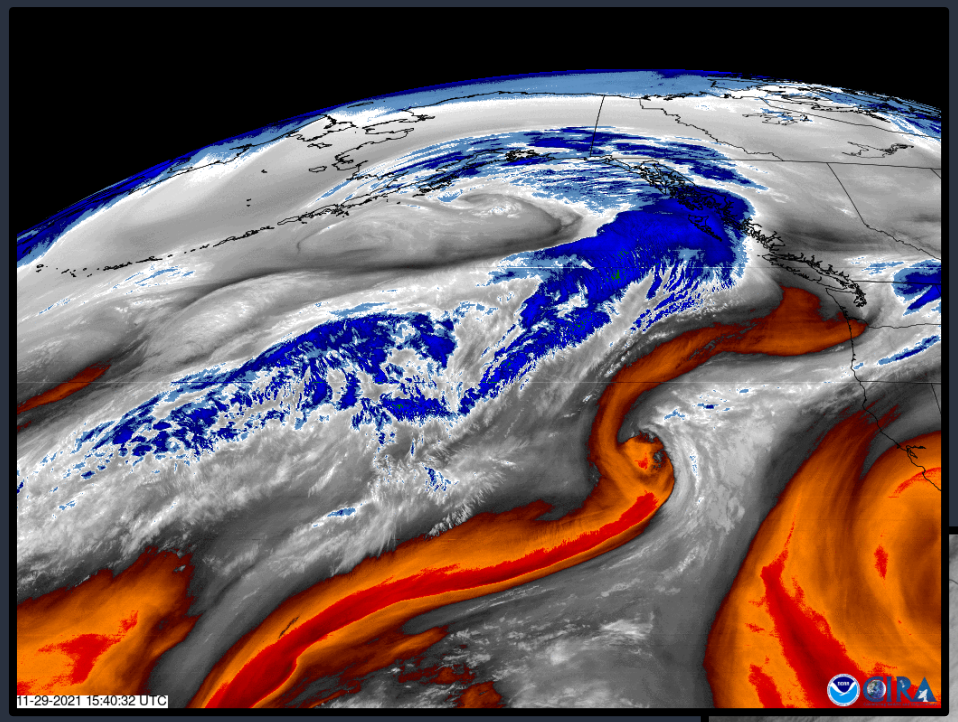
NOAA's Next Geostationary Satellite System, GeoXO

B6.01 National EO Satellite Missions
Thursday, May 26th, 2022
ESA Living Planet Symposium 2022

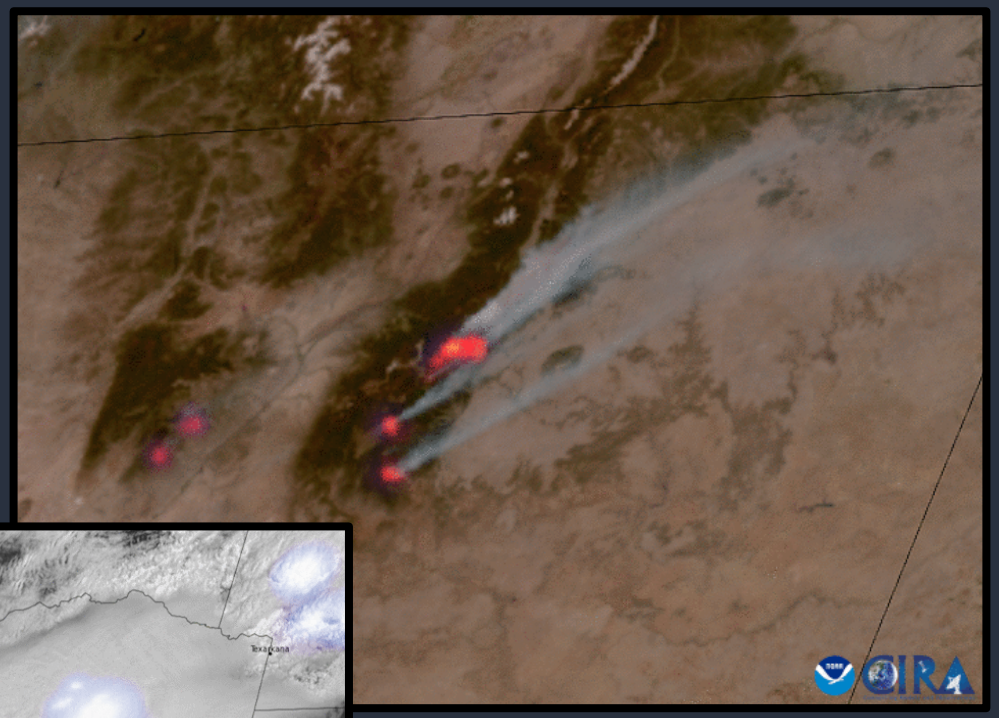
Pam Sullivan, GeoXO Program Director

NOAA
National Environmental Satellite, Data, and Information Service

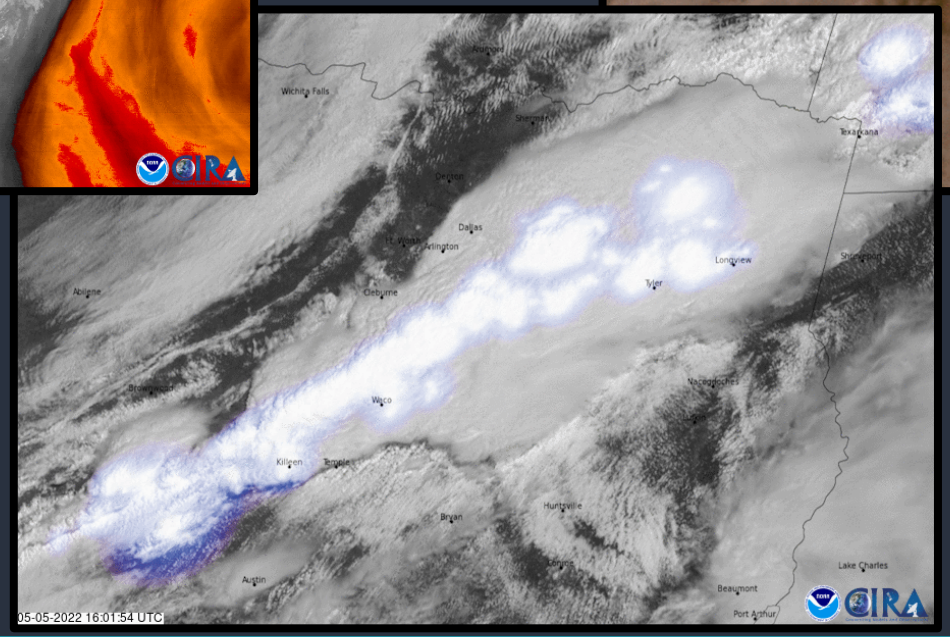
Reminders of the Need for Continuity of Observations



Atmospheric River Causes Flooding in British Columbia

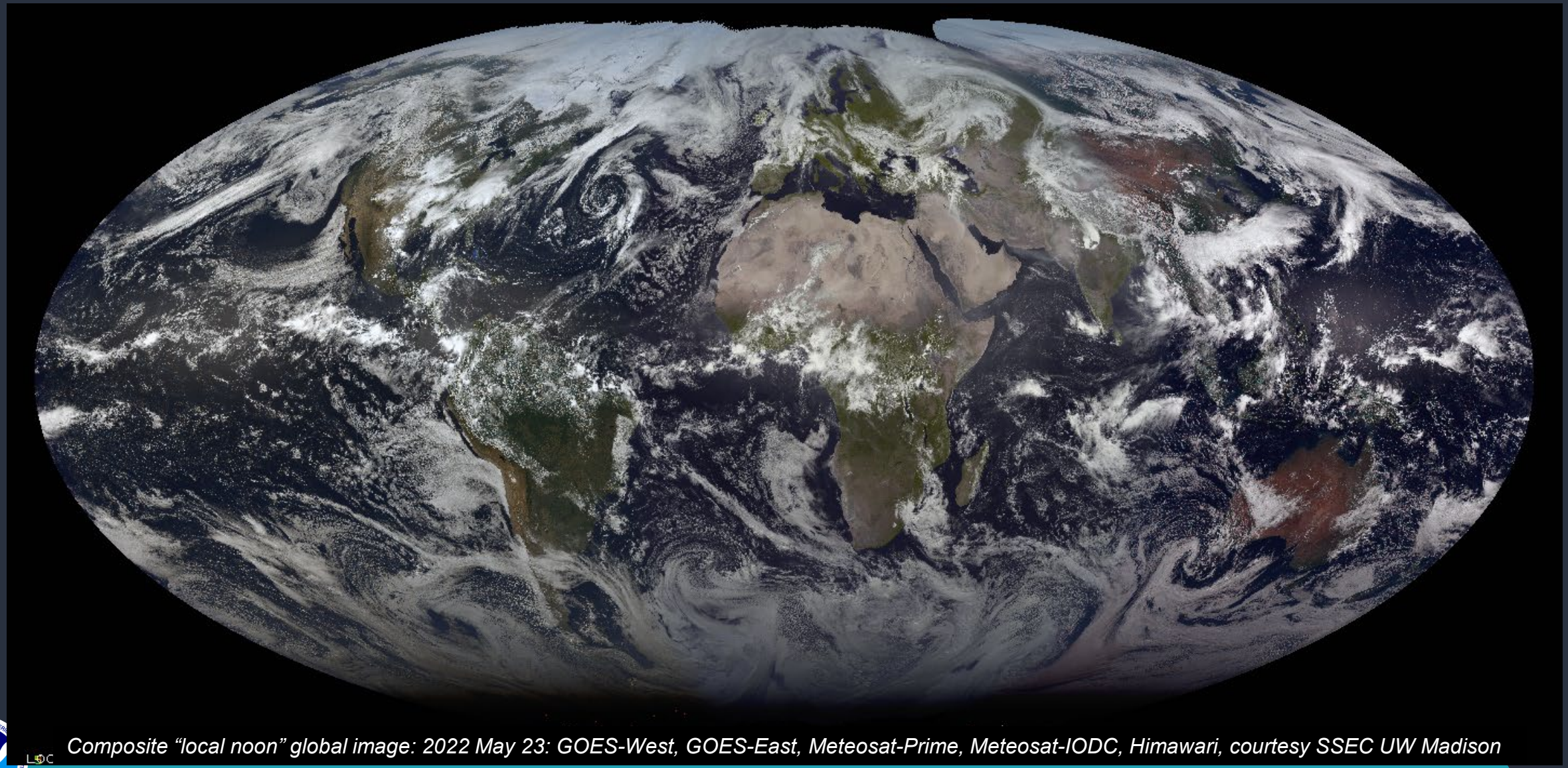


Fires in New Mexico



Thunderstorms race across Texas

View from the GEO Ring of Meteorological Satellites



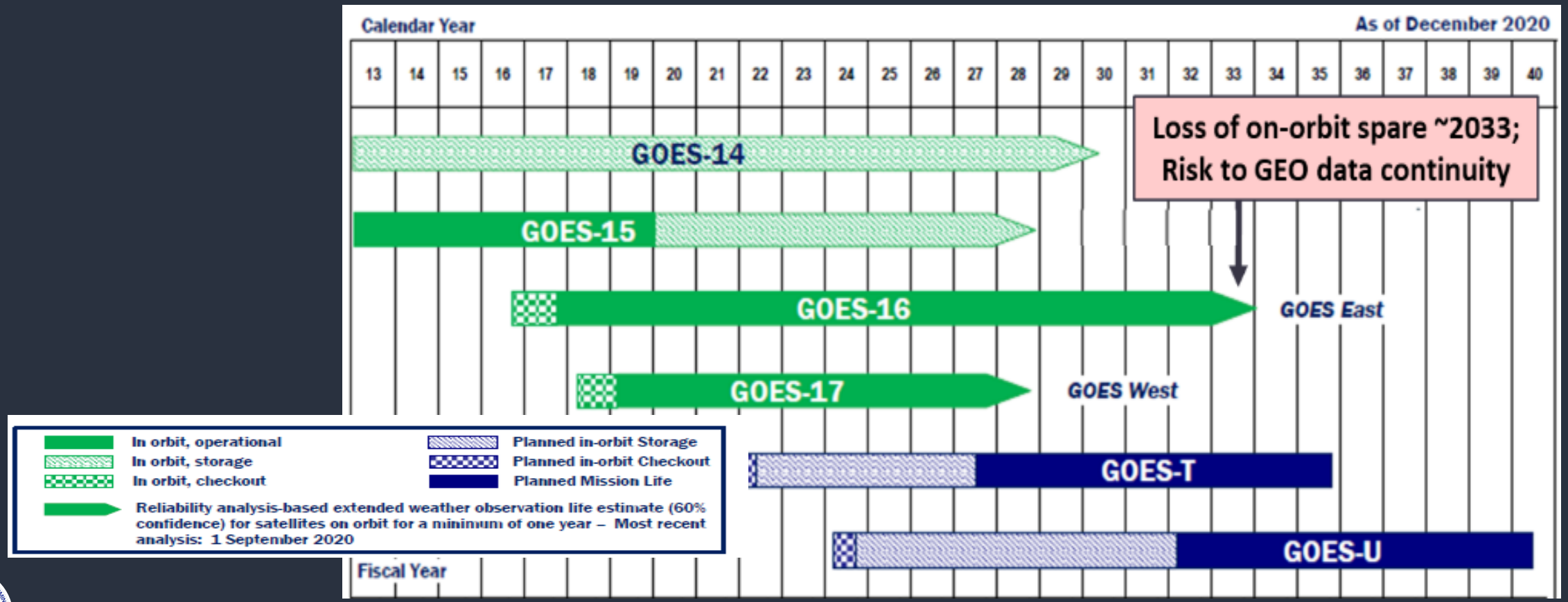
Composite "local noon" global image: 2022 May 23: GOES-West, GOES-East, Meteosat-Prime, Meteosat-IODC, Himawari, courtesy SSEC UW Madison

View from NOAA's GOES-R Series Satellites

GOES-16 and 17 Composite Image

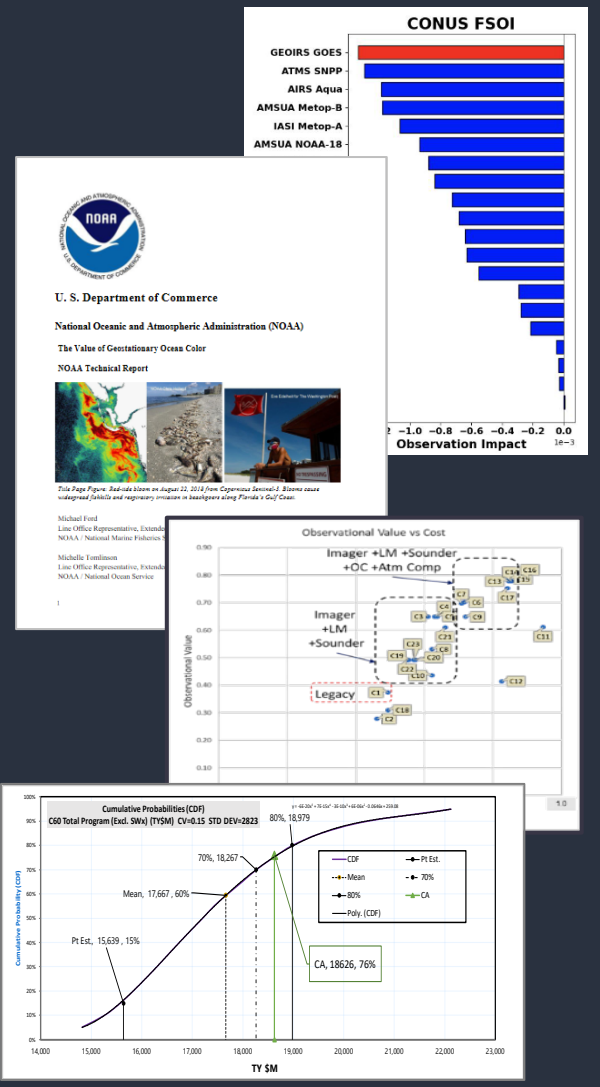
GeoXO will Provide Continuity

- **NOAA has begun its next-gen GEO satellite system, Geostationary Extended Observations (GeoXO)**
- Need date for the 1st GeoXO launch is 2032, set by the projected loss of the on-orbit spare in ~2033



GeoXO Pre-Formulation Phase Completed in 2021

- Determined GeoXO observational priorities, informed by:
  - User needs assessments via workshops, surveys, conferences, town halls
  - Observational value assessments for proposed new instruments
  - Feedback from NOAA Observing System Council
- Selected constellation to meet observing needs, informed by:
  - Industry and Program studies of instruments and architecture options
  - Risk-informed cost estimates and affordability analysis
- Completed Mission Concept Review and Key Decision Point A
  - Demonstrated mission concept is feasible, meets defined requirements, and that planning is sufficient to enter Phase A/Formulation
  - Independent cost estimates confirmed cost range
- Completed Milestone 1
  - Officially initiating the program and starting the formulation phase



GeoXO: Mission Needs Served

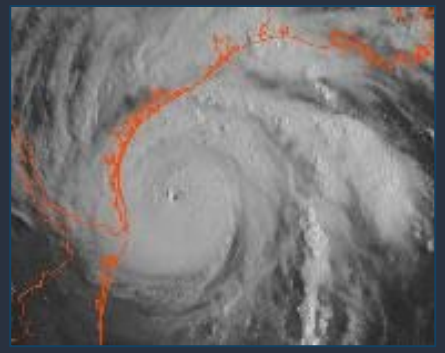
Ongoing Needs: Users require continuity of existing observations with improved performance

- **Data for short-range forecasting, severe weather watches and warnings, and monitoring hazardous environmental conditions** including tropical storms, severe storms with lightning and damaging winds, snow, ice, flooding, fog, fires, smoke, and volcanic ash.
  - ➢ Delivered by Imager and Lightning Mapper

Growing Needs: Users expect NOAA to meet new requirements with new observations:

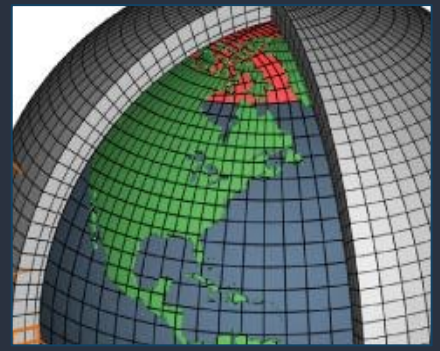
- **Improved numerical weather prediction and local nowcasting**
  - ➢ Delivered by Hyperspectral IR Sounder
- **Monitoring dynamic coast/ocean features, ecosystem change, water quality, and hazards**
  - ➢ Delivered by Ocean Color Instrument
- **Monitoring air quality and linkage with weather and climate**
  - ➢ Delivered by Atmospheric Composition Instrument

Vis/Near-IR Imagery

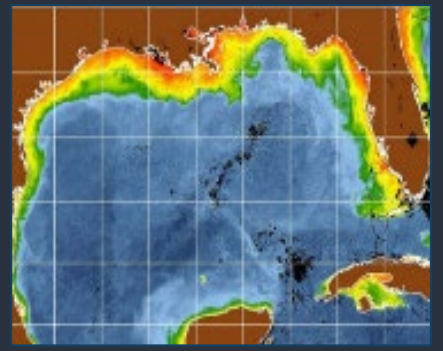


Lightning Mapping

IR Sounding



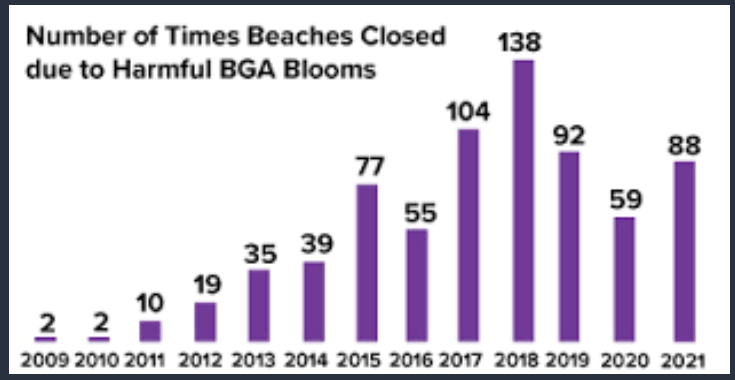
Ocean Color



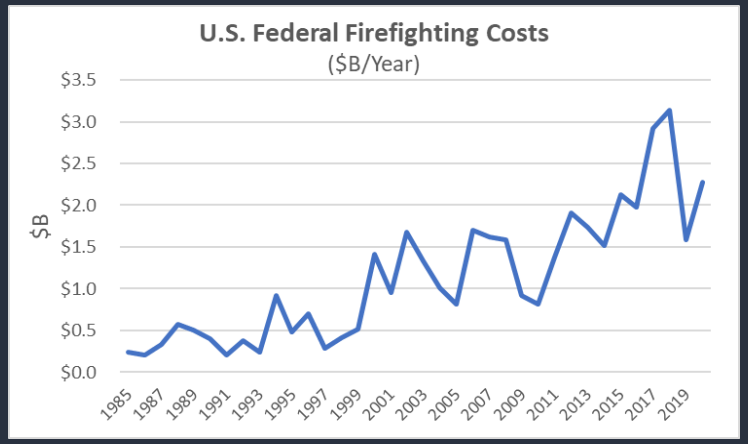
Atmo. Composition

Planning for the Planet in 2030 & Beyond

- **Beach closures are increasing:** ocean color observations will more precisely and more frequently monitor the presence of harmful algal blooms
- **Wildfires are growing in size and frequency**: higher spatial resolution imagery will detect fires earlier, and atmospheric composition measurements can track where dangerous smoke travels
- **Link between air pollution and mortality more clearly understood:** real real time measurements of air quality will enable more accurate warnings and improve controls, with likely advancements to health outcomes
- **Hurricanes are becoming stronger:** improved imagery will more rapidly detect tropical storm generation and intensification
- **Forecast needs are increasing:** real time hyperspectral sounding data, along with advanced numerical models and high performance computing, will enable more accurate, more timely, and longer-range forecasts



N.Y. State Beach Closures



U.S. Federal Firefighting Costs

GeoXO Constellation

(Preliminary, pending program approval)

GEO-West

Visible/Infrared Imager
Lightning Mapper
Ocean Color

GEO-Central

Hyperspectral Infrared Sounder
Atmospheric Composition
Partner Payload

GEO-East

Visible/Infrared Imager
Lightning Mapper
Ocean Color

GOES-R versus GeoXO Imager (GXI) Comparison

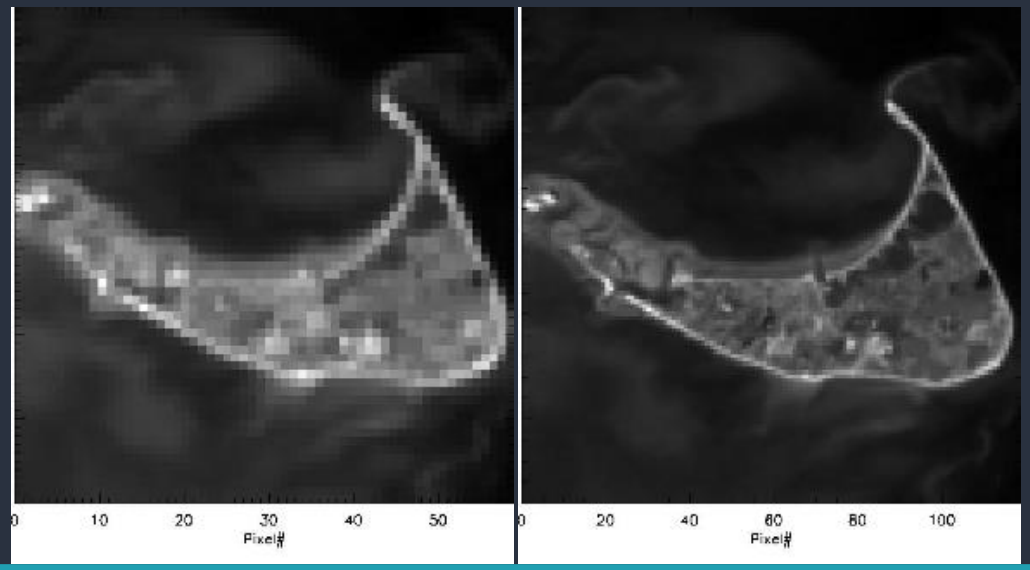
	Wavelength	GOES-R Pixel	GeoXO Pixel
	0.47μm	1.0km	**0.5km (TBR)**
	0.64μm	0.5km	**0.25km***
	0.865μm	1.0km	**0.5km (TBR)**
	0.91μm	-	**1.0km (TBR)**
	1.378μm	2.0km	2.0km
	1.61μm	1.0km	1.0km
	2.25μm	2.0km	**1.0km (TBR)**
	3.9*μm	2.0km	**1.0km**
	5.15μm	-	1.0km
	6.185μm	2.0km	2.0km
	6.95μm	2.0km	**1.0km** (TBR)**
	7.34μm	2.0km	2.0km
	8.50μm	2.0km	2.0km
	9.61μm	2.0km	2.0km
	10.35μm	2.0km	**1.0km** (TBR)**
	11.20μm	2.0km	2.0km
	12.30μm	2.0km	2.0km
	13.30μm	2.0km	2.0km

*MTF to 0.3 km acceptable;
** MTF to 1.5 km acceptable if needed

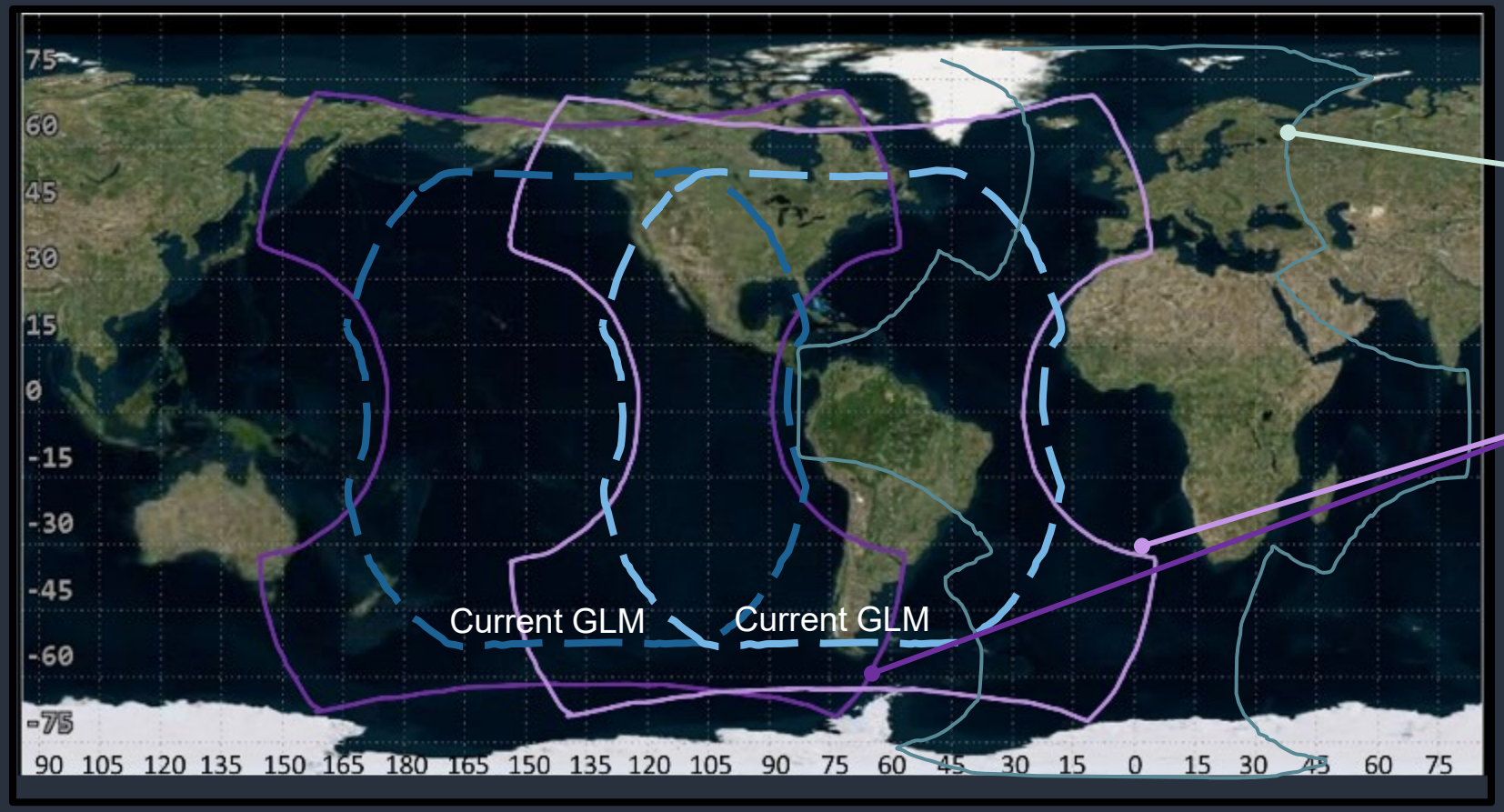
Improved spatial resolution in multiple channels for more precise warning and watch areas, improved forecasting, and earlier wildfire detection

New channels improve measurement of low level water vapor, Water vapor in the lowest few km of the atmosphere is key for severe weather and is a region where numerical models often struggle.

Nantucket Island at ABI 0.5km vs GXI 0.25km Resolution



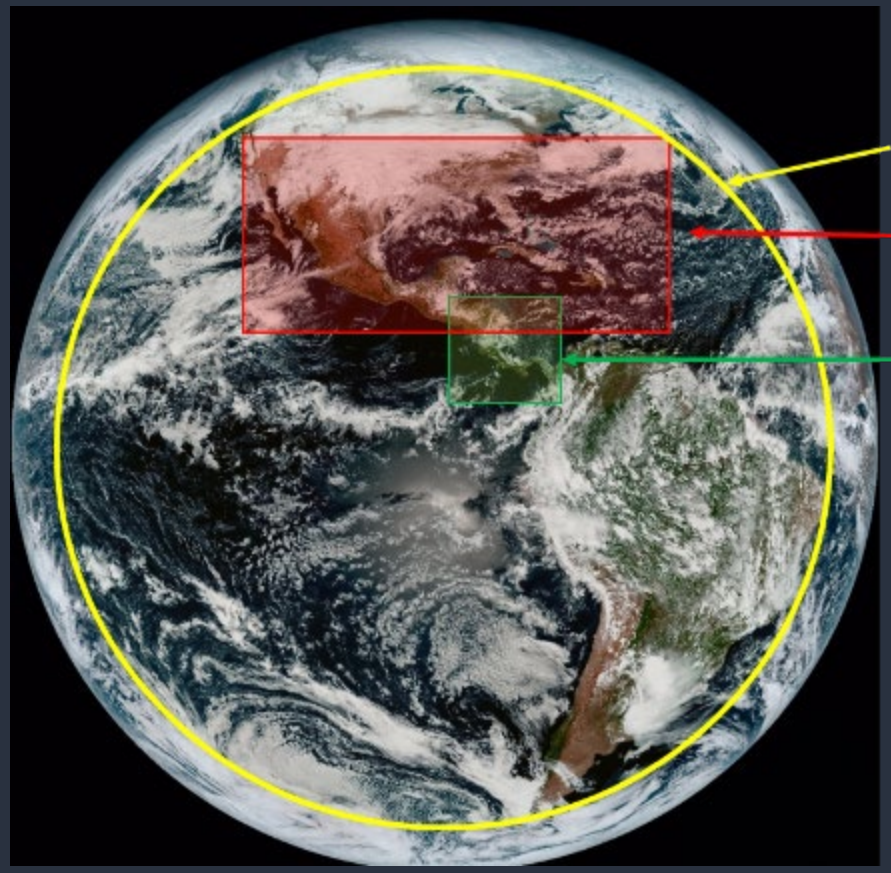
GeoXO Lightning Mapper (LMX)

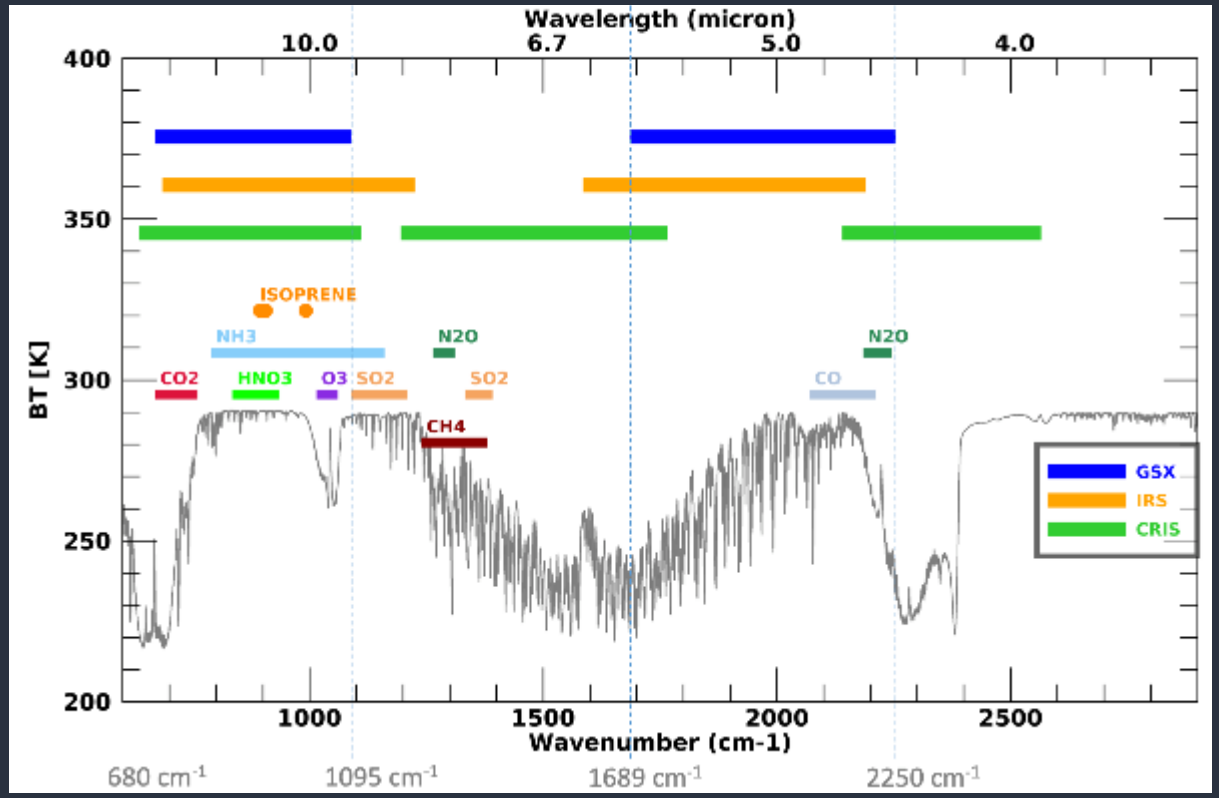


Lightning Full Disk to 62 deg N and 62 deg S, +/- 45 deg E/W at 500 Hz

Studying improved coverage and spatial resolution of 4 - 6 km for LMX (purples) vs. 8 km of GLM (greens)[1]

GeoXO Infrared Sounder (GXS)





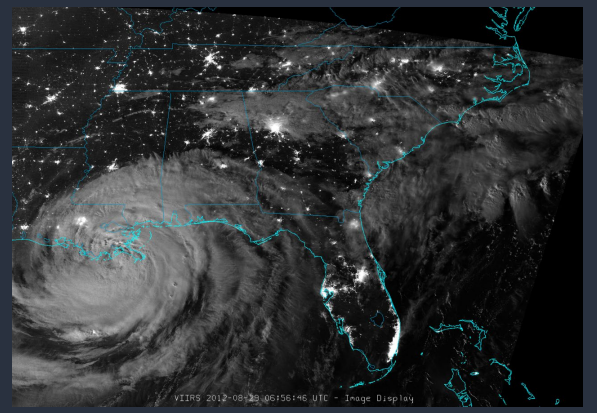
- GXS provides atmospheric soundings for forecasting, numerical weather prediction, and environmental observation
- Data products: Temperature and Water Vapor Profiles, Atmospheric Composition including Carbon Dioxide, Carbon Monoxide, Ammonia, Nitric Acid, Nitrous oxide, Isoprene

Spectral Range	GXS baseline (cm^{-1}, nm)
680 - 1095(cm^{-1}) 14.7 – 9.13 (um)	0.625, 10.3
1689 – 2250 (cm^{-1}) 5.92 – 4.44 (um)	0.625, 1.72

Addition of visible "Night Band" at 0.5 km is being studied

GeoXO Ocean Color (OCX)

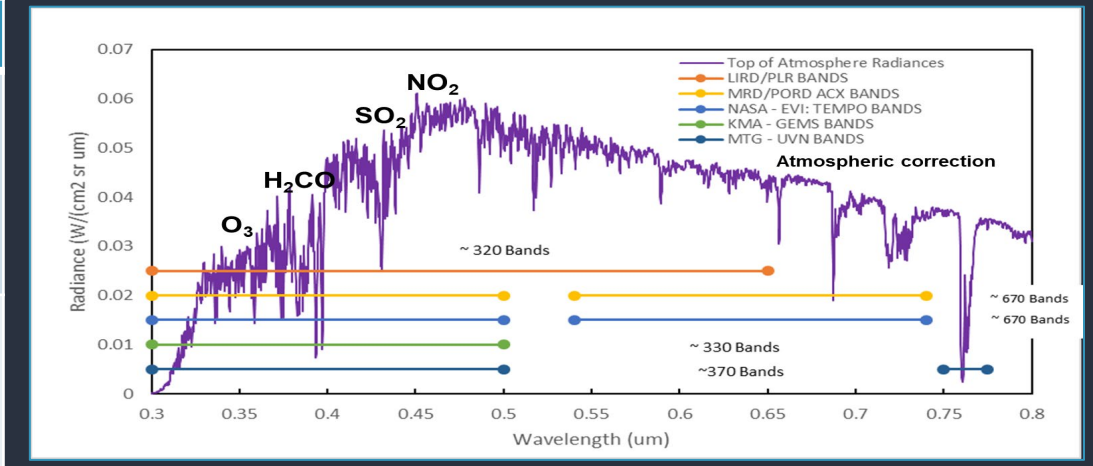
Observation parameter		Science and operational rationale
Field of Regard	EEZ East (coastline out to EEZ plus Caribbean andGreat Lakes) -or- EEZ West (coastline out to EEZ plus EEZ Hawaii plus southern Alaska)	Matches U.S. commercial fishing areas, protected species population areas, and regions for HAB forecasting and water quality monitoring associated with NOAA Mission Objectives.
Spatial Resolution	300 m at nadir	Allows specificity to HAB forecasts and ability of forecasts to perform in coastal areas. Detailed data on ocean color can match oceanographic features at that scale. Enhanced input for coupled ecosystem models.
Temporal Resolution	180 min	Multiple images per day allow mitigation of cloud cover in coverage area. Provides a more accurate depiction of bloom extent and movement. Enables dynamic ocean management predictions to become a “real-time” service. Better match to observe coastal ocean dynamics.
Spectral Coverage	Hyperspectral: • 20 nm resolution for 0.35-1.02 um • 10 nm resolution for 0.67-0.68 um	Allows phytoplankton functional type products, and enhances HAB type identification. Allows compatibility with previous products and helps realize a multi-instrument, multi-mission, long-term time series for ocean color.

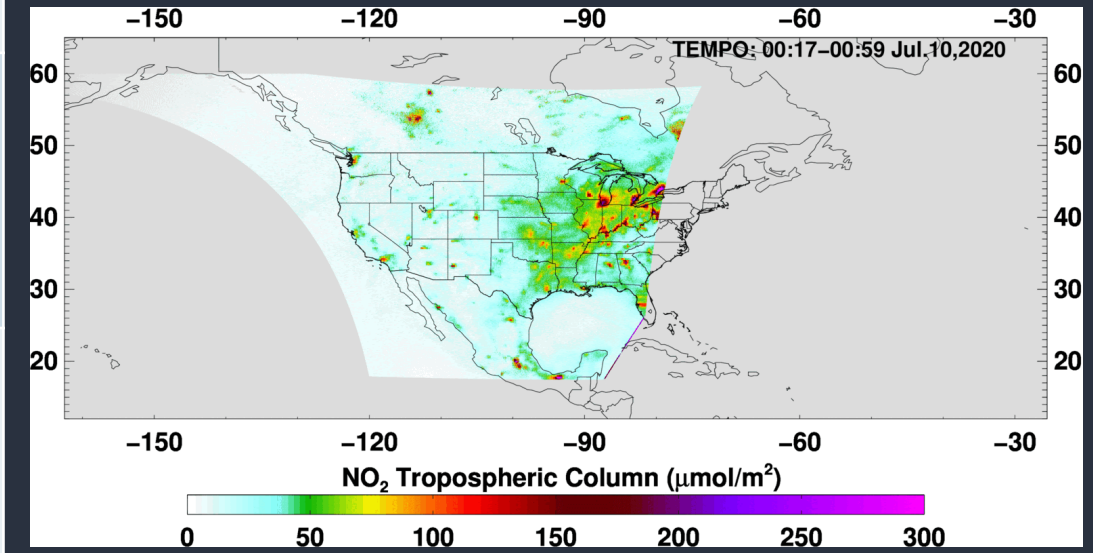


Addition of “Night Band” at 0.5 km is being studied

GeoXO Atmospheric Composition Instrument (ACX)

Observation parameter		Science and obsevation rationale
Coverage	CONUS, southern Canada, northern Mexico and Caribbean	Hourly inputs to national air quality, hazard and fire forecasting capabilities and warnings.
Spatial Resolution	5x5 km^2 @ nadir	Resolve sources, including cities, highway corridors, airports, oil/gas fields, 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. 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 With 3x sampling	UV: ozone, NO2, formaldehyde, SO2, absorption aerosol optical depth. Vis: cloud/aerosol layer height, PBL ozone, vegetation. High resolution critical for spectral fingerprinting.





Animations of NO_2 from simulated TEMPO by Dr Shobha Kondragunta

GeoXO Key Formulation Activities

GeoXO Formulation Event/Activity	Timeframe	Note
✓ Imager Phase A Study Contracts Awarded	April 2021	L3Harris & Raytheon
✓ **Mission Concept Review**	**June 2021**	
✓ **NOAA-NASA Key Decision Point A**	**July 2021**	
✓ Sounder Phase A Study Contracts Awarded	September 2021	Ball Aerospace & L3Harris
✓ **DOC Milestone 1 Review (DOC DepSec Approval)**	**October 2021**	**Program Initiation**
✓ Lightning Mapper Phase A Study Contracts Awarded	April 2o22	Lockheed and Northrop
✓ AC Instrument Phase A Study Contracts Awarded	May 2022	Ball Aerospace & Raytheon
• OC Instrument Phase A Study Contracts Awarded	May 2022	
• Spacecraft Phase A Study Contracts Awarded	July 2022	
• **System Requirements Review**	**August 2022**	Requirements Baselined
• **DOC Milestone 2 Review (DOC DepSec Approval)**	**December 2022**	**Program Approval**
• Imager Implementation Phase Contract Awarded	January 2023	
• Other Implementation Phase Contracts Awarded	1Q – 3QFY24	

GeoXO has Begun

- Formulation Phase A/B is planned over 2021-2025 and will include:
  - Industry studies for candidate instruments
  - Finalization of partnerships for system elements
  - Initiation of major flight element acquisitions
  - Benchmarking and pilot projects to inform Ground system definition
  - Continued user needs assessments to define system, products, services
- We look forward to working with the community to develop GeoXO

For more info: https://www.nesdis.noaa.gov/GeoXO

GOES-18 ABI – Data preliminary and non-operational

GeoXO will continue and advance NOAA's observational capabilities through 2050