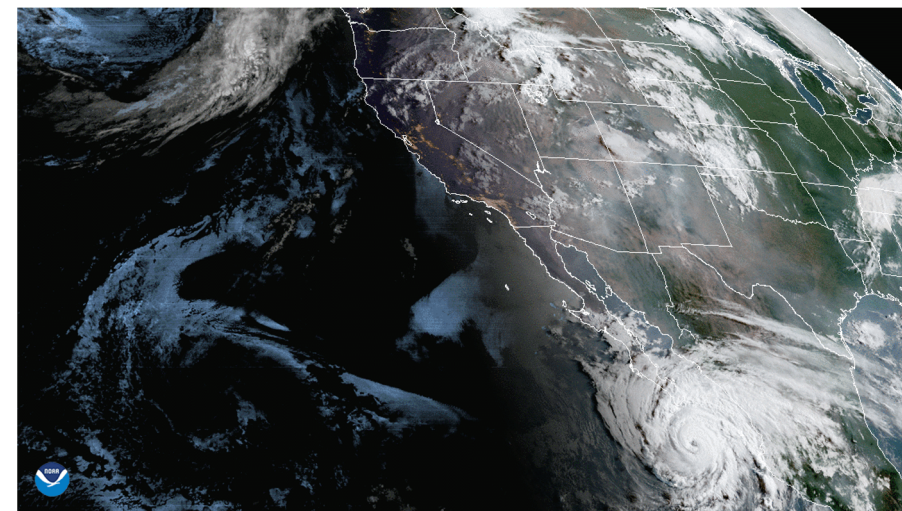
Advantages of GEO AC Observations



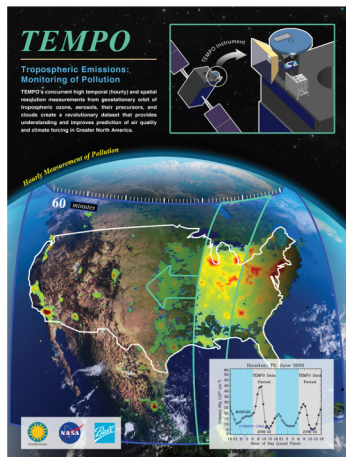
Fishman et al., BAMS, 2008

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

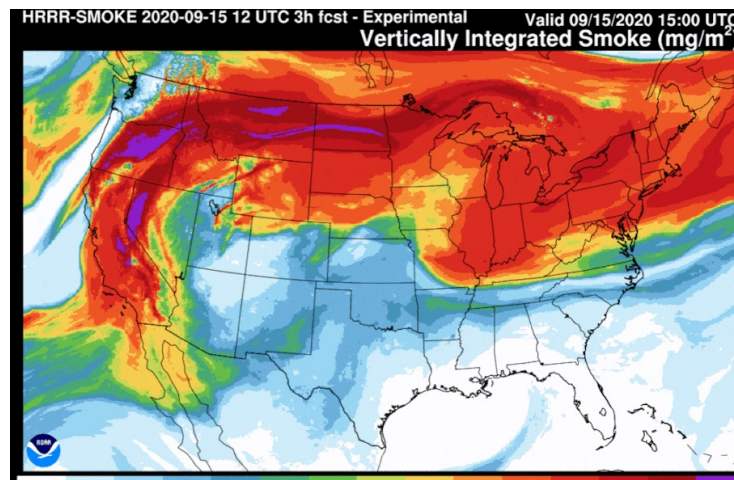
- Monitoring hourly variations
- Detecting episodic events
- Selecting cloud-free conditions



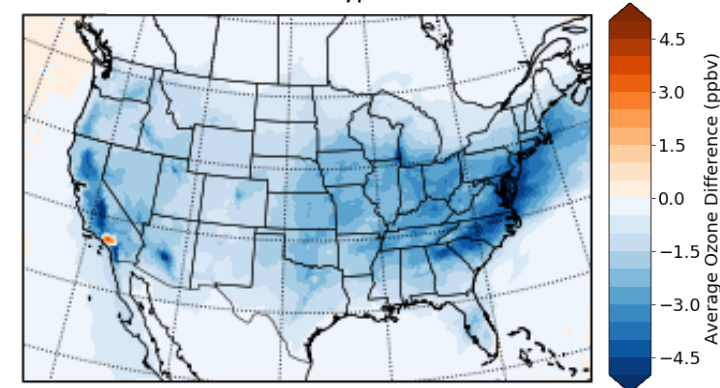
Once TEMPO data are available, NOAA's forecasting systems will become reliant on these data and will improve accordingly.



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

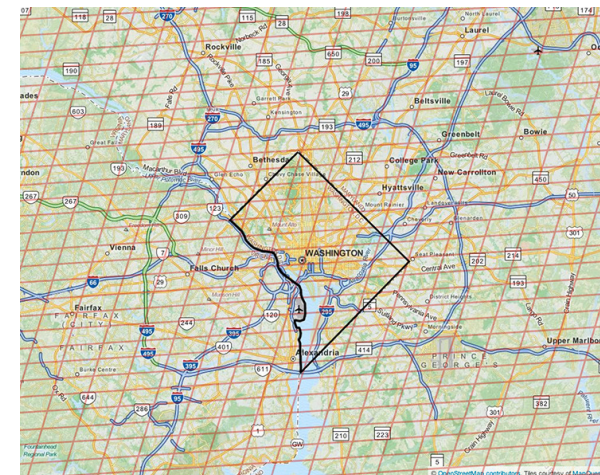
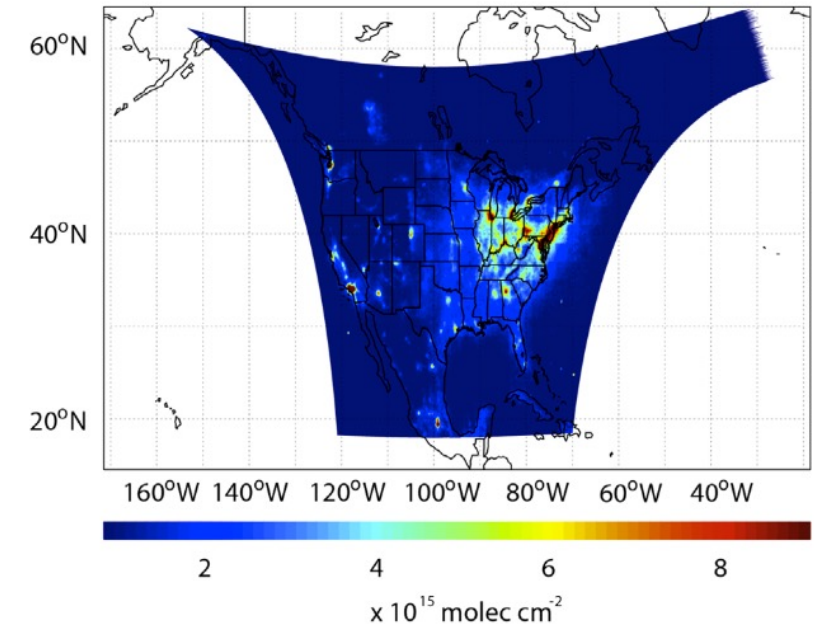


Potential GEO-XO ACX Attributes

(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 NO₂ sampled over TEMPO field of regard



Example TEMPO pixels over the Washington DC region

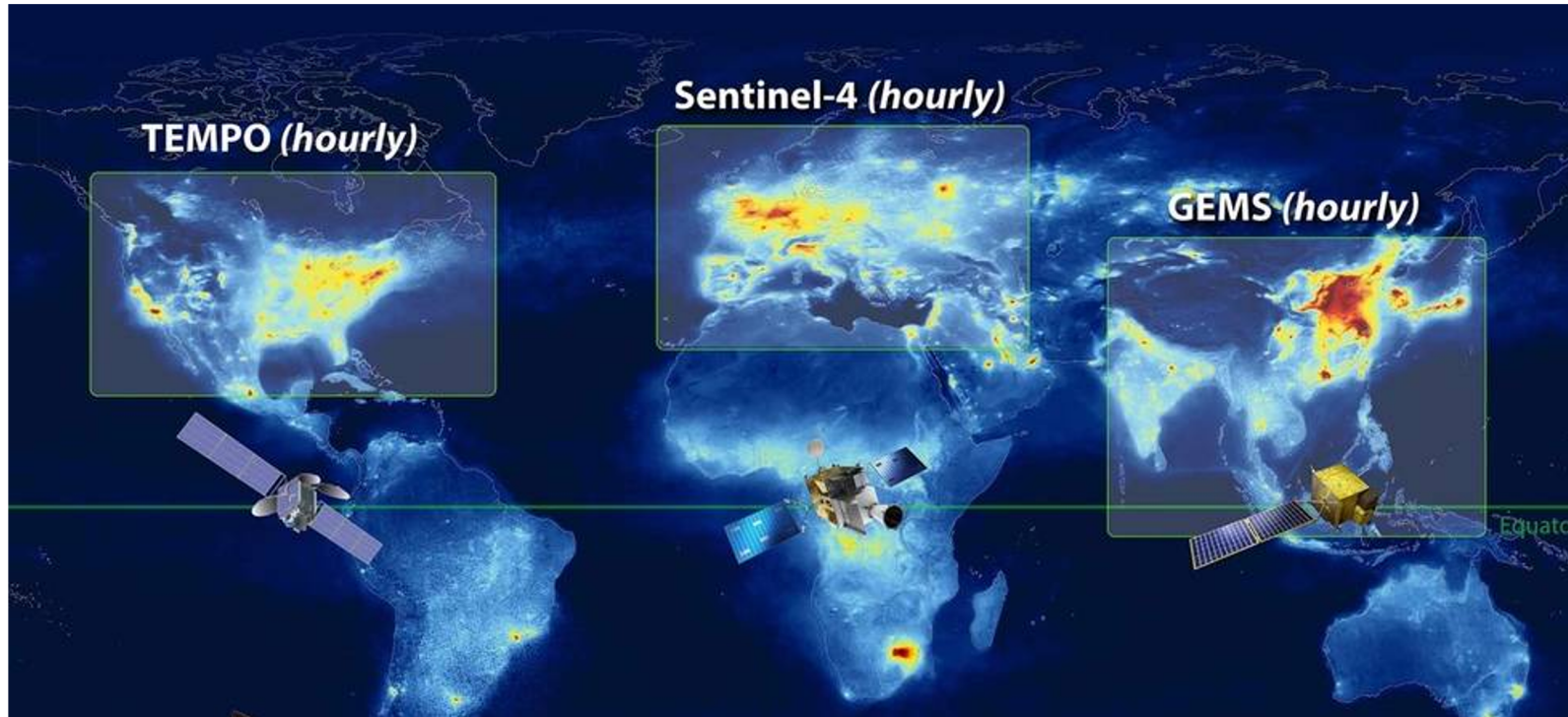
GEO-XO ACX: NOAA's Contribution to Geo-Ring

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.

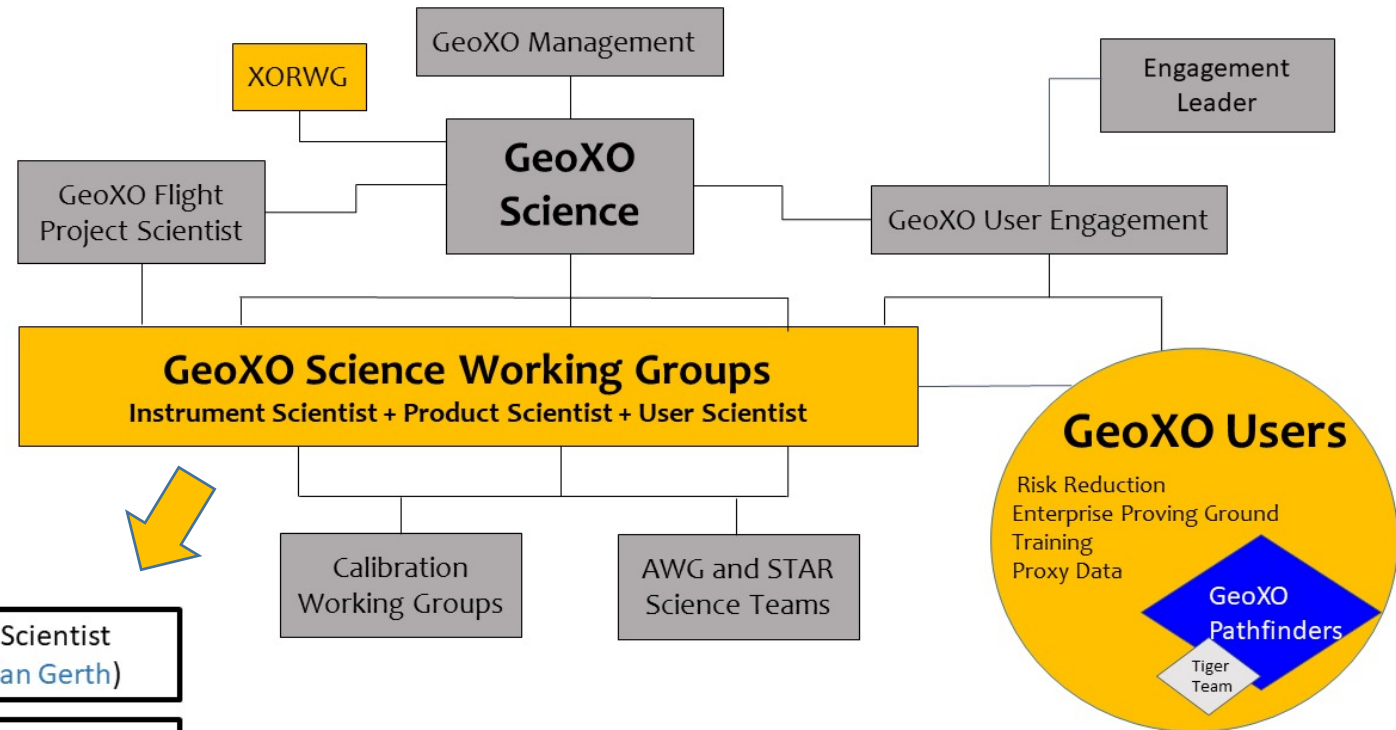
NASA has no planned follow-on to TEMPO.



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



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?*

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

