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IN FOCUS

February 4, 2025

NOAA's Future Geostationary Extended Observations (GeoXO) Mission

About every two decades since 1975, the National Oceanic and Atmospheric Administration (NOAA) has deployed a new generation of geostationary satellites. In 2019, NOAA began defining requirements for its next mission, Geostationary Extended Observations (GeoXO). Through workshops with expected future users, including government researchers, industry, and academia, NOAA identified that users are seeking data to better understand fires, weather, agriculture and land use, human health, and oceans. GeoXO would be a constellation of three operational satellites expected to continuously collect environmental data from the Western Hemisphere through 2055. NOAA anticipates that deployment of GeoXO satellites will begin in 2032, around the time NOAA's current geostationary mission, the Geostationary Operational Environmental Satellites R Series (GOES-R Series), is to near the end of its operational lifetime. The National Aeronautics and Space Administration (NASA) launched the final GOES-R Series satellite on June 25, 2024. NOAA plans for GeoXO to continue and improve on the GOES-R Series observations.

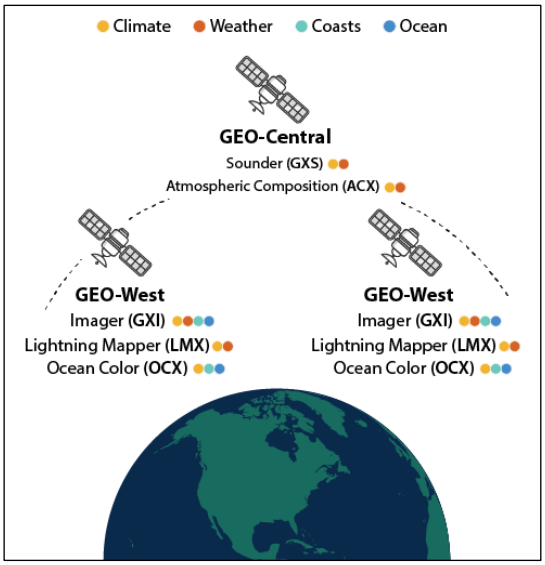
Congress has shown support for NOAA's GeoXO mission. In FY2024, Congress appropriated $285.0 million for NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) Geostationary Earth Orbit program, which includes GeoXO. In FY2025, NOAA requested $798.4 million to continue developing the GeoXO program. Given the high cost, in addition to the long time frame, to develop a major satellite program (as defined in 33 U.S.C. §878a), congressional oversight may include tracking GeoXO's progress, including any program delays and cost overruns. This CRS In Focus provides a descriptive overview of GeoXO.

GeoXO Instruments

The GeoXO constellation is to comprise three satellites: GEO-West, GEO-Central, and GEO-East. All three would be positioned over the Western Hemisphere. The GeoXO constellation would host five instruments to provide continuous imagery and data of Earth's atmosphere, land, and ocean (**Figure 1**):

1. **GeoXO Lightning Mapper** (LMX) would be a single-channel, near-infrared optical detector used to detect, locate, and measure lightning characteristics, such as its intensity, duration, and extent.
2. **GeoXO Sounder** (GXS) would be a camera-like device whose detector is sensitive to fine-scale ranges of infrared wavelengths used to collect real-time data of the troposphere (where weather occurs). The device is to measure the vertical distribution of atmospheric moisture, winds, and temperature.
3. **GeoXO Imager** (GXI) would include 18 channels for viewing visible and infrared wavelengths used to collect real-time, high-resolution imagery.
4. **GeoXO Atmospheric Composition** (ACX) would be a hyperspectral spectrometer that measures ultraviolet to visible light. The instrument is to provide hourly observations of air pollutants, including ozone, particulate matter, nitrogen dioxide formaldehyde, glyoxal, and sulfur dioxide.
5. **GeoXO Ocean Color** (OCX) would be a hyperspectral, ultraviolet through near-infrared passive imaging radiometer used to provide ocean color observations every two hours over the U.S. ocean waters.

Figure 1. Planned GeoXO Constellation and Instruments for Climate, Weather, Coasts, and Ocean Observations



Source: CRS, using information from NASA, "GeoXO."

GXS, ACX, and OCX would be new instruments to support air quality, ocean, coasts, climate, and weather prediction capabilities. LMX and GXI would be improved versions of GOES-R Series' instruments for weather applications.

NASA plans to build and launch the satellites, and NOAA plans to operate and manage GeoXO's mission. NASA, on

behalf of NOAA, has contracted several companies to develop GeoXO instruments and spacecraft (**Table 1**). The mission plans for six total spacecraft, with a maximum of three operating simultaneously (i.e., a replacement for each to maintain data collection, if needed).

Table 1. Awarded Contracts for GeoXO Instruments and Spacecraft

Instrument	Cost Plus Award Fee (in millions)	Company (City, State)
LMX	$297.1	Lockheed Martin (Littleton, CO)
GXS	$486.9	Ball Aerospace & Technologies Corporation (Boulder, CO)
GXI	$765.5	L3Harris (Fort Wayne, IN)
ACX	$365.0	BAE Systems (Boulder, CO)
OXO	$450.0	BAE Systems (Boulder, CO)
Spacecraft	$2,270.0	Lockheed Martin (Littleton, CO)

Sources: NOAA, "NASA Selects L3Harris to Develop NOAA GeoXO Imager," March 13, 2023; NOAA, "NASA Selects Ball Aerospace to Develop NOAA's GeoXO Sounder Instrument," September 11, 2023; NOAA, "NASA Selects BAE Systems to Develop Air Quality Instrument for NOAA," May 1, 2024; NOAA, "NASA Selects BAE Systems to Develop Ocean Color Instrument for NOAA," May 20, 2024; NOAA, "NASA Selects Lockheed Martin to Build NOAA's Next-Gen Spacecraft," June 18, 2024; and NOAA, "NASA Selects Lockheed Martin to Develop Lightning Mapper for NOAA," September 17, 2024.

Notes: The work for the spacecraft is to take place at Lockheed Martin's facility in Colorado and NASA's Kennedy Space Center in Florida. BAE Systems was formerly known as Ball Aerospace & Technologies Corporation.

GeoXO Applications

NOAA plans to use the GeoXO satellite constellation to support its strategic objectives in terrestrial weather prediction and warning; climate adaptation and mitigation; healthy oceans; and resilient coastal communities and economies. GeoXO data would be made accessible to research communities through the NESDIS Common Cloud Framework (NCCF). NOAA plans to send GeoXO data "directly from the NCCF to the weather and forecasting community." Experts expect the data obtained from GeoXO will contribute to numerical weather prediction (NWP), hurricane monitoring, wildfire and smoke detection, air quality monitoring, ocean applications (e.g., oil spills, harmful algal blooms), and climate records.

Numerical Weather Prediction. Federal experts anticipate GXS instruments will improve weather forecasts up to three to five days in advance. NOAA expects GXS data to be assimilated into regional and global NWP models to improve severe storm and wind forecasts. GXS, LMX, and GXI data are expected to improve severe storm warnings.

Hurricane Monitoring. Forecasters rely on geostationary satellites to provide information for storm monitoring over the open ocean, where ground-based radar is absent. NOAA expects GXI imagery and GXS data to improve the detection of hurricane formation and estimates about certain storm characteristics, such as intensity and the location and trajectory of a storm's center. In addition, researchers have identified a relationship between increased lightning activity and a change in hurricane intensity. NOAA expects LMX observations to improve forecasts for rapid intensification of hurricanes, especially over the Atlantic and Pacific Oceans, where lightning observations are limited.

Fires and Smoke Detection. Early detection of a wildfire increases the likelihood of containment and suppression as well as the issuance of timely public alerts. GXI is anticipated to improve spatial resolution (by a factor-of-four improvement in pixel size) compared with the GOES-R Series imager. Improved resolution allows for smaller fires or fires burning at a lower temperature (compared with background levels) to be detected earlier. In addition, GXI is intended to detect and track wildfire smoke in real time, allowing for timely air quality alerts.

Air Quality Monitoring. Poor air quality contributes to about 100,000 premature deaths annually in the United States, according to NOAA. Decisionmakers use air quality monitoring and forecasts to mitigate health impacts from air pollution and smoke events and to mitigate aviation hazards. The GeoXO mission plans to use ACX, GXI, and GXS as part of a multi-instrument strategy to improve air quality monitoring and forecasting by providing hourly observations of air pollutants emitted by specific sources, such as traffic, power plants, volcanoes, and wildfires.

Ocean Applications. Researchers plan to use OCX data to monitor dynamic biological, chemical, and ecological features of the ocean. Data also could help monitor oil spills, nuisance species such as sargassum, and water quality. In addition, ocean color imagery could be used to identify algal species and primary productivity levels (the base of the marine food web). Data may be used to inform fishing activities, predict disruptions to the marine food web, and improve forecasts of harmful algal blooms.

Climate Records. NOAA anticipates many measurements and information obtained from GeoXO will contribute to climate monitoring efforts. Climate scientists plan to use GeoXO data to extend records of clouds, surface temperature and radiative fluxes, precipitation, fire, aerosol size, and vegetation indexes. These records may help spatially and temporally resolve cloud and moisture properties, which may improve the accuracy of climate model projections.

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IF12898

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